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CCFE-R(15)26
December 2015

Mark R. Gilbert
Jean-Christophe Sublet
Robin A. Forrest

Handbook of activation, transmutation, and radiation damage properties of the elements simulated using FISPACT-II & TENDL-2014; Magnetic Fusion Plants

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Mark R. Gilbert
Jean-Christophe Sublet
Robin A. Forrest*

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UK Atomic Energy Authority
Culham Science Centre
Abingdon
Oxfordshire
OX14 3DB

*International Atomic Energy Agency
Nuclear Data Section
P.O. Box 100
1400 Vienna
Austria

Contact Dr Mark R. Gilbert
Culham Centre for Fusion Energy
Culham Science Centre
Abingdon
Oxfordshire
OX14 3DB
United Kingdom

Telephone: +44 (0)1235-465316
email: mark.gilbert@ccfe.ac.uk

Disclaimer

Neither the authors nor the United Kingdom Atomic Energy Authority accept responsibility for consequences arising from any errors either in the present documentation or the FISPACT-II code, or for reliance upon the information contained in the data or its completeness or accuracy.

Acknowledgement

This work was funded by the RCUK Energy Programme under grant EP/I501045.

The authors would like to gratefully acknowledge the preparatory work performed by Evrard Lacroix of Grenoble INP Phelma, France and Emmanuel Andrieu of Imperial College, London. We also acknowledge the work of J.W. Eastwood and J.G. Morgan from Culham Electromagnetics Ltd to the development of FISPACT-II, and also for their assistance with the formatting of this report.

CCFE is the fusion research arm of the United Kingdom Atomic Energy Authority.

The work was also partially carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 under grant agreement number 633053.

CCFE is certified to ISO 9001 and ISO 14001.

Executive Summary

Accurate predictions of material inventories is a key input to virtually all aspects of the operation, safety and environmental assessment of nuclear plants. Additionally, the neutron-induced transmutation (change) of material composition (inventory) with time, and the creation and evolution of configurational damage from atomic displacements, require precise quantification because they can lead to a change in material properties, and thus influence reactor-component lifetime.

This report provides a detailed and comprehensive set of data concerning the activation, transmutation (depletion and build-up) response, and immediate damage response under neutron irradiation of all naturally occurring elements from hydrogen to bismuth. Whilst the goal of this 'handbook' is to provide a global picture of the response of a material, covering the majority of nuclear technological space, special focus is given to the in-vessel conditions predicted for a demonstration fusion power plant (DEMO). Results are presented from simulations with the inventory code FISPACT-II using the latest version of the TENDL nuclear data libraries – TENDL-2014.

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1 Introduction

Predicting the activation properties of materials under neutron irradiation is an important aspect of the engineering design and operation of current and planned nuclear reactor systems. For fusion reactors in particular, such as the under construction ITER experiment or a future power plant demonstration reactor (DEMO), it is vital to accurately predict the radioactive decay characteristics of reactor components for the safety of operators, to plan maintenance schedules and routes, and to know the amount and type of waste for disposal. Furthermore, the irradiating neutrons can displace atoms from their equilibrium positions within a material leading to the accumulation of structural radiation damage, and simultaneously induce nuclear reactions that change the chemical composition of the material (transmutation). Both of these effects can change the original properties and behaviour of a material and thus also require accurate quantification prior to plant construction and operation so that component performance and lifetime can be reliably predicted.

Over the past approximately 30 years, the Culham Centre for Fusion Energy (CCFE) – part of the United Kingdom Atomic Energy Authority (UKAEA) – has led the development and maintenance of a nuclear inventory code system, originally called the European Activation SYstem (EASY) [1], which is able to predict the evolution of a material composition (inventory) during neutron irradiation and afterward, during cooling via radioactive decay. This was accomplished by a legacy inventory code FISPACT [2], which used as input a large database of nuclear reaction cross section and radionuclide decay data.

More recently, in the last five years, FISPACT has been re-engineered – now called FISPACT-II [3] – using modern computer programming. Notably, it can now utilise the latest, more complete nuclear data libraries, developed from new processing technologies during the same period, including the TALYS-based Evaluated Nuclear Data Library (TENDL) [4, 5], which are also part of the updated EASY-II [6] activation system.

To complement this redevelopment, a new set of (largely automated) verification and validation (V&V) exercises have been developed (or in some cases redeveloped), which benchmark the EASY-II system against various databases of experimental data. These include a decay heat validation [7] and integral cross section bench-marking [8].

The present report is both a further verification test of EASY-II – demonstrating its robustness with demanding simulations and testing extended features – but also an important reference document for materials modellers and experimentalists, and nuclear scientists and engineers. It answers a need within these communities for a comprehensive handbook of activation, transmutation, depletion, and first-stage radiation-damage characteristics, that can be used as a quick reference without the need to run codes. For example, this handbook can be used to assess the likely impact on activation and transmutation of suggesting new elements, perhaps as part of a complex alloy, for a fusion application. However, the reader should be aware that a detailed in-

ventory calculation, with a fully-defined material composition and irradiation scenario of interest, should always be performed at some stage because this scoping handbook cannot cover all material and irradiation possibilities.

The report is an update and extension of earlier reports from 2004 [9, 10] and 2007 [11], calculated using the earlier EASY code system, that were aimed primarily at quantifying post irradiation radioactivity, and were themselves based on a much earlier pair of reports from the 1990s [12, 13]. As with the updated validation exercises [7, 8], an important goal when compiling this new report was to automate, as much as possible, its creation, to reduce both user-induced error and the time taken to produce the report. This latter point is particularly important in the current era of modern nuclear data libraries, which are often released annually, because rapidly improving and evolving nuclear data files require more efficient V&V. Previous editions of the handbook and validation exercises would often take 6-12 months to produce, while with the new automated 'hands-off' approach this can be reduced to a matter of weeks.

Alongside the development of EASY-II, several post-processing and result-visualization tools have been created (in some cases redeveloped) and prototyped for future inclusion in the EASY-II code system, and many of these have been utilised in the present handbook report. These include: automatic output of activation and dominant nuclide data for plotting (already included in FISPACT-II); 'importance diagrams' [14, 15] that display a neutron-spectrum-independent summary of the dominant radionuclides contributing to activation properties over time; nuclide maps [15] that show in a tableau all nuclides contributing to the composition or activation at a given time with colouring to indicate relative contributions; and, for radiation damage modelling, calculations of the energy distributions and types of displaced atoms, also known as primary knock-on atoms (PKAs), produced as a result of nuclear reactions[16].

Using these new tools, together with complementary tabular representations of activation properties and nuclear reaction pathways, results have been simulated using FISPACT-II, or otherwise for early prototyping (see section 1.7), with the latest TENDL-2014 [4] nuclear data libraries, for all the naturally occurring elements from hydrogen up to and including (by mass) bismuth (Bi). A separate analysis for actinides, with specific characteristics relevant for nuclear fission applications, is planned for a future handbook. Furthermore, real materials are <u>not</u> pure elements, and so a future report – dedicated to presenting results for a database of nuclear-relevant alloys and compounds – is also planned.

The remainder of this introductory section briefly describes the FISPACT-II inventory code and TENDL-2014 nuclear data library used for the simulations, and then, using examples, explains the different results sections presented for each element. Then there follows the bulk of the report – that of the results for each element. A short summary is also included at the end of this introduction.

Note that at the start of each elemental material section there is a short table showing, for reference, the naturally occurring isotope composition of the element, and, where

applicable, the half-lives of the constituent isotopes.

1.1 FISPACT-II

FISPACT-II is an inventory code developed to perform modelling of activation, transmutation and burn-up induced by neutron, proton, alpha, deuteron or gamma particles incident on matter. It is a re-engineered inventory code, which replaces an earlier development series known simply as FISPACT (the last version was released in 2007 [2]), but has significantly extended capabilities [3]. In particular, it can now read ENDF-6 format [17] data libraries, of which the technologically-advanced TALYS-based TENDL-2014 [4] is the latest and most complete. It can also account for self-shielding using probability tables generated by CALENDF-2010 [18, 19], which in this handbook has been included at the input isotope level for all calculations except those used for the importance diagrams (see below).

FISPACT-II uses the external libraries of nuclear data to trace the time evolution in the number of atoms of each nuclide species, both during irradiation through reaction and decay events, and afterwards during cooling via decay alone. Nuclides are created and lost through combinations of nuclear reactions and/or decays and the rate of change (in time) of the nuclide inventory is determined by coupled-differential equations given, for each nuclide, by

$$\frac{dN_i}{dt} = \underbrace{-N_i(\lambda_i + \sigma_i\phi)}_{\text{loss}} + \sum_{j\neq i} \underbrace{N_j(\lambda_{ji} + \sigma_{ji}\phi)}_{\text{creation}}, \tag{1}$$

where N_i is the number of atoms of nuclide i at a given time t, and the 'loss' term has λ_i as the decay constant of the nuclide, ϕ as the total neutron flux (n cm^{-2} s^{-1}), and σ_i as the total collapsed cross section for all possible reactions on the nuclide (measured in barns and calculated by combining the energy-dependent specified neutron field with nuclear-reaction cross section data). The corresponding 'creation' term in the equation is the sum over all other nuclides with the ji subscripts indicating the production of nuclide i from a reaction or decay on j. Note that in this formulation the contributions to creation and loss from fission events are included in the σ_{ji} and σ_i terms, respectively.

To perform an inventory simulation FISPACT-II thus requires the user to provide the composition and mass of the material to be irradiated, a description of the incident particle spectrum, details of the irradiation scenario, and, for the period following shutdown, a series of decay times at which inventories are required. The user can select various other options that control additional calculations and output data forms, such as uncertainties and reaction pathways, and must also indicate which nuclear data libraries should be used to evolve the system. Further details are given in the user manual [3].

1.1.1 Self-shielding correction factors

In the FISPACT-II simulations performed for the transmutation (section 1.6), pathways (1.8), and activation (1.3 and 1.4) analyses the resonance self-shielding effect was accounted for. This is a new capability of the inventory code, and it allows one to more accurately account for the reduced reaction rates that result from resonances in, particularly, the capture (n, γ) cross section curves of several important nuclides, including those of W [20]. These resonances are very peaked in energy at low temperature and are on the very limit of resolution of the fine 709-group energy structure employed here (see section 1.2), although the overestimation this causes is significantly less than that which occurs with the legacy coarse group structures, such as Vitamin-J 175 (see [3]). FISPACT-II can read probability tables, calculated using CALENDF-2010 [19], which provides isotopic resonance self-shielding correction factors [20] for the appropriate cross section channels. In the present report, these are applied only to the group-wise reaction rates of resonant reactions on the nuclides present in the starting material, which here are the naturally occurring isotopes of each element. Strictly speaking, a more complete analysis should also consider both the spatial and time dependence of self-shielding. For instance, the nuclides created via transmutation may also require self-shielding corrections. Meanwhile, spatial dependence of self-shielding occurs because the resonances cause, in a real neutron irradiation field, a localised depletion in neutrons at and just below the resonant energy, which further reduces the overall reaction rate. This effect, which is very dependent on the particular geometry under which a material is being irradiated, can be included in FISPACT-II (via the `SSFGEOMETRY` keyword [3]), or indeed by performing detailed neutron-transport simulations for every material and at every position in the appropriate geometry, but this is beyond the remit of this scoping report.

1.2 TENDL-2014

While any libraries in the ENDF-6 [17] format can be read by FISPACT-II, its development has run parallel with the development of the TALYS [5] -based Evaluated Nuclear Data Library (TENDL) project, and these European libraries are now the ones recommended for use within the EASY-II system. Three processing codes are used in sequence and in parallel to process the TENDL evaluation libraries, of which TENDL-2014 [4] is the latest version, and produce and check the group format libraries used by FISPACT-II. These codes are NJOY-2012 [21], PREPRO-2012 [22], and CALENDF-2010 [19]. The FISPACT-II code also reads directly the complex covariance information contained within each TENDL evaluation.

The standard and recommended group format used to represent the neutron-induced reaction cross sections of TENDL-2014 within EASY-II is the extended, high-resolution 709-group structure defined at CCFE to meet the needs of several nuclear analysis communities, including those in fission, fusion, astrophysics and medical physics. Details of this group structure, which evolved from an original 616-group structure developed

at LLNL (see the TART-2012 Monte-Carlo code [23]), is given in [3]. Note that while the 709-group structure has a maximum energy of 1 GeV, in TENDL-2014 the neutron cross section data only extends up to 200 MeV, and so data above this limit in the libraries processed for EASY-II are extrapolations from the point-wise TENDL data. In total, the processed TENDL-2014 library contains neutron cross section data for 2632 targets ranging from ^{1}H to ^{281}Ds, which covers all stable nuclides and all radionuclides with a half-live greater than 1 s. Data for a particular reaction are explicitly included in the library if the resulting daughter has a half-life greater than 0.1 s (reactions producing shorter-lived daughters are added to the channel of the nearest isomeric state). In the present work we used a version of the library that includes Doppler broadening effects appropriate for room temperature (293.6K).

In addition to the nuclear cross section data, FISPACT-II also needs information about the decay characteristics of the radionuclides that might be produced under irradiation, or indeed via decay of other radionuclides. For the present, a decay library developed in 2012 'dec_2012' has been employed, which is part of EASY-II and contains information for 3875 nuclides (including stables).

Note that in the case of carbon the TENDL-2014 evaluation is taken directly from JENDL-4.0 [24] and relates only to the natural element, while for all remaining elements the evaluations are isotopic. For C, this means that not all pathway details (section 1.8) can be explicitly extracted. Additionally, the data for the certain light nuclides are imported directly into TENDL from ENDF/B-VII.1 [25] without modification, which, in particular, means that they do not contain data above 20 MeV. These nuclides are ^{1}H, ^{2}H, ^{3}H, ^{3}He, ^{4}He, ^{6}Li, ^{7}Li, ^{9}Be, ^{10}B, ^{11}B, ^{14}N, ^{15}N, ^{16}O, and ^{19}F.

1.3 DEMO FW Activation tables

The first part of the presentation for each element is a set of six activation tables. These display the important radionuclides produced by the irradiation of a 1 kg pure sample of the element for 2 fpy (full power years) in the neutron spectrum predicted for the outboard equatorial first wall (FW) of a recent conceptual design for the next-step fusion demonstration power plant 'DEMO'. This DEMO model, whose toroidal cross-section is depicted in Figure 1, was produced in 2013 under the EFDA work programme on Power Plant Physics and Technology (3PT) (see [26, 27]), and has simplified, homogeneous tritium-breeding modules based on a helium-cooled pebble bed (HCPB) blanket with a mixture of lithium orthosilicate (Li_4SiO_4) and beryllium pebbles. The neutron flux and spectrum for the FW (and for other regions used in the activation graphs – see section 1.4) was calculated using the MCNP [28, 29] neutron transport code. The total, volume-averaged flux for the outboard equatorial FW spectrum (at label 'A' in Figure 1) was 5.90×10^{14} n cm^{-2} s^{-1} and the calculated spectrum is shown in Figure 2.

Following the 2 fpy irradiation, which is the typical lifetime expected for FW compo-

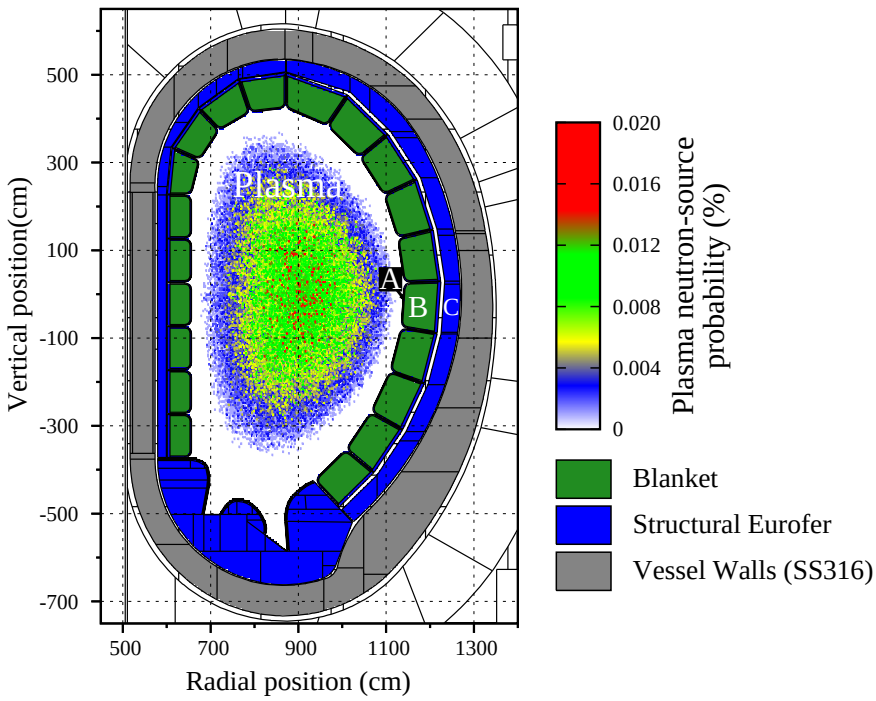


Figure 1: A 2D toroidal cross-section schematic (based on the MCNP model) of the DEMO fusion reactor geometry used to generate the spectra (see Figure 2) used in the handbook. The labels A, B, and C indicate, respectively, the first wall, blanket, and shield positions within the geometry where the neutron spectrum was calculated. The probability source distribution of the toroidal plasma source is also shown, using a sample of 30000 source particles and coloured according to the profile shown in the legend.

nents in DEMO, 10^4 years of cooling was simulated, and the resulting FISPACT-II inventory output was used to construct six tables, one for each of the following activation quantities, all of which are standard response quantities calculated by FISPACT-II (the abbreviations given in brackets below are those used in the tables):

1. Specific Activity (**Act**) – the total activity in Bq kg^{-1} (Bequerels per kilogram of material) from all radionuclides present in the material.
2. Decay Power/Heat Output (**Heat**) – the rate of heat production in kW kg^{-1} (kilowatts per kilogram of material) due to the power generated from all radionuclides via α, β, or γ decay.
3. Gamma (γ) Dose rate (**Dose**) – contact dose rate in Sv h^{-1} (Sieverts per hour) calculated for a semi-infinite slab of material.
4. Ingestion dose (**Ing**) – the dose in Sv kg^{-1} (Sieverts per kilogram of material) that would be received from the material by an average person over a 50-year period following intake via ingestion.

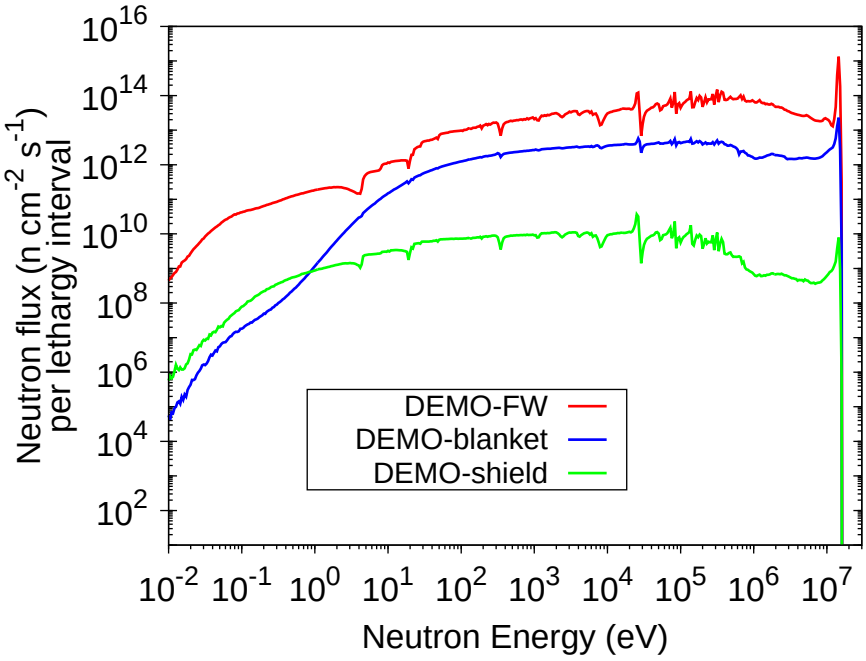


Figure 2: The MCNP-calculated DEMO neutron flux spectra used in the FISPACT-II inventory simulations used to produce the data in the handbook. Note that a high-resolution 616-group structure (see [3] for details) developed at LLNL was used to define the energy bins of the tallies within MCNP.

5. Inhalation dose (**Inh**) – as above, but intake via inhalation.
6. Clearance Index (**Clear**) – (no units) indicates whether, according to IAEA guidelines, a material can be disposed of with no special precautions. A clearance index of less that one indicates that the material can be treated (disposed of) as if it were non-radioactive.

Note that for some special cases, the contribution from high-energy β-particle bremsstrahlung to the γ-dose rate can be significant, and can be included in FISPACT-II via the `BREMSSTRAHLUNG` keyword [3], but for the present work this has not been considered. For specific materials, such as beryllium, this may mean that there is little or no dose rate calculated, while there would be if bremsstrahlung radiation were included.

For each table data are presented at six different decay times following irradiation: 0 years (immediately upon shutdown after the 2-fpy irradiation); 10^{-5} years (5.26 minutes); 10^{-2} years (3.65 days); 1 year; 100 years and 10^4 years. Table 1, shows an example of one of these tables, in this case for the total heat output from pure aluminium (Al). In the table the important radionuclides are listed, together with their corresponding % contribution to the particular activation quantity at each cooling time. Nuclides are listed if they contribute more than 1% to the activation quantity at any cooling time, and are presented in descending order of contribution for the

Table 1: The post-irradiation decay heat table for aluminium.

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.49E-01	2.27E-01	3.04E-03	2.30E-07	2.28E-08	2.22E-08
Na24	78.0	85.3	100.0			
Mg27	18.8	14.0				
Al28	3.0	0.7				
H3				46.0	1.8	
Na22				44.3		
Al26				9.7	98.2	100.0

decay time where they first appear. In the first results row of each table, immediately below the headings, the total of the activation quantity in the material is given at each cooling time (also corresponding to the points on the 'DEMO-FW' curve in the activation graphs – see section 1.4).

In the Table 1 example for Al, ^{24}Na is the main contributor to decay power during the first three cooling times, contributing 78.0%, 85.3%, and 100.0%, respectively after 0, 5.3 minutes, and 3.7 days of cooling. ^{27}Mg and ^{28}Al also contribute over this period, but after 1 year of cooling an entirely different set of radionuclides take over, with ^{3}H (tritium) and ^{22}Na dominating at 1-year, before ^{26}Al, with a half-life of 7.2×10^5 years, dominates at the longer cooling times.

1.4 Activation graphs

In this part three pairs of plots are given, one for each of the three main activation properties introduced earlier (see section 1.3): Specific activity, Decay power, and γ dose rate. These activation graphs, and the other plots and images in this handbook, including those showing the transmutation response (see section 1.6) and the importance diagrams (section 1.5), have all been created using the GNUPLOT [30] plotting package, which is particularly well suited to automated processing via scripting. The first plot in each pair, in the left-hand column of the page of activation characteristics for each material, shows the time-evolution during 10^4 years of cooling of the particular activation property following simulations of 2-fpy irradiations of 1 kg samples in three DEMO irradiation scenarios. The first of these is the same HCPB DEMO outboard equatorial FW flux used for the activation tables in section 1.3, then there is the volume-averaged spectrum in the outboard equatorial tritium-breeding blanket module for the same HCPB DEMO concept (position 'B' in Figure 1), and lastly the spectrum predicted behind both of these in the shield or manifold (position 'C'). All three spectra are shown in Figure 2, and the total fluxes are, respectively for the FW, blanket, and shield, $5.90 \times 10^{14}, 3.77 \times 10^{13}$, and 9.62×10^{10} n cm^{-2} s^{-1}.

The plot in Figure 3a shows the specific activity plot for copper (Cu). For each scenario, the curve with points shows the radiological response with uncertainty error-bars at

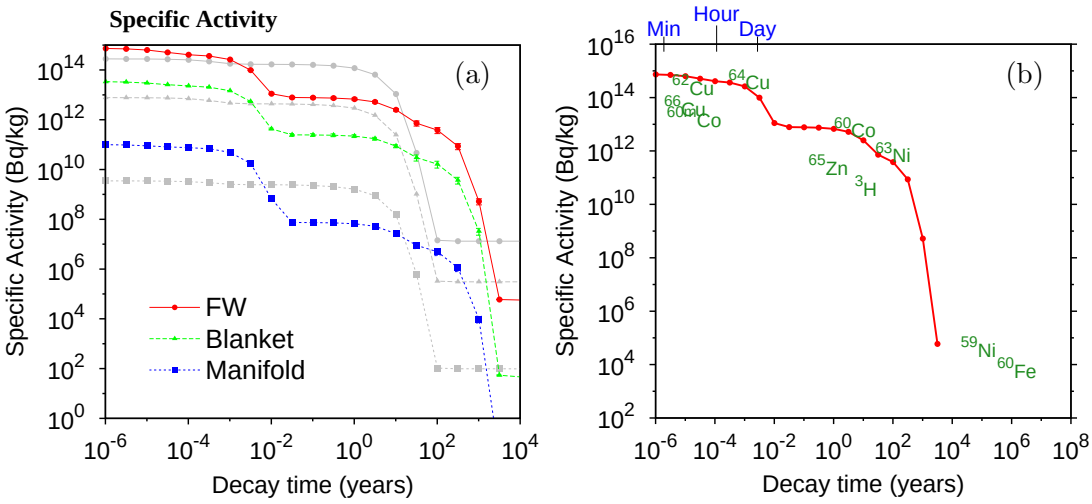


Figure 3: (a) the time-evolution in specific activity from Cu following 2-fpy irradiations in three DEMO fusion reactor scenarios, with equivalent results for Fe in light-grey and using the same line and point formats as indicated in the legend for Cu. (b) time-evolution in specific activity from Cu following the DEMO FW irradiation, and also showing the important nuclides contributing to the activity plotted as labels at half-life versus shutdown contribution to specific activity; i.e., when they are most significant.

each point (as vertical lines crossing the points, obtained using the `UNCERTAINTY 1` flag in FISPACT-II [3]) above 1 Bq kg^{-1} for specific activity, above 1 μW per gram for decay power, and above 1 μSv h^{-1} for dose rate. Note that on the logarithmic scale of the plots the uncertainty error-bars with TENDL-2014 are often too small to be distinguishable from the points themselves, but there are notable exceptions – see for example the decay heat plot for silicon (Si) shown in Figure 4.

In the graphs, and in all such graphs in the report, the equivalent curves corresponding to pure iron (Fe) are also shown, without uncertainties, in light-grey, but using the same line and point format for each irradiation scenario. This is a deliberate response, following experience with previous versions of the handbook, to the almost universal need for fusion applications to measure the response of a material relative to Fe, since this will form, as part of steels, the majority of most reactor components and therefore represents a baseline of activity that cannot be avoided.

In the γ dose rate graph for each element a labelled horizontal dashed line at 10 mSv h^{-1} is also included to represent the typical remote recycling limit expected for fusion reactor components (see, for example, [31, 32]).

As would be expected, in Figure 3a, the FW scenario produces the highest specific activity at all cooling times, followed by the blanket (the next deepest position in the reactor relative to the plasma), and then the shield.

The second plot for each property, on the right-hand side of each page of activation plots, gives the result for the FW scenario again (this time without uncertainties, but using the same colouring as in the left-hand plot – as indicated by the legend at the

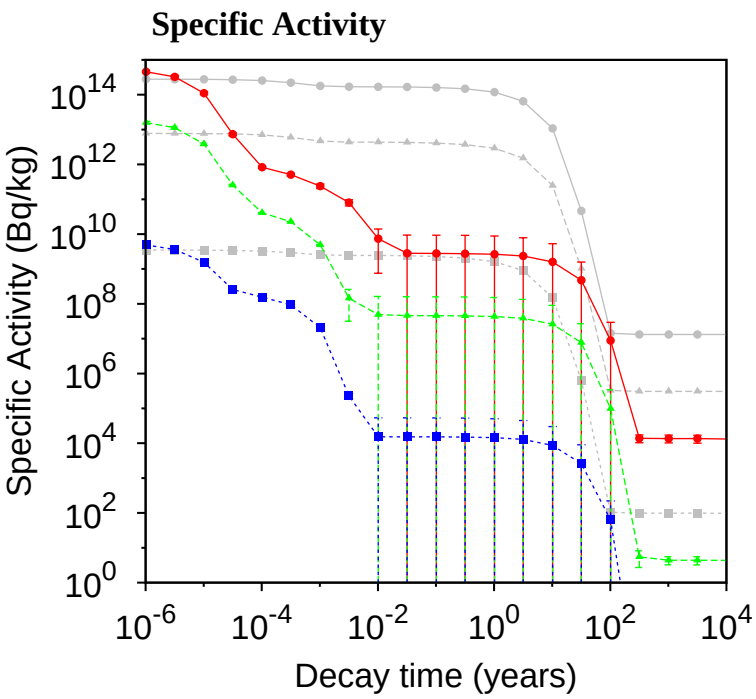


Figure 4: the time-evolution in decay heat from Si following 2-fpy irradiations in three DEMO fusion reactor scenarios, following the same legend as shown in Figure 3(a), with equivalent results for Fe in light-grey also shown. Note the large uncertainty bars in the results at longer cooling times (greater than around 1 day).

bottom of each page of activation plots), but then additionally shows the important radionuclides that contribute to the activation. Important nuclides appear in the plot (as a green text label) at the position on the time (x) axis corresponding to their half-life and on the activity (y) axis corresponding to their contribution to activity at shutdown, immediately after the 2-fpy irradiation in the FW scenario – in essence when they are predominant. This provides a visual indication of which nuclides produce a particular level of activity in the element. This type of plot is a new feature built directly into FISPACT-II (via the `GRAPH` keyword – see the FISPACT-II manual [3]), and has proven very useful in some of the validation exercises – see, for example, the decay-heat validation [7]. Note in these plots, that the time (x) axis sometimes extends beyond the 10^4-year limit of the cooling times in order to show occasional very long-lived radionuclides that are nonetheless contributing significantly to the activity.

The plot in Figure 3b shows the specific activity plot with radionuclides for Cu. There are three main groupings of radionuclides, corresponding to three steps in the activity of the material. First, at cooling times of less than 1 day, four short-lived nuclides contribute – ^{62}Cu ($T_{1/2}$ = 9.7 min), ^{66}Cu (5.1 min), ^{60m}Co (10.5 min), and ^{64}Cu (12.7 hours). As these decay away, they are replaced by another group of four nuclides with half-lives ranging from a few hundred days to more than 100 years – ^{65}Zn (244.1 days), ^{60}Co (5.3 years), ^{3}H or tritium (12.3 years), and ^{63}Ni (100.6 years). Fi-

nally, at much longer cooling times, there is a low-plateau in specific activity dominated by two long-lived nuclides – ^{59}Ni ($T_{1/2} = 7.6 \times 10^4$ years) and ^{60}Fe (1.5×10^6 years).

1.5 Importance diagrams

Importance diagrams [14, 15] visualize the general post-irradiation activation response of a material in a way that it is independent of any neutron irradiation spectrum. They show the regions of the incident-neutron-energy vs. decay-time landscape where a single radionuclide dominates a particular activation quantity - i.e., where it contributes 50% or more. Full details or these diagrams are given in [14], and their full inclusion into the EASY-II infrastructure has recently been prototyped by the writing of a computer code [15], which fully automates the required FISPACT-II inventory runs, processing of output, and creation of plotting scripts (for GNUPLOT [30]). The new approach, which completely removes the need for proprietary plotting software, which was a barrier to widespread adoption of importance diagrams by users of EASY, is applied in the present report to produce three sets of diagrams for every element – one for each of specific activity, heat output, and γ dose rate.

To generate the diagrams for each material, a sequence of 2 fpy irradiations simulations are performed under mono-energetic neutron fluxes of 10^{15} n cm^{-2} s^{-1}, which are then followed by a long cooling phase of more than 10^6 years. An inventory run was performed for each bin of the high-resolution 709-group structure used in conjunction with the TENDL-2014 cross section libraries within FISPACT-II [3], although only a portion of the 10 μeV to 1 GeV energy range of this group structure – from 10 meV to 30 MeV – is depicted in the importance diagrams shown in this report. In total, for the 81 elements represented in this handbook, these importance diagrams required more than 57000 separate FISPACT-II simulations – a significant computational undertaking. By comparison, less than 1000 further inventory runs were needed to produce all of the remaining data presented.

The automatic processing tool [15] subsequently analyses the inventory output files and identifies, for each importance diagram, the regions where single radionuclides dominate the radiological response, which are then output as closed loops of points that GNUPLOT can plot as shaded areas of colour (using the `filledcurves` plotting style – see the GNUPLOT[30] manual). The result is an importance diagram that gives no information on the magnitude of a radiological quantity (a neutron spectrum and flux is needed for such data), but instead summarises which nuclides will be important at particular decay times, when neutrons of various energies are present.

Figure 5 shows, as a typical example, the decay heat output importance diagrams for pure tungsten (W). For all three radiological quantities, two separate importance diagrams are presented: the first has a logarithmic scale on both the y energy-axis and x decay-time-axis, with the former ranging from 10 meV to 30 MeV. Next to this main, large plot, a second smaller diagram shows, on a linear energy scale, but using the same 1 second to 1.5×10^6 years logarithmic decay-time scale, the portion of the importance

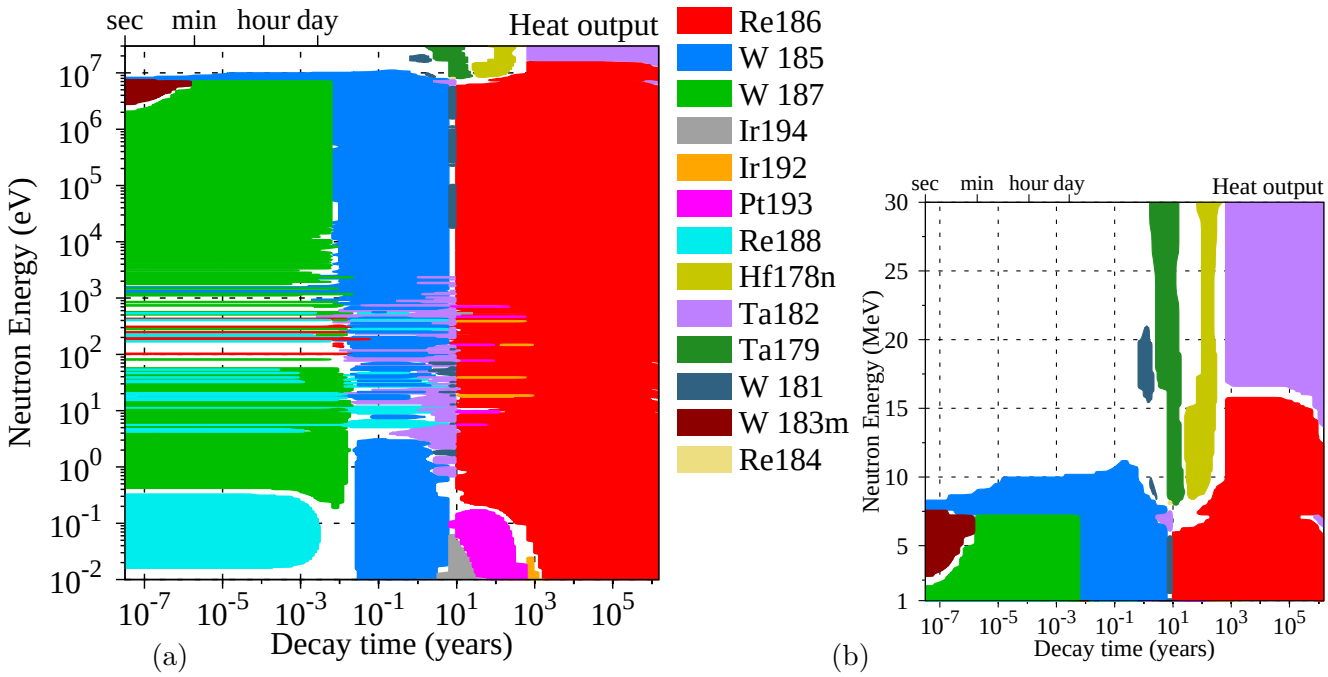


Figure 5: The decay heat output importance diagrams for pure W. (a) has a logarithmic eV energy scale and shows the regions of dominance at all energies from 0.01 eV to 30 MeV. (b) has a linear energy scale and focuses on the important fusion range from 1 to 30 MeV.

landscape above 1 MeV. The 1 to 30 MeV range shown, which is difficult to appreciate in the main plot due to the necessary logarithmic scale, is particularly relevant for fusion applications where the majority of neutrons hitting in-vessel components are above 1 MeV.

Notice in Figure 5 that the importance diagrams are not completely shaded because for some neutron energies and cooling times there is no single nuclide dominating the response. The figure shows that at short cooling times of less than approximately 1 day two nuclides – ^{187}W and ^{188}Re – dominate decay-heat production over most of the neutron energy range. At intermediate cooling times up to around 1 year ^{185}W predominates, while at longer times, the landscape is almost completely filled by regions of ^{186}Re dominance. Note that nuclides are listed in the key of each pair of diagrams in order of largest contour of points in the main, logarithmic diagram, which typically means that the most important ones appear first (this is not always true as some contours may have a large number of points due to a complex structure but take up relatively little space in the landscape).

As well as the four major nuclides in Figure 5a, there are several other nuclides dominating in small areas of the diagram, particularly at the higher neutron energies where different nuclides become important due to the increase of threshold nuclear reactions rather than pure radiative capture. Figure 5b shows the dominance of these latter

nuclides. Another feature observable in the diagram are horizontal bands in the eV to keV energy range, which are associated with resonances in the neutron capture (n, γ) cross section channel. For a given resonance energy, there is a pronounced increase in the production of residual radionuclides, causing them to be dominant over a wider range of decay times; hence horizontal bands that extend below the main regions of dominance of certain radionuclides. In Figure 5a, however, the main influence of these resonances is actually to produce empty horizontal bands that break up the regions of dominance of, in particular, ^{187}W. This is primarily due to the resonances in the capture cross section of ^{184}W, increasing the production of ^{185}W, and causing no single nuclide to be dominant at the resonance energies. It was noted in [15], that in a W importance diagram of total or specific activity, where ^{187}W is largely absent, ^{185}W does indeed have a series of pronounced horizontal bands, whilst there is only one in Figure 5a.

1.6 DEMO FW Transmutation results

The transmutation response of each material under DEMO FW conditions is depicted using two different, but complementary representations. Firstly, a line chart shows, at an elemental level, the time-evolution of an initially pure 1 kg sample of the element during a 2 fpy irradiation. The concentration of each transmutant element created during the irradiation simulation is given in atomic parts per million (appm) as a function of irradiation time. Note that only elements whose concentration exceeds 10^{-2} appm during the 2-fpy are shown. For reference, the 1 and 10 atomic % grid lines – equivalent to 10^4 and 10^5 appm, respectively – are labelled in each plot.

Figure 6a shows an example of these plots – for pure Fe. It shows that during the 2 fpy the main impurity elements generated by the nuclear reactions are H and Mn, which both reach concentrations of around 1000 appm. Cr and He reach concentrations of a few hundred appm, with V, Co, and Ti also produced in minor concentrations.

To emphasise the importance of gas production in the modelling of material behaviour, the helium and hydrogen concentrations after the first fpy, to the nearest appm, are given below each plot. For the Fe case in Figure 6a 113 appm He and 617 appm H are present in the composition after 1 fpy.

The second graphic in this section is a nuclide map, showing the composition of the irradiated sample at the end of the 2 fpy FW DEMO irradiation. The nuclide map depiction of an inventory composition, or indeed the distribution of activity from that inventory, is a new technique, recently developed [15] for future inclusion into the EASY-II code system, that allows the full complexity of an inventory simulation to be graphically represented. Nuclides are presented in a tableau with atomic number Z of the parent element increasing vertically and the neutron number N of the nuclide increasing horizontally. The square corresponding to each nuclide is then coloured according to a defined gradient to represent the concentration of, or activity from, that nuclide. A key feature of this representation, plotted using GNUPLOT [30], is

the ability to create snapshots at different times during an irradiation-and-cooling scenario for subsequent animation. This has been explored elsewhere [15], and in the present report only a single snapshot of concentration is given – at $t = 2$ fpy.

Figure 6b shows the example result for Fe of the plots in this handbook. Note that while it is possible to show every possible nuclide on a map, of which there are 3875 in the decay file used with TENDL-2014 by FISPACT-II, it is more practical to only show those regions of the map where there are likely to be non-zero contributions for a particular inventory simulation. For the present report on pure elements this is the region in Z either side of the element, with an N range centred on the nuclide closest to the atomic mass of that element – in the automated scripts for the report we use a fixed range of ± 3 in Z and ± 7 in N for all elements above oxygen (below this the entire tableau between H and O is shown). Additionally, a second region is included in the plot, showing the light hydrogen and helium isotopes emitted by many nuclear reactions. In Figure 6b, some of the nuclides are highlighted with an asterisk in the top-left corner of their square; these are the nuclides that were present in the initial composition, in this case the naturally occurring isotopes of Fe. Furthermore, in the maps of other elements there may also be an 'm' label in the bottom right corner of the square, which indicates that the composition for that particular nuclide is dominated by one or more metastable or excited states rather than the ground state.

From Figure 6b, we can now see which nuclides contribute to the elemental composition shown in Figure 6a. For example, it shows that even though the majority of the composition is still Fe, the actual make-up of the Fe has changed somewhat, with a significant concentration of the ^{55}Fe radionuclide, which was not present to begin with. As would be expected, ^{1}H (protons) and ^{4}He (alphas) are the main light isotopes of hydrogen and helium produced. From plots such as this it is also often possible to deduce the main reaction pathways for some nuclides, particularly when they are only one or two steps removed from the input isotopes. Looking at the change in neutron and atomic numbers between ^{56}Fe and ^{55}Fe, we can immediately see that the main production pathway was an $(n, 2n)$ reaction because Z is unchanged and N has decreased by one. Similarly, the main transmutant Cr nuclide ^{53}Cr was created mainly via (n, α) reactions on ^{56}Fe, where N decreases by 3 and Z decreases by 2 because the emitted ^{4}He (α) nucleus contains 2 protons and 2 neutrons (including one provided by the incoming neutron). Figure 7 displays on a nuclide chart centred on the original parent (or target) nucleus the most common nuclear reactions (black text) and decays (red), respectively, with their position indicating the position of the new daughter nuclide that results.

1.7 DEMO FW PKA distributions

This section for each element displays results from recent work to define the nature and energy distributions of the displaced, residual and emitted particles produced when neutrons interact with matter. These displaced species, known as the primary knock-

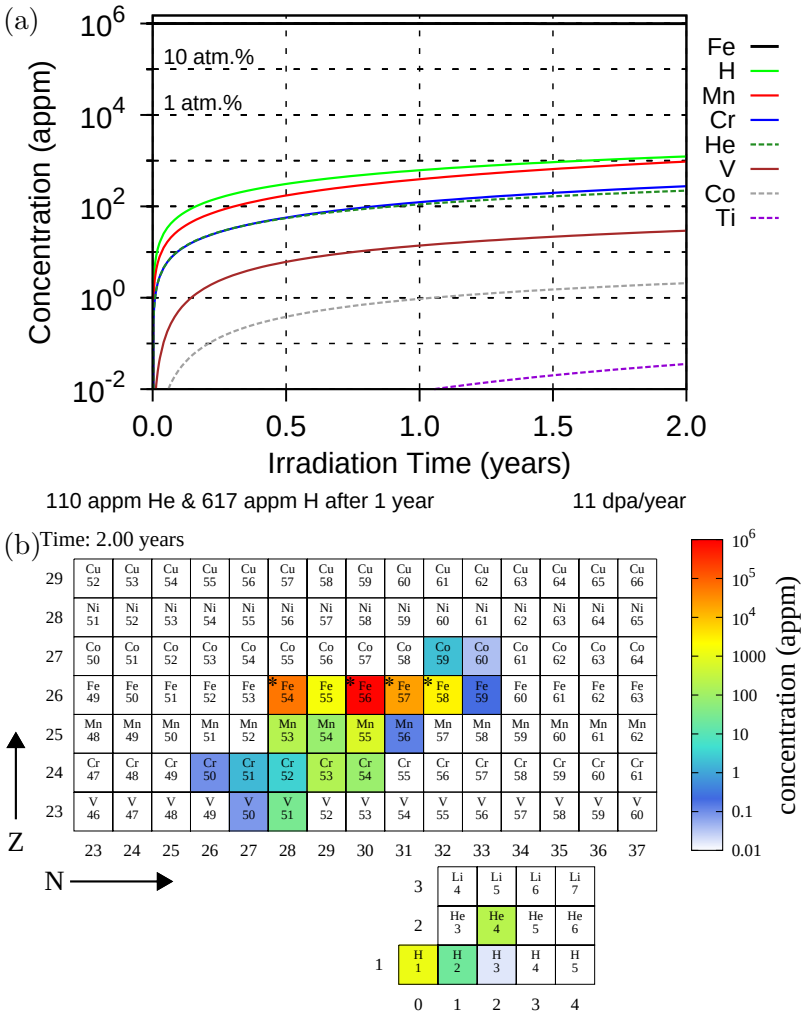


Figure 6: (a) The elemental transmutation response of pure Fe during a 2 fpy irradiation in DEMO FW conditions. (b) a nuclide map showing the transmuted composition of the Fe sample at the end of the 2-fpy irradiation.

on atoms (PKAs), recoil through a material causing a cascade of further displacements, which can lead to the production of significant and long-lived radiation-induced damage in the lattice. Such damage can have severe consequences for the properties of materials and can reduce component lifetime dramatically. Huge effort is being expended, via both molecular simulation and experimental irradiations, to model, quantify and predict the production and evolution of this type of damage. The nuclear data community has a vitally important role to play in this endeavour because it has the tools and fundamental physical information that can be used to provide the input to both the simulations and experimental design – namely the types, quantities and energies of PKAs. In the handbook we employ a recently developed methodology [16] to present PKA distributions for each element under DEMO FW conditions, whose spectrum is shown in Figure 2.

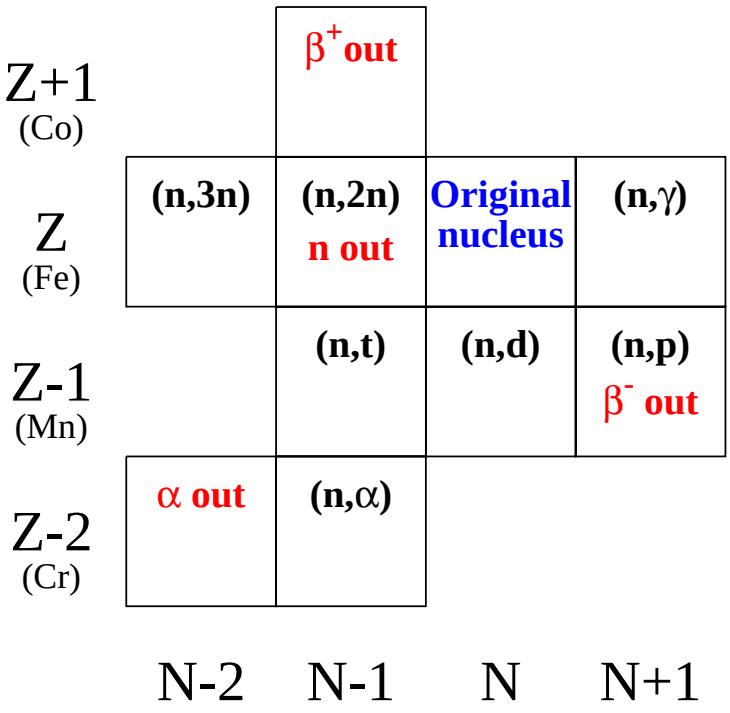


Figure 7: Nuclide charts showing the position, relative to the original parent nuclide, of the daughters that result from the common nuclear reaction (black) and decay (red) channels. The elements in brackets below each change in Z label are examples of the situation in pure Fe – see Figure 6b.

The first step involves the nuclear data processing code NJOY [21], whose `GROUPR` routine can calculate group-to-group recoil matrices. Using the full point-wise TENDL-2014 [4] neutron-interaction data, NJOY-2012 calculates incident-to-recoil energy group-to-group (both in 709-group format) cross section matrices for all possible reaction channels for the 283 naturally occurring isotopes of the 81 elements considered in this handbook. The result is a set of matrices for each nuclide that include the probability of recoils due to elastic and inelastic neutron scattering, the recoil of the residuals in non-elastic nuclear reactions, and the recoil of the light charged particles of some of those reactions. TENDL-2014 is the only nuclear library that has the complete set of outgoing energy-angular distribution data that are essential to these processing steps.

Note that for the present work the detailed angular distributions of the recoiling nuclei and scattered particles, which are also calculated by NJOY-2012 from the TENDL-2014 evaluations, are not explicitly considered beyond the impact they have on the recoil energy distribution. There is currently insufficient information regarding the precise and relative orientations of material grains in fusion reactor designs and directions of incoming neutrons from the neutron-transport simulations to justify consideration of the direction vectors of recoil particles – an isotropic distribution is an acceptable approximation for this level of simulation accuracy.

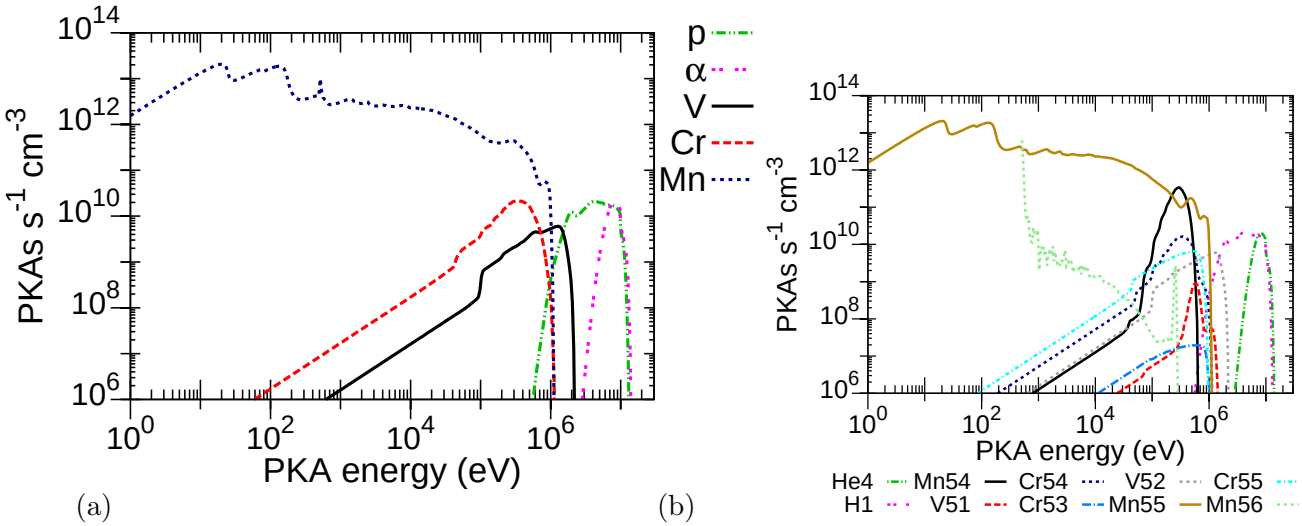


Figure 8: (a) elemental and (b) isotopic PKA distributions for pure Mn under DEMO FW conditions.

A newly written computer program, SPECTER2 [16], whose subroutines are for future incorporation into EASY-II, reads the cross section matrices output from NJOY-2012 and collapses them with a user-defined neutron spectrum, which for the present report is the FW DEMO spectrum, to produce the distribution of PKAs associated with each reaction channel. These 'raw' distributions are available from the SPECTER2 output, but from a damage evolution perspective the channel does not matter – only the type of the recoiling species matters. Thus, SPECTER2 produces summed distributions as a function of both nuclide and, more importantly, element type, which is the level of detail, at best, that can be considered in molecular simulations. Furthermore, SPECTER2 can perform the collapses for a set of different target nuclide matrices and sum according to a known material composition; a functionality used here to produce PKA distributions for naturally occurring compositions of the elements.

For each element two PKA distribution plots are output: one showing the elemental distributions, and one showing the more complex picture at the isotopic level. Figure 8 shows the two PKA plots for pure manganese (Mn). In all PKA plots the y-axis units are PKAs s^{-1} cm^{-3}, which are obtained by converting the raw PKAs s^{-1} per target nuclide obtained from the matrix-spectrum collapse using the standard element densities from FISPACT-II. Note that only recoils with energies above 1 eV are displayed, and even these are below the interest limit for most materials because a recoil energy of several 10s of eV (the 'threshold displacement energy' – see, for example, table 9 of [3]) is generally required before an atom is actually displaced from its equilibrium position within a material lattice. Furthermore, the lower limit for PKA flux to be plotted is 1×10^6 PKAs s^{-1} cm^{-3}, which is usually many orders of magnitude below the peak fluxes – as it is in Figure 8.

Figure 8a shows that, at an elemental level, Mn itself is the dominant PKA type across

most PKA energies, with a maximum PKA energy of around 1 MeV. However, two other heavy residual PKA-types are also produced; Cr and V. The V recoil are particularly significant in a materials damage context as they have a maximum energy around 2 MeV. Two further elemental distributions are shown, corresponding to the recoil spectrum of secondary emitted light gas particles of hydrogen and helium. Such elemental distributions will almost always be dominated by ^{1}H and ^{4}He, coming from the common (n, p) and (n, α) reactions, respectively, and the labels for these emitted particles have been chosen as p and α to reflect this. In practice there may be a contribution to the 'p' distribution from deuterium and tritium, and for the 'α' distribution there is a chance that ^{3}He may be significant, but in such cases this would be evident from the second 'isotopic' PKA plot.

For Mn, Figure 8b, demonstrates that the main contribution to the Mn recoils in Figure 8a comes from the recoils of ^{55}Mn. This is perfectly understandable as ^{55}Mn is the only naturally occurring isotope of Mn and the elastic and inelastic scattering channels, which do not change the target species, are typically the dominant reaction channels in the sub-1 MeV range. Interestingly, the main vanadium PKA nuclide is not one of its naturally occurring isotopes, but rather a short-lived (on the nuclear rather than radiation damage scale) radionuclide ^{52}V. As was predicted above, the only contributors to the light particle PKAs are indeed protons ^{1}H and alphas ^{4}He.

As a final note about these PKA distributions it is important to realise that they represent a time $t = 0$ snapshot of the recoil events in a material under irradiation (BOL beginning of life, as opposed to EOL end of life). In particular, we have made no attempt to consider how the PKA distributions may change as a material's constituent atoms are transmuted, which could lead to a variation in the relative importance of different nuclear reaction channels. In a highly transmuting material, it is possible that there would be a significant enough alteration of the composition to produce a noticeable change in the PKA distributions and consequently the rate of damage production in a material. Additionally, no attempt has been made to consider any additional PKAs that might originate purely from decay events of radionuclides.

The most likely application of the PKA distributions presented here is as sampling distributions. For example, PKAs could be used in a modelling approach based on a combination of molecular dynamics simulations of displacement cascades, which define the damage produced by a PKA at a given energy, and a larger length-scale model that would take these results and statistically sample in time and space from the PKA distributions to build up a picture of damage creation. For this reason, all of the elemental PKA distributions plotted in this handbook are also given in tabular form, with one table for each PKA type of each target element, in a separate supplementary document [33], from which sampling distributions can be created. The PKA plots from the main report are also reproduced in the supplement for reference.

1.8 Reaction pathways table

The final section of the output for each material gives the main reaction pathways from the input isotopes, which for the elements are their naturally occurring isotopes, to the important radionuclides identified by appearance in either the activation tables (see section 1.3) or importance diagrams (as described in section 1.5). The target daughter radionuclides are listed in order of increasing half-life (given in the table for reference). For each daughter, a pathway is listed if it contributes more than 1% (as defined in the FISPACT-II simulation output) to the creation of the daughter at any of four neutron energy regions. In this respect, the data in each 'pathways analysis' table is generated by processing the results from four separate FISPACT-II inventory simulations – one for each of four neutron energy regions:

- thermal or slow neutrons at energies from 0.02 to 0.05 eV (groups 525-545 inclusive).
- intermediate neutrons from 20 to 40 keV (230-245).
- fast neutrons at energies typically generated in fission reactors, from 1 to 3 MeV (136-160).
- 13 to 15 MeV neutrons covering the 14 MeV neutrons generated in Deuterium-Tritium fusion reactions (85-95).

The group ranges listed in brackets above are the corresponding energy groups from the fine 709-group structure used to represent the TENDL-2014 cross section data and neutron spectra (see the FISPACT-II manual [3] for more details). For each simulation a uniform (flat) neutron spectrum across the specified range of energy groups was used, with a total flux of 1×10^{15} n cm^{-2} s^{-1} – a typical fusion power-plant FW value. As is standard in this report, a 1 kg sample of the element was irradiated for 2 fpy, which was then followed by cooling times of up to 10^6 years.

Note that as part of the previously mentioned aim to make the production of this handbook as automatic as possible, there have been no special or extraordinary attempts, via additional inventory calculations, to find pathways for a particular target radionuclide. Only the pathways produced via the four standard runs are given. For FISPACT-II users, the pertinent keyword and variables for these runs are that the `UNCERTAINTY` keyword was used with a `-1` flag to overwrite the default limits, then the maximum 'depth' of the pathway search was increased to 25 reactions (from the default of 10), and the 'path floor' defining the minimum fractional contribution to a target was reduced to 0.001 (from the default of 0.005) – see the FISPACT-II manual [3] for further details. The `LOOKAHEAD` keyword was also used to search the cooling times for extra dominant nuclides, which might not otherwise have been included in a pathway analysis based on the irradiation phase (the default behaviour). However, the use of this latter keyword, in particular, can cause failure of a FISPACT-II calculation due to heap exhaustion [3], or excessively long simulations. In this case an automatic check

for either failure or excessive run-time was used, and subsequently, as necessary, the FISPACT-II input was modified by removal of some or all of the cooling steps, until a successful simulation was performed.

A final modification to the standard FISPACT-II calculations of pathways was made using the `TOLERANCE` keyword, which improves the accuracy of results for minor constituents of the inventory [3]. For the pathway calculations, in particular, `TOLERANCE 1 5.0E1 1.0E-4` was used to enforce tolerance values several orders of magnitude below the default values (a separate instance of the keyword, via `TOLERANCE 0`, is required to change the tolerances for the main inventory calculation).

The use of standard input parameters for the pathway searches can mean that for some radionuclides no pathways are identified at any neutron energy, or for others that the total contribution from the identified pathways is not close to 100% for a particular energy range. In such cases, and if there is interest, the reader is advised to use FISPACT-II to look for these 'difficult-to-find' pathways using the `ROUTES` keyword that can be used look for pathways between specific parent and daughter targets (see the manual [3] for more details).

Where no pathways are found in the standard four simulation outputs, perhaps because the target radionuclide is only created via reactions that happen at energies outside of the four regions considered, or, more likely, because the standard pathway search could not find any production pathways, the target nuclide is still given, but with an appropriate 'no pathways found' flag. Note that, for low Z elements this flag often appears because of the difficulty in allocating the daughters and emitted particles from certain complex breakup reactions [17].

Table 2 shows, as an example, the pathway analysis result for Si. The radionuclide ^{31}Si, with a half-life of 2.62 hours, is one of those shown, and for all four neutron energy regions the dominant pathway is a single-step (n, γ) reaction from ^{30}Si, which is one of Si's minor naturally occurring isotopes (^{28}Si is the major one at more than 92% abundance). On the other hand, for ^{24}Na, with a half-life of 14.96 hours, pathways are only identified for the highest energy-range of neutrons, and here two main two-step pathways dominate at 44 and 39%, both from ^{28}Si and including either ^{27}Al or ^{24}Mg, with several other pathways providing minor contributions.

Table 2: The pathway analysis table for silicon (Si).

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Al28	2.24m	Si28(n,p)Al28				99.7
Al29	6.56m	Si29(n,p)Al29			100.0	97.2
		Si30(n,2n)Si29(n,p)Al29				1.6
Mg27	9.46m	Si29(n,α)Mg26(n,γ)Mg27			100.0	
		Si30(n,α)Mg27				80.3
		Si28(n,np)Al27(n,p)Mg27				16.9
		Si28(n,d)Al27(n,p)Mg27				2.0
Si31	2.62h	Si30(n,γ)Si31	98.9	99.9	99.9	99.2
		Si29(n,γ)Si30(n,γ)Si31	1.0			
Na24	14.96h	Si28(n,np)Al27(n,α)Na24				44.6
		Si28(n,nα)Mg24(n,p)Na24				39.6
		Si28(n,d)Al27(n,α)Na24				5.2
		Si28(n,α)Mg25(n,d)Na24				3.7
		Si28(n,α)Mg25(n,2n)Mg24(n,p)Na24				3.7
		Si28(n,α)Mg25(n,np)Na24				1.9
		Si30(n,α)Mg27(β^-)Al27(n,α)Na24				1.0
Mg28	20.90h	Si28(n,p)Al28(n,p)Mg28				97.9
		Si29(n,p)Al29(n,d)Mg28				1.3
P32	14.27d	Si30(n,γ)Si31(β^-)P31(n,γ)P32	99.5	100.0	99.9	98.9
Na22	2.60y	Si28(n,nα)Mg24(n,np)Na23(n,2n)Na22				46.5
		Si28(n,np)Al27(n,nα)Na23(n,2n)Na22				18.0
		Si28(n,nα)Mg24(n,d)Na23(n,2n)Na22				14.2
		Si29(n,α)Mg26(n,α)Ne23(β^-)Na23(n,2n)Na22				5.7
		Si28(n,np)Al27(n,2n)Al26(n,nα)Na22				4.7
		Si28(n,α)Mg25(n,t)Na23(n,2n)Na22				2.8
		Si28(n,α)Mg25(n,2n)Mg24(n,np)Na23(n,2n)Na22				2.3
		Si28(n,d)Al27(n,nα)Na23(n,2n)Na22				2.1
H3	12.33y	Si30(n,γ)Si31(β^-)P31(n,γ)P32(n,p)H1(n,γ)H2(n,γ)H3	99.7			
		Si29(n,t)H3				61.0
		Si28(n,α)Mg25(n,t)H3				29.7
		Si28(n,np)Al27(n,t)H3				7.1
Si32	132.00y	Si30(n,γ)Si31(n,γ)Si32	50.3	98.5	49.3	61.4
		Si30(n,γ)Si31(β^-)P31(n,γ)P32(n,p)Si32	49.3	1.4	50.6	38.1
C14	5.7 10^3y	Si28(n,nα)Mg24(n,α)Ne21(n,2α)C14				75.9
		Si28(n,α)Mg25(n,nα)Ne21(n,2α)C14				13.4
		Si28(n,α)Mg25(n,2n)Mg24(n,α)Ne21(n,2α)C14				3.6
		Si28(n,nα)Mg24(n,α)Ne21(n,nα)O17(n,α)C14				1.7
		Si28(n,α)Mg25(n,α)Ne22(n,2n)Ne21(n,2α)C14				1.7
		Si28(n,nα)Mg24(n,nα)Ne20(n,α)O17(n,α)C14				1.3
Cl36	3.0 10^5y	Si30(n,γ)Si31(β^-)P31(n,γ)P32(β^-)S32(n,γ)S33(n,γ)S34(n,γ) S35(β^-)Cl35(n,γ)Cl36	87.5			
		Si30(n,γ)Si31(β^-)P31(n,γ)P32(n,γ)P33(β^-)S33(n,γ)S34(n,γ) S35(β^-)Cl35(n,γ)Cl36	10.6			
		Si30(n,γ)Si31(β^-)P31(n,γ)P32(n,γ)P33(n,γ)P34(β^-)S34(n,γ) S35(β^-)Cl35(n,γ)Cl36	1.5			
Al26	7.2 10^5y	Si28(n,np)Al27(n,2n)Al26				87.0
		Si28(n,d)Al27(n,2n)Al26				10.2
		Si30(n,α)Mg27(β^-)Al27(n,2n)Al26				2.0
Be10	1.6 10^6y	Si28(n,nα)Mg24(n,nα)Ne20(n,2α)C13(n,α)Be10				73.0
		Si28(n,nα)Mg24(n,α)Ne21(n,nα)O17(n,nα)C13(n,α)Be10				7.5
		Si28(n,nα)Mg24(n,nα)Ne20(n,nα)O16(n,α)C13(n,α)Be10				5.7
		Si28(n,nα)Mg24(n,nα)Ne20(n,α)O17(n,nα)C13(n,α)Be10				5.7
		Si28(n,α)Mg25(n,2n)Mg24(n,nα)Ne20(n,2α)C13(n,α)Be10				2.8
		Si28(n,α)Mg25(n,nα)Ne21(n,nα)O17(n,nα)C13(n,α)Be10				1.3

There are a large number of possible reactions and decay modes that may occur in a production pathway for a radionuclide. The ones appearing in this work are, for reactions:

(n,γ) – neutron absorbed, gamma photon emitted, e.g. $^{7}\mathrm{Li}(n,\gamma)^{8}\mathrm{Li}$

$(n,2n)$ – neutron absorbed, two neutrons emitted, e.g. $^{14}\mathrm{N}(n,2n)^{13}\mathrm{N}$

(n,α) – neutron absorbed, alpha particle emitted, e.g. $^{25}\mathrm{Mg}(n,\alpha)^{22}\mathrm{Ne}$

(n,p) – neutron absorbed, proton emitted, e.g. $^{28}\mathrm{Si}(n,p)^{28}\mathrm{Al}$

(n,n') – inelastic scattering, e.g. $^{129}\mathrm{Xe}(n,n')^{129m}\mathrm{Xe}$

(n,E) – elastic scattering, e.g. $^{108m}\mathrm{Ag}(n,E)^{108}\mathrm{Ag}$

(n,t) – neutron absorbed, triton emitted (or combination of 2 neutrons and a proton), e.g. $^{55}\mathrm{Fe}(n,t)^{53}\mathrm{Mn}$

$(n,n\alpha)$ – neutron absorbed, alpha particle and neutron emitted, e.g. $^{35}\mathrm{Cl}(n,n\alpha)^{31}\mathrm{P}$

$(n,3n)$ – neutron absorbed, three neutrons emitted, e.g. $^{181}\mathrm{Ta}(n,3n)^{179}\mathrm{Ta}$

(n,d) – neutron absorbed, deuteron emitted (or a neutron and a proton), e.g. $^{59}\mathrm{Co}(n,d)^{58}\mathrm{Fe}$

(n,h) – neutron absorbed, $^{3}\mathrm{He}$ nucleus (helion) emitted, e.g. $^{32}\mathrm{S}(n,h)^{3}\mathrm{He}$

$(n,2p)$ – neutron absorbed, two protons emitted, e.g. $^{40}\mathrm{Ca}(n,2p)^{39}\mathrm{Ar}$

(n,X) – neutron absorbed, heavy nucleus recoiled (important in the production of $^{3}\mathrm{H}$), e.g. $^{9}\mathrm{Be}(n,X)^{3}\mathrm{H}$

$(n,2n\alpha)$ – neutron absorbed, alpha particle and two neutrons emitted, e.g. $^{151}\mathrm{Gd}(n,2n\alpha)^{146}\mathrm{Sm}$

$(n,p\alpha)$ – neutron absorbed, alpha particle and proton emitted, e.g. $^{41}\mathrm{Ca}(n,p\alpha)^{13}\mathrm{C}$

$(n,2\alpha)$ – neutron absorbed, 2 alpha particles emitted, e.g. $^{144}\mathrm{Sm}(n,2\alpha)^{137}\mathrm{Ce}$

and for decay modes:

(β^-) – beta decay, e.g. $^{205}\mathrm{Hg}(\beta^-)^{205}\mathrm{Tl}$

(β^+) – positron decay (including electron capture), e.g. $^{181}\mathrm{W}(\beta^+)^{181}\mathrm{Ta}$

(α) – alpha decay, e.g. $^{211}\mathrm{Bi}(\alpha)^{207}\mathrm{Tl}$

$(\beta^-\alpha)$ - beta decay followed by alpha emission, e.g. $^{11}\mathrm{Be}(\beta^-\alpha)^{7}\mathrm{Li}$

(IT) – isomeric transition resulting in gamma ray emission, e.g. $^{24m}\mathrm{Na}(IT)^{24}\mathrm{Na}$

(n) – decay via neutron emission, e.g. $^{7}\mathrm{He}(n)^{6}\mathrm{He}$

2 Summary

This report focuses on the simulation of the radiological responses and physical aspects of material subjected to neutron irradiation. Every naturally occurring element from hydrogen to bismuth is systematically analysed under conditions predicted for a prototype fusion power plant. The data presented includes detailed analyses of activation response, which is important for the assessment of all aspects of the operation, safety and environmental impact of nuclear plants.

For material science, the presentation gives information about the physical changes in an irradiated material, including the transmutation response and details of the source terms (PKAs) of radiation damage. These physical evaluations are of vital importance for subsequent fully-fledged predictions of material properties under neutron irradiation via modelling, simulation, and experiment at the molecular level. The scale, completeness and accuracy of this compendium is above and beyond anything that has been available before.

Hydrogen

Isotope	Atom % abundance
H1	99.99
H2	0.01

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.34E+07	2.34E+07	2.34E+07	2.21E+07	1.01E+05	0.00E+00
H3	100.0	100.0	100.0	100.0	100.0	

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.14E-11	2.14E-11	2.14E-11	2.02E-11	9.26E-14	0.00E+00
H3	100.0	100.0	100.0	100.0	100.0	

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

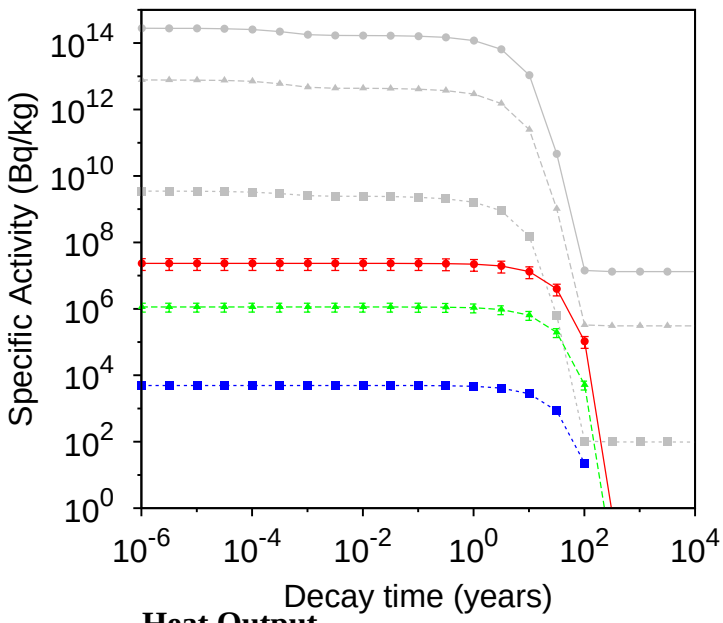
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	9.81E-04	9.81E-04	9.81E-04	9.28E-04	4.25E-06	0.00E+00
H3	100.0	100.0	100.0	100.0	100.0	

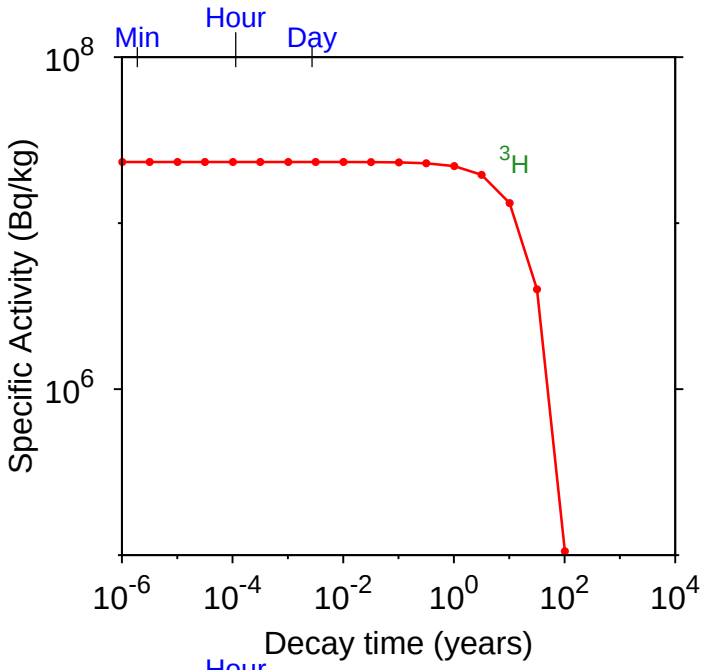
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.07E-03	6.07E-03	6.07E-03	5.74E-03	2.63E-05	0.00E+00
H3	100.0	100.0	100.0	100.0	100.0	

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.34E+02	2.34E+02	2.34E+02	2.21E+02	1.01E+00	0.00E+00
H3	100.0	100.0	100.0	100.0	100.0	

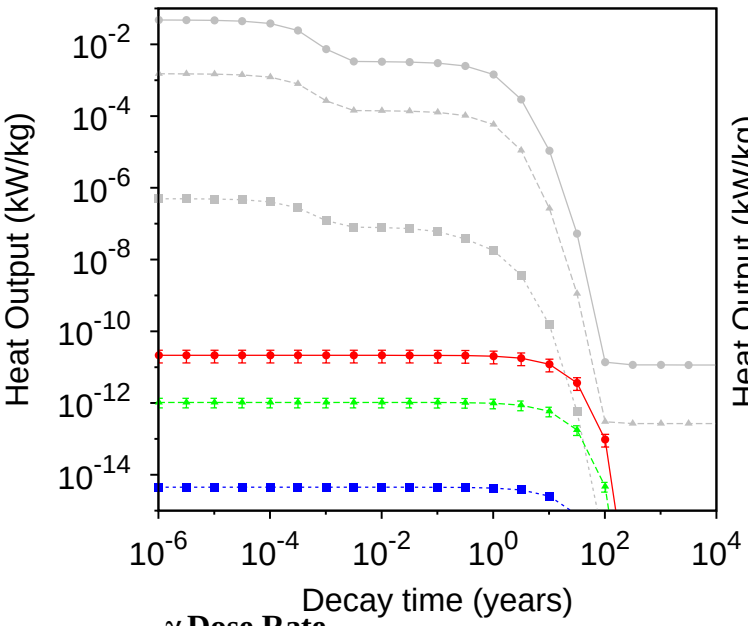
Hydrogen activation characteristics

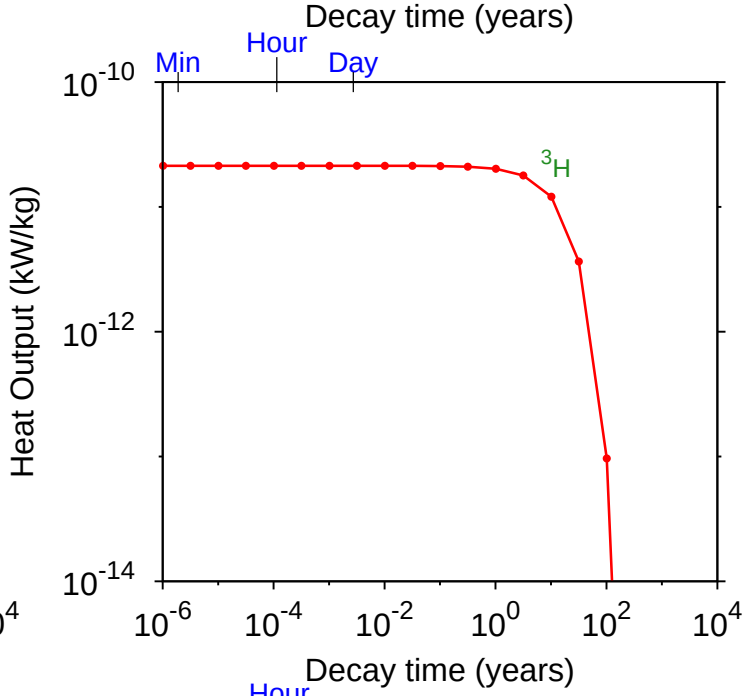
Specific Activity



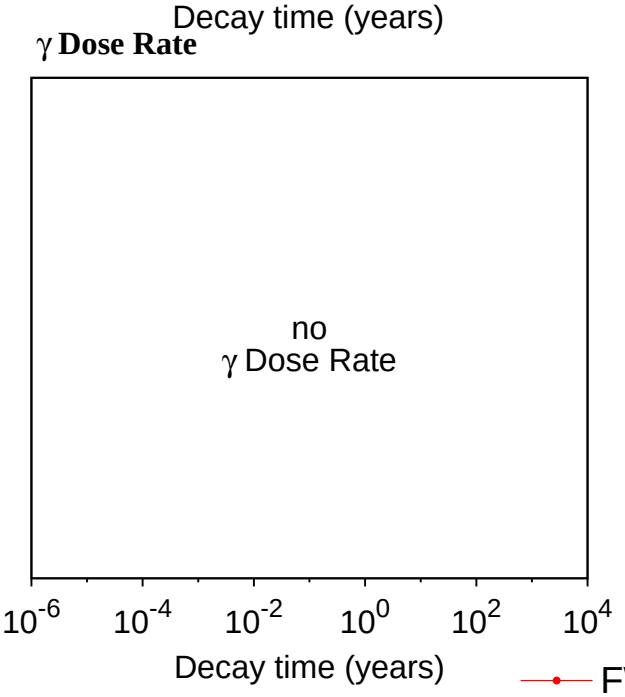


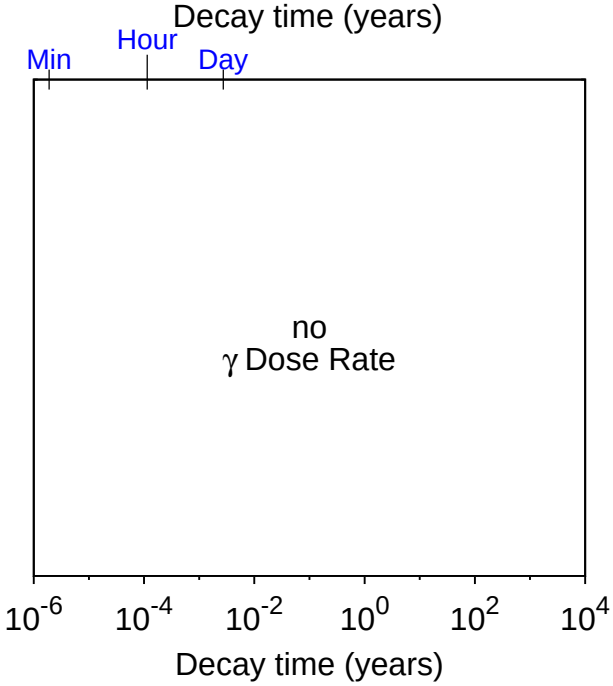
Heat Output





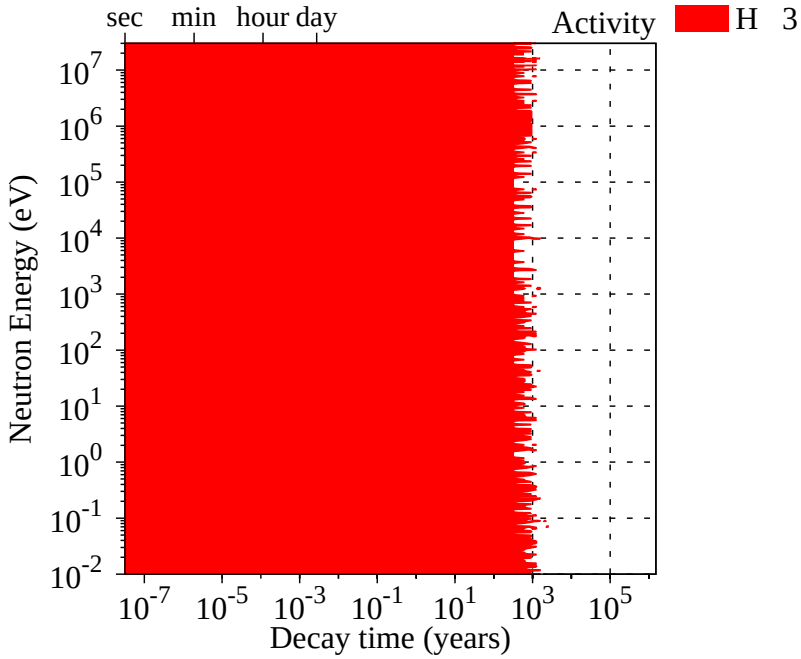
γ Dose Rate

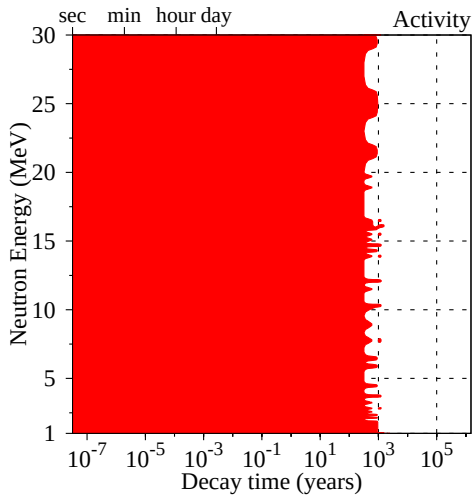


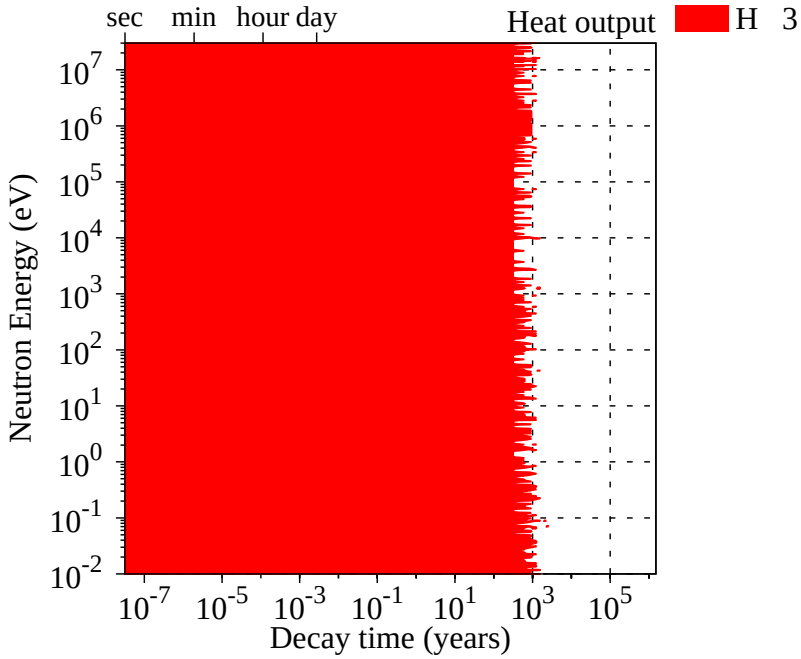


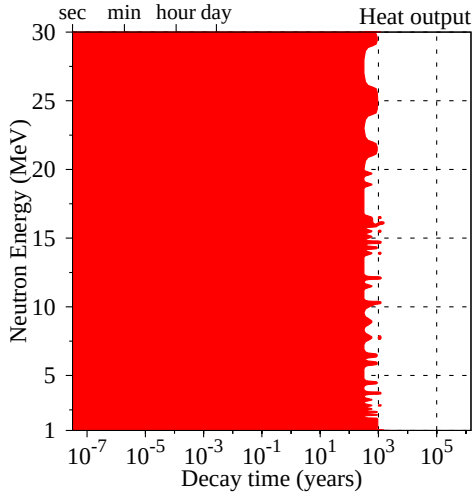
FW
Blanket
Manifold
Fe results

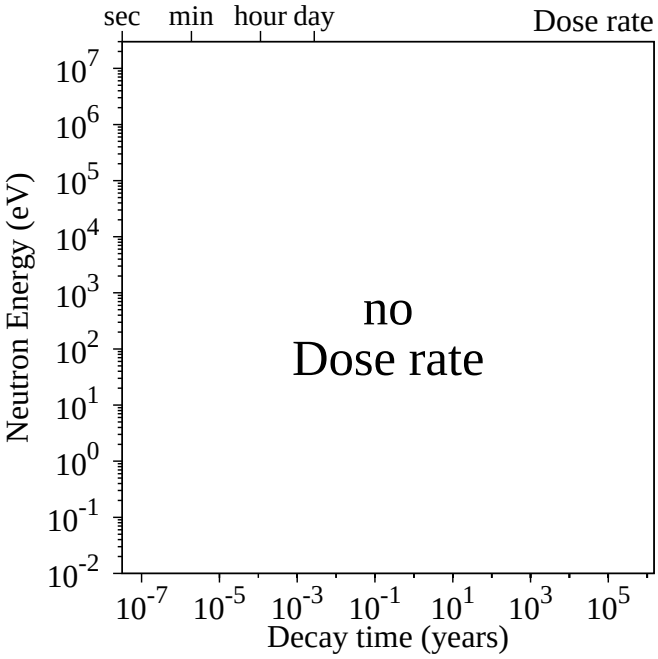
Hydrogen Importance diagrams

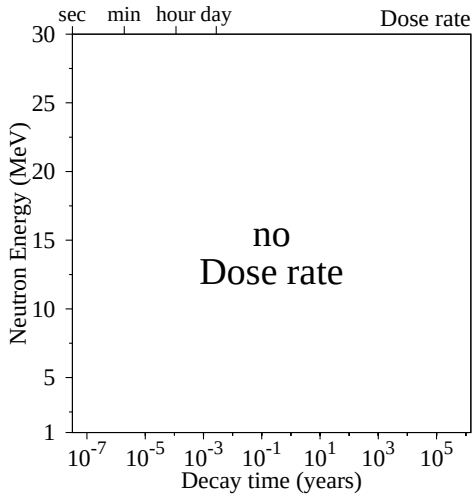




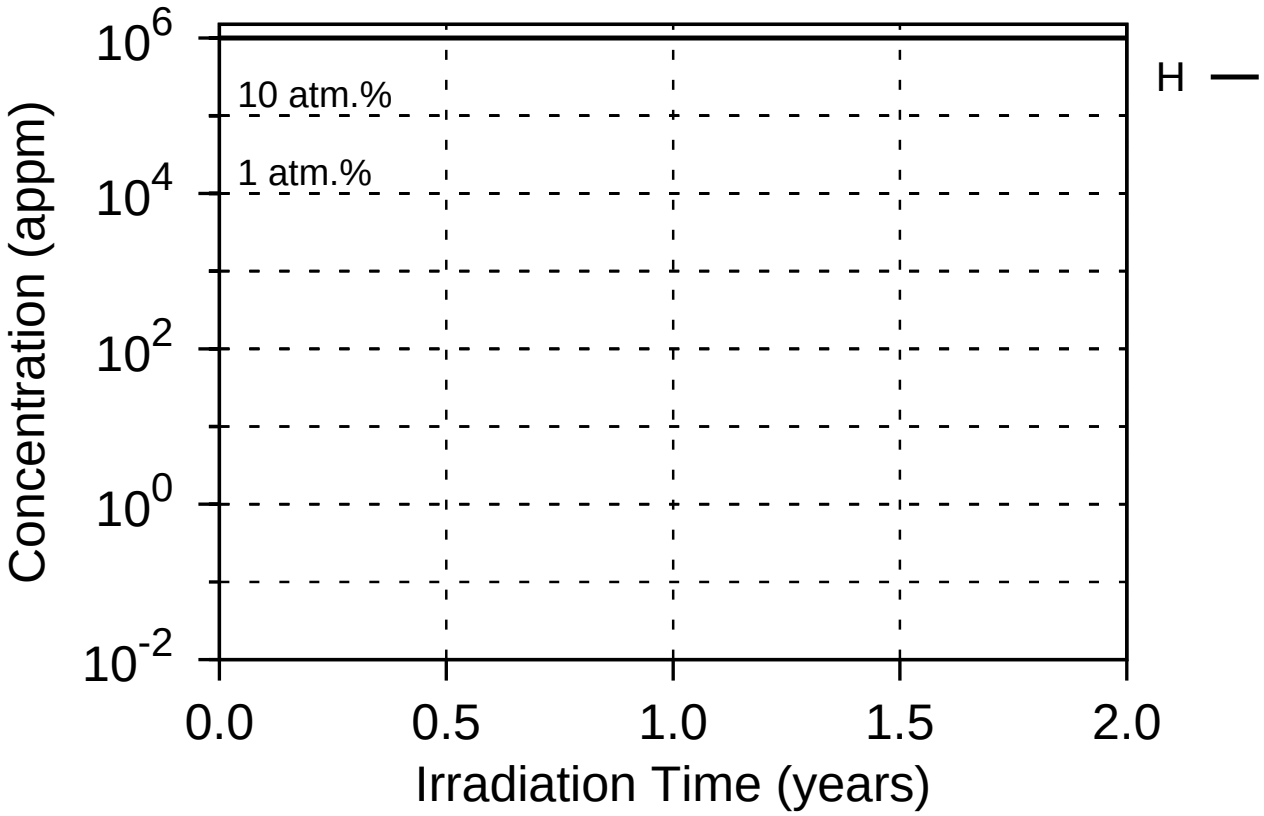






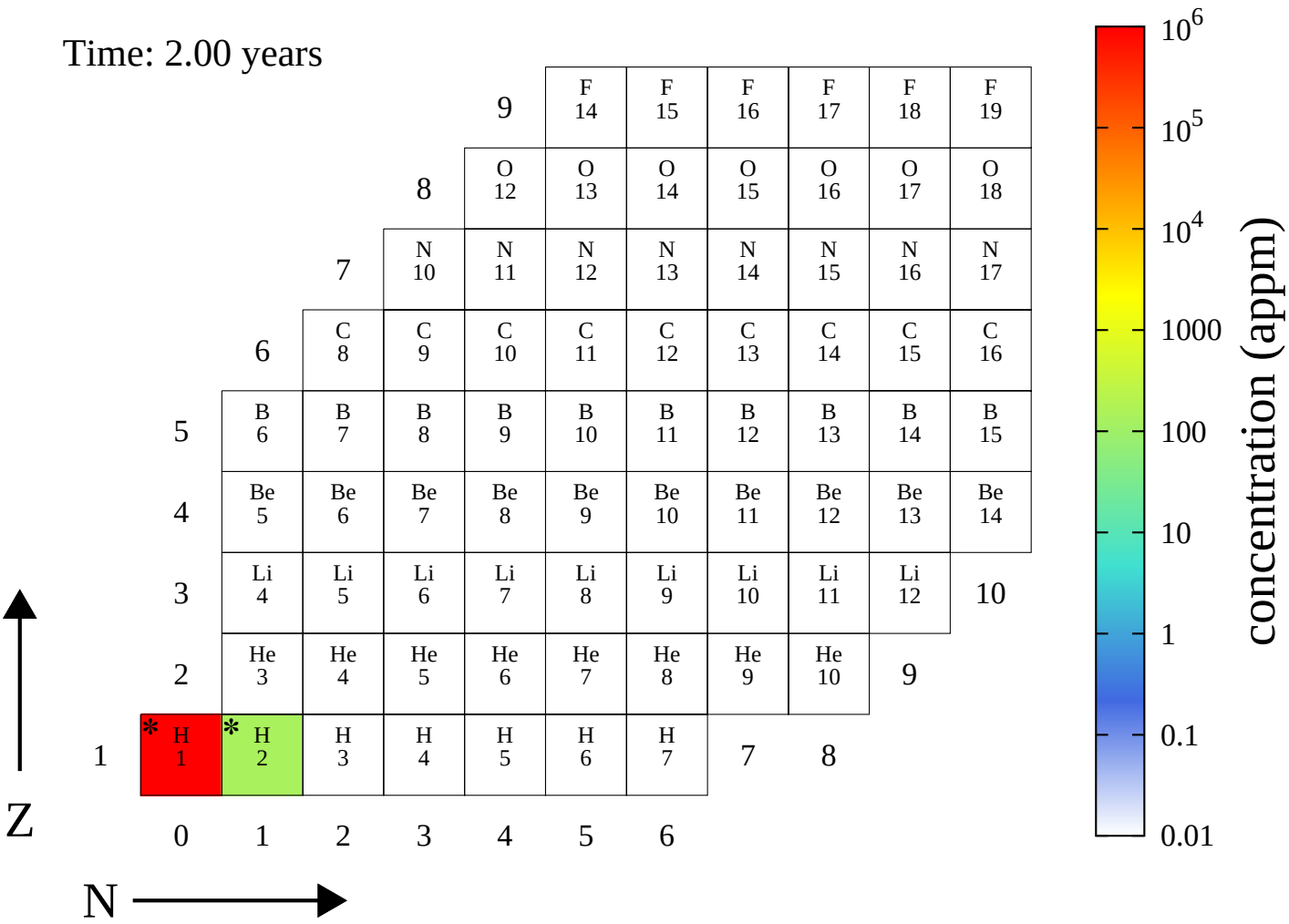


Hydrogen FW Transmutation

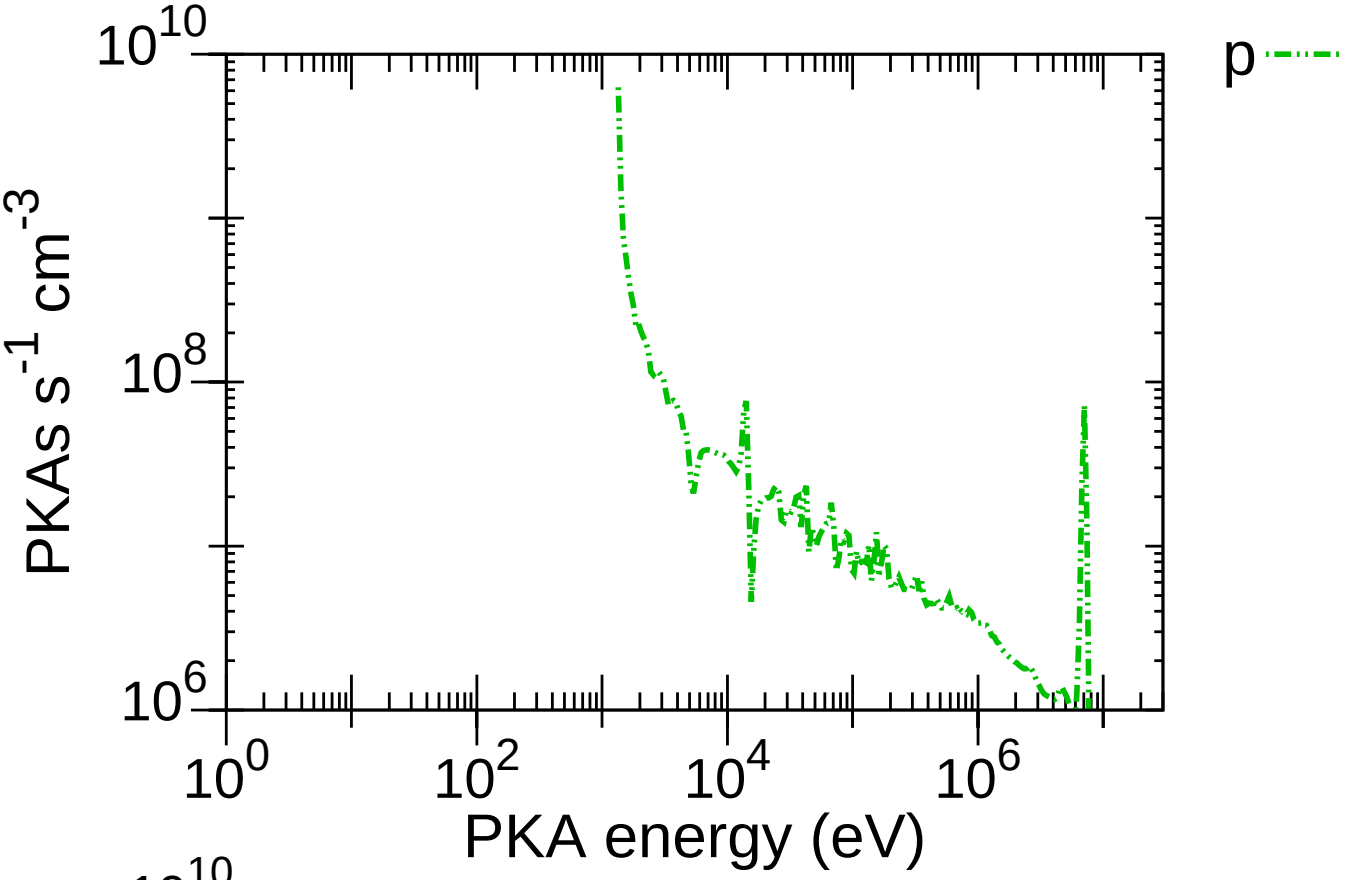


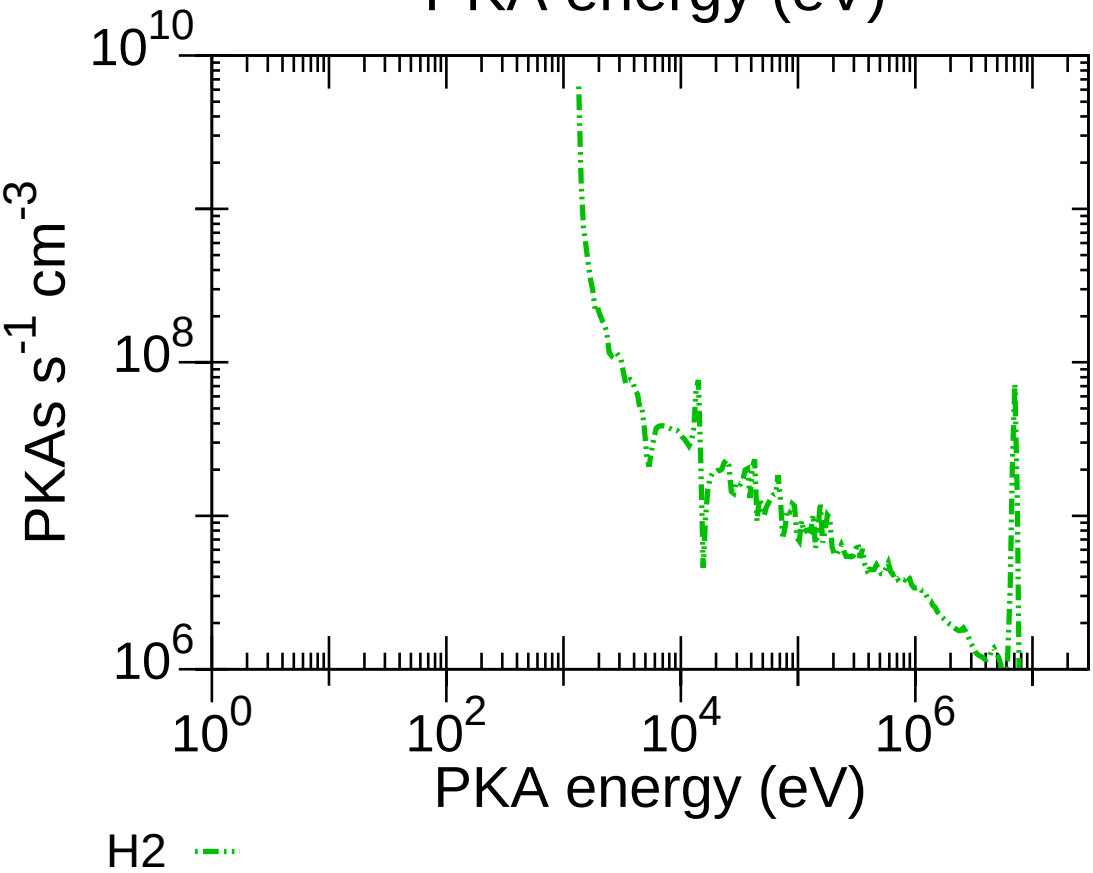
0 appm He after 1 year

1 dpa/year



Hydrogen FW PKA distributions





Hydrogen Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
H3	12.33y	H1(n,γ)H2(n,γ)H3	98.8	7.2	1.0	
		H2(n,γ)H3	1.2	92.3	98.9	99.2

Helium

Isotope	Atom % abundance
He3	< 0.01
He4	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.02E+11	1.02E+11	1.02E+11	9.62E+10	5.58E+08	0.00E+00
H3	100.0	100.0	100.0	100.0	100.0	

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	9.30E-08	9.30E-08	9.30E-08	8.79E-08	5.10E-10	0.00E+00
H3	100.0	100.0	100.0	100.0	100.0	

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

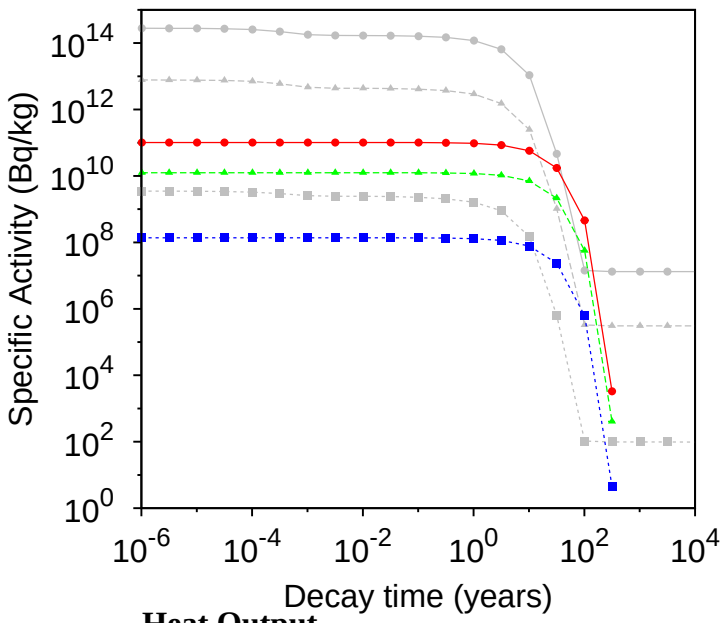
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.27E+00	4.27E+00	4.27E+00	4.04E+00	2.34E-02	0.00E+00
H3	100.0	100.0	100.0	100.0	100.0	

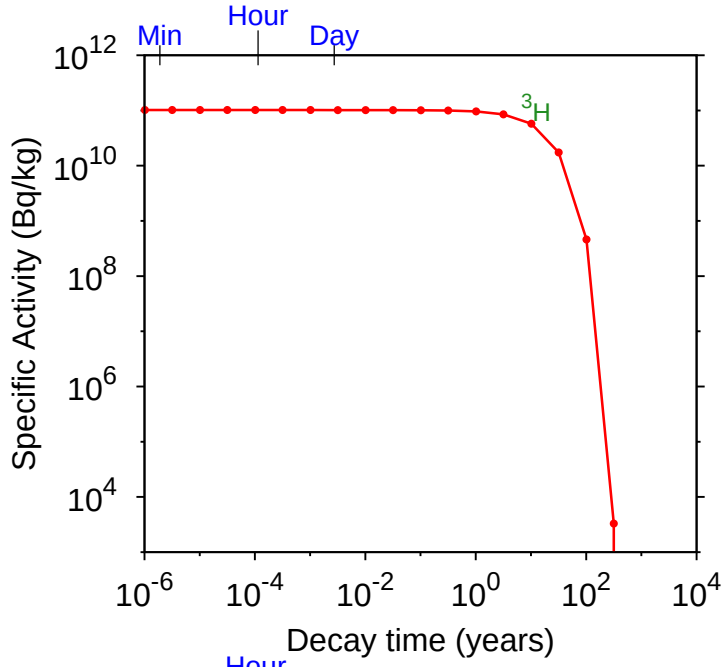
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.64E+01	2.64E+01	2.64E+01	2.50E+01	1.45E-01	0.00E+00
H3	100.0	100.0	100.0	100.0	100.0	

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.02E+06	1.02E+06	1.02E+06	9.62E+05	5.58E+03	0.00E+00
H3	100.0	100.0	100.0	100.0	100.0	

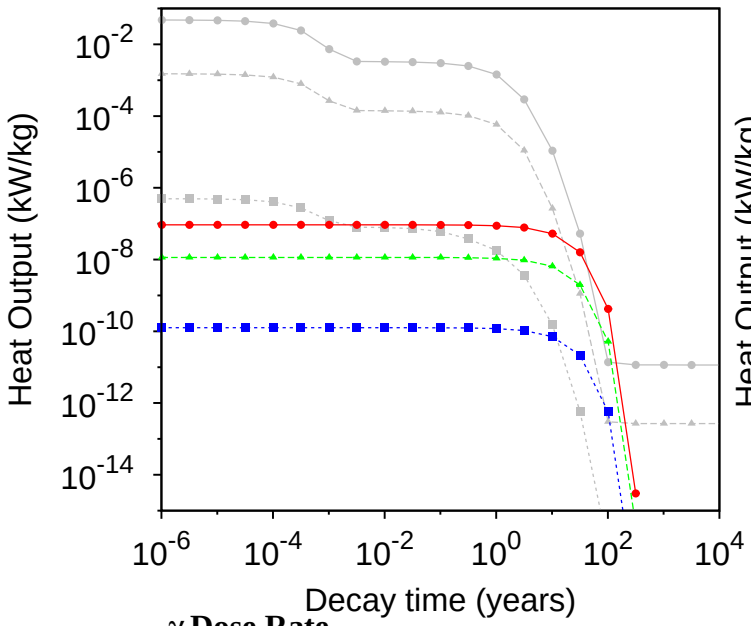
Helium activation characteristics

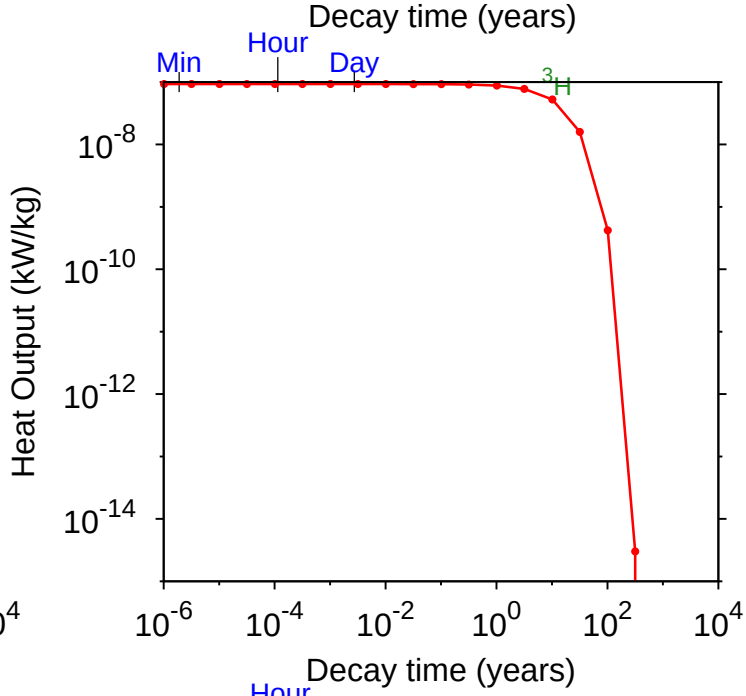
Specific Activity



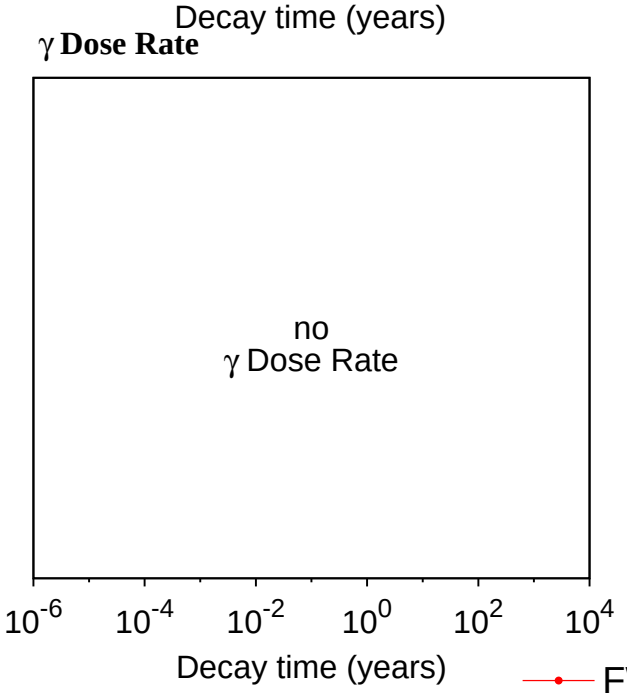


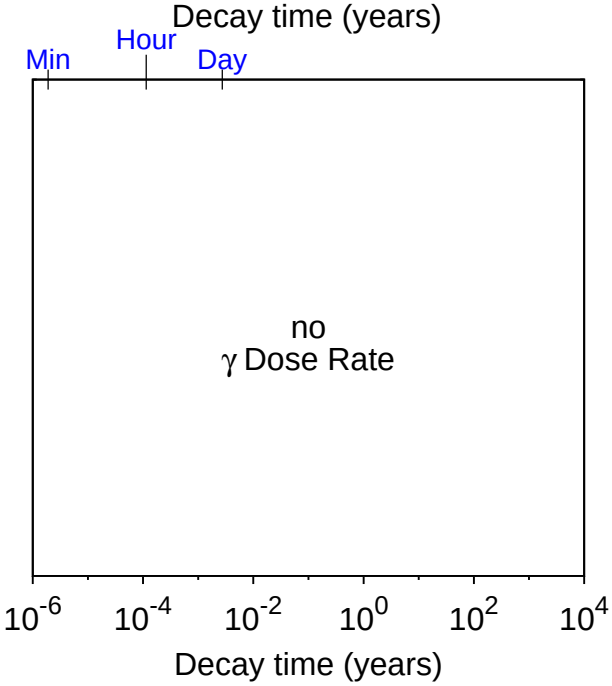
Heat Output





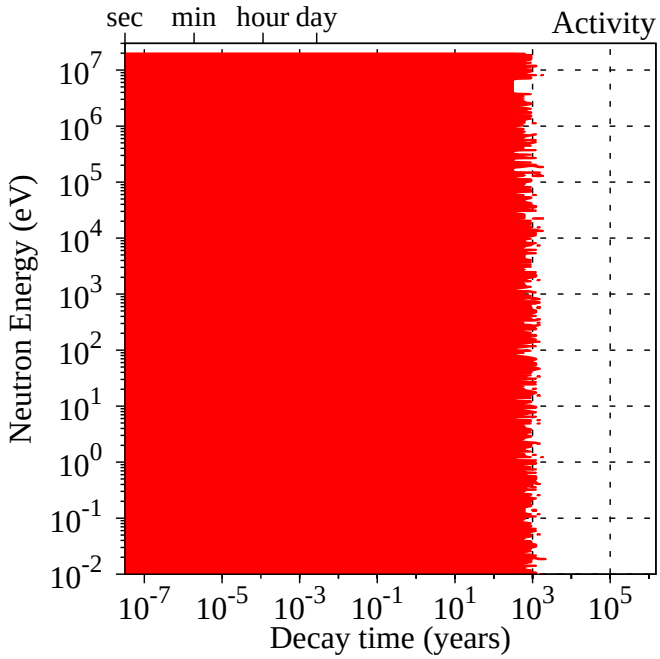
γ Dose Rate

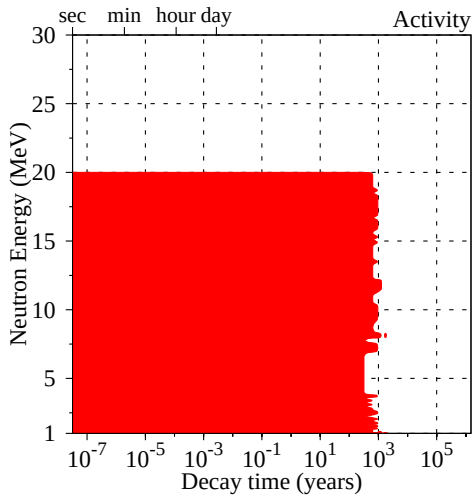


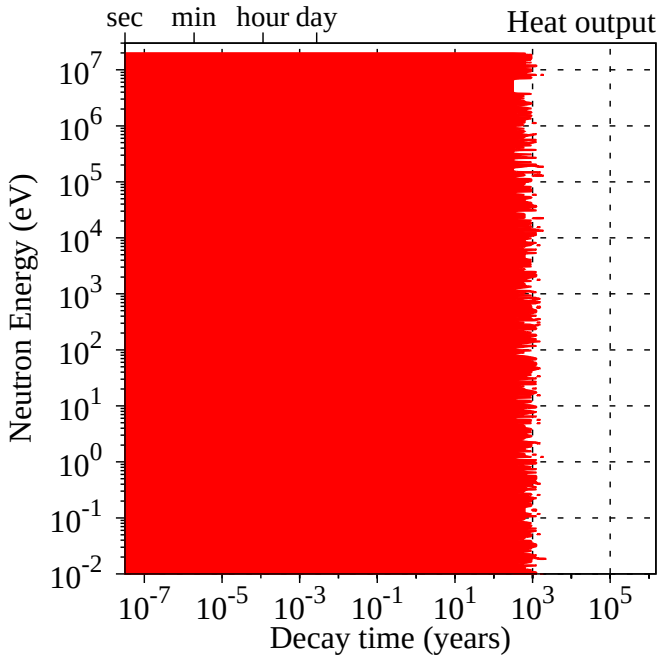


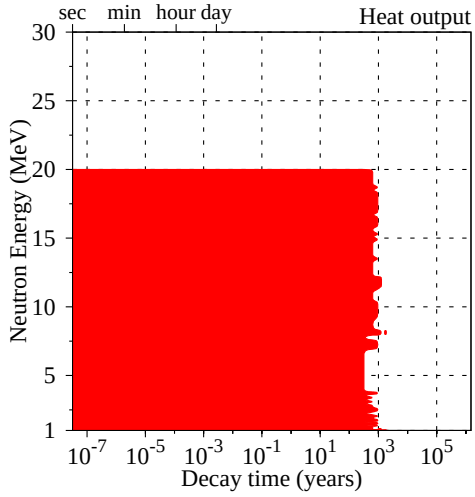
FW
Blanket
Manifold
Fe results

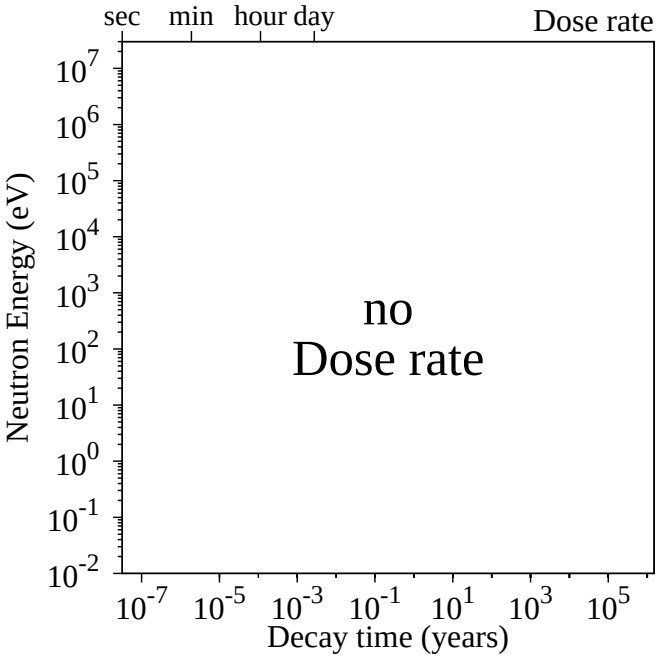
Helium Importance diagrams

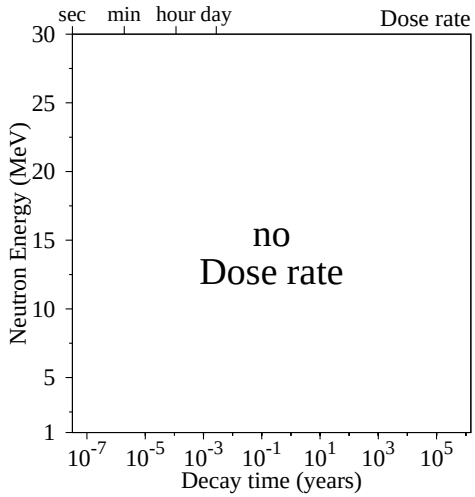




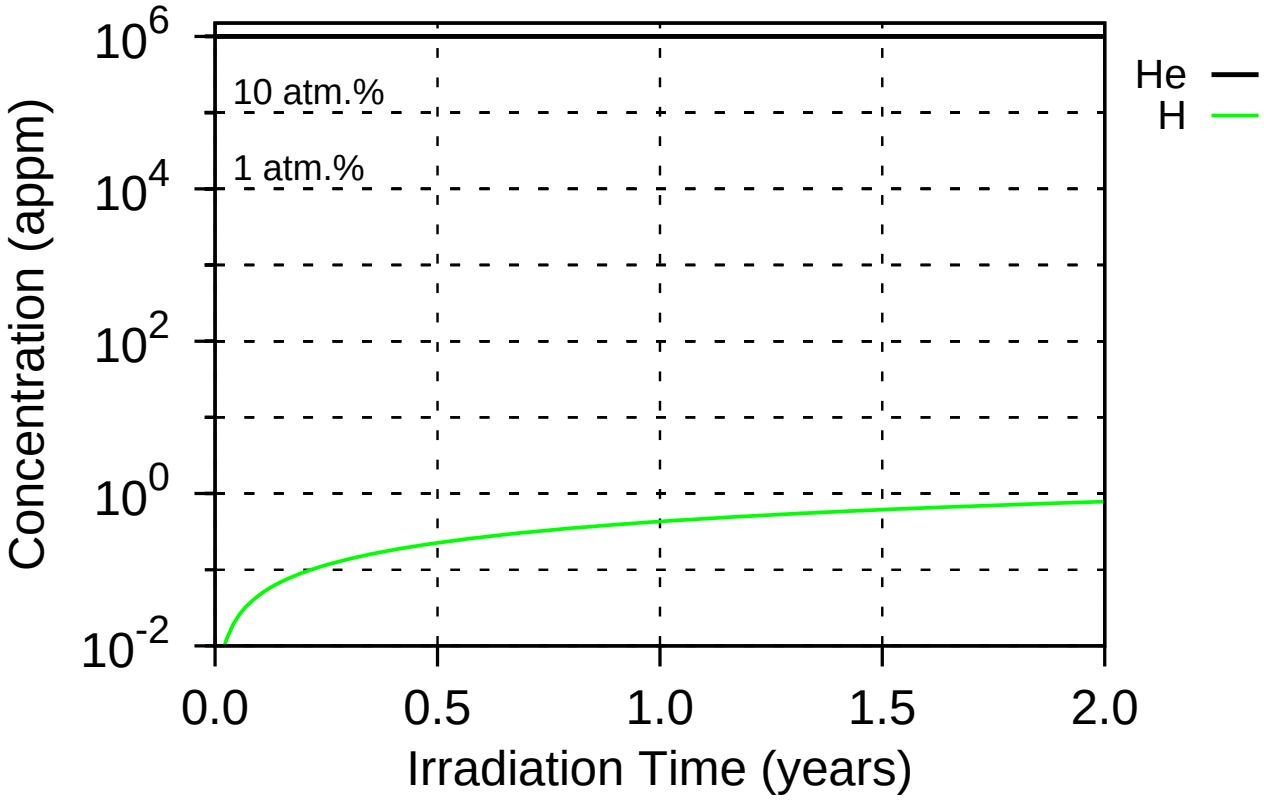






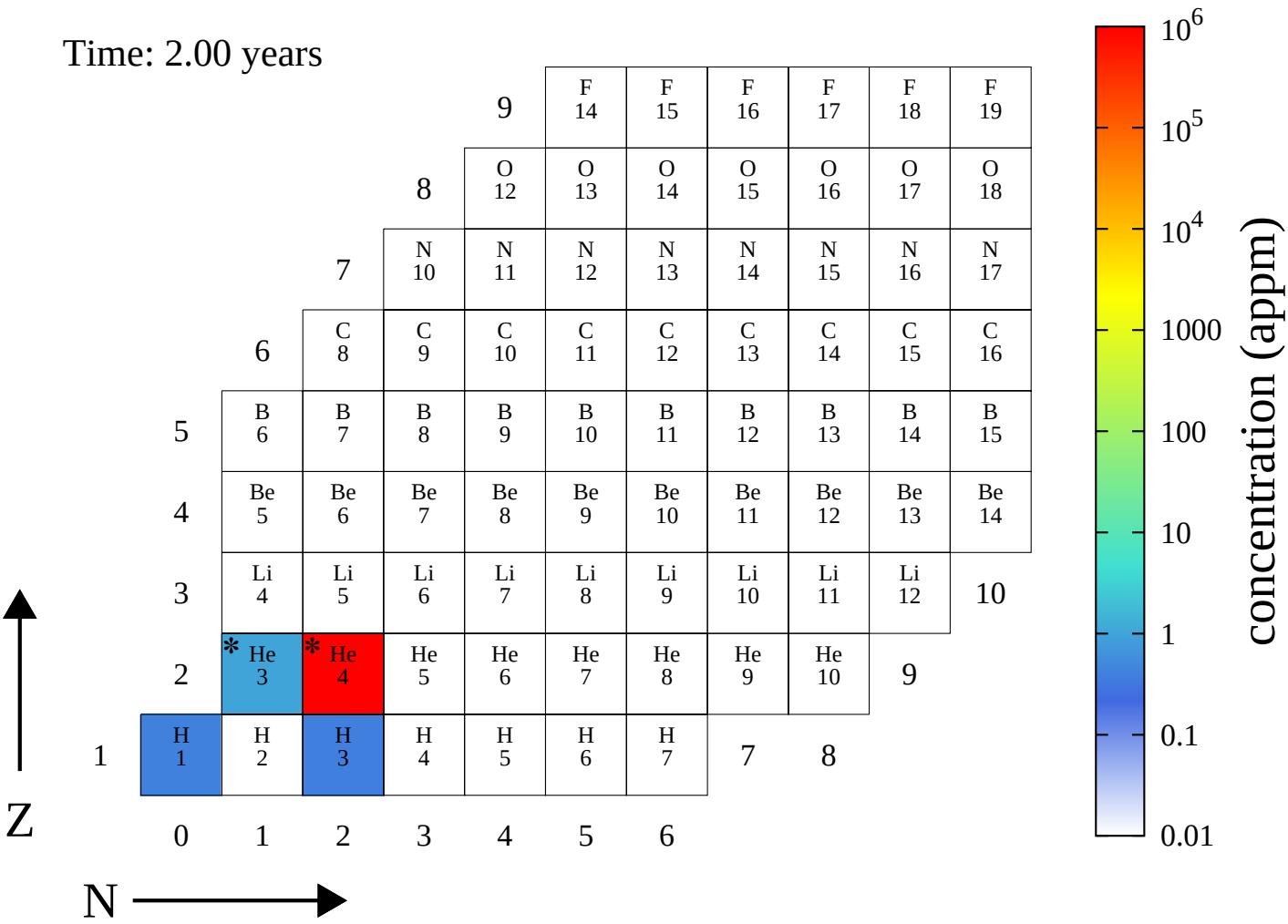


Helium FW Transmutation

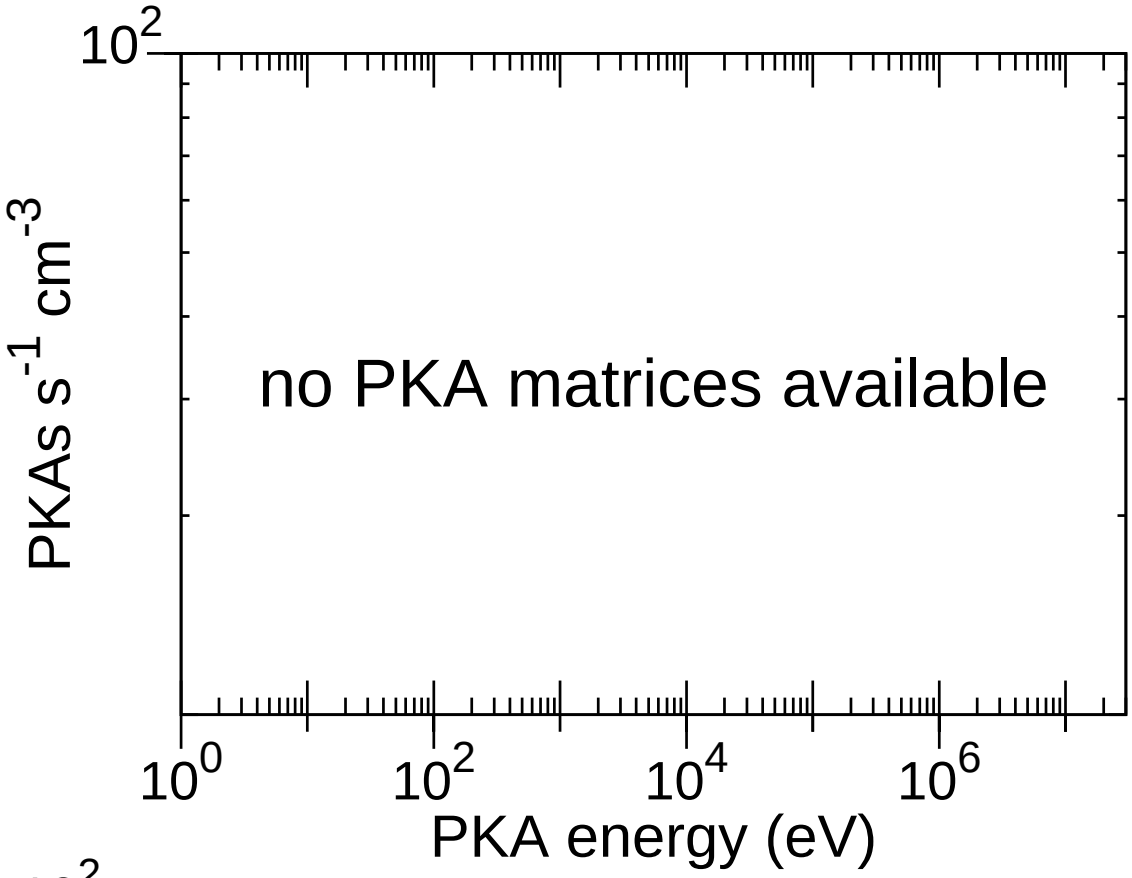


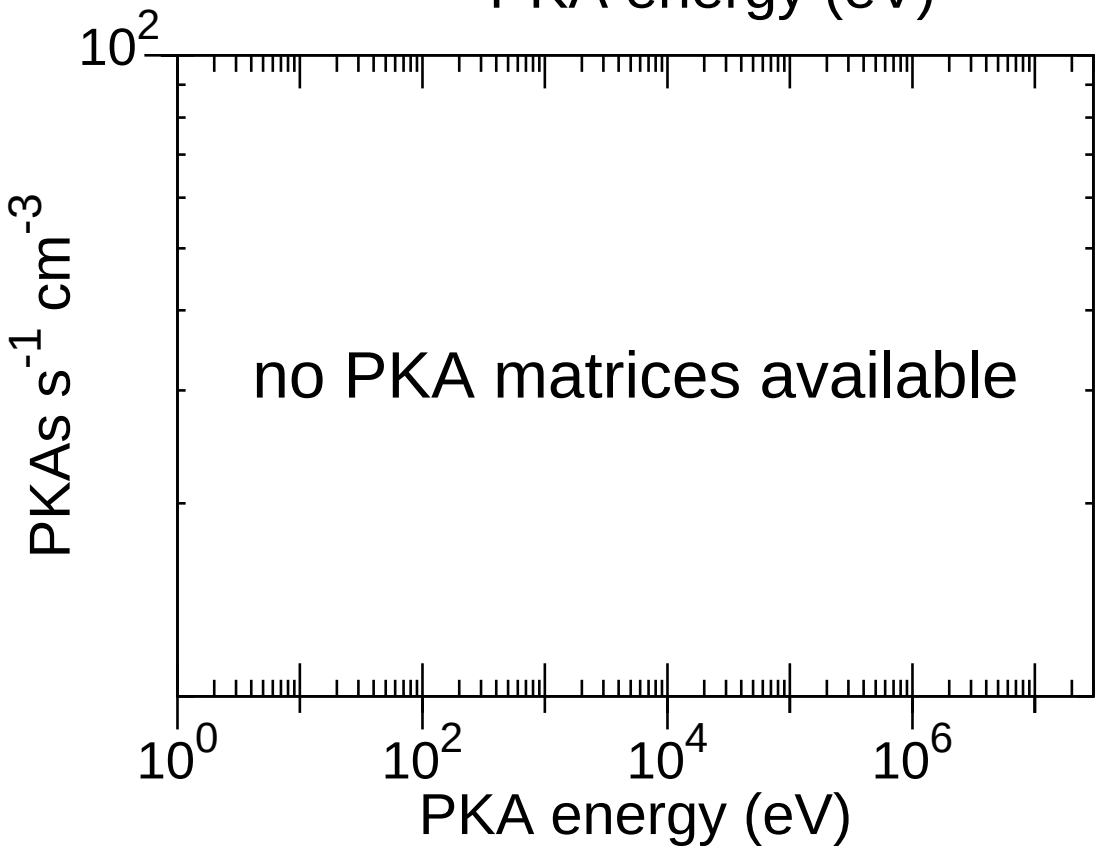
0 appm H after 1 year

2 dpa/year



Helium FW PKA distributions





Helium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
H3	12.33y	He3(n,p)H3	100.0	99.5	99.9	100.0

Lithium

Isotope	Atom % abundance
Li6	7.59
Li7	92.41

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.00E+15	8.79E+14	8.79E+14	8.31E+14	4.33E+12	0.00E+00
H3	87.7	100.0	100.0	100.0	100.0	
He6	11.9					

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.65E-02	8.04E-04	8.03E-04	7.60E-04	3.96E-06	0.00E+00
He6	81.8					
Li8	16.0					
H3	2.2	100.0	100.0	100.0	100.0	

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

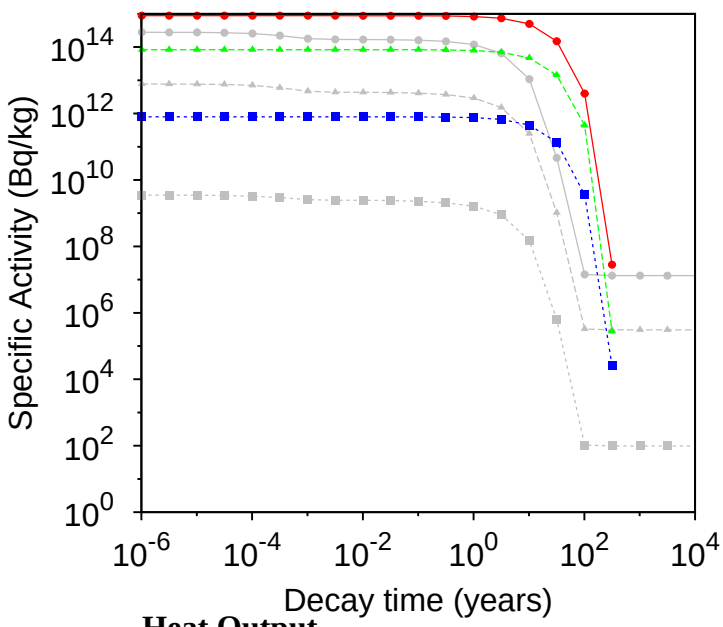
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.87E+04	3.69E+04	3.69E+04	3.49E+04	1.82E+02	0.00E+00
H3	95.4	100.0	100.0	100.0	100.0	
He6	4.6					

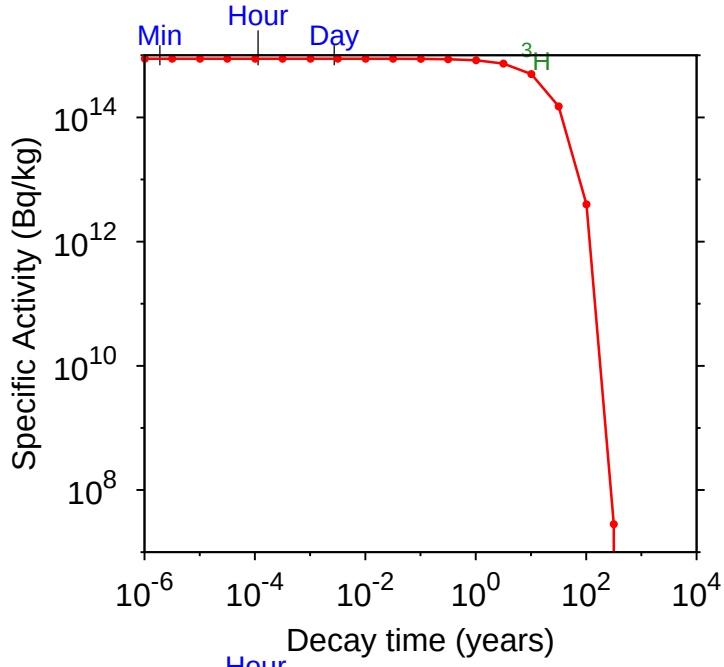
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.29E+05	2.29E+05	2.28E+05	2.16E+05	1.13E+03	0.00E+00
H3	99.6	100.0	100.0	100.0	100.0	

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	3.06E+10	8.78E+09	8.78E+09	8.30E+09	4.33E+07	0.00E+00
He6	62.8					
H3	28.7	100.0	100.0	100.0	100.0	
Li8	8.5					

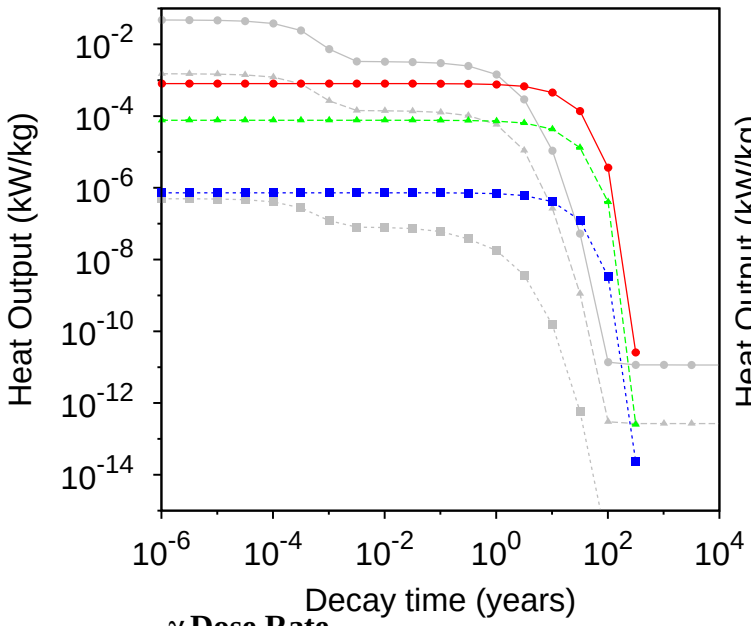
Lithium activation characteristics

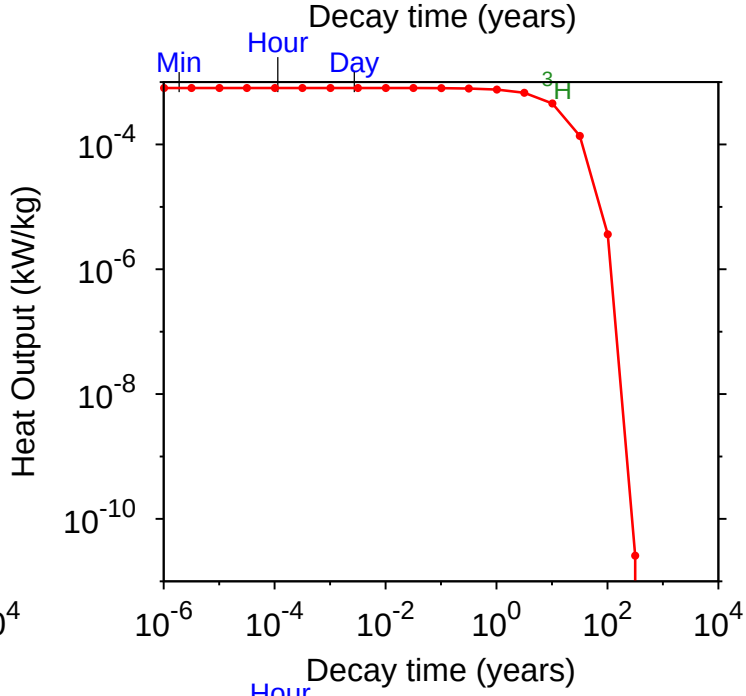
Specific Activity



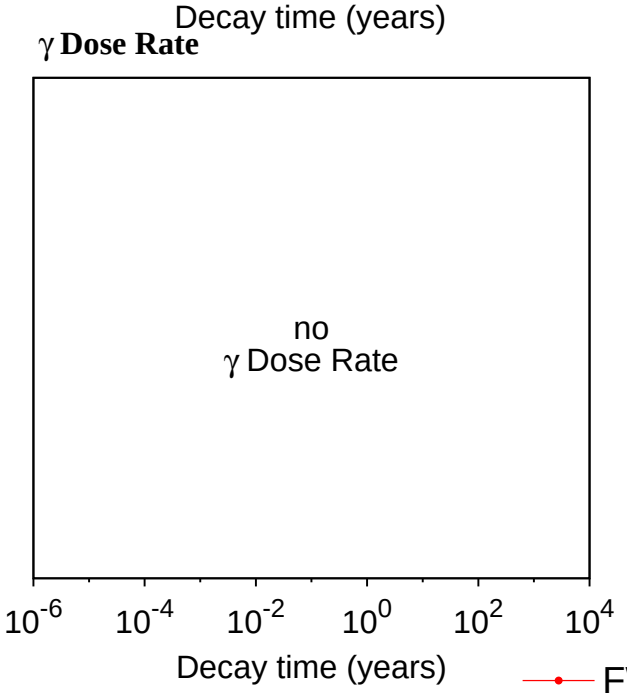


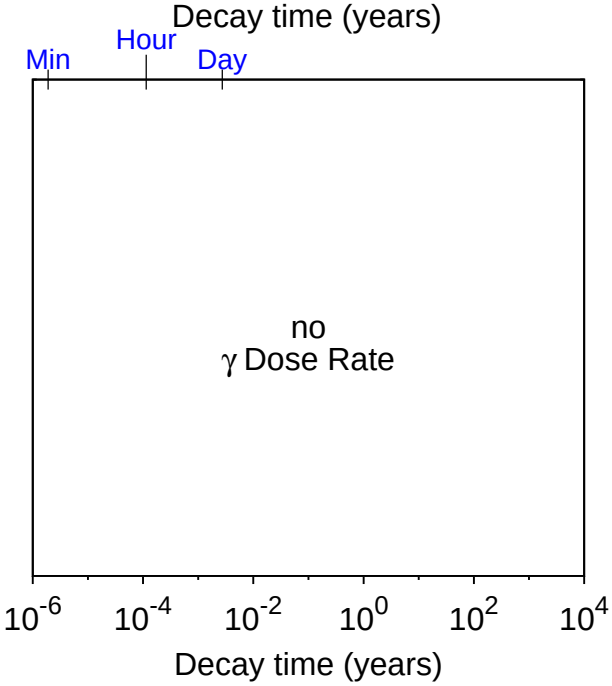
Heat Output





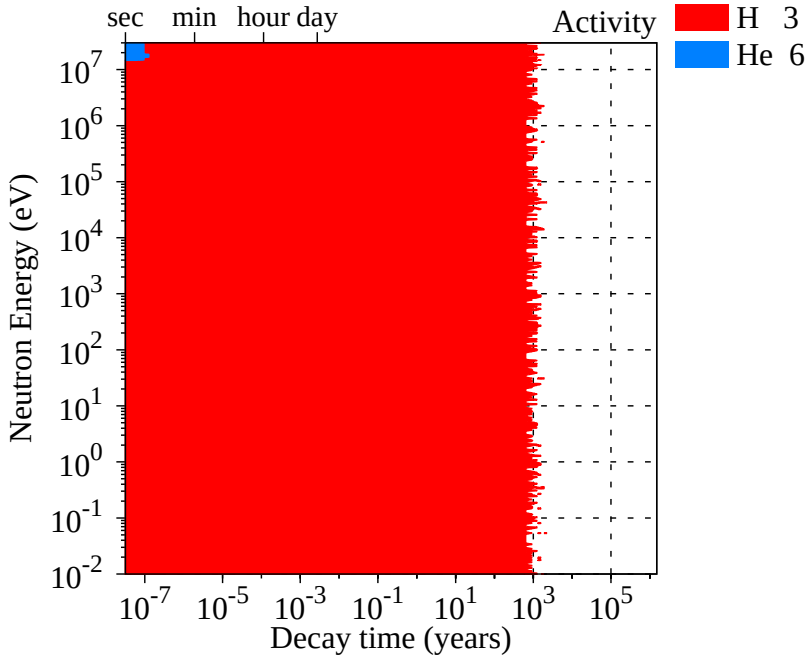
γ Dose Rate

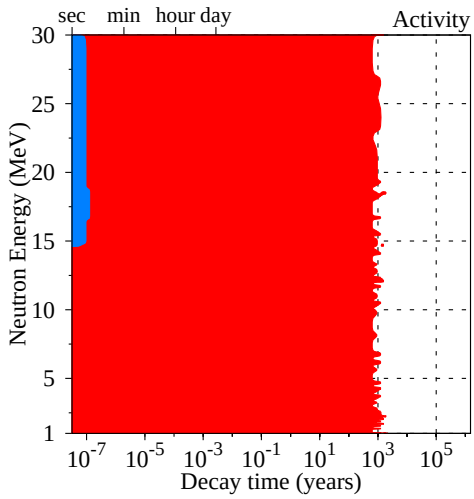


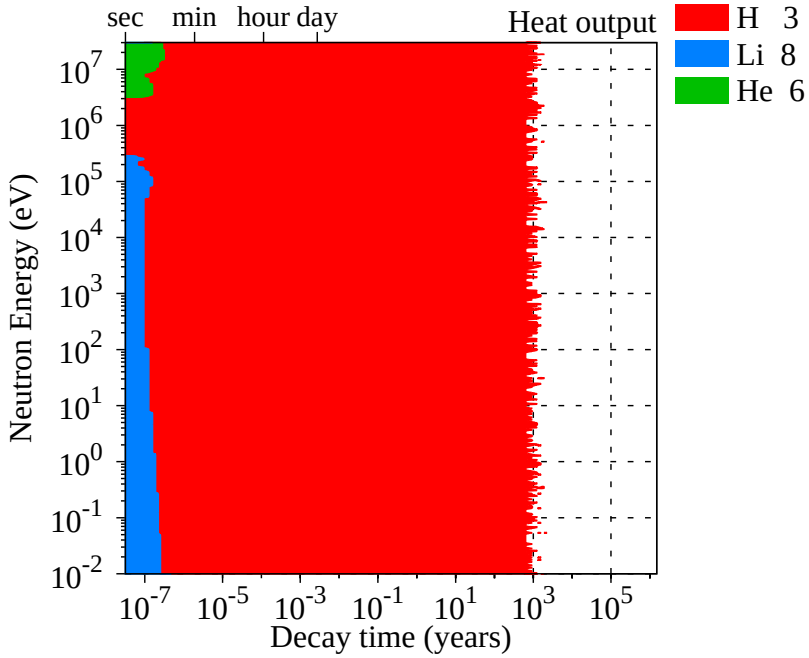


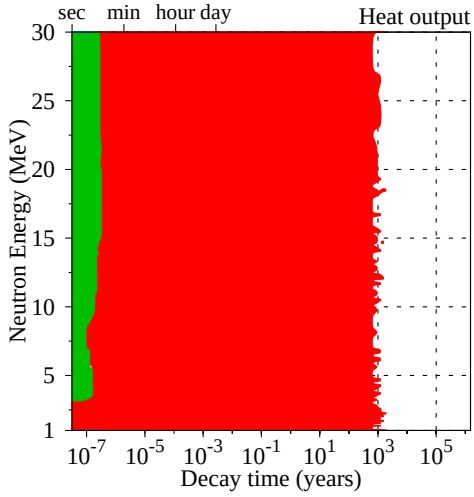
FW
Blanket
Manifold
Fe results

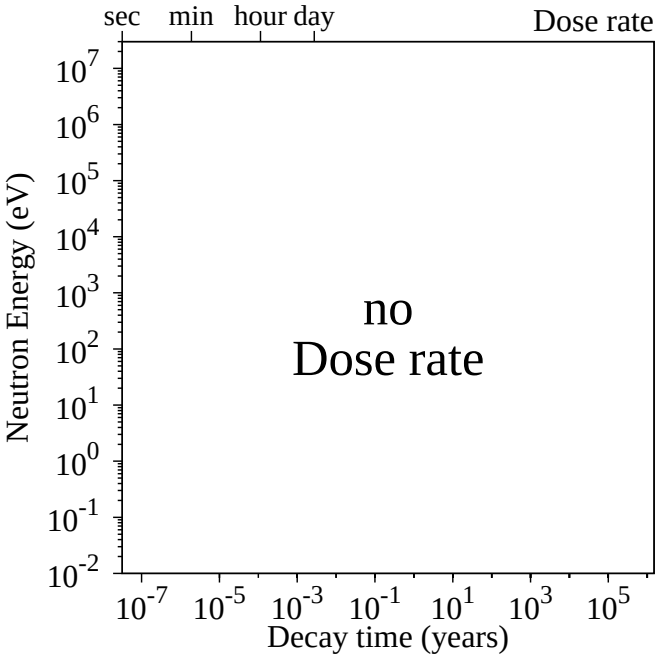
Lithium Importance diagrams

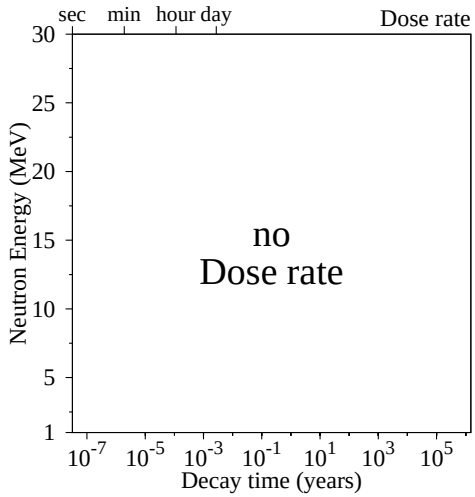




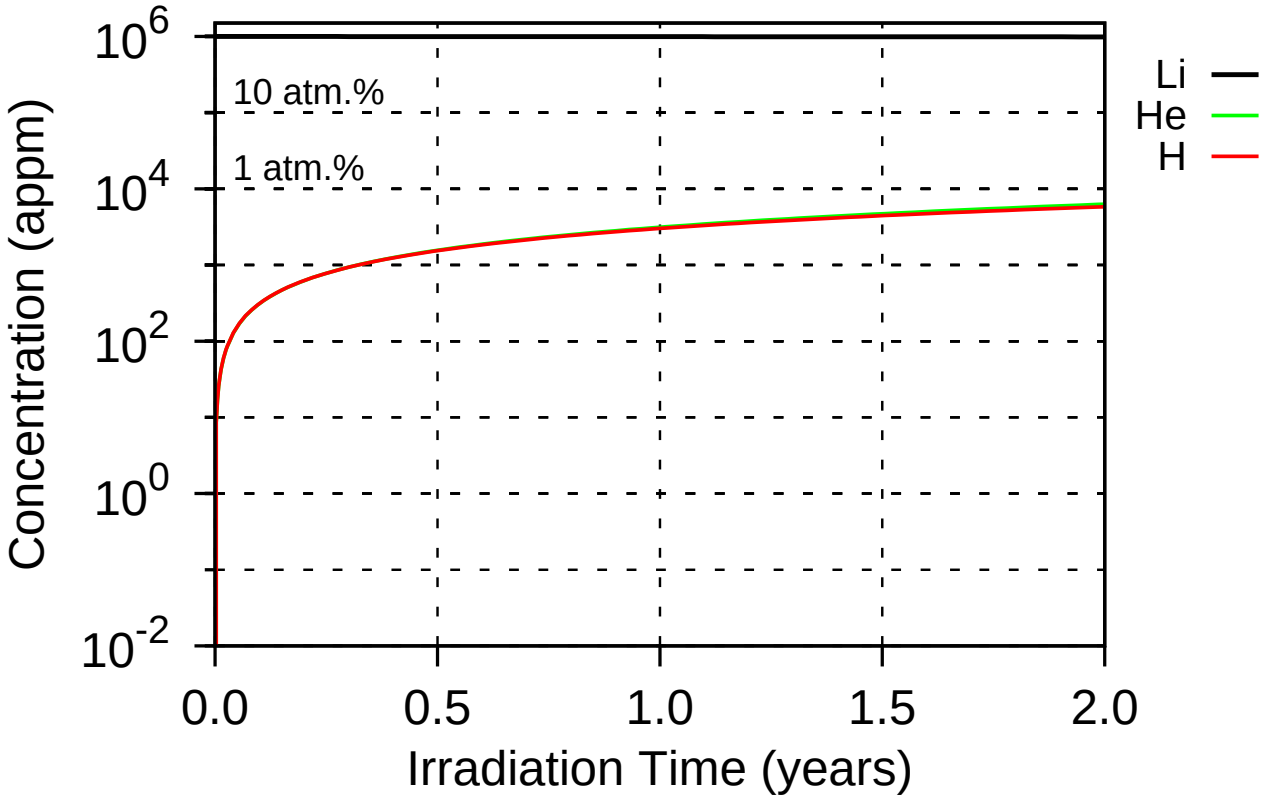




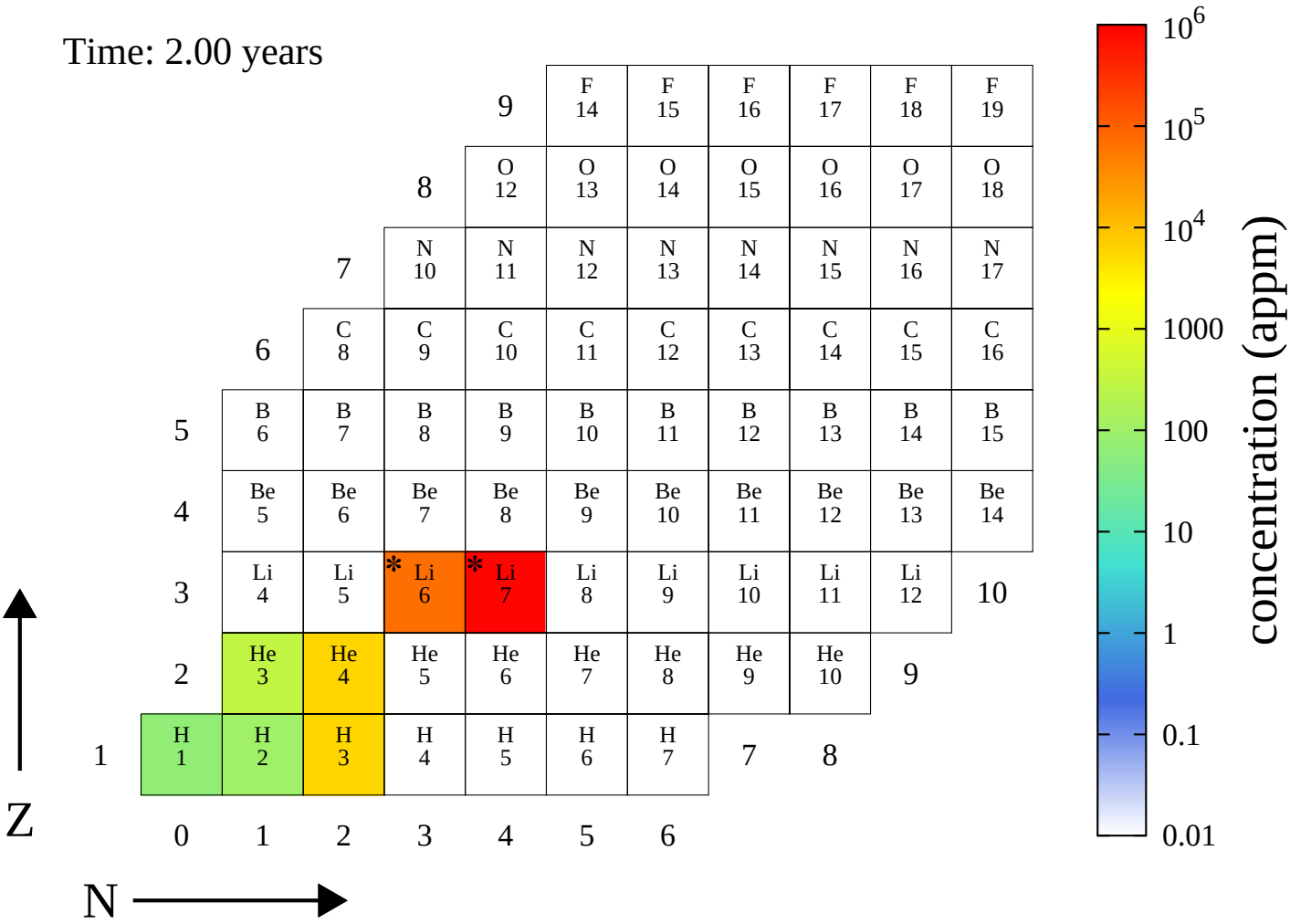




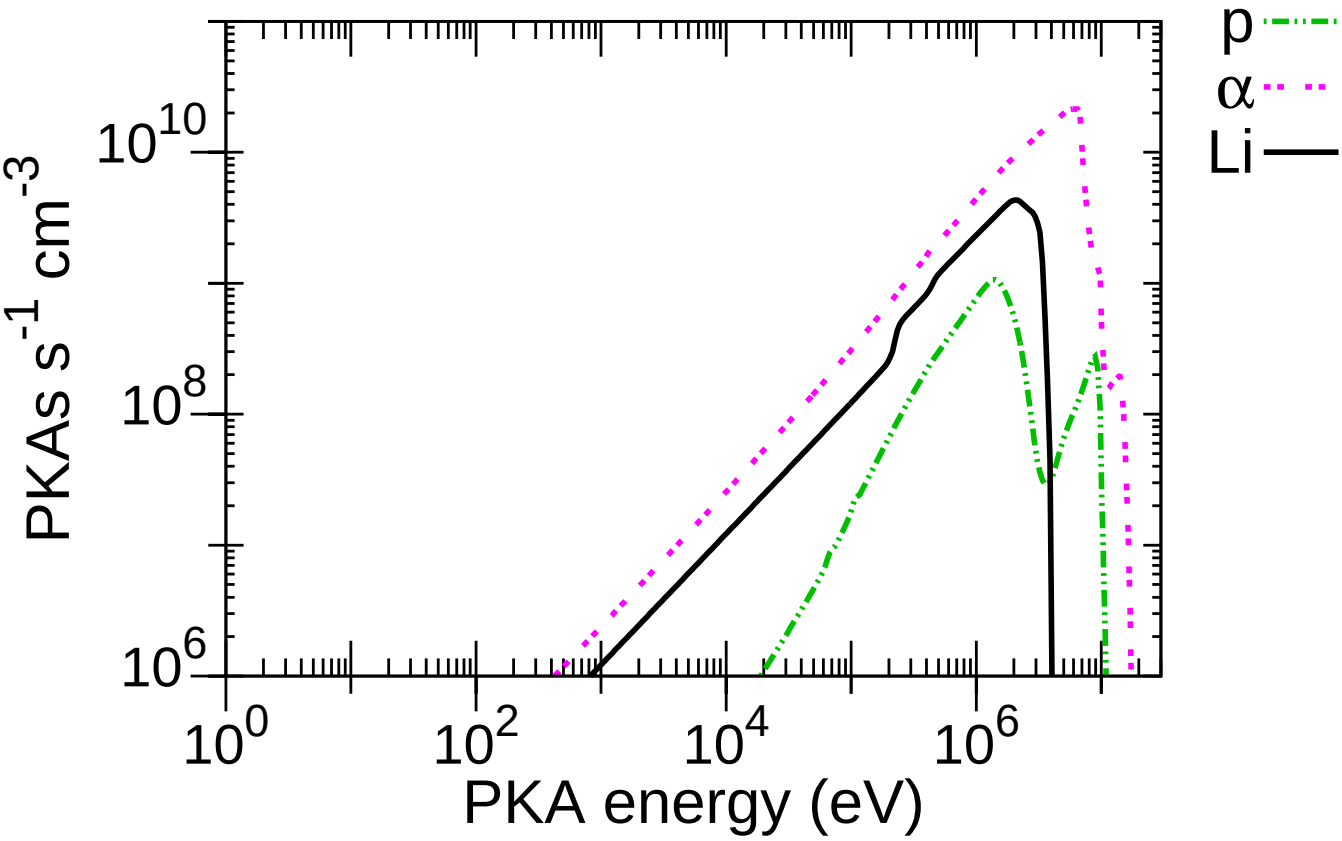
Lithium FW Transmutation

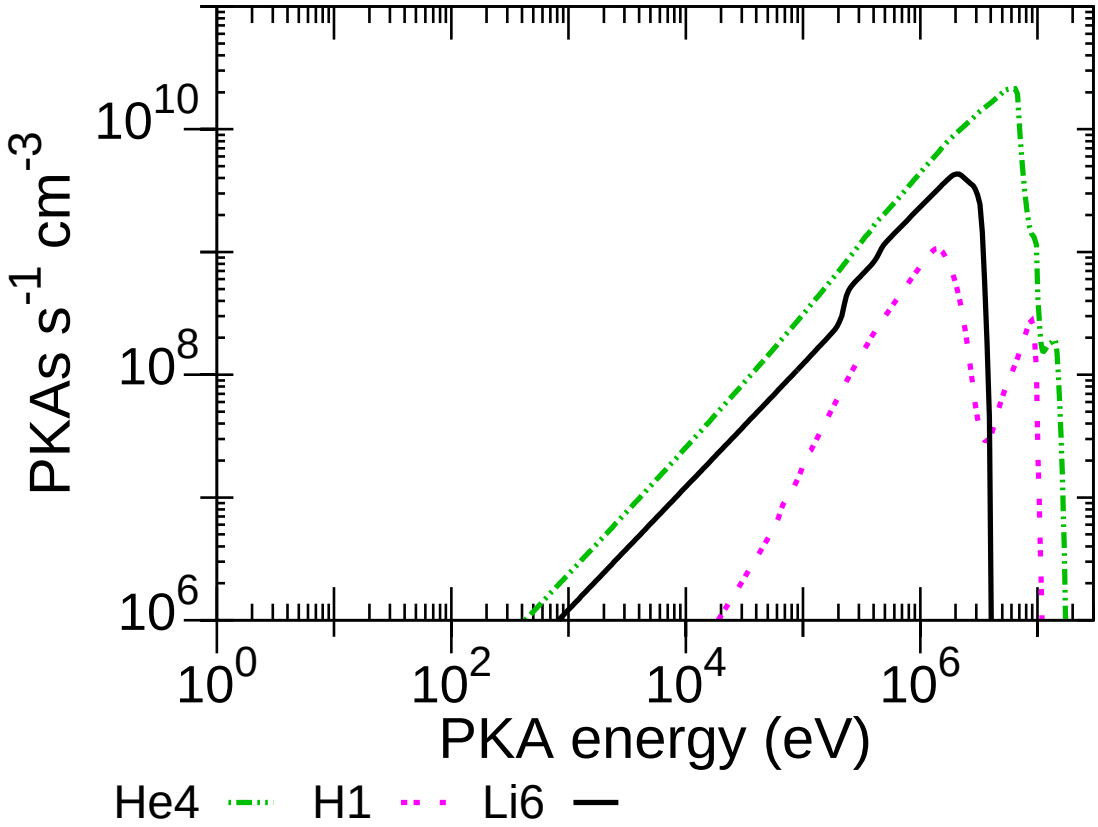


3133 appm He & 3019 appm H after 1 year 3 dpa/year



Lithium FW PKA distributions





Lithium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
He6	0.81s	Li7(n,d)He6				71.5
		Li7(n,p)He7(n)He6				25.2
		Li6(n,p)He6				3.2
Li8	0.84s	Li7(n,γ)Li8	100.0	100.0	100.0	100.0
H3	12.33y	Li6(n,t)H3	99.9	99.4	41.0	2.8
		Li6(n,α)H3			58.9	1.8
		Li7(n,t)H3				58.6
		Li7(n,α)H4(n)H3				36.7

Beryllium

Isotope	Atom % abundance
Be9	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.33E+14	1.45E+13	1.45E+13	1.37E+13	6.77E+10	6.52E+05
He6	95.6					
H3	4.4	100.0	100.0	100.0	100.0	
Be10						100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	8.00E-02	1.33E-05	1.33E-05	1.26E-05	6.19E-08	2.64E-11
He6	99.8					
H3		100.0	100.0	100.0	100.0	
Be10						100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	5.88E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Be11	100.0					

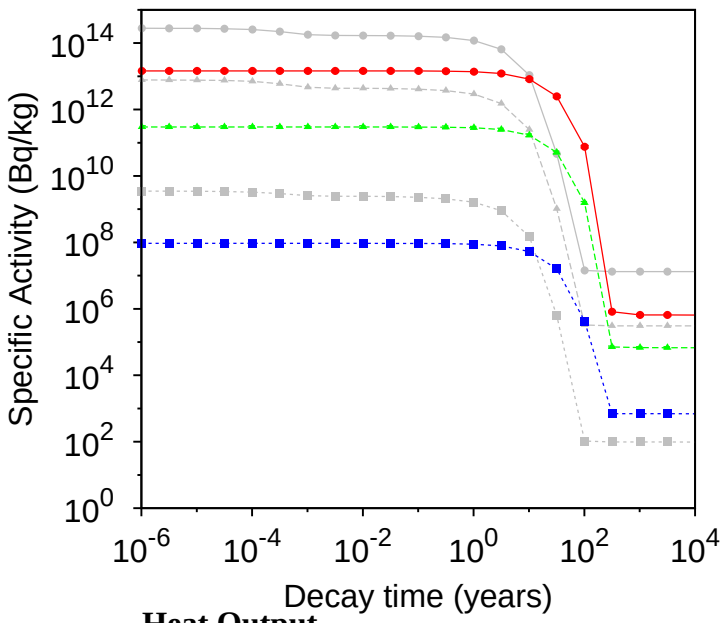
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	5.38E+03	6.11E+02	6.10E+02	5.77E+02	2.84E+00	7.17E-04
He6	88.7					
H3	11.3	100.0	100.0	100.0	100.0	
Be10						100.0

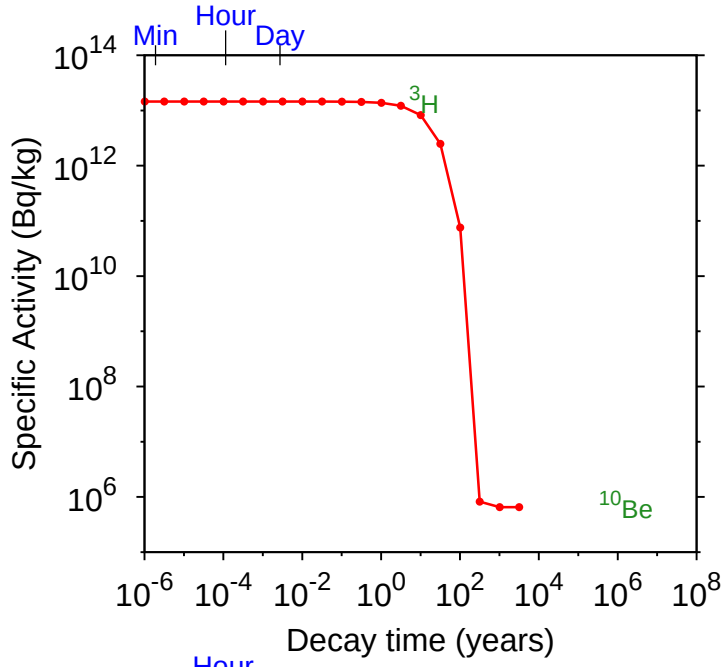
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.10E+03	3.78E+03	3.78E+03	3.57E+03	1.76E+01	2.28E-02
H3	61.9	100.0	100.0	100.0	99.9	
He6	38.1					
Be10					0.1	100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	5.16E+10	1.45E+08	1.45E+08	1.37E+08	6.77E+05	1.63E+01
He6	99.5					
H3	0.3	100.0	100.0	100.0	100.0	
Be10						100.0

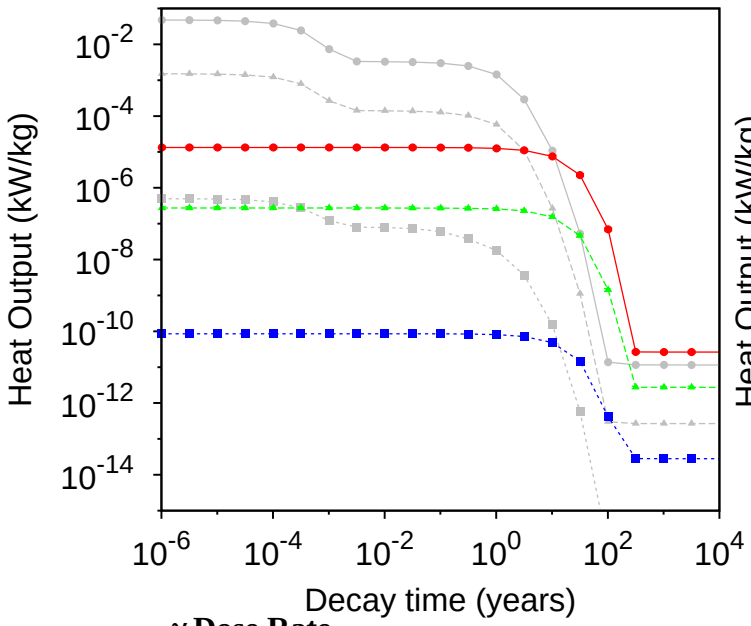
Beryllium activation characteristics

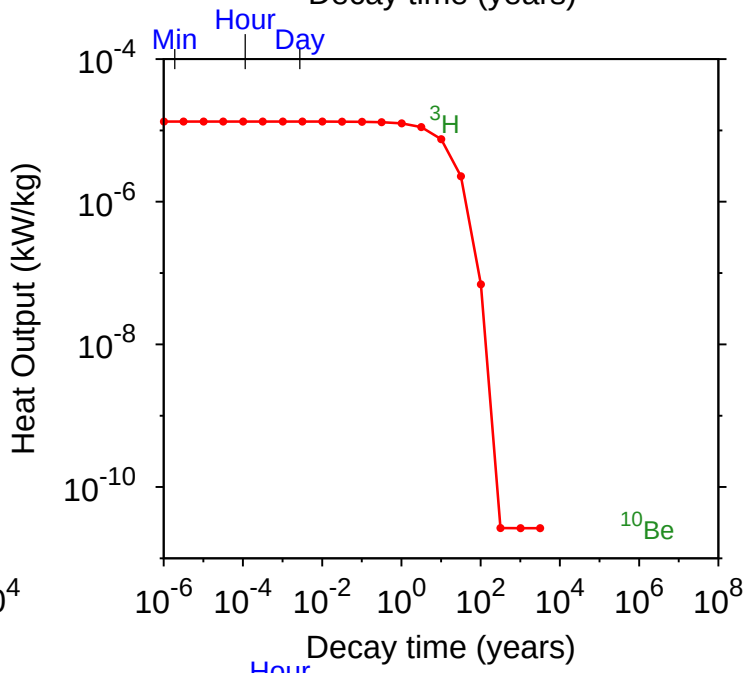
Specific Activity



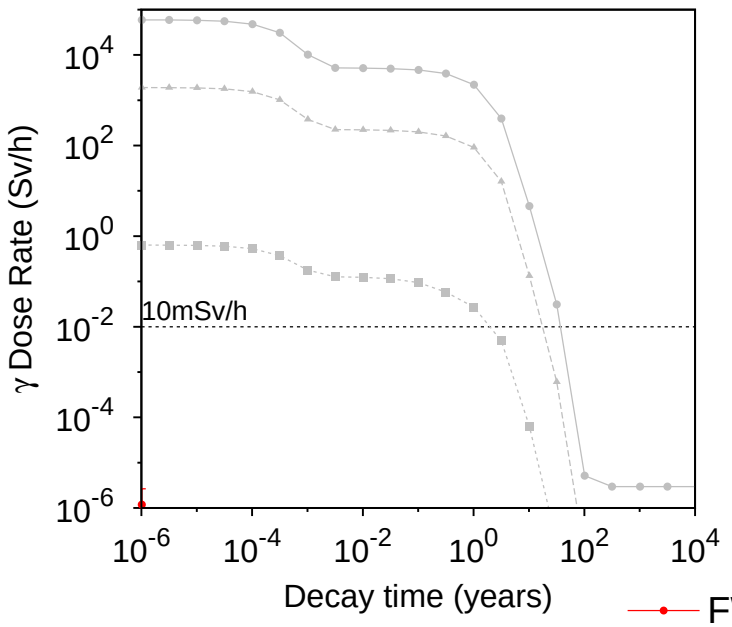


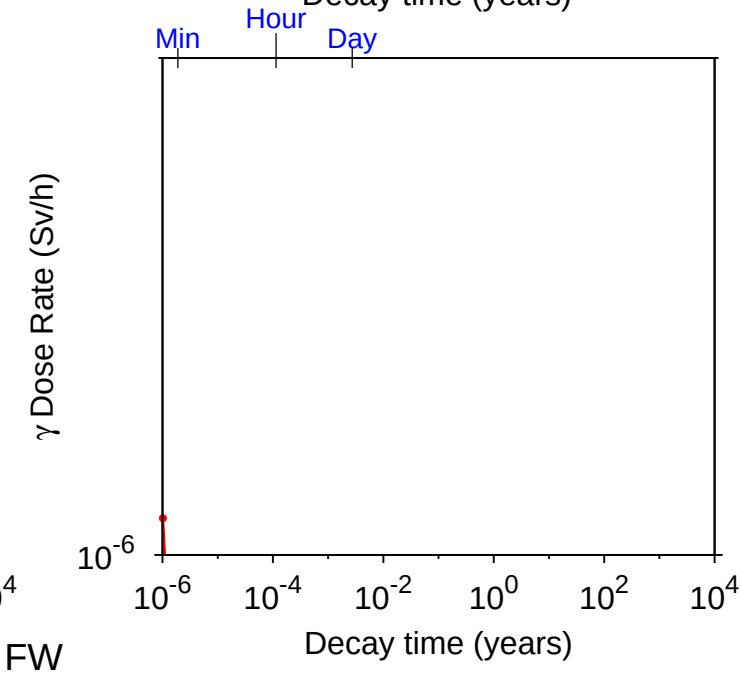
Heat Output





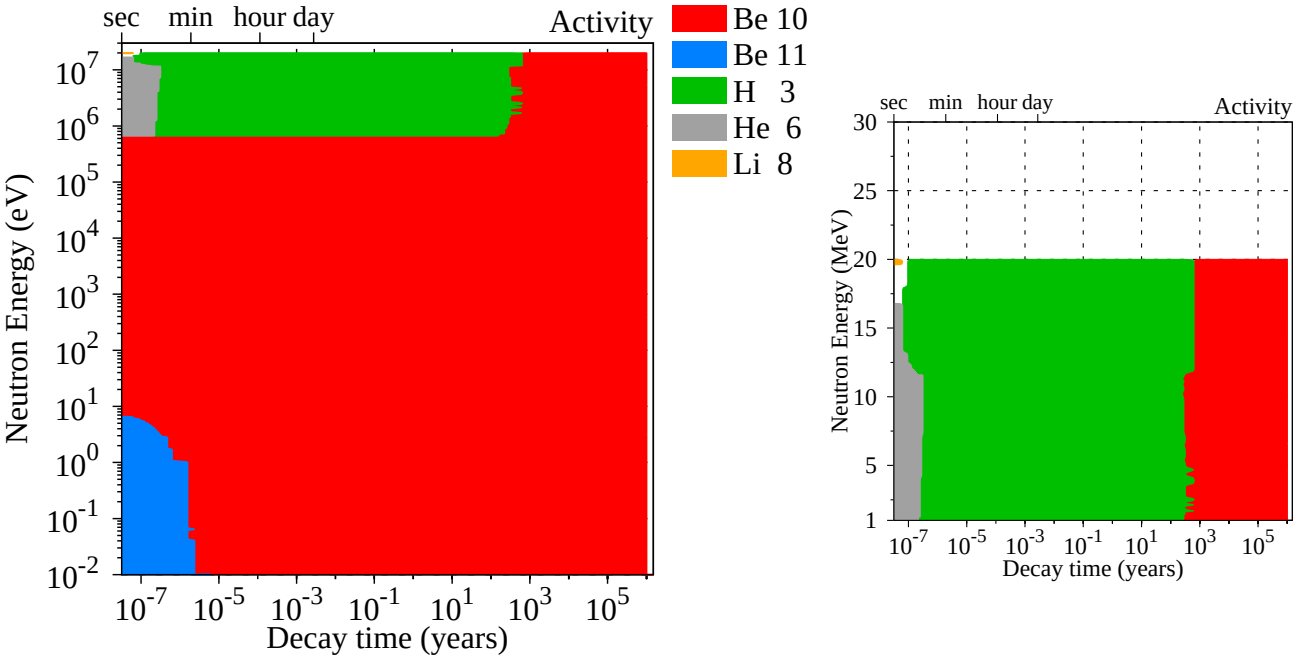
γ Dose Rate

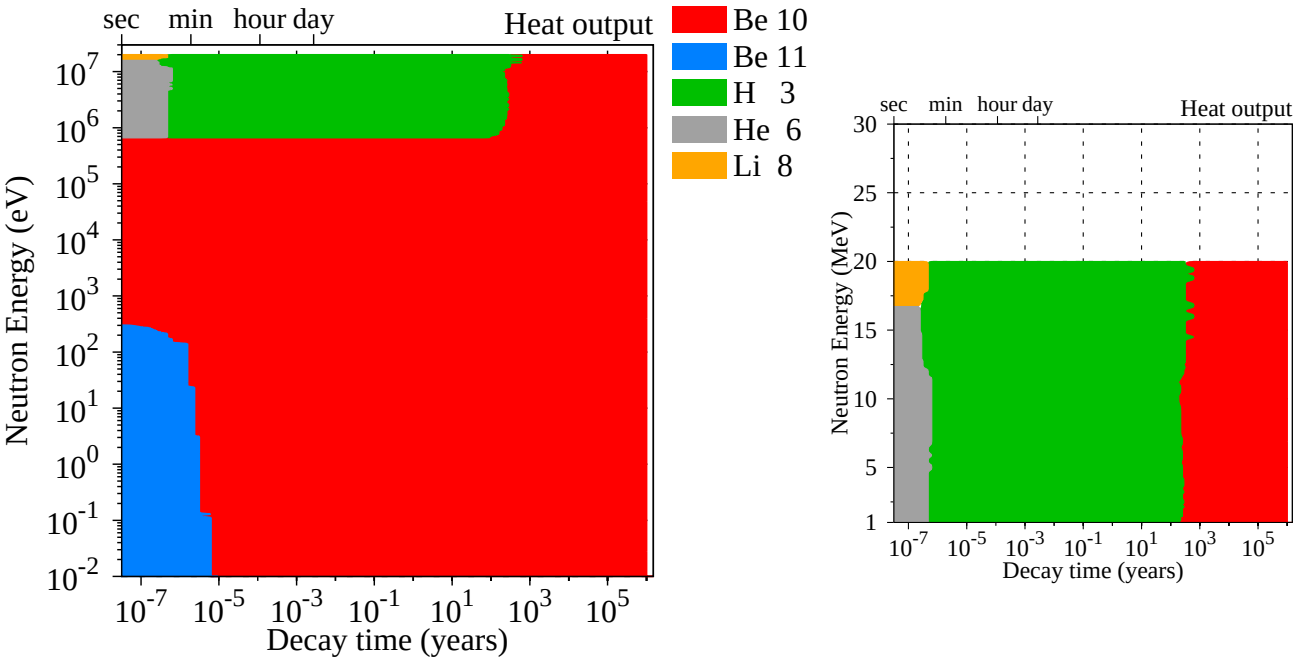


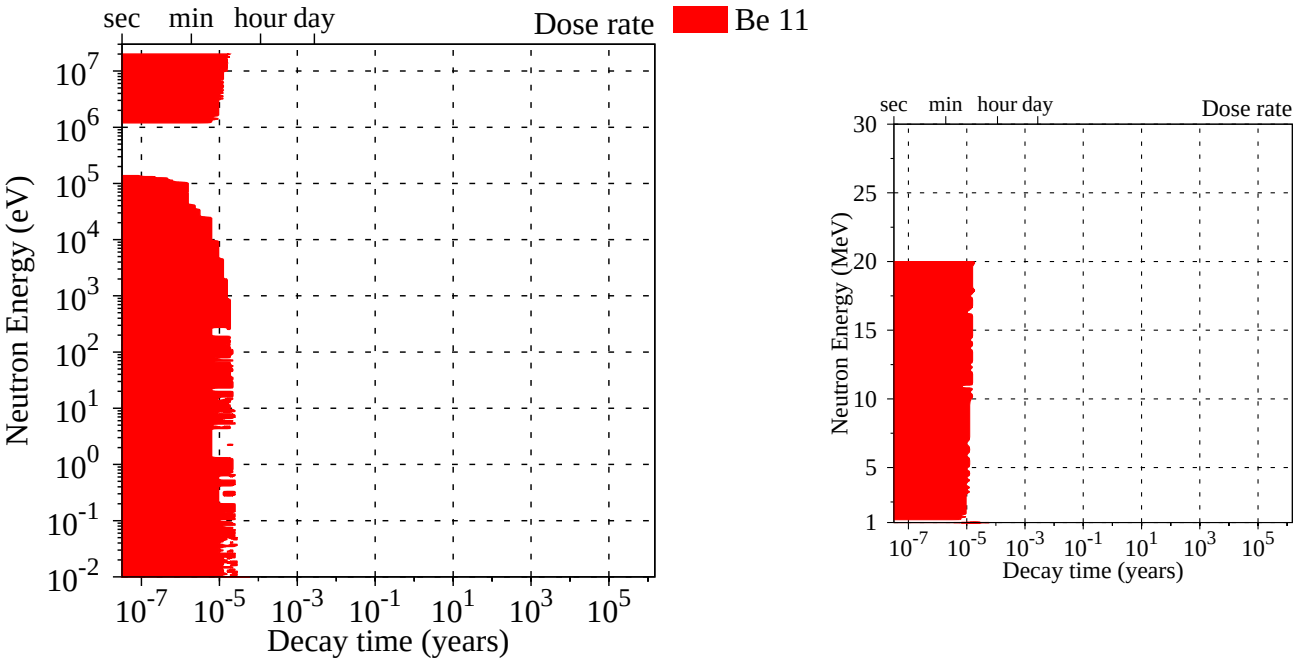


FW
Blanket
Manifold
Fe results

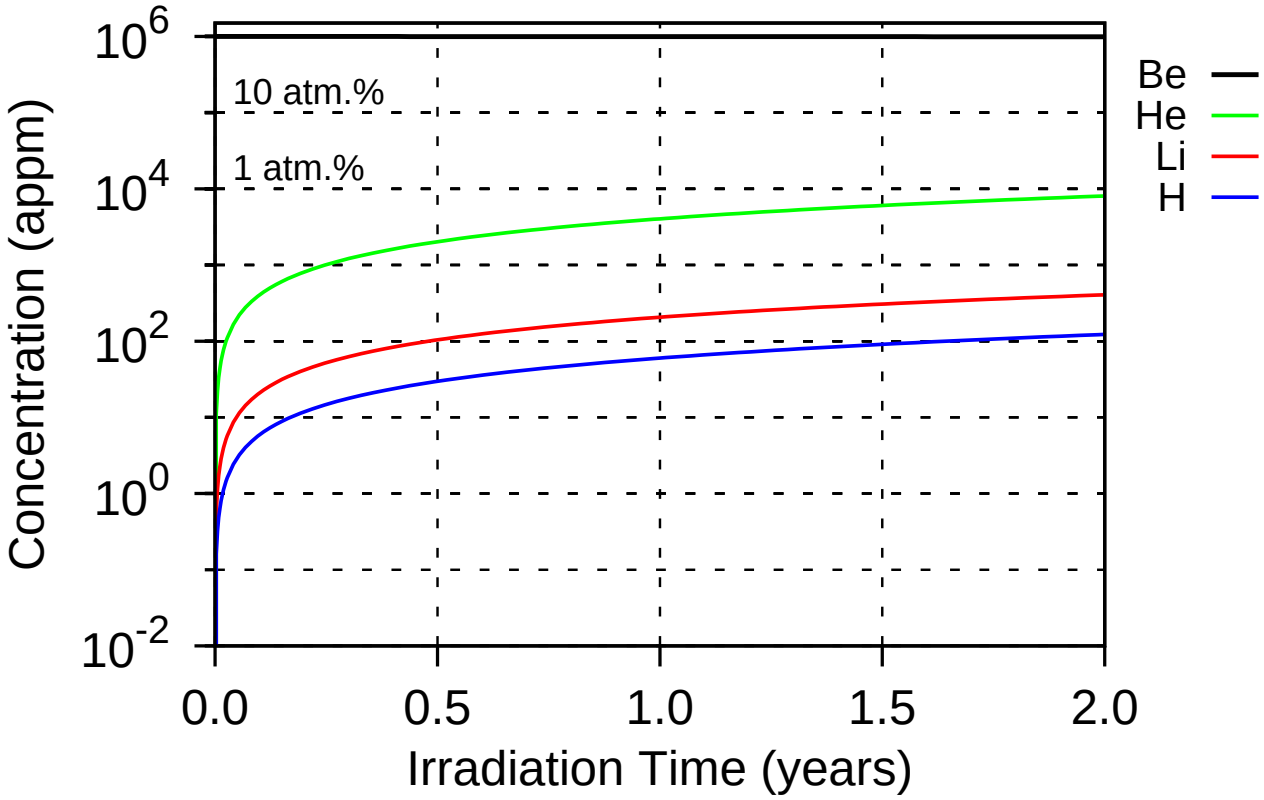
Beryllium Importance diagrams



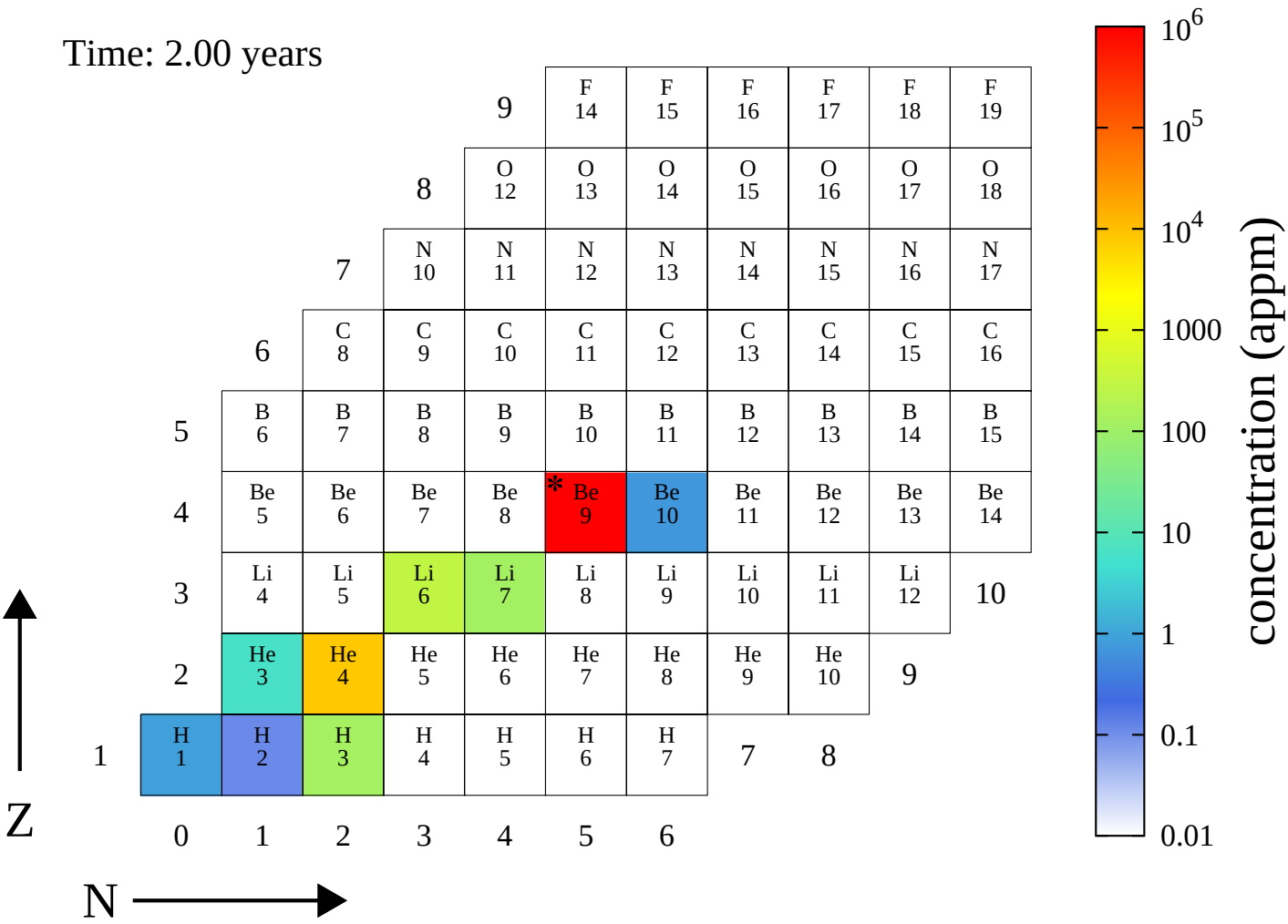




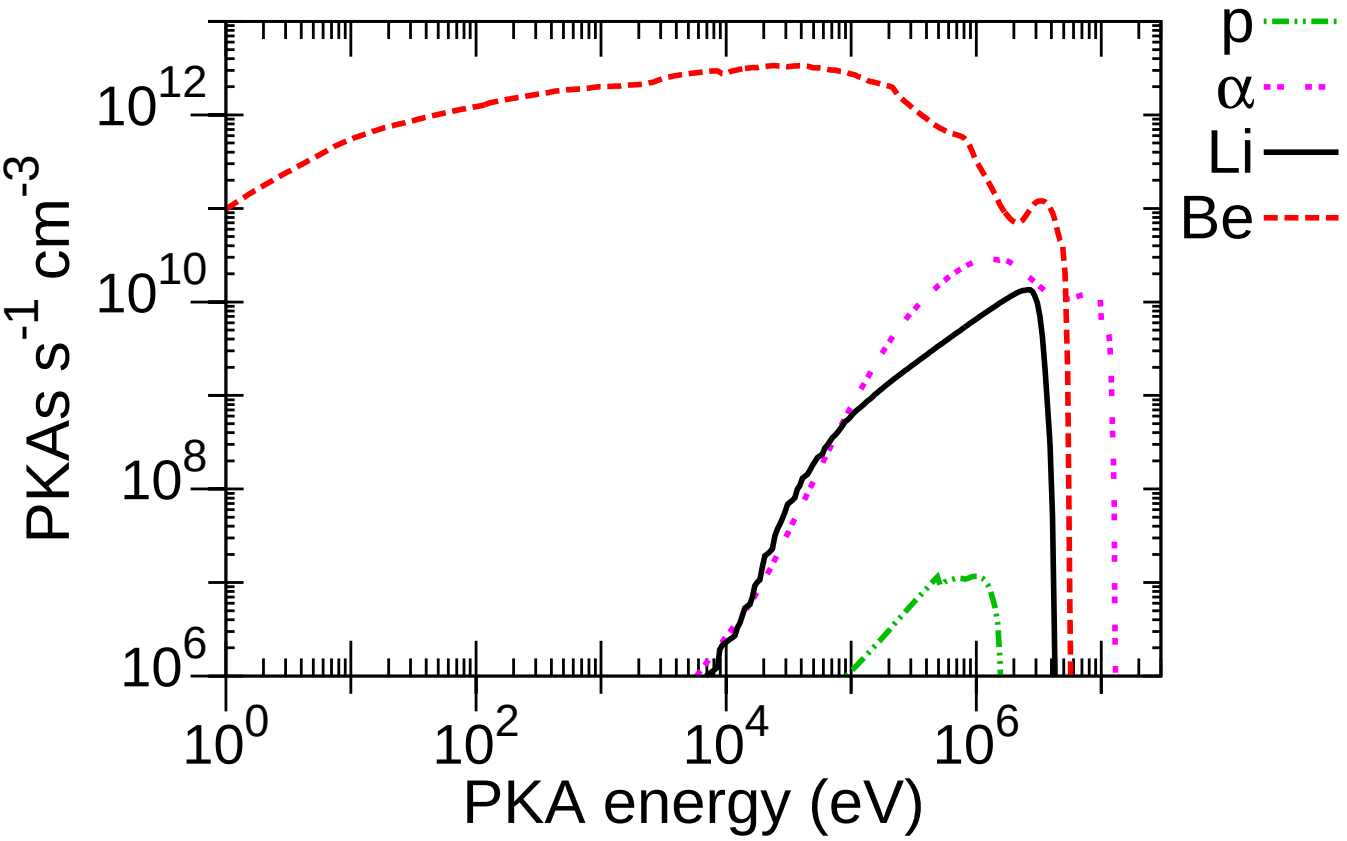
Beryllium FW Transmutation

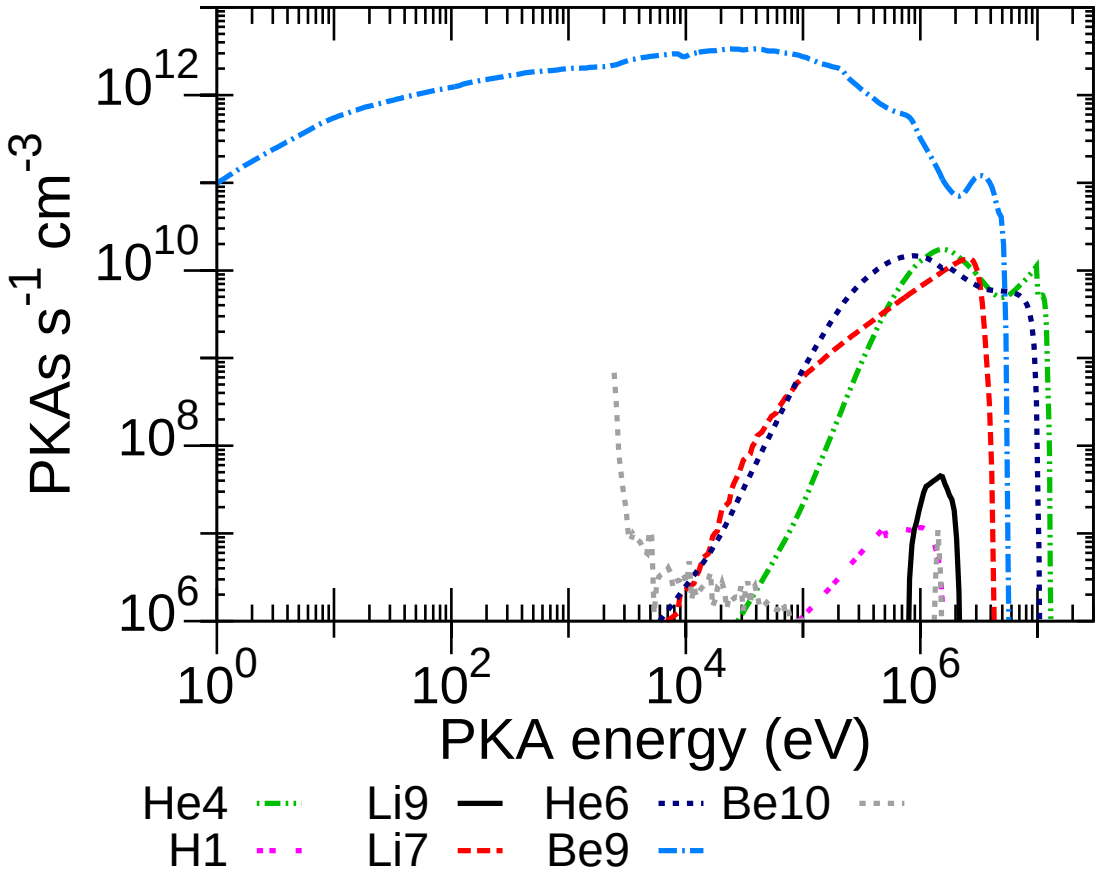


4037 appm He & 60 appm H after 1 year 6 dpa/year



Beryllium FW PKA distributions





Beryllium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
He6	0.81s	Be9(n,α)He6			100.0	99.7
Li8	0.84s	Be9(n,γ)Be10(β^-)B10(n,α)Li7(n,γ)Li8	67.1			
		Be9(n,γ)Be10(n,γ)Be11($\beta^-\alpha$)Li7(n,γ)Li8	32.9			
		Be9(n,t)Li7(n,γ)Li8				100.0
Be11	13.81s	Be9(n,γ)Be10(n,γ)Be11	100.0		100.0	100.0
H3	12.33y	Be9(n,γ)Be10(β^-)B10(n,t2a)H3	100.0	99.9		
		Be9(n,α)He6(β^-)Li6(n,α)H3			58.9	
		Be9(n,α)He6(β^-)Li6(n,t)H3			41.1	
		Be9(n,t)H3				99.7
Be10	1.6 10^6y	Be9(n,γ)Be10	100.0	100.0	100.0	100.0

Boron

Isotope	Atom % abundance
B10	19.80
B11	80.20

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.83E+14	2.33E+13	2.33E+13	2.20E+13	1.08E+11	4.26E+07
Li8	73.1					
H3	12.7	100.0	100.0	100.0	100.0	
Be11	11.9					
He6	2.0					
Be10						100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.23E-01	2.13E-05	2.13E-05	2.01E-05	1.01E-07	1.72E-09
Li8	89.9					
Be11	9.5					
H3		100.0	100.0	100.0	98.3	
Be10					1.7	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.16E+04	7.33E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Be11	99.9	100.0				

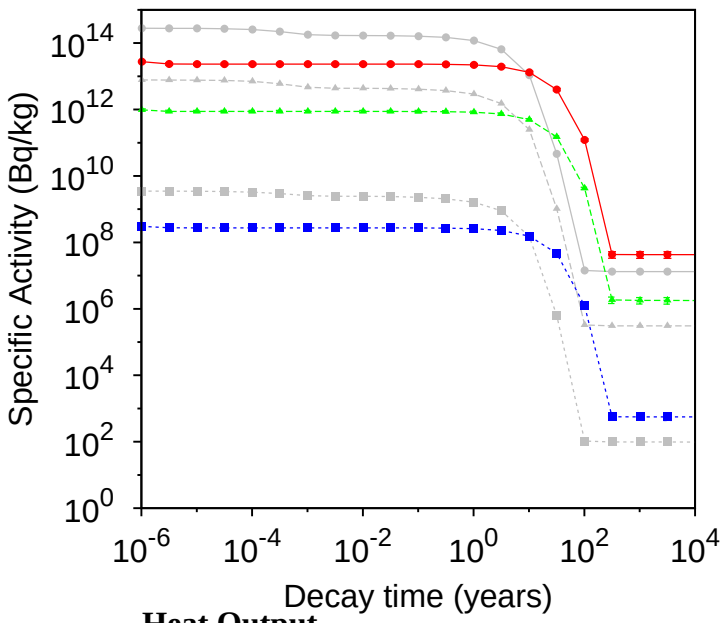
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.05E+03	9.79E+02	9.78E+02	9.25E+02	4.60E+00	4.69E-02
H3	92.9	100.0	100.0	100.0	99.0	
He6	5.2					
Li8	1.3					
Be10					1.0	100.0

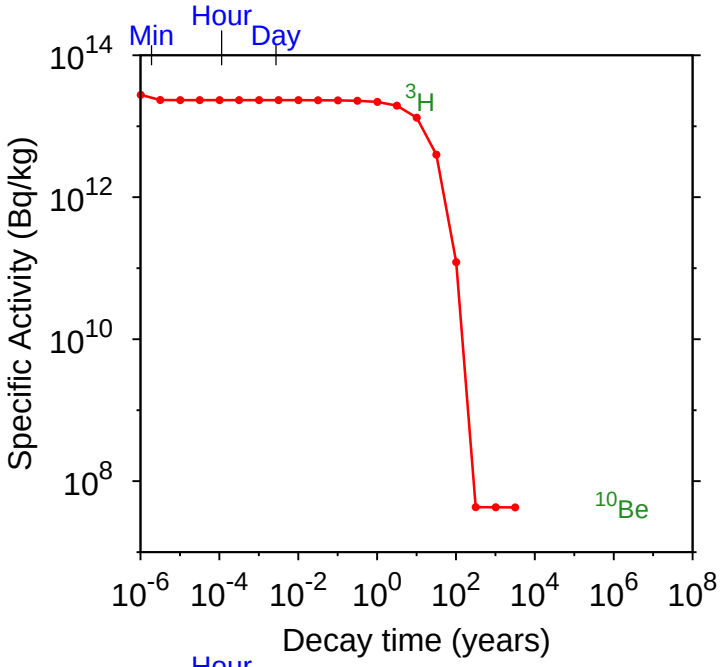
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.10E+03	6.06E+03	6.06E+03	5.73E+03	2.97E+01	1.49E+00
H3	99.3	100.0	100.0	100.0	95.0	
Be10					5.0	100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.31E+11	2.32E+08	2.32E+08	2.19E+08	1.08E+06	1.06E+03
Li8	67.9					
Be11	31.2					
H3	0.2	100.0	100.0	100.0	99.9	
Be10					0.1	100.0

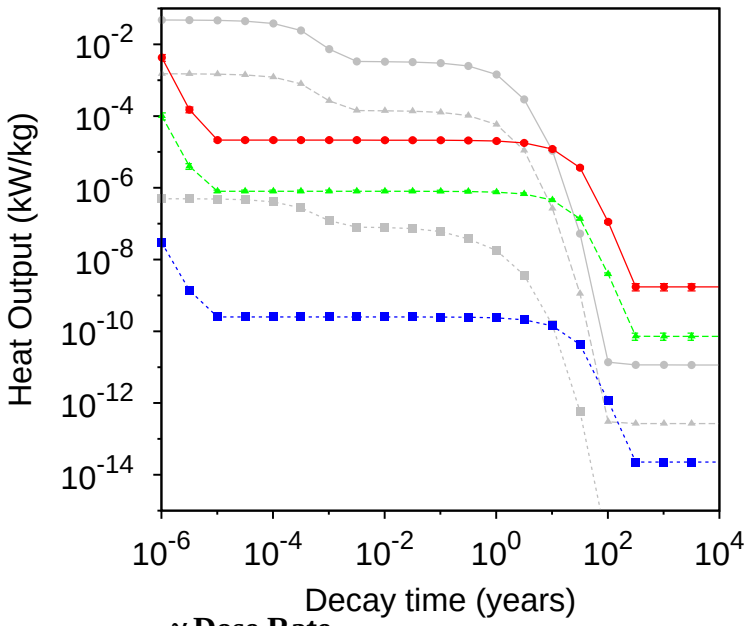
Boron activation characteristics

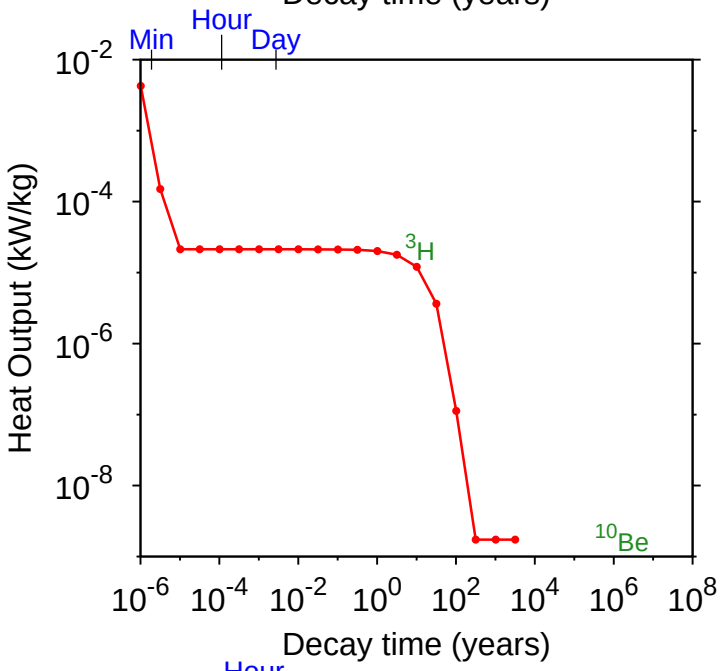
Specific Activity



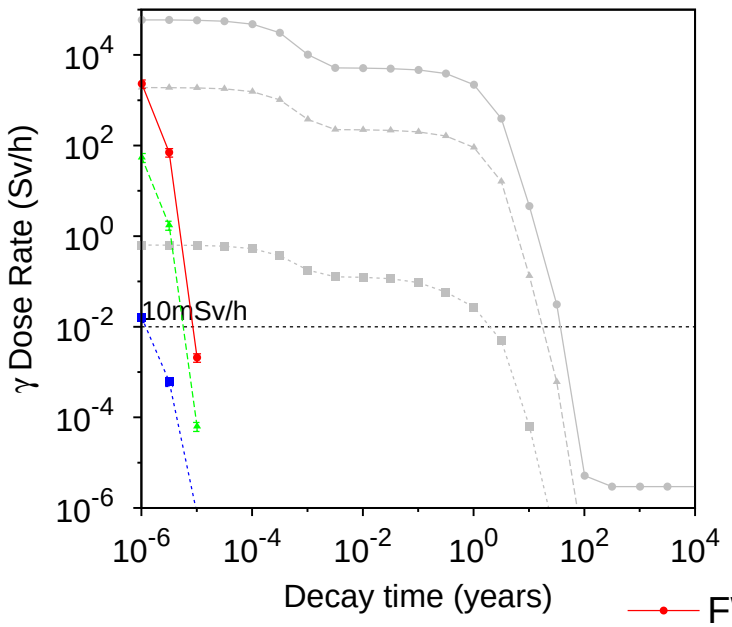


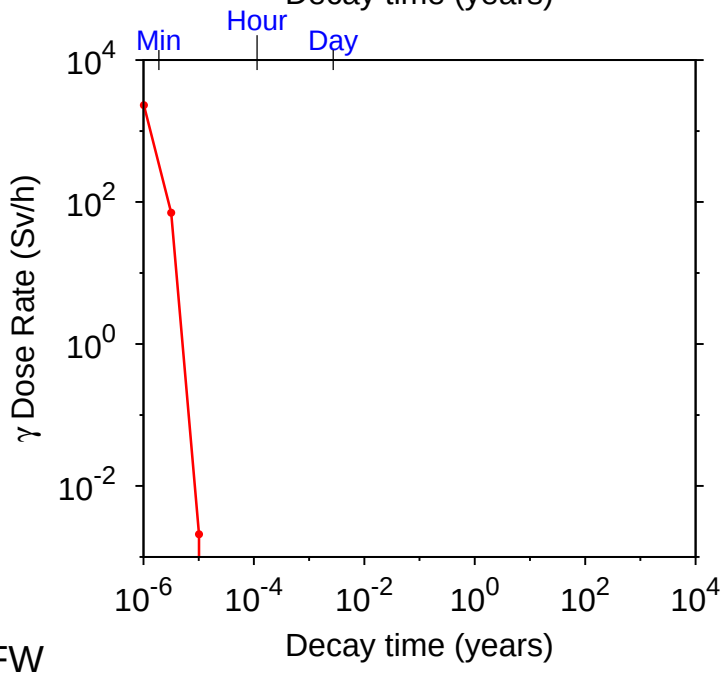
Heat Output





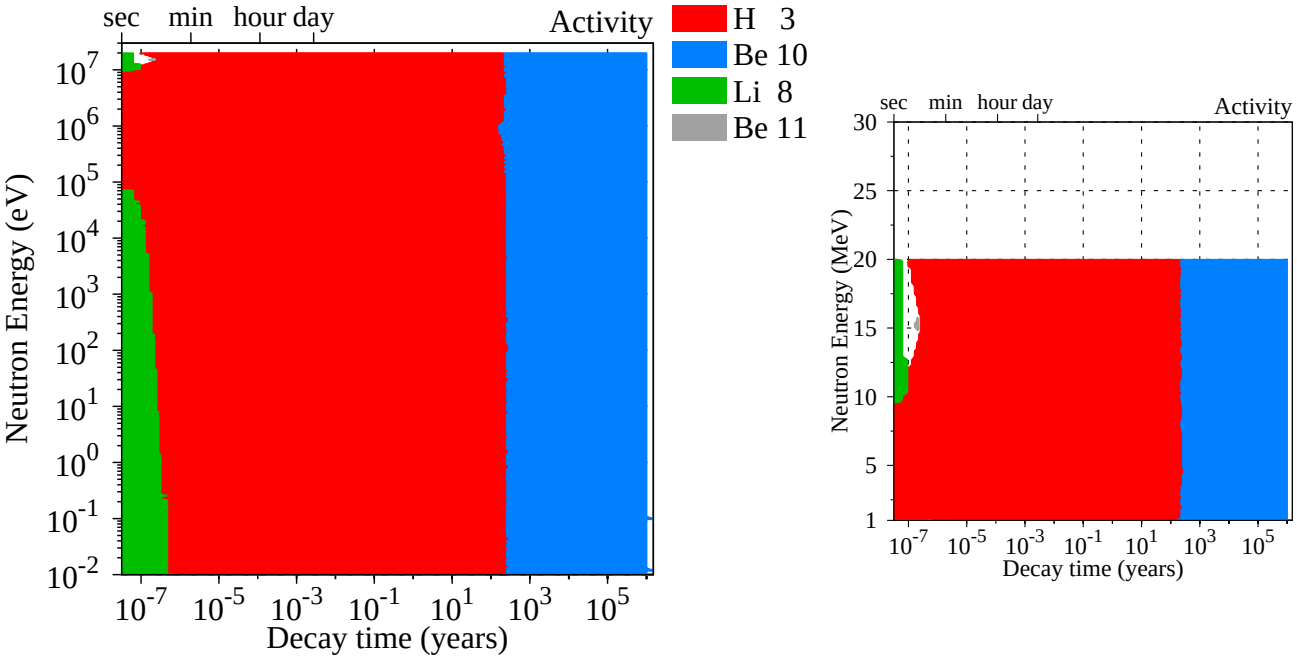
γ Dose Rate

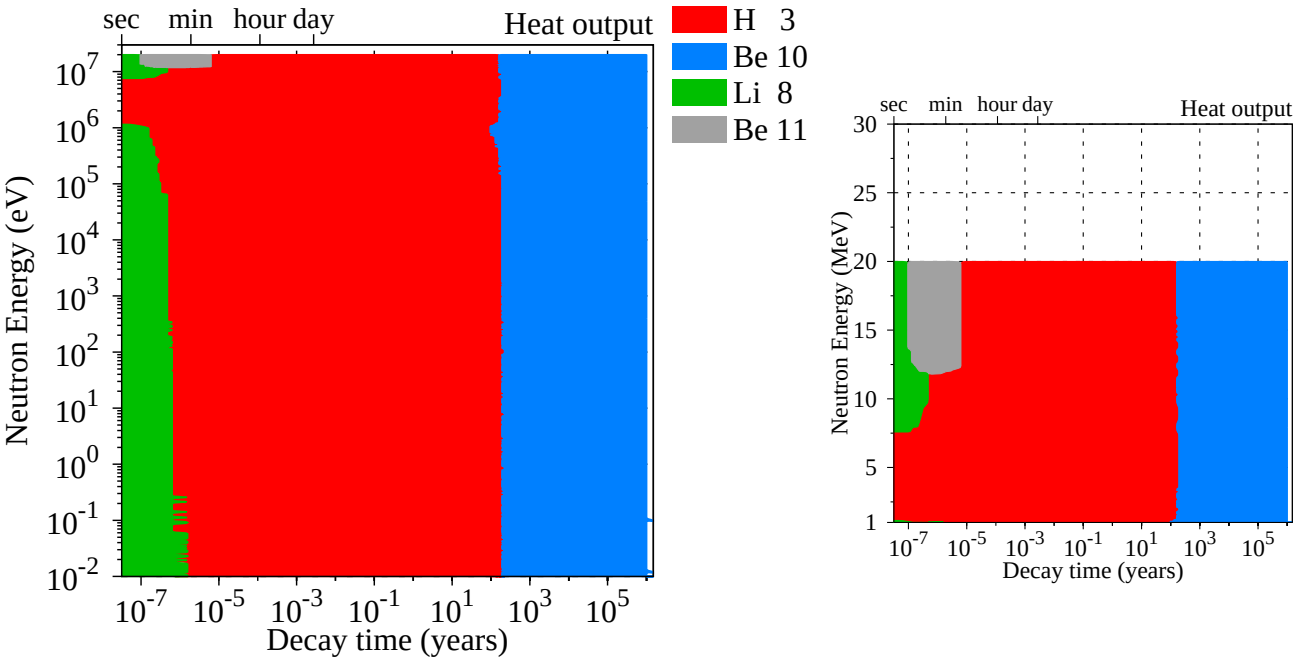


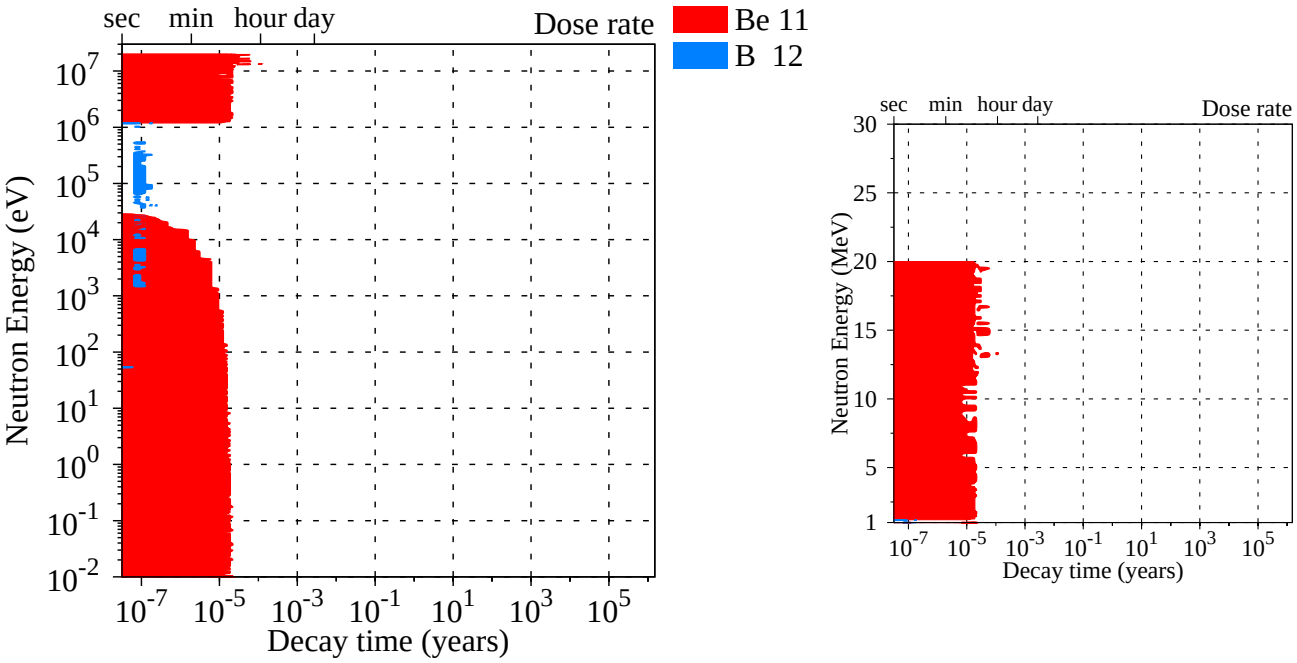


FW
Blanket
Manifold
Fe results

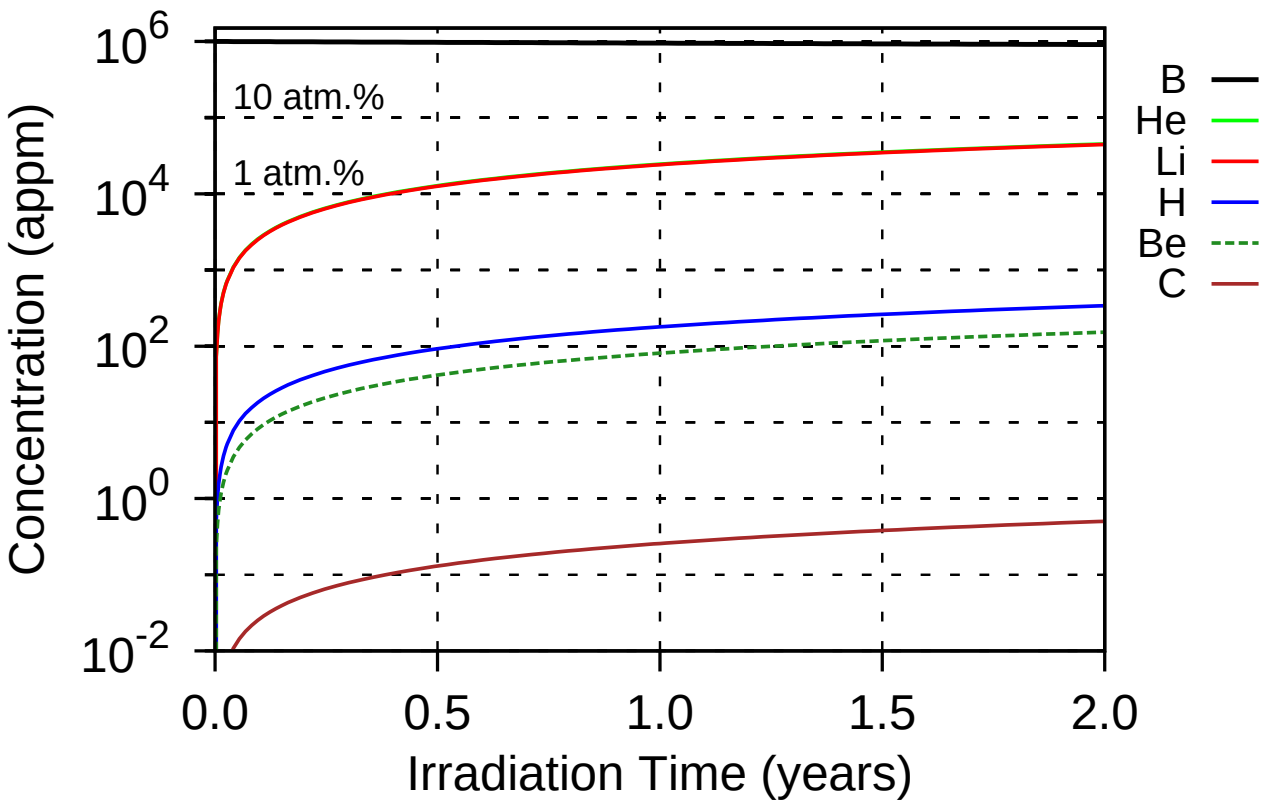
Boron Importance diagrams



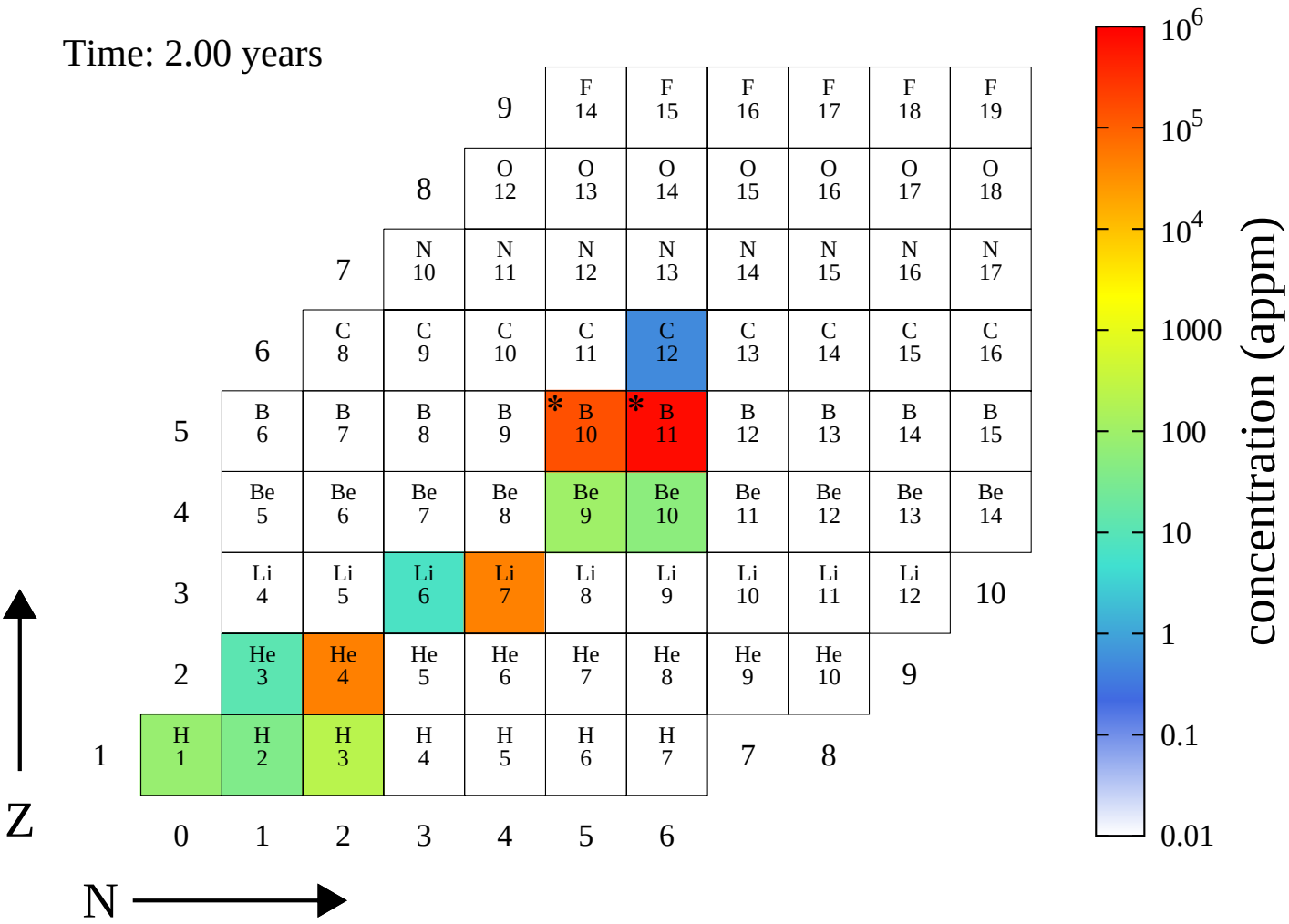




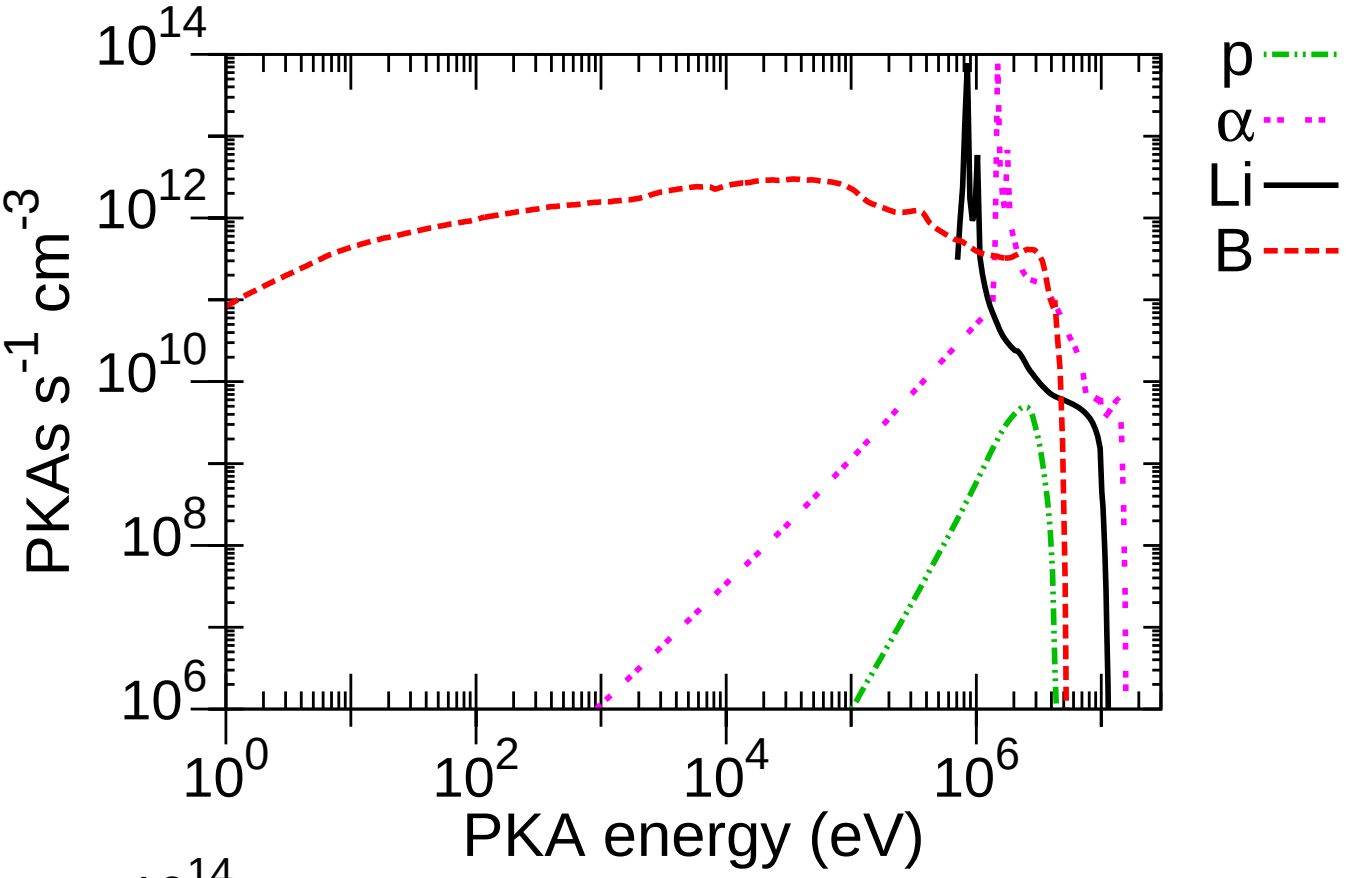
Boron FW Transmutation

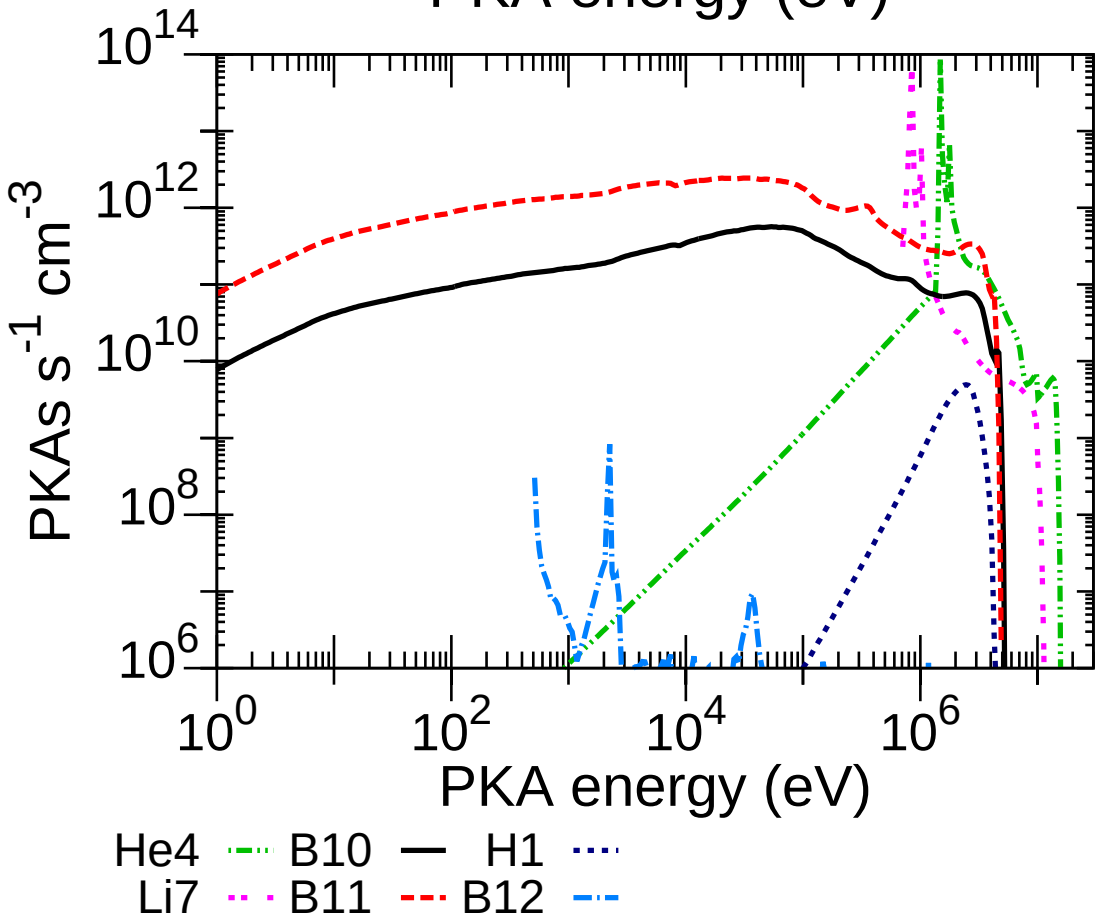


24503 appm He & 180 appm H after 1 year 14 dpa/year



Boron FW PKA distributions





Boron Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
B12	0.02s	B11(n,γ)B12	100.0	100.0	100.0	100.0
He6	0.81s	B11(n,nα)Li7(n,d)He6				61.0
		B11(n,nα)Li7(n,p)He7(n)He6				21.5
		B10(n,p)Be10(n,α)He7(n)He6				8.8
		B11(n,t)Be9(n,α)He6				2.6
		B10(n,α)Li7(n,d)He6				2.4
		B10(n,d)Be9(n,α)He6				1.4
		B11(n,np)Be10(n,α)He7(n)He6				1.2
Li8	0.84s	B10(n,α)Li7(n,γ)Li8	100.0	100.0	100.0	
		B11(n,α)Li8				100.0
Be11	13.81s	B10(n,p)Be10(n,γ)Be11	100.0		100.0	
		B11(n,p)Be11				100.0
H3	12.33y	B10(n,t2a)H3	100.0	99.5	99.9	61.7
		B11(n,t)H3				36.4
		B11(n,nα)Li7(n,t)H3				1.0
Be10	1.6 10^6y	B10(n,p)Be10	100.0	100.0	100.0	88.1
		B11(n,np)Be10				11.7

Carbon

Isotope	Atom % abundance
C12	98.89
C13	1.11

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.13E+12	1.86E+10	1.86E+10	1.76E+10	1.15E+08	7.67E+06
B12	83.1					
He6	10.9					
B13	4.3					
H3	1.7	100.0	100.0	100.0	92.4	
Be10					6.3	94.2
C14					1.3	5.8

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.04E-03	1.73E-08	1.73E-08	1.64E-08	4.02E-10	2.96E-10
B12	92.1					
B13	4.9					
He6	3.0					
H3		98.2	98.2	98.1	24.1	
Be10		1.7	1.7	1.8	72.9	98.8
C14		0.1	0.1	0.1	2.9	1.2

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.38E+01	3.02E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B12	80.3					
B13	19.7					
Be11		87.7				
N13		12.3				

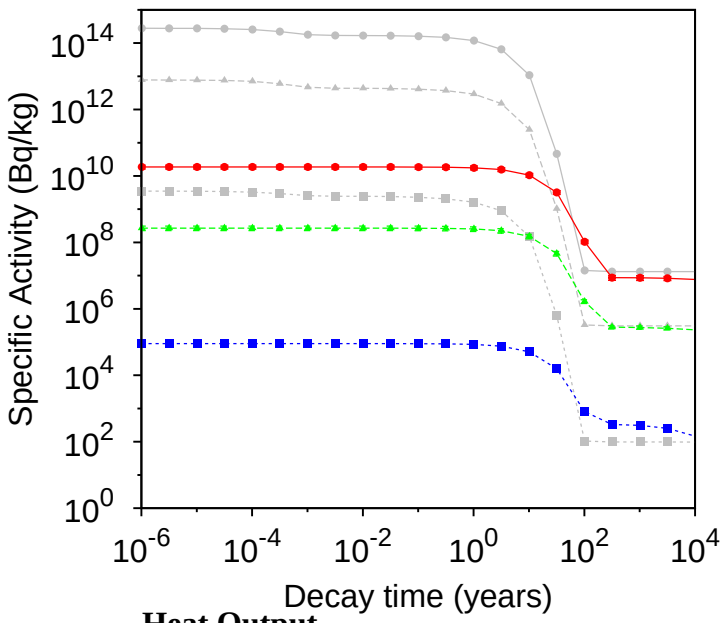
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.64E+00	7.91E-01	7.91E-01	7.48E-01	1.33E-02	8.21E-03
He6	69.8					
H3	29.7	98.9	98.9	98.8	33.5	
Be10	0.3	1.0	1.0	1.1	60.0	96.8
C14		0.1	0.1	0.1	6.5	3.2

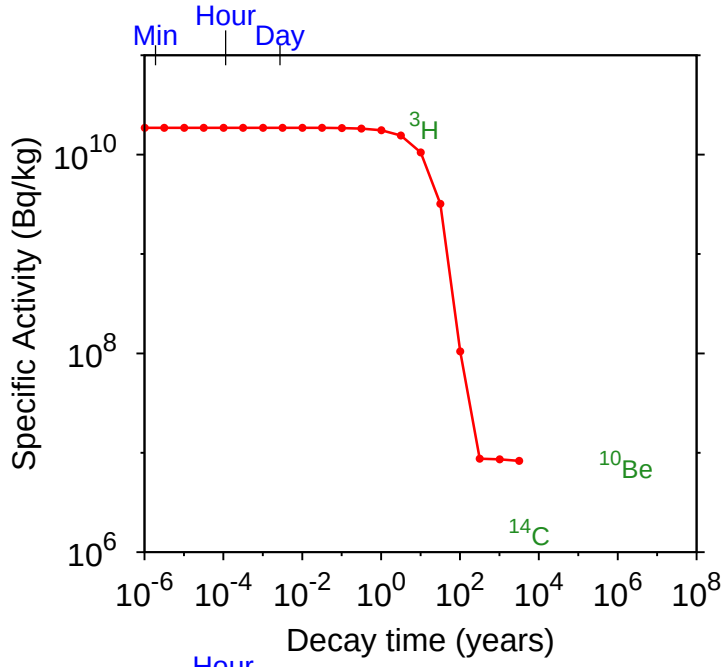
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.00E+00	5.11E+00	5.10E+00	4.84E+00	2.90E-01	2.56E-01
H3	80.7	94.9	94.8	94.6	9.5	
He6	14.9					
Be10	4.2	5.0	5.0	5.2	87.5	99.0
C14	0.1	0.2	0.2	0.2	3.0	1.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	7.33E+08	1.88E+05	1.88E+05	1.78E+05	2.73E+03	6.27E+02
B12	91.2					
B13	6.0					
He6	2.7					
H3		99.1	99.1	99.0	38.8	
C14		0.8	0.8	0.8	54.6	71.2
Be10		0.1	0.1	0.1	6.6	28.8

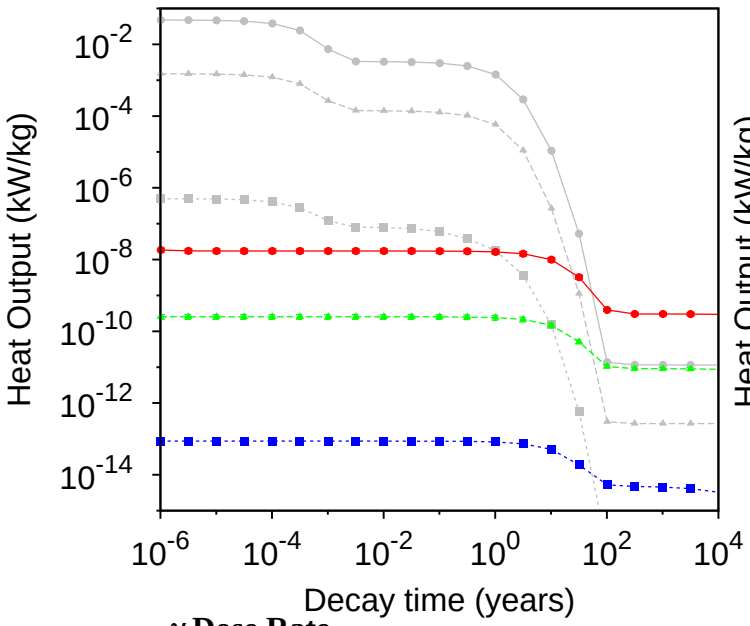
Carbon activation characteristics

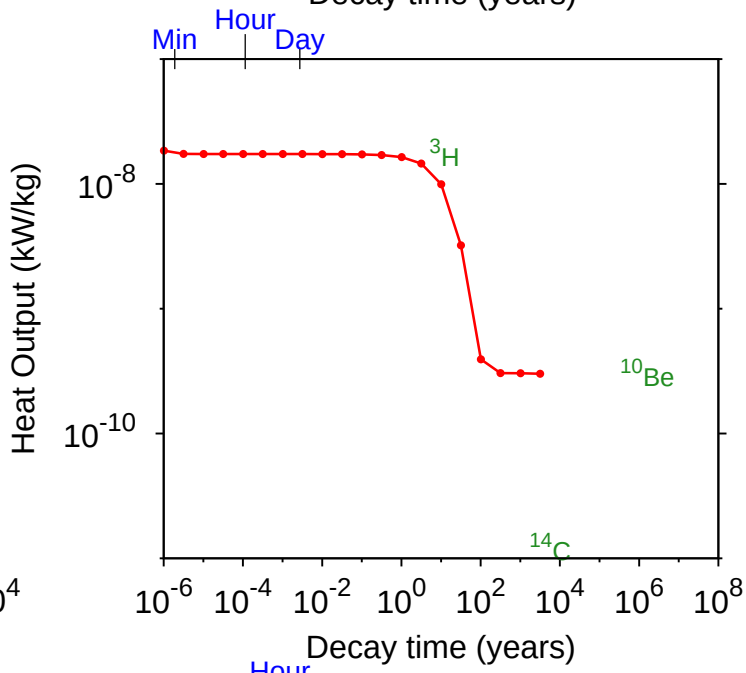
Specific Activity



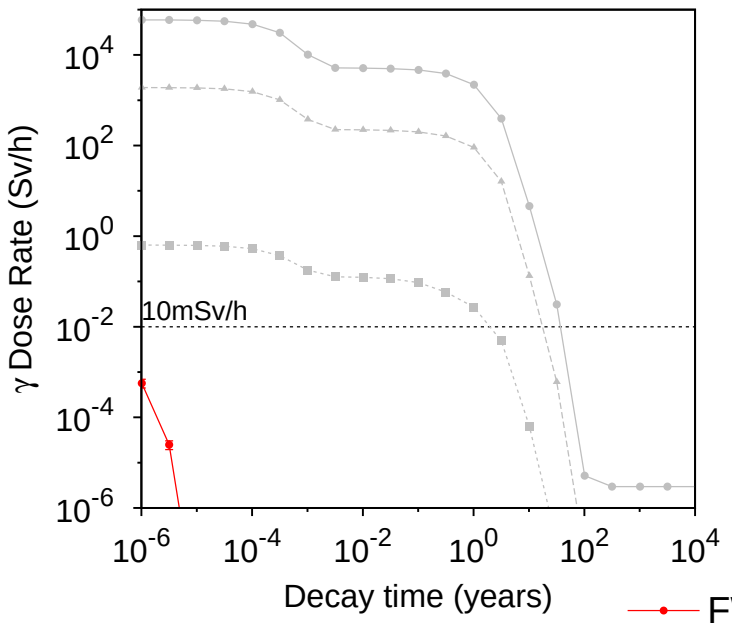


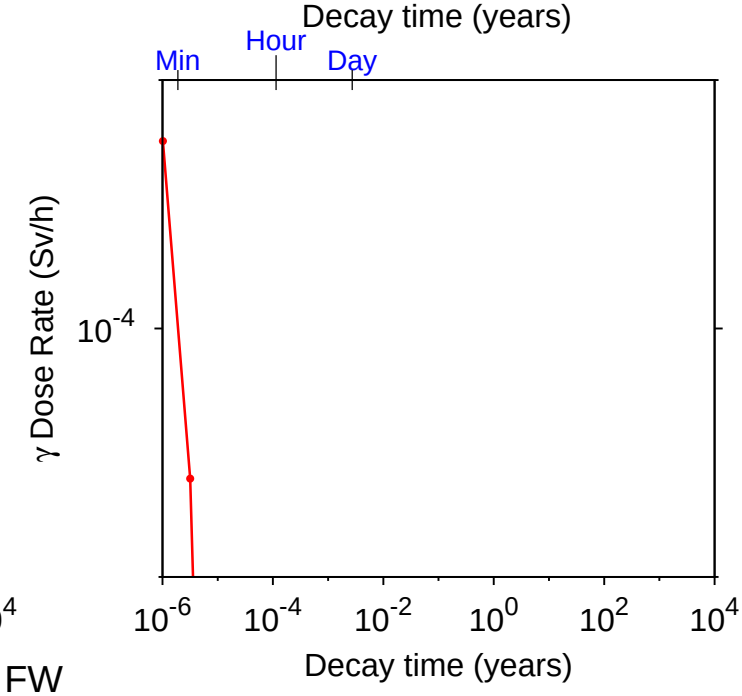
Heat Output





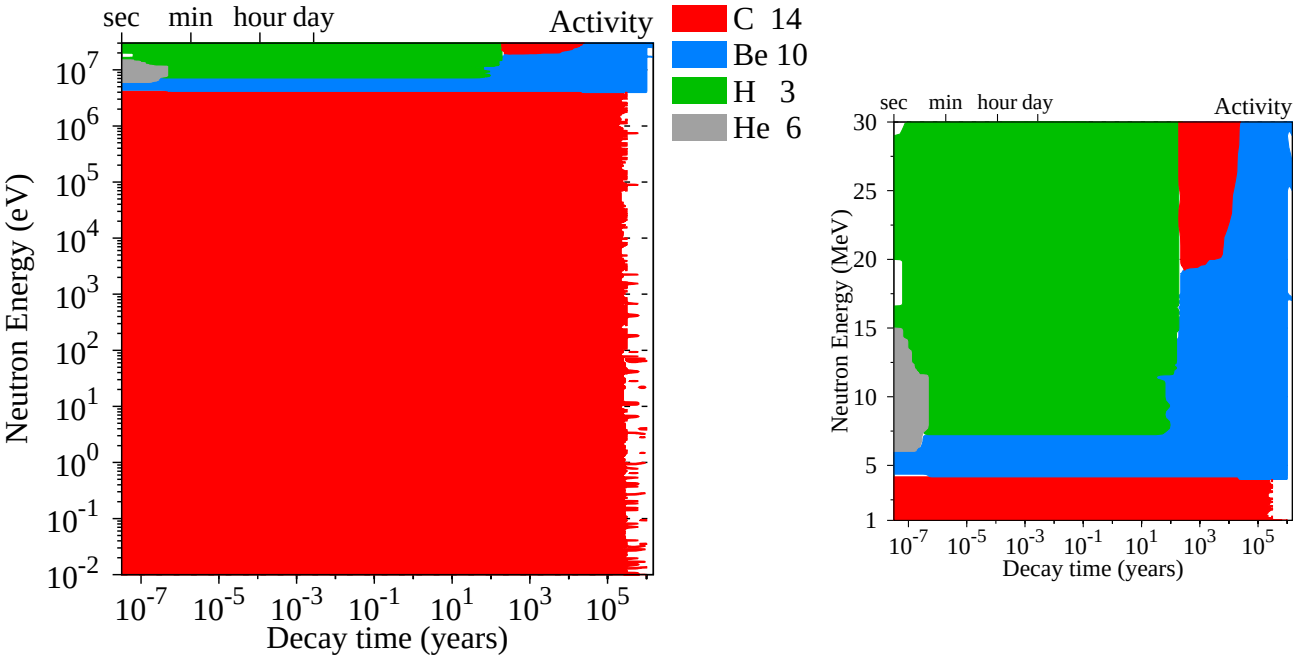
γ Dose Rate

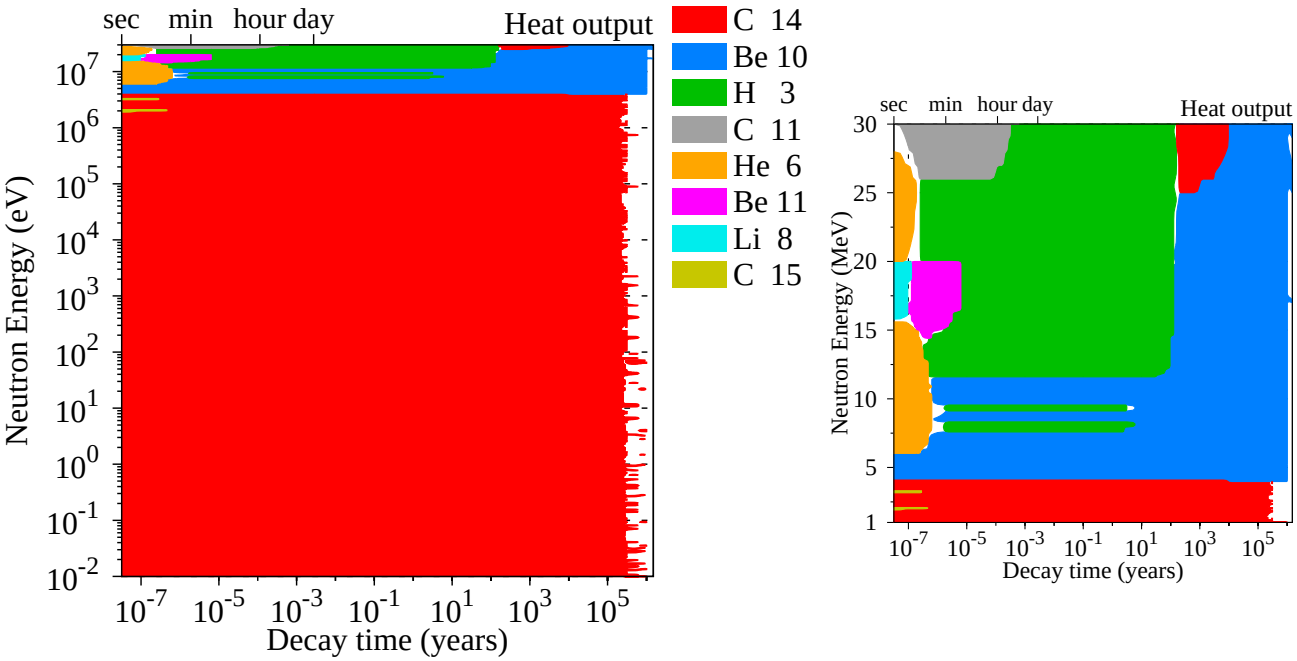


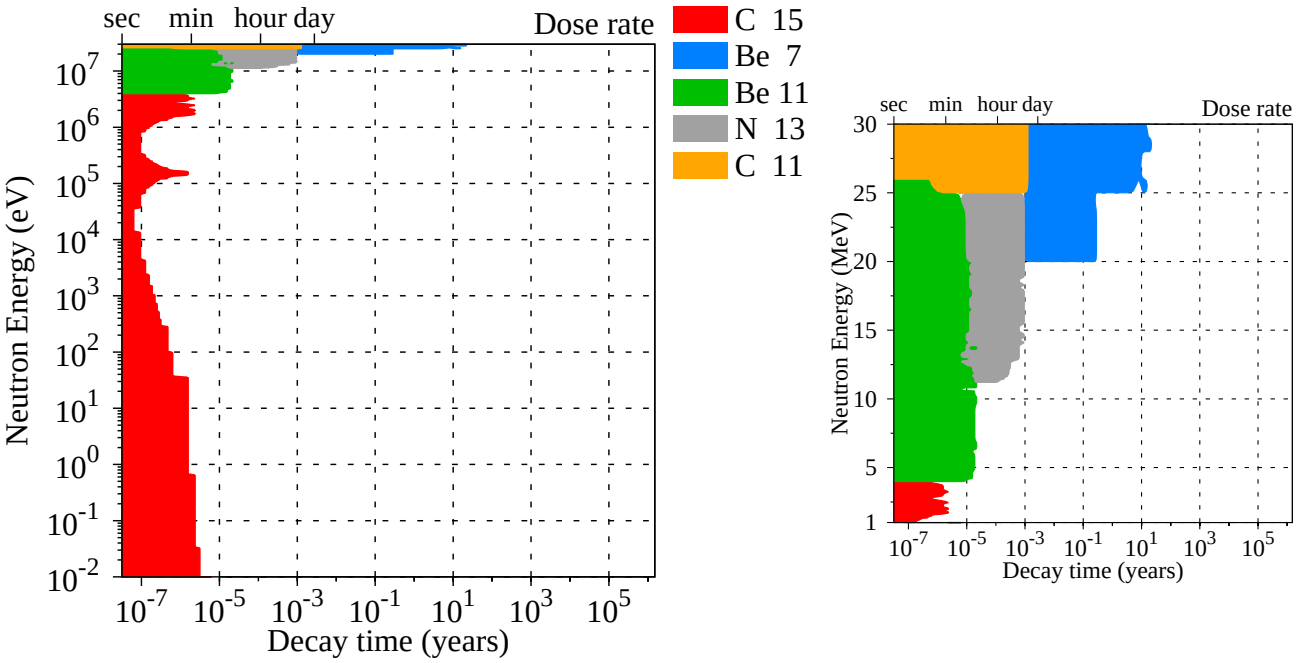


FW
Blanket
Manifold
Fe results

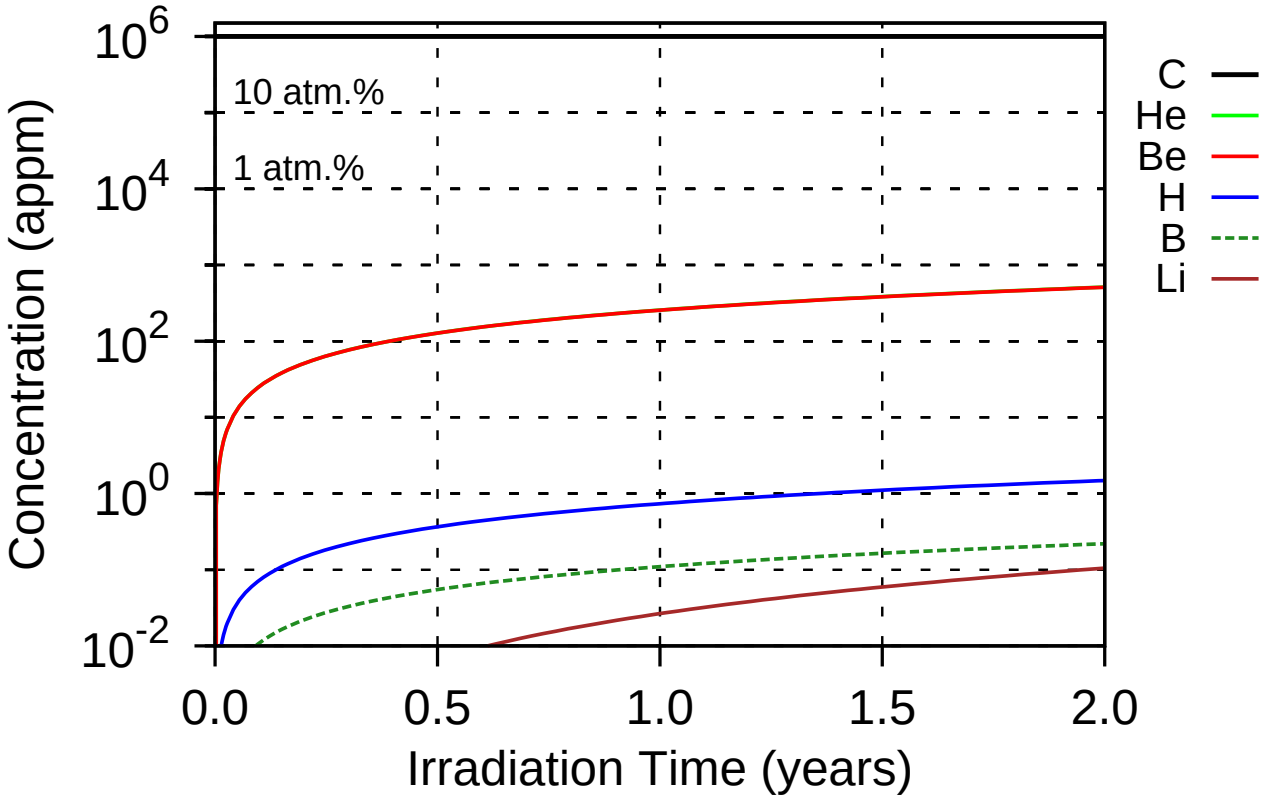
Carbon Importance diagrams



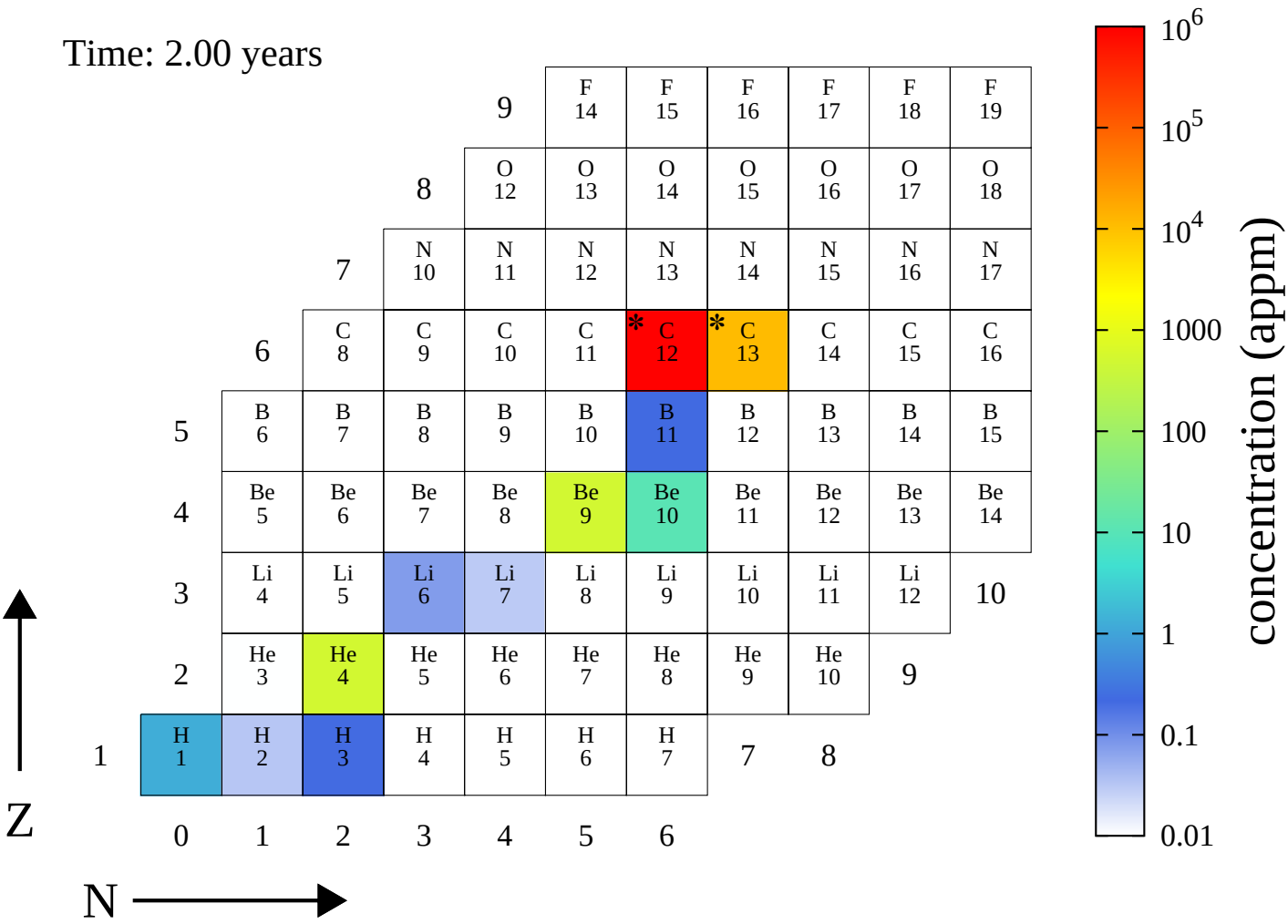




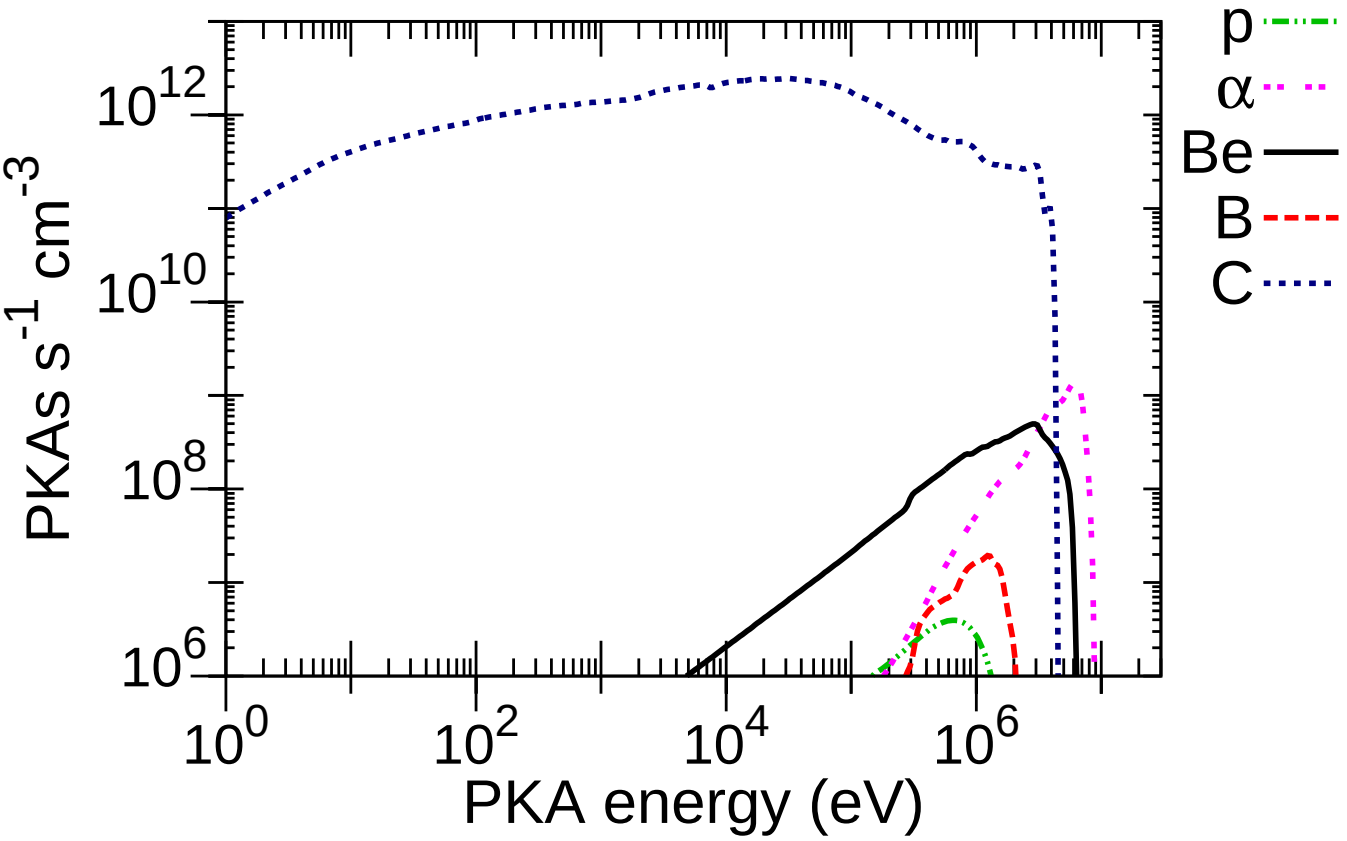
Carbon FW Transmutation

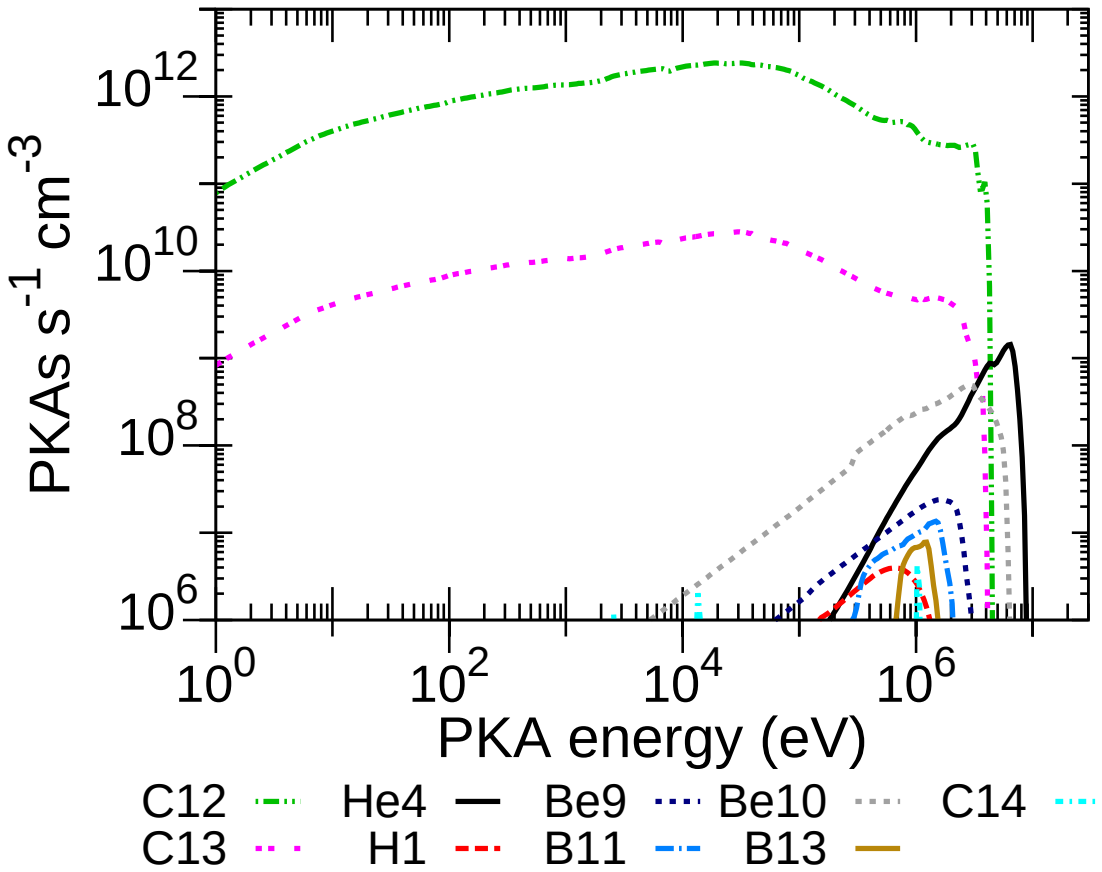


256 appm He & 1 appm H after 1 year 8 dpa/year



Carbon FW PKA distributions





Carbon Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
B13	0.02s	C13(n,p)B13				100.0
B12	0.02s	C12(n,p)B12				100.0
He6	0.81s	C12(n,α)Be9(n,α)He6				88.7
		C13(n,α)Be10(n,α)He7(n)He6				11.0
Li8	0.84s	C13(n,t)B11(n,α)Li8				100.0
C15	2.45s	C13(n,γ)C14(n,γ)C15	99.0		100.0	99.9
		C12(n,γ)C13(n,γ)C14(n,γ)C15	1.0			
Be11	13.81s	C13(n,t)B11(n,p)Be11				95.5
		C13(n,γ)C14(n,α)Be11				3.5
		C13(n,α)Be10(n,γ)Be11				1.0
N13	9.97m	C13(n,γ)C14(β^-)N14(n,2n)N13				100.0
C11	20.37m	no pathways found				
Be7	53.24d	no pathways found				
H3	12.33y	C13(n,γ)C14(β^-)N14(n,p)H1(n,γ)H2(n,γ)H3	99.7			
		C12(n,α)Be9(n,t)H3				57.0
		C13(n,t)H3				42.8
C14	5.7 10^3y	C13(n,γ)C14	99.0	100.0	100.0	100.0
		C12(n,γ)C13(n,γ)C14	1.0			
Be10	1.6 10^6y	C13(n,α)Be10				100.0

Nitrogen

Isotope	Atom % abundance
N14	99.63
N15	0.37

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.91E+13	3.03E+13	1.36E+13	1.29E+13	1.78E+11	4.77E+10
N13	61.3	55.0				
H3	34.5	44.6	99.0	98.9	23.2	
B12	2.6					
C14	0.4	0.5	1.0	1.1	76.8	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	7.41E-03	4.04E-03	1.34E-05	1.28E-05	1.12E-06	3.78E-07
N13	78.3	99.7				
B12	13.9					
C15	3.9					
Li8	2.8					
H3	0.2	0.3	91.9	91.4	3.4	
C14			8.1	8.6	96.6	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	5.22E+03	3.32E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
N13	91.9	100.0				
C15	7.2					

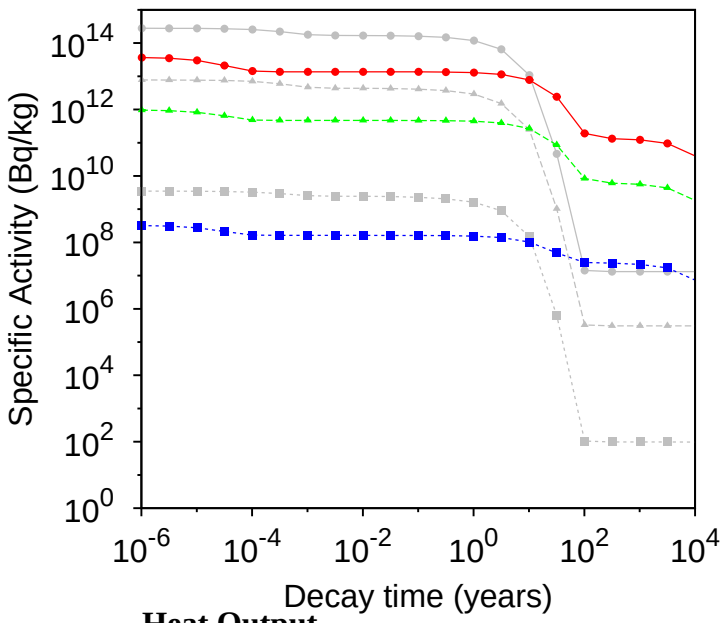
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	9.60E+02	8.64E+02	6.47E+02	6.17E+02	8.08E+01	2.76E+01
H3	59.1	65.7	87.6	87.0	2.1	
N13	32.5	25.0				
C14	8.3	9.3	12.4	13.0	97.9	100.0

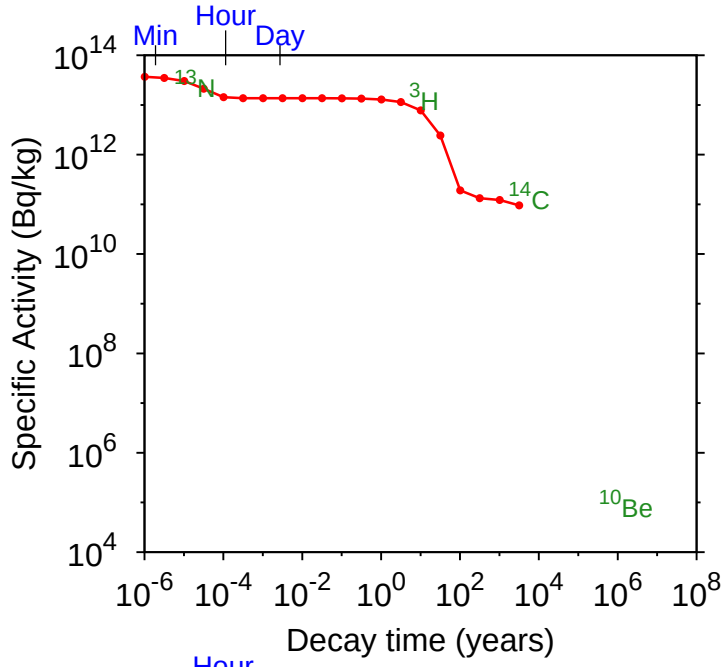
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.54E+03	4.47E+03	4.31E+03	4.12E+03	8.02E+02	2.76E+02
H3	77.4	78.6	81.4	80.6	1.3	
C14	17.6	17.9	18.6	19.4	98.7	100.0
N13	5.0	3.5				

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.78E+10	1.80E+10	2.73E+08	2.66E+08	1.37E+08	4.77E+07
N13	91.8	98.5				
C15	3.9					
B12	2.6					
C14	0.5	0.8	50.5	51.9	99.7	100.0
H3	0.5	0.8	49.5	48.1	0.3	

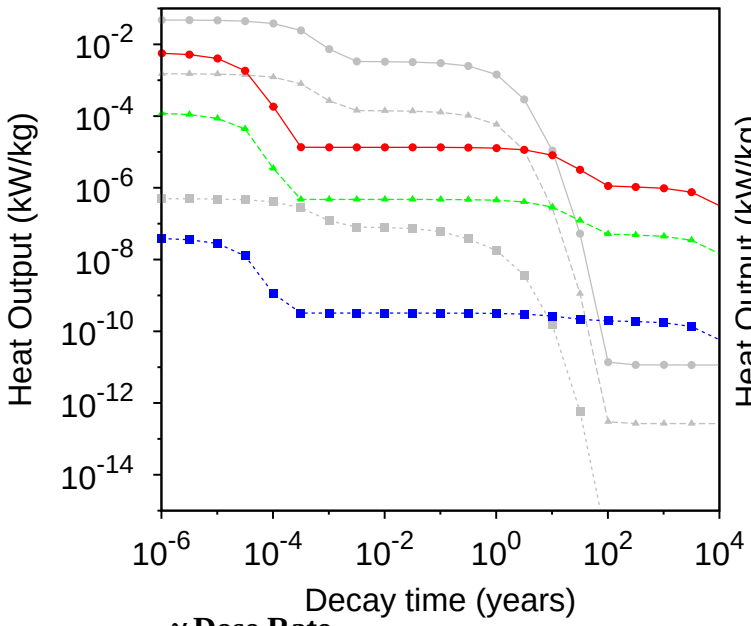
Nitrogen activation characteristics

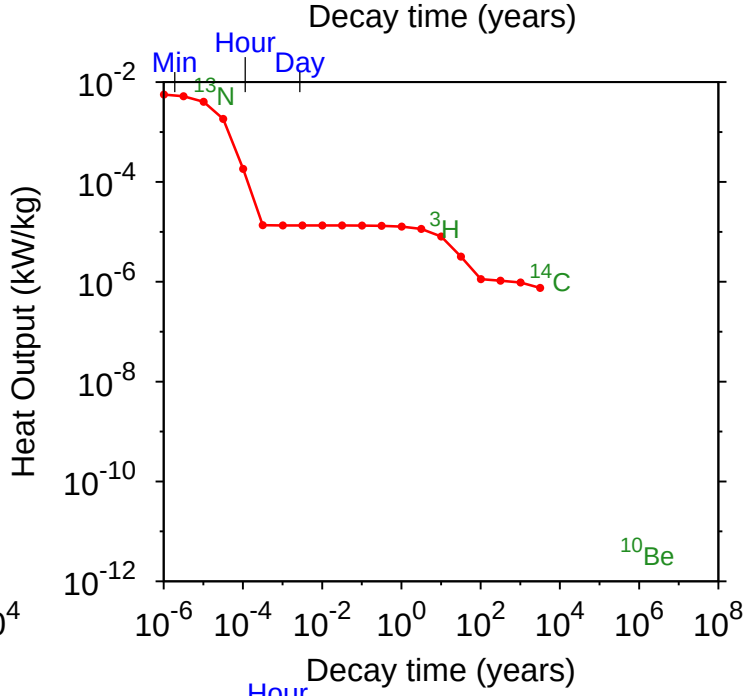
Specific Activity



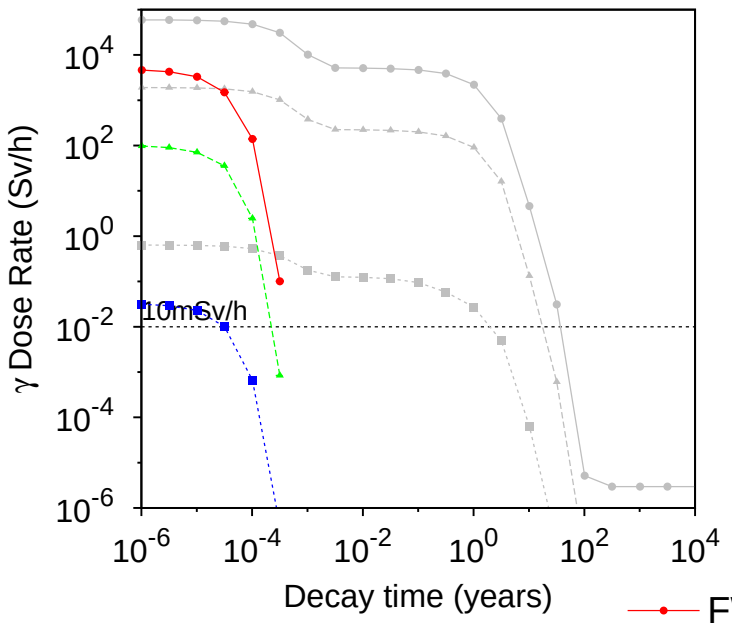


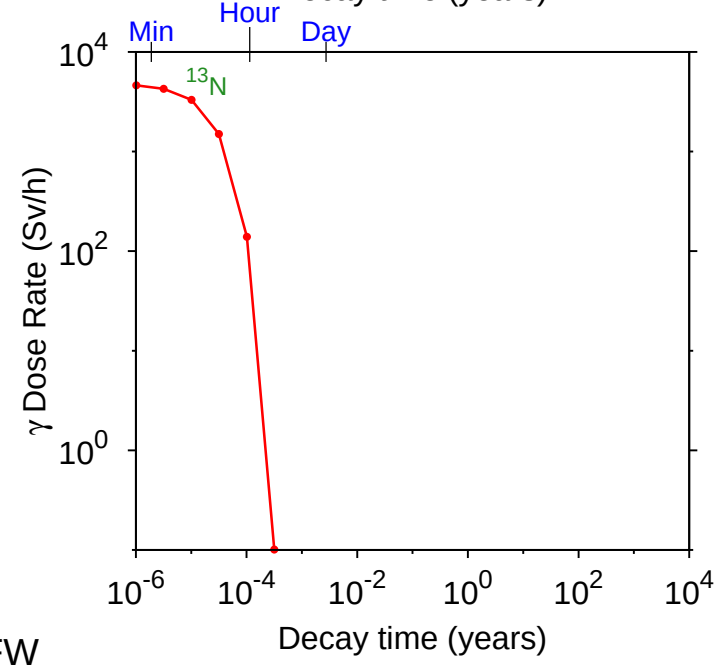
Heat Output





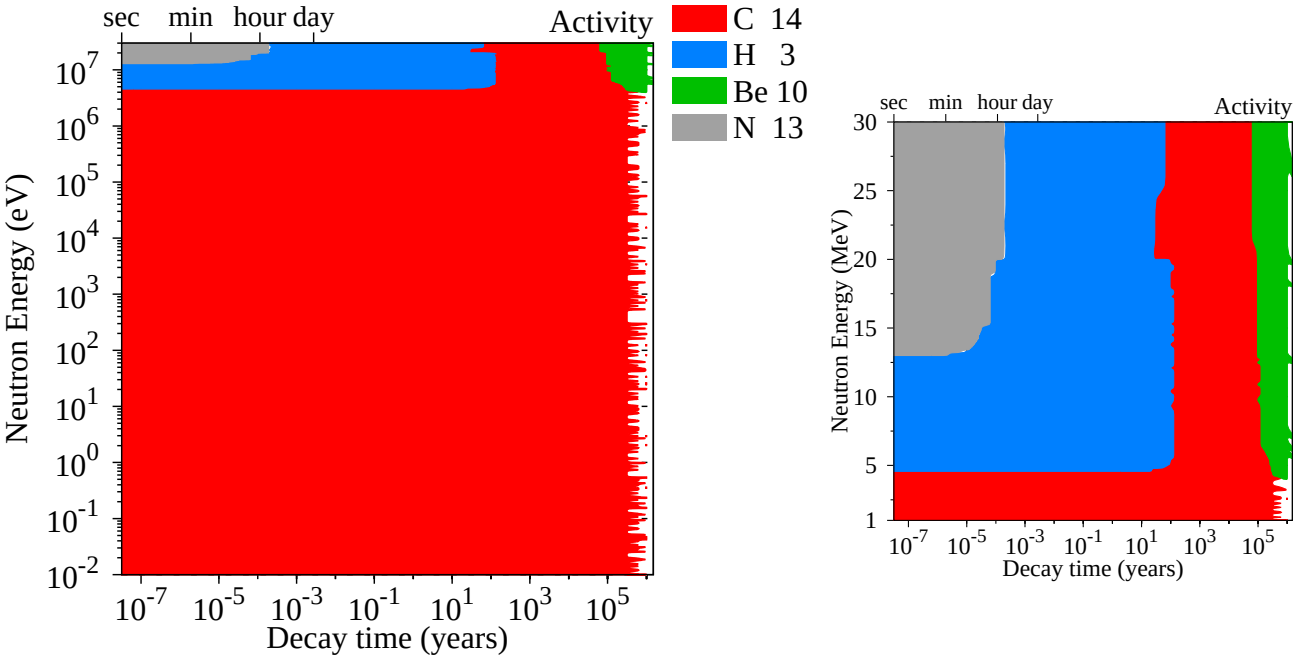
γ Dose Rate

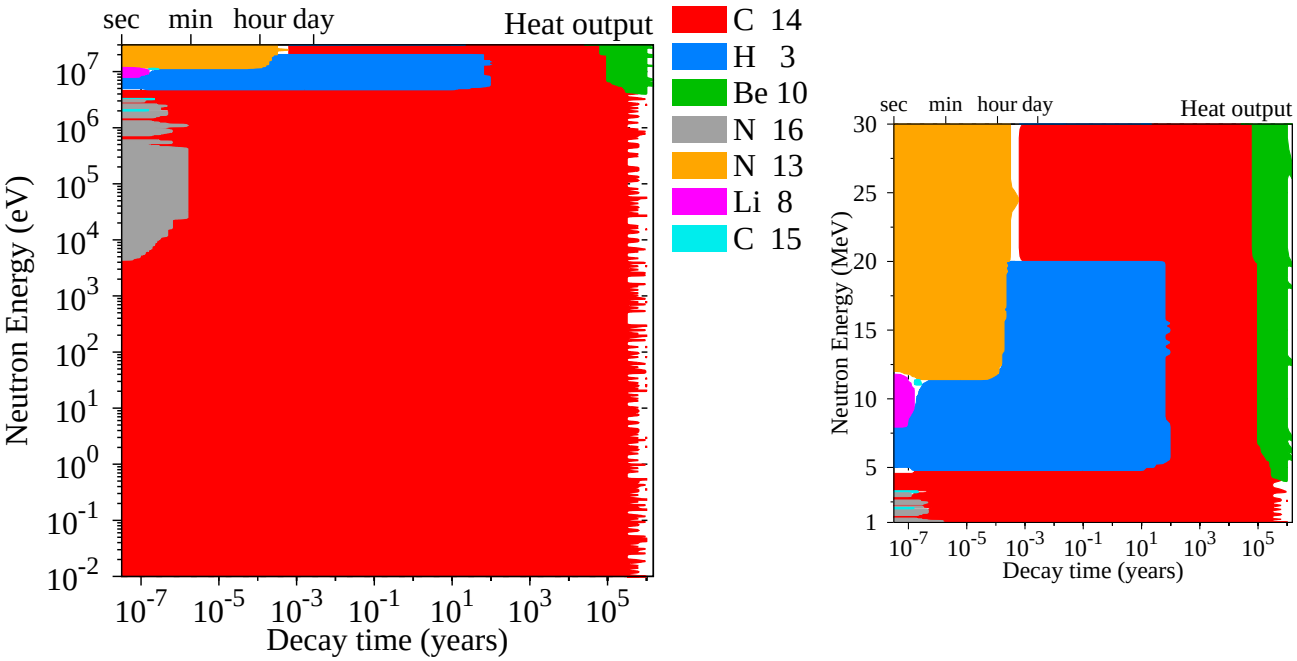


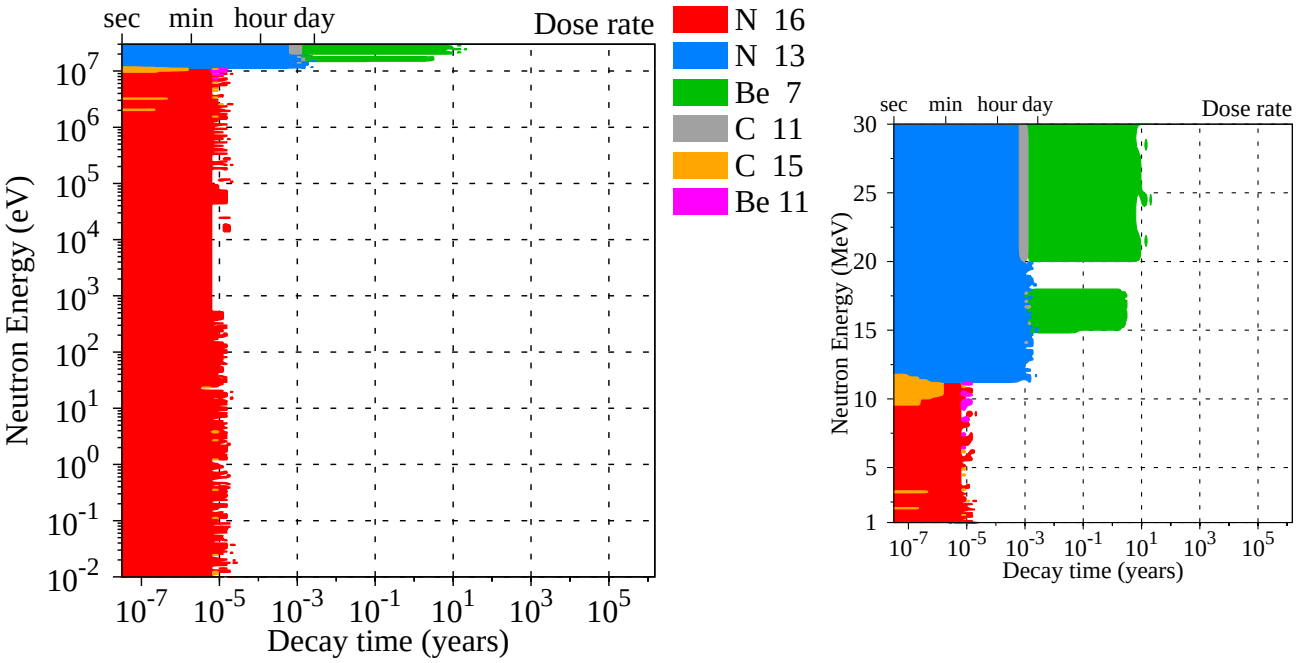


FW
Blanket
Manifold
Fe results

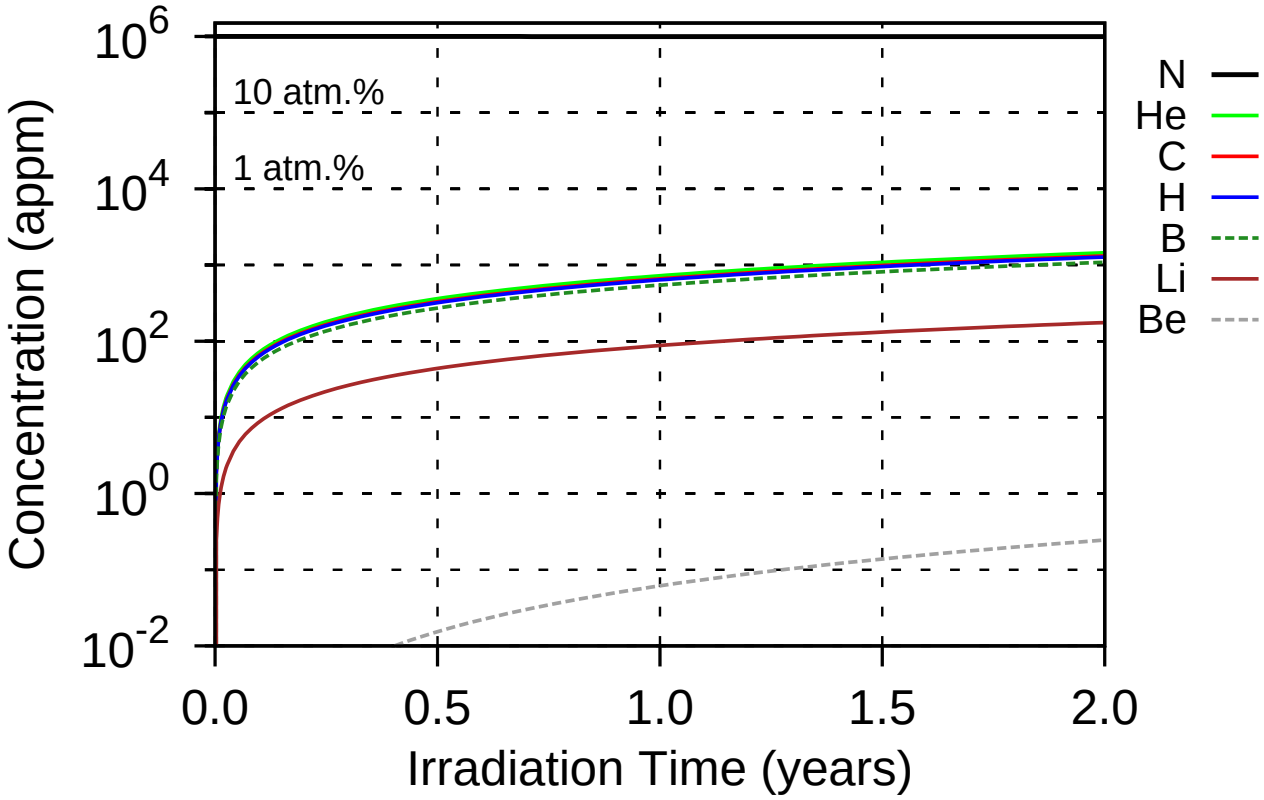
Nitrogen Importance diagrams



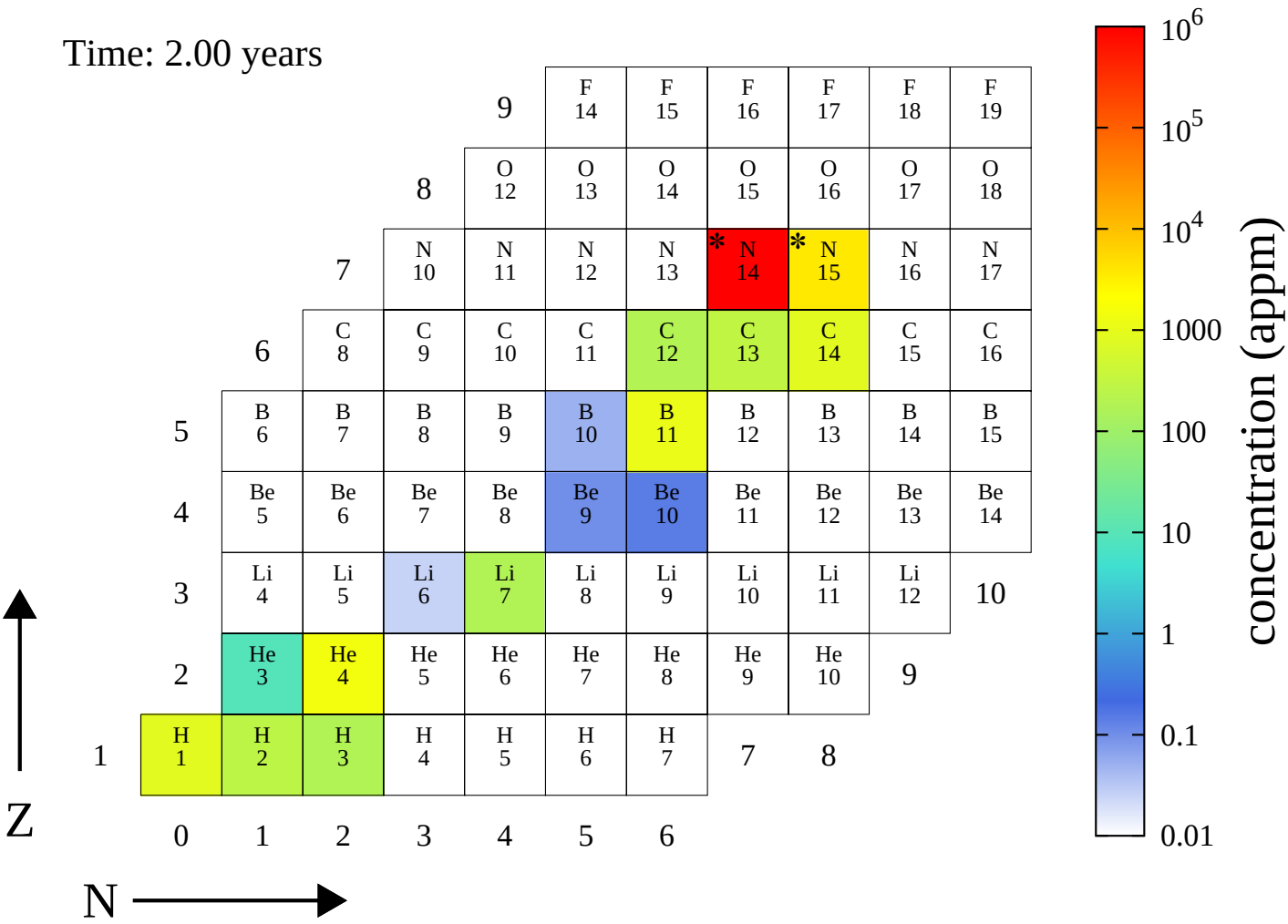




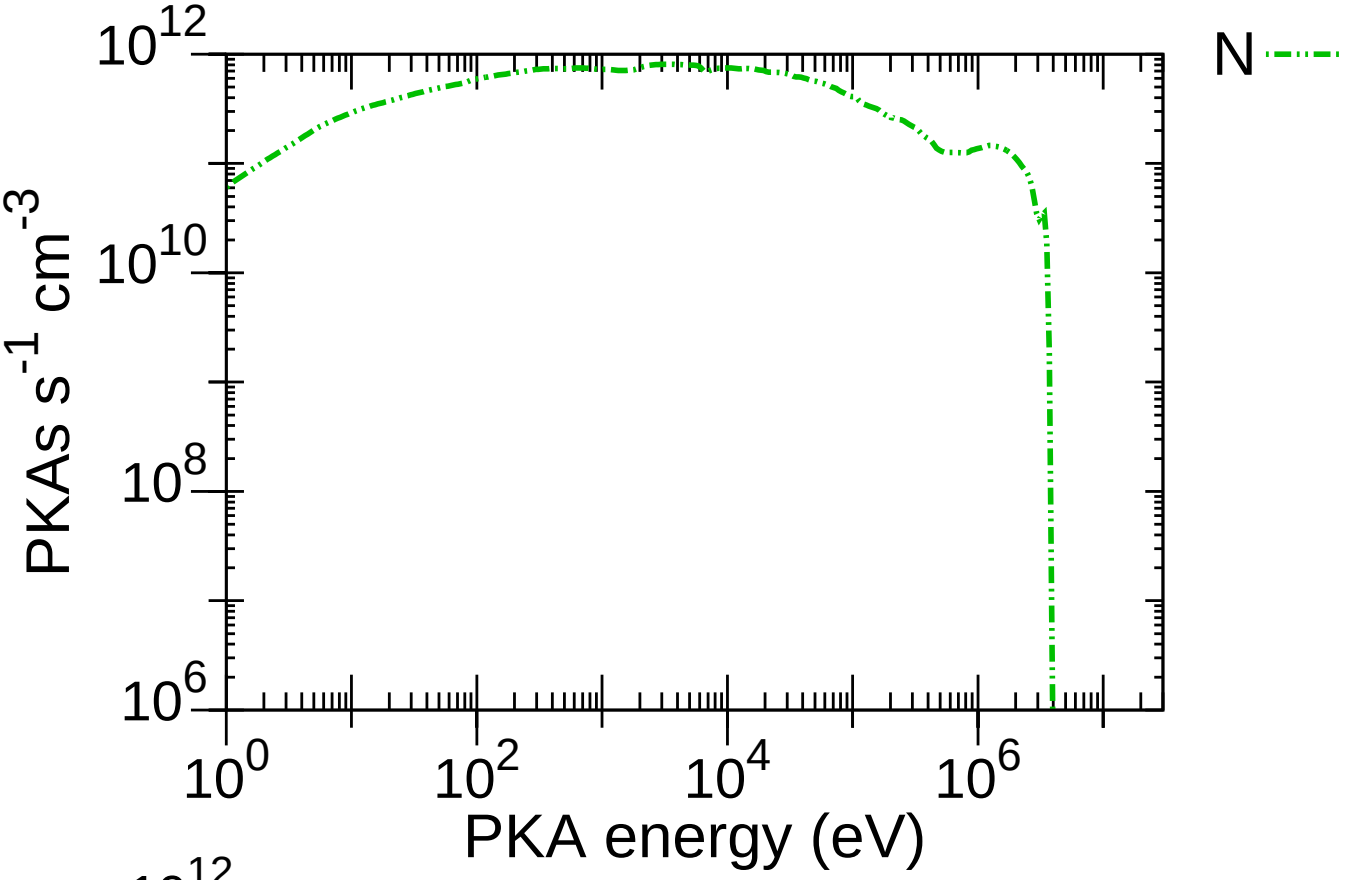
Nitrogen FW Transmutation

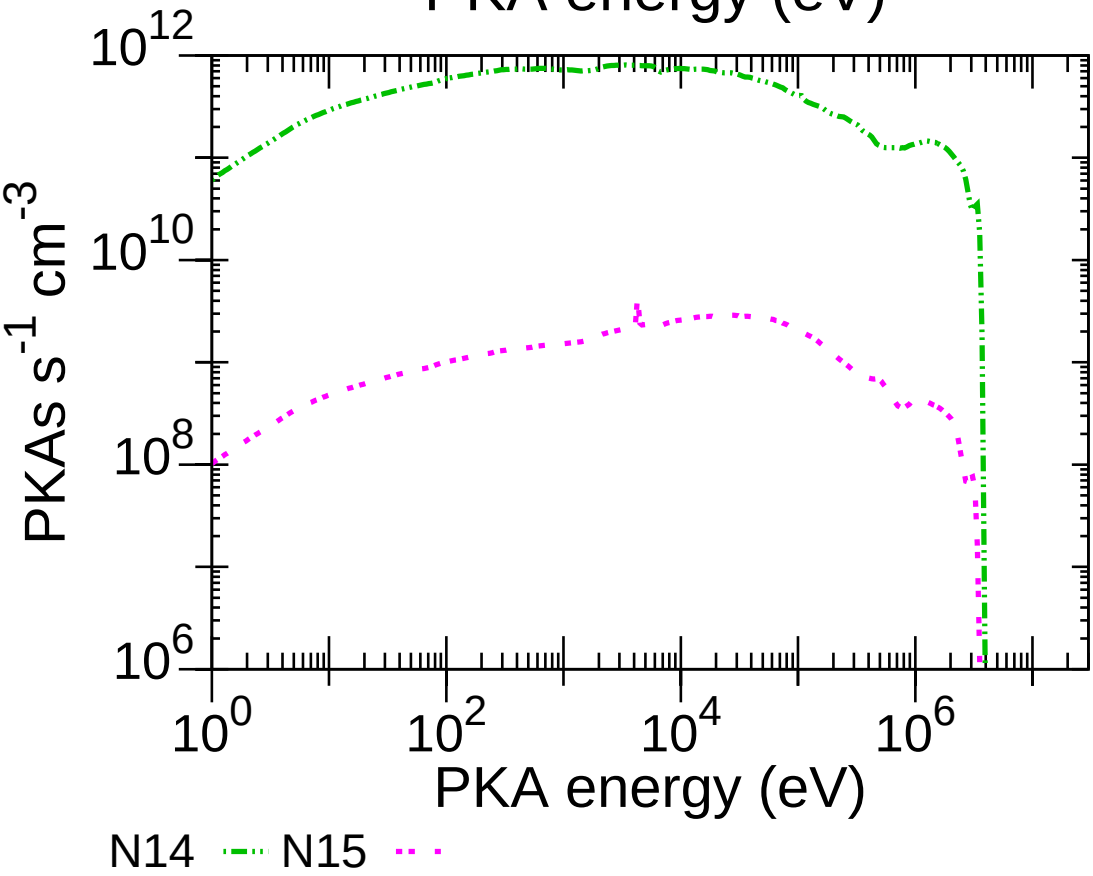


723 appm He & 638 appm H after 1 year 11 dpa/year



Nitrogen FW PKA distributions





Nitrogen Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
B12	0.02s	N14(n,α)B11(n,γ)B12			100.0	
		N15(n,α)B12				99.7
Li8	0.84s	N14(n,α)B11(n,α)Li8				99.9
C15	2.45s	N14(n,p)C14(n,γ)C15	100.0	100.0	100.0	
		N15(n,p)C15				99.8
N16	7.13s	N14(n,γ)N15(n,γ)N16	52.7			
		N15(n,γ)N16	47.3	99.9	99.9	99.6
Be11	13.81s	N14(n,α)B11(n,p)Be11				51.3
		N14(n,p)C14(n,α)Be11				48.4
N13	9.97m	N14(n,2n)N13				100.0
C11	20.37m	N14(n,2n)N13(n,t)C11				100.0
Be7	53.24d	no pathways found				
H3	12.33y	N14(n,p)H1(n,γ)H2(n,γ)H3	100.0	99.9	100.0	
		N14(n,t)H3				99.4
C14	5.7 10^3y	N14(n,p)C14	100.0	100.0	100.0	99.5
Be10	1.6 10^6y	N14(n,d)C13(n,α)Be10				86.7
		N14(n,2n)N13(β^+)C13(n,α)Be10				11.6
		N14(n,α)B11(n,np)Be10				1.2

Oxygen

Isotope	Atom % abundance
O16	99.76
O17	0.04
O18	0.20

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.46E+14	1.89E+09	1.89E+09	1.80E+09	2.09E+08	5.97E+07
N16	99.6					
H3		89.1	89.2	88.7	4.0	
C14		10.7	10.7	11.3	95.9	99.6

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.70E-01	4.18E-09	3.16E-09	3.07E-09	1.61E-09	4.81E-10
N16	99.7					
C14		38.5	50.9	52.3	98.9	97.9
H3		36.9	48.8	47.4	0.5	
O19		16.0				
F18		5.6				
N13		2.7				
Be10		0.2	0.3	0.3	0.6	2.1

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.45E+05	7.02E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
N16	99.7	0.4				
O19		53.4				
F18		32.9				
N13		13.3				

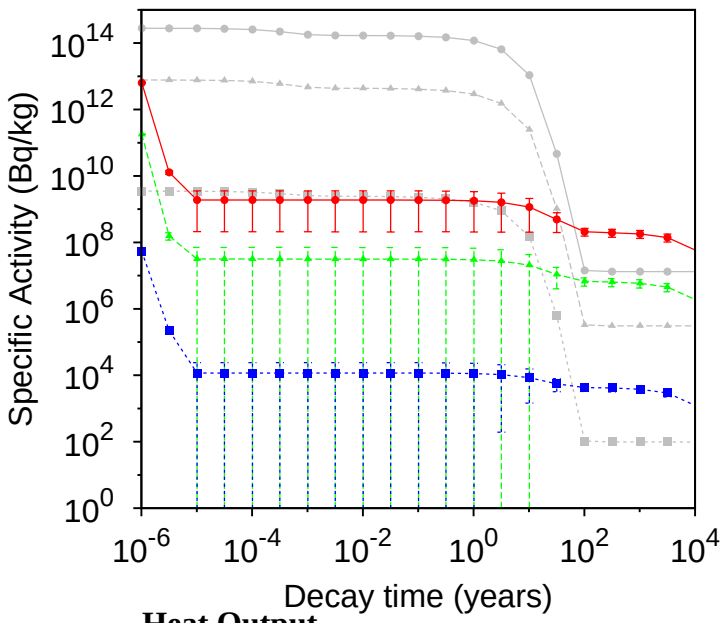
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.06E+02	1.89E-01	1.89E-01	1.85E-01	1.17E-01	3.47E-02
N16	99.7					
C14	0.1	62.3	62.3	63.6	99.5	99.2
H3	0.1	37.5	37.5	36.2	0.3	

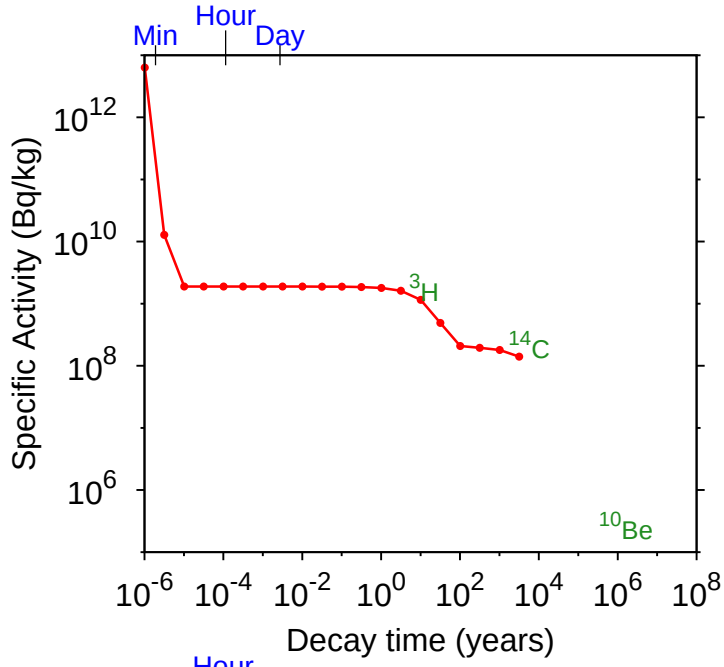
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	8.16E+01	1.62E+00	1.62E+00	1.60E+00	1.17E+00	3.53E-01
N16	97.9					
C14	1.4	72.5	72.5	73.5	99.1	97.6
H3	0.5	27.0	27.0	25.9	0.2	
Be10		0.5	0.5	0.5	0.7	2.4

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	7.28E+11	2.22E+05	2.20E+05	2.19E+05	2.00E+05	5.94E+04
N16	99.7					
C14		91.3	92.3	92.7	100.0	100.0
H3		7.6	7.7	7.3		

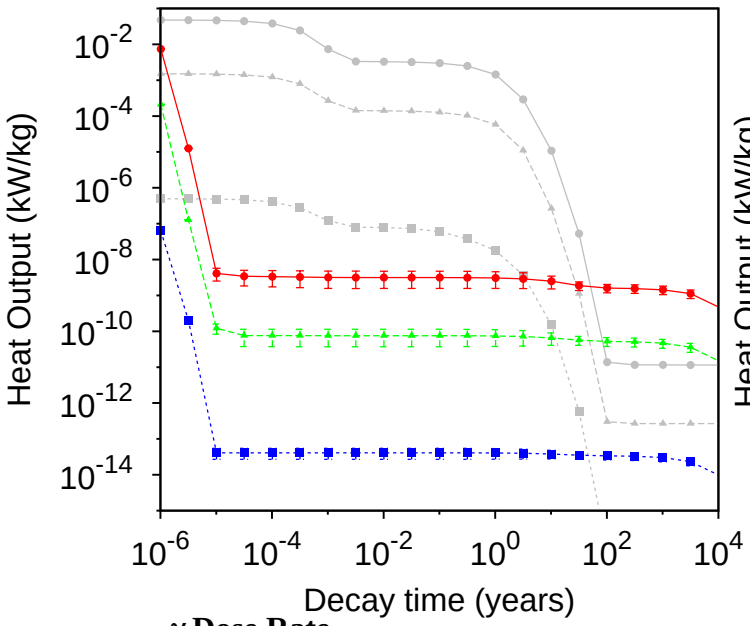
Oxygen activation characteristics

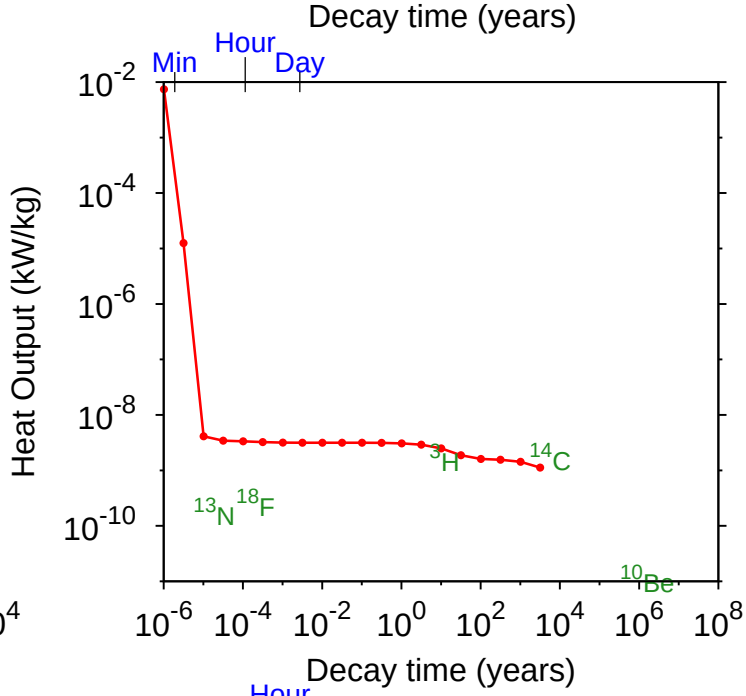
Specific Activity



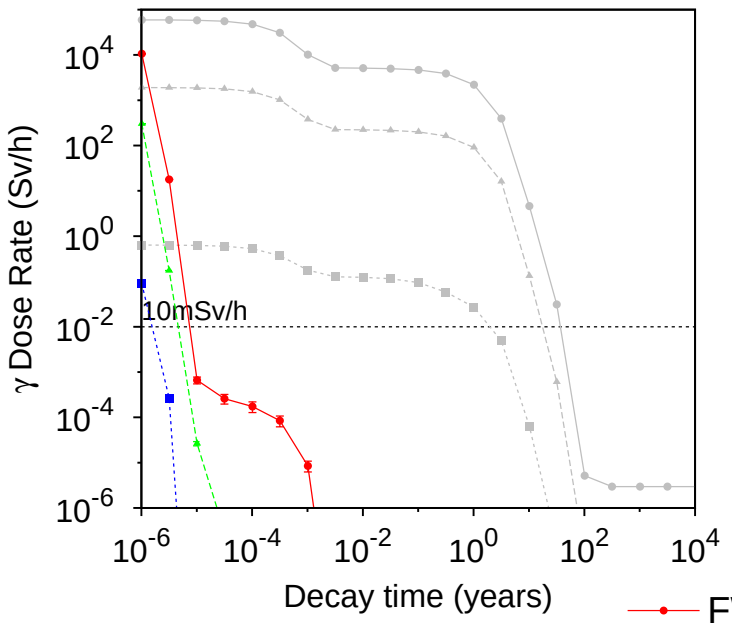


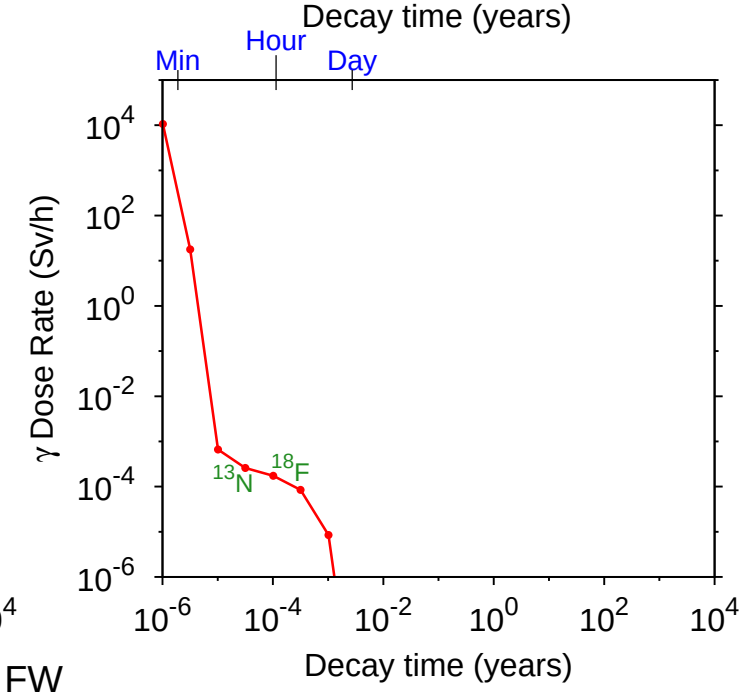
Heat Output





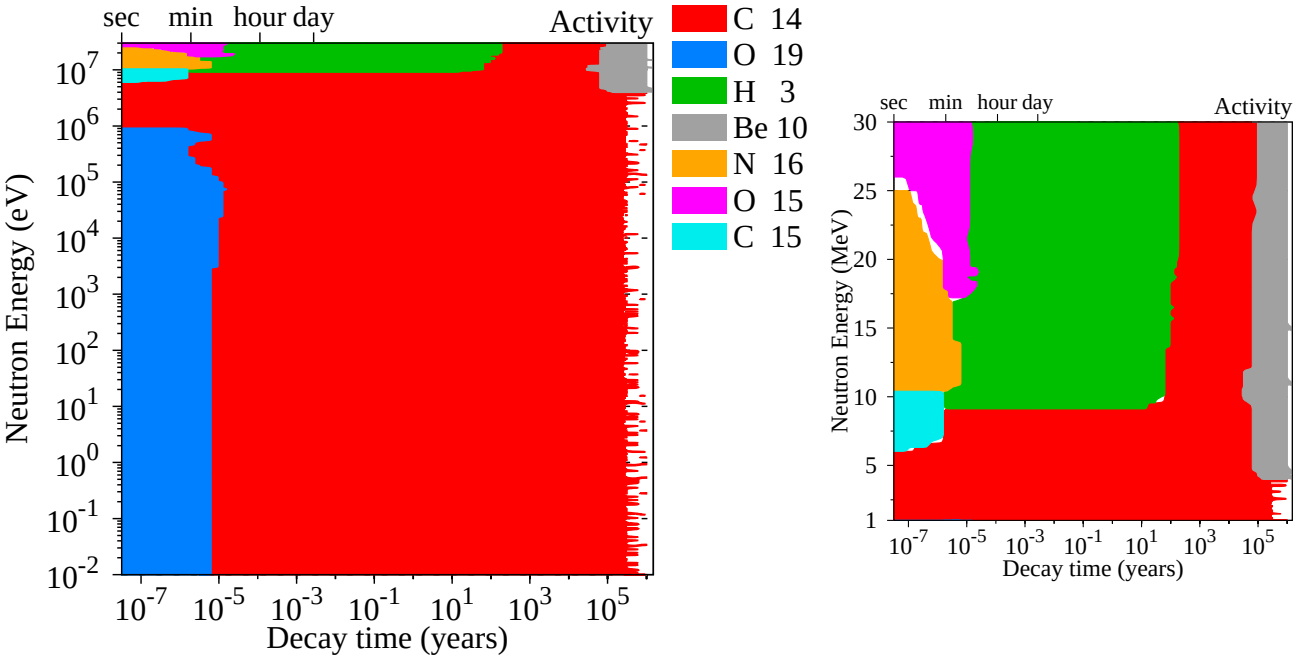
γ Dose Rate

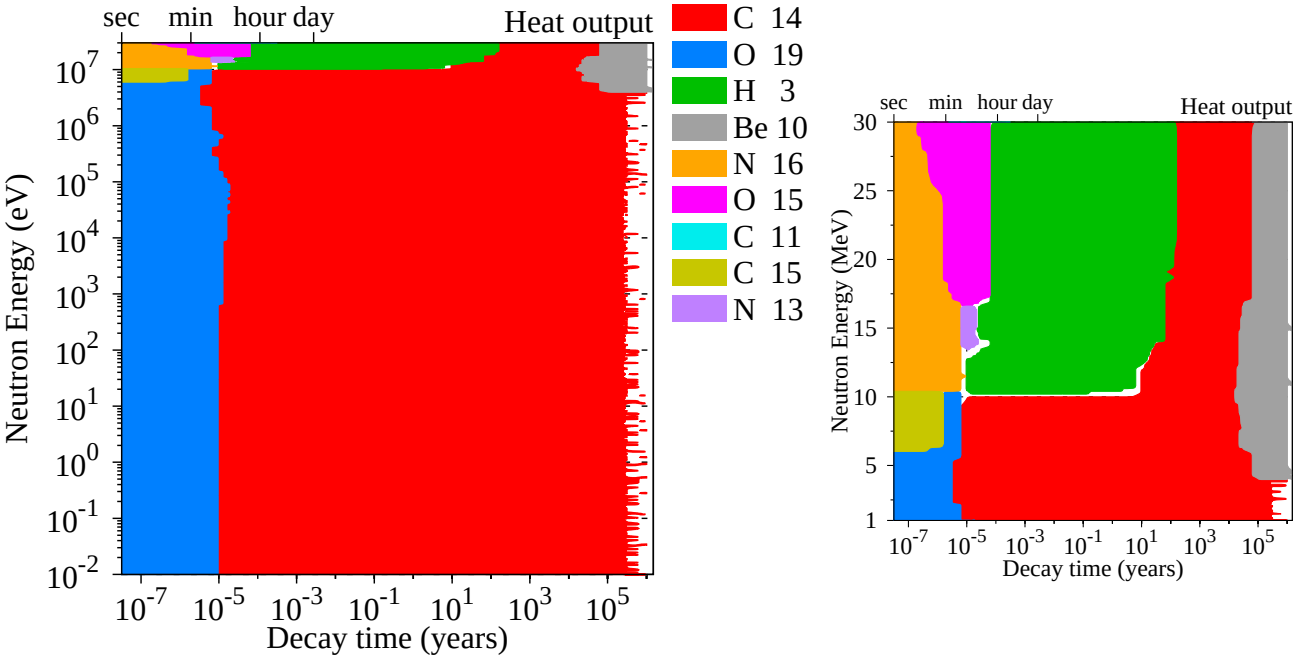


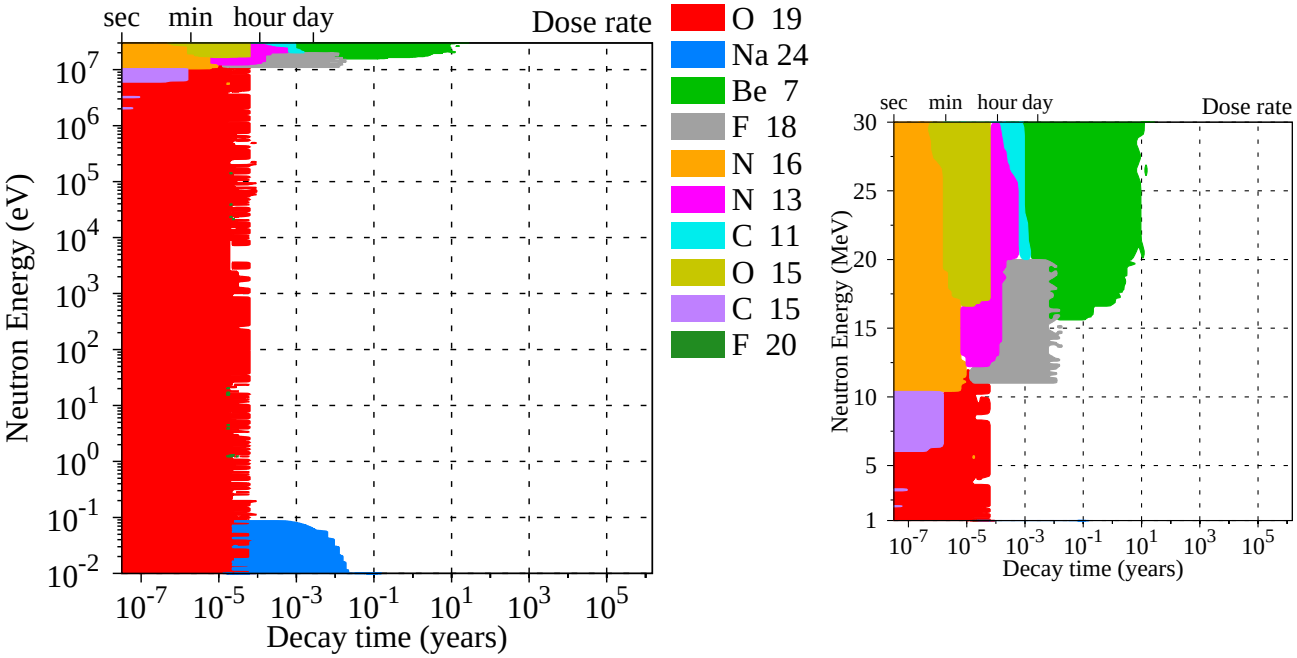


FW
Blanket
Manifold
Fe results

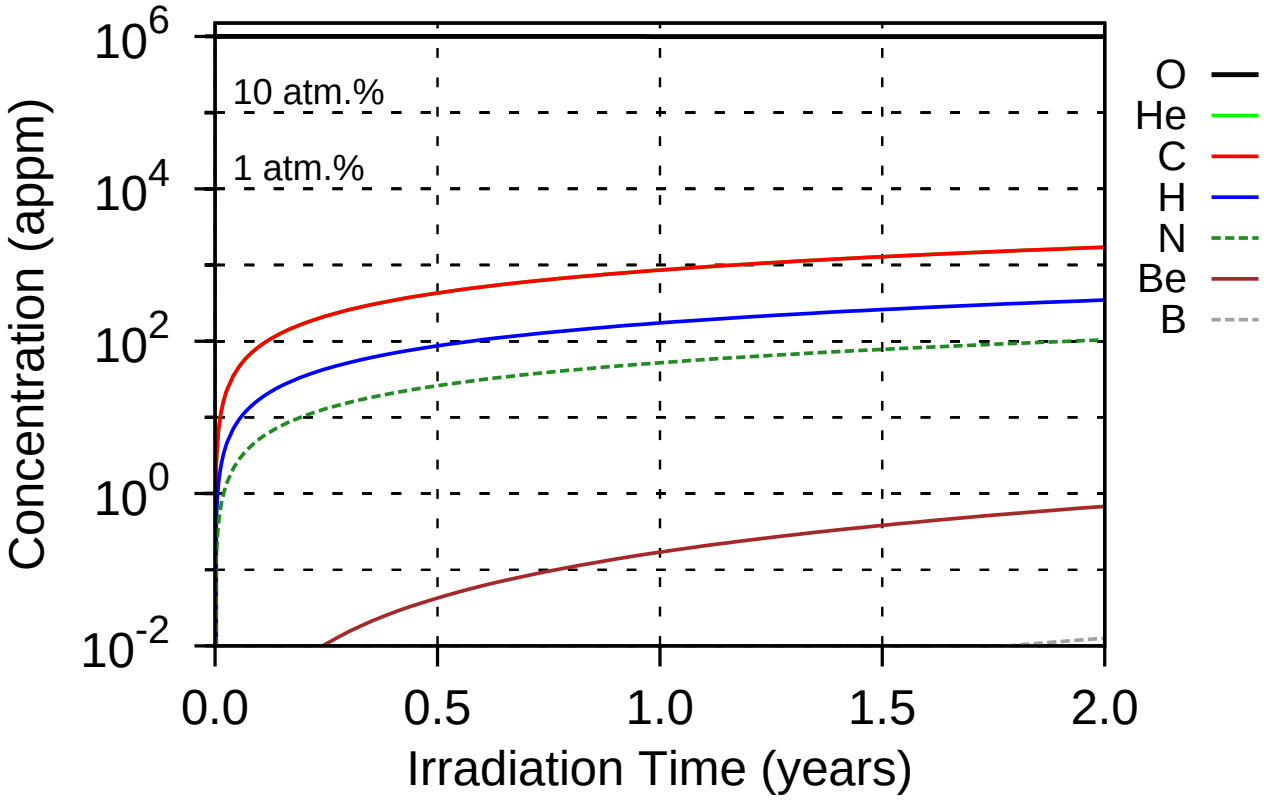
Oxygen Importance diagrams



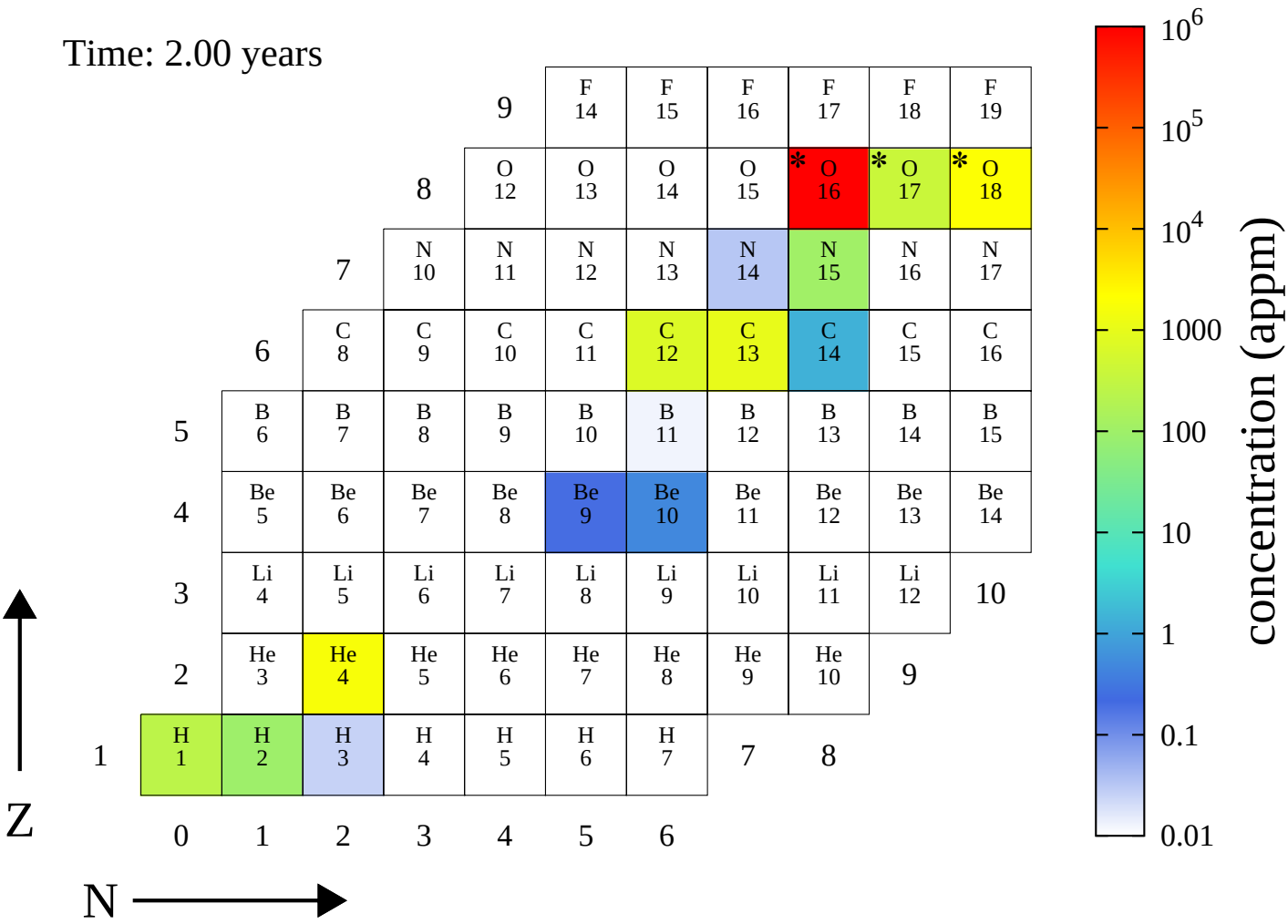




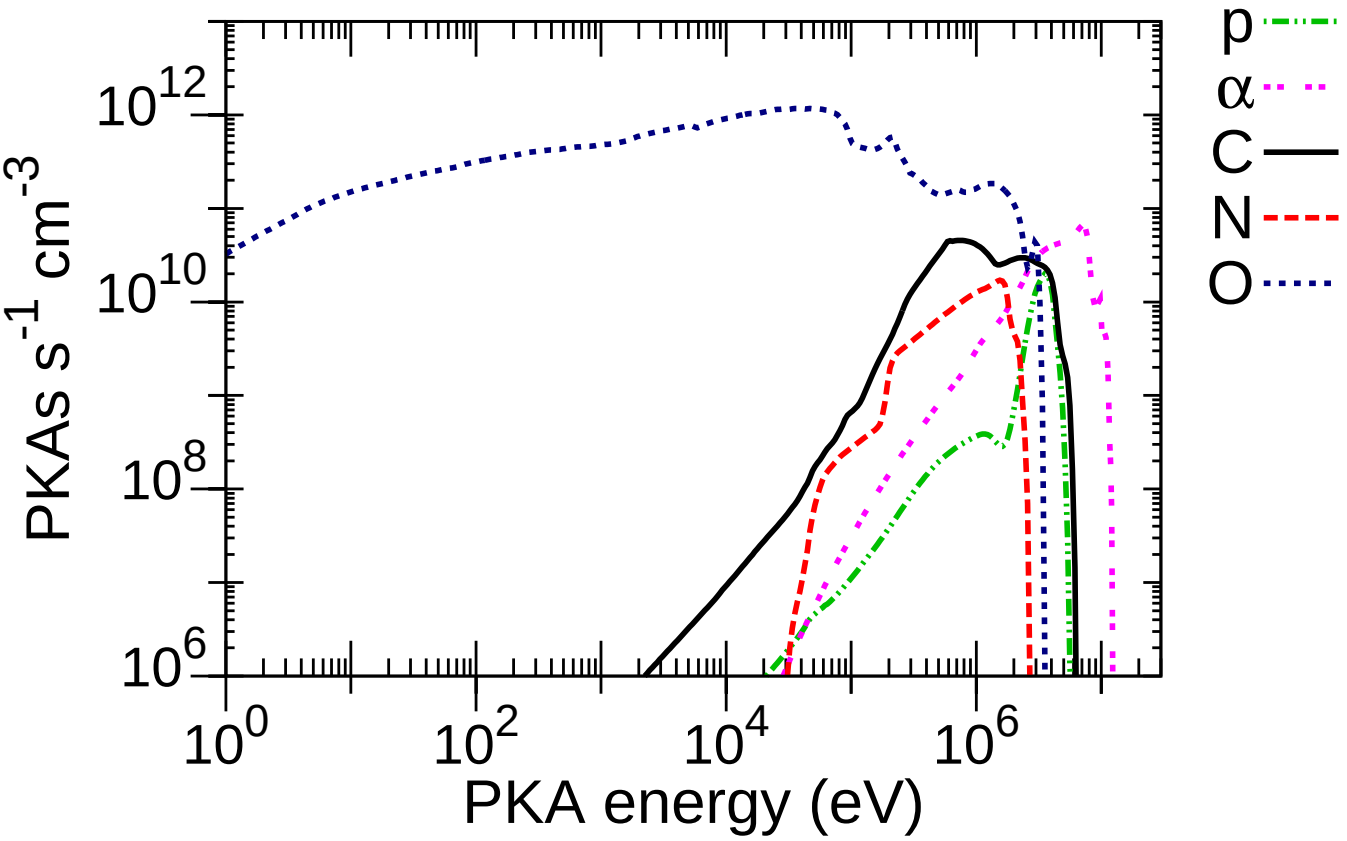
Oxygen FW Transmutation

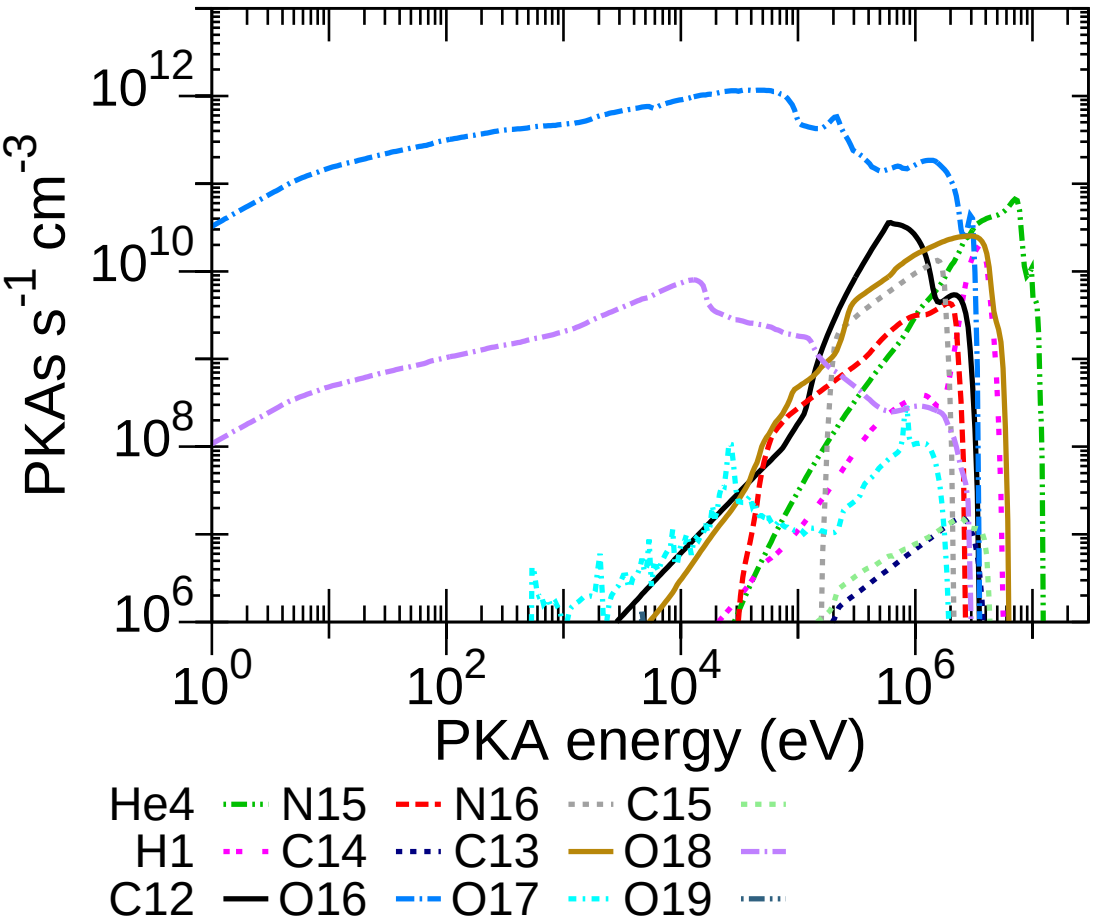


858 appm He & 174 appm H after 1 year 14 dpa/year



Oxygen FW PKA distributions





Oxygen Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
C15	2.45s	O17(n,α)C14(n,γ)C15	98.6		99.2	
		O16(n,γ)O17(n,α)C14(n,γ)C15	1.4			
		O18(n,α)C15				85.9
		O16(n,d)N15(n,p)C15				12.9
		O16(n,np)N15(n,p)C15				1.1
N16	7.13s	O18(n,γ)O19(β^-)F19(n,α)N16			99.6	
		O16(n,p)N16				99.7
F20	11.03s	O18(n,γ)O19(β^-)F19(n,γ)F20	100.0	100.0	100.0	99.7
O19	26.91s	O18(n,γ)O19	100.0	100.0	100.0	99.9
O15	2.04m	no pathways found				
N13	9.97m	O16(n,d)N15(n,2n)N14(n,2n)N13				91.4
		O16(n,np)N15(n,2n)N14(n,2n)N13				7.7
C11	20.37m	no pathways found				
F18	1.83h	O18(n,γ)O19(β^-)F19(n,2n)F18				99.9
Na24	14.96h	no pathways found				
Be7	53.24d	no pathways found				
H3	12.33y	O17(n,α)C14(β^-)N14(n,p)H1(n,γ)H2(n,γ)H3	99.5			
		O16(n,α)C13(n,t)H3				55.3
		O16(n,d)N15(n,t)H3				33.6
		O17(n,t)H3				6.7
		O16(n,np)N15(n,t)H3				2.8
C14	5.7 10^3y	O17(n,α)C14	98.6	99.8	99.2	22.2
		O16(n,γ)O17(n,α)C14	1.4			
		O18(n,nα)C14				59.2
		O16(n,d)N15(n,np)C14				11.2
		O16(n,d)N15(n,d)C14				4.2
		O18(n,2n)O17(n,α)C14				1.3
Be10	1.6 10^6y	O16(n,α)C13(n,α)Be10				99.9

Fluorine

Isotope	Atom % abundance
F19	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.81E+14	1.18E+14	3.99E+12	3.78E+12	1.86E+10	2.43E+07
N16	44.9					
F18	31.0	96.6				
O19	18.6					
F20	4.2					
H3	1.0	3.4	100.0	100.0	99.6	
C14					0.4	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.66E-01	2.26E-02	3.65E-06	3.46E-06	1.75E-08	1.93E-10
N16	75.3					
O19	11.6					
F18	8.8	99.9				
F20	4.0					
H3			100.0	100.0	96.7	
C14					3.3	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	3.50E+05	2.34E+04	4.02E-10	0.00E+00	0.00E+00	0.00E+00
N16	85.5					
F18	6.9	100.0	100.0			
O19	5.2					
F20	2.3					

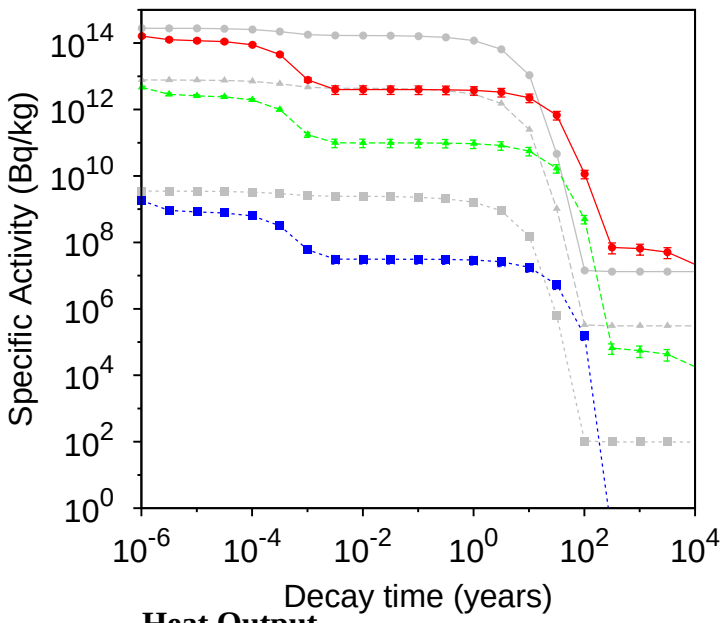
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.16E+03	5.77E+03	1.68E+02	1.59E+02	8.19E-01	1.41E-02
F18	94.0	97.1				
H3	2.7	2.9	100.0	100.0	94.9	
N16	2.0					
O19	1.2					
C14					5.1	100.0

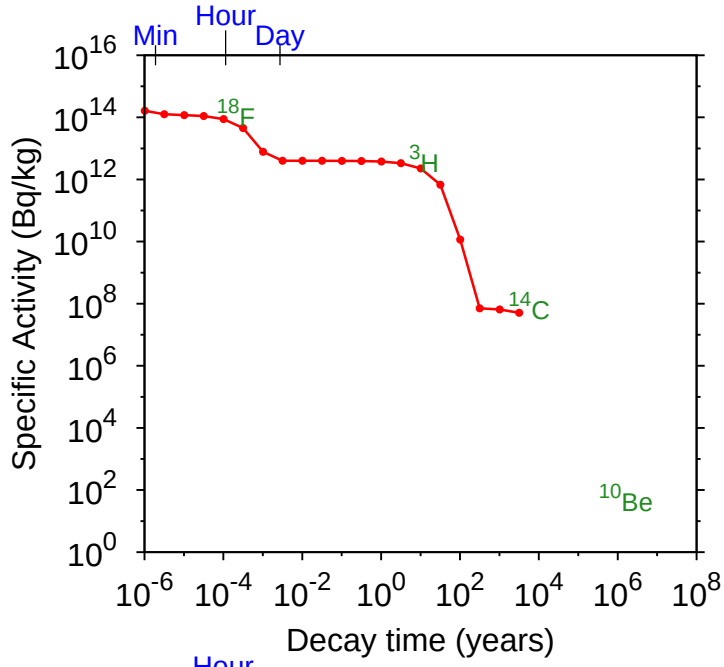
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	8.17E+03	7.78E+03	1.04E+03	9.83E+02	5.23E+00	1.41E-01
F18	85.4	86.6				
H3	12.7	13.3	100.0	100.0	92.0	
N16	1.2					
C14					8.0	100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	9.82E+11	1.15E+10	4.00E+07	3.79E+07	2.57E+05	2.43E+04
N16	87.0					
O19	8.5	0.2				
F20	3.1					
F18	1.2	99.4				
H3		0.3	99.8	99.8	71.8	
C14			0.2	0.2	28.2	100.0

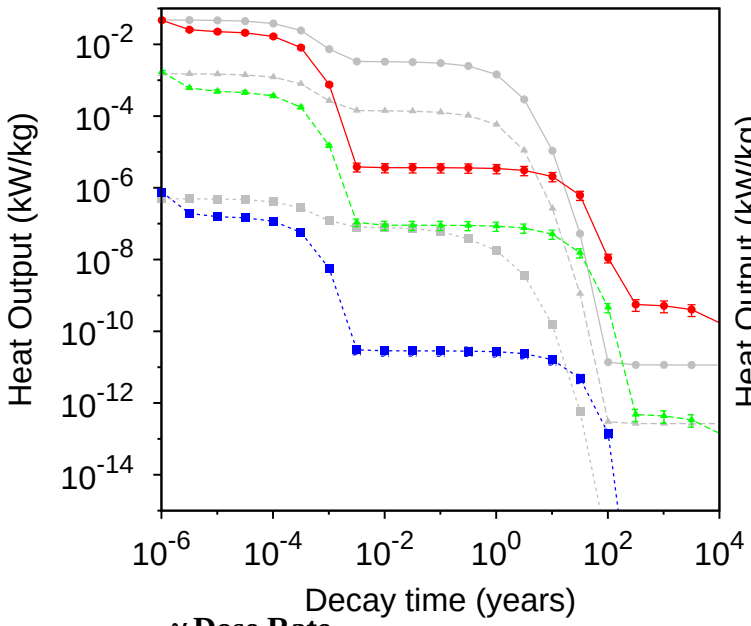
Fluorine activation characteristics

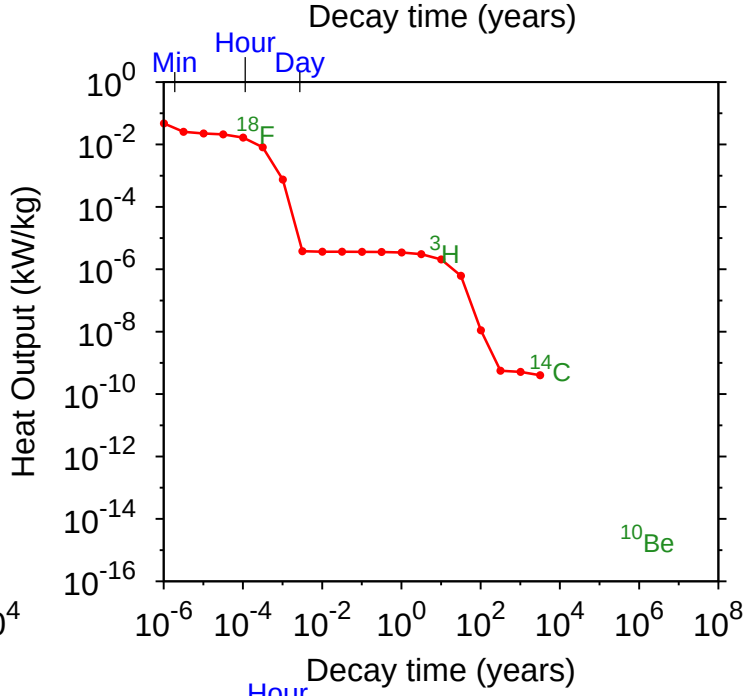
Specific Activity



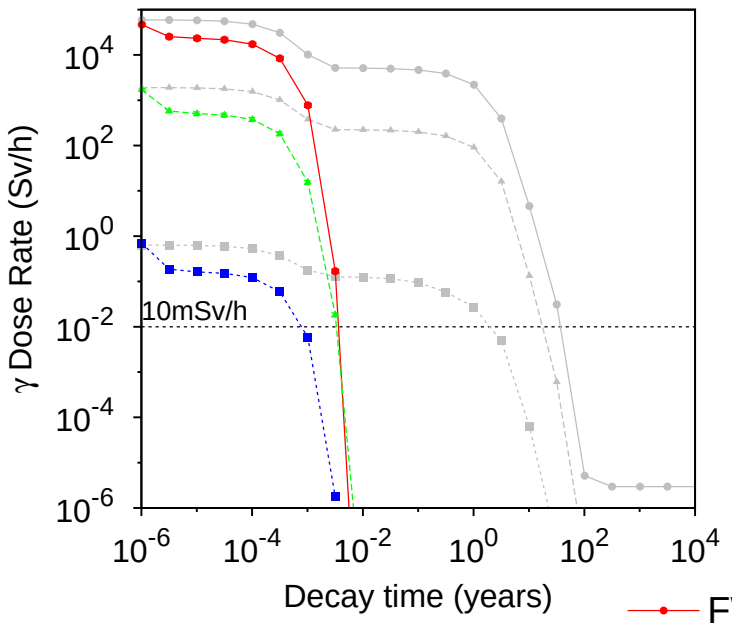


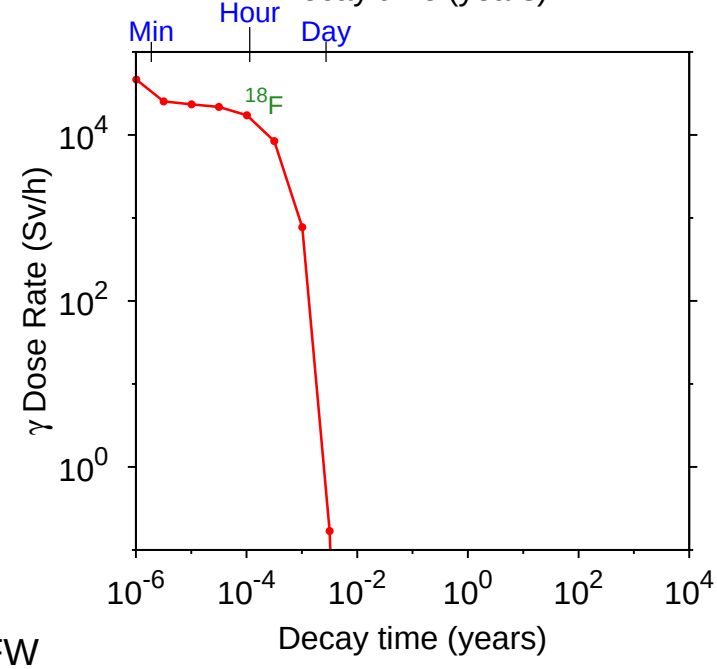
Heat Output





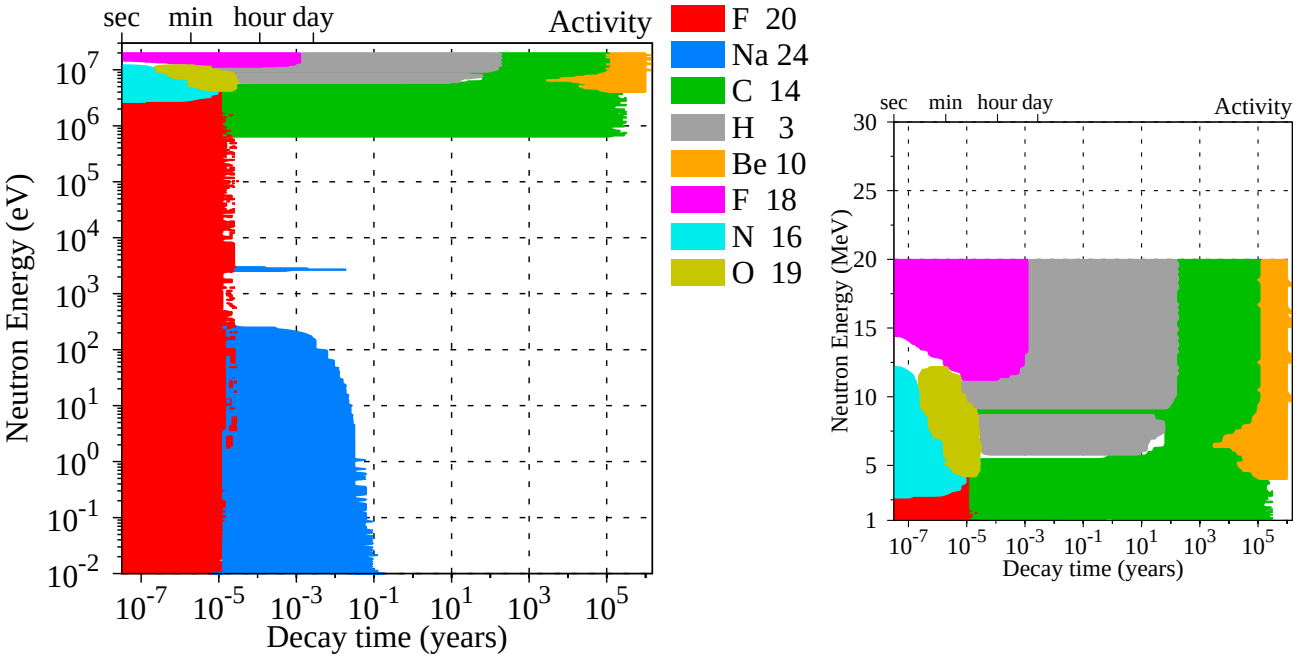
γ Dose Rate

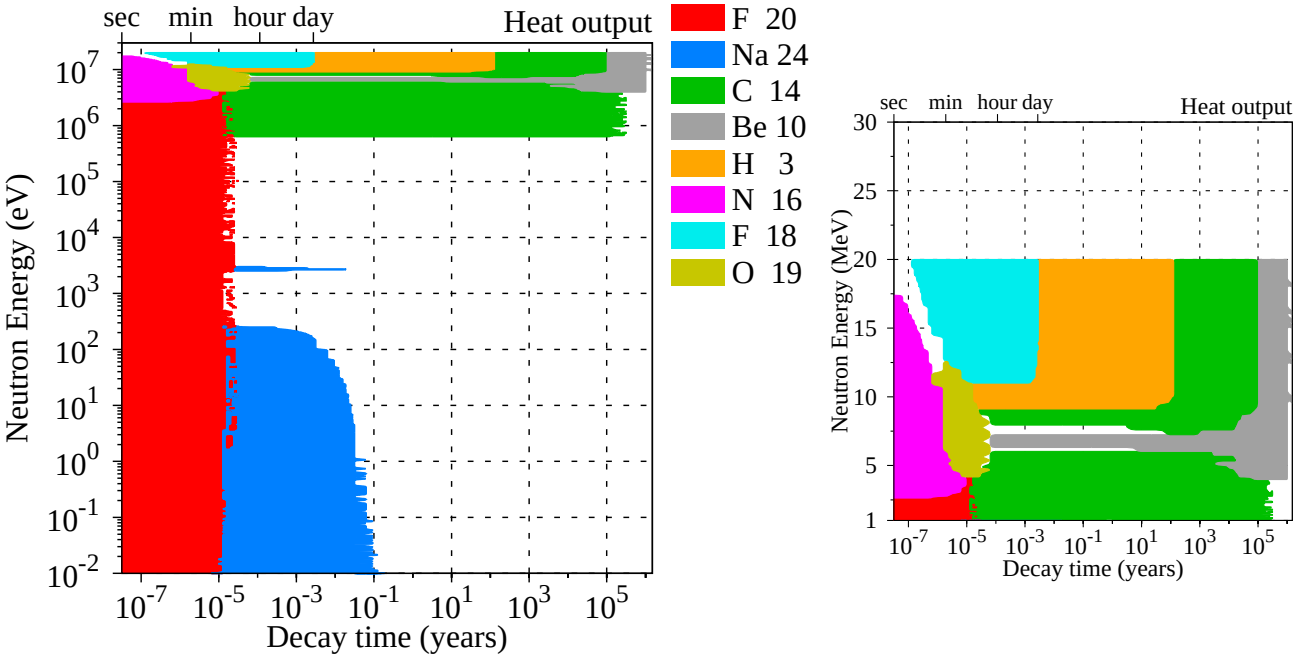


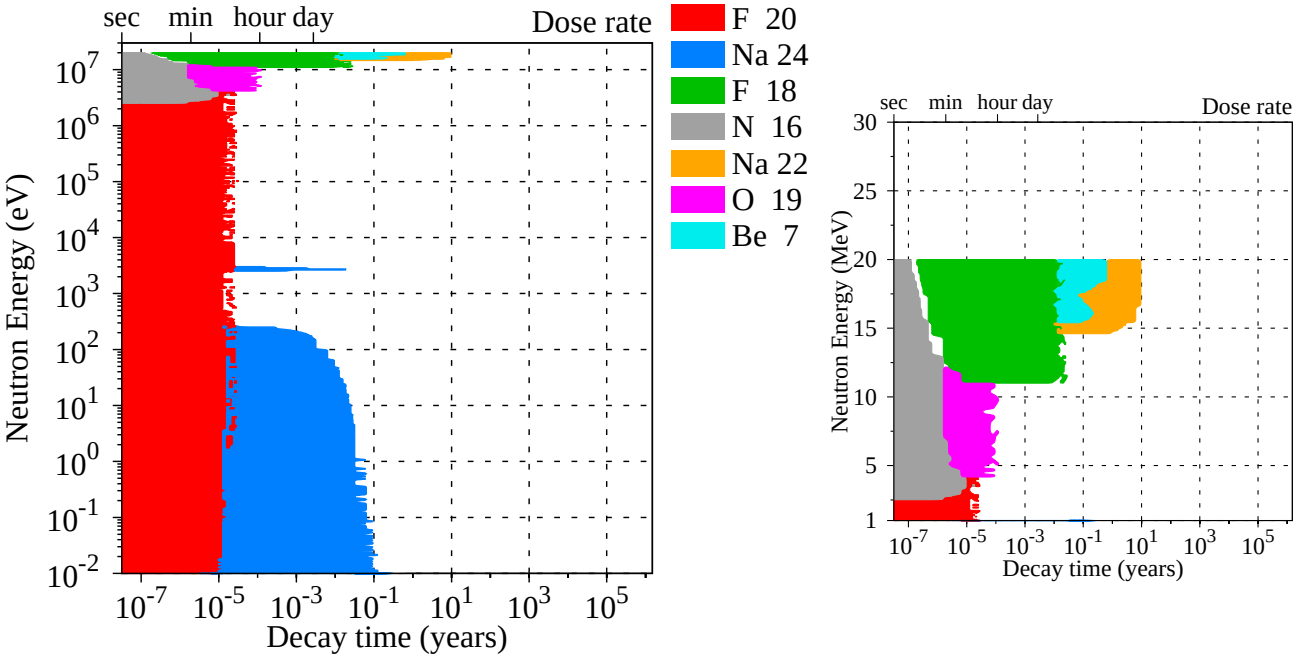


FW
Blanket
Manifold
Fe results

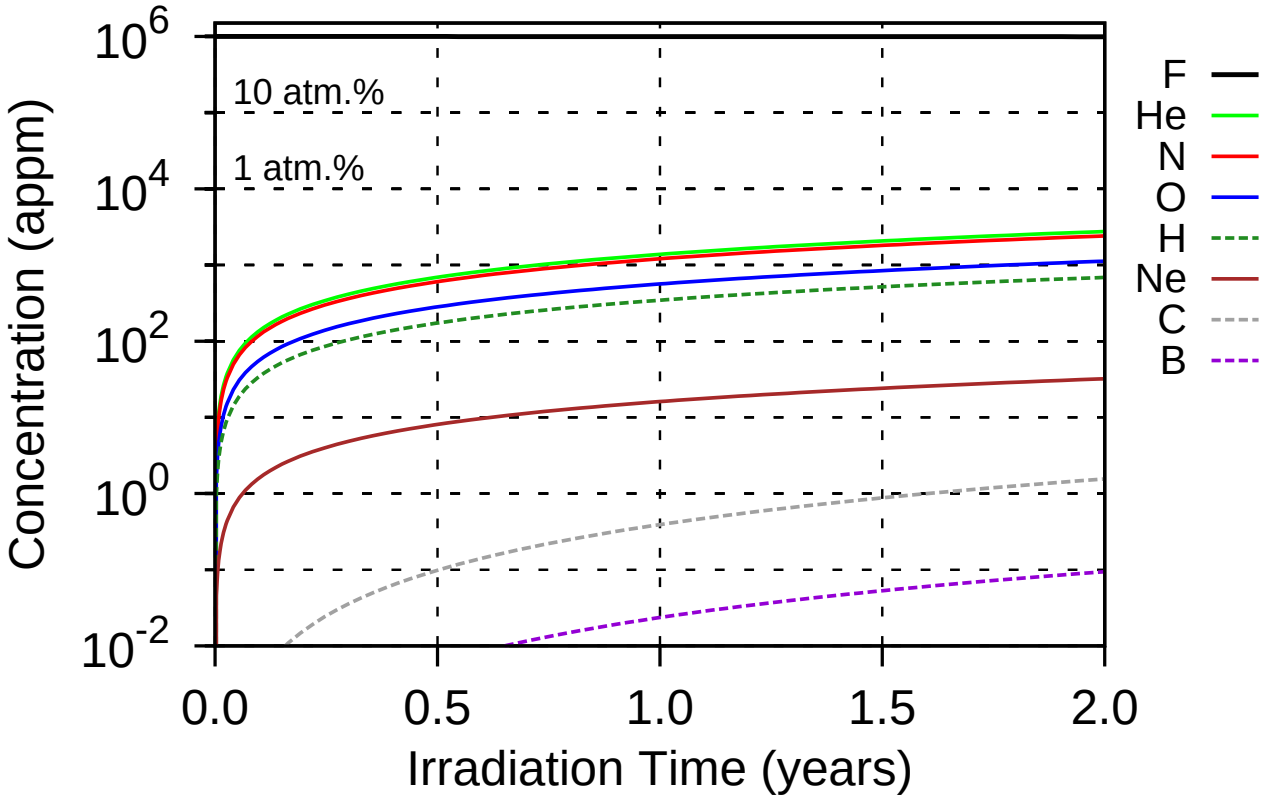
Fluorine Importance diagrams



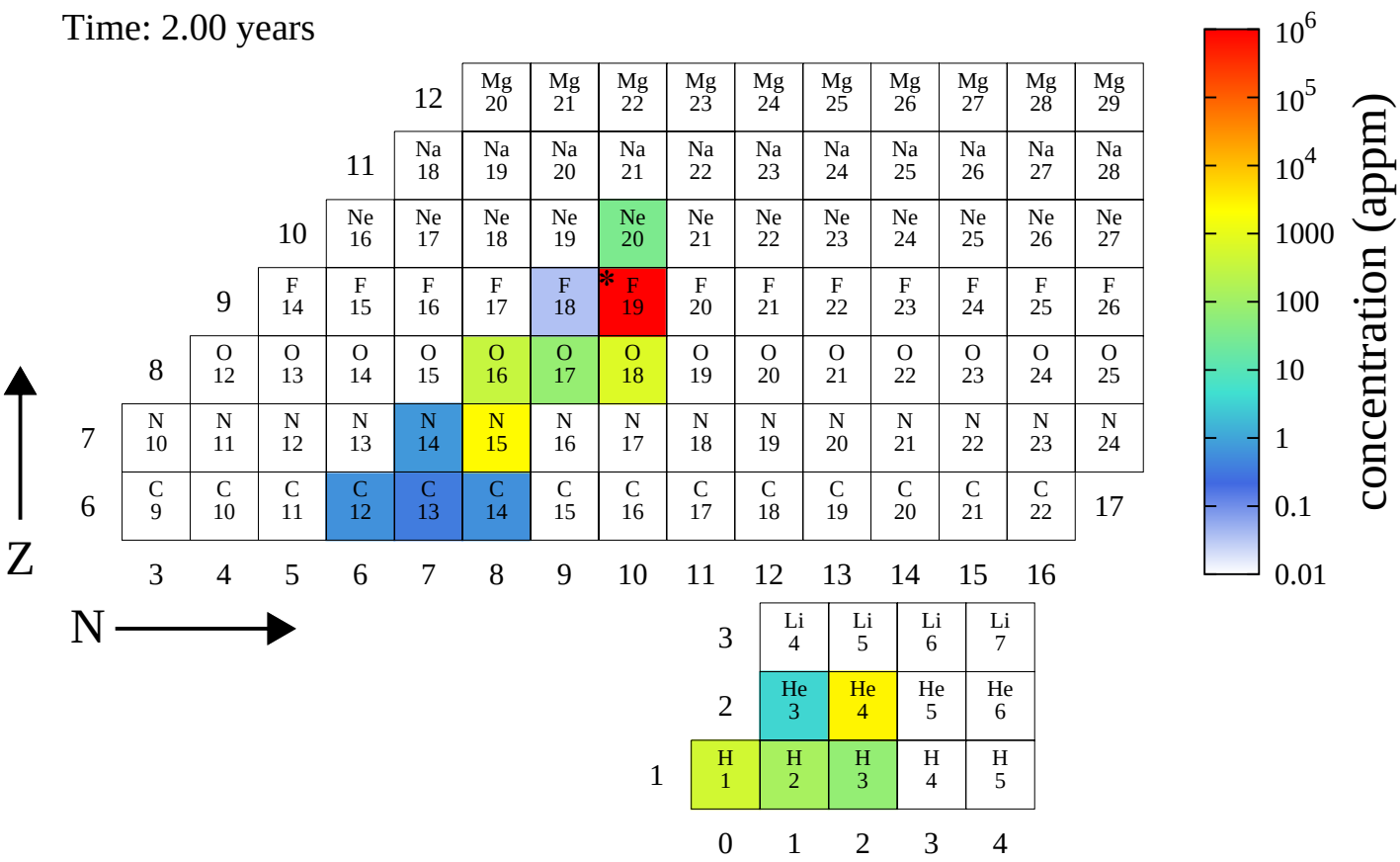




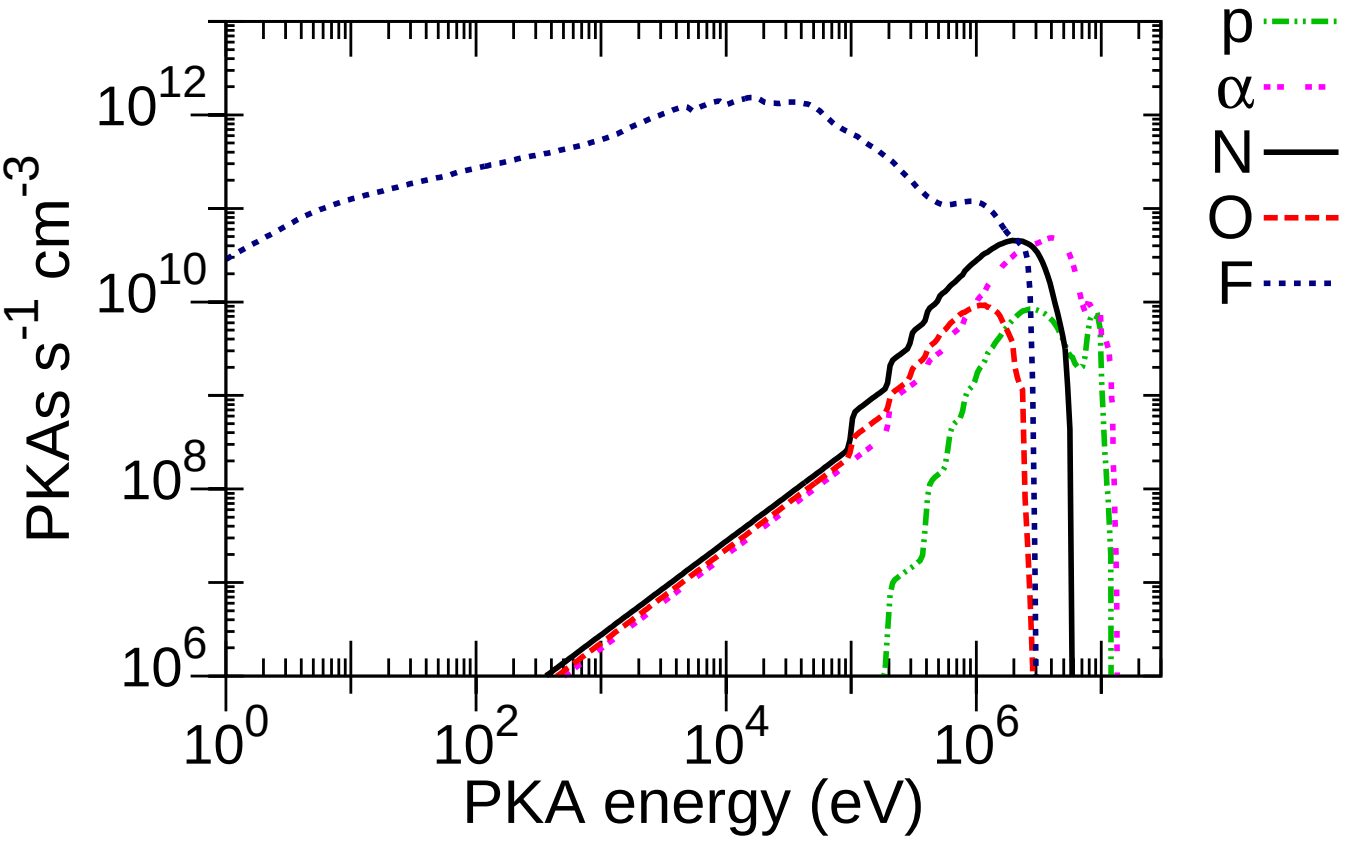
Fluorine FW Transmutation

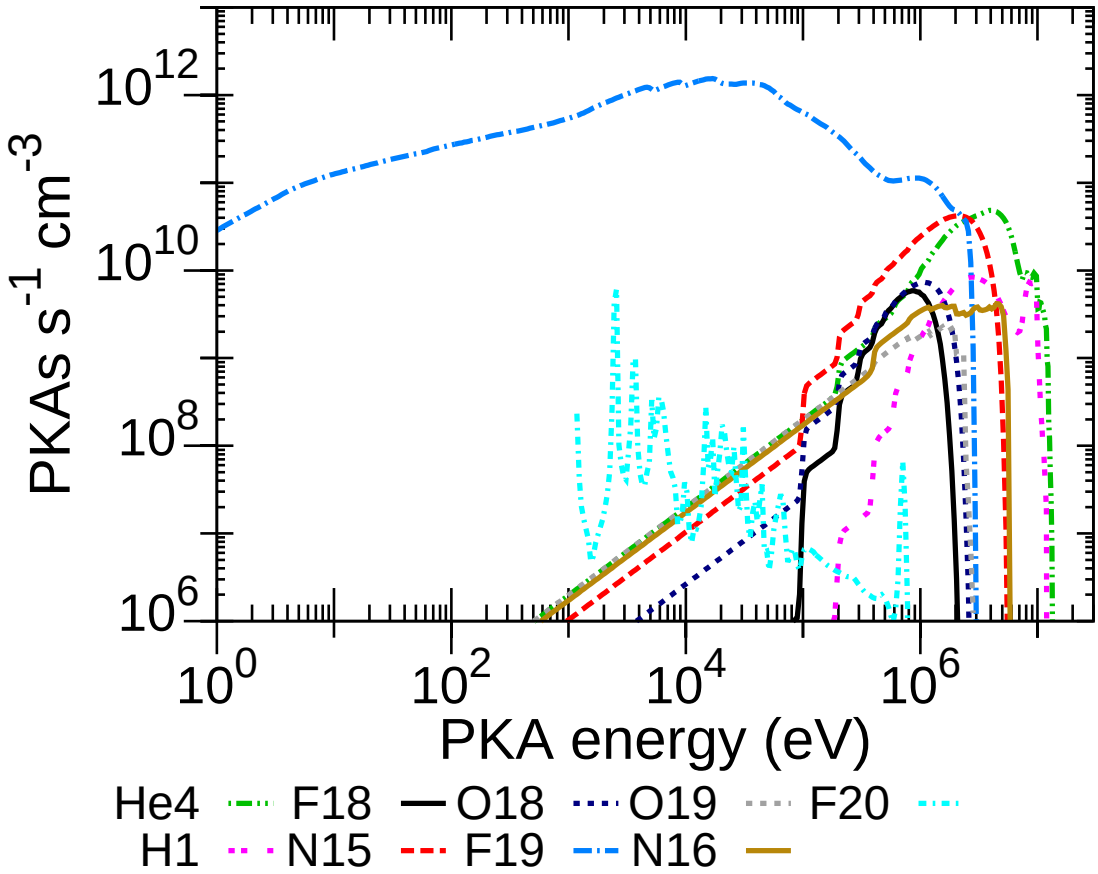


1379 appm He & 345 appm H after 1 year 19 dpa/year



Fluorine FW PKA distributions





Fluorine Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
N16	7.13s	F19(n,α)N16			100.0	99.6
F20	11.03s	F19(n,γ)F20	100.0	100.0	100.0	99.3
O19	26.91s	F19(n,p)O19				99.9
F18	1.83h	F19(n,2n)F18				99.9
Na24	14.96h	F19(n,γ)F20(β^-)Ne20(n,γ)Ne21(n,γ)Ne22(n,γ)Ne23(β^-) Na23(n,γ)Na24	100.0			
Be7	53.24d	no pathways found				
Na22	2.60y	no pathways found				
H3	12.33y	F19(n,t)H3				98.0
		F19(n,nα)N15(n,t)H3				1.9
C14	5.7 10^3y	F19(n,γ)F20(β^-)Ne20(n,α)O17(n,α)C14			99.3	
		F19(n,nα)N15(n,np)C14				53.8
		F19(n,nα)N15(n,d)C14				19.9
		F19(n,np)O18(n,nα)C14				10.4
		F19(n,2n)F18(β^+)O18(n,nα)C14				7.1
		F19(n,t)O17(n,α)C14				4.4
		F19(n,d)O18(n,nα)C14				3.9
Be10	1.6 10^6y	F19(n,nα)N15(n,t)C13(n,α)Be10				50.1
		F19(n,α)N16(β^-)O16(n,α)C13(n,α)Be10				30.8
		F19(n,t)O17(n,nα)C13(n,α)Be10				16.8

Neon

Isotope	Atom % abundance
Ne20	90.48
Ne21	0.27
Ne22	9.25

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.39E+14	1.43E+10	2.77E+09	2.63E+09	2.22E+08	6.38E+07
F20	95.2					
O19	3.9	20.0				
F18		55.2				
H3		17.8	92.1	91.7	4.1	
Ne23	0.1	5.1				
C14		1.5	7.8	8.2	95.9	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.56E-01	3.09E-06	5.65E-09	4.62E-09	1.70E-09	5.06E-10
F20	96.1					
O19	2.6	40.2				
F18		50.5				
Ne23	0.1	7.9				
Na24		1.2	12.3			
H3		0.1	41.3	47.8	0.5	
C14		0.1	30.3	37.0	99.5	99.9
Na22			16.1	15.3		

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.12E+05	2.34E+00	2.46E-03	9.88E-04	2.58E-13	0.00E+00
F20	95.7					
O19	2.1	30.1				
F22	1.8					
F18		66.1				
Na24		2.6	48.3			
Ne23		1.1				
Na22		0.1	51.7	100.0	100.0	

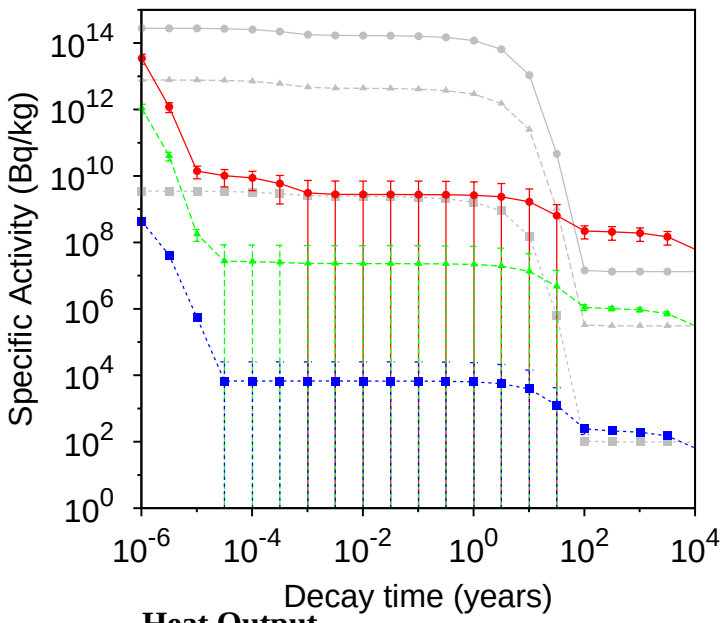
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.04E+02	1.31E+00	2.40E-01	2.32E-01	1.24E-01	3.70E-02
Ne23	76.3	50.1				
F20	20.2					
O19	3.1	0.2				
F18	0.1	29.7				
C14		9.6	52.1	53.8	99.7	100.0
H3		8.2	44.6	43.7	0.3	
Na24		1.6	0.2			
Na22		0.6	3.2	2.5		

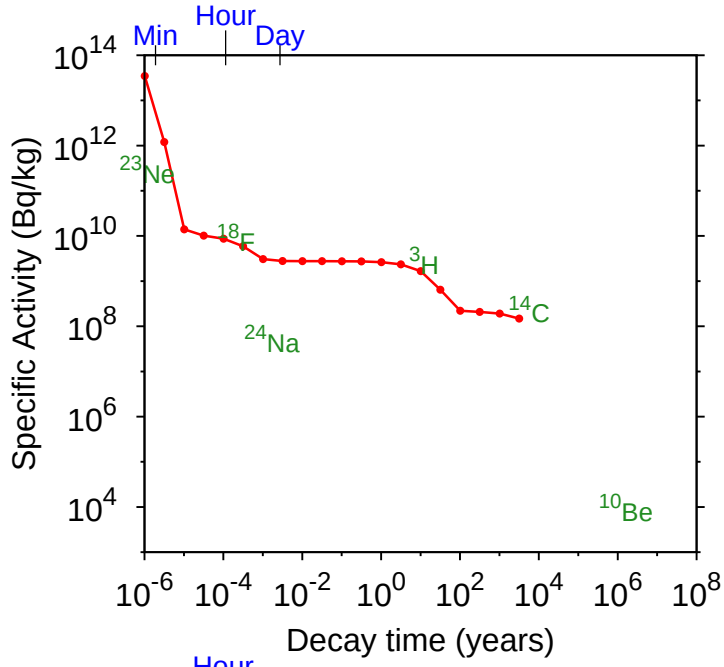
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.00E+02	2.72E+00	1.92E+00	1.88E+00	1.24E+00	3.70E-01
Ne23	57.4	11.9				
F20	37.6					
O19	3.6	0.1				
C14	0.6	45.9	65.2	66.5	99.8	99.9
H3	0.3	24.4	34.6	33.4	0.2	
F18	0.2	17.2				

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	4.49E+11	4.74E+06	2.66E+05	2.58E+05	2.13E+05	6.38E+04
F20	95.7	0.1				
O19	2.5	71.1				
F22	1.5					
F18		16.7				
Ne23		5.5				
C14		4.5	81.1	83.5	100.0	100.0
Na24		1.0	0.4			
H3		0.5	9.6	9.4		
Na22		0.5	8.9	7.1		

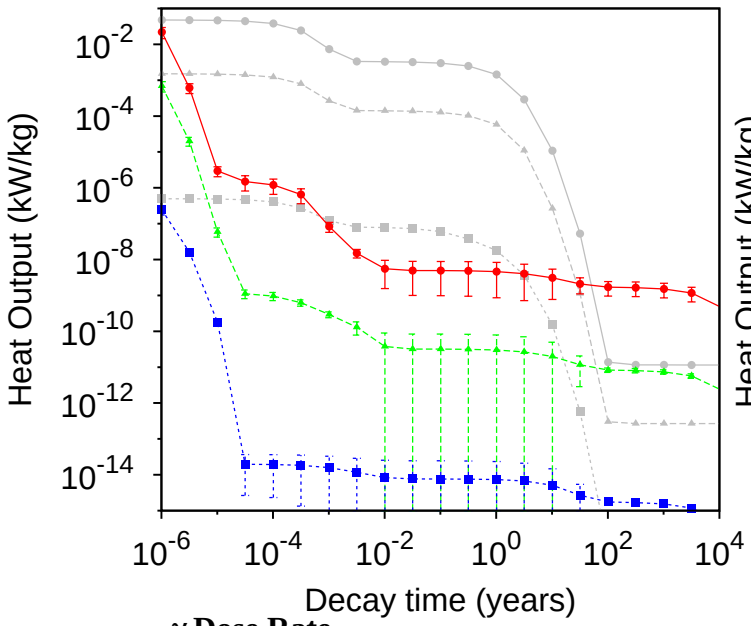
Neon activation characteristics

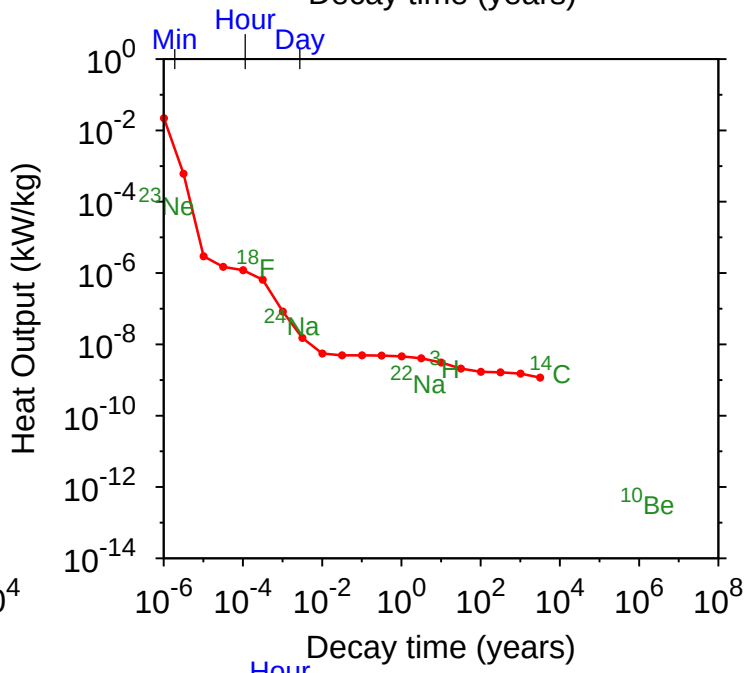
Specific Activity



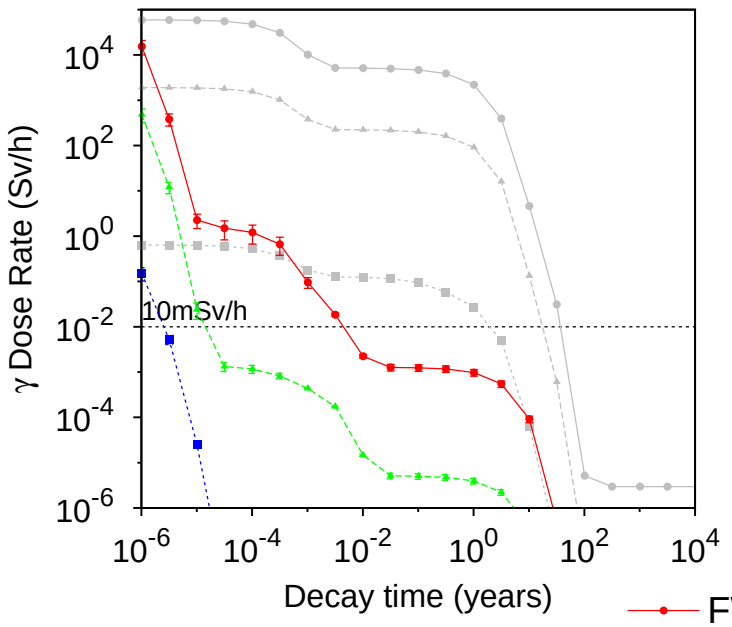


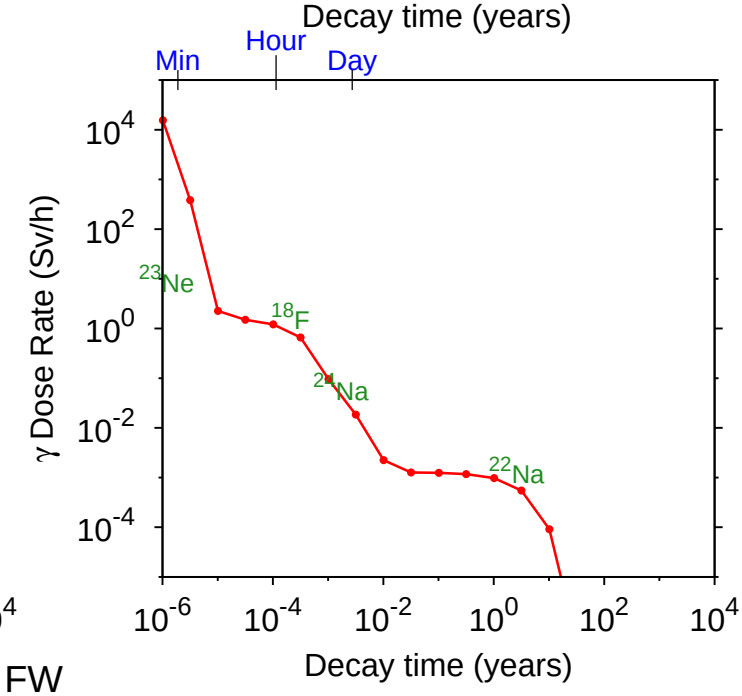
Heat Output





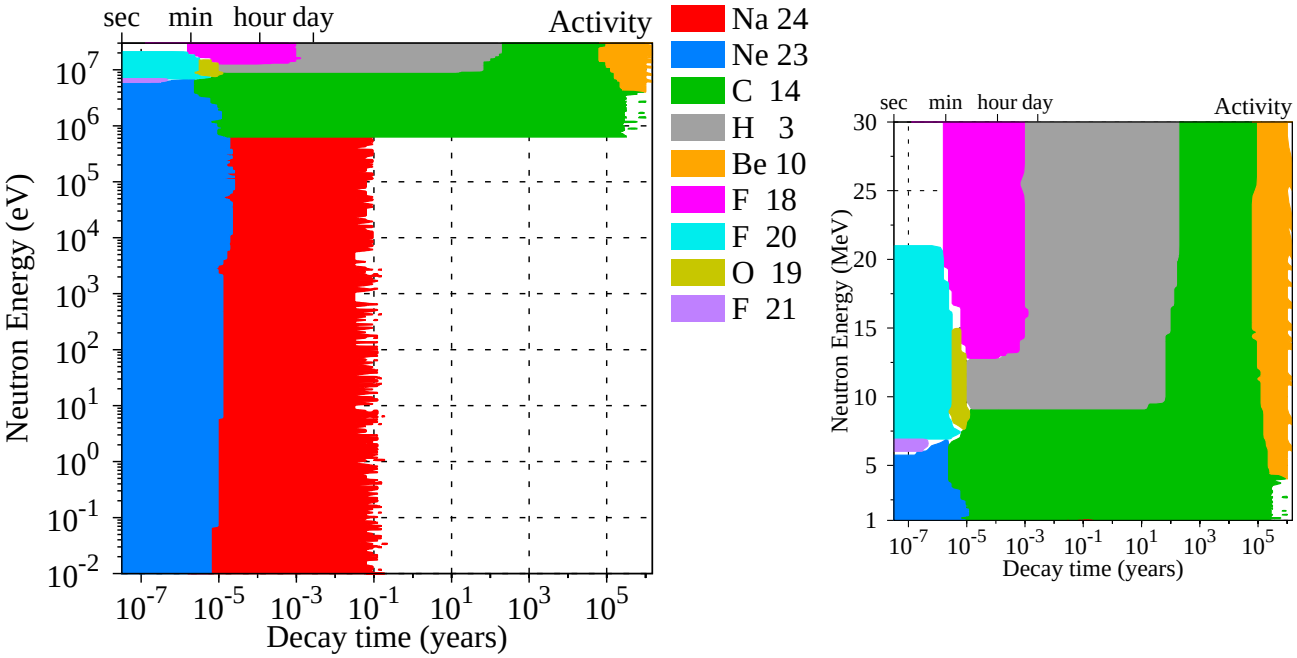
γ Dose Rate

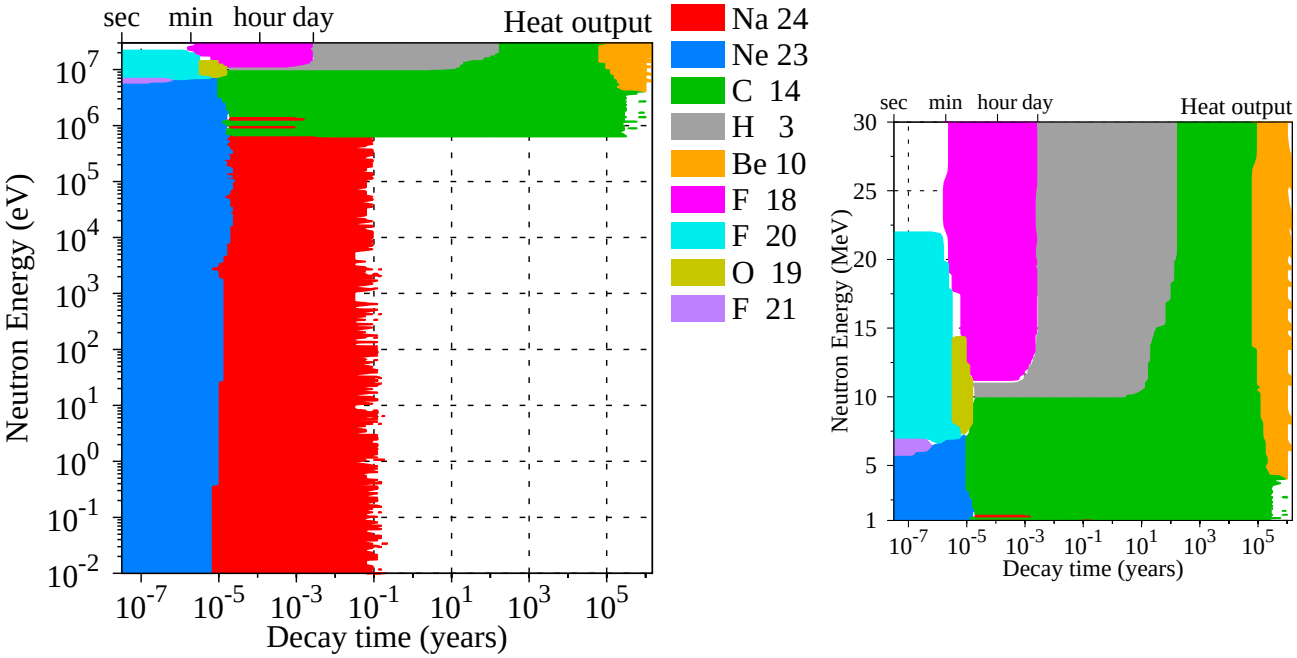


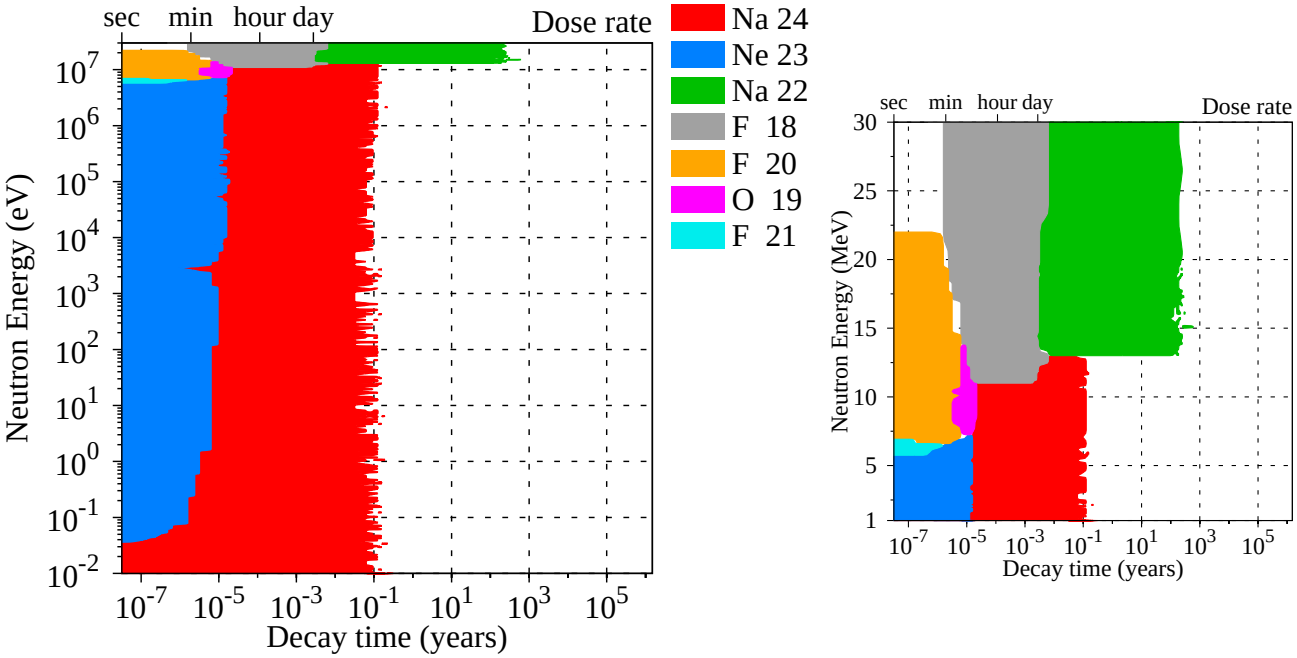


FW
Blanket
Manifold
Fe results

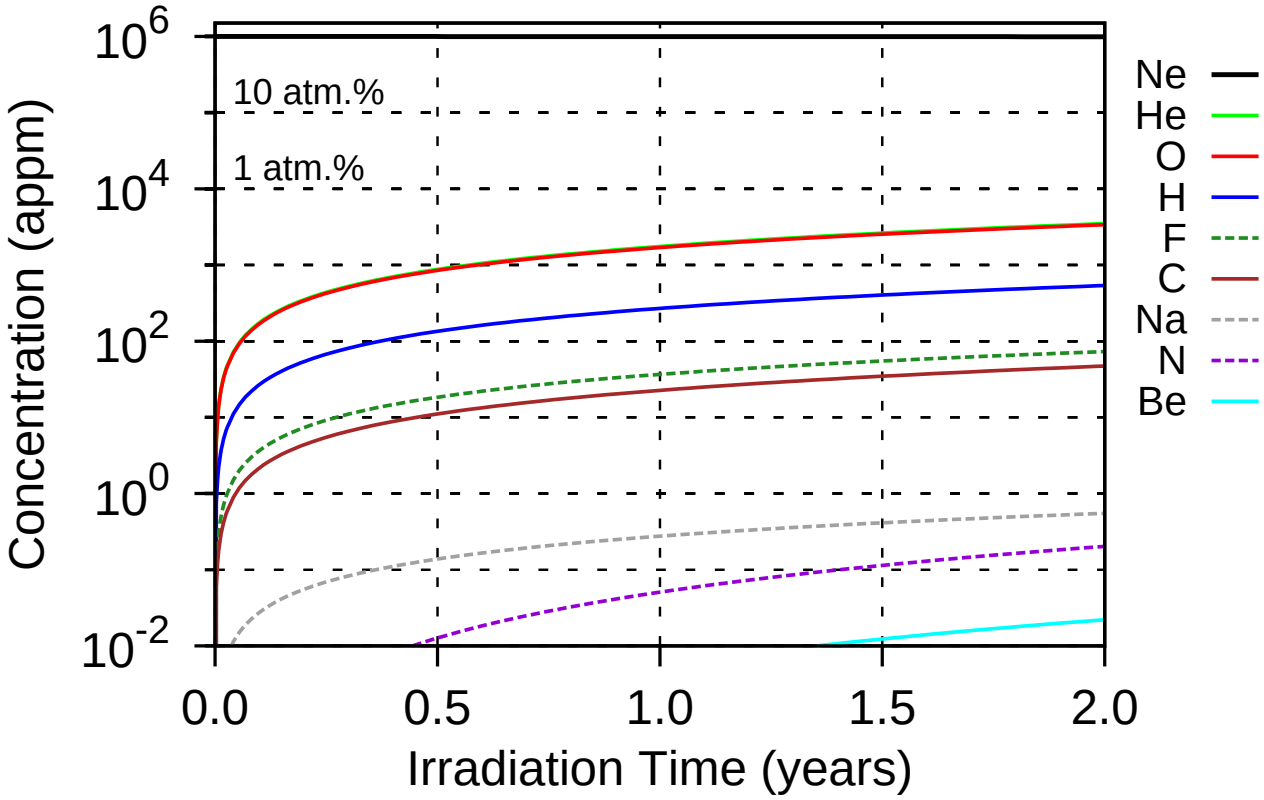
Neon Importance diagrams



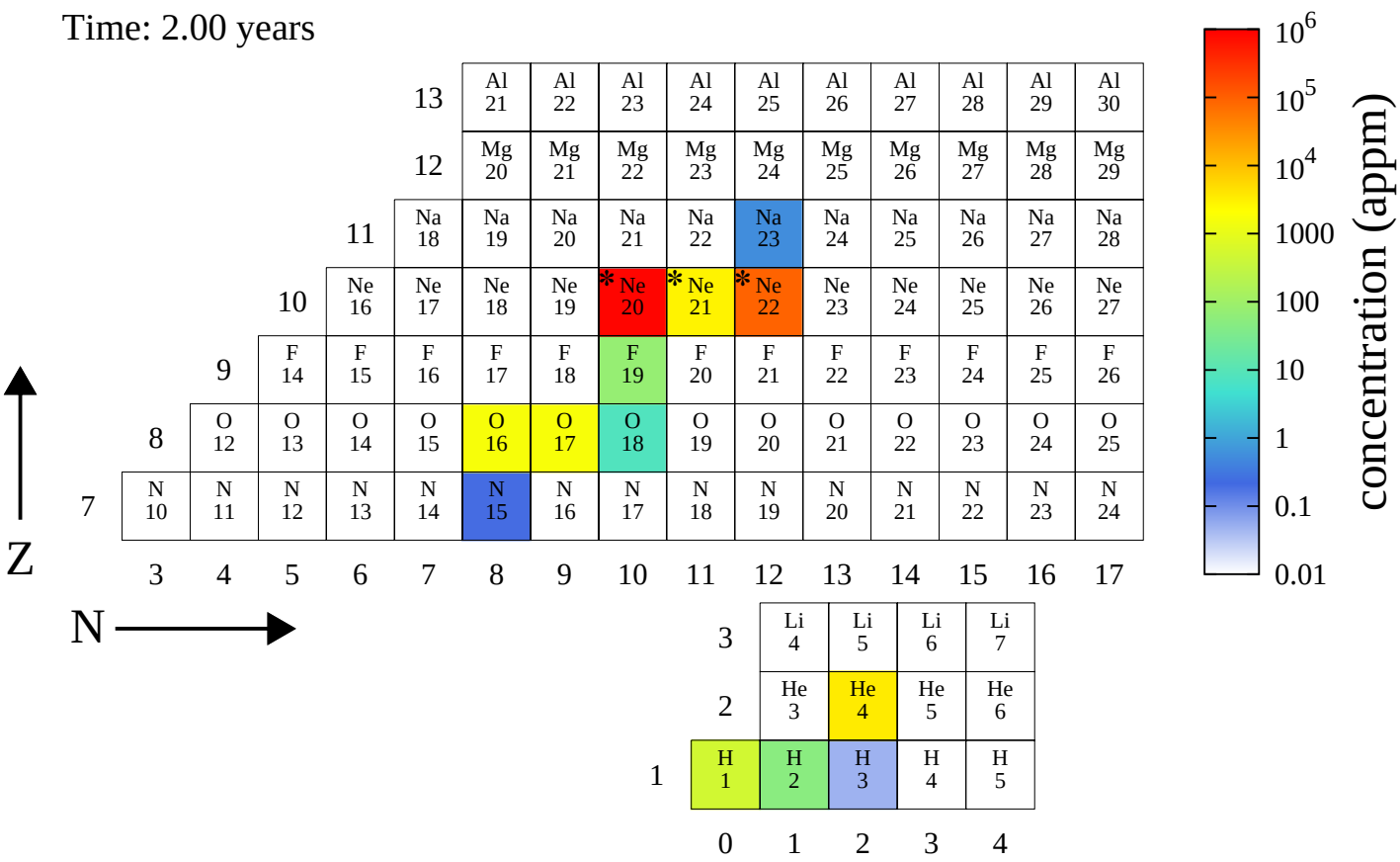




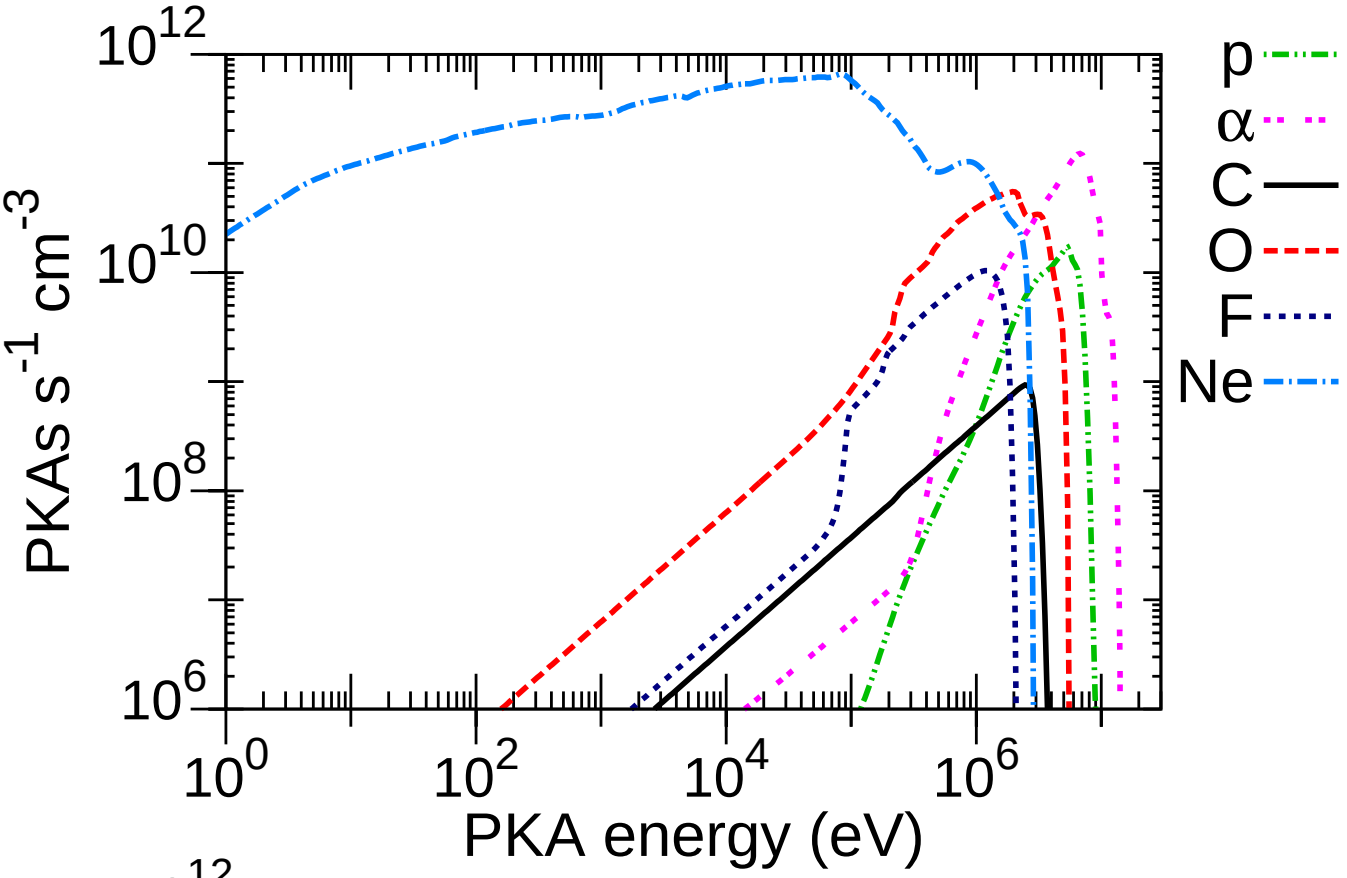
Neon FW Transmutation

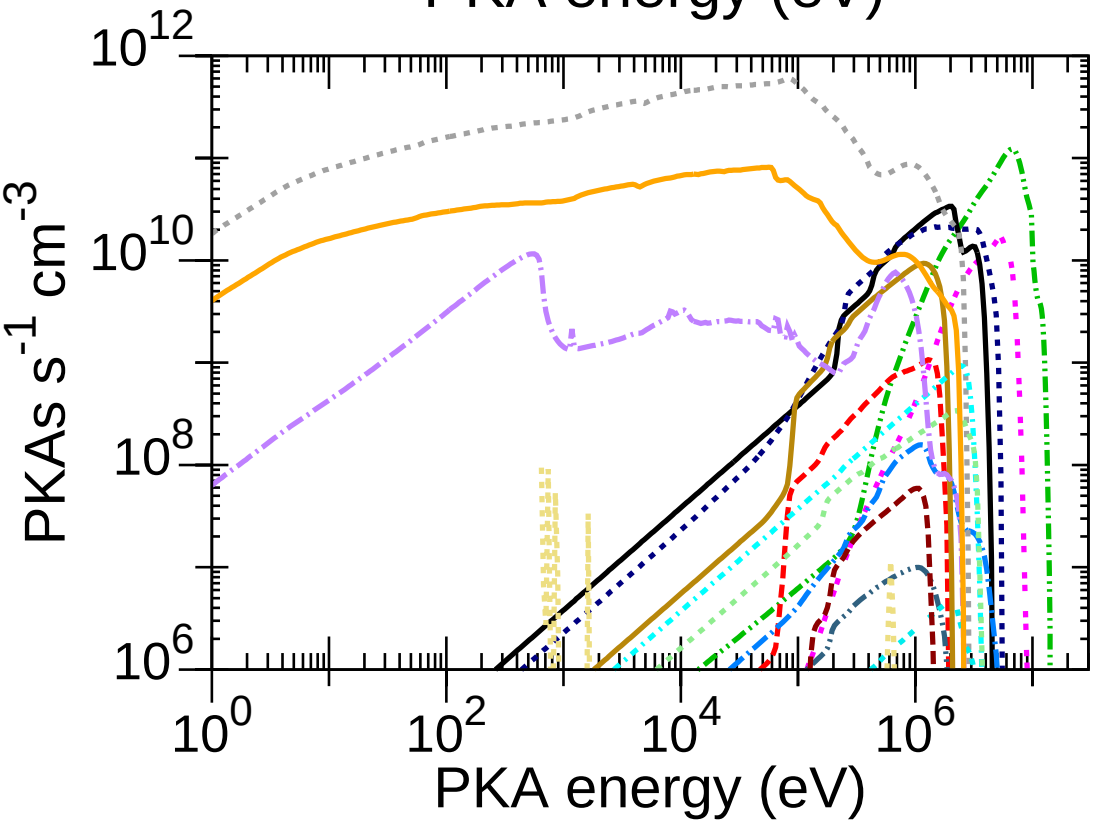


1751 appm He & 269 appm H after 1 year 14 dpa/year



Neon FW PKA distributions





Neon Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
F21	4.16s	Ne21(n,p)F21				52.8
		Ne22(n,2n)Ne21(n,p)F21				45.3
		Ne22(n,d)F21				1.6
F22	4.23s	Ne22(n,p)F22				100.0
F20	11.03s	Ne20(n,p)F20				99.4
O19	26.91s	Ne21(n,α)O18(n,γ)O19	73.6	100.0	98.6	
		Ne20(n,γ)Ne21(n,α)O18(n,γ)O19	26.4		1.4	
		Ne22(n,α)O19				99.5
Ne23	37.21s	Ne22(n,γ)Ne23	99.9	100.0	100.0	99.7
F18	1.83h	Ne20(n,d)F19(n,2n)F18				66.6
		Ne22(n,α)O19(β^-)F19(n,2n)F18				26.9
		Ne20(n,np)F19(n,2n)F18				6.2
Na24	14.96h	Ne22(n,γ)Ne23(β^-)Na23(n,γ)Na24	99.9	100.0	100.0	99.3
Na22	2.60y	Ne22(n,γ)Ne23(β^-)Na23(n,2n)Na22				99.9
H3	12.33y	Ne20(n,α)O17(n,t)H3				76.3
		Ne20(n,d)F19(n,t)H3				7.2
		Ne21(n,t)H3				7.1
		Ne22(n,2n)Ne21(n,t)H3				3.0
		Ne22(n,α)O19(β^-)F19(n,t)H3				2.9
		Ne20(n,2α)C13(n,t)H3				1.6
C14	5.7 10^3y	Ne20(n,α)O17(n,α)C14			100.0	92.3
		Ne21(n,2α)C14				4.8
		Ne22(n,2n)Ne21(n,2α)C14				2.0
Be10	1.6 10^6y	Ne20(n,2α)C13(n,α)Be10				79.2
		Ne20(n,nα)O16(n,α)C13(n,α)Be10				10.3
		Ne20(n,α)O17(n,nα)C13(n,α)Be10				10.2

Sodium

Isotope	Atom % abundance
Na23	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	4.55E+14	7.91E+13	6.12E+12	3.88E+12	1.04E+09	2.23E+04
F20	59.1					
Ne23	23.4	0.4				
Na24	16.3	93.4	19.6			
Na22	1.0	5.9	75.7	93.0		
H3	0.1	0.4	4.7	7.0	100.0	
C14						100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.70E-01	5.72E-02	2.67E-03	1.38E-03	9.52E-10	1.76E-13
F20	65.7					
Na24	20.6	96.7	33.6			
Ne23	13.0	0.2				
Na22	0.7	3.1	66.4	100.0		
H3					99.9	
C14					0.1	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.36E+05	1.00E+05	4.15E+03	2.00E+03	2.24E-08	0.00E+00
F20	55.8					
Na24	41.4	97.4	38.1			
Ne23	1.6					
Na22	1.1	2.6	61.9	100.0	100.0	

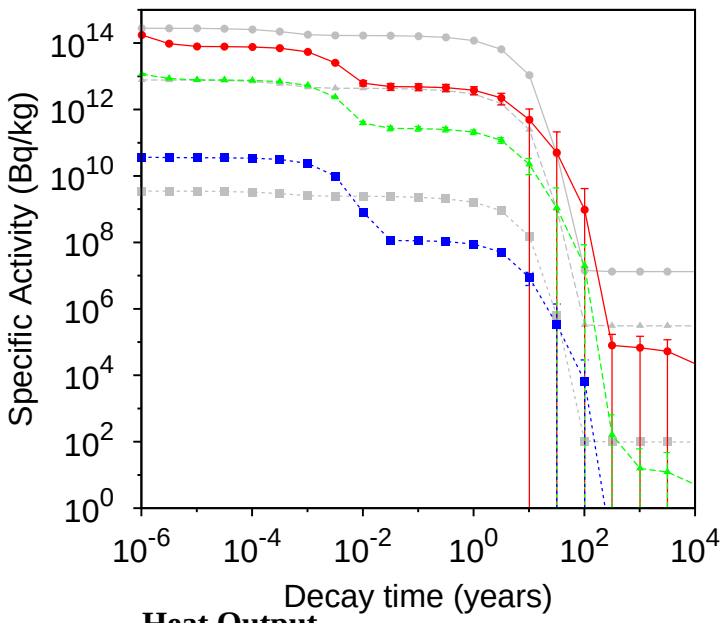
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.42E+05	4.69E+04	1.54E+04	1.15E+04	4.37E-02	1.29E-05
Ne23	66.9	0.6				
Na24	22.5	67.7	3.4			
Na22	10.5	31.7	96.6	99.9		
H3			0.1	0.1	99.9	
C14					0.1	100.0

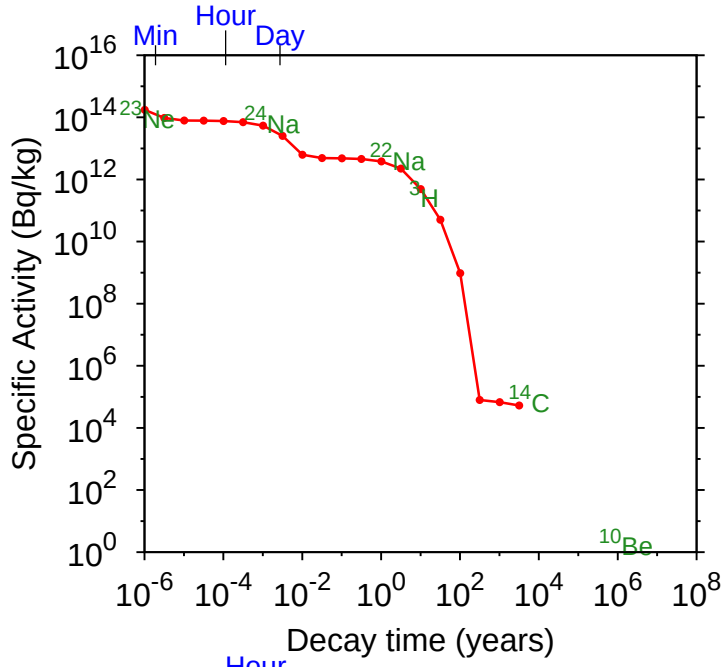
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	7.31E+04	2.62E+04	6.43E+03	4.76E+03	2.71E-01	1.29E-04
Ne23	64.1	0.5				
Na24	27.4	76.1	5.0			
Na22	8.3	23.1	93.8	98.5		
H3	0.1	0.3	1.2	1.5	99.8	
C14					0.2	100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	6.66E+11	1.21E+11	4.76E+10	3.61E+10	1.05E+04	2.23E+01
F20	76.1					
Na24	11.1	61.3	2.5			
Na22	7.0	38.6	97.5	100.0		
Ne23	5.7	0.1				
H3					99.3	
C14					0.7	100.0

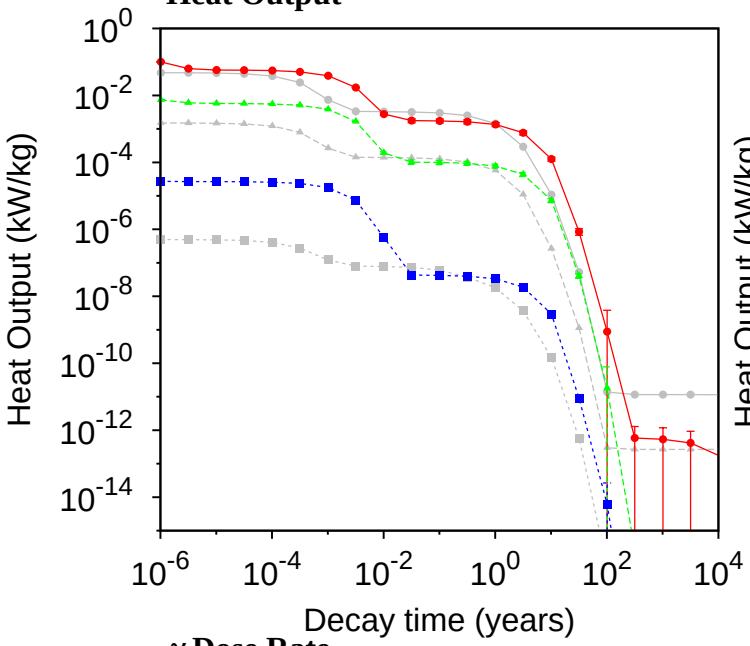
Sodium activation characteristics

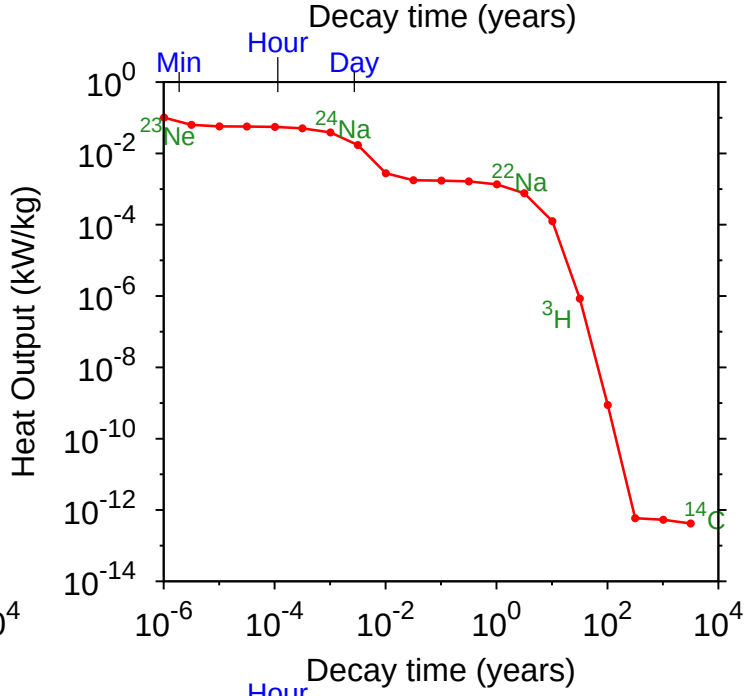
Specific Activity



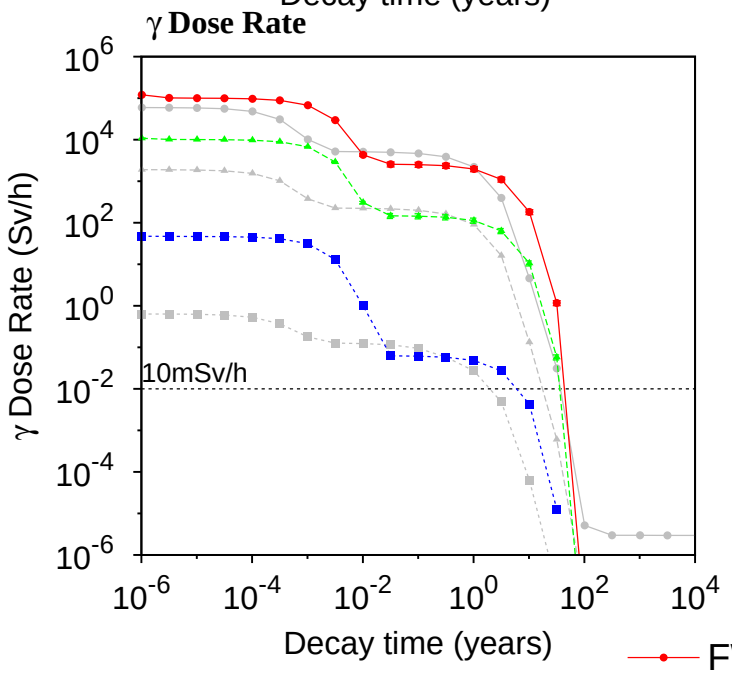


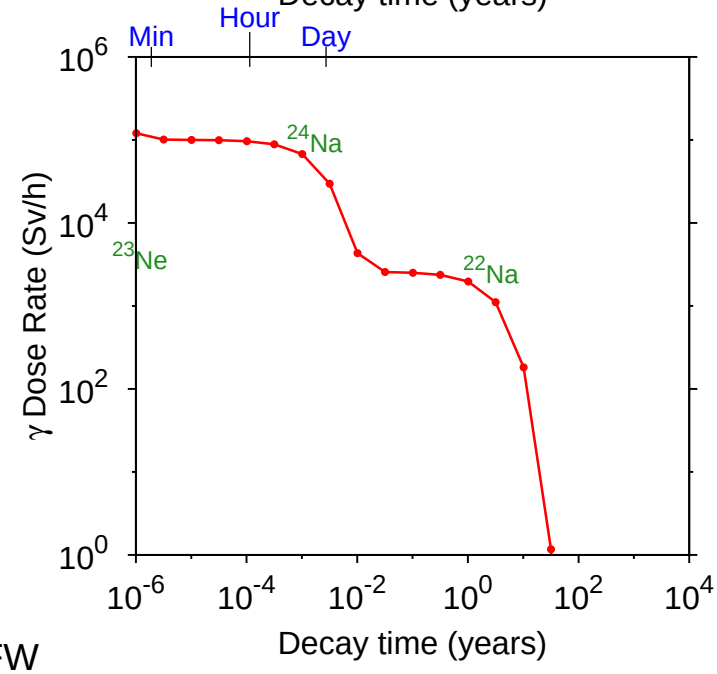
Heat Output





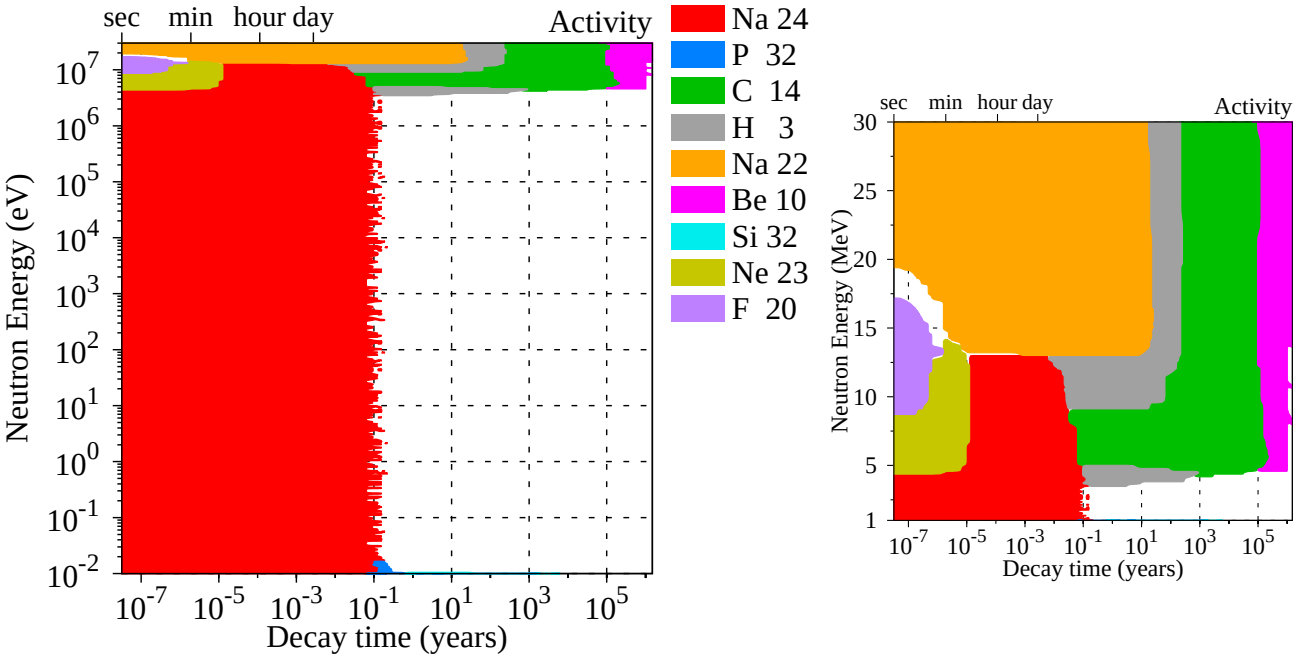
γ Dose Rate

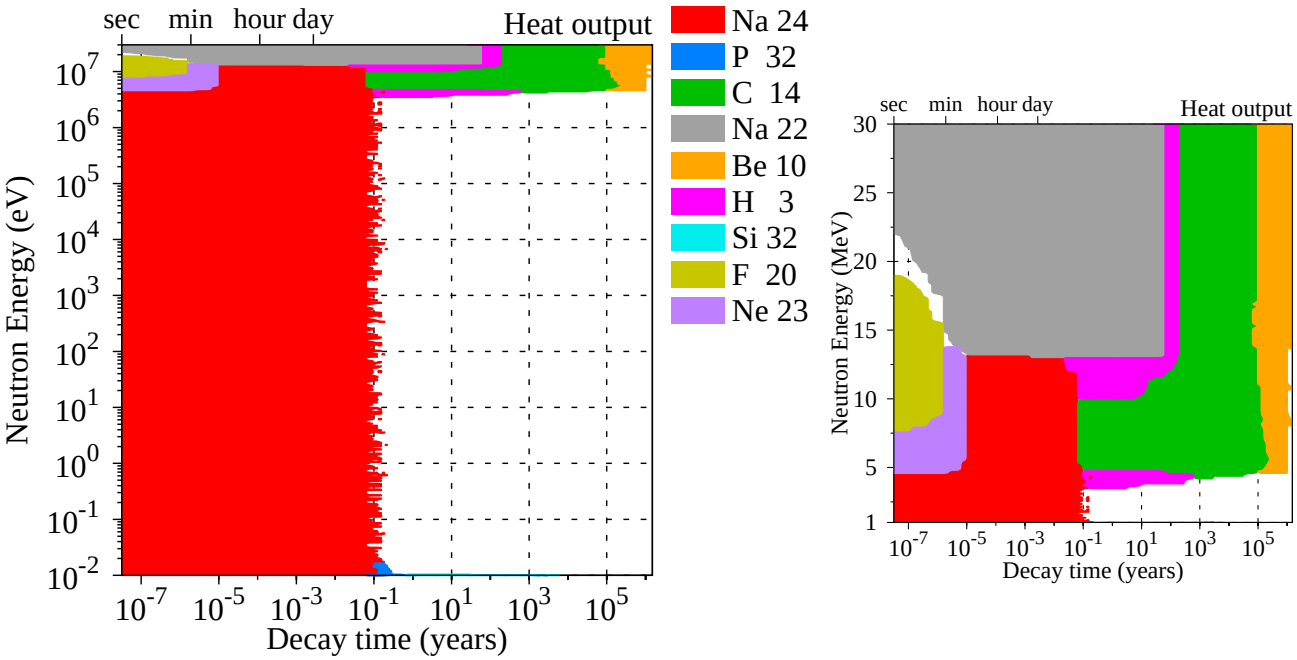


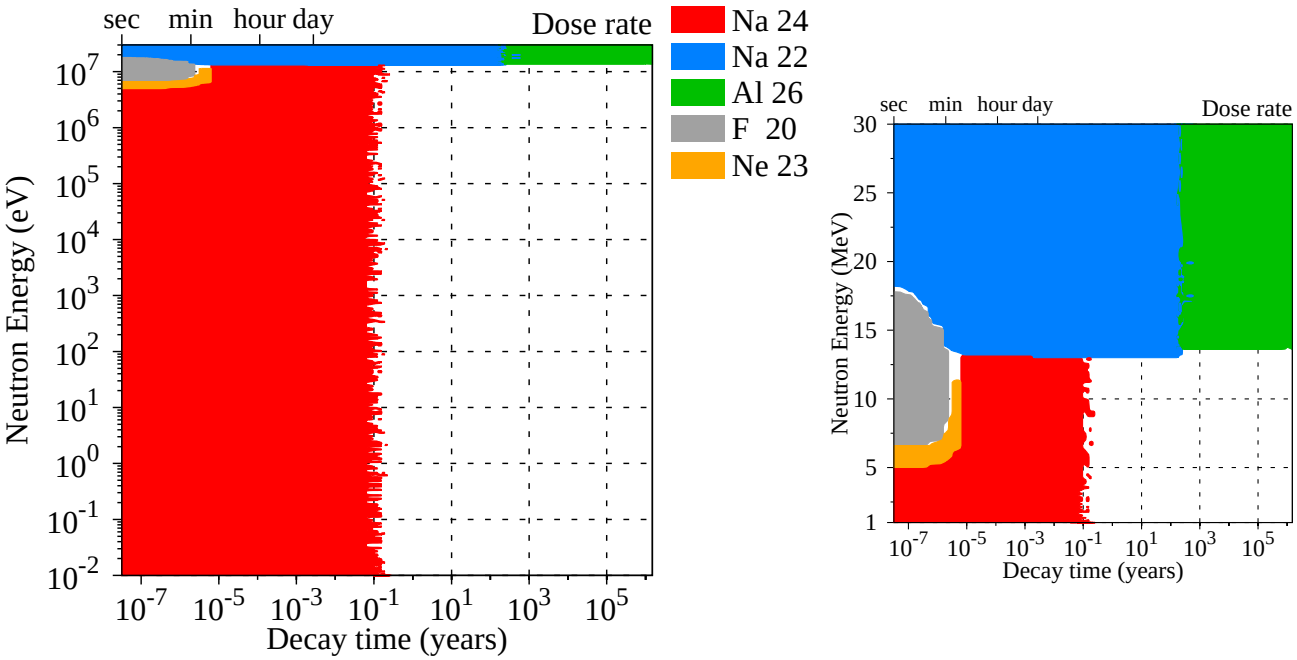


FW
Blanket
Manifold
Fe results

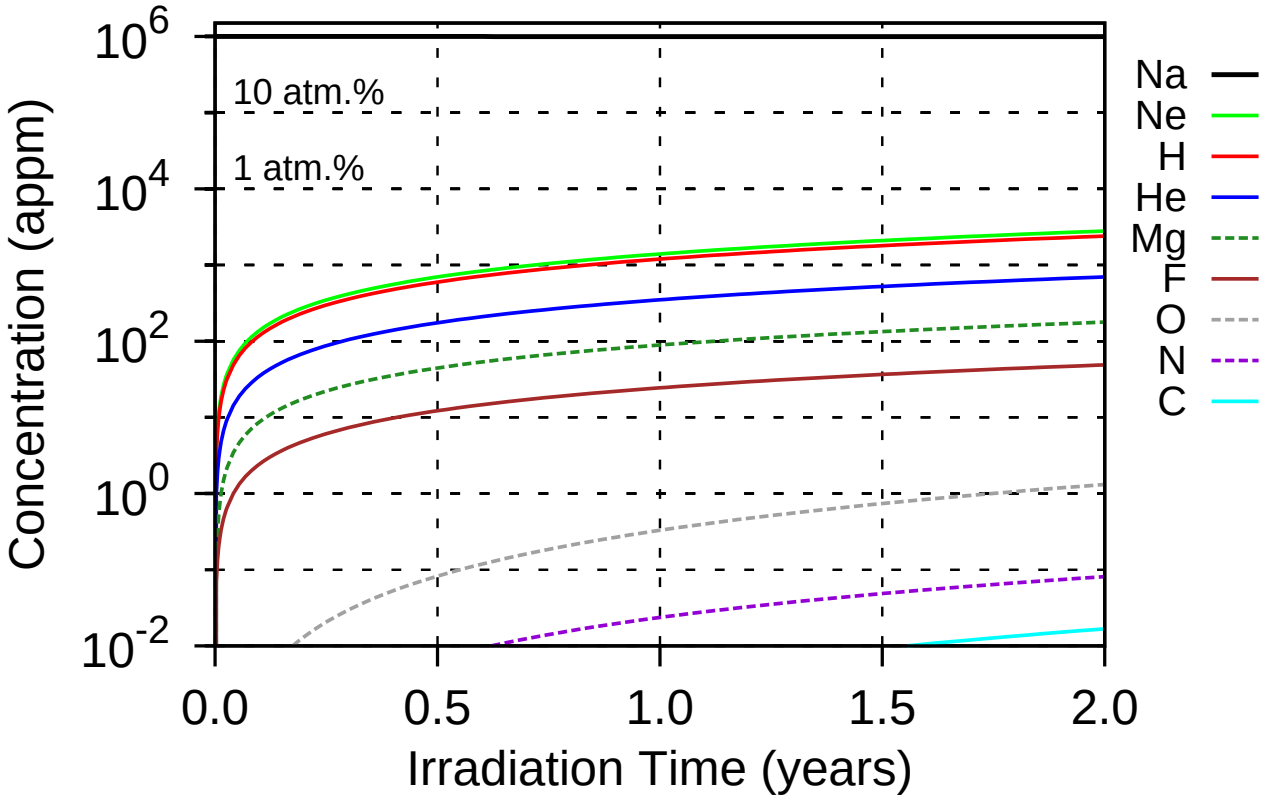
Sodium Importance diagrams



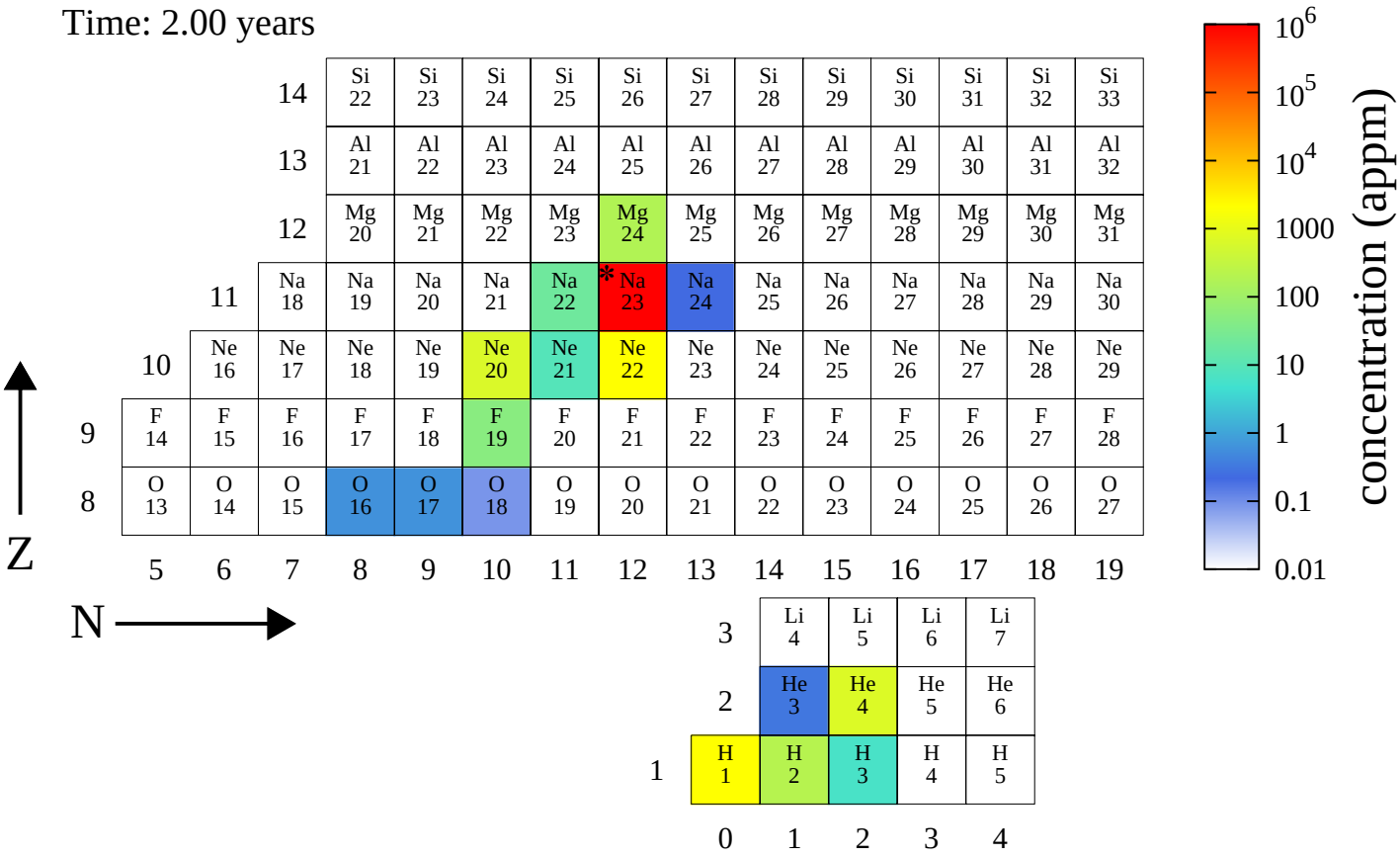




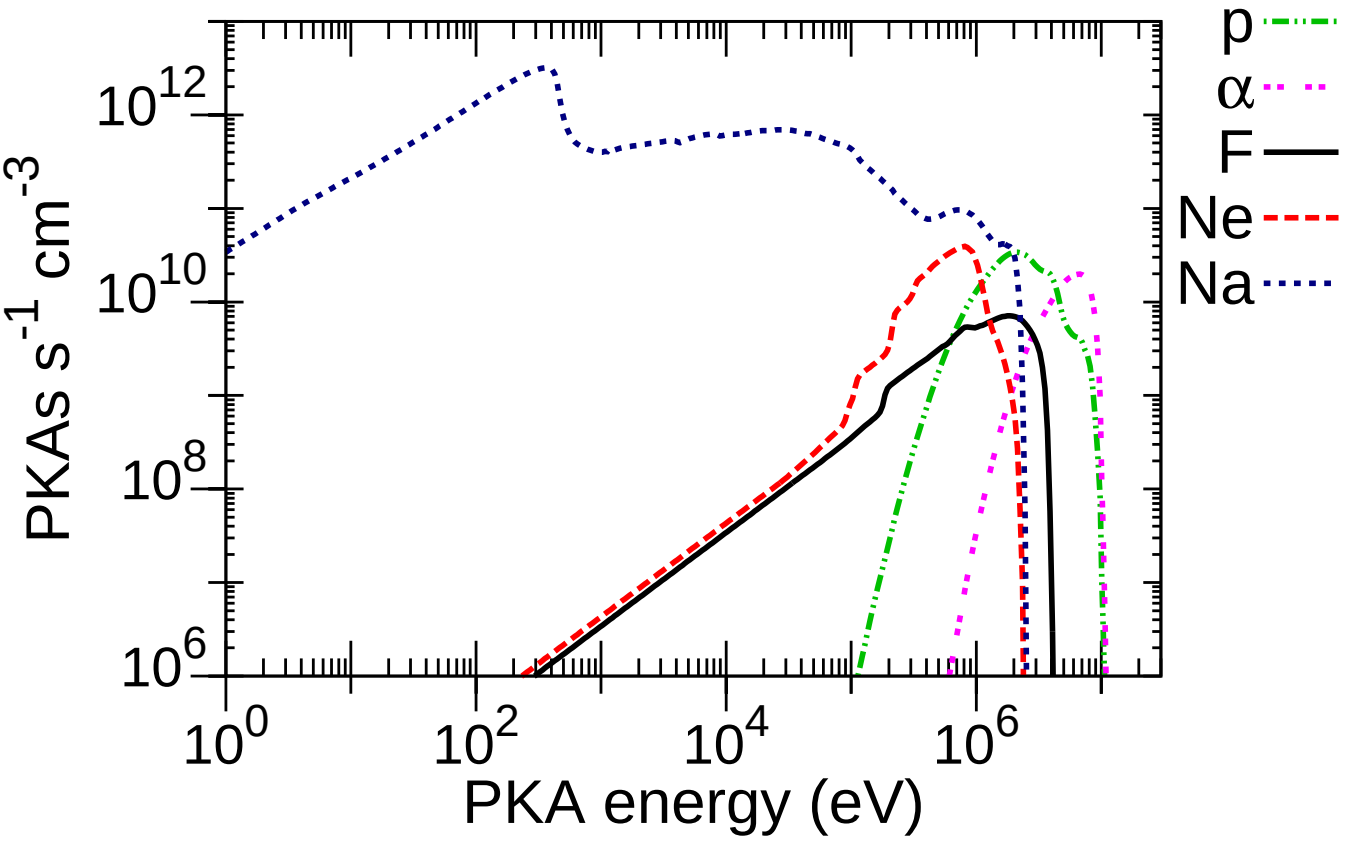
Sodium FW Transmutation

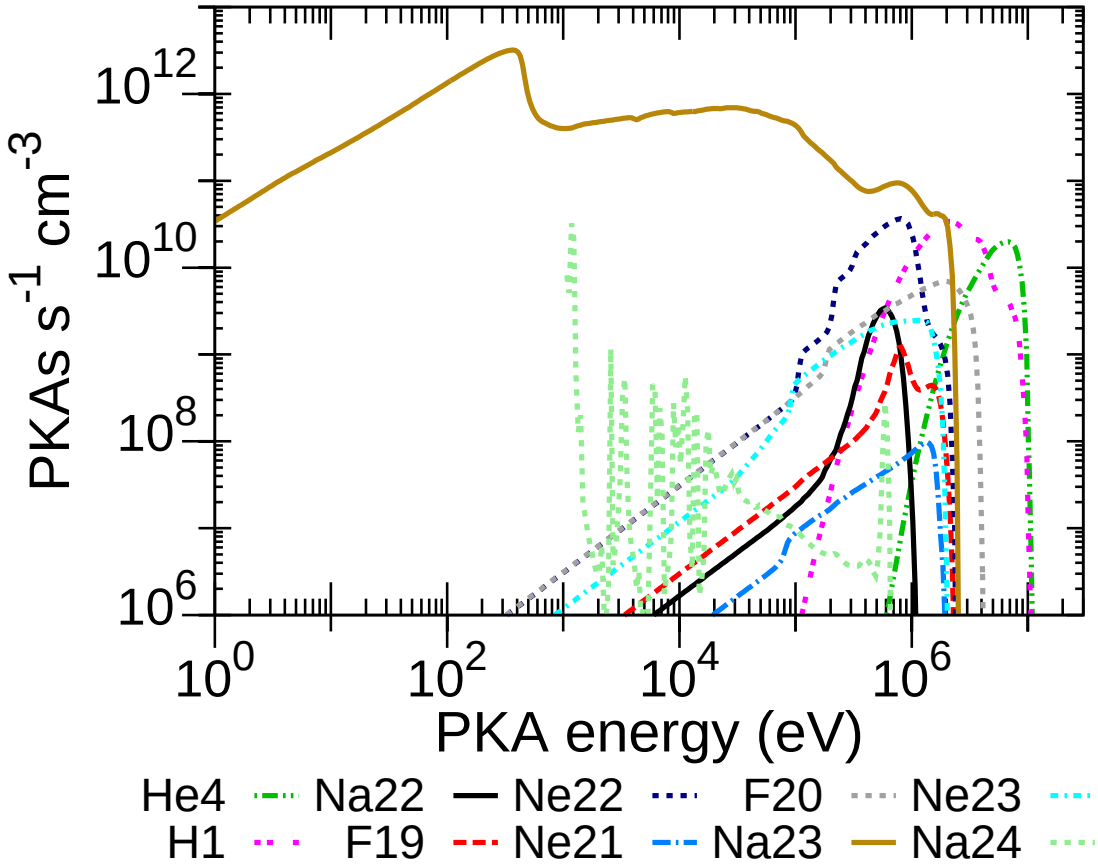


349 appm He & 1196 appm H after 1 year 18 dpa/year



Sodium FW PKA distributions





Sodium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
F20	11.03s	Na23(n,α)F20				99.2
Ne23	37.21s	Na23(n,p)Ne23				99.8
Na24	14.96h	Na23(n,γ)Na24	100.0	100.0	100.0	99.8
P32	14.27d	no pathways found				
Na22	2.60y	Na23(n,2n)Na22				99.9
H3	12.33y	Na23(n,t)H3				99.1
Si32	132.00y	no pathways found				
C14	5.7 10^3y	Na23(n,α)F20(β^-)Ne20(n,α)O17(n,α)C14				43.2
		Na23(n,np)Ne22(n,2n)Ne21(n,2α)C14				28.6
		Na23(n,t)Ne21(n,2α)C14				10.9
		Na23(n,d)Ne22(n,2n)Ne21(n,2α)C14				3.2
		Na23(n,np)Ne22(n,nα)O18(n,nα)C14				2.8
		Na23(n,nα)F19(n,nα)N15(n,np)C14				2.3
		Na23(n,2n)Na22(n,2α)N15(n,np)C14				2.3
		Na23(n,2n)Na22(n,np)Ne21(n,2α)C14				1.2
Al26	7.2 10^5y	no pathways found				
Be10	1.6 10^6y	Na23(n,α)F20(β^-)Ne20(n,2α)C13(n,α)Be10				83.0
		Na23(n,α)F20(β^-)Ne20(n,nα)O16(n,α)C13(n,α)Be10				8.1
		Na23(n,α)F20(β^-)Ne20(n,α)O17(n,nα)C13(n,α)Be10				8.0

Magnesium

Isotope	Atom % abundance
Mg24	78.99
Mg25	10.00
Mg26	11.01

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	4.03E+14	3.66E+14	4.89E+12	2.10E+10	7.91E+07	1.05E+06
Na24	90.9	99.8	99.5			
Ne23	4.3					
Na25	3.8	0.1				
H3			0.4	93.9	95.6	
Na22				6.1		
C14					4.4	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.88E-01	2.74E-01	3.65E-03	5.05E-07	9.69E-11	8.32E-12
Na24	95.3	99.9	100.0			
Ne23	2.0					
Na25	1.6					
Na22				96.4		
H3				3.6	71.3	
C14					28.7	99.8

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	4.72E+05	4.65E+05	6.21E+03	6.84E-01	1.95E-08	1.93E-08
Na24	99.0	100.0	100.0			
Na22				100.0	0.1	
Al26					99.9	100.0

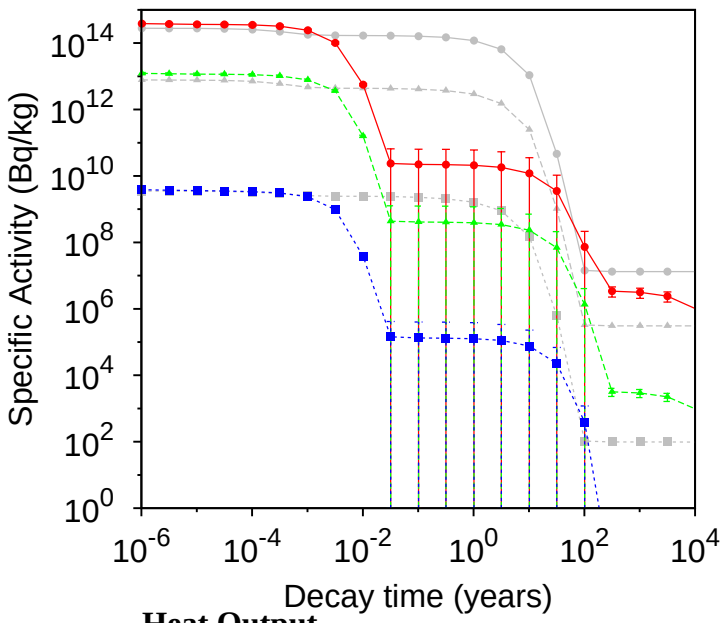
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.73E+05	1.57E+05	2.10E+03	4.90E+00	5.21E-03	6.08E-04
Na24	91.0	100.0	99.7			
Ne23	9.0					
Na22			0.3	83.1		
H3				16.9	61.0	
C14					39.0	100.0

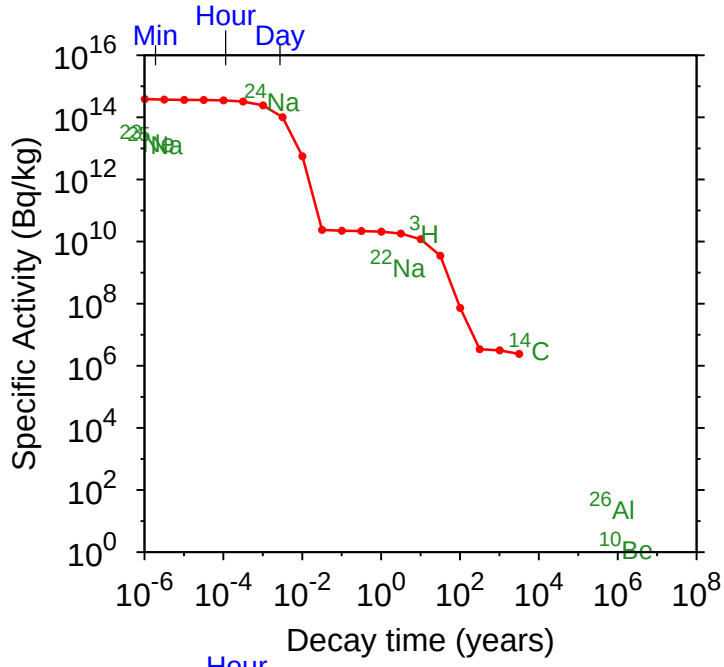
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.07E+05	9.85E+04	1.32E+03	6.80E+00	4.00E-02	6.08E-03
Na24	92.8	100.0	99.4			
Ne23	7.2					
H3			0.4	75.3	49.2	
Na22			0.2	24.4		
C14				0.3	50.8	100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	3.91E+11	3.65E+11	4.88E+09	1.29E+07	4.26E+03	1.05E+03
Na24	93.8	99.9	99.7			
Na25	2.3	0.1				
Na26	2.1					
Ne23	1.6					
Na22			0.3	98.4		
H3				1.5	17.8	
C14					82.2	100.0

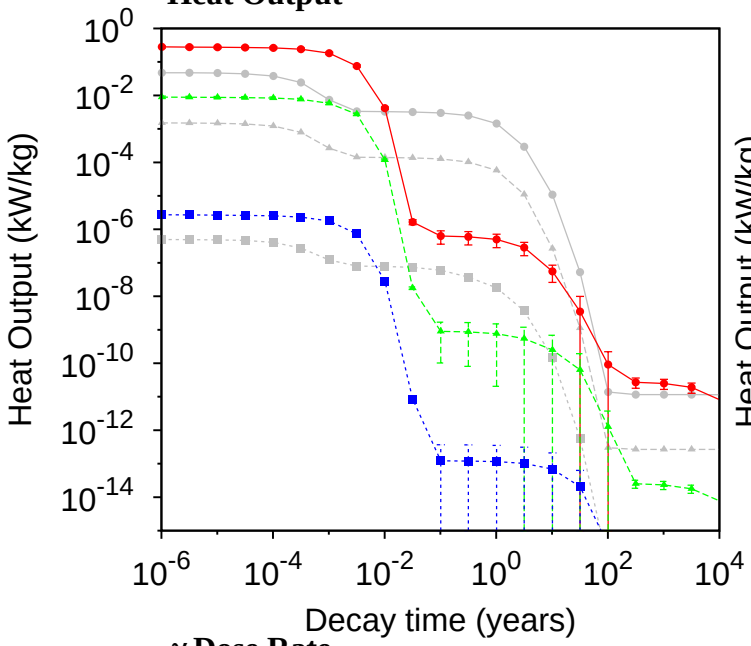
Magnesium activation characteristics

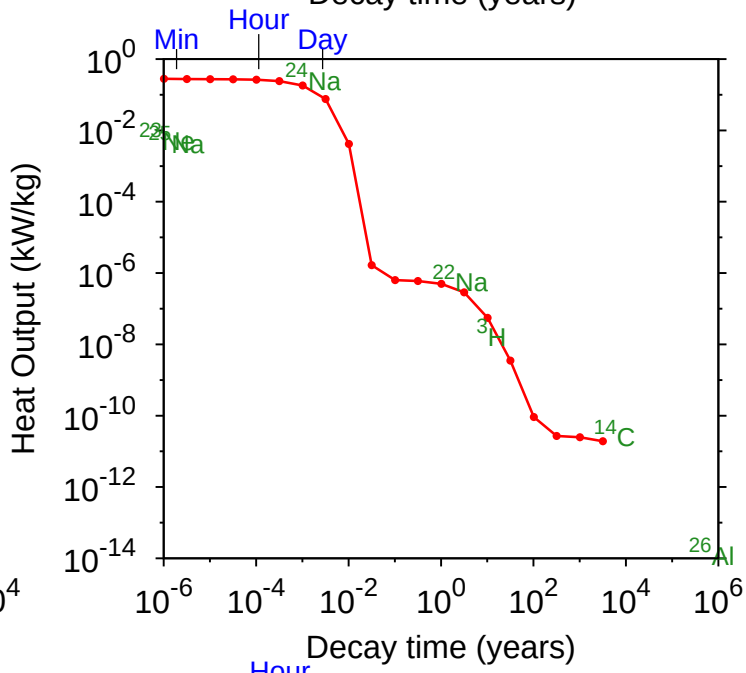
Specific Activity



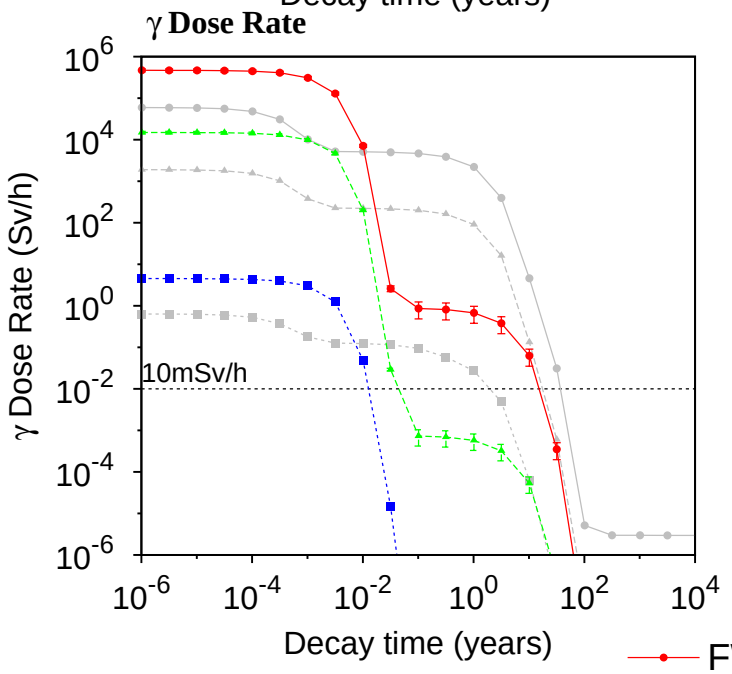


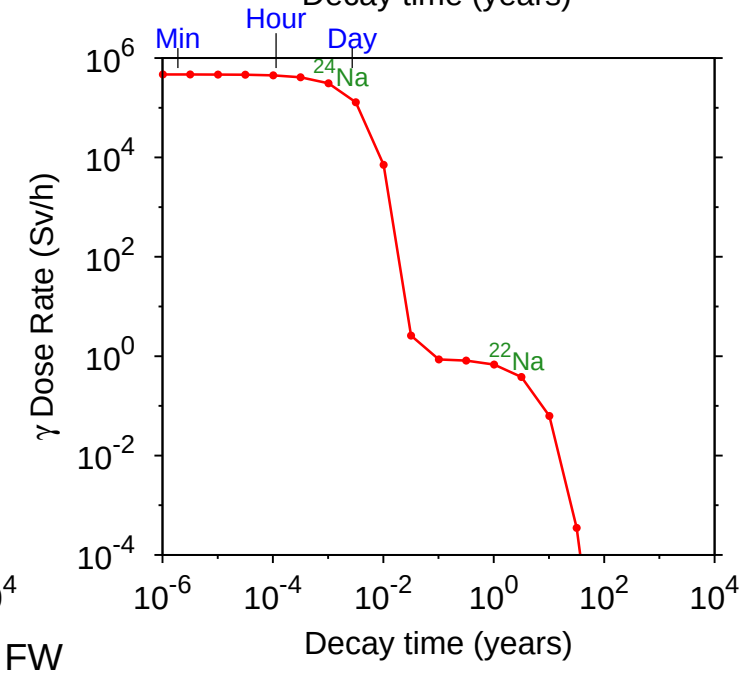
Heat Output





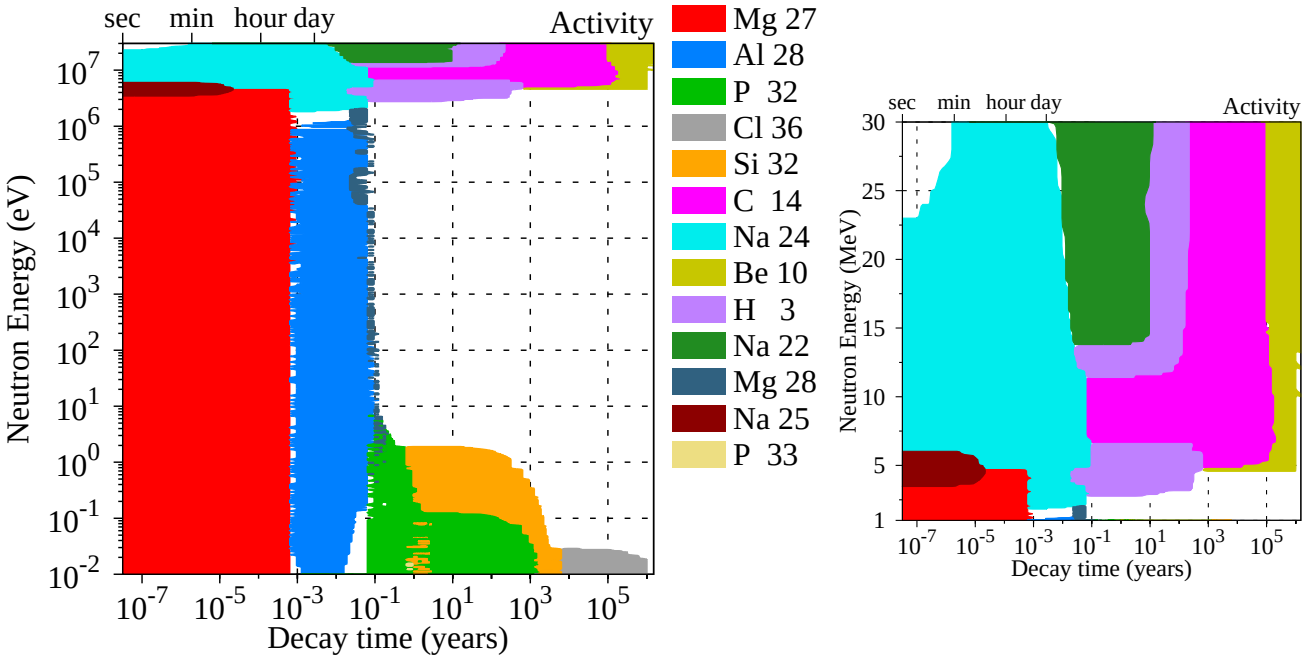
γ Dose Rate

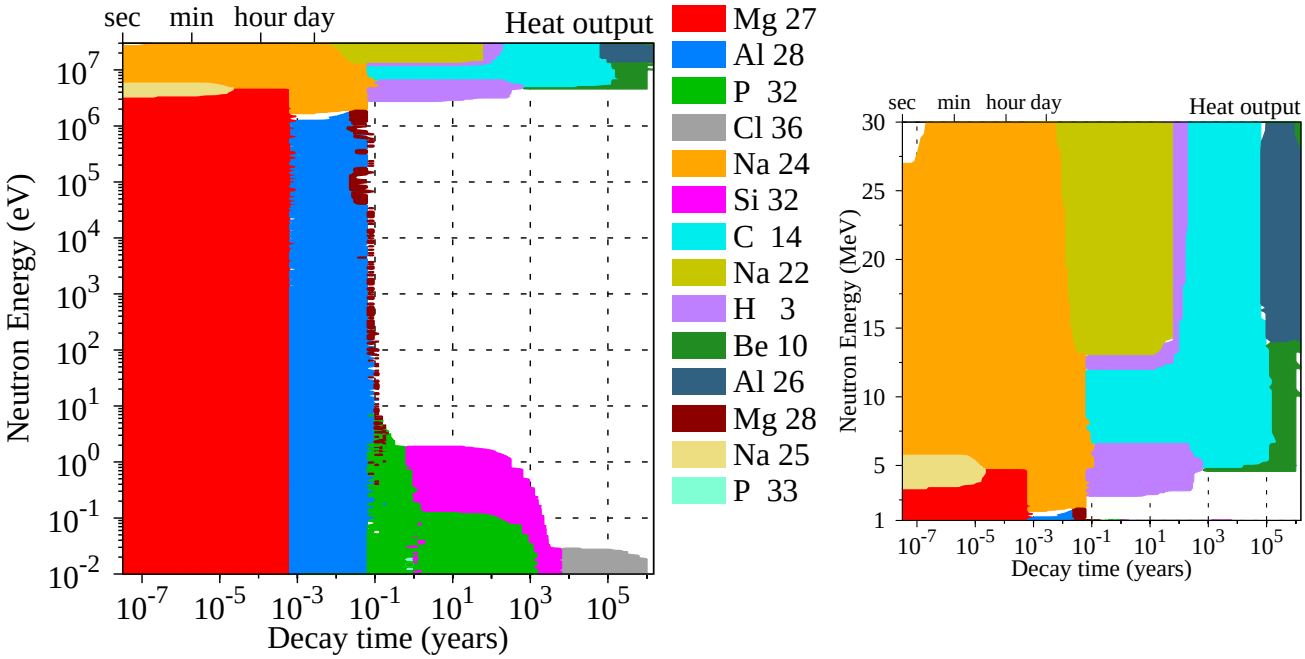


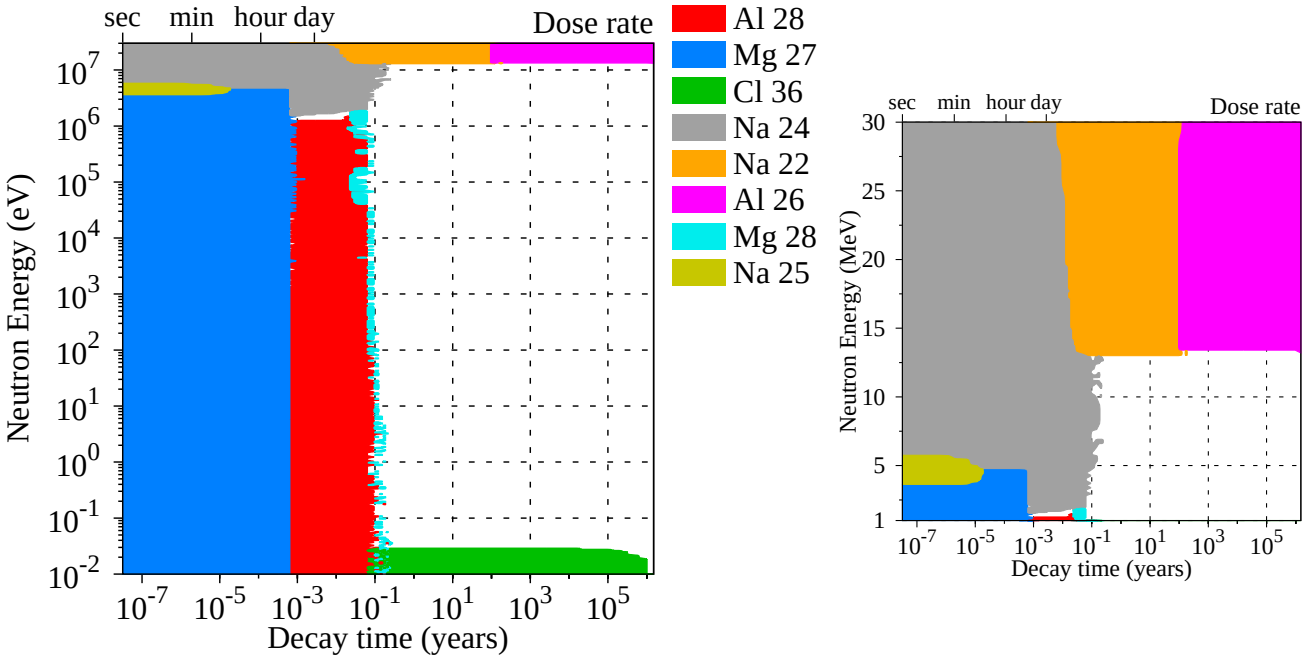


FW
Blanket
Manifold
Fe results

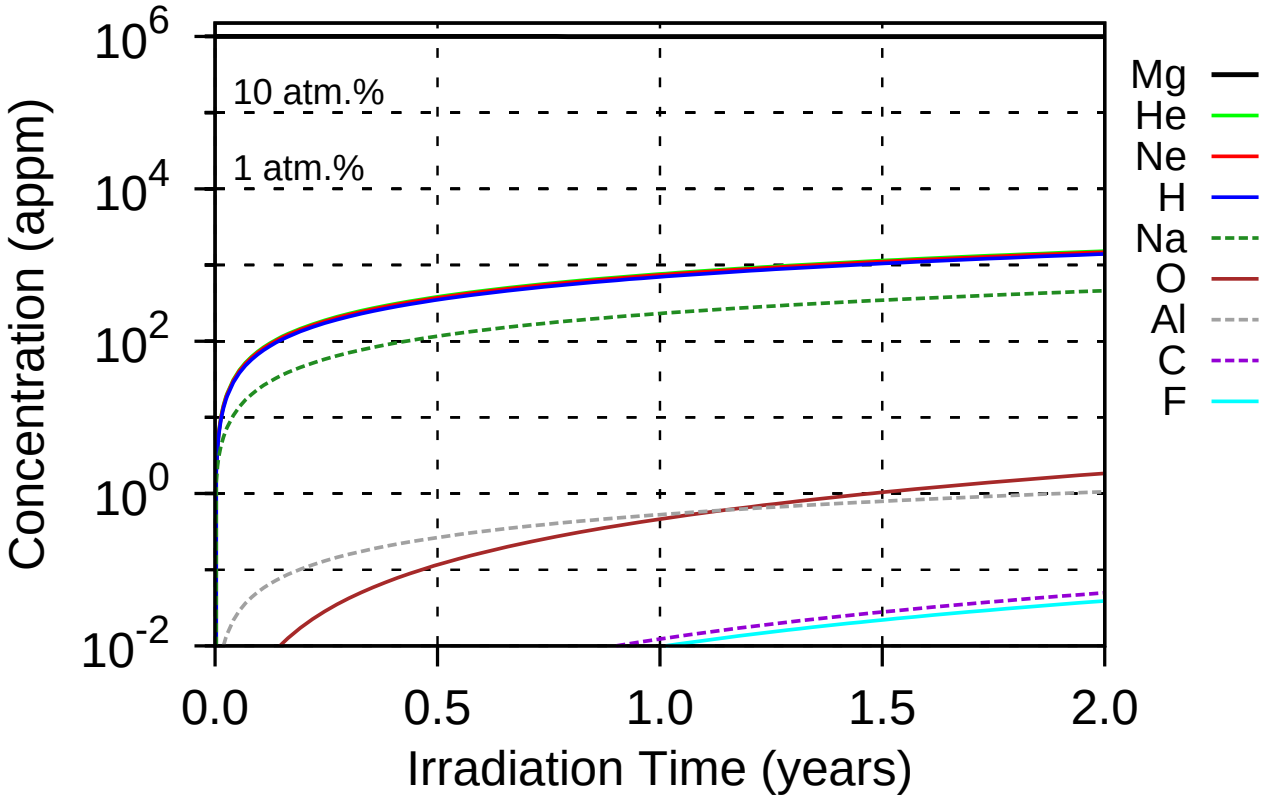
Magnesium Importance diagrams



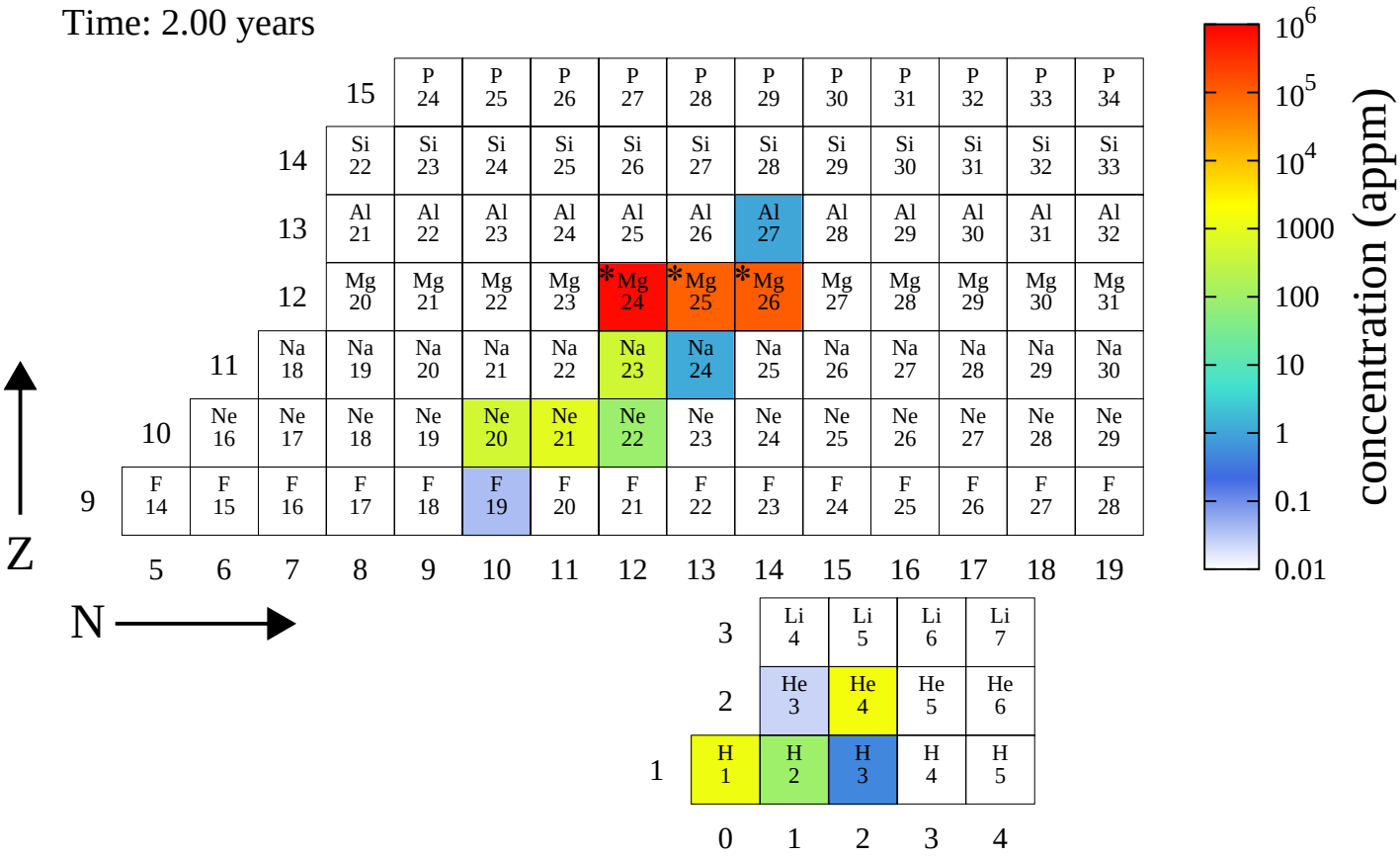




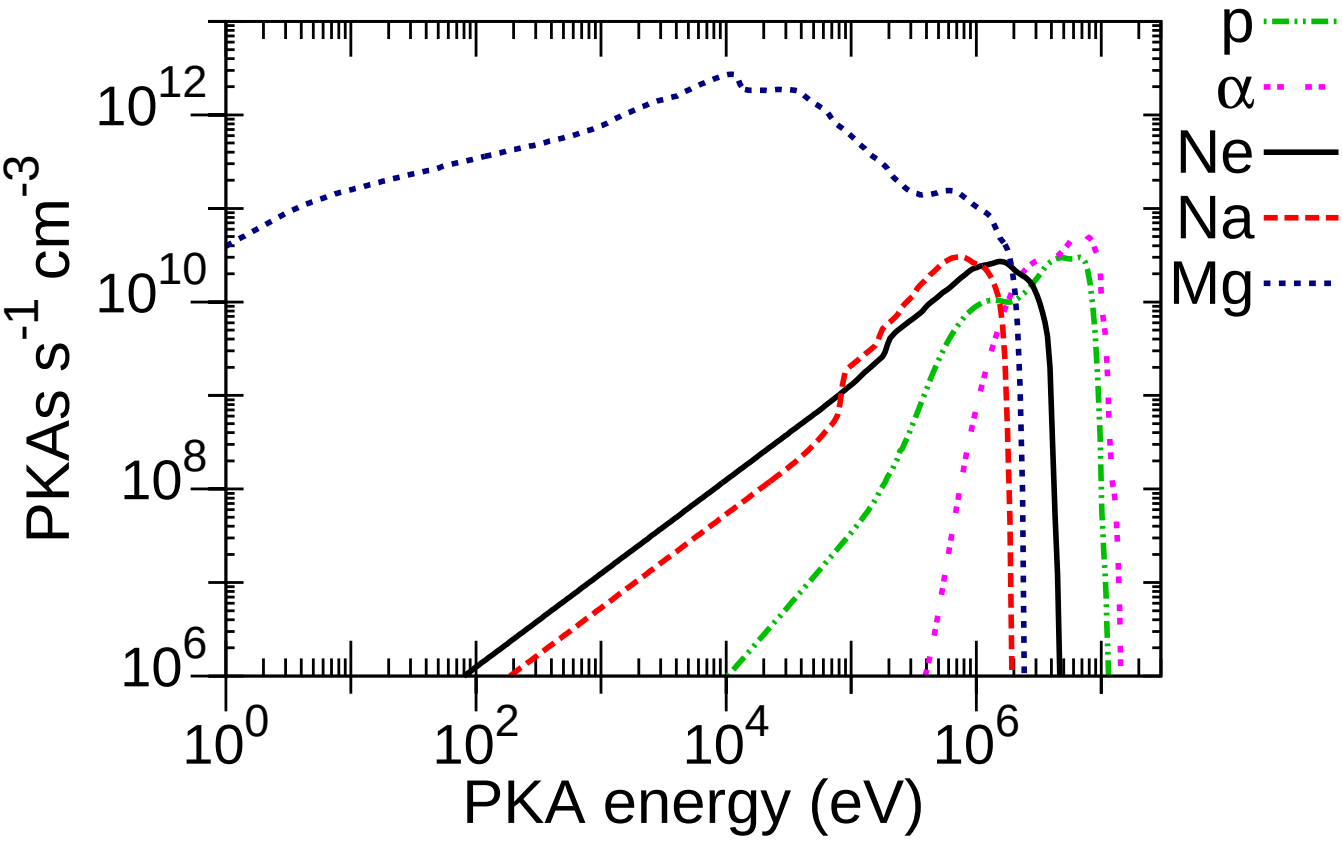
Magnesium FW Transmutation

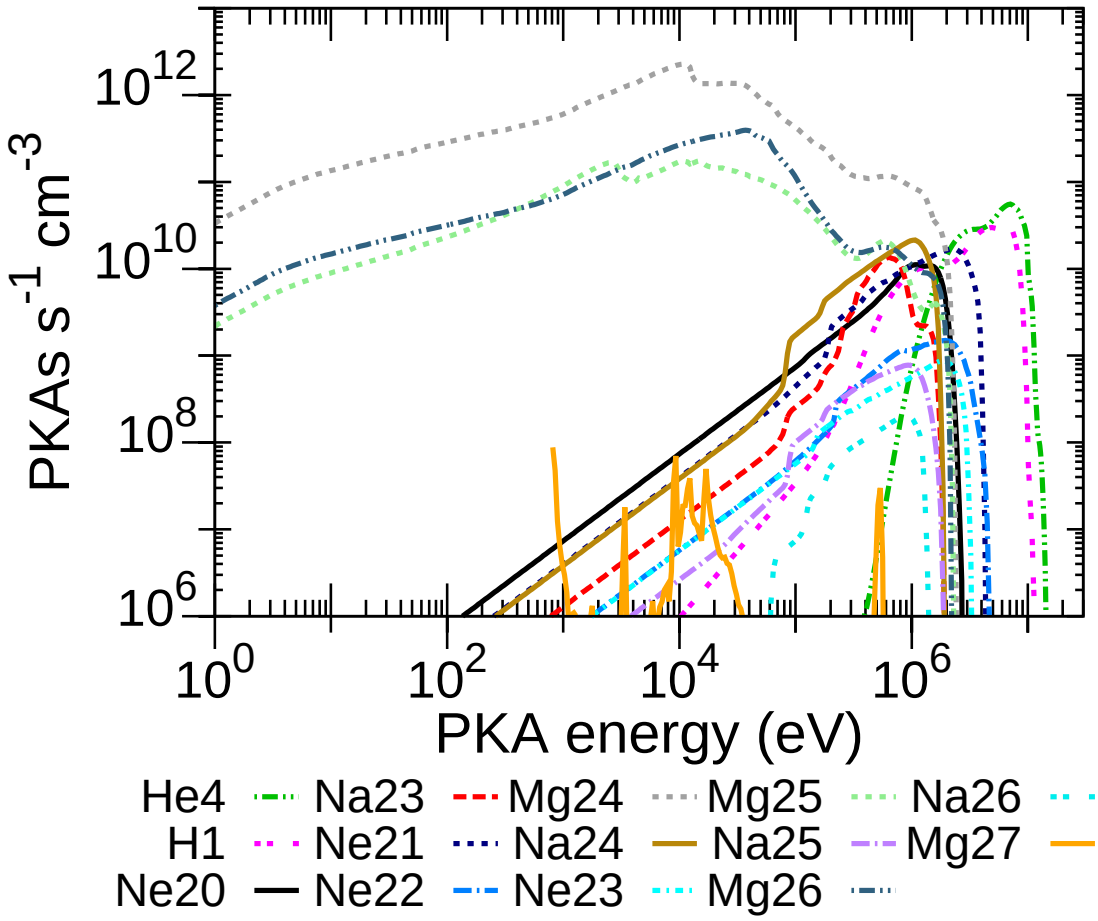


762 appm He & 698 appm H after 1 year 22 dpa/year



Magnesium FW PKA distributions





Magnesium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Na26	1.08s	Mg26(n,p)Na26				99.9
Ne23	37.21s	Mg25(n,α)Ne22(n,γ)Ne23	98.9		100.0	
		Mg24(n,γ)Mg25(n,α)Ne22(n,γ)Ne23	1.1			
		Mg26(n,α)Ne23				97.6
		Mg24(n,np)Na23(n,p)Ne23				1.6
Na25	59.60s	Mg25(n,p)Na25				96.0
		Mg26(n,2n)Mg25(n,p)Na25				2.2
		Mg26(n,d)Na25				1.4
Al28	2.24m	Mg26(n,γ)Mg27(β^-)Al27(n,γ)Al28	99.5	100.0	100.0	98.9
Mg27	9.46m	Mg26(n,γ)Mg27	99.0	100.0	100.0	99.4
		Mg25(n,γ)Mg26(n,γ)Mg27	1.0			
Na24	14.96h	Mg25(n,α)Ne22(n,γ)Ne23(β^-)Na23(n,γ)Na24	99.2		100.0	
		Mg24(n,p)Na24				99.1
Mg28	20.90h	Mg26(n,γ)Mg27(n,γ)Mg28	99.0	100.0	100.0	99.4
		Mg25(n,γ)Mg26(n,γ)Mg27(n,γ)Mg28	1.0			
P32	14.27d	Mg26(n,γ)Mg27(β^-)Al27(n,γ)Al28(β^-)Si28(n,γ)Si29(n,γ) Si30(n,γ)Si31(β^-)P31(n,γ)P32	99.8			
P33	25.38d	Mg26(n,γ)Mg27(β^-)Al27(n,γ)Al28(β^-)Si28(n,γ)Si29(n,γ) Si30(n,γ)Si31(β^-)P31(n,γ)P32(n,γ)P33	99.2			
Na22	2.60y	Mg24(n,np)Na23(n,2n)Na22				68.5
		Mg24(n,d)Na23(n,2n)Na22				20.9
		Mg26(n,α)Ne23(β^-)Na23(n,2n)Na22				9.9
H3	12.33y	Mg25(n,t)H3				89.7
		Mg24(n,α)Ne21(n,t)H3				6.0
		Mg24(n,np)Na23(n,t)H3				1.9
		Mg26(n,2n)Mg25(n,t)H3				1.0
Si32	132.00y	Mg26(n,γ)Mg27(β^-)Al27(n,γ)Al28(β^-)Si28(n,γ)Si29(n,γ) Si30(n,γ)Si31(n,γ)Si32	77.2			
		Mg26(n,γ)Mg27(β^-)Al27(n,γ)Al28(β^-)Si28(n,γ)Si29(n,γ) Si30(n,γ)Si31(β^-)P31(n,γ)P32(n,p)Si32	22.6			
C14	5.7 10^3y	Mg24(n,α)Ne21(n,2α)C14				93.1
		Mg24(n,α)Ne21(n,nα)O17(n,α)C14				2.9
		Mg24(n,nα)Ne20(n,α)O17(n,α)C14				2.1
Cl36	3.0 10^5y	no pathways found				
Al26	7.2 10^5y	Mg26(n,γ)Mg27(β^-)Al27(n,2n)Al26				99.8
Be10	1.6 10^6y	Mg24(n,nα)Ne20(n,2α)C13(n,α)Be10				73.4
		Mg24(n,α)Ne21(n,nα)O17(n,nα)C13(n,α)Be10				9.5
		Mg24(n,nα)Ne20(n,nα)O16(n,α)C13(n,α)Be10				7.2
		Mg24(n,nα)Ne20(n,α)O17(n,nα)C13(n,α)Be10				7.1

Aluminium

Isotope	Atom % abundance
Al27	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	4.59E+14	3.86E+14	4.18E+12	1.16E+11	4.90E+08	4.51E+07
Na24	56.5	66.9	97.1			
Mg27	39.9	32.3				
Al28	3.4	0.8				
H3			2.9	99.7	90.7	
Al26					9.3	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.49E-01	2.27E-01	3.04E-03	2.30E-07	2.28E-08	2.22E-08
Na24	78.0	85.3	100.0			
Mg27	18.8	14.0				
Al28	3.0	0.7				
H3				46.0	1.8	
Na22				44.3		
Al26				9.7	98.2	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	3.89E+05	3.67E+05	5.29E+03	1.80E-01	3.39E-02	3.36E-02
Na24	86.8	91.7	100.0			
Mg27	10.9	7.9				
Al28	2.2	0.5				
Na22				81.2		
Al26				18.8	100.0	100.0

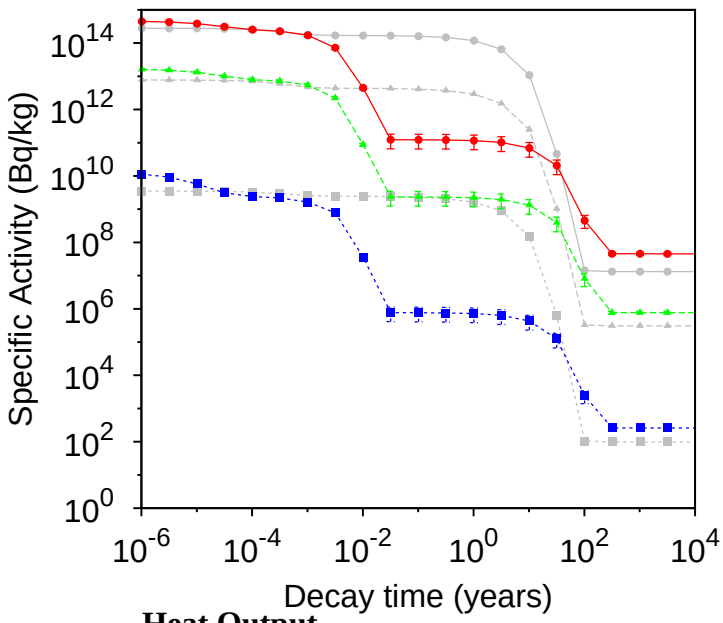
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.15E+05	1.13E+05	1.75E+03	5.88E+00	1.78E-01	1.58E-01
Na24	96.7	98.0	99.6			
Mg27	2.9	2.0				
H3			0.3	82.8	10.5	
Na22			0.1	14.5		
Al26				2.7	89.5	100.0

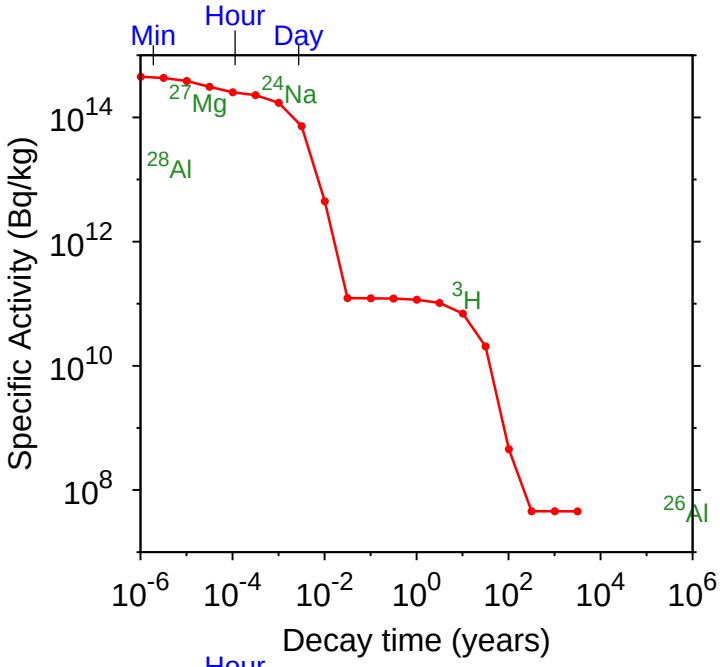
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	7.20E+04	7.09E+04	1.13E+03	3.14E+01	1.03E+00	9.01E-01
Na24	97.2	98.3	97.1			
Mg27	2.3	1.6				
H3			2.8	96.0	11.3	
Al26			0.1	2.9	88.7	100.0
Na22				1.1		

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	4.74E+11	3.89E+11	4.07E+09	3.95E+06	1.27E+05	1.22E+05
Na24	54.8	66.4	99.9			
Mg27	38.7	32.1				
Al28	6.4	1.5				
Na22			0.1	67.5		
H3				29.3	3.5	
Al26				3.1	96.5	100.0

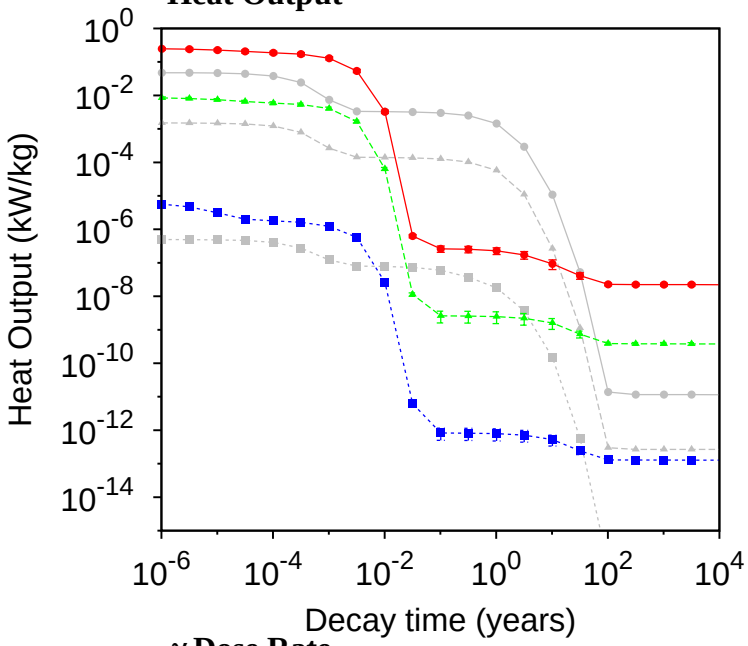
Aluminium activation characteristics

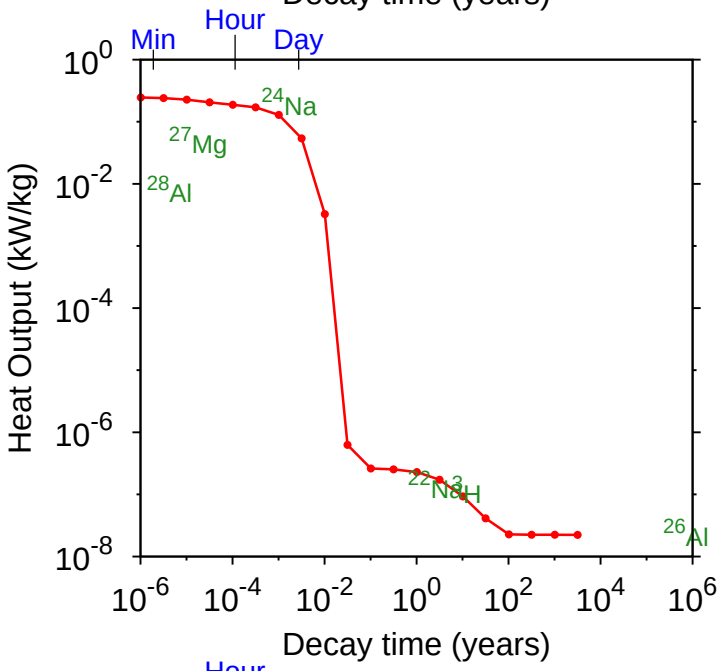
Specific Activity



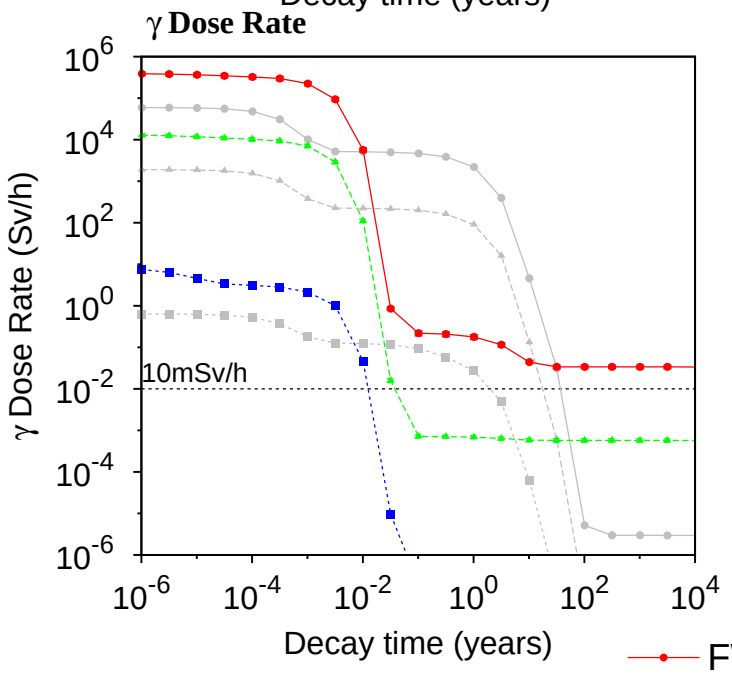


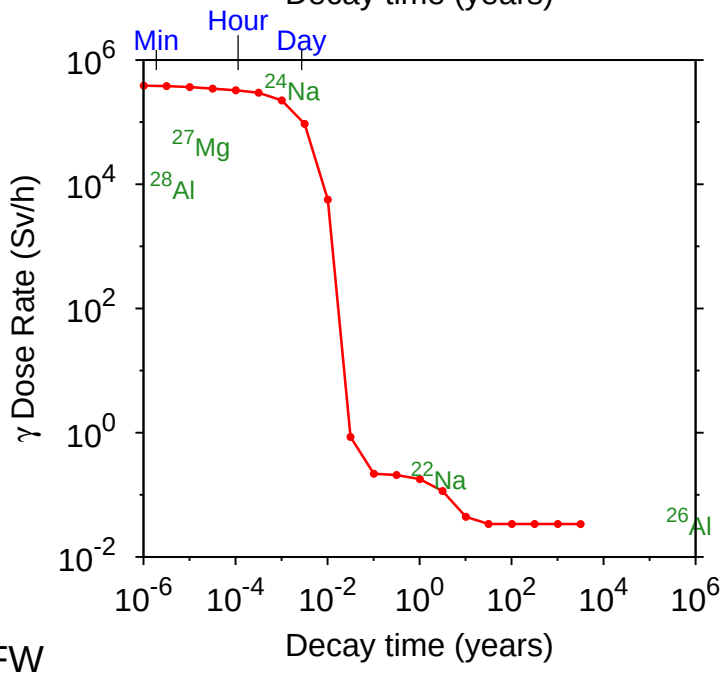
Heat Output





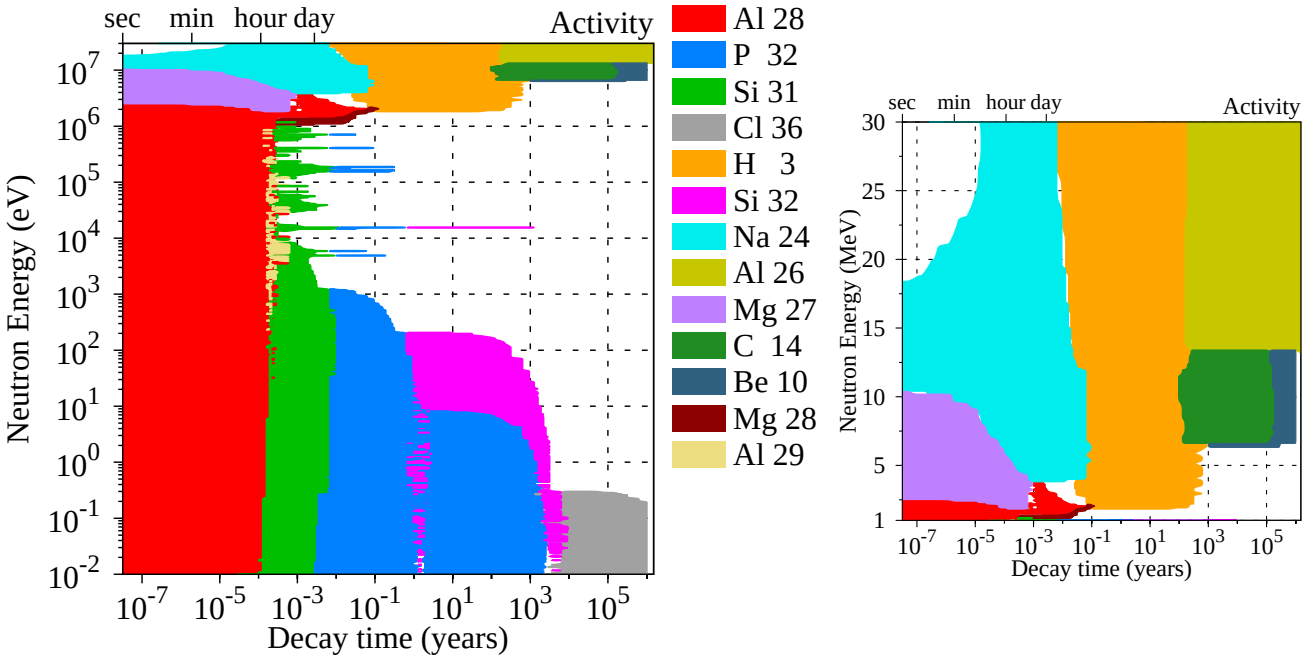
γ Dose Rate

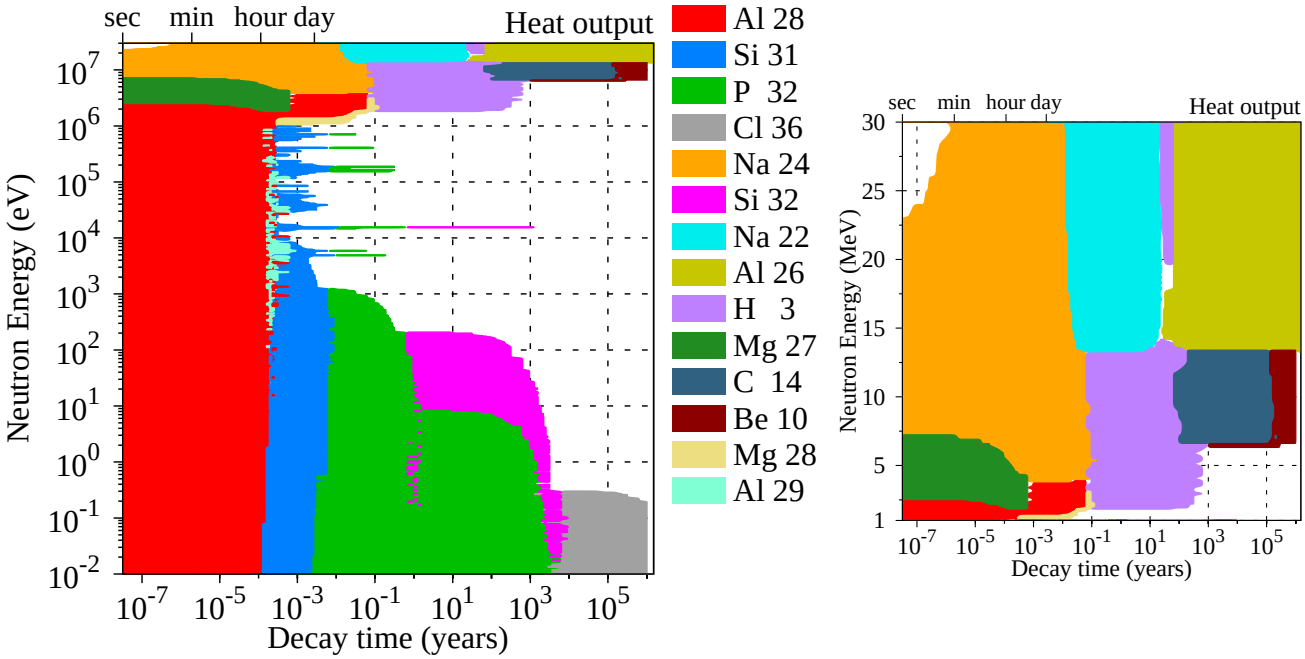


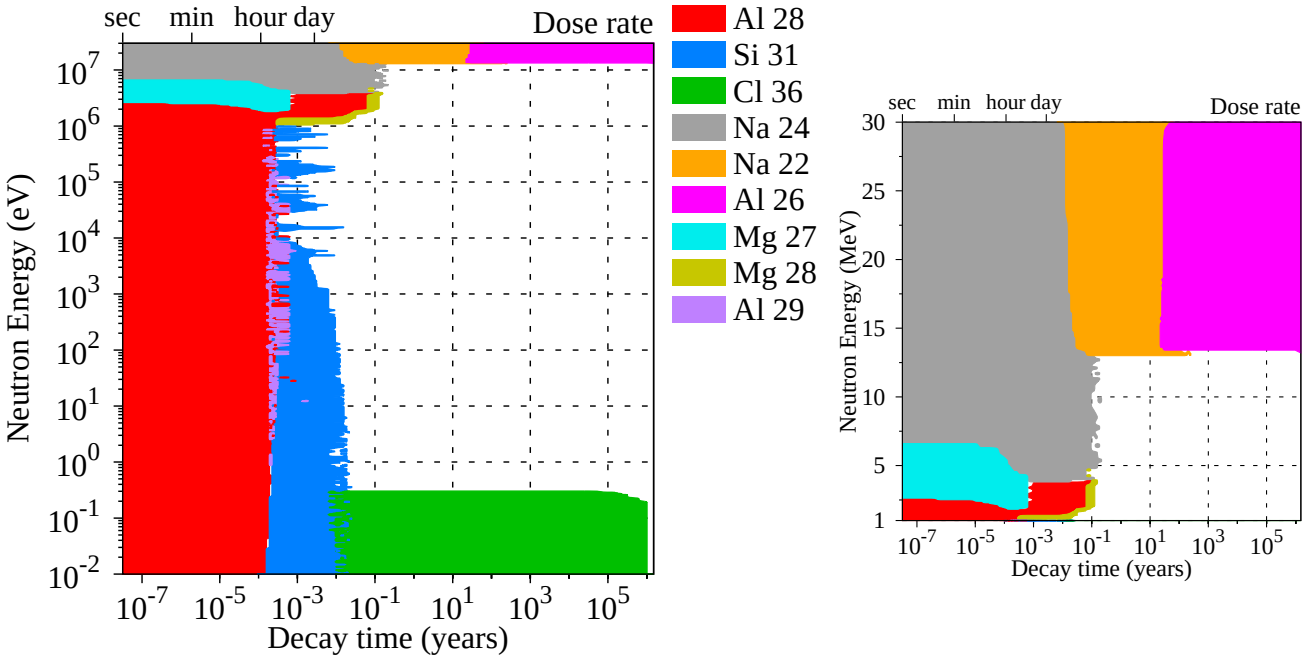


FW
Blanket
Manifold
Fe results

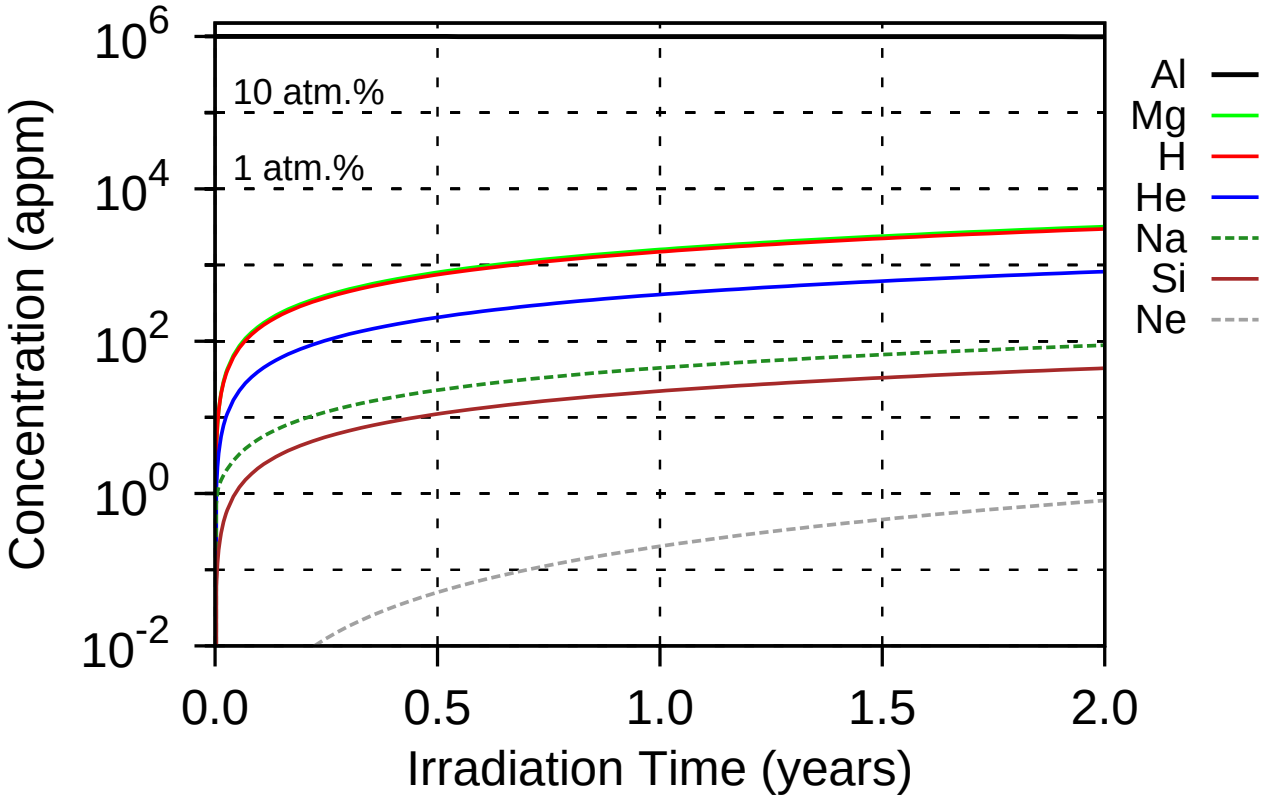
Aluminium Importance diagrams



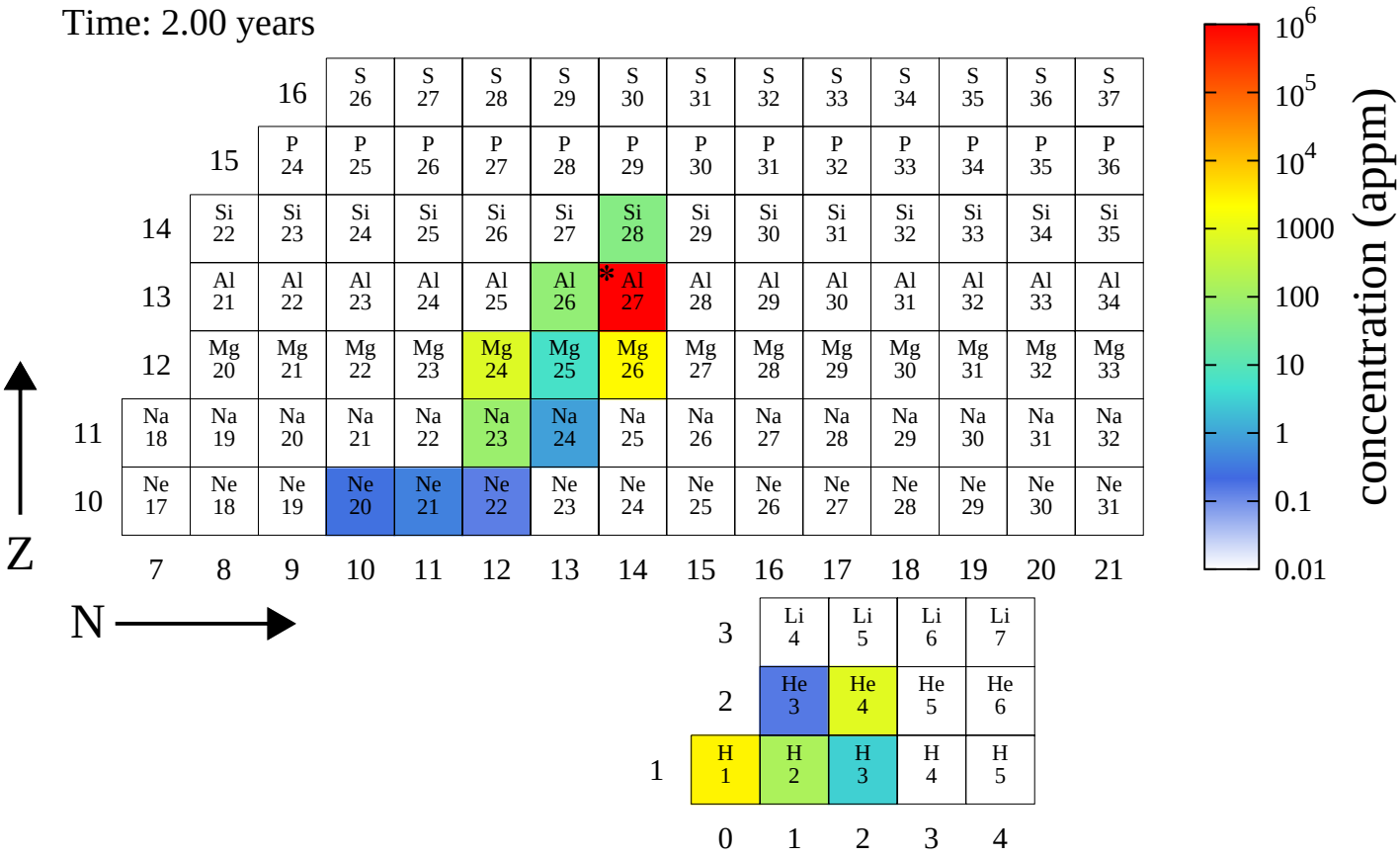




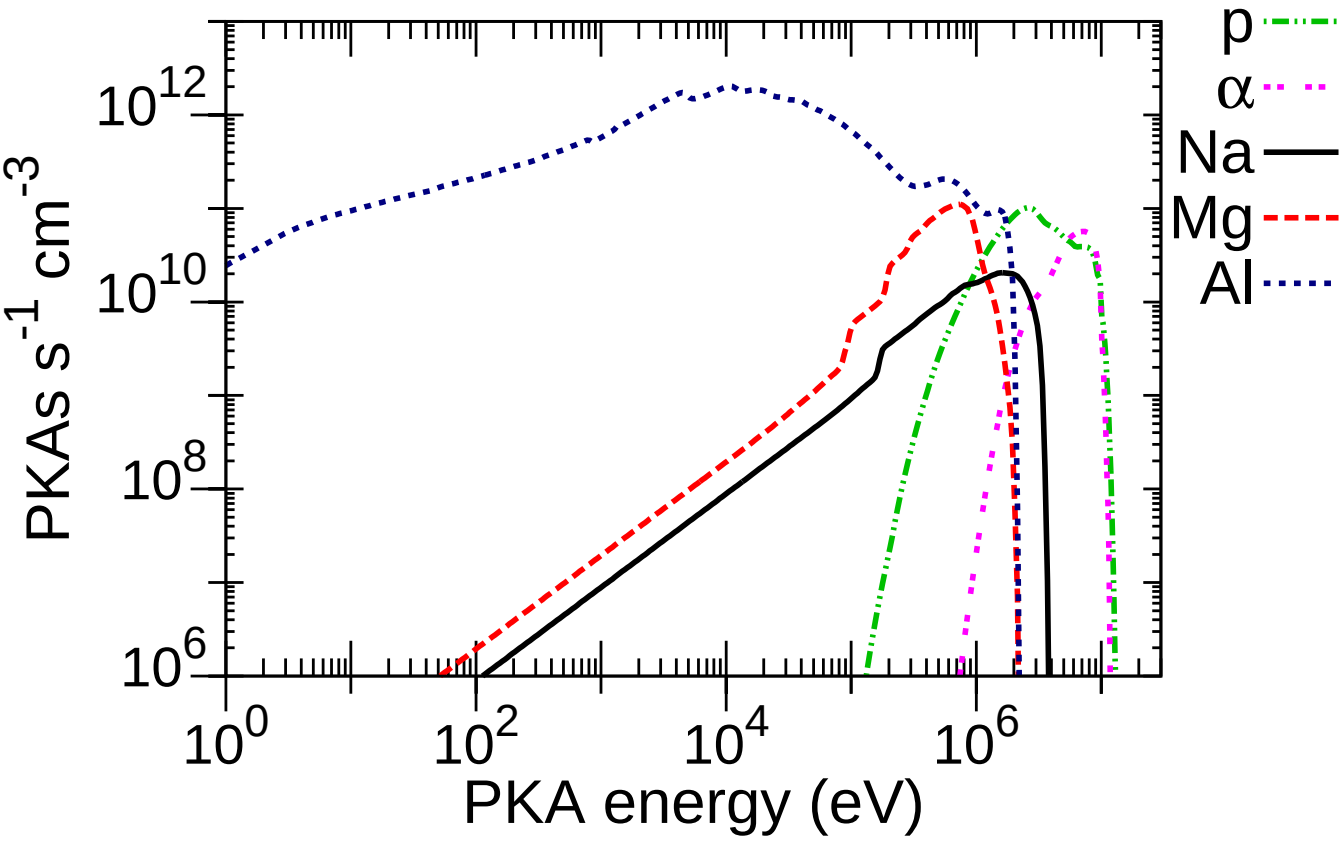
Aluminium FW Transmutation

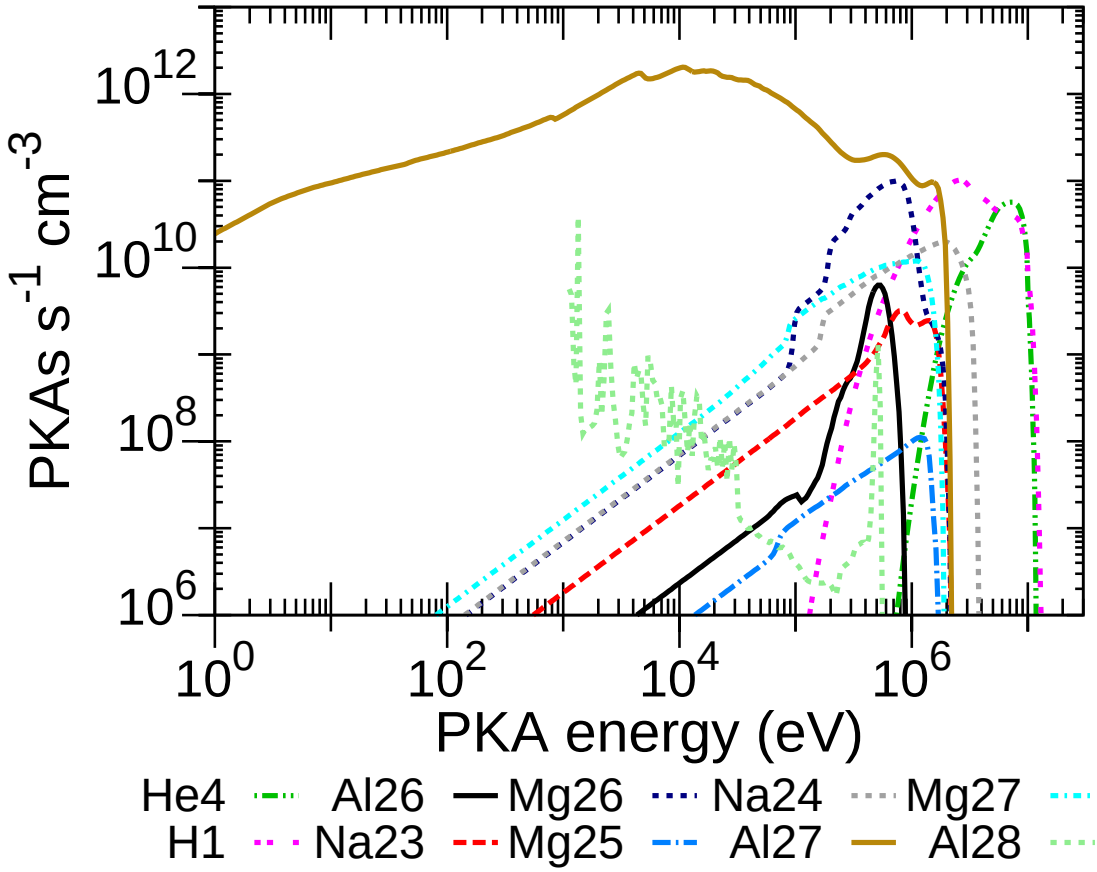


410 appm He & 1492 appm H after 1 year 17 dpa/year



Aluminium FW PKA distributions





Aluminium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Al28	2.24m	Al27(n,γ)Al28	100.0	100.0	100.0	99.5
Al29	6.56m	Al27(n,γ)Al28(n,γ)Al29	100.0	100.0	100.0	
		Al27(n,γ)Al28(β^-)Si28(n,γ)Si29(n,p)Al29				98.8
Mg27	9.46m	Al27(n,p)Mg27			100.0	99.5
Si31	2.62h	Al27(n,γ)Al28(β^-)Si28(n,γ)Si29(n,γ)Si30(n,γ)Si31	100.0	100.0		
Na24	14.96h	Al27(n,α)Na24				99.5
Mg28	20.90h	Al27(n,γ)Al28(n,p)Mg28			59.7	13.4
		Al27(n,p)Mg27(n,γ)Mg28			40.3	86.1
P32	14.27d	Al27(n,γ)Al28(β^-)Si28(n,γ)Si29(n,γ)Si30(n,γ)Si31(β^-) P31(n,γ)P32	100.0			
Na22	2.60y	Al27(n,nα)Na23(n,2n)Na22				75.3
		Al27(n,2n)Al26(n,nα)Na22				19.6
		Al27(n,np)Mg26(n,α)Ne23(β^-)Na23(n,2n)Na22				3.1
H3	12.33y	Al27(n,p)H1(n,γ)H2(n,γ)H3			100.0	
		Al27(n,t)H3				99.3
Si32	132.00y	Al27(n,γ)Al28(β^-)Si28(n,γ)Si29(n,γ)Si30(n,γ) Si31(n,γ)Si32	73.5			
		Al27(n,γ)Al28(β^-)Si28(n,γ)Si29(n,γ)Si30(n,γ)Si31(β^-) P31(n,γ)P32(n,p)Si32	26.5			
C14	5.7 10^3y	Al27(n,α)Na24(β^-)Mg24(n,α)Ne21(n,2α)C14				94.4
		Al27(n,α)Na24(β^-)Mg24(n,α)Ne21(n,nα)O17(n,α)C14				2.2
		Al27(n,α)Na24(β^-)Mg24(n,nα)Ne20(n,α)O17(n,α)C14				1.6
Cl36	3.0 10^5y	Al27(n,γ)Al28(β^-)Si28(n,γ)Si29(n,γ)Si30(n,γ)Si31(β^-) P31(n,γ)P32(β^-)S32(n,γ)S33(n,γ)S34(n,γ)S35(β^-) Cl35(n,γ)Cl36	83.3			
		Al27(n,γ)Al28(β^-)Si28(n,γ)Si29(n,γ)Si30(n,γ)Si31(β^-) P31(n,γ)P32(n,γ)P33(β^-)S33(n,γ)S34(n,γ)S35(β^-) Cl35(n,γ)Cl36	13.5			
		Al27(n,γ)Al28(β^-)Si28(n,γ)Si29(n,γ)Si30(n,γ)Si31(β^-) P31(n,γ)P32(n,γ)P33(n,γ)P34(β^-)S34(n,γ)S35(β^-) Cl35(n,γ)Cl36	3.0			
Al26	7.2 10^5y	Al27(n,2n)Al26				99.8
Be10	1.6 10^6y	Al27(n,α)Na24(β^-)Mg24(n,nα)Ne20(n,2α)C13(n,α)Be10				70.0
		Al27(n,nα)Na23(n,α)F20(β^-)Ne20(n,2α)C13(n,α)Be10				8.1
		Al27(n,α)Na24(β^-)Mg24(n,α)Ne21(n,nα)O17(n,nα) C13(n,α)Be10				7.2
		Al27(n,α)Na24(β^-)Mg24(n,nα)Ne20(n,nα)O16(n,α) C13(n,α)Be10				5.5
		Al27(n,α)Na24(β^-)Mg24(n,nα)Ne20(n,α)O17(n,nα) C13(n,α)Be10				5.4

Silicon

Isotope	Atom % abundance
Si28	92.23
Si29	4.68
Si30	3.09

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	5.40E+14	1.14E+14	7.65E+09	2.65E+09	1.03E+07	1.33E+04
Al28	96.2	90.0				
Al29	2.5	6.8				
Mg27	0.8	2.4				
Na24	0.1	0.2	63.1			
H3			36.7	100.0	99.9	
Al26					0.1	99.1

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.60E-01	5.34E-02	3.62E-06	2.52E-09	1.59E-11	6.48E-12
Al28	96.8	92.7				
Al29	2.0	5.5				
Mg27	0.4	1.3				
Na24	0.1	0.4	99.9			
H3			0.1	96.1	58.9	
Na22				3.6		
Al26				0.3	41.1	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.89E+05	5.91E+04	6.06E+00	1.36E-04	9.56E-06	9.47E-06
Al28	97.0	93.3				
Al29	1.8	5.1				
Mg27	0.3	1.0				
Na24	0.1	0.6	100.0			
Na22				93.0		
Al26				7.0	100.0	100.0

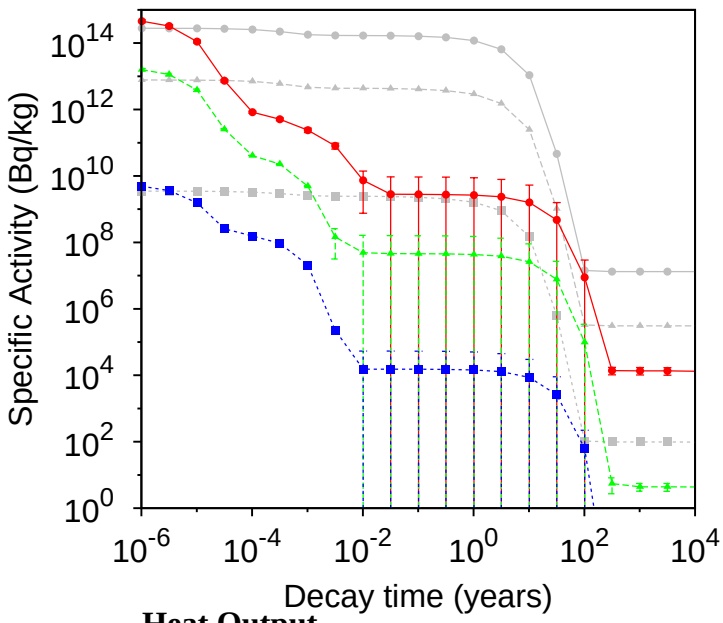
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	5.35E+03	1.36E+03	2.24E+00	1.12E-01	4.77E-04	4.61E-05
Al28	89.3	69.3				
Al29	5.3	12.0				
Na24	2.3	8.8	92.6			
Si31	1.6	6.2				
Mg27	1.4	3.7				
H3			5.3	99.3	90.2	
P32			2.0			
Al26					9.7	99.8

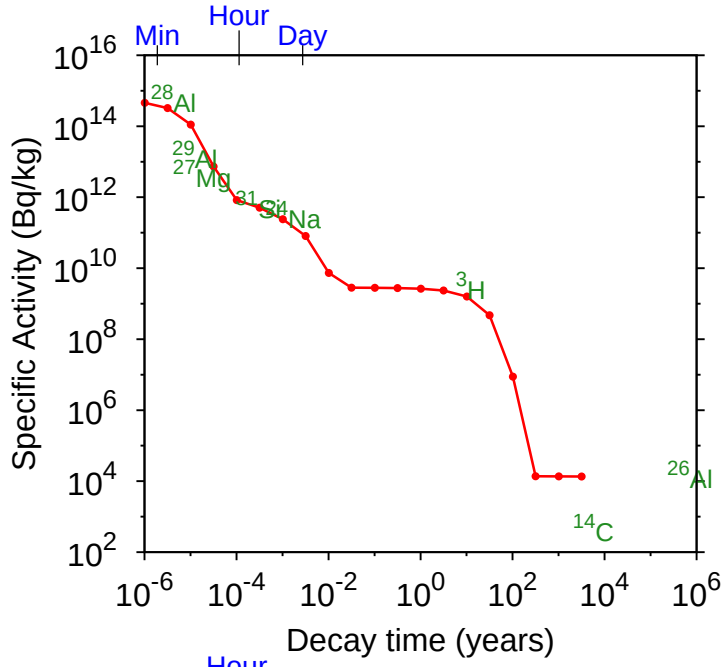
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.79E+03	9.35E+02	2.10E+00	6.91E-01	2.93E-03	2.64E-04
Al28	90.4	72.2				
Al29	5.4	12.5				
Na24	2.0	8.1	62.1			
Si31	1.1	4.5				
Mg27	1.0	2.7				
H3		0.1	34.8	99.9	90.8	
P32			3.1			
Al26					9.1	99.7

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.03E+12	2.11E+11	4.86E+06	2.90E+04	1.39E+02	3.57E+01
Al28	96.9	93.1				
Al29	1.9	5.4				
Mg27	0.4	1.3				
Na24		0.1	99.4			
H3			0.6	91.6	73.8	
Na22			0.1	8.2		
Al26				0.1	25.9	99.7

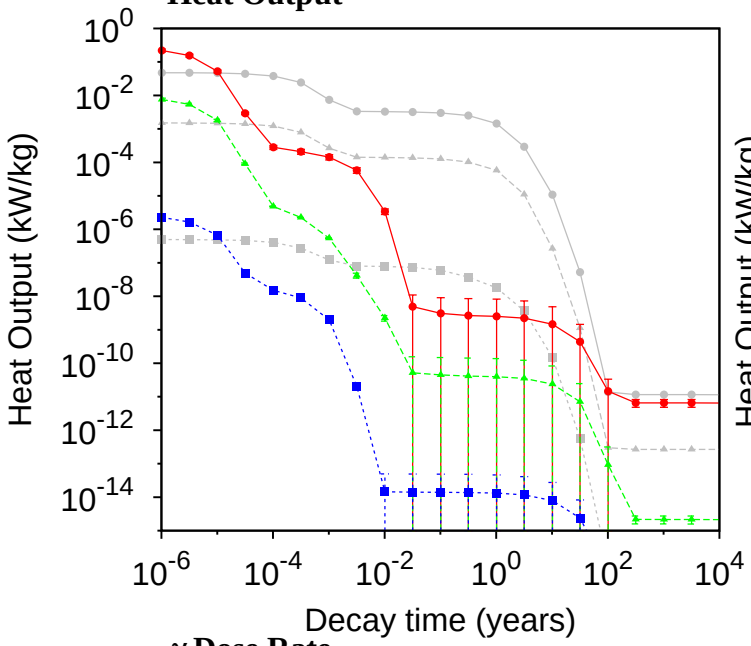
Silicon activation characteristics

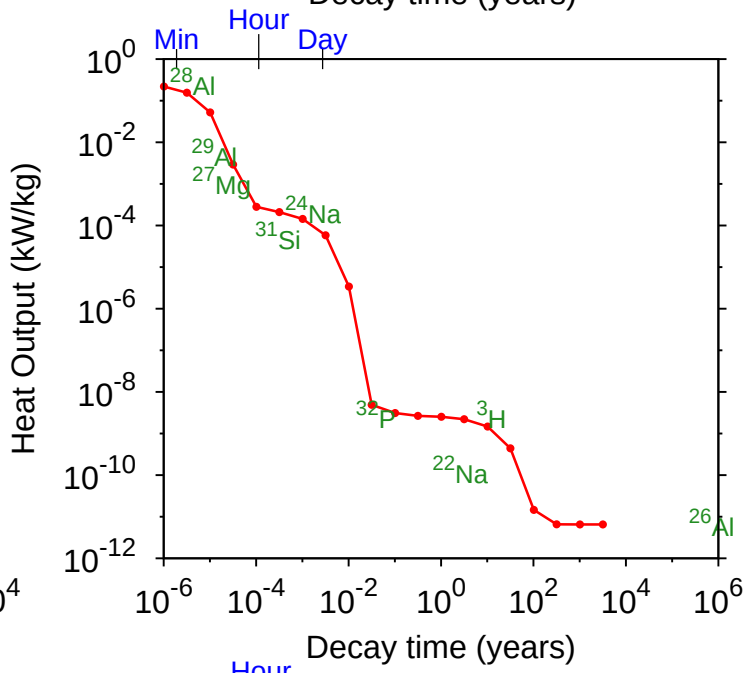
Specific Activity



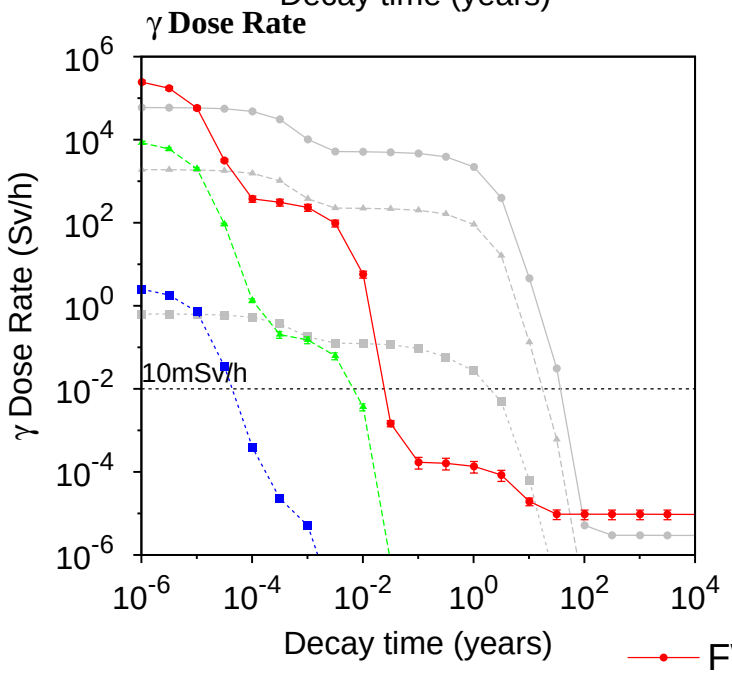


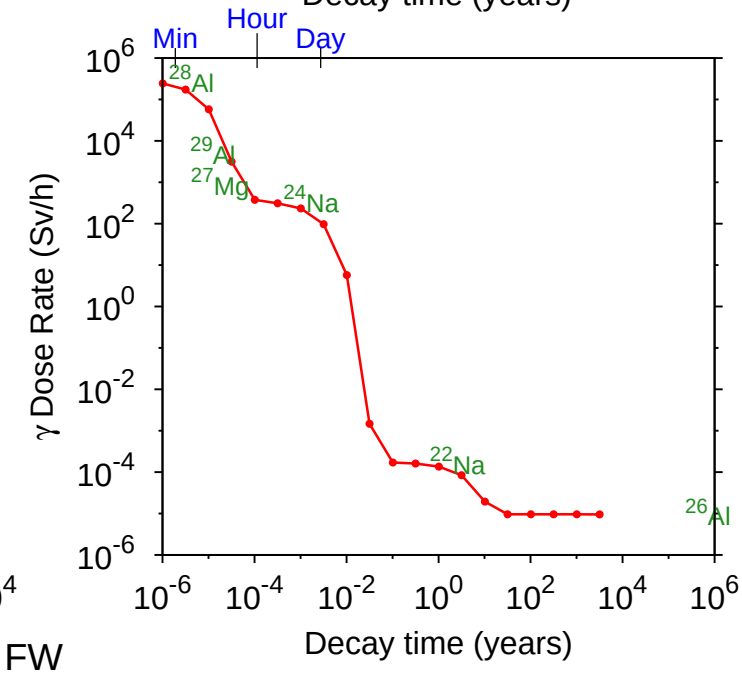
Heat Output





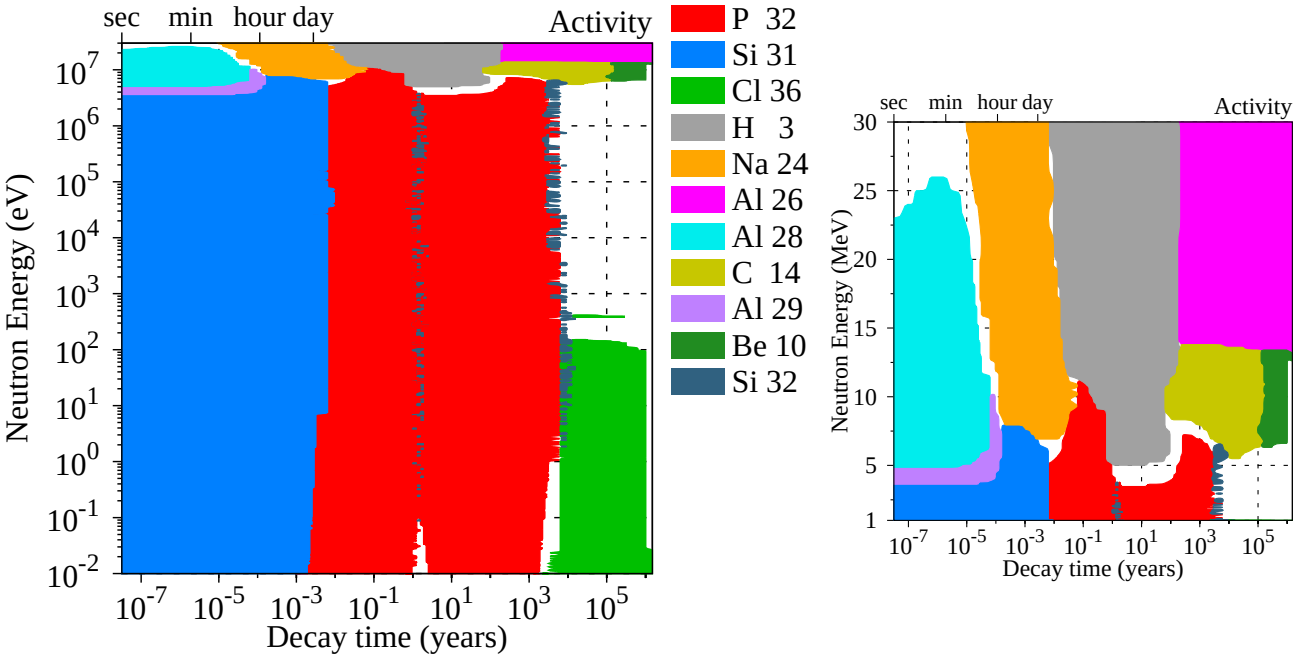
γ Dose Rate

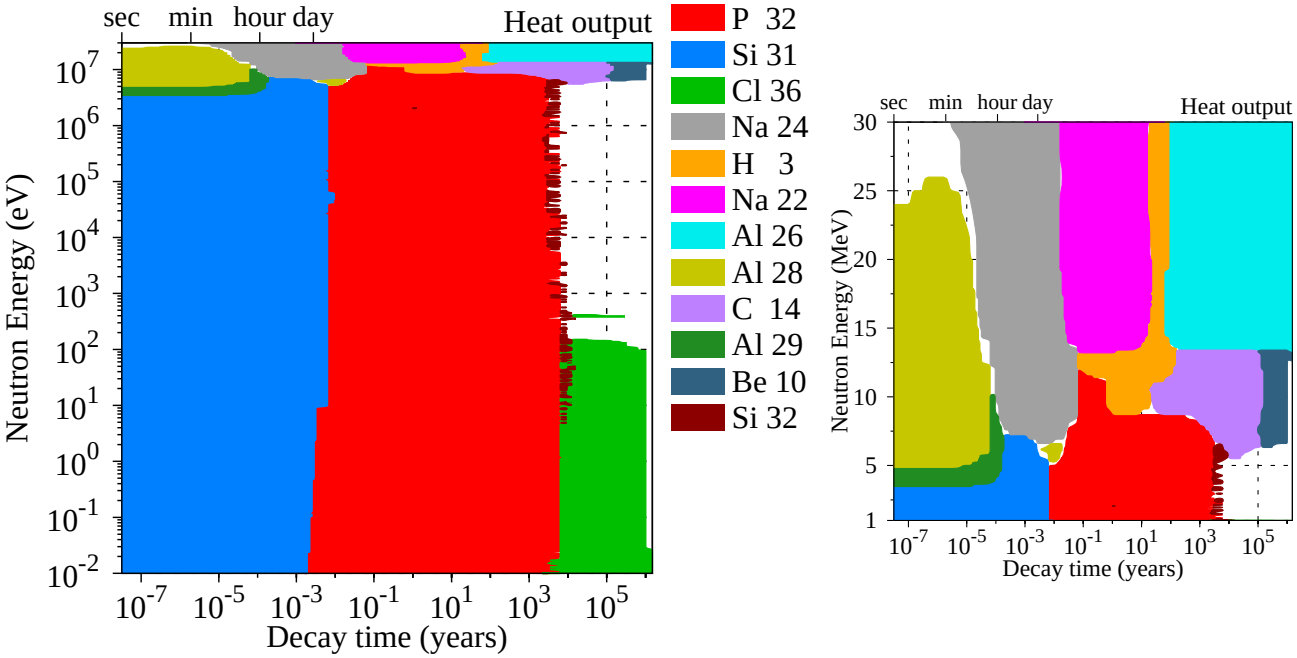


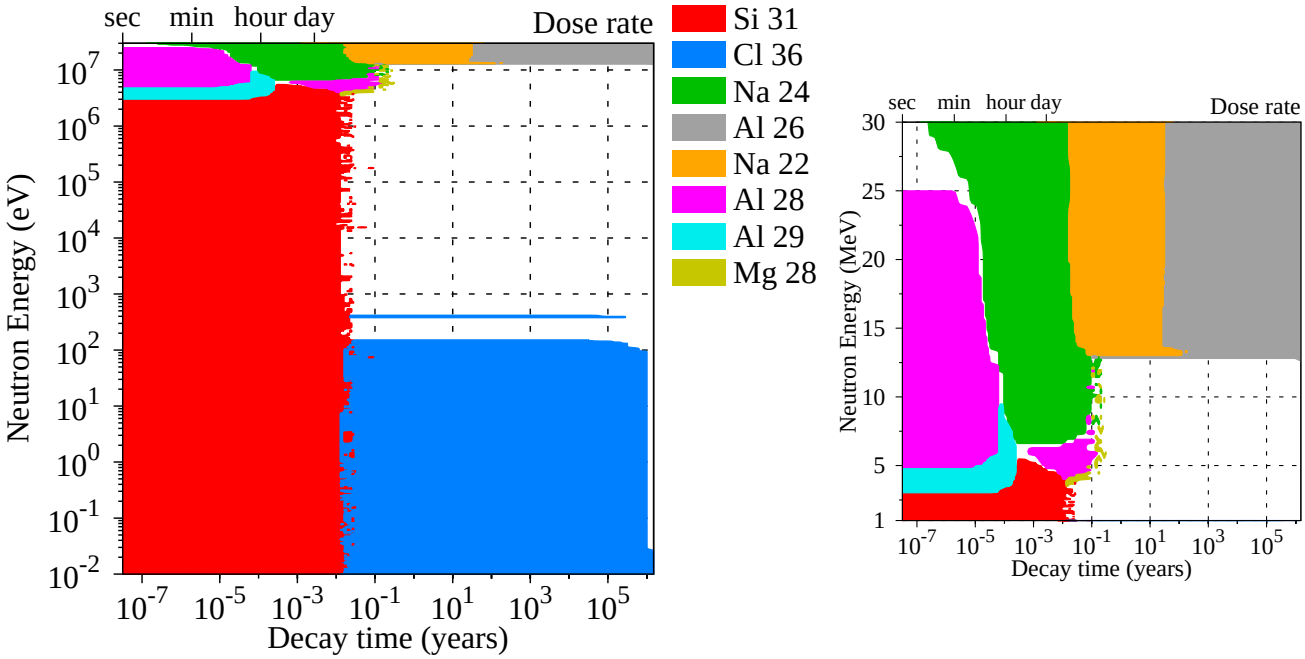


FW
Blanket
Manifold
Fe results

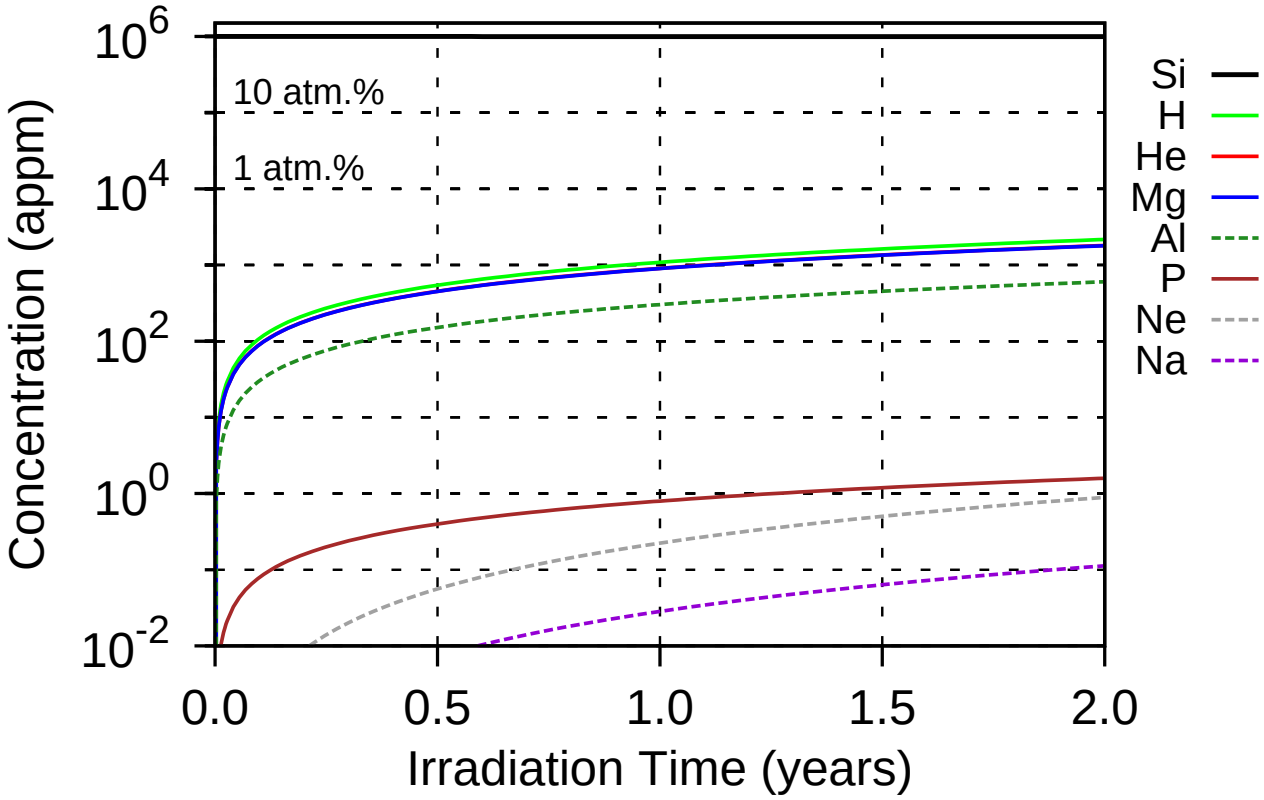
Silicon Importance diagrams



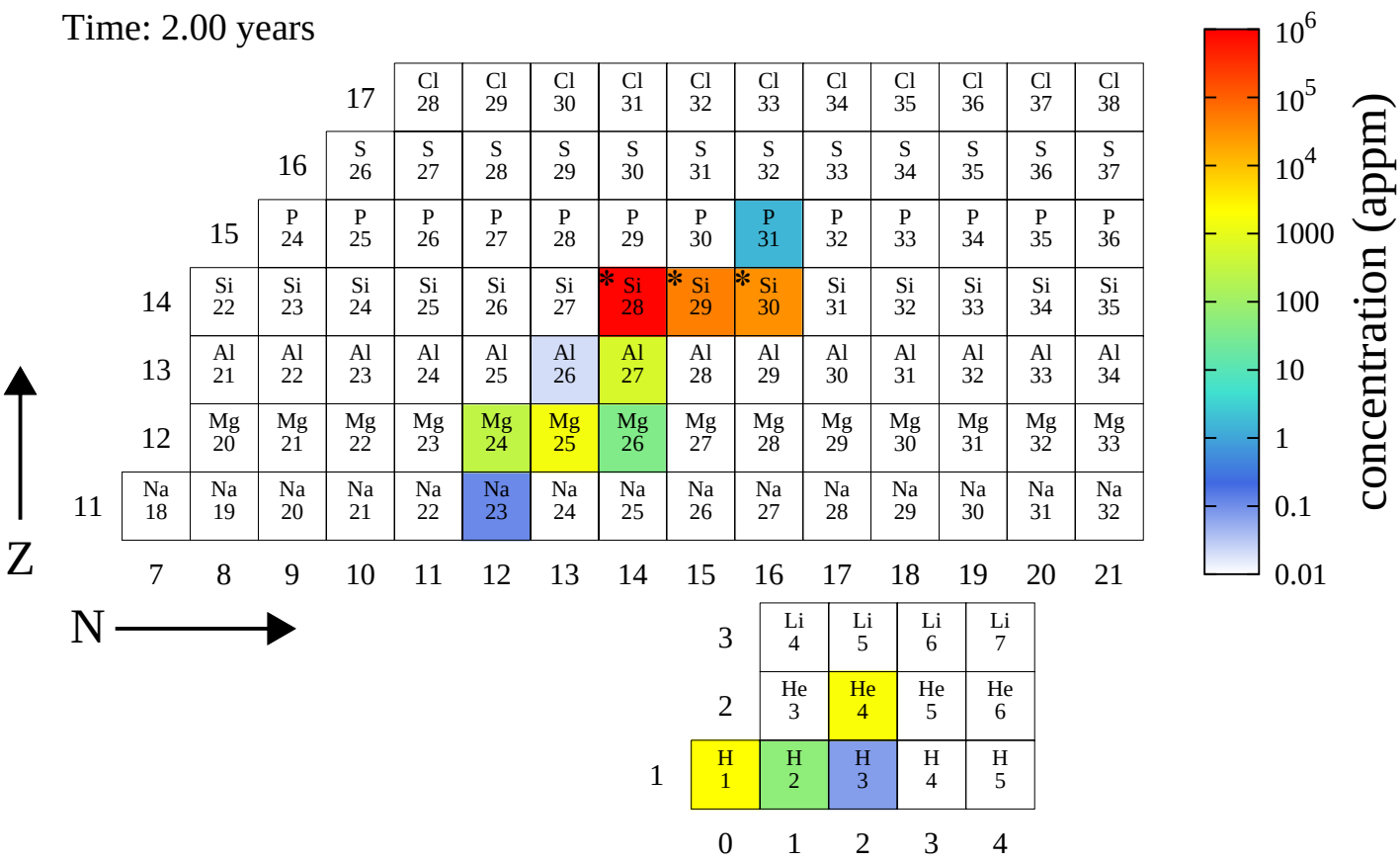




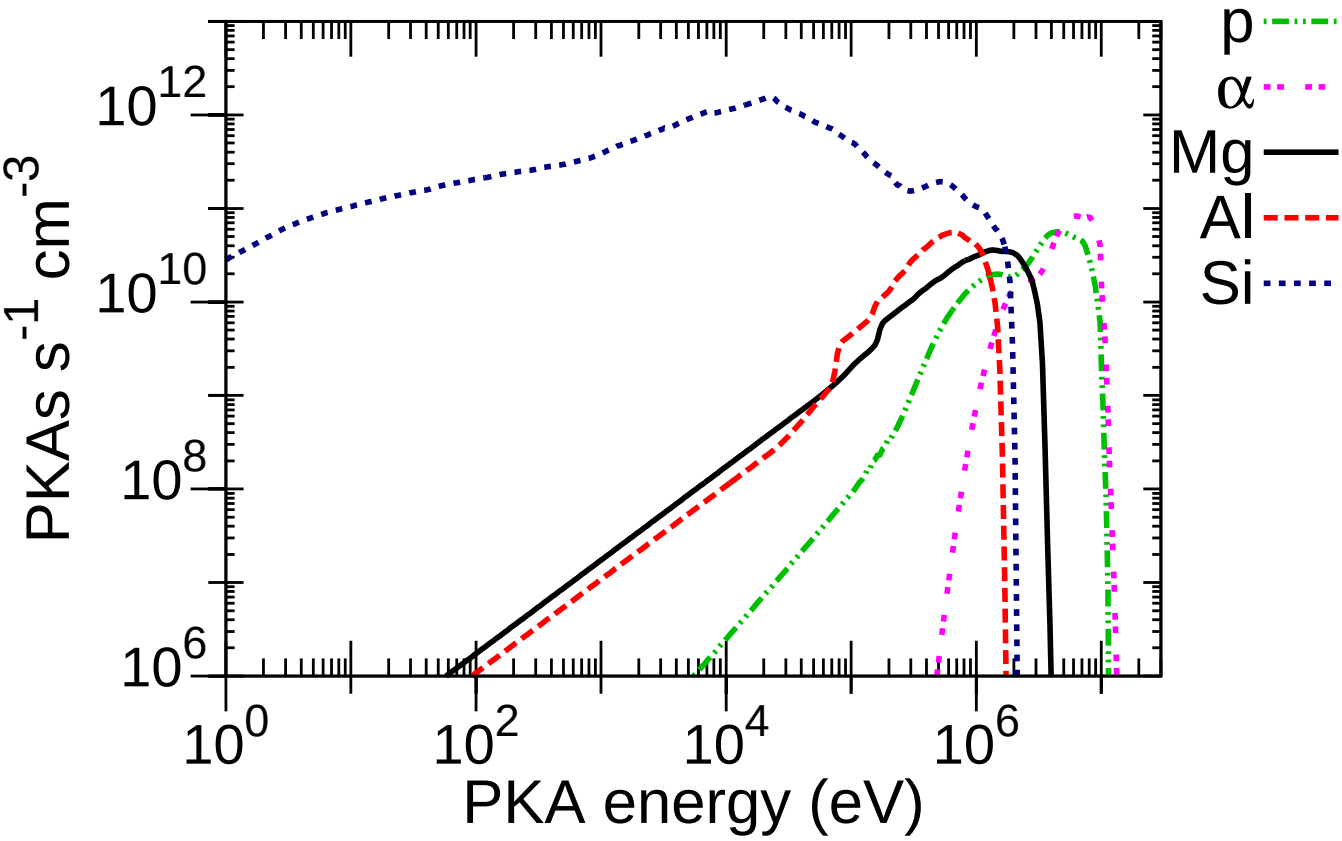
Silicon FW Transmutation

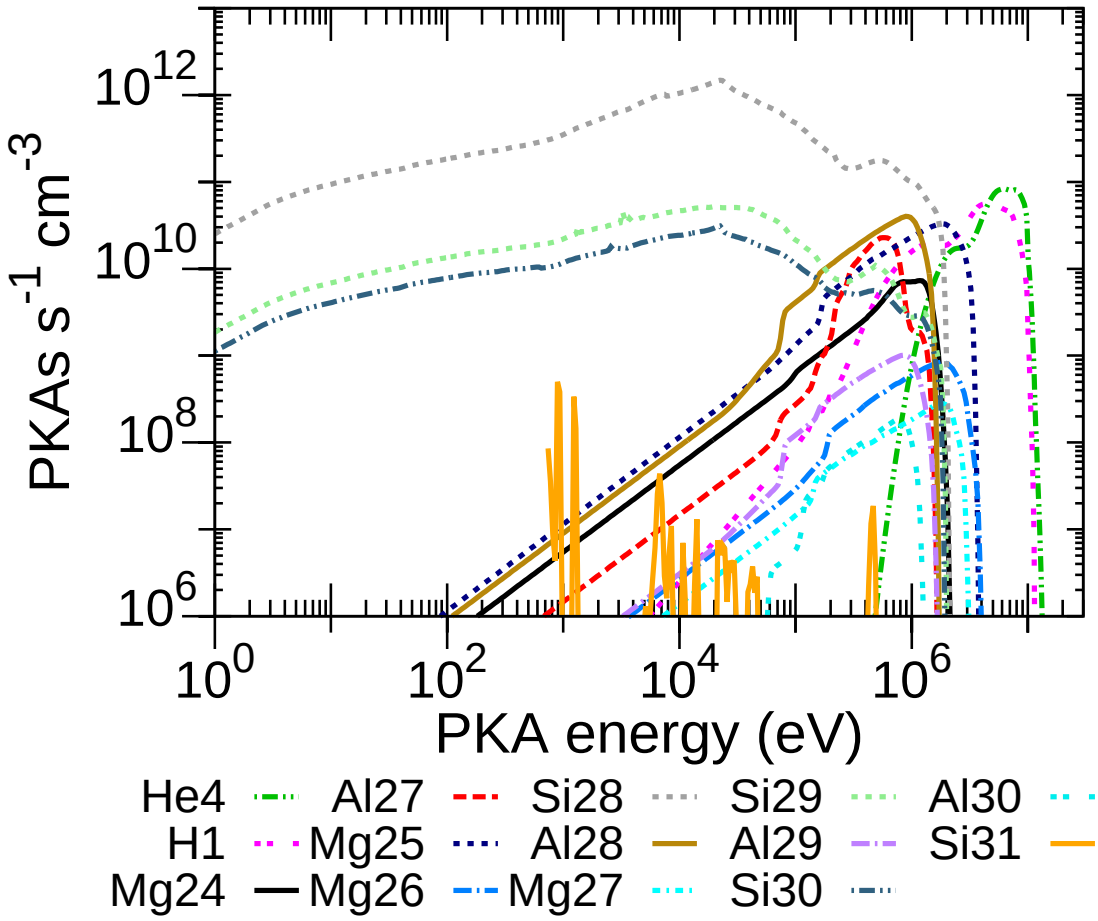


904 appm He & 1085 appm H after 1 year 19 dpa/year



Silicon FW PKA distributions





Silicon Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Al28	2.24m	Si28(n,p)Al28				99.7
Al29	6.56m	Si29(n,p)Al29			100.0	97.2
		Si30(n,2n)Si29(n,p)Al29				1.6
Mg27	9.46m	Si29(n,α)Mg26(n,γ)Mg27			100.0	
		Si30(n,α)Mg27				80.3
		Si28(n,np)Al27(n,p)Mg27				16.9
		Si28(n,d)Al27(n,p)Mg27				2.0
Si31	2.62h	Si30(n,γ)Si31	98.9	99.9	99.9	99.2
		Si29(n,γ)Si30(n,γ)Si31	1.0			
Na24	14.96h	Si28(n,np)Al27(n,α)Na24				44.6
		Si28(n,nα)Mg24(n,p)Na24				39.6
		Si28(n,d)Al27(n,α)Na24				5.2
		Si28(n,α)Mg25(n,d)Na24				3.7
		Si28(n,α)Mg25(n,2n)Mg24(n,p)Na24				3.7
		Si28(n,α)Mg25(n,np)Na24				1.9
		Si30(n,α)Mg27(β^-)Al27(n,α)Na24				1.0
Mg28	20.90h	Si28(n,p)Al28(n,p)Mg28				97.9
		Si29(n,p)Al29(n,d)Mg28				1.3
P32	14.27d	Si30(n,γ)Si31(β^-)P31(n,γ)P32	99.5	100.0	99.9	98.9
Na22	2.60y	Si28(n,nα)Mg24(n,np)Na23(n,2n)Na22				46.5
		Si28(n,np)Al27(n,nα)Na23(n,2n)Na22				18.0
		Si28(n,nα)Mg24(n,d)Na23(n,2n)Na22				14.2
		Si29(n,α)Mg26(n,α)Ne23(β^-)Na23(n,2n)Na22				5.7
		Si28(n,np)Al27(n,2n)Al26(n,nα)Na22				4.7
		Si28(n,α)Mg25(n,t)Na23(n,2n)Na22				2.8
		Si28(n,α)Mg25(n,2n)Mg24(n,np)Na23(n,2n)Na22				2.3
		Si28(n,d)Al27(n,nα)Na23(n,2n)Na22				2.1
H3	12.33y	Si30(n,γ)Si31(β^-)P31(n,γ)P32(n,p)H1(n,γ)H2(n,γ)H3	99.7			
		Si29(n,t)H3				61.0
		Si28(n,α)Mg25(n,t)H3				29.7
		Si28(n,np)Al27(n,t)H3				7.1
Si32	132.00y	Si30(n,γ)Si31(n,γ)Si32	50.3	98.5	49.3	61.4
		Si30(n,γ)Si31(β^-)P31(n,γ)P32(n,p)Si32	49.3	1.4	50.6	38.1
C14	5.7 10^3y	Si28(n,nα)Mg24(n,α)Ne21(n,2α)C14				75.9
		Si28(n,α)Mg25(n,nα)Ne21(n,2α)C14				13.4
		Si28(n,α)Mg25(n,2n)Mg24(n,α)Ne21(n,2α)C14				3.6
		Si28(n,nα)Mg24(n,α)Ne21(n,nα)O17(n,α)C14				1.7
		Si28(n,α)Mg25(n,α)Ne22(n,2n)Ne21(n,2α)C14				1.7
		Si28(n,nα)Mg24(n,nα)Ne20(n,α)O17(n,α)C14				1.3
Cl36	3.0 10^5y	Si30(n,γ)Si31(β^-)P31(n,γ)P32(β^-)S32(n,γ)S33(n,γ)S34(n,γ) S35(β^-)Cl35(n,γ)Cl36	87.5			
		Si30(n,γ)Si31(β^-)P31(n,γ)P32(n,γ)P33(β^-)S33(n,γ)S34(n,γ) S35(β^-)Cl35(n,γ)Cl36	10.6			
		Si30(n,γ)Si31(β^-)P31(n,γ)P32(n,γ)P33(n,γ)P34(β^-)S34(n,γ) S35(β^-)Cl35(n,γ)Cl36	1.5			
Al26	7.2 10^5y	Si28(n,np)Al27(n,2n)Al26				87.0
		Si28(n,d)Al27(n,2n)Al26				10.2
		Si30(n,α)Mg27(β^-)Al27(n,2n)Al26				2.0
Be10	1.6 10^6y	Si28(n,nα)Mg24(n,nα)Ne20(n,2α)C13(n,α)Be10				73.0
		Si28(n,nα)Mg24(n,α)Ne21(n,nα)O17(n,nα)C13(n,α)Be10				7.5
		Si28(n,nα)Mg24(n,nα)Ne20(n,nα)O16(n,α)C13(n,α)Be10				5.7
		Si28(n,nα)Mg24(n,nα)Ne20(n,α)O17(n,nα)C13(n,α)Be10				5.7
		Si28(n,α)Mg25(n,2n)Mg24(n,nα)Ne20(n,2α)C13(n,α)Be10				2.8
		Si28(n,α)Mg25(n,nα)Ne21(n,nα)O17(n,nα)C13(n,α)Be10				1.3

Phosphorus

Isotope	Atom % abundance
P31	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	5.32E+14	3.05E+14	7.93E+12	1.29E+11	4.94E+08	1.65E+03
Al28	47.6	16.3				
Si31	46.2	78.7				
P30	4.3	1.8				
P32	1.7	3.0	98.3		0.3	
H3			1.7	100.0	99.4	
Al26						100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.56E-01	5.03E-02	8.67E-04	1.19E-07	6.31E-10	8.15E-13
Al28	78.3	47.9				
Si31	15.0	45.6				
P30	5.8	4.2				
P32	0.7	2.1	100.0	0.2	26.3	
H3				99.8	71.2	
Si32					2.4	
Al26					0.1	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.45E+05	2.88E+04	4.23E-01	5.76E-06	1.23E-06	1.22E-06
Al28	96.4	95.6				
P30	3.3	3.8				
Na24		0.1	99.9			
Na22				78.6		
Al26				21.4	100.0	100.0

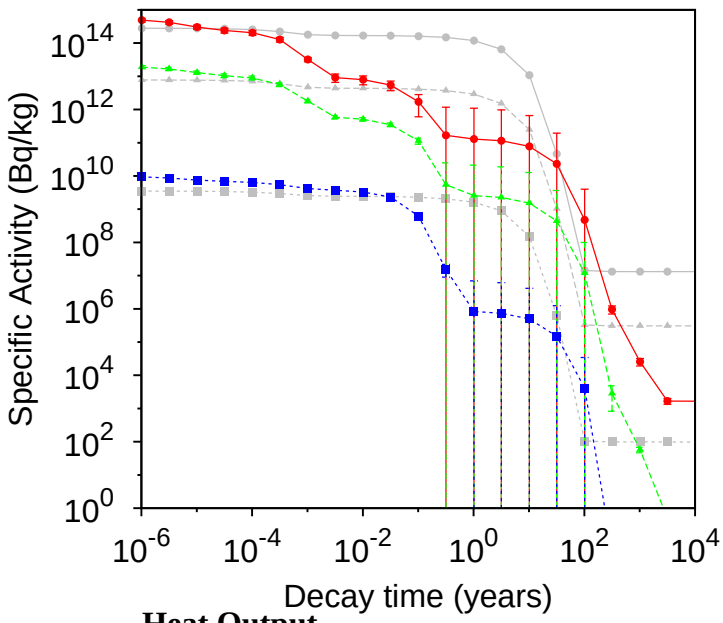
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.42E+04	6.13E+04	1.87E+04	5.44E+00	2.50E-02	5.79E-06
Si31	61.3	62.7				
P32	34.8	36.4	100.0	0.1	14.3	
Al28	3.6	0.7				
H3				99.9	82.4	
Si32					3.3	
Al26						100.0

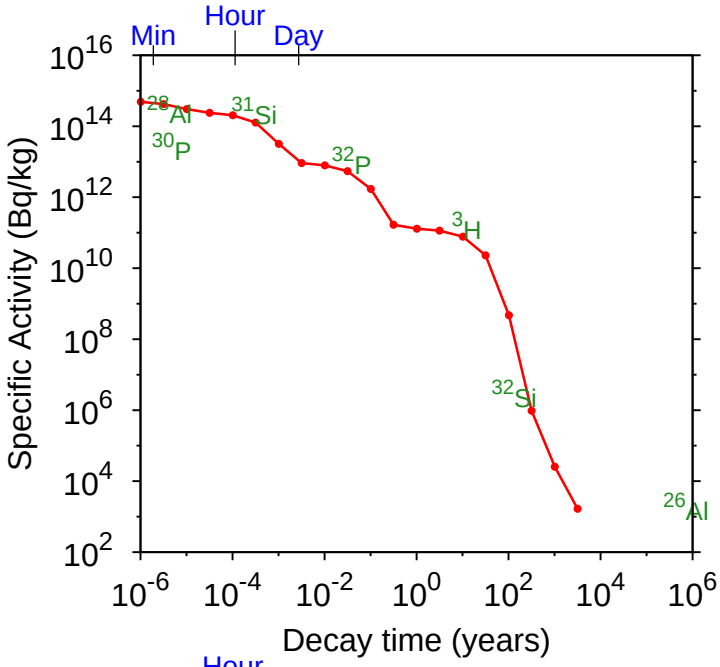
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	5.32E+04	5.11E+04	2.65E+04	3.39E+01	2.96E-01	3.31E-05
P32	59.5	61.9	99.9		1.7	
Si31	36.5	37.2				
Al28	3.1	0.6				
H3	0.1	0.1	0.1	99.2	43.1	
Si32				0.8	55.2	
Al26						100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	5.15E+11	1.03E+11	9.49E+06	1.29E+06	4.93E+03	4.47E+00
Al28	94.5	93.4				
P30	5.2	6.1				
P32			82.1			
H3			14.4	100.0	99.7	
Na24			3.5			
Al26					0.1	100.0

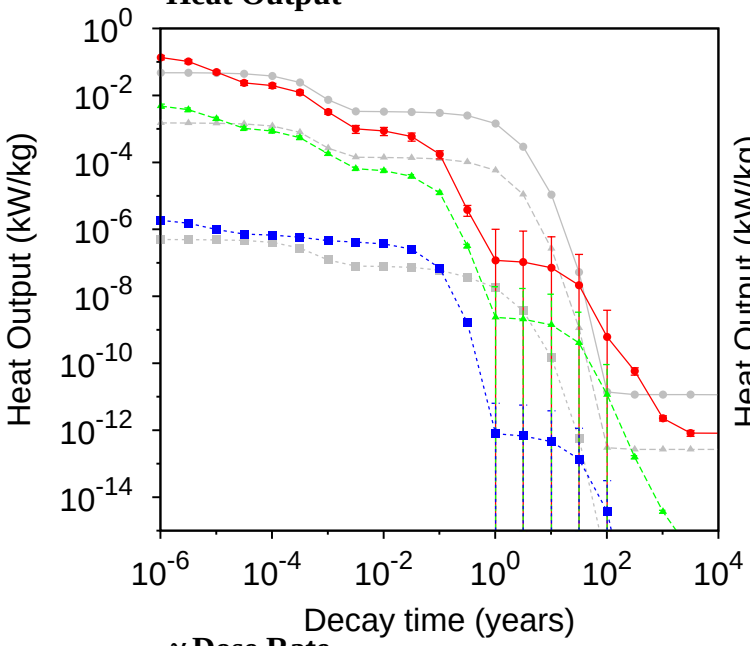
Phosphorus activation characteristics

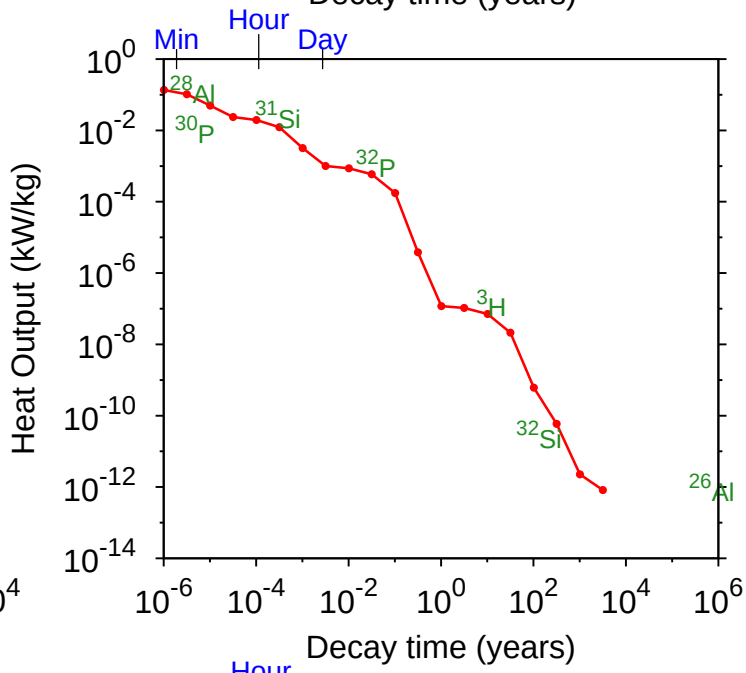
Specific Activity



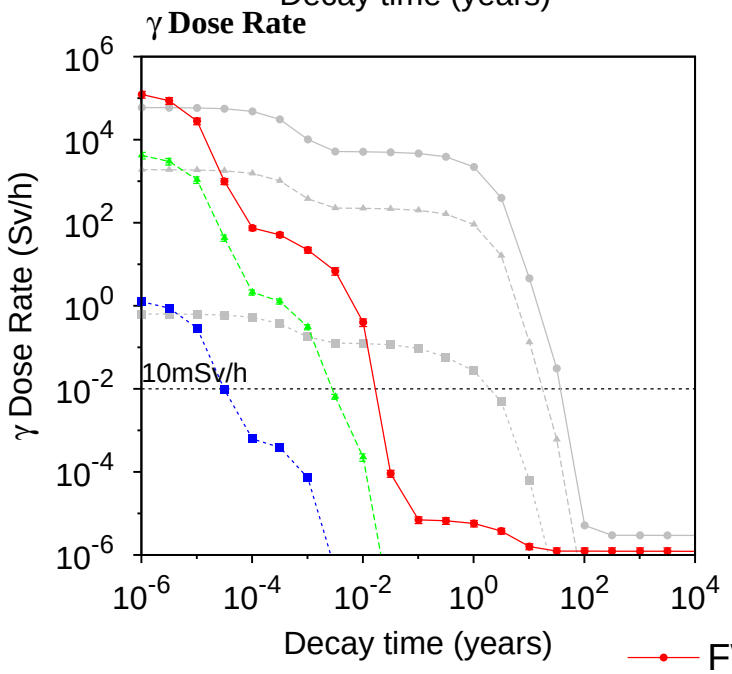


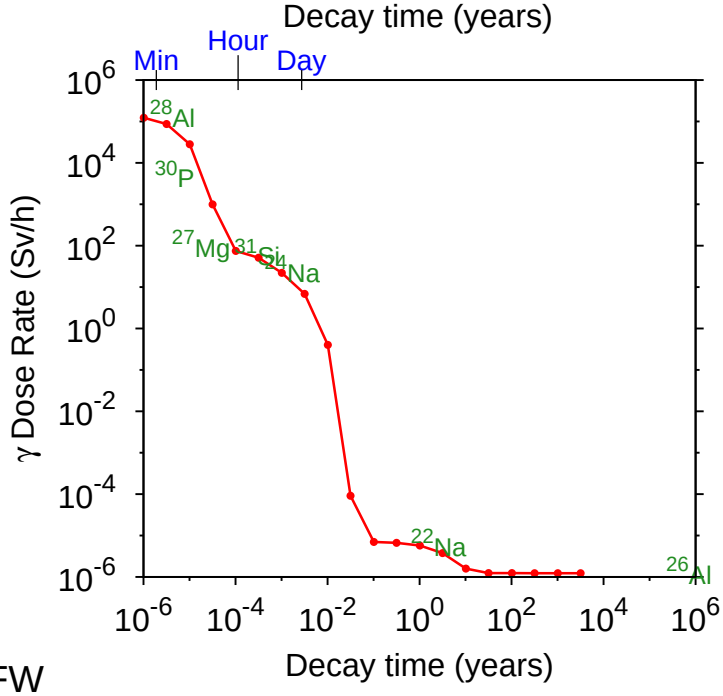
Heat Output





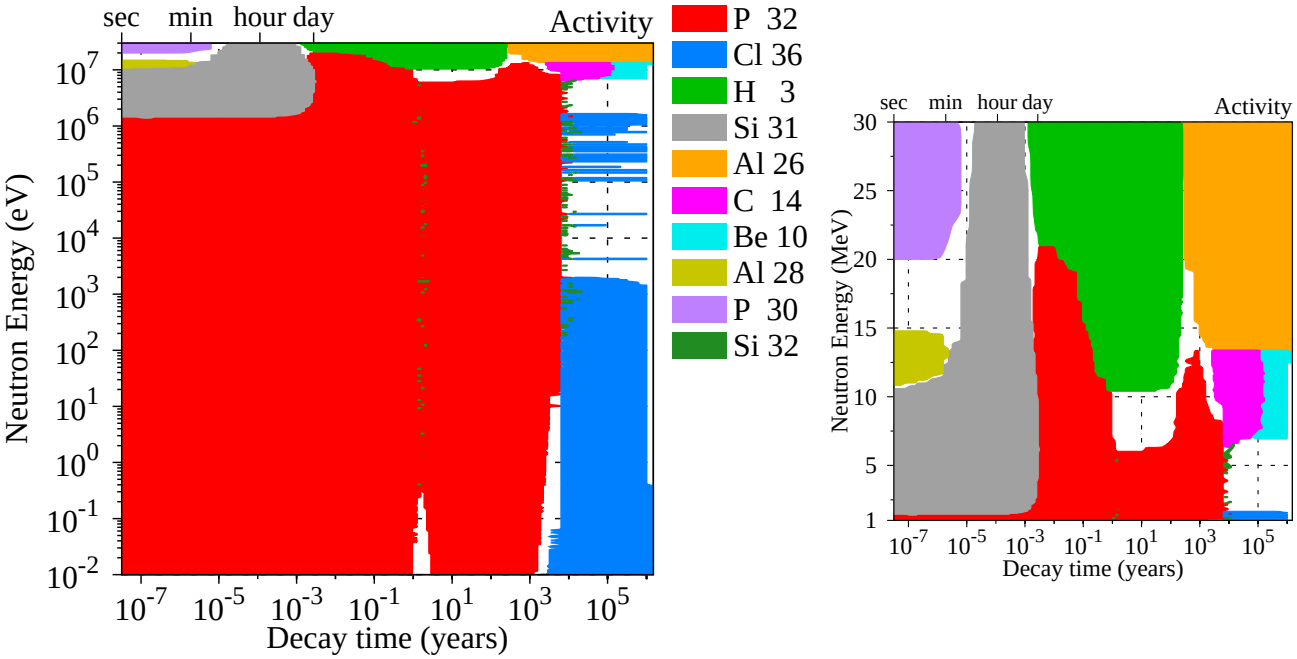
γ Dose Rate

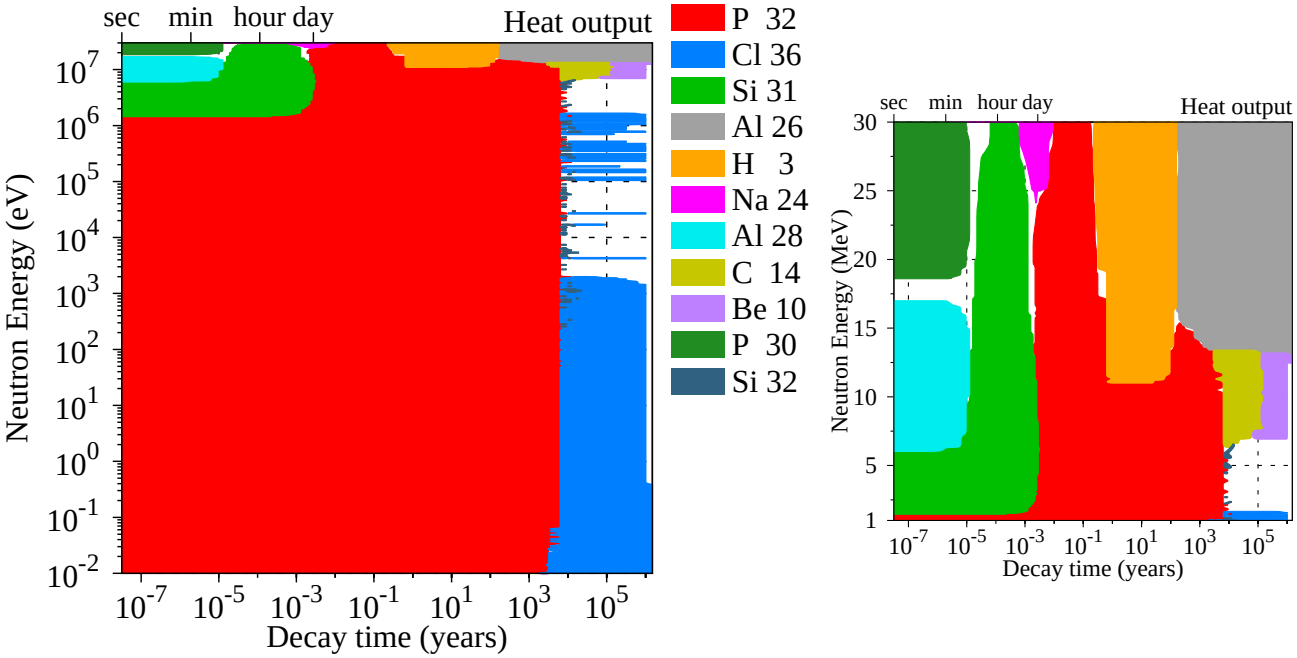


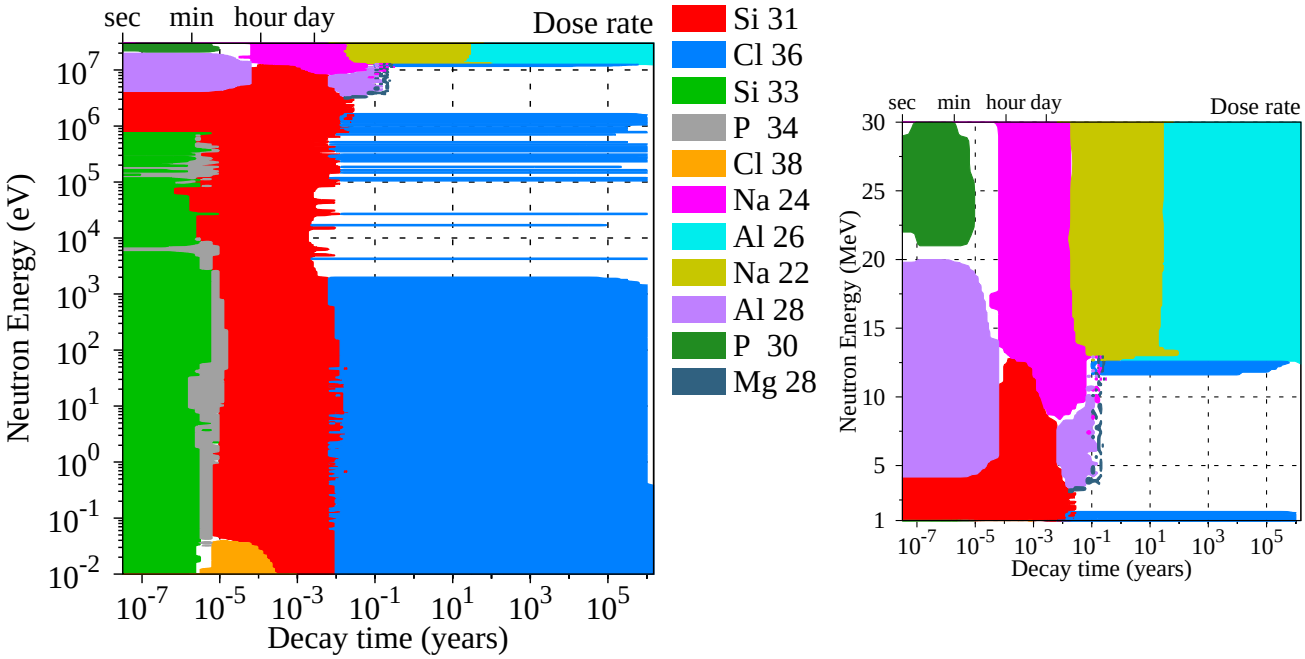


FW
Blanket
Manifold
Fe results

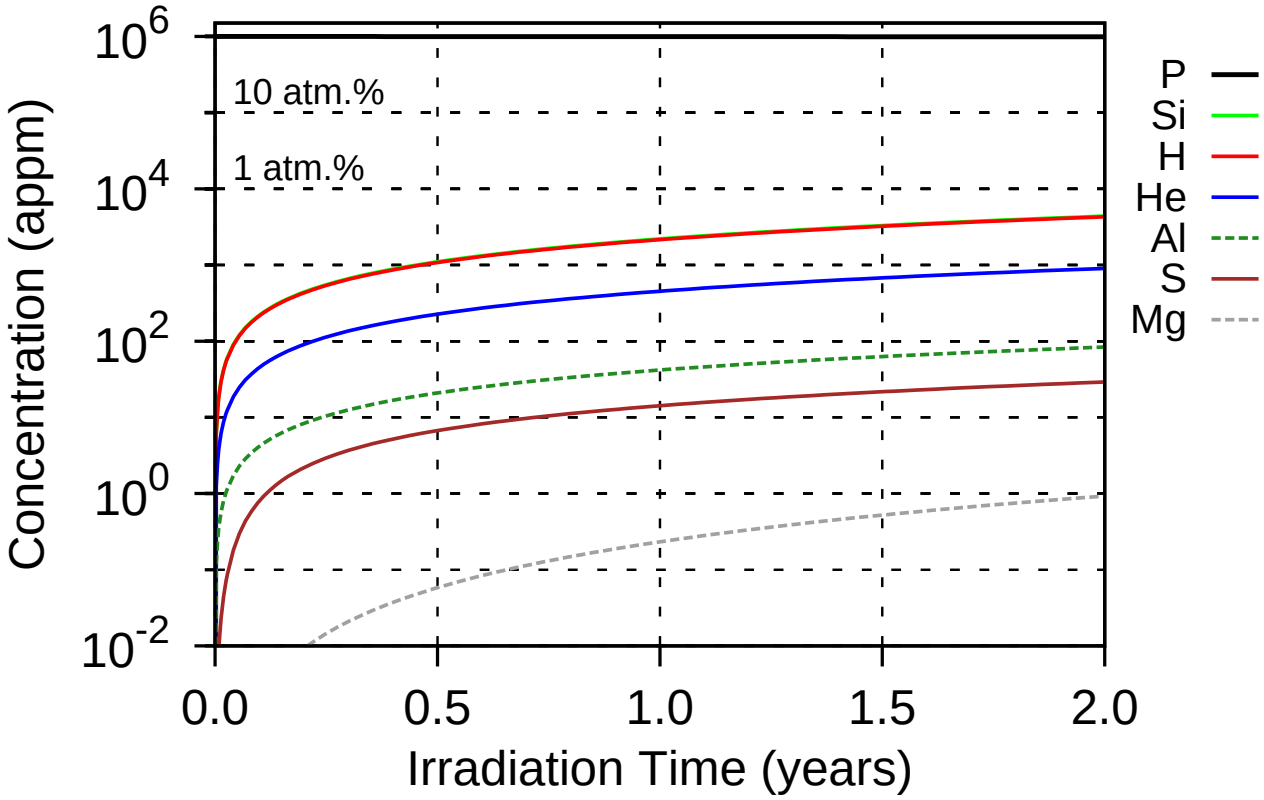
Phosphorus Importance diagrams



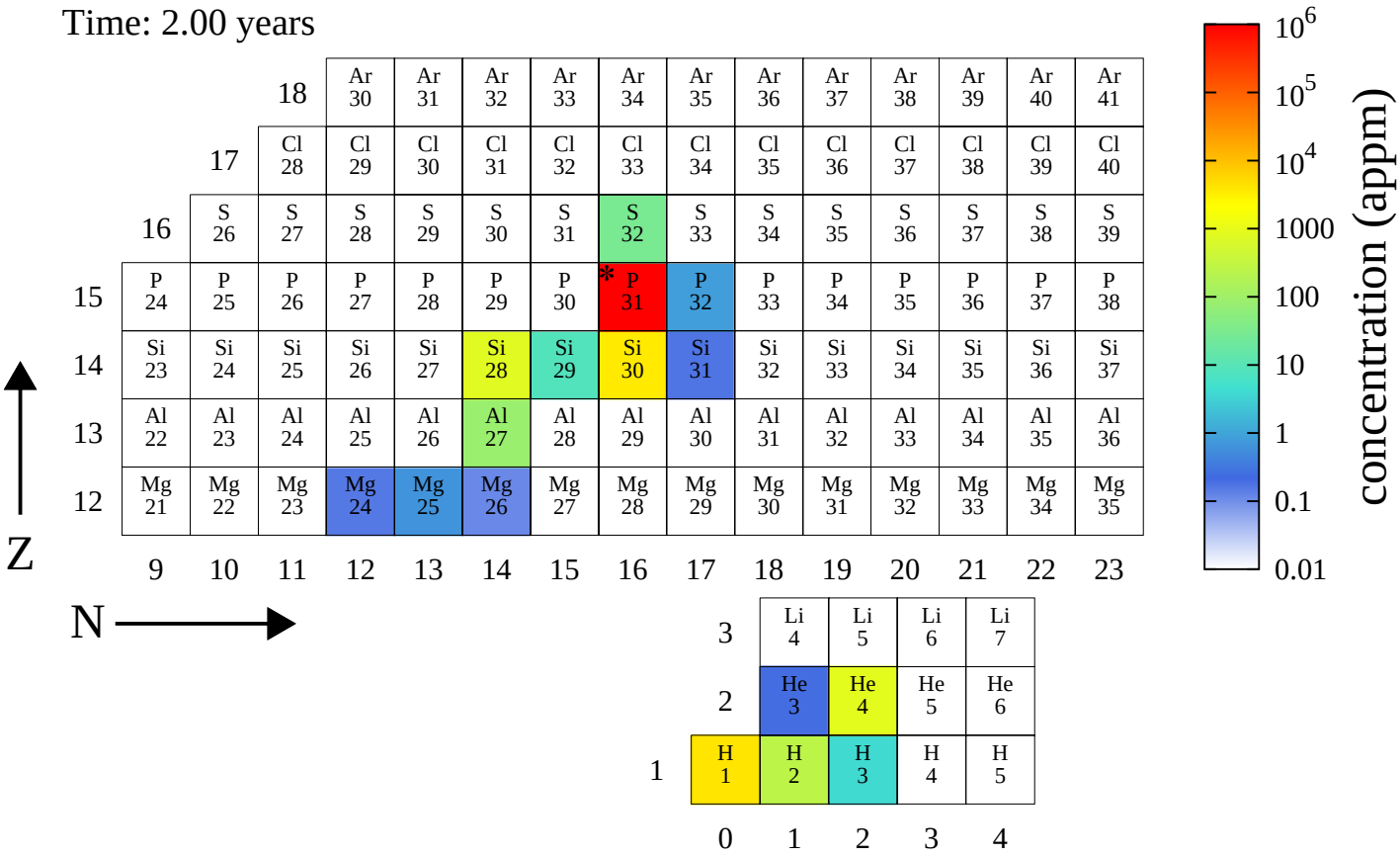




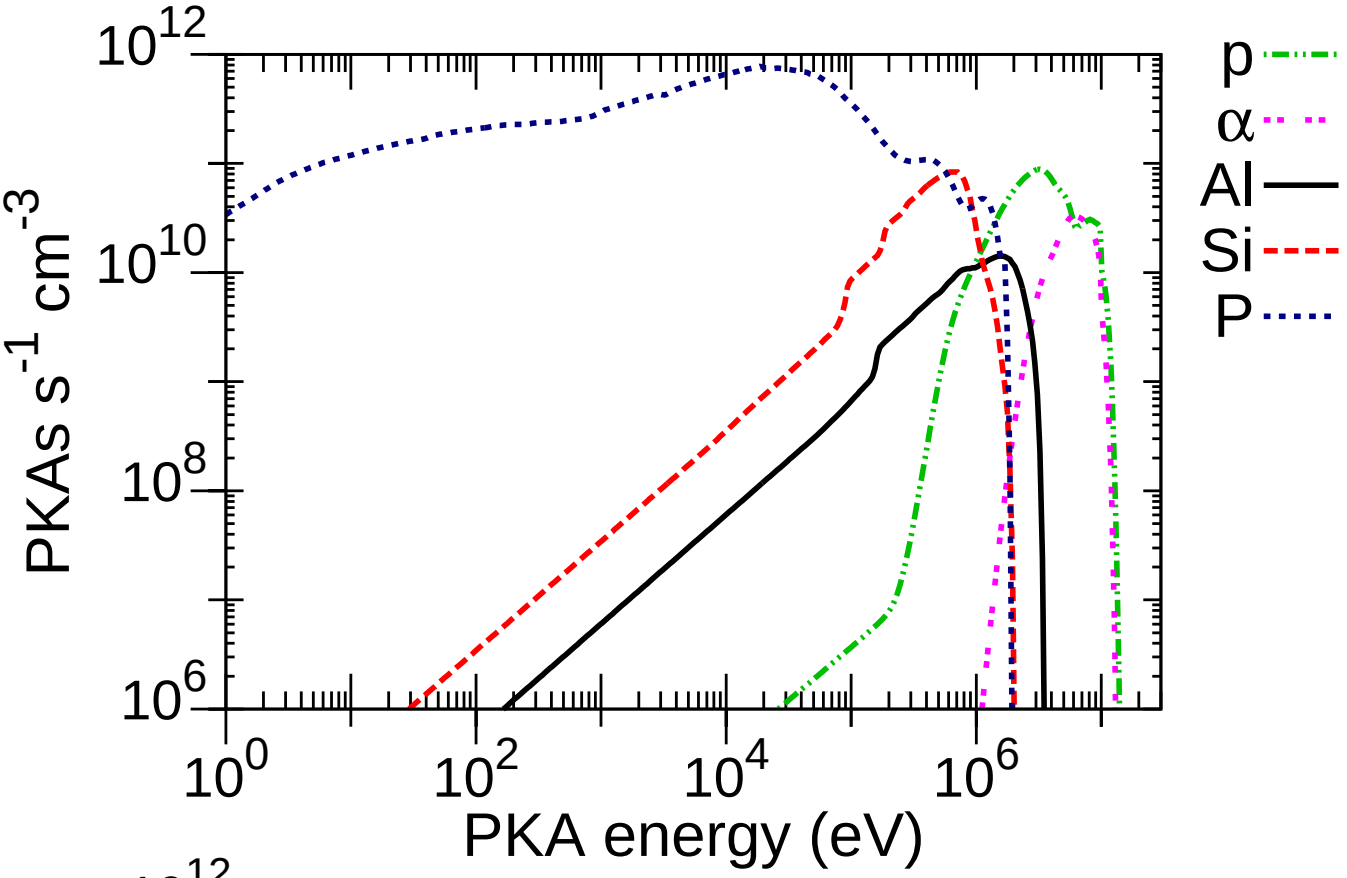
Phosphorus FW Transmutation

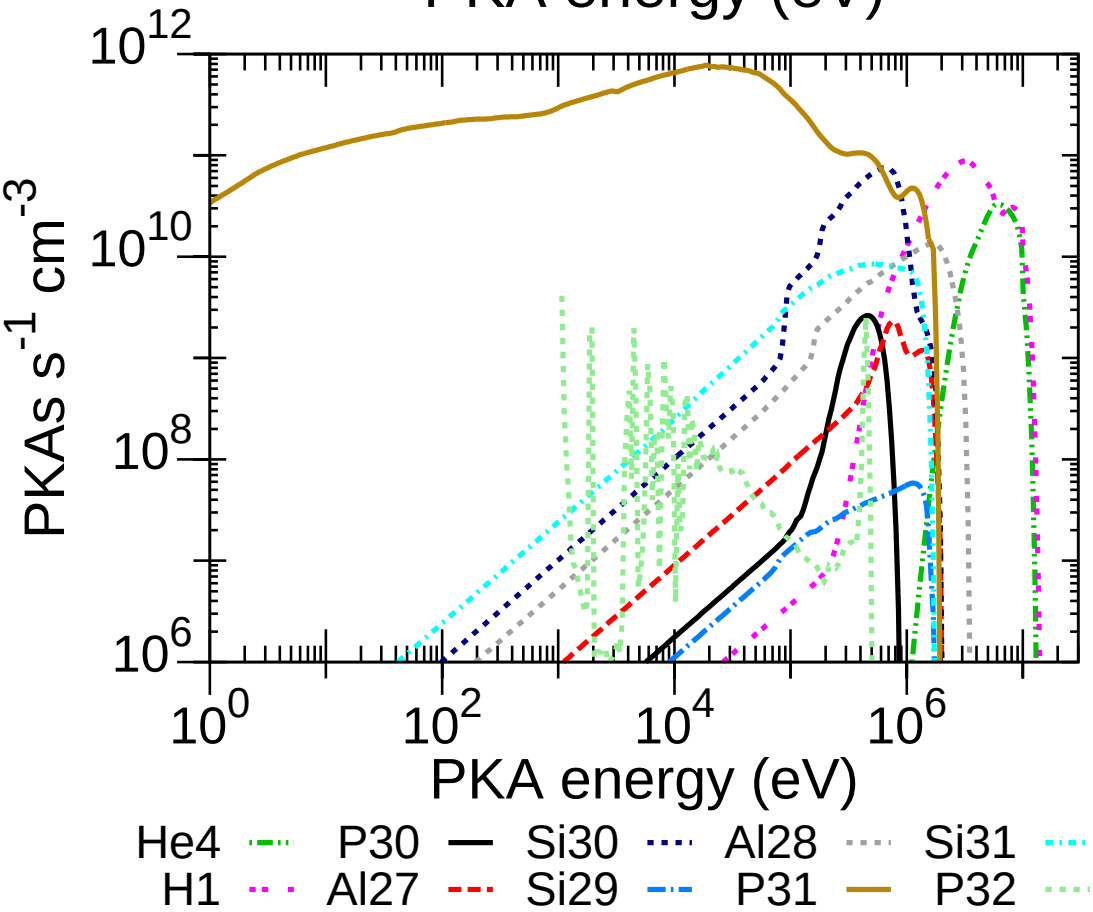


453 appm He & 2153 appm H after 1 year 18 dpa/year



Phosphorus FW PKA distributions





Phosphorus Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Si33	6.18s	P31(n,γ)P32(n,p)Si32(n,γ)Si33	100.0	100.0	99.8	94.7
		P31(n,γ)P32(n,γ)P33(n,p)Si33				3.5
P34	12.40s	P31(n,γ)P32(n,γ)P33(n,γ)P34	99.0			
Al28	2.24m	P31(n,α)Al28				99.4
P30	2.50m	P31(n,2n)P30				99.4
Cl38	37.21m	P31(n,γ)P32(β^-)S32(n,γ)S33(n,γ)S34(n,γ)S35(β^-)Cl35(n,γ) Cl36(n,γ)Cl37(n,γ)Cl38	78.6			
		P31(n,γ)P32(n,γ)P33(β^-)S33(n,γ)S34(n,γ)S35(β^-)Cl35(n,γ) Cl36(n,γ)Cl37(n,γ)Cl38	9.5			
		P31(n,γ)P32(β^-)S32(n,γ)S33(n,γ)S34(n,γ)S35(β^-)Cl35(n,γ) Cl36(n,γ)Cl37(n,γ)Cl38m(IT)Cl38	9.1			
		P31(n,γ)P32(n,γ)P33(n,γ)P34(β^-)S34(n,γ)S35(β^-)Cl35(n,γ) Cl36(n,γ)Cl37(n,γ)Cl38	1.3			
		P31(n,γ)P32(n,γ)P33(β^-)S33(n,γ)S34(n,γ)S35(β^-)Cl35(n,γ) Cl36(n,γ)Cl37(n,γ)Cl38m(IT)Cl38	1.1			
Si31	2.62h	P31(n,γ)P32(β^-)S32(n,γ)S33(n,α)Si30(n,γ)Si31	92.4	99.0		
		P31(n,γ)P32(n,γ)P33(β^-)S33(n,α)Si30(n,γ)Si31	6.3	1.0		
		P31(n,γ)P32(β^-)S32(n,α)Si29(n,γ)Si30(n,γ)Si31	1.3			
		P31(n,p)Si31			99.9	99.4
Na24	14.96h	P31(n,nα)Al27(n,α)Na24				86.3
		P31(n,np)Si30(n,α)Mg27(β^-)Al27(n,α)Na24				6.8
		P31(n,α)Al28(β^-)Si28(n,np)Al27(n,α)Na24				2.3
		P31(n,α)Al28(β^-)Si28(n,nα)Mg24(n,p)Na24				2.1
Mg28	20.90h	P31(n,p)Si31(n,α)Mg28				91.0
		P31(n,α)Al28(n,p)Mg28				8.4
P32	14.27d	P31(n,γ)P32	100.0	100.0	99.7	99.4
Na22	2.60y	P31(n,nα)Al27(n,nα)Na23(n,2n)Na22				69.1
		P31(n,nα)Al27(n,2n)Al26(n,nα)Na22				18.0
		P31(n,np)Si30(n,α)Mg27(β^-)Al27(n,nα)Na23(n,2n)Na22				2.8
		P31(n,α)Al28(β^-)Si28(n,nα)Mg24(n,np)Na23(n,2n)Na22				2.5
		P31(n,nα)Al27(n,np)Mg26(n,α)Ne23(β^-)Na23(n,2n)Na22				2.1
		P31(n,α)Al28(β^-)Si28(n,np)Al27(n,nα)Na23(n,2n)Na22				1.0
H3	12.33y	P31(n,γ)P32(n,p)H1(n,γ)H2(n,γ)H3	99.9			
		P31(n,p)H1(n,γ)H2(n,γ)H3			99.9	
		P31(n,t)H3				99.6
Si32	132.00y	P31(n,γ)P32(n,p)Si32	100.0	100.0	99.8	98.5
C14	5.7 10^3y	P31(n,α)Al28(β^-)Si28(n,nα)Mg24(n,α)Ne21(n,2α)C14				64.0
		P31(n,nα)Al27(n,α)Na24(β^-)Mg24(n,α)Ne21(n,2α)C14				16.1
		P31(n,α)Al28(β^-)Si28(n,α)Mg25(n,nα)Ne21(n,2α)C14				11.3
		P31(n,α)Al28(β^-)Si28(n,α)Mg25(n,2n)Mg24(n,α) Ne21(n,2α)C14				2.4
		P31(n,α)Al28(β^-)Si28(n,α)Mg25(n,α)Ne22(n,2n) Ne21(n,2α)C14				1.1
Cl36	3.0 10^5y	P31(n,γ)P32(β^-)S32(n,γ)S33(n,γ)S34(n,γ)S35(β^-) Cl35(n,γ)Cl36	89.4			
		P31(n,γ)P32(n,γ)P33(β^-)S33(n,γ)S34(n,γ)S35(β^-) Cl35(n,γ)Cl36	9.4			
		P31(n,γ)P32(n,γ)P33(n,γ)P34(β^-)S34(n,γ)S35(β^-) Cl35(n,γ)Cl36	1.0			
Al26	7.2 10^5y	P31(n,nα)Al27(n,2n)Al26				92.4
		P31(n,np)Si30(n,α)Mg27(β^-)Al27(n,2n)Al26				4.9
		P31(n,α)Al28(β^-)Si28(n,np)Al27(n,2n)Al26				1.7
Be10	1.6 10^6y	P31(n,α)Al28(β^-)Si28(n,nα)Mg24(n,nα)Ne20(n,2α) C13(n,α)Be10				60.0
		P31(n,nα)Al27(n,α)Na24(β^-)Mg24(n,nα)Ne20(n,2α) C13(n,α)Be10				15.1
		P31(n,α)Al28(β^-)Si28(n,α)Mg25(n,2n)Mg24(n,nα)Ne20(n,2α) C13(n,α)Be10				1.9
		P31(n,nα)Al27(n,nα)Na23(n,α)F20(β^-)Ne20(n,2α) C13(n,α)Be10				1.7

Sulphur

Isotope	Atom % abundance
S32	95.02
S33	0.75
S34	4.21
S36	0.02

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	6.22E+14	6.14E+14	5.05E+14	3.40E+10	2.45E+08	1.76E+03
P32	95.9	97.1	99.0	0.7	47.4	
Si31	2.0	1.9				
S35	0.1	0.1	0.1	86.7		
H3				11.1	5.3	
Si32				0.6	47.3	
Cl36						99.6

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	7.09E-02	6.78E-02	5.57E-02	2.67E-07	1.41E-08	8.04E-14
P32	93.6	97.9	99.9	10.4	91.4	
P34	3.6					
Si31	1.6	1.7				
S35				86.2		
H3				1.3	0.1	
P33	0.1	0.1	0.1	1.3		
Si32				0.8	8.5	
Cl36						95.5
Al26						4.5

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.47E+03	2.22E+02	4.62E-03	1.20E-07	5.28E-09	5.23E-09
Al28	45.4	59.1	0.2			
P34	43.1					
Al29	9.9	37.7				
Si31	0.2	1.3				
Na24		0.1	99.7			
Na22				95.6		
Al26				4.4	99.9	99.9

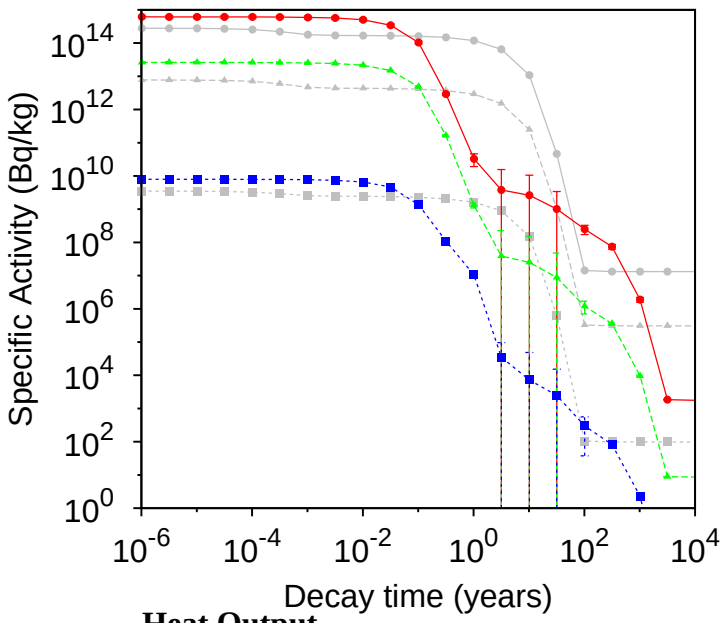
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.44E+06	1.44E+06	1.20E+06	2.36E+01	3.44E-01	1.66E-06
P32	99.8	99.8	99.9	2.5	81.0	
S35				96.0		
Si32				0.5	18.9	
Cl36						98.5
Al26						1.5

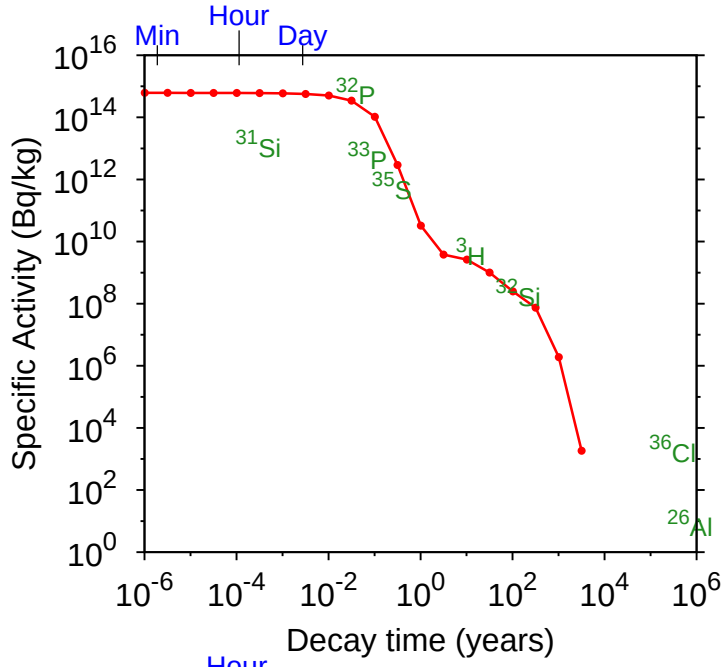
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.04E+06	2.04E+06	1.71E+06	7.97E+01	1.32E+01	1.30E-05
P32	99.5	99.5	99.6	1.1	3.0	
S35			0.1	70.3		
Si32				26.9	97.0	
H3				1.2		
Cl36						98.9
Al26						1.1

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	7.19E+09	1.43E+09	5.09E+08	3.35E+05	1.02E+03	1.77E+00
P34	49.2					
Al28	33.2	32.9				
P32	8.3	41.8	98.1	0.1	11.4	
Al29	7.7	22.3				
S35	0.1	0.4	1.0	88.1		
H3				11.3	12.8	
Si32				0.4	75.7	
Cl36					0.2	98.9
Al26						1.1

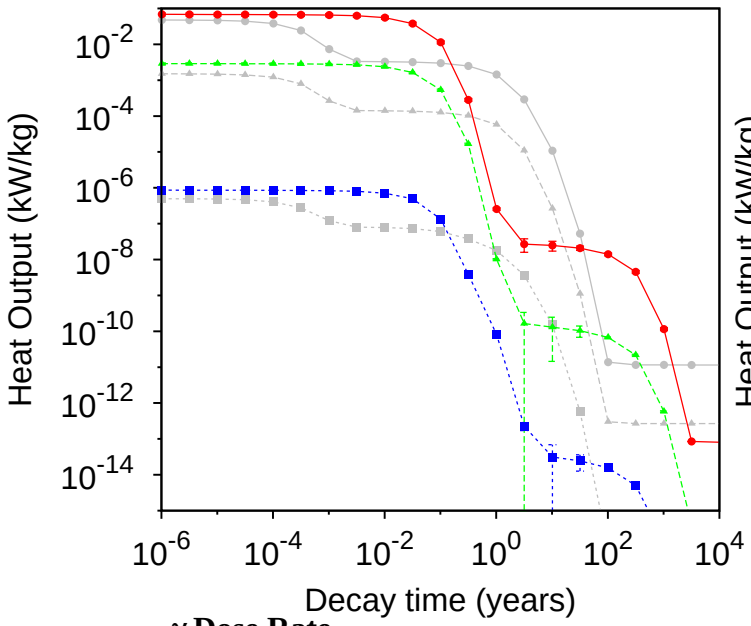
Sulphur activation characteristics

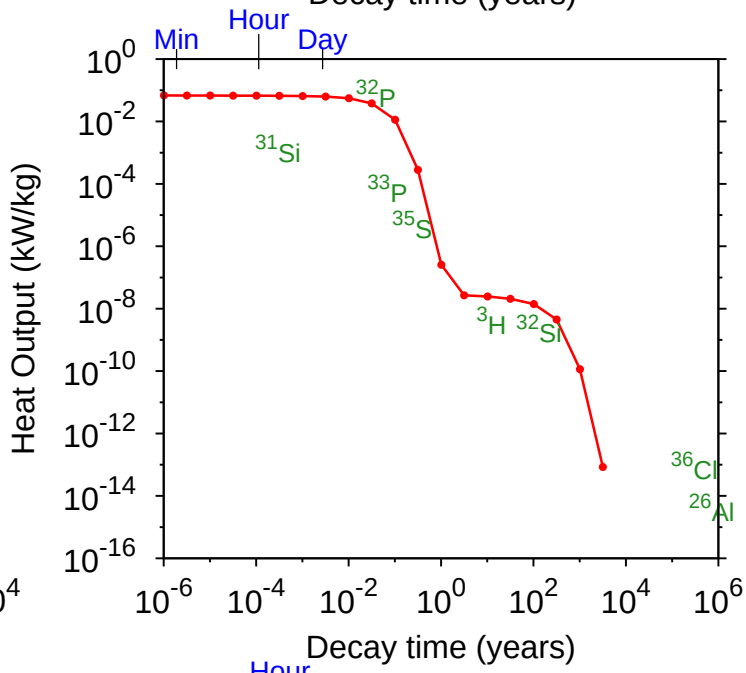
Specific Activity



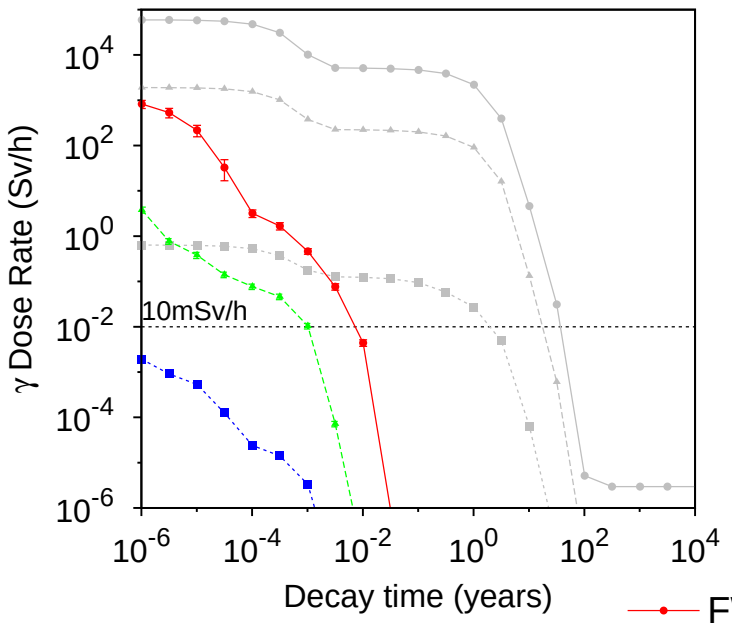


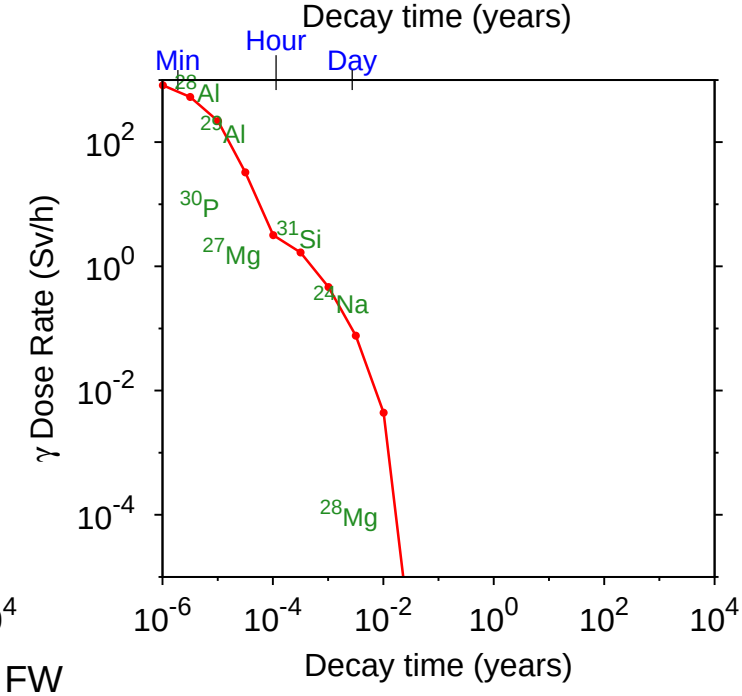
Heat Output





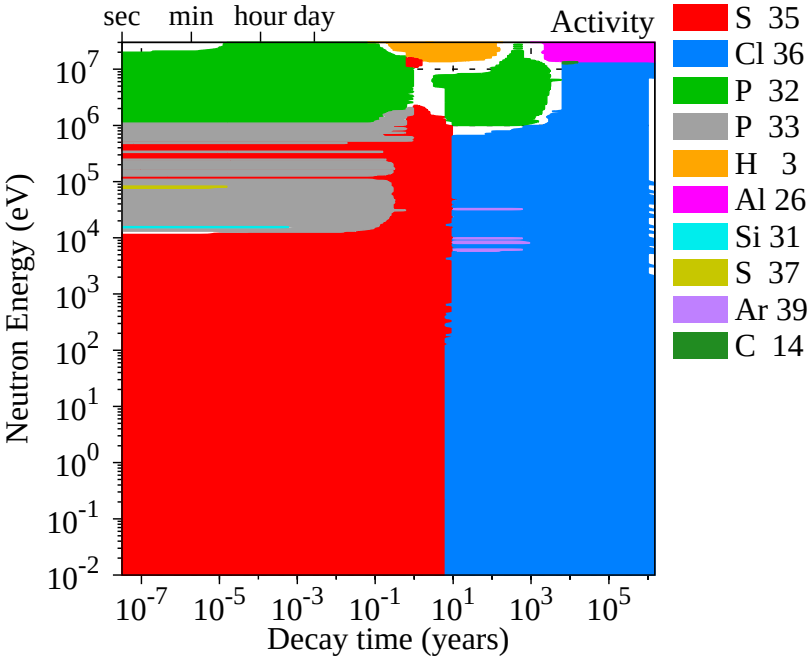
γ Dose Rate

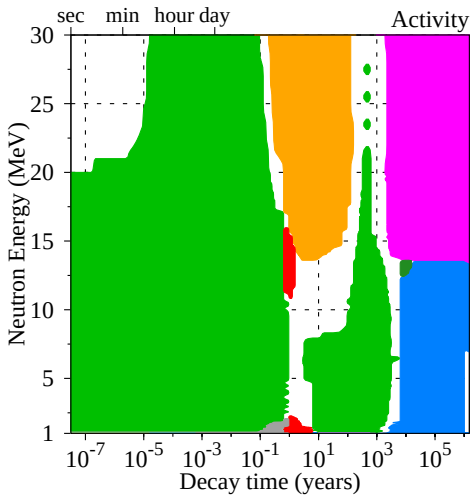


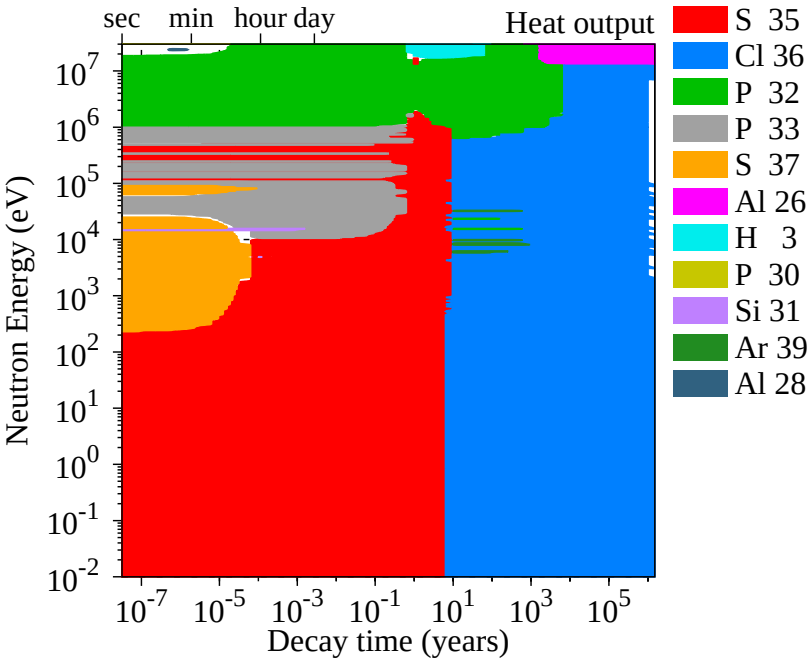


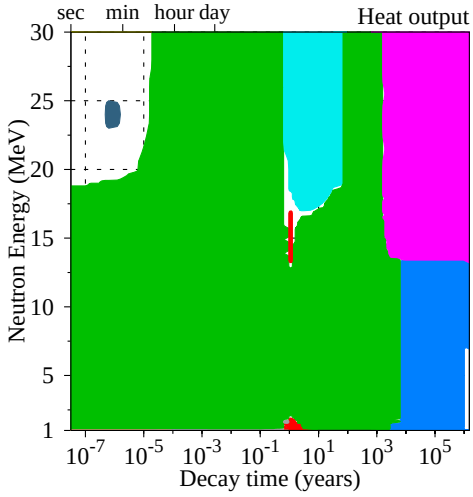
FW
Blanket
Manifold
Fe results

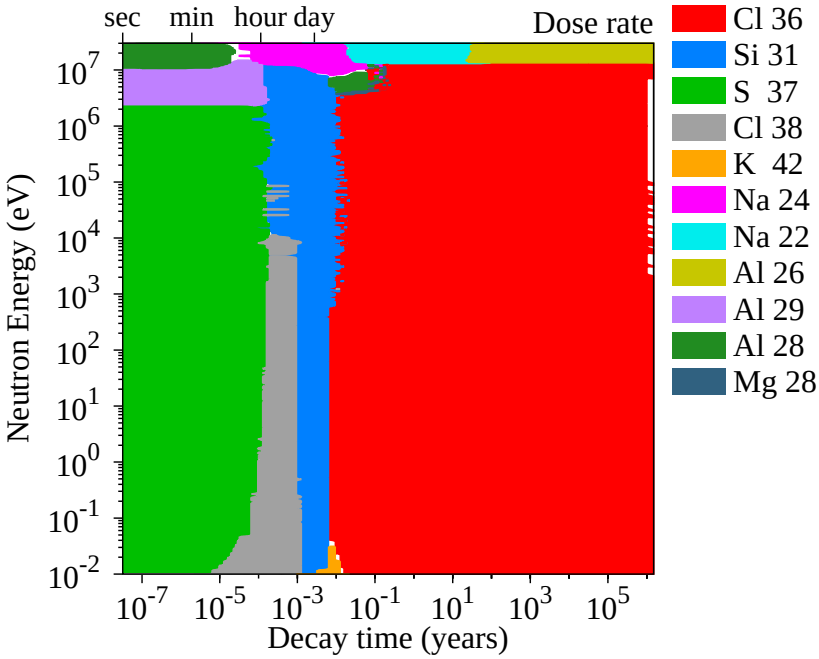
Sulphur Importance diagrams

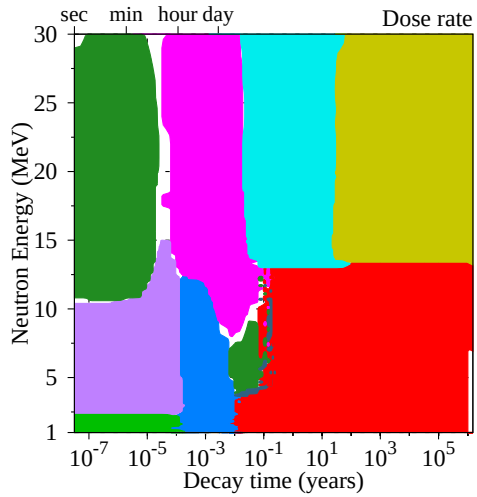




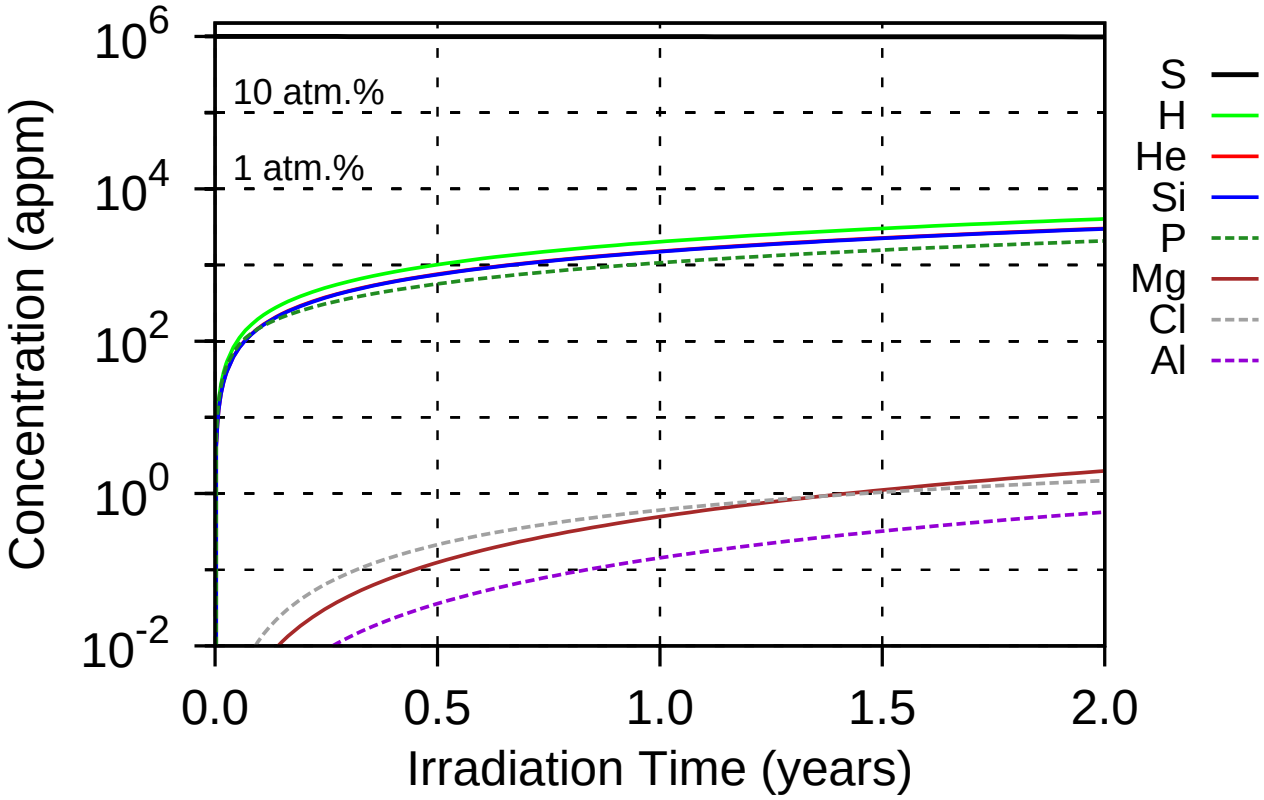




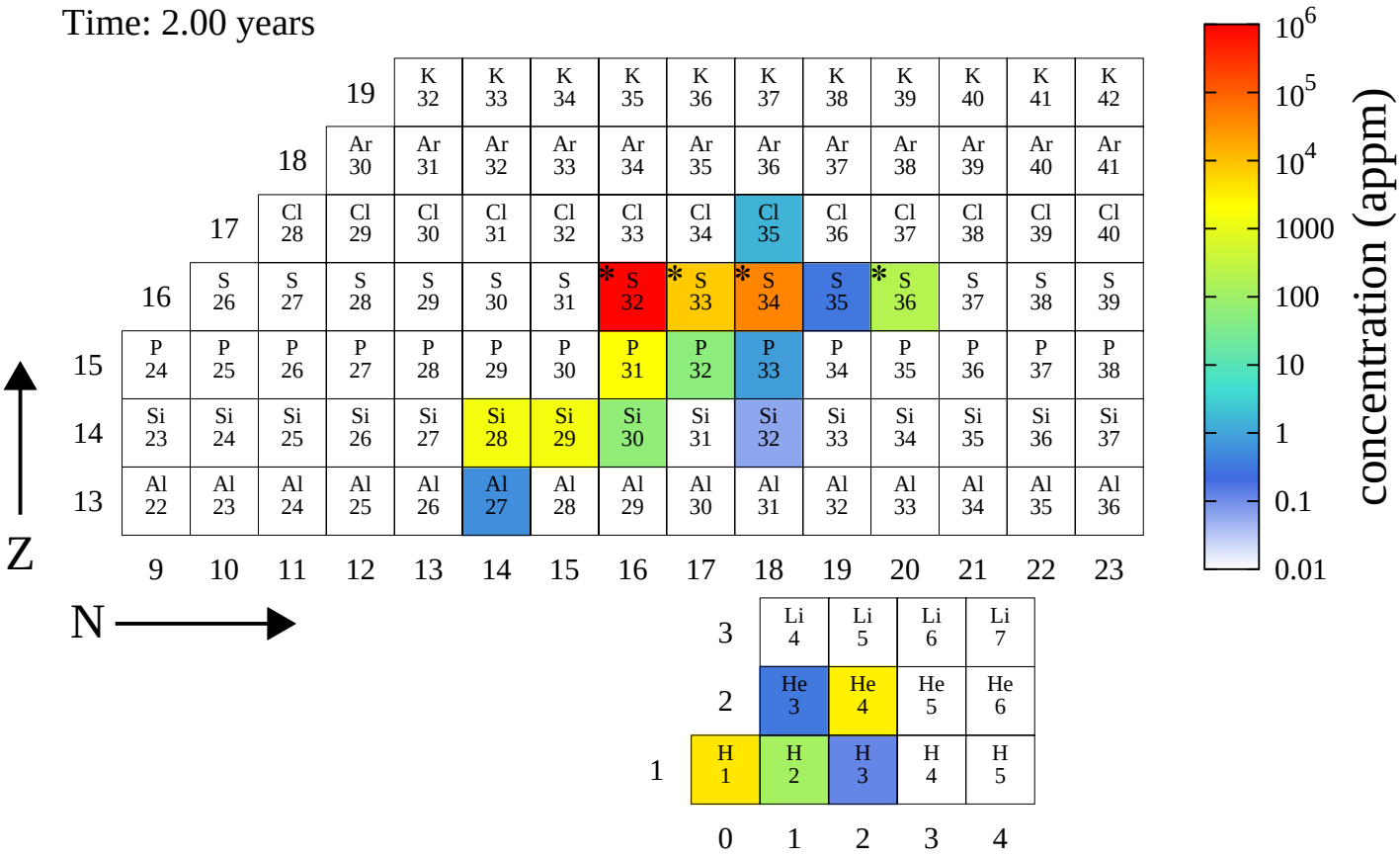




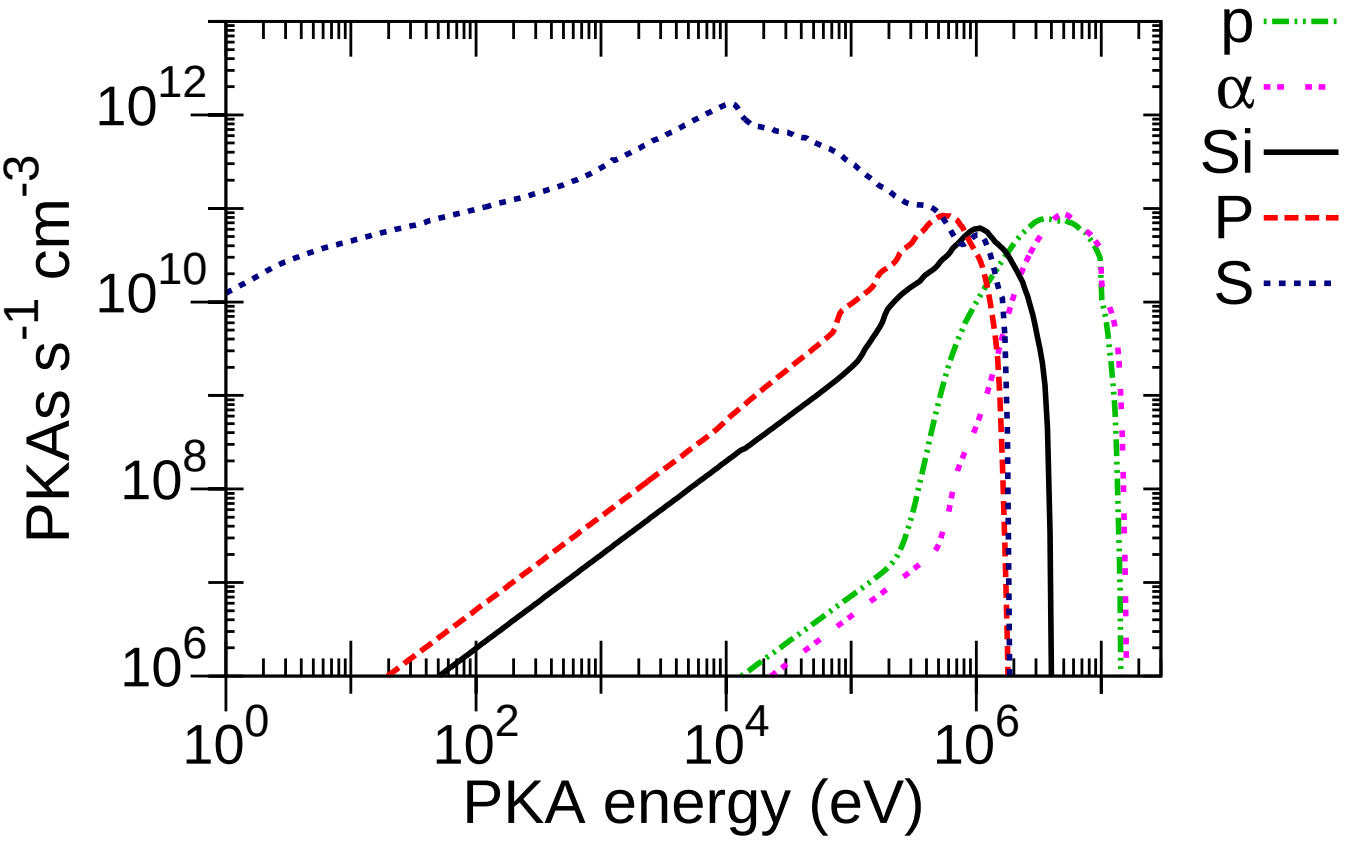
Sulphur FW Transmutation

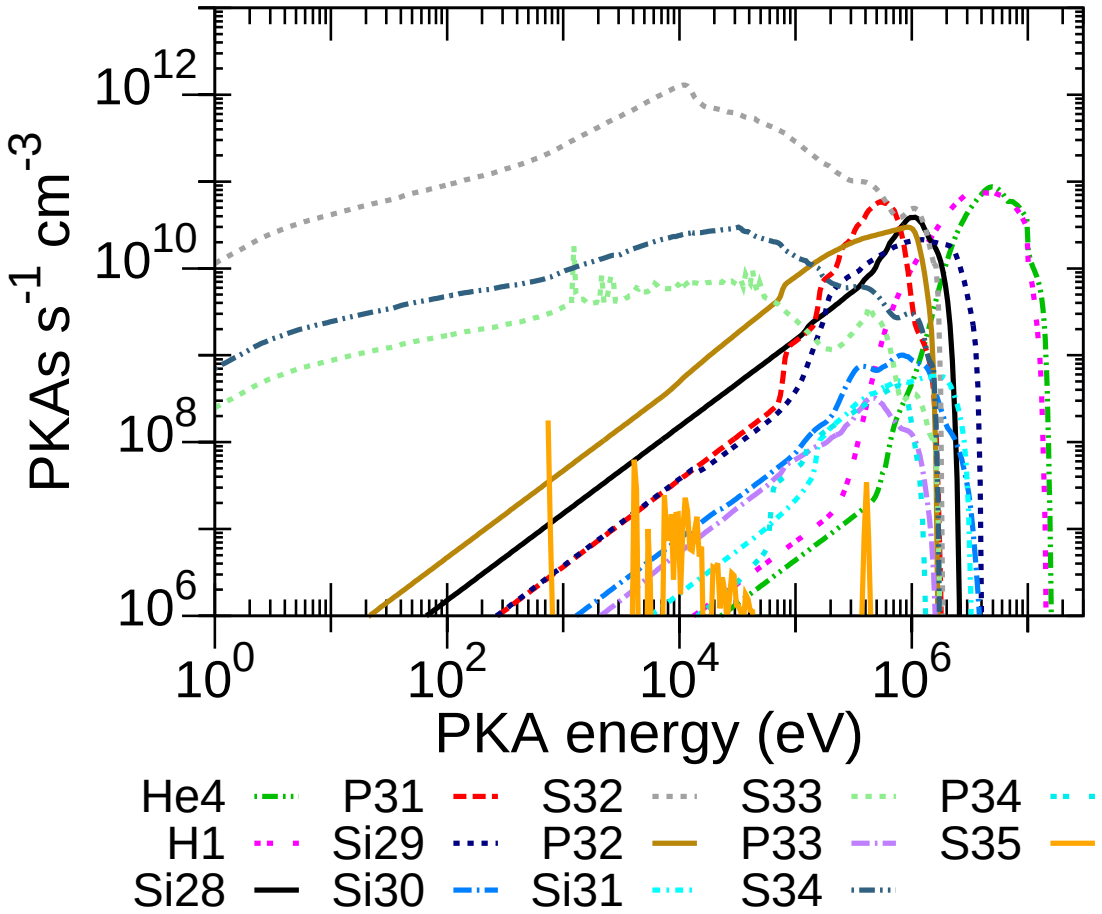


1514 appm He & 2018 appm H after 1 year 20 dpa/year



Sulphur FW PKA distributions





Sulphur Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
P34	12.40s	S32(n,γ)S33(n,p)P33(n,γ)P34	78.3		3.3	
		S33(n,p)P33(n,γ)P34	21.5	99.1	96.3	
		S34(n,p)P34				99.5
Al28	2.24m	S32(n,nα)Si28(n,p)Al28				58.5
		S32(n,np)P31(n,α)Al28				36.7
		S32(n,d)P31(n,α)Al28				2.4
P30	2.50m	S32(n,np)P31(n,2n)P30				90.8
		S32(n,d)P31(n,2n)P30				5.8
		S34(n,α)Si31(β^-)P31(n,2n)P30				1.7
S37	4.99m	S36(n,γ)S37	99.1	100.0	100.0	99.9
Al29	6.56m	S32(n,p)P32(n,α)Al29			99.8	2.2
		S32(n,α)Si29(n,p)Al29				96.0
Cl38	37.21m	S34(n,γ)S35(β^-)Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38	84.8			
		S34(n,γ)S35(β^-)Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38m(IT)Cl38	9.8			
		S36(n,γ)S37(β^-)Cl37(n,γ)Cl38	4.5	87.9	70.8	69.6
		S36(n,γ)S37(β^-)Cl37(n,γ)Cl38m(IT)Cl38		12.1	29.1	30.0
Si31	2.62h	S32(n,γ)S33(n,α)Si30(n,γ)Si31	65.0		1.7	
		S33(n,α)Si30(n,γ)Si31	34.1	99.5	94.0	
		S34(n,α)Si31			4.1	69.4
		S32(n,np)P31(n,p)Si31				21.9
		S32(n,2p)Si31				5.7
		S32(n,d)P31(n,p)Si31				1.4
K42	12.36h	S34(n,γ)S35(β^-)Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38(β^-) Ar38(n,γ)Ar39(n,γ)Ar40(n,γ)Ar41(β^-)K41(n,γ)K42	69.1			
		S36(n,γ)S37(β^-)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39(n,γ) Ar40(n,γ)Ar41(β^-)K41(n,γ)K42	20.4			
		S34(n,γ)S35(β^-)Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38m(IT) Cl38(β^-)Ar38(n,γ)Ar39(n,γ)Ar40(n,γ)Ar41(β^-)K41(n,γ)K42	8.0			
		S36(n,γ)S37(β^-)Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,γ) Ar39(n,γ)Ar40(n,γ)Ar41(β^-)K41(n,γ)K42	2.3			
Na24	14.96h	S32(n,nα)Si28(n,np)Al27(n,α)Na24				40.7
		S32(n,nα)Si28(n,nα)Mg24(n,p)Na24				36.1
		S32(n,np)P31(n,nα)Al27(n,α)Na24				7.7
		S32(n,nα)Si28(n,d)Al27(n,α)Na24				4.8
		S32(n,nα)Si28(n,α)Mg25(n,d)Na24				3.4
		S32(n,nα)Si28(n,α)Mg25(n,2n)Mg24(n,p)Na24				2.3
		S32(n,nα)Si28(n,α)Mg25(n,np)Na24				1.7
Mg28	20.90h	S34(n,α)Si31(n,α)Mg28				64.9
		S32(n,np)P31(n,p)Si31(n,α)Mg28				20.4
		S32(n,2p)Si31(n,α)Mg28				5.3
		S32(n,nα)Si28(n,p)Al28(n,p)Mg28				3.0
		S32(n,np)P31(n,α)Al28(n,p)Mg28				1.9
		S32(n,d)P31(n,p)Si31(n,α)Mg28				1.3
P32	14.27d	S32(n,γ)S33(n,α)Si30(n,γ)Si31(β^-)P31(n,γ)P32	41.7			
		S33(n,α)Si30(n,γ)Si31(β^-)P31(n,γ)P32	33.7	99.7		
		S34(n,γ)S35(β^-)Cl35(n,α)P32	23.7			
		S32(n,p)P32			99.8	99.6
P33	25.38d	S32(n,γ)S33(n,p)P33	78.3		3.3	
		S33(n,p)P33	21.5	99.1	96.3	46.9
		S34(n,np)P33				37.0
		S34(n,d)P33				11.4
		S34(n,2n)S33(n,p)P33				3.5
S35	87.32d	S34(n,γ)S35	98.1	100.0	99.5	8.7
		S36(n,2n)S35				90.8
Na22	2.60y	S32(n,α)Si29(n,α)Mg26(n,α)Ne23(β^-)Na23(n,2n)Na22				41.6
		S32(n,nα)Si28(n,nα)Mg24(n,np)Na23(n,2n)Na22				27.2
		S32(n,nα)Si28(n,np)Al27(n,nα)Na23(n,2n)Na22				10.5
		S32(n,nα)Si28(n,nα)Mg24(n,d)Na23(n,2n)Na22				8.3
		S32(n,nα)Si28(n,np)Al27(n,2n)Al26(n,nα)Na22				2.8
		S32(n,np)P31(n,nα)Al27(n,nα)Na23(n,2n)Na22				2.0
		S32(n,nα)Si28(n,α)Mg25(n,t)Na23(n,2n)Na22				1.6
		S32(n,nα)Si28(n,d)Al27(n,nα)Na23(n,2n)Na22				1.2
		S32(n,nα)Si28(n,α)Mg25(n,2n)Mg24(n,np)Na23(n,2n)Na22				1.1

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
H3	12.33y	S34(n,γ)S35(β^-)Cl35(n,p)H1(n,γ)H2(n,γ)H3	48.7			
		S33(n,p)H1(n,γ)H2(n,γ)H3	25.2	99.6	1.5	
		S32(n,γ)S33(n,p)H1(n,γ)H2(n,γ)H3	24.0			
		S34(n,γ)S35(β^-)Cl35(n,γ)Cl36(n,p)H1(n,γ)H2(n,γ)H3	2.0			
		S32(n,p)H1(n,γ)H2(n,γ)H3			98.4	
		S33(n,t)H3				41.9
		S32(n,np)P31(n,t)H3				33.0
		S32(n,α)Si29(n,t)H3				5.8
		S32(n,p)P32(n,t)H3				5.0
		S32(n,t)H3				4.8
		S34(n,t)H3				2.8
		S32(n,d)P31(n,t)H3				2.1
		S34(n,2n)S33(n,t)H3				1.7
		S32(n,h)He3(n,p)H3				1.1
Si32	132.00y	S32(n,γ)S33(n,α)Si30(n,γ)Si31(n,γ)Si32	29.5			
		S33(n,α)Si30(n,γ)Si31(n,γ)Si32	23.1	98.7		
		S34(n,γ)S35(β^-)Cl35(n,α)P32(n,p)Si32	17.3			
		S33(n,α)Si30(n,γ)Si31(β^-)P31(n,γ)P32(n,p)Si32	14.7			
		S32(n,γ)S33(n,α)Si30(n,γ)Si31(β^-)P31(n,γ)P32(n,p)Si32	13.7			
		S32(n,p)P32(n,p)Si32			99.9	94.0
		S33(n,2p)Si32				3.5
Ar39	269.01y	S34(n,γ)S35(β^-)Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38(β^-) Ar38(n,γ)Ar39	80.4			
		S34(n,γ)S35(β^-)Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38m(IT) Cl38(β^-)Ar38(n,γ)Ar39	9.3			
		S36(n,γ)S37(β^-)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39	8.9	87.9	73.3	69.7
		S36(n,γ)S37(β^-)Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,γ)Ar39	1.0	12.1	29.4	30.0
C14	5.7 10^3y	S32(n,nα)Si28(n,nα)Mg24(n,α)Ne21(n,2α)C14				76.8
		S32(n,nα)Si28(n,α)Mg25(n,nα)Ne21(n,2α)C14				13.6
		S32(n,nα)Si28(n,α)Mg25(n,2n)Mg24(n,α)Ne21(n,2α)C14				2.9
		S32(n,nα)Si28(n,nα)Mg24(n,α)Ne21(n,nα)O17(n,α)C14				1.4
		S32(n,nα)Si28(n,α)Mg25(n,α)Ne22(n,2n)Ne21(n,2α)C14				1.3
		S32(n,nα)Si28(n,nα)Mg24(n,nα)Ne20(n,α)O17(n,α)C14				1.1
Cl36	3.0 10^5y	S34(n,γ)S35(β^-)Cl35(n,γ)Cl36	99.3	100.0	99.9	7.8
		S36(n,2n)S35(β^-)Cl35(n,γ)Cl36				82.2
		S36(n,γ)S37(β^-)Cl37(n,2n)Cl36				9.8
Al26	7.2 10^5y	S32(n,nα)Si28(n,np)Al27(n,2n)Al26				72.5
		S32(n,np)P31(n,nα)Al27(n,2n)Al26				13.9
		S32(n,nα)Si28(n,d)Al27(n,2n)Al26				8.5
		S34(n,nα)Si30(n,α)Mg27(β^-)Al27(n,2n)Al26				1.2

Chlorine

Isotope	Atom % abundance
Cl35	75.77
Cl37	24.23

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	5.68E+14	5.46E+14	4.88E+14	1.74E+13	2.51E+09	1.88E+09
S35	55.2	57.4	62.4	99.4		
P32	37.2	38.7	36.3		7.2	
P34	2.5					
S37	1.4	0.7				
P33	1.3	1.3	1.3			
Cl36					76.6	100.0
H3				0.6	9.0	
Si32					7.2	

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	4.23E-02	3.26E-02	2.22E-02	1.36E-04	1.06E-07	8.24E-08
P32	55.6	72.1	88.9		18.9	
P34	14.4					
S37	11.1	7.0				
S35	5.8	7.5	10.7	99.8		
Cl34m	4.8	5.5				
Cl34	4.3	3.4				
Cl38	3.4	4.0				
Cl36				0.1	79.2	100.0
Si32					1.8	

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.45E+04	8.08E+03	7.36E-05	6.31E-06	6.30E-06	6.16E-06
S37	53.6	46.4				
Cl34m	20.1	32.2				
P34	10.9					
Cl38	9.6	15.6				
Cl34	5.2	5.7				
Na24			64.8			
Ar37			25.3	0.2		
Cl36			8.6	99.8	100.0	100.0

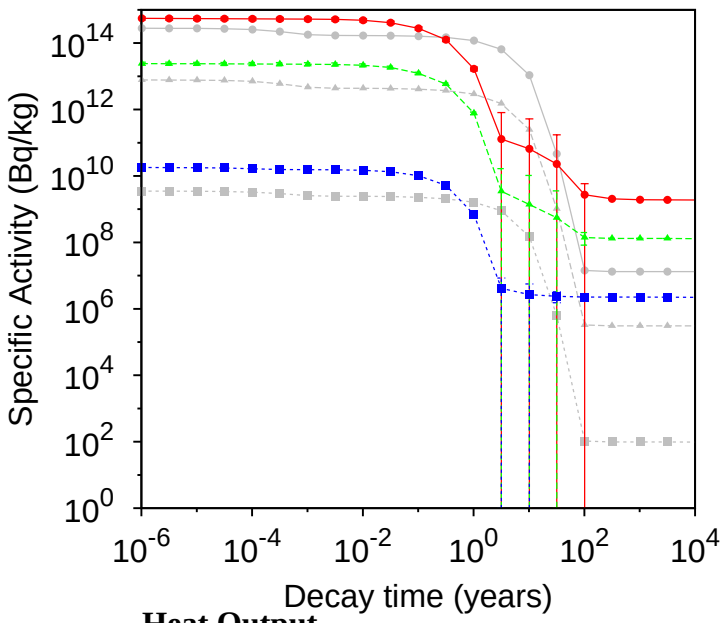
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	7.52E+05	7.51E+05	6.61E+05	1.34E+04	2.79E+00	1.75E+00
P32	67.5	67.5	64.3		15.5	
S35	32.1	32.1	35.5	99.9		
Cl36					64.2	100.0
Ar39					16.3	
Si32					3.6	

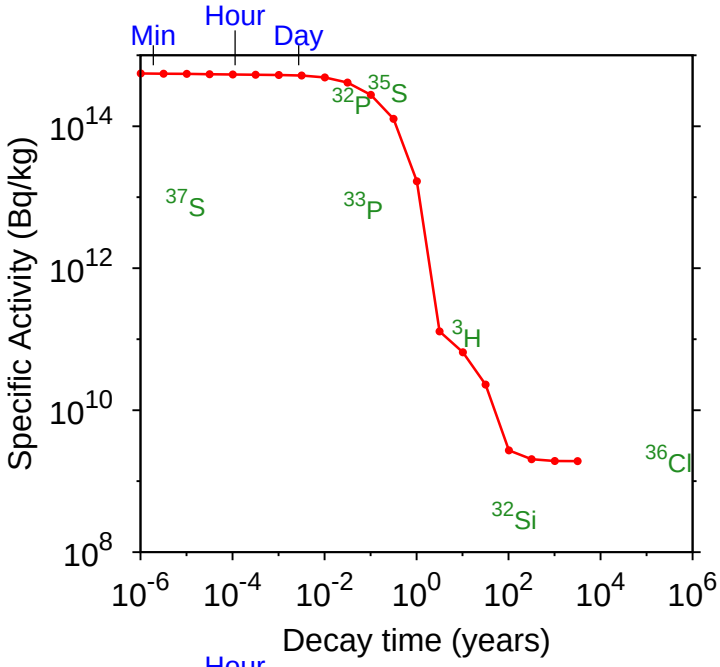
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.33E+06	1.33E+06	1.19E+06	3.30E+04	5.02E+01	1.37E+01
P32	54.2	54.2	50.6		1.2	
S35	44.9	44.9	48.6	99.7		
Si32				0.1	39.5	
Ar39				0.1	31.2	
Cl36					28.0	100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	5.16E+10	2.74E+10	3.23E+09	1.76E+08	1.93E+06	1.88E+06
S37	46.3	41.9				
Cl34m	20.7	34.7				
P34	16.5					
Cl34	8.7	10.1				
S35	6.1	11.4	94.2	98.3		
P32	0.4	0.8	5.5			
Cl36			0.1	1.1	99.8	100.0

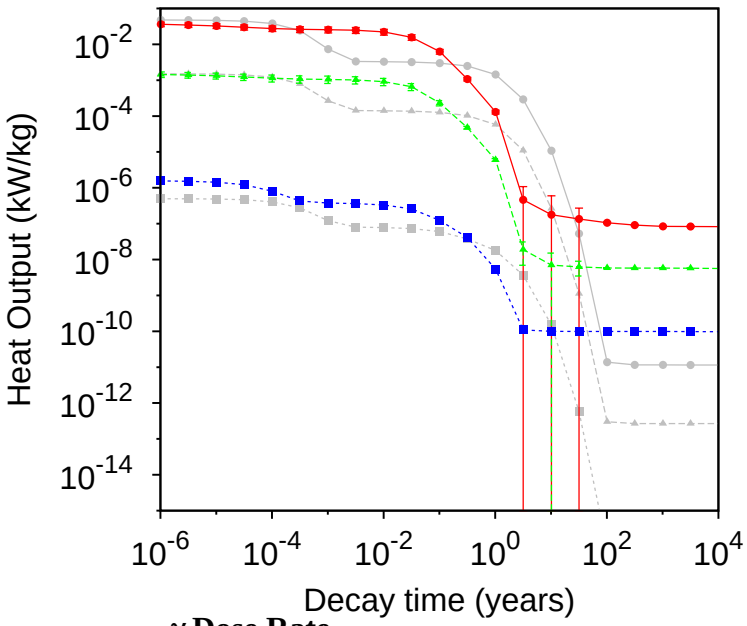
Chlorine activation characteristics

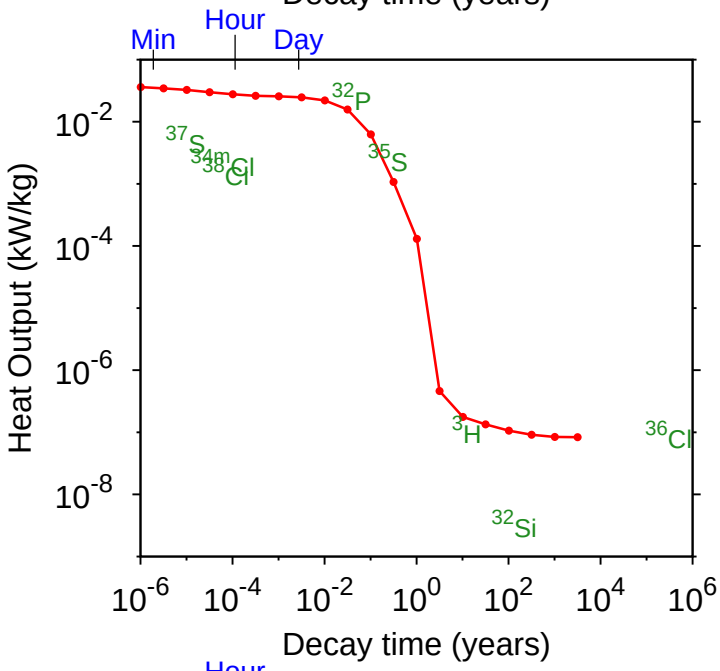
Specific Activity



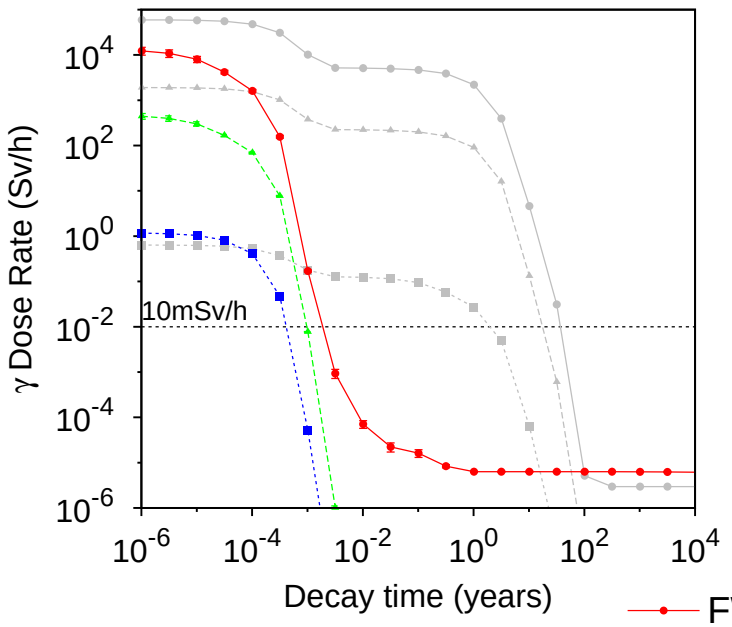


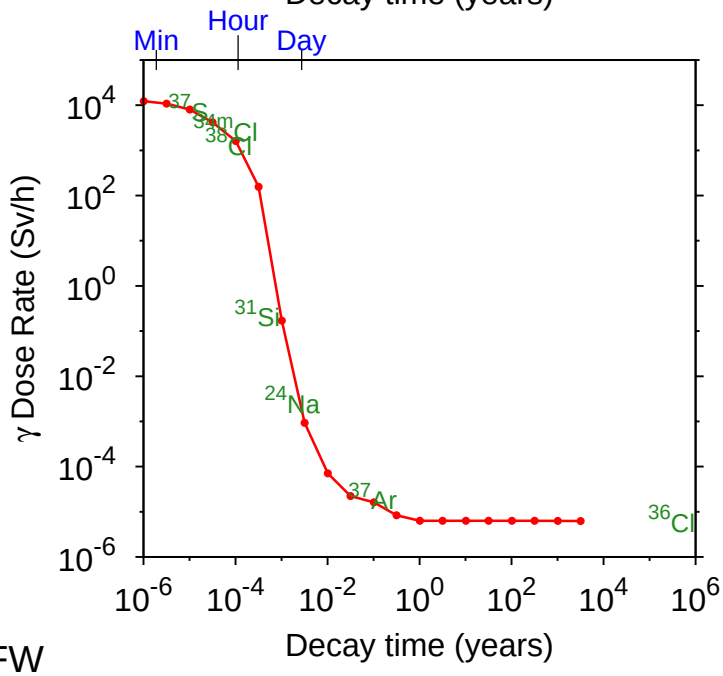
Heat Output





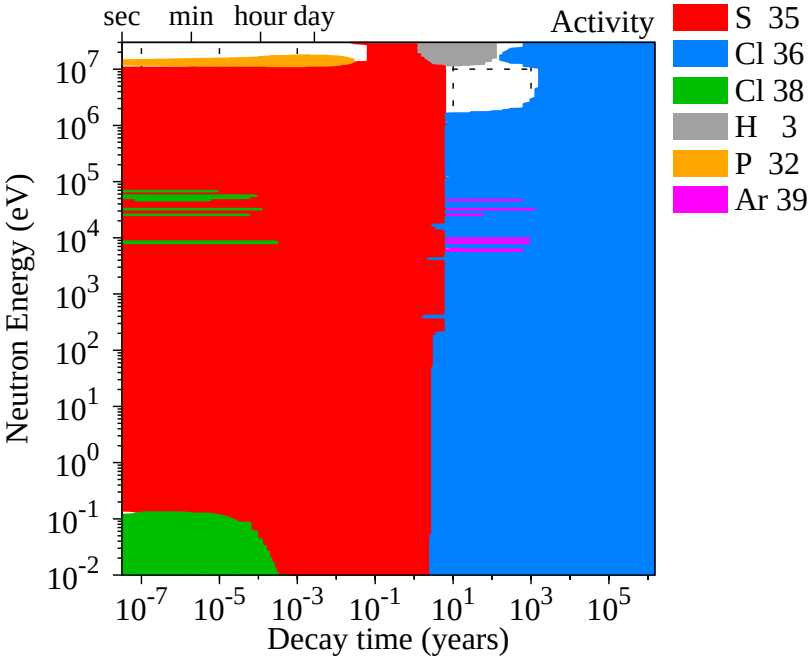
γ Dose Rate

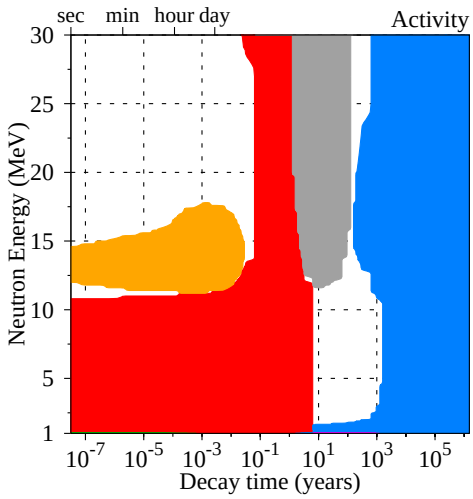


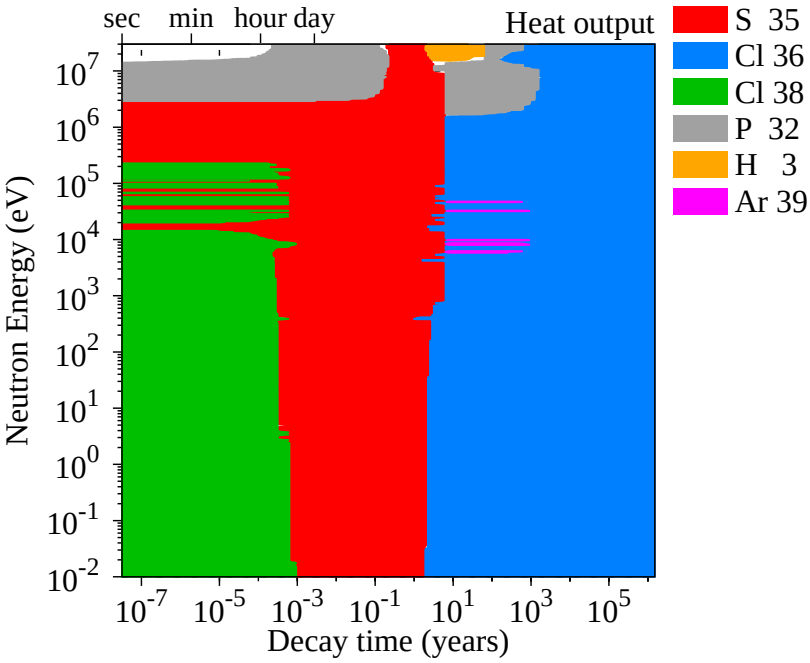


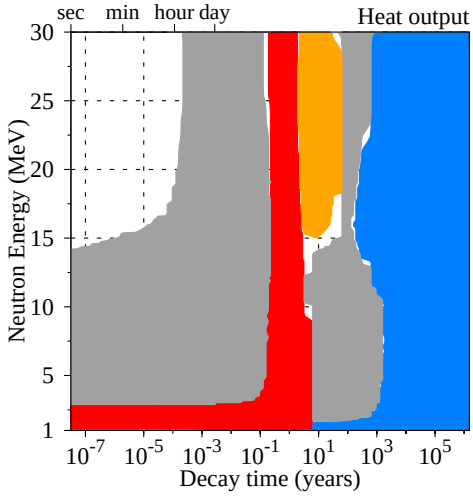
FW
Blanket
Manifold
Fe results

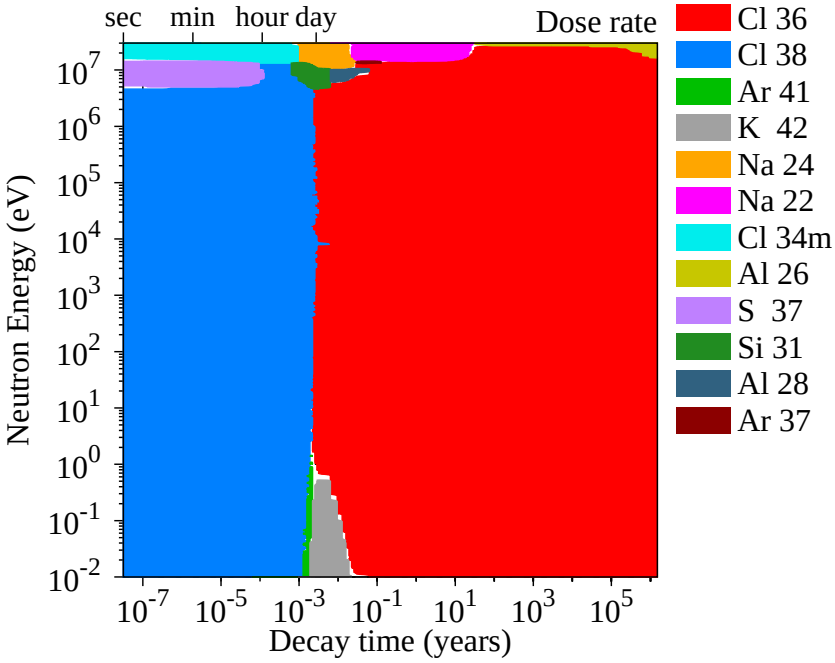
Chlorine Importance diagrams

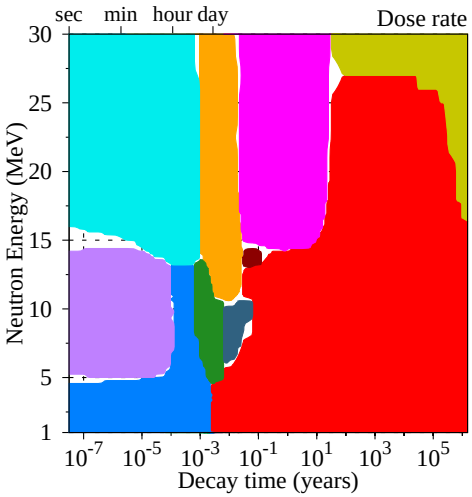




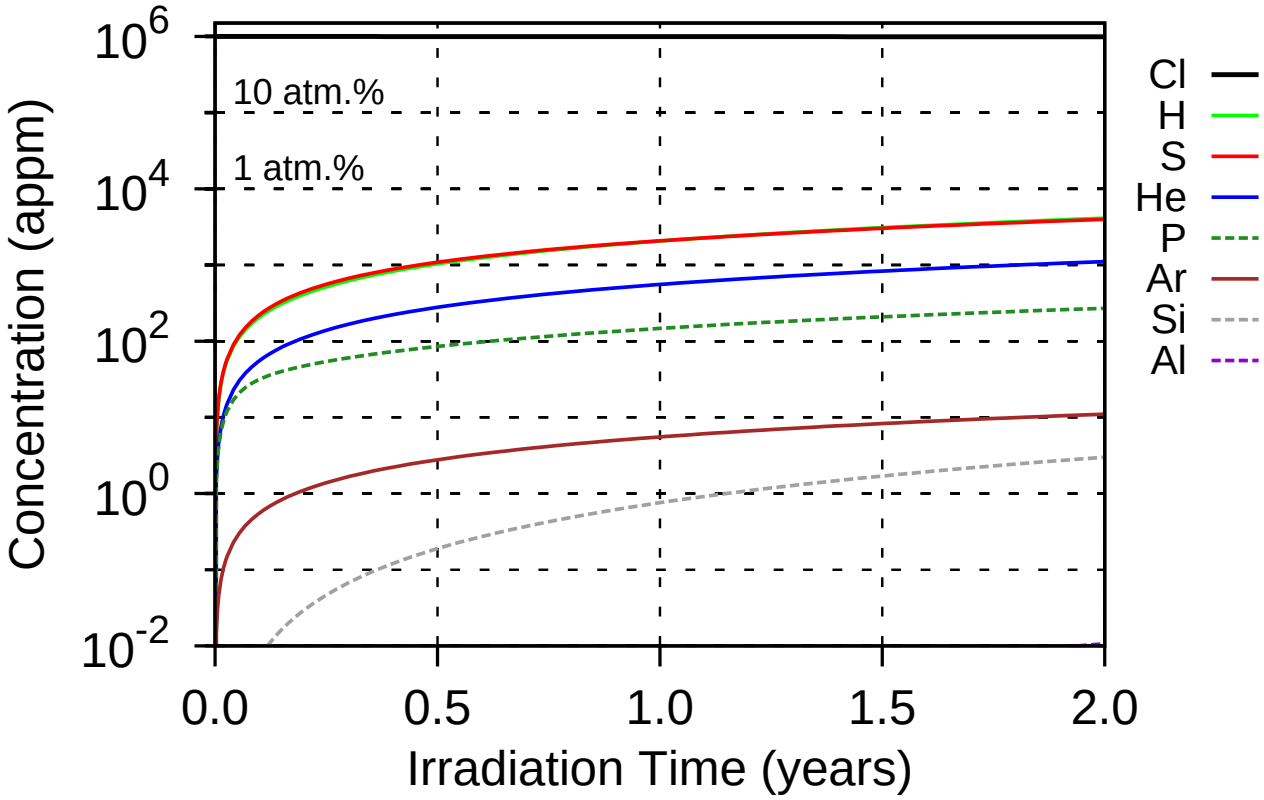




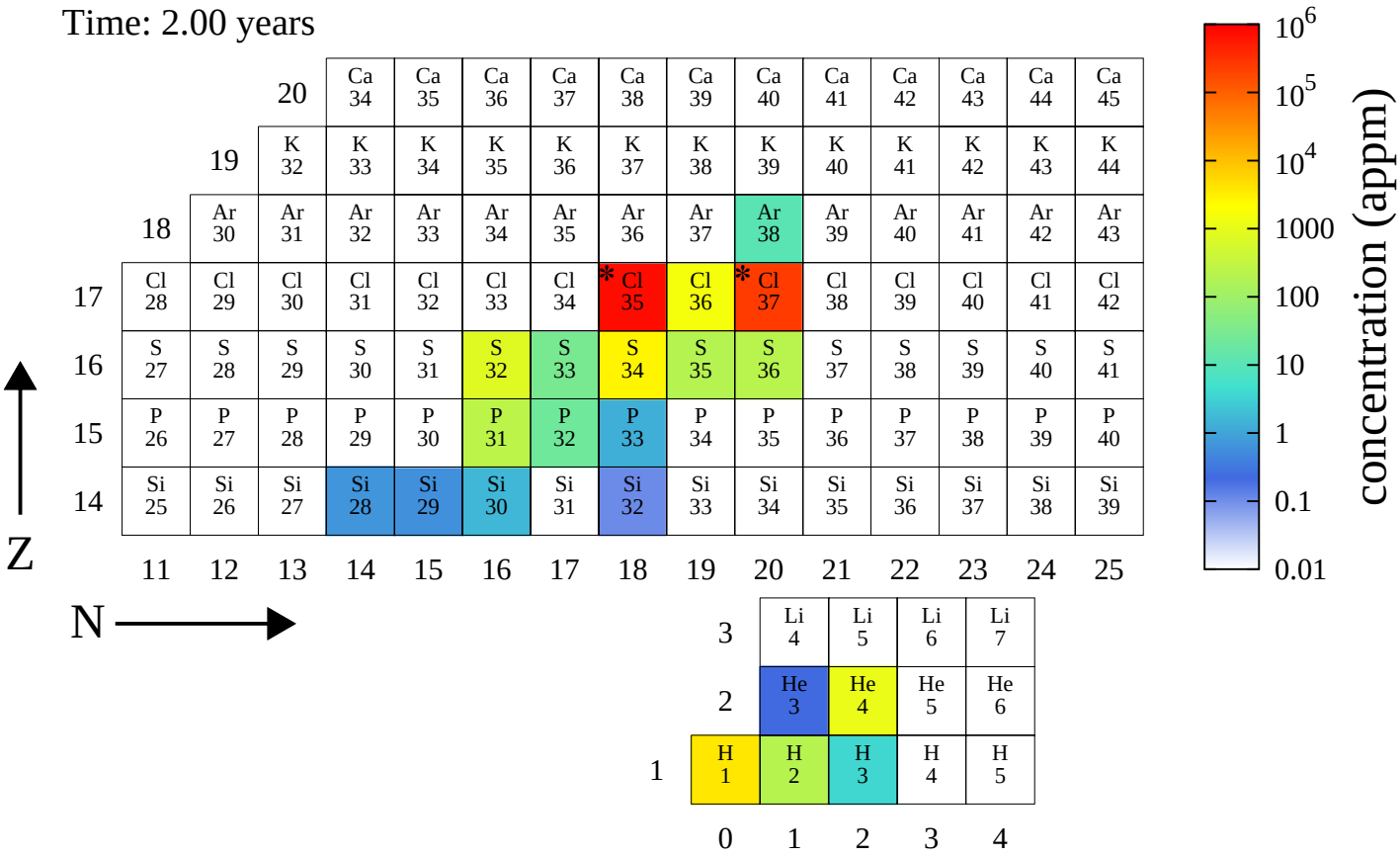




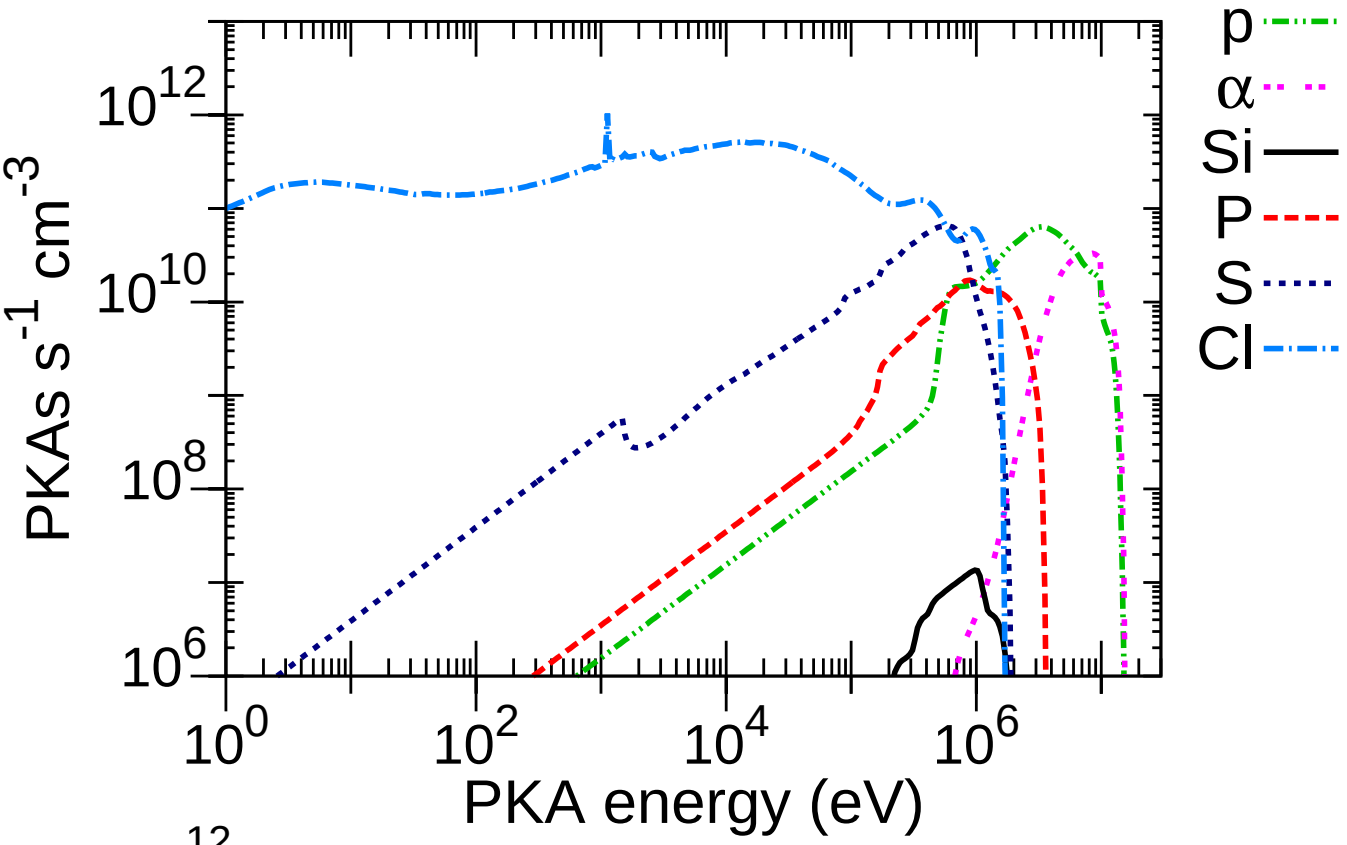
Chlorine FW Transmutation

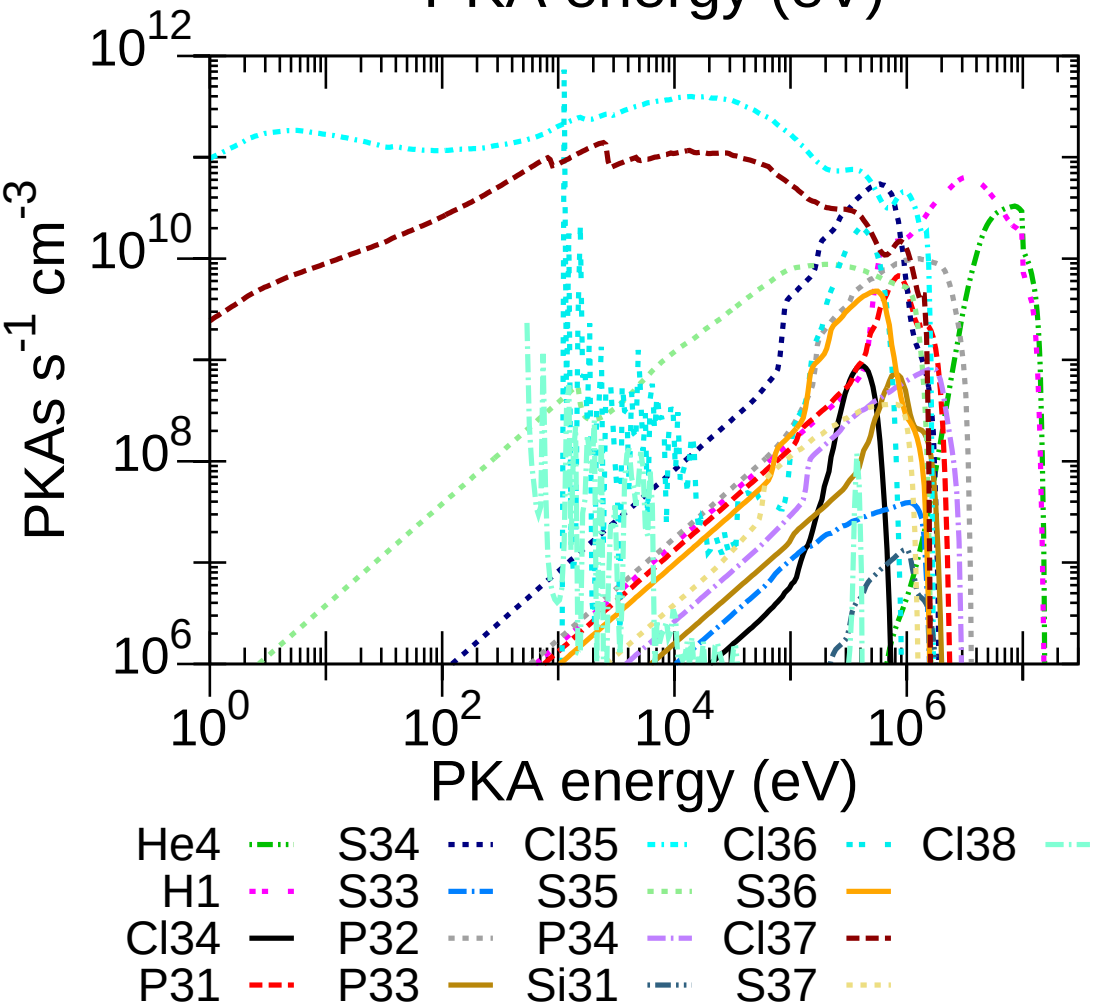


556 appm He & 2065 appm H after 1 year 18 dpa/year



Chlorine FW PKA distributions





Chlorine Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cl34	1.53s	Cl35(n,2n)Cl34m(IT)Cl34				66.0
		Cl35(n,2n)Cl34				33.5
P34	12.40s	Cl35(n,γ)Cl36(n,α)P33(n,γ)P34	99.2	100.0	3.8	
		Cl37(n,α)P34			96.2	78.4
		Cl35(n,np)S34(n,p)P34				19.4
		Cl35(n,d)S34(n,p)P34				1.4
Al28	2.24m	Cl35(n,nα)P31(n,α)Al28				87.6
		Cl35(n,np)S34(n,α)Si31(β^-)P31(n,α)Al28				4.0
		Cl35(n,α)P32(β^-)S32(n,nα)Si28(n,p)Al28				3.6
		Cl35(n,α)P32(β^-)S32(n,np)P31(n,α)Al28				2.3
S37	4.99m	Cl35(n,γ)Cl36(n,p)S36(n,γ)S37	97.4	100.0	84.0	
		Cl35(n,p)S35(n,γ)S36(n,γ)S37	2.2		15.9	
		Cl37(n,p)S37				99.9
Cl34m	32.10m	Cl35(n,2n)Cl34m				99.5
Cl38	37.21m	Cl37(n,γ)Cl38	46.4	88.0	70.9	69.4
		Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38	43.1			
		Cl37(n,γ)Cl38m(IT)Cl38	5.3	12.0	29.1	29.8
		Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38m(IT)Cl38	5.0			
Ar41	1.83h	Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39(n,γ)Ar40(n,γ)Ar41	74.0	88.0		
		Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39(n,γ) Ar40(n,γ)Ar41	15.6			
		Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,γ)Ar39(n,γ) Ar40(n,γ)Ar41	8.5	12.0		
		Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,γ) Ar39(n,γ)Ar40(n,γ)Ar41	1.8			
Si31	2.62h	Cl35(n,γ)Cl36(n,α)P33(β^-)S33(n,α)Si30(n,γ)Si31	99.5	100.0	48.9	
		Cl35(n,α)P32(β^-)S32(n,γ)S33(n,α)Si30(n,γ)Si31			50.0	
		Cl35(n,np)S34(n,α)Si31				82.3
		Cl35(n,d)S34(n,α)Si31				5.7
		Cl35(n,nα)P31(n,p)Si31				5.4
		Cl35(n,pα)Si31				2.3
		Cl37(n,α)P34(β^-)S34(n,α)Si31				1.7
K42	12.36h	Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39(n,γ)Ar40(n,γ)Ar41(β^-) K41(n,γ)K42	78.8	87.8		
		Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39(n,γ) Ar40(n,γ)Ar41(β^-)K41(n,γ)K42	10.9			
		Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,γ)Ar39(n,γ)Ar40(n,γ) Ar41(β^-)K41(n,γ)K42	9.1	12.0		
		Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,γ) Ar39(n,γ)Ar40(n,γ)Ar41(β^-)K41(n,γ)K42	1.3			
Na24	14.96h	Cl35(n,nα)P31(n,nα)Al27(n,α)Na24				65.8
		Cl35(n,np)S34(n,nα)Si30(n,α)Mg27(β^-)Al27(n,α)Na24				9.3
		Cl35(n,α)P32(β^-)S32(n,nα)Si28(n,np)Al27(n,α)Na24				5.8
		Cl35(n,α)P32(β^-)S32(n,nα)Si28(n,nα)Mg24(n,p)Na24				5.1
		Cl35(n,nα)P31(n,np)Si30(n,α)Mg27(β^-)Al27(n,α)Na24				3.5
		Cl35(n,np)S34(n,α)Si31(β^-)P31(n,nα)Al27(n,α)Na24				2.0
		Cl35(n,nα)P31(n,α)Al28(β^-)Si28(n,np)Al27(n,α)Na24				1.2
		Cl35(n,α)P32(β^-)S32(n,np)P31(n,nα)Al27(n,α)Na24				1.1
		Cl35(n,nα)P31(n,α)Al28(β^-)Si28(n,nα)Mg24(n,p)Na24				1.1
P32	14.27d	Cl35(n,α)P32	100.0	100.0	99.3	99.2
P33	25.38d	Cl35(n,γ)Cl36(n,α)P33	99.2	100.0	99.4	
		Cl37(n,nα)P33				70.7
		Cl37(n,2n)Cl36(n,α)P33				15.1
		Cl35(n,np)S34(n,np)P33				8.5
		Cl35(n,np)S34(n,d)P33				2.6
Ar37	35.03d	Cl35(n,γ)Cl36(β^-)Ar36(n,γ)Ar37	99.5	100.0	99.9	
		Cl37(n,γ)Cl38(β^-)Ar38(n,2n)Ar37				69.7
		Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,2n)Ar37				30.0
S35	87.32d	Cl35(n,p)S35	100.0	100.0	99.5	96.0
		Cl37(n,np)S36(n,2n)S35				1.9
		Cl37(n,2n)Cl36(n,np)S35				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Na22	2.60y	Cl35(n,nα)P31(n,nα)Al27(n,nα)Na23(n,2n)Na22				48.3
		Cl35(n,nα)P31(n,nα)Al27(n,2n)Al26(n,nα)Na22				12.6
		Cl35(n,α)P32(β^-)S32(n,α)Si29(n,α)Mg26(n,α)Ne23(β^-) Na23(n,2n)Na22				9.6
		Cl35(n,α)P32(β^-)S32(n,nα)Si28(n,nα)Mg24(n,np) Na23(n,2n)Na22				6.3
		Cl35(n,np)S34(n,nα)Si30(n,α)Mg27(β^-)Al27(n,nα) Na23(n,2n)Na22				4.1
		Cl35(n,α)P32(β^-)S32(n,nα)Si28(n,np)Al27(n,nα) Na23(n,2n)Na22				2.4
		Cl35(n,α)P32(β^-)S32(n,nα)Si28(n,nα)Mg24(n,d) Na23(n,2n)Na22				1.9
		Cl35(n,nα)P31(n,np)Si30(n,α)Mg27(β^-)Al27(n,nα) Na23(n,2n)Na22				1.5
		Cl35(n,nα)P31(n,α)Al28(β^-)Si28(n,nα)Mg24(n,np) Na23(n,2n)Na22				1.4
		Cl35(n,nα)P31(n,nα)Al27(n,np)Mg26(n,α)Ne23(β^-) Na23(n,2n)Na22				1.2
		Cl35(n,np)S34(n,nα)Si30(n,α)Mg27(β^-)Al27(n,2n) Al26(n,nα)Na22				1.1
H3	12.33y	Cl35(n,p)H1(n,γ)H2(n,γ)H3	94.5	99.6	99.9	
		Cl35(n,γ)Cl36(n,p)H1(n,γ)H2(n,γ)H3	5.5			
		Cl35(n,t)H3				84.8
		Cl37(n,t)H3				13.7
		Cl37(n,2n)Cl36(n,t)H3				1.0
Si32	132.00y	Cl35(n,α)P32(n,p)Si32	99.2	14.2	9.8	26.2
		Cl35(n,p)S35(n,α)Si32		85.7	90.0	68.2
		Cl37(n,np)S36(n,nα)Si32				2.1
Ar39	269.01y	Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39	65.3	88.0	70.8	69.7
		Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39	24.3			
		Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,γ)Ar39	7.5	12.0	29.1	30.0
		Cl35(n,γ)Cl36(n,γ)Cl37(n,γ)Cl38m(IT)Cl38(β^-) Ar38(n,γ)Ar39	2.8			
Cl36	3.0 10^5y	Cl35(n,γ)Cl36	99.1	100.0	99.8	
		Cl37(n,2n)Cl36				99.5
Al26	7.2 10^5y	Cl35(n,nα)P31(n,nα)Al27(n,2n)Al26				77.0
		Cl35(n,np)S34(n,nα)Si30(n,α)Mg27(β^-)Al27(n,2n)Al26				8.1
		Cl35(n,α)P32(β^-)S32(n,nα)Si28(n,np)Al27(n,2n)Al26				4.9
		Cl35(n,nα)P31(n,np)Si30(n,α)Mg27(β^-)Al27(n,2n)Al26				3.0
		Cl35(n,np)S34(n,α)Si31(β^-)P31(n,nα)Al27(n,2n)Al26				1.7
		Cl35(n,nα)P31(n,α)Al28(β^-)Si28(n,np)Al27(n,2n)Al26				1.0

Argon

Isotope	Atom % abundance
Ar36	0.34
Ar38	0.06
Ar40	99.60

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	6.47E+13	2.86E+13	5.06E+12	4.06E+12	3.12E+12	1.01E+07
Cl40	42.4	6.4				
S37	29.5	32.1				
Ar41	18.4	40.2				
Ar39	6.2	14.1	79.9	99.3	100.0	
Cl39	1.4	2.9				
Ar37	0.9	2.0	10.5			
S35	0.7	1.7	9.2	0.7		
Cl36						100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.99E-02	1.09E-02	1.46E-04	1.41E-04	1.09E-04	4.41E-10
Cl40	61.7	15.0				
S37	28.6	50.5				
Ar41	8.4	29.7				
Cl39	0.8	2.8				
Ar39	0.4	1.3	96.7	99.9	100.0	
S35			2.5	0.1		
Cl36						100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	6.27E+04	1.70E+04	1.26E-02	2.18E-05	2.07E-06	3.55E-08
Cl40	60.0	14.7				
S37	31.8	56.3				
Ar41	7.4	26.5				
Cl39	0.6	2.1				
Ar37			50.6	25.9		
K42			49.4	74.0	98.2	
Cl36				0.2	1.7	97.9
K40						2.1

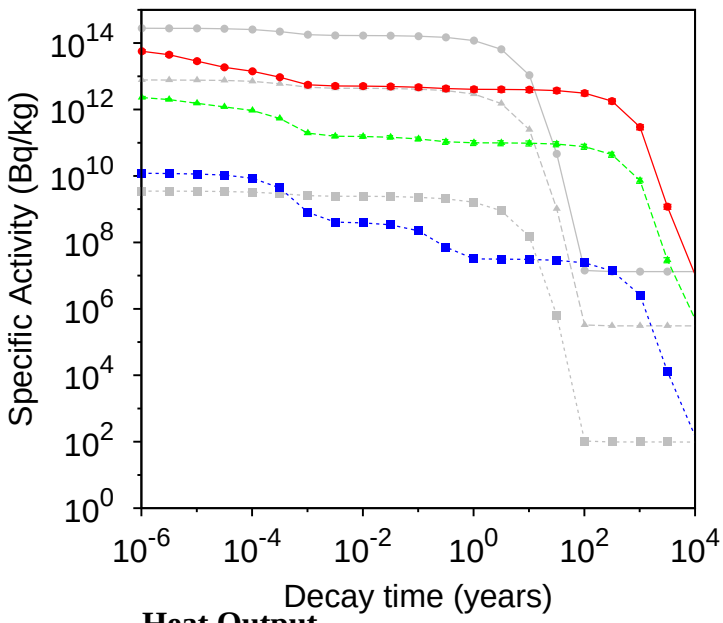
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.00E+06	5.95E+06	4.45E+06	4.43E+06	3.44E+06	9.50E-03
Ar39	74.1	74.7	99.9	100.0	100.0	1.3
Ar41	25.8	25.2				
Cl36						98.7

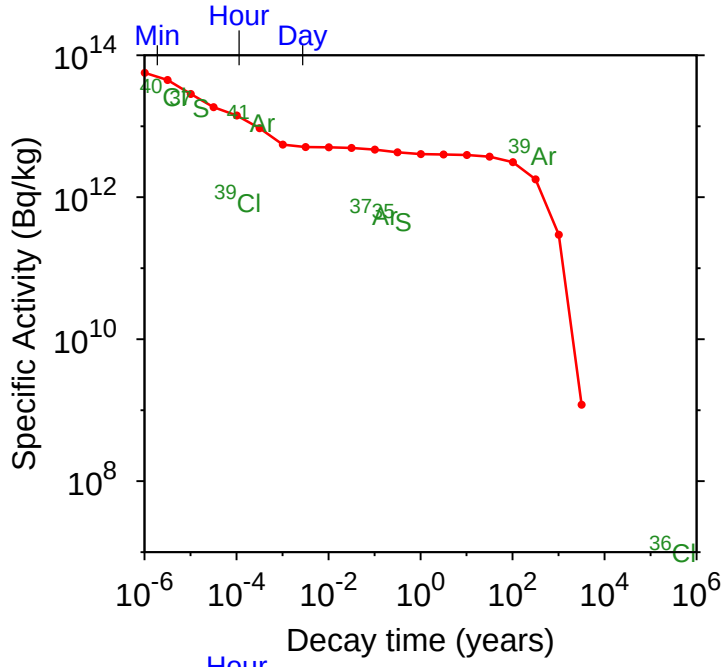
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.54E+08	1.54E+08	1.54E+08	1.53E+08	1.19E+08	7.80E-02
Ar39	99.5	99.5	100.0	100.0	100.0	5.6
Cl36						94.4

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.90E+11	5.24E+10	2.18E+08	2.12E+08	1.64E+08	1.01E+04
Cl40	60.3	14.5				
S37	30.5	53.3				
Ar41	8.4	29.3				
Cl39	0.7	2.4				
Ar39	0.1	0.4	97.7	99.9	100.0	
S35			2.1	0.1		
Cl36						100.0

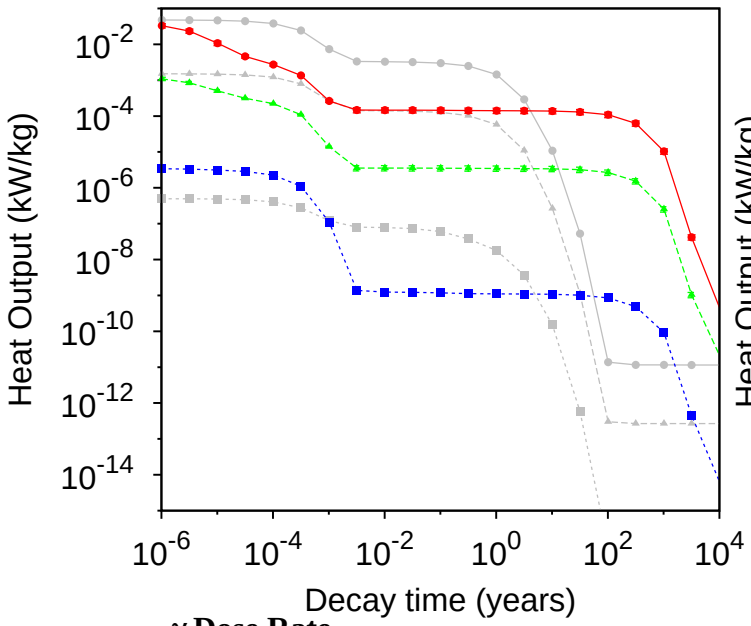
Argon activation characteristics

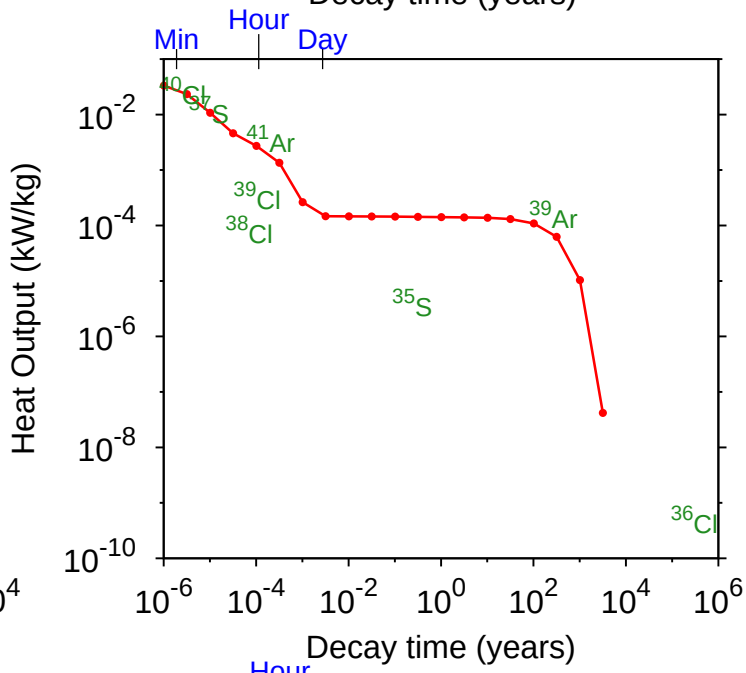
Specific Activity



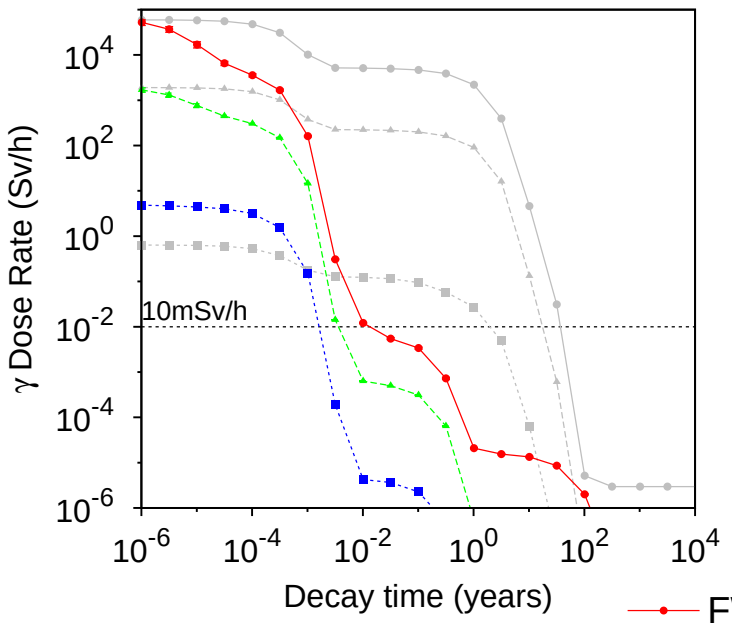


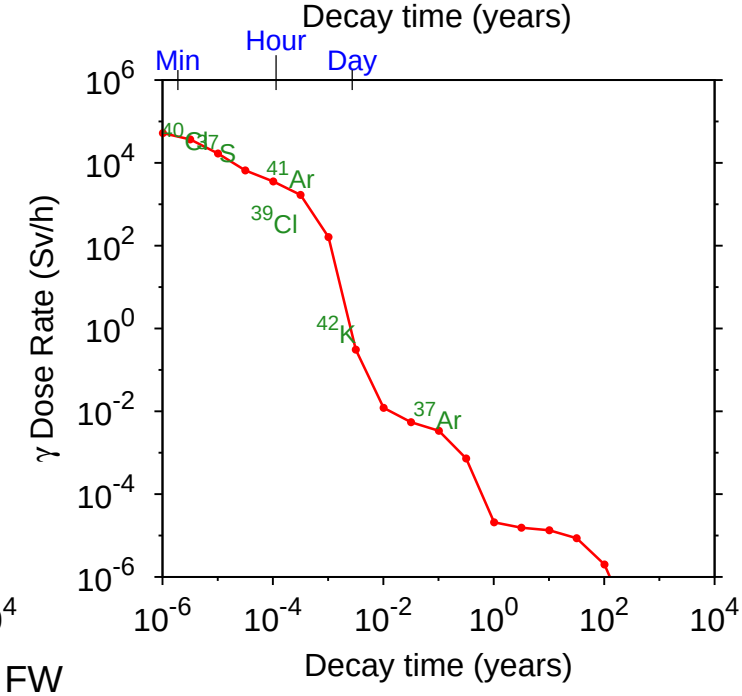
Heat Output





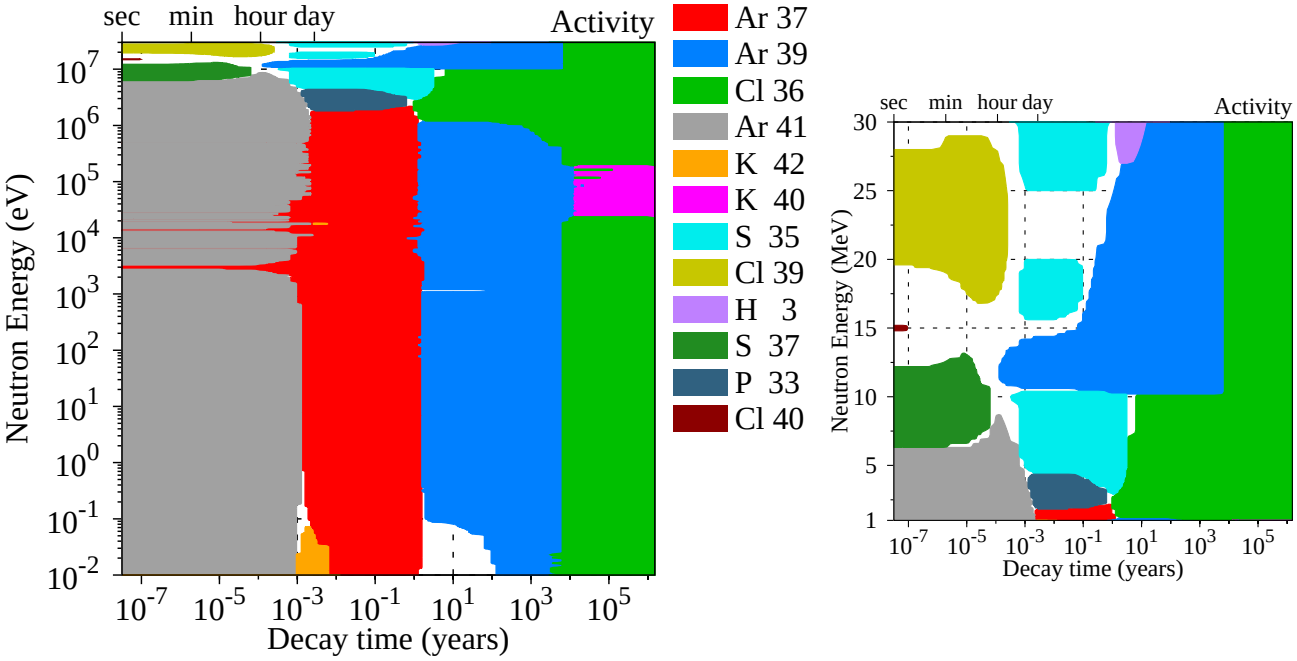
γ Dose Rate

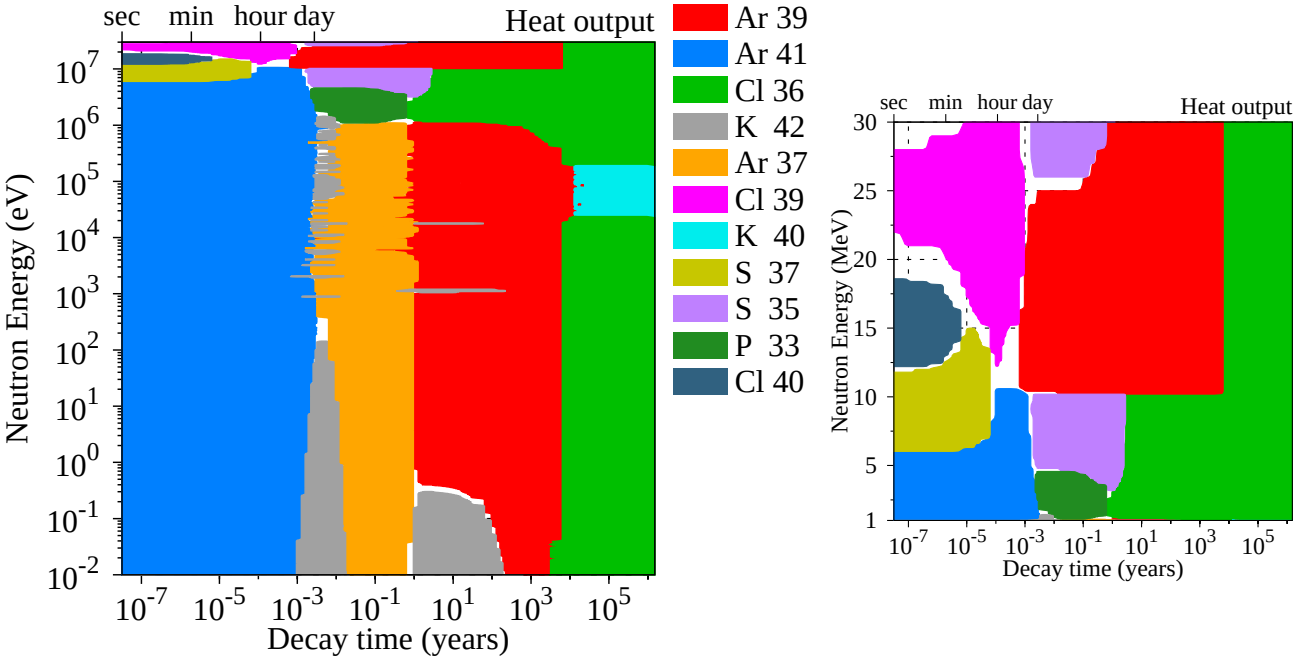


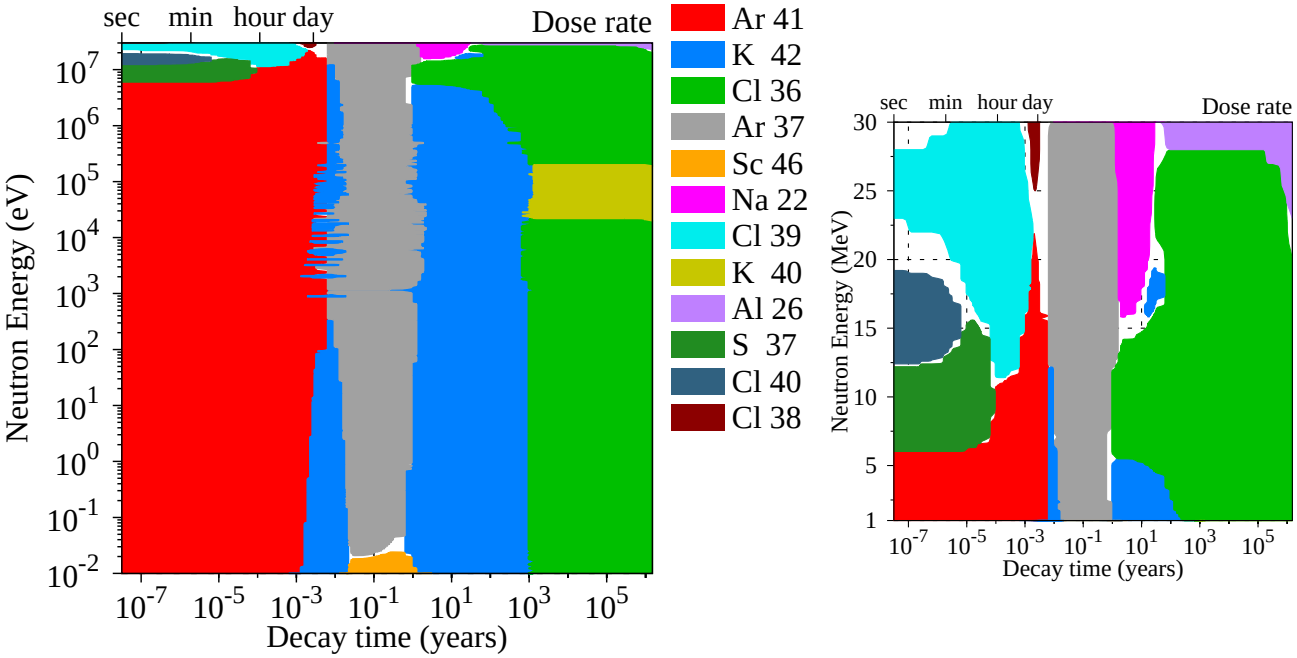


FW
Blanket
Manifold
Fe results

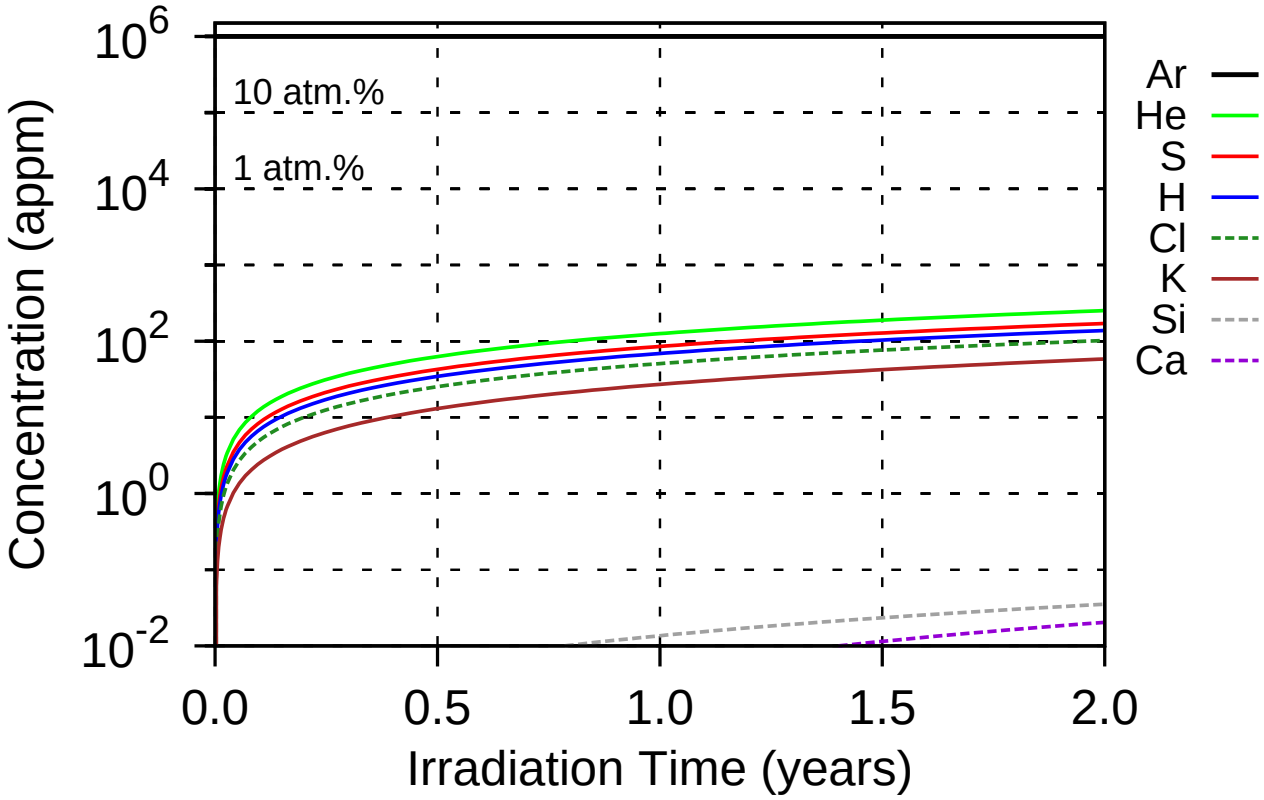
Argon Importance diagrams



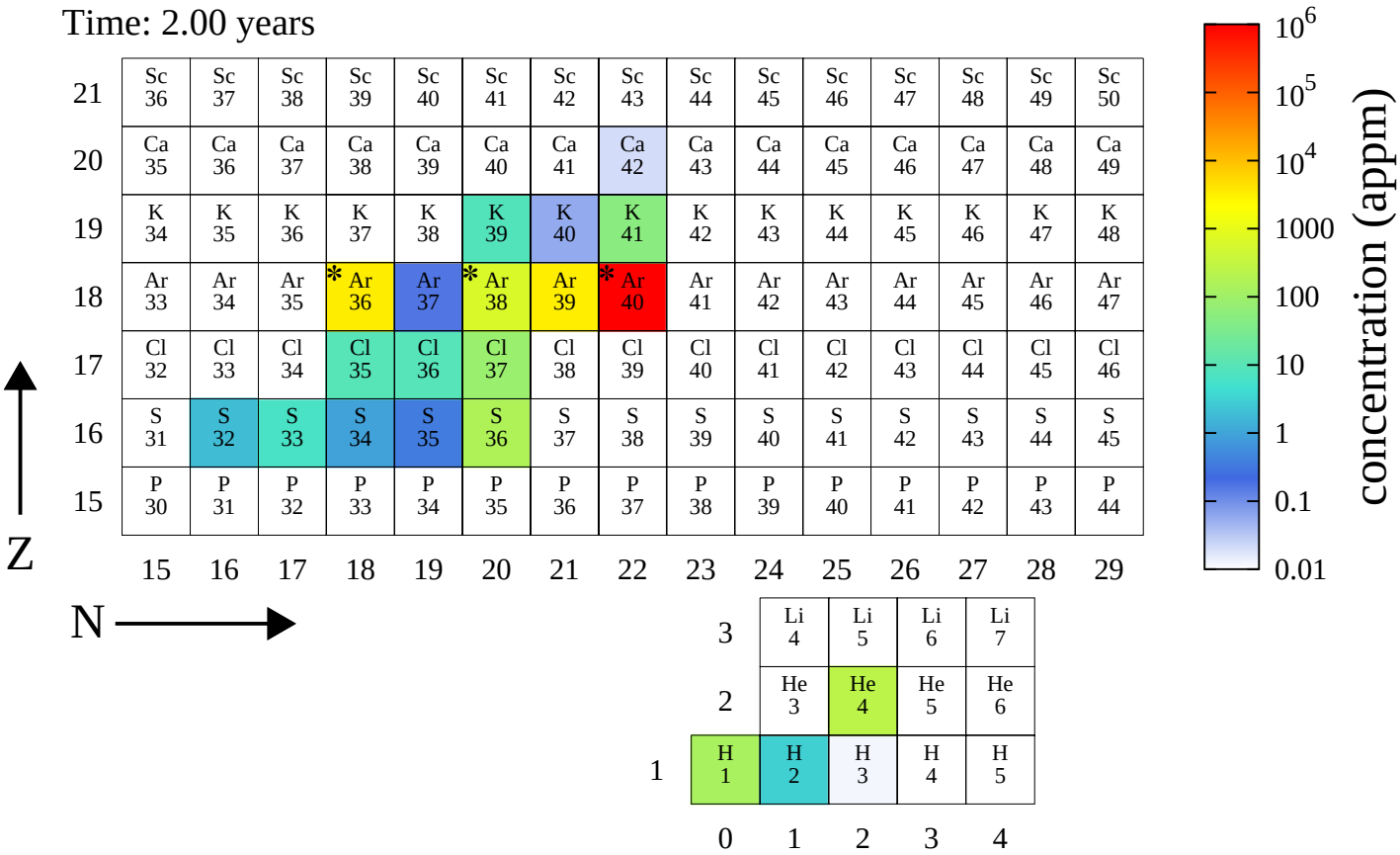




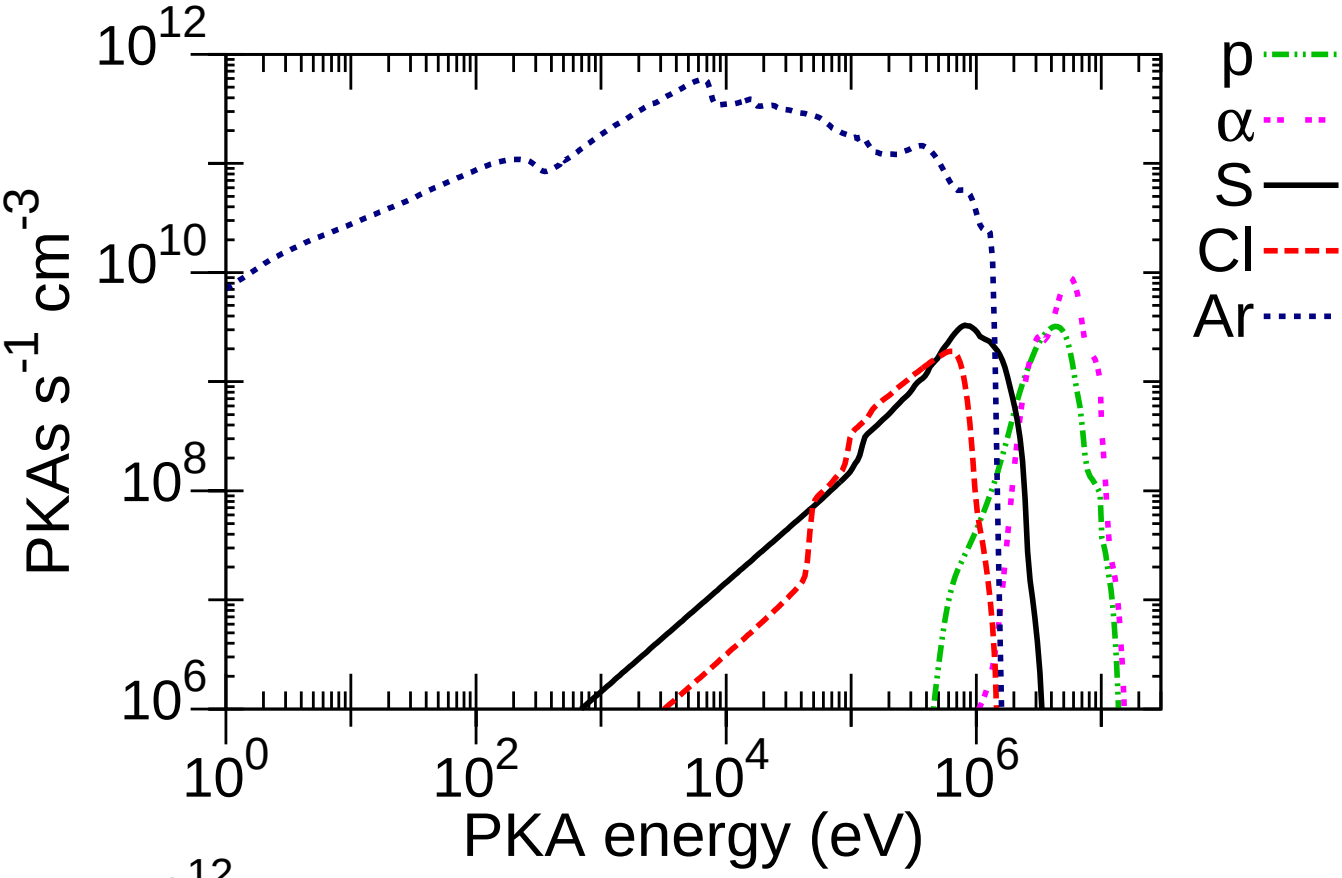
Argon FW Transmutation

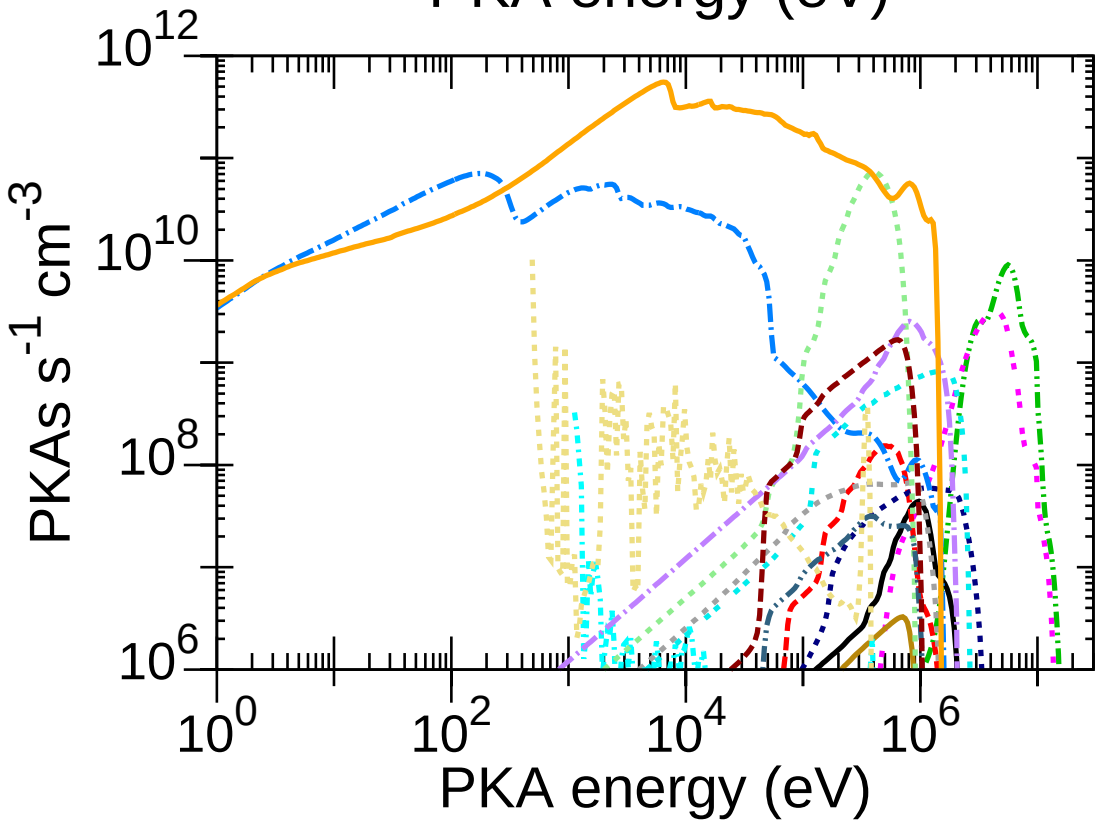


126 appm He & 69 appm H after 1 year 17 dpa/year



Argon FW PKA distributions





Argon Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cl40	1.35m	Ar36(n,γ)Ar37(β^+)Cl37(n,γ)Cl38(n,γ)Cl39(n,γ)Cl40	70.3			
		Ar36(n,γ)Ar37(n,p)Cl37(n,γ)Cl38(n,γ)Cl39(n,γ)Cl40	19.4			
		Ar36(n,γ)Ar37(β^+)Cl37(n,γ)Cl38m(IT)Cl38(n,γ) Cl39(n,γ)Cl40	8.1			
		Ar36(n,γ)Ar37(n,p)Cl37(n,γ)Cl38m(IT)Cl38(n,γ) Cl39(n,γ)Cl40	2.2			
		Ar40(n,p)Cl40				99.9
S37	4.99m	Ar36(n,p)Cl36(n,p)S36(n,γ)S37	73.7		100.0	
		Ar36(n,γ)Ar37(n,α)S34(n,γ)S35(n,γ)S36(n,γ)S37	21.1			
		Ar38(n,γ)Ar39(n,α)S36(n,γ)S37	3.4	99.9		
		Ar36(n,γ)Ar37(n,α)S34(n,γ)S35(β^-)Cl35(n,γ)Cl36(n,p) S36(n,γ)S37	1.7			
		Ar40(n,α)S37				99.8
Cl38	37.21m	Ar36(n,γ)Ar37(β^+)Cl37(n,γ)Cl38	70.3	87.7	6.4	
		Ar36(n,γ)Ar37(n,p)Cl37(n,γ)Cl38	19.4			
		Ar36(n,γ)Ar37(β^+)Cl37(n,γ)Cl38m(IT)Cl38	8.1	12.1	2.6	
		Ar36(n,γ)Ar37(n,p)Cl37(n,γ)Cl38m(IT)Cl38	2.2			
		Ar40(n,γ)Ar41(β^-)K41(n,α)Cl38			90.6	
		Ar40(n,2n)Ar39(n,np)Cl38				28.8
		Ar40(n,2n)Ar39(n,d)Cl38				16.1
		Ar40(n,2n)Ar39(n,2n)Ar38(n,p)Cl38				14.5
		Ar40(n,2n)Ar39(n,np)Cl38m(IT)Cl38				12.1
		Ar40(n,2n)Ar39(n,d)Cl38m(IT)Cl38				11.2
		Ar38(n,p)Cl38				9.7
		Ar40(n,2n)Ar39(n,2n)Ar38(n,p)Cl38m(IT)Cl38				3.9
		Ar38(n,p)Cl38m(IT)Cl38				2.6
Cl39	55.59m	Ar36(n,γ)Ar37(β^+)Cl37(n,γ)Cl38(n,γ)Cl39	70.3	87.7		
		Ar36(n,γ)Ar37(n,p)Cl37(n,γ)Cl38(n,γ)Cl39	19.4			
		Ar36(n,γ)Ar37(β^+)Cl37(n,γ)Cl38m(IT)Cl38(n,γ)Cl39	8.1	12.1		
		Ar36(n,γ)Ar37(n,p)Cl37(n,γ)Cl38m(IT)Cl38(n,γ)Cl39	2.2			
		Ar40(n,γ)Ar41(β^-)K41(n,γ)K42(n,α)Cl39			79.0	
		Ar38(n,γ)Ar39(n,p)Cl39			20.9	
		Ar40(n,2n)Ar39(n,p)Cl39				75.0
		Ar40(n,d)Cl39				20.9
		Ar40(n,np)Cl39				3.8
Ar41	1.83h	Ar40(n,γ)Ar41	100.0	100.0	100.0	99.6
K42	12.36h	Ar40(n,γ)Ar41(β^-)K41(n,γ)K42	100.0	100.0	100.0	99.1
P33	25.38d	Ar36(n,α)S33(n,p)P33	93.9	99.5	48.4	12.5
		Ar36(n,p)Cl36(n,α)P33	5.8		51.4	15.0
		Ar40(n,nα)S36(n,α)Si33(β^-)P33				36.9
		Ar40(n,α)S37(β^-)Cl37(n,nα)P33				29.1
		Ar40(n,α)S37(β^-)Cl37(n,2n)Cl36(n,α)P33				3.1
		Ar40(n,2n)Ar39(n,α)S36(n,α)Si33(β^-)P33				1.1
Ar37	35.03d	Ar36(n,γ)Ar37	100.0	100.0	100.0	1.1
		Ar40(n,2n)Ar39(n,2n)Ar38(n,2n)Ar37				55.2
		Ar38(n,2n)Ar37				42.4
Sc46	83.79d	Ar40(n,γ)Ar41(β^-)K41(n,γ)K42(β^-)Ca42(n,γ)Ca43(n,γ) Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46	75.5			
		Ar40(n,γ)Ar41(β^-)K41(n,γ)K42(β^-)Ca42(n,γ)Ca43(n,γ) Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46m(IT)Sc46	22.1			
		Ar40(n,γ)Ar41(β^-)K41(n,γ)K42(n,γ)K43(β^-)Ca43(n,γ) Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46	1.9			
S35	87.32d	Ar36(n,γ)Ar37(n,α)S34(n,γ)S35	99.3	100.0		
		Ar38(n,α)S35			99.5	3.4
		Ar40(n,2n)Ar39(n,nα)S35				46.1
		Ar40(n,nα)S36(n,2n)S35				43.3
		Ar40(n,2n)Ar39(n,2n)Ar38(n,α)S35				3.6
		Ar36(n,2p)S35				1.2
		Ar40(n,2n)Ar39(n,α)S36(n,2n)S35				1.2

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Na22	2.60y	Ar36(n,2α)Si29(n,α)Mg26(n,α)Ne23(β^-)Na23(n,2n)Na22				52.6
		Ar36(n,α)S33(n,nα)Si29(n,α)Mg26(n,α)Ne23(β^-) Na23(n,2n)Na22				14.5
		Ar36(n,nα)S32(n,α)Si29(n,α)Mg26(n,α)Ne23(β^-) Na23(n,2n)Na22				10.6
		Ar36(n,nα)S32(n,nα)Si28(n,nα)Mg24(n,np)Na23(n,2n)Na22				6.9
		Ar36(n,α)S33(n,α)Si30(n,α)Mg27(β^-)Al27(n,nα) Na23(n,2n)Na22				3.1
		Ar36(n,nα)S32(n,nα)Si28(n,np)Al27(n,nα)Na23(n,2n)Na22				2.7
		Ar36(n,nα)S32(n,nα)Si28(n,nα)Mg24(n,d)Na23(n,2n)Na22				2.1
H3	12.33y	Ar36(n,γ)Ar37(n,p)H1(n,γ)H2(n,γ)H3	99.8	99.8		
		Ar36(n,p)H1(n,γ)H2(n,γ)H3			99.8	
		Ar40(n,2n)Ar39(n,t)H3				70.2
		Ar40(n,t)H3				2.9
		Ar40(n,α)S37(β^-)Cl37(n,t)H3				2.0
Ar39	269.01y	Ar38(n,γ)Ar39	98.1	100.0	100.0	
		Ar36(n,γ)Ar37(β^+)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39	1.1			
		Ar40(n,2n)Ar39				99.7
Cl36	3.0 10^5y	Ar36(n,p)Cl36	94.8	100.0	100.0	81.4
		Ar36(n,γ)Ar37(n,α)S34(n,γ)S35(β^-)Cl35(n,γ)Cl36	5.2			
		Ar40(n,α)S37(β^-)Cl37(n,2n)Cl36				17.8
Al26	7.2 10^5y	Ar36(n,α)S33(n,α)Si30(n,α)Mg27(β^-)Al27(n,2n)Al26				37.4
		Ar36(n,nα)S32(n,nα)Si28(n,np)Al27(n,2n)Al26				32.2
		Ar36(n,nα)S32(n,np)P31(n,nα)Al27(n,2n)Al26				6.2
		Ar38(n,nα)S34(n,nα)Si30(n,α)Mg27(β^-)Al27(n,2n)Al26				5.9
		Ar36(n,np)Cl35(n,nα)P31(n,nα)Al27(n,2n)Al26				4.5
		Ar36(n,nα)S32(n,nα)Si28(n,d)Al27(n,2n)Al26				3.8
		Ar38(n,nα)S34(n,α)Si31(β^-)P31(n,nα)Al27(n,2n)Al26				1.3
K40	1.3 10^9y	Ar38(n,γ)Ar39(β^-)K39(n,γ)K40	99.6	100.0	100.0	
		Ar40(n,γ)Ar41(β^-)K41(n,2n)K40				99.5

Potassium

Isotope	Atom % abundance
K39	93.26
K40	0.01
K41	6.73

($T_{1/2}$ =1.3 10^9y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.49E+13	2.20E+13	5.51E+12	1.86E+12	1.29E+12	1.25E+09
K42	25.5	28.6	0.8			
Ar41	19.4	21.2				
Cl38	16.5	16.9				
S35	11.0	12.4	48.0	8.1		
K38	10.5	7.3				
Ar39	6.7	7.6	30.3	89.5	99.9	
Cl38m	3.9					
Ar37	3.2	3.6	13.2			
K38m	1.2					
P33	1.1	1.3	4.7			
P32	0.6	0.6	2.1			
H3	0.2	0.2	0.8	2.3		
Cl36				0.1	0.1	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	7.28E-03	6.08E-03	1.08E-04	5.95E-05	4.52E-05	5.49E-08
Cl38	27.2	29.5				
K38	25.2	18.7				
K42	23.7	28.2	11.6			
Ar41	18.5	21.5				
K38m	2.1					
Cl38m	1.4					
Ar39	0.8	1.0	54.0	97.9	99.9	
S35	0.3	0.3	19.1	2.0		
P32	0.2	0.3	12.1			
P33		0.1	2.9			
Cl36			0.1	0.1	0.1	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	6.72E+03	5.39E+03	3.75E+00	3.25E-05	1.11E-05	8.76E-06
K38	34.6	26.7				
Cl38	28.0	31.7				
Ar41	26.1	31.4				
K42	7.6	9.5	99.8	55.0	20.3	
Cl38m	2.2					
Ar37			0.2	17.8		
K40				14.7	43.0	54.6
Cl36				12.5	36.7	45.4

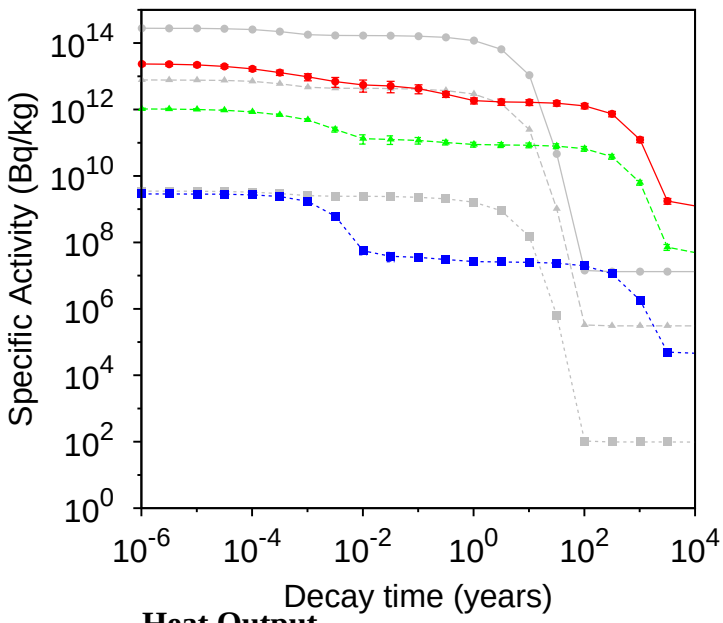
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.47E+06	2.45E+06	1.84E+06	1.83E+06	1.42E+06	1.17E+00
Ar39	74.1	74.8	99.5	100.0	100.0	
Ar41	25.3	24.7				
Cl36						99.9

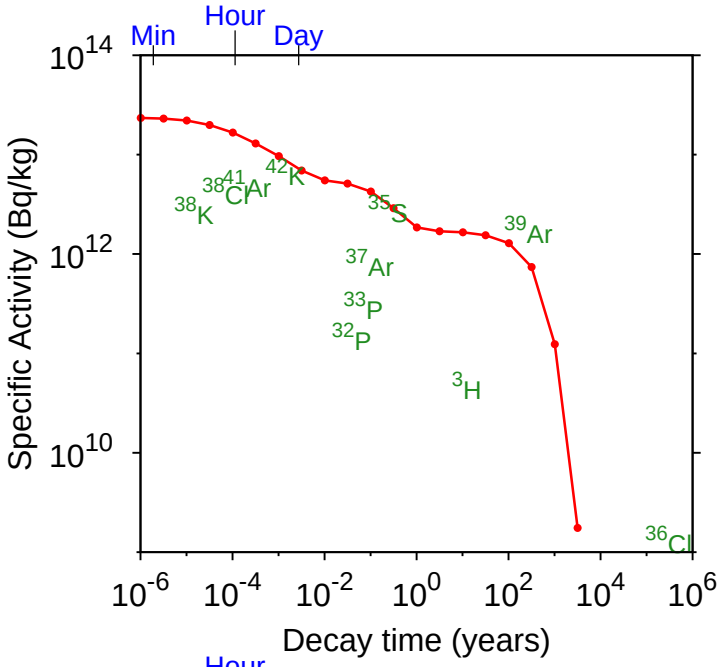
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.37E+07	6.37E+07	6.34E+07	6.32E+07	4.90E+07	9.16E+00
Ar39	99.4	99.5	99.9	100.0	100.0	
Cl36						100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.75E+10	1.29E+10	1.21E+08	9.08E+07	6.91E+07	1.25E+06
K38	49.8	41.9				
Ar41	36.8	48.4				
Cl38m	3.7					
K42	3.6	4.9	3.8			
Cl38	2.3	2.9				
K38m	2.1					
Ar39	0.5	0.7	72.3	96.5	98.1	
S35	0.2	0.2	21.8	1.7		
Cl36			1.1	1.4	1.9	100.0

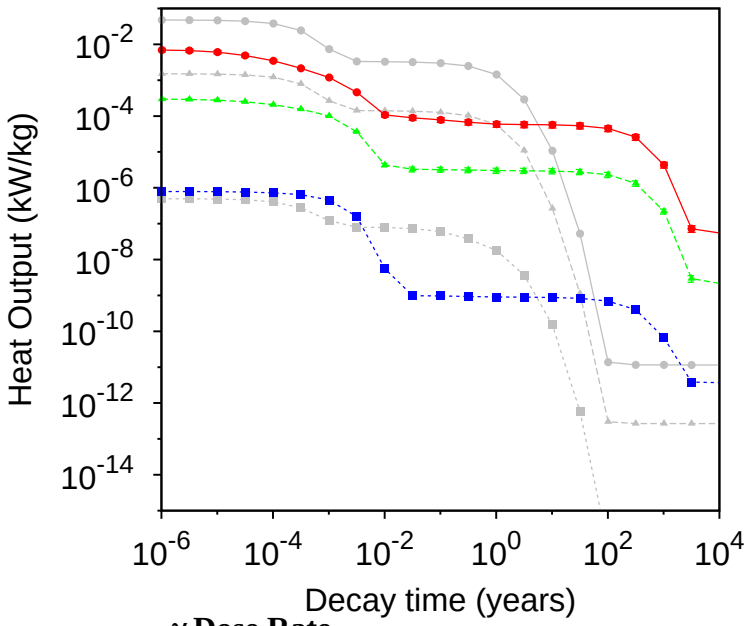
Potassium activation characteristics

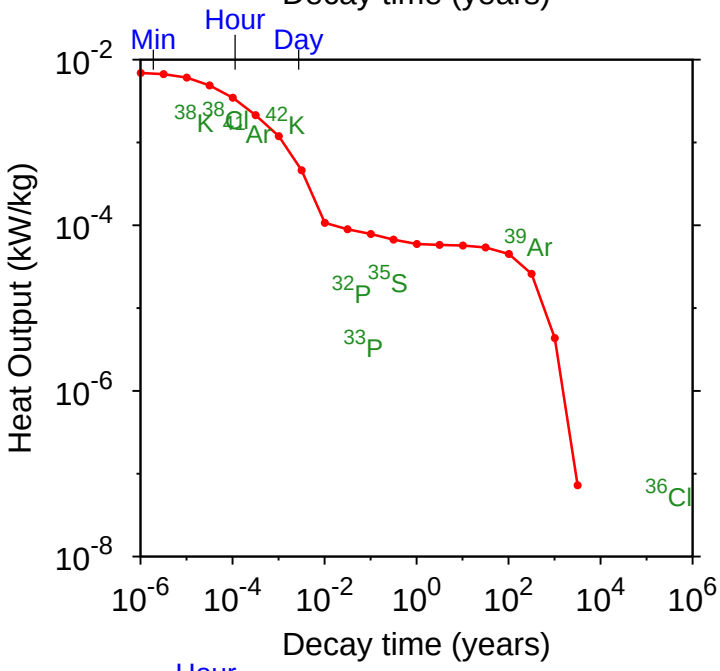
Specific Activity



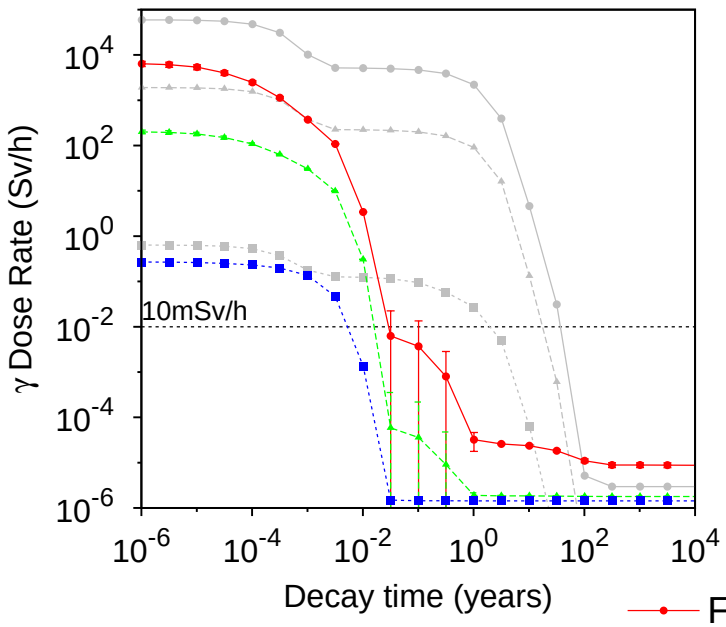


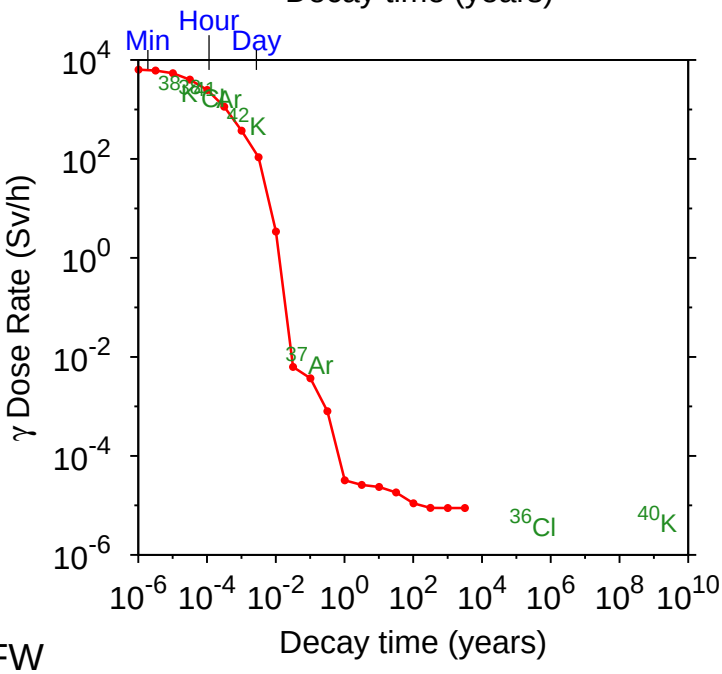
Heat Output





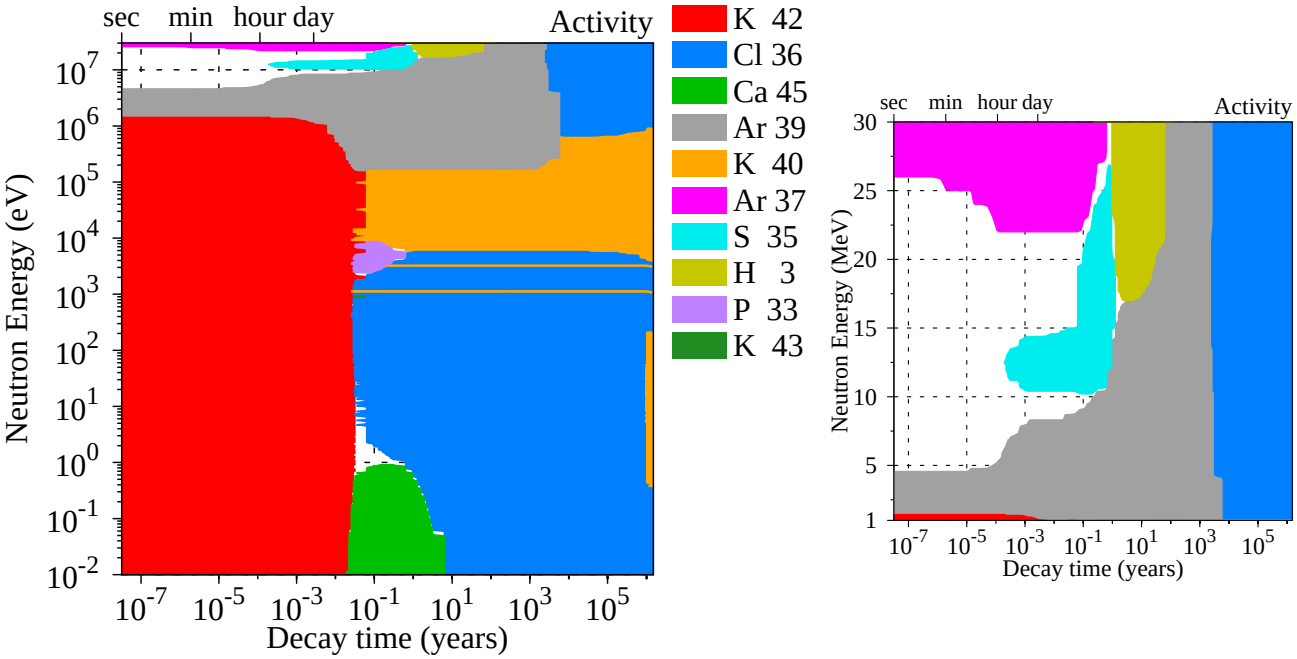
γ Dose Rate

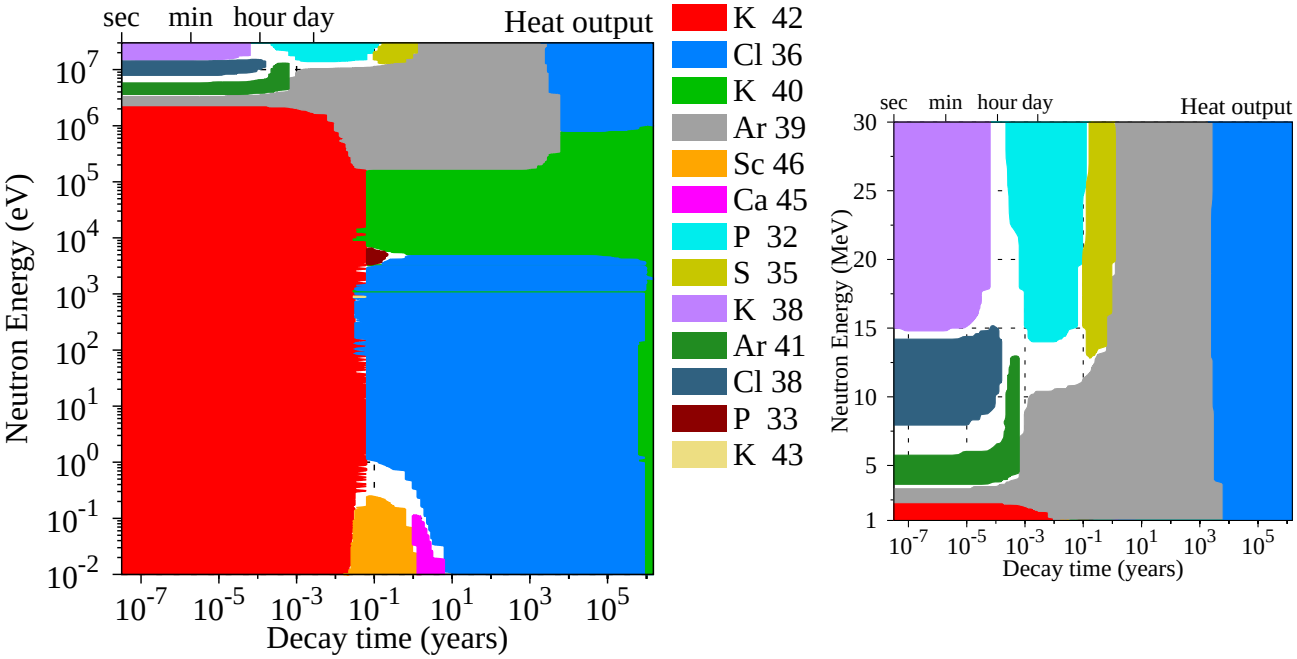


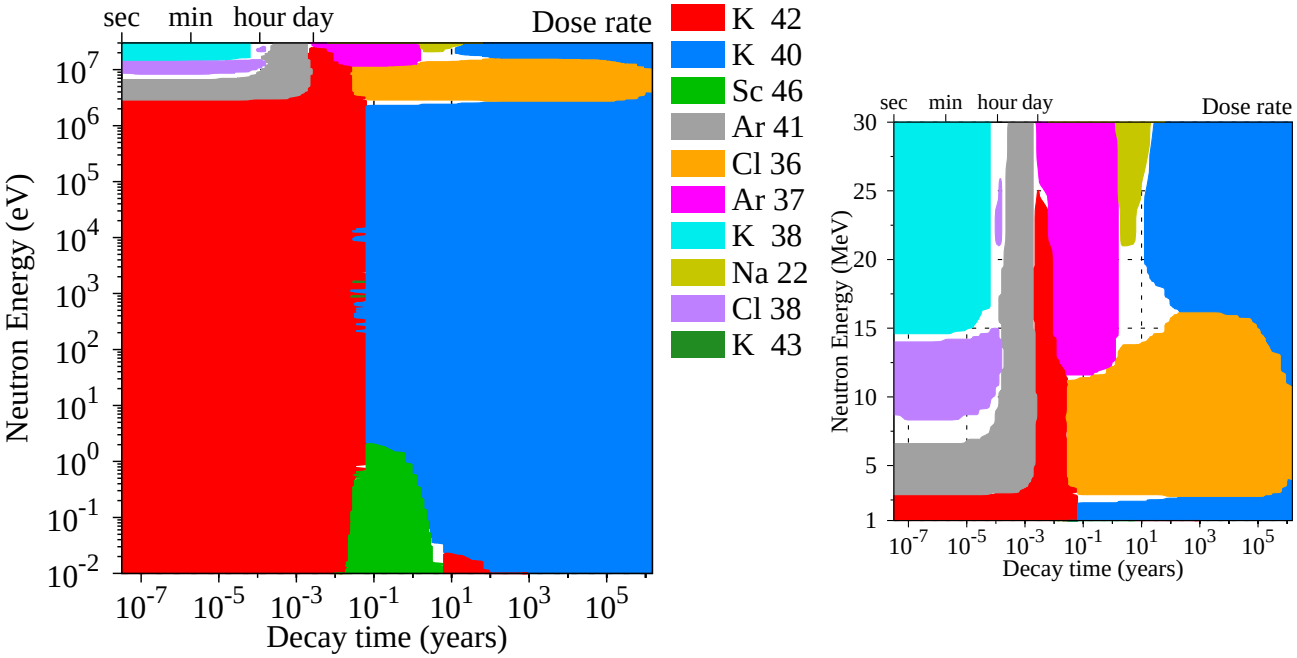


FW
Blanket
Manifold
Fe results

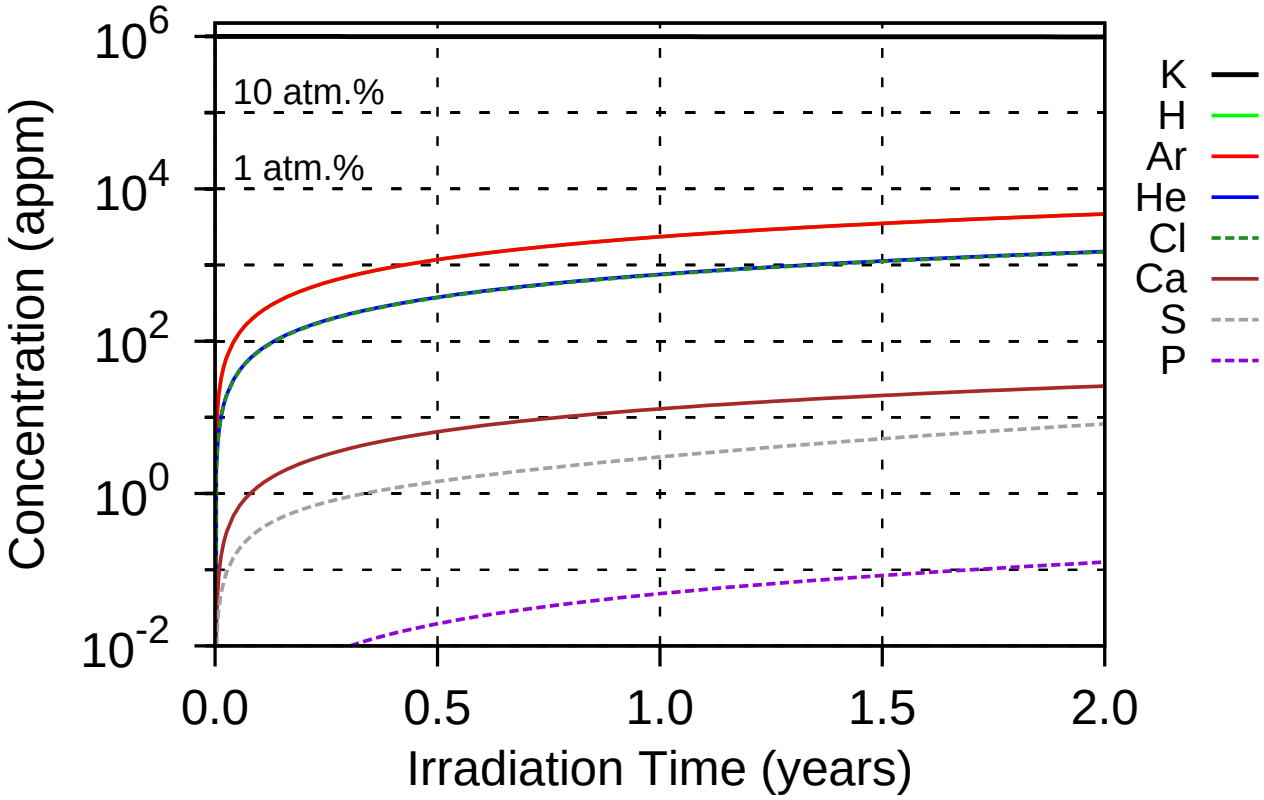
Potassium Importance diagrams



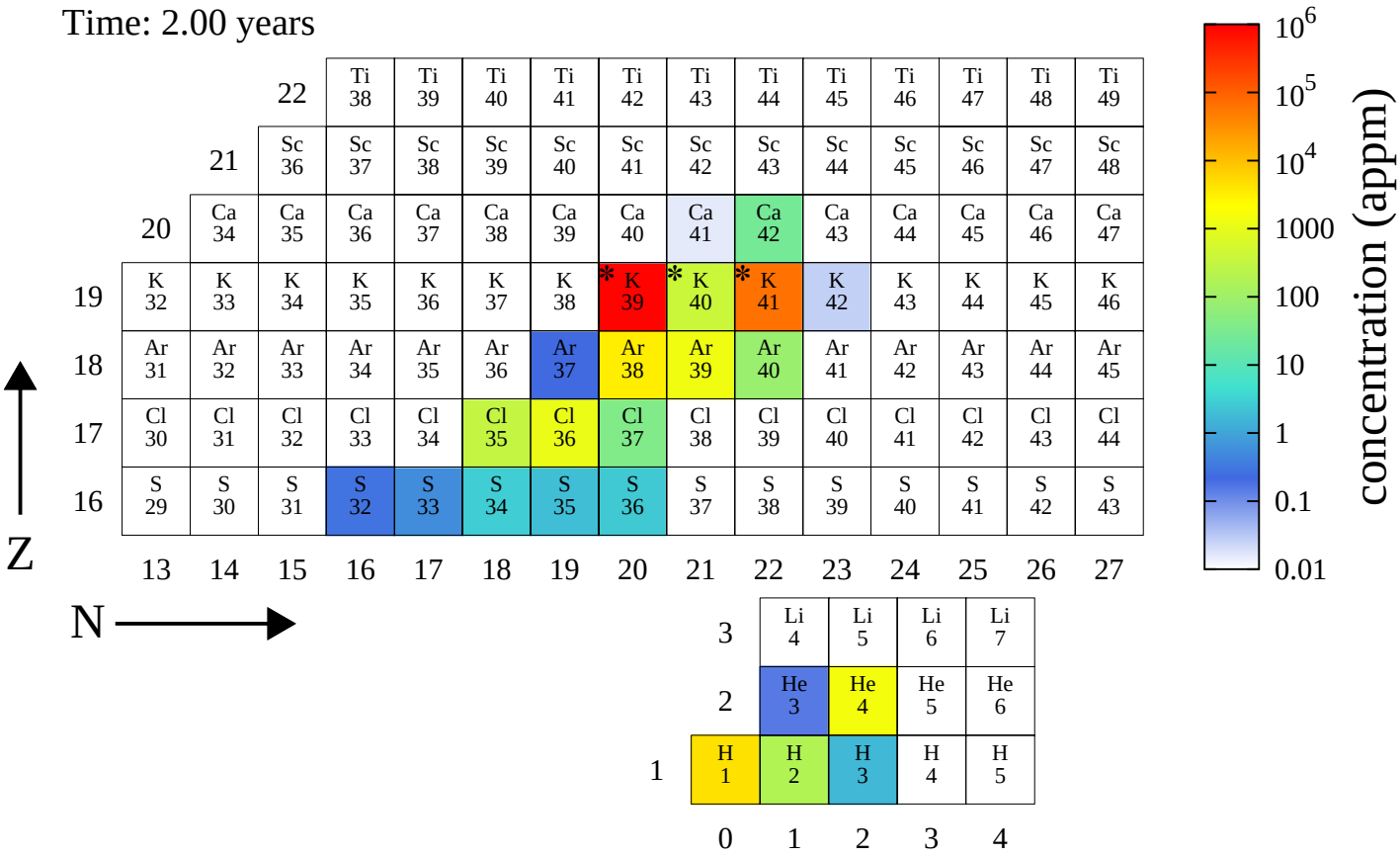




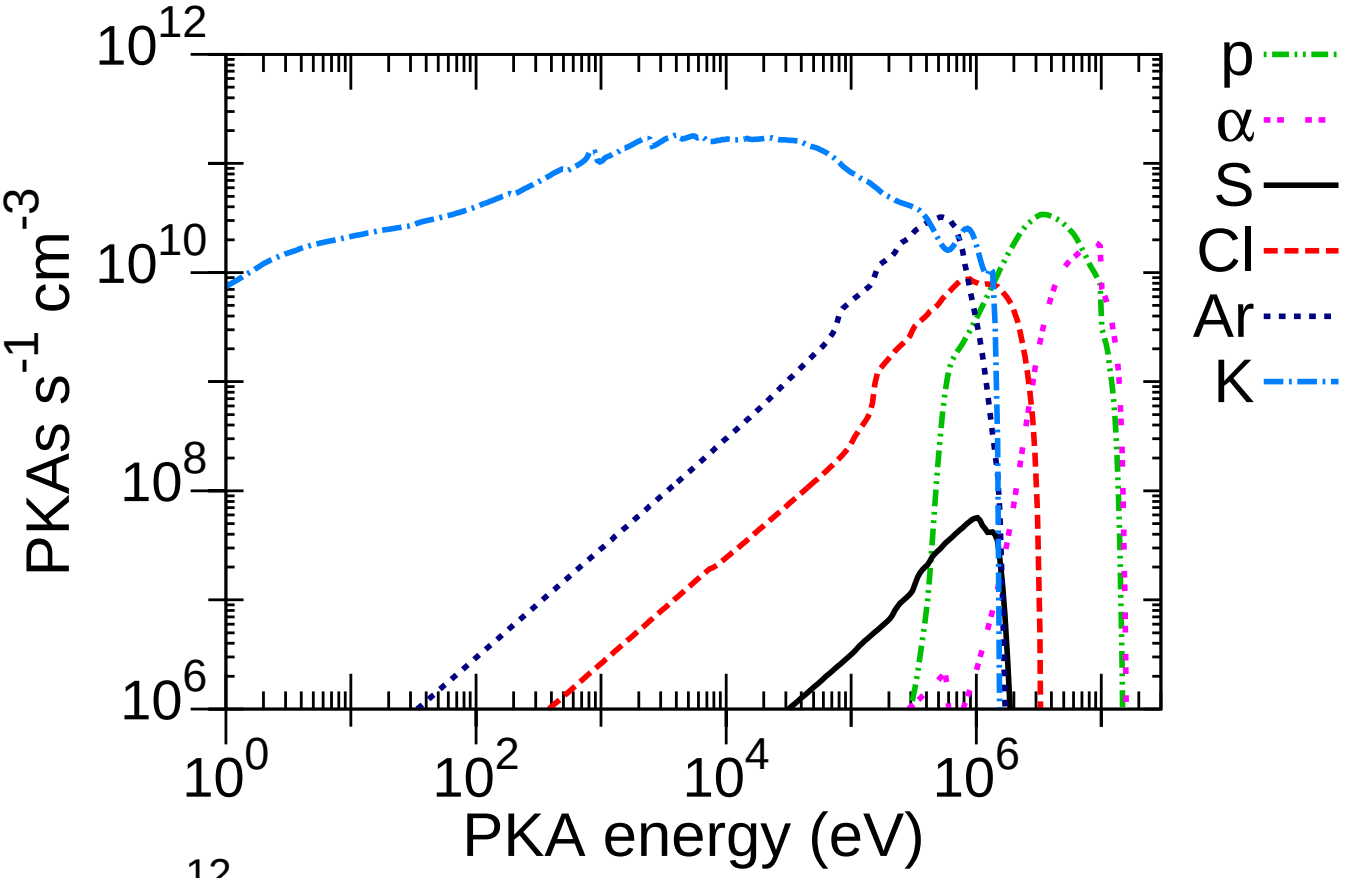
Potassium FW Transmutation

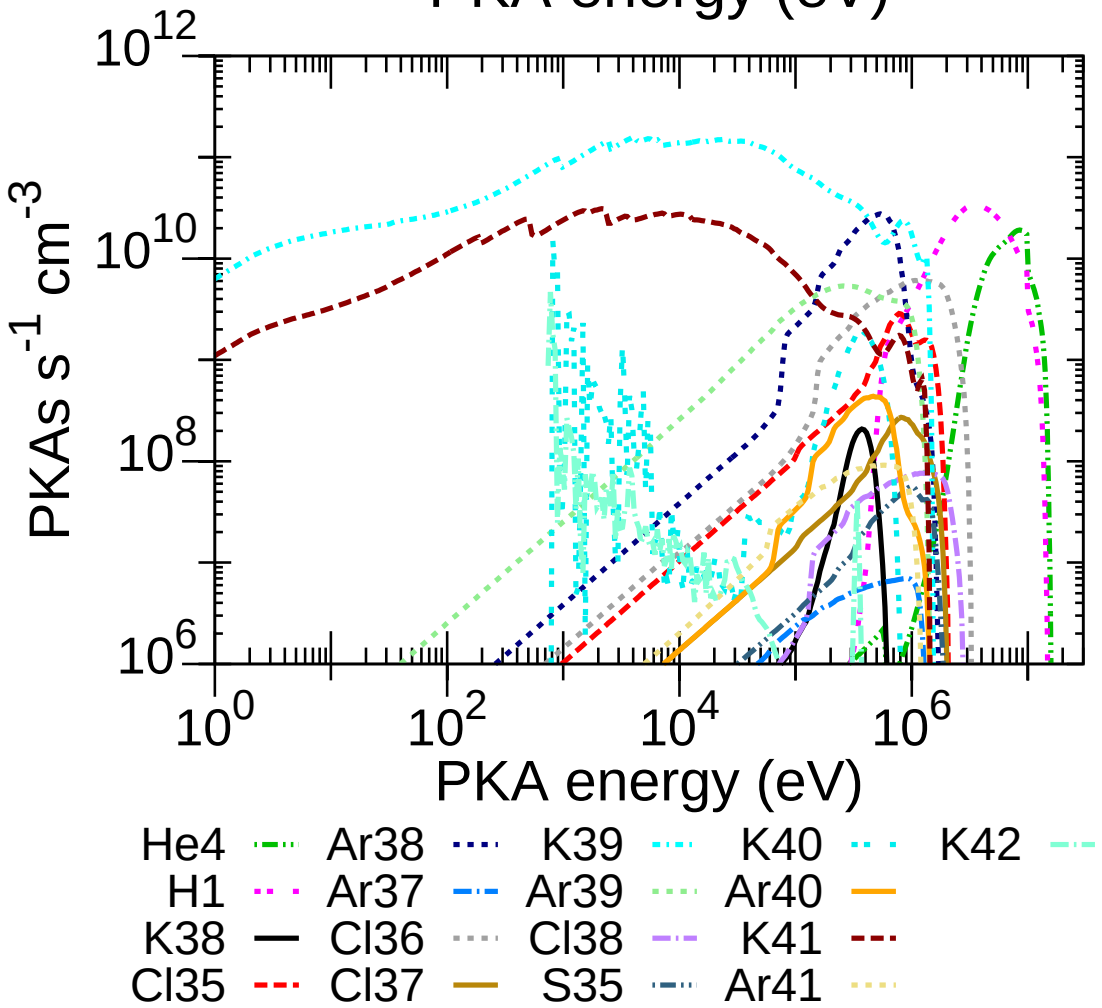


753 appm He & 2352 appm H after 1 year 18 dpa/year



Potassium FW PKA distributions





Potassium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cl38m	0.72s	K39(n,γ)K40(n,α)Cl37(n,γ)Cl38m	92.7	26.2		
		K39(n,α)Cl36(n,γ)Cl37(n,γ)Cl38m	7.2			
		K40(n,α)Cl37(n,γ)Cl38m		73.8	4.3	
		K41(n,α)Cl38m			95.1	40.7
		K39(n,np)Ar38(n,p)Cl38m				53.5
		K39(n,d)Ar38(n,p)Cl38m				2.9
K38m	0.92s	K39(n,2n)K38m				100.0
K38	7.61m	K39(n,2n)K38				100.0
Cl38	37.21m	K39(n,γ)K40(n,α)Cl37(n,γ)Cl38	83.1	23.0		
		K39(n,γ)K40(n,α)Cl37(n,γ)Cl38m(IT)Cl38	9.6	3.2		
		K39(n,α)Cl36(n,γ)Cl37(n,γ)Cl38	6.4			
		K40(n,α)Cl37(n,γ)Cl38		64.9		
		K40(n,α)Cl37(n,γ)Cl38m(IT)Cl38		8.9		
		K41(n,α)Cl38			99.7	28.8
		K39(n,np)Ar38(n,p)Cl38				44.7
		K39(n,np)Ar38(n,p)Cl38m(IT)Cl38				12.0
		K41(n,α)Cl38m(IT)Cl38				9.1
		K39(n,d)Ar38(n,p)Cl38				2.5
Ar41	1.83h	K39(n,γ)K40(n,p)Ar40(n,γ)Ar41	99.8	26.2		
		K40(n,p)Ar40(n,γ)Ar41		73.8		
		K41(n,p)Ar41			100.0	99.7
K42	12.36h	K41(n,γ)K42	54.6	100.0	100.0	99.7
		K39(n,γ)K40(n,γ)K41(n,γ)K42	45.2			
K43	22.20h	K41(n,γ)K42(n,γ)K43	54.7	100.0	99.6	42.2
		K39(n,γ)K40(n,γ)K41(n,γ)K42(n,γ)K43	45.1			
		K41(n,γ)K42(β^-)Ca42(n,γ)Ca43(n,p)K43				56.9
P32	14.27d	K39(n,α)Cl36(n,α)P33(β^-)S33(n,α)Si30(n,γ)Si31(β^-) P31(n,γ)P32	99.8		11.4	
		K41(n,α)Cl38(β^-)Ar38(n,α)S35(β^-)Cl35(n,α)P32			87.9	
		K39(n,nα)Cl35(n,α)P32				51.1
		K39(n,α)Cl36(n,nα)P32				41.7
		K39(n,α)Cl36(n,2n)Cl35(n,α)P32				2.0
		K39(n,np)Ar38(n,α)S35(β^-)Cl35(n,α)P32				1.6
		K39(n,pα)S35(β^-)Cl35(n,α)P32				1.0
P33	25.38d	K39(n,α)Cl36(n,α)P33	100.0	100.0	99.8	98.0
Ar37	35.03d	K39(n,α)Cl36(β^-)Ar36(n,γ)Ar37	100.0	98.0	98.7	
		K40(β^-)Ca40(n,α)Ar37		1.5	1.1	
		K39(n,np)Ar38(n,2n)Ar37				85.8
		K39(n,t)Ar37				8.1
		K39(n,d)Ar38(n,2n)Ar37				4.7
Sc46	83.79d	K41(n,γ)K42(β^-)Ca42(n,γ)Ca43(n,γ)Ca44(n,γ)Ca45(β^-) Sc45(n,γ)Sc46	71.8	75.5		
		K41(n,γ)K42(β^-)Ca42(n,γ)Ca43(n,γ)Ca44(n,γ)Ca45(β^-) Sc45(n,γ)Sc46m(IT)Sc46	21.0	19.4		
		K39(n,γ)K40(n,γ)K41(n,γ)K42(β^-)Ca42(n,γ)Ca43(n,γ) Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46	4.0			
		K41(n,γ)K42(n,γ)K43(β^-)Ca43(n,γ)Ca44(n,γ)Ca45(β^-) Sc45(n,γ)Sc46	1.5	3.9		
		K39(n,γ)K40(n,γ)K41(n,γ)K42(β^-)Ca42(n,γ)Ca43(n,γ) Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46m(IT)Sc46	1.2			
		K41(n,γ)K42(n,γ)K43(β^-)Ca43(n,γ)Ca44(n,γ)Ca45(β^-) Sc45(n,γ)Sc46m(IT)Sc46		1.0		
S35	87.32d	K39(n,α)Cl36(n,α)P33(β^-)S33(n,γ)S34(n,γ)S35	91.1			
		K39(n,α)Cl36(n,α)P33(n,γ)P34(β^-)S34(n,γ)S35	7.9			
		K41(n,α)Cl38(β^-)Ar38(n,α)S35			99.1	
		K39(n,np)Ar38(n,α)S35				53.8
		K39(n,pα)S35				17.3
		K39(n,α)Cl36(n,np)S35				15.4
		K39(n,nα)Cl35(n,p)S35				3.4
		K39(n,p)Ar39(n,nα)S35				3.0
		K39(n,d)Ar38(n,α)S35				3.0
		K39(n,α)Cl36(n,d)S35				2.3

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ca45	162.99d	K41(n,γ)K42(β^-)Ca42(n,γ)Ca43(n,γ)Ca44(n,γ)Ca45	90.5	96.5	99.7	
		K39(n,γ)K40(n,γ)K41(n,γ)K42(β^-)Ca42(n,γ)Ca43(n,γ) Ca44(n,γ)Ca45	7.9			
		K41(n,γ)K42(n,γ)K43(β^-)Ca43(n,γ)Ca44(n,γ)Ca45	1.3	3.5		
Na22	2.60y	no pathways found				
H3	12.33y	K39(n,γ)K40(n,p)H1(n,γ)H2(n,γ)H3	99.6	15.1		
		K40(n,p)H1(n,γ)H2(n,γ)H3		84.8		
		K39(n,p)H1(n,γ)H2(n,γ)H3			100.0	
		K39(n,t)H3				84.6
		K41(n,t)H3				10.5
		K39(n,α)Cl36(n,t)H3				3.1
Ar39	269.01y	K39(n,γ)K40(n,α)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39	83.5	13.3		
		K39(n,γ)K40(n,α)Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,γ)Ar39	9.6	1.8		
		K39(n,α)Cl36(n,γ)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39	5.9			
		K40(n,α)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39		74.6		
		K40(n,α)Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,γ)Ar39		10.3		
		K39(n,p)Ar39			100.0	99.4
Cl36	3.0 10^5y	K39(n,α)Cl36	100.0	100.0	100.0	99.9
K40	1.3 10^9y	K39(n,γ)K40	100.0	41.5	21.5	1.7
		K41(n,2n)K40				91.6

Calcium

Isotope	Atom % abundance
Ca40	96.94
Ca42	0.65
Ca43	0.14
Ca44	2.09
Ca46	< 0.01
Ca48	0.19

($T_{1/2}$ =5.3 10^{19}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.93E+14	2.93E+14	2.68E+14	5.32E+11	1.28E+11	2.37E+08
Ar37	96.5	96.7	98.4	39.6		
Ar39	0.1	0.1	0.1	31.0	99.8	
Ca45	0.2	0.2	0.3	28.7		
Ca41					0.2	91.9
Cl36						7.8

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.35E-03	2.16E-03	5.04E-04	7.77E-06	4.48E-06	9.88E-10
K42	24.6	26.6	0.8			
K44	23.7	21.8				
Ca47	22.5	24.4	59.9			
Ar41	8.2	8.6				
Ca49	6.0	4.2				
Sc47	4.3	4.7	17.4			
Ar37	4.2	4.6	18.2	0.9		
K43	1.8	1.9	0.5			
Sc49	1.2	1.3				
P34	1.0					
Ca45	0.4	0.4	1.7	24.3		
Ar39	0.2	0.3	1.1	74.3	100.0	
Cl36						82.2
Ca41						11.6
K40						6.2

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.05E+03	1.84E+03	4.11E+02	3.56E-02	3.71E-05	3.13E-05
Ca47	32.9	36.5	93.8			
K44	30.5	28.7				
Ar41	11.9	12.8				
Ca49	10.6	7.7				
K42	8.2	9.0	0.3	0.1	15.0	
K43	1.9	2.1	0.6			
S37	1.5	0.8				
Sc47	1.1	1.2	4.6			
Sc46			0.2	94.8		
Ar37	0.1	0.1	0.5	5.0		
K40				0.1	75.2	89.1
Ca41					9.7	10.7

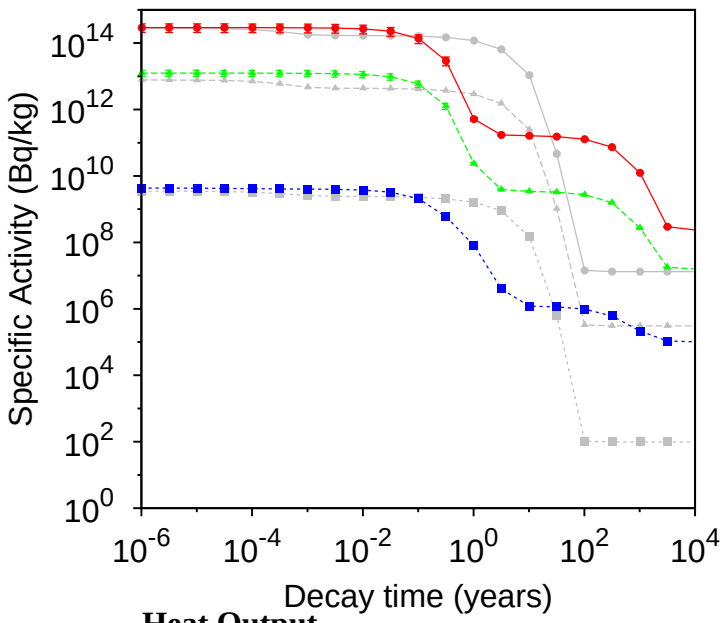
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.08E+06	3.08E+06	2.79E+06	1.84E+05	1.41E+05	6.25E-02
Ar37	91.0	91.1	93.4	1.1		
Ar39	5.9	5.9	6.5	98.8	100.0	
Ar41	2.9	2.8				
Ca41						66.2
Cl36						27.6
K40						6.2

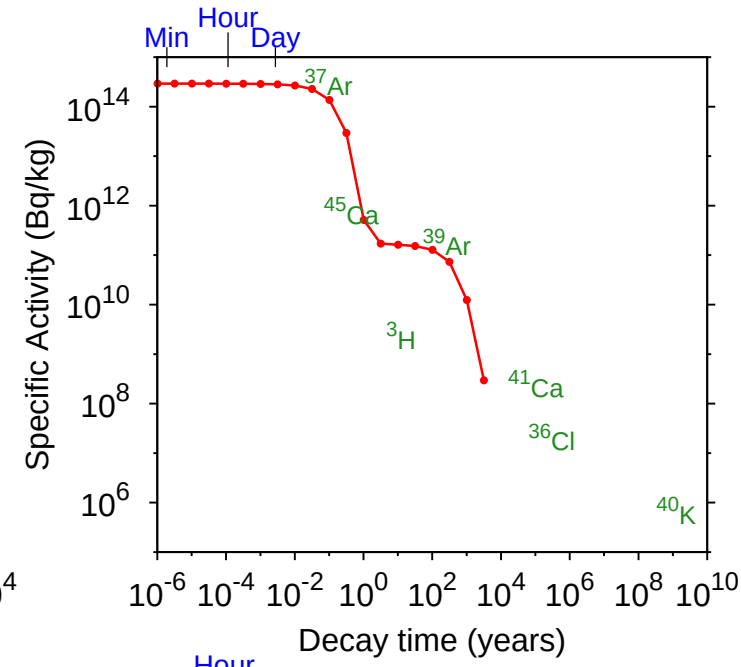
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.71E+07	1.71E+07	1.63E+07	6.27E+06	4.85E+06	1.76E-01
Ar37	62.9	62.9	61.4	0.1		
Ar39	36.8	36.8	38.6	99.9	100.0	
Cl36						77.0
Ca41						22.2

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	4.99E+09	4.27E+09	3.30E+08	1.10E+07	6.74E+06	1.88E+04
K44	46.6	46.3				
Ar41	18.4	20.8				
Ca49	14.0	10.7				
Ca47	4.7	5.5	40.6			
K42	4.3	5.0	0.5			
K43	4.1	4.8	4.0			
Ar37	2.8	3.3	39.8	1.0		
S37	2.0	1.1				
Sc47	0.5	0.5	6.1			
Sc46	0.3	0.3	4.0	6.0		
Ar39	0.2	0.2	2.6	78.7	99.7	
Ca45	0.1	0.2	2.2	13.9		
Cl36				0.2	0.3	98.8

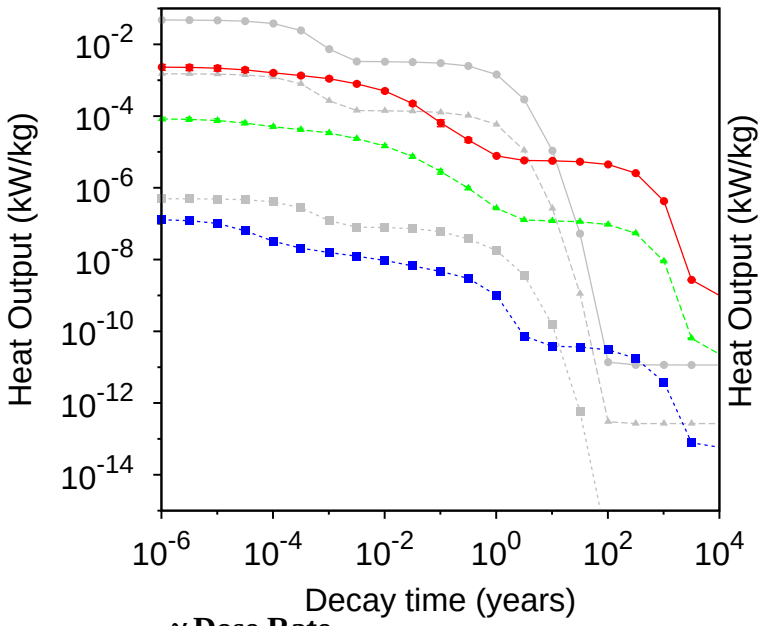
Calcium activation characteristics

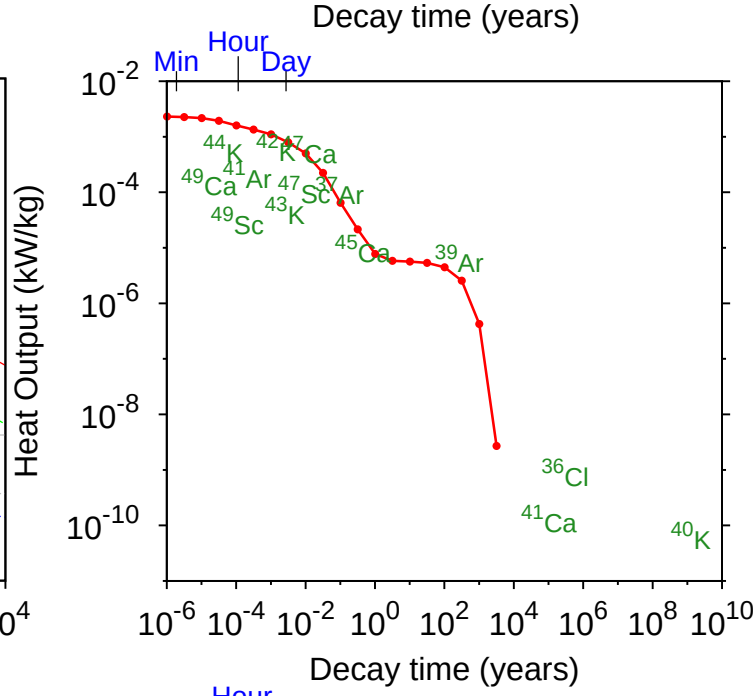
Specific Activity



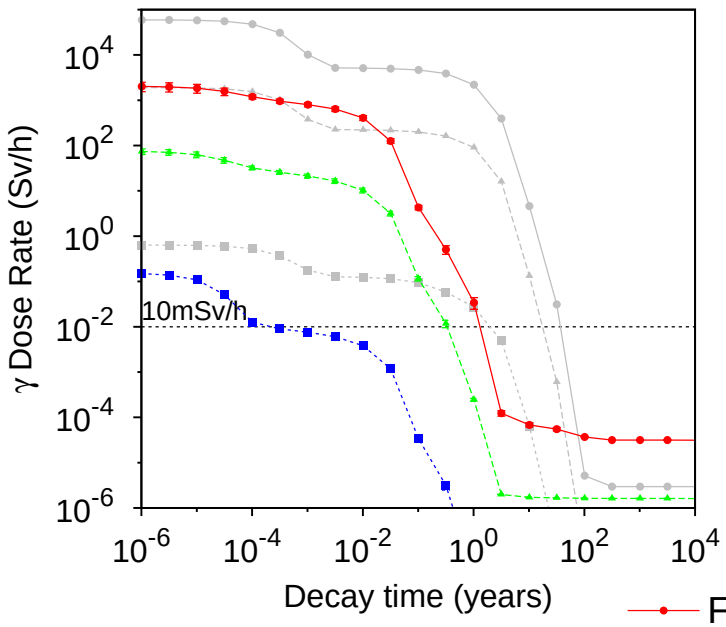


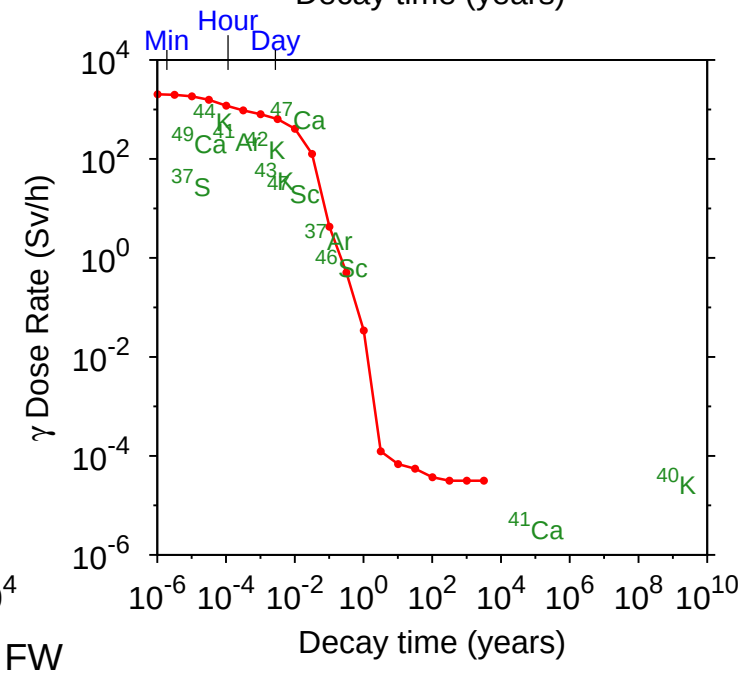
Heat Output





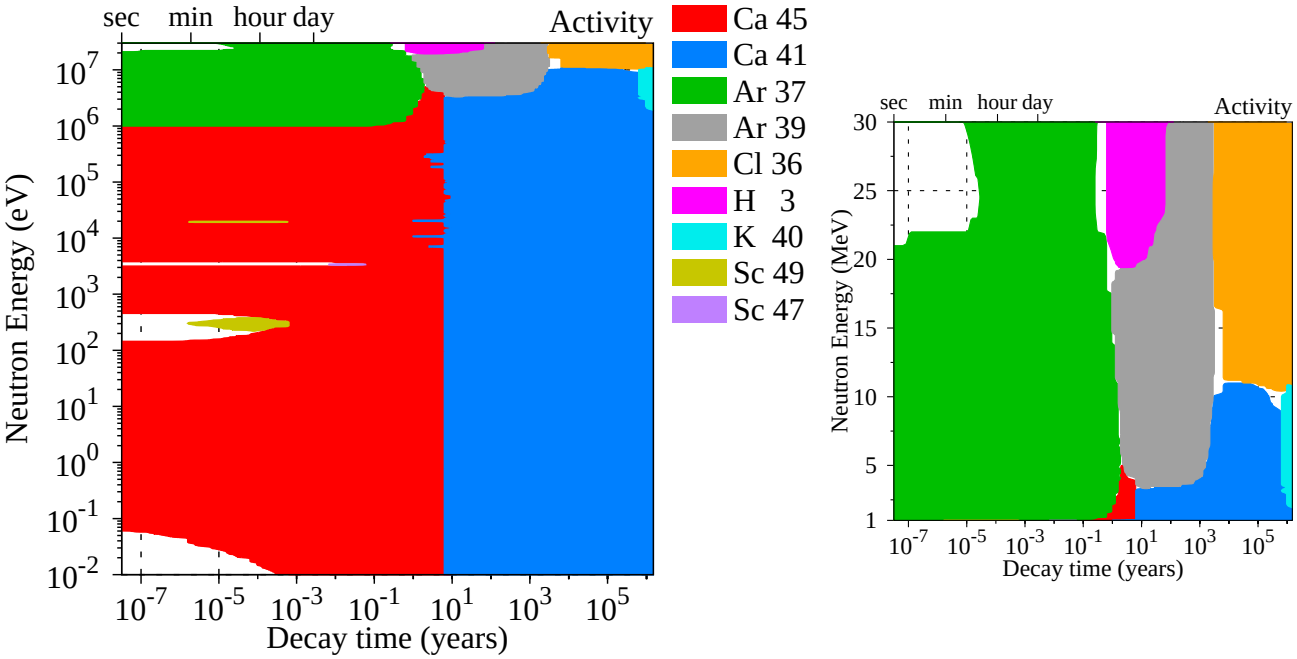
γ Dose Rate

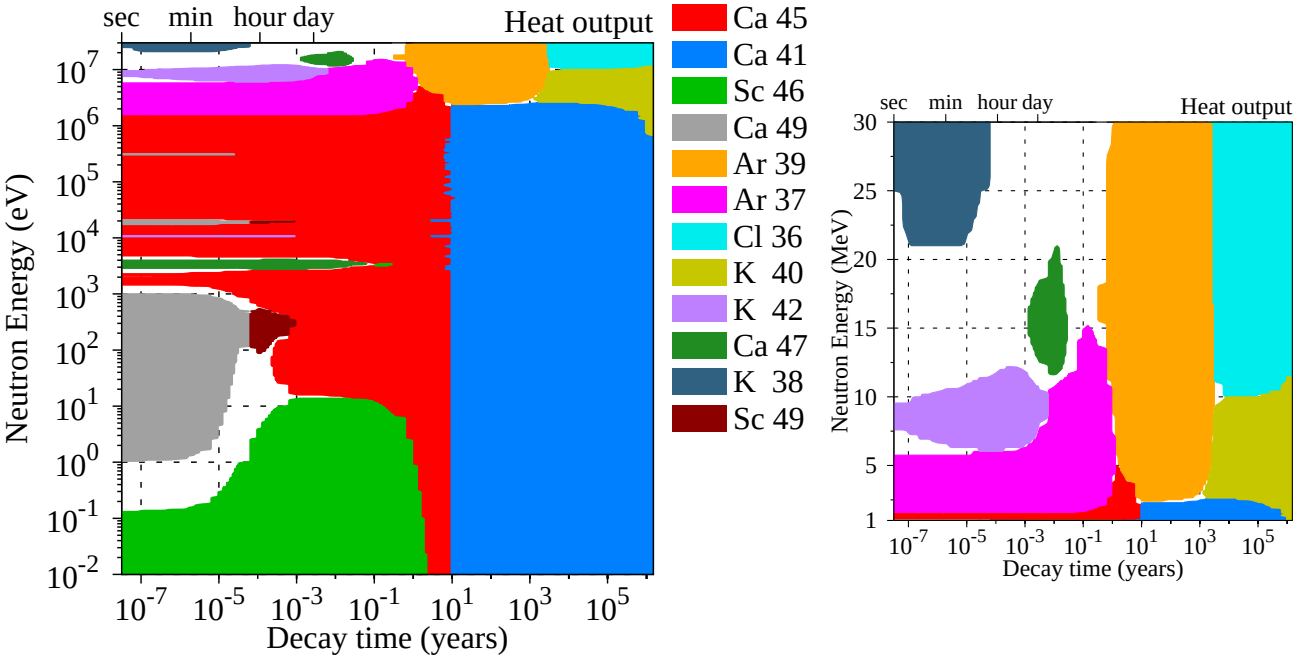


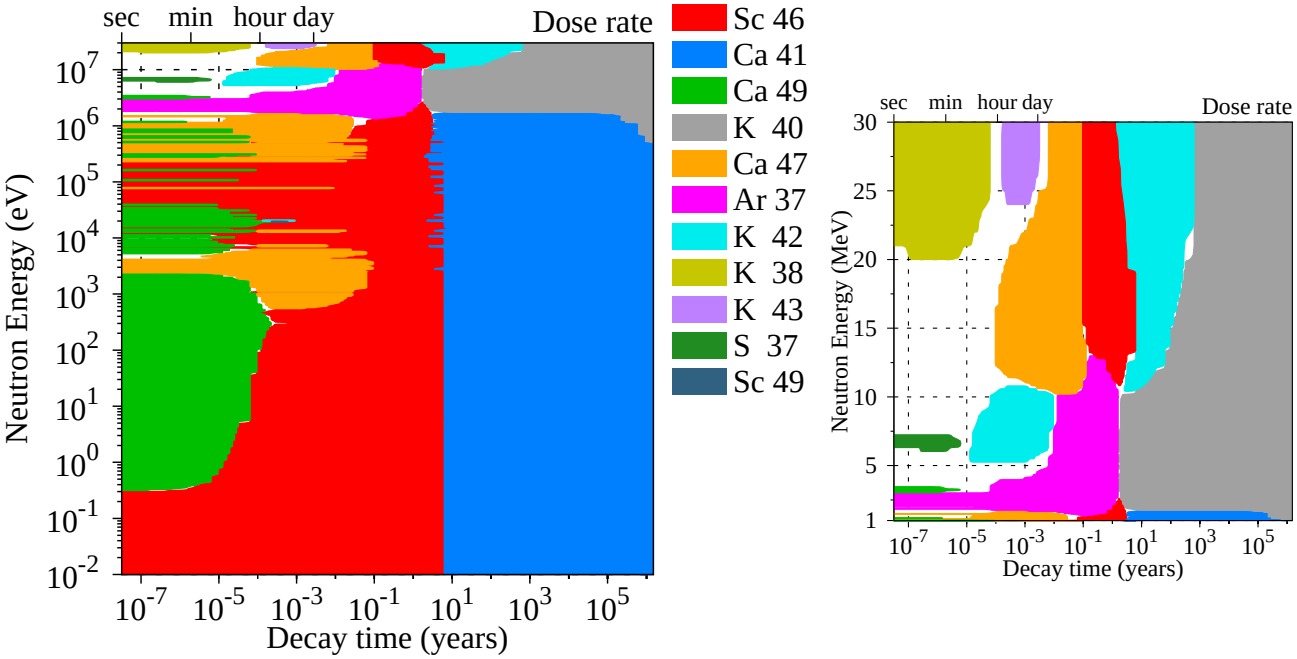


FW
Blanket
Manifold
Fe results

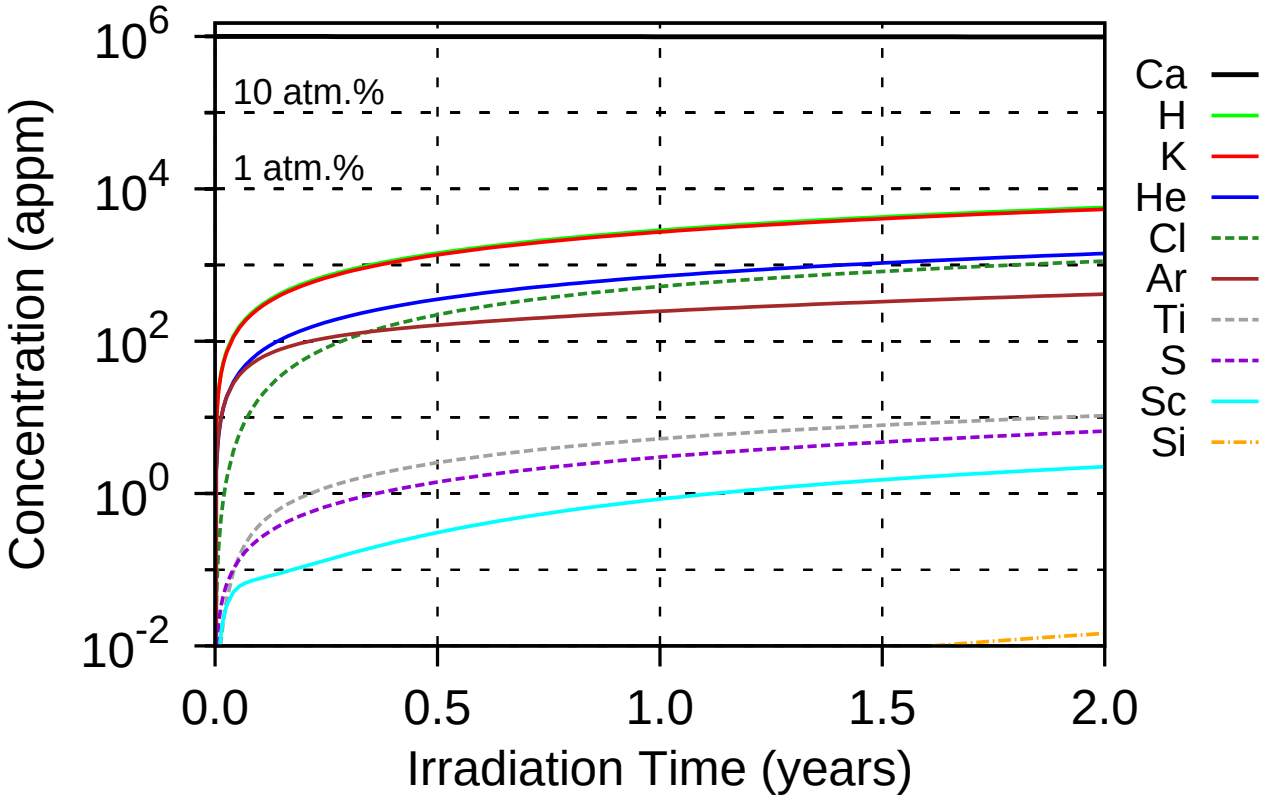
Calcium Importance diagrams



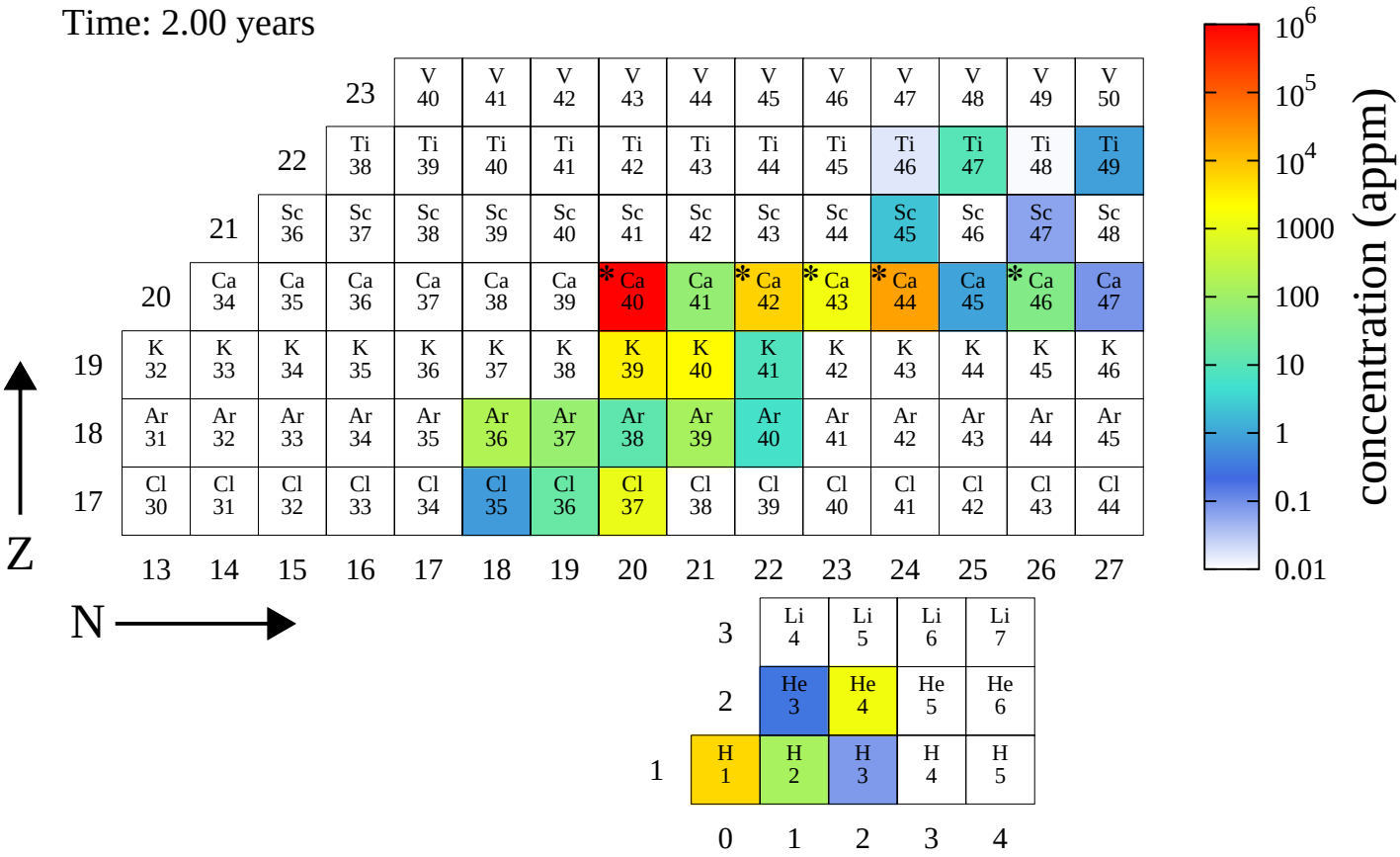




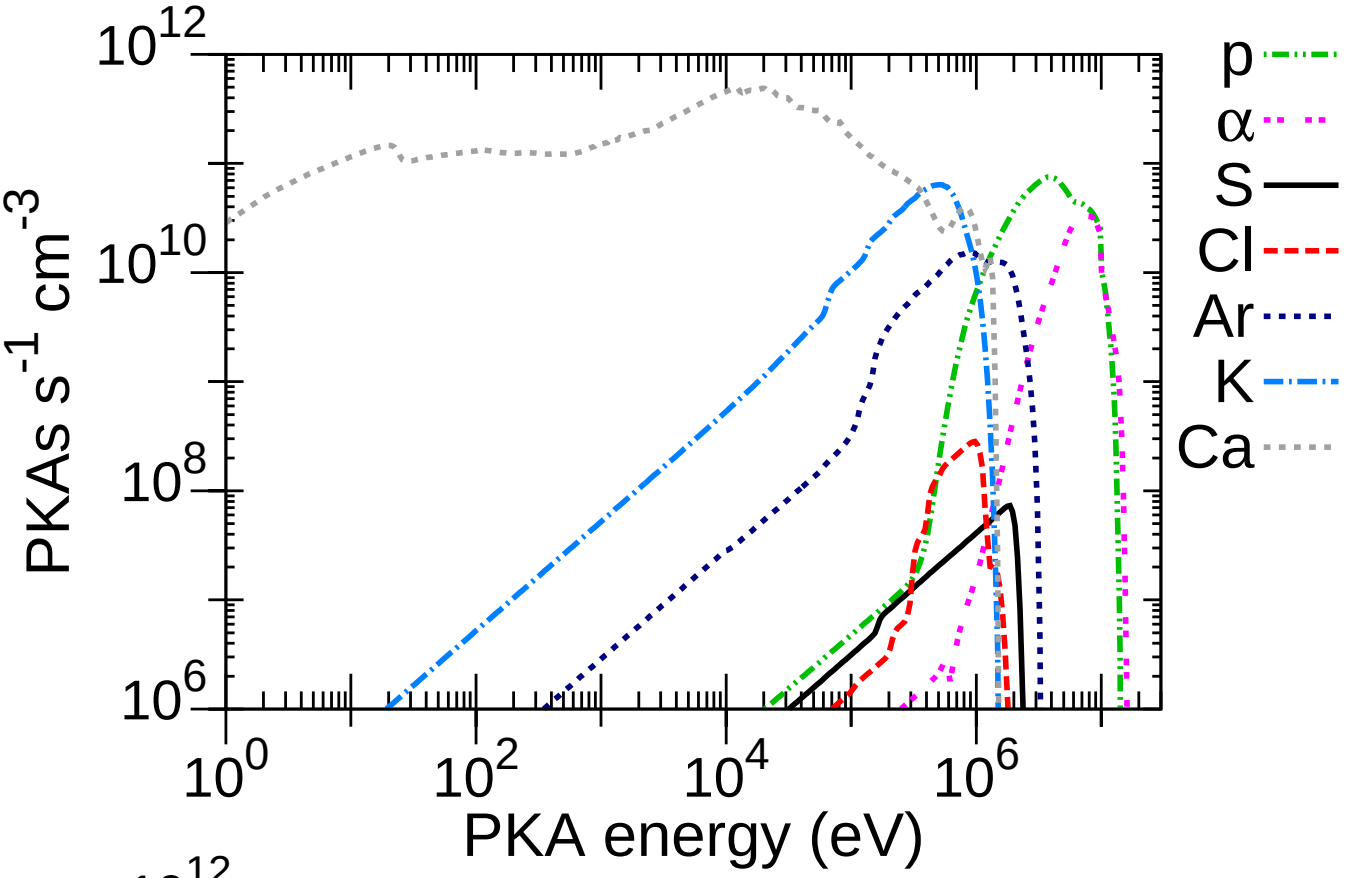
Calcium FW Transmutation

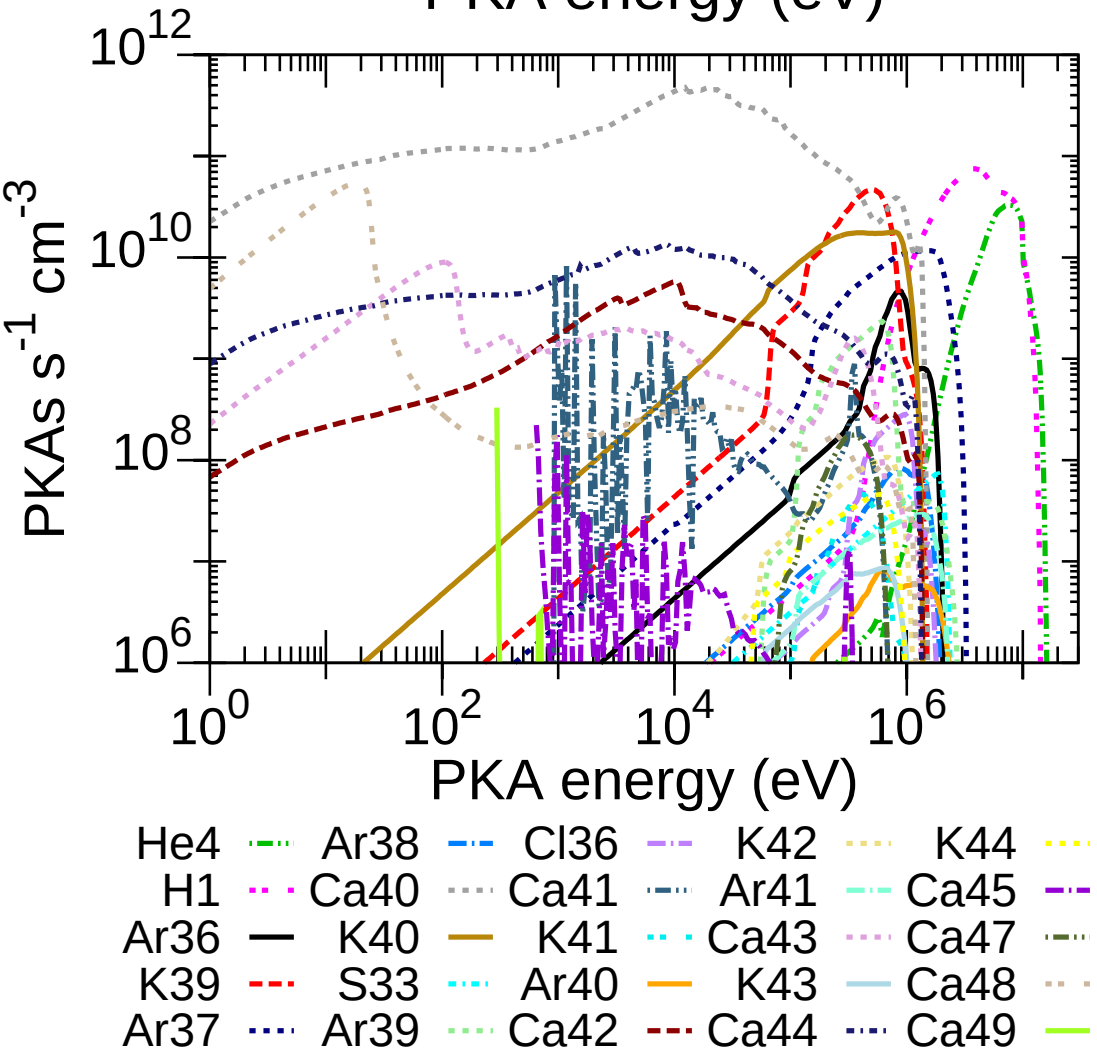


709 appm He & 2861 appm H after 1 year 13 dpa/year



Calcium FW PKA distributions





Calcium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
P34	12.40s	Ca40(n,α)Ar37(β^+)Cl37(n,α)P34			99.1	98.2
		Ca40(n,p)K40(n,α)Cl37(n,α)P34				1.1
S37	4.99m	Ca40(n,α)Ar37(n,α)S34(n,γ)S35(n,γ)S36(n,γ)S37	92.1			
		Ca40(n,α)Ar37(n,α)S34(n,γ)S35(β^-)Cl35(n,γ)Cl36(n,p) S36(n,γ)S37	7.2			
		Ca40(n,α)Ar37(β^+)Cl37(n,p)S37				98.2
		Ca40(n,p)K40(n,α)Cl37(n,p)S37				1.1
K38	7.61m	Ca40(n,np)K39(n,2n)K38				95.3
		Ca40(n,d)K39(n,2n)K38				4.2
Ca49	8.72m	Ca48(n,γ)Ca49	100.0	100.0	100.0	100.0
K44	22.13m	Ca40(n,γ)Ca41(n,p)K41(n,γ)K42(n,γ)K43(n,γ)K44	96.7			
		Ca40(n,γ)Ca41(β^+)K41(n,γ)K42(n,γ)K43(n,γ)K44	3.2			
		Ca43(n,p)K43(n,γ)K44			99.8	
		Ca44(n,p)K44				99.8
Sc49	57.19m	Ca48(n,γ)Ca49(β^-)Sc49	100.0	100.0	100.0	99.8
Ar41	1.83h	Ca40(n,γ)Ca41(n,α)Ar38(n,γ)Ar39(n,γ)Ar40(n,γ)Ar41	67.5			
		Ca40(n,α)Ar37(β^+)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39(n,γ) Ar40(n,γ)Ar41	11.1			
		Ca43(n,α)Ar40(n,γ)Ar41	9.7	98.9	1.8	
		Ca40(n,α)Ar37(n,γ)Ar38(n,γ)Ar39(n,γ)Ar40(n,γ)Ar41	5.9			
		Ca40(n,α)Ar37(n,p)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39(n,γ) Ar40(n,γ)Ar41	3.1			
		Ca40(n,α)Ar37(β^+)Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,γ) Ar39(n,γ)Ar40(n,γ)Ar41	1.3			
		Ca42(n,γ)Ca43(n,α)Ar40(n,γ)Ar41	1.0			
		Ca40(n,p)K40(n,p)Ar40(n,γ)Ar41			98.0	
		Ca44(n,α)Ar41				99.3
K42	12.36h	Ca40(n,γ)Ca41(n,p)K41(n,γ)K42	96.8	98.6	69.5	
		Ca40(n,γ)Ca41(β^+)K41(n,γ)K42	3.2	1.4		
		Ca40(n,p)K40(n,γ)K41(n,γ)K42			30.3	
		Ca42(n,p)K42				97.6
K43	22.20h	Ca40(n,γ)Ca41(n,p)K41(n,γ)K42(n,γ)K43	96.7	98.6		
		Ca40(n,γ)Ca41(β^+)K41(n,γ)K42(n,γ)K43	3.2	1.4		
		Ca43(n,p)K43			99.8	60.8
		Ca44(n,2n)Ca43(n,p)K43				28.3
		Ca44(n,d)K43				6.4
		Ca44(n,np)K43				3.9
Sc47	3.35d	Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46(n,γ)Sc47	60.8	31.5		
		Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46m(IT)Sc46(n,γ)Sc47	17.8	8.1		
		Ca44(n,γ)Ca45(n,γ)Ca46(n,γ)Ca47(β^-)Sc47	16.7			
		Ca46(n,γ)Ca47(β^-)Sc47	3.8	60.4	99.9	
		Ca48(n,2n)Ca47(β^-)Sc47				99.2
Ca47	4.54d	Ca44(n,γ)Ca45(n,γ)Ca46(n,γ)Ca47	80.8			
		Ca46(n,γ)Ca47	18.4	100.0	100.0	
		Ca48(n,2n)Ca47				100.0
Ar37	35.03d	Ca40(n,α)Ar37	100.0	100.0	100.0	99.9
Sc46	83.79d	Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46	76.7	79.5	85.2	
		Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46m(IT)Sc46	22.4	20.5	13.8	
		Ca48(n,2n)Ca47(β^-)Sc47(β^-)Ti47(n,np)Sc46				61.6
		Ca48(n,2n)Ca47(β^-)Sc47(n,2n)Sc46				11.1
		Ca48(n,2n)Ca47(β^-)Sc47(β^-)Ti47(n,np)Sc46m(IT)Sc46				8.2
		Ca48(n,2n)Ca47(β^-)Sc47(β^-)Ti47(n,2n)Ti46(n,p)Sc46				6.2
		Ca48(n,2n)Ca47(β^-)Sc47(β^-)Ti47(n,d)Sc46				6.1
		Ca48(n,2n)Ca47(β^-)Sc47(β^-)Ti47(n,2n)Ti46(n,p) Sc46m(IT)Sc46				2.3
		Ca48(n,2n)Ca47(β^-)Sc47(n,2n)Sc46m(IT)Sc46				1.8
		Ca48(n,2n)Ca47(β^-)Sc47(β^-)Ti47(n,d)Sc46m(IT)Sc46				1.6
Ca45	162.99d	Ca44(n,γ)Ca45	98.3	100.0	99.9	31.3
		Ca43(n,γ)Ca44(n,γ)Ca45	1.6			
		Ca46(n,2n)Ca45				68.1

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
H3	12.33y	Ca40(n,α)Ar37(n,p)H1(n,γ)H2(n,γ)H3	92.0			
		Ca40(n,γ)Ca41(n,p)H1(n,γ)H2(n,γ)H3	8.0			
		Ca40(n,p)H1(n,γ)H2(n,γ)H3			99.9	
		Ca40(n,p)K40(n,t)H3				77.5
		Ca40(n,np)K39(n,t)H3				12.8
		Ca40(n,α)Ar37(β^+)Cl37(n,t)H3				4.5
Ar39	269.01y	Ca40(n,γ)Ca41(n,α)Ar38(n,γ)Ar39	76.1	100.0		
		Ca40(n,α)Ar37(β^+)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39	13.4			
		Ca40(n,α)Ar37(n,γ)Ar38(n,γ)Ar39	4.8			
		Ca40(n,α)Ar37(n,p)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39	3.7			
		Ca40(n,α)Ar37(β^+)Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,γ)Ar39	1.5			
		Ca42(n,α)Ar39			100.0	2.4
		Ca40(n,2p)Ar39				81.9
		Ca40(n,p)K40(n,np)Ar39				8.1
		Ca40(n,np)K39(n,p)Ar39				6.4
Ca41	1.0 10^5y	Ca40(n,γ)Ca41	100.0	100.0	100.0	36.0
		Ca42(n,2n)Ca41				63.3
Cl36	3.0 10^5y	Ca40(n,α)Ar37(n,α)S34(n,γ)S35(β^-)Cl35(n,γ)Cl36	99.7		1.4	
		Ca42(n,α)Ar39(β^-)K39(n,α)Cl36			98.5	
		Ca40(n,np)K39(n,α)Cl36				33.9
		Ca40(n,pα)Cl36				29.5
		Ca40(n,α)Ar37(β^+)Cl37(n,2n)Cl36				23.6
		Ca40(n,p)K40(n,nα)Cl36				5.9
		Ca40(n,nα)Ar36(n,p)Cl36				3.1
		Ca40(n,α)Ar37(n,np)Cl36				1.9
		Ca40(n,d)K39(n,α)Cl36				1.5
K40	1.3 10^9y	Ca40(n,γ)Ca41(n,α)Ar38(n,γ)Ar39(β^-)K39(n,γ)K40	75.2	100.0		
		Ca40(n,α)Ar37(β^+)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39(β^-) K39(n,γ)K40	11.9			
		Ca40(n,α)Ar37(n,γ)Ar38(n,γ)Ar39(β^-)K39(n,γ)K40	7.8			
		Ca40(n,α)Ar37(n,p)Cl37(n,γ)Cl38(β^-)Ar38(n,γ)Ar39(β^-) K39(n,γ)K40	3.3			
		Ca40(n,α)Ar37(β^+)Cl37(n,γ)Cl38m(IT)Cl38(β^-)Ar38(n,γ) Ar39(β^-)K39(n,γ)K40	1.4			
		Ca40(n,p)K40			100.0	100.0

Scandium

Isotope	Atom % abundance
Sc45	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.03E+15	9.39E+14	5.49E+14	4.25E+13	1.91E+08	4.91E+05
Sc45m	49.9					
Sc46	17.5	37.9	62.9	40.9		
Sc44	13.9	29.8	8.1			
Sc44m	5.8	12.6	7.7			
Ca45	5.8	12.6	21.2	59.0		
Sc46m	3.8					
K42	3.2	7.0	0.1		5.5	
H3				0.1	47.8	
Ar39					41.0	
Ar42					5.5	
Ca41					0.3	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.74E-01	2.69E-01	1.41E-01	6.22E-03	6.06E-09	2.58E-13
Sc44	45.1	45.6	13.9			
Sc46	44.2	45.0	83.5	95.0		
K42	6.5	6.6	0.1		46.8	
Sc44m	2.1	2.2	1.5			
Ca45	0.5	0.5	1.0	5.0		
Ar39					45.4	
Ar42					6.4	
H3					1.4	
Ca41						99.9

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	3.53E+05	3.51E+05	2.13E+05	9.44E+03	8.77E-04	7.34E-09
Sc46	54.8	55.1	88.1	100.0		
Sc44	42.0	41.8	11.0			
K42	1.6	1.6			100.0	
Sc44m	1.5	1.5	0.9			
Ca41						98.6
K40						1.4

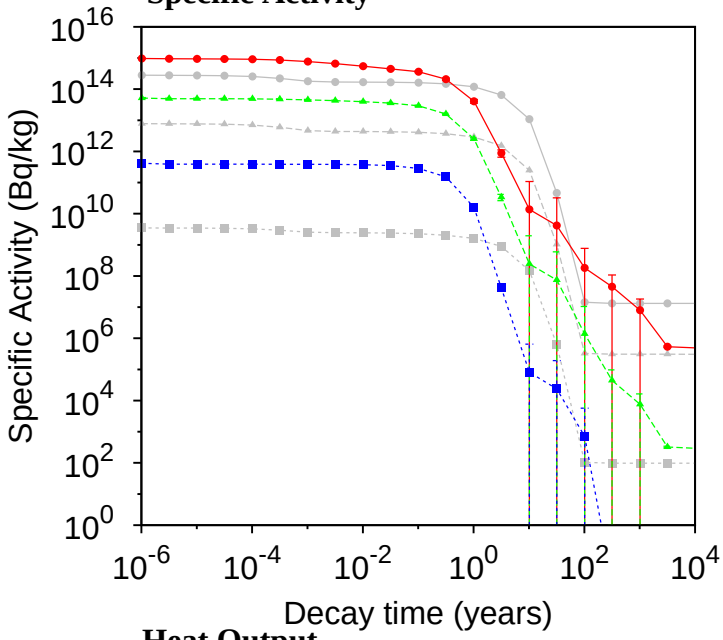
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.04E+06	1.04E+06	7.18E+05	4.43E+04	1.28E+02	9.32E-05
Sc46	51.2	51.3	72.1	58.9		
Sc44m	27.3	27.3	14.1			
Sc44	9.5	9.4	2.2			
Ca45	8.1	8.1	11.5	40.1		
K42	2.7	2.7				
Ar41	1.1	1.0				
Ar39				0.3	67.4	
Ar42				0.7	32.6	
Ca41						100.0

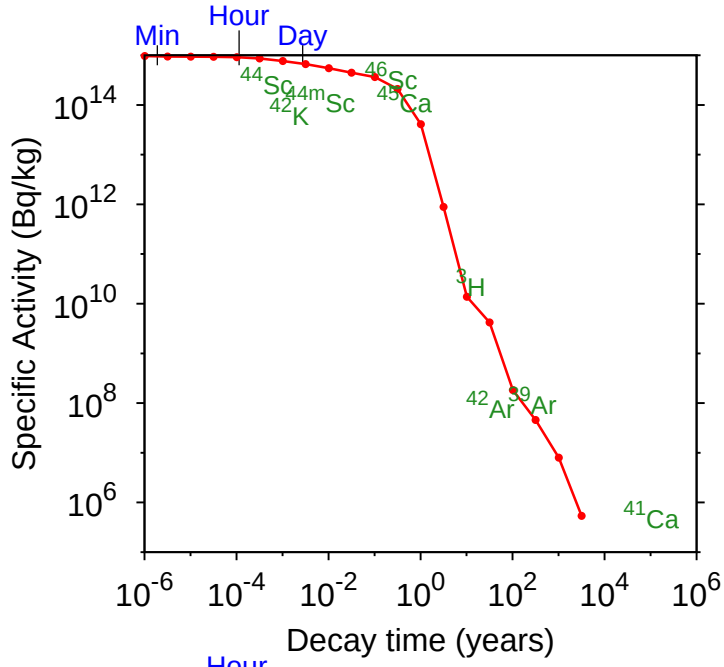
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.11E+06	3.11E+06	2.86E+06	2.28E+05	4.65E+03	8.84E-05
Sc46	77.9	77.9	82.0	51.9		
Ca45	14.1	14.1	15.1	40.7		
Sc44m	5.3	5.3	2.1			
Sc44	1.6	1.6	0.3			
Ar42	0.4	0.4	0.5	5.8	35.9	
Ar39	0.1	0.1	0.1	1.7	64.1	0.1
Ca41						99.9

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	4.22E+12	4.21E+12	3.56E+12	1.74E+11	8.17E+03	3.53E-01
Sc46	84.3	84.6	96.9	99.9		
Sc44	14.5	14.4	2.7			
Ar39					50.5	
Ar42					25.5	
K42	0.2	0.2			12.8	
H3					11.2	
Ca41						99.1

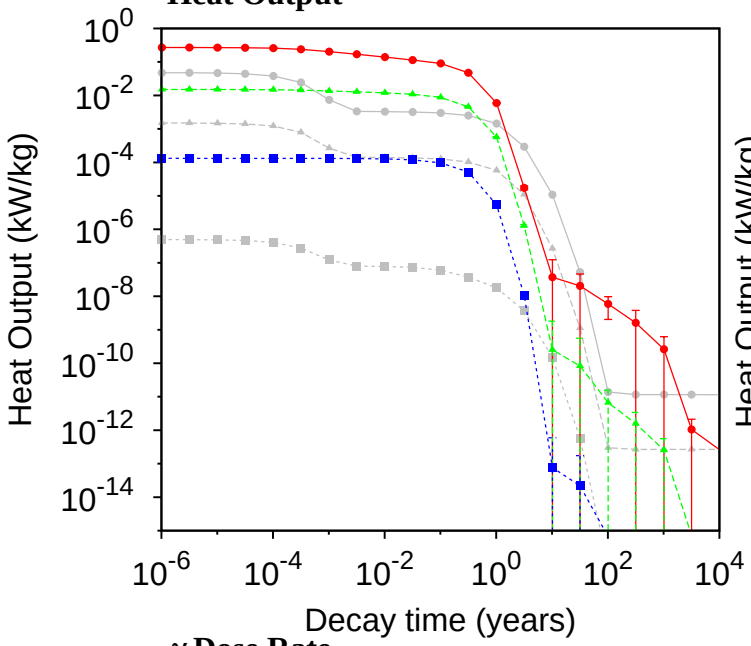
Scandium activation characteristics

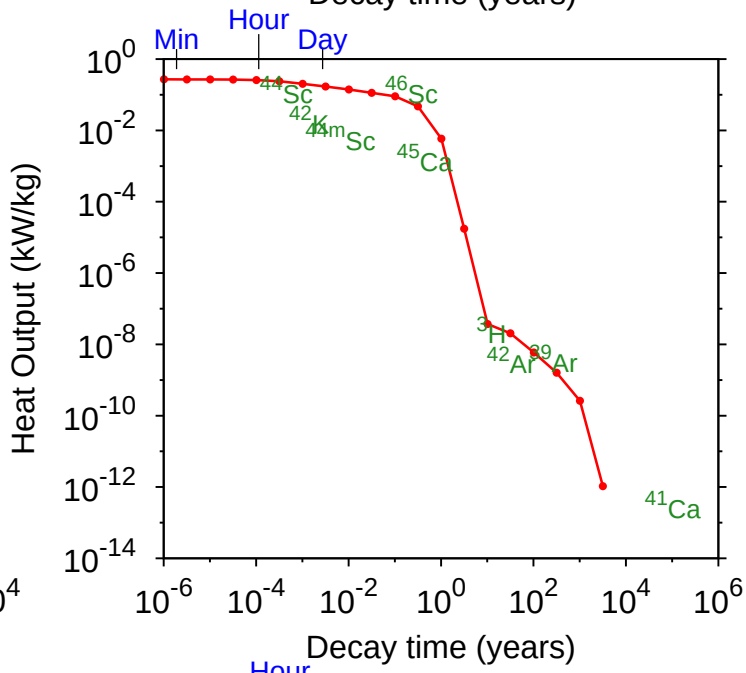
Specific Activity



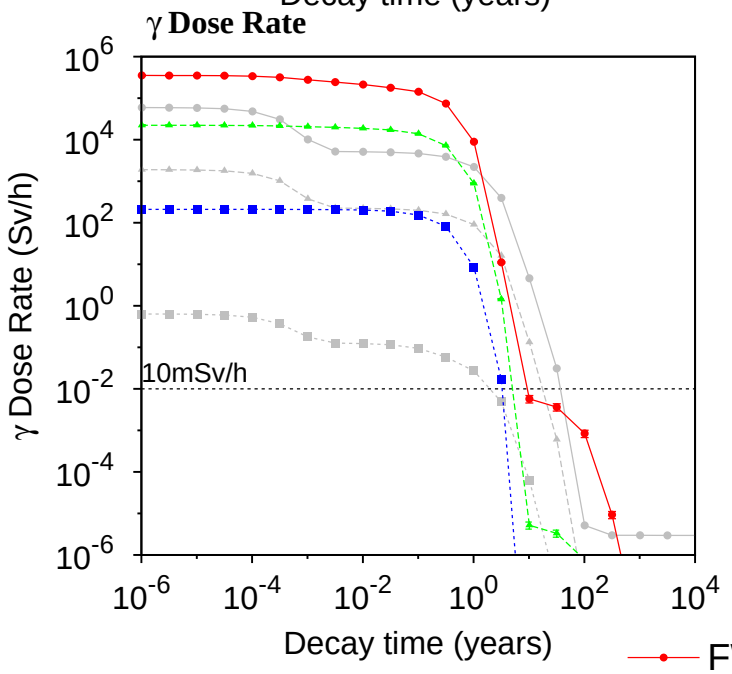


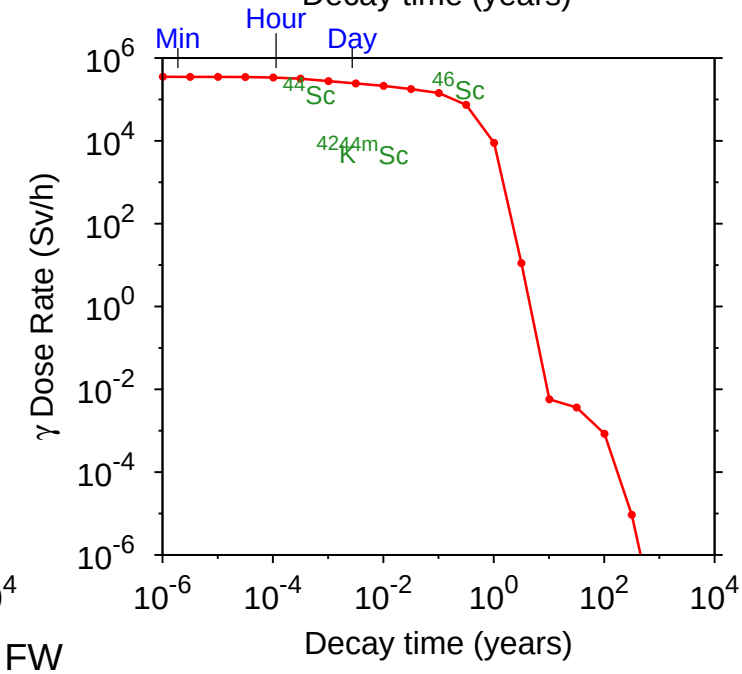
Heat Output





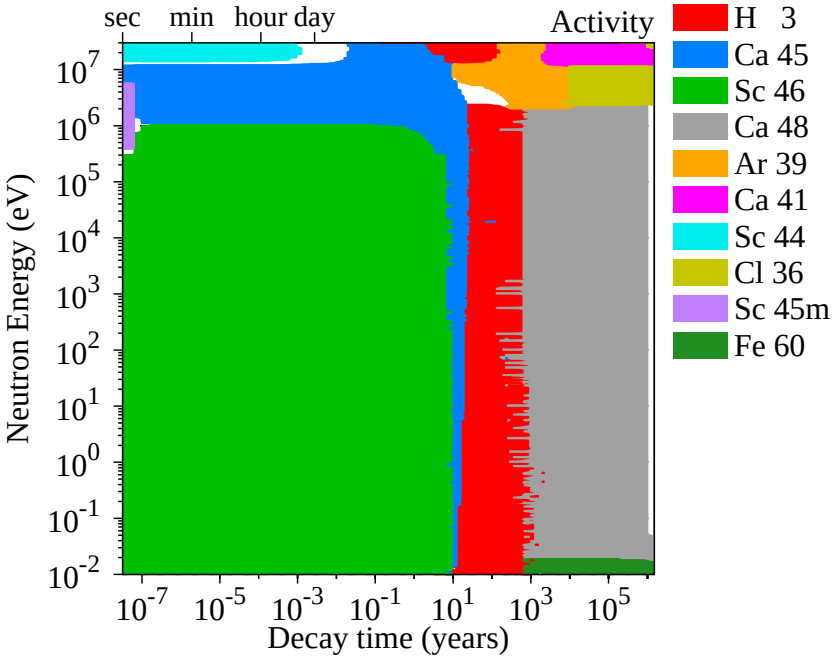
γ Dose Rate

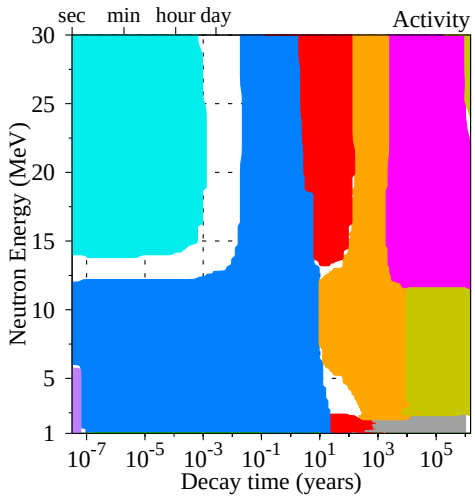


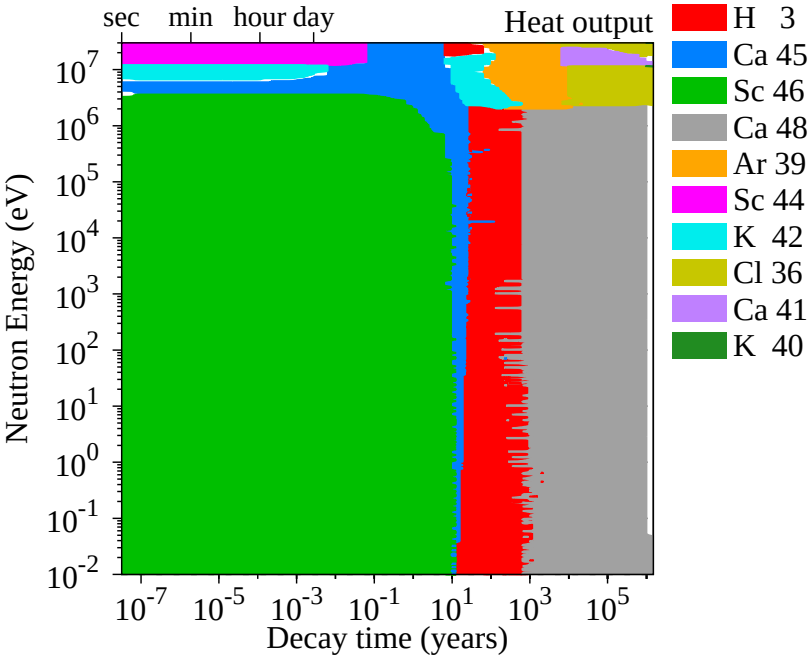


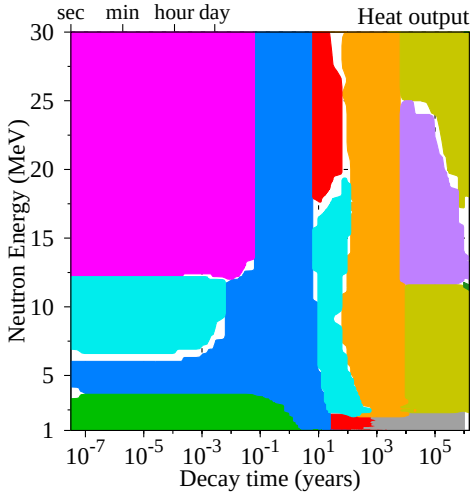
FW
Blanket
Manifold
Fe results

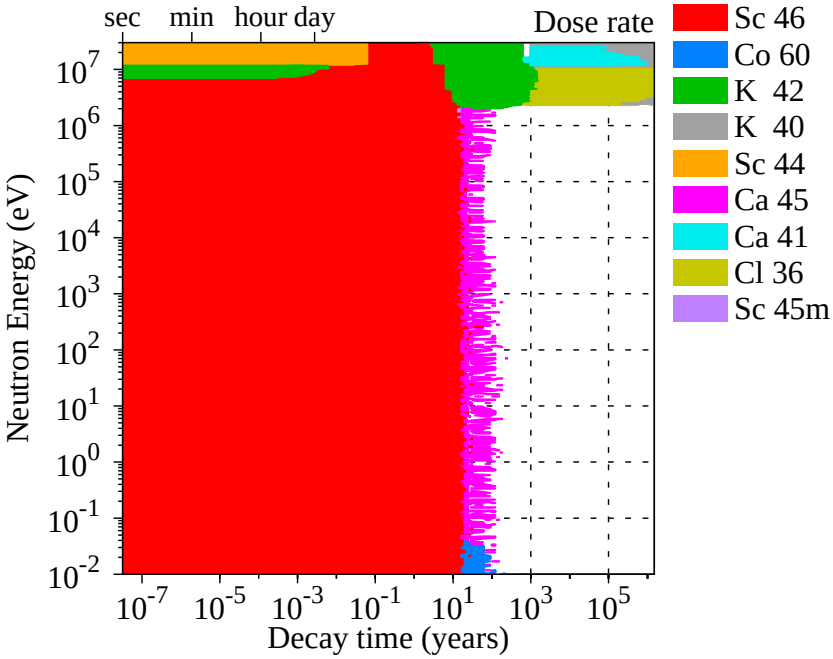
Scandium Importance diagrams

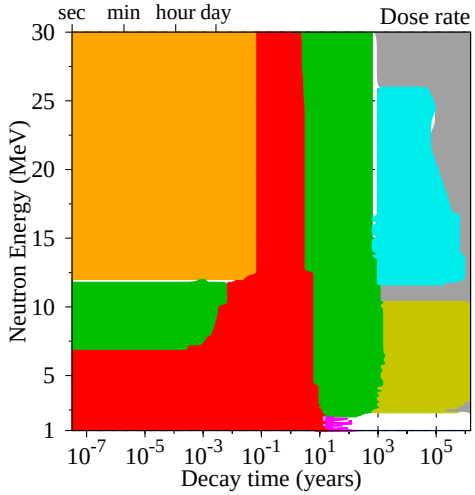




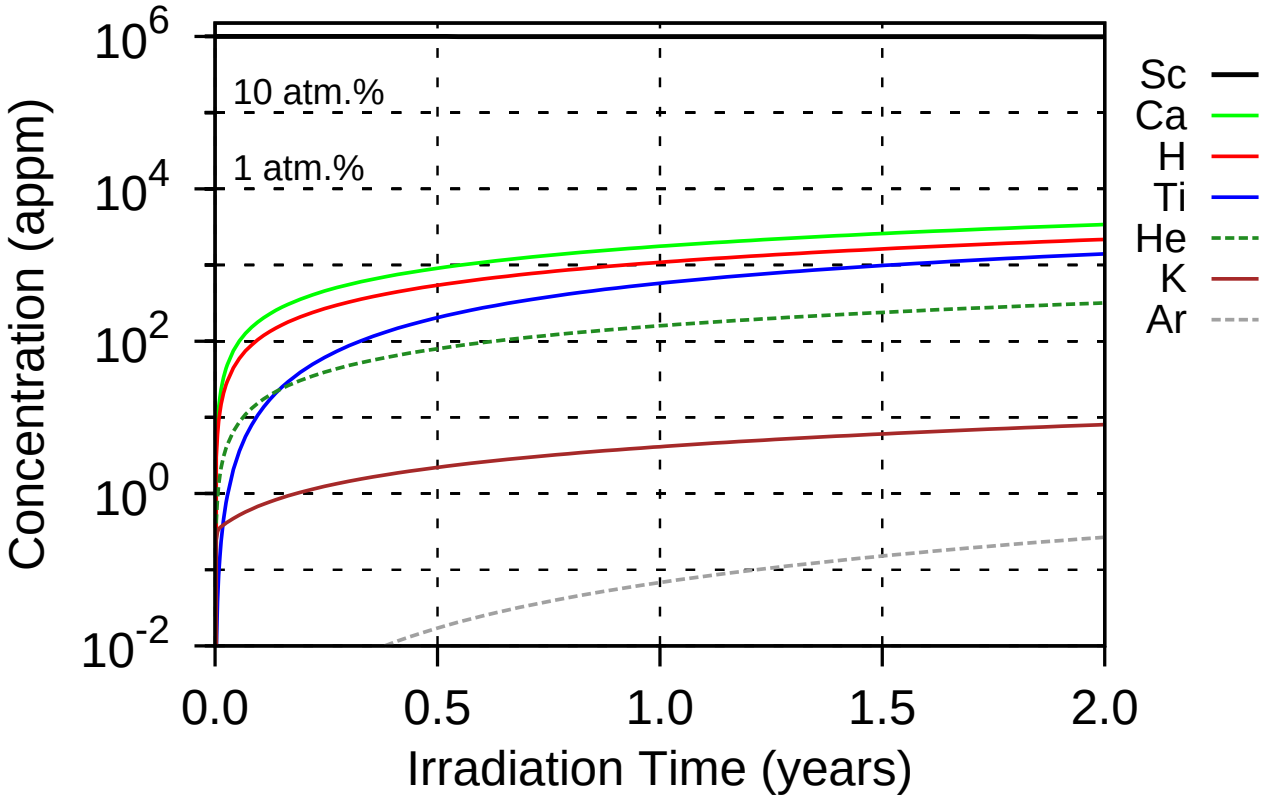




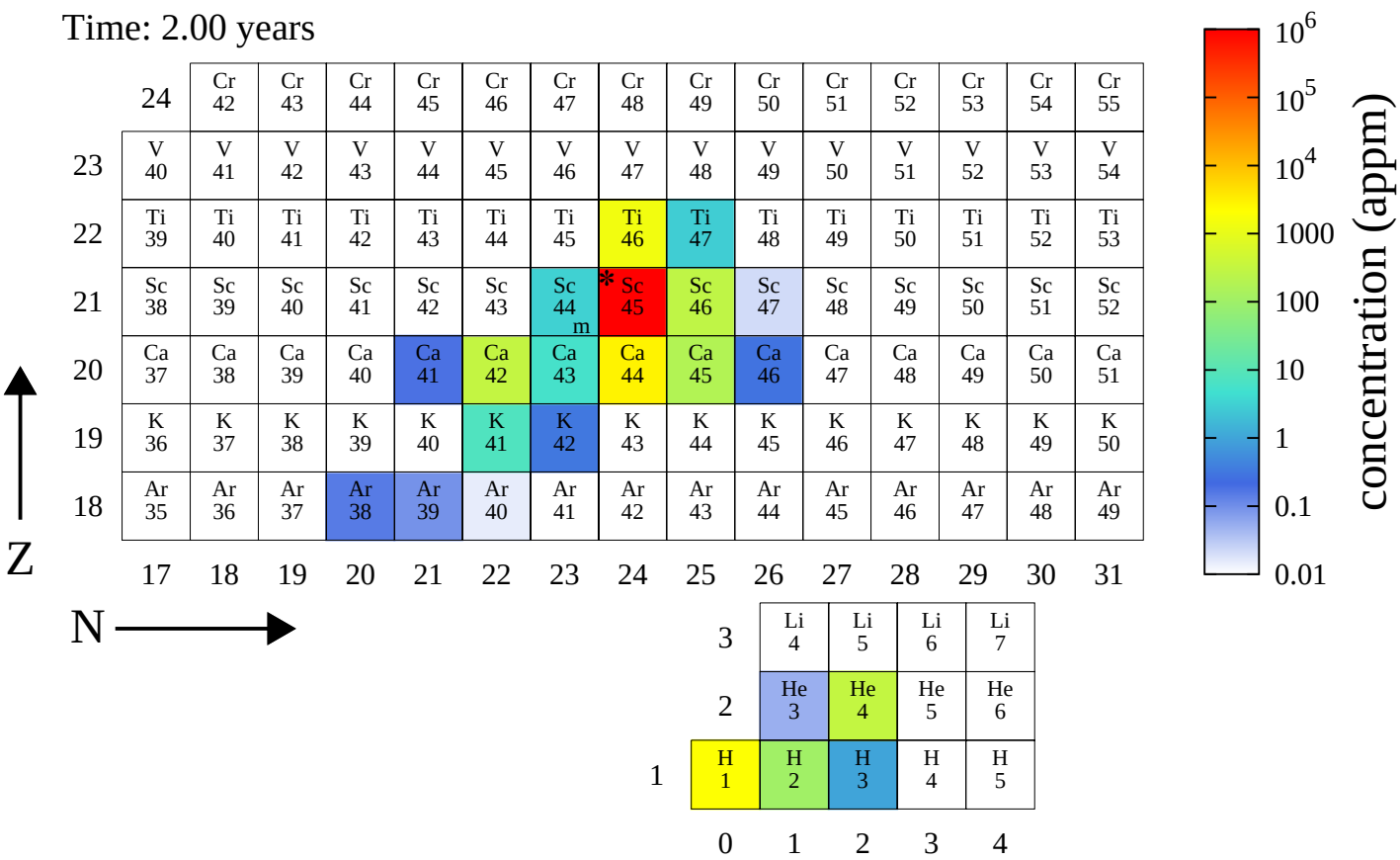




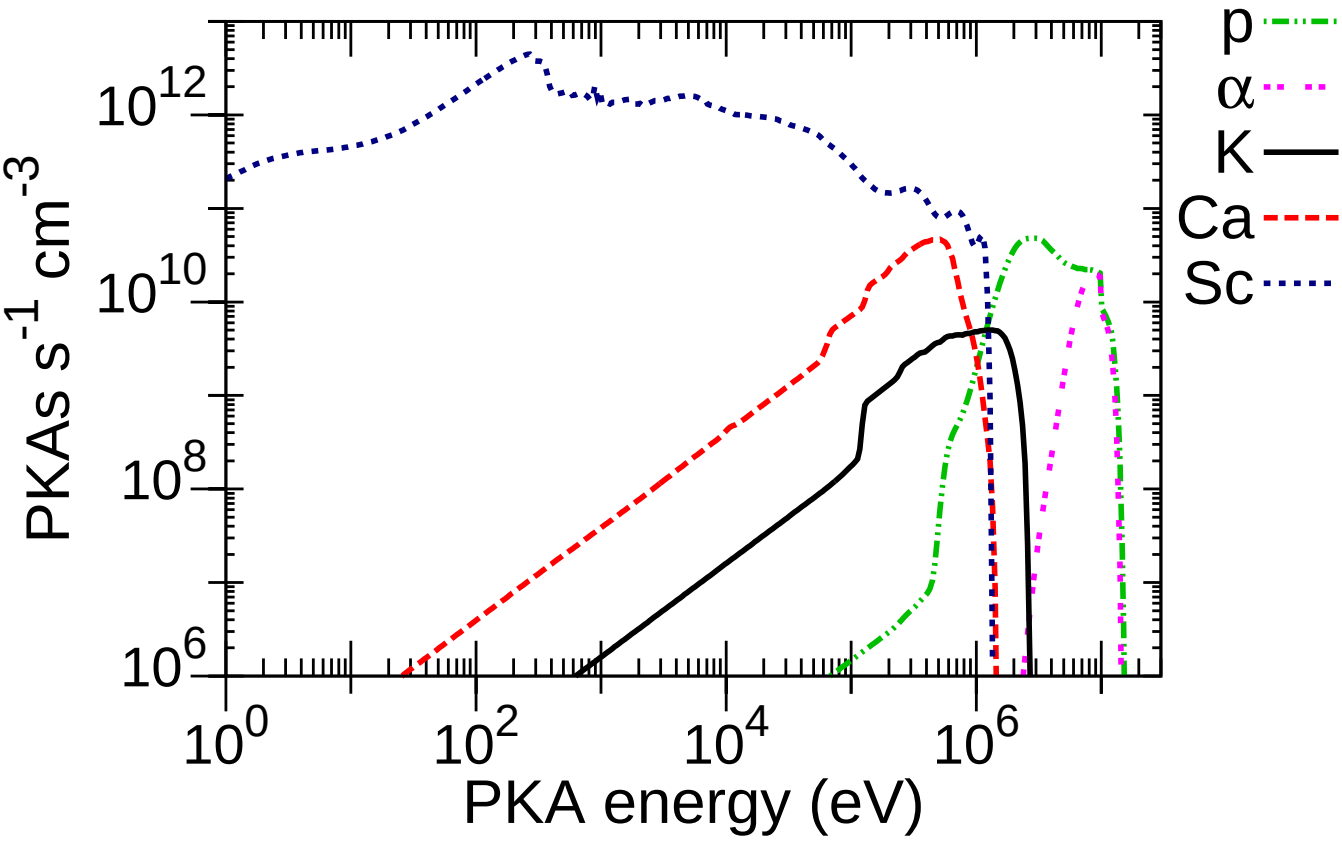
Scandium FW Transmutation

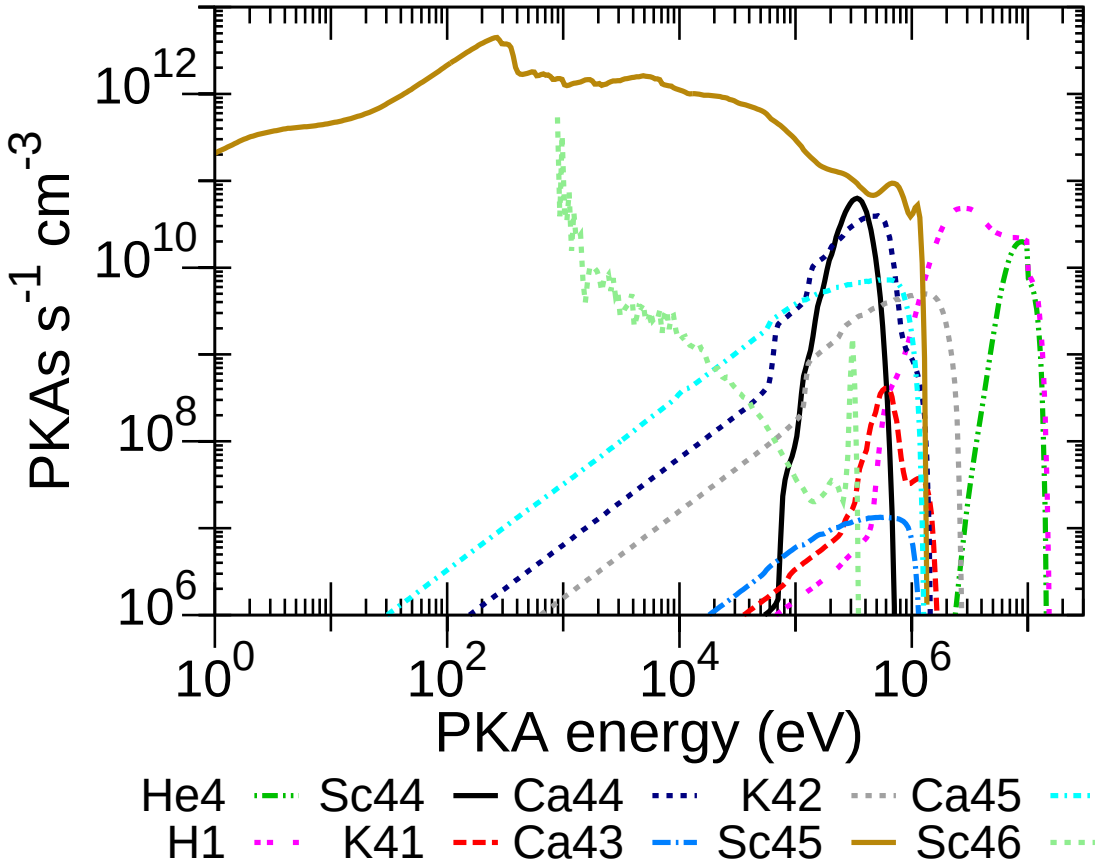


159 appm He & 1085 appm H after 1 year 20 dpa/year



Scandium FW PKA distributions





Scandium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sc45m	0.32s	Sc45(n,p)Ca45(β^-)Sc45m	100.0			
		Sc45(n,n′)Sc45m		99.8	99.9	98.7
Sc46m	18.70s	Sc45(n,γ)Sc46m	100.0	99.8	98.4	96.4
		Sc45(n,γ)Sc46(n,n′)Sc46m			1.3	
		Sc45(n,γ)Sc46(β^-)Ti46(n,p)Sc46m				1.6
Ar41	1.83h	Sc45(n,np)Ca44(n,α)Ar41				51.1
		Sc45(n,2n)Sc44(β^+)Ca44(n,α)Ar41				25.3
		Sc45(n,2n)Sc44m(IT)Sc44(β^+)Ca44(n,α)Ar41				18.1
		Sc45(n,d)Ca44(n,α)Ar41				3.5
Sc44	3.97h	Sc45(n,2n)Sc44				57.4
		Sc45(n,2n)Sc44m(IT)Sc44				41.3
K42	12.36h	Sc45(n,α)K42			99.9	98.7
Sc44m	2.44d	Sc45(n,2n)Sc44m				98.7
Sc46	83.79d	Sc45(n,γ)Sc46	77.4	79.4	85.8	80.2
		Sc45(n,γ)Sc46m(IT)Sc46	22.6	20.5	13.9	17.6
Ca45	162.99d	Sc45(n,p)Ca45	100.0	99.9	100.0	99.0
Co60	5.27y	no pathways found				
H3	12.33y	Sc45(n,γ)Sc46(n,p)H1(n,γ)H2(n,γ)H3	57.3	4.3		
		Sc45(n,p)H1(n,γ)H2(n,γ)H3	25.8	94.4	99.4	
		Sc45(n,γ)Sc46m(IT)Sc46(n,p)H1(n,γ)H2(n,γ)H3	16.8	1.1		
		Sc45(n,t)H3				99.3
Ar42	33.00y	Sc45(n,p)Ca45(n,α)Ar42			96.7	97.4
		Sc45(n,α)K42(n,p)Ar42			2.3	2.1
Ar39	269.01y	Sc45(n,α)K42(β^-)Ca42(n,α)Ar39			99.1	97.6
Ca41	1.0 10^5y	Sc45(n,α)K42(β^-)Ca42(n,2n)Ca41				99.1
Cl36	3.0 10^5y	Sc45(n,nα)K41(n,nα)Cl37(n,2n)Cl36				40.2
		Sc45(n,nα)K41(n,2n)K40(n,nα)Cl36				23.6
		Sc45(n,α)K42(β^-)Ca42(n,nα)Ar38(n,np)Cl37(n,2n)Cl36				8.4
		Sc45(n,α)K42(β^-)Ca42(n,nα)Ar38(n,2n)Ar37(β^+) Cl37(n,2n)Cl36				3.5
		Sc45(n,np)Ca44(n,α)Ar41(β^-)K41(n,nα)Cl37(n,2n)Cl36				2.9
		Sc45(n,2n)Sc44m(n,nα)K40(n,nα)Cl36				2.3
		Sc45(n,α)K42(β^-)Ca42(n,2n)Ca41(n,np)K40(n,nα)Cl36				2.2
		Sc45(n,np)Ca44(n,α)Ar41(β^-)K41(n,2n)K40(n,nα)Cl36				1.7
		Sc45(n,α)K42(β^-)Ca42(n,2n)Ca41(n,nα)Ar37(β^+) Cl37(n,2n)Cl36				1.6
		Sc45(n,α)K42(β^-)Ca42(n,np)K41(n,nα)Cl37(n,2n)Cl36				1.4
		Sc45(n,2n)Sc44(β^+)Ca44(n,α)Ar41(β^-)K41(n,nα) Cl37(n,2n)Cl36				1.4
		Sc45(n,2n)Sc44m(IT)Sc44(β^+)Ca44(n,α)Ar41(β^-)K41(n,nα) Cl37(n,2n)Cl36				1.0
Fe60	1.5 10^6y	no pathways found				
K40	1.3 10^9y	Sc45(n,nα)K41(n,2n)K40				68.8
		Sc45(n,α)K42(β^-)Ca42(n,2n)Ca41(n,np)K40				8.5
		Sc45(n,np)Ca44(n,α)Ar41(β^-)K41(n,2n)K40				6.7
		Sc45(n,2n)Sc44m(n,nα)K40				4.5
		Sc45(n,α)K42(β^-)Ca42(n,np)K41(n,2n)K40				3.3
		Sc45(n,2n)Sc44(β^+)Ca44(n,α)Ar41(β^-)K41(n,2n)K40				3.3
		Sc45(n,2n)Sc44m(IT)Sc44(β^+)Ca44(n,α)Ar41(β^-)K41(n,2n)K40				2.3
Ca48	5.3 10^{19}y	Sc45(n,γ)Sc46(n,p)Ca46(n,γ)Ca47(n,γ)Ca48	74.0			
		Sc45(n,γ)Sc46m(IT)Sc46(n,p)Ca46(n,γ)Ca47(n,γ)Ca48	21.6			
		Sc45(n,p)Ca45(n,γ)Ca46(n,γ)Ca47(n,γ)Ca48	4.2			

Titanium

Isotope	Atom % abundance
Ti46	8.25
Ti47	7.44
Ti48	73.72
Ti49	5.41
Ti50	5.18

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.50E+14	1.34E+14	7.73E+13	6.65E+12	6.07E+06	2.96E+03
Sc48	36.4	40.8	17.5			
Sc46	20.9	23.5	39.3	22.9		
Ca45	16.2	18.1	30.9	77.1		
Sc47	12.8	14.3	11.9			
Sc46m	5.5					
Sc45m	4.5					
Sc49	1.4	1.5				
Ti45	1.0	1.1				
Ar42					34.4	
K42					34.4	
Ar39					19.4	
H3					11.6	
Ca41					0.1	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	4.45E-02	4.37E-02	1.88E-02	5.81E-04	6.88E-10	1.55E-15
Sc48	70.1	71.2	41.2			
Sc46	23.9	24.3	54.8	89.1		
Sc47	1.9	1.9	2.1			
Sc50	1.1	0.1				
Ca45	0.7	0.7	1.6	10.9		
K42					82.5	
Ar42					11.3	
Ar39					6.0	
Ca41						100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	7.03E+04	6.96E+04	2.98E+04	8.41E+02	1.79E-04	4.02E-11
Sc48	73.5	74.1	43.1			
Sc46	24.6	24.8	56.3	100.0		
K42					99.6	
Ca41						99.9

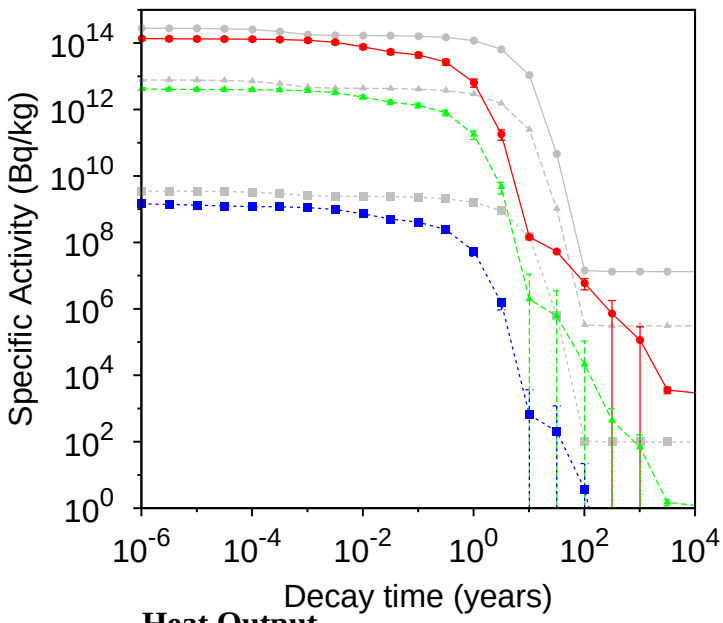
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.70E+05	1.69E+05	9.11E+04	5.99E+03	9.65E+00	5.62E-07
Sc48	54.4	54.9	25.3			
Sc46	27.6	27.8	50.1	38.1		
Ca45	10.1	10.2	18.6	60.7		
Sc47	6.1	6.1	5.4			
Ar42			0.1	1.1	86.6	
Ar39					13.4	
Ca41						100.0

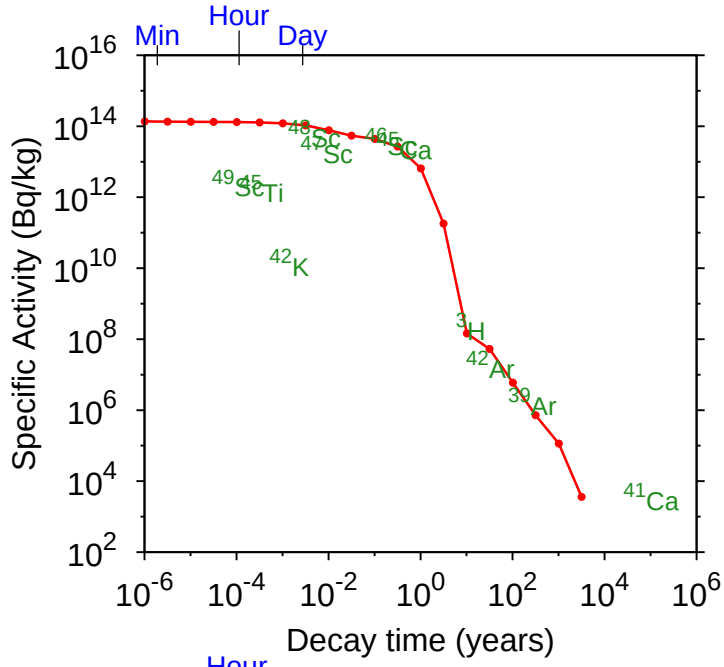
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.81E+05	3.81E+05	3.20E+05	3.20E+04	3.79E+02	5.32E-07
Sc46	55.8	56.0	64.6	32.4		
Ca45	23.5	23.5	27.6	59.2		
Sc48	15.7	15.7	4.7			
Sc47	3.7	3.7	2.1			
Ar42	0.7	0.7	0.8	8.3	88.2	
Ar39				0.2	11.8	
Ca41						100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	3.73E+11	3.70E+11	3.18E+11	1.53E+10	6.99E+02	2.11E-03
Sc46	83.9	84.6	95.6	99.7		
Sc48	14.6	14.7	4.3			
Ar42					59.8	
K42					29.9	
Ar39					8.9	
H3					1.0	
Ca41						99.9

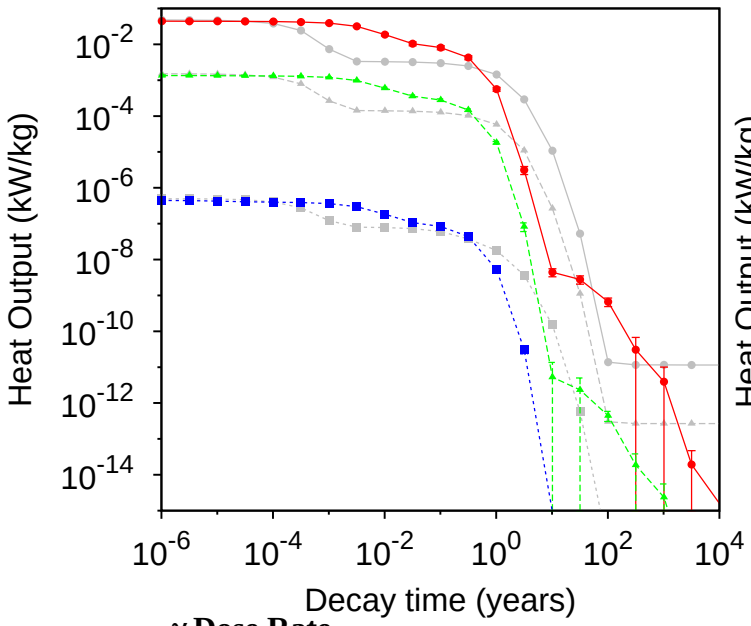
Titanium activation characteristics

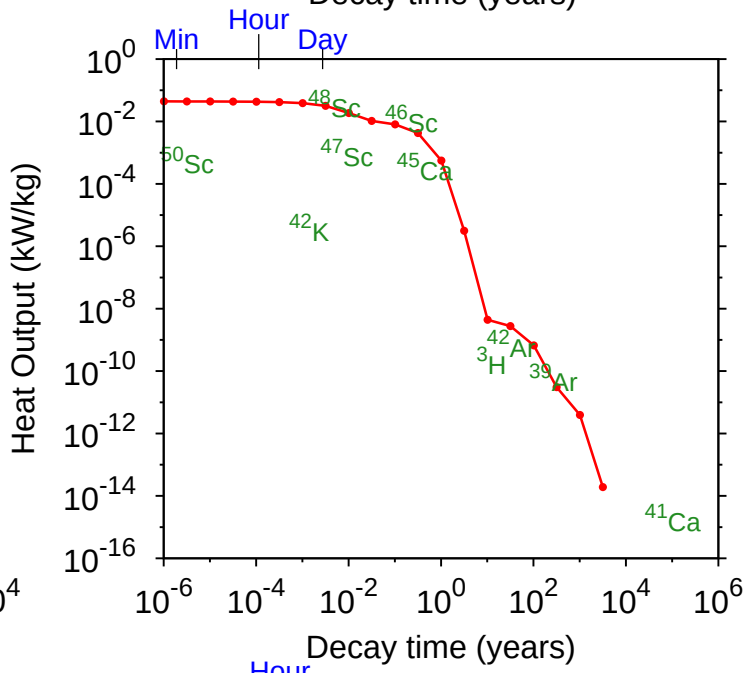
Specific Activity



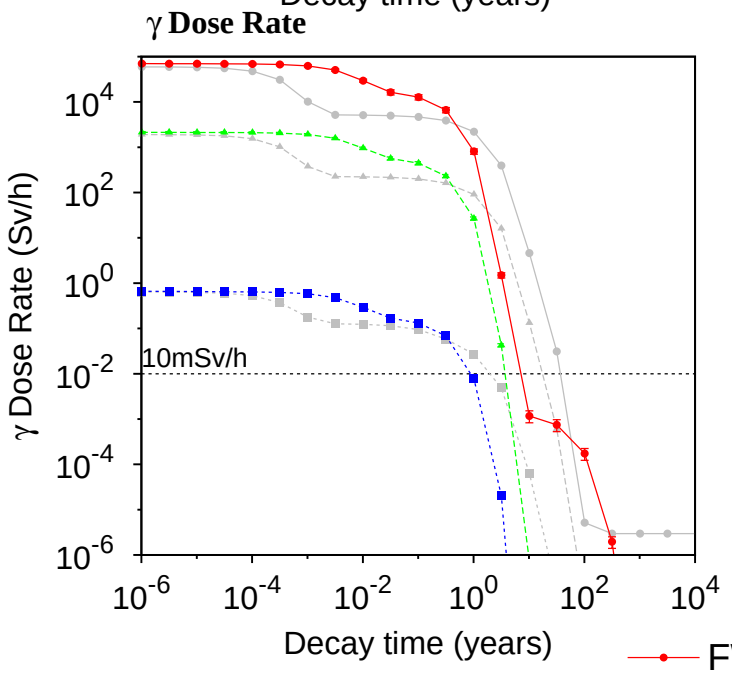


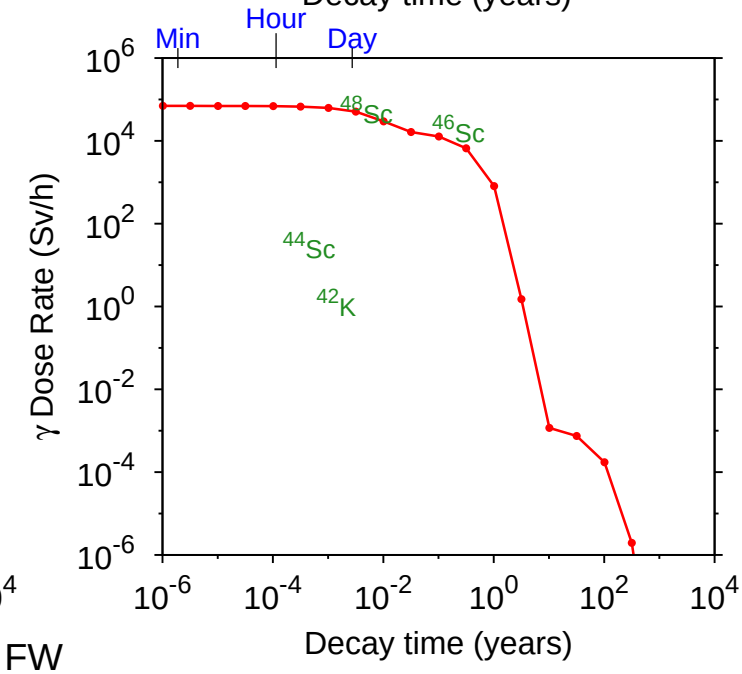
Heat Output





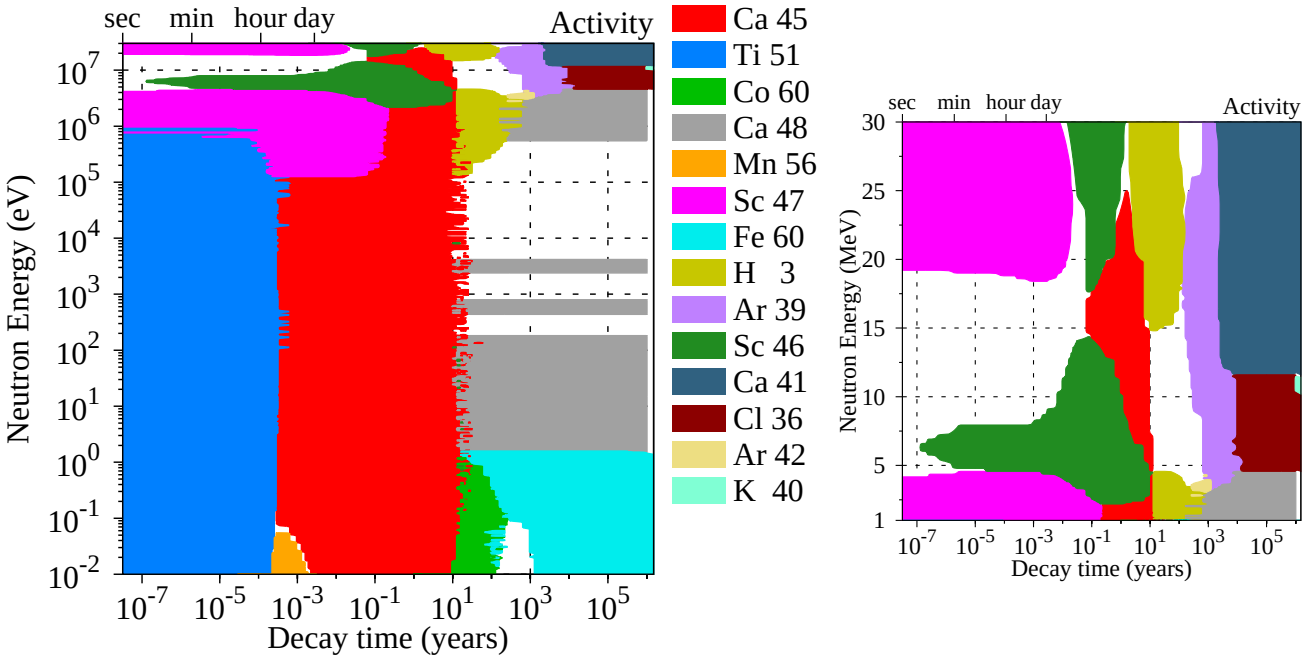
γ Dose Rate

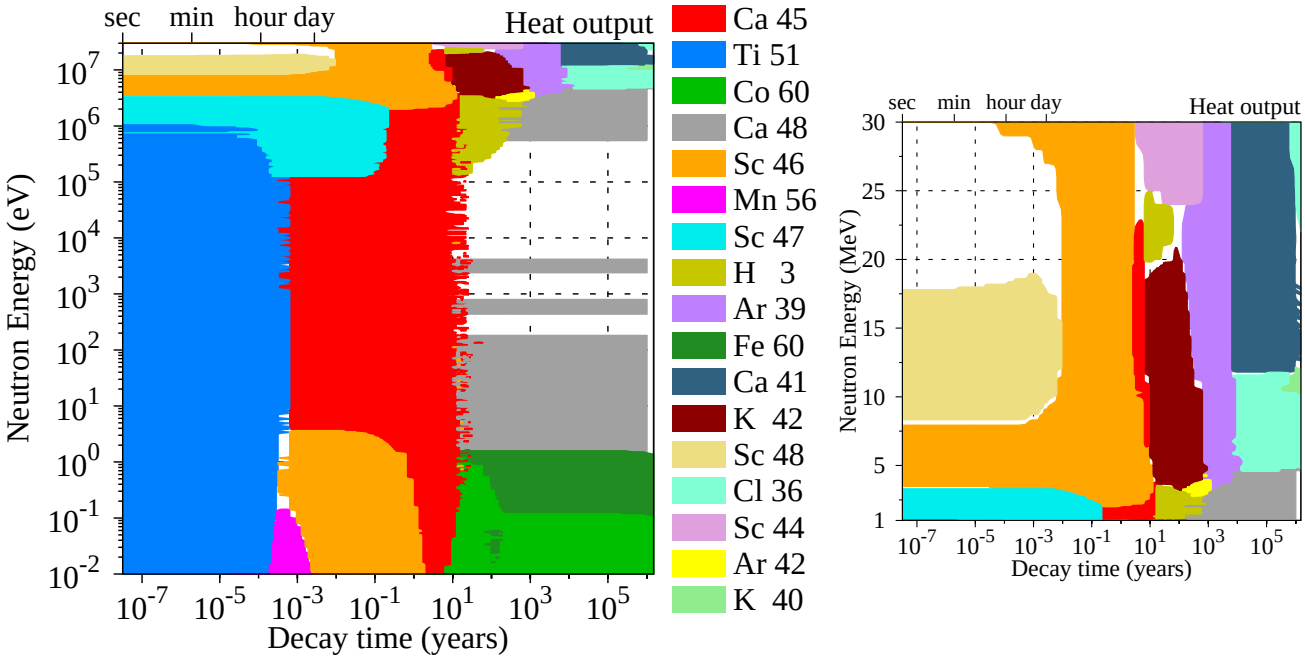


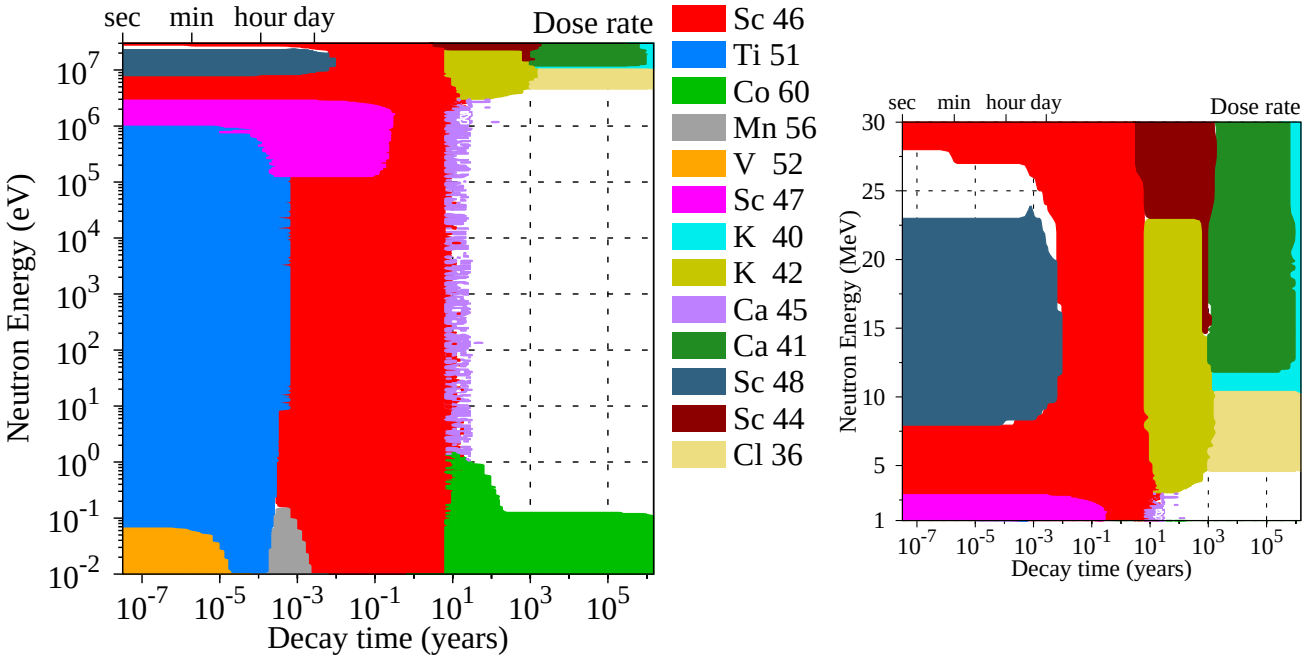


FW
Blanket
Manifold
Fe results

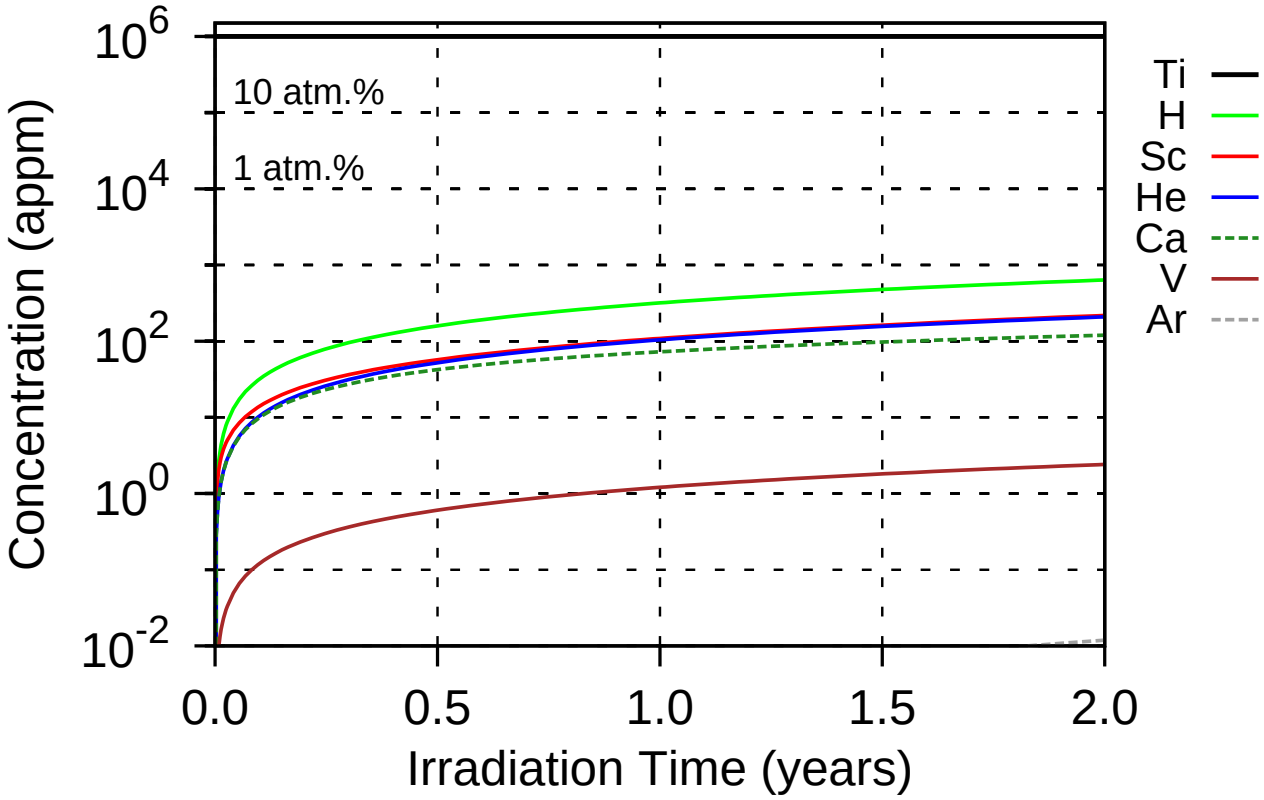
Titanium Importance diagrams



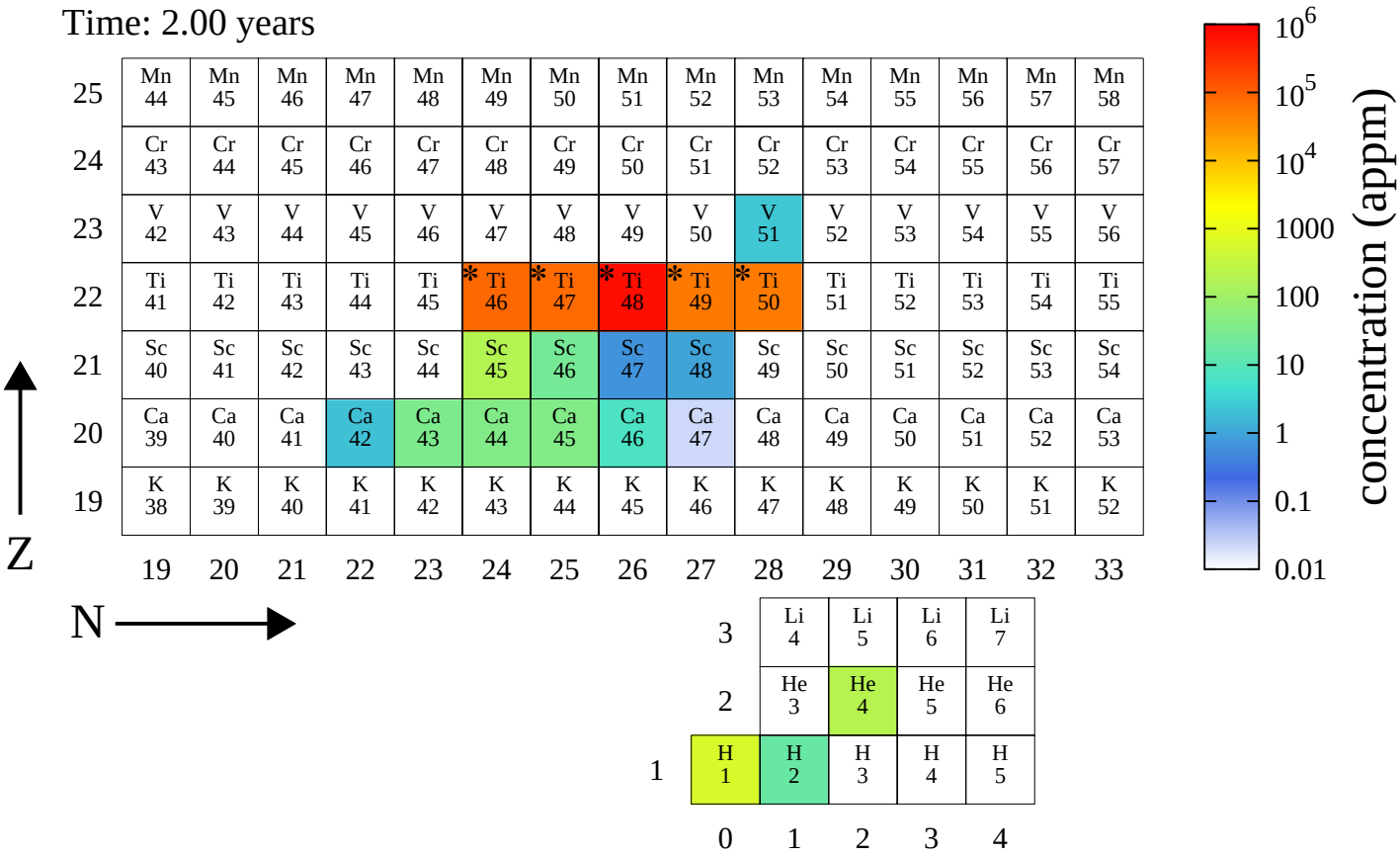




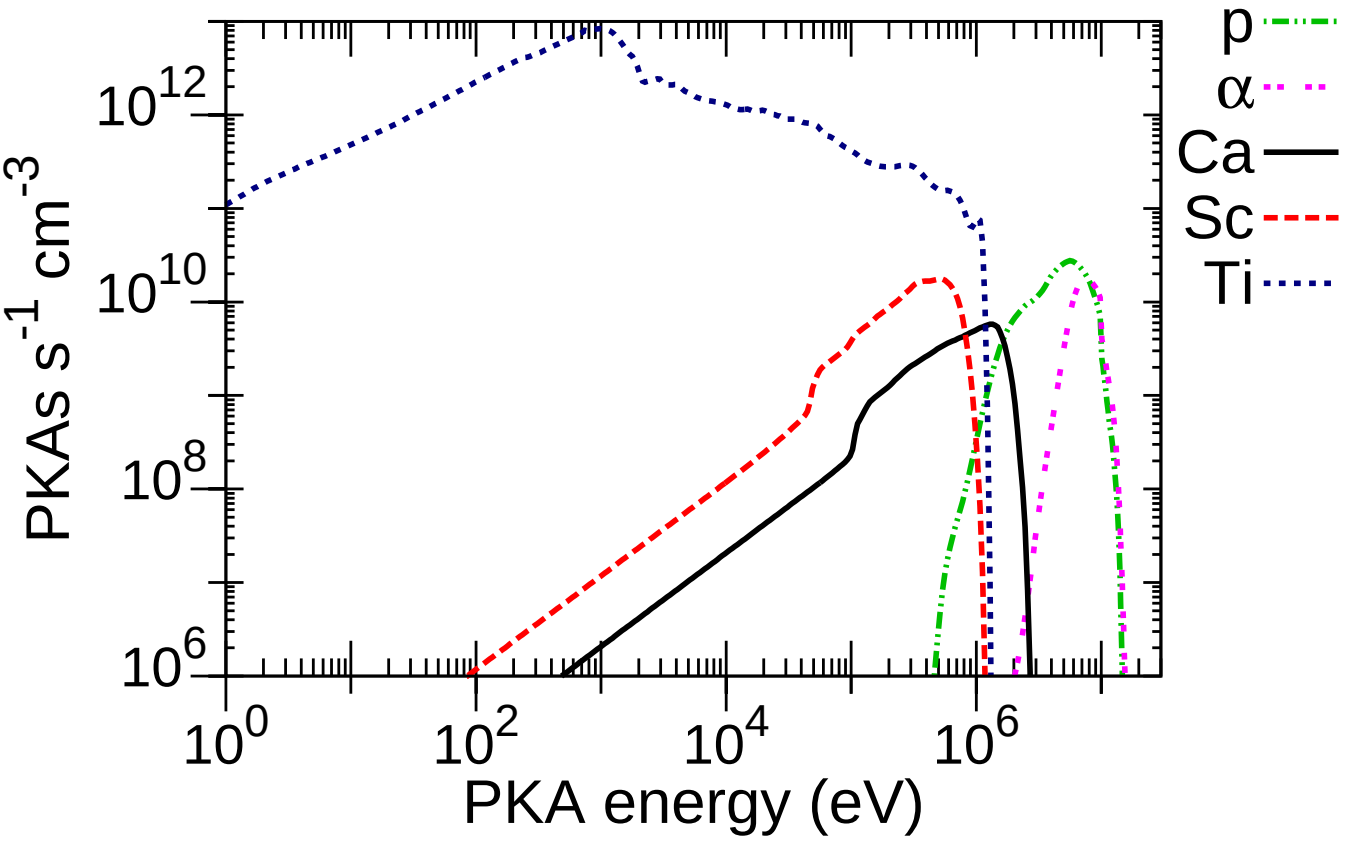
Titanium FW Transmutation

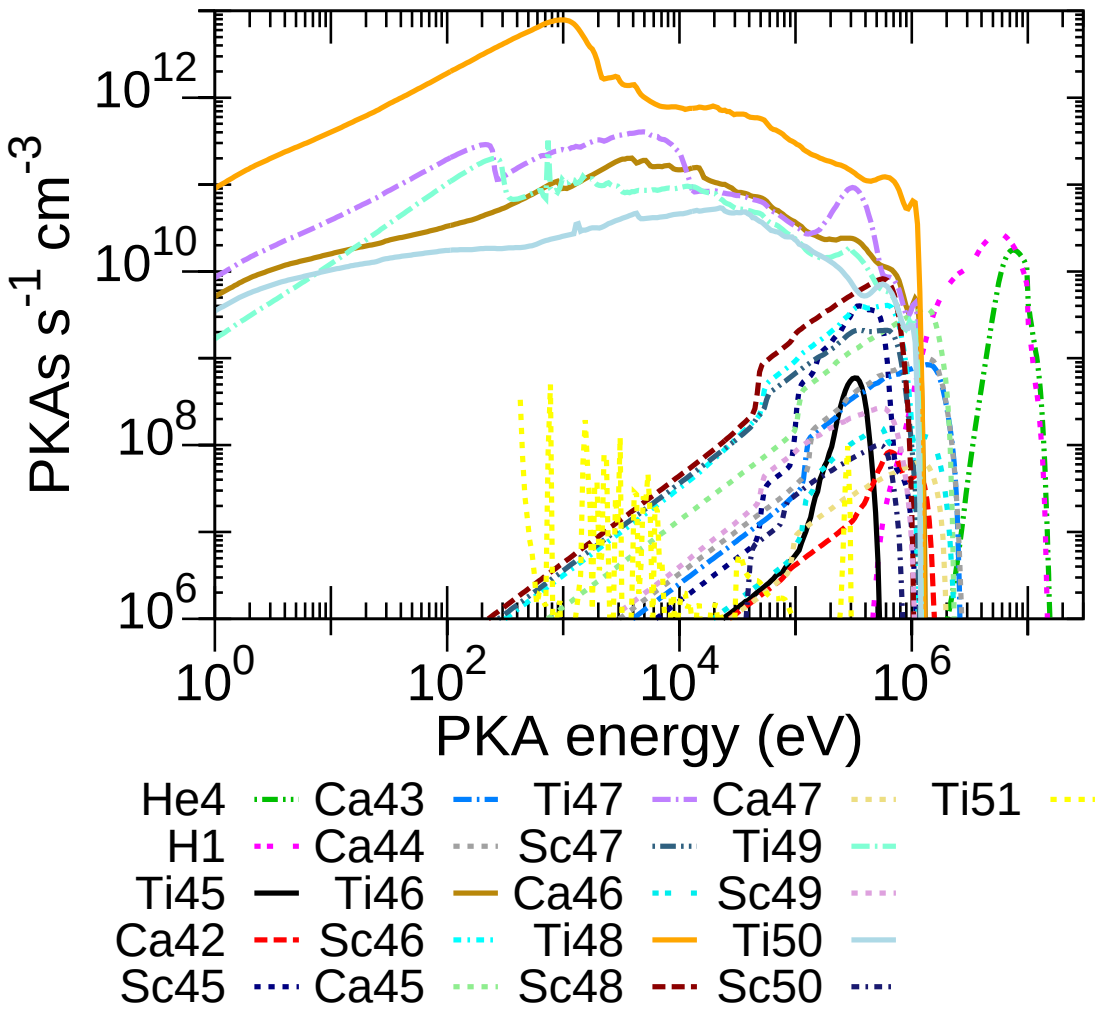


104 appm He & 318 appm H after 1 year 12 dpa/year



Titanium FW PKA distributions





Titanium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sc45m	0.32s	Ti47(n,α)Ca44(n,γ)Ca45(β^-)Sc45(n,n′)Sc45m			99.1	
		Ti46(n,np)Sc45m				88.4
		Ti47(n,2n)Ti46(n,np)Sc45m				2.5
		Ti46(n,d)Sc45m				2.4
		Ti48(n,α)Ca45(β^-)Sc45(n,n′)Sc45m				2.4
		Ti46(n,np)Sc45(n,n′)Sc45m				1.6
Sc46m	18.70s	Ti47(n,α)Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46m	98.8			
		Ti46(n,γ)Ti47(n,α)Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46m	1.2			
		Ti46(n,p)Sc46m			99.5	90.7
		Ti47(n,np)Sc46m				3.9
		Ti47(n,2n)Ti46(n,p)Sc46m				2.6
Sc50	1.71m	Ti49(n,p)Sc49(n,γ)Sc50			59.3	
		Ti49(n,p)Sc49(n,γ)Sc50m(IT)Sc50			40.5	
		Ti50(n,p)Sc50m(IT)Sc50				58.3
		Ti50(n,p)Sc50				41.6
V52	3.74m	Ti50(n,γ)Ti51(β^-)V51(n,γ)V52	85.4	99.9	100.0	99.6
		Ti48(n,γ)Ti49(n,γ)Ti50(n,γ)Ti51(β^-)V51(n,γ)V52	9.7			
		Ti49(n,γ)Ti50(n,γ)Ti51(β^-)V51(n,γ)V52	4.8			
Ti51	5.80m	Ti50(n,γ)Ti51	70.8	99.8	100.0	99.7
		Ti48(n,γ)Ti49(n,γ)Ti50(n,γ)Ti51	21.6			
		Ti49(n,γ)Ti50(n,γ)Ti51	7.6			
Sc49	57.19m	Ti47(n,α)Ca44(n,γ)Ca45(n,γ)Ca46(n,γ)Ca47(n,γ)Ca48(n,γ) Ca49(β^-)Sc49	85.1			
		Ti47(n,α)Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46(n,γ)Sc47(n,γ) Sc48(n,γ)Sc49	9.0			
		Ti47(n,α)Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46m(IT)Sc46(n,γ) Sc47(n,γ)Sc48(n,γ)Sc49	2.6			
		Ti47(n,α)Ca44(n,γ)Ca45(n,γ)Ca46(n,γ)Ca47(β^-)Sc47(n,γ) Sc48(n,γ)Sc49	2.4			
		Ti49(n,p)Sc49			99.7	94.8
		Ti50(n,2n)Ti49(n,p)Sc49				3.6
Mn56	2.58h	Ti50(n,γ)Ti51(β^-)V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ) Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56	96.4			
		Ti49(n,γ)Ti50(n,γ)Ti51(β^-)V51(n,γ)V52(β^-)Cr52(n,γ) Cr53(n,γ)Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56	1.9			
		Ti48(n,γ)Ti49(n,γ)Ti50(n,γ)Ti51(β^-)V51(n,γ)V52(β^-) Cr52(n,γ)Cr53(n,γ)Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56	1.7			
Ti45	3.08h	Ti46(n,2n)Ti45				96.4
		Ti47(n,2n)Ti46(n,2n)Ti45				2.7
Sc44	3.97h	Ti48(n,α)Ca45(β^-)Sc45(n,2n)Sc44				26.7
		Ti48(n,α)Ca45(β^-)Sc45(n,2n)Sc44m(IT)Sc44				19.1
		Ti46(n,np)Sc45(n,2n)Sc44				17.7
		Ti46(n,np)Sc45(n,2n)Sc44m(IT)Sc44				12.7
		Ti46(n,np)Sc45m(IT)Sc45(n,2n)Sc44				9.3
		Ti46(n,np)Sc45m(IT)Sc45(n,2n)Sc44m(IT)Sc44				6.6
		Ti46(n,2n)Ti45(β^+)Sc45(n,2n)Sc44				2.5
		Ti46(n,2n)Ti45(β^+)Sc45(n,2n)Sc44m(IT)Sc44				1.8
K42	12.36h	Ti48(n,α)Ca45(β^-)Sc45(n,α)K42				41.5
		Ti46(n,np)Sc45(n,α)K42				27.9
		Ti46(n,np)Sc45m(IT)Sc45(n,α)K42				14.6
		Ti46(n,nα)Ca42(n,p)K42				3.9
		Ti46(n,2n)Ti45(β^+)Sc45(n,α)K42				3.9
		Ti46(n,α)Ca43(n,np)K42				2.5
		Ti46(n,α)Ca43(n,2n)Ca42(n,p)K42				1.3
Sc48	1.82d	Ti47(n,α)Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46(n,γ) Sc47(n,γ)Sc48	63.2			
		Ti47(n,α)Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46m(IT)Sc46(n,γ) Sc47(n,γ)Sc48	18.5			
		Ti47(n,α)Ca44(n,γ)Ca45(n,γ)Ca46(n,γ)Ca47(β^-) Sc47(n,γ)Sc48	17.2			
		Ti47(n,p)Sc47(n,γ)Sc48			99.9	
		Ti48(n,p)Sc48				99.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sc47	3.35d	Ti47(n,α)Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46(n,γ)Sc47	63.2	79.4		
		Ti47(n,α)Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46m(IT) Sc46(n,γ)Sc47	18.5	20.5		
		Ti47(n,α)Ca44(n,γ)Ca45(n,γ)Ca46(n,γ)Ca47(β^-)Sc47	17.2			
		Ti47(n,p)Sc47			99.9	61.0
		Ti48(n,d)Sc47				13.1
		Ti48(n,2n)Ti47(n,p)Sc47				12.0
		Ti48(n,np)Sc47				10.2
		Ti50(n,α)Ca47(β^-)Sc47				2.5
Sc46	83.79d	Ti47(n,α)Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46	76.6	79.5		
		Ti47(n,α)Ca44(n,γ)Ca45(β^-)Sc45(n,γ)Sc46m(IT)Sc46	22.4	20.5		
		Ti46(n,p)Sc46			54.1	62.5
		Ti46(n,p)Sc46m(IT)Sc46			45.7	22.9
		Ti47(n,np)Sc46				7.5
		Ti47(n,2n)Ti46(n,p)Sc46				1.5
		Ti48(n,2n)Ti47(n,np)Sc46				1.3
		Ti47(n,np)Sc46m(IT)Sc46				1.0
Ca45	162.99d	Ti47(n,α)Ca44(n,γ)Ca45	98.4	99.9	99.9	
		Ti46(n,γ)Ti47(n,α)Ca44(n,γ)Ca45	1.6			
		Ti48(n,α)Ca45				98.6
Co60	5.27y	Ti50(n,γ)Ti51(β^-)V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ) Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ) Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT)Co60	45.3			
		Ti50(n,γ)Ti51(β^-)V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ) Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ) Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60	27.6			
		Ti50(n,γ)Ti51(β^-)V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ) Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ) Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT)Co60	15.8			
		Ti50(n,γ)Ti51(β^-)V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ) Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ) Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60	9.6			
H3	12.33y	Ti47(n,p)H1(n,γ)H2(n,γ)H3			98.8	
		Ti47(n,t)H3				29.2
		Ti49(n,t)H3				12.1
		Ti48(n,2n)Ti47(n,t)H3				2.9
		Ti48(n,α)Ca45(β^-)Sc45(n,t)H3				3.2
		Ti46(n,np)Sc45(n,t)H3				2.6
		Ti46(n,p)Sc46(n,t)H3				2.2
		Ti46(n,np)Sc45m(IT)Sc45(n,t)H3				1.4
		Ti46(n,α)Ca43(n,t)H3				1.1
Ar42	33.00y	Ti48(n,α)Ca45(n,α)Ar42				99.2
Ar39	269.01y	Ti46(n,α)Ca43(n,nα)Ar39				49.7
		Ti46(n,nα)Ca42(n,α)Ar39				32.3
		Ti46(n,α)Ca43(n,2n)Ca42(n,α)Ar39				7.1
		Ti46(n,α)Ca43(n,α)Ar40(n,2n)Ar39				4.8
		Ti48(n,α)Ca45(β^-)Sc45(n,α)K42(β^-)Ca42(n,α)Ar39				1.1
		Ti46(n,np)Sc45(n,α)K42(β^-)Ca42(n,α)Ar39				1.0
Ca41	1.0 10^5y	Ti46(n,nα)Ca42(n,2n)Ca41				74.6
		Ti46(n,α)Ca43(n,2n)Ca42(n,2n)Ca41				16.4
		Ti48(n,α)Ca45(β^-)Sc45(n,α)K42(β^-)Ca42(n,2n)Ca41				2.4
		Ti46(n,np)Sc45(n,α)K42(β^-)Ca42(n,2n)Ca41				2.4
		Ti46(n,np)Sc45m(IT)Sc45(n,α)K42(β^-)Ca42(n,2n)Ca41				1.3

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cl36	3.0 10^5y	Ti46(n,nα)Ca42(n,nα)Ar38(n,np)Cl37(n,2n)Cl36				14.6
		Ti46(n,α)Ca43(n,α)Ar40(n,α)S37(β^-)Cl37(n,2n)Cl36				8.4
		Ti46(n,nα)Ca42(n,nα)Ar38(n,2n)Ar37(β^+)Cl37(n,2n)Cl36				6.1
		Ti46(n,nα)Ca42(n,2n)Ca41(n,np)K40(n,nα)Cl36				3.8
		Ti46(n,nα)Ca42(n,2n)Ca41(n,nα)Ar37(β^+)Cl37(n,2n)Cl36				2.8
		Ti46(n,nα)Ca42(n,np)K41(n,nα)Cl37(n,2n)Cl36				2.5
		Ti46(n,α)Ca43(n,nα)Ar39(β^-)K39(n,α)Cl36				2.4
		Ti46(n,α)Ca43(n,2n)Ca42(n,nα)Ar38(n,np)Cl37(n,2n)Cl36				1.9
		Ti46(n,np)Sc45(n,nα)K41(n,nα)Cl37(n,2n)Cl36				1.7
		Ti46(n,nα)Ca42(n,2n)Ca41(n,pα)Cl37(n,2n)Cl36				1.6
		Ti46(n,nα)Ca42(n,α)Ar39(β^-)K39(n,α)Cl36				1.6
		Ti48(n,α)Ca45(β^-)Sc45(n,nα)K41(n,nα)Cl37(n,2n)Cl36				1.5
		Ti46(n,nα)Ca42(n,np)K41(n,2n)K40(n,nα)Cl36				1.5
		Ti46(n,np)Sc45(n,nα)K41(n,2n)K40(n,nα)Cl36				1.0
		Ti46(n,nα)Ca42(n,nα)Ar38(n,2n)Ar37(n,np)Cl36				1.0
Fe60	1.5 10^6y	Ti50(n,γ)Ti51(β^-)V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ) Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ) Fe58(n,γ)Fe59(n,γ)Fe60	74.4			
		Ti50(n,γ)Ti51(β^-)V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ) Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ) Fe58(n,γ)Fe59(n,γ)Fe60	23.8			
K40	1.3 10^9y	Ti47(n,α)Ca44(n,α)Ar41(β^-)K41(n,2n)K40				49.0
		Ti46(n,nα)Ca42(n,2n)Ca41(n,np)K40				16.5
		Ti46(n,nα)Ca42(n,np)K41(n,2n)K40				6.4
		Ti48(n,α)Ca45(β^-)Sc45(n,nα)K41(n,2n)K40				4.4
		Ti46(n,np)Sc45(n,nα)K41(n,2n)K40				4.3
		Ti46(n,α)Ca43(n,2n)Ca42(n,2n)Ca41(n,np)K40				2.7
		Ti48(n,2n)Ti47(n,α)Ca44(n,α)Ar41(β^-)K41(n,2n)K40				2.4
		Ti46(n,np)Sc45m(IT)Sc45(n,nα)K41(n,2n)K40				2.3
		Ti48(n,α)Ca45(n,2n)Ca44(n,α)Ar41(β^-)K41(n,2n)K40				1.3
		Ti46(n,α)Ca43(n,2n)Ca42(n,np)K41(n,2n)K40				1.1
Ca48	5.3 10^{19}y	Ti48(n,p)Sc48(n,p)Ca48				96.0
		Ti49(n,2p)Ca48				3.3

Vanadium

Isotope	Atom % abundance
V50	0.25
V51	99.75

($T_{1/2}$ =1.4 10^{17}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.43E+14	1.09E+14	6.78E+12	1.11E+12	8.66E+06	1.03E-02
V52	77.6	65.2				
Ti51	14.5	17.2				
Sc48	6.7	14.9	59.7			
V49	1.0	2.2	35.0	99.8		
Cr51	0.1	0.2	3.5			
Sc47	0.1	0.2	1.7			
H3				0.2	100.0	
V50						97.7
Ca41						2.2

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	9.23E-02	4.18E-02	2.33E-03	8.21E-07	7.95E-12	2.33E-18
V52	82.3	68.7				
Sc48	10.1	22.3	99.6			
Ti51	7.6	8.9				
V49			0.1	98.1		
H3				0.2	99.6	
V50						100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.01E+05	4.83E+04	3.91E+03	2.54E-01	8.01E-09	4.43E-12
V52	82.0	64.8				
Sc48	15.6	32.5	99.9			
Ti51	2.4	2.7				
V49				94.7		
Sc46				5.2		
K42					99.9	
V50					0.1	100.0

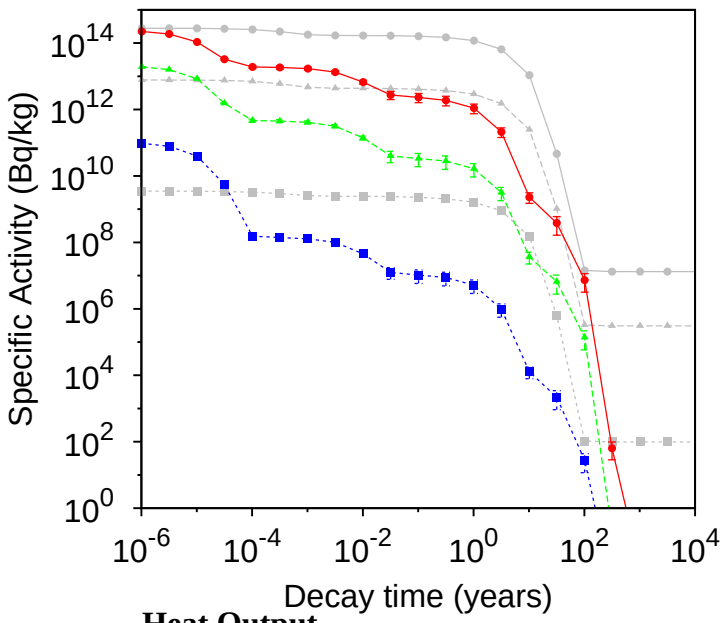
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.11E+04	2.92E+04	7.01E+03	2.04E+01	7.33E-04	6.71E-11
Sc48	89.1	94.9	98.2			
V52	8.5	3.4				
Ti51	1.7	1.0				
V49	0.1	0.1	0.6	97.9		
Ca45				1.4		
Ar42					50.3	
H3				0.4	49.7	
V50						96.3
Ar39						3.6

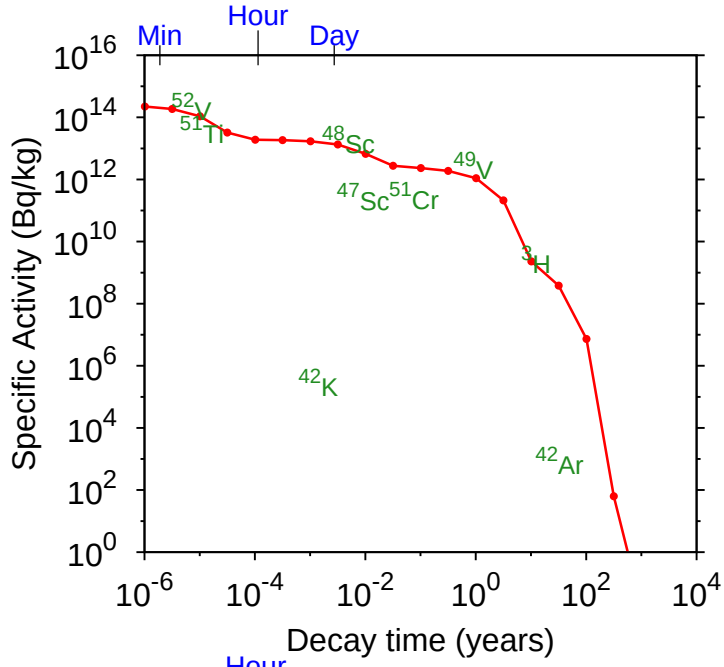
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.04E+04	1.91E+04	4.65E+03	4.01E+01	1.70E-02	1.96E-10
Sc48	88.1	93.9	95.8			
V52	8.5	3.4				
Ti51	1.9	1.1				
Sc47	0.8	0.9	1.8			
V49	0.4	0.4	1.7	94.1		
Ca45			0.2	3.8		
H3				1.4	13.2	
Ar42				0.3	86.7	
V50						56.8
Ar39						43.2

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	3.27E+11	1.36E+11	4.07E+09	1.71E+06	8.66E+01	1.44E-05
V52	90.1	81.7				
Sc48	5.0	12.0	99.7			
Ti51	4.9	6.3				
V49			0.1	84.6		
Sc46			0.1	13.9		
H3				1.3	100.0	
V50						100.0

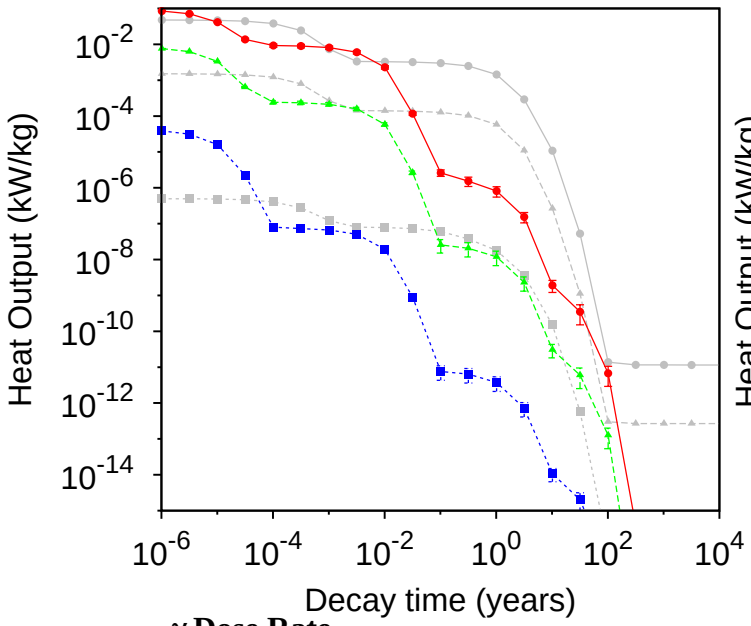
Vanadium activation characteristics

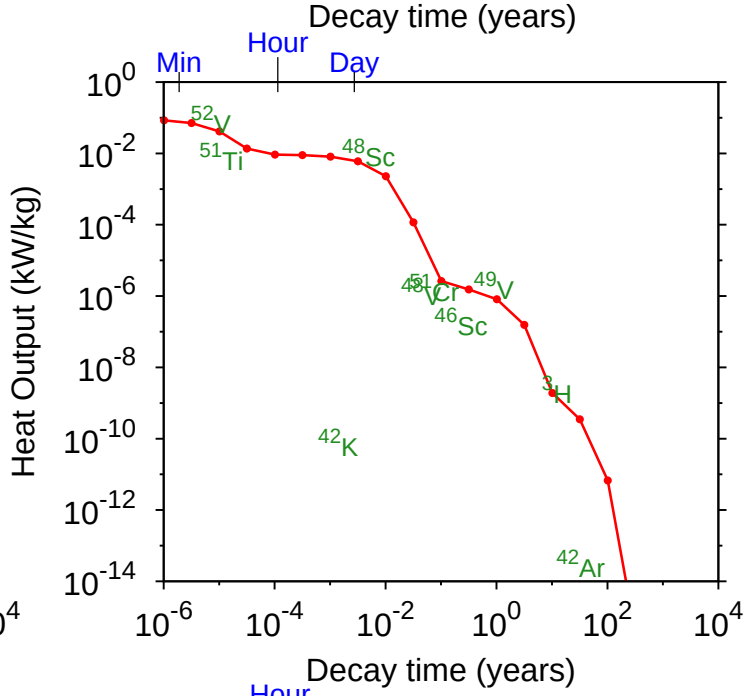
Specific Activity



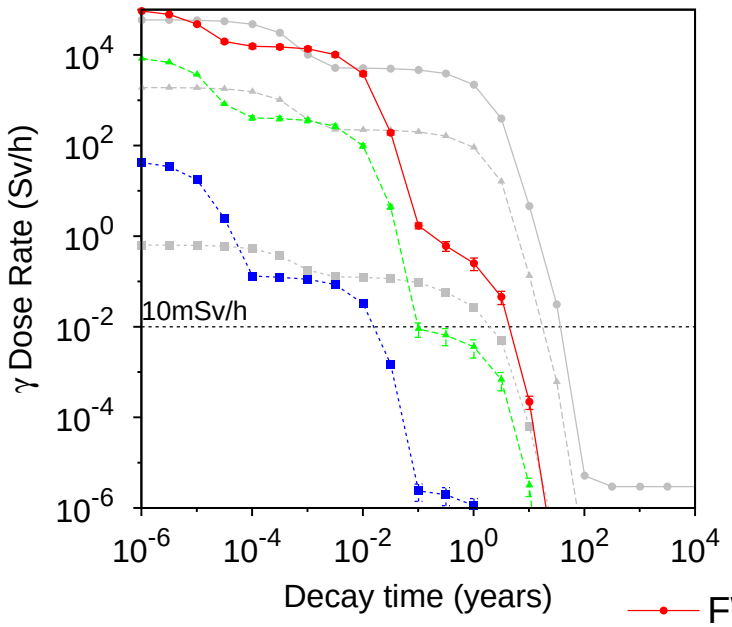


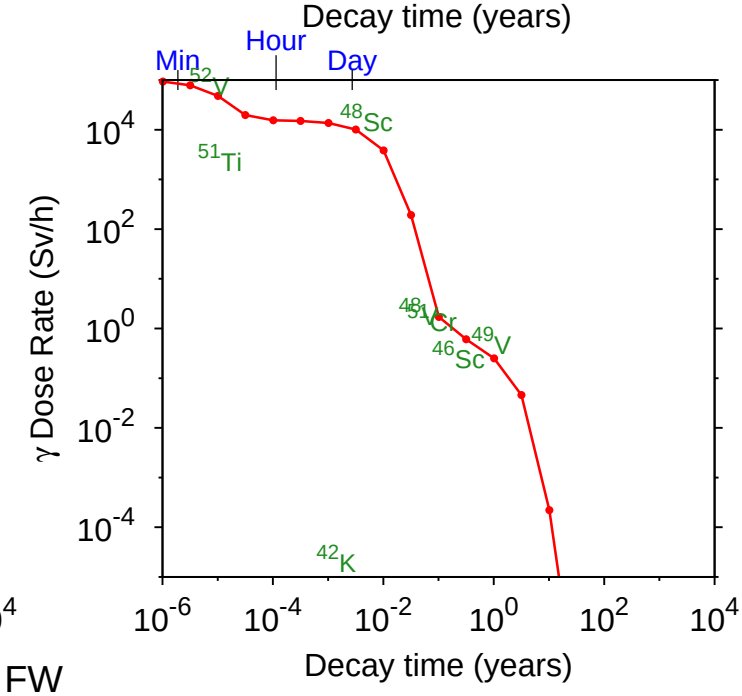
Heat Output





γ Dose Rate





FW
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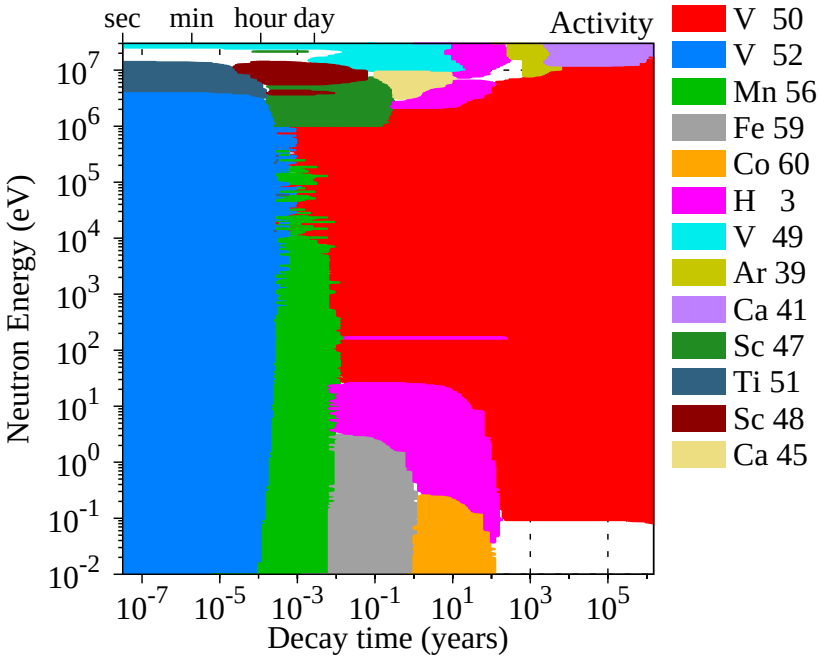
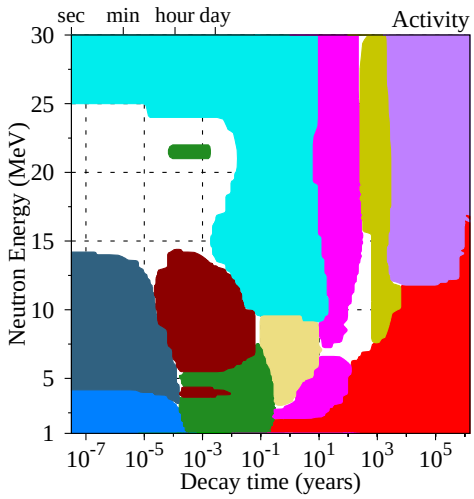
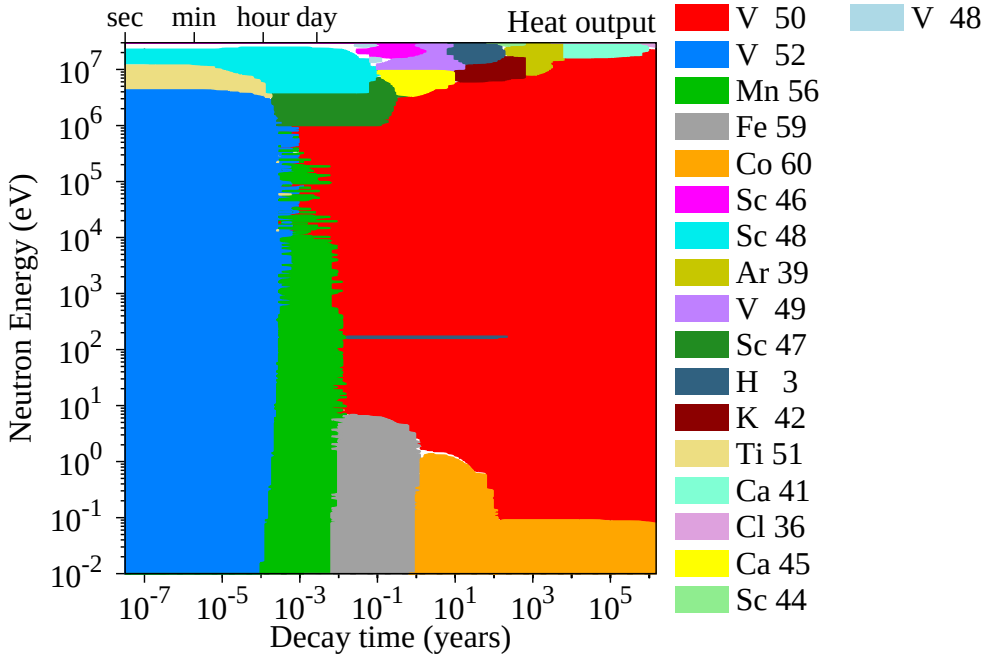
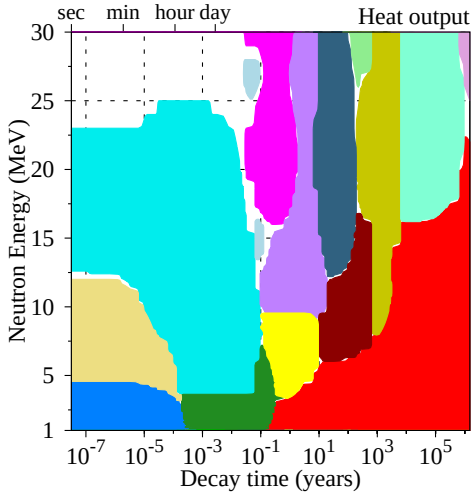
Fe results

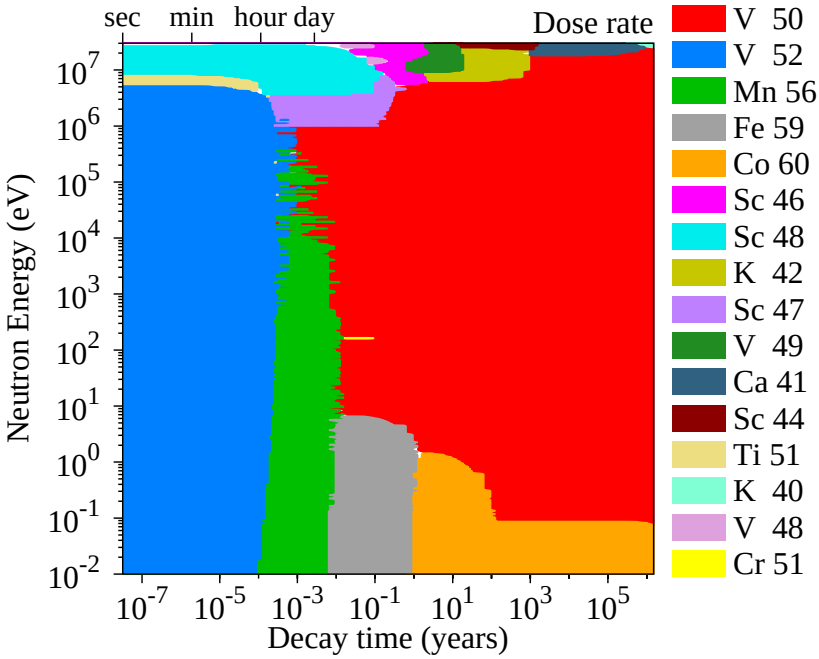
Vanadium Importance diagrams

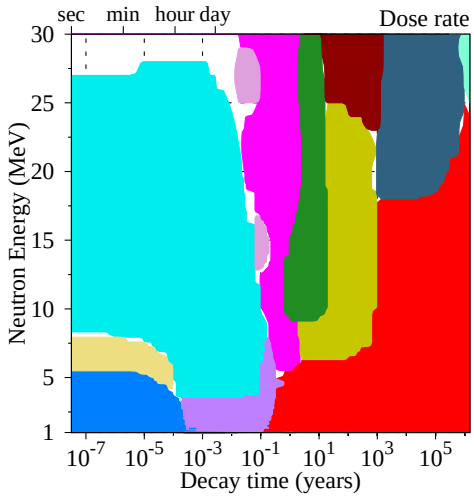




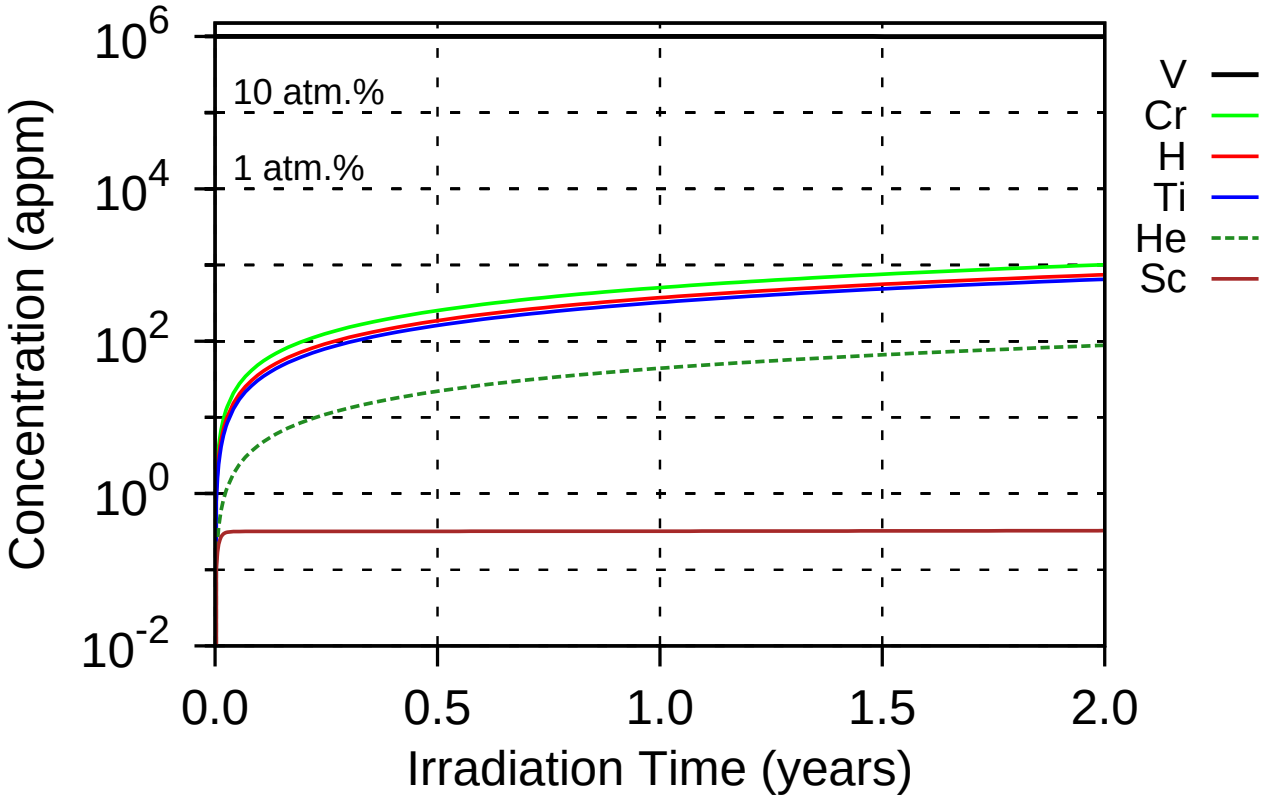




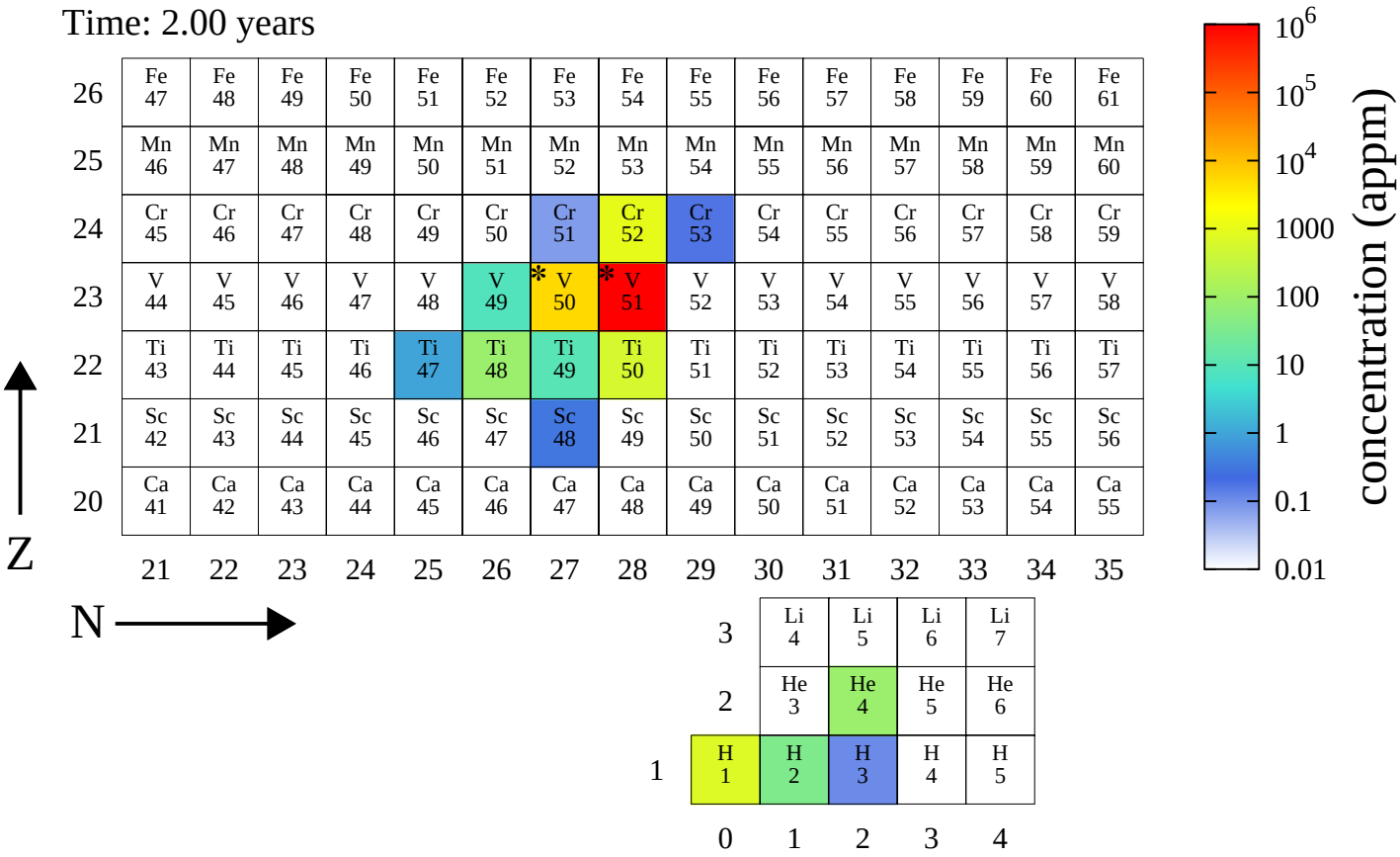




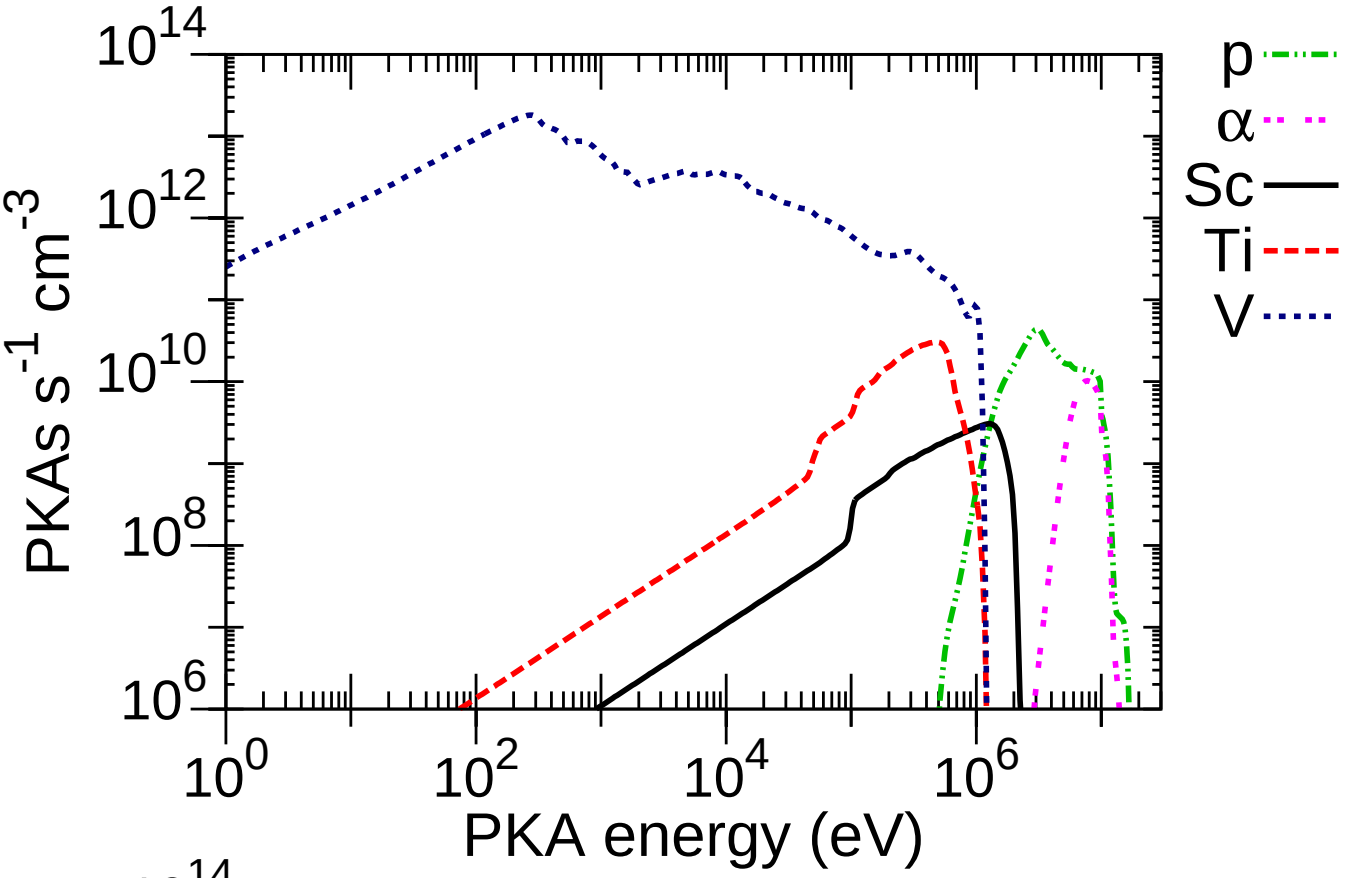
Vanadium FW Transmutation

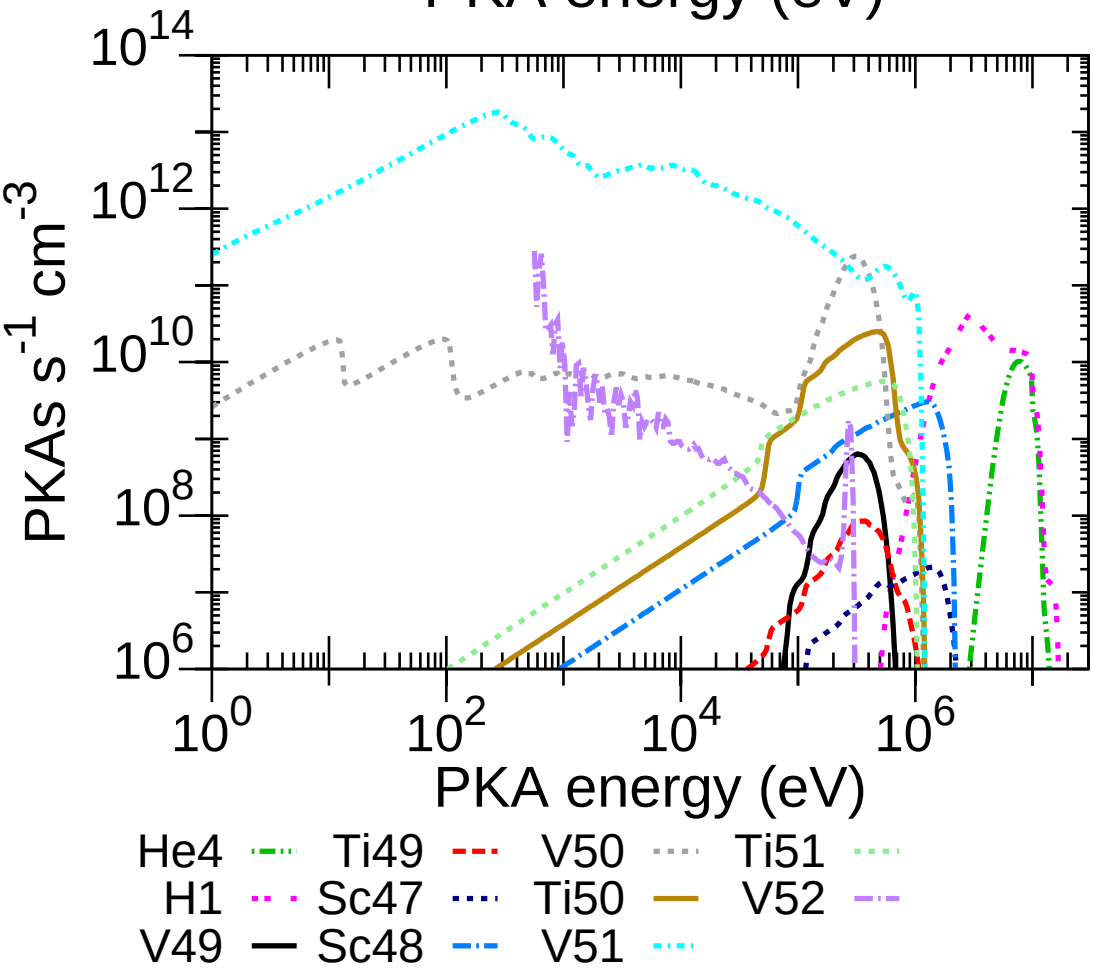


44 appm He & 372 appm H after 1 year 14 dpa/year



Vanadium FW PKA distributions





Vanadium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
V52	3.74m	V51(n,γ)V52	99.7	100.0	100.0	99.2
Ti51	5.80m	V50(n,p)Ti50(n,γ)Ti51	100.0	100.0		
		V51(n,p)Ti51			99.9	99.8
Mn56	2.58h	V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ)Cr54(n,γ)Cr55(β^-) Mn55(n,γ)Mn56	99.8	100.0		
Sc44	3.97h	V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-)Sc45(n,2n)Sc44				56.6
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-)Sc45(n,2n)Sc44m(IT)Sc44				40.2
K42	12.36h	V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-)Sc45(n,α)K42				95.7
Sc48	1.82d	V50(n,α)Sc47(n,γ)Sc48			99.9	
		V51(n,α)Sc48				99.4
Sc47	3.35d	V50(n,α)Sc47			99.9	6.9
		V51(n,2n)V50(n,α)Sc47				88.0
		V51(n,np)Ti50(n,α)Ca47(β^-)Sc47				3.3
V48	15.97d	V51(n,2n)V50(n,2n)V49(n,2n)V48				88.5
		V50(n,2n)V49(n,2n)V48				11.4
Cr51	27.70d	V51(n,γ)V52(β^-)Cr52(n,2n)Cr51				99.6
Fe59	44.50d	V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ)Cr54(n,γ)Cr55(β^-) Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59	80.0			
		V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ)Cr54(n,γ)Cr55(β^-) Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ)Fe58(n,γ)Fe59	19.8			
Sc46	83.79d	V51(n,2n)V50(n,2n)V49(n,α)Sc46				61.2
		V51(n,2n)V50(n,2n)V49(n,α)Sc46m(IT)Sc46				14.7
		V50(n,2n)V49(n,α)Sc46				9.1
		V51(n,2n)V50(n,α)Sc47(β^-)Ti47(n,np)Sc46				3.7
		V51(n,2n)V50(n,nα)Sc46				2.6
		V50(n,2n)V49(n,α)Sc46m(IT)Sc46				2.2
		V51(n,2n)V50(n,α)Sc47(n,2n)Sc46				1.3
Ca45	162.99d	V50(n,α)Sc47(β^-)Ti47(n,α)Ca44(n,γ)Ca45			99.9	
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45				97.9
V49	330.01d	V51(n,2n)V50(n,2n)V49				88.9
		V50(n,2n)V49				11.1
Co60	5.27y	V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ)Cr54(n,γ)Cr55(β^-) Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60m(IT)Co60	47.3			
		V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ)Cr54(n,γ)Cr55(β^-) Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60	28.8			
		V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ)Cr54(n,γ)Cr55(β^-) Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60m(IT)Co60	14.8			
		V51(n,γ)V52(β^-)Cr52(n,γ)Cr53(n,γ)Cr54(n,γ)Cr55(β^-) Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60	9.0			
H3	12.33y	V50(n,p)H1(n,γ)H2(n,γ)H3	100.0	99.8	96.1	
		V51(n,p)H1(n,γ)H2(n,γ)H3			3.9	
		V51(n,t)H3				81.3
		V51(n,2n)V50(n,t)H3				16.1
		V50(n,t)H3				2.5
Ar42	33.00y	V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(n,α)Ar42				98.7
Ar39	269.01y	V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-)Sc45(n,α)K42(β^-) Ca42(n,α)Ar39				50.1
		V51(n,2n)V50(n,α)Sc47(β^-)Ti47(n,nα)Ca43(n,nα)Ar39				6.5
		V51(n,2n)V50(n,α)Sc47(β^-)Ti47(n,α)Ca44(n,2n) Ca43(n,nα)Ar39				4.8
		V51(n,α)Sc48(β^-)Ti48(n,2n)Ti47(n,nα)Ca43(n,nα)Ar39				1.6
		V51(n,α)Sc48(β^-)Ti48(n,2n)Ti47(n,α)Ca44(n,2n) Ca43(n,nα)Ar39				1.2
Ca41	1.0 10^5y	V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-)Sc45(n,α)K42(β^-) Ca42(n,2n)Ca41				80.7
		V50(n,2n)V49(n,α)Sc46(β^-)Ti46(n,nα)Ca42(n,2n)Ca41				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cl36	3.0 10^5y	V51(n,2n)V50(n,α)Sc47(β^-)Ti47(n,α)Ca44(n,α)Ar41(β^-) K41(n,nα)Cl37(n,2n)Cl36				21.1
		V51(n,2n)V50(n,α)Sc47(β^-)Ti47(n,α)Ca44(n,α)Ar41(β^-) K41(n,2n)K40(n,nα)Cl36				12.4
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-)Sc45(n,nα)K41(n,nα) Cl37(n,2n)Cl36				10.9
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-)Sc45(n,nα)K41(n,2n) K40(n,nα)Cl36				6.4
		V51(n,α)Sc48(β^-)Ti48(n,2n)Ti47(n,α)Ca44(n,α)Ar41(β^-) K41(n,nα)Cl37(n,2n)Cl36				5.3
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(n,2n)Ca44(n,α)Ar41(β^-) K41(n,nα)Cl37(n,2n)Cl36				3.4
		V51(n,α)Sc48(β^-)Ti48(n,2n)Ti47(n,α)Ca44(n,α)Ar41(β^-) K41(n,2n)K40(n,nα)Cl36				3.1
		V51(n,α)Sc48(β^-)Ti48(n,nα)Ca44(n,α)Ar41(β^-)K41(n,nα) Cl37(n,2n)Cl36				2.1
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(n,2n)Ca44(n,α)Ar41(β^-) K41(n,2n)K40(n,nα)Cl36				2.0
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(n,α)Ar42(n,2n)Ar41(β^-) K41(n,nα)Cl37(n,2n)Cl36				1.9
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-)Sc45(n,α)K42(β^-) Ca42(n,nα)Ar38(n,np)Cl37(n,2n)Cl36				1.3
		V51(n,α)Sc48(β^-)Ti48(n,nα)Ca44(n,α)Ar41(β^-)K41(n,2n) K40(n,nα)Cl36				1.3
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-)Sc45(n,2n)Sc44m(n,nα) K40(n,nα)Cl36				1.2
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(n,α)Ar42(n,2n)Ar41(β^-) K41(n,2n)K40(n,nα)Cl36				1.1
K40	1.3 10^9y	V51(n,2n)V50(n,α)Sc47(β^-)Ti47(n,α)Ca44(n,α)Ar41(β^-) K41(n,2n)K40				36.3
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-)Sc45(n,nα)K41(n,2n)K40				17.7
		V51(n,α)Sc48(β^-)Ti48(n,2n)Ti47(n,α)Ca44(n,α)Ar41(β^-) K41(n,2n)K40				9.1
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(n,2n)Ca44(n,α)Ar41(β^-) K41(n,2n)K40				5.5
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(n,α)Ar42(n,2n)Ar41(β^-) K41(n,2n)K40				3.1
		V51(n,α)Sc48(β^-)Ti48(n,nα)Ca44(n,α)Ar41(β^-)K41(n,2n)K40				3.1
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-)Sc45(n,2n) Sc44m(n,nα)K40				2.7
		V51(n,np)Ti50(n,α)Ca47(β^-)Sc47(β^-)Ti47(n,α)Ca44(n,α) Ar41(β^-)K41(n,2n)K40				1.3
		V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-)Sc45(n,α)K42(β^-) Ca42(n,2n)Ca41(n,np)K40				1.2
V50	1.4 10^{17}y	V51(n,2n)V50				92.7

Chromium

Isotope	Atom % abundance
Cr50	4.35
Cr52	83.79
Cr53	9.50
Cr54	2.37

($T_{1/2}$ =1.8 10^{17}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.52E+14	2.91E+14	2.34E+14	7.54E+12	3.46E+06	4.73E-01
Cr51	67.8	82.2	93.1	0.3		
V52	25.5	11.7				
V49	4.6	5.6	6.9	99.7		
V53	1.5	0.2				
H3					100.0	
Mn53						86.9
Cr50						12.9

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	4.01E-02	1.55E-02	1.29E-03	5.70E-06	3.16E-12	1.18E-17
V52	90.1	88.1				
V53	4.4	1.2				
Cr51	3.5	9.0	98.2	2.2		
V54	1.1					
V49		0.1	0.9	95.8		
Mn54				1.1		
H3					100.0	
Cr50						96.6
Mn53						3.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	4.22E+04	1.62E+04	1.24E+03	1.71E+00	6.72E-11	2.07E-13
V52	91.1	89.6				
V53	3.8	1.0				
Cr51	3.2	8.2	98.2	7.0		
V54	1.5					
V49			0.2	82.1		
Mn54				5.8		
Sc46			0.1	5.2		
K42					99.7	
Mn53					0.2	56.9
V50					0.1	43.1

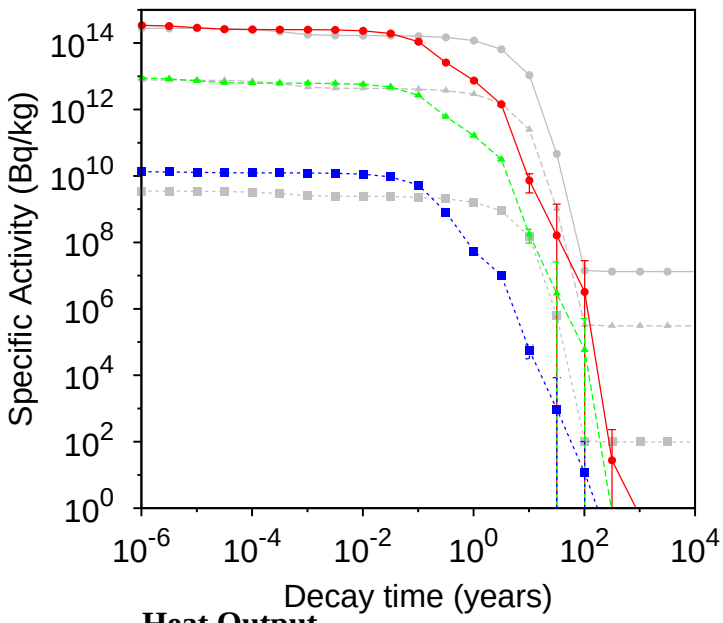
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.08E+04	9.97E+03	8.62E+03	1.37E+02	1.49E-04	9.31E-11
Cr51	84.2	91.0	96.1	0.6		
V52	11.6	4.8				
V49	2.7	2.9	3.4	99.0		
H3					97.1	
Ar42					2.1	
Cr50						85.1
Mn53						13.2
V50						1.4

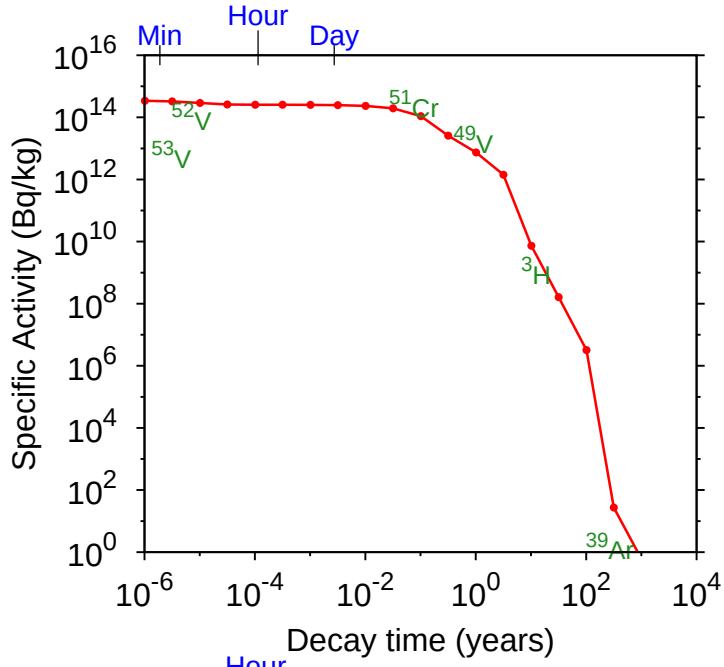
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.04E+04	9.82E+03	8.68E+03	2.58E+02	1.06E-03	1.04E-10
Cr51	85.3	90.0	92.9	0.3		
V52	8.0	3.2				
V49	5.3	5.6	6.3	98.9		
H3				0.1	84.5	
Ar42					11.8	
Ar39					3.7	
Cr50						76.2
Mn53						21.4
V50						2.2

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.52E+11	5.69E+10	2.26E+09	1.61E+07	3.46E+01	1.15E-05
V52	92.3	93.2				
V53	4.1	1.2				
Cr51	1.6	4.2	96.3	1.3		
V54	1.4					
Cr49	0.4	1.1				
Sc46		0.1	1.4	10.1		
V49			0.9	60.6		
Mn54			0.4	27.9		
H3				0.1	100.0	
Cr50						61.6
Mn53						35.8
V50						2.6

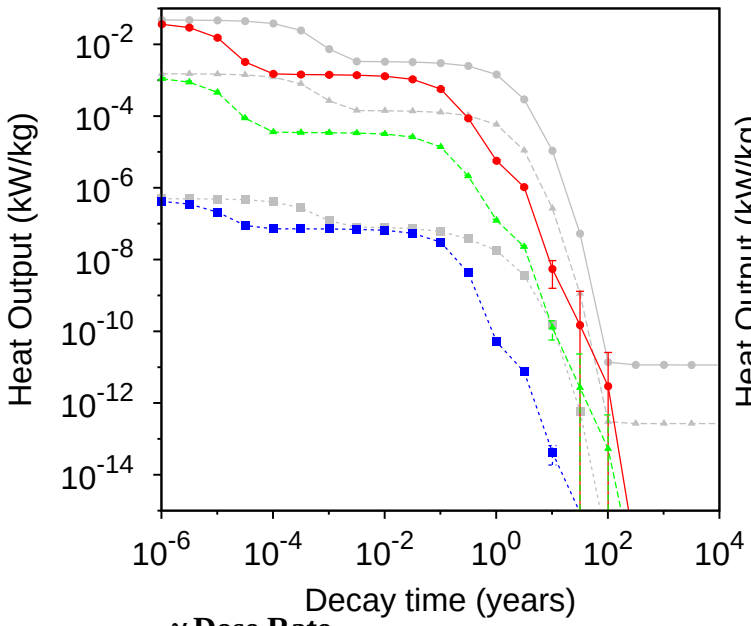
Chromium activation characteristics

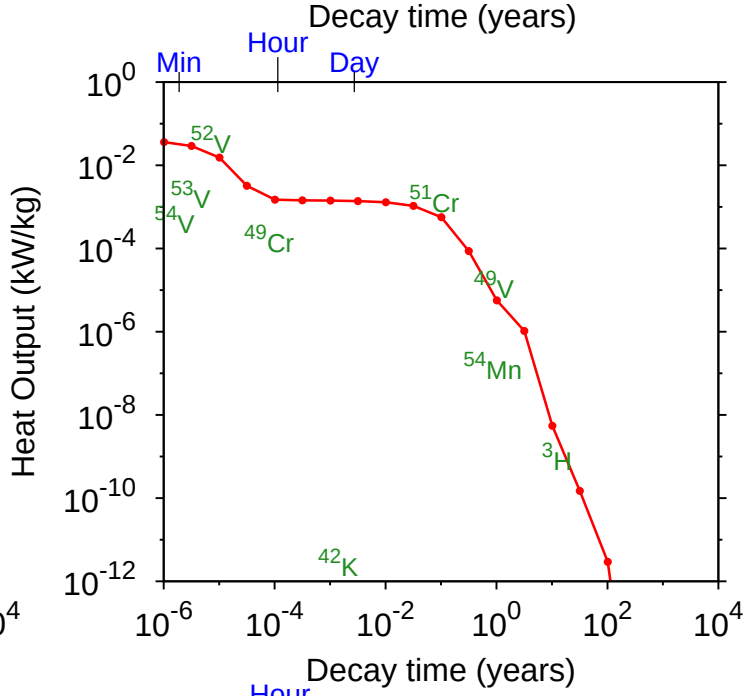
Specific Activity



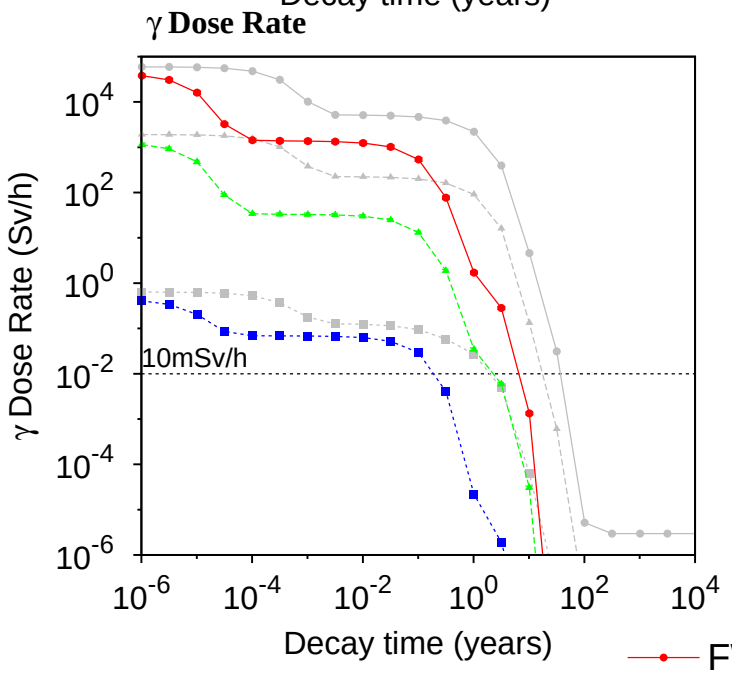


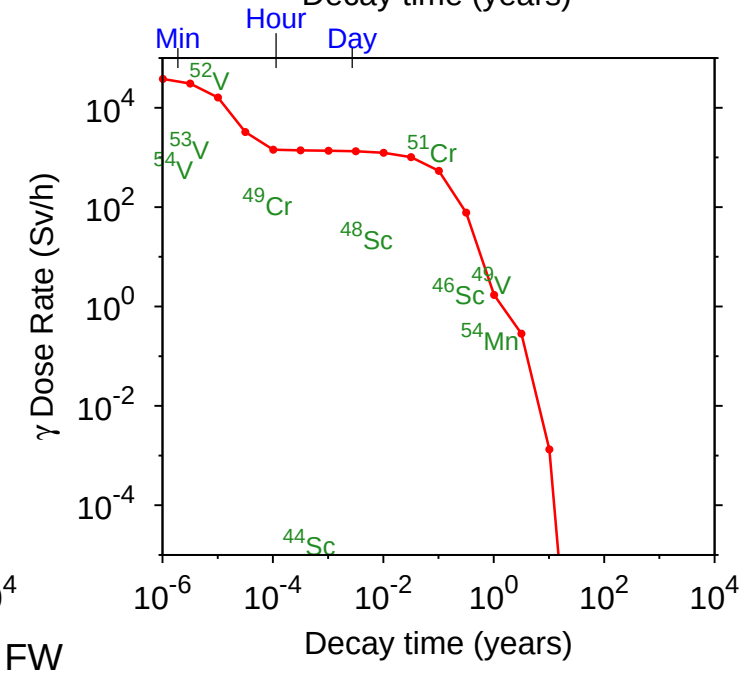
Heat Output





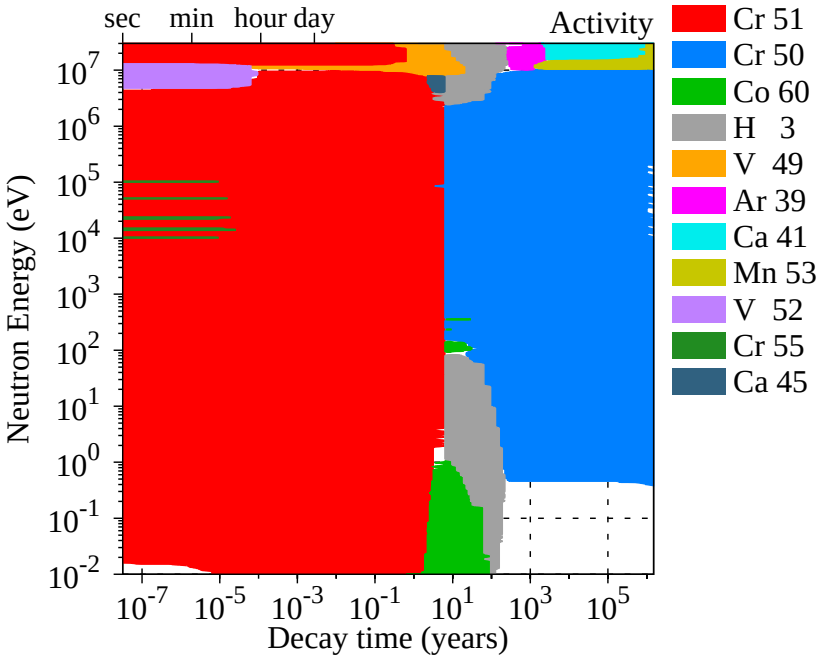
γ Dose Rate

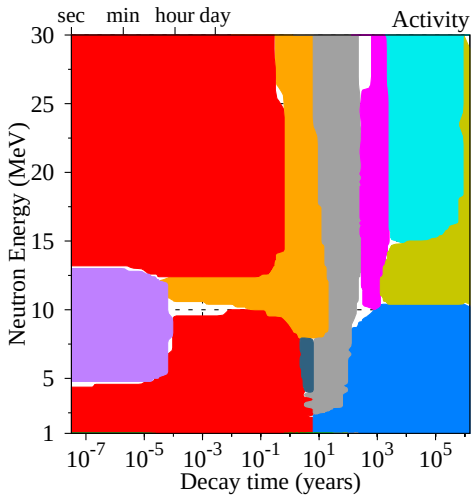


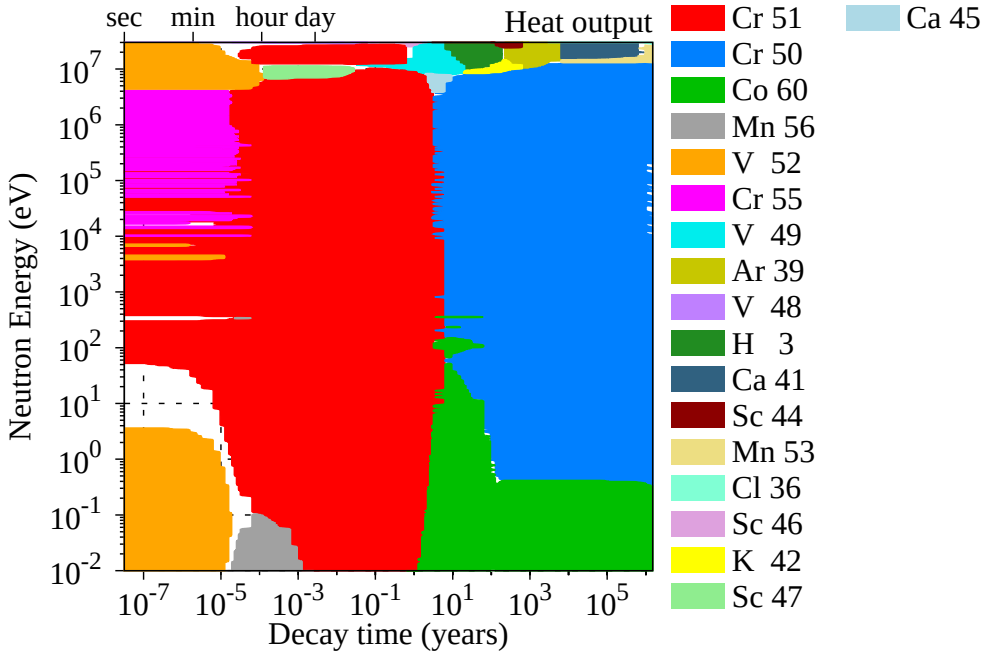


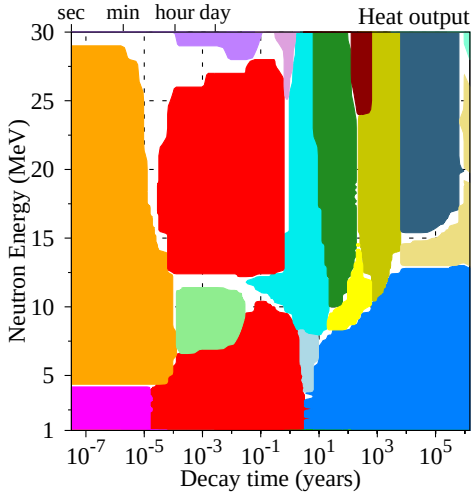
FW
Blanket
Manifold
Fe results

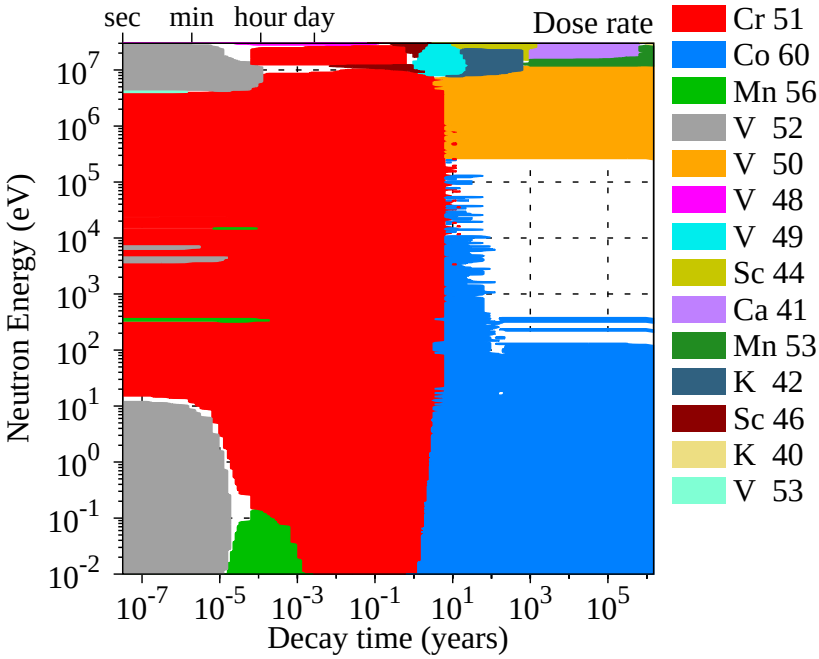
Chromium Importance diagrams

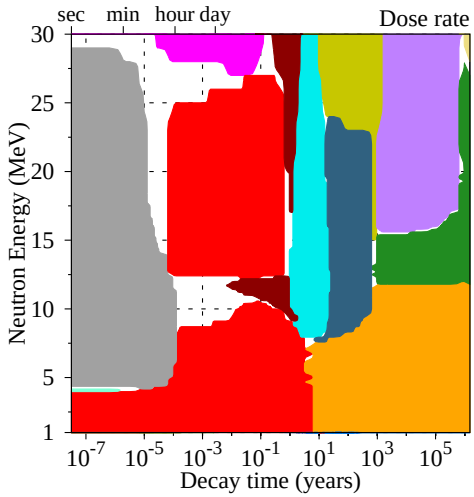




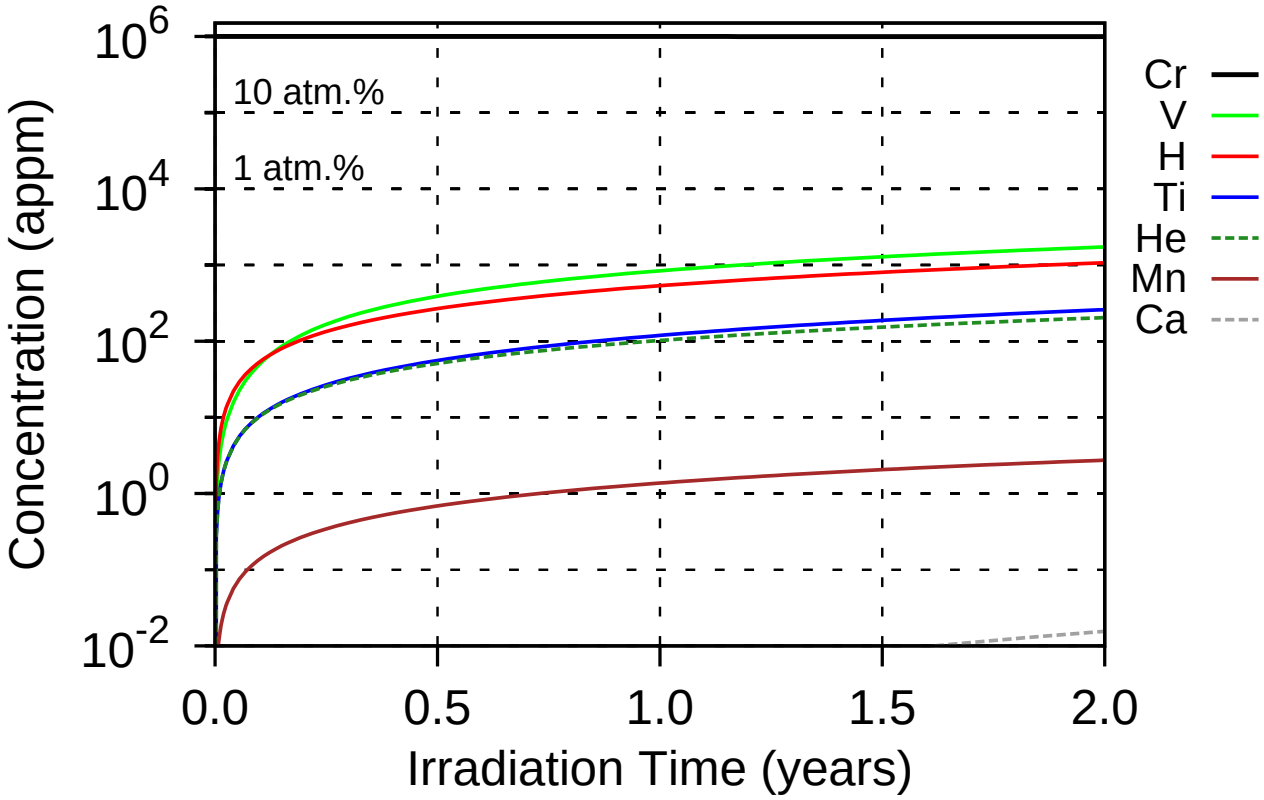




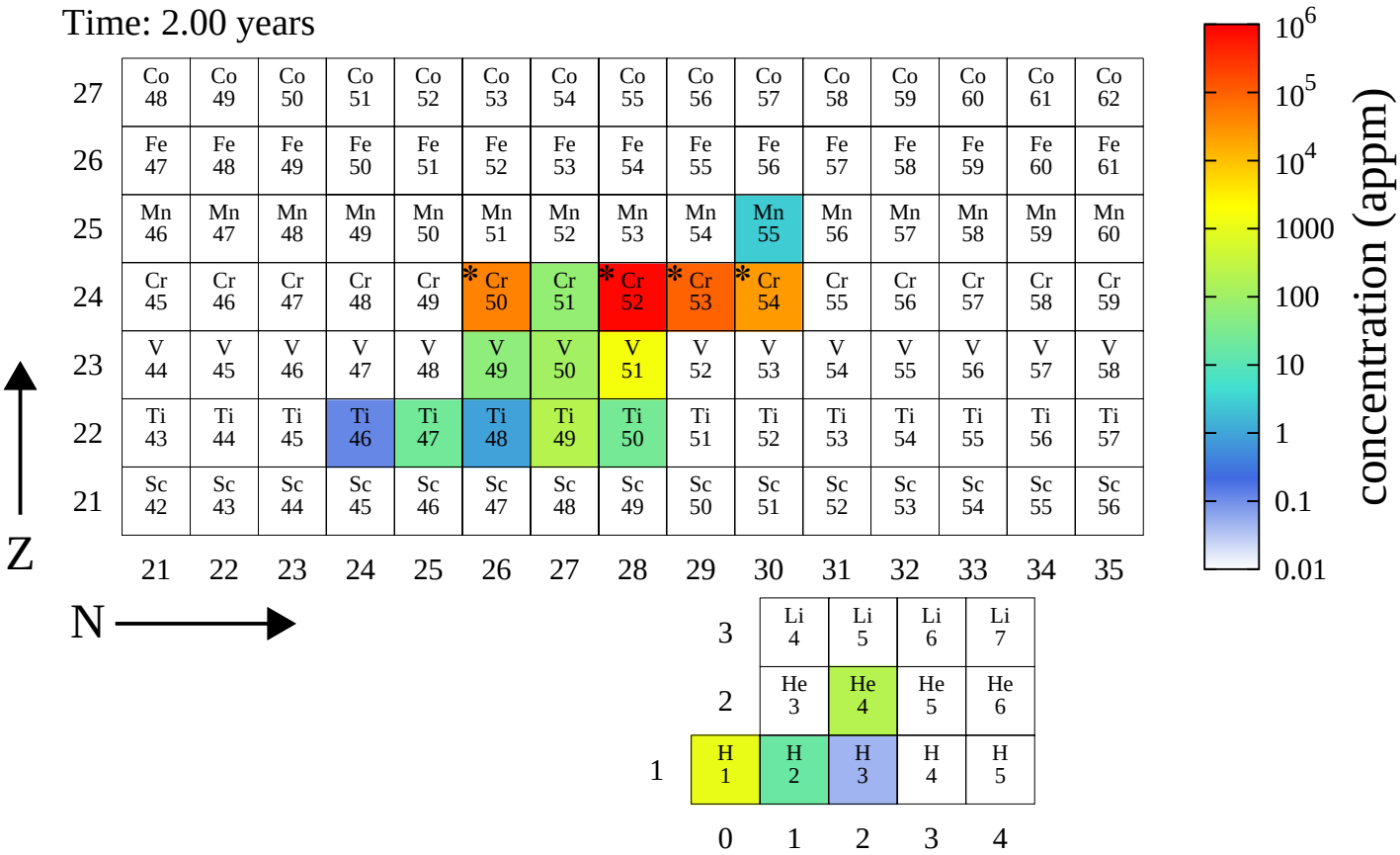




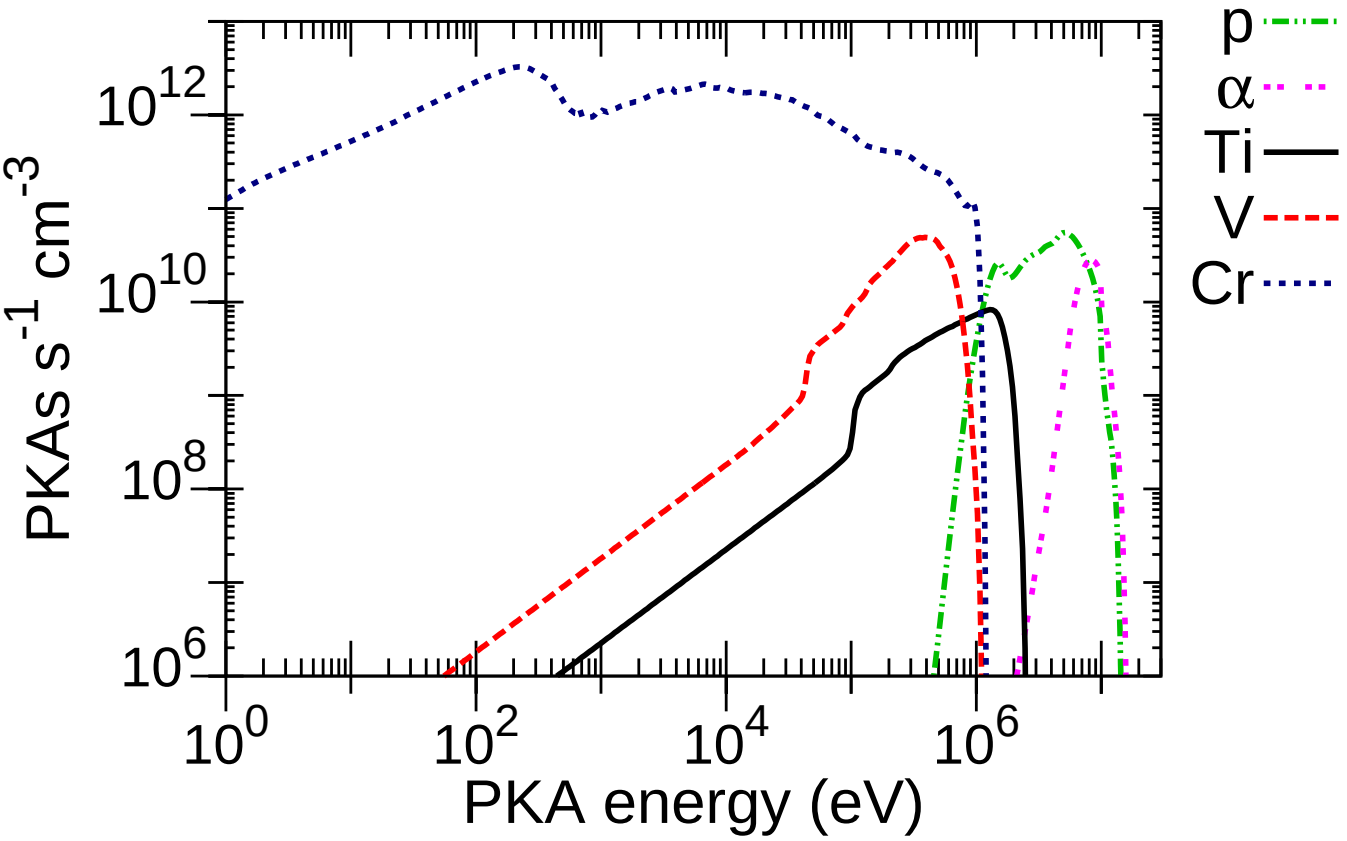
Chromium FW Transmutation

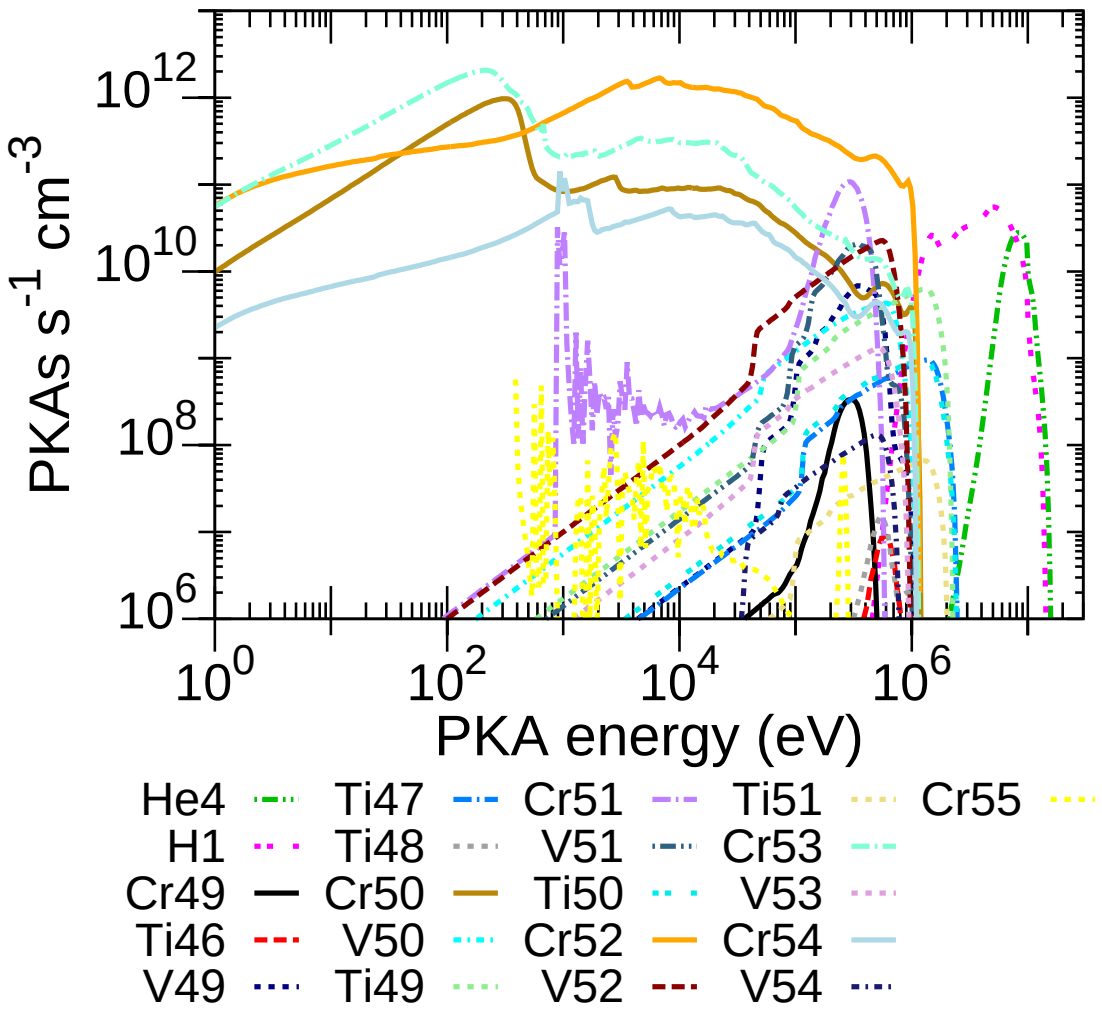


102 appm He & 535 appm H after 1 year 12 dpa/year



Chromium FW PKA distributions





Chromium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
V54	49.80s	Cr50(n,γ)Cr51(β^+)V51(n,γ)V52(n,γ)V53(n,γ)V54	97.8			
		Cr50(n,γ)Cr51(n,p)V51(n,γ)V52(n,γ)V53(n,γ)V54	2.2			
		Cr54(n,p)V54				99.9
V53	1.62m	Cr50(n,γ)Cr51(β^+)V51(n,γ)V52(n,γ)V53	97.8	100.0		
		Cr50(n,γ)Cr51(n,p)V51(n,γ)V52(n,γ)V53	2.2			
		Cr53(n,p)V53			99.9	98.3
		Cr54(n,2n)Cr53(n,p)V53				1.2
Cr55	3.54m	Cr53(n,γ)Cr54(n,γ)Cr55	61.5			
		Cr54(n,γ)Cr55	23.0	99.2	99.9	99.7
		Cr52(n,γ)Cr53(n,γ)Cr54(n,γ)Cr55	15.5			
V52	3.74m	Cr50(n,γ)Cr51(β^+)V51(n,γ)V52	97.8	100.0	99.9	
		Cr50(n,γ)Cr51(n,p)V51(n,γ)V52	2.2			
		Cr52(n,p)V52				98.1
Cr49	41.90m	Cr50(n,2n)Cr49				100.0
Mn56	2.58h	Cr53(n,γ)Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56	57.3			
		Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56	33.2	99.6	100.0	99.5
		Cr52(n,γ)Cr53(n,γ)Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56	9.6			
Sc44	3.97h	Cr52(n,α)Ti49(n,2n)Ti48(n,α)Ca45(β^-)Sc45(n,2n)Sc44				10.4
		Cr50(n,α)Ti47(n,2n)Ti46(n,np)Sc45(n,2n)Sc44				8.1
		Cr52(n,α)Ti49(n,2n)Ti48(n,α)Ca45(β^-)Sc45(n,2n) Sc44m(IT)Sc44				7.3
		Cr50(n,α)Ti47(n,2n)Ti46(n,np)Sc45(n,2n)Sc44m(IT)Sc44				5.7
		Cr52(n,α)Ti49(n,α)Ca46(n,2n)Ca45(β^-)Sc45(n,2n)Sc44				4.9
		Cr50(n,α)Ti47(n,2n)Ti46(n,np)Sc45m(IT)Sc45(n,2n)Sc44				4.2
		Cr52(n,α)Ti49(n,α)Ca46(n,2n)Ca45(β^-)Sc45(n,2n) Sc44m(IT)Sc44				3.5
		Cr50(n,α)Ti47(n,2n)Ti46(n,np)Sc45m(IT)Sc45(n,2n) Sc44m(IT)Sc44				3.0
		Cr50(n,np)V49(n,α)Sc46(n,2n)Sc45(n,2n)Sc44				2.9
		Cr50(n,np)V49(n,np)Ti48(n,α)Ca45(β^-)Sc45(n,2n)Sc44				2.7
		Cr50(n,nα)Ti46(n,np)Sc45(n,2n)Sc44				2.7
		Cr50(n,np)V49(n,α)Sc46(n,2n)Sc45(n,2n)Sc44m(IT)Sc44				2.1
		Cr50(n,np)V49(n,np)Ti48(n,α)Ca45(β^-)Sc45(n,2n) Sc44m(IT)Sc44				1.9
		Cr50(n,nα)Ti46(n,np)Sc45(n,2n)Sc44m(IT)Sc44				1.9
		Cr50(n,np)V49(β^+)Ti49(n,2n)Ti48(n,α)Ca45(β^-) Sc45(n,2n)Sc44				1.9
		Cr50(n,np)V49(n,2n)V48(β^+)Ti48(n,α)Ca45(β^-) Sc45(n,2n)Sc44				1.5
		Cr50(n,np)V49(n,nα)Sc45(n,2n)Sc44				1.4
		Cr50(n,nα)Ti46(n,np)Sc45m(IT)Sc45(n,2n)Sc44				1.4
		Cr52(n,2n)Cr51(n,α)Ti48(n,α)Ca45(β^-)Sc45(n,2n)Sc44				1.4
		Cr50(n,np)V49(β^+)Ti49(n,2n)Ti48(n,α)Ca45(β^-)Sc45(n,2n) Sc44m(IT)Sc44				1.3
		Cr50(n,np)V49(n,α)Sc46(β^-)Ti46(n,np)Sc45(n,2n)Sc44				1.3
		Cr50(n,α)Ti47(n,2n)Ti46(n,2n)Ti45(β^+)Sc45(n,2n)Sc44				1.1
		Cr52(n,2n)Cr51(β^+)V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-) Sc45(n,2n)Sc44				1.1
		Cr50(n,np)V49(n,2n)V48(β^+)Ti48(n,α)Ca45(β^-)Sc45(n,2n) Sc44m(IT)Sc44				1.0
		Cr50(n,np)V49(n,nα)Sc45(n,2n)Sc44m(IT)Sc44				1.0
		Cr50(n,nα)Ti46(n,np)Sc45m(IT)Sc45(n,2n)Sc44m(IT)Sc44				1.0
		Cr52(n,2n)Cr51(n,α)Ti48(n,α)Ca45(β^-)Sc45(n,2n) Sc44m(IT)Sc44				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
K42	12.36h	Cr52(n,α)Ti49(n,2n)Ti48(n,α)Ca45(β^-)Sc45(n,α)K42				15.6
		Cr50(n,α)Ti47(n,2n)Ti46(n,np)Sc45(n,α)K42				12.2
		Cr52(n,α)Ti49(n,α)Ca46(n,2n)Ca45(β^-)Sc45(n,α)K42				7.3
		Cr50(n,α)Ti47(n,2n)Ti46(n,np)Sc45m(IT)Sc45(n,α)K42				6.4
		Cr50(n,np)V49(n,α)Sc46(n,2n)Sc45(n,α)K42				4.4
		Cr50(n,np)V49(n,np)Ti48(n,α)Ca45(β^-)Sc45(n,α)K42				4.1
		Cr50(n,nα)Ti46(n,np)Sc45(n,α)K42				4.0
		Cr50(n,np)V49(β^+)Ti49(n,2n)Ti48(n,α)Ca45(β^-)Sc45(n,α)K42				2.8
		Cr50(n,np)V49(n,2n)V48(β^+)Ti48(n,α)Ca45(β^-)Sc45(n,α)K42				2.2
		Cr50(n,np)V49(n,nα)Sc45(n,α)K42				2.1
		Cr50(n,nα)Ti46(n,np)Sc45m(IT)Sc45(n,α)K42				2.1
		Cr52(n,2n)Cr51(n,α)Ti48(n,α)Ca45(β^-)Sc45(n,α)K42				2.1
		Cr50(n,np)V49(n,α)Sc46(β^-)Ti46(n,np)Sc45(n,α)K42				1.9
		Cr50(n,α)Ti47(n,2n)Ti46(n,nα)Ca42(n,p)K42				1.7
		Cr50(n,α)Ti47(n,2n)Ti46(n,2n)Ti45(β^+)Sc45(n,α)K42				1.7
		Cr52(n,2n)Cr51(β^+)V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-) Sc45(n,α)K42				1.7
		Cr50(n,np)V49(n,α)Sc46(n,nα)K42				1.6
		Cr50(n,np)V49(β^+)Ti49(n,α)Ca46(n,2n)Ca45(β^-)Sc45(n,α)K42				1.3
		Cr50(n,np)V49(n,α)Sc46(n,2n)Sc45m(IT)Sc45(n,α)K42				1.3
		Cr50(n,α)Ti47(n,α)Ca44(n,2n)Ca43(n,np)K42				1.2
		Cr50(n,α)Ti47(n,2n)Ti46(n,α)Ca43(n,np)K42				1.1
		Cr50(n,np)V49(n,α)Sc46m(IT)Sc46(n,2n)Sc45(n,α)K42				1.1
		Cr50(n,α)Ti47(n,np)Sc46(n,2n)Sc45(n,α)K42				1.0
		Cr50(n,α)Ti47(n,nα)Ca43(n,np)K42				1.0
		Cr50(n,np)V49(n,α)Sc46(β^-)Ti46(n,np)Sc45m(IT) Sc45(n,α)K42				1.0
		Cr52(n,nα)Ti48(n,α)Ca45(β^-)Sc45(n,α)K42				1.0
Sc47	3.35d	Cr50(n,α)Ti47(n,p)Sc47			80.4	40.0
		Cr50(n,p)V50(n,α)Sc47			19.6	44.8
		Cr52(n,2n)Cr51(β^+)V51(n,2n)V50(n,α)Sc47				8.1
		Cr53(n,α)Ti50(n,α)Ca47(β^-)Sc47				2.5
		Cr52(n,np)V51(n,2n)V50(n,α)Sc47				2.4
V48	15.97d	Cr50(n,np)V49(n,2n)V48				92.9
		Cr50(n,2n)Cr49(β^+)V49(n,2n)V48				2.8
		Cr50(n,d)V49(n,2n)V48				2.0
		Cr50(n,p)V50(n,2n)V49(n,2n)V48				2.0
Cr51	27.70d	Cr50(n,γ)Cr51	100.0	100.0	100.0	
		Cr52(n,2n)Cr51				98.8
Sc46	83.79d	Cr50(n,np)V49(n,α)Sc46				57.3
		Cr50(n,α)Ti47(n,np)Sc46				15.8
		Cr50(n,np)V49(n,α)Sc46m(IT)Sc46				13.8
		Cr50(n,α)Ti47(n,np)Sc46m(IT)Sc46				2.1
		Cr50(n,2n)Cr49(β^+)V49(n,α)Sc46				1.7
		Cr50(n,α)Ti47(n,2n)Ti46(n,p)Sc46				1.6
		Cr50(n,α)Ti47(n,d)Sc46				1.6
		Cr50(n,d)V49(n,α)Sc46				1.2
		Cr50(n,p)V50(n,2n)V49(n,α)Sc46				1.1
Ca45	162.99d	Cr50(n,α)Ti47(n,α)Ca44(n,γ)Ca45			100.0	
		Cr52(n,α)Ti49(n,2n)Ti48(n,α)Ca45				38.5
		Cr52(n,α)Ti49(n,α)Ca46(n,2n)Ca45				18.1
		Cr50(n,np)V49(n,np)Ti48(n,α)Ca45				9.3
		Cr50(n,np)V49(β^+)Ti49(n,2n)Ti48(n,α)Ca45				8.5
		Cr50(n,np)V49(n,2n)V48(β^+)Ti48(n,α)Ca45				5.1
		Cr52(n,2n)Cr51(β^+)V51(n,α)Sc48(β^-)Ti48(n,α)Ca45				4.3
		Cr50(n,np)V49(β^+)Ti49(n,α)Ca46(n,2n)Ca45				4.0
		Cr52(n,2n)Cr51(n,α)Ti48(n,α)Ca45				3.8
		Cr52(n,nα)Ti48(n,α)Ca45				1.7
		Cr52(n,np)V51(n,α)Sc48(β^-)Ti48(n,α)Ca45				1.3
Mn54	312.16d	Cr54(n,γ)Cr55(β^-)Mn55(n,2n)Mn54				99.9
V49	330.01d	Cr50(n,np)V49				92.8
		Cr50(n,2n)Cr49(β^+)V49				2.8
		Cr50(n,p)V50(n,2n)V49				2.0
		Cr50(n,d)V49				2.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Co60	5.27y	Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT)Co60	32.4			
		Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60	19.7			
		Cr53(n,γ)Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT)Co60	17.7			
		Cr53(n,γ)Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60	10.8			
		Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT)Co60	6.7			
		Cr53(n,γ)Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT)Co60	4.2			
		Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60	4.1			
		Cr53(n,γ)Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60	2.6			
		Cr52(n,γ)Cr53(n,γ)Cr54(n,γ)Cr55(β^-)Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT)Co60	1.0			
H3	12.33y	Cr50(n,γ)Cr51(n,p)H1(n,γ)H2(n,γ)H3	100.0	99.9		
		Cr50(n,p)H1(n,γ)H2(n,γ)H3			99.9	
		Cr53(n,t)H3				95.6
		Cr50(n,p)V50(n,t)H3				1.3
		Cr52(n,2n)Cr51(β^+)V51(n,t)H3				1.2
Ar42	33.00y	Cr52(n,α)Ti49(n,2n)Ti48(n,α)Ca45(n,α)Ar42				38.2
		Cr52(n,α)Ti49(n,α)Ca46(n,2n)Ca45(n,α)Ar42				18.0
		Cr50(n,np)V49(n,np)Ti48(n,α)Ca45(n,α)Ar42				10.0
		Cr50(n,np)V49(β^+)Ti49(n,2n)Ti48(n,α)Ca45(n,α)Ar42				6.9
		Cr50(n,np)V49(n,2n)V48(β^+)Ti48(n,α)Ca45(n,α)Ar42				5.4
		Cr52(n,2n)Cr51(n,α)Ti48(n,α)Ca45(n,α)Ar42				5.1
		Cr52(n,2n)Cr51(β^+)V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(n,α)Ar42				4.1
		Cr50(n,np)V49(β^+)Ti49(n,α)Ca46(n,2n)Ca45(n,α)Ar42				3.3
		Cr52(n,nα)Ti48(n,α)Ca45(n,α)Ar42				2.4
		Cr52(n,np)V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(n,α)Ar42				1.3
Ar39	269.01y	Cr50(n,α)Ti47(n,nα)Ca43(n,nα)Ar39				20.0
		Cr50(n,α)Ti47(n,α)Ca44(n,2n)Ca43(n,nα)Ar39				18.6
		Cr50(n,α)Ti47(n,2n)Ti46(n,α)Ca43(n,nα)Ar39				15.9
		Cr50(n,α)Ti47(n,2n)Ti46(n,nα)Ca42(n,α)Ar39				10.3
		Cr50(n,nα)Ti46(n,α)Ca43(n,nα)Ar39				7.0
		Cr50(n,nα)Ti46(n,nα)Ca42(n,α)Ar39				4.5
		Cr50(n,np)V49(n,α)Sc46(β^-)Ti46(n,α)Ca43(n,nα)Ar39				2.3
		Cr50(n,α)Ti47(n,nα)Ca43(n,2n)Ca42(n,α)Ar39				2.1
		Cr50(n,α)Ti47(n,α)Ca44(n,2n)Ca43(n,2n)Ca42(n,α)Ar39				1.6
		Cr50(n,np)V49(n,α)Sc46(β^-)Ti46(n,nα)Ca42(n,α)Ar39				1.5
		Cr50(n,α)Ti47(n,nα)Ca43(n,α)Ar40(n,2n)Ar39				1.4
		Cr50(n,α)Ti47(n,2n)Ti46(n,α)Ca43(n,2n)Ca42(n,α)Ar39				1.4
		Cr50(n,α)Ti47(n,α)Ca44(n,2n)Ca43(n,α)Ar40(n,2n)Ar39				1.1
Ca41	1.0 10^5y	Cr50(n,α)Ti47(n,2n)Ti46(n,nα)Ca42(n,2n)Ca41				40.6
		Cr50(n,nα)Ti46(n,nα)Ca42(n,2n)Ca41				17.8
		Cr50(n,α)Ti47(n,nα)Ca43(n,2n)Ca42(n,2n)Ca41				8.4
		Cr50(n,α)Ti47(n,α)Ca44(n,2n)Ca43(n,2n)Ca42(n,2n)Ca41				6.2
		Cr50(n,np)V49(n,α)Sc46(β^-)Ti46(n,nα)Ca42(n,2n)Ca41				6.0
		Cr50(n,α)Ti47(n,2n)Ti46(n,α)Ca43(n,2n)Ca42(n,2n)Ca41				5.3
		Cr50(n,nα)Ti46(n,α)Ca43(n,2n)Ca42(n,2n)Ca41				2.9
		Cr50(n,np)V49(n,α)Sc46m(IT)Sc46(β^-)Ti46(n,nα)Ca42(n,2n)Ca41				1.4
		Cr50(n,α)Ti47(n,np)Sc46(β^-)Ti46(n,nα)Ca42(n,2n)Ca41				1.2
Cl36	3.0 10^5y	no pathways found				
Mn53	3.7 10^6y	Cr54(n,γ)Cr55(β^-)Mn55(n,2n)Mn54(n,2n)Mn53				99.9
K40	1.3 10^9y	no pathways found				
V50	1.4 10^{17}y	Cr50(n,p)V50			100.0	80.3
		Cr52(n,2n)Cr51(β^+)V51(n,2n)V50				14.6
		Cr52(n,np)V51(n,2n)V50				4.3
Cr50	1.8 10^{17}y	no pathways found				

Manganese

Isotope	Atom % abundance
Mn55	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.63E+15	1.57E+15	5.45E+14	2.44E+14	4.92E+07	3.77E+05
Mn56	62.8	63.7				
Mn54	33.7	34.9	99.9	99.8		
Cr55	2.0	0.8				
V52	1.5	0.6				
H3					99.2	
Mn53					0.8	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	5.05E-01	4.85E-01	7.33E-02	3.28E-02	4.49E-11	3.28E-13
Mn56	82.3	83.6				
Mn54	14.6	15.2	100.0	100.0		
V52	2.0	0.8				
Cr55	1.1	0.4				
H3					99.3	
Mn53					0.7	100.0

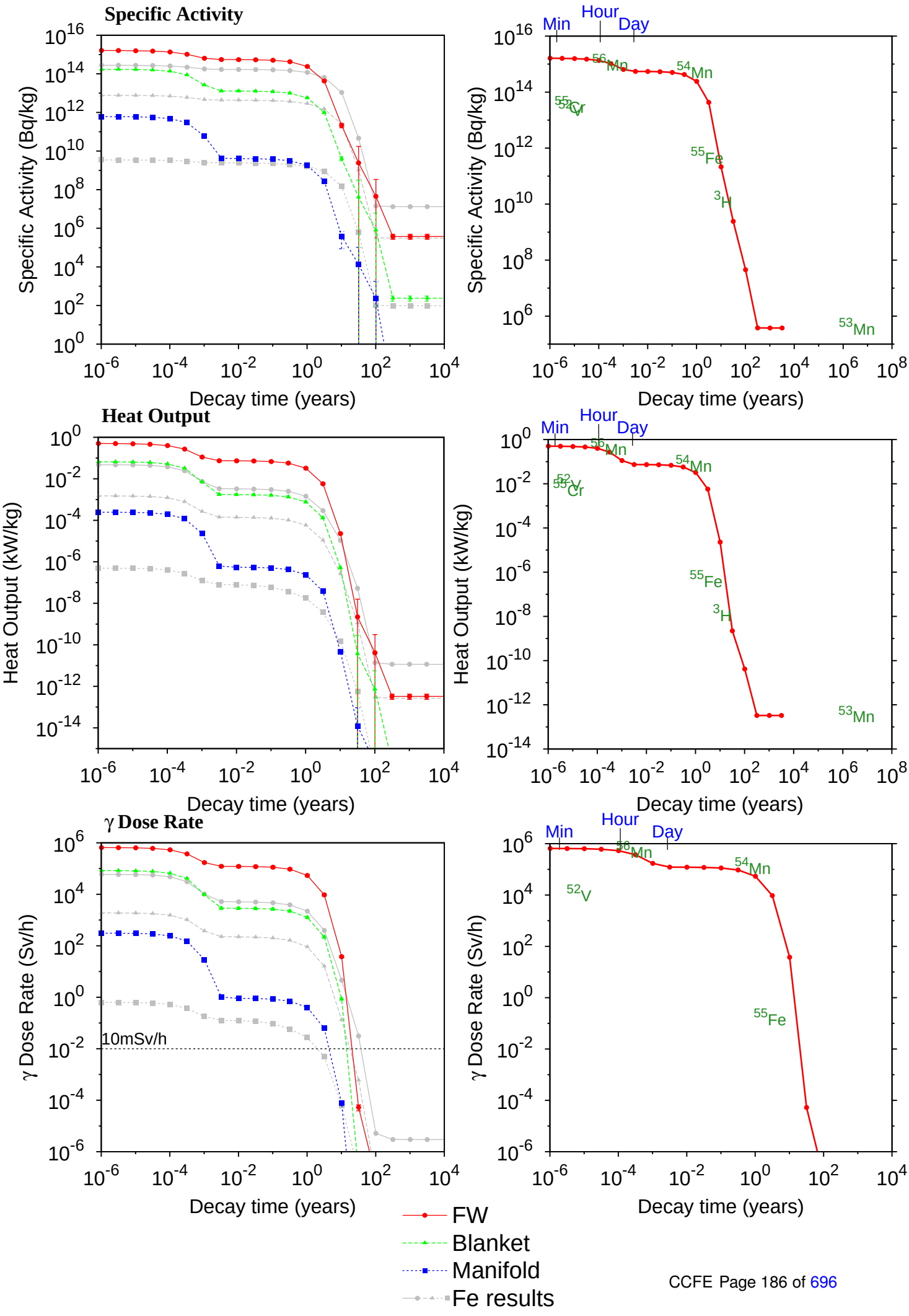
Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	6.56E+05	6.37E+05	1.21E+05	5.43E+04	9.69E-08	9.67E-08
Mn56	79.8	80.2				
Mn54	18.6	19.2	100.0	100.0		
V52	1.6	0.6				
Mn53					100.0	100.0

Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.46E+05	6.40E+05	3.87E+05	1.73E+05	2.06E-03	1.13E-05
Mn54	60.3	60.9	100.0	99.9		
Mn56	39.6	39.1				
H3					99.4	
Mn53					0.6	100.0

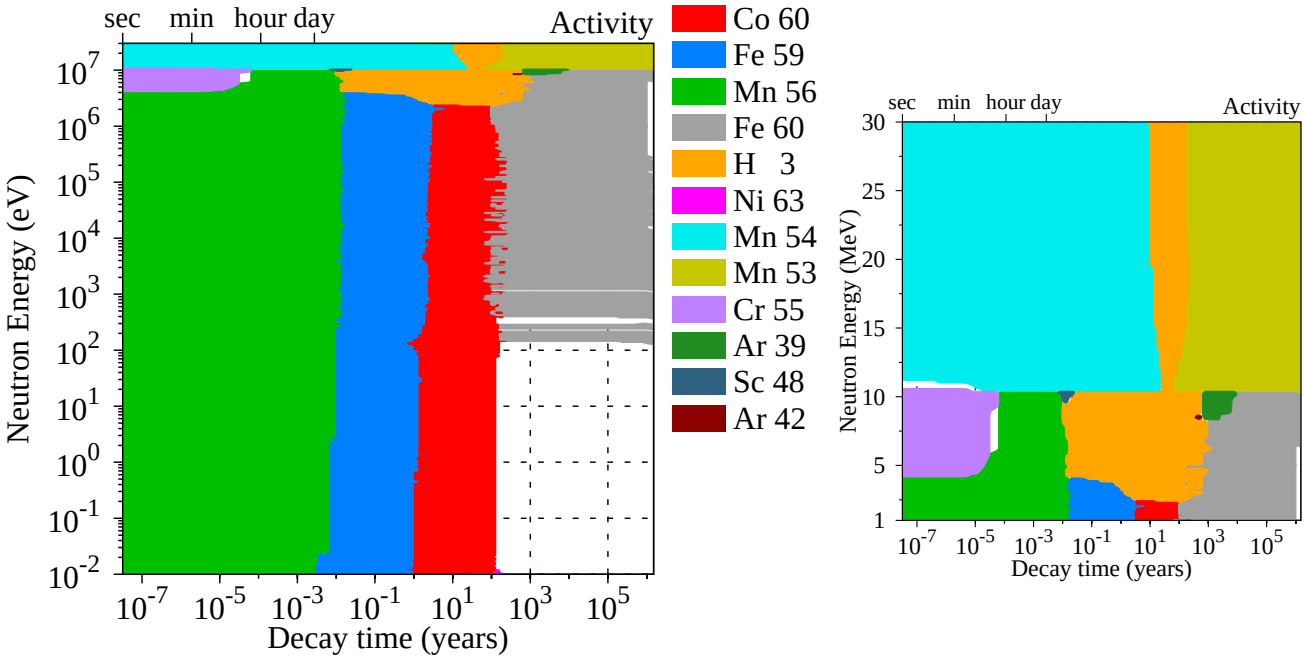
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	9.47E+05	9.44E+05	8.17E+05	3.66E+05	1.27E-02	2.04E-05
Mn54	87.0	87.2	100.0	99.9		
Mn56	13.0	12.7				
H3					99.8	
Mn53					0.2	100.0

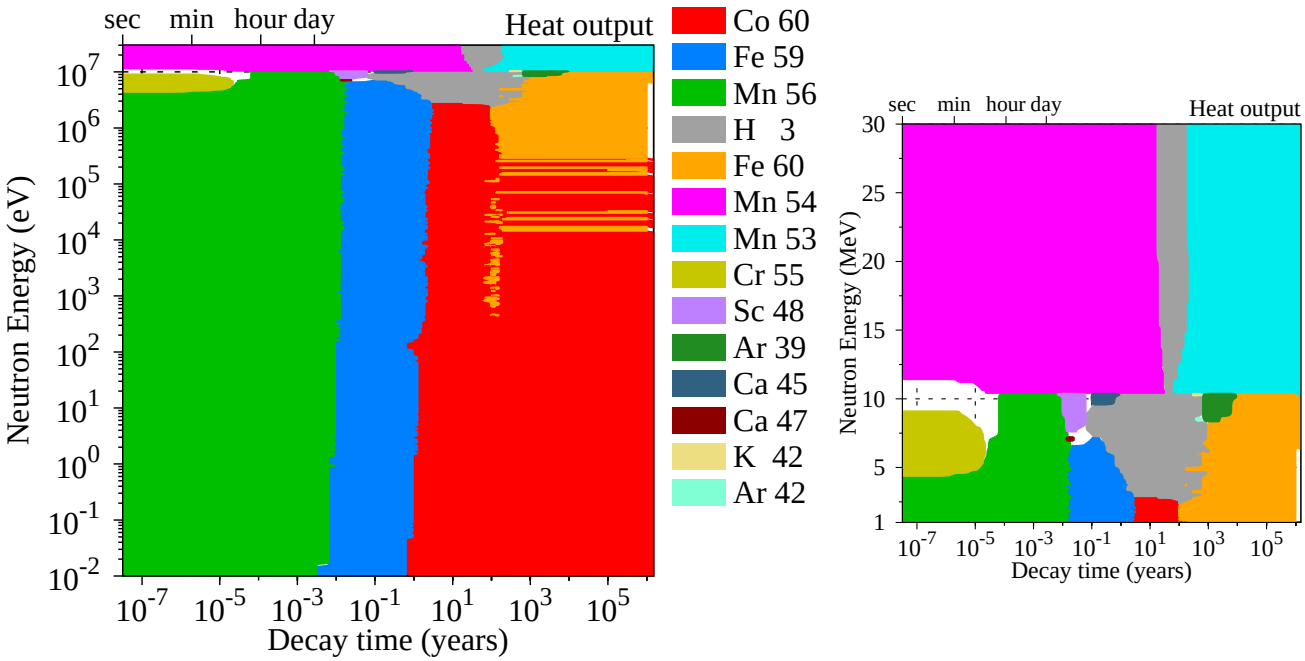
Clear	0s	5.3m	3.7d	1y	100y	10^4y
	5.63E+12	5.60E+12	5.44E+12	2.44E+12	4.92E+02	3.77E+00
Mn54	97.4	97.9	100.0	100.0		
Mn56	1.8	1.8				
H3					99.2	
Mn53					0.8	100.0

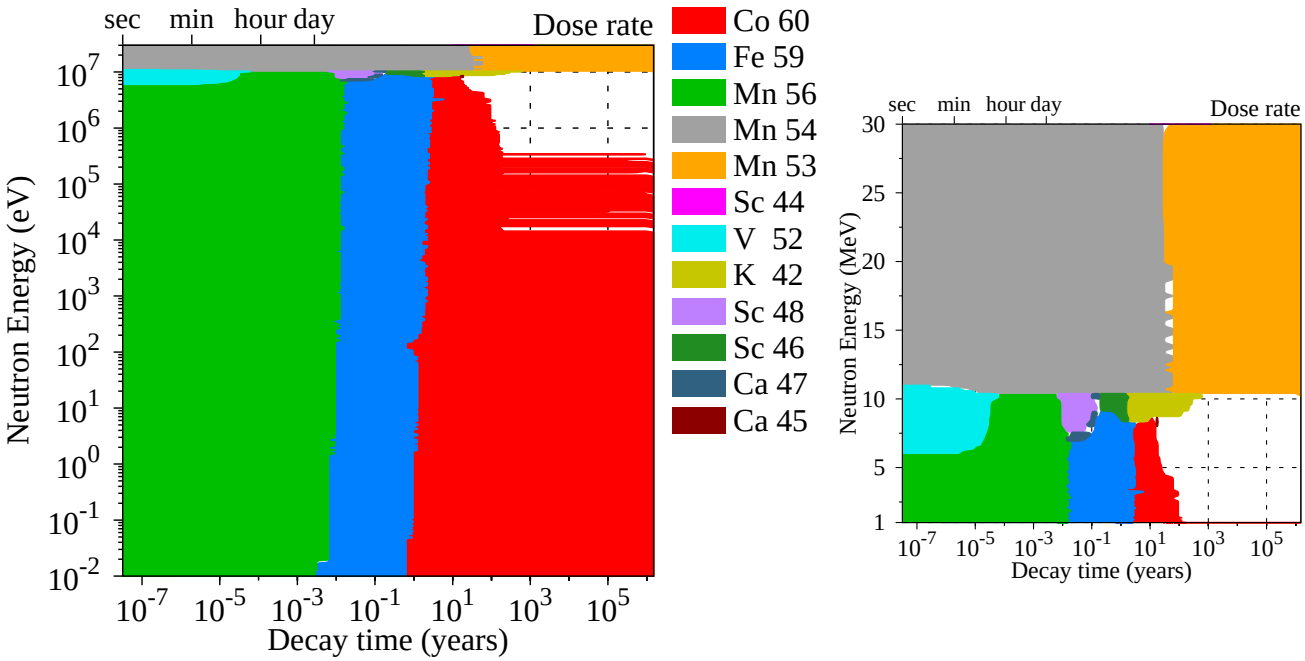
Manganese activation characteristics



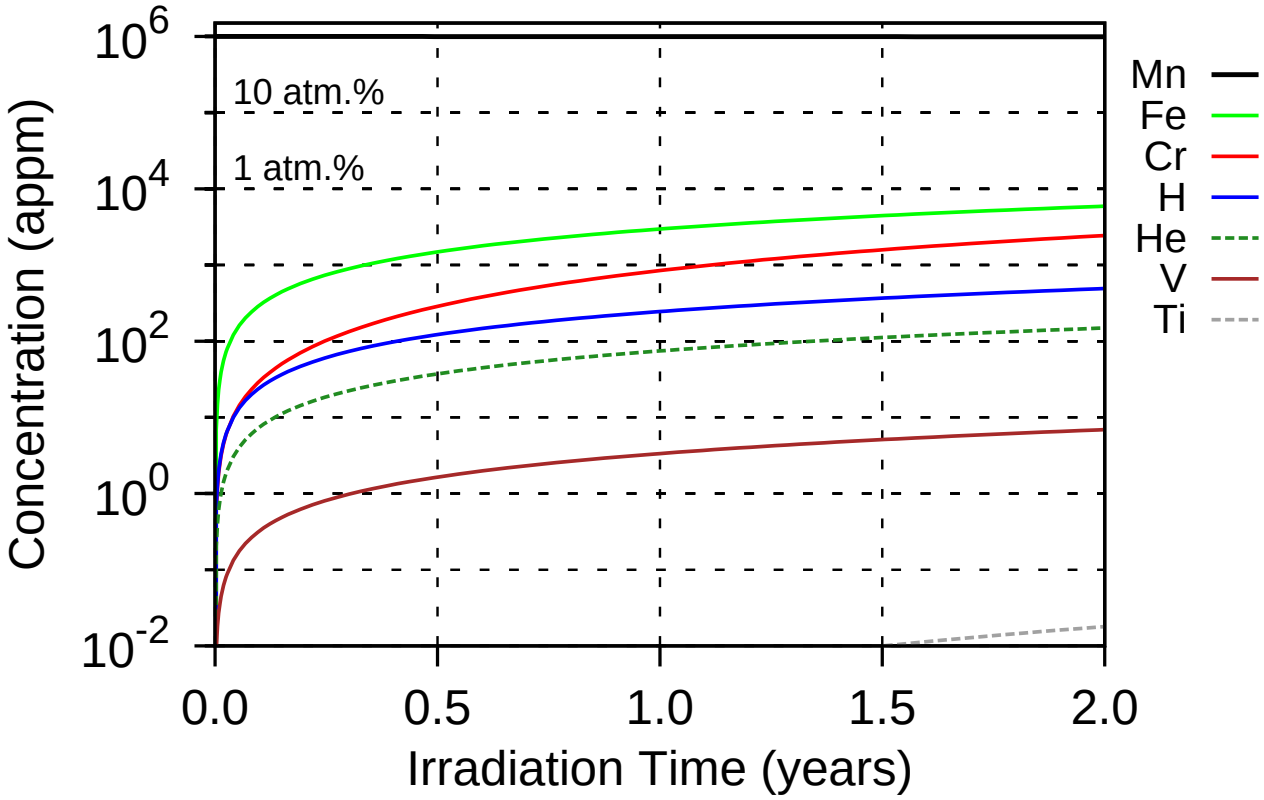
Manganese Importance diagrams



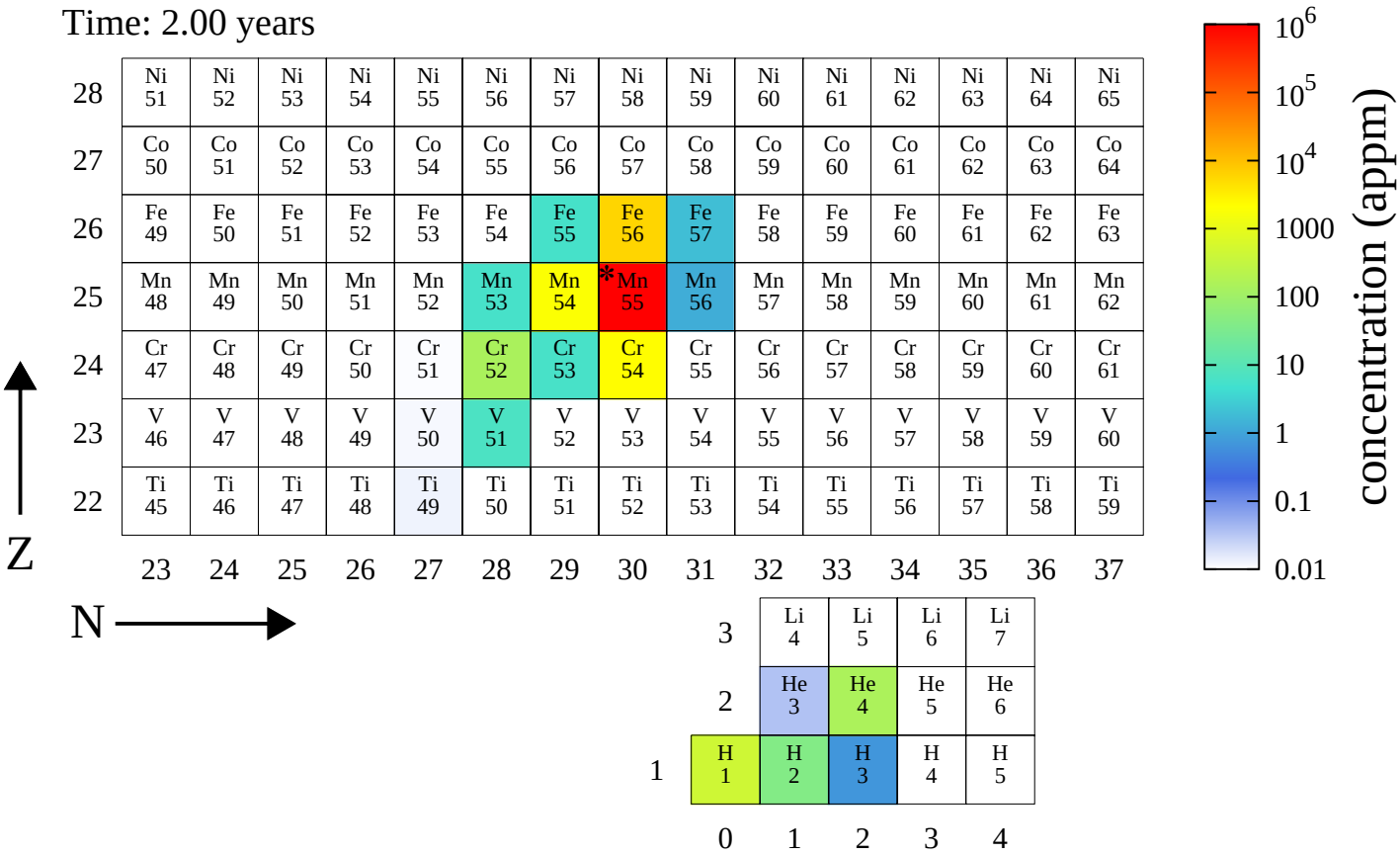




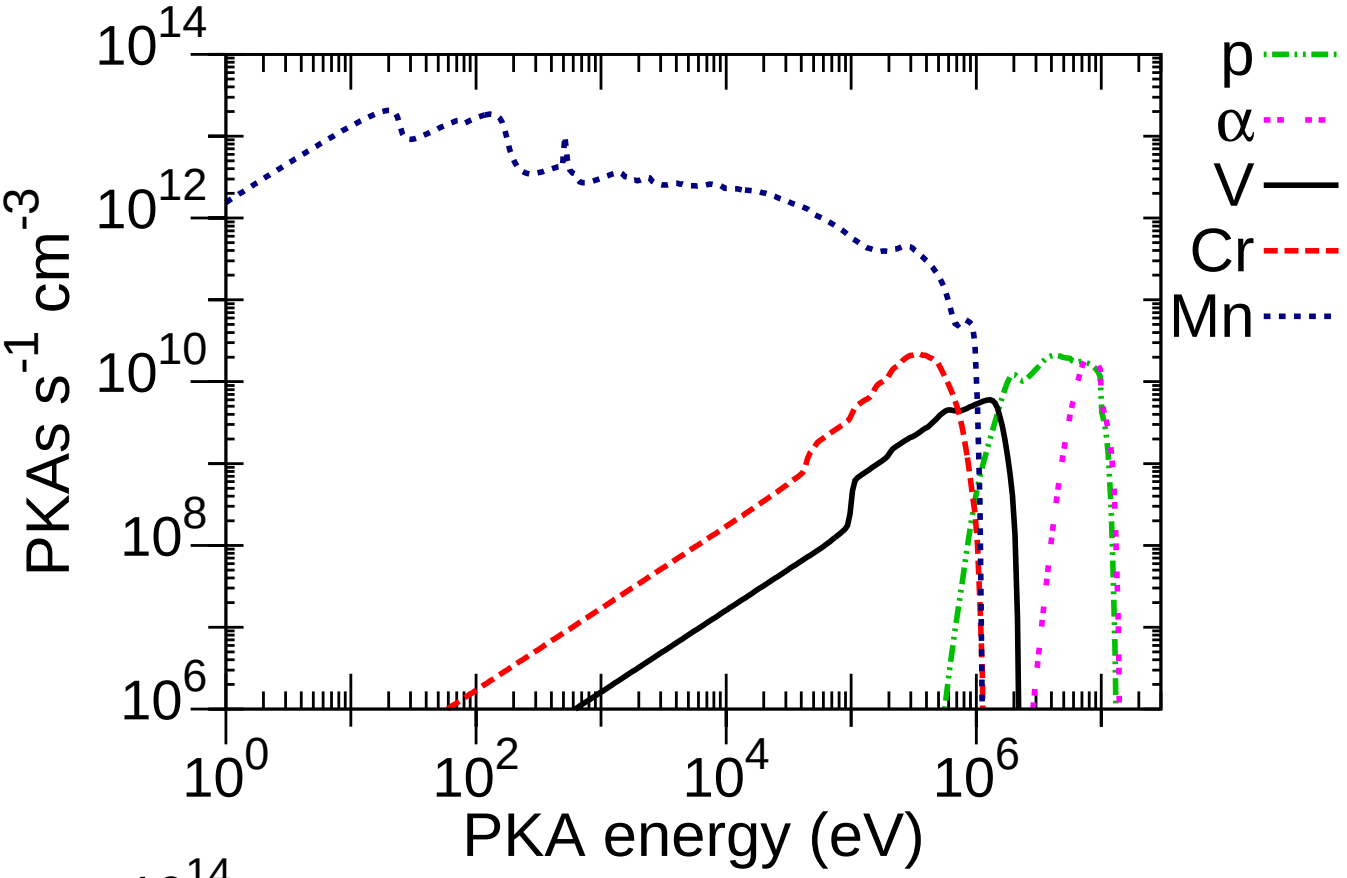
Manganese FW Transmutation

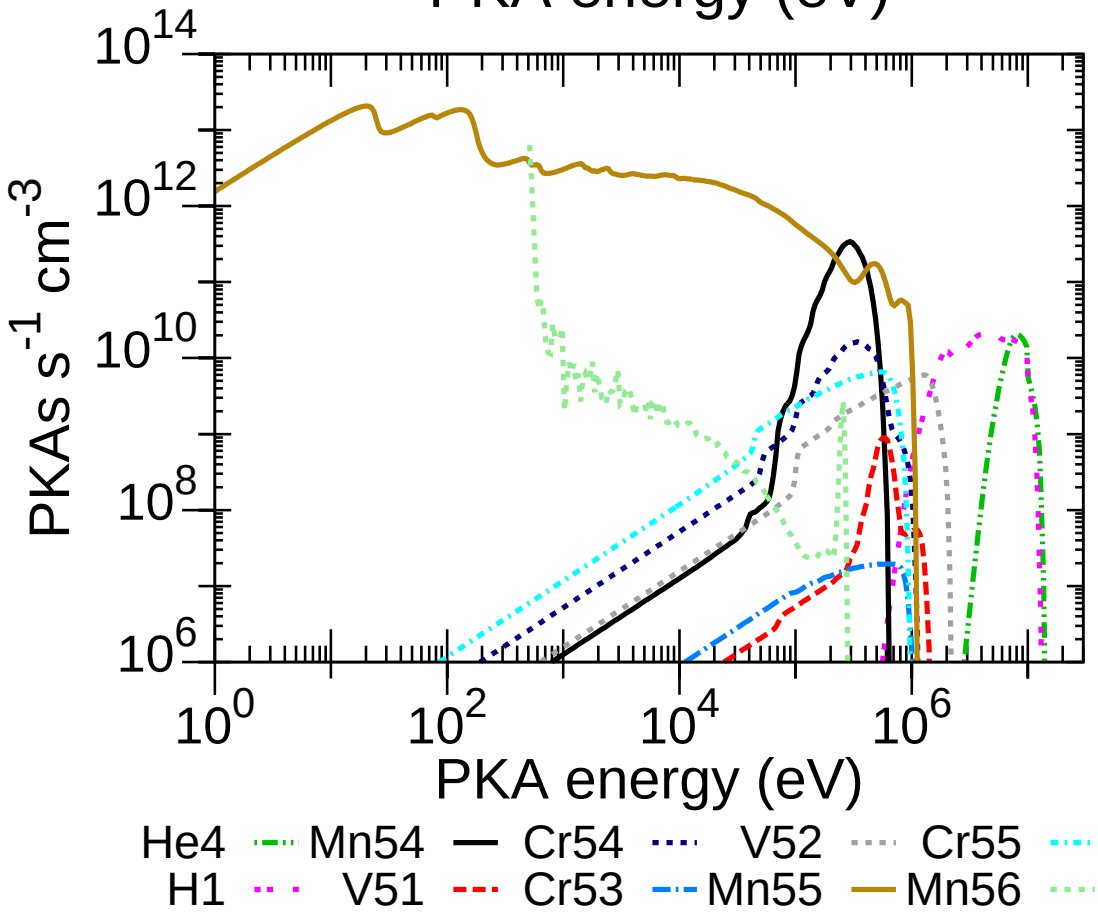


74 appm He & 245 appm H after 1 year 12 dpa/year



Manganese FW PKA distributions





Manganese Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cr55	3.54m	Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,α)Cr54(n,γ)Cr55	91.0			
		Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,α)Cr54(n,γ)Cr55	9.0			
		Mn55(n,p)Cr55			100.0	99.7
V52	3.74m	Mn55(n,α)V52			100.0	99.2
Mn56	2.58h	Mn55(n,γ)Mn56	100.0	100.0	100.0	99.1
Sc44	3.97h	no pathways found				
K42	12.36h	no pathways found				
Sc48	1.82d	Mn55(n,nα)V51(n,α)Sc48				57.0
		Mn55(n,2n)Mn54(n,α)V51(n,α)Sc48				27.0
		Mn55(n,α)V52(β^-)Cr52(n,2n)Cr51(β^+)V51(n,α)Sc48				7.6
		Mn55(n,2n)Mn54(β^+)Cr54(n,α)Ti51(β^-)V51(n,α)Sc48				4.5
		Mn55(n,α)V52(β^-)Cr52(n,np)V51(n,α)Sc48				2.2
Ca47	4.54d	Mn55(n,2n)Mn54(β^+)Cr54(n,2n)Cr53(n,α)Ti50(n,α)Ca47				26.8
		Mn55(n,nα)V51(n,np)Ti50(n,α)Ca47				20.1
		Mn55(n,2n)Mn54(β^+)Cr54(n,nα)Ti50(n,α)Ca47				11.9
		Mn55(n,2n)Mn54(n,pα)Ti50(n,α)Ca47				11.6
		Mn55(n,2n)Mn54(n,α)V51(n,np)Ti50(n,α)Ca47				7.1
		Mn55(n,np)Cr54(n,2n)Cr53(n,α)Ti50(n,α)Ca47				5.7
		Mn55(n,2n)Mn54(n,np)Cr53(n,α)Ti50(n,α)Ca47				5.4
		Mn55(n,np)Cr54(n,nα)Ti50(n,α)Ca47				2.0
		Mn55(n,α)V52(β^-)Cr52(n,2n)Cr51(β^+)V51(n,np)Ti50(n,α)Ca47				1.7
		Mn55(n,nα)V51(n,d)Ti50(n,α)Ca47				1.3
		Mn55(n,t)Cr53(n,α)Ti50(n,α)Ca47				1.0
Fe59	44.50d	Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59	90.4	98.7	99.8	
		Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ)Fe58(n,γ)Fe59	9.6	1.3		
Sc46	83.79d	Mn55(n,nα)V51(n,2n)V50(n,2n)V49(n,α)Sc46				31.7
		Mn55(n,2n)Mn54(n,2n)Mn53(n,α)V50(n,2n)V49(n,α)Sc46				19.8
		Mn55(n,2n)Mn54(n,α)V51(n,2n)V50(n,2n)V49(n,α)Sc46				8.7
		Mn55(n,nα)V51(n,2n)V50(n,2n)V49(n,α)Sc46m(IT)Sc46				7.6
		Mn55(n,2n)Mn54(n,2n)Mn53(n,α)V50(n,2n)V49(n,α) Sc46m(IT)Sc46				4.8
		Mn55(n,2n)Mn54(n,2n)Mn53(n,nα)V49(n,α)Sc46				3.2
		Mn55(n,2n)Mn54(n,nα)V50(n,2n)V49(n,α)Sc46				2.2
		Mn55(n,2n)Mn54(n,α)V51(n,2n)V50(n,2n)V49(n,α) Sc46m(IT)Sc46				2.1
		Mn55(n,nα)V51(n,2n)V50(n,nα)Sc46				1.8
		Mn55(n,α)V52(β^-)Cr52(n,2n)Cr51(β^+)V51(n,2n)V50(n,2n) V49(n,α)Sc46				1.8
		Mn55(n,nα)V51(n,2n)V50(n,α)Sc47(β^-)Ti47(n,np)Sc46				1.7
		Mn55(n,2n)Mn54(n,2n)Mn53(n,α)V50(n,nα)Sc46				1.3
		Mn55(n,2n)Mn54(n,2n)Mn53(n,α)V50(n,α)Sc47(β^-) Ti47(n,np)Sc46				1.0
Ca45	162.99d	Mn55(n,nα)V51(n,α)Sc48(β^-)Ti48(n,α)Ca45				39.1
		Mn55(n,α)V52(β^-)Cr52(n,α)Ti49(n,2n)Ti48(n,α)Ca45				25.2
		Mn55(n,2n)Mn54(n,α)V51(n,α)Sc48(β^-)Ti48(n,α)Ca45				12.1
		Mn55(n,α)V52(β^-)Cr52(n,α)Ti49(n,α)Ca46(n,2n)Ca45				11.9
		Mn55(n,α)V52(β^-)Cr52(n,2n)Cr51(n,α)Ti48(n,α)Ca45				3.4
		Mn55(n,α)V52(β^-)Cr52(n,2n)Cr51(β^+)V51(n,α)Sc48(β^-) Ti48(n,α)Ca45				2.7
		Mn55(n,α)V52(β^-)Cr52(n,nα)Ti48(n,α)Ca45				1.6
		Mn55(n,2n)Mn54(β^+)Cr54(n,α)Ti51(β^-)V51(n,α)Sc48(β^-) Ti48(n,α)Ca45				1.2
Mn54	312.16d	Mn55(n,2n)Mn54				99.9
Co60	5.27y	Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60m(IT)Co60	53.2	57.3	47.6	
		Mn55(n,γ)Mn56(β^-)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60	32.4	40.5	51.4	
		Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60m(IT)Co60	9.0	1.3		
		Mn55(n,γ)Mn56(n,γ)Mn57(β^-)Fe57(n,γ)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60	5.5			
H3	12.33y	Mn55(n,p)H1(n,γ)H2(n,γ)H3			100.0	
		Mn55(n,t)H3				97.5
		Mn55(n,2n)Mn54(n,t)H3				2.4

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ar42	33.00y	Mn55(n,nα)V51(n,α)Sc48(β⁻)Ti48(n,α)Ca45(n,α)Ar42				44.6
		Mn55(n,α)V52(β⁻)Cr52(n,α)Ti49(n,2n)Ti48(n,α) Ca45(n,α)Ar42				22.4
		Mn55(n,2n)Mn54(n,α)V51(n,α)Sc48(β⁻)Ti48(n,α) Ca45(n,α)Ar42				11.3
		Mn55(n,α)V52(β⁻)Cr52(n,α)Ti49(n,α)Ca46(n,2n) Ca45(n,α)Ar42				10.5
		Mn55(n,α)V52(β⁻)Cr52(n,2n)Cr51(n,α)Ti48(n,α) Ca45(n,α)Ar42				3.7
		Mn55(n,α)V52(β⁻)Cr52(n,2n)Cr51(β⁺)V51(n,α)Sc48(β⁻) Ti48(n,α)Ca45(n,α)Ar42				2.3
		Mn55(n,α)V52(β⁻)Cr52(n,nα)Ti48(n,α)Ca45(n,α)Ar42				1.8
Ni63	100.62y	Mn55(n,γ)Mn56(β⁻)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β⁻) Co59(n,γ)Co60m(IT)Co60(n,γ)Co61(β⁻)Ni61(n,γ) Ni62(n,γ)Ni63	42.7			
		Mn55(n,γ)Mn56(β⁻)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β⁻) Co59(n,γ)Co60(n,γ)Co61(β⁻)Ni61(n,γ)Ni62(n,γ)Ni63	26.0			
		Mn55(n,γ)Mn56(n,γ)Mn57(β⁻)Fe57(n,γ)Fe58(n,γ)Fe59(β⁻) Co59(n,γ)Co60m(IT)Co60(n,γ)Co61(β⁻)Ni61(n,γ) Ni62(n,γ)Ni63	11.6			
		Mn55(n,γ)Mn56(β⁻)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(n,γ) Fe60(n,γ)Fe61(β⁻)Co61(β⁻)Ni61(n,γ)Ni62(n,γ)Ni63	7.2			
		Mn55(n,γ)Mn56(n,γ)Mn57(β⁻)Fe57(n,γ)Fe58(n,γ)Fe59(β⁻) Co59(n,γ)Co60(n,γ)Co61(β⁻)Ni61(n,γ)Ni62(n,γ)Ni63	7.1			
		Mn55(n,γ)Mn56(n,γ)Mn57(β⁻)Fe57(n,γ)Fe58(n,γ)Fe59(n,γ) Fe60(n,γ)Fe61(β⁻)Co61(β⁻)Ni61(n,γ)Ni62(n,γ)Ni63	1.8			
		Mn55(n,γ)Mn56(β⁻)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β⁻) Co59(n,γ)Co60m(IT)Co60(β⁻)Ni60(n,γ)Ni61(n,γ) Ni62(n,γ)Ni63	1.5			
Ar39	269.01y	Mn55(n,α)V52(β⁻)Cr52(n,α)Ti49(n,α)Ca46(n,α)Ar43(β⁻) K43(β⁻)Ca43(n,nα)Ar39				5.6
		Mn55(n,nα)V51(n,2n)V50(n,α)Sc47(β⁻)Ti47(n,nα) Ca43(n,nα)Ar39				4.2
		Mn55(n,nα)V51(n,2n)V50(n,α)Sc47(β⁻)Ti47(n,2n)Ti46(n,α) Ca43(n,nα)Ar39				2.2
		Mn55(n,2n)Mn54(n,2n)Mn53(n,α)V50(n,α)Sc47(β⁻)Ti47(n,nα) Ca43(n,nα)Ar39				2.0
		Mn55(n,nα)V51(n,2n)V50(n,α)Sc47(β⁻)Ti47(n,2n)Ti46(n,nα) Ca42(n,α)Ar39				1.4
		Mn55(n,nα)V51(n,2n)V50(n,2n)V49(n,α)Sc46(β⁻)Ti46(n,α) Ca43(n,nα)Ar39				1.1
		Mn55(n,nα)V51(n,α)Sc48(β⁻)Ti48(n,2n)Ti47(n,nα) Ca43(n,nα)Ar39				1.1
Fe60	1.5 10^6y	Mn55(n,γ)Mn56(β⁻)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ) Fe59(n,γ)Fe60	87.5	98.2		
		Mn55(n,γ)Mn56(n,γ)Mn57(β⁻)Fe57(n,γ)Fe58(n,γ) Fe59(n,γ)Fe60	12.5	1.8		
Mn53	3.7 10^6y	Mn55(n,2n)Mn54(n,2n)Mn53				99.9

Iron

Isotope	Atom % abundance
Fe54	5.85
Fe56	91.75
Fe57	2.12
Fe58	0.28

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.80E+14	2.76E+14	1.69E+14	1.20E+14	1.44E+07	1.32E+07
Fe55	50.5	51.2	83.5	91.6		
Mn56	38.8	38.5				
Mn54	8.1	8.2	13.4	8.4		
Cr51	1.9	1.9	2.9			
Mn53					92.0	100.0
H3					8.0	

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	4.78E-02	4.65E-02	3.28E-03	1.46E-03	1.40E-11	1.15E-11
Mn56	92.3	92.7				
Mn54	6.4	6.6	92.5	93.1		
Fe55	0.3	0.3	3.9	6.8		
Fe59	0.2	0.2	2.4			
Mn53					82.3	99.8
Co60					10.1	0.2
H3					7.5	

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	5.95E+04	5.82E+04	5.10E+03	2.22E+03	5.38E-06	2.96E-06
Mn56	91.2	91.1				
Mn54	8.3	8.5	95.9	98.6		
Fe59	0.2	0.2	2.5			
Fe55	0.1	0.1	0.7	1.3		
Mn53					54.6	99.0
Co60					45.4	1.0

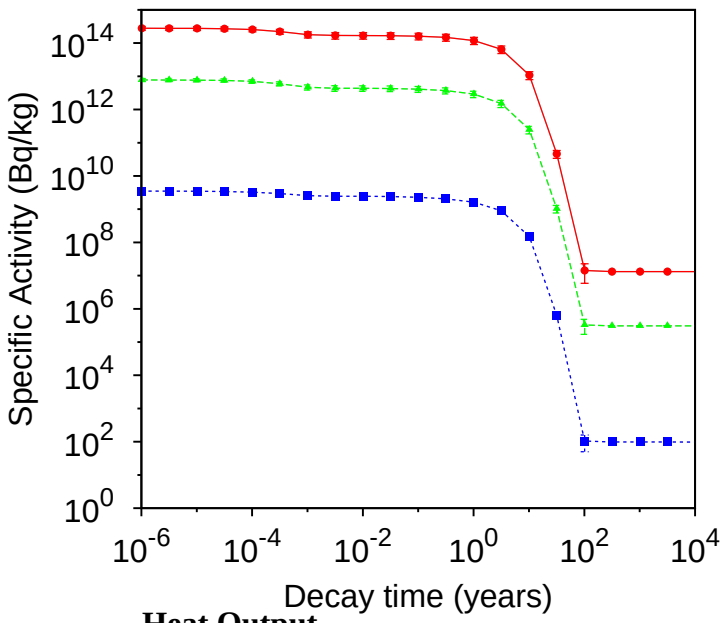
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	9.09E+04	9.03E+04	6.34E+04	4.34E+04	4.63E-04	4.01E-04
Fe55	51.3	51.6	73.4	83.5	0.1	
Mn56	29.9	29.4				
Mn54	17.7	17.9	25.2	16.5		
Fe59	0.8	0.8	1.1			
Mn53					85.9	98.8
H3					10.5	
Co60					2.5	
Fe60					1.0	1.1

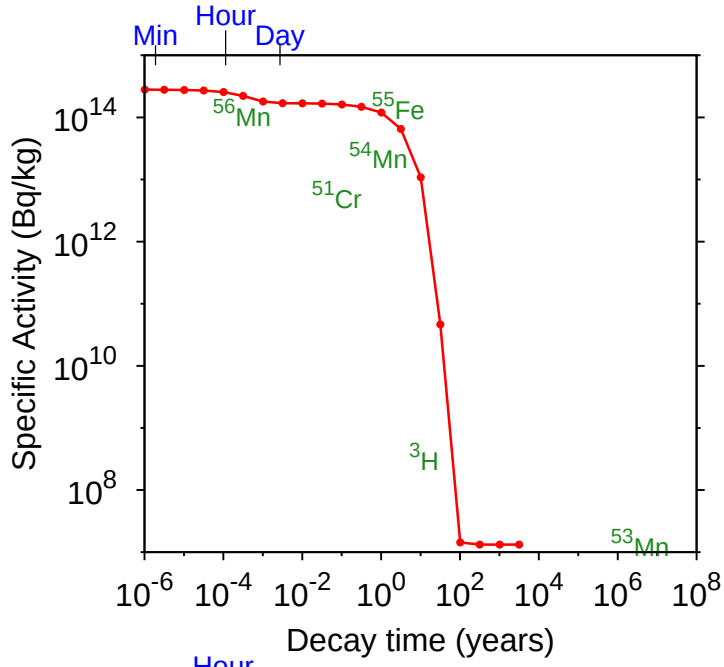
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.58E+05	1.57E+05	1.44E+05	9.96E+04	1.13E-03	7.27E-04
Fe55	69.0	69.1	75.3	84.7	0.1	
Mn54	21.6	21.6	23.5	15.2		
Mn56	8.3	8.1				
Fe59	1.0	1.0	1.0			
Mn53					63.1	98.2
H3					26.4	
Co60					9.3	0.2
Fe60					1.0	1.6

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.39E+11	2.39E+11	2.26E+11	1.01E+11	1.78E+02	1.33E+02
Mn54	94.9	95.2	99.7	99.9		
Mn56	4.5	4.5				
Mn53					74.4	99.7
Co60					19.1	0.3
H3					6.5	

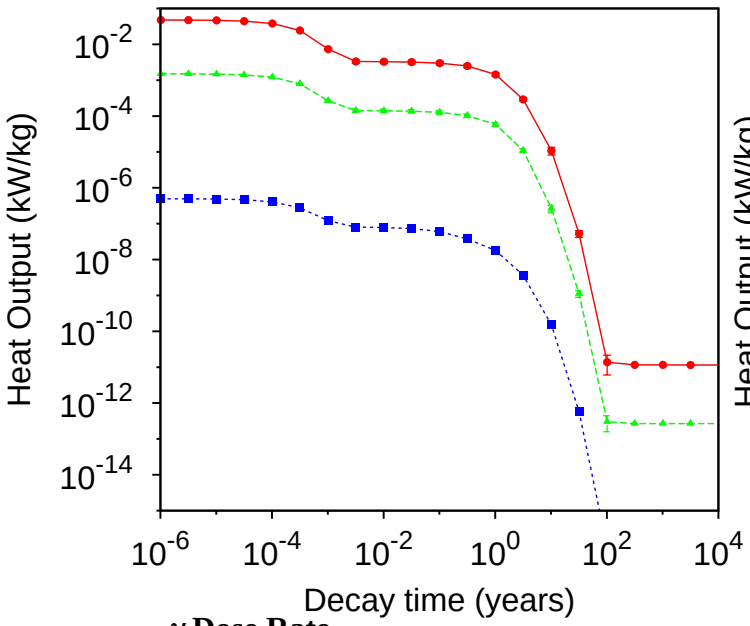
Iron activation characteristics

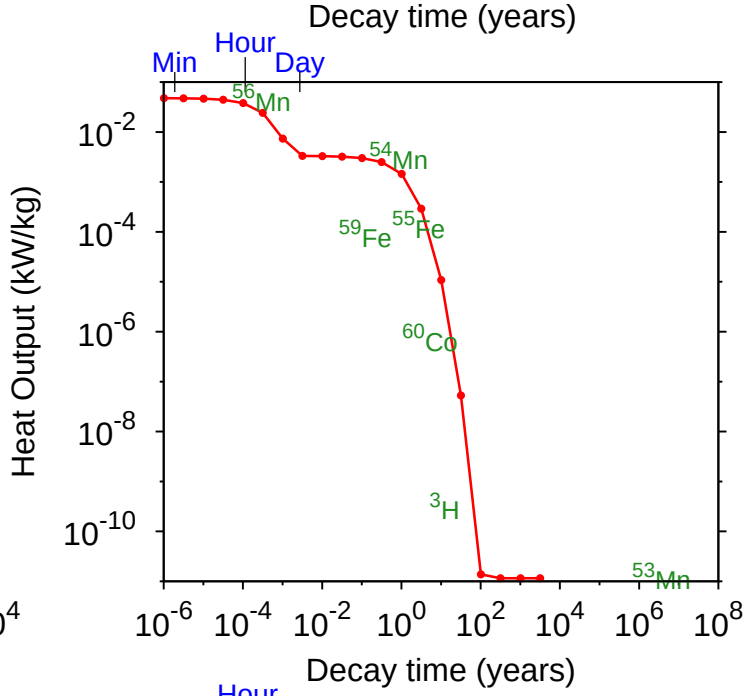
Specific Activity



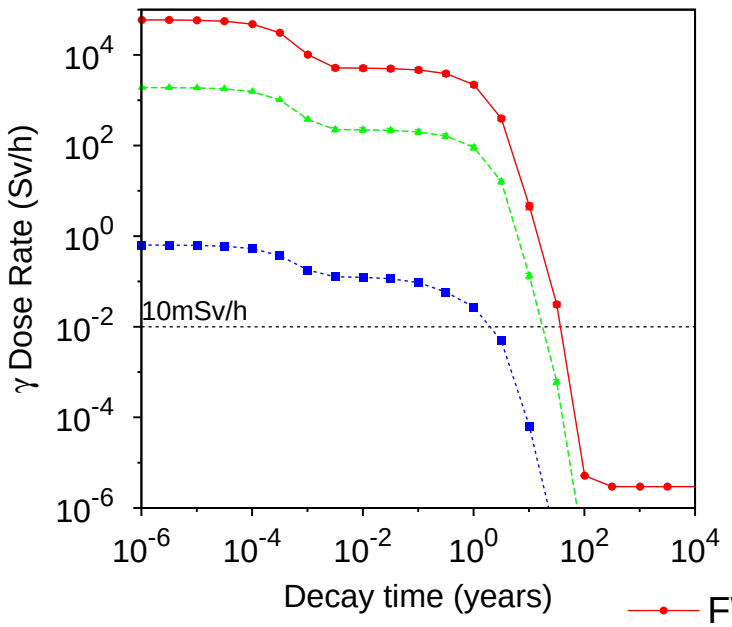


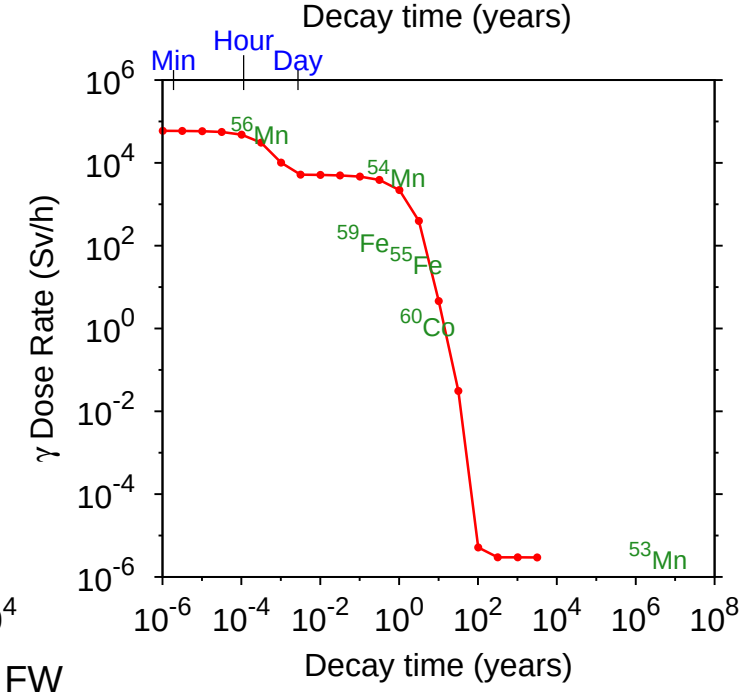
Heat Output





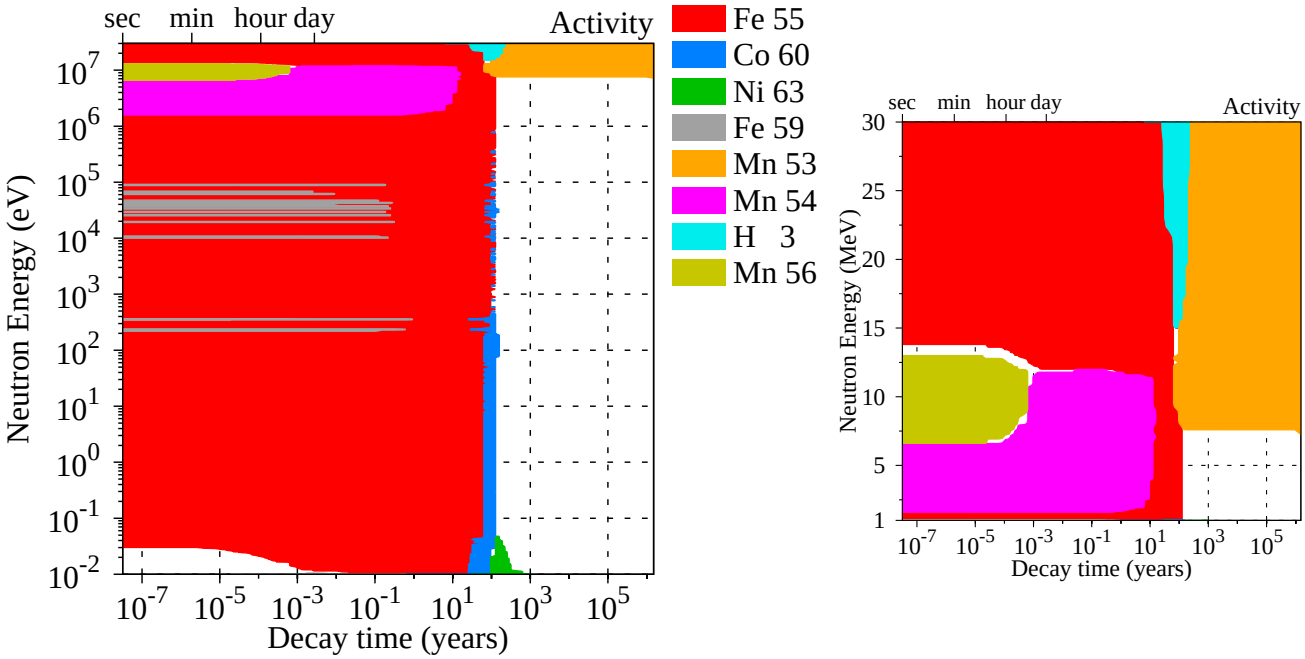
γ Dose Rate

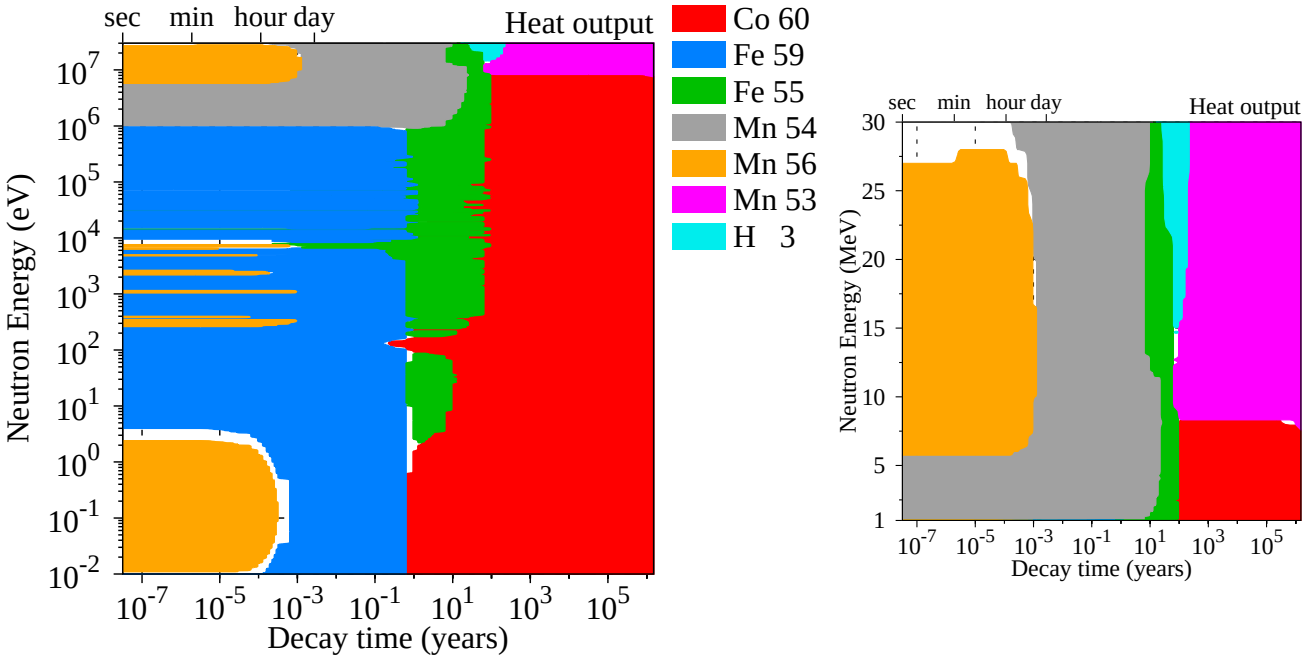


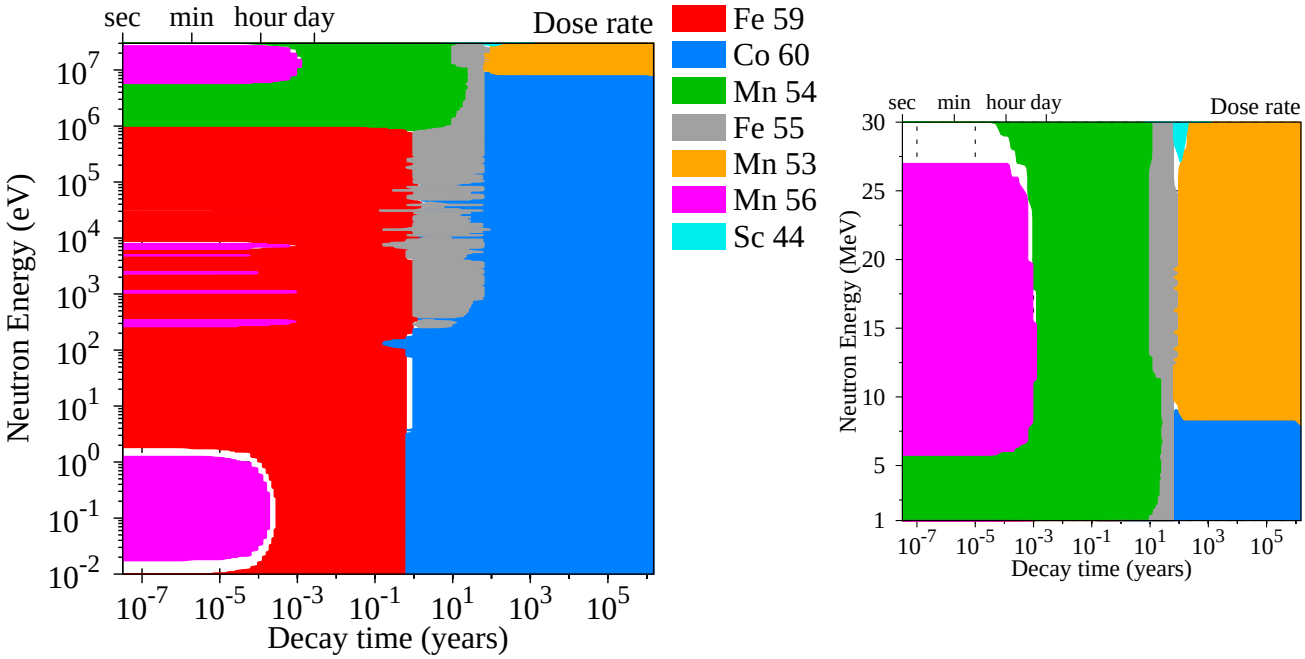


FW
Blanket
Manifold
Fe results

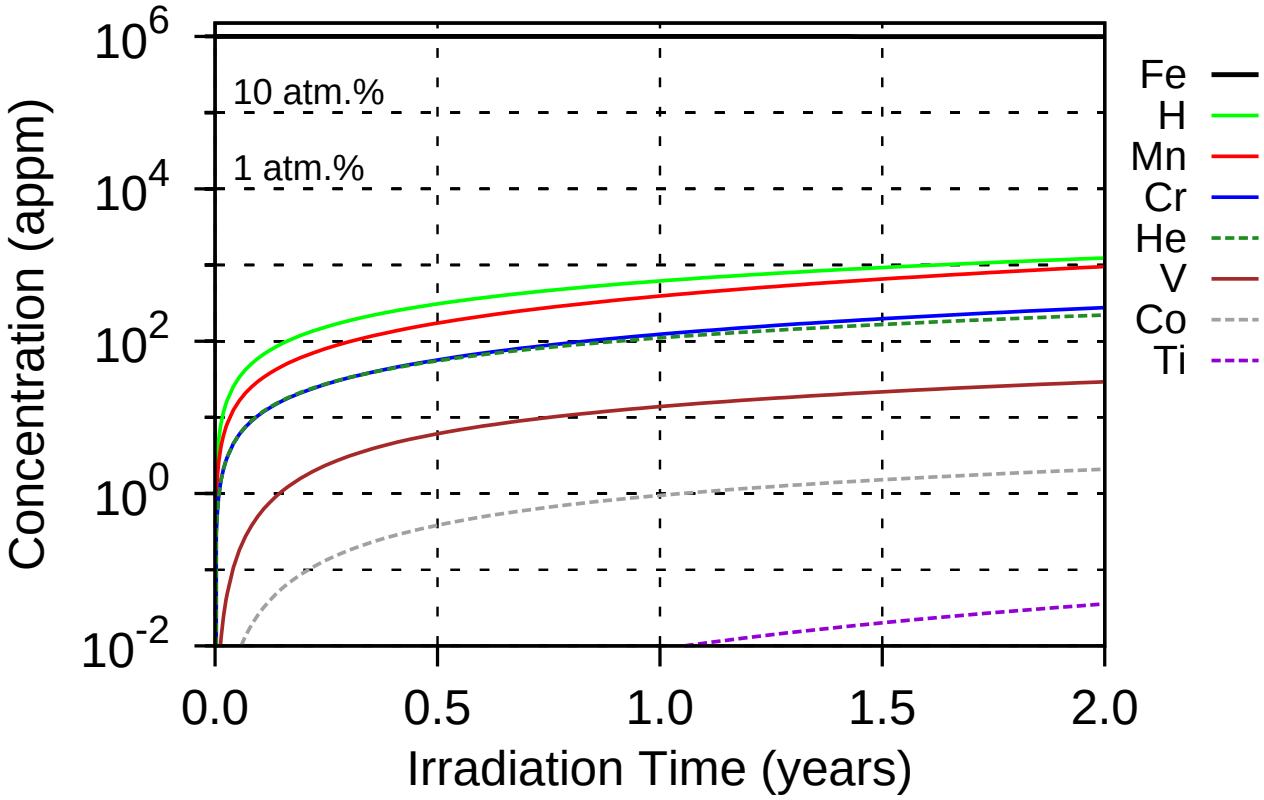
Iron Importance diagrams





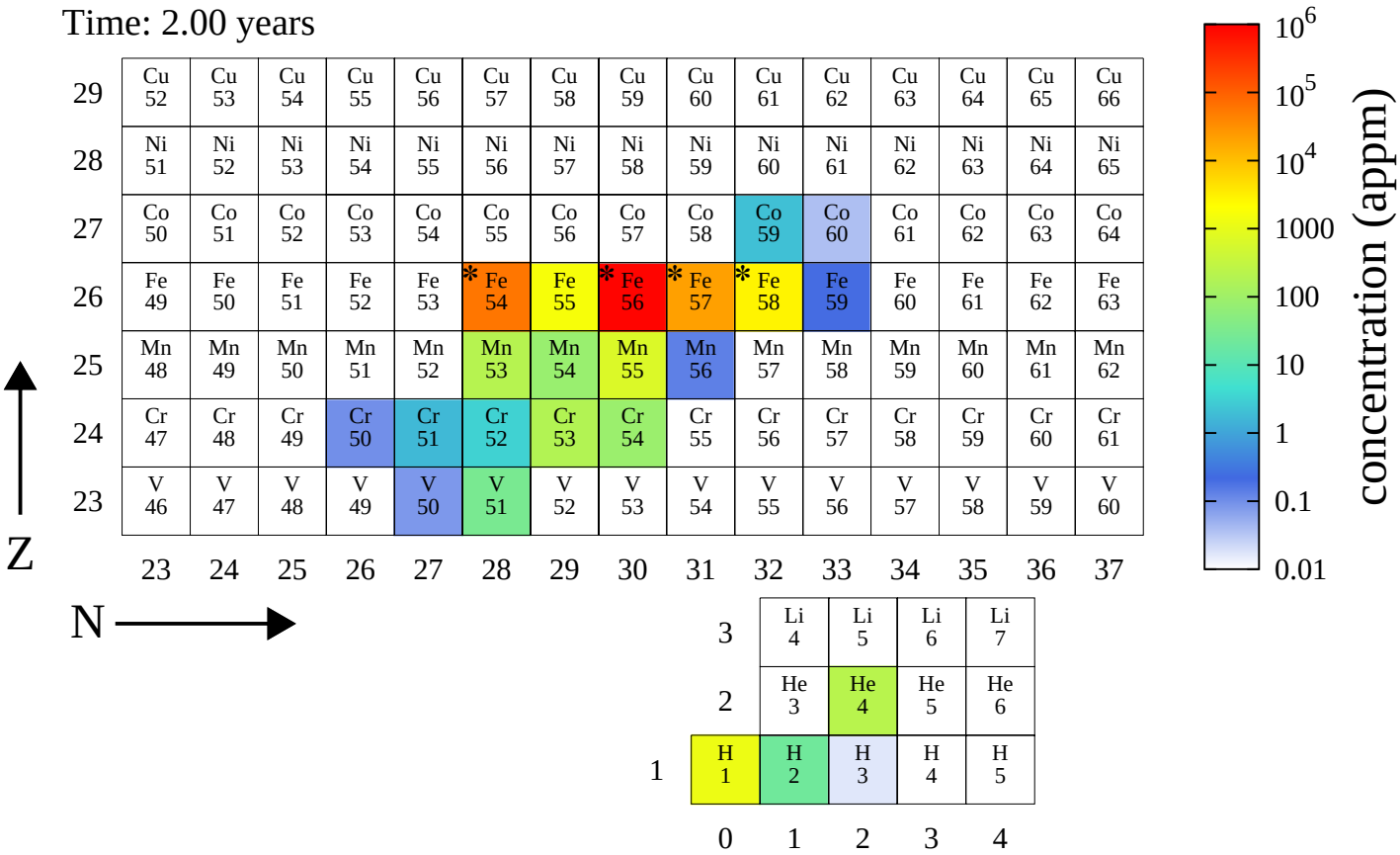


Iron FW Transmutation

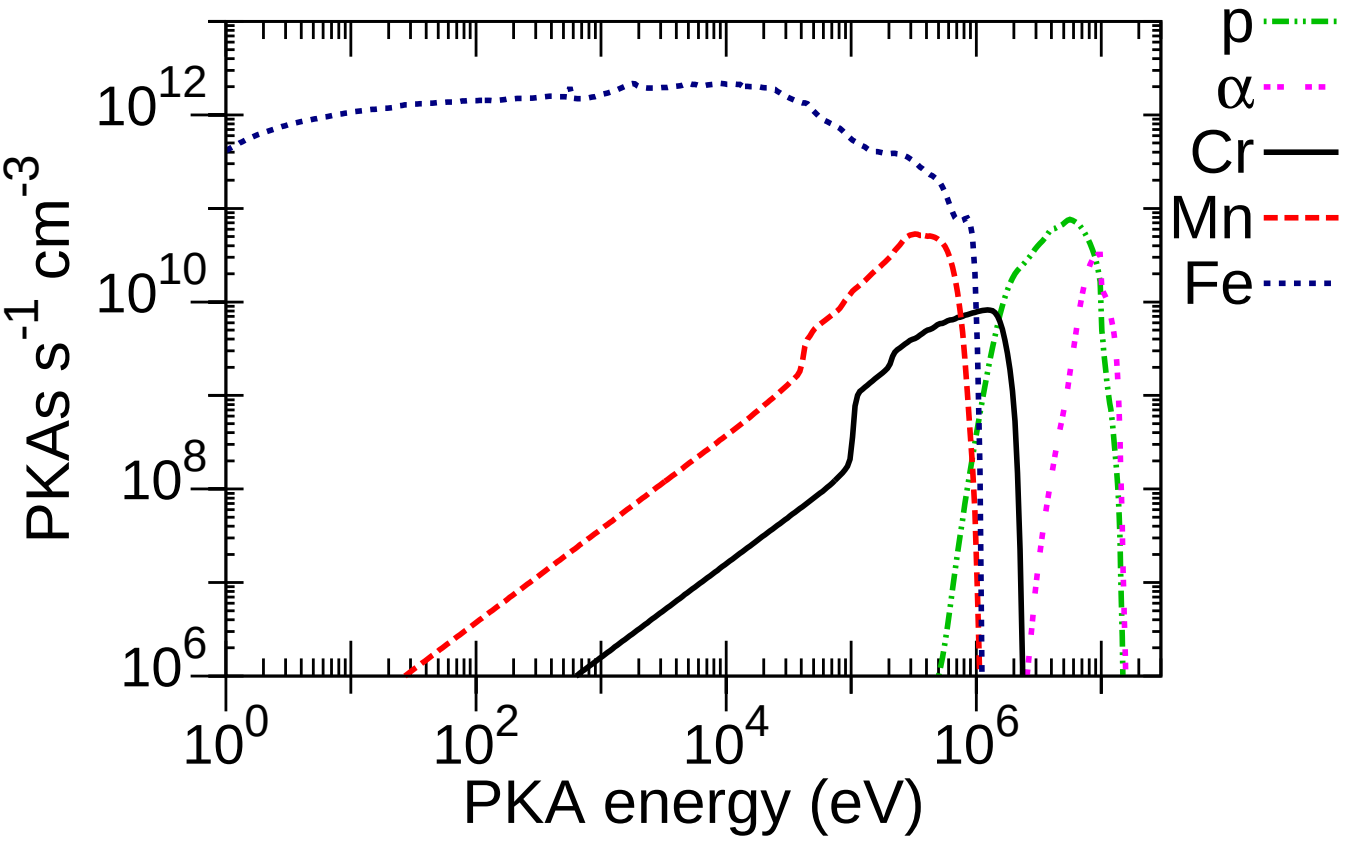


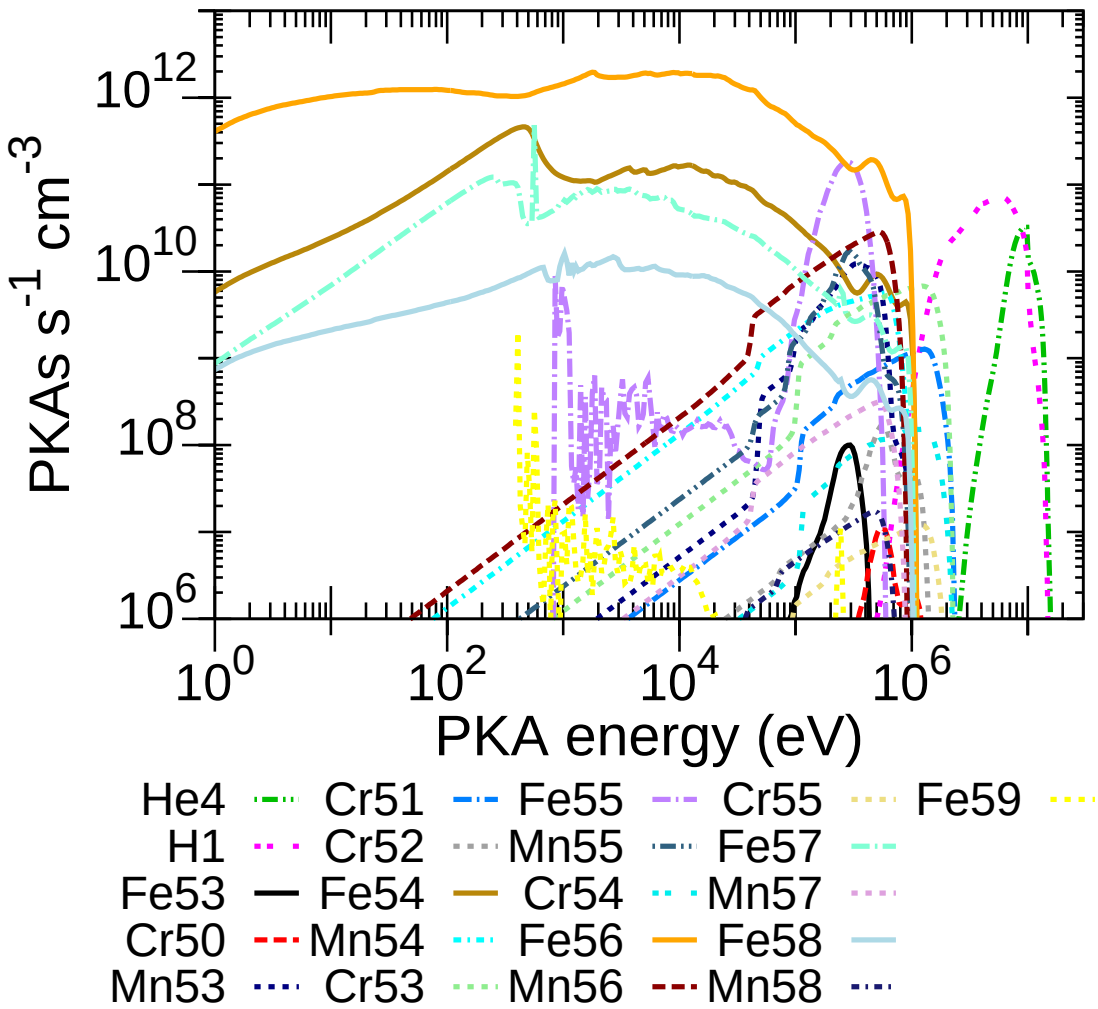
110 appm He & 617 appm H after 1 year

11 dpa/year



Iron FW PKA distributions





Iron Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Mn56	2.58h	Fe54(n,γ)Fe55(β^+)Mn55(n,γ)Mn56	94.3	100.0	99.1	
		Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(n,α)Cr56(β^-)Mn56	3.3			
		Fe58(n,γ)Fe59(n,α)Cr56(β^-)Mn56	1.1			
		Fe57(n,γ)Fe58(n,γ)Fe59(n,α)Cr56(β^-)Mn56	1.1			
		Fe56(n,p)Mn56				99.0
Sc44	3.97h	Fe54(n,α)Cr51(n,α)Ti48(n,α)Ca45(β^-)Sc45(n,2n)Sc44				31.4
		Fe54(n,α)Cr51(β^+)V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-) Sc45(n,2n)Sc44				25.1
		Fe54(n,α)Cr51(n,α)Ti48(n,α)Ca45(β^-)Sc45(n,2n) Sc44m(IT)Sc44				22.3
		Fe54(n,α)Cr51(β^+)V51(n,α)Sc48(β^-)Ti48(n,α)Ca45(β^-) Sc45(n,2n)Sc44m(IT)Sc44				17.7
Cr51	27.70d	Fe54(n,α)Cr51	100.0		100.0	98.9
Fe59	44.50d	Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59	59.2			
		Fe58(n,γ)Fe59	20.8	97.0	99.9	99.6
		Fe57(n,γ)Fe58(n,γ)Fe59	20.0	3.0		
Mn54	312.16d	Fe54(n,p)Mn54			100.0	81.6
		Fe56(n,2n)Fe55(n,np)Mn54				7.6
		Fe56(n,2n)Fe55(β^+)Mn55(n,2n)Mn54				6.1
		Fe56(n,np)Mn55(n,2n)Mn54				3.6
Fe55	2.73y	Fe54(n,γ)Fe55	100.0	100.0	100.0	
		Fe56(n,2n)Fe55				99.5
Co60	5.27y	Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT)Co60	30.8	58.0	47.5	49.2
		Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ) Co60m(IT)Co60	19.5			
		Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60	18.8	41.0	51.5	50.4
		Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60	11.9			
		Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT)Co60	11.8			
		Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60	7.2			
H3	12.33y	Fe54(n,γ)Fe55(n,p)H1(n,γ)H2(n,γ)H3	100.0			
		Fe54(n,p)H1(n,γ)H2(n,γ)H3			99.9	
		Fe57(n,t)H3				71.9
		Fe56(n,2n)Fe55(n,t)H3				8.4
		Fe56(n,2n)Fe55(β^+)Mn55(n,t)H3				5.4
		Fe56(n,t)H3				4.0
		Fe56(n,np)Mn55(n,t)H3				3.5
		Fe54(n,p)Mn54(n,t)H3				2.5
		Fe56(n,α)Cr53(n,t)H3				2.3
Ni63	100.62y	Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT)Co60(n,γ)Co61(β^-) Ni61(n,γ)Ni62(n,γ)Ni63	40.5	57.4		
		Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60(n,γ)Co61(β^-)Ni61(n,γ) Ni62(n,γ)Ni63	24.6	40.6		
		Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT)Co60(n,γ) Co61(β^-)Ni61(n,γ)Ni62(n,γ)Ni63	7.5			
		Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT) Co60(n,γ)Co61(β^-)Ni61(n,γ)Ni62(n,γ)Ni63	7.0			
		Fe58(n,γ)Fe59(n,γ)Fe60(n,γ)Fe61(β^-)Co61(β^-)Ni61(n,γ) Ni62(n,γ)Ni63	4.7			
		Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60(n,γ)Co61(β^-) Ni61(n,γ)Ni62(n,γ)Ni63	4.5			
		Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60(n,γ) Co61(β^-)Ni61(n,γ)Ni62(n,γ)Ni63	4.2			
		Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60m(IT)Co60(β^-)Ni60(n,γ) Ni61(n,γ)Ni62(n,γ)Ni63	2.2			
		Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60(β^-)Ni60(n,γ)Ni61(n,γ) Ni62(n,γ)Ni63	1.3			
		Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(n,γ)Fe60(n,γ)Fe61(β^-) Co61(β^-)Ni61(n,γ)Ni62(n,γ)Ni63	1.1			
		Fe57(n,γ)Fe58(n,γ)Fe59(n,γ)Fe60(n,γ)Fe61(β^-)Co61(β^-) Ni61(n,γ)Ni62(n,γ)Ni63	1.0			
Fe60	1.5 10^6y	Fe58(n,γ)Fe59(n,γ)Fe60	40.9	98.5	100.0	99.5
		Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59(n,γ)Fe60	39.3			
		Fe57(n,γ)Fe58(n,γ)Fe59(n,γ)Fe60	19.8	1.5		
Mn53	3.7 10^6y	Fe54(n,np)Mn53				96.7
		Fe54(n,d)Mn53				1.7

Cobalt

Isotope	Atom % abundance
Co59	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	5.63E+15	4.65E+15	1.84E+15	1.11E+15	2.04E+09	9.41E+06
Co60m	59.3	50.7				8.8
Co60	22.1	26.8	67.6	98.5	97.8	8.8
Co58	10.0	12.2	29.8	1.4		
Co58m	6.5	7.9				
Fe59	0.9	1.1	2.6			
H3					1.8	
Ni59					0.4	73.7
Fe60						8.8

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	6.71E-01	6.61E-01	6.17E-01	4.58E-01	8.31E-07	3.67E-10
Co60	77.3	78.5	84.0	99.4	100.0	93.7
Co58	13.6	13.9	14.4	0.6		
Co60m	5.0	3.6				2.3
Mn56	1.8	1.7				
Fe59	1.6	1.6	1.6			
Ni59						2.2
Fe60						1.8

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.08E+06	1.08E+06	1.06E+06	7.98E+05	1.45E+00	6.02E-04
Co60	83.6	83.7	85.6	99.5	100.0	99.4
Co58	13.0	13.0	12.9	0.5		
Fe59	1.6	1.6	1.6			
Mn56	1.4	1.3				

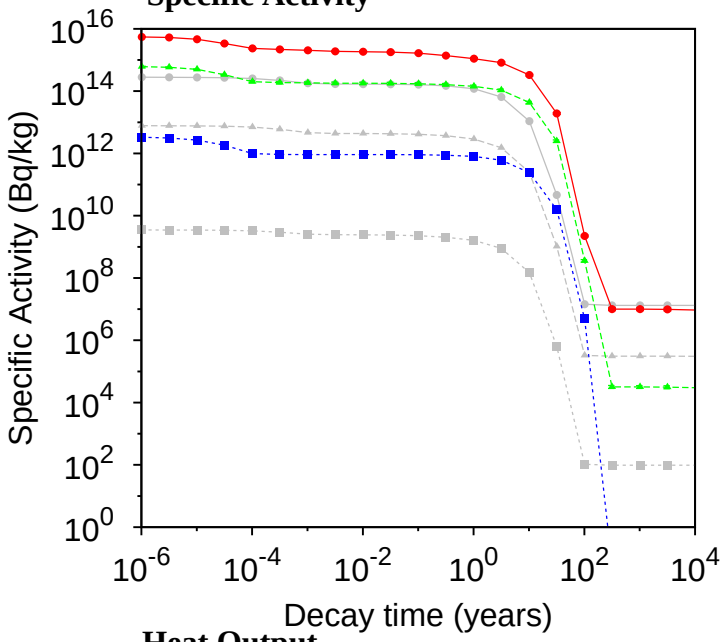
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.77E+06	4.77E+06	4.72E+06	3.72E+06	6.88E+00	9.42E-02
Co60	88.8	88.8	89.6	99.7	98.6	3.0
Co58	8.8	8.8	8.6	0.3		
Fe59	1.9	1.9	1.8			
Fe60					1.3	96.6

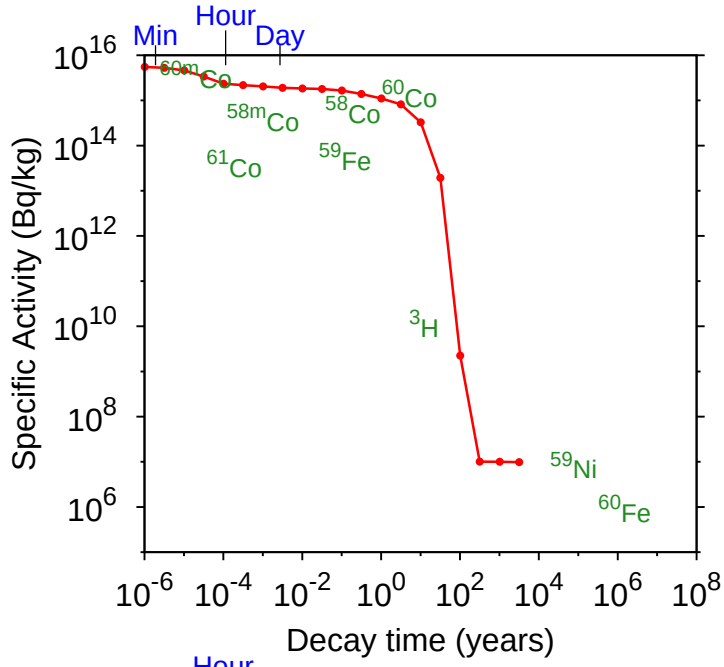
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.00E+07	4.00E+07	3.99E+07	3.39E+07	6.21E+01	2.60E-01
Co60	96.5	96.5	96.6	99.9	99.6	9.8
Co58	3.0	3.0	2.9	0.1		
Fe60					0.4	89.0
Ni59						1.2

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.31E+13	1.31E+13	1.30E+13	1.09E+13	1.99E+07	8.32E+03
Co60	95.2	95.2	95.4	99.9	100.0	99.1
Co58	4.3	4.3	4.2	0.1		

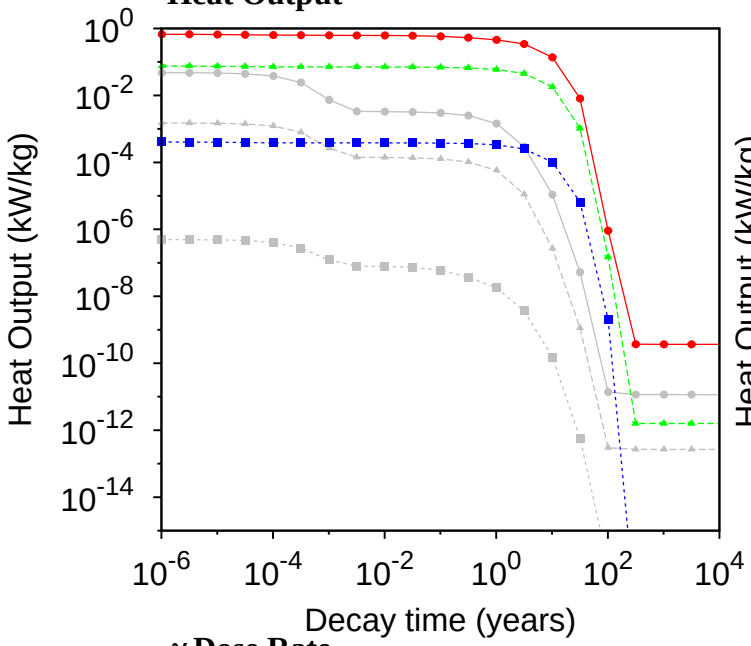
Cobalt activation characteristics

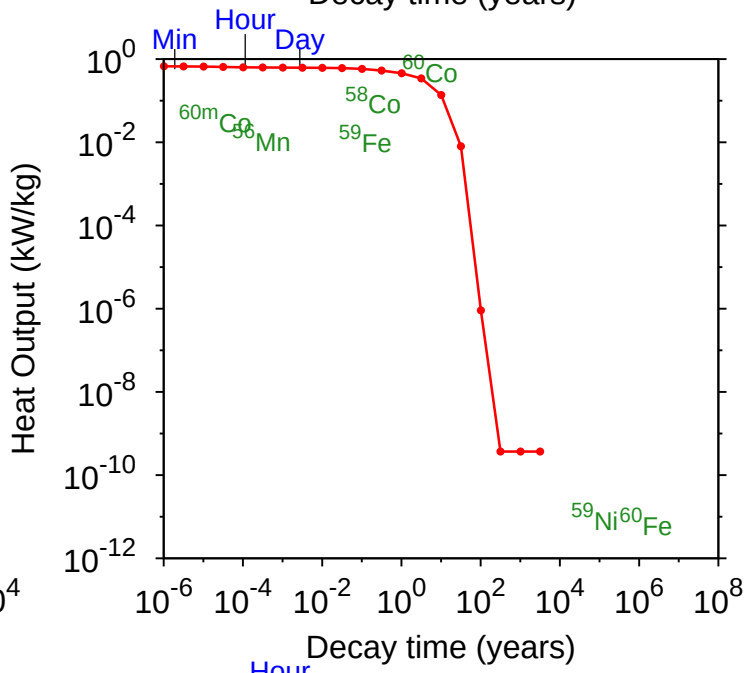
Specific Activity



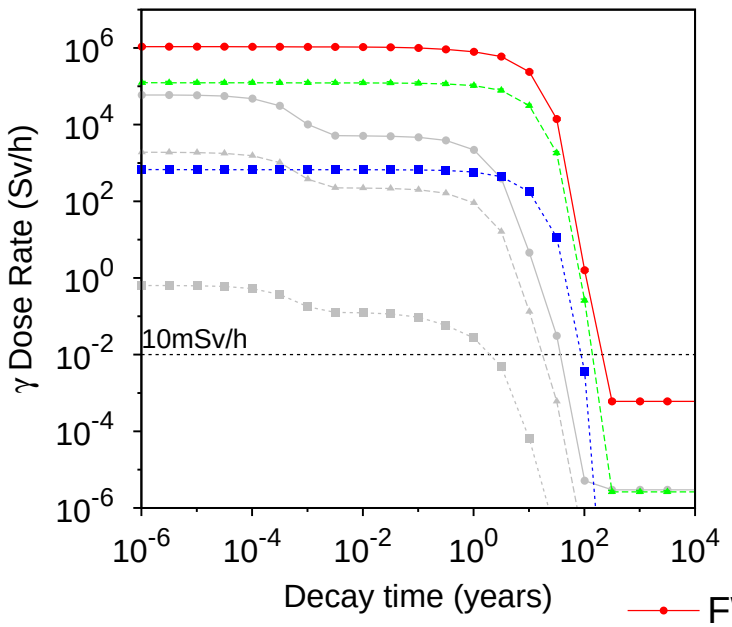


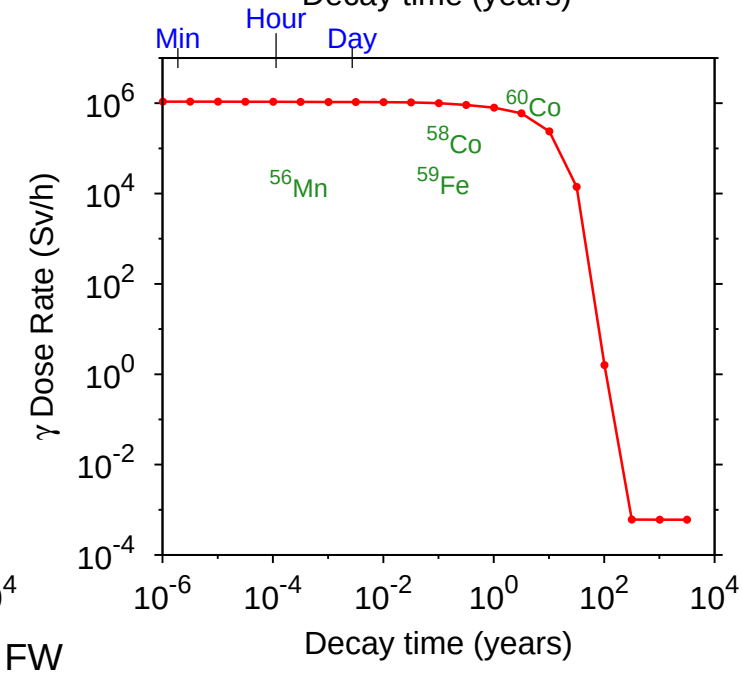
Heat Output





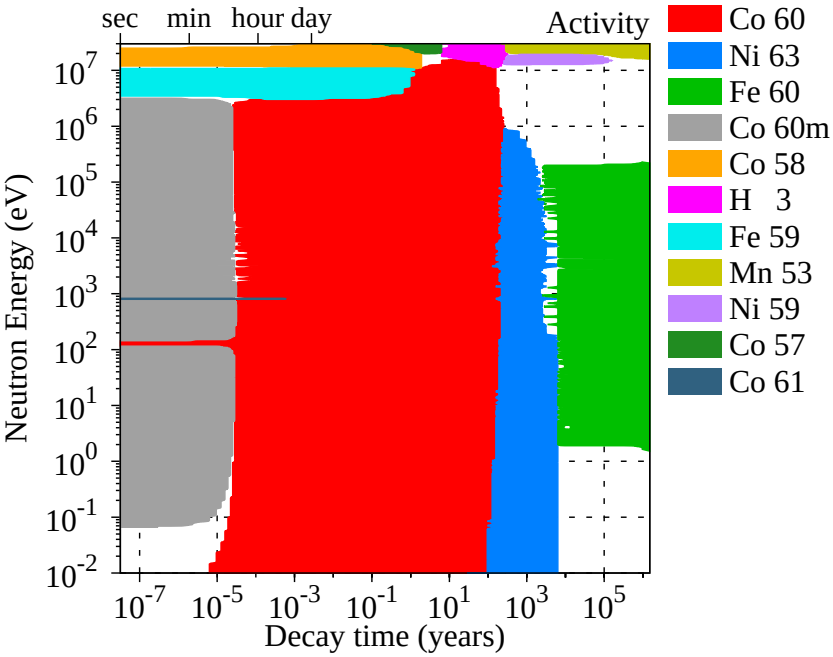
γ Dose Rate

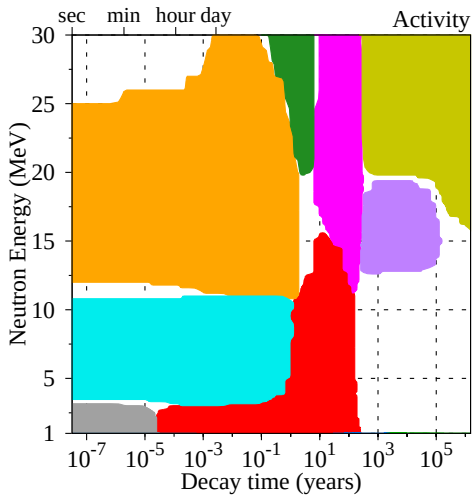


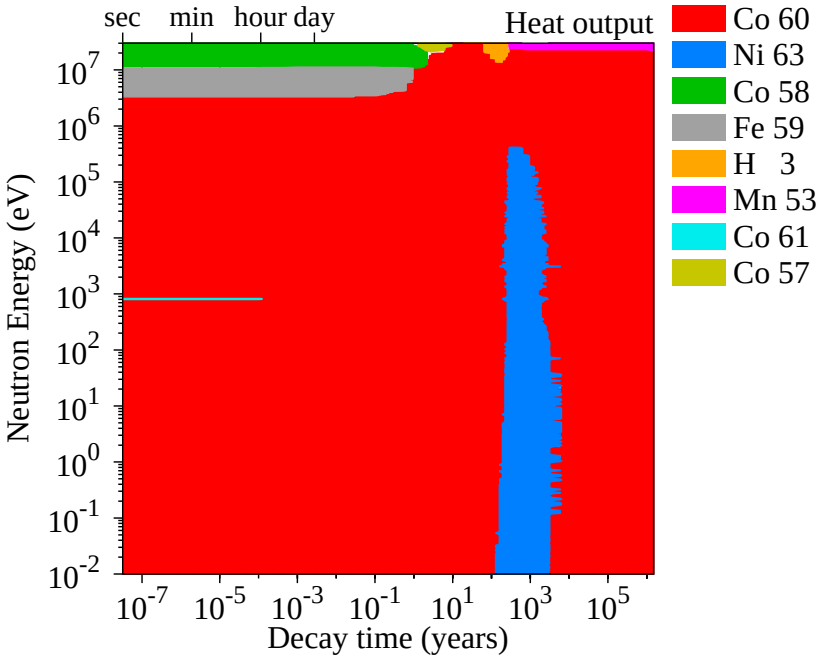


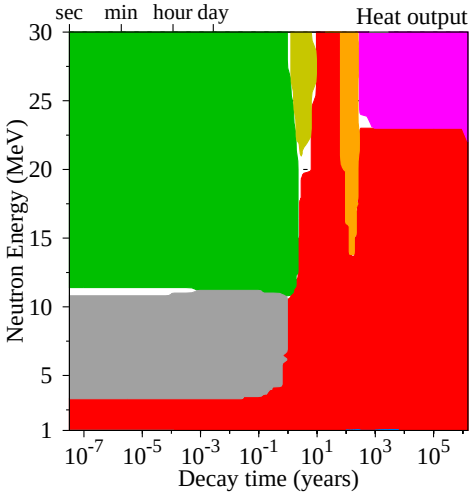
FW
Blanket
Manifold
Fe results

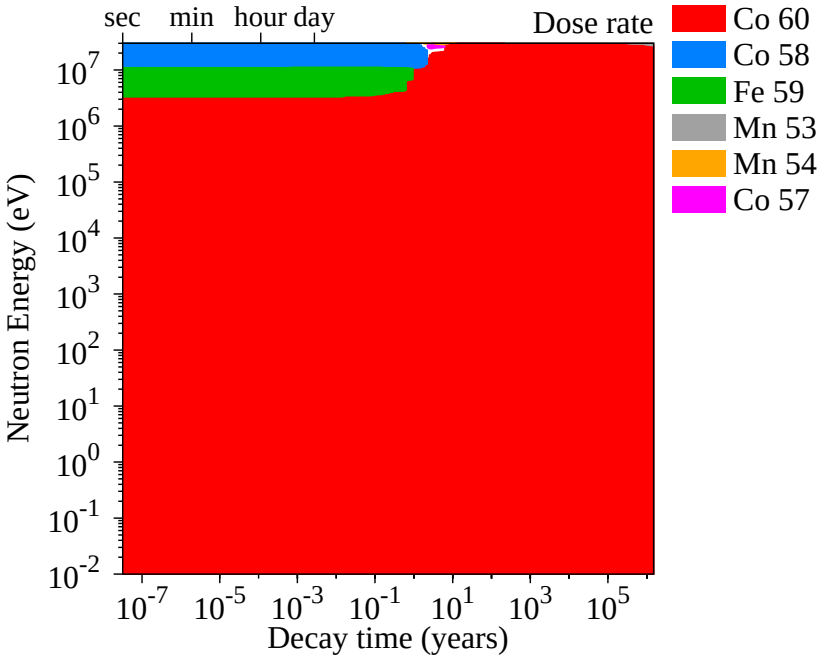
Cobalt Importance diagrams

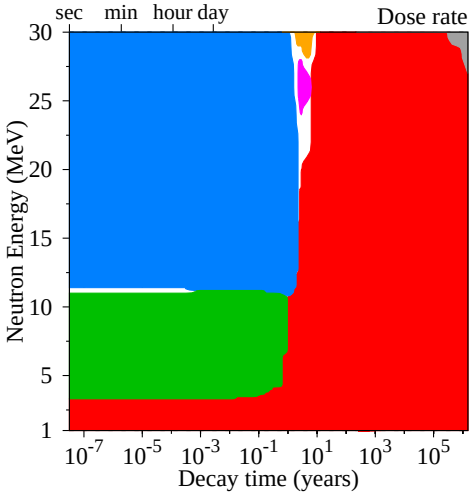




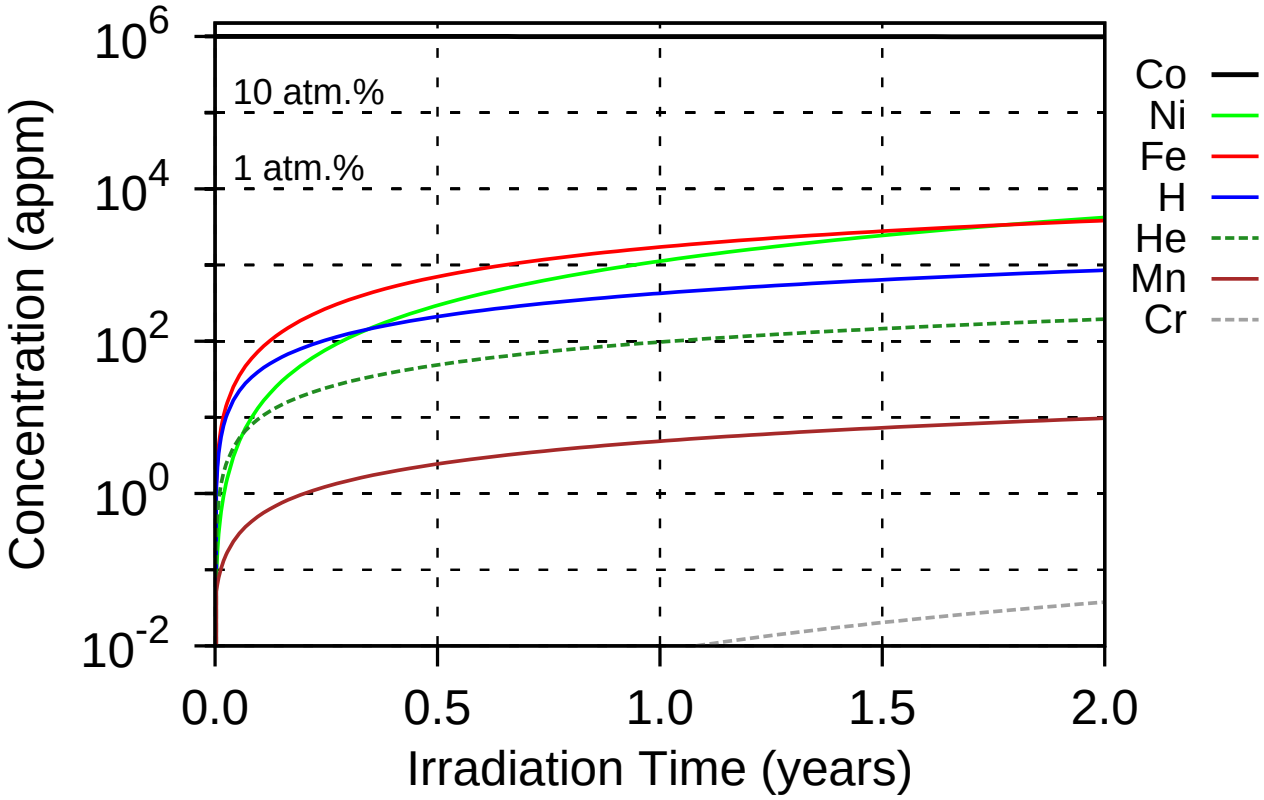




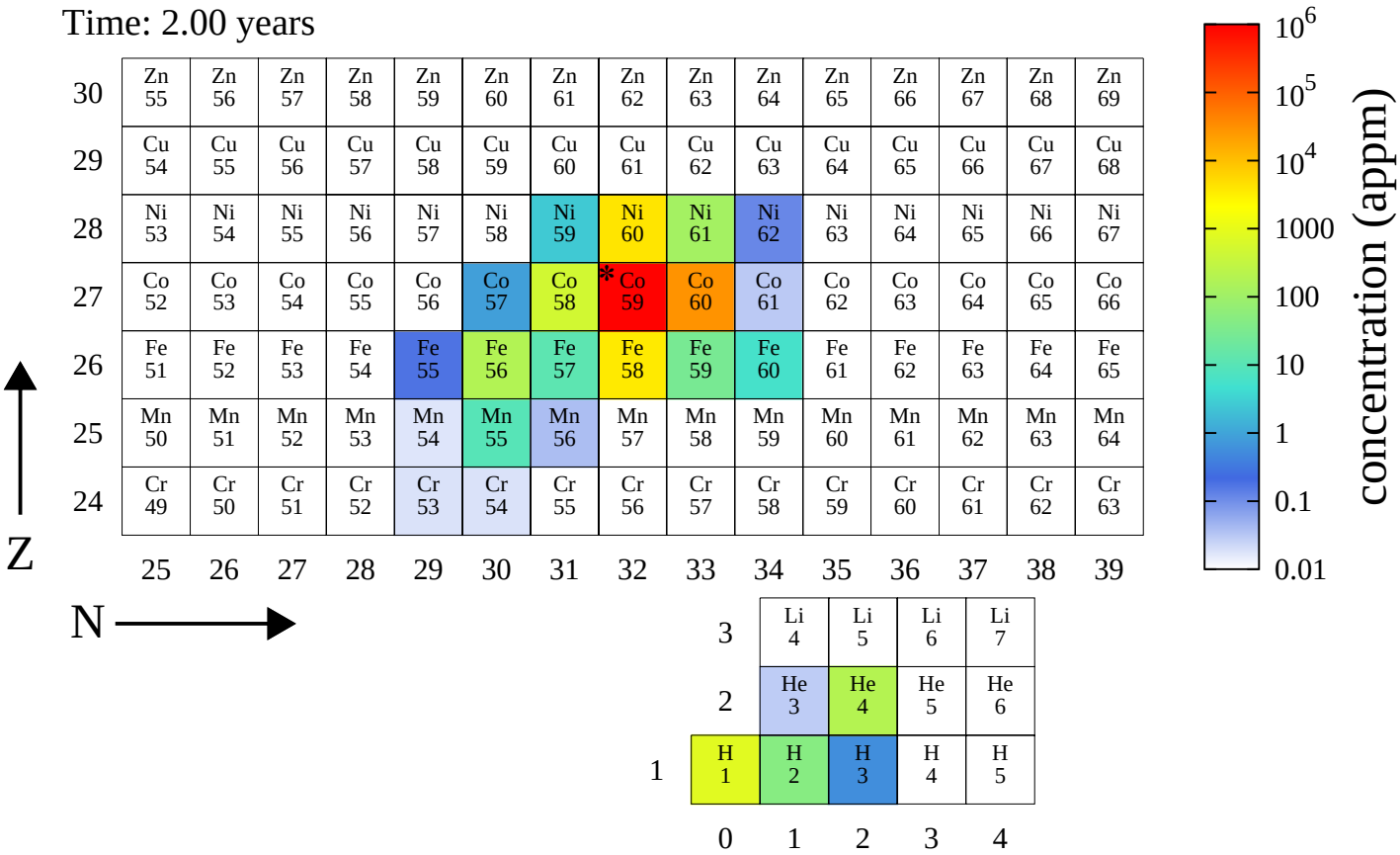




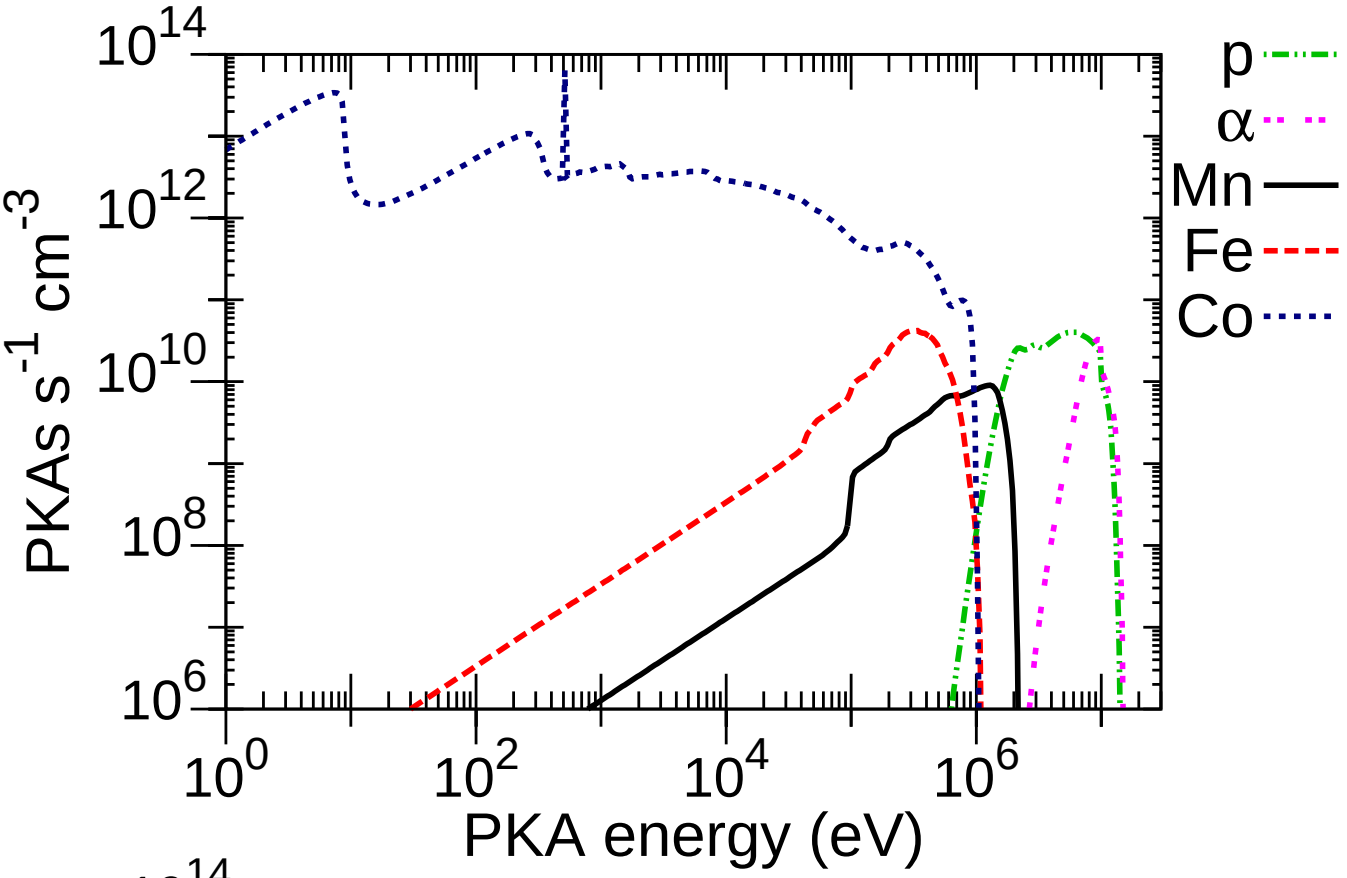
Cobalt FW Transmutation

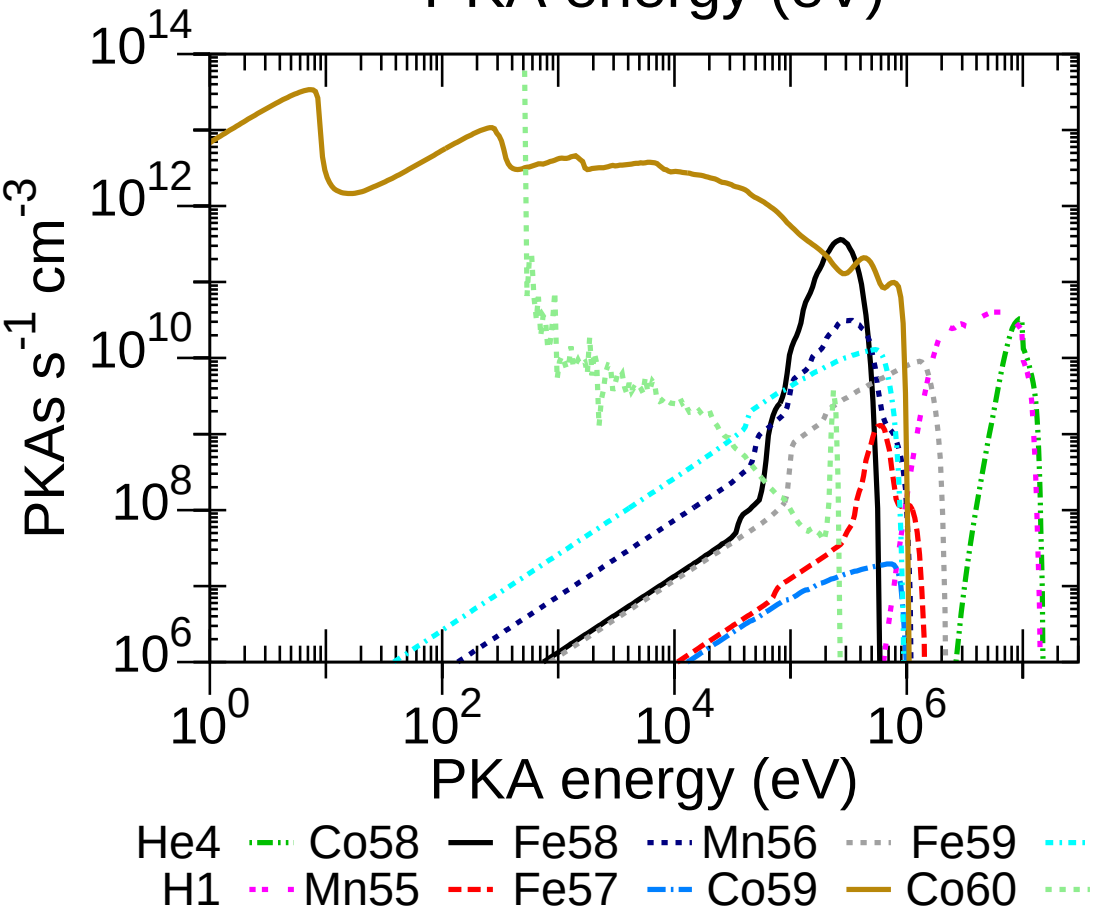


97 appm He & 425 appm H after 1 year 12 dpa/year



Cobalt FW PKA distributions





Cobalt Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Co60m	10.47m	Co59(n,γ)Co60m	100.0	100.0	97.1	98.2
		Co59(n,γ)Co60(n,n$'$)Co60m			2.9	
Co61	1.65h	Co59(n,γ)Co60m(IT)Co60(n,γ)Co61	62.2	58.6	48.0	48.9
		Co59(n,γ)Co60(n,γ)Co61	37.8	41.4	52.0	50.1
Mn56	2.58h	Co59(n,γ)Co60m(IT)Co60(n,γ)Co61(β^-)Ni61(n,α)Fe58(n,γ) Fe59(n,α)Cr56(β^-)Mn56	57.4			
		Co59(n,γ)Co60(n,γ)Co61(β^-)Ni61(n,α)Fe58(n,γ)Fe59(n,α) Cr56(β^-)Mn56	34.9			
		Co59(n,γ)Co60m(IT)Co60(β^-)Ni60(n,γ)Ni61(n,α)Fe58(n,γ) Fe59(n,α)Cr56(β^-)Mn56	4.6			
		Co59(n,γ)Co60(β^-)Ni60(n,γ)Ni61(n,α)Fe58(n,γ)Fe59(n,α) Cr56(β^-)Mn56	2.8			
		Co59(n,α)Mn56			100.0	99.0
Co58m	8.90h	Co59(n,2n)Co58m				99.5
Fe59	44.50d	Co59(n,γ)Co60m(IT)Co60(n,γ)Co61(β^-)Ni61(n,α) Fe58(n,γ)Fe59	57.4	58.3		
		Co59(n,γ)Co60(n,γ)Co61(β^-)Ni61(n,α)Fe58(n,γ)Fe59	34.9	41.2		
		Co59(n,γ)Co60m(IT)Co60(β^-)Ni60(n,γ)Ni61(n,α) Fe58(n,γ)Fe59	4.6			
		Co59(n,γ)Co60(β^-)Ni60(n,γ)Ni61(n,α)Fe58(n,γ)Fe59	2.8			
		Co59(n,p)Fe59			100.0	99.7
Co58	70.87d	Co59(n,2n)Co58m(IT)Co58				63.0
		Co59(n,2n)Co58				36.6
Co57	271.77d	Co59(n,2n)Co58m(IT)Co58(n,2n)Co57				62.8
		Co59(n,2n)Co58(n,2n)Co57				36.5
Mn54	312.16d	Co59(n,nα)Mn55(n,2n)Mn54				48.7
		Co59(n,2n)Co58m(IT)Co58(n,nα)Mn54				13.7
		Co59(n,2n)Co58(n,nα)Mn54				7.9
		Co59(n,2n)Co58m(IT)Co58(n,α)Mn55(n,2n)Mn54				6.2
		Co59(n,2n)Co58m(IT)Co58(n,2n)Co57(n,α)Mn54				5.7
		Co59(n,2n)Co58(n,α)Mn55(n,2n)Mn54				3.6
		Co59(n,2n)Co58m(IT)Co58(β^+)Fe58(n,α)Cr55(β^-) Mn55(n,2n)Mn54				3.6
		Co59(n,2n)Co58(n,2n)Co57(n,α)Mn54				3.3
		Co59(n,2n)Co58(β^+)Fe58(n,α)Cr55(β^-)Mn55(n,2n)Mn54				2.1
		Co59(n,α)Mn56(β^-)Fe56(n,2n)Fe55(n,np)Mn54				1.7
		Co59(n,α)Mn56(β^-)Fe56(n,2n)Fe55(β^+)Mn55(n,2n)Mn54				1.0
Co60	5.27y	Co59(n,γ)Co60m(IT)Co60	62.2	58.6	48.0	49.1
		Co59(n,γ)Co60	37.8	41.4	52.0	50.3
H3	12.33y	Co59(n,γ)Co60m(IT)Co60(n,γ)Co61(β^-)Ni61(n,γ)Ni62(n,γ) Ni63(β^-)Cu63(n,γ)Cu64(n,p)H1(n,γ)H2(n,γ)H3	58.1			
		Co59(n,γ)Co60(n,γ)Co61(β^-)Ni61(n,γ)Ni62(n,γ)Ni63(β^-) Cu63(n,γ)Cu64(n,p)H1(n,γ)H2(n,γ)H3	35.4			
		Co59(n,γ)Co60m(IT)Co60(β^-)Ni60(n,γ)Ni61(n,γ)Ni62(n,γ) Ni63(β^-)Cu63(n,γ)Cu64(n,p)H1(n,γ)H2(n,γ)H3	2.1			
		Co59(n,γ)Co60m(IT)Co60(n,γ)Co61(β^-)Ni61(n,γ)Ni62(n,γ) Ni63(β^-)Cu63(n,γ)Cu64(β^-)Zn64(n,γ)Zn65(n,p)H1(n,γ) H2(n,γ)H3	1.4			
		Co59(n,γ)Co60(β^-)Ni60(n,γ)Ni61(n,γ)Ni62(n,γ)Ni63(β^-) Cu63(n,γ)Cu64(n,p)H1(n,γ)H2(n,γ)H3	1.3			
		Co59(n,p)H1(n,γ)H2(n,γ)H3			99.9	
		Co59(n,t)H3				98.1
		Co59(n,2n)Co58m(IT)Co58(n,t)H3				1.1
Ni63	100.62y	Co59(n,γ)Co60m(IT)Co60(n,γ)Co61(β^-)Ni61(n,γ) Ni62(n,γ)Ni63	57.8	58.2	46.3	46.7
		Co59(n,γ)Co60(n,γ)Co61(β^-)Ni61(n,γ)Ni62(n,γ)Ni63	35.2	41.2	50.1	47.9
		Co59(n,γ)Co60m(IT)Co60(β^-)Ni60(n,γ)Ni61(n,γ) Ni62(n,γ)Ni63	4.2		1.2	2.3
		Co59(n,γ)Co60(β^-)Ni60(n,γ)Ni61(n,γ)Ni62(n,γ)Ni63	2.5		1.3	2.4
Ni59	7.6 10^4y	Co59(n,γ)Co60(β^-)Ni60(n,2n)Ni59				49.7
		Co59(n,γ)Co60m(IT)Co60(β^-)Ni60(n,2n)Ni59				48.5
		Co59(n,γ)Co60m(β^-)Ni60(n,2n)Ni59				1.5

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Fe60	1.5 10^6y	Co59(n,γ)Co60m(IT)Co60(n,γ)Co61(β^-)Ni61(n,α)Fe58(n,γ) Fe59(n,γ)Fe60	57.9			
		Co59(n,γ)Co60(n,γ)Co61(β^-)Ni61(n,α)Fe58(n,γ) Fe59(n,γ)Fe60	35.3			
		Co59(n,γ)Co60m(IT)Co60(β^-)Ni60(n,γ)Ni61(n,α)Fe58(n,γ) Fe59(n,γ)Fe60	3.6			
		Co59(n,γ)Co60(β^-)Ni60(n,γ)Ni61(n,α)Fe58(n,γ) Fe59(n,γ)Fe60	2.2			
		Co59(n,γ)Co60m(IT)Co60(n,p)Fe60		57.0	47.4	38.7
		Co59(n,γ)Co60(n,p)Fe60		40.3	51.3	39.7
		Co59(n,γ)Co60m(n,p)Fe60		2.6		
		Co59(n,p)Fe59(n,γ)Fe60			1.3	21.3
Mn53	3.7 10^6y	Co59(n,nα)Mn55(n,2n)Mn54(n,2n)Mn53				36.5
		Co59(n,2n)Co58m(IT)Co58(n,nα)Mn54(n,2n)Mn53				14.8
		Co59(n,2n)Co58m(IT)Co58(n,2n)Co57(n,nα)Mn53				11.3
		Co59(n,2n)Co58(n,nα)Mn54(n,2n)Mn53				8.6
		Co59(n,2n)Co58(n,2n)Co57(n,nα)Mn53				6.6
		Co59(n,2n)Co58m(IT)Co58(n,2n)Co57(n,α)Mn54(n,2n)Mn53				4.4
		Co59(n,2n)Co58m(IT)Co58(n,α)Mn55(n,2n)Mn54(n,2n)Mn53				4.1
		Co59(n,2n)Co58(n,2n)Co57(n,α)Mn54(n,2n)Mn53				2.5
		Co59(n,2n)Co58(n,α)Mn55(n,2n)Mn54(n,2n)Mn53				2.4
		Co59(n,α)Mn56(β^-)Fe56(n,2n)Fe55(n,2n)Fe54(n,np)Mn53				2.3
		Co59(n,2n)Co58m(IT)Co58(β^+)Fe58(n,α)Cr55(β^-)Mn55(n,2n) Mn54(n,2n)Mn53				1.7
		Co59(n,2n)Co58(β^+)Fe58(n,α)Cr55(β^-)Mn55(n,2n) Mn54(n,2n)Mn53				1.0
		Co59(n,α)Mn56(β^-)Fe56(n,2n)Fe55(n,np)Mn54(n,2n)Mn53				1.0

Nickel

Isotope	Atom % abundance
Ni58	68.08
Ni60	26.22
Ni61	1.14
Ni62	3.63
Ni64	0.93

($T_{1/2}$ =7.0 10^{20}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	9.15E+14	9.06E+14	7.08E+14	1.82E+14	1.31E+11	2.26E+09
Co57	37.8	38.2	48.4	74.9		
Co58	35.6	36.0	44.6	5.1		
Co58m	16.7	16.8				
Fe55	3.9	4.0	5.1	15.3		
Co60m	2.7	1.9				
Ni57	1.6	1.6	0.4			
Co60	1.0	1.0	1.3	4.5		
Ni63				0.1	98.1	
Ni59					1.9	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	7.20E-02	7.14E-02	6.41E-02	8.05E-03	3.70E-07	2.60E-09
Co58	73.4	74.0	79.6	18.5		
Co57	11.0	11.1	12.3	38.9		
Ni57	6.9	7.0	1.4			
Co60	5.4	5.4	6.0	42.1	2.3	0.1
Ni63					96.9	
Ni59					0.8	99.9

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	9.65E+04	9.61E+04	8.66E+04	9.07E+03	1.49E-02	6.85E-04
Co58	80.5	80.9	86.8	24.2		
Ni57	8.0	8.0	1.6			
Co60	6.7	6.7	7.5	62.7	95.0	0.7
Co57	3.0	3.1	3.4	12.8		
Ni59					5.0	99.3

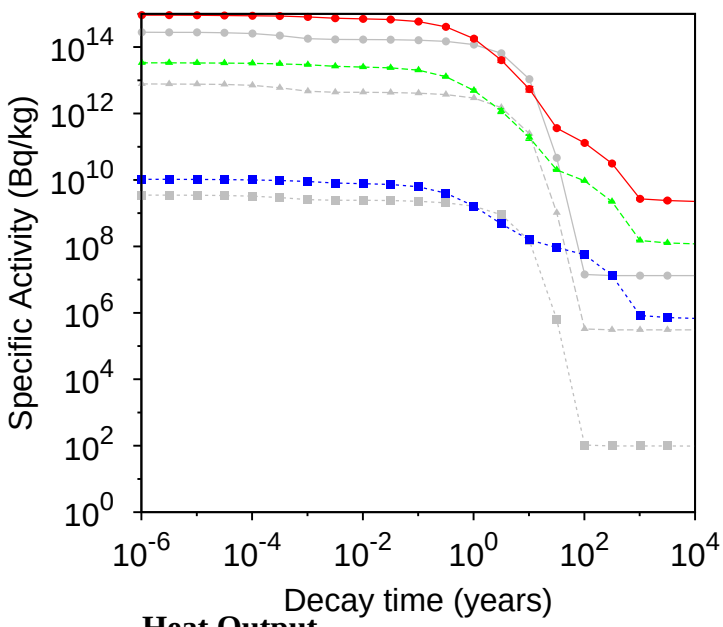
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.81E+05	3.77E+05	3.54E+05	7.24E+04	1.95E+01	1.43E-01
Co58	63.4	64.0	66.0	9.4		
Co57	19.1	19.2	20.3	39.5		
Co60	8.3	8.4	8.9	38.2	0.4	
Ni57	3.4	3.4	0.7			
Fe55	3.1	3.1	3.3	12.7		
Co62	1.0	0.1				
Ni63				0.1	98.8	
Ni59					0.8	99.4

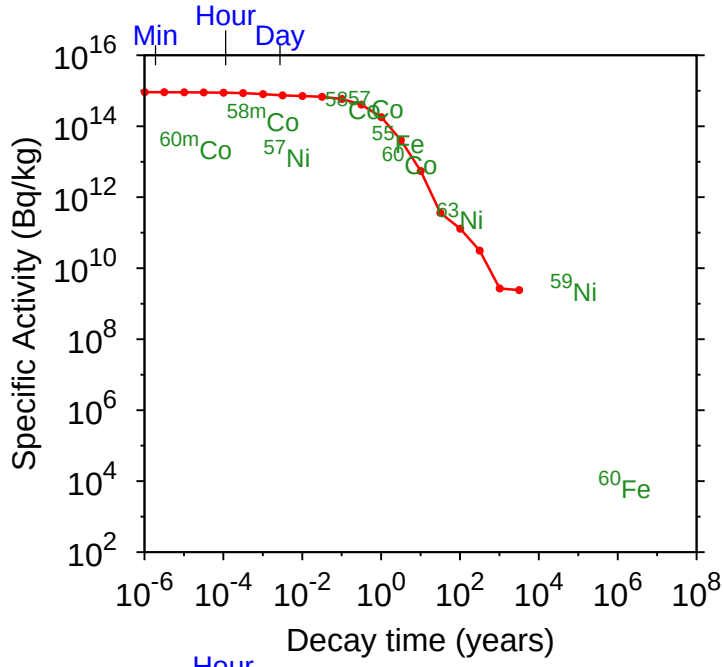
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.37E+06	1.36E+06	1.33E+06	4.30E+05	1.69E+02	9.98E-01
Co58	50.1	50.2	49.9	4.5		
Co57	25.3	25.4	25.8	31.7		
Co60	21.1	21.1	21.6	58.7	0.4	
Fe55	2.0	2.0	2.1	5.0		
Ni63				0.1	99.0	
Ni59					0.6	99.8

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	8.01E+11	7.99E+11	7.61E+11	2.28E+11	1.51E+06	2.27E+04
Co57	43.2	43.3	45.0	59.8		
Co58	40.7	40.8	41.4	4.0		
Co60	11.6	11.6	12.2	35.7	13.4	0.3
Ni57	3.6	3.6	0.7			
Ni63					84.9	
Ni59					1.6	99.7

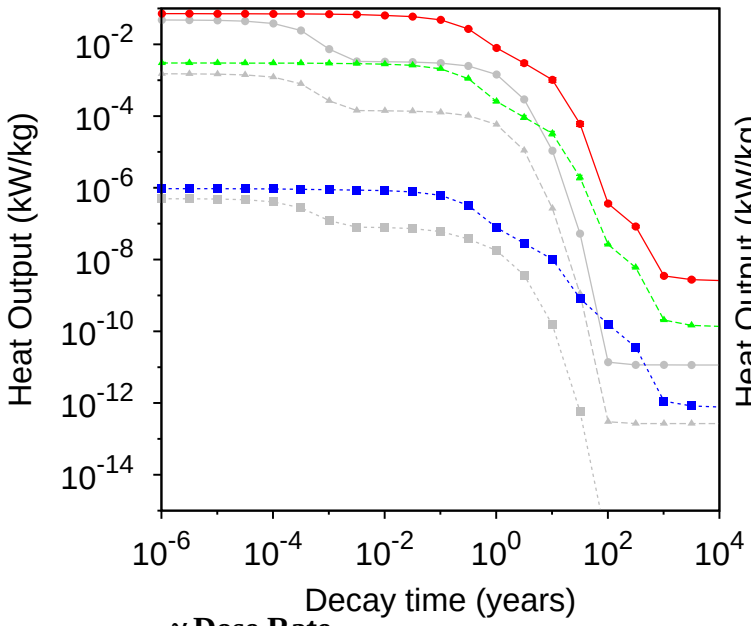
Nickel activation characteristics

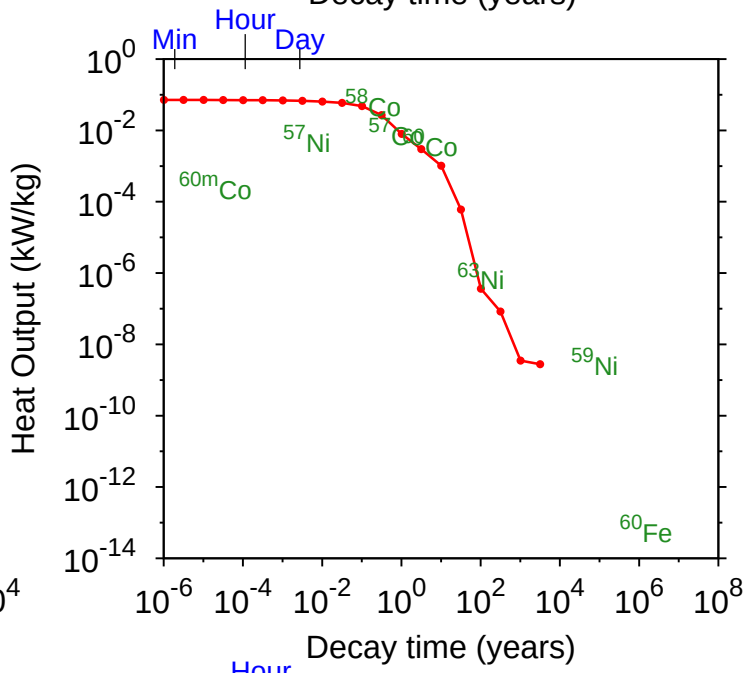
Specific Activity



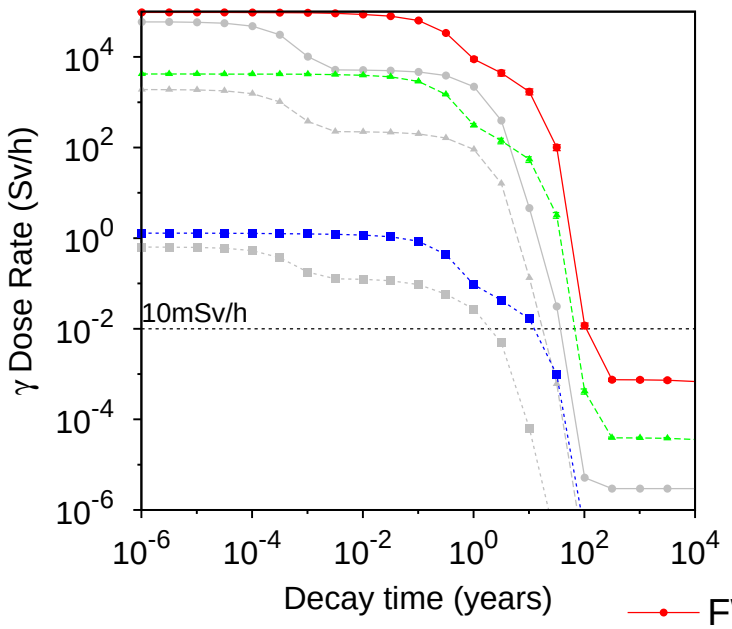


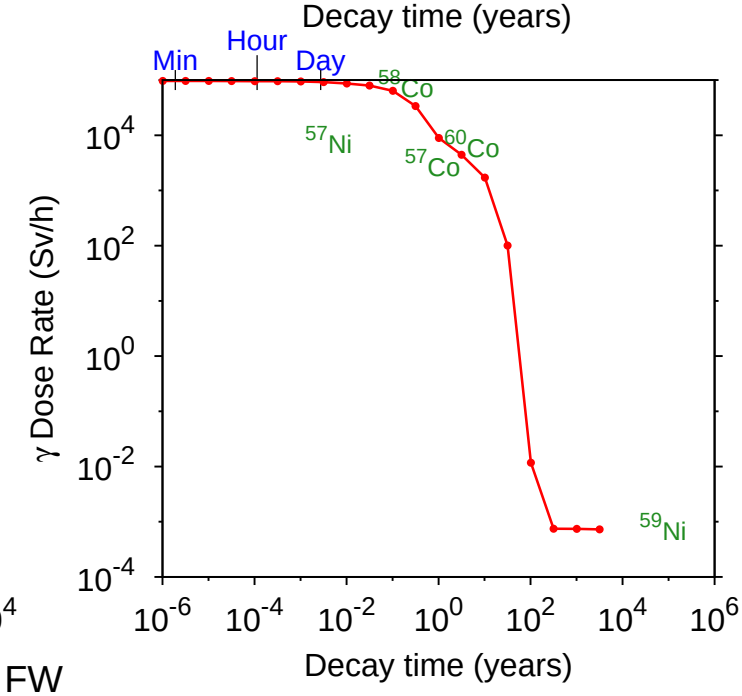
Heat Output





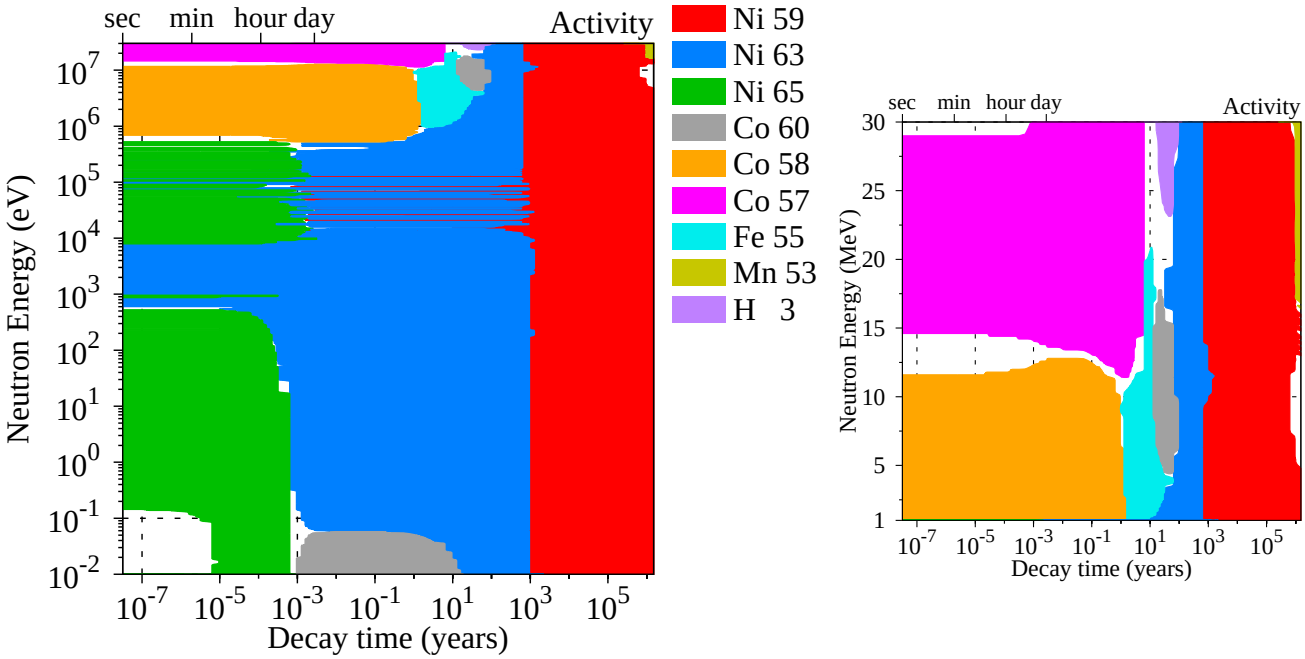
γ Dose Rate

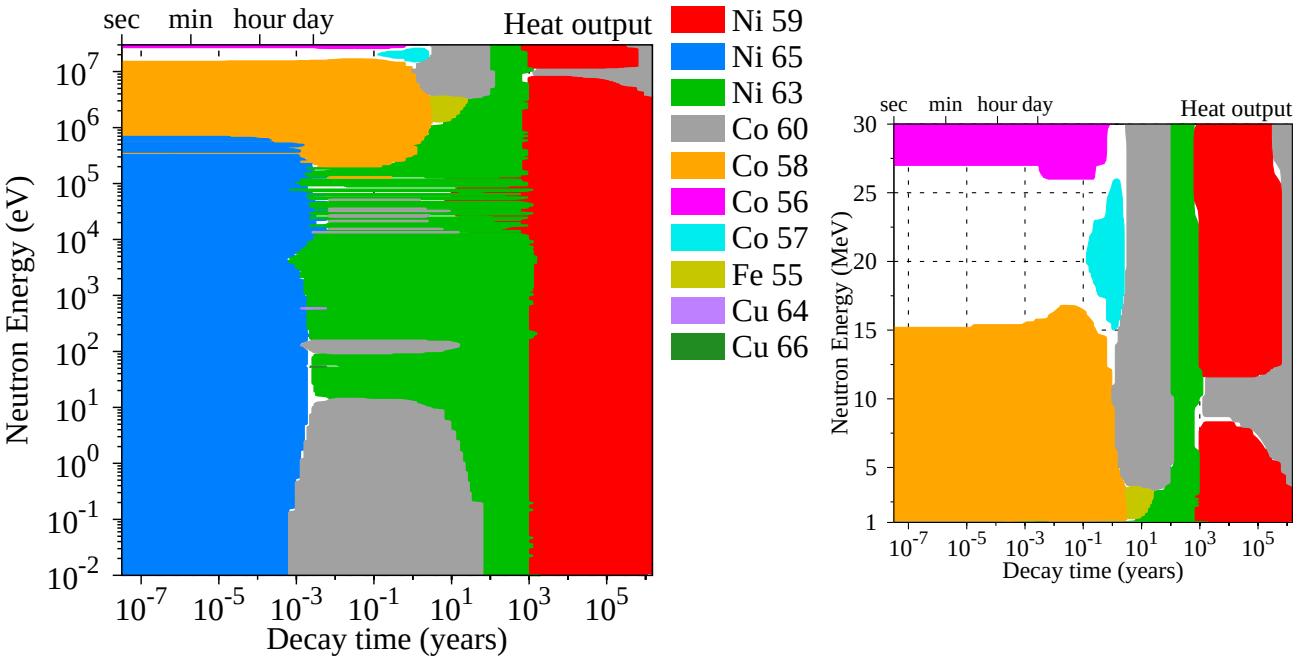


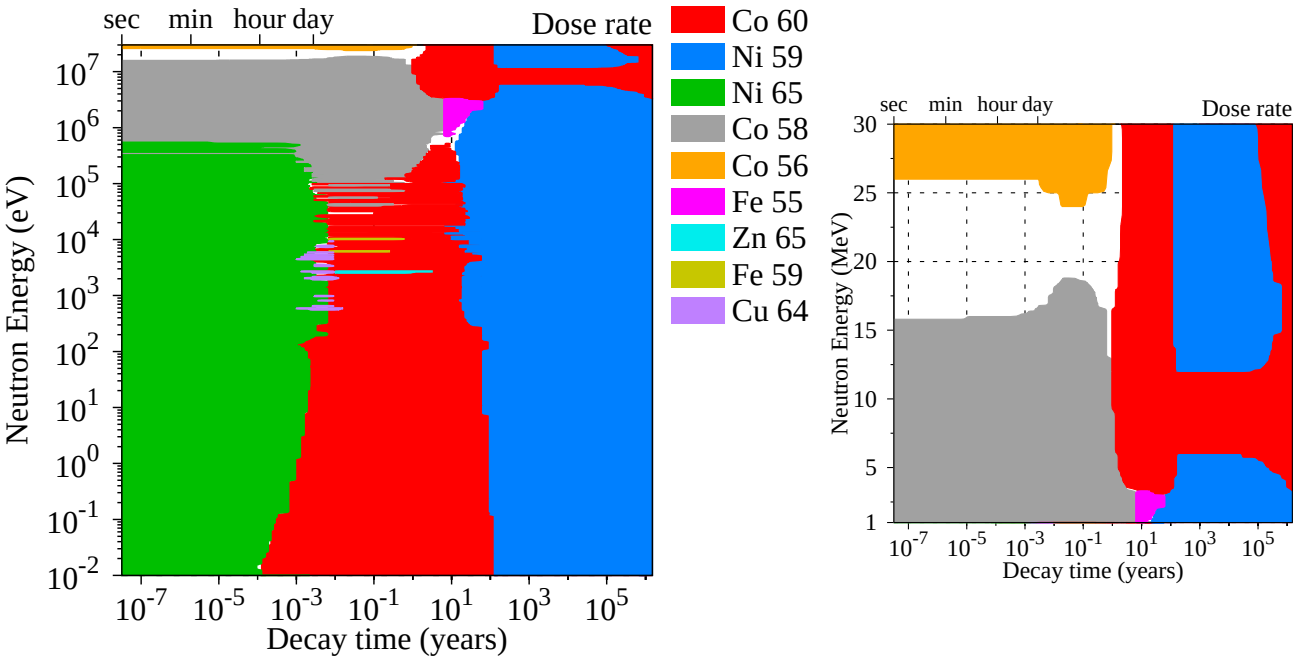


FW
Blanket
Manifold
Fe results

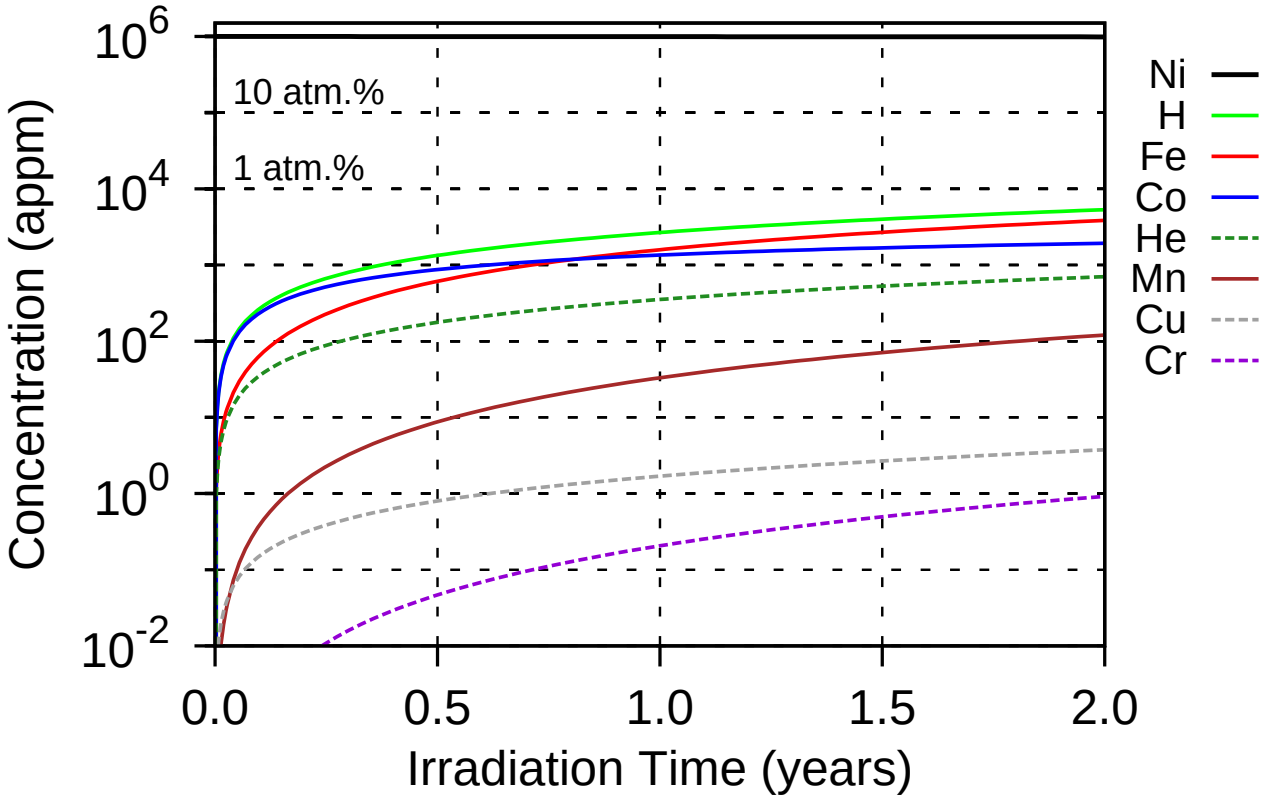
Nickel Importance diagrams



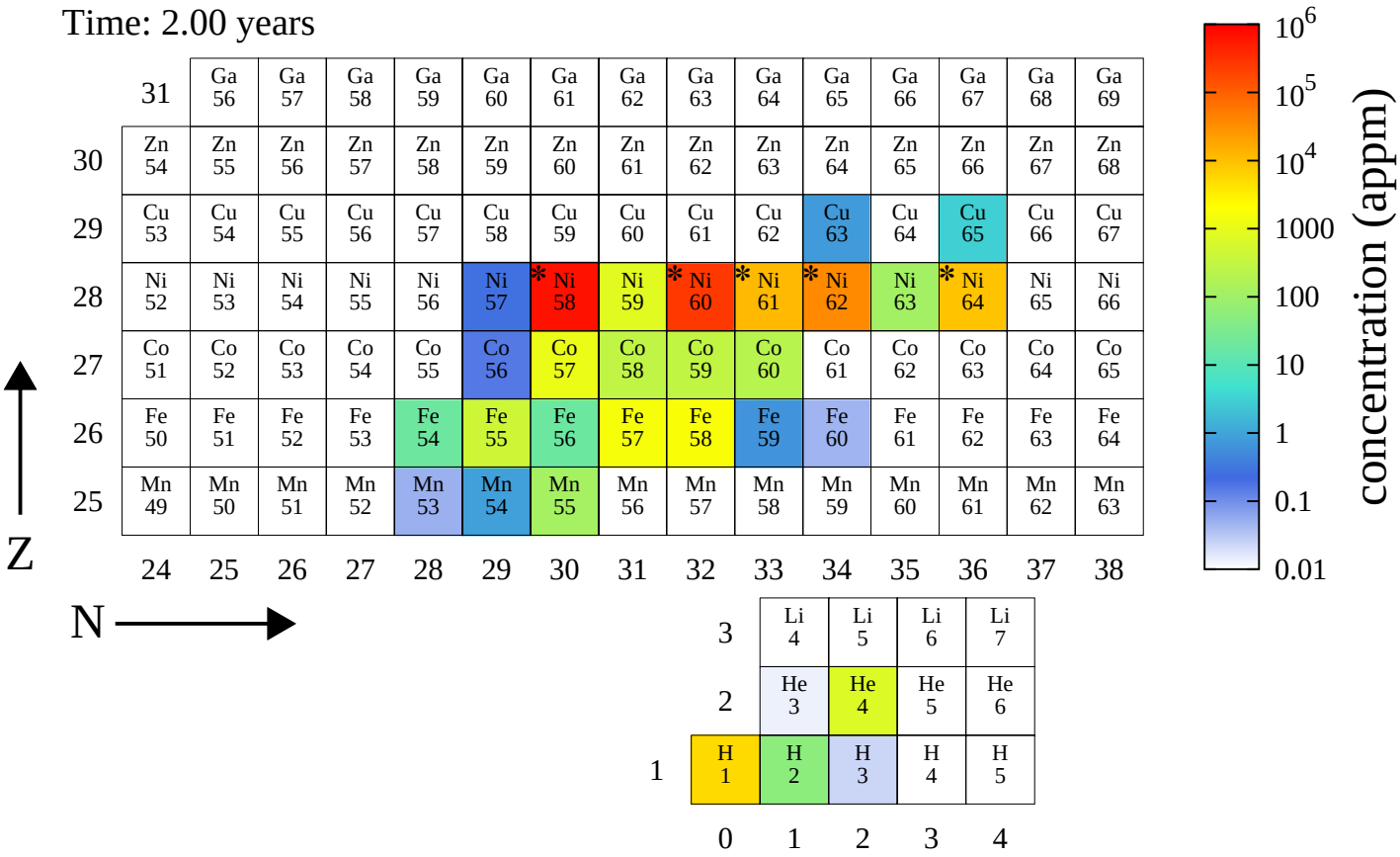




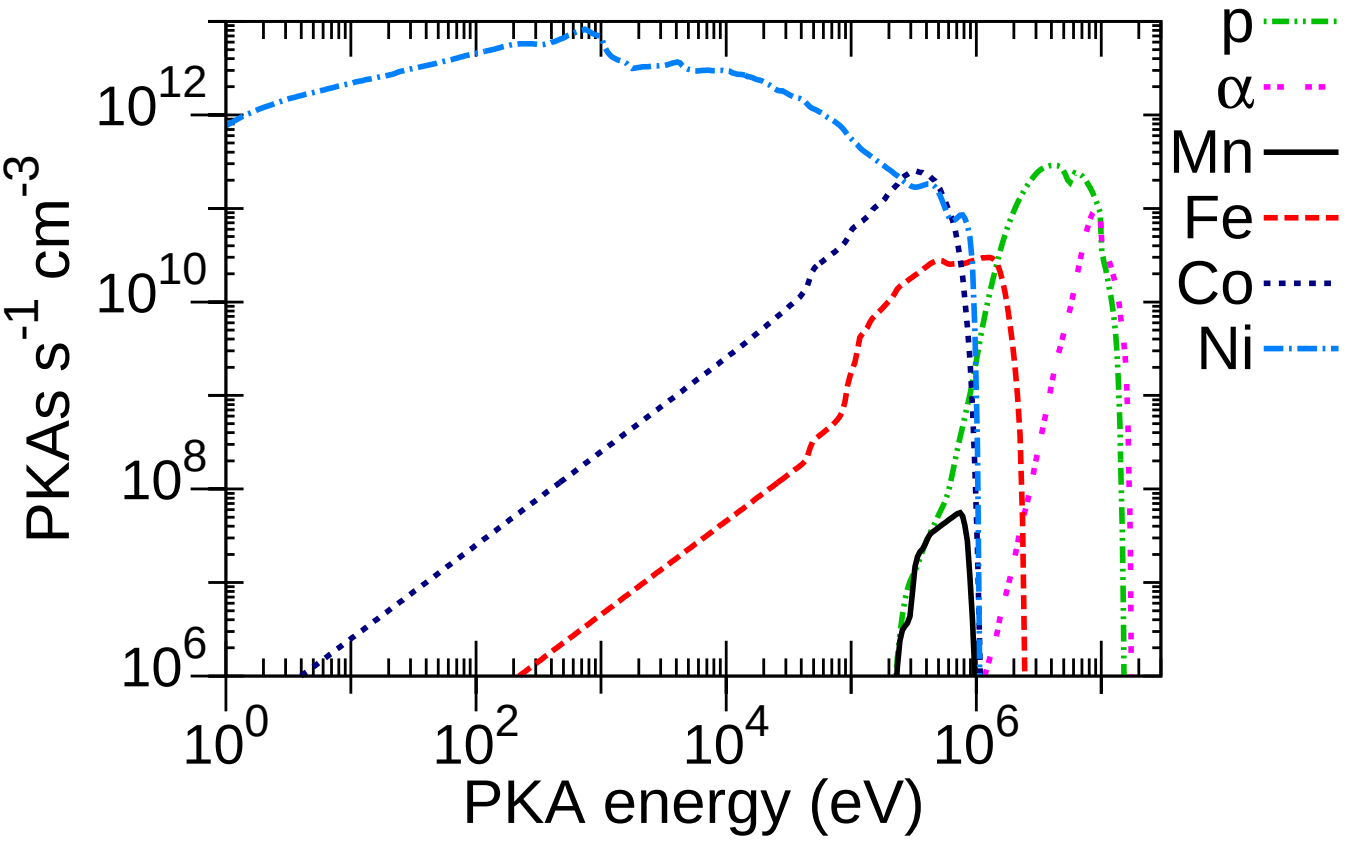
Nickel FW Transmutation

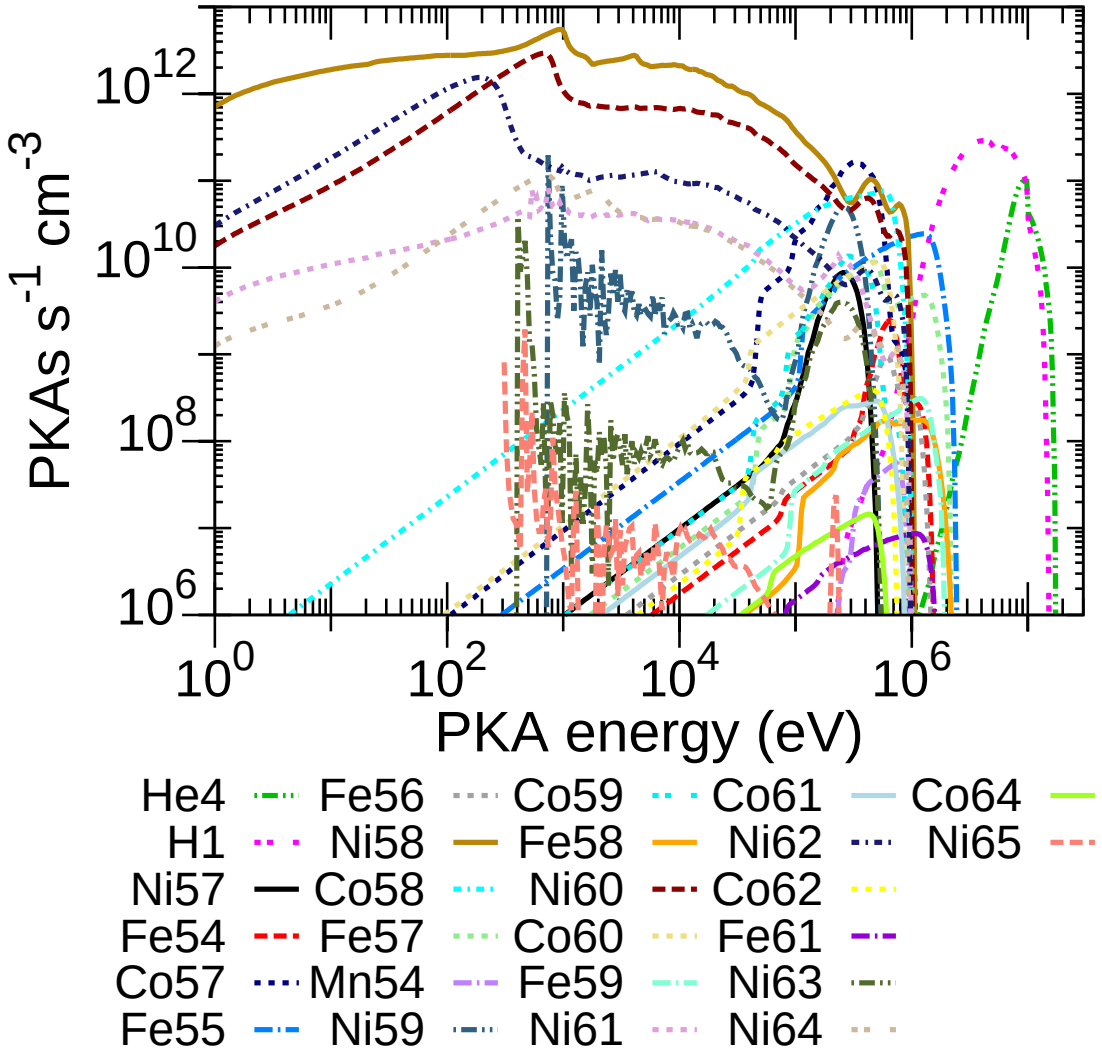


352 appm He & 2669 appm H after 1 year 13 dpa/year



Nickel FW PKA distributions





Nickel Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Co62	1.50m	Ni58(n,γ)Ni59(n,p)Co59(n,γ)Co60m(IT)Co60(n,γ)Co61(n,γ)Co62	61.7			
		Ni58(n,γ)Ni59(n,p)Co59(n,γ)Co60(n,γ)Co61(n,γ)Co62	37.5			
		Ni61(n,p)Co61(n,γ)Co62			97.7	
		Ni61(n,p)Co61(n,γ)Co62m(IT)Co62			1.2	
		Ni60(n,γ)Ni61(n,p)Co61(n,γ)Co62			1.0	
		Ni62(n,p)Co62				98.9
Cu66	5.10m	Ni64(n,γ)Ni65(β^-)Cu65(n,γ)Cu66	67.5	100.0	100.0	99.7
		Ni62(n,γ)Ni63(n,γ)Ni64(n,γ)Ni65(β^-)Cu65(n,γ)Cu66	31.5			
Co60m	10.47m	Ni58(n,γ)Ni59(n,p)Co59(n,γ)Co60m	100.0	98.2	59.0	
		Ni58(n,γ)Ni59(β^+)Co59(n,γ)Co60m		1.8		
		Ni60(n,p)Co60m			25.0	98.0
		Ni58(n,p)Co58(n,γ)Co59(n,γ)Co60m			7.9	
		Ni58(n,p)Co58m(IT)Co58(n,γ)Co59(n,γ)Co60m			2.8	
Ni65	2.52h	Ni62(n,γ)Ni63(n,γ)Ni64(n,γ)Ni65	53.3			
		Ni64(n,γ)Ni65	45.1	100.0	100.0	99.9
Co58m	8.90h	Ni58(n,p)Co58m		99.5	98.6	98.5
		Ni58(n,p)Co58(n,n′)Co58m			1.0	
Cu64	12.70h	Ni62(n,γ)Ni63(β^-)Cu63(n,γ)Cu64	97.1	99.9	100.0	
		Ni61(n,γ)Ni62(n,γ)Ni63(β^-)Cu63(n,γ)Cu64	1.5			
		Ni60(n,γ)Ni61(n,γ)Ni62(n,γ)Ni63(β^-)Cu63(n,γ)Cu64	1.3			
		Ni64(n,γ)Ni65(β^-)Cu65(n,2n)Cu64				99.0
Ni57	1.50d	Ni58(n,2n)Ni57				100.0
Fe59	44.50d	Ni58(n,γ)Ni59(n,α)Fe56(n,γ)Fe57(n,γ)Fe58(n,γ)Fe59	46.1			
		Ni60(n,γ)Ni61(n,α)Fe58(n,γ)Fe59	29.5	1.1		
		Ni61(n,α)Fe58(n,γ)Fe59	20.2	98.6		
		Ni58(n,γ)Ni59(n,γ)Ni60(n,γ)Ni61(n,α)Fe58(n,γ)Fe59	3.3			
		Ni62(n,α)Fe59				86.9
		Ni60(n,np)Co59(n,p)Fe59				7.4
		Ni60(n,p)Co60m(IT)Co60(n,np)Fe59				1.3
Co58	70.87d	Ni58(n,p)Co58	100.0	99.6	73.7	49.1
		Ni58(n,p)Co58m(IT)Co58			25.9	49.8
Co56	77.29d	Ni58(n,np)Co57(n,2n)Co56				94.3
		Ni58(n,2n)Ni57(β^+)Co57(n,2n)Co56				3.4
		Ni58(n,d)Co57(n,2n)Co56				1.9
Zn65	244.14d	Ni62(n,γ)Ni63(β^-)Cu63(n,γ)Cu64(β^-)Zn64(n,γ)Zn65	98.4	100.0	100.0	
		Ni61(n,γ)Ni62(n,γ)Ni63(β^-)Cu63(n,γ)Cu64(β^-)Zn64(n,γ)Zn65	1.0			
		Ni64(n,γ)Ni65(β^-)Cu65(n,2n)Cu64(β^-)Zn64(n,γ)Zn65				63.7
		Ni64(n,γ)Ni65(β^-)Cu65(n,γ)Cu66(β^-)Zn66(n,2n)Zn65				35.8
Co57	271.77d	Ni58(n,np)Co57				94.4
		Ni58(n,2n)Ni57(β^+)Co57				3.4
		Ni58(n,d)Co57				1.9
Fe55	2.73y	Ni58(n,α)Fe55	100.0	100.0	100.0	99.8
Co60	5.27y	Ni58(n,γ)Ni59(n,p)Co59(n,γ)Co60m(IT)Co60	62.2	57.5	22.0	
		Ni58(n,γ)Ni59(n,p)Co59(n,γ)Co60	37.8	40.7	23.9	
		Ni58(n,γ)Ni59(β^+)Co59(n,γ)Co60m(IT)Co60		1.1		
		Ni60(n,p)Co60m(IT)Co60			26.0	58.0
		Ni60(n,p)Co60			14.0	40.7
		Ni58(n,p)Co58(n,γ)Co59(n,γ)Co60			4.1	
		Ni58(n,p)Co58(n,γ)Co59(n,γ)Co60m(IT)Co60			3.8	
		Ni58(n,p)Co58m(IT)Co58(n,γ)Co59(n,γ)Co60			1.5	
		Ni58(n,p)Co58m(IT)Co58(n,γ)Co59(n,γ)Co60m(IT)Co60			1.3	

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
H3	12.33y	Ni58(n,γ)Ni59(n,p)H1(n,γ)H2(n,γ)H3	100.0	99.9		
		Ni58(n,p)H1(n,γ)H2(n,γ)H3			26.0	
		Ni61(n,t)H3				27.3
		Ni58(n,t)H3				20.6
		Ni58(n,np)Co57(β^+)Fe57(n,t)H3				9.8
		Ni60(n,2n)Ni59(n,t)H3				9.1
		Ni58(n,np)Co57(n,t)H3				6.1
		Ni58(n,p)Co58m(IT)Co58(n,t)H3				4.7
		Ni58(n,p)Co58(n,t)H3				4.6
		Ni60(n,t)H3				1.5
		Ni60(n,p)Co60m(IT)Co60(n,t)H3				2.6
		Ni60(n,p)Co60(n,t)H3				1.8
		Ni62(n,2n)Ni61(n,t)H3				1.5
		Ni60(n,np)Co59(n,t)H3				1.3
		Ni58(n,2p)Fe57(n,t)H3				1.3
		Ni58(n,α)Fe55(n,t)H3				1.1
		Ni60(n,α)Fe57(n,t)H3				1.0
Ni63	100.62y	Ni62(n,γ)Ni63	93.8	99.9	100.0	
		Ni60(n,γ)Ni61(n,γ)Ni62(n,γ)Ni63	3.3			
		Ni61(n,γ)Ni62(n,γ)Ni63	2.6			
		Ni64(n,2n)Ni63				99.2
Ni59	7.6 10^4y	Ni58(n,γ)Ni59	100.0	100.0	100.0	
		Ni60(n,2n)Ni59				99.1
Mn53	3.7 10^6y	Ni58(n,nα)Fe54(n,np)Mn53				48.7
		Ni58(n,np)Co57(n,nα)Mn53				20.4
		Ni58(n,α)Fe55(n,2n)Fe54(n,np)Mn53				9.9
		Ni58(n,np)Co57(n,α)Mn54(n,2n)Mn53				8.6
		Ni58(n,α)Fe55(n,np)Mn54(n,2n)Mn53				3.8
		Ni58(n,α)Fe55(β^+)Mn55(n,2n)Mn54(n,2n)Mn53				2.1
		Ni58(n,pα)Mn54(n,2n)Mn53				1.5
		Ni58(n,np)Co57(n,2n)Co56(n,α)Mn53				1.0

Copper

Isotope	Atom % abundance
Cu63	69.17
Cu65	30.83

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	7.47E+14	6.35E+14	1.13E+13	6.76E+12	3.86E+11	5.72E+04
Cu64	55.3	64.7	30.5			
Cu62	34.5	27.9				
Cu66	5.7	3.3				
Co60m	2.2	1.8				11.6
Co60	0.9	1.1	59.0	86.7		11.6
Ni63	0.1	0.1	6.8	11.3	100.0	
Zn65			2.3	1.4		
Ni59						65.3
Fe60						11.6

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.30E-01	9.48E-02	3.00E-03	2.45E-03	1.08E-06	2.92E-12
Cu62	73.0	68.8				
Cu64	16.1	21.9	5.8			
Cu66	6.1	4.1				
Co60	2.1	2.9	92.5	99.5	0.7	94.4
Ni63			0.1	0.1	99.3	
Co60m	0.1	0.1				2.3
Fe60						1.9
Ni59						1.5

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	7.88E+04	6.03E+04	5.08E+03	4.29E+03	1.30E-02	4.83E-06
Cu62	67.5	60.8				
Cu64	20.6	26.8	2.7			
Co60	6.2	8.1	95.8	99.6	100.0	99.6
Co62m	2.0	2.0				
Co62	1.4	0.2				
Cu66	1.2	0.8				
Ni65	0.9	1.2				

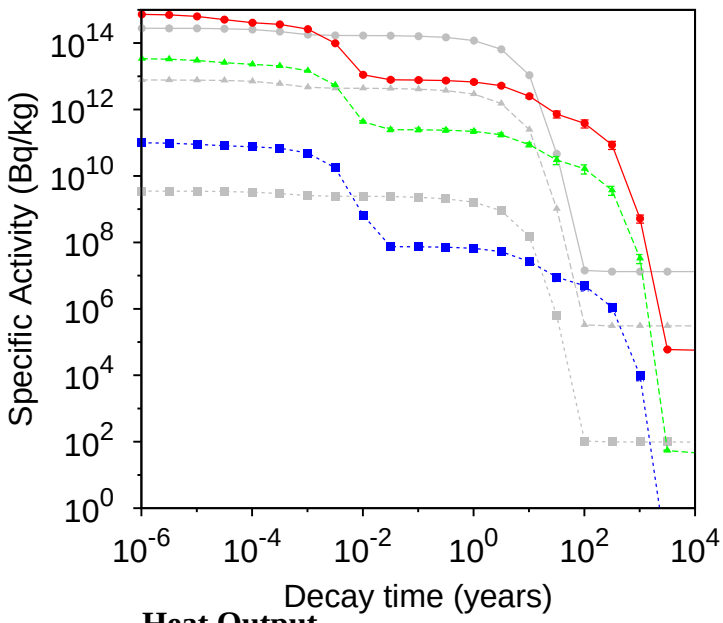
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.02E+05	8.66E+04	2.44E+04	2.04E+04	5.79E+01	7.53E-04
Cu64	48.4	57.0	1.7			
Co60	22.2	26.2	92.9	97.6	0.1	3.0
Cu62	15.4	12.5				
Co62	11.2	1.3				
Zn65	1.0	1.2	4.2	1.8		
Ni63	0.1	0.1	0.5	0.6	99.9	
Fe60						96.7

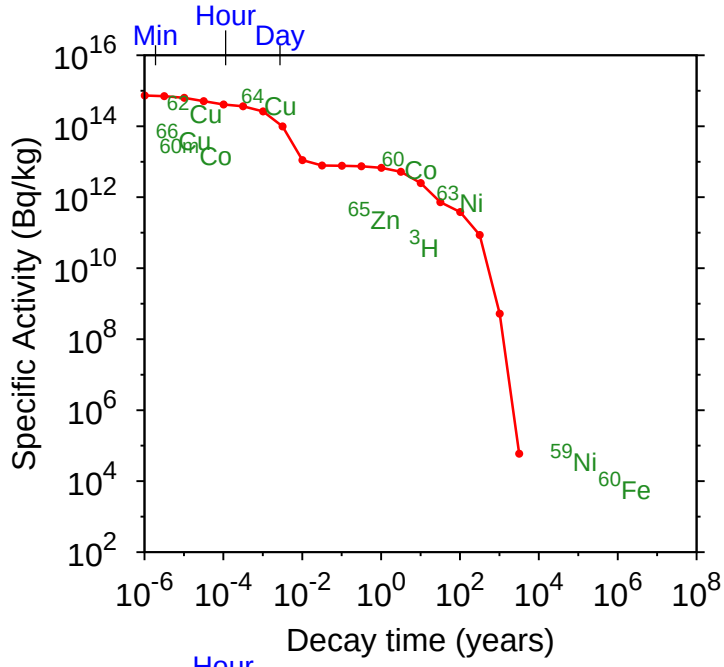
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.79E+05	2.67E+05	2.09E+05	1.83E+05	5.02E+02	2.08E-03
Co60	74.3	77.6	98.9	99.3	0.1	9.9
Cu64	17.8	18.5	0.2			
Cu62	3.5	2.5				
Co62	3.4	0.3				
Ni63	0.4	0.4	0.5	0.5	99.9	
Fe60						89.3

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	3.80E+11	2.80E+11	6.95E+10	5.95E+10	4.03E+06	6.65E+01
Cu62	77.2	71.9				
Co60	17.6	23.8	96.0	98.4	4.4	99.4
Cu66	2.1	1.4				
Cu64	1.1	1.5				
Co62	1.0	0.1				
Zn65	0.7	0.9	3.8	1.6		
Ni63					95.5	

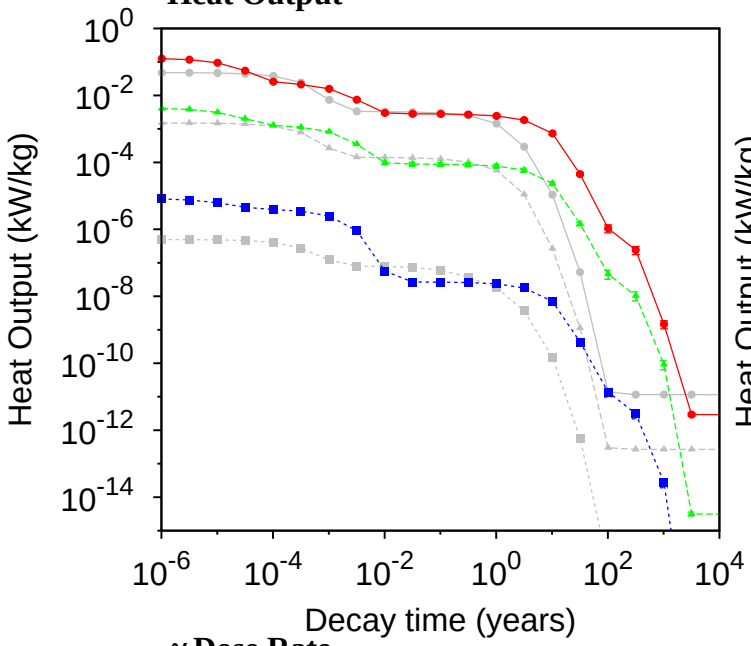
Copper activation characteristics

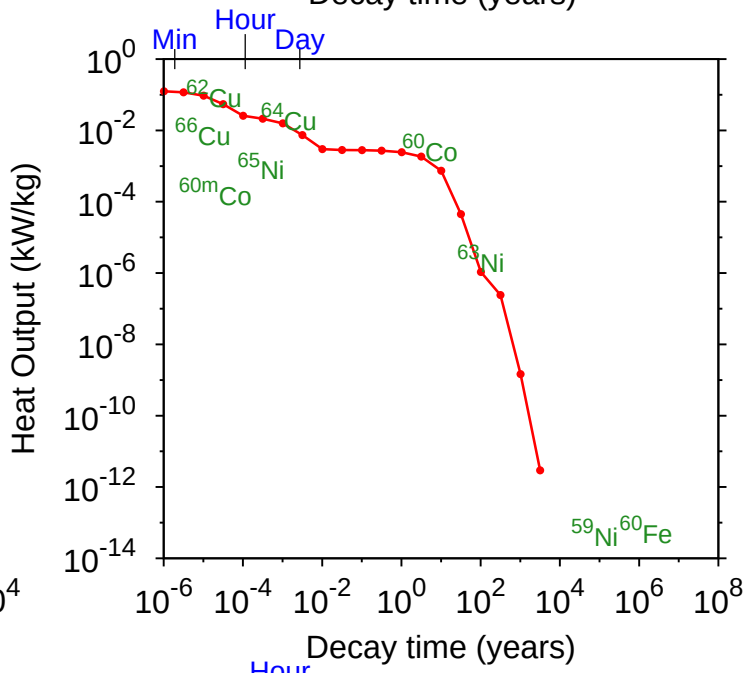
Specific Activity



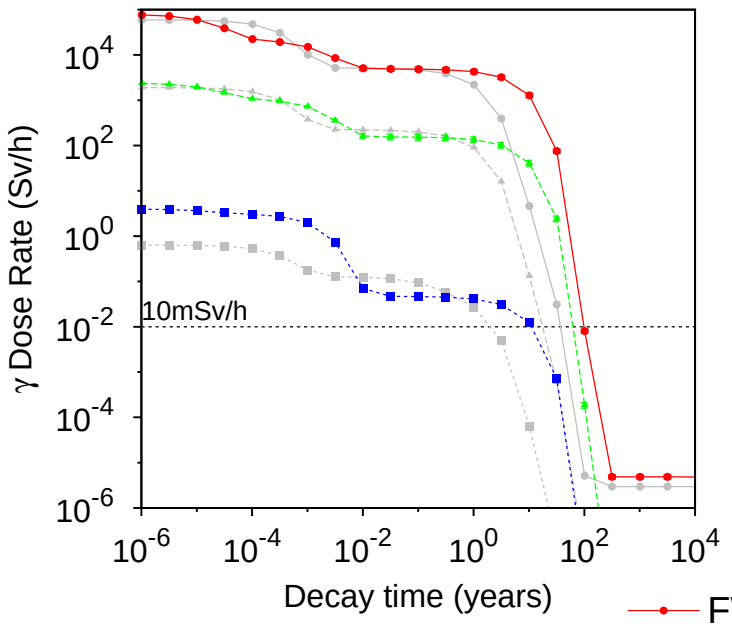


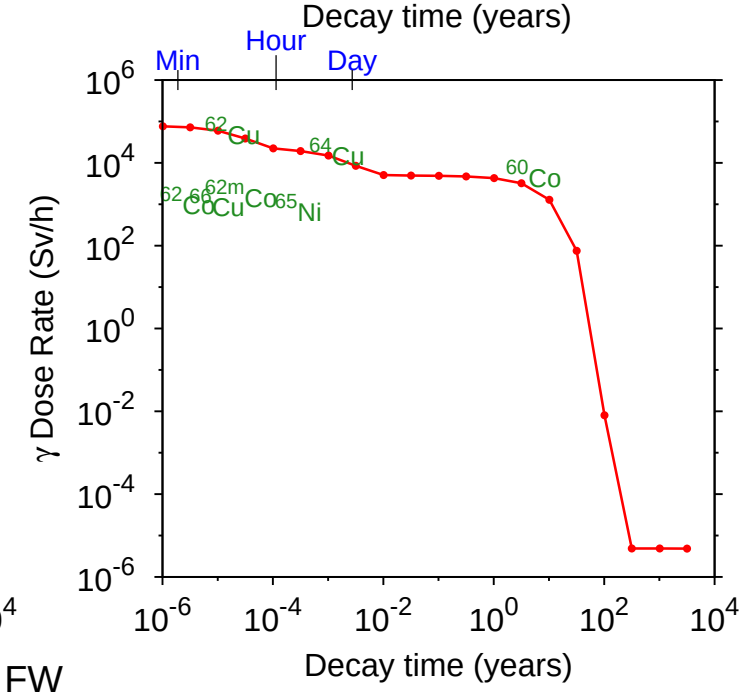
Heat Output





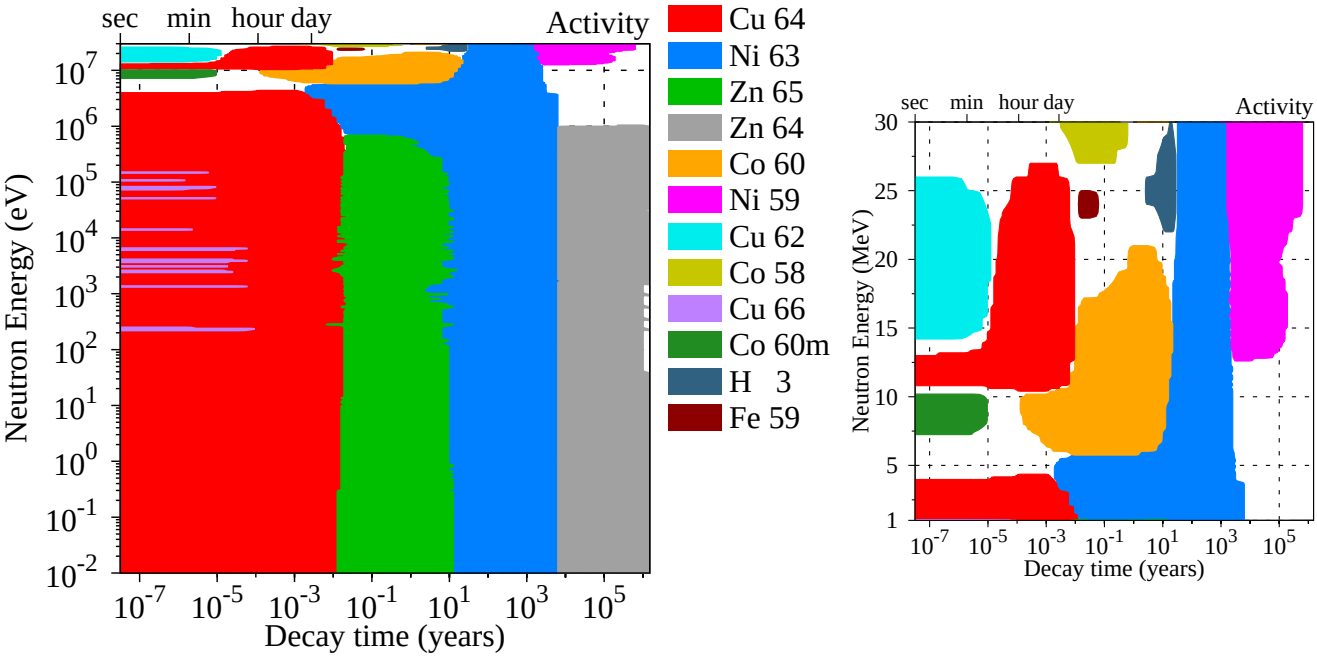
γ Dose Rate

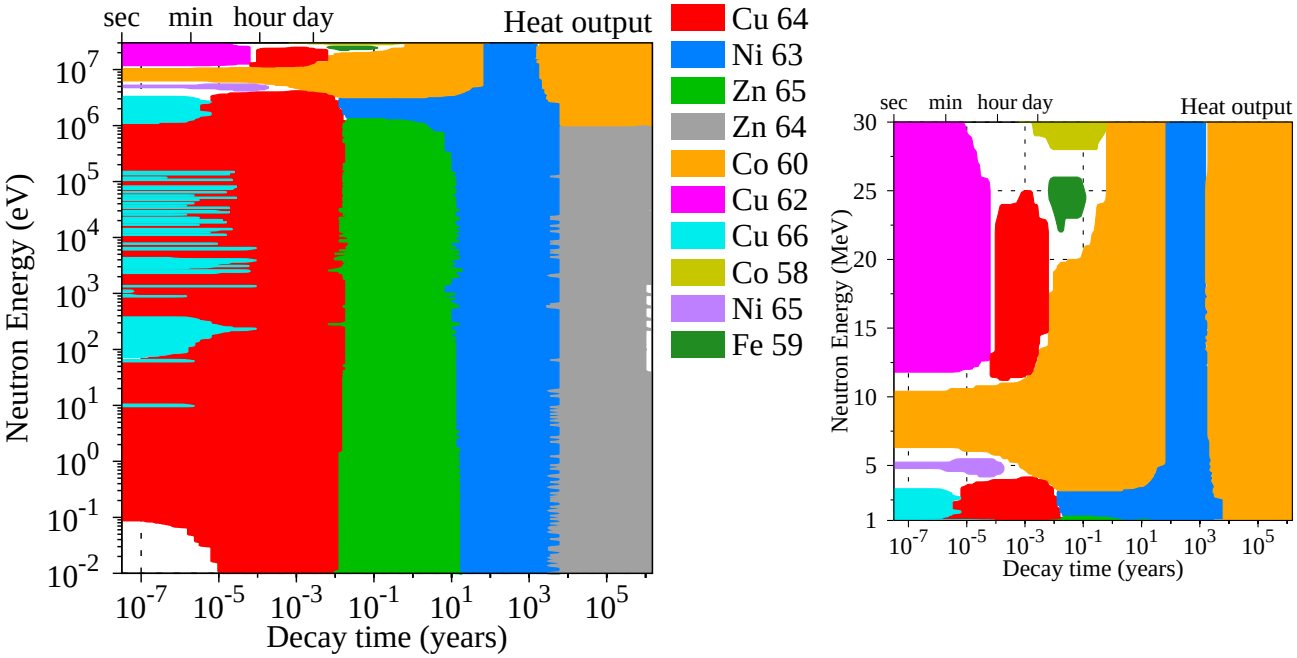


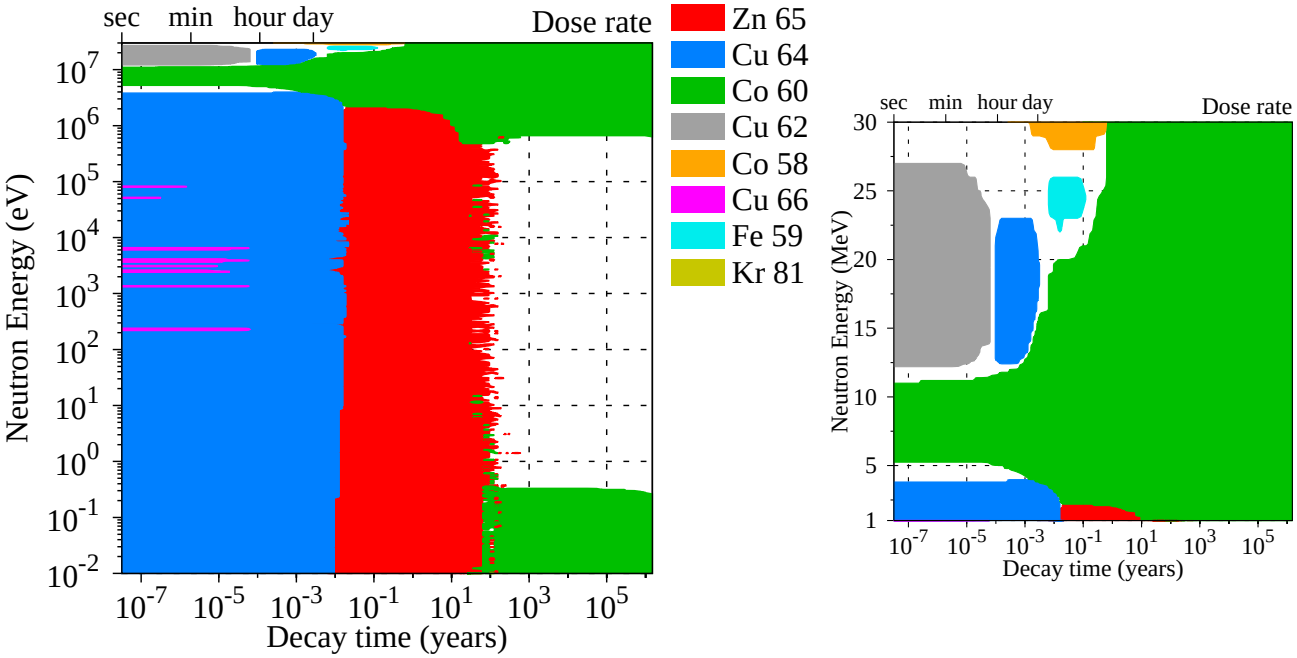


FW
Blanket
Manifold
Fe results

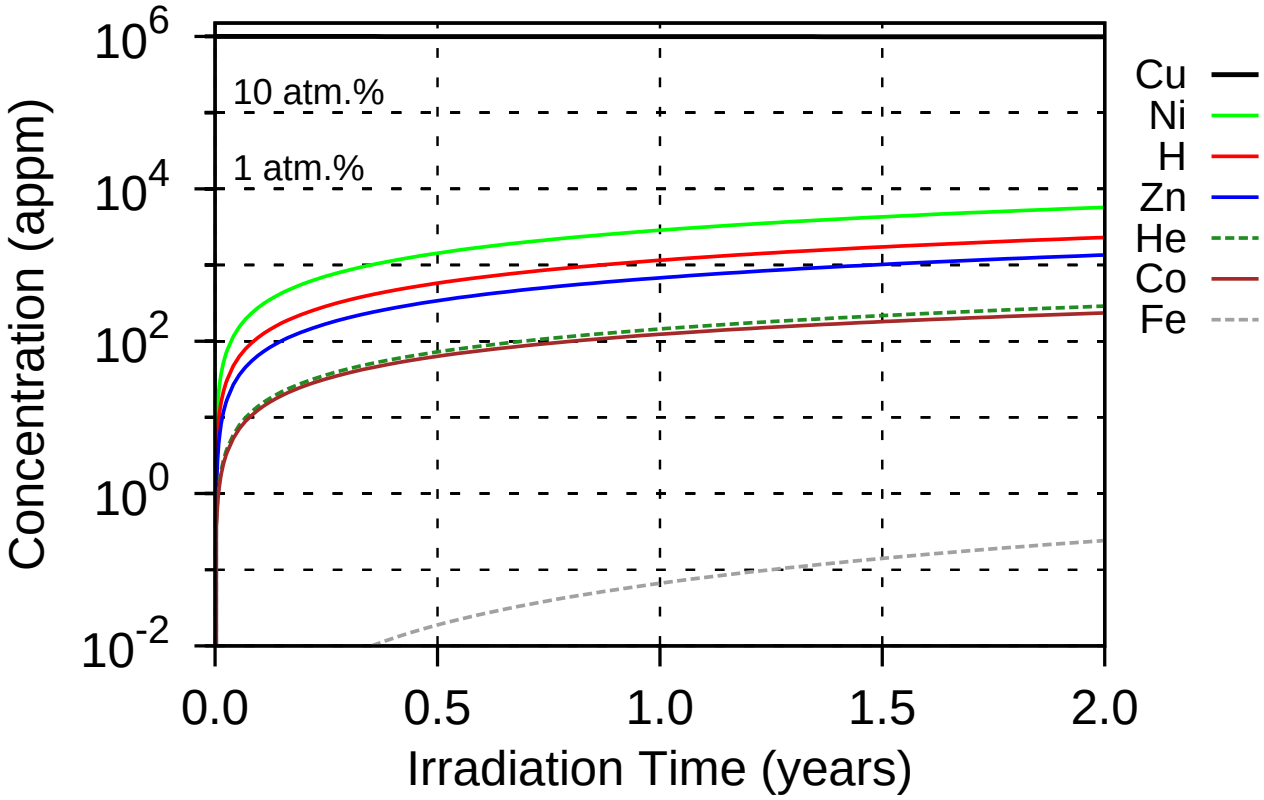
Copper Importance diagrams



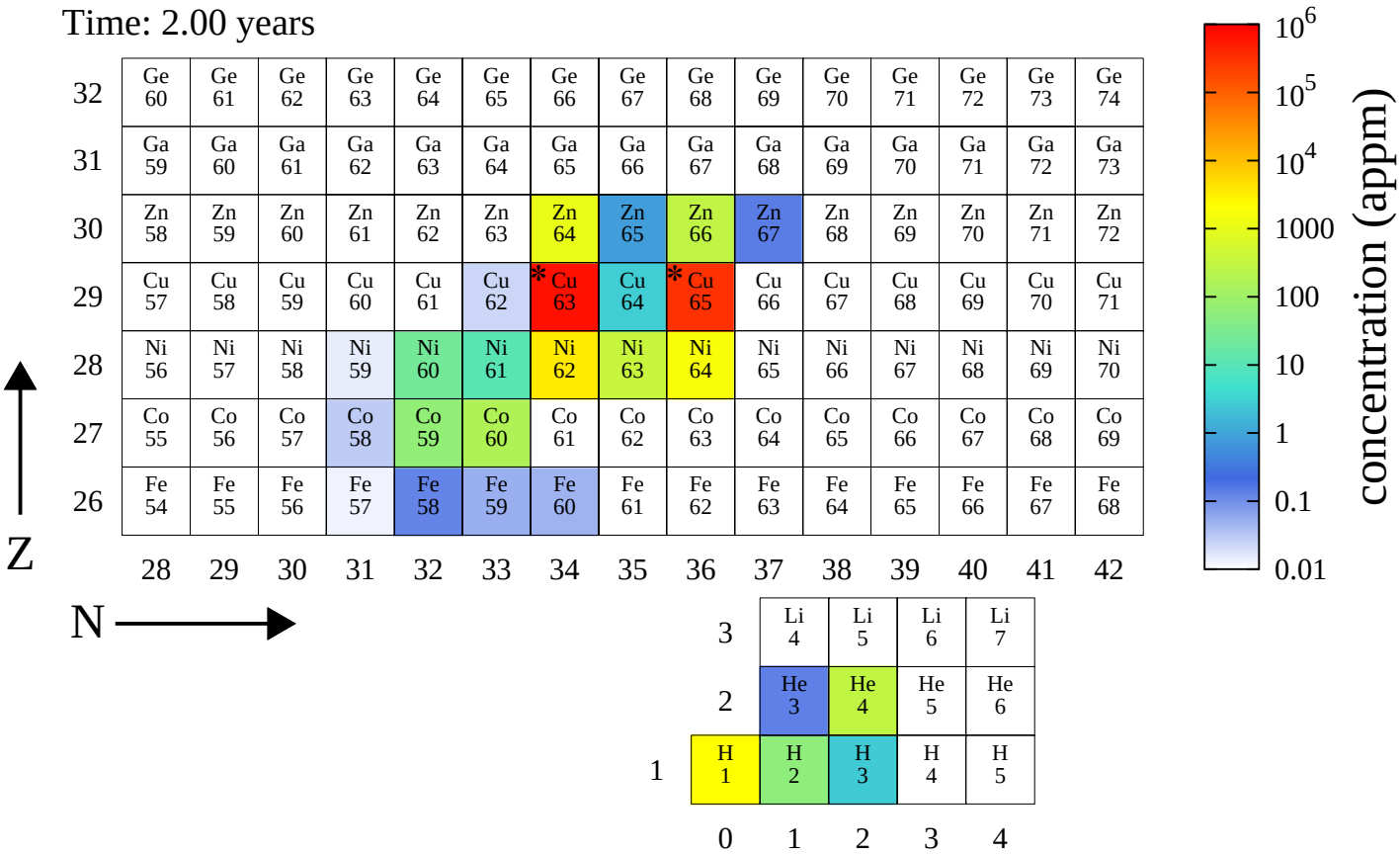




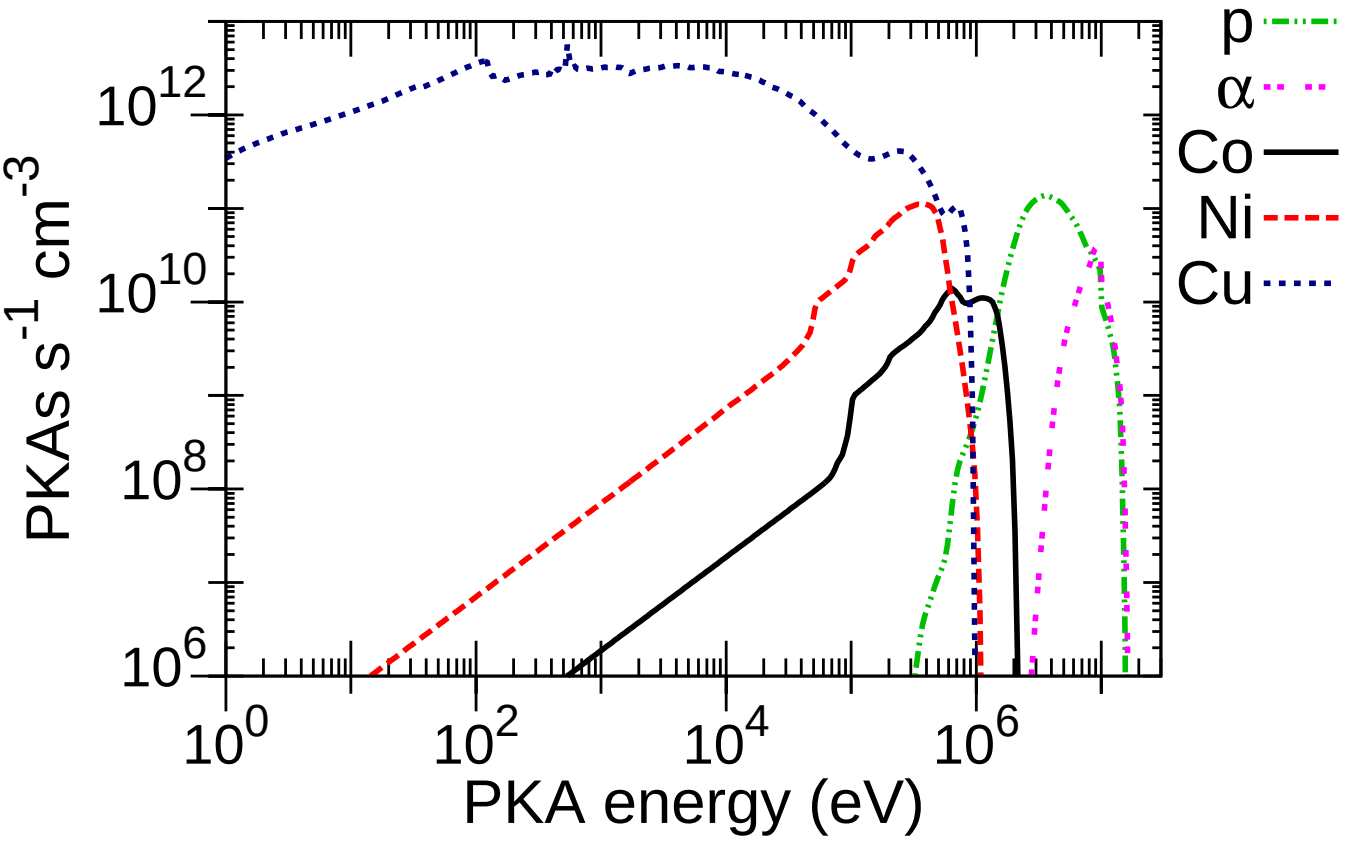
Copper FW Transmutation

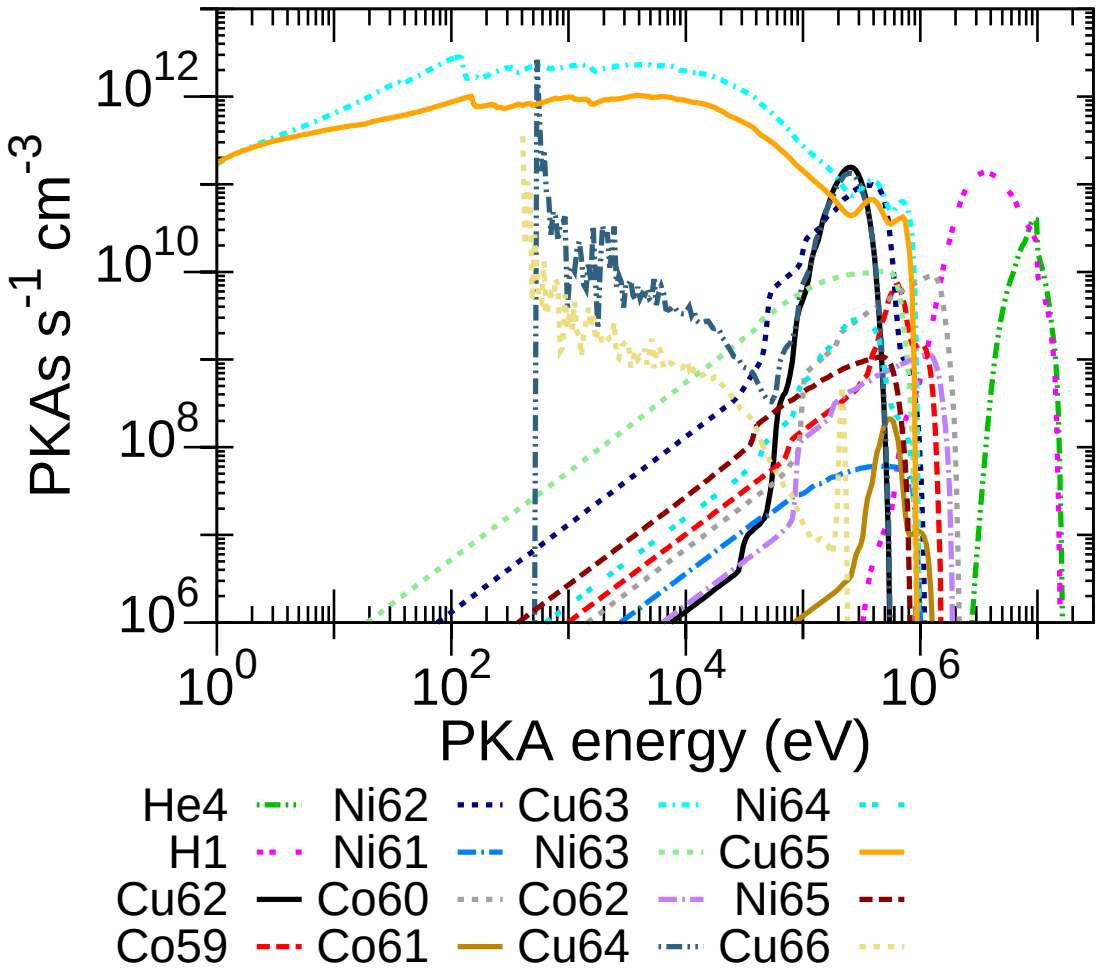


144 appm He & 1153 appm H after 1 year 12 dpa/year



Copper FW PKA distributions





Copper Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Co62	1.50m	Cu63(n,γ)Cu64(n,α)Co61(n,γ)Co62	99.3			
		Cu65(n,α)Co62			99.2	74.1
		Cu63(n,np)Ni62(n,p)Co62				12.6
		Cu63(n,2n)Cu62(β^+)Ni62(n,p)Co62				11.7
Cu66	5.10m	Cu65(n,γ)Cu66	97.4	100.0	100.0	99.5
		Cu63(n,γ)Cu64(β^+)Ni64(n,γ)Ni65(β^-)Cu65(n,γ)Cu66	1.5			
Cu62	9.75m	Cu63(n,2n)Cu62				100.0
Co60m	10.47m	Cu63(n,γ)Cu64(β^-)Zn64(n,α)Ni61(n,α)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60m	94.7			
		Cu63(n,γ)Cu64(n,α)Co61(β^-)Ni61(n,α)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60m	5.3			
		Cu63(n,α)Co60m			97.0	98.6
		Cu63(n,α)Co60(n,n$'$)Co60m			3.0	
Co62m	13.91m	Cu63(n,γ)Cu64(n,α)Co61(n,γ)Co62m	100.0			
		Cu65(n,α)Co62m			100.0	77.3
		Cu63(n,np)Ni62(n,p)Co62m				11.5
		Cu63(n,2n)Cu62(β^+)Ni62(n,p)Co62m				10.6
Ni65	2.52h	Cu63(n,γ)Cu64(β^+)Ni64(n,γ)Ni65	98.2	100.0	32.6	
		Cu63(n,γ)Cu64(n,p)Ni64(n,γ)Ni65	1.8			
		Cu65(n,p)Ni65			67.4	99.8
Cu64	12.70h	Cu63(n,γ)Cu64	100.0	100.0	100.0	
		Cu65(n,2n)Cu64				99.3
Fe59	44.50d	Cu63(n,γ)Cu64(β^-)Zn64(n,α)Ni61(n,α)Fe58(n,γ)Fe59	95.7	100.0	100.0	
		Cu63(n,γ)Cu64(n,α)Co61(β^-)Ni61(n,α)Fe58(n,γ)Fe59	4.3			
		Cu63(n,np)Ni62(n,α)Fe59				47.3
		Cu63(n,2n)Cu62(β^+)Ni62(n,α)Fe59				43.7
		Cu63(n,nα)Co59(n,p)Fe59				3.1
		Cu63(n,d)Ni62(n,α)Fe59				1.2
		Cu63(n,α)Co60m(IT)Co60(n,np)Fe59				1.1
Co58	70.87d	Cu63(n,nα)Co59(n,2n)Co58m(IT)Co58				56.7
		Cu63(n,nα)Co59(n,2n)Co58				33.0
		Cu63(n,α)Co60m(IT)Co60(n,2n)Co59(n,2n)Co58m(IT)Co58				2.3
		Cu63(n,α)Co60(n,2n)Co59(n,2n)Co58m(IT)Co58				1.9
		Cu63(n,α)Co60m(IT)Co60(n,2n)Co59(n,2n)Co58				1.3
		Cu63(n,α)Co60(n,2n)Co59(n,2n)Co58				1.1
		Cu63(n,np)Ni62(n,α)Fe59(β^-)Co59(n,2n)Co58m(IT)Co58				1.0
Zn65	244.14d	Cu63(n,γ)Cu64(β^-)Zn64(n,γ)Zn65	100.0	100.0	100.0	
		Cu65(n,2n)Cu64(β^-)Zn64(n,γ)Zn65				63.8
		Cu65(n,γ)Cu66(β^-)Zn66(n,2n)Zn65				35.9
Co60	5.27y	Cu63(n,γ)Cu64(β^-)Zn64(n,α)Ni61(n,α)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60m(IT)Co60	58.0			
		Cu63(n,γ)Cu64(β^-)Zn64(n,α)Ni61(n,α)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60	35.3			
		Cu63(n,γ)Cu64(n,α)Co61(β^-)Ni61(n,α)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60m(IT)Co60	4.1			
		Cu63(n,γ)Cu64(n,α)Co61(β^-)Ni61(n,α)Fe58(n,γ)Fe59(β^-) Co59(n,γ)Co60	2.5			
		Cu63(n,α)Co60			52.9	44.9
		Cu63(n,α)Co60m(IT)Co60			47.1	54.6
H3	12.33y	Cu63(n,γ)Cu64(n,p)H1(n,γ)H2(n,γ)H3	93.3	49.1		
		Cu63(n,γ)Cu64(β^-)Zn64(n,γ)Zn65(n,p)H1(n,γ)H2(n,γ)H3	6.6	1.3		
		Cu63(n,p)H1(n,γ)H2(n,γ)H3		49.5	100.0	
		Cu63(n,t)H3				84.8
		Cu65(n,t)H3				15.1
Ni63	100.62y	Cu63(n,p)Ni63	98.2	100.0	100.0	89.8
		Cu65(n,γ)Cu66(β^-)Zn66(n,α)Ni63	1.5			
		Cu65(n,2n)Cu64(β^+)Ni64(n,2n)Ni63				9.4
Ni59	7.6 10^4y	Cu63(n,α)Co60m(IT)Co60(β^-)Ni60(n,2n)Ni59				46.6
		Cu63(n,α)Co60(β^-)Ni60(n,2n)Ni59				38.3
		Cu65(n,2n)Cu64(β^-)Zn64(n,nα)Ni60(n,2n)Ni59				9.9
		Cu63(n,np)Ni62(n,2n)Ni61(n,2n)Ni60(n,2n)Ni59				1.5
		Cu63(n,α)Co60m(β^-)Ni60(n,2n)Ni59				1.4
		Cu63(n,2n)Cu62(β^+)Ni62(n,2n)Ni61(n,2n)Ni60(n,2n)Ni59				1.4
Kr81	2.1 10^5y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Fe60	1.5 10^6y	Cu63(n,γ)Cu64(β^-)Zn64(n,α)Ni61(n,α)Fe58(n,γ) Fe59(n,γ)Fe60	94.3			
		Cu63(n,γ)Cu64(n,α)Co61(β^-)Ni61(n,α)Fe58(n,γ) Fe59(n,γ)Fe60	5.7			
		Cu63(n,p)Ni63(n,α)Fe60			90.7	26.9
		Cu63(n,α)Co60(n,p)Fe60			4.9	31.9
		Cu63(n,α)Co60m(IT)Co60(n,p)Fe60			4.4	38.8
		Cu65(n,2n)Cu64(β^+)Ni64(n,2n)Ni63(n,α)Fe60				1.9
Zn64	2.3 10^{18}y	Cu63(n,γ)Cu64(β^-)Zn64	100.0	100.0	100.0	
		Cu65(n,2n)Cu64(β^-)Zn64				99.6

Zinc

Isotope	Atom % abundance
Zn64	48.63
Zn66	27.90
Zn67	4.10
Zn68	18.75
Zn70	0.62

($T_{1/2}$ =2.3 10^{18}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	4.14E+14	3.92E+14	1.75E+14	6.22E+13	7.20E+10	8.76E+05
Zn65	42.3	44.6	98.9	99.7		
Cu64	24.8	26.0	0.5			
Zn69	14.9	14.9	0.1			
Zn63	8.7	8.3				
Cu66	4.2	2.2				
Zn69m	2.4	2.5	0.1			
Ni63			0.1	0.2	100.0	
Ni59						99.9

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	4.32E-02	3.86E-02	1.64E-02	5.86E-03	2.01E-07	1.19E-12
Zn65	38.1	42.8	99.4	99.9		
Zn63	26.8	27.4				
Cu64	12.0	13.4	0.3			
Cu66	7.4	4.0				
Zn69	7.4	7.8				
Cu68	3.8	0.4				
Zn69m	1.6	1.8	0.1			
Ni63					100.0	
Ni59						84.4
Co60				0.1		14.9

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	4.39E+04	4.16E+04	2.81E+04	1.00E+04	1.29E-05	5.31E-07
Zn65	64.5	68.0	99.8	99.9		
Zn63	18.9	18.1				
Cu64	9.1	9.5	0.1			
Cu68	2.7	0.3				
Zn69m	1.9	2.0				
Co60				0.1	98.1	58.1
Ni59					1.9	41.8

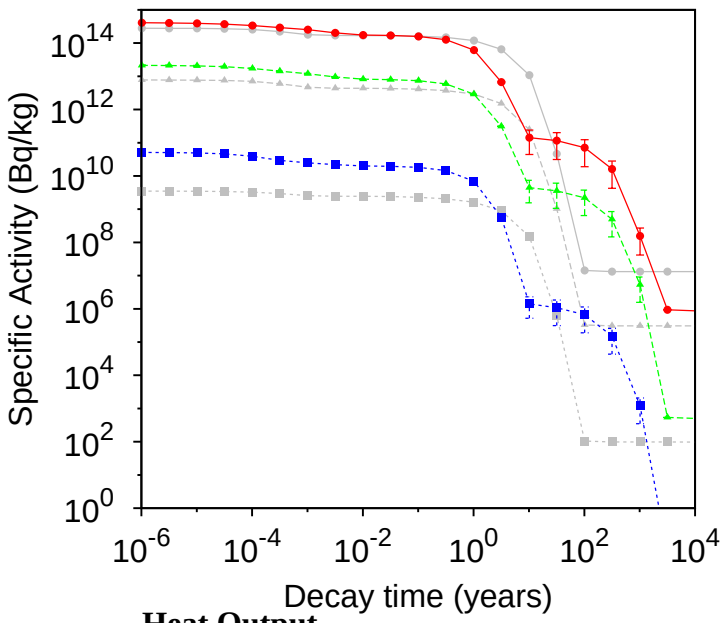
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	7.09E+05	7.04E+05	6.75E+05	2.42E+05	1.08E+01	1.04E-04
Zn65	96.2	96.8	99.9	100.0		
Cu64	1.7	1.7				
Ni63					100.0	
Ni59						53.0
Fe60						45.2
Co60						1.4

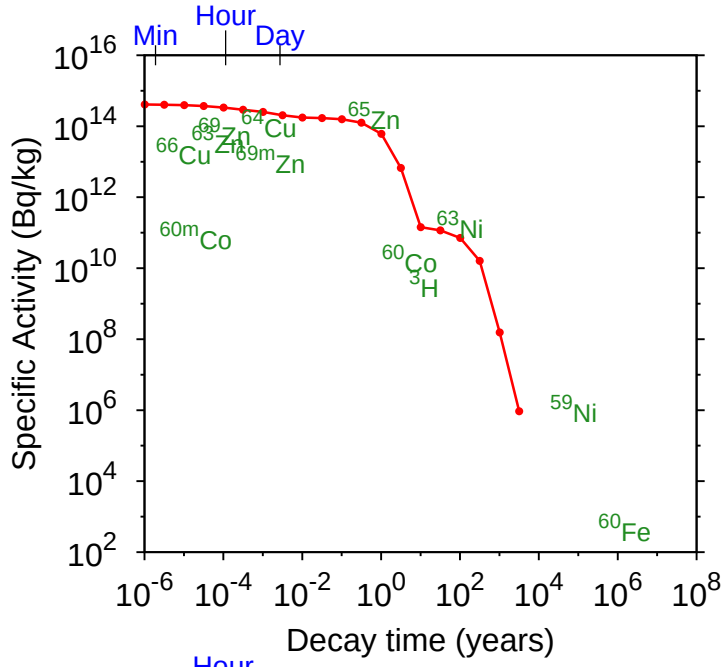
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.09E+05	4.06E+05	3.82E+05	1.37E+05	9.36E+01	5.18E-04
Zn65	94.1	94.9	99.7	99.5		
Cu64	3.0	3.0				
Ni63				0.1	100.0	
Ni59						74.3
Fe60						23.1
Co60	0.1	0.1	0.1	0.3		2.5

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.80E+12	1.79E+12	1.73E+12	6.20E+11	7.20E+05	1.30E+01
Zn65	96.9	97.5	100.0	100.0		
Zn63	2.4	2.2				
Ni63					100.0	
Ni59						67.2
Co60						32.7

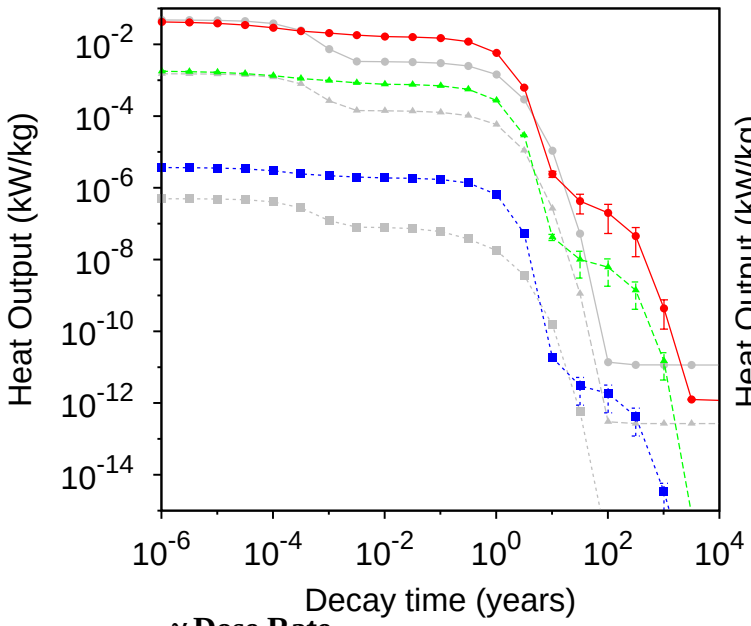
Zinc activation characteristics

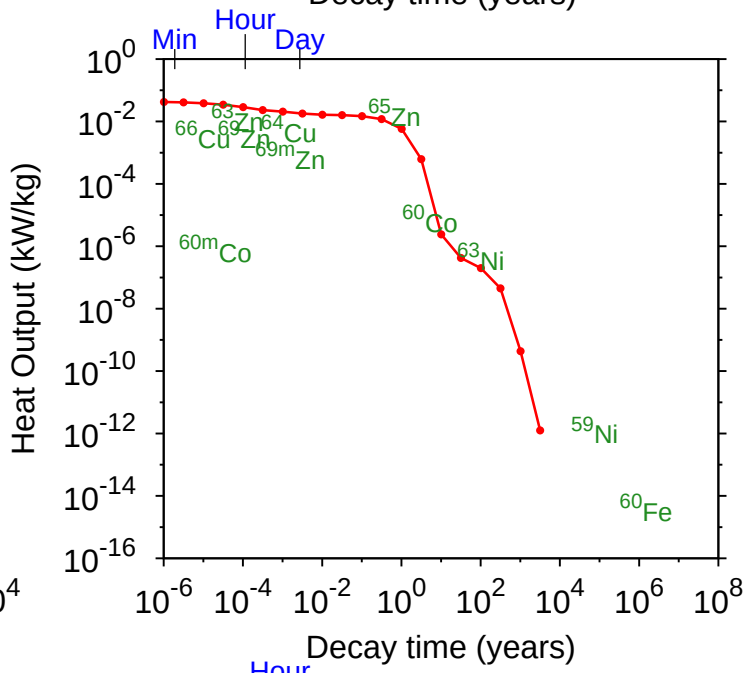
Specific Activity



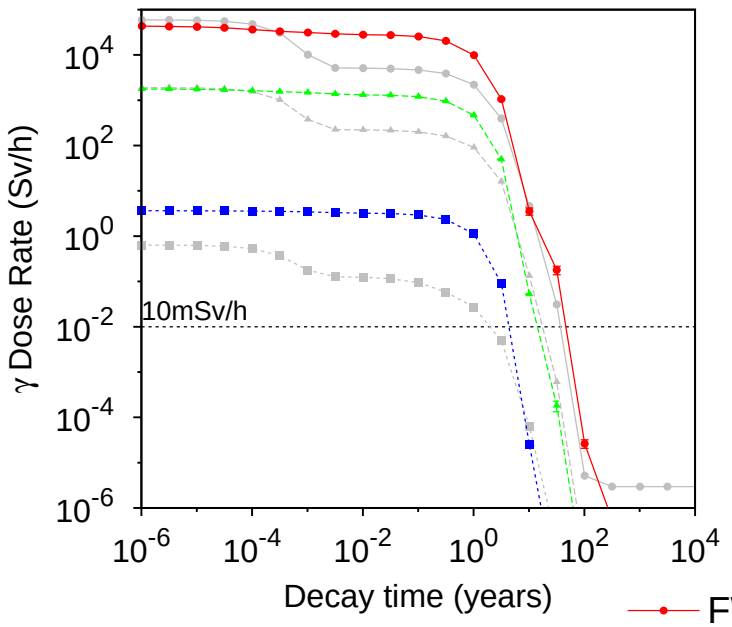


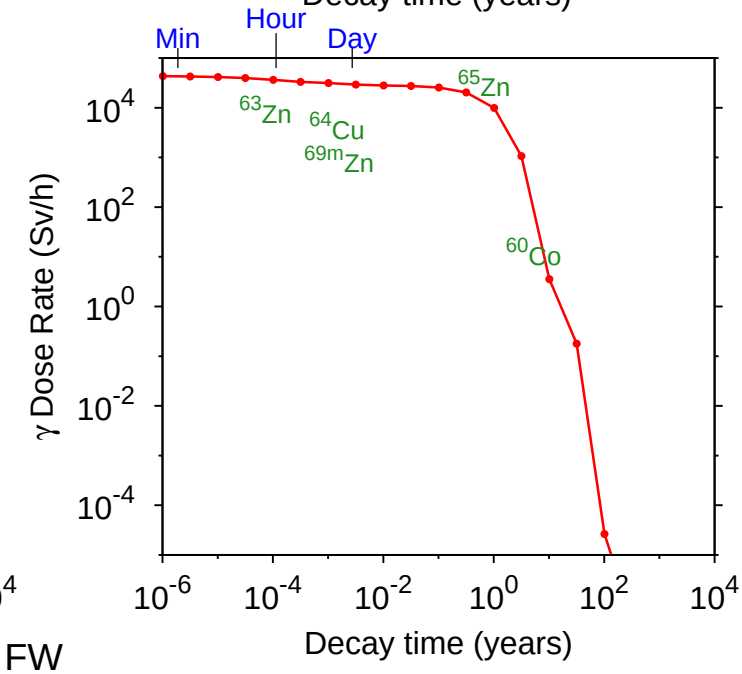
Heat Output





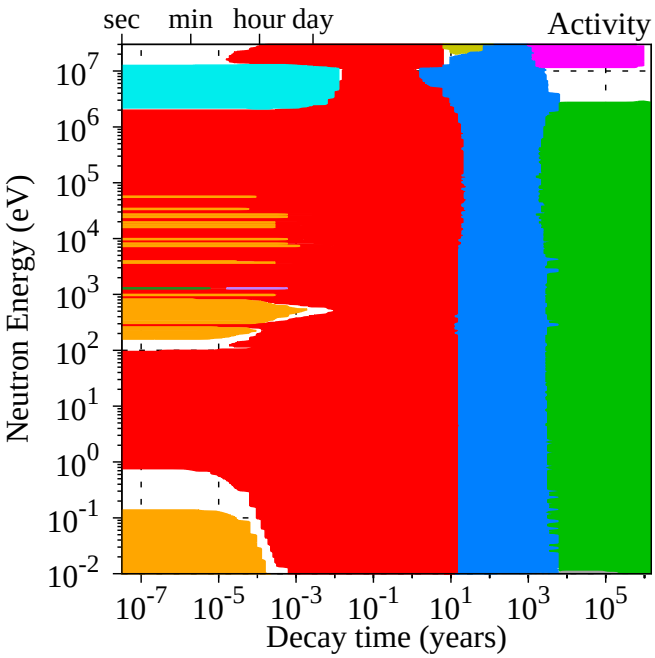
γ Dose Rate

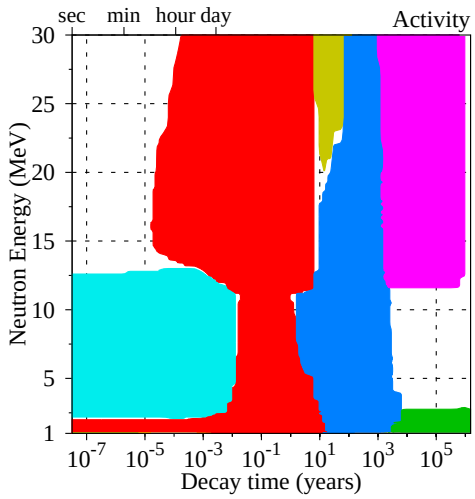


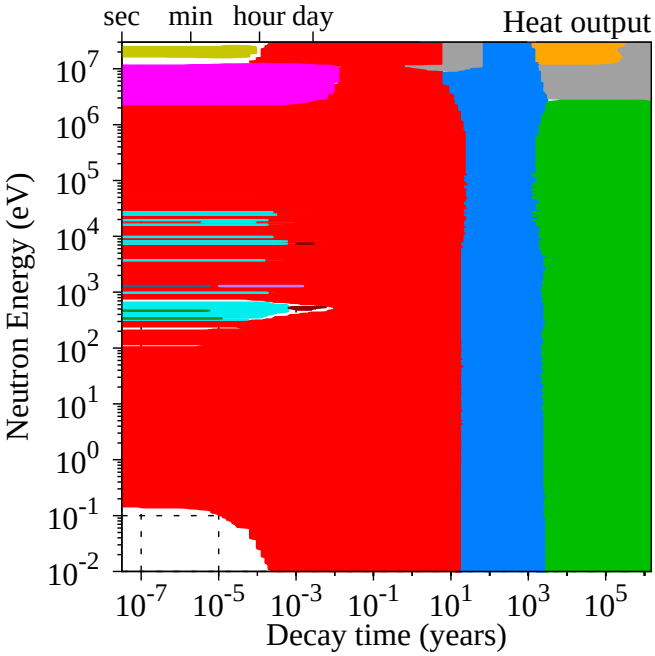


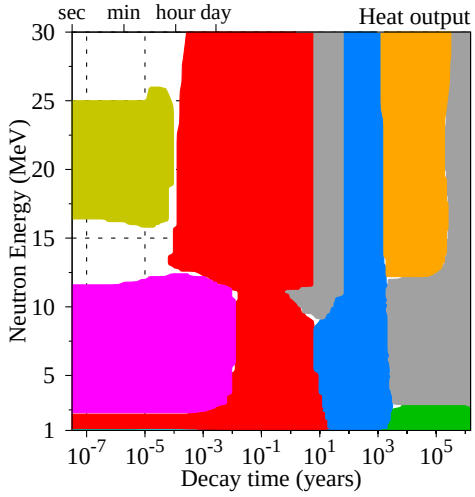
FW
Blanket
Manifold
Fe results

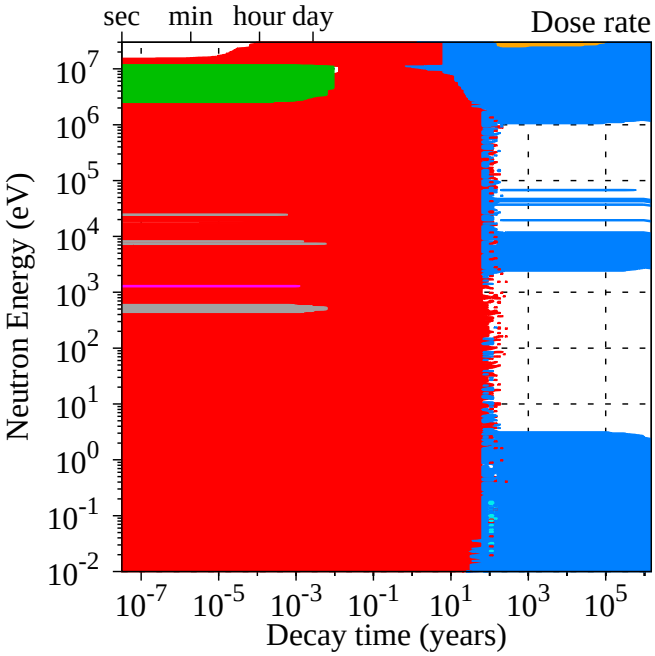
Zinc Importance diagrams

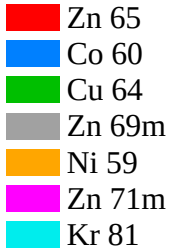


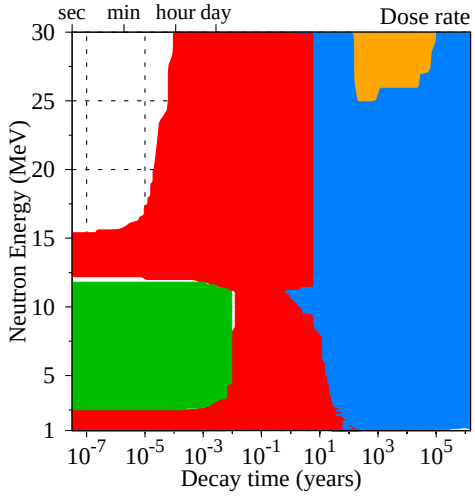




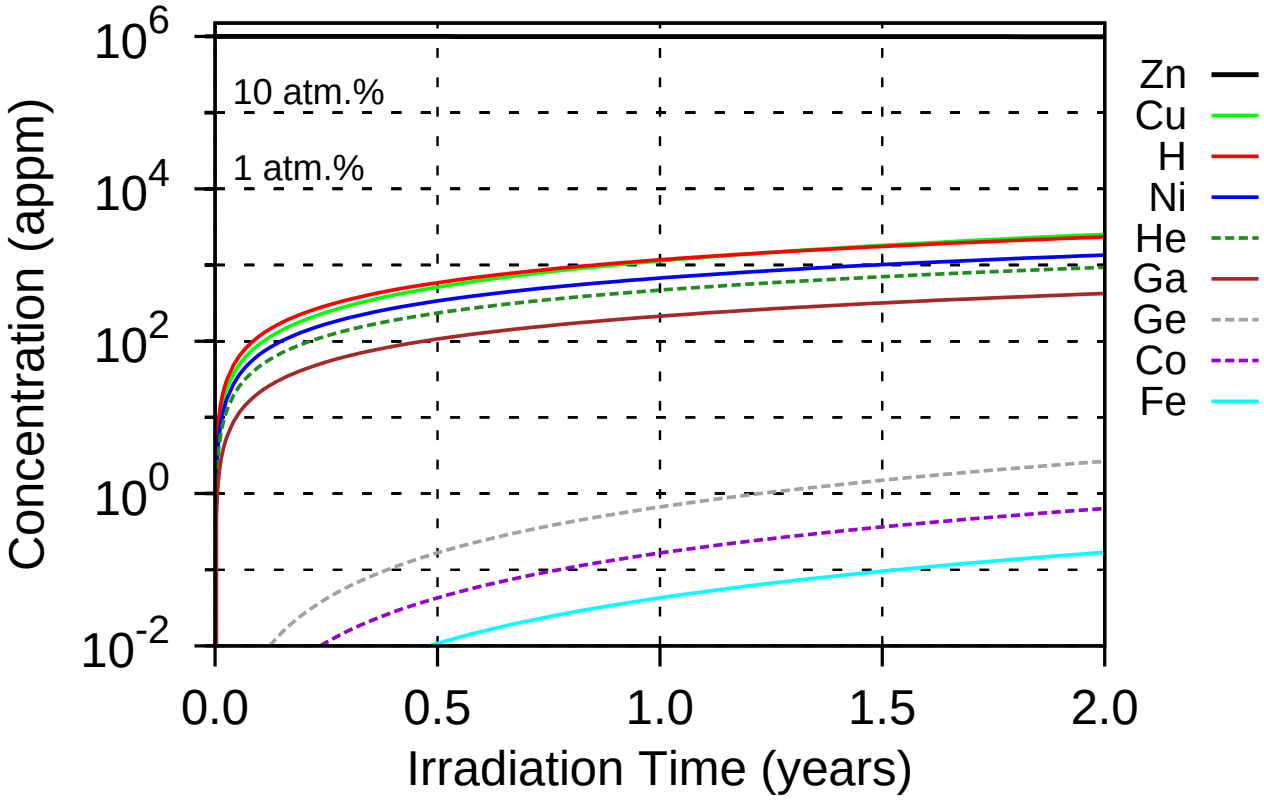




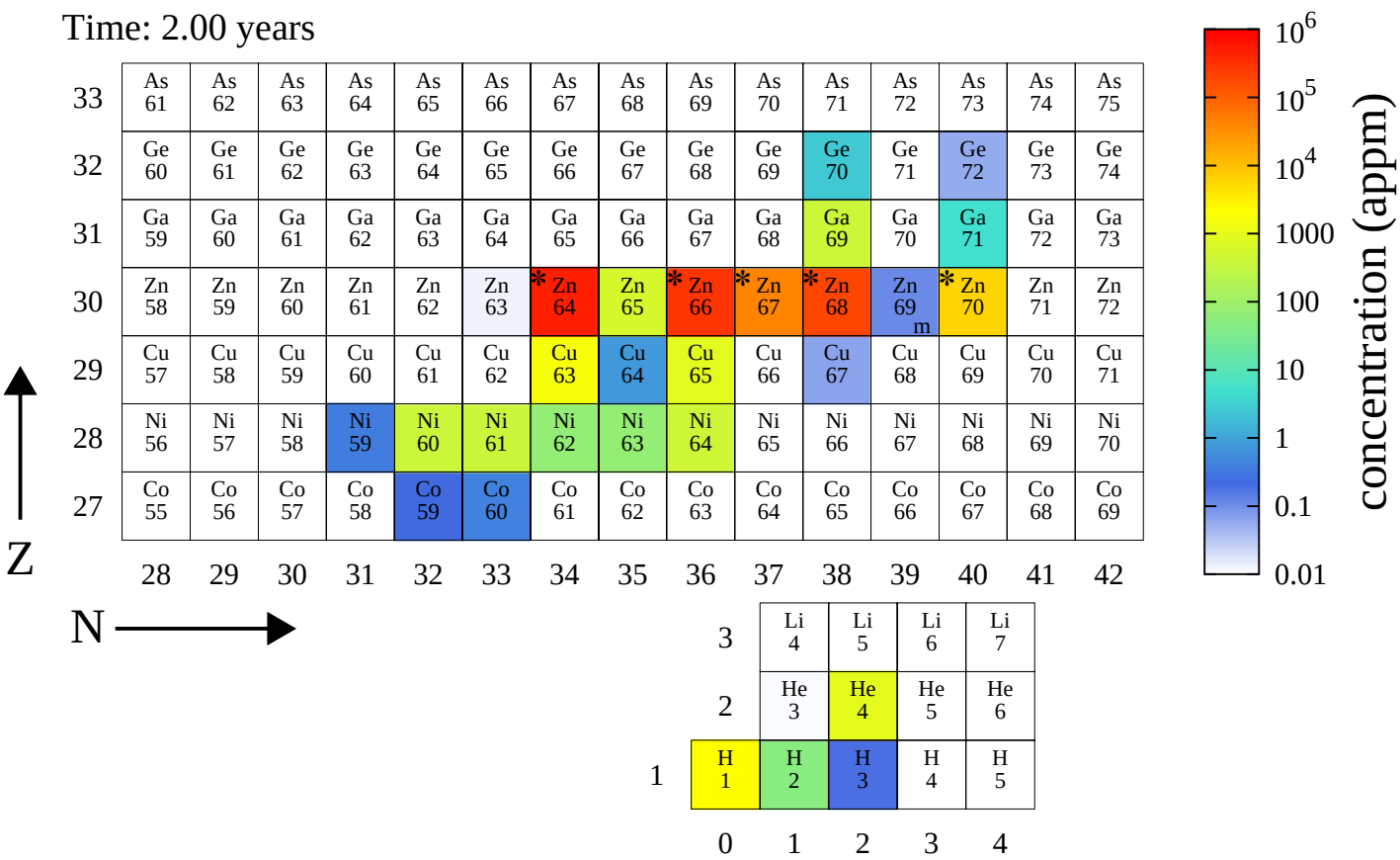




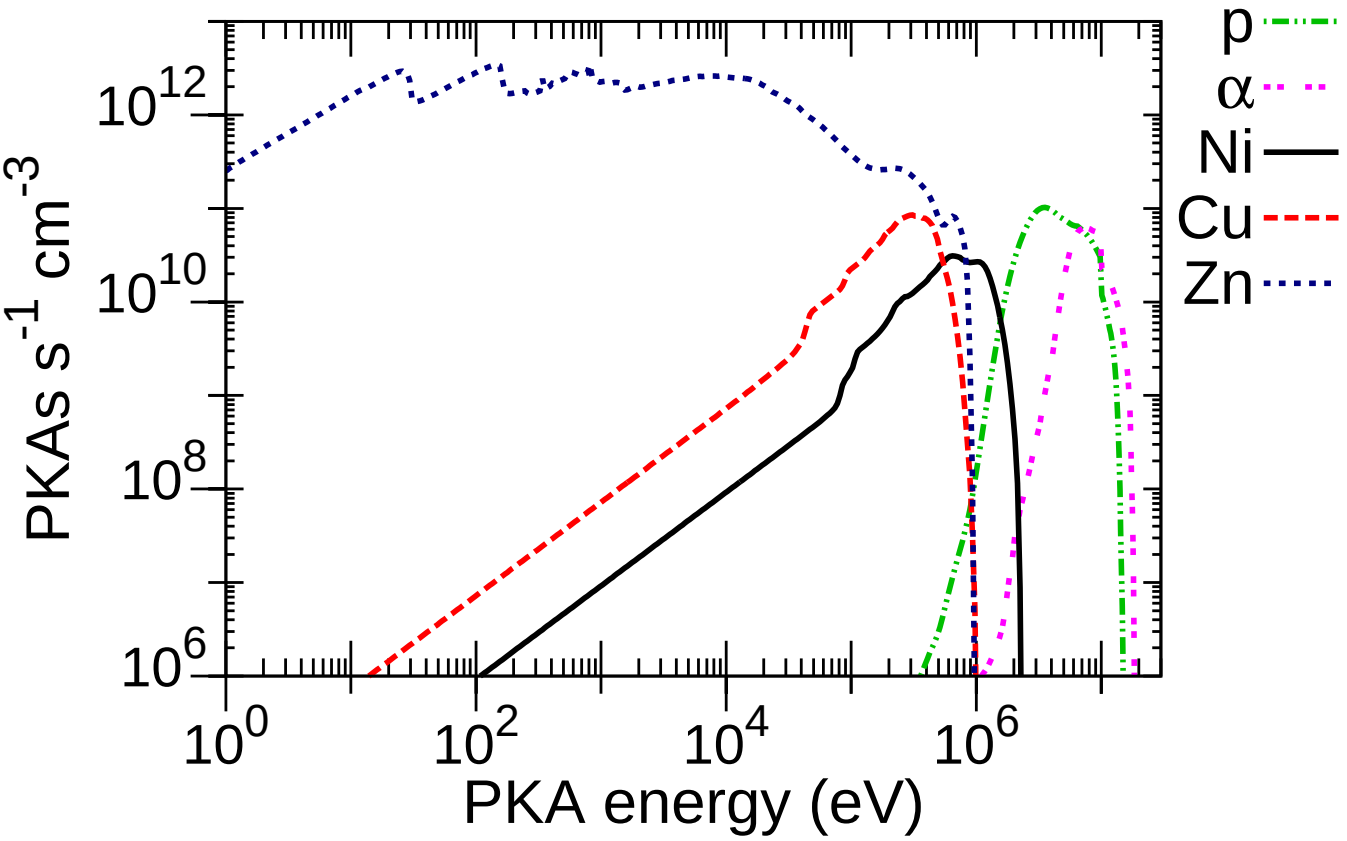
Zinc FW Transmutation

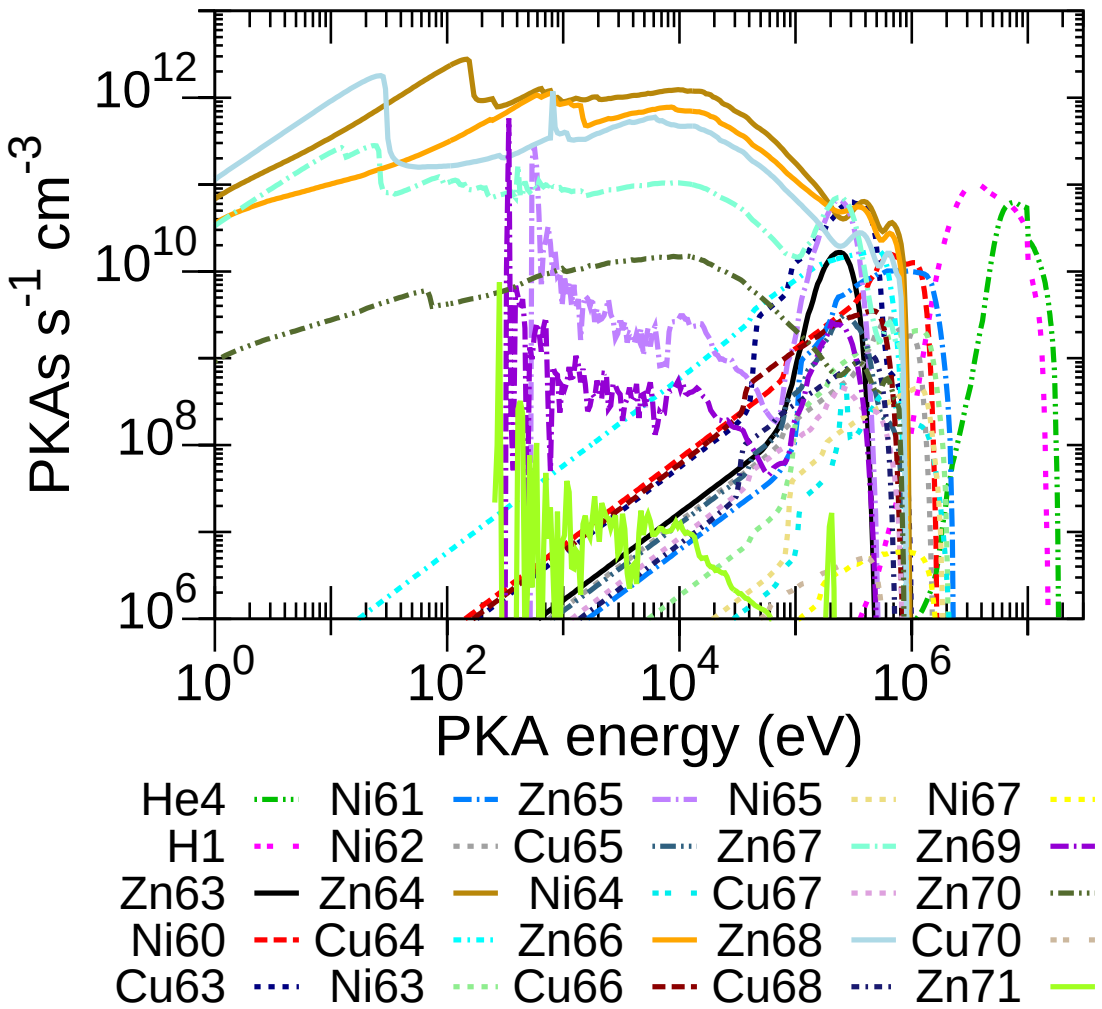


468 appm He & 1170 appm H after 1 year 21 dpa/year



Zinc FW PKA distributions





Zinc Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cu68	31.10s	Zn64(n,γ)Zn65(n,p)Cu65(n,γ)Cu66(n,γ)Cu67(n,γ)Cu68	51.3			
		Zn64(n,γ)Zn65(β^+)Cu65(n,γ)Cu66(n,γ)Cu67(n,γ)Cu68	47.8			
		Zn67(n,p)Cu67(n,γ)Cu68			86.7	
		Zn67(n,p)Cu67(n,γ)Cu68m(IT)Cu68			12.9	
		Zn68(n,p)Cu68				78.0
		Zn68(n,p)Cu68m(IT)Cu68				21.9
Zn71	2.45m	Zn70(n,γ)Zn71	99.9	100.0	100.0	99.9
Cu66	5.10m	Zn64(n,γ)Zn65(n,p)Cu65(n,γ)Cu66	51.7			
		Zn64(n,γ)Zn65(β^+)Cu65(n,γ)Cu66	48.2	99.8	98.5	
		Zn66(n,p)Cu66			1.3	95.2
		Zn67(n,np)Cu66				1.8
Ga70	21.14m	Zn68(n,γ)Zn69(β^-)Ga69(n,γ)Ga70	85.2	86.7	70.0	
		Zn68(n,γ)Zn69m(IT)Zn69(β^-)Ga69(n,γ)Ga70	10.4	13.2	30.0	
		Zn67(n,γ)Zn68(n,γ)Zn69(β^-)Ga69(n,γ)Ga70	3.6			
		Zn70(n,γ)Zn71m(β^-)Ga71(n,2n)Ga70				28.2
		Zn70(n,γ)Zn71(β^-)Ga71(n,2n)Ga70				27.4
		Zn70(n,2n)Zn69m(IT)Zn69(β^-)Ga69(n,γ)Ga70				26.5
		Zn70(n,2n)Zn69(β^-)Ga69(n,γ)Ga70				16.8
Zn63	38.41m	Zn64(n,2n)Zn63				99.5
Zn69	56.41m	Zn68(n,γ)Zn69	81.8	86.6	70.0	1.0
		Zn68(n,γ)Zn69m(IT)Zn69	10.0	13.2	30.0	1.0
		Zn67(n,γ)Zn68(n,γ)Zn69	6.5			
		Zn70(n,2n)Zn69m(IT)Zn69				59.8
		Zn70(n,2n)Zn69				37.9
Zn71m	3.96h	Zn70(n,γ)Zn71m	99.9	100.0	100.0	99.8
Cu64	12.70h	Zn66(n,α)Ni63(β^-)Cu63(n,γ)Cu64	83.1			
		Zn64(n,γ)Zn65(n,α)Ni62(n,γ)Ni63(β^-)Cu63(n,γ)Cu64	15.4	99.4		
		Zn64(n,p)Cu64			100.0	93.4
		Zn66(n,2n)Zn65(β^+)Cu65(n,2n)Cu64				4.9
Zn69m	13.78h	Zn68(n,γ)Zn69m	91.8	99.8	100.0	1.6
		Zn67(n,γ)Zn68(n,γ)Zn69m	7.3			
		Zn70(n,2n)Zn69m				98.1
Zn65	244.14d	Zn64(n,γ)Zn65	100.0	100.0	100.0	
		Zn66(n,2n)Zn65				98.7
Co60	5.27y	Zn64(n,α)Ni61(n,α)Fe58(n,γ)Fe59(β^-)Co59(n,γ) Co60m(IT)Co60	62.2		2.2	
		Zn64(n,α)Ni61(n,α)Fe58(n,γ)Fe59(β^-)Co59(n,γ)Co60	37.8		2.4	
		Zn66(n,α)Ni63(β^-)Cu63(n,α)Co60			50.0	
		Zn66(n,α)Ni63(β^-)Cu63(n,α)Co60m(IT)Co60			44.5	
		Zn64(n,nα)Ni60(n,p)Co60m(IT)Co60				24.3
		Zn64(n,np)Cu63(n,α)Co60m(IT)Co60				24.0
		Zn64(n,np)Cu63(n,α)Co60				19.7
		Zn64(n,nα)Ni60(n,p)Co60				17.0
		Zn64(n,2n)Zn63(β^+)Cu63(n,α)Co60m(IT)Co60				4.0
		Zn64(n,2n)Zn63(β^+)Cu63(n,α)Co60				3.3
		Zn64(n,α)Ni61(n,np)Co60				3.0
		Zn64(n,α)Ni61(n,np)Co60m(IT)Co60				1.7
H3	12.33y	Zn64(n,γ)Zn65(n,p)H1(n,γ)H2(n,γ)H3	100.0	99.9		
		Zn64(n,p)H1(n,γ)H2(n,γ)H3			99.7	
		Zn67(n,t)H3				56.2
		Zn64(n,t)H3				12.6
		Zn64(n,np)Cu63(n,t)H3				9.2
		Zn68(n,2n)Zn67(n,t)H3				7.5
		Zn66(n,2n)Zn65(n,t)H3				6.4
		Zn66(n,t)H3				3.2
		Zn64(n,2n)Zn63(β^+)Cu63(n,t)H3				1.5
		Zn66(n,2n)Zn65(β^+)Cu65(n,t)H3				1.0
Ni63	100.62y	Zn66(n,α)Ni63	74.0		100.0	78.9
		Zn64(n,γ)Zn65(n,α)Ni62(n,γ)Ni63	23.2	99.5		
		Zn64(n,γ)Zn65(n,γ)Zn66(n,α)Ni63	1.4			
		Zn64(n,α)Ni61(n,γ)Ni62(n,γ)Ni63	1.3			
		Zn64(n,p)Cu64(β^+)Ni64(n,2n)Ni63				10.9
		Zn64(n,np)Cu63(n,p)Ni63				3.3
		Zn64(n,2p)Ni63				2.9
		Zn67(n,nα)Ni63				2.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ni59	7.6 10^4y	Zn64(n,nα)Ni60(n,2n)Ni59				98.5
		Zn64(n,α)Ni61(n,2n)Ni60(n,2n)Ni59				1.3
Kr81	2.1 10^5y	no pathways found				
Se79	3.8 10^5y	Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ) Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ) Se78(n,γ)Se79m(IT)Se79	9.6			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT) Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	9.6			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ) Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ) Se78(n,γ)Se79	6.9			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT) Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77(n,γ)Se78(n,γ)Se79	6.9			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ) Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT) Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	3.3			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT) Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	3.3			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ) Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	3.1			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT) Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-) Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	3.1			
		Zn70(n,γ)Zn71m(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ) Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ) Se78(n,γ)Se79m(IT)Se79	3.0			
		Zn70(n,γ)Zn71m(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT) Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	3.0			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(n,γ)Ga73(β^-)Ge73m(IT) Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	2.7			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ) Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT) Se77(n,γ)Se78(n,γ)Se79	2.4			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT) Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77m(IT)Se77(n,γ)Se78(n,γ)Se79	2.4			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ) Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77(n,γ)Se78(n,γ)Se79	2.2			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT) Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-) Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79	2.2			
		Zn70(n,γ)Zn71m(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ) Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ) Se78(n,γ)Se79	2.1			
		Zn70(n,γ)Zn71m(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT) Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77(n,γ)Se78(n,γ)Se79	2.1			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(n,γ)Ga73(β^-)Ge73m(IT) Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77(n,γ)Se78(n,γ)Se79	1.9			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ) Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	1.1			
		Zn70(n,γ)Zn71(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT) Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-) Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	1.1			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Se79	cont.	Zn70(n,γ)Zn71m(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	1.0			
		Zn70(n,γ)Zn71m(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	1.0			
		Zn70(n,γ)Zn71m(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	1.0			
		Zn70(n,γ)Zn71m(β^-)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	1.0			
Fe60	1.5 10^6y	Zn64(n,α)Ni61(n,α)Fe58(n,γ)Fe59(n,γ)Fe60	100.0	100.0		
		Zn66(n,α)Ni63(n,α)Fe60			100.0	72.5
		Zn64(n,p)Cu64(β^+)Ni64(n,2n)Ni63(n,α)Fe60				6.7
		Zn64(n,nα)Ni60(n,p)Co60m(IT)Co60(n,p)Fe60				3.0
		Zn64(n,np)Cu63(n,α)Co60m(IT)Co60(n,p)Fe60				3.0
		Zn64(n,2p)Ni63(n,α)Fe60				2.7
		Zn64(n,np)Cu63(n,α)Co60(n,p)Fe60				2.5
		Zn64(n,nα)Ni60(n,p)Co60(n,p)Fe60				2.1
		Zn64(n,np)Cu63(n,p)Ni63(n,α)Fe60				2.0
		Zn67(n,nα)Ni63(n,α)Fe60				1.8
Zn64	2.3 10^{18}y	no pathways found				

Gallium

Isotope	Atom % abundance
Ga69	60.11
Ga71	39.89

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.40E+15	1.28E+15	8.77E+12	2.84E+10	8.06E+07	9.08E-02
Ga70	41.1	37.9				
Ga72	29.2	31.9	62.9			
Ga68	25.4	26.3				
Zn69	1.4	1.5	2.0			
Zn69m	0.9	1.0	1.8			
Ge71	0.2	0.2	28.1			
Ge69	0.1	0.1	3.4			
Cu67			1.4			
H3			0.2	71.6	87.1	
Zn65			0.3	28.3		
Ni63				0.1	12.9	
Fe60						44.5
Co60						44.4
Ni59						11.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.75E-01	3.57E-01	2.92E-03	7.80E-07	9.32E-11	1.72E-17
Ga72	56.3	58.9	97.2			
Ga68	25.7	25.6		0.1		
Ga70	16.0	14.2				
Ge69	0.1	0.1	1.7			
Zn65			0.1	97.5		
H3				2.4	68.9	
Ni63					31.1	
Co60						98.0
Fe60						1.9

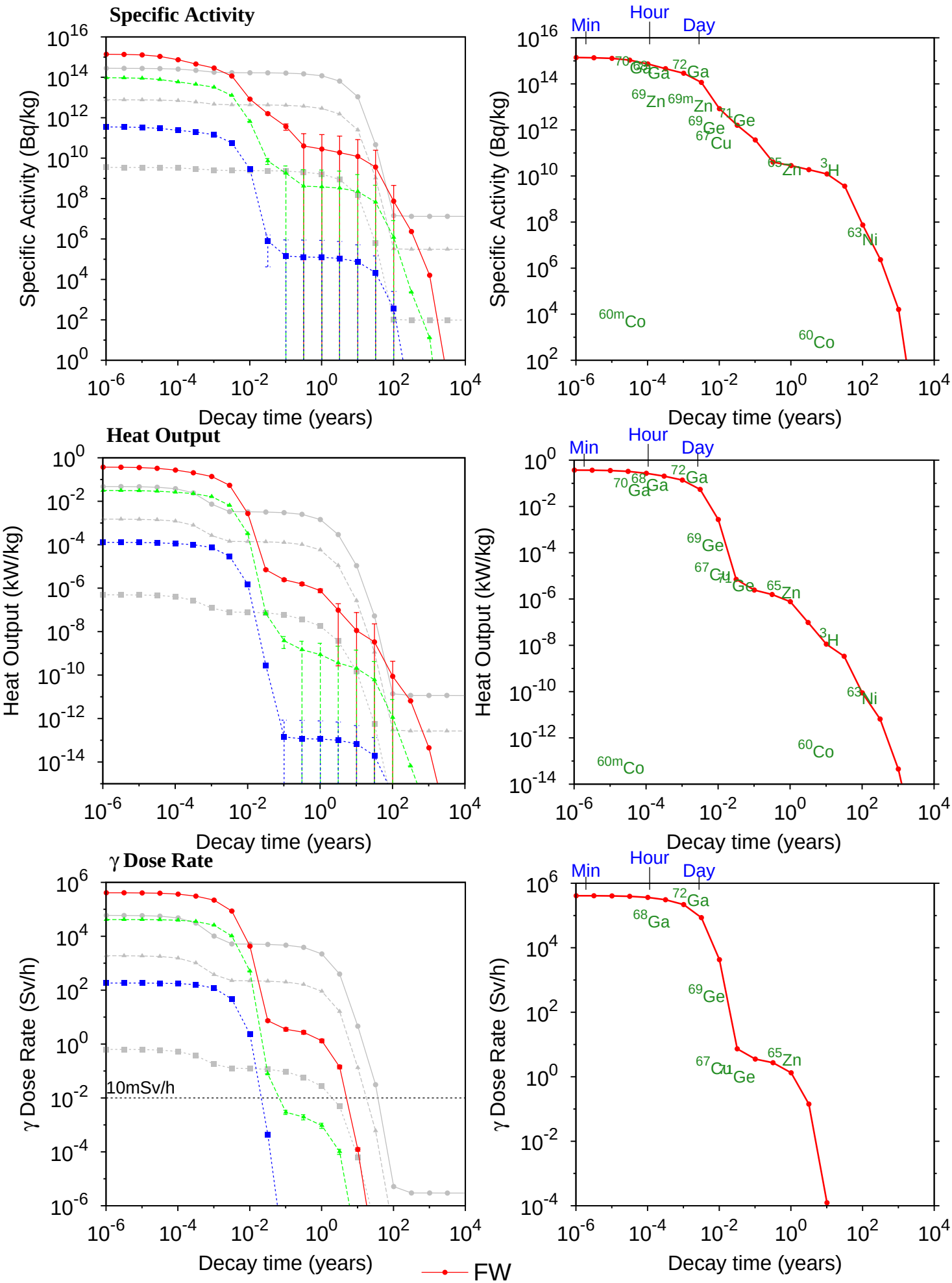
Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	4.12E+05	4.06E+05	4.60E+03	1.34E+00	3.01E-11	3.01E-11
Ga72	81.4	82.3	98.0			
Ga68	17.3	16.6				
Ge69	0.1	0.1	1.6			
Zn65			0.1	100.0		
Co60					100.0	100.0

Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	5.36E+05	5.10E+05	6.35E+03	3.23E+01	4.51E-03	4.59E-09
Ga72	84.1	88.0	95.5			
Ga68	6.6	6.6				
Zn71	4.6	1.1				
Ga70	3.3	2.9				
Zn65			1.4	97.3		
Ge69	0.1	0.1	1.1			
H3				2.6	65.4	
Ni63					34.6	
Fe60						97.0
Co60						3.0

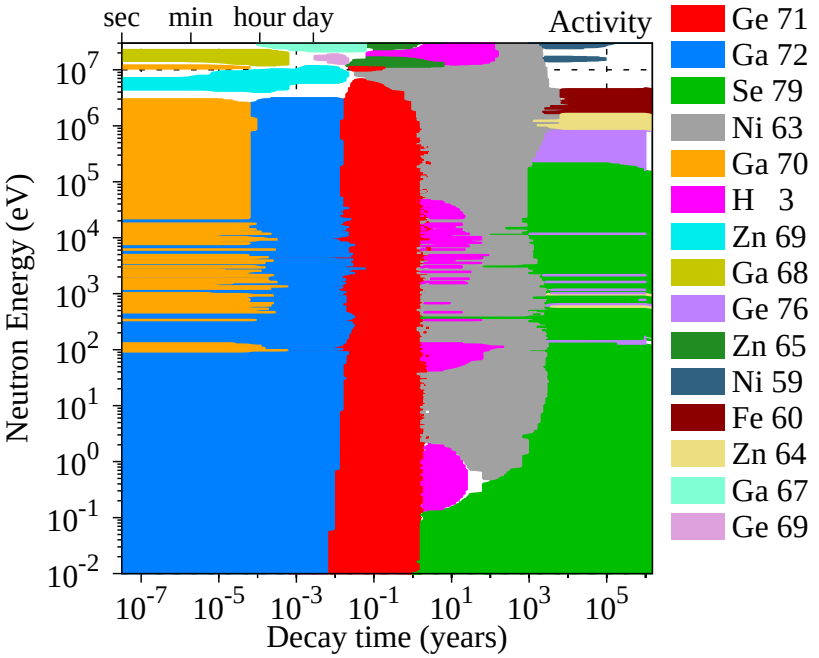
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.69E+05	2.51E+05	3.21E+03	2.31E+01	3.18E-02	1.26E-08
Ga72	80.7	86.3	91.0			
Zn71	7.3	1.8				
Ga68	6.5	6.6				
Ga70	3.4	3.1				
Zn69m	1.3	1.4	1.3			
Ge69	0.2	0.2	2.7			
Cu67	0.1	0.1	2.3			
Zn65			1.5	76.8		
H3			0.2	22.9	57.5	
Ni63				0.1	42.5	
Fe60						90.0
Co60						9.9

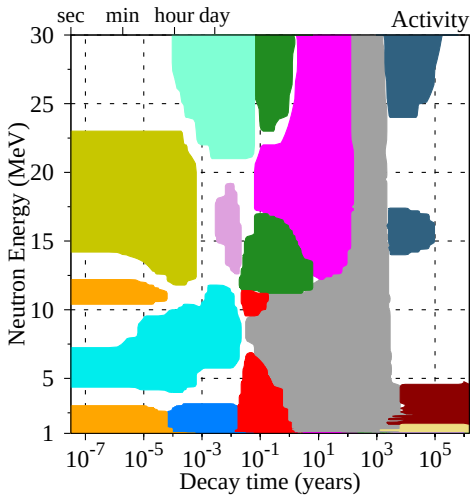
Clear	0s	5.3m	3.7d	1y	100y	10^4y
	4.62E+11	4.31E+11	1.10E+09	8.08E+07	8.06E+02	4.04E-04
Ga68	78.7	79.8				
Ga70	8.9	8.0				
Ga72	8.9	9.5	50.0			
Zn71m	1.5	1.6				
Ge69	0.3	0.3	26.7			
Zn65		0.1	20.4	99.7		
Zn69m	0.3	0.3	1.4			
Cu67			1.4			
H3				0.3	87.1	
Ni63					12.9	
Co60						99.9

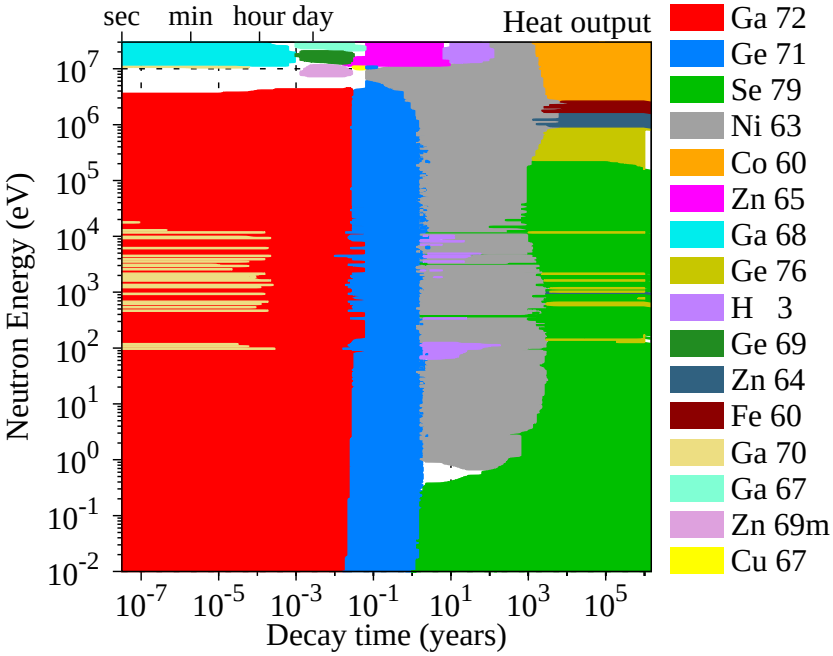
Gallium activation characteristics

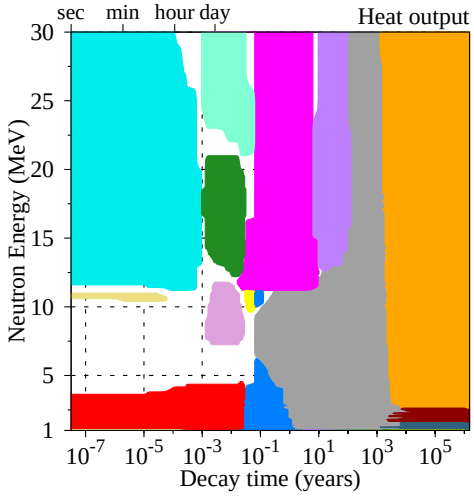


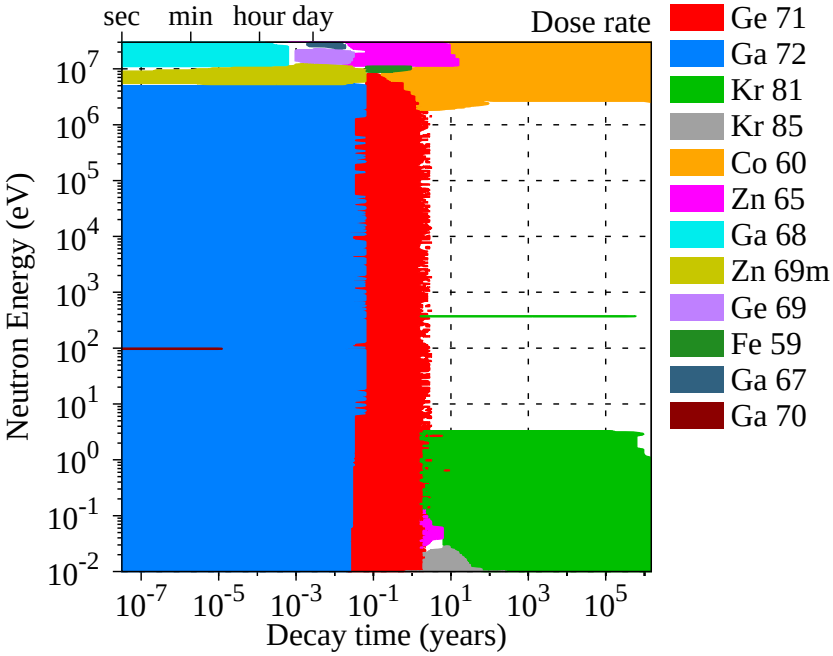
Gallium Importance diagrams

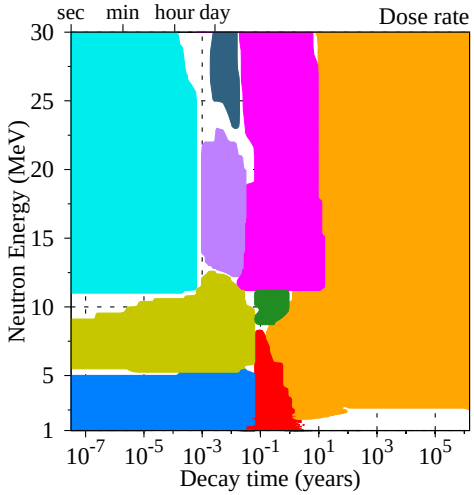




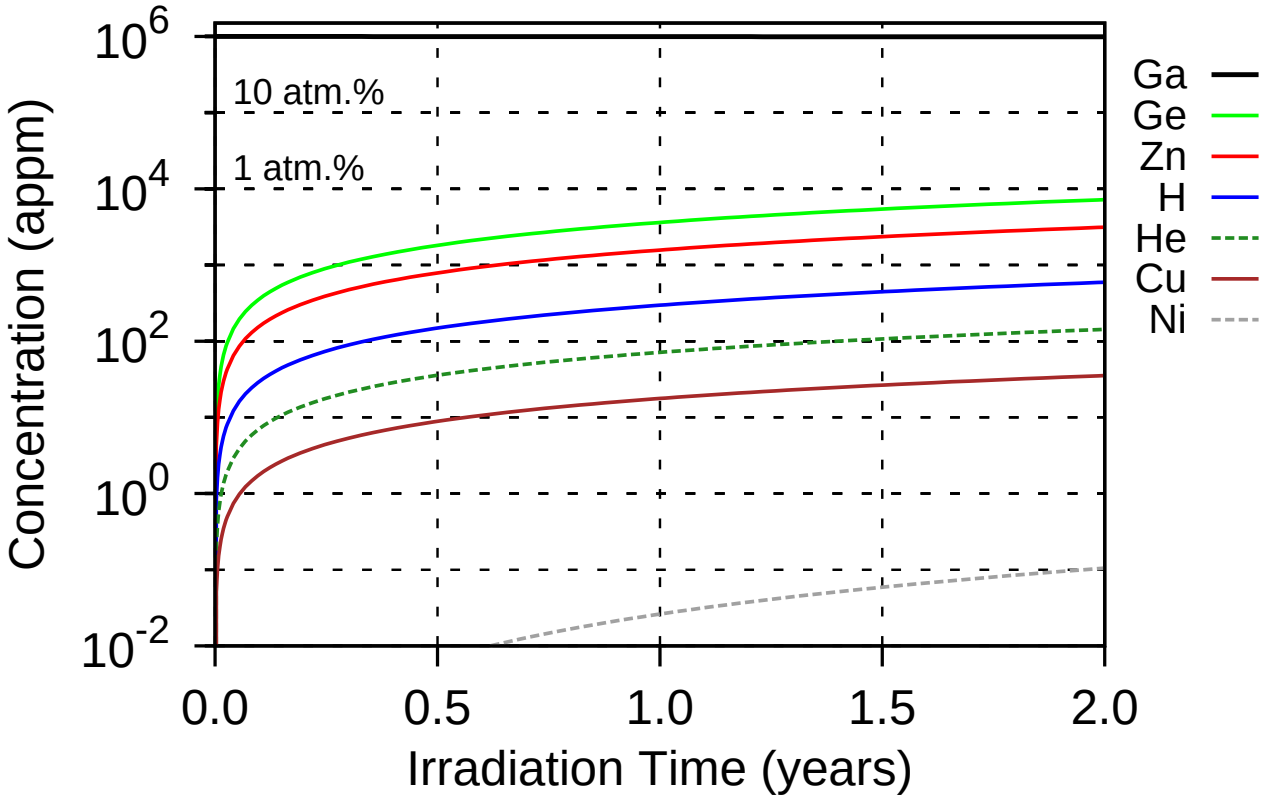




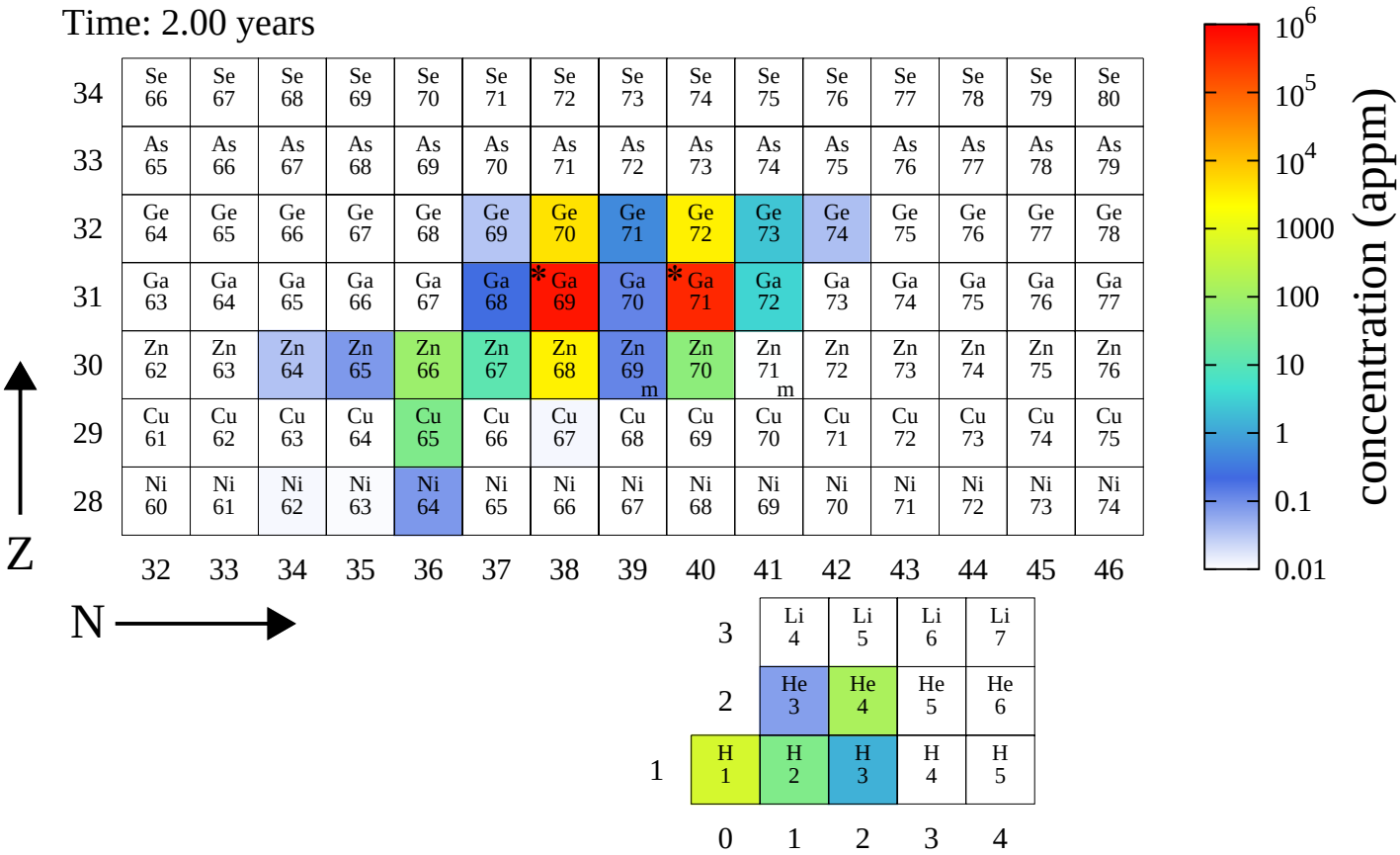




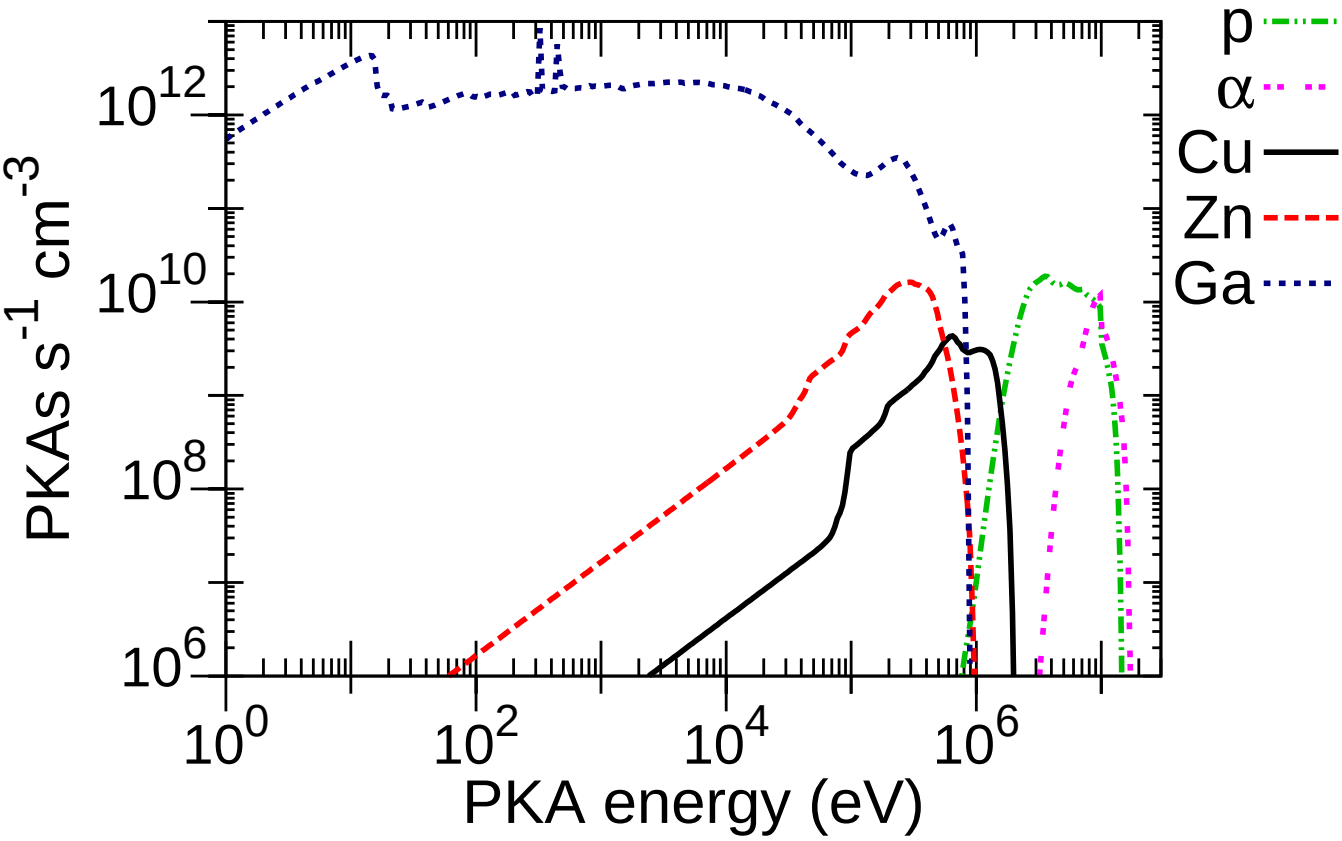
Gallium FW Transmutation

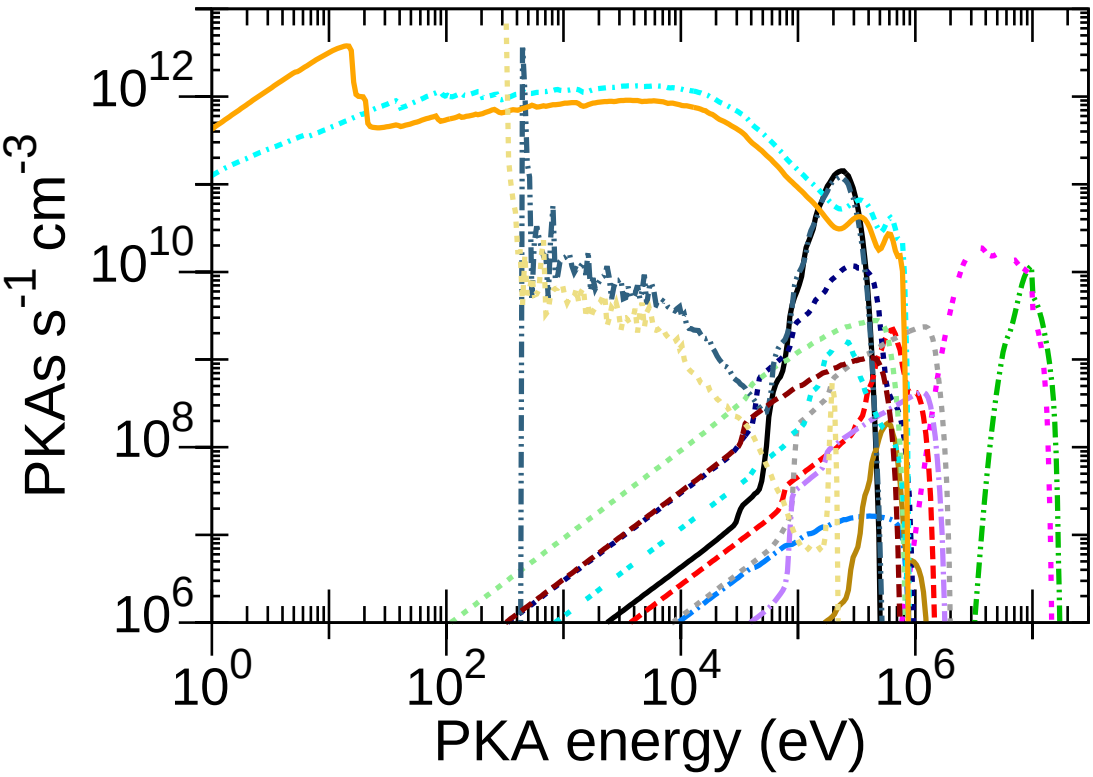


71 appm He & 297 appm H after 1 year 19 dpa/year



Gallium FW PKA distributions





He4	Zn68	Ga69	Zn70
H1	Zn67	Zn69	Ga71
Ga68	Cu66	Cu68	Zn71
Cu65	Cu67	Ga70	Ga72

Gallium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Zn71	2.45m	Ga69(n,γ)Ga70(β^+)Zn70(n,γ)Zn71	100.0	100.0	98.8	
		Ga71(n,p)Zn71			1.2	99.9
Ga70	21.14m	Ga69(n,γ)Ga70	100.0	100.0	100.0	
		Ga71(n,2n)Ga70				99.4
Zn69	56.41m	Ga69(n,γ)Ga70(β^-)Ge70(n,γ)Ge71(n,α)Zn68(n,γ)Zn69	89.2	86.7		
		Ga69(n,γ)Ga70(β^-)Ge70(n,γ)Ge71(n,α)Zn68(n,γ) Zn69m(IT)Zn69	10.8	13.2		
		Ga69(n,p)Zn69			72.7	26.9
		Ga69(n,p)Zn69m(IT)Zn69			27.3	69.9
Ga68	1.13h	Ga69(n,2n)Ga68				99.7
Zn71m	3.96h	Ga69(n,γ)Ga70(β^+)Zn70(n,γ)Zn71m	100.0	100.0	99.8	
		Ga71(n,p)Zn71m				99.9
Zn69m	13.78h	Ga69(n,γ)Ga70(β^-)Ge70(n,γ)Ge71(n,α)Zn68(n,γ)Zn69m	100.0	100.0		
		Ga69(n,p)Zn69m			100.0	97.4
		Ga71(n,np)Zn70(n,2n)Zn69m				1.2
Ga72	14.10h	Ga71(n,γ)Ga72	98.6	100.0	100.0	99.6
		Ga69(n,γ)Ga70(β^-)Ge70(n,γ)Ge71(β^+)Ga71(n,γ)Ga72	1.4			
Ge69	1.63d	Ga71(n,2n)Ga70(β^-)Ge70(n,2n)Ge69				99.6
Cu67	2.58d	Ga69(n,γ)Ga70(n,α)Cu67	100.0	100.0	83.4	
		Ga69(n,γ)Ga70(β^-)Ge70(n,α)Zn67(n,p)Cu67			13.9	
		Ga69(n,α)Cu66(β^-)Zn66(n,γ)Zn67(n,p)Cu67			1.8	
		Ga71(n,nα)Cu67				71.6
		Ga69(n,2n)Ga68(β^+)Zn68(n,np)Cu67				14.4
		Ga69(n,2n)Ga68(β^+)Zn68(n,2n)Zn67(n,p)Cu67				4.9
		Ga69(n,2n)Ga68(β^+)Zn68(n,d)Cu67				4.4
		Ga69(n,np)Zn68(n,np)Cu67				1.9
Ga67	3.26d	Ga69(n,2n)Ga68(n,2n)Ga67				99.1
Ge71	11.43d	Ga69(n,γ)Ga70(β^-)Ge70(n,γ)Ge71	100.0	100.0	100.0	
		Ga71(n,2n)Ga70(β^-)Ge70(n,γ)Ge71				75.4
		Ga71(n,γ)Ga72(β^-)Ge72(n,2n)Ge71				24.3
Fe59	44.50d	Ga69(n,α)Cu66(β^-)Zn66(n,nα)Ni62(n,α)Fe59				79.2
		Ga69(n,nα)Cu65(n,α)Co62(β^-)Ni62(n,α)Fe59				6.5
		Ga69(n,nα)Cu65(n,α)Co62m(β^-)Ni62(n,α)Fe59				5.8
		Ga69(n,α)Cu66(β^-)Zn66(n,2n)Zn65(n,α)Ni62(n,α)Fe59				1.6
		Ga69(n,α)Cu66(β^-)Zn66(n,α)Ni63(n,2n)Ni62(n,α)Fe59				1.6
		Ga71(n,2n)Ga70(β^-)Ge70(n,nα)Zn66(n,nα)Ni62(n,α)Fe59				1.1
Zn65	244.14d	Ga69(n,α)Cu66(β^-)Zn66(n,2n)Zn65				96.6
		Ga71(n,2n)Ga70(β^-)Ge70(n,nα)Zn66(n,2n)Zn65				1.7
		Ga69(n,2n)Ga68(β^+)Zn68(n,2n)Zn67(n,2n)Zn66(n,2n)Zn65				1.1
Co60	5.27y	Ga69(n,nα)Cu65(n,2n)Cu64(β^-)Zn64(n,nα)Ni60(n,p) Co60m(IT)Co60				17.1
		Ga69(n,nα)Cu65(n,2n)Cu64(β^-)Zn64(n,np)Cu63(n,α) Co60m(IT)Co60				16.9
		Ga69(n,nα)Cu65(n,2n)Cu64(β^-)Zn64(n,np)Cu63(n,α)Co60				13.9
		Ga69(n,nα)Cu65(n,2n)Cu64(β^-)Zn64(n,nα)Ni60(n,p)Co60				12.0
		Ga69(n,nα)Cu65(n,2n)Cu64(β^-)Zn64(n,2n)Zn63(β^+)Cu63(n,α) Co60m(IT)Co60				2.8
		Ga69(n,nα)Cu65(n,2n)Cu64(β^-)Zn64(n,2n)Zn63(β^+) Cu63(n,α)Co60				2.3
		Ga69(n,α)Cu66(β^-)Zn66(n,α)Ni63(β^-)Cu63(n,α)Co60m(IT)Co60				2.2
		Ga69(n,α)Cu66(β^-)Zn66(n,α)Ni63(β^-)Cu63(n,α)Co60				1.8
		Ga69(n,nα)Cu65(n,2n)Cu64(n,nα)Co60				1.3
		Ga69(n,nα)Cu65(n,2n)Cu64(n,nα)Co60m(IT)Co60				1.0
Kr85	10.75y	no pathways found				
H3	12.33y	Ga69(n,γ)Ga70(n,p)H1(n,γ)H2(n,γ)H3	76.0			
		Ga69(n,γ)Ga70(β^-)Ge70(n,γ)Ge71(n,p)H1(n,γ)H2(n,γ)H3	24.0			
		Ga69(n,p)H1(n,γ)H2(n,γ)H3			27.3	
		Ga69(n,t)H3				69.5
		Ga71(n,t)H3				12.5
Ni63	100.62y	Ga69(n,α)Cu66(β^-)Zn66(n,α)Ni63	100.0		100.0	75.9
		Ga69(n,2n)Ga68(β^+)Zn68(n,2n)Zn67(n,nα)Ni63				7.6
		Ga69(n,nα)Cu65(n,2n)Cu64(β^+)Ni64(n,2n)Ni63				7.5
		Ga69(n,2n)Ga68(β^+)Zn68(n,nα)Ni64(n,2n)Ni63				2.9
		Ga71(n,2n)Ga70(β^-)Ge70(n,nα)Zn66(n,α)Ni63				1.2
		Ga69(n,np)Zn68(n,2n)Zn67(n,nα)Ni63				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ni59	7.6 10^4y	Ga69(n,nα)Cu65(n,2n)Cu64(β^-)Zn64(n,nα)Ni60(n,2n)Ni59				91.3
		Ga69(n,α)Cu66(β^-)Zn66(n,2n)Zn65(n,2n)Zn64(n,nα) Ni60(n,2n)Ni59				2.3
		Ga69(n,2n)Ga68(β^+)Zn68(n,α)Ni65(β^-)Cu65(n,2n)Cu64(β^-) Zn64(n,nα)Ni60(n,2n)Ni59				1.0
Kr81	2.1 10^5y	Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-) As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	13.8			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	13.8			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-) As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	6.2			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	6.2			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-) As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	4.7			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ) Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	4.7			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75m(IT) Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	4.5			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ) Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	4.5			
		Ga71(n,γ)Ga72(n,γ)Ga73(β^-)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	4.3			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-) As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81	2.9			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81	2.9			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-) As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	2.1			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ) Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ) Kr81m(IT)Kr81	2.1			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75m(IT) Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	2.0			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ) Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ) Kr81m(IT)Kr81	2.0			
		Ga71(n,γ)Ga72(n,γ)Ga73(β^-)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	1.9			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75m(IT) Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ) Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	1.5			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT) Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-) Kr80(n,γ)Kr81	1.5			
		Ga71(n,γ)Ga72(n,γ)Ga73(β^-)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ) Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	1.5			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Kr81	cont.	Ga71(n,γ)Ga72(n,γ)Ga73(β^-)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	1.4			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	1.3			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	1.3			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81	1.0			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81	1.0			
Se79	3.8 10^5y	Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	14.5	12.7		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	14.5	10.1		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79	10.4	10.9		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79	10.4	8.7		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	4.9	5.9		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	4.9	4.7		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	4.7	4.6		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	4.7	3.7		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79	3.6	5.1		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79	3.6	4.0		
		Ga71(n,γ)Ga72(n,γ)Ga73(β^-)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	3.5	1.8		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79	3.4	4.0		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79	3.4	3.2		
		Ga71(n,γ)Ga72(n,γ)Ga73(β^-)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79	2.5	1.5		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	1.6	2.1		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	1.6	1.7		
		Ga71(n,γ)Ga72(n,γ)Ga73(β^-)Ge73m(IT)Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	1.2			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Se79	cont.	Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75m(IT) Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ) Se78(n,γ)Se79	1.1	1.8		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT) Se77(n,γ)Se78(n,γ)Se79	1.1	1.5		
		Ga71(n,γ)Ga72(n,γ)Ga73(β^-)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ) Se78(n,γ)Se79m(IT)Se79	1.1			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-) As75(n,γ)As76(n,γ)As77(β^-)Se77(n,γ)Se78(n,γ) Se79m(IT)Se79		1.8		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75(β^-) As75(n,γ)As76(n,γ)As77(β^-)Se77(n,γ)Se78(n,γ)Se79		1.5		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75(β^-)As75(n,γ)As76(n,γ)As77(β^-)Se77(n,γ)Se78(n,γ) Se79m(IT)Se79		1.4		
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75(β^-)As75(n,γ)As76(n,γ)As77(β^-)Se77(n,γ)Se78(n,γ)Se79		1.2		
Fe60	1.5 10^6y	Ga69(n,α)Cu66(β^-)Zn66(n,α)Ni63(n,α)Fe60			99.9	80.0
		Ga69(n,2n)Ga68(β^+)Zn68(n,2n)Zn67(n,nα)Ni63(n,α)Fe60				6.0
		Ga69(n,nα)Cu65(n,2n)Cu64(β^+)Ni64(n,2n)Ni63(n,α)Fe60				6.0
		Ga69(n,2n)Ga68(β^+)Zn68(n,nα)Ni64(n,2n)Ni63(n,α)Fe60				2.3
Zn64	2.3 10^{18}y	Ga69(n,nα)Cu65(n,2n)Cu64(β^-)Zn64				92.9
		Ga69(n,α)Cu66(β^-)Zn66(n,2n)Zn65(n,2n)Zn64				3.4
		Ga69(n,2n)Ga68(β^+)Zn68(n,α)Ni65(β^-)Cu65(n,2n) Cu64(β^-)Zn64				1.7
Ge76	1.6 10^{21}y	Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ) Ge75(n,γ)Ge76	35.2			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75(n,γ)Ge76	35.1			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73(n,γ)Ge74(n,γ)Ge75m(IT) Ge75(n,γ)Ge76	11.4			
		Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75m(IT)Ge75(n,γ)Ge76	11.3			
		Ga71(n,γ)Ga72(n,γ)Ga73(β^-)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75(n,γ)Ge76	4.5			
		Ga71(n,γ)Ga72(n,γ)Ga73(β^-)Ge73m(IT)Ge73(n,γ)Ge74(n,γ) Ge75m(IT)Ge75(n,γ)Ge76	1.5			

Germanium

Isotope	Atom % abundance
Ge70	20.37
Ge72	27.31
Ge73	7.76
Ge74	36.73
Ge76	7.83

($T_{1/2}$ =1.6 10^{21}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	5.03E+14	3.83E+14	1.65E+14	5.85E+09	9.79E+06	4.61E+02
Ge71	36.9	48.4	90.3			
Ge75	17.6	22.3				
Ge69	12.9	16.9	8.3			
Ge73m	12.0	0.5				
Ge75m	9.9	0.1				
Ga70	2.5	2.8				
Ga72	2.4	3.1	0.1			
As77	1.1	1.4	0.8			
Zn65				47.4		
H3				23.0	54.7	
Se75				22.7		
Ga68	0.1	0.1		3.3		
Ge68				3.3		
Ni63				0.2	45.3	
Se79						100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.32E-02	2.93E-02	2.86E-03	4.01E-07	1.73E-11	3.89E-15
Ge69	33.5	37.9	82.1			
Ge75	19.5	21.2				
Ga72	18.4	20.8	2.9			
Ga74	7.4	5.4				
Ga70	3.9	3.8				
Ge75m	3.4					
As76	2.6	2.9	2.9			
Ge77	2.4	2.7	0.1			
Ge73m	1.9	0.1				
Ge77m	1.6					
Zn71m	0.9	1.0				
Ge71	0.8	0.9	7.8			
As74	0.2	0.3	2.3			
As77	0.6	0.7	1.8			
Zn65				65.2		
Se75				21.5		
Ga68	0.3	0.3		12.9		
Ni63					71.6	
H3				0.3	28.3	
Se79						99.8

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	3.20E+04	3.03E+04	3.69E+03	5.62E-01	1.38E-11	1.30E-11
Ge69	50.4	53.2	92.2			
Ga72	30.6	32.2	3.6			
Ga74	10.9	7.4				
Ge77	2.2	2.3	0.1			
Ge75	1.2	1.2				
As76	1.1	1.2	0.9			
Zn71m	1.0	1.0				
As74	0.2	0.2	1.7			
Ge71	0.2	0.2	1.4			
Zn65				82.9		
Se75				10.3		
Ga68	0.2	0.2		6.8		
Co60					100.0	100.0

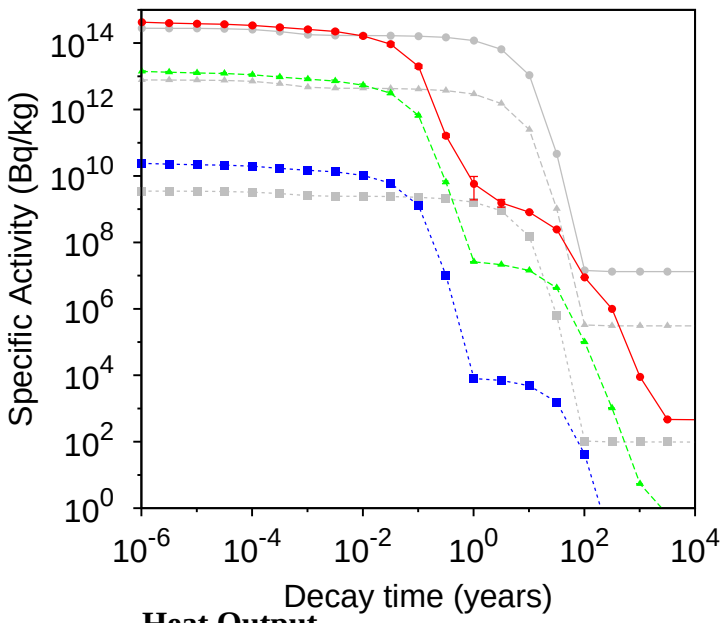
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.46E+04	5.39E+04	6.94E+03	1.46E+01	8.91E-04	1.34E-06
Ge69	24.1	28.8	47.3			
Ga72	20.2	24.1	2.5			
Ga74	14.9	11.4				
Zn71	13.0	3.5				
As76	8.8	10.6	8.1			
Ge75	6.3	7.3				
Ge71	3.4	4.1	25.7			
As77	3.4	4.0	8.0			
Ge77	1.5	1.8	0.1			
As74	0.9	1.1	7.3			
Zn65		0.1	0.4	74.1		
Se75		0.1	0.4	23.6		
Ge68				1.7		
Ni63					74.6	
H3				0.4	25.2	
Se79					0.2	99.9

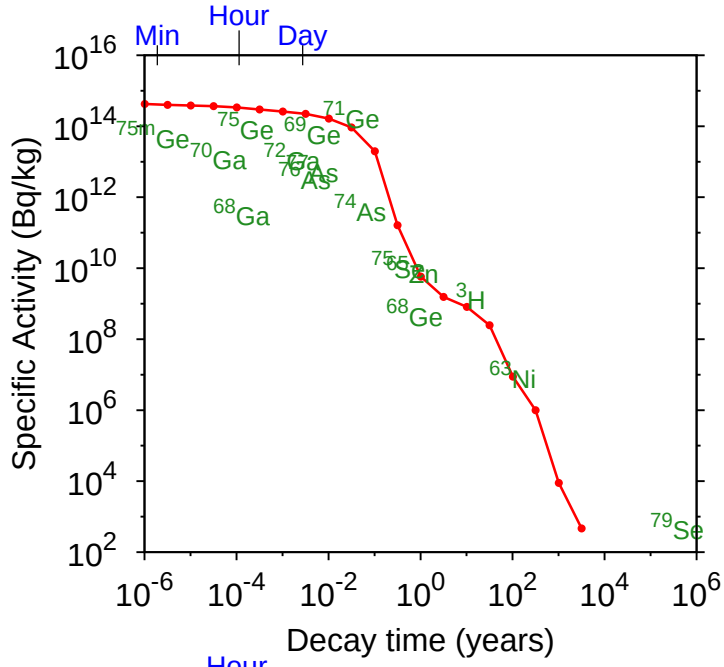
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	5.03E+04	4.28E+04	7.36E+03	1.09E+01	7.16E-03	3.14E-06
Ge69	37.4	43.9	53.9			
Zn71	13.2	3.5				
Ga72	12.5	14.7	1.2			
Ga74	9.9	7.5				
Ge75	6.4	7.2				
As76	5.3	6.2	3.5			
As77	4.2	5.0	7.3			
Ge71	4.1	4.8	22.2			
Ge77	2.1	2.5	0.1			
As74	1.9	2.2	11.2			
Zn69m	0.9	1.0	0.1			
Zn65			0.2	56.1		
Ge68			0.1	24.6		
Se75			0.2	15.9		
H3				3.2	19.4	
Ni63				0.1	80.5	
Se79						99.8

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	9.80E+10	8.76E+10	1.39E+10	2.93E+07	9.79E+01	2.60E-03
Ge69	66.2	73.9	98.5			
Ga74	12.3	8.8				
Ge75	7.0	7.5				
Ge75m	3.4					
Ge77	3.4	3.8	0.1			
Zn71m	1.5	1.7				
Ga72	1.2	1.4	0.1			
Ge73m	1.0					
Zn65	0.1	0.1	0.6	94.7		
Se75			0.1	4.5		
H3					54.7	
Ni63					45.3	
Se79						93.3
Co60						6.6

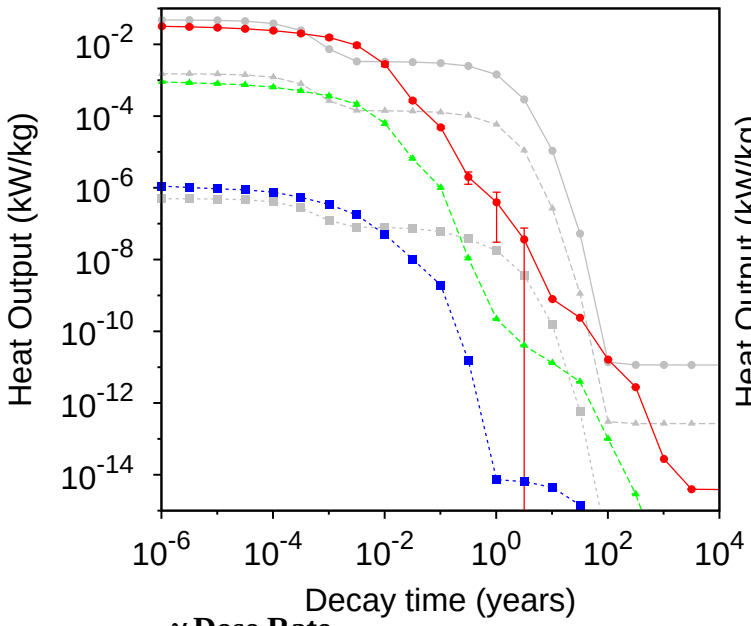
Germanium activation characteristics

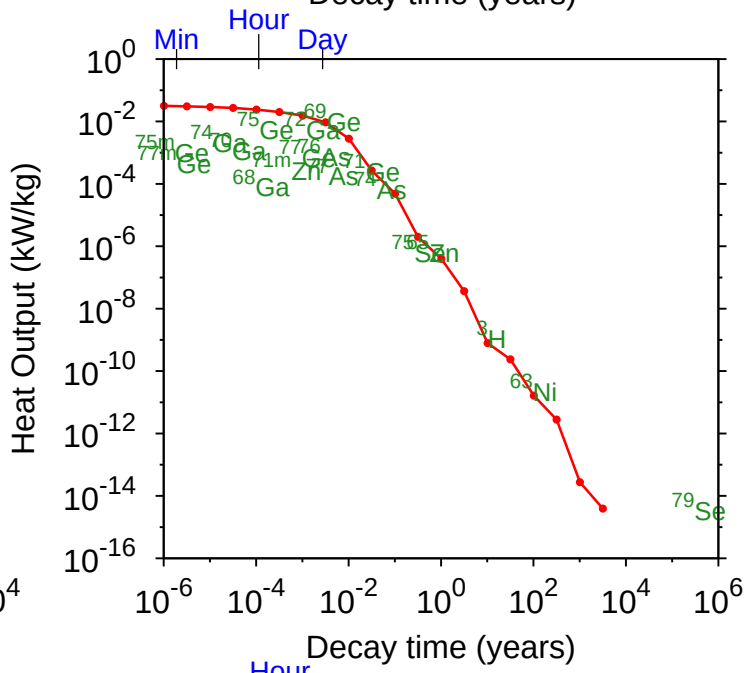
Specific Activity



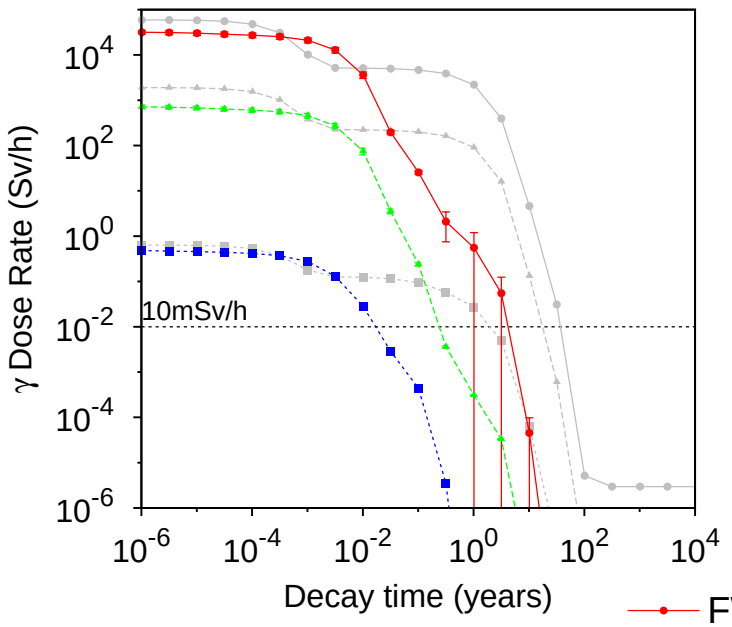


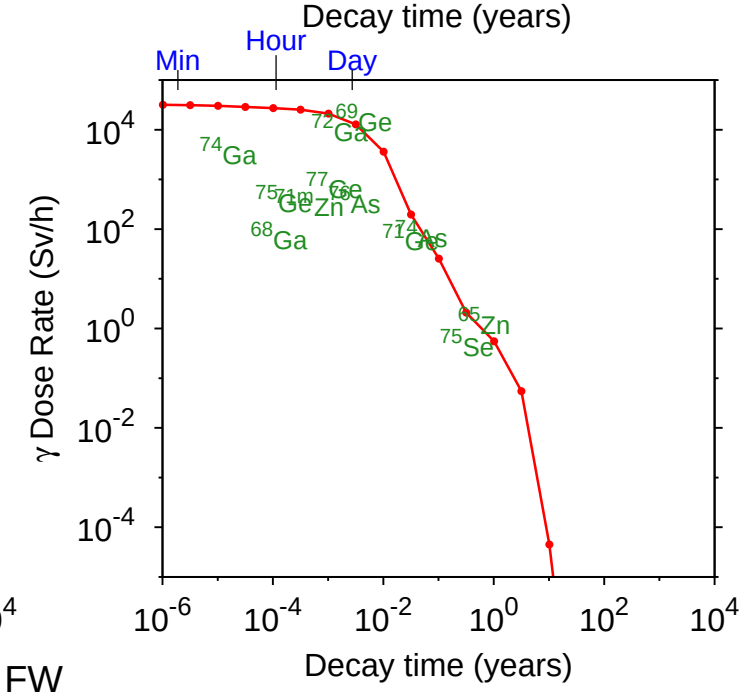
Heat Output





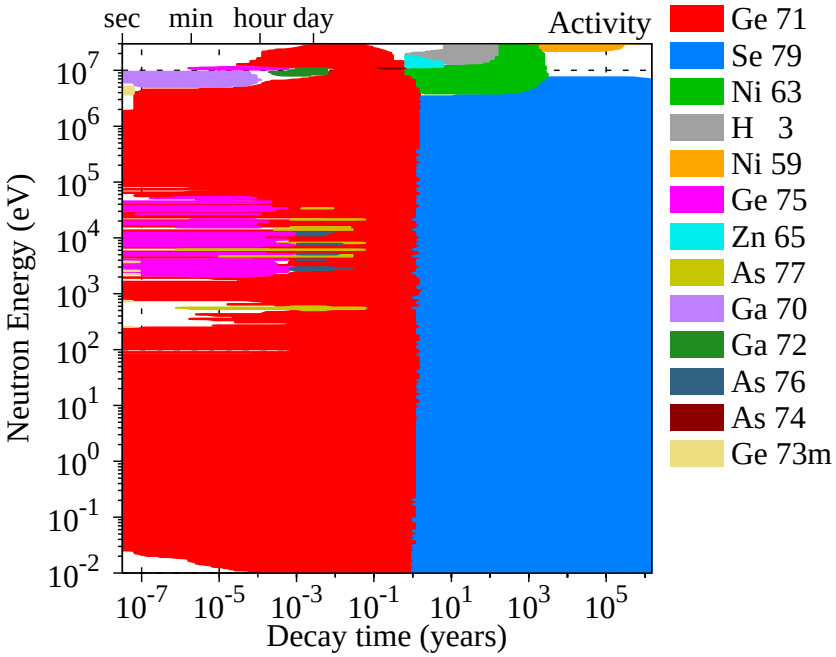
γ Dose Rate

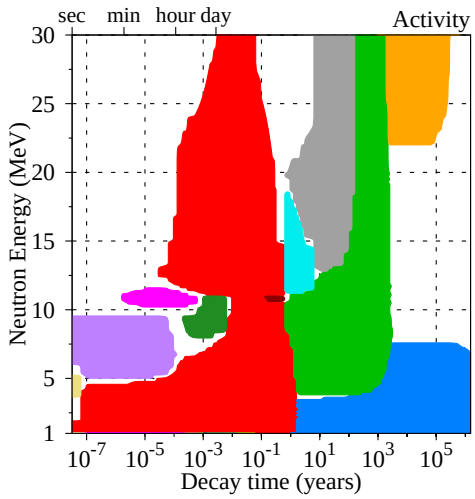


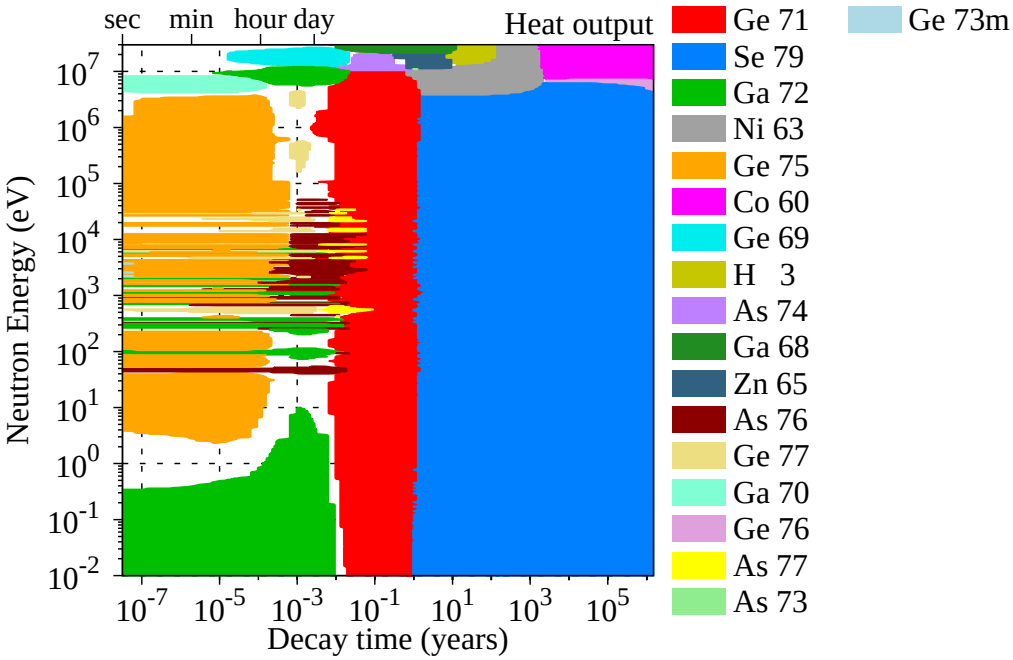


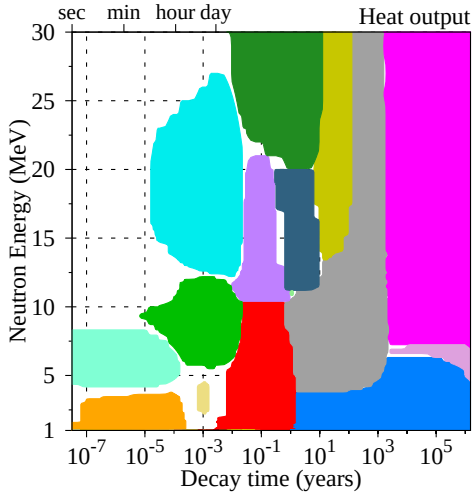
FW
Blanket
Manifold
Fe results

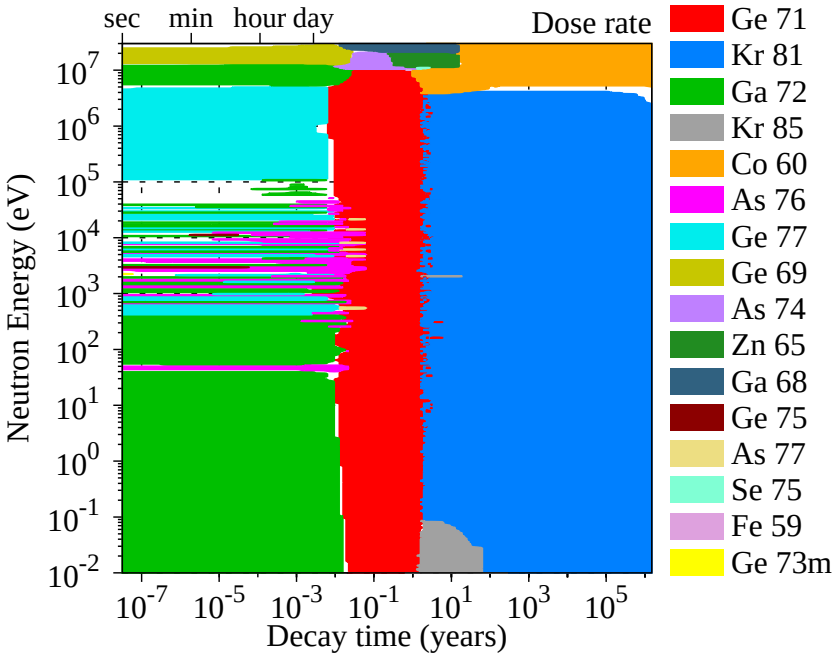
Germanium Importance diagrams

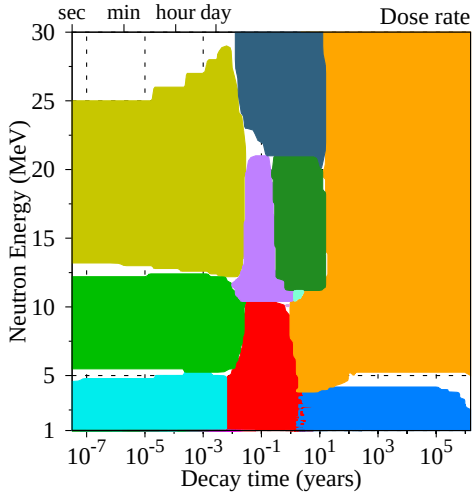




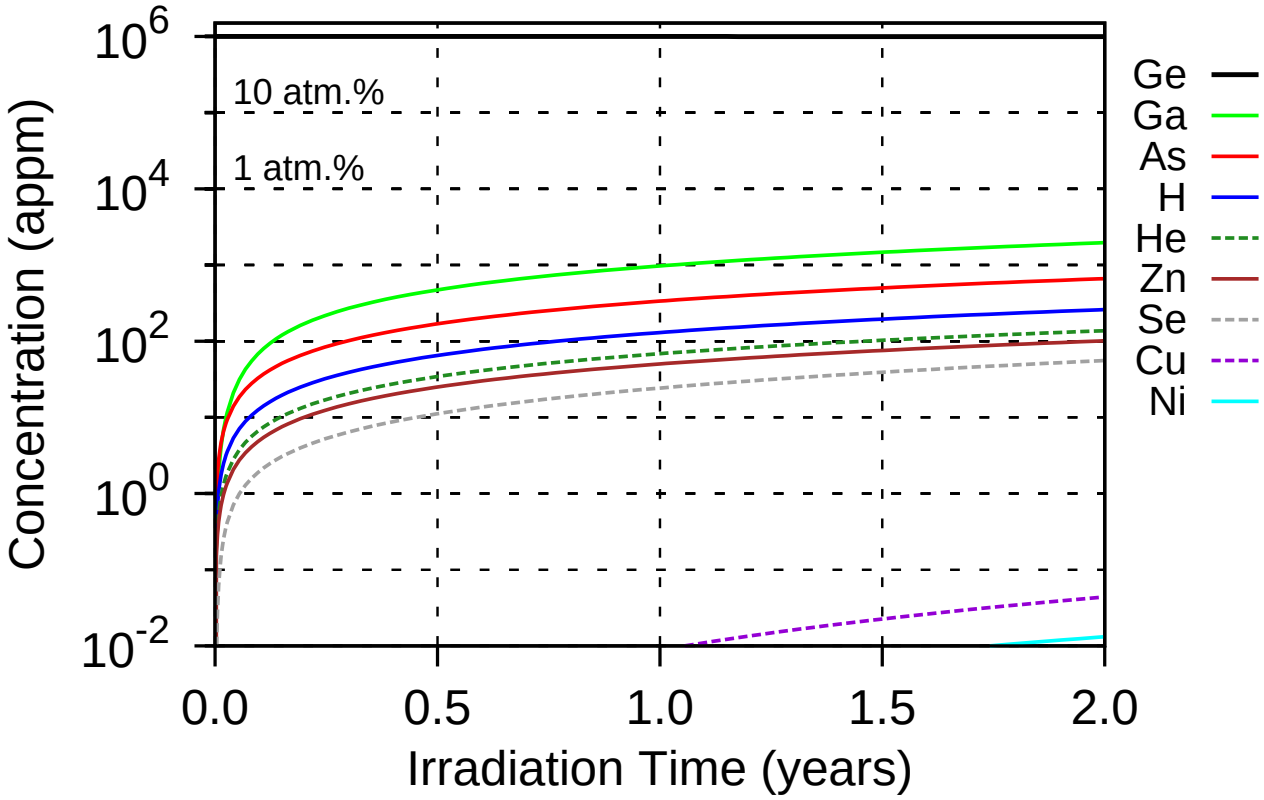




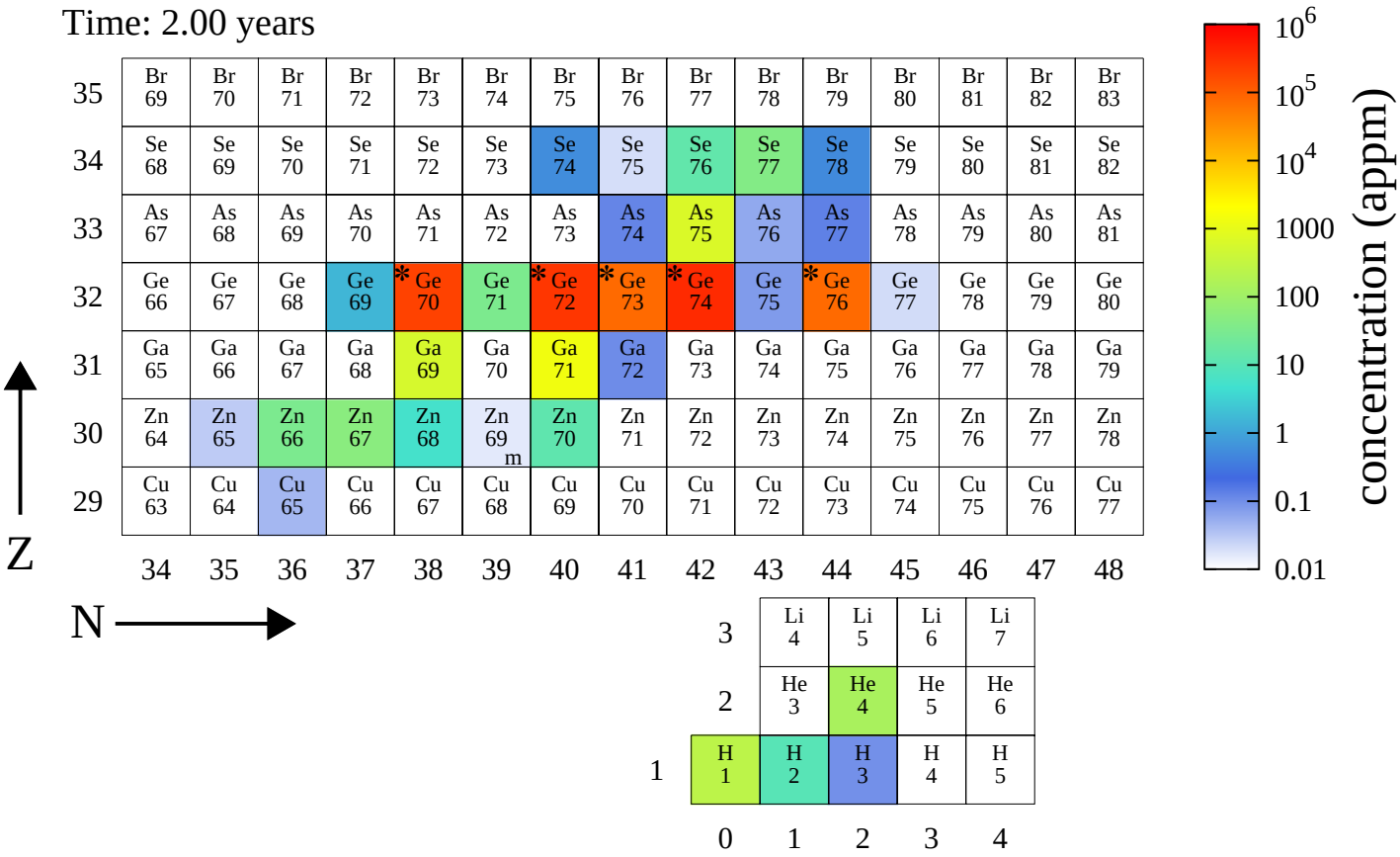




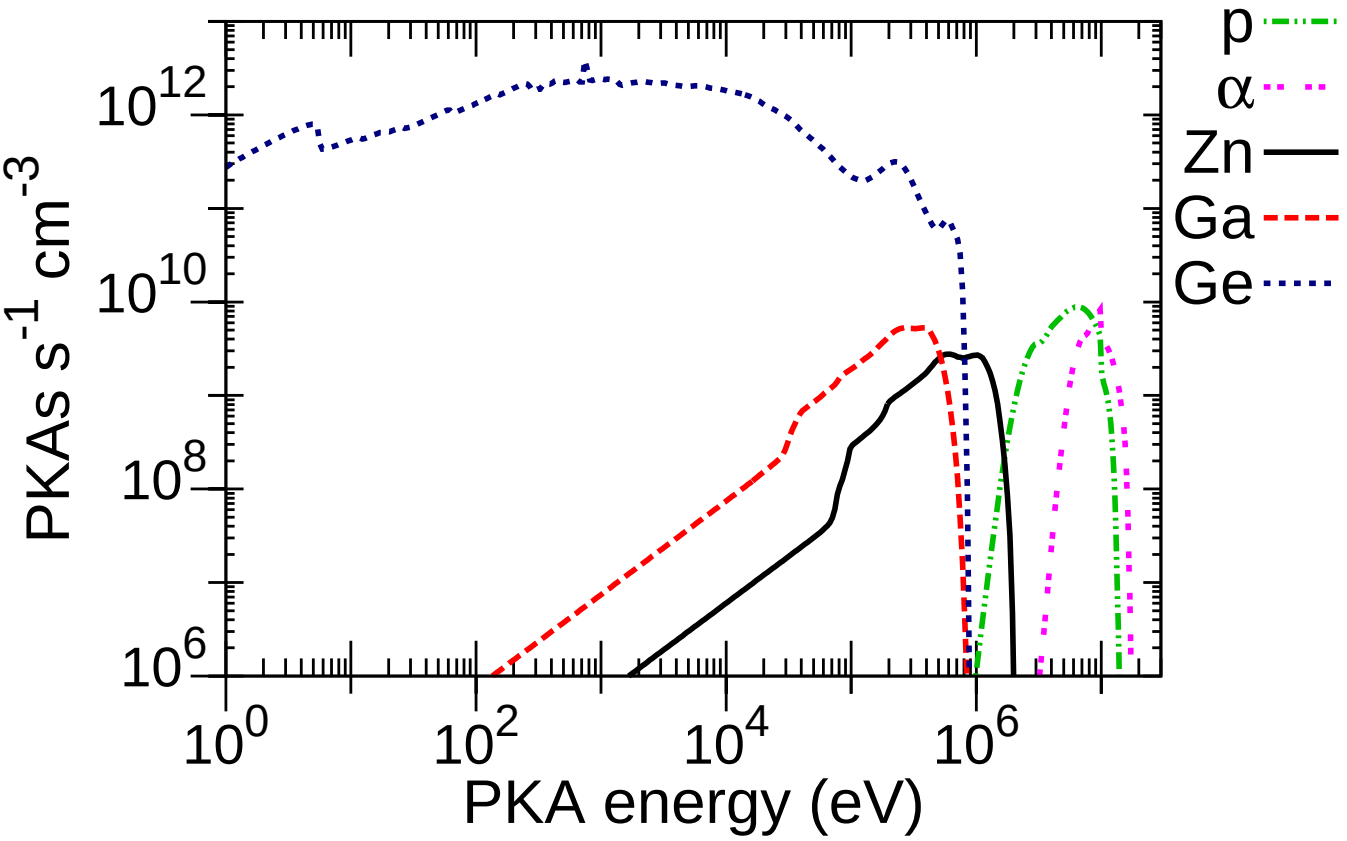
Germanium FW Transmutation

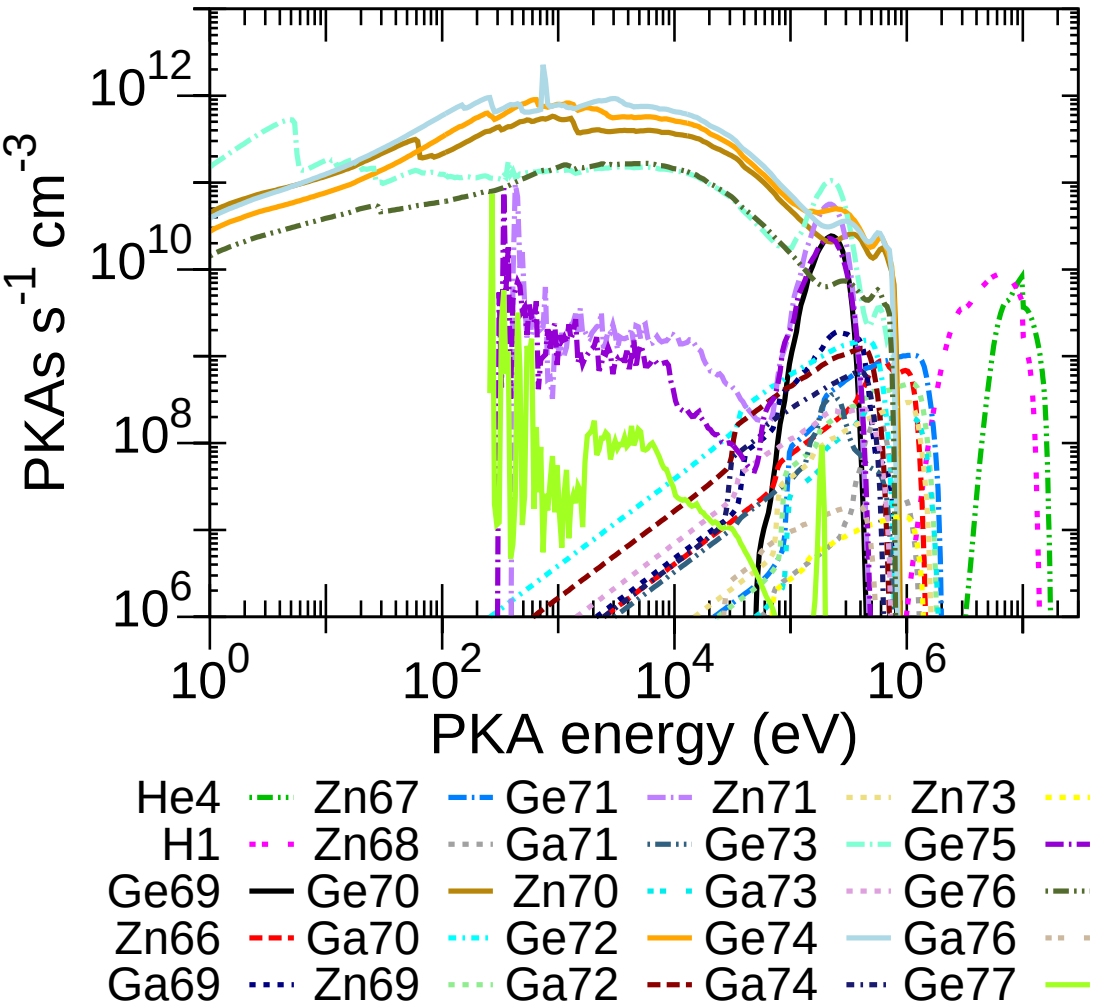


69 appm He & 130 appm H after 1 year 19 dpa/year



Germanium FW PKA distributions





Germanium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ge73m	0.50s	Ge72(n,γ)Ge73m	98.3	100.0	5.5	
		Ge70(n,γ)Ge71(β^+)Ga71(n,γ)Ga72(β^-)Ge72(n,γ)Ge73m	1.4			
		Ge73(n,n$'$)Ge73m			94.3	3.9
		Ge74(n,2n)Ge73m				88.4
		Ge73(n,p)Ga73(β^-)Ge73m				4.2
		Ge74(n,2n)Ge73(n,p)Ga73(β^-)Ge73m				1.1
		Ge74(n,2n)Ge73(n,n$'$)Ge73m				1.0
Ge75m	48.00s	Ge74(n,γ)Ge75m	88.1	99.7	100.0	
		Ge73(n,γ)Ge74(n,γ)Ge75m	10.8			
		Ge76(n,2n)Ge75m				99.6
Ge77m	52.91s	Ge76(n,γ)Ge77m	100.0	100.0	100.0	100.0
Zn71	2.45m	Ge73(n,α)Zn70(n,γ)Zn71	90.5	99.5	95.6	
		Ge72(n,γ)Ge73(n,α)Zn70(n,γ)Zn71	4.6			
		Ge72(n,γ)Ge73m(IT)Ge73(n,α)Zn70(n,γ)Zn71	4.5			
		Ge70(n,p)Ga70(β^+)Zn70(n,γ)Zn71			3.6	
		Ge74(n,α)Zn71				91.7
		Ge72(n,2n)Ge71(β^+)Ga71(n,p)Zn71				7.9
Ga74	8.12m	Ge70(n,γ)Ge71(β^+)Ga71(n,γ)Ga72(n,γ)Ga73(n,γ)Ga74	63.3	66.5		
		Ge70(n,γ)Ge71(β^+)Ga71(n,γ)Ga72(n,γ)Ga73(n,γ) Ga74m(IT)Ga74	36.7	33.5		
		Ge73(n,p)Ga73(n,γ)Ga74			75.7	
		Ge73(n,p)Ga73(n,γ)Ga74m(IT)Ga74			24.0	
		Ge74(n,p)Ga74				79.8
		Ge74(n,p)Ga74m(IT)Ga74				20.1
Ga70	21.14m	Ge70(n,γ)Ge71(n,α)Zn68(n,γ)Zn69(β^-)Ga69(n,γ)Ga70	89.2	86.8		
		Ge70(n,γ)Ge71(n,α)Zn68(n,γ)Zn69m(IT)Zn69(β^-) Ga69(n,γ)Ga70	10.8	13.2		
		Ge70(n,p)Ga70			100.0	52.1
		Ge72(n,2n)Ge71(β^+)Ga71(n,2n)Ga70				45.9
Ga68	1.13h	Ge70(n,2n)Ge69(β^+)Ga69(n,2n)Ga68				83.3
		Ge70(n,np)Ga69(n,2n)Ga68				11.1
		Ge72(n,α)Zn69m(IT)Zn69(β^-)Ga69(n,2n)Ga68				2.0
		Ge72(n,α)Zn69(β^-)Ga69(n,2n)Ga68				1.9
Ge75	1.38h	Ge74(n,γ)Ge75	66.6	73.0	60.5	
		Ge74(n,γ)Ge75m(IT)Ge75	21.5	26.6	39.5	
		Ge73(n,γ)Ge74(n,γ)Ge75	8.2			
		Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75	2.6			
		Ge76(n,2n)Ge75m(IT)Ge75				64.2
		Ge76(n,2n)Ge75				35.3
Zn71m	3.96h	Ge73(n,α)Zn70(n,γ)Zn71m	90.5	99.5	95.7	
		Ge72(n,γ)Ge73(n,α)Zn70(n,γ)Zn71m	4.6			
		Ge72(n,γ)Ge73m(IT)Ge73(n,α)Zn70(n,γ)Zn71m	4.5			
		Ge70(n,p)Ga70(β^+)Zn70(n,γ)Zn71m			3.6	
		Ge74(n,α)Zn71m				87.5
		Ge72(n,2n)Ge71(β^+)Ga71(n,p)Zn71m				12.0
Ge77	11.30h	Ge76(n,γ)Ge77	77.3	79.8	88.2	94.1
		Ge76(n,γ)Ge77m(IT)Ge77	22.7	20.2	11.8	5.9
Zn69m	13.78h	Ge70(n,γ)Ge71(n,α)Zn68(n,γ)Zn69m	100.0	100.0		
		Ge72(n,α)Zn69m			99.2	84.0
		Ge70(n,2n)Ge69(β^+)Ga69(n,p)Zn69m				5.4
		Ge73(n,α)Zn70(n,2n)Zn69m				3.0
		Ge73(n,nα)Zn69m				2.5
		Ge73(n,2n)Ge72(n,α)Zn69m				1.8
Ga72	14.10h	Ge70(n,γ)Ge71(β^+)Ga71(n,γ)Ga72	100.0	100.0	100.0	
		Ge72(n,p)Ga72				93.9
		Ge73(n,2n)Ge72(n,p)Ga72				2.0
		Ge73(n,np)Ga72				1.4
As76	1.09d	Ge74(n,γ)Ge75(β^-)As75(n,γ)As76	70.2	73.2	60.5	
		Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76	22.7	26.7	39.5	
		Ge73(n,γ)Ge74(n,γ)Ge75(β^-)As75(n,γ)As76	5.0			
		Ge73(n,γ)Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76	1.6			
		Ge76(n,2n)Ge75m(IT)Ge75(β^-)As75(n,γ)As76				63.8
		Ge76(n,2n)Ge75(β^-)As75(n,γ)As76				35.1

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
As77	1.62d	Ge76(n,γ)Ge77m(β^-)As77	48.8	46.3	33.4	19.9
		Ge76(n,γ)Ge77(β^-)As77	38.9	42.9	58.7	75.1
		Ge76(n,γ)Ge77m(IT)Ge77(β^-)As77	11.5	10.9	7.8	4.7
Ge69	1.63d	Ge70(n,2n)Ge69				99.4
Ge71	11.43d	Ge70(n,γ)Ge71	100.0	100.0	100.0	
		Ge72(n,2n)Ge71				97.3
		Ge73(n,2n)Ge72(n,2n)Ge71				2.0
As74	17.78d	Ge76(n,2n)Ge75m(IT)Ge75(β^-)As75(n,2n)As74				64.2
		Ge76(n,2n)Ge75(β^-)As75(n,2n)As74				35.3
Fe59	44.50d	Ge70(n,nα)Zn66(n,nα)Ni62(n,α)Fe59				88.9
		Ge70(n,α)Zn67(n,2n)Zn66(n,nα)Ni62(n,α)Fe59				2.7
		Ge70(n,nα)Zn66(n,2n)Zn65(n,α)Ni62(n,α)Fe59				1.8
		Ge70(n,nα)Zn66(n,α)Ni63(n,2n)Ni62(n,α)Fe59				1.8
As73	80.30d	Ge76(n,2n)Ge75m(IT)Ge75(β^-)As75(n,2n)As74(n,2n)As73				21.5
		Ge76(n,2n)Ge75m(IT)Ge75(β^-)As75(n,2n)As74(β^-) Se74(n,np)As73				17.7
		Ge76(n,2n)Ge75m(IT)Ge75(β^-)As75(n,2n)As74(β^-)Se74(n,2n) Se73(β^+)As73				13.0
		Ge76(n,2n)Ge75(β^-)As75(n,2n)As74(n,2n)As73				11.8
		Ge76(n,2n)Ge75(β^-)As75(n,2n)As74(β^-)Se74(n,np)As73				9.7
		Ge76(n,2n)Ge75m(IT)Ge75(β^-)As75(n,2n)As74(β^-)Se74(n,2n) Se73m(IT)Se73(β^+)As73				8.6
		Ge76(n,2n)Ge75(β^-)As75(n,2n)As74(β^-)Se74(n,2n) Se73(β^+)As73				7.1
		Ge76(n,2n)Ge75(β^-)As75(n,2n)As74(β^-)Se74(n,2n)Se73m(IT) Se73(β^+)As73				4.7
		Ge76(n,2n)Ge75m(IT)Ge75(β^-)As75(n,2n)As74(β^-)Se74(n,2n) Se73m(β^+)As73				3.2
		Ge76(n,2n)Ge75(β^-)As75(n,2n)As74(β^-)Se74(n,2n) Se73m(β^+)As73				1.8
Se75	119.63d	Ge76(n,2n)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-) Se76(n,2n)Se75				25.8
		Ge76(n,2n)Ge75m(IT)Ge75(β^-)As75(n,2n)As74(β^-) Se74(n,γ)Se75				23.7
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,2n)Se76(n,2n)Se75				16.9
		Ge76(n,2n)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,2n)Se75				14.2
		Ge76(n,2n)Ge75(β^-)As75(n,2n)As74(β^-)Se74(n,γ)Se75				13.1
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,2n)Se76(n,2n)Se75				4.5
		Ge76(n,γ)Ge77m(IT)Ge77(β^-)As77(β^-)Se77(n,2n) Se76(n,2n)Se75				1.1
Zn65	244.14d	Ge70(n,nα)Zn66(n,2n)Zn65				94.4
		Ge70(n,α)Zn67(n,2n)Zn66(n,2n)Zn65				3.5
Ge68	270.94d	Ge70(n,2n)Ge69(n,2n)Ge68				99.7
Co60	5.27y	Ge70(n,nα)Zn66(n,nα)Ni62(n,2n)Ni61(n,np)Co60				16.4
		Ge70(n,nα)Zn66(n,α)Ni63(β^-)Cu63(n,α)Co60m(IT)Co60				11.5
		Ge70(n,nα)Zn66(n,2n)Zn65(n,nα)Ni61(n,np)Co60				10.6
		Ge70(n,nα)Zn66(n,α)Ni63(β^-)Cu63(n,α)Co60				9.4
		Ge70(n,nα)Zn66(n,nα)Ni62(n,2n)Ni61(n,np)Co60m(IT)Co60				9.4
		Ge70(n,nα)Zn66(n,2n)Zn65(n,nα)Ni61(n,np)Co60m(IT)Co60				6.1
		Ge70(n,α)Zn67(n,nα)Ni63(β^-)Cu63(n,α)Co60m(IT)Co60				3.0
		Ge70(n,α)Zn67(n,nα)Ni63(β^-)Cu63(n,α)Co60				2.5
		Ge70(n,nα)Zn66(n,2n)Zn65(n,2n)Zn64(n,np)Cu63(n,α) Co60m(IT)Co60				2.3
		Ge70(n,nα)Zn66(n,nα)Ni62(n,2n)Ni61(n,d)Co60m(IT)Co60				2.1
		Ge70(n,nα)Zn66(n,2n)Zn65(n,2n)Zn64(n,np)Cu63(n,α)Co60				1.9
		Ge70(n,nα)Zn66(n,nα)Ni62(n,2n)Ni61(n,d)Co60				1.8
		Ge70(n,nα)Zn66(n,2n)Zn65(n,nα)Ni61(n,d)Co60m(IT)Co60				1.4
		Ge70(n,nα)Zn66(n,2n)Zn65(n,nα)Ni61(n,d)Co60				1.2

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Kr85	10.75y	Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT) Se79(n,γ)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	6.1			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT) Se79(n,γ)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	5.3			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT) Se79(n,γ)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	4.8			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79(n,γ) Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ) Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	4.4			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT) Se79(n,γ)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	4.2			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79(n,γ) Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ) Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	3.8			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79(n,γ) Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ) Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	3.5			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79(n,γ) Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ) Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	3.0			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT) Se79(n,γ)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85	2.4			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT) Se79(n,γ)Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT) Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	2.2			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT) Se79(n,γ)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	2.1			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT) Se79(n,γ)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85	1.9			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT) Se79(n,γ)Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT) Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ) Kr85m(IT)Kr85	1.9			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79(n,γ) Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ) Kr83(n,γ)Kr84(n,γ)Kr85	1.8			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT) Se79(n,γ)Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT) Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	1.8			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT) Se79(n,γ)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	1.7			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79(n,γ) Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	1.6			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79(n,γ) Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ) Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	1.5			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT) Se79(n,γ)Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT) Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ) Kr85m(IT)Kr85	1.5			
		Ge76(n,γ)Ge77m(IT)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ) Se79m(IT)Se79(n,γ)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT) Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	1.4			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79(n,γ) Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ) Kr83(n,γ)Kr84(n,γ)Kr85	1.4			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Kr85	cont.	Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79(n,γ) Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	1.4			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79(n,γ) Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	1.3			
		Ge76(n,γ)Ge77m(IT)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ) Se79m(IT)Se79(n,γ)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT) Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ) Kr85m(IT)Kr85	1.2			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79(n,γ) Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ) Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	1.2			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79(n,γ) Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	1.1			
		Ge76(n,γ)Ge77m(IT)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ) Se79(n,γ)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	1.0			
H3	12.33y	Ge70(n,γ)Ge71(n,p)H1(n,γ)H2(n,γ)H3	98.3		1.5	
		Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(n,p)H1(n,γ)H2(n,γ)H3	1.2			
		Ge70(n,p)H1(n,γ)H2(n,γ)H3			97.1	
		Ge73(n,p)H1(n,γ)H2(n,γ)H3			1.3	
		Ge73(n,t)H3				74.5
		Ge74(n,2n)Ge73(n,t)H3				9.6
		Ge70(n,2n)Ge69(β^+)Ga69(n,t)H3				3.4
		Ge72(n,2n)Ge71(β^+)Ga71(n,t)H3				2.1
		Ge70(n,t)H3				1.8
		Ge72(n,t)H3				1.3
		Ge74(n,2n)Ge73m(IT)Ge73(n,t)H3				1.3
Ni63	100.62y	Ge70(n,nα)Zn66(n,α)Ni63				75.4
		Ge70(n,α)Zn67(n,nα)Ni63				19.6
		Ge70(n,α)Zn67(n,2n)Zn66(n,α)Ni63				2.5
		Ge70(n,α)Zn67(n,α)Ni64(n,2n)Ni63				1.2
Ni59	7.6 10^4y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Kr81	2.1 10^5y	Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	21.4			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	17.0			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	9.6			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	7.6			
		Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ) Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	7.3			
		Ge76(n,γ)Ge77m(IT)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	5.0			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81	4.5			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81	3.5			
		Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ) Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ) Kr81m(IT)Kr81	3.3			
		Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT) Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-) Kr80(n,γ)Kr81	2.5			
		Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-) Kr80(n,γ)Kr81	2.4			
		Ge76(n,γ)Ge77m(IT)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	2.2			
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	2.0			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	1.6			
		Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ) Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80m(IT)Br80(β^-) Kr80(n,γ)Kr81	1.5			
		Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT) Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ) Kr81m(IT)Kr81	1.1			
		Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ) Kr81m(IT)Kr81	1.1			
		Ge76(n,γ)Ge77m(IT)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81	1.0			
Se79	3.8 10^5y	Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ) Se79m(IT)Se79	18.2		12.2	4.3
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	14.5		21.3	16.1
		Ge76(n,γ)Ge77m(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79	13.1		20.9	15.4
		Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ) Se78(n,γ)Se79m(IT)Se79	11.5			
		Ge76(n,γ)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79	10.4		36.6	57.7
		Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ) Se78(n,γ)Se79	8.3			
		Ge76(n,γ)Ge77m(IT)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ) Se79m(IT)Se79	4.3		2.9	1.0
		Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT) Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	3.9			
		Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	3.7			
		Ge76(n,γ)Ge77m(IT)Ge77(β^-)As77(β^-)Se77(n,γ)Se78(n,γ)Se79	3.1		4.9	3.6
		Ge74(n,γ)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT) Se77(n,γ)Se78(n,γ)Se79	2.8			
		Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77(n,γ)Se78(n,γ)Se79	2.7			
		Ge74(n,γ)Ge75m(IT)Ge75(β^-)As75(n,γ)As76(β^-)Se76(n,γ) Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	1.3			
Ge76	1.6 10^{21}y	no pathways found				

Arsenic

Isotope	Atom % abundance
As75	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.35E+15	2.33E+15	7.71E+14	3.35E+12	2.24E+07	3.50E+02
As76	68.4	68.9	20.6			
As74	28.6	28.9	75.8			
Se75	1.2	1.2	3.5	98.9		
H3				0.2	100.0	
Se79						100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	5.01E-01	5.00E-01	1.36E-01	2.16E-04	2.05E-11	2.94E-15
As76	76.4	76.4	27.8			
As74	22.1	22.2	70.9			
Se75	0.4	0.4	1.3	99.8		
H3					100.0	
Se79						100.0

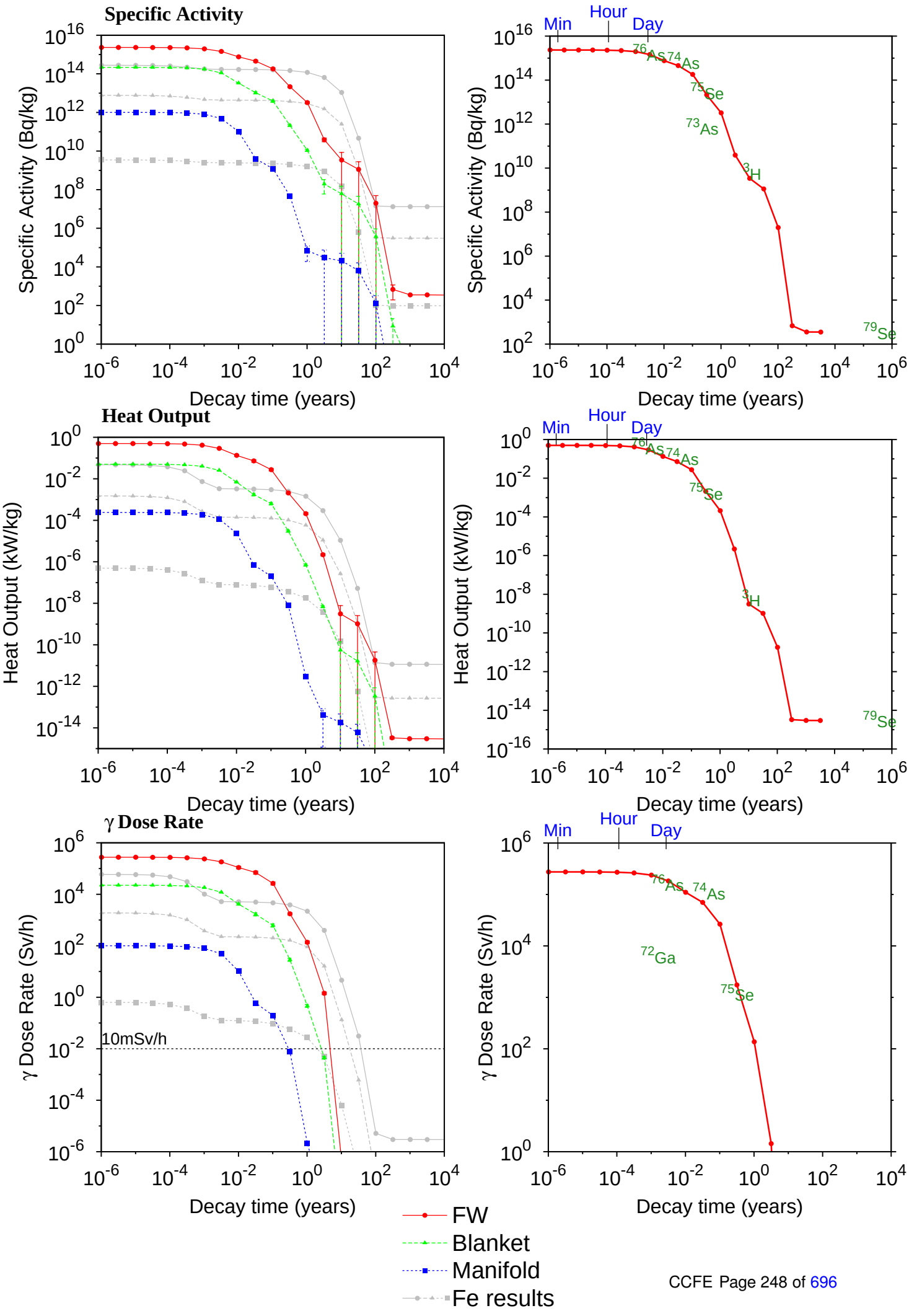
Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.75E+05	2.74E+05	1.11E+05	1.41E+02	3.04E-18	2.94E-18
As76	57.8	57.8	14.1			
As74	39.4	39.5	84.8	0.1		
Ga72	2.3	2.3	0.1			
Se75	0.4	0.4	1.0	99.9		
Kr81					100.0	100.0

Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.54E+06	3.53E+06	1.08E+06	8.64E+03	9.42E-04	1.01E-06
As76	72.9	72.9	23.4			
As74	24.8	24.8	70.1			
Se75	2.0	2.0	6.5	99.9		
H3					99.9	
Se79					0.1	100.0

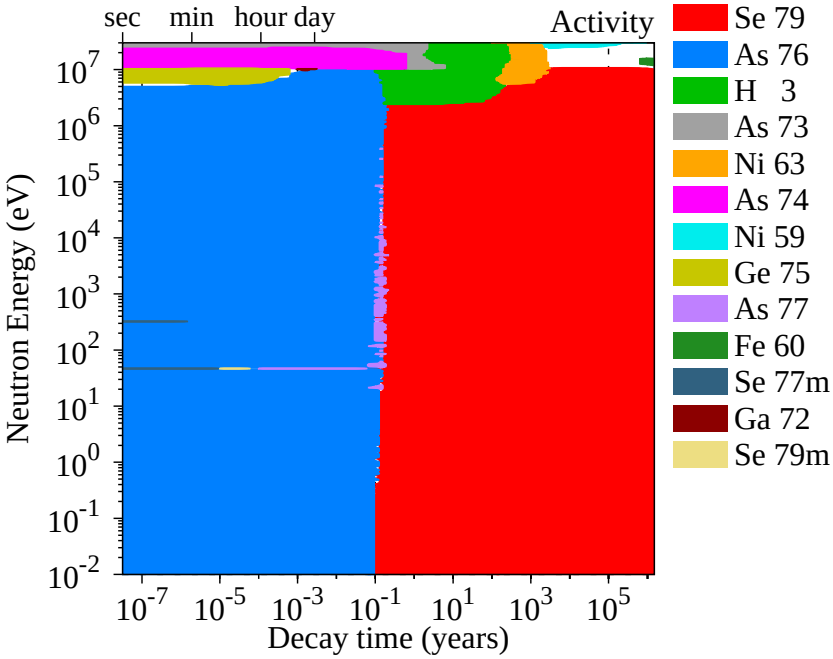
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.65E+06	2.64E+06	1.38E+06	4.34E+03	5.83E-03	2.38E-06
As74	53.4	53.5	88.9			
As76	45.0	45.0	8.5			
Se75	1.4	1.4	2.5	99.3		
H3					100.0	
Se79						100.0

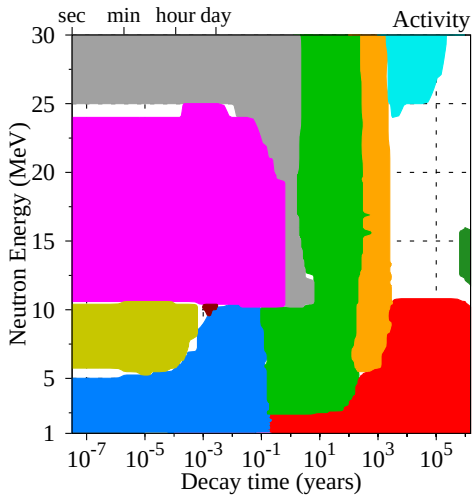
Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.60E+11	2.58E+11	1.01E+11	3.32E+09	2.24E+02	1.84E-03
As76	62.0	62.3	15.7			
As74	25.9	26.1	57.7			
Se75	10.6	10.7	26.6	100.0		
H3					100.0	
Se79						100.0

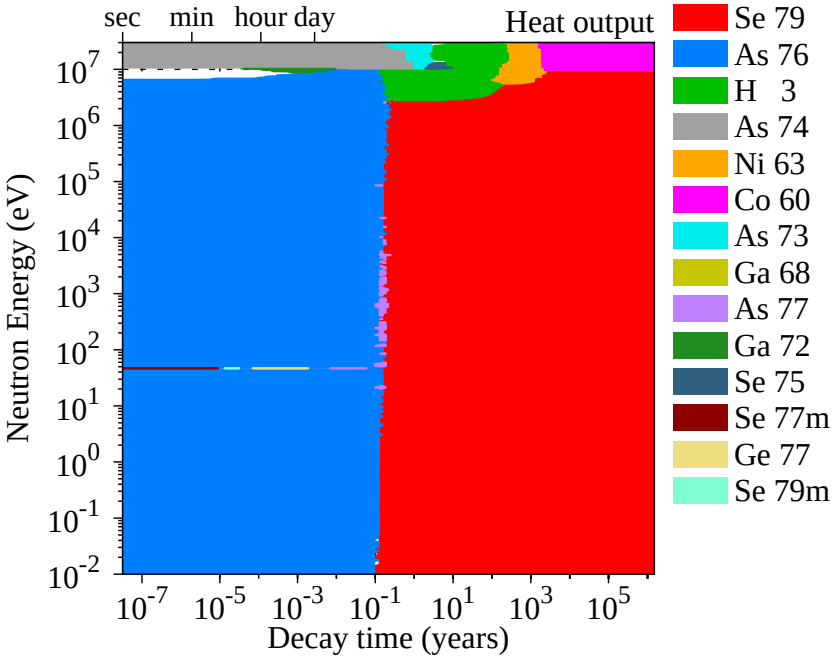
Arsenic activation characteristics

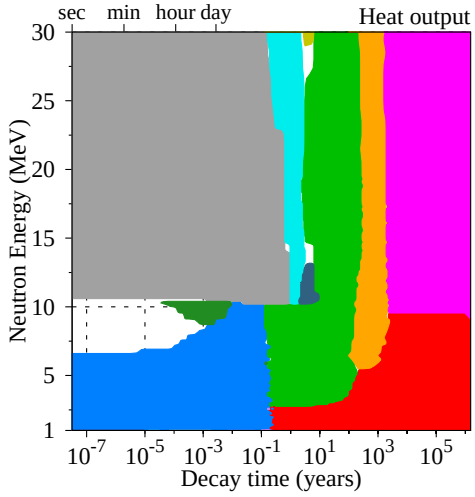


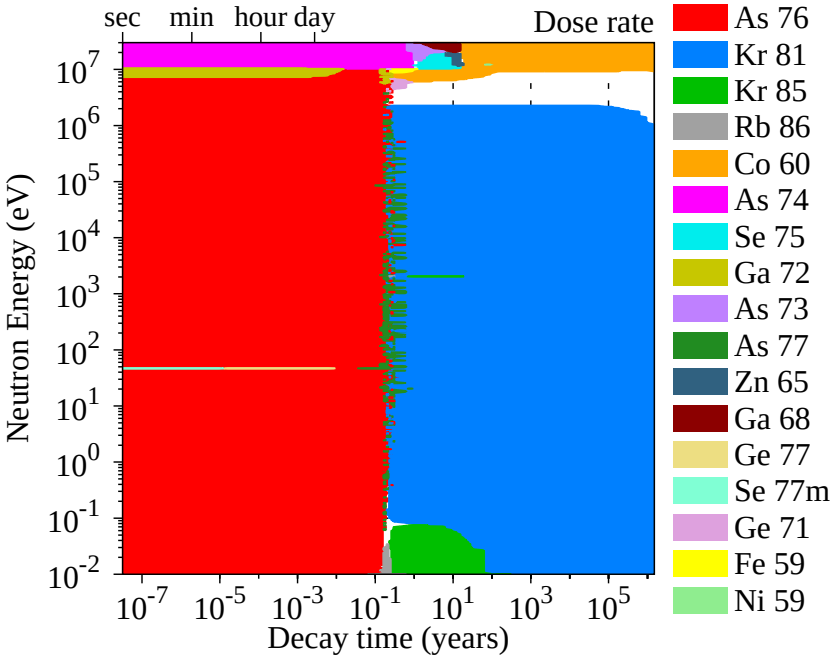
Arsenic Importance diagrams

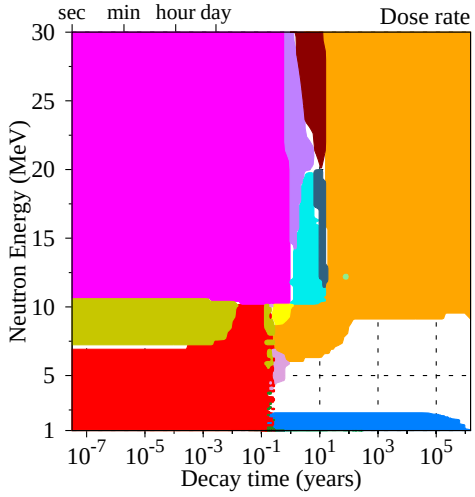




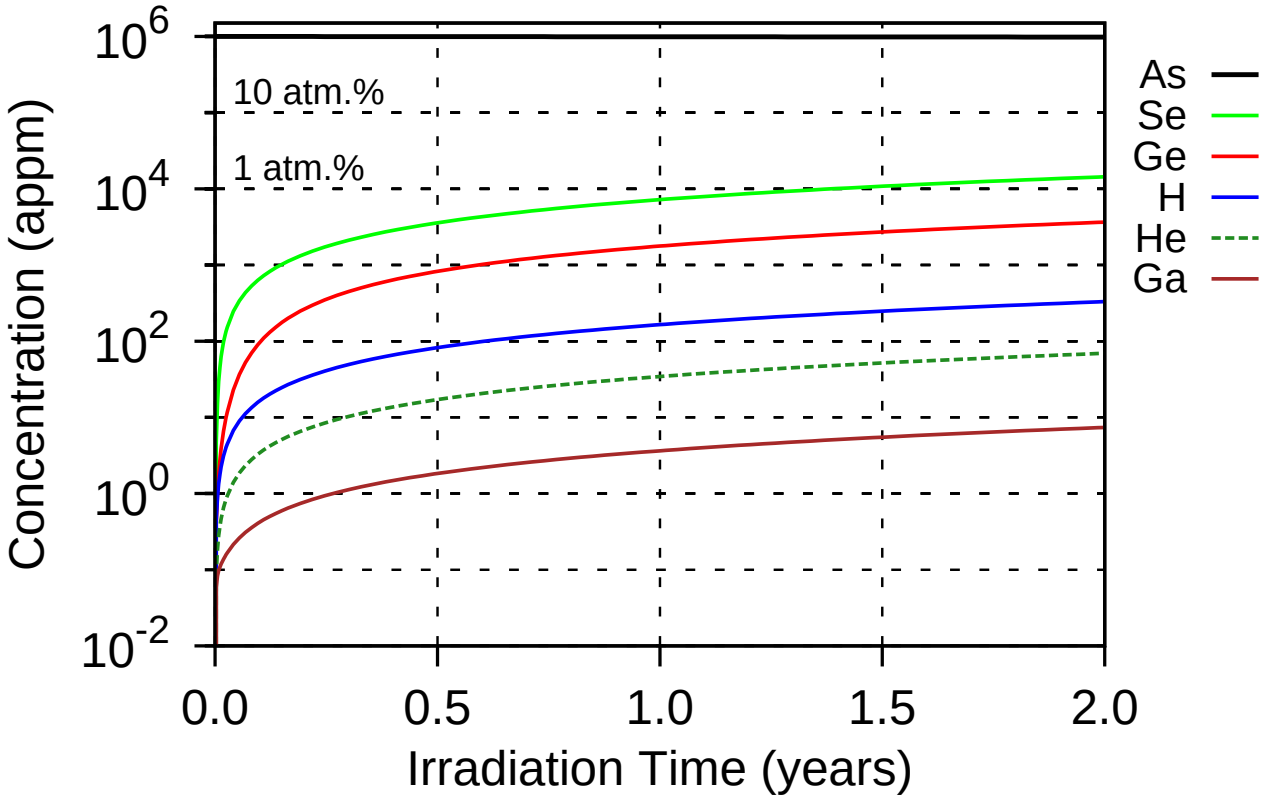




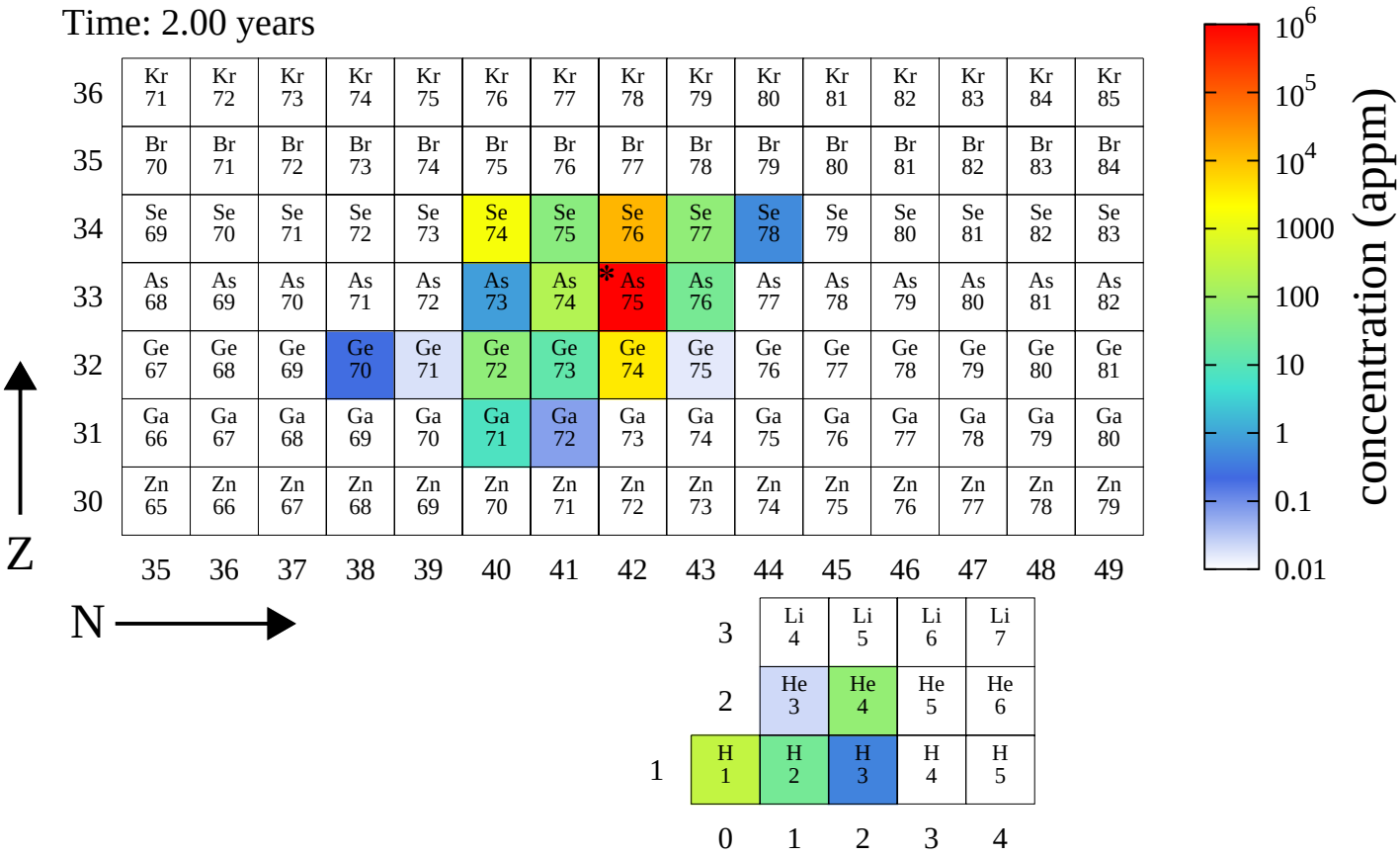




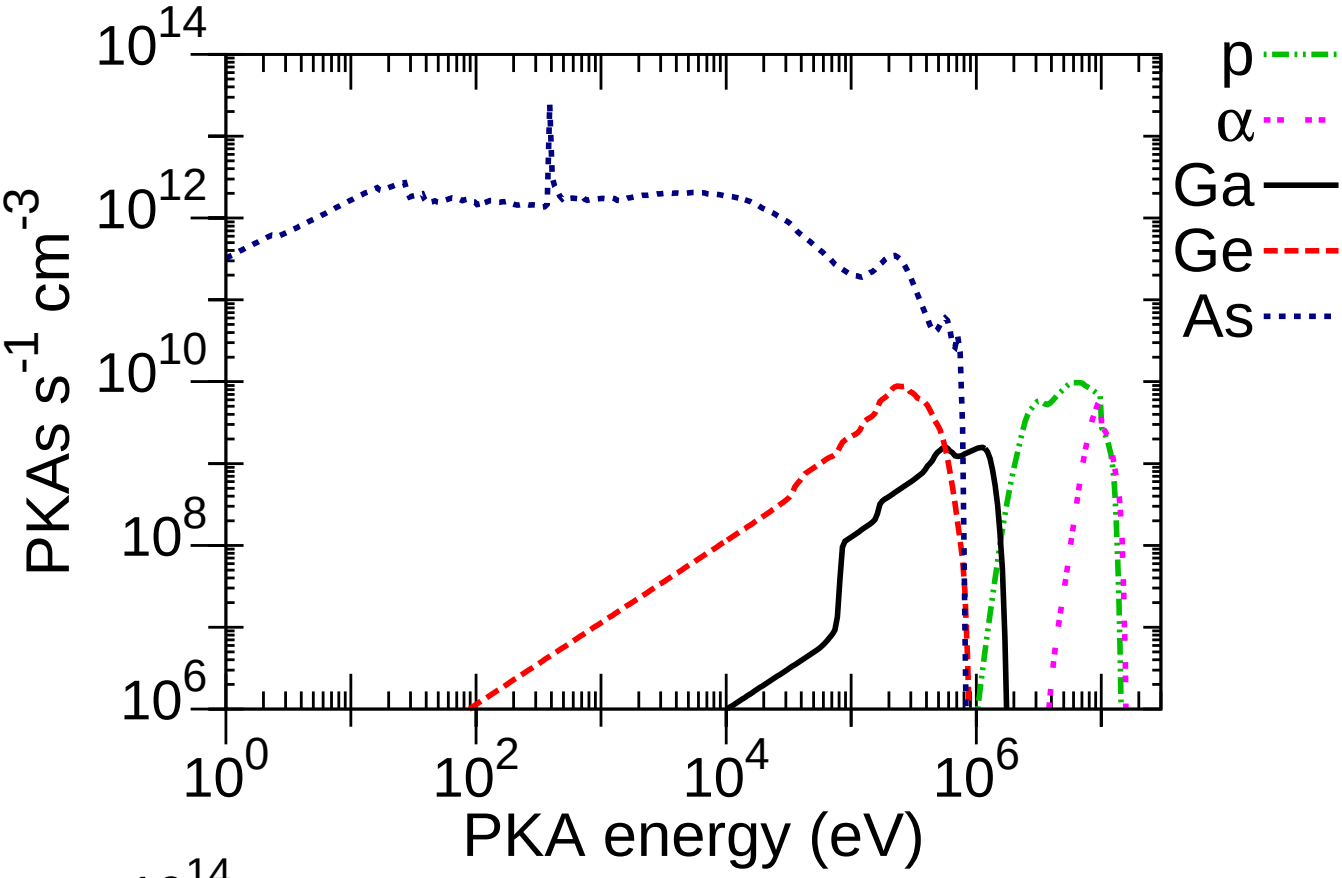
Arsenic FW Transmutation

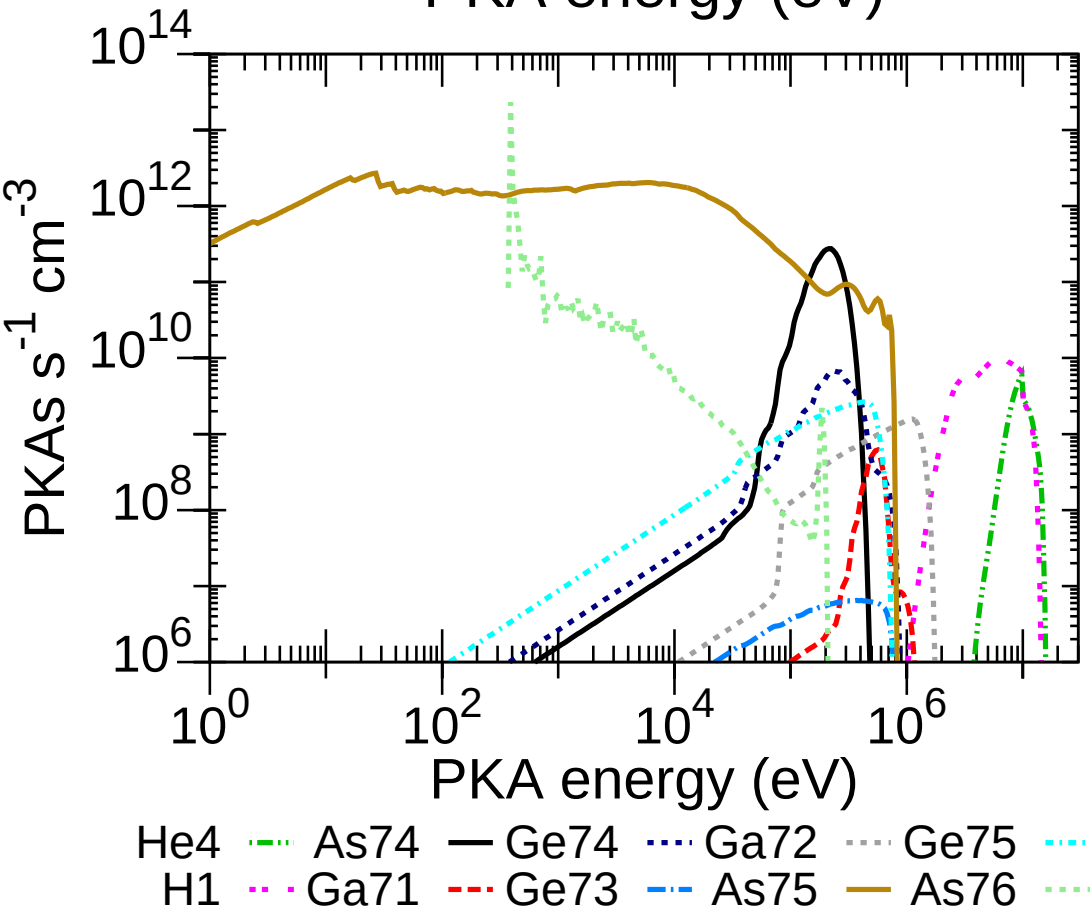


34 appm He & 165 appm H after 1 year 18 dpa/year



Arsenic FW PKA distributions





Arsenic Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Se77m	17.36s	As75(n,γ)As76(β^-)Se76(n,γ)Se77m	100.0	100.0	96.6	98.6
		As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,n$'$)Se77m			3.4	
Se79m	3.90m	As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m	74.4	66.0	51.8	
		As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ) Se78(n,γ)Se79m	25.3	30.5	47.1	
		As75(n,γ)As76(n,γ)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m		3.5		
Ga68	1.13h	As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,2n)Ge69(β^+) Ga69(n,2n)Ga68				31.9
		As75(n,α)Ga72(β^-)Ge72(n,α)Zn69m(IT)Zn69(β^-) Ga69(n,2n)Ga68				21.9
		As75(n,α)Ga72(β^-)Ge72(n,α)Zn69(β^-)Ga69(n,2n)Ga68				20.7
		As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,np)Ga69(n,2n)Ga68				4.3
		As75(n,nα)Ga71(n,2n)Ga70(β^-)Ge70(n,2n)Ge69(β^+) Ga69(n,2n)Ga68				2.8
		As75(n,2n)As74(β^+)Ge74(n,2n)Ge73(n,nα)Zn69m(IT)Zn69(β^-) Ga69(n,2n)Ga68				2.3
		As75(n,2n)As74(β^+)Ge74(n,nα)Zn70(n,2n)Zn69m(IT)Zn69(β^-) Ga69(n,2n)Ga68				1.3
		As75(n,2n)As74(β^+)Ge74(n,2n)Ge73(n,nα)Zn69(β^-) Ga69(n,2n)Ga68				1.3
		As75(n,2n)As74(n,2n)As73(n,nα)Ga69(n,2n)Ga68				1.2
		As75(n,2n)As74(β^-)Se74(n,np)As73(n,nα)Ga69(n,2n)Ga68				1.0
Ge75	1.38h	As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,α)Ge74(n,γ)Ge75	56.2	48.4		
		As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,α) Ge74(n,γ)Ge75	19.1	22.4		
		As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,α)Ge74(n,γ) Ge75m(IT)Ge75	18.2	17.6		
		As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,α)Ge74(n,γ) Ge75m(IT)Ge75	6.2	8.1		
		As75(n,γ)As76(n,γ)As77(β^-)Se77(n,α)Ge74(n,γ)Ge75		2.5		
		As75(n,p)Ge75			61.3	42.4
		As75(n,p)Ge75m(IT)Ge75			38.7	57.4
Ge77	11.30h	As75(n,γ)As76(n,p)Ge76(n,γ)Ge77	77.3	79.7	88.2	90.0
		As75(n,γ)As76(n,p)Ge76(n,γ)Ge77m(IT)Ge77	22.7	20.3		5.6
		As75(n,p)Ge75m(IT)Ge75(n,γ)Ge76(n,γ)Ge77				2.0
		As75(n,p)Ge75(n,γ)Ge76(n,γ)Ge77				1.5
Ga72	14.10h	As75(n,α)Ga72			100.0	99.6
As76	1.09d	As75(n,γ)As76	100.0	100.0	100.0	99.5
As77	1.62d	As75(n,γ)As76(n,γ)As77	100.0	100.0	99.8	61.4
		As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,p)As77				24.8
		As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,p)As77				12.9
Ge71	11.43d	As75(n,2n)As74(β^-)Se74(n,α)Ge71				68.5
		As75(n,α)Ga72(β^-)Ge72(n,2n)Ge71				29.6
		As75(n,2n)As74(β^+)Ge74(n,2n)Ge73(n,2n)Ge72(n,2n)Ge71				1.0
As74	17.78d	As75(n,2n)As74				99.6
Rb86	18.64d	no pathways found				
Fe59	44.50d	As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,nα)Zn66(n,nα) Ni62(n,α)Fe59				77.9
		As75(n,nα)Ga71(n,2n)Ga70(β^-)Ge70(n,nα)Zn66(n,nα) Ni62(n,α)Fe59				7.1
		As75(n,2n)As74(n,nα)Ga70(β^-)Ge70(n,nα)Zn66(n,nα) Ni62(n,α)Fe59				2.7
		As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,α)Zn67(n,2n) Zn66(n,nα)Ni62(n,α)Fe59				1.4
		As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,nα)Zn66(n,2n) Zn65(n,α)Ni62(n,α)Fe59				1.1
As73	80.30d	As75(n,2n)As74(β^-)Se74(n,np)As73				32.8
		As75(n,2n)As74(β^-)Se74(n,2n)Se73(β^+)As73				24.0
		As75(n,2n)As74(n,2n)As73				20.7
		As75(n,2n)As74(β^-)Se74(n,2n)Se73m(IT)Se73(β^+)As73				15.9
		As75(n,2n)As74(β^-)Se74(n,2n)Se73m(β^+)As73				6.0
Se75	119.63d	As75(n,γ)As76(β^-)Se76(n,2n)Se75				51.1
		As75(n,2n)As74(β^-)Se74(n,γ)Se75				48.7

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Zn65	244.14d	As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,nα)Zn66(n,2n)Zn65				81.3
		As75(n,nα)Ga71(n,2n)Ga70(β^-)Ge70(n,nα)Zn66(n,2n)Zn65				7.3
		As75(n,2n)As74(n,nα)Ga70(β^-)Ge70(n,nα)Zn66(n,2n)Zn65				2.4
		As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,α)Zn67(n,2n) Zn66(n,2n)Zn65				1.6
		As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,2n)Ge69(n,nα)Zn65				1.5
		As75(n,2n)As74(β^-)Se74(n,α)Ge71(β^+)Ga71(n,2n)Ga70(β^-) Ge70(n,nα)Zn66(n,2n)Zn65				1.1
Co60	5.27y	As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,nα)Zn66(n,α)Ni63(β^-) Cu63(n,α)Co60m(IT)Co60				9.2
		As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,nα)Zn66(n,α)Ni63(β^-) Cu63(n,α)Co60				7.6
		As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,α)Zn67(n,nα)Ni63(β^-) Cu63(n,α)Co60m(IT)Co60				2.4
		As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,α)Zn67(n,nα)Ni63(β^-) Cu63(n,α)Co60				2.0
Kr85	10.75y	no pathways found				
H3	12.33y	As75(n,γ)As76(n,p)H1(n,γ)H2(n,γ)H3	100.0	99.9		
		As75(n,p)H1(n,γ)H2(n,γ)H3			38.7	
		As75(n,t)H3				12.9
Ni63	100.62y	As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,nα)Zn66(n,α)Ni63				61.6
		As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,α)Zn67(n,nα)Ni63				16.1
		As75(n,nα)Ga71(n,2n)Ga70(β^-)Ge70(n,nα)Zn66(n,α)Ni63				5.6
		As75(n,nα)Ga71(n,nα)Cu67(β^-)Zn67(n,nα)Ni63				2.2
		As75(n,2n)As74(n,nα)Ga70(β^-)Ge70(n,nα)Zn66(n,α)Ni63				2.0
		As75(n,nα)Ga71(n,2n)Ga70(β^-)Ge70(n,α)Zn67(n,nα)Ni63				1.4
		As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,α)Zn67(n,2n) Zn66(n,α)Ni63				1.2
Ni59	7.6 10^4y	no pathways found				
Kr81	2.1 10^5y	As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	42.4	37.5		
		As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	19.0	13.0		
		As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	14.4	17.3		
		As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81	8.8	9.8		
		As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	6.5	6.0		
		As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	3.9	3.4		
		As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81	3.0	4.5		
		As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ) Se79m(β^-)Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ) Kr81m(IT)Kr81	1.3	1.6		
		As75(n,γ)As76(n,γ)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81		3.9		
		As75(n,γ)As76(n,γ)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81		1.4		
		As75(n,γ)As76(n,γ)As77(β^-)Se77(n,γ)Se78(n,γ)Se79m(β^-) Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81		1.0		
Se79	3.8 10^5y	As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ) Se79m(IT)Se79	43.2	35.1	19.2	7.4
		As75(n,γ)As76(β^-)Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79	31.1	30.2	33.0	26.4
		As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ) Se79m(IT)Se79	14.7	16.2	17.4	14.1
		As75(n,γ)As76(β^-)Se76(n,γ)Se77m(IT)Se77(n,γ) Se78(n,γ)Se79	10.6	13.9	29.9	50.5
		As75(n,γ)As76(n,γ)As77(β^-)Se77(n,γ)Se78(n,γ) Se79m(IT)Se79		2.4		
		As75(n,γ)As76(n,γ)As77(β^-)Se77(n,γ)Se78(n,γ)Se79		2.1		

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Fe60	1.5 10^6y	As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,nα)Zn66(n,α) Ni63(n,α)Fe60				60.8
		As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,α)Zn67(n,nα) Ni63(n,α)Fe60				15.9
		As75(n,nα)Ga71(n,2n)Ga70(β^-)Ge70(n,nα)Zn66(n,α) Ni63(n,α)Fe60				5.7
		As75(n,nα)Ga71(n,nα)Cu67(β^-)Zn67(n,nα)Ni63(n,α)Fe60				2.7
		As75(n,2n)As74(n,nα)Ga70(β^-)Ge70(n,nα)Zn66(n,α) Ni63(n,α)Fe60				2.5
		As75(n,nα)Ga71(n,2n)Ga70(β^-)Ge70(n,α)Zn67(n,nα) Ni63(n,α)Fe60				1.5
		As75(n,2n)As74(β^-)Se74(n,nα)Ge70(n,α)Zn67(n,2n)Zn66(n,α) Ni63(n,α)Fe60				1.0

Selenium

Isotope	Atom % abundance
Se74	0.89
Se76	9.37
Se77	7.63
Se78	23.77
Se80	49.61
Se82	8.73

($T_{1/2}$ =1.2 10^{20}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	7.06E+14	3.96E+14	1.34E+14	1.58E+13	1.45E+09	1.43E+09
Se77m	32.9					
Se81	19.4	31.5				
Se75	18.4	32.8	94.8	99.2		
Se79m	12.4	8.7				
Se81m	10.6	17.6				
As76	1.2	2.1	0.6			
Br82	0.7	1.2	0.6			
As77	0.6	1.1	0.7			
As73	0.4	0.8	2.2	0.8		
Se79					99.9	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.99E-02	2.98E-02	9.08E-03	1.02E-03	1.22E-08	1.20E-08
Se81	33.9	41.6				
Se75	21.1	28.3	90.9	99.8		
Se77m	15.1					
Br82	5.2	7.0	4.1			
As76	5.0	6.7	2.2			
As80	4.0					
As78	3.9	5.0				
Se79m	3.4	1.8				
Se81m	3.1	3.9				
Se73	0.9	1.2				
Se83	0.9	1.1				
As74	0.5	0.7	2.0			
Se79					100.0	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.46E+04	1.25E+04	6.26E+03	6.65E+02	9.40E-09	8.50E-09
Se75	37.8	44.0	86.3	100.0		
Br82	22.5	26.1	9.4			
As78	9.8	10.9				
Se77m	7.3					
As76	5.8	6.7	1.3			
As80	4.1					
Se83	3.8	3.7				
Se73	2.2	2.5				
Ge77	1.6	1.9				
As74	1.4	1.7	2.9			
Se81	1.2	1.3				
Se83m	1.0	0.1				
Kr81					93.4	100.0
Kr85					6.6	

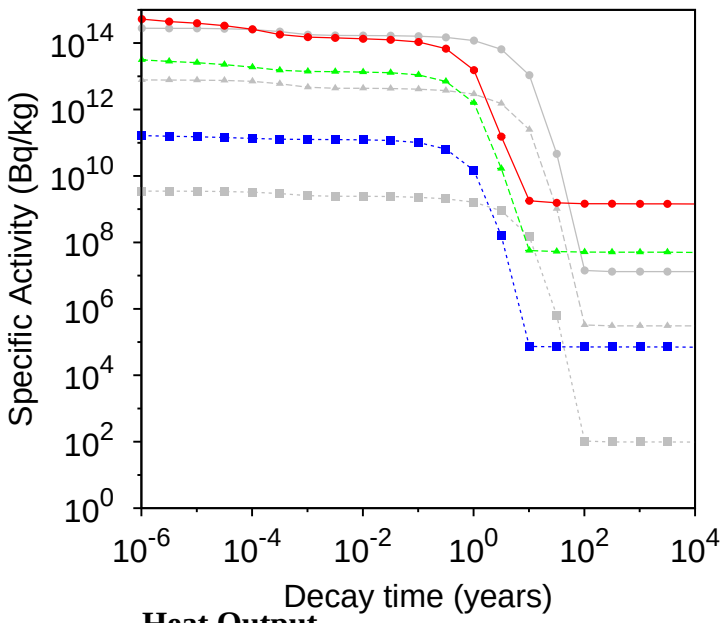
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	5.36E+05	3.74E+05	3.35E+05	4.08E+04	4.22E+00	4.14E+00
Se75	63.0	90.5	98.7	99.9		
Se77m	26.8					
Se83m	3.3	0.2				
As76	2.5	3.6	0.4			
Kr83m	0.8	1.1				
Se79					99.9	99.9

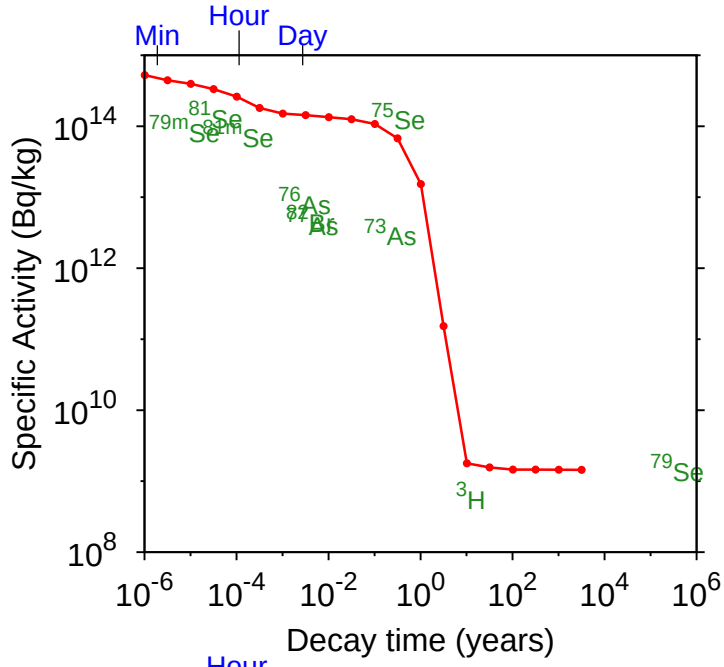
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.52E+05	1.97E+05	1.72E+05	2.06E+04	1.01E+01	9.83E+00
Se75	48.0	85.9	96.0	99.0		
Se77m	38.9					
Se83m	4.9	0.4				
As76	1.8	3.1	0.4			
Se81m	1.1	1.8				
As73	0.9	1.5	1.7	0.6		
Br82	0.8	1.5	0.3			
As74	0.8	1.4	1.4			
Kr83m	0.6	1.1				
Se79					98.2	98.7
Kr81					1.3	1.3

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.87E+11	1.57E+11	1.28E+11	1.57E+10	7.66E+03	7.51E+03
Se75	69.6	82.6	99.2	100.0		
Se77m	12.4					
Se81	5.2	5.7				
As78	2.9	3.3				
Br82	2.5	3.0	0.7			
As80	1.5					
Se81m	1.0	1.2				
Se79m	1.0	0.5				
Se83	1.0	1.0				
Se73	0.9	1.1				
Se79					99.8	100.0

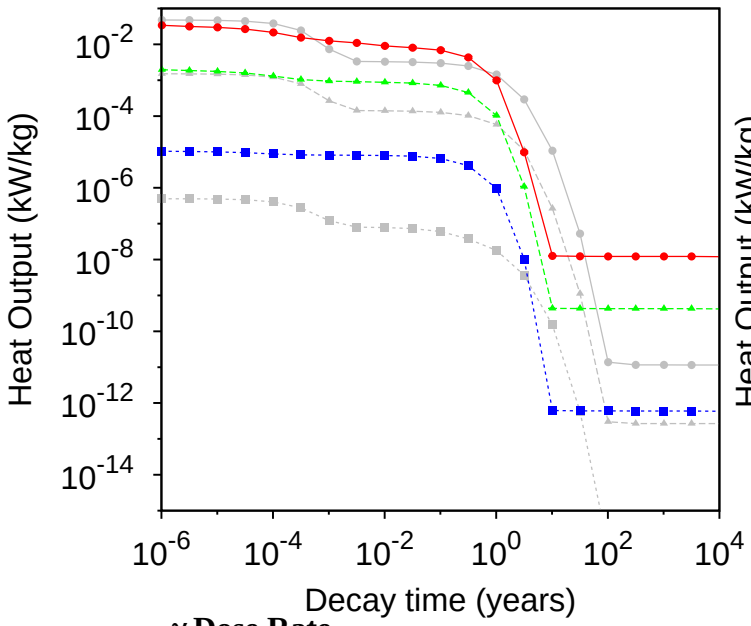
Selenium activation characteristics

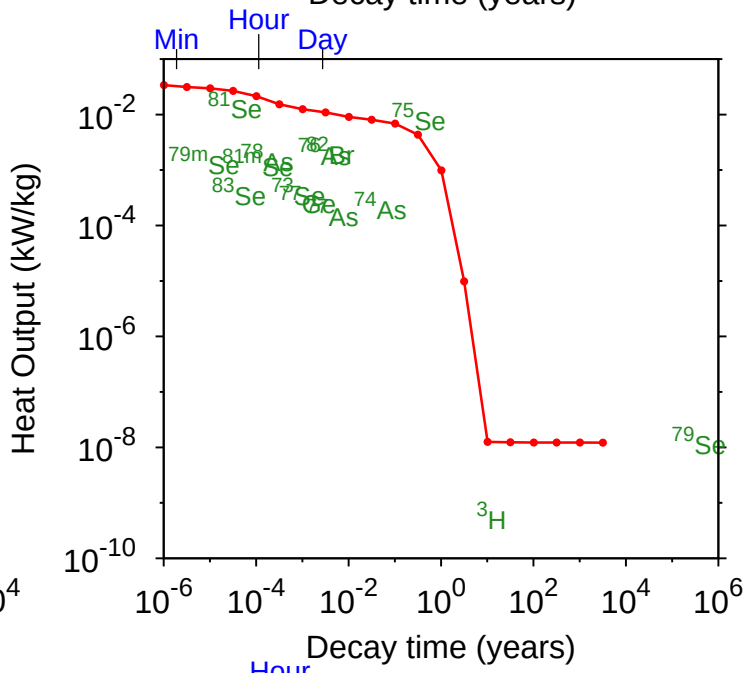
Specific Activity



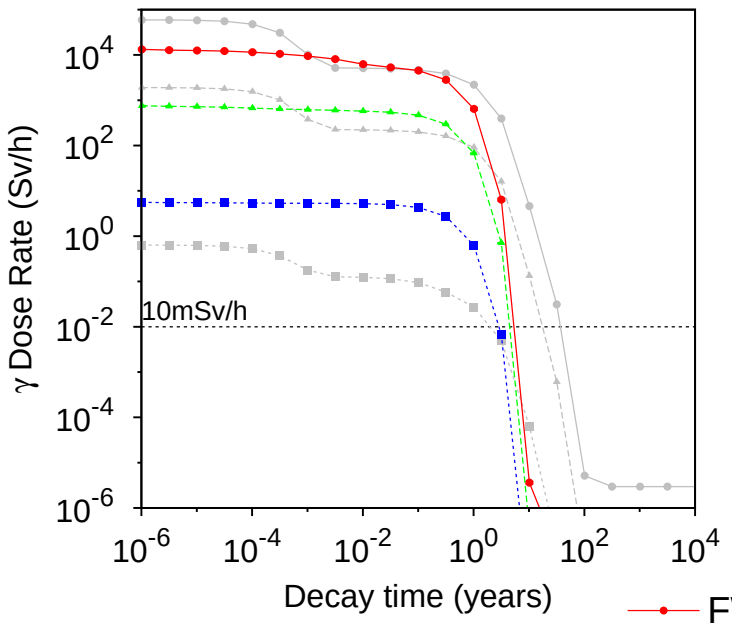


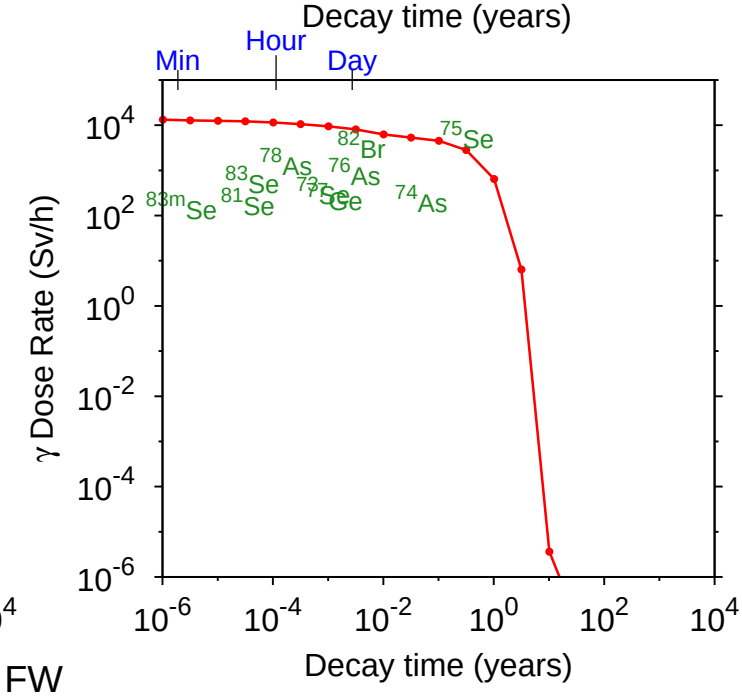
Heat Output





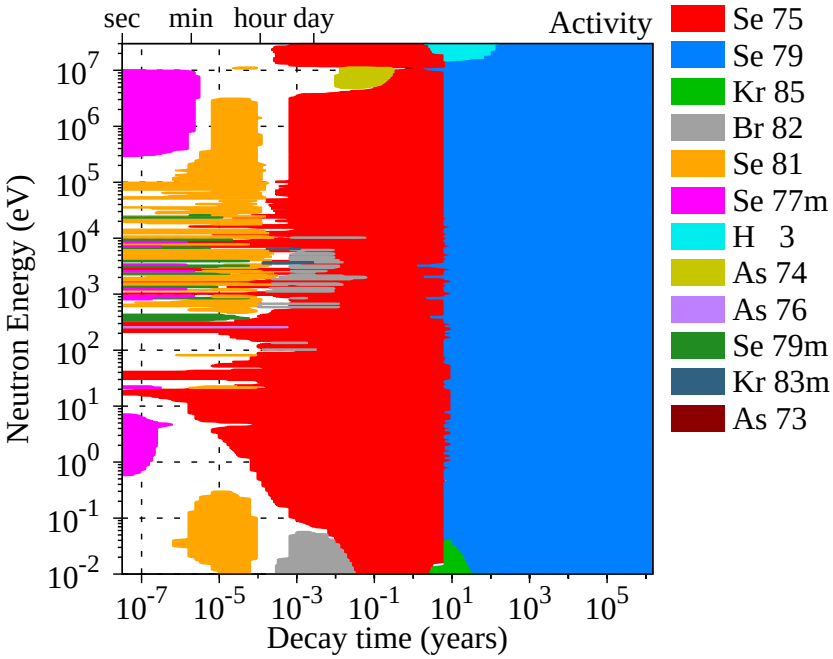
γ Dose Rate

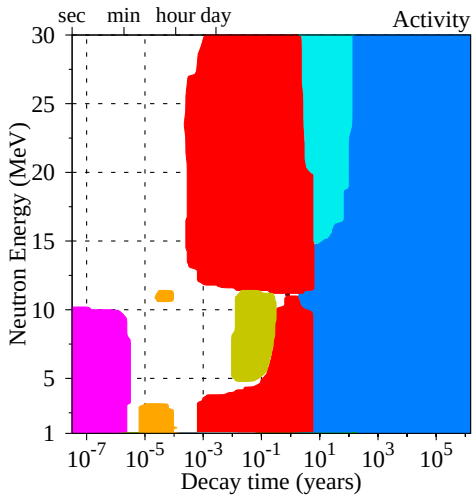


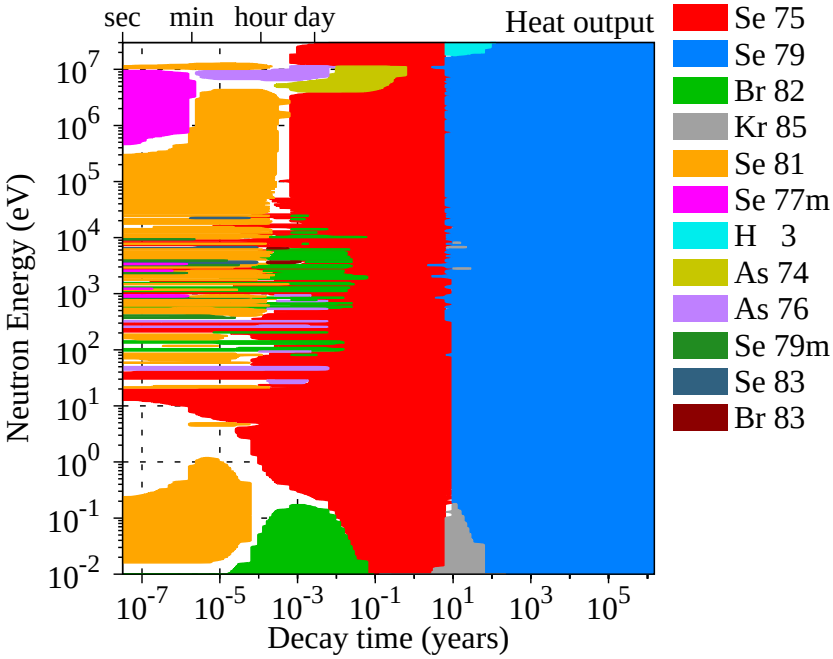


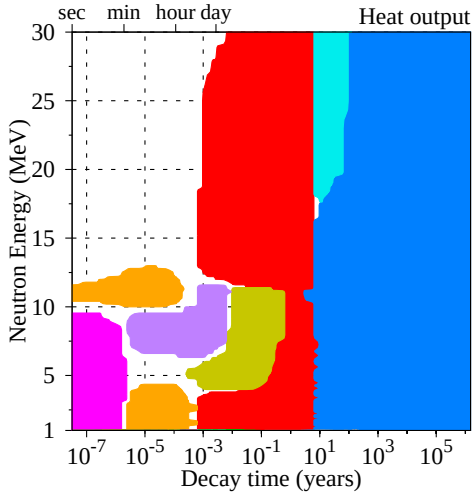
FW
Blanket
Manifold
Fe results

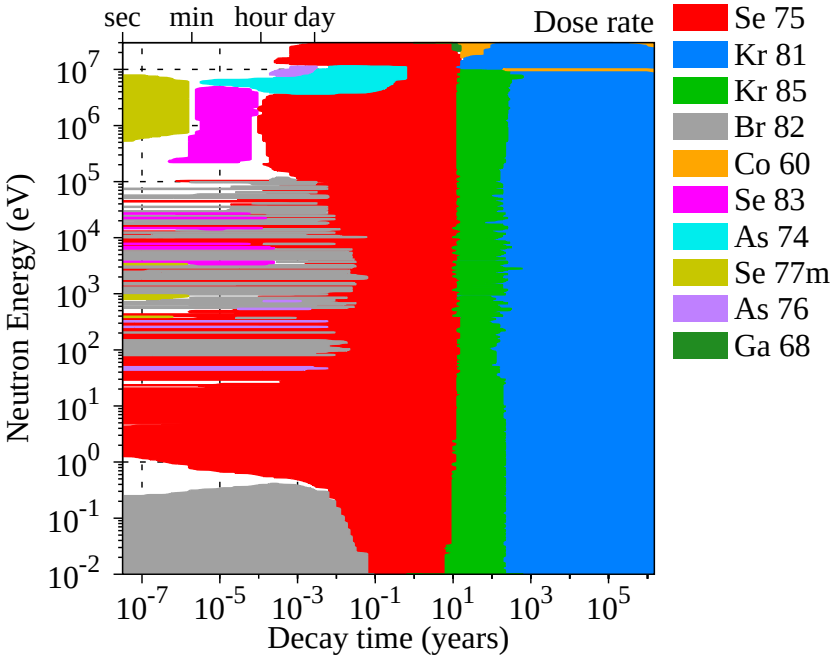
Selenium Importance diagrams

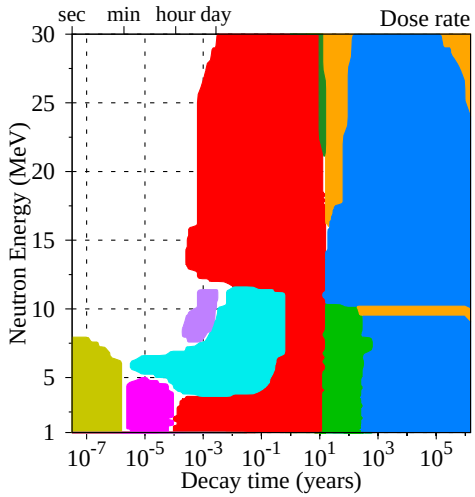




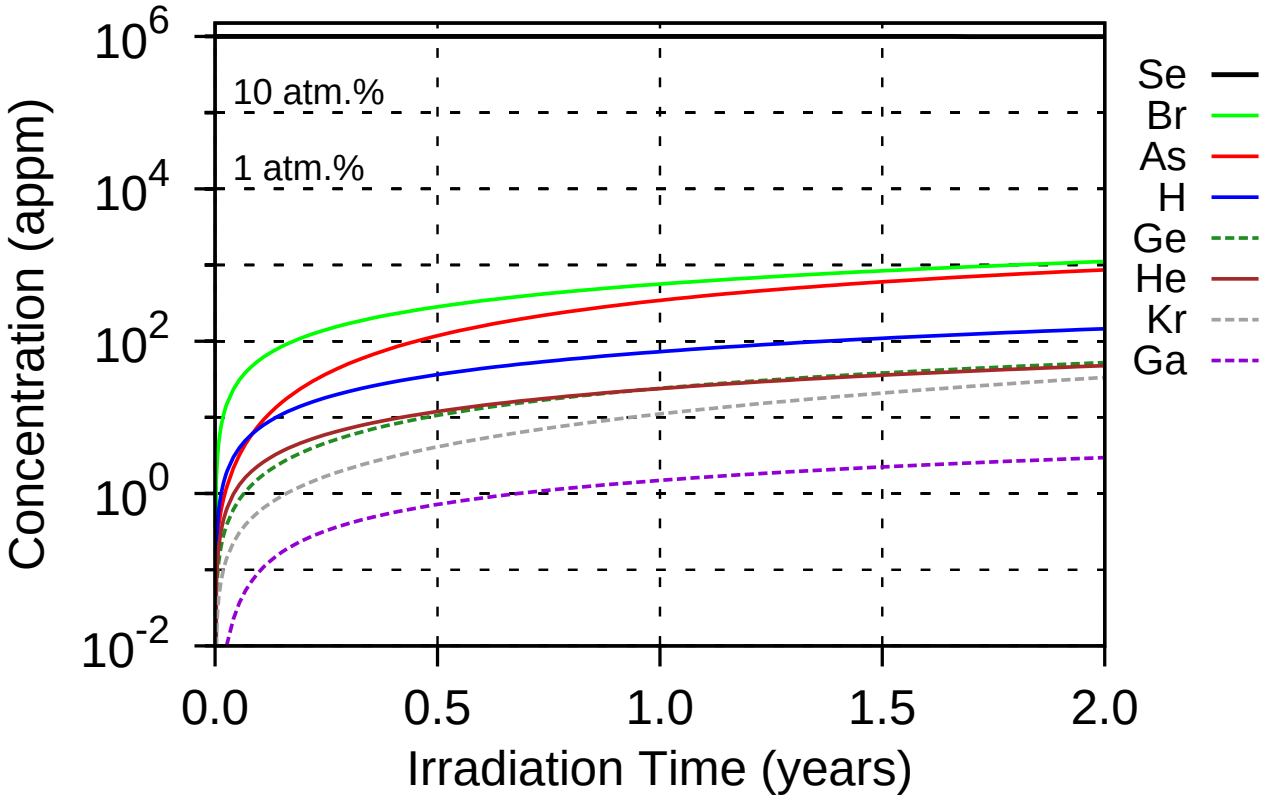




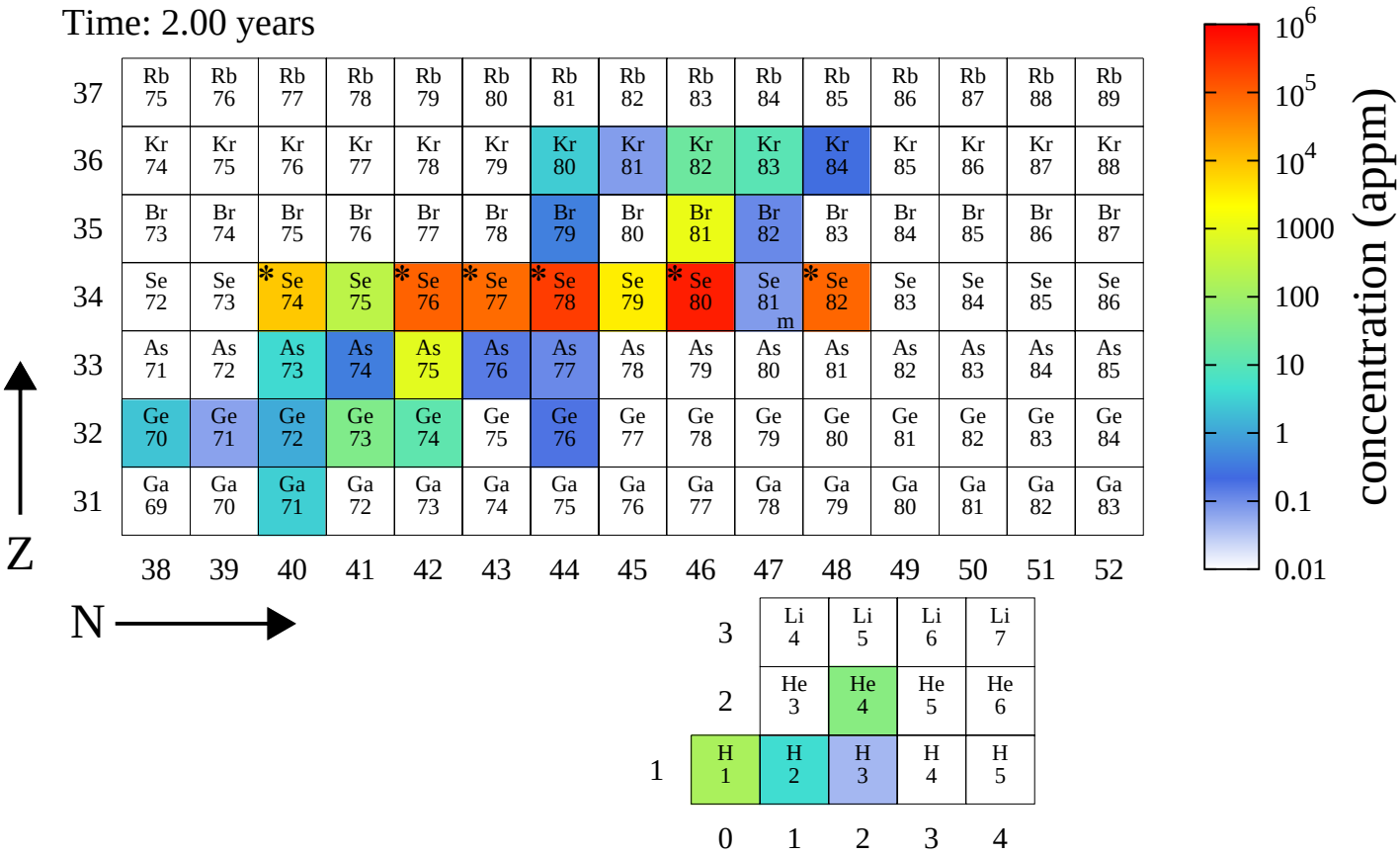




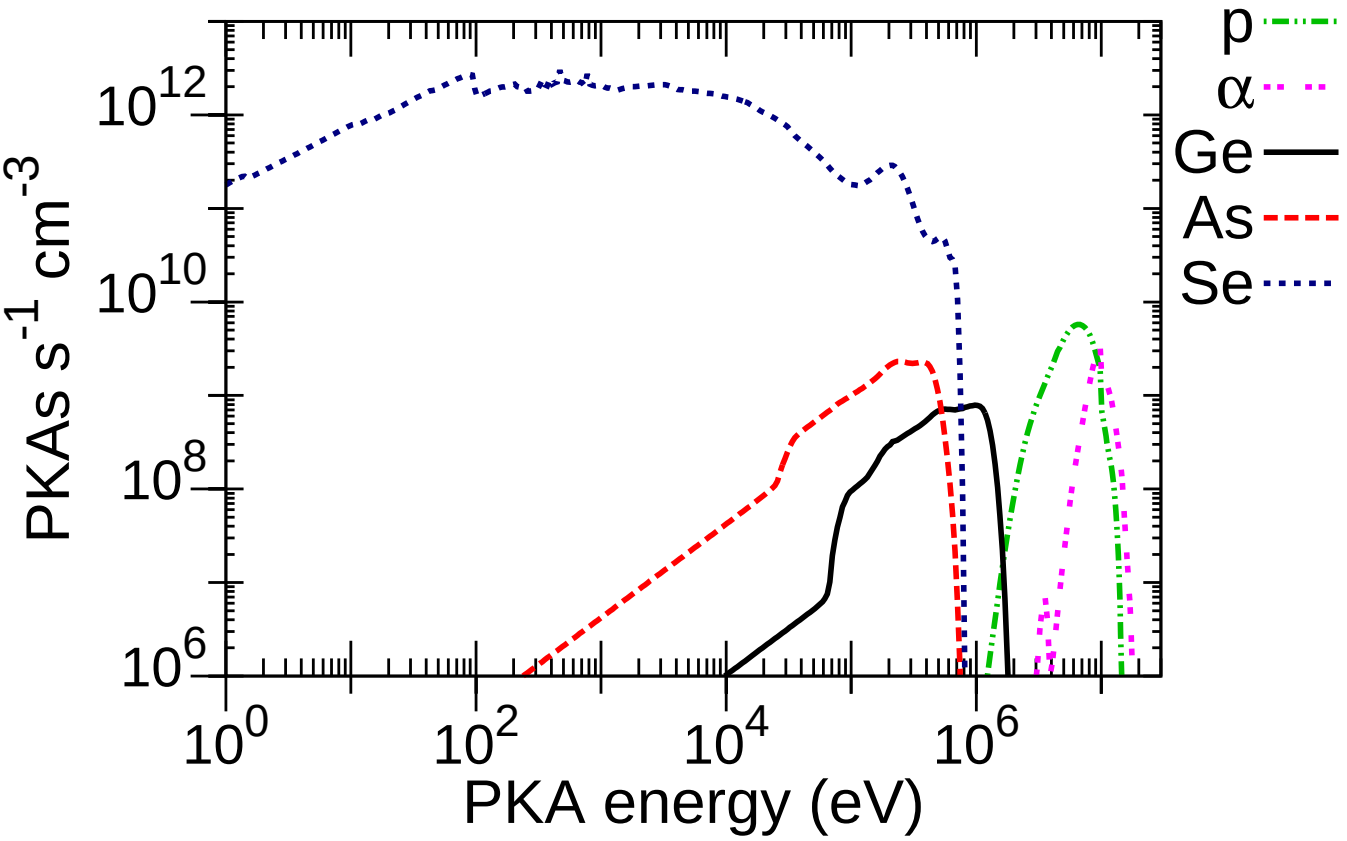
Selenium FW Transmutation

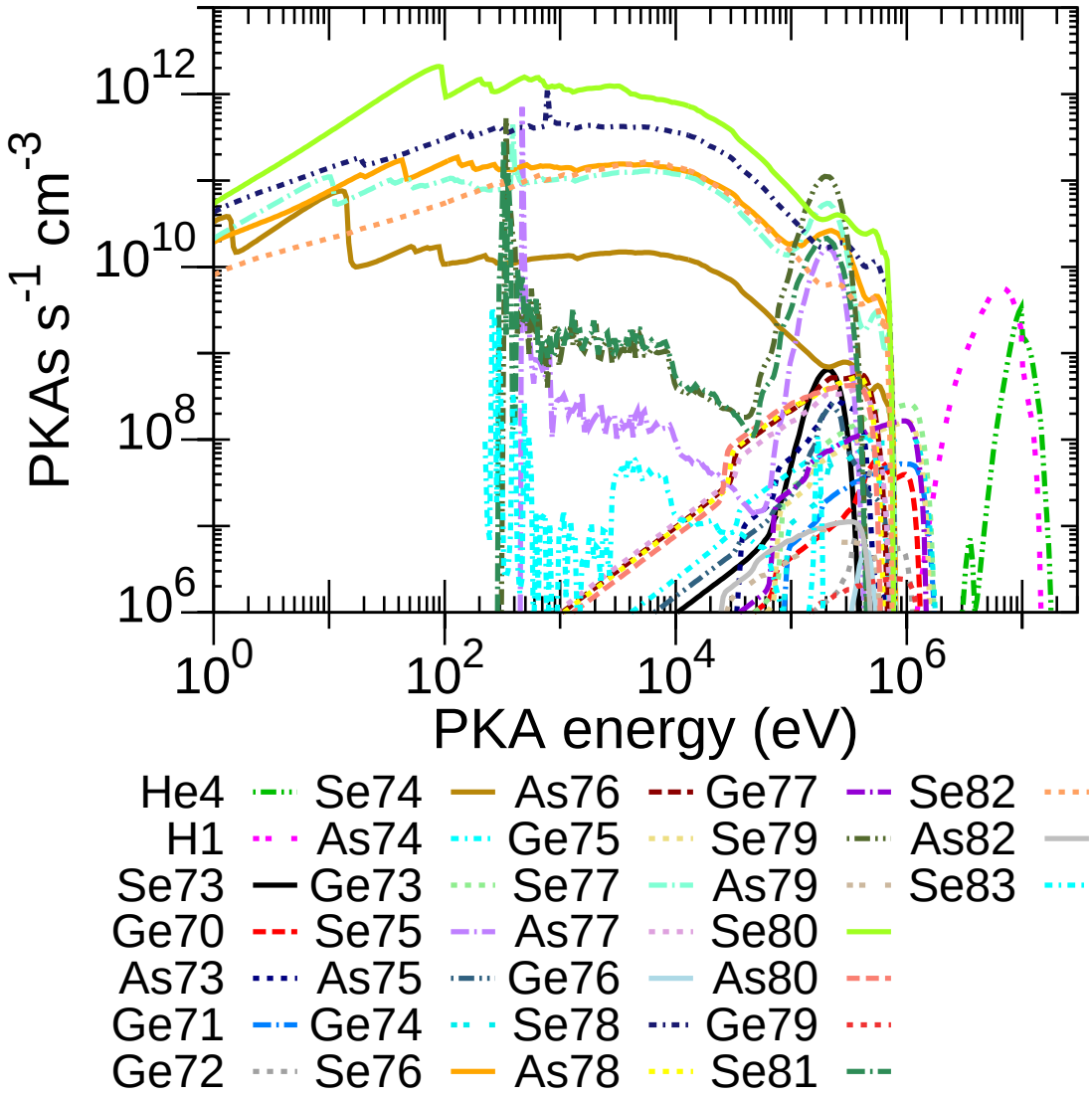


24 appm He & 73 appm H after 1 year 19 dpa/year



Selenium FW PKA distributions





Selenium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
As80	15.20s	Se80(n,p)As80				99.9
Se77m	17.36s	Se76(n,γ)Se77m	53.8	100.0	1.3	
		Se74(n,γ)Se75(n,γ)Se76(n,γ)Se77m	41.6			
		Se74(n,γ)Se75(β^+)As75(n,γ)As76(β^-)Se76(n,γ)Se77m	4.6			
		Se77(n,n′)Se77m			98.6	10.8
		Se78(n,2n)Se77m				87.9
Se83m	1.17m	Se82(n,γ)Se83m	100.0	100.0	100.0	100.0
Se79m	3.90m	Se78(n,γ)Se79m	60.9	99.1	96.9	
		Se77(n,γ)Se78(n,γ)Se79m	17.9			
		Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m	15.0			
		Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m	5.1			
		Se78(n,γ)Se79(n,n′)Se79m			3.1	
		Se80(n,2n)Se79m				97.3
		Se80(n,2n)Se79(n,n′)Se79m				1.2
Se81	18.39m	Se80(n,γ)Se81	73.1	69.3	48.9	
		Se80(n,γ)Se81m(IT)Se81	26.5	30.7	51.1	
		Se82(n,2n)Se81m(IT)Se81				72.6
		Se82(n,2n)Se81				26.4
Se83	22.33m	Se82(n,γ)Se83	100.0	100.0	100.0	100.0
Se81m	57.28m	Se80(n,γ)Se81m	99.6	100.0	100.0	
		Se82(n,2n)Se81m				99.2
Ga68	1.13h	Se74(n,nα)Ge70(n,2n)Ge69(β^+)Ga69(n,2n)Ga68				74.7
		Se74(n,nα)Ge70(n,np)Ga69(n,2n)Ga68				10.0
		Se74(n,np)As73(n,nα)Ga69(n,2n)Ga68				1.8
		Se74(n,α)Ge71(β^+)Ga71(n,2n)Ga70(β^-)Ge70(n,2n)Ge69(β^+) Ga69(n,2n)Ga68				1.7
		Se74(n,2n)Se73(β^+)As73(n,nα)Ga69(n,2n)Ga68				1.3
As78	1.51h	Se74(n,γ)Se75(β^+)As75(n,γ)As76(n,γ)As77(n,γ)As78	99.9	100.0		
		Se77(n,p)As77(n,γ)As78			99.8	
		Se78(n,p)As78				98.1
Kr83m	1.83h	Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m	48.9			
		Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m	17.7			
		Se82(n,γ)Se83(β^-)Br83(β^-)Kr83m	15.0	57.4	70.5	75.4
		Se82(n,γ)Se83m(β^-)Br83(β^-)Kr83m	12.0	42.5	29.5	24.0
		Se80(n,γ)Se81(β^-)Br81(n,γ)Br82(β^-)Kr82(n,γ)Kr83m	2.9			
		Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(β^-)Kr82(n,γ)Kr83m	1.2			
		Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82(β^-) Kr82(n,γ)Kr83m	1.1			
Br83	2.40h	Se82(n,γ)Se83(β^-)Br83	54.2	57.5	70.5	75.7
		Se82(n,γ)Se83m(β^-)Br83	43.5	42.5	29.5	24.1
		Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(n,γ)Br83	1.6			
Se73	7.15h	Se74(n,2n)Se73				59.6
		Se74(n,2n)Se73m(IT)Se73				39.4
Ge77	11.30h	Se74(n,γ)Se75(β^+)As75(n,γ)As76(n,p)Ge76(n,γ)Ge77	74.0	79.5		
		Se74(n,γ)Se75(β^+)As75(n,γ)As76(n,p)Ge76(n,γ) Ge77m(IT)Ge77	21.8	20.2		
		Se77(n,α)Ge74(n,γ)Ge75(n,γ)Ge76(n,γ)Ge77	1.2			
		Se78(n,γ)Se79(n,α)Ge76(n,γ)Ge77			55.2	
		Se78(n,γ)Se79m(IT)Se79(n,α)Ge76(n,γ)Ge77			32.1	
		Se78(n,γ)Se79(n,α)Ge76(n,γ)Ge77m(IT)Ge77			7.4	
		Se78(n,γ)Se79m(IT)Se79(n,α)Ge76(n,γ)Ge77m(IT)Ge77			4.3	
		Se80(n,α)Ge77				94.4
		Se80(n,α)Ge77m(IT)Ge77				5.5
As76	1.09d	Se74(n,γ)Se75(β^+)As75(n,γ)As76	99.9	100.0	100.0	
		Se76(n,p)As76				85.5
		Se77(n,2n)Se76(n,p)As76				5.3
		Se77(n,np)As76				5.2
		Se77(n,d)As76				1.6

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Br82	1.47d	Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82	69.1	63.0	36.9	
		Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82	25.1	27.9	38.6	
		Se80(n,γ)Se81(β^-)Br81(n,γ)Br82	4.1	6.2	11.9	
		Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82	1.5	2.8	12.5	
		Se82(n,2n)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82				43.2
		Se82(n,2n)Se81m(IT)Se81(β^-)Br81(n,γ)Br82				29.3
		Se82(n,2n)Se81(β^-)Br81(n,γ)Br82m(IT)Br82				15.8
		Se82(n,2n)Se81(β^-)Br81(n,γ)Br82				10.7
As77	1.62d	Se74(n,γ)Se75(β^+)As75(n,γ)As76(n,γ)As77	99.9	100.0		
		Se77(n,p)As77			99.8	56.6
		Se80(n,α)Ge77(β^-)As77				20.5
		Se78(n,2n)Se77m(IT)Se77(n,p)As77				7.2
		Se80(n,α)Ge77m(β^-)As77				5.1
		Se78(n,d)As77				3.1
		Se78(n,2n)Se77(n,p)As77				3.0
		Se78(n,np)As77				2.7
		Se80(n,α)Ge77m(IT)Ge77(β^-)As77				1.2
As74	17.78d	Se74(n,p)As74			100.0	25.8
		Se76(n,2n)Se75(β^+)As75(n,2n)As74				66.8
		Se77(n,2n)Se76(n,2n)Se75(β^+)As75(n,2n)As74				1.7
		Se78(n,α)Ge75m(IT)Ge75(β^-)As75(n,2n)As74				1.3
		Se76(n,np)As75(n,2n)As74				1.2
		Se76(n,2n)Se75(n,np)As74				1.1
As73	80.30d	Se74(n,np)As73				41.0
		Se74(n,2n)Se73(β^+)As73				30.0
		Se74(n,2n)Se73m(IT)Se73(β^+)As73				19.8
		Se74(n,2n)Se73m(β^+)As73				7.5
Se75	119.63d	Se74(n,γ)Se75	100.0	100.0	100.0	
		Se76(n,2n)Se75				94.6
		Se77(n,2n)Se76(n,2n)Se75				4.6
Co60	5.27y	Se74(n,nα)Ge70(n,nα)Zn66(n,α)Ni63(β^-)Cu63(n,α) Co60m(IT)Co60				11.4
		Se74(n,nα)Ge70(n,nα)Zn66(n,α)Ni63(β^-)Cu63(n,α)Co60				9.4
		Se74(n,nα)Ge70(n,α)Zn67(n,nα)Ni63(β^-)Cu63(n,α) Co60m(IT)Co60				3.0
		Se74(n,nα)Ge70(n,α)Zn67(n,nα)Ni63(β^-)Cu63(n,α)Co60				2.4
Kr85	10.75y	Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ) Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	10.2			
		Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ) Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	8.8			
		Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ) Kr83(n,γ)Kr84(n,γ)Kr85	4.0			
		Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	3.7			
		Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ) Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	3.5			
		Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	3.2			
		Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85	1.5			
		Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	1.3			
		Se82(n,γ)Se83(β^-)Br83(β^-)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85			59.5	69.1
		Se82(n,γ)Se83m(β^-)Br83(β^-)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85			24.9	22.0
		Se82(n,γ)Se83(β^-)Br83(β^-)Kr83m(IT)Kr83(n,γ)Kr84(n,γ) Kr85m(IT)Kr85			10.6	6.5
		Se82(n,γ)Se83m(β^-)Br83(β^-)Kr83m(IT)Kr83(n,γ)Kr84(n,γ) Kr85m(IT)Kr85			4.4	2.1

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
H3	12.33y	Se74(n,γ)Se75(n,p)H1(n,γ)H2(n,γ)H3	100.0			
		Se77(n,p)H1(n,γ)H2(n,γ)H3			88.7	
		Se74(n,p)H1(n,γ)H2(n,γ)H3			10.6	
		Se77(n,t)H3				81.0
		Se80(n,2n)Se79(n,t)H3				6.2
		Se78(n,2n)Se77m(IT)Se77(n,t)H3				5.2
		Se78(n,2n)Se77(n,t)H3				2.2
		Se80(n,2n)Se79m(IT)Se79(n,t)H3				1.3
Kr81	2.1 10^5y	Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	46.0	58.6	53.4	
		Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ) Kr81m(IT)Kr81	20.6	20.3	9.8	
		Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80m(IT)Br80(β^-) Kr80(n,γ)Kr81	9.6	15.3	30.1	
		Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-) Kr80(n,γ)Kr81	6.4			
		Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ) Kr81m(IT)Kr81	4.3	5.3	5.5	
		Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-) Kr80(n,γ)Kr81	3.3			
		Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-)Kr80(n,γ) Kr81m(IT)Kr81	2.9			
		Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80(β^-) Kr80(n,γ)Kr81m(IT)Kr81	1.5			
		Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ)Br80m(IT)Br80(β^-) Kr80(n,γ)Kr81	1.3			
		Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(β^-)Br79(n,γ) Br80(β^-)Kr80(n,γ)Kr81	1.1			
		Se82(n,2n)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,2n)Kr81				14.9
		Se82(n,γ)Se83(β^-)Br83(β^-)Kr83m(IT)Kr83(n,2n) Kr82(n,2n)Kr81				11.8
		Se82(n,2n)Se81m(IT)Se81(β^-)Br81(n,γ)Br82(β^-) Kr82(n,2n)Kr81				10.1
		Se82(n,2n)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,2n)Kr81				5.4
		Se82(n,γ)Se83m(β^-)Br83(β^-)Kr83m(IT)Kr83(n,2n) Kr82(n,2n)Kr81				3.8
		Se82(n,2n)Se81(β^-)Br81(n,γ)Br82(β^-)Kr82(n,2n)Kr81				3.7
		Se82(n,2n)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-) Kr82(n,2n)Kr81m(IT)Kr81				2.6
		Se82(n,γ)Se83(β^-)Br83(β^-)Kr83m(IT)Kr83(n,2n)Kr82(n,2n) Kr81m(IT)Kr81				2.1
		Se82(n,2n)Se81m(IT)Se81(β^-)Br81(n,γ)Br82(β^-)Kr82(n,2n) Kr81m(IT)Kr81				1.8
		Se82(n,2n)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,2n) Kr81m(IT)Kr81				1.0
Se79	3.8 10^5y	Se78(n,γ)Se79m(IT)Se79	41.0	53.5	36.5	
		Se78(n,γ)Se79	29.5	46.1	62.6	
		Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	8.7			
		Se77(n,γ)Se78(n,γ)Se79	6.3			
		Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	6.0			
		Se76(n,γ)Se77(n,γ)Se78(n,γ)Se79	4.3			
		Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79m(IT)Se79	2.1			
		Se76(n,γ)Se77m(IT)Se77(n,γ)Se78(n,γ)Se79	1.5			
		Se80(n,2n)Se79				82.8
		Se80(n,2n)Se79m(IT)Se79				16.9

Bromine

Isotope	Atom % abundance
Br79	50.69
Br81	49.31

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	4.02E+15	3.13E+15	9.62E+13	7.41E+09	3.44E+08	3.12E+08
Br80	47.5	52.5				
Br82	13.1	16.8	98.3			
Br82m	12.5	8.8				
Br80m	12.4	15.7				
Br78	6.6	4.8				
Br79m	6.1					
Kr79	0.2	0.2	1.2			
H3				75.1	6.6	
Se75				20.5		
Kr81				3.4	73.4	78.3
Se79				0.9	20.0	21.7

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	5.93E-01	5.09E-01	4.23E-02	1.05E-07	1.12E-09	1.07E-09
Br80	41.3	41.5				
Br82	39.6	46.1	99.6			
Br78	14.8	9.8				
Br79m	1.4					
Br80m	1.2	1.3				
Br82m	1.1	0.7				
Se75				93.9		
H3				4.8	1.9	
Se79				0.6	51.9	53.3
Kr81				0.5	46.2	46.7

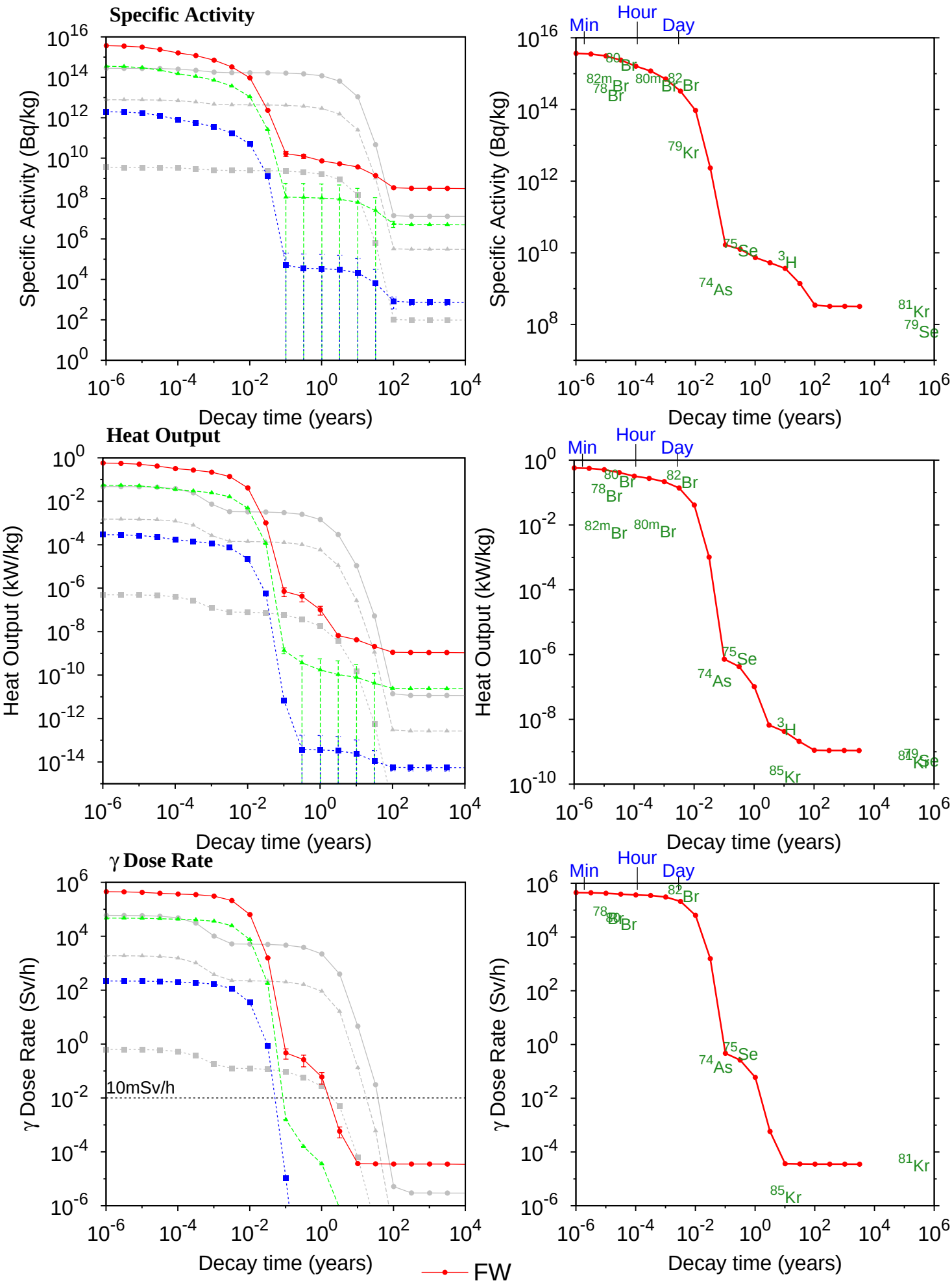
Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	4.59E+05	4.25E+05	6.52E+04	6.20E-02	3.54E-05	3.42E-05
Br82	78.9	85.2	99.8			
Br78	12.5	7.7				
Br80	7.2	6.7				
Se75				99.9		
Kr81				0.1	100.0	100.0

Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.86E+06	5.23E+06	5.29E+05	2.51E+01	1.59E+01	1.54E+01
Br78	50.6	37.7				
Kr79	39.4	51.5	90.2			
Br82	4.2	5.4	9.7			
Br82m	3.5	2.5				
Br80m	0.8	1.0				
Kr81				62.3	98.7	98.7
Kr85				20.3	0.1	
Se75				15.7		
Se79				0.8	1.3	1.3

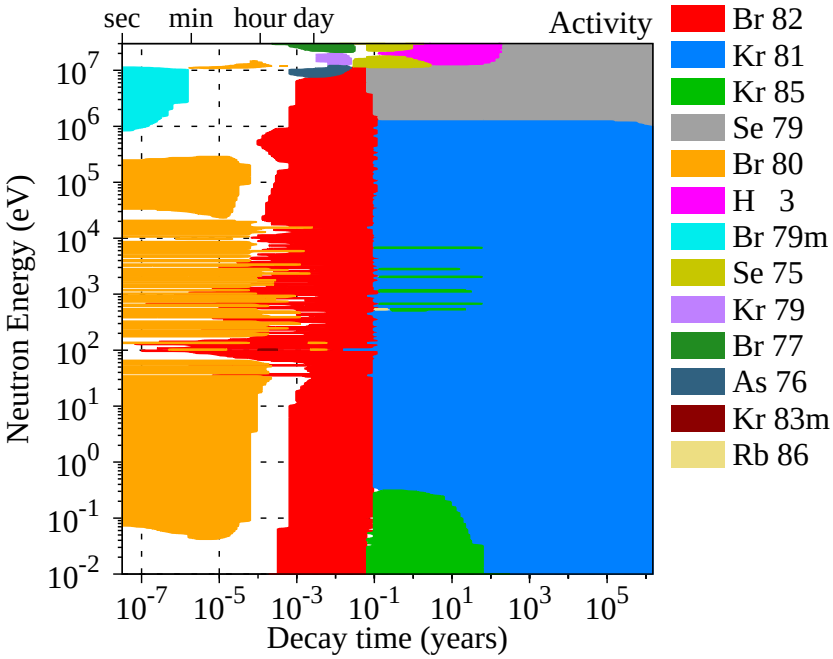
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.10E+06	4.25E+06	3.11E+05	7.36E+02	5.56E+02	5.38E+02
Br78	65.5	53.6				
Kr79	23.2	33.3	80.5			
Br82	5.4	7.8	19.2			
Br82m	4.4	3.5				
Kr81			0.2	75.5	99.9	99.9
Kr85			0.1	23.9	0.1	

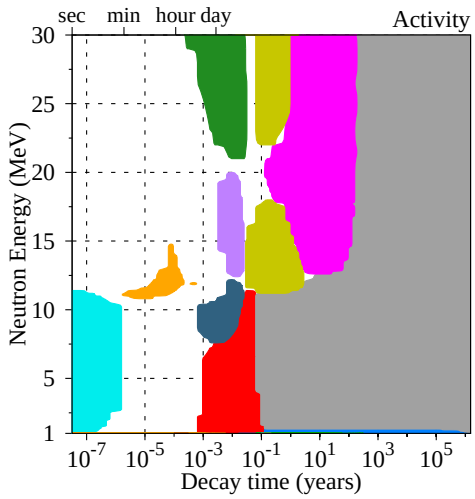
Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.19E+12	9.69E+11	9.49E+10	1.58E+06	2.53E+03	2.24E+03
Br82	44.4	54.3	99.6			
Br78	25.5	17.8				
Br80	24.0	25.3				
Br79m	3.4					
Br80m	1.3	1.5				
Se75				96.3		
H3				3.5	9.0	
Kr81				0.1	76.7	84.1
Se79					14.3	15.9

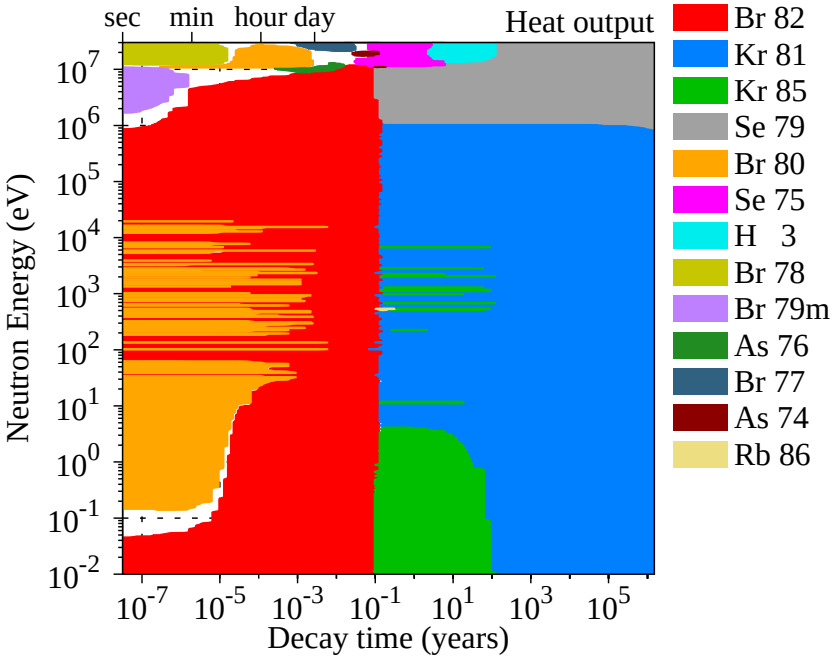
Bromine activation characteristics

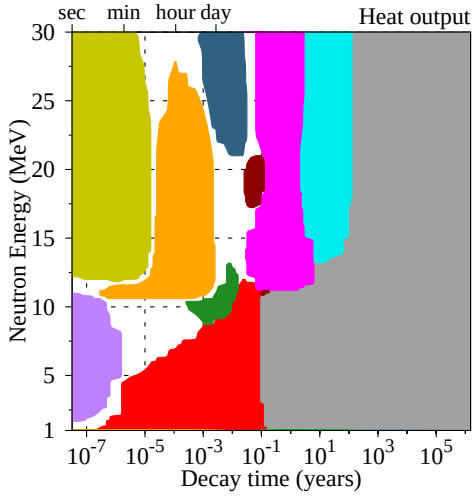


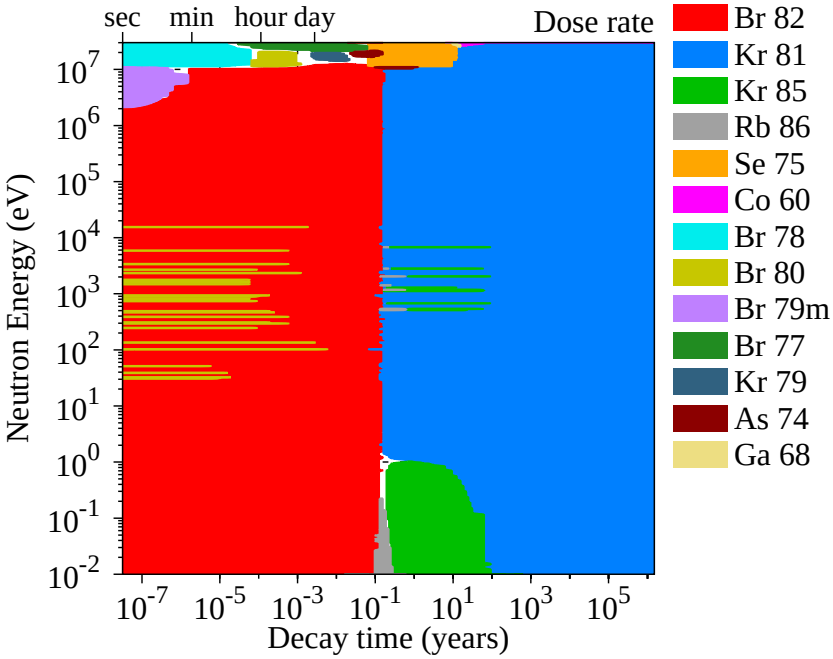
Bromine Importance diagrams

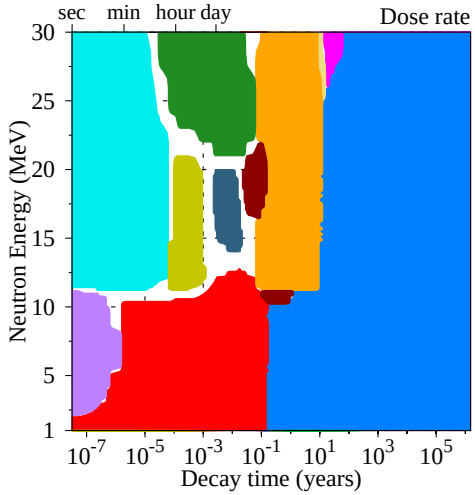




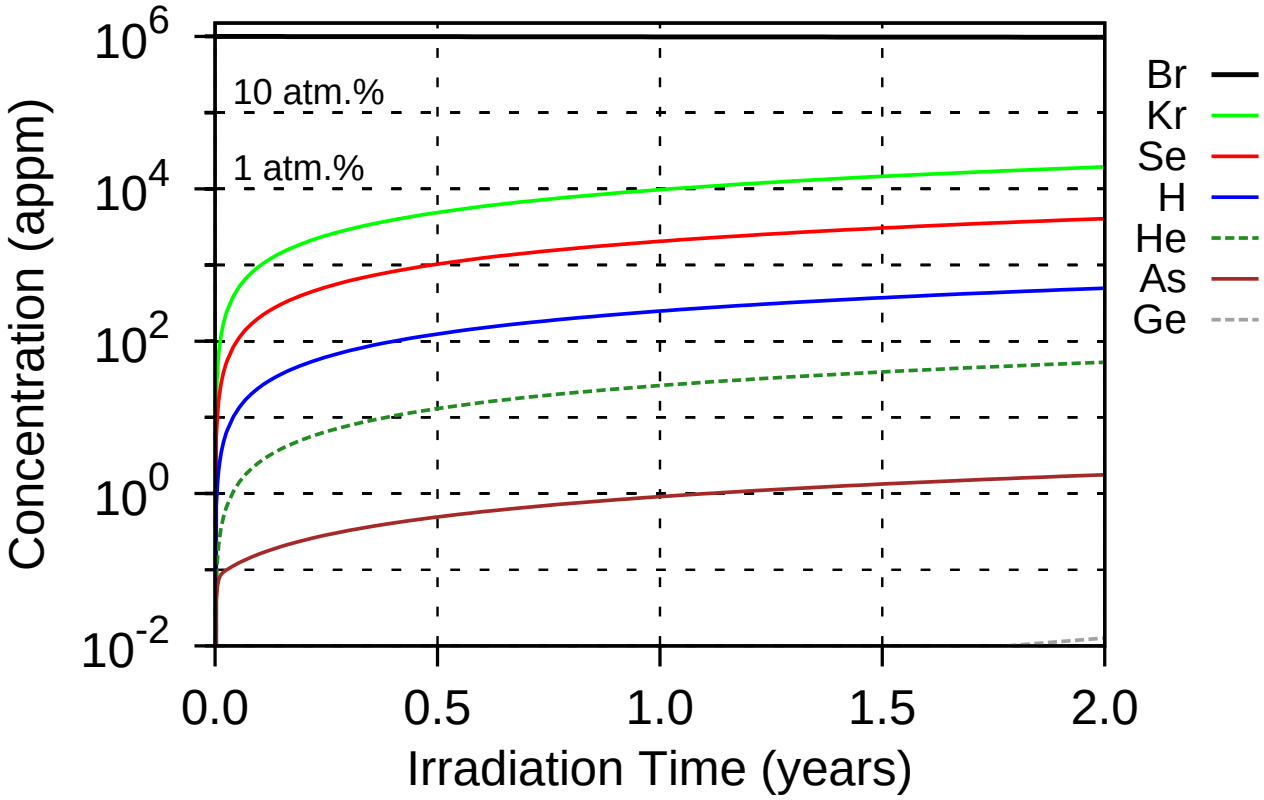




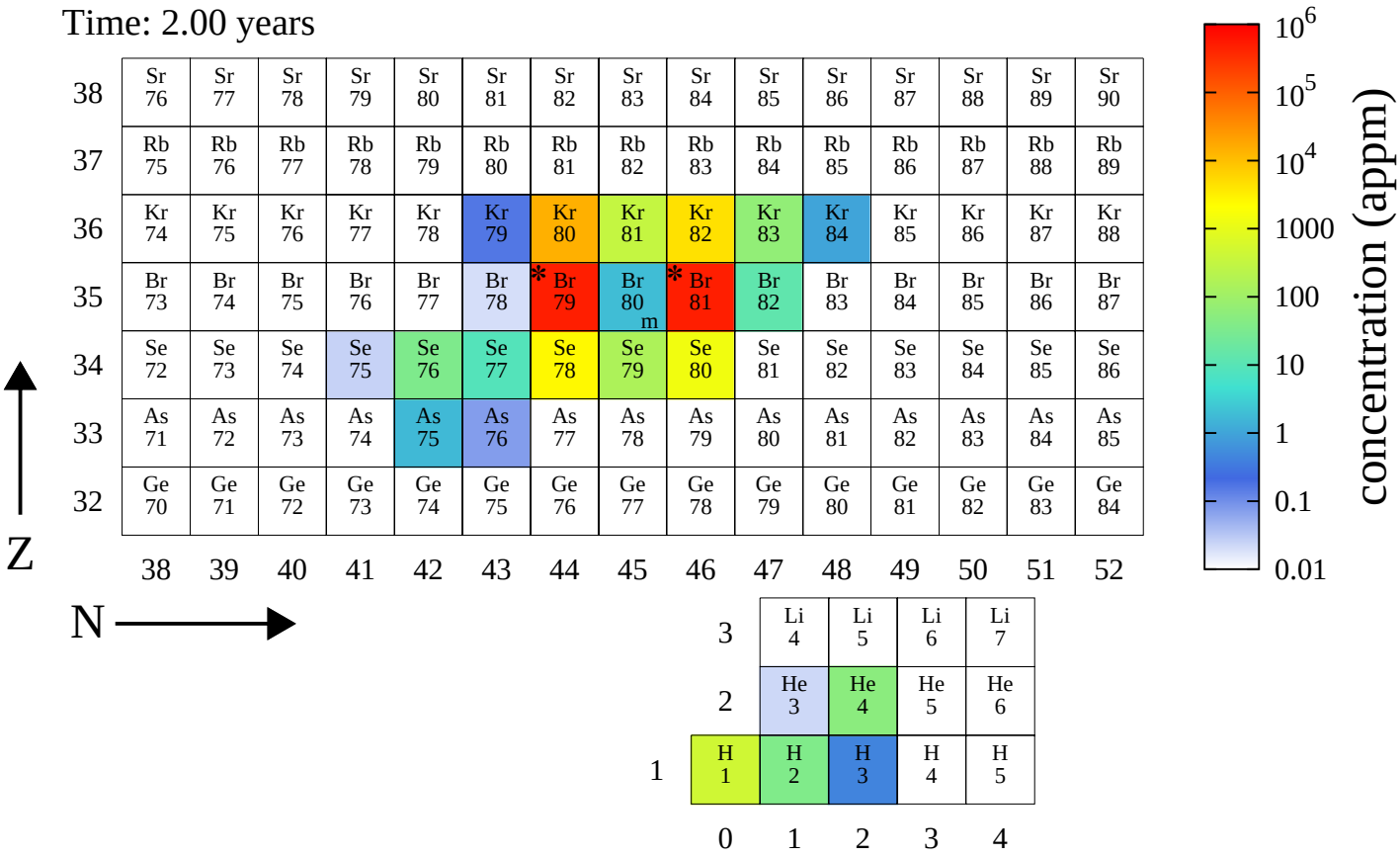




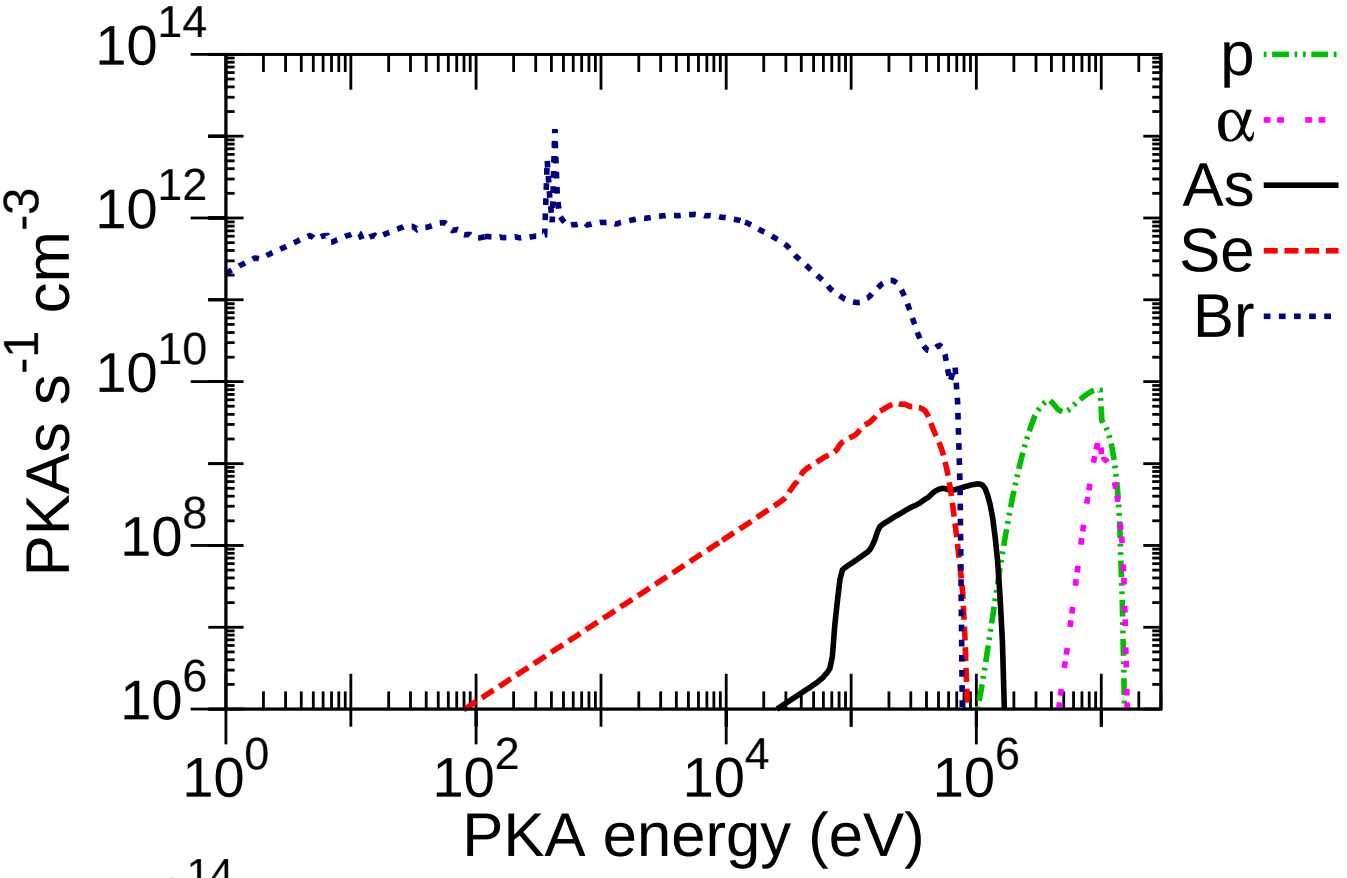
Bromine FW Transmutation

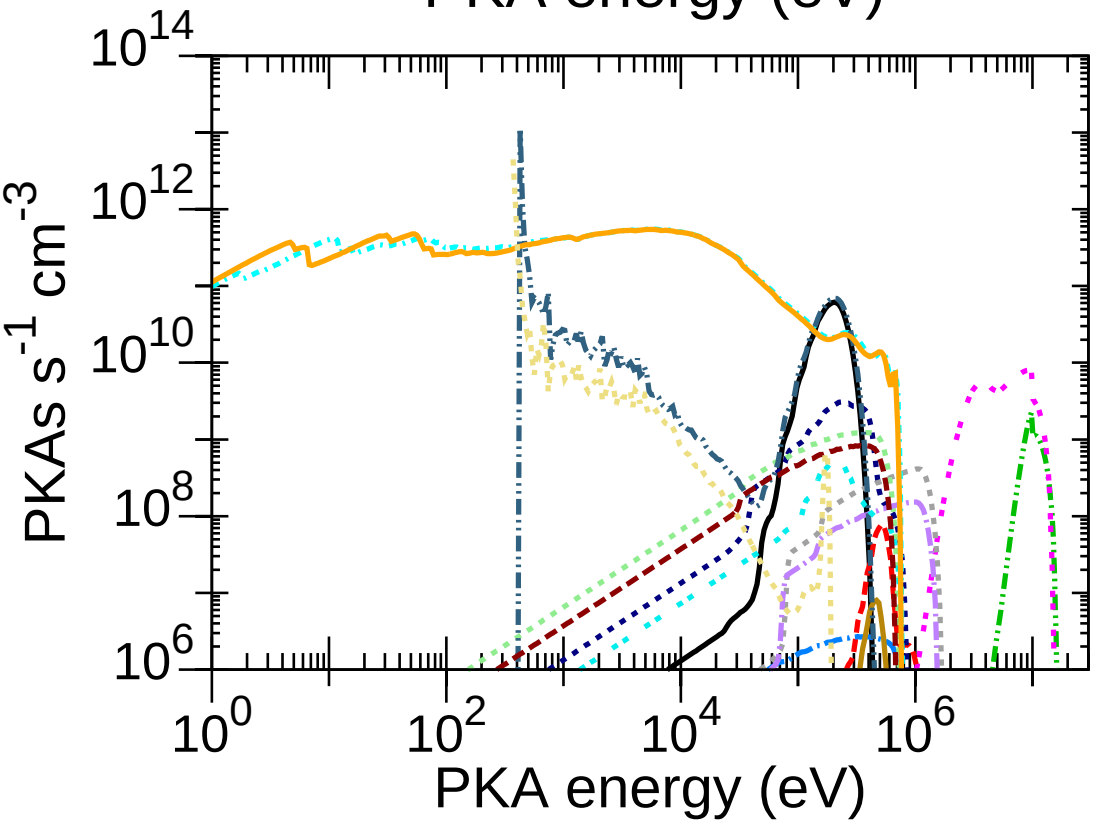


26 appm He & 248 appm H after 1 year 17 dpa/year



Bromine FW PKA distributions





He4	Se78	Br79	Se80
H1	Se77	Se79	Br81
Br78	As76	As78	Se81
As75	As77	Br80	Br82

Bromine Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Br79m	4.86s	Br79(n,n′)Br79m			100.0	99.7
Br82m	6.09m	Br81(n,γ)Br82m	99.9	100.0	100.0	99.6
Br78	6.46m	Br79(n,2n)Br78				99.9
Br80	17.60m	Br79(n,γ)Br80	82.7	79.3	63.9	
		Br79(n,γ)Br80m(IT)Br80	17.3	20.7	36.0	
		Br81(n,2n)Br80m(IT)Br80				63.3
		Br81(n,2n)Br80				35.9
Ga68	1.13h	no pathways found				
Kr83m	1.83h	Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ)Kr83m	66.7	86.0	71.9	
		Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81(n,γ)Kr82(n,γ)Kr83m	15.6			
		Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81(n,γ) Kr82(n,γ)Kr83m	7.0			
		Br81(n,γ)Br82(β^-)Kr82(n,γ)Kr83m	4.0	8.5	23.2	
		Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81(n,γ) Kr82(n,γ)Kr83m	3.3			
		Br81(n,γ)Br82m(β^-)Kr82(n,γ)Kr83m	1.6	2.1	1.8	
		Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81(n,γ) Kr82(n,γ)Kr83m	1.5			
		Br81(n,γ)Br82m(IT)Br82(n,γ)Br83(β^-)Kr83m		3.0	1.1	
Br80m	4.41h	Br79(n,γ)Br80m	100.0	100.0	100.0	
		Br81(n,2n)Br80m				99.1
As76	1.09d	Br79(n,α)As76			100.0	99.4
Kr79	1.46d	Br81(n,2n)Br80m(IT)Br80(β^-)Kr80(n,2n)Kr79				33.6
		Br81(n,2n)Br80m(IT)Br80(β^-)Kr80(n,2n)Kr79m(IT)Kr79				29.9
		Br81(n,2n)Br80(β^-)Kr80(n,2n)Kr79				19.1
		Br81(n,2n)Br80(β^-)Kr80(n,2n)Kr79m(IT)Kr79				17.0
Br82	1.47d	Br81(n,γ)Br82m(IT)Br82	94.3	91.0	75.6	59.4
		Br81(n,γ)Br82	5.6	9.0	24.4	40.2
Br77	2.38d	Br79(n,2n)Br78(n,2n)Br77m(IT)Br77				41.1
		Br79(n,2n)Br78(n,2n)Br77				39.6
		Br81(n,2n)Br80m(IT)Br80(β^-)Kr80(n,2n)Kr79(n,2n) Kr78(n,np)Br77				2.4
		Br81(n,2n)Br80m(IT)Br80(β^-)Kr80(n,2n)Kr79(n,2n) Kr78(n,np)Br77m(IT)Br77				2.4
		Br81(n,2n)Br80m(IT)Br80(β^-)Kr80(n,2n)Kr79m(IT)Kr79(n,2n) Kr78(n,np)Br77				2.2
		Br81(n,2n)Br80m(IT)Br80(β^-)Kr80(n,2n)Kr79m(IT)Kr79(n,2n) Kr78(n,np)Br77m(IT)Br77				2.1
		Br81(n,2n)Br80m(IT)Br80(β^-)Kr80(n,2n)Kr79(n,2n) Kr78(n,2n)Kr77(β^+)Br77				1.5
		Br81(n,2n)Br80(β^-)Kr80(n,2n)Kr79(n,2n)Kr78(n,np)Br77				1.4
		Br81(n,2n)Br80m(IT)Br80(β^-)Kr80(n,2n)Kr79m(IT)Kr79(n,2n) Kr78(n,2n)Kr77(β^+)Br77				1.4
		Br81(n,2n)Br80(β^-)Kr80(n,2n)Kr79(n,2n)Kr78(n,np) Br77m(IT)Br77				1.3
		Br81(n,2n)Br80(β^-)Kr80(n,2n)Kr79m(IT)Kr79(n,2n) Kr78(n,np)Br77				1.2
		Br81(n,2n)Br80(β^-)Kr80(n,2n)Kr79m(IT)Kr79(n,2n) Kr78(n,np)Br77m(IT)Br77				1.2
As74	17.78d	Br79(n,nα)As75(n,2n)As74				62.7
		Br79(n,α)As76(β^-)Se76(n,2n)Se75(β^+)As75(n,2n)As74				16.5
		Br79(n,2n)Br78(β^+)Se78(n,α)Ge75m(IT)Ge75(β^-) As75(n,2n)As74				10.3
		Br79(n,2n)Br78(β^+)Se78(n,α)Ge75(β^-)As75(n,2n)As74				6.5

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Rb86	18.64d	Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85m(β^-)Rb85(n,γ)Rb86	54.8	46.8	19.7	
		Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ)Kr83(n,γ)Kr84(n,γ) Kr85m(β^-)Rb85(n,γ)Rb86	21.8	25.2	24.5	
		Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85m(β^-)Rb85(n,γ)Rb86m(IT)Rb86	3.8	5.3	10.9	
		Br81(n,γ)Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ) Kr85m(β^-)Rb85(n,γ)Rb86	3.3	4.6	6.3	
		Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81(n,γ)Kr82(n,γ)Kr83m(IT) Kr83(n,γ)Kr84(n,γ)Kr85m(β^-)Rb85(n,γ)Rb86	3.3			
		Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ)Kr83(n,γ)Kr84(n,γ) Kr85m(β^-)Rb85(n,γ)Rb86m(IT)Rb86	1.5	2.8	13.6	
		Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81(n,γ)Kr82(n,γ) Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85m(β^-)Rb85(n,γ)Rb86	1.5			
		Br81(n,γ)Br82m(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ) Kr85m(β^-)Rb85(n,γ)Rb86	1.4	1.2		
		Br81(n,γ)Br82(β^-)Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85m(β^-) Rb85(n,γ)Rb86	1.3	2.5	7.9	
		Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81(n,γ)Kr82(n,γ)Kr83(n,γ) Kr84(n,γ)Kr85m(β^-)Rb85(n,γ)Rb86	1.3			
		Br81(n,γ)Br82m(IT)Br82(n,γ)Br83(β^-)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85m(β^-)Rb85(n,γ)Rb86		6.7	1.2	
		Br81(n,γ)Br82(β^-)Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85m(β^-) Rb85(n,γ)Rb86m(IT)Rb86			4.4	
		Br81(n,γ)Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ) Kr85m(β^-)Rb85(n,γ)Rb86m(IT)Rb86			3.5	
Se75	119.63d	Br79(n,α)As76(β^-)Se76(n,2n)Se75				94.7
		Br79(n,2n)Br78(β^+)Se78(n,2n)Se77m(IT)Se77(n,2n) Se76(n,2n)Se75				2.4
		Br79(n,2n)Br78(β^+)Se78(n,2n)Se77(n,2n)Se76(n,2n)Se75				1.0
Co60	5.27y	no pathways found				
Kr85	10.75y	Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85	31.7	32.7	27.2	
		Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85m(IT)Kr85	27.5	20.5	4.9	
		Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ)Kr83(n,γ) Kr84(n,γ)Kr85	12.6	17.6	33.9	
		Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,γ)Kr83(n,γ)Kr84(n,γ) Kr85m(IT)Kr85	10.9	11.0	6.0	
		Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81(n,γ)Kr82(n,γ)Kr83m(IT) Kr83(n,γ)Kr84(n,γ)Kr85	2.0			
		Br81(n,γ)Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85	1.9	3.2	8.8	
		Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81(n,γ)Kr82(n,γ)Kr83m(IT) Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	1.8			
		Br81(n,γ)Br82(β^-)Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ) Kr85m(IT)Kr85	1.6	2.0	1.6	
		Br81(n,γ)Br82m(IT)Br82(n,γ)Br83(β^-)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85		4.5	1.6	
		Br81(n,γ)Br82m(IT)Br82(n,γ)Br83(β^-)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85m(IT)Kr85		2.8		
		Br81(n,γ)Br82(β^-)Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85		1.7	10.9	
		Br81(n,γ)Br82(β^-)Kr82(n,γ)Kr83(n,γ)Kr84(n,γ) Kr85m(IT)Kr85		1.1	2.0	
H3	12.33y	Br79(n,γ)Br80(n,p)H1(n,γ)H2(n,γ)H3	82.6	78.0		
		Br79(n,γ)Br80m(IT)Br80(n,p)H1(n,γ)H2(n,γ)H3	17.2	20.4		
		Br79(n,p)H1(n,γ)H2(n,γ)H3			31.1	
		Br79(n,t)H3				32.1
		Br81(n,t)H3				5.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Kr81	2.1 10^5y	Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81	57.2	58.9	54.1	
		Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	25.6	20.4	9.9	
		Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81	11.9	15.4	30.4	
		Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81	5.3	5.3	5.6	
		Br81(n,2n)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81				29.1
		Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,2n)Kr81				25.2
		Br81(n,γ)Br82(β^-)Kr82(n,2n)Kr81				17.0
		Br81(n,2n)Br80(β^-)Kr80(n,γ)Kr81				16.5
		Br81(n,γ)Br82m(IT)Br82(β^-)Kr82(n,2n)Kr81m(IT)Kr81				4.5
		Br81(n,γ)Br82(β^-)Kr82(n,2n)Kr81m(IT)Kr81				3.0
		Br81(n,2n)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81				2.3
		Br81(n,2n)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81				1.3
Se79	3.8 10^5y	Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81(n,α)Se78(n,γ) Se79m(IT)Se79	32.7			
		Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81(n,α)Se78(n,γ)Se79	23.5			
		Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81(n,α)Se78(n,γ) Se79m(IT)Se79	14.6			
		Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81(n,α) Se78(n,γ)Se79	10.5			
		Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81(n,α)Se78(n,γ) Se79m(IT)Se79	6.8			
		Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81(n,α) Se78(n,γ)Se79	4.9			
		Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81(n,α) Se78(n,γ)Se79m(IT)Se79	3.0			
		Br79(n,γ)Br80m(IT)Br80(β^-)Kr80(n,γ)Kr81m(IT)Kr81(n,α) Se78(n,γ)Se79	2.2			
		Br79(n,p)Se79	1.0	91.8	68.8	78.7
		Br79(n,p)Se79m(IT)Se79		8.1	31.2	15.4
		Br81(n,2n)Br80m(IT)Br80(β^+)Se80(n,2n)Se79				2.6
		Br81(n,2n)Br80(β^+)Se80(n,2n)Se79				1.5

Krypton

Isotope	Atom % abundance
Kr78	0.35
Kr80	2.28
Kr82	11.58
Kr83	11.49
Kr84	57.00
Kr86	17.30

($T_{1/2}$ =1.1 10^{20}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.00E+14	2.61E+14	2.09E+13	1.51E+13	2.65E+10	7.09E+08
Kr83m	51.4	57.2				
Kr85m	20.5	23.2				
Kr81m	7.7					
Kr79	5.5	6.3	14.0			
Kr85	5.4	6.2	77.1	99.9	97.2	
Kr79m	2.0					
Br83	0.9	1.0				
Rb86	0.2	0.2	2.7			
Br77	0.5	0.6	2.5			
Br82	0.7	0.8	1.8			
Rb84	0.1	0.1	1.3			
Kr81					2.8	99.7

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.24E-02	1.03E-02	1.04E-03	5.59E-04	9.54E-07	1.46E-09
Kr85m	32.7	38.6				
Br84m	12.9	8.4				
Kr83m	8.3	9.7				
Br84	7.9	8.4				
Br82	7.4	8.8	15.8			
Kr79	6.0	7.2	12.7			
Kr81m	5.7					
Kr85	4.8	5.7	57.2	99.8	99.8	
Br80	2.8	3.0				
Kr87	2.6	3.0				
Br78	1.6	1.1				
Br83	1.2	1.4				
Kr79m	1.0					
Rb86	0.6	0.7	6.5			
Rb84	0.4	0.5	4.2			
Br77	0.6	0.8	2.6			
Kr81					0.2	98.8
Se79						1.2

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	7.36E+03	5.85E+03	5.21E+02	7.74E+00	1.21E-02	9.72E-05
Br84m	29.7	20.4				
Br82	19.5	24.5	49.3			
Br84	15.5	17.4				
Kr79	11.1	13.9	27.6			
Kr85m	10.3	12.8				
Kr87	3.1	3.7				
Kr81m	2.0					
Br78	1.7	1.2				
Br86	1.7					
Br77	1.2	1.5	5.9			
Kr77	1.0	1.2				
Rb84	0.9	1.1	11.6	0.4		
Rb86	0.2	0.3	3.0			
Kr85	0.1	0.1	1.4	90.6	99.2	
Se75	0.1	0.1	1.1	8.9		
Kr81					0.8	100.0

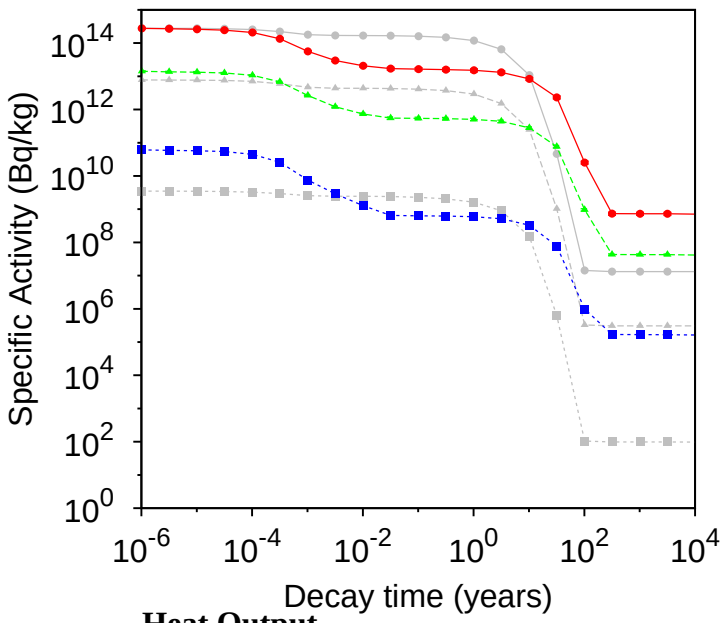
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.98E+07	2.97E+07	1.89E+07	1.66E+07	2.84E+04	4.38E+01
Kr85	59.5	59.8	93.8	100.0	99.8	
Kr79	22.2	22.3	6.2			
Kr85m	15.9	15.7				
Kr83m	1.7	1.6				
Kr81					0.2	100.0

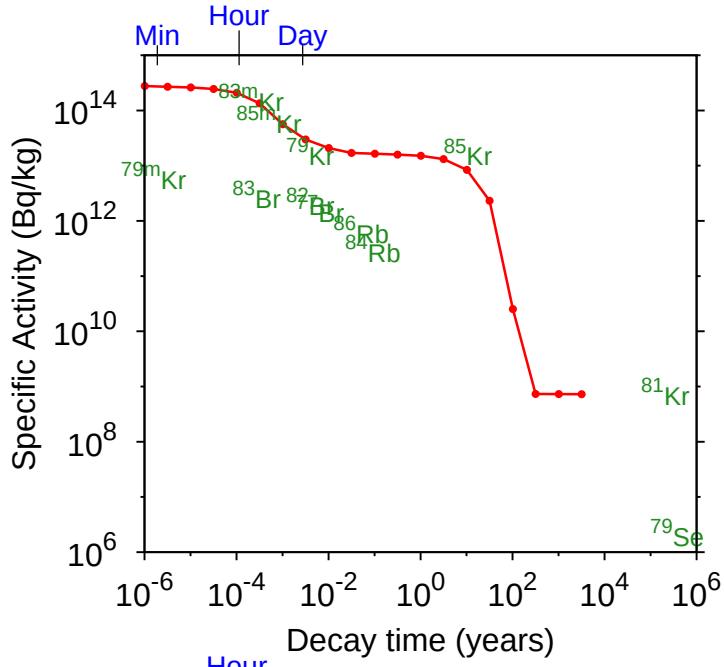
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.19E+08	6.19E+08	6.13E+08	5.74E+08	9.82E+05	1.56E+03
Kr85	99.0	99.0	99.9	100.0	99.8	
Kr81					0.2	100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	3.88E+10	3.02E+10	2.59E+09	8.57E+08	1.44E+06	5.45E+03
Kr85m	28.8	36.4				
Br84m	19.9	14.0				
Kr79	11.2	14.4	29.7			
Br84	9.9	11.3				
Kr81m	8.2					
Br82	5.3	6.8	14.2			
Kr83m	2.7	3.3				
Kr85	2.3	3.0	34.6	98.0	99.6	
Kr87	2.3	2.8				
Br78	1.7	1.3				
Br77	1.3	1.6	6.5			
Kr77	1.1	1.3				
Br80	1.1	1.2				
Br86	1.0					
Rb84	0.7	0.9	9.4			
Se75	0.4	0.5	5.4	2.0		
Kr81					0.4	99.8

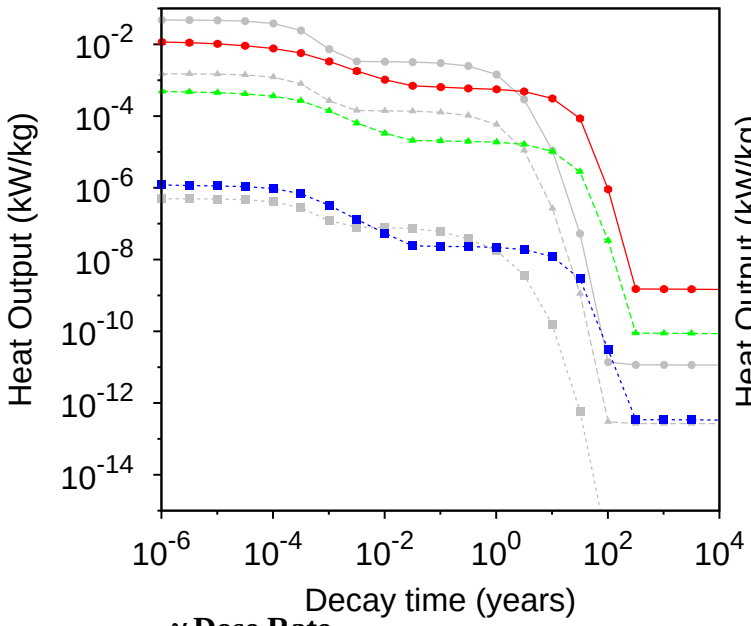
Krypton activation characteristics

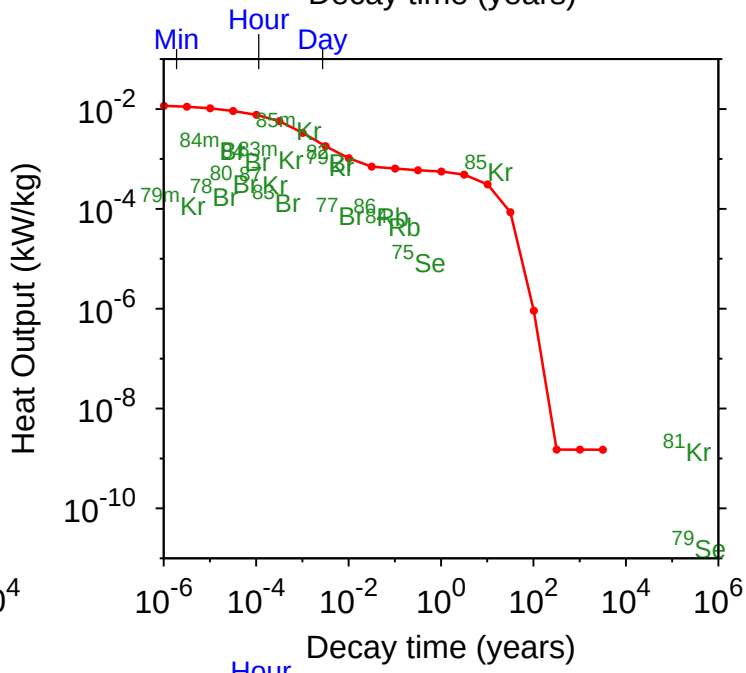
Specific Activity



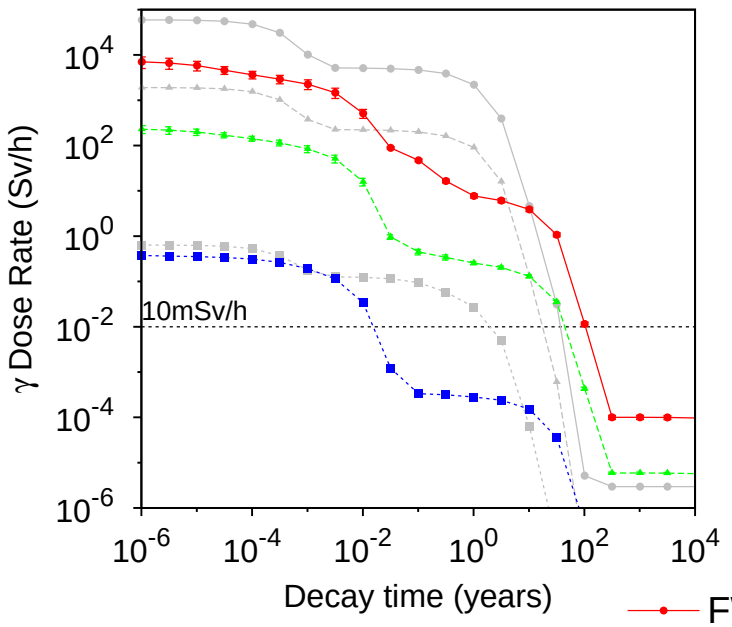


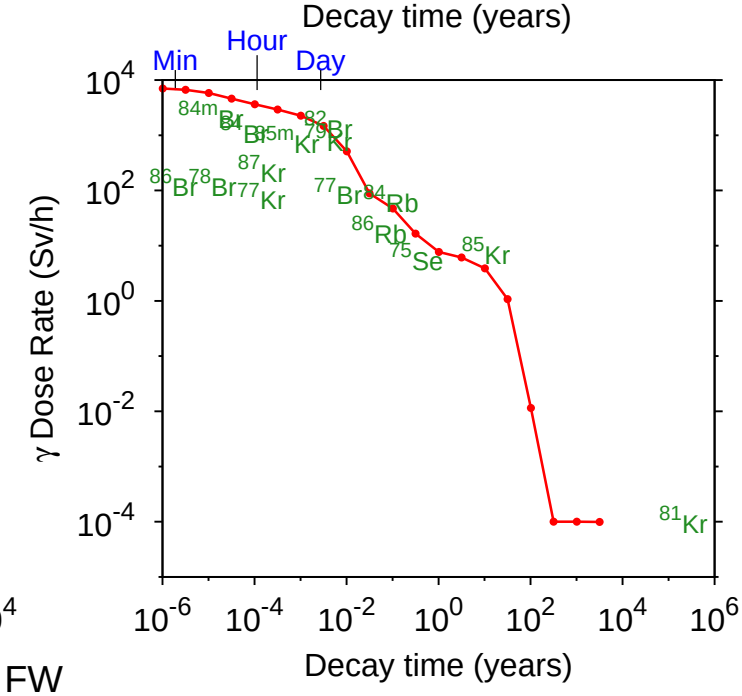
Heat Output





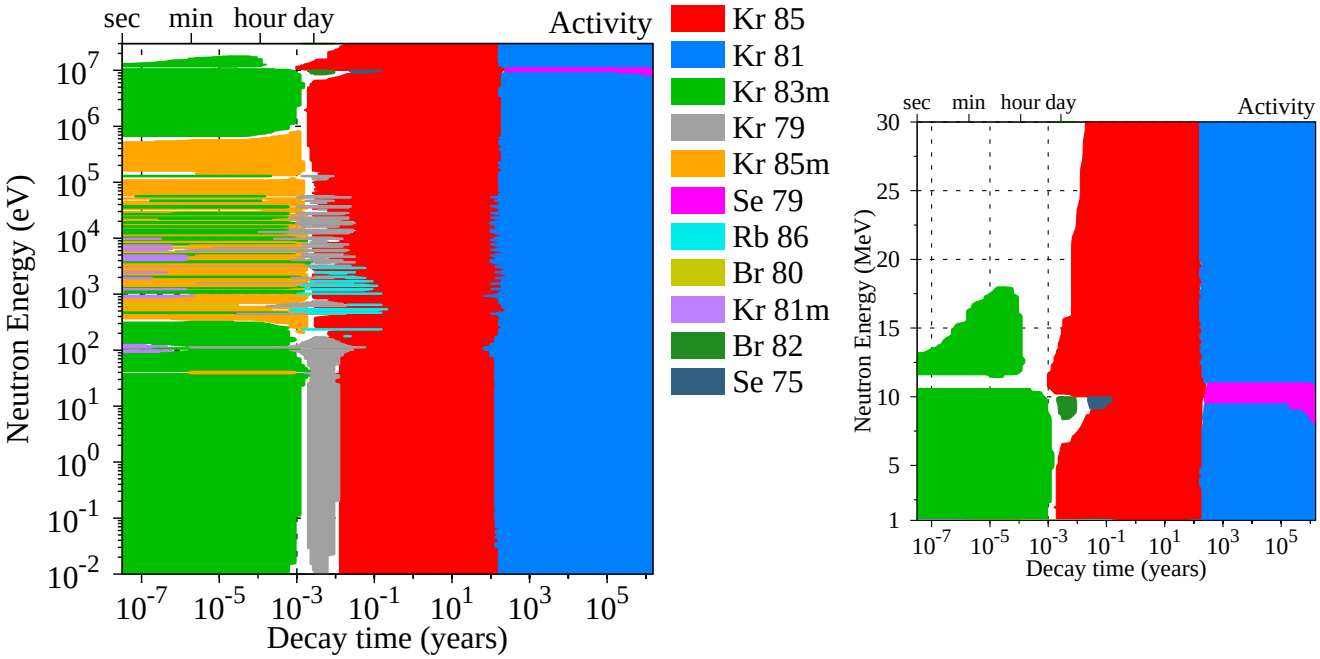
γ Dose Rate

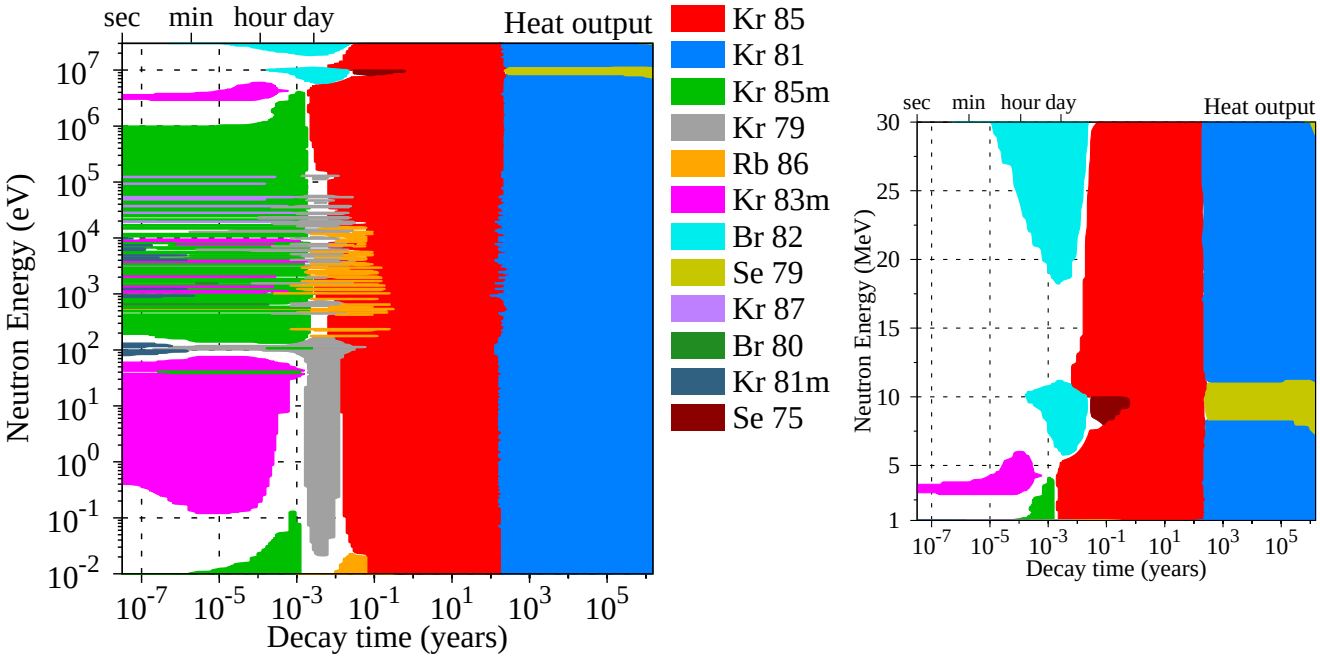


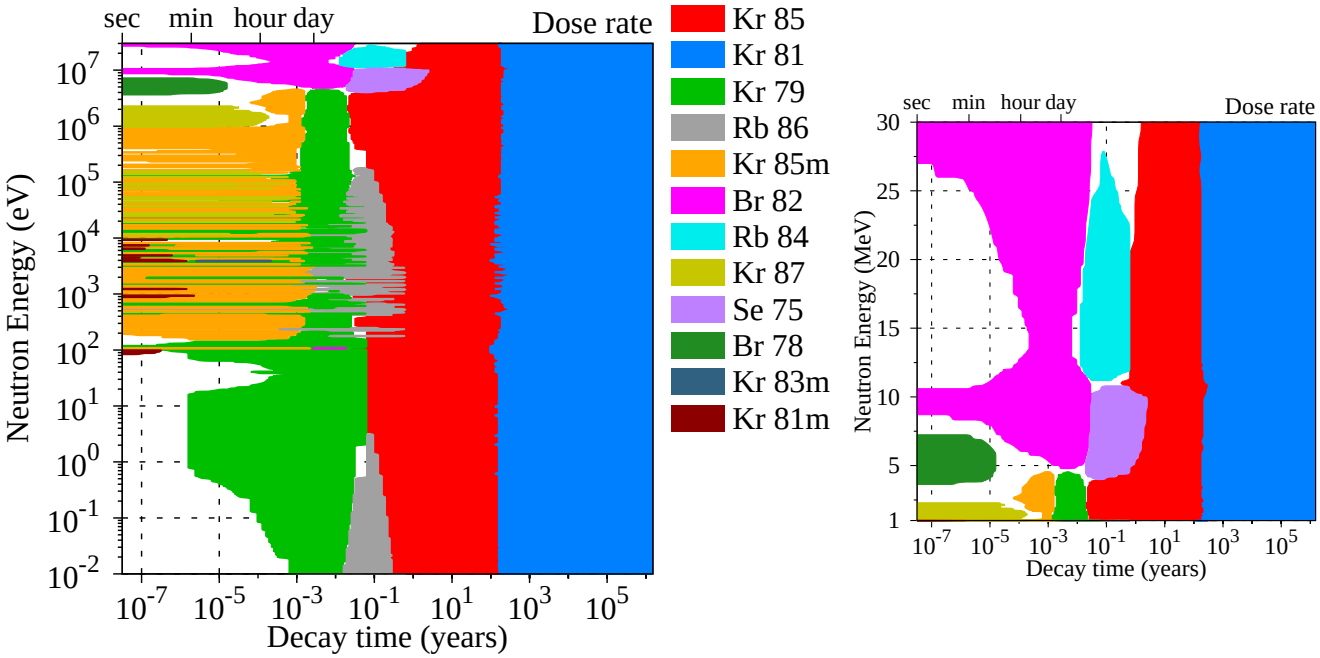


FW
Blanket
Manifold
Fe results

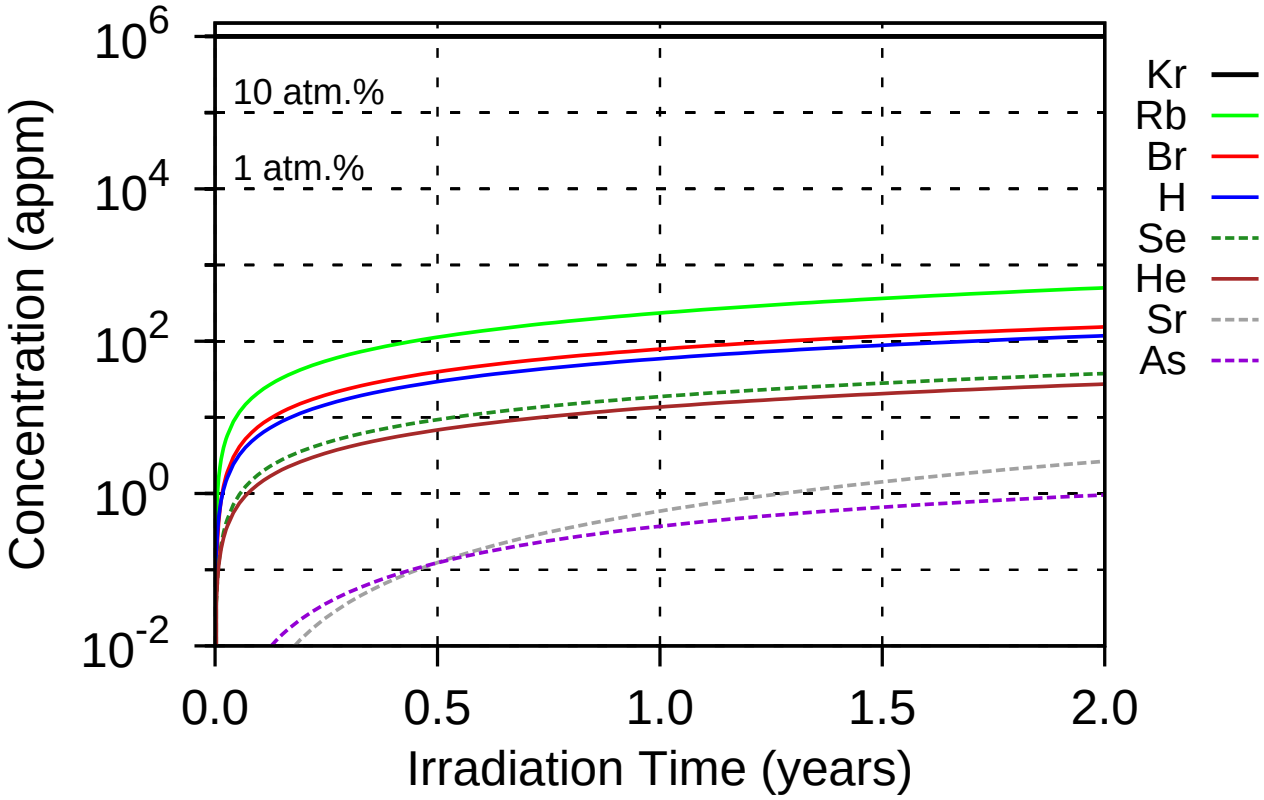
Krypton Importance diagrams



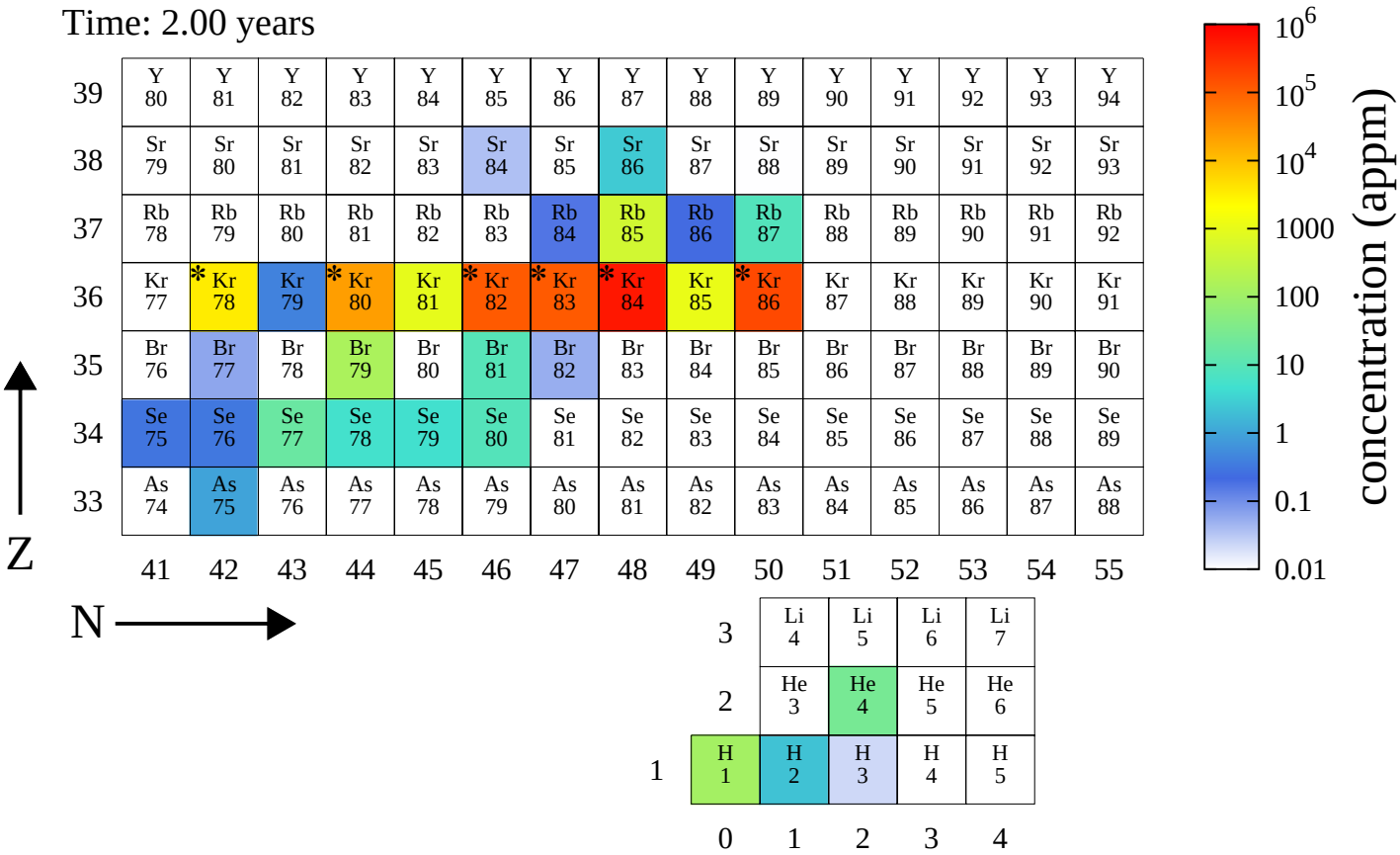




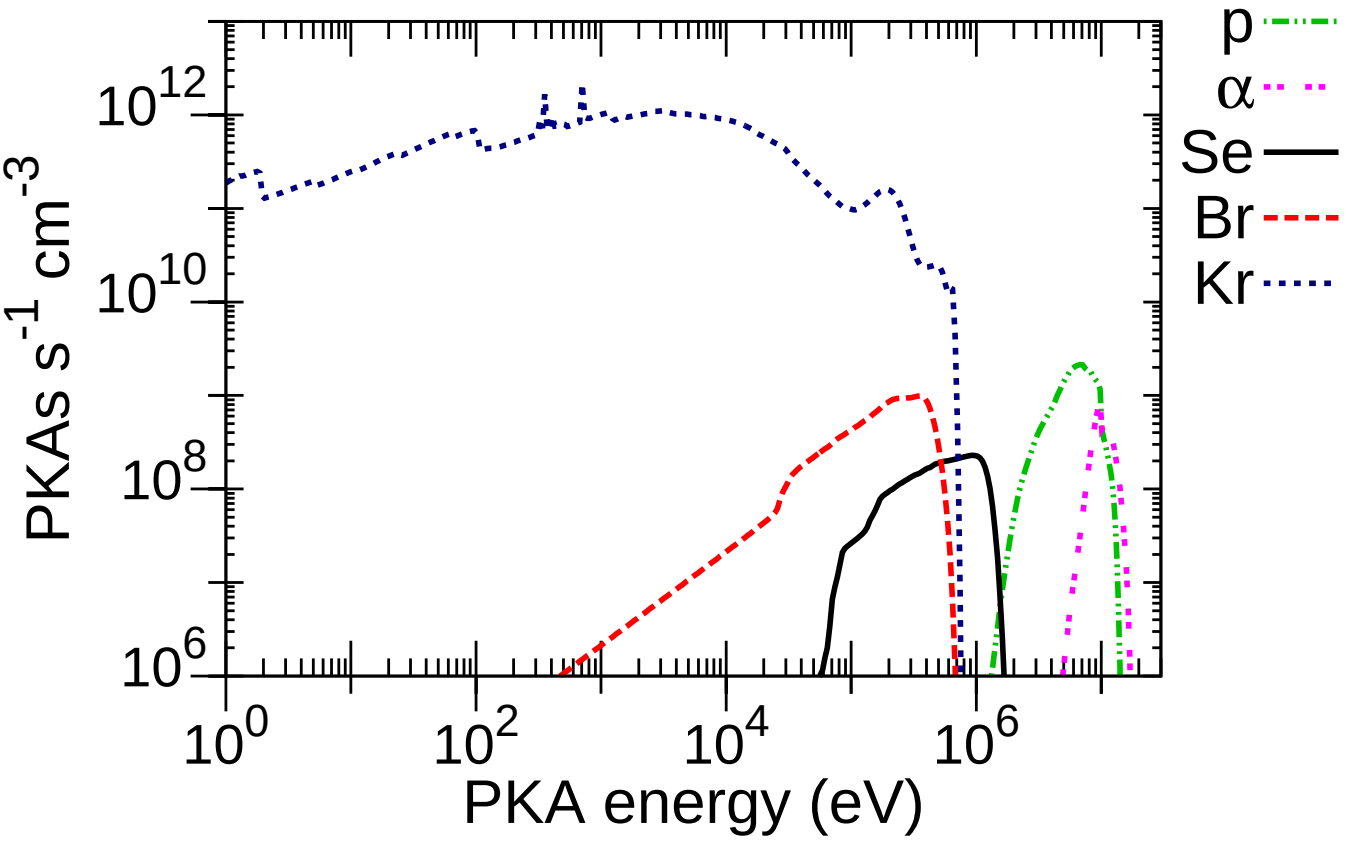
Krypton FW Transmutation

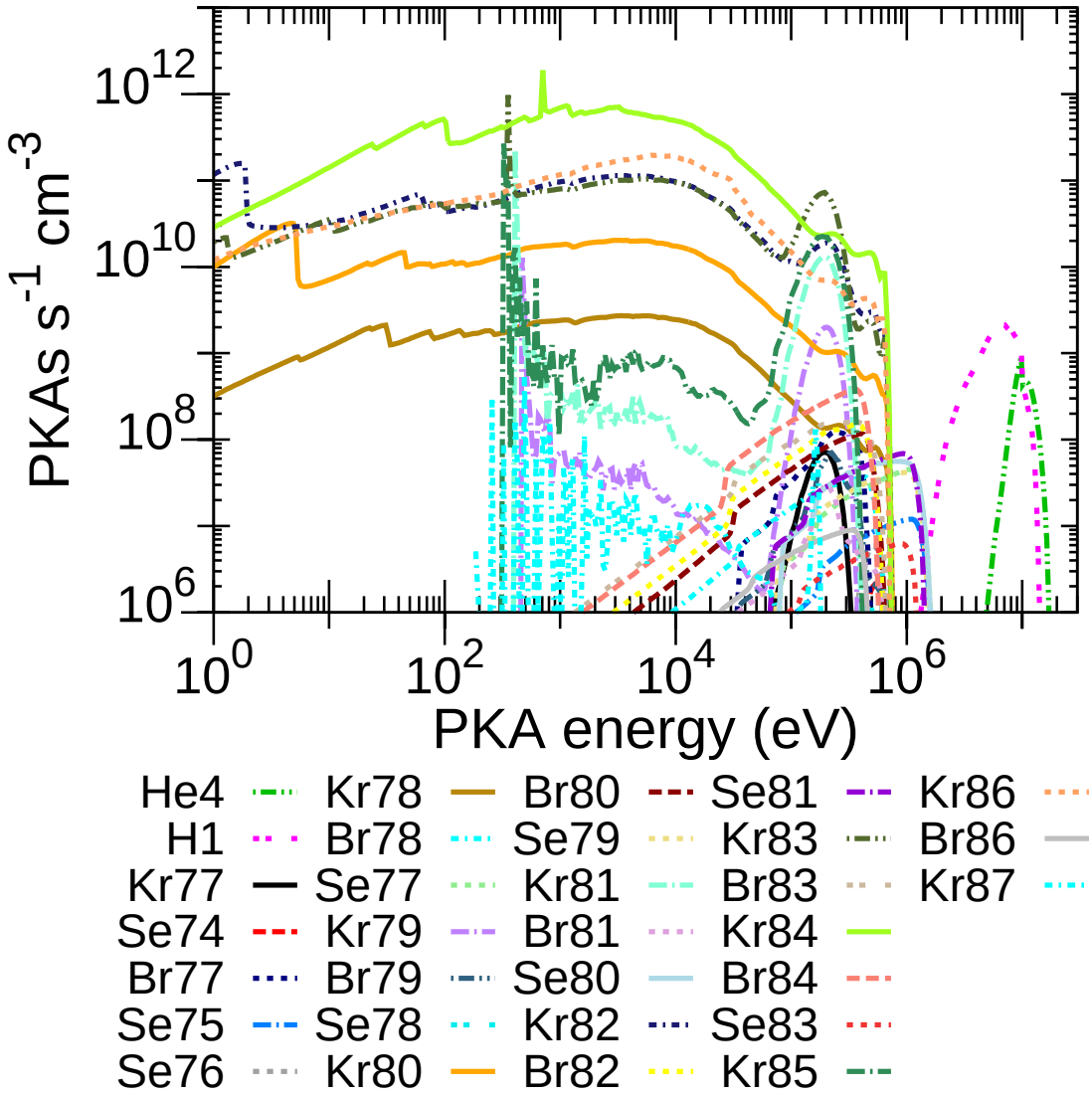


14 appm He & 59 appm H after 1 year 19 dpa/year



Krypton FW PKA distributions





Krypton Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Kr81m	13.20s	Kr80(n,γ)Kr81m	98.3	100.0	90.1	
		Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80(β^-)Kr80(n,γ)Kr81m	1.1			
		Kr80(n,γ)Kr81(n,n$'$)Kr81m			9.9	
		Kr82(n,2n)Kr81m				90.4
		Kr83(n,2n)Kr82(n,2n)Kr81m				6.4
		Kr82(n,2n)Kr81(n,n$'$)Kr81m				1.6
Kr79m	50.01s	Kr78(n,γ)Kr79m	100.0	100.0	100.0	
		Kr80(n,2n)Kr79m				98.4
Br86	55.01s	Kr86(n,p)Br86				100.0
Br84m	6.00m	Kr83(n,p)Br83(n,γ)Br84m			99.9	
		Kr84(n,p)Br84m				99.8
Br78	6.46m	Kr78(n,p)Br78			100.0	45.7
		Kr80(n,2n)Kr79(β^+)Br79(n,2n)Br78				27.4
		Kr80(n,2n)Kr79m(IT)Kr79(β^+)Br79(n,2n)Br78				24.4
		Kr80(n,np)Br79(n,2n)Br78				1.1
Br80	17.60m	Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80	67.0	60.3	34.9	
		Kr78(n,γ)Kr79m(IT)Kr79(β^+)Br79(n,γ)Br80	15.7	18.9	21.7	
		Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80m(IT)Br80	14.0	15.8	19.6	
		Kr78(n,γ)Kr79m(IT)Kr79(β^+)Br79(n,γ)Br80m(IT)Br80	3.3	4.9	12.2	
		Kr80(n,p)Br80			8.7	26.2
		Kr80(n,p)Br80m(IT)Br80			2.2	63.3
		Kr82(n,2n)Kr81(n,np)Br80m(IT)Br80				1.7
		Kr84(n,α)Se81m(IT)Se81(β^-)Br81(n,2n)Br80m(IT)Br80				1.3
		Kr82(n,2n)Kr81(n,np)Br80				1.2
Br84	31.80m	Kr80(n,γ)Kr81m(β^+)Br81(n,γ)Br82m(IT)Br82(n,γ) Br83(n,γ)Br84	17.8			
		Kr80(n,γ)Kr81(β^+)Br81(n,γ)Br82m(IT)Br82(n,γ) Br83(n,γ)Br84	4.2			
		Kr80(n,γ)Kr81m(IT)Kr81(β^+)Br81(n,γ)Br82m(IT)Br82(n,γ) Br83(n,γ)Br84	1.9			
		Kr80(n,γ)Kr81m(β^+)Br81(n,γ)Br82(n,γ)Br83(n,γ)Br84	1.1			
		Kr83(n,p)Br83(n,γ)Br84			99.9	
		Kr84(n,p)Br84				99.8
Kr77	1.24h	Kr78(n,2n)Kr77				100.0
Kr87	1.27h	Kr86(n,γ)Kr87	100.0	100.0	100.0	99.9
Kr83m	1.83h	Kr82(n,γ)Kr83m	92.3	100.0	2.8	
		Kr80(n,γ)Kr81(n,γ)Kr82(n,γ)Kr83m	5.3			
		Kr80(n,γ)Kr81m(IT)Kr81(n,γ)Kr82(n,γ)Kr83m	2.4			
		Kr83(n,n$'$)Kr83m			97.1	4.3
		Kr84(n,2n)Kr83m				90.3
		Kr83(n,p)Br83(β^-)Kr83m				2.7
		Kr84(n,2n)Kr83(n,n$'$)Kr83m				1.1

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Br83	2.40h	Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80(β^+)Se80(n,γ)Se81(β^-) Br81(n,γ)Br82m(IT)Br82(n,γ)Br83	29.1			
		Kr80(n,γ)Kr81m(β^+)Br81(n,γ)Br82m(IT)Br82(n,γ)Br83	17.8	58.9		
		Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80(β^+)Se80(n,γ)Se81m(IT) Se81(β^-)Br81(n,γ)Br82m(IT)Br82(n,γ)Br83	10.6			
		Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80m(n,γ)Br81(n,γ)Br82m(IT) Br82(n,γ)Br83	7.2			
		Kr78(n,γ)Kr79m(IT)Kr79(β^+)Br79(n,γ)Br80(β^+)Se80(n,γ) Se81(β^-)Br81(n,γ)Br82m(IT)Br82(n,γ)Br83	6.8			
		Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80m(IT)Br80(β^+)Se80(n,γ) Se81(β^-)Br81(n,γ)Br82m(IT)Br82(n,γ)Br83	6.1			
		Kr80(n,γ)Kr81(β^+)Br81(n,γ)Br82m(IT)Br82(n,γ)Br83	4.2	22.1		
		Kr78(n,γ)Kr79m(IT)Kr79(β^+)Br79(n,γ)Br80(β^+)Se80(n,γ) Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(n,γ)Br83	2.5			
		Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80m(IT)Br80(β^+)Se80(n,γ) Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(n,γ)Br83	2.2			
		Kr80(n,γ)Kr81m(IT)Kr81(β^+)Br81(n,γ)Br82m(IT) Br82(n,γ)Br83	1.9	7.7		
		Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80(β^+)Se80(n,γ)Se81(β^-) Br81(n,γ)Br82(n,γ)Br83	1.7			
		Kr78(n,γ)Kr79m(IT)Kr79(β^+)Br79(n,γ)Br80m(n,γ)Br81(n,γ) Br82m(IT)Br82(n,γ)Br83	1.7			
		Kr78(n,γ)Kr79m(IT)Kr79(β^+)Br79(n,γ)Br80m(IT)Br80(β^+) Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82(n,γ)Br83	1.4			
		Kr80(n,γ)Kr81m(β^+)Br81(n,γ)Br82(n,γ)Br83	1.1	5.8		
		Kr80(n,γ)Kr81(β^+)Br81(n,γ)Br82(n,γ)Br83		2.2		
		Kr83(n,p)Br83			99.9	70.7
		Kr84(n,2n)Kr83(n,p)Br83				17.9
		Kr84(n,2n)Kr83m(IT)Kr83(n,p)Br83				4.8
		Kr84(n,np)Br83				2.0
		Kr84(n,d)Br83				1.8
		Kr86(n,α)Se83(β^-)Br83				1.5
Kr85m	4.48h	Kr84(n,γ)Kr85m	75.1	99.5	98.5	
		Kr83(n,γ)Kr84(n,γ)Kr85m	15.1			
		Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85m	6.9			
		Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85m	2.7			
		Kr84(n,γ)Kr85(n,n$'$)Kr85m			1.2	
		Kr86(n,2n)Kr85m				98.3
Kr79	1.46d	Kr78(n,γ)Kr79	81.0	76.1	61.6	
		Kr78(n,γ)Kr79m(IT)Kr79	19.0	23.9	38.4	
		Kr80(n,2n)Kr79				52.1
		Kr80(n,2n)Kr79m(IT)Kr79				46.4

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Br82	1.47d	Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80(β^+)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82	29.2			
		Kr80(n,γ)Kr81m(β^+)Br81(n,γ)Br82m(IT)Br82	17.8	59.0	8.9	
		Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80(β^+)Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82	10.6			
		Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80m(n,γ)Br81(n,γ)Br82m(IT)Br82	7.2			
		Kr78(n,γ)Kr79m(IT)Kr79(β^+)Br79(n,γ)Br80(β^+)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82	6.8			
		Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80m(IT)Br80(β^+)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82	6.1			
		Kr80(n,γ)Kr81(β^+)Br81(n,γ)Br82m(IT)Br82	4.2	22.2	6.2	
		Kr78(n,γ)Kr79m(IT)Kr79(β^+)Br79(n,γ)Br80(β^+)Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82	2.5			
		Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80m(IT)Br80(β^+)Se80(n,γ)Se81m(IT)Se81(β^-)Br81(n,γ)Br82m(IT)Br82	2.2			
		Kr80(n,γ)Kr81m(IT)Kr81(β^+)Br81(n,γ)Br82m(IT)Br82	1.9	7.7	1.1	
		Kr78(n,γ)Kr79(β^+)Br79(n,γ)Br80(β^+)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82	1.7			
		Kr78(n,γ)Kr79m(IT)Kr79(β^+)Br79(n,γ)Br80m(n,γ)Br81(n,γ)Br82m(IT)Br82	1.7			
		Kr78(n,γ)Kr79m(IT)Kr79(β^+)Br79(n,γ)Br80m(IT)Br80(β^+)Se80(n,γ)Se81(β^-)Br81(n,γ)Br82m(IT)Br82	1.4			
		Kr80(n,γ)Kr81m(β^+)Br81(n,γ)Br82	1.1	5.9	2.9	
		Kr80(n,γ)Kr81(β^+)Br81(n,γ)Br82		2.2	2.0	
		Kr80(n,γ)Kr81(n,p)Br81(n,γ)Br82m(IT)Br82			49.4	
		Kr80(n,γ)Kr81(n,p)Br81(n,γ)Br82			15.9	
		Kr80(n,γ)Kr81m(IT)Kr81(n,p)Br81(n,γ)Br82m(IT)Br82			9.0	
		Kr80(n,γ)Kr81m(IT)Kr81(n,p)Br81(n,γ)Br82			2.9	
		Kr82(n,p)Br82m(IT)Br82				50.1
		Kr82(n,p)Br82				35.0
		Kr83(n,2n)Kr82(n,p)Br82m(IT)Br82				3.6
		Kr83(n,2n)Kr82(n,p)Br82				2.5
		Kr83(n,np)Br82				1.8
		Kr83(n,d)Br82m(IT)Br82				1.4
		Kr83(n,d)Br82				1.2
Br77	2.38d	Kr78(n,np)Br77				38.2
		Kr78(n,np)Br77m(IT)Br77				37.1
		Kr78(n,2n)Kr77(β^+)Br77				24.1
Rb86	18.64d	Kr84(n,γ)Kr85m(β^-)Rb85(n,γ)Rb86	72.4	86.0	57.7	
		Kr83(n,γ)Kr84(n,γ)Kr85m(β^-)Rb85(n,γ)Rb86	13.3			
		Kr84(n,γ)Kr85m(β^-)Rb85(n,γ)Rb86m(IT)Rb86	5.0	9.7	32.0	
		Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85m(β^-)Rb85(n,γ)Rb86	3.4			
		Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85m(β^-)Rb85(n,γ)Rb86	1.4			
		Kr84(n,γ)Kr85(β^-)Rb85(n,γ)Rb86	1.3	2.2	5.2	
		Kr84(n,γ)Kr85m(IT)Kr85(β^-)Rb85(n,γ)Rb86	1.1	1.4		
		Kr84(n,γ)Kr85(β^-)Rb85(n,γ)Rb86m(IT)Rb86			2.9	
		Kr86(n,γ)Kr87(β^-)Rb87(n,2n)Rb86				44.5
		Kr86(n,γ)Kr87(β^-)Rb87(n,2n)Rb86m(IT)Rb86				29.7
		Kr86(n,2n)Kr85m(β^-)Rb85(n,γ)Rb86				12.0
		Kr86(n,2n)Kr85m(β^-)Rb85(n,γ)Rb86m(IT)Rb86				7.9
		Kr86(n,2n)Kr85(β^-)Rb85(n,γ)Rb86				3.1
		Kr86(n,2n)Kr85(β^-)Rb85(n,γ)Rb86m(IT)Rb86				2.0
Rb84	33.50d	Kr86(n,2n)Kr85m(β^-)Rb85(n,2n)Rb84				46.9
		Kr86(n,2n)Kr85m(β^-)Rb85(n,2n)Rb84m(IT)Rb84				31.4
		Kr86(n,2n)Kr85(β^-)Rb85(n,2n)Rb84				11.7
		Kr86(n,2n)Kr85(β^-)Rb85(n,2n)Rb84m(IT)Rb84				7.8
Se75	119.63d	Kr78(n,α)Se75	100.0	100.0	100.0	97.8

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Kr85	10.75y	Kr84(n,γ)Kr85	42.6	61.5	84.7	
		Kr84(n,γ)Kr85m(IT)Kr85	36.9	38.2	15.1	
		Kr83(n,γ)Kr84(n,γ)Kr85	7.9			
		Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	6.8			
		Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85	2.2			
		Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ)Kr85m(IT)Kr85	1.9			
		Kr86(n,2n)Kr85				93.6
		Kr86(n,2n)Kr85m(IT)Kr85				5.9
Kr81	2.1 10^5y	Kr80(n,γ)Kr81	68.7	74.2	84.5	
		Kr80(n,γ)Kr81m(IT)Kr81	30.7	25.8	15.5	
		Kr82(n,2n)Kr81				81.5
		Kr82(n,2n)Kr81m(IT)Kr81				14.5
		Kr83(n,2n)Kr82(n,2n)Kr81				2.9
Se79	3.8 10^5y	Kr80(n,γ)Kr81(n,α)Se78(n,γ)Se79m(IT)Se79	27.8	39.4		
		Kr80(n,γ)Kr81(n,α)Se78(n,γ)Se79	20.0	33.9		
		Kr80(n,γ)Kr81m(IT)Kr81(n,α)Se78(n,γ)Se79m(IT)Se79	12.5	13.7		
		Kr80(n,γ)Kr81m(IT)Kr81(n,α)Se78(n,γ)Se79	9.0	11.8		
		Kr78(n,γ)Kr79(β^+)Br79(n,p)Se79			24.0	
		Kr78(n,γ)Kr79m(IT)Kr79(β^+)Br79(n,p)Se79			15.0	
		Kr78(n,γ)Kr79(β^+)Br79(n,p)Se79m(IT)Se79			10.9	
		Kr78(n,γ)Kr79m(IT)Kr79(β^+)Br79(n,p)Se79m(IT)Se79			6.8	
		Kr82(n,α)Se79				69.9
		Kr82(n,α)Se79m(IT)Se79				18.3
		Kr83(n,α)Se80(n,2n)Se79				3.4
		Kr83(n,2n)Kr82(n,α)Se79				2.5
		Kr80(n,2n)Kr79(β^+)Br79(n,p)Se79				1.0

Rubidium

Isotope	Atom % abundance
Rb85	72.17
Rb87	27.83

($T_{1/2}$ =4.8 10^{10}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.31E+15	1.16E+15	8.84E+14	2.70E+12	4.55E+09	9.46E+05
Rb86	41.0	46.1	53.1	0.1		
Rb84	33.7	37.9	46.3	9.3		
Rb84m	13.6	12.8				
Rb86m	8.7	0.3				
Rb88	1.4	1.2				
Kr85	0.2	0.2	0.3	88.3	99.9	
Sr85	0.2	0.2	0.2	1.5		
Rb87						94.0
Kr81						6.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.72E-01	1.58E-01	1.25E-01	1.34E-04	1.68E-07	1.18E-11
Rb84	42.4	46.1	54.3	30.8		
Rb86	37.6	40.8	45.3	0.1		
Rb84m	7.7	7.0				
Rb86m	5.9	0.2				
Rb88	4.5	4.0				
Kr85	0.1	0.1	0.1	65.7	100.0	
Sr85	0.1	0.1	0.1	2.6		
Rb87						99.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.44E+05	1.29E+05	1.06E+05	6.30E+01	2.08E-03	1.98E-08
Rb84	68.8	76.8	87.2	89.4		
Rb86	10.3	11.4	12.2	0.1		
Rb86m	8.8	0.3				
Rb84m	7.1	6.6				
Rb88	2.7	2.4				
Br82	1.5	1.6	0.4			
Sr85	0.1	0.2	0.2	6.8		
Rb83				2.0		
Kr85				1.7	100.0	
Kr81						100.0

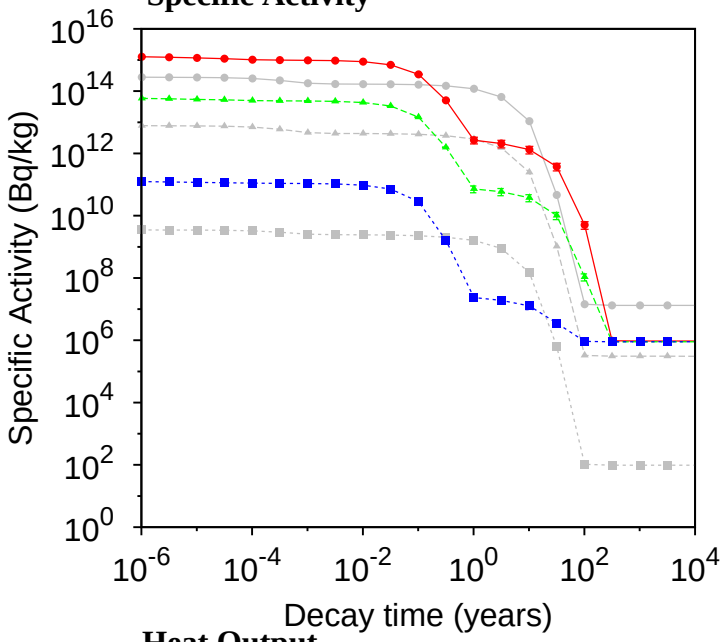
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.05E+06	6.03E+06	5.26E+06	2.63E+06	5.01E+03	4.87E-03
Kr85	46.3	46.5	53.2	100.0	100.0	
Rb86	24.9	25.0	25.0			
Rb84	20.4	20.5	21.8			
Kr85m	4.2	4.1				
Kr87	3.8	3.6				
Kr81						72.6
Rb87						27.4

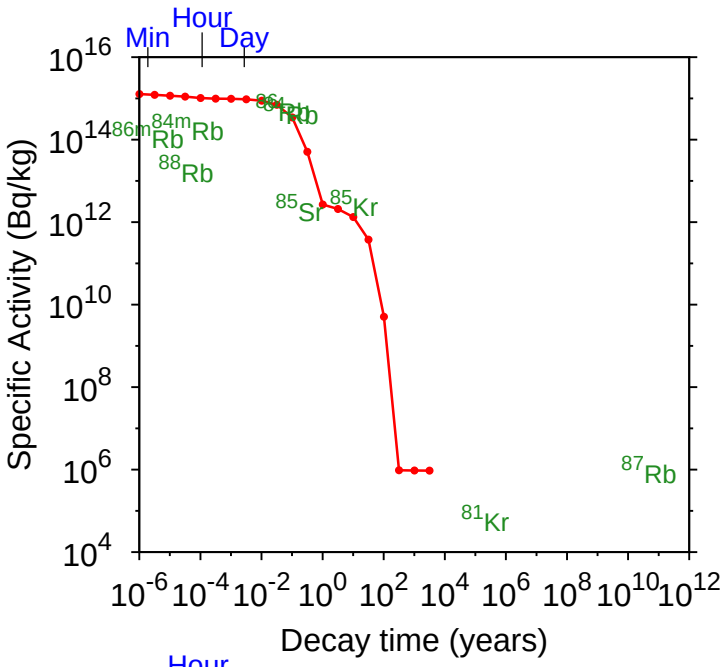
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	9.80E+07	9.80E+07	9.76E+07	9.08E+07	1.73E+05	1.26E-01
Kr85	98.8	98.8	99.1	100.0	100.0	
Kr81						99.6

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	5.64E+11	4.87E+11	3.79E+11	4.08E+08	2.54E+05	8.90E+02
Rb84	71.1	82.3	98.0	55.8		
Rb84m	12.2	11.8				
Rb86m	11.3	0.4				
Rb88	2.9	2.7				
Rb86	1.0	1.1	1.2			
Kr85				32.5	99.6	
Sr85	0.4	0.4	0.5	10.1		
Rb83				1.5		
Rb87					0.4	100.0

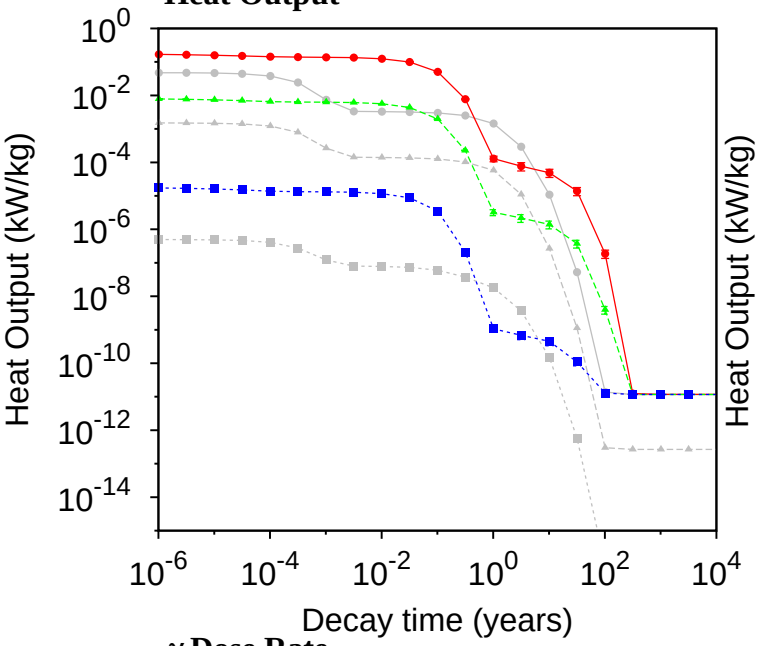
Rubidium activation characteristics

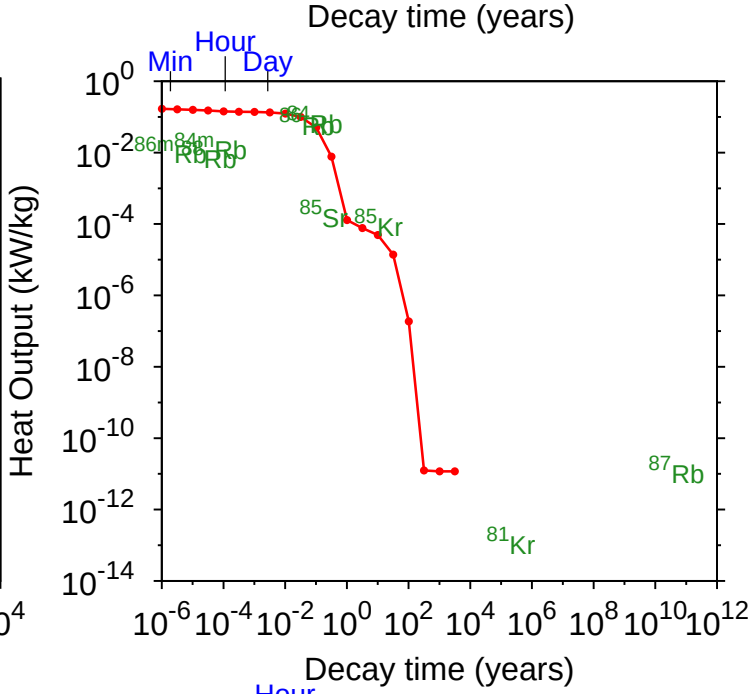
Specific Activity



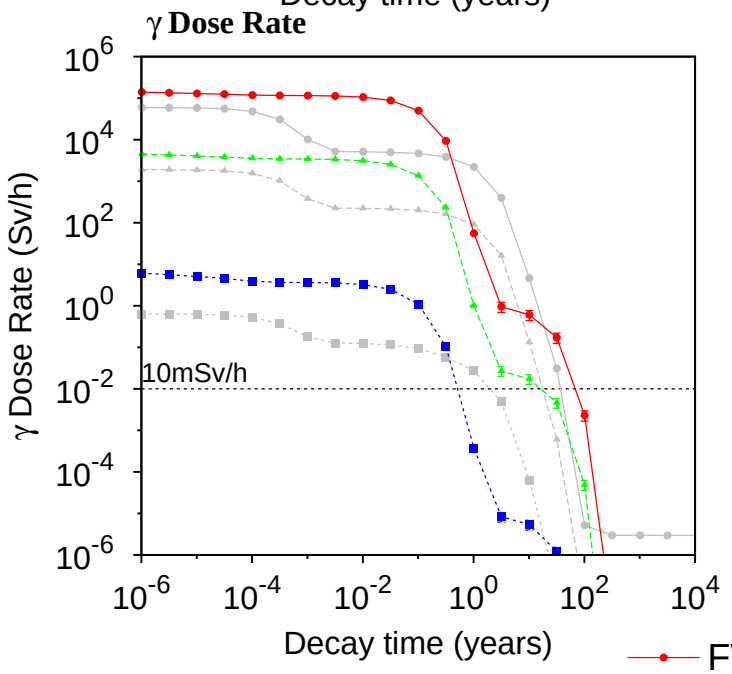


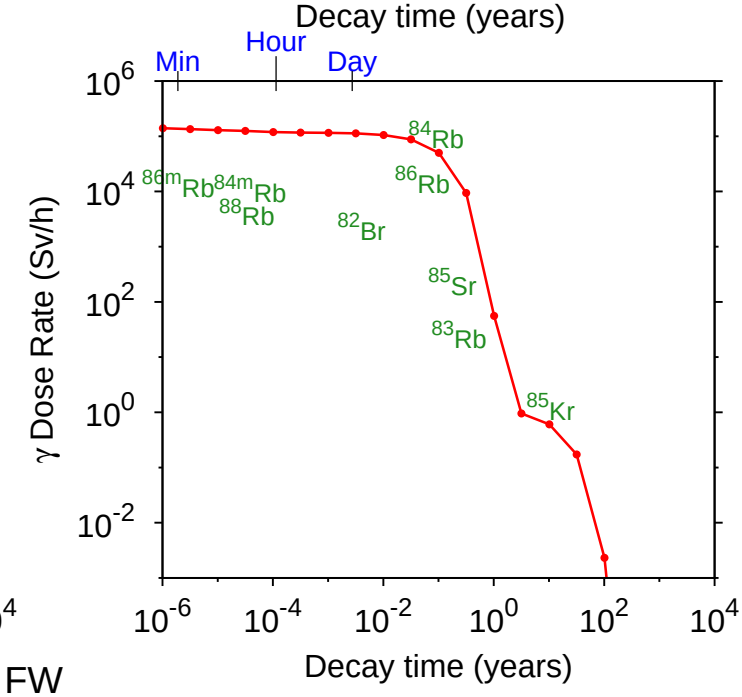
Heat Output





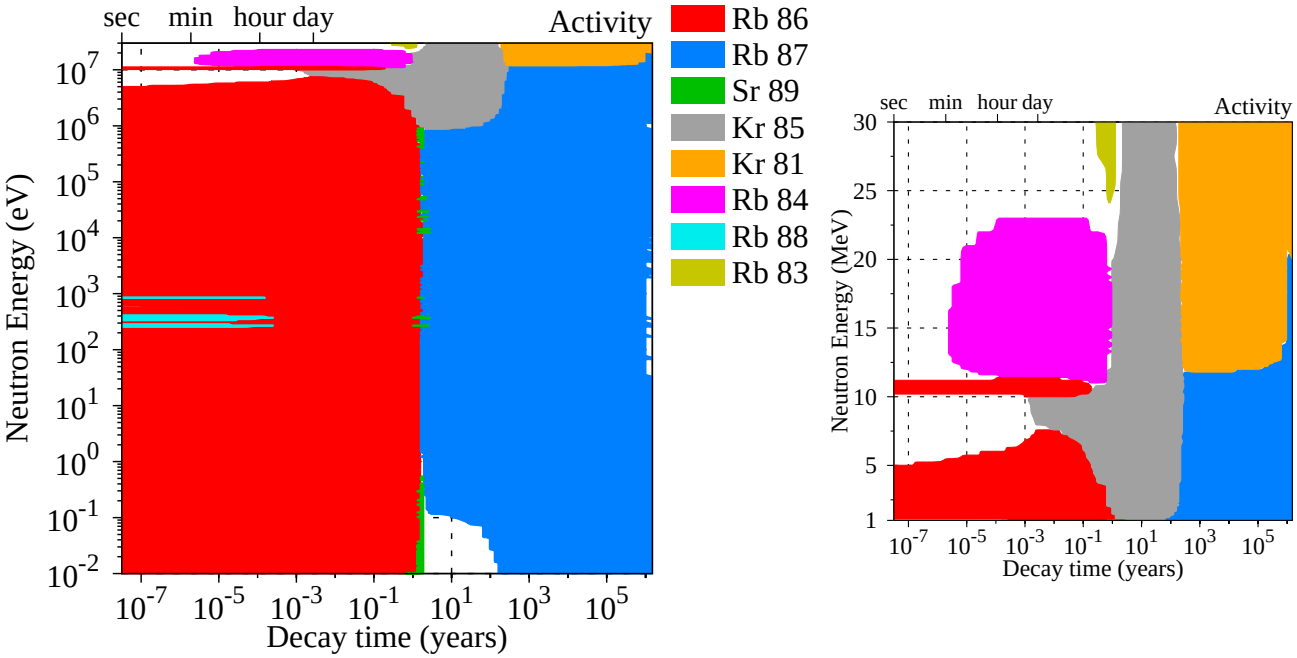
γ Dose Rate

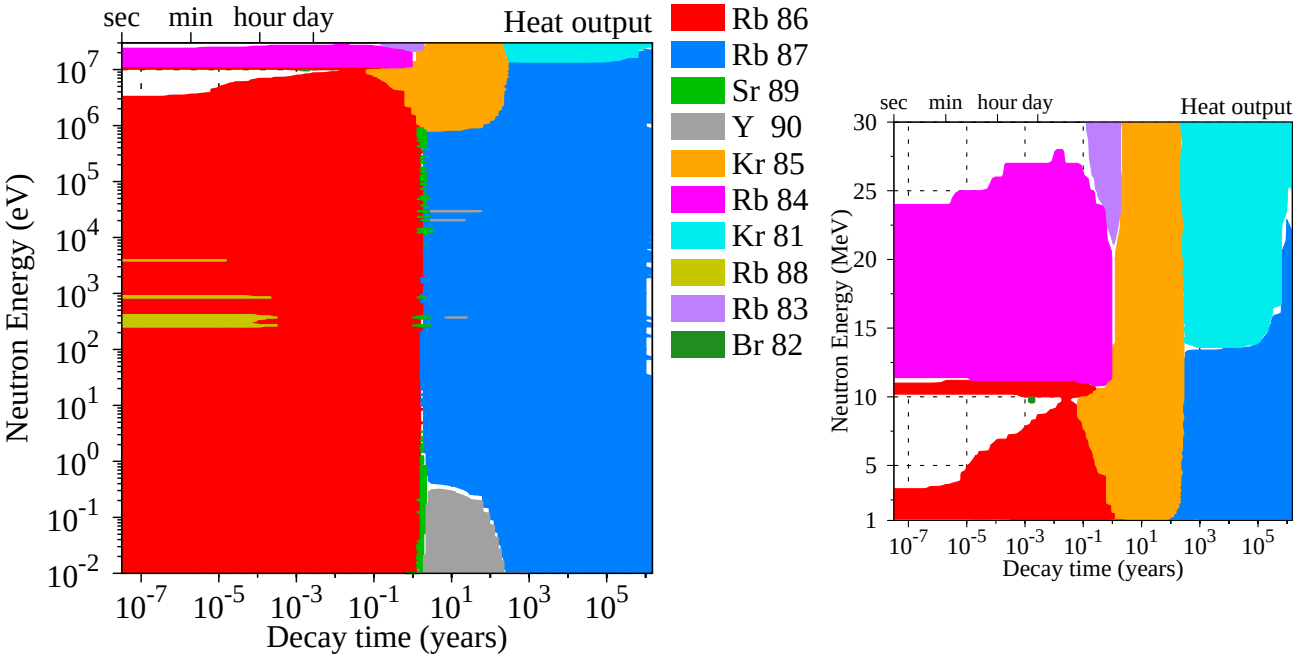


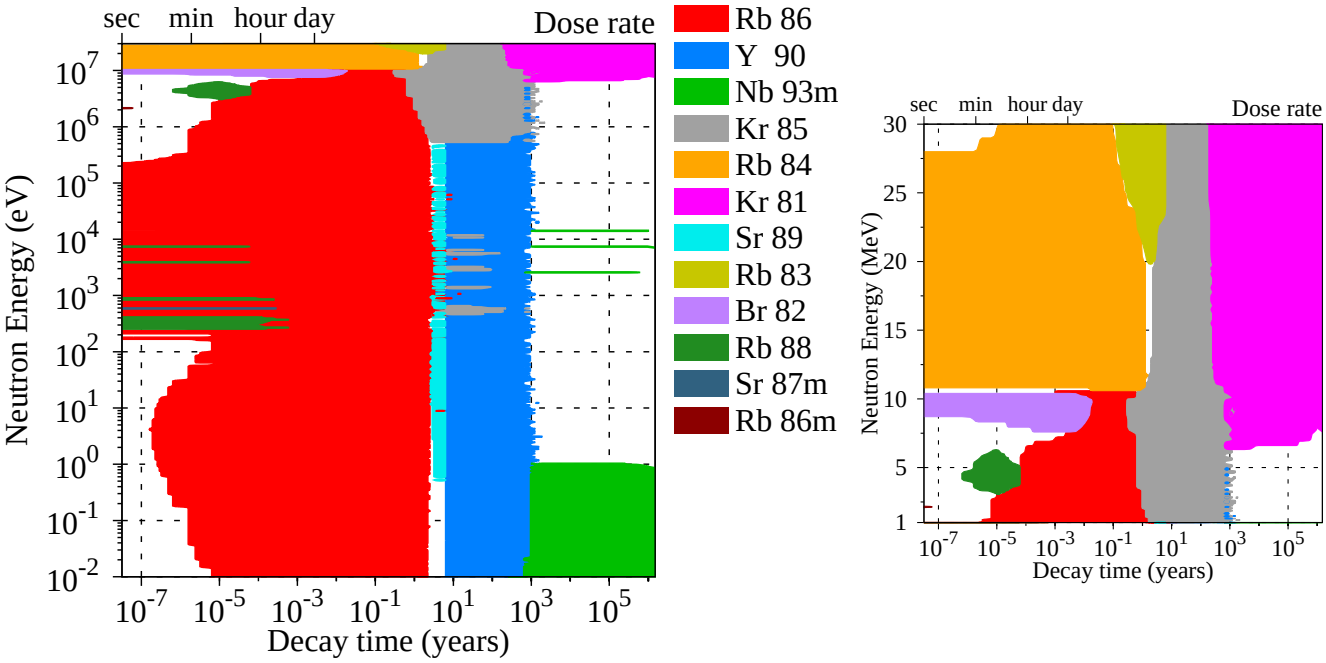


FW
Blanket
Manifold
Fe results

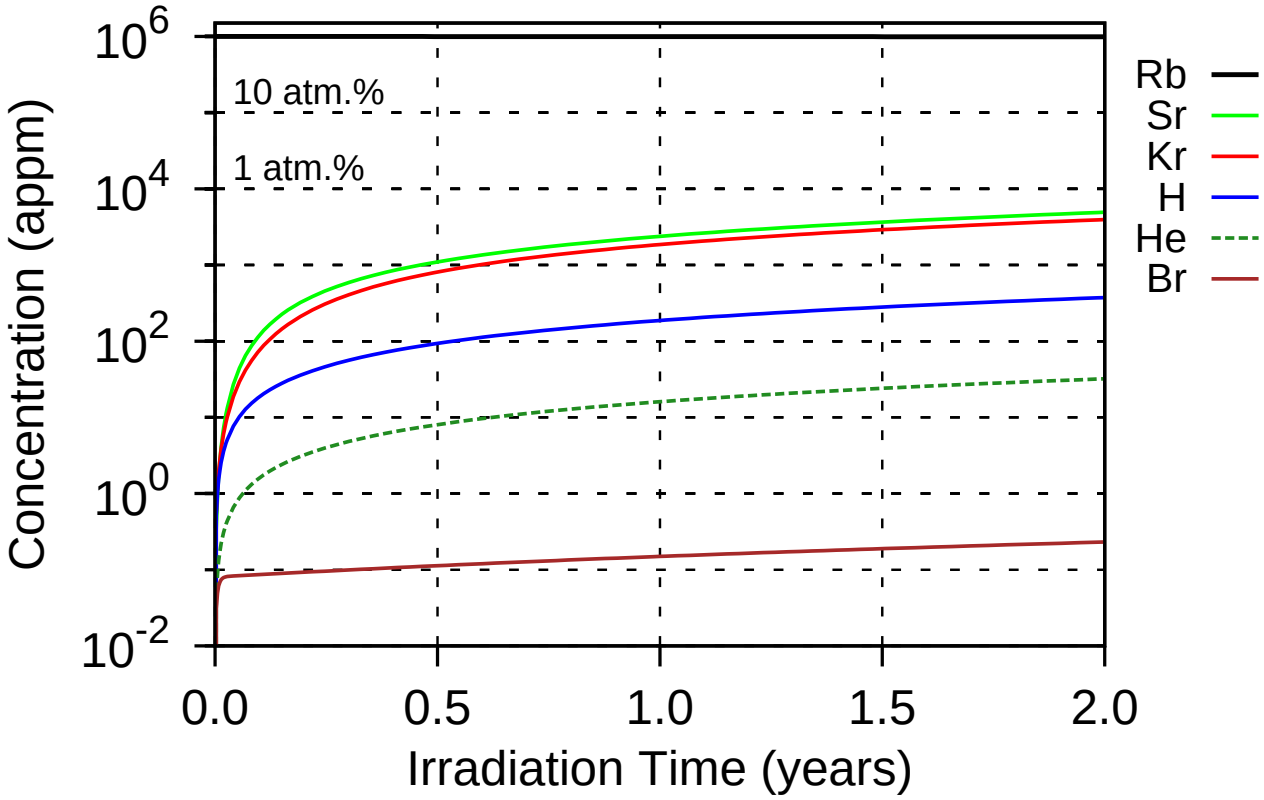
Rubidium Importance diagrams



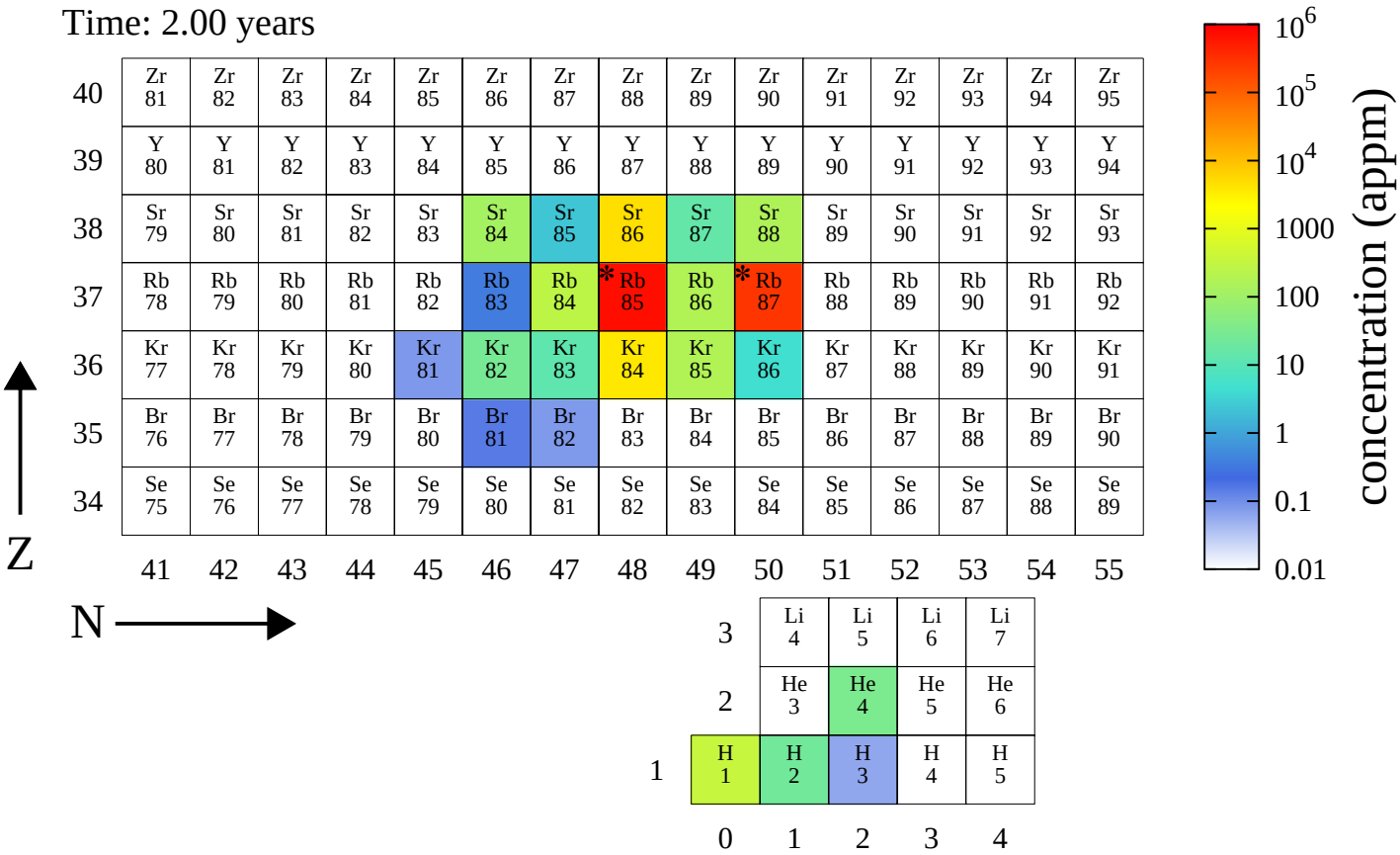




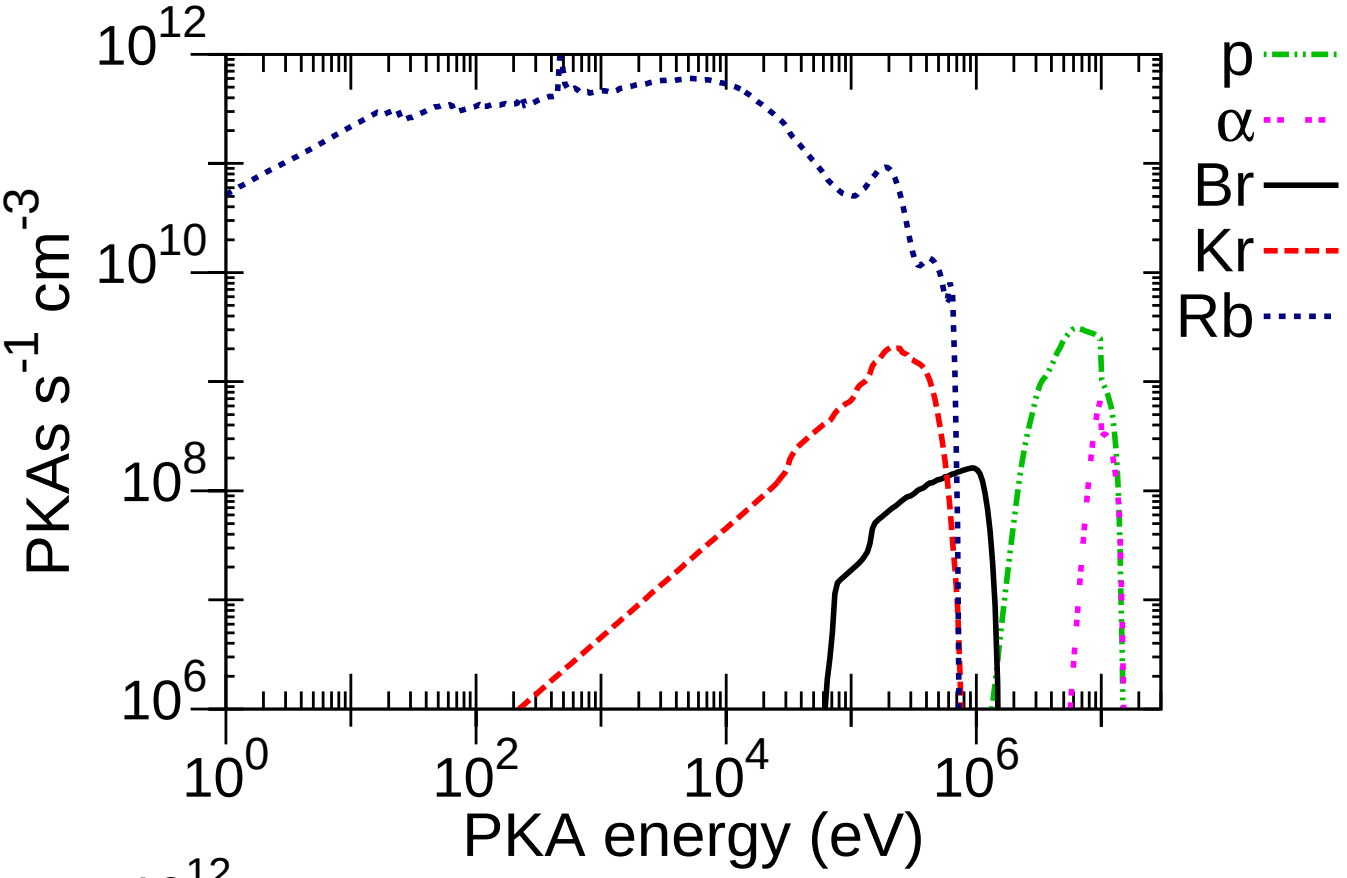
Rubidium FW Transmutation

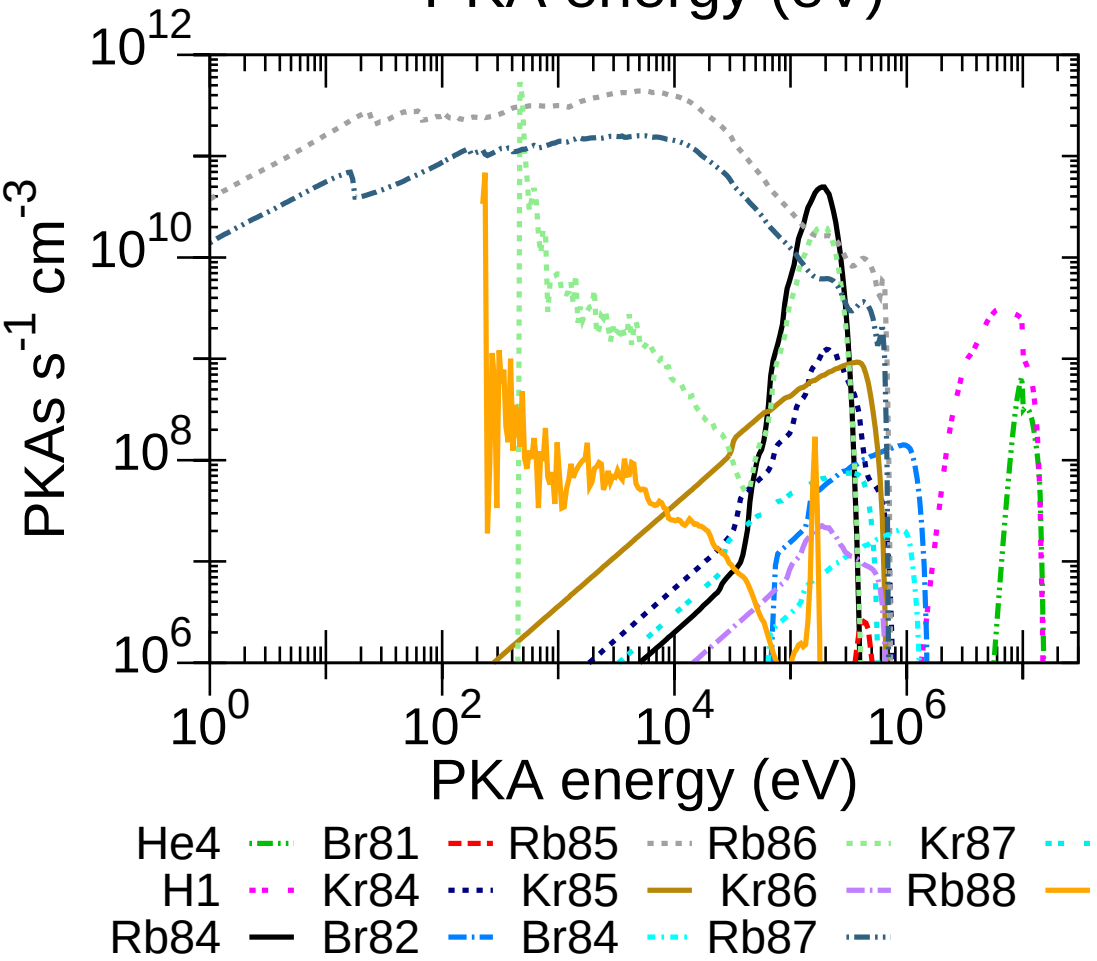


16 appm He & 187 appm H after 1 year 18 dpa/year



Rubidium FW PKA distributions





Rubidium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Rb86m	1.02m	Rb85(n,γ)Rb86m	100.0	100.0	99.8	
		Rb87(n,2n)Rb86m				99.4
Rb88	17.80m	Rb87(n,γ)Rb88	99.7	100.0	100.0	99.9
Rb84m	20.40m	Rb85(n,2n)Rb84m				99.8
Kr87	1.27h	Rb85(n,γ)Rb86(β^+)Kr86(n,γ)Kr87	92.2	89.8	62.1	
		Rb85(n,γ)Rb86m(IT)Rb86(β^+)Kr86(n,γ)Kr87	6.4	10.2	34.5	
		Rb85(n,γ)Rb86(n,p)Kr86(n,γ)Kr87	1.3		1.2	
		Rb85(n,p)Kr85(n,γ)Kr86(n,γ)Kr87			1.5	
		Rb87(n,p)Kr87				99.9
Sr87m	2.82h	Rb85(n,γ)Rb86(β^-)Sr86(n,γ)Sr87m	93.5	89.8	63.6	
		Rb85(n,γ)Rb86m(IT)Rb86(β^-)Sr86(n,γ)Sr87m	6.5	10.2	35.3	
		Rb87(n,2n)Rb86(β^-)Sr86(n,γ)Sr87m				48.2
		Rb87(n,2n)Rb86m(IT)Rb86(β^-)Sr86(n,γ)Sr87m				32.1
		Rb87(n,γ)Rb88(β^-)Sr88(n,2n)Sr87m				18.7
Kr85m	4.48h	Rb85(n,γ)Rb86(β^-)Sr86(n,γ)Sr87m(n,α)Kr84(n,γ)Kr85m	11.3			
		Rb85(n,p)Kr85m			85.0	96.0
		Rb85(n,p)Kr85(n,n′)Kr85m			14.8	2.1
Br82	1.47d	Rb85(n,α)Br82			55.2	44.7
		Rb85(n,α)Br82m(IT)Br82			44.8	55.0
Y90	2.67d	Rb87(n,γ)Rb88(β^-)Sr88(n,γ)Sr89(β^-)Y89(n,γ)Y90	95.7	99.1	91.1	
		Rb87(n,γ)Rb88(β^-)Sr88(n,γ)Sr89(β^-)Y89(n,γ)Y90m(IT)Y90			8.0	
Rb86	18.64d	Rb85(n,γ)Rb86	93.5	89.8	64.3	
		Rb85(n,γ)Rb86m(IT)Rb86	6.5	10.2	35.7	
		Rb87(n,2n)Rb86				59.6
		Rb87(n,2n)Rb86m(IT)Rb86				39.8
Rb84	33.50d	Rb85(n,2n)Rb84				59.8
		Rb85(n,2n)Rb84m(IT)Rb84				40.0
Sr89	50.58d	Rb87(n,γ)Rb88(β^-)Sr88(n,γ)Sr89	93.8	100.0	100.0	99.9
Sr85	64.85d	Rb87(n,2n)Rb86(β^-)Sr86(n,2n)Sr85				47.0
		Rb87(n,2n)Rb86m(IT)Rb86(β^-)Sr86(n,2n)Sr85				31.4
		Rb87(n,2n)Rb86(β^-)Sr86(n,2n)Sr85m(IT)Sr85				12.7
		Rb87(n,2n)Rb86m(IT)Rb86(β^-)Sr86(n,2n)Sr85m(IT)Sr85				8.5
Rb83	86.20d	Rb85(n,2n)Rb84(n,2n)Rb83				50.9
		Rb85(n,2n)Rb84m(IT)Rb84(n,2n)Rb83				34.1
		Rb85(n,2n)Rb84(β^-)Sr84(n,2n)Sr83(β^+)Rb83				6.4
		Rb85(n,2n)Rb84m(IT)Rb84(β^-)Sr84(n,2n)Sr83(β^+)Rb83				4.3
		Rb85(n,2n)Rb84(β^-)Sr84(n,np)Rb83				1.3
		Rb85(n,2n)Rb84(β^-)Sr84(n,2n)Sr83m(IT)Sr83(β^+)Rb83				1.2
Kr85	10.75y	Rb85(n,γ)Rb86(β^-)Sr86(n,γ)Sr87m(n,α)Kr84(n,γ)Kr85		7.5		
		Rb85(n,γ)Rb86(β^-)Sr86(n,γ)Sr87m(n,α)Kr84(n,γ) Kr85m(IT)Kr85		4.7		
		Rb85(n,p)Kr85			98.6	97.6
		Rb85(n,p)Kr85m(IT)Kr85			1.3	2.2
Nb93m	16.11y	no pathways found				
Kr81	2.1 10^5y	Rb85(n,α)Br82m(IT)Br82(β^-)Kr82(n,2n)Kr81				39.4
		Rb85(n,α)Br82(β^-)Kr82(n,2n)Kr81				32.1
		Rb85(n,α)Br82m(IT)Br82(β^-)Kr82(n,2n)Kr81m(IT)Kr81				7.0
		Rb85(n,α)Br82(β^-)Kr82(n,2n)Kr81m(IT)Kr81				5.7
		Rb85(n,2n)Rb84(β^-)Sr84(n,α)Kr81				4.9
		Rb85(n,2n)Rb84m(IT)Rb84(β^-)Sr84(n,α)Kr81				3.3
		Rb85(n,2n)Rb84(β^+)Kr84(n,2n)Kr83(n,2n)Kr82(n,2n)Kr81				1.5
		Rb85(n,α)Br82m(β^-)Kr82(n,2n)Kr81				1.0
		Rb85(n,2n)Rb84m(IT)Rb84(β^+)Kr84(n,2n)Kr83(n,2n) Kr82(n,2n)Kr81				1.0
Rb87	4.8 10^{10}y	no pathways found				

Strontium

Isotope	Atom % abundance
Sr84	0.56
Sr86	9.86
Sr87	7.00
Sr88	82.58

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.57E+14	2.50E+14	6.40E+13	1.44E+12	3.50E+08	5.45E+05
Sr87m	63.8	64.1				
Sr85	19.6	20.1	75.7	71.0		
Sr85m	6.1	6.0				
Sr89	3.4	3.5	13.0	4.1		
Rb88	2.5	2.1				
Rb86	1.2	1.2	4.3			
Rb83	0.8	0.8	3.0	7.4		
Kr83m	0.6	0.7	2.3	5.6		
Kr85	0.1	0.1	0.3	11.6	98.5	
Kr81					0.2	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.98E-02	1.89E-02	5.53E-03	1.08E-04	1.32E-08	1.11E-12
Sr87m	51.4	52.7				
Sr85	21.5	22.5	74.0	79.6		
Rb88	14.4	12.3				
Sr89	4.2	4.3	14.1	5.1		
Sr85m	2.9	2.9				
Rb86	1.9	2.0	5.9			
Sr83	1.3	1.3	0.7			
Rb83	0.8	0.8	2.8	8.0		
Rb84	0.6	0.6	1.9	0.1		
Kr85			0.1	5.7	96.8	
Y90					2.7	
Kr81						99.9

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.59E+04	1.53E+04	5.50E+03	1.19E+02	1.56E-04	1.79E-07
Sr87m	50.6	51.3				
Sr85	32.8	34.0	91.3	89.1		
Rb88	8.8	7.5				
Sr85m	2.1	2.1				
Sr83	1.9	2.0	0.9			
Rb83	1.2	1.3	3.5	8.9		
Rb84	1.0	1.0	2.6	0.1		
Rb86	0.5	0.6	1.4			
Y88	0.1	0.1	0.4	1.8		
Kr85				0.1	99.9	
Kr81					0.1	100.0

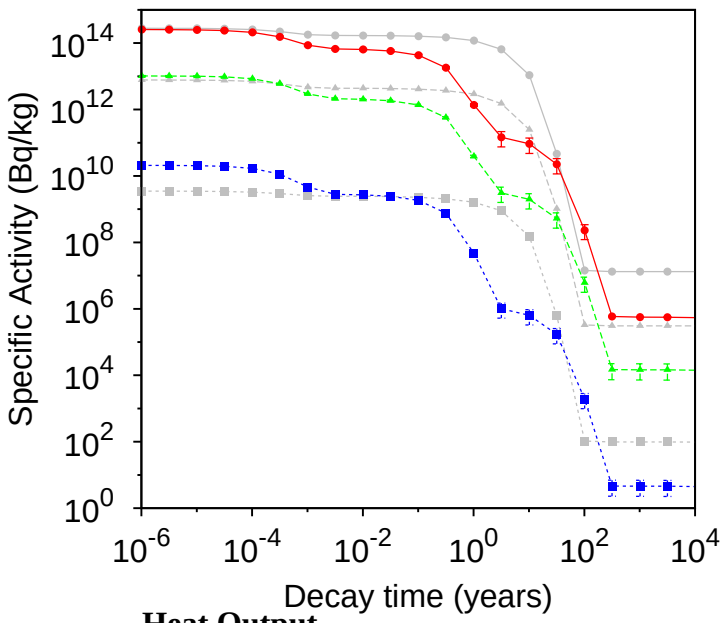
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.29E+05	3.28E+05	2.63E+05	1.85E+05	3.80E+02	3.38E-02
Kr85	59.7	59.8	74.6	99.4	100.0	
Kr85m	16.9	16.7				
Sr85	8.6	8.6	10.3	0.3		
Sr89	6.9	7.0	8.3	0.1		
Rb86	2.7	2.7	2.9			
Kr83m	1.6	1.6	1.8	0.1		
Sr87m	1.5	1.5				
Rb83	1.1	1.1	1.4	0.1		
Kr81						100.0

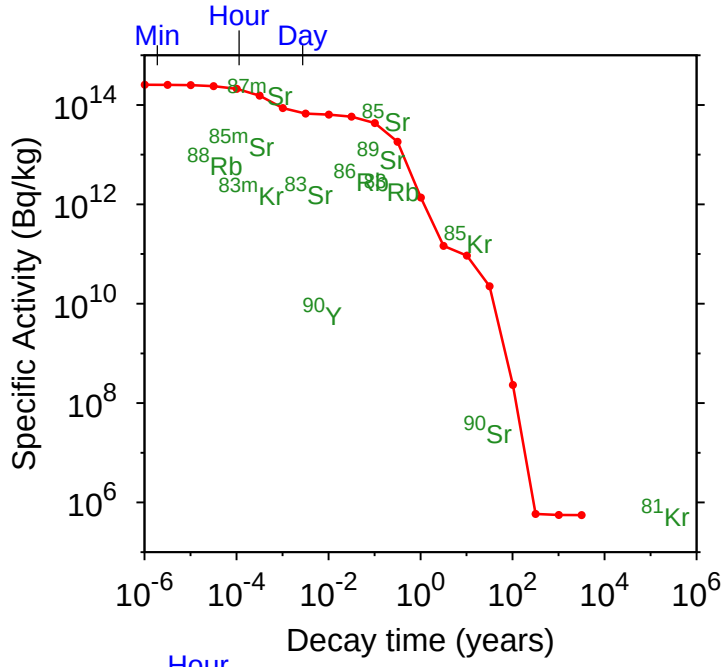
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.93E+06	6.93E+06	6.88E+06	6.36E+06	1.31E+04	1.20E+00
Kr85	97.8	97.8	98.4	100.0	100.0	
Sr89	1.0	1.0	1.0			
Kr81						100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	6.20E+10	6.03E+10	5.03E+10	1.09E+09	2.16E+04	4.27E+00
Sr85	81.3	83.6	96.3	93.5		
Rb88	9.6	8.0				
Sr87m	2.6	2.7				
Sr83	2.1	2.2	0.4			
Rb83	1.6	1.6	1.9	4.9		
Rb84	1.0	1.0	1.1			
Kr85				0.9	88.9	
Sr90					11.1	
Kr81						98.1
Rb87						1.9

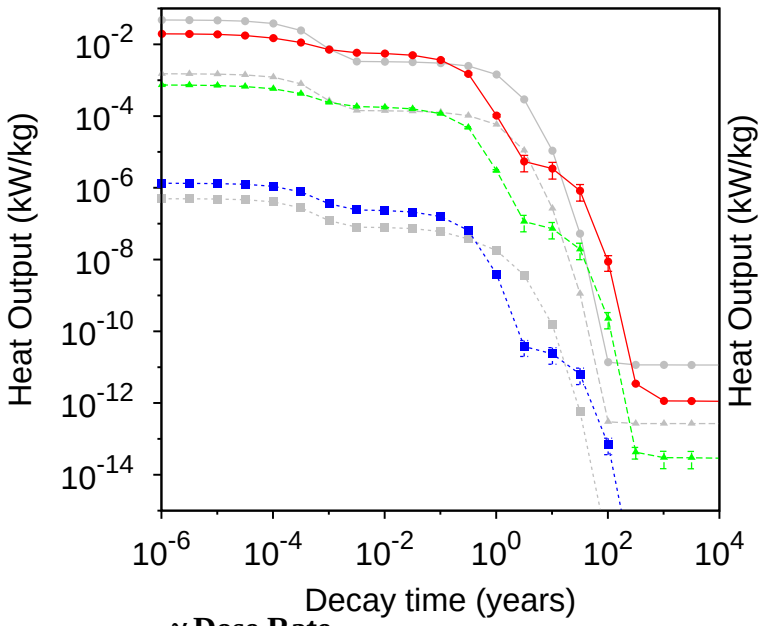
Strontium activation characteristics

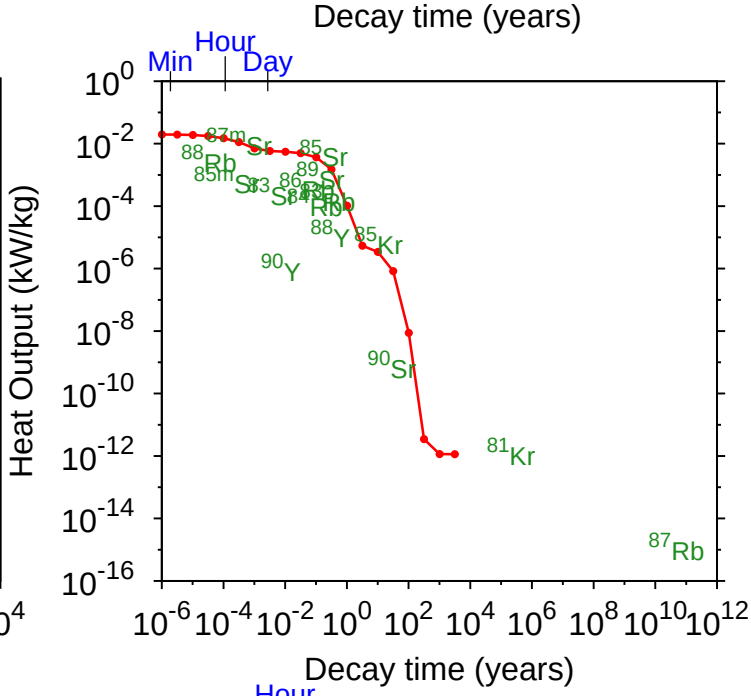
Specific Activity



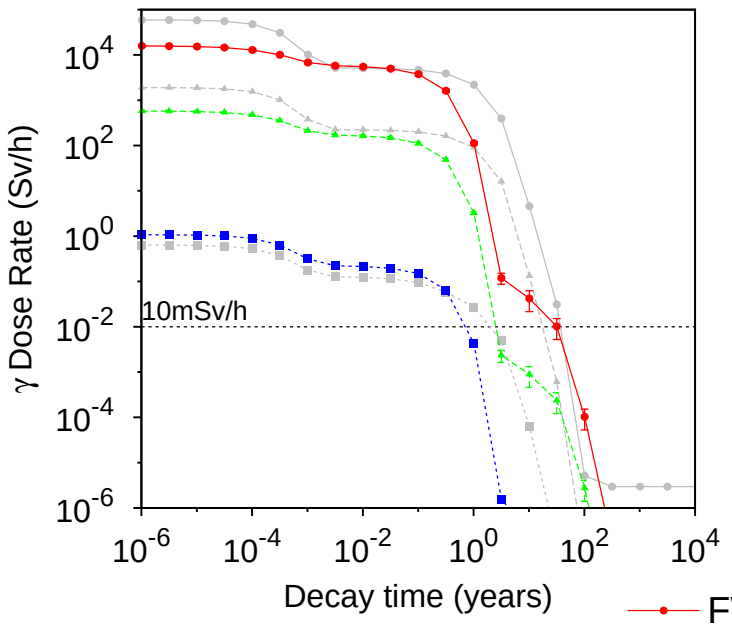


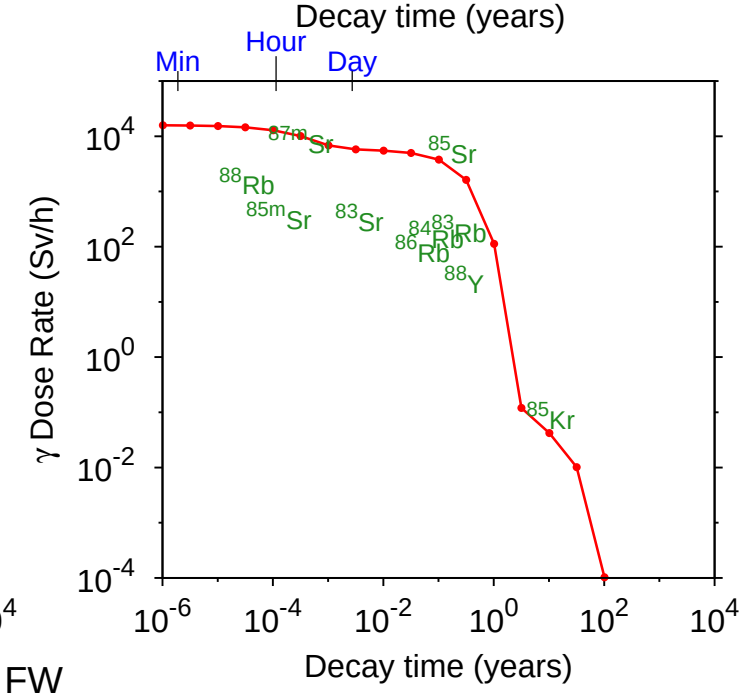
Heat Output





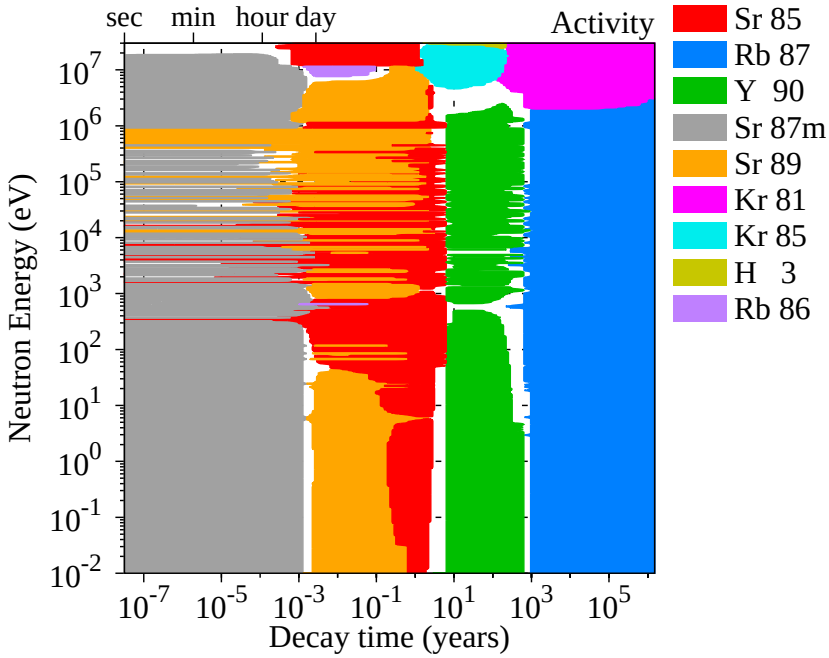
γ Dose Rate

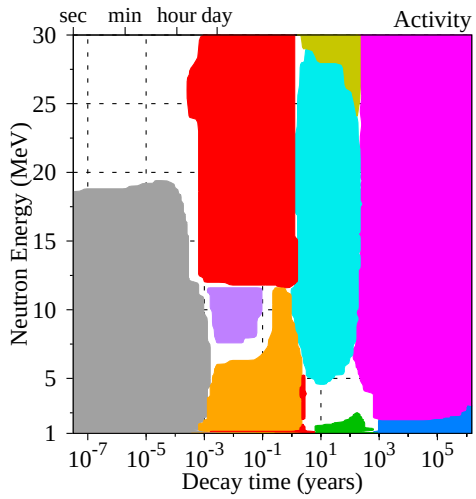


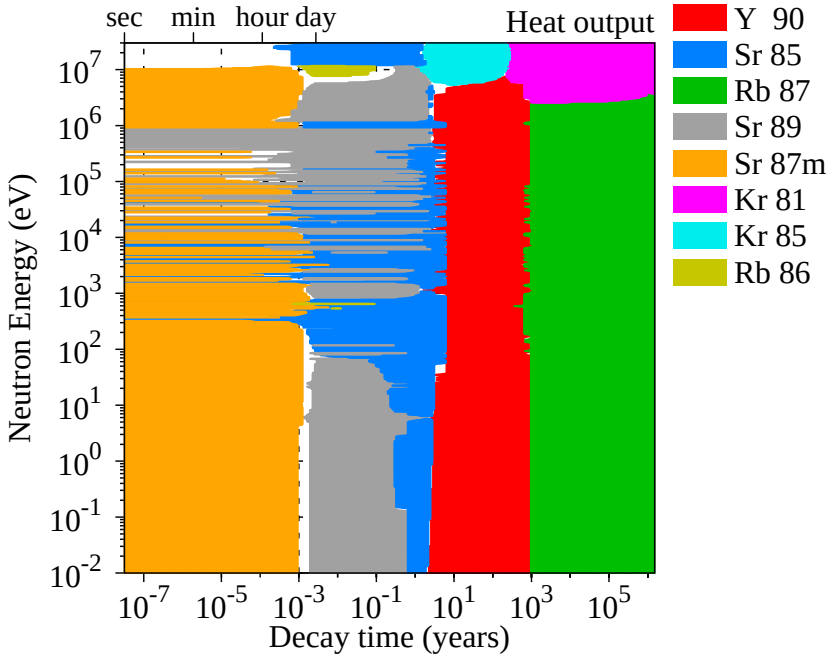


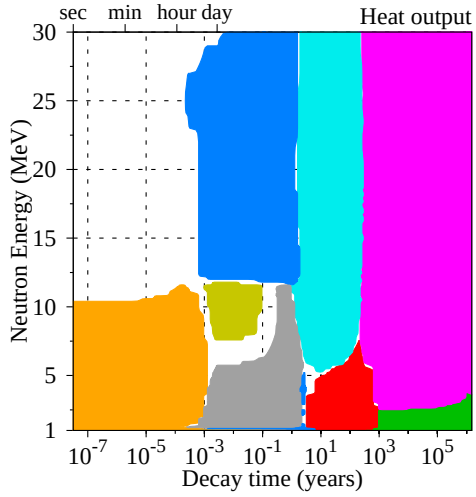
FW
Blanket
Manifold
Fe results

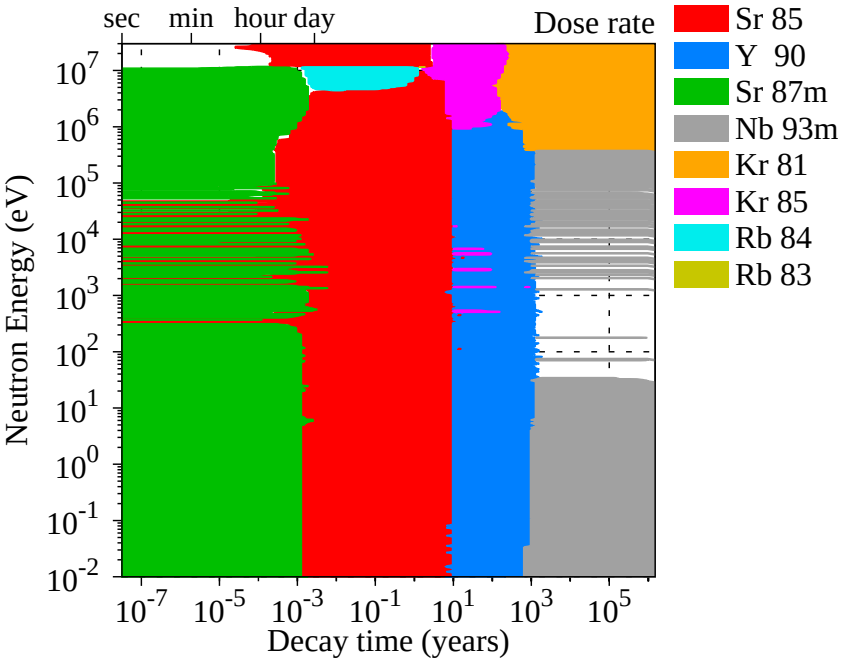
Strontium Importance diagrams

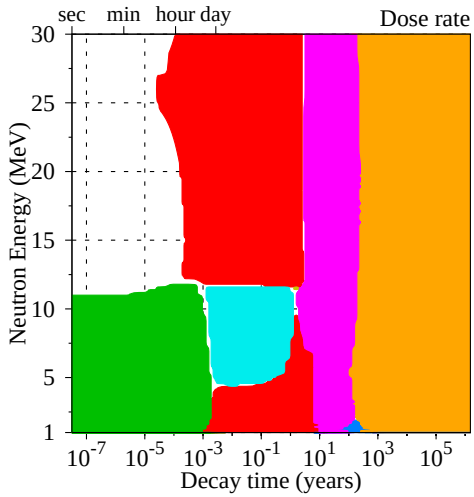




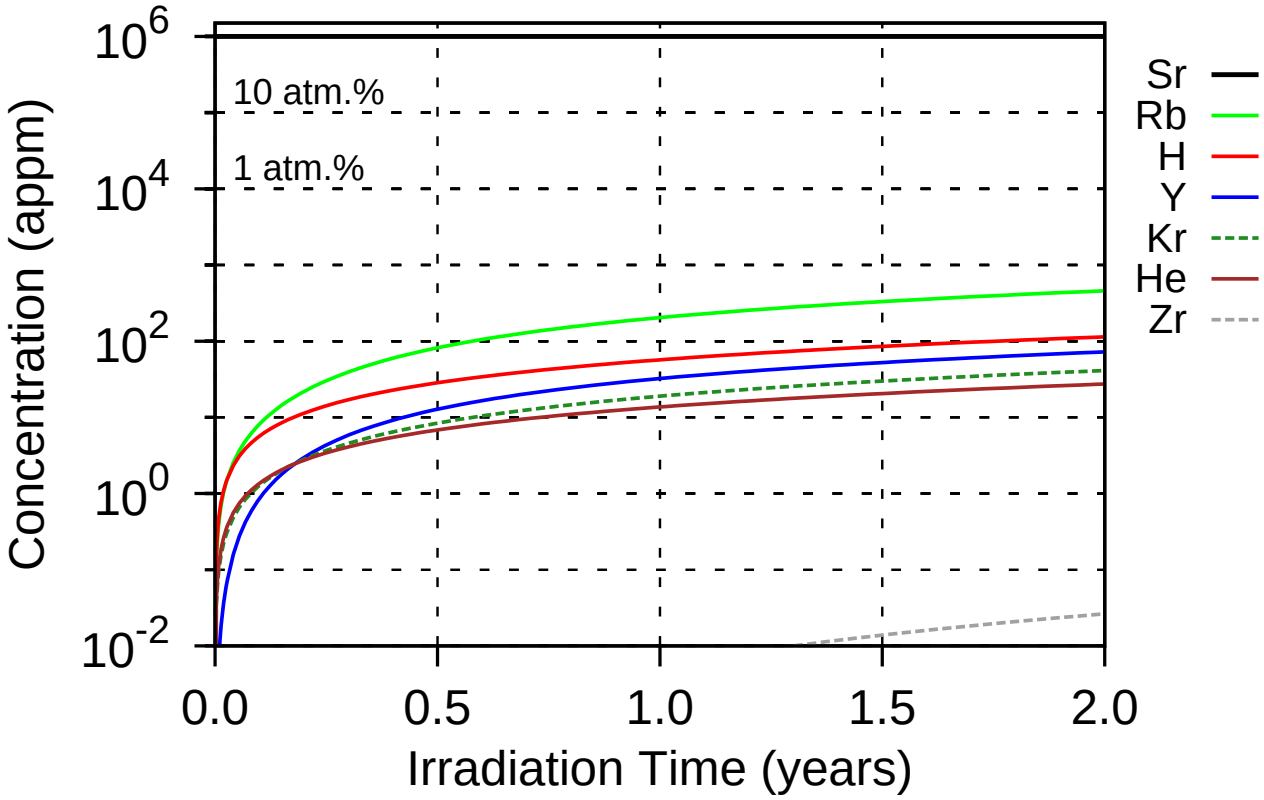




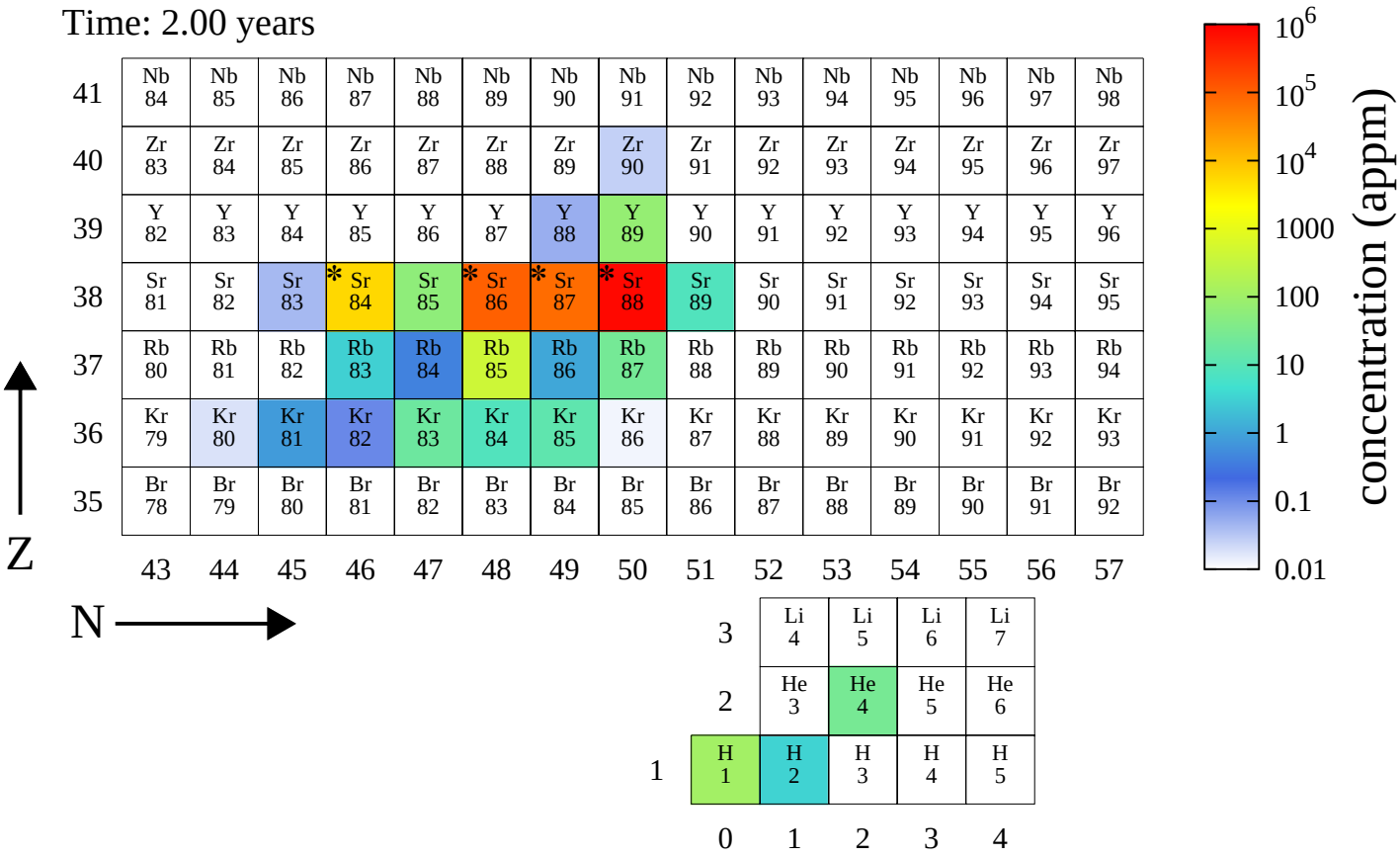




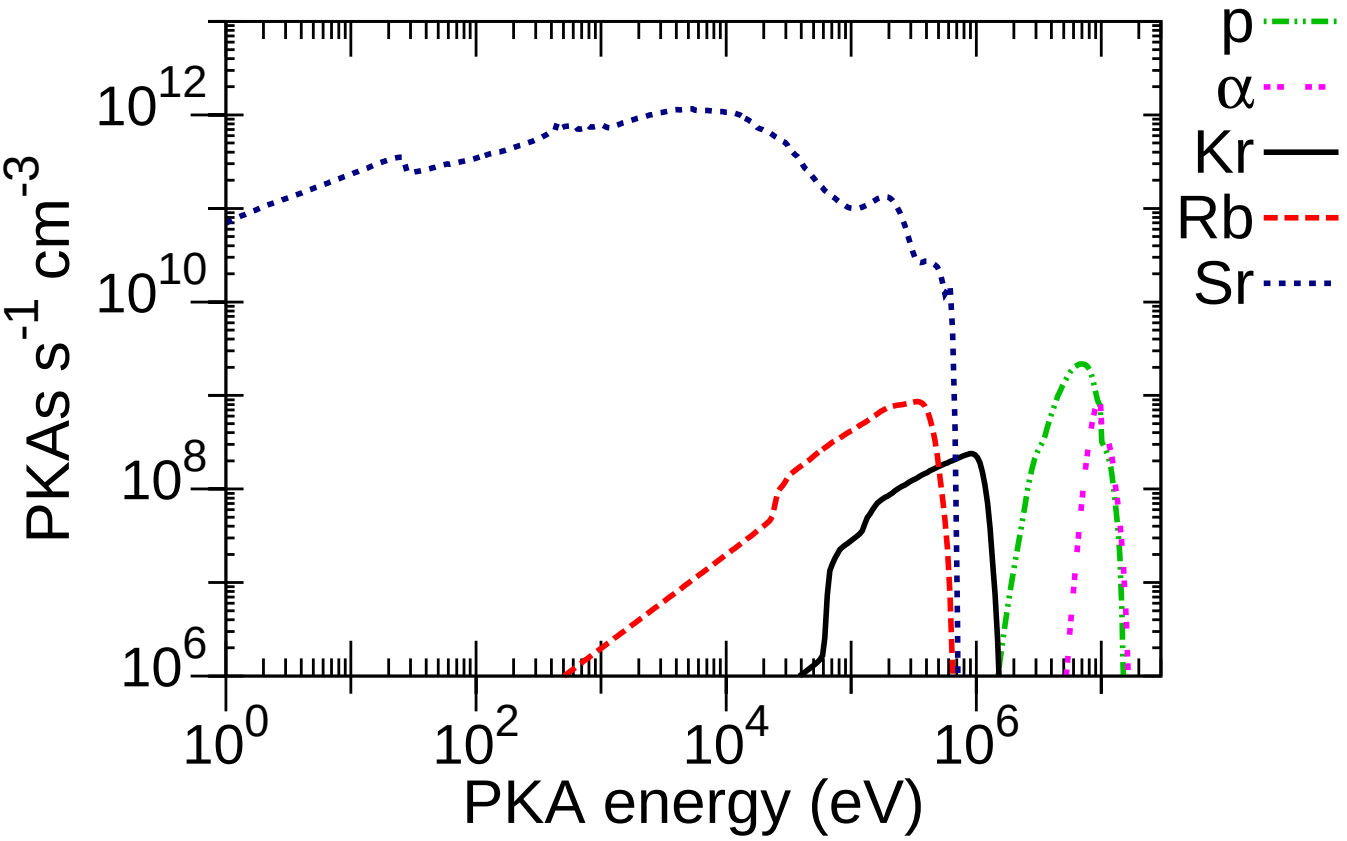
Strontium FW Transmutation

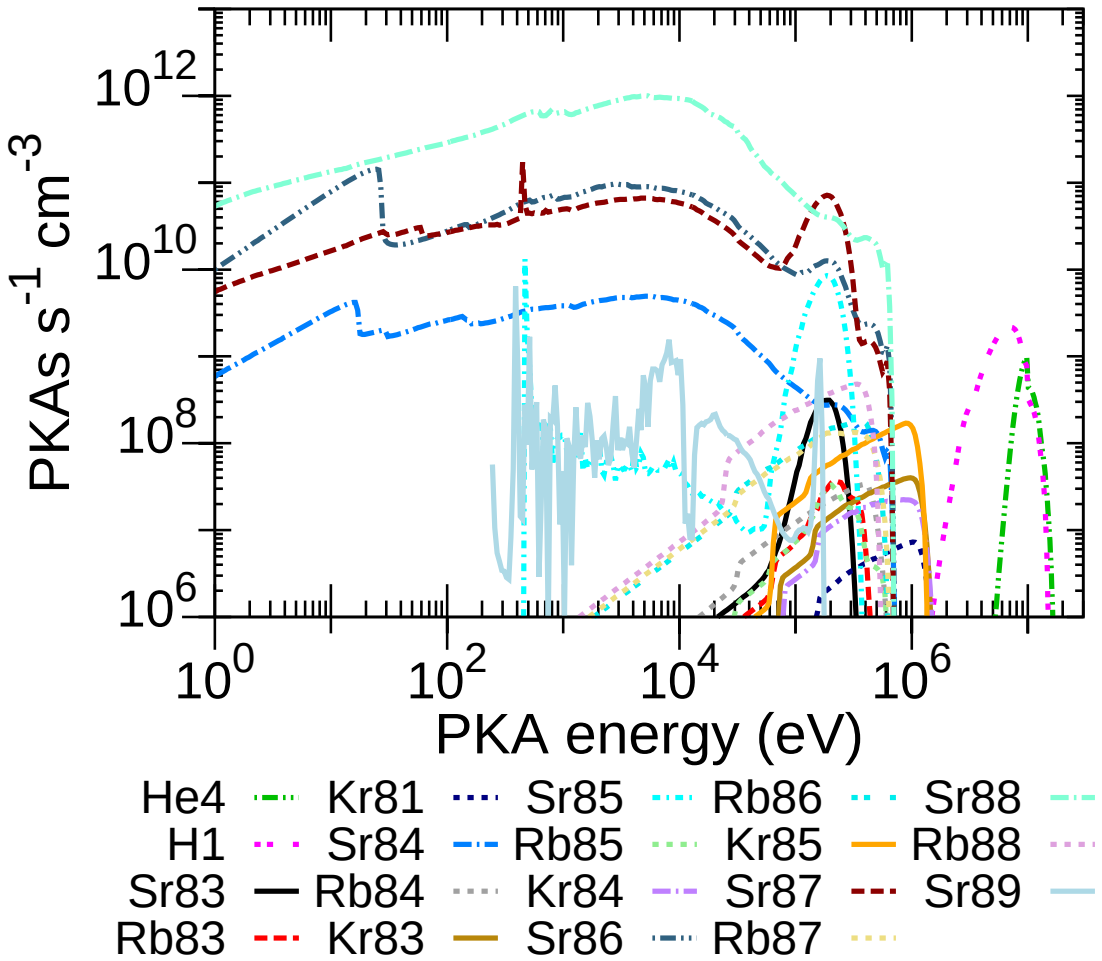


14 appm He & 57 appm H after 1 year 20 dpa/year



Strontium FW PKA distributions





Strontium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Rb88	17.80m	Sr86(n,γ)Sr87m(β^+)Rb87(n,γ)Rb88	99.4	100.0	6.8	
		Sr87(n,n′)Sr87m(β^+)Rb87(n,γ)Rb88			81.9	
		Sr87(n,p)Rb87(n,γ)Rb88			10.4	
		Sr88(n,p)Rb88				99.9
Sr85m	1.13h	Sr84(n,γ)Sr85m	100.0	100.0	99.6	
		Sr86(n,2n)Sr85m				93.7
		Sr87(n,2n)Sr86(n,2n)Sr85m				4.5
		Sr88(n,2n)Sr87(n,2n)Sr86(n,2n)Sr85m				1.0
Kr83m	1.83h	Sr84(n,γ)Sr85m(IT)Sr85(n,α)Kr82(n,γ)Kr83m	70.0	65.9		
		Sr84(n,γ)Sr85(n,α)Kr82(n,γ)Kr83m	23.5	32.3		
		Sr84(n,γ)Sr85m(n,α)Kr82(n,γ)Kr83m	6.5	1.8		
		Sr86(n,α)Kr83m			92.9	8.4
		Sr86(n,α)Kr83(n,n′)Kr83m			5.7	
		Sr84(n,2n)Sr83(β^+)Rb83(β^+)Kr83m				62.8
		Sr84(n,np)Rb83(β^+)Kr83m				12.7
		Sr84(n,2n)Sr83m(IT)Sr83(β^+)Rb83(β^+)Kr83m				12.1
Sr87m	2.82h	Sr86(n,γ)Sr87m	100.0	100.0	7.8	
		Sr87(n,n′)Sr87m			92.2	4.1
		Sr88(n,2n)Sr87m				93.2
		Sr88(n,2n)Sr87(n,n′)Sr87m				1.9
Kr85m	4.48h	Sr84(n,γ)Sr85m(IT)Sr85(n,α)Kr82(n,γ)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85m	40.3			
		Sr87(n,α)Kr84(n,γ)Kr85m	17.7	99.7		
		Sr84(n,γ)Sr85m(IT)Sr85(n,α)Kr82(n,γ)Kr83(n,γ) Kr84(n,γ)Kr85m	16.1			
		Sr84(n,γ)Sr85(n,α)Kr82(n,γ)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85m	13.5			
		Sr84(n,γ)Sr85(n,α)Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85m	5.4			
		Sr84(n,γ)Sr85m(n,α)Kr82(n,γ)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85m	4.3			
		Sr84(n,γ)Sr85m(n,α)Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85m	1.7			
		Sr84(n,p)Rb84(β^+)Kr84(n,γ)Kr85m			72.8	
		Sr84(n,γ)Sr85(β^+)Rb85(n,p)Kr85m			10.9	
		Sr84(n,γ)Sr85m(IT)Sr85(β^+)Rb85(n,p)Kr85m			9.0	
		Sr84(n,p)Rb84m(IT)Rb84(β^+)Kr84(n,γ)Kr85m			2.6	
		Sr84(n,γ)Sr85m(β^+)Rb85(n,p)Kr85m			1.6	
		Sr88(n,α)Kr85m				97.6
		Sr86(n,2n)Sr85(β^+)Rb85(n,p)Kr85m				1.2
Sr83	1.35d	Sr84(n,2n)Sr83				83.4
		Sr84(n,2n)Sr83m(IT)Sr83				16.0
Y90	2.67d	Sr88(n,γ)Sr89(β^-)Y89(n,γ)Y90	96.7	99.2	90.9	71.6
		Sr87(n,γ)Sr88(n,γ)Sr89(β^-)Y89(n,γ)Y90	2.8			
		Sr88(n,γ)Sr89(β^-)Y89(n,γ)Y90m(IT)Y90			8.0	27.7
Rb86	18.64d	Sr84(n,γ)Sr85m(IT)Sr85(β^+)Rb85(n,γ)Rb86	60.9	53.8	20.6	
		Sr84(n,γ)Sr85(β^+)Rb85(n,γ)Rb86	20.4	26.3	24.9	
		Sr84(n,γ)Sr85m(β^+)Rb85(n,γ)Rb86	12.1	9.7	3.7	
		Sr84(n,γ)Sr85m(IT)Sr85(β^+)Rb85(n,γ)Rb86m(IT)Rb86	4.2	6.1	11.5	
		Sr84(n,γ)Sr85(β^+)Rb85(n,γ)Rb86m(IT)Rb86	1.4	3.0	13.8	
		Sr84(n,γ)Sr85m(β^+)Rb85(n,γ)Rb86m(IT)Rb86		1.1	2.0	
		Sr86(n,p)Rb86			23.3	58.1
		Sr86(n,p)Rb86m(IT)Rb86				24.2
		Sr87(n,2n)Sr86(n,p)Rb86				2.7
		Sr87(n,p)Rb87(n,2n)Rb86				2.4
		Sr87(n,p)Rb87(n,2n)Rb86m(IT)Rb86				1.6
		Sr87(n,2n)Sr86(n,p)Rb86m(IT)Rb86				1.1
		Sr87(n,d)Rb86				1.0
		Sr87(n,np)Rb86m(IT)Rb86				1.0
Rb84	33.50d	Sr84(n,p)Rb84			96.4	8.7
		Sr84(n,p)Rb84m(IT)Rb84			3.5	5.9
		Sr86(n,2n)Sr85(β^+)Rb85(n,2n)Rb84				36.8
		Sr86(n,2n)Sr85(β^+)Rb85(n,2n)Rb84m(IT)Rb84				24.6
		Sr86(n,2n)Sr85m(IT)Sr85(β^+)Rb85(n,2n)Rb84				9.9
		Sr86(n,2n)Sr85m(IT)Sr85(β^+)Rb85(n,2n)Rb84m(IT)Rb84				6.6
		Sr86(n,2n)Sr85m(β^+)Rb85(n,2n)Rb84				1.8
		Sr86(n,2n)Sr85m(β^+)Rb85(n,2n)Rb84m(IT)Rb84				1.2

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sr89	50.58d	Sr88(n,γ)Sr89	95.1	100.0	100.0	99.8
		Sr87(n,γ)Sr88(n,γ)Sr89	4.7			
Sr85	64.85d	Sr84(n,γ)Sr85m(IT)Sr85	74.9	67.1	45.3	
		Sr84(n,γ)Sr85	25.1	32.9	54.5	
		Sr86(n,2n)Sr85				74.6
		Sr86(n,2n)Sr85m(IT)Sr85				20.1
		Sr87(n,2n)Sr86(n,2n)Sr85				3.1
Rb83	86.20d	Sr84(n,2n)Sr83(β^+)Rb83				70.7
		Sr84(n,np)Rb83				14.3
		Sr84(n,2n)Sr83m(IT)Sr83(β^+)Rb83				13.6
Y88	106.63d	Sr88(n,γ)Sr89(β^-)Y89(n,2n)Y88				99.9
Kr85	10.75y	Sr84(n,γ)Sr85m(IT)Sr85(n,α)Kr82(n,γ)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85	18.6			
		Sr84(n,γ)Sr85m(IT)Sr85(n,α)Kr82(n,γ)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85m(IT)Kr85	16.1			
		Sr87(n,α)Kr84(n,γ)Kr85	15.3	61.4		
		Sr87(n,α)Kr84(n,γ)Kr85m(IT)Kr85	13.2	38.4		
		Sr84(n,γ)Sr85m(IT)Sr85(n,α)Kr82(n,γ)Kr83(n,γ) Kr84(n,γ)Kr85	7.4			
		Sr84(n,γ)Sr85m(IT)Sr85(n,α)Kr82(n,γ)Kr83(n,γ)Kr84(n,γ) Kr85m(IT)Kr85	6.4			
		Sr84(n,γ)Sr85(n,α)Kr82(n,γ)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85	6.2			
		Sr84(n,γ)Sr85(n,α)Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ) Kr85m(IT)Kr85	5.4			
		Sr84(n,γ)Sr85(n,α)Kr82(n,γ)Kr83(n,γ)Kr84(n,γ)Kr85	2.5			
		Sr84(n,γ)Sr85m(n,α)Kr82(n,γ)Kr83m(IT)Kr83(n,γ) Kr84(n,γ)Kr85	2.2			
		Sr84(n,γ)Sr85(n,α)Kr82(n,γ)Kr83(n,γ)Kr84(n,γ) Kr85m(IT)Kr85	2.2			
		Sr84(n,γ)Sr85m(n,α)Kr82(n,γ)Kr83m(IT)Kr83(n,γ)Kr84(n,γ) Kr85m(IT)Kr85	1.9			
		Sr84(n,γ)Sr85(β^+)Rb85(n,p)Kr85			37.8	
		Sr84(n,γ)Sr85m(IT)Sr85(β^+)Rb85(n,p)Kr85			31.3	
		Sr84(n,p)Rb84(β^+)Kr84(n,γ)Kr85			19.1	
		Sr84(n,γ)Sr85m(β^+)Rb85(n,p)Kr85			6.2	
		Sr84(n,p)Rb84(β^+)Kr84(n,γ)Kr85m(IT)Kr85			3.4	
		Sr88(n,α)Kr85				86.4
		Sr88(n,α)Kr85m(IT)Kr85				10.1
		Sr86(n,2n)Sr85(β^+)Rb85(n,p)Kr85				2.5
H3	12.33y	Sr84(n,γ)Sr85m(IT)Sr85(n,p)H1(n,γ)H2(n,γ)H3	65.5			
		Sr84(n,γ)Sr85(n,p)H1(n,γ)H2(n,γ)H3	22.0			
		Sr84(n,γ)Sr85m(n,p)H1(n,γ)H2(n,γ)H3	12.5			
		Sr87(n,p)H1(n,γ)H2(n,γ)H3			90.1	
		Sr84(n,p)H1(n,γ)H2(n,γ)H3			7.9	
		Sr86(n,p)H1(n,γ)H2(n,γ)H3			1.2	
		Sr87(n,t)H3				66.0
		Sr88(n,2n)Sr87(n,t)H3				15.5
		Sr88(n,2n)Sr87m(IT)Sr87(n,t)H3				4.9
		Sr86(n,2n)Sr85(β^+)Rb85(n,t)H3				3.4
		Sr86(n,2n)Sr85m(IT)Sr85(β^+)Rb85(n,t)H3				1.2
Nb93m	16.11y	no pathways found				
Sr90	28.79y	Sr88(n,γ)Sr89(n,γ)Sr90	97.1	100.0	100.0	99.9
		Sr87(n,γ)Sr88(n,γ)Sr89(n,γ)Sr90	2.8			
Kr81	2.1 10^5y	Sr84(n,α)Kr81			83.5	84.9
		Sr84(n,α)Kr81m(IT)Kr81			16.5	12.5
Rb87	4.8 10^{10}y	Sr86(n,γ)Sr87m(β^+)Rb87	99.4	100.0	6.8	
		Sr87(n,n′)Sr87m(β^+)Rb87			81.9	
		Sr87(n,p)Rb87			10.4	57.3
		Sr88(n,2n)Sr87(n,p)Rb87				13.4
		Sr88(n,2n)Sr87m(β^+)Rb87				10.2
		Sr88(n,d)Rb87				7.3
		Sr88(n,np)Rb87				6.7
		Sr88(n,2n)Sr87m(IT)Sr87(n,p)Rb87				4.2

Yttrium

Isotope	Atom % abundance
Y89	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.13E+15	5.07E+14	4.76E+14	4.28E+13	9.10E+06	1.47E-01
Y89m	55.0					
Y88	40.7	90.5	94.2	99.8		
Y90	2.5	5.5	2.3		42.7	
Sr89	1.2	2.7	2.7	0.2		
Sr90					42.7	
H3					7.6	
Kr85					7.0	
Rb87						85.2
Kr81						8.8
Zr93						3.0
Nb93m						2.9

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.95E-01	2.05E-01	1.97E-01	1.85E-02	7.13E-10	1.70E-18
Y88	67.3	97.0	98.3	100.0		
Y89m	30.6					
Y90	1.4	2.0	0.8		81.4	
Sr90					15.2	
Kr85					3.3	
Rb87						96.4
Kr81						1.6
Nb93m						1.3

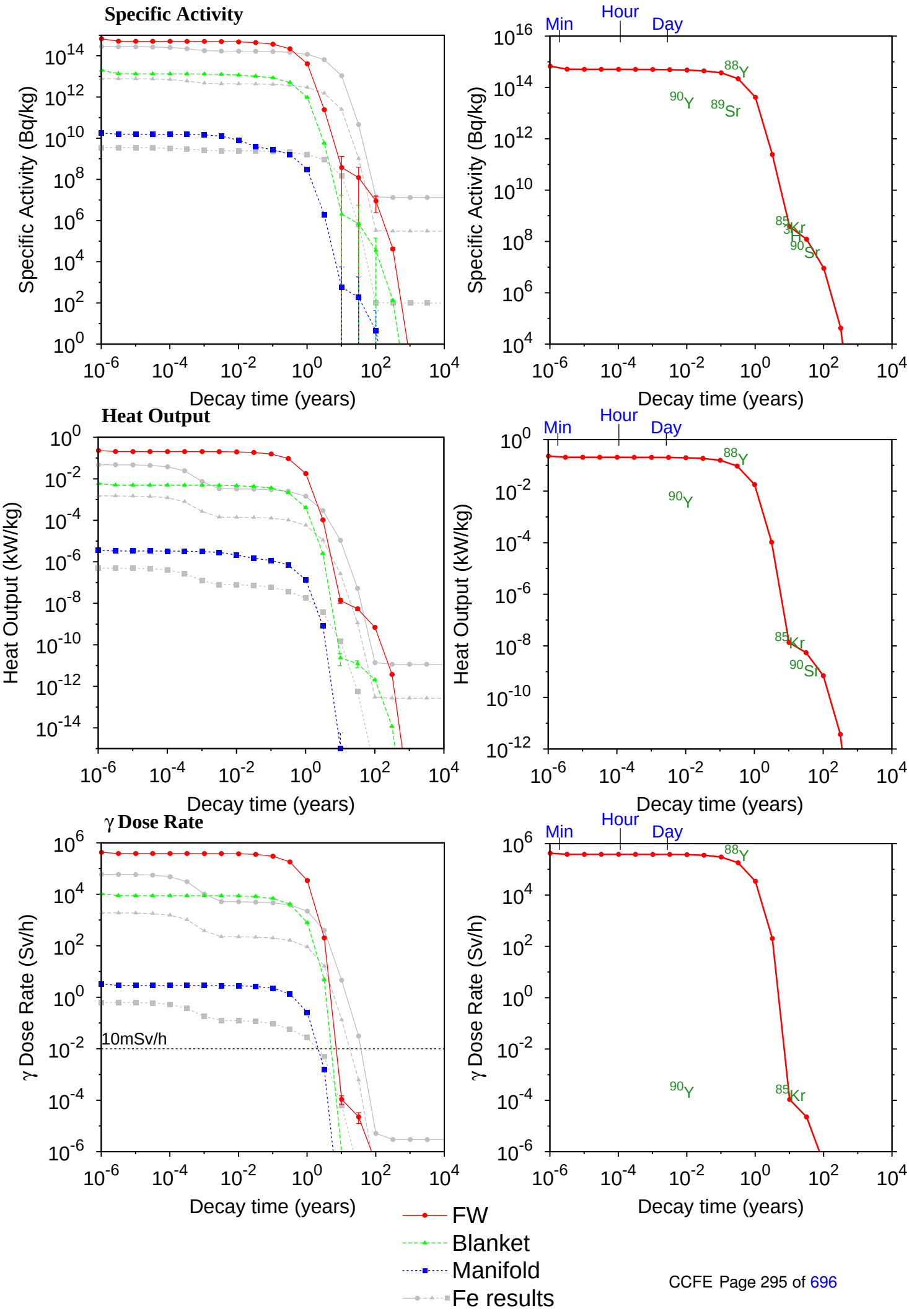
Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	5.34E+05	3.84E+05	3.75E+05	3.56E+04	2.82E-07	4.23E-15
Y88	71.9	99.9	100.0	100.0		
Y89m	28.0					
Kr85					100.0	
Kr81						92.8
Nb93m						7.2

Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	8.19E+05	7.20E+05	6.56E+05	5.61E+04	8.20E-01	9.96E-10
Y88	72.9	82.9	88.8	98.9		
Y89m	12.1					
Y90	9.1	10.4	4.4		1.3	
Sr89	4.3	4.9	5.1	0.4		
Rb86	1.4	1.6	1.5			
Kr85	0.1	0.1	0.1	0.7	85.5	
Sr90					13.3	
Kr81						80.6
Rb87						18.8

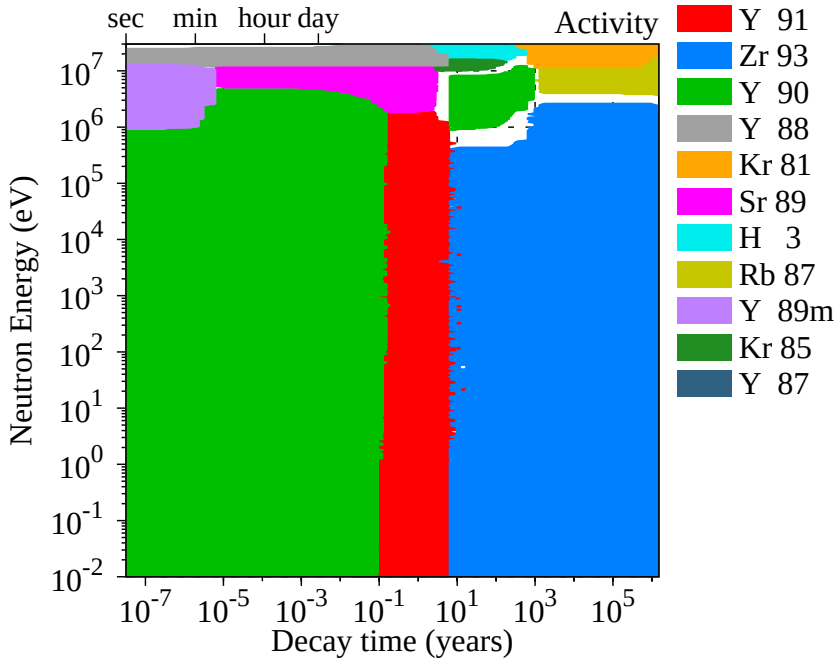
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.24E+06	2.19E+06	2.11E+06	2.02E+05	2.48E+01	2.87E-08
Y88	90.2	92.3	93.5	92.7		
Sr89	4.8	4.9	4.9	0.4		
Y89m	2.3					
Y90	1.9	1.9	0.8			
Kr85	0.7	0.7	0.7	6.9	97.5	
Sr90					2.5	
Kr81						99.4

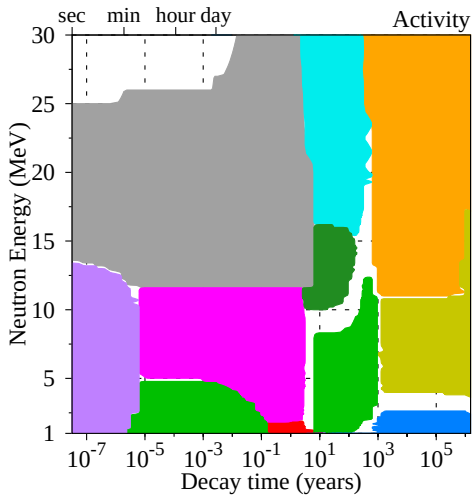
Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.81E+12	1.24E+12	1.21E+12	1.15E+11	3.93E+03	1.26E-04
Y88	68.7	99.9	100.0	100.0		
Y89m	31.2					
Sr90					98.8	
Rb87						99.2

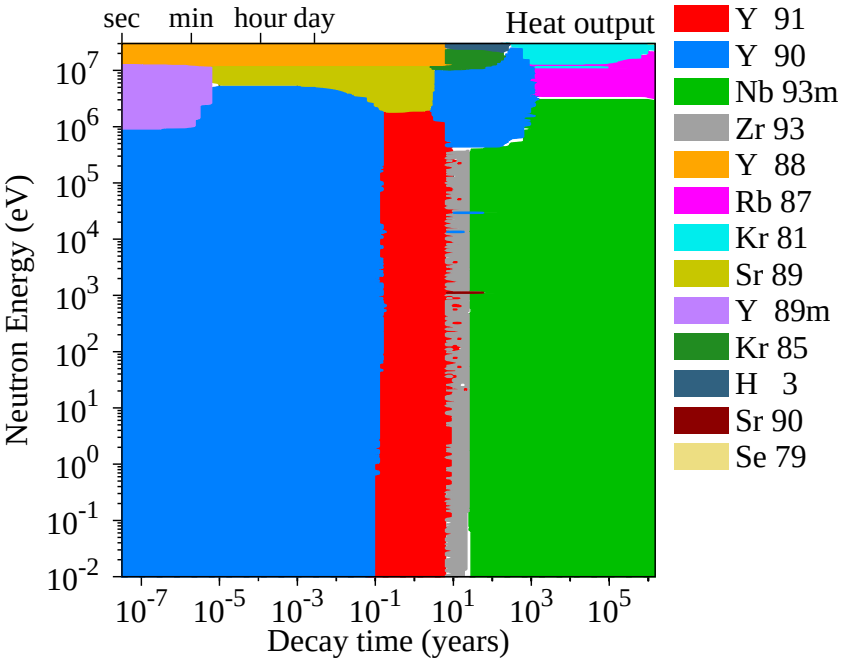
Yttrium activation characteristics

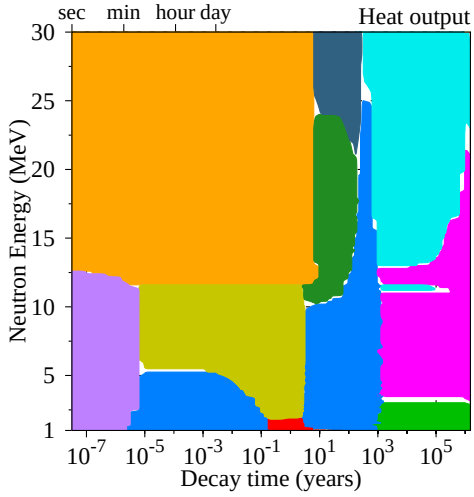


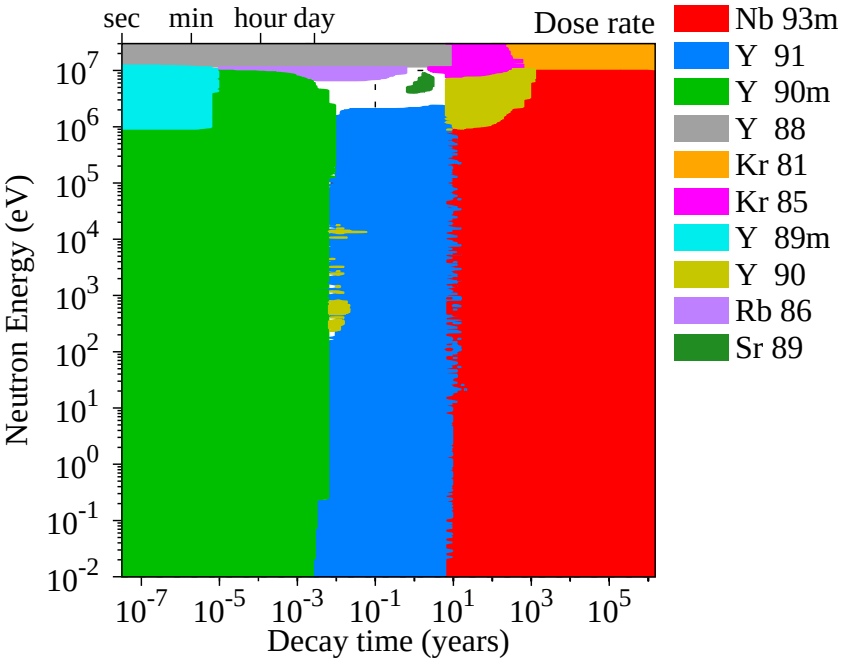
Yttrium Importance diagrams

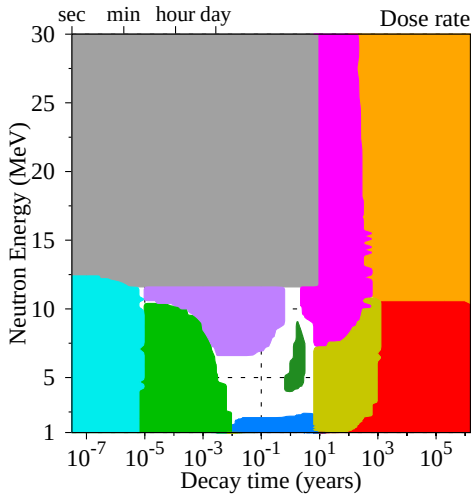




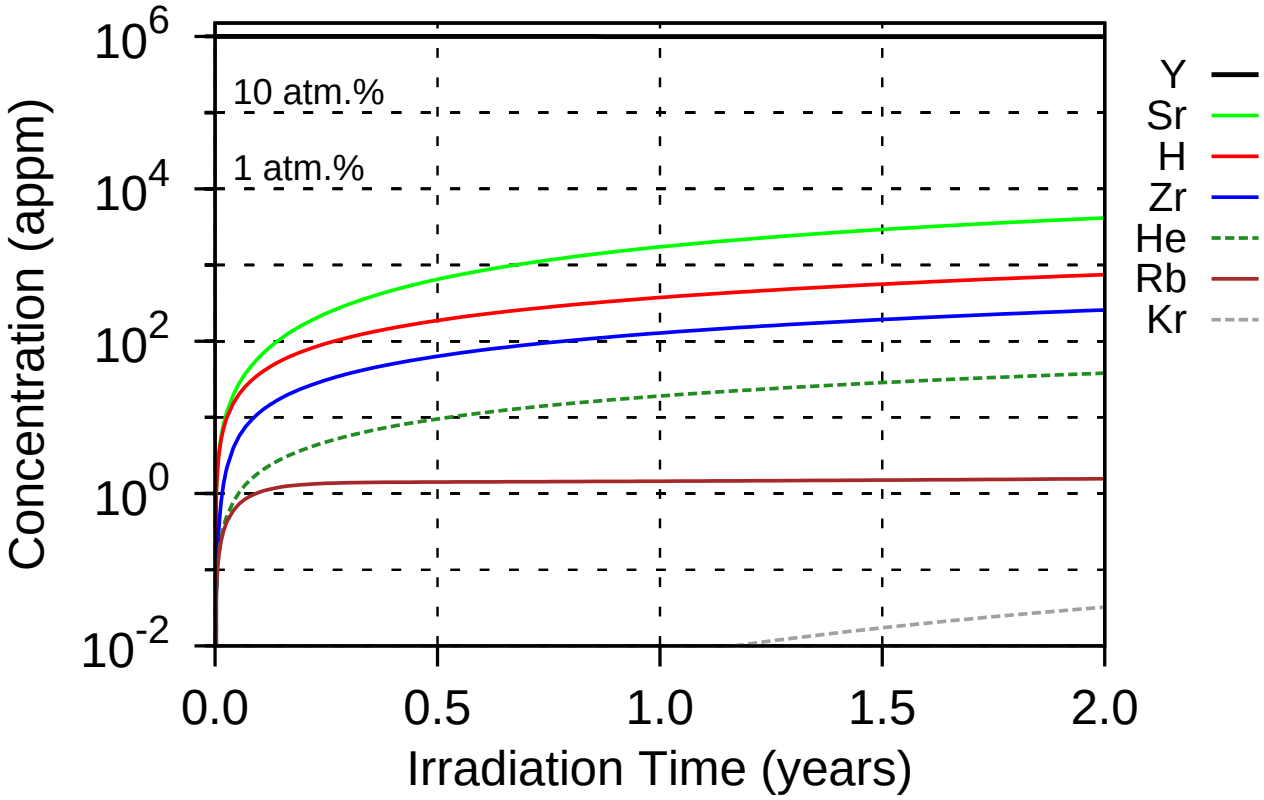




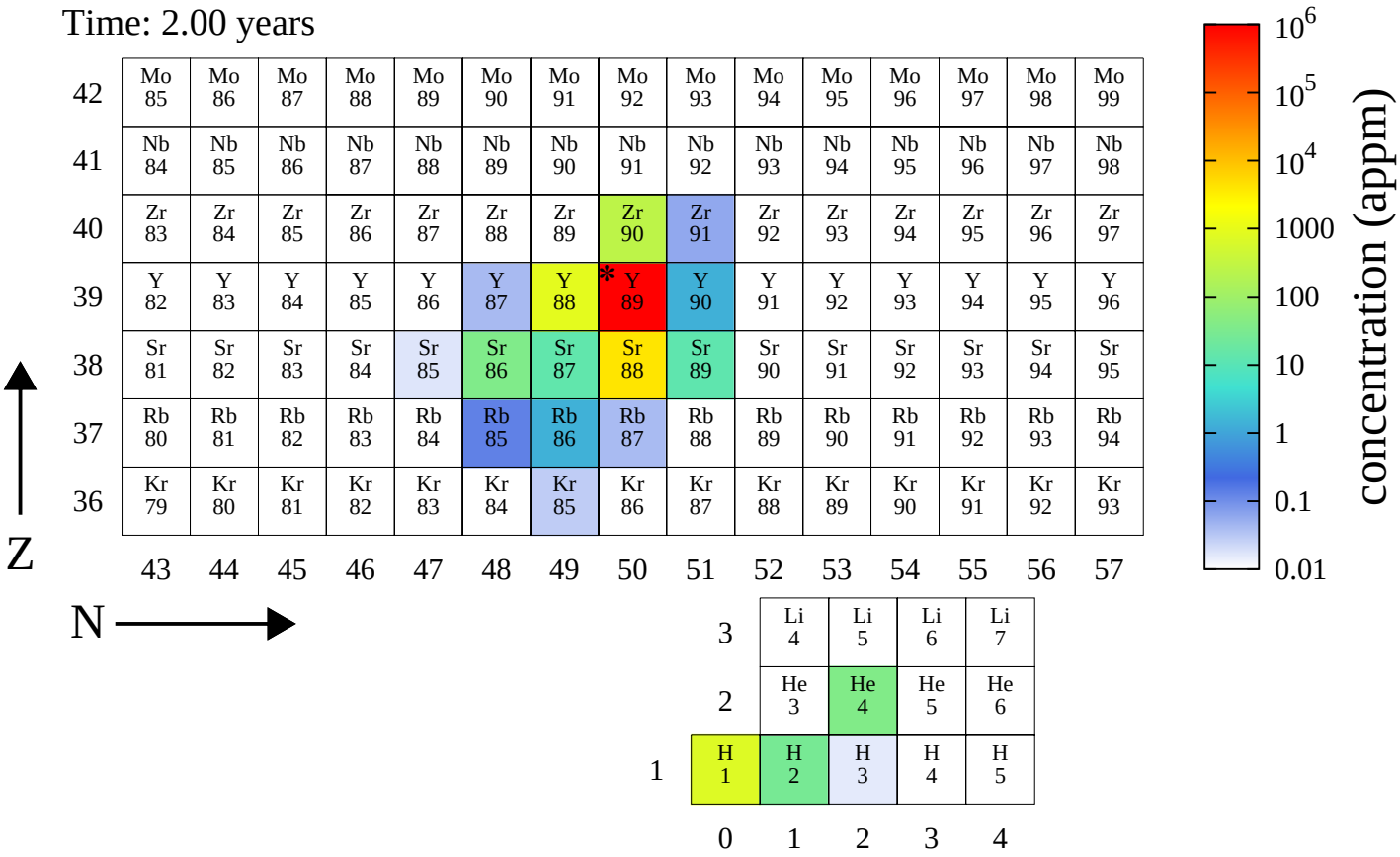




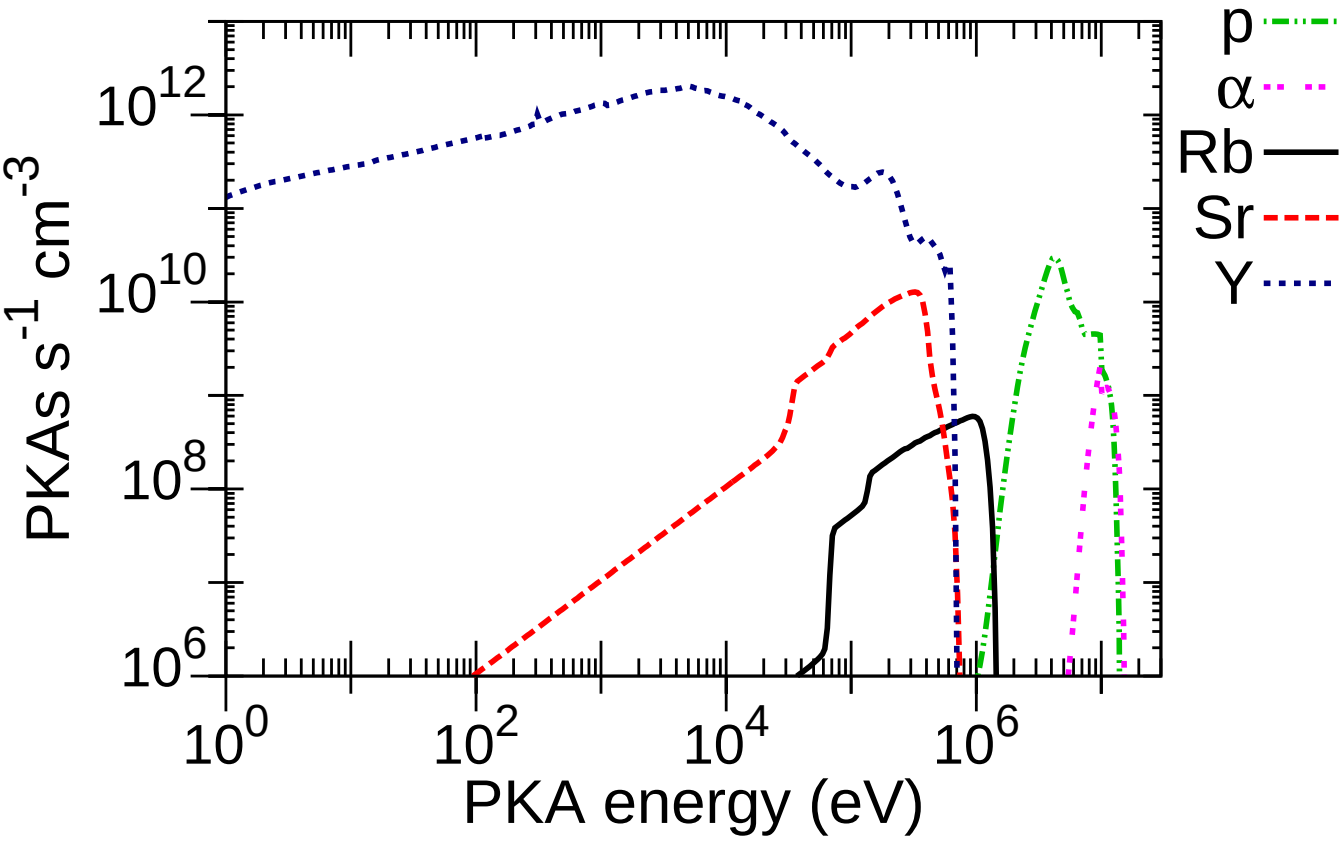
Yttrium FW Transmutation

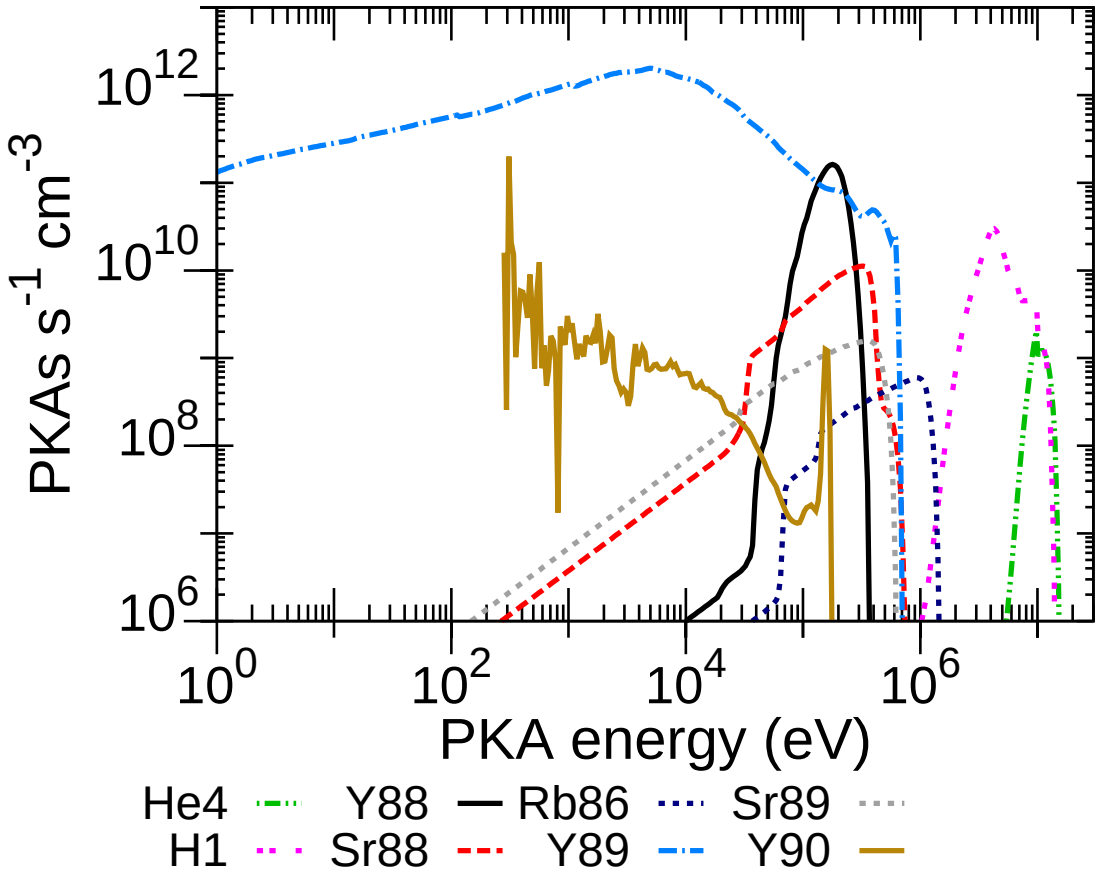


19 appm He & 374 appm H after 1 year 19 dpa/year



Yttrium FW PKA distributions





Yttrium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Y89m	15.66s	Y89(n,n′)Y89m			100.0	99.9
Y90m	3.19h	Y89(n,γ)Y90m	100.0	100.0	99.9	99.6
Y90	2.67d	Y89(n,γ)Y90	99.8	99.5	91.9	71.8
		Y89(n,γ)Y90m(IT)Y90			8.1	27.8
Y87	3.35d	Y89(n,2n)Y88(n,2n)Y87m(IT)Y87				76.9
		Y89(n,2n)Y88(n,2n)Y87				23.0
Rb86	18.64d	Y89(n,n′)Y89m(n,α)Rb86			93.3	
		Y89(n,n′)Y89m(n,α)Rb86m(IT)Rb86			6.6	
		Y89(n,α)Rb86				73.3
		Y89(n,α)Rb86m(IT)Rb86				26.2
Sr89	50.58d	Y89(n,γ)Y90(n,γ)Y91(β^-)Zr91(n,α)Sr88(n,γ)Sr89	65.6	8.1		
		Y89(n,γ)Y90(n,γ)Y91m(IT)Y91(β^-)Zr91(n,α)Sr88(n,γ)Sr89	22.7	3.8		
		Y89(n,γ)Y90(β^-)Zr90(n,γ)Zr91(n,α)Sr88(n,γ)Sr89	11.0	87.6		
		Y89(n,p)Sr89			100.0	99.6
Y91	58.52d	Y89(n,γ)Y90(n,γ)Y91	73.8	67.7	43.9	25.3
		Y89(n,γ)Y90(n,γ)Y91m(IT)Y91	25.5	31.8	47.3	36.3
		Y89(n,γ)Y90m(IT)Y90(n,γ)Y91m(IT)Y91			4.1	14.1
		Y89(n,γ)Y90m(IT)Y90(n,γ)Y91			3.9	9.8
		Y89(n,γ)Y90(β^-)Zr90(n,γ)Zr91(n,p)Y91m(IT)Y91				4.7
		Y89(n,γ)Y90(β^-)Zr90(n,γ)Zr91(n,p)Y91				3.6
		Y89(n,γ)Y90m(IT)Y90(β^-)Zr90(n,γ)Zr91(n,p)Y91m(IT)Y91				1.8
		Y89(n,γ)Y90m(IT)Y90(β^-)Zr90(n,γ)Zr91(n,p)Y91				1.4
Y88	106.63d	Y89(n,2n)Y88				99.9
Kr85	10.75y	Y89(n,2n)Y88(β^+)Sr88(n,α)Kr85				73.2
		Y89(n,np)Sr88(n,α)Kr85				15.0
		Y89(n,2n)Y88(β^+)Sr88(n,α)Kr85m(IT)Kr85				8.5
		Y89(n,np)Sr88(n,α)Kr85m(IT)Kr85				1.8
H3	12.33y	Y89(n,p)H1(n,γ)H2(n,γ)H3			99.6	
		Y89(n,t)H3				23.4
		Y89(n,2n)Y88(n,t)H3				4.1
Nb93m	16.11y	Y89(n,γ)Y90(n,γ)Y91(β^-)Zr91(n,γ)Zr92(n,γ)Zr93(β^-)Nb93m	43.7			
		Y89(n,γ)Y90(n,γ)Y91(n,γ)Y92(β^-)Zr92(n,γ)Zr93(β^-)Nb93m	25.0			
		Y89(n,γ)Y90(n,γ)Y91m(IT)Y91(β^-)Zr91(n,γ)Zr92(n,γ) Zr93(β^-)Nb93m	15.1			
		Y89(n,γ)Y90(n,γ)Y91m(IT)Y91(n,γ)Y92(β^-)Zr92(n,γ) Zr93(β^-)Nb93m	8.7			
		Y89(n,γ)Y90(β^-)Zr90(n,γ)Zr91(n,γ)Zr92(n,γ)Zr93(β^-)Nb93m	5.6			
Sr90	28.79y	Y89(n,γ)Y90(n,γ)Y91(β^-)Zr91(n,γ)Zr92(n,γ)Zr93(n,α)Sr90	31.1			
		Y89(n,γ)Y90(n,γ)Y91(β^-)Zr91(n,α)Sr88(n,γ)Sr89(n,γ)Sr90	19.0			
		Y89(n,γ)Y90(n,γ)Y91(n,γ)Y92(β^-)Zr92(n,γ)Zr93(n,α)Sr90	18.1			
		Y89(n,γ)Y90(n,γ)Y91m(IT)Y91(β^-)Zr91(n,γ)Zr92(n,γ) Zr93(n,α)Sr90	10.8			
		Y89(n,γ)Y90(n,γ)Y91m(IT)Y91(β^-)Zr91(n,α)Sr88(n,γ) Sr89(n,γ)Sr90	6.6			
		Y89(n,γ)Y90(n,γ)Y91m(IT)Y91(n,γ)Y92(β^-)Zr92(n,γ) Zr93(n,α)Sr90	6.3			
		Y89(n,γ)Y90(β^-)Zr90(n,γ)Zr91(n,γ)Zr92(n,γ)Zr93(n,α)Sr90	4.0			
		Y89(n,γ)Y90(β^-)Zr90(n,γ)Zr91(n,α)Sr88(n,γ)Sr89(n,γ)Sr90	2.6			
		Y89(n,p)Sr89(n,γ)Sr90			85.5	92.2
		Y89(n,γ)Y90(n,p)Sr90			12.7	5.5
		Y89(n,γ)Y90m(IT)Y90(n,p)Sr90			1.1	2.1

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Kr81	2.1 10^5y	Y89(n,α)Rb86(β^-)Sr86(n,α)Kr83(n,2n)Kr82(n,2n)Kr81				11.2
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85(n,2n)Sr84(n,α)Kr81				8.9
		Y89(n,2n)Y88(n,α)Rb85(n,α)Br82m(IT)Br82(β^-) Kr82(n,2n)Kr81				5.2
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85(n,α)Kr82(n,2n)Kr81				5.0
		Y89(n,α)Rb86(β^-)Sr86(n,α)Kr83m(IT)Kr83(n,2n) Kr82(n,2n)Kr81				4.4
		Y89(n,2n)Y88(n,α)Rb85(n,α)Br82(β^-)Kr82(n,2n)Kr81				4.2
		Y89(n,α)Rb86m(IT)Rb86(β^-)Sr86(n,α)Kr83(n,2n) Kr82(n,2n)Kr81				4.0
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85(n,nα)Kr81				3.9
		Y89(n,α)Rb86m(IT)Rb86(β^-)Sr86(n,2n)Sr85(n,2n) Sr84(n,α)Kr81				3.2
		Y89(n,α)Rb86(β^-)Sr86(n,nα)Kr82(n,2n)Kr81				2.7
		Y89(n,α)Rb86(n,α)Br83(β^-)Kr83m(IT)Kr83(n,2n) Kr82(n,2n)Kr81				2.5
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85m(IT)Sr85(n,2n) Sr84(n,α)Kr81				2.4
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85(β^+)Rb85(n,α)Br82m(IT) Br82(β^-)Kr82(n,2n)Kr81				2.1
		Y89(n,α)Rb86(β^-)Sr86(n,α)Kr83(n,2n)Kr82(n,2n) Kr81m(IT)Kr81				2.0
		Y89(n,α)Rb86m(IT)Rb86(β^-)Sr86(n,2n)Sr85(n,α) Kr82(n,2n)Kr81				1.8
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85(β^+)Rb85(n,α)Br82(β^-) Kr82(n,2n)Kr81				1.7
		Y89(n,α)Rb86m(IT)Rb86(β^-)Sr86(n,α)Kr83m(IT)Kr83(n,2n) Kr82(n,2n)Kr81				1.6
		Y89(n,α)Rb86m(IT)Rb86(β^-)Sr86(n,2n)Sr85(n,nα)Kr81				1.4
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85m(IT)Sr85(n,α) Kr82(n,2n)Kr81				1.3
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85(n,2n)Sr84(n,α) Kr81m(IT)Kr81				1.3
		Y89(n,α)Rb86(n,2n)Rb85(n,α)Br82m(IT)Br82(β^-) Kr82(n,2n)Kr81				1.1
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85m(IT)Sr85(n,nα)Kr81				1.1
		Y89(n,α)Rb86m(IT)Rb86(β^-)Sr86(n,nα)Kr82(n,2n)Kr81				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Se79	3.8 10^5y	Y89(n,α)Rb86(β^-)Sr86(n,α)Kr83(n,α)Se80(n,2n)Se79				11.8
		Y89(n,α)Rb86(β^-)Sr86(n,α)Kr83(n,2n)Kr82(n,α)Se79				8.7
		Y89(n,α)Rb86(β^-)Sr86(n,α)Kr83m(IT)Kr83(n,α) Se80(n,2n)Se79				4.6
		Y89(n,α)Rb86m(IT)Rb86(β^-)Sr86(n,α)Kr83(n,α) Se80(n,2n)Se79				4.2
		Y89(n,2n)Y88(n,α)Rb85(n,α)Br82m(IT)Br82(β^-)Kr82(n,α)Se79				4.0
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85(n,α)Kr82(n,α)Se79				3.9
		Y89(n,α)Rb86(β^-)Sr86(n,α)Kr83m(IT)Kr83(n,2n) Kr82(n,α)Se79				3.4
		Y89(n,2n)Y88(n,α)Rb85(n,α)Br82(β^-)Kr82(n,α)Se79				3.3
		Y89(n,α)Rb86m(IT)Rb86(β^-)Sr86(n,α)Kr83(n,2n) Kr82(n,α)Se79				3.1
		Y89(n,α)Rb86(n,α)Br83(β^-)Kr83m(IT)Kr83(n,α) Se80(n,2n)Se79				2.6
		Y89(n,α)Rb86(β^-)Sr86(n,α)Kr83(n,α)Se80(n,2n) Se79m(IT)Se79				2.4
		Y89(n,α)Rb86(β^-)Sr86(n,α)Kr83(n,2n)Kr82(n,α) Se79m(IT)Se79				2.3
		Y89(n,α)Rb86(β^-)Sr86(n,nα)Kr82(n,α)Se79				2.1
		Y89(n,α)Rb86(n,α)Br83(β^-)Kr83m(IT)Kr83(n,2n) Kr82(n,α)Se79				1.9
		Y89(n,α)Rb86m(IT)Rb86(β^-)Sr86(n,α)Kr83m(IT)Kr83(n,α) Se80(n,2n)Se79				1.6
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85(β^+)Rb85(n,α)Br82m(IT) Br82(β^-)Kr82(n,α)Se79				1.6
		Y89(n,α)Rb86m(IT)Rb86(β^-)Sr86(n,2n)Sr85(n,α) Kr82(n,α)Se79				1.4
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85(β^+)Rb85(n,α)Br82(β^-) Kr82(n,α)Se79				1.3
		Y89(n,α)Rb86m(IT)Rb86(β^-)Sr86(n,α)Kr83m(IT)Kr83(n,2n) Kr82(n,α)Se79				1.2
		Y89(n,2n)Y88(n,α)Rb85(n,α)Br82m(IT)Br82(β^-)Kr82(n,α) Se79m(IT)Se79				1.1
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85m(IT)Sr85(n,α) Kr82(n,α)Se79				1.0
		Y89(n,α)Rb86(β^-)Sr86(n,2n)Sr85(n,α)Kr82(n,α) Se79m(IT)Se79				1.0
Zr93	1.5 10^6y	Y89(n,γ)Y90(n,γ)Y91(β^-)Zr91(n,γ)Zr92(n,γ)Zr93	47.3	8.2		
		Y89(n,γ)Y90(n,γ)Y91(n,γ)Y92(β^-)Zr92(n,γ)Zr93	20.8	6.3		
		Y89(n,γ)Y90(n,γ)Y91m(IT)Y91(β^-)Zr91(n,γ)Zr92(n,γ)Zr93	16.3	3.9		
		Y89(n,γ)Y90(n,γ)Y91m(IT)Y91(n,γ)Y92(β^-)Zr92(n,γ)Zr93	7.2	3.0		
		Y89(n,γ)Y90(β^-)Zr90(n,γ)Zr91(n,γ)Zr92(n,γ)Zr93	6.9	78.0	90.1	
		Y89(n,γ)Y90m(IT)Y90(β^-)Zr90(n,γ)Zr91(n,γ)Zr92(n,γ)Zr93			7.9	
Rb87	4.8 10^{10}y	Y89(n,γ)Y90(n,α)Rb87	99.7	99.3	91.0	
		Y89(n,γ)Y90m(IT)Y90(n,α)Rb87			8.0	
		Y89(n,2n)Y88(β^+)Sr88(n,2n)Sr87m(β^+)Rb87				19.6
		Y89(n,2n)Y88(β^+)Sr88(n,2n)Sr87(n,p)Rb87				14.7
		Y89(n,2n)Y88(β^+)Sr88(n,d)Rb87				14.0
		Y89(n,2n)Y88(n,2n)Y87m(IT)Y87(β^+)Sr87(n,p)Rb87				13.4
		Y89(n,2n)Y88(β^+)Sr88(n,np)Rb87				12.9
		Y89(n,2n)Y88(β^+)Sr88(n,2n)Sr87m(IT)Sr87(n,p)Rb87				4.6
		Y89(n,np)Sr88(n,2n)Sr87m(β^+)Rb87				4.0
		Y89(n,2n)Y88(n,2n)Y87(β^+)Sr87(n,p)Rb87				4.0
		Y89(n,np)Sr88(n,2n)Sr87(n,p)Rb87				3.5
		Y89(n,np)Sr88(n,d)Rb87				2.9
		Y89(n,np)Sr88(n,np)Rb87				2.7
		Y89(n,np)Sr88(n,2n)Sr87m(IT)Sr87(n,p)Rb87				1.1

Zirconium

Isotope	Atom % abundance	
Zr90	51.45	
Zr91	11.22	
Zr92	17.15	
Zr94	17.38	($T_{1/2}$ =6.0 10^{15}y)
Zr96	2.80	($T_{1/2}$ =3.9 10^{19}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	7.43E+14	4.79E+14	2.37E+14	2.07E+12	5.60E+08	2.93E+08
Zr90m	32.3					
Y89m	25.2	37.2	34.6			
Zr89	24.1	37.3	34.7			
Zr95	4.3	6.7	12.9	29.7		
Nb95	4.3	6.6	13.4	64.1		
Zr89m	3.3	2.2				
Y90	1.6	2.5	2.0	0.1	22.9	
Nb97	1.0	1.5	0.1			
Zr97	1.0	1.5	0.1			
Nb97m	0.9	1.4	0.1			
Y91	0.4	0.6	1.2	1.9		
Y88	0.1	0.2	0.3	3.3		
Zr93					26.6	50.6
Nb93m					25.4	49.1
Sr90				0.1	22.9	
H3				0.1	2.0	

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.45E-01	5.28E-02	2.64E-02	2.91E-04	2.43E-08	1.38E-09
Zr90m	61.6					
Y89m	18.8	49.2	45.4			
Zr89	6.9	18.8	17.3			
Zr95	3.0	8.3	15.9	28.9		
Nb95	2.9	7.8	15.6	59.1		
Zr89m	1.8	2.1				
Y90	1.2	3.3	2.6	0.1	79.2	
Nb97	0.9	2.5	0.1			
Zr97	0.7	1.9	0.1			
Nb97m	0.6	1.5	0.1			
Y92	0.4	1.2				
Y88	0.2	0.6	1.2	10.3		
Y91	0.2	0.6	1.1	1.3		
Sr90					14.8	
Nb93m					2.9	51.6
Zr93					1.9	33.0
Nb94					1.2	15.4

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.56E+05	6.90E+04	3.58E+04	4.04E+02	4.37E-04	3.13E-04
Zr90m	71.5					
Y89m	17.5	62.2	55.3			
Zr89	3.6	13.2	11.7			
Nb95	2.3	8.4	16.1	59.4		
Zr95	2.2	8.0	14.9	26.4		
Zr89m	1.3	2.0				
Nb97m	0.5	1.7	0.1			
Nb97	0.4	1.6	0.1			
Y88	0.2	0.9	1.7	14.3		
Nb94					97.9	97.0
Nb93m					2.1	3.0

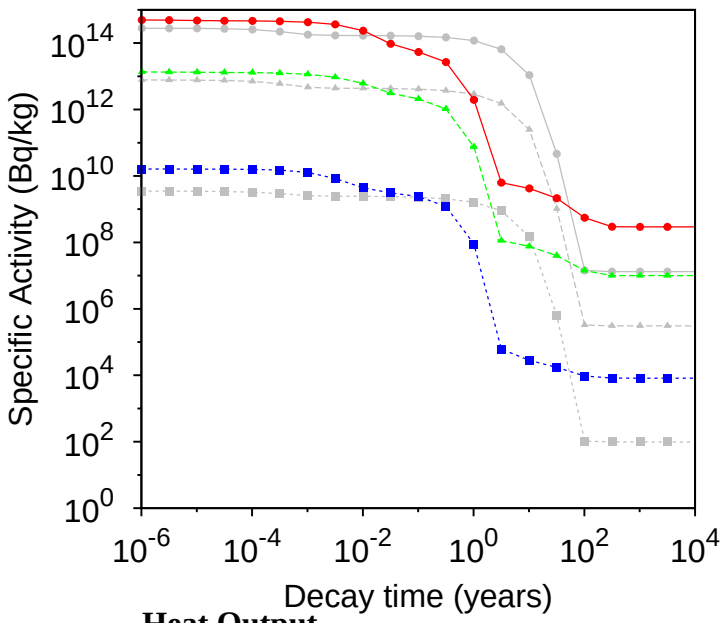
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.82E+05	2.80E+05	1.50E+05	1.61E+03	4.13E+00	1.81E-01
Zr89	50.1	50.4	43.4			
Y90	11.3	11.4	8.4	0.2	8.4	
Zr95	10.8	10.8	19.5	36.3		
Y89m	10.6	10.2	8.8			
Nb95	6.6	6.6	12.3	47.8		
Zr97	5.4	5.4	0.3			
Y91	2.6	2.6	4.6	6.0		
Sr89	1.0	1.0	1.8	1.2		
Y88	0.3	0.3	0.6	5.6		
Sr90				2.4	87.1	
Zr93					4.0	89.8
Nb93m					0.4	9.5

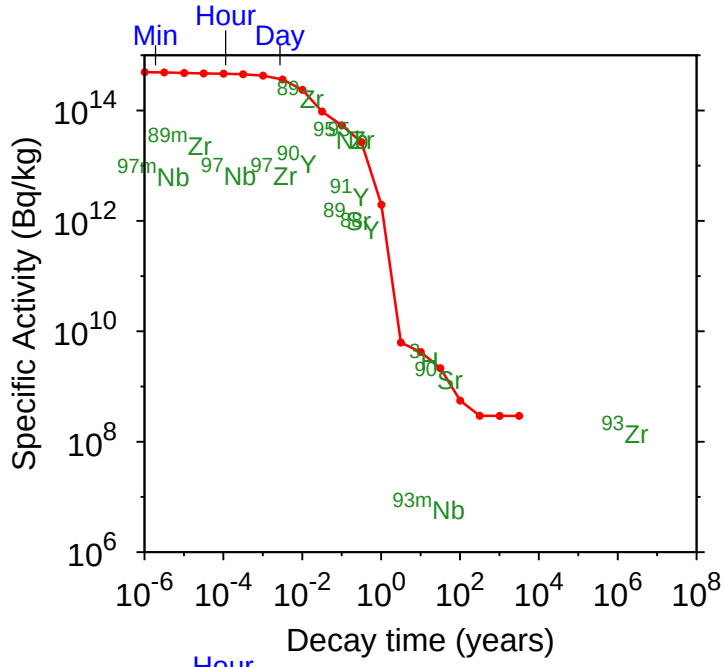
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.25E+05	4.24E+05	3.36E+05	7.07E+03	2.49E+01	4.00E+00
Zr95	44.3	44.4	54.0	51.2		
Zr89	23.1	23.1	13.5			
Nb95	13.5	13.5	17.1	33.7		
Y91	6.3	6.3	7.7	5.0		
Y90	4.2	4.2	2.1		0.8	
Y89m	3.6	3.4	2.0			
Sr89	2.1	2.1	2.5	0.8		
Zr97	1.6	1.5	0.1			
Y88	0.8	0.8	0.9	4.3		
Sr90	0.1	0.1	0.1	3.2	82.4	
Kr85				1.5	0.7	
Zr93				0.1	14.9	92.6
Nb93m					1.0	6.5

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	8.66E+11	2.91E+11	1.61E+11	2.13E+09	1.69E+05	3.68E+04
Zr90m	64.4					
Y89m	19.6	55.7	46.4			
Zr89	5.4	16.1	13.4			
Zr95	3.7	11.0	19.1	28.8		
Nb95	3.7	10.9	19.7	62.3		
Zr89m	1.8	2.2				
Nb97m	0.6	1.7	0.1			
Y88	0.2	0.7	1.2	8.8		
Sr90				0.1	76.2	
Zr93					8.8	40.2
Nb93m					8.5	39.0
Nb94					6.4	20.7

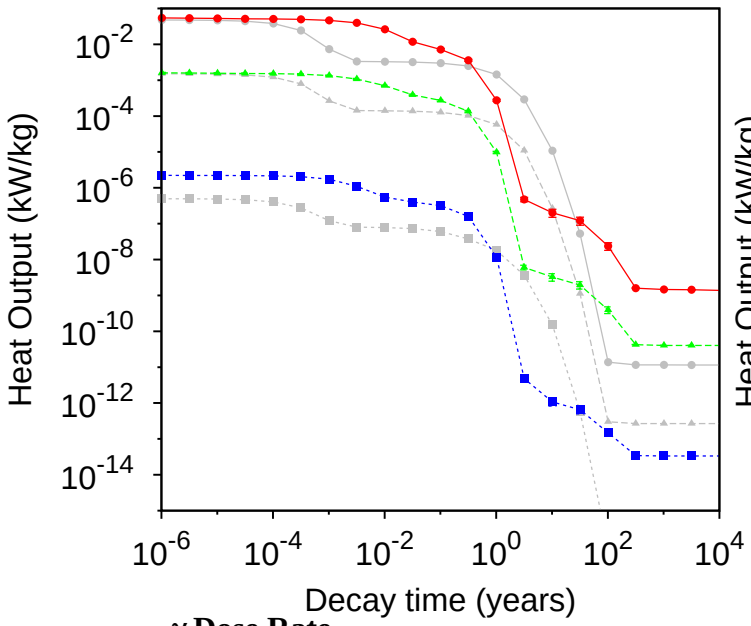
Zirconium activation characteristics

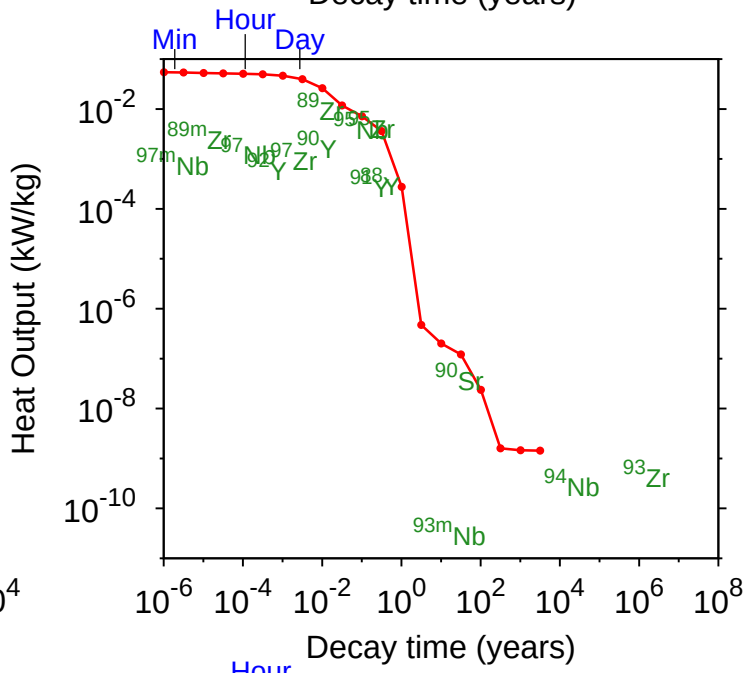
Specific Activity



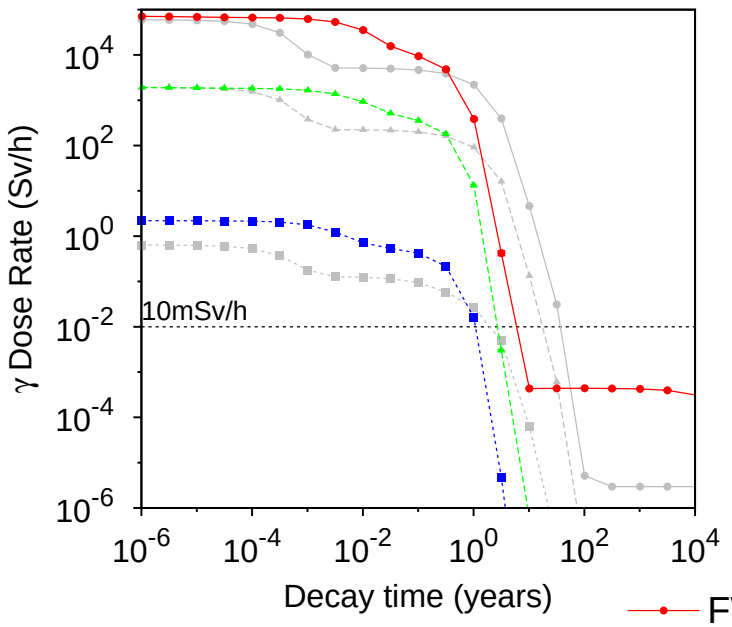


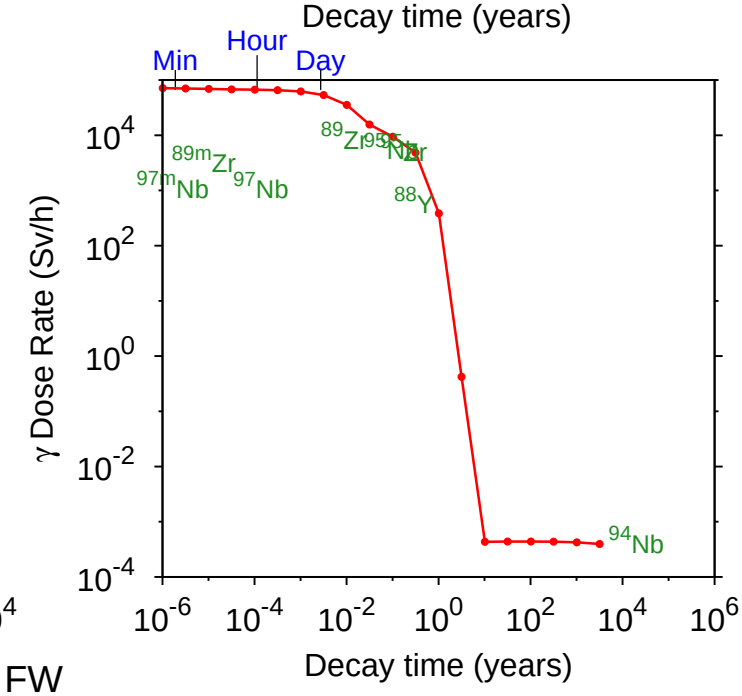
Heat Output





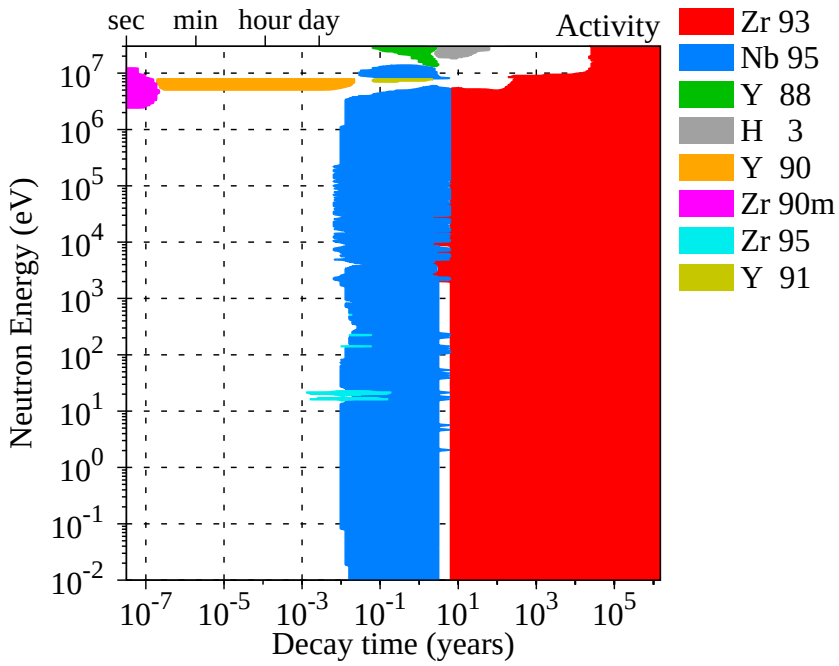
γ Dose Rate

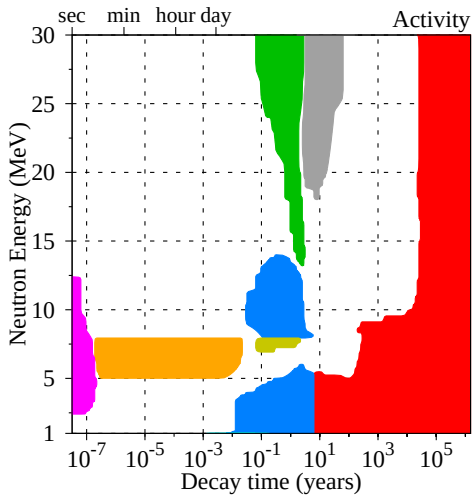


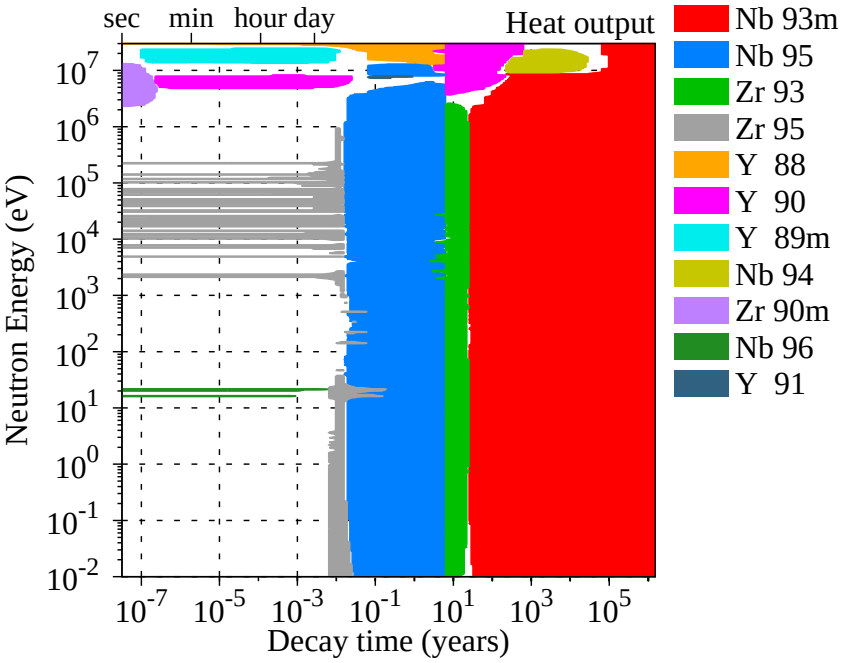


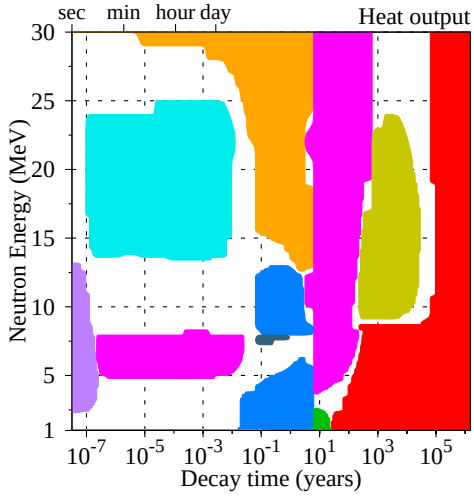
FW
Blanket
Manifold
Fe results

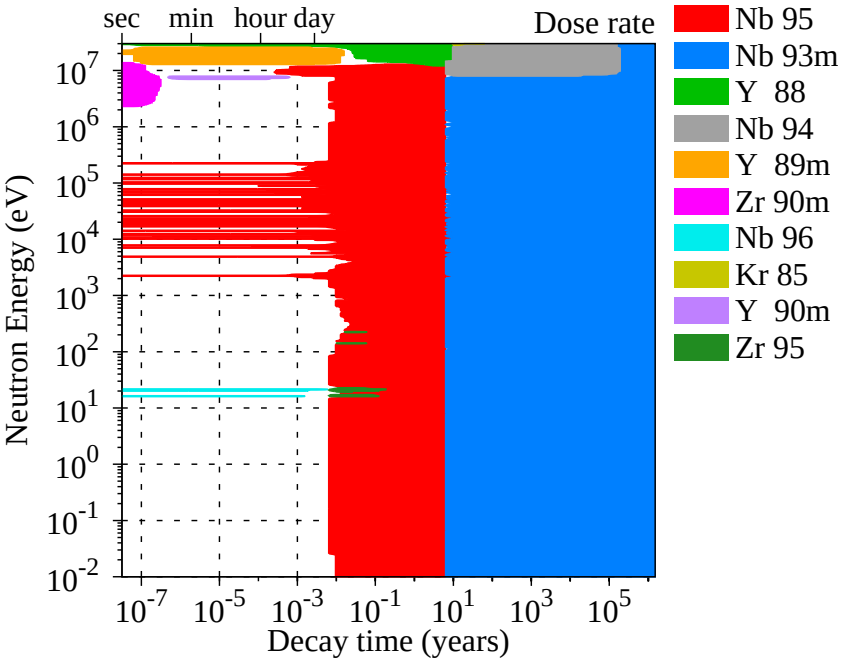
Zirconium Importance diagrams

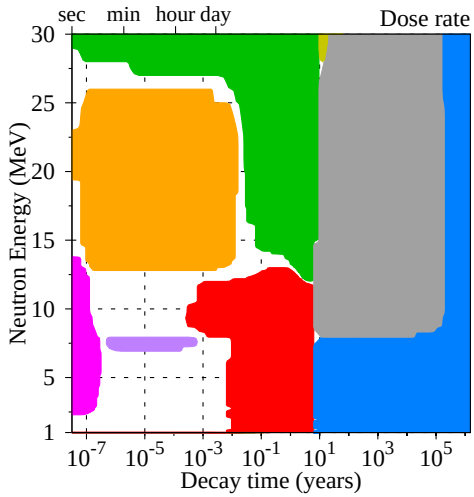




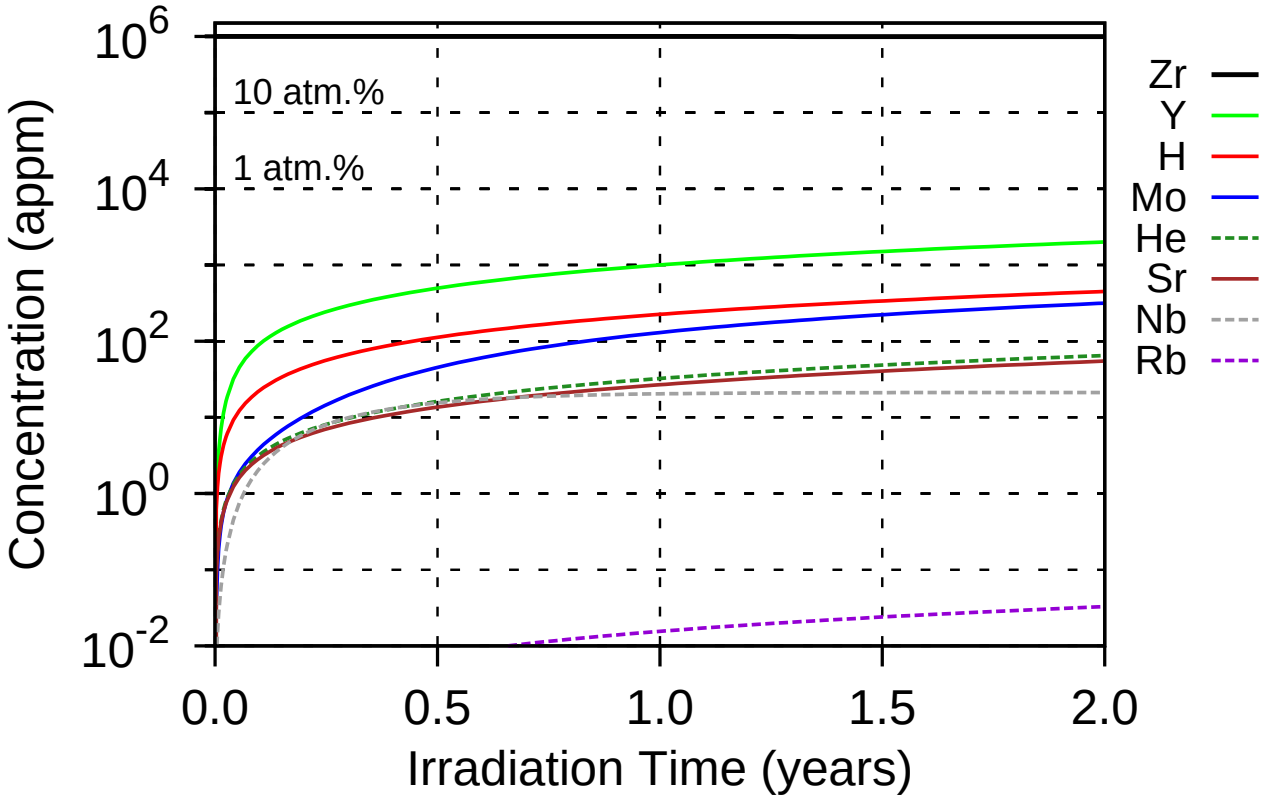




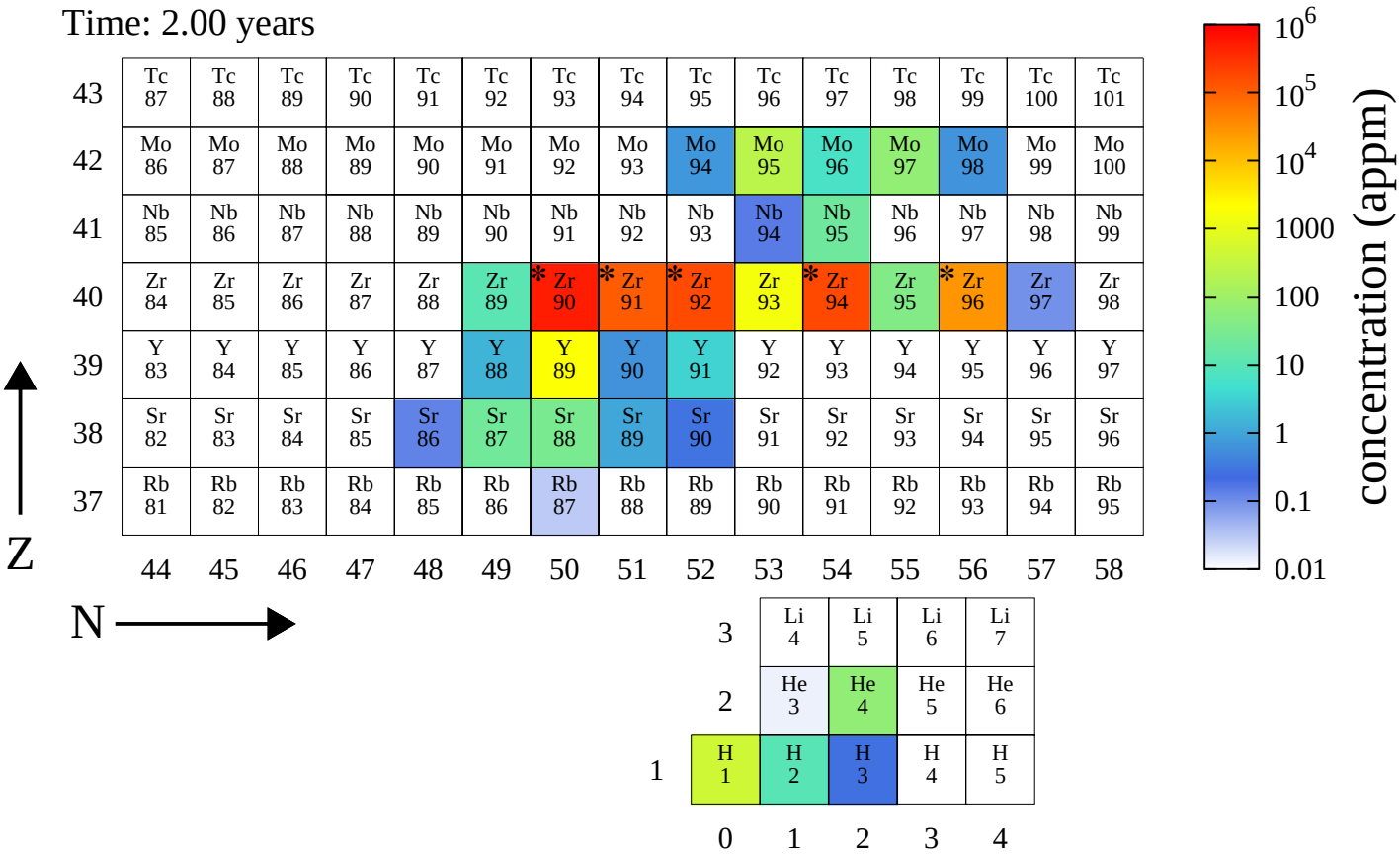




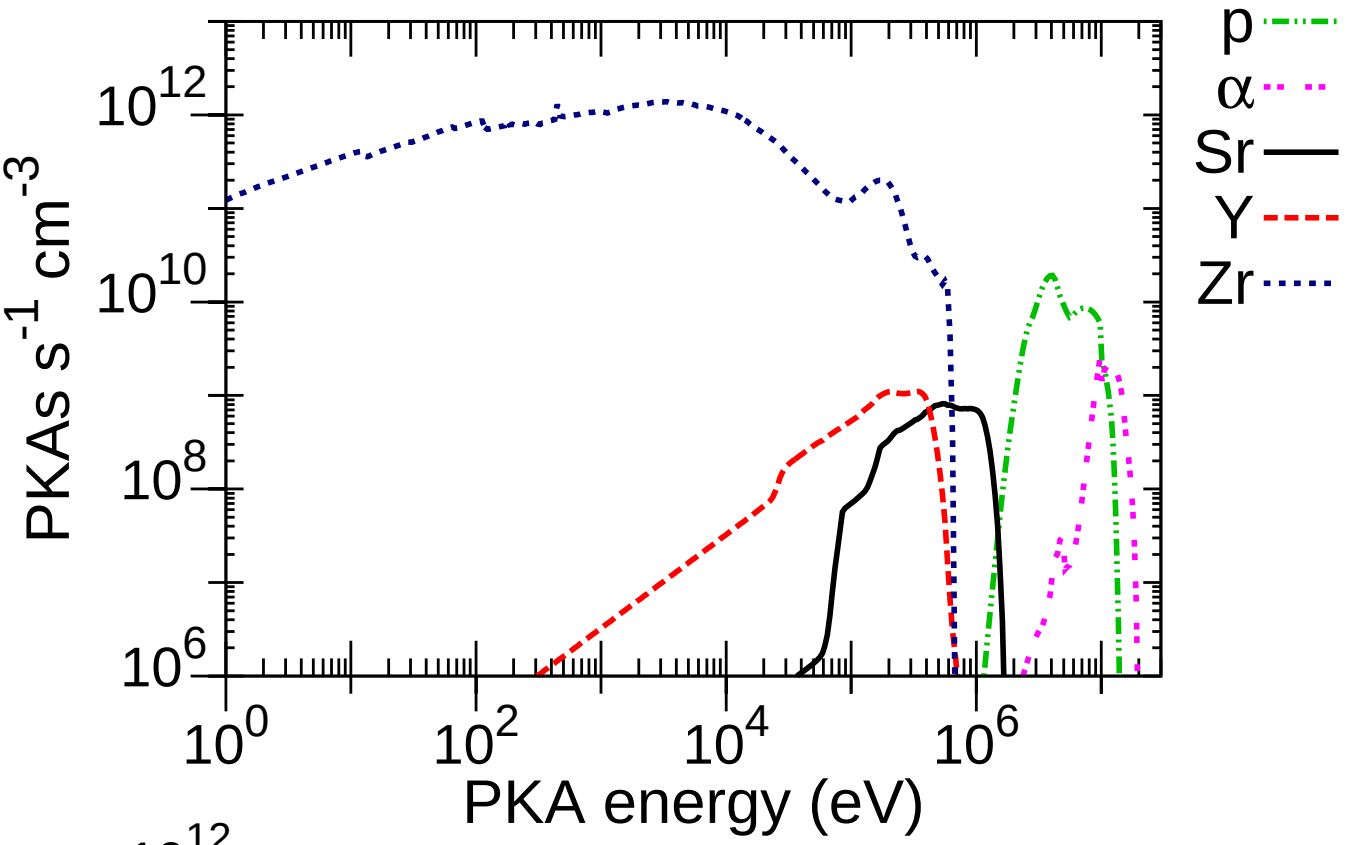
Zirconium FW Transmutation

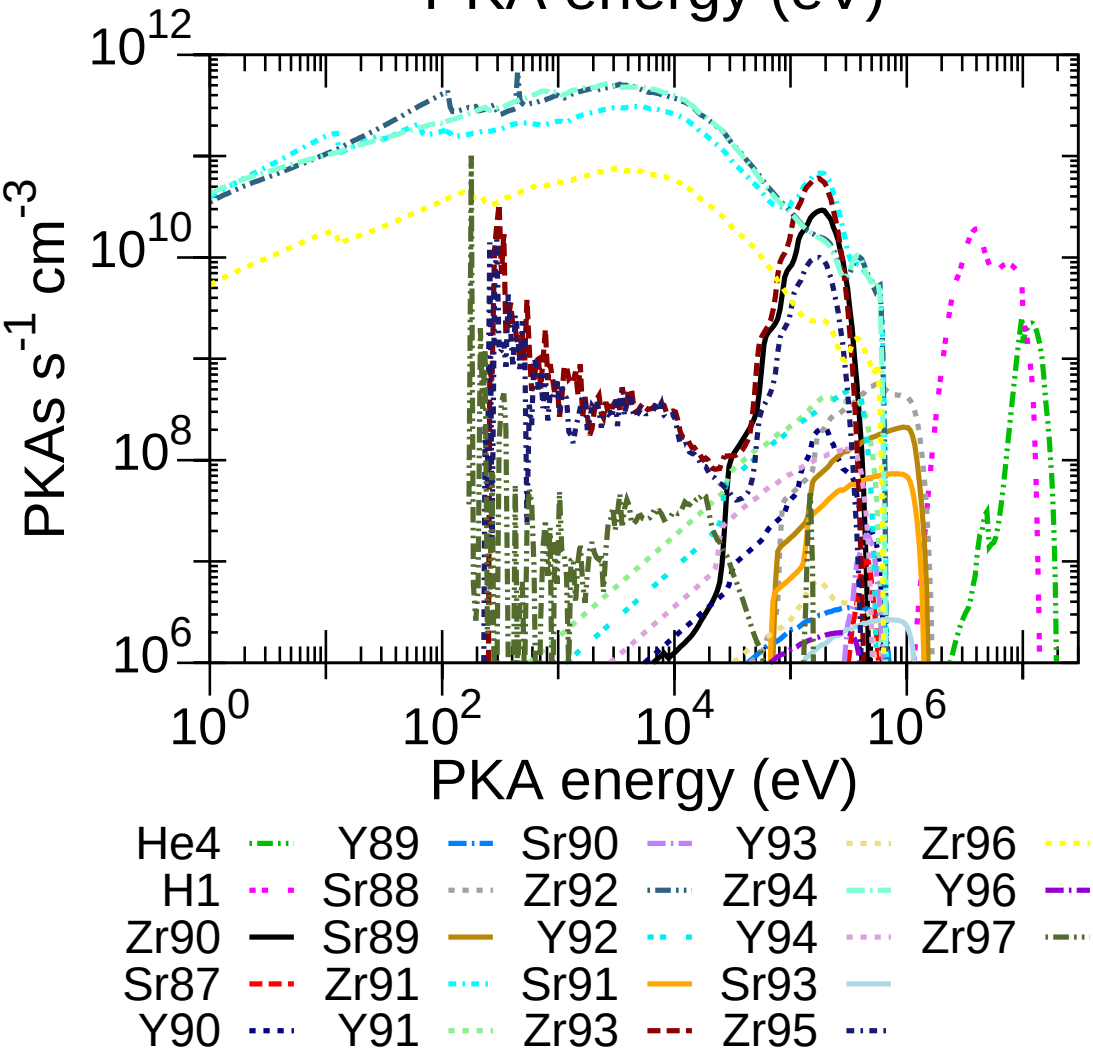


32 appm He & 225 appm H after 1 year 12 dpa/year



Zirconium FW PKA distributions





Zirconium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Zr90m	0.81s	Zr90(n,n′)Zr90m			99.9	74.9
		Zr91(n,2n)Zr90m				21.6
		Zr92(n,2n)Zr91(n,2n)Zr90m				2.8
Y89m	15.66s	Zr91(n,α)Sr88(n,γ)Sr89(β^-)Y89m	99.3	99.2		
		Zr92(n,α)Sr89(β^-)Y89(n,n′)Y89m			97.3	
		Zr91(n,α)Sr88(n,γ)Sr89(β^-)Y89(n,n′)Y89m			1.3	
		Zr90(n,2n)Zr89(β^+)Y89m				81.9
		Zr90(n,2n)Zr89m(IT)Zr89(β^+)Y89m				11.8
		Zr90(n,np)Y89m				3.8
Nb97m	52.71s	Zr96(n,γ)Zr97(β^-)Nb97m	99.9	100.0	100.0	100.0
Zr89m	4.18m	Zr90(n,2n)Zr89m				98.1
Nb97	1.20h	Zr96(n,γ)Zr97(β^-)Nb97m(IT)Nb97	94.9	95.0	95.0	94.9
		Zr96(n,γ)Zr97(β^-)Nb97	4.9	5.0	5.0	4.9
Y90m	3.19h	Zr91(n,α)Sr88(n,γ)Sr89(β^-)Y89(n,γ)Y90m	98.8	98.5	1.2	
		Zr92(n,α)Sr89(β^-)Y89(n,γ)Y90m	1.1	1.4	88.9	
		Zr90(n,p)Y90(n,n′)Y90m			9.3	
		Zr90(n,p)Y90m				92.9
		Zr91(n,np)Y90m				3.1
		Zr91(n,d)Y90m				1.3
Y92	3.54h	Zr94(n,γ)Zr95(β^-)Nb95(n,α)Y92	55.1	96.9	7.9	
		Zr92(n,γ)Zr93(n,α)Sr90(n,γ)Sr91(β^-)Y91m(IT)Y91(n,γ)Y92	12.7			
		Zr91(n,α)Sr88(n,γ)Sr89(β^-)Y89(n,γ)Y90(n,γ)Y91(n,γ)Y92	11.0			
		Zr92(n,γ)Zr93(n,α)Sr90(n,γ)Sr91(β^-)Y91(n,γ)Y92	8.9			
		Zr91(n,α)Sr88(n,γ)Sr89(β^-)Y89(n,γ)Y90(n,γ)Y91m(IT) Y91(n,γ)Y92	3.8			
		Zr94(n,γ)Zr95(β^-)Nb95m(n,α)Y92	2.7	1.9		
		Zr92(n,γ)Zr93(n,α)Sr90(β^-)Y90(n,γ)Y91(n,γ)Y92	2.5			
		Zr94(n,γ)Zr95(β^-)Nb95m(IT)Nb95(n,α)Y92		1.0		
		Zr91(n,p)Y91(n,γ)Y92			81.5	
		Zr91(n,p)Y91m(IT)Y91(n,γ)Y92			8.3	
		Zr92(n,p)Y92				98.9
Zr97	16.74h	Zr96(n,γ)Zr97	99.9	100.0	100.0	100.0
Nb96	23.35h	Zr94(n,γ)Zr95(β^-)Nb95(n,γ)Nb96	98.9	98.9	98.9	
		Zr94(n,γ)Zr95(β^-)Nb95m(IT)Nb95(n,γ)Nb96	1.0	1.0	1.0	
		Zr96(n,2n)Zr95(β^-)Nb95(n,γ)Nb96				96.0
		Zr96(n,2n)Zr95(β^-)Nb95m(IT)Nb95(n,γ)Nb96				1.0
Y90	2.67d	Zr91(n,α)Sr88(n,γ)Sr89(β^-)Y89(n,γ)Y90	80.5	68.9		
		Zr92(n,γ)Zr93(n,α)Sr90(β^-)Y90	18.0	29.4		
		Zr92(n,α)Sr89(β^-)Y89(n,γ)Y90		1.0		
		Zr90(n,p)Y90			99.2	58.6
		Zr90(n,p)Y90m(IT)Y90				33.5
		Zr91(n,np)Y90				2.6
		Zr91(n,np)Y90m(IT)Y90				1.1
Zr89	3.27d	Zr90(n,2n)Zr89				85.8
		Zr90(n,2n)Zr89m(IT)Zr89				12.3
Nb95	34.99d	Zr94(n,γ)Zr95(β^-)Nb95	98.9	99.0	99.0	
		Zr94(n,γ)Zr95(β^-)Nb95m(IT)Nb95	1.0	1.0	1.0	
		Zr96(n,2n)Zr95(β^-)Nb95				98.3
		Zr96(n,2n)Zr95(β^-)Nb95m(IT)Nb95				1.0
Sr89	50.58d	Zr91(n,α)Sr88(n,γ)Sr89	99.3	99.2	2.6	
		Zr92(n,α)Sr89			97.4	79.8
		Zr90(n,2n)Zr89(β^+)Y89m(IT)Y89(n,p)Sr89				13.6
		Zr90(n,np)Y89(n,p)Sr89				2.1
		Zr90(n,2n)Zr89m(IT)Zr89(β^+)Y89m(IT)Y89(n,p)Sr89				2.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Y91	58.52d	Zr92(n,γ)Zr93(n,α)Sr90(n,γ)Sr91(β^-)Y91m(IT)Y91	31.3	57.0		
		Zr91(n,α)Sr88(n,γ)Sr89(β^-)Y89(n,γ)Y90(n,γ)Y91	27.1	1.1		
		Zr92(n,γ)Zr93(n,α)Sr90(n,γ)Sr91(β^-)Y91	21.9	39.9		
		Zr91(n,α)Sr88(n,γ)Sr89(β^-)Y89(n,γ)Y90(n,γ)Y91m(IT)Y91	9.4			
		Zr92(n,γ)Zr93(n,α)Sr90(β^-)Y90(n,γ)Y91	6.2			
		Zr92(n,γ)Zr93(n,α)Sr90(β^-)Y90(n,γ)Y91m(IT)Y91	2.1			
		Zr91(n,p)Y91			89.5	30.4
		Zr91(n,p)Y91m(IT)Y91			9.1	40.5
		Zr94(n,α)Sr91(β^-)Y91m(IT)Y91				7.6
		Zr94(n,α)Sr91(β^-)Y91				5.3
		Zr92(n,2n)Zr91(n,p)Y91m(IT)Y91				4.6
		Zr92(n,2n)Zr91(n,p)Y91				3.5
		Zr92(n,np)Y91				2.6
		Zr92(n,np)Y91m(IT)Y91				2.4
		Zr92(n,d)Y91				1.6
		Zr92(n,d)Y91m(IT)Y91				1.1
Zr95	64.03d	Zr94(n,γ)Zr95	100.0	100.0	100.0	
		Zr96(n,2n)Zr95				99.5
Y88	106.63d	Zr90(n,2n)Zr89(β^+)Y89m(IT)Y89(n,2n)Y88				71.9
		Zr90(n,np)Y89(n,2n)Y88				11.2
		Zr90(n,2n)Zr89m(IT)Zr89(β^+)Y89m(IT)Y89(n,2n)Y88				10.3
		Zr90(n,np)Y89m(IT)Y89(n,2n)Y88				3.4
Kr85	10.75y	Zr91(n,α)Sr88(n,α)Kr85				41.4
		Zr90(n,2n)Zr89(β^+)Y89m(IT)Y89(n,2n)Y88(β^+)Sr88(n,α)Kr85				23.7
		Zr90(n,2n)Zr89(β^+)Y89m(IT)Y89(n,np)Sr88(n,α)Kr85				5.6
		Zr91(n,α)Sr88(n,α)Kr85m(IT)Kr85				4.8
		Zr92(n,nα)Sr88(n,α)Kr85				4.4
		Zr90(n,np)Y89(n,2n)Y88(β^+)Sr88(n,α)Kr85				3.7
		Zr90(n,2n)Zr89m(IT)Zr89(β^+)Y89m(IT)Y89(n,2n)Y88(β^+) Sr88(n,α)Kr85				3.4
		Zr92(n,2n)Zr91(n,α)Sr88(n,α)Kr85				1.8
		Zr90(n,np)Y89m(IT)Y89(n,2n)Y88(β^+)Sr88(n,α)Kr85				1.1
H3	12.33y	Zr91(n,t)H3				40.9
		Zr92(n,t)H3				1.3
		Zr92(n,2n)Zr91(n,t)H3				2.7
		Zr94(n,t)H3				1.5
		Zr94(n,2n)Zr93(n,t)H3				1.2
Nb93m	16.11y	Zr92(n,γ)Zr93(β^-)Nb93m	98.5	99.9	99.9	
		Zr91(n,γ)Zr92(n,γ)Zr93(β^-)Nb93m	1.5			
		Zr96(n,2n)Zr95(β^-)Nb95(n,2n)Nb94(n,2n)Nb93m				35.8
		Zr96(n,2n)Zr95(β^-)Nb95(n,2n)Nb94m(IT)Nb94(n,2n)Nb93m				27.6
		Zr94(n,2n)Zr93(β^-)Nb93m				12.5
		Zr96(n,2n)Zr95(β^-)Nb95(β^-)Mo95(n,2n)Mo94(n,np)Nb93m				9.6
		Zr96(n,2n)Zr95(β^-)Nb95(β^-)Mo95(n,t)Nb93m				6.8
		Zr96(n,2n)Zr95(β^-)Nb95(β^-)Mo95(n,2n)Mo94(n,d)Nb93m				3.0
Sr90	28.79y	Zr92(n,γ)Zr93(n,α)Sr90	97.8	99.1	92.3	
		Zr91(n,γ)Zr92(n,γ)Zr93(n,α)Sr90	1.5			
		Zr92(n,α)Sr89(n,γ)Sr90			7.6	
		Zr94(n,2n)Zr93(n,α)Sr90				65.6
		Zr94(n,nα)Sr90				33.9
Nb94	2.0 10^4y	Zr92(n,γ)Zr93(β^-)Nb93m(n,γ)Nb94m(IT)Nb94	60.0	58.4	60.1	
		Zr92(n,γ)Zr93(β^-)Nb93m(n,E)Nb93(n,γ)Nb94m(IT)Nb94	15.1	18.5	7.4	
		Zr92(n,γ)Zr93(β^-)Nb93m(n,E)Nb93(n,γ)Nb94	7.5	10.3	8.4	
		Zr92(n,γ)Zr93(β^-)Nb93(n,γ)Nb94m(IT)Nb94	6.4	4.8	4.5	
		Zr92(n,γ)Zr93(β^-)Nb93m(IT)Nb93(n,γ)Nb94m(IT)Nb94	4.3	3.0	2.9	
		Zr92(n,γ)Zr93(β^-)Nb93(n,γ)Nb94	3.2	2.7	5.1	
		Zr92(n,γ)Zr93(β^-)Nb93m(IT)Nb93(n,γ)Nb94	2.1	1.7	3.3	
		Zr92(n,γ)Zr93(β^-)Nb93m(n,γ)Nb94			4.8	
		Zr92(n,γ)Zr93(β^-)Nb93m(n,n$'$)Nb93(n,γ)Nb94			1.9	
		Zr92(n,γ)Zr93(β^-)Nb93m(n,n$'$)Nb93(n,γ)Nb94m(IT)Nb94			1.6	
		Zr96(n,2n)Zr95(β^-)Nb95(n,2n)Nb94				52.9
		Zr96(n,2n)Zr95(β^-)Nb95(n,2n)Nb94m(IT)Nb94				40.9
		Zr96(n,2n)Zr95(β^-)Nb95(β^-)Mo95(n,np)Nb94m(IT)Nb94				1.5
		Zr96(n,2n)Zr95(β^-)Nb95(β^-)Mo95(n,np)Nb94				1.4

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Zr93	1.5 10^6y	Zr92(n,γ)Zr93	97.8	99.9	100.0	
		Zr91(n,γ)Zr92(n,γ)Zr93	2.2			
		Zr94(n,2n)Zr93				99.8

Niobium

Isotope	Atom % abundance
Nb93	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	6.27E+14	4.87E+14	2.44E+14	9.99E+12	1.84E+11	2.31E+10
Nb94m	50.0	36.0				
Nb92m	43.4	55.9	87.0			
Nb95	3.1	4.0	7.4	0.1		
Nb93m	1.7	2.1	4.2	99.3	80.8	0.1
Y90	1.0	1.3	1.0			
Nb94				0.3	17.6	99.7
Nb91					1.5	

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	4.91E-02	4.78E-02	3.60E-02	6.06E-05	9.82E-06	6.44E-06
Nb92m	86.9	89.1	92.3			
Nb95	5.1	5.2	6.5	3.0		
Nb94m	4.9	2.8				
Y90	1.9	1.9	1.0			
Nb93m	0.1	0.1	0.1	81.0	7.5	
Nb94				15.0	92.4	99.9

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	7.40E+04	7.35E+04	5.74E+04	1.66E+01	1.28E+01	9.10E+00
Nb92m	93.8	94.5	94.3			
Nb95	4.7	4.7	5.6	15.0		
Nb94				77.7	99.9	99.9
Nb93m				3.6	0.1	
Y88				3.1		

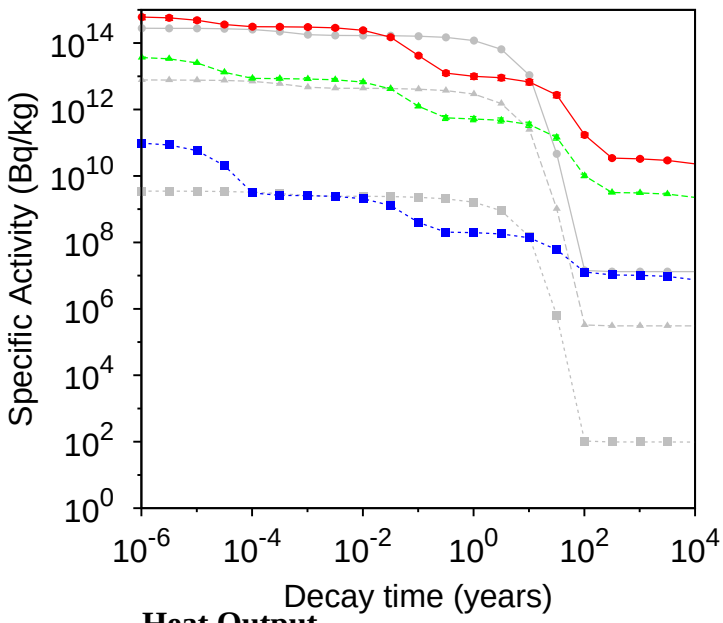
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.00E+05	1.97E+05	1.46E+05	1.26E+03	7.35E+01	3.93E+01
Nb92m	81.6	82.9	87.1			
Y90	8.2	8.4	4.5			
Nb95	5.6	5.7	7.1	0.6		
Nb94m	3.1	1.8				
Nb93m	0.6	0.6	0.8	94.1	24.3	
Nb94				4.4	75.2	99.9

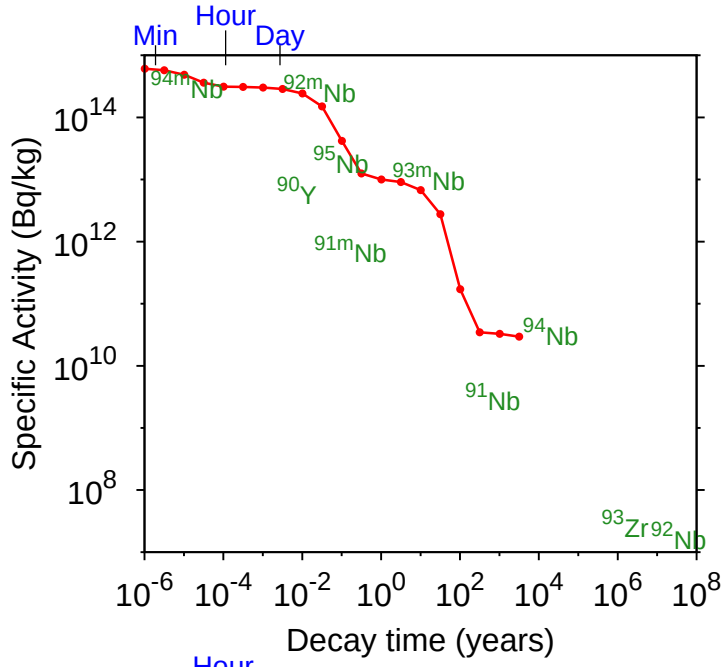
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.38E+05	2.33E+05	1.84E+05	1.95E+04	1.88E+03	1.13E+03
Nb92m	67.6	68.9	68.2			
Nb95	14.7	14.9	17.7	0.1		
Nb93m	7.8	8.0	10.1	91.4	14.3	
Nb94m	4.2	2.4				
Y90	3.9	3.9	2.0			
Nb94	0.7	0.7	0.9	8.2	85.0	99.9

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	3.01E+11	2.98E+11	2.32E+11	1.33E+09	3.40E+08	2.31E+08
Nb92m	90.4	91.4	91.6			
Nb95	6.4	6.5	7.8	1.0		
Nb94m	1.7	0.9				
Nb93m	0.3	0.3	0.4	74.3	4.4	
Nb94	0.1	0.1	0.1	24.5	95.6	100.0

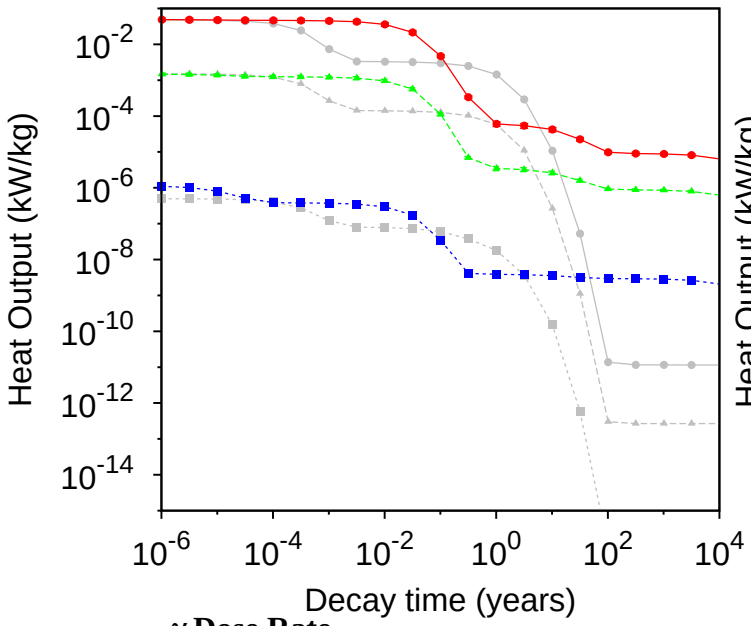
Niobium activation characteristics

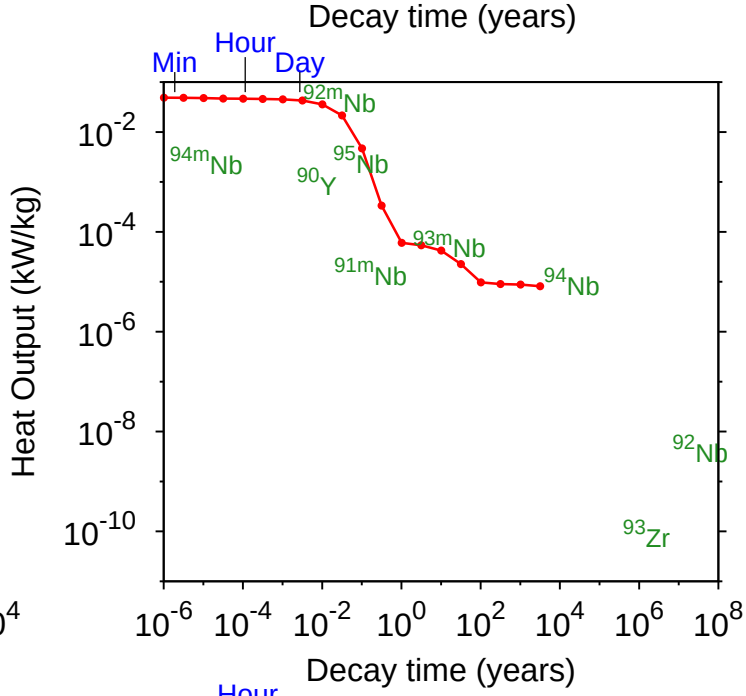
Specific Activity



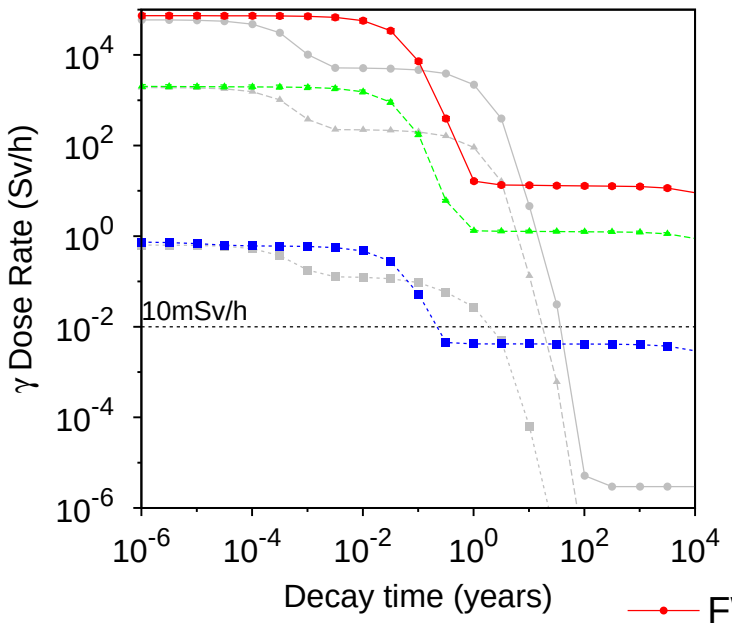


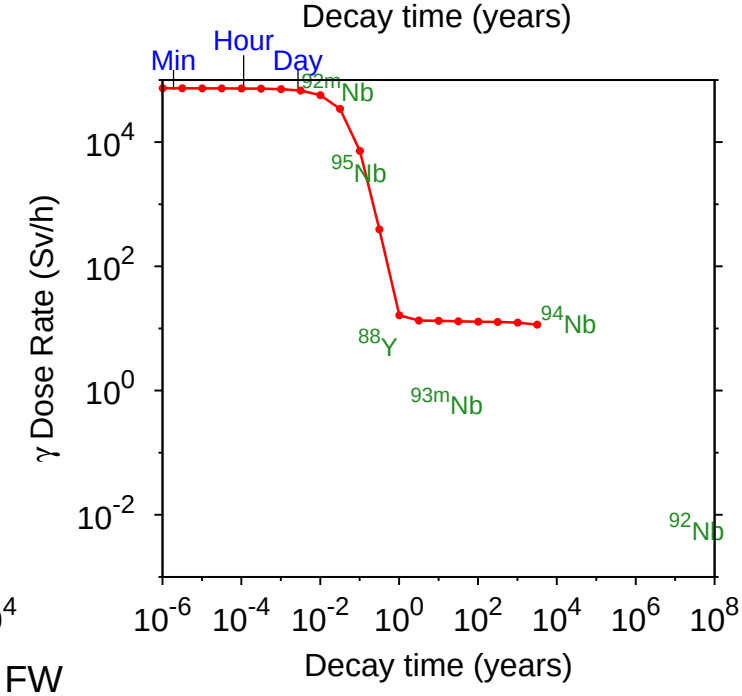
Heat Output





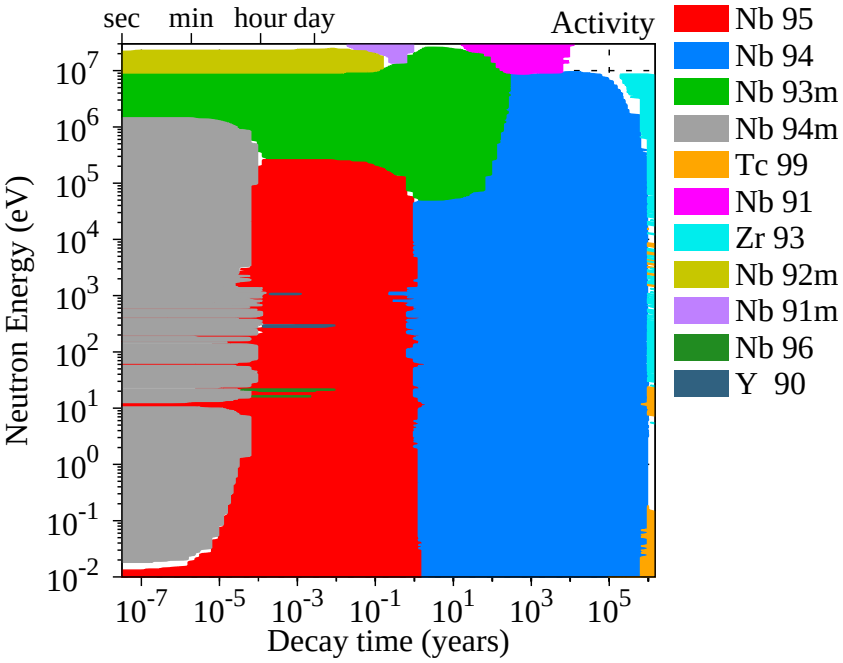
γ Dose Rate

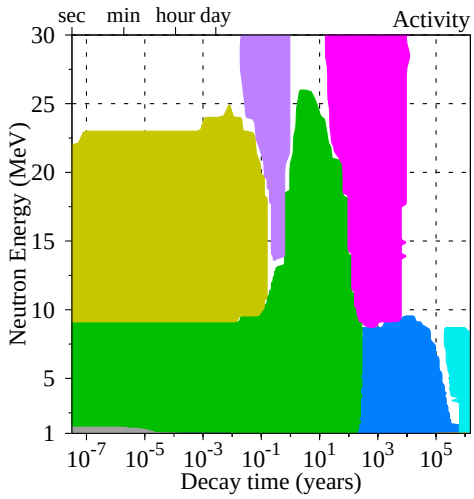


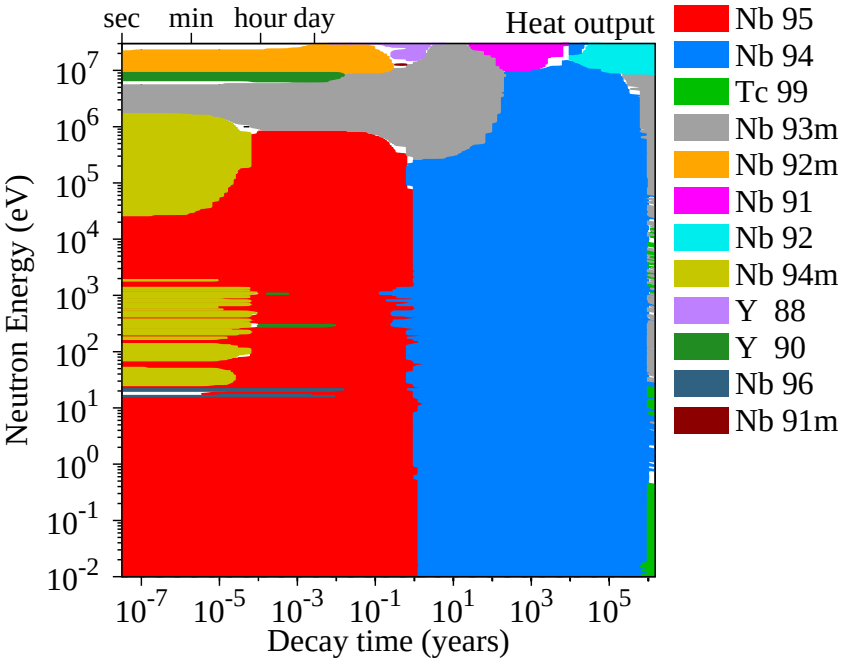


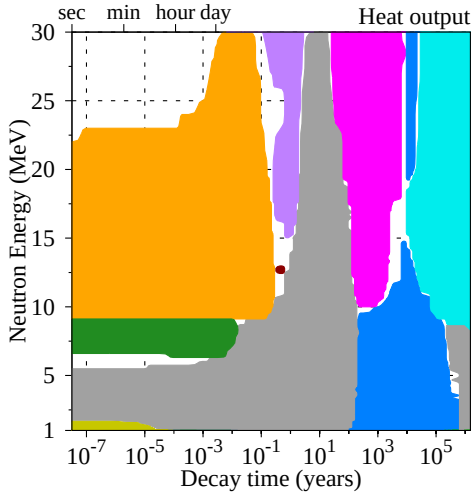
FW
Blanket
Manifold
Fe results

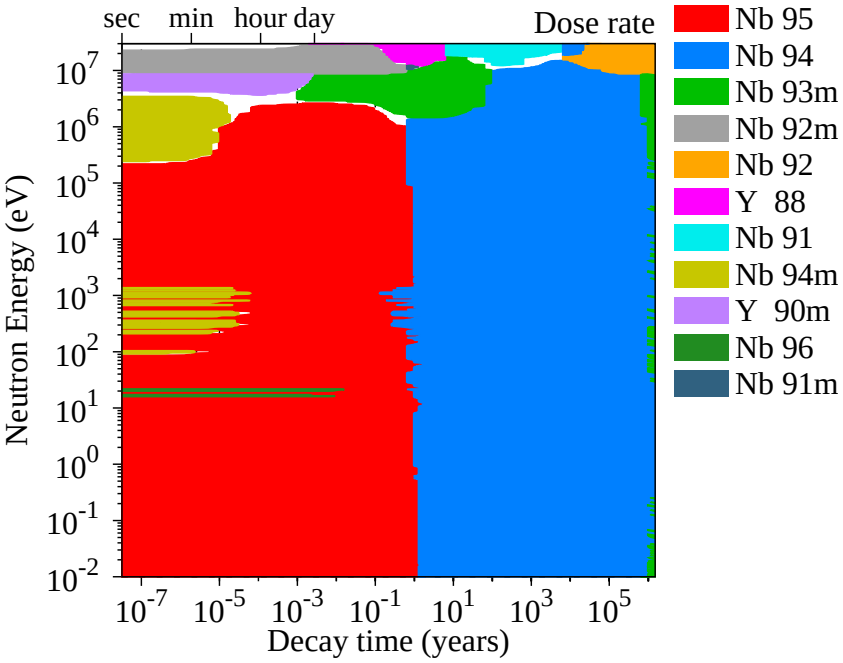
Niobium Importance diagrams

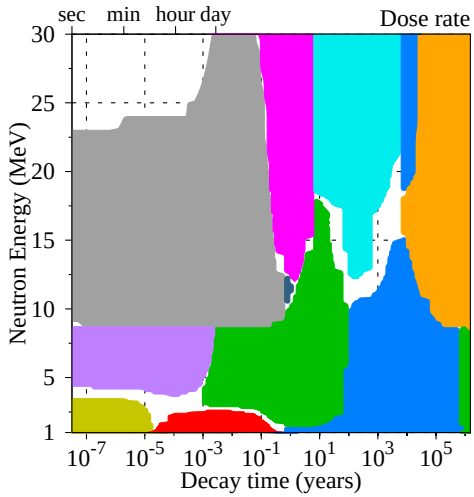




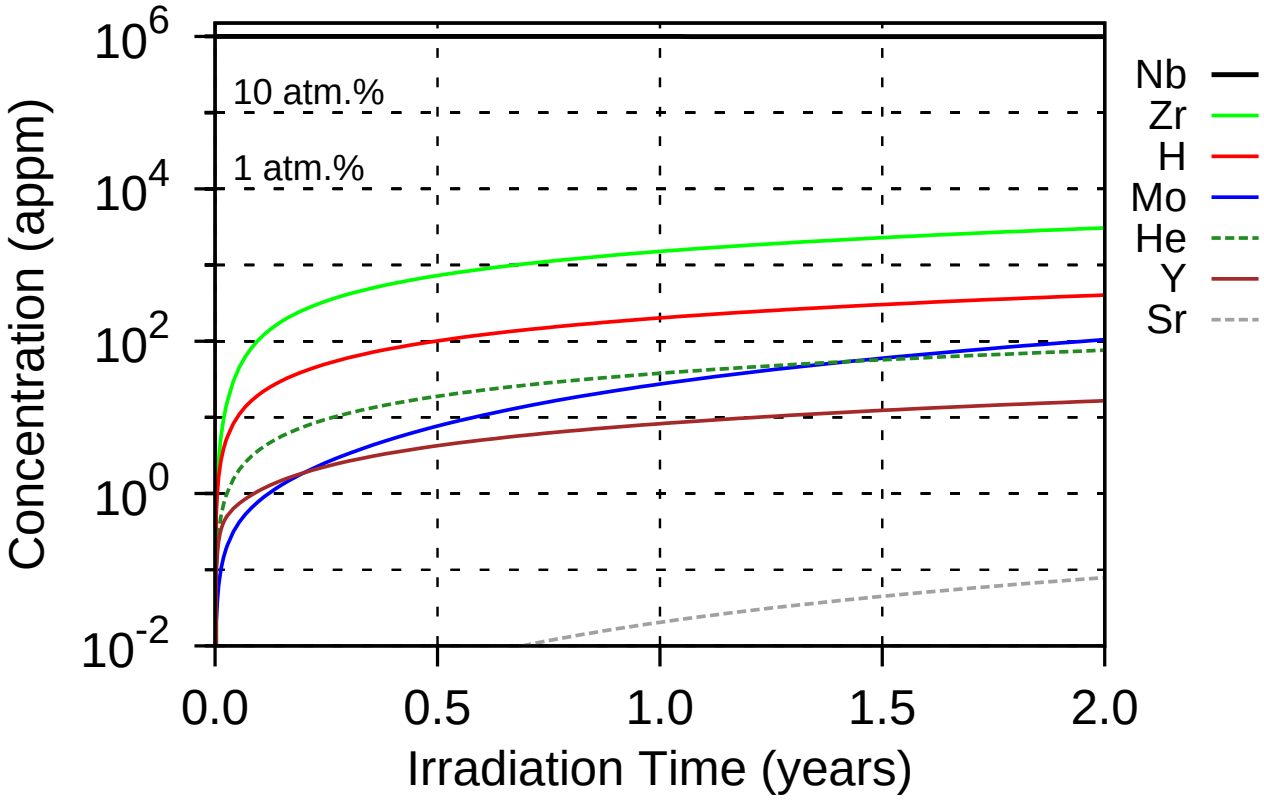




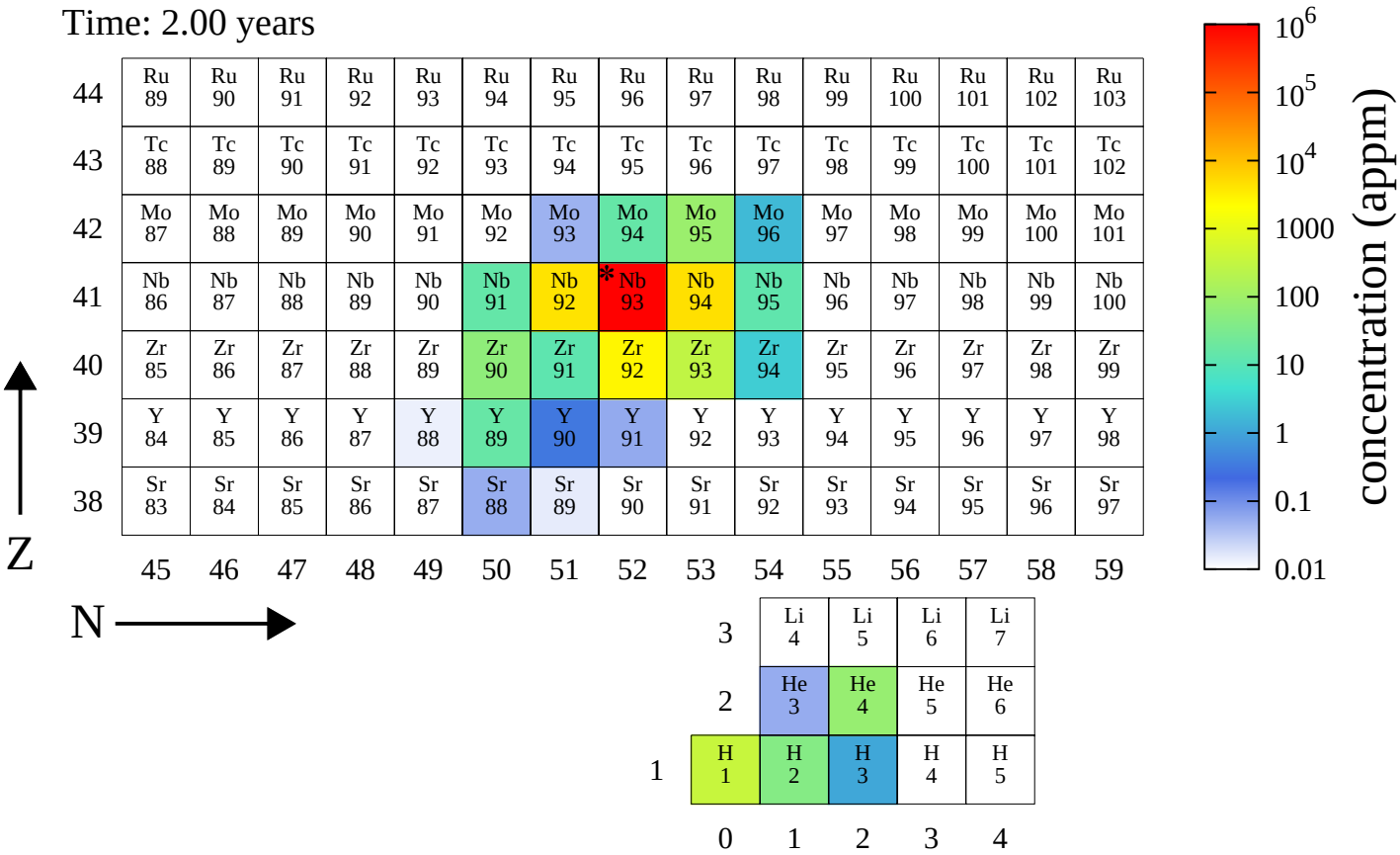




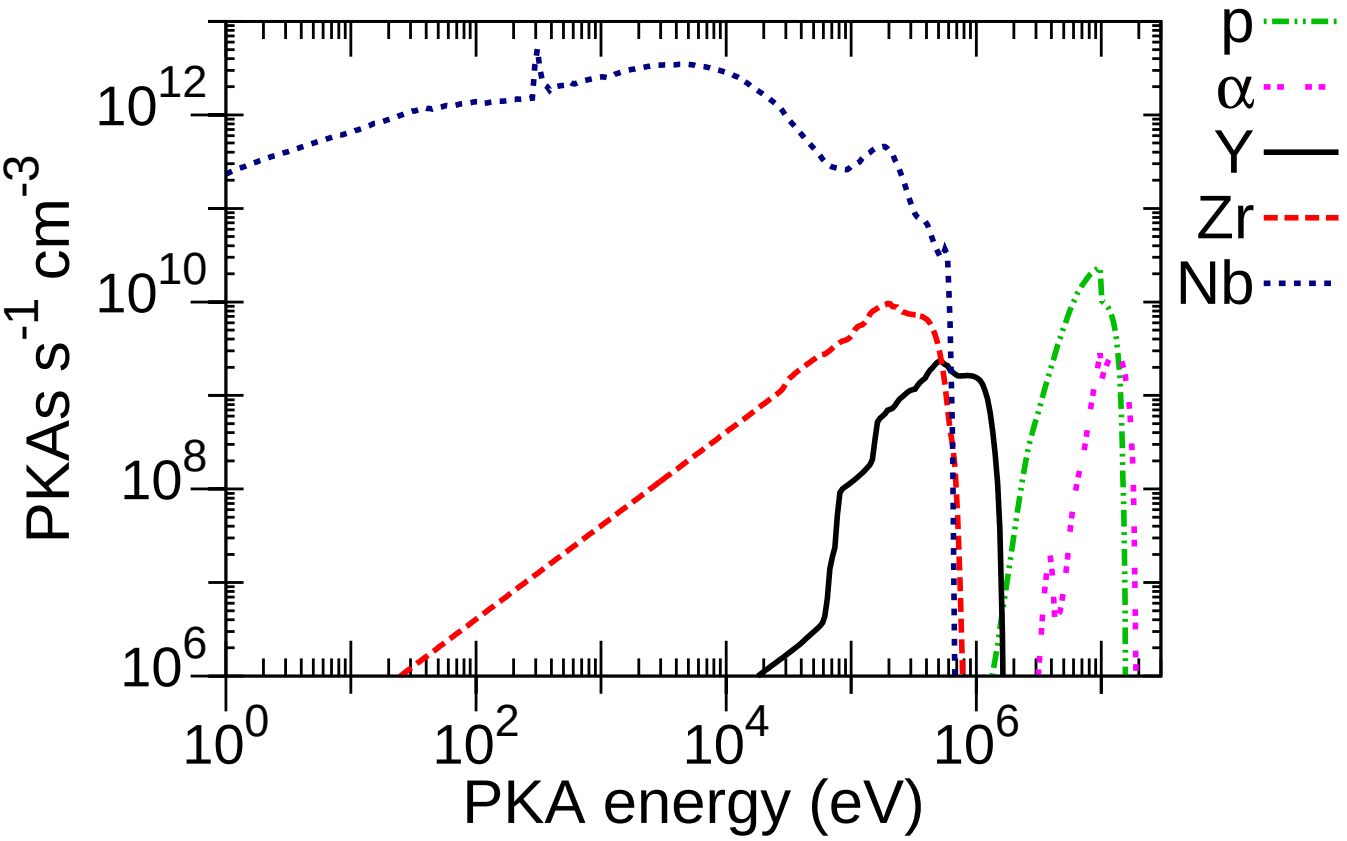
Niobium FW Transmutation

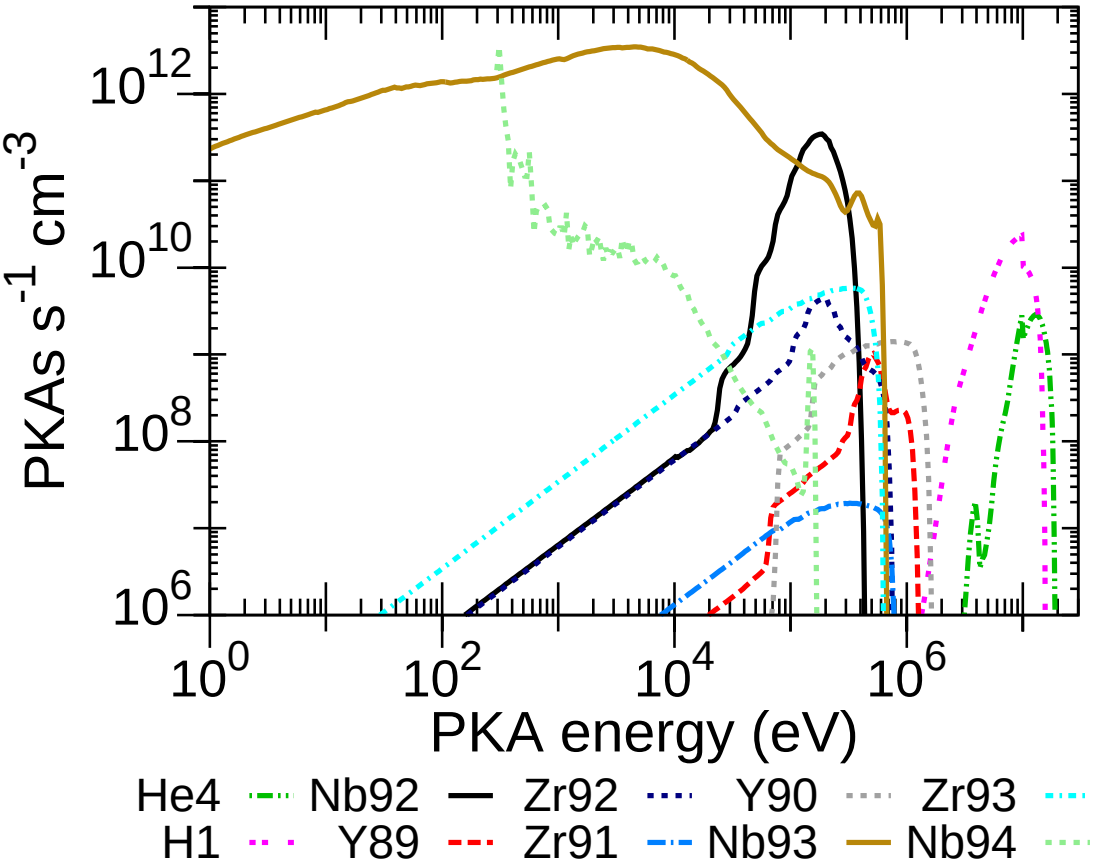


38 appm He & 202 appm H after 1 year 11 dpa/year



Niobium FW PKA distributions





Niobium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Nb94m	6.26m	Nb93(n,γ)Nb94m	100.0	100.0	93.7	98.3
		Nb93(n,γ)Nb94(n,n$'$)Nb94m			5.8	1.1
Y90m	3.19h	Nb93(n,α)Y90m	100.0	100.0	99.7	99.2
Nb96	23.35h	Nb93(n,γ)Nb94m(IT)Nb94(n,γ)Nb95(n,γ)Nb96	66.6	63.9	46.5	
		Nb93(n,γ)Nb94(n,γ)Nb95(n,γ)Nb96	33.0	35.4	52.7	
Y90	2.67d	Nb93(n,α)Y90	98.3	98.1	80.9	51.6
		Nb93(n,α)Y90m(IT)Y90	1.7	1.9	17.5	47.4
		Nb93(n,n$'$)Nb93m(n,α)Y90			1.4	
Nb92m	10.15d	Nb93(n,2n)Nb92m				97.8
		Nb93(n,2n)Nb92(n,n$'$)Nb92m				1.7
Nb95	34.99d	Nb93(n,γ)Nb94m(IT)Nb94(n,γ)Nb95	66.7	63.9	46.5	49.8
		Nb93(n,γ)Nb94(n,γ)Nb95	33.0	35.5	52.7	42.1
		Nb93(n,γ)Nb94m(IT)Nb94(n,γ)Nb95m(IT)Nb95				3.7
		Nb93(n,γ)Nb94(n,γ)Nb95m(IT)Nb95				3.2
Nb91m	60.92d	Nb93(n,2n)Nb92(n,2n)Nb91m				96.8
		Nb93(n,2n)Nb92m(n,2n)Nb91m				1.9
Y88	106.63d	Nb93(n,nα)Y89m(IT)Y89(n,2n)Y88				34.3
		Nb93(n,nα)Y89(n,2n)Y88				19.8
		Nb93(n,2n)Nb92(n,α)Y89m(IT)Y89(n,2n)Y88				15.6
		Nb93(n,2n)Nb92(n,2n)Nb91(n,α)Y88				8.4
		Nb93(n,2n)Nb92(n,nα)Y88				8.1
		Nb93(n,2n)Nb92(n,α)Y89(n,2n)Y88				3.4
		Nb93(n,2n)Nb92(n,2n)Nb91m(IT)Nb91(n,α)Y88				2.3
		Nb93(n,2n)Nb92m(β^+)Zr92(n,α)Sr89(β^-)Y89(n,2n)Y88				1.9
		Nb93(n,α)Y90(β^-)Zr90(n,2n)Zr89(β^+)Y89m(IT)Y89(n,2n)Y88				1.3
		Nb93(n,α)Y90m(IT)Y90(β^-)Zr90(n,2n)Zr89(β^+)Y89m(IT) Y89(n,2n)Y88				1.2
Nb93m	16.11y	Nb93(n,γ)Nb94m(IT)Nb94(n,γ)Nb95(β^-)Mo95(n,α)Zr92(n,γ) Zr93(β^-)Nb93m	48.9			
		Nb93(n,γ)Nb94(n,γ)Nb95(β^-)Mo95(n,α)Zr92(n,γ) Zr93(β^-)Nb93m	24.2			
		Nb93(n,γ)Nb94m(IT)Nb94(n,α)Y91m(IT)Y91(β^-)Zr91(n,γ) Zr92(n,γ)Zr93(β^-)Nb93m	5.3			
		Nb93(n,γ)Nb94m(IT)Nb94(n,α)Y91(β^-)Zr91(n,γ)Zr92(n,γ) Zr93(β^-)Nb93m	4.2			
		Nb93(n,γ)Nb94m(IT)Nb94(n,α)Y91m(IT)Y91(n,γ)Y92(β^-) Zr92(n,γ)Zr93(β^-)Nb93m	3.7			
		Nb93(n,γ)Nb94m(IT)Nb94(n,α)Y91(n,γ)Y92(β^-)Zr92(n,γ) Zr93(β^-)Nb93m	2.9			
		Nb93(n,γ)Nb94(n,α)Y91m(IT)Y91(β^-)Zr91(n,γ)Zr92(n,γ) Zr93(β^-)Nb93m	2.6			
		Nb93(n,γ)Nb94(n,α)Y91(β^-)Zr91(n,γ)Zr92(n,γ)Zr93(β^-)Nb93m	2.1			
		Nb93(n,γ)Nb94(n,α)Y91m(IT)Y91(n,γ)Y92(β^-)Zr92(n,γ) Zr93(β^-)Nb93m	1.8			
		Nb93(n,γ)Nb94(n,α)Y91(n,γ)Y92(β^-)Zr92(n,γ)Zr93(β^-)Nb93m	1.5			
		Nb93(n,p)Zr93(β^-)Nb93m	1.0			
		Nb93(n,n$'$)Nb93m		100.0	99.9	100.0
Nb91	680.02y	Nb93(n,2n)Nb92(n,2n)Nb91				75.3
		Nb93(n,2n)Nb92(n,2n)Nb91m(IT)Nb91				21.0
		Nb93(n,2n)Nb92m(n,2n)Nb91				2.1
Nb94	2.0 10^4y	Nb93(n,γ)Nb94m(IT)Nb94	66.9	64.3	46.8	53.7
		Nb93(n,γ)Nb94	33.1	35.7	53.0	45.4

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tc99	2.1 10^5y	Nb93(n,γ)Nb94m(IT)Nb94(n,γ)Nb95(β^-)Mo95(n,γ)Mo96(n,γ) Mo97(n,γ)Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99	44.6	34.3		
		Nb93(n,γ)Nb94(n,γ)Nb95(β^-)Mo95(n,γ)Mo96(n,γ)Mo97(n,γ) Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99	22.1	19.1		
		Nb93(n,γ)Nb94m(IT)Nb94(n,γ)Nb95(n,γ)Nb96(β^-)Mo96(n,γ) Mo97(n,γ)Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99	10.6	20.0		
		Nb93(n,γ)Nb94m(IT)Nb94(n,γ)Nb95(β^-)Mo95(n,γ)Mo96(n,γ) Mo97(n,γ)Mo98(n,γ)Mo99(β^-)Tc99	6.1	4.7		
		Nb93(n,γ)Nb94(n,γ)Nb95(n,γ)Nb96(β^-)Mo96(n,γ)Mo97(n,γ) Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99	5.3	11.1		
		Nb93(n,γ)Nb94m(IT)Nb94(n,γ)Nb95(n,γ)Nb96(n,γ)Nb97(β^-) Mo97(n,γ)Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99	3.4	1.8		
		Nb93(n,γ)Nb94(n,γ)Nb95(β^-)Mo95(n,γ)Mo96(n,γ)Mo97(n,γ) Mo98(n,γ)Mo99(β^-)Tc99	3.0	2.6		
		Nb93(n,γ)Nb94(n,γ)Nb95(n,γ)Nb96(n,γ)Nb97(β^-)Mo97(n,γ) Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99	1.7	1.0		
		Nb93(n,γ)Nb94m(IT)Nb94(n,γ)Nb95(n,γ)Nb96(β^-)Mo96(n,γ) Mo97(n,γ)Mo98(n,γ)Mo99(β^-)Tc99	1.4	2.7		
		Nb93(n,γ)Nb94(n,γ)Nb95(n,γ)Nb96(β^-)Mo96(n,γ)Mo97(n,γ) Mo98(n,γ)Mo99(β^-)Tc99		1.5		
Zr93	1.5 10^6y	Nb93(n,γ)Nb94m(IT)Nb94(n,γ)Nb95(β^-)Mo95(n,α) Zr92(n,γ)Zr93	49.7	44.7		
		Nb93(n,γ)Nb94(n,γ)Nb95(β^-)Mo95(n,α)Zr92(n,γ)Zr93	24.7	24.8		
		Nb93(n,γ)Nb94m(IT)Nb94(n,α)Y91m(IT)Y91(β^-)Zr91(n,γ) Zr92(n,γ)Zr93	5.7			
		Nb93(n,γ)Nb94m(IT)Nb94(n,α)Y91(β^-)Zr91(n,γ)Zr92(n,γ)Zr93	4.5			
		Nb93(n,γ)Nb94m(IT)Nb94(n,α)Y91m(IT)Y91(n,γ)Y92(β^-) Zr92(n,γ)Zr93	3.2			
		Nb93(n,γ)Nb94(n,α)Y91m(IT)Y91(β^-)Zr91(n,γ)Zr92(n,γ)Zr93	2.8			
		Nb93(n,γ)Nb94m(IT)Nb94(n,α)Y91(n,γ)Y92(β^-)Zr92(n,γ)Zr93	2.5			
		Nb93(n,γ)Nb94(n,α)Y91(β^-)Zr91(n,γ)Zr92(n,γ)Zr93	2.2			
		Nb93(n,γ)Nb94(n,α)Y91m(IT)Y91(n,γ)Y92(β^-)Zr92(n,γ)Zr93	1.6			
		Nb93(n,γ)Nb94(n,α)Y91(n,γ)Y92(β^-)Zr92(n,γ)Zr93	1.2			
		Nb93(n,p)Zr93		29.4	97.7	99.8
		Nb93(n,n′)Nb93m(n,p)Zr93			2.3	
Nb92	3.5 10^7y	Nb93(n,2n)Nb92				99.7

Molybdenum

Isotope	Atom % abundance	
Mo92	14.84	($T_{1/2}$ =1.9 10^{20}y)
Mo94	9.25	
Mo95	15.92	
Mo96	16.68	
Mo97	9.55	
Mo98	24.13	($T_{1/2}$ =1.0 10^{14}y)
Mo100	9.63	($T_{1/2}$ =9.9 10^{18}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.85E+14	3.65E+14	1.44E+14	5.94E+11	1.98E+11	9.68E+09
Mo99	36.2	38.2	38.5			
Tc99m	32.0	33.7	37.3			
Mo101	6.8	5.6				
Tc101	6.8	7.0				
Nb91m	5.1	5.4	13.1	52.1		
Mo91	3.1	2.6				
Nb92m	2.3	2.4	4.7			
Tc100	1.9					
Nb95	1.5	1.6	3.9	7.4		
Nb91			0.1	27.6	75.0	0.1
Mo93				4.4	12.9	47.5
Nb93m				4.4	11.5	42.0
Zr95	0.3	0.3	0.6	3.2		
Tc99				0.1	0.4	8.8
Nb94					0.1	1.7

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.88E-02	3.34E-02	8.65E-03	1.67E-05	6.91E-07	8.93E-08
Mo99	31.3	36.2	55.8			
Mo101	21.4	19.3				
Mo91	12.1	11.1				
Tc101	8.9	10.0				
Tc99m	7.2	8.4	14.2			
Tc100	4.3					
Nb92m	3.5	4.1	12.4			
Nb96	2.2	2.6	0.7			
Nb95	2.0	2.3	8.4	34.2		
Nb98m	1.3	1.4				
Nb91m	1.1	1.2	4.6	39.1		
Y89m	0.7	0.9	1.5			
Zr95	0.3	0.4	1.5	15.3		
Y88			0.1	6.7		
Nb91				2.9	63.3	
Nb93m				0.8	16.2	22.5
Mo93				0.4	9.4	13.0
Nb94				0.4	9.3	51.3
Tc99				0.1	1.7	13.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.61E+04	2.26E+04	5.39E+03	1.61E+01	2.00E-01	6.67E-02
Mo101	39.0	35.1				
Mo99	16.4	19.0	31.7			
Mo91	8.8	8.0				
Nb92m	8.6	9.9	32.5			
Tc101	5.1	5.7				
Nb96	4.6	5.3	1.7			
Nb95	4.0	4.7	18.6	49.0		
Nb98m	2.5	2.7				
Tc99m	2.0	2.3	4.3			
Y89m	1.8	2.1	4.1			
Zr90m	1.1	0.8	0.1			
Nb91m	0.6	0.7	3.0	16.4		
Zr95	0.6	0.7	3.0	19.9		
Y88	0.1	0.1	0.3	13.3		
Nb91				0.7	49.8	
Nb94				0.6	45.8	97.5
Mo93					3.7	2.0

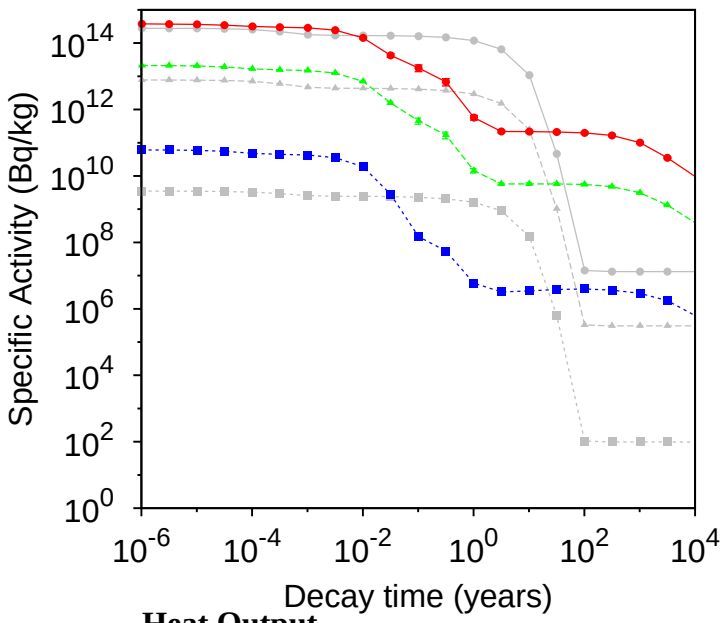
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.48E+05	1.16E+05	5.61E+04	3.37E+02	9.24E+01	1.56E+01
Mo99	56.6	72.3	59.4			
Tc100	21.4					
Nb91m	8.4	10.8	21.3	57.8		
Nb92m	3.6	4.5	7.3			
Nb95	2.3	2.9	5.8	7.6		
Tc99m	1.8	2.3	2.1			
Nb96	1.5	1.9	0.3			
Zr89	1.1	1.4	1.3			
Zr95	0.6	0.8	1.6	5.3		
Mo93	0.1	0.1	0.1	23.9	85.8	91.6
Nb91				3.1	10.3	
Nb93m				0.9	2.9	3.1
Tc99				0.2	0.6	3.5
Nb94				0.1	0.4	1.8

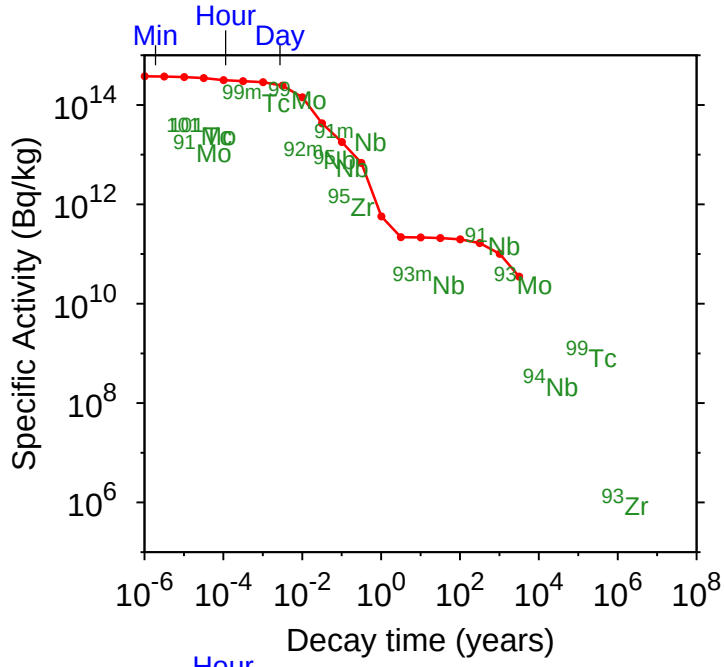
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.43E+05	2.13E+05	1.21E+05	1.72E+03	7.30E+02	3.71E+01
Mo99	56.9	64.7	45.3			
Nb91m	18.7	21.3	36.0	41.5		
Tc100	11.9					
Nb95	4.4	5.0	8.3	4.6		
Zr95	2.4	2.7	4.6	6.4		
Nb92m	2.1	2.4	3.3			
Tc99m	1.0	1.2	0.9			
Nb91	0.3	0.3	0.5	39.2	83.2	0.1
Mo93				3.5	8.1	28.5
Nb93m				2.7	5.6	19.7
Tc99				0.7	1.6	29.9
Nb94				0.7	1.6	21.7

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	7.37E+10	6.61E+10	2.19E+10	9.51E+07	9.96E+06	3.36E+06
Mo99	18.9	21.1	25.3			
Mo91	18.3	16.2				
Tc101	13.7	14.9				
Nb92m	11.9	13.3	31.2			
Nb95	8.0	8.9	25.5	46.3		
Nb96	6.7	7.5	1.7			
Mo101	3.6	3.1				
Nb98m	3.4	3.5				
Y89m	2.5	2.7	3.8			
Tc100	2.1					
Tc99m	1.7	1.9	2.5			
Mo91m	1.4	0.1				
Zr95	1.3	1.5	4.3	19.7		
Nb91m	1.3	1.4	4.1	15.5		
Zr90m	1.2	0.9				
Zr89	0.7	0.8	1.1			
Y88	0.1	0.1	0.2	7.3		
Mo93				2.7	25.7	13.7
Nb93m				2.7	22.7	12.1
Nb94				2.4	23.2	48.9
Nb91				2.3	19.6	
Tc99				0.9	8.8	25.3

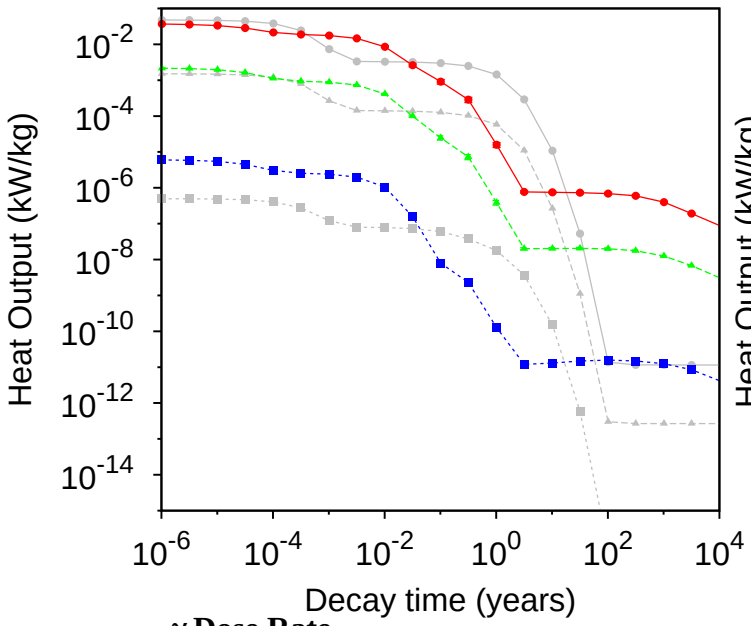
Molybdenum activation characteristics

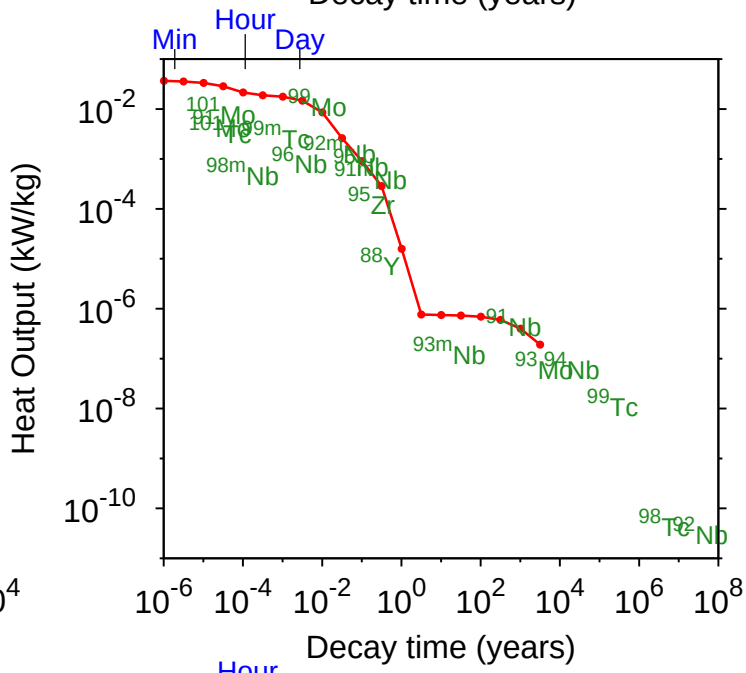
Specific Activity



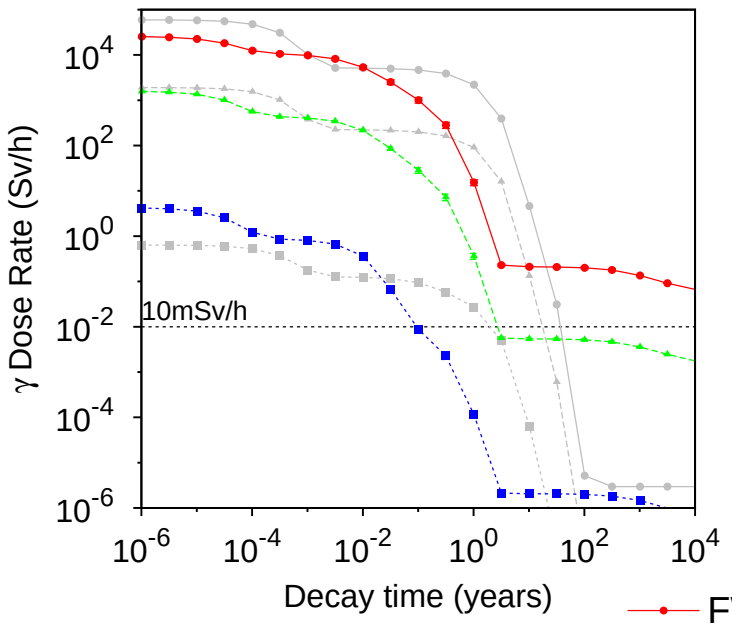


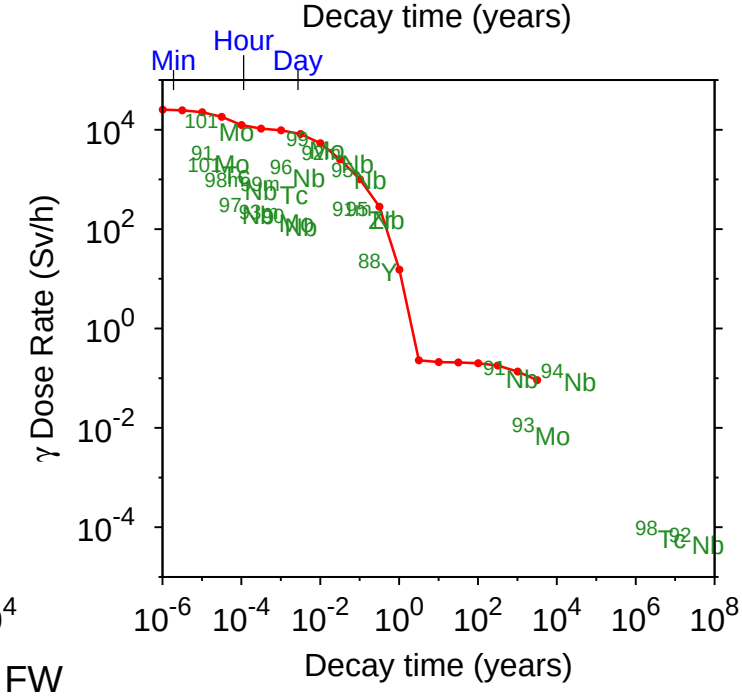
Heat Output





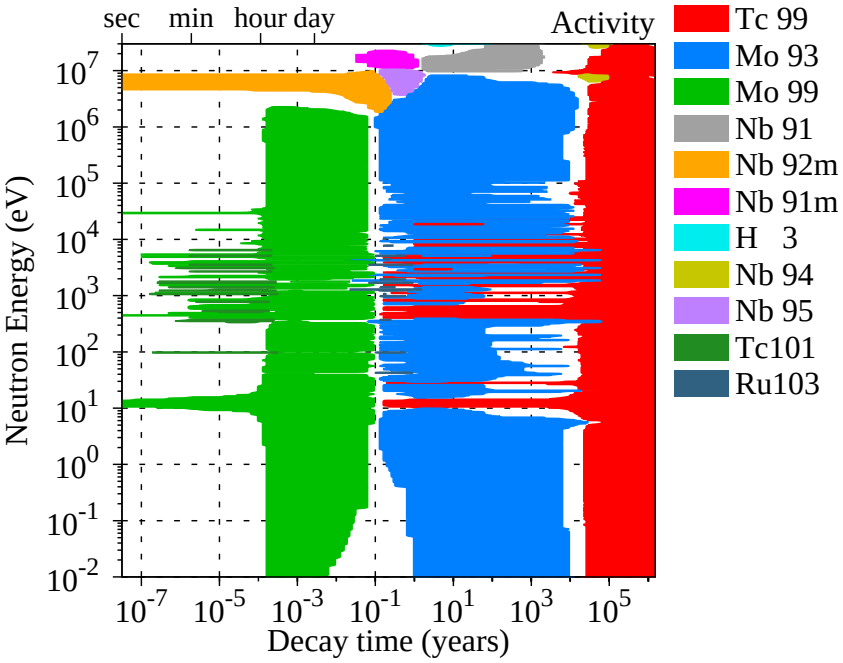
γ Dose Rate

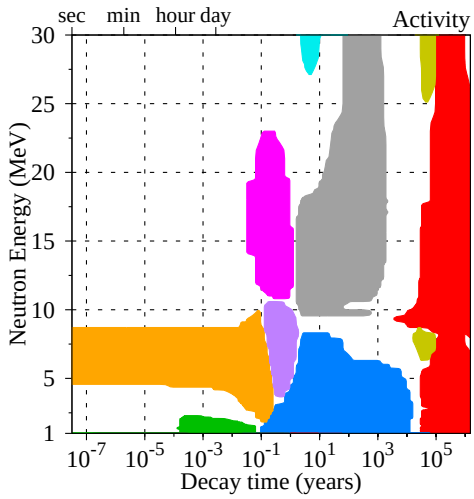


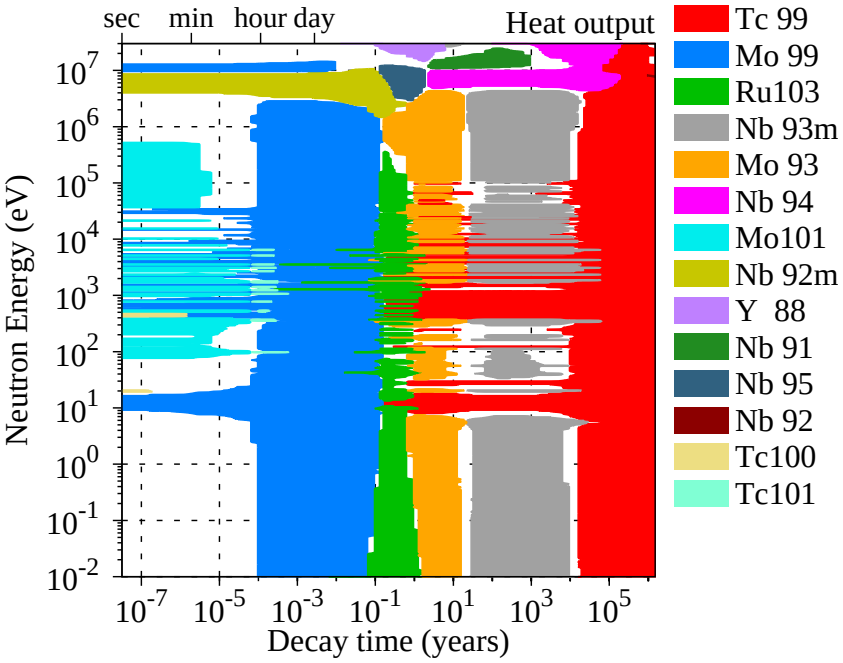


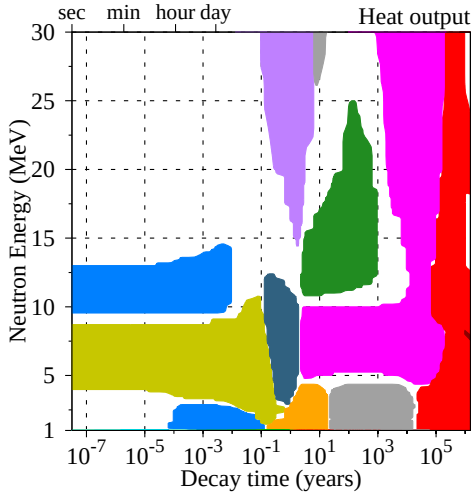
FW
Blanket
Manifold
Fe results

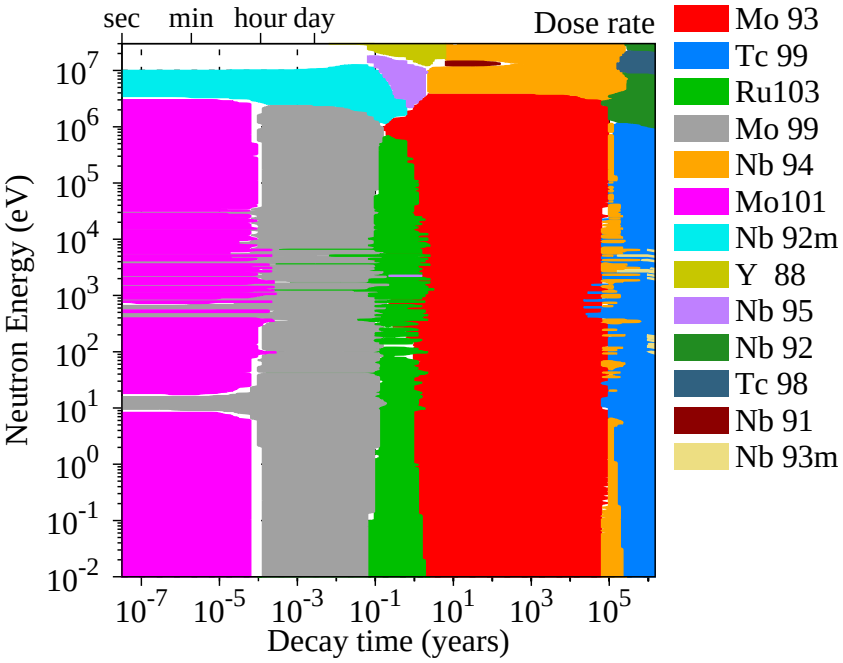
Molybdenum Importance diagrams

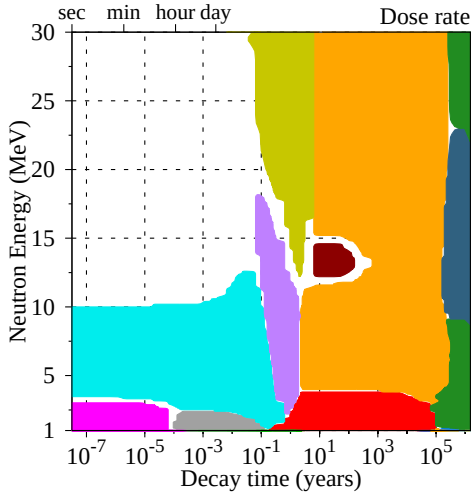




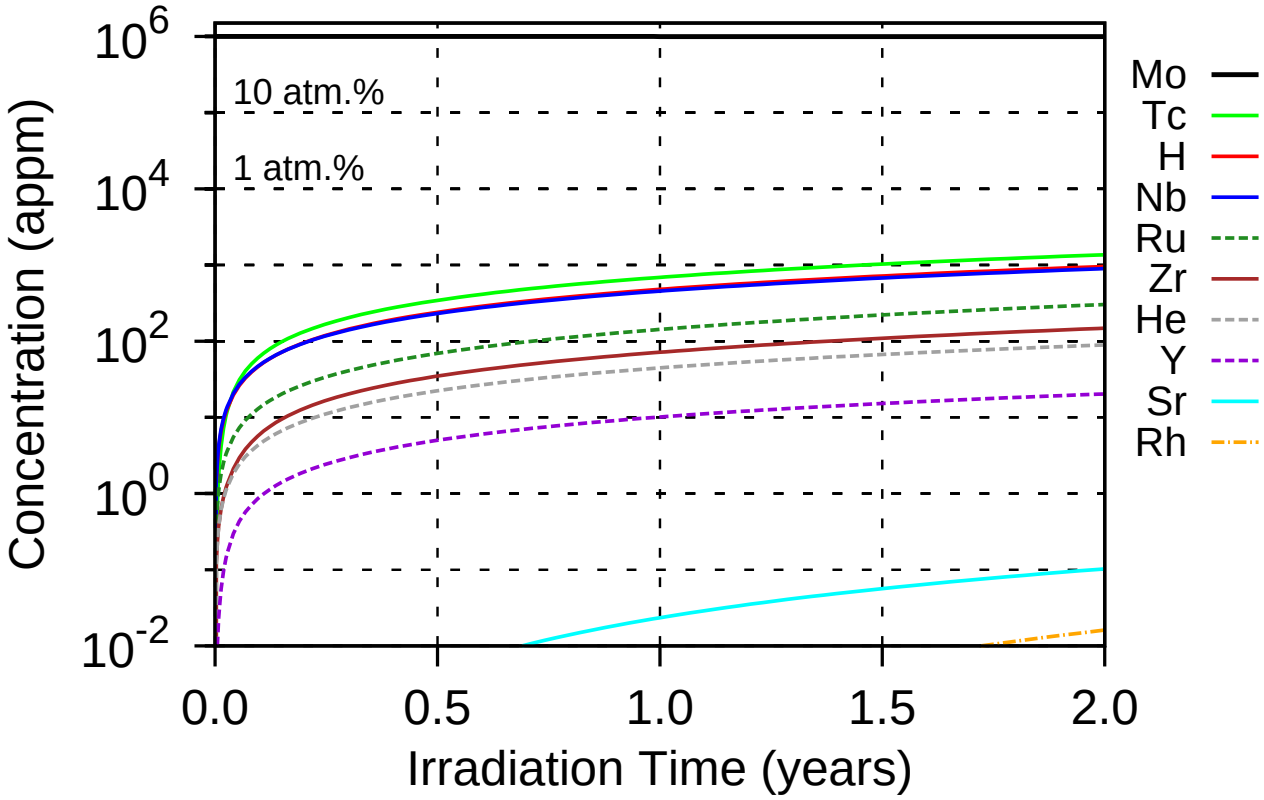




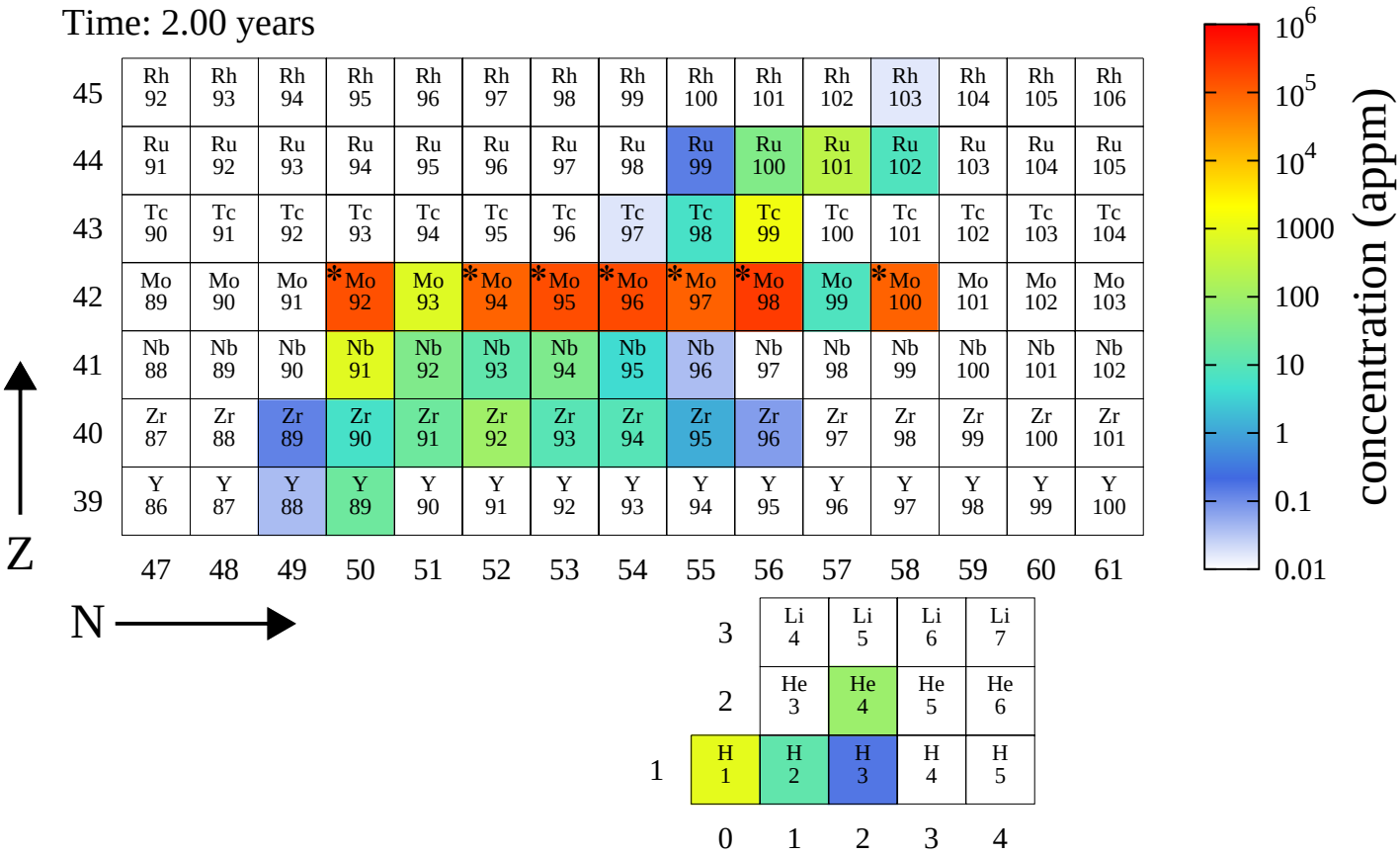




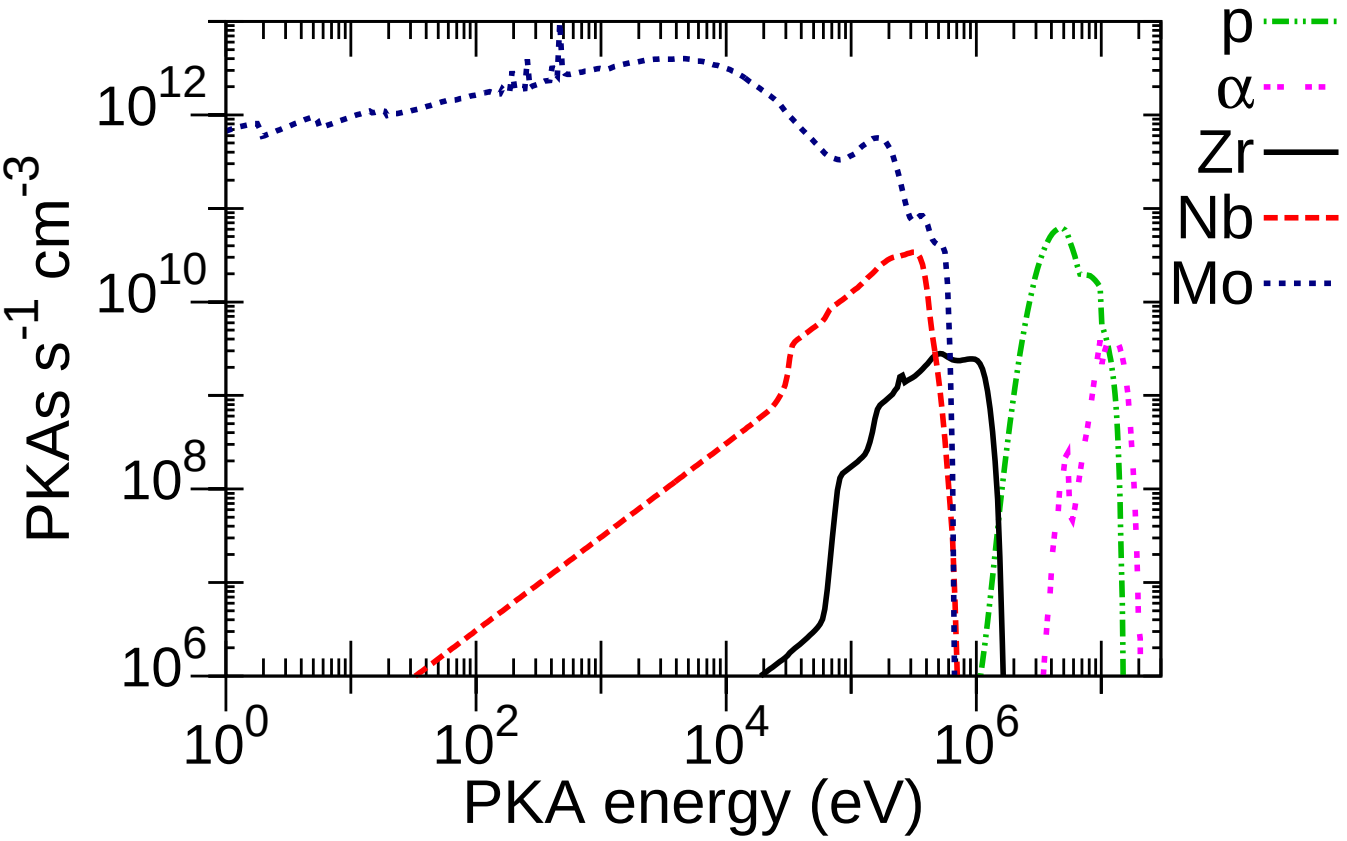
Molybdenum FW Transmutation

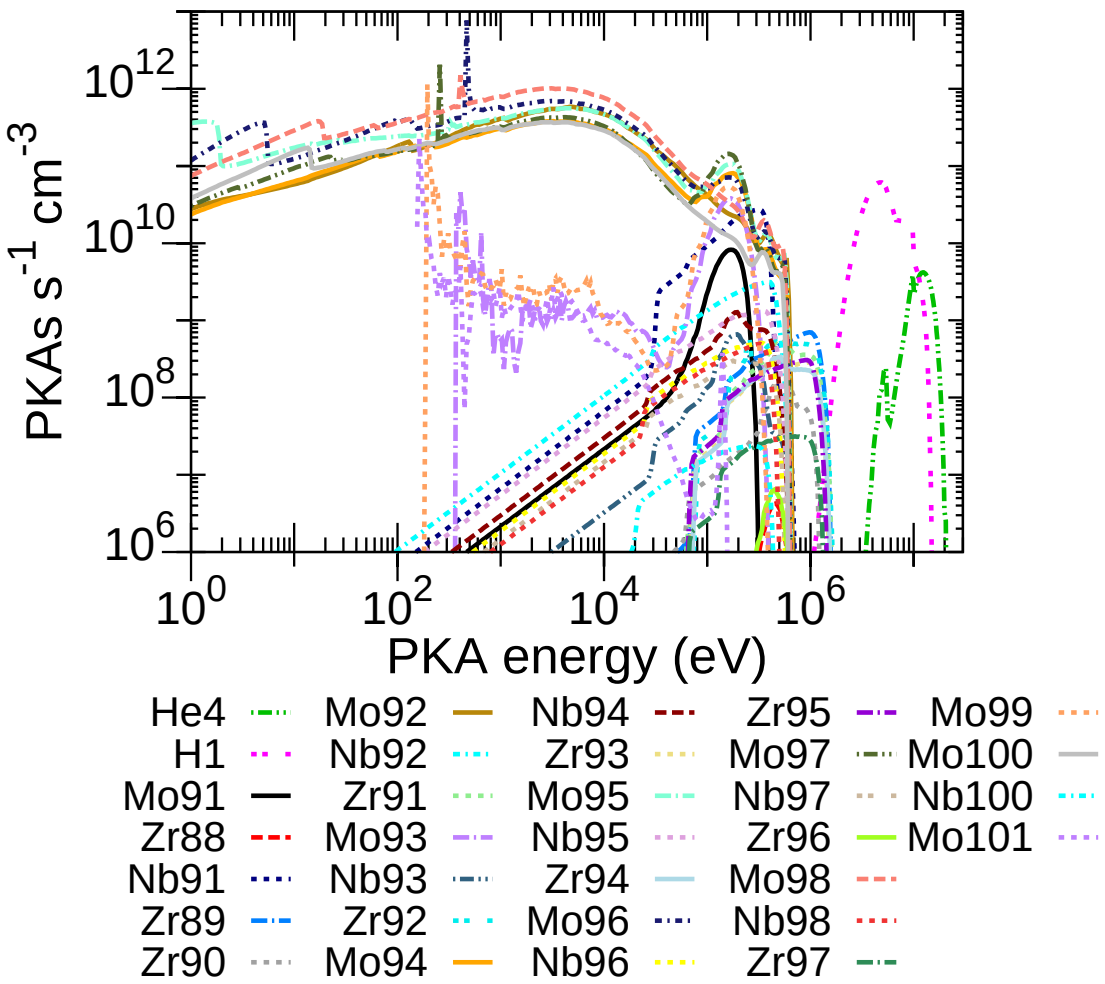


45 appm He & 479 appm H after 1 year 7 dpa/year



Molybdenum FW PKA distributions





Molybdenum Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Zr90m	0.81s	Mo92(n,γ)Mo93(n,α)Zr90m	100.0	100.0	98.7	
		Mo92(n,γ)Mo93(n,α)Zr90(n,n$'$)Zr90m			1.3	
		Mo92(n,np)Nb91(n,2n)Nb90(β^+)Zr90m				31.3
		Mo92(n,np)Nb91(n,np)Zr90m				14.9
		Mo92(n,np)Nb91m(IT)Nb91(n,2n)Nb90(β^+)Zr90m				10.2
		Mo92(n,np)Nb91(n,2n)Nb90m(IT)Nb90(β^+)Zr90m				9.9
		Mo92(n,2n)Mo91(β^+)Nb91(n,2n)Nb90(β^+)Zr90m				6.6
		Mo92(n,np)Nb91m(IT)Nb91(n,np)Zr90m				4.9
		Mo92(n,np)Nb91m(IT)Nb91(n,2n)Nb90m(IT)Nb90(β^+)Zr90m				3.3
		Mo92(n,2n)Mo91(β^+)Nb91(n,np)Zr90m				3.1
		Mo94(n,2n)Mo93(n,α)Zr90m				2.7
		Mo92(n,2n)Mo91(β^+)Nb91(n,2n)Nb90m(IT)Nb90(β^+)Zr90m				2.1
		Mo94(n,α)Zr91(n,2n)Zr90m				1.2
		Mo92(n,np)Nb91m(n,2n)Nb90(β^+)Zr90m				1.2
		Mo94(n,nα)Zr90m				1.1
		Mo92(n,np)Nb91m(n,np)Zr90m				1.0
Y89m	15.66s	Mo92(n,α)Zr89(β^+)Y89m	99.9	100.0	92.3	66.3
		Mo92(n,α)Zr89m(IT)Zr89(β^+)Y89m			7.6	28.2
Tc100	15.80s	Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99(n,γ)Tc100	85.4	87.6	87.3	
		Mo98(n,γ)Mo99(β^-)Tc99(n,γ)Tc100	11.6	11.9	11.8	
		Mo97(n,γ)Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99(n,γ)Tc100	2.5			
		Mo100(n,2n)Mo99(β^-)Tc99m(IT)Tc99(n,γ)Tc100				87.3
		Mo100(n,2n)Mo99(β^-)Tc99(n,γ)Tc100				11.8
Mo91m	1.08m	Mo92(n,2n)Mo91m				99.8
Tc101	14.20m	Mo100(n,γ)Mo101(β^-)Tc101	100.0	100.0	100.0	99.8
Mo101	14.61m	Mo100(n,γ)Mo101	100.0	100.0	100.0	100.0
Mo91	15.49m	Mo92(n,2n)Mo91				96.3
		Mo92(n,2n)Mo91m(IT)Mo91				3.5
Nb98m	51.30m	Mo98(n,p)Nb98m				99.9
Tc99m	6.01h	Mo98(n,γ)Mo99(β^-)Tc99m	95.4	99.1	99.8	
		Mo97(n,γ)Mo98(n,γ)Mo99(β^-)Tc99m	4.5			
		Mo100(n,2n)Mo99(β^-)Tc99m				99.2
Nb96	23.35h	Mo92(n,γ)Mo93(β^+)Nb93m(n,γ)Nb94m(IT)Nb94(n,γ) Nb95(n,γ)Nb96	43.8	13.5		
		Mo92(n,γ)Mo93(β^+)Nb93(n,γ)Nb94m(IT)Nb94(n,γ) Nb95(n,γ)Nb96	20.6	4.9		
		Mo92(n,γ)Mo93(β^+)Nb93m(n,E)Nb93(n,γ)Nb94m(IT)Nb94(n,γ) Nb95(n,γ)Nb96	10.6	4.0		
		Mo92(n,γ)Mo93(β^+)Nb93(n,γ)Nb94(n,γ)Nb95(n,γ)Nb96	10.2	2.7		
		Mo92(n,γ)Mo93(β^+)Nb93m(n,E)Nb93(n,γ)Nb94(n,γ) Nb95(n,γ)Nb96	5.3	2.2		
		Mo92(n,γ)Mo93(β^+)Nb93m(IT)Nb93(n,γ)Nb94m(IT)Nb94(n,γ) Nb95(n,γ)Nb96	3.0			
		Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99(n,α)Nb96	3.0	32.0	54.0	
		Mo92(n,γ)Mo93(β^+)Nb93m(IT)Nb93(n,γ)Nb94(n,γ) Nb95(n,γ)Nb96	1.5			
		Mo97(n,α)Zr94(n,γ)Zr95(β^-)Nb95(n,γ)Nb96		34.2		
		Mo98(n,γ)Mo99(β^-)Tc99(n,α)Nb96		4.3	7.3	
		Mo95(n,p)Nb95(n,γ)Nb96			32.9	
		Mo95(n,p)Nb95m(IT)Nb95(n,γ)Nb96			2.8	
		Mo98(n,α)Zr95(β^-)Nb95(n,γ)Nb96			2.3	
		Mo96(n,p)Nb96				89.3
		Mo97(n,2n)Mo96(n,p)Nb96				4.3
		Mo97(n,d)Nb96				2.0
		Mo97(n,np)Nb96				1.7
		Mo100(n,2n)Mo99(β^-)Tc99m(IT)Tc99(n,α)Nb96				1.1
Mo99	2.75d	Mo98(n,γ)Mo99	95.4	99.1	100.0	
		Mo97(n,γ)Mo98(n,γ)Mo99	4.5			
		Mo100(n,2n)Mo99				99.7
Zr89	3.27d	Mo92(n,α)Zr89	100.0	100.0	92.4	66.7
		Mo92(n,α)Zr89m(IT)Zr89			7.6	28.4
Nb92m	10.15d	Mo92(n,p)Nb92m			100.0	96.8
		Mo94(n,2n)Mo93(n,np)Nb92m				1.4

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Nb95	34.99d	Mo92(n,γ)Mo93(β^+)Nb93m(n,γ)Nb94m(IT)Nb94(n,γ)Nb95	45.4	21.3		
		Mo92(n,γ)Mo93(β^+)Nb93(n,γ)Nb94m(IT)Nb94(n,γ)Nb95	21.4	7.7		
		Mo92(n,γ)Mo93(β^+)Nb93m(n,E)Nb93(n,γ)Nb94m(IT) Nb94(n,γ)Nb95	11.0	6.4		
		Mo92(n,γ)Mo93(β^+)Nb93(n,γ)Nb94(n,γ)Nb95	10.6	4.3		
		Mo92(n,γ)Mo93(β^+)Nb93m(n,E)Nb93(n,γ)Nb94(n,γ)Nb95	5.5	3.5		
		Mo92(n,γ)Mo93(β^+)Nb93m(IT)Nb93(n,γ)Nb94m(IT) Nb94(n,γ)Nb95	3.1	1.0		
		Mo92(n,γ)Mo93(β^+)Nb93m(IT)Nb93(n,γ)Nb94(n,γ)Nb95	1.6			
		Mo97(n,α)Zr94(n,γ)Zr95(β^-)Nb95		53.9		
		Mo95(n,p)Nb95			86.5	58.4
		Mo95(n,p)Nb95m(IT)Nb95			7.2	13.0
		Mo98(n,α)Zr95(β^-)Nb95			6.1	15.4
		Mo96(n,2n)Mo95(n,p)Nb95				4.8
		Mo96(n,d)Nb95				3.0
		Mo96(n,np)Nb95				2.0
		Mo96(n,2n)Mo95(n,p)Nb95m(IT)Nb95				1.1
Ru103	39.27d	Mo100(n,γ)Mo101(β^-)Tc101(β^-)Ru101(n,γ)Ru102(n,γ)Ru103	96.0	100.0		99.9
		Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99(n,γ)Tc100(β^-)Ru100(n,γ) Ru101(n,γ)Ru102(n,γ)Ru103	3.4			
Nb91m	60.92d	Mo92(n,np)Nb91m				93.6
		Mo92(n,d)Nb91m				2.0
		Mo92(n,2n)Mo91m(β^+)Nb91m				1.8
		Mo92(n,np)Nb91(n,n′)Nb91m				1.4
Zr95	64.03d	Mo97(n,α)Zr94(n,γ)Zr95	95.7	99.6		
		Mo96(n,γ)Mo97(n,α)Zr94(n,γ)Zr95	2.2			
		Mo95(n,α)Zr92(n,γ)Zr93(n,γ)Zr94(n,γ)Zr95	1.2			
		Mo98(n,α)Zr95			99.8	99.8
Y88	106.63d	Mo92(n,α)Zr89(β^+)Y89m(IT)Y89(n,2n)Y88				32.5
		Mo92(n,np)Nb91(n,α)Y88				29.4
		Mo92(n,α)Zr89m(IT)Zr89(β^+)Y89m(IT)Y89(n,2n)Y88				13.9
		Mo92(n,np)Nb91m(IT)Nb91(n,α)Y88				9.3
		Mo92(n,2n)Mo91(β^+)Nb91(n,α)Y88				6.2
		Mo92(n,nα)Zr88(β^+)Y88				3.3
		Mo92(n,np)Nb91m(n,α)Y88				1.8
		Mo92(n,α)Zr89m(β^+)Y89(n,2n)Y88				1.0
H3	12.33y	Mo92(n,p)H1(n,γ)H2(n,γ)H3			98.7	
		Mo95(n,t)H3				27.2
		Mo97(n,t)H3				6.0
		Mo100(n,2n)Mo99(β^-)Tc99m(IT)Tc99(n,t)H3				3.4
		Mo94(n,t)H3				3.1
		Mo98(n,2n)Mo97(n,t)H3				1.9
		Mo98(n,t)H3				1.5
		Mo96(n,2n)Mo95(n,t)H3				1.2
		Mo96(n,t)H3				1.1
Nb93m	16.11y	Mo92(n,γ)Mo93(β^+)Nb93m	100.0	100.0	92.4	
		Mo92(n,γ)Mo93(n,p)Nb93m			7.4	
		Mo94(n,np)Nb93m				60.9
		Mo94(n,d)Nb93m				19.0
		Mo94(n,2n)Mo93(n,p)Nb93m				6.8
		Mo95(n,2n)Mo94(n,np)Nb93m				4.0
		Mo94(n,2n)Mo93(β^+)Nb93m				2.3
		Mo95(n,t)Nb93m				1.6
		Mo95(n,2n)Mo94(n,d)Nb93m				1.3
		Mo94(n,p)Nb94m(IT)Nb94(n,2n)Nb93m				1.3
Nb91	680.02y	Mo92(n,np)Nb91				63.4
		Mo92(n,np)Nb91m(IT)Nb91				20.8
		Mo92(n,2n)Mo91(β^+)Nb91				13.3
Mo93	4.0 10^3y	Mo92(n,γ)Mo93	100.0	100.0	100.0	
		Mo94(n,2n)Mo93				93.2
		Mo95(n,2n)Mo94(n,2n)Mo93				5.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Nb94	2.0 10^4y	Mo92(n,γ)Mo93(β^+)Nb93m(n,γ)Nb94m(IT)Nb94	45.3	46.5	1.7	
		Mo92(n,γ)Mo93(β^+)Nb93(n,γ)Nb94m(IT)Nb94	21.4	16.9		
		Mo92(n,γ)Mo93(β^+)Nb93m(n,E)Nb93(n,γ)Nb94m(IT)Nb94	11.7	14.7		
		Mo92(n,γ)Mo93(β^+)Nb93(n,γ)Nb94	10.6	9.4		
		Mo92(n,γ)Mo93(β^+)Nb93m(n,E)Nb93(n,γ)Nb94	5.8	8.2		
		Mo92(n,γ)Mo93(β^+)Nb93m(IT)Nb93(n,γ)Nb94m(IT)Nb94	3.3	2.4		
		Mo92(n,γ)Mo93(β^+)Nb93m(IT)Nb93(n,γ)Nb94	1.7	1.3		
		Mo94(n,p)Nb94m(IT)Nb94			87.0	42.4
		Mo94(n,p)Nb94			6.7	26.0
		Mo92(n,γ)Mo93(n,p)Nb93(n,γ)Nb94			1.2	
		Mo92(n,γ)Mo93(n,p)Nb93(n,γ)Nb94m(IT)Nb94			1.1	
		Mo95(n,np)Nb94m(IT)Nb94				10.0
		Mo95(n,np)Nb94				9.3
		Mo95(n,d)Nb94m(IT)Nb94				3.2
		Mo95(n,2n)Mo94(n,p)Nb94m(IT)Nb94				2.7
		Mo95(n,d)Nb94				1.7
		Mo95(n,2n)Mo94(n,p)Nb94				1.7
Tc99	2.1 10^5y	Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99	85.5	87.6	87.3	
		Mo98(n,γ)Mo99(β^-)Tc99	11.6	11.9	11.8	
		Mo97(n,γ)Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99	2.5			
		Mo100(n,2n)Mo99(β^-)Tc99m(IT)Tc99				87.6
		Mo100(n,2n)Mo99(β^-)Tc99				11.9
Tc98	4.3 10^6y	Mo100(n,2n)Mo99(β^-)Tc99m(IT)Tc99(n,2n)Tc98				87.6
		Mo100(n,2n)Mo99(β^-)Tc99(n,2n)Tc98				11.9
Nb92	3.5 10^7y	Mo92(n,p)Nb92			67.6	96.2
		Mo92(n,p)Nb92m(n,E)Nb92			29.7	
		Mo92(n,p)Nb92m(n,n$'$)Nb92			2.7	
		Mo94(n,2n)Mo93(n,np)Nb92				1.9

Ruthenium

Isotope	Atom % abundance
Ru96	5.54
Ru98	1.87
Ru99	12.76
Ru100	12.60
Ru101	17.06
Ru102	31.55
Ru104	18.62

($T_{1/2}$ =6.7 10^{16}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	8.29E+14	8.09E+14	5.40E+14	1.17E+12	7.71E+08	1.92E+08
Ru103	32.2	33.0	46.4	36.4		
Rh103m	32.1	32.9	45.9	36.0		
Ru105	9.6	9.7				
Rh105	9.6	9.8	3.0			
Ru97	5.0	5.1	3.2			
Rh105m	2.7	2.8				
Tc95	2.6	2.7	0.2	0.1		
Ru95	1.9	1.9				
Rh104	1.6					
Rh102				12.7		
Rh102m	0.1	0.1	0.1	11.6		
Tc95m	0.2	0.2	0.3	2.4		
Mo93					48.1	34.8
Nb93m					42.0	30.7
Tc99					5.9	22.8
Tc97					2.8	11.1

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	5.94E-02	5.58E-02	2.74E-02	1.10E-04	3.50E-09	1.38E-09
Ru103	40.6	43.2	82.5	34.9		
Ru105	25.4	26.7				
Ru95	5.7	5.8				
Rh105	4.9	5.3	2.2			
Tc95	4.7	5.0	0.6	0.1		
Tc96	4.5	4.8	5.5			
Rh104	3.5	0.1				
Ru97	2.8	3.0	2.5			
Rh103m	2.7	2.9	5.4	2.3		
Rh102	0.1	0.1	0.2	46.4		
Rh102m	0.1	0.1	0.2	13.2		
Tc95m	0.3	0.4	0.7	2.9		
Nb93m					45.7	21.2
Mo93					26.8	12.3
Tc99					17.6	43.5
Tc98					6.1	15.5
Nb94					1.7	3.2
Tc97					1.7	4.3

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	5.49E+04	5.40E+04	2.75E+04	1.33E+02	4.89E-04	3.73E-04
Ru103	46.6	47.4	87.1	30.6		
Ru105	23.3	23.3				
Ru95	8.6	8.4				
Tc96	7.8	7.9	8.6			
Tc95	7.4	7.5	0.8	0.2		
Ru97	1.7	1.7	1.4			
Rh105	1.5	1.6	0.6			
Tc102m	1.2	0.5				
Rh102	0.2	0.2	0.3	56.2		
Rh102m	0.1	0.1	0.2	10.1		
Tc95m	0.5	0.5	0.9	3.0		
Tc98					58.5	76.6
Mo93					19.1	4.5
Nb94					17.7	16.5
Nb93m					3.3	0.8
Tc97					1.2	1.6

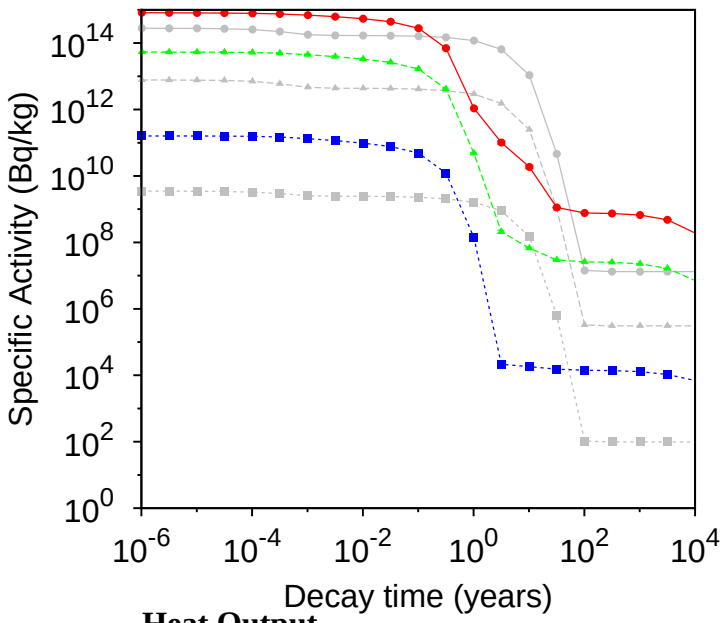
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.35E+05	3.34E+05	1.99E+05	8.86E+02	1.22E+00	2.46E-01
Ru103	44.9	58.5	91.9	35.1		
Tc102m	35.5	20.0				
Rh105	6.7	8.8	3.0			
Ru105	4.7	6.1				
Tc100	2.6					
Tc96	1.7	2.2	2.1			
Ru97	1.4	1.8	1.3			
Tc95	0.9	1.2	0.1			
Rh102	0.1	0.1	0.2	43.8		
Rh102m	0.1	0.2	0.3	18.4		
Tc95m	0.2	0.3	0.5	1.8		
Mo93				0.1	94.1	84.3
Nb93m					3.2	2.9
Tc99					2.4	11.4

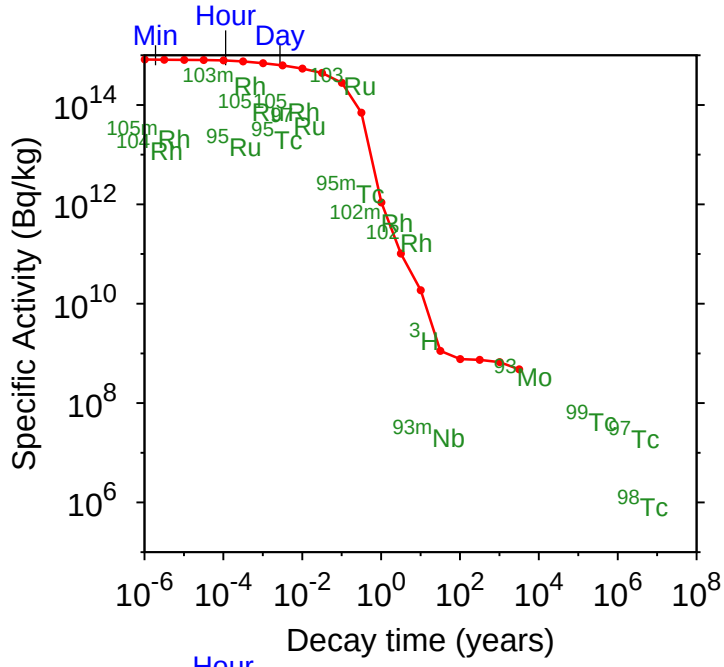
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.02E+06	9.27E+05	7.73E+05	4.86E+03	2.12E+00	9.14E-01
Ru103	78.9	86.6	97.4	26.3		
Tc102m	13.4	6.4				
Rh105	2.7	3.0	0.7			
Ru105	1.4	1.5				
Rh102	0.3	0.3	0.4	52.2		
Rh102m	0.3	0.4	0.4	19.9		
Mo93					40.2	16.8
Tc99					27.7	62.2
Nb93m					27.5	11.6
Tc98					1.9	4.3
Tc97					1.8	4.2

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	3.34E+11	3.29E+11	2.59E+11	8.35E+08	1.20E+05	6.12E+04
Ru103	80.1	81.3	96.7	51.0		
Ru95	6.0	5.8				
Tc95	5.0	5.1	0.3	0.1		
Ru105	2.4	2.4				
Tc96	2.0	2.0	1.4			
Ru97	1.2	1.2	0.7			
Rh102	0.1	0.1	0.2	38.0		
Rh102m	0.1	0.1	0.1	8.1		
Tc95m	0.4	0.4	0.5	2.4		
Tc99					37.5	71.4
Mo93					30.8	10.9
Nb93m					26.9	9.6
Nb94					1.8	2.5
Tc97					1.8	3.5
Tc98					1.0	2.0

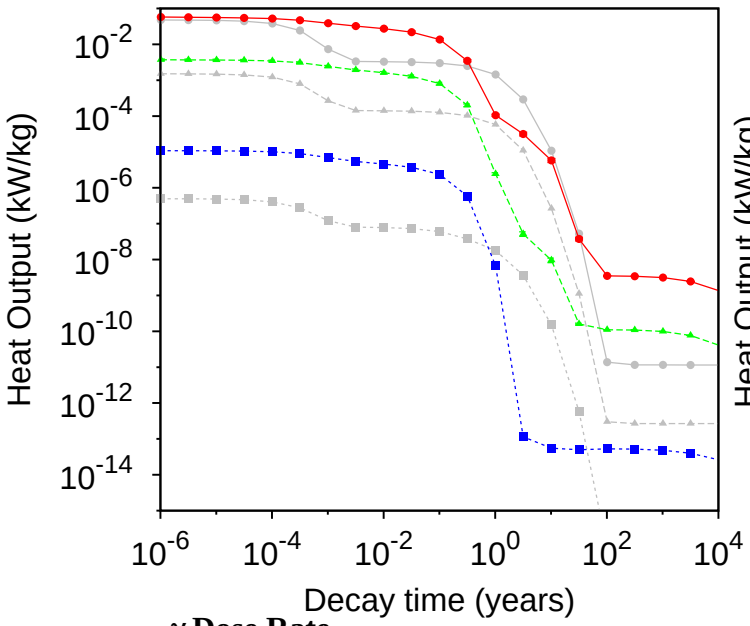
Ruthenium activation characteristics

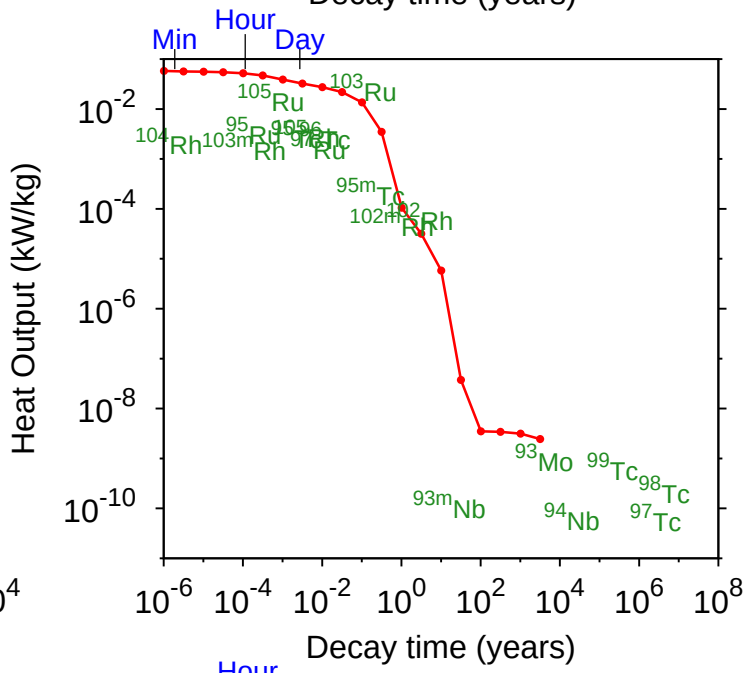
Specific Activity



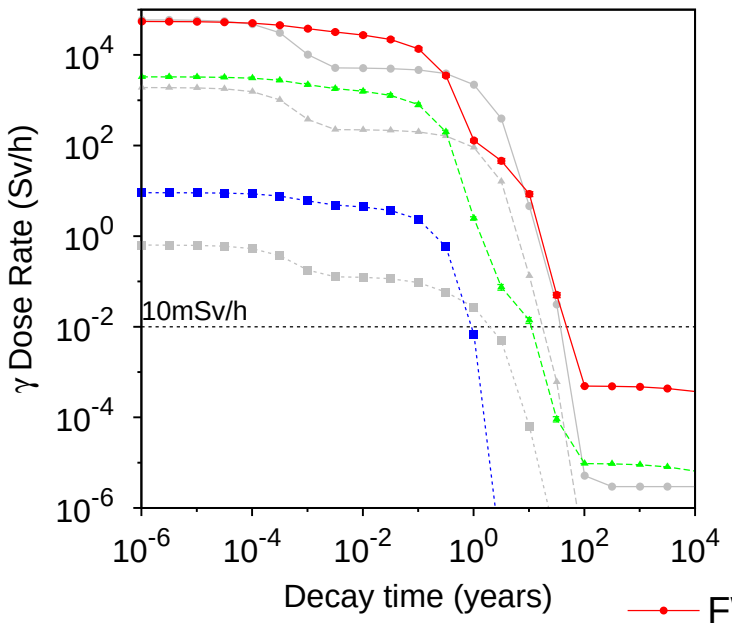


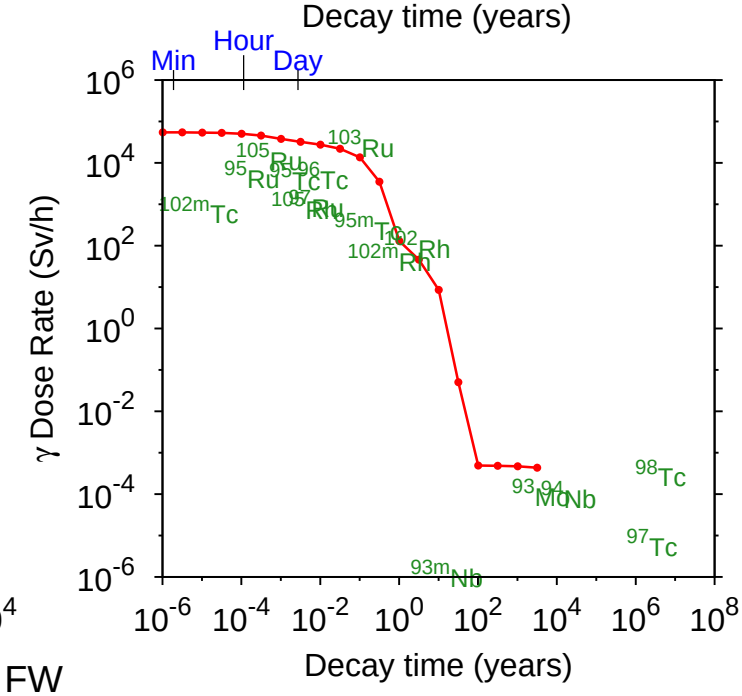
Heat Output





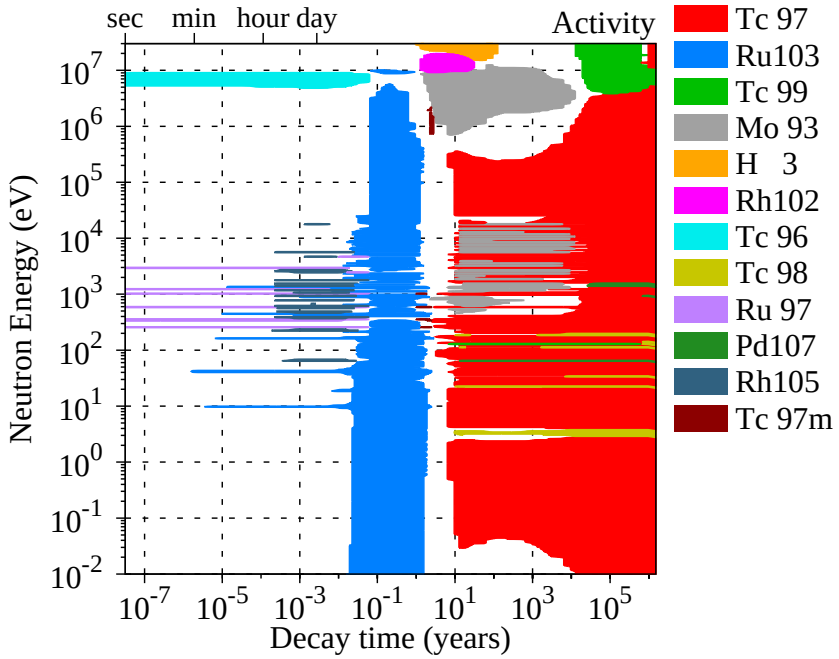
γ Dose Rate

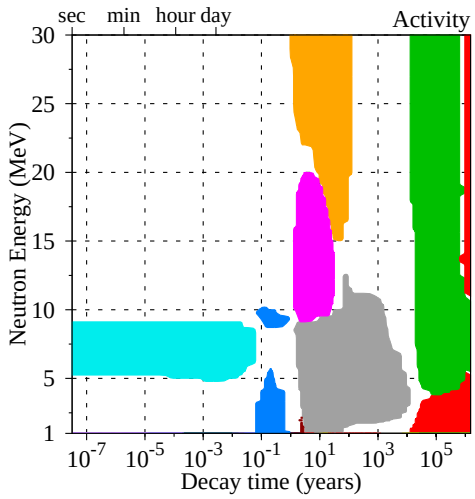


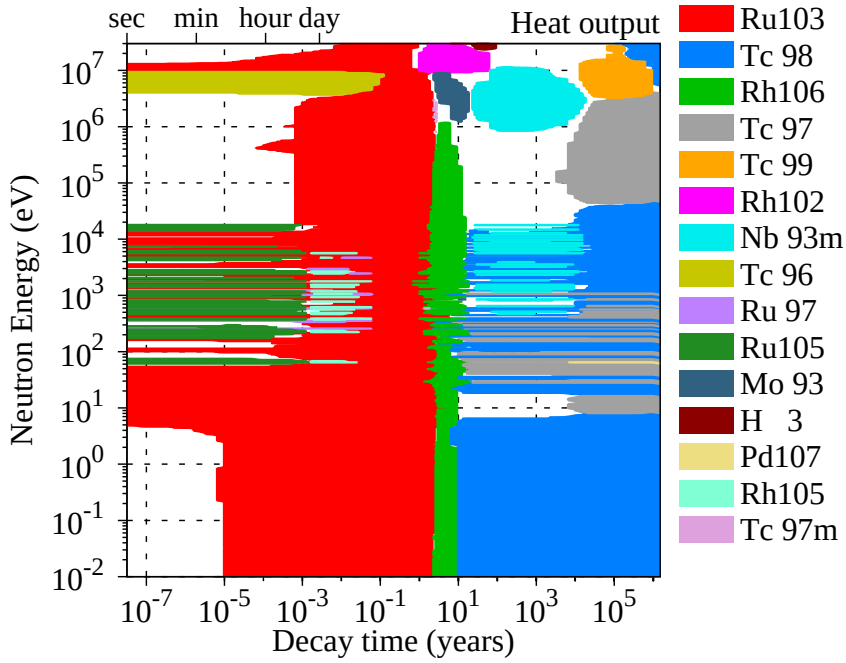


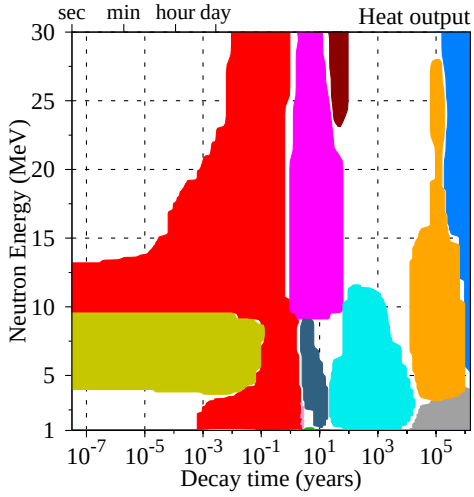
FW
Blanket
Manifold
Fe results

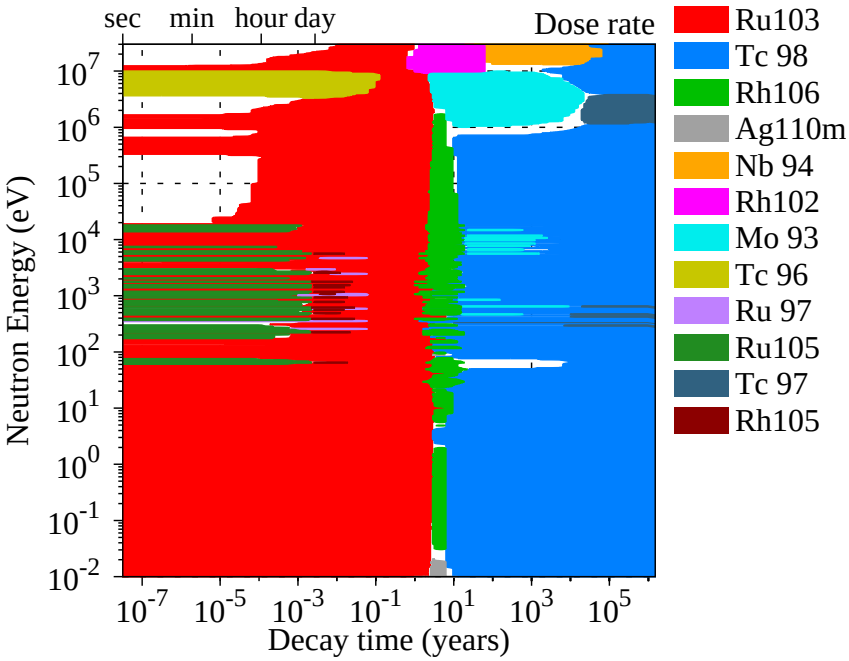
Ruthenium Importance diagrams

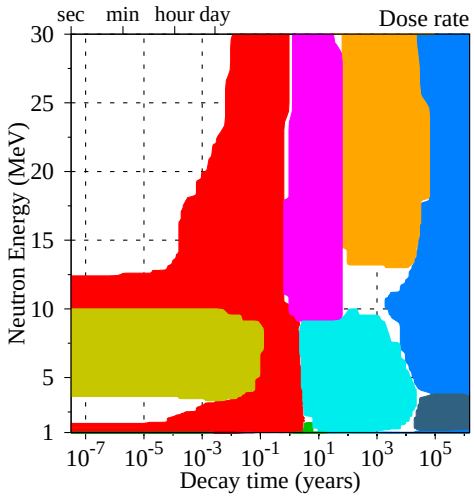




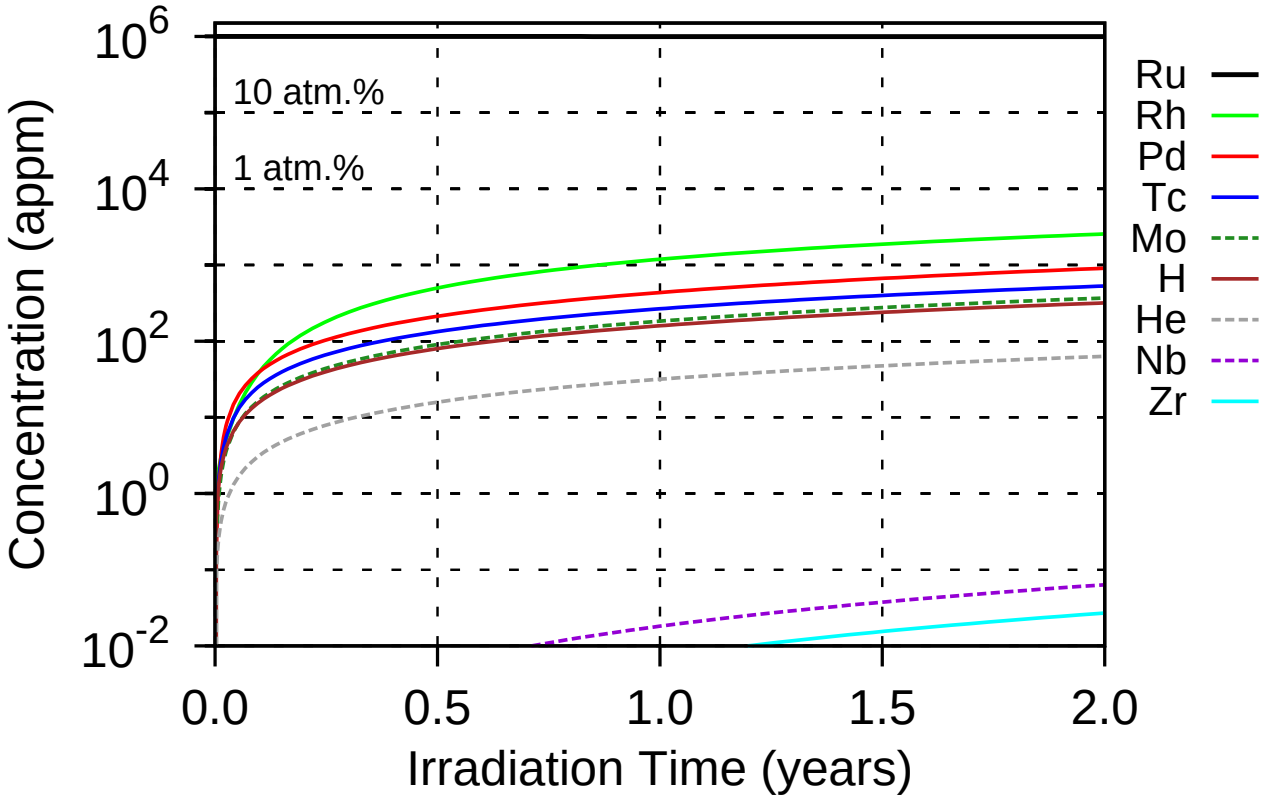




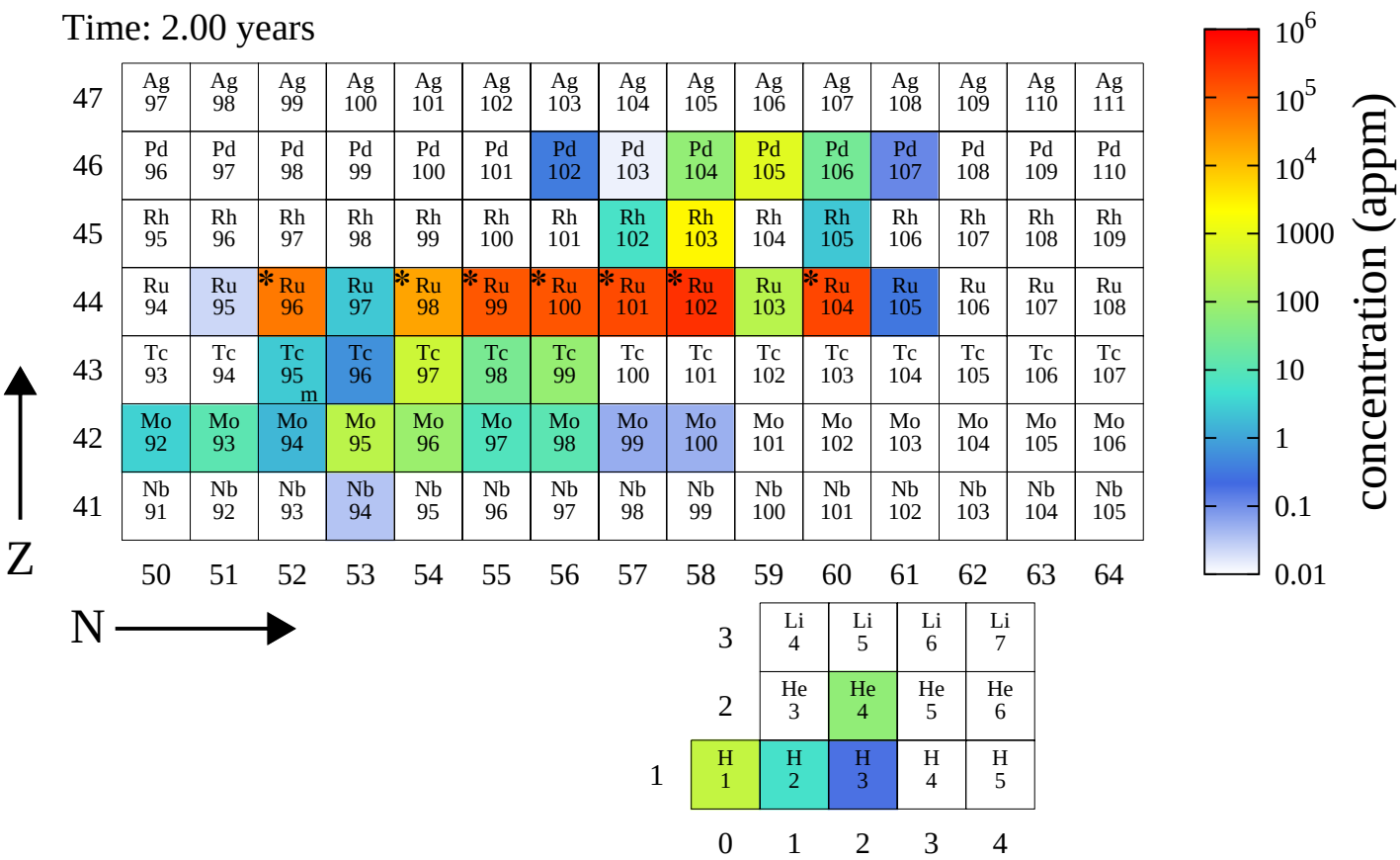




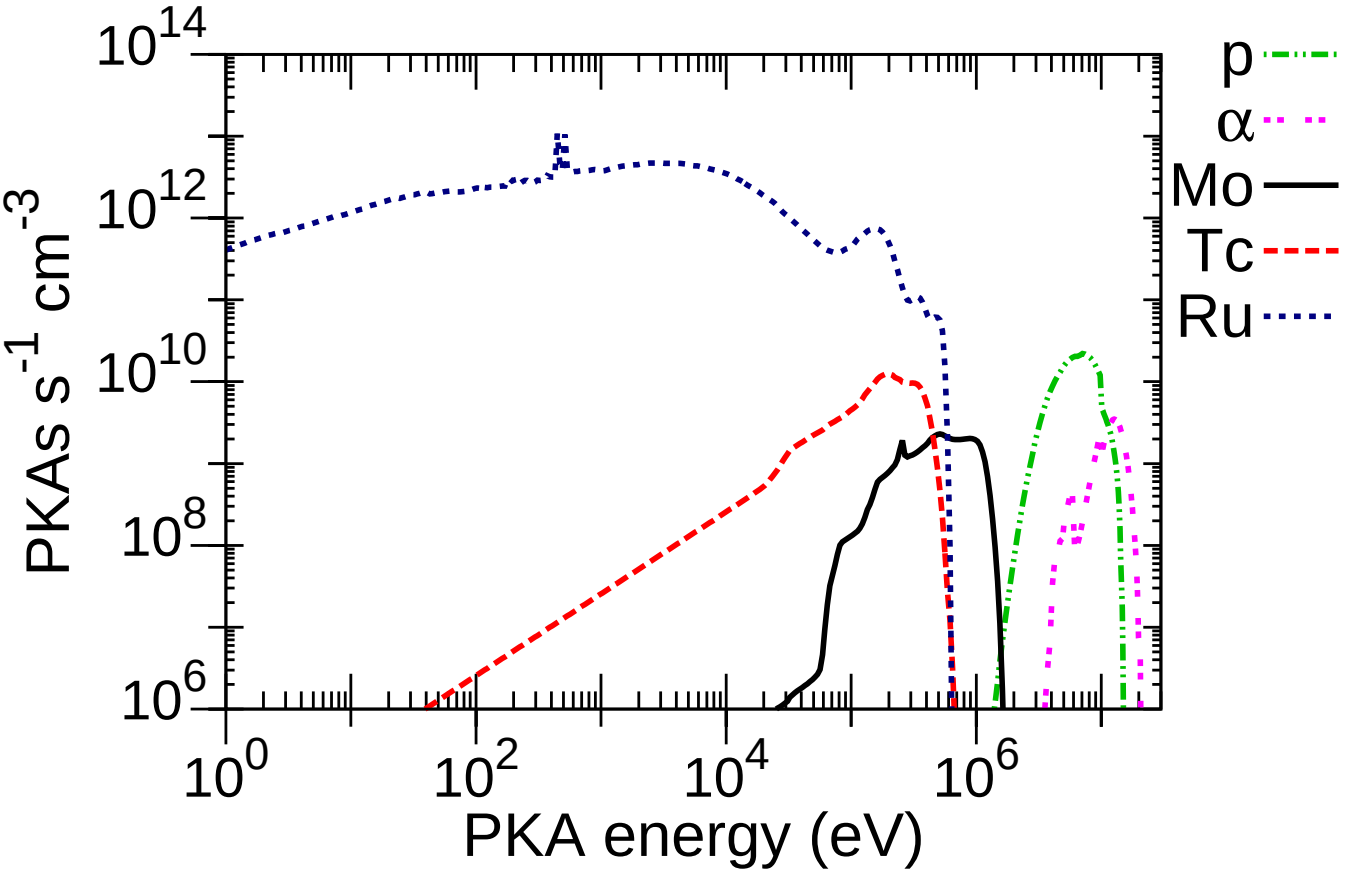
Ruthenium FW Transmutation

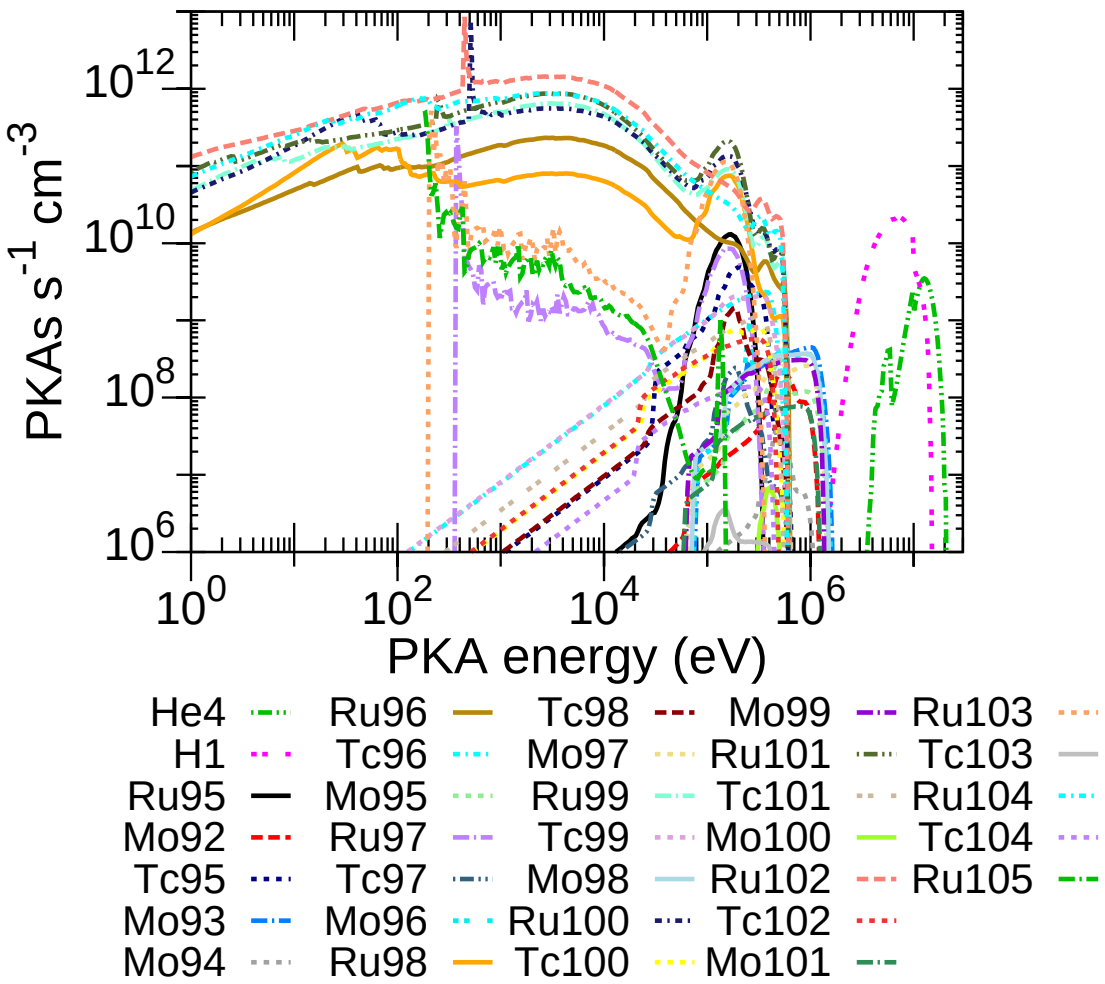


32 appm He & 159 appm H after 1 year 17 dpa/year



Ruthenium FW PKA distributions





Ruthenium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tc100	15.80s	Ru96(n,γ)Ru97(β^+)Tc97(n,γ)Tc98(n,γ)Tc99(n,γ)Tc100	97.7	96.9		
		Ru96(n,γ)Ru97(β^+)Tc97(n,γ)Tc98(n,γ)Tc99m(IT) Tc99(n,γ)Tc100	2.3	3.1		
		Ru99(n,p)Tc99(n,γ)Tc100			83.9	
		Ru99(n,p)Tc99m(IT)Tc99(n,γ)Tc100			14.8	
		Ru100(n,p)Tc100				74.6
		Ru101(n,2n)Ru100(n,p)Tc100				9.6
		Ru101(n,np)Tc100				7.1
		Ru104(n,2n)Ru103(β^-)Rh103m(IT)Rh103(n,α)Tc100				3.3
		Ru101(n,d)Tc100				2.9
		Ru102(n,2n)Ru101(n,np)Tc100				1.1
Rh106	30.01s	Ru104(n,γ)Ru105(β^-)Rh105(n,γ)Rh106	71.5	64.9	66.8	47.0
		Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105(n,γ)Rh106	28.4	25.7	26.5	18.6
		Ru104(n,γ)Ru105(n,γ)Ru106(β^-)Rh106		9.3	6.8	22.2
		Ru104(n,γ)Ru105(β^-)Rh105(β^-)Pd105(n,γ)Pd106(n,p)Rh106				8.4
		Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105(β^-)Pd105(n,γ) Pd106(n,p)Rh106				3.3
Rh105m	40.00s	Ru104(n,γ)Ru105(β^-)Rh105m	99.9	100.0	100.0	99.4
Rh104	42.29s	Ru102(n,γ)Ru103(β^-)Rh103m(IT)Rh103(n,γ)Rh104	84.1	90.4	79.7	
		Ru101(n,γ)Ru102(n,γ)Ru103(β^-)Rh103m(IT)Rh103(n,γ)Rh104	9.9	1.6		
		Ru102(n,γ)Ru103(β^-)Rh103m(IT)Rh103(n,γ)Rh104m(IT)Rh104	3.0	6.7	19.0	
		Ru102(n,γ)Ru103(β^-)Rh103(n,γ)Rh104	1.0	1.1	1.0	
		Ru100(n,γ)Ru101(n,γ)Ru102(n,γ)Ru103(β^-)Rh103m(IT) Rh103(n,γ)Rh104	1.0			
		Ru104(n,2n)Ru103(β^-)Rh103m(IT)Rh103(n,γ)Rh104m(IT)Rh104				53.3
		Ru104(n,2n)Ru103(β^-)Rh103m(IT)Rh103(n,γ)Rh104				43.2
Tc102m	4.35m	Ru102(n,p)Tc102m				99.8
Rh103m	56.11m	Ru102(n,γ)Ru103(β^-)Rh103m	86.9	96.7	99.9	
		Ru101(n,γ)Ru102(n,γ)Ru103(β^-)Rh103m	11.7	3.3		
		Ru100(n,γ)Ru101(n,γ)Ru102(n,γ)Ru103(β^-)Rh103m	1.3			
		Ru104(n,2n)Ru103(β^-)Rh103m				99.6
Ru95	1.64h	Ru96(n,2n)Ru95				100.0
Ru105	4.44h	Ru104(n,γ)Ru105	99.9	100.0	100.0	100.0
Tc95	20.00h	Ru96(n,2n)Ru95(β^+)Tc95				71.3
		Ru96(n,np)Tc95				27.7
Rh105	1.47d	Ru104(n,γ)Ru105(β^-)Rh105	71.5	71.6	71.6	71.3
		Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105	28.4	28.4	28.4	28.3
Ru97	2.90d	Ru96(n,γ)Ru97	100.0	100.0	100.0	
		Ru98(n,2n)Ru97				63.3
		Ru99(n,2n)Ru98(n,2n)Ru97				34.9
		Ru100(n,2n)Ru99(n,2n)Ru98(n,2n)Ru97				1.4
Tc96	4.28d	Ru96(n,p)Tc96			83.0	66.8
		Ru96(n,p)Tc96m(IT)Tc96			17.0	16.5
		Ru98(n,2n)Ru97(β^+)Tc97(n,2n)Tc96				9.2
		Ru98(n,2n)Ru97(β^+)Tc97(n,2n)Tc96m(IT)Tc96				3.4
		Ru99(n,2n)Ru98(n,2n)Ru97(β^+)Tc97(n,2n)Tc96				2.5
Ru103	39.27d	Ru102(n,γ)Ru103	86.9	96.7	99.9	
		Ru101(n,γ)Ru102(n,γ)Ru103	11.7	3.3		
		Ru100(n,γ)Ru101(n,γ)Ru102(n,γ)Ru103	1.3			
		Ru104(n,2n)Ru103				99.6
Tc95m	61.01d	Ru96(n,np)Tc95m				75.9
		Ru96(n,2n)Ru95(β^+)Tc95m				22.8
		Ru96(n,d)Tc95m				1.3

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tc97m	90.20d	Ru96(n,γ)Ru97(β^+)Tc97m	100.0	100.0	6.3	
		Ru96(n,γ)Ru97(β^+)Tc97(n,n$'$)Tc97m			93.5	
		Ru98(n,np)Tc97m				35.0
		Ru98(n,2n)Ru97(β^+)Tc97(n,n$'$)Tc97m				18.2
		Ru99(n,2n)Ru98(n,np)Tc97m				16.1
		Ru98(n,d)Tc97m				5.1
		Ru99(n,2n)Ru98(n,2n)Ru97(β^+)Tc97(n,n$'$)Tc97m				4.4
		Ru98(n,2n)Ru97(β^+)Tc97m				4.2
		Ru99(n,np)Tc98(n,2n)Tc97m				3.8
		Ru99(n,t)Tc97m				2.4
		Ru98(n,p)Tc98(n,2n)Tc97m				2.3
		Ru99(n,2n)Ru98(n,d)Tc97m				2.3
		Ru99(n,2n)Ru98(n,2n)Ru97(β^+)Tc97m				1.9
Rh102m	208.00d	Ru104(n,2n)Ru103(β^-)Rh103m(IT)Rh103(n,2n)Rh102m				97.6
		Ru104(n,2n)Ru103(β^-)Rh103(n,2n)Rh102m				1.2
Ag110m	249.77d	Ru104(n,γ)Ru105(β^-)Rh105(n,γ)Rh106(β^-)Pd106(n,γ) Pd107(n,γ)Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m	33.5			
		Ru104(n,γ)Ru105(β^-)Rh105(n,γ)Rh106m(β^-)Pd106(n,γ) Pd107(n,γ)Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m	24.9			
		Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105(n,γ)Rh106(β^-) Pd106(n,γ)Pd107(n,γ)Pd108(n,γ)Pd109(β^-)Ag109m(IT) Ag109(n,γ)Ag110m	13.3			
		Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105(n,γ)Rh106m(β^-) Pd106(n,γ)Pd107(n,γ)Pd108(n,γ)Pd109(β^-)Ag109m(IT) Ag109(n,γ)Ag110m	9.9			
		Ru104(n,γ)Ru105(β^-)Rh105(n,γ)Rh106m(n,γ)Rh107(β^-) Pd107(n,γ)Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m	8.8			
		Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105(n,γ)Rh106m(n,γ) Rh107(β^-)Pd107(n,γ)Pd108(n,γ)Pd109(β^-)Ag109m(IT) Ag109(n,γ)Ag110m	3.5			
		Ru104(n,γ)Ru105(β^-)Rh105(β^-)Pd105(n,γ)Pd106(n,γ) Pd107(n,γ)Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m	3.4			
		Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105(β^-)Pd105(n,γ) Pd106(n,γ)Pd107(n,γ)Pd108(n,γ)Pd109(β^-)Ag109m(IT) Ag109(n,γ)Ag110m	1.4			
Rh102	2.90y	Ru104(n,2n)Ru103(β^-)Rh103m(IT)Rh103(n,2n)Rh102				93.6
		Ru104(n,2n)Ru103(β^-)Rh103m(IT)Rh103(n,2n) Rh102m(n,E)Rh102				2.3
		Ru104(n,2n)Ru103(β^-)Rh103m(IT)Rh103(n,2n)Rh102m(IT)Rh102				1.9
		Ru104(n,2n)Ru103(β^-)Rh103(n,2n)Rh102				1.1
H3	12.33y	Ru96(n,γ)Ru97(n,p)H1(n,γ)H2(n,γ)H3	13.7			
		Ru96(n,p)H1(n,γ)H2(n,γ)H3			16.4	
		Ru99(n,p)H1(n,γ)H2(n,γ)H3			4.3	
		Ru101(n,t)H3				11.1
		Ru99(n,t)H3				13.1
		Ru104(n,2n)Ru103(β^-)Rh103m(IT)Rh103(n,t)H3				2.7
		Ru102(n,2n)Ru101(n,t)H3				2.6
		Ru100(n,2n)Ru99(n,t)H3				1.2
Nb93m	16.11y	Ru96(n,α)Mo93(β^+)Nb93m	100.0	100.0	92.5	14.9
		Ru96(n,α)Mo93(n,p)Nb93m			7.4	43.3
		Ru98(n,2n)Ru97(β^+)Tc97(n,nα)Nb93m				13.8
		Ru96(n,2n)Ru95(β^+)Tc95(β^+)Mo95(n,2n)Mo94(n,np)Nb93m				5.4
		Ru96(n,2n)Ru95(β^+)Tc95(β^+)Mo95(n,t)Nb93m				3.3
		Ru99(n,2n)Ru98(n,2n)Ru97(β^+)Tc97(n,nα)Nb93m				2.6
		Ru96(n,np)Tc95(β^+)Mo95(n,2n)Mo94(n,np)Nb93m				2.1
		Ru96(n,2n)Ru95(β^+)Tc95(β^+)Mo95(n,2n)Mo94(n,d)Nb93m				1.7
		Ru96(n,α)Mo93m(IT)Mo93(n,p)Nb93m				1.4
		Ru96(n,np)Tc95(β^+)Mo95(n,t)Nb93m				1.3
Mo93	4.0 10^3y	Ru96(n,α)Mo93	100.0	100.0	100.0	94.7
		Ru96(n,α)Mo93m(IT)Mo93				3.1
		Ru96(n,2n)Ru95(β^+)Tc95(β^+)Mo95(n,2n)Mo94(n,2n)Mo93				1.3

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Nb94	2.0 10^4y	Ru96(n,γ)Ru97(β^+)Tc97(n,α)Nb94m(IT)Nb94	53.9	51.1	46.7	
		Ru96(n,γ)Ru97(β^+)Tc97(n,α)Nb94	45.8	46.8	52.7	
		Ru96(n,α)Mo93(β^+)Nb93m(n,γ)Nb94m(IT)Nb94		1.0		
		Ru98(n,2n)Ru97(β^+)Tc97(n,α)Nb94m(IT)Nb94				21.5
		Ru98(n,2n)Ru97(β^+)Tc97(n,α)Nb94				19.9
		Ru96(n,2n)Ru95(β^+)Tc95(β^+)Mo95(n,np)Nb94m(IT)Nb94				11.0
		Ru96(n,2n)Ru95(β^+)Tc95(β^+)Mo95(n,np)Nb94				10.3
		Ru96(n,np)Tc95(β^+)Mo95(n,np)Nb94m(IT)Nb94				4.3
		Ru96(n,np)Tc95(β^+)Mo95(n,np)Nb94				4.0
		Ru99(n,2n)Ru98(n,2n)Ru97(β^+)Tc97(n,α)Nb94m(IT)Nb94				4.0
		Ru99(n,2n)Ru98(n,2n)Ru97(β^+)Tc97(n,α)Nb94				3.7
		Ru96(n,2n)Ru95(β^+)Tc95(β^+)Mo95(n,d)Nb94m(IT)Nb94				3.6
		Ru96(n,2n)Ru95(β^+)Tc95(β^+)Mo95(n,2n)Mo94(n,p) Nb94m(IT)Nb94				2.0
		Ru96(n,2n)Ru95(β^+)Tc95(β^+)Mo95(n,d)Nb94				1.9
		Ru96(n,np)Tc95(β^+)Mo95(n,d)Nb94m(IT)Nb94				1.4
		Ru96(n,2n)Ru95(β^+)Tc95(β^+)Mo95(n,2n)Mo94(n,p)Nb94				1.2
Tc99	2.1 10^5y	Ru96(n,γ)Ru97(β^+)Tc97(n,γ)Tc98(n,γ)Tc99	97.7	96.9		
		Ru96(n,γ)Ru97(β^+)Tc97(n,γ)Tc98(n,γ)Tc99m(IT)Tc99	2.3	3.1		
		Ru99(n,p)Tc99			84.2	64.6
		Ru99(n,p)Tc99m(IT)Tc99			14.9	11.6
		Ru102(n,α)Mo99(β^-)Tc99m(IT)Tc99				11.0
		Ru100(n,np)Tc99				5.4
		Ru100(n,2n)Ru99(n,p)Tc99				2.5
		Ru102(n,α)Mo99(β^-)Tc99				1.5
Tc97	2.6 10^6y	Ru96(n,γ)Ru97(β^+)Tc97	100.0	100.0	99.7	
		Ru98(n,2n)Ru97(β^+)Tc97				75.1
		Ru99(n,2n)Ru98(n,2n)Ru97(β^+)Tc97				20.8
		Ru98(n,np)Tc97				1.4
Tc98	4.3 10^6y	Ru96(n,γ)Ru97(β^+)Tc97(n,γ)Tc98	100.0	100.0	99.8	
		Ru99(n,np)Tc98				43.4
		Ru98(n,p)Tc98				26.9
		Ru99(n,p)Tc99(n,2n)Tc98				9.7
		Ru99(n,2n)Ru98(n,p)Tc98				7.5
		Ru99(n,d)Tc98				5.2
		Ru99(n,p)Tc99m(IT)Tc99(n,2n)Tc98				1.7
		Ru100(n,2n)Ru99(n,np)Tc98				1.7
		Ru102(n,α)Mo99(β^-)Tc99m(IT)Tc99(n,2n)Tc98				1.6
Pd107	6.5 10^6y	Ru104(n,γ)Ru105(β^-)Rh105(n,γ)Rh106(β^-)Pd106(n,γ)Pd107	34.9			
		Ru104(n,γ)Ru105(β^-)Rh105(n,γ)Rh106m(β^-)Pd106(n,γ)Pd107	25.9			
		Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105(n,γ)Rh106(β^-) Pd106(n,γ)Pd107	13.8			
		Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105(n,γ)Rh106m(β^-) Pd106(n,γ)Pd107	10.3			
		Ru104(n,γ)Ru105(β^-)Rh105(β^-)Pd105(n,γ)Pd106(n,γ)Pd107	5.4	70.4	64.7	42.2
		Ru104(n,γ)Ru105(β^-)Rh105(n,γ)Rh106m(n,γ)Rh107(β^-)Pd107	4.8			
		Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105(β^-)Pd105(n,γ) Pd106(n,γ)Pd107	2.1	27.9	25.7	16.7
		Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105(n,γ)Rh106m(n,γ) Rh107(β^-)Pd107	1.9			
		Ru104(n,γ)Ru105(β^-)Rh105(β^-)Pd105(n,γ)Pd106(n,γ) Pd107m(IT)Pd107			6.1	28.6
		Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105(β^-)Pd105(n,γ) Pd106(n,γ)Pd107m(IT)Pd107			2.4	11.3

Rhodium

Isotope	Atom % abundance
Rh103	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	4.50E+15	1.37E+15	4.53E+14	1.86E+14	3.87E+07	7.79E+06
Rh104	68.5	7.1				
Rh103m	18.3	56.5	6.9			
Rh102m	5.6	18.4	55.1	40.2		
Rh104m	3.5	5.0				
Rh102	3.1	10.1	30.6	59.6		
Pd103	0.4	1.4	3.7			
Ru103	0.3	1.1	3.3			
H3					79.2	
Tc99					20.8	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	5.78E-01	9.78E-02	7.57E-02	4.59E-02	1.43E-10	1.07E-10
Rh104	85.2	16.0				
Rh102	8.2	48.5	62.6	82.6	3.1	
Rh102m	4.7	27.6	35.2	17.4		
Rh103m	0.9	4.8	0.2			
Rh104m	0.6	1.5				
Ru103	0.2	1.4	1.8			
Tc99					76.9	99.4
H3					19.6	

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.03E+05	9.56E+04	9.47E+04	6.24E+04	7.29E-06	8.38E-07
Rh102	67.1	72.1	72.6	88.2	88.5	
Rh102m	24.1	25.9	25.8	11.8		
Rh104	6.9	0.2				
Ru103	1.4	1.5	1.5			
Tc98					11.5	99.9

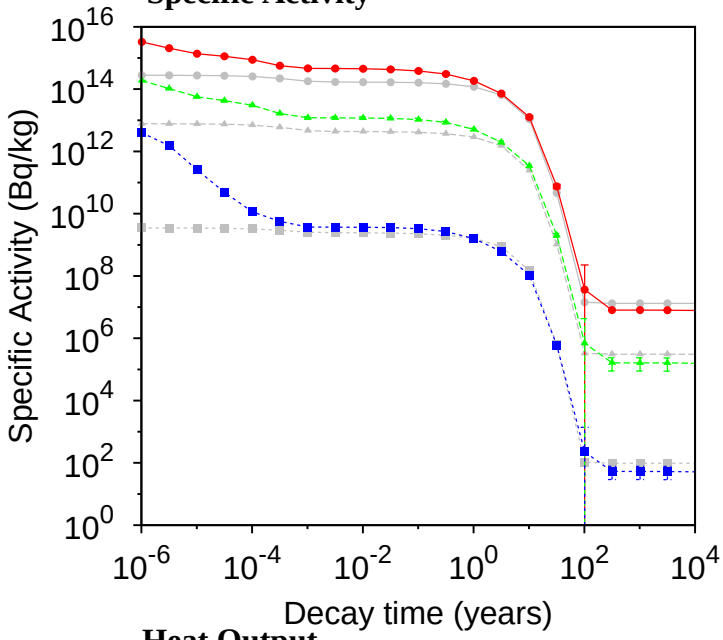
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	7.14E+05	6.84E+05	6.74E+05	3.78E+05	6.47E-03	4.99E-03
Rh102	50.6	52.8	53.4	76.2	0.5	
Rh102m	42.4	44.3	44.4	23.7		
Tc100	3.4					
Ru103	1.6	1.7	1.6			
Tc99					79.5	99.9
H3					19.9	

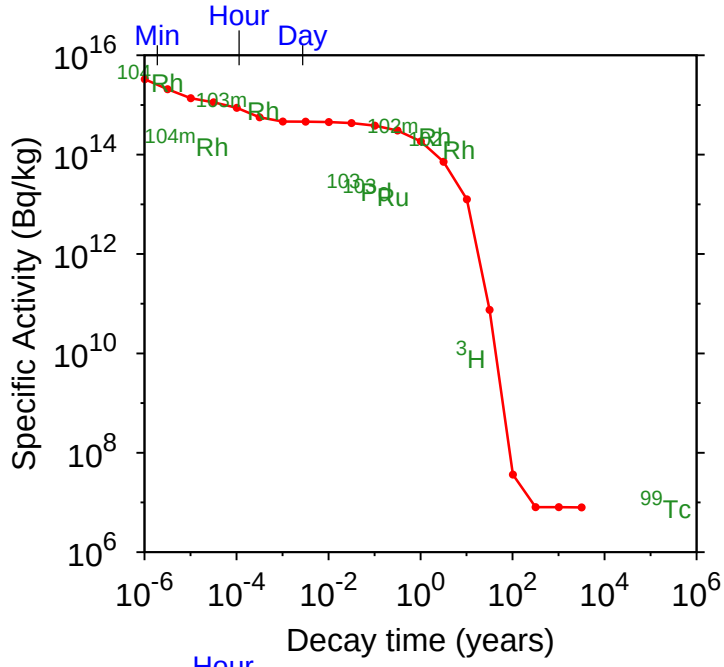
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.24E+06	4.21E+06	4.18E+06	2.42E+06	1.13E-01	1.01E-01
Rh102	55.7	56.0	56.3	78.0	0.2	
Rh102m	42.3	42.5	42.4	22.0		
Ru103	1.1	1.1	1.1			
Tc99					92.6	99.9
H3					7.1	

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	7.99E+11	4.53E+11	4.35E+11	2.73E+11	8.38E+03	7.79E+03
Rh104	43.9	2.5				
Rh102	37.0	65.2	67.8	86.3	0.3	
Rh102m	15.8	27.8	28.7	13.7		
Ru103	2.0	3.5	3.4			
Rh104m	1.1	0.8				
Tc99					96.0	100.0
H3					3.7	

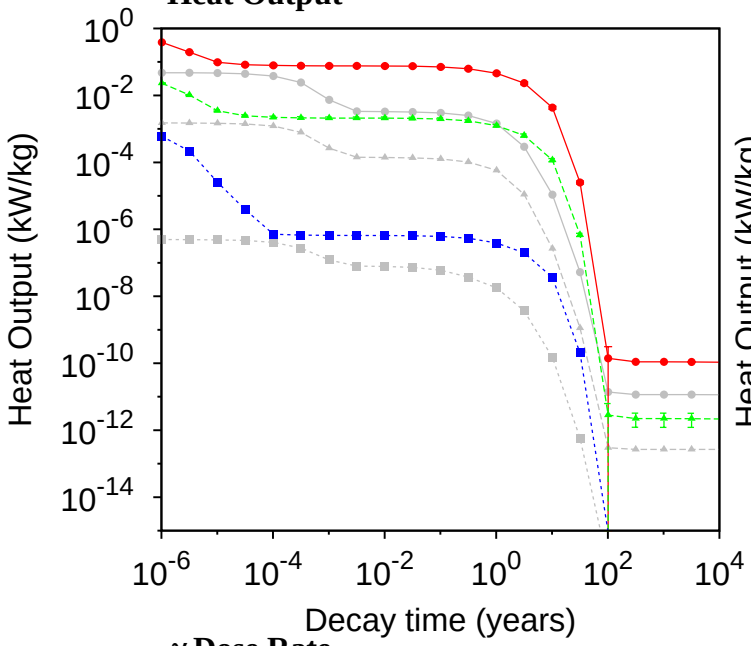
Rhodium activation characteristics

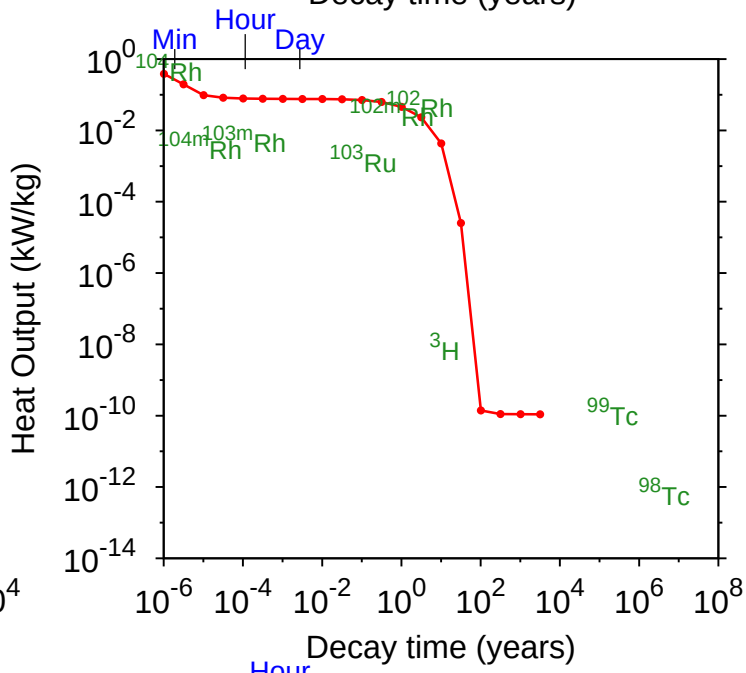
Specific Activity



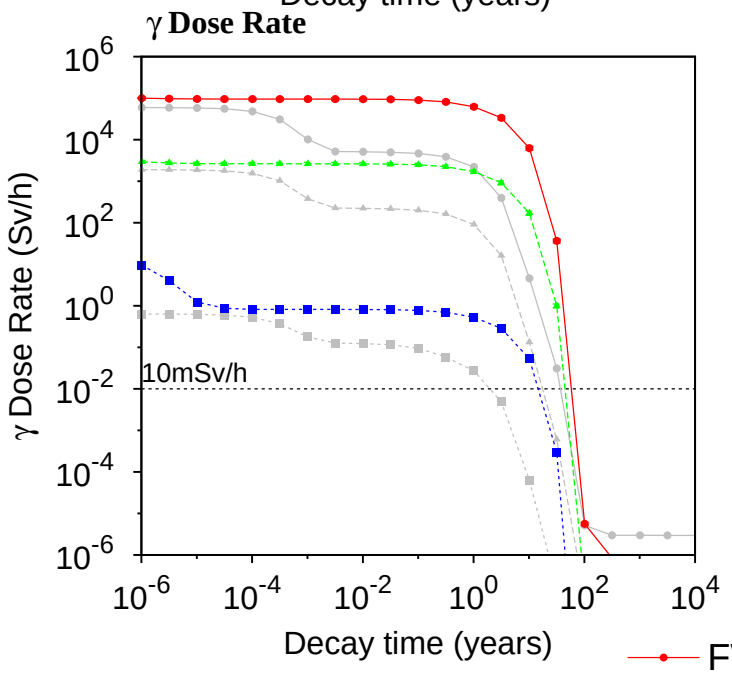


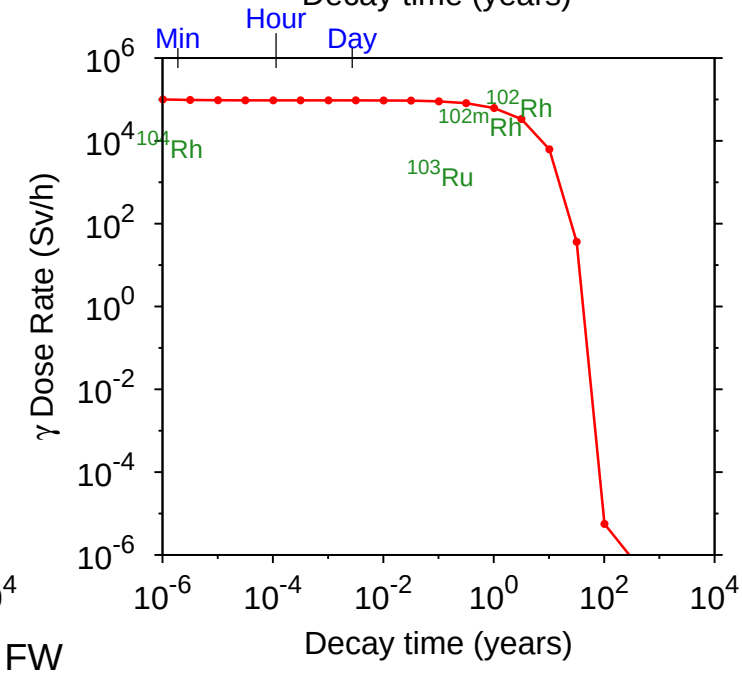
Heat Output





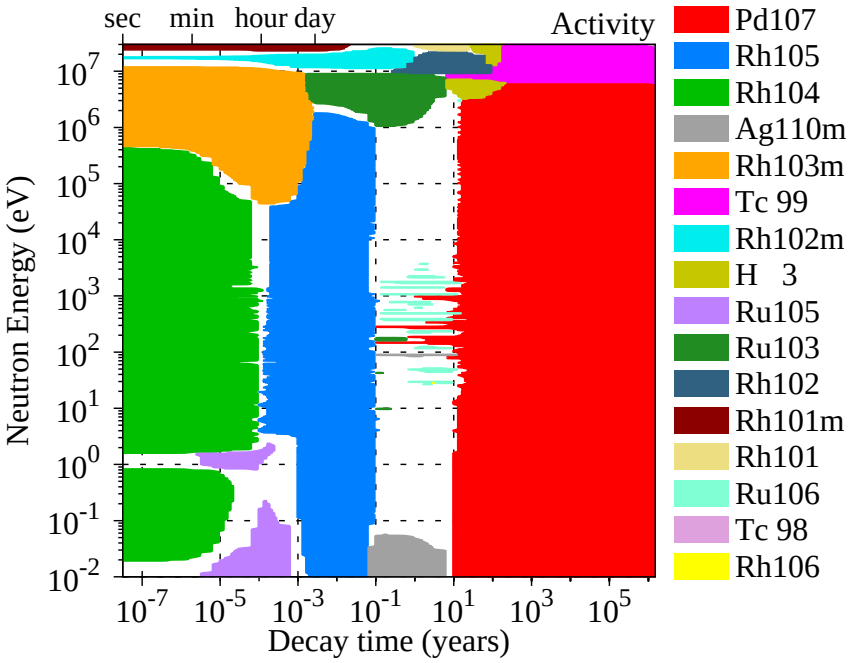
γ Dose Rate

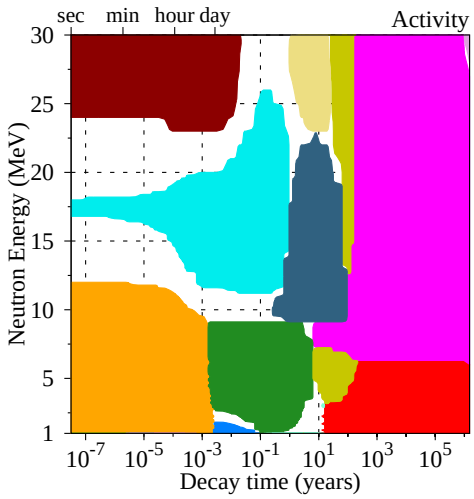


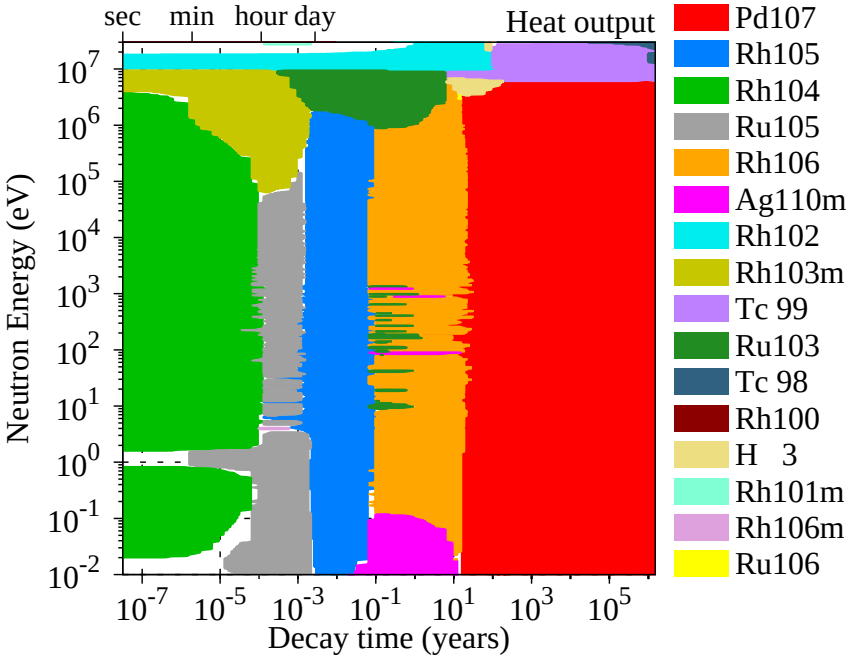


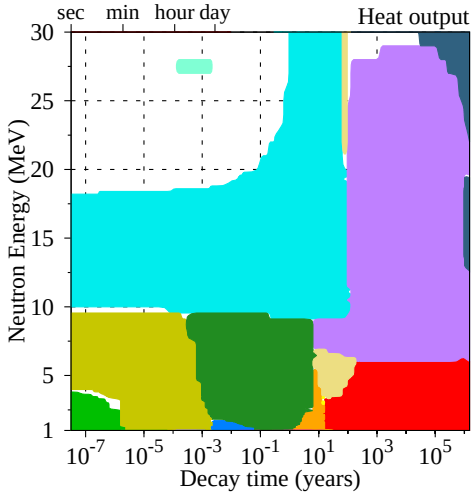
FW
Blanket
Manifold
Fe results

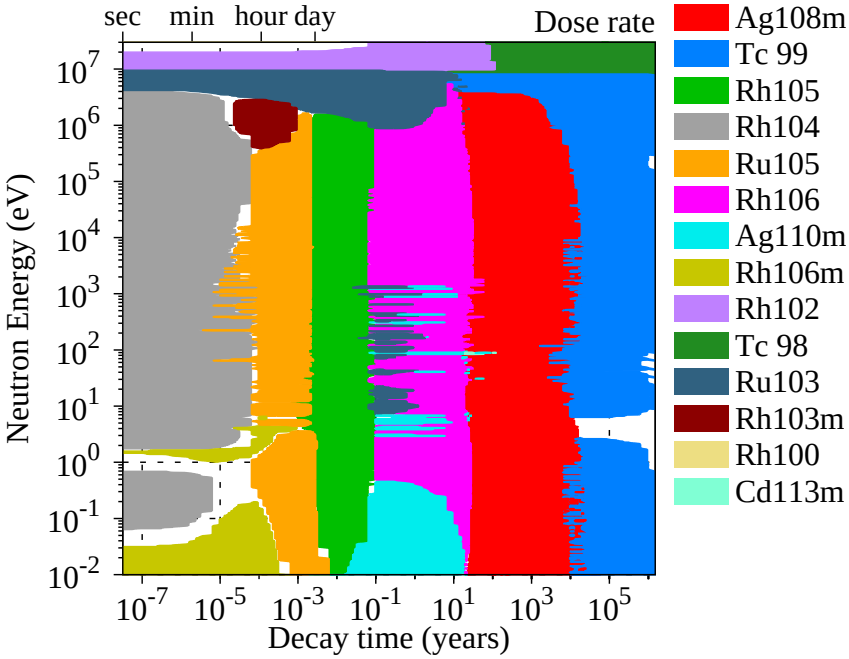
Rhodium Importance diagrams

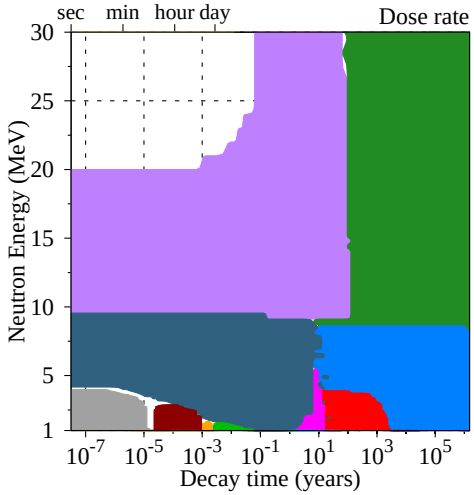




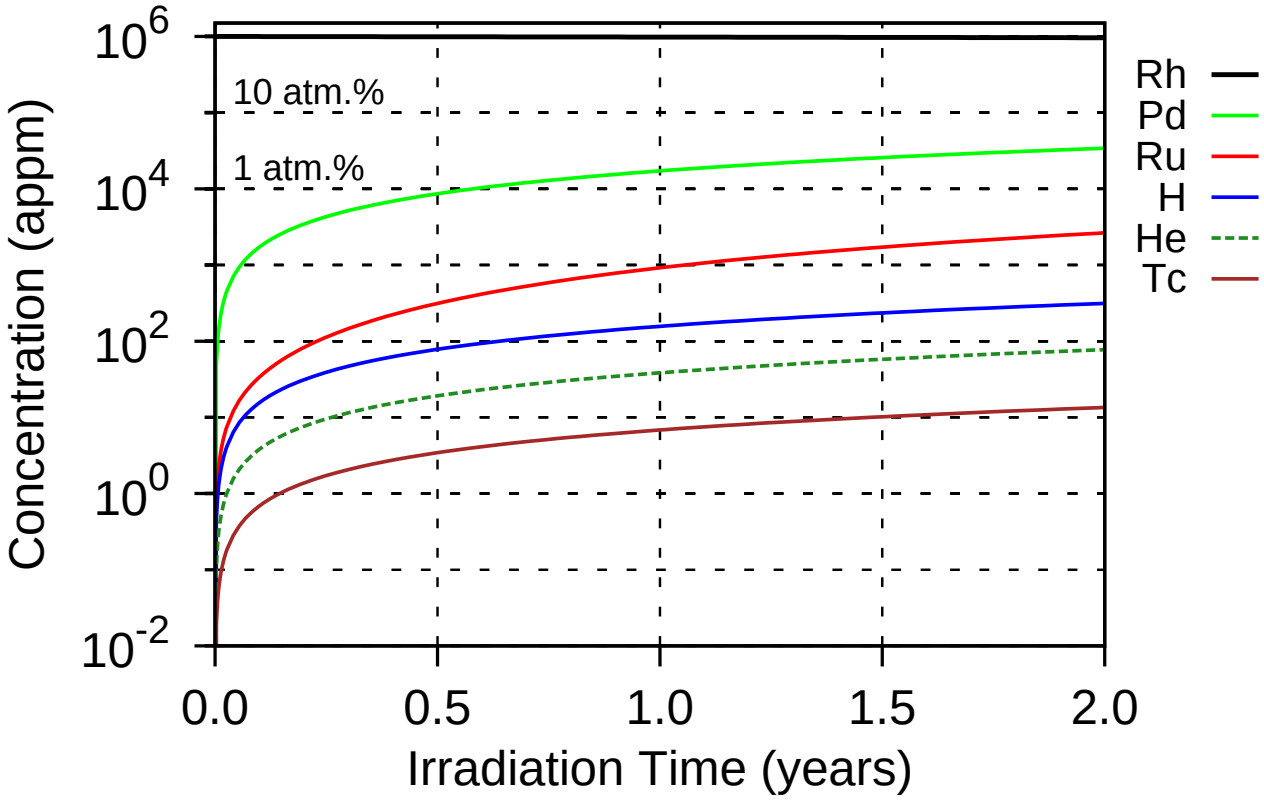




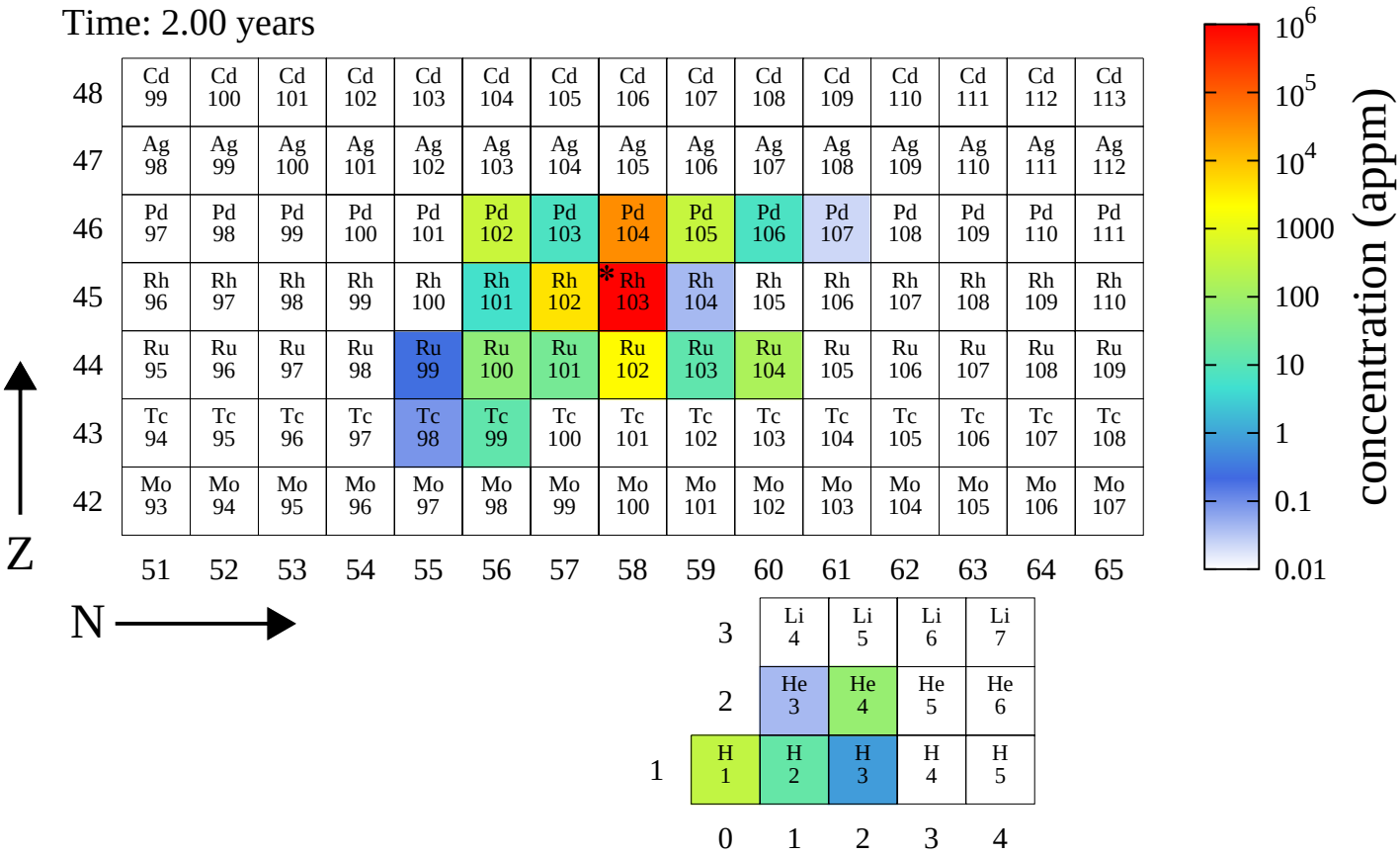




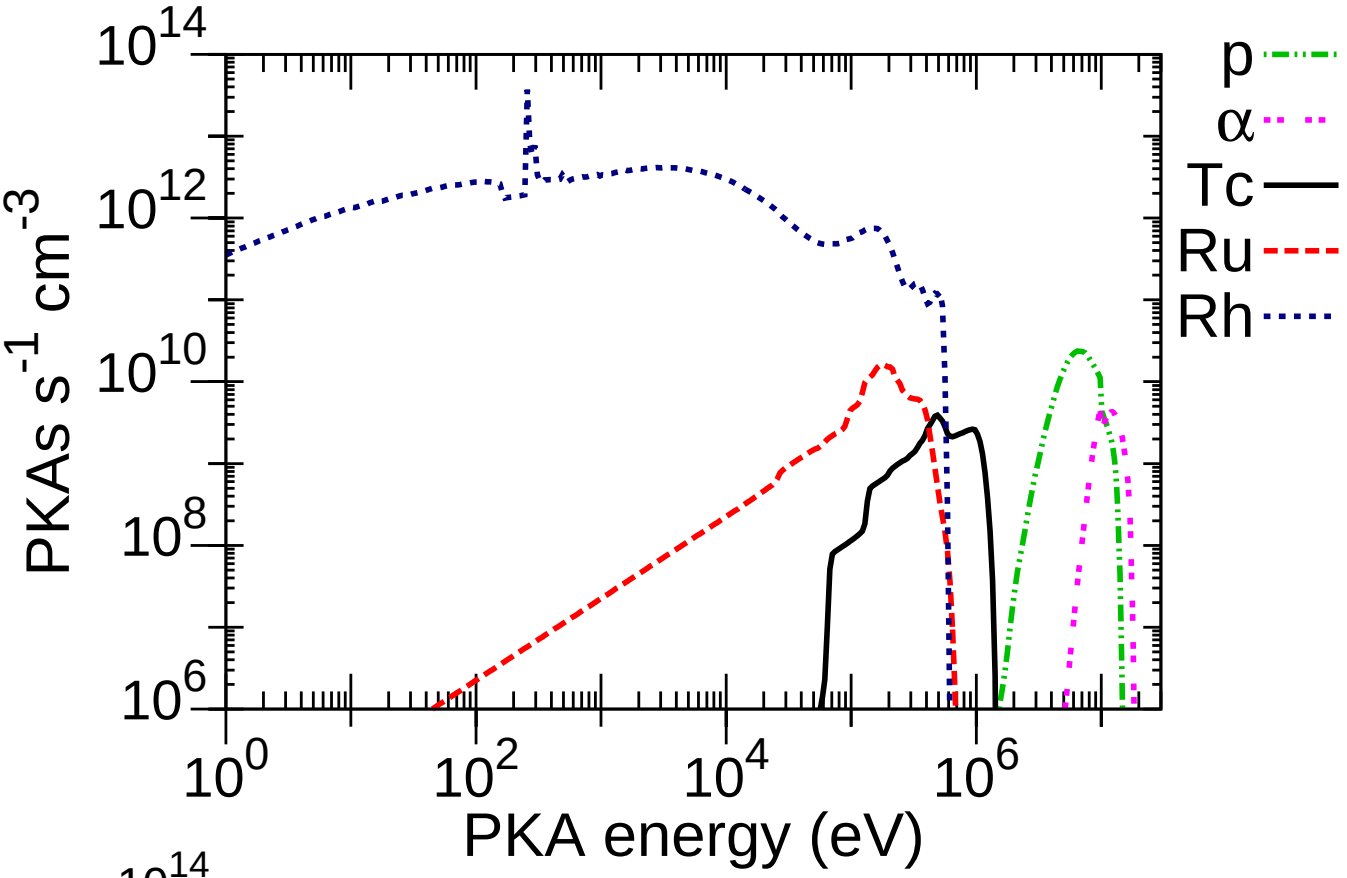
Rhodium FW Transmutation

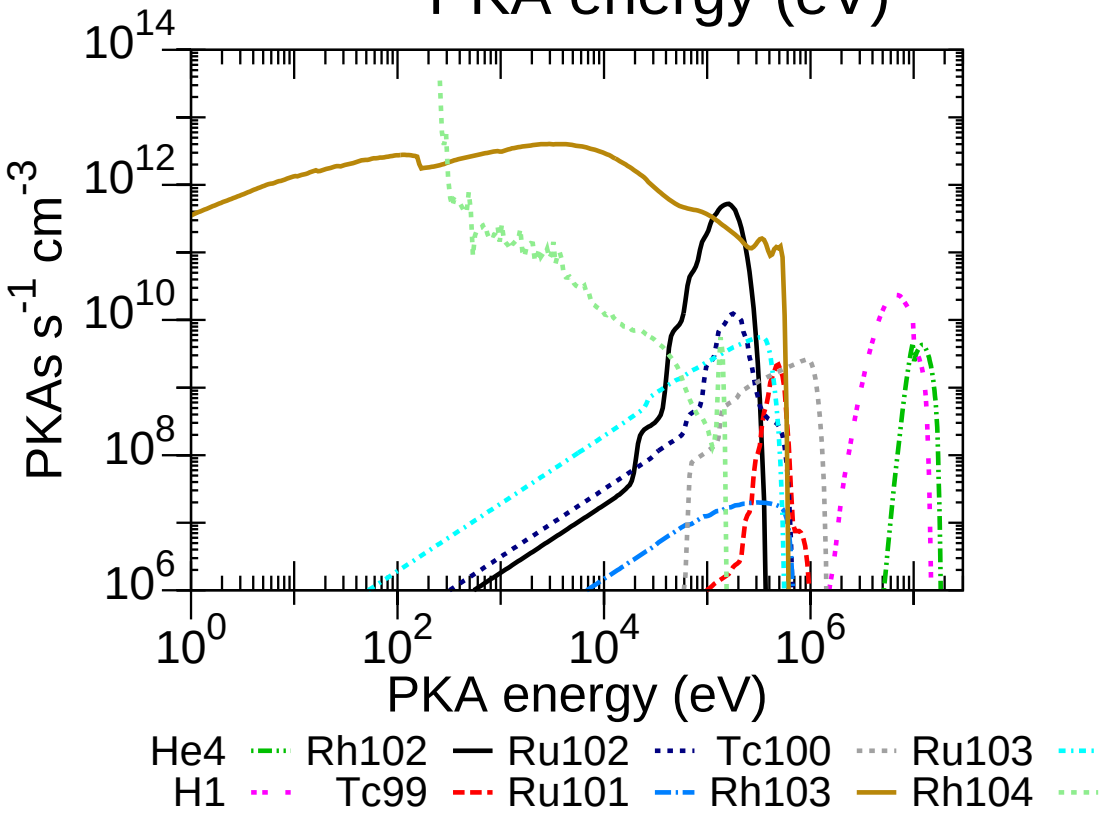


38 appm He & 157 appm H after 1 year 18 dpa/year



Rhodium FW PKA distributions





Rhodium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tc100	15.80s	Rh103(n,α)Tc100		100.0	100.0	99.6
Rh106	30.01s	Rh103(n,γ)Rh104(β^+)Ru104(n,γ)Ru105(β^-)Rh105(n,γ)Rh106	69.1	62.6	55.3	
		Rh103(n,γ)Rh104(β^+)Ru104(n,γ)Ru105(β^-)Rh105m(IT) Rh105(n,γ)Rh106	27.4	24.8	21.9	
		Rh103(n,γ)Rh104m(IT)Rh104(β^+)Ru104(n,γ)Ru105(β^-) Rh105(n,γ)Rh106	2.5	4.6	13.2	
		Rh103(n,γ)Rh104m(IT)Rh104(β^+)Ru104(n,γ)Ru105(β^-) Rh105m(IT)Rh105(n,γ)Rh106	1.0	1.8	5.2	
		Rh103(n,γ)Rh104(β^+)Ru104(n,γ)Ru105(n,γ)Ru106(β^-)Rh106		5.5	3.4	
Rh104	42.29s	Rh103(n,γ)Rh104	96.6	93.1	80.7	44.6
		Rh103(n,γ)Rh104m(IT)Rh104	3.5	6.9	19.3	55.0
Rh104m	4.34m	Rh103(n,γ)Rh104m	100.0	100.0	100.0	99.7
Rh103m	56.11m	Rh103(n,γ)Rh104(β^-)Pd104(n,γ)Pd105(n,α)Ru102(n,γ) Ru103(β^-)Rh103m	93.8	92.7		
		Rh103(n,γ)Rh104m(IT)Rh104(β^-)Pd104(n,γ)Pd105(n,α) Ru102(n,γ)Ru103(β^-)Rh103m	3.4	6.8		
		Rh103(n,γ)Rh104(β^-)Pd104(n,α)Ru101(n,γ)Ru102(n,γ) Ru103(β^-)Rh103m	2.6			
		Rh103(n,n$'$)Rh103m			100.0	92.6
		Rh103(n,p)Ru103(β^-)Rh103m				7.1
Rh106m	2.20h	Rh103(n,γ)Rh104(β^+)Ru104(n,γ)Ru105(β^-)Rh105(n,γ)Rh106m	69.1	66.5	57.8	
		Rh103(n,γ)Rh104(β^+)Ru104(n,γ)Ru105(β^-)Rh105m(IT) Rh105(n,γ)Rh106m	27.4	26.4	22.9	
		Rh103(n,γ)Rh104m(IT)Rh104(β^+)Ru104(n,γ)Ru105(β^-) Rh105(n,γ)Rh106m	2.5	4.9	13.8	
		Rh103(n,γ)Rh104m(IT)Rh104(β^+)Ru104(n,γ)Ru105(β^-) Rh105m(IT)Rh105(n,γ)Rh106m	1.0	1.9	5.5	
Ru105	4.44h	Rh103(n,γ)Rh104(β^+)Ru104(n,γ)Ru105	96.5	93.1	80.7	
		Rh103(n,γ)Rh104m(IT)Rh104(β^+)Ru104(n,γ)Ru105	3.5	6.9	19.3	
Rh100	20.80h	Rh103(n,2n)Rh102(n,2n)Rh101(n,2n)Rh100				27.9
		Rh103(n,2n)Rh102(n,2n)Rh101(n,2n)Rh100m(IT)Rh100				27.7
		Rh103(n,2n)Rh102m(n,2n)Rh101(n,2n)Rh100				7.6
		Rh103(n,2n)Rh102m(n,2n)Rh101(n,2n)Rh100m(IT)Rh100				7.6
		Rh103(n,2n)Rh102(n,2n)Rh101m(IT)Rh101(n,2n)Rh100				5.8
		Rh103(n,2n)Rh102(n,2n)Rh101m(IT)Rh101(n,2n) Rh100m(IT)Rh100				5.7
		Rh103(n,2n)Rh102m(n,2n)Rh101m(IT)Rh101(n,2n)Rh100				3.5
		Rh103(n,2n)Rh102m(n,2n)Rh101m(IT)Rh101(n,2n) Rh100m(IT)Rh100				3.5
		Rh103(n,2n)Rh102(n,2n)Rh101m(n,2n)Rh100m(IT)Rh100				1.9
		Rh103(n,2n)Rh102(n,2n)Rh101m(n,2n)Rh100				1.0
Rh105	1.47d	Rh103(n,γ)Rh104(β^+)Ru104(n,γ)Ru105(β^-)Rh105	69.1	66.5	57.8	20.2
		Rh103(n,γ)Rh104(β^+)Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105	27.4	26.4	22.9	8.0
		Rh103(n,γ)Rh104m(IT)Rh104(β^+)Ru104(n,γ)Ru105(β^-)Rh105	2.5	4.9	13.8	24.9
		Rh103(n,γ)Rh104m(IT)Rh104(β^+)Ru104(n,γ)Ru105(β^-) Rh105m(IT)Rh105	1.0	1.9	5.5	9.9
		Rh103(n,γ)Rh104m(IT)Rh104(β^-)Pd104(n,γ)Pd105(n,p)Rh105				12.3
		Rh103(n,γ)Rh104(β^-)Pd104(n,γ)Pd105(n,p)Rh105				10.0
		Rh103(n,γ)Rh104m(IT)Rh104(β^-)Pd104(n,γ)Pd105(n,p) Rh105m(IT)Rh105				7.0
		Rh103(n,γ)Rh104(β^-)Pd104(n,γ)Pd105(n,p)Rh105m(IT)Rh105				5.7
Rh101m	4.35d	Rh103(n,2n)Rh102(n,2n)Rh101m				59.8
		Rh103(n,2n)Rh102m(n,2n)Rh101m				28.7
		Rh103(n,2n)Rh102m(β^-)Pd102(n,2n)Pd101(β^+)Rh101m				6.8
		Rh103(n,2n)Rh102m(n,E)Rh102(n,2n)Rh101m				2.0
		Rh103(n,2n)Rh102m(IT)Rh102(n,2n)Rh101m				1.6
Pd103	16.98d	Rh103(n,γ)Rh104m(IT)Rh104(β^-)Pd104(n,2n)Pd103				50.9
		Rh103(n,γ)Rh104(β^-)Pd104(n,2n)Pd103				41.3
		Rh103(n,2n)Rh102m(β^-)Pd102(n,γ)Pd103				6.6
Ru103	39.27d	Rh103(n,γ)Rh104(β^-)Pd104(n,γ)Pd105(n,α)Ru102(n,γ)Ru103	93.8	92.7		
		Rh103(n,γ)Rh104m(IT)Rh104(β^-)Pd104(n,γ)Pd105(n,α) Ru102(n,γ)Ru103	3.4	6.8		
		Rh103(n,γ)Rh104(β^-)Pd104(n,α)Ru101(n,γ)Ru102(n,γ)Ru103	2.6			
		Rh103(n,p)Ru103			100.0	99.7
Rh102m	208.00d	Rh103(n,2n)Rh102m				99.5

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ag110m	249.77d	Rh103(n,γ)Rh104(β^-)Pd104(n,γ)Pd105(n,γ)Pd106(n,γ) Pd107(n,γ)Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m	93.3	89.9		
		Rh103(n,γ)Rh104m(IT)Rh104(β^-)Pd104(n,γ)Pd105(n,γ) Pd106(n,γ)Pd107(n,γ)Pd108(n,γ)Pd109(β^-)Ag109m(IT) Ag109(n,γ)Ag110m	3.4	6.6		
		Rh103(n,γ)Rh104(β^-)Pd104(n,γ)Pd105(n,γ)Pd106(n,γ) Pd107(n,γ)Pd108(n,γ)Pd109m(IT)Pd109(β^-)Ag109m(IT) Ag109(n,γ)Ag110m		2.1		
Ru106	1.02y	Rh103(n,γ)Rh104(β^+)Ru104(n,γ)Ru105(n,γ)Ru106	96.5	93.1	80.7	
		Rh103(n,γ)Rh104m(IT)Rh104(β^+)Ru104(n,γ)Ru105(n,γ)Ru106	3.5	6.9	19.3	
Rh102	2.90y	Rh103(n,2n)Rh102				94.0
		Rh103(n,2n)Rh102m(n,E)Rh102				3.2
		Rh103(n,2n)Rh102m(IT)Rh102				2.5
Rh101	3.20y	Rh103(n,2n)Rh102(n,2n)Rh101				58.5
		Rh103(n,2n)Rh102m(n,2n)Rh101				16.0
		Rh103(n,2n)Rh102(n,2n)Rh101m(IT)Rh101				12.1
		Rh103(n,2n)Rh102m(n,2n)Rh101m(IT)Rh101				7.3
		Rh103(n,2n)Rh102m(n,E)Rh102(n,2n)Rh101				1.6
		Rh103(n,2n)Rh102m(IT)Rh102(n,2n)Rh101				1.3
		Rh103(n,2n)Rh102m(β^-)Pd102(n,2n)Pd101(β^+)Rh101m(IT)Rh101				1.0
H3	12.33y	Rh103(n,γ)Rh104(n,p)H1(n,γ)H2(n,γ)H3	96.5			
		Rh103(n,γ)Rh104m(IT)Rh104(n,p)H1(n,γ)H2(n,γ)H3	3.5			
		Rh103(n,p)H1(n,γ)H2(n,γ)H3			100.0	
		Rh103(n,t)H3				95.8
		Rh103(n,2n)Rh102(n,t)H3				2.5
		Rh103(n,2n)Rh102m(n,t)H3				1.4
Cd113m	14.60y	no pathways found				
Ag108m	417.97y	Rh103(n,γ)Rh104(β^-)Pd104(n,γ)Pd105(n,γ)Pd106(n,γ) Pd107(β^-)Ag107(n,γ)Ag108m	94.5	92.1		
		Rh103(n,γ)Rh104m(IT)Rh104(β^-)Pd104(n,γ)Pd105(n,γ) Pd106(n,γ)Pd107(β^-)Ag107(n,γ)Ag108m	3.4	6.8		
Tc99	2.1 10^5y	Rh103(n,γ)Rh104(β^-)Pd104(n,α)Ru101(n,α)Mo98(n,γ)Mo99(β^-) Tc99m(IT)Tc99			67.6	
		Rh103(n,γ)Rh104m(IT)Rh104(β^-)Pd104(n,α)Ru101(n,α) Mo98(n,γ)Mo99(β^-)Tc99m(IT)Tc99			16.2	
		Rh103(n,α)Tc100(β^-)Ru100(n,γ)Ru101(n,α)Mo98(n,γ)Mo99(β^-) Tc99m(IT)Tc99			3.7	
		Rh103(n,nα)Tc99				68.5
		Rh103(n,nα)Tc99m(IT)Tc99				11.2
		Rh103(n,2n)Rh102(n,α)Tc99				9.7
		Rh103(n,2n)Rh102m(n,α)Tc99				5.4
		Rh103(n,2n)Rh102(n,α)Tc99m(IT)Tc99				1.6
		Rh103(n,2n)Rh102m(β^+)Ru102(n,α)Mo99(β^-)Tc99m(IT)Tc99				1.0
Tc98	4.3 10^6y	Rh103(n,nα)Tc99(n,2n)Tc98				51.1
		Rh103(n,2n)Rh102(n,nα)Tc98				17.0
		Rh103(n,2n)Rh102m(n,nα)Tc98				8.9
		Rh103(n,nα)Tc99m(IT)Tc99(n,2n)Tc98				8.4
		Rh103(n,2n)Rh102(n,α)Tc99(n,2n)Tc98				5.1
		Rh103(n,2n)Rh102m(n,α)Tc99(n,2n)Tc98				3.2
		Rh103(n,2n)Rh102(n,2n)Rh101(n,α)Tc98				1.2
Pd107	6.5 10^6y	Rh103(n,γ)Rh104(β^-)Pd104(n,γ)Pd105(n,γ)Pd106(n,γ)Pd107	95.1	92.1	73.4	26.3
		Rh103(n,γ)Rh104m(IT)Rh104(β^-)Pd104(n,γ)Pd105(n,γ) Pd106(n,γ)Pd107	3.4	6.8	17.5	32.5
		Rh103(n,γ)Rh104(β^-)Pd104(n,γ)Pd105(n,γ)Pd106(n,γ) Pd107m(IT)Pd107			6.9	17.9
		Rh103(n,γ)Rh104m(IT)Rh104(β^-)Pd104(n,γ)Pd105(n,γ) Pd106(n,γ)Pd107m(IT)Pd107			1.7	22.0

Palladium

Isotope	Atom % abundance
Pd102	1.02
Pd104	11.14
Pd105	22.33
Pd106	27.33
Pd108	26.46
Pd110	11.72

($T_{1/2}$ =6.0 10^{17}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.38E+15	1.22E+15	1.70E+14	8.61E+11	2.66E+09	6.65E+07
Ag109m	34.0	38.1	3.3	3.8		
Pd109	33.7	38.1	3.2			
Rh103m	5.4	6.1	37.1	0.2		
Pd103	5.2	5.9	36.5			
Pd107m	4.8					
Ag110	3.5			0.6		
Pd111	2.7	2.6				
Ag111	2.7	3.1	15.6			
Ag111m	2.7	2.7				
Pd109m	2.3	1.2				
Rh101m	0.4	0.4	1.8			
Ag110m	0.1	0.1	0.6	42.3		
Rh102			0.1	21.7		
Rh101			0.1	15.8		
Rh102m			0.2	11.2		
Cd109				3.8		
Ag108m				0.3	89.6	
Ag108	0.2				7.8	
Pd107					2.5	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	5.92E-02	4.42E-02	3.47E-03	2.50E-04	6.50E-07	9.93E-11
Pd109	45.6	60.9	9.2			
Ag110	15.9		0.1	0.4		
Ag109m	11.2	14.8	2.3	0.2		
Pd111	8.9	10.2				
Pd107m	3.9					
Ag111	3.8	5.1	46.3			
Rh104	2.0	0.4				
Pd109m	1.6	1.0				
Ag110m	0.8	1.0	13.0	66.3		
Rh103m	0.8	1.0	11.0			
Pd103	0.4	0.5	5.9			
Rh101m	0.4	0.6	4.5			
Ru103	0.1	0.2	2.4	0.1		
Rh102	0.1	0.2	2.3	25.6		
Rh105	0.6	0.8	1.7			
Rh102m	0.1	0.1	1.0	4.1		
Rh101			0.3	3.0		
Ag108m				0.3	96.8	0.2
Ag108	0.4	0.1			3.2	
Pd107						99.8

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	4.75E+03	3.10E+03	1.19E+03	3.69E+02	8.49E-01	2.15E-07
Pd107m	16.9					
Ag110m	15.3	23.4	60.5	71.4		
Rh108m	11.7	9.8				
Rh106m	10.6	15.8				
Pd111	9.0	11.9				
Ag110	7.5					
Pd101	6.2	9.5				
Rh101m	4.2	6.4	10.1			
Ag111	2.6	4.0	7.5			
Rh102	2.5	3.8	9.9	25.3		
Pd109m	2.0	1.4				
Rh105	1.9	3.0	1.4			
Ru103	1.9	2.9	7.2			
Ru105	1.3	2.0				
Pd109	1.3	2.0	0.1			
Rh102m	0.7	1.0	2.7	2.6		
Ag108m			0.1	0.3	99.9	97.7
Tc98						2.1

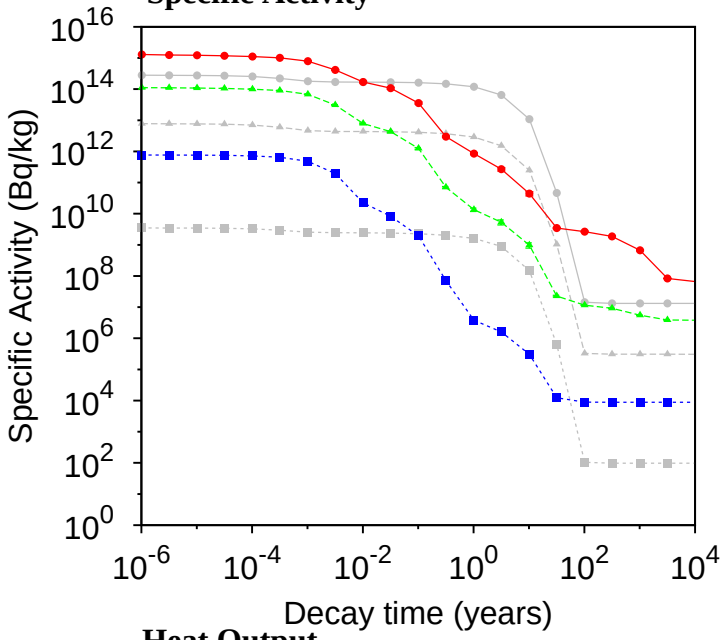
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.32E+05	3.30E+05	5.55E+04	1.77E+03	5.49E+00	2.46E-03
Pd109	77.2	77.3	5.4			
Ag111	14.6	14.6	62.2			
Pd103	4.1	4.2	21.3			
Rh105	1.0	1.0	1.1			
Ag110m	0.8	0.9	5.0	57.6		
Ru103	0.2	0.2	1.2	0.1		
Rh101m	0.3	0.3	1.2			
Rh102	0.2	0.2	1.1	27.4		
Rh102m	0.1	0.1	0.7	6.5		
Rh101			0.2	4.2		
Cd109			0.2	3.7		
Ag108m				0.4	99.9	0.1
Pd107						99.8

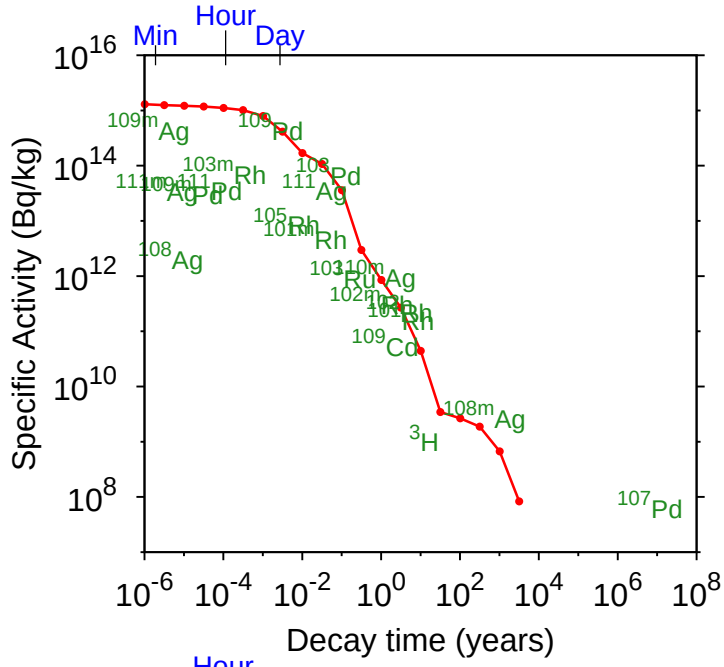
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.00E+05	2.98E+05	9.90E+04	9.35E+03	8.83E+01	3.93E-02
Pd109	57.5	57.5	2.1			
Ag111	21.1	21.2	45.6			
Pd103	10.8	10.9	28.3			
Ag110m	4.0	4.0	12.1	46.8		
Rh102	1.3	1.3	4.0	34.0		
Pd111	1.2	1.0				
Rh105	1.1	1.1	0.6			
Ru103	1.0	1.0	2.7			
Rh102m	0.8	0.8	2.3	7.3		
Rh101	0.3	0.3	0.9	7.8		
Cd109	0.2	0.2	0.5	2.8		
Ag108m			0.1	1.1	99.9	0.1
Pd107						99.8

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	6.25E+10	3.90E+10	1.30E+10	4.18E+09	3.93E+06	6.51E+01
Pd107m	16.9					
Ag110m	16.1	25.8	76.2	87.3		
Ag109m	14.2	22.5	0.8			
Ag110	11.6					
Pd111	7.7	10.6				
Pd109	7.5	11.9	0.4			
Pd109m	6.1	4.5				
Rh108m	3.7	3.2				
Rh106m	3.2	5.0				
Pd101	2.7	4.3				
Rh101m	2.4	3.9	7.0			
Ru103	1.5	2.5	6.9			
Rh104	1.3	0.3				
Rh102	0.8	1.3	3.8	9.5		
Ag111m	0.7	1.1				
Ag111	0.6	1.0	2.0			
Rh102m	0.3	0.4	1.2	1.2		
Rh101	0.1	0.1	0.4	1.0		
Ag108m				0.1	99.6	1.5
Pd107						92.9
Tc99						5.6

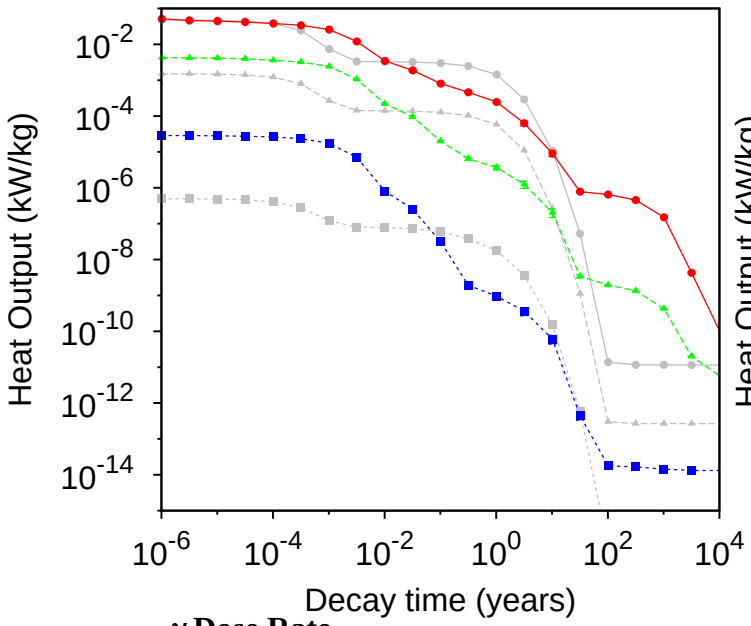
Palladium activation characteristics

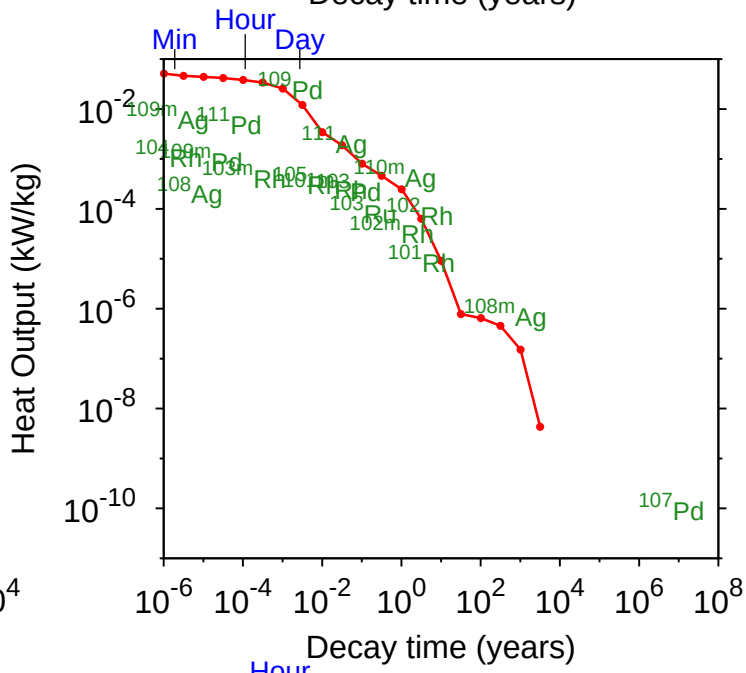
Specific Activity



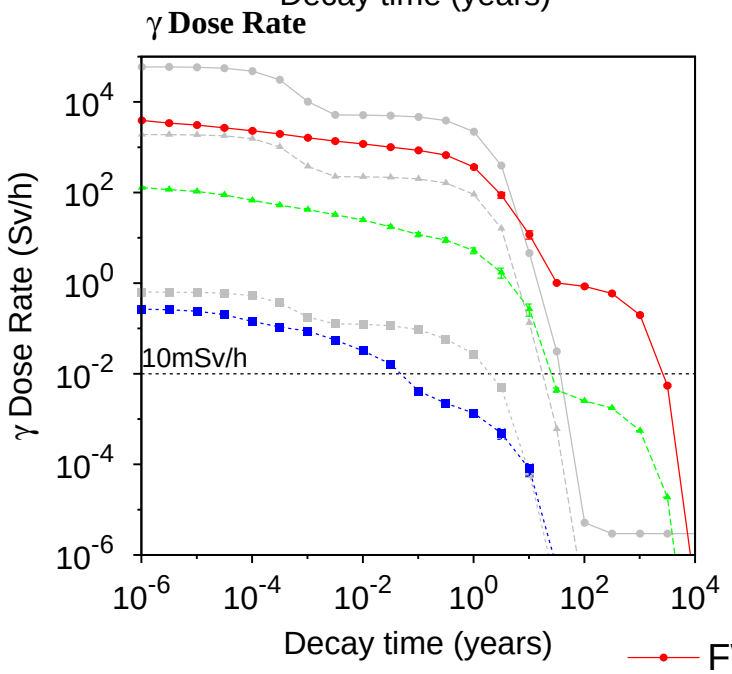


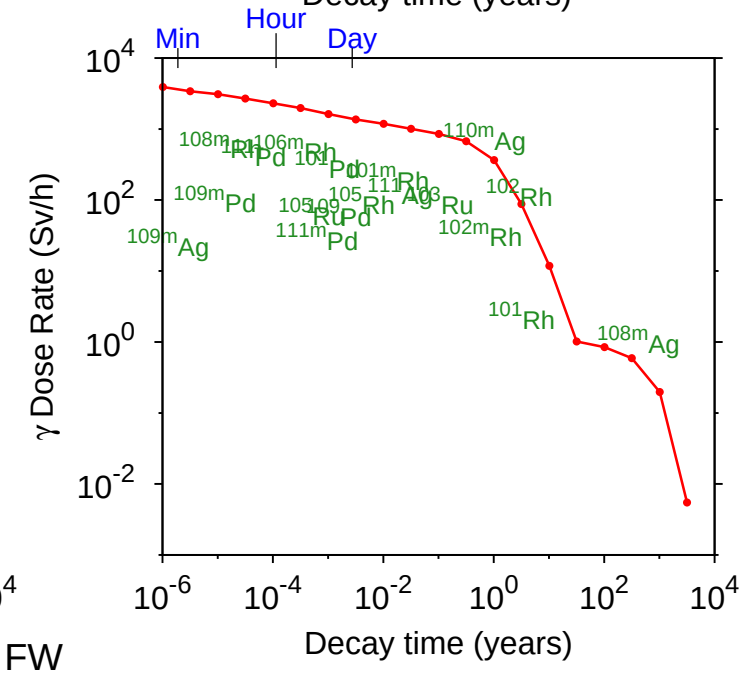
Heat Output





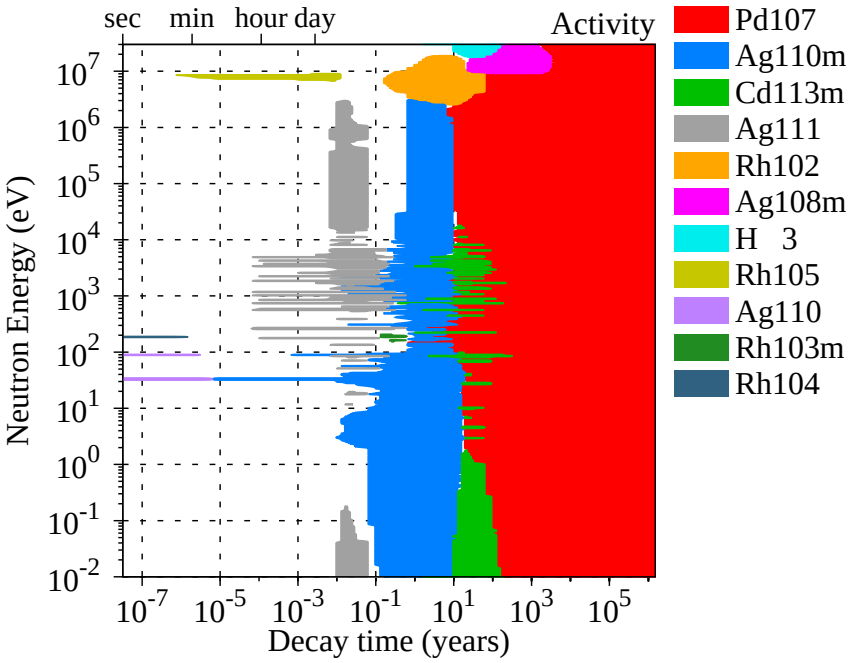
γ Dose Rate

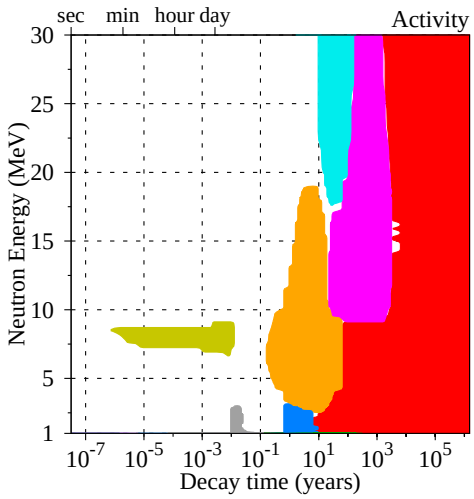


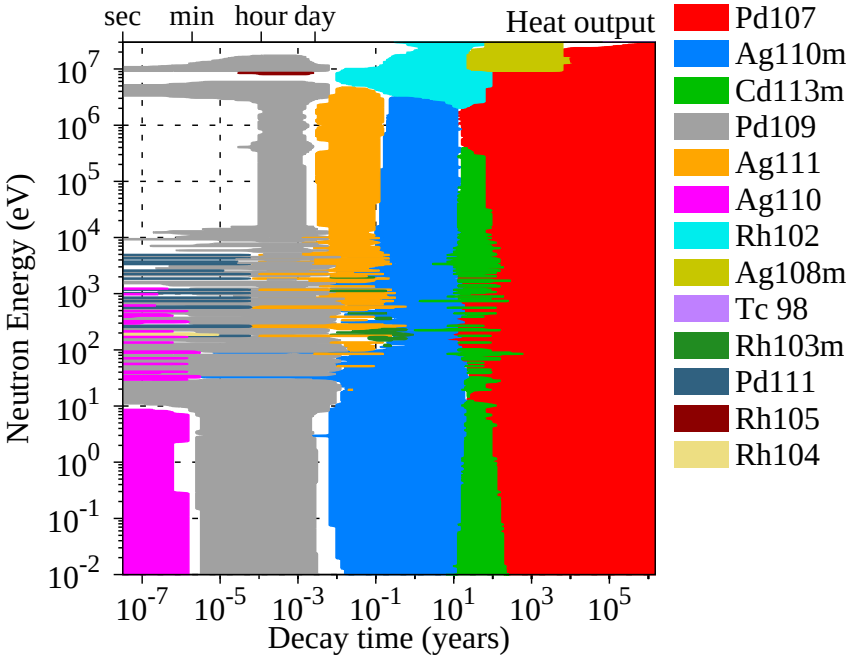


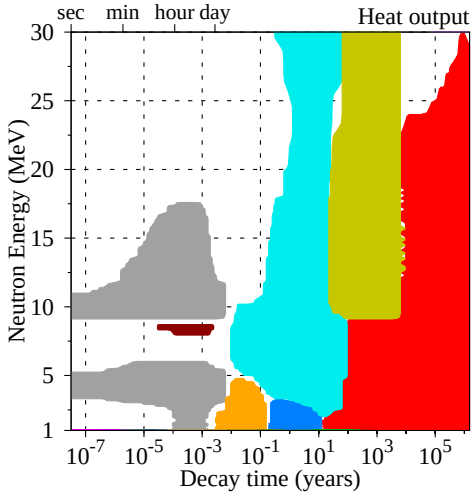
FW
Blanket
Manifold
Fe results

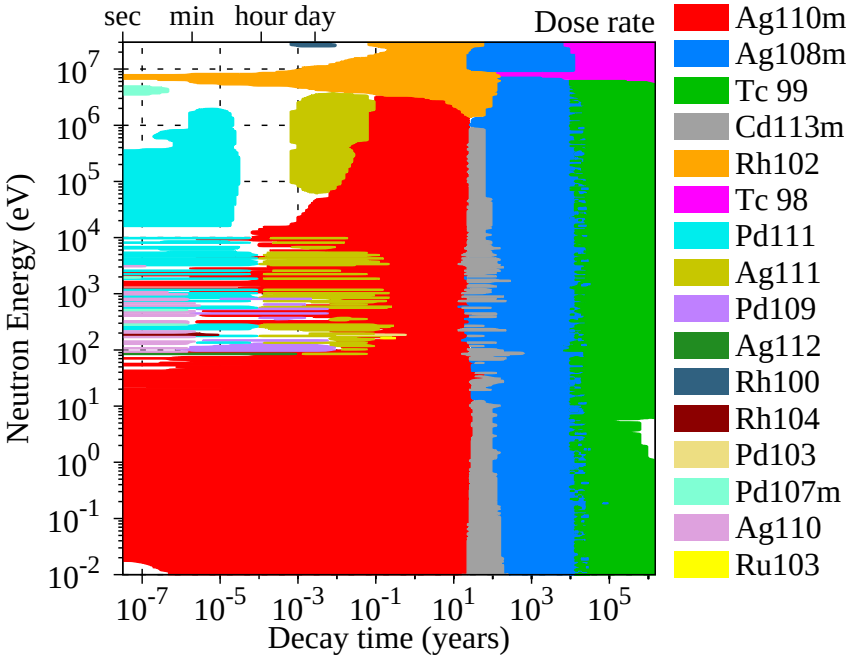
Palladium Importance diagrams

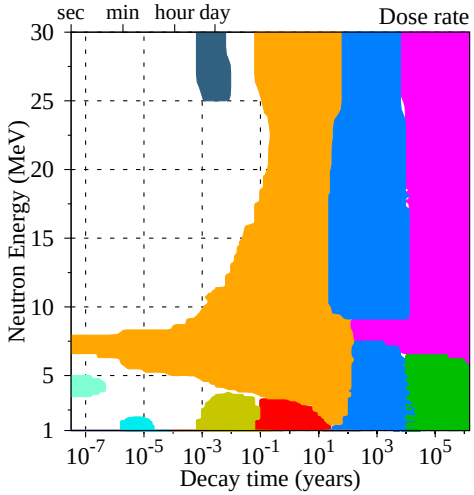




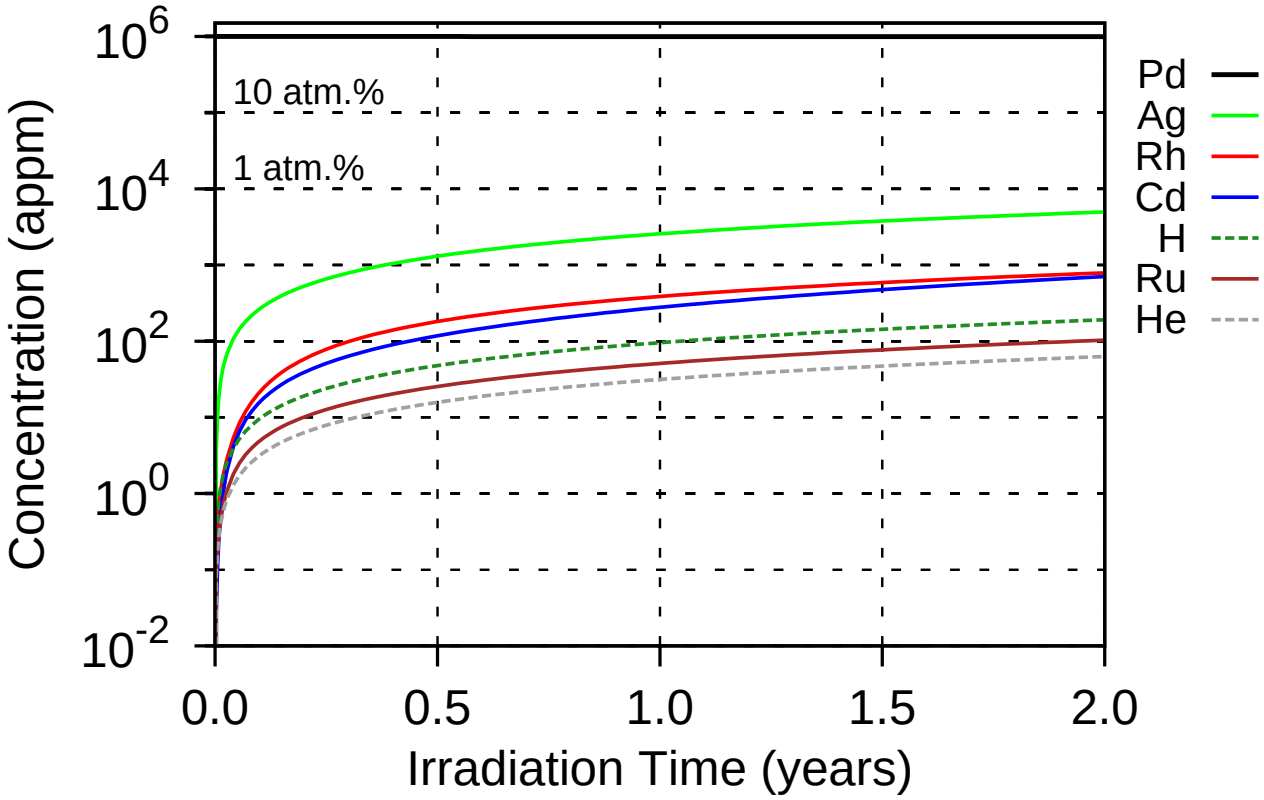




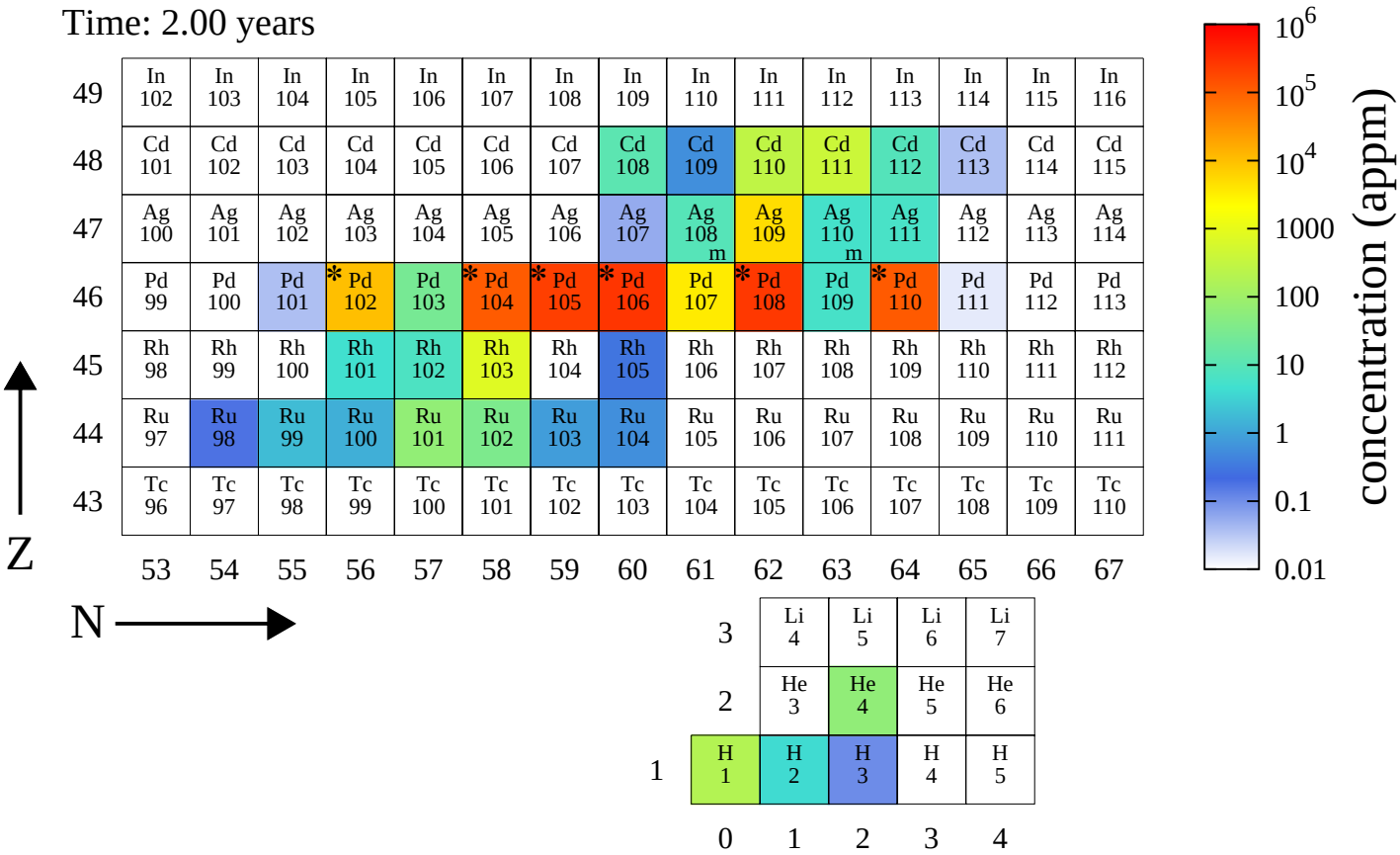




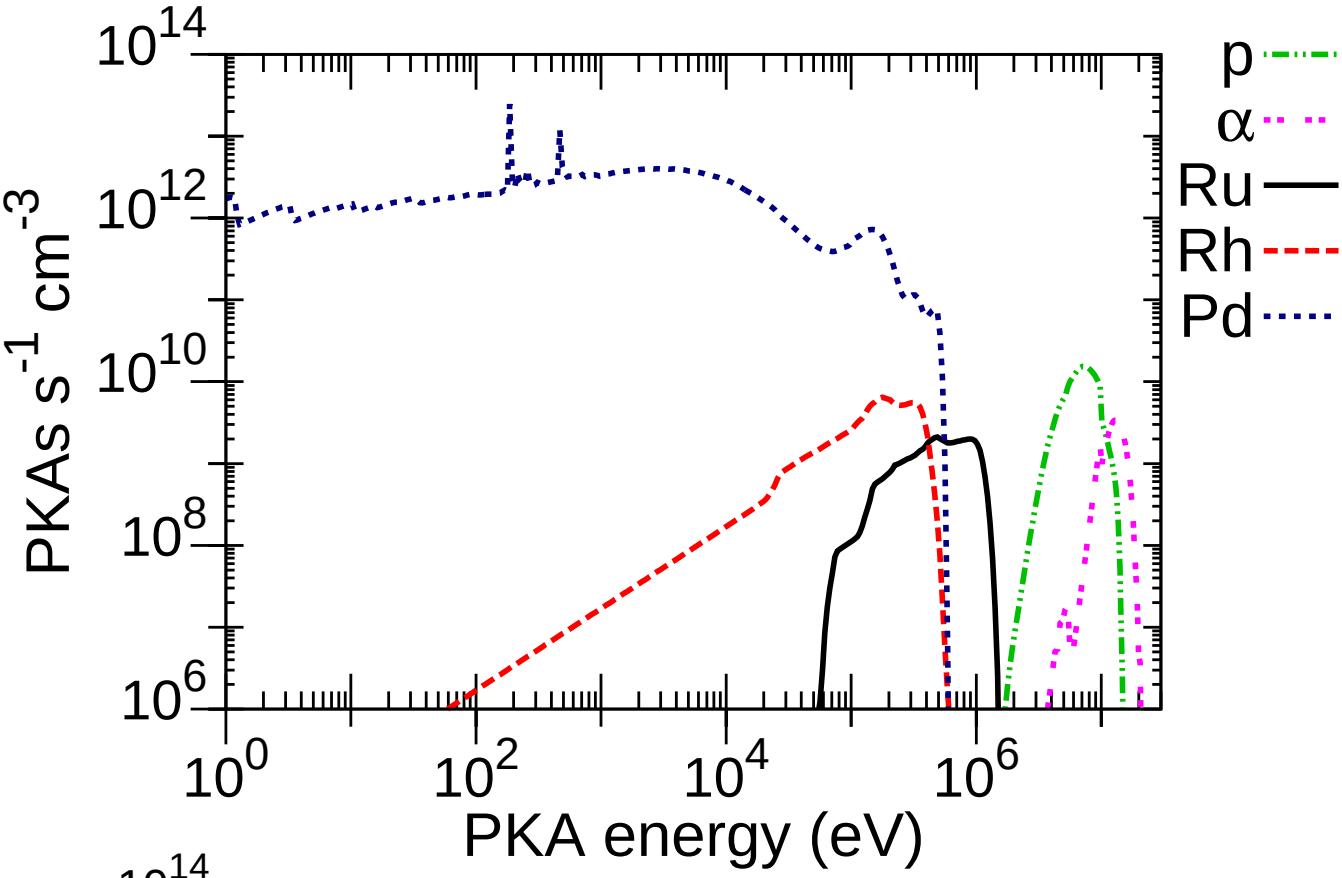
Palladium FW Transmutation

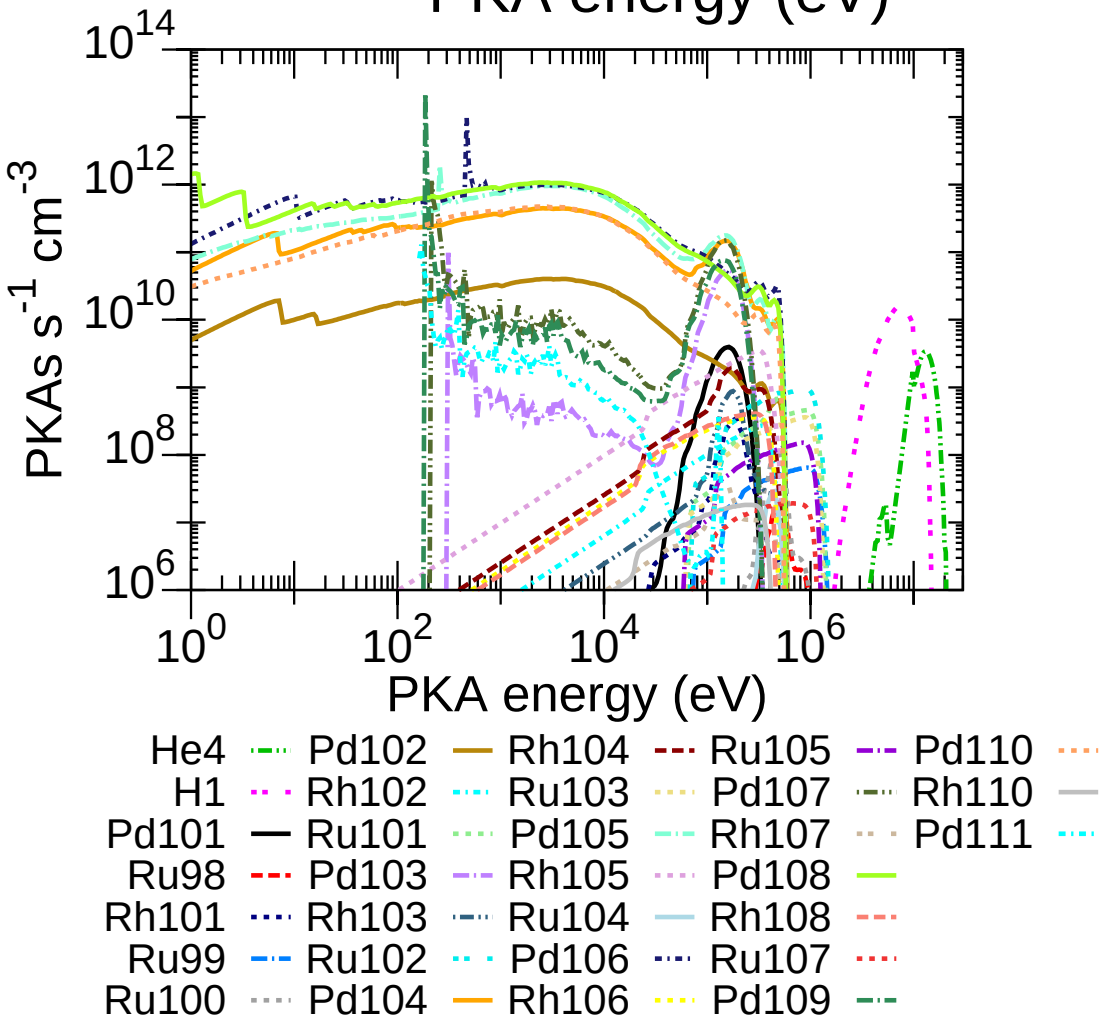


31 appm He & 96 appm H after 1 year 17 dpa/year



Palladium FW PKA distributions





Palladium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Pd107m	21.30s	Pd106(n,γ)Pd107m	63.1	93.9	91.3	
		Pd105(n,γ)Pd106(n,γ)Pd107m	36.5	6.1		
		Pd106(n,γ)Pd107(n,n$'$)Pd107m			7.8	
		Pd108(n,2n)Pd107m				97.3
		Pd108(n,2n)Pd107(n,n$'$)Pd107m				1.6
Ag110	24.56s	Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110	98.7	97.0	86.1	
		Pd108(n,γ)Pd109m(IT)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110		2.3	12.4	
		Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m(n,E)Ag110			1.0	
		Pd110(n,2n)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110				69.1
		Pd110(n,2n)Pd109m(IT)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110				26.6
		Pd110(n,2n)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m(n,E)Ag110				1.2
Ag109m	39.70s	Pd108(n,γ)Pd109(β^-)Ag109m	99.0	97.6	87.4	
		Pd108(n,γ)Pd109m(IT)Pd109(β^-)Ag109m		2.3	12.5	
		Pd110(n,2n)Pd109(β^-)Ag109m				72.0
		Pd110(n,2n)Pd109m(IT)Pd109(β^-)Ag109m				27.7
Rh104	42.29s	Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,γ)Rh104	96.2	93.1	80.7	
		Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,γ)Rh104m(IT)Rh104	3.5	6.9	19.3	
		Pd104(n,p)Rh104				32.0
		Pd104(n,p)Rh104m(IT)Rh104				25.1
		Pd105(n,np)Rh104m(IT)Rh104				14.6
		Pd105(n,np)Rh104				11.7
		Pd105(n,2n)Pd104(n,p)Rh104				5.6
		Pd105(n,2n)Pd104(n,p)Rh104m(IT)Rh104				4.4
		Pd106(n,2n)Pd105(n,np)Rh104m(IT)Rh104				1.5
		Pd105(n,d)Rh104m(IT)Rh104				1.4
		Pd105(n,d)Rh104				1.2
		Pd106(n,2n)Pd105(n,np)Rh104				1.2
Ag111m	1.08m	Pd110(n,γ)Pd111(β^-)Ag111m	64.5	99.4	94.6	50.2
		Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m(n,γ)Ag111m	34.9			
		Pd110(n,γ)Pd111m(IT)Pd111(β^-)Ag111m			4.2	39.1
		Pd110(n,γ)Pd111m(β^-)Ag111m			1.1	10.5
Ag108	2.40m	Pd106(n,γ)Pd107(β^-)Ag107(n,γ)Ag108	77.5	96.8	90.1	
		Pd105(n,γ)Pd106(n,γ)Pd107(β^-)Ag107(n,γ)Ag108	22.1	2.1		
		Pd106(n,γ)Pd107m(IT)Pd107(β^-)Ag107(n,γ)Ag108			8.5	
		Pd110(n,2n)Pd109(β^-)Ag109m(IT)Ag109(n,2n)Ag108				66.7
		Pd110(n,2n)Pd109m(IT)Pd109(β^-)Ag109m(IT)Ag109(n,2n)Ag108				25.6
		Pd110(n,2n)Pd109(β^-)Ag109m(IT)Ag109(n,2n) Ag108m(n,E)Ag108				4.5
		Pd110(n,2n)Pd109m(IT)Pd109(β^-)Ag109m(IT)Ag109(n,2n) Ag108m(n,E)Ag108				1.7
Pd109m	4.69m	Pd108(n,γ)Pd109m	99.8	99.9	100.0	
		Pd110(n,2n)Pd109m				99.4
Rh108m	6.00m	Pd108(n,p)Rh108m				99.9
Pd111	23.40m	Pd110(n,γ)Pd111	99.6	99.5	95.7	56.2
		Pd110(n,γ)Pd111m(IT)Pd111			4.3	43.7
Rh103m	56.11m	Pd102(n,γ)Pd103(β^+)Rh103m	100.0	100.0	100.0	
		Pd104(n,2n)Pd103(β^+)Rh103m				82.7
		Pd105(n,2n)Pd104(n,2n)Pd103(β^+)Rh103m				13.8
		Pd106(n,α)Ru103(β^-)Rh103m				1.1
Rh106m	2.20h	Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,γ)Rh104(β^+) Ru104(n,γ)Ru105(β^-)Rh105(n,γ)Rh106m	62.2			
		Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,γ)Rh104(β^+) Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105(n,γ)Rh106m	24.6			
		Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,γ)Rh104m(n,γ) Rh105(n,γ)Rh106m	7.3			
		Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,γ)Rh104m(IT) Rh104(β^+)Ru104(n,γ)Ru105(β^-)Rh105(n,γ)Rh106m	2.2			
		Pd105(n,p)Rh105(n,γ)Rh106m			72.9	
		Pd105(n,p)Rh105m(IT)Rh105(n,γ)Rh106m			24.6	
		Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,α)Rh106m			2.0	
		Pd106(n,p)Rh106m				96.5
		Pd110(n,2n)Pd109(β^-)Ag109m(IT)Ag109(n,α)Rh106m				1.1

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ag112	3.13h	Pd110(n,γ)Pd111(β^-)Ag111m(IT)Ag111(n,γ)Ag112	62.4	98.3	93.0	
		Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m(n,γ) Ag111m(IT)Ag111(n,γ)Ag112	33.9			
		Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m(n,γ) Ag111(n,γ)Ag112	1.5			
		Pd110(n,γ)Pd111(n,γ)Pd112(β^-)Ag112	1.0			
		Pd110(n,γ)Pd111m(IT)Pd111(β^-)Ag111m(IT)Ag111(n,γ)Ag112			4.2	
		Pd110(n,γ)Pd111m(β^-)Ag111m(IT)Ag111(n,γ)Ag112			1.1	
Ru105	4.44h	Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,γ)Rh104(β^+) Ru104(n,γ)Ru105	96.2			
		Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,γ)Rh104m(IT) Rh104(β^+)Ru104(n,γ)Ru105	3.5			
		Pd108(n,α)Ru105			52.9	99.9
		Pd106(n,γ)Pd107(n,α)Ru104(n,γ)Ru105			3.9	
Pd101	8.47h	Pd102(n,2n)Pd101				99.6
Pd109	13.70h	Pd108(n,γ)Pd109	99.0	97.6	87.4	
		Pd108(n,γ)Pd109m(IT)Pd109		2.3	12.5	
		Pd110(n,2n)Pd109				72.0
		Pd110(n,2n)Pd109m(IT)Pd109				27.7
Rh100	20.80h	Pd102(n,2n)Pd101(β^+)Rh101m(IT)Rh101(n,2n)Rh100				31.2
		Pd102(n,2n)Pd101(β^+)Rh101m(IT)Rh101(n,2n)Rh100m(IT)Rh100				31.0
		Pd102(n,np)Rh101(n,2n)Rh100				8.0
		Pd102(n,np)Rh101(n,2n)Rh100m(IT)Rh100				7.9
		Pd102(n,2n)Pd101(β^+)Rh101m(n,2n)Rh100m(IT)Rh100				5.8
		Pd102(n,2n)Pd101(β^+)Rh101m(n,2n)Rh100				3.2
		Pd102(n,np)Rh101m(IT)Rh101(n,2n)Rh100				1.4
		Pd102(n,np)Rh101m(IT)Rh101(n,2n)Rh100m(IT)Rh100				1.4
		Pd102(n,2n)Pd101(β^+)Rh101(n,2n)Rh100				1.2
		Pd102(n,2n)Pd101(β^+)Rh101(n,2n)Rh100m(IT)Rh100				1.2
Rh105	1.47d	Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,γ)Rh104(β^+) Ru104(n,γ)Ru105(β^-)Rh105	62.2			
		Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,γ)Rh104(β^+) Ru104(n,γ)Ru105(β^-)Rh105m(IT)Rh105	24.6			
		Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,γ)Rh104m(n,γ)Rh105	7.3			
		Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,γ)Rh104m(IT) Rh104(β^+)Ru104(n,γ)Ru105(β^-)Rh105	2.2			
		Pd105(n,p)Rh105			74.6	54.5
		Pd105(n,p)Rh105m(IT)Rh105			25.2	31.2
		Pd106(n,2n)Pd105(n,p)Rh105				5.4
		Pd106(n,2n)Pd105(n,p)Rh105m(IT)Rh105				3.1
		Pd108(n,α)Ru105(β^-)Rh105				2.9
		Pd108(n,α)Ru105(β^-)Rh105m(IT)Rh105				1.1
Rh101m	4.35d	Pd102(n,2n)Pd101(β^+)Rh101m				92.4
		Pd102(n,np)Rh101m				4.0
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,2n) Rh102(n,2n)Rh101m				1.3
Ag111	7.45d	Pd110(n,γ)Pd111(β^-)Ag111m(IT)Ag111	63.1	98.6	93.5	48.0
		Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m(n,γ) Ag111m(IT)Ag111	34.3			
		Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m(n,γ)Ag111	1.5			
		Pd110(n,γ)Pd111m(IT)Pd111(β^-)Ag111m(IT)Ag111			4.2	37.3
		Pd110(n,γ)Pd111m(β^-)Ag111m(IT)Ag111			1.1	10.0
		Pd110(n,γ)Pd111m(β^-)Ag111				3.9
Pd103	16.98d	Pd102(n,γ)Pd103	100.0	100.0	100.0	
		Pd104(n,2n)Pd103				84.5
		Pd105(n,2n)Pd104(n,2n)Pd103				14.4
Ru103	39.27d	Pd105(n,α)Ru102(n,γ)Ru103	94.8	99.6	71.7	
		Pd102(n,γ)Pd103(n,α)Ru100(n,γ)Ru101(n,γ)Ru102(n,γ)Ru103	4.1			
		Pd104(n,γ)Pd105(n,α)Ru102(n,γ)Ru103	1.0			
		Pd106(n,α)Ru103			24.3	88.7
		Pd102(n,γ)Pd103(β^+)Rh103m(IT)Rh103(n,p)Ru103			3.8	
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,p)Ru103				8.8

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Rh102m	208.00d	Pd102(n,p)Rh102m			84.1	11.7
		Pd102(n,p)Rh102(n,n′)Rh102m			15.9	
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102m				79.3
		Pd105(n,2n)Pd104(n,2n)Pd103(β^+)Rh103m(IT) Rh103(n,2n)Rh102m				5.3
		Pd106(n,α)Ru103(β^-)Rh103m(IT)Rh103(n,2n)Rh102m				1.0
Ag110m	249.77d	Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m	99.1	97.6	87.4	
		Pd108(n,γ)Pd109m(IT)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m		2.3	12.5	
		Pd110(n,2n)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m				69.7
		Pd110(n,2n)Pd109m(IT)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m				26.8
		Pd110(n,γ)Pd111(β^-)Ag111m(IT)Ag111(n,2n)Ag110m				1.1
Cd109	1.27y	Pd106(n,γ)Pd107(β^-)Ag107(n,γ)Ag108(β^-)Cd108(n,γ)Cd109	82.3	97.7	89.7	
		Pd105(n,γ)Pd106(n,γ)Pd107(β^-)Ag107(n,γ)Ag108(β^-) Cd108(n,γ)Cd109	17.4	1.3		
		Pd106(n,γ)Pd107m(IT)Pd107(β^-)Ag107(n,γ)Ag108(β^-) Cd108(n,γ)Cd109			8.5	
		Pd110(n,2n)Pd109(β^-)Ag109m(IT)Ag109(n,2n)Ag108(β^-) Cd108(n,γ)Cd109				27.8
		Pd110(n,2n)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110(β^-) Cd110(n,2n)Cd109				19.4
		Pd110(n,γ)Pd111(β^-)Ag111m(IT)Ag111(β^-)Cd111(n,2n) Cd110(n,2n)Cd109				13.2
		Pd110(n,2n)Pd109m(IT)Pd109(β^-)Ag109m(IT)Ag109(n,2n) Ag108(β^-)Cd108(n,γ)Cd109				10.7
		Pd110(n,γ)Pd111m(IT)Pd111(β^-)Ag111m(IT)Ag111(β^-) Cd111(n,2n)Cd110(n,2n)Cd109				10.2
		Pd110(n,2n)Pd109m(IT)Pd109(β^-)Ag109m(IT)Ag109(n,γ) Ag110(β^-)Cd110(n,2n)Cd109				7.4
		Pd110(n,2n)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m(β^-) Cd110(n,2n)Cd109				2.8
		Pd110(n,γ)Pd111m(β^-)Ag111m(IT)Ag111(β^-)Cd111(n,2n) Cd110(n,2n)Cd109				2.8
		Pd110(n,γ)Pd111m(β^-)Ag111(β^-)Cd111(n,2n)Cd110(n,2n)Cd109				1.1
		Pd110(n,2n)Pd109m(IT)Pd109(β^-)Ag109m(IT)Ag109(n,γ) Ag110m(β^-)Cd110(n,2n)Cd109				1.1
		Pd110(n,2n)Pd109(β^-)Ag109m(IT)Ag109(n,2n)Ag108m(n,E) Ag108(β^-)Cd108(n,γ)Cd109				1.0
Rh102	2.90y	Pd102(n,p)Rh102			99.6	22.0
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102				66.9
		Pd105(n,2n)Pd104(n,2n)Pd103(β^+)Rh103m(IT) Rh103(n,2n)Rh102				4.0
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,2n) Rh102m(n,E)Rh102				1.7
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102m(IT)Rh102				1.4
Rh101	3.20y	Pd102(n,2n)Pd101(β^+)Rh101m(IT)Rh101				69.5
		Pd102(n,np)Rh101				17.7
		Pd102(n,np)Rh101m(IT)Rh101				3.0
		Pd102(n,2n)Pd101(β^+)Rh101				2.6
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,2n) Rh102(n,2n)Rh101				1.7
		Pd102(n,2n)Pd101(β^+)Rh101m(n,E)Rh101				1.2
H3	12.33y	Pd102(n,γ)Pd103(n,p)H1(n,γ)H2(n,γ)H3	23.9			
		Pd105(n,p)H1(n,γ)H2(n,γ)H3			24.2	
		Pd102(n,p)H1(n,γ)H2(n,γ)H3			3.8	
		Pd105(n,t)H3				33.6
		Pd106(n,2n)Pd105(n,t)H3				1.7
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,t)H3				2.4
		Pd108(n,2n)Pd107(n,t)H3				1.4
		Pd110(n,2n)Pd109(β^-)Ag109m(IT)Ag109(n,t)H3				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cd113m	14.60y	Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110(β^-) Cd110(n,γ)Cd111(n,γ)Cd112(n,γ)Cd113m	58.0			
		Pd110(n,γ)Pd111(β^-)Ag111m(IT)Ag111(β^-)Cd111(n,γ) Cd112(n,γ)Cd113m	29.3			45.7
		Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m(n,γ) Ag111m(IT)Ag111(β^-)Cd111(n,γ)Cd112(n,γ)Cd113m	8.6			
		Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110(β^-) Cd110(n,γ)Cd111m(IT)Cd111(n,γ)Cd112(n,γ)Cd113m	1.3			
		Pd110(n,γ)Pd111(β^-)Ag111m(IT)Ag111(n,γ)Ag112(β^-) Cd112(n,γ)Cd113m			3.7	1.8
		Pd110(n,γ)Pd111m(IT)Pd111(β^-)Ag111m(IT)Ag111(β^-) Cd111(n,γ)Cd112(n,γ)Cd113m				35.5
		Pd110(n,γ)Pd111m(β^-)Ag111m(IT)Ag111(β^-)Cd111(n,γ) Cd112(n,γ)Cd113m				9.6
		Pd110(n,γ)Pd111m(β^-)Ag111(β^-)Cd111(n,γ)Cd112(n,γ)Cd113m				3.7
		Pd110(n,γ)Pd111m(IT)Pd111(β^-)Ag111m(IT)Ag111(n,γ) Ag112(β^-)Cd112(n,γ)Cd113m				1.4
Ag108m	417.97y	Pd106(n,γ)Pd107(β^-)Ag107(n,γ)Ag108m	79.7	97.6	91.1	
		Pd105(n,γ)Pd106(n,γ)Pd107(β^-)Ag107(n,γ)Ag108m	20.1	1.7		
		Pd106(n,γ)Pd107m(IT)Pd107(β^-)Ag107(n,γ)Ag108m			8.6	
		Pd110(n,2n)Pd109(β^-)Ag109m(IT)Ag109(n,2n)Ag108m				71.5
		Pd110(n,2n)Pd109m(IT)Pd109(β^-)Ag109m(IT) Ag109(n,2n)Ag108m				27.5
Tc99	2.1 10^5y	Pd102(n,α)Ru99(n,p)Tc99			78.1	5.2
		Pd102(n,α)Ru99(n,p)Tc99m(IT)Tc99			13.8	
		Pd102(n,p)Rh102(n,α)Tc99			5.3	2.8
		Pd102(n,p)Rh102(n,α)Tc99m(IT)Tc99			1.9	
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,nα)Tc99				54.4
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,nα)Tc99m(IT)Tc99				8.9
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102(n,α)Tc99				5.2
		Pd105(n,α)Ru102(n,α)Mo99(β^-)Tc99m(IT)Tc99				5.2
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102m(n,α)Tc99				3.3
		Pd105(n,2n)Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,nα)Tc99				3.1
Tc98	4.3 10^6y	Pd102(n,2n)Pd101(β^+)Rh101m(IT)Rh101(n,α)Tc98				24.0
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,nα)Tc99(n,2n)Tc98				15.6
		Pd102(n,α)Ru99(n,np)Tc98				10.4
		Pd102(n,2n)Pd101(β^+)Rh101m(n,α)Tc98				7.0
		Pd102(n,np)Rh101(n,α)Tc98				6.2
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102(n,nα)Tc98				5.4
		Pd102(n,nα)Ru98(n,p)Tc98				4.0
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,2n) Rh102m(n,nα)Tc98				3.3
		Pd102(n,p)Rh102(n,nα)Tc98				2.9
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,nα)Tc99m(IT) Tc99(n,2n)Tc98				2.6
		Pd102(n,α)Ru99(n,p)Tc99(n,2n)Tc98				1.6
		Pd105(n,α)Ru102(n,α)Mo99(β^-)Tc99m(IT)Tc99(n,2n)Tc98				1.5
		Pd102(n,α)Ru99(n,d)Tc98				1.3
		Pd102(n,α)Ru99(n,2n)Ru98(n,p)Tc98				1.2
		Pd104(n,2n)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102(n,α) Tc99(n,2n)Tc98				1.2
		Pd102(n,np)Rh101m(IT)Rh101(n,α)Tc98				1.0
Pd107	6.5 10^6y	Pd106(n,γ)Pd107	73.7	96.1	90.9	
		Pd105(n,γ)Pd106(n,γ)Pd107	26.0	3.2		
		Pd106(n,γ)Pd107m(IT)Pd107			8.6	
		Pd108(n,2n)Pd107				63.7
		Pd108(n,2n)Pd107m(IT)Pd107				35.5

Silver

Isotope	Atom % abundance
Ag107	51.84
Ag109	48.16

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	4.56E+15	6.95E+14	2.18E+14	4.99E+13	5.01E+11	1.84E+06
Ag110	51.1	0.2	0.6	0.9		
Ag108	22.7	32.5		0.1	8.0	0.2
Ag107m	8.1	1.3				
Ag109m	7.6	3.1	6.0	15.3		
Ag106	4.5	25.4				
Ag106m	2.8	18.5	43.7			
Ag110m	2.0	13.3	41.9	67.3		
Cd109	0.3	1.9	6.0	15.3		
Pd109	0.2	1.0				
Ag111	0.1	0.6	1.3			
Ag108m		0.1	0.2	1.1	92.0	2.1
Pd107						97.7

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	7.09E-01	1.58E-01	8.48E-02	1.56E-02	1.26E-04	1.34E-11
Ag110	63.9	0.2	0.3	0.6		
Ag108	14.7	14.4			3.2	2.6
Ag106m	8.1	36.1	50.0			
Ag110m	5.9	26.5	49.1	97.6		
Ag106	5.6	21.6				
Ag108m		0.1	0.2	0.9	96.8	77.5
Pd107						19.9

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.01E+05	1.77E+05	1.30E+05	2.41E+04	1.61E+02	1.38E-05
Ag106m	43.2	49.1	49.6			
Ag110m	32.8	37.2	50.2	99.2		
Ag106	13.1	12.8				
Ag110	8.3					
Ag108	2.3	0.6			0.1	0.1
Ag108m	0.1	0.1	0.1	0.8	99.9	99.9

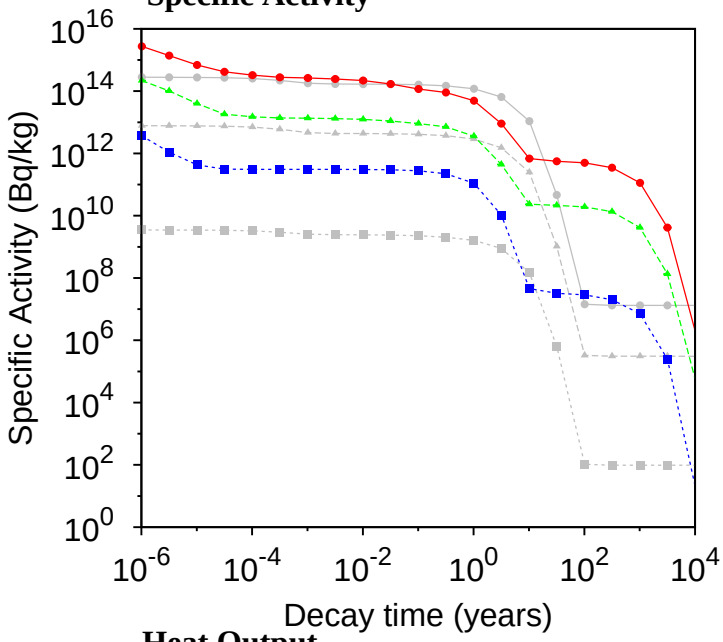
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.99E+05	4.96E+05	4.31E+05	1.11E+05	1.06E+03	1.57E-04
Ag110m	52.0	52.3	59.5	85.1		
Ag106m	38.8	39.0	33.2			
Cd109	5.3	5.3	6.1	13.8		
Ag106	1.3	1.1				
Ag111	1.1	1.1	0.9			
Ag108m	0.3	0.3	0.3	1.1	100.0	57.7
Pd107						42.3

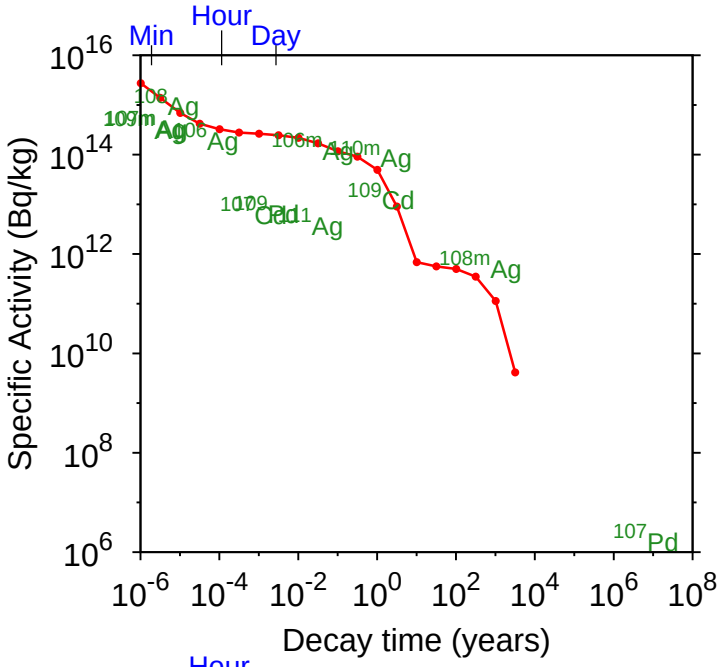
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.39E+06	1.39E+06	1.34E+06	4.85E+05	1.70E+04	2.52E-03
Ag110m	79.7	79.7	82.3	83.1		
Ag106m	10.2	10.2	7.9			
Cd109	7.7	7.7	7.9	12.7		
Ag108m	1.4	1.4	1.5	4.1	100.0	57.9
Pd107						42.1

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.91E+12	1.46E+12	1.20E+12	3.45E+11	7.58E+08	6.66E+01
Ag110m	48.5	63.6	76.6	97.5		
Ag106m	18.8	24.6	22.2			
Ag110	18.2					
Ag106	8.3	9.3				
Ag108	4.5	1.3			0.4	0.4
Cd109	0.7	0.9	1.1	2.2		
Ag108m		0.1	0.1	0.3	99.6	97.1
Pd107						2.5

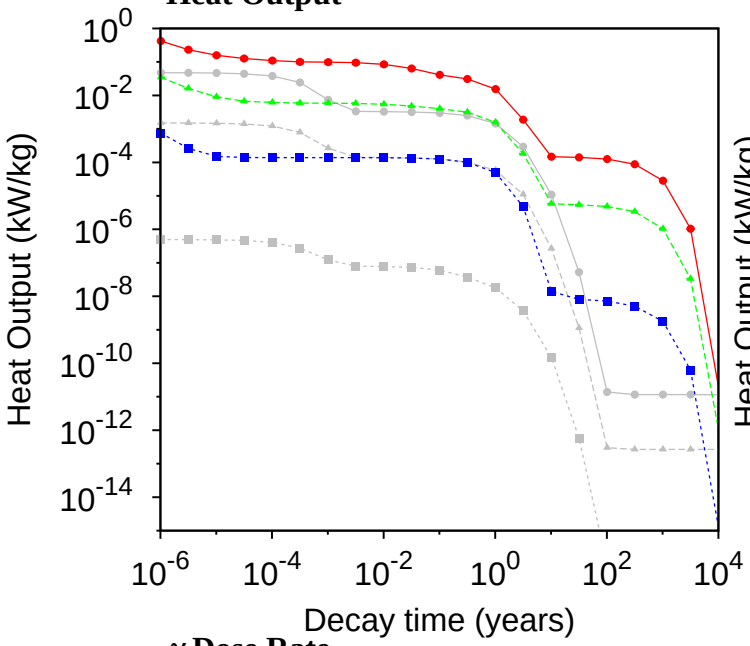
Silver activation characteristics

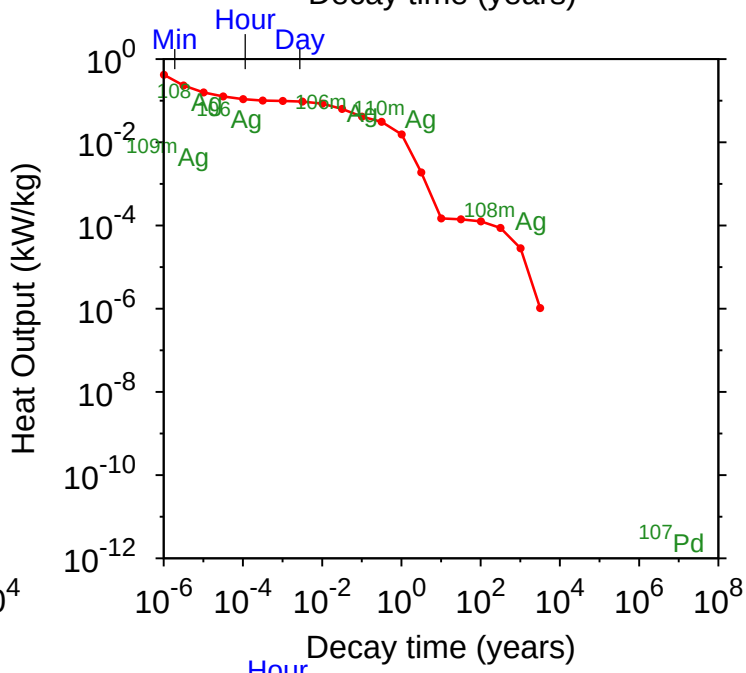
Specific Activity



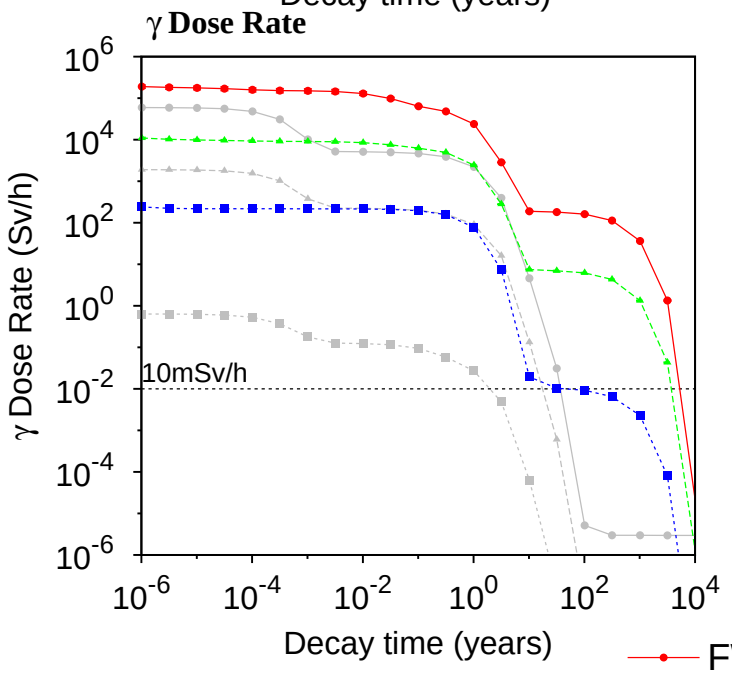


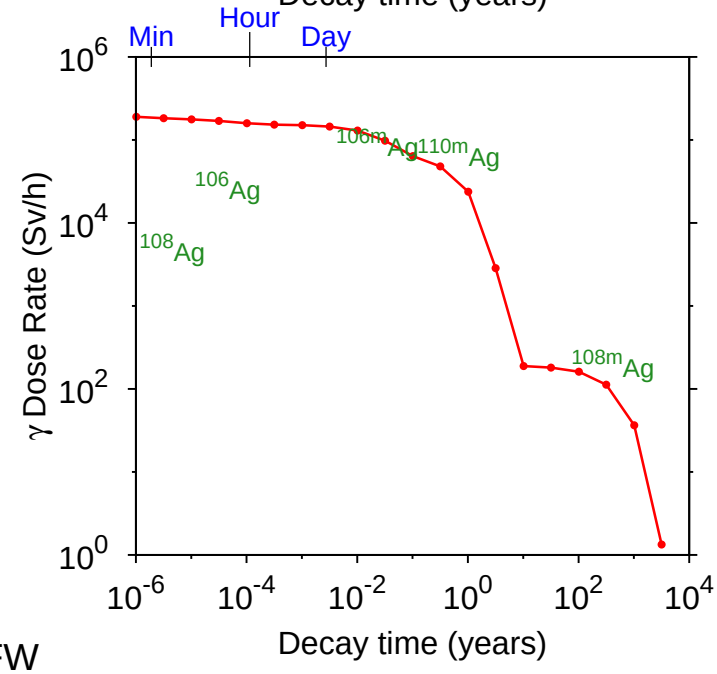
Heat Output





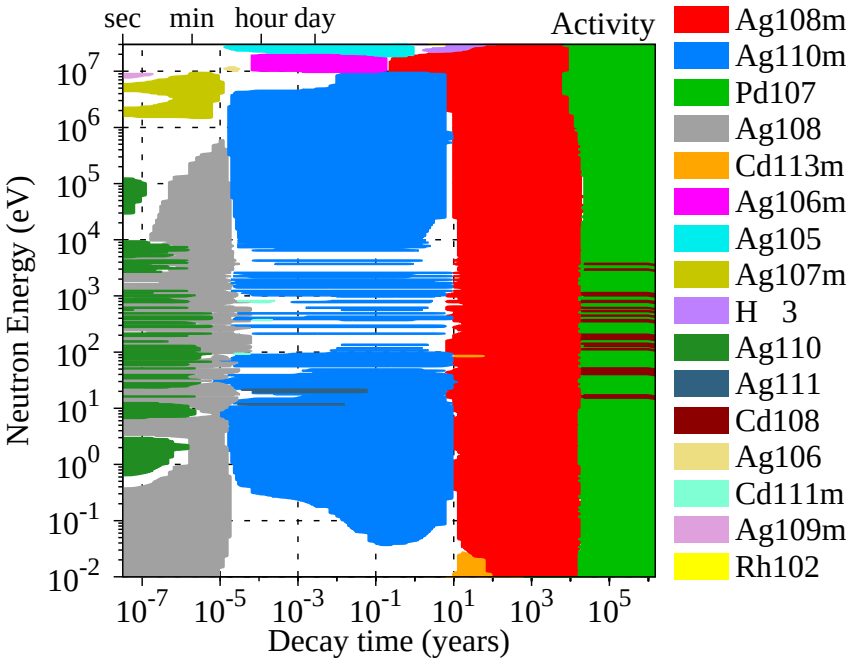
γ Dose Rate

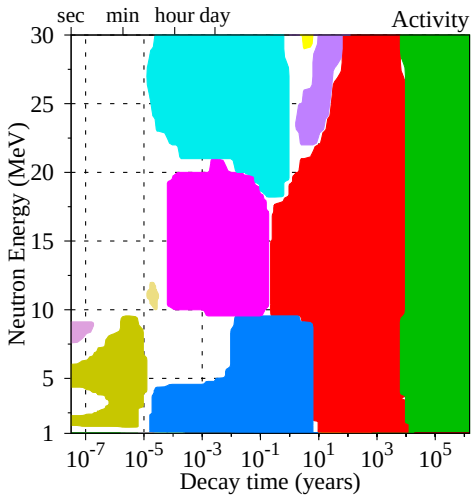


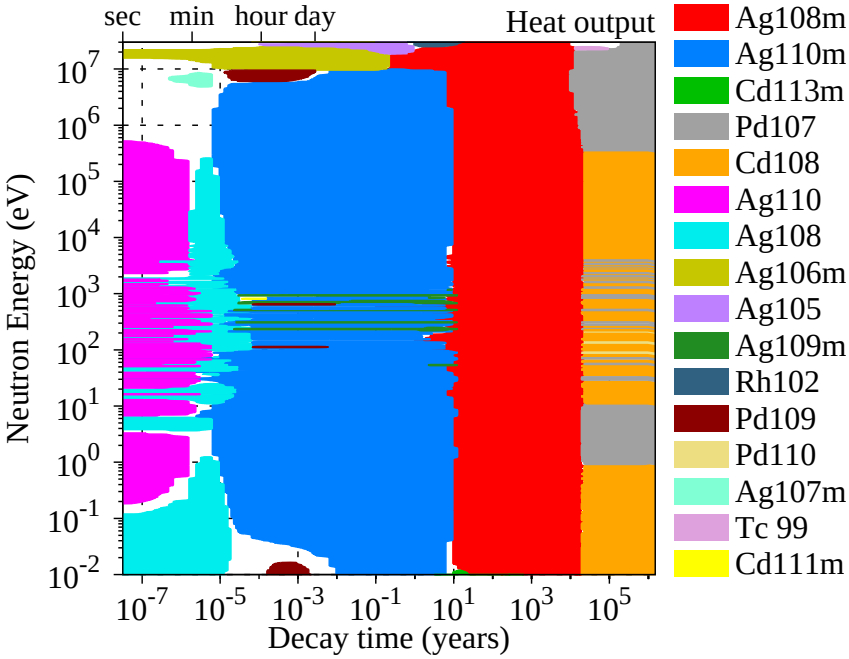


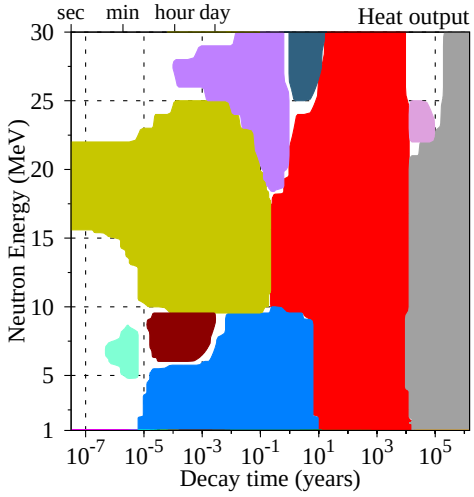
FW
Blanket
Manifold
Fe results

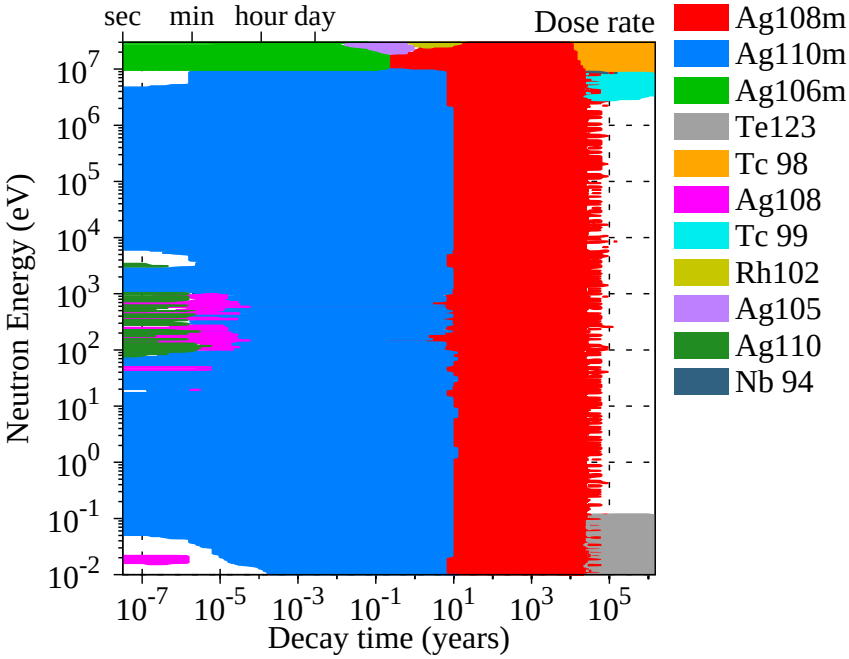
Silver Importance diagrams

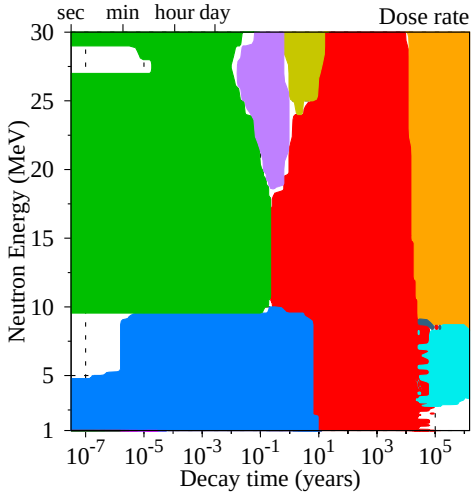




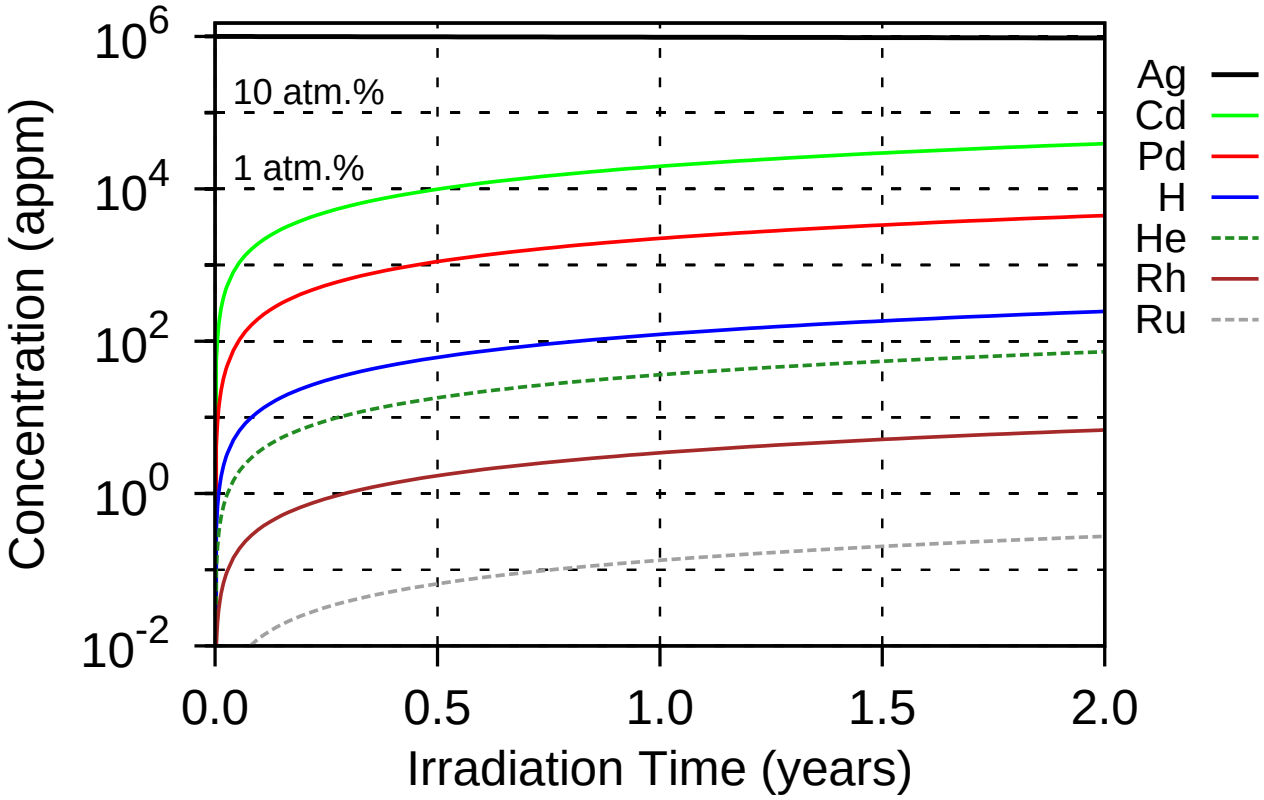




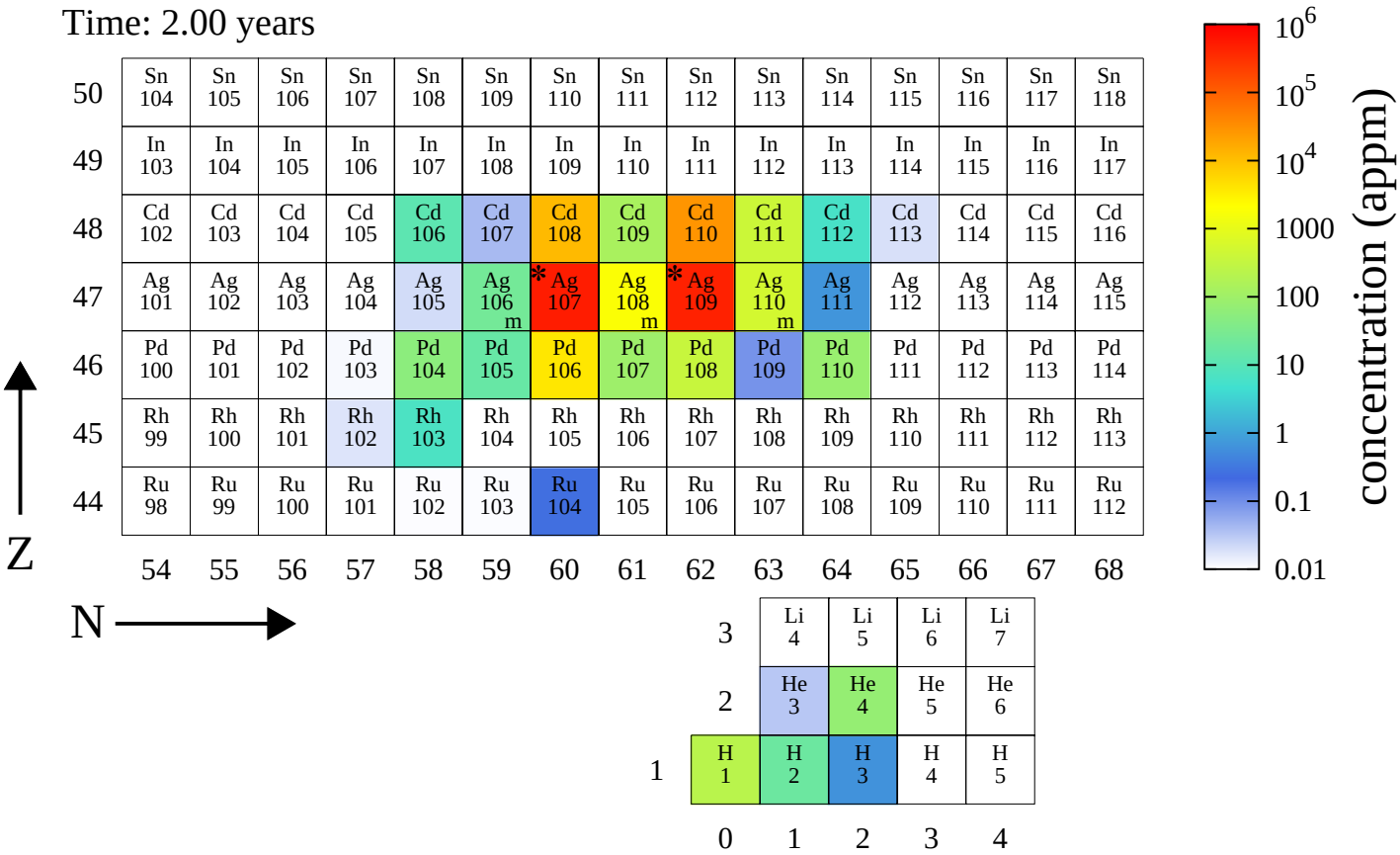




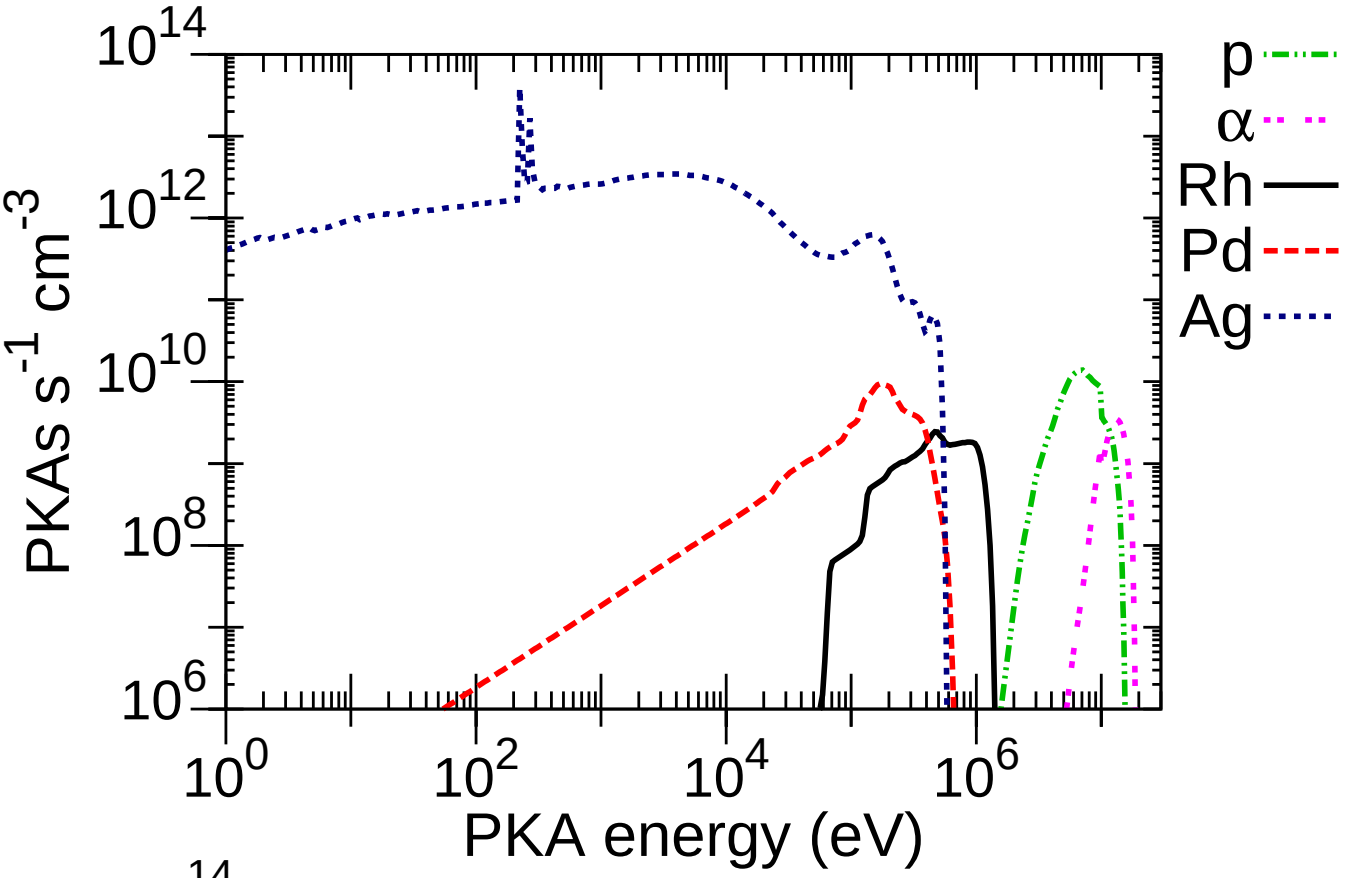
Silver FW Transmutation

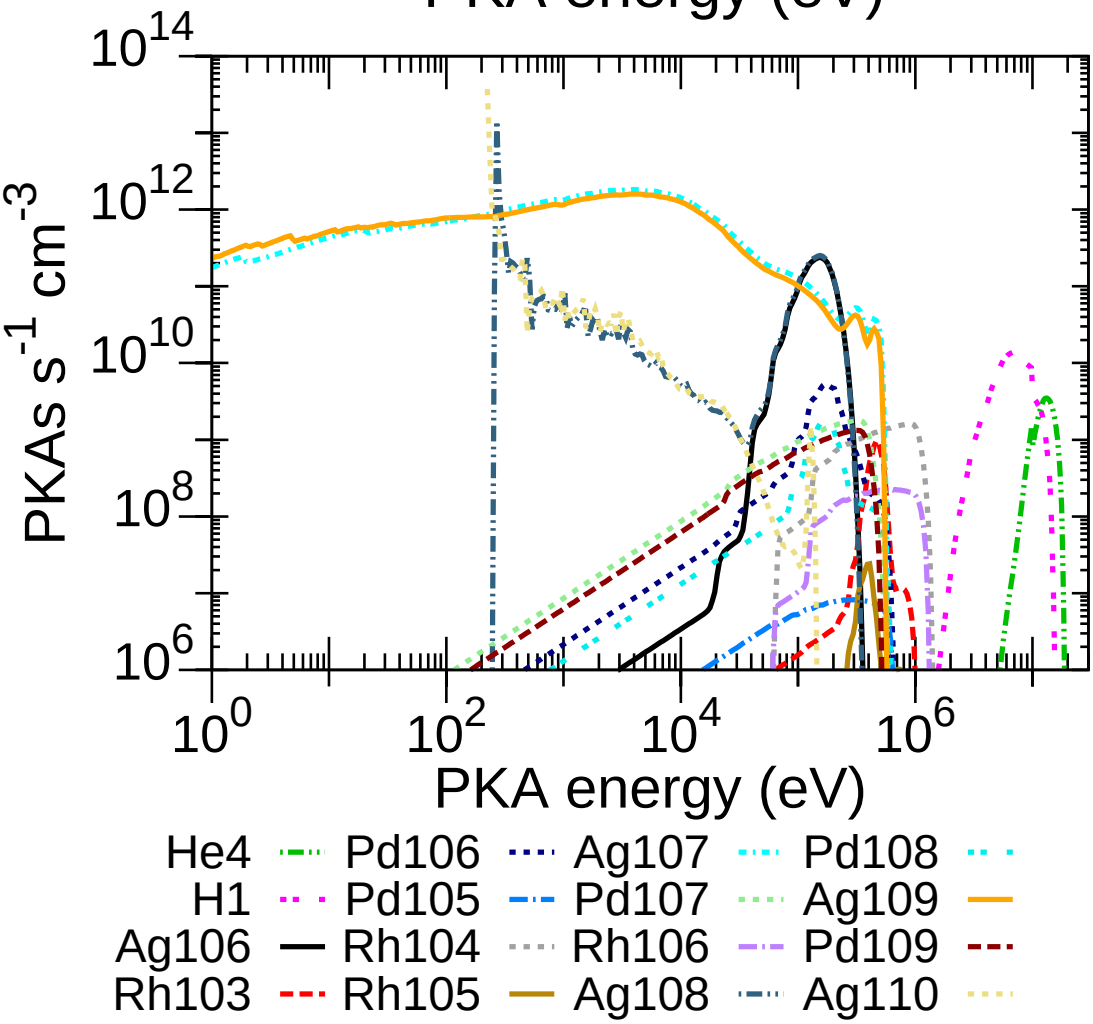


36 appm He & 123 appm H after 1 year 7 dpa/year



Silver FW PKA distributions





Silver Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ag110	24.56s	Ag109(n,γ)Ag110	63.2	99.1	97.9	96.7
		Ag107(n,γ)Ag108(β^+)Pd108(n,γ)Pd109(β^-)Ag109m(IT) Ag109(n,γ)Ag110	18.7			
		Ag107(n,γ)Ag108m(n,γ)Ag109m(IT)Ag109(n,γ)Ag110	14.2			
		Ag107(n,γ)Ag108(β^-)Cd108(n,γ)Cd109(β^+)Ag109m(IT) Ag109(n,γ)Ag110	1.9			
		Ag107(n,γ)Ag108m(n,γ)Ag109(n,γ)Ag110	1.2			
		Ag109(n,γ)Ag110m(n,E)Ag110			1.6	2.5
Ag109m	39.70s	Ag107(n,γ)Ag108(β^+)Pd108(n,γ)Pd109(β^-)Ag109m	61.3	4.1		
		Ag107(n,γ)Ag108m(n,γ)Ag109m	31.6	40.9		
		Ag107(n,γ)Ag108(β^-)Cd108(n,γ)Cd109(β^+)Ag109m	6.5	54.7		
		Ag109(n,n$'$)Ag109m			100.0	93.1
		Ag109(n,p)Pd109(β^-)Ag109m				3.8
		Ag109(n,p)Pd109m(IT)Pd109(β^-)Ag109m				2.8
Ag107m	44.29s	Ag107(n,n$'$)Ag107m			100.0	72.7
		Ag109(n,2n)Ag108m(n,2n)Ag107m				13.0
		Ag109(n,2n)Ag108(β^-)Cd108(n,2n)Cd107(β^+)Ag107m				13.0
Ag108	2.40m	Ag107(n,γ)Ag108	99.9	99.2	97.2	
		Ag107(n,γ)Ag108m(n,E)Ag108			2.6	
		Ag109(n,2n)Ag108				87.7
		Ag109(n,2n)Ag108m(n,E)Ag108				11.4
Ag106	24.00m	Ag107(n,2n)Ag106				99.5
Cd111m	48.74m	Ag109(n,γ)Ag110(β^-)Cd110(n,γ)Cd111m	93.6	96.2	87.1	
		Ag107(n,γ)Ag108(β^-)Cd108(n,γ)Cd109(n,γ)Cd110(n,γ)Cd111m	3.0			
		Ag109(n,γ)Ag110m(β^-)Cd110(n,γ)Cd111m	1.4	3.3	8.0	
		Ag109(n,γ)Ag110(β^-)Cd110(n,γ)Cd111(n,n$'$)Cd111m			2.6	
		Ag109(n,γ)Ag110m(n,E)Ag110(β^-)Cd110(n,γ)Cd111m			1.0	
Pd109	13.70h	Ag107(n,γ)Ag108(β^+)Pd108(n,γ)Pd109	99.1	97.2	73.0	
		Ag107(n,γ)Ag108(β^+)Pd108(n,γ)Pd109m(IT)Pd109		2.3	10.5	
		Ag109(n,p)Pd109			13.9	57.4
		Ag107(n,γ)Ag108m(n,E)Ag108(β^+)Pd108(n,γ)Pd109			1.0	
		Ag109(n,p)Pd109m(IT)Pd109				42.5
Ag111	7.45d	Ag109(n,γ)Ag110m(n,γ)Ag111m(IT)Ag111	79.1	94.8	96.0	87.9
		Ag107(n,γ)Ag108(β^+)Pd108(n,γ)Pd109(β^-)Ag109m(IT) Ag109(n,γ)Ag110m(n,γ)Ag111m(IT)Ag111	6.3			
		Ag107(n,γ)Ag108m(n,γ)Ag109m(IT)Ag109(n,γ)Ag110m(n,γ) Ag111m(IT)Ag111	6.3			
		Ag109(n,γ)Ag110m(n,γ)Ag111	3.4	4.5	3.5	10.1
		Ag109(n,γ)Ag110(β^+)Pd110(n,γ)Pd111(β^-)Ag111m(IT)Ag111	3.1			
Ag106m	8.46d	Ag107(n,2n)Ag106m				99.7
Ag105	41.29d	Ag107(n,2n)Ag106m(n,2n)Ag105m(IT)Ag105				69.0
		Ag107(n,2n)Ag106(β^-)Cd106(n,2n)Cd105(β^+)Ag105				21.2
		Ag107(n,2n)Ag106m(n,2n)Ag105				5.9
		Ag107(n,2n)Ag106(β^-)Cd106(n,np)Ag105m(IT)Ag105				2.3
Ag110m	249.77d	Ag109(n,γ)Ag110m	84.2	100.0	100.0	99.8
		Ag107(n,γ)Ag108(β^+)Pd108(n,γ)Pd109(β^-)Ag109m(IT) Ag109(n,γ)Ag110m	7.3			
		Ag107(n,γ)Ag108m(n,γ)Ag109m(IT)Ag109(n,γ)Ag110m	7.1			
Cd109	1.27y	Ag107(n,γ)Ag108(β^-)Cd108(n,γ)Cd109	99.9	99.7	98.9	
		Ag107(n,γ)Ag108m(n,E)Ag108(β^-)Cd108(n,γ)Cd109			1.0	
		Ag109(n,2n)Ag108(β^-)Cd108(n,γ)Cd109				52.7
		Ag109(n,γ)Ag110(β^-)Cd110(n,2n)Cd109				36.7
		Ag109(n,γ)Ag110m(β^-)Cd110(n,2n)Cd109				6.5
		Ag109(n,2n)Ag108m(n,E)Ag108(β^-)Cd108(n,γ)Cd109				2.6

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Rh102	2.90y	Ag107(n,nα)Rh103m(IT)Rh103(n,2n)Rh102				64.5
		Ag107(n,nα)Rh103(n,2n)Rh102				10.7
		Ag107(n,α)Rh104m(IT)Rh104(β^-)Pd104(n,2n)Pd103(β^+) Rh103m(IT)Rh103(n,2n)Rh102				8.5
		Ag107(n,α)Rh104(β^-)Pd104(n,2n)Pd103(β^+)Rh103m(IT) Rh103(n,2n)Rh102				4.8
		Ag107(n,2n)Ag106(β^+)Pd106(n,α)Ru103(β^-)Rh103m(IT) Rh103(n,2n)Rh102				2.9
		Ag107(n,2n)Ag106m(β^+)Pd106(n,α)Ru103(β^-)Rh103m(IT) Rh103(n,2n)Rh102				1.8
		Ag107(n,nα)Rh103m(IT)Rh103(n,2n)Rh102m(n,E)Rh102				1.7
		Ag107(n,nα)Rh103m(IT)Rh103(n,2n)Rh102m(IT)Rh102				1.3
H3	12.33y	Ag107(n,γ)Ag108(n,p)H1(n,γ)H2(n,γ)H3	88.8			
		Ag107(n,γ)Ag108m(n,p)H1(n,γ)H2(n,γ)H3	11.1			
		Ag107(n,t)H3				65.9
		Ag109(n,t)H3				9.8
		Ag109(n,2n)Ag108m(n,t)H3				1.3
Cd113m	14.60y	Ag109(n,γ)Ag110(β^-)Cd110(n,γ)Cd111(n,γ)Cd112(n,γ)Cd113m	84.7	63.5	56.8	
		Ag109(n,γ)Ag110m(n,γ)Ag111m(IT)Ag111(β^-)Cd111(n,γ) Cd112(n,γ)Cd113m	10.7	28.7	22.5	
		Ag109(n,γ)Ag110(β^-)Cd110(n,γ)Cd111m(IT)Cd111(n,γ) Cd112(n,γ)Cd113m	1.9	3.2	13.6	
		Ag109(n,γ)Ag110m(n,γ)Ag111m(IT)Ag111(n,γ)Ag112(β^-) Cd112(n,γ)Cd113m		1.4	1.1	
		Ag109(n,γ)Ag110m(n,γ)Ag111(β^-)Cd111(n,γ)Cd112(n,γ)Cd113m		1.3		
		Ag109(n,γ)Ag110m(β^-)Cd110(n,γ)Cd111(n,γ)Cd112(n,γ)Cd113m		1.2	2.9	
Ag108m	417.97y	Ag107(n,γ)Ag108m	100.0	100.0	100.0	
		Ag109(n,2n)Ag108m				99.0
Nb94	2.0 10^4y	no pathways found				
Tc99	2.1 10^5y	Ag107(n,nα)Rh103m(IT)Rh103(n,nα)Tc99				49.4
		Ag107(n,nα)Rh103(n,nα)Tc99				8.2
		Ag107(n,nα)Rh103m(IT)Rh103(n,nα)Tc99m(IT)Tc99				8.1
		Ag107(n,α)Rh104m(IT)Rh104(β^-)Pd104(n,2n)Pd103(β^+) Rh103m(IT)Rh103(n,nα)Tc99				6.2
		Ag107(n,nα)Rh103m(IT)Rh103(n,2n)Rh102(n,α)Tc99				4.8
		Ag107(n,α)Rh104(β^-)Pd104(n,2n)Pd103(β^+)Rh103m(IT) Rh103(n,nα)Tc99				3.6
		Ag107(n,nα)Rh103m(IT)Rh103(n,2n)Rh102m(n,α)Tc99				3.1
		Ag107(n,2n)Ag106(β^+)Pd106(n,α)Ru103(β^-)Rh103m(IT) Rh103(n,nα)Tc99				2.2
		Ag107(n,nα)Rh103(n,nα)Tc99m(IT)Tc99				1.3
		Ag107(n,2n)Ag106m(β^+)Pd106(n,α)Ru103(β^-)Rh103m(IT) Rh103(n,nα)Tc99				1.3
		Ag107(n,α)Rh104m(IT)Rh104(β^-)Pd104(n,2n)Pd103(β^+) Rh103m(IT)Rh103(n,nα)Tc99m(IT)Tc99				1.0
Tc98	4.3 10^6y	Ag107(n,nα)Rh103m(IT)Rh103(n,nα)Tc99(n,2n)Tc98				36.7
		Ag107(n,nα)Rh103m(IT)Rh103(n,2n)Rh102(n,nα)Tc98				12.7
		Ag107(n,nα)Rh103m(IT)Rh103(n,2n)Rh102m(n,nα)Tc98				7.6
		Ag107(n,nα)Rh103(n,nα)Tc99(n,2n)Tc98				6.1
		Ag107(n,nα)Rh103m(IT)Rh103(n,nα)Tc99m(IT)Tc99(n,2n)Tc98				6.0
		Ag107(n,α)Rh104m(IT)Rh104(β^-)Pd104(n,2n)Pd103(β^+) Rh103m(IT)Rh103(n,nα)Tc99(n,2n)Tc98				3.4
		Ag107(n,nα)Rh103m(IT)Rh103(n,2n)Rh102(n,α)Tc99(n,2n)Tc98				2.8
		Ag107(n,nα)Rh103(n,2n)Rh102(n,nα)Tc98				2.1
		Ag107(n,α)Rh104(β^-)Pd104(n,2n)Pd103(β^+)Rh103m(IT) Rh103(n,nα)Tc99(n,2n)Tc98				1.9
		Ag107(n,nα)Rh103m(IT)Rh103(n,2n)Rh102m(n,α) Tc99(n,2n)Tc98				1.9
		Ag107(n,nα)Rh103(n,2n)Rh102m(n,nα)Tc98				1.2
		Ag107(n,α)Rh104m(IT)Rh104(β^-)Pd104(n,2n)Pd103(β^+) Rh103m(IT)Rh103(n,2n)Rh102(n,nα)Tc98				1.2
		Ag107(n,2n)Ag106(β^+)Pd106(n,α)Ru103(β^-)Rh103m(IT) Rh103(n,nα)Tc99(n,2n)Tc98				1.1
		Ag107(n,nα)Rh103(n,nα)Tc99m(IT)Tc99(n,2n)Tc98				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Pd107	6.5 10^6y	Ag109(n,γ)Ag110m(n,α)Rh107(β^-)Pd107	79.9	47.0		
		Ag107(n,γ)Ag108(β^-)Cd108(n,γ)Cd109(n,α)Pd106(n,γ)Pd107	8.4	52.0		
		Ag107(n,γ)Ag108m(n,α)Rh105(n,γ)Rh106(β^-)Pd106(n,γ)Pd107	4.2			
		Ag107(n,γ)Ag108m(n,α)Rh105(n,γ)Rh106m(β^-)Pd106(n,γ)Pd107	3.1			
		Ag107(n,p)Pd107			96.3	42.1
		Ag107(n,p)Pd107m(IT)Pd107			3.3	49.4
		Ag109(n,2n)Ag108(β^+)Pd108(n,2n)Pd107				2.3
		Ag109(n,2n)Ag108(β^+)Pd108(n,2n)Pd107m(IT)Pd107				1.3
Te123	9.2 10^{16}y	no pathways found				
Cd108	4.1 10^{17}y	Ag107(n,γ)Ag108(β^-)Cd108	99.9	99.6	98.5	
		Ag107(n,γ)Ag108m(n,E)Ag108(β^-)Cd108			1.4	
		Ag109(n,2n)Ag108(β^-)Cd108				92.6
		Ag109(n,2n)Ag108m(n,E)Ag108(β^-)Cd108				6.2
Pd110	6.0 10^{17}y	Ag109(n,γ)Ag110(β^+)Pd110	98.0	99.4	98.6	91.8
		Ag109(n,γ)Ag110m(n,E)Ag110(β^+)Pd110			1.1	1.6
		Ag109(n,γ)Ag110m(n,p)Pd110				5.2

Cadmium

Isotope	Atom % abundance	
Cd106	1.25	($T_{1/2}$ =6.6 10^{18}y)
Cd108	0.89	($T_{1/2}$ =4.1 10^{17}y)
Cd110	12.49	
Cd111	12.80	
Cd112	24.13	
Cd113	12.22	($T_{1/2}$ =7.8 10^{15}y)
Cd114	28.73	($T_{1/2}$ =6.0 10^{17}y)
Cd116	7.49	($T_{1/2}$ =3.4 10^{19}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	5.96E+14	5.72E+14	2.37E+14	7.58E+13	1.14E+11	9.60E+04
Cd111m	18.5	17.9				
In115m	16.9	17.6	14.8			
Cd115	16.8	17.5	13.6			
Ag109m	9.3	9.6	22.8	41.5		
Cd109	9.1	9.5	22.8	41.5		
Cd115m	6.7	7.0	15.8	0.2		
In116m	3.9	3.8				
Ag107m	2.6	2.7				
Cd107	2.6	2.7				
Cd113m	2.2	2.3	5.5	16.4	99.5	
Cd117	1.9	2.0				
In117m	1.8	1.9				
In117	1.4	1.5				
Ag105	1.0	1.1	2.4			
Pd107						99.9

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	4.78E-02	4.46E-02	1.09E-02	1.05E-03	3.48E-06	1.63E-13
In116m	21.8	21.8				
Cd115	17.1	18.4	24.1			
Cd111m	14.6	14.5				
In115m	11.3	12.1	17.4			
Cd115m	8.5	9.1	35.2	1.3		
Cd117	5.8	6.1				
In117	2.7	2.9				
Cd105	2.6	2.6				
Ag110	1.9			0.1		
In117m	1.9	2.0				
Cd117m	1.8	1.9				
Ag109m	1.6	1.7	7.0	42.5		
Ag105	1.1	1.2	4.6	0.1		
Ag112	1.1	1.1				
In116	1.1					
Cd113m	0.8	0.9	3.5	35.1	96.0	
Ag110m	0.6	0.7	2.8	10.7		
Cd109	0.4	0.4	1.7	10.1		
Ag106m	0.4	0.5	1.4			
In114	0.3	0.3	1.1	0.1		
Ag108m					3.9	11.8
Pd107						87.6

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	3.46E+04	3.29E+04	3.36E+03	1.84E+02	1.82E-01	2.58E-08
In116m	49.8	48.8				
Cd115	10.0	10.5	33.1			
Cd117	9.7	9.9				
Cd111m	6.0	5.9				
In115m	5.8	6.1	20.8			
Cd105	5.2	5.1				
Cd117m	4.3	4.4				
In117	2.5	2.7				
Ag105	1.4	1.5	14.0	0.6		
Ag110m	1.4	1.5	14.4	96.9		
Cd115m	1.0	1.1	9.9	0.6		
Ag106m	0.9	1.0	7.1			
Ag108m				0.1	99.6	99.9

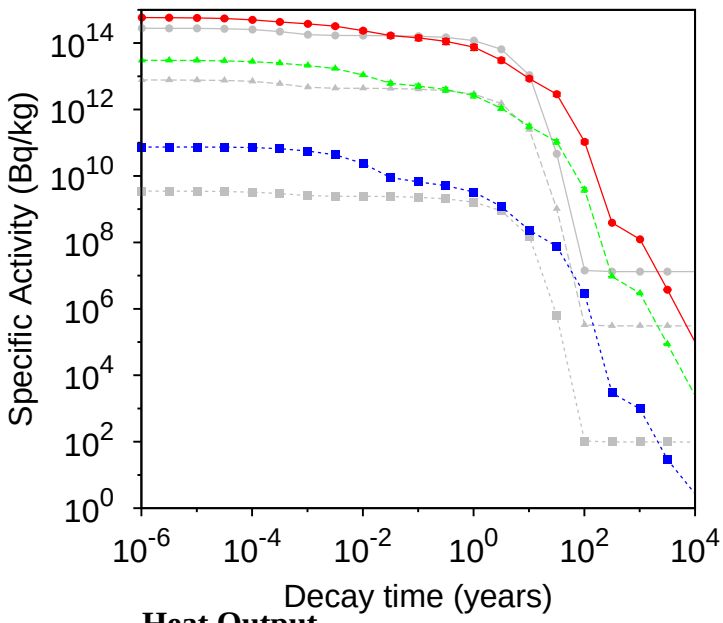
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	7.26E+05	7.24E+05	5.91E+05	3.50E+05	2.60E+03	3.78E-06
Cd113m	41.3	41.3	50.6	81.6	100.0	
Cd115	19.4	19.4	7.6			
Cd115m	18.1	18.1	21.0	0.1		
Cd109	15.0	15.0	18.3	18.0		
Cd111m	1.7	1.6				
In115m	1.2	1.2	0.5			
Pd107						93.9
Ag108m						4.4

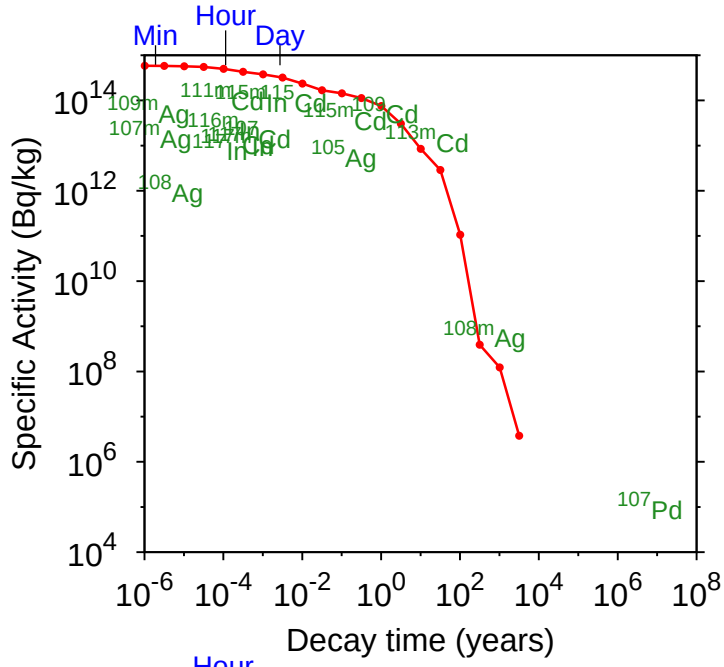
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.35E+06	2.35E+06	2.22E+06	1.62E+06	1.24E+04	5.98E-05
Cd113m	60.9	61.0	64.4	84.0	99.8	
Cd109	18.8	18.8	19.7	15.7		
Cd115m	13.0	13.1	13.0	0.1		
Cd115	4.7	4.7	1.6			
Pd107						94.5
Ag108m					0.2	4.5

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.08E+11	2.00E+11	7.29E+10	3.48E+10	2.93E+06	2.29E-01
In116m	27.8	27.2				
Cd109	26.1	27.3	74.3	90.5		
Cd111m	15.5	15.0				
Cd117	6.2	6.3				
Cd115	4.8	5.0	4.4			
Cd105	3.3	3.2				
Ag110m	3.3	3.4	9.2	7.1		
Ag105	2.9	3.0	7.8			
In117	2.9	3.0				
Cd117m	2.4	2.4				
Ag109m	0.5	0.5	1.4	1.7		
Ag106m	0.6	0.7	1.3			
Cd113m	0.1	0.1	0.3	0.7	71.3	
Ag108m					28.6	52.1
Pd107						38.1
Tc99						8.8

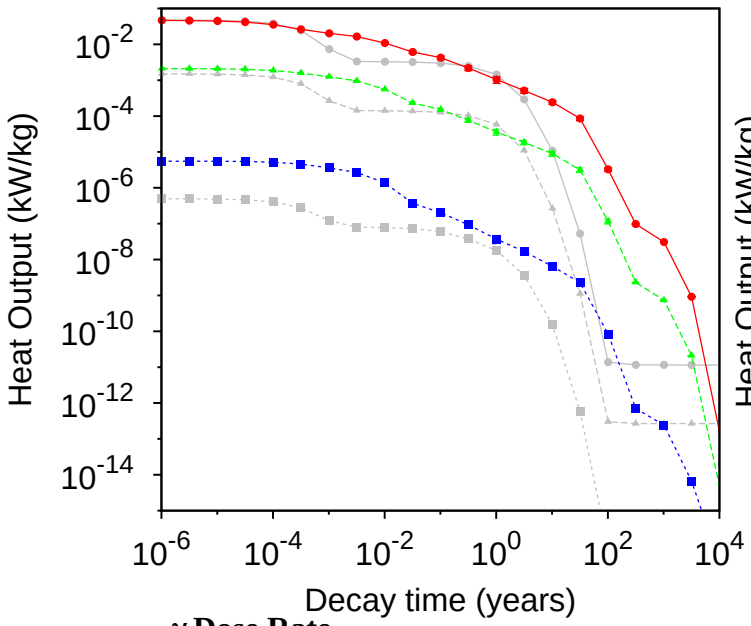
Cadmium activation characteristics

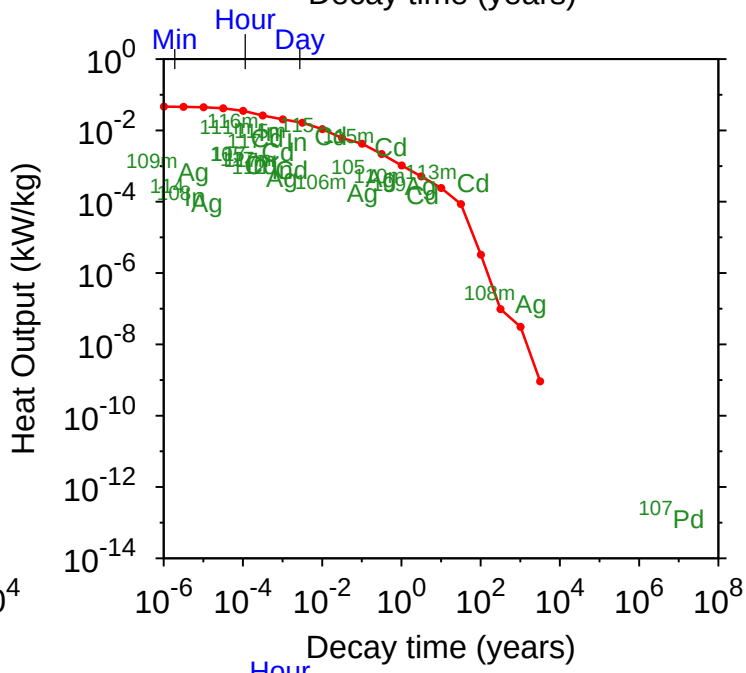
Specific Activity



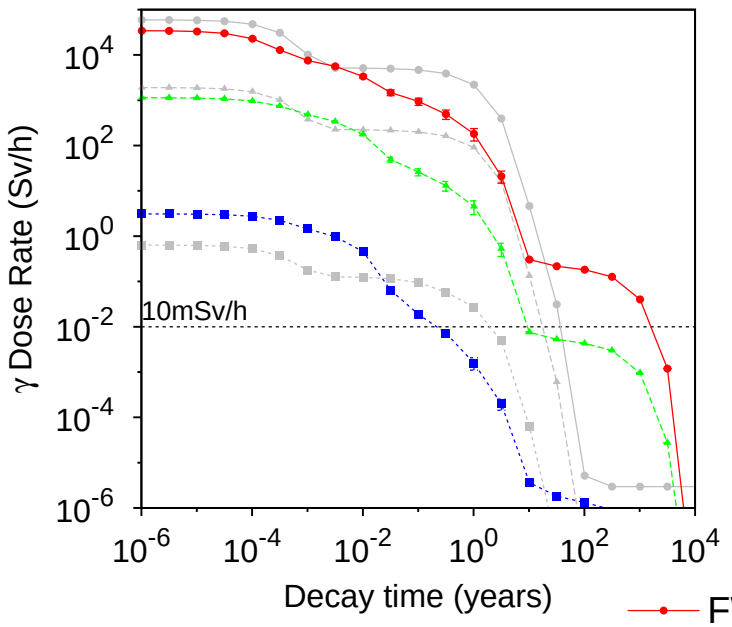


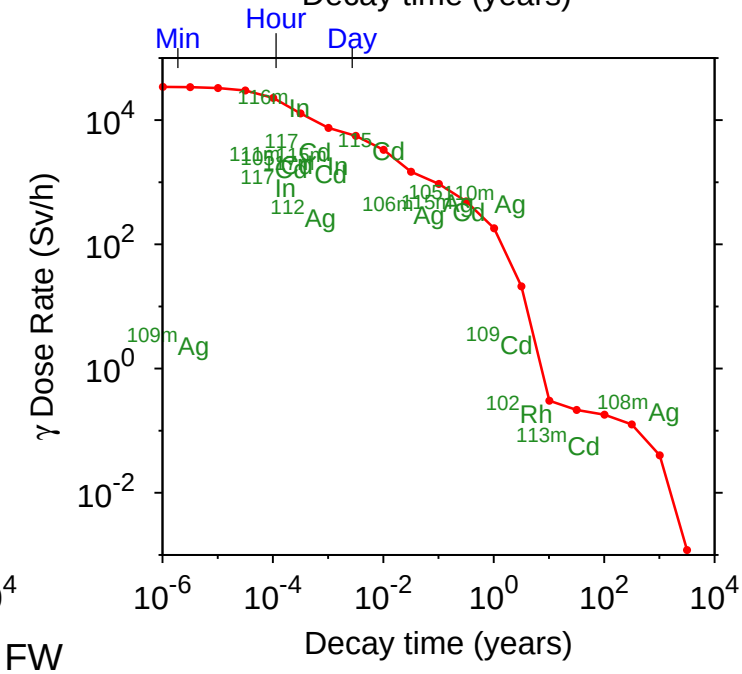
Heat Output





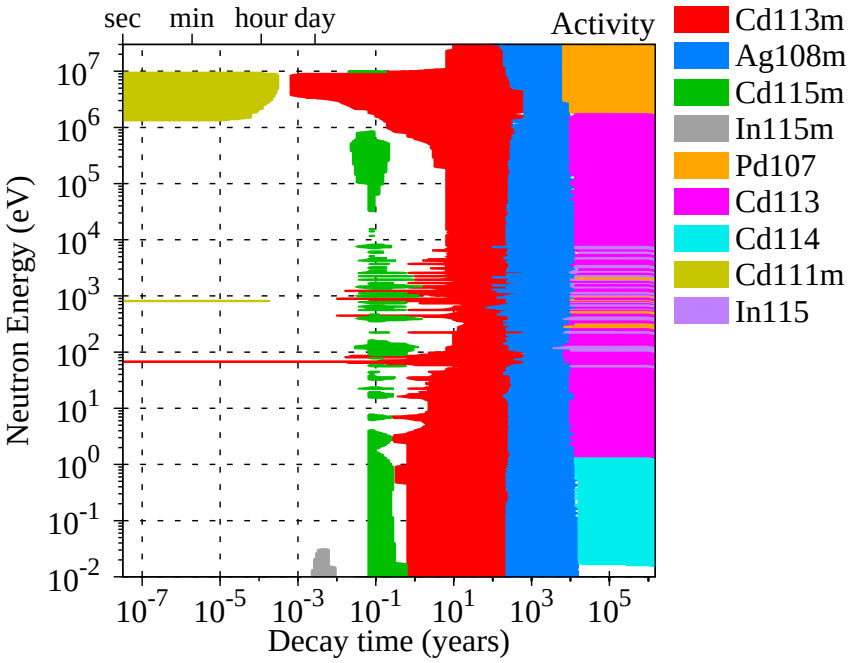
γ Dose Rate

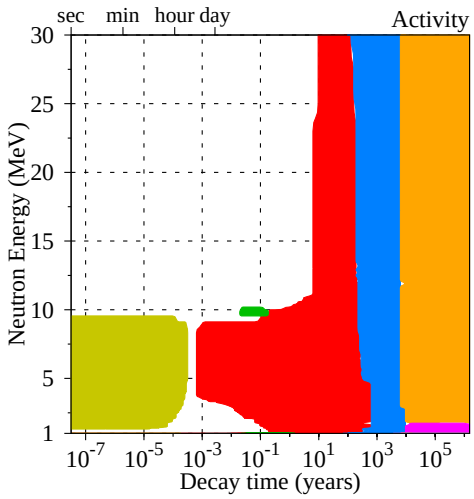


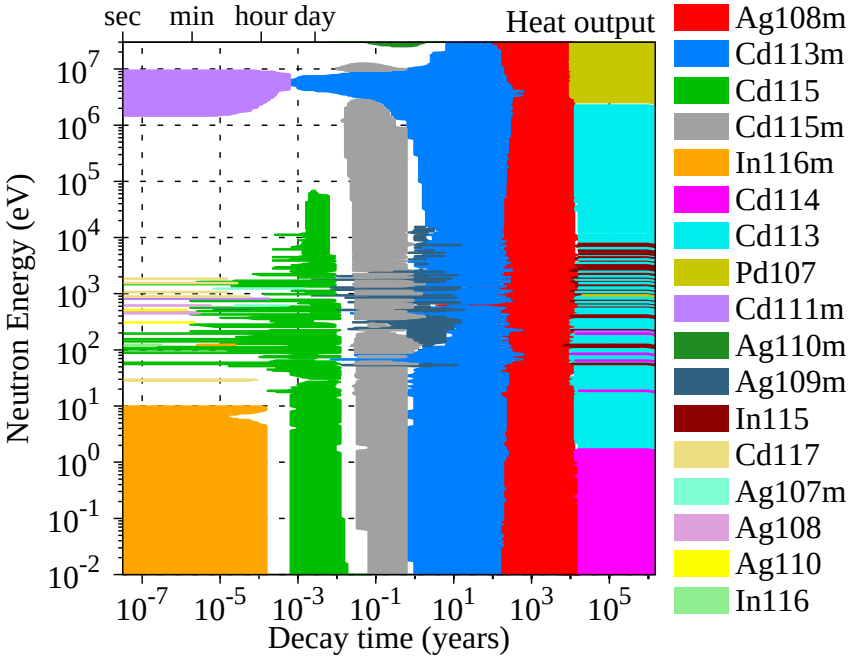


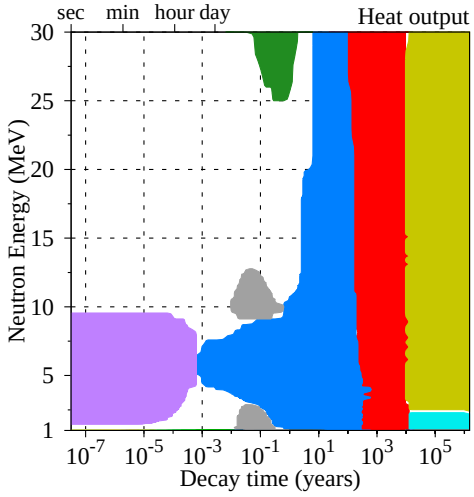
FW
Blanket
Manifold
Fe results

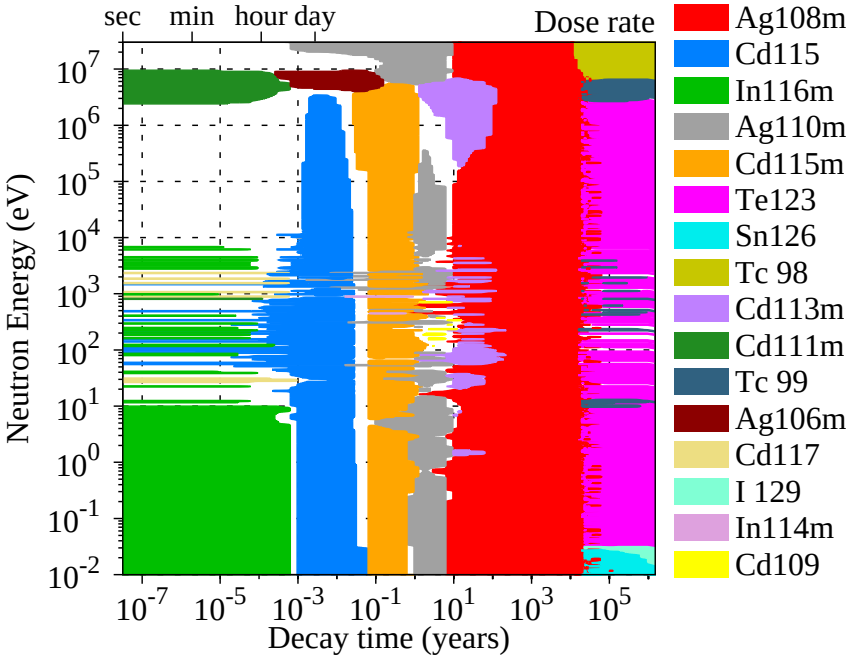
Cadmium Importance diagrams

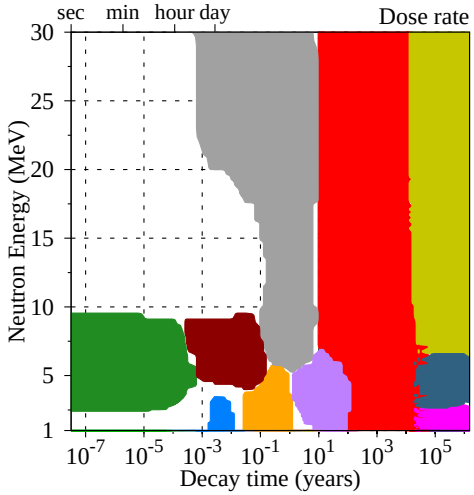




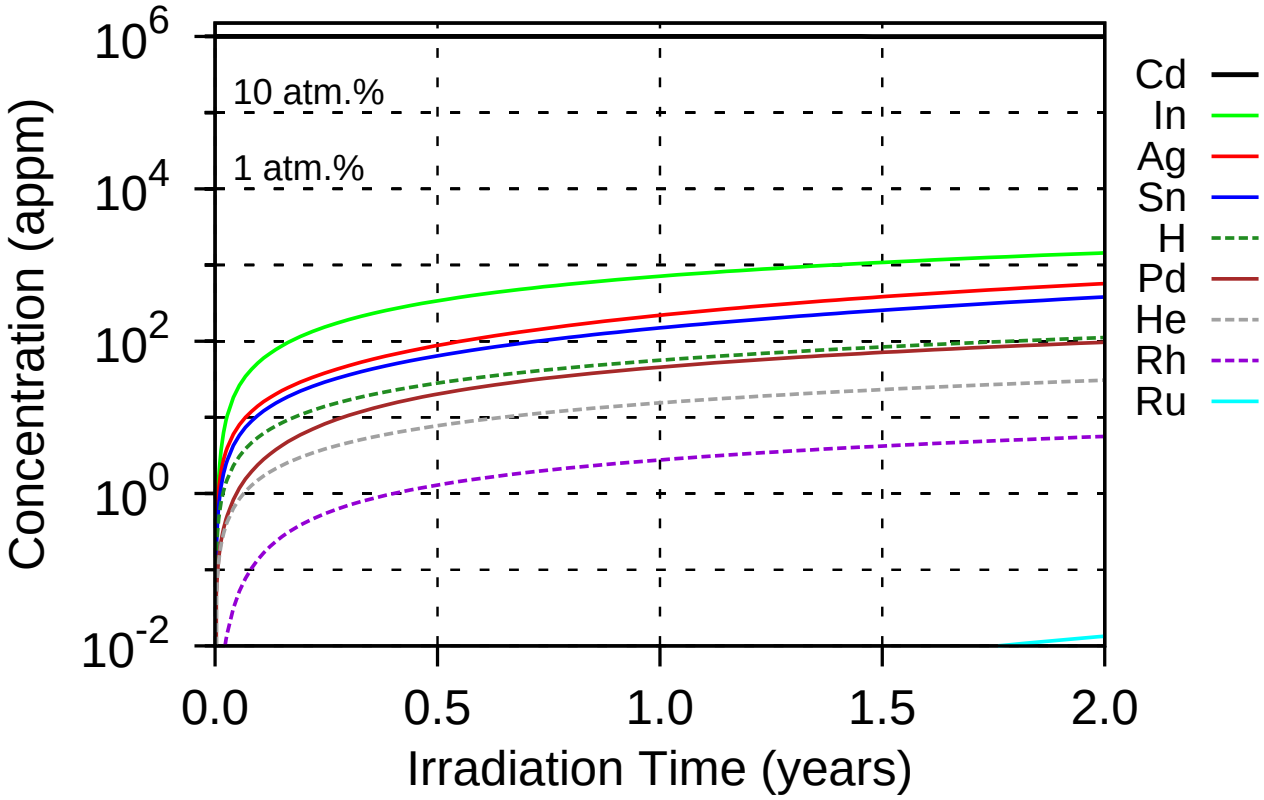






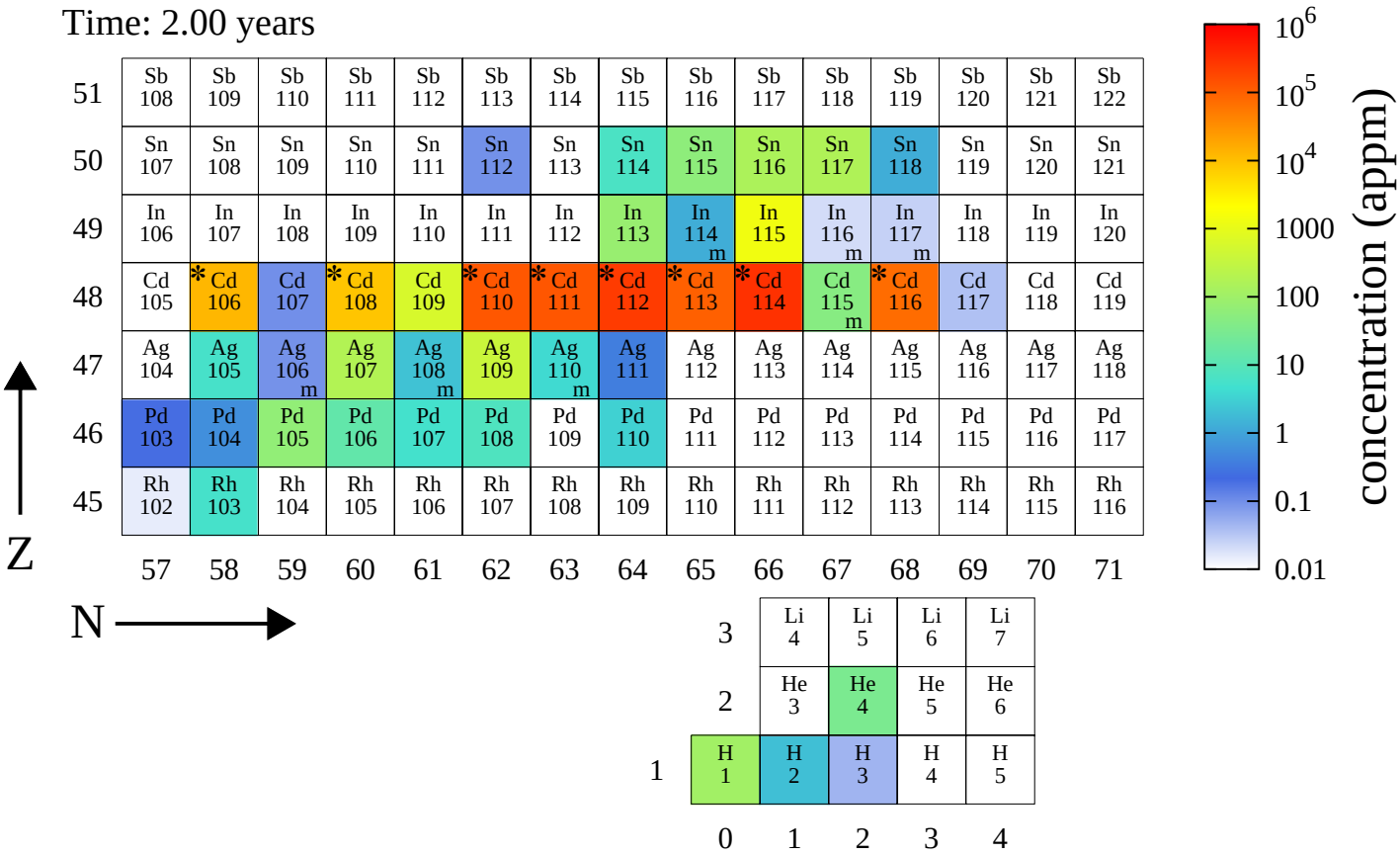


Cadmium FW Transmutation

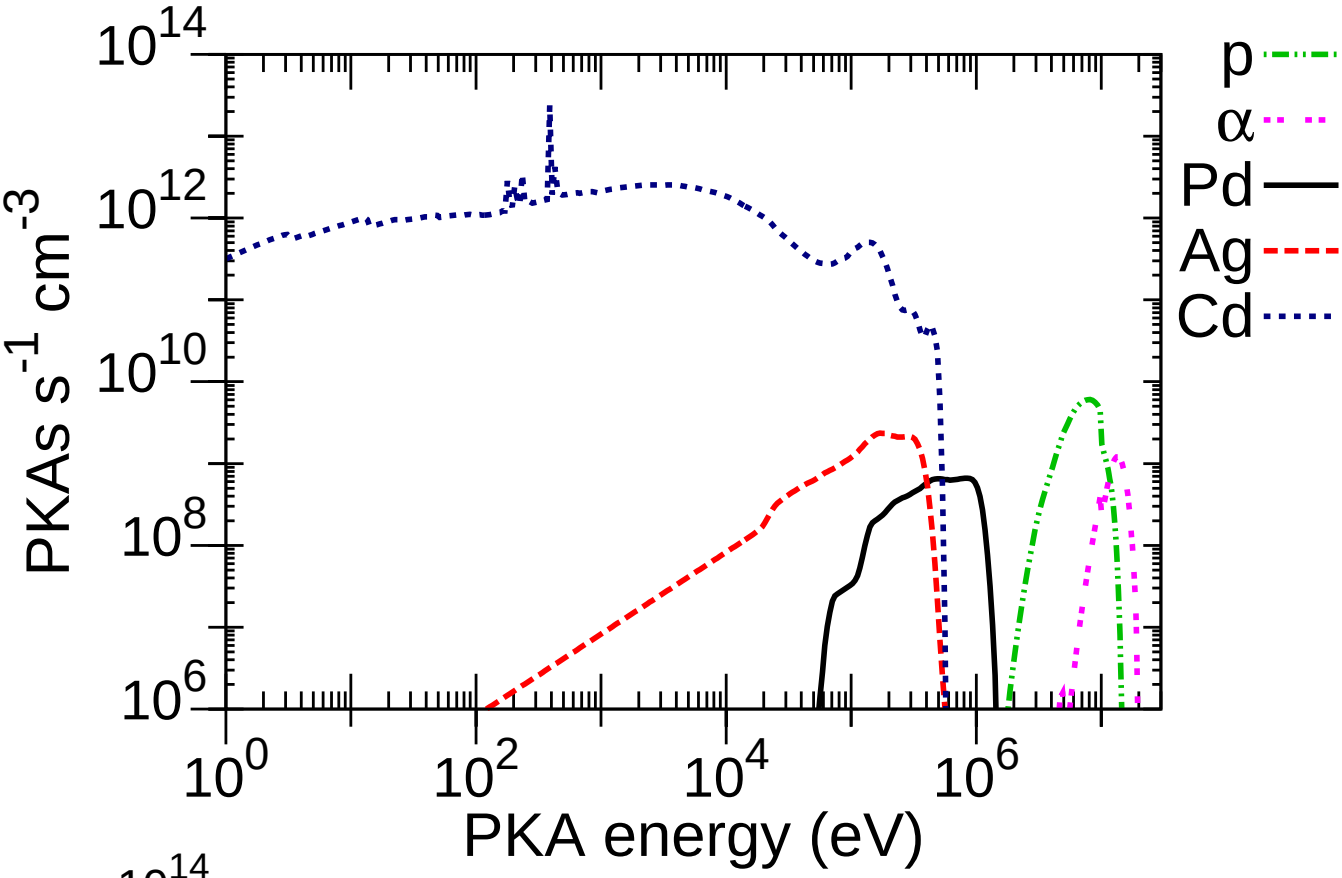


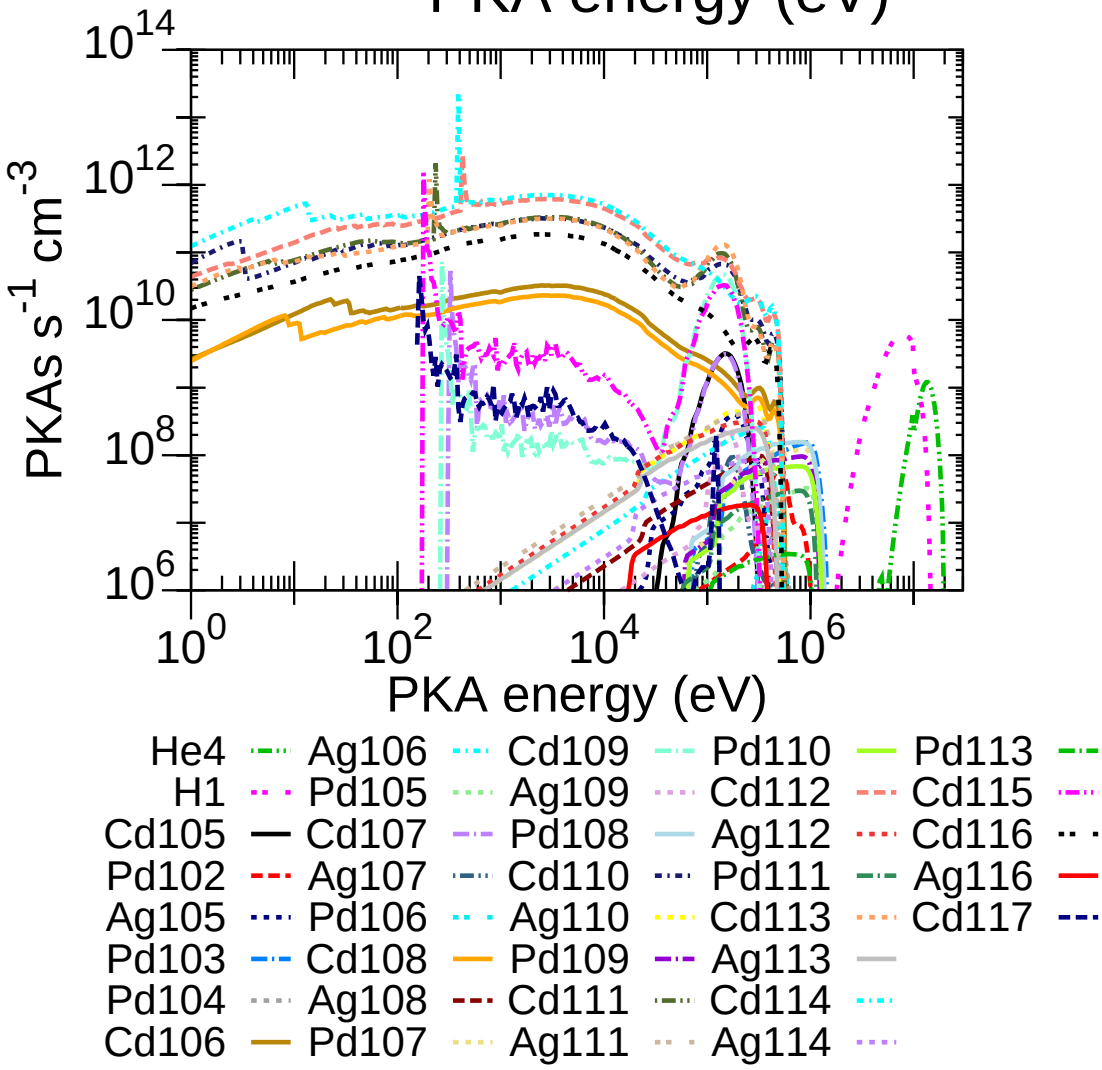
15 appm He & 56 appm H after 1 year

16 dpa/year



Cadmium FW PKA distributions





Cadmium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
In116	14.20s	Cd114(n,γ)Cd115(β^-)In115m(n,γ)In116	64.1			
		Cd113(n,γ)Cd114(n,γ)Cd115(β^-)In115m(n,γ)In116	27.3			
		Cd112(n,γ)Cd113(n,γ)Cd114(n,γ)Cd115(β^-)In115m(n,γ)In116	6.1			
		Cd114(n,γ)Cd115(β^-)In115m(IT)In115(n,γ)In116		87.7	67.8	
		Cd114(n,γ)Cd115m(β^-)In115(n,γ)In116		10.8	30.7	
Ag110	24.56s	Cd108(n,γ)Cd109(β^+)Ag109m(IT)Ag109(n,γ)Ag110	51.6	99.5	98.8	
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108m(n,γ) Ag109m(IT)Ag109(n,γ)Ag110	26.3			
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108(β^+) Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110	17.8			
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108m(n,γ) Ag109(n,γ)Ag110	2.1			
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108(β^-) Cd108(n,γ)Cd109(β^+)Ag109m(IT)Ag109(n,γ)Ag110	1.6			
		Cd110(n,p)Ag110				79.9
		Cd111(n,2n)Cd110(n,p)Ag110				7.8
		Cd111(n,np)Ag110				4.1
		Cd110(n,p)Ag110m(n,E)Ag110				3.4
		Cd111(n,d)Ag110				1.5
Ag109m	39.70s	Cd108(n,γ)Cd109(β^+)Ag109m	47.6	99.9	100.0	
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108m(n,γ)Ag109m	28.3			
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108(β^+) Pd108(n,γ)Pd109(β^-)Ag109m	21.8			
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108(β^-) Cd108(n,γ)Cd109(β^+)Ag109m	2.0			
		Cd110(n,2n)Cd109(β^+)Ag109m				92.0
		Cd111(n,2n)Cd110(n,2n)Cd109(β^+)Ag109m				5.3
Ag107m	44.29s	Cd106(n,γ)Cd107(β^+)Ag107m	100.0	100.0	100.0	
		Cd108(n,2n)Cd107(β^+)Ag107m				92.7
		Cd110(n,2n)Cd109(n,2n)Cd108(n,2n)Cd107(β^+)Ag107m				3.3
		Cd108(n,np)Ag107m				1.4
In114	1.20m	Cd112(n,γ)Cd113m(β^-)In113(n,γ)In114m(IT)In114	55.3	71.7	7.5	
		Cd112(n,γ)Cd113m(β^-)In113(n,γ)In114	34.5	25.2	2.1	
		Cd111(n,γ)Cd112(n,γ)Cd113m(β^-)In113(n,γ)In114m(IT)In114	4.5			
		Cd111(n,γ)Cd112(n,γ)Cd113m(β^-)In113(n,γ)In114	2.9			
		Cd112(n,γ)Cd113m(β^-)In113(n,γ)In114m(n,E)In114	1.5	2.2		
		Cd113(n,n′)Cd113m(β^-)In113(n,γ)In114m(IT)In114			68.9	
		Cd113(n,n′)Cd113m(β^-)In113(n,γ)In114			18.9	
		Cd113(n,n′)Cd113m(β^-)In113(n,γ)In114m(n,E)In114			1.8	
		Cd116(n,2n)Cd115m(β^-)In115(n,2n)In114m(IT)In114				40.7
		Cd116(n,2n)Cd115(β^-)In115m(IT)In115(n,2n)In114m(IT)In114				39.6
		Cd116(n,2n)Cd115m(β^-)In115(n,2n)In114				8.6
		Cd116(n,2n)Cd115(β^-)In115m(IT)In115(n,2n)In114				8.3
Ag108	2.40m	Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108	99.9	99.5	98.4	
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108m(n,E)Ag108			1.4	
		Cd110(n,2n)Cd109(β^+)Ag109m(IT)Ag109(n,2n)Ag108				78.8
		Cd108(n,p)Ag108				9.3
		Cd110(n,2n)Cd109(β^+)Ag109m(IT)Ag109(n,2n) Ag108m(n,E)Ag108				3.9
		Cd111(n,2n)Cd110(n,2n)Cd109(β^+)Ag109m(IT) Ag109(n,2n)Ag108				2.8
		Cd108(n,p)Ag108m(n,E)Ag108				1.1
In117	43.20m	Cd116(n,γ)Cd117(β^-)In117m(IT)In117	67.4	62.0	37.2	12.1
		Cd116(n,γ)Cd117m(β^-)In117	16.3	25.8	55.2	84.8
		Cd116(n,γ)Cd117(β^-)In117	13.1	12.0	7.2	2.3
		Cd114(n,γ)Cd115(β^-)In115m(IT)In115(n,γ)In116m(n,γ)In117	1.6			
Cd111m	48.74m	Cd110(n,γ)Cd111m	99.6	100.0	5.0	
		Cd111(n,n′)Cd111m			94.8	14.2
		Cd112(n,2n)Cd111m				80.2
		Cd113(n,2n)Cd112(n,2n)Cd111m				3.9
		Cd112(n,2n)Cd111(n,n′)Cd111m				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
In116m	54.60m	Cd114(n,γ)Cd115(β^-)In115m(IT)In115(n,γ)In116m	59.8	72.0	46.8	
		Cd113(n,γ)Cd114(n,γ)Cd115(β^-)In115m(IT)In115(n,γ)In116m	25.5			
		Cd112(n,γ)Cd113(n,γ)Cd114(n,γ)Cd115(β^-)In115m(IT) In115(n,γ)In116m	5.6			
		Cd114(n,γ)Cd115m(β^-)In115(n,γ)In116m	2.8	8.9	21.2	
		Cd114(n,γ)Cd115(β^-)In115m(IT)In115(n,γ)In116n(IT)In116m	2.4	15.8	21.1	
		Cd113(n,γ)Cd114(n,γ)Cd115m(β^-)In115(n,γ)In116m	1.2			
		Cd114(n,γ)Cd115m(β^-)In115(n,γ)In116n(IT)In116m		1.9	9.6	
		Cd116(n,2n)Cd115m(β^-)In115(n,γ)In116m				31.0
		Cd116(n,2n)Cd115(β^-)In115m(IT)In115(n,γ)In116m				29.9
		Cd116(n,2n)Cd115m(β^-)In115(n,γ)In116n(IT)In116m				19.2
		Cd116(n,2n)Cd115(β^-)In115m(IT)In115(n,γ)In116n(IT)In116m				18.5
Cd105	55.49m	Cd106(n,2n)Cd105				100.0
In117m	1.94h	Cd116(n,γ)Cd117(β^-)In117m	99.4	99.7	98.9	
		Cd116(n,γ)Cd117m(β^-)In117m			1.1	
Cd117	2.49h	Cd116(n,γ)Cd117	99.7	100.0	100.0	100.0
Ag112	3.13h	Cd108(n,γ)Cd109(β^+)Ag109m(IT)Ag109(n,γ)Ag110m(n,γ) Ag111m(IT)Ag111(n,γ)Ag112	54.3	95.0		
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108m(n,γ) Ag109m(IT)Ag109(n,γ)Ag110m(n,γ)Ag111m(IT)Ag111(n,γ)Ag112	23.6			
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108(β^+) Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m(n,γ) Ag111m(IT)Ag111(n,γ)Ag112	14.3			
		Cd108(n,γ)Cd109(β^+)Ag109m(IT)Ag109(n,γ)Ag110m(n,γ) Ag111(n,γ)Ag112	2.3	4.5		
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108m(n,γ) Ag109(n,γ)Ag110m(n,γ)Ag111m(IT)Ag111(n,γ)Ag112	1.9			
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108(β^-) Cd108(n,γ)Cd109(β^+)Ag109m(IT)Ag109(n,γ)Ag110m(n,γ) Ag111m(IT)Ag111(n,γ)Ag112	1.3			
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108m(n,γ) Ag109m(IT)Ag109(n,γ)Ag110m(n,γ)Ag111(n,γ)Ag112	1.0			
		Cd111(n,p)Ag111(n,γ)Ag112			56.8	
		Cd111(n,p)Ag111m(IT)Ag111(n,γ)Ag112			39.8	
		Cd112(n,p)Ag112				92.9
		Cd113(n,2n)Cd112(n,p)Ag112				4.5
Cd117m	3.36h	Cd116(n,γ)Cd117m	99.7	100.0	100.0	100.0
In115m	4.49h	Cd114(n,γ)Cd115(β^-)In115m	65.1	97.6	98.2	
		Cd113(n,γ)Cd114(n,γ)Cd115(β^-)In115m	27.7	1.9		
		Cd112(n,γ)Cd113(n,γ)Cd114(n,γ)Cd115(β^-)In115m	6.2			
		Cd114(n,γ)Cd115m(n,E)Cd115(β^-)In115m			1.1	
		Cd116(n,2n)Cd115(β^-)In115m				97.3
		Cd116(n,2n)Cd115m(n,E)Cd115(β^-)In115m				1.5
Cd107	6.52h	Cd106(n,γ)Cd107	100.0	100.0	100.0	
		Cd108(n,2n)Cd107				95.1
		Cd110(n,2n)Cd109(n,2n)Cd108(n,2n)Cd107				3.5
Cd115	2.23d	Cd114(n,γ)Cd115	65.1	97.6	98.7	
		Cd113(n,γ)Cd114(n,γ)Cd115	27.7	1.9		
		Cd112(n,γ)Cd113(n,γ)Cd114(n,γ)Cd115	6.2			
		Cd114(n,γ)Cd115m(n,E)Cd115			1.1	
		Cd116(n,2n)Cd115				98.2
		Cd116(n,2n)Cd115m(n,E)Cd115				1.5
Ag106m	8.46d	Cd106(n,p)Ag106m			100.0	71.7
		Cd108(n,2n)Cd107(β^+)Ag107m(IT)Ag107(n,2n)Ag106m				26.9
Ag105	41.29d	Cd106(n,2n)Cd105(β^+)Ag105				87.6
		Cd106(n,np)Ag105m(IT)Ag105				9.5
		Cd106(n,np)Ag105				2.5
Cd115m	44.45d	Cd114(n,γ)Cd115m	65.4	98.2	99.9	
		Cd113(n,γ)Cd114(n,γ)Cd115m	27.8	1.8		
		Cd112(n,γ)Cd113(n,γ)Cd114(n,γ)Cd115m	5.9			
		Cd116(n,2n)Cd115m				99.6

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
In114m	49.98d	Cd112(n,γ)Cd113m(β^-)In113(n,γ)In114m	91.5	99.1	9.8	
		Cd111(n,γ)Cd112(n,γ)Cd113m(β^-)In113(n,γ)In114m	7.4			
		Cd110(n,γ)Cd111(n,γ)Cd112(n,γ)Cd113m(β^-)In113(n,γ)In114m	1.1			
		Cd113(n,n′)Cd113m(β^-)In113(n,γ)In114m			89.6	
		Cd116(n,2n)Cd115m(β^-)In115(n,2n)In114m				50.0
		Cd116(n,2n)Cd115(β^-)In115m(IT)In115(n,2n)In114m				48.7
Ag110m	249.77d	Cd108(n,γ)Cd109(β^+)Ag109m(IT)Ag109(n,γ)Ag110m	56.3	100.0	100.0	
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108m(n,γ) Ag109m(IT)Ag109(n,γ)Ag110m	24.8			
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108(β^+) Pd108(n,γ)Pd109(β^-)Ag109m(IT)Ag109(n,γ)Ag110m	15.2			
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108m(n,γ) Ag109(n,γ)Ag110m	2.0			
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108(β^-) Cd108(n,γ)Cd109(β^+)Ag109m(IT)Ag109(n,γ)Ag110m	1.4			
		Cd110(n,p)Ag110m				87.8
		Cd111(n,2n)Cd110(n,p)Ag110m				5.7
		Cd111(n,np)Ag110m				3.8
		Cd111(n,d)Ag110m				1.4
Cd109	1.27y	Cd108(n,γ)Cd109	95.9	100.0	100.0	
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108(β^-) Cd108(n,γ)Cd109	4.1			
		Cd110(n,2n)Cd109				94.2
		Cd111(n,2n)Cd110(n,2n)Cd109				5.4
Cd113m	14.60y	Cd112(n,γ)Cd113m	85.2	98.4	9.8	
		Cd111(n,γ)Cd112(n,γ)Cd113m	12.1	1.6		
		Cd110(n,γ)Cd111(n,γ)Cd112(n,γ)Cd113m	2.7			
		Cd113(n,n′)Cd113m			89.9	9.5
		Cd114(n,2n)Cd113m				89.8
Ag108m	417.97y	Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,γ)Ag108m	99.9	99.9	99.9	
		Cd110(n,2n)Cd109(β^+)Ag109m(IT)Ag109(n,2n)Ag108m				72.9
		Cd108(n,p)Ag108m				21.1
		Cd111(n,2n)Cd110(n,2n)Cd109(β^+)Ag109m(IT) Ag109(n,2n)Ag108m				1.9
Tc99	2.1 10^5y	Cd106(n,α)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102(n,α)Tc99				6.8
		Cd106(n,α)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102m(n,α)Tc99				4.3
		Cd106(n,α)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102(n,α) Tc99m(IT)Tc99				1.1
Sn126	2.3 10^5y	no pathways found				
Tc98	4.3 10^6y	Cd106(n,α)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102(n,nα)Tc98				15.7
		Cd106(n,α)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102m(n,nα)Tc98				9.4
		Cd106(n,α)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102(n,α) Tc99(n,2n)Tc98				3.3
		Cd106(n,nα)Pd102(n,2n)Pd101(β^+)Rh101m(IT)Rh101(n,α)Tc98				3.0
		Cd106(n,α)Pd103(β^+)Rh103m(IT)Rh103(n,2n)Rh102m(n,α) Tc99(n,2n)Tc98				2.3
		Cd106(n,nα)Pd102(n,2n)Pd101(β^+)Rh101m(n,α)Tc98				1.3
		Cd106(n,nα)Pd102(n,α)Ru99(n,np)Tc98				1.3
Pd107	6.5 10^6y	Cd108(n,γ)Cd109(n,α)Pd106(n,γ)Pd107	48.0	99.1		
		Cd110(n,α)Pd107	14.9		32.5	51.2
		Cd108(n,α)Pd105(n,γ)Pd106(n,γ)Pd107	6.2			
		Cd106(n,γ)Cd107(β^+)Ag107m(IT)Ag107(n,p)Pd107			26.9	
		Cd110(n,α)Pd107m(IT)Pd107			2.5	34.4
		Cd111(n,α)Pd108(n,2n)Pd107				3.2
		Cd111(n,2n)Cd110(n,α)Pd107				2.5
		Cd111(n,α)Pd108(n,2n)Pd107m(IT)Pd107				1.8
		Cd111(n,nα)Pd107				1.8
		Cd111(n,2n)Cd110(n,α)Pd107m(IT)Pd107				1.7
		Cd111(n,nα)Pd107m(IT)Pd107				1.2
I129	1.6 10^7y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
In115	4.4 10^{14}y	Cd114(n,γ)Cd115(β^-)In115m(IT)In115	62.2	87.8	67.9	
		Cd113(n,γ)Cd114(n,γ)Cd115(β^-)In115m(IT)In115	26.5			
		Cd112(n,γ)Cd113(n,γ)Cd114(n,γ)Cd115(β^-)In115m(IT)In115	5.8			
		Cd114(n,γ)Cd115m(β^-)In115	2.9	10.8	30.7	
		Cd113(n,γ)Cd114(n,γ)Cd115m(β^-)In115	1.2			
		Cd116(n,2n)Cd115m(β^-)In115				50.3
		Cd116(n,2n)Cd115(β^-)In115m(IT)In115				48.5
Cd113	7.8 10^{15}y	Cd112(n,γ)Cd113	80.6	2.0		
		Cd111(n,γ)Cd112(n,γ)Cd113	14.8			
		Cd110(n,γ)Cd111(n,γ)Cd112(n,γ)Cd113	4.0			
		Cd114(n,2n)Cd113				8.7
Te123	9.2 10^{16}y	Cd116(n,γ)Cd117(β^-)In117m(β^-)Sn117(n,γ)Sn118(n,γ) Sn119(n,γ)Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122(β^-) Te122(n,γ)Te123	38.4			
		Cd116(n,γ)Cd117(β^-)In117m(IT)In117(β^-)Sn117(n,γ) Sn118(n,γ)Sn119(n,γ)Sn120(n,γ)Sn121(β^-)Sb121(n,γ) Sb122(β^-)Te122(n,γ)Te123	34.1			
		Cd116(n,γ)Cd117m(β^-)In117(β^-)Sn117(n,γ)Sn118(n,γ) Sn119(n,γ)Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122(β^-) Te122(n,γ)Te123	8.2			
		Cd116(n,γ)Cd117(β^-)In117(β^-)Sn117(n,γ)Sn118(n,γ) Sn119(n,γ)Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122(β^-) Te122(n,γ)Te123	6.6			
		Cd116(n,γ)Cd117(n,γ)Cd118(β^-)In118(β^-)Sn118(n,γ) Sn119(n,γ)Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122(β^-) Te122(n,γ)Te123	1.8			
		Cd116(n,γ)Cd117(β^-)In117m(β^-)Sn117(n,γ)Sn118(n,γ) Sn119m(n,γ)Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122(β^-) Te122(n,γ)Te123	1.7			
		Cd116(n,γ)Cd117(β^-)In117m(IT)In117(β^-)Sn117(n,γ) Sn118(n,γ)Sn119m(n,γ)Sn120(n,γ)Sn121(β^-)Sb121(n,γ) Sb122(β^-)Te122(n,γ)Te123	1.5			
Cd114	6.0 10^{17}y	Cd113(n,γ)Cd114	27.7	1.9		
		Cd112(n,γ)Cd113(n,γ)Cd114	6.2			

Indium

Isotope	Atom % abundance
In113	4.29
In115	95.71

($T_{1/2}$ =4.4 10^{14}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.40E+16	1.21E+16	1.15E+15	8.47E+12	5.04E+08	2.07E+02
In116m	81.8	88.5				
In114	5.2	4.9	48.6	44.0		
In114m	4.4	5.0	50.3	45.6		
In116n	4.3					
In116	3.0					
In115m	0.9	1.0				
In113m	0.1	0.1	0.3	4.7		
Sn113			0.3	4.7		
Cd113m				0.7	98.9	
H3					1.1	
In115						99.8

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	5.37E+00	4.92E+00	9.14E-02	6.41E-04	1.47E-08	5.04E-15
In116m	95.7	97.8				
In116	1.7					
In114	1.7	1.5	75.9	72.1		
In114m	0.4	0.5	23.4	22.2		
In113m			0.2	3.9		
Ag110m				1.1		
Cd113m				0.3	99.8	
In115						100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	8.49E+06	7.94E+06	6.50E+03	6.58E+01	2.52E-05	3.03E-13
In116m	99.9	99.9				
In114m	0.1	0.1	91.7	60.3		
In114			5.3	3.5		
In113m			1.7	19.3		
Ag110m			0.5	16.5		
Ag108m					91.0	100.0
Cd113m					8.9	

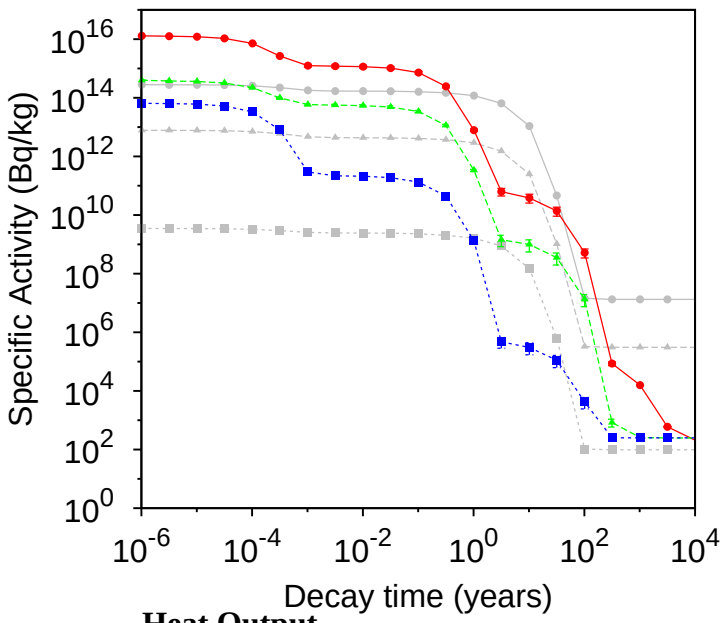
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.82E+06	3.68E+06	2.40E+06	1.76E+04	1.15E+01	6.62E-06
In114m	65.4	67.9	99.0	89.9		
In116m	19.2	18.6				
Sn113m	14.2	12.4				
Cd113m			0.1	7.6	100.0	
Sn113	0.1	0.1	0.1	1.6		
In115						100.0

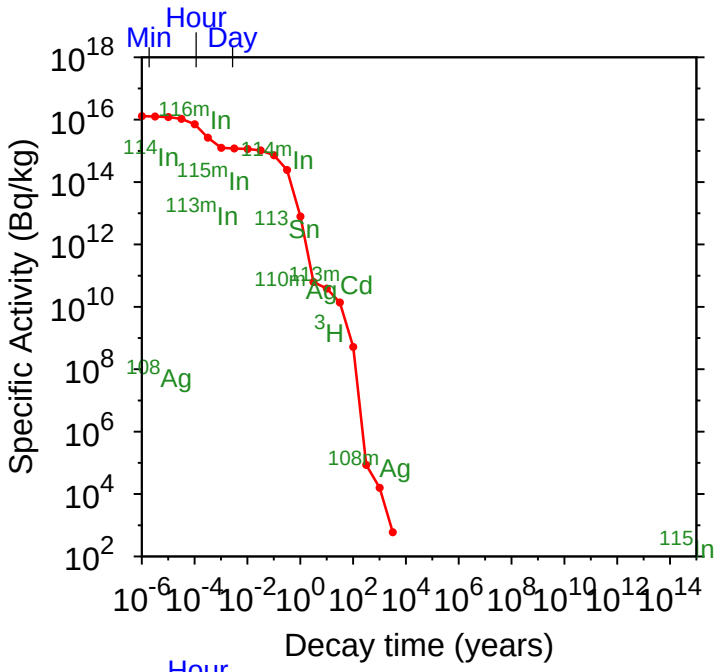
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	7.09E+06	6.92E+06	5.44E+06	4.37E+04	5.48E+01	8.07E-05
In114m	80.0	82.0	99.1	82.3		
Sn113m	11.8	10.2				
In116m	7.3	7.0				
Cd113m	0.1	0.1	0.1	14.6	100.0	
Sn113	0.1	0.1	0.2	2.5		
In115						100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.88E+13	2.69E+13	1.09E+11	1.25E+09	9.37E+03	2.07E-01
In116m	99.2	99.5				
In114m	0.2	0.2	53.2	30.9		
In114	0.2	0.2	42.8	24.8		
Sn113			3.2	31.7		
Ag110m			0.4	12.1		
Cd113m				0.1	98.2	
Ag108m					1.1	
In115						100.0

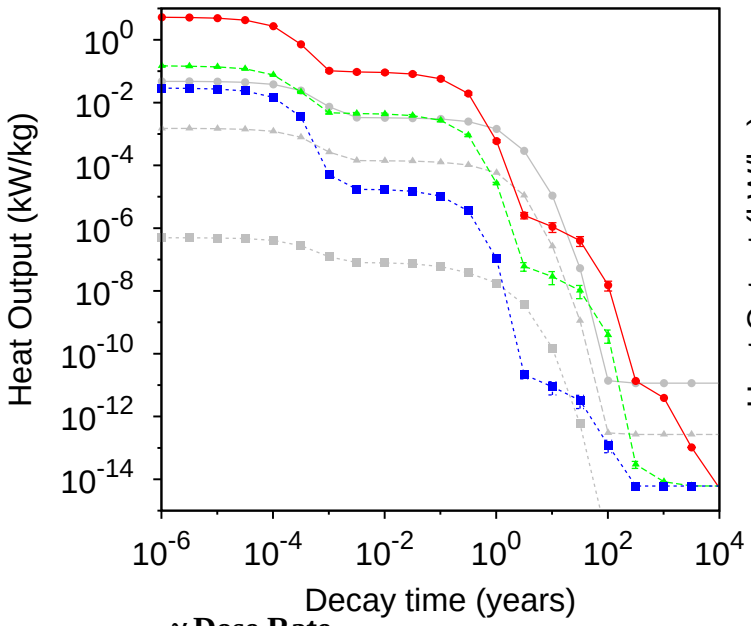
Indium activation characteristics

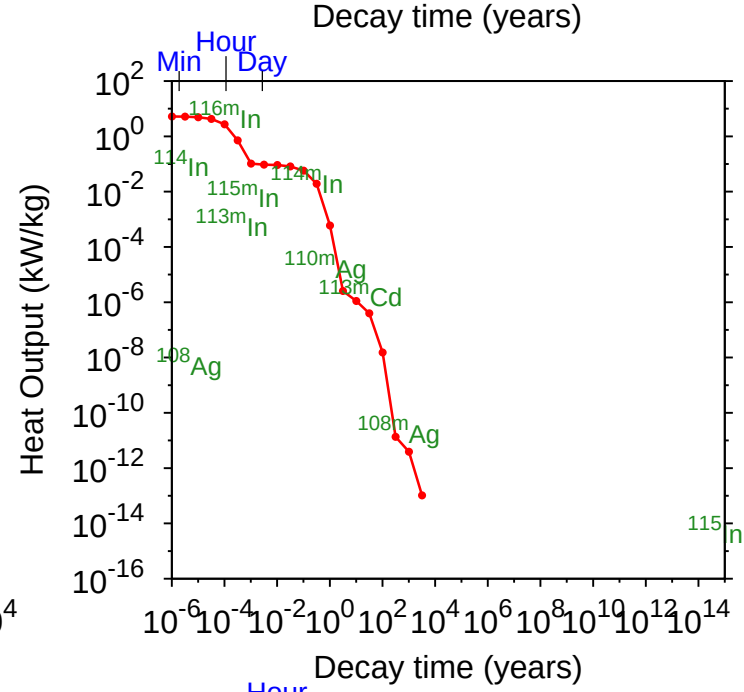
Specific Activity



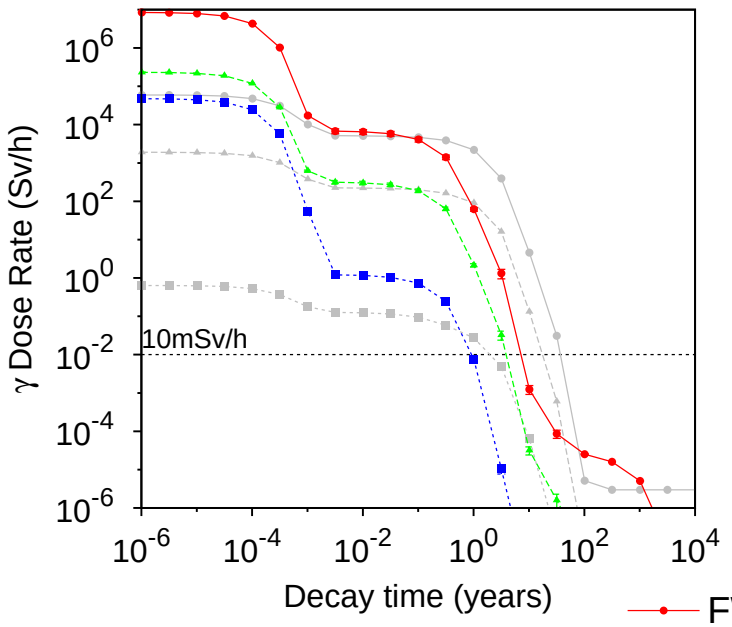


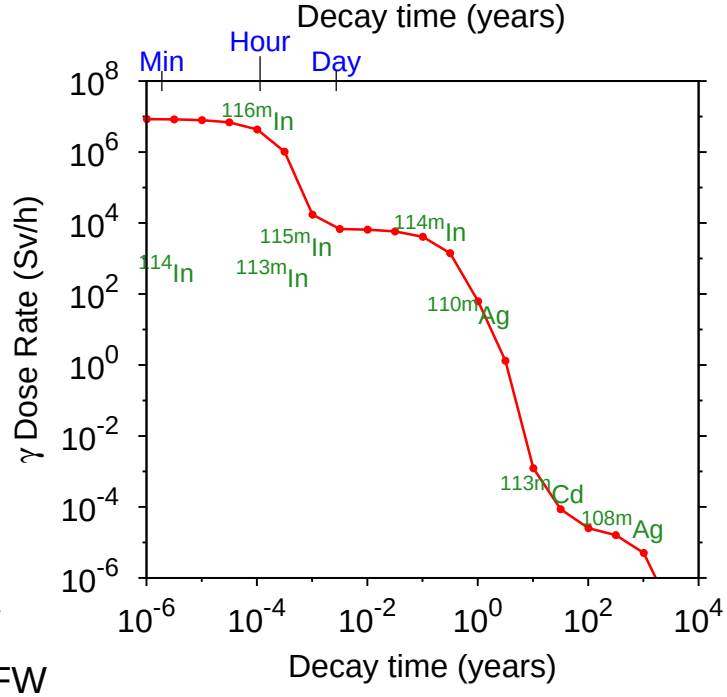
Heat Output





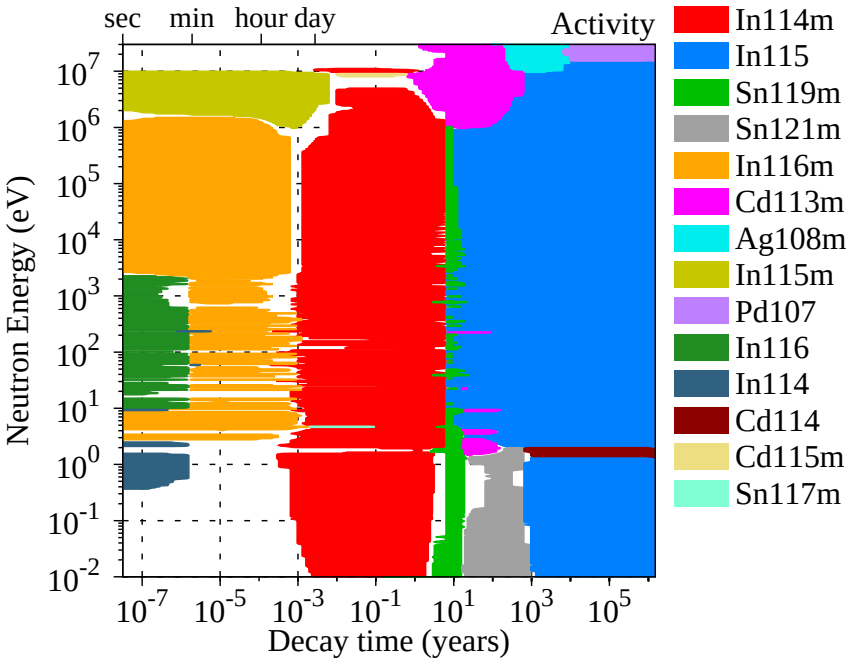
γ Dose Rate

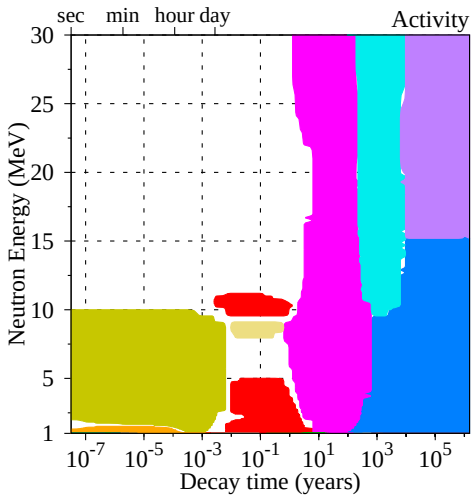


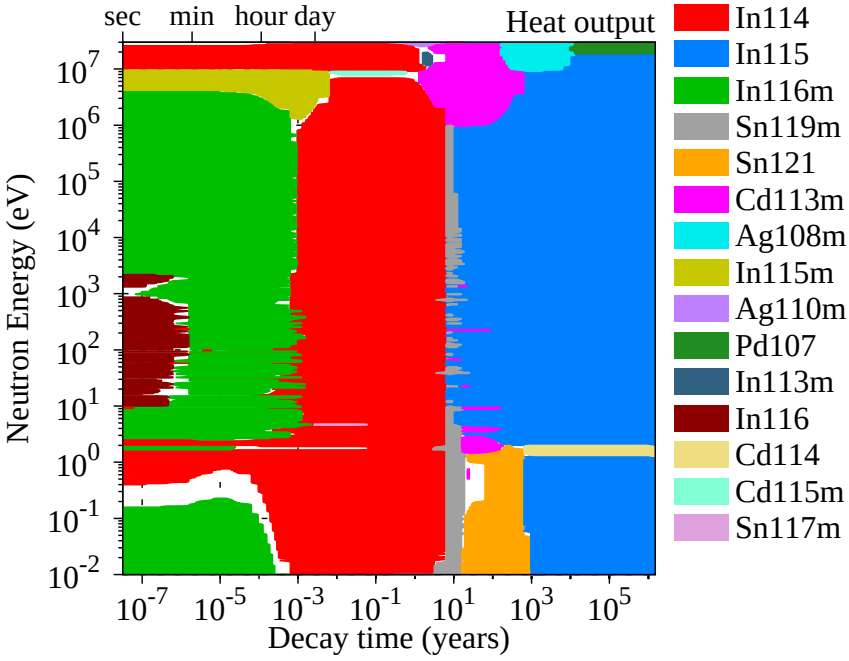


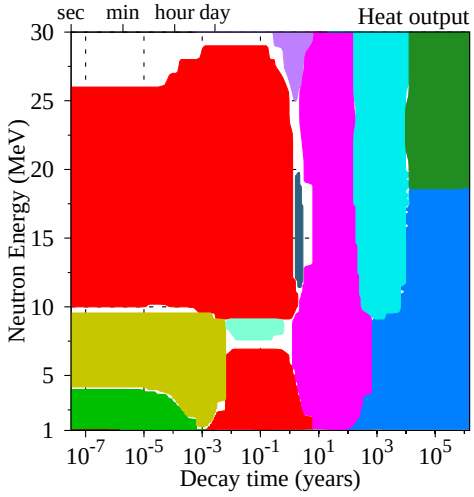
FW
Blanket
Manifold
Fe results

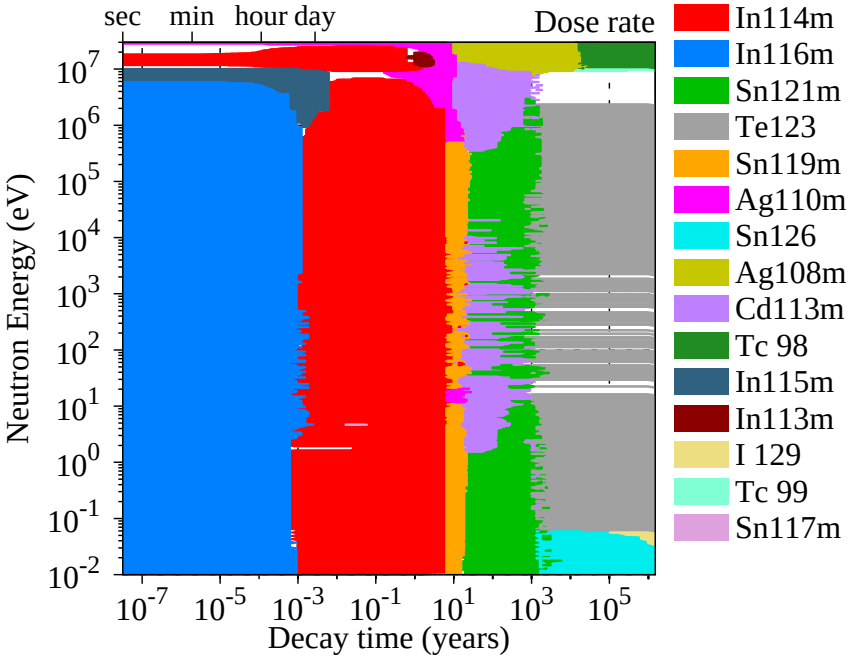
Indium Importance diagrams

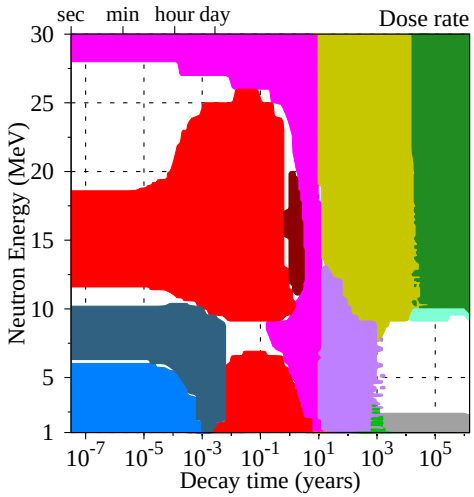




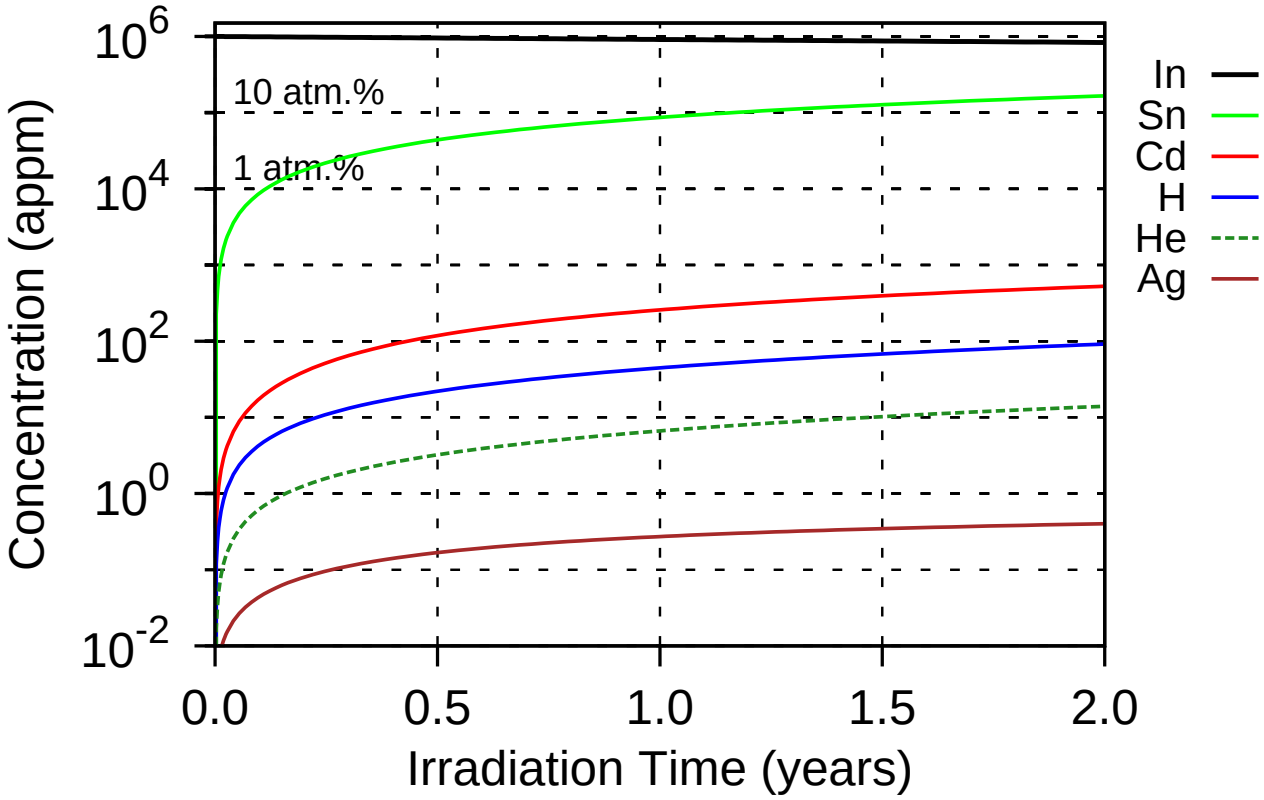






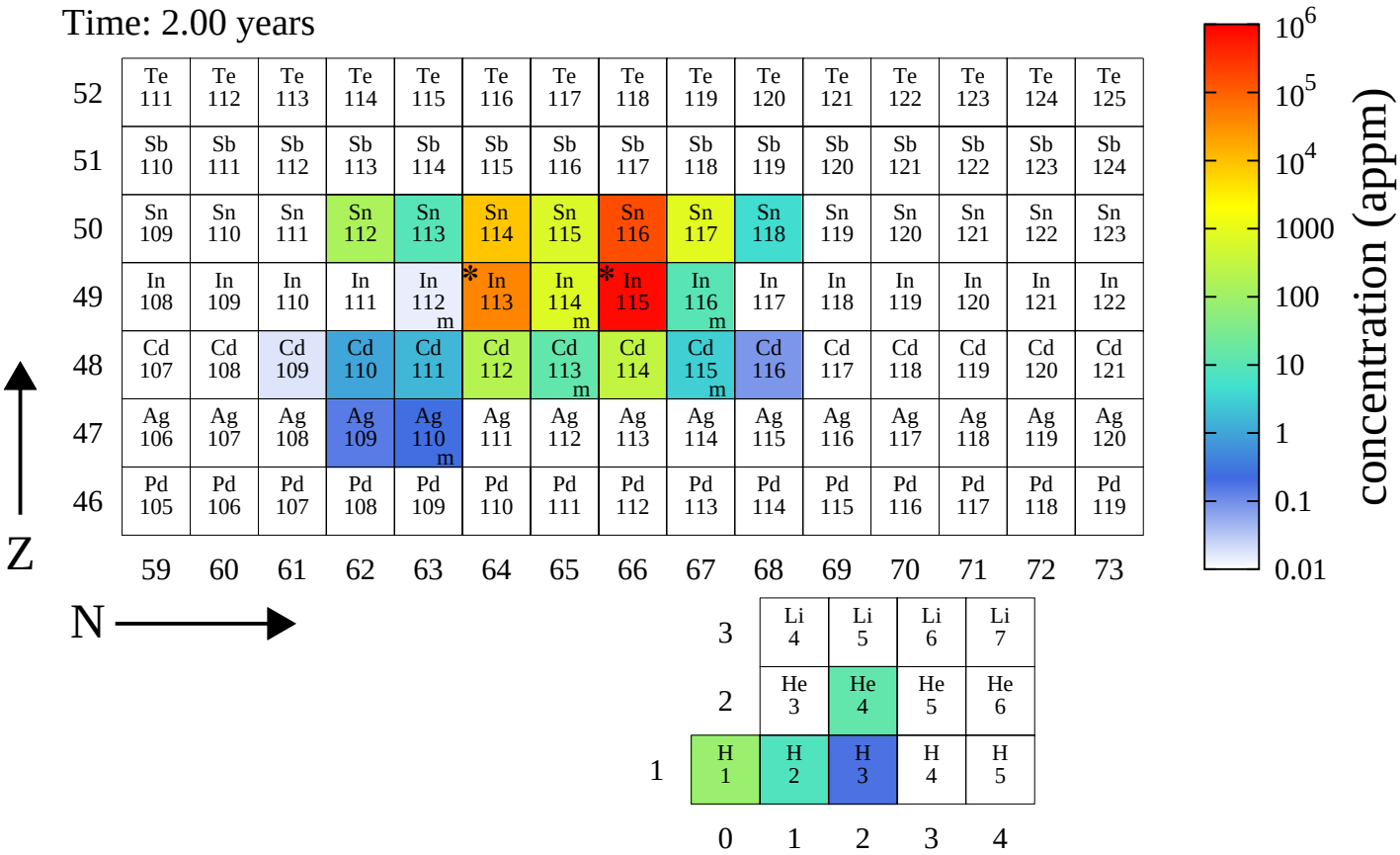


Indium FW Transmutation

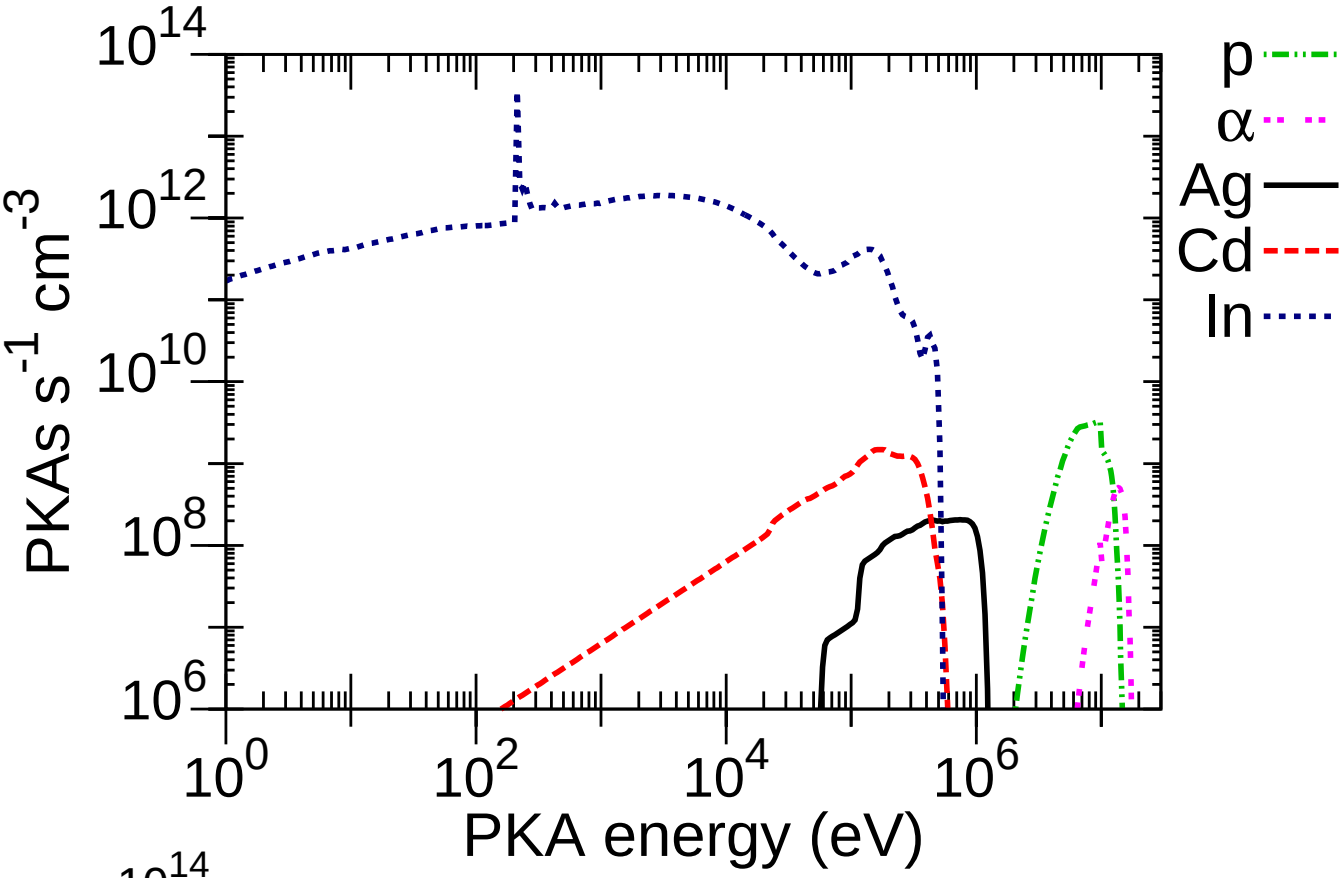


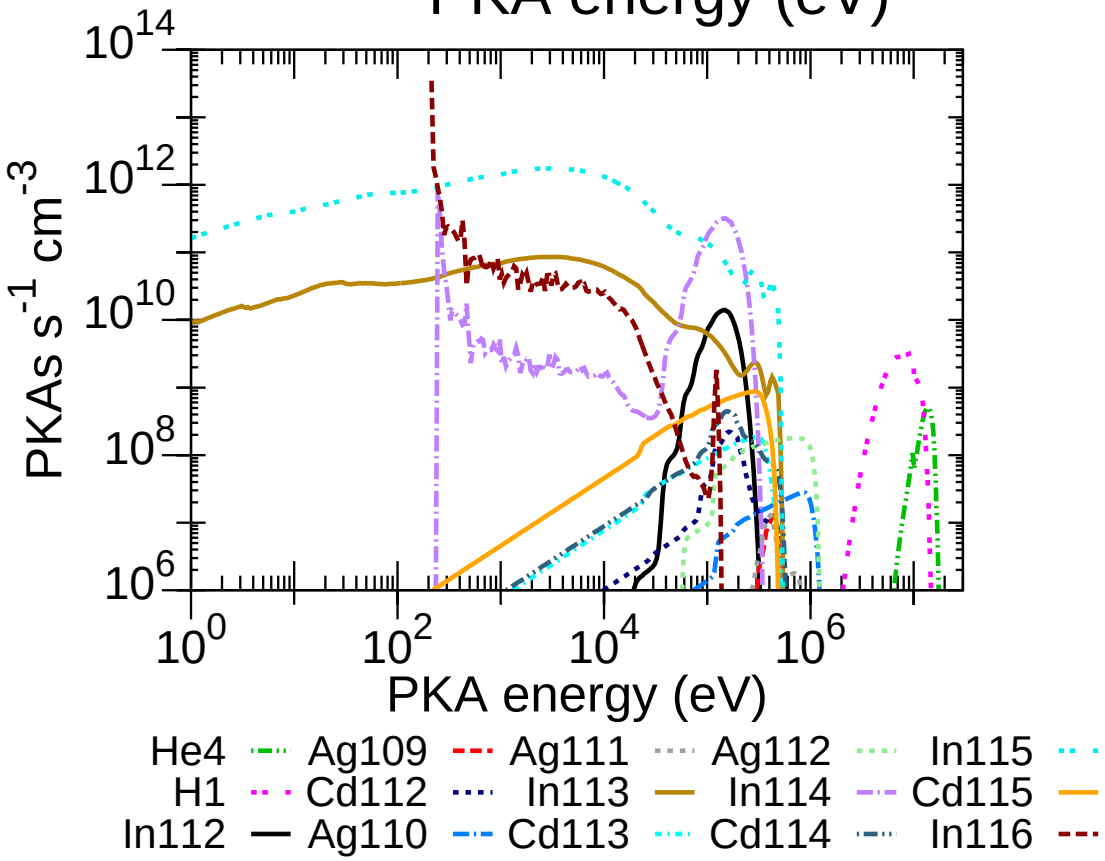
7 appm He & 45 appm H after 1 year

16 dpa/year



Indium FW PKA distributions





Indium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
In116n	2.17s	In113(n,γ)In114m(n,γ)In115(n,γ)In116n	91.7			
		In113(n,γ)In114m(n,γ)In115m(IT)In115(n,γ)In116n	8.2			
		In115(n,γ)In116n		100.0	100.0	99.4
In116	14.20s	In113(n,γ)In114m(n,γ)In115m(n,γ)In116	84.3			
		In113(n,γ)In114m(n,γ)In115(n,γ)In116m(n,E)In116	13.0			
		In113(n,γ)In114m(n,γ)In115m(IT)In115(n,γ) In116m(n,E)In116	1.2			
		In115(n,γ)In116		100.0	100.0	98.7
In114	1.20m	In113(n,γ)In114m(IT)In114	62.4	75.5	79.6	
		In113(n,γ)In114	35.9	22.2	18.2	
		In113(n,γ)In114m(n,E)In114	1.7	2.3	2.1	
		In115(n,2n)In114m(IT)In114				82.4
		In115(n,2n)In114				15.6
		In115(n,2n)In114m(n,E)In114				1.4
Sn113m	20.90m	In115(n,2n)In114m(IT)In114(β^-)Sn114(n,2n)Sn113m				80.8
		In115(n,2n)In114(β^-)Sn114(n,2n)Sn113m				17.0
		In115(n,2n)In114m(n,E)In114(β^-)Sn114(n,2n)Sn113m				1.3
In116m	54.60m	In113(n,γ)In114m(n,γ)In115(n,γ)In116m	88.2			
		In113(n,γ)In114m(n,γ)In115m(IT)In115(n,γ)In116m	7.9			
		In113(n,γ)In114m(n,γ)In115(n,γ)In116n(IT)In116m	3.5			
		In115(n,γ)In116m		82.0	68.9	61.4
		In115(n,γ)In116n(IT)In116m		18.0	31.1	38.0
In113m	1.66h	In113(n,n$'$)In113m			100.0	4.4
		In115(n,2n)In114m(IT)In114(β^-)Sn114(n,2n)Sn113m(IT) Sn113(β^+)In113m				62.5
		In115(n,2n)In114(β^-)Sn114(n,2n)Sn113m(IT)Sn113(β^+)In113m				13.5
		In115(n,2n)In114m(IT)In114(β^-)Sn114(n,2n)Sn113(β^+)In113m				12.8
		In115(n,2n)In114(β^-)Sn114(n,2n)Sn113(β^+)In113m				2.8
		In115(n,2n)In114m(n,2n)In113m				1.7
		In115(n,2n)In114m(n,E)In114(β^-)Sn114(n,2n)Sn113m(IT) Sn113(β^+)In113m				1.0
In115m	4.49h	In113(n,γ)In114m(n,γ)In115m	98.9	84.2		
		In113(n,γ)In114m(β^+)Cd114(n,γ)Cd115(β^-)In115m		13.3		
		In113(n,γ)In114m(IT)In114(β^+)Cd114(n,γ)Cd115(β^-)In115m		1.8		
		In115(n,n$'$)In115m			100.0	96.1
		In115(n,p)Cd115(β^-)In115m				3.3
Sn121	1.12d	no pathways found				
Sn117m	13.60d	In115(n,γ)In116m(β^-)Sn116(n,γ)Sn117m	95.3	69.0	59.0	58.4
		In115(n,γ)In116n(IT)In116m(β^-)Sn116(n,γ)Sn117m	3.8	15.1	26.6	36.1
		In115(n,γ)In116(β^-)Sn116(n,γ)Sn117m		15.8	11.0	4.0
		In115(n,γ)In116m(β^-)Sn116(n,γ)Sn117(n,n$'$)Sn117m			2.1	
Cd115m	44.45d	In113(n,γ)In114m(β^+)Cd114(n,γ)Cd115m	81.5	84.2	83.1	
		In113(n,γ)In114m(IT)In114(β^+)Cd114(n,γ)Cd115m	11.2	11.6	11.5	
		In113(n,γ)In114(β^+)Cd114(n,γ)Cd115m	6.9	3.8	2.9	
		In115(n,p)Cd115m			1.7	99.5
In114m	49.98d	In113(n,γ)In114m	100.0	100.0	100.0	
		In115(n,2n)In114m				99.4
Sn113	115.08d	In115(n,2n)In114m(IT)In114(β^-)Sn114(n,2n)Sn113m(IT)Sn113				66.9
		In115(n,2n)In114(β^-)Sn114(n,2n)Sn113m(IT)Sn113				14.4
		In115(n,2n)In114m(IT)In114(β^-)Sn114(n,2n)Sn113				13.7
		In115(n,2n)In114(β^-)Sn114(n,2n)Sn113				3.0
		In115(n,2n)In114m(n,E)In114(β^-)Sn114(n,2n) Sn113m(IT)Sn113				1.1
Ag110m	249.77d	In113(n,α)Ag110m			99.1	95.9
Sn119m	293.01d	no pathways found				
H3	12.33y	In113(n,γ)In114m(n,p)H1(n,γ)H2(n,γ)H3	99.0			
		In115(n,t)H3				41.1
		In113(n,t)H3				2.2
		In115(n,2n)In114m(n,t)H3				6.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cd113m	14.60y	In113(n,γ)In114m(n,γ)In115m(β^-)Sn115(n,α) Cd112(n,γ)Cd113m	51.4	2.1		
		In113(n,γ)In114m(IT)In114(β^-)Sn114(n,γ)Sn115(n,α) Cd112(n,γ)Cd113m	25.6	61.6		
		In113(n,γ)In114(β^-)Sn114(n,γ)Sn115(n,α)Cd112(n,γ)Cd113m	17.3	25.5		
		In113(n,γ)In114m(n,α)Ag111m(IT)Ag111(β^-)Cd111(n,γ) Cd112(n,γ)Cd113m	3.8	6.2		
		In113(n,γ)In114m(n,E)In114(β^-)Sn114(n,γ)Sn115(n,α) Cd112(n,γ)Cd113m		1.9		
		In113(n,γ)In114m(n,α)Ag111(β^-)Cd111(n,γ)Cd112(n,γ)Cd113m		1.7		
		In113(n,p)Cd113m			98.6	47.3
		In115(n,2n)In114m(β^+)Cd114(n,2n)Cd113m				38.6
		In115(n,2n)In114m(IT)In114(β^+)Cd114(n,2n)Cd113m				5.3
		In115(n,np)Cd114(n,2n)Cd113m				1.6
		In115(n,2n)In114m(n,np)Cd113m				1.5
		In115(n,d)Cd114(n,2n)Cd113m				1.3
		In115(n,2n)In114(β^+)Cd114(n,2n)Cd113m				1.2
Sn121m	43.90y	no pathways found				
Ag108m	417.97y	In113(n,nα)Ag109m(IT)Ag109(n,2n)Ag108m				51.7
		In113(n,nα)Ag109(n,2n)Ag108m				14.7
		In113(n,2n)In112m(IT)In112(β^-)Sn112(n,α)Cd109(β^+) Ag109m(IT)Ag109(n,2n)Ag108m				12.9
		In113(n,α)Ag110m(n,2n)Ag109m(IT)Ag109(n,2n)Ag108m				5.2
		In113(n,2n)In112(β^-)Sn112(n,α)Cd109(β^+)Ag109m(IT) Ag109(n,2n)Ag108m				2.9
		In113(n,2n)In112m(IT)In112(β^+)Cd112(n,α)Pd109m(IT) Pd109(β^-)Ag109m(IT)Ag109(n,2n)Ag108m				2.5
		In113(n,2n)In112m(IT)In112(β^+)Cd112(n,α)Pd109(β^-) Ag109m(IT)Ag109(n,2n)Ag108m				2.2
		In113(n,α)Ag110(β^-)Cd110(n,2n)Cd109(β^+)Ag109m(IT) Ag109(n,2n)Ag108m				1.7
		In113(n,α)Ag110m(n,2n)Ag109(n,2n)Ag108m				1.0
Tc99	2.1 10^5y	no pathways found				
Sn126	2.3 10^5y	no pathways found				
Tc98	4.3 10^6y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Pd107	6.5 10^6y	In113(n,α)Ag110m(n,α)Rh107(β^-)Pd107			54.8	12.5
		In113(n,α)Ag110(β^-)Cd110(n,α)Pd107			33.6	16.5
		In113(n,α)Ag110m(β^-)Cd110(n,α)Pd107			6.6	7.0
		In113(n,α)Ag110(β^-)Cd110(n,α)Pd107m(IT)Pd107			2.6	11.1
		In113(n,α)Ag110m(β^-)Cd110(n,α)Pd107m(IT)Pd107				4.7
		In113(n,2n)In112m(IT)In112(β^-)Sn112(n,2n)Sn111(β^+) In111(β^+)Cd111(n,nα)Pd107				2.4
		In113(n,2n)In112m(IT)In112(β^-)Sn112(n,2n)Sn111(β^+) In111(β^+)Cd111(n,α)Pd108(n,2n)Pd107				2.1
		In113(n,2n)In112m(IT)In112(β^+)Cd112(n,2n) Cd111(n,nα)Pd107				1.8
		In113(n,2n)In112m(IT)In112(β^+)Cd112(n,2n)Cd111m(IT) Cd111(n,nα)Pd107				1.8
		In113(n,2n)In112m(IT)In112(β^-)Sn112(n,2n)Sn111(β^+) In111(β^+)Cd111(n,2n)Cd110(n,α)Pd107				1.7
		In113(n,2n)In112m(IT)In112(β^+)Cd112(n,2n)Cd111(n,α) Pd108(n,2n)Pd107				1.6
		In113(n,2n)In112m(IT)In112(β^+)Cd112(n,2n)Cd111m(IT) Cd111(n,α)Pd108(n,2n)Pd107				1.6
		In113(n,2n)In112m(IT)In112(β^-)Sn112(n,2n)Sn111(β^+) In111(β^+)Cd111(n,nα)Pd107m(IT)Pd107				1.5
		In113(n,2n)In112m(IT)In112(β^+)Cd112(n,2n)Cd111(n,2n) Cd110(n,α)Pd107				1.3
		In113(n,2n)In112m(IT)In112(β^+)Cd112(n,2n)Cd111m(IT) Cd111(n,2n)Cd110(n,α)Pd107				1.2
		In113(n,2n)In112m(IT)In112(β^+)Cd112(n,2n)Cd111(n,nα) Pd107m(IT)Pd107				1.2
		In113(n,2n)In112m(IT)In112(β^-)Sn112(n,2n)Sn111(β^+) In111(β^+)Cd111(n,α)Pd108(n,2n)Pd107m(IT)Pd107				1.2
		In113(n,2n)In112m(IT)In112(β^+)Cd112(n,2n)Cd111m(IT) Cd111(n,nα)Pd107m(IT)Pd107				1.1
		In113(n,2n)In112m(IT)In112(β^-)Sn112(n,2n)Sn111(β^+) In111(β^+)Cd111(n,2n)Cd110(n,α)Pd107m(IT)Pd107				1.1
I129	1.6 10^7y	no pathways found				
In115	4.4 10^{14}y	In113(n,γ)In114m(n,γ)In115	91.7			
		In113(n,γ)In114m(n,γ)In115m(IT)In115	8.2			
Te123	9.2 10^{16}y	no pathways found				
Cd114	6.0 10^{17}y	In113(n,γ)In114m(β^+)Cd114	81.5	84.2	84.5	
		In113(n,γ)In114m(IT)In114(β^+)Cd114	11.2	11.6	11.6	
		In113(n,γ)In114(β^+)Cd114	6.9	3.8	2.9	
		In115(n,2n)In114m(β^+)Cd114				80.1
		In115(n,2n)In114m(IT)In114(β^+)Cd114				11.0
		In115(n,np)Cd114				3.1
		In115(n,d)Cd114				2.5
		In115(n,2n)In114(β^+)Cd114				2.3

Tin

Isotope	Atom % abundance
Sn112	0.97
Sn114	0.66
Sn115	0.34
Sn116	14.54
Sn117	7.68
Sn118	24.22
Sn119	8.59
Sn120	32.58
Sn122	4.63
Sn124	5.79

($T_{1/2}$ =1.0 10^{17}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.41E+14	3.32E+14	2.39E+14	4.83E+13	2.68E+11	6.27E+02
Sn117m	30.4	31.2	35.9			
Sn119m	25.3	26.0	35.7	75.2		
Sn121	11.1	11.4	1.9	1.2	43.7	
Sn123	9.2	9.5	12.9	9.2		
Sn123m	4.9	4.6				
In113m	3.2	3.3	4.5	2.5		
Sn113	3.2	3.3	4.5	2.5		
Sn125m	2.8	1.9				
Sn113m	2.0	1.7				
In111	1.4	1.5	0.8			
Sn111	1.4	1.3				
Sb125	1.1	1.1	1.6	6.0		
Sn121m	0.2	0.2	0.3	1.5	56.3	
Te125m	0.2	0.2	0.3	1.4		
Sn126						35.5
Sb126m	0.2	0.2				35.5
Sb126n	0.1					23.8
Sb126						5.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.81E-02	1.65E-02	1.02E-02	1.27E-03	3.16E-06	1.01E-13
Sn117m	28.7	31.6	42.5			
Sn123	14.7	16.2	25.7	29.6		
Sn125m	9.5	7.2				
Sn123m	9.2	9.2				
Sn119m	6.8	7.5	12.1	41.1		
Sn121	3.9	4.2	0.8	0.8	68.8	
In113m	3.8	4.2	6.7	6.0		
In116m	2.9	3.0				
Sn111	2.9	2.9				
In120m	2.1					
Sb124	2.1	2.3	3.6	0.4		
In111	1.9	2.1	1.4			
Sb125	1.8	2.0	3.2	19.8		
In118m	1.6	0.8				
Sb122	1.6	1.7	1.1			
Sb126m	1.5	1.3				78.1
Te125m	0.1	0.1	0.2	1.2		
Sn121m				0.4	31.1	
Sb126	0.3	0.3	0.4			15.5
Sn126						5.9

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	5.40E+03	4.27E+03	1.80E+03	3.07E+02	3.01E-03	9.75E-08
In116m	16.2	19.2				
Sb124	10.5	13.3	30.3	2.8		
Sn111	9.6	10.9				
In120m	9.0	0.1				
Sn125m	8.2	7.0				
In118m	7.7	4.3				
In113m	6.5	8.2	19.0	12.7		
Sn117m	6.4	8.1	16.0			
Sb125	5.9	7.5	17.6	80.9		
Sb126m	4.9	5.1				79.9
Sb122	2.7	3.4	3.2			
In111	1.8	2.3	2.3			
Sb126	1.3	1.6	3.1			20.0
Sn123	1.2	1.5	3.4	2.9		
Sb120m	1.1	1.3	2.0			
Sn123m	1.0	1.2				
Sn125	1.0	1.2	2.2			
In117	0.9	1.1				
Sn121m					96.1	
Ag108m					3.9	

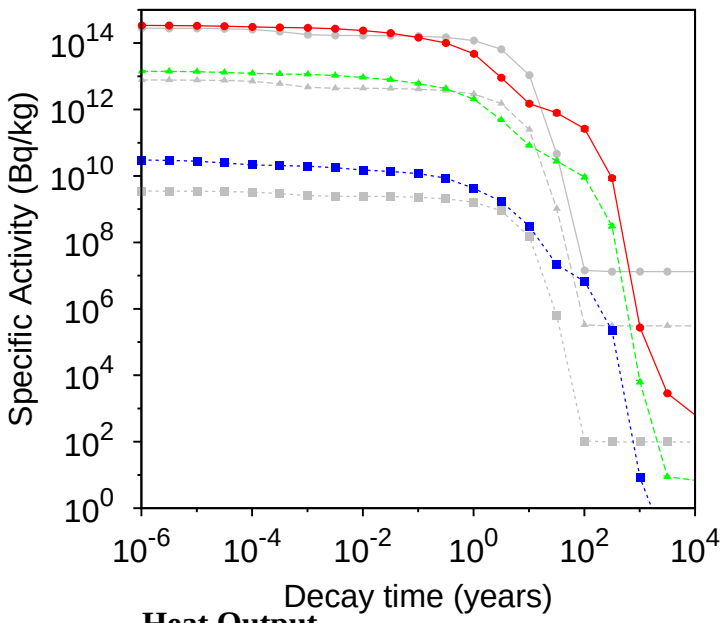
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	9.61E+06	6.76E+06	1.78E+05	2.73E+04	8.70E+01	3.75E-05
Sn125m	88.8	86.2				
Sn113m	9.0	10.8				
Sn117m	0.8	1.1	34.3			
Sn123	0.7	1.0	36.4	34.0		
Sn119m	0.3	0.4	16.4	45.3		
Sn113	0.1	0.1	4.4	3.3		
Sb125		0.1	2.3	11.8		
Sb124			1.4	0.1		
In114m			1.1			
Te125m			0.4	2.2		
Cd113m			0.2	1.1	3.1	
Sn121m			0.2	1.0	65.9	
Sn121	0.1	0.1	0.6	0.5	31.0	
Sn124						97.0
Sn126						2.8

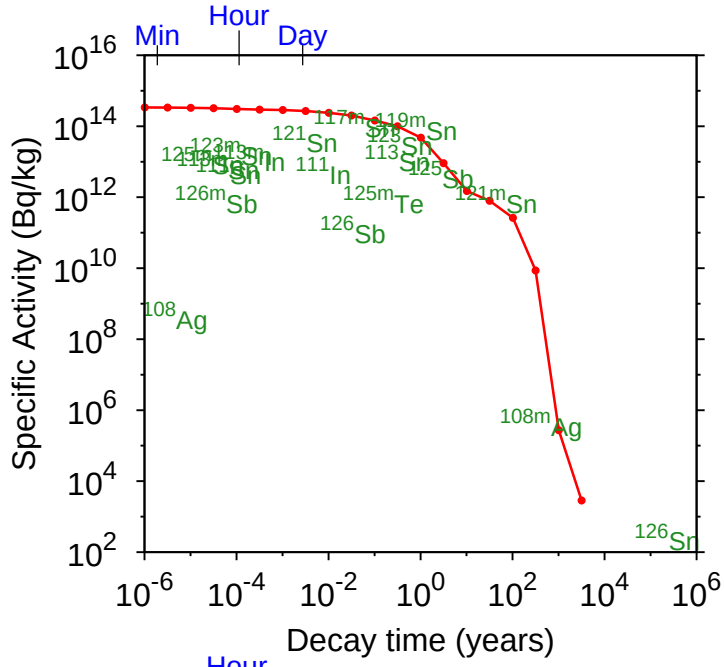
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.62E+07	1.15E+07	7.45E+05	1.63E+05	7.19E+02	1.40E-04
Sn125m	86.8	83.3				
Sn113m	8.2	9.7				
Sn123	1.6	2.2	33.5	22.0		
Sn117m	1.5	2.2	27.7			
Sn119m	1.2	1.6	25.2	49.2		
Sb125	0.3	0.4	6.0	21.5		
Sn113	0.2	0.3	3.9	2.0		
Sb124	0.1	0.1	1.2	0.1		
Sn121m			0.4	2.0	94.4	
Te125m			0.4	1.8		
Sn121	0.1	0.1	0.1	0.1	3.7	
Cd113m			0.2	0.9	1.8	
Sn124						95.5
Sn126						4.5

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	9.17E+10	8.62E+10	6.86E+10	3.15E+10	2.62E+06	4.69E-01
Sb125	40.9	43.5	54.5	92.7		
Sn117m	19.5	20.7	21.6			
Sn113	12.0	12.8	15.7	3.9		
Sn125m	4.5	3.2				
Sn123m	3.5	3.4				
In116m	3.2	3.2				
Sn111	2.7	2.6				
Sn123	2.0	2.1	2.6	0.8		
In120m	1.9					
Sn119m	1.8	1.9	2.4	2.2		
In118m	1.6	0.8				
Sb126m	1.3	1.2				77.9
Sb124	1.2	1.2	1.5	0.1		
Sn121	0.5	0.5	0.1		51.9	
Sn121m					48.0	
Sb126	0.3	0.3	0.4			18.5
Sn126						3.2

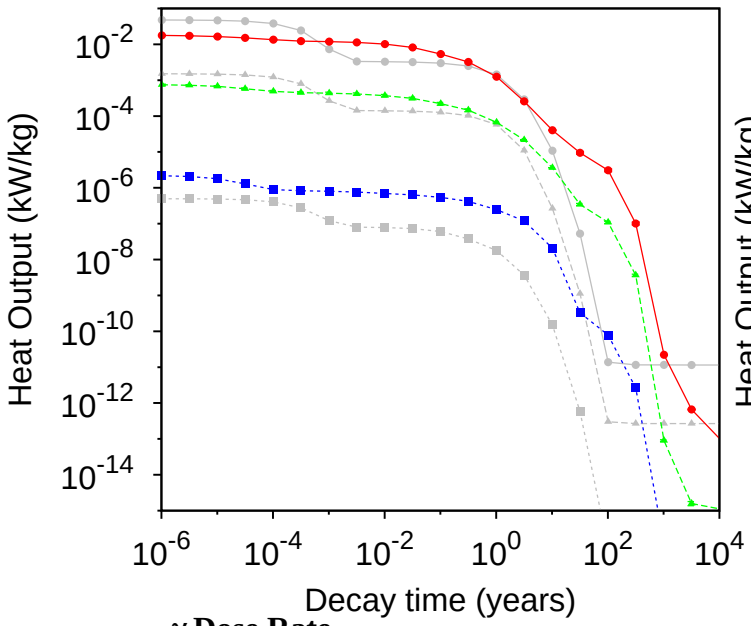
Tin activation characteristics

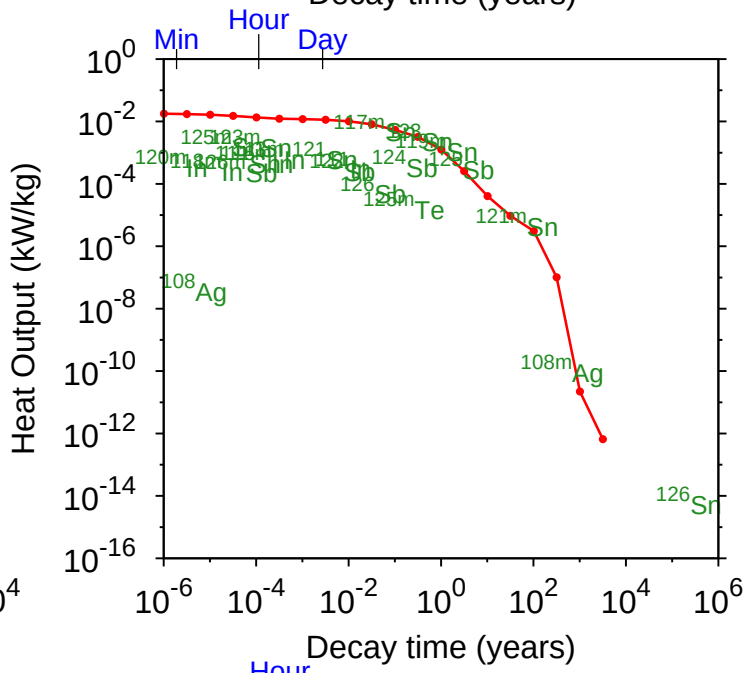
Specific Activity



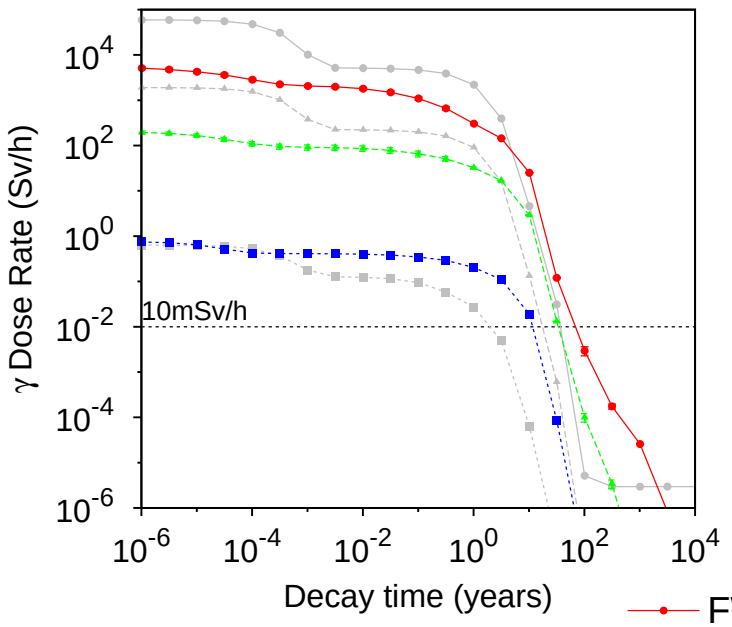


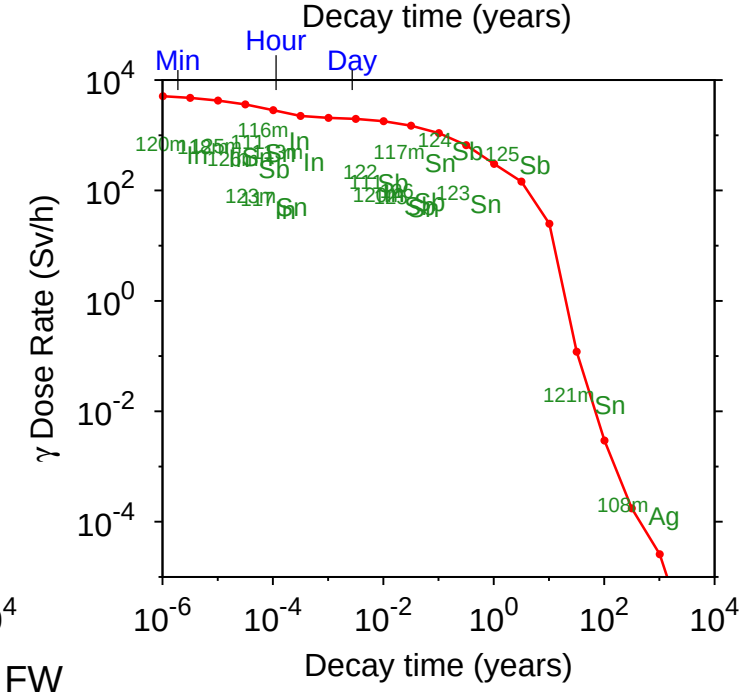
Heat Output





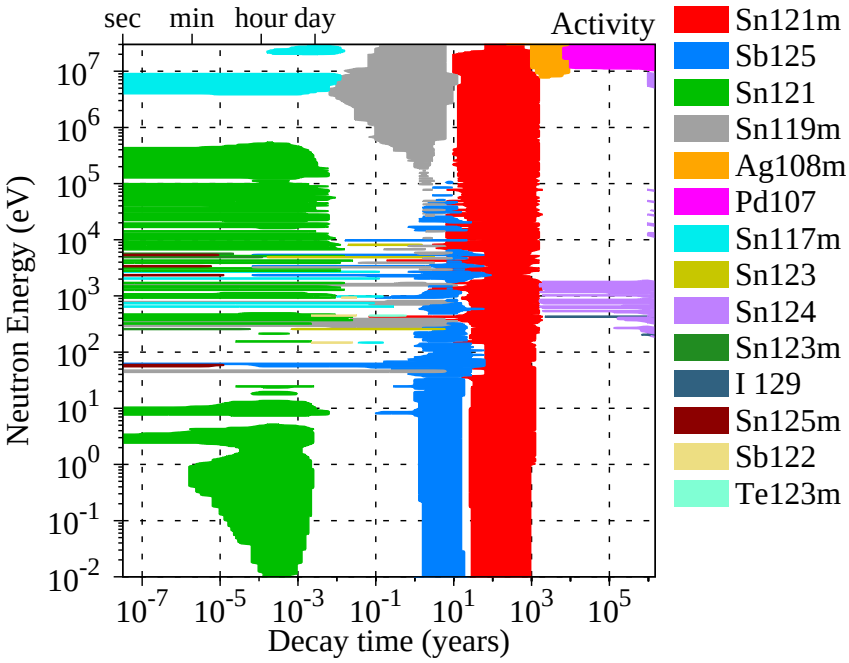
γ Dose Rate

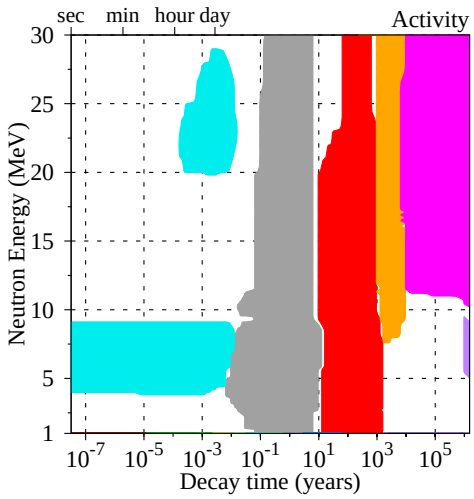


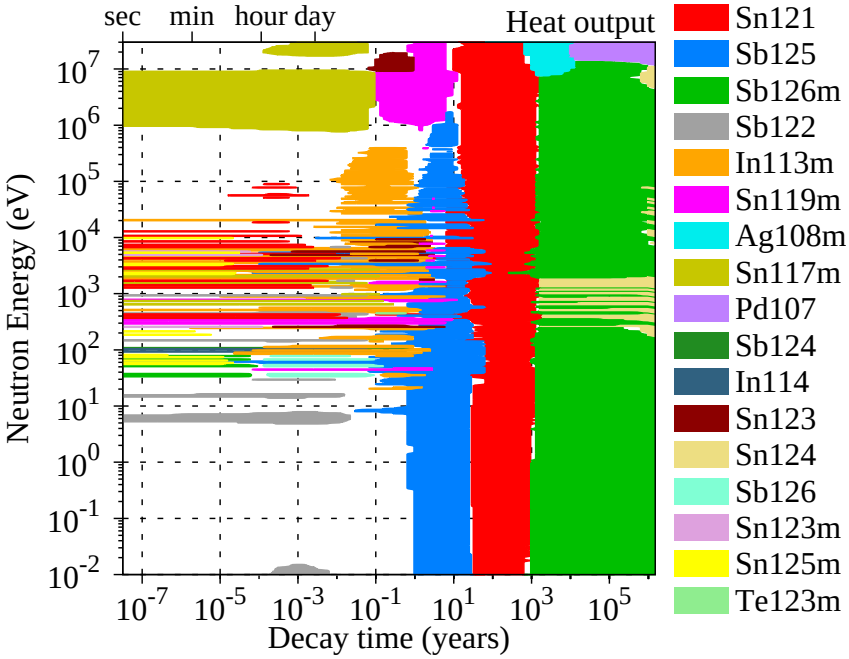


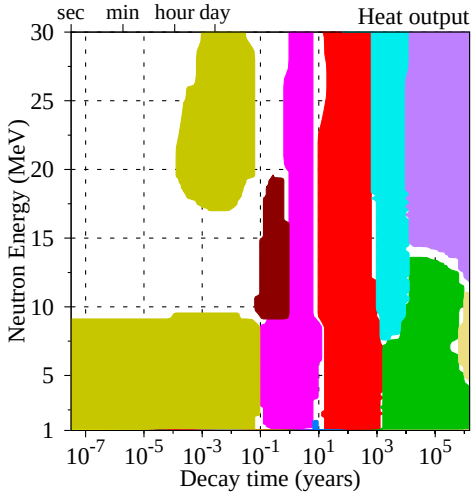
FW
Blanket
Manifold
Fe results

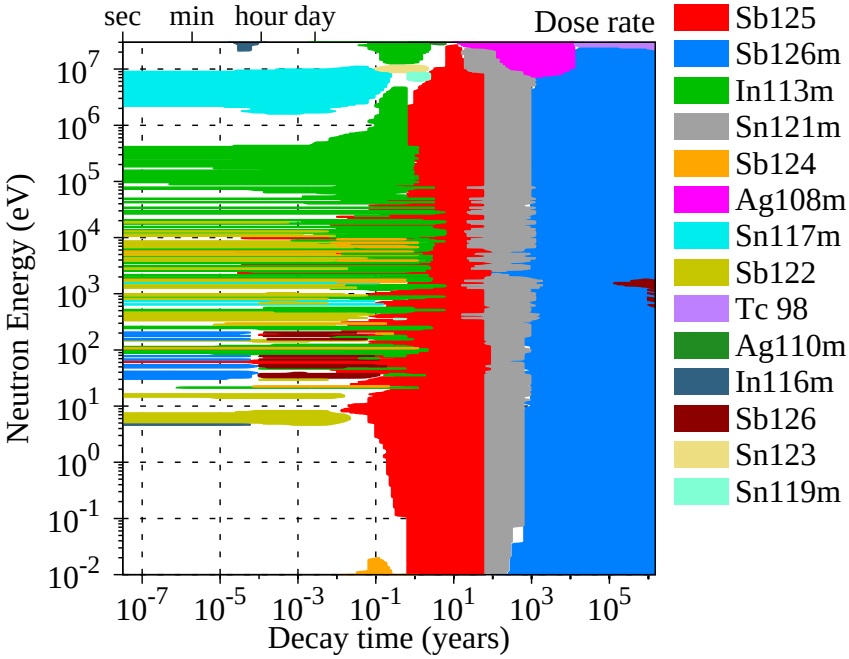
Tin Importance diagrams

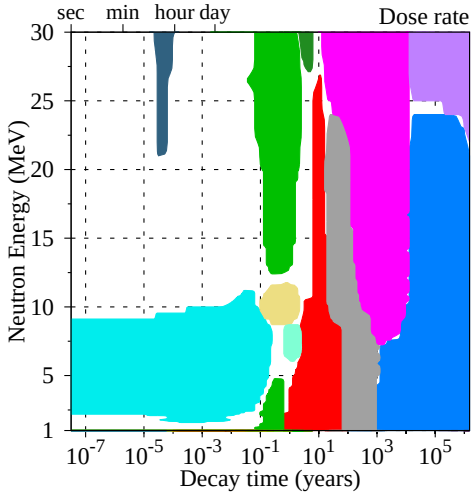




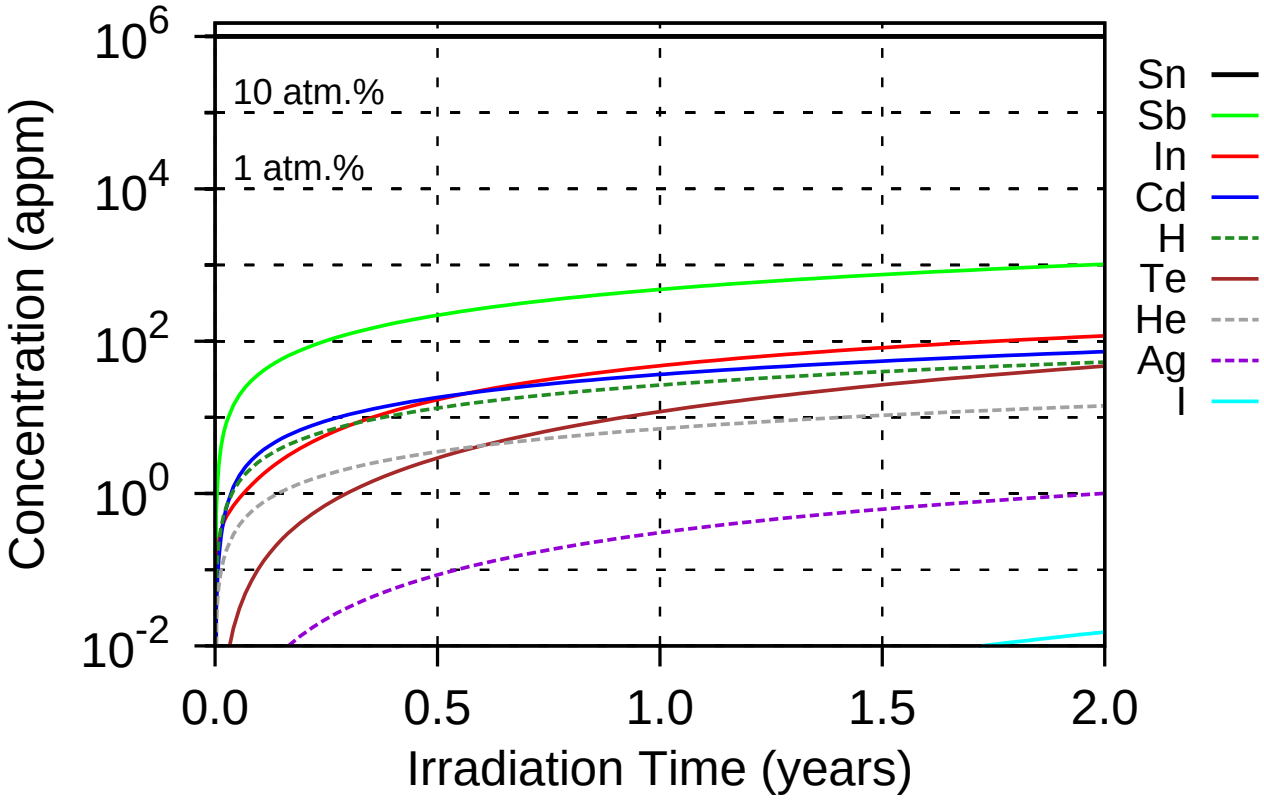






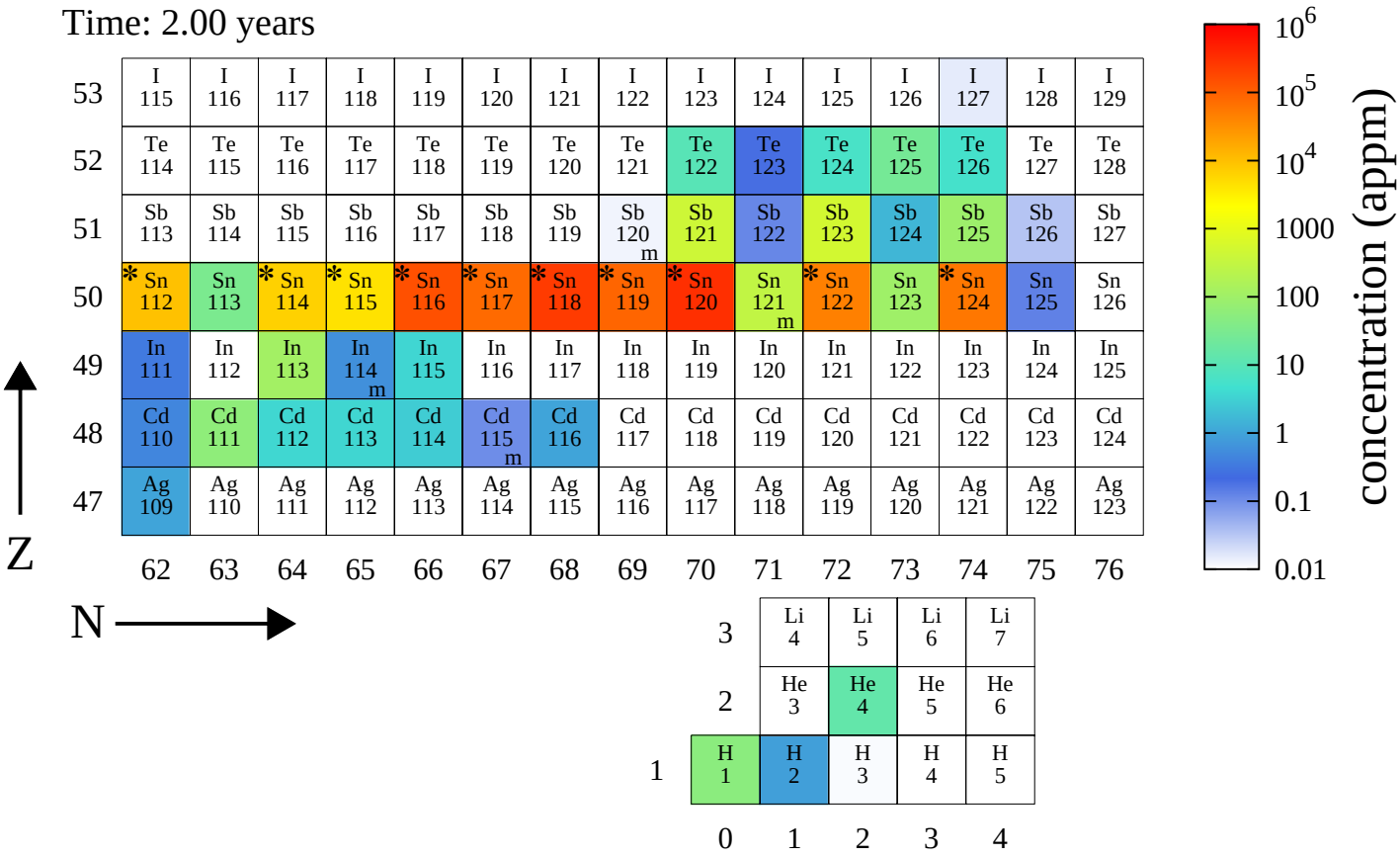


Tin FW Transmutation

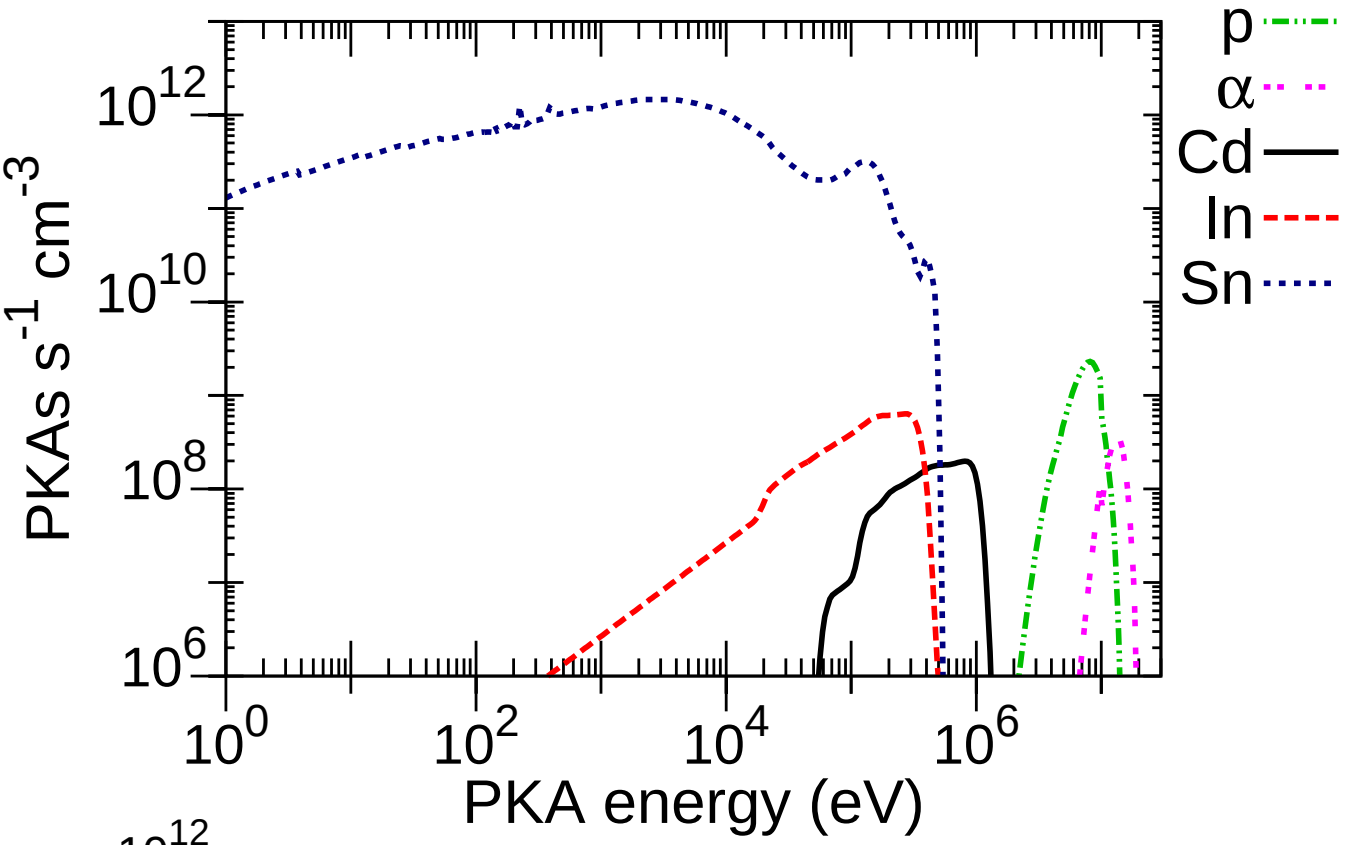


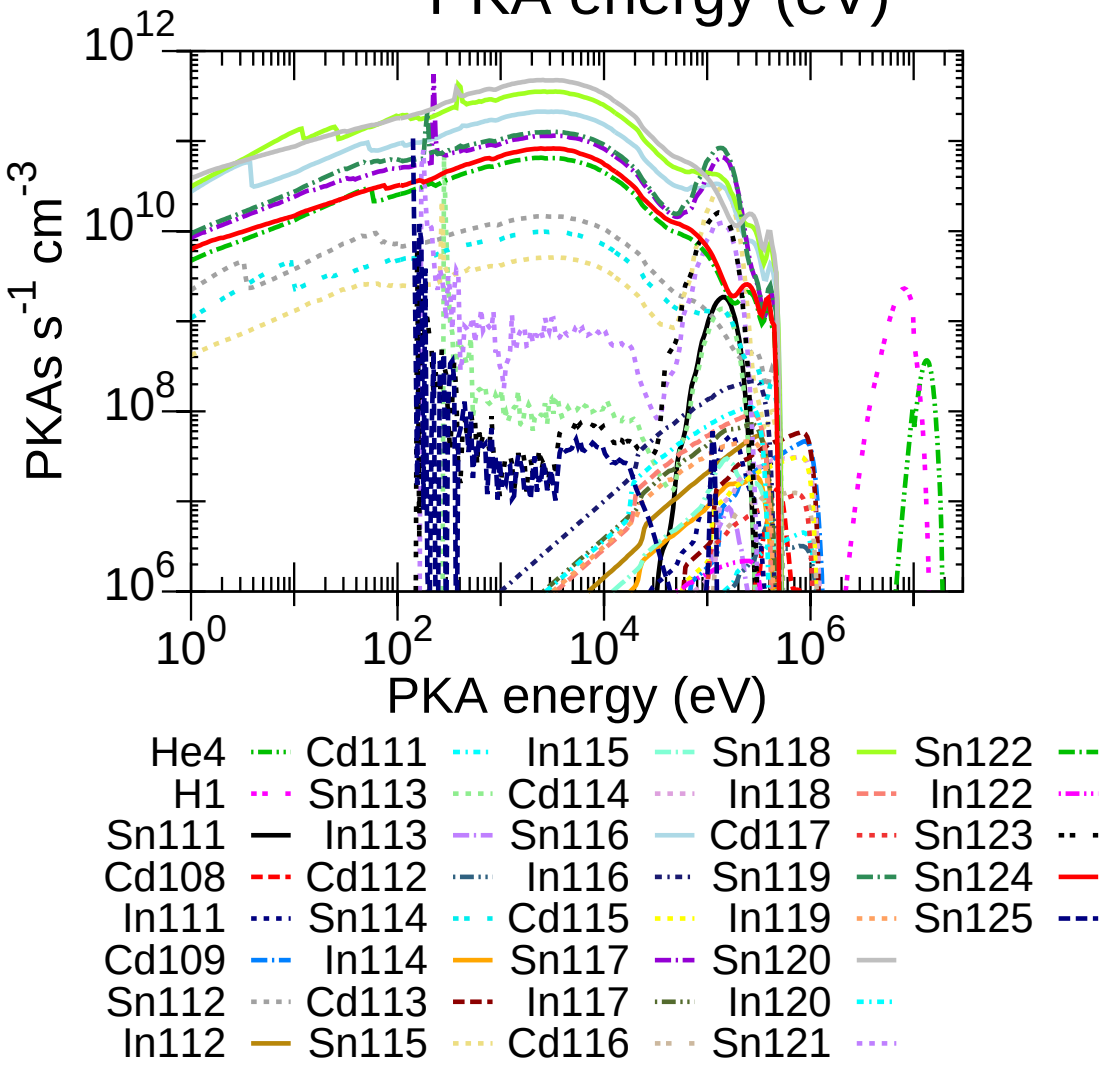
7 appm He & 27 appm H after 1 year

15 dpa/year



Tin FW PKA distributions





Tin Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sb126n	11.00s	Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126n	94.9	92.9	59.5	
		Sn124(n,γ)Sn125(β^-)Sb125(n,γ)Sb126n	4.3	7.1	40.4	
In120m	46.21s	Sn120(n,p)In120m				99.8
In114	1.20m	Sn112(n,γ)Sn113(β^+)In113m(IT)In113(n,γ)In114m(IT)In114	36.6	38.6	23.5	
		Sn112(n,γ)Sn113(β^+)In113m(IT)In113(n,γ)In114	22.8	12.9	6.1	
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,γ) In114m(IT)In114	21.3	30.6	47.9	
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,γ)In114	13.2	10.3	12.5	
		Sn112(n,γ)Sn113m(β^+)In113(n,γ)In114m(IT)In114	2.8	4.0	6.3	
		Sn112(n,γ)Sn113m(β^+)In113(n,γ)In114	1.7	1.3	1.6	
		Sn112(n,γ)Sn113(β^+)In113m(IT)In113(n,γ)In114m(n,E)In114	1.0	1.2		
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,γ) In114m(n,E)In114			1.2	
		Sn114(n,p)In114m(IT)In114				39.8
		Sn114(n,p)In114				17.5
		Sn116(n,2n)Sn115(n,np)In114m(IT)In114				5.4
		Sn116(n,2n)Sn115(n,np)In114				4.0
		Sn118(n,α)Cd115(β^-)In115m(IT)In115(n,2n)In114m(IT)In114				3.5
		Sn118(n,α)Cd115m(β^-)In115(n,2n)In114m(IT)In114				3.4
		Sn116(n,2n)Sn115(n,p)In115(n,2n)In114m(IT)In114				2.3
		Sn116(n,2n)Sn115(n,2n)Sn114(n,p)In114m(IT)In114				2.3
		Sn115(n,np)In114m(IT)In114				1.9
		Sn115(n,p)In115(n,2n)In114m(IT)In114				1.6
		Sn115(n,2n)Sn114(n,p)In114m(IT)In114				1.6
		Sn116(n,2n)Sn115(n,p)In115m(IT)In115(n,2n) In114m(IT)In114				1.4
		Sn116(n,np)In115(n,2n)In114m(IT)In114				1.3
		Sn115(n,np)In114				1.3
		Sn116(n,2n)Sn115(n,2n)Sn114(n,p)In114				1.2
		Sn115(n,p)In115m(IT)In115(n,2n)In114m(IT)In114				1.0
In118m	4.45m	Sn118(n,p)In118m				86.0
		Sn118(n,p)In118n(IT)In118m				9.1
		Sn119(n,2n)Sn118(n,p)In118m				3.1
Sn125m	9.53m	Sn124(n,γ)Sn125m	100.0	100.0	100.0	
Sb126m	19.10m	Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126n(IT)Sb126m	59.5	56.7	32.3	20.5
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126m	35.4	36.2	27.2	14.8
		Sn124(n,γ)Sn125(β^-)Sb125(n,γ)Sb126n(IT)Sb126m	2.7	4.3	22.0	37.5
		Sn124(n,γ)Sn125(β^-)Sb125(n,γ)Sb126m	1.6	2.8	18.5	27.1
Sn113m	20.90m	Sn112(n,γ)Sn113m	100.0	100.0	99.5	
		Sn114(n,2n)Sn113m				88.6
		Sn116(n,2n)Sn115(n,2n)Sn114(n,2n)Sn113m				6.2
		Sn115(n,2n)Sn114(n,2n)Sn113m				4.0
Sn111	35.30m	Sn112(n,2n)Sn111				99.7
Sn123m	40.06m	Sn122(n,γ)Sn123m	99.8	100.0	99.5	
		Sn124(n,2n)Sn123m				99.8

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
In117	43.20m	Sn112(n,γ)Sn113(β^+)In113m(IT)In113(n,γ)In114m(n,γ) In115(n,γ)In116m(n,γ)In117	51.2			
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,γ) In114m(n,γ)In115(n,γ)In116m(n,γ)In117	29.8			
		Sn112(n,γ)Sn113(β^+)In113m(IT)In113(n,γ)In114m(n,γ) In115m(IT)In115(n,γ)In116m(n,γ)In117	4.6			
		Sn112(n,γ)Sn113m(β^+)In113(n,γ)In114m(n,γ)In115(n,γ) In116m(n,γ)In117	3.9			
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,γ) In114m(n,γ)In115m(IT)In115(n,γ)In116m(n,γ)In117	2.7			
		Sn112(n,γ)Sn113(β^+)In113m(IT)In113(n,γ)In114m(n,γ) In115(n,γ)In116n(IT)In116m(n,γ)In117	2.0			
		Sn112(n,γ)Sn113(β^+)In113m(IT)In113(n,γ)In114m(n,γ) In115(n,γ)In116m(n,γ)In117m(IT)In117	2.0			
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,γ) In114m(n,γ)In115(n,γ)In116n(IT)In116m(n,γ)In117	1.2			
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,γ) In114m(n,γ)In115(n,γ)In116m(n,γ)In117m(IT)In117	1.2			
		Sn117(n,p)In117			92.9	57.5
		Sn117(n,p)In117m(IT)In117			5.8	9.4
		Sn118(n,2n)Sn117m(IT)Sn117(n,p)In117				8.3
		Sn118(n,2n)Sn117(n,p)In117				8.3
		Sn120(n,α)Cd117m(β^-)In117				6.4
		Sn120(n,α)Cd117(β^-)In117m(IT)In117				2.2
		Sn118(n,np)In117				1.6
		Sn118(n,2n)Sn117m(IT)Sn117(n,p)In117m(IT)In117				1.4
		Sn118(n,2n)Sn117(n,p)In117m(IT)In117				1.3
In116m	54.60m	Sn112(n,γ)Sn113(β^+)In113m(IT)In113(n,γ)In114m(n,γ) In115(n,γ)In116m	53.2	38.9		
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,γ) In114m(n,γ)In115(n,γ)In116m	30.9	30.8		
		Sn112(n,γ)Sn113(β^+)In113m(IT)In113(n,γ)In114m(n,γ) In115m(IT)In115(n,γ)In116m	4.8	3.7		
		Sn112(n,γ)Sn113m(β^+)In113(n,γ)In114m(n,γ) In115(n,γ)In116m	4.1	4.8		
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,γ) In114m(n,γ)In115m(IT)In115(n,γ)In116m	2.8	2.9		
		Sn112(n,γ)Sn113(β^+)In113m(IT)In113(n,γ)In114m(n,γ) In115(n,γ)In116n(IT)In116m	2.1	8.5		
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,γ) In114m(n,γ)In115(n,γ)In116n(IT)In116m	1.2	6.8		
		Sn112(n,γ)Sn113m(β^+)In113(n,γ)In114m(n,γ)In115(n,γ) In116n(IT)In116m		1.1		
		Sn115(n,p)In115(n,γ)In116m			31.6	
		Sn115(n,p)In115m(IT)In115(n,γ)In116m			15.3	
		Sn115(n,p)In115(n,γ)In116n(IT)In116m			14.2	
		Sn115(n,p)In115m(IT)In115(n,γ)In116n(IT)In116m			6.9	
		Sn116(n,p)In116m				59.8
		Sn116(n,p)In116n(IT)In116m				33.0
		Sn117(n,2n)Sn116(n,p)In116m				3.2
		Sn117(n,2n)Sn116(n,p)In116n(IT)In116m				1.8
In113m	1.66h	Sn112(n,γ)Sn113(β^+)In113m	63.2	55.8	32.9	
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m	36.8	44.2	67.0	
		Sn114(n,2n)Sn113m(IT)Sn113(β^+)In113m				75.6
		Sn114(n,2n)Sn113(β^+)In113m				15.5
		Sn116(n,2n)Sn115(n,2n)Sn114(n,2n)Sn113m(IT) Sn113(β^+)In113m				3.5
		Sn115(n,2n)Sn114(n,2n)Sn113m(IT)Sn113(β^+)In113m				2.7
Sn121	1.12d	Sn120(n,γ)Sn121	96.1	97.0	84.2	
		Sn119(n,γ)Sn120(n,γ)Sn121	3.0			
		Sn120(n,γ)Sn121m(n,E)Sn121		2.5	13.9	
		Sn120(n,γ)Sn121m(IT)Sn121			1.1	
		Sn122(n,2n)Sn121				72.7
		Sn122(n,2n)Sn121m(n,E)Sn121				22.5
		Sn122(n,2n)Sn121m(IT)Sn121				3.3

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sb122	2.70d	Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122	97.6	97.9	86.0	
		Sn119(n,γ)Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122	1.6			
		Sn120(n,γ)Sn121m(n,E)Sn121(β^-)Sb121(n,γ)Sb122		1.4	7.5	
		Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122m(IT)Sb122			4.8	
		Sn124(n,2n)Sn123(β^-)Sb123(n,2n)Sb122				43.1
		Sn124(n,2n)Sn123m(β^-)Sb123(n,2n)Sb122				27.6
		Sn124(n,2n)Sn123(β^-)Sb123(n,2n)Sb122m(IT)Sb122				17.8
		Sn124(n,2n)Sn123m(β^-)Sb123(n,2n)Sb122m(IT)Sb122				11.4
In111	2.81d	Sn112(n,2n)Sn111(β^+)In111				96.7
		Sn112(n,np)In111				2.4
Sb120m	5.76d	Sn122(n,2n)Sn121(β^-)Sb121(n,2n)Sb120m				83.0
		Sn122(n,2n)Sn121m(n,E)Sn121(β^-)Sb121(n,2n)Sb120m				13.2
		Sn122(n,2n)Sn121m(IT)Sn121(β^-)Sb121(n,2n)Sb120m				1.9
Sn125	9.64d	Sn124(n,γ)Sn125	100.0	100.0	100.0	100.0
Sb126	12.40d	Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126n(IT)Sb126m(IT)Sb126	57.2	50.9	14.1	5.9
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126m(IT)Sb126	34.0	32.6	11.9	4.2
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126	3.7	9.4	33.5	25.2
		Sn124(n,γ)Sn125(β^-)Sb125(n,γ)Sb126n(IT)Sb126m(IT)Sb126	2.6	3.9	9.6	10.8
		Sn124(n,γ)Sn125(β^-)Sb125(n,γ)Sb126m(IT)Sb126	1.5	2.5	8.1	7.8
		Sn124(n,γ)Sn125(β^-)Sb125(n,γ)Sb126			22.7	46.1
Sn117m	13.60d	Sn116(n,γ)Sn117m	97.8	99.9	9.6	
		Sn115(n,γ)Sn116(n,γ)Sn117m	2.2			
		Sn117(n,n′)Sn117m			89.7	5.7
		Sn118(n,2n)Sn117m				88.8
		Sn119(n,2n)Sn118(n,2n)Sn117m				3.1
In114m	49.98d	Sn112(n,γ)Sn113(β^+)In113m(IT)In113(n,γ)In114m	60.3	52.7	30.3	
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,γ)In114m	35.1	41.8	61.6	
		Sn112(n,γ)Sn113m(β^+)In113(n,γ)In114m	4.6	5.4	8.1	
		Sn114(n,p)In114m				57.5
		Sn116(n,2n)Sn115(n,np)In114m				7.7
		Sn118(n,α)Cd115(β^-)In115m(IT)In115(n,2n)In114m				5.0
		Sn118(n,α)Cd115m(β^-)In115(n,2n)In114m				4.9
		Sn116(n,2n)Sn115(n,p)In115(n,2n)In114m				3.4
		Sn116(n,2n)Sn115(n,2n)Sn114(n,p)In114m				3.3
		Sn115(n,np)In114m				2.7
		Sn115(n,p)In115(n,2n)In114m				2.4
		Sn115(n,2n)Sn114(n,p)In114m				2.3
		Sn116(n,2n)Sn115(n,p)In115m(IT)In115(n,2n)In114m				2.0
		Sn116(n,np)In115(n,2n)In114m				1.9
		Sn115(n,p)In115m(IT)In115(n,2n)In114m				1.4
		Sn116(n,2n)Sn115(n,d)In114m				1.3
		Sn116(n,d)In115m(IT)In115(n,2n)In114m				1.2
Te125m	57.39d	Sn124(n,γ)Sn125m(β^-)Sb125(β^-)Te125m	92.0	92.9	57.2	34.6
		Sn124(n,γ)Sn125(β^-)Sb125(β^-)Te125m	4.1	7.1	38.7	63.2
		Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122(β^-)Te122(n,γ) Te123(n,γ)Te124(n,γ)Te125m	1.2			
		Sn122(n,γ)Sn123m(β^-)Sb123(n,γ)Sb124(β^-)Te124(n,γ)Te125m	1.0			
		Sn124(n,γ)Sn125(β^-)Sb125(β^-)Te125(n,n′)Te125m				1.2

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sb124	60.18d	Sn122(n,γ)Sn123m(β^-)Sb123(n,γ)Sb124	62.6	58.4	28.3	
		Sn122(n,γ)Sn123m(β^-)Sb123(n,γ)Sb124m(IT)Sb124	15.1	15.1	11.3	
		Sn122(n,γ)Sn123(β^-)Sb123(n,γ)Sb124	14.2	16.9	26.7	
		Sn122(n,γ)Sn123(β^-)Sb123(n,γ)Sb124m(IT)Sb124	3.4	4.4	10.7	
		Sn122(n,γ)Sn123m(β^-)Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124	2.9	4.0	11.6	
		Sn122(n,γ)Sn123(β^-)Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124		1.2	10.9	
		Sn124(n,2n)Sn123(β^-)Sb123(n,γ)Sb124				16.8
		Sn124(n,γ)Sn125(β^-)Sb125(n,2n)Sb124				14.1
		Sn124(n,2n)Sn123m(β^-)Sb123(n,γ)Sb124				11.2
		Sn124(n,2n)Sn123(β^-)Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124				10.1
		Sn124(n,γ)Sn125(β^-)Sb125(n,2n)Sb124n(IT)Sb124m(IT)Sb124				9.7
		Sn124(n,γ)Sn125m(β^-)Sb125(n,2n)Sb124				7.7
		Sn124(n,2n)Sn123m(β^-)Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124				6.7
		Sn124(n,2n)Sn123(β^-)Sb123(n,γ)Sb124m(IT)Sb124				5.9
		Sn124(n,γ)Sn125(β^-)Sb125(n,2n)Sb124m(IT)Sb124				5.4
		Sn124(n,γ)Sn125m(β^-)Sb125(n,2n)Sb124n(IT)Sb124m(IT)Sb124				5.3
		Sn124(n,2n)Sn123m(β^-)Sb123(n,γ)Sb124m(IT)Sb124				3.9
		Sn124(n,γ)Sn125m(β^-)Sb125(n,2n)Sb124m(IT)Sb124				2.9
Sn113	115.08d	Sn112(n,γ)Sn113	63.2	55.8	32.9	
		Sn112(n,γ)Sn113m(IT)Sn113	36.8	44.2	67.1	
		Sn114(n,2n)Sn113m(IT)Sn113				76.0
		Sn114(n,2n)Sn113				15.6
		Sn116(n,2n)Sn115(n,2n)Sn114(n,2n)Sn113m(IT)Sn113				3.5
		Sn115(n,2n)Sn114(n,2n)Sn113m(IT)Sn113				2.7
Te123m	119.51d	Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123m	98.3	98.6	87.8	
		Sn119(n,γ)Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122(β^-) Te122(n,γ)Te123m	1.1			
		Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122m(IT)Sb122(β^-) Te122(n,γ)Te123m			4.9	
		Sn120(n,γ)Sn121m(n,E)Sn121(β^-)Sb121(n,γ)Sb122(β^-) Te122(n,γ)Te123m			4.6	
		Sn120(n,γ)Sn121(β^-)Sb121(n,γ)Sb122(β^-)Te122(n,γ) Te123(n,n$'$)Te123m			1.2	
		Sn124(n,γ)Sn125(β^-)Sb125(n,2n)Sb124(β^-)Te124(n,2n)Te123m				5.6
		Sn124(n,2n)Sn123(β^-)Sb123(n,γ)Sb124(β^-)Te124(n,2n)Te123m				4.8
		Sn124(n,2n)Sn123m(β^-)Sb123(n,γ)Sb124(β^-) Te124(n,2n)Te123m				4.2
		Sn124(n,γ)Sn125(β^-)Sb125(n,2n)Sb124n(IT)Sb124m(IT) Sb124(β^-)Te124(n,2n)Te123m				3.9
		Sn124(n,γ)Sn125m(β^-)Sb125(n,2n)Sb124(β^-) Te124(n,2n)Te123m				3.2
		Sn124(n,2n)Sn123(β^-)Sb123(n,γ)Sb124n(IT)Sb124m(IT) Sb124(β^-)Te124(n,2n)Te123m				2.9
		Sn124(n,2n)Sn123m(β^-)Sb123(n,γ)Sb124n(IT)Sb124m(IT) Sb124(β^-)Te124(n,2n)Te123m				2.5
		Sn124(n,γ)Sn125m(β^-)Sb125(n,2n)Sb124n(IT)Sb124m(IT) Sb124(β^-)Te124(n,2n)Te123m				2.2
		Sn124(n,γ)Sn125(β^-)Sb125(β^-)Te125(n,2n)Te124(n,2n)Te123m				2.2
		Sn124(n,γ)Sn125(β^-)Sb125(n,2n)Sb124m(IT)Sb124(β^-) Te124(n,2n)Te123m				2.1
		Sn124(n,γ)Sn125(β^-)Sb125(n,2n)Sb124n(IT)Sb124m(β^-) Te124(n,2n)Te123m				1.7
		Sn124(n,2n)Sn123(β^-)Sb123(n,γ)Sb124m(IT)Sb124(β^-) Te124(n,2n)Te123m				1.7
		Sn124(n,2n)Sn123m(β^-)Sb123(n,γ)Sb124m(IT)Sb124(β^-) Te124(n,2n)Te123m				1.5
		Sn124(n,2n)Sn123(β^-)Sb123(n,γ)Sb124n(IT)Sb124m(β^-) Te124(n,2n)Te123m				1.3
		Sn124(n,γ)Sn125m(β^-)Sb125(β^-)Te125(n,2n) Te124(n,2n)Te123m				1.3
		Sn124(n,γ)Sn125m(β^-)Sb125(n,2n)Sb124m(IT)Sb124(β^-) Te124(n,2n)Te123m				1.2
		Sn124(n,2n)Sn123m(β^-)Sb123(n,γ)Sb124n(IT)Sb124m(β^-) Te124(n,2n)Te123m				1.1

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Te123m	cont.	Sn124(n,γ)Sn125m(β^-)Sb125(n,2n)Sb124n(IT)Sb124m(β^-) Te124(n,2n)Te123m				1.0
Sn123	129.21d	Sn122(n,γ)Sn123	99.9	100.0	100.0	
		Sn124(n,2n)Sn123				99.9
Ag110m	249.77d	Sn112(n,α)Cd109(β^+)Ag109m(IT)Ag109(n,γ)Ag110m		100.0		
		Sn114(n,2n)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,α)Ag110m				39.1
		Sn112(n,2n)Sn111(β^+)In111(β^+)Cd111(n,np)Ag110m				19.0
		Sn112(n,2n)Sn111(β^+)In111(β^+)Cd111(n,2n)Cd110(n,p)Ag110m				16.1
		Sn114(n,2n)Sn113(β^+)In113m(IT)In113(n,α)Ag110m				8.0
		Sn112(n,2n)Sn111(β^+)In111(β^+)Cd111(n,d)Ag110m				6.9
		Sn114(n,2n)Sn113m(β^+)In113(n,α)Ag110m				5.5
Sn119m	293.01d	Sn118(n,γ)Sn119m	98.7	99.6	15.6	
		Sn117(n,γ)Sn118(n,γ)Sn119m	1.3			
		Sn119(n,n′)Sn119m			83.7	6.1
		Sn120(n,2n)Sn119m				92.7
Sb125	2.76y	Sn124(n,γ)Sn125m(β^-)Sb125	94.9	92.9	59.6	35.3
		Sn124(n,γ)Sn125(β^-)Sb125	4.3	7.1	40.4	64.7
Cd113m	14.60y	Sn115(n,α)Cd112(n,γ)Cd113m	97.3	99.4	5.0	
		Sn112(n,γ)Sn113(n,α)Cd110(n,γ)Cd111(n,γ)Cd112(n,γ)Cd113m	1.1			
		Sn116(n,α)Cd113m			34.8	91.4
		Sn112(n,γ)Sn113m(IT)Sn113(β^+)In113m(IT)In113(n,p)Cd113m			22.0	
		Sn112(n,p)In112(β^+)Cd112(n,γ)Cd113m			16.3	
		Sn112(n,γ)Sn113(β^+)In113m(IT)In113(n,p)Cd113m			10.8	
		Sn112(n,p)In112m(IT)In112(β^+)Cd112(n,γ)Cd113m			6.0	
		Sn112(n,γ)Sn113m(β^+)In113(n,p)Cd113m			3.2	
		Sn116(n,α)Cd113(n,n′)Cd113m			1.2	
		Sn117(n,α)Cd114(n,2n)Cd113m				2.7
		Sn117(n,2n)Sn116(n,α)Cd113m				2.6
Sn121m	43.90y	Sn120(n,γ)Sn121m	97.8	99.8	100.0	
		Sn119(n,γ)Sn120(n,γ)Sn121m	2.2			
		Sn122(n,2n)Sn121m				99.1
Ag108m	417.97y	Sn112(n,α)Cd109(β^+)Ag109m(IT)Ag109(n,2n)Ag108m				94.4
		Sn112(n,nα)Cd108(n,p)Ag108m				1.7
Sn126	2.3 10^5y	Sn124(n,γ)Sn125(n,γ)Sn126	99.3	99.3	100.0	99.9
Tc98	4.3 10^6y	no pathways found				
Pd107	6.5 10^6y	Sn112(n,α)Cd109(n,α)Pd106(n,γ)Pd107	98.6	99.3	90.6	
		Sn112(n,α)Cd109(n,α)Pd106(n,γ)Pd107m(IT)Pd107			8.6	
		Sn112(n,2n)Sn111(β^+)In111(β^+)Cd111(n,α)Pd108(n,2n)Pd107				21.9
		Sn112(n,2n)Sn111(β^+)In111(β^+)Cd111(n,nα)Pd107				18.3
		Sn112(n,2n)Sn111(β^+)In111(β^+)Cd111(n,2n)Cd110(n,α)Pd107				17.1
		Sn112(n,2n)Sn111(β^+)In111(β^+)Cd111(n,α)Pd108(n,2n) Pd107m(IT)Pd107				12.2
		Sn112(n,2n)Sn111(β^+)In111(β^+)Cd111(n,nα)Pd107m(IT)Pd107				11.9
		Sn112(n,2n)Sn111(β^+)In111(β^+)Cd111(n,2n)Cd110(n,α) Pd107m(IT)Pd107				11.5

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
I129	1.6 10^7y	Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126n(IT)Sb126m(IT) Sb126(n,γ)Sb127(β^-)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	27.0	2.0		
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126m(IT)Sb126(n,γ) Sb127(β^-)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	16.1	1.3		
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126n(IT)Sb126m(IT) Sb126(n,γ)Sb127(β^-)Te127(n,γ)Te128(n,γ)Te129(β^-)I129	2.7			
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126(n,γ)Sb127(β^-) Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	1.8			
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126m(IT)Sb126(n,γ) Sb127(β^-)Te127(n,γ)Te128(n,γ)Te129(β^-)I129	1.6			
		Sn124(n,γ)Sn125(β^-)Sb125(n,γ)Sb126n(IT)Sb126m(IT) Sb126(n,γ)Sb127(β^-)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	1.2			
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126n(IT)Sb126m(β^-) Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		21.9		
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126m(β^-)Te126(n,γ) Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ)Te129(β^-)I129		14.0		
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126n(IT)Sb126m(β^-) Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129		10.3		
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126m(β^-)Te126(n,γ) Te127m(n,γ)Te128(n,γ)Te129(β^-)I129		6.6		
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126n(IT)Sb126m(IT) Sb126(β^-)Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		3.2		
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126n(IT)Sb126m(IT) Sb126(n,γ)Sb127(β^-)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		2.2		
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126m(IT)Sb126(β^-) Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		2.0		
		Sn124(n,γ)Sn125(β^-)Sb125(n,γ)Sb126n(IT)Sb126m(β^-) Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		1.5		
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126n(IT)Sb126m(IT) Sb126(β^-)Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129		1.5		
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126m(IT)Sb126(n,γ) Sb127(β^-)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		1.4		
		Sn124(n,γ)Sn125(β^-)Sb125(n,γ)Sb126m(β^-)Te126(n,γ) Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ)Te129(β^-)I129		1.0		
		Sn124(n,γ)Sn125m(β^-)Sb125(n,γ)Sb126m(IT)Sb126(β^-) Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129		1.0		
Sn124	1.0 10^{17}y	no pathways found				

Antimony

Isotope	Atom % abundance
Sb121	57.21
Sb123	42.79

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.09E+15	1.88E+15	8.69E+14	8.77E+12	3.81E+10	2.20E-01
Sb122	51.0	56.6	47.9			
Sb124	18.0	20.0	41.5	64.0		
Sb120	12.8	11.3				
Sb124m	5.8	1.7				
Sb120m	5.5	6.1	8.5			
Sb122m	4.6	2.1				
Sb124n	1.2	1.1				
Sb125			0.1	7.6		
Te123m	0.3	0.3	0.6	7.2		
Te121	0.3	0.3	0.7	6.0		
Te121m	0.1	0.1	0.3	5.9		
Sn119m			0.1	3.4		
Sn123	0.1	0.1	0.1	2.0		
Te125m				1.8		
Sn121m				1.2	56.3	
Sn121	0.2	0.2		0.9	43.7	
Sn126						87.5
Sb126						12.3

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	4.00E-01	3.83E-01	2.27E-01	2.19E-03	4.49E-07	1.86E-17
Sb122	42.8	44.7	29.6			
Sb124	33.7	35.1	56.9	91.7		
Sb120m	11.5	12.0	13.1			
Sb120	8.2	6.8				
Sb124m	2.7	0.7				
Sb125				2.6		
Te121	0.2	0.2	0.2	2.3		
Te121m			0.1	1.1		
Te123m	0.1	0.1	0.1	1.1		
Sn121				0.1	68.9	
Sn121m					31.1	
Sb126						72.4
Sn126						27.5

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	3.98E+05	3.84E+05	2.75E+05	3.11E+03	4.01E-04	1.69E-11
Sb124	50.3	52.1	69.8	96.1		
Sb122	22.3	23.1	12.6			
Sb120m	18.5	19.2	17.3			
Sb120	5.6	4.6				
Sb124m	2.9	0.8				
Sb125				1.8		
Te121	0.2	0.2	0.2	1.7		
Sn121m					100.0	
Sb126						99.7

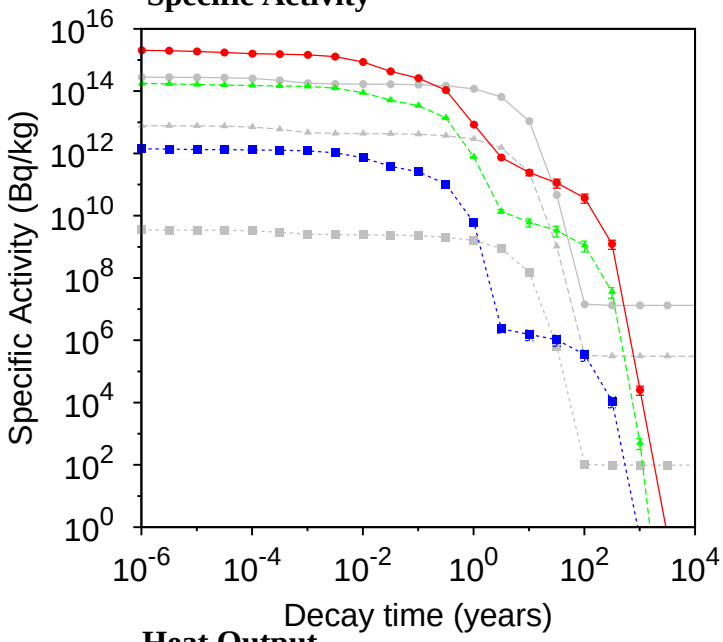
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.91E+06	2.91E+06	1.72E+06	1.77E+04	1.20E+01	1.11E-09
Sb122	62.1	62.1	41.2			
Sb124	32.3	32.3	52.5	79.1		
Sb120m	4.7	4.7	5.2			
Te121m	0.2	0.2	0.4	6.7		
Te123m	0.3	0.3	0.4	5.0		
Sb125			0.1	4.1		
Sn123	0.1	0.1	0.2	2.1		
Te121	0.1	0.1	0.1	1.3		
Sn121m				0.2	68.0	
Sn121				0.1	32.0	
Sn126						81.3
Sn124						12.5
Sb126						5.8

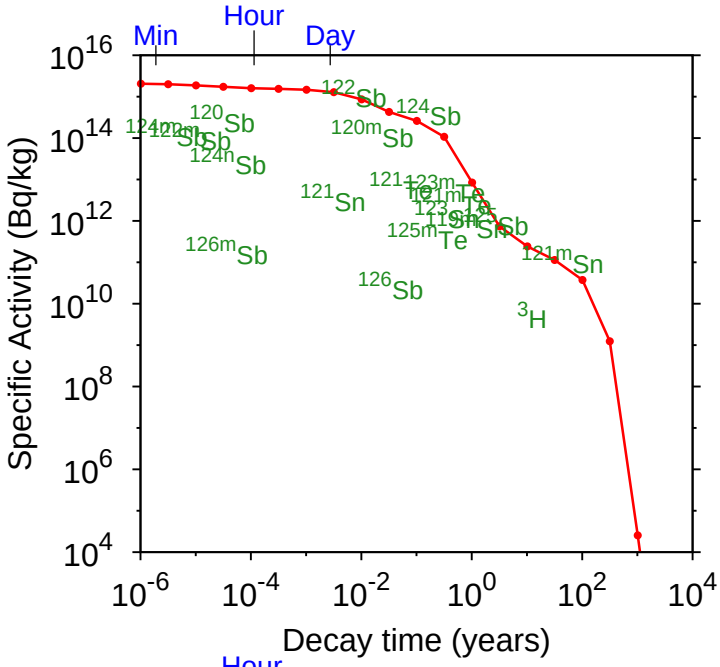
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.61E+06	4.60E+06	3.71E+06	6.59E+04	1.00E+02	6.00E-09
Sb124	70.3	70.3	83.6	73.3		
Sb122	25.4	25.4	12.3			
Sb120m	2.7	2.7	2.2			
Sb125	0.2	0.2	0.3	12.1		
Te123m	0.6	0.6	0.7	4.9		
Te121m	0.3	0.3	0.4	4.5		
Sn123	0.2	0.2	0.3	2.2		
Te125m				1.0		
Sn121m				0.7	96.2	
Sn121					3.8	
Sn126						90.0
Sn124						8.5
Sb126						1.4

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	9.79E+11	9.05E+11	6.01E+11	1.33E+10	3.73E+05	9.13E-05
Sb124	38.4	41.6	60.1	42.2		
Sb120m	28.6	30.9	30.0			
Sb120	13.6	11.7				
Sb122	10.9	11.7	6.9			
Sb124m	5.7	1.6				
Sb125	0.9	0.9	1.4	49.8		
Te123m	0.5	0.6	0.9	4.7		
Te121	0.4	0.4	0.6	2.3		
Sn121					52.0	
Sn121m					48.0	
Sb126						82.1
Sn126						14.1
I129						3.3

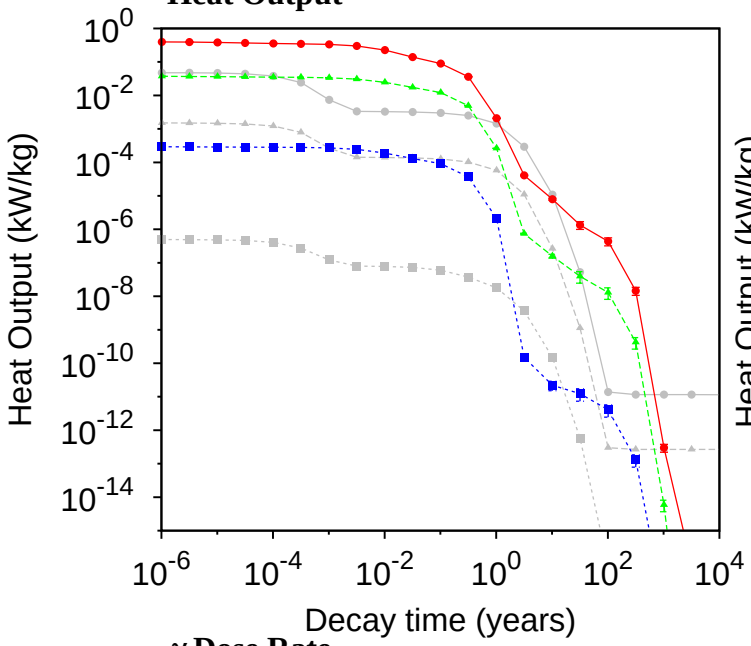
Antimony activation characteristics

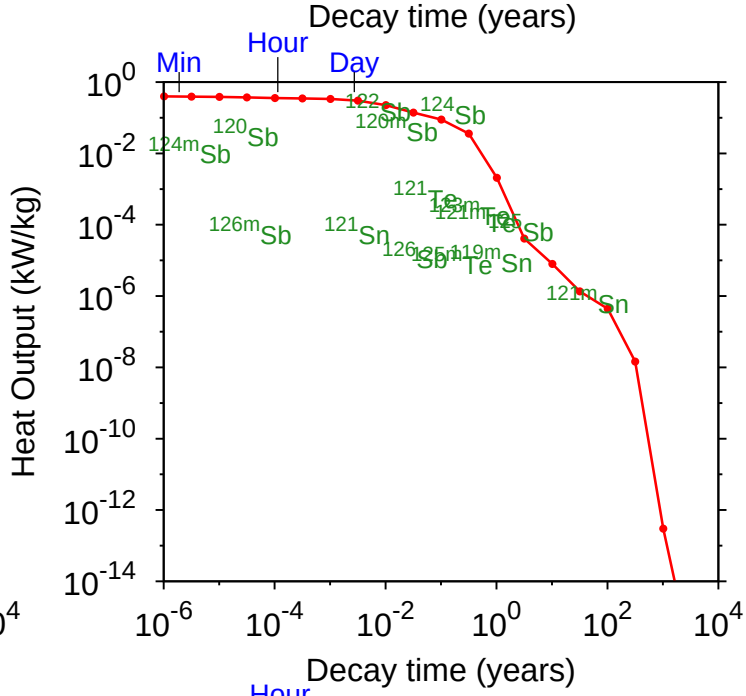
Specific Activity



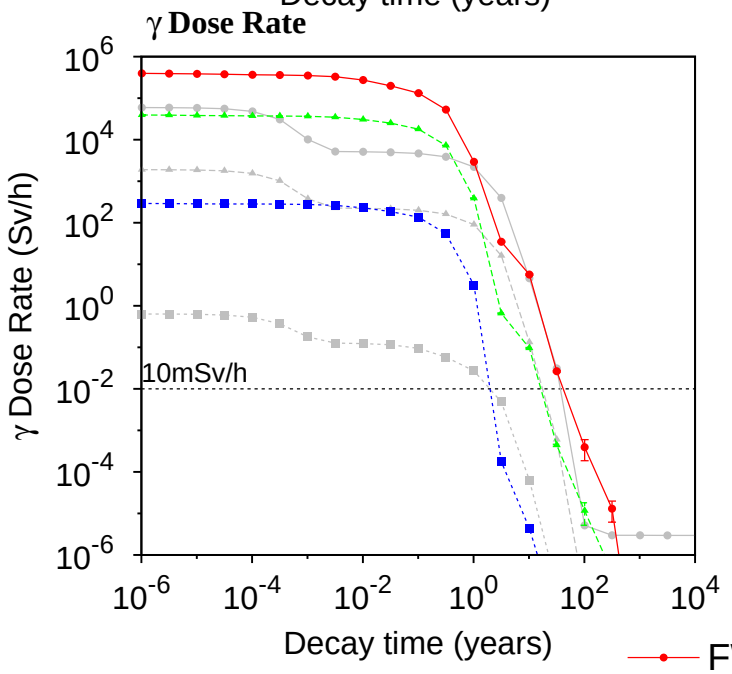


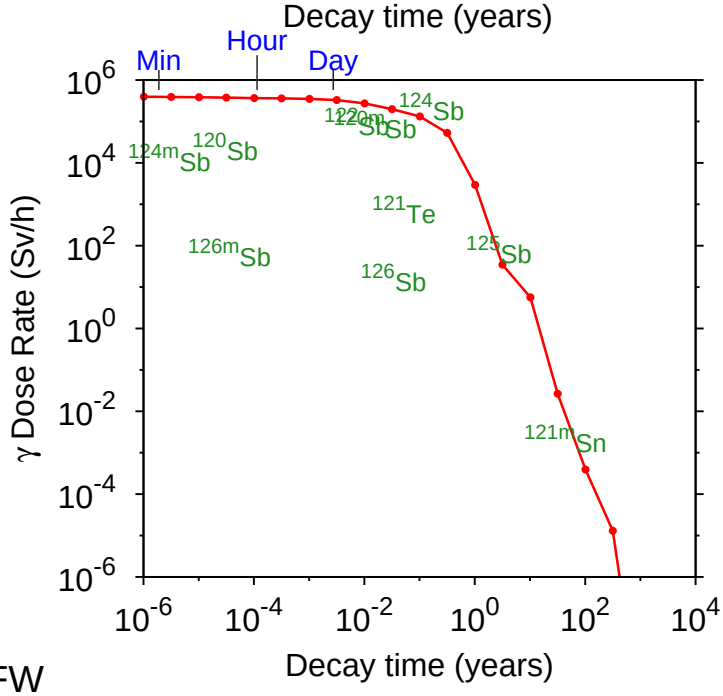
Heat Output





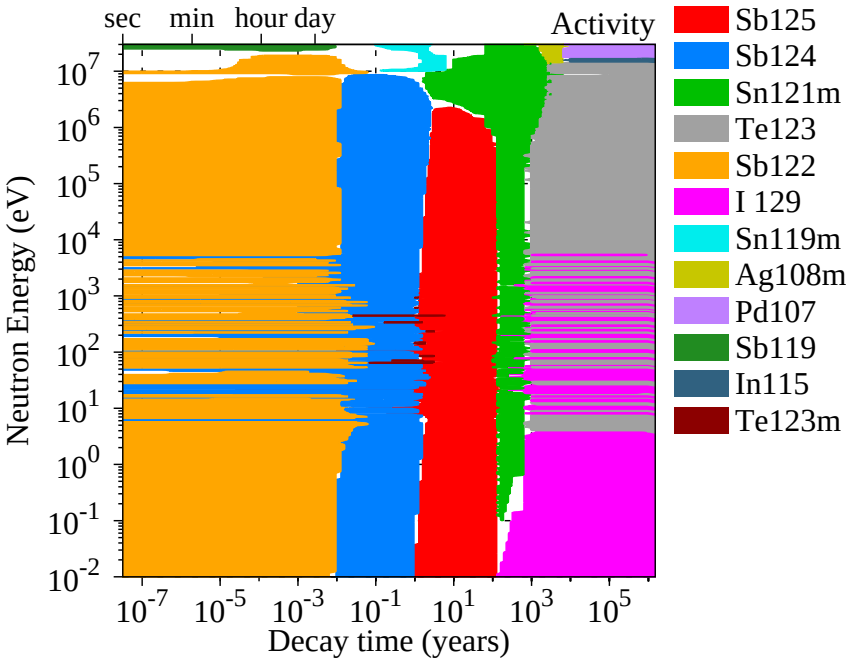
γ Dose Rate

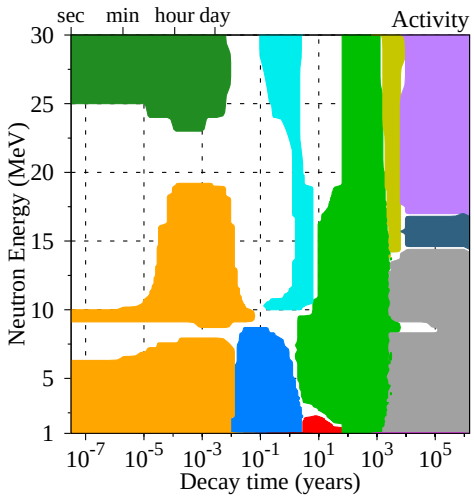


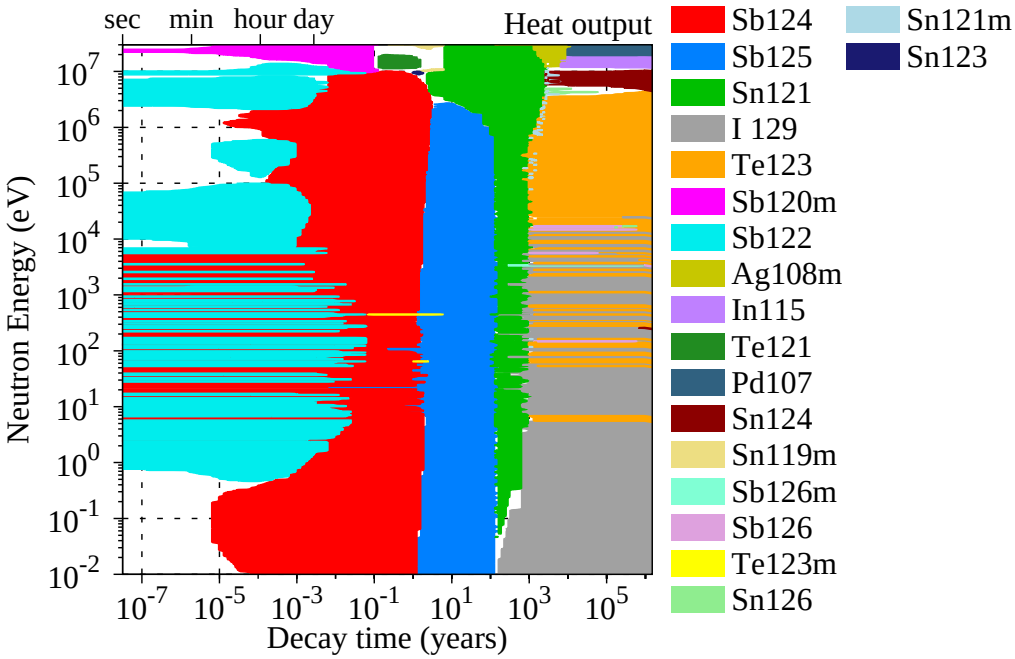


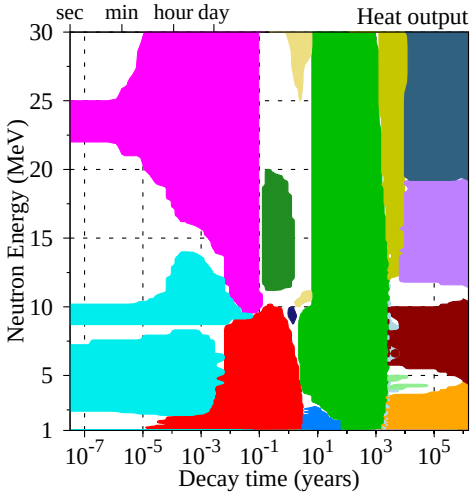
FW
Blanket
Manifold
Fe results

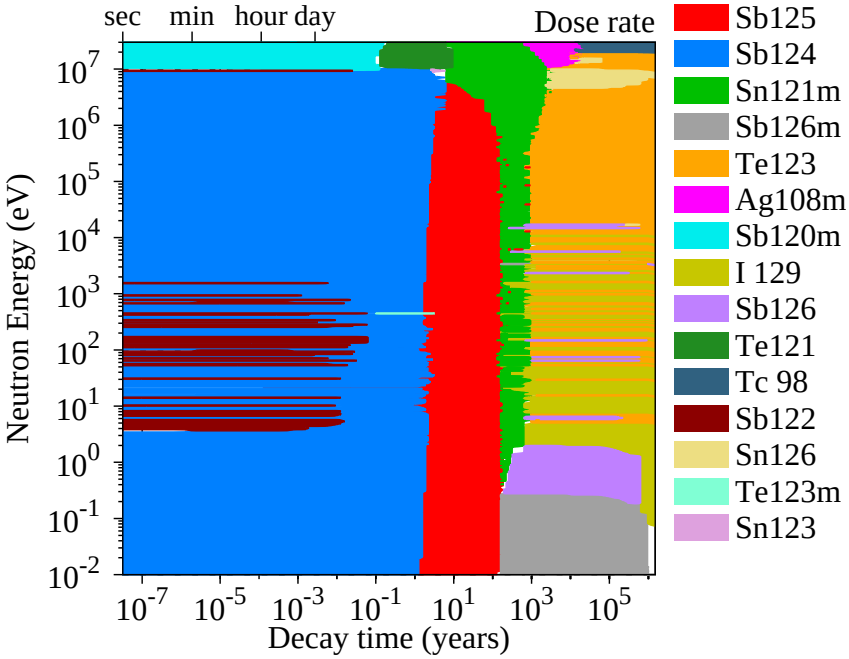
Antimony Importance diagrams

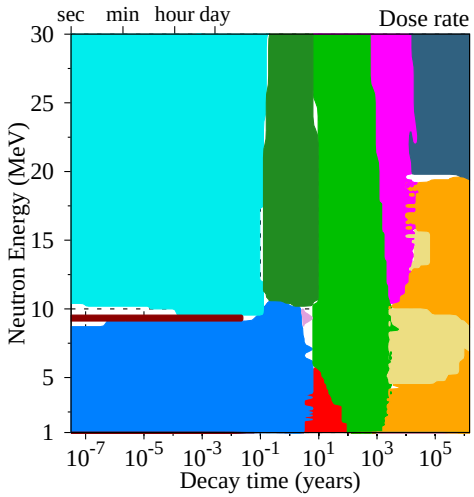




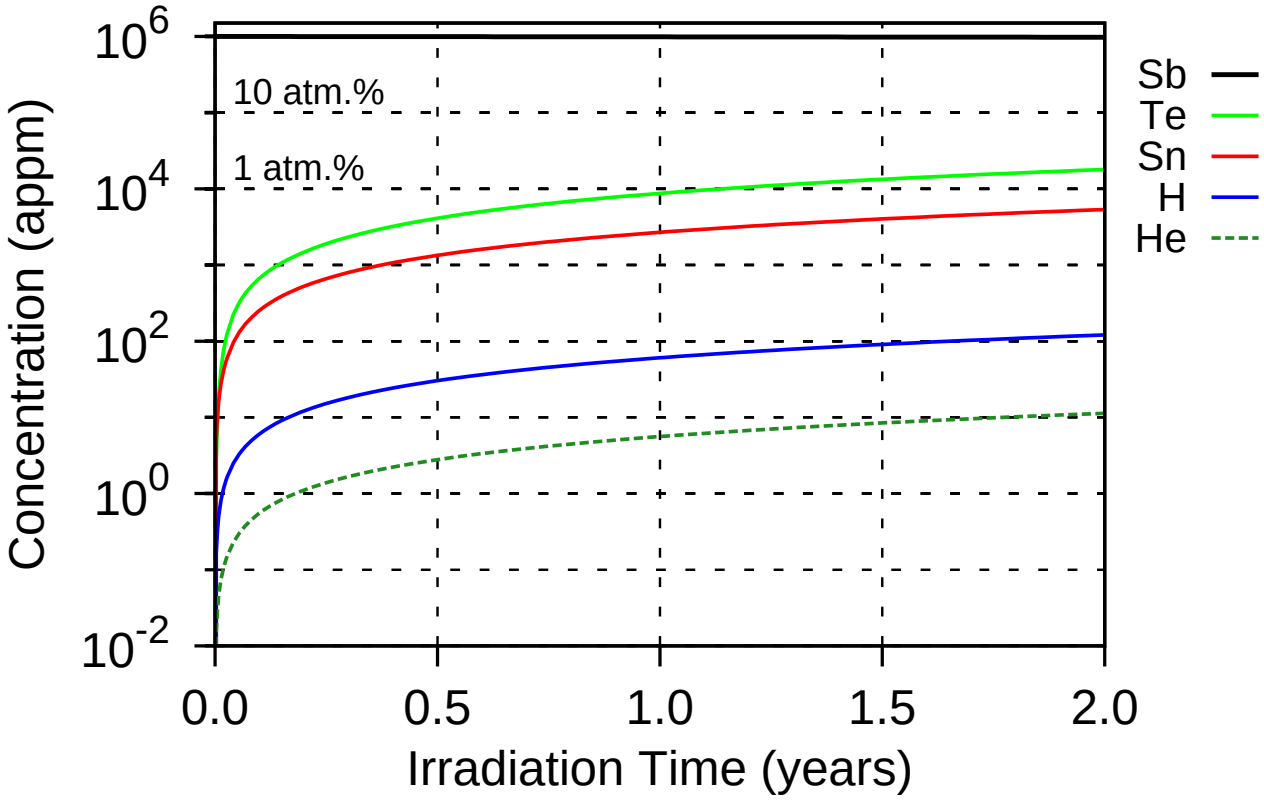






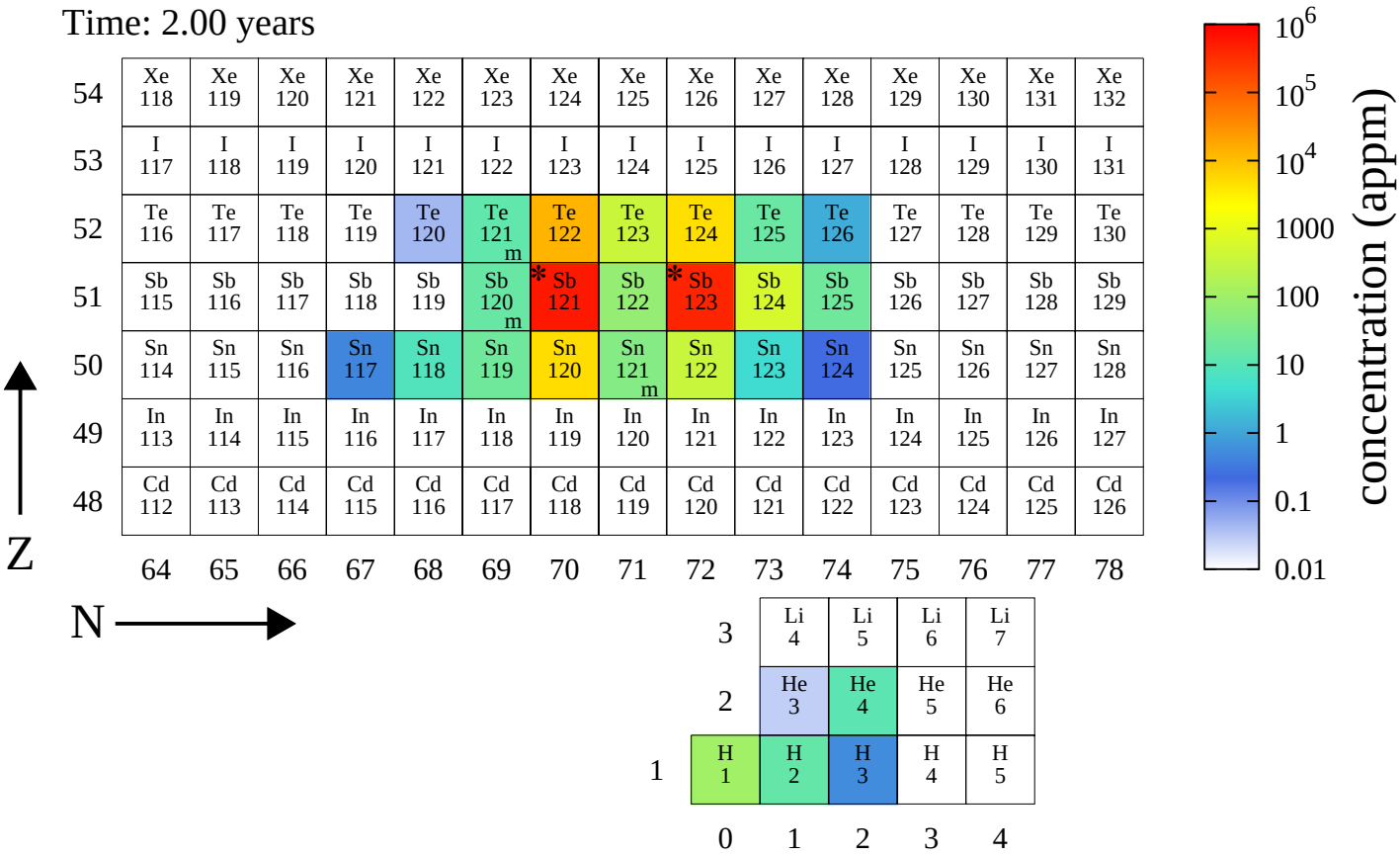


Antimony FW Transmutation

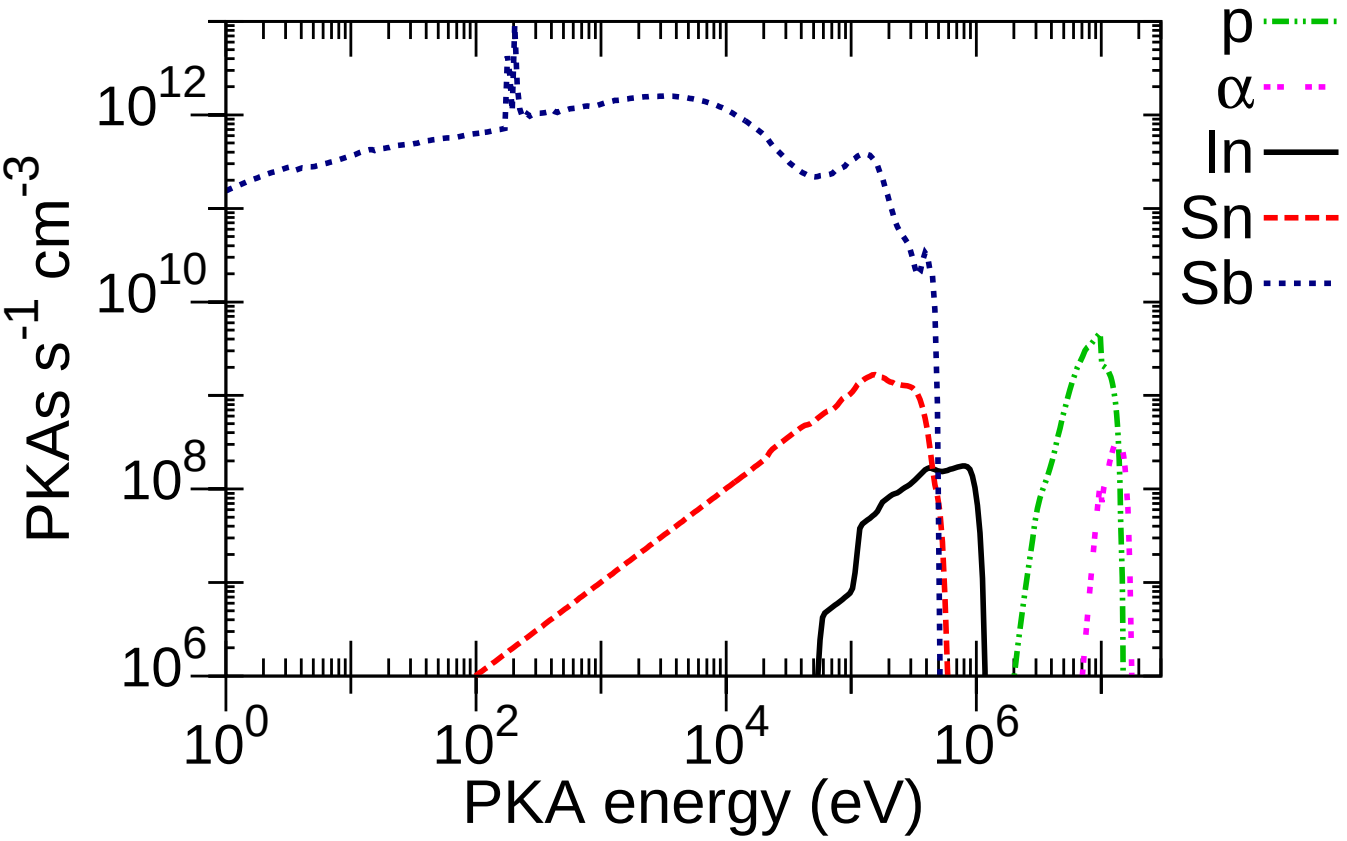


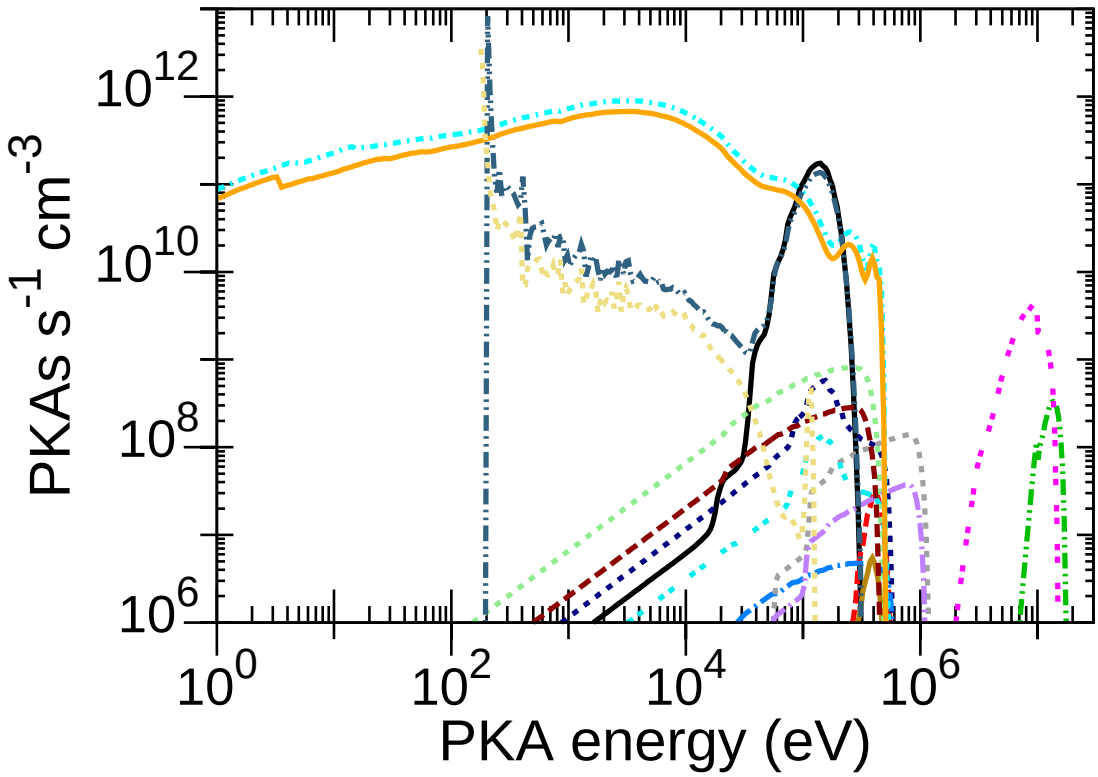
6 appm He & 61 appm H after 1 year

15 dpa/year



Antimony FW PKA distributions





Antimony Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sb124m	1.55m	Sb123(n,γ)Sb124m	83.3	78.9	49.0	37.0
		Sb123(n,γ)Sb124n(IT)Sb124m	16.2	20.9	50.2	62.7
Sb122m	4.19m	Sb121(n,γ)Sb122m	100.0	100.0	100.0	
		Sb123(n,2n)Sb122m				99.8
Sb120	15.90m	Sb121(n,2n)Sb120				99.6
Sb126m	19.10m	Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m	48.6	45.9	29.9	
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126m	28.9	29.4	25.1	
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m	11.7	11.9	12.0	
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126m	7.0	7.6	10.1	
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ) Sb126n(IT)Sb126m	2.3	3.1	12.3	
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126m	1.4	2.0	10.3	
Sb124n	20.20m	Sb123(n,γ)Sb124n	99.5	100.0	99.7	99.8
Sn121	1.12d	Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123(n,α)Sn120(n,γ)Sn121	79.5	84.9		
		Sb123(n,γ)Sb124(β^-)Te124(n,α)Sn121	8.1	3.4		
		Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123m(n,α)Sn120(n,γ)Sn121	3.6			
		Sb123(n,γ)Sb124m(IT)Sb124(β^-)Te124(n,α)Sn121	1.9			
		Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123m(IT)Te123(n,α) Sn120(n,γ)Sn121		7.4		
		Sb121(n,p)Sn121			77.4	60.4
		Sb121(n,p)Sn121m(n,E)Sn121			19.9	21.5
		Sb121(n,p)Sn121m(IT)Sn121			1.6	3.1
		Sb121(n,p)Sn121m(n,n′)Sn121			1.1	
		Sb123(n,2n)Sb122(β^+)Sn122(n,2n)Sn121				7.6
		Sb123(n,2n)Sb122m(IT)Sb122(β^+)Sn122(n,2n)Sn121				3.1
		Sb123(n,2n)Sb122(β^+)Sn122(n,2n)Sn121m(n,E)Sn121				1.2
Sb119	1.60d	Sb121(n,2n)Sb120m(n,2n)Sb119				92.8
		Sb123(n,2n)Sb122(β^-)Te122(n,2n)Te121m(n,2n)Te120(n,2n) Te119m(β^+)Sb119				1.6
		Sb123(n,2n)Sb122(β^-)Te122(n,2n)Te121m(n,2n)Te120(n,2n) Te119(β^+)Sb119				1.5
Sb122	2.70d	Sb121(n,γ)Sb122	99.8	99.6	94.7	
		Sb121(n,γ)Sb122m(IT)Sb122			5.3	
		Sb123(n,2n)Sb122				70.7
		Sb123(n,2n)Sb122m(IT)Sb122				29.1
Sb120m	5.76d	Sb121(n,2n)Sb120m				99.7
Sb126	12.40d	Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m(IT)Sb126	46.6	41.3	13.1	8.5
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126m(IT)Sb126	27.7	26.4	11.0	6.1
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126n(IT) Sb126m(IT)Sb126	11.3	10.7	5.2	3.0
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126m(IT)Sb126	6.7	6.8	4.4	2.2
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126	3.0	7.6	31.0	36.4
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ) Sb126n(IT)Sb126m(IT)Sb126	2.2	2.8	5.4	5.1
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ) Sb126m(IT)Sb126	1.3	1.8	4.5	3.7
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126		2.0	12.4	12.9
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126			12.7	21.8
Te121	19.16d	Sb123(n,2n)Sb122(β^-)Te122(n,2n)Te121				44.4
		Sb123(n,2n)Sb122(β^-)Te122(n,2n)Te121m(IT)Te121				24.8
		Sb123(n,2n)Sb122m(IT)Sb122(β^-)Te122(n,2n)Te121				18.3
		Sb123(n,2n)Sb122m(IT)Sb122(β^-)Te122(n,2n)Te121m(IT)Te121				10.2
		Sb123(n,2n)Sb122(β^-)Te122(n,2n)Te121m(n,E)Te121				1.4
Te125m	57.39d	Sb123(n,γ)Sb124(β^-)Te124(n,γ)Te125m	45.0	31.8	45.4	42.1
		Sb123(n,γ)Sb124(n,γ)Sb125(β^-)Te125m	18.0	40.4		
		Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123(n,γ)Te124(n,γ)Te125m	12.0			
		Sb123(n,γ)Sb124m(IT)Sb124(β^-)Te124(n,γ)Te125m	10.9	8.2	18.2	14.9
		Sb123(n,γ)Sb124m(β^-)Te124(n,γ)Te125m	4.5	3.2	7.0	5.7
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(β^-)Te125m	4.3	10.5		
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(β^-)Te124(n,γ)Te125m	2.1	2.2	18.6	25.2
		Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123m(n,γ)Te124(n,γ)Te125m	1.2			
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(β^-)Te125m		2.8		
		Sb123(n,γ)Sb124n(IT)Sb124m(β^-)Te124(n,γ)Te125m			7.2	9.7

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sb124	60.18d	Sb123(n,γ)Sb124	77.3	75.3	55.1	51.1
		Sb123(n,γ)Sb124m(IT)Sb124	18.6	19.5	22.0	18.1
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124	3.6	5.2	22.6	30.6
Te123m	119.51d	Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123m	99.8	99.5	92.3	
		Sb121(n,γ)Sb122m(IT)Sb122(β^-)Te122(n,γ)Te123m			5.2	
		Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123(n,n$'$)Te123m			1.8	
		Sb123(n,2n)Sb122(β^-)Te122(n,γ)Te123m				47.9
		Sb123(n,2n)Sb122m(IT)Sb122(β^-)Te122(n,γ)Te123m				19.8
		Sb123(n,γ)Sb124(β^-)Te124(n,2n)Te123m				13.6
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(β^-)Te124(n,2n)Te123m				8.1
		Sb123(n,γ)Sb124m(IT)Sb124(β^-)Te124(n,2n)Te123m				4.8
		Sb123(n,γ)Sb124n(IT)Sb124m(β^-)Te124(n,2n)Te123m				3.2
		Sb123(n,γ)Sb124m(β^-)Te124(n,2n)Te123m				1.9
Sn123	129.21d	Sb121(n,γ)Sb122(β^+)Sn122(n,γ)Sn123			93.7	
		Sb121(n,γ)Sb122m(IT)Sb122(β^+)Sn122(n,γ)Sn123			5.3	
		Sb123(n,p)Sn123			1.0	99.9
Te121m	154.01d	Sb123(n,2n)Sb122(β^-)Te122(n,2n)Te121m				70.6
		Sb123(n,2n)Sb122m(IT)Sb122(β^-)Te122(n,2n)Te121m				29.1
Sn119m	293.01d	Sb121(n,γ)Sb122(β^-)Te122(n,α)Sn119m	99.8	99.5	92.7	
		Sb121(n,γ)Sb122m(IT)Sb122(β^-)Te122(n,α)Sn119m			5.2	
		Sb121(n,γ)Sb122(β^-)Te122(n,α)Sn119(n,n$'$)Sn119m			1.7	
		Sb121(n,2n)Sb120(β^+)Sn120(n,2n)Sn119m				69.0
		Sb121(n,2n)Sb120m(β^+)Sn120(n,2n)Sn119m				29.2
Sb125	2.76y	Sb123(n,γ)Sb124(n,γ)Sb125	77.4	75.3	55.1	51.0
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125	18.7	19.5	22.0	18.0
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125	3.6	5.2	22.6	30.6
Sn121m	43.90y	Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123(n,α)Sn120(n,γ)Sn121m	65.9	79.0		
		Sb123(n,γ)Sb124(β^-)Te124(n,α)Sn121m	17.5	8.9		
		Sb123(n,γ)Sb124m(IT)Sb124(β^-)Te124(n,α)Sn121m	4.2	2.3		
		Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123m(n,α)Sn120(n,γ)Sn121m	3.0	1.0		
		Sb123(n,γ)Sb124m(β^-)Te124(n,α)Sn121m	1.8	1.0		
		Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123m(IT)Te123(n,α) Sn120(n,γ)Sn121m		6.2		
		Sb121(n,p)Sn121m			100.0	91.6
		Sb123(n,2n)Sb122(β^+)Sn122(n,2n)Sn121m				5.2
		Sb123(n,2n)Sb122m(IT)Sb122(β^+)Sn122(n,2n)Sn121m				2.1
Ag108m	417.97y	no pathways found				
Sn126	2.3 10^5y	Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126(n,p)Sn126			3.0	
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m(IT) Sb126(n,p)Sn126			1.3	
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ) Sb126(n,p)Sn126			1.2	
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126(n,p)Sn126			1.2	
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126m(IT)Sb126(n,p)Sn126			1.1	
Tc98	4.3 10^6y	no pathways found				
Pd107	6.5 10^6y	Sb121(n,nα)In117(β^-)Sn117(n,α)Cd114(n,α)Pd111(β^-) Ag111m(IT)Ag111(β^-)Cd111(n,nα)Pd107				1.3

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
I129	1.6 10^7y	Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m(IT) Sb126(n,γ)Sb127(β^-)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	22.0	1.5		
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126m(IT)Sb126(n,γ) Sb127(β^-)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	13.1			
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m(β^-) Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	10.4	7.1	1.2	
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126m(β^-)Te126(n,γ) Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	6.2	4.5	1.0	
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126n(IT) Sb126m(IT)Sb126(n,γ)Sb127(β^-)Te127m(n,γ)Te128(n,γ) Te129(β^-)I129	5.3			
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m(β^-) Te126(n,γ)Te127(n,γ)Te128(n,γ)Te129(β^-)I129	4.7			
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126m(IT) Sb126(n,γ)Sb127(β^-)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	3.2			
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126m(β^-)Te126(n,γ) Te127(n,γ)Te128(n,γ)Te129(β^-)I129	2.8			
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126n(IT) Sb126m(β^-)Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	2.5	1.8		
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m(IT) Sb126(n,γ)Sb127(β^-)Te127(n,γ)Te128(n,γ)Te129(β^-)I129	2.2			
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m(IT) Sb126(β^-)Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	1.5	1.0		
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126m(β^-) Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	1.5	1.2		
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126(n,γ)Sb127(β^-) Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	1.4			
		Sb123(n,γ)Sb124(β^-)Te124(n,γ)Te125(n,γ)Te126(n,γ) Te127m(n,γ)Te128(n,γ)Te129(β^-)I129	1.3	2.7	7.7	
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126m(IT)Sb126(n,γ) Sb127(β^-)Te127(n,γ)Te128(n,γ)Te129(β^-)I129	1.3			
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126n(IT) Sb126m(β^-)Te126(n,γ)Te127(n,γ)Te128(n,γ)Te129(β^-)I129	1.1			
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m(β^-) Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129	1.1	14.5		
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ) Sb126n(IT)Sb126m(IT)Sb126(n,γ)Sb127(β^-)Te127m(n,γ) Te128(n,γ)Te129(β^-)I129	1.0			
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126m(β^-)Te126(n,γ) Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ)Te129(β^-)I129		9.3		
		Sb123(n,γ)Sb124(β^-)Te124(n,γ)Te125(n,γ)Te126(n,γ) Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ)Te129(β^-)I129		5.1	1.5	
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126n(IT) Sb126m(β^-)Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		3.8		
		Sb123(n,γ)Sb124(n,γ)Sb125(β^-)Te125(n,γ)Te126(n,γ) Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ)Te129(β^-)I129		3.4		
		Sb123(n,γ)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126m(β^-) Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		2.4		
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m(IT) Sb126(β^-)Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		2.1		
		Sb123(n,γ)Sb124(n,γ)Sb125(β^-)Te125(n,γ)Te126(n,γ) Te127m(n,γ)Te128(n,γ)Te129(β^-)I129		1.8		
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m(IT) Sb126(n,γ)Sb127(β^-)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		1.5		
		Sb123(n,γ)Sb124(n,γ)Sb125(β^-)Te125m(n,γ)Te126(n,γ) Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ)Te129(β^-)I129		1.5		
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126m(IT)Sb126(β^-) Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		1.3		

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
I129	cont.	Sb123(n,γ)Sb124m(IT)Sb124(β^-)Te124(n,γ)Te125(n,γ) Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		1.3		
		Sb123(n,γ)Sb124(β^-)Te124(n,γ)Te125m(n,γ)Te126(n,γ) Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ)Te129(β^-)I129		1.0	3.4	
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ) Sb126n(IT)Sb126m(β^-)Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+) Te128(n,γ)Te129(β^-)I129		1.0		
		Sb123(n,γ)Sb124(n,γ)Sb125(n,γ)Sb126m(IT)Sb126(n,γ) Sb127(β^-)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		1.0		
		Sb123(n,γ)Sb124(β^-)Te124(n,γ)Te125m(n,γ)Te126(n,γ) Te127m(n,γ)Te128(n,γ)Te129(β^-)I129			17.5	
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(β^-)Te124(n,γ) Te125m(n,γ)Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129			7.2	
		Sb123(n,γ)Sb124m(IT)Sb124(β^-)Te124(n,γ)Te125m(n,γ) Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129			7.0	
		Sb123(n,γ)Sb124n(IT)Sb124m(β^-)Te124(n,γ)Te125m(n,γ) Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129			3.9	
		Sb123(n,γ)Sb124m(β^-)Te124(n,γ)Te125m(n,γ)Te126(n,γ) Te127m(n,γ)Te128(n,γ)Te129(β^-)I129			3.8	
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(β^-)Te124(n,γ) Te125(n,γ)Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129			3.1	
		Sb123(n,γ)Sb124m(IT)Sb124(β^-)Te124(n,γ)Te125(n,γ) Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129			3.1	
		Sb123(n,γ)Sb124(β^-)Te124(n,γ)Te125m(IT)Te125(n,γ) Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129			2.0	
		Sb123(n,γ)Sb124n(IT)Sb124m(β^-)Te124(n,γ)Te125(n,γ) Te126(n,γ)Te127m(n,γ)Te128(n,γ)Te129(β^-)I129			1.8	
		Sb123(n,γ)Sb124m(β^-)Te124(n,γ)Te125(n,γ)Te126(n,γ) Te127m(n,γ)Te128(n,γ)Te129(β^-)I129			1.8	
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(β^-)Te124(n,γ) Te125m(n,γ)Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+) Te128(n,γ)Te129(β^-)I129			1.4	
		Sb123(n,γ)Sb124m(IT)Sb124(β^-)Te124(n,γ)Te125m(n,γ) Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129			1.4	

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
In115	4.4 10^{14}y	Sb121(n,α)In118m(β^-)Sn118(n,α)Cd115(β^-)In115m(IT)In115				11.7
		Sb121(n,α)In118m(β^-)Sn118(n,α)Cd115m(β^-)In115				10.6
		Sb121(n,α)In118(β^-)Sn118(n,α)Cd115(β^-)In115m(IT)In115				8.7
		Sb121(n,α)In118(β^-)Sn118(n,α)Cd115m(β^-)In115				7.9
		Sb121(n,α)In118n(IT)In118m(β^-)Sn118(n,α)Cd115(β^-) In115m(IT)In115				5.9
		Sb121(n,2n)Sb120(β^+)Sn120(n,2n)Sn119(n,α)Cd116(n,2n) Cd115(β^-)In115m(IT)In115				5.6
		Sb121(n,α)In118n(IT)In118m(β^-)Sn118(n,α)Cd115m(β^-)In115				5.3
		Sb121(n,2n)Sb120(β^+)Sn120(n,2n)Sn119(n,2n)Sn118(n,α) Cd115(β^-)In115m(IT)In115				4.8
		Sb121(n,2n)Sb120(β^+)Sn120(n,2n)Sn119(n,α)Cd116(n,2n) Cd115m(β^-)In115				4.7
		Sb121(n,2n)Sb120(β^+)Sn120(n,2n)Sn119(n,2n)Sn118(n,α) Cd115m(β^-)In115				3.8
		Sb121(n,2n)Sb120(β^+)Sn120(n,2n)Sn119m(n,2n)Sn118(n,α) Cd115(β^-)In115m(IT)In115				2.6
		Sb121(n,2n)Sb120m(β^+)Sn120(n,2n)Sn119(n,α)Cd116(n,2n) Cd115(β^-)In115m(IT)In115				2.3
		Sb121(n,2n)Sb120(β^+)Sn120(n,2n)Sn119m(n,2n)Sn118(n,α) Cd115m(β^-)In115				2.1
		Sb121(n,2n)Sb120m(β^+)Sn120(n,2n)Sn119(n,2n)Sn118(n,α) Cd115(β^-)In115m(IT)In115				2.0
		Sb121(n,2n)Sb120m(β^+)Sn120(n,2n)Sn119(n,α)Cd116(n,2n) Cd115m(β^-)In115				1.9
		Sb121(n,2n)Sb120m(β^+)Sn120(n,2n)Sn119(n,2n)Sn118(n,α) Cd115m(β^-)In115				1.6
		Sb121(n,2n)Sb120(β^+)Sn120(n,2n)Sn119m(n,α)Cd116(n,2n) Cd115(β^-)In115m(IT)In115				1.1
		Sb121(n,2n)Sb120(β^+)Sn120(n,2n)Sn119m(IT)Sn119(n,α) Cd116(n,2n)Cd115(β^-)In115m(IT)In115				1.1
		Sb121(n,2n)Sb120m(β^+)Sn120(n,2n)Sn119m(n,2n)Sn118(n,α) Cd115(β^-)In115m(IT)In115				1.1
		Sb121(n,2n)Sb120(β^+)Sn120(n,2n)Sn119(n,nα) Cd115m(β^-)In115				1.0
		Sb121(n,2n)Sb120(β^+)Sn120(n,2n)Sn119m(n,α)Cd116(n,2n) Cd115m(β^-)In115				1.0
Te123	9.2 10^{16}y	Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123	98.9	89.9	71.9	
		Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123m(IT)Te123		9.1	21.0	
		Sb121(n,γ)Sb122m(IT)Sb122(β^-)Te122(n,γ)Te123			4.0	
		Sb121(n,γ)Sb122(β^-)Te122(n,γ)Te123m(n,E)Te123			1.3	
		Sb121(n,γ)Sb122m(IT)Sb122(β^-)Te122(n,γ)Te123m(IT)Te123			1.2	
		Sb123(n,2n)Sb122(β^-)Te122(n,γ)Te123m(IT)Te123				24.4
		Sb123(n,2n)Sb122(β^-)Te122(n,γ)Te123				24.2
		Sb123(n,2n)Sb122m(IT)Sb122(β^-)Te122(n,γ)Te123m(IT)Te123				10.1
		Sb123(n,2n)Sb122m(IT)Sb122(β^-)Te122(n,γ)Te123				10.0
		Sb123(n,γ)Sb124(β^-)Te124(n,2n)Te123m(IT)Te123				6.2
		Sb123(n,γ)Sb124(β^-)Te124(n,2n)Te123				6.1
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(β^-)Te124(n,2n) Te123m(IT)Te123				3.7
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(β^-)Te124(n,2n)Te123				3.6
		Sb123(n,γ)Sb124m(IT)Sb124(β^-)Te124(n,2n)Te123m(IT)Te123				2.2
		Sb123(n,γ)Sb124m(IT)Sb124(β^-)Te124(n,2n)Te123				2.1
		Sb123(n,γ)Sb124n(IT)Sb124m(β^-)Te124(n,2n)Te123m(IT)Te123				1.6
		Sb123(n,γ)Sb124n(IT)Sb124m(β^-)Te124(n,2n)Te123				1.5
		Sb123(n,2n)Sb122(β^-)Te122(n,γ)Te123m(n,E)Te123				1.0
		Sb123(n,γ)Sb124m(β^-)Te124(n,2n)Te123m(IT)Te123				1.0
Sn124	1.0 10^{17}y	Sb123(n,γ)Sb124(n,p)Sn124			48.3	25.8
		Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124(n,p)Sn124			19.8	15.5
		Sb123(n,γ)Sb124m(IT)Sb124(n,p)Sn124			19.3	9.1
		Sb121(n,γ)Sb122(β^+)Sn122(n,γ)Sn123(n,γ)Sn124			11.5	
		Sb123(n,p)Sn123(n,γ)Sn124				49.5

Tellurium

Isotope	Atom % abundance	
Te120	0.09	
Te122	2.55	
Te123	0.89	($T_{1/2}$ =9.2 10^{16}y)
Te124	4.74	
Te125	7.07	
Te126	18.84	
Te128	31.74	($T_{1/2}$ =2.2 10^{24}y)
Te130	34.08	($T_{1/2}$ =7.9 10^{23}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	9.40E+14	9.29E+14	6.42E+14	3.22E+13	5.81E+08	2.37E+07
Te127	25.4	25.6	19.6	39.0		
Te129	23.4	23.1	14.6	0.2		
Te129m	16.9	17.1	22.9	0.3		
Te127m	13.9	14.1	19.9	39.8		
Te125m	11.0	11.1	15.4	4.1		
Te123m	2.2	2.3	3.2	7.8		
I128	2.1	1.8				
Te121	1.6	1.6	2.1	4.1		
Te121m	0.7	0.7	1.0	4.0		
Sn121m					53.9	
Sn121					41.8	
I129					4.1	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	5.24E-02	5.12E-02	2.83E-02	9.98E-04	6.88E-09	3.30E-10
Te129	40.7	40.5	32.2	0.5		
Te127	16.7	17.1	16.3	46.3		
Te129m	14.8	15.2	25.5	0.4		
I128	5.0	4.4				
Te125m	4.4	4.5	7.9	2.9		
I130	4.4	4.5	0.1			
Te127m	3.8	3.8	6.8	19.3		
Te121	2.7	2.7	4.6	12.4		
Te131	1.8	1.6				
Te123m	1.6	1.6	2.8	9.9		
I131	1.0	1.0	1.4			
Te121m	0.6	0.6	1.1	6.2		
Sb125			0.1	1.8		
Sn121					65.6	
Sn121m					29.6	
I129					4.8	99.6

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.08E+04	1.05E+04	4.49E+03	2.01E+02	8.53E-06	2.74E-06
I130	26.5	27.1	0.5			
Te129	23.1	23.0	23.6	0.3		
Te121	14.0	14.4	31.1	66.6		
Te129m	10.4	10.7	23.3	0.3		
Te131	3.9	3.5				
I128	2.9	2.6				
I131	2.7	2.8	4.9			
Te131m	2.7	2.8	0.9			
Te127	1.8	1.9	2.3	5.2		
Te121m	1.3	1.3	3.0	13.4		
I126	1.3	1.3	2.5			
Sb126m	1.1	0.9			11.6	35.1
Sb124	1.0	1.0	2.3	0.8		
Te123m	0.6	0.6	1.4	3.8		
Te119m	0.8	0.9	1.2			
Sb125	0.2	0.2	0.5	9.2		
Sn121m					67.4	
I129					18.0	56.1
Sb126	0.5	0.5	1.0		2.9	8.8

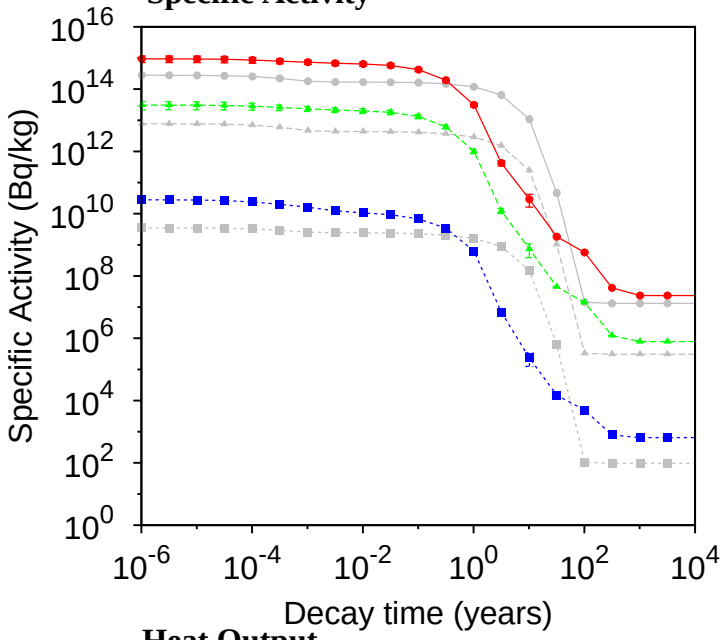
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.39E+06	1.37E+06	1.18E+06	4.05E+04	2.78E+00	2.60E+00
Te129m	34.1	34.9	37.5	0.6		
Te127m	21.6	22.1	25.0	72.9		
I131	8.8	9.0	7.8			
Te125m	6.5	6.6	7.3	2.8		
Xe127	6.2	6.3	6.9	0.2		
Sn125m	3.9	2.7				
Xe131m	3.8	3.9	4.2			
I126	3.4	3.5	3.4			
Te127	2.9	3.0	1.8	5.3		
Te123m	2.1	2.2	2.4	8.7		
Sn127m	1.3	0.6				
Xe129m	1.2	1.3	1.1			
Te121m	1.1	1.1	1.3	7.4		
Te121	0.5	0.5	0.5	1.4		
I129					93.7	100.0
Sn121m					4.3	
Sn121					2.0	

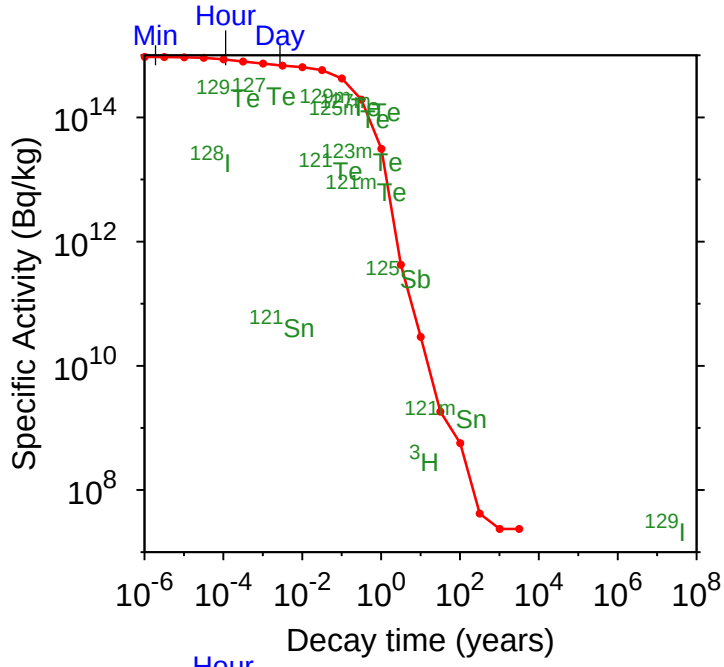
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.81E+06	3.76E+06	3.47E+06	1.58E+05	2.32E+00	8.52E-01
Te127m	33.7	34.1	36.1	79.8		
Te129m	32.9	33.3	33.5	0.4		
Te125m	11.4	11.5	12.0	3.5		
Xe127	9.2	9.4	9.5	0.2		
Te123m	2.8	2.8	3.0	8.2		
Sn125m	2.4	1.6				
Xe131m	2.1	2.1	2.1			
I131	1.1	1.1	0.9			
Te121m	1.0	1.0	1.1	4.7		
Sb125	0.1	0.1	0.1	1.6		
Te127	0.9	0.9	0.5	1.1		
Sn121m					60.8	
I129					36.7	100.0
Sn121					2.4	

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	7.38E+10	7.28E+10	6.29E+10	7.05E+09	2.37E+06	2.37E+06
Te123m	28.5	28.9	32.7	35.8		
Te129m	21.5	21.8	23.4	0.1		
Te127m	17.8	18.0	20.4	18.2		
Te121	11.8	12.0	12.8	10.9		
I128	4.3	3.8				
Sb125	3.7	3.8	4.4	30.4		
Te129	3.0	2.9	1.5			
Te121m	2.1	2.1	2.4	4.2		
I129					99.8	100.0

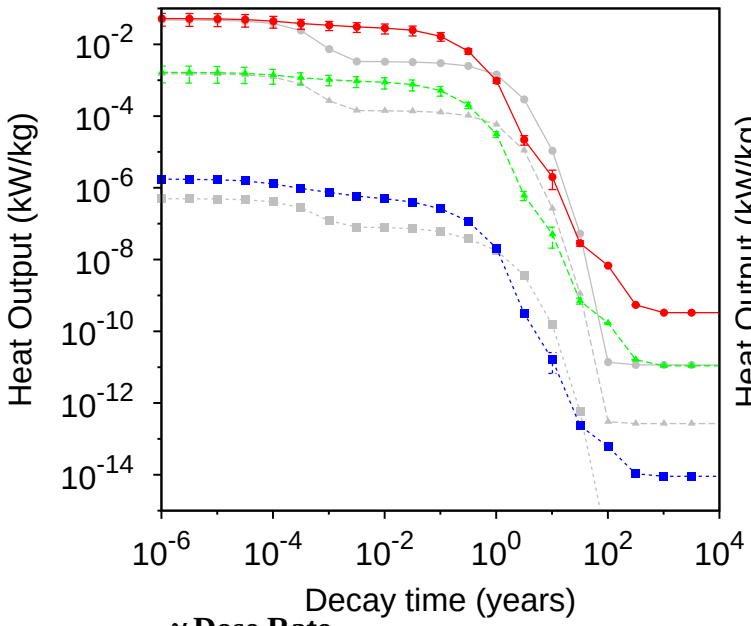
Tellurium activation characteristics

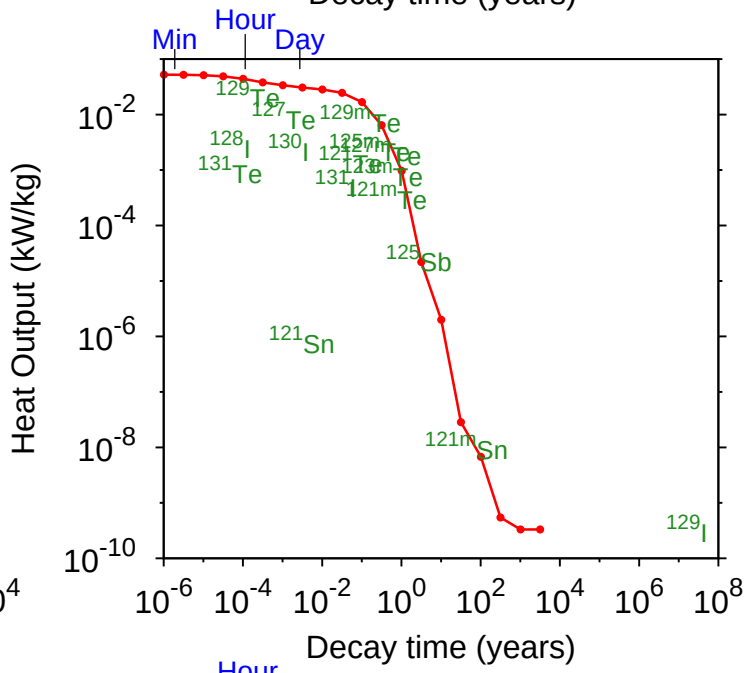
Specific Activity



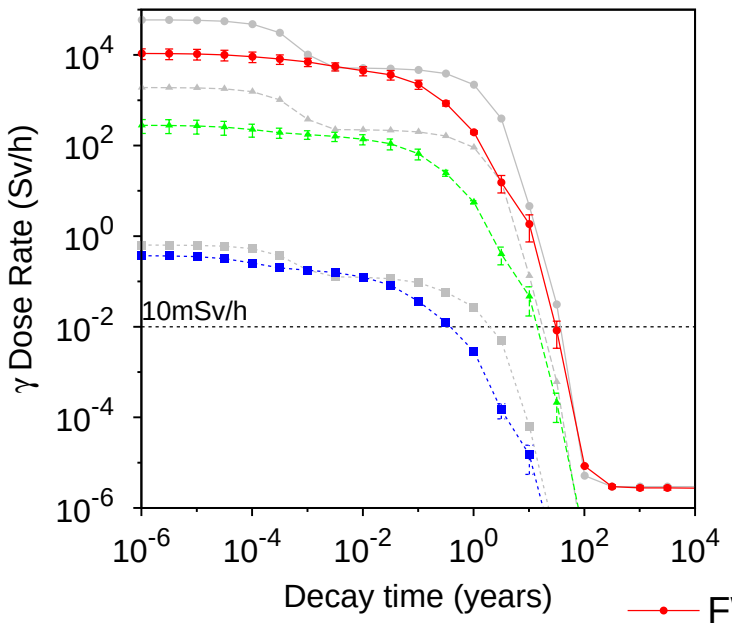


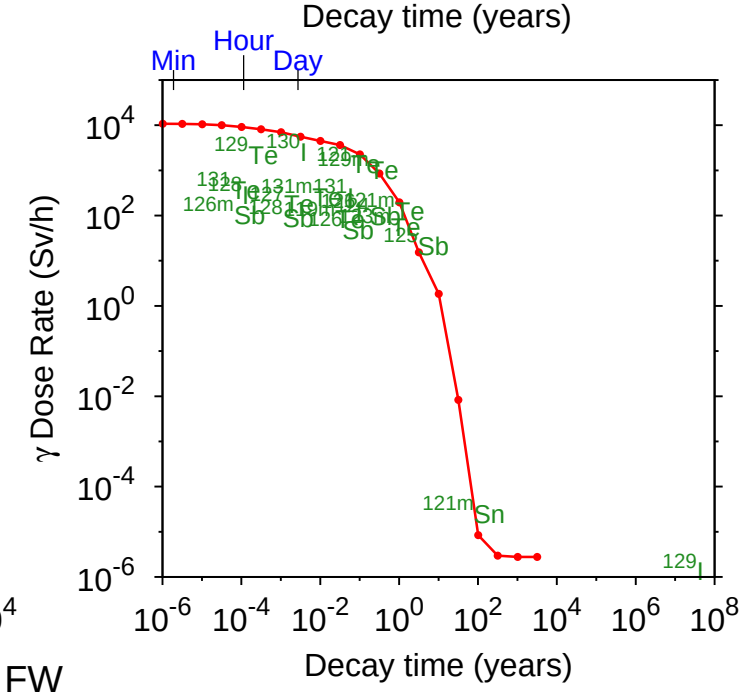
Heat Output





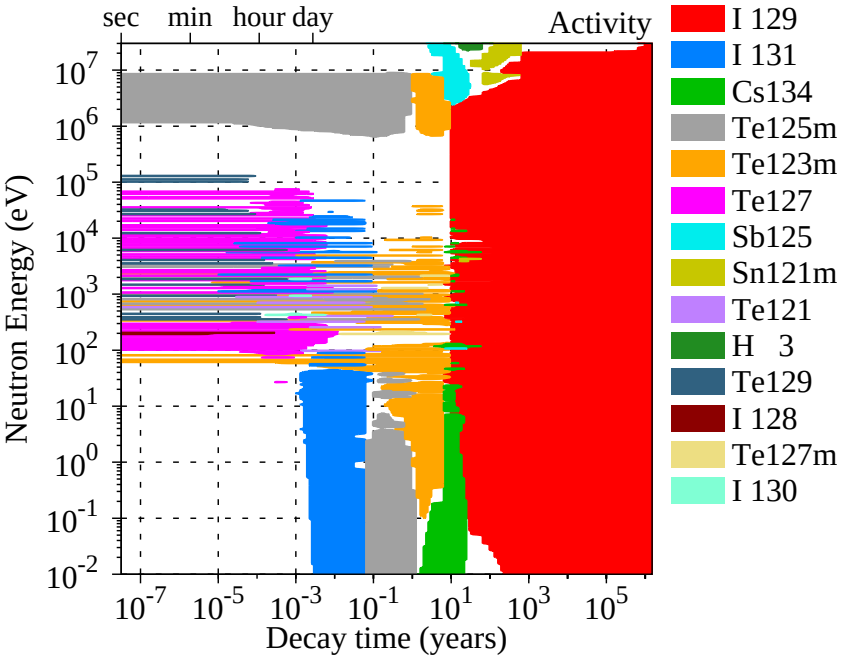
γ Dose Rate

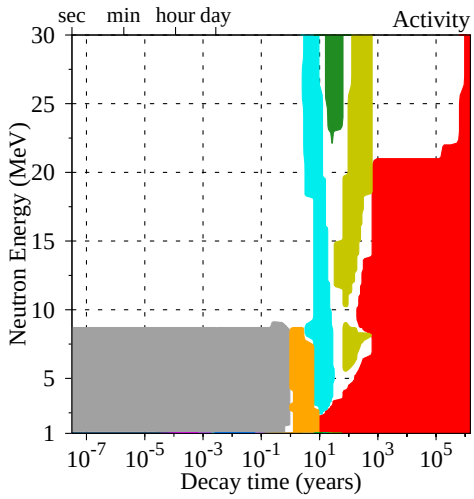


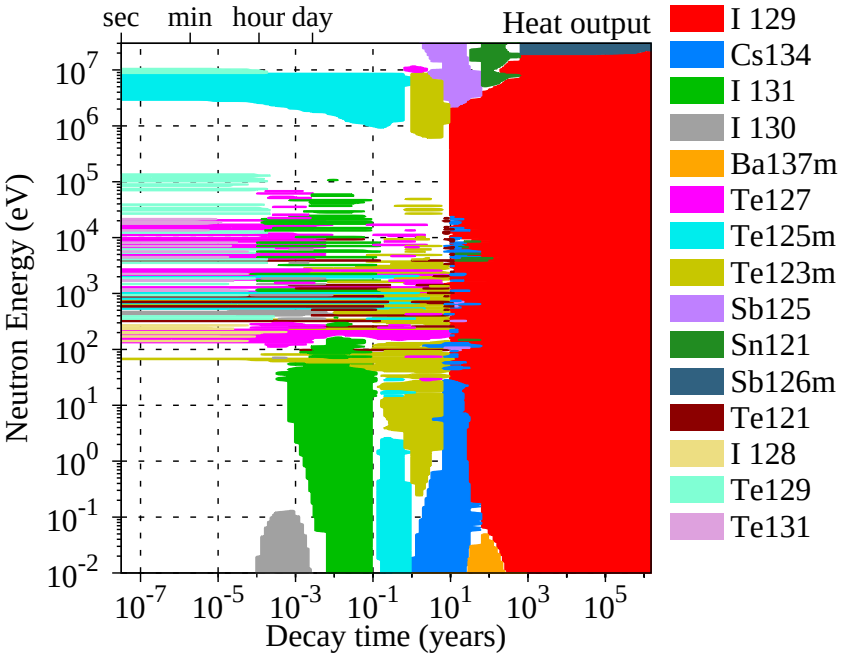


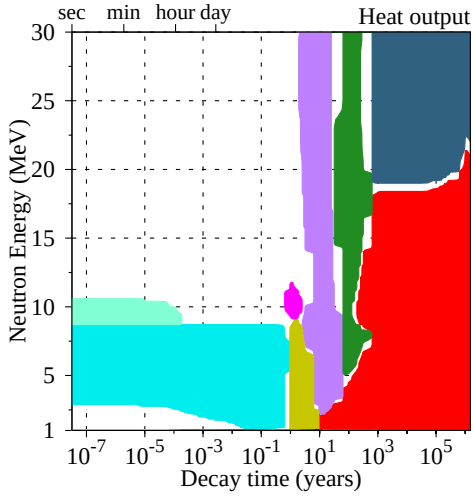
FW
Blanket
Manifold
Fe results

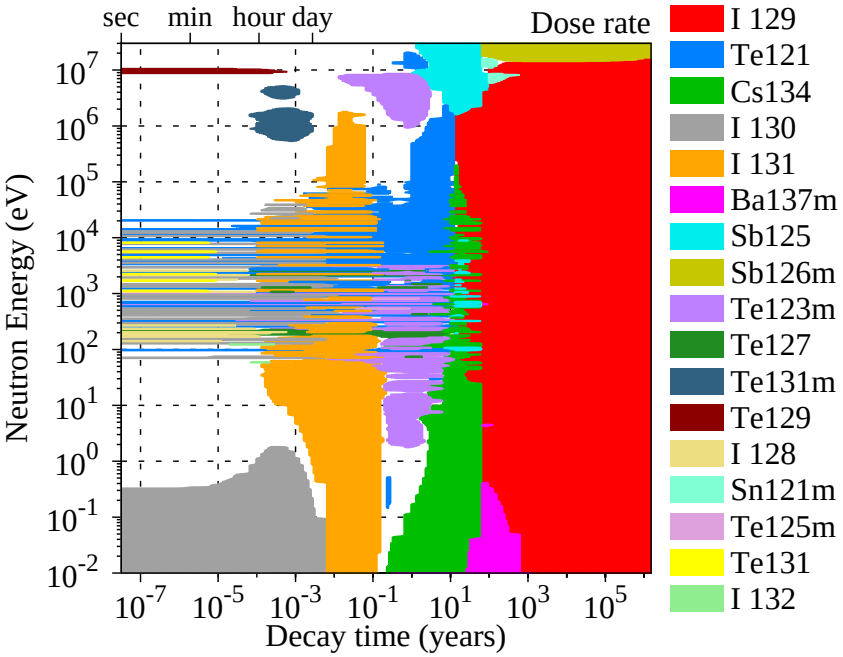
Tellurium Importance diagrams

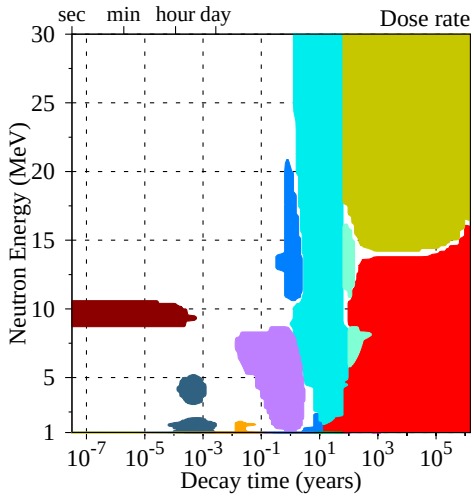




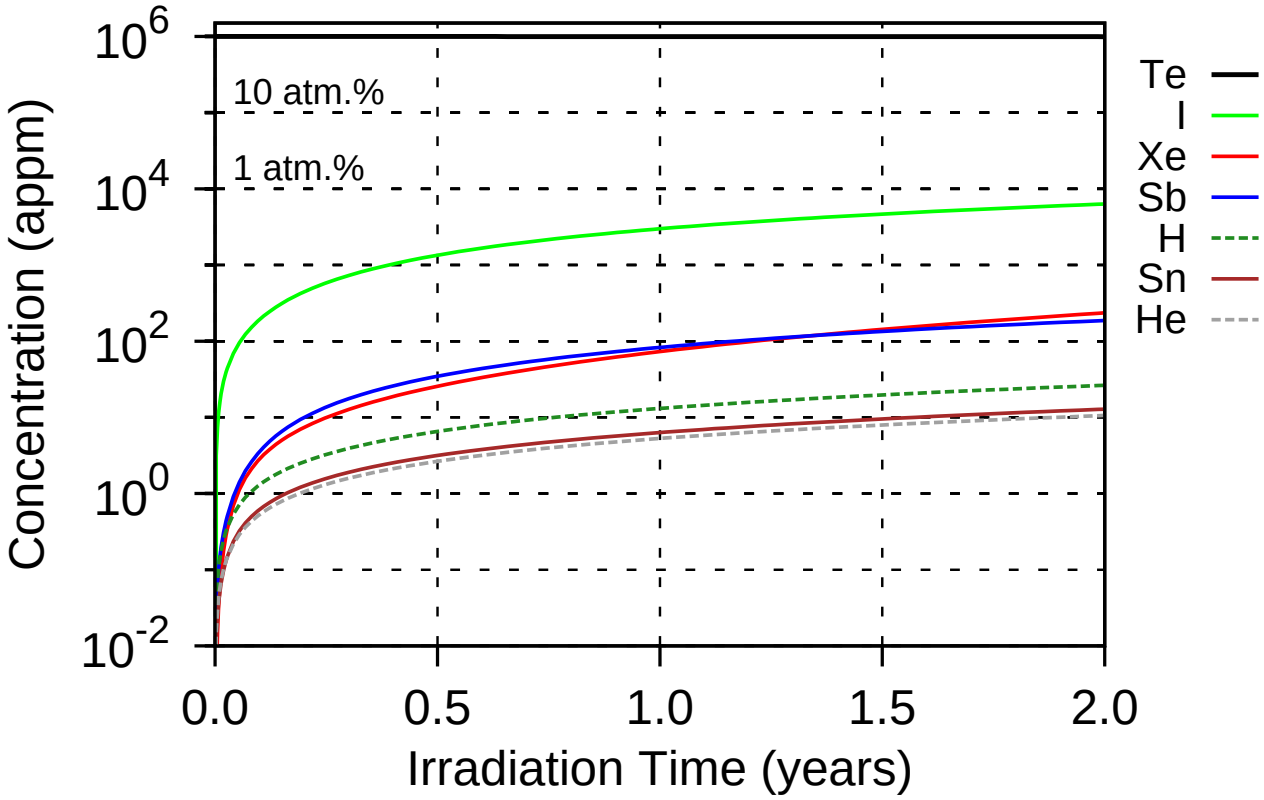






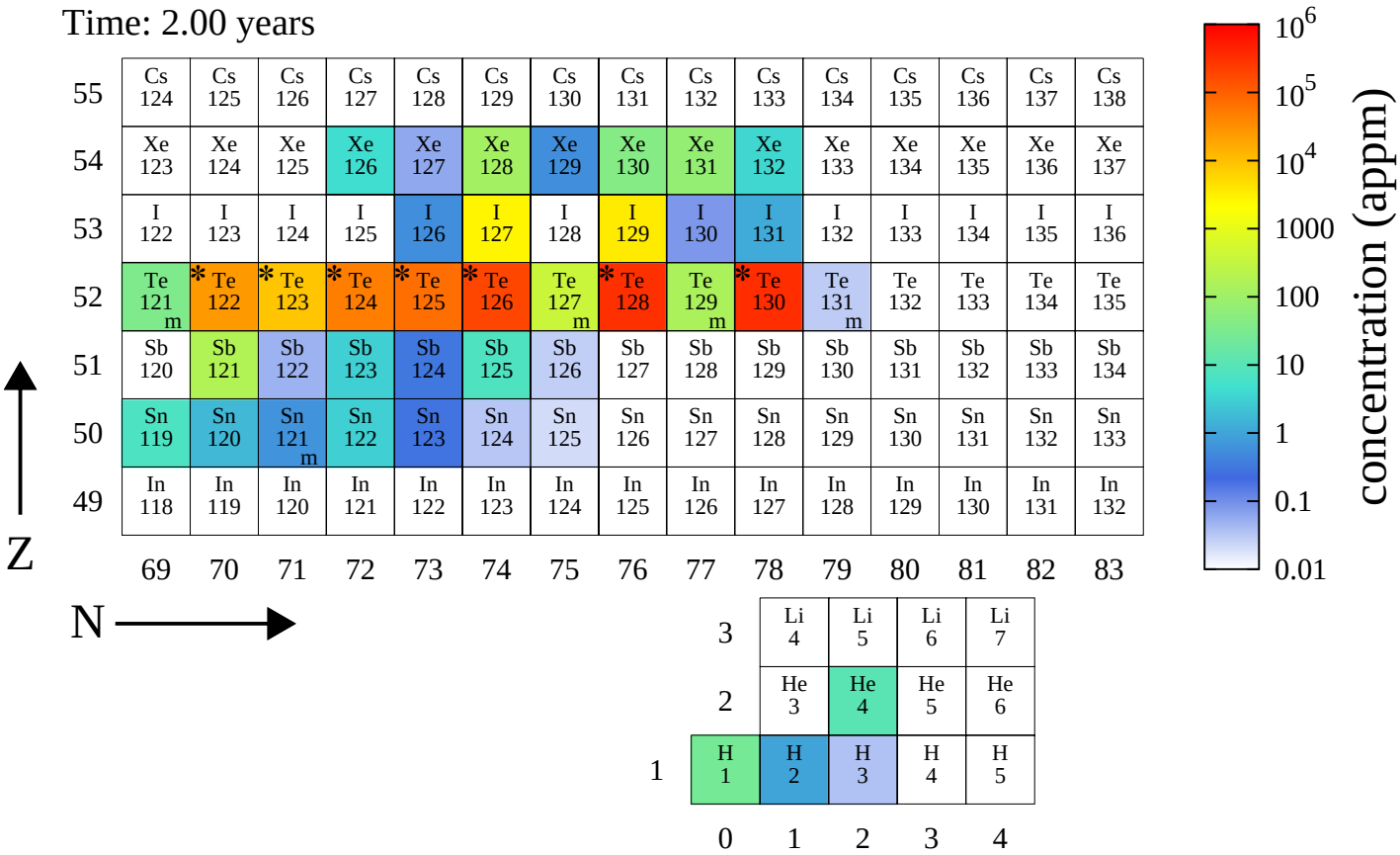


Tellurium FW Transmutation

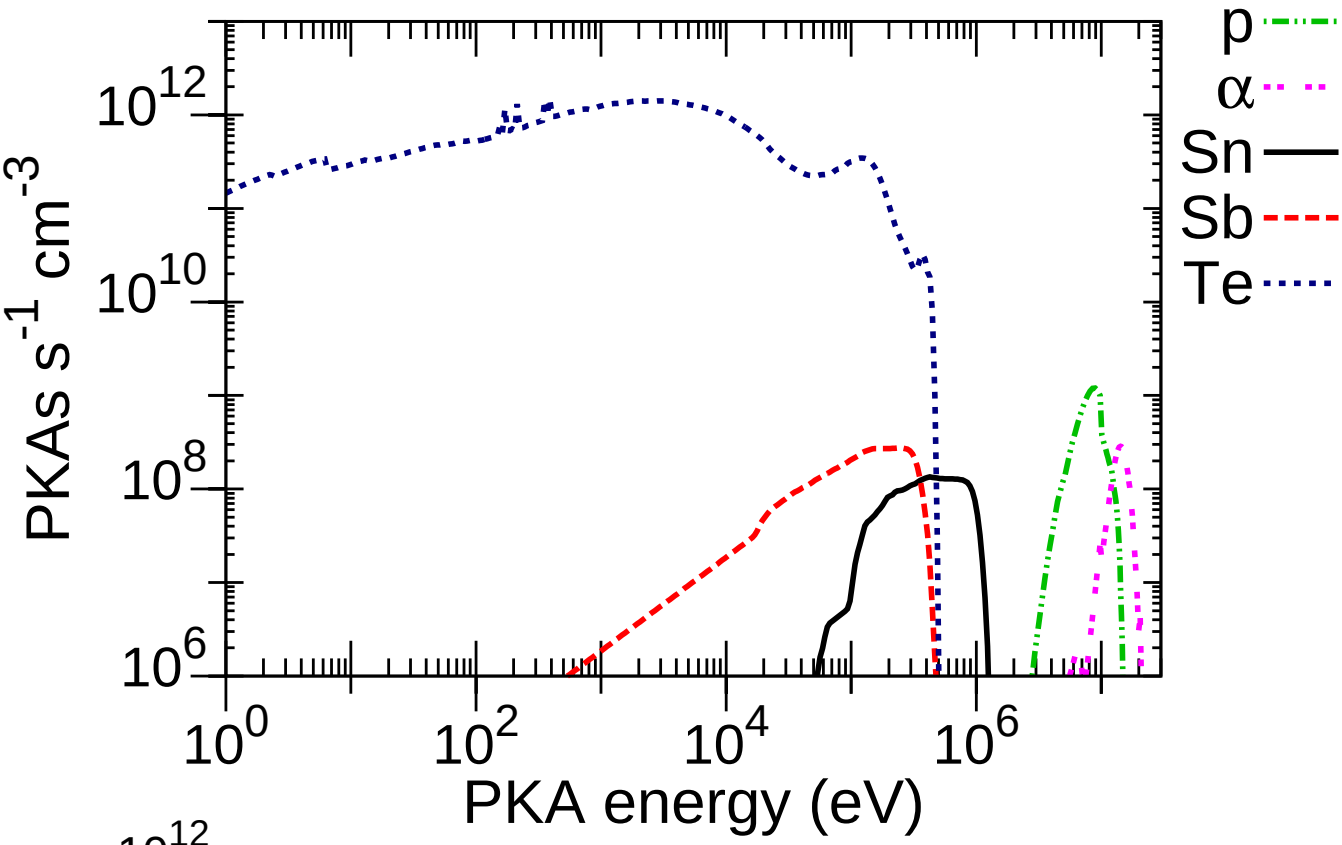


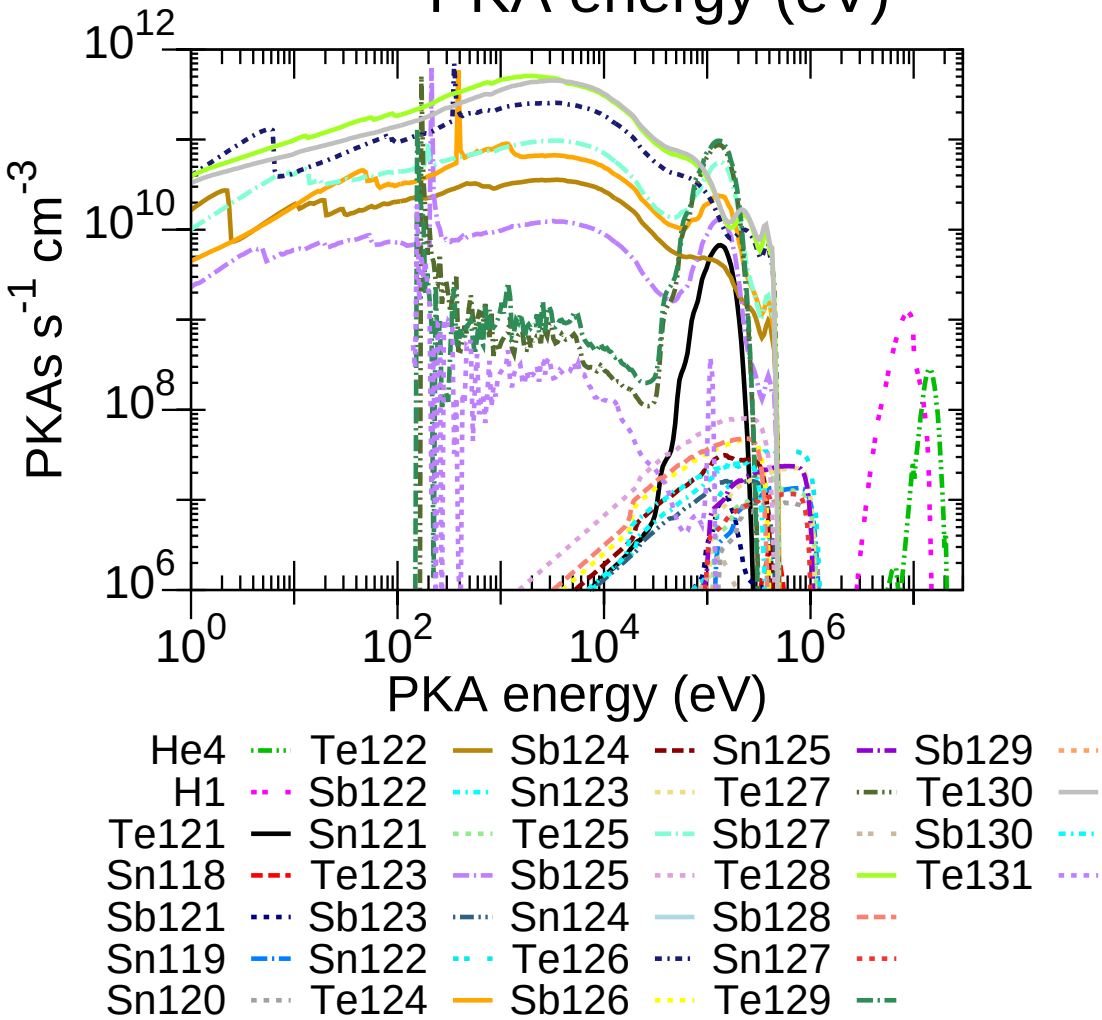
5 appm He & 13 appm H after 1 year

15 dpa/year



Tellurium FW PKA distributions





Tellurium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ba137m	2.55m	no pathways found				
Sn127m	4.13m	Te130(n,α)Sn127m				100.0
Sn125m	9.53m	Te128(n,α)Sn125m				99.6
Sb126m	19.10m	Te125(n,p)Sb125(n,γ)Sb126n(IT)Sb126m			53.4	
		Te125(n,p)Sb125(n,γ)Sb126m			44.9	
		Te126(n,p)Sb126n(IT)Sb126m				56.8
		Te126(n,p)Sb126m				37.0
		Te130(n,2n)Te129(β^-)I129(n,α)Sb126n(IT)Sb126m				1.3
		Te130(n,2n)Te129m(IT)Te129(β^-)I129(n,α)Sb126n(IT)Sb126m				1.2
I128	24.99m	Te126(n,γ)Te127(β^-)I127(n,γ)I128	98.4	92.6	72.4	
		Te125(n,γ)Te126(n,γ)Te127(β^-)I127(n,γ)I128	1.4			
		Te126(n,γ)Te127m(IT)Te127(β^-)I127(n,γ)I128		6.2	25.2	
		Te126(n,γ)Te127m(n,E)Te127(β^-)I127(n,γ)I128			1.6	
		Te130(n,2n)Te129(β^-)I129(n,2n)I128				39.4
		Te130(n,2n)Te129m(IT)Te129(β^-)I129(n,2n)I128				38.0
		Te130(n,2n)Te129m(β^-)I129(n,2n)I128				21.6
Te131	25.00m	Te130(n,γ)Te131	99.0	98.3	89.8	79.3
		Te130(n,γ)Te131m(IT)Te131		1.7	10.1	20.6
Te129	1.16h	Te128(n,γ)Te129	98.8	97.6	86.3	
		Te128(n,γ)Te129m(IT)Te129	1.1	2.3	13.2	
		Te130(n,2n)Te129m(IT)Te129				50.2
		Te130(n,2n)Te129				48.7
I132	2.29h	Te130(n,γ)Te131(β^-)I131(n,γ)I132	94.5	90.4	54.8	
		Te130(n,γ)Te131m(β^-)I131(n,γ)I132	3.4	5.8	23.2	
		Te130(n,γ)Te131(β^-)I131(n,γ)I132m(IT)I132	1.0	1.8	9.3	
		Te130(n,γ)Te131m(IT)Te131(β^-)I131(n,γ)I132		1.5	6.2	
		Te130(n,γ)Te131m(β^-)I131(n,γ)I132m(IT)I132			3.9	
		Te130(n,γ)Te131m(n,γ)Te132(β^-)I132			1.4	
		Te130(n,γ)Te131m(IT)Te131(β^-)I131(n,γ)I132m(IT)I132			1.0	
Te127	9.35h	Te126(n,γ)Te127	96.9	90.9	68.3	
		Te125(n,γ)Te126(n,γ)Te127	2.6	1.0		
		Te126(n,γ)Te127m(IT)Te127		7.5	29.6	
		Te126(n,γ)Te127m(n,E)Te127			1.9	
		Te128(n,2n)Te127m(IT)Te127				60.4
		Te128(n,2n)Te127				37.1
		Te128(n,2n)Te127m(n,E)Te127				2.3
I130	12.36h	Te128(n,γ)Te129(β^-)I129(n,γ)I130	59.3	60.4	66.3	
		Te128(n,γ)Te129(β^-)I129(n,γ)I130m(IT)I130	38.9	36.1	15.0	
		Te128(n,γ)Te129m(IT)Te129(β^-)I129(n,γ)I130		1.4	9.5	
		Te128(n,γ)Te129m(β^-)I129(n,γ)I130			5.4	
		Te128(n,γ)Te129m(IT)Te129(β^-)I129(n,γ)I130m(IT)I130			2.1	
		Te128(n,γ)Te129m(β^-)I129(n,γ)I130m(IT)I130			1.2	
		Te130(n,2n)Te129(β^-)I129(n,γ)I130				30.7
		Te130(n,2n)Te129m(IT)Te129(β^-)I129(n,γ)I130				29.6
		Te130(n,2n)Te129m(β^-)I129(n,γ)I130				16.9
		Te130(n,2n)Te129(β^-)I129(n,γ)I130m(IT)I130				8.3
		Te130(n,2n)Te129m(IT)Te129(β^-)I129(n,γ)I130m(IT)I130				8.0
		Te130(n,2n)Te129m(β^-)I129(n,γ)I130m(IT)I130				4.5
Sn121	1.12d	Te123(n,α)Sn120(n,γ)Sn121	57.9	96.5	9.8	
		Te122(n,γ)Te123(n,α)Sn120(n,γ)Sn121	29.3	1.7		
		Te124(n,α)Sn121	7.2		78.9	45.5
		Te123(n,γ)Te124(n,α)Sn121	1.4			
		Te122(n,γ)Te123m(n,α)Sn120(n,γ)Sn121	1.3			
		Te123(n,α)Sn120(n,γ)Sn121m(n,E)Sn121		1.4		
		Te124(n,α)Sn121m(n,E)Sn121			7.4	12.4
		Te120(n,γ)Te121(β^+)Sb121(n,p)Sn121			1.1	
		Te125(n,α)Sn122(n,2n)Sn121				11.4
		Te125(n,2n)Te124(n,α)Sn121				7.1
		Te122(n,2n)Te121(β^+)Sb121(n,p)Sn121				4.8
		Te125(n,nα)Sn121				2.9
		Te122(n,2n)Te121m(IT)Te121(β^+)Sb121(n,p)Sn121				2.7
		Te125(n,α)Sn122(n,2n)Sn121m(n,E)Sn121				1.8
		Te124(n,α)Sn121m(IT)Sn121				1.8
		Te125(n,nα)Sn121m(n,E)Sn121				1.0
		Te125(n,2n)Te124(n,α)Sn121m(n,E)Sn121				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Te131m	1.25d	Te130(n,γ)Te131m	100.0	100.0	100.0	100.0
Te119m	4.70d	Te120(n,2n)Te119m				97.4
		Te122(n,2n)Te121m(n,2n)Te120(n,2n)Te119m				1.8
I131	8.02d	Te130(n,γ)Te131(β^-)I131	95.6	92.5	65.1	44.6
		Te130(n,γ)Te131m(β^-)I131	3.4	5.9	27.6	43.7
		Te130(n,γ)Te131m(IT)Te131(β^-)I131		1.6	7.3	11.6
Xe129m	8.88d	Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^-)Xe128(n,γ)Xe129m	98.9	93.8	74.4	
		Te126(n,γ)Te127m(IT)Te127(β^-)I127(n,γ)I128(β^-) Xe128(n,γ)Xe129m		5.3	21.8	
		Te126(n,γ)Te127m(n,E)Te127(β^-)I127(n,γ)I128(β^-) Xe128(n,γ)Xe129m			1.4	
		Te126(n,γ)Te127(β^-)I127(n,γ)I128(β^-)Xe128(n,γ) Xe129(n,n$'$)Xe129m			1.0	
Xe131m	11.93d	Te130(n,γ)Te131(β^-)I131(β^-)Xe131m	66.4	92.2	21.1	26.9
		Te128(n,γ)Te129(β^-)I129(n,γ)I130(β^-)Xe130(n,γ)Xe131m	16.7			
		Te128(n,γ)Te129(β^-)I129(n,γ)I130m(IT)I130(β^-) Xe130(n,γ)Xe131m	10.9			
		Te130(n,γ)Te131m(β^-)I131(β^-)Xe131m	2.4	5.9	8.9	26.4
		Te128(n,γ)Te129(β^-)I129(n,γ)I130m(β^-)Xe130(n,γ)Xe131m	2.2			
		Te130(n,γ)Te131m(IT)Te131(β^-)I131(β^-)Xe131m		1.6	2.4	7.0
		Te130(n,γ)Te131(β^-)I131(β^-)Xe131(n,n$'$)Xe131m			44.1	17.4
		Te130(n,γ)Te131m(β^-)I131(β^-)Xe131(n,n$'$)Xe131m			18.6	17.0
		Te130(n,γ)Te131m(IT)Te131(β^-)I131(β^-)Xe131(n,n$'$)Xe131m			4.9	4.5
Sb126	12.40d	Te125(n,p)Sb125(n,γ)Sb126			55.3	
		Te125(n,p)Sb125(n,γ)Sb126n(IT)Sb126m(IT)Sb126			23.3	
		Te125(n,p)Sb125(n,γ)Sb126m(IT)Sb126			19.6	
		Te126(n,p)Sb126				45.2
		Te126(n,p)Sb126n(IT)Sb126m(IT)Sb126				27.9
		Te126(n,p)Sb126m(IT)Sb126				18.2
		Te130(n,2n)Te129(β^-)I129(n,α)Sb126				2.1
		Te130(n,2n)Te129m(IT)Te129(β^-)I129(n,α)Sb126				2.0
		Te130(n,2n)Te129m(β^-)I129(n,α)Sb126				1.1
I126	12.98d	Te128(n,2n)Te127m(IT)Te127(β^-)I127(n,2n)I126				54.3
		Te128(n,2n)Te127(β^-)I127(n,2n)I126				42.0
		Te128(n,2n)Te127m(n,E)Te127(β^-)I127(n,2n)I126				2.1
		Te128(n,2n)Te127m(β^-)I127(n,2n)I126				1.3
Te121	19.16d	Te120(n,γ)Te121	97.8	92.1	77.4	
		Te120(n,γ)Te121m(IT)Te121	1.9	7.3	20.5	
		Te120(n,γ)Te121m(n,E)Te121			1.8	
		Te122(n,2n)Te121				53.4
		Te122(n,2n)Te121m(IT)Te121				40.5
		Te122(n,2n)Te121m(n,E)Te121				2.3
		Te123(n,2n)Te122(n,2n)Te121				1.8
		Te123(n,2n)Te122(n,2n)Te121m(IT)Te121				1.0
Te129m	33.60d	Te128(n,γ)Te129m	99.9	100.0	100.0	
		Te130(n,2n)Te129m				99.9
Xe127	36.40d	Te130(n,2n)Te129(β^-)I129(n,2n)I128(β^-)Xe128(n,2n) Xe127m(IT)Xe127				24.0
		Te130(n,2n)Te129m(IT)Te129(β^-)I129(n,2n)I128(β^-) Xe128(n,2n)Xe127m(IT)Xe127				21.5
		Te130(n,2n)Te129(β^-)I129(n,2n)I128(β^-)Xe128(n,2n)Xe127				17.2
		Te130(n,2n)Te129m(IT)Te129(β^-)I129(n,2n)I128(β^-) Xe128(n,2n)Xe127				15.4
		Te130(n,2n)Te129m(β^-)I129(n,2n)I128(β^-)Xe128(n,2n) Xe127m(IT)Xe127				12.2
		Te130(n,2n)Te129m(β^-)I129(n,2n)I128(β^-)Xe128(n,2n)Xe127				8.8
Te125m	57.39d	Te124(n,γ)Te125m	76.8	98.7	2.8	
		Te123(n,γ)Te124(n,γ)Te125m	14.6	1.3		
		Te122(n,γ)Te123(n,γ)Te124(n,γ)Te125m	7.7			
		Te125(n,n$'$)Te125m			97.1	6.0
		Te126(n,2n)Te125m				92.2

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sb124	60.18d	Te120(n,γ)Te121(β^+)Sb121(n,γ)Sb122(n,γ)Sb123(n,γ)Sb124	75.6	68.8		
		Te120(n,γ)Te121(β^+)Sb121(n,γ)Sb122(n,γ)Sb123(n,γ) Sb124m(IT)Sb124	18.2	17.8		
		Te120(n,γ)Te121m(IT)Te121(β^+)Sb121(n,γ)Sb122(n,γ) Sb123(n,γ)Sb124	1.2	3.1		
		Te120(n,γ)Te121(β^+)Sb121(n,γ)Sb122(n,γ)Sb123(n,γ) Sb124n(IT)Sb124m(IT)Sb124		4.7		
		Te120(n,γ)Te121(β^+)Sb121(n,γ)Sb122(β^+)Sn122(n,γ) Sn123m(β^-)Sb123(n,γ)Sb124		1.4		
		Te123(n,p)Sb123(n,γ)Sb124			53.0	
		Te123(n,p)Sb123(n,γ)Sb124n(IT)Sb124m(IT)Sb124			21.7	
		Te123(n,p)Sb123(n,γ)Sb124m(IT)Sb124			21.2	
		Te126(n,γ)Te127(β^-)I127(n,α)Sb124			1.1	
		Te124(n,p)Sb124				35.3
		Te124(n,p)Sb124m(IT)Sb124				10.3
		Te124(n,p)Sb124n(IT)Sb124m(IT)Sb124				9.0
		Te125(n,p)Sb125(n,2n)Sb124				5.5
		Te125(n,2n)Te124(n,p)Sb124				4.9
		Te125(n,p)Sb125(n,2n)Sb124n(IT)Sb124m(IT)Sb124				3.8
		Te125(n,d)Sb124				3.0
		Te128(n,2n)Te127m(IT)Te127(β^-)I127(n,α)Sb124				3.0
		Te128(n,2n)Te127(β^-)I127(n,α)Sb124				2.4
		Te125(n,np)Sb124				2.3
		Te125(n,p)Sb125(n,2n)Sb124m(IT)Sb124				2.1
		Te125(n,2n)Te124(n,p)Sb124m(IT)Sb124				1.4
		Te128(n,2n)Te127m(IT)Te127(β^-)I127(n,α)Sb124n(IT) Sb124m(IT)Sb124				1.3
		Te125(n,2n)Te124(n,p)Sb124n(IT)Sb124m(IT)Sb124				1.2
		Te125(n,d)Sb124m(IT)Sb124				1.2
		Te125(n,np)Sb124m(IT)Sb124				1.1
		Te128(n,2n)Te127(β^-)I127(n,α)Sb124n(IT)Sb124m(IT)Sb124				1.0
		Te128(n,2n)Te127m(IT)Te127(β^-)I127(n,α)Sb124m(IT)Sb124				1.0
Te127m	109.00d	Te126(n,γ)Te127m	97.0	99.1	99.9	
		Te125(n,γ)Te126(n,γ)Te127m	2.6			
		Te128(n,2n)Te127m				99.8
Te123m	119.51d	Te122(n,γ)Te123m	99.9	100.0	18.9	
		Te123(n,n′)Te123m			80.4	3.6
		Te124(n,2n)Te123m				83.5
		Te125(n,2n)Te124(n,2n)Te123m				10.3
Te121m	154.01d	Te120(n,γ)Te121m	100.0	100.0	99.8	
		Te122(n,2n)Te121m				96.8
		Te123(n,2n)Te122(n,2n)Te121m				2.5
Cs134	2.06y	Te130(n,γ)Te131(β^-)I131(β^-)Xe131(n,γ)Xe132(n,γ)Xe133(β^-) Cs133(n,γ)Cs134	82.7	86.5	41.4	
		Te130(n,γ)Te131(β^-)I131(n,γ)I132(β^-)Xe132(n,γ)Xe133(β^-) Cs133(n,γ)Cs134	8.7	1.7	1.4	
		Te130(n,γ)Te131m(β^-)I131(β^-)Xe131(n,γ)Xe132(n,γ) Xe133(β^-)Cs133(n,γ)Cs134	2.9	5.5	17.4	
		Te128(n,γ)Te129(β^-)I129(n,γ)I130(β^-)Xe130(n,γ)Xe131(n,γ) Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134	1.1			
		Te130(n,γ)Te131(β^-)I131(β^-)Xe131(n,γ)Xe132(n,γ) Xe133m(IT)Xe133(β^-)Cs133(n,γ)Cs134		2.2	12.5	
		Te130(n,γ)Te131m(IT)Te131(β^-)I131(β^-)Xe131(n,γ) Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134		1.5	4.6	
		Te130(n,γ)Te131(β^-)I131(β^-)Xe131(n,γ)Xe132(n,γ)Xe133(β^-) Cs133(n,γ)Cs134m(IT)Cs134		1.0	5.7	
		Te130(n,γ)Te131m(β^-)I131(β^-)Xe131(n,γ)Xe132(n,γ) Xe133m(IT)Xe133(β^-)Cs133(n,γ)Cs134			5.2	
		Te130(n,γ)Te131m(β^-)I131(β^-)Xe131(n,γ)Xe132(n,γ) Xe133(β^-)Cs133(n,γ)Cs134m(IT)Cs134			2.4	
		Te130(n,γ)Te131(β^-)I131(β^-)Xe131(n,γ)Xe132(n,γ) Xe133m(IT)Xe133(β^-)Cs133(n,γ)Cs134m(IT)Cs134			1.7	
		Te130(n,γ)Te131m(IT)Te131(β^-)I131(β^-)Xe131(n,γ) Xe132(n,γ)Xe133m(IT)Xe133(β^-)Cs133(n,γ)Cs134			1.4	

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sb125	2.76y	Te120(n,γ)Te121(β^+)Sb121(n,γ)Sb122(n,γ)Sb123(n,γ) Sb124(n,γ)Sb125		69.6		
		Te120(n,γ)Te121(β^+)Sb121(n,γ)Sb122(n,γ)Sb123(n,γ) Sb124m(IT)Sb124(n,γ)Sb125		18.0		
		Te120(n,γ)Te121(β^+)Sb121(n,γ)Sb122(n,γ)Sb123(n,γ) Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125		4.8		
		Te120(n,γ)Te121m(IT)Te121(β^+)Sb121(n,γ)Sb122(n,γ) Sb123(n,γ)Sb124(n,γ)Sb125		2.7		
		Te120(n,γ)Te121(β^+)Sb121(n,γ)Sb122(β^+)Sn122(n,γ) Sn123m(β^-)Sb123(n,γ)Sb124(n,γ)Sb125		1.1		
		Te125(n,p)Sb125			98.8	68.7
		Te128(n,α)Sn125(β^-)Sb125				10.0
		Te128(n,α)Sn125m(β^-)Sb125				7.4
		Te126(n,2n)Te125m(IT)Te125(n,p)Sb125				5.1
		Te126(n,2n)Te125(n,p)Sb125				3.6
		Te126(n,d)Sb125				2.4
		Te126(n,np)Sb125				1.2
H3	12.33y	Te120(n,γ)Te121(β^+)Sb121(n,γ)Sb122(n,p)H1(n,γ)H2(n,γ)H3	77.7			
		Te120(n,γ)Te121(n,p)H1(n,γ)H2(n,γ)H3	14.4			
		Te120(n,γ)Te121m(n,p)H1(n,γ)H2(n,γ)H3	5.8			
		Te120(n,γ)Te121m(IT)Te121(β^+)Sb121(n,γ)Sb122(n,p)H1(n,γ) H2(n,γ)H3	1.0			
		Te125(n,t)H3				61.3
		Te123(n,t)H3				11.2
		Te126(n,2n)Te125m(IT)Te125(n,t)H3				4.1
		Te126(n,2n)Te125(n,t)H3				3.0
		Te128(n,2n)Te127m(IT)Te127(β^-)I127(n,t)H3				1.6
		Te128(n,2n)Te127(β^-)I127(n,t)H3				1.4
		Te130(n,2n)Te129(β^-)I129(n,t)H3				1.0
		Te130(n,2n)Te129m(IT)Te129(β^-)I129(n,t)H3				1.4
		Te124(n,2n)Te123m(IT)Te123(n,t)H3				1.1
		Te124(n,2n)Te123(n,t)H3				1.0
Sn121m	43.90y	Te123(n,α)Sn120(n,γ)Sn121m	56.7	98.2	10.2	
		Te122(n,γ)Te123(n,α)Sn120(n,γ)Sn121m	20.8	1.2		
		Te124(n,α)Sn121m	16.4		87.4	68.5
		Te123(n,γ)Te124(n,α)Sn121m	3.1			
		Te122(n,γ)Te123(n,γ)Te124(n,α)Sn121m	1.3			
		Te120(n,γ)Te121(β^+)Sb121(n,p)Sn121m			1.7	
		Te125(n,α)Sn122(n,2n)Sn121m				10.2
		Te125(n,nα)Sn121m				5.6
		Te125(n,2n)Te124(n,α)Sn121m				5.6
		Te122(n,2n)Te121(β^+)Sb121(n,p)Sn121m				4.7
		Te122(n,2n)Te121m(IT)Te121(β^+)Sb121(n,p)Sn121m				2.2
I129	1.6 10^7y	Te128(n,γ)Te129(β^-)I129	98.3	96.5	81.3	
		Te128(n,γ)Te129m(IT)Te129(β^-)I129	1.0	2.2	11.7	
		Te128(n,γ)Te129m(β^-)I129		1.2	6.7	
		Te130(n,2n)Te129(β^-)I129				39.5
		Te130(n,2n)Te129m(IT)Te129(β^-)I129				38.0
		Te130(n,2n)Te129m(β^-)I129				21.7

Iodine

Isotope	Atom % abundance
I127	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.99E+15	1.80E+15	5.21E+14	9.53E+11	8.82E+06	7.97E+03
I128	67.6	64.6				
I126	30.2	33.4	94.8			
Xe127	0.7	0.8	2.5	1.4		
Te127m	0.2	0.2	0.8	46.1		
Te127	0.5	0.5	0.8	45.2		
I125	0.1	0.1	0.3	2.7		
Te125m	0.1	0.1	0.3	2.3		
Sb124	0.1	0.1	0.2	1.8		
H3				0.2	98.9	
I129					0.1	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.36E-01	2.11E-01	4.72E-02	3.01E-05	9.12E-12	1.11E-13
I128	75.4	72.8				
I126	23.7	26.4	97.2			
Xe127	0.3	0.3	1.4	2.2		
Te127	0.1	0.2	0.3	52.6		
Te127m			0.1	21.9		
Sb124	0.2	0.2	0.8	20.0		
Te125m			0.1	1.6		
H3					87.5	
Sn121					7.8	
Sn121m					3.5	
I129					1.2	100.0

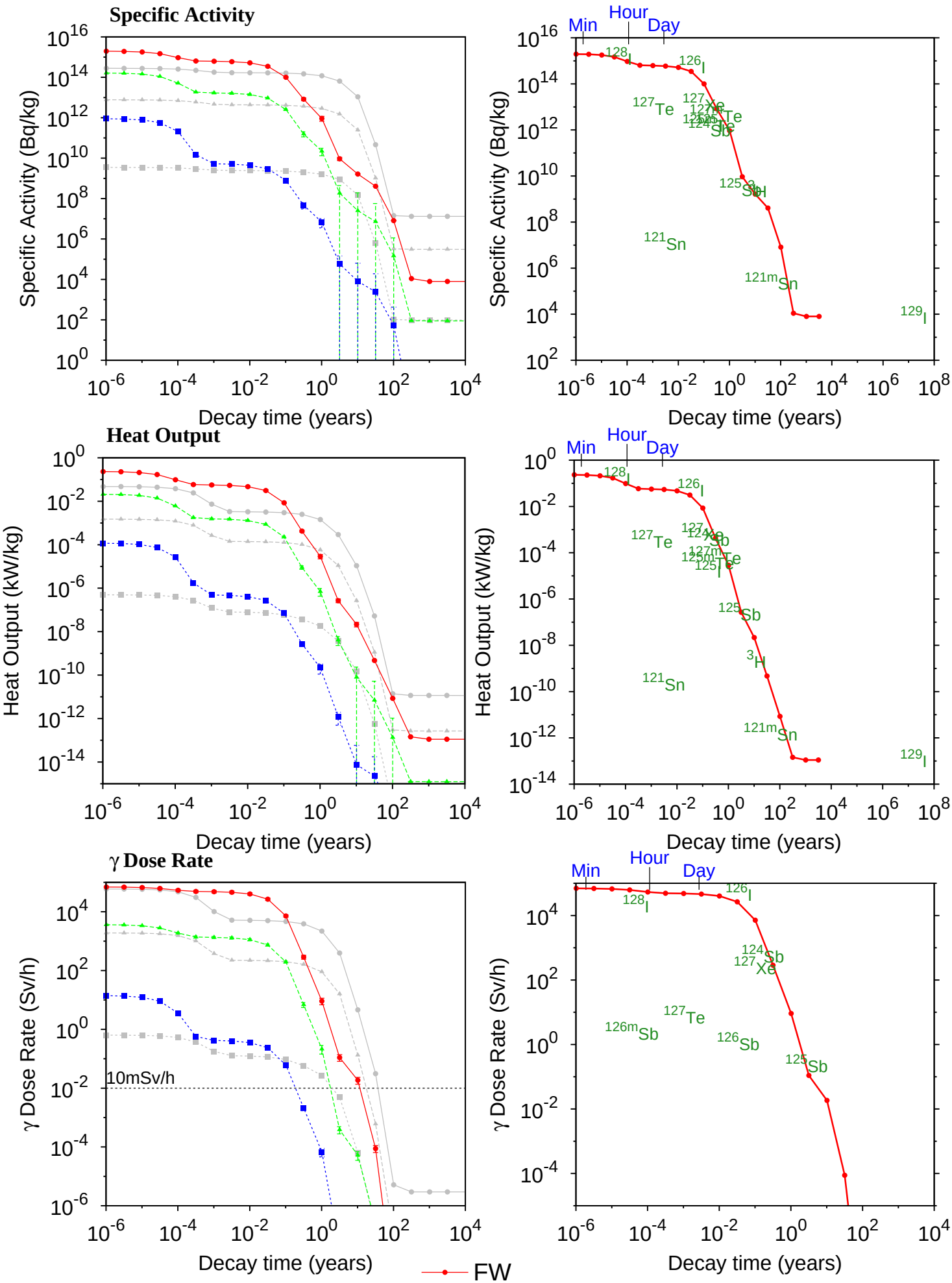
Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	6.97E+04	6.69E+04	4.04E+04	9.69E+00	1.41E-09	5.00E-10
I126	69.0	71.9	98.0			
I128	29.6	26.7				
Sb124	0.9	0.9	1.4	91.7		
Te127				3.5		
Xe127	0.4	0.4	0.6	2.5		
Sb125				1.9	0.9	
Sn121m					63.6	
I129					35.0	98.6
Sb126					0.5	1.4

Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.82E+07	3.81E+07	3.31E+07	2.04E+04	1.27E-03	8.77E-04
Xe127	51.6	51.6	55.4	92.5		
I126	45.6	45.6	43.2			
Xe129m	1.4	1.4	1.2			
Xe125	1.1	1.1				
Te127m				5.0		
I125	0.1	0.1	0.1	1.9		
I129					69.0	100.0
H3					28.8	
Sn121m					1.5	

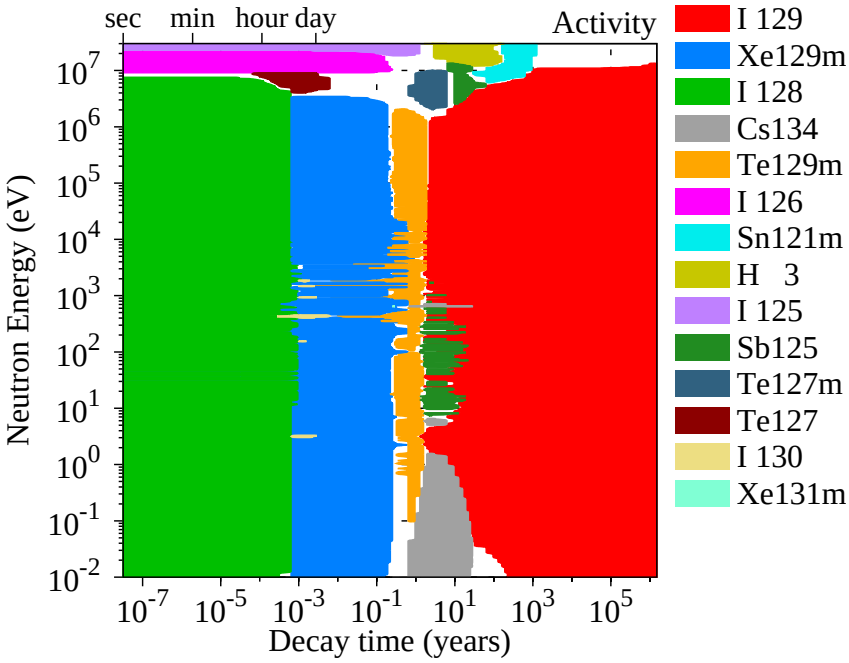
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	8.69E+07	8.69E+07	8.01E+07	8.15E+04	2.79E-03	2.87E-04
Xe127	92.2	92.2	93.3	94.2		
I126	6.8	6.8	6.0			
Te127m	0.1	0.1	0.1	5.3		
H3					81.4	
I129					10.3	100.0
Sn121m					8.0	

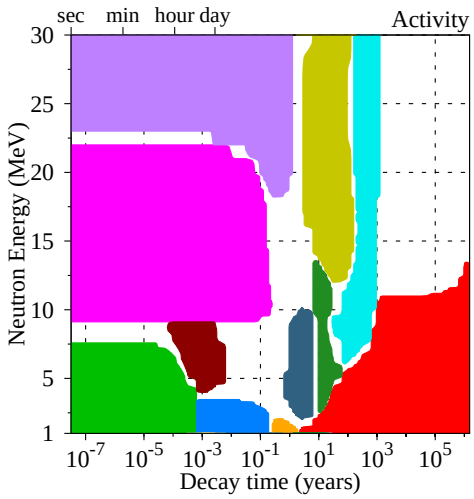
Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.84E+11	2.54E+11	5.48E+10	8.84E+07	8.86E+02	7.97E+02
I128	76.1	73.8				
I126	21.1	23.7	90.2			
Xe127	1.4	1.6	6.8	4.4		
Sb124	0.4	0.4	2.0	19.1		
Te127m	0.2	0.2	0.8	49.7		
Sb125			0.1	25.1		
I129					90.1	100.0
H3					9.8	

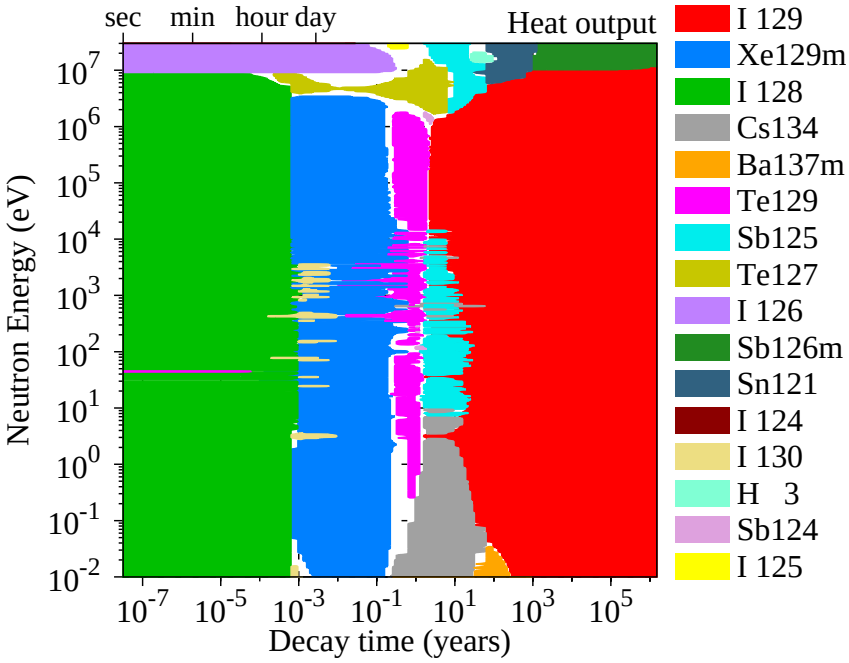
Iodine activation characteristics

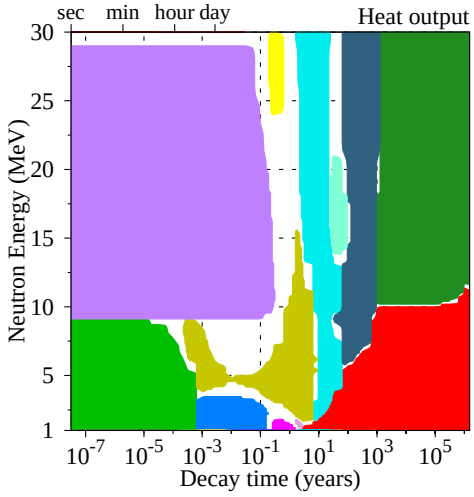


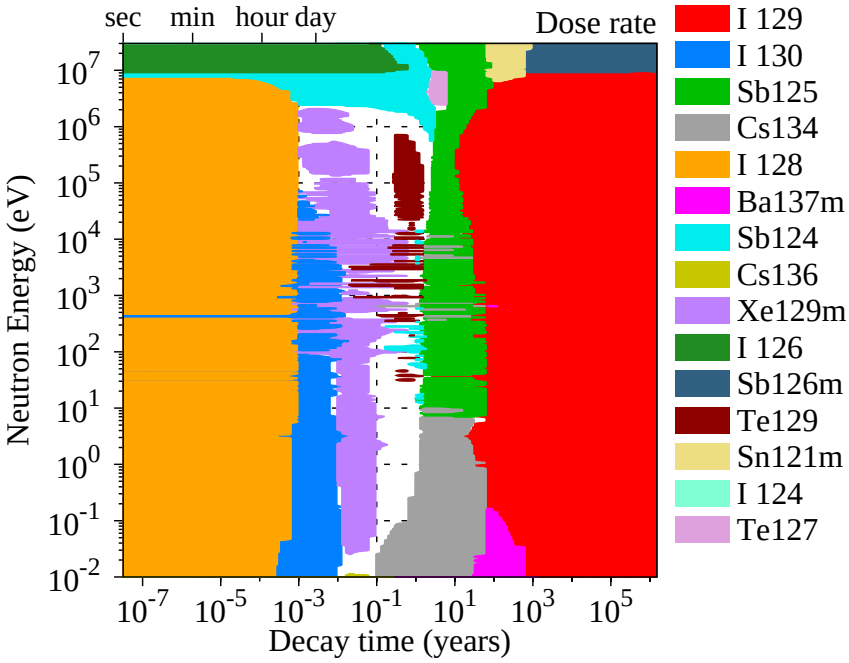
Iodine Importance diagrams

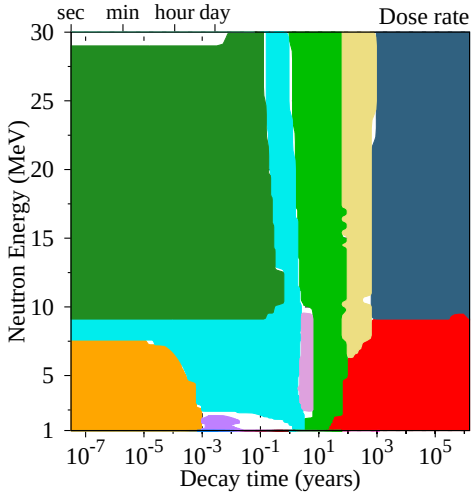




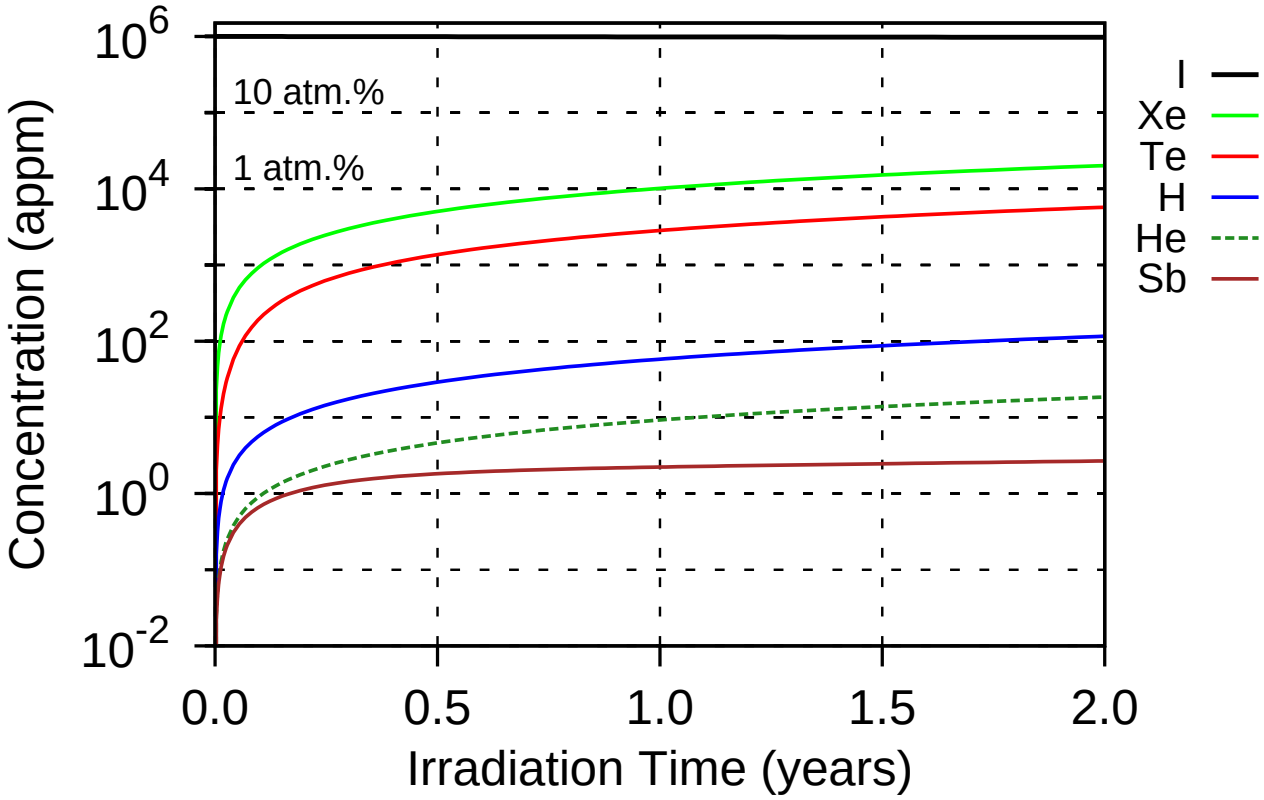






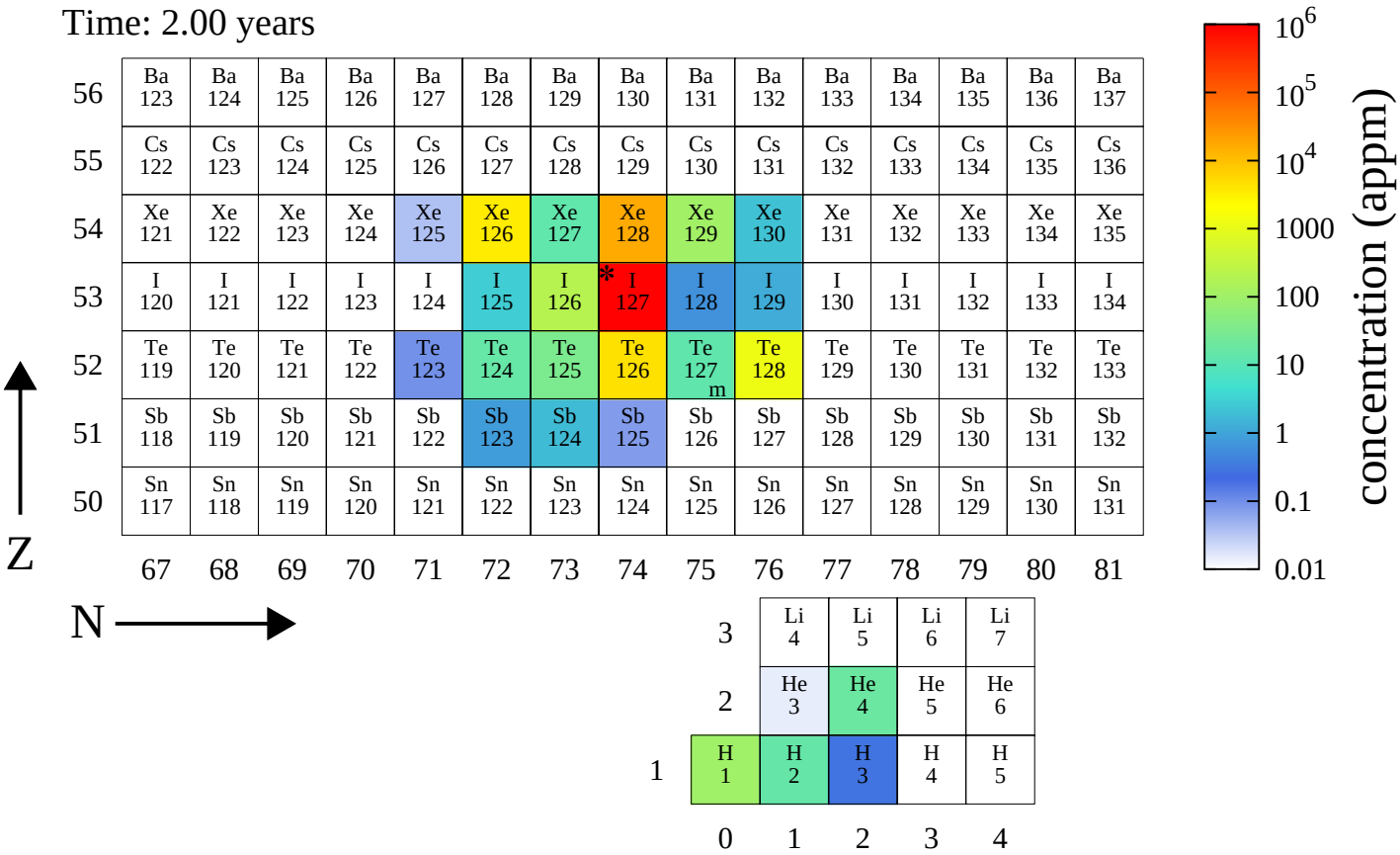


Iodine FW Transmutation

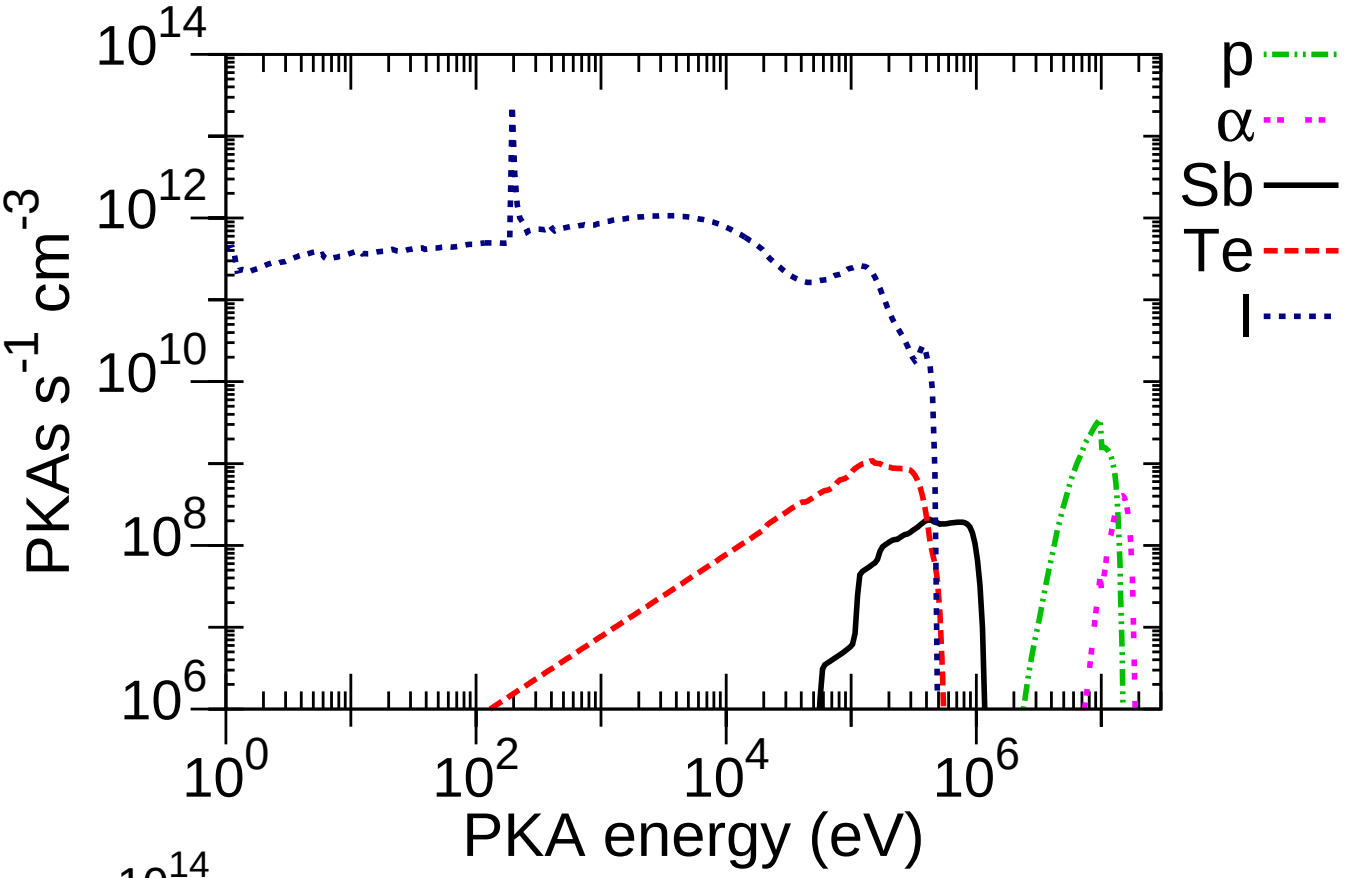


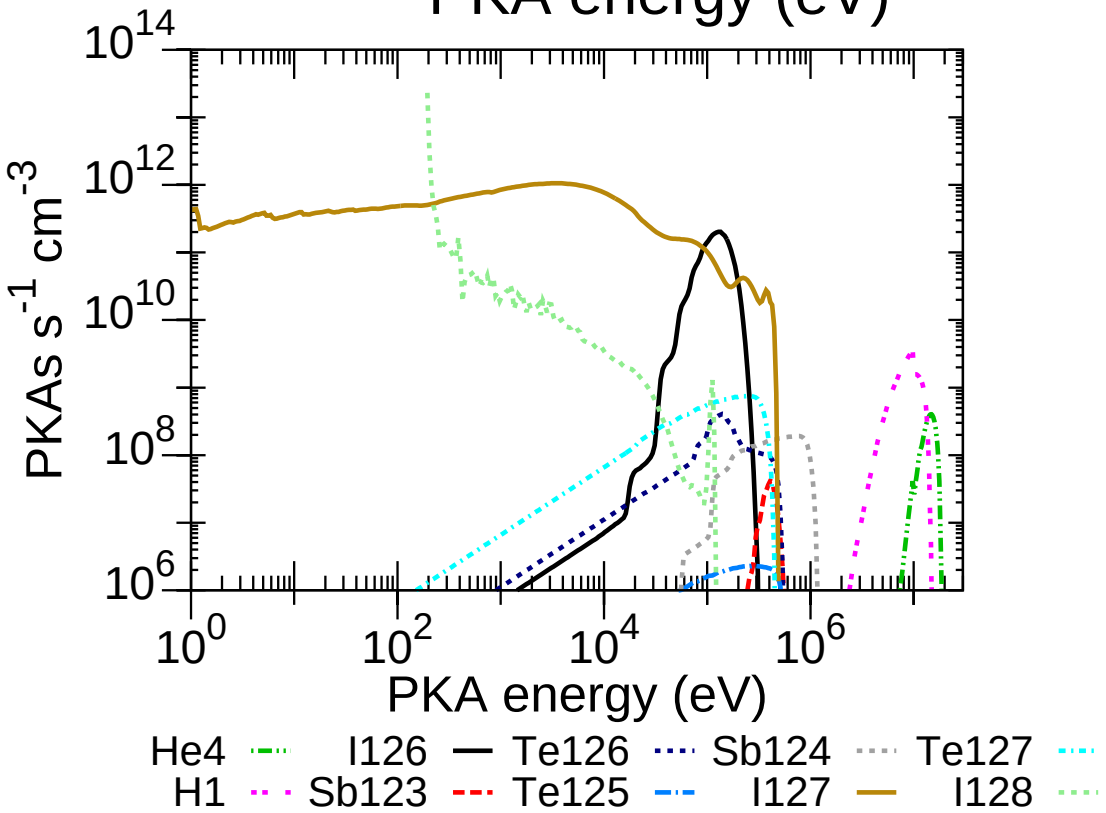
9 appm He & 58 appm H after 1 year

14 dpa/year



Iodine FW PKA distributions





Iodine Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ba137m	2.55m	I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136(n,γ)Cs137(β^-)Ba137m	39.0			
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136m(IT)Cs136(n,γ)Cs137(β^-)Ba137m	1.9			
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ)Xe131m(IT)Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136(n,γ)Cs137(β^-)Ba137m	1.1			
Sb126m	19.10m	I127(n,γ)I128(n,α)Sb125(n,γ)Sb126n(IT)Sb126m	55.4	50.2		
		I127(n,γ)I128(n,α)Sb125(n,γ)Sb126m	32.9	32.1		
		I127(n,α)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m	5.9	8.9	38.9	
		I127(n,α)Sb124(n,γ)Sb125(n,γ)Sb126m	3.5	5.7	32.7	
		I127(n,α)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m	1.2	1.9	9.7	
		I127(n,α)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126m		1.2	8.2	
		I127(n,α)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m			4.4	
		I127(n,α)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126m			3.7	
		I127(n,2n)I126(β^+)Te126(n,p)Sb126n(IT)Sb126m				60.1
		I127(n,2n)I126(β^+)Te126(n,p)Sb126m				39.2
I128 Te129	24.99m	I127(n,γ)I128	100.0	100.0	100.0	99.8
	1.16h	I127(n,γ)I128(β^+)Te128(n,γ)Te129	98.9	97.7	87.1	66.9
		I127(n,γ)I128(β^+)Te128(n,γ)Te129m(IT)Te129	1.0	2.2	12.5	32.1
Te127	9.35h	I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,α)Te126(n,γ)Te127	98.5	91.4		
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129m(IT)Xe129(n,α)Te126(n,γ)Te127	1.4	3.5		
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,α)Te126(n,γ)Te127m(IT)Te127		4.5		
		I127(n,p)Te127			57.8	33.7
		I127(n,p)Te127m(IT)Te127			39.4	63.5
		I127(n,p)Te127m(n,E)Te127			2.5	2.4
I130	12.36h	I127(n,γ)I128(β^+)Te128(n,γ)Te129(β^-)I129(n,γ)I130	55.1	58.7	67.0	
		I127(n,γ)I128(β^+)Te128(n,γ)Te129(β^-)I129(n,γ)I130m(IT)I130	36.2	35.2	15.1	
		I127(n,γ)I128(n,γ)I129(n,γ)I130	4.3	1.8		
		I127(n,γ)I128(n,γ)I129(n,γ)I130m(IT)I130	2.9	1.1		
		I127(n,γ)I128(β^+)Te128(n,γ)Te129m(IT)Te129(β^-)I129(n,γ)I130		1.2	9.0	
		I127(n,γ)I128(β^+)Te128(n,γ)Te129m(β^-)I129(n,γ)I130			5.2	
		I127(n,γ)I128(β^+)Te128(n,γ)Te129m(IT)Te129(β^-)I129(n,γ)I130m(IT)I130			2.0	
		I127(n,γ)I128(β^+)Te128(n,γ)Te129m(β^-)I129(n,γ)I130m(IT)I130			1.2	
Xe125	16.90h	I127(n,2n)I126(β^-)Xe126(n,2n)Xe125m(IT)Xe125				63.5
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125				36.4

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sn121	1.12d	I127(n,α)Sb124(β^-)Te124(n,α)Sn121			63.0	10.2
		I127(n,α)Sb124m(IT)Sb124(β^-)Te124(n,α)Sn121			15.8	3.3
		I127(n,α)Sb124n(IT)Sb124m(IT)Sb124(β^-)Te124(n,α)Sn121			7.2	4.3
		I127(n,α)Sb124m(β^-)Te124(n,α)Sn121			6.0	1.3
		I127(n,α)Sb124(β^-)Te124(n,α)Sn121m(n,E)Sn121			2.8	1.3
		I127(n,α)Sb124n(IT)Sb124m(β^-)Te124(n,α)Sn121			2.7	1.6
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(IT)Te125(n,α) Sn122(n,2n)Sn121				7.6
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(IT)Te125(n,nα)Sn121				6.5
		I127(n,2n)I126(β^+)Te126(n,2n)Te125(n,α)Sn122(n,2n)Sn121				6.0
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125m(IT)Xe125(β^+)I125(β^+) Te125(n,α)Sn122(n,2n)Sn121				4.9
		I127(n,2n)I126(β^+)Te126(n,2n)Te125(n,nα)Sn121				4.7
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(IT)Te125(n,2n) Te124(n,α)Sn121				4.7
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125m(IT)Xe125(β^+)I125(β^+) Te125(n,nα)Sn121				4.2
		I127(n,2n)I126(β^+)Te126(n,2n)Te125(n,2n)Te124(n,α)Sn121				3.7
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125m(IT)Xe125(β^+)I125(β^+) Te125(n,2n)Te124(n,α)Sn121				3.0
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125(β^+)I125(β^+)Te125(n,α) Sn122(n,2n)Sn121				2.8
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125(β^+)I125(β^+) Te125(n,nα)Sn121				2.4
		I127(n,2n)I126(β^+)Te126(n,nα)Sn122(n,2n)Sn121				2.4
		I127(n,2n)I126(n,2n)I125(β^+)Te125(n,α)Sn122(n,2n)Sn121				1.9
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125(β^+)I125(β^+) Te125(n,2n)Te124(n,α)Sn121				1.7
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(n,2n)Te124(n,α)Sn121				1.6
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(n,α)Sn122(n,2n)Sn121				1.5
		I127(n,2n)I126(β^+)Te126(n,α)Sn123(n,2n)Sn122(n,2n)Sn121				1.3
		I127(n,2n)I126(n,2n)I125(β^+)Te125(n,2n)Te124(n,α)Sn121				1.2
		I127(n,2n)I126(n,2n)I125(β^+)Te125(n,nα)Sn121				1.1
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125m(IT)Xe125(β^+) I125(n,2n)I124(β^+)Te124(n,α)Sn121				1.0
I124	4.18d	I127(n,2n)I126(β^-)Xe126(n,2n)Xe125m(IT)Xe125(β^+) I125(n,2n)I124				58.4
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125(β^+)I125(n,2n)I124				33.5
		I127(n,2n)I126(n,2n)I125(n,2n)I124				7.7
Xe129m	8.88d	I127(n,γ)I128(β^-)Xe128(n,γ)Xe129m	100.0	100.0	97.5	98.9
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,n$'$)Xe129m			2.0	
Xe131m	11.93d	I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ)Xe131m	98.0	95.4	70.0	
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129m(IT)Xe129(n,γ) Xe130(n,γ)Xe131m	1.4	3.6	16.9	
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129m(n,γ)Xe130(n,γ)Xe131m			8.5	
		I127(n,γ)I128(β^+)Te128(n,γ)Te129(β^-)I129(n,γ)I130(β^-) Xe130(n,γ)Xe131m			1.4	
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ) Xe131(n,n$'$)Xe131m			1.1	

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sb126	12.40d	I127(n,γ)I128(n,α)Sb125(n,γ)Sb126n(IT)Sb126m(IT)Sb126	53.2	45.1		
		I127(n,γ)I128(n,α)Sb125(n,γ)Sb126m(IT)Sb126	31.6	28.9		
		I127(n,α)Sb124(n,γ)Sb125(n,γ)Sb126n(IT)Sb126m(IT)Sb126	5.6	7.9	17.0	
		I127(n,γ)I128(n,α)Sb125(n,γ)Sb126	3.5	8.3		
		I127(n,α)Sb124(n,γ)Sb125(n,γ)Sb126m(IT)Sb126	3.3	5.1	14.3	
		I127(n,α)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126n(IT) Sb126m(IT)Sb126	1.2	1.7	4.3	
		I127(n,α)Sb124(n,γ)Sb125(n,γ)Sb126		1.5	40.2	
		I127(n,α)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126m(IT)Sb126		1.1	3.6	
		I127(n,α)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126			10.1	
		I127(n,α)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ)Sb126			4.6	
		I127(n,α)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ) Sb126n(IT)Sb126m(IT)Sb126			1.9	
		I127(n,α)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125(n,γ) Sb126m(IT)Sb126			1.6	
		I127(n,2n)I126(β^+)Te126(n,p)Sb126				49.2
		I127(n,2n)I126(β^+)Te126(n,p)Sb126n(IT)Sb126m(IT)Sb126				30.4
		I127(n,2n)I126(β^+)Te126(n,p)Sb126m(IT)Sb126				19.8
I126	12.98d	I127(n,2n)I126				99.9
Cs136	13.03d	I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ) Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,γ) Cs135(n,γ)Cs136	88.9			
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ) Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,γ) Cs135(n,γ)Cs136m(IT)Cs136	4.4			
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ) Xe131m(IT)Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ) Cs134(n,γ)Cs135(n,γ)Cs136	2.6			
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129m(IT)Xe129(n,γ) Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ) Cs134(n,γ)Cs135(n,γ)Cs136	1.2			
Te129m	33.60d	I127(n,γ)I128(β^+)Te128(n,γ)Te129m	100.0	100.0	100.0	99.7
Xe127	36.40d	I127(n,γ)I128(β^-)Xe128(n,2n)Xe127m(IT)Xe127				37.7
		I127(n,γ)I128(β^-)Xe128(n,2n)Xe127				27.0
		I127(n,2n)I126(β^-)Xe126(n,γ)Xe127m(IT)Xe127				20.0
		I127(n,2n)I126(β^-)Xe126(n,γ)Xe127				15.2
Te125m	57.39d	I127(n,γ)I128(β^-)Xe128(n,α)Te125m	82.4	89.2	73.1	
		I127(n,γ)I128(n,α)Sb125(β^-)Te125m	11.8	7.8		
		I127(n,α)Sb124(β^-)Te124(n,γ)Te125m	3.1	1.1	15.6	
		I127(n,α)Sb124(n,γ)Sb125(β^-)Te125m	1.2	1.3		
		I127(n,α)Sb124m(IT)Sb124(β^-)Te124(n,γ)Te125m			3.9	
		I127(n,γ)I128(β^-)Xe128(n,α)Te125(n,n$'$)Te125m			1.9	
		I127(n,α)Sb124n(IT)Sb124m(IT)Sb124(β^-)Te124(n,γ)Te125m			1.8	
		I127(n,α)Sb124m(β^-)Te124(n,γ)Te125m			1.5	
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m				98.2
I125	59.43d	I127(n,2n)I126(β^-)Xe126(n,2n)Xe125m(IT)Xe125(β^+)I125				58.4
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125(β^+)I125				33.5
		I127(n,2n)I126(n,2n)I125				7.6
Sb124	60.18d	I127(n,α)Sb124	79.9	82.2	73.0	57.2
		I127(n,α)Sb124m(IT)Sb124	16.6	17.8	18.3	18.6
		I127(n,α)Sb124n(IT)Sb124m(IT)Sb124	3.4		8.3	23.9
Te127m	109.00d	I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,α)Te126(n,γ)Te127m	98.6	96.3		
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129m(IT)Xe129(n,α) Te126(n,γ)Te127m	1.4	3.6		
		I127(n,p)Te127m			100.0	99.7

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cs134	2.06y	I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ) Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134	93.4	84.5		
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ) Xe131m(IT)Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134	2.8	5.6		
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129m(IT)Xe129(n,γ) Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134	1.3	3.0		
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ) Xe131(n,γ)Xe132(n,γ)Xe133m(IT)Xe133(β^-)Cs133(n,γ)Cs134		2.1		
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ) Xe131m(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134		1.6		
		I127(n,γ)I128(β^-)Xe128(n,γ)Xe129(n,γ)Xe130(n,γ) Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134m(IT)Cs134		1.0		
Sb125	2.76y	I127(n,γ)I128(n,α)Sb125	88.3	82.3	1.0	
		I127(n,α)Sb124(n,γ)Sb125	9.4	14.5	72.3	
		I127(n,α)Sb124m(IT)Sb124(n,γ)Sb125	1.9	3.1	18.1	
		I127(n,α)Sb124n(IT)Sb124m(IT)Sb124(n,γ)Sb125			8.3	
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(IT)Te125(n,p)Sb125				21.5
		I127(n,2n)I126(β^+)Te126(n,d)Sb125				18.1
		I127(n,2n)I126(β^+)Te126(n,2n)Te125(n,p)Sb125				16.9
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125m(IT)Xe125(β^+)I125(β^+) Te125(n,p)Sb125				13.8
		I127(n,2n)I126(β^+)Te126(n,np)Sb125				9.1
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125(β^+)I125(β^+) Te125(n,p)Sb125				7.9
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(n,p)Sb125				6.2
		I127(n,2n)I126(n,2n)I125(β^+)Te125(n,p)Sb125				5.1
H3	12.33y	I127(n,γ)I128(n,p)H1(n,γ)H2(n,γ)H3	100.0			
		I127(n,p)H1(n,γ)H2(n,γ)H3			42.9	
		I127(n,t)H3				38.7
Sn121m	43.90y	I127(n,α)Sb124(β^-)Te124(n,α)Sn121m			65.6	14.8
		I127(n,α)Sb124m(IT)Sb124(β^-)Te124(n,α)Sn121m			16.4	4.8
		I127(n,α)Sb124n(IT)Sb124m(IT)Sb124(β^-)Te124(n,α)Sn121m			7.5	6.2
		I127(n,α)Sb124m(β^-)Te124(n,α)Sn121m			6.9	2.0
		I127(n,α)Sb124n(IT)Sb124m(β^-)Te124(n,α)Sn121m			3.1	2.6
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(IT)Te125(n,nα)Sn121m				8.1
		I127(n,2n)I126(β^+)Te126(n,2n)Te125(n,nα)Sn121m				6.4
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(IT)Te125(n,α) Sn122(n,2n)Sn121m				6.4
		I127(n,2n)I126(β^+)Te126(n,2n)Te125(n,α)Sn122(n,2n)Sn121m				5.5
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125m(IT)Xe125(β^+)I125(β^+) Te125(n,nα)Sn121m				5.2
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125m(IT)Xe125(β^+)I125(β^+) Te125(n,α)Sn122(n,2n)Sn121m				4.1
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(IT)Te125(n,2n) Te124(n,α)Sn121m				3.5
		I127(n,2n)I126(β^+)Te126(n,2n)Te125(n,2n)Te124(n,α)Sn121m				3.0
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125(β^+)I125(β^+) Te125(n,nα)Sn121m				3.0
		I127(n,2n)I126(β^+)Te126(n,nα)Sn122(n,2n)Sn121m				2.9
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125(β^+)I125(β^+)Te125(n,α) Sn122(n,2n)Sn121m				2.4
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125m(IT)Xe125(β^+)I125(β^+) Te125(n,2n)Te124(n,α)Sn121m				2.3
		I127(n,2n)I126(n,2n)I125(β^+)Te125(n,α)Sn122(n,2n)Sn121m				2.0
		I127(n,2n)I126(n,2n)I125(β^+)Te125(n,nα)Sn121m				2.0
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(n,α) Sn122(n,2n)Sn121m				1.6
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(n,2n) Te124(n,α)Sn121m				1.6
		I127(n,2n)I126(β^+)Te126(n,α)Sn123(n,2n)Sn122(n,2n)Sn121m				1.4
		I127(n,2n)I126(β^+)Te126(n,2n)Te125m(n,nα)Sn121m				1.3
		I127(n,2n)I126(β^-)Xe126(n,2n)Xe125(β^+)I125(β^+) Te125(n,2n)Te124(n,α)Sn121m				1.3
		I127(n,2n)I126(n,2n)I125(β^+)Te125(n,2n)Te124(n,α)Sn121m				1.1

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sn121m	cont.	I127(n,2n)I126(β^-)Xe126(n,2n)Xe125m(IT)Xe125(β^+) I125(n,2n)I124(β^+)Te124(n,α)Sn121m				1.0
I129	1.6 10^7y	I127(n,γ)I128(β^+)Te128(n,γ)Te129(β^-)I129	91.4	93.9	82.1	57.7
		I127(n,γ)I128(n,γ)I129	7.2	2.9		
		I127(n,γ)I128(β^+)Te128(n,γ)Te129m(IT)Te129(β^-)I129		2.0	11.1	26.0
		I127(n,γ)I128(β^+)Te128(n,γ)Te129m(β^-)I129		1.1	6.3	14.8

Xenon

Isotope	Atom % abundance	
Xe124	0.10	($T_{1/2}$ =2.0 10^{14}y)
Xe126	0.09	
Xe128	1.91	
Xe129	26.40	
Xe130	4.07	
Xe131	21.23	
Xe132	26.89	
Xe134	10.44	($T_{1/2}$ =1.1 10^{16}y)
Xe136	8.86	($T_{1/2}$ =2.1 10^{20}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	5.36E+14	5.17E+14	3.01E+14	1.48E+12	9.86E+09	4.00E+07
Xe131m	32.4	33.6	46.7			
Xe133	17.9	18.5	22.1			
Xe129m	13.6	14.1	18.2			
Xe135	12.5	12.9				
Xe135m	6.7	5.5				
Xe133m	6.5	6.7	3.6			
Xe127	2.4	2.5	4.0	0.8		
Xe125	2.1	2.1	0.1			
I125	2.0	2.1	3.4	10.2		
Xe127m	1.3	0.1				
Cs134	0.3	0.3	0.6	82.1		
Cs137				3.3	51.2	
Ba137m				3.2	48.3	
Cs135					0.4	99.5

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.51E-02	2.31E-02	1.00E-02	3.44E-04	6.56E-07	4.86E-10
Xe135	24.1	26.0	0.1			
Xe131m	18.1	19.6	36.6			
Xe135m	12.0	10.2				
Xe129m	11.0	11.9	20.8			
Xe133	11.0	11.9	19.2			
Xe133m	5.1	5.5	4.0			
Cs136	2.8	3.0	5.8			
Xe127	2.6	2.8	6.0	0.2		
Xe134m	2.3					
Xe125	2.2	2.3	0.1			
Cs134	1.9	2.0	4.7	97.5		
Xe137	1.4	0.6				
Xe127m	1.3	0.1				
Ba137m			0.1	1.4	76.8	
Cs137				0.4	23.2	
Cs135					0.1	99.4

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	7.96E+03	6.45E+03	1.94E+03	4.40E+02	6.48E-01	1.24E-08
Xe135m	33.7	32.7				
Xe135	16.3	20.0	0.1			
Cs136	13.5	16.7	45.7			
Xe134m	10.8					
Cs134	7.6	9.4	31.1	98.5		
I132	3.1	3.7				
Xe125	2.9	3.6	0.3			
Xe127	2.9	3.5	11.0			
I134	1.8	2.1				
Cs132	1.5	1.9	4.2			
I130	1.2	1.4				
I126	0.7	0.9	2.5			
I131	0.4	0.5	1.1			
Ba137m	0.1	0.1	0.3	1.4	100.0	
I129						100.0

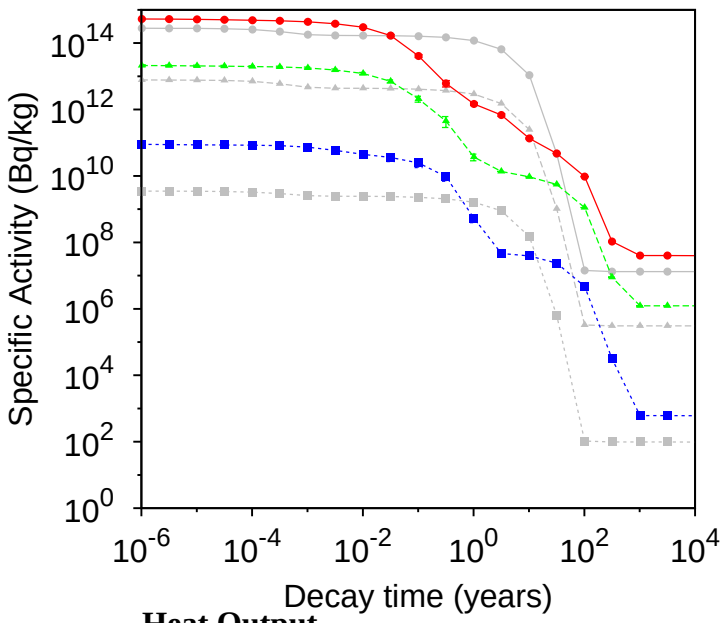
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.90E+08	2.90E+08	2.02E+08	4.43E+04	1.56E+02	1.01E-01
Xe131m	39.0	39.0	45.2			
Xe129m	22.2	22.2	23.9			
Xe133	18.8	18.8	18.8			
Xe133m	7.9	7.9	3.6			
Xe127	6.2	6.3	8.4	39.1		
Xe135	4.8	4.8				
Cs134				52.3		
I125	0.1	0.1	0.1	5.1		
Ba137m				2.0	57.9	
Cs137				1.5	42.0	
Cs135					0.1	78.7
I129						21.3

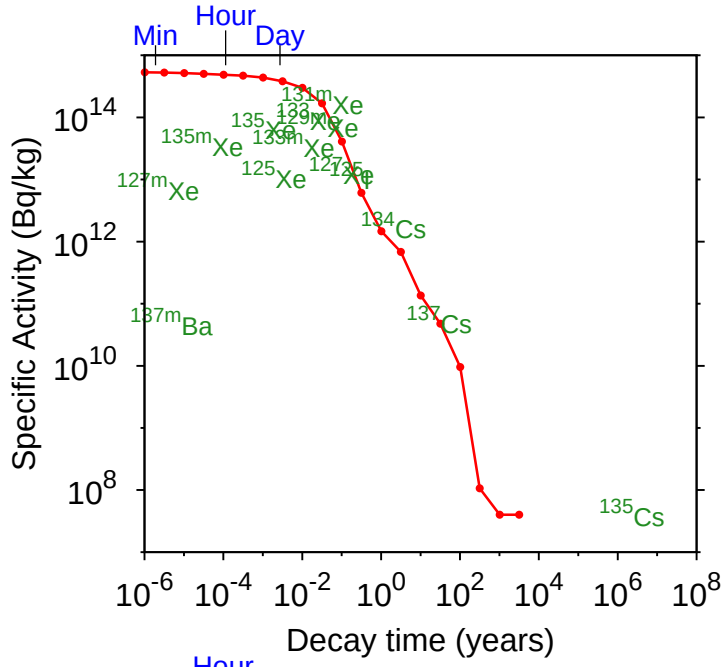
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.85E+08	3.85E+08	2.97E+08	9.81E+04	2.54E+02	3.49E-01
Xe131m	43.8	43.8	46.0			
Xe127	19.2	19.2	23.2	71.8		
Xe129m	19.0	19.0	18.5			
Xe133	11.7	11.7	10.6			
Xe133m	4.0	4.0	1.7			
Xe135	1.9	1.9				
Cs134				24.8		
Cs137				2.0	77.4	
Ba137m				0.6	22.5	
Cs135					0.1	97.9
I129						2.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	8.59E+10	7.72E+10	3.63E+10	1.27E+10	5.33E+07	2.00E+04
Xe135	21.6	24.0	0.1			
Cs134	19.8	22.1	46.8	95.8		
Xe135m	18.3	16.0				
Xe131m	7.0	7.8	13.4			
Xe133	6.6	7.3	10.8			
Xe129m	6.1	6.8	10.8			
Xe127	4.3	4.8	9.5			
Xe134m	4.0					
Xe125	3.6	4.0	0.2			
Xe133m	2.4	2.6	1.8			
Cs136	2.2	2.5	4.4			
Xe127m	1.5	0.1				
Cs137	0.6	0.7	1.4	3.9	94.7	
Ba137m			0.1	0.2	5.3	
I129						98.0
Cs135						2.0

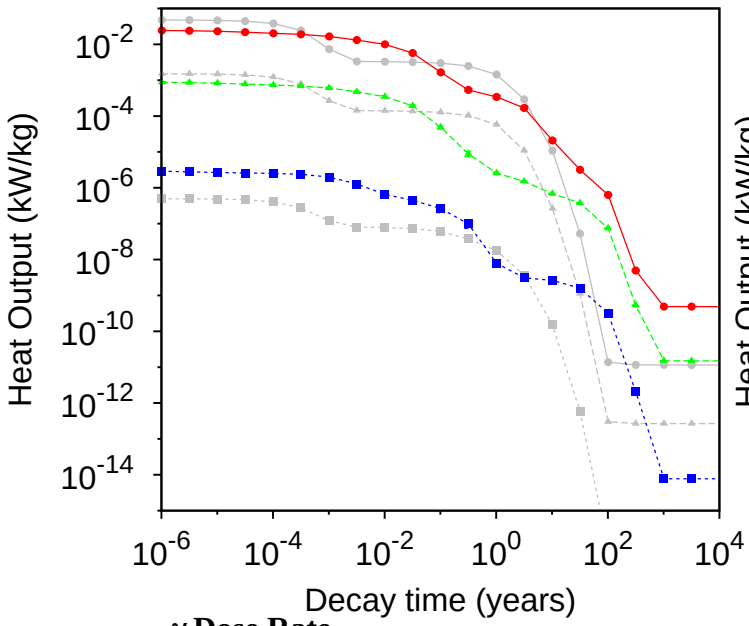
Xenon activation characteristics

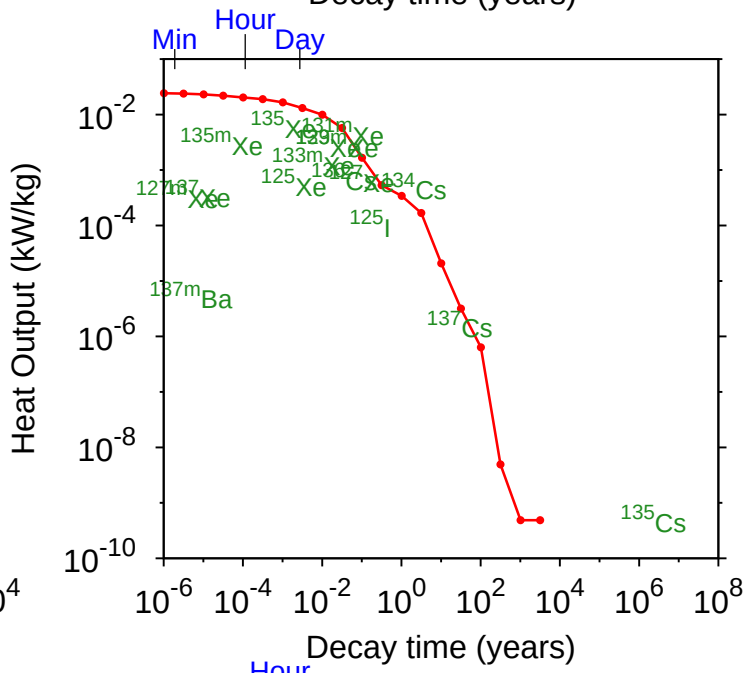
Specific Activity



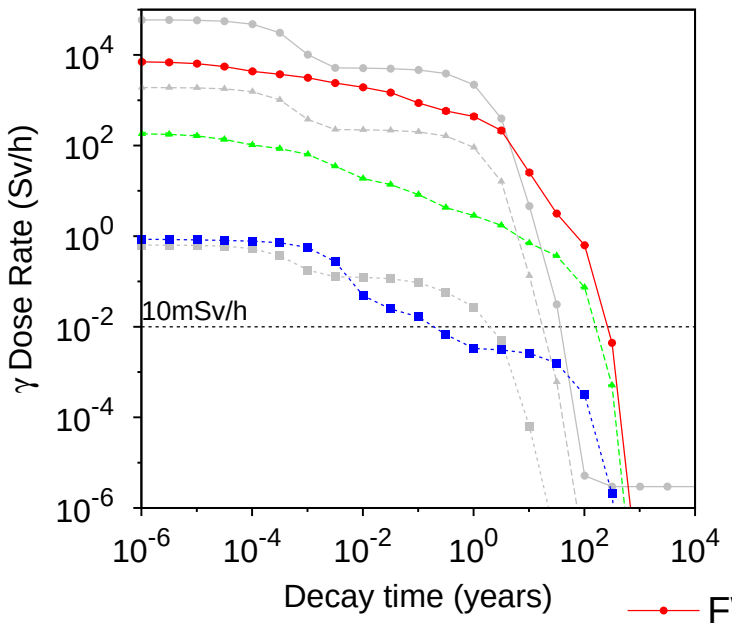


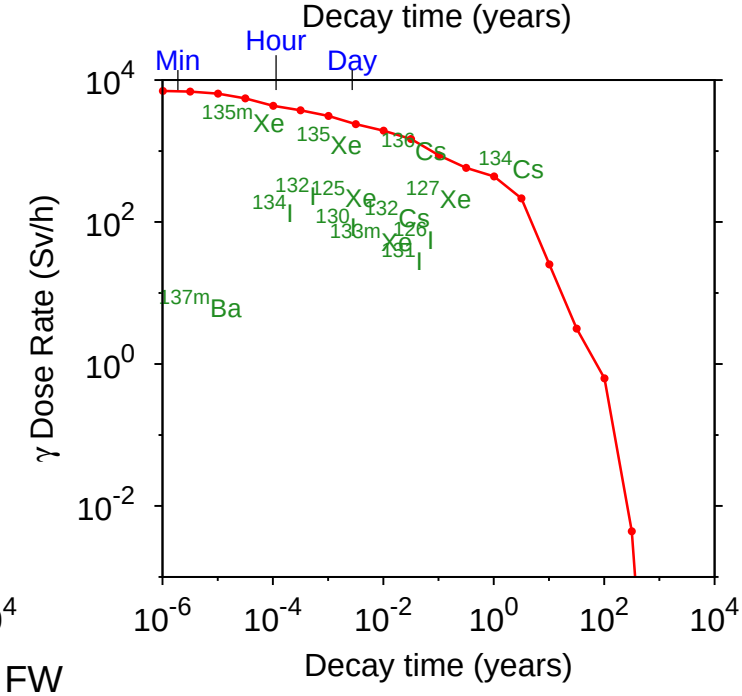
Heat Output





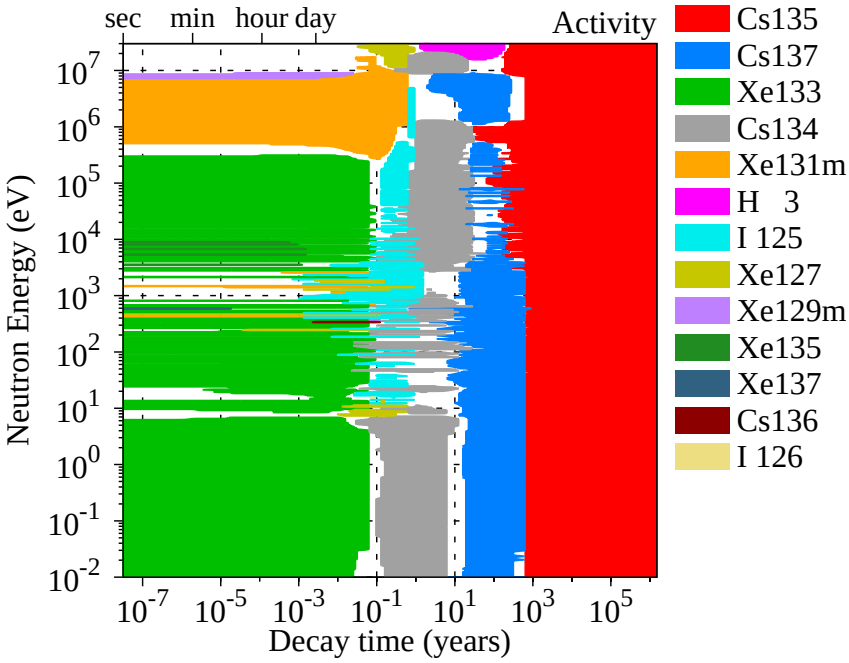
γ Dose Rate

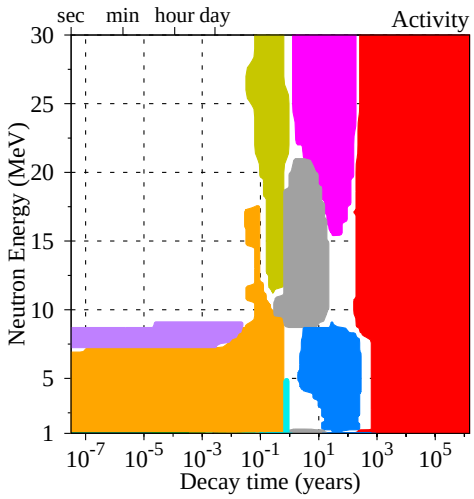


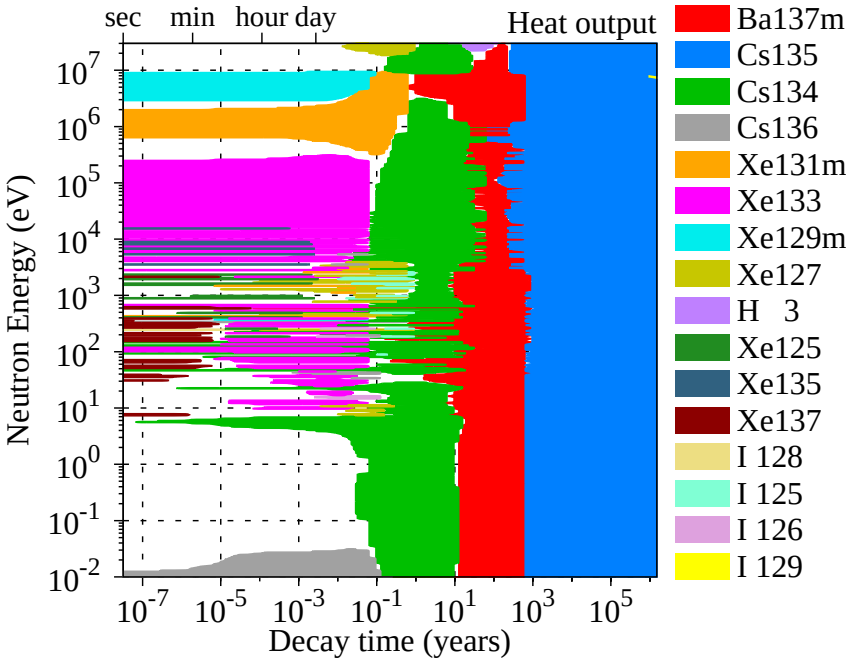


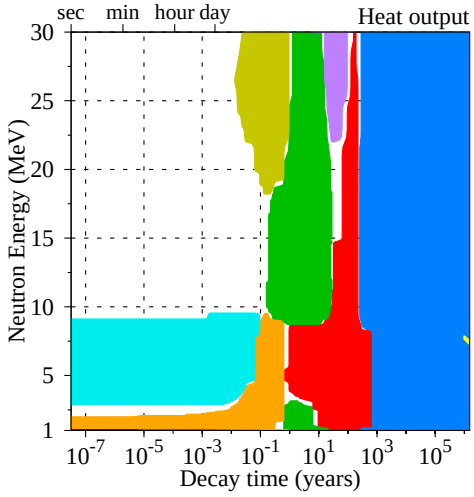
FW
Blanket
Manifold
Fe results

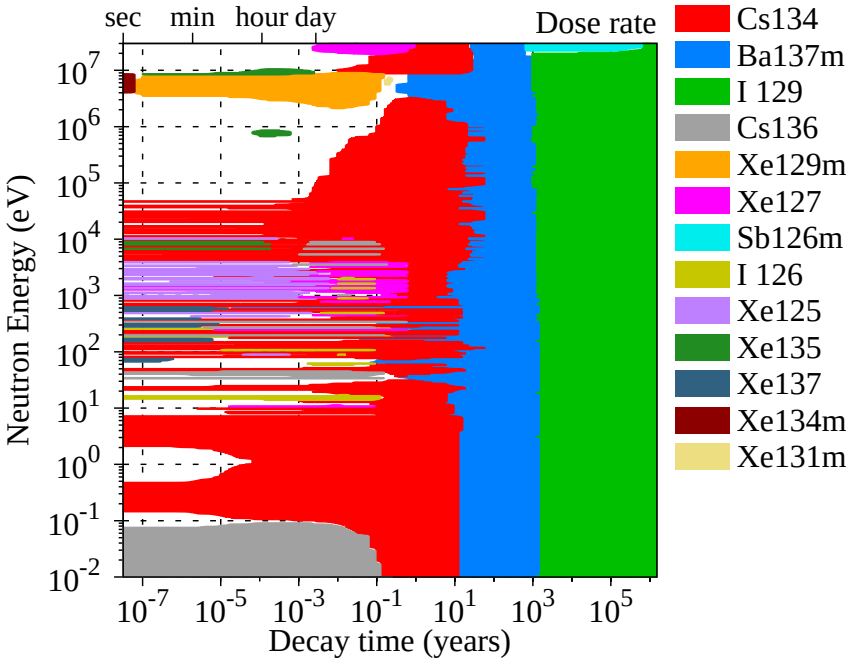
Xenon Importance diagrams

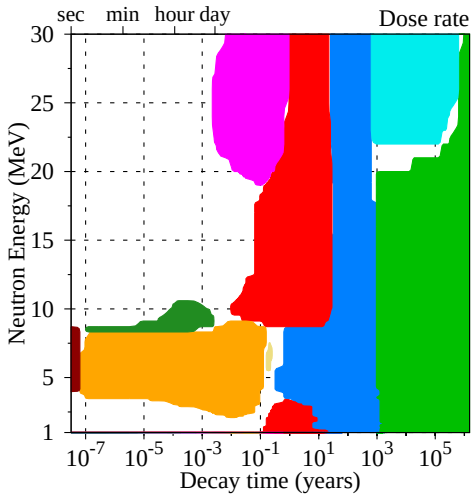




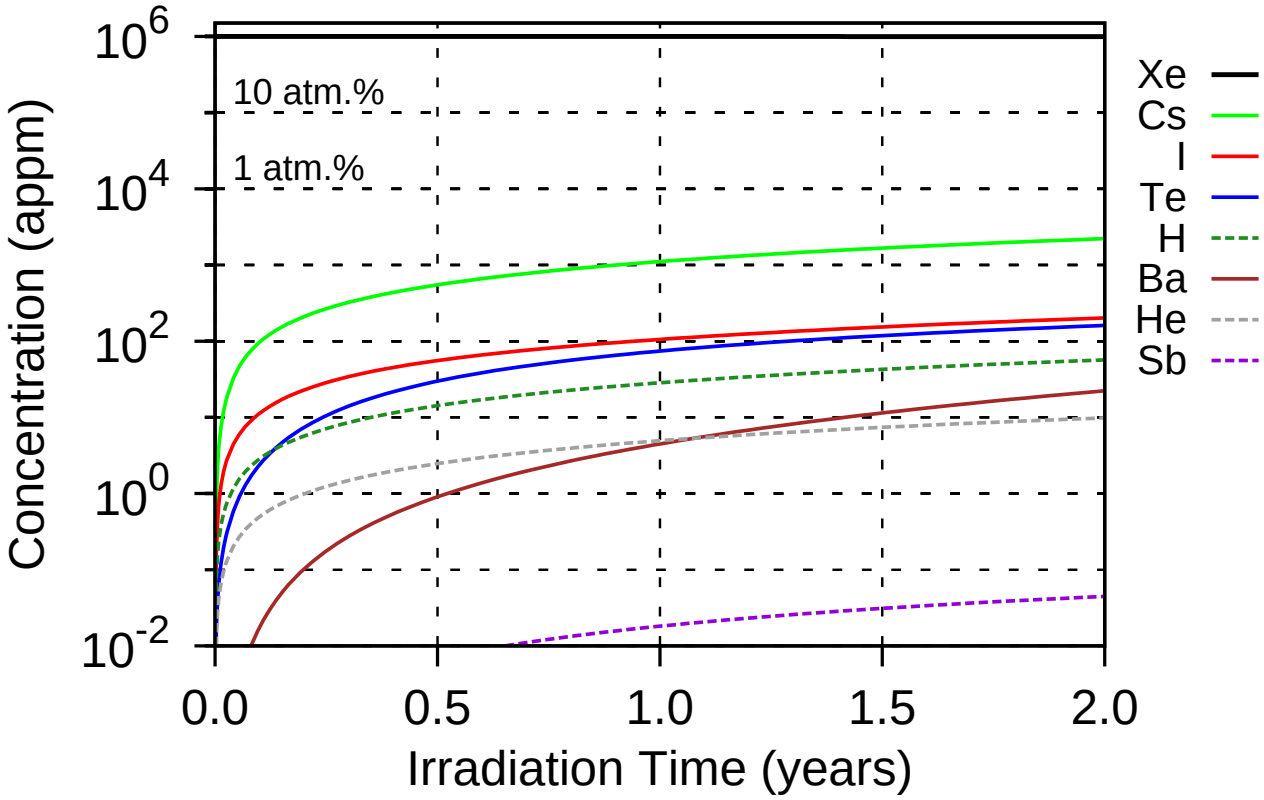




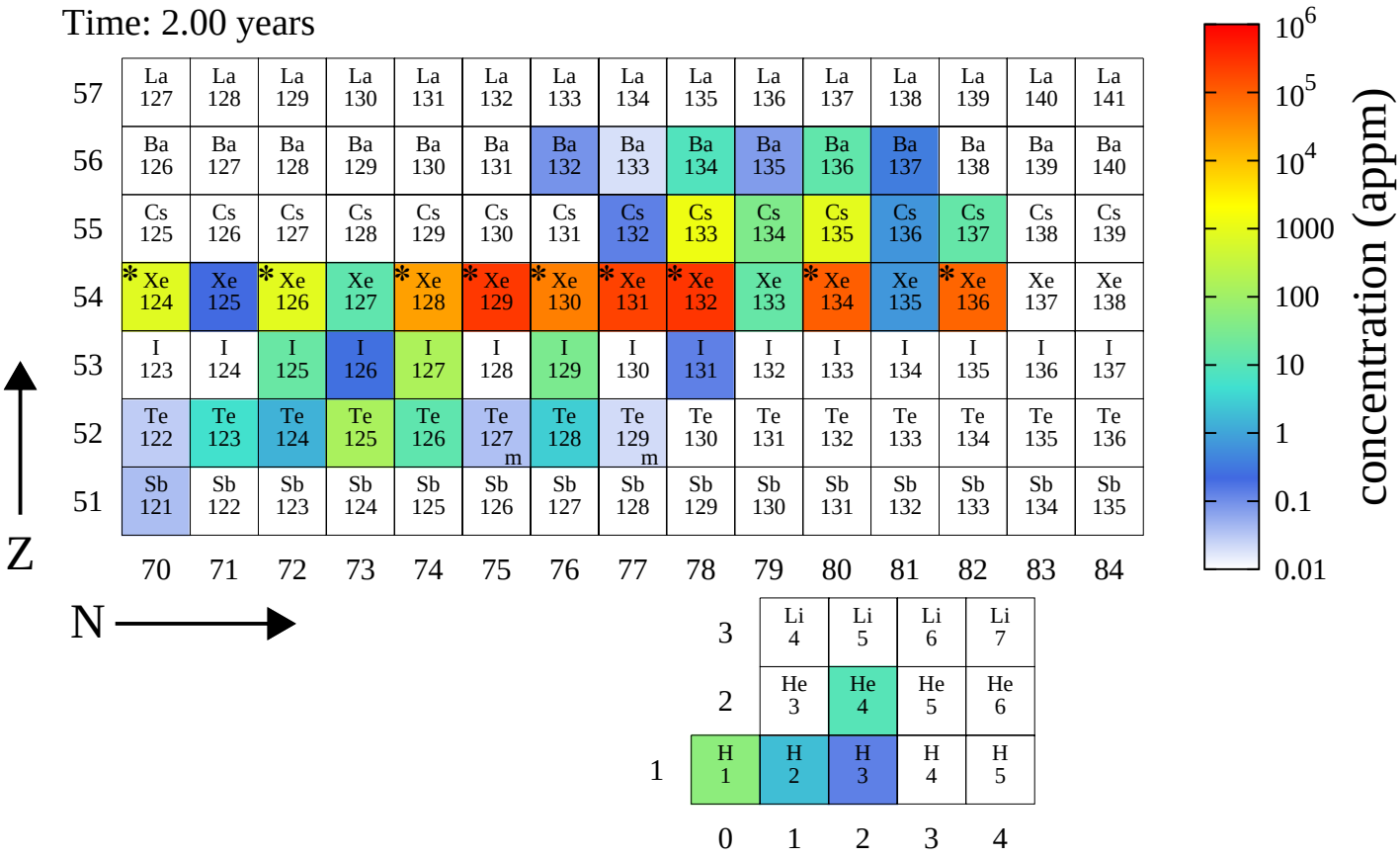




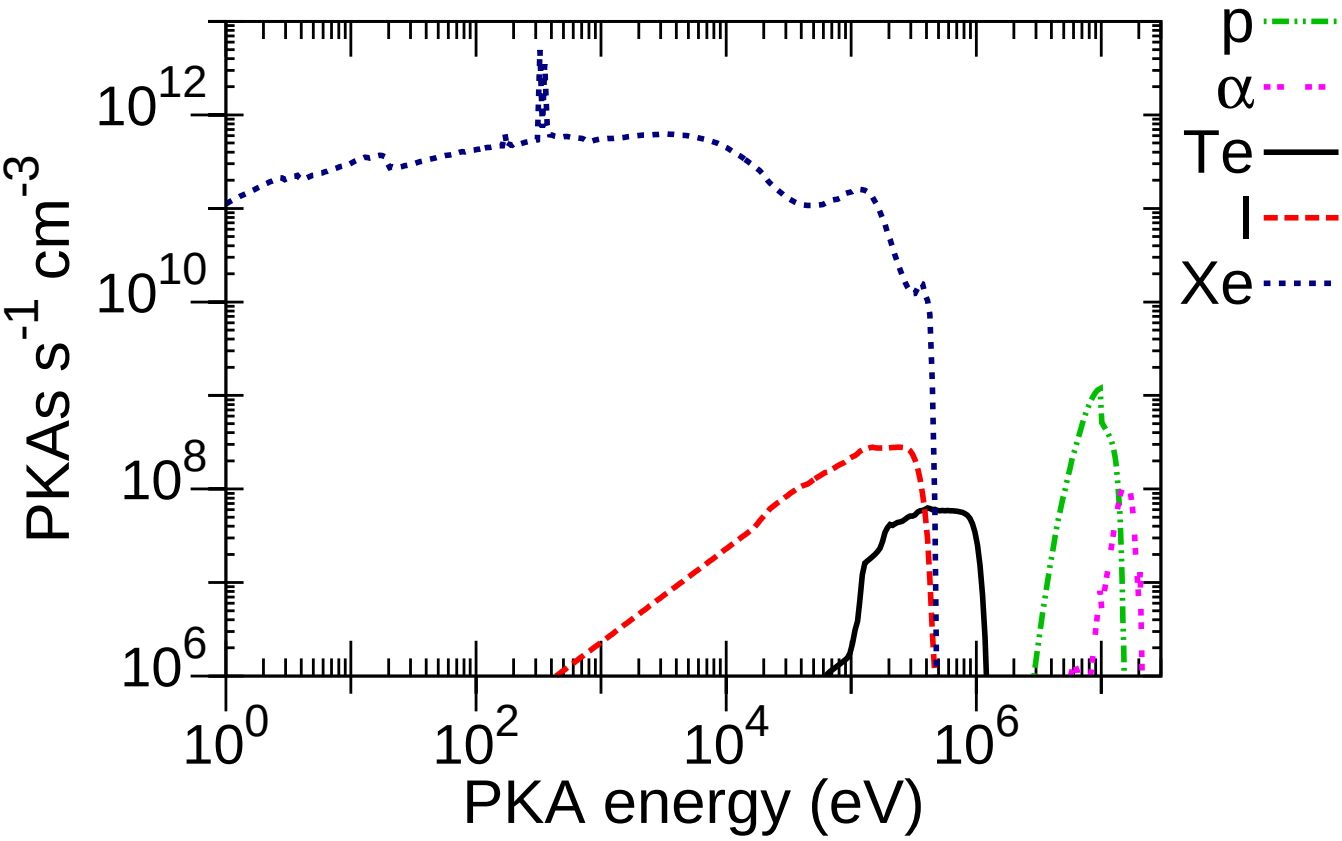
Xenon FW Transmutation

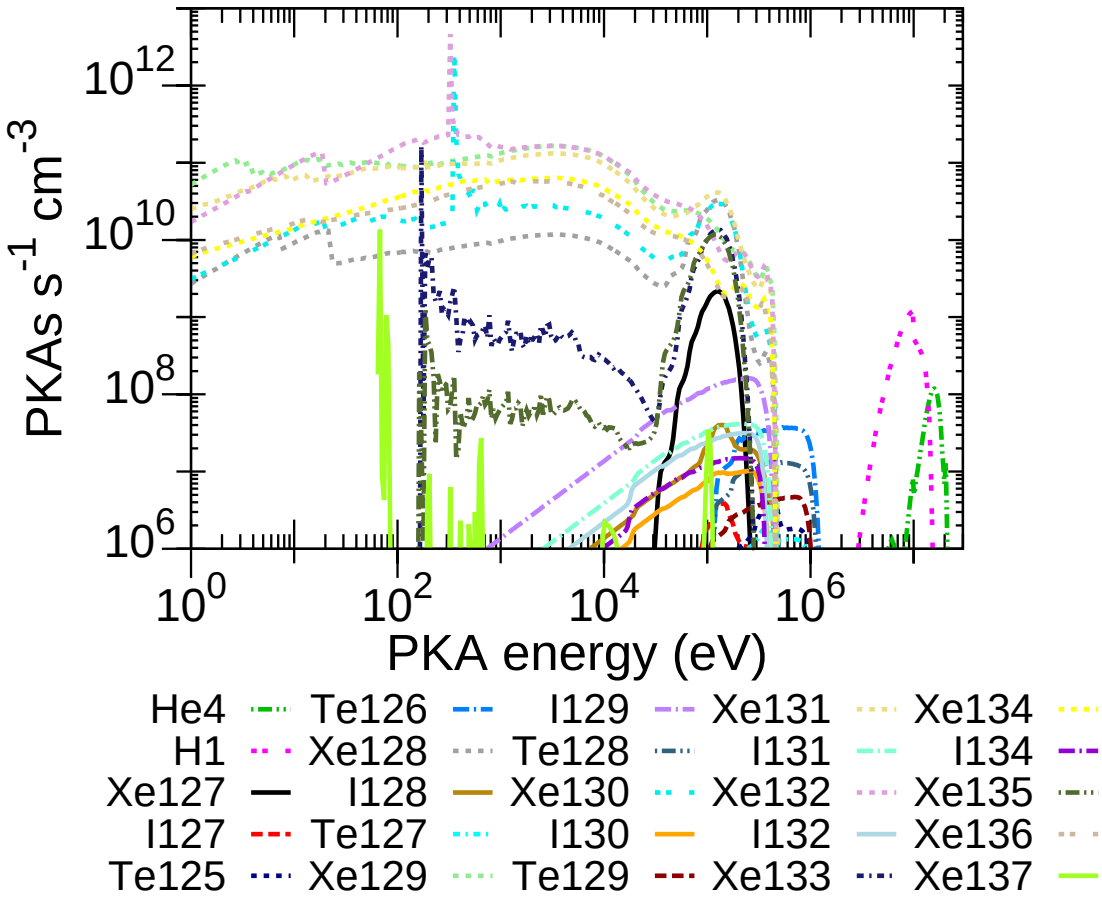


5 appm He & 28 appm H after 1 year 15 dpa/year



Xenon FW PKA distributions





Xenon Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Xe134m	0.29s	Xe132(n,γ)Xe133m(n,γ)Xe134m	39.2	49.2		
		Xe131(n,γ)Xe132(n,γ)Xe133m(n,γ)Xe134m	30.9			
		Xe132(n,γ)Xe133(n,γ)Xe134m	13.5	47.7		
		Xe131(n,γ)Xe132(n,γ)Xe133(n,γ)Xe134m	10.6			
		Xe129(n,γ)Xe130(n,γ)Xe131(n,γ)Xe132(n,γ) Xe133m(n,γ)Xe134m	2.8			
		Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133m(n,γ)Xe134m	1.1			
		Xe129(n,γ)Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133(n,γ)Xe134m	1.0			
		Xe132(n,γ)Xe133m(IT)Xe133(n,γ)Xe134m		1.2		
		Xe134(n,n′)Xe134m			100.0	99.5
Xe127m	1.16m	Xe126(n,γ)Xe127m	95.6	100.0	99.5	
		Xe124(n,γ)Xe125(β^+)I125(n,γ)I126(β^-)Xe126(n,γ)Xe127m	3.6			
		Xe129(n,2n)Xe128(n,2n)Xe127m				56.4
		Xe128(n,2n)Xe127m				42.4
Ba137m	2.55m	Xe136(n,γ)Xe137(β^-)Cs137(β^-)Ba137m	97.7	99.8	99.9	99.4
Xe137	3.82m	Xe136(n,γ)Xe137	98.2	100.0	100.0	100.0
		Xe134(n,γ)Xe135(n,γ)Xe136(n,γ)Xe137	1.8			
Xe135m	15.29m	Xe134(n,γ)Xe135m	98.9	100.0	100.0	
		Xe136(n,2n)Xe135m				99.8
Sb126m	19.10m	Xe129(n,p)I129(n,α)Sb126n(IT)Sb126m				27.1
		Xe129(n,p)I129(n,α)Sb126m				19.2
		Xe129(n,α)Te126(n,p)Sb126n(IT)Sb126m				17.5
		Xe129(n,α)Te126(n,p)Sb126m				11.4
		Xe128(n,2n)Xe127m(IT)Xe127(β^+)I127(n,2n)I126(β^+) Te126(n,p)Sb126n(IT)Sb126m				5.4
		Xe128(n,2n)Xe127(β^+)I127(n,2n)I126(β^+)Te126(n,p) Sb126n(IT)Sb126m				3.8
		Xe128(n,2n)Xe127m(IT)Xe127(β^+)I127(n,2n)I126(β^+) Te126(n,p)Sb126m				3.5
		Xe128(n,2n)Xe127(β^+)I127(n,2n)I126(β^+)Te126(n,p)Sb126m				2.5
		Xe129(n,2n)Xe128(n,2n)Xe127m(IT)Xe127(β^+)I127(n,2n) I126(β^+)Te126(n,p)Sb126n(IT)Sb126m				2.2
		Xe129(n,2n)Xe128(n,2n)Xe127(β^+)I127(n,2n)I126(β^+) Te126(n,p)Sb126n(IT)Sb126m				1.6
		Xe129(n,2n)Xe128(n,2n)Xe127m(IT)Xe127(β^+)I127(n,2n) I126(β^+)Te126(n,p)Sb126m				1.4
		Xe129(n,2n)Xe128(n,2n)Xe127(β^+)I127(n,2n)I126(β^+) Te126(n,p)Sb126m				1.0
I128	24.99m	Xe124(n,γ)Xe125(β^+)I125(n,γ)I126(n,γ)I127(n,γ)I128	72.3			
		Xe126(n,γ)Xe127(β^+)I127(n,γ)I128	16.1	90.8	75.7	
		Xe124(n,γ)Xe125m(IT)Xe125(β^+)I125(n,γ)I126(n,γ) I127(n,γ)I128	9.7			
		Xe126(n,γ)Xe127m(IT)Xe127(β^+)I127(n,γ)I128	1.1	9.2	24.2	
		Xe129(n,2n)Xe128(n,p)I128				28.3
		Xe129(n,p)I129(n,2n)I128				27.1
		Xe128(n,p)I128				21.3
		Xe129(n,np)I128				11.6
		Xe129(n,d)I128				9.5
I134	52.51m	Xe134(n,p)I134				83.9
		Xe134(n,p)I134m(IT)I134				15.9
I132	2.29h	Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,α)I131(n,γ)I132	50.2			
		Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,α) I131(n,γ)I132	34.0			
		Xe129(n,γ)Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133(β^-) Cs133(n,γ)Cs134(n,α)I131(n,γ)I132	1.2			
		Xe131(n,p)I131(n,γ)I132			42.6	
		Xe134(n,γ)Xe135(β^-)Cs135(n,α)I132			35.2	
		Xe134(n,γ)Xe135m(IT)Xe135(β^-)Cs135(n,α)I132			10.8	
		Xe131(n,p)I131(n,γ)I132m(IT)I132			7.2	
		Xe134(n,γ)Xe135(β^-)Cs135(n,α)I132m(IT)I132			2.8	
		Xe132(n,p)I132				89.5
		Xe132(n,p)I132m(IT)I132				9.4

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Xe135	9.14h	Xe134(n,γ)Xe135	98.6	98.1	76.5	
		Xe134(n,γ)Xe135m(IT)Xe135		1.9	23.5	
		Xe136(n,2n)Xe135m(IT)Xe135				54.9
		Xe136(n,2n)Xe135				44.9
I130	12.36h	Xe124(n,γ)Xe125(β^+)I125(n,γ)I126(n,γ)I127(n,γ)I128(β^+) Te128(n,γ)Te129(β^-)I129(n,γ)I130	43.6			
		Xe124(n,γ)Xe125(β^+)I125(n,γ)I126(n,γ)I127(n,γ)I128(β^+) Te128(n,γ)Te129(β^-)I129(n,γ)I130m(IT)I130	28.6			
		Xe124(n,γ)Xe125m(IT)Xe125(β^+)I125(n,γ)I126(n,γ)I127(n,γ) I128(β^+)Te128(n,γ)Te129(β^-)I129(n,γ)I130	5.9			
		Xe124(n,γ)Xe125(β^+)I125(n,γ)I126(n,γ)I127(n,γ)I128(n,γ) I129(n,γ)I130	4.1			
		Xe124(n,γ)Xe125m(IT)Xe125(β^+)I125(n,γ)I126(n,γ)I127(n,γ) I128(β^+)Te128(n,γ)Te129(β^-)I129(n,γ)I130m(IT)I130	3.9			
		Xe124(n,γ)Xe125(β^+)I125(n,γ)I126(n,γ)I127(n,γ)I128(n,γ) I129(n,γ)I130m(IT)I130	2.7			
		Xe131(n,α)Te128(n,γ)Te129(β^-)I129(n,γ)I130		1.9		
		Xe131(n,α)Te128(n,γ)Te129(β^-)I129(n,γ)I130m(IT)I130		1.1		
		Xe129(n,p)I129(n,γ)I130			80.2	
		Xe129(n,p)I129(n,γ)I130m(IT)I130			18.1	
		Xe130(n,p)I130				37.1
		Xe131(n,2n)Xe130(n,p)I130				20.8
		Xe130(n,p)I130m(IT)I130				15.3
		Xe131(n,2n)Xe130(n,p)I130m(IT)I130				8.6
		Xe131(n,d)I130				5.4
		Xe131(n,d)I130m(IT)I130				3.5
		Xe131(n,np)I130				1.8
		Xe131(n,np)I130m(IT)I130				1.0
Xe125	16.90h	Xe124(n,γ)Xe125	88.1	84.8	68.3	
		Xe124(n,γ)Xe125m(IT)Xe125	11.9	15.2	31.7	
		Xe126(n,2n)Xe125m(IT)Xe125				59.9
		Xe126(n,2n)Xe125				34.4
		Xe128(n,2n)Xe127m(IT)Xe127(β^+)I127(n,2n)I126(β^-) Xe126(n,2n)Xe125m(IT)Xe125				1.0
Xe133m	2.19d	Xe132(n,γ)Xe133m	52.8	98.2	99.9	
		Xe131(n,γ)Xe132(n,γ)Xe133m	41.6	1.8		
		Xe129(n,γ)Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133m	3.8			
		Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133m	1.5			
		Xe134(n,2n)Xe133m				99.4
Xe133	5.24d	Xe132(n,γ)Xe133	52.5	95.7	76.5	
		Xe131(n,γ)Xe132(n,γ)Xe133	41.4	1.8		
		Xe129(n,γ)Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133	3.8			
		Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133	1.5			
		Xe132(n,γ)Xe133m(IT)Xe133		2.5	23.4	
		Xe134(n,2n)Xe133				52.1
		Xe134(n,2n)Xe133m(IT)Xe133				47.3
Cs132	6.53d	Xe134(n,2n)Xe133(β^-)Cs133(n,2n)Cs132				52.2
		Xe134(n,2n)Xe133m(IT)Xe133(β^-)Cs133(n,2n)Cs132				47.2
I131	8.02d	Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,α)I131	50.8	95.7		
		Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,α)I131	34.4			
		Xe124(n,γ)Xe125(β^+)I125(n,γ)I126(n,γ)I127(n,γ)I128(β^+) Te128(n,γ)Te129(β^-)I129(n,γ)I130(n,γ)I131	5.1			
		Xe124(n,γ)Xe125(β^+)I125(n,γ)I126(n,γ)I127(n,γ)I128(β^+) Te128(n,γ)Te129(β^-)I129(n,γ)I130m(IT)I130(n,γ)I131	3.3			
		Xe129(n,γ)Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133(β^-) Cs133(n,γ)Cs134(n,α)I131	1.3			
		Xe132(n,γ)Xe133m(IT)Xe133(β^-)Cs133(n,γ)Cs134(n,α)I131		2.4		
		Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134m(IT)Cs134(n,α)I131		1.2		
		Xe131(n,p)I131			99.7	83.9
		Xe132(n,2n)Xe131m(IT)Xe131(n,p)I131				6.4
		Xe132(n,2n)Xe131(n,p)I131				3.8
		Xe132(n,d)I131				2.7

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Xe129m	8.88d	Xe128(n,γ)Xe129m	98.7	100.0		
		Xe129(n,n′)Xe129m			99.3	46.9
		Xe130(n,2n)Xe129m				33.3
		Xe131(n,2n)Xe130(n,2n)Xe129m				18.1
Xe131m	11.93d	Xe129(n,γ)Xe130(n,γ)Xe131m	82.6	19.1		
		Xe130(n,γ)Xe131m	16.4	80.9		
		Xe128(n,γ)Xe129(n,γ)Xe130(n,γ)Xe131m	1.0			
		Xe131(n,n′)Xe131m			99.3	8.4
		Xe132(n,2n)Xe131m				90.4
I126	12.98d	Xe124(n,γ)Xe125(β^+)I125(n,γ)I126	88.1	84.9	68.3	
		Xe124(n,γ)Xe125m(IT)Xe125(β^+)I125(n,γ)I126	11.9	15.2	31.7	
		Xe128(n,2n)Xe127m(IT)Xe127(β^+)I127(n,2n)I126				35.7
		Xe128(n,2n)Xe127(β^+)I127(n,2n)I126				25.6
		Xe129(n,2n)Xe128(n,2n)Xe127m(IT)Xe127(β^+)I127(n,2n)I126				21.7
		Xe129(n,2n)Xe128(n,2n)Xe127(β^+)I127(n,2n)I126				15.6
Cs136	13.03d	Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136	59.7			
		Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,γ) Cs135(n,γ)Cs136	32.9			
		Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,γ)Cs135(n,γ) Cs136m(IT)Cs136	3.0			
		Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,γ) Cs135(n,γ)Cs136m(IT)Cs136	1.6			
		Xe134(n,γ)Xe135(β^-)Cs135(n,γ)Cs136		92.8	69.3	
		Xe134(n,γ)Xe135(β^-)Cs135(n,γ)Cs136m(IT)Cs136		5.0	7.1	
		Xe134(n,γ)Xe135m(IT)Xe135(β^-)Cs135(n,γ)Cs136		1.8	21.2	
		Xe134(n,γ)Xe135m(IT)Xe135(β^-)Cs135(n,γ)Cs136m(IT)Cs136			2.2	
		Xe136(n,2n)Xe135m(IT)Xe135(β^-)Cs135(n,γ)Cs136				30.9
		Xe136(n,γ)Xe137(β^-)Cs137(n,2n)Cs136				30.0
		Xe136(n,2n)Xe135(β^-)Cs135(n,γ)Cs136				25.3
		Xe136(n,γ)Xe137(β^-)Cs137(n,2n)Cs136m(IT)Cs136				4.8
		Xe136(n,2n)Xe135m(IT)Xe135(β^-)Cs135(n,γ)Cs136m(IT)Cs136				4.7
		Xe136(n,2n)Xe135(β^-)Cs135(n,γ)Cs136m(IT)Cs136				3.9
Xe127	36.40d	Xe126(n,γ)Xe127	89.5	90.8	75.7	
		Xe126(n,γ)Xe127m(IT)Xe127	6.0	9.2	24.1	
		Xe124(n,γ)Xe125(β^+)I125(n,γ)I126(β^-)Xe126(n,γ)Xe127	3.3			
		Xe129(n,2n)Xe128(n,2n)Xe127m(IT)Xe127				31.9
		Xe128(n,2n)Xe127m(IT)Xe127				25.8
		Xe129(n,2n)Xe128(n,2n)Xe127				22.8
		Xe128(n,2n)Xe127				18.5
I125	59.43d	Xe124(n,γ)Xe125(β^+)I125	88.0	84.9	68.3	
		Xe124(n,γ)Xe125m(IT)Xe125(β^+)I125	11.9	15.2	31.7	
		Xe126(n,2n)Xe125m(IT)Xe125(β^+)I125				60.1
		Xe126(n,2n)Xe125(β^+)I125				34.5
Cs134	2.06y	Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134	57.4	95.7	67.0	
		Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134	39.0			
		Xe129(n,γ)Xe130(n,γ)Xe131(n,γ)Xe132(n,γ)Xe133(β^-) Cs133(n,γ)Cs134	1.5			
		Xe132(n,γ)Xe133m(IT)Xe133(β^-)Cs133(n,γ)Cs134		2.4	20.3	
		Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134m(IT)Cs134		1.2	9.2	
		Xe132(n,γ)Xe133m(IT)Xe133(β^-)Cs133(n,γ)Cs134m(IT)Cs134			2.8	
		Xe136(n,2n)Xe135m(IT)Xe135(β^-)Cs135(n,2n)Cs134				39.4
		Xe136(n,2n)Xe135(β^-)Cs135(n,2n)Cs134				32.3
		Xe136(n,2n)Xe135m(IT)Xe135(β^-)Cs135(n,2n)Cs134m(IT)Cs134				15.1
		Xe136(n,2n)Xe135(β^-)Cs135(n,2n)Cs134m(IT)Cs134				12.3
H3	12.33y	Xe124(n,γ)Xe125(β^+)I125(n,γ)I126(n,p)H1(n,γ)H2(n,γ)H3	85.3			
		Xe124(n,γ)Xe125m(IT)Xe125(β^+)I125(n,γ)I126(n,p)H1(n,γ) H2(n,γ)H3	11.5			
		Xe129(n,p)H1(n,γ)H2(n,γ)H3			91.5	
		Xe124(n,p)H1(n,γ)H2(n,γ)H3			7.3	
		Xe129(n,t)H3				67.3
		Xe131(n,t)H3				27.9
		Xe132(n,2n)Xe131m(IT)Xe131(n,t)H3				1.1
Cs137	30.04y	Xe136(n,γ)Xe137(β^-)Cs137	98.5	100.0	100.0	100.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cs135	2.3 10^6y	Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,γ)Cs135	62.4			
		Xe131(n,γ)Xe132(n,γ)Xe133(β^-)Cs133(n,γ)Cs134(n,γ)Cs135	34.8			
		Xe134(n,γ)Xe135(β^-)Cs135		97.7	76.4	
		Xe134(n,γ)Xe135m(IT)Xe135(β^-)Cs135		1.9	23.4	
		Xe136(n,2n)Xe135m(IT)Xe135(β^-)Cs135				54.6
		Xe136(n,2n)Xe135(β^-)Cs135				44.7
I129	1.6 10^7y	Xe124(n,γ)Xe125(β^+)I125(n,γ)I126(n,γ)I127(n,γ)I128(β^+) Te128(n,γ)Te129(β^-)I129	72.3			
		Xe124(n,γ)Xe125m(IT)Xe125(β^+)I125(n,γ)I126(n,γ)I127(n,γ) I128(β^+)Te128(n,γ)Te129(β^-)I129	9.7			
		Xe124(n,γ)Xe125(β^+)I125(n,γ)I126(n,γ)I127(n,γ) I128(n,γ)I129	6.8			
		Xe131(n,α)Te128(n,γ)Te129(β^-)I129		3.0		
		Xe129(n,p)I129			99.4	95.6
		Xe132(n,α)Te129(β^-)I129				1.3

Caesium

Isotope	Atom % abundance
Cs133	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.34E+15	1.34E+15	1.12E+15	5.10E+14	2.86E+08	2.19E+07
Cs134	53.1	53.2	63.4	100.0		
Cs132	43.8	43.8	35.5			
Cs134m	1.5	1.5				
Ba133					89.4	
Cs135					7.7	100.0
H3					2.0	

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.67E-01	2.67E-01	2.43E-01	1.40E-01	1.91E-08	2.66E-10
Cs134	73.6	73.7	80.6	100.0		
Cs132	25.7	25.7	19.2			
Ba133					97.7	
Cs135					1.4	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	3.42E+05	3.42E+05	3.12E+05	1.79E+05	9.55E-03	3.26E-10
Cs134	73.0	73.0	79.9	100.0		
Cs132	26.8	26.8	20.0			
Ba133					98.3	
Ba137m					1.7	
I129						100.0

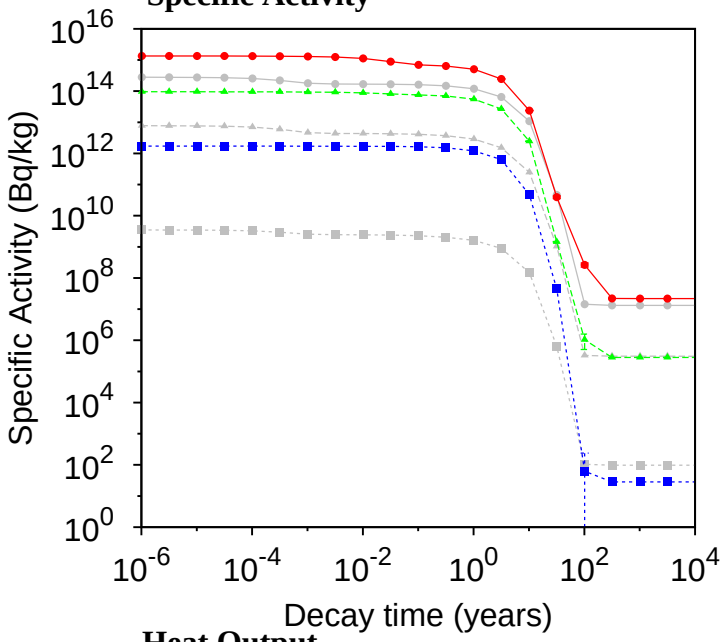
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.42E+07	2.42E+07	2.01E+07	9.69E+06	4.67E-01	4.39E-02
Cs134	56.1	56.1	67.0	100.0		
Xe133	22.3	22.3	19.2			
Xe133m	11.9	11.8	4.5			
Xe131m	8.5	8.5	8.3			
Cs132	1.2	1.2	1.0			
Ba133					81.9	
Cs135					9.4	99.7
Ba137m					5.0	
Cs137					3.6	

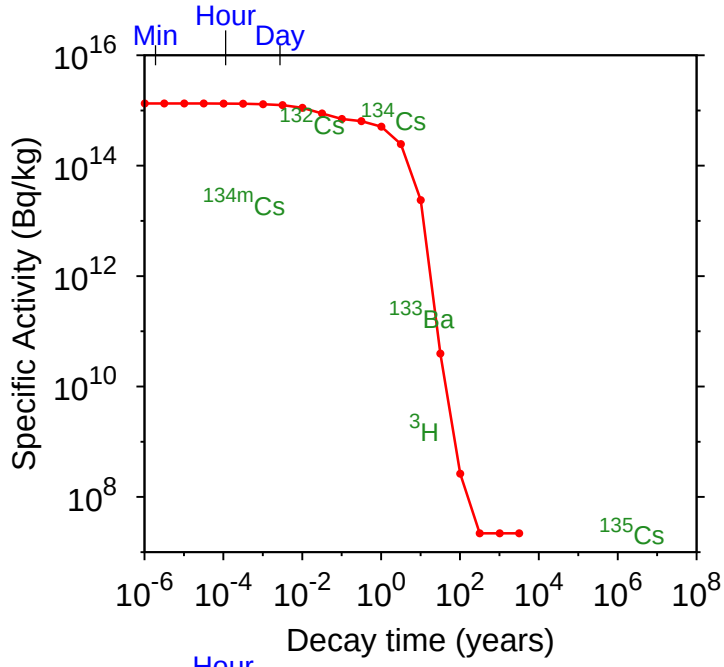
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.39E+07	2.39E+07	2.06E+07	1.02E+07	2.81E+00	1.88E-01
Cs134	59.6	59.6	68.9	100.0		
Xe133	18.6	18.6	15.4			
Xe131m	12.9	12.9	12.1			
Xe133m	8.2	8.2	3.0			
Ba133					90.9	
Cs135					6.7	100.0
Cs137					1.8	

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	7.19E+12	7.19E+12	7.15E+12	5.10E+12	1.16E+05	3.33E+02
Cs134	99.1	99.2	99.4	100.0		
Ba133					87.8	
Cs137					11.2	
Cs135					0.2	65.6
I129					0.1	34.4

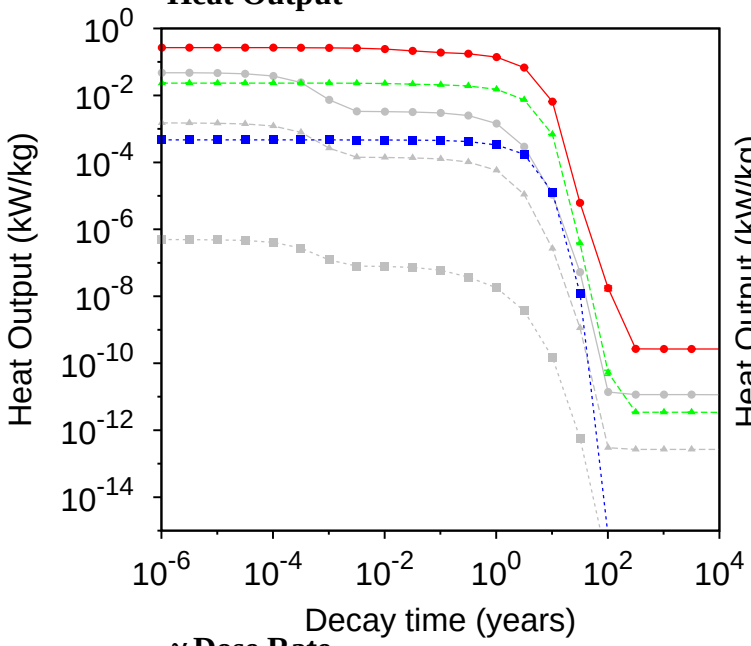
Caesium activation characteristics

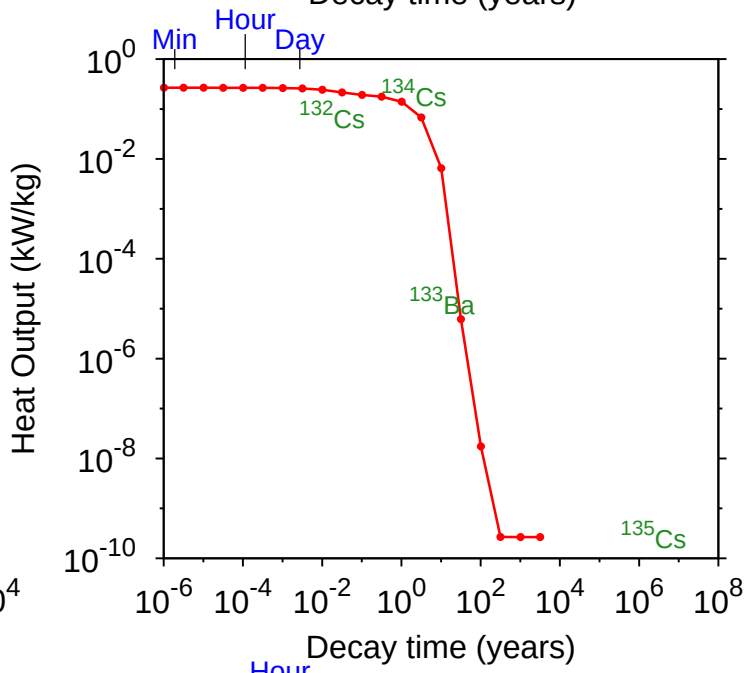
Specific Activity



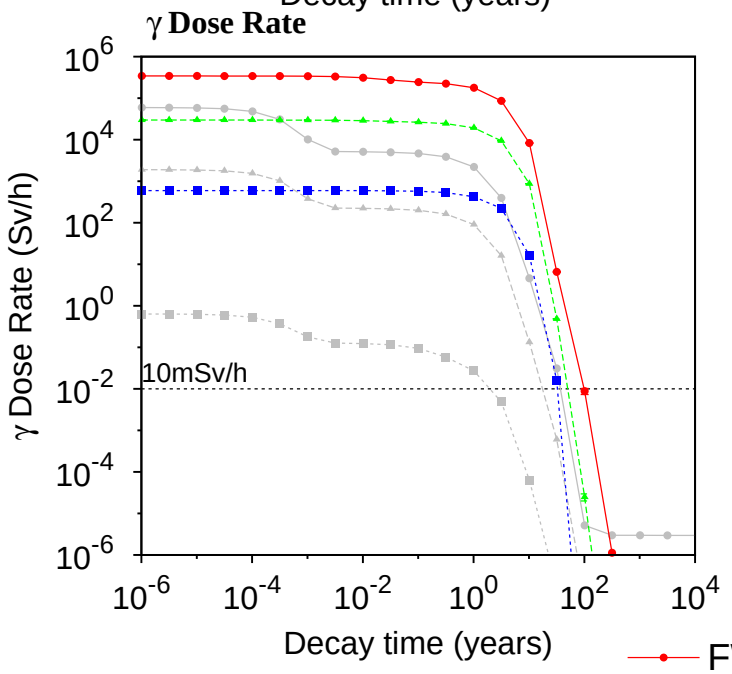


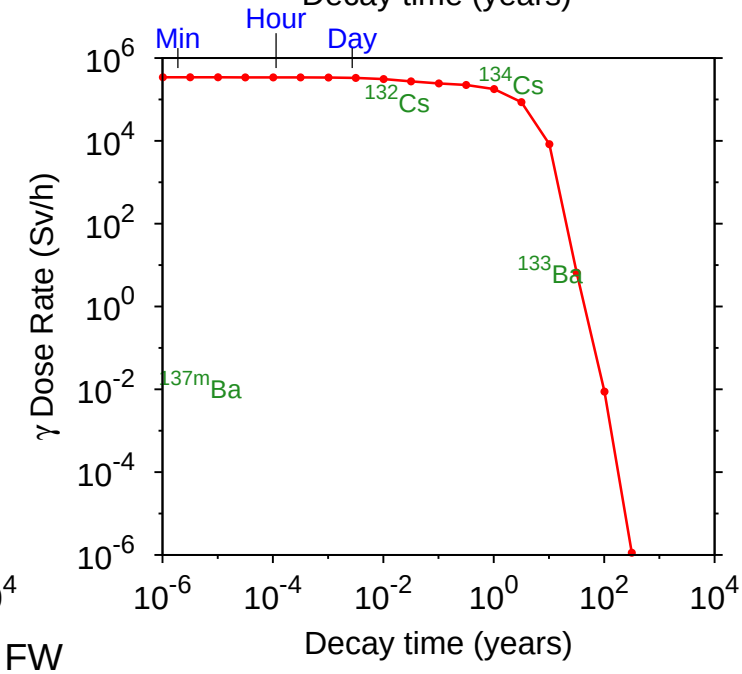
Heat Output





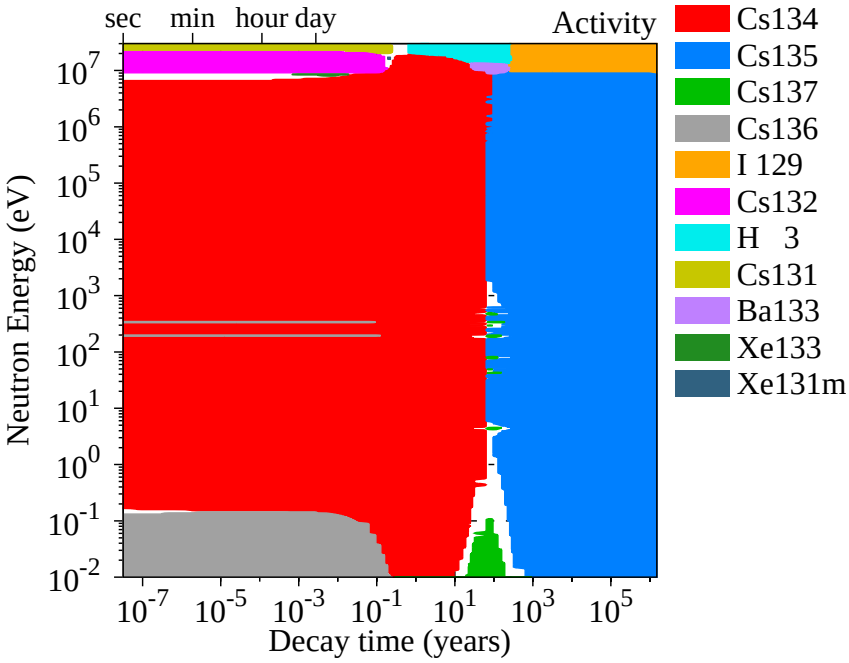
γ Dose Rate

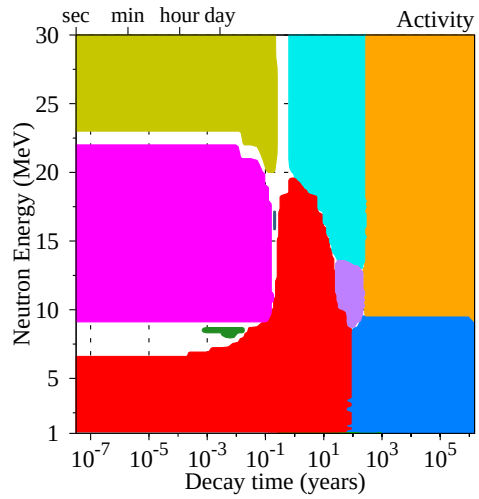


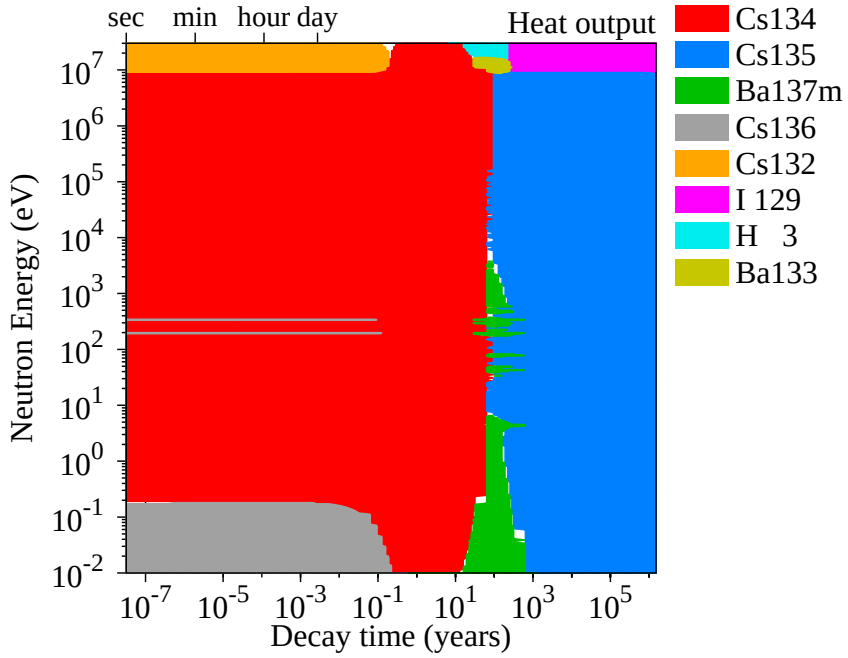


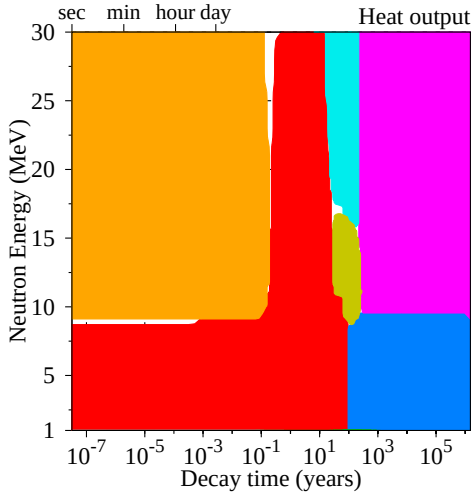
FW
Blanket
Manifold
Fe results

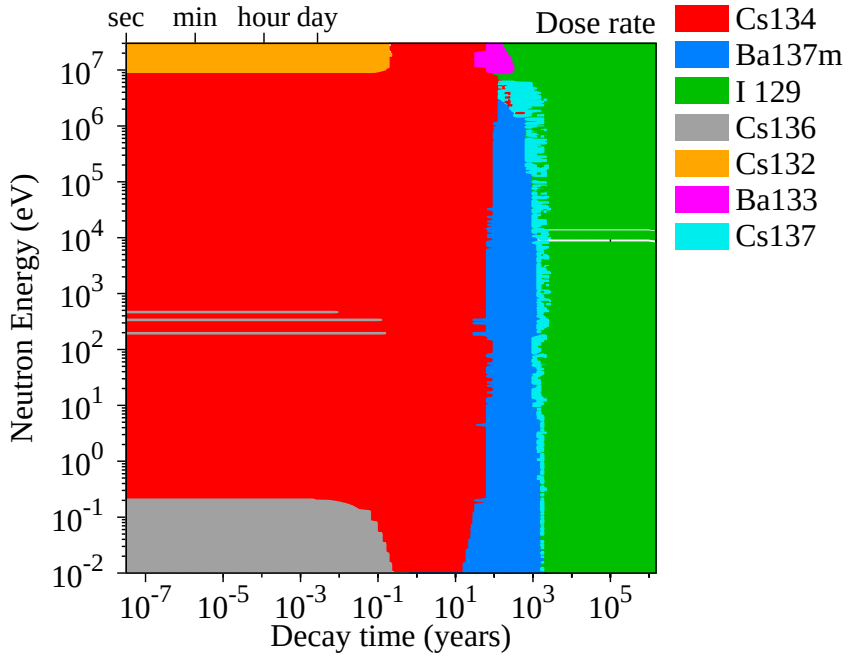
Caesium Importance diagrams

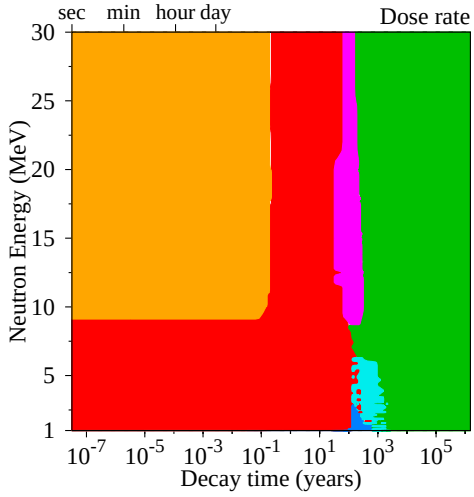




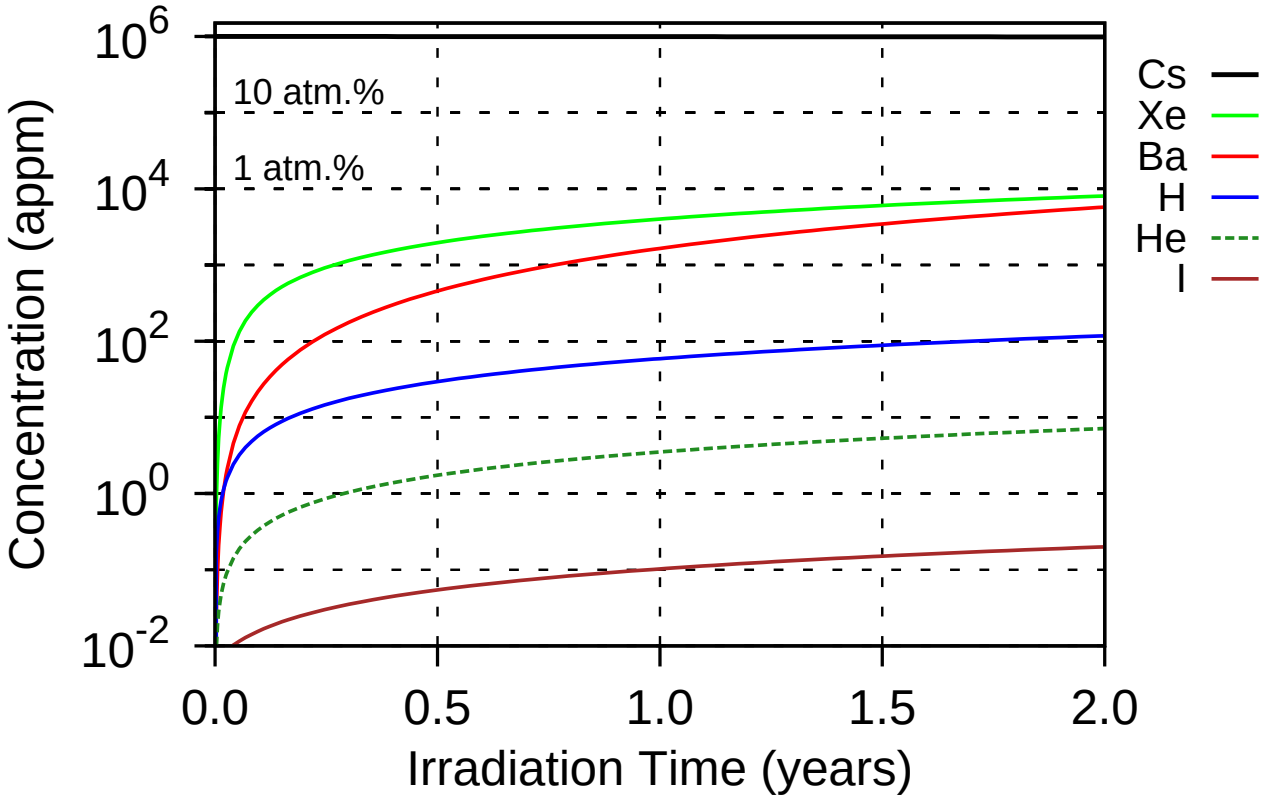






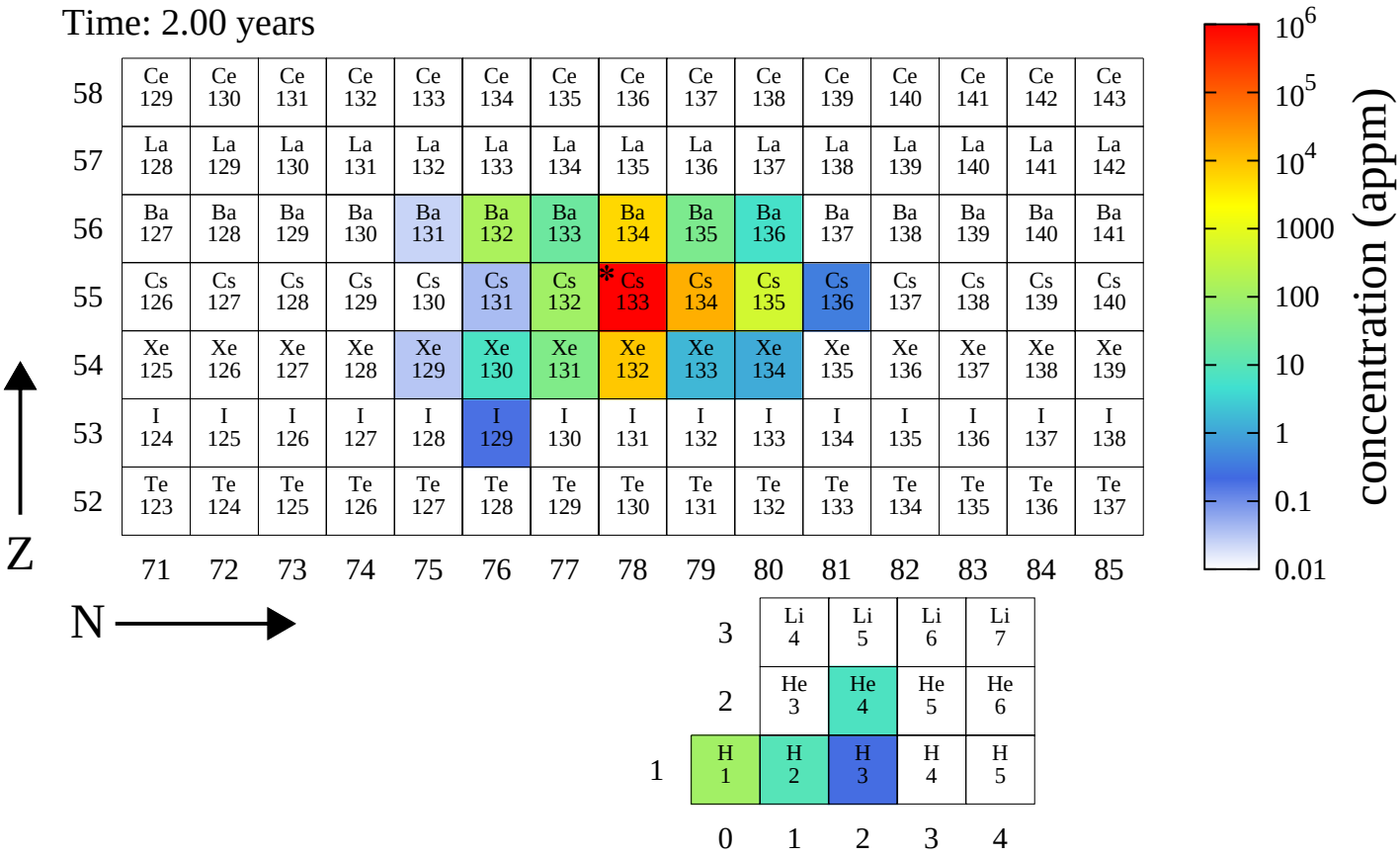


Caesium FW Transmutation

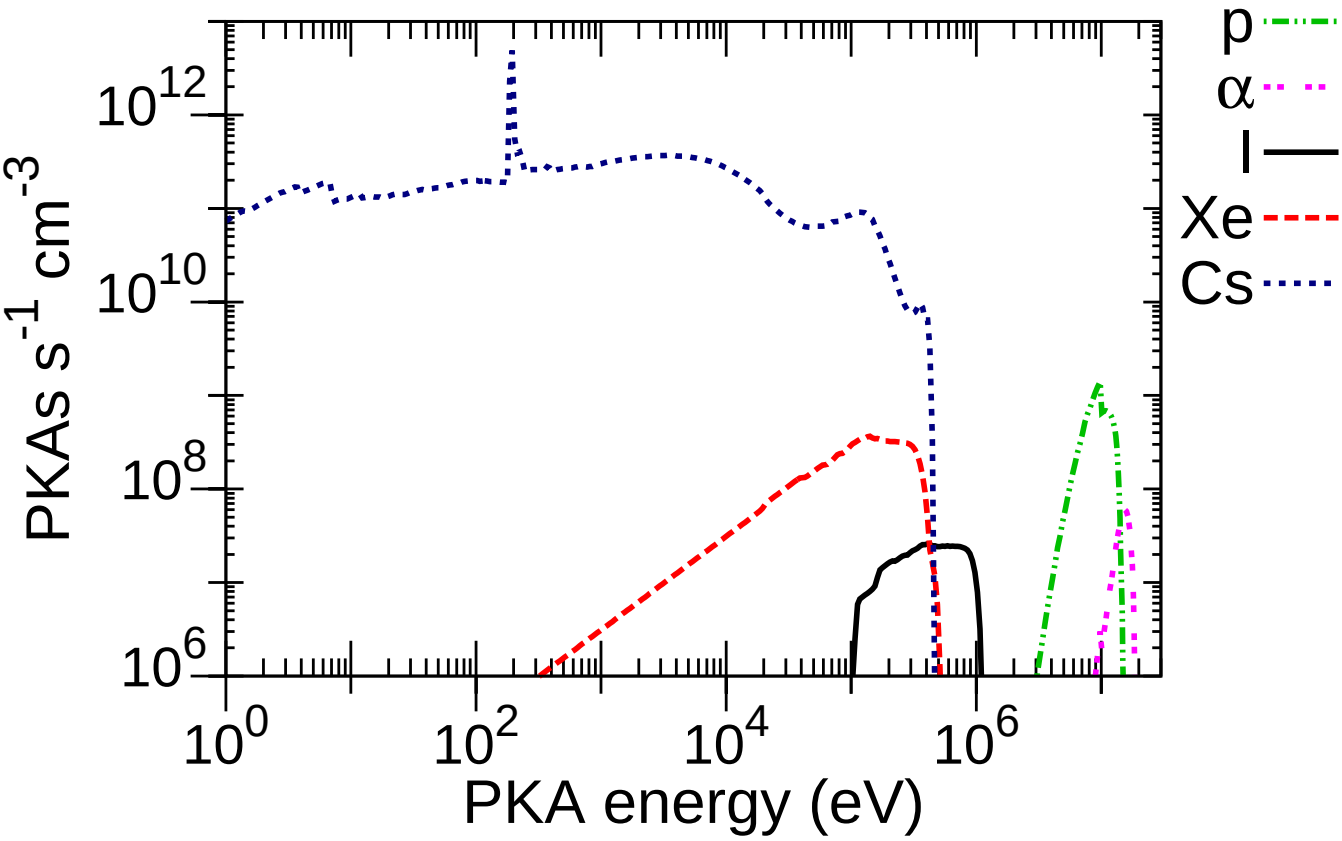


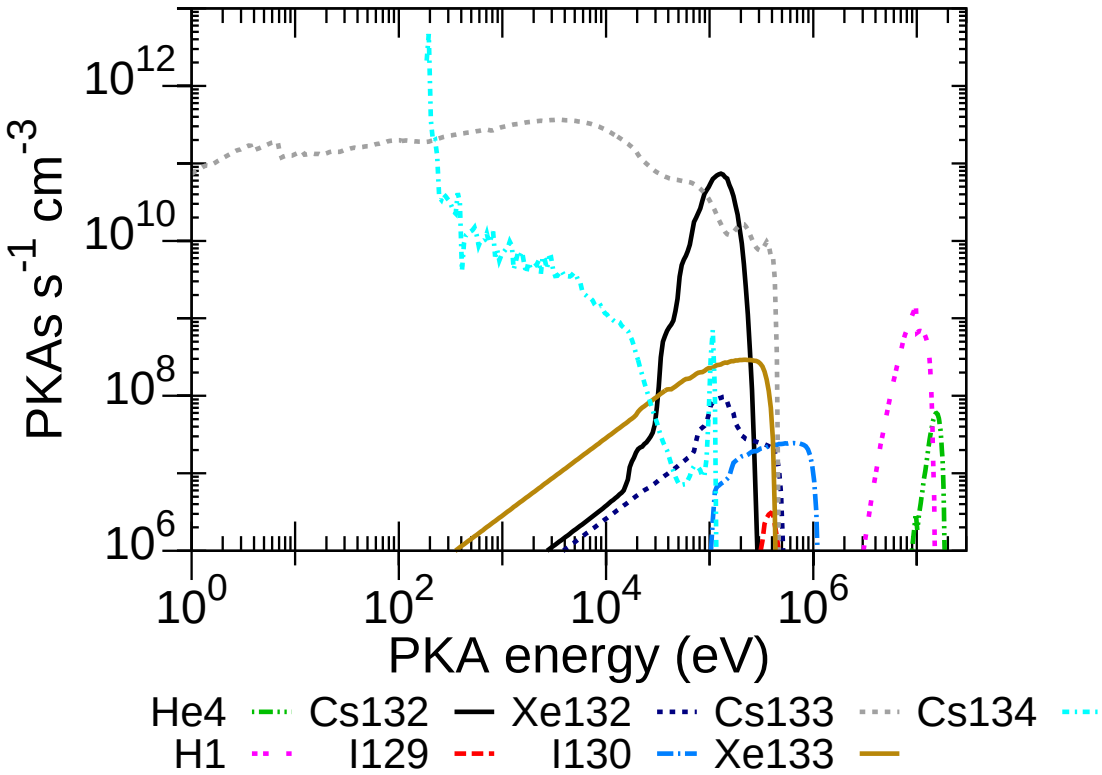
4 appm He & 59 appm H after 1 year

14 dpa/year



Caesium FW PKA distributions





Caesium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ba137m	2.55m	Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136(β^-)Ba136(n,γ)Ba137m	50.3	74.9	15.8	
		Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136(n,γ)Cs137(β^-)Ba137m	41.6	3.3		
		Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136m(β^-)Ba136(n,γ)Ba137m	2.7	4.3	1.8	
		Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136m(IT)Cs136(β^-) Ba136(n,γ)Ba137m	2.5	4.0	1.6	
		Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136m(IT)Cs136(n,γ) Cs137(β^-)Ba137m	2.1			
		Cs133(n,γ)Cs134(β^-)Ba134(n,γ)Ba135(n,γ)Ba136(n,γ)Ba137m		11.1	44.7	
		Cs133(n,γ)Cs134(β^-)Ba134(n,γ)Ba135m(IT)Ba135(n,γ) Ba136(n,γ)Ba137m			17.0	
		Cs133(n,γ)Cs134m(IT)Cs134(β^-)Ba134(n,γ)Ba135(n,γ) Ba136(n,γ)Ba137m			6.2	
		Cs133(n,γ)Cs134(β^-)Ba134(n,γ)Ba135(n,γ)Ba136m(IT) Ba136(n,γ)Ba137m			3.3	
		Cs133(n,γ)Cs134m(IT)Cs134(β^-)Ba134(n,γ)Ba135m(IT) Ba135(n,γ)Ba136(n,γ)Ba137m			2.3	
		Cs133(n,γ)Cs134m(IT)Cs134(n,γ)Cs135(n,γ)Cs136(β^-) Ba136(n,γ)Ba137m			2.2	
		Cs133(n,γ)Cs134(β^-)Ba134(n,γ)Ba135m(IT)Ba135(n,γ) Ba136m(IT)Ba136(n,γ)Ba137m			1.2	
Cs134m	2.91h	Cs133(n,γ)Cs134m	100.0	100.0	91.3	97.9
		Cs133(n,γ)Cs134(n,n$'$)Cs134m			8.7	1.5
Xe133m	2.19d	Cs133(n,γ)Cs134(n,α)I131(β^-)Xe131(n,γ)Xe132(n,γ)Xe133m	85.9			
		Cs133(n,γ)Cs134(n,α)I131(n,γ)I132(β^-)Xe132(n,γ)Xe133m	7.3			
		Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136(n,α)I133(β^-)Xe133m	4.1			
		Cs133(n,p)Xe133m			100.0	99.3
Xe133	5.24d	Cs133(n,γ)Cs134(n,α)I131(β^-)Xe131(n,γ)Xe132(n,γ)Xe133	88.4			
		Cs133(n,γ)Cs134(n,α)I131(n,γ)I132(β^-)Xe132(n,γ)Xe133	7.5			
		Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136(n,α)I133(β^-)Xe133	1.0			
		Cs133(n,p)Xe133			65.4	39.0
		Cs133(n,p)Xe133m(IT)Xe133			34.6	60.2
Cs132	6.53d	Cs133(n,2n)Cs132				99.9
Cs131	9.69d	Cs133(n,2n)Cs132(n,2n)Cs131				48.3
		Cs133(n,2n)Cs132(β^-)Ba132(n,2n)Ba131m(IT)Ba131(β^+)Cs131				30.1
		Cs133(n,2n)Cs132(β^-)Ba132(n,2n)Ba131(β^+)Cs131				21.3
Xe131m	11.93d	Cs133(n,γ)Cs134(n,α)I131(β^-)Xe131m	99.3	98.5	4.5	
		Cs133(n,γ)Cs134m(IT)Cs134(n,α)I131(β^-)Xe131m		1.2		
		Cs133(n,γ)Cs134(β^-)Ba134(n,α)Xe131m			35.8	
		Cs133(n,α)I130(β^-)Xe130(n,γ)Xe131m			26.1	
		Cs133(n,α)I130m(IT)I130(β^-)Xe130(n,γ)Xe131m			16.2	
		Cs133(n,γ)Cs134(n,α)I131(β^-)Xe131(n,n$'$)Xe131m			5.3	
		Cs133(n,γ)Cs134m(IT)Cs134(β^-)Ba134(n,α)Xe131m			4.9	
		Cs133(n,α)I130m(β^-)Xe130(n,γ)Xe131m			3.3	
		Cs133(n,γ)Cs134(β^-)Ba134(n,α)Xe131(n,n$'$)Xe131m			1.0	
		Cs133(n,2n)Cs132(β^+)Xe132(n,2n)Xe131m				99.1
Cs136	13.03d	Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136	94.6	93.6	76.8	58.5
		Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136m(IT)Cs136	4.7	5.0	7.9	8.9
		Cs133(n,γ)Cs134m(IT)Cs134(n,γ)Cs135(n,γ)Cs136		1.1	10.6	17.3
		Cs133(n,γ)Cs134(n,γ)Cs135m(IT)Cs135(n,γ)Cs136			2.3	8.1
		Cs133(n,γ)Cs134m(IT)Cs134(n,γ)Cs135(n,γ)Cs136m(IT)Cs136			1.1	2.6
		Cs133(n,γ)Cs134m(IT)Cs134(n,γ)Cs135m(IT)Cs135(n,γ)Cs136				2.4
		Cs133(n,γ)Cs134(n,γ)Cs135m(IT)Cs135(n,γ)Cs136m(IT)Cs136				1.2
Cs134	2.06y	Cs133(n,γ)Cs134	99.3	98.8	87.2	76.9
		Cs133(n,γ)Cs134m(IT)Cs134		1.2	12.0	22.8
Ba133	10.54y	Cs133(n,γ)Cs134(β^-)Ba134(n,2n)Ba133m(IT)Ba133				37.1
		Cs133(n,γ)Cs134(β^-)Ba134(n,2n)Ba133				36.1
		Cs133(n,γ)Cs134m(IT)Cs134(β^-)Ba134(n,2n)Ba133m(IT)Ba133				11.0
		Cs133(n,γ)Cs134m(IT)Cs134(β^-)Ba134(n,2n)Ba133				10.7
		Cs133(n,2n)Cs132(β^-)Ba132(n,γ)Ba133m(IT)Ba133				2.5
		Cs133(n,2n)Cs132(β^-)Ba132(n,γ)Ba133				2.1
H3	12.33y	Cs133(n,γ)Cs134(n,p)H1(n,γ)H2(n,γ)H3	96.7			
		Cs133(n,t)H3				47.5

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cs137	30.04y	Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136(n,γ)Cs137	94.6	93.6	76.9	
		Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136m(IT)Cs136(n,γ)Cs137	4.7	5.0	7.9	
		Cs133(n,γ)Cs134m(IT)Cs134(n,γ)Cs135(n,γ)Cs136(n,γ)Cs137		1.1	10.6	
		Cs133(n,γ)Cs134(n,γ)Cs135m(IT)Cs135(n,γ)Cs136(n,γ)Cs137			2.3	
		Cs133(n,γ)Cs134m(IT)Cs134(n,γ)Cs135(n,γ)Cs136m(IT) Cs136(n,γ)Cs137			1.1	
Cs135	2.3 10^6y	Cs133(n,γ)Cs134(n,γ)Cs135	99.3	98.7	84.8	67.4
		Cs133(n,γ)Cs134m(IT)Cs134(n,γ)Cs135		1.2	11.7	20.0
		Cs133(n,γ)Cs134(n,γ)Cs135m(IT)Cs135			2.6	9.4
		Cs133(n,γ)Cs134m(IT)Cs134(n,γ)Cs135m(IT)Cs135				2.8
I129	1.6 10^7y	Cs133(n,nα)I129				54.0
		Cs133(n,2n)Cs132(β^+)Xe132(n,α)Te129(β^-)I129				20.7
		Cs133(n,2n)Cs132(n,α)I129				11.6
		Cs133(n,2n)Cs132(β^+)Xe132(n,α)Te129m(IT)Te129(β^-)I129				8.2
		Cs133(n,2n)Cs132(β^+)Xe132(n,α)Te129m(β^-)I129				4.7

Barium

Isotope	Atom % abundance
Ba130	0.11
Ba132	0.10
Ba134	2.42
Ba135	6.59
Ba136	7.85
Ba137	11.23
Ba138	71.70

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.74E+14	1.42E+14	1.91E+13	2.01E+12	5.78E+09	4.81E+05
Ba137m	71.0	44.8	0.1	0.7	24.8	
Ba135m	13.7	36.0	32.4			
Ba136m	7.8					
Ba133m	2.1	5.4	8.2			
Ba131	1.3	3.5	20.9			
Cs131	1.3	3.5	25.4			
Ba139	1.2	3.1				
Ba133	0.6	1.5	10.9	96.5	48.9	
Cs134			0.3	2.0		
Cs137			0.1	0.7	26.3	
Cs135						99.7

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	4.20E-02	1.11E-02	9.21E-04	1.55E-04	4.03E-07	5.84E-12
Ba137m	66.8	60.7	0.2	1.0	37.6	
Ba136m	22.6					
Ba135m	5.2	19.8	28.8			
Ba139	1.7	6.0				
Ba131	1.0	3.6	35.1			
Ba133m	0.8	3.2	7.9			
Cs138	0.7	2.3				
Ba133	0.4	1.4	16.4	91.5	51.1	
Cs136	0.2	0.6	6.3			
Cs131	0.1	0.2	2.5			
Cs134		0.1	1.7	7.2		
Cs137				0.3	11.3	
Cs135						99.9

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	5.23E+04	9.78E+03	4.64E+02	8.72E+01	2.96E-01	5.90E-10
Ba137m	68.4	87.9	0.4	2.2	65.2	
Ba136m	29.2					
Cs138	0.7	3.2				
Ba131	0.6	3.1	52.8			
Ba135m	0.3	1.5	3.8			
Cs136	0.2	1.1	18.9			
Ba129m	0.2	1.0				
Ba133	0.1	0.8	16.3	81.4	34.8	
Cs134		0.2	4.3	16.4		
Ba133m		0.3	1.1			
La137						81.4
La138						18.4

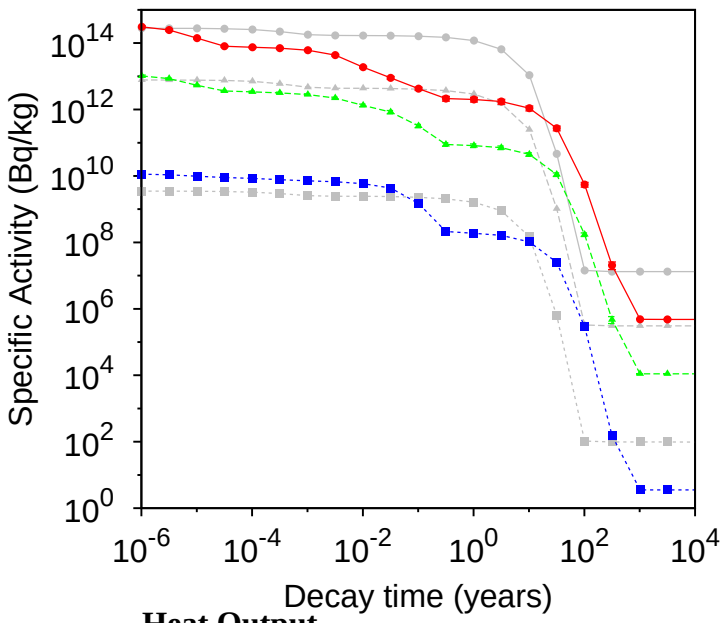
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.06E+06	2.20E+06	5.66E+04	4.16E+03	5.12E+01	9.59E-04
Ba137m	83.2	55.1	0.5	6.4	53.2	
Ba129m	11.1	29.8				
Xe135	2.1	5.8	0.3			
Ba129	1.8	4.8				
Xe131m	0.5	1.3	39.7			
Ba135m	0.4	1.0	4.7			
Xe133	0.2	0.7	19.3			
Xe127	0.1	0.4	12.7	0.2		
Ba133	0.1	0.1	5.5	70.1	8.3	
Xe133m	0.1	0.4	4.8			
Xe129m	0.1	0.1	4.2			
Ba131		0.1	3.2			
Cs134			1.9	18.6		
Ba133m	0.1	0.2	1.5			
Cs137			0.3	4.7	38.5	
Cs135						100.0

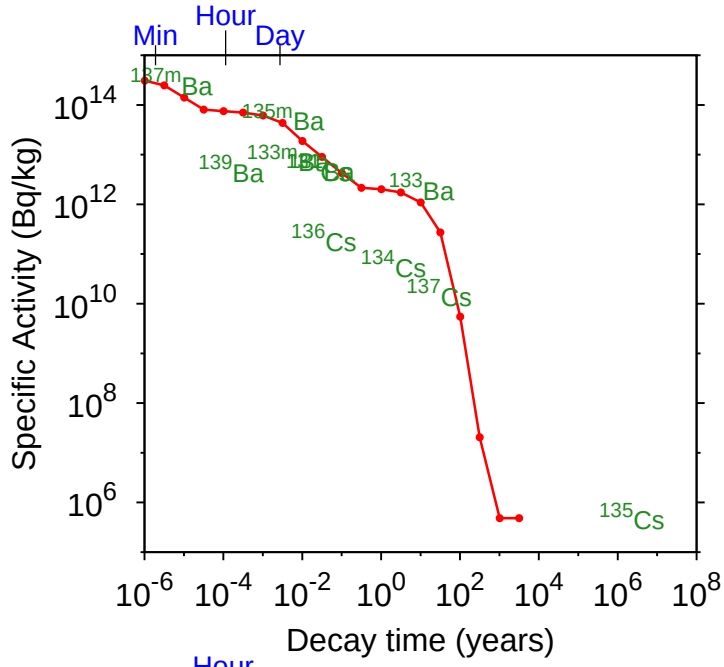
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.94E+06	1.50E+06	1.06E+05	2.10E+04	1.05E+02	4.14E-03
Ba137m	80.9	51.0	0.2	0.8	16.4	
Ba129m	11.7	29.9				
Ba129	1.9	4.9				
Xe135	1.7	4.5	0.1			
Xe131m	1.1	2.8	31.5			
Xe127	0.8	2.1	27.6	0.1		
Ba133	0.5	1.4	19.5	92.4	27.0	
Ba135m	0.5	1.2	2.1			
Xe133	0.3	0.8	8.5			
Ba131	0.1	0.3	3.3			
Xe129m	0.1	0.2	2.5			
Xe133m	0.2	0.4	1.8			
Cs134		0.1	1.1	3.9		
Cs137			0.6	2.8	56.6	
Cs135						99.7

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.21E+11	4.63E+10	2.80E+09	1.34E+09	1.72E+07	5.08E+00
Ba137m	70.6	81.1	0.3	0.6	4.9	
Ba136m	25.3					
Ba135m	1.9	9.2	18.4			
Ba133	0.4	1.8	29.7	58.0	6.6	
Ba133m	0.3	1.5	5.1			
Ba139	0.3	1.3				
Cs134	0.3	1.2	20.3	30.3		
Ba131	0.2	1.1	14.3			
Cs136	0.1	0.4	5.6			
Cs137	0.1	0.3	5.4	11.1	88.5	
Cs135						94.3
I129						4.9

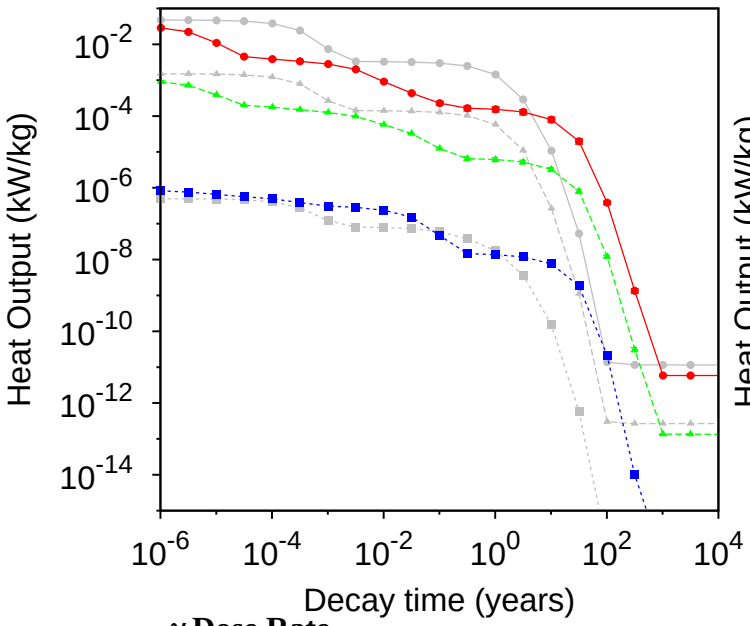
Barium activation characteristics

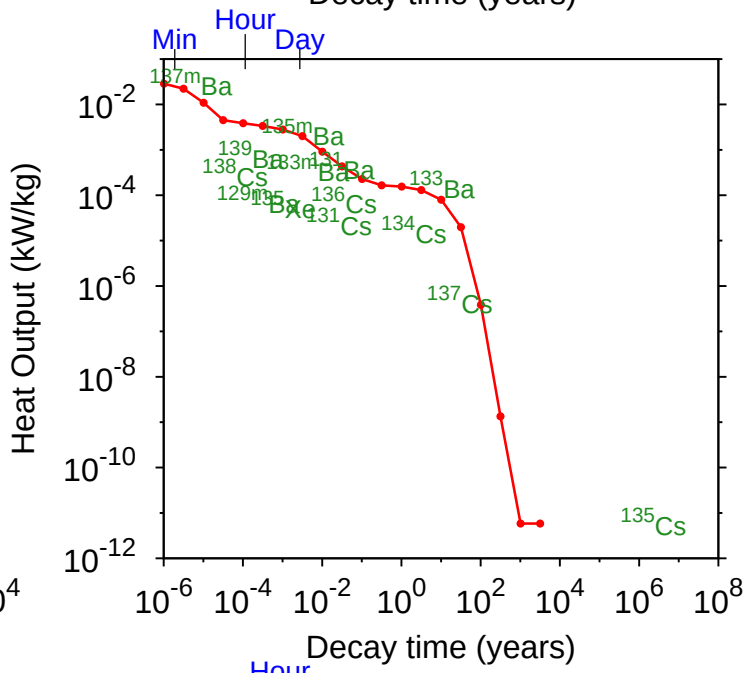
Specific Activity



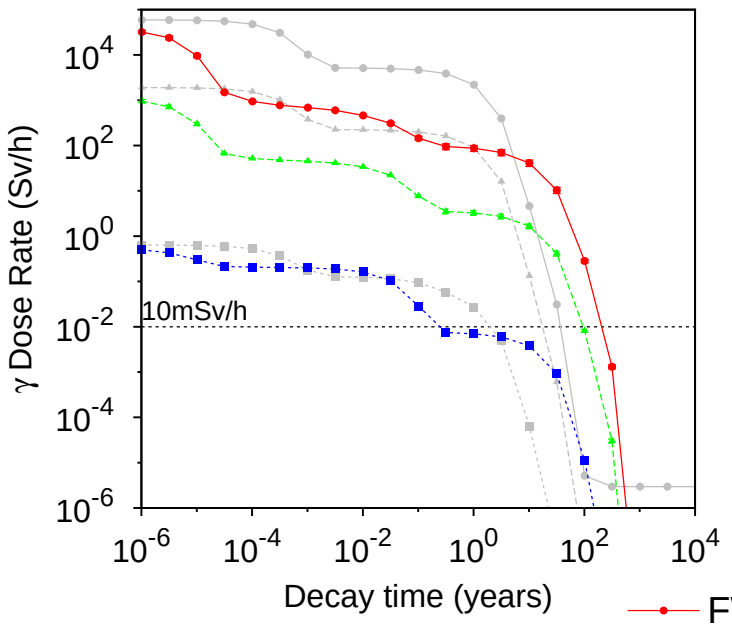


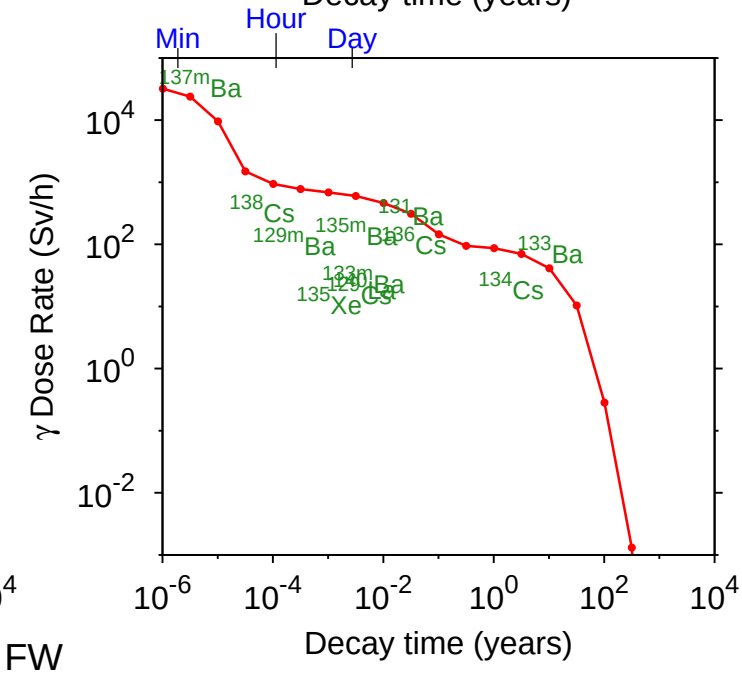
Heat Output





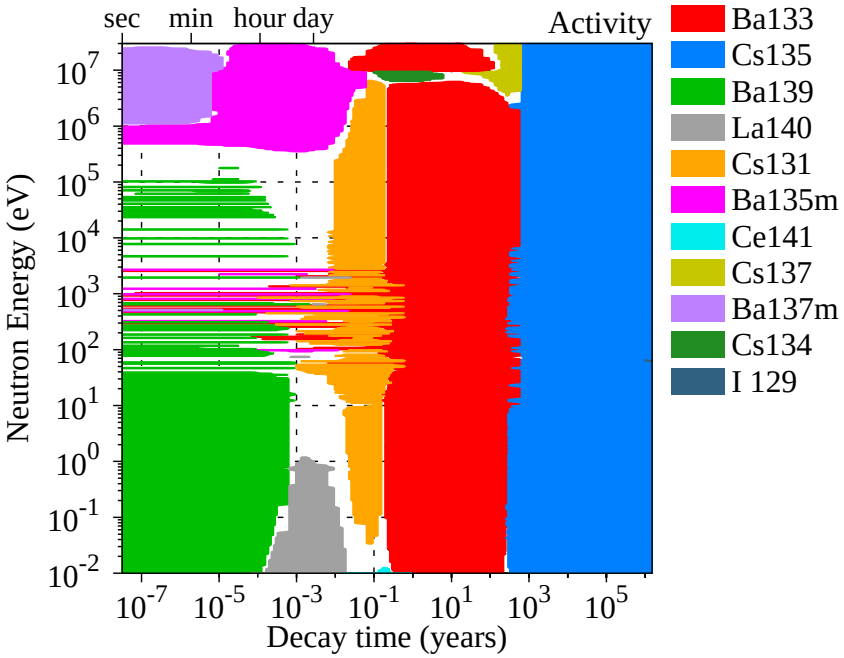
γ Dose Rate

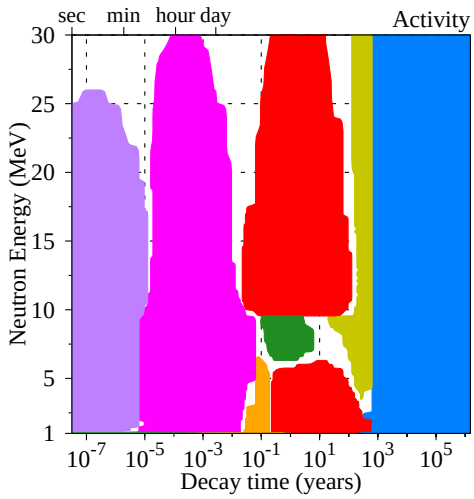


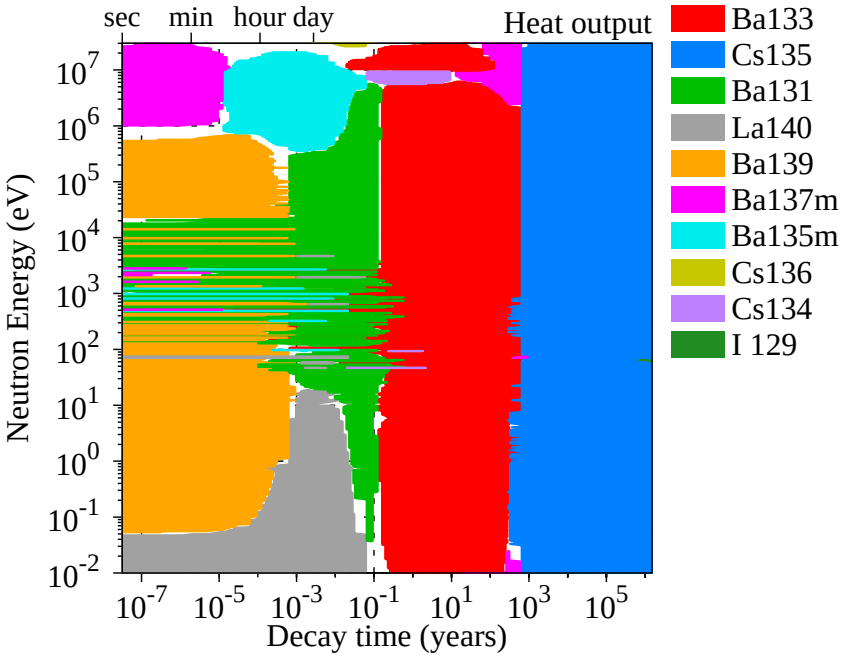


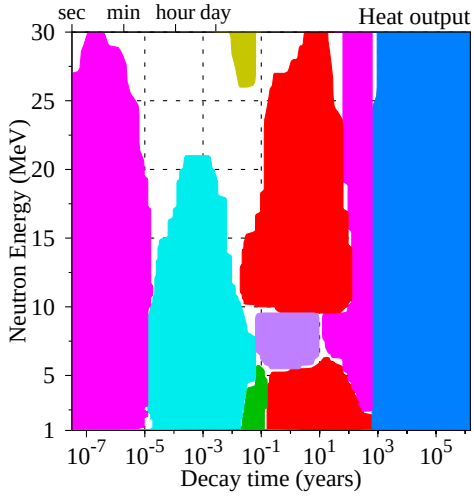
FW
Blanket
Manifold
Fe results

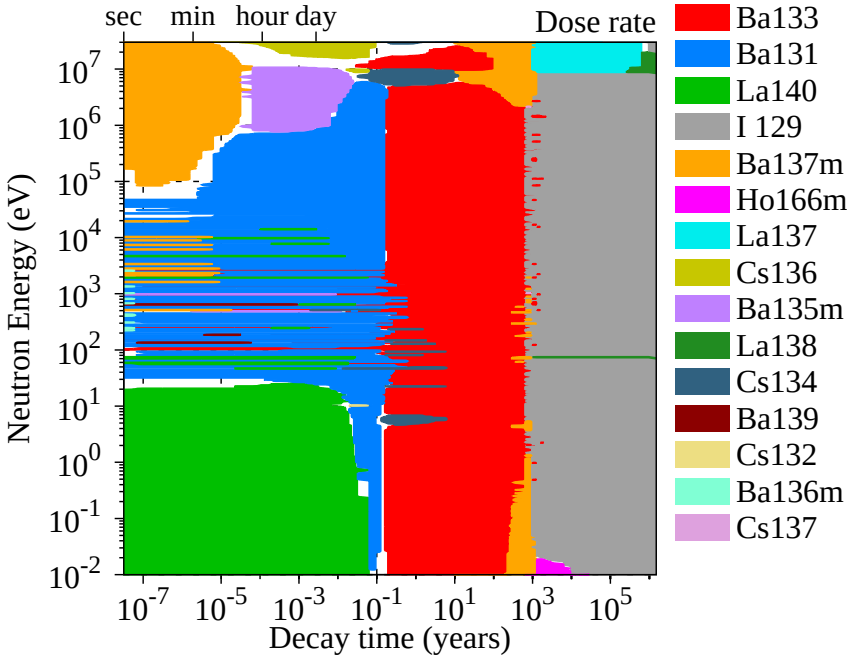
Barium Importance diagrams

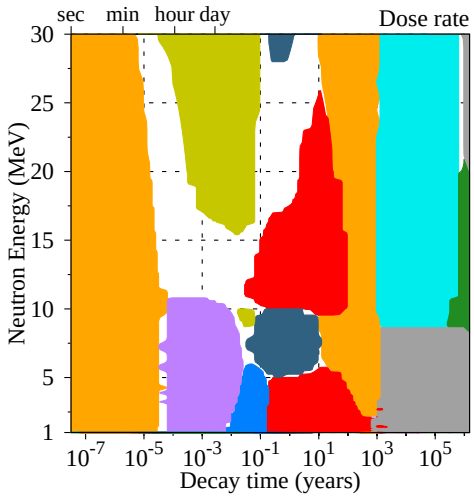




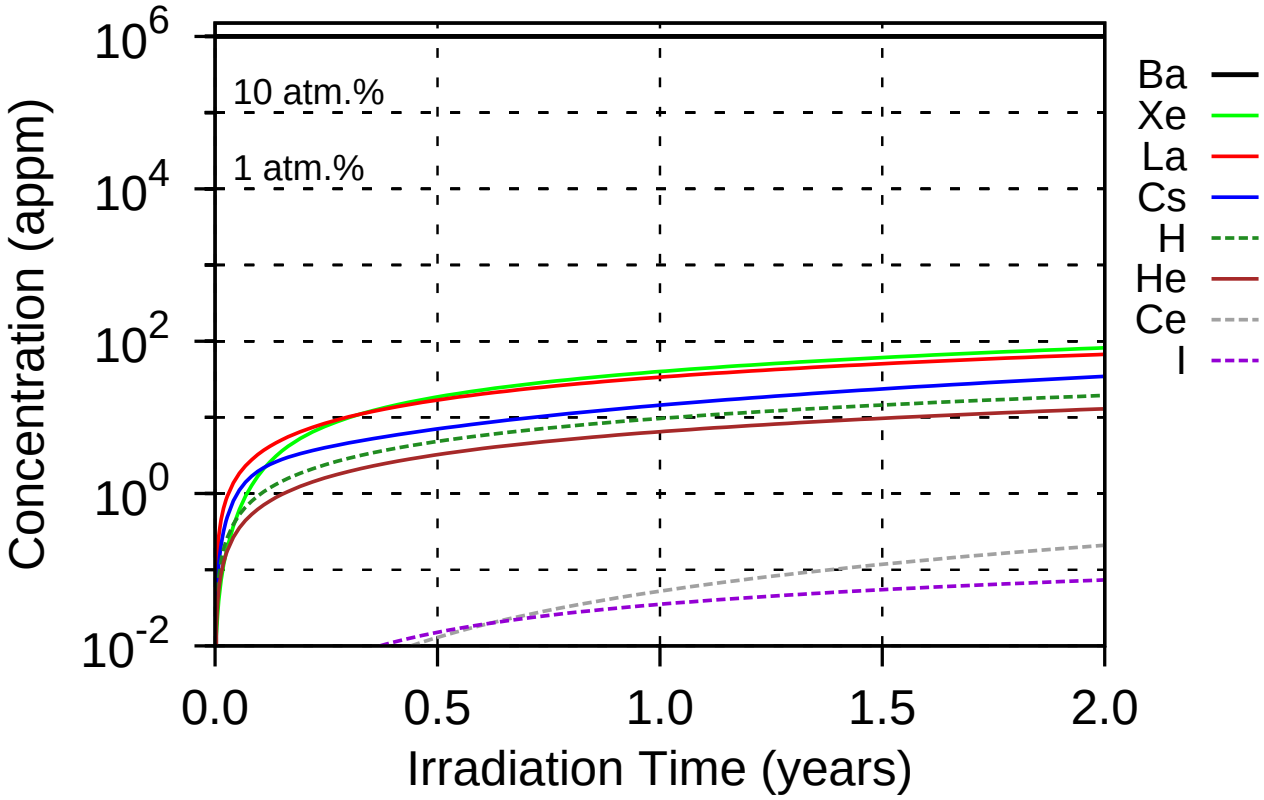






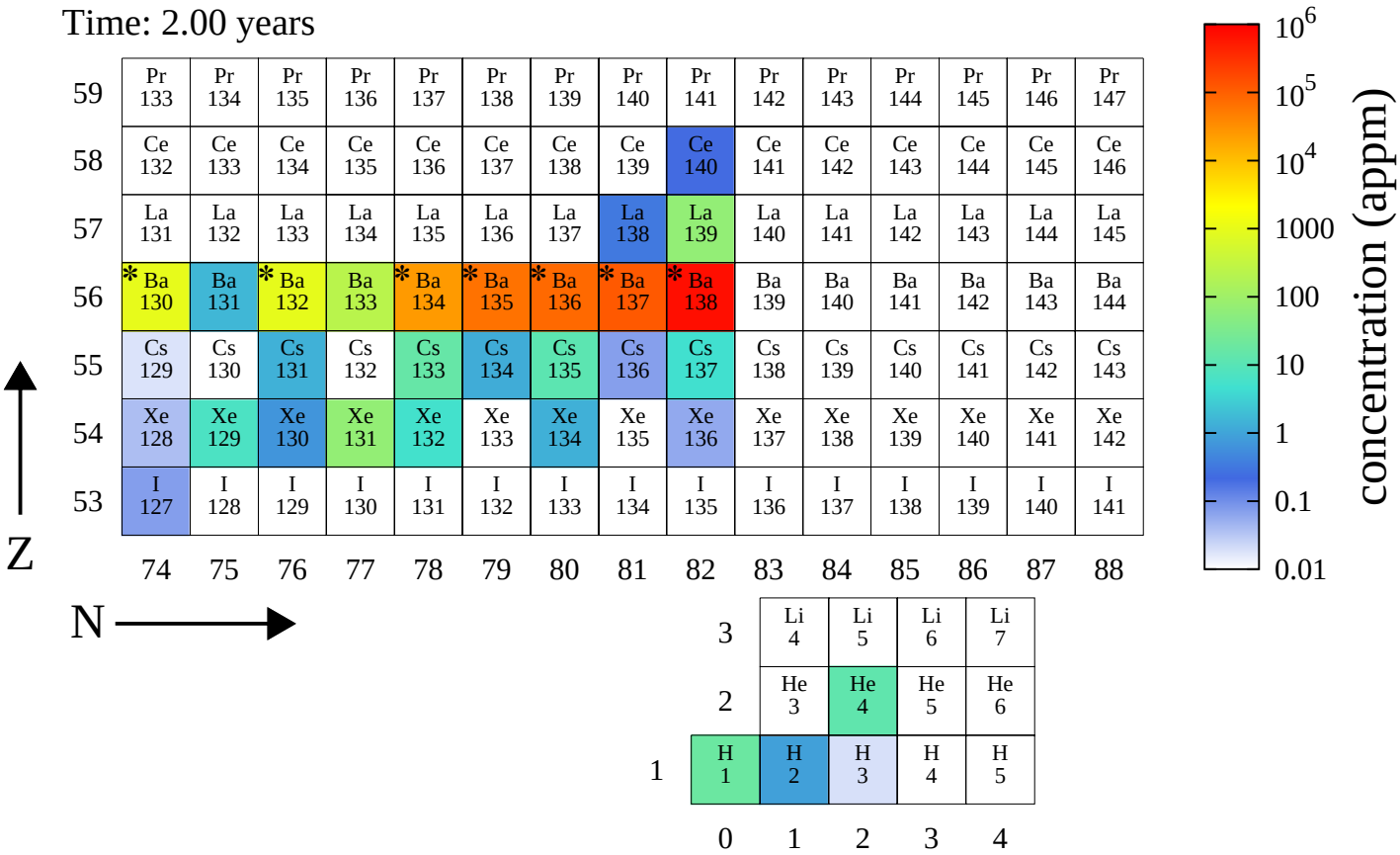


Barium FW Transmutation

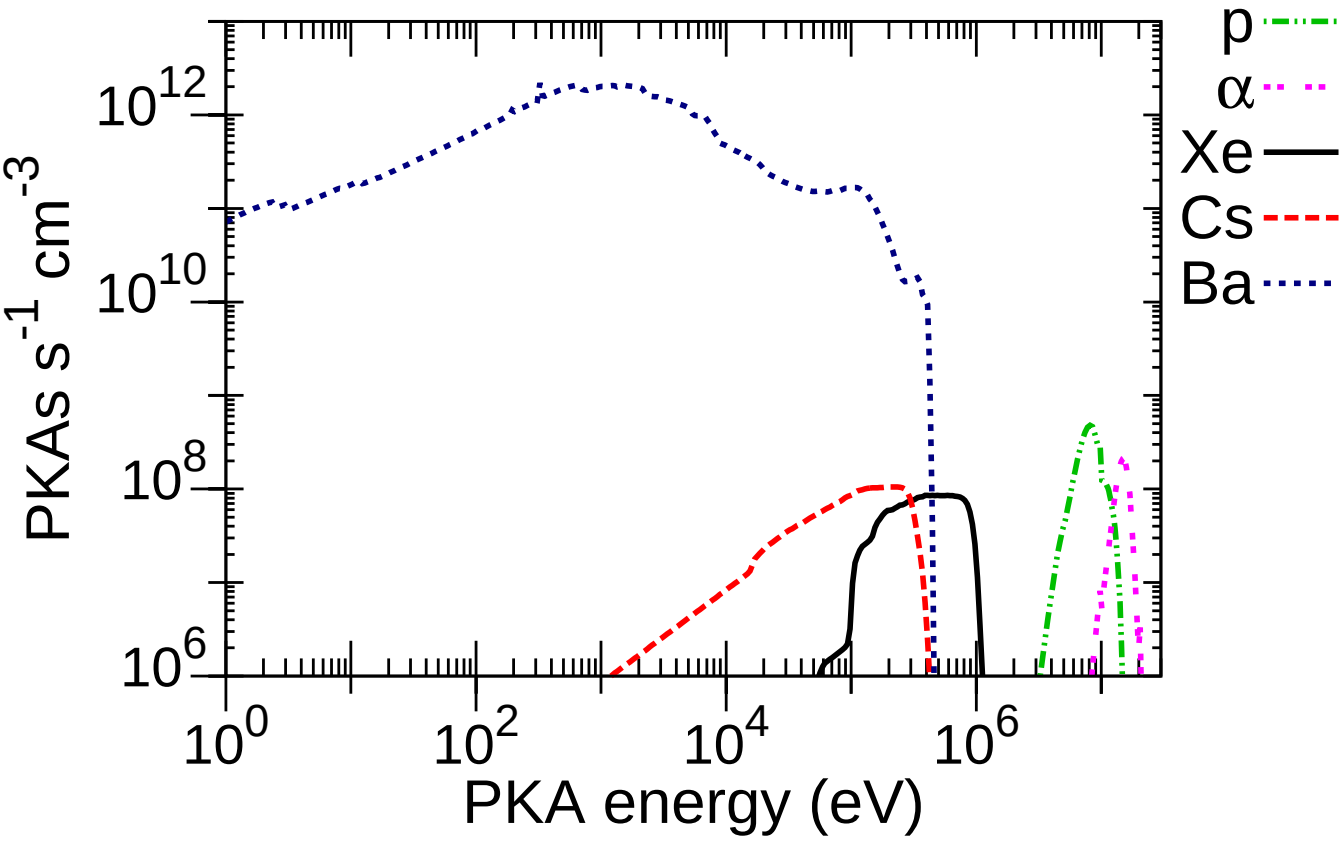


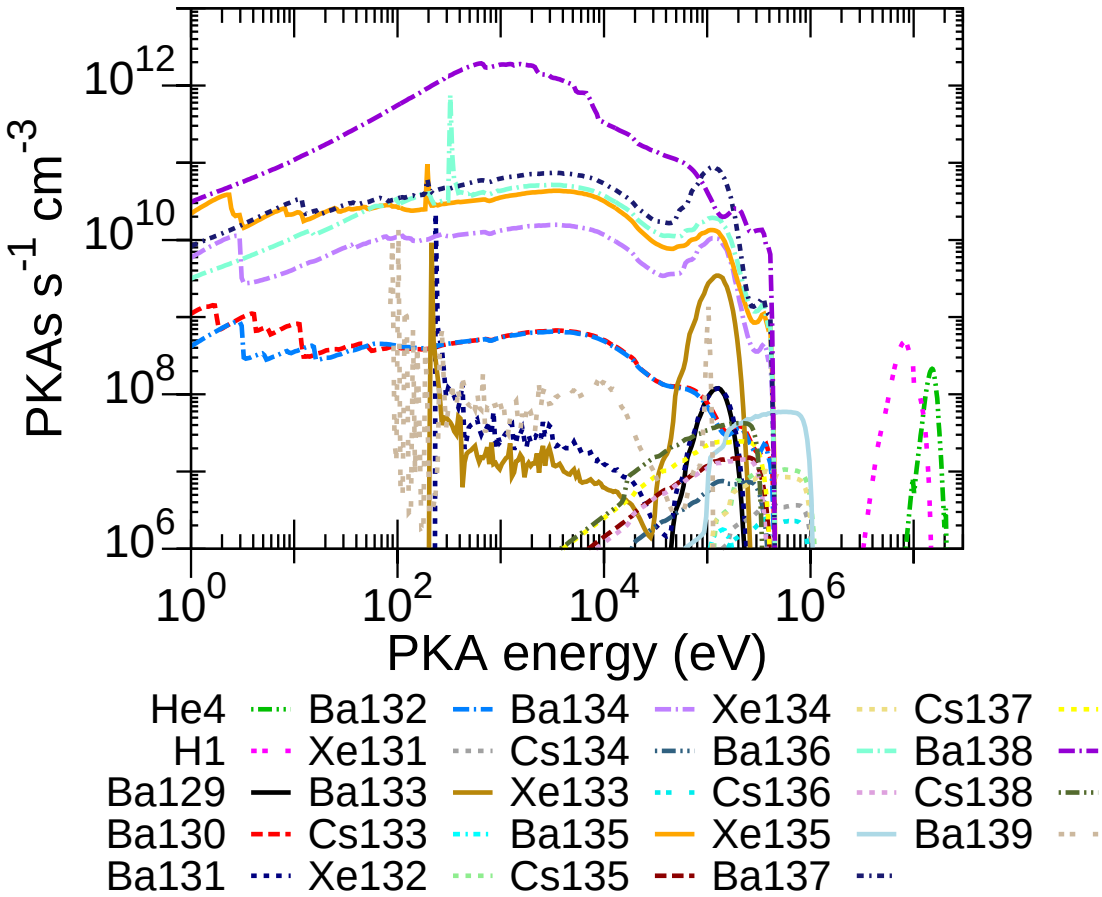
6 appm He & 10 appm H after 1 year

17 dpa/year



Barium FW PKA distributions





Barium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ba136m	0.31s	Ba135(n,γ)Ba136m	96.5	99.6	67.9	
		Ba134(n,γ)Ba135(n,γ)Ba136m	3.4			
		Ba136(n,n$'$)Ba136m			31.8	5.9
		Ba137(n,2n)Ba136m				59.8
		Ba138(n,2n)Ba137m(IT)Ba137(n,2n)Ba136m				19.2
		Ba138(n,2n)Ba137(n,2n)Ba136m				13.7
Ba137m	2.55m	Ba136(n,γ)Ba137m	80.2	97.4	1.7	
		Ba135(n,γ)Ba136(n,γ)Ba137m	19.4	2.6		
		Ba137(n,n$'$)Ba137m			98.3	3.4
		Ba138(n,2n)Ba137m				95.8
Cs138	33.41m	Ba138(n,γ)Ba139(β^-)La139(n,γ)La140(n,α)Cs137(n,γ)Cs138	3.1			
		Ba137(n,p)Cs137(n,γ)Cs138			54.5	
		Ba137(n,p)Cs137(n,γ)Cs138m(IT)Cs138			45.5	
		Ba138(n,p)Cs138				75.6
		Ba138(n,p)Cs138m(IT)Cs138				24.3
Ba139	1.38h	Ba138(n,γ)Ba139	97.1	99.9	100.0	100.0
		Ba137(n,γ)Ba138(n,γ)Ba139	2.9			
Ba129m	2.14h	Ba130(n,2n)Ba129m				100.0
Ba129	2.38h	Ba130(n,2n)Ba129				100.0
Xe135	9.14h	Ba137(n,α)Xe134(n,γ)Xe135		97.8	1.0	
		Ba137(n,α)Xe134(n,γ)Xe135m(IT)Xe135		1.9		
		Ba138(n,α)Xe135			94.2	56.0
		Ba138(n,α)Xe135m(IT)Xe135			4.4	43.8
Ba135m	1.20d	Ba134(n,γ)Ba135m	99.8	100.0	1.8	
		Ba135(n,n$'$)Ba135m			98.1	9.4
		Ba136(n,2n)Ba135m				74.0
		Ba137(n,2n)Ba136(n,2n)Ba135m				8.1
		Ba137(n,2n)Ba136m(IT)Ba136(n,2n)Ba135m				3.5
		Ba138(n,2n)Ba137m(IT)Ba137(n,2n)Ba136(n,2n)Ba135m				1.3
Ba133m	1.59d	Ba132(n,γ)Ba133m	97.4	100.0	96.5	
		Ba130(n,γ)Ba131(n,γ)Ba132(n,γ)Ba133m	2.5			
		Ba132(n,γ)Ba133(n,n$'$)Ba133m			2.9	
		Ba134(n,2n)Ba133m				75.6
		Ba135(n,2n)Ba134(n,2n)Ba133m				21.8
La140	1.68d	Ba138(n,γ)Ba139(β^-)La139(n,γ)La140	98.4	100.0	100.0	100.0
		Ba137(n,γ)Ba138(n,γ)Ba139(β^-)La139(n,γ)La140	1.6			
Xe133m	2.19d	Ba130(n,γ)Ba131(β^+)Cs131(β^+)Xe131(n,γ)Xe132(n,γ)Xe133m	93.6	87.4		
		Ba130(n,γ)Ba131(β^+)Cs131(n,γ)Cs132(β^+)Xe132(n,γ)Xe133m	3.5	7.4		
		Ba130(n,γ)Ba131m(IT)Ba131(β^+)Cs131(β^+)Xe131(n,γ) Xe132(n,γ)Xe133m	2.7	4.3		
		Ba136(n,α)Xe133m			45.5	55.4
		Ba135(n,α)Xe132(n,γ)Xe133m			23.1	
		Ba137(n,α)Xe134(n,2n)Xe133m				14.5
		Ba137(n,2n)Ba136(n,α)Xe133m				6.0
		Ba137(n,α)Xe134m(IT)Xe134(n,2n)Xe133m				4.6
		Ba137(n,nα)Xe133m				2.7
		Ba137(n,2n)Ba136m(IT)Ba136(n,α)Xe133m				2.6
		Ba138(n,2n)Ba137m(IT)Ba137(n,α)Xe134(n,2n)Xe133m				2.3
		Ba138(n,2n)Ba137(n,α)Xe134(n,2n)Xe133m				1.7
		Ba134(n,2n)Ba133m(IT)Ba133(β^+)Cs133(n,p)Xe133m				1.4
		Ba134(n,2n)Ba133(β^+)Cs133(n,p)Xe133m				1.4
		Ba138(n,nα)Xe134(n,2n)Xe133m				1.0
		Ba138(n,2n)Ba137m(IT)Ba137(n,2n)Ba136(n,α)Xe133m				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Xe133	5.24d	Ba130(n,γ)Ba131(β^+)Cs131(β^+)Xe131(n,γ)Xe132(n,γ)Xe133	93.1	85.3		
		Ba130(n,γ)Ba131(β^+)Cs131(n,γ)Cs132(β^+)Xe132(n,γ)Xe133	3.5	7.3		
		Ba130(n,γ)Ba131m(IT)Ba131(β^+)Cs131(β^+)Xe131(n,γ) Xe132(n,γ)Xe133	2.7	4.2		
		Ba130(n,γ)Ba131(β^+)Cs131(β^+)Xe131(n,γ)Xe132(n,γ) Xe133m(IT)Xe133		2.1		
		Ba136(n,α)Xe133			44.6	25.8
		Ba135(n,α)Xe132(n,γ)Xe133			15.1	
		Ba136(n,α)Xe133m(IT)Xe133			9.1	28.8
		Ba135(n,α)Xe132(n,γ)Xe133m(IT)Xe133			4.6	
		Ba137(n,α)Xe134(n,2n)Xe133				8.3
		Ba137(n,α)Xe134(n,2n)Xe133m(IT)Xe133				7.5
		Ba137(n,2n)Ba136(n,α)Xe133m(IT)Xe133				3.1
		Ba137(n,2n)Ba136(n,α)Xe133				2.8
		Ba137(n,α)Xe134m(IT)Xe134(n,2n)Xe133				2.6
		Ba137(n,α)Xe134m(IT)Xe134(n,2n)Xe133m(IT)Xe133				2.4
		Ba137(n,nα)Xe133m(IT)Xe133				1.4
		Ba137(n,2n)Ba136m(IT)Ba136(n,α)Xe133m(IT)Xe133				1.3
		Ba138(n,2n)Ba137m(IT)Ba137(n,α)Xe134(n,2n)Xe133				1.3
		Ba137(n,2n)Ba136m(IT)Ba136(n,α)Xe133				1.2
		Ba138(n,2n)Ba137m(IT)Ba137(n,α)Xe134(n,2n) Xe133m(IT)Xe133				1.2
Cs132	6.53d	Ba130(n,γ)Ba131(β^+)Cs131(n,γ)Cs132	97.2	95.3	78.5	
		Ba130(n,γ)Ba131m(IT)Ba131(β^+)Cs131(n,γ)Cs132	2.8	4.7	21.3	
		Ba134(n,2n)Ba133m(IT)Ba133(β^+)Cs133(n,2n)Cs132				40.0
		Ba134(n,2n)Ba133(β^+)Cs133(n,2n)Cs132				38.8
		Ba132(n,p)Cs132				4.8
		Ba135(n,2n)Ba134(n,2n)Ba133m(IT)Ba133(β^+) Cs133(n,2n)Cs132				3.9
		Ba135(n,2n)Ba134(n,2n)Ba133(β^+)Cs133(n,2n)Cs132				3.8
		Ba136(n,α)Xe133m(IT)Xe133(β^-)Cs133(n,2n)Cs132				1.0
Xe129m	8.88d	Ba130(n,γ)Ba131(n,α)Xe128(n,γ)Xe129m	91.6	8.6		
		Ba132(n,α)Xe129m	4.3	90.4	95.6	19.2
		Ba130(n,γ)Ba131m(IT)Ba131(n,α)Xe128(n,γ)Xe129m	2.7			
		Ba132(n,α)Xe129(n,n$'$)Xe129m			4.4	
		Ba130(n,2n)Ba129m(β^+)Cs129(β^+)Xe129(n,n$'$)Xe129m				41.9
		Ba130(n,2n)Ba129(β^+)Cs129(β^+)Xe129(n,n$'$)Xe129m				13.2
		Ba132(n,2n)Ba131m(IT)Ba131(β^+)Cs131(β^+)Xe131(n,2n) Xe130(n,2n)Xe129m				7.7
		Ba132(n,2n)Ba131(β^+)Cs131(β^+)Xe131(n,2n) Xe130(n,2n)Xe129m				5.5
		Ba130(n,p)Cs130m(IT)Cs130(β^+)Xe130(n,2n)Xe129m				1.6
		Ba130(n,p)Cs130(β^+)Xe130(n,2n)Xe129m				1.2
		Ba134(n,2n)Ba133m(IT)Ba133(n,α)Xe130(n,2n)Xe129m				1.1
		Ba134(n,2n)Ba133(n,α)Xe130(n,2n)Xe129m				1.1
Cs131	9.69d	Ba130(n,γ)Ba131(β^+)Cs131	97.2	95.3	78.7	
		Ba130(n,γ)Ba131m(IT)Ba131(β^+)Cs131	2.8	4.7	21.3	
		Ba132(n,2n)Ba131m(IT)Ba131(β^+)Cs131				52.8
		Ba132(n,2n)Ba131(β^+)Cs131				37.4
		Ba134(n,2n)Ba133m(IT)Ba133(n,2n)Ba132(n,2n)Ba131m(IT) Ba131(β^+)Cs131				2.5
		Ba134(n,2n)Ba133(n,2n)Ba132(n,2n)Ba131m(IT) Ba131(β^+)Cs131				2.4
		Ba134(n,2n)Ba133m(IT)Ba133(n,2n)Ba132(n,2n) Ba131(β^+)Cs131				1.8
		Ba134(n,2n)Ba133(n,2n)Ba132(n,2n)Ba131(β^+)Cs131				1.7
Ba131	11.55d	Ba130(n,γ)Ba131	97.2	95.3	78.7	
		Ba130(n,γ)Ba131m(IT)Ba131	2.8	4.7	21.3	
		Ba132(n,2n)Ba131m(IT)Ba131				52.8
		Ba132(n,2n)Ba131				37.4
		Ba134(n,2n)Ba133m(IT)Ba133(n,2n)Ba132(n,2n) Ba131m(IT)Ba131				2.6
		Ba134(n,2n)Ba133(n,2n)Ba132(n,2n)Ba131m(IT)Ba131				2.5
		Ba134(n,2n)Ba133m(IT)Ba133(n,2n)Ba132(n,2n)Ba131				1.8
		Ba134(n,2n)Ba133(n,2n)Ba132(n,2n)Ba131				1.8

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Xe131m	11.93d	Ba132(n,γ)Ba133(n,α)Xe130(n,γ)Xe131m	81.7	37.6		
		Ba132(n,γ)Ba133m(IT)Ba133(n,α)Xe130(n,γ)Xe131m	1.9	1.5		
		Ba134(n,α)Xe131m		60.8		49.5
		Ba130(n,γ)Ba131(β^+)Cs131(β^+)Xe131(n,n$'$)Xe131m			78.7	
		Ba130(n,γ)Ba131m(IT)Ba131(β^+)Cs131(β^+)Xe131(n,n$'$)Xe131m			21.3	
		Ba135(n,α)Xe132(n,2n)Xe131m				15.2
		Ba135(n,2n)Ba134(n,α)Xe131m				14.1
		Ba132(n,2n)Ba131m(IT)Ba131(β^+)Cs131(β^+)Xe131(n,n$'$)Xe131m				5.2
		Ba132(n,2n)Ba131(β^+)Cs131(β^+)Xe131(n,n$'$)Xe131m				3.7
		Ba135(n,nα)Xe131m				3.4
		Ba134(n,2n)Ba133m(IT)Ba133(β^+)Cs133(n,2n)Cs132(β^+) Xe132(n,2n)Xe131m				1.9
		Ba134(n,2n)Ba133(β^+)Cs133(n,2n)Cs132(β^+) Xe132(n,2n)Xe131m				1.8
Cs136	13.03d	Ba132(n,γ)Ba133(β^+)Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136	79.8	90.0		
		Ba130(n,γ)Ba131(β^+)Cs131(β^+)Xe131(n,γ)Xe132(n,γ) Xe133(β^-)Cs133(n,γ)Cs134(n,γ)Cs135(n,γ)Cs136	9.6			
		Ba132(n,γ)Ba133(β^+)Cs133(n,γ)Cs134(n,γ)Cs135(n,γ) Cs136m(IT)Cs136	4.0	4.8		
		Ba130(n,γ)Ba131(β^+)Cs131(n,γ)Cs132(n,γ)Cs133(n,γ) Cs134(n,γ)Cs135(n,γ)Cs136	1.9			
		Ba132(n,γ)Ba133m(IT)Ba133(β^+)Cs133(n,γ)Cs134(n,γ) Cs135(n,γ)Cs136	1.8	3.6		
		Ba132(n,γ)Ba133(β^+)Cs133(n,γ)Cs134m(IT)Cs134(n,γ) Cs135(n,γ)Cs136		1.1		
		Ba135(n,p)Cs135(n,γ)Cs136			83.6	
		Ba135(n,p)Cs135(n,γ)Cs136m(IT)Cs136			8.6	
		Ba138(n,γ)Ba139(β^-)La139(n,α)Cs136			4.5	
		Ba138(n,α)Xe135(β^-)Cs135(n,γ)Cs136			1.9	
		Ba138(n,γ)Ba139(β^-)La139(n,α)Cs136m(IT)Cs136			1.0	
		Ba136(n,p)Cs136				58.8
		Ba137(n,p)Cs137(n,2n)Cs136				9.6
		Ba137(n,2n)Ba136(n,p)Cs136				6.3
		Ba136(n,p)Cs136m(IT)Cs136				5.8
		Ba137(n,2n)Ba136m(IT)Ba136(n,p)Cs136				2.7
		Ba137(n,d)Cs136				2.5
		Ba137(n,p)Cs137(n,2n)Cs136m(IT)Cs136				1.5
		Ba138(n,2n)Ba137m(IT)Ba137(n,p)Cs137(n,2n)Cs136				1.5
		Ba138(n,d)Cs137(n,2n)Cs136				1.1
		Ba138(n,2n)Ba137(n,p)Cs137(n,2n)Cs136				1.1
		Ba138(n,2n)Ba137m(IT)Ba137(n,2n)Ba136(n,p)Cs136				1.0
		Ba137(n,np)Cs136				1.0
Ce141	32.51d	Ba138(n,γ)Ba139(β^-)La139(n,γ)La140(β^-)Ce140(n,γ)Ce141	96.0	71.7	99.8	99.3
		Ba138(n,γ)Ba139(β^-)La139(n,γ)La140(n,γ)La141(β^-)Ce141	2.9	28.3		
		Ba137(n,γ)Ba138(n,γ)Ba139(β^-)La139(n,γ)La140(β^-) Ce140(n,γ)Ce141	1.0			
Xe127	36.40d	Ba130(n,α)Xe127	93.3	92.3	77.9	31.1
		Ba130(n,α)Xe127m(IT)Xe127	6.7	7.7	22.0	45.8
		Ba130(n,2n)Ba129m(β^+)Cs129(β^+)Xe129(n,2n)Xe128(n,2n) Xe127m(IT)Xe127				9.9
		Ba130(n,2n)Ba129m(β^+)Cs129(β^+)Xe129(n,2n) Xe128(n,2n)Xe127				7.1
		Ba130(n,2n)Ba129(β^+)Cs129(β^+)Xe129(n,2n)Xe128(n,2n) Xe127m(IT)Xe127				3.1
		Ba130(n,2n)Ba129(β^+)Cs129(β^+)Xe129(n,2n)Xe128(n,2n)Xe127				2.2

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cs134	2.06y	Ba132(n,γ)Ba133(β^+)Cs133(n,γ)Cs134	81.7	94.9	71.2	
		Ba130(n,γ)Ba131(β^+)Cs131(β^+)Xe131(n,γ)Xe132(n,γ) Xe133(β^-)Cs133(n,γ)Cs134	12.7			
		Ba132(n,γ)Ba133m(IT)Ba133(β^+)Cs133(n,γ)Cs134	1.9	3.8	16.1	
		Ba130(n,γ)Ba131(β^+)Cs131(n,γ)Cs132(n,γ)Cs133(n,γ)Cs134	1.2			
		Ba132(n,γ)Ba133(β^+)Cs133(n,γ)Cs134m(IT)Cs134		1.1	9.8	
		Ba132(n,γ)Ba133m(IT)Ba133(β^+)Cs133(n,γ)Cs134m(IT)Cs134			2.2	
		Ba134(n,p)Cs134				43.8
		Ba138(n,α)Xe135(β^-)Cs135(n,2n)Cs134				9.7
		Ba138(n,α)Xe135m(IT)Xe135(β^-)Cs135(n,2n)Cs134				7.6
		Ba135(n,2n)Ba134(n,p)Cs134				7.2
		Ba134(n,p)Cs134m(IT)Cs134				5.7
		Ba135(n,d)Cs134				4.8
		Ba135(n,p)Cs135(n,2n)Cs134				4.6
		Ba138(n,α)Xe135(β^-)Cs135(n,2n)Cs134m(IT)Cs134				3.7
		Ba135(n,np)Cs134				3.4
		Ba138(n,α)Xe135m(IT)Xe135(β^-)Cs135(n,2n)Cs134m(IT)Cs134				2.9
		Ba135(n,p)Cs135(n,2n)Cs134m(IT)Cs134				1.8
Ba133	10.54y	Ba132(n,γ)Ba133	96.5	96.1	81.2	
		Ba132(n,γ)Ba133m(IT)Ba133	2.2	3.9	18.4	
		Ba130(n,γ)Ba131(n,γ)Ba132(n,γ)Ba133	1.2			
		Ba134(n,2n)Ba133m(IT)Ba133				43.7
		Ba134(n,2n)Ba133				42.2
		Ba135(n,2n)Ba134(n,2n)Ba133m(IT)Ba133				6.6
		Ba135(n,2n)Ba134(n,2n)Ba133				6.3
Cs137	30.04y	Ba138(n,γ)Ba139(β^-)La139(n,γ)La140(n,α)Cs137	3.6	95.0		
		Ba137(n,p)Cs137			99.9	69.2
		Ba138(n,2n)Ba137m(IT)Ba137(n,p)Cs137				11.2
		Ba138(n,d)Cs137				8.1
		Ba138(n,2n)Ba137(n,p)Cs137				8.0
		Ba138(n,np)Cs137				3.0
Ho166m	1.2 10^3y	no pathways found				
La137	6.0 10^4y	Ba138(n,γ)Ba139(β^-)La139(n,2n)La138(n,2n)La137				100.0
Cs135	2.3 10^6y	Ba132(n,γ)Ba133(β^+)Cs133(n,γ)Cs134(n,γ)Cs135	83.6	94.8		
		Ba130(n,γ)Ba131(β^+)Cs131(β^+)Xe131(n,γ)Xe132(n,γ) Xe133(β^-)Cs133(n,γ)Cs134(n,γ)Cs135	10.3			
		Ba130(n,γ)Ba131(β^+)Cs131(n,γ)Cs132(n,γ)Cs133(n,γ) Cs134(n,γ)Cs135	1.9			
		Ba132(n,γ)Ba133m(IT)Ba133(β^+)Cs133(n,γ)Cs134(n,γ)Cs135	1.9	3.8		
		Ba132(n,γ)Ba133(β^+)Cs133(n,γ)Cs134m(IT)Cs134(n,γ)Cs135		1.1		
		Ba135(n,p)Cs135			97.6	20.0
		Ba138(n,α)Xe135(β^-)Cs135			2.2	42.1
		Ba138(n,α)Xe135m(IT)Xe135(β^-)Cs135				32.9
		Ba135(n,p)Cs135m(IT)Cs135				1.3
I129	1.6 10^7y	Ba130(n,α)Xe127(β^+)I127(n,γ)I128(β^+)Te128(n,γ) Te129(β^-)I129		10.9		
		Ba132(n,α)Xe129(n,p)I129			6.3	
		Ba132(n,α)Xe129m(IT)Xe129(n,p)I129			1.3	
		Ba130(n,2n)Ba129m(β^+)Cs129(β^+)Xe129(n,p)I129				73.7
		Ba130(n,2n)Ba129(β^+)Cs129(β^+)Xe129(n,p)I129				23.1
La138	1.0 10^{11}y	Ba138(n,γ)Ba139(β^-)La139(n,γ)La140(β^-)Ce140(n,γ) Ce141(β^-)Pr141(n,α)La138	94.2	56.1	99.6	
		Ba138(n,γ)Ba139(β^-)La139(n,γ)La140(n,γ)La141(β^-) Ce141(β^-)Pr141(n,α)La138	5.1	43.9		
		Ba138(n,γ)Ba139(β^-)La139(n,2n)La138				100.0

Lanthanum

Isotope	Atom % abundance
La138	0.09
La139	99.91

($T_{1/2}$ =1.0 10^{11}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	6.38E+13	6.32E+13	1.44E+13	5.79E+10	9.57E+07	7.78E+07
La140	95.5	96.3	93.8			
Ba139	2.1	2.1				
Cs136	1.0	1.0	3.6			
Ce139	0.6	0.6	2.4	97.6		
H3				2.0	4.4	
La137				0.2	91.0	100.0
Cs137					2.4	
Ba137m					2.2	

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.83E-02	2.82E-02	6.35E-03	1.78E-06	7.48E-10	4.03E-10
La140	98.2	98.4	96.8			
Cs136	0.8	0.8	3.0			
Ce139			0.2	98.2		
Cs134				1.5		
La137					60.0	99.5
Ba137m				0.1	30.1	
Cs137					9.1	

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	4.10E+04	4.09E+04	9.27E+03	1.85E-01	3.12E-04	2.64E-05
La140	99.0	99.1	96.9			
Cs136	0.8	0.8	3.1			
Ce139				80.5		
Cs134				18.0		
Ba137m				1.5	90.6	
La137					8.3	87.1
La138					1.1	12.9

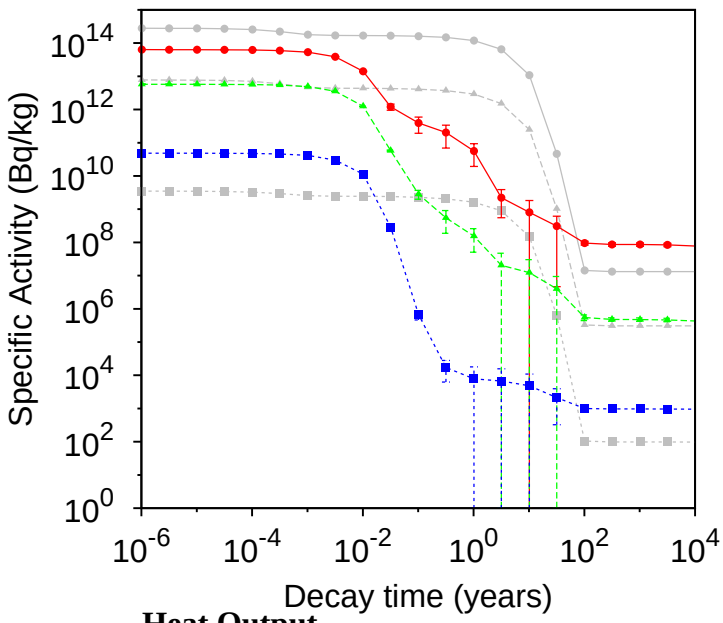
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.24E+05	1.24E+05	2.86E+04	1.73E+01	7.72E-02	6.34E-03
La140	98.0	98.2	94.2			
Cs136	1.5	1.5	5.4			
Ce139	0.1	0.1	0.3	85.1		
Cs134				10.6		
Ba137m	0.3	0.1		2.3	52.5	
Cs137				1.7	38.1	
La137					9.1	99.3

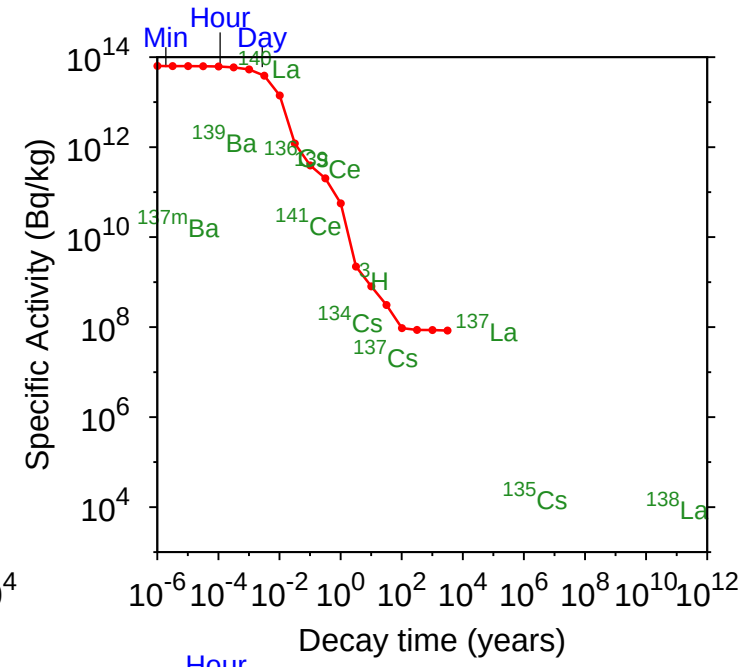
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	6.98E+04	6.96E+04	1.70E+04	1.12E+02	8.74E-01	6.79E-01
La140	96.0	96.2	87.1			
Cs136	2.5	2.5	8.5			
Ce139	1.0	1.0	3.9	96.3		
Cs134				1.7		
La137				0.7	86.7	99.8
Cs137				0.8	10.1	
Ba137m	0.3	0.1		0.2	2.9	

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	6.24E+10	6.20E+10	1.43E+10	5.77E+07	2.62E+04	2.06E+03
La140	97.6	98.1	93.9			
Cs136	1.0	1.0	3.6			
Ce139	0.6	0.6	2.4	97.9		
Cs134				1.7		
Cs137				0.4	86.3	
La137					8.7	99.5
Ba137m					4.8	

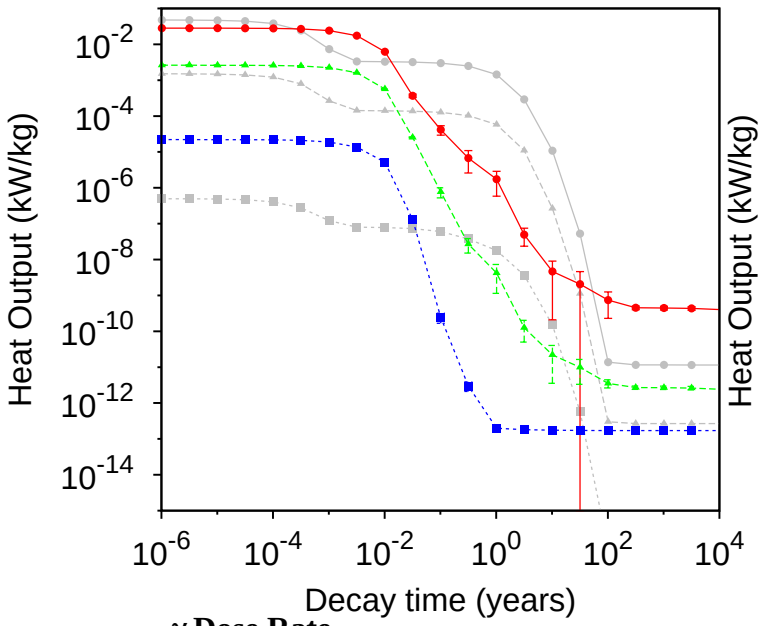
Lanthanum activation characteristics

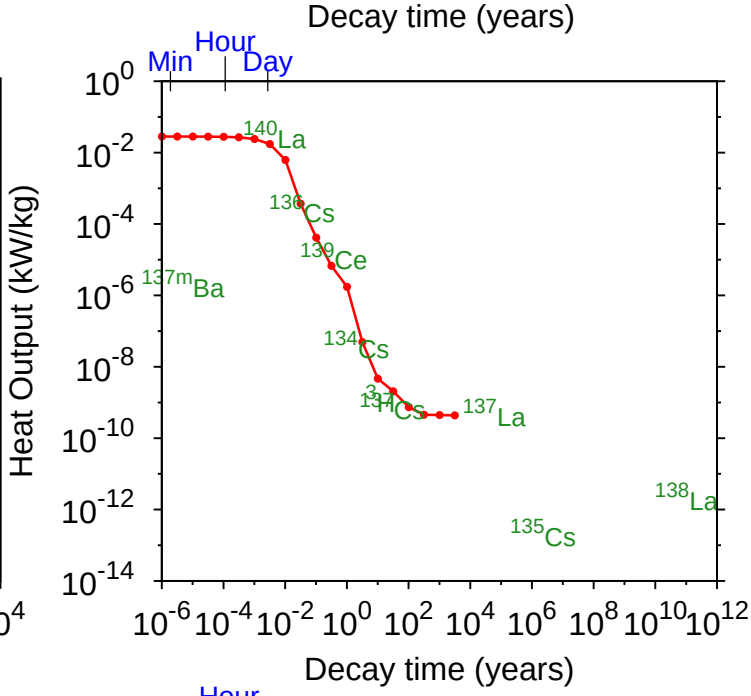
Specific Activity



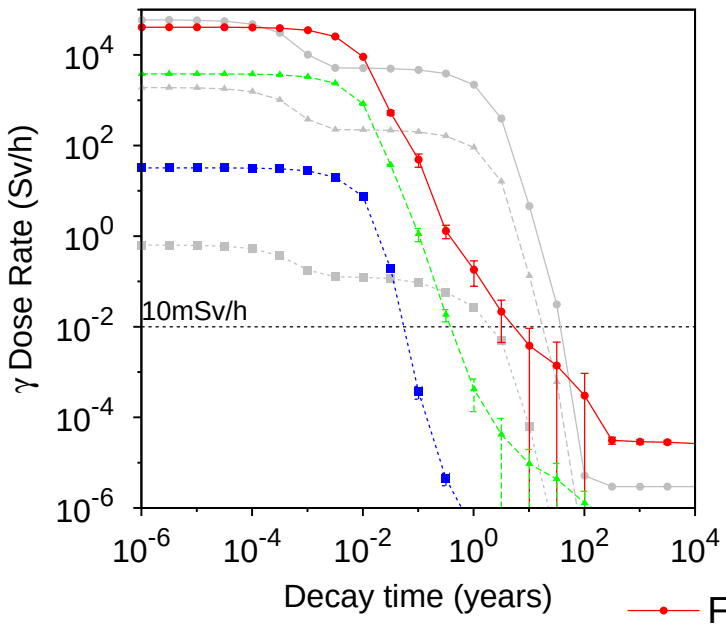


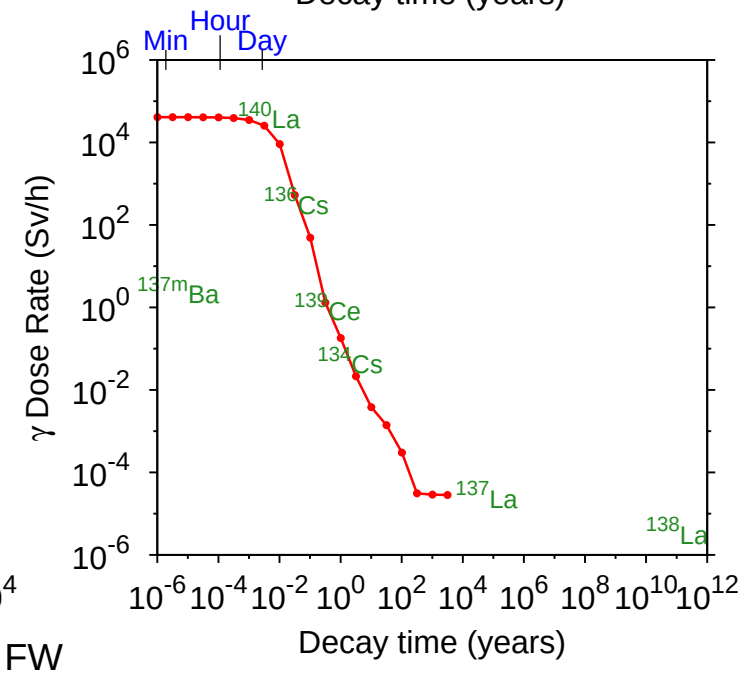
Heat Output





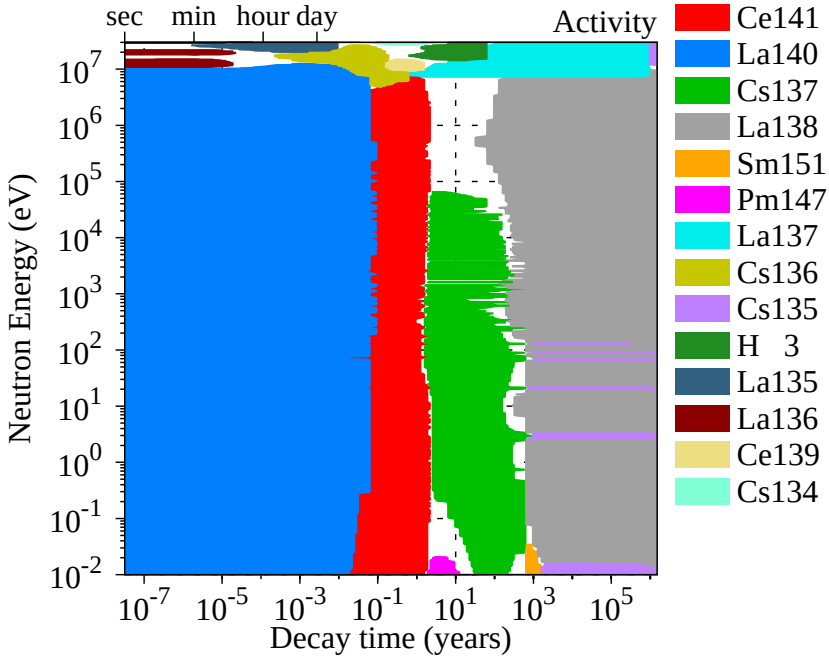
γ Dose Rate

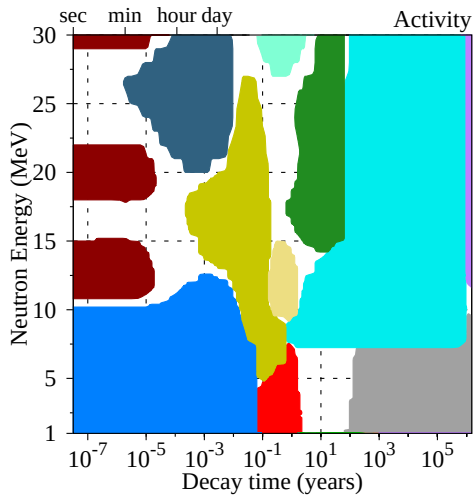


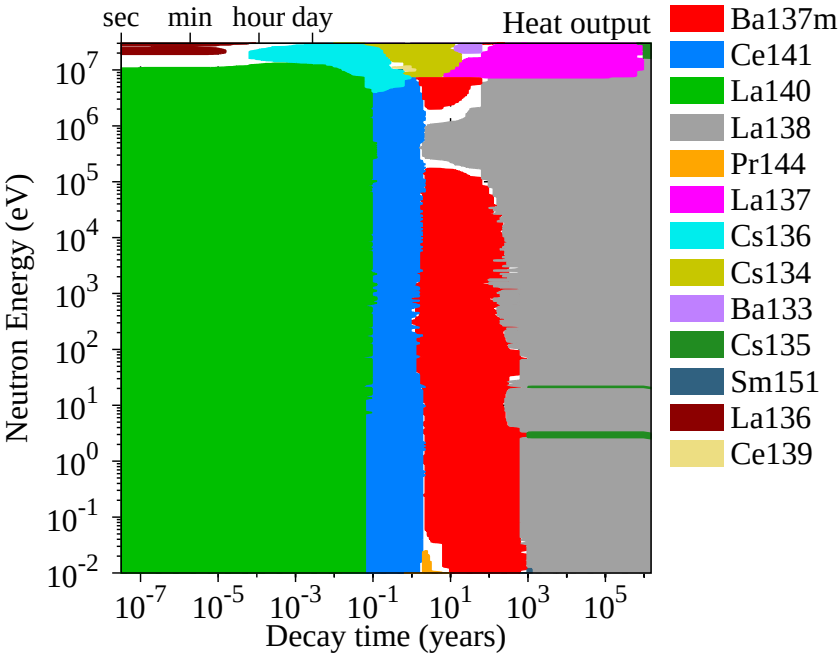


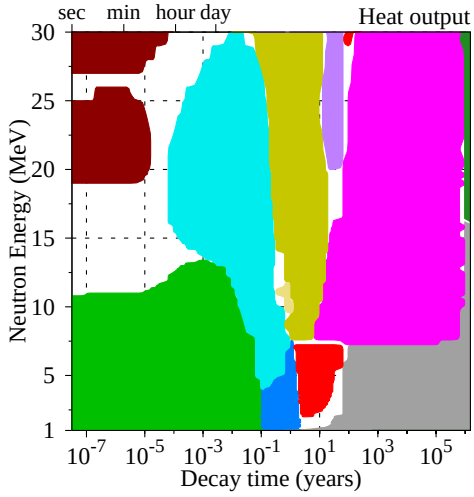
FW
Blanket
Manifold
Fe results

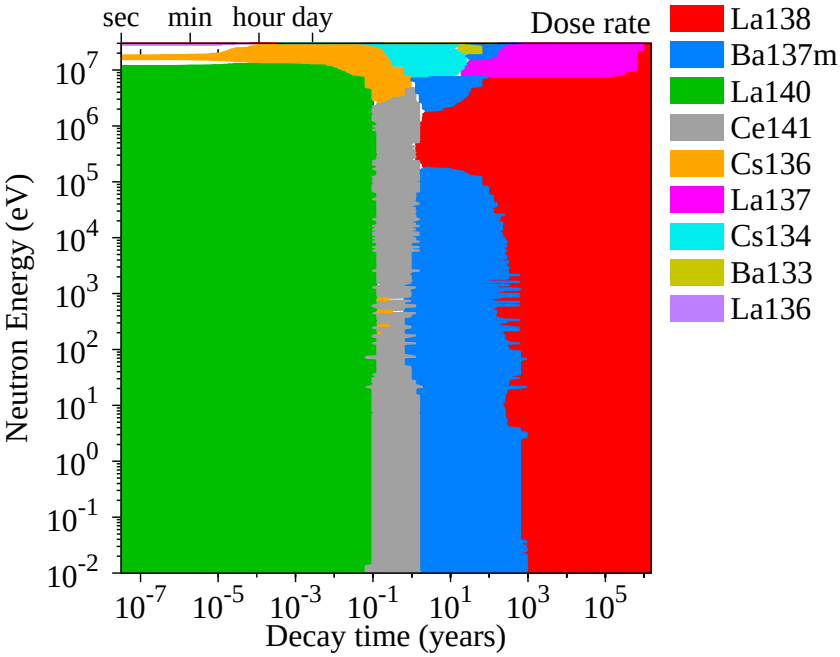
Lanthanum Importance diagrams

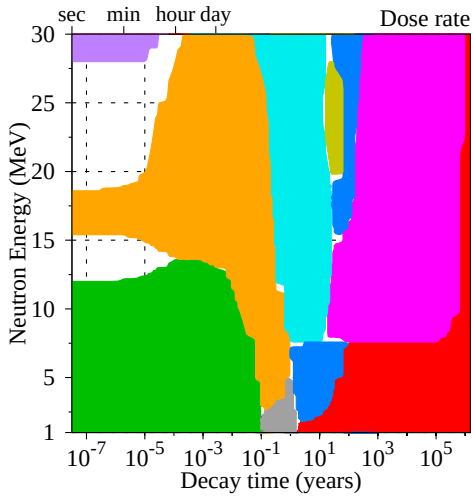




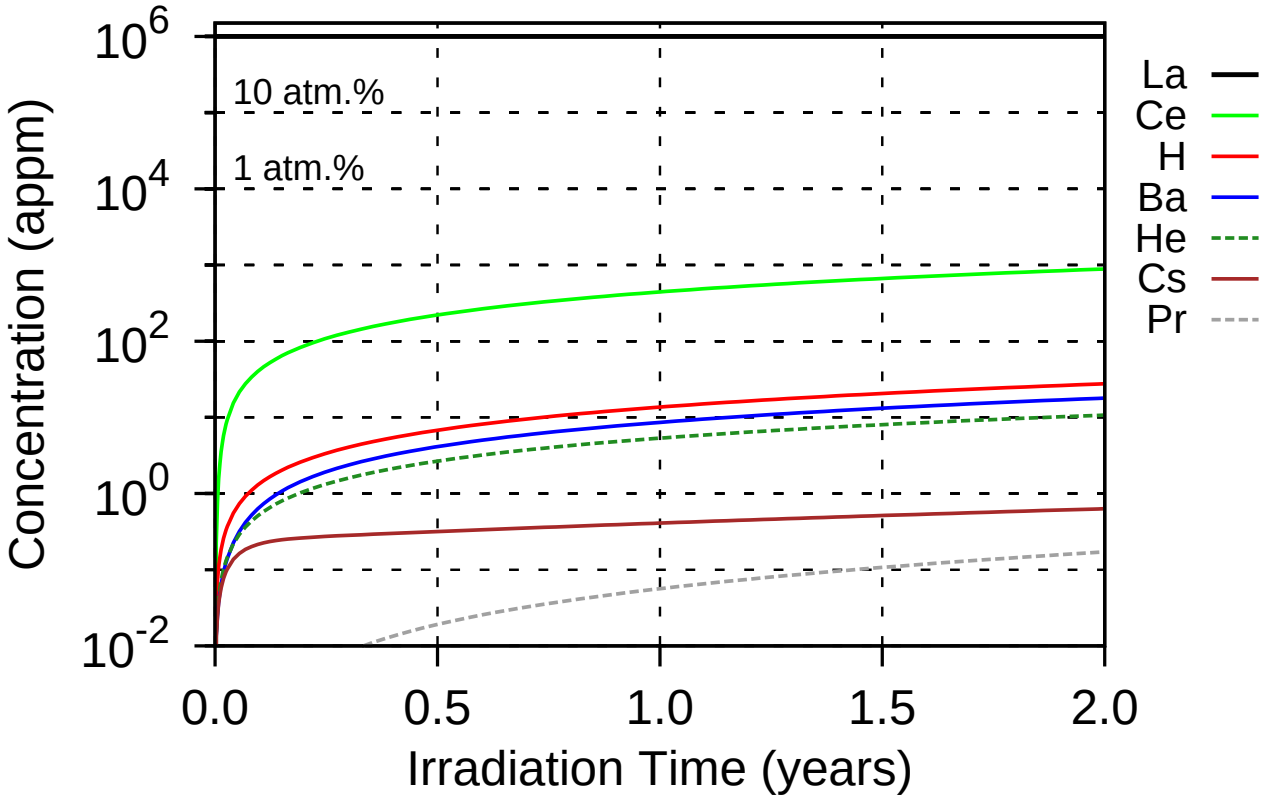






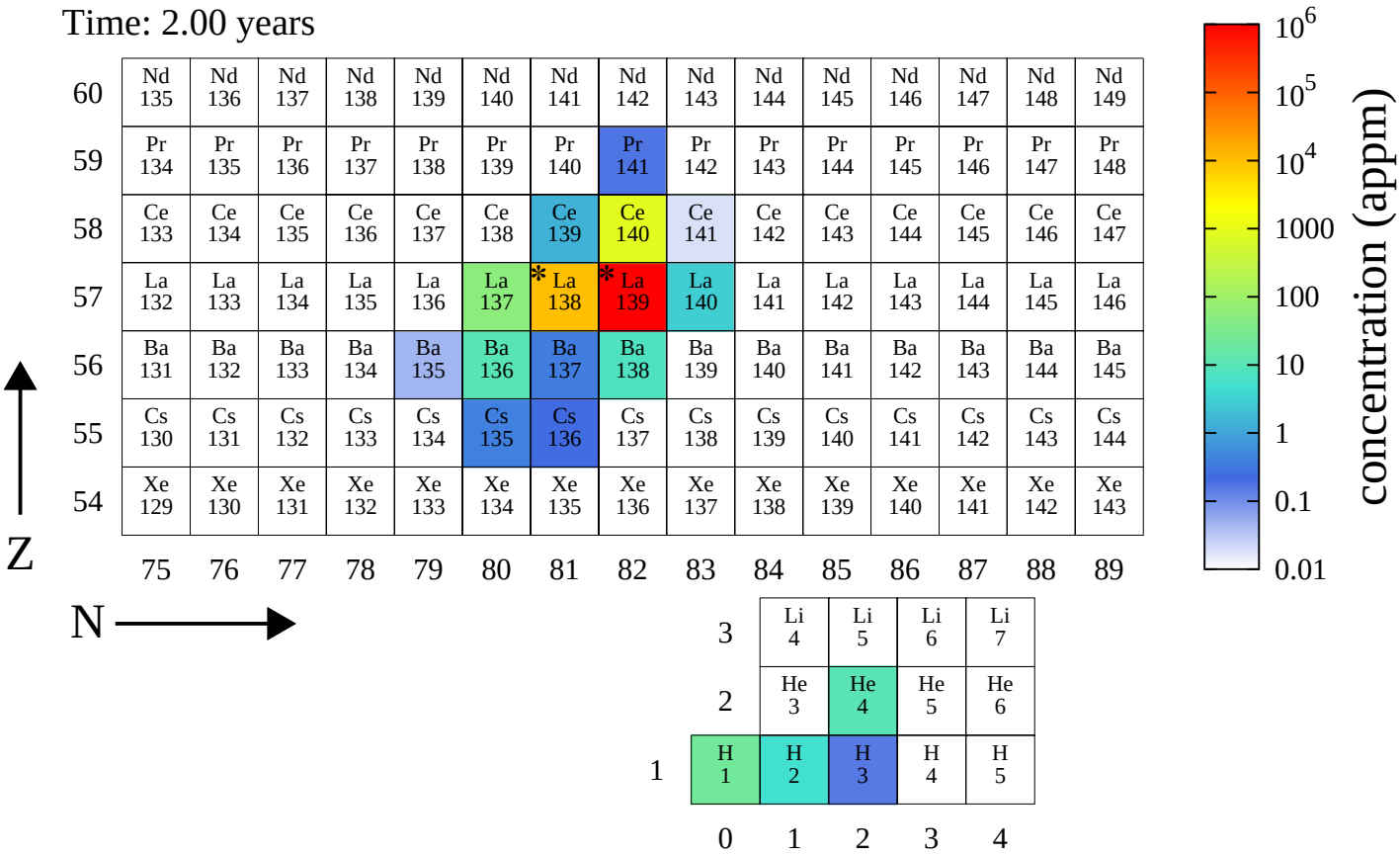


Lanthanum FW Transmutation

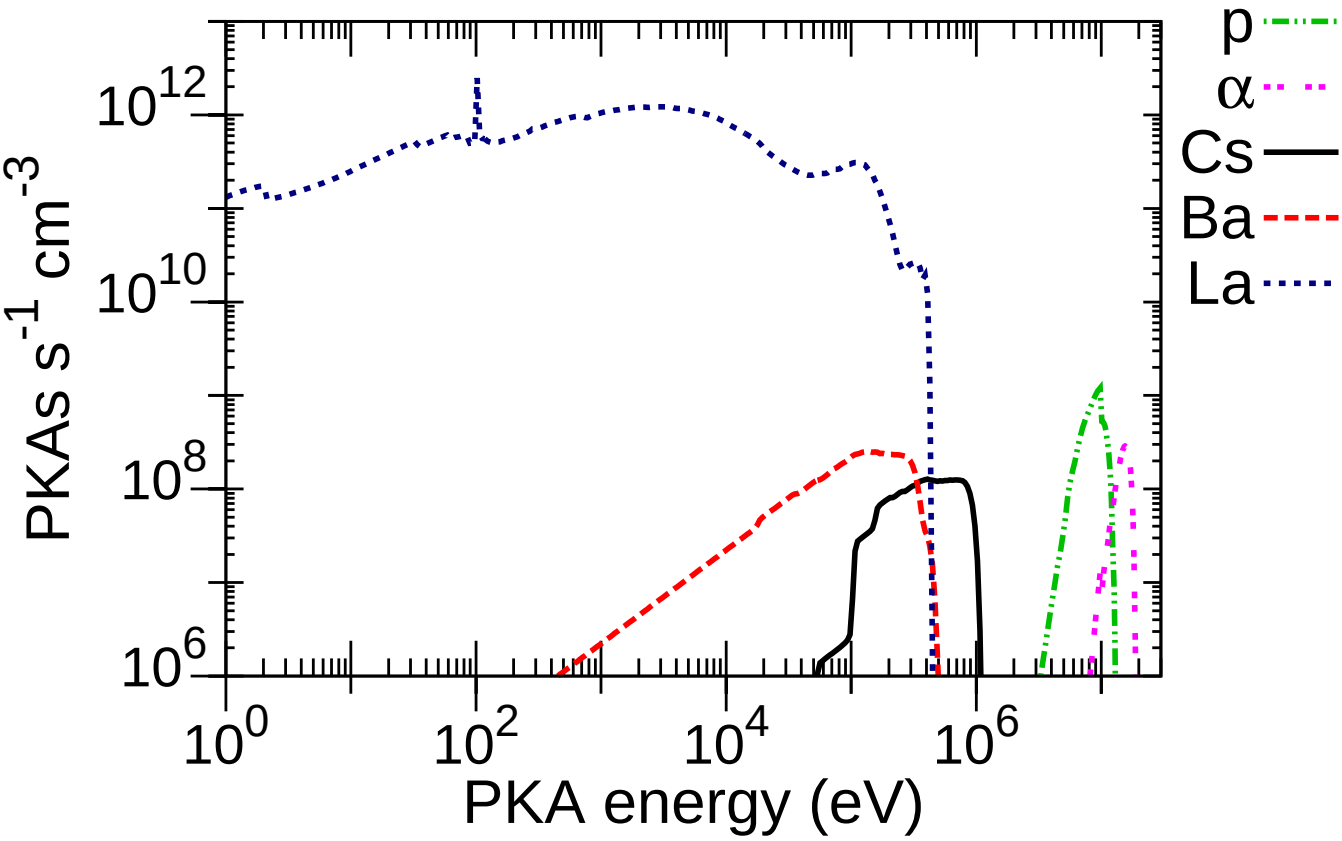


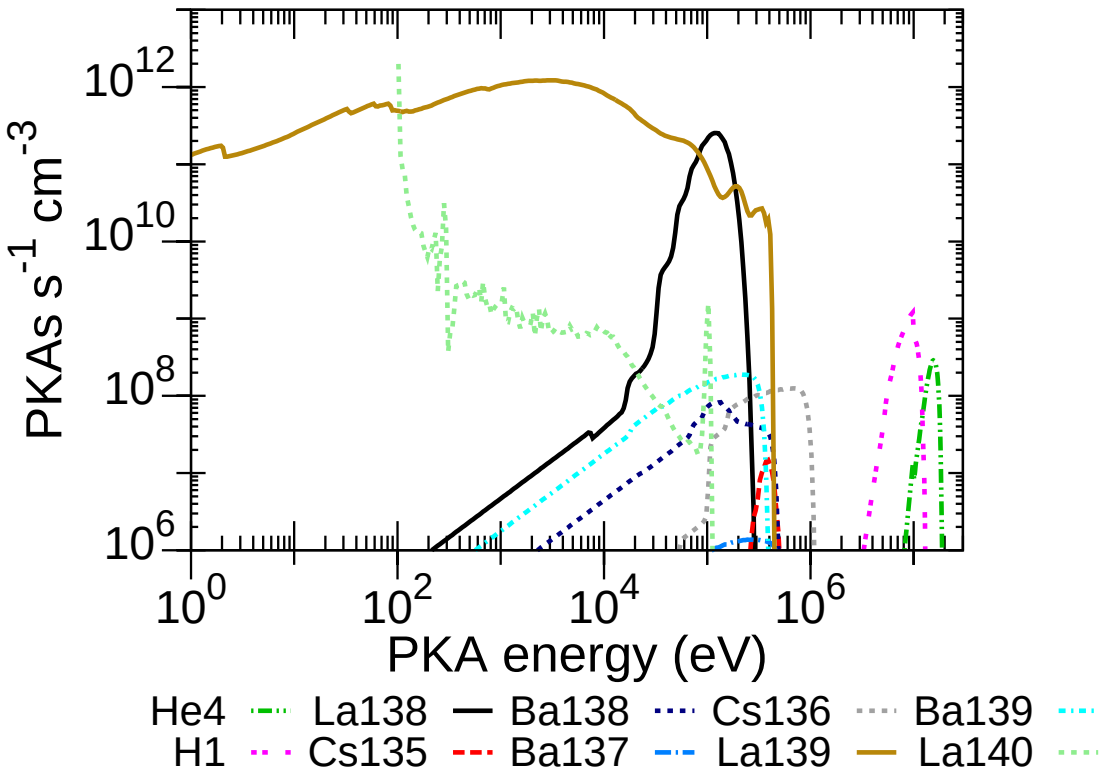
5 appm He & 14 appm H after 1 year

15 dpa/year



Lanthanum FW PKA distributions





Lanthanum Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ba137m	2.55m	La139(n,γ)La140(n,α)Cs137(β^-)Ba137m	99.9	100.0	4.8	
		La139(n,γ)La140(β^-)Ce140(n,α)Ba137m			37.8	
		La139(n,α)Cs136(β^-)Ba136(n,γ)Ba137m			34.5	
		La139(n,α)Cs136m(β^-)Ba136(n,γ)Ba137m			7.8	
		La139(n,α)Cs136m(IT)Cs136(β^-)Ba136(n,γ)Ba137m			7.6	
		La139(n,γ)La140(β^-)Ce140(n,α)Ba137(n,n$'$)Ba137m			6.3	
		La139(n,2n)La138(n,d)Ba137m				33.3
		La139(n,2n)La138(n,np)Ba137m				21.5
		La139(n,2n)La138(n,p)Ba138(n,2n)Ba137m				14.0
		La139(n,2n)La138(n,2n)La137(n,p)Ba137m				13.6
		La139(n,d)Ba138(n,2n)Ba137m				9.4
		La139(n,np)Ba138(n,2n)Ba137m				3.4
		La139(n,t)Ba137m				2.7
La136	9.87m	La139(n,2n)La138(n,2n)La137(n,2n)La136				98.3
		La138(n,2n)La137(n,2n)La136				1.7
Pr144	17.28m	La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(n,γ)Ce142(n,γ) Ce143(β^-)Pr143(n,γ)Pr144m(IT)Pr144	66.9	41.5		
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(n,γ)Ce142(n,γ) Ce143(β^-)Pr143(n,γ)Pr144	16.0	9.6		
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142(n,γ)Pr143(n,γ)Pr144m(IT)Pr144	8.6	11.1		
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142m(IT)Pr142(n,γ)Pr143(n,γ)Pr144m(IT)Pr144	2.5	4.2		
		La139(n,γ)La140(n,γ)La141(β^-)Ce141(n,γ)Ce142(n,γ) Ce143(β^-)Pr143(n,γ)Pr144m(IT)Pr144	2.1	16.9		
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142(n,γ)Pr143(n,γ)Pr144	2.1	2.6		
		La139(n,γ)La140(n,γ)La141(β^-)Ce141(β^-)Pr141(n,γ) Pr142(n,γ)Pr143(n,γ)Pr144m(IT)Pr144		4.5		
		La139(n,γ)La140(n,γ)La141(β^-)Ce141(n,γ)Ce142(n,γ) Ce143(β^-)Pr143(n,γ)Pr144		3.9		
		La139(n,γ)La140(n,γ)La141(β^-)Ce141(β^-)Pr141(n,γ) Pr142m(IT)Pr142(n,γ)Pr143(n,γ)Pr144m(IT)Pr144		1.7		
		La139(n,γ)La140(n,γ)La141(β^-)Ce141(β^-)Pr141(n,γ) Pr142(n,γ)Pr143(n,γ)Pr144		1.0		
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142m(IT)Pr142(n,γ)Pr143(n,γ)Pr144		1.0		
Ba139	1.38h	La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(n,α)Ba138(n,γ)Ba139	95.8			
		La139(n,γ)La140(n,γ)La141(β^-)Ce141(n,α)Ba138(n,γ)Ba139	2.9			
		La138(n,p)Ba138(n,γ)Ba139		99.7	100.0	
		La139(n,p)Ba139				100.0
La135	19.50h	no pathways found				
La140	1.68d	La139(n,γ)La140	99.9	100.0	100.0	99.9
Cs136	13.03d	La138(n,α)Cs135(n,γ)Cs136	72.1	38.7		
		La139(n,α)Cs136	23.0	59.2	82.0	87.9
		La138(n,α)Cs135(n,γ)Cs136m(IT)Cs136	3.6	2.1		
		La139(n,α)Cs136m(IT)Cs136	1.3		18.0	12.0
Ce141	32.51d	La139(n,γ)La140(β^-)Ce140(n,γ)Ce141	98.7	83.4	99.9	99.6
		La139(n,γ)La140(n,γ)La141(β^-)Ce141	1.3	16.6		
Ce139	137.63d	La138(β^-)Ce138(n,γ)Ce139		93.7	58.0	
		La138(β^-)Ce138(n,γ)Ce139m(IT)Ce139		3.8	21.3	
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142(β^-)Nd142(n,α)Ce139		1.1	9.5	
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142m(IT)Pr142(β^-)Nd142(n,α)Ce139			9.6	
		La139(n,γ)La140(β^-)Ce140(n,2n)Ce139m(IT)Ce139				55.2
		La139(n,γ)La140(β^-)Ce140(n,2n)Ce139				44.6

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cs134	2.06y	La138(n,α)Cs135(n,γ)Cs136(n,α)I133(β^-)Xe133(β^-)Cs133(n,γ)Cs134	63.8			
		La139(n,α)Cs136(n,α)I133(β^-)Xe133(β^-)Cs133(n,γ)Cs134	28.2			
		La138(n,α)Cs135(n,γ)Cs136m(IT)Cs136(n,α)I133(β^-)Xe133(β^-)Cs133(n,γ)Cs134	3.2			
		La139(n,α)Cs136m(IT)Cs136(n,α)I133(β^-)Xe133(β^-)Cs133(n,γ)Cs134	1.6			
		La139(n,2n)La138(n,2n)La137(n,α)Cs134				25.0
		La139(n,2n)La138(n,α)Cs135(n,2n)Cs134				24.4
		La139(n,2n)La138(n,nα)Cs134				9.3
		La139(n,2n)La138(n,α)Cs135(n,2n)Cs134m(IT)Cs134				9.3
		La139(n,nα)Cs135(n,2n)Cs134				8.9
		La139(n,2n)La138(n,2n)La137(n,α)Cs134m(IT)Cs134				5.7
		La139(n,2n)La138(n,nα)Cs134m(IT)Cs134				4.7
		La139(n,2n)La138(n,α)Cs135m(IT)Cs135(n,2n)Cs134				4.0
		La139(n,nα)Cs135(n,2n)Cs134m(IT)Cs134				3.4
		La139(n,2n)La138(n,α)Cs135m(IT)Cs135(n,2n)Cs134m(IT)Cs134				1.5
Pm147	2.62y	La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	65.6			
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	19.0			
		La139(n,γ)La140(n,γ)La141(β^-)Ce141(β^-)Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	6.6			
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(n,γ)Ce142(n,γ)Ce143(β^-)Pr143(β^-)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	4.5			
		La139(n,γ)La140(n,γ)La141(β^-)Ce141(β^-)Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	1.9			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ba133	10.54y	La139(n,α)Cs136(β^-)Ba136(n,2n)Ba135m(IT)Ba135(n,2n)Ba134(n,2n)Ba133m(IT)Ba133				10.5
		La139(n,α)Cs136(β^-)Ba136(n,2n)Ba135m(IT)Ba135(n,2n)Ba134(n,2n)Ba133				10.2
		La139(n,α)Cs136(β^-)Ba136(n,2n)Ba135(n,2n)Ba134(n,2n)Ba133m(IT)Ba133				6.4
		La139(n,α)Cs136(β^-)Ba136(n,2n)Ba135(n,2n)Ba134(n,2n)Ba133				6.3
		La139(n,2n)La138(n,2n)La137(n,2n)La136(β^+)Ba136(n,2n)Ba135m(IT)Ba135(n,2n)Ba134(n,2n)Ba133m(IT)Ba133				5.2
		La139(n,2n)La138(n,2n)La137(n,2n)La136(β^+)Ba136(n,2n)Ba135m(IT)Ba135(n,2n)Ba134(n,2n)Ba133				5.2
		La139(n,2n)La138(n,2n)La137(n,α)Cs134(β^-)Ba134(n,2n)Ba133m(IT)Ba133				4.0
		La139(n,2n)La138(n,2n)La137(n,α)Cs134(β^-)Ba134(n,2n)Ba133				3.9
		La139(n,2n)La138(n,α)Cs135(n,2n)Cs134(β^-)Ba134(n,2n)Ba133m(IT)Ba133				3.9
		La139(n,2n)La138(n,α)Cs135(n,2n)Cs134(β^-)Ba134(n,2n)Ba133				3.8
		La139(n,2n)La138(n,2n)La137(n,2n)La136(β^+)Ba136(n,2n)Ba135(n,2n)Ba134(n,2n)Ba133m(IT)Ba133				3.2
		La139(n,2n)La138(n,2n)La137(n,2n)La136(β^+)Ba136(n,2n)Ba135(n,2n)Ba134(n,2n)Ba133				3.2
		La139(n,2n)La138(n,nα)Cs134(β^-)Ba134(n,2n)Ba133m(IT)Ba133				2.6
		La139(n,2n)La138(n,nα)Cs134(β^-)Ba134(n,2n)Ba133				2.5
		La139(n,nα)Cs135(n,2n)Cs134(β^-)Ba134(n,2n)Ba133m(IT)Ba133				2.4
		La139(n,nα)Cs135(n,2n)Cs134(β^-)Ba134(n,2n)Ba133				2.4
		La139(n,α)Cs136m(β^-)Ba136(n,2n)Ba135m(IT)Ba135(n,2n)Ba134(n,2n)Ba133m(IT)Ba133				1.6
		La139(n,α)Cs136m(β^-)Ba136(n,2n)Ba135m(IT)Ba135(n,2n)Ba134(n,2n)Ba133				1.5
		La139(n,2n)La138(n,α)Cs135(n,2n)Cs134m(IT)Cs134(β^-)Ba134(n,2n)Ba133m(IT)Ba133				1.5
		La139(n,2n)La138(n,α)Cs135(n,2n)Cs134m(IT)Cs134(β^-)Ba134(n,2n)Ba133				1.4
		La139(n,α)Cs136m(IT)Cs136(β^-)Ba136(n,2n)Ba135m(IT)Ba135(n,2n)Ba134(n,2n)Ba133m(IT)Ba133				1.4
		La139(n,α)Cs136m(IT)Cs136(β^-)Ba136(n,2n)Ba135m(IT)Ba135(n,2n)Ba134(n,2n)Ba133				1.4
		La139(n,2n)La138(n,nα)Cs134m(IT)Cs134(β^-)Ba134(n,2n)Ba133m(IT)Ba133				1.3
		La139(n,2n)La138(n,nα)Cs134m(IT)Cs134(β^-)Ba134(n,2n)Ba133				1.2
		La139(n,α)Cs136m(β^-)Ba136(n,2n)Ba135(n,2n)Ba134(n,2n)Ba133m(IT)Ba133				1.0
H3	12.33y	La138(n,p)H1(n,γ)H2(n,γ)H3	100.0			
		La139(n,t)H3				29.3
		La139(n,2n)La138(n,t)H3				4.2

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cs137	30.04y	La139(n,γ)La140(n,α)Cs137	99.9	100.0	99.5	2.3
		La139(n,2n)La138(n,d)Ba137(n,p)Cs137				15.8
		La139(n,2n)La138(n,d)Ba137m(IT)Ba137(n,p)Cs137				15.1
		La139(n,2n)La138(n,np)Ba137m(IT)Ba137(n,p)Cs137				9.7
		La139(n,2n)La138(n,np)Ba137(n,p)Cs137				6.8
		La139(n,t)Ba137(n,p)Cs137				5.0
		La139(n,d)Ba138(n,d)Cs137				4.6
		La139(n,2n)La138(n,p)Ba138(n,d)Cs137				4.6
		La139(n,d)Ba138(n,2n)Ba137m(IT)Ba137(n,p)Cs137				4.2
		La139(n,α)Cs136(n,γ)Cs137				3.9
		La139(n,t)Ba137m(IT)Ba137(n,p)Cs137				3.6
		La139(n,2n)La138(n,p)Ba138(n,2n)Ba137m(IT) Ba137(n,p)Cs137				3.2
		La139(n,2n)La138(n,2n)La137(n,p)Ba137m(IT) Ba137(n,p)Cs137				3.1
		La139(n,d)Ba138(n,2n)Ba137(n,p)Cs137				3.0
		La139(n,2n)La138(n,p)Ba138(n,2n)Ba137(n,p)Cs137				2.3
		La139(n,2n)La138(n,2n)La137(n,p)Ba137(n,p)Cs137				2.0
		La139(n,d)Ba138(n,np)Cs137				1.7
		La139(n,2n)La138(n,p)Ba138(n,np)Cs137				1.7
		La139(n,np)Ba138(n,d)Cs137				1.7
		La139(n,np)Ba138(n,2n)Ba137m(IT)Ba137(n,p)Cs137				1.5
		La139(n,np)Ba138(n,2n)Ba137(n,p)Cs137				1.1
Sm151	89.98y	La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ) Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151	24.2			
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ) Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151	21.9			
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ) Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(n,γ) Pm150(β^-)Sm150(n,γ)Sm151	8.5			
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ) Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(n,γ) Pm150(β^-)Sm150(n,γ)Sm151	7.7			
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	7.0			
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	6.4			
		La139(n,γ)La140(n,γ)La141(β^-)Ce141(β^-)Pr141(n,γ) Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ) Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151	2.7			
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151	2.5			
		La139(n,γ)La140(n,γ)La141(β^-)Ce141(β^-)Pr141(n,γ) Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ) Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151	2.5			
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151	2.2			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sm151	cont.	La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(n,γ)Ce142(n,γ) Ce143(β^-)Pr143(β^-)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ) Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151	1.8			
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(n,γ)Ce142(n,γ) Ce143(β^-)Pr143(β^-)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ) Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151	1.6			
		La139(n,γ)La140(β^-)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ) Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β^-)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151	1.3			
La137	6.0 10^4y	La139(n,2n)La138(n,2n)La137				98.3
		La138(n,2n)La137				1.7
Cs135	2.3 10^6y	La138(n,α)Cs135	100.0	100.0	99.4	1.2
		La139(n,2n)La138(n,α)Cs135				67.7
		La139(n,nα)Cs135				17.3
		La139(n,2n)La138(n,α)Cs135m(IT)Cs135				11.0
		La139(n,α)Cs136(n,2n)Cs135				1.2
La138	1.0 10^{11}y	La139(n,2n)La138				99.1

Cerium

Isotope	Atom % abundance	
Ce136	0.18	($T_{1/2}$ =7.0 10^{13}y)
Ce138	0.25	
Ce140	88.45	
Ce142	11.11	($T_{1/2}$ =5.0 10^{16}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	8.43E+14	5.77E+14	5.40E+14	7.35E+13	1.09E+08	9.55E+07
Ce139	54.9	80.2	84.1	99.9		
Ce139m	32.0	1.0				
Ce141	10.2	14.9	14.8			
La137					98.3	100.0
Ba133					1.0	

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	5.36E-02	2.15E-02	1.79E-02	2.27E-03	6.48E-10	4.92E-10
Ce139m	60.8	3.1				
Ce139	26.6	66.4	78.5	99.9		
Ce141	6.3	15.7	17.5	0.1		
La140	3.6	8.9	2.4			
Ce143	0.9	2.2	0.4			
Pr143	0.4	1.0	1.1			
La137					84.9	100.0
Ba133					12.4	
Ba137m	0.2	0.1			2.1	

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	4.56E+04	5.33E+03	1.87E+03	1.83E+02	8.35E-05	2.66E-05
Ce139m	89.8	15.9				
La140	6.1	51.8	32.7			
Ce139	2.5	21.6	60.5	100.0		
Ce135	0.3	2.7	0.2			
Ce143	0.3	2.5	1.1			
Ce141	0.2	2.0	5.2			
La142	0.2	1.9				
Ba133					44.8	
La137					35.6	100.0
Ba137m	0.2	0.5			19.6	

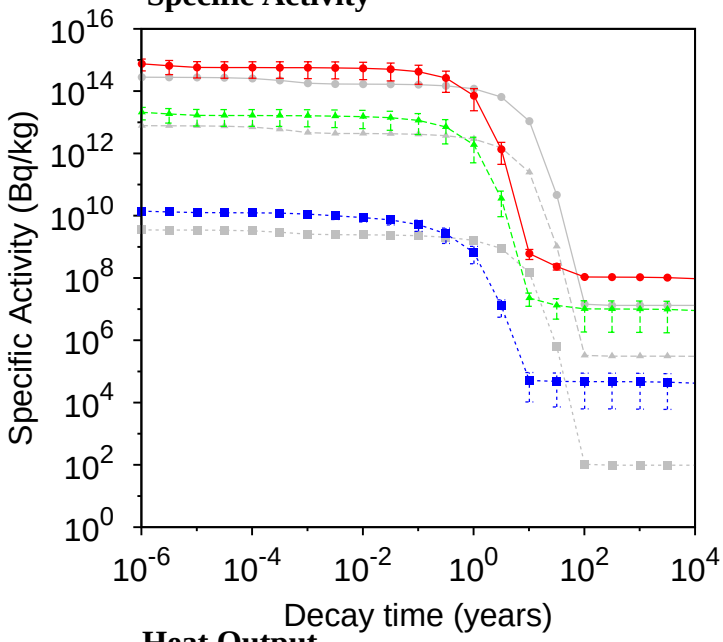
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.18E+05	2.06E+05	1.82E+05	1.91E+04	1.44E-02	7.73E-03
Ce139	55.1	58.3	64.9	99.9		
Ce141	28.0	29.7	31.1	0.1		
Ba137m	7.1	1.8			16.6	
La140	3.8	4.1	1.0			
Pr143	2.3	2.4	2.5			
Ce143	2.1	2.2	0.4			
La137					59.8	100.0
Cs137					12.0	
Ba133					11.4	

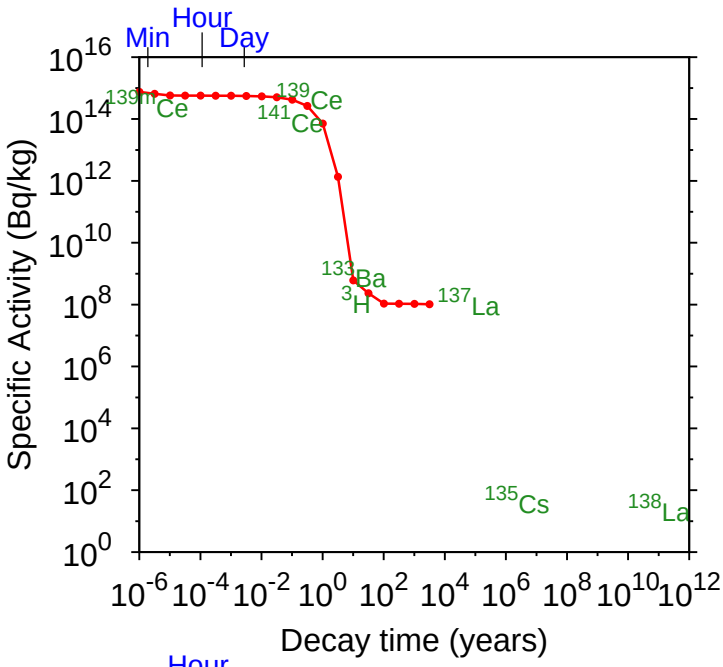
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.24E+06	1.23E+06	1.18E+06	1.40E+05	9.46E-01	8.30E-01
Ce139	71.1	71.5	73.3	99.9		
Ce141	26.5	26.7	25.8	0.1		
La137					98.1	100.0
Ba133					1.2	

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	6.63E+11	4.74E+11	4.56E+11	7.35E+10	4.66E+03	2.51E+03
Ce139	69.7	97.6	99.6	100.0		
Ce139m	29.0	0.8				
La137					60.2	100.0
Cs137					28.6	
Ba133					9.4	
Ba137m	0.1				1.6	

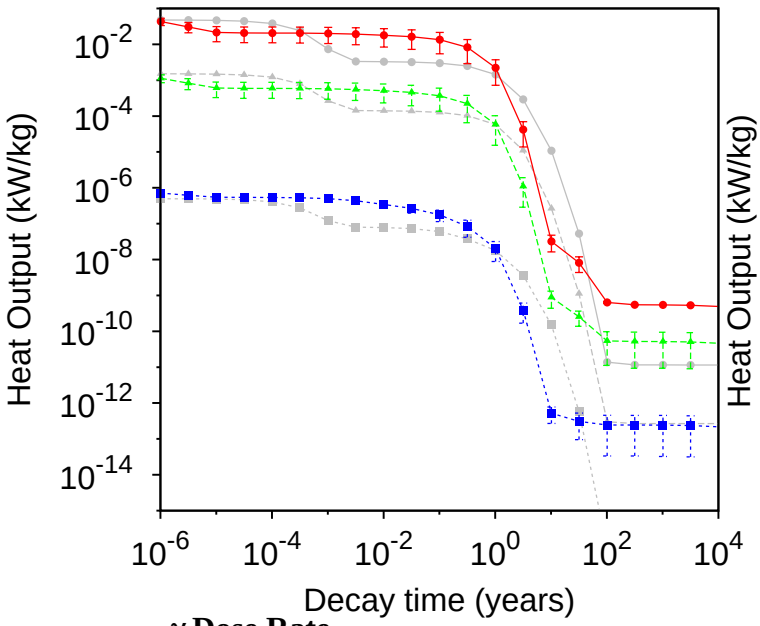
Cerium activation characteristics

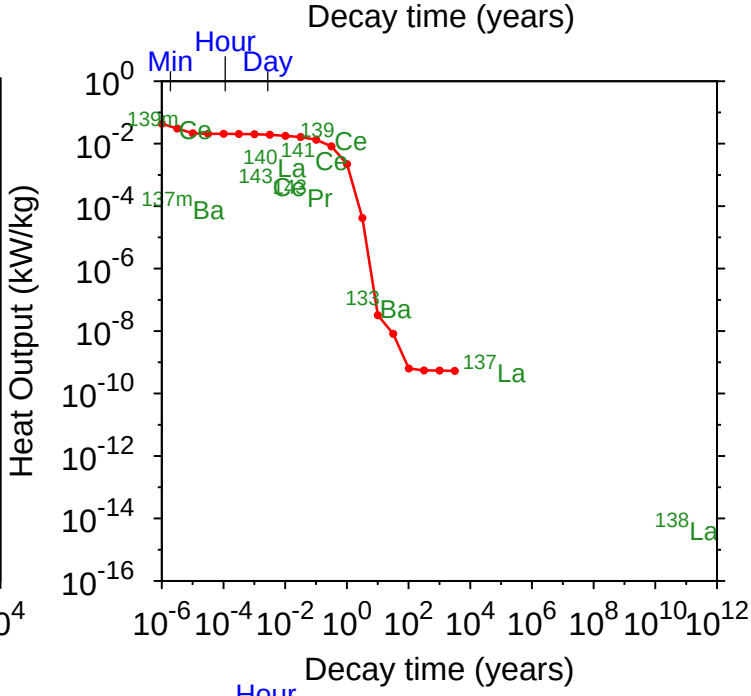
Specific Activity



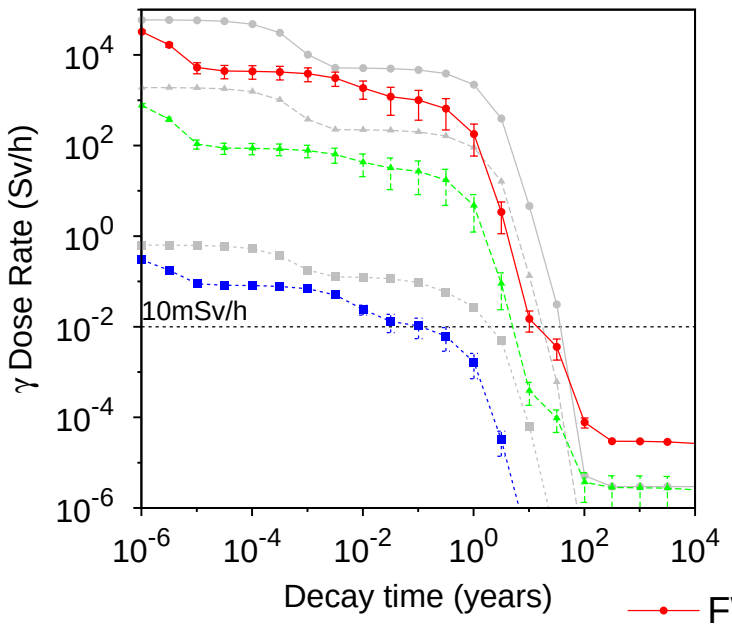


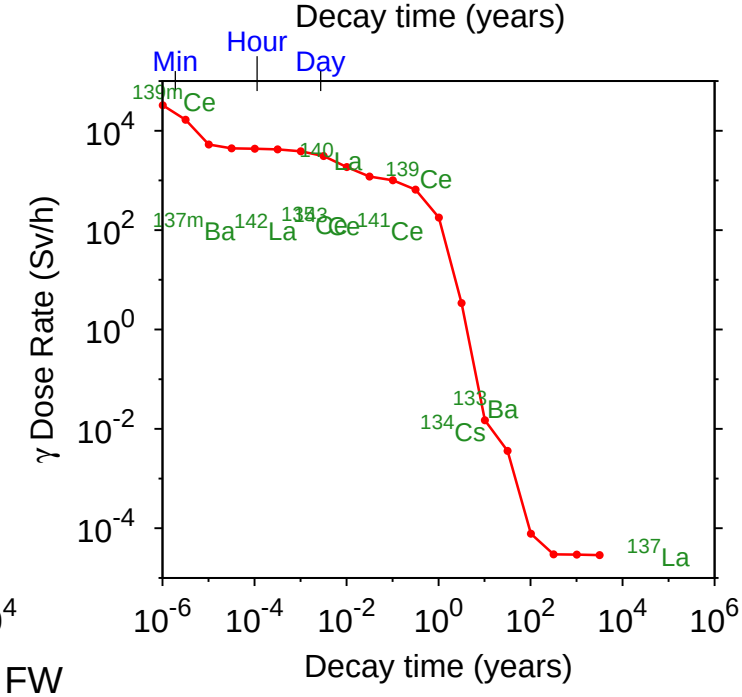
Heat Output





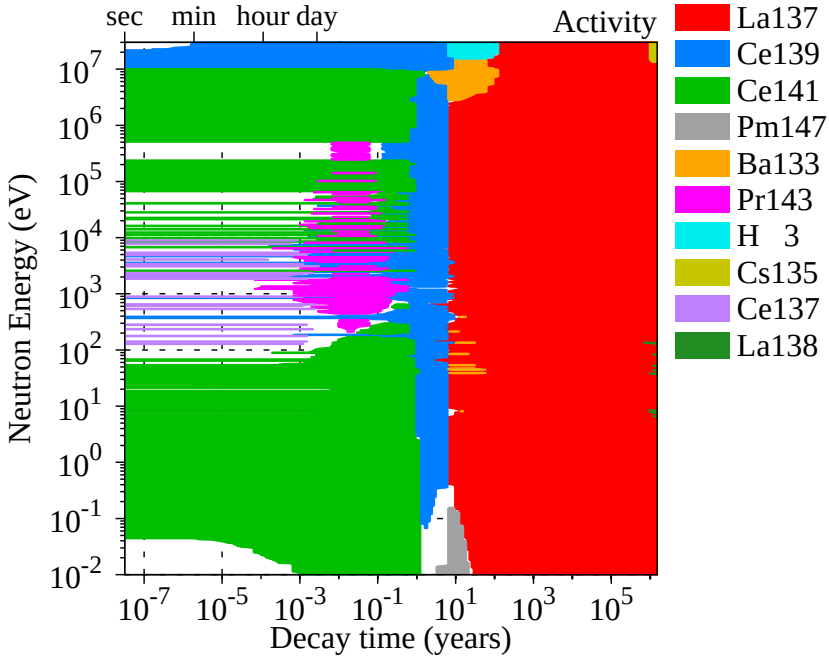
γ Dose Rate

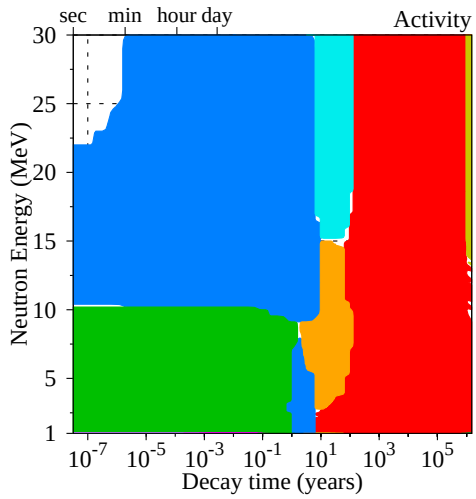


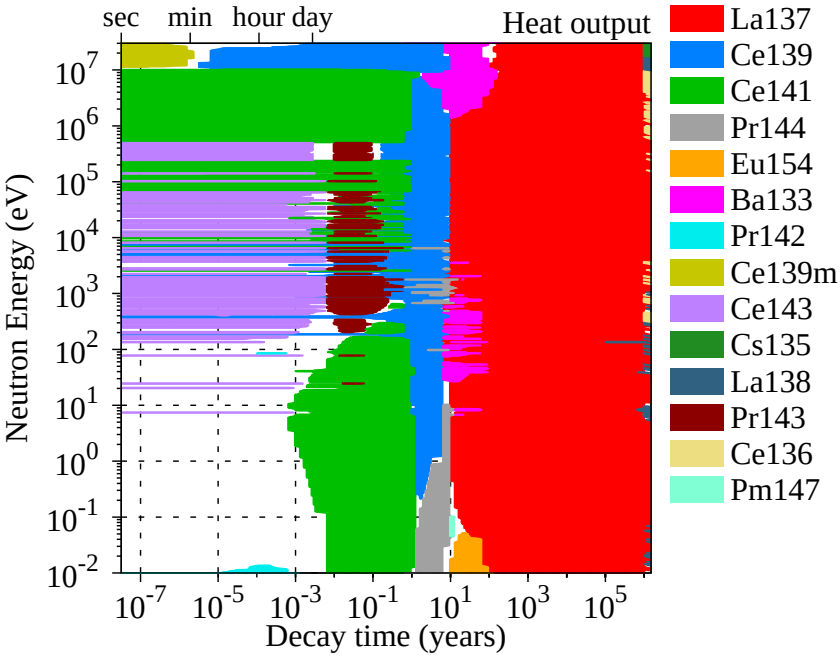


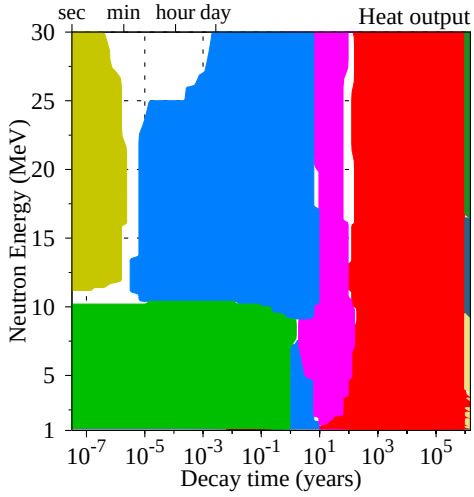
FW
Blanket
Manifold
Fe results

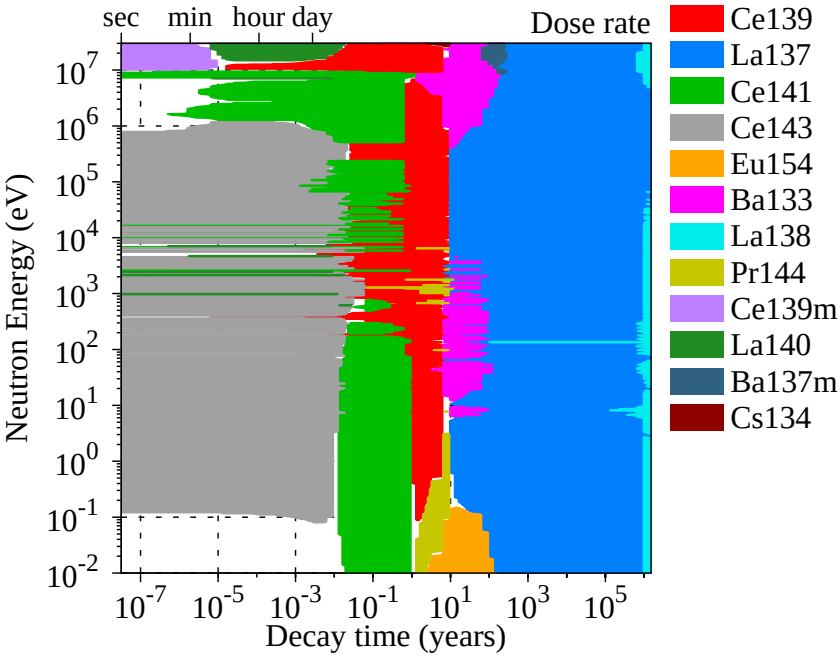
Cerium Importance diagrams

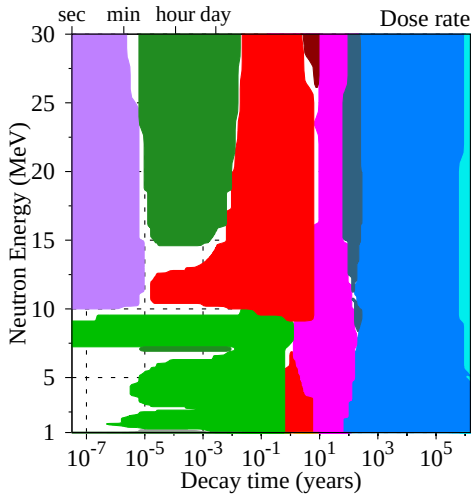




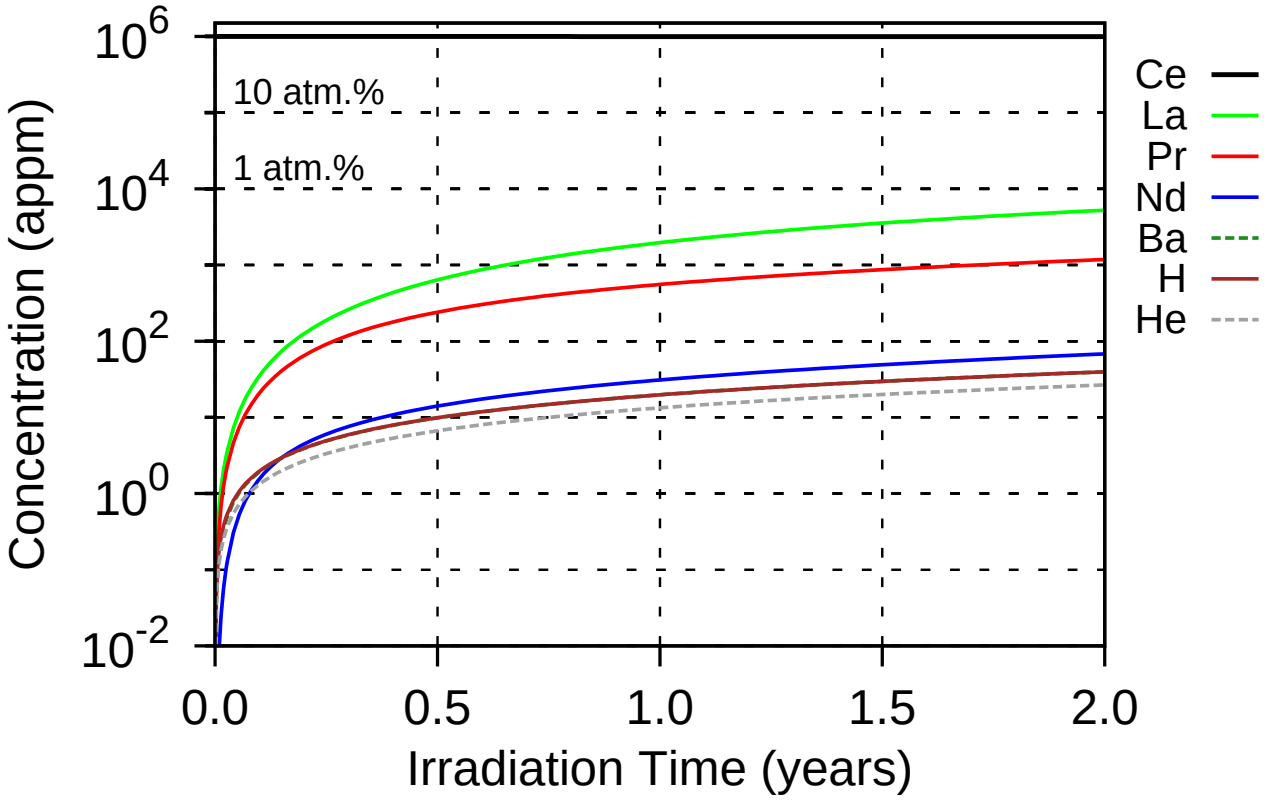




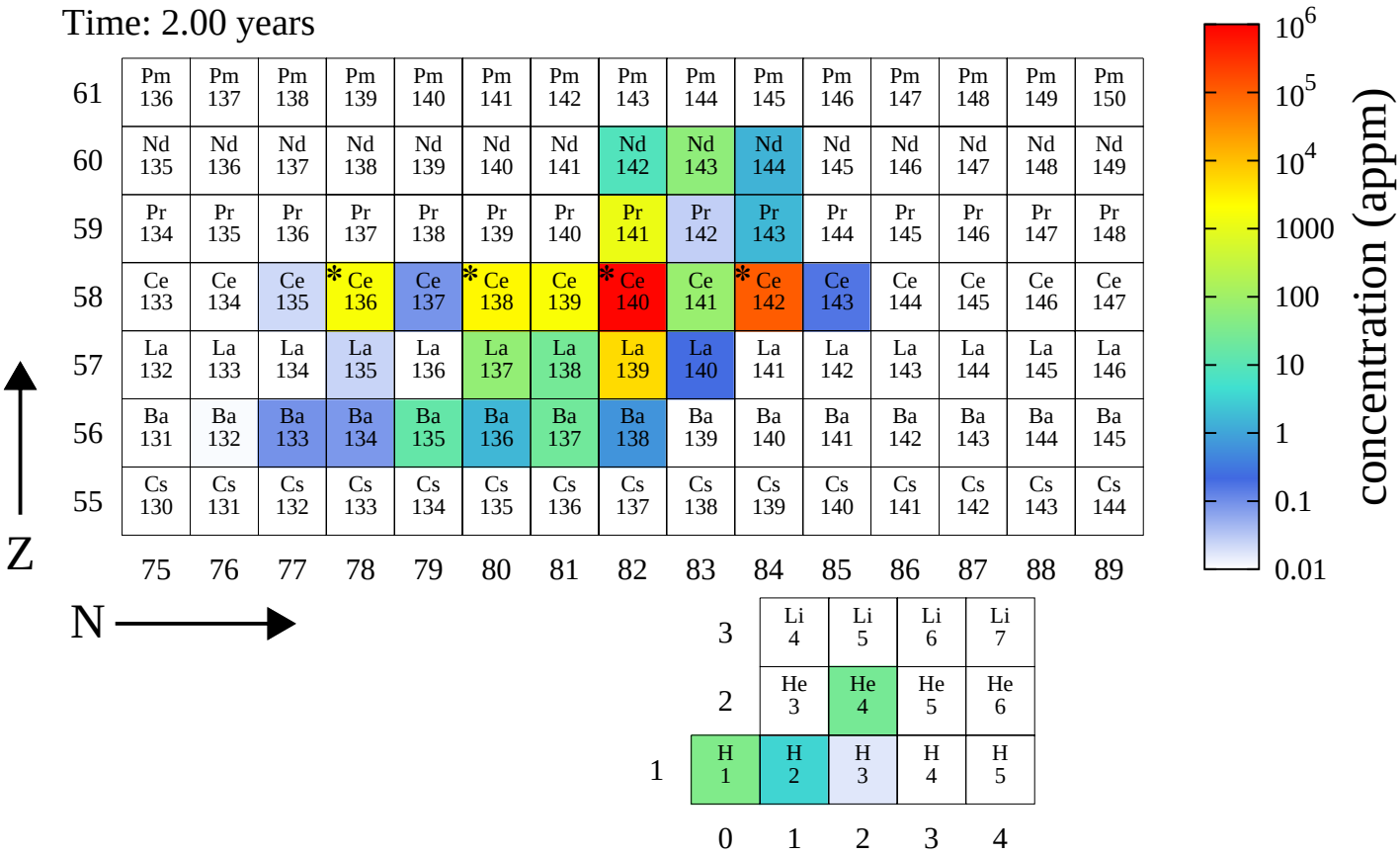




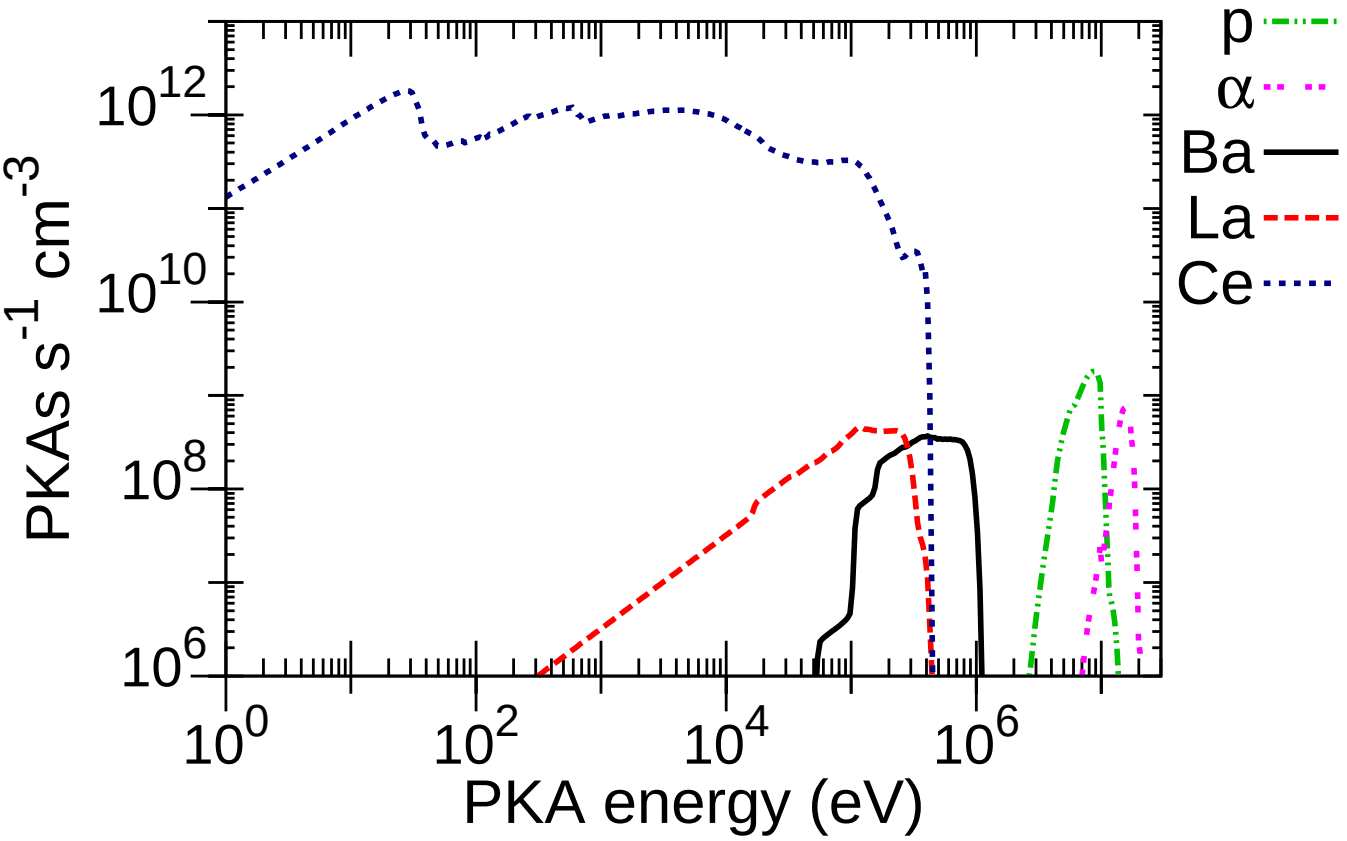
Cerium FW Transmutation

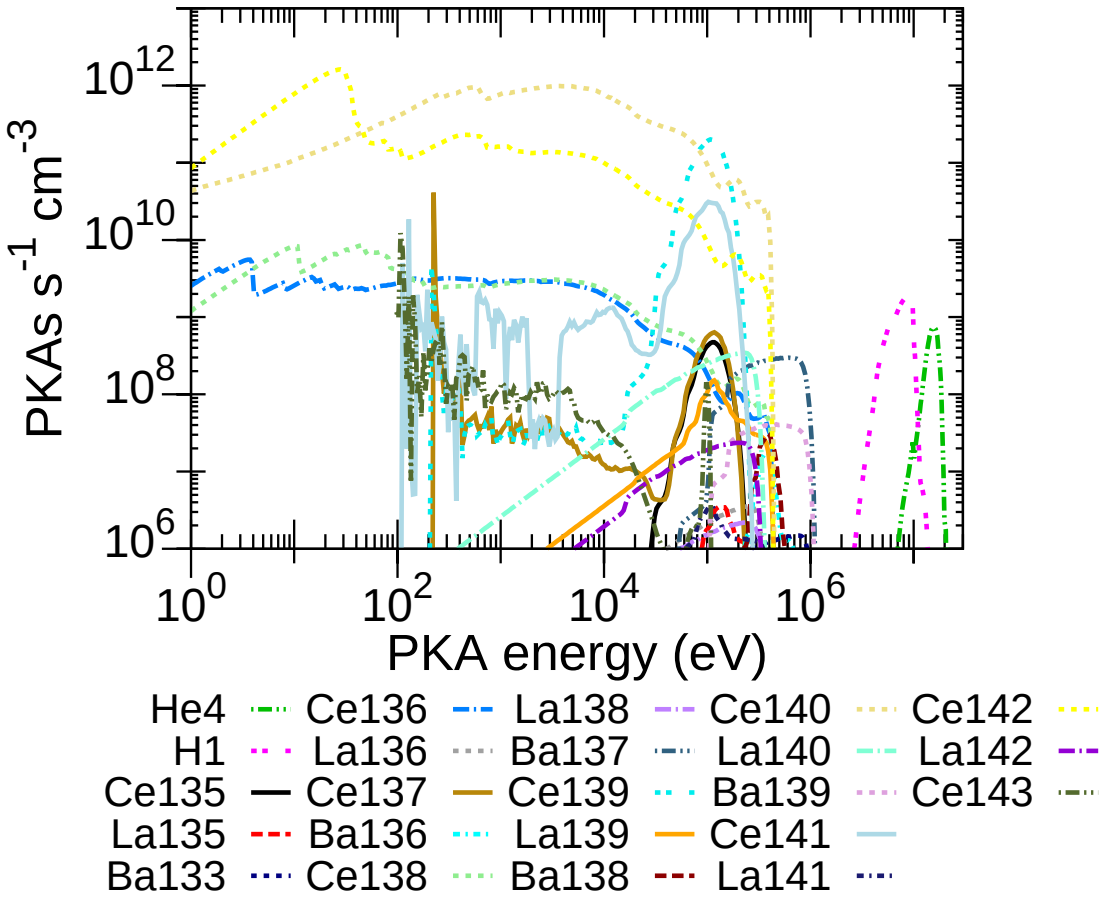


13 appm He & 20 appm H after 1 year 14 dpa/year



Cerium FW PKA distributions





Cerium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ce139m	56.08s	Ce138(n,γ)Ce139m	100.0	100.0	98.5	
		Ce138(n,γ)Ce139(n,n$'$)Ce139m			1.1	
		Ce140(n,2n)Ce139m				99.2
Ba137m	2.55m	Ce140(n,α)Ba137m	65.9	99.7	74.4	98.0
		Ce138(n,γ)Ce139(n,α)Ba136(n,γ)Ba137m	29.0			
		Ce136(n,γ)Ce137(β^+)La137(n,γ)La138(n,γ)La139(n,γ) La140(n,α)Cs137(β^-)Ba137m	3.6			
		Ce140(n,α)Ba137(n,n$'$)Ba137m			25.0	1.0
Pr144	17.28m	Ce142(n,γ)Ce143(β^-)Pr143(n,γ)Pr144m(IT)Pr144	78.2	78.7	88.3	80.4
		Ce142(n,γ)Ce143(β^-)Pr143(n,γ)Pr144	18.7	18.2	10.6	19.4
		Ce140(n,γ)Ce141(n,γ)Ce142(n,γ)Ce143(β^-)Pr143(n,γ) Pr144m(IT)Pr144	1.9			
		Ce142(n,γ)Ce143(n,γ)Ce144(β^-)Pr144		3.0	1.0	
La142	1.52h	Ce142(n,p)La142				100.0
Ce137	9.00h	Ce136(n,γ)Ce137	99.0	96.7	76.2	
		Ce136(n,γ)Ce137m(IT)Ce137	1.0	3.3	23.8	
		Ce138(n,2n)Ce137m(IT)Ce137				35.5
		Ce138(n,2n)Ce137				25.3
		Ce140(n,2n)Ce139m(IT)Ce139(n,2n)Ce138(n,2n) Ce137m(IT)Ce137				12.6
		Ce140(n,2n)Ce139(n,2n)Ce138(n,2n)Ce137m(IT)Ce137				10.1
		Ce140(n,2n)Ce139m(IT)Ce139(n,2n)Ce138(n,2n)Ce137				9.0
		Ce140(n,2n)Ce139(n,2n)Ce138(n,2n)Ce137				7.3
Ce135	17.70h	Ce136(n,2n)Ce135m(IT)Ce135				54.8
		Ce136(n,2n)Ce135				45.2
Pr142	19.12h	Ce140(n,γ)Ce141(β^-)Pr141(n,γ)Pr142	77.5	72.2	49.7	
		Ce140(n,γ)Ce141(β^-)Pr141(n,γ)Pr142m(IT)Pr142	22.5	27.7	50.3	
Ce143	1.38d	Ce142(n,γ)Ce143	97.6	100.0	100.0	100.0
		Ce140(n,γ)Ce141(n,γ)Ce142(n,γ)Ce143	2.4			
La140	1.68d	Ce136(n,γ)Ce137(β^+)La137(n,γ)La138(n,γ)La139(n,γ)La140	90.8			
		Ce138(n,γ)Ce139(β^+)La139(n,γ)La140	8.2	96.1	72.9	
		Ce138(n,γ)Ce139m(IT)Ce139(β^+)La139(n,γ)La140		3.9	26.8	
		Ce140(n,p)La140				98.6
Pr143	13.56d	Ce142(n,γ)Ce143(β^-)Pr143	97.3	100.0	100.0	99.9
		Ce140(n,γ)Ce141(n,γ)Ce142(n,γ)Ce143(β^-)Pr143	2.3			
Ce141	32.51d	Ce140(n,γ)Ce141	100.0	100.0	100.0	
		Ce142(n,2n)Ce141				99.3
Ce139	137.63d	Ce138(n,γ)Ce139	98.6	96.1	72.9	
		Ce138(n,γ)Ce139m(IT)Ce139	1.4	3.9	26.8	
		Ce140(n,2n)Ce139m(IT)Ce139				55.1
		Ce140(n,2n)Ce139				44.5

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cs134	2.06y	Ce136(n,α)Ba133(β^+)Cs133(n,γ)Cs134	95.1	92.3	29.7	
		Ce136(n,α)Ba133m(IT)Ba133(β^+)Cs133(n,γ)Cs134	2.1	2.4	4.2	
		Ce136(n,γ)Ce137(β^+)La137(n,α)Cs134	2.1	3.9	44.0	
		Ce136(n,α)Ba133(β^+)Cs133(n,γ)Cs134m(IT)Cs134		1.1	4.1	
		Ce136(n,γ)Ce137m(IT)Ce137(β^+)La137(n,α)Cs134			13.7	
		Ce136(n,γ)Ce137(β^+)La137(n,α)Cs134m(IT)Cs134			2.3	
		Ce138(n,2n)Ce137m(IT)Ce137(β^+)La137(n,α)Cs134				22.9
		Ce138(n,2n)Ce137(β^+)La137(n,α)Cs134				16.4
		Ce138(n,2n)Ce137m(IT)Ce137(β^+)La137(n,α)Cs134m(IT)Cs134				5.2
		Ce138(n,2n)Ce137(β^+)La137(n,α)Cs134m(IT)Cs134				3.8
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,2n)La138(n,2n) La137(n,α)Cs134				3.6
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,2n)La138(n,α) Cs135(n,2n)Cs134				3.5
		Ce140(n,2n)Ce139(β^+)La139(n,2n)La138(n,2n) La137(n,α)Cs134				2.9
		Ce140(n,2n)Ce139(β^+)La139(n,2n)La138(n,α) Cs135(n,2n)Cs134				2.8
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,2n) La138(n,nα)Cs134				2.1
		Ce140(n,2n)Ce139m(IT)Ce139(n,2n)Ce138(n,2n)Ce137m(IT) Ce137(β^+)La137(n,α)Cs134				2.0
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,nα) Cs135(n,2n)Cs134				2.0
		Ce136(n,2n)Ce135m(IT)Ce135(β^+)La135(β^+)Ba135(n,d)Cs134				1.9
		Ce136(n,2n)Ce135m(IT)Ce135(β^+)La135(β^+)Ba135(n,2n) Ba134(n,p)Cs134				1.8
		Ce140(n,2n)Ce139(β^+)La139(n,2n)La138(n,nα)Cs134				1.7
		Ce140(n,2n)Ce139(n,2n)Ce138(n,2n)Ce137m(IT)Ce137(β^+) La137(n,α)Cs134				1.6
		Ce140(n,2n)Ce139(β^+)La139(n,nα)Cs135(n,2n)Cs134				1.6
		Ce136(n,2n)Ce135(β^+)La135(β^+)Ba135(n,d)Cs134				1.6
		Ce136(n,2n)Ce135(β^+)La135(β^+)Ba135(n,2n)Ba134(n,p)Cs134				1.5
		Ce140(n,2n)Ce139m(IT)Ce139(n,2n)Ce138(n,2n)Ce137(β^+) La137(n,α)Cs134				1.5
		Ce136(n,2n)Ce135m(IT)Ce135(β^+)La135(β^+)Ba135(n,np)Cs134				1.3
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,2n)La138(n,α) Cs135(n,2n)Cs134m(IT)Cs134				1.3
		Ce140(n,2n)Ce139(n,2n)Ce138(n,2n)Ce137(β^+) La137(n,α)Cs134				1.2
		Ce136(n,2n)Ce135m(IT)Ce135(β^+)La135(β^+)Ba135(n,p) Cs135(n,2n)Cs134				1.2
		Ce136(n,2n)Ce135(β^+)La135(β^+)Ba135(n,np)Cs134				1.1
		Ce140(n,2n)Ce139(β^+)La139(n,2n)La138(n,α)Cs135(n,2n) Cs134m(IT)Cs134				1.1
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,2n)La138(n,nα) Cs134m(IT)Cs134				1.0
Pm147	2.62y	Ce142(n,γ)Ce143(β^-)Pr143(β^-)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	78.8			
		Ce142(n,γ)Ce143(β^-)Pr143(n,γ)Pr144m(IT)Pr144(β^-) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	10.2			
		Ce142(n,γ)Ce143(β^-)Pr143(n,γ)Pr144(β^-)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	2.4			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Eu154	8.59y	Ce142(n,γ)Ce143(β^-)Pr143(β^-)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	30.1			
		Ce142(n,γ)Ce143(β^-)Pr143(β^-)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	27.1			
		Ce142(n,γ)Ce143(β^-)Pr143(β^-)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	10.5			
		Ce142(n,γ)Ce143(β^-)Pr143(β^-)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	9.5			
		Ce142(n,γ)Ce143(β^-)Pr143(n,γ)Pr144m(IT)Pr144(β^-) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148(n,γ)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	4.2			
		Ce142(n,γ)Ce143(β^-)Pr143(n,γ)Pr144m(IT)Pr144(β^-) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148m(n,γ)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	3.7			
		Ce142(n,γ)Ce143(β^-)Pr143(β^-)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β^-) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	2.0			
		Ce142(n,γ)Ce143(β^-)Pr143(n,γ)Pr144m(IT)Pr144(β^-) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148(n,γ)Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	1.5			
		Ce142(n,γ)Ce143(β^-)Pr143(n,γ)Pr144m(IT)Pr144(β^-) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148m(n,γ)Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	1.3			
		Ce142(n,γ)Ce143(β^-)Pr143(n,γ)Pr144(β^-)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	1.0			
Ba133	10.54y	Ce136(n,α)Ba133	97.8	97.4	87.1	38.1
		Ce136(n,α)Ba133m(IT)Ba133	2.2	2.6	12.5	39.8
		Ce136(n,2n)Ce135m(IT)Ce135(β^+)La135(β^+)Ba135(n,2n) Ba134(n,2n)Ba133m(IT)Ba133				5.8
		Ce136(n,2n)Ce135m(IT)Ce135(β^+)La135(β^+)Ba135(n,2n) Ba134(n,2n)Ba133				5.6
		Ce136(n,2n)Ce135(β^+)La135(β^+)Ba135(n,2n)Ba134(n,2n) Ba133m(IT)Ba133				4.8
		Ce136(n,2n)Ce135(β^+)La135(β^+)Ba135(n,2n)Ba134(n,2n)Ba133				4.6
H3	12.33y	Ce136(n,γ)Ce137(β^+)La137(n,γ)La138(n,p)H1(n,γ)H2(n,γ)H3	96.7			
		Ce136(n,γ)Ce137(n,p)H1(n,γ)H2(n,γ)H3	2.0			
		Ce142(n,t)H3				46.8
		Ce140(n,t)H3				12.5
		Ce140(n,2n)Ce139m(IT)Ce139(n,t)H3				4.5
		Ce142(n,2n)Ce141(n,t)H3				4.1
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,t)H3				2.8
		Ce140(n,2n)Ce139(n,t)H3				3.7
		Ce140(n,2n)Ce139(β^+)La139(n,t)H3				2.3
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,2n)La138(n,t)H3				1.4
		Ce140(n,2n)Ce139(β^+)La139(n,2n)La138(n,t)H3				1.1
Cs137	30.04y	Ce136(n,γ)Ce137(β^+)La137(n,γ)La138(n,γ)La139(n,γ) La140(n,α)Cs137	82.1			
		Ce140(n,α)Ba137(n,p)Cs137			33.4	45.6
		Ce140(n,α)Ba137m(IT)Ba137(n,p)Cs137			2.2	52.8

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
La137	6.0 10^4y	Ce136(n,γ)Ce137(β^+)La137	99.0	96.7	76.1	
		Ce136(n,γ)Ce137m(IT)Ce137(β^+)La137	1.0	3.3	23.7	
		Ce138(n,2n)Ce137m(IT)Ce137(β^+)La137				36.2
		Ce138(n,2n)Ce137(β^+)La137				25.9
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,2n) La138(n,2n)La137				11.6
		Ce140(n,2n)Ce139(β^+)La139(n,2n)La138(n,2n)La137				9.4
		Ce140(n,2n)Ce139m(IT)Ce139(n,2n)Ce138(n,2n)Ce137m(IT) Ce137(β^+)La137				5.2
		Ce140(n,2n)Ce139(n,2n)Ce138(n,2n)Ce137m(IT) Ce137(β^+)La137				4.2
		Ce140(n,2n)Ce139m(IT)Ce139(n,2n)Ce138(n,2n) Ce137(β^+)La137				3.8
		Ce140(n,2n)Ce139(n,2n)Ce138(n,2n)Ce137(β^+)La137				3.0
Cs135	2.3 10^6y	Ce136(n,γ)Ce137(β^+)La137(n,γ)La138(n,α)Cs135	81.1	84.8		
		Ce136(n,α)Ba133(β^+)Cs133(n,γ)Cs134(n,γ)Cs135	17.0	11.2	1.8	
		Ce136(n,γ)Ce137m(IT)Ce137(β^+)La137(n,γ)La138(n,α)Cs135		2.9		
		Ce136(n,γ)Ce137(β^+)La137(n,α)Cs134(n,γ)Cs135			3.7	
		Ce136(n,γ)Ce137m(IT)Ce137(β^+)La137(n,α)Cs134(n,γ)Cs135			1.1	
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,2n)La138(n,α)Cs135				28.4
		Ce140(n,2n)Ce139(β^+)La139(n,2n)La138(n,α)Cs135				22.9
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,nα)Cs135				12.8
		Ce140(n,2n)Ce139(β^+)La139(n,nα)Cs135				10.4
		Ce136(n,2n)Ce135m(IT)Ce135(β^+)La135(β^+)Ba135(n,p)Cs135				6.5
		Ce136(n,2n)Ce135(β^+)La135(β^+)Ba135(n,p)Cs135				5.3
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,2n)La138(n,α) Cs135m(IT)Cs135				4.6
		Ce140(n,2n)Ce139(β^+)La139(n,2n)La138(n,α)Cs135m(IT)Cs135				3.7
La138	1.0 10^{11}y	Ce136(n,γ)Ce137(β^+)La137(n,γ)La138	99.1	96.7	76.1	
		Ce136(n,γ)Ce137m(IT)Ce137(β^+)La137(n,γ)La138	1.0	3.3	23.6	
		Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,2n)La138				54.9
		Ce140(n,2n)Ce139(β^+)La139(n,2n)La138				44.4
Ce136	7.0 10^{13}y	no pathways found				

Praseodymium

Isotope	Atom % abundance
Pr141	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	8.75E+14	4.45E+14	1.49E+13	6.03E+11	1.81E+07	5.96E+05
Pr140	72.0	48.1				
Pr142	21.2	41.5	52.1			
Pr142m	5.4	8.3				
Ce139	0.4	0.8	24.7	98.9		
Ce141	0.4	0.8	23.1	0.3		
H3				0.8	96.3	
La137					3.7	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.36E-01	6.35E-02	1.33E-03	1.85E-05	1.94E-11	3.07E-12
Pr140	80.5	59.0				
Pr142	18.9	40.5	81.1			
Ce141	0.1	0.2	10.1	0.3		
Ce139	0.1	0.2	8.6	99.6		
H3					82.0	
La137					17.6	99.9

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	5.80E+04	2.18E+04	1.58E+02	1.41E+00	2.35E-07	1.59E-07
Pr140	93.2	84.3				
Pr142	5.8	15.3	89.1			
Ce139			5.5	99.9		
La140		0.1	2.8			
Ce141			2.5	0.1		
La137					74.1	97.7
Ba137m					24.4	
La138					1.5	2.3

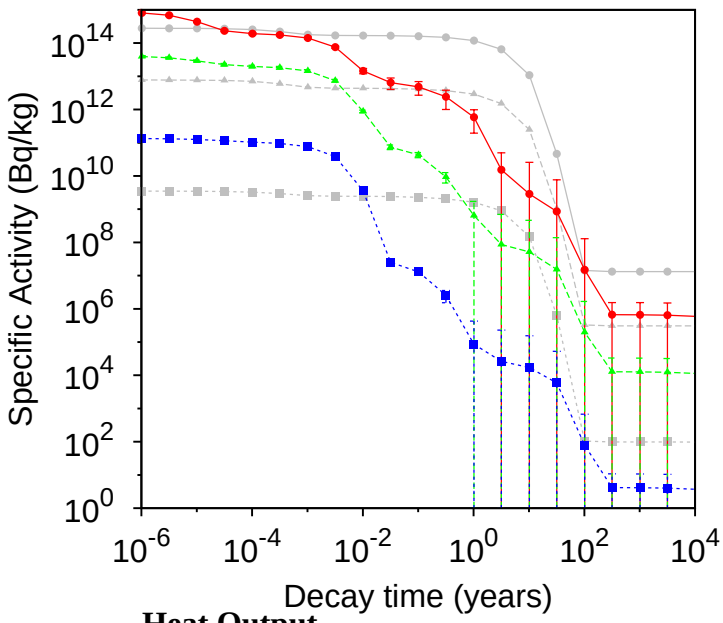
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.50E+05	2.46E+05	1.35E+04	1.56E+02	8.01E-04	4.83E-05
Pr142	96.6	97.7	74.7			
Pr140	1.5	0.5				
Ce141	1.1	1.1	18.1	0.7		
Ce139	0.4	0.4	7.1	99.2		
H3				0.1	91.4	
La137					6.7	100.0
Ba137m	0.1				1.1	

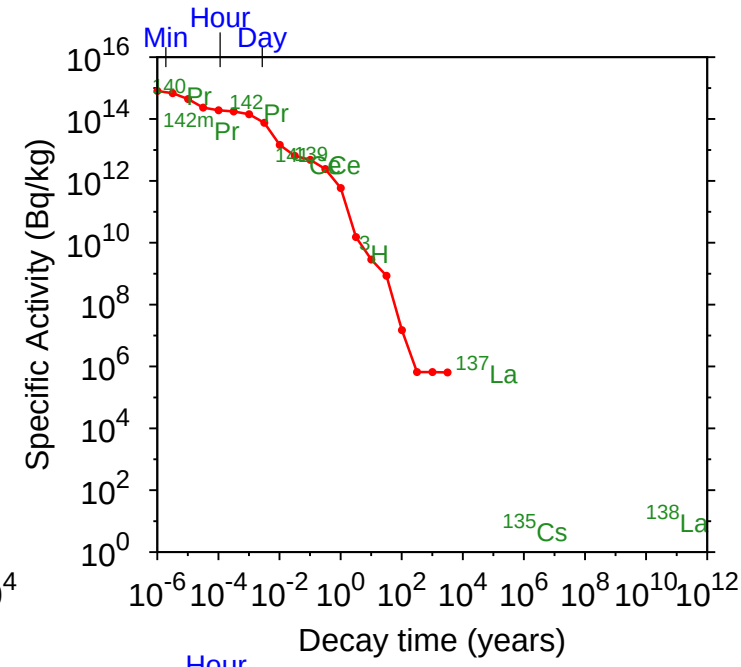
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.27E+05	1.24E+05	2.43E+04	1.14E+03	1.04E-02	5.18E-03
Pr142	80.5	81.8	17.5			
Ce141	11.1	11.3	53.6	0.5		
Ce139	5.6	5.7	28.8	99.4		
Pr140	2.4	0.8				
La137					56.0	100.0
H3				0.1	43.8	

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	3.79E+11	1.32E+11	3.80E+09	5.96E+08	1.97E+02	1.57E+01
Pr140	97.8	95.5				
Ce139	1.0	2.8	96.9	100.0		
Pr142	0.5	1.4	2.0			
H3					88.5	
La137					8.9	99.9
Cs137					2.4	

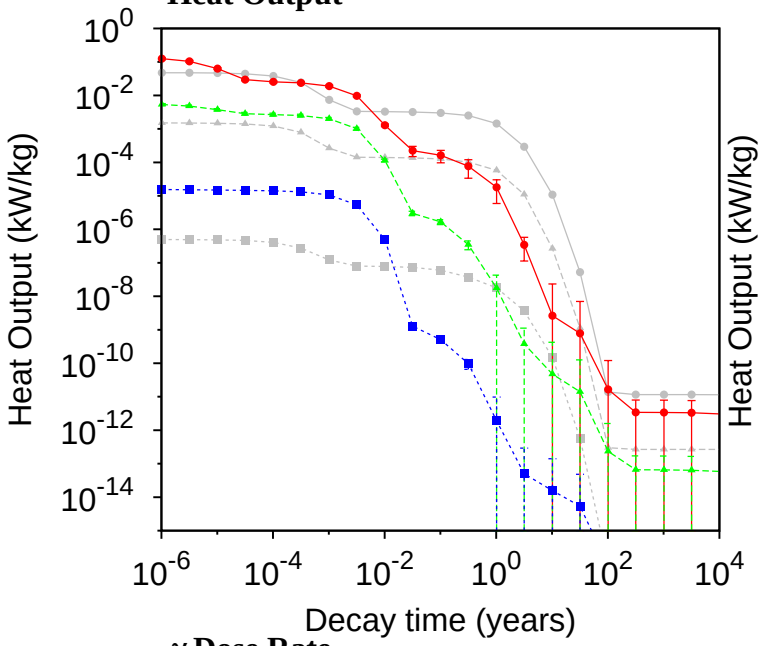
Praseodymium activation characteristics

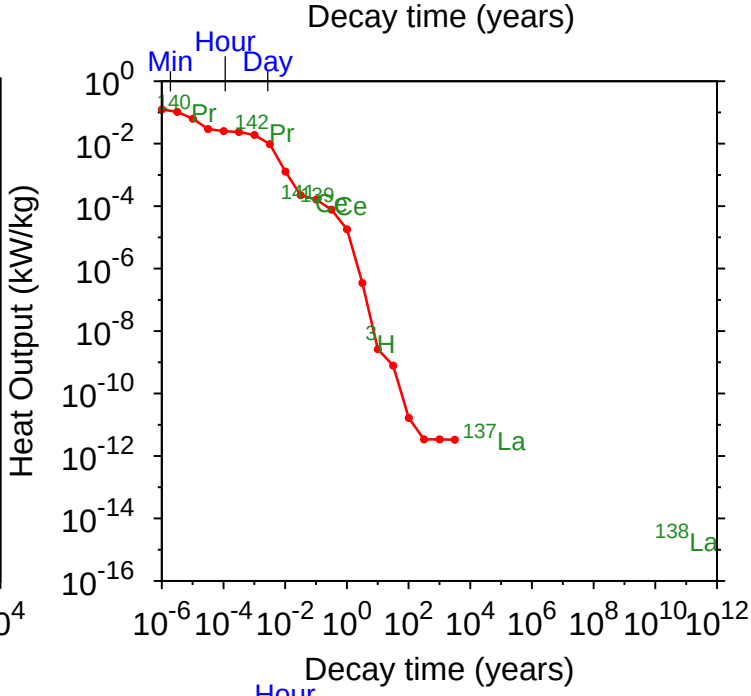
Specific Activity



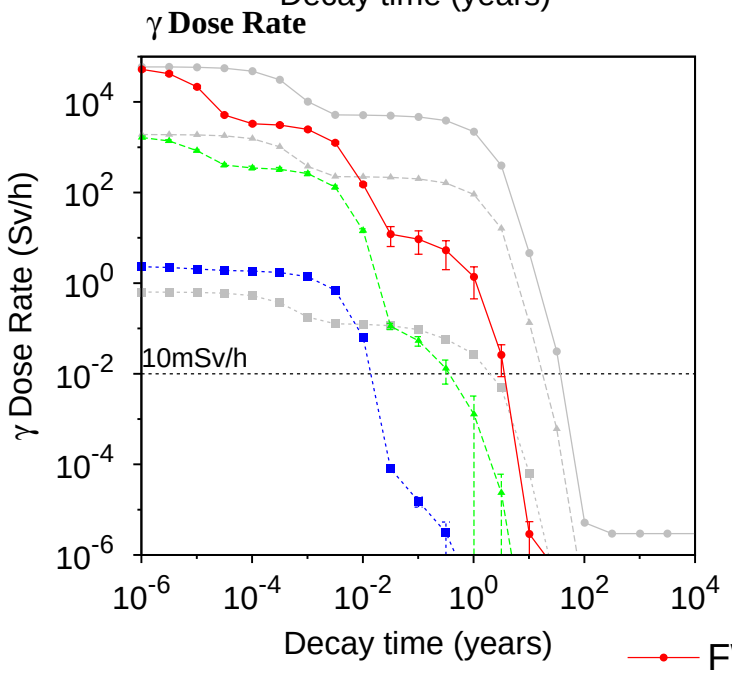


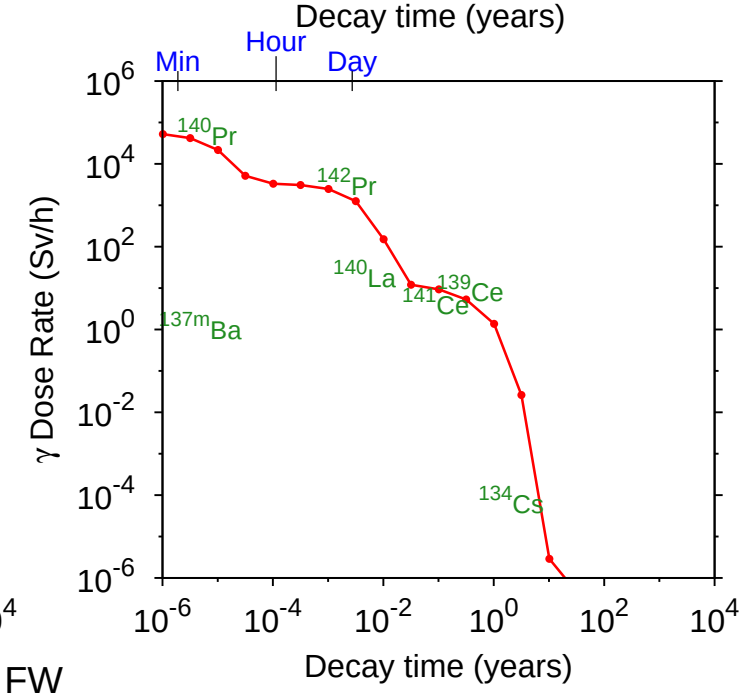
Heat Output





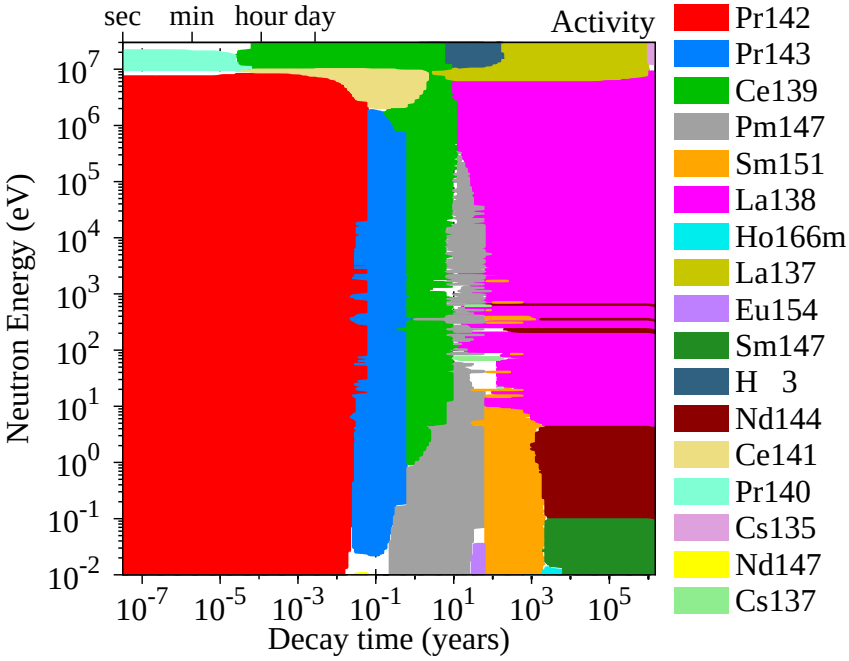
γ Dose Rate

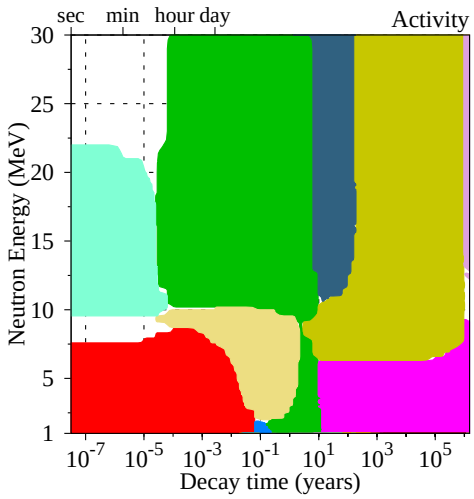


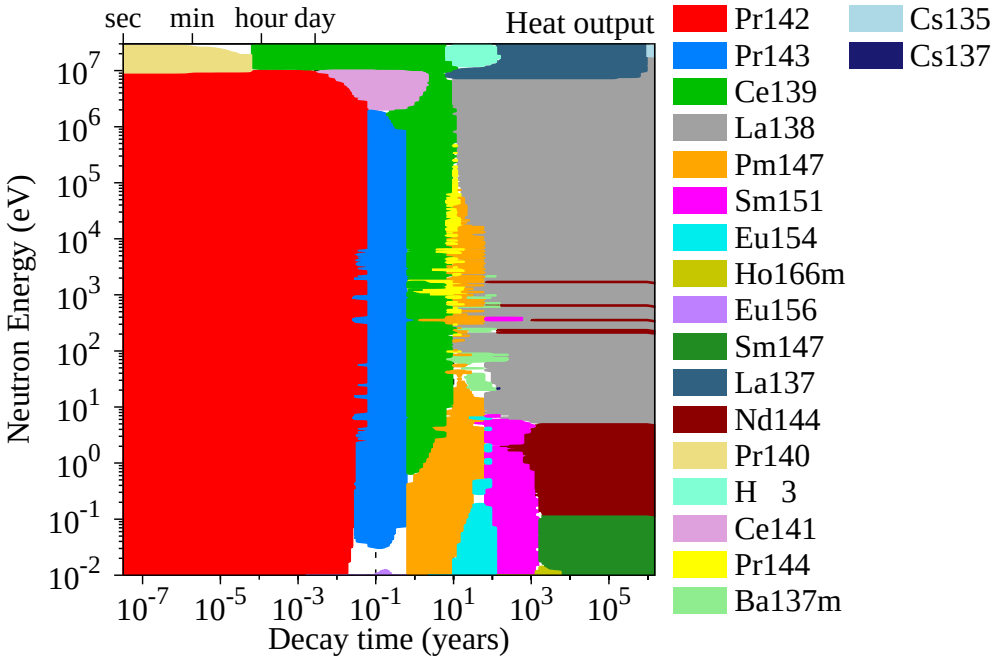


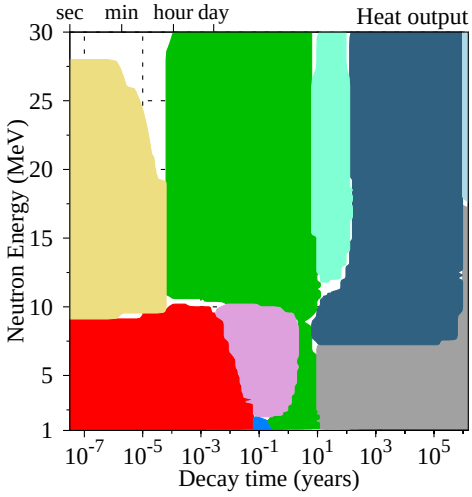
FW
Blanket
Manifold
Fe results

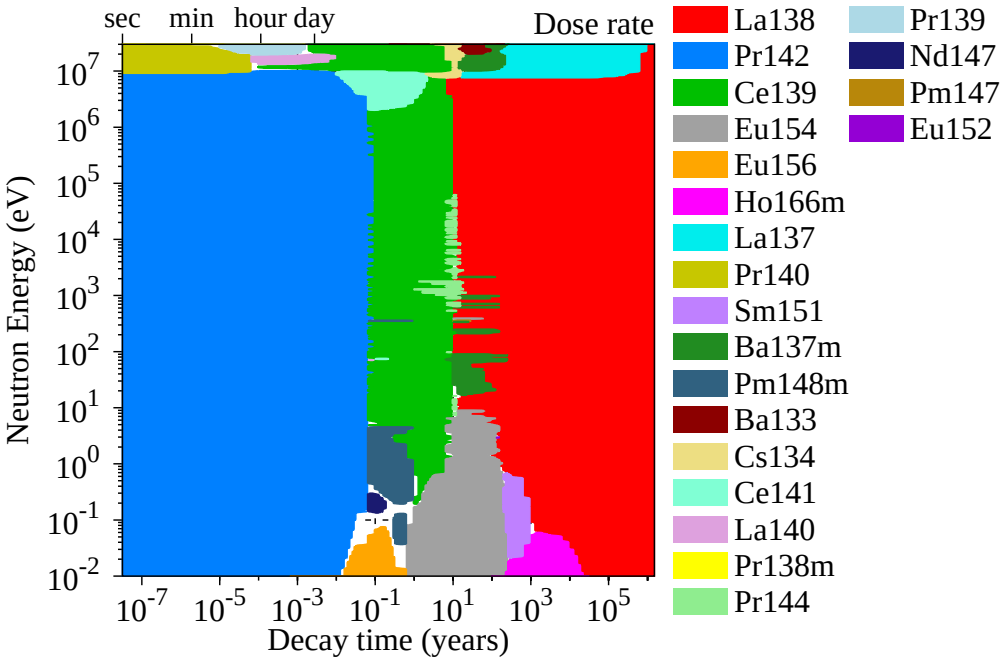
Praseodymium Importance diagrams

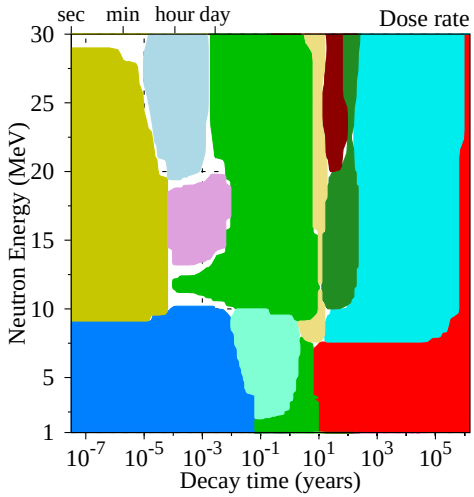




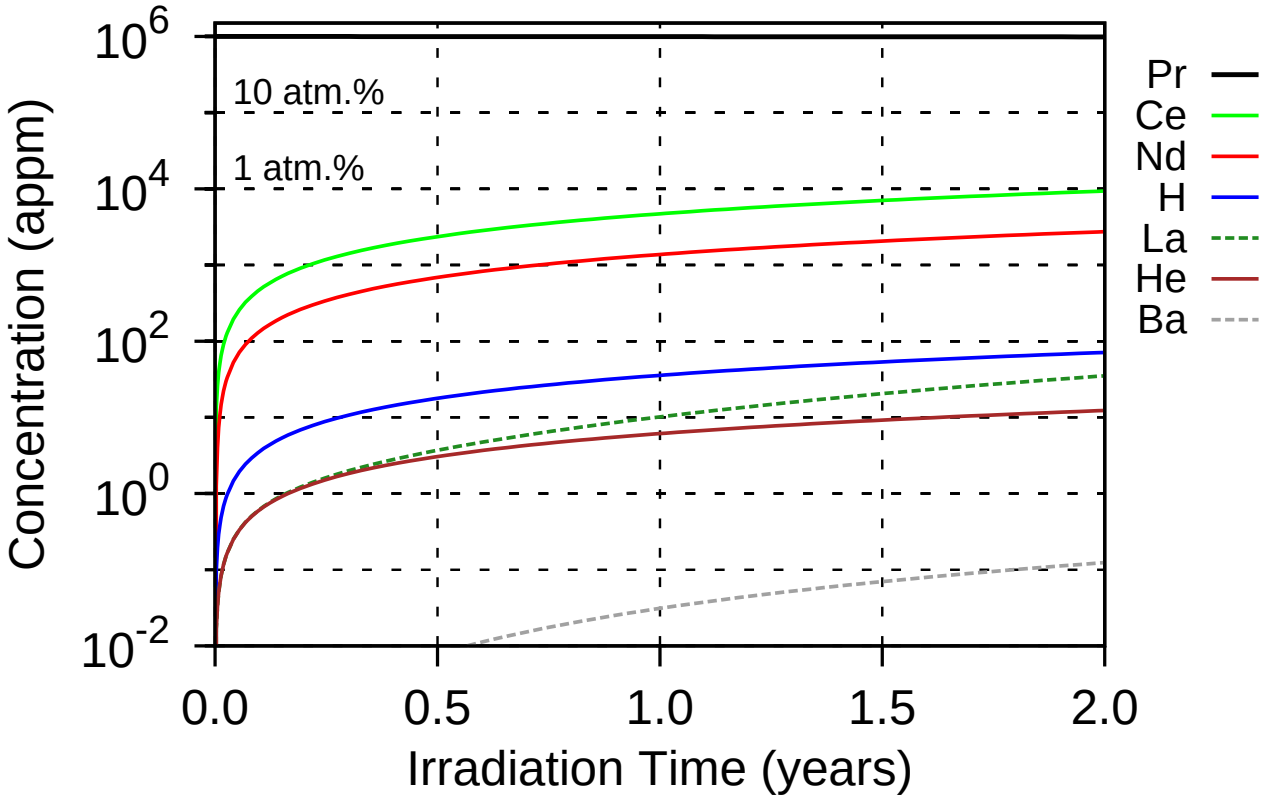




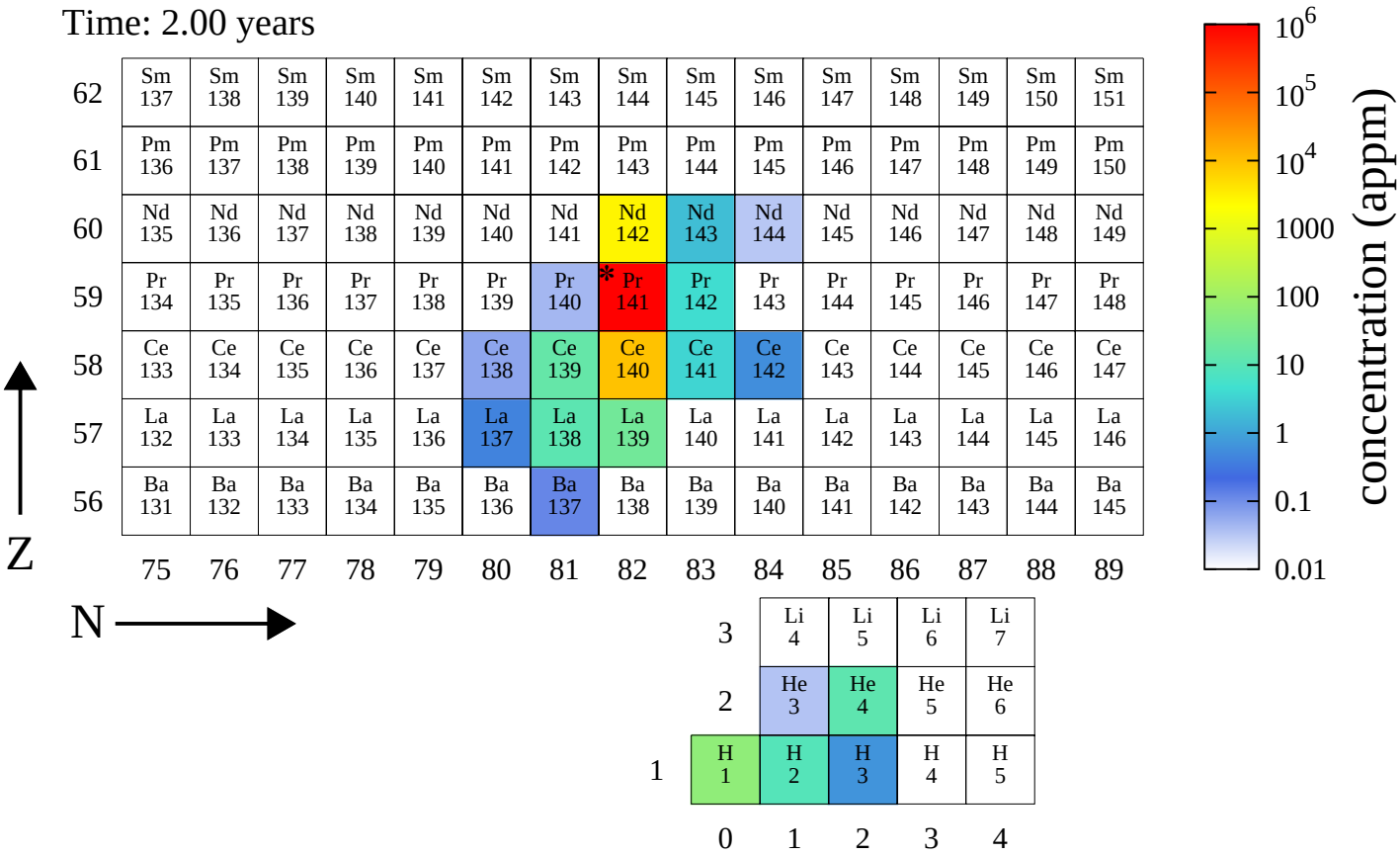




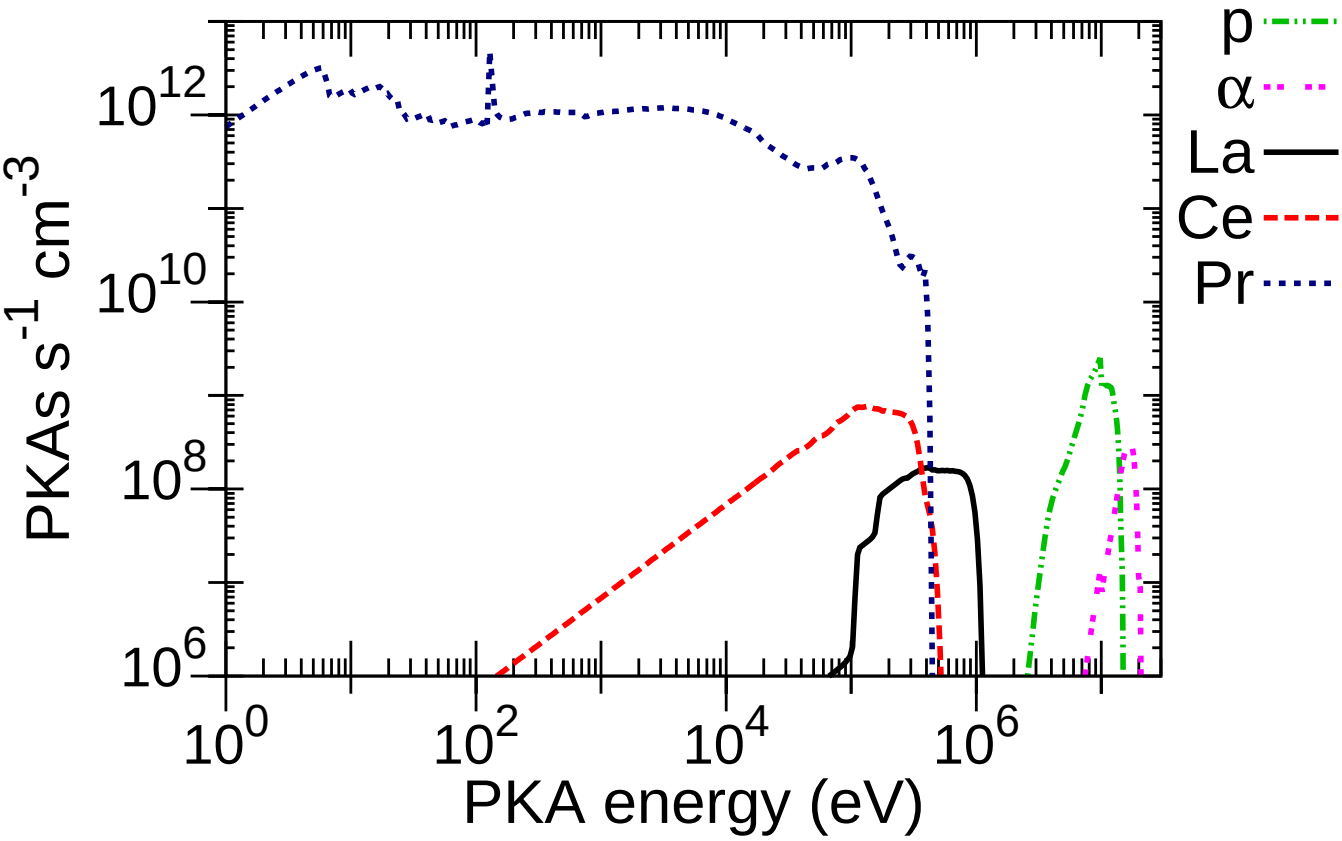
Praseodymium FW Transmutation

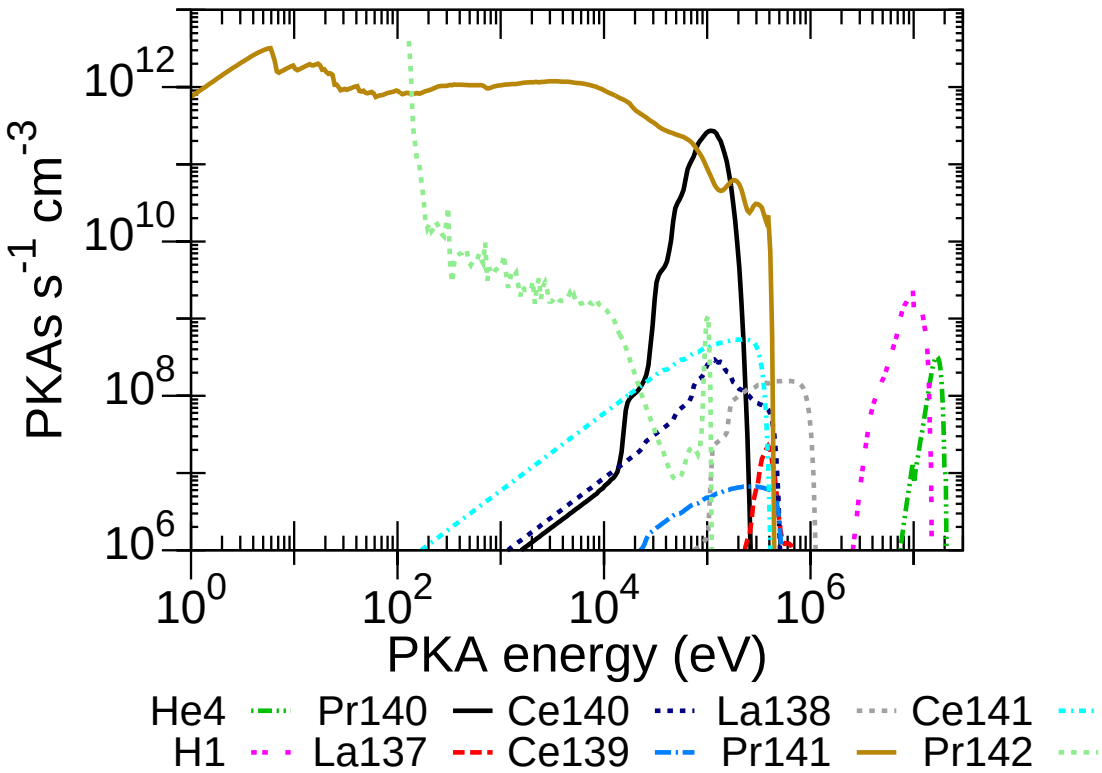


6 appm He & 36 appm H after 1 year 14 dpa/year



Praseodymium FW PKA distributions





Praseodymium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ba137m	2.55m	Pr141(n,γ)Pr142(n,α)La139(n,γ)La140(n,α)Cs137(β^-)Ba137m	17.1			
		Pr141(n,γ)Pr142m(IT)Pr142(n,α)La139(n,γ)La140(n,α) Cs137(β^-)Ba137m	4.9			
		Pr141(n,α)La138(n,γ)La139(n,γ)La140(n,α)Cs137(β^-)Ba137m	1.8			
		Pr141(n,2n)Pr140(β^+)Ce140(n,α)Ba137m				98.4
Pr140	3.39m	Pr141(n,2n)Pr140				99.9
Pr142m	14.60m	Pr141(n,γ)Pr142m	100.0	100.0	100.0	99.9
Pr144	17.28m	Pr141(n,γ)Pr142(n,γ)Pr143(n,γ)Pr144m(IT)Pr144	61.8	57.9	42.3	
		Pr141(n,γ)Pr142m(IT)Pr142(n,γ)Pr143(n,γ)Pr144m(IT)Pr144	17.9	22.3	42.7	
		Pr141(n,γ)Pr142(n,γ)Pr143(n,γ)Pr144	14.7	13.4	5.1	
		Pr141(n,γ)Pr142m(IT)Pr142(n,γ)Pr143(n,γ)Pr144	4.3	5.2	5.1	
		Pr141(n,γ)Pr142m(n,γ)Pr143(n,γ)Pr144m(IT)Pr144			2.1	
		Pr141(n,γ)Pr142m(IT)Pr142(β^+)Ce142(n,γ)Ce143(β^-) Pr143(n,γ)Pr144m(IT)Pr144			1.1	
		Pr141(n,γ)Pr142(β^+)Ce142(n,γ)Ce143(β^-)Pr143(n,γ) Pr144m(IT)Pr144			1.1	
Pr138m	2.12h	Pr141(n,2n)Pr140(n,2n)Pr139(n,2n)Pr138m				99.9
Pr139	4.41h	Pr141(n,2n)Pr140(n,2n)Pr139				99.9
Pr142	19.12h	Pr141(n,γ)Pr142	77.5	72.2	49.7	38.2
		Pr141(n,γ)Pr142m(IT)Pr142	22.5	27.8	50.3	61.7
La140	1.68d	Pr141(n,γ)Pr142(n,α)La139(n,γ)La140	65.4	62.9	4.0	
		Pr141(n,γ)Pr142m(IT)Pr142(n,α)La139(n,γ)La140	19.0	24.2	4.0	
		Pr141(n,α)La138(n,γ)La139(n,γ)La140	9.1	9.1	36.5	
		Pr141(n,γ)Pr142(β^-)Nd142(n,α)Ce139(β^+)La139(n,γ)La140	4.8	2.5	25.8	
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,α)Ce139(β^+) La139(n,γ)La140	1.4	1.0	26.1	
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,α)Ce139m(IT) Ce139(β^+)La139(n,γ)La140			1.6	
		Pr141(n,γ)Pr142(β^-)Nd142(n,α)Ce139m(IT)Ce139(β^+) La139(n,γ)La140			1.6	
		Pr141(n,2n)Pr140(β^+)Ce140(n,p)La140				99.3
Nd147	10.98d	Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147	77.0	64.8	49.6	
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147	22.3	24.9	50.1	
		Pr141(n,γ)Pr142(n,γ)Pr143(β^-)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147		6.5		
		Pr141(n,γ)Pr142m(IT)Pr142(n,γ)Pr143(β^-)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147		2.5		
Pr143	13.56d	Pr141(n,γ)Pr142(n,γ)Pr143	76.6	71.3	47.3	28.7
		Pr141(n,γ)Pr142m(IT)Pr142(n,γ)Pr143	22.2	27.4	47.8	46.4
		Pr141(n,γ)Pr142m(n,γ)Pr143			2.4	
		Pr141(n,γ)Pr142m(IT)Pr142(β^+)Ce142(n,γ)Ce143(β^-)Pr143			1.2	4.1
		Pr141(n,γ)Pr142(β^+)Ce142(n,γ)Ce143(β^-)Pr143			1.2	2.5
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,p)Pr143				9.6
		Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,p)Pr143				5.9
		Pr141(n,p)Ce141(n,γ)Ce142(n,γ)Ce143(β^-)Pr143				1.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Eu156	15.19d	Pr141(n,γ)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148(n,γ) Pm149(β⁻)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β⁻)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	28.4			
		Pr141(n,γ)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m(n,γ) Pm149(β⁻)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β⁻)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	25.6			
		Pr141(n,γ)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148(n,γ) Pm149(n,γ)Pm150(β⁻)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β⁻)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	9.9			
		Pr141(n,γ)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m(n,γ) Pm149(n,γ)Pm150(β⁻)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β⁻)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	9.0			
		Pr141(n,γ)Pr142m(IT)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ) Pm148(n,γ)Pm149(β⁻)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β⁻)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	8.2			
		Pr141(n,γ)Pr142m(IT)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ) Pm148m(n,γ)Pm149(β⁻)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β⁻)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	7.4			
		Pr141(n,γ)Pr142m(IT)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ) Pm148(n,γ)Pm149(n,γ)Pm150(β⁻)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β⁻)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	2.9			
		Pr141(n,γ)Pr142m(IT)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ) Pm148m(n,γ)Pm149(n,γ)Pm150(β⁻)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β⁻)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	2.6			
		Pr141(n,γ)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β⁻) Pm149(β⁻)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β⁻)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	1.7			
Ce141	32.51d	Pr141(n,γ)Pr142(β⁻)Nd142(n,γ)Nd143(n,α)Ce140(n,γ)Ce141	45.1	51.3		
		Pr141(n,γ)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ)Nd144(n,α)Ce141	29.9	14.9		
		Pr141(n,γ)Pr142m(IT)Pr142(β⁻)Nd142(n,γ)Nd143(n,α) Ce140(n,γ)Ce141	13.1	19.7		
		Pr141(n,γ)Pr142m(IT)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ) Nd144(n,α)Ce141	8.7	5.7		
		Pr141(n,γ)Pr142(β⁻)Nd142(n,α)Ce139(n,γ)Ce140(n,γ)Ce141	1.4			
		Pr141(n,γ)Pr142(n,γ)Pr143(β⁻)Nd143(n,α)Ce140(n,γ)Ce141		3.4		
		Pr141(n,γ)Pr142m(IT)Pr142(n,γ)Pr143(β⁻)Nd143(n,α) Ce140(n,γ)Ce141		1.3		
		Pr141(n,γ)Pr142(n,γ)Pr143(β⁻)Nd143(n,γ)Nd144(n,α)Ce141		1.0		
		Pr141(n,p)Ce141			100.0	98.6
		Pr141(n,2n)Pr140(β⁺)Ce140(n,γ)Ce141				1.3
Pm148m	41.06d	Pr141(n,γ)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m	76.9	63.2		
		Pr141(n,γ)Pr142m(IT)Pr142(β⁻)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m	22.3	24.3		
		Pr141(n,γ)Pr142(n,γ)Pr143(β⁻)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m		7.7		
		Pr141(n,γ)Pr142m(IT)Pr142(n,γ)Pr143(β⁻)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m		3.0		
		Pr141(n,γ)Pr142(n,γ)Pr143(n,γ)Pr144m(IT)Pr144(β⁻) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m		1.0		
Ce139	137.63d	Pr141(n,γ)Pr142(β⁻)Nd142(n,α)Ce139	77.3	71.9	46.7	
		Pr141(n,γ)Pr142m(IT)Pr142(β⁻)Nd142(n,α)Ce139	22.4	27.7	47.2	
		Pr141(n,γ)Pr142m(IT)Pr142(β⁻)Nd142(n,α)Ce139m(IT)Ce139			2.9	
		Pr141(n,γ)Pr142(β⁻)Nd142(n,α)Ce139m(IT)Ce139			2.9	
		Pr141(n,2n)Pr140(β⁺)Ce140(n,2n)Ce139m(IT)Ce139				55.0
		Pr141(n,2n)Pr140(β⁺)Ce140(n,2n)Ce139				44.4

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Cs134	2.06y	Pr141(n,α)La138(n,2n)La137(n,α)Cs134				18.2
		Pr141(n,α)La138(n,α)Cs135(n,2n)Cs134				17.7
		Pr141(n,nα)La137(n,α)Cs134				16.4
		Pr141(n,α)La138(n,nα)Cs134				6.8
		Pr141(n,α)La138(n,2n)La137(n,α)Cs134m(IT)Cs134				4.2
		Pr141(n,nα)La137(n,α)Cs134m(IT)Cs134				3.8
		Pr141(n,α)La138(n,nα)Cs134m(IT)Cs134				3.4
		Pr141(n,α)La138(n,α)Cs135m(IT)Cs135(n,2n)Cs134				2.9
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139m(IT)Ce139(β^+) La139(n,2n)La138(n,2n)La137(n,α)Cs134				1.6
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139m(IT)Ce139(β^+) La139(n,2n)La138(n,α)Cs135(n,2n)Cs134				1.5
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139(β^+)La139(n,2n) La138(n,2n)La137(n,α)Cs134				1.3
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139(β^+)La139(n,2n) La138(n,α)Cs135(n,2n)Cs134				1.2
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139m(IT)Ce139(β^+) La139(n,2n)La138(n,nα)Cs134				1.1
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139m(IT)Ce139(n,2n) Ce138(n,2n)Ce137m(IT)Ce137(β^+)La137(n,α)Cs134				1.1
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139m(IT)Ce139(β^+) La139(n,nα)Cs135(n,2n)Cs134				1.1
Pm147	2.62y	Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	76.9	63.6	49.6	
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	22.3	24.5	50.1	
		Pr141(n,γ)Pr142(n,γ)Pr143(β^-)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147		7.4		
		Pr141(n,γ)Pr142m(IT)Pr142(n,γ)Pr143(β^-)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147		2.9		
Eu154	8.59y	Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	28.6			
		Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	25.8			
		Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	10.0			
		Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	9.0			
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148(n,γ)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	8.3			
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148m(n,γ)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	7.5			
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148(n,γ)Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	2.9			
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148m(n,γ)Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	2.6			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Eu154	cont.	Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β^-) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	1.7			
Ba133	10.54y	no pathways found				
H3	12.33y	Pr141(n,p)H1(n,γ)H2(n,γ)H3			99.7	
		Pr141(n,t)H3				35.3
Eu152	13.52y	Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(β^-)Eu151(n,γ)Eu152	28.3			
		Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(β^-)Eu151(n,γ)Eu152	25.5			
		Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(β^-)Eu151(n,γ)Eu152	9.9			
		Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(β^-)Eu151(n,γ)Eu152	8.9			
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148(n,γ)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(β^-) Eu151(n,γ)Eu152	8.2			
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148m(n,γ)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(β^-) Eu151(n,γ)Eu152	7.4			
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148(n,γ)Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(β^-) Eu151(n,γ)Eu152	2.9			
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148m(n,γ)Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(β^-) Eu151(n,γ)Eu152	2.6			
		Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β^-) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(β^-)Eu151(n,γ)Eu152	1.8			
Cs137	30.04y	Pr141(n,γ)Pr142(n,α)La139(n,γ)La140(n,α)Cs137	68.1			
		Pr141(n,γ)Pr142m(IT)Pr142(n,α)La139(n,γ)La140(n,α)Cs137	19.8			
		Pr141(n,α)La138(n,γ)La139(n,γ)La140(n,α)Cs137	7.2			
		Pr141(n,γ)Pr142(β^-)Nd142(n,α)Ce139(β^+)La139(n,γ) La140(n,α)Cs137	3.2			
		Pr141(n,2n)Pr140(β^+)Ce140(n,α)Ba137m(IT)Ba137(n,p)Cs137				52.5
		Pr141(n,2n)Pr140(β^+)Ce140(n,α)Ba137(n,p)Cs137				45.4

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sm151	89.98y	Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	28.6			
		Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	25.7			
		Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151	10.0			
		Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151	9.0			
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148(n,γ)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	8.3			
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148m(n,γ)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	7.5			
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148(n,γ)Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151	2.9			
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148m(n,γ)Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151	2.6			
		Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β^-) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	1.9			
Ho166m	1.2 10^3y	no pathways found				
La137	6.0 10^4y	Pr141(n,α)La138(n,2n)La137				45.5
		Pr141(n,nα)La137				28.9
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139m(IT)Ce139(β^+) La139(n,2n)La138(n,2n)La137				7.0
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139(β^+)La139(n,2n) La138(n,2n)La137				5.6
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139m(IT)Ce139(n,2n) Ce138(n,2n)Ce137m(IT)Ce137(β^+)La137				4.1
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139(n,2n)Ce138(n,2n) Ce137m(IT)Ce137(β^+)La137				3.3
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139m(IT)Ce139(n,2n) Ce138(n,2n)Ce137(β^+)La137				2.9
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139(n,2n)Ce138(n,2n) Ce137(β^+)La137				2.4
Cs135	2.3 10^6y	Pr141(n,α)La138(n,α)Cs135	100.0	100.0	99.4	59.6
		Pr141(n,α)La138(n,α)Cs135m(IT)Cs135				9.7
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139m(IT)Ce139(β^+) La139(n,2n)La138(n,α)Cs135				9.1
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139(β^+)La139(n,2n) La138(n,α)Cs135				7.4
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139m(IT)Ce139(β^+) La139(n,nα)Cs135				5.4
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139(β^+)La139(n,nα)Cs135				4.3
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139m(IT)Ce139(β^+) La139(n,2n)La138(n,α)Cs135m(IT)Cs135				1.5
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139(β^+)La139(n,2n) La138(n,α)Cs135m(IT)Cs135				1.2
La138	1.0 10^{11}y	Pr141(n,α)La138	100.0	100.0	100.0	60.9
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139m(IT)Ce139(β^+) La139(n,2n)La138				21.4
		Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139(β^+)La139(n,2n)La138				17.3

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sm147	1.1 10^{11}y	Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(β^-)Sm147	76.8	62.3	49.6	
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(β^-)Sm147	22.3	24.0	50.2	
		Pr141(n,γ)Pr142(n,γ)Pr143(β^-)Nd143(n,γ)Nd144(n,γ) Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(β^-)Sm147		8.3		
		Pr141(n,γ)Pr142m(IT)Pr142(n,γ)Pr143(β^-)Nd143(n,γ) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(β^-)Sm147		3.2		
		Pr141(n,γ)Pr142(n,γ)Pr143(n,γ)Pr144m(IT)Pr144(β^-) Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(β^-)Sm147		1.2		
Nd144	2.3 10^{15}y	Pr141(n,γ)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144	77.2	67.7	49.6	35.6
		Pr141(n,γ)Pr142m(IT)Pr142(β^-)Nd142(n,γ)Nd143(n,γ)Nd144	22.4	26.0	50.2	57.4
		Pr141(n,γ)Pr142(n,γ)Pr143(β^-)Nd143(n,γ)Nd144		4.2		
		Pr141(n,γ)Pr142m(IT)Pr142(n,γ)Pr143(β^-)Nd143(n,γ)Nd144		1.6		
		Pr141(n,γ)Pr142m(IT)Pr142(n,γ)Pr143(n,γ)Pr144m(IT) Pr144(β^-)Nd144				2.9
		Pr141(n,γ)Pr142(n,γ)Pr143(n,γ)Pr144m(IT)Pr144(β^-)Nd144				1.8

Neodymium

Isotope	Atom % abundance	
Nd142	27.20	
Nd143	12.20	
Nd144	23.80	($T_{1/2}$ =2.3 10^{15}y)
Nd145	8.30	
Nd146	17.20	
Nd148	5.70	($T_{1/2}$ =2.7 10^{18}y)
Nd150	5.60	($T_{1/2}$ =2.1 10^{19}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	4.92E+14	4.24E+14	1.16E+14	2.06E+13	1.10E+11	3.98E+03
Nd141	28.1	31.9				
Pm149	14.5	16.8	20.3			
Nd149	14.5	16.3				
Nd147	14.1	16.4	47.6			
Nd141m	11.6	0.4				
Pm147	5.2	6.0	22.1	98.2		
Nd151	3.8	3.3				
Pm151	3.8	4.4	1.9			
Pm148	1.4	1.7	3.9			
Pm148m	0.6	0.7	2.4			
Sm151		0.1	0.2	1.1	100.0	
Sm146						45.2
La137						31.8
Sm147						20.7
Gd150						2.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.81E-02	2.96E-02	7.51E-03	2.13E-04	3.53E-07	1.09E-12
Nd149	26.2	32.5				
Nd141m	18.2	0.6				
Nd147	11.9	15.3	47.9			
Nd151	11.5	11.1				
Pm149	11.4	14.6	19.0			
Nd141	5.5	6.9				
Pm151	5.0	6.4	3.0			
Pm148	3.9	5.0	12.5			
Pm148m	2.7	3.5	12.9	1.0		
Pr142	1.1	1.5	0.2			
Pm147	0.7	0.9	3.4	94.1		
Pm146			0.1	3.1		
Ce139			0.2	1.0		
Sm151				0.4	99.5	
Sm146						67.9
Sm147						27.9
Gd150						3.3

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.05E+04	1.12E+04	2.71E+03	1.04E+01	2.42E-03	3.26E-10
Nd141m	40.9	2.0				
Nd151	16.6	22.6				
Nd149	13.6	24.0				
Nd141	7.3	13.0				
Pm148m	5.7	10.4	40.6	23.8		
Pm148	5.3	9.7	25.4	0.5		
Nd147	4.9	8.9	29.4			
Pm151	3.6	6.6	3.2			
Pm146		0.1	0.3	64.7	1.2	
Eu154				6.6	9.7	
Eu152				2.7	72.6	
Ce139				1.6		
Eu150					13.6	
Sm151					2.8	
La137						97.0
La138						3.0

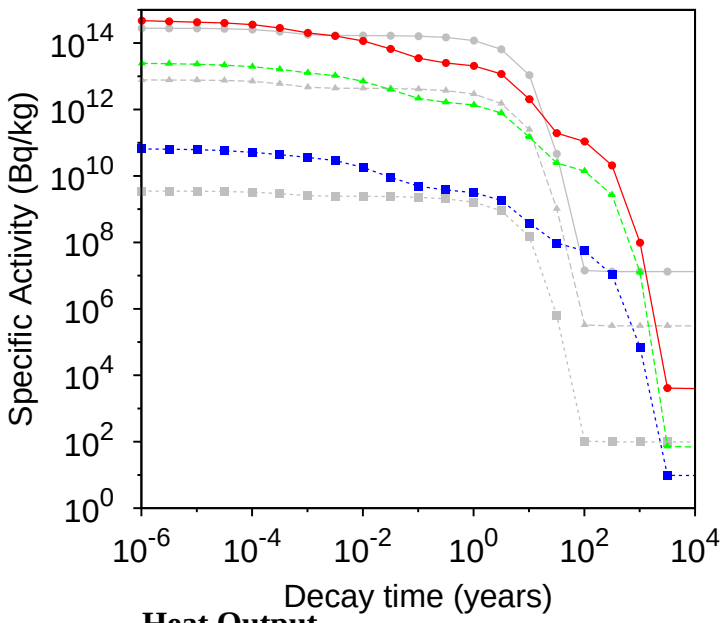
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.09E+05	2.08E+05	1.11E+05	5.37E+03	1.08E+01	1.42E-04
Nd147	36.7	36.7	54.8			
Pm149	33.9	34.0	21.0			
Pm148	9.2	9.2	11.0			
Pm151	6.6	6.6	1.5			
Nd149	4.1	4.0				
Pm147	3.2	3.2	6.0	98.0		
Pm148m	2.4	2.4	4.3	0.2		
Pr142	1.9	1.9	0.2			
Sm151				0.4	99.9	
Sm146						68.2
Sm147						28.3
Gd150						3.0

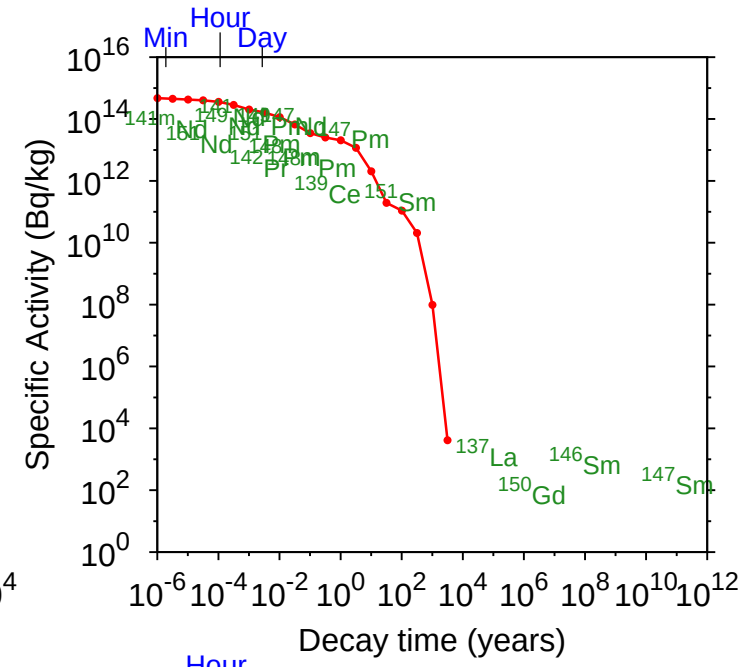
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.04E+05	4.04E+05	3.11E+05	1.03E+05	4.42E+02	3.44E-02
Nd147	41.3	41.3	42.6			
Pm147	31.6	31.6	41.2	97.7		
Pm149	12.9	12.9	5.5			
Pm148m	4.2	4.2	5.1			
Pm148	3.9	3.9	3.2			
Pm151	2.1	2.1	0.3			
Nd149	1.6	1.5				
Sm151	0.2	0.2	0.3	0.9	99.9	
Sm146						57.5
Sm147						22.9
Gd150						19.5

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	8.98E+10	4.47E+10	1.05E+10	1.74E+08	1.84E+05	8.79E-01
Nd141m	45.3	2.4				
Nd151	19.1	28.6				
Nd141	11.8	23.3				
Pm151	7.5	15.1	7.6			
Pm148m	6.6	13.3	53.2	7.2		
Pm148	5.3	10.6	28.5	0.1		
Nd147	0.8	1.6	5.2			
Nd149	0.8	1.5				
Ce139	0.5	1.0	4.2	40.9		
Pm146		0.1	0.4	21.2	0.1	
Eu154		0.1	0.2	12.5	4.1	
Pm147		0.1	0.2	11.6		
Eu152			0.1	5.9	34.8	
Sm151				0.1	59.9	
Eu150					1.0	
Sm147						93.6
La137						3.8
Sm146						1.1
Nd144						1.1

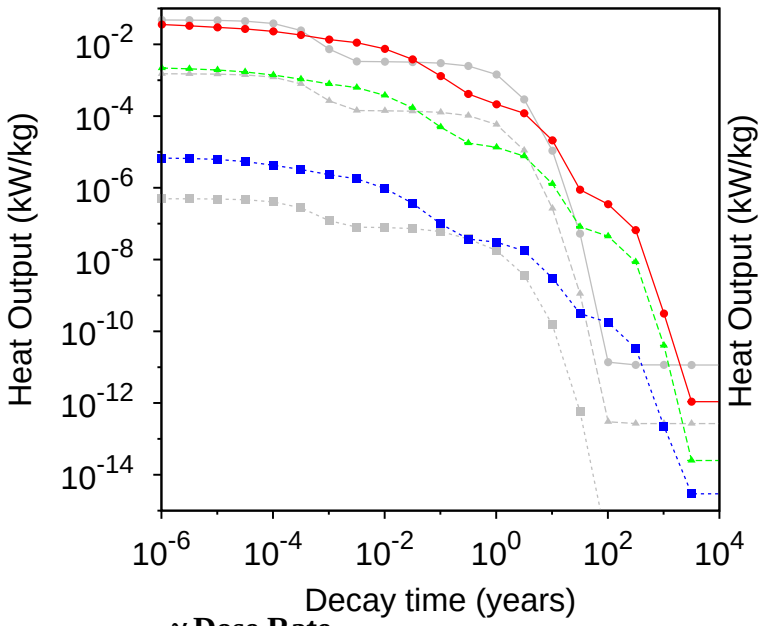
Neodymium activation characteristics

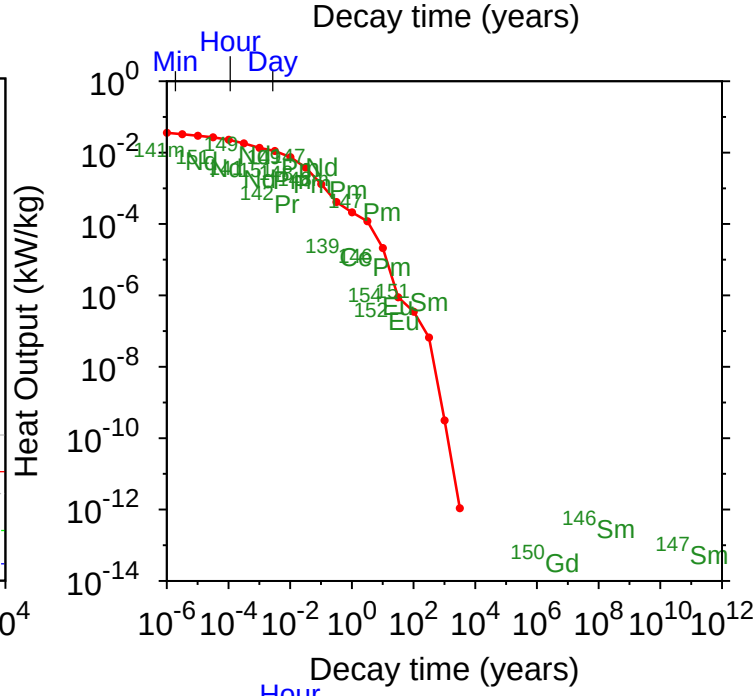
Specific Activity



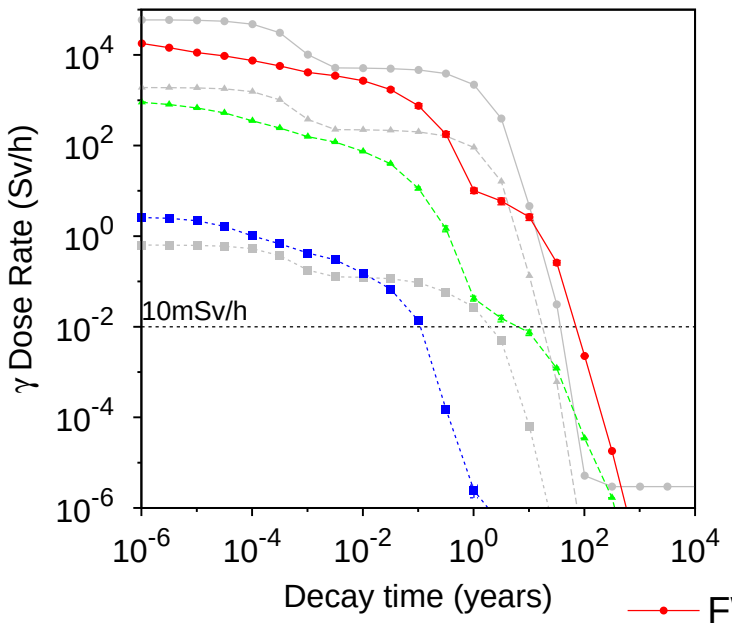


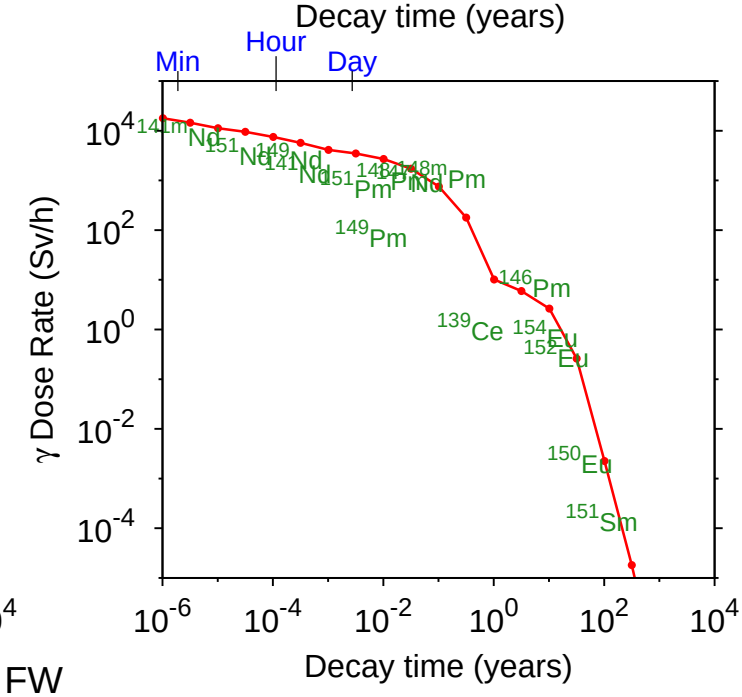
Heat Output





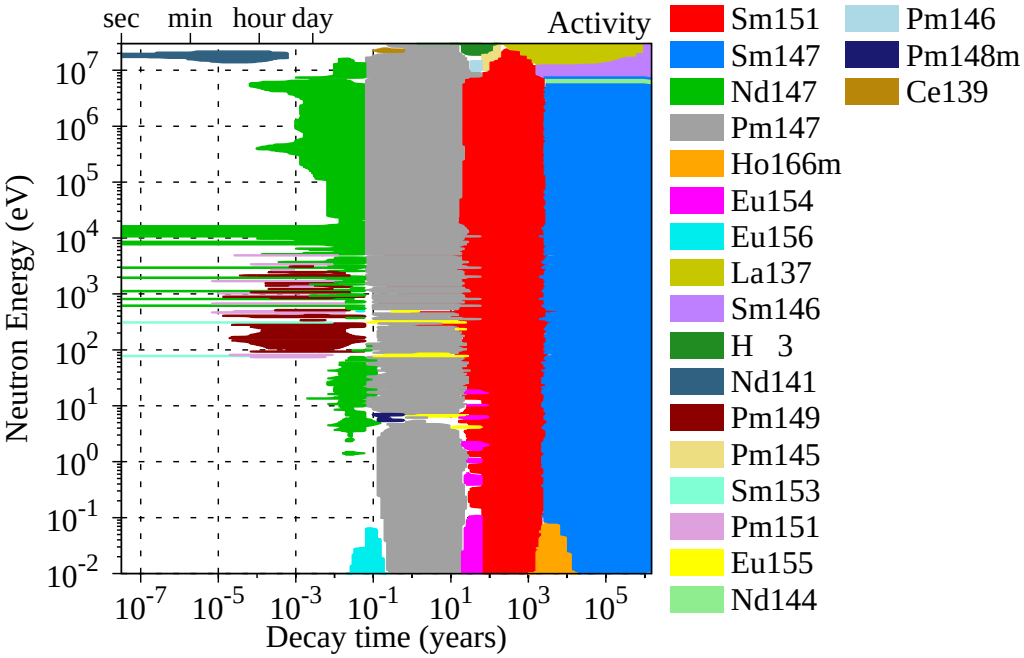
γ Dose Rate

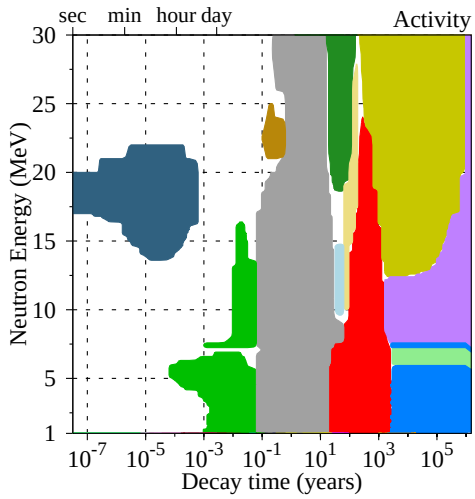


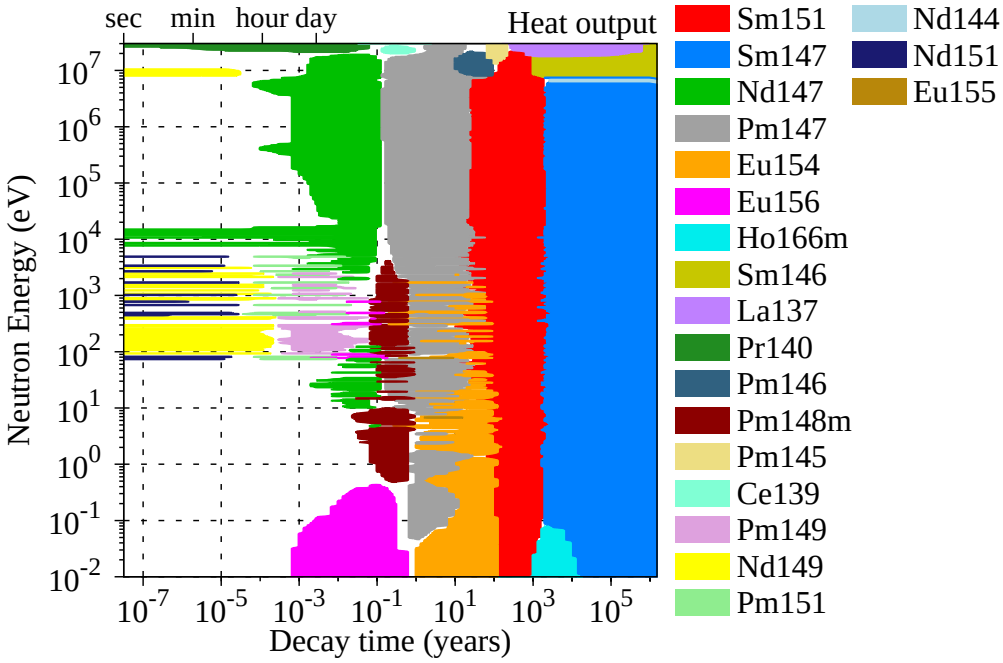


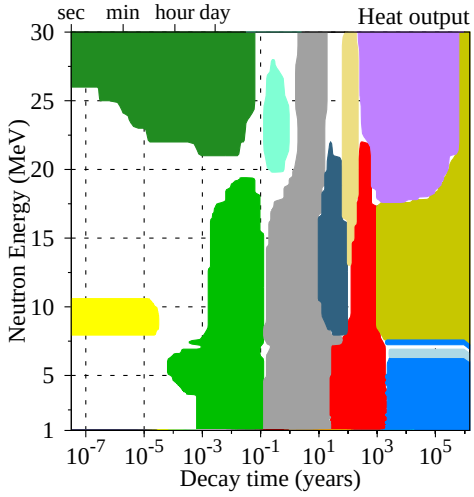
FW
Blanket
Manifold
Fe results

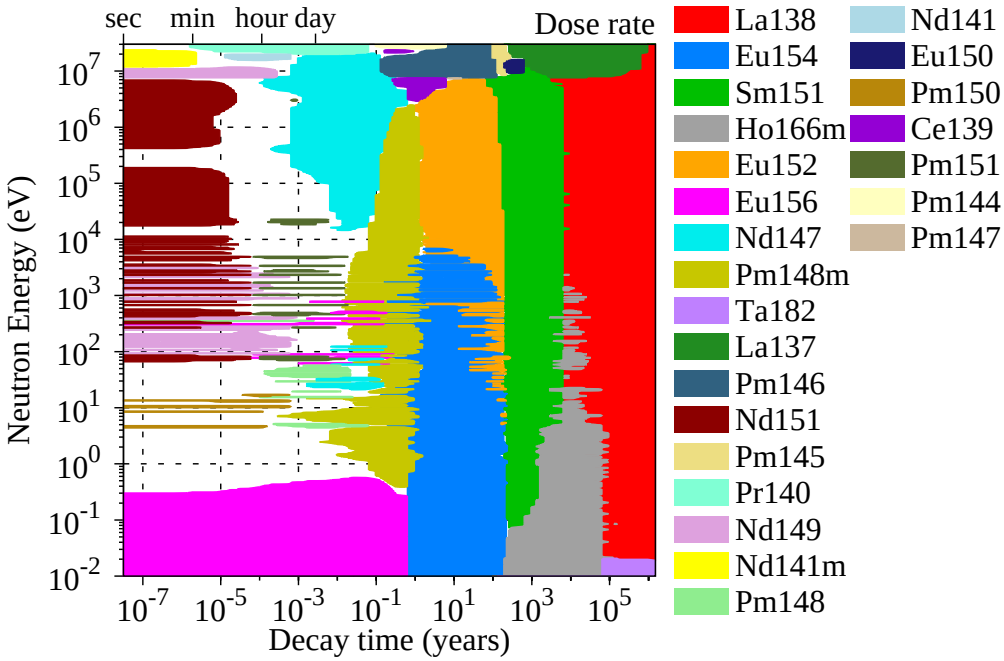
Neodymium Importance diagrams

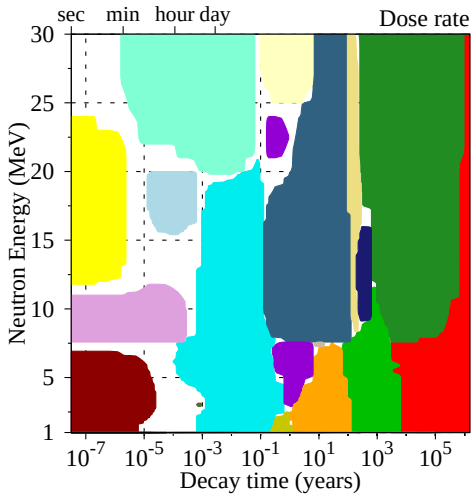




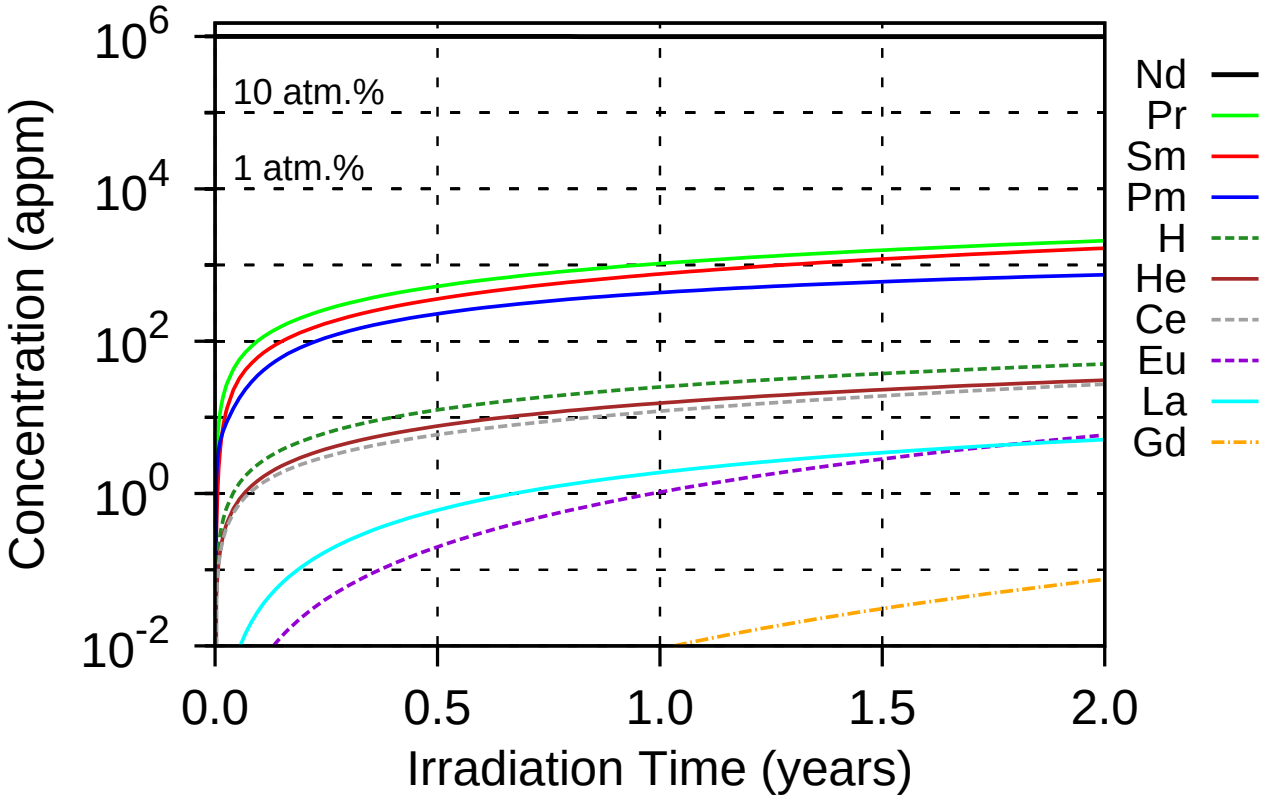




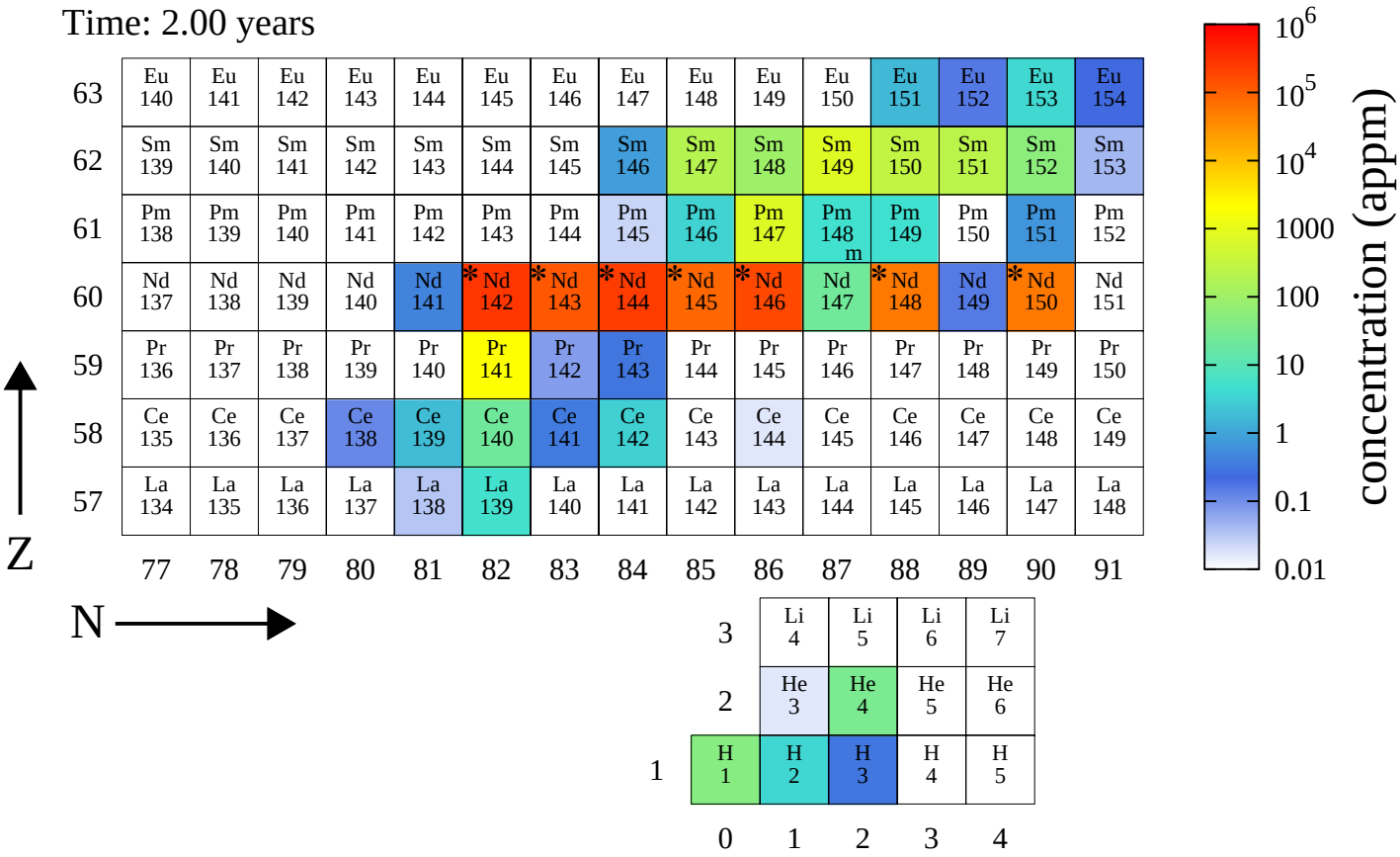




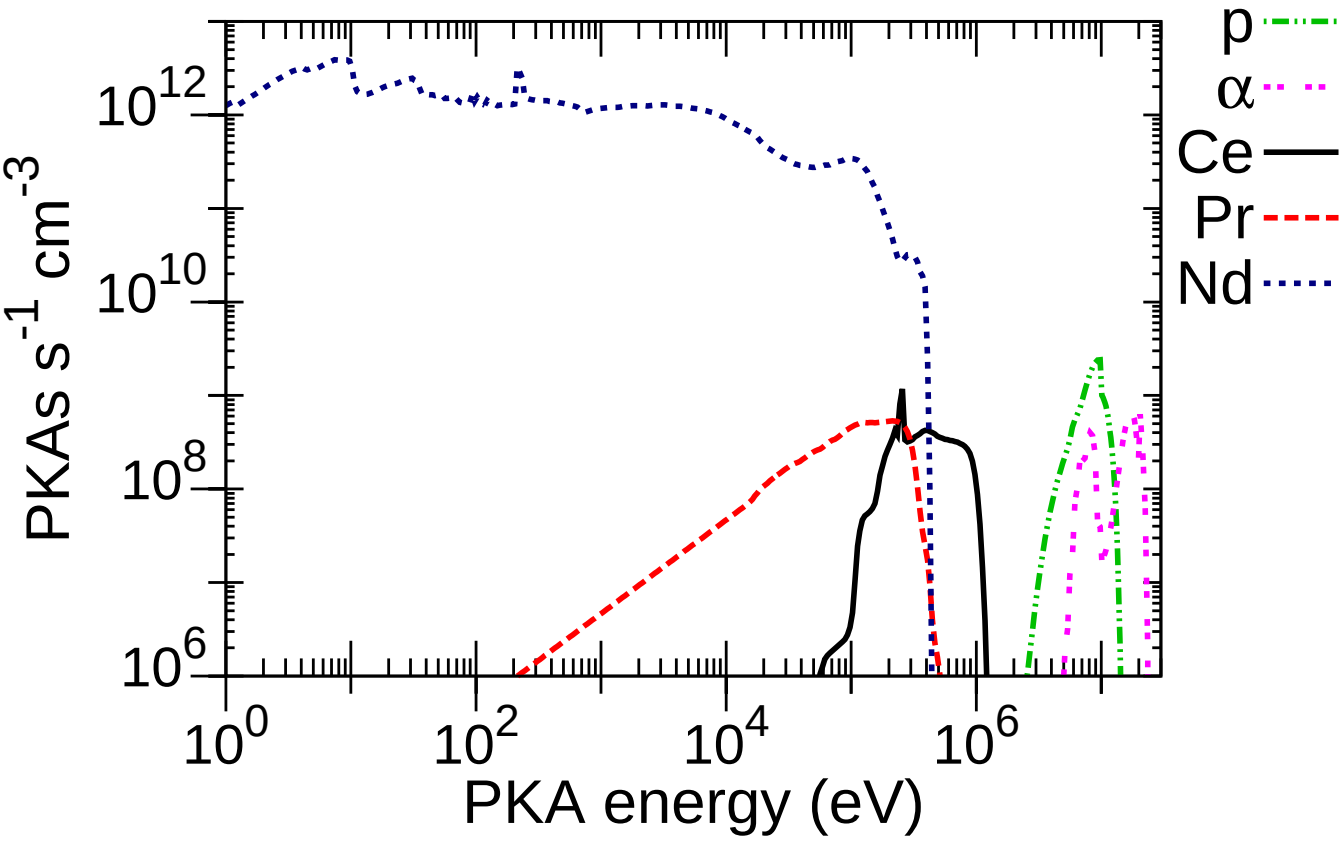
Neodymium FW Transmutation

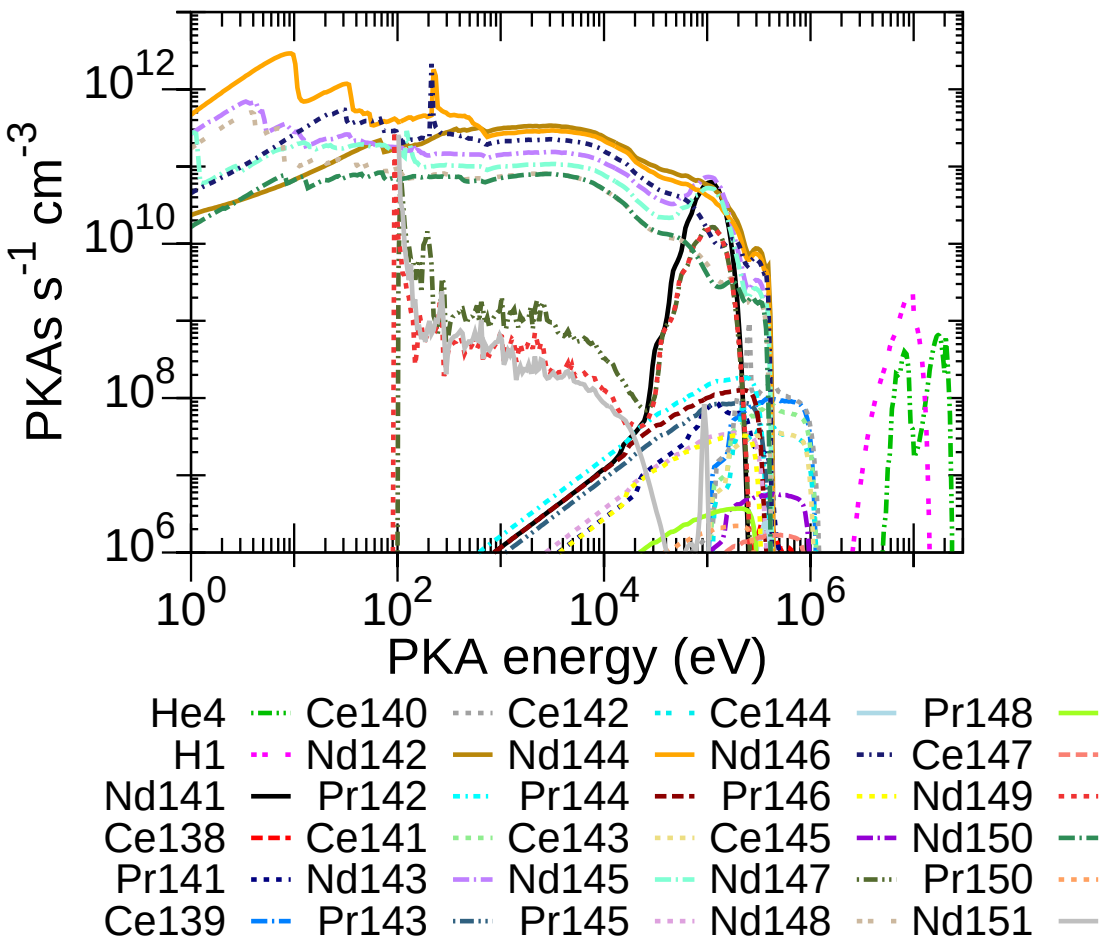


15 appm He & 25 appm H after 1 year 14 dpa/year



Neodymium FW PKA distributions





Neodymium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Nd141m	1.03m	Nd142(n,2n)Nd141m				94.8
		Nd143(n,2n)Nd142(n,2n)Nd141m				4.7
Pr140	3.39m	Nd142(n,2n)Nd141(β^+)Pr141(n,2n)Pr140				56.8
		Nd142(n,2n)Nd141m(IT)Nd141(β^+)Pr141(n,2n)Pr140				40.0
		Nd143(n,2n)Nd142(n,2n)Nd141(β^+)Pr141(n,2n)Pr140				1.4
		Nd143(n,2n)Nd142(n,2n)Nd141m(IT)Nd141(β^+) Pr141(n,2n)Pr140				1.0
Nd151	12.44m	Nd150(n,γ)Nd151	100.0	100.0	100.0	100.0
Nd149	1.73h	Nd148(n,γ)Nd149	88.0	100.0	100.0	
		Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149	8.3			
		Nd145(n,γ)Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149	2.7			
		Nd150(n,2n)Nd149				99.9
Nd141	2.49h	Nd142(n,2n)Nd141				55.6
		Nd142(n,2n)Nd141m(IT)Nd141				39.2
		Nd143(n,2n)Nd142(n,2n)Nd141				2.7
		Nd143(n,2n)Nd142(n,2n)Nd141m(IT)Nd141				1.9
Pm150	2.68h	Nd148(n,γ)Nd149(β^-)Pm149(n,γ)Pm150	40.1	99.9	100.0	
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(n,γ)Pm150	16.6			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(n,γ)Pm150	14.7			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(n,γ)Pm150	7.5			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(n,γ)Pm150	6.7			
		Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β^-)Pm149(n,γ)Pm150	3.7			
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148(n,γ)Pm149(n,γ)Pm150	2.6			
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148m(n,γ)Pm149(n,γ)Pm150	2.3			
		Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-) Pm147(n,γ)Pm148(n,γ)Pm149(n,γ)Pm150	1.2			
		Nd145(n,γ)Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β^-) Pm149(n,γ)Pm150	1.2			
		Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-) Pm147(n,γ)Pm148m(n,γ)Pm149(n,γ)Pm150	1.1			
Pr142	19.12h	Nd144(n,α)Ce141(β^-)Pr141(n,γ)Pr142	22.9	70.9	49.4	
		Nd143(n,α)Ce140(n,γ)Ce141(β^-)Pr141(n,γ)Pr142	17.5	1.1		
		Nd142(n,γ)Nd143(n,α)Ce140(n,γ)Ce141(β^-)Pr141(n,γ)Pr142	15.2			
		Nd143(n,γ)Nd144(n,α)Ce141(β^-)Pr141(n,γ)Pr142	11.3			
		Nd142(n,γ)Nd143(n,γ)Nd144(n,α)Ce141(β^-)Pr141(n,γ)Pr142	10.1			
		Nd144(n,α)Ce141(β^-)Pr141(n,γ)Pr142m(IT)Pr142	6.7	27.2	50.0	
		Nd143(n,α)Ce140(n,γ)Ce141(β^-)Pr141(n,γ)Pr142m(IT)Pr142	5.1			
		Nd142(n,γ)Nd143(n,α)Ce140(n,γ)Ce141(β^-)Pr141(n,γ) Pr142m(IT)Pr142	4.4			
		Nd143(n,γ)Nd144(n,α)Ce141(β^-)Pr141(n,γ)Pr142m(IT)Pr142	3.3			
		Nd142(n,γ)Nd143(n,γ)Nd144(n,α)Ce141(β^-)Pr141(n,γ) Pr142m(IT)Pr142	2.9			
		Nd142(n,p)Pr142m(IT)Pr142				78.3
		Nd142(n,p)Pr142				11.6
		Nd143(n,2n)Nd142(n,p)Pr142m(IT)Pr142				3.8
		Nd143(n,d)Pr142m(IT)Pr142				1.5
		Nd143(n,np)Pr142m(IT)Pr142				1.4
Pm151	1.18d	Nd150(n,γ)Nd151(β^-)Pm151	99.9	100.0	100.0	99.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sm153	1.93d	Nd148(n,γ)Nd149(β⁻)Pm149(β⁻)Sm149(n,γ)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153	26.9			
		Nd150(n,γ)Nd151(β⁻)Pm151(β⁻)Sm151(n,γ)Sm152(n,γ)Sm153	14.4			
		Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148(n,γ)Pm149(β⁻) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	10.9			
		Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m(n,γ)Pm149(β⁻) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	9.6			
		Nd148(n,γ)Nd149(β⁻)Pm149(n,γ)Pm150(β⁻)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153	9.4			
		Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148(n,γ) Pm149(β⁻)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	4.3			
		Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m(n,γ) Pm149(β⁻)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	3.8			
		Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148(n,γ)Pm149(n,γ) Pm150(β⁻)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	3.8			
		Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m(n,γ)Pm149(n,γ) Pm150(β⁻)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	3.4			
		Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β⁻)Pm149(β⁻) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	1.8			
		Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148(n,γ) Pm149(n,γ)Pm150(β⁻)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	1.5			
		Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m(n,γ) Pm149(n,γ)Pm150(β⁻)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	1.3			
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ) Pm148(n,γ)Pm149(β⁻)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153	1.1			
		Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148(β⁻)Sm148(n,γ) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	1.1			
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ) Pm148m(n,γ)Pm149(β⁻)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153	1.0			
		Nd150(n,γ)Nd151(β⁻)Pm151(n,γ)Pm152(β⁻)Sm152(n,γ)Sm153			1.2	
Pm149	2.21d	Nd148(n,γ)Nd149(β⁻)Pm149	40.1	99.9	100.0	
		Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148(n,γ)Pm149	16.6			
		Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m(n,γ)Pm149	14.7			
		Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148(n,γ)Pm149	7.5			
		Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m(n,γ)Pm149	6.7			
		Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β⁻)Pm149	3.7			
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ) Pm148(n,γ)Pm149	2.6			
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ) Pm148m(n,γ)Pm149	2.3			
		Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻) Pm147(n,γ)Pm148(n,γ)Pm149	1.2			
		Nd145(n,γ)Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β⁻)Pm149	1.2			
		Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻) Pm147(n,γ)Pm148m(n,γ)Pm149	1.1			
		Nd150(n,2n)Nd149(β⁻)Pm149				99.9
Pm148	5.37d	Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148	57.5	95.5	95.5	
		Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148	26.1			
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148	9.2			
		Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β⁻) Pm147(n,γ)Pm148	4.3			
		Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ) Nd147(β⁻)Pm147(n,γ)Pm148	2.8			
		Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m(IT)Pm148		2.1	2.7	
		Nd146(n,γ)Nd147(β⁻)Pm147(n,γ)Pm148m(n,E)Pm148		1.7	1.2	
		Nd150(n,2n)Nd149(β⁻)Pm149(n,2n)Pm148				76.9
		Nd148(n,2n)Nd147(β⁻)Pm147(n,γ)Pm148				8.1
		Nd150(n,2n)Nd149(β⁻)Pm149(β⁻)Sm149(n,2n)Sm148(n,p)Pm148				4.5
		Nd150(n,2n)Nd149(β⁻)Pm149(β⁻)Sm149(n,d)Pm148				4.3
		Nd150(n,2n)Nd149(β⁻)Pm149(β⁻)Sm149(n,np)Pm148				3.1
		Nd150(n,2n)Nd149(β⁻)Pm149(n,2n)Pm148m(IT)Pm148				1.8

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Nd147	10.98d	Nd146(n,γ)Nd147	55.5	98.8	99.9	
		Nd145(n,γ)Nd146(n,γ)Nd147	25.8	1.2		
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147	10.3			
		Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147	4.9			
		Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147	3.5			
		Nd148(n,2n)Nd147				99.1
Eu156	15.19d	Nd148(n,γ)Nd149(β^-)Pm149(β^-)Sm149(n,γ)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ) Eu155(n,γ)Eu156	27.1			
		Nd150(n,γ)Nd151(β^-)Pm151(β^-)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	14.5			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	10.8			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	9.5			
		Nd148(n,γ)Nd149(β^-)Pm149(n,γ)Pm150(β^-)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ) Eu155(n,γ)Eu156	9.5			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	4.0			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(n,γ) Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	3.8			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	3.5			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(n,γ) Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	3.3			
		Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β^-)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	1.6			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	1.4			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	1.2			
Pm148m	41.06d	Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m	57.5	99.4	99.9	
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m	26.1			
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m	9.2			
		Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-) Pm147(n,γ)Pm148m	4.3			
		Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ) Nd147(β^-)Pm147(n,γ)Pm148m	2.8			
		Nd150(n,2n)Nd149(β^-)Pm149(n,2n)Pm148m				79.7
		Nd148(n,2n)Nd147(β^-)Pm147(n,γ)Pm148m				8.0
		Nd150(n,2n)Nd149(β^-)Pm149(β^-)Sm149(n,d)Pm148m				4.5
		Nd150(n,2n)Nd149(β^-)Pm149(β^-)Sm149(n,2n)Sm148(n,p)Pm148m				4.3
		Nd150(n,2n)Nd149(β^-)Pm149(β^-)Sm149(n,np)Pm148m				3.3
Ta182	114.71d	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ce139	137.63d	Nd142(n,α)Ce139	99.7	99.6	93.8	21.7
		Nd142(n,α)Ce139m(IT)Ce139			5.8	28.0
		Nd142(n,2n)Nd141(β^+)Pr141(n,2n)Pr140(β^+)Ce140(n,2n) Ce139m(IT)Ce139				13.4
		Nd142(n,2n)Nd141(β^+)Pr141(n,2n)Pr140(β^+)Ce140(n,2n)Ce139				10.8
		Nd142(n,2n)Nd141m(IT)Nd141(β^+)Pr141(n,2n)Pr140(β^+) Ce140(n,2n)Ce139m(IT)Ce139				9.4
		Nd142(n,2n)Nd141m(IT)Nd141(β^+)Pr141(n,2n)Pr140(β^+) Ce140(n,2n)Ce139				7.6
		Nd143(n,α)Ce140(n,2n)Ce139m(IT)Ce139				1.9
		Nd143(n,α)Ce140(n,2n)Ce139				1.5
		Nd143(n,2n)Nd142(n,α)Ce139m(IT)Ce139				1.0
Pm144	363.01d	Nd148(n,2n)Nd147(β^-)Pm147(n,2n)Pm146(n,2n) Pm145(n,2n)Pm144				79.5
		Nd148(n,2n)Nd147(β^-)Pm147(n,3n)Pm145(n,2n)Pm144				9.8
		Nd148(n,2n)Nd147(β^-)Pm147(n,2n)Pm146(n,3n)Pm144				7.9
Pm147	2.62y	Nd146(n,γ)Nd147(β^-)Pm147	57.5	99.3	99.9	
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	26.1			
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	9.2			
		Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147	4.4			
		Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ) Nd147(β^-)Pm147	2.8			
		Nd148(n,2n)Nd147(β^-)Pm147				99.3
Eu155	4.75y	Nd148(n,γ)Nd149(β^-)Pm149(β^-)Sm149(n,γ)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155	26.8			
		Nd150(n,γ)Nd151(β^-)Pm151(β^-)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155	14.4			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155	10.7			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155	9.5			
		Nd148(n,γ)Nd149(β^-)Pm149(n,γ)Pm150(β^-)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155	9.4			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155	4.0			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(n,γ) Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155	3.7			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155	3.6			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(n,γ) Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155	3.3			
		Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β^-)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155	1.6			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155	1.4			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155	1.2			
		Nd150(n,γ)Nd151(β^-)Pm151(n,γ)Pm152(β^-)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155			2.8	
Pm146	5.53y	Nd148(n,2n)Nd147(β^-)Pm147(n,2n)Pm146				99.4

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Eu154	8.59y	Nd148(n,γ)Nd149(β^-)Pm149(β^-)Sm149(n,γ)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	27.5			
		Nd150(n,γ)Nd151(β^-)Pm151(β^-)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	14.7			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154	11.0			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154	9.7			
		Nd148(n,γ)Nd149(β^-)Pm149(n,γ)Pm150(β^-)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	9.6			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	4.1			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(n,γ) Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154	3.8			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	3.7			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(n,γ) Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154	3.4			
		Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β^-)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154	1.7			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	1.4			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	1.3			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(β^-)Sm148(n,γ) Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154	1.0			
		Nd150(n,γ)Nd151(β^-)Pm151(n,γ)Pm152(β^-)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154			2.2	
H3	12.33y	Nd143(n,t)H3				56.3
		Nd145(n,t)H3				22.1
		Nd144(n,2n)Nd143(n,t)H3				5.7
		Nd144(n,t)H3				1.4
		Nd146(n,2n)Nd145(n,t)H3				2.4
		Nd146(n,t)H3				1.8
		Nd148(n,2n)Nd147(β^-)Pm147(n,t)H3				1.7
		Nd150(n,2n)Nd149(β^-)Pm149(β^-)Sm149(n,t)H3				1.0
Eu152	13.52y	Nd150(n,γ)Nd151(β^-)Pm151(β^-)Sm151(β^-)Eu151(n,γ)Eu152				73.0
		Nd150(n,γ)Nd151(β^-)Pm151(β^-)Sm151(β^-)Eu151(n,γ) Eu152n(IT)Eu152				26.9
Pm145	17.70y	Nd148(n,2n)Nd147(β^-)Pm147(n,2n)Pm146(n,2n)Pm145				87.6
		Nd148(n,2n)Nd147(β^-)Pm147(n,3n)Pm145				8.6
Eu150	36.36y	Nd150(n,γ)Nd151(β^-)Pm151(β^-)Sm151(β^-)Eu151(n,2n)Eu150				100.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sm151	89.98y	Nd148(n,γ)Nd149(β^-)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	26.4			
		Nd150(n,γ)Nd151(β^-)Pm151(β^-)Sm151	14.2	99.9	100.0	100.0
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151	10.8			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151	9.5			
		Nd148(n,γ)Nd149(β^-)Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151	9.2			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	4.5			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	4.0			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ)Pm149(n,γ) Pm150(β^-)Sm150(n,γ)Sm151	3.8			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ)Pm149(n,γ) Pm150(β^-)Sm150(n,γ)Sm151	3.3			
		Nd146(n,γ)Nd147(n,γ)Nd148(n,γ)Nd149(β^-)Pm149(β^-) Sm149(n,γ)Sm150(n,γ)Sm151	2.0			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151	1.6			
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148m(n,γ) Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151	1.4			
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148(n,γ)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	1.3			
		Nd146(n,γ)Nd147(β^-)Pm147(n,γ)Pm148(β^-)Sm148(n,γ) Sm149(n,γ)Sm150(n,γ)Sm151	1.2			
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(n,γ) Pm148m(n,γ)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	1.1			
Ho166m	1.2 10^3y	no pathways found				
La137	6.0 10^4y	Nd142(n,α)Ce139m(IT)Ce139(β^+)La139(n,2n)La138(n,2n)La137				13.2
		Nd142(n,α)Ce139(β^+)La139(n,2n)La138(n,2n)La137				10.2
		Nd142(n,2n)Nd141(β^+)Pr141(n,α)La138(n,2n)La137				9.8
		Nd142(n,2n)Nd141(β^+)Pr141(n,nα)La137				9.3
		Nd142(n,nα)Ce138(n,2n)Ce137m(IT)Ce137(β^+)La137				9.3
		Nd142(n,2n)Nd141m(IT)Nd141(β^+)Pr141(n,α)La138(n,2n)La137				6.9
		Nd142(n,nα)Ce138(n,2n)Ce137(β^+)La137				6.6
		Nd142(n,2n)Nd141m(IT)Nd141(β^+)Pr141(n,nα)La137				6.6
		Nd142(n,α)Ce139m(IT)Ce139(n,2n)Ce138(n,2n)Ce137m(IT) Ce137(β^+)La137				6.0
		Nd142(n,α)Ce139(n,2n)Ce138(n,2n)Ce137m(IT)Ce137(β^+)La137				4.6
		Nd142(n,α)Ce139m(IT)Ce139(n,2n)Ce138(n,2n)Ce137(β^+)La137				4.3
		Nd142(n,α)Ce139(n,2n)Ce138(n,2n)Ce137(β^+)La137				3.3
Gd150	1.8 10^6y	Nd150(n,γ)Nd151(β^-)Pm151(β^-)Sm151(β^-)Eu151(n,2n) Eu150m(β^-)Gd150				99.2
Sm146	1.0 10^8y	Nd148(n,2n)Nd147(β^-)Pm147(n,2n)Pm146(β^-)Sm146				12.6
La138	1.0 10^{11}y	Nd144(n,α)Ce141(β^-)Pr141(n,α)La138	32.3	98.7	99.6	
		Nd143(n,α)Ce140(n,γ)Ce141(β^-)Pr141(n,α)La138	23.6	1.0		
		Nd142(n,γ)Nd143(n,α)Ce140(n,γ)Ce141(β^-)Pr141(n,α)La138	16.7			
		Nd143(n,γ)Nd144(n,α)Ce141(β^-)Pr141(n,α)La138	15.6			
		Nd142(n,γ)Nd143(n,γ)Nd144(n,α)Ce141(β^-)Pr141(n,α)La138	11.2			
		Nd142(n,α)Ce139m(IT)Ce139(β^+)La139(n,2n)La138				30.1
		Nd142(n,α)Ce139(β^+)La139(n,2n)La138				23.3
		Nd142(n,2n)Nd141(β^+)Pr141(n,α)La138				19.0
		Nd142(n,2n)Nd141m(IT)Nd141(β^+)Pr141(n,α)La138				13.4
		Nd142(n,2n)Nd141(β^+)Pr141(n,2n)Pr140(β^+)Ce140(n,2n) Ce139m(IT)Ce139(β^+)La139(n,2n)La138				2.9
		Nd142(n,2n)Nd141(β^+)Pr141(n,2n)Pr140(β^+)Ce140(n,2n) Ce139(β^+)La139(n,2n)La138				2.3
		Nd142(n,2n)Nd141m(IT)Nd141(β^+)Pr141(n,2n)Pr140(β^+) Ce140(n,2n)Ce139m(IT)Ce139(β^+)La139(n,2n)La138				2.0
		Nd142(n,2n)Nd141m(IT)Nd141(β^+)Pr141(n,2n)Pr140(β^+) Ce140(n,2n)Ce139(β^+)La139(n,2n)La138				1.7

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sm147	1.1 10^{11}y	Nd146(n,γ)Nd147(β^-)Pm147(β^-)Sm147	64.0	99.6	100.0	
		Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(β^-)Sm147	25.0			
		Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-)Pm147(β^-)Sm147	6.5			
		Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ)Nd147(β^-) Pm147(β^-)Sm147	3.0			
		Nd142(n,γ)Nd143(n,γ)Nd144(n,γ)Nd145(n,γ)Nd146(n,γ) Nd147(β^-)Pm147(β^-)Sm147	1.6			
		Nd148(n,2n)Nd147(β^-)Pm147(β^-)Sm147				98.5
Nd144	2.3 10^{15}y	Nd142(n,γ)Nd143(n,γ)Nd144	34.6			
		Nd143(n,γ)Nd144	22.3			
		Nd145(n,2n)Nd144				3.7

Samarium

Isotope	Atom % abundance	
Sm144	3.07	
Sm147	14.99	($T_{1/2}$ =1.1 10^{11}y)
Sm148	11.24	($T_{1/2}$ =7.0 10^{15}y)
Sm149	13.82	($T_{1/2}$ =2.0 10^{15}y)
Sm150	7.38	
Sm152	26.75	
Sm154	22.75	

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.49E+15	2.46E+15	7.37E+14	7.91E+13	1.92E+12	1.46E+06
Sm153	86.9	87.9	79.2			
Sm155	5.3	4.6				
Eu156	2.7	2.7	7.7			
Eu155	1.7	1.7	5.6	45.5		
Eu154	1.4	1.4	4.7	40.0	0.6	
Pm143	0.4	0.4	1.3	4.6		
Sm151	0.2	0.2	0.6	5.1	98.7	
Sm145	0.2	0.2	0.6	2.6		
Sm146						92.1
Sm147						7.8

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.61E-01	1.57E-01	5.64E-02	8.87E-03	9.71E-06	5.97E-10
Sm153	71.3	72.9	54.7			
Eu156	11.3	11.6	27.3			
Sm155	8.9	7.7				
Eu154	5.2	5.3	14.8	86.9	27.2	
Sm143	1.1	0.8				
Eu155	0.5	0.5	1.5	8.1		
Pm143	0.3	0.3	0.9	2.1		
Eu152	0.1	0.1	0.3	1.8	10.1	
Sm151				0.1	62.0	
Sm146						92.8
Sm147						7.1

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	3.98E+04	3.87E+04	3.23E+04	1.04E+04	4.68E+00	4.07E-13
Eu156	59.8	61.4	62.2			
Eu154	26.8	27.6	33.0	95.1	72.1	
Sm153	4.7	4.8	1.6			
Sm143	2.3	1.6				
Sm143m	1.6	0.1				
Pm143	1.4	1.5	1.7	2.1		
Eu152	0.5	0.6	0.7	2.0	27.7	
La137						98.7
La138						1.3

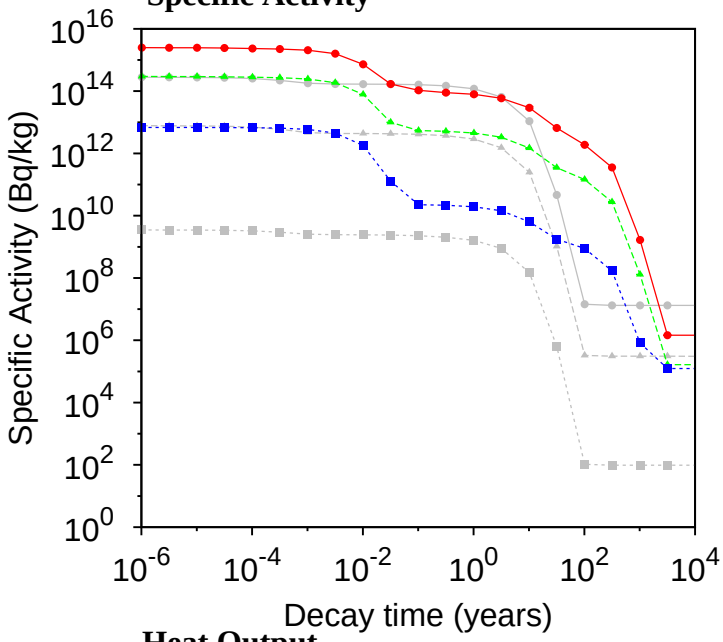
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.85E+06	1.85E+06	6.45E+05	7.79E+04	2.15E+02	7.83E-02
Sm153	86.8	86.8	66.9			
Eu156	8.0	8.0	19.4			
Eu154	3.7	3.7	10.6	81.3	10.1	
Eu155	0.7	0.7	2.1	14.8		
Eu152	0.1	0.1	0.2	1.4	3.1	
Pm143	0.1	0.1	0.3	1.1		
Sm151			0.1	0.5	86.3	
Sm146						92.8
Sm147						7.1

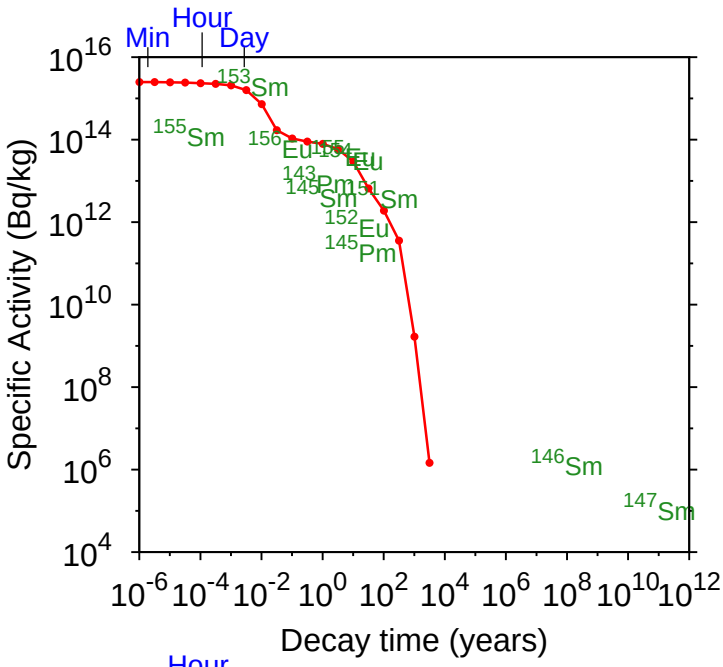
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.79E+06	3.78E+06	2.75E+06	1.99E+06	8.39E+03	1.60E+01
Eu154	48.1	48.1	66.2	84.4	6.8	
Sm153	36.1	36.0	13.4			
Eu155	7.6	7.6	10.5	12.5		
Eu156	6.0	6.0	7.0			
Eu152	0.9	0.9	1.2	1.6	2.4	
Sm151	0.4	0.4	0.6	0.8	90.2	
Sm146					0.2	92.4
Sm147						6.8

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	5.38E+11	5.29E+11	4.75E+11	3.62E+11	1.58E+08	1.22E+02
Eu154	63.8	64.9	72.1	87.5	68.5	
Eu156	16.0	16.3	15.3			
Eu155	7.7	7.9	8.7	9.9		
Sm153	4.0	4.1	1.2			
Sm155	3.9	3.4				
Eu152	1.5	1.5	1.7	2.1	30.1	
Sm143	1.1	0.8				
Sm151					1.2	
Sm147						93.8
Sm146						6.1

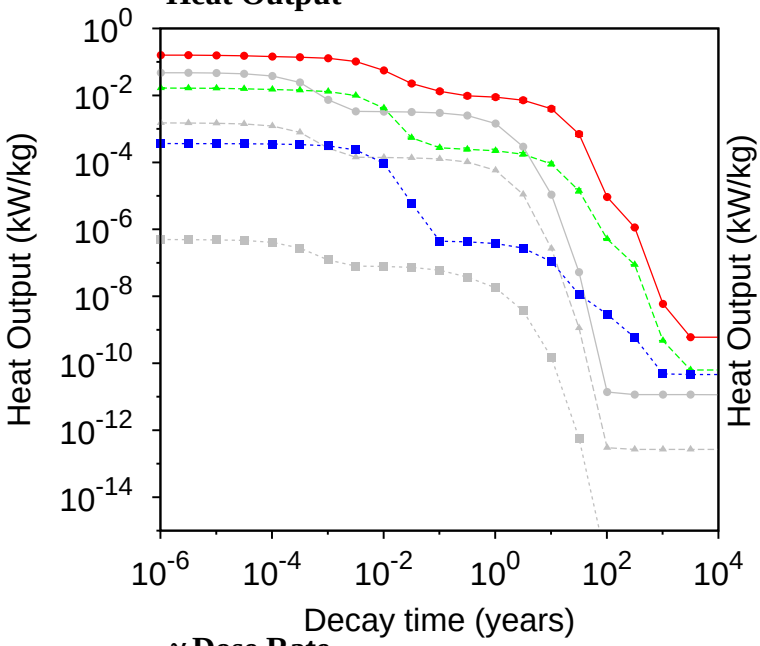
Samarium activation characteristics

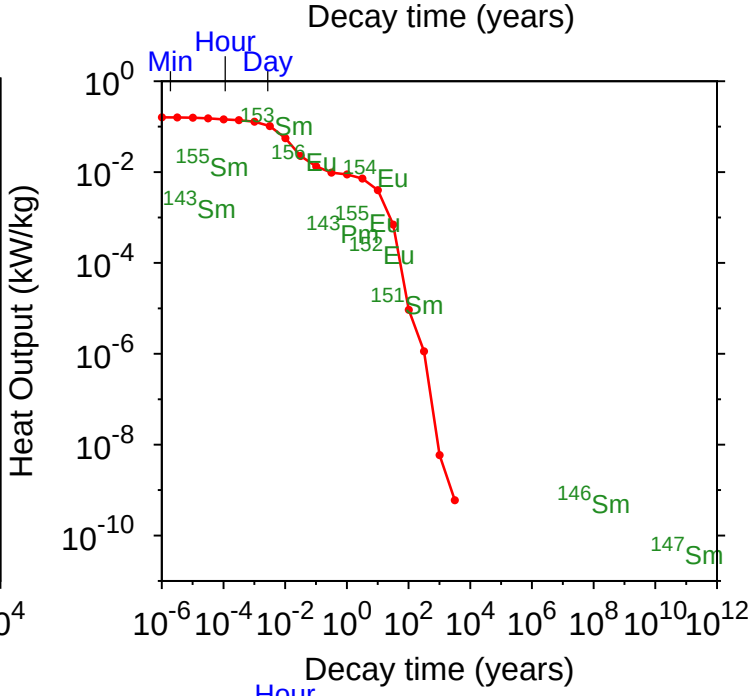
Specific Activity



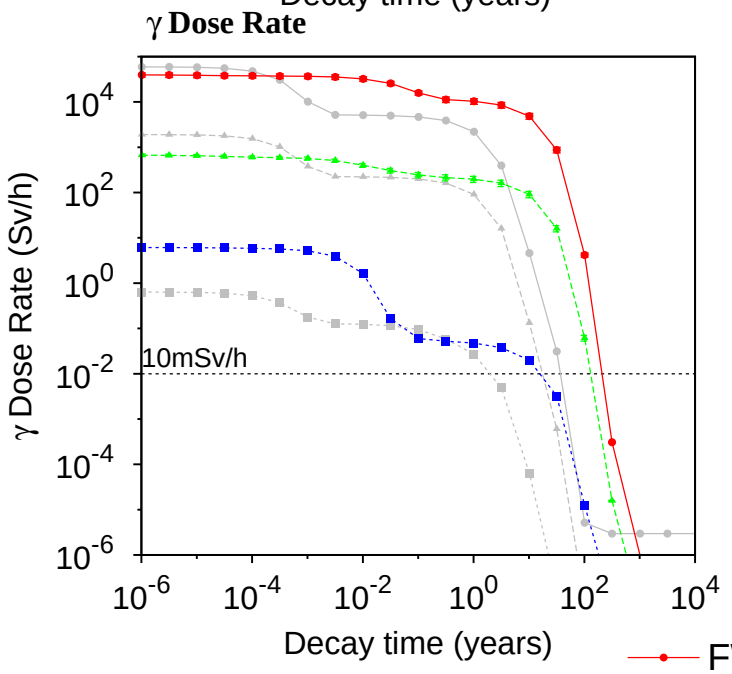


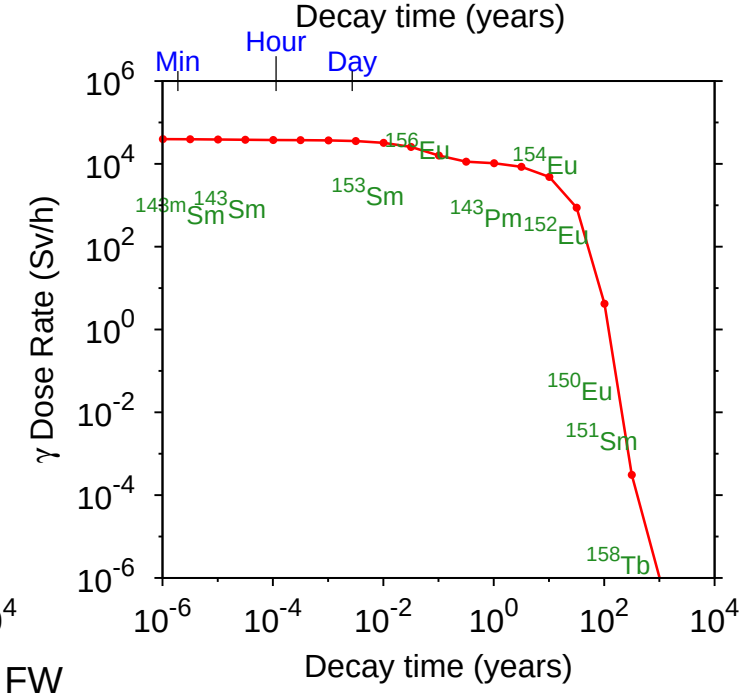
Heat Output





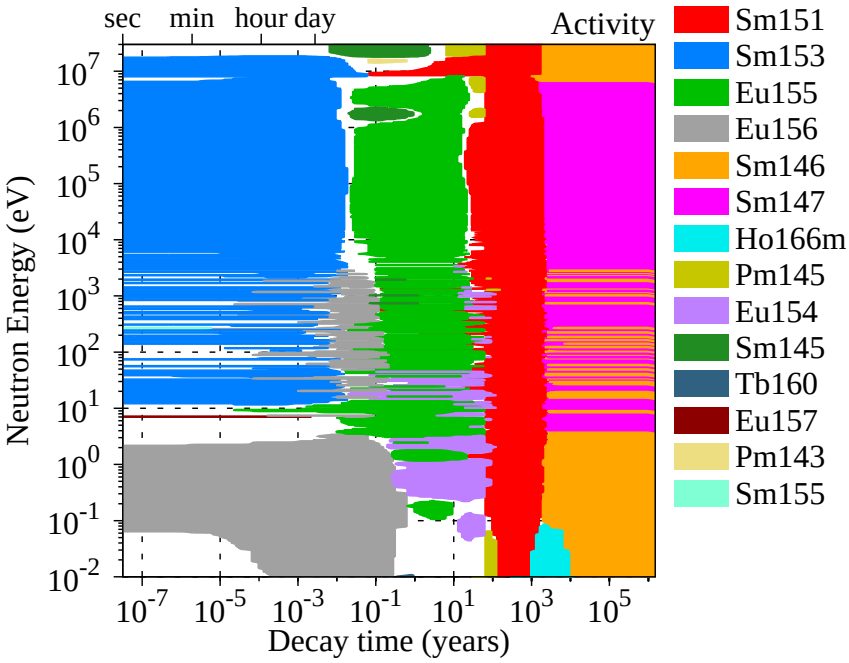
γ Dose Rate

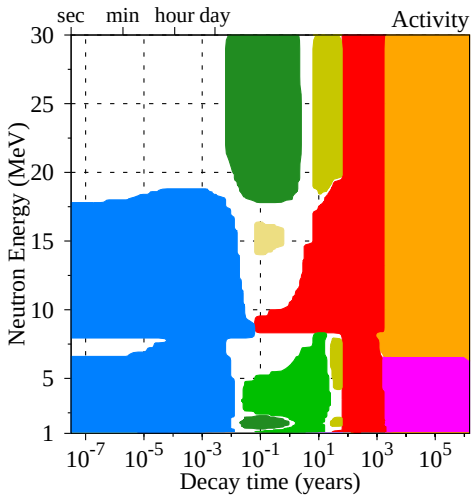


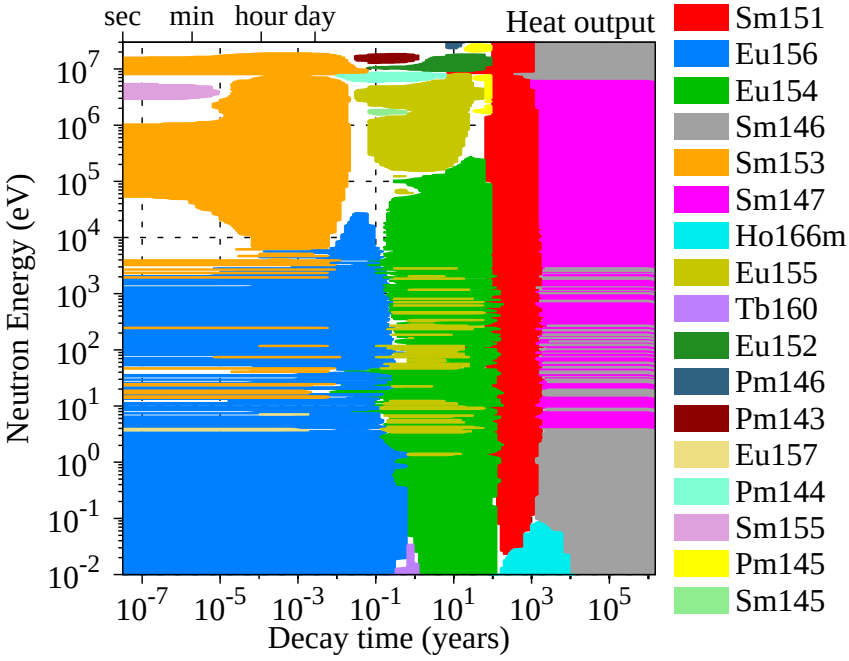


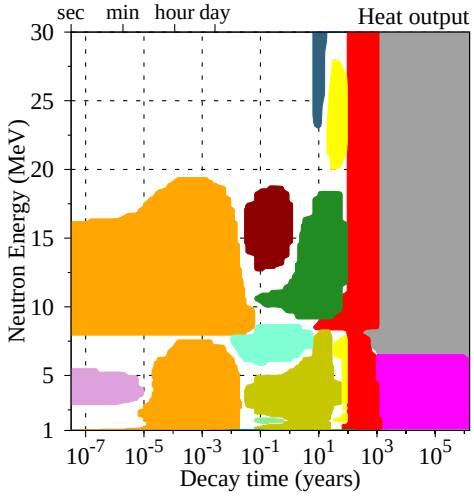
FW
Blanket
Manifold
Fe results

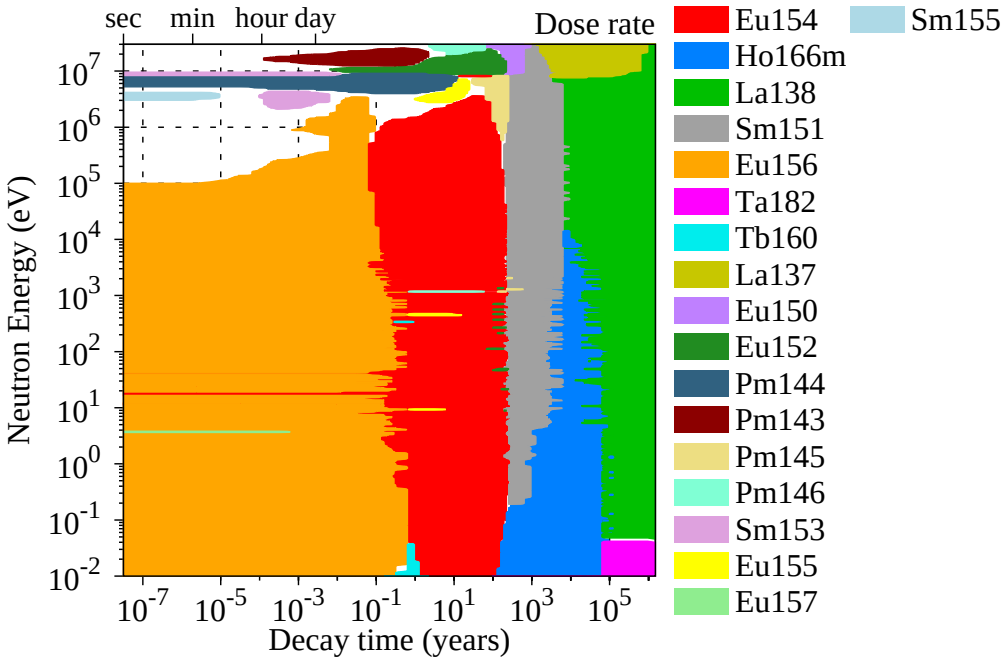
Samarium Importance diagrams

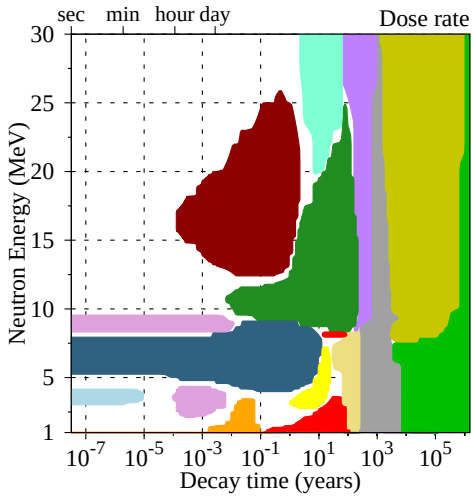




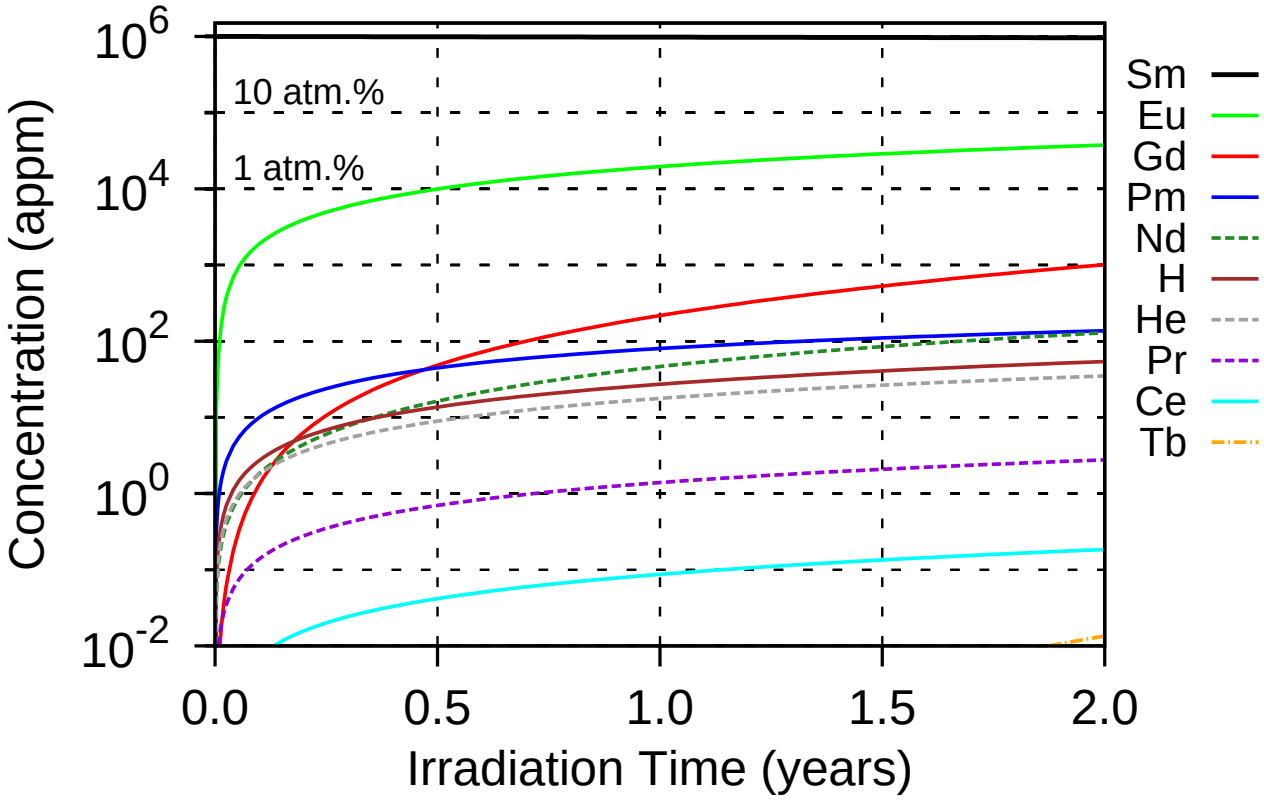




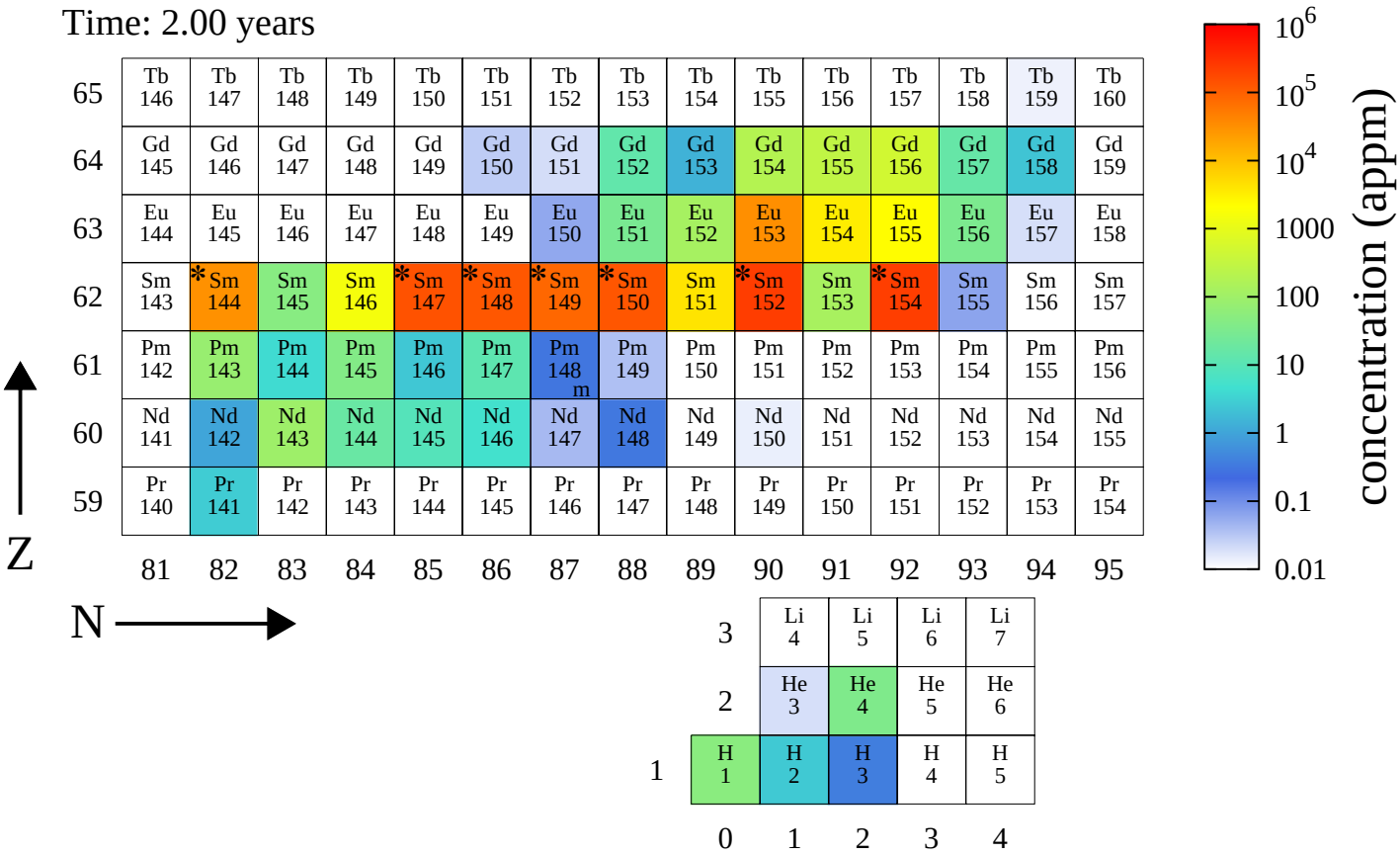




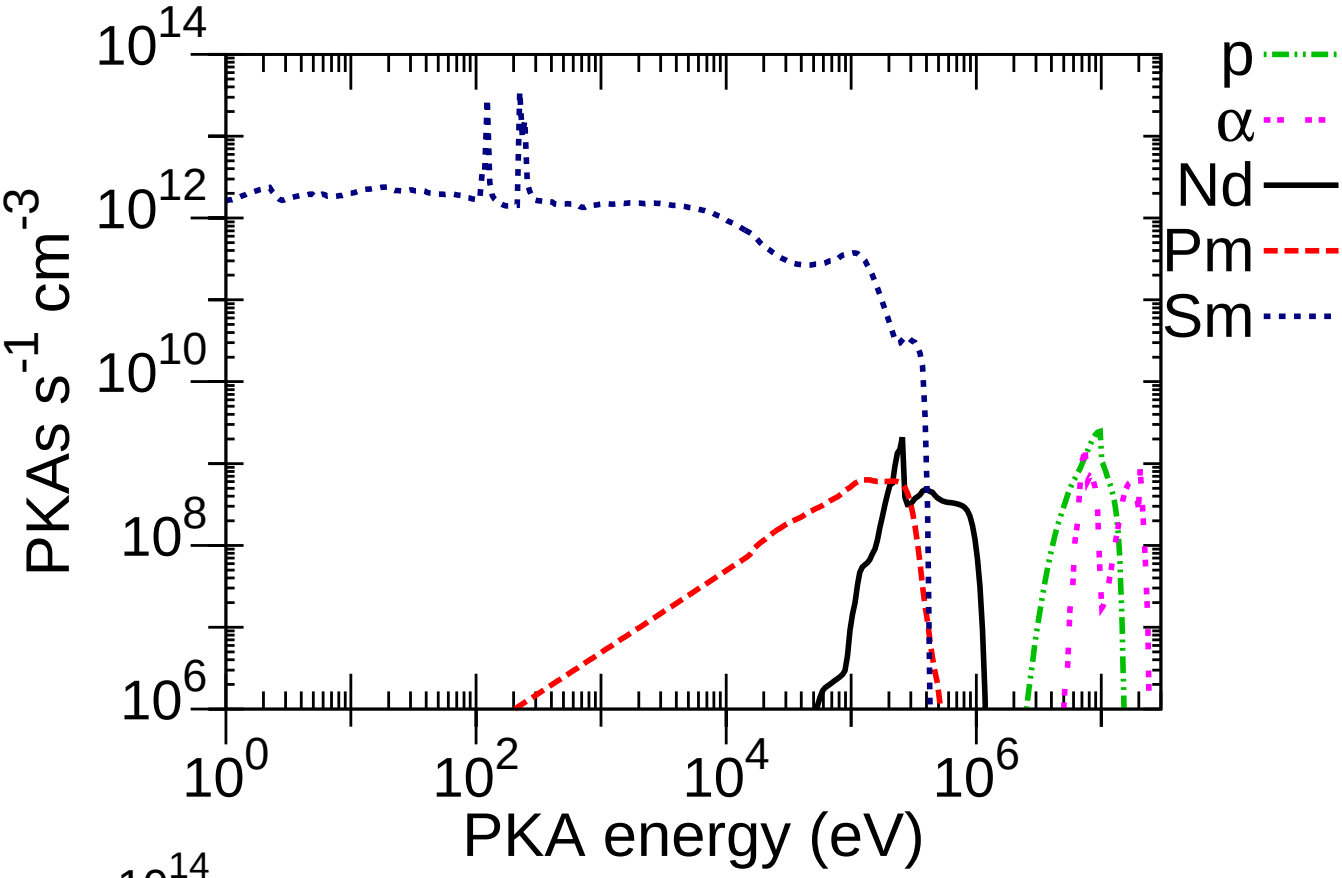
Samarium FW Transmutation

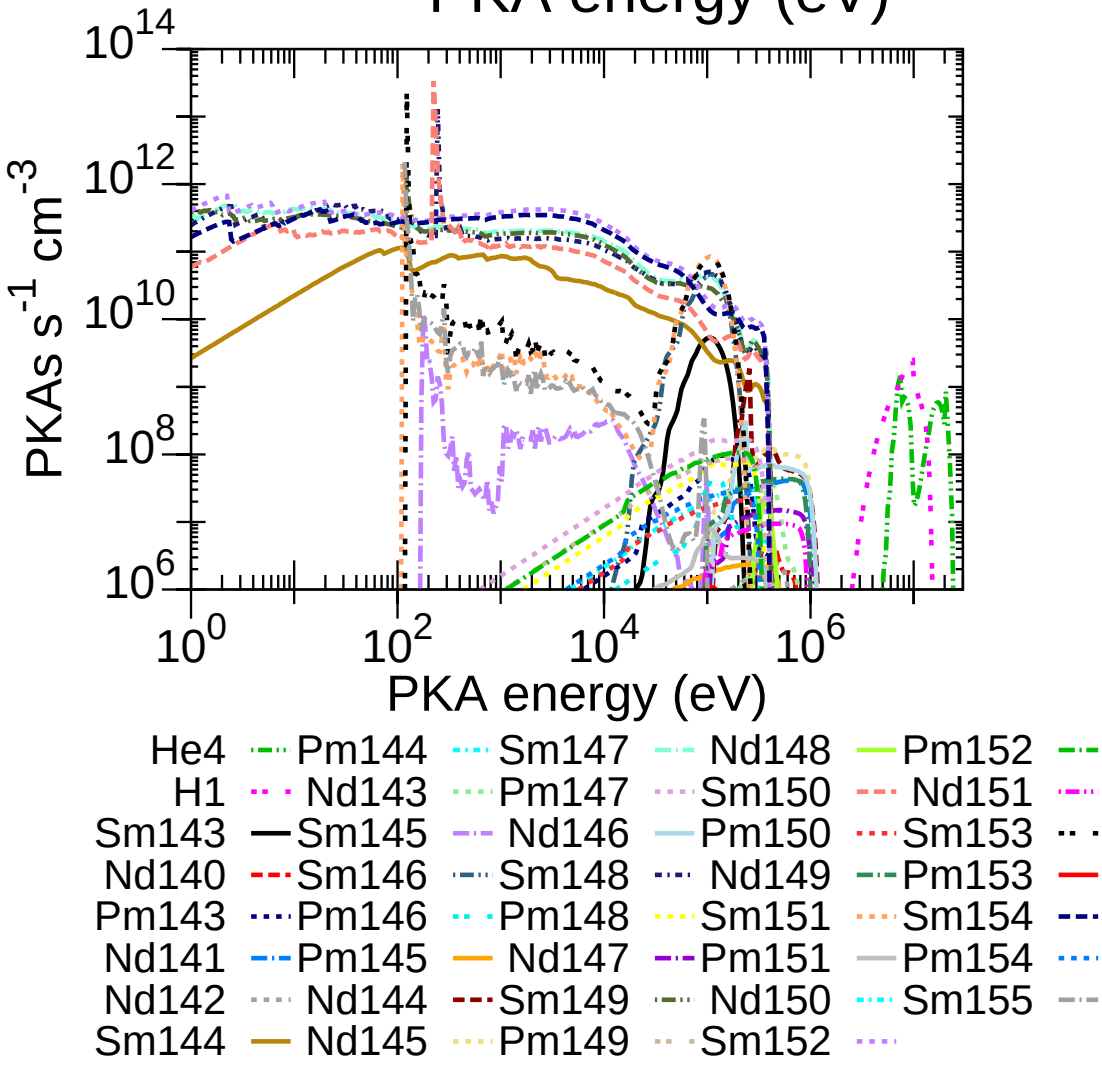


18 appm He & 27 appm H after 1 year 15 dpa/year



Samarium FW PKA distributions





Samarium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sm143m	1.10m	Sm144(n,2n)Sm143m				99.9
Sm143	8.75m	Sm144(n,2n)Sm143				58.8
		Sm144(n,2n)Sm143m(IT)Sm143				41.2
Sm155	22.30m	Sm154(n,γ)Sm155	83.1	100.0	100.0	100.0
		Sm152(n,γ)Sm153(n,γ)Sm154(n,γ)Sm155	8.6			
		Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(n,γ) Sm154(n,γ)Sm155	4.8			
		Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(n,γ)Sm154(n,γ)Sm155	2.6			
Eu157	15.18h	Sm154(n,γ)Sm155(β^-)Eu155(n,γ)Eu156(n,γ)Eu157	55.3	97.9	100.0	
		Sm147(n,γ)Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157	11.9			
		Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157	10.3			
		Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157	7.2			
		Sm152(n,γ)Sm153(n,γ)Sm154(n,γ)Sm155(β^-)Eu155(n,γ) Eu156(n,γ)Eu157	5.7			
		Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ) Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157	3.8			
		Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(n,γ) Sm154(n,γ)Sm155(β^-)Eu155(n,γ)Eu156(n,γ)Eu157	3.2			
		Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(n,γ)Sm154(n,γ) Sm155(β^-)Eu155(n,γ)Eu156(n,γ)Eu157	1.7			
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157		2.0		
Sm153	1.93d	Sm147(n,γ)Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153	44.0			
		Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	35.9			
		Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	12.9			
		Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153	6.9			
		Sm152(n,γ)Sm153		99.9	100.0	
		Sm154(n,2n)Sm153				99.8
Eu156	15.19d	Sm154(n,γ)Sm155(β^-)Eu155(n,γ)Eu156	55.3	97.9	100.0	99.9
		Sm147(n,γ)Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	12.0			
		Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	10.3			
		Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	7.2			
		Sm152(n,γ)Sm153(n,γ)Sm154(n,γ)Sm155(β^-)Eu155(n,γ)Eu156	5.7			
		Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ) Eu154(n,γ)Eu155(n,γ)Eu156	3.8			
		Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(n,γ) Sm154(n,γ)Sm155(β^-)Eu155(n,γ)Eu156	3.2			
		Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(n,γ)Sm154(n,γ) Sm155(β^-)Eu155(n,γ)Eu156	1.7			
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156		2.0		

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tb160	72.28d	Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160	35.2			
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160	17.1			
		Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160	15.3			
		Sm154(n,γ)Sm155(β^-)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160	8.5	28.4	7.7	
		Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ) Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-)Gd157(n,γ) Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160	8.2			
		Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(β^-)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160	6.1			
		Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ) Eu154(n,γ)Eu155(n,γ)Eu156(β^-)Gd156(n,γ)Gd157(n,γ) Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160	3.2			
		Sm154(n,γ)Sm155(β^-)Eu155(n,γ)Eu156(β^-)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160	3.2	65.6	83.4	
		Sm154(n,γ)Sm155(β^-)Eu155(β^-)Gd155(n,γ)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160		5.6	8.9	
Ta182	114.71d	no pathways found				
Pm143	266.00d	Sm144(n,2n)Sm143(β^+)Pm143				56.9
		Sm144(n,2n)Sm143m(IT)Sm143(β^+)Pm143				39.9
		Sm144(n,np)Pm143				2.8
Sm145	339.94d	Sm144(n,γ)Sm145	100.0	100.0	100.0	
		Sm147(n,2n)Sm146(n,2n)Sm145				96.7
		Sm148(n,2n)Sm147(n,2n)Sm146(n,2n)Sm145				3.0
Pm144	363.01d	Sm144(n,p)Pm144			100.0	65.6
		Sm147(n,2n)Sm146(n,2n)Sm145(β^+)Pm145(n,2n)Pm144				32.2
Eu155	4.75y	Sm154(n,γ)Sm155(β^-)Eu155	55.9	97.8	100.0	100.0
		Sm147(n,γ)Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ) Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155	12.4			
		Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155	10.5			
		Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-) Eu153(n,γ)Eu154(n,γ)Eu155	6.2			
		Sm152(n,γ)Sm153(n,γ)Sm154(n,γ)Sm155(β^-)Eu155	5.8			
		Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ) Eu154(n,γ)Eu155	3.3			
		Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(n,γ) Sm154(n,γ)Sm155(β^-)Eu155	3.2			
		Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(n,γ)Sm154(n,γ) Sm155(β^-)Eu155	1.7			
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155		2.2		
Pm146	5.53y	Sm144(n,γ)Sm145(β^+)Pm145(n,γ)Pm146	100.0	100.0	100.0	
		Sm147(n,np)Pm146				30.5
		Sm147(n,d)Pm146				23.1
		Sm147(n,p)Pm147(n,2n)Pm146				21.7
		Sm147(n,2n)Sm146(n,p)Pm146				16.8
		Sm150(n,α)Nd147(β^-)Pm147(n,2n)Pm146				1.6
		Sm148(n,2n)Sm147(n,np)Pm146				1.3
		Sm148(n,2n)Sm147(n,d)Pm146				1.0
		Sm148(n,np)Pm147(n,2n)Pm146				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Eu154	8.59y	Sm147(n,γ)Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	38.3			
		Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	32.4			
		Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	18.6			
		Sm150(n,γ)Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	9.9			
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154		99.6	96.1	
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154m(IT)Eu154			3.8	
		Sm154(n,2n)Sm153(β^-)Eu153(n,γ)Eu154				39.2
		Sm154(n,γ)Sm155(β^-)Eu155(n,2n)Eu154				38.5
		Sm154(n,γ)Sm155(β^-)Eu155(n,2n)Eu154m(IT)Eu154				12.2
		Sm154(n,2n)Sm153(β^-)Eu153(n,γ)Eu154m(IT)Eu154				9.9
Eu152	13.52y	Sm147(n,γ)Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151(β^-)Eu151(n,γ)Eu152	48.9			
		Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151(β^-)Eu151(n,γ)Eu152	38.7			
		Sm149(n,γ)Sm150(n,γ)Sm151(β^-)Eu151(n,γ)Eu152	7.2	6.4		
		Sm150(n,γ)Sm151(β^-)Eu151(n,γ)Eu152	3.8	93.0	94.1	
		Sm150(n,γ)Sm151(β^-)Eu151(n,γ)Eu152n(IT)Eu152			5.5	
		Sm154(n,2n)Sm153(β^-)Eu153(n,2n)Eu152				72.9
		Sm154(n,2n)Sm153(β^-)Eu153(n,2n)Eu152n(IT)Eu152				26.8
Pm145	17.70y	Sm144(n,γ)Sm145(β^+)Pm145	100.0	100.0	100.0	
		Sm147(n,2n)Sm146(n,2n)Sm145(β^+)Pm145				95.9
		Sm148(n,2n)Sm147(n,2n)Sm146(n,2n)Sm145(β^+)Pm145				2.1
Eu150	36.36y	Sm152(n,2n)Sm151(β^-)Eu151(n,2n)Eu150				83.1
		Sm154(n,2n)Sm153(β^-)Eu153(n,2n)Eu152(n,2n)Eu151(n,2n)Eu150				10.7
		Sm154(n,2n)Sm153(β^-)Eu153(n,2n)Eu152n(IT)Eu152(n,2n)Eu151(n,2n)Eu150				3.9
		Sm154(n,2n)Sm153(β^-)Eu153(n,2n)Eu152(n,3n)Eu150				1.2
Sm151	89.98y	Sm147(n,γ)Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151	49.5			
		Sm148(n,γ)Sm149(n,γ)Sm150(n,γ)Sm151	39.1			
		Sm149(n,γ)Sm150(n,γ)Sm151	7.2	11.8		
		Sm150(n,γ)Sm151	3.8	88.2	99.3	
		Sm152(n,2n)Sm151				99.8

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ho166m	1.2 10^3y	Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	26.4			
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	11.4			
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	6.9			
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	5.0			
		Sm154(n,γ)Sm155(β^-)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	4.5			
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	3.0			
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	2.1			
		Sm154(n,γ)Sm155(β^-)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165(β^-)Ho165(n,γ)Ho166m	2.0			
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	1.1			
		Sm154(n,γ)Sm155(β^-)Eu155(n,γ)Eu156(β^-)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	1.0			
		Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162(β^-)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	1.0			
La137	6.0 10^4y	Sm144(n,α)Nd141m(IT)Nd141(β^+)Pr141(n,α)La138(n,2n)La137				13.9
		Sm144(n,α)Nd141m(IT)Nd141(β^+)Pr141(n,nα)La137				13.3
		Sm144(n,α)Nd141(β^+)Pr141(n,α)La138(n,2n)La137				11.1
		Sm144(n,α)Nd141(β^+)Pr141(n,nα)La137				10.6
		Sm144(n,2α)Ce137m(IT)Ce137(β^+)La137				1.7
		Sm144(n,2α)Ce137(β^+)La137				1.5
		Sm144(n,nα)Nd140(n,α)Ce137m(IT)Ce137(β^+)La137				1.0
Sm146	1.0 10^8y	Sm144(n,γ)Sm145(n,γ)Sm146	100.0	98.8	99.7	
		Sm144(n,γ)Sm145(β^+)Pm145(n,γ)Pm146(β^-)Sm146		1.2		
		Sm147(n,2n)Sm146				95.8
		Sm148(n,2n)Sm147(n,2n)Sm146				4.0
La138	1.0 10^{11}y	Sm144(n,α)Nd141(β^+)Pr141(n,α)La138	98.9		89.8	18.5
		Sm144(n,α)Nd141m(IT)Nd141(β^+)Pr141(n,α)La138	1.1		10.2	23.1
Sm147	1.1 10^{11}y	Sm144(n,γ)Sm145(n,γ)Sm146(n,γ)Sm147	6.0			
		Sm148(n,2n)Sm147				7.6

Europium

Isotope	Atom % abundance
Eu151	47.81
Eu153	52.19

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	5.07E+15	5.05E+15	2.31E+15	1.38E+15	3.27E+12	5.18E+07
Eu152m	46.0	45.8	0.1			
Eu156	11.8	11.8	21.9			
Eu154	11.5	11.6	25.3	39.0	5.5	
Eu152	8.0	8.0	17.5	27.9	73.1	
Eu155	7.3	7.4	16.1	23.3		
Gd153	7.3	7.3	15.9	9.4		
Sm153	3.6	3.6	2.1			
Eu152n	2.0	1.9				
Eu150m	1.4	1.4				
Eu150	0.1	0.1	0.2	0.3	20.2	
Sm151					1.2	
Gd150						100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	7.26E-01	7.23E-01	3.82E-01	2.21E-01	7.00E-04	2.32E-08
Eu152m	41.8	41.7	0.1			
Eu156	22.2	22.3	35.7			
Eu154	19.6	19.7	37.1	59.4	6.2	
Eu152	11.5	11.5	21.8	35.9	70.3	
Sm153	1.3	1.3	0.7			
Gd153	1.2	1.2	2.2	1.4		
Eu155	1.0	1.0	1.9	2.9		
Eu150	0.2	0.2	0.3	0.5	23.5	
Gd150						100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	6.64E+05	6.63E+05	4.66E+05	2.70E+05	8.63E+02	2.99E-21
Eu156	31.4	31.4	37.8			
Eu154	27.0	27.0	38.4	61.3	6.3	
Eu152m	24.8	24.7	0.1			
Eu152	16.3	16.4	23.3	38.2	74.4	
Eu150	0.2	0.2	0.2	0.4	19.3	
La137						78.8
La138						21.2

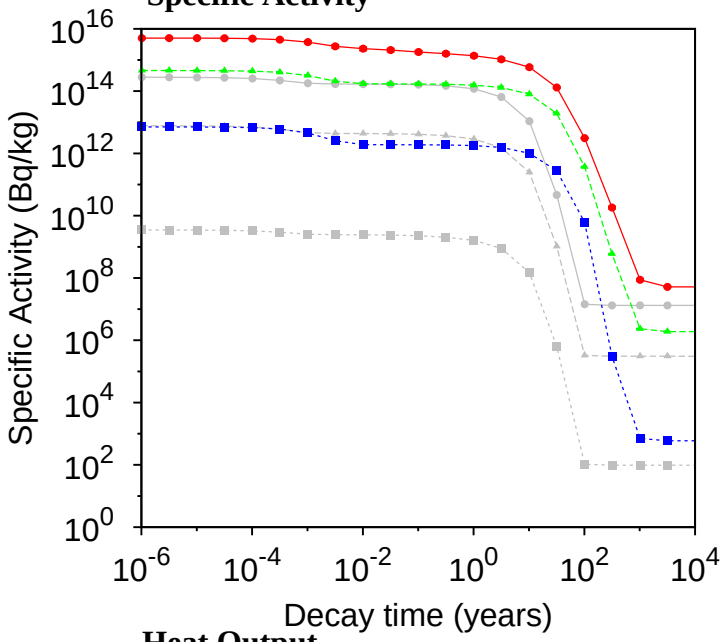
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.62E+06	4.61E+06	3.11E+06	1.76E+06	4.56E+03	2.69E+00
Eu156	28.4	28.5	35.7			
Eu154	25.3	25.3	37.5	61.2	7.8	
Eu152m	25.2	25.1	0.1			
Eu152	12.3	12.3	18.2	30.6	73.3	
Sm153	2.9	2.9	1.2			
Eu155	2.6	2.6	3.8	5.8		
Gd153	2.2	2.2	3.2	2.0		
Eu150	0.1	0.1	0.2	0.3	18.8	
Gd150					0.1	100.0

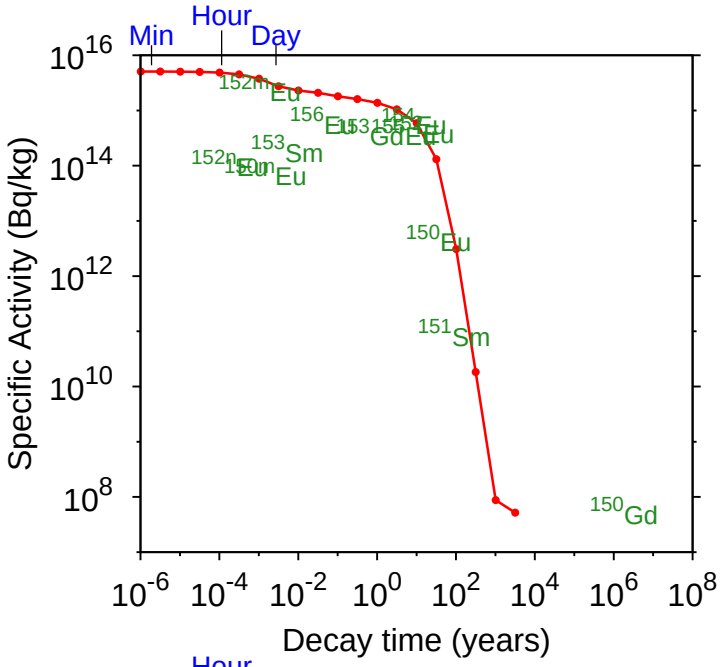
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	5.42E+07	5.42E+07	5.32E+07	4.74E+07	1.49E+05	4.30E+03
Eu154	57.1	57.1	58.1	60.2	6.3	
Eu152	31.3	31.3	31.9	34.0	67.2	
Eu155	4.7	4.7	4.8	4.7		
Eu156	3.7	3.7	3.2			
Gd153	1.4	1.4	1.4	0.6		
Eu150	0.4	0.4	0.4	0.5	23.4	
Gd150					2.9	100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.11E+13	1.11E+13	1.09E+13	9.55E+12	2.66E+10	2.15E+03
Eu154	52.5	52.6	53.3	56.3	6.7	
Eu152	36.4	36.4	37.0	40.2	89.5	
Eu156	6.9	6.9	5.9			
Eu155	3.3	3.3	3.4	3.4		
Eu150	0.1	0.1	0.1	0.1	3.8	
Gd150						100.0

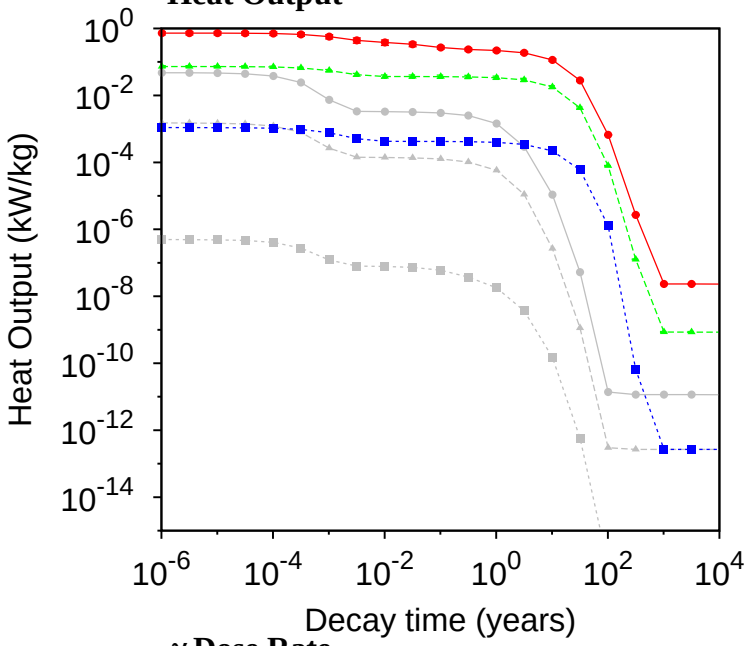
Europium activation characteristics

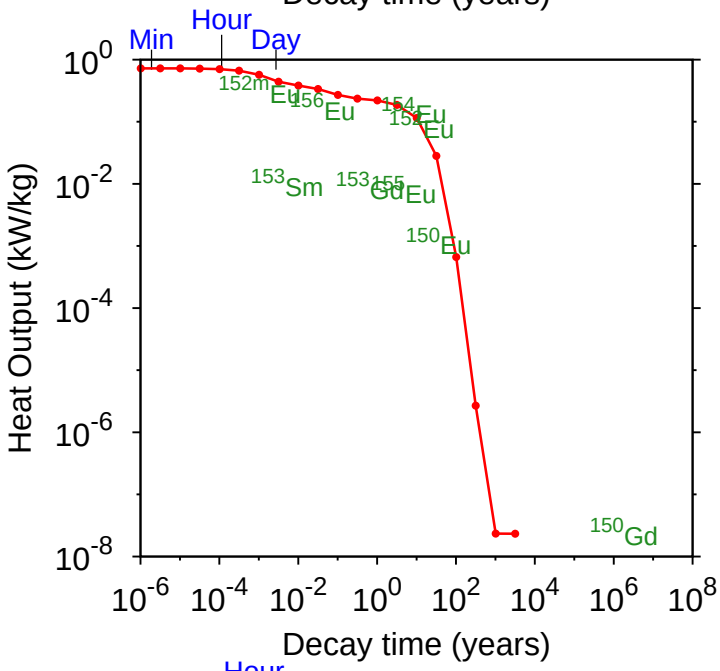
Specific Activity



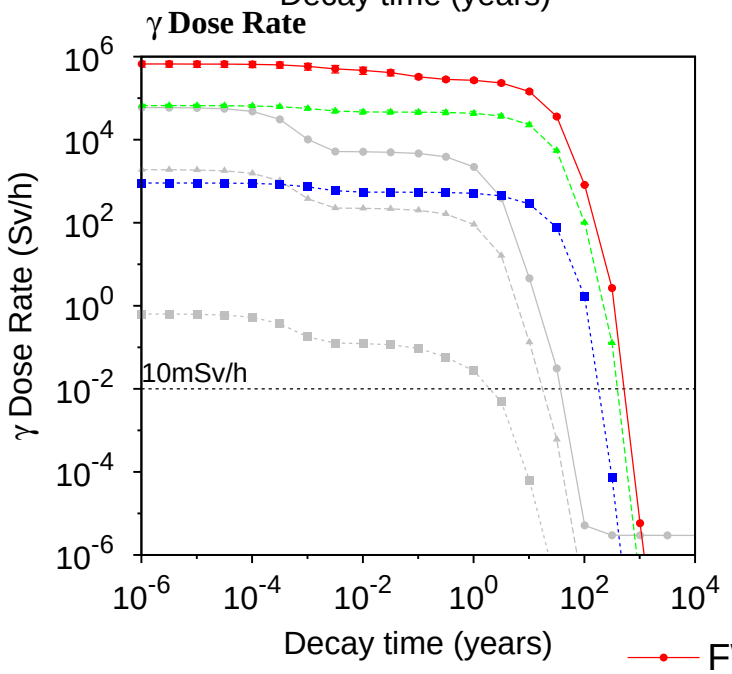


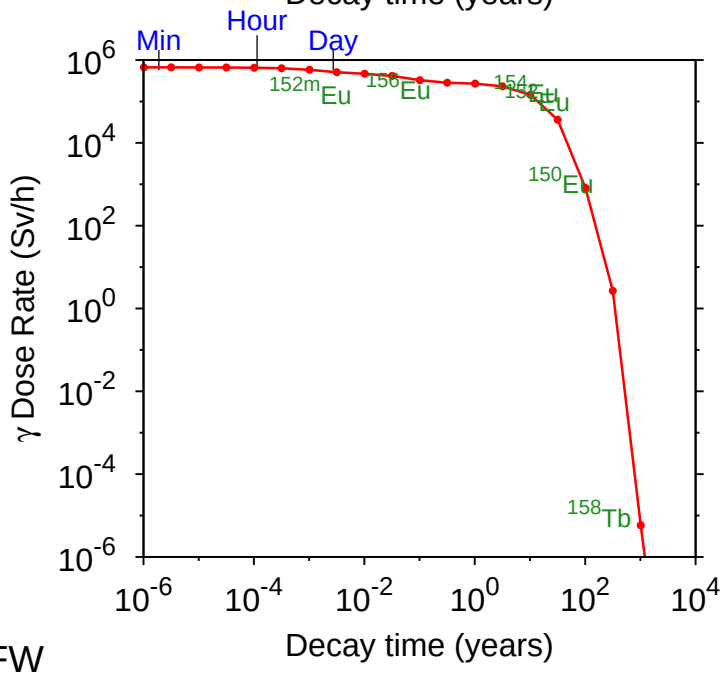
Heat Output





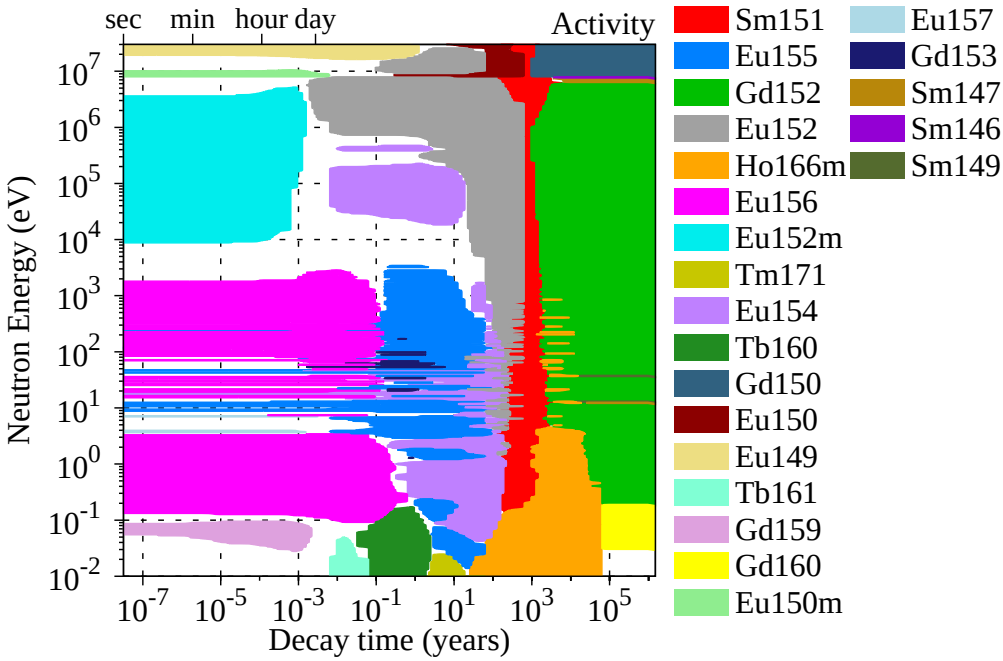
γ Dose Rate

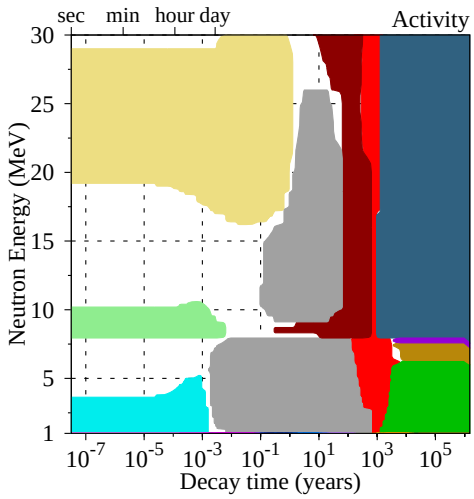


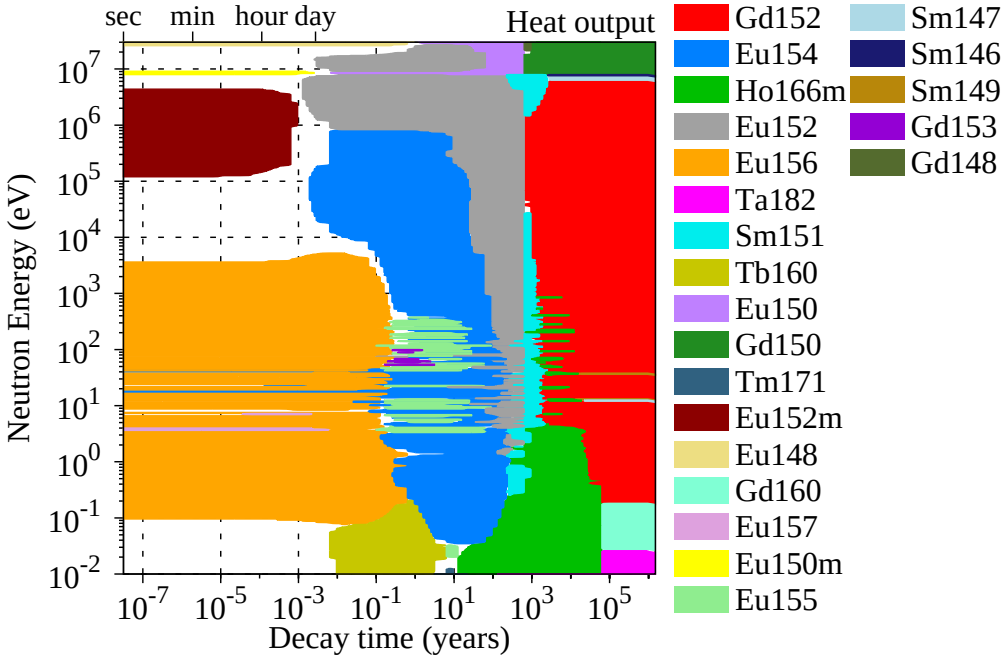


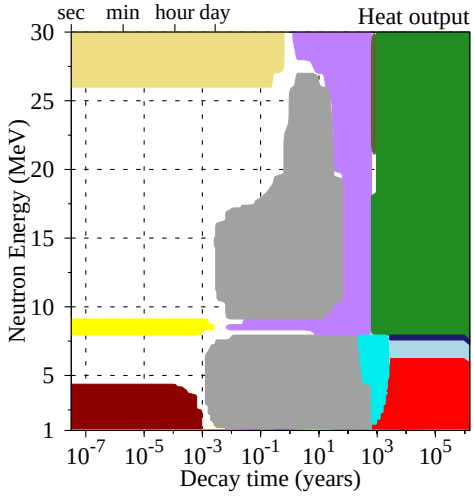
FW
Blanket
Manifold
Fe results

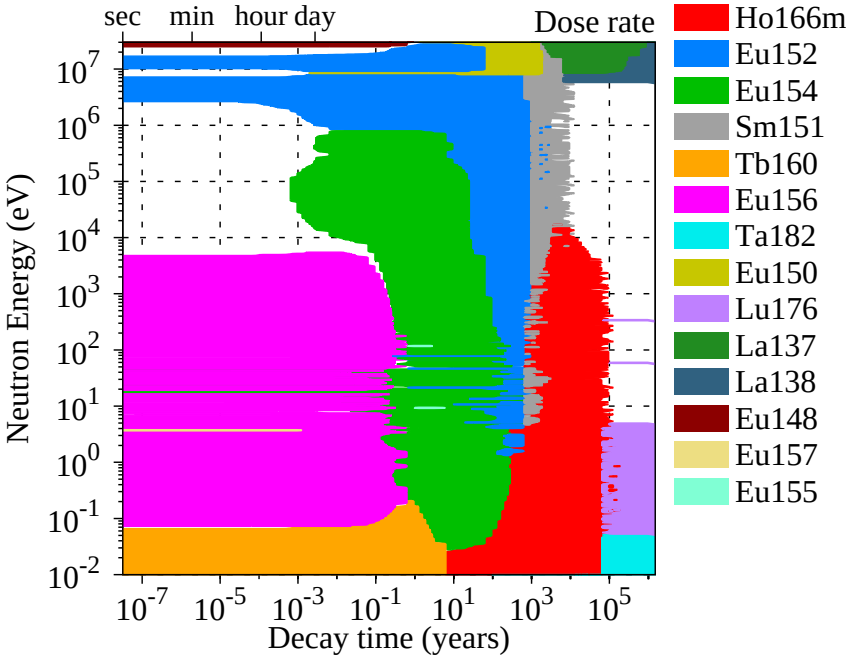
Europium Importance diagrams

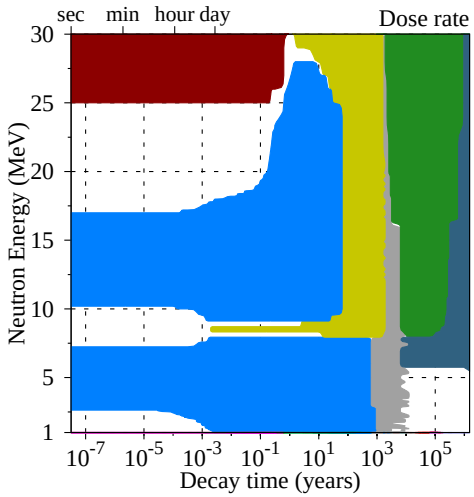




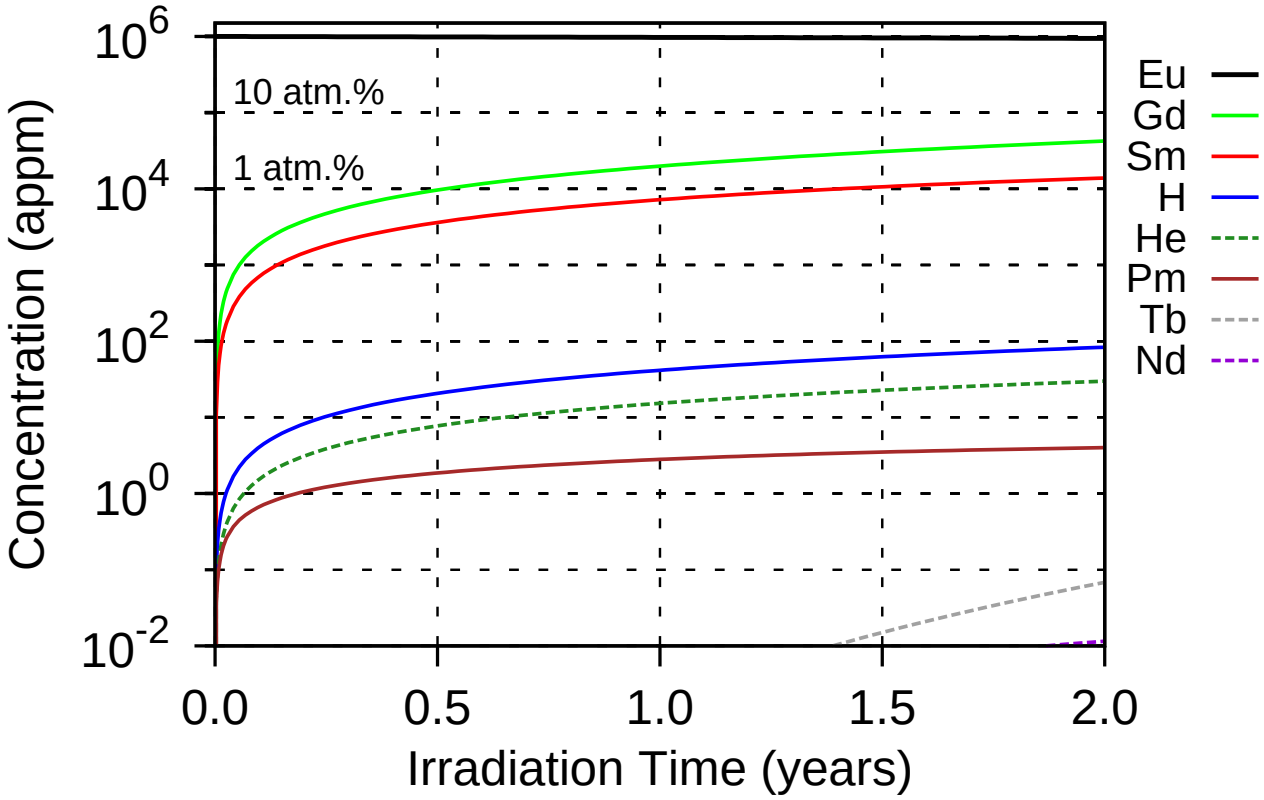






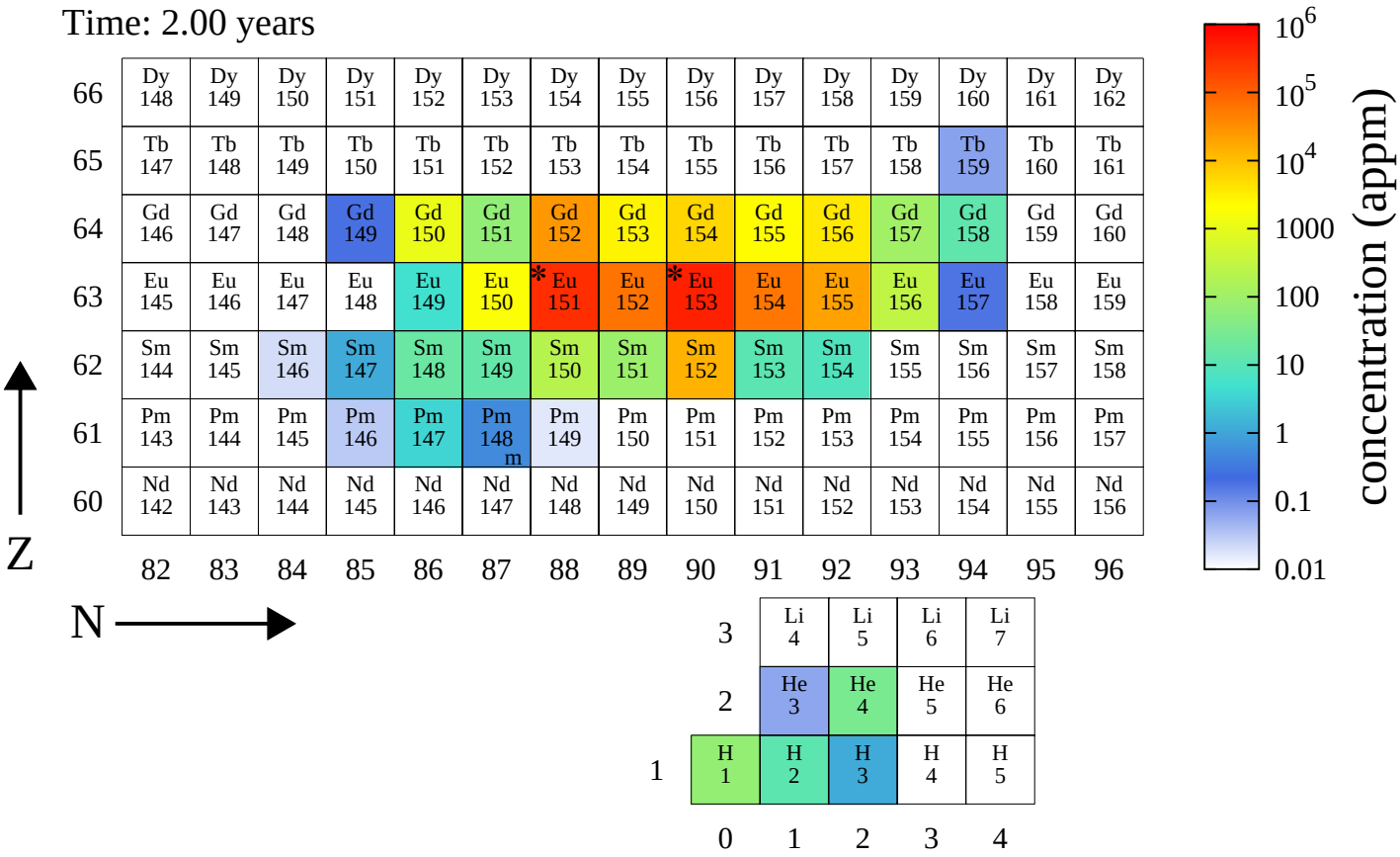


Europium FW Transmutation

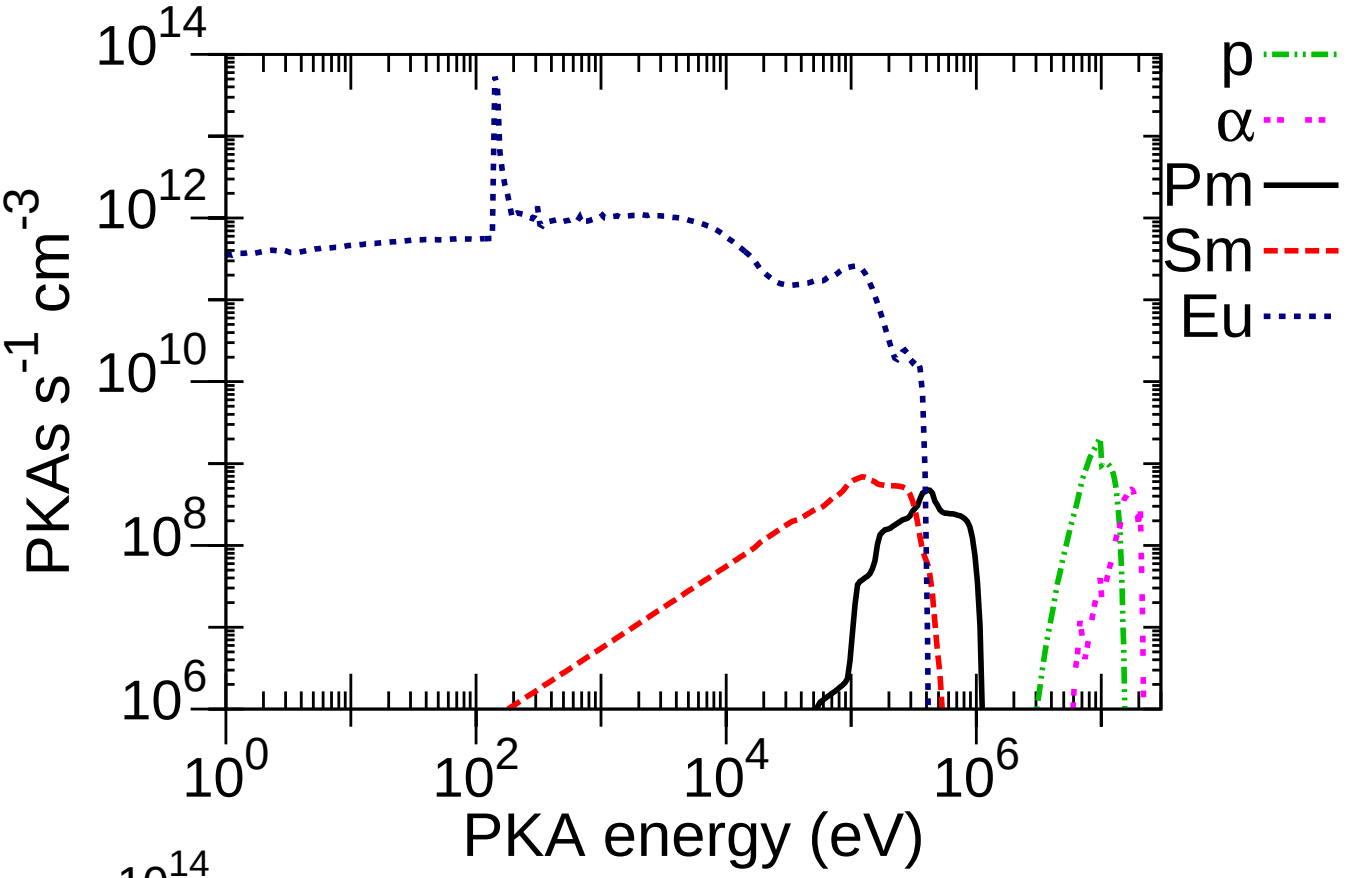


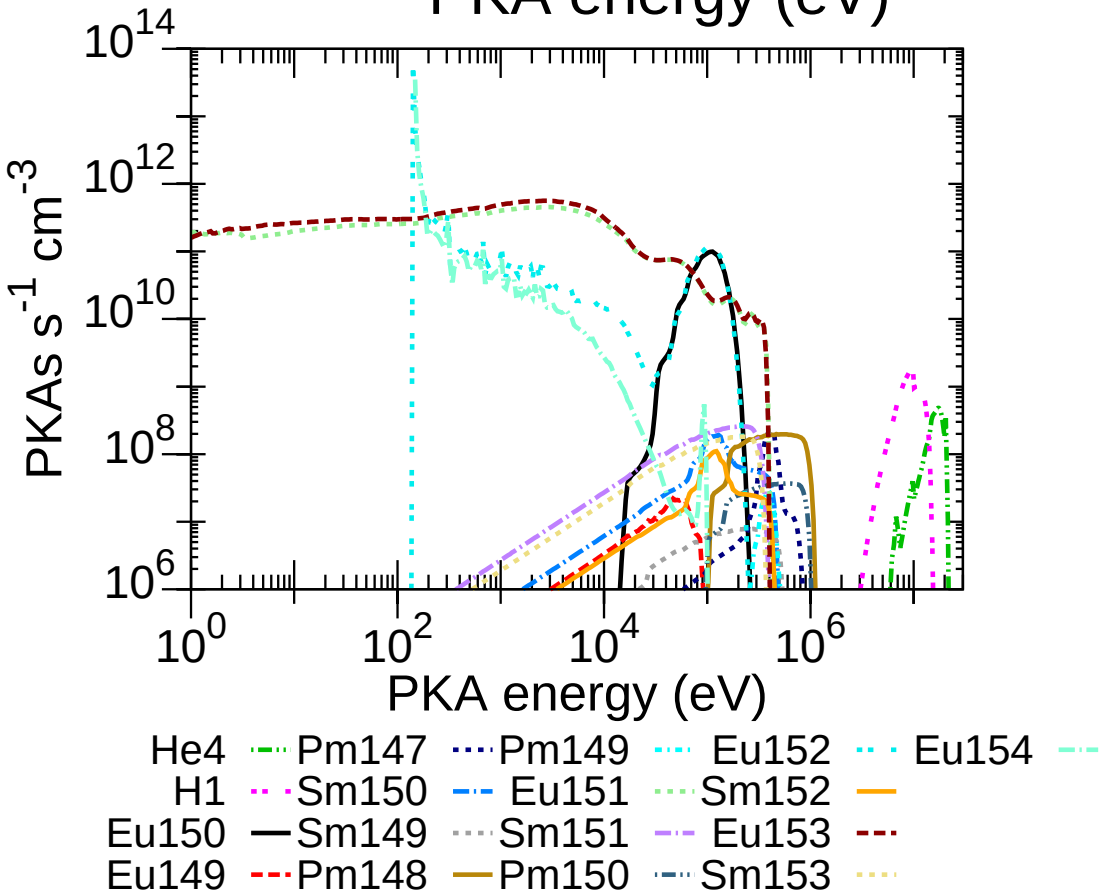
15 appm He & 41 appm H after 1 year

14 dpa/year



Europium FW PKA distributions





Europium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Eu152n	1.60h	Eu151(n,γ)Eu152n		100.0	96.6	
		Eu151(n,γ)Eu152(n,n$'$)Eu152n			3.2	
		Eu153(n,2n)Eu152n				98.9
Eu152m	9.27h	Eu151(n,γ)Eu152m		100.0	76.6	
		Eu151(n,γ)Eu152(n,n$'$)Eu152m			22.1	
		Eu151(n,γ)Eu152n(IT)Eu152(n,n$'$)Eu152m			1.3	
		Eu153(n,2n)Eu152m				91.8
		Eu153(n,2n)Eu152(n,n$'$)Eu152m				5.9
		Eu153(n,2n)Eu152n(IT)Eu152(n,n$'$)Eu152m				2.2
Eu150m	12.80h	Eu151(n,2n)Eu150m				96.2
		Eu151(n,2n)Eu150(n,n$'$)Eu150m				3.2
Eu157	15.18h	Eu151(n,γ)Eu152m(β^+)Sm152(n,γ)Sm153(n,γ)Sm154(n,γ) Sm155(β^-)Eu155(n,γ)Eu156(n,γ)Eu157	97.2			
		Eu151(n,γ)Eu152m(β^+)Sm152(n,γ)Sm153(β^-)Eu153(n,γ) Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157	1.7			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157		99.0	96.1	
		Eu153(n,γ)Eu154m(IT)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157			3.8	
Gd159	18.48h	Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159	26.9	25.9	5.4	
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(β^-)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159	25.9	66.6	64.5	
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159	16.7			
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159	16.1			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159	5.7			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159	5.5			
		Eu151(n,γ)Eu152m(β^-)Gd152(n,γ)Gd153(n,γ)Gd154(n,γ) Gd155(n,γ)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159	1.3			
		Eu153(n,γ)Eu154(n,γ)Eu155(β^-)Gd155(n,γ)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159		6.1	7.4	
		Eu153(n,γ)Eu154(β^-)Gd154(n,γ)Gd155(n,γ)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159			18.8	
		Eu153(n,γ)Eu154m(IT)Eu154(n,γ)Eu155(n,γ)Eu156(β^-) Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159			2.5	
Sm153	1.93d	Eu151(n,γ)Eu152m(β^+)Sm152(n,γ)Sm153	84.6	80.0	61.7	
		Eu151(n,γ)Eu152(n,α)Pm149(β^-)Sm149(n,γ)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153	6.3			
		Eu151(n,γ)Eu152m(n,α)Pm149(β^-)Sm149(n,γ)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153	3.2			
		Eu151(n,γ)Eu152(n,α)Pm149(n,γ)Pm150(β^-)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153	2.2			
		Eu151(n,γ)Eu152m(β^-)Gd152(n,γ)Gd153(n,γ)Gd154(n,α) Sm151(n,γ)Sm152(n,γ)Sm153	1.3			
		Eu151(n,γ)Eu152m(n,α)Pm149(n,γ)Pm150(β^-)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153	1.1			
		Eu151(n,γ)Eu152m(β^-)Gd152(n,α)Sm149(n,γ)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153	1.0			
		Eu151(n,γ)Eu152(β^+)Sm152(n,γ)Sm153		19.9	27.1	
		Eu151(n,γ)Eu152(n,n$'$)Eu152m(β^+)Sm152(n,γ)Sm153			9.1	
		Eu151(n,γ)Eu152n(IT)Eu152(β^+)Sm152(n,γ)Sm153			1.6	
		Eu153(n,p)Sm153				99.8

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tb161	6.89d	Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ)Tb161	34.6	32.0		
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161	21.5			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(β^-)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ)Tb161	18.5	62.0		
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161	11.4			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161	7.3			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161	3.9			
		Eu153(n,γ)Eu154(n,γ)Eu155(β^-)Gd155(n,γ)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ)Tb161		4.7		
Eu156	15.19d	Eu151(n,γ)Eu152m(β^+)Sm152(n,γ)Sm153(n,γ)Sm154(n,γ) Sm155(β^-)Eu155(n,γ)Eu156	97.2			
		Eu151(n,γ)Eu152m(β^+)Sm152(n,γ)Sm153(β^-)Eu153(n,γ) Eu154(n,γ)Eu155(n,γ)Eu156	1.7			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156		99.0	96.1	
		Eu153(n,γ)Eu154m(IT)Eu154(n,γ)Eu155(n,γ)Eu156			3.8	
Eu148	54.50d	Eu151(n,2n)Eu150(n,2n)Eu149(n,2n)Eu148				71.3
		Eu151(n,2n)Eu150m(β^-)Gd150(n,2n)Gd149(β^+) Eu149(n,2n)Eu148				27.0
Tb160	72.28d	Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160	34.4	31.7		
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160	21.4			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(β^-)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160	18.7	62.3		
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160	11.6			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160	7.3			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160	4.0			
		Eu153(n,γ)Eu154(n,γ)Eu155(β^-)Gd155(n,γ)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160		4.7		
Eu149	93.10d	Eu151(n,2n)Eu150(n,2n)Eu149				71.4
		Eu151(n,2n)Eu150m(β^-)Gd150(n,2n)Gd149(β^+)Eu149				27.3
Ta182	114.71d	no pathways found				
Gd153	240.41d	Eu151(n,γ)Eu152m(β^-)Gd152(n,γ)Gd153		97.1	85.1	
		Eu151(n,γ)Eu152(β^-)Gd152(n,γ)Gd153		2.9	4.4	
		Eu151(n,γ)Eu152(n,n′)Eu152m(β^-)Gd152(n,γ)Gd153			9.7	
		Eu153(n,2n)Eu152m(β^-)Gd152(n,γ)Gd153				58.4
		Eu153(n,γ)Eu154(β^-)Gd154(n,2n)Gd153				25.4
		Eu153(n,γ)Eu154m(IT)Eu154(β^-)Gd154(n,2n)Gd153				6.4
		Eu153(n,2n)Eu152(β^-)Gd152(n,γ)Gd153				5.6
		Eu153(n,2n)Eu152n(IT)Eu152(β^-)Gd152(n,γ)Gd153				2.1
		Eu153(n,2n)Eu152(n,n′)Eu152m(β^-)Gd152(n,γ)Gd153				1.5

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm171	1.92y	Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-) Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	12.9			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	5.6			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-) Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	5.1			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	2.2			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(β^-)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-) Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.9			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(β^-) Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-) Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.6			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ) Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.5			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT) Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.4			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(n,γ)Dy166(β^-)Ho166(n,γ)Ho167(β^-) Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.4			
Eu155	4.75y	Eu151(n,γ)Eu152m(β^+)Sm152(n,γ)Sm153(n,γ)Sm154(n,γ) Sm155(β^-)Eu155	98.0			
		Eu151(n,γ)Eu152m(β^+)Sm152(n,γ)Sm153(β^-)Eu153(n,γ) Eu154(n,γ)Eu155	1.2			
		Eu153(n,γ)Eu154(n,γ)Eu155		99.0	96.1	79.7
		Eu153(n,γ)Eu154m(IT)Eu154(n,γ)Eu155			3.8	20.2
Eu154	8.59y	Eu151(n,γ)Eu152m(β^+)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	75.9			
		Eu153(n,γ)Eu154	9.6	98.4	96.0	79.6
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154	6.3	1.2		
		Eu151(n,γ)Eu152(n,α)Pm149(β^-)Sm149(n,γ)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	2.4			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154	2.1			
		Eu151(n,γ)Eu152m(n,α)Pm149(β^-)Sm149(n,γ)Sm150(n,γ) Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	1.2			
		Eu153(n,γ)Eu154m(IT)Eu154			3.8	20.1
Eu152	13.52y	Eu151(n,γ)Eu152		99.5	94.4	
		Eu151(n,γ)Eu152n(IT)Eu152			5.5	
		Eu153(n,2n)Eu152				72.9
		Eu153(n,2n)Eu152n(IT)Eu152				26.8
Eu150	36.36y	Eu151(n,2n)Eu150				99.7

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Gd148	74.99y	Eu151(n,2n)Eu150m(β^-)Gd150(n,2n)Gd149(n,2n)Gd148				98.8
		Eu151(n,2n)Eu150(n,n′)Eu150m(β^-)Gd150(n,2n) Gd149(n,2n)Gd148				1.1
Sm151	89.98y	Eu151(n,γ)Eu152(n,α)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	40.6	6.7		
		Eu151(n,γ)Eu152m(n,α)Pm149(β^-)Sm149(n,γ)Sm150(n,γ)Sm151	20.4			
		Eu151(n,γ)Eu152(n,α)Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151	14.2			
		Eu151(n,γ)Eu152m(β^-)Gd152(n,γ)Gd153(n,γ)Gd154(n,α)Sm151	9.5			
		Eu151(n,γ)Eu152m(n,α)Pm149(n,γ)Pm150(β^-)Sm150(n,γ)Sm151	7.1			
		Eu151(n,γ)Eu152m(β^-)Gd152(n,α)Sm149(n,γ)Sm150(n,γ)Sm151	6.4			
		Eu153(n,γ)Eu154(n,α)Pm151(β^-)Sm151		90.7		
		Eu151(n,γ)Eu152m(β^-)Gd152(n,γ)Gd153(n,α)Sm150(n,γ)Sm151		1.2		
		Eu151(n,p)Sm151			99.9	67.9
		Eu153(n,2n)Eu152m(β^+)Sm152(n,2n)Sm151				16.5
		Eu153(n,2n)Eu152(β^+)Sm152(n,2n)Sm151				9.3
		Eu153(n,2n)Eu152n(IT)Eu152(β^+)Sm152(n,2n)Sm151				3.4
Ho166m	1.2 10^3y	Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	23.0			
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	14.2			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165(β^-)Ho165(n,γ)Ho166m	10.0			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(β^-)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	6.7			
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	6.2			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	4.9			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(β^-) Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	4.7			
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	4.2			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(β^-)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(β^-)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165(β^-)Ho165(n,γ)Ho166m	2.9			
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	2.9			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	2.1			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(β^-) Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165(β^-)Ho165(n,γ)Ho166m	2.0			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ho166m	cont.	Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	1.8			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	1.4			
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	1.2			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(β^-)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(β^-) Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	1.1			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	1.0			
La137	6.0 10^4y	Eu151(n,nα)Pm147(n,nα)Pr143(n,nα)La139(n,2n) La138(n,2n)La137				50.7
		Eu151(n,nα)Pm147(n,2n)Pm146(n,α)Pr143(n,nα)La139(n,2n) La138(n,2n)La137				14.3
		Eu151(n,2n)Eu150(n,nα)Pm146(n,α)Pr143(n,nα)La139(n,2n) La138(n,2n)La137				9.7
		Eu151(n,2n)Eu150(n,α)Pm147(n,nα)Pr143(n,nα)La139(n,2n) La138(n,2n)La137				4.3
		Eu151(n,2n)Eu150(n,2α)Pr143(n,nα)La139(n,2n) La138(n,2n)La137				1.9
		Eu151(n,2n)Eu150(n,α)Pm147(n,2n)Pm146(n,α)Pr143(n,nα) La139(n,2n)La138(n,2n)La137				1.0
Gd150	1.8 10^6y	Eu151(n,2n)Eu150m(β^-)Gd150				98.1
		Eu151(n,2n)Eu150(n,n′)Eu150m(β^-)Gd150				1.6
Sm146	1.0 10^8y	Eu151(n,2n)Eu150m(β^-)Gd150(n,nα)Sm146				52.8
		Eu151(n,nα)Pm147(β^-)Sm147(n,2n)Sm146				16.1
		Eu151(n,α)Pm148(β^-)Sm148(n,2n)Sm147(n,2n)Sm146				9.3
		Eu151(n,2n)Eu150m(β^-)Gd150(n,α)Sm147(n,2n)Sm146				7.7
		Eu151(n,α)Pm148m(β^-)Sm148(n,2n)Sm147(n,2n)Sm146				3.4
		Eu151(n,nα)Pm147(n,2n)Pm146(β^-)Sm146				2.3
		Eu151(n,2n)Eu150(n,α)Pm147(β^-)Sm147(n,2n)Sm146				1.7
		Eu151(n,2n)Eu150(n,nα)Pm146(β^-)Sm146				1.7
Lu176	4.0 10^{10}y	no pathways found				
La138	1.0 10^{11}y	Eu151(n,nα)Pm147(n,nα)Pr143(n,nα)La139(n,2n)La138				49.6
		Eu151(n,nα)Pm147(n,2n)Pm146(n,α)Pr143(n,nα) La139(n,2n)La138				17.4
		Eu151(n,2n)Eu150(n,nα)Pm146(n,α)Pr143(n,nα) La139(n,2n)La138				12.1
		Eu151(n,2n)Eu150(n,α)Pm147(n,nα)Pr143(n,nα) La139(n,2n)La138				5.2
		Eu151(n,2n)Eu150(n,2α)Pr143(n,nα)La139(n,2n)La138				1.9
		Eu151(n,2n)Eu150(n,α)Pm147(n,2n)Pm146(n,α)Pr143(n,nα) La139(n,2n)La138				1.5

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Sm147	1.1 10^{11}y	Eu151(n,γ)Eu152(n,α)Pm149(β^-)Sm149(n,α)Nd146(n,γ) Nd147(β^-)Pm147(β^-)Sm147	28.8	95.5		
		Eu151(n,γ)Eu152(n,α)Pm149(β^-)Sm149(n,γ)Sm150(n,α) Nd147(β^-)Pm147(β^-)Sm147	23.7			
		Eu151(n,γ)Eu152m(n,α)Pm149(β^-)Sm149(n,α)Nd146(n,γ) Nd147(β^-)Pm147(β^-)Sm147	14.6			
		Eu151(n,γ)Eu152m(n,α)Pm149(β^-)Sm149(n,γ)Sm150(n,α) Nd147(β^-)Pm147(β^-)Sm147	12.0			
		Eu151(n,γ)Eu152(n,α)Pm149(n,γ)Pm150(β^-)Sm150(n,α) Nd147(β^-)Pm147(β^-)Sm147	8.3			
		Eu151(n,γ)Eu152m(n,α)Pm149(n,γ)Pm150(β^-)Sm150(n,α) Nd147(β^-)Pm147(β^-)Sm147	4.2			
		Eu151(n,γ)Eu152m(β^-)Gd152(n,α)Sm149(n,α)Nd146(n,γ) Nd147(β^-)Pm147(β^-)Sm147	4.0	1.1		
		Eu151(n,γ)Eu152m(β^-)Gd152(n,α)Sm149(n,γ)Sm150(n,α) Nd147(β^-)Pm147(β^-)Sm147	3.5			
		Eu151(n,nα)Pm147(β^-)Sm147			100.0	36.1
		Eu151(n,α)Pm148(β^-)Sm148(n,2n)Sm147				22.1
		Eu151(n,2n)Eu150m(β^-)Gd150(n,α)Sm147				18.0
		Eu151(n,α)Pm148m(β^-)Sm148(n,2n)Sm147				8.6
		Eu151(n,2n)Eu150(n,α)Pm147(β^-)Sm147				5.3
		Eu151(n,2n)Eu150(n,2n)Eu149(β^+)Sm149(n,2n) Sm148(n,2n)Sm147				3.0
		Eu151(n,2n)Eu150(n,2n)Eu149(n,2n)Eu148(β^+) Sm148(n,2n)Sm147				1.6
		Eu151(n,2n)Eu150m(β^-)Gd150(n,2n)Gd149(β^+)Eu149(β^+) Sm149(n,2n)Sm148(n,2n)Sm147				1.0
Gd152	1.1 10^{14}y	Eu151(n,γ)Eu152m(β^-)Gd152		96.3	81.5	
		Eu151(n,γ)Eu152(β^-)Gd152		3.6	5.4	
		Eu151(n,γ)Eu152(n,n$'$)Eu152m(β^-)Gd152			12.1	
		Eu153(n,2n)Eu152m(β^-)Gd152				82.2
		Eu153(n,2n)Eu152(β^-)Gd152				10.3
		Eu153(n,2n)Eu152n(IT)Eu152(β^-)Gd152				3.8
		Eu153(n,2n)Eu152(n,n$'$)Eu152m(β^-)Gd152				2.7
		Eu153(n,2n)Eu152n(IT)Eu152(n,n$'$)Eu152m(β^-)Gd152				1.0
Sm149	2.0 10^{15}y	Eu151(n,α)Pm148(β^-)Sm148(n,γ)Sm149	96.2		13.0	
		Eu151(n,α)Pm148m(β^-)Sm148(n,γ)Sm149	1.0		4.6	
		Eu151(n,γ)Eu152(n,α)Pm149(β^-)Sm149		97.7	41.0	
		Eu151(n,γ)Eu152m(β^-)Gd152(n,α)Sm149		1.2	31.2	
		Eu151(n,γ)Eu152(n,n$'$)Eu152m(β^-)Gd152(n,α)Sm149			3.1	
		Eu151(n,γ)Eu152n(IT)Eu152(n,α)Pm149(β^-)Sm149			2.4	
		Eu151(n,α)Pm148m(n,γ)Pm149(β^-)Sm149			2.3	
		Eu151(n,γ)Eu152(β^-)Gd152(n,α)Sm149			1.4	
		Eu151(n,2n)Eu150(n,2n)Eu149(β^+)Sm149				65.7
		Eu151(n,2n)Eu150m(β^-)Gd150(n,2n)Gd149(β^+)Eu149(β^+)Sm149				24.3
		Eu151(n,2n)Eu150m(β^+)Sm150(n,2n)Sm149				4.9
		Eu151(n,3n)Eu149(β^+)Sm149				1.2
		Eu151(n,2n)Eu150(β^+)Sm150(n,2n)Sm149				1.1
Gd160	1.3 10^{17}y	Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(n,γ)Eu157(β^-) Gd157(n,γ)Gd158(n,γ)Gd159(n,γ)Gd160	35.9			
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(n,γ)Gd160	22.3			
		Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156(β^-)Gd156(n,γ) Gd157(n,γ)Gd158(n,γ)Gd159(n,γ)Gd160	17.2			
		Eu151(n,γ)Eu152(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(n,γ)Gd160	10.7			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(n,γ)Eu157(β^-)Gd157(n,γ)Gd158(n,γ)Gd159(n,γ)Gd160	7.6			
		Eu151(n,γ)Eu152m(n,γ)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ) Eu156(β^-)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(n,γ)Gd160	3.6			

Gadolinium

Isotope	Atom % abundance	
Gd152	0.20	($T_{1/2}$ =1.1 10^{14}y)
Gd154	2.18	
Gd155	14.80	
Gd156	20.47	
Gd157	15.65	
Gd158	24.84	
Gd160	21.86	($T_{1/2}$ =1.3 10^{17}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	5.10E+14	4.78E+14	1.17E+14	1.48E+13	7.97E+09	1.87E+03
Gd159	66.1	70.4	10.7			
Tb161	10.4	11.1	31.4			
Gd161	9.4	3.7				
Gd153	7.4	7.9	31.8	88.6		
Tb160	5.7	6.0	23.8	5.9		
Eu155	0.1	0.1	0.3	2.3		
Eu154	0.1	0.1	0.3	2.3	1.5	
Tb158				0.1	95.2	
Sm151					1.5	
Eu152				0.1	1.2	
Gd150						99.9

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.73E-02	3.24E-02	9.58E-03	5.96E-04	1.18E-06	8.37E-13
Gd159	53.0	60.8	7.7			
Gd161	20.3	8.6				
Tb160	17.2	19.8	64.7	32.5		
Tb161	5.4	6.2	14.5			
Gd153	2.4	2.7	9.1	51.4		
Eu156	0.8	1.0	2.8			
Eu154	0.2	0.3	0.9	13.9	2.5	
Eu155			0.1	1.1		
Tb158				0.3	95.7	
Eu152				0.5	1.6	
Gd150						99.9

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.13E+04	1.04E+04	8.00E+03	3.55E+02	1.45E+00	1.91E-10
Tb160	67.8	74.3	93.0	65.4		
Gd161	13.4	5.4				
Gd159	12.4	13.5	0.7			
Eu156	3.6	3.9	4.3			
Eu154	1.0	1.1	1.4	29.9	2.6	
Gd153	0.3	0.3	0.4	3.0		
Eu152			0.1	1.1	1.7	
Tb158				0.6	95.6	
Ho166m						100.0

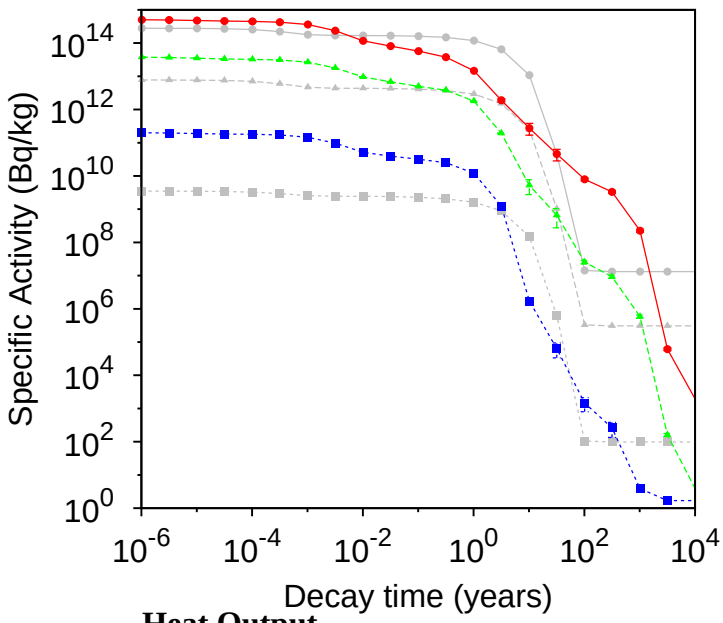
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.69E+05	2.67E+05	9.07E+04	5.79E+03	8.74E+00	9.71E-05
Gd159	61.5	61.8	6.8			
Tb160	17.2	17.3	49.2	24.1		
Tb161	14.2	14.4	29.3			
Gd153	3.8	3.8	11.1	61.3		
Tb162	1.8	1.1				
Eu156	0.9	0.9	2.4			
Eu154	0.3	0.3	0.8	11.8	2.7	
Eu155			0.1	1.9		
Tb158				0.2	95.5	
Eu152				0.4	1.5	
Gd150						99.9

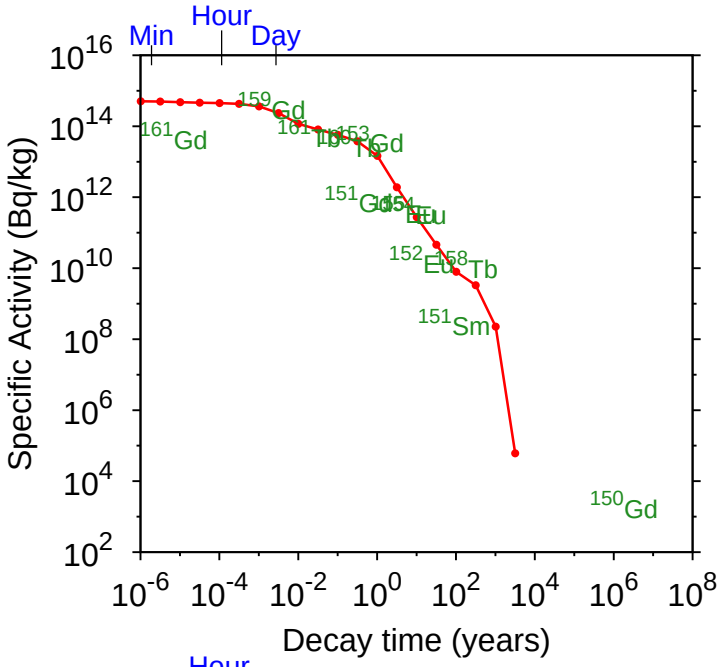
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.76E+05	4.73E+05	3.52E+05	5.54E+04	3.61E+02	1.55E-01
Tb160	42.5	42.7	55.4	11.0		
Gd159	19.1	19.2	1.0			
Gd153	16.6	16.7	22.2	49.9		
Tb161	14.5	14.6	13.6			
Eu154	4.1	4.1	5.6	32.7	1.8	
Tb162	1.1	0.7				
Eu155	0.6	0.6	0.8	4.3		
Eu152	0.1	0.1	0.2	1.1	1.1	
Tb158	0.1	0.1	0.1	0.9	96.9	
Gd150						100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	6.74E+10	5.32E+10	3.92E+10	6.10E+09	8.45E+06	7.98E-02
Tb160	42.9	54.2	71.1	14.3		
Gd161	32.5	15.2				
Gd153	5.6	7.1	9.5	21.5		
Eu154	5.5	6.9	9.4	55.9	14.1	
Gd159	5.0	6.3	0.3			
Tb161	4.2	5.3	4.9			
Eu156	2.2	2.8	3.2			
Eu155	0.6	0.7	1.0	5.6		
Eu152	0.2	0.3	0.4	2.4	10.9	
Tb158				0.2	74.9	
Gd150						97.4
Gd152						1.3
Ho166m						1.3

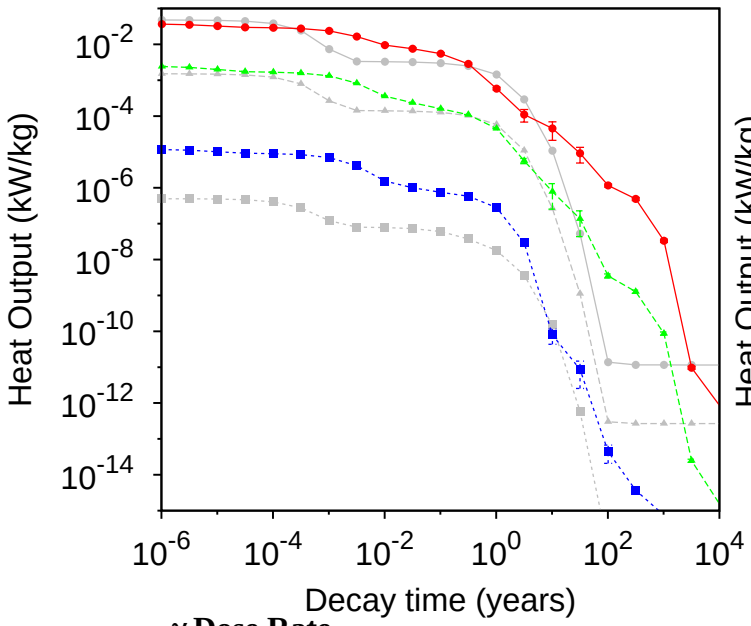
Gadolinium activation characteristics

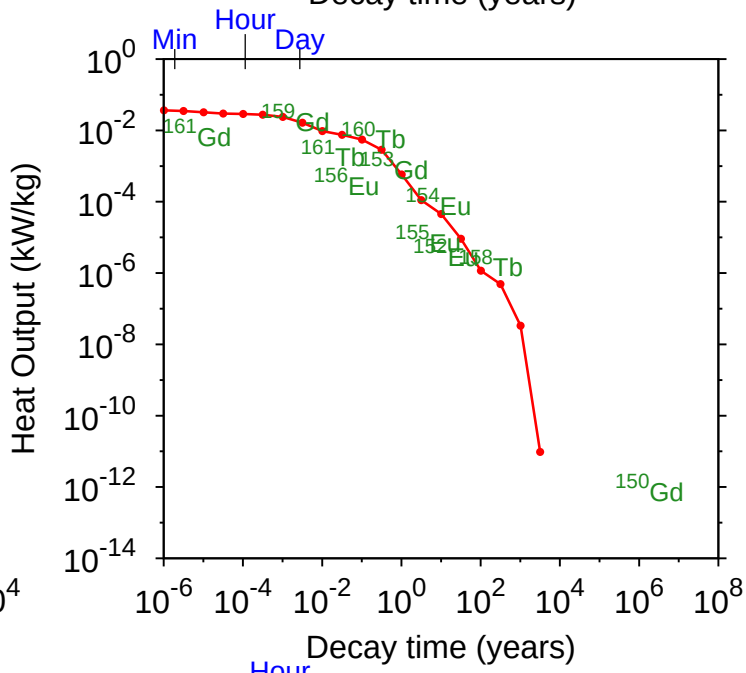
Specific Activity



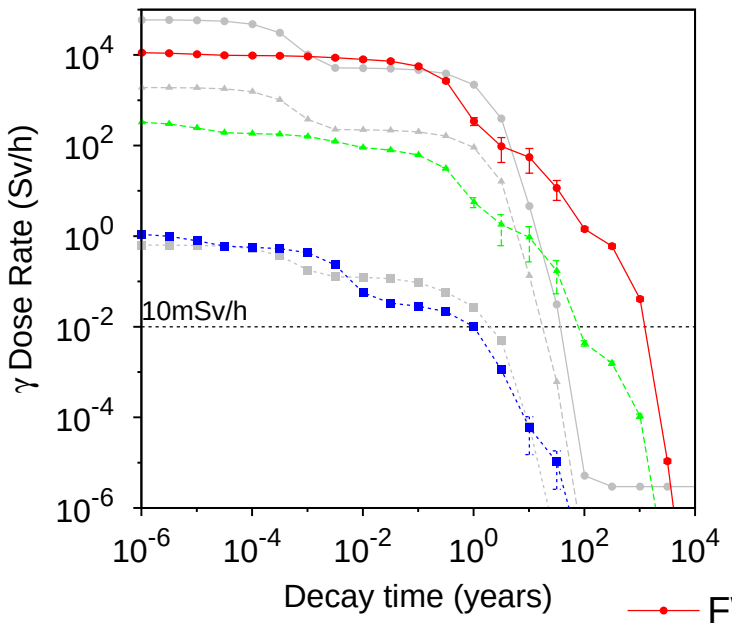


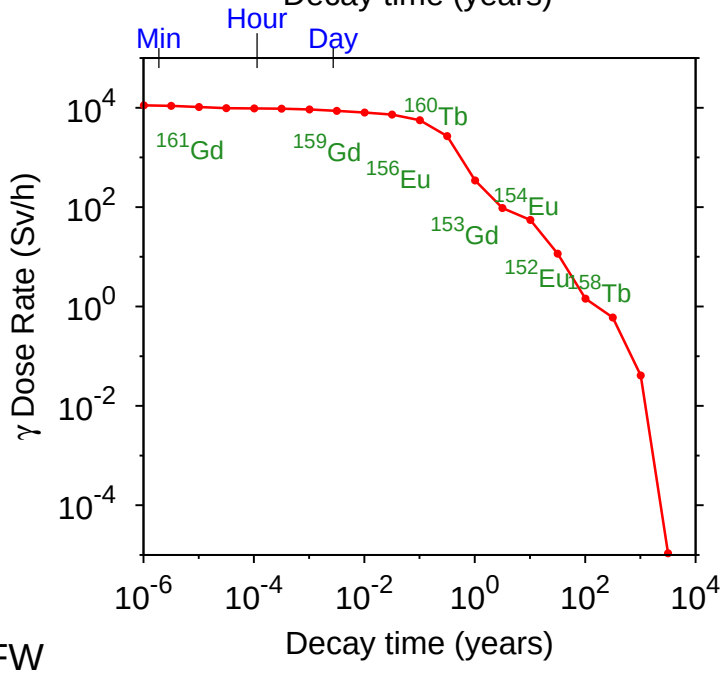
Heat Output





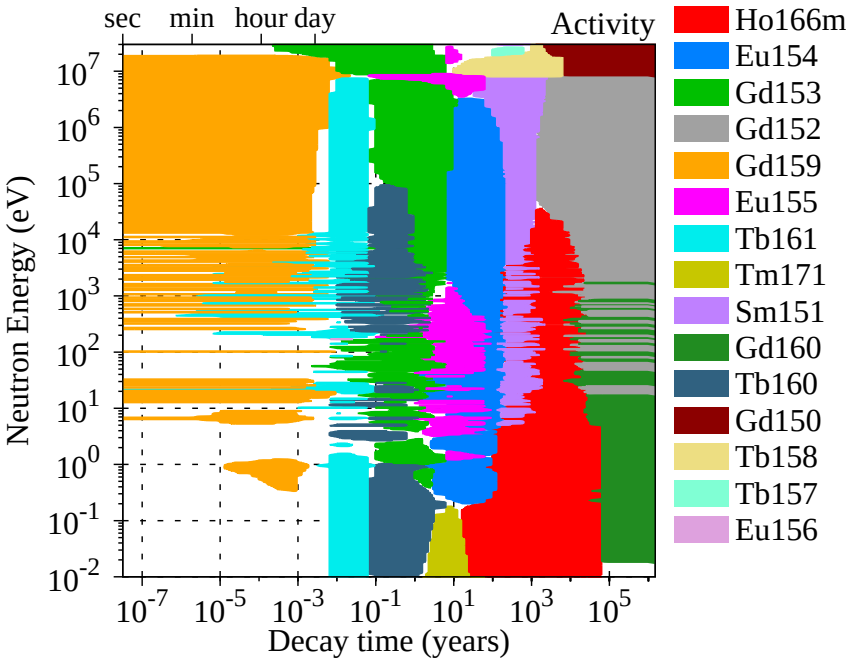
γ Dose Rate

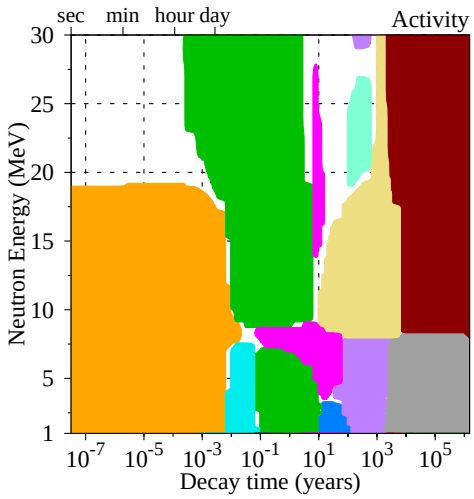


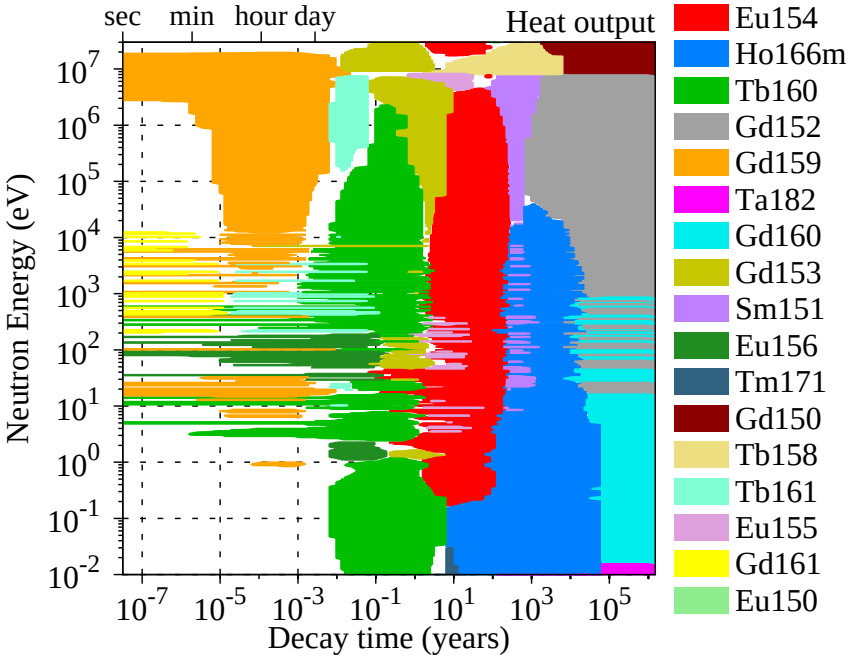


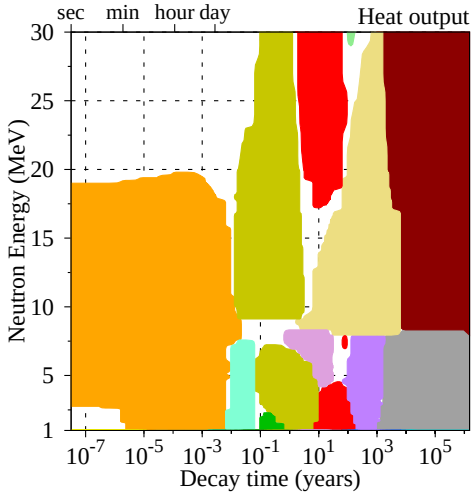
FW
Blanket
Manifold
Fe results

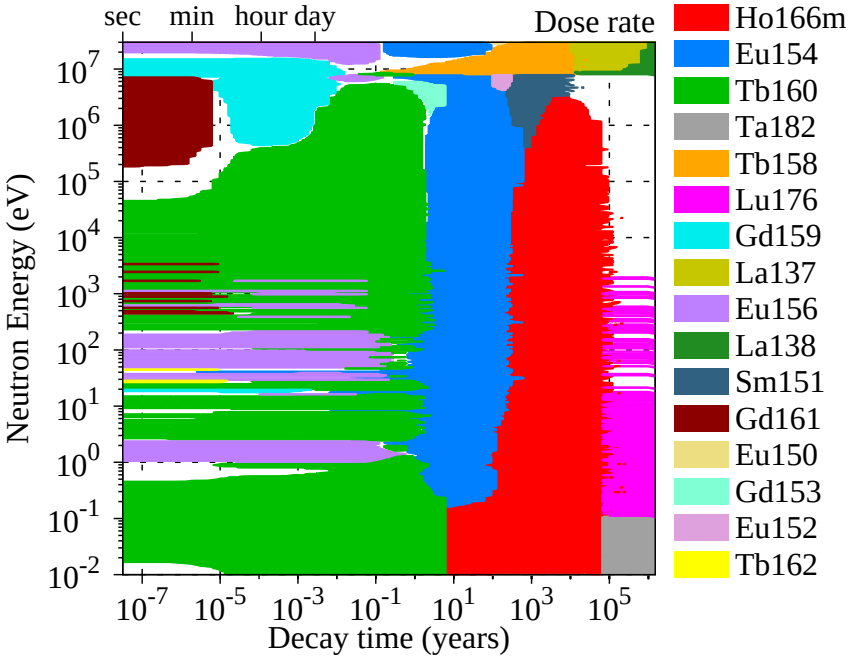
Gadolinium Importance diagrams

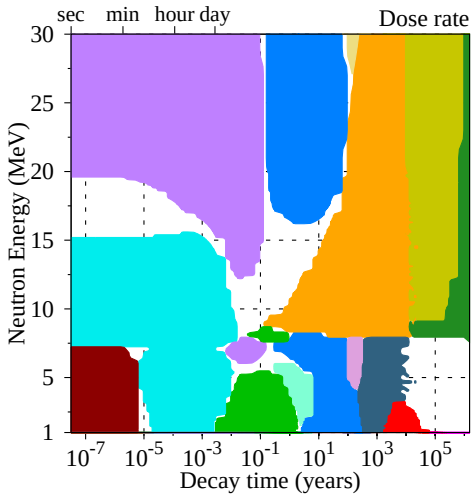




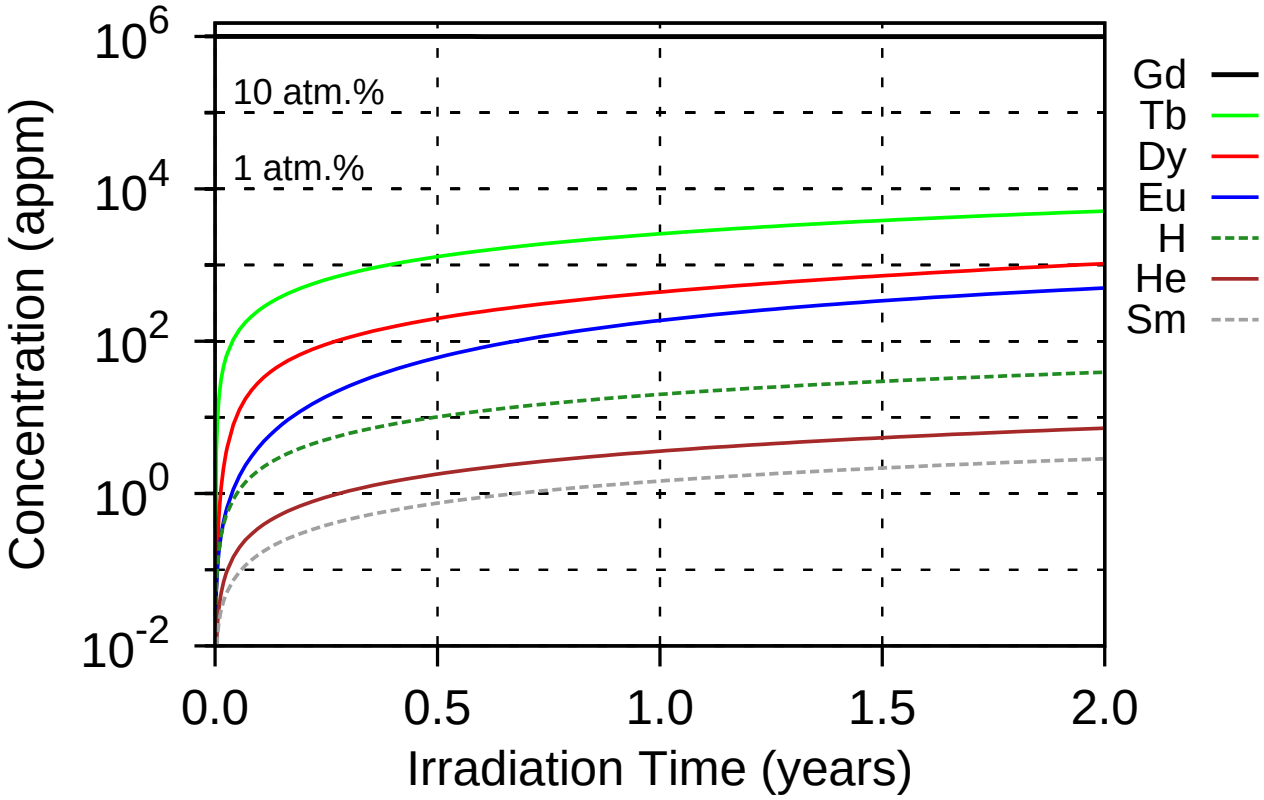




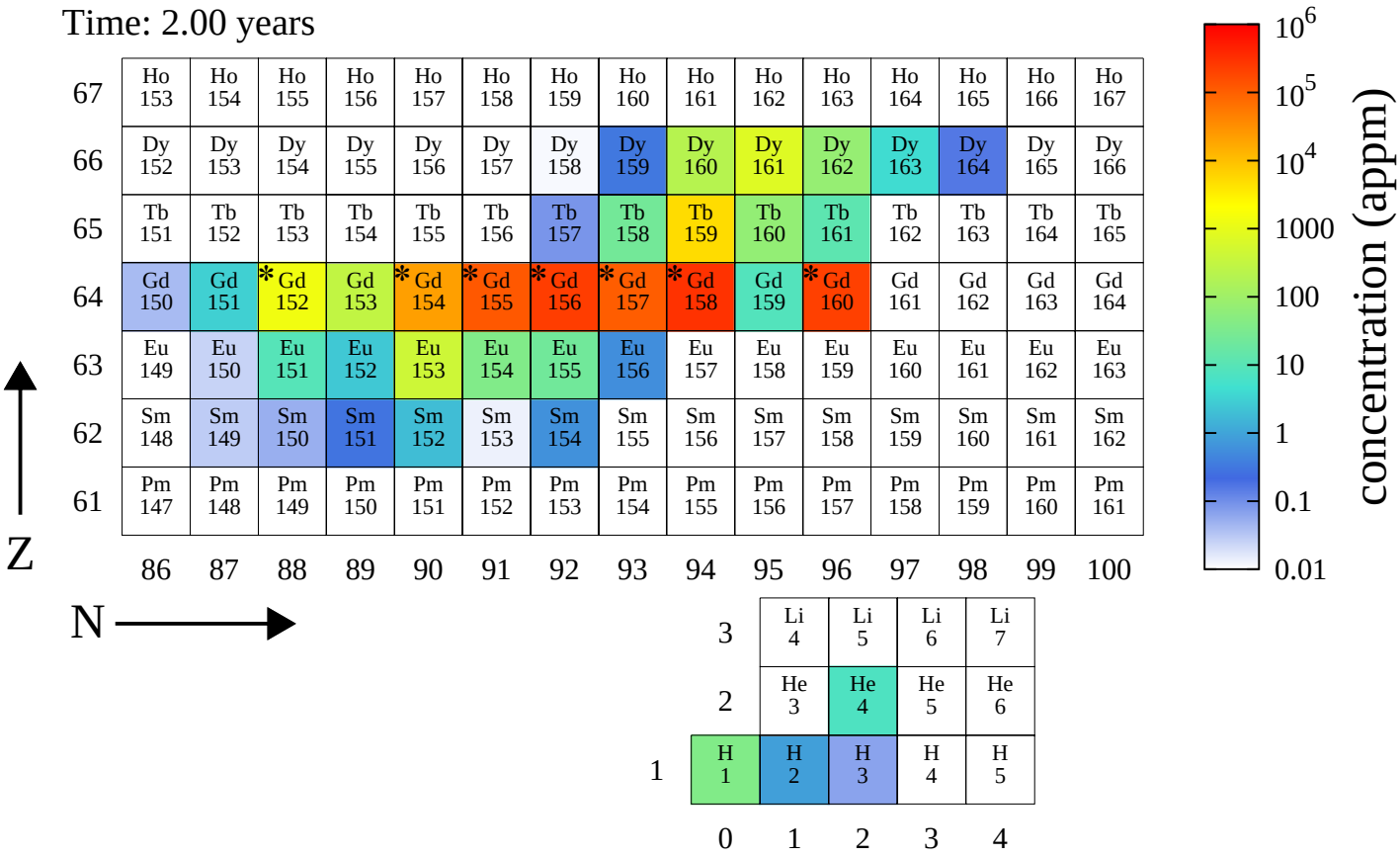




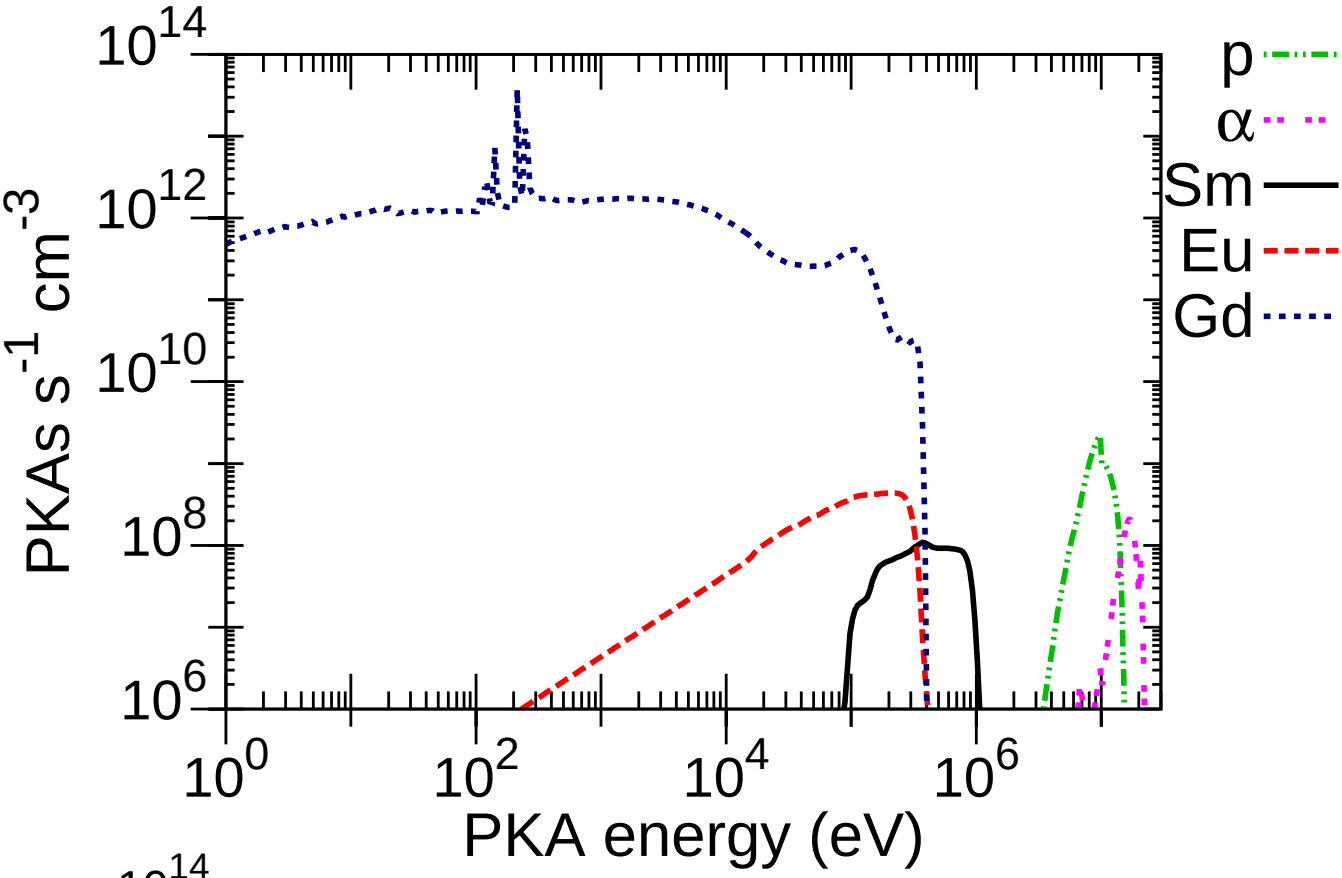
Gadolinium FW Transmutation

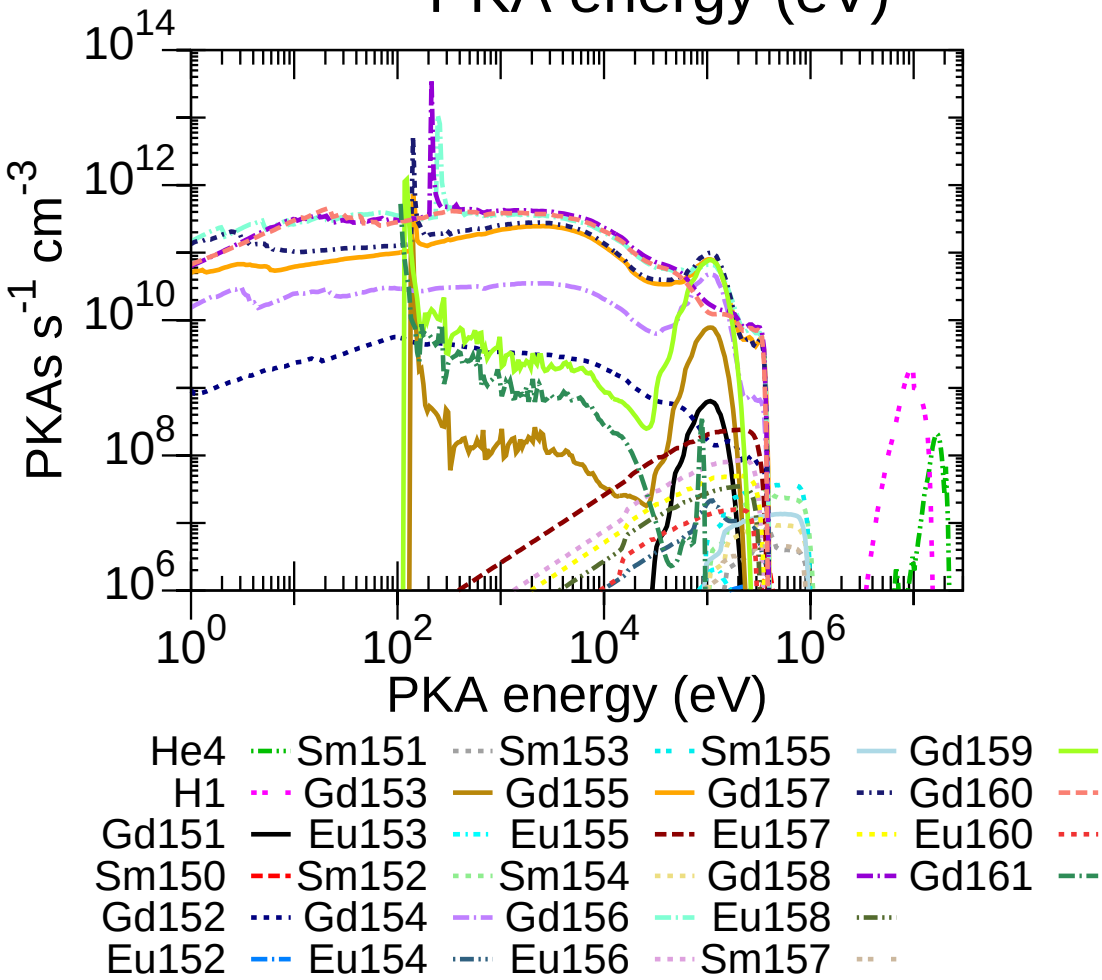


4 appm He & 20 appm H after 1 year 15 dpa/year



Gadolinium FW PKA distributions





Gadolinium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Gd161	3.66m	Gd160(n,γ)Gd161	99.9	100.0	100.0	100.0
Tb162	7.60m	Gd160(n,γ)Gd161(β^-)Tb161(n,γ)Tb162	36.0	98.9	100.0	
		Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162	34.3	1.0		
		Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ) Tb161(n,γ)Tb162	21.6			
		Gd160(n,γ)Gd161(n,γ)Gd162(β^-)Tb162	5.1			
		Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ) Tb160(n,γ)Tb161(n,γ)Tb162	1.6			
		Gd155(n,γ)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162	1.2			
Gd159	18.48h	Gd158(n,γ)Gd159	56.0	94.5	99.8	
		Gd157(n,γ)Gd158(n,γ)Gd159	35.3	5.4		
		Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159	4.8			
		Gd155(n,γ)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159	3.5			
		Gd160(n,2n)Gd159				99.9
Tb161	6.89d	Gd160(n,γ)Gd161(β^-)Tb161	38.0	98.9	100.0	99.9
		Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ)Tb161	36.1	1.0		
		Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160(n,γ)Tb161	22.8			
		Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ) Tb160(n,γ)Tb161	1.7			
		Gd155(n,γ)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160(n,γ)Tb161	1.3			
Eu156	15.19d	Gd154(n,α)Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ) Eu154(n,γ)Eu155(n,γ)Eu156	64.7			
		Gd154(n,α)Sm151(n,γ)Sm152(n,γ)Sm153(n,γ)Sm154(n,γ) Sm155(β^-)Eu155(n,γ)Eu156	18.3			
		Gd152(n,γ)Gd153(n,γ)Gd154(n,α)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	6.7			
		Gd152(n,α)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156	5.8			
		Gd152(n,α)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(n,γ)Sm154(n,γ)Sm155(β^-)Eu155(n,γ)Eu156	2.3			
		Gd152(n,γ)Gd153(n,γ)Gd154(n,α)Sm151(n,γ)Sm152(n,γ) Sm153(n,γ)Sm154(n,γ)Sm155(β^-)Eu155(n,γ)Eu156	1.7			
		Gd152(n,γ)Gd153(β^+)Eu153(n,γ)Eu154(n,γ)Eu155(n,γ)Eu156		99.6	2.3	
		Gd158(n,γ)Gd159(β^-)Tb159(n,α)Eu156			63.5	
		Gd155(n,p)Eu155(n,γ)Eu156			31.0	
		Gd158(n,α)Sm155(β^-)Eu155(n,γ)Eu156			2.9	
		Gd156(n,p)Eu156				86.8
		Gd157(n,2n)Gd156(n,p)Eu156				7.9
		Gd160(n,2n)Gd159(β^-)Tb159(n,α)Eu156				2.6
Tb160	72.28d	Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160	58.2	97.4	99.9	
		Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160	36.7	2.5		
		Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-)Tb159(n,γ)Tb160	2.8			
		Gd155(n,γ)Gd156(n,γ)Gd157(n,γ)Gd158(n,γ)Gd159(β^-) Tb159(n,γ)Tb160	2.0			
		Gd160(n,2n)Gd159(β^-)Tb159(n,γ)Tb160				97.9
		Gd160(n,γ)Gd161(β^-)Tb161(n,2n)Tb160				1.9
Ta182	114.71d	no pathways found				
Gd153	240.41d	Gd154(n,α)Sm151(β^-)Eu151(n,γ)Eu152m(β^-)Gd152(n,γ)Gd153	84.9			
		Gd152(n,γ)Gd153		100.0	100.0	
		Gd154(n,2n)Gd153				65.8
		Gd155(n,2n)Gd154(n,2n)Gd153				32.2
		Gd156(n,2n)Gd155(n,2n)Gd154(n,2n)Gd153				1.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm171	1.92y	Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	19.9			
		Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171	8.6			
		Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	7.9			
		Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	7.1			
		Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171	3.4			
		Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	3.4			
		Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-) Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	3.1			
		Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	2.7			
		Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(n,γ)Dy166(β^-) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	1.6			
		Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-) Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171	1.5			
		Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	1.2			
		Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.1			
Eu155	4.75y	Gd154(n,α)Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ) Eu154(n,γ)Eu155	62.9			
		Gd154(n,α)Sm151(n,γ)Sm152(n,γ)Sm153(n,γ)Sm154(n,γ) Sm155(β^-)Eu155	20.3			
		Gd152(n,γ)Gd153(n,γ)Gd154(n,α)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155	6.5			
		Gd152(n,α)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154(n,γ)Eu155	5.5			
		Gd152(n,α)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(n,γ)Sm154(n,γ)Sm155(β^-)Eu155	2.5			
		Gd152(n,γ)Gd153(n,γ)Gd154(n,α)Sm151(n,γ)Sm152(n,γ) Sm153(n,γ)Sm154(n,γ)Sm155(β^-)Eu155	1.9			
		Gd152(n,γ)Gd153(β^+)Eu153(n,γ)Eu154(n,γ)Eu155		99.6	6.9	
		Gd155(n,p)Eu155			84.6	86.7
		Gd158(n,α)Sm155(β^-)Eu155			7.9	3.9
		Gd156(n,2n)Gd155(n,p)Eu155				7.1

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Eu154	8.59y	Gd154(n,α)Sm151(n,γ)Sm152(n,γ)Sm153(β^-)Eu153(n,γ)Eu154	83.6			
		Gd152(n,γ)Gd153(n,γ)Gd154(n,α)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	8.7			
		Gd152(n,α)Sm149(n,γ)Sm150(n,γ)Sm151(n,γ)Sm152(n,γ) Sm153(β^-)Eu153(n,γ)Eu154	7.2			
		Gd152(n,γ)Gd153(β^+)Eu153(n,γ)Eu154		99.6	96.1	
		Gd152(n,γ)Gd153(β^+)Eu153(n,γ)Eu154m(IT)Eu154			3.8	
		Gd155(n,p)Eu155(n,2n)Eu154				32.5
		Gd154(n,p)Eu154				17.7
		Gd155(n,d)Eu154				10.9
		Gd155(n,p)Eu155(n,2n)Eu154m(IT)Eu154				10.4
		Gd155(n,np)Eu154				7.5
		Gd155(n,2n)Gd154(n,p)Eu154				6.7
		Gd154(n,p)Eu154m(IT)Eu154				2.8
		Gd156(n,2n)Gd155(n,p)Eu155(n,2n)Eu154				1.8
		Gd158(n,α)Sm155(β^-)Eu155(n,2n)Eu154				1.5
		Gd155(n,d)Eu154m(IT)Eu154				1.4
		Gd155(n,np)Eu154m(IT)Eu154				1.1
		Gd155(n,2n)Gd154(n,p)Eu154m(IT)Eu154				1.1
Eu152	13.52y	Gd154(n,α)Sm151(β^-)Eu151(n,γ)Eu152	84.2	94.2	93.9	
		Gd152(n,γ)Gd153(n,γ)Gd154(n,α)Sm151(β^-)Eu151(n,γ)Eu152	8.8			
		Gd152(n,α)Sm149(n,γ)Sm150(n,γ)Sm151(β^-)Eu151(n,γ)Eu152	5.9			
		Gd152(n,γ)Gd153(n,α)Sm150(n,γ)Sm151(β^-)Eu151(n,γ)Eu152		4.9		
		Gd154(n,α)Sm151(β^-)Eu151(n,γ)Eu152n(IT)Eu152			5.5	
		Gd154(n,2n)Gd153(β^+)Eu153(n,2n)Eu152				58.4
		Gd154(n,2n)Gd153(β^+)Eu153(n,2n)Eu152n(IT)Eu152				21.5
		Gd155(n,2n)Gd154(n,2n)Gd153(β^+)Eu153(n,2n)Eu152				11.8
		Gd155(n,2n)Gd154(n,2n)Gd153(β^+)Eu153(n,2n) Eu152n(IT)Eu152				4.3
		Gd156(n,α)Sm153(β^-)Eu153(n,2n)Eu152				1.4
Eu150	36.36y	Gd152(n,2n)Gd151(β^+)Eu151(n,2n)Eu150				98.2
Sm151	89.98y	Gd154(n,α)Sm151	85.1	86.5	100.0	48.6
		Gd152(n,γ)Gd153(n,γ)Gd154(n,α)Sm151	8.9			
		Gd152(n,α)Sm149(n,γ)Sm150(n,γ)Sm151	5.9			
		Gd152(n,γ)Gd153(n,α)Sm150(n,γ)Sm151		12.5		
		Gd155(n,2n)Gd154(n,α)Sm151				17.9
		Gd155(n,α)Sm152(n,2n)Sm151				15.8
		Gd155(n,nα)Sm151				11.3
		Gd156(n,nα)Sm152(n,2n)Sm151				1.1
Tb157	98.98y	Gd160(n,2n)Gd159(β^-)Tb159(n,2n)Tb158(n,2n)Tb157				78.5
		Gd160(n,2n)Gd159(β^-)Tb159(n,2n)Tb158m(IT) Tb158(n,2n)Tb157				21.3
Tb158	180.04y	Gd160(n,2n)Gd159(β^-)Tb159(n,2n)Tb158				78.5
		Gd160(n,2n)Gd159(β^-)Tb159(n,2n)Tb158m(IT)Tb158				21.4
Ho166m	1.2 10^3y	Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	29.7			
		Gd160(n,γ)Gd161(β^-)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	12.8			
		Gd160(n,γ)Gd161(β^-)Tb161(n,γ)Tb162(β^-)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	1.1			
La137	6.0 10^4y	no pathways found				
Gd150	1.8 10^6y	Gd152(n,2n)Gd151(n,2n)Gd150				67.2
		Gd152(n,2n)Gd151(β^+)Eu151(n,2n)Eu150m(β^-)Gd150				31.0
Lu176	4.0 10^{10}y	no pathways found				
La138	1.0 10^{11}y	no pathways found				
Gd152	1.1 10^{14}y	Gd154(n,α)Sm151(β^-)Eu151(n,γ)Eu152m(β^-)Gd152	84.9			
		Gd154(n,2n)Gd153(n,2n)Gd152				3.6
		Gd155(n,2n)Gd154(n,2n)Gd153(n,2n)Gd152				1.0
Gd160	1.3 10^{17}y	no pathways found				

Terbium

Isotope	Atom % abundance
Tb159	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.32E+15	3.18E+15	2.93E+15	8.67E+13	2.63E+12	4.25E+00
Tb160	80.2	83.8	87.7	92.6		
Tb161	14.9	15.5	11.7			
Tb158m	4.3					
Tb158	0.1	0.1	0.1	4.4	99.3	
Dy159	0.4	0.5	0.5	2.9		
Ho166m						98.7
Ho163						1.3

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	6.14E-01	6.12E-01	5.85E-01	1.84E-02	3.87E-04	1.19E-15
Tb160	96.3	96.8	97.7	96.8		
Tb161	3.0	3.0	2.2			
Tb158	0.1	0.1	0.1	3.1	100.0	
Ho166m						100.0

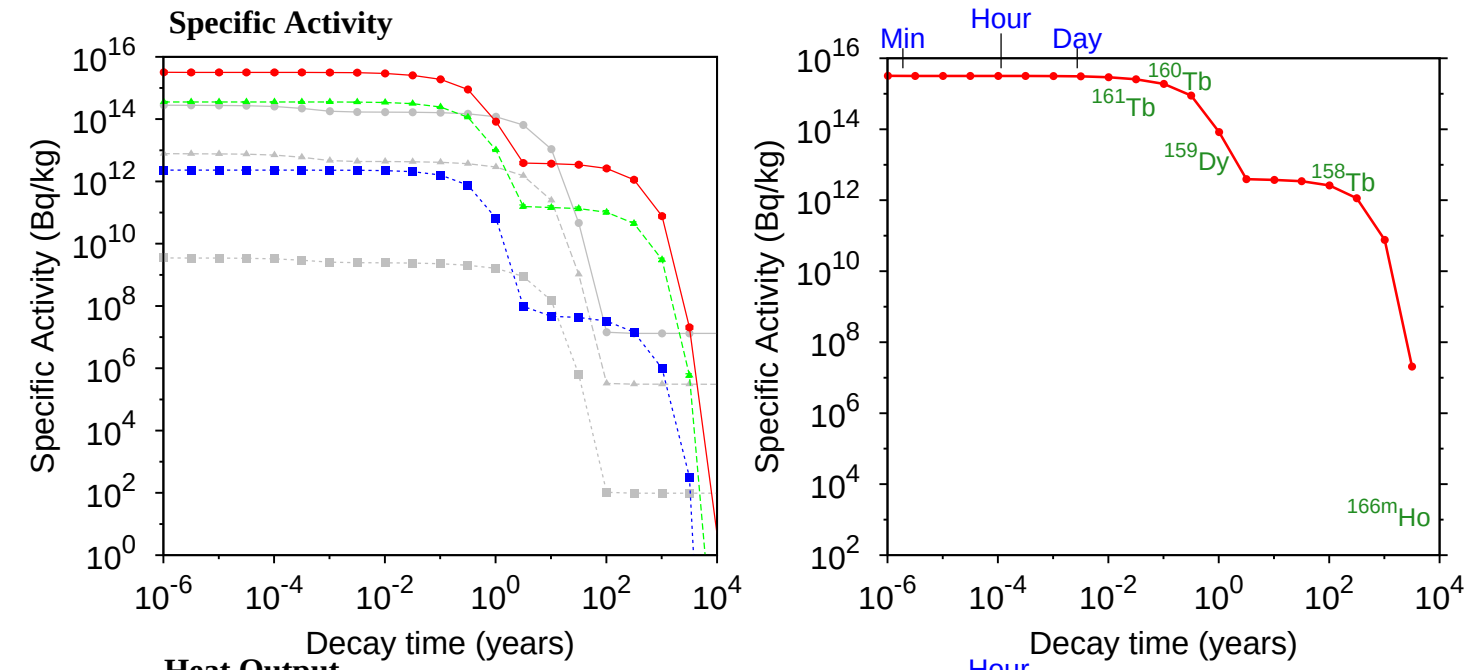
Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	7.02E+05	7.02E+05	6.78E+05	2.18E+04	4.70E+02	1.26E-09
Tb160	99.8	99.8	99.9	96.8		
Tb158	0.1	0.1	0.1	3.2	100.0	
Ho166m						100.0

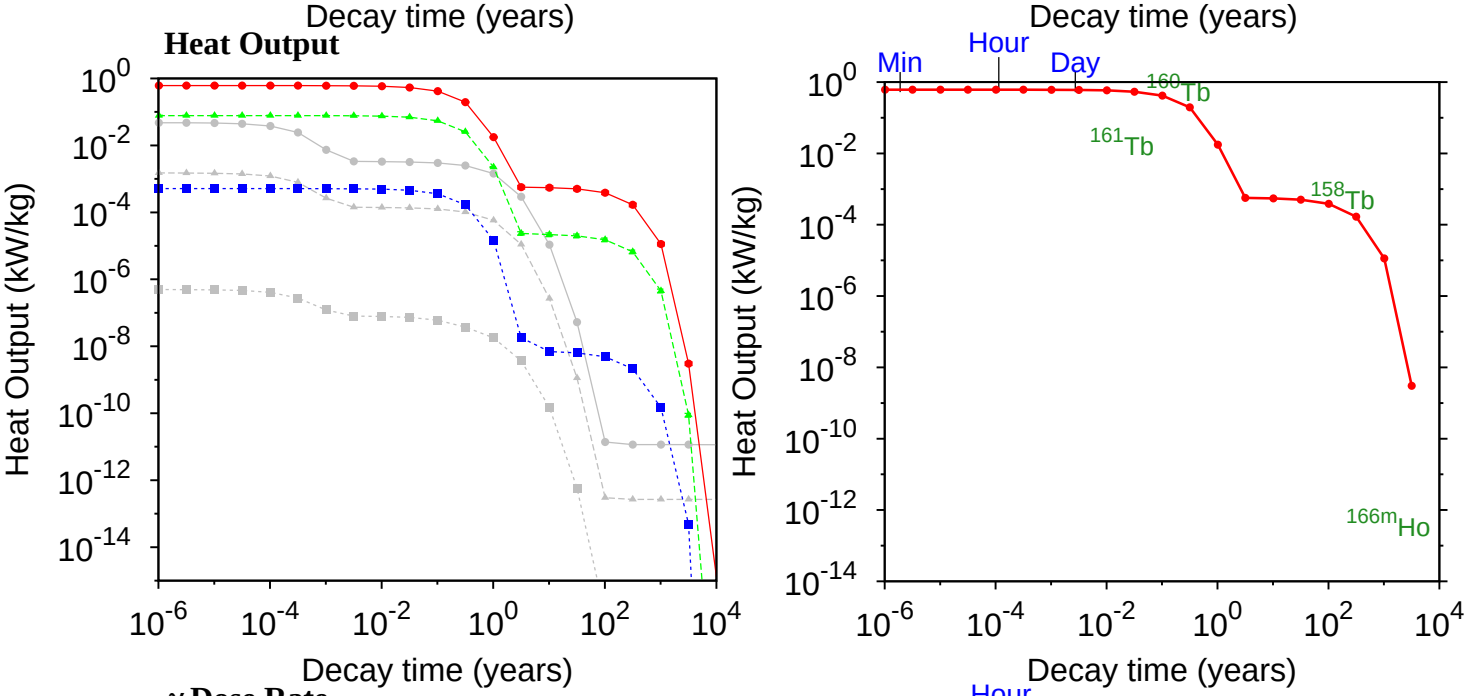
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.67E+06	4.65E+06	4.37E+06	1.33E+05	2.87E+03	8.39E-09
Tb160	91.2	91.6	94.2	96.6		
Tb161	7.6	7.6	5.6			
Tb158	0.1	0.1	0.1	3.2	100.0	
Ho166m						100.0

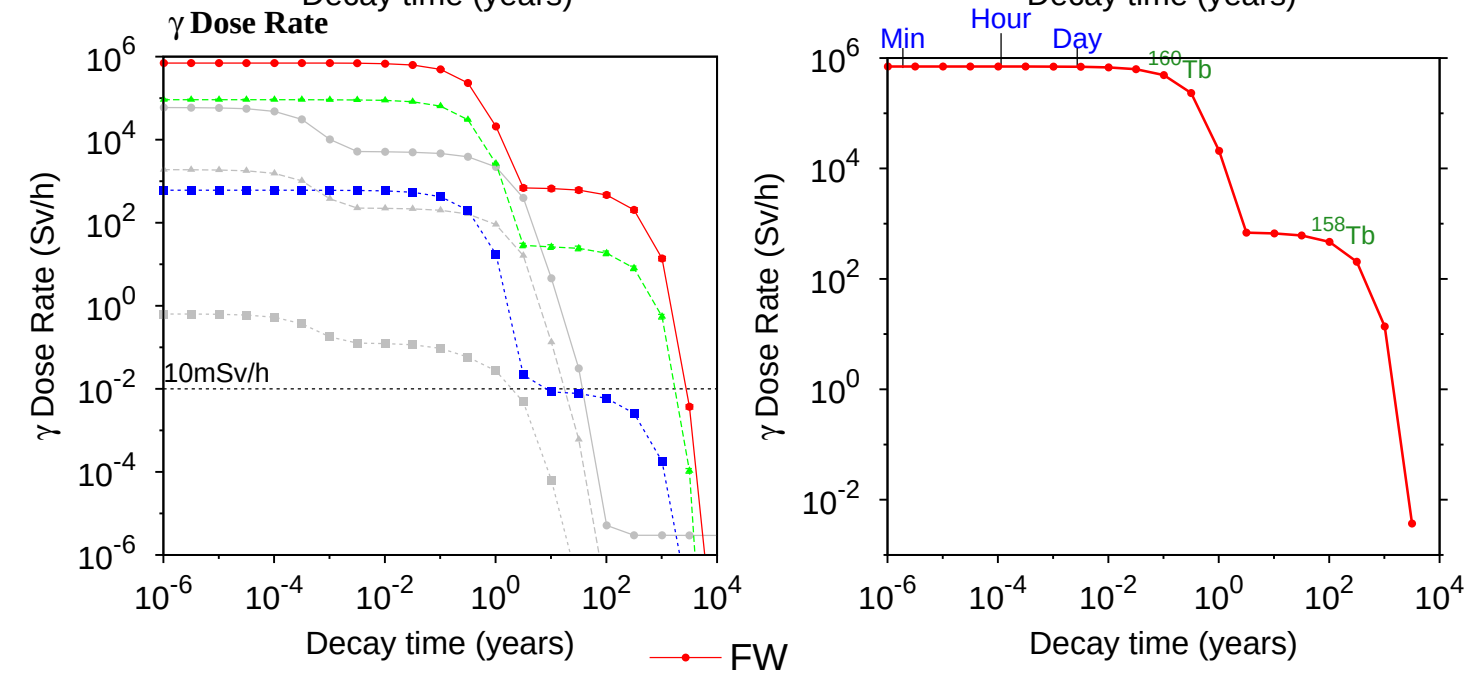
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.95E+07	1.95E+07	1.86E+07	7.39E+05	1.20E+05	5.03E-07
Tb160	95.5	95.6	96.6	76.1		
Tb161	3.3	3.3	2.4			
Tb158	0.9	0.9	0.9	23.8	100.0	
Ho166m						100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.70E+12	2.69E+12	2.59E+12	8.36E+10	2.17E+09	6.88E-03
Tb160	98.6	98.8	99.1	96.0		
Tb158	0.1	0.1	0.1	3.8	100.0	
Ho166m						100.0

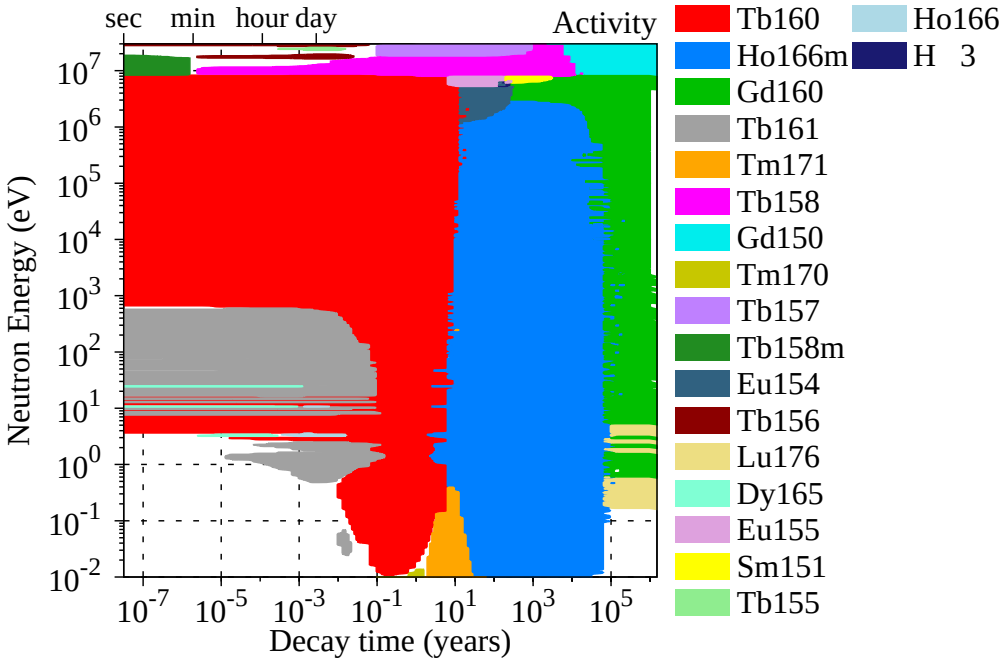
Terbium activation characteristics

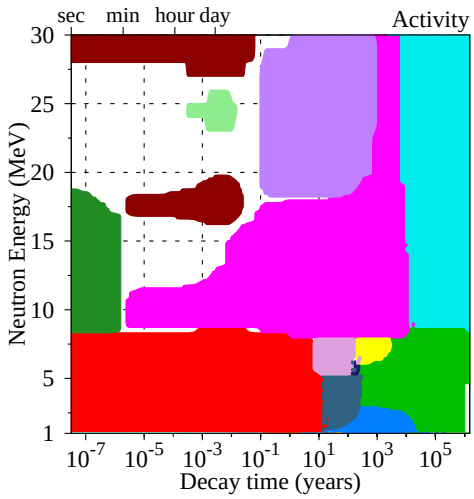


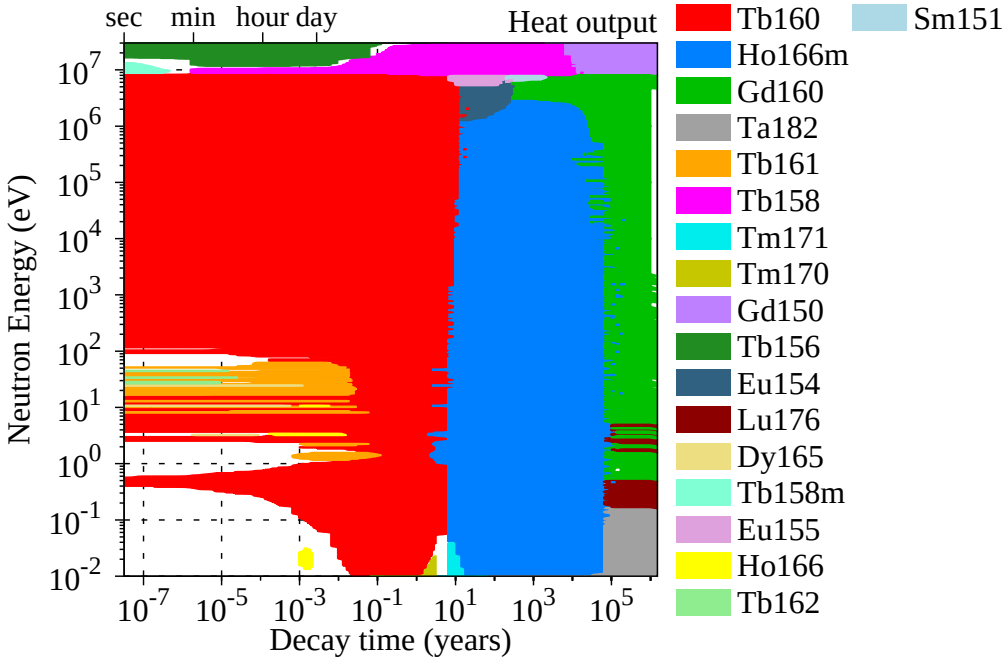


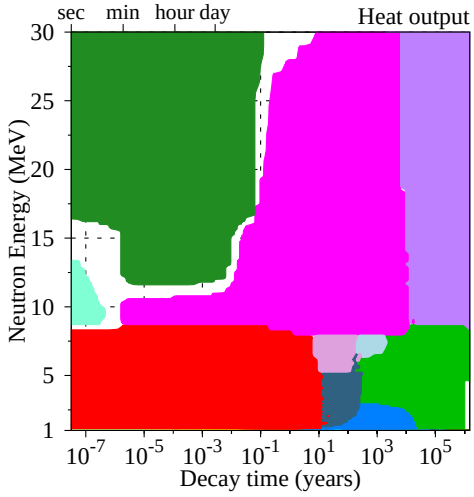


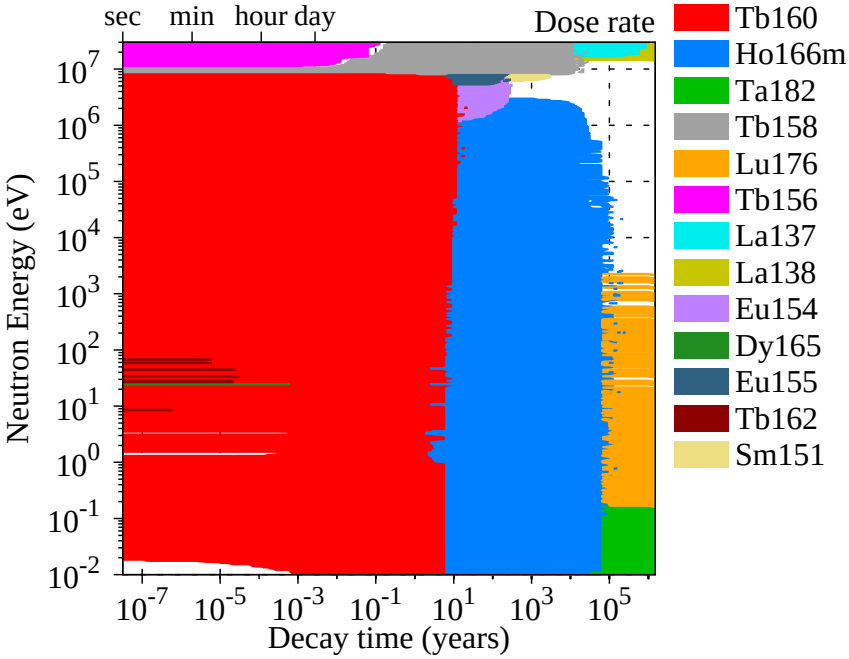
Terbium Importance diagrams

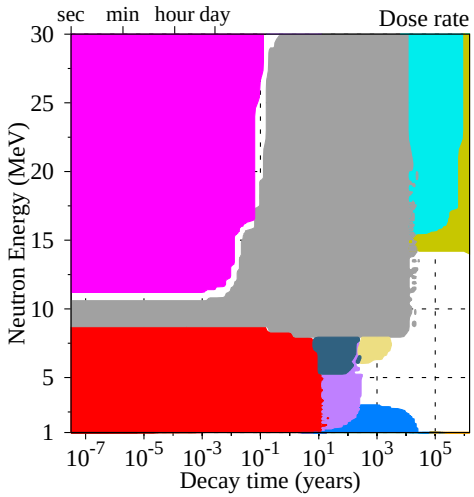




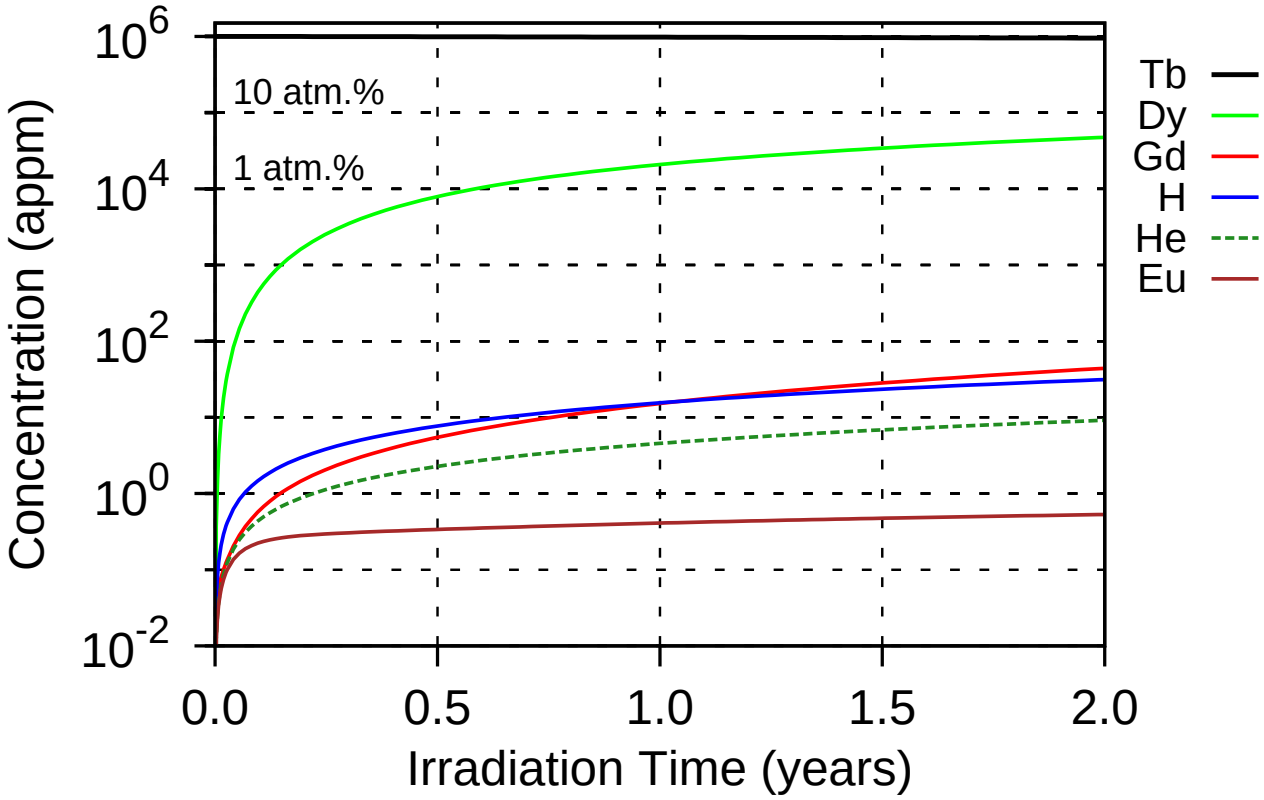




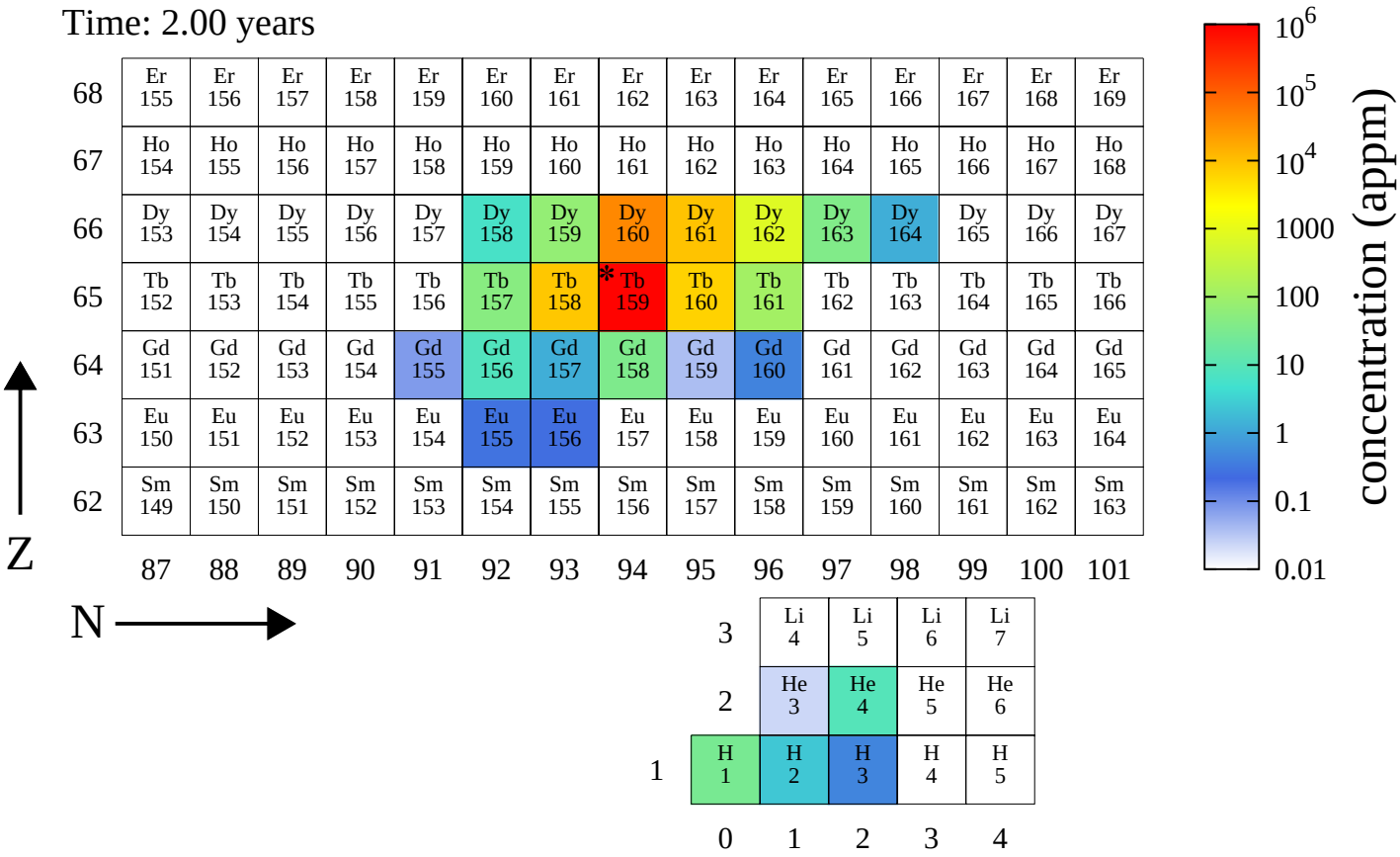




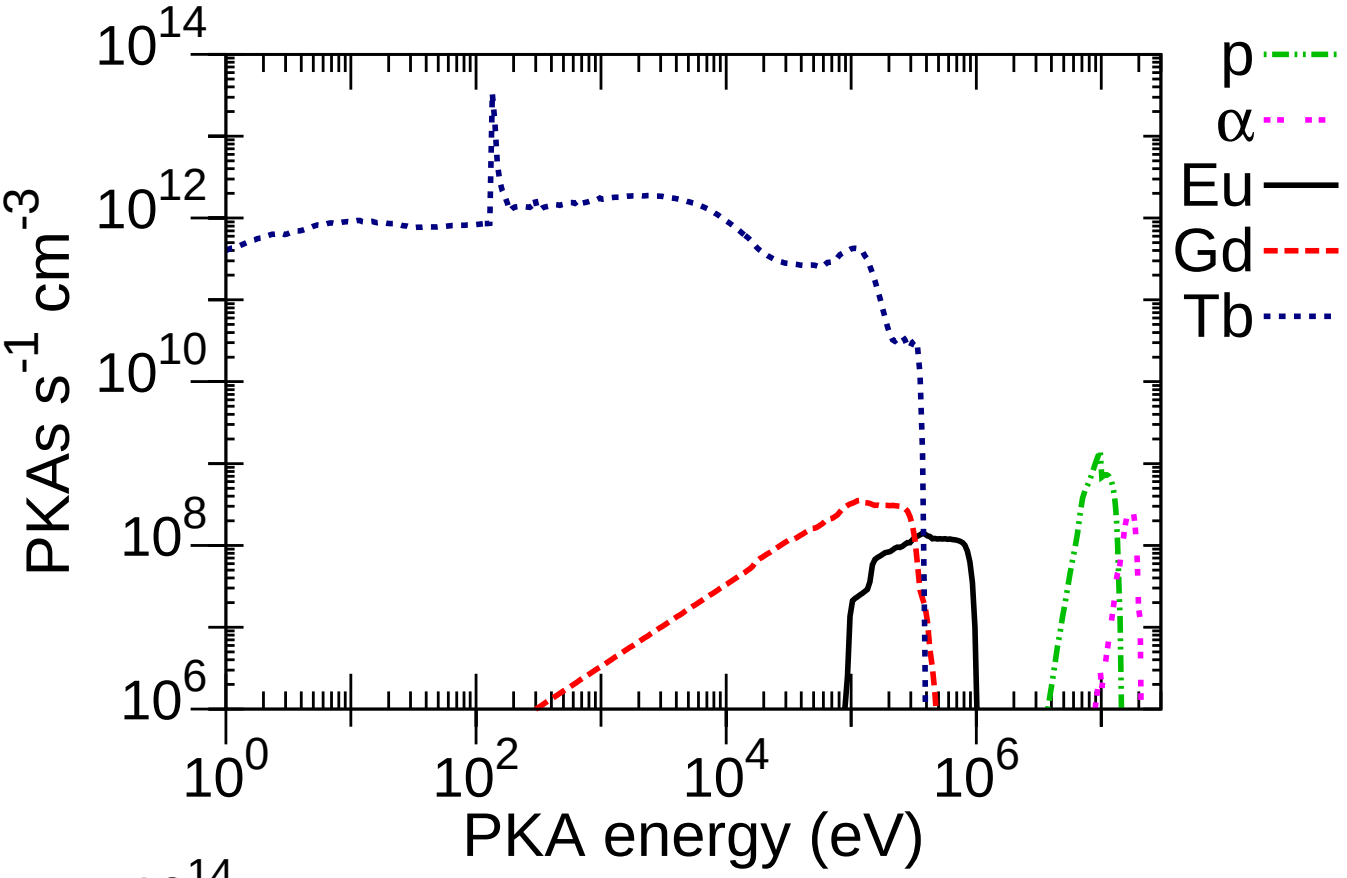
Terbium FW Transmutation

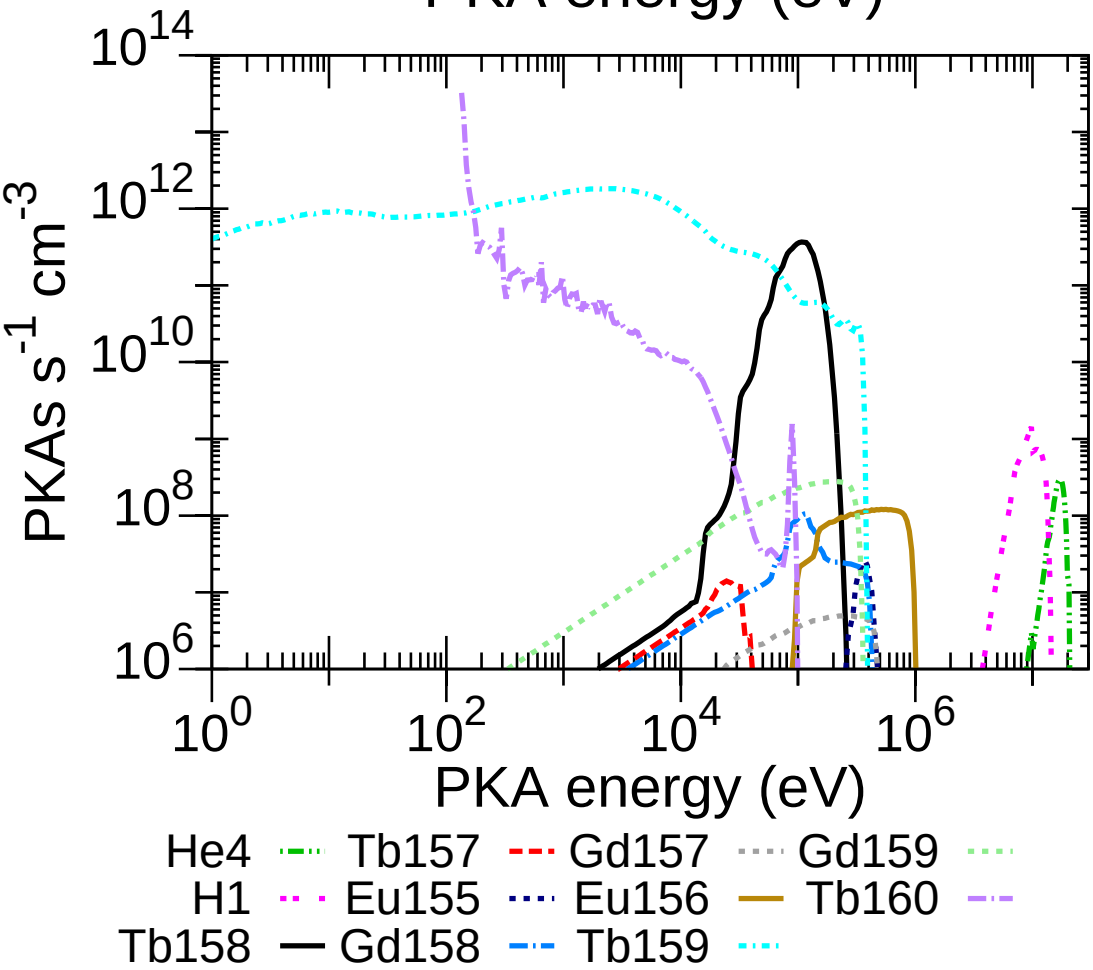


5 appm He & 16 appm H after 1 year 15 dpa/year



Terbium FW PKA distributions





Terbium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tb158m	10.80s	Tb159(n,2n)Tb158m				99.7
Tb162	7.60m	Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162	100.0	100.0	100.0	
Dy165	2.33h	Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165	47.4	50.2	9.4	
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165	20.7	9.2	38.6	
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165	20.5	29.8	9.8	
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165	9.0	5.5	40.4	
		Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162(β^-)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165	1.7	3.3		
		Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162(β^-)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165		2.0		
Ho166	1.12d	Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166	48.3	48.9		
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166	20.9	29.0		
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166	16.0	7.6		
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166	6.9	4.5		
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(n,γ)Dy166(β^-)Ho166	1.8			
		Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162(β^-)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166	1.7	4.0		
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(β^-)Ho165(n,γ)Ho166	1.2	1.2		
		Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162(β^-)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166		2.4		
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166m(n,E)Ho166		1.0		
Tb156	5.17d	Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156				56.4
		Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156n(IT)Tb156				19.7
		Tb159(n,2n)Tb158m(IT)Tb158(n,2n)Tb157(n,2n)Tb156				15.3
		Tb159(n,2n)Tb158m(IT)Tb158(n,2n)Tb157(n,2n) Tb156n(IT)Tb156				5.4
		Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156m(IT)Tb156				2.4
Tb155	5.32d	Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156(n,2n)Tb155				55.4
		Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156n(IT) Tb156(n,2n)Tb155				19.4
		Tb159(n,2n)Tb158m(IT)Tb158(n,2n)Tb157(n,2n) Tb156(n,2n)Tb155				15.1
		Tb159(n,2n)Tb158m(IT)Tb158(n,2n)Tb157(n,2n)Tb156n(IT) Tb156(n,2n)Tb155				5.3
		Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156m(IT) Tb156(n,2n)Tb155				2.4
Tb161	6.89d	Tb159(n,γ)Tb160(n,γ)Tb161	100.0	100.0	100.0	99.7
Tb160	72.28d	Tb159(n,γ)Tb160	100.0	100.0	100.0	100.0
Ta182	114.71d	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm170	128.61d	Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170	24.5			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	10.6			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170	9.7			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170	9.7			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170	4.6			
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170	4.3			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	4.2			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-) Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170	4.2			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170	3.3			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-) Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	2.0			
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.9			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(n,γ)Dy166(β^-) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170	1.8			
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170	1.7			
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170	1.4			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170	1.4			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170	1.3			
		Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162(β^-)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170	1.0			
Dy159	144.39d	Tb159(n,γ)Tb160(β^-)Dy160(n,2n)Dy159				99.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm171	1.92y	Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	24.9			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171	10.8			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	9.8			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	8.9			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171	4.3			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	4.2			
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	4.1			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-) Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	3.9			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	3.4			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(n,γ)Dy166(β^-) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	2.0			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-) Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171	1.8			
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171	1.8			
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	1.6			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	1.5			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.3			
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.3			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm171	cont.	Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162(β^-)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	1.0			
Eu155	4.75y	Tb159(n,2n)Tb158(n,α)Eu155				56.3
		Tb159(n,nα)Eu155				25.8
		Tb159(n,2n)Tb158m(IT)Tb158(n,α)Eu155				15.3
		Tb159(n,α)Eu156(n,2n)Eu155				2.4
Eu154	8.59y	Tb159(n,2n)Tb158(n,α)Eu155(n,2n)Eu154				21.7
		Tb159(n,2n)Tb158(n,2n)Tb157(n,α)Eu154				17.6
		Tb159(n,nα)Eu155(n,2n)Eu154				15.1
		Tb159(n,2n)Tb158(n,nα)Eu154				8.5
		Tb159(n,2n)Tb158(n,α)Eu155(n,2n)Eu154m(IT)Eu154				6.9
		Tb159(n,2n)Tb158m(IT)Tb158(n,α)Eu155(n,2n)Eu154				5.9
		Tb159(n,nα)Eu155(n,2n)Eu154m(IT)Eu154				4.8
		Tb159(n,2n)Tb158m(IT)Tb158(n,2n)Tb157(n,α)Eu154				4.8
		Tb159(n,2n)Tb158(n,2n)Tb157(n,α)Eu154m(IT)Eu154				3.9
		Tb159(n,2n)Tb158(n,nα)Eu154m(IT)Eu154				2.7
		Tb159(n,2n)Tb158m(IT)Tb158(n,nα)Eu154				2.3
		Tb159(n,2n)Tb158m(IT)Tb158(n,α)Eu155(n,2n) Eu154m(IT)Eu154				1.9
		Tb159(n,α)Eu156(n,2n)Eu155(n,2n)Eu154				1.3
		Tb159(n,2n)Tb158m(IT)Tb158(n,2n)Tb157(n,α) Eu154m(IT)Eu154				1.1
H3	12.33y	Tb159(n,t)H3				96.6
		Tb159(n,2n)Tb158(n,t)H3				2.6
Sm151	89.98y	Tb159(n,α)Eu156(β^-)Gd156(n,nα)Sm152(n,2n)Sm151				8.7
		Tb159(n,α)Eu156(β^-)Gd156(n,2n)Gd155(n,nα)Sm151				7.1
		Tb159(n,2n)Tb158(n,α)Eu155(n,2n)Eu154(n,α)Pm151(β^-)Sm151				6.1
		Tb159(n,nα)Eu155(n,2n)Eu154(n,α)Pm151(β^-)Sm151				5.7
		Tb159(n,α)Eu156(β^-)Gd156(n,2n)Gd155(n,2n)Gd154(n,α)Sm151				5.5
		Tb159(n,2n)Tb158(n,2n)Tb157(n,α)Eu154(n,α)Pm151(β^-)Sm151				4.9
		Tb159(n,α)Eu156(β^-)Gd156(n,2n)Gd155(n,α)Sm152(n,2n)Sm151				4.8
		Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156(β^+)Gd156(n,nα) Sm152(n,2n)Sm151				4.3
		Tb159(n,2n)Tb158(n,α)Eu155(n,nα)Pm151(β^-)Sm151				4.0
		Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156(β^+)Gd156(n,2n) Gd155(n,nα)Sm151				3.6
		Tb159(n,2n)Tb158(n,nα)Eu154(n,α)Pm151(β^-)Sm151				3.2
		Tb159(n,nα)Eu155(n,nα)Pm151(β^-)Sm151				2.8
		Tb159(n,2n)Tb158(n,α)Eu155(n,2n)Eu154m(IT)Eu154(n,α) Pm151(β^-)Sm151				1.9
		Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156(β^+)Gd156(n,2n) Gd155(n,2n)Gd154(n,α)Sm151				1.9
		Tb159(n,nα)Eu155(n,2n)Eu154m(IT)Eu154(n,α)Pm151(β^-)Sm151				1.8
		Tb159(n,2n)Tb158(n,α)Eu155(n,α)Pm152(β^-)Sm152(n,2n)Sm151				1.7
		Tb159(n,2n)Tb158m(IT)Tb158(n,α)Eu155(n,2n)Eu154(n,α) Pm151(β^-)Sm151				1.7
		Tb159(n,nα)Eu155(n,α)Pm152(β^-)Sm152(n,2n)Sm151				1.6
		Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156(β^+)Gd156(n,2n) Gd155(n,α)Sm152(n,2n)Sm151				1.6
		Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156n(IT)Tb156(β^+) Gd156(n,nα)Sm152(n,2n)Sm151				1.5
		Tb159(n,2n)Tb158m(IT)Tb158(n,2n)Tb157(n,α)Eu154(n,α) Pm151(β^-)Sm151				1.3
		Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156n(IT)Tb156(β^+) Gd156(n,2n)Gd155(n,nα)Sm151				1.2
		Tb159(n,2n)Tb158m(IT)Tb158(n,2n)Tb157(n,2n)Tb156(β^+) Gd156(n,nα)Sm152(n,2n)Sm151				1.2
		Tb159(n,2n)Tb158m(IT)Tb158(n,α)Eu155(n,nα)Pm151(β^-)Sm151				1.1
		Tb159(n,2n)Tb158(n,2n)Tb157(n,α)Eu154m(IT)Eu154(n,α) Pm151(β^-)Sm151				1.1
		Tb159(n,2n)Tb158(n,nα)Eu154m(IT)Eu154(n,α)Pm151(β^-)Sm151				1.0
		Tb159(n,2n)Tb158m(IT)Tb158(n,2n)Tb157(n,2n)Tb156(β^+) Gd156(n,2n)Gd155(n,nα)Sm151				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tb157	98.98y	Tb159(n,2n)Tb158(n,2n)Tb157				78.6
		Tb159(n,2n)Tb158m(IT)Tb158(n,2n)Tb157				21.4
Tb158	180.04y	Tb159(n,2n)Tb158				78.6
		Tb159(n,2n)Tb158m(IT)Tb158				21.4
Ho166m	1.2 10^3y	Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	50.2	50.1	11.5	
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	21.7	29.7	12.0	
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	16.6	7.0	35.3	
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	7.2	4.2	37.0	
		Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162(β^-)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	1.8	4.7	1.5	
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(β^-)Ho165(n,γ)Ho166m	1.3	1.2		
		Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162(β^-)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m		2.8	1.6	
Ho163	4.6 10^3y	no pathways found				
La137	6.0 10^4y	no pathways found				
Gd150	1.8 10^6y	no pathways found				
Lu176	4.0 10^{10}y	Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	16.8			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	10.7			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ) Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	7.3			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	6.6			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ) Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	4.6			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	4.2			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ) Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	3.6			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ) Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	2.8			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Lu176	cont.	Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ) Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	2.3			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(n,γ)Dy166(β^-) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	2.0			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-) Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	2.0			
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.9			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ) Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.8			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.7			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-) Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.6			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(n,γ)Dy166(β^-) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.5			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-) Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.5			
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.1			
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.0			
La138	1.0 10^{11}y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Gd160	1.3 10^{17}y	Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,γ)Dy162(n,γ) Dy163(n,α)Gd160	77.3	71.9		
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,α)Gd160	19.7	13.2		
		Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162(β^-)Dy162(n,γ) Dy163(n,α)Gd160	2.9	4.8		
		Tb159(n,γ)Tb160(n,γ)Tb161(β^-)Dy161(n,α)Gd158(n,γ) Gd159(n,γ)Gd160		8.1		
		Tb159(n,γ)Tb160(β^-)Dy160(n,γ)Dy161(n,α)Gd158(n,γ) Gd159(n,γ)Gd160		1.8		
		Tb159(n,γ)Tb160(n,p)Gd160			100.0	99.3

Dysprosium

Isotope	Atom % abundance
Dy156	0.06
Dy158	0.10
Dy160	2.34
Dy161	18.91
Dy162	25.51
Dy163	24.90
Dy164	28.18

($T_{1/2}$ =1.0 10^{18}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	6.97E+14	4.49E+14	2.33E+13	2.93E+12	5.47E+10	6.92E+06
Dy165	51.2	77.9				
Dy165m	36.2	3.1				
Ho166	7.4	11.5	23.0			
Dy159	2.3	3.6	68.0	95.1		
Dy157	1.0	1.6				
Tb160	0.2	0.3	5.1	1.3		
Tb161	0.1	0.2	2.3			
Tb157			0.4	3.3	87.2	
Tb158				0.2	9.0	
Ho166m				0.1	3.7	96.7
Ho163						3.3

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.97E-02	3.42E-02	1.08E-03	3.63E-05	1.43E-06	1.90E-09
Dy165	68.4	77.7				
Ho166	15.1	17.5	57.7			
Dy165m	12.7	0.8				
Dy157	1.0	1.2				
Tb160	0.7	0.8	24.5	22.8		
Dy159	0.4	0.4	13.7	71.9		
Tb161	0.1	0.1	1.8			
Tb156	0.1	0.1	1.4			
Tb158			0.1	3.0	51.1	
Ho166m			0.1	1.7	40.3	100.0
Tb157				0.7	8.6	

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.53E+03	2.10E+03	3.72E+02	1.26E+01	1.50E+00	1.99E-03
Dy165	43.2	51.0				
Dy165m	13.6	0.9				
Tb160	12.8	15.4	84.2	77.5		
Ho166	11.7	14.0	8.3			
Dy157	7.5	9.0				
Tb164	2.6	0.9				
Tb162	2.3	1.7				
Ho167	2.3	2.7				
Tb156	1.3	1.5	5.4			
Dy155	1.1	1.3				
Dy159	0.2	0.2	1.3	6.9		
Tb158	0.1	0.1	0.4	10.3	59.1	
Ho166m			0.2	5.1	40.5	100.0

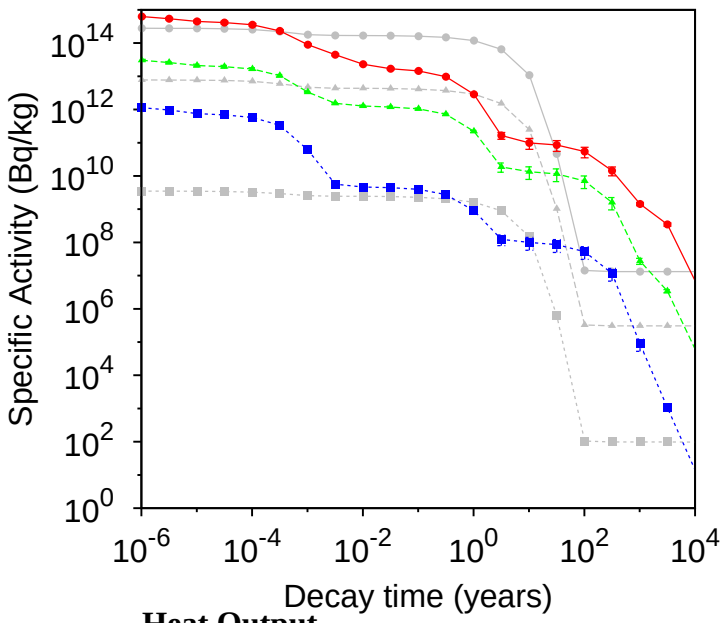
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.32E+05	1.26E+05	1.15E+04	3.54E+02	1.11E+01	1.34E-02
Ho166	54.7	57.1	65.2			
Dy165	29.8	30.5				
Tb163	6.2	5.4				
Tb162	4.1	2.7				
Tb160	1.5	1.6	16.6	16.8		
Dy159	1.2	1.3	13.8	78.8		
Tb164	1.0	0.3				
Tb161	0.4	0.4	3.3			
Tb158			0.1	2.2	48.8	
Ho166m				1.2	36.7	100.0
Tb157				0.9	14.5	

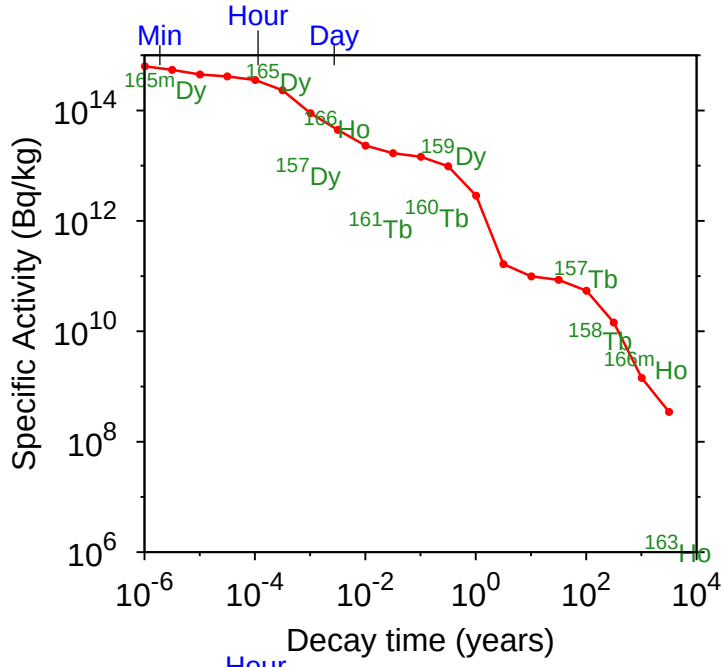
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	8.98E+04	8.39E+04	1.92E+04	2.00E+03	5.30E+02	8.03E-01
Ho166	37.3	39.9	18.1			
Dy165	23.9	25.0				
Tb163	10.9	9.7				
Tb160	9.6	10.3	43.4	13.0		
Tb162	7.0	4.6				
Dy159	6.6	7.1	30.5	51.6		
Tb164	1.8	0.6				
Tb161	1.1	1.2	3.6			
Tb158	0.4	0.4	1.7	16.6	42.9	
Ho166m	0.3	0.3	1.4	13.0	46.3	100.0
Tb157	0.1	0.1	0.6	5.7	10.8	

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.54E+10	7.68E+09	2.16E+09	1.81E+08	7.99E+06	1.10E+04
Dy165m	49.4	5.5				
Dy157	16.5	32.9	0.1			
Tb160	8.0	16.1	55.1	20.6		
Dy159	5.0	10.0	34.8	73.5		
Ho167	4.6	9.2				
Ho166	3.3	6.7	2.5			
Dy165	2.3	4.6				
Tb162	2.0	2.5				
Tb164	1.9	1.1				
Tb163	1.3	2.1				
Ho164	1.2	2.2				
Dy155	1.1	2.2				
Tb156	0.9	1.9	4.1			
Ho164m	0.7	1.3				
Tb155	0.3	0.6	1.5			
Tb161	0.3	0.5	1.3			
Tb158		0.1	0.3	3.3	51.5	
Ho166m			0.2	2.0	41.9	100.0
Tb157				0.6	6.6	

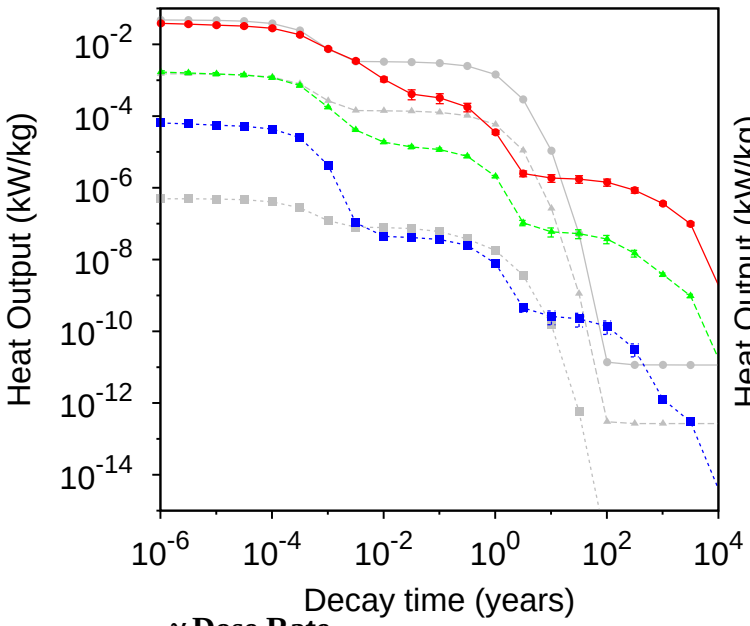
Dysprosium activation characteristics

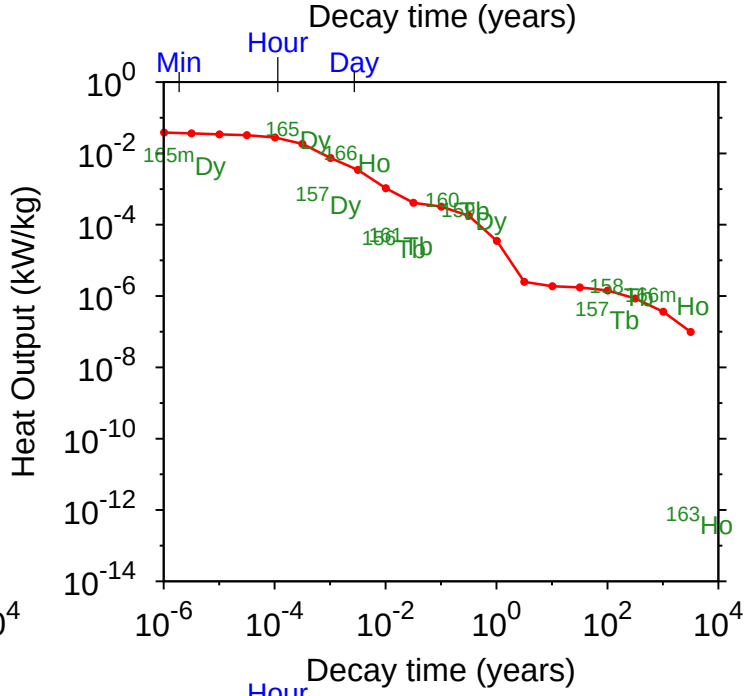
Specific Activity



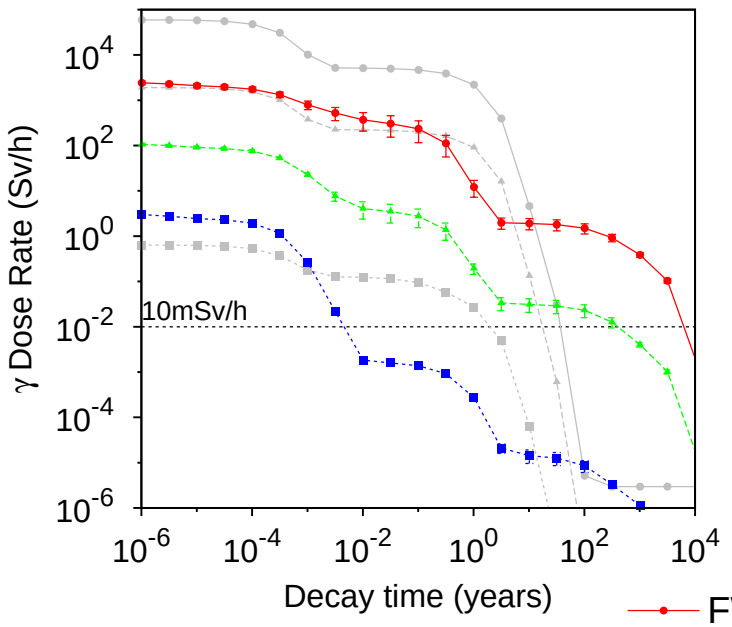


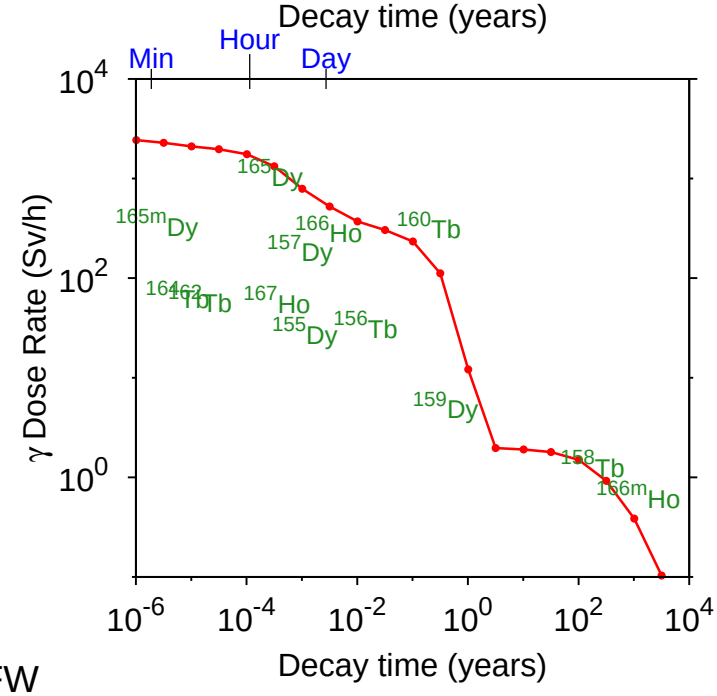
Heat Output





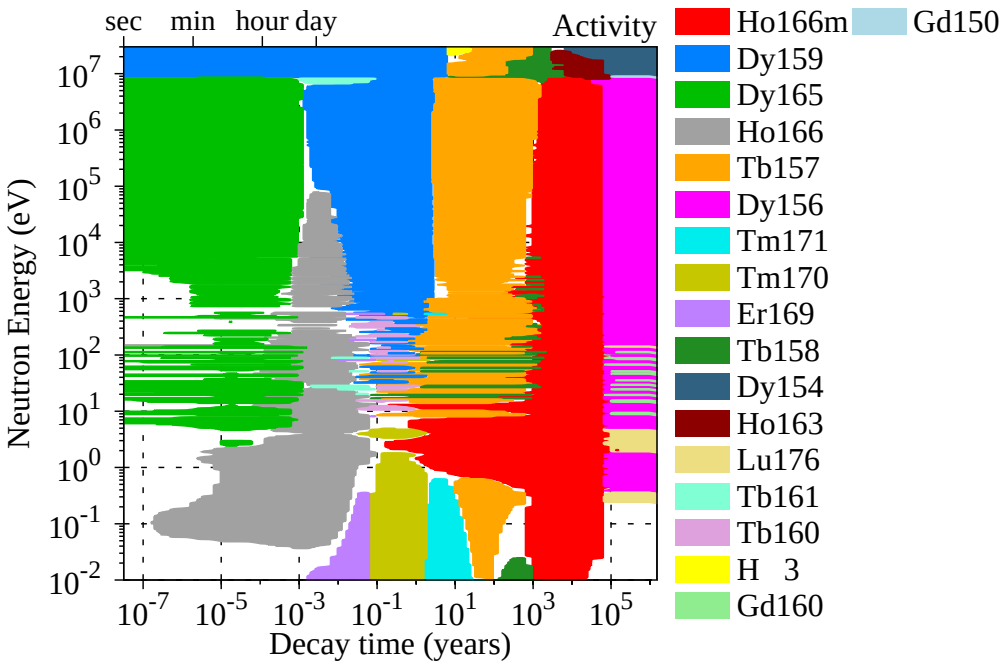
γ Dose Rate

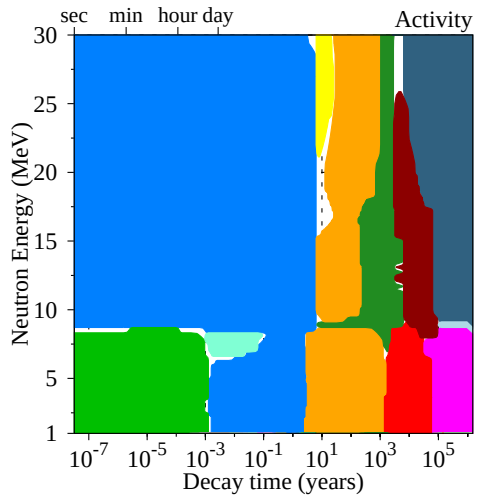


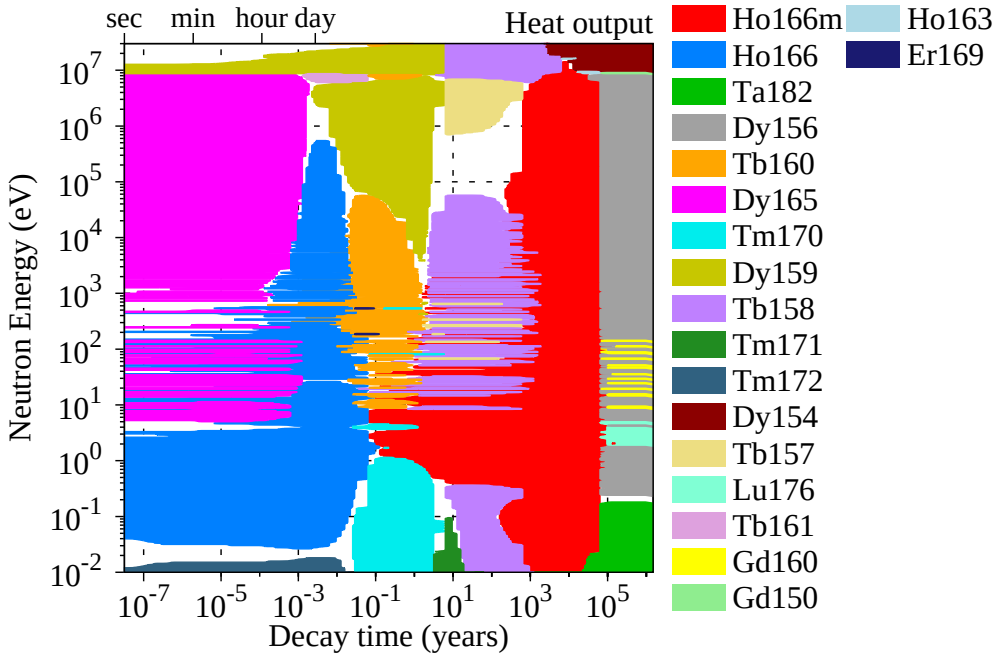


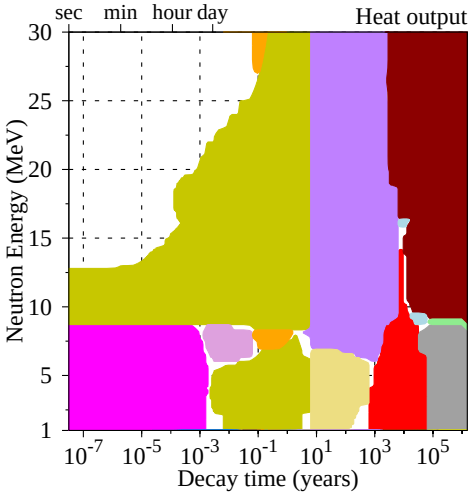
FW
Blanket
Manifold
Fe results

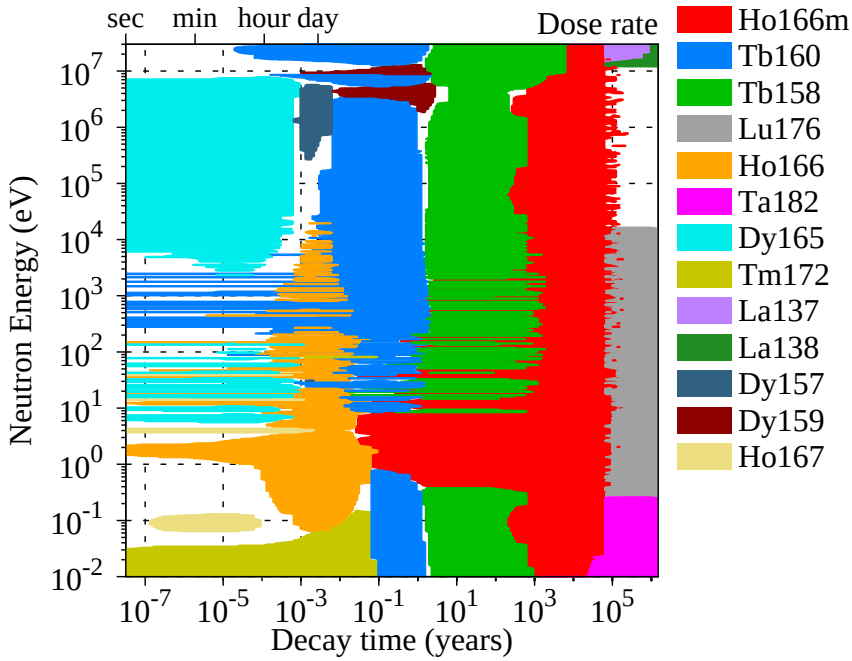
Dysprosium Importance diagrams

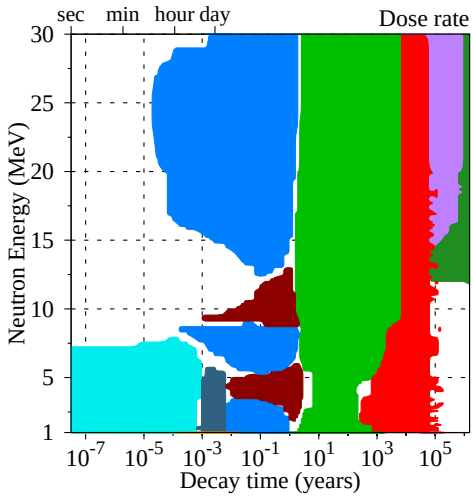




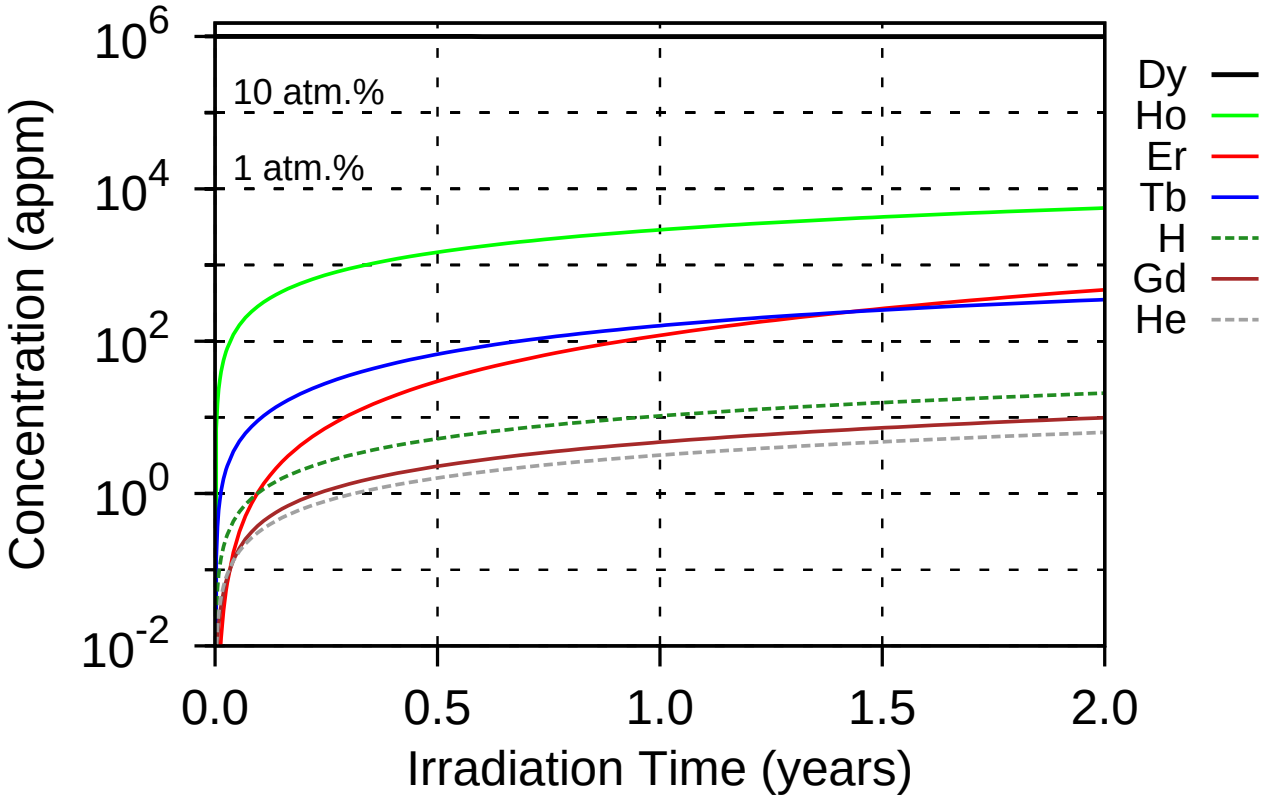






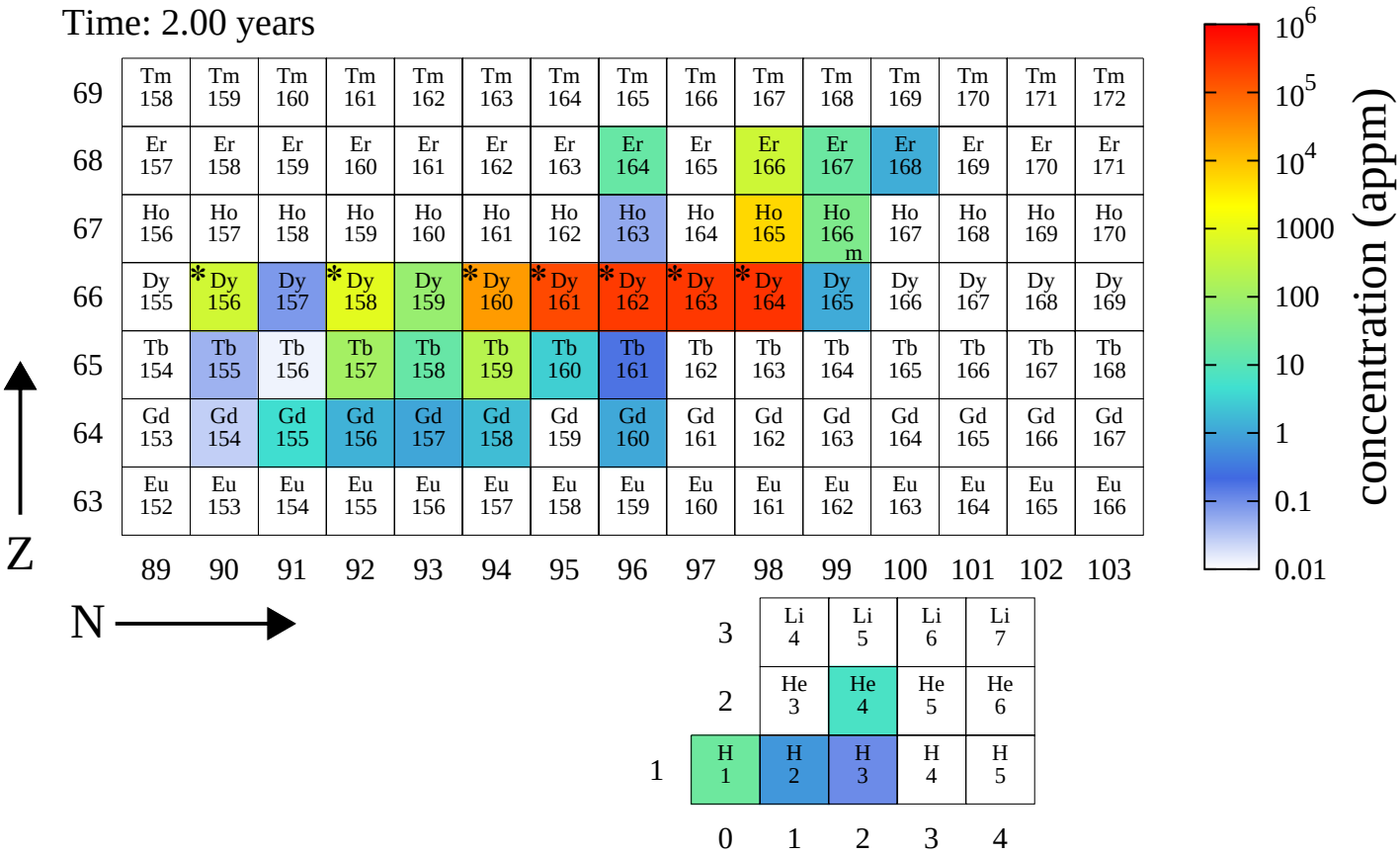


Dysprosium FW Transmutation

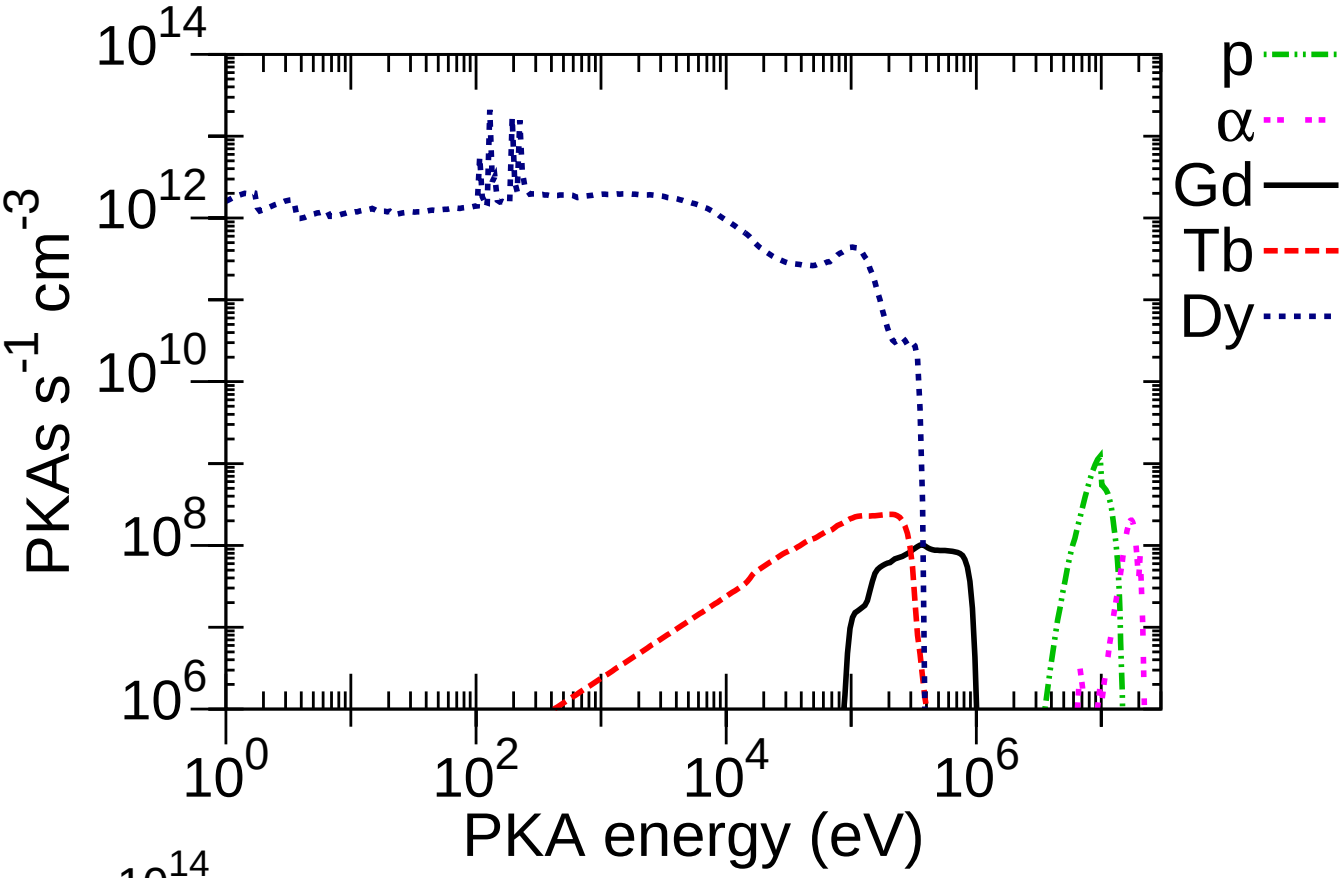


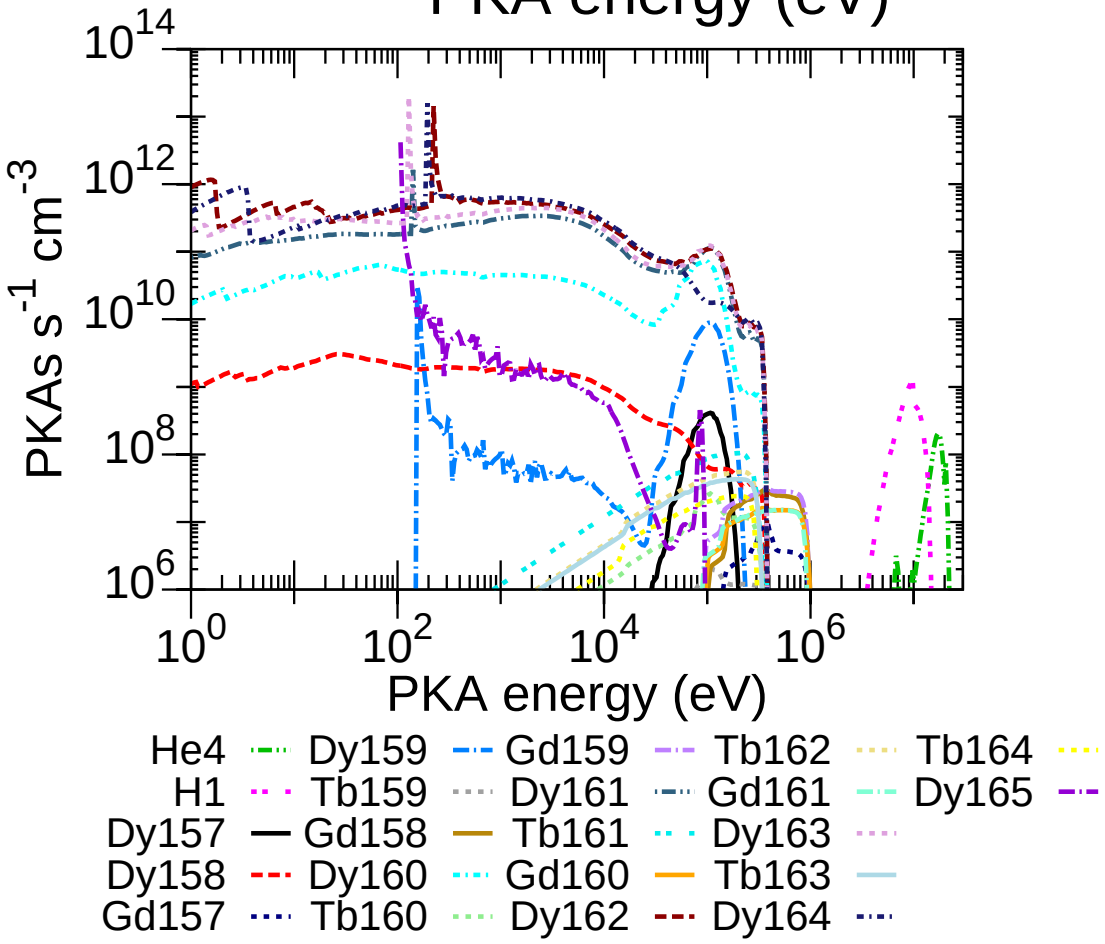
3 appm He & 10 appm H after 1 year

15 dpa/year



Dysprosium FW PKA distributions





Dysprosium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Dy165m	1.26m	Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m	52.1			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m	18.6			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m	17.7			
		Dy163(n,γ)Dy164(n,γ)Dy165m	5.8	5.8		
		Dy158(n,γ)Dy159(n,γ)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m	4.6			
		Dy164(n,γ)Dy165m		94.1	99.9	100.0
Tb164	3.00m	Dy164(n,p)Tb164				100.0
Tb162	7.60m	Dy156(n,γ)Dy157(β^+)Tb157(n,γ)Tb158(n,γ)Tb159(n,γ) Tb160(n,γ)Tb161(n,γ)Tb162	83.2	2.0		
		Dy156(n,γ)Dy157(β^+)Tb157(n,γ)Tb158m(IT)Tb158(n,γ) Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162	14.3			
		Dy158(n,γ)Dy159(β^+)Tb159(n,γ)Tb160(n,γ)Tb161(n,γ)Tb162	1.6	97.6		
		Dy164(n,γ)Dy165(β^-)Ho165(n,α)Tb162			50.1	
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,α)Tb162			47.8	
		Dy164(n,γ)Dy165m(β^-)Ho165(n,α)Tb162			1.2	
		Dy162(n,p)Tb162				84.8
		Dy163(n,2n)Dy162(n,p)Tb162				10.9
		Dy163(n,d)Tb162				2.2
Tb163	19.50m	Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,α)Tb163		33.0	47.0	
		Dy158(n,γ)Dy159(β^+)Tb159(n,γ)Tb160(n,γ)Tb161(n,γ) Tb162(n,γ)Tb163		28.5		
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,α)Tb163		19.6	49.3	
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,α)Tb163		9.2	1.1	
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,α)Tb163		5.5	1.2	
		Dy164(n,γ)Dy165m(β^-)Ho165(n,γ)Ho166m(n,α)Tb163			1.2	
		Dy163(n,p)Tb163				85.4
		Dy164(n,2n)Dy163(n,p)Tb163				12.2
		Dy164(n,d)Tb163				1.9
Ho164	28.60m	Dy164(n,γ)Dy165(β^-)Ho165(n,2n)Ho164				38.7
		Dy164(n,γ)Dy165(β^-)Ho165(n,2n)Ho164m(IT)Ho164				35.6
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,2n)Ho164				13.1
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,2n)Ho164m(IT)Ho164				12.0
Ho164m	37.61m	Dy164(n,γ)Dy165(β^-)Ho165(n,2n)Ho164m				74.2
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,2n)Ho164m				25.1
Dy165	2.33h	Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165	36.3			
		Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165	15.7			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165	13.0			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165	12.3			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165	5.6			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165	5.3			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165	4.0	3.7		
		Dy158(n,γ)Dy159(n,γ)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165	3.2			
		Dy163(n,γ)Dy164(n,γ)Dy165	1.7	2.2		
		Dy158(n,γ)Dy159(n,γ)Dy160(n,γ)Dy161(n,γ)Dy162(n,γ) Dy163(n,γ)Dy164(n,γ)Dy165	1.4			
		Dy164(n,γ)Dy165m(IT)Dy165		59.0	48.8	25.3
		Dy164(n,γ)Dy165		35.1	51.1	74.7

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ho167	3.10h	Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167	15.5			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167	12.8			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167	10.3			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167	6.7			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167	6.2			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167	6.1			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167	5.5			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167	5.2			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167	4.5			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167	4.2	1.4		
		Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167	3.8			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167	2.7			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167	2.7			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167	2.5	59.7	48.2	
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167	2.2			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167	1.8			
		Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167	1.6			
		Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167	1.5			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167	1.1	35.5	50.5	
		Dy164(n,γ)Dy165m(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167		1.5	1.2	
Dy157	8.14h	Dy156(n,γ)Dy157	100.0	100.0	100.0	
		Dy158(n,2n)Dy157				90.7
		Dy160(n,2n)Dy159(n,2n)Dy158(n,2n)Dy157				6.4
		Dy161(n,2n)Dy160(n,2n)Dy159(n,2n)Dy158(n,2n)Dy157				2.7
Dy155	9.90h	Dy156(n,2n)Dy155				100.0
Ho166	1.12d	Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166	21.7			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166	18.0			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166	14.4	1.8		
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166	9.4			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166	8.6	57.1	45.6	23.3
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166	7.8			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166	6.2	1.1		
		Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166	5.3			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166	3.7	33.9	47.8	69.0
		Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166	2.3			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,E)Ho166		2.8	2.3	1.7
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,E)Ho166		1.7	2.4	5.0
		Dy164(n,γ)Dy165m(β^-)Ho165(n,γ)Ho166		1.4	1.1	

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm172	2.65d	Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	8.4			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	6.7			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	6.1			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	6.0			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	4.4			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	4.0			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	3.6			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	3.4			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	3.3			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	2.9			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	2.8			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	2.7			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	2.6			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	2.6			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	2.4			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	2.2			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.9			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.9			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.7			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.7			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.5			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm172	cont.	Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.5			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.4			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.2			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.1			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.1			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.1			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.1			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	1.0			
Tb156	5.17d	Dy156(n,p)Tb156			86.6	2.5
		Dy156(n,p)Tb156m(IT)Tb156			13.0	
		Dy158(n,2n)Dy157(β^+)Tb157(n,2n)Tb156				64.9
		Dy158(n,2n)Dy157(β^+)Tb157(n,2n)Tb156n(IT)Tb156				22.7
		Dy158(n,2n)Dy157(β^+)Tb157(n,2n)Tb156m(IT)Tb156				2.8
		Dy160(n,2n)Dy159(n,2n)Dy158(n,2n)Dy157(β^+)Tb157(n,2n)Tb156				1.8
		Dy160(n,2n)Dy159(β^+)Tb159(n,2n)Tb158(n,2n)Tb157(n,2n)Tb156				1.3
Tb155	5.32d	Dy156(n,2n)Dy155(β^+)Tb155				99.9
Tb161	6.89d	Dy156(n,γ)Dy157(β^+)Tb157(n,γ)Tb158(n,γ)Tb159(n,γ)Tb160(n,γ)Tb161	83.9	2.0		
		Dy156(n,γ)Dy157(β^+)Tb157(n,γ)Tb158m(IT)Tb158(n,γ)Tb159(n,γ)Tb160(n,γ)Tb161	14.4			
		Dy158(n,γ)Dy159(β^+)Tb159(n,γ)Tb160(n,γ)Tb161	1.6	97.6	51.1	
		Dy161(n,p)Tb161			42.2	73.6
		Dy164(n,α)Gd161(β^-)Tb161			6.4	9.4
		Dy162(n,2n)Dy161(n,p)Tb161				12.7
		Dy162(n,d)Tb161				2.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Er169	9.40d	Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169	6.9	13.5		
		Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	6.4			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	5.7			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	5.6			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169	5.2			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169	4.7			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	4.2			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169	3.4			
		Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169	3.2	8.2		
		Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169	3.0	8.0		
		Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	2.8			
		Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166m(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	2.6	33.6		
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169	2.5			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	2.4			
		Dy163(n,γ)Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	2.4			
		Dy163(n,γ)Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169	2.3			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166m(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	2.3			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169	2.2			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166m(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	2.2			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169	2.1			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	1.8			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166m(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	1.7			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169	1.6			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169	1.5			
		Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169	1.4	4.9		
		Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166m(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	1.1	20.0		
		Dy163(n,γ)Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169	1.1			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166m(n,γ)Ho167(β⁻)Er167(n,γ)Er168(n,γ)Er169	1.0			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β⁻)Ho165(n,γ)Ho166(β⁻)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169	1.0			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Er169	cont.	Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169	1.0			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169		4.6		
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169		2.7		
Tb160	72.28d	Dy156(n,γ)Dy157(β^+)Tb157(n,γ)Tb158(n,γ)Tb159(n,γ)Tb160	83.9	2.1		
		Dy156(n,γ)Dy157(β^+)Tb157(n,γ)Tb158m(IT)Tb158(n,γ)Tb159(n,γ)Tb160	14.4			
		Dy158(n,γ)Dy159(β^+)Tb159(n,γ)Tb160	1.6	97.6	100.0	
		Dy160(n,p)Tb160				34.8
		Dy161(n,2n)Dy160(n,p)Tb160				30.9
		Dy161(n,np)Tb160				14.7
		Dy161(n,d)Tb160				11.5
		Dy162(n,2n)Dy161(n,2n)Dy160(n,p)Tb160				2.4
		Dy162(n,2n)Dy161(n,np)Tb160				2.2
		Dy162(n,2n)Dy161(n,d)Tb160				1.7
Ta182	114.71d	no pathways found				
Tm170	128.61d	Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	7.9			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	6.5			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	6.3	12.8		
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	6.1			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	4.4			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	4.4			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	3.7			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	3.4			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	3.1	34.6		
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	3.0	7.8		
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	2.8			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	2.7	7.6		
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	2.7			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	2.6			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	2.6			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	2.4			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	2.1			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm170	cont.	Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.9			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.9			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.8			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.7			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.6			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.4	20.6		
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.3	4.6		
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.2			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.1			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.1			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.1			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.1			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170		4.7		
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170		2.8		
Dy159	144.39d	Dy158(n,γ)Dy159	99.4	100.0	100.0	
		Dy160(n,2n)Dy159				54.6
		Dy161(n,2n)Dy160(n,2n)Dy159				42.2
		Dy162(n,2n)Dy161(n,2n)Dy160(n,2n)Dy159				3.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm171	1.92y	Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	8.4			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	6.6			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	6.1			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	6.0			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	4.4			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	4.0			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	3.6			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	3.3			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	3.3			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	2.9			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	2.8			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	2.6			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	2.6			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	2.6			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	2.4			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	2.2			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.9			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.9			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.7			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.7			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.6			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.4			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm171	cont.	Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ) Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.4			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ) Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.2			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171	1.1			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	1.1			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT) Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.1			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ) Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	1.1			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-) Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	1.0			
H3	12.33y	Dy161(n,t)H3				61.6
		Dy163(n,t)H3				26.1
		Dy162(n,2n)Dy161(n,t)H3				5.4
		Dy164(n,t)H3				2.0
		Dy164(n,2n)Dy163(n,t)H3				1.9
		Dy162(n,t)H3				1.8
Tb157	98.98y	Dy156(n,γ)Dy157(β^+)Tb157	100.0	100.0	100.0	
		Dy158(n,2n)Dy157(β^+)Tb157				93.3
		Dy160(n,2n)Dy159(n,2n)Dy158(n,2n)Dy157(β^+)Tb157				2.7
		Dy160(n,2n)Dy159(β^+)Tb159(n,2n)Tb158(n,2n)Tb157				1.9
Tb158	180.04y	Dy156(n,γ)Dy157(β^+)Tb157(n,γ)Tb158	85.4	85.8	90.2	
		Dy156(n,γ)Dy157(β^+)Tb157(n,γ)Tb158m(IT)Tb158	14.7	14.2	9.5	
		Dy160(n,2n)Dy159(β^+)Tb159(n,2n)Tb158				59.3
		Dy161(n,2n)Dy160(n,2n)Dy159(β^+)Tb159(n,2n)Tb158				17.4
		Dy160(n,2n)Dy159(β^+)Tb159(n,2n)Tb158m(IT)Tb158				16.1
		Dy161(n,2n)Dy160(n,2n)Dy159(β^+)Tb159(n,2n) Tb158m(IT)Tb158				4.7
Ho166m	1.2 10^3y	Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-) Ho165(n,γ)Ho166m	21.8			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT) Dy165(β^-)Ho165(n,γ)Ho166m	18.0			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	14.5	1.5		
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	9.4			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	8.6	60.3	48.2	25.1
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-) Ho165(n,γ)Ho166m	7.8			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	6.3			
		Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	5.3			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m	3.7	35.9	50.6	74.2
		Dy160(n,γ)Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ) Dy165(β^-)Ho165(n,γ)Ho166m	2.3			
		Dy164(n,γ)Dy165m(β^-)Ho165(n,γ)Ho166m		1.5	1.2	
Ho163	4.6 10^3y	Dy164(n,γ)Dy165(β^-)Ho165(n,2n)Ho164(β^-)Er164(n,2n) Er163(β^+)Ho163				38.4
		Dy164(n,γ)Dy165(β^-)Ho165(n,2n)Ho164m(IT)Ho164(β^-) Er164(n,2n)Er163(β^+)Ho163				35.3
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,2n)Ho164(β^-) Er164(n,2n)Er163(β^+)Ho163				13.0
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,2n)Ho164m(IT) Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163				11.9
La137	6.0 10^4y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Gd150	1.8 10^6y	Dy156(n,nα)Gd152(n,2n)Gd151(n,2n)Gd150				58.1
		Dy156(n,nα)Gd152(n,2n)Gd151(β^+)Eu151(n,2n) Eu150m(β^-)Gd150				18.5
		Dy156(n,α)Gd153(n,2n)Gd152(n,2n)Gd151(n,2n)Gd150				7.9
		Dy156(n,2n)Dy155(β^+)Tb155(β^+)Gd155(n,2n)Gd154(n,2n) Gd153(n,2n)Gd152(n,2n)Gd151(n,2n)Gd150				3.0
		Dy156(n,2n)Dy155(n,2n)Dy154(n,nα)Gd150				2.4
		Dy156(n,α)Gd153(n,2n)Gd152(n,2n)Gd151(β^+)Eu151(n,2n) Eu150m(β^-)Gd150				2.1
		Dy156(n,2n)Dy155(β^+)Tb155(n,nα)Eu151(n,2n) Eu150m(β^-)Gd150				1.1
Dy154	3.0 10^6y	Dy156(n,2n)Dy155(n,2n)Dy154				100.0
Lu176	4.0 10^{10}y	Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ) Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	7.2			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ) Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	7.1			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	4.0			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ) Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	3.6			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-) Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ) Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ) Yb175(β^-)Lu175(n,γ)Lu176	3.1			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-) Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ) Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ) Yb175(β^-)Lu175(n,γ)Lu176	3.1			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ) Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	2.8			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ) Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ) Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	2.8			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-) Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ) Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	2.8			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-) Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	2.4			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-) Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-) Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	2.3			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-) Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	2.0			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT) Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ) Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-) Lu175(n,γ)Lu176	1.8			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Lu176	cont.	Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.7			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.6			
		Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.6			
		Dy161(n,γ)Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.4			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.4			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.2			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.2			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.2			
		Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.2			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.1			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.1			
		Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.0			
		Dy162(n,γ)Dy163(n,γ)Dy164(n,γ)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.0			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.0			
		Dy164(n,γ)Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.0			
La138	1.0 10^{11}y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Gd160	1.3 10^{17}y	Dy163(n,α)Gd160		98.5	99.7	91.2
		Dy162(n,γ)Dy163(n,α)Gd160		1.4		
		Dy164(n,2n)Dy163(n,α)Gd160				6.5
		Dy164(n,nα)Gd160				2.3
Dy156	1.0 10^{18}y	no pathways found				

Holmium

Isotope	Atom % abundance
Ho165	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	4.39E+15	4.19E+15	3.18E+14	2.28E+11	2.05E+11	7.36E+08
Ho166	69.8	72.8	99.7			
Ho164	14.2	13.9				
Ho164m	6.8	6.4				
Ho167	4.2	4.3				
Er167m	2.9	0.5				
Er165	1.5	1.6	0.1			
Ho166m			0.1	95.2	99.8	85.7
H3				4.0		
Ho163				0.2	0.2	14.3

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	4.07E-01	4.00E-01	3.69E-02	6.15E-05	5.80E-05	1.79E-07
Ho166	87.4	88.7	99.8			
Ho164	5.2	5.0				
Ho167	4.3	4.3				
Ho164m	1.6	1.5				
Er167m	1.1	0.2				
Ho166m			0.2	99.9	100.0	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.41E+04	2.35E+04	1.87E+03	6.37E+01	6.02E+01	1.85E-01
Ho166	72.2	74.0	96.6			
Ho167	22.9	23.1				
Er167m	2.0	0.3				
Ho164	1.5	1.5				
Ho166m	0.3	0.3	3.4	100.0	100.0	100.0

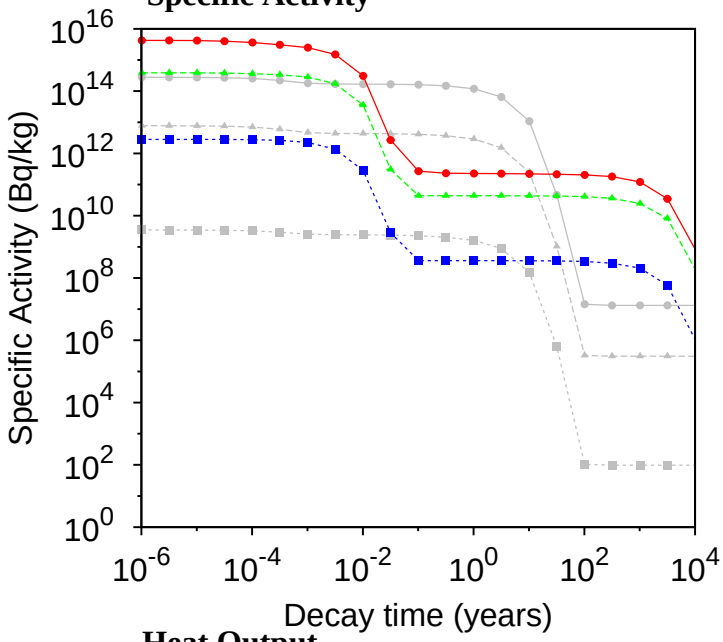
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.32E+06	4.31E+06	4.45E+05	4.35E+02	4.09E+02	1.26E+00
Ho166	99.2	99.3	99.9			
Ho166m			0.1	99.6	100.0	99.8

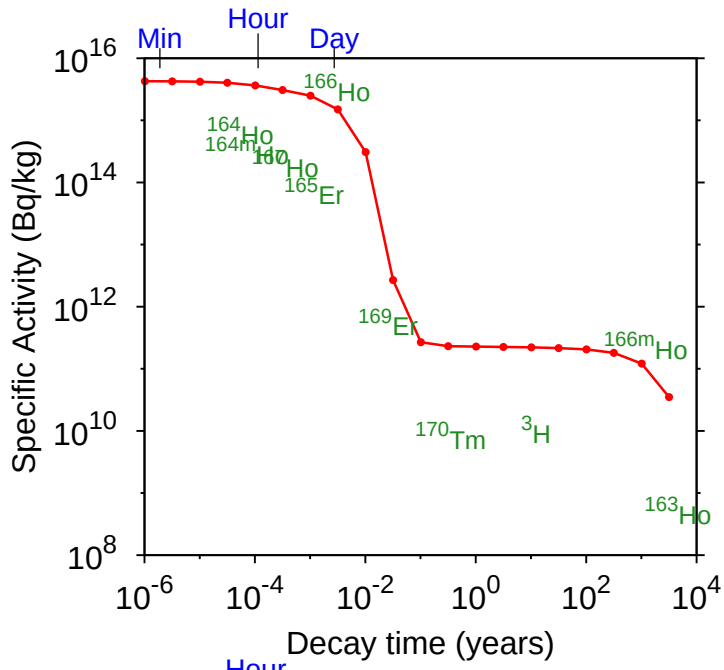
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.05E+06	2.04E+06	2.33E+05	2.60E+04	2.46E+04	7.57E+01
Ho166	97.3	97.4	88.6			
Ho166m	1.3	1.3	11.2	100.0	100.0	100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.66E+11	1.49E+11	3.54E+09	3.55E+08	3.35E+08	1.03E+06
Ho167	42.6	46.5				
Ho166	18.4	20.5	89.7			
Ho164	17.9	18.6				
Ho164m	10.5	10.7				
Er167m	8.3	1.6				
Er165	1.6	1.7	0.2			
Ho166m	0.2	0.2	10.1	100.0	100.0	100.0

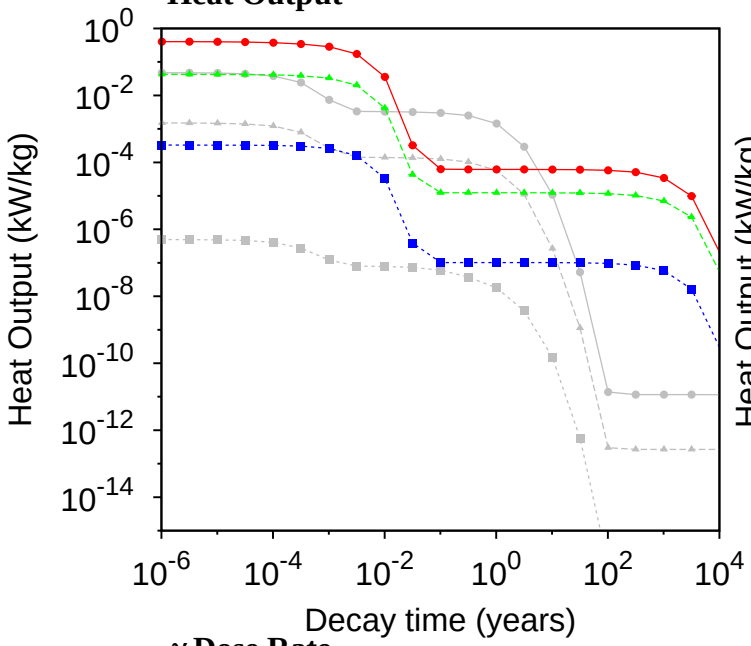
Holmium activation characteristics

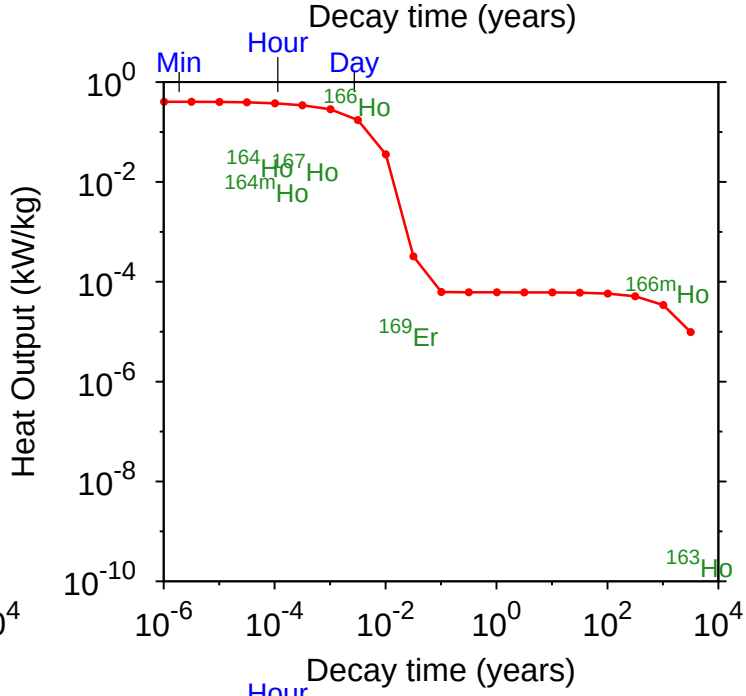
Specific Activity



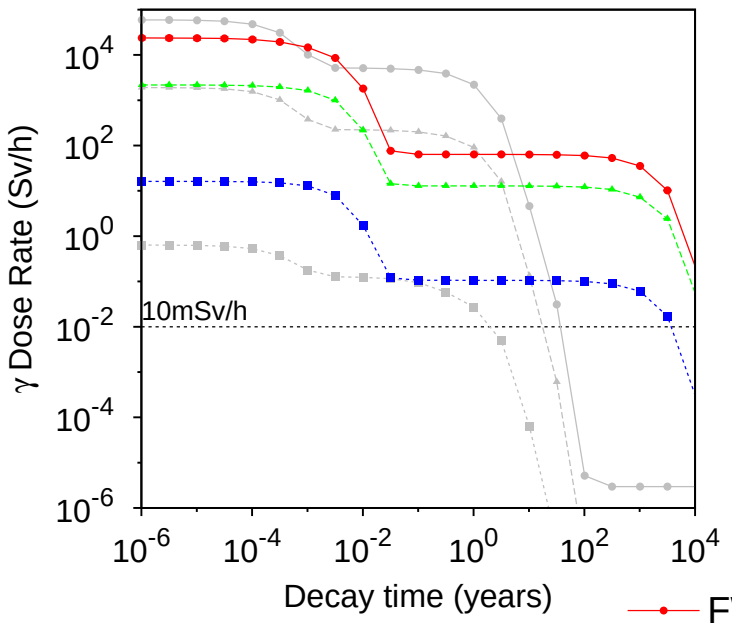


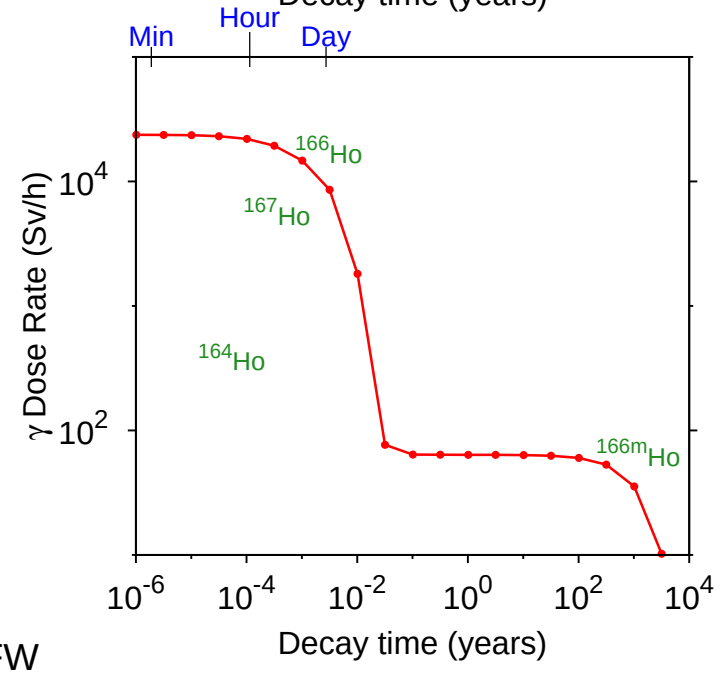
Heat Output





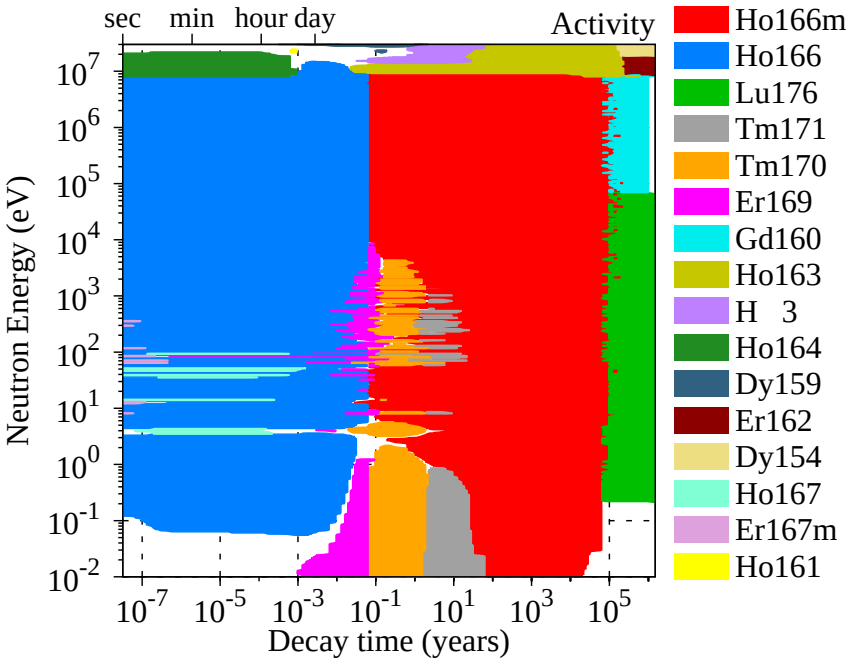
γ Dose Rate

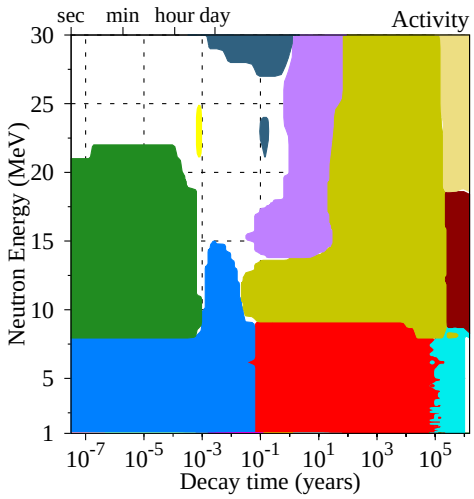


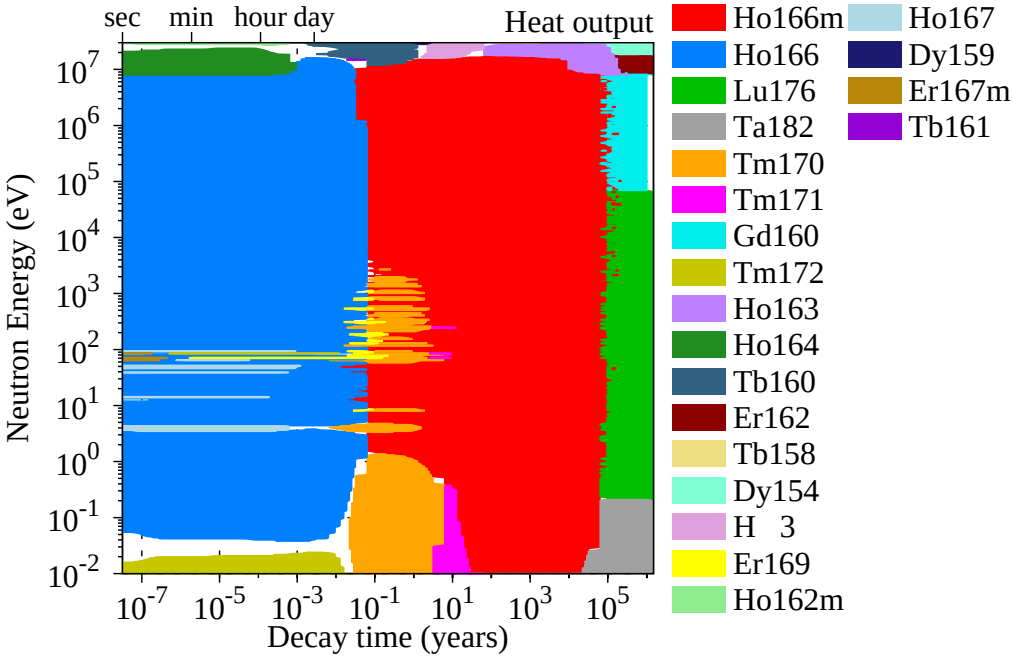


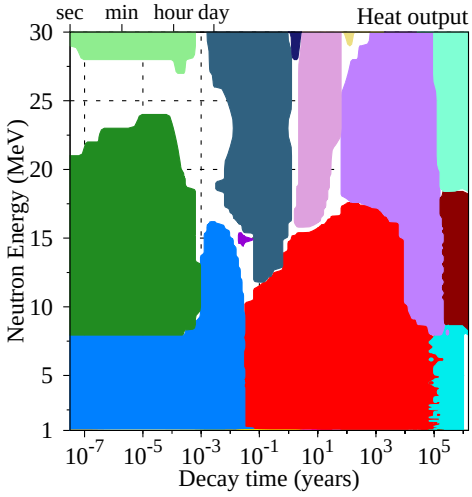
FW
Blanket
Manifold
Fe results

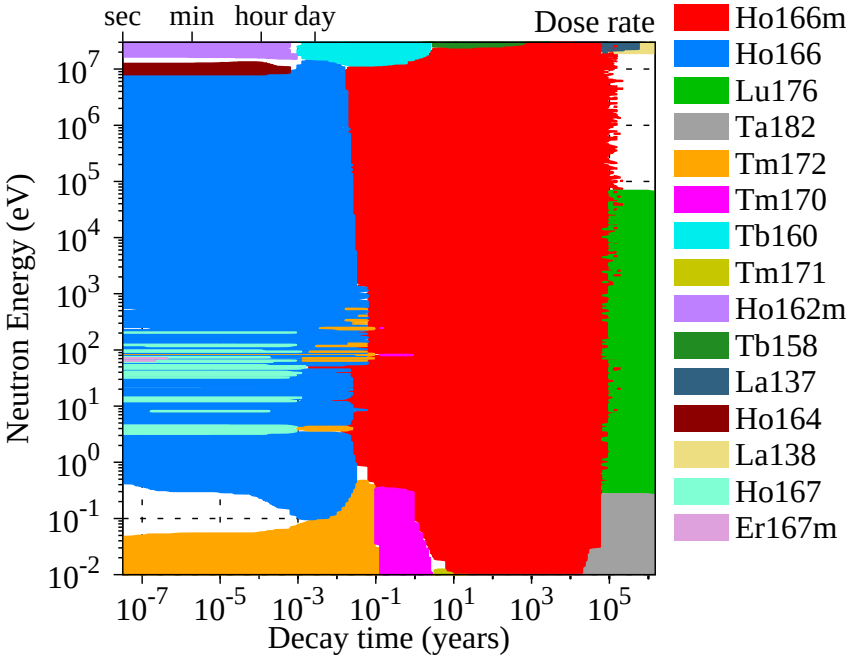
Holmium Importance diagrams

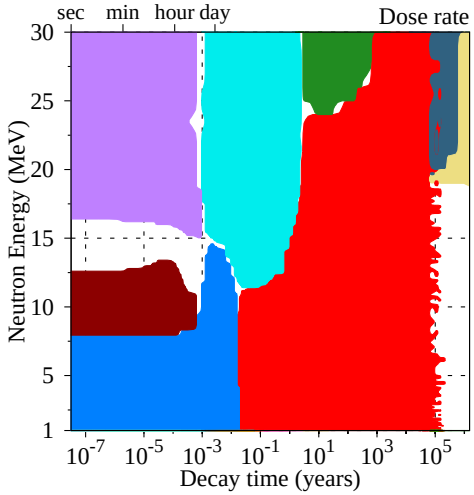




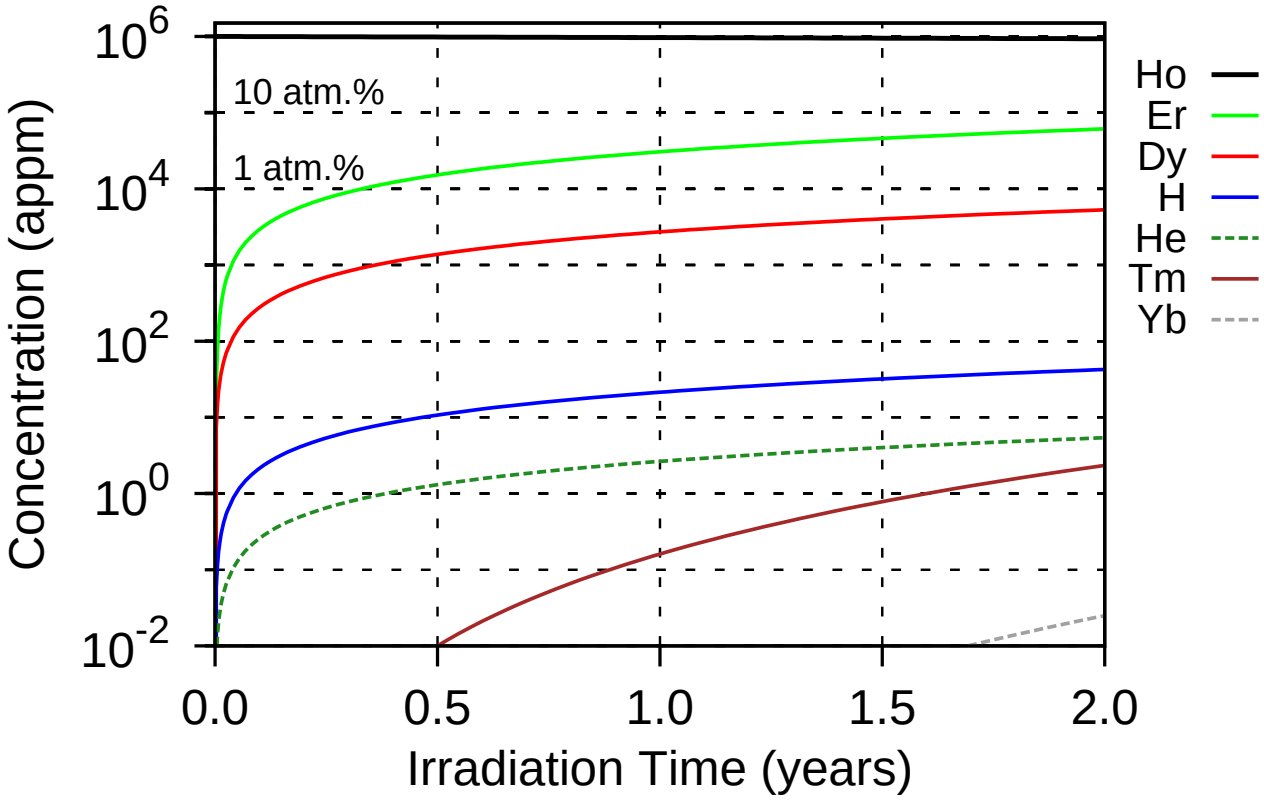




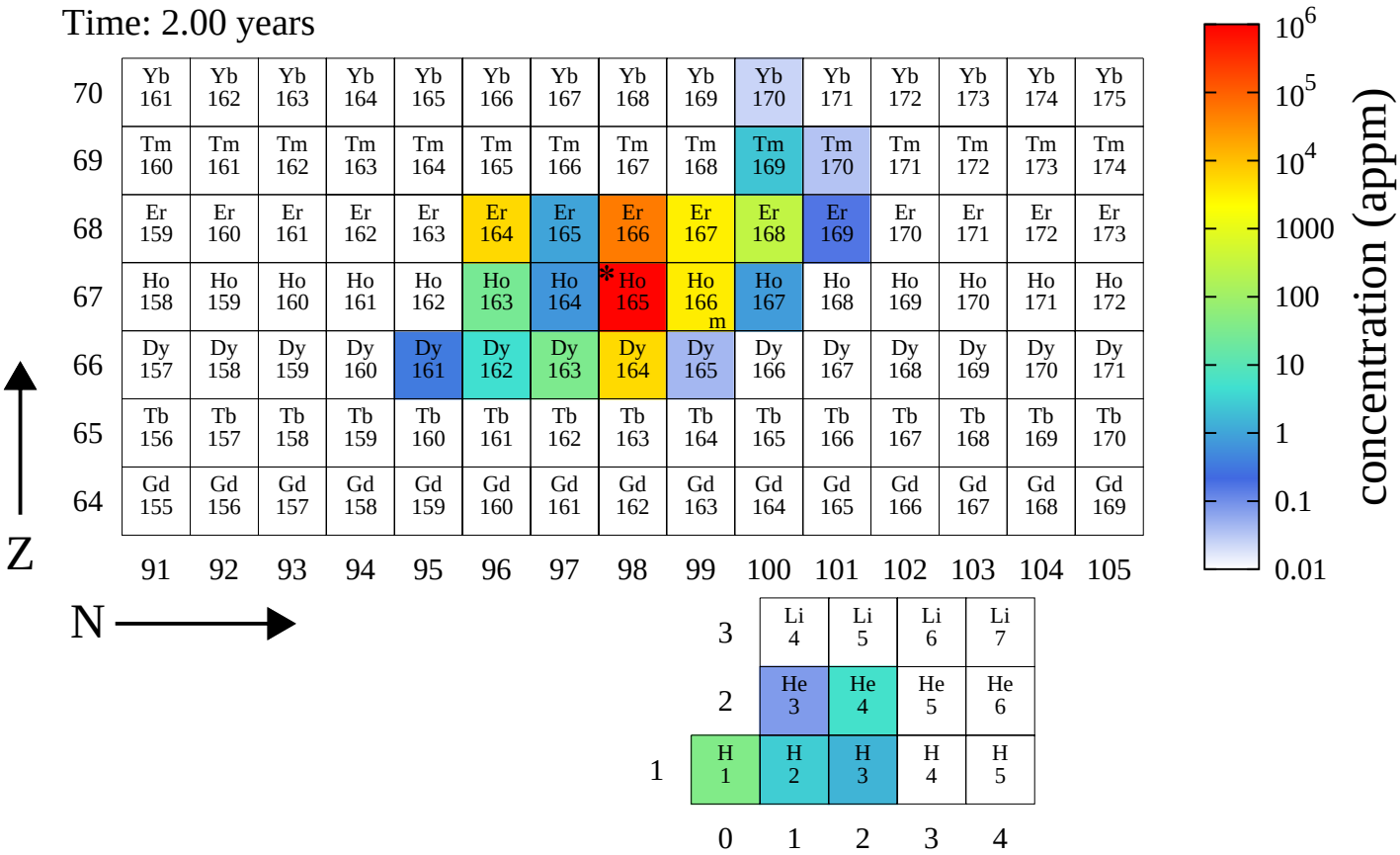




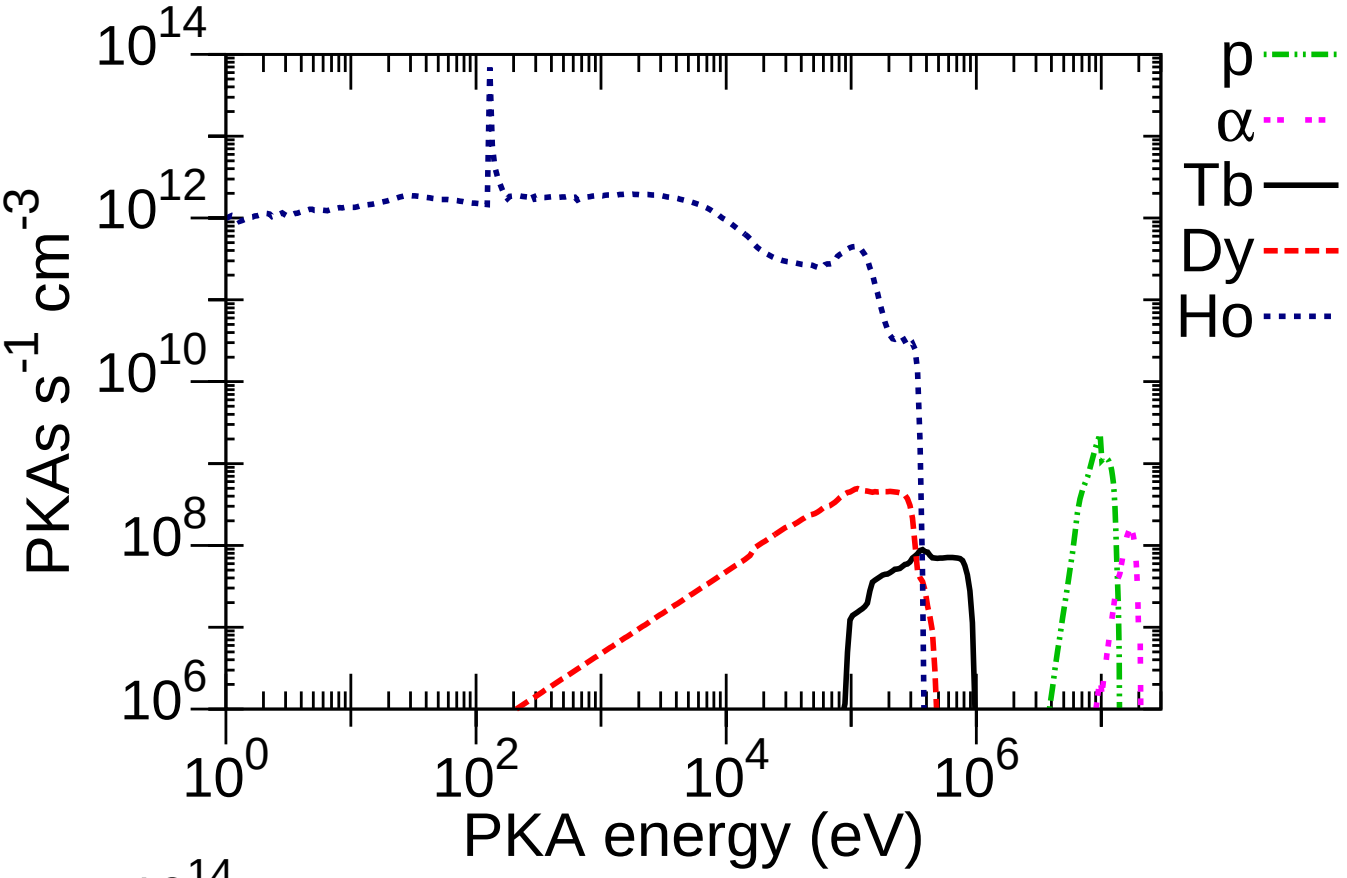
Holmium FW Transmutation

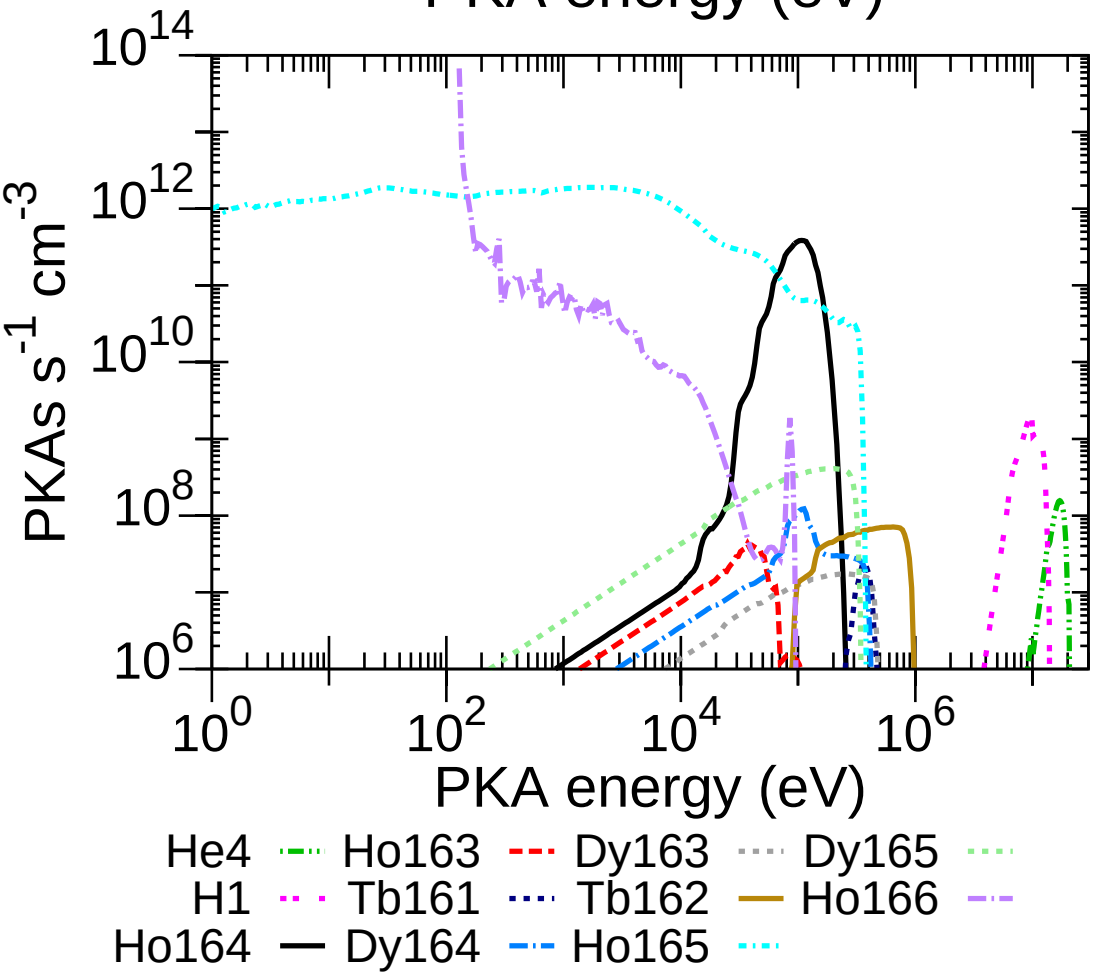


3 appm He & 21 appm H after 1 year 14 dpa/year



Holmium FW PKA distributions





Holmium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Er167m	2.27s	Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m	98.3	79.6	50.4	37.2
		Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167m	1.2			
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167m		16.4	38.0	59.0
		Ho165(n,γ)Ho166m(n,E)Ho166(β^-)Er166(n,γ)Er167m		3.9	2.6	2.7
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,n′)Er167m			7.0	
		Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,n′)Er167m			1.5	
Ho164	28.60m	Ho165(n,2n)Ho164				52.0
		Ho165(n,2n)Ho164m(IT)Ho164				47.9
Ho164m	37.61m	Ho165(n,2n)Ho164m				99.9
Ho162m	1.12h	Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,2n)Ho162m				51.7
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,2n)Ho162m				47.6
Ho161	2.48h	Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(n,2n)Er162(n,2n) Er161(β^+)Ho161				30.0
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(n,2n) Er162(n,2n)Er161(β^+)Ho161				27.6
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,2n) Ho162m(n,2n)Ho161				16.0
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,2n)Ho162m(n,2n)Ho161				14.7
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,2n) Ho162(n,2n)Ho161				2.1
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,2n)Ho162(n,2n)Ho161				2.0
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,2n) Ho162m(IT)Ho162(n,2n)Ho161				1.8
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,2n)Ho162m(IT)Ho162(n,2n)Ho161				1.7
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,2n) Ho162m(n,2n)Ho161m(IT)Ho161				1.3
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,2n)Ho162m(n,2n)Ho161m(IT)Ho161				1.2
Ho167	3.10h	Ho165(n,γ)Ho166(n,γ)Ho167	71.2			
		Ho165(n,γ)Ho166m(n,γ)Ho167	28.7	99.4	100.0	99.8
Er165	10.36h	Ho165(n,γ)Ho166(β^-)Er166(n,2n)Er165				45.0
		Ho165(n,2n)Ho164(β^-)Er164(n,γ)Er165				26.8
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,γ)Er165				24.7
		Ho165(n,γ)Ho166m(n,E)Ho166(β^-)Er166(n,2n)Er165				3.3
Ho166	1.12d	Ho165(n,γ)Ho166	100.0	92.9	90.1	87.2
		Ho165(n,γ)Ho166m(n,E)Ho166		7.1	8.6	12.2
		Ho165(n,γ)Ho166m(n,n′)Ho166			1.2	
Tm172	2.65d	Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	37.1	1.1		
		Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	26.5	20.8		
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	14.8	56.2		
		Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	12.5	12.6		
		Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	5.0			
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	2.0	7.6		
Tb161	6.89d	Ho165(n,γ)Ho166(β^-)Er166(n,α)Dy163(n,α)Gd160(n,γ) Gd161(β^-)Tb161	80.1			
		Ho165(n,α)Tb162(β^-)Dy162(n,γ)Dy163(n,α)Gd160(n,γ) Gd161(β^-)Tb161	19.7			
		Ho165(n,nα)Tb161				57.7
		Ho165(n,2n)Ho164(β^+)Dy164(n,α)Gd161(β^-)Tb161				21.8
		Ho165(n,2n)Ho164m(IT)Ho164(β^+)Dy164(n,α)Gd161(β^-)Tb161				20.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Er169	9.40d	Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169	33.8	23.2		
		Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169	31.5			
		Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169	16.0	14.1		
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)Er169	12.5	53.5		
		Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169	4.3			
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169	1.7	7.3		
Tb160	72.28d	Ho165(n,α)Tb162(β^-)Dy162(n,α)Gd159(β^-)Tb159(n,γ)Tb160	100.0			
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,α)Tb160				50.2
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,α)Tb160				46.2
		Ho165(n,nα)Tb161(n,2n)Tb160				1.6
Ta182	114.71d	no pathways found				
Tm170	128.61d	Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170	36.0			
		Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	28.8	21.6		
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170	14.4	55.8		
		Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170	13.6	13.1		
		Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	4.9			
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	1.9	7.6		
Dy159	144.39d	Ho165(n,nα)Tb161(β^-)Dy161(n,2n)Dy160(n,2n)Dy159				18.5
		Ho165(n,2n)Ho164(β^-)Er164(n,nα)Dy160(n,2n)Dy159				11.9
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,nα) Dy160(n,2n)Dy159				11.0
		Ho165(n,α)Tb162(β^-)Dy162(n,2n)Dy161(n,2n) Dy160(n,2n)Dy159				11.0
		Ho165(n,2n)Ho164(β^-)Er164(n,α)Dy161(n,2n) Dy160(n,2n)Dy159				9.6
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,α)Dy161(n,2n) Dy160(n,2n)Dy159				8.9
		Ho165(n,2n)Ho164(β^+)Dy164(n,2n)Dy163(n,2n)Dy162(n,2n) Dy161(n,2n)Dy160(n,2n)Dy159				4.2
		Ho165(n,2n)Ho164m(IT)Ho164(β^+)Dy164(n,2n)Dy163(n,2n) Dy162(n,2n)Dy161(n,2n)Dy160(n,2n)Dy159				3.9
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,α) Tb160(β^-)Dy160(n,2n)Dy159				3.7
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,α)Tb160(β^-)Dy160(n,2n)Dy159				3.4
		Ho165(n,2n)Ho164(β^+)Dy164(n,α)Gd161(β^-)Tb161(β^-) Dy161(n,2n)Dy160(n,2n)Dy159				2.0
		Ho165(n,2n)Ho164m(IT)Ho164(β^+)Dy164(n,α)Gd161(β^-) Tb161(β^-)Dy161(n,2n)Dy160(n,2n)Dy159				1.8
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,2n) Ho162(β^+)Dy162(n,2n)Dy161(n,2n)Dy160(n,2n)Dy159				1.5
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,2n)Ho162(β^+)Dy162(n,2n)Dy161(n,2n) Dy160(n,2n)Dy159				1.4
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,2n) Ho162m(IT)Ho162(β^+)Dy162(n,2n)Dy161(n,2n) Dy160(n,2n)Dy159				1.3
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,2n)Ho162m(IT)Ho162(β^+)Dy162(n,2n)Dy161(n,2n) Dy160(n,2n)Dy159				1.2
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,2n) Ho162m(β^+)Dy162(n,2n)Dy161(n,2n)Dy160(n,2n)Dy159				1.0
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,2n)Ho162m(β^+)Dy162(n,2n)Dy161(n,2n) Dy160(n,2n)Dy159				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm171	1.92y	Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	37.0	1.1		
		Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	26.6	20.8		
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	14.7	56.1		
		Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ) Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	12.6	12.6		
		Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	5.0			
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ) Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	2.0	7.6		
H3	12.33y	Ho165(n,t)H3				99.9
Tb158	180.04y	Ho165(n,nα)Tb161(β^-)Dy161(n,2n)Dy160(n,2n)Dy159(β^+) Tb159(n,2n)Tb158				8.0
		Ho165(n,α)Tb162(β^-)Dy162(n,α)Gd159(β^-)Tb159(n,2n)Tb158				6.7
		Ho165(n,2n)Ho164(β^-)Er164(n,nα)Dy160(n,2n)Dy159(β^+) Tb159(n,2n)Tb158				5.3
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,nα) Tb159(n,2n)Tb158				5.2
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,nα)Dy160(n,2n) Dy159(β^+)Tb159(n,2n)Tb158				4.9
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,nα)Tb159(n,2n)Tb158				4.8
		Ho165(n,2n)Ho164(β^+)Dy164(n,2n)Dy163(n,2n)Dy162(n,α) Gd159(β^-)Tb159(n,2n)Tb158				3.3
		Ho165(n,2n)Ho164(β^+)Dy164(n,2n)Dy163(n,nα)Gd159(β^-) Tb159(n,2n)Tb158				3.2
		Ho165(n,2n)Ho164m(IT)Ho164(β^+)Dy164(n,2n)Dy163(n,2n) Dy162(n,α)Gd159(β^-)Tb159(n,2n)Tb158				3.1
		Ho165(n,α)Tb162(β^-)Dy162(n,2n)Dy161(n,2n)Dy160(n,2n) Dy159(β^+)Tb159(n,2n)Tb158				3.0
		Ho165(n,2n)Ho164m(IT)Ho164(β^+)Dy164(n,2n)Dy163(n,nα) Gd159(β^-)Tb159(n,2n)Tb158				2.9
		Ho165(n,2n)Ho164(β^-)Er164(n,α)Dy161(n,2n)Dy160(n,2n) Dy159(β^+)Tb159(n,2n)Tb158				2.7
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,α)Dy161(n,2n) Dy160(n,2n)Dy159(β^+)Tb159(n,2n)Tb158				2.5
		Ho165(n,nα)Tb161(β^-)Dy161(n,2n)Dy160(n,2n)Dy159(β^+) Tb159(n,2n)Tb158m(IT)Tb158				2.2
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,α) Tb160(n,2n)Tb159(n,2n)Tb158				1.8
		Ho165(n,α)Tb162(β^-)Dy162(n,α)Gd159(β^-)Tb159(n,2n) Tb158m(IT)Tb158				1.8
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,α)Tb160(n,2n)Tb159(n,2n)Tb158				1.7
		Ho165(n,2n)Ho164(β^+)Dy164(n,2n)Dy163(n,α)Gd160(n,2n) Gd159(β^-)Tb159(n,2n)Tb158				1.7
		Ho165(n,2n)Ho164m(IT)Ho164(β^+)Dy164(n,2n)Dy163(n,α) Gd160(n,2n)Gd159(β^-)Tb159(n,2n)Tb158				1.5
		Ho165(n,2n)Ho164(β^+)Dy164(n,nα)Gd160(n,2n)Gd159(β^-) Tb159(n,2n)Tb158				1.5
		Ho165(n,2n)Ho164(β^-)Er164(n,nα)Dy160(n,2n)Dy159(β^+) Tb159(n,2n)Tb158m(IT)Tb158				1.4
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,nα) Tb159(n,2n)Tb158m(IT)Tb158				1.4
		Ho165(n,2n)Ho164m(IT)Ho164(β^+)Dy164(n,nα)Gd160(n,2n) Gd159(β^-)Tb159(n,2n)Tb158				1.4
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,nα)Dy160(n,2n) Dy159(β^+)Tb159(n,2n)Tb158m(IT)Tb158				1.3
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+) Ho163(n,nα)Tb159(n,2n)Tb158m(IT)Tb158				1.3
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,2n) Ho162(β^+)Dy162(n,α)Gd159(β^-)Tb159(n,2n)Tb158				1.2

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tb158	cont.	Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+)				
		Ho163(n,2n)Ho162(β^+)Dy162(n,α)Gd159(β^-)Tb159(n,2n)Tb158				1.1
		Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163(n,2n)				
		Ho162m(IT)Ho162(β^+)Dy162(n,α)Gd159(β^-)Tb159(n,2n)Tb158				1.0
Ho166m	1.2 10^3y	Ho165(n,γ)Ho166m	100.0	100.0	100.0	100.0
Ho163	4.6 10^3y	Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163				51.7
		Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163				47.6
La137	6.0 10^4y	no pathways found				
Dy154	3.0 10^6y	no pathways found				
Lu176	4.0 10^{10}y	Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)				
		Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)				
		Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	23.8			
		Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)				
		Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)				
		Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	23.1			
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)				
		Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)				
		Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	9.3			
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167(n,γ)Er168(n,γ)				
		Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)				
		Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	9.1			
		Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)				
		Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)				
		Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)				
		Lu175(n,γ)Lu176	7.7			
		Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m(IT)Er167(n,γ)				
		Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)				
		Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)				
		Lu175(n,γ)Lu176	6.5			
		Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)				
		Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)				
		Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	3.6			
		Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)				
		Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)				
		Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)				
		Lu175(n,γ)Lu176	3.2			
		Ho165(n,γ)Ho166(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)				
		Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)				
		Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)				
		Lu175(n,γ)Lu176	3.1			
		Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167(n,γ)Er168(n,γ)				
		Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)				
		Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	3.1			
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)				
		Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)				
		Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)				
		Lu175(n,γ)Lu176	1.3			
		Ho165(n,γ)Ho166m(n,γ)Ho167(β^-)Er167m(IT)Er167(n,γ)				
		Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)				
		Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)				
		Lu175(n,γ)Lu176	1.2			
La138	1.0 10^{11}y	no pathways found				
Er162	1.4 10^{14}y	no pathways found				
Gd160	1.3 10^{17}y	Ho165(n,γ)Ho166(β^-)Er166(n,α)Dy163(n,α)Gd160	80.4			
		Ho165(n,α)Tb162(β^-)Dy162(n,γ)Dy163(n,α)Gd160	19.5			

Erbium

Isotope	Atom % abundance
Er162	0.14
Er164	1.60
Er166	33.50
Er167	22.87
Er168	26.98
Er170	14.91

($T_{1/2}$ =1.4 10^{14}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.06E+15	7.60E+14	2.56E+14	2.92E+13	7.26E+09	1.23E+09
Er167m	27.7					
Er165	26.4	36.6	0.3			
Er169	22.9	31.9	72.3			
Er171	7.8	10.8				
Ho166	3.9	5.4	1.7			
Tm171	3.6	5.0	14.7	90.0		
Er163	2.1	2.8				
Tm170	1.9	2.6	7.6	9.5		
Tm172	1.6	2.3	2.6			
Ho164	1.2	1.5				
Ho163					76.0	99.6
Ho166m					24.0	0.4

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.64E-02	2.65E-02	6.21E-03	2.87E-04	4.96E-07	1.85E-09
Er171	28.7	39.2	0.1			
Er167m	26.8					
Ho166	13.2	18.1	8.0			
Er169	10.9	15.0	48.7			
Tm172	7.6	10.5	17.2			
Er165	5.3	7.2	0.1			
Tm170	2.9	4.0	16.7	51.7		
Ho164	1.2	1.5				
Tm168	1.2	1.6	6.6	9.7		
Tm171	0.4	0.6	2.5	38.5		
Ho166m				0.2	99.5	71.9
Ho163					0.5	28.1

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	6.47E+03	5.36E+03	1.36E+03	3.04E+01	5.06E-01	1.37E-03
Tm172	36.0	43.4	65.8			
Er171	31.7	38.0				
Er167m	16.2					
Tm168	7.0	8.4	32.3	97.8		
Ho166	3.6	4.3	1.8			
Er161	2.1	2.5				
Er165	1.1	1.3				
Ho166m				1.8	100.0	100.0

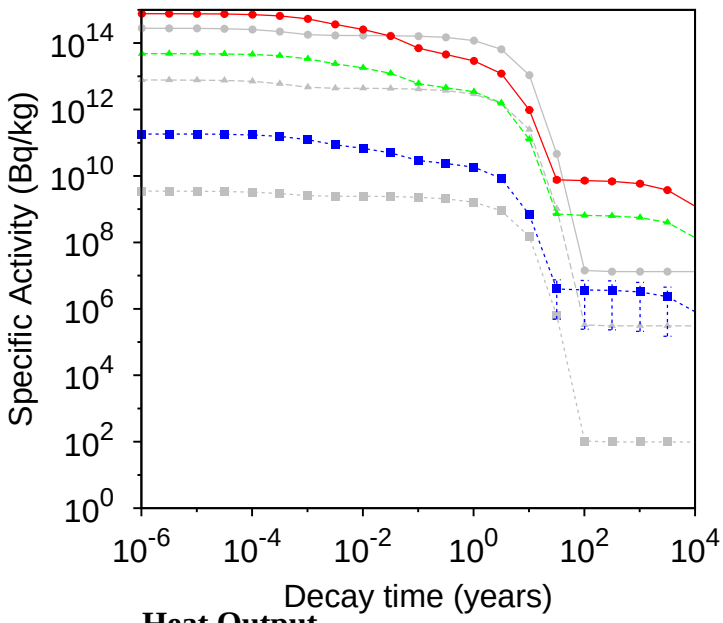
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.44E+05	2.44E+05	1.17E+05	6.64E+03	3.61E+00	3.76E-02
Er169	36.7	36.8	58.5			
Ho166	23.7	23.6	5.1			
Er171	12.2	12.1				
Tm172	12.0	12.0	9.6			
Tm170	10.6	10.6	21.7	54.6		
Er165	2.2	2.2				
Tm171	1.7	1.7	3.5	43.5		
Tm168	0.8	0.8	1.6	1.9		
Ho166m				0.1	96.5	25.0
Ho163					3.5	75.0

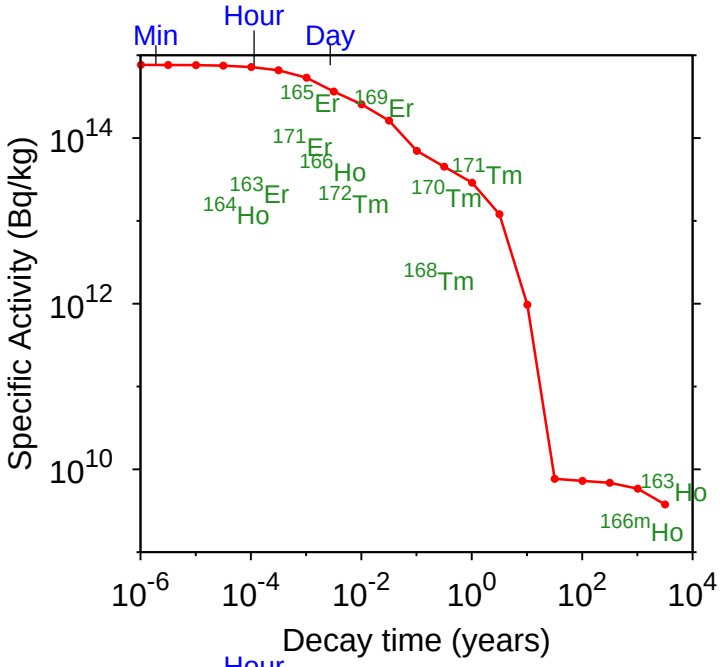
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	5.08E+05	5.08E+05	3.91E+05	5.69E+04	2.09E+02	6.30E-01
Er169	47.8	47.8	47.4			
Tm170	27.5	27.5	35.0	34.3		
Tm171	10.4	10.4	13.4	64.6		
Ho166	5.3	5.3	0.7			
Tm172	3.7	3.7	1.9			
Er171	3.6	3.5				
Tm168	1.2	1.2	1.5	0.7		
Ho166m			0.1	0.4	99.9	89.7
Ho163					0.1	10.3

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	5.90E+10	2.71E+10	6.42E+09	2.21E+08	2.86E+06	8.03E+03
Er167m	53.4	0.1				
Er165	18.2	39.5	0.5			
Tm172	15.3	33.4	54.2			
Tm168	4.2	9.2	37.6	74.1		
Er163	1.5	3.1				
Er171	1.4	3.0				
Ho167	1.2	2.6				
Ho164	1.0	2.0				
Er161	1.0	2.2				
Ho166	0.7	1.5	0.7			
Tm170	0.3	0.7	3.0	12.6		
Er169	0.4	0.9	2.9			
Tm171	0.1	0.1	0.6	11.9		
Ho166m				1.4	99.9	96.0
Ho163					0.1	4.0

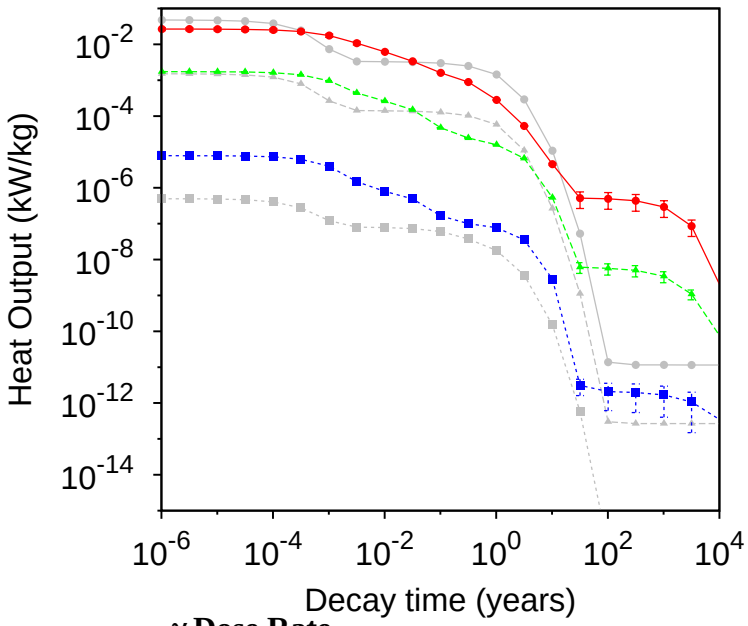
Erbium activation characteristics

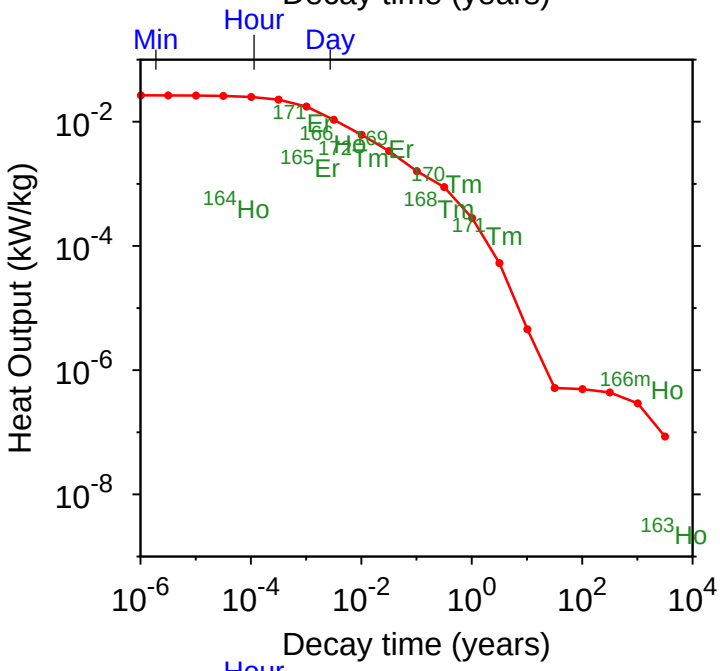
Specific Activity



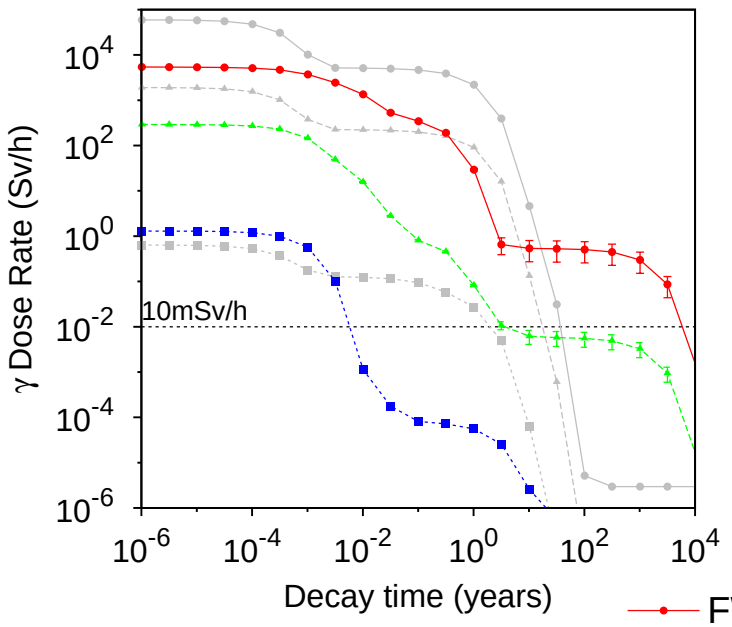


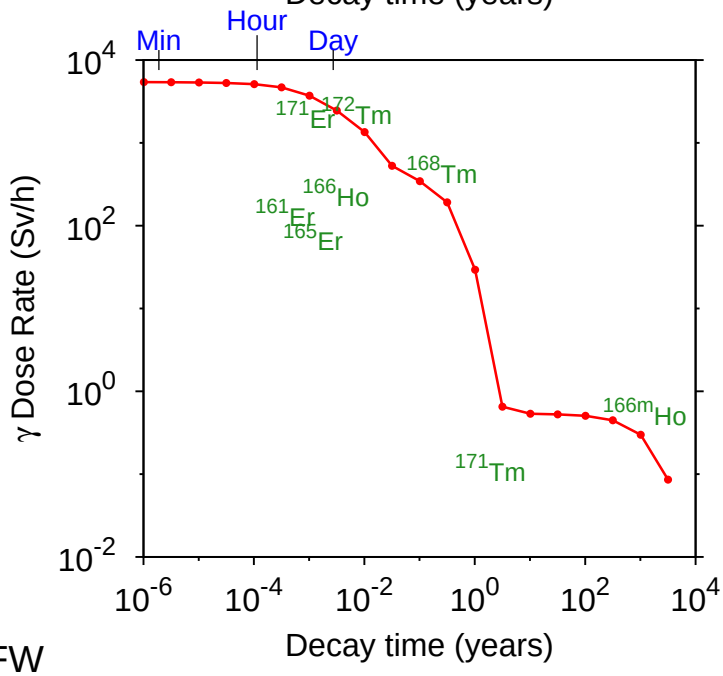
Heat Output





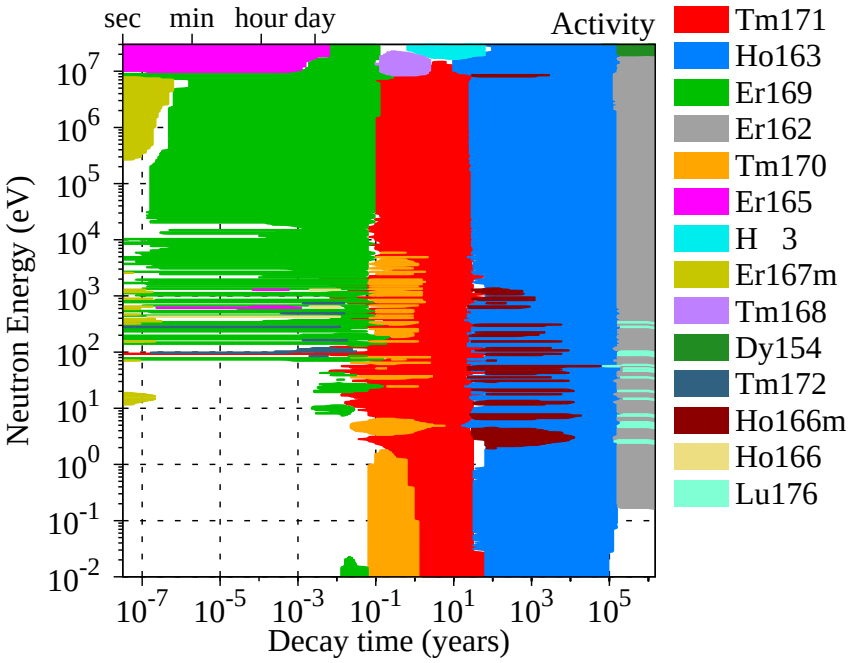
γ Dose Rate

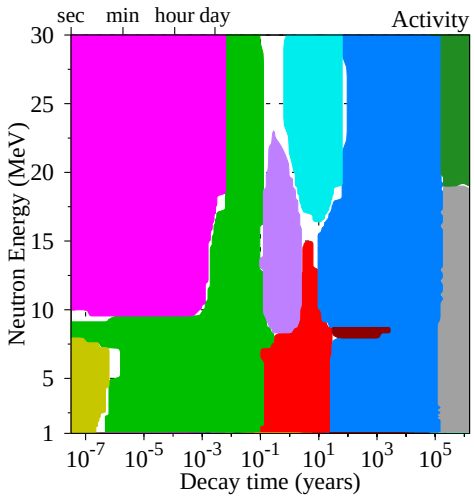


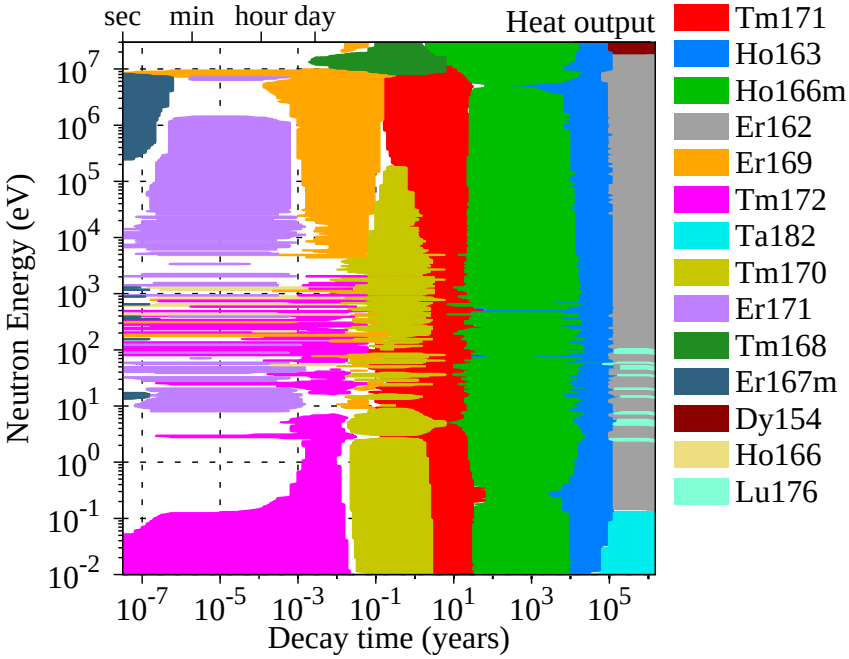


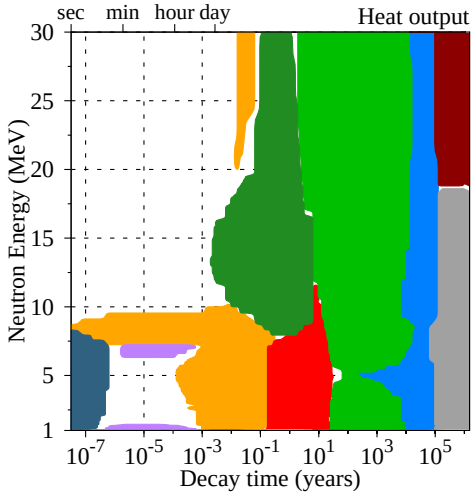
FW
Blanket
Manifold
Fe results

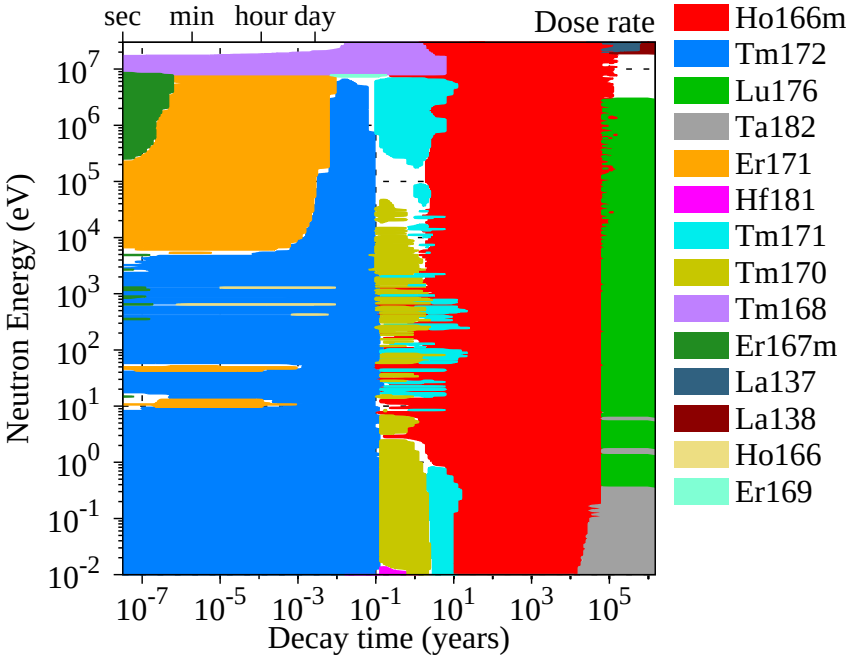
Erbium Importance diagrams

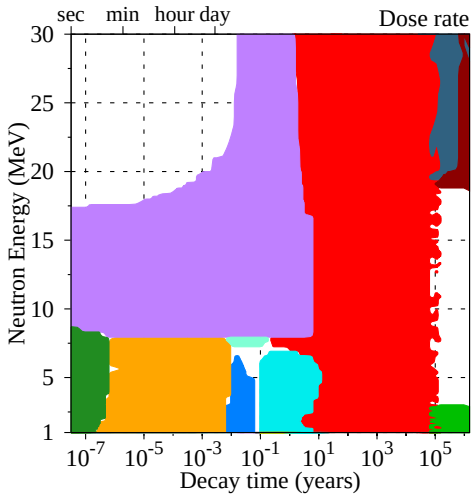




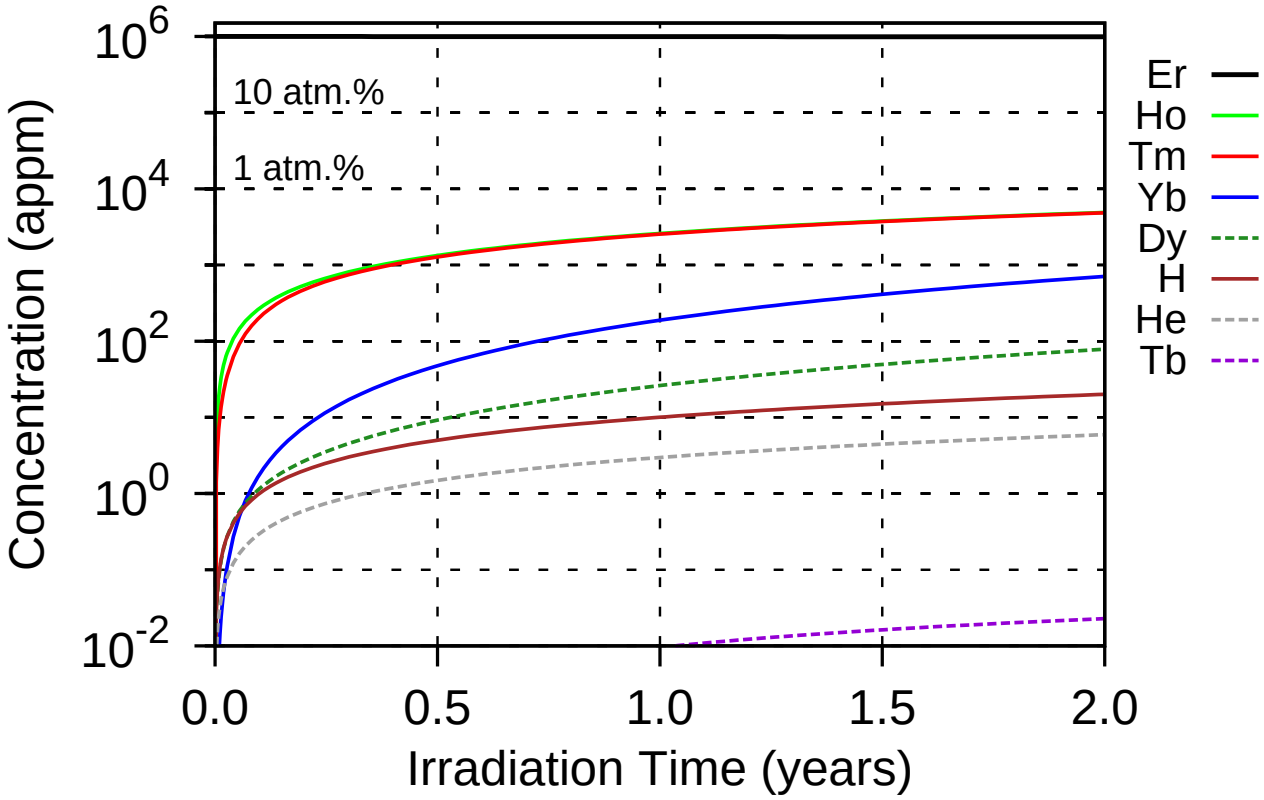




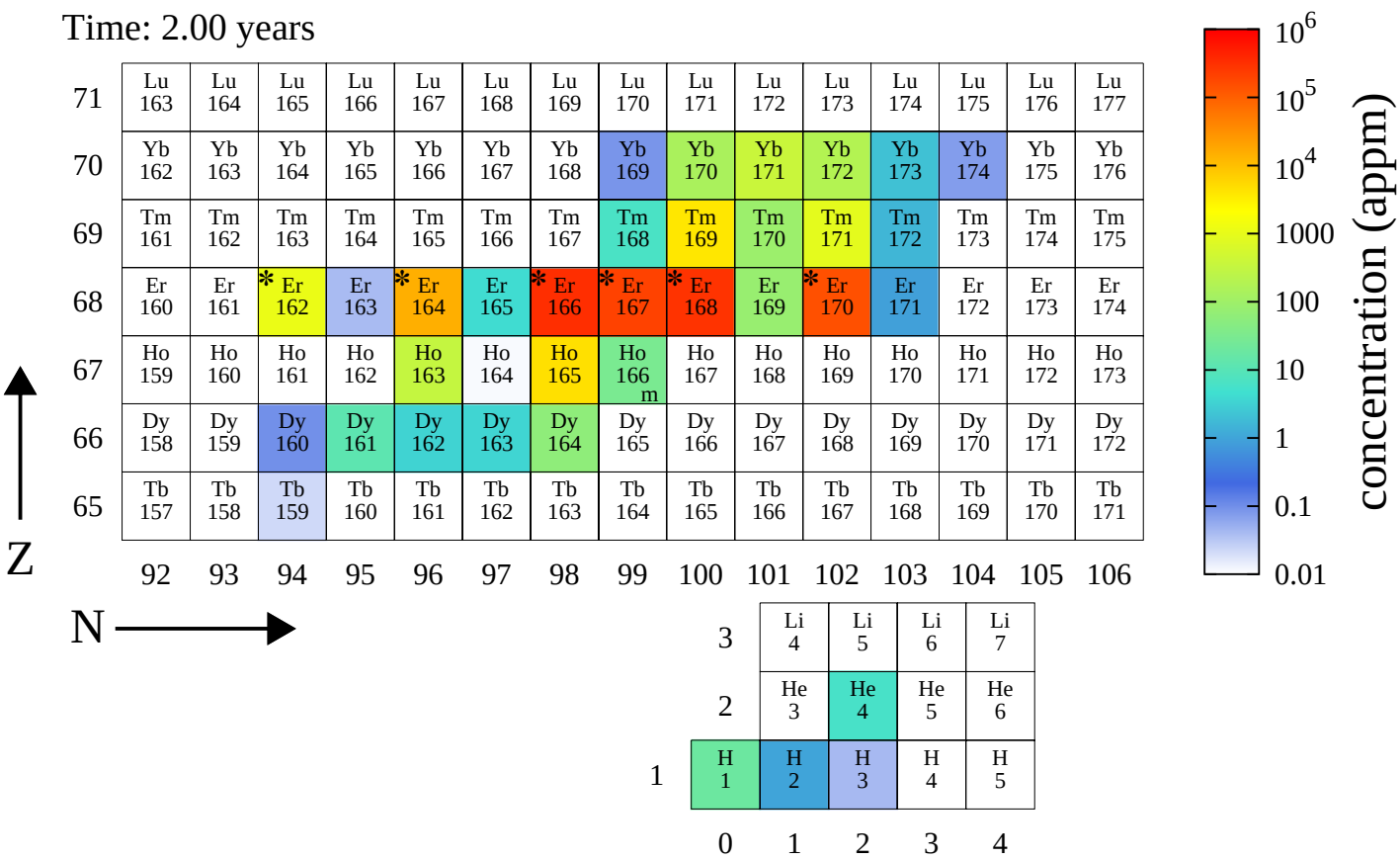




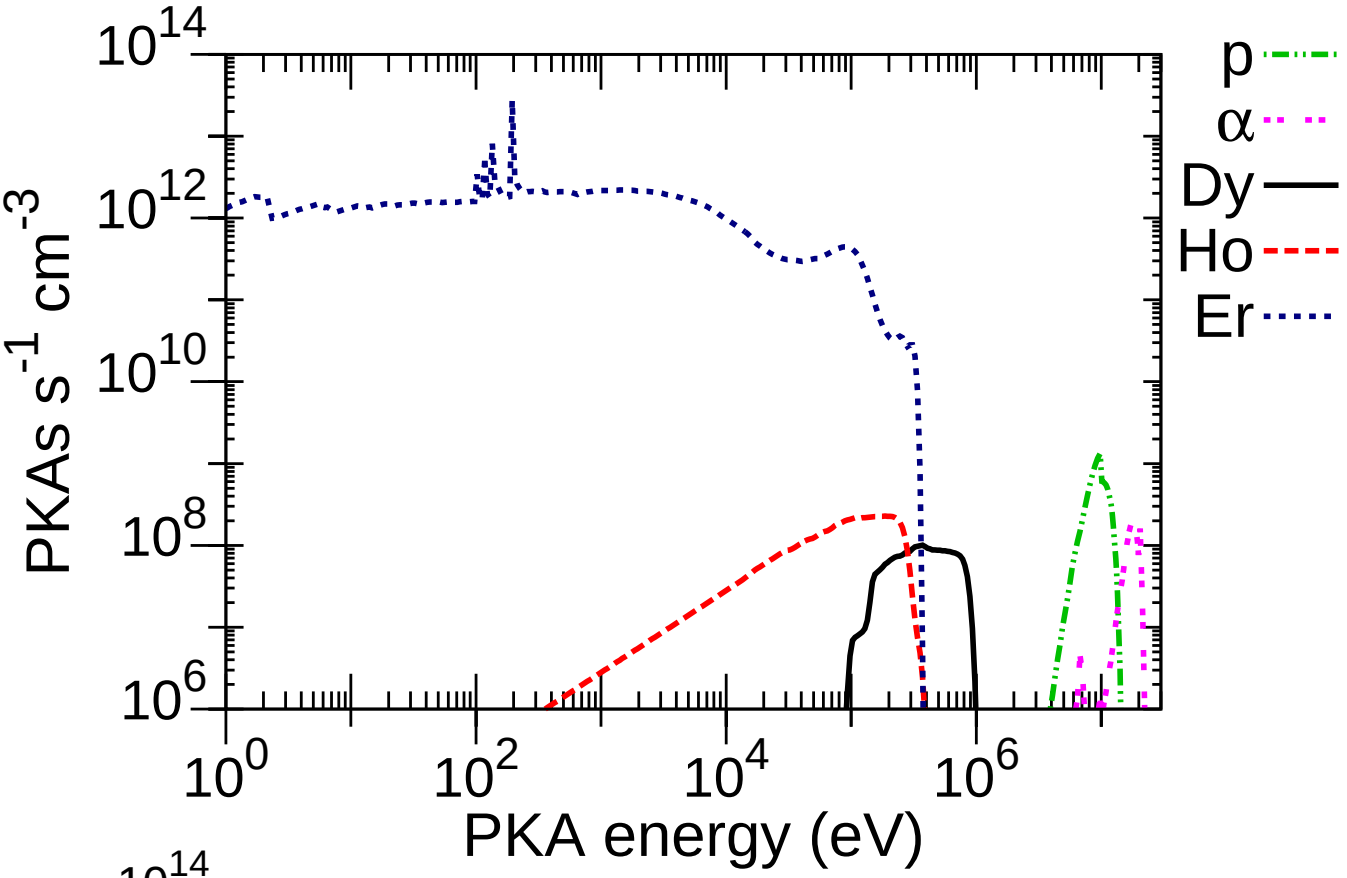
Erbium FW Transmutation

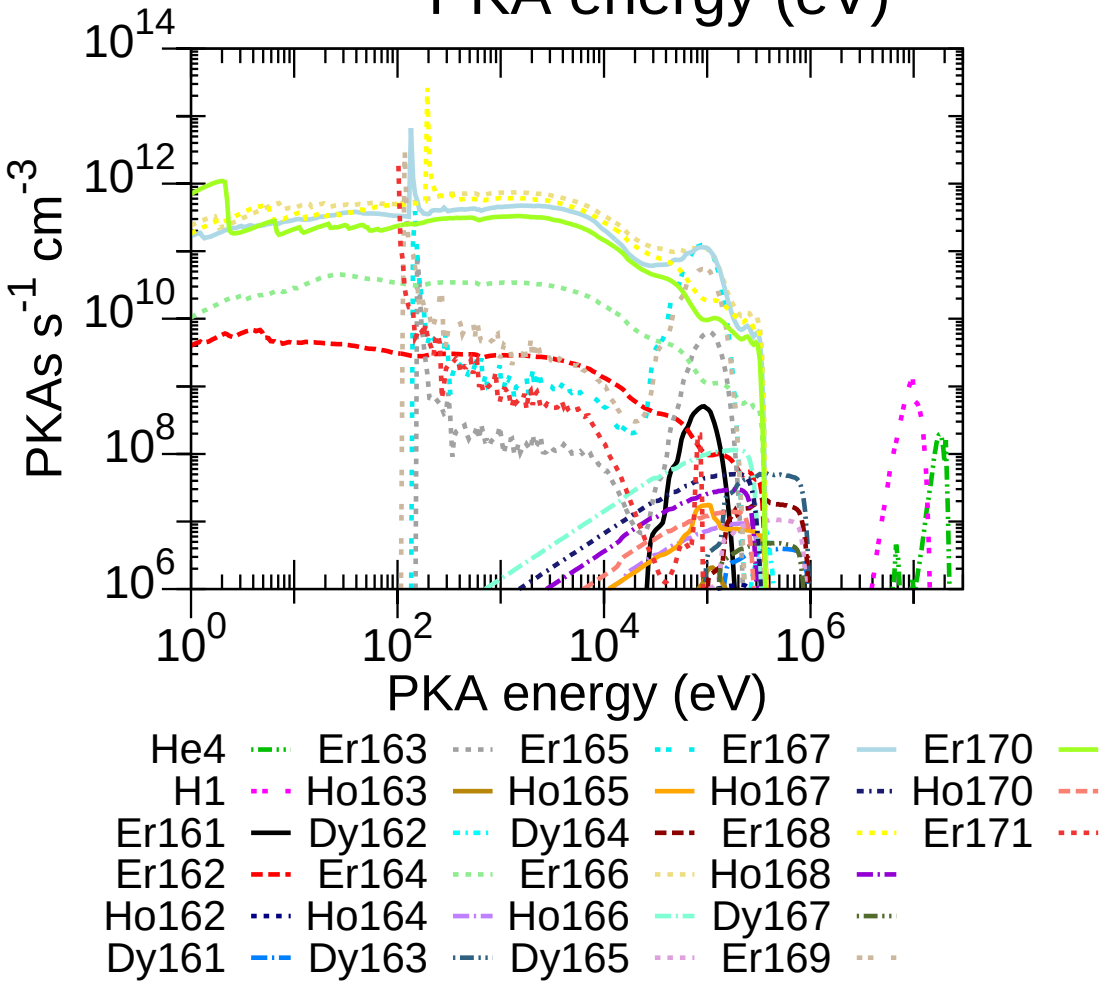


3 appm He & 10 appm H after 1 year 14 dpa/year



Erbium FW PKA distributions





Erbium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Er167m	2.27s	Er166(n,γ)Er167m	97.3	100.0	8.0	
		Er164(n,γ)Er165(β^+)Ho165(n,γ)Ho166(β^-)Er166(n,γ)Er167m	2.2			
		Er167(n,n′)Er167m			91.6	8.9
		Er168(n,2n)Er167m				88.3
		Er168(n,2n)Er167(n,n′)Er167m				1.1
Ho164	28.60m	Er162(n,γ)Er163(β^+)Ho163(n,γ)Ho164	86.8	86.4	72.8	
		Er162(n,γ)Er163(β^+)Ho163(n,γ)Ho164m(IT)Ho164	13.2	13.6	27.2	
		Er166(n,2n)Er165(β^+)Ho165(n,2n)Ho164				49.6
		Er166(n,2n)Er165(β^+)Ho165(n,2n)Ho164m(IT)Ho164				45.6
		Er167(n,2n)Er166(n,2n)Er165(β^+)Ho165(n,2n)Ho164				2.2
		Er167(n,2n)Er166(n,2n)Er165(β^+)Ho165(n,2n) Ho164m(IT)Ho164				2.1
Er163	1.25h	Er162(n,γ)Er163	100.0	100.0	100.0	
		Er164(n,2n)Er163				92.2
		Er166(n,2n)Er165(β^+)Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163				3.9
		Er166(n,2n)Er165(β^+)Ho165(n,2n)Ho164m(IT)Ho164(β^-) Er164(n,2n)Er163				3.6
Ho167	3.10h	Er164(n,γ)Er165(β^+)Ho165(n,γ)Ho166(n,γ)Ho167	66.3			
		Er164(n,γ)Er165(β^+)Ho165(n,γ)Ho166m(n,γ)Ho167	26.5	99.0	99.9	
		Er162(n,γ)Er163(β^+)Ho163(n,γ)Ho164(β^+)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166(n,γ)Ho167	2.1			
		Er162(n,γ)Er163(β^+)Ho163(n,γ)Ho164(β^-)Er164(n,γ) Er165(β^+)Ho165(n,γ)Ho166(n,γ)Ho167	1.4			
		Er167(n,p)Ho167				79.4
		Er168(n,2n)Er167(n,p)Ho167				10.2
		Er170(n,α)Dy167(β^-)Ho167				5.9
		Er168(n,d)Ho167				1.9
		Er168(n,2n)Er167m(IT)Er167(n,p)Ho167				1.8
Er161	3.21h	Er162(n,2n)Er161				100.0
Er171	7.52h	Er170(n,γ)Er171	97.5	100.0	100.0	100.0
		Er168(n,γ)Er169(n,γ)Er170(n,γ)Er171	1.1			
Er165	10.36h	Er164(n,γ)Er165	96.5	99.9	100.0	
		Er162(n,γ)Er163(β^+)Ho163(n,γ)Ho164(β^-)Er164(n,γ)Er165	3.0			
		Er166(n,2n)Er165				91.1
		Er167(n,2n)Er166(n,2n)Er165				8.2
Ho166	1.12d	Er164(n,γ)Er165(β^+)Ho165(n,γ)Ho166	92.7	95.3	94.5	
		Er162(n,γ)Er163(β^+)Ho163(n,γ)Ho164(β^+)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166	2.9			
		Er162(n,γ)Er163(β^+)Ho163(n,γ)Ho164(β^-)Er164(n,γ) Er165(β^+)Ho165(n,γ)Ho166	1.9			
		Er162(n,γ)Er163(β^+)Ho163(n,γ)Ho164(β^+)Dy164(n,γ) Dy165(β^-)Ho165(n,γ)Ho166	1.2			
		Er164(n,γ)Er165(β^+)Ho165(n,γ)Ho166m(n,E)Ho166		4.7	4.8	
		Er166(n,p)Ho166				79.8
		Er167(n,2n)Er166(n,p)Ho166				7.2
		Er166(n,p)Ho166m(n,E)Ho166				6.7
		Er166(n,2n)Er165(β^+)Ho165(n,γ)Ho166				1.9
		Er170(n,2n)Er169(β^-)Tm169(n,α)Ho166				1.4
Tm172	2.65d	Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172	47.3	99.6	100.0	99.8
		Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	21.1			
		Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ) Tm171(n,γ)Tm172	17.9			
		Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	8.2			
		Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171(n,γ)Tm172	3.9			
Er169	9.40d	Er168(n,γ)Er169	37.3	92.9	99.8	
		Er167(n,γ)Er168(n,γ)Er169	31.8	7.0		
		Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169	20.6			
		Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169	9.7			
		Er170(n,2n)Er169				99.8

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hf181	42.38d	Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	13.0			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	10.9			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	10.4			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	9.5			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	9.4			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	8.6			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181	3.4			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181	2.9			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181	2.7			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181	2.5			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181	2.5			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181	2.3			
		Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ) Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-) Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	1.0			
Tm168	93.10d	Er170(n,2n)Er169(β^-)Tm169(n,2n)Tm168				99.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ta182	114.71d	Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	8.1			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	8.1			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	7.4			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	6.0			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	5.2			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	5.1			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	4.6			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	4.6			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	4.2			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	3.4			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	3.0			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	2.9			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	2.1			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	2.1			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	1.9			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	1.6			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ta182	cont.	Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182	1.4			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182	1.3			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	1.2			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	1.2			
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	1.1			
Tm170	128.61d	Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	40.1	96.9	99.9	
		Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	34.1	3.1		
		Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170	17.2			
		Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170	8.1			
		Er170(n,2n)Er169(β^-)Tm169(n,γ)Tm170				57.6
		Er170(n,γ)Er171(β^-)Tm171(n,2n)Tm170				42.3
Tm171	1.92y	Er170(n,γ)Er171(β^-)Tm171	47.4	99.7	100.0	100.0
		Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	21.2			
		Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171	18.0			
		Er166(n,γ)Er167m(IT)Er167(n,γ)Er168(n,γ)Er169(β^-) Tm169(n,γ)Tm170(n,γ)Tm171	8.2			
		Er166(n,γ)Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171	3.9			
H3	12.33y	Er166(n,2n)Er165(β^+)Ho165(n,t)H3				39.6
		Er167(n,t)H3				39.0
		Er170(n,2n)Er169(β^-)Tm169(n,t)H3				1.5
		Er166(n,t)H3				2.1
		Er168(n,2n)Er167(n,t)H3				2.5
		Er170(n,t)H3				1.6
		Er168(n,t)H3				1.0
		Er167(n,2n)Er166(n,2n)Er165(β^+)Ho165(n,t)H3				1.2
Ho166m	1.2 10^3y	Er164(n,γ)Er165(β^+)Ho165(n,γ)Ho166m	92.9	100.0	100.0	
		Er162(n,γ)Er163(β^+)Ho163(n,γ)Ho164(β^+)Dy164(n,γ) Dy165m(IT)Dy165(β^-)Ho165(n,γ)Ho166m	2.9			
		Er162(n,γ)Er163(β^+)Ho163(n,γ)Ho164(β^-)Er164(n,γ) Er165(β^+)Ho165(n,γ)Ho166m	1.9			
		Er162(n,γ)Er163(β^+)Ho163(n,γ)Ho164(β^+)Dy164(n,γ) Dy165(β^-)Ho165(n,γ)Ho166m	1.2			
		Er166(n,p)Ho166m				90.0
		Er167(n,2n)Er166(n,p)Ho166m				4.2
		Er166(n,2n)Er165(β^+)Ho165(n,γ)Ho166m				1.9
		Er167(n,d)Ho166m				1.5
		Er170(n,2n)Er169(β^-)Tm169(n,α)Ho166m				1.0
		Er167(n,np)Ho166m				1.0
Ho163	4.6 10^3y	Er162(n,γ)Er163(β^+)Ho163	100.0	100.0	100.0	
		Er164(n,2n)Er163(β^+)Ho163				97.0
		Er166(n,2n)Er165(β^+)Ho165(n,2n)Ho164(β^-)Er164(n,2n) Er163(β^+)Ho163				1.4
		Er166(n,2n)Er165(β^+)Ho165(n,2n)Ho164m(IT)Ho164(β^-) Er164(n,2n)Er163(β^+)Ho163				1.3
La137	6.0 10^4y	no pathways found				
Dy154	3.0 10^6y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Lu176	4.0 10^{10}y	Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	47.0	77.4	90.7	
		Er170(n,γ)Er171(β^-)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	26.8	9.7	3.9	
		Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ) Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-) Lu175(n,γ)Lu176	6.4			
		Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ) Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-) Lu175(n,γ)Lu176	5.0			
		Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ) Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ) Yb175(β^-)Lu175(n,γ)Lu176	4.8			
		Er167(n,γ)Er168(n,γ)Er169(β^-)Tm169(n,γ)Tm170(n,γ) Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ) Yb175(β^-)Lu175(n,γ)Lu176	3.9			
		Er170(n,γ)Er171(β^-)Tm171(β^-)Yb171(n,γ)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.5	12.4	5.3	
La138	1.0 10^{11}y	no pathways found				
Er162	1.4 10^{14}y	no pathways found				

Thulium

Isotope	Atom % abundance
Tm169	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.83E+15	2.82E+15	2.73E+15	3.97E+14	1.41E+08	3.78E+05
Tm170	72.4	72.5	73.5	72.0		
Tm168	20.7	20.7	20.9	9.7		
Tm171	3.7	3.7	3.8	18.3		
Tm172	1.7	1.7	0.7			
Ho166m					91.3	100.0
H3					8.7	

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.42E-01	2.42E-01	2.32E-01	2.37E-02	3.65E-08	1.07E-10
Tm168	51.1	51.1	52.0	34.5		
Tm170	44.9	44.9	46.0	64.2		
Tm172	3.2	3.2	1.3			
Tm171	0.2	0.2	0.2	1.3		
Ho166m					100.0	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.37E+05	1.37E+05	1.30E+05	8.63E+03	3.67E-02	1.08E-04
Tm168	95.3	95.3	98.0	99.9		
Tm172	4.6	4.6	1.9			
Ho166m					100.0	100.0

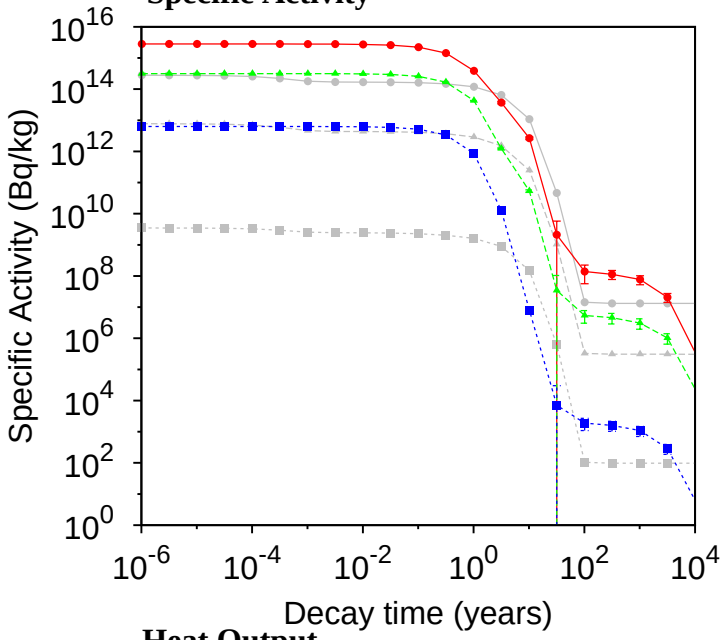
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.33E+06	3.33E+06	3.21E+06	4.16E+05	2.58E-01	7.56E-04
Tm170	79.8	79.8	81.2	89.2		
Tm168	16.9	16.9	17.0	8.9		
Tm172	2.4	2.4	1.0			
Tm171	0.3	0.3	0.4	1.9		
Ho166m					99.8	100.0

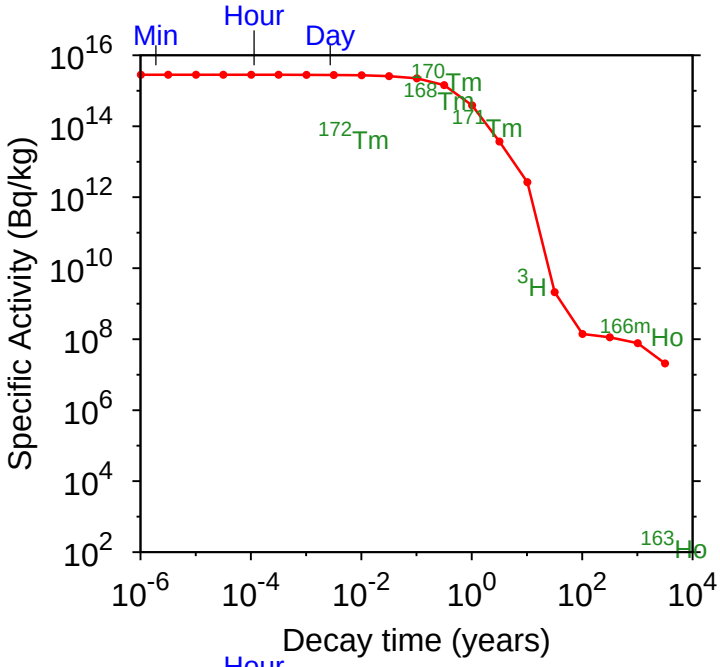
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.64E+07	1.64E+07	1.60E+07	2.22E+06	1.54E+01	4.54E-02
Tm170	87.3	87.3	87.6	90.0		
Tm168	11.1	11.1	11.0	5.4		
Tm171	0.9	0.9	0.9	4.6		
Ho166m					100.0	100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	7.83E+11	7.82E+11	7.47E+11	5.12E+10	2.11E+05	6.20E+02
Tm168	93.5	93.5	95.3	94.3		
Tm172	3.2	3.2	1.3			
Tm170	2.6	2.6	2.7	5.6		
Ho166m					99.9	100.0

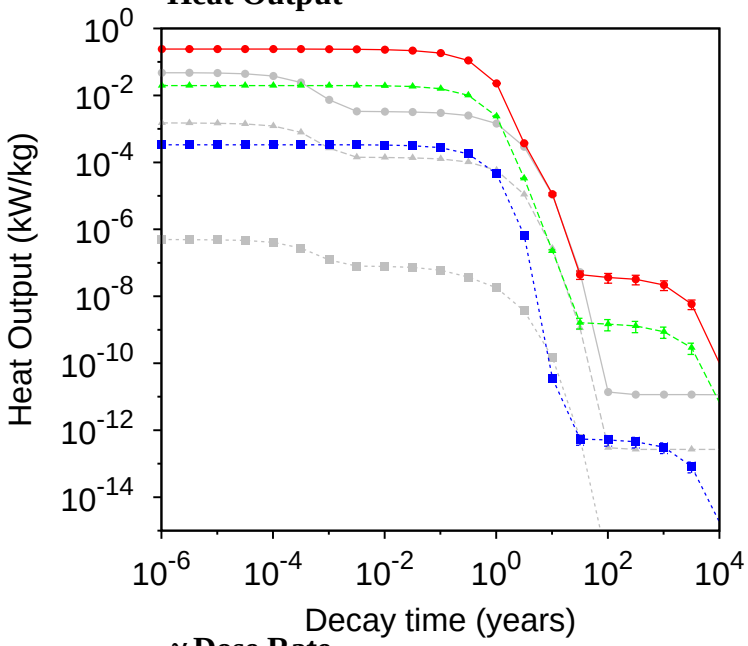
Thulium activation characteristics

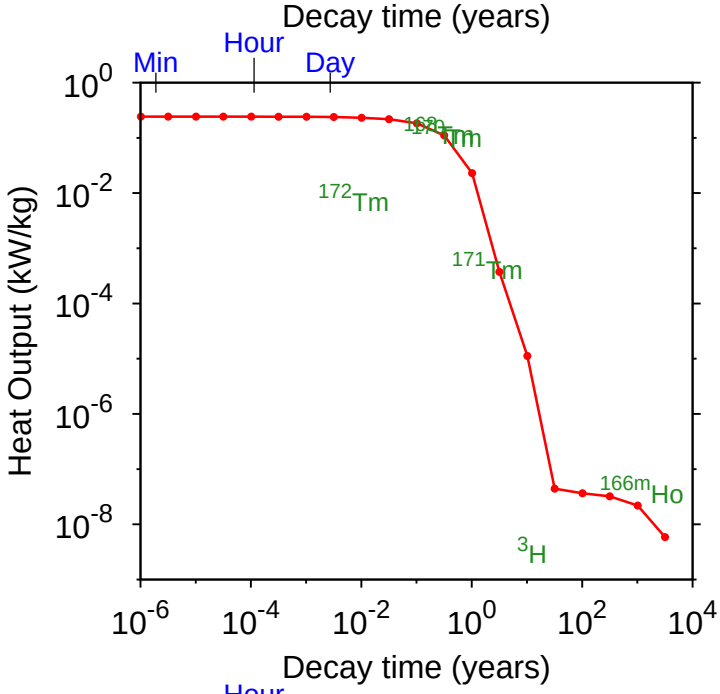
Specific Activity



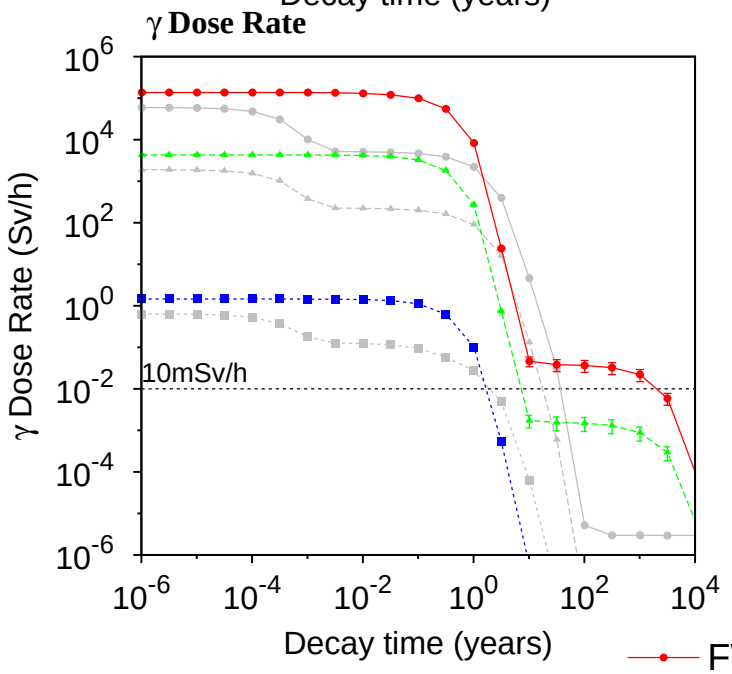


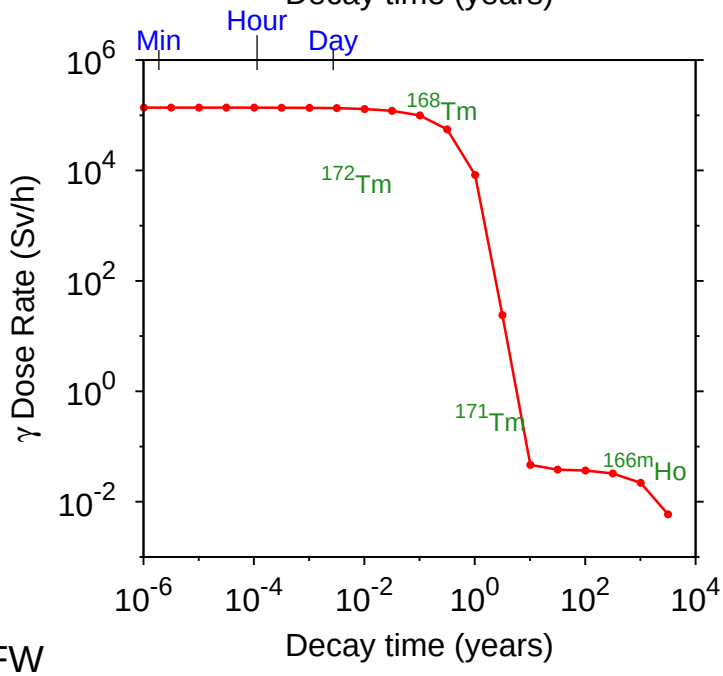
Heat Output





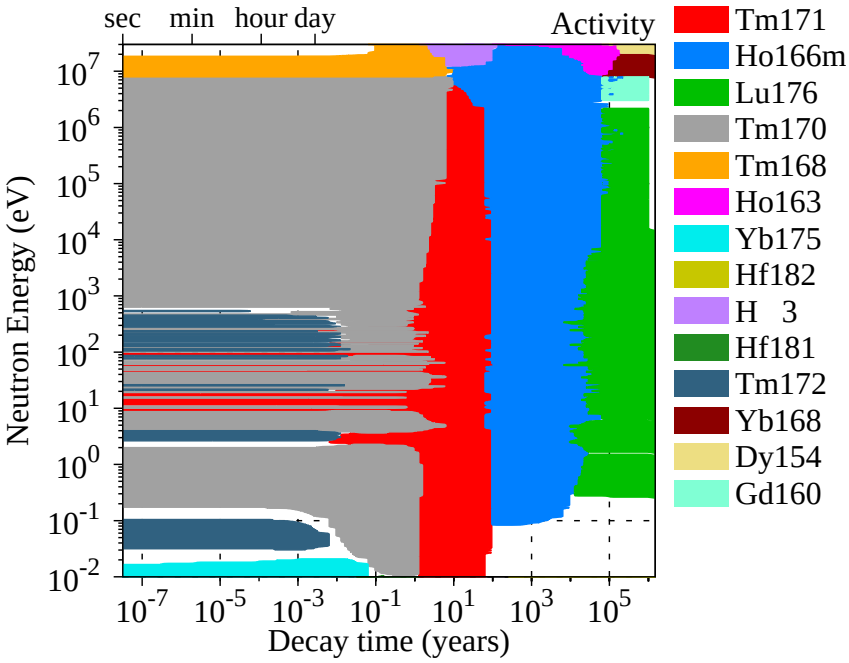
γ Dose Rate

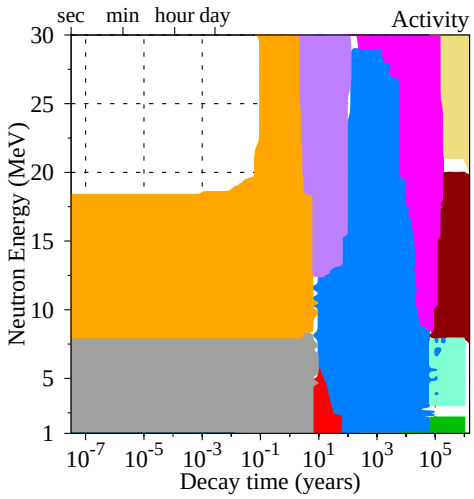


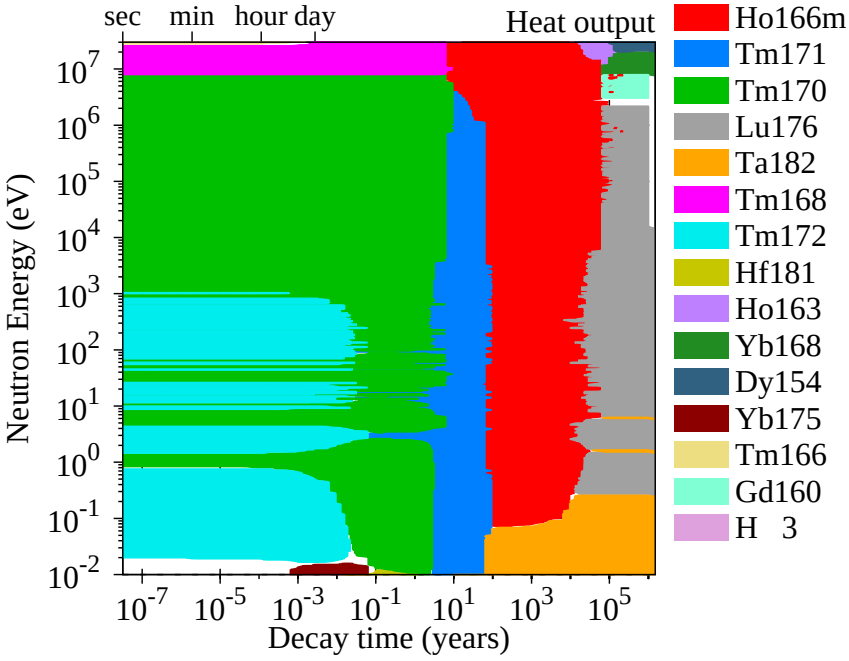


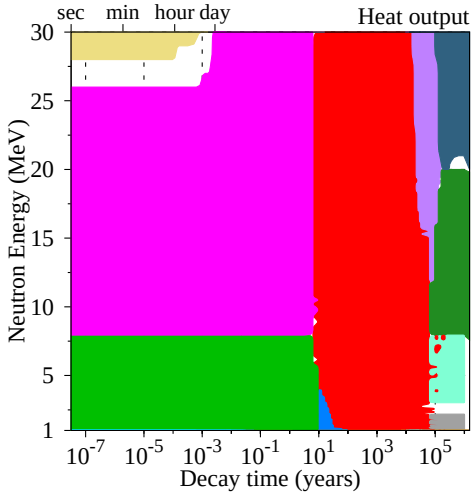
FW
Blanket
Manifold
Fe results

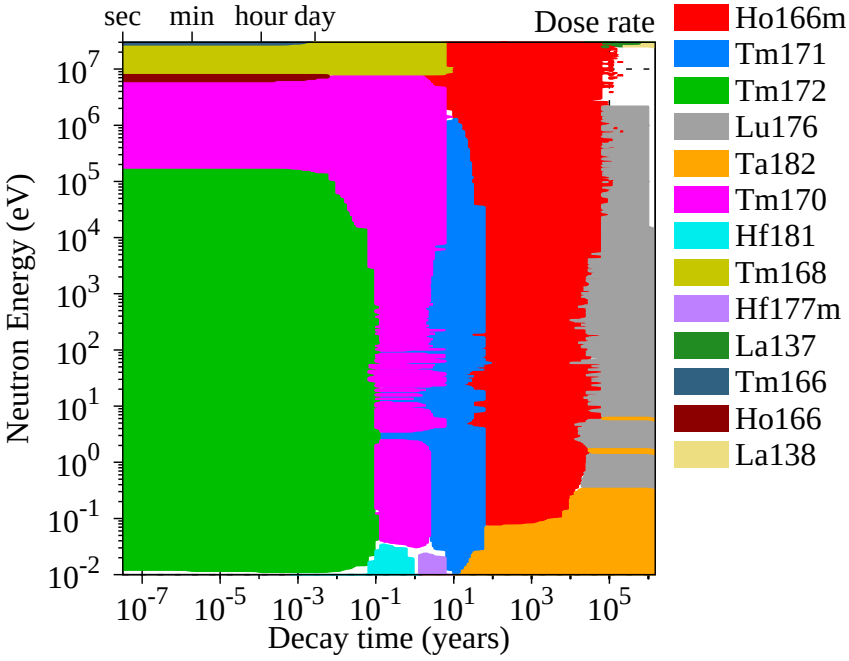
Thulium Importance diagrams

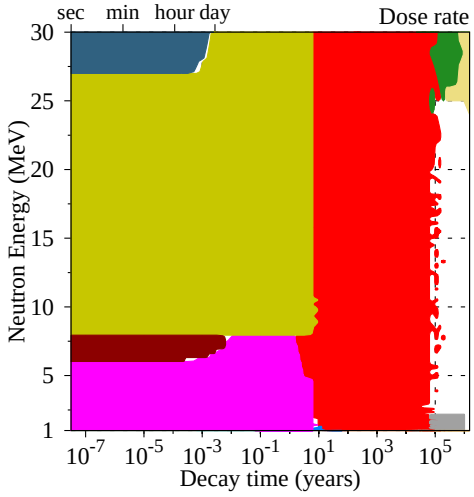




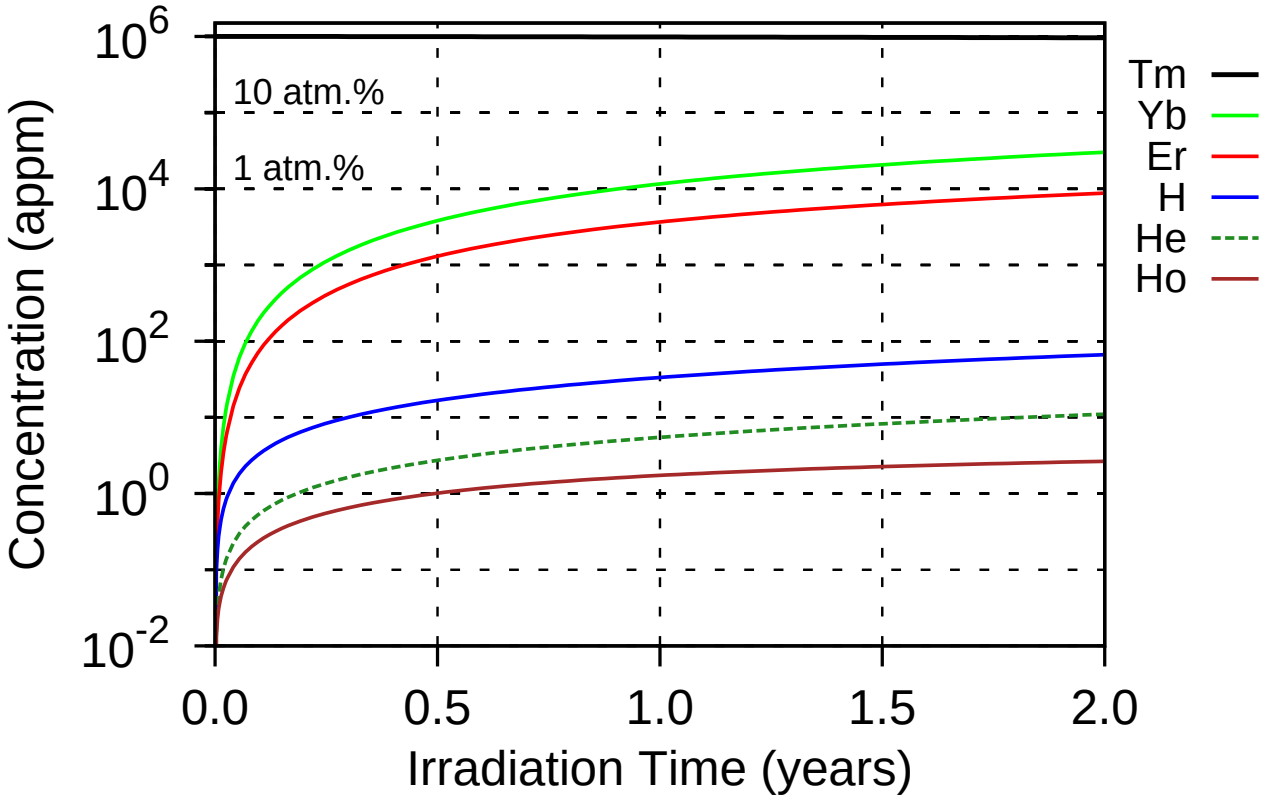






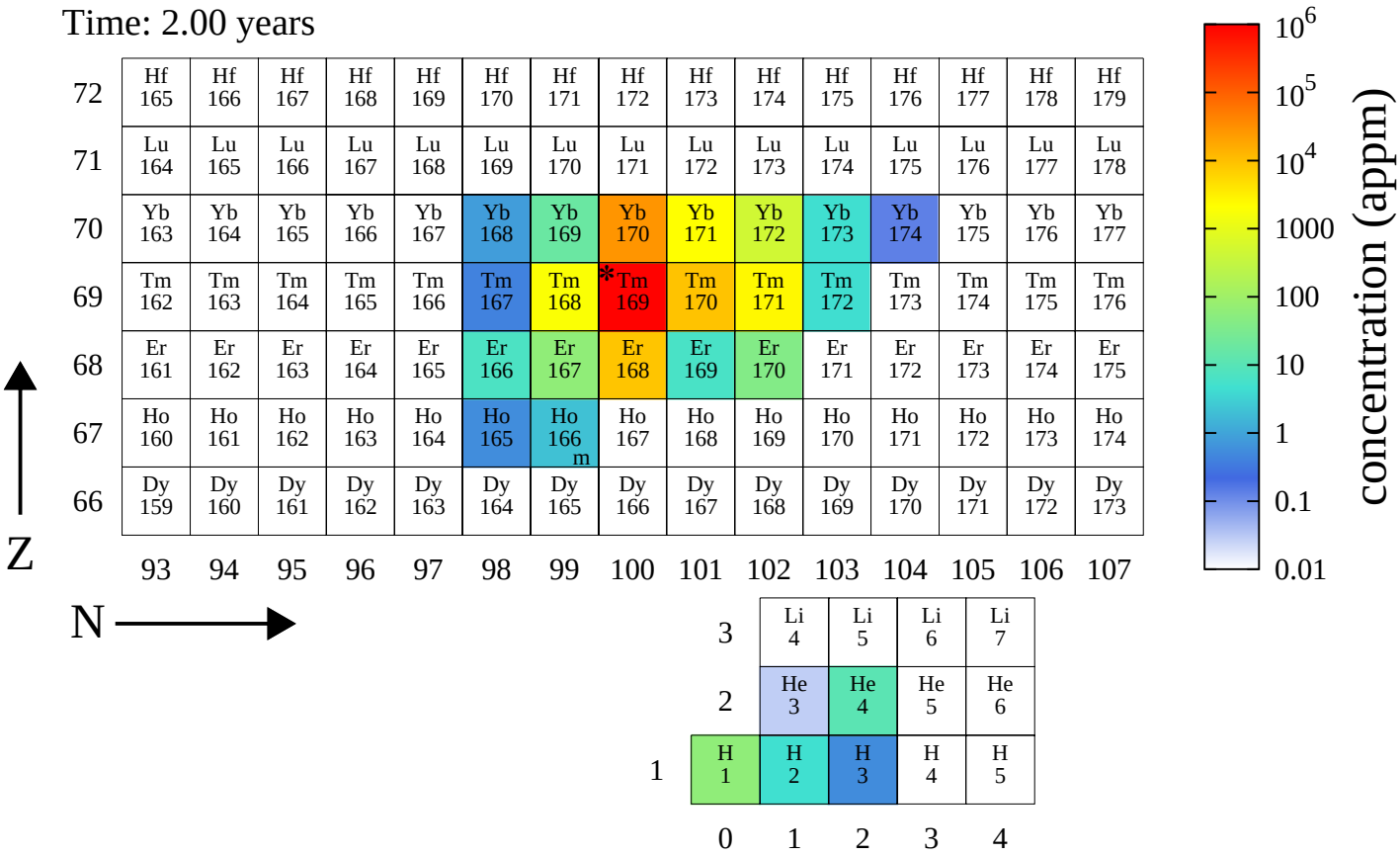


Thulium FW Transmutation

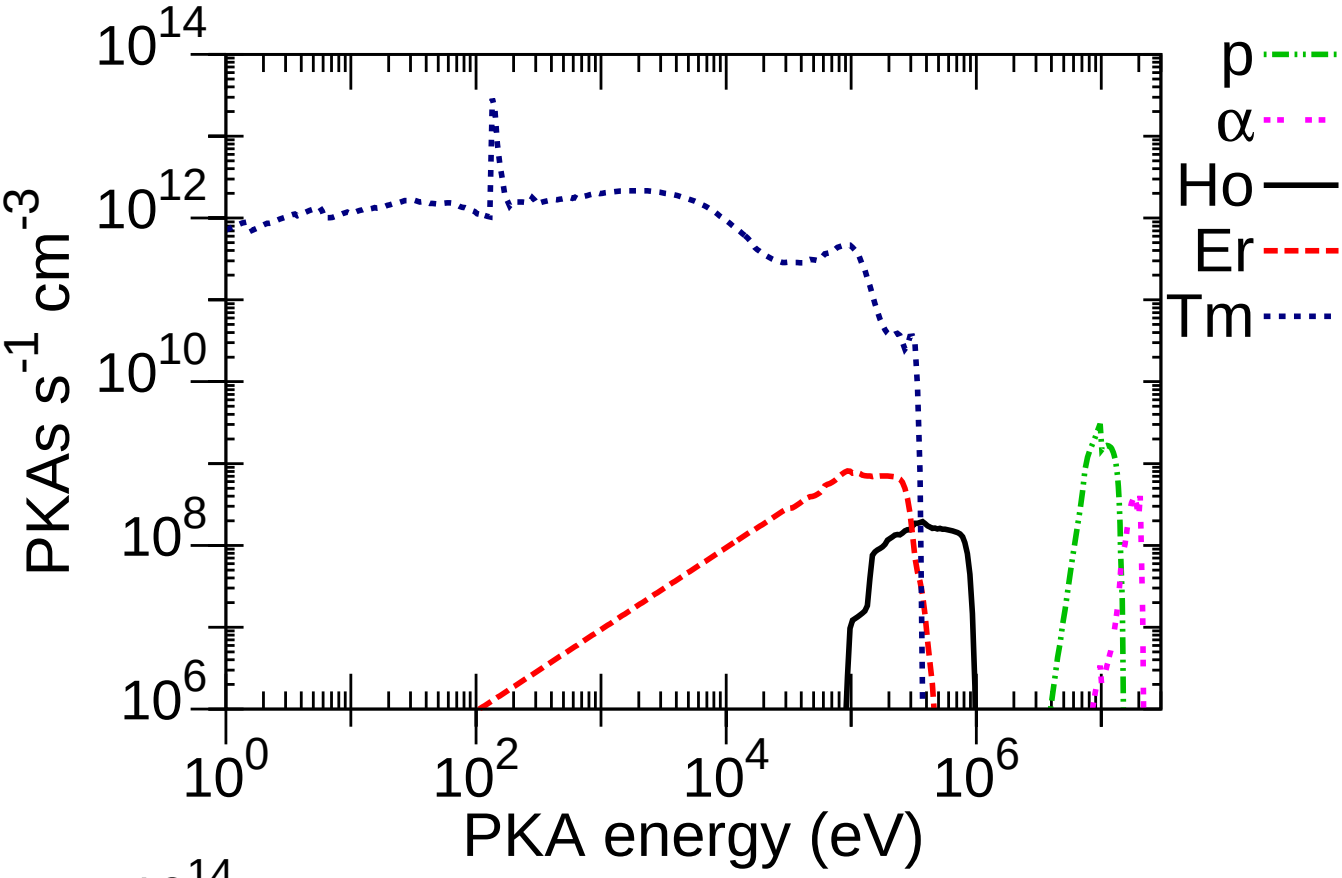


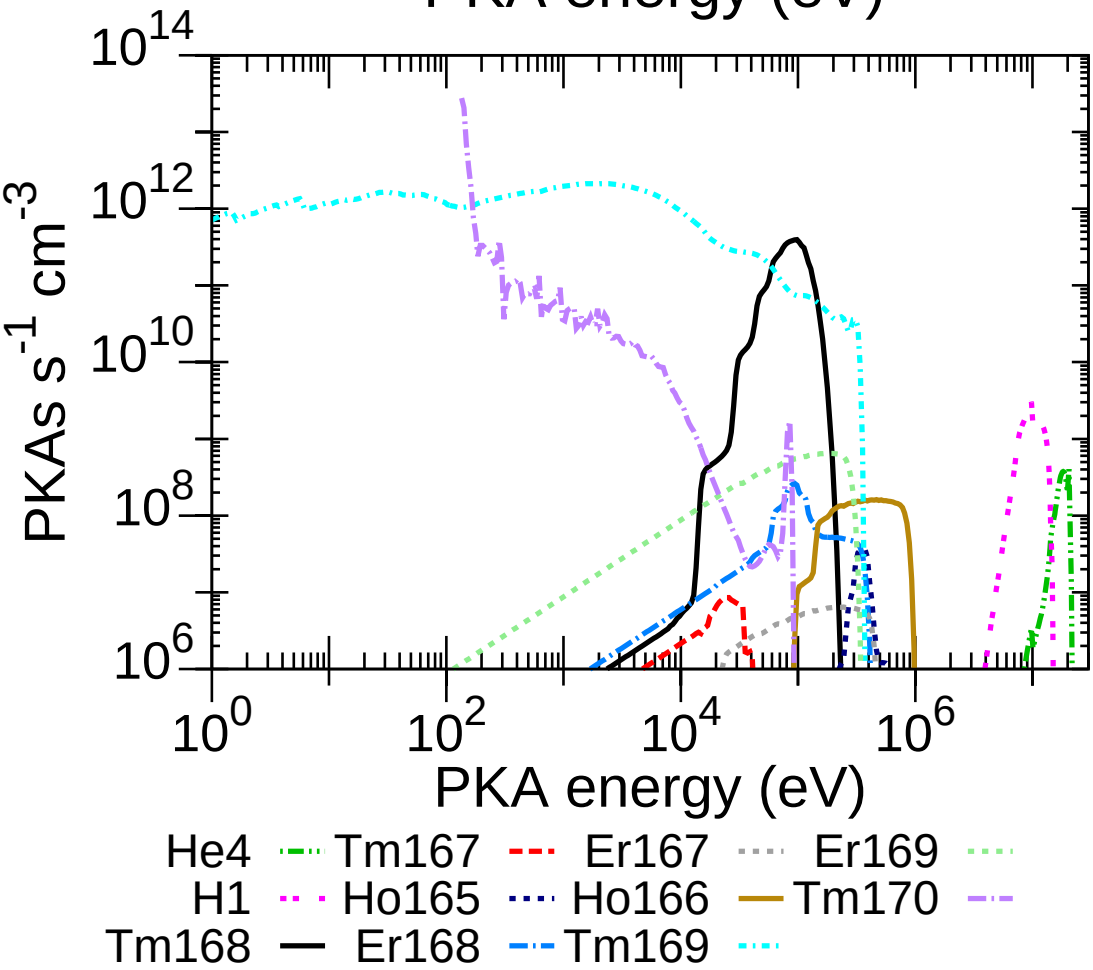
5 appm He & 33 appm H after 1 year

14 dpa/year



Thulium FW PKA distributions





Thulium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hf177m	1.08s	Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177m(β^-)Hf177m	57.5			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177m(β^-)Hf177m	37.9			
		Tm169(n,γ)Tm170(β^-)Yb170(n,γ)Yb171(n,γ)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177m(β^-)Hf177m	2.7			
		Tm169(n,γ)Tm170(n,γ)Tm171(β^-)Yb171(n,γ)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177m(β^-)Hf177m	1.7			
Tm166	7.70h	Tm169(n,2n)Tm168(n,2n)Tm167(n,2n)Tm166				99.9
Ho166	1.12d	Tm169(n,α)Ho166	99.9	96.2	96.2	89.6
		Tm169(n,α)Ho166m(n,E)Ho166		3.8	3.4	9.7
Tm172	2.65d	Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	99.5	100.0	99.9	99.6
Yb175	4.18d	Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175	70.5	57.6	33.5	
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175	20.7	5.5	1.1	
		Tm169(n,γ)Tm170(β^-)Yb170(n,γ)Yb171(n,γ)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175	5.9	25.4	62.9	
		Tm169(n,γ)Tm170(n,γ)Tm171(β^-)Yb171(n,γ)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175	2.8	11.5	2.4	
Hf181	42.38d	Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	14.9			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	12.6			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	12.0			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	10.9			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	10.5			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	9.9			
Tm168	93.10d	Tm169(n,2n)Tm168				99.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ta182	114.71d	Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	9.3			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	9.1			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	8.4			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	6.7			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	5.8			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	5.6			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	5.3			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	5.2			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	4.8			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	3.8			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	3.3			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	3.2			
Tm170	128.61d	Tm169(n,γ)Tm170	100.0	100.0	100.0	99.9
Tm171	1.92y	Tm169(n,γ)Tm170(n,γ)Tm171	99.5	100.0	99.9	99.7
H3	12.33y	Tm169(n,t)H3				23.9
		Tm169(n,2n)Tm168(n,t)H3				1.3
Ho166m	1.2 10^3y	Tm169(n,α)Ho166m	99.8	100.0	100.0	99.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ho163	4.6 10^3y	Tm169(n,nα)Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163				16.2
		Tm169(n,nα)Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n) Er163(β^+)Ho163				14.9
		Tm169(n,2n)Tm168(n,α)Ho165(n,2n)Ho164(β^-)Er164(n,2n) Er163(β^+)Ho163				8.7
		Tm169(n,2n)Tm168(n,α)Ho165(n,2n)Ho164m(IT)Ho164(β^-) Er164(n,2n)Er163(β^+)Ho163				8.0
		Tm169(n,2n)Tm168(n,nα)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163				7.7
		Tm169(n,α)Ho166(β^-)Er166(n,2n)Er165(β^+)Ho165(n,2n) Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163				5.9
		Tm169(n,2n)Tm168(n,nα)Ho164m(IT)Ho164(β^-)Er164(n,2n) Er163(β^+)Ho163				5.9
		Tm169(n,α)Ho166(β^-)Er166(n,2n)Er165(β^+)Ho165(n,2n) Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163				5.4
		Tm169(n,α)Ho166m(n,2n)Ho165(n,2n)Ho164(β^-)Er164(n,2n) Er163(β^+)Ho163				3.7
		Tm169(n,α)Ho166m(n,2n)Ho165(n,2n)Ho164m(IT)Ho164(β^-) Er164(n,2n)Er163(β^+)Ho163				3.4
		Tm169(n,2n)Tm168(n,2n)Tm167(β^+)Er167m(IT)Er167(n,2n) Er166(n,2n)Er165(β^+)Ho165(n,2n)Ho164(β^-)Er164(n,2n) Er163(β^+)Ho163				3.0
		Tm169(n,2n)Tm168(n,2n)Tm167(β^+)Er167m(IT)Er167(n,2n) Er166(n,2n)Er165(β^+)Ho165(n,2n)Ho164m(IT)Ho164(β^-) Er164(n,2n)Er163(β^+)Ho163				2.7
		Tm169(n,2n)Tm168(β^+)Er168(n,2n)Er167(n,2n)Er166(n,2n) Er165(β^+)Ho165(n,2n)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163				2.5
		Tm169(n,2n)Tm168(β^+)Er168(n,2n)Er167(n,2n)Er166(n,2n) Er165(β^+)Ho165(n,2n)Ho164m(IT)Ho164(β^-)Er164(n,2n) Er163(β^+)Ho163				2.3
		Tm169(n,2n)Tm168(n,2n)Tm167(n,nα)Ho163				1.9
		Tm169(n,2n)Tm168(β^+)Er168(n,α)Dy165(β^-)Ho165(n,2n) Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163				1.1
		Tm169(n,2n)Tm168(β^+)Er168(n,α)Dy165(β^-)Ho165(n,2n) Ho164m(IT)Ho164(β^-)Er164(n,2n)Er163(β^+)Ho163				1.0
La137	6.0 10^4y	no pathways found				
Dy154	3.0 10^6y	no pathways found				
Hf182	9.0 10^6y	Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	14.6			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	14.3			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	13.2			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	10.6			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	9.2			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	8.7			
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(n,γ)Lu178m(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	1.1			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Lu176	4.0 10^{10}y	Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(β^-)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	62.3	62.3		
		Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172(n,γ)Tm173(β^-) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	31.9	8.7		
		Tm169(n,γ)Tm170(β^-)Yb170(n,γ)Yb171(n,γ)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	3.6	19.7		
		Tm169(n,γ)Tm170(n,γ)Tm171(β^-)Yb171(n,γ)Yb172(n,γ) Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	2.1	9.1		
La138	1.0 10^{11}y	no pathways found				
Yb168	1.3 10^{14}y	Tm169(n,2n)Tm168(β^-)Yb168				99.8
Gd160	1.3 10^{17}y	Tm169(n,nα)Ho165(n,2n)Ho164(β^+)Dy164(n,nα)Gd160				3.9
		Tm169(n,nα)Ho165(n,2n)Ho164m(IT)Ho164(β^+) Dy164(n,nα)Gd160				3.6
		Tm169(n,2n)Tm168(β^+)Er168(n,nα)Dy164(n,nα)Gd160				3.4
		Tm169(n,2n)Tm168(β^+)Er168(n,2n)Er167(n,α) Dy164(n,nα)Gd160				2.4
		Tm169(n,2n)Tm168(n,α)Ho165(n,2n)Ho164(β^+) Dy164(n,nα)Gd160				2.1
		Tm169(n,2n)Tm168(n,2n)Tm167(β^+)Er167m(IT)Er167(n,α) Dy164(n,nα)Gd160				2.0
		Tm169(n,2n)Tm168(n,α)Ho165(n,2n)Ho164m(IT)Ho164(β^+) Dy164(n,nα)Gd160				2.0
		Tm169(n,2n)Tm168(n,nα)Ho164(β^+)Dy164(n,nα)Gd160				1.9
		Tm169(n,α)Ho166(β^-)Er166(n,2n)Er165(β^+)Ho165(n,2n) Ho164(β^+)Dy164(n,nα)Gd160				1.4
		Tm169(n,2n)Tm168(n,nα)Ho164m(IT)Ho164(β^+) Dy164(n,nα)Gd160				1.4
		Tm169(n,α)Ho166(β^-)Er166(n,2n)Er165(β^+)Ho165(n,2n) Ho164m(IT)Ho164(β^+)Dy164(n,nα)Gd160				1.3

Ytterbium

Isotope	Atom % abundance
Yb168	0.13
Yb170	3.04
Yb171	14.28
Yb172	21.83
Yb173	16.13
Yb174	31.83
Yb176	12.76

($T_{1/2}$ =1.3 10^{14}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.76E+14	2.51E+14	1.37E+14	1.05E+12	2.69E+06	3.34E+02
Yb175	55.6	61.0	61.3			
Yb169	13.4	14.7	25.0	1.3		
Lu177	6.7	7.4	9.4			
Yb169m	6.6	0.1				
Yb177	6.6	7.0				
Lu176m	6.2	6.7				
Yb177m	1.5					
Tm170	1.2	1.3	2.4	44.1		
Tm171	0.1	0.1	0.3	23.3		
Lu174	0.1	0.1	0.2	21.0		
Lu174m	0.2	0.2	0.3	7.8		
Tm168	0.1	0.1	0.2	2.1		
H3				0.1	95.5	
Ho166m					2.3	73.0
Hf178m					1.1	
Hf178n					1.1	
Lu176						18.3
Ho163						8.5

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.22E-02	1.16E-02	5.72E-03	3.95E-05	3.10E-11	7.69E-14
Yb175	40.5	42.7	47.3			
Yb169	20.6	21.8	40.7	2.4		
Yb177	14.9	15.2				
Lu176m	10.8	11.3				
Lu177	4.4	4.6	6.5			
Yb177m	1.7					
Yb176m	1.7					
Tm170	1.4	1.5	3.0	62.3		
Tm168	0.6	0.6	1.2	11.7		
Lu174			0.1	14.5	0.1	
Lu174m	0.1	0.1	0.2	5.9		
Tm171				2.6		
Ho166m					56.5	89.9
Hf178n					19.0	
Hf178m					16.8	
H3					7.6	
Lu176						9.9

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.99E+03	1.87E+03	6.75E+02	9.39E+00	2.40E-05	7.11E-08
Yb177	38.9	40.2				
Yb175	36.5	38.9	58.8			
Yb169	8.6	9.2	23.5	0.7		
Tm168	3.7	4.0	10.7	52.1		
Tm172	3.4	3.6	3.9			
Yb176m	2.6					
Tm174	2.0	1.1				
Lu177	0.9	1.0	1.9			
Lu174	0.2	0.2	0.6	44.8	0.1	
Lu174m			0.1	1.5		
Ho166m					73.3	97.6
Hf178n					16.5	
Hf178m	0.1				10.1	
Lu176						2.4

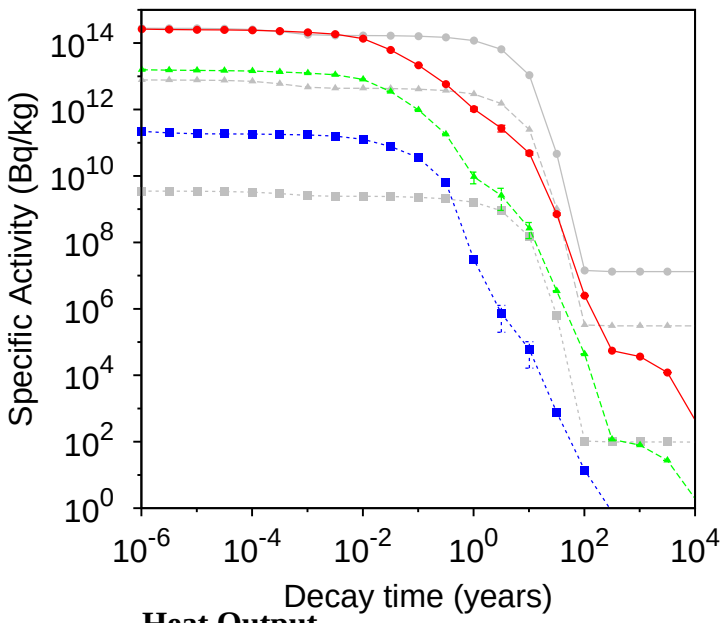
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.15E+05	1.15E+05	7.34E+04	7.65E+02	3.65E-04	6.28E-07
Yb175	58.8	58.9	50.2			
Yb169	22.9	22.9	33.1	1.3		
Lu177	8.6	8.6	9.2			
Tm170	3.8	3.8	5.8	78.8		
Lu176m	2.5	2.5				
Yb177	1.4	1.4				
Lu174	0.1	0.1	0.1	7.8	0.1	
Lu174m	0.2	0.2	0.3	5.7		
Tm171			0.1	3.5		
Tm168	0.3	0.3	0.4	2.8		
Hf178n					36.4	
Ho166m					33.9	77.7
H3					29.6	
Lu176						17.6
Yb168						4.6

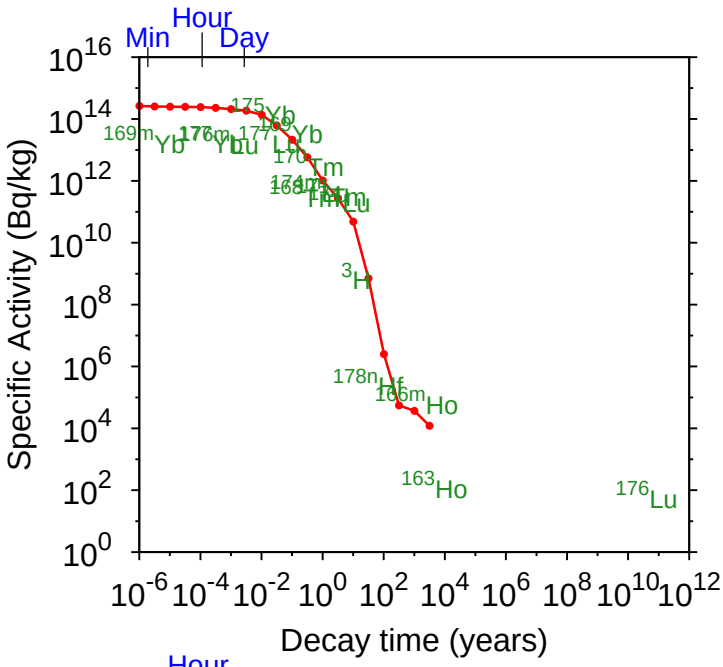
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.78E+05	2.78E+05	2.07E+05	4.98E+03	1.54E-02	3.36E-05
Yb175	40.3	40.3	29.5			
Yb169	39.9	40.0	49.5	0.8		
Tm170	8.4	8.4	11.0	65.2		
Lu177	8.0	8.0	7.4			
Lu174	0.3	0.3	0.5	18.6		
Tm171	0.2	0.2	0.2	6.9		
Lu174m	0.7	0.7	1.0	6.9		
Tm168	0.4	0.4	0.5	1.4		
Ho166m					48.0	87.0
Hf178n					47.6	
H3					4.3	
Lu176						12.8

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.27E+10	2.04E+10	1.27E+10	7.05E+07	1.91E+02	4.61E-01
Yb169	52.6	58.5	86.9	6.3		
Yb177	19.5	21.0				
Yb175	6.8	7.5	6.6			
Yb176m	5.0					
Lu176m	4.7	5.2				
Yb177m	3.0					
Tm168	1.8	2.0	3.2	38.9		
Tm172	1.2	1.3	0.8			
Tm174	1.2	0.7				
Tm173	0.9	1.0				
Lu177	0.8	0.9	1.0			
Lu174	0.1	0.1	0.2	37.8	0.1	
Lu174m	0.2	0.2	0.3	8.3		
Tm170	0.1	0.2	0.3	6.6		
Hf175	0.1	0.1	0.2	1.0		
Ho166m					53.0	86.7
Hf178n					18.3	
Hf178m	0.1				15.1	
H3					13.5	
Lu176						13.3

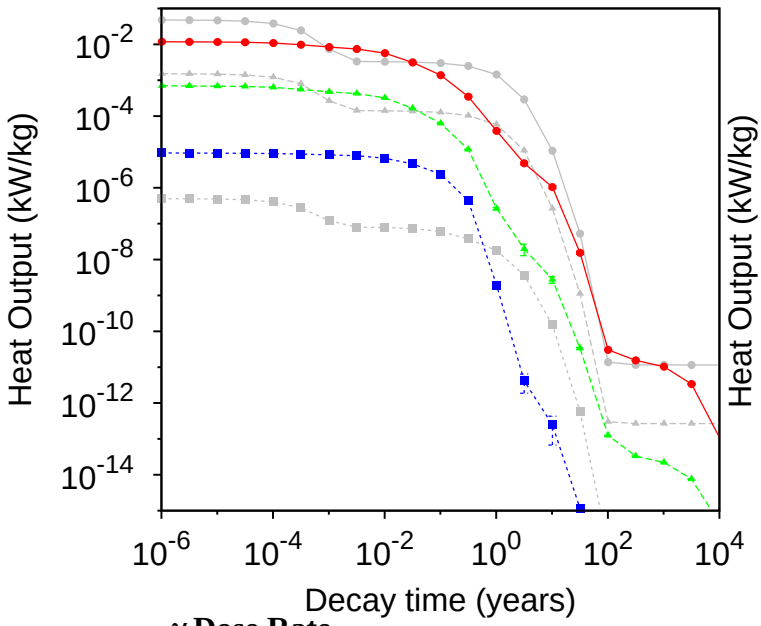
Ytterbium activation characteristics

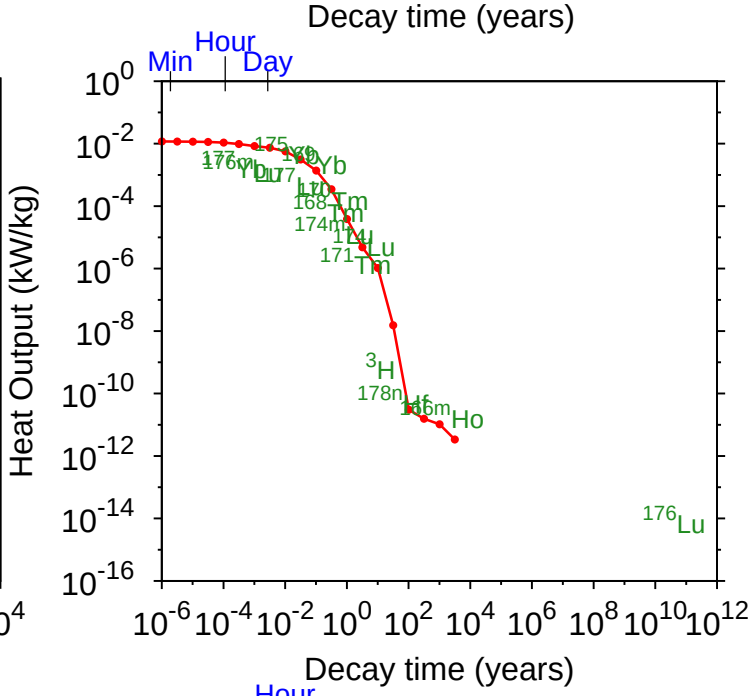
Specific Activity



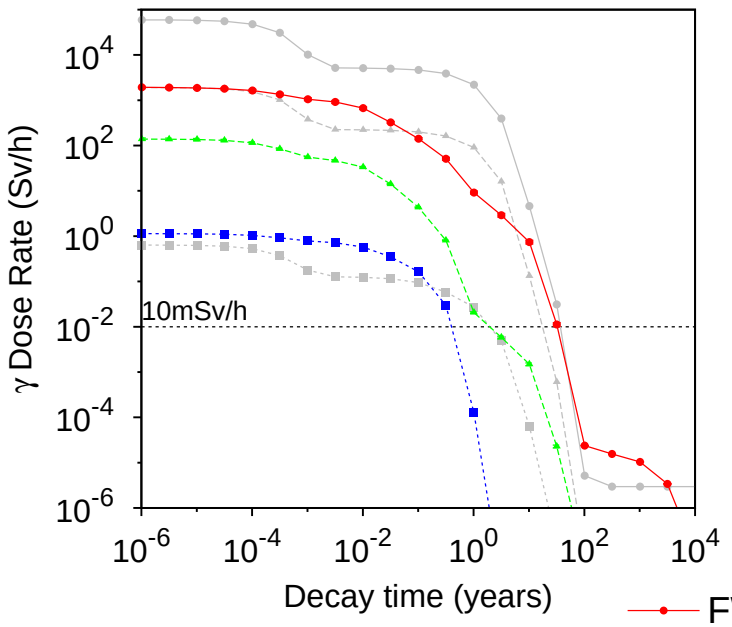


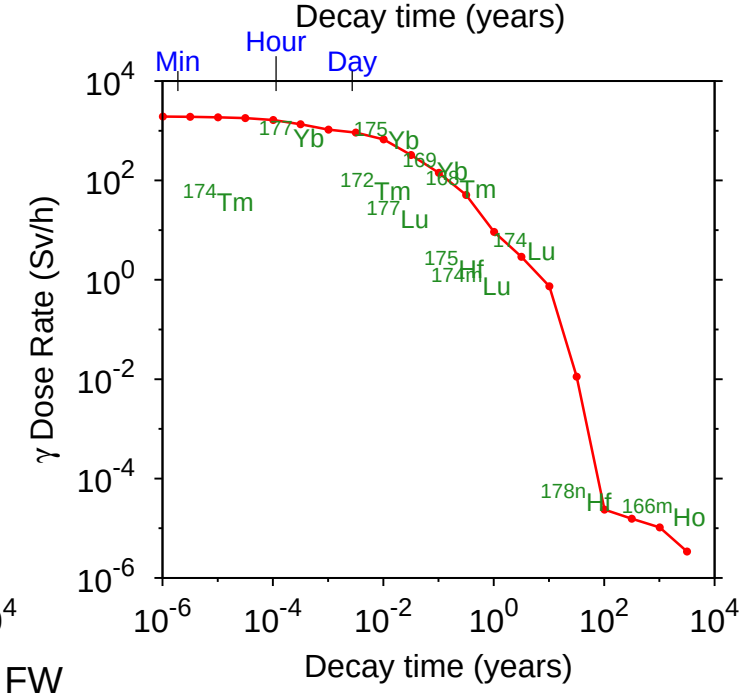
Heat Output





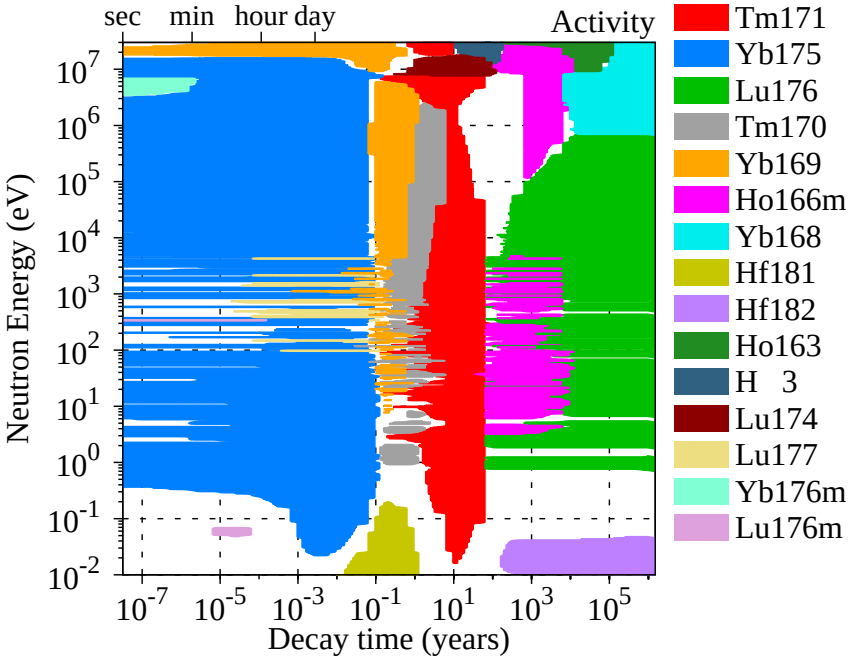
γ Dose Rate

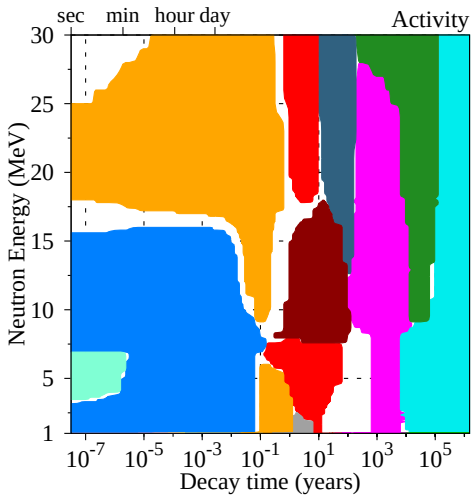


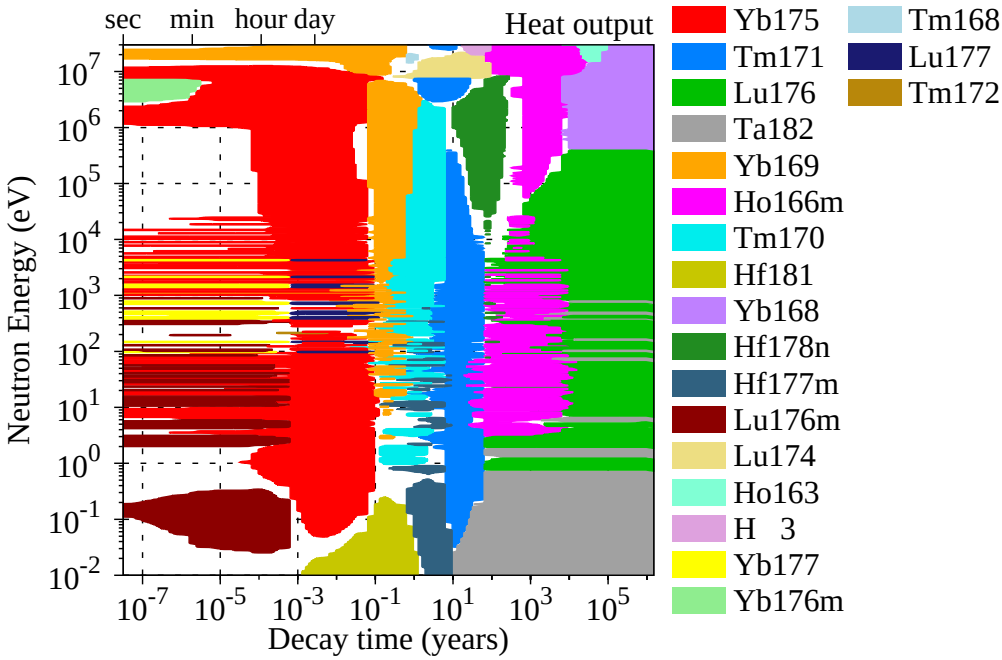


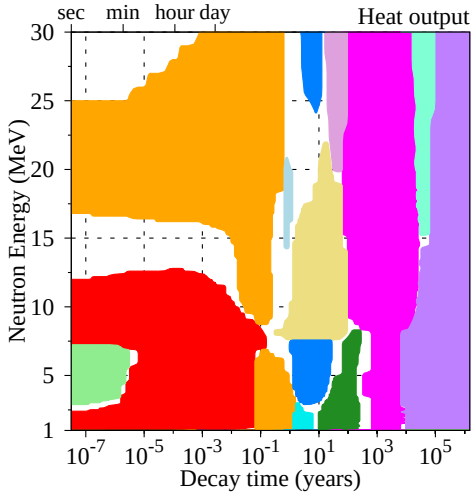
FW
Blanket
Manifold
Fe results

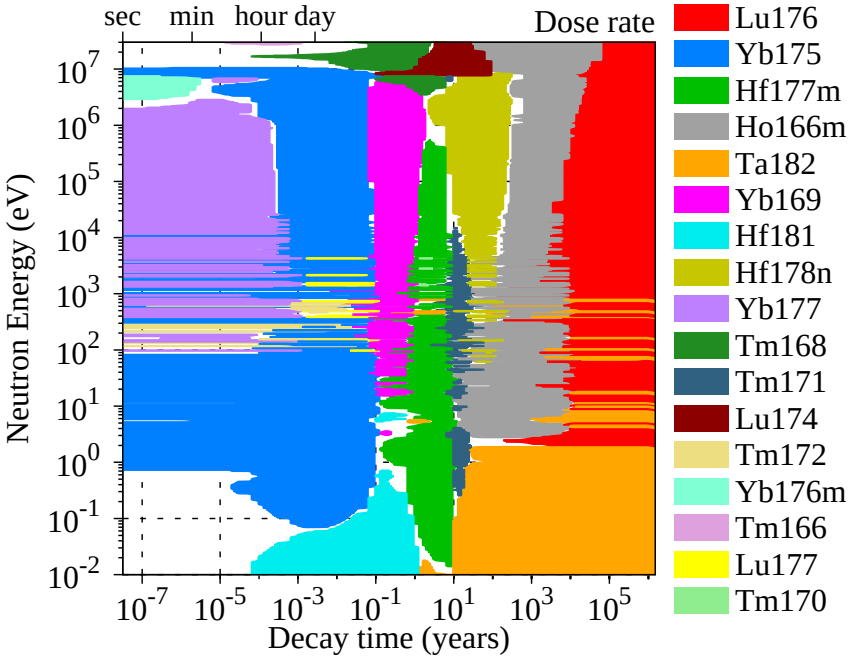
Ytterbium Importance diagrams

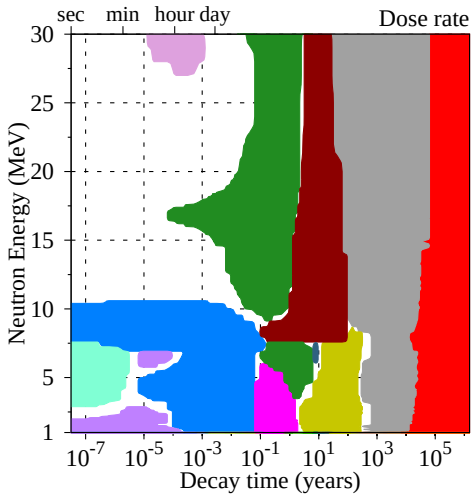




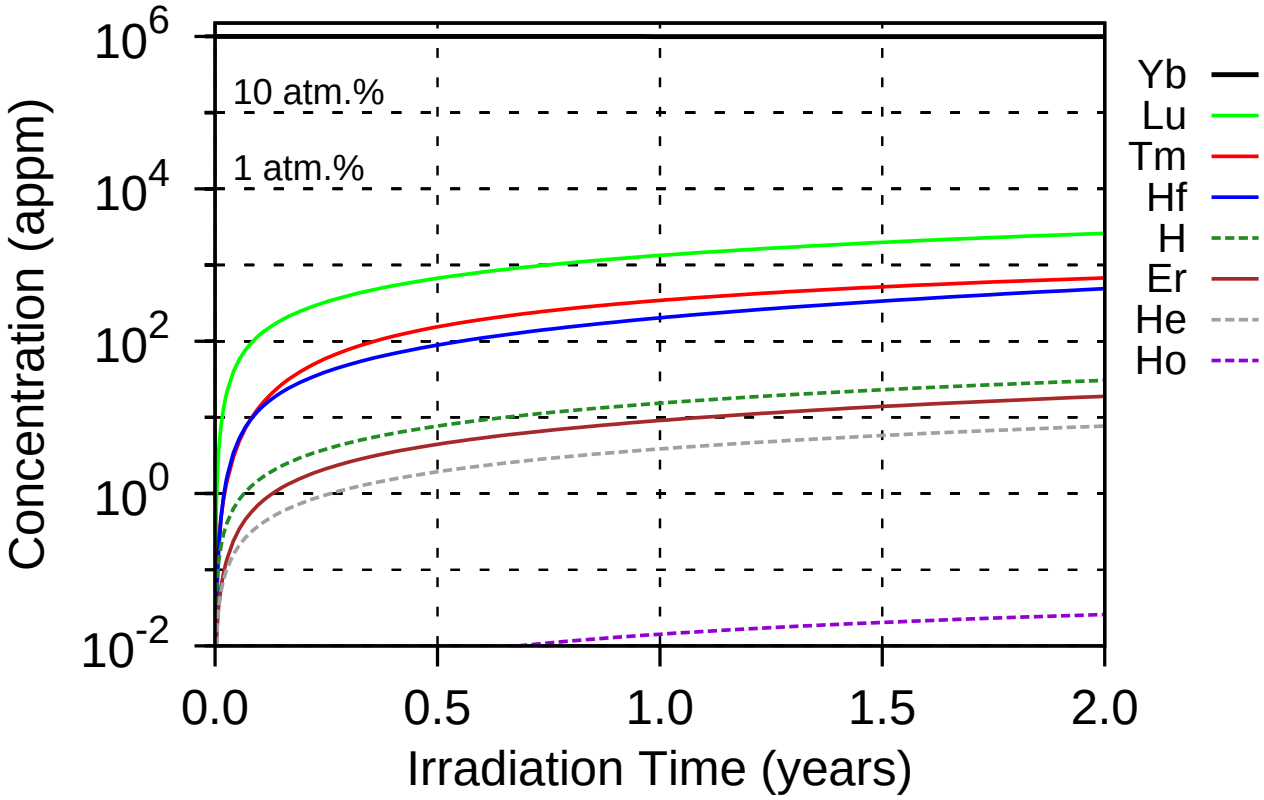






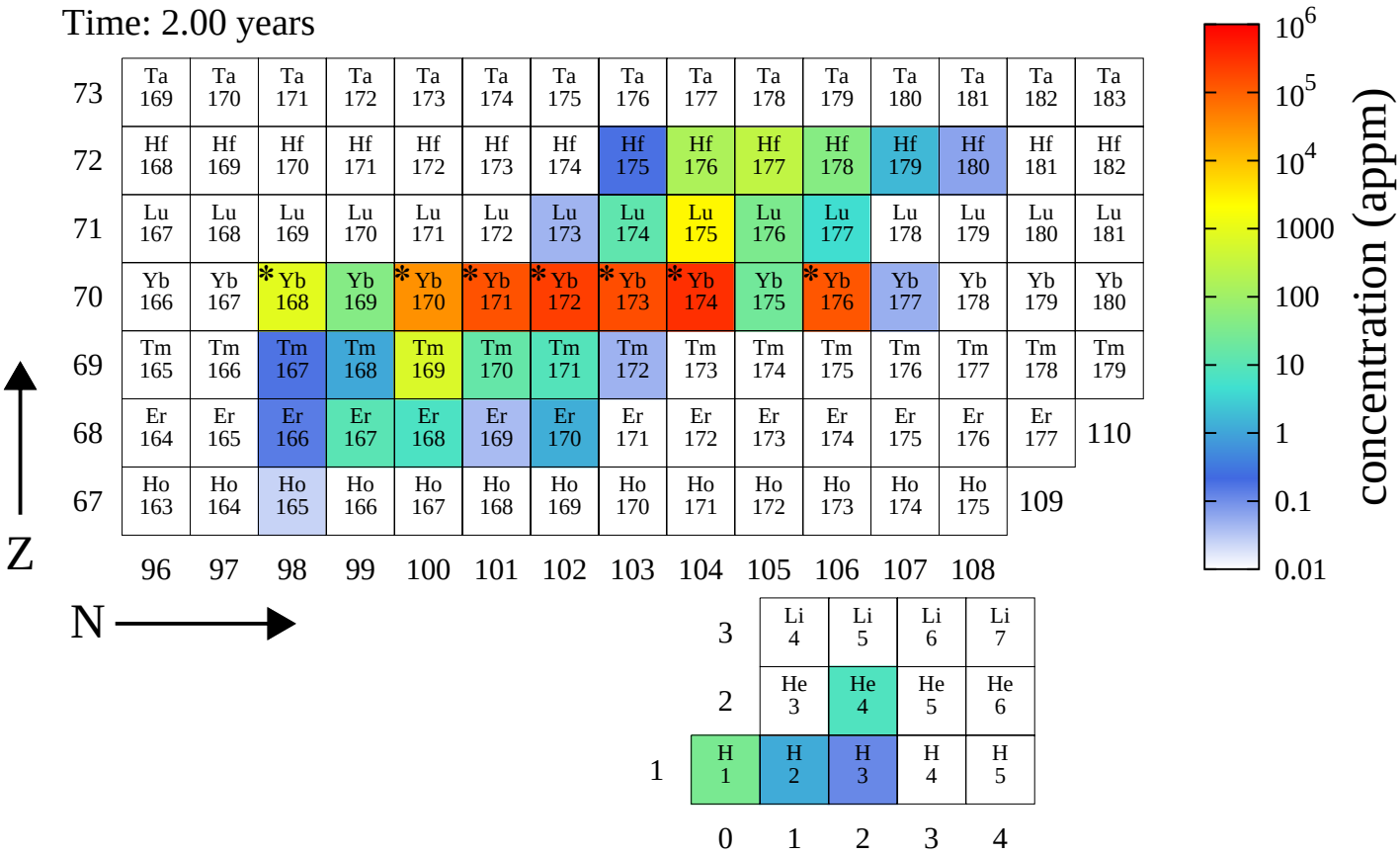


Ytterbium FW Transmutation

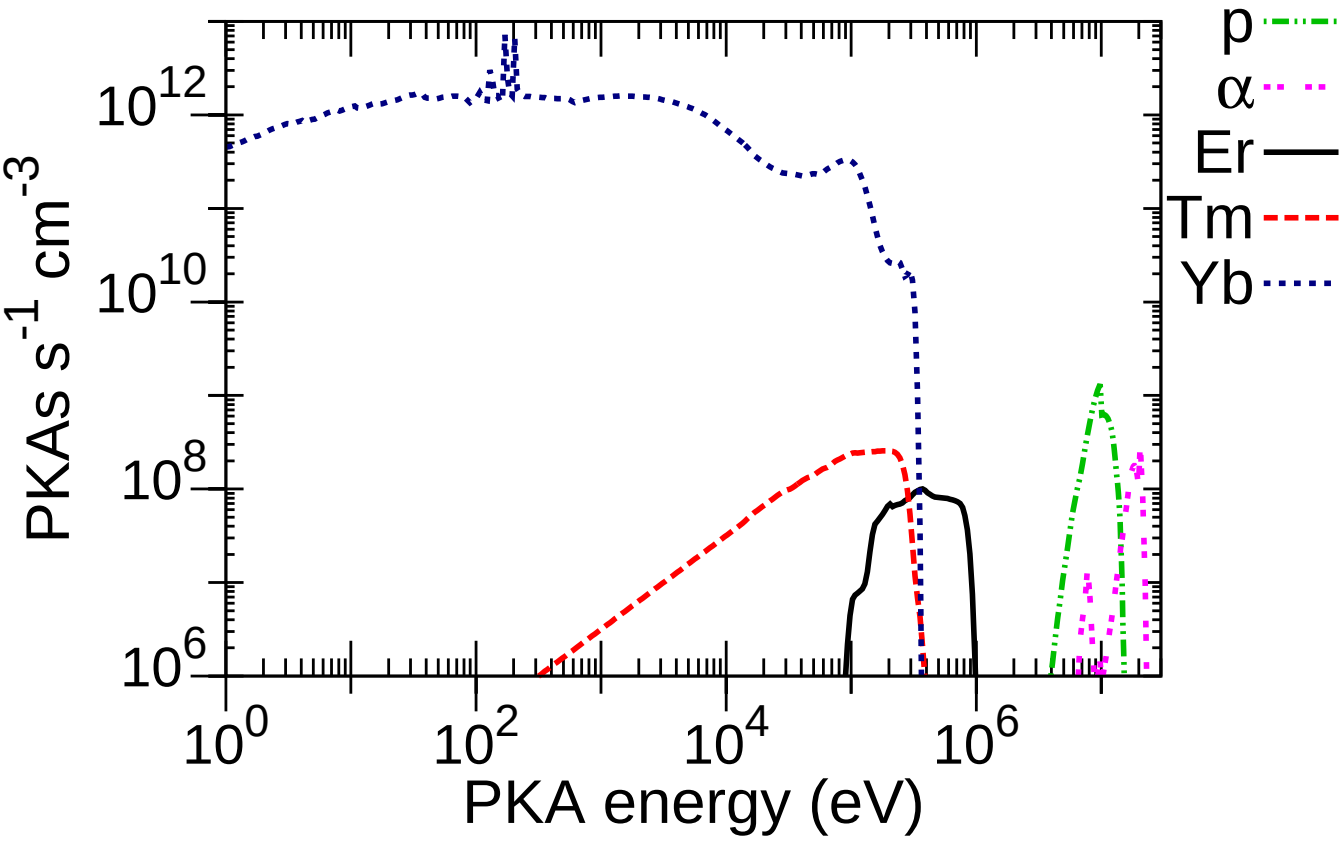


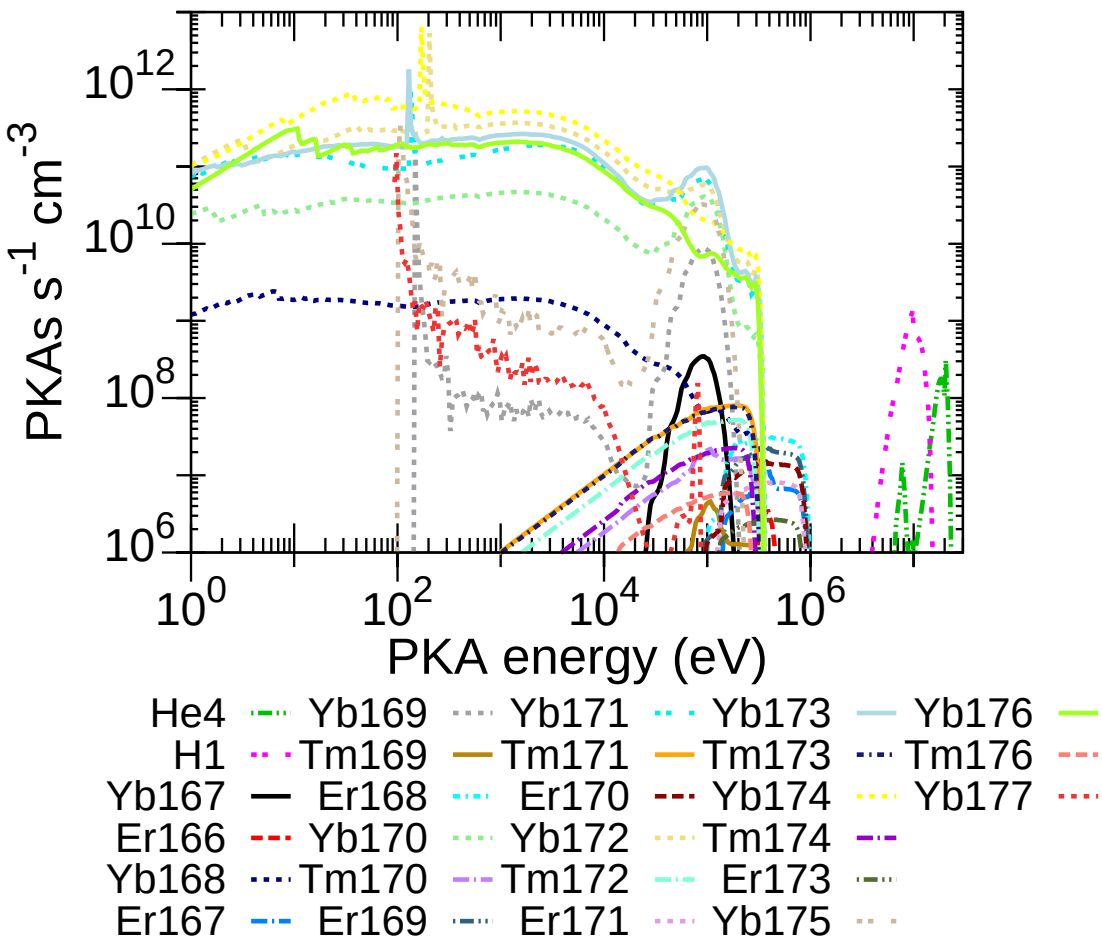
4 appm He & 15 appm H after 1 year

14 dpa/year



Ytterbium FW PKA distributions





Ytterbium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hf177m	1.08s	Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177m(β^-)Hf177m	76.6	99.0	21.2	
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177m(β^-)Hf177m	22.1			
		Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ) Lu176(n,γ)Lu177m(β^-)Hf177m	1.0			
		Yb176(n,γ)Yb177(β^-)Lu177(n,n$'$)Lu177m(β^-)Hf177m			64.4	6.9
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177(n,n$'$)Lu177m(β^-)Hf177m			11.1	
		Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,n$'$)Hf177m			2.7	79.0
		Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,p)Lu177m(β^-)Hf177m				7.1
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177(β^-)Hf177(n,n$'$)Hf177m				4.8
Hf178m	4.00s	Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178m	66.4			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178m	13.1			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-) Hf177(n,γ)Hf178m	8.8			
		Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,γ)Hf178m	4.5	79.4	85.2	92.1
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178m	3.6			
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177(β^-)Hf177(n,γ)Hf178m	1.5	20.4	14.7	5.6
		Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,γ)Hf178(n,n$'$)Hf178m				1.1
Yb177m	6.41s	Yb176(n,γ)Yb177m	95.9	100.0	100.0	99.9
		Yb174(n,γ)Yb175(n,γ)Yb176(n,γ)Yb177m	3.0			
Yb176m	11.40s	Yb173(n,γ)Yb174(n,γ)Yb175(n,γ)Yb176m	82.2	2.7		
		Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(n,γ)Yb176m	10.0			
		Yb171(n,γ)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(n,γ)Yb176m	4.8			
		Yb174(n,γ)Yb175(n,γ)Yb176m	2.9	97.3		
		Yb176(n,n$'$)Yb176m			100.0	99.9
Yb169m	46.00s	Yb168(n,γ)Yb169m		100.0	99.5	
		Yb170(n,2n)Yb169m				60.4
		Yb171(n,2n)Yb170(n,2n)Yb169m				35.8
		Yb172(n,2n)Yb171(n,2n)Yb170(n,2n)Yb169m				3.5
Tm174	5.40m	Yb176(n,γ)Yb177(β^-)Lu177(n,α)Tm174		77.6	85.0	
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177(n,α)Tm174		19.9	14.6	
		Yb174(n,p)Tm174				99.4
Yb177	1.91h	Yb176(n,γ)Yb177	72.4	79.6	85.3	94.1
		Yb176(n,γ)Yb177m(IT)Yb177	23.5	20.4	14.7	5.8
		Yb174(n,γ)Yb175(n,γ)Yb176(n,γ)Yb177	2.3			
Lu176m	3.63h	Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m	67.2	98.6	98.3	
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m	30.3	1.4		
		Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m	1.8			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,n$'$)Lu176m			1.6	
		Yb176(n,2n)Yb175(β^-)Lu175(n,γ)Lu176m				97.7
		Yb176(n,γ)Yb177(β^-)Lu177(n,2n)Lu176m				1.0
Tm166	7.70h	Yb168(n,2n)Yb167(β^+)Tm167(n,2n)Tm166				91.5
		Yb170(n,2n)Yb169(β^+)Tm169(n,2n)Tm168(n,2n) Tm167(n,2n)Tm166				3.4
		Yb170(n,2n)Yb169(n,2n)Yb168(n,2n)Yb167(β^+) Tm167(n,2n)Tm166				1.4
		Yb170(n,2n)Yb169m(IT)Yb169(β^+)Tm169(n,2n)Tm168(n,2n) Tm167(n,2n)Tm166				1.2
Tm173	8.24h	Yb168(n,γ)Yb169m(IT)Yb169(β^+)Tm169(n,γ)Tm170(n,γ) Tm171(n,γ)Tm172(n,γ)Tm173	38.4			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,α)Tm173	19.6	13.6		
		Yb168(n,γ)Yb169(β^+)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ) Tm172(n,γ)Tm173	14.3			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,α)Tm173	8.7			
		Yb176(n,α)Er173(β^-)Tm173	5.8		99.3	2.1
		Yb174(n,γ)Yb175(β^-)Lu175(n,α)Tm172(n,γ)Tm173	4.3			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(n,α)Tm173	3.5			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,α)Tm172(n,γ)Tm173	1.9			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(n,α)Tm173	1.6			
		Yb173(n,p)Tm173				77.2
		Yb174(n,2n)Yb173(n,p)Tm173				19.6

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm172	2.65d	Yb168(n,γ)Yb169m(IT)Yb169(β^+)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	64.2			
		Yb168(n,γ)Yb169(β^+)Tm169(n,γ)Tm170(n,γ)Tm171(n,γ)Tm172	24.0			
		Yb174(n,γ)Yb175(β^-)Lu175(n,α)Tm172	7.3		79.3	
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,α)Tm172	3.3			
		Yb174(n,α)Er171(β^-)Tm171(n,γ)Tm172			15.3	
		Yb171(n,p)Tm171(n,γ)Tm172			4.4	
		Yb172(n,p)Tm172				83.5
		Yb173(n,2n)Yb172(n,p)Tm172				7.6
		Yb173(n,d)Tm172				2.7
		Yb176(n,2n)Yb175(β^-)Lu175(n,α)Tm172				2.2
		Yb173(n,np)Tm172				1.5
		Yb174(n,2n)Yb173(n,2n)Yb172(n,p)Tm172				1.0
Yb175	4.18d	Yb173(n,γ)Yb174(n,γ)Yb175	82.2	2.7		
		Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175	10.0			
		Yb171(n,γ)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175	4.8			
		Yb174(n,γ)Yb175	2.9	97.3	99.9	
		Yb176(n,2n)Yb175				99.7
Lu177	6.65d	Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177	43.2			
		Yb176(n,γ)Yb177(β^-)Lu177	23.5	79.3	85.3	94.1
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177	19.1			
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177	7.6	20.4	14.7	5.7
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(n,γ)Lu177	2.5			
		Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177	1.1			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(n,γ)Lu177	1.1			
Yb169	32.01d	Yb168(n,γ)Yb169m(IT)Yb169		70.4	53.9	
		Yb168(n,γ)Yb169		29.6	45.8	
		Yb170(n,2n)Yb169				46.0
		Yb171(n,2n)Yb170(n,2n)Yb169				25.6
		Yb170(n,2n)Yb169m(IT)Yb169				16.1
		Yb171(n,2n)Yb170(n,2n)Yb169m(IT)Yb169				8.9
		Yb172(n,2n)Yb171(n,2n)Yb170(n,2n)Yb169				2.3

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hf181	42.38d	Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	28.5			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-) Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	13.8			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ) Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	12.8			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181	7.5			
		Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	5.4			
		Yb176(n,γ)Yb177(β^-)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	4.9			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-) Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181	3.6			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ) Lu178(β^-)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181	3.3			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	2.4			
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177(β^-)Hf177(n,γ) Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	1.7			
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177(n,γ)Lu178(β^-) Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	1.6			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	1.5			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	1.4			
		Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181	1.4			
		Yb176(n,γ)Yb177(β^-)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181	1.3			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ) Lu178m(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	1.0			
Hf175	70.00d	Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,2n)Hf176(n,2n)Hf175				64.8
		Yb176(n,2n)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,2n)Hf175				30.1
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177(β^-)Hf177(n,2n) Hf176(n,2n)Hf175				4.0
Tm168	93.10d	Yb168(n,p)Tm168			100.0	
		Yb170(n,2n)Yb169(β^+)Tm169(n,2n)Tm168				58.7
		Yb170(n,2n)Yb169m(IT)Yb169(β^+)Tm169(n,2n)Tm168				20.5
		Yb171(n,2n)Yb170(n,2n)Yb169(β^+)Tm169(n,2n)Tm168				14.0
		Yb171(n,2n)Yb170(n,2n)Yb169m(IT)Yb169(β^+) Tm169(n,2n)Tm168				4.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ta182	114.71d	Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182	15.4			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-) Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182	9.4			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ) Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182	9.2			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	8.8			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-) Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	5.4			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ) Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	5.2			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182	4.0			
		Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	4.0			
		Yb176(n,γ)Yb177(β^-)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	3.8			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-) Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182	2.5			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ) Lu178(β^-)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182	2.4			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182m(IT)Ta182	2.3			
		Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ) Ta182m(IT)Ta182	2.3			
		Yb176(n,γ)Yb177(β^-)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ) Ta182m(IT)Ta182	2.2			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-) Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182m(IT)Ta182	1.4			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ) Lu178(β^-)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182m(IT)Ta182	1.4			
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177(β^-)Hf177(n,γ) Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182	1.3			
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177(n,γ)Lu178(β^-) Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182	1.2			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	1.1			
		Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	1.0			
		Yb176(n,γ)Yb177(β^-)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	1.0			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Tm170	128.61d	Yb168(n,γ)Yb169m(IT)Yb169(β^+)Tm169(n,γ)Tm170	72.4	70.4	53.9	
		Yb168(n,γ)Yb169(β^+)Tm169(n,γ)Tm170	27.0	29.6	45.8	
		Yb170(n,p)Tm170				37.6
		Yb171(n,p)Tm171(n,2n)Tm170				18.3
		Yb171(n,2n)Yb170(n,p)Tm170				17.1
		Yb171(n,d)Tm170				11.6
		Yb171(n,np)Tm170				6.2
		Yb172(n,2n)Yb171(n,d)Tm170				1.7
		Yb172(n,2n)Yb171(n,p)Tm171(n,2n)Tm170				1.6
		Yb174(n,α)Er171(β^-)Tm171(n,2n)Tm170				1.5
		Yb172(n,2n)Yb171(n,2n)Yb170(n,p)Tm170				1.4
Lu174m	141.99d	Yb176(n,2n)Yb175(β^-)Lu175(n,2n)Lu174m				99.4
Tm171	1.92y	Yb168(n,γ)Yb169m(IT)Yb169(β^+)Tm169(n,γ)Tm170(n,γ)Tm171	72.0			
		Yb168(n,γ)Yb169(β^+)Tm169(n,γ)Tm170(n,γ)Tm171	26.9			
		Yb174(n,α)Er171(β^-)Tm171			73.9	6.4
		Yb171(n,p)Tm171			21.5	79.7
		Yb172(n,2n)Yb171(n,p)Tm171				8.7
		Yb172(n,d)Tm171				2.9
		Yb172(n,np)Tm171				1.2
Lu174	3.56y	Yb176(n,2n)Yb175(β^-)Lu175(n,2n)Lu174				65.5
		Yb176(n,2n)Yb175(β^-)Lu175(n,2n)Lu174m(IT)Lu174				32.5
		Yb176(n,2n)Yb175(β^-)Lu175(n,2n)Lu174m(n,E)Lu174				1.6
H3	12.33y	Yb171(n,t)H3				46.4
		Yb173(n,t)H3				29.2
		Yb172(n,t)H3				4.6
		Yb172(n,2n)Yb171(n,t)H3				4.5
		Yb174(n,2n)Yb173(n,t)H3				3.7
		Yb176(n,2n)Yb175(β^-)Lu175(n,t)H3				3.6
		Yb174(n,t)H3				3.6
		Yb176(n,t)H3				2.2
Hf178n	31.00y	Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178n	57.1			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178n	11.1			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177m(β^-) Hf177m(n,γ)Hf178n	10.8			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-) Hf177(n,γ)Hf178n	7.7			
		Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,γ)Hf178n	3.9	79.5	85.3	94.2
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178n	3.1			
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177(β^-)Hf177(n,γ)Hf178n	1.3	20.4	14.7	5.8
Ho166m	1.2 10^3y	Yb168(n,α)Er165(β^+)Ho165(n,γ)Ho166m	95.0	99.3	98.5	
		Yb170(n,2n)Yb169(β^+)Tm169(n,α)Ho166m				60.8
		Yb170(n,2n)Yb169m(IT)Yb169(β^+)Tm169(n,α)Ho166m				21.3
		Yb171(n,2n)Yb170(n,2n)Yb169(β^+)Tm169(n,α)Ho166m				11.5
		Yb171(n,2n)Yb170(n,2n)Yb169m(IT)Yb169(β^+) Tm169(n,α)Ho166m				4.0
Ho163	4.6 10^3y	Yb168(n,nα)Er164(n,2n)Er163(β^+)Ho163				62.5
		Yb168(n,α)Er165(β^+)Ho165(n,2n)Ho164(β^-)Er164(n,2n) Er163(β^+)Ho163				11.5
		Yb168(n,α)Er165(β^+)Ho165(n,2n)Ho164m(IT)Ho164(β^-) Er164(n,2n)Er163(β^+)Ho163				10.6
		Yb168(n,2n)Yb167(β^+)Tm167(β^+)Er167m(IT)Er167(n,2n) Er166(n,2n)Er165(β^+)Ho165(n,2n)Ho164(β^-)Er164(n,2n) Er163(β^+)Ho163				3.9
		Yb168(n,2n)Yb167(β^+)Tm167(β^+)Er167m(IT)Er167(n,2n) Er166(n,2n)Er165(β^+)Ho165(n,2n)Ho164m(IT)Ho164(β^-) Er164(n,2n)Er163(β^+)Ho163				3.6
		Yb168(n,2n)Yb167(β^+)Tm167(n,nα)Ho163				1.5

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hf182	9.0 10^6y	Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(n,γ)Hf182	24.1			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-) Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(n,γ)Hf182	14.8			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ) Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(n,γ)Hf182	14.4			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	6.3			
		Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	6.2			
		Yb176(n,γ)Yb177(β^-)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	6.0			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(β^-) Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	3.9			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ) Lu178(β^-)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	3.8			
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177(β^-)Hf177(n,γ) Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	2.0			
		Yb176(n,γ)Yb177m(IT)Yb177(β^-)Lu177(n,γ)Lu178(β^-) Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	1.9			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176m(β^-) Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	1.7			
		Yb176(n,γ)Yb177(β^-)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	1.6			
		Yb176(n,γ)Yb177(β^-)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	1.6			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	1.2			
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ) Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	1.2			
		Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176(n,γ)Lu177(n,γ) Lu178m(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(n,γ)Hf182	1.1			
Lu176	4.0 10^{10}y	Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	67.4	98.9	100.0	
		Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	30.1			
		Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175(β^-)Lu175(n,γ)Lu176	1.8			
		Yb176(n,2n)Yb175(β^-)Lu175(n,γ)Lu176				96.9
		Yb176(n,γ)Yb177(β^-)Lu177(n,2n)Lu176				2.7
Yb168	1.3 10^{14}y	Yb170(n,2n)Yb169(n,2n)Yb168				1.5

Lutetium

Isotope	Atom % abundance
Lu175	97.41
Lu176	2.59

($T_{1/2}$ =4.0 10^{10}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.91E+15	2.87E+15	6.25E+14	1.83E+14	1.68E+07	5.45E+04
Lu176m	74.4	74.2				
Lu177	11.5	11.7	36.7			
Lu174m	7.5	7.6	34.3	20.0		
Lu174	5.3	5.4	24.6	78.5	5.3	
Hf175	0.7	0.7	3.2	0.3		
H3					87.4	
Hf178m					3.5	
Hf178n					3.5	
Lu176					0.3	100.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.89E-01	1.86E-01	1.86E-02	4.93E-03	2.72E-10	6.80E-12
Lu176m	88.1	88.1				
Lu177	5.1	5.2	35.8			
Lu174m	3.3	3.4	33.0	21.3		
Lu174	2.1	2.1	21.4	75.6	8.5	
Hf175	0.7	0.7	7.0	0.7		
Hf177m	0.1	0.1	1.4	1.1		
Hf178n					44.6	
Hf178m	0.1				39.5	
H3					4.9	
Lu176					2.5	100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	4.59E+03	4.49E+03	4.09E+03	2.81E+03	1.47E-04	1.50E-06
Lu174	63.1	64.4	70.8	96.4	11.5	
Hf175	10.6	10.8	11.5	0.5		
Lu174m	8.1	8.3	8.9	2.2		
Lu177	6.9	7.1	5.3			
Lu176m	3.5	3.5				
Tm172	1.5	1.5	0.6			
Hf177m	1.5	1.5	1.6	0.5		
Lu178	1.3	1.2				
Hf178m	1.1				33.3	
Hf178n					54.2	
Lu176					1.0	100.0

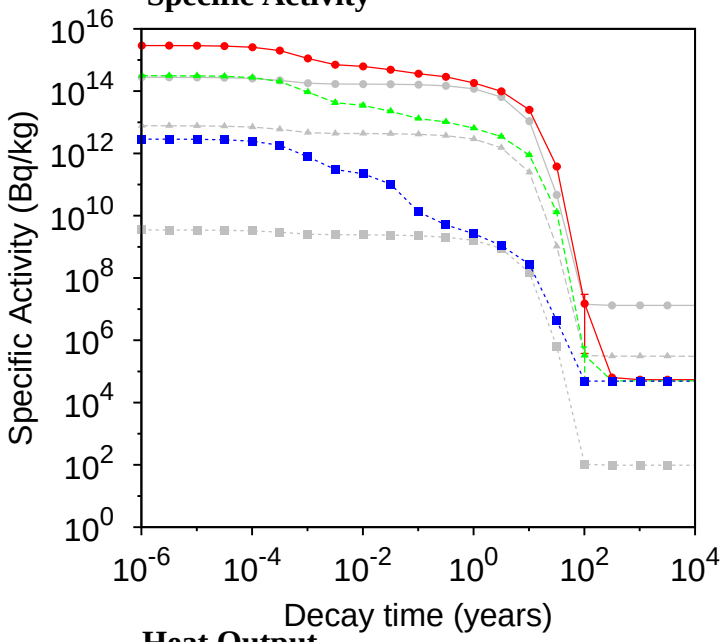
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	7.18E+05	7.11E+05	2.90E+05	5.96E+04	3.70E-03	9.81E-05
Lu176m	51.3	50.9				
Lu177	24.8	25.0	42.0	0.1		
Lu174m	16.1	16.3	39.3	32.7		
Lu174	5.8	5.8	14.4	65.3	6.5	
Hf175	1.2	1.2	2.8	0.4		
Hf178n					74.2	
H3					16.6	
Lu176					2.7	100.0

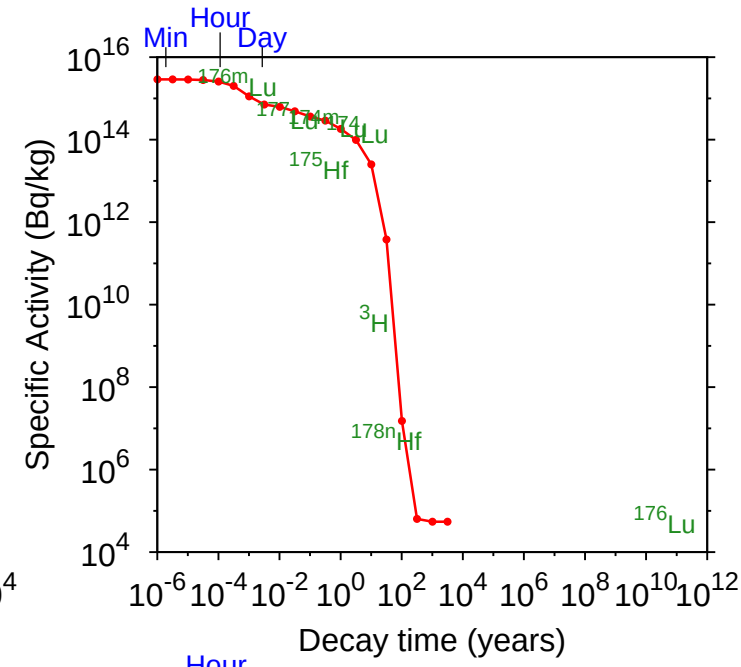
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.29E+06	2.28E+06	1.88E+06	7.69E+05	1.63E-01	3.82E-03
Lu174m	40.1	40.2	47.9	20.1		
Lu174	28.3	28.3	34.4	78.7	2.3	
Lu177	17.6	17.7	14.7			
Lu176m	11.4	11.2				
Lu177m	1.1	1.1	1.3	0.7		
Hf175	1.1	1.1	1.3	0.1		
Hf178n					93.0	
Lu176					2.3	100.0
H3					2.3	

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.85E+11	1.81E+11	4.57E+10	2.08E+10	1.62E+03	5.45E+01
Lu176m	73.0	73.5				
Lu174	10.0	10.2	40.5	83.6	6.6	
Lu174m	8.4	8.6	33.5	12.6		
Hf175	4.1	4.2	16.2	1.0		
Lu177	1.8	1.9	5.0			
Hf177m	0.7	0.7	2.9	1.3		
Lu173	0.2	0.2	0.9	1.2		
Hf178n					44.3	
Hf178m	0.3				36.7	
H3					9.0	
Lu176					3.4	100.0

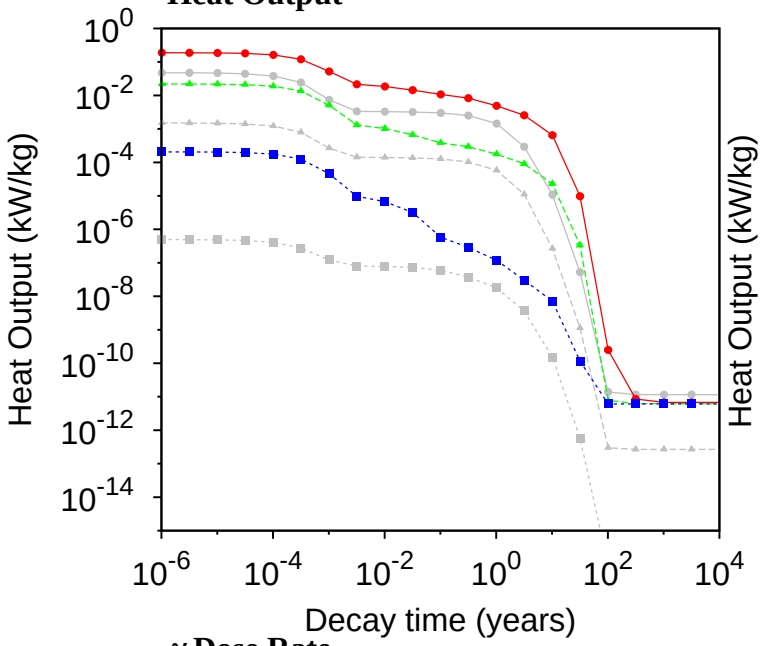
Lutetium activation characteristics

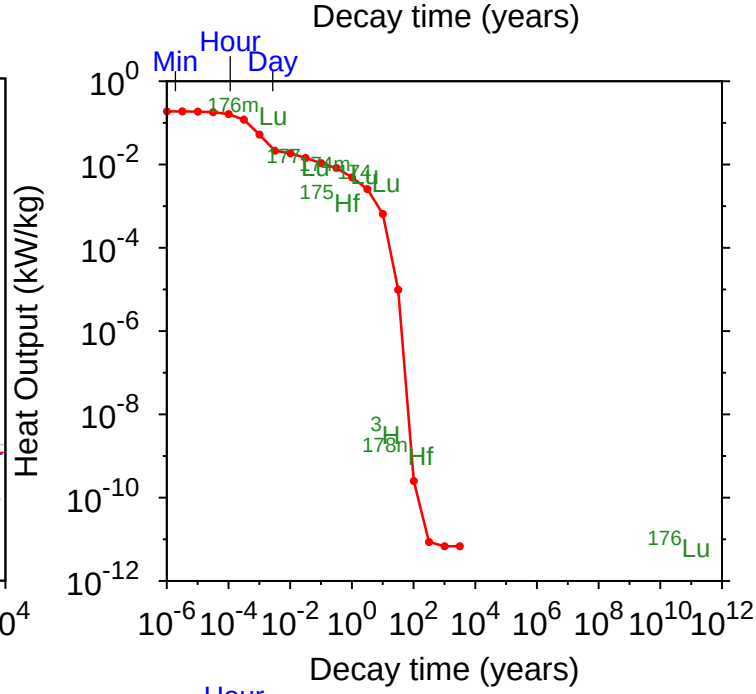
Specific Activity



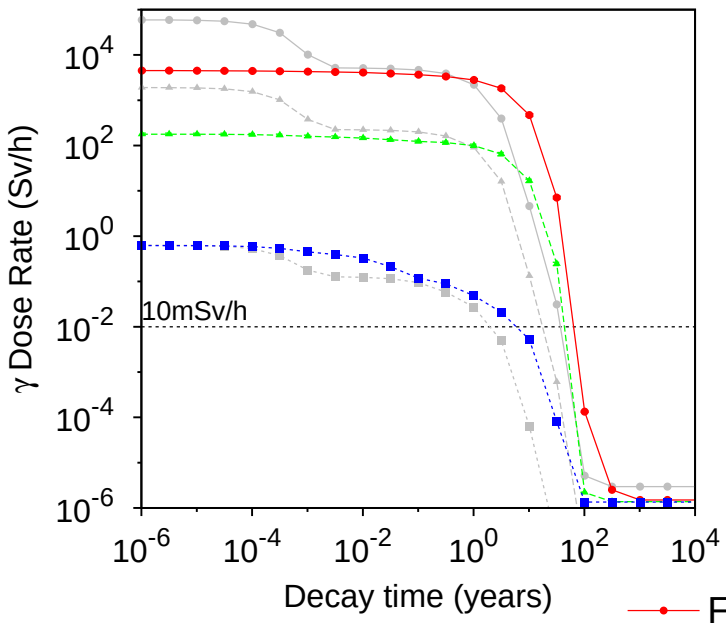


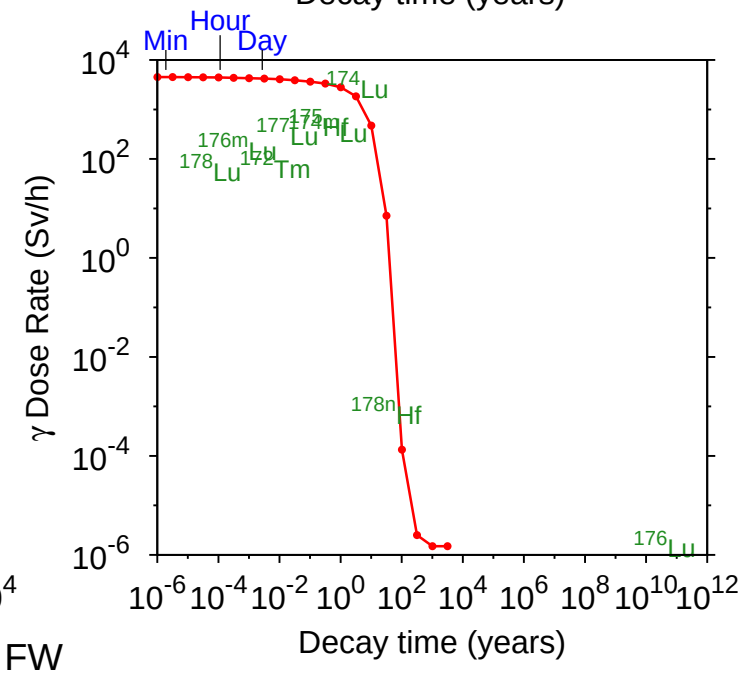
Heat Output





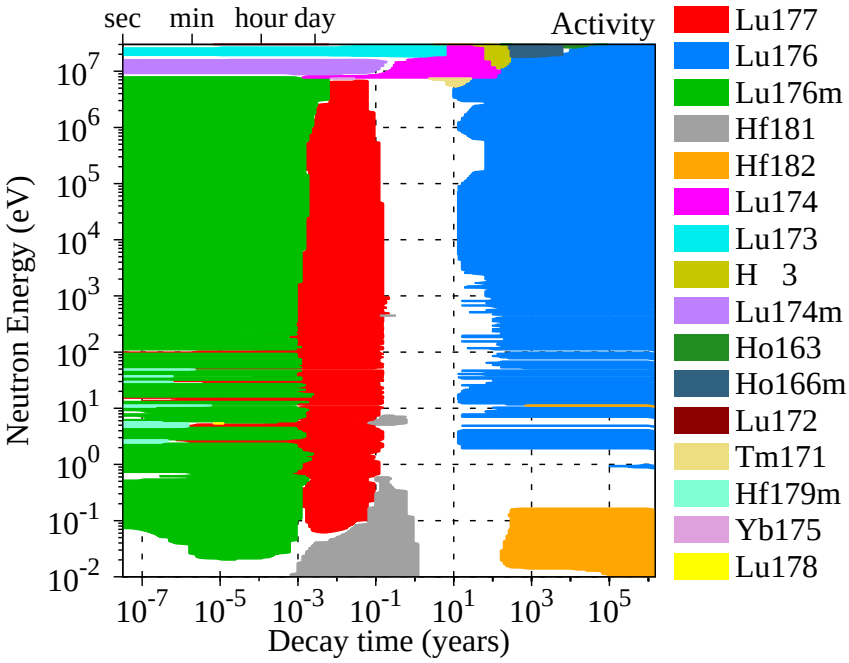
γ Dose Rate

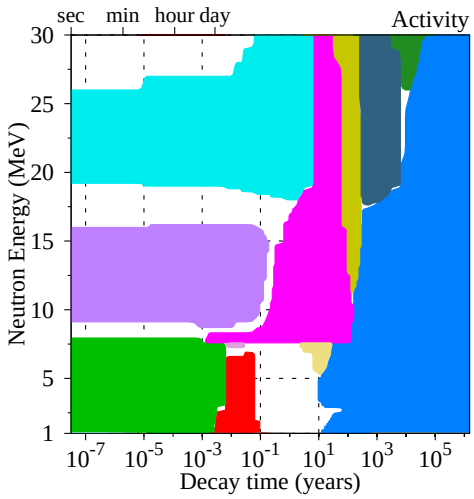


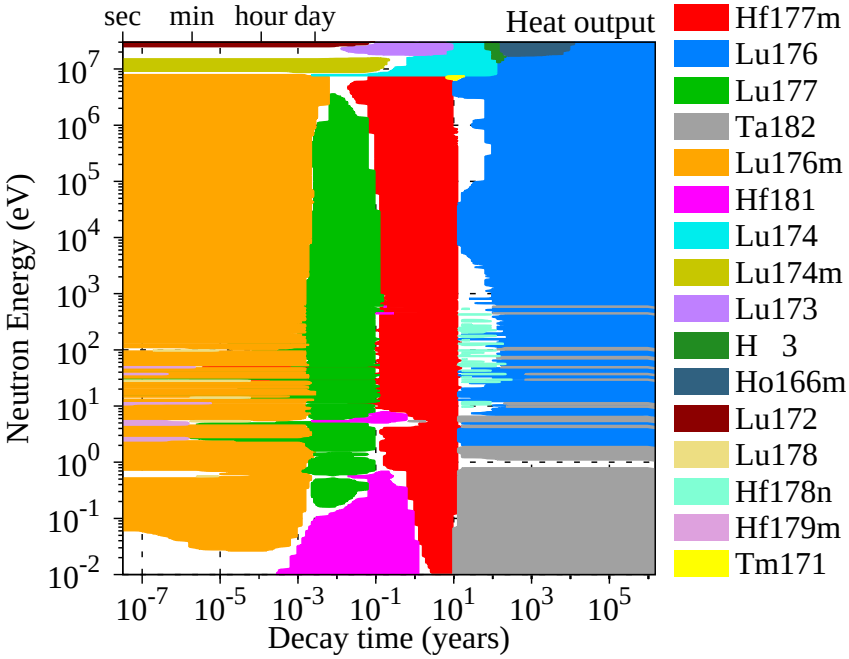


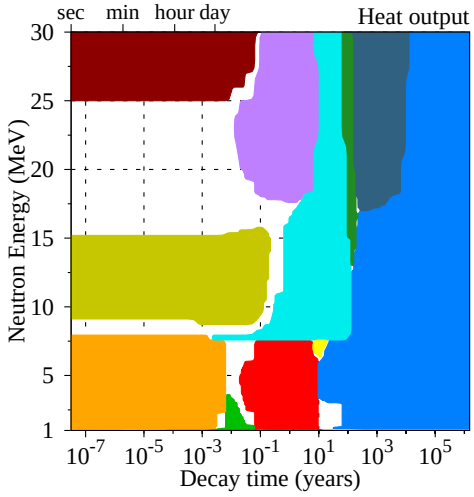
FW
Blanket
Manifold
Fe results

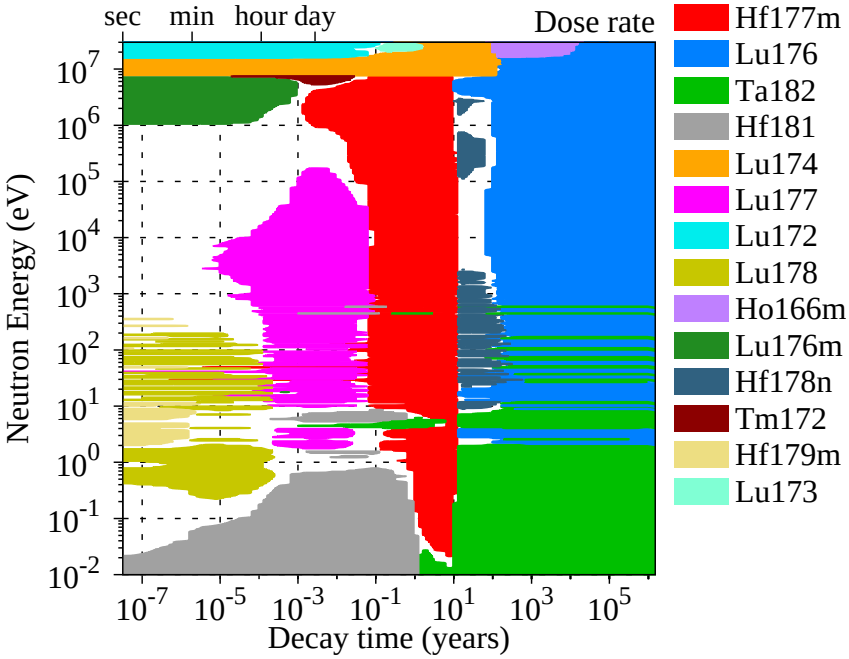
Lutetium Importance diagrams

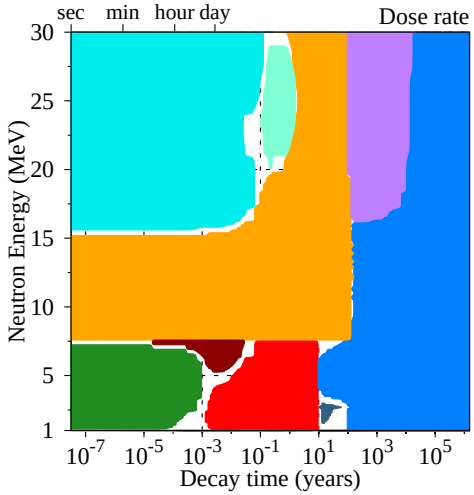




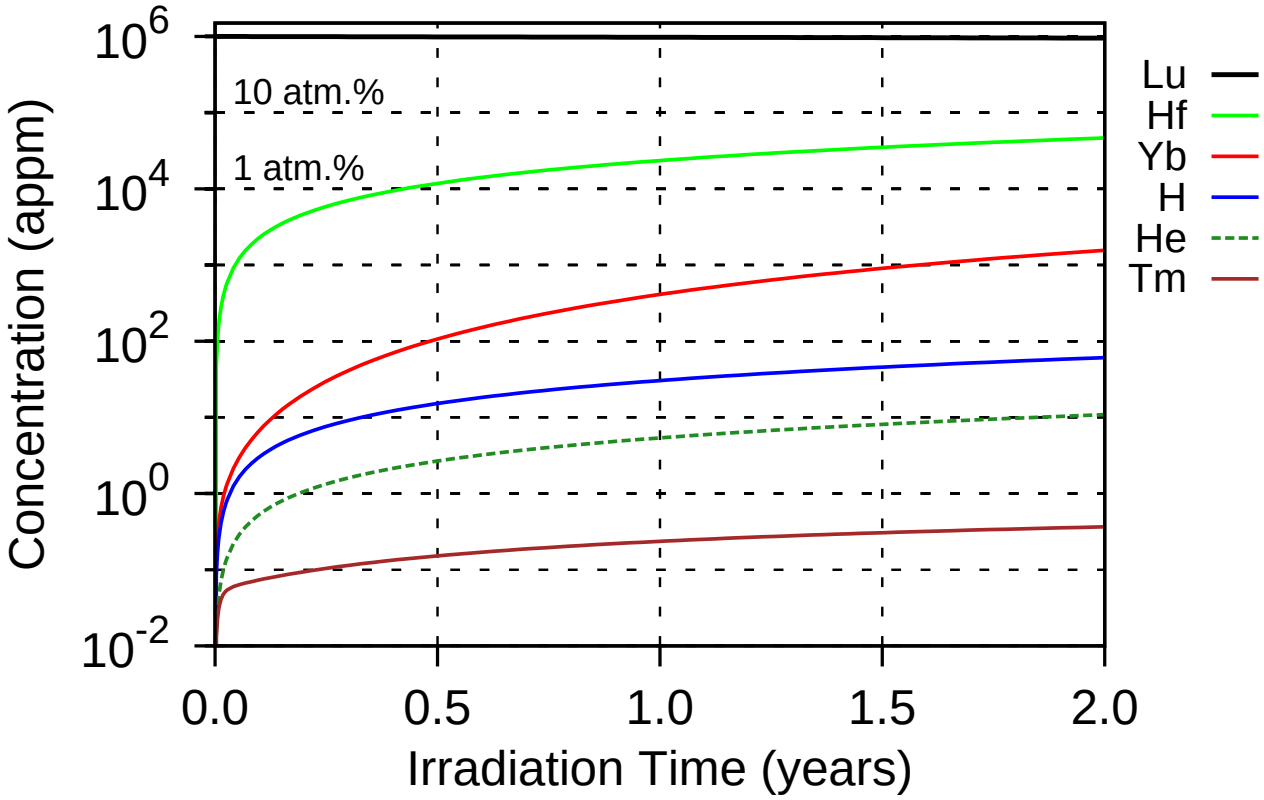






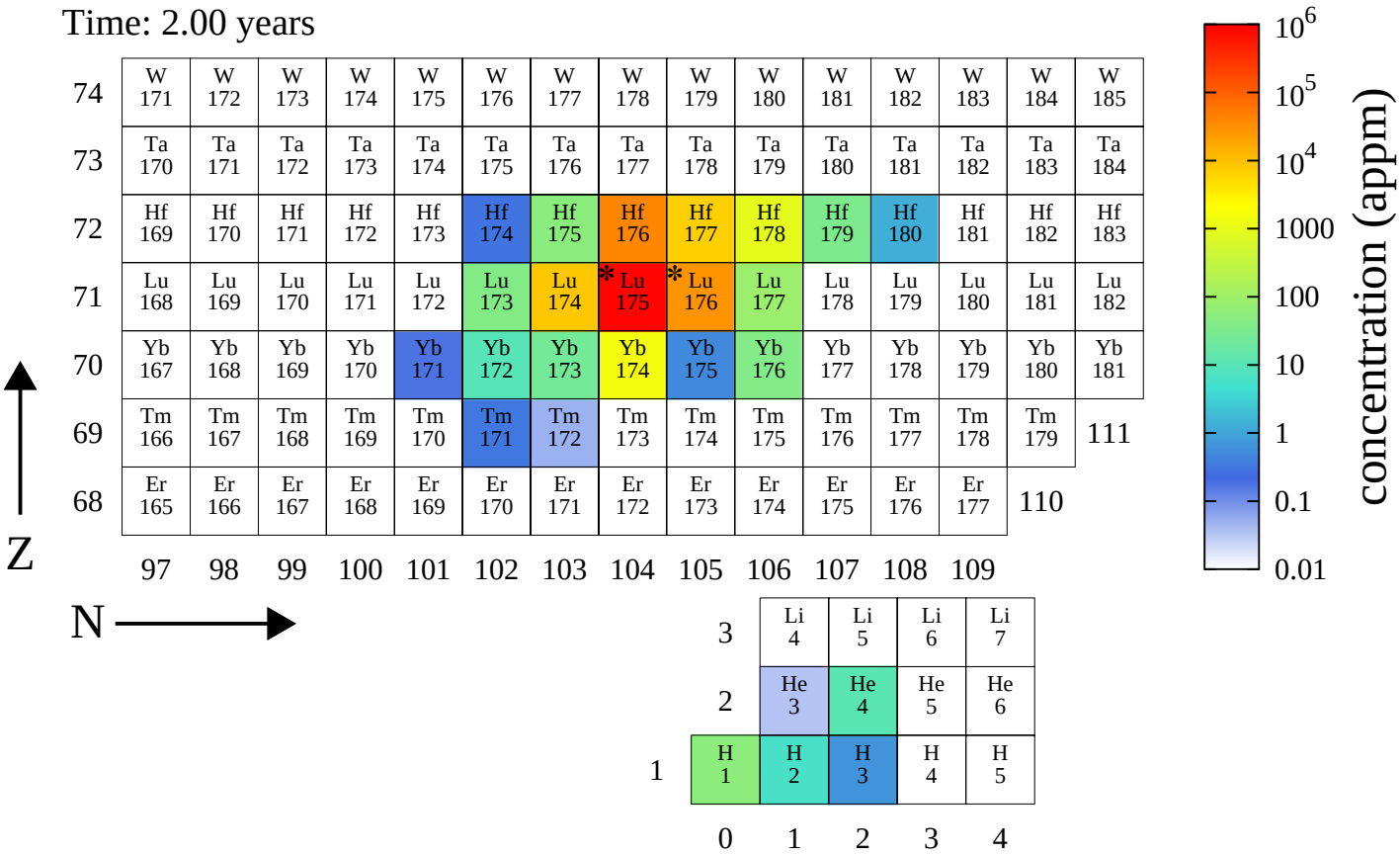


Lutetium FW Transmutation

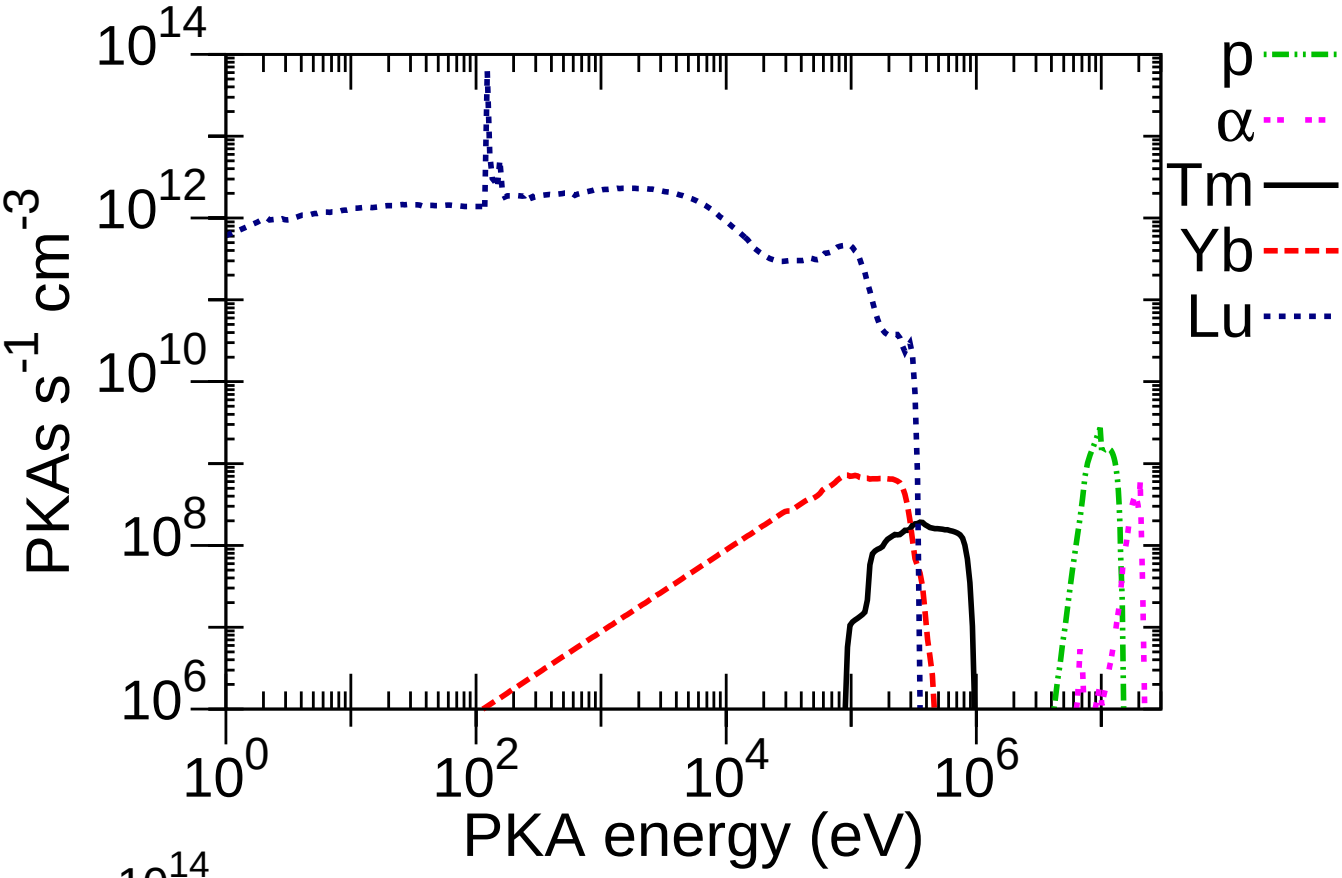


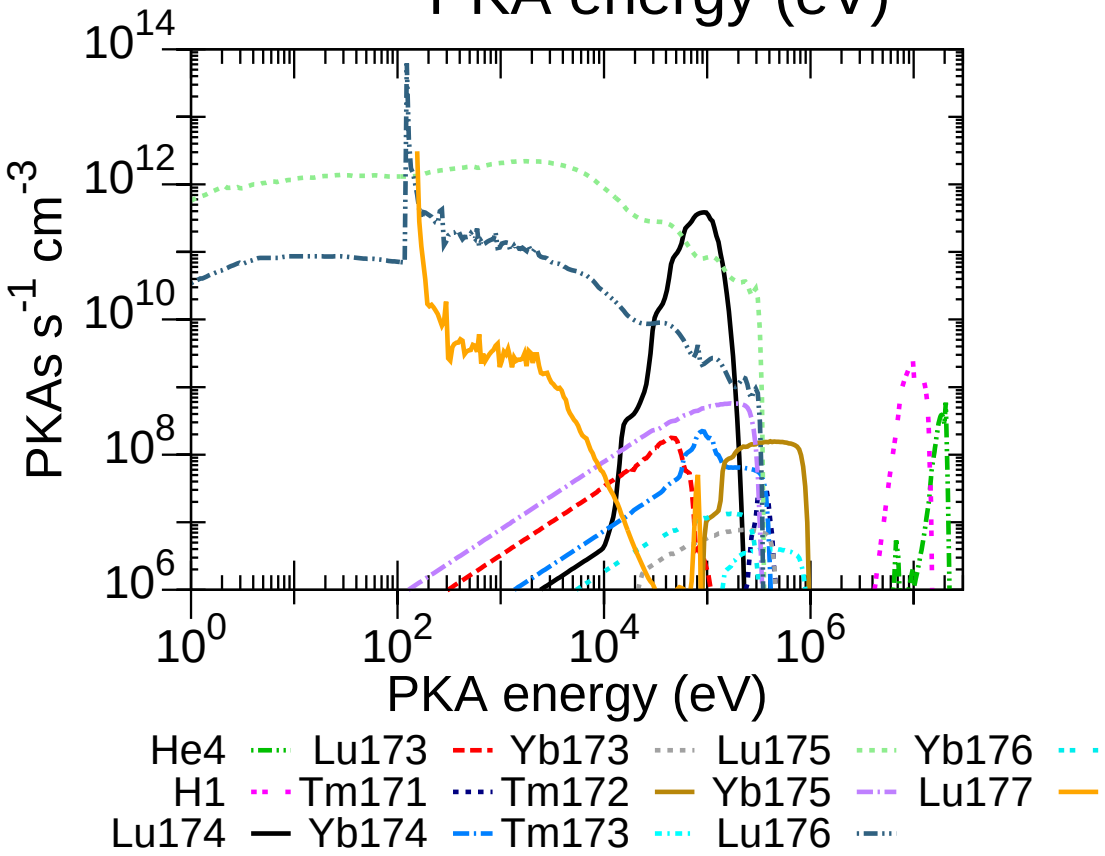
5 appm He & 30 appm H after 1 year

13 dpa/year



Lutetium FW PKA distributions





Lutetium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hf177m	1.08s	Lu175(n,γ)Lu176(n,γ)Lu177m(β⁻)Hf177m	97.4	34.6	1.7	
		Lu176(n,γ)Lu177m(β⁻)Hf177m	2.6	65.3	98.2	96.9
		Lu176(n,n′)Lu176m(β⁻)Hf176(n,γ)Hf177m				2.7
Hf178m	4.00s	Lu175(n,γ)Lu176m(β⁻)Hf176(n,γ)Hf177(n,γ)Hf178m	90.0	22.7	8.1	
		Lu175(n,γ)Lu176(n,γ)Lu177(β⁻)Hf177(n,γ)Hf178m	9.4	19.0		
		Lu176(n,γ)Lu177(β⁻)Hf177(n,γ)Hf178m		57.9	76.0	
		Lu176(n,n′)Lu176m(β⁻)Hf176(n,γ)Hf177(n,γ)Hf178m			11.8	
		Lu176(n,γ)Lu177m(β⁻)Hf177m(IT)Hf177(n,γ)Hf178m			2.1	
Hf179m	18.67s	Lu175(n,γ)Lu176m(β⁻)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m	77.0	16.9	5.0	
		Lu175(n,γ)Lu176(n,γ)Lu177(β⁻)Hf177(n,γ)Hf178(n,γ)Hf179m	11.3	14.0		
		Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β⁻)Hf178(n,γ)Hf179m	9.0			
		Lu176(n,γ)Lu177(β⁻)Hf177(n,γ)Hf178(n,γ)Hf179m		64.7	70.1	
		Lu176(n,γ)Lu177(n,γ)Lu178(β⁻)Hf178(n,γ)Hf179m		2.0	1.1	
		Lu176(n,n′)Lu176m(β⁻)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m			7.3	
		Lu176(n,γ)Lu177(β⁻)Hf177(n,γ)Hf178m(IT)Hf178(n,γ)Hf179m			4.6	
		Lu176(n,γ)Lu177m(n,γ)Lu178(β⁻)Hf178(n,γ)Hf179m			3.2	
		Lu176(n,γ)Lu177m(n,γ)Lu178m(β⁻)Hf178(n,γ)Hf179m			1.8	
		Lu176(n,γ)Lu177m(β⁻)Hf177m(IT)Hf177(n,γ)Hf178(n,γ)Hf179m			1.6	
Lu178	28.40m	Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178	94.3	35.3		
		Lu175(n,γ)Lu176m(n,γ)Lu177(n,γ)Lu178	5.3			
		Lu176(n,γ)Lu177(n,γ)Lu178		53.5	20.9	
		Lu176(n,γ)Lu177m(n,γ)Lu178		7.1	76.9	
		Lu175(n,γ)Lu176(n,γ)Lu177m(n,γ)Lu178		3.8	1.3	
Lu176m	3.63h	Lu175(n,γ)Lu176m	100.0	100.0	41.3	7.5
		Lu176(n,n′)Lu176m			57.3	92.3
		Lu175(n,γ)Lu176(n,n′)Lu176m			1.4	
Tm172	2.65d	Lu175(n,α)Tm172	100.0	100.0	100.0	99.4
Yb175	4.18d	Lu175(n,γ)Lu176m(β⁻)Hf176(n,α)Yb173(n,γ)Yb174(n,γ)Yb175	54.4	2.7		
		Lu175(n,γ)Lu176(n,α)Tm173(β⁻)Yb173(n,γ)Yb174(n,γ)Yb175	12.7			
		Lu175(n,γ)Lu176m(β⁻)Hf176(n,γ)Hf177(n,γ)Hf178(n,α)Yb175	9.4			
		Lu175(n,α)Tm172(β⁻)Yb172(n,γ)Yb173(n,γ)Yb174(n,γ)Yb175	9.2			
		Lu175(n,γ)Lu176m(β⁻)Hf176(n,γ)Hf177(n,α)Yb174(n,γ)Yb175	3.6	15.6		
		Lu175(n,α)Tm172(n,γ)Tm173(β⁻)Yb173(n,γ)Yb174(n,γ)Yb175	2.8			
		Lu175(n,γ)Lu176m(n,α)Tm173(β⁻)Yb173(n,γ)Yb174(n,γ)Yb175	2.3			
		Lu176(n,α)Tm173(β⁻)Yb173(n,γ)Yb174(n,γ)Yb175	2.1			
		Lu175(n,γ)Lu176(n,γ)Lu177(β⁻)Hf177(n,γ)Hf178(n,α)Yb175	1.4			
		Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β⁻)Hf178(n,α)Yb175	1.1			
		Lu176(n,γ)Lu177(β⁻)Hf177(n,α)Yb174(n,γ)Yb175		60.5		
		Lu175(n,γ)Lu176(n,γ)Lu177(β⁻)Hf177(n,α)Yb174(n,γ)Yb175		13.0		
		Lu176(n,γ)Lu177(β⁻)Hf177(n,γ)Hf178(n,α)Yb175		4.2		
		Lu175(n,p)Yb175			99.6	98.7
Lu177	6.65d	Lu175(n,γ)Lu176(n,γ)Lu177	94.3	39.6	2.2	
		Lu175(n,γ)Lu176m(n,γ)Lu177	5.4			
		Lu176(n,γ)Lu177		60.0	96.2	95.3
		Lu176(n,γ)Lu177m(IT)Lu177			1.0	3.5
Lu172	6.70d	Lu175(n,2n)Lu174(n,2n)Lu173(n,2n)Lu172				36.0
		Lu175(n,2n)Lu174m(IT)Lu174(n,2n)Lu173(n,2n)Lu172				18.7
		Lu175(n,2n)Lu174(n,2n)Lu173(n,2n)Lu172m(IT)Lu172				15.0
		Lu175(n,2n)Lu174m(n,2n)Lu173(n,2n)Lu172				13.4
		Lu175(n,2n)Lu174m(IT)Lu174(n,2n)Lu173(n,2n) Lu172m(IT)Lu172				7.8
		Lu175(n,2n)Lu174m(n,2n)Lu173(n,2n)Lu172m(IT)Lu172				5.6
		Lu175(n,3n)Lu173(n,2n)Lu172				1.3

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hf181	42.38d	Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	36.5			
		Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	15.3			
		Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	13.8			
		Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181	9.6			
		Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT) Hf179(n,γ)Hf180(n,γ)Hf181	4.8			
		Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT) Hf179(n,γ)Hf180(n,γ)Hf181	4.1			
		Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181	4.0			
		Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181	3.6			
		Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ) Hf180(n,γ)Hf181	1.3			
		Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179(n,γ) Hf180(n,γ)Hf181	1.1			
		Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178m(β^-)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	1.0			
Hf175	70.00d	Lu176(n,n$'$)Lu176m(β^-)Hf176(n,2n)Hf175				92.5
		Lu175(n,γ)Lu176m(β^-)Hf176(n,2n)Hf175				7.4
Ta182	114.71d	Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	18.7			
		Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ) Ta182m(IT)Ta182	10.6			
		Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	10.2			
		Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	9.7			
		Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ) Ta182m(IT)Ta182	5.8			
		Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ) Ta182m(IT)Ta182	5.5			
		Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	4.9			
		Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT) Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	4.6			
		Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT) Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	4.2			
		Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	2.8			
		Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	2.7			
		Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT) Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	2.6			
		Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	2.5			
		Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT) Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	2.4			
		Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	1.5			
		Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	1.4			
		Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ) Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	1.2			
		Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179(n,γ) Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	1.1			
Lu174m	141.99d	Lu175(n,2n)Lu174m				99.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Lu177m	160.29d	Lu175(n,γ)Lu176(n,γ)Lu177m	97.4	34.6	1.7	
		Lu176(n,γ)Lu177m	2.6	65.3	98.3	99.9
Lu173	1.34y	Lu175(n,2n)Lu174(n,2n)Lu173				51.0
		Lu175(n,2n)Lu174m(IT)Lu174(n,2n)Lu173				26.7
		Lu175(n,2n)Lu174m(n,2n)Lu173				18.8
		Lu175(n,3n)Lu173				1.8
		Lu175(n,2n)Lu174m(n,E)Lu174(n,2n)Lu173				1.3
Tm171	1.92y	Lu175(n,α)Tm172(β^-)Yb172(n,α)Er169(β^-)Tm169(n,γ) Tm170(n,γ)Tm171	38.4	7.4		
		Lu175(n,γ)Lu176m(β^-)Hf176(n,α)Yb173(n,γ)Yb174(n,α) Er171(β^-)Tm171	33.8			
		Lu175(n,γ)Lu176(n,α)Tm173(β^-)Yb173(n,γ)Yb174(n,α) Er171(β^-)Tm171	8.7			
		Lu175(n,α)Tm172(β^-)Yb172(n,γ)Yb173(n,γ)Yb174(n,α) Er171(β^-)Tm171	5.6			
		Lu175(n,γ)Lu176m(β^-)Hf176(n,α)Yb173(n,α)Er170(n,γ) Er171(β^-)Tm171	2.8	54.0	1.4	
		Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,α)Yb174(n,α) Er171(β^-)Tm171	2.4			
		Lu175(n,α)Tm172(n,γ)Tm173(β^-)Yb173(n,γ)Yb174(n,α) Er171(β^-)Tm171	1.9			
		Lu175(n,γ)Lu176m(n,α)Tm173(β^-)Yb173(n,γ)Yb174(n,α) Er171(β^-)Tm171	1.6			
		Lu175(n,γ)Lu176(n,α)Tm173(β^-)Yb173(n,α)Er170(n,γ) Er171(β^-)Tm171	1.0	3.9		
		Lu175(n,α)Tm172(β^-)Yb172(n,γ)Yb173(n,α)Er170(n,γ) Er171(β^-)Tm171		4.9		
		Lu175(n,2n)Lu174(n,α)Tm171				34.3
		Lu175(n,nα)Tm171				31.0
		Lu175(n,2n)Lu174m(IT)Lu174(n,α)Tm171				17.7
		Lu175(n,2n)Lu174m(n,α)Tm171				14.1
Lu174	3.56y	Lu175(n,2n)Lu174				60.4
		Lu175(n,2n)Lu174m(IT)Lu174				37.3
		Lu175(n,2n)Lu174m(n,E)Lu174				1.8
H3	12.33y	Lu175(n,t)H3				93.1
		Lu176(n,t)H3				4.0
		Lu175(n,2n)Lu174(n,t)H3				1.3
Hf178n	31.00y	Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178n	78.3	18.2	6.1	
		Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178n	8.3	15.2		
		Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178n		65.9	81.7	
		Lu176(n,n$'$)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178n			8.8	
		Lu176(n,γ)Lu177m(β^-)Hf177m(IT)Hf177(n,γ)Hf178n			1.9	

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ho166m	1.2 10^3y	Lu175(n,2n)Lu174(n,2n)Lu173(n,nα)Tm169(n,α)Ho166m				6.6
		Lu175(n,nα)Tm171(n,2n)Tm170(n,nα)Ho166m				6.3
		Lu175(n,nα)Tm171(n,2n)Tm170(n,2n)Tm169(n,α)Ho166m				4.6
		Lu175(n,α)Tm172(β^-)Yb172(n,α)Er169(β^-)Tm169(n,α)Ho166m				4.5
		Lu175(n,2n)Lu174(n,nα)Tm170(n,nα)Ho166m				4.4
		Lu175(n,2n)Lu174(n,2n)Lu173(n,α)Tm170(n,nα)Ho166m				3.9
		Lu175(n,2n)Lu174(n,α)Tm171(n,2n)Tm170(n,nα)Ho166m				3.9
		Lu175(n,2n)Lu174m(n,2n)Lu173(n,nα)Tm169(n,α)Ho166m				3.4
		Lu175(n,2n)Lu174(n,nα)Tm170(n,2n)Tm169(n,α)Ho166m				3.1
		Lu175(n,α)Tm172(β^-)Yb172(n,2n)Yb171(n,2n)Yb170(n,2n) Yb169(β^+)Tm169(n,α)Ho166m				3.1
		Lu175(n,2n)Lu174m(IT)Lu174(n,2n)Lu173(n,nα) Tm169(n,α)Ho166m				2.5
		Lu175(n,nα)Tm171(n,2n)Tm170(β^-)Yb170(n,2n)Yb169(β^+) Tm169(n,α)Ho166m				2.4
		Lu175(n,2n)Lu174(n,2n)Lu173(n,α)Tm170(n,2n) Tm169(n,α)Ho166m				2.2
		Lu175(n,2n)Lu174(n,α)Tm171(n,2n)Tm170(n,2n) Tm169(n,α)Ho166m				2.2
		Lu175(n,2n)Lu174m(n,α)Tm171(n,2n)Tm170(n,nα)Ho166m				2.1
		Lu175(n,2n)Lu174m(IT)Lu174(n,nα)Tm170(n,nα)Ho166m				2.0
		Lu175(n,2n)Lu174m(n,2n)Lu173(n,α)Tm170(n,nα)Ho166m				1.9
		Lu175(n,2n)Lu174m(n,nα)Tm170(n,nα)Ho166m				1.6
		Lu175(n,2n)Lu174(n,nα)Tm170(β^-)Yb170(n,2n)Yb169(β^+) Tm169(n,α)Ho166m				1.6
		Lu175(n,nα)Tm171(n,3n)Tm169(n,α)Ho166m				1.6
		Lu175(n,2n)Lu174m(IT)Lu174(n,2n)Lu173(n,α) Tm170(n,nα)Ho166m				1.6
		Lu175(n,2n)Lu174m(IT)Lu174(n,α)Tm171(n,2n) Tm170(n,nα)Ho166m				1.6
		Lu175(n,2n)Lu174m(n,nα)Tm170(n,2n)Tm169(n,α)Ho166m				1.4
		Lu175(n,2n)Lu174m(n,α)Tm171(n,2n)Tm170(n,2n) Tm169(n,α)Ho166m				1.3
		Lu175(n,2n)Lu174m(IT)Lu174(n,nα)Tm170(n,2n) Tm169(n,α)Ho166m				1.2
		Lu175(n,2n)Lu174m(n,2n)Lu173(n,α)Tm170(n,2n) Tm169(n,α)Ho166m				1.2
		Lu175(n,2n)Lu174(n,2n)Lu173(n,2n)Lu172(β^+)Yb172(n,α) Er169(β^-)Tm169(n,α)Ho166m				1.1
		Lu175(n,α)Tm172(β^-)Yb172(n,2n)Yb171(n,2n)Yb170(n,2n) Yb169m(IT)Yb169(β^+)Tm169(n,α)Ho166m				1.1
		Lu175(n,2n)Lu174(n,2nα)Tm169(n,α)Ho166m				1.0
Ho163	4.6 10^3y	no pathways found				
Hf182	9.0 10^6y	Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	29.2			
		Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	15.9			
		Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	15.2			
		Lu175(n,γ)Lu176m(β^-)Hf176(n,γ)Hf177(n,γ)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	7.7			
		Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179m(IT) Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	7.3			
		Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179m(IT) Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	6.6			
		Lu175(n,γ)Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	4.2			
		Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ) Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	4.0			
		Lu176(n,γ)Lu177(β^-)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	1.9			
		Lu176(n,γ)Lu177(n,γ)Lu178(β^-)Hf178(n,γ)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	1.7			
		Lu175(n,γ)Lu176(n,γ)Lu177(n,γ)Lu178m(β^-)Hf178(n,γ) Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	1.1			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Lu176	4.0 10^{10}y	Lu175(n,γ)Lu176	100.0	40.1	2.3	

Hafnium

Isotope	Atom % abundance
Hf174	0.16
Hf176	5.26
Hf177	18.60
Hf178	27.28
Hf179	13.62
Hf180	35.08

($T_{1/2}$ =2.0 10^{15}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.15E+15	1.62E+14	1.34E+14	2.53E+12	4.07E+09	1.84E+05
Hf179m	82.4					
Hf181	7.1	50.4	57.4	8.2		
Hf175	3.7	26.2	30.6	45.2		
Hf178m	3.1			0.7	50.0	
Hf180m	1.2	8.6				
Hf179n	0.8	5.5	6.0			
Ta182	0.6	4.0	4.7	28.1		50.0
Lu176m	0.4	2.7				
Lu173		0.3	0.4	12.9		
Lu174			0.1	2.9		
Hf178n				0.7	50.0	
Hf182						50.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	8.21E-02	1.87E-02	1.48E-02	2.92E-04	7.97E-07	2.62E-11
Hf179m	69.0					
Hf181	11.7	51.5	61.3	8.4		
Hf178m	7.8			1.2	46.9	
Hf175	3.4	14.9	18.2	25.6		
Hf180m	3.1	13.6				
Hf179n	1.9	8.5	9.7			
Ta182	1.9	8.3	10.3	58.5		84.7
Lu176m	0.4	1.8				
Lu173		0.1	0.1	3.9		
Hf178n				1.3	53.1	
Hf182						15.3

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.94E+04	9.49E+03	7.82E+03	2.70E+02	4.41E-01	3.00E-05
Hf179m	35.8					
Hf181	23.4	47.8	54.7	4.3		
Hf178m	14.8			0.6	38.0	
Ta182	10.6	21.6	25.7	83.4		97.6
Hf180m	6.2	12.6				
Hf175	5.0	10.3	12.1	9.7		
Hf179n	3.3	6.7	7.4			
Hf178n				0.9	62.0	
Hf182						2.4

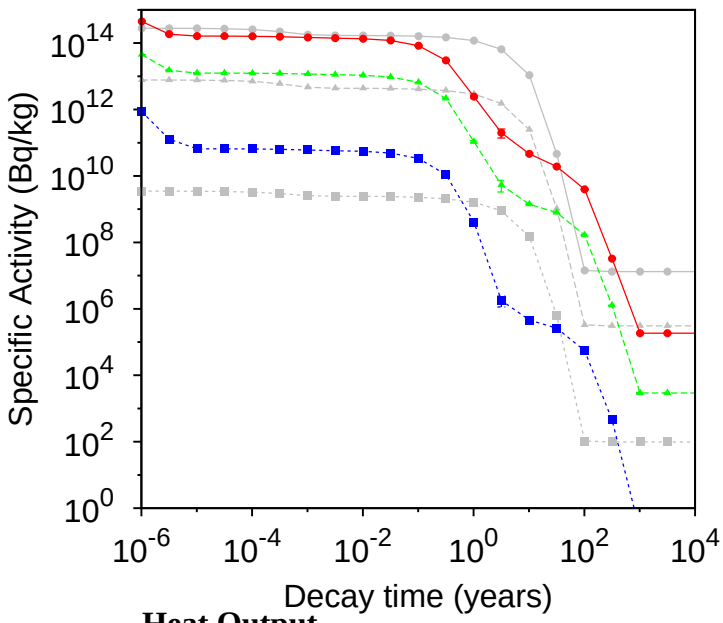
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.33E+05	1.33E+05	1.22E+05	1.97E+03	9.57E+00	4.15E-04
Hf181	67.6	67.7	69.6	11.6		
Hf175	13.1	13.1	13.8	23.8		
Hf179n	8.1	8.1	8.0			
Ta182	7.3	7.3	7.8	54.0		33.3
Hf180m	1.8	1.8				
Hf178n	0.1	0.1	0.1	4.4	100.0	
Lu173	0.1	0.1	0.1	4.3		
Hf182						66.7

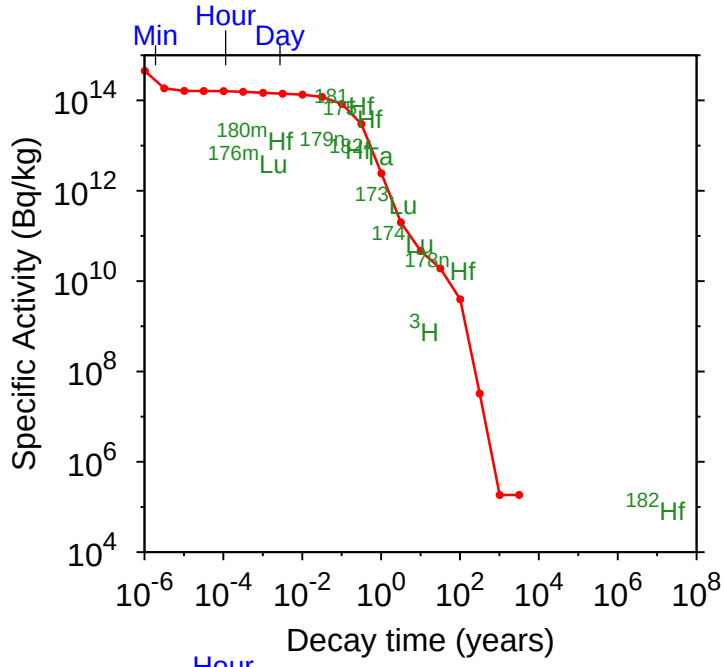
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	5.72E+05	5.71E+05	5.37E+05	1.56E+04	5.29E+02	2.95E-02
Hf181	71.5	71.6	71.7	6.7		
Ta182	11.3	11.3	11.8	45.6		3.1
Hf175	8.9	8.9	9.2	8.8		
Hf179n	6.0	6.0	5.7			
Hf178n	0.9	0.9	0.9	31.1	100.0	
Lu173	0.2	0.2	0.2	5.0		
Lu174	0.1	0.1	0.1	2.0		
Hf182						96.9

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	4.65E+11	1.86E+11	1.63E+11	7.84E+09	4.59E+06	9.44E+02
Hf179m	52.0					
Hf181	17.6	44.1	47.2	2.6		
Ta182	13.9	34.8	38.7	90.5		97.6
Hf178m	7.7			0.2	45.2	
Hf175	3.4	8.5	9.3	5.4		
Hf180m	3.1	7.6				
Hf179n	1.8	4.4	4.5			
Hf178n				0.3	54.7	
Hf182						2.4

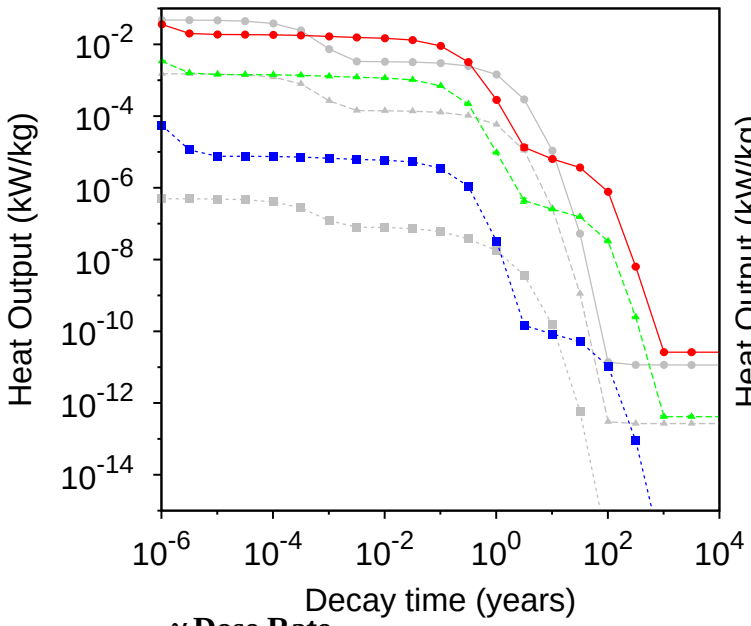
Hafnium activation characteristics

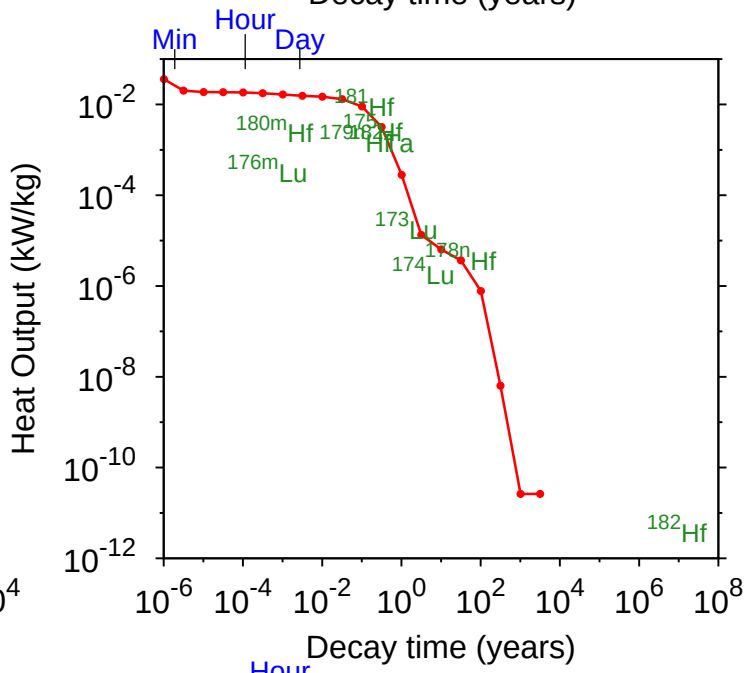
Specific Activity



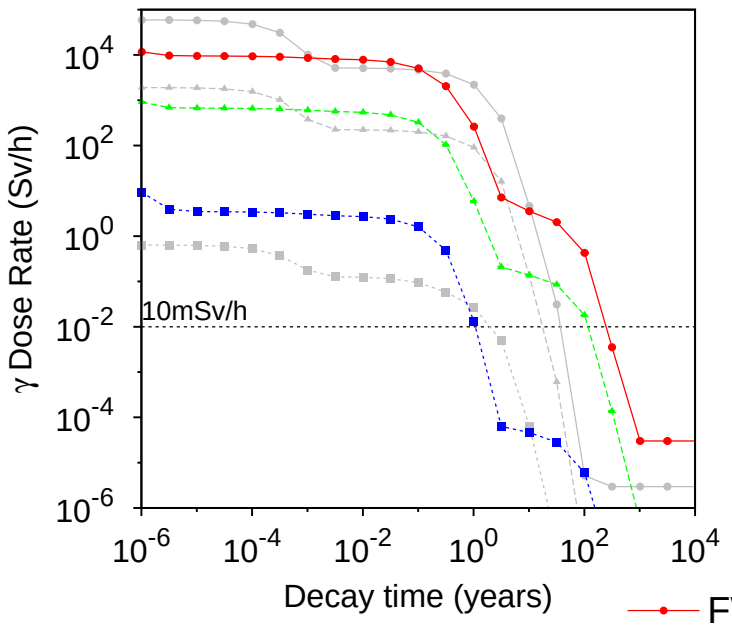


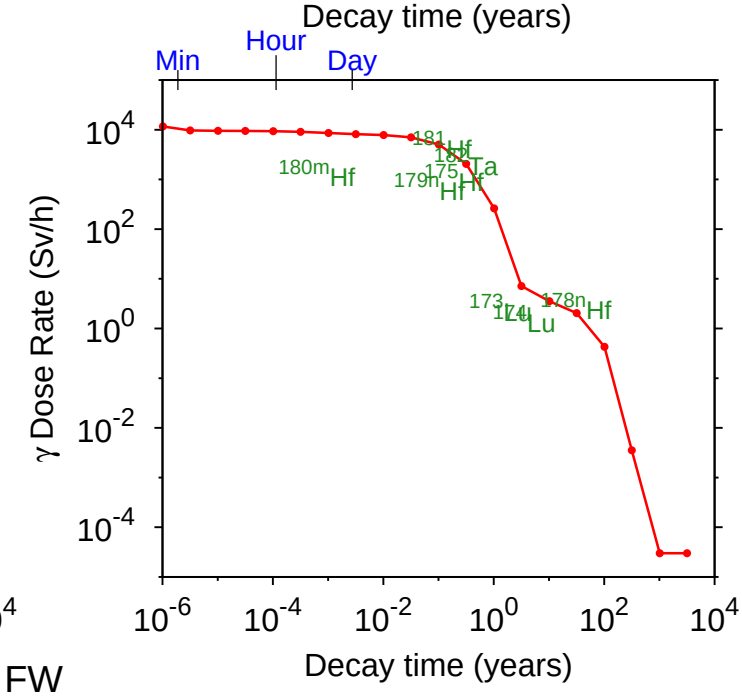
Heat Output





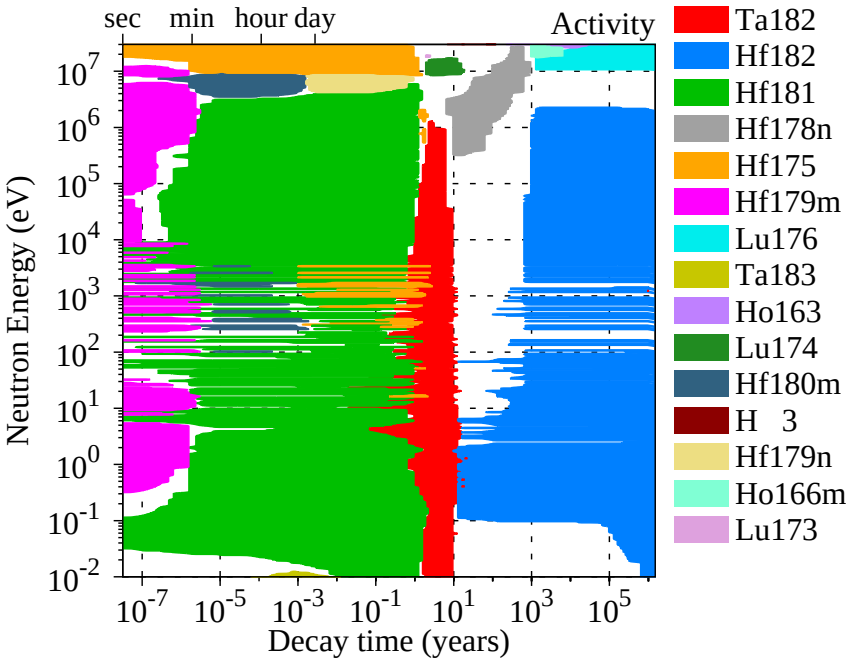
γ Dose Rate

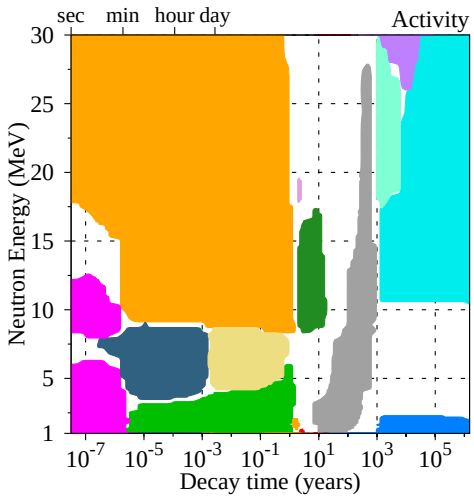


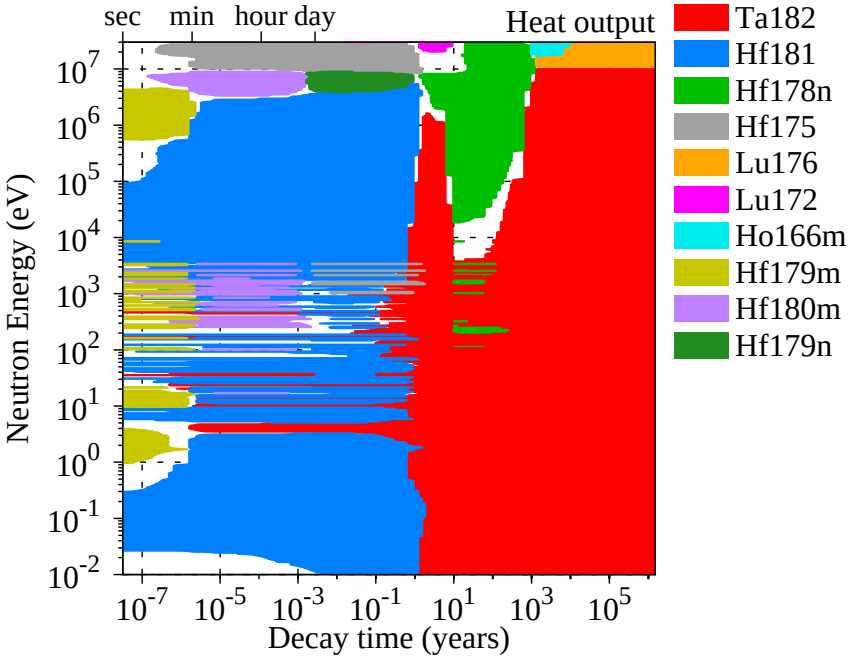


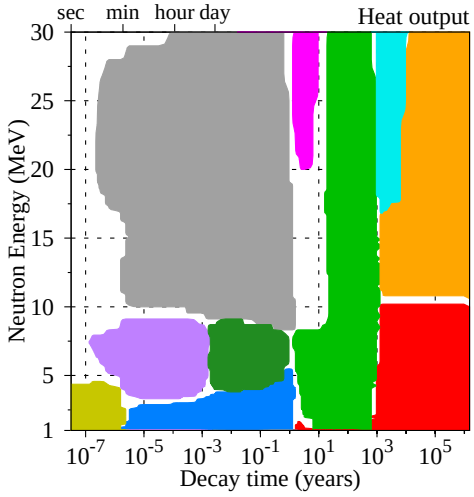
FW
Blanket
Manifold
Fe results

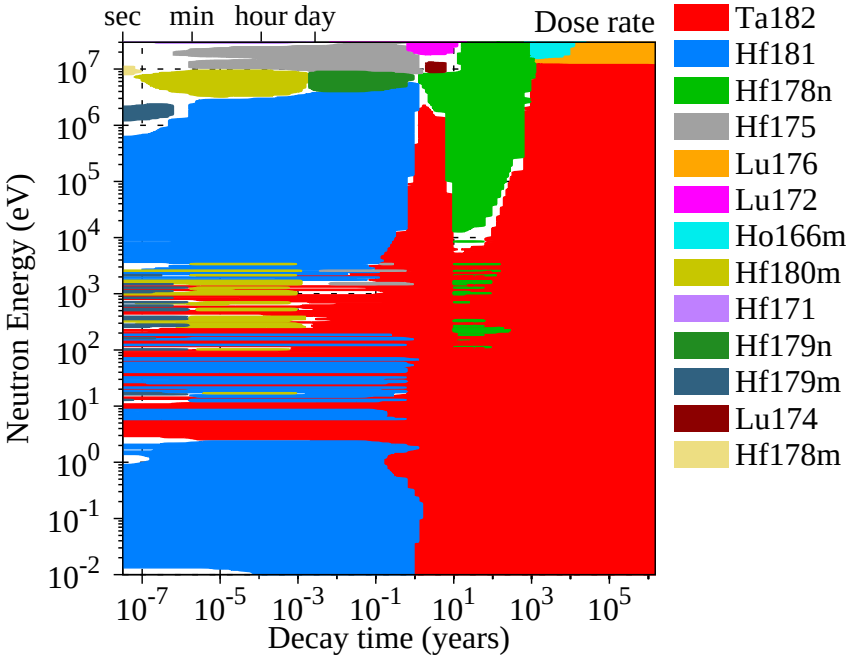
Hafnium Importance diagrams

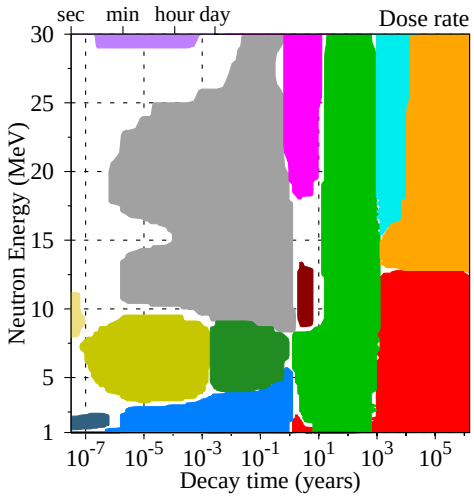




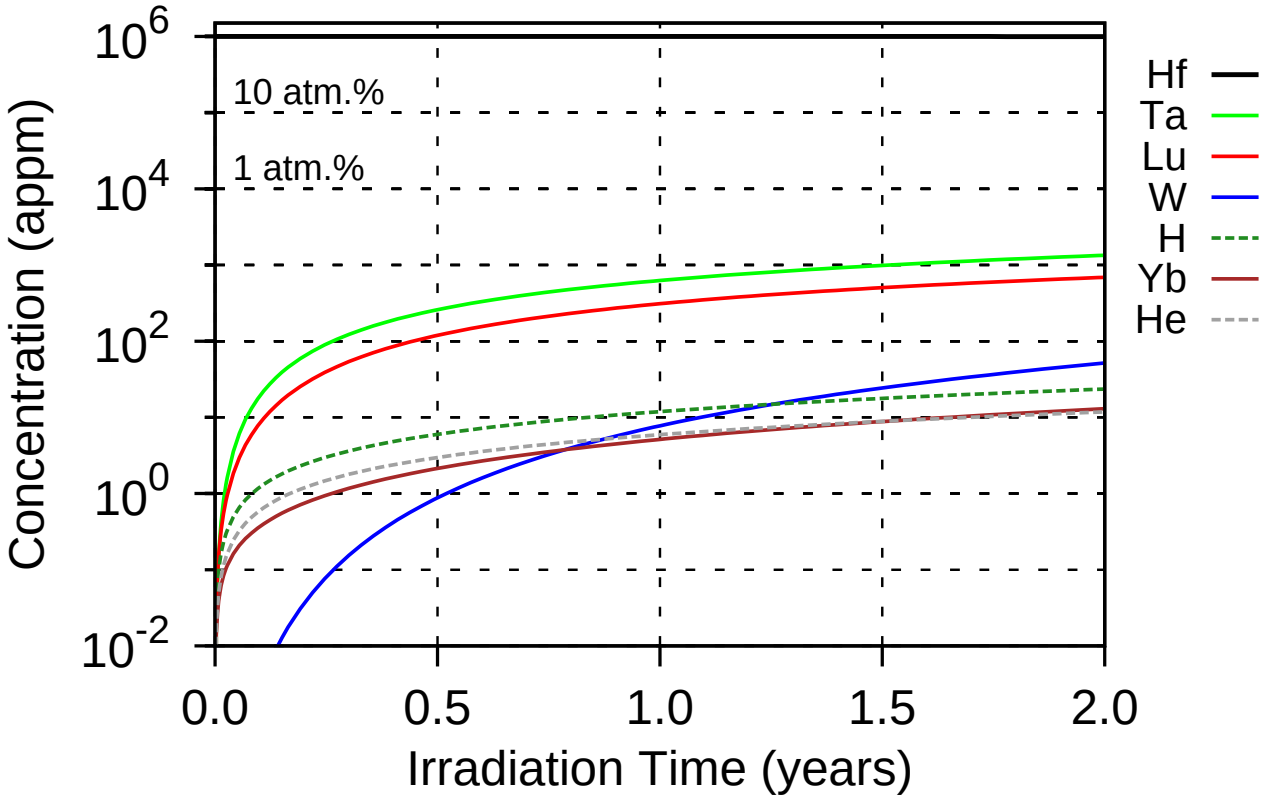






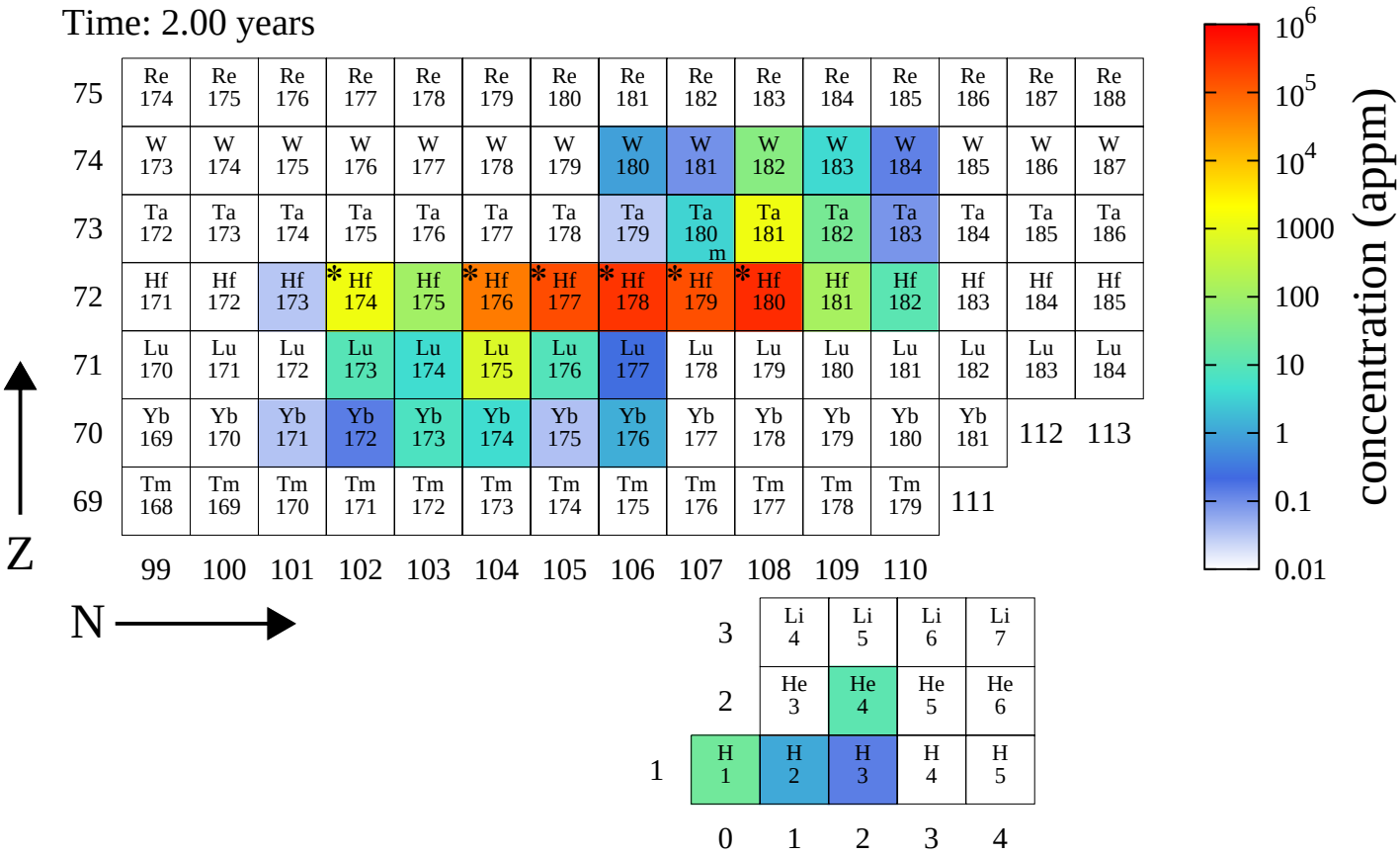


Hafnium FW Transmutation

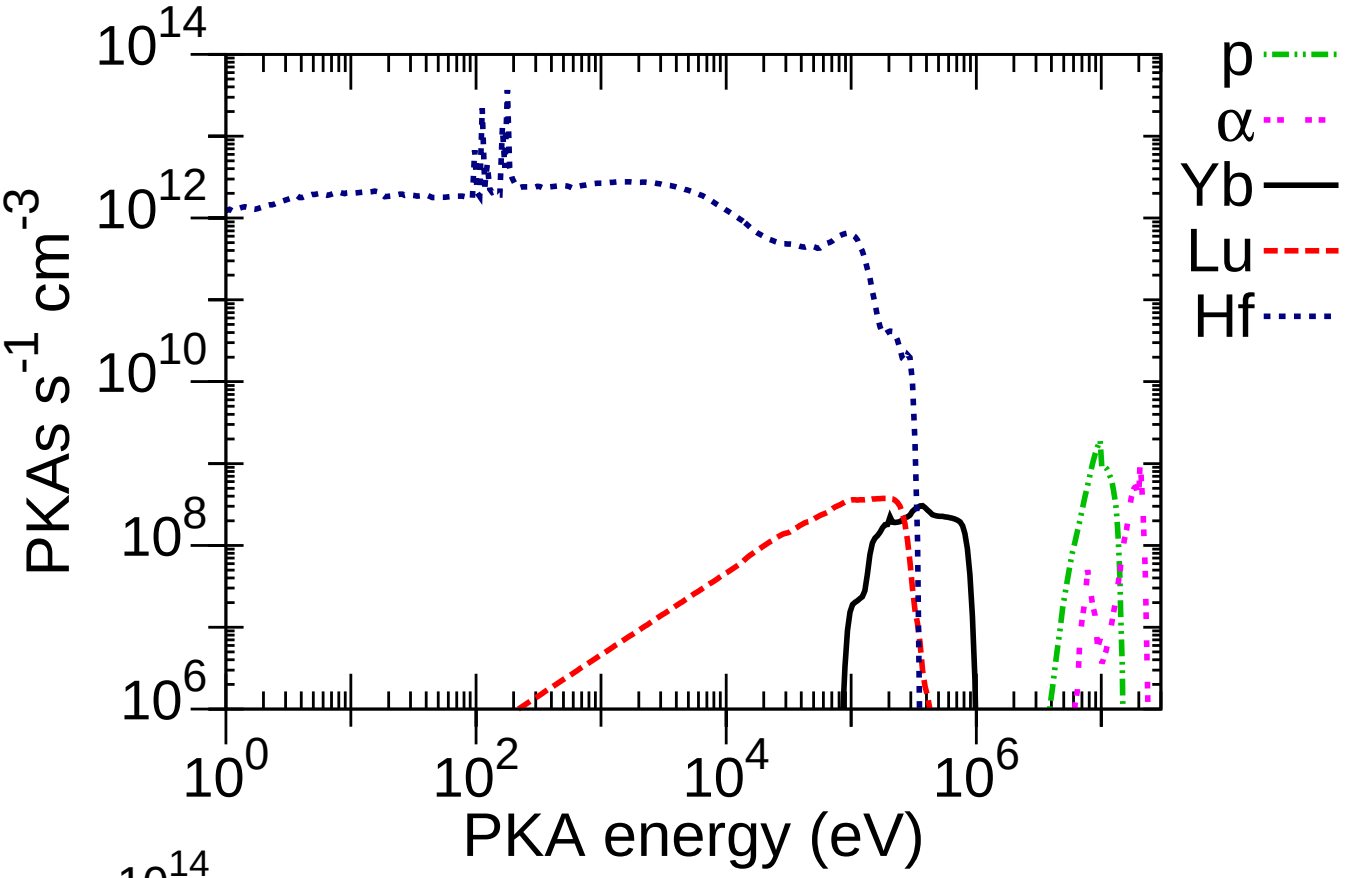


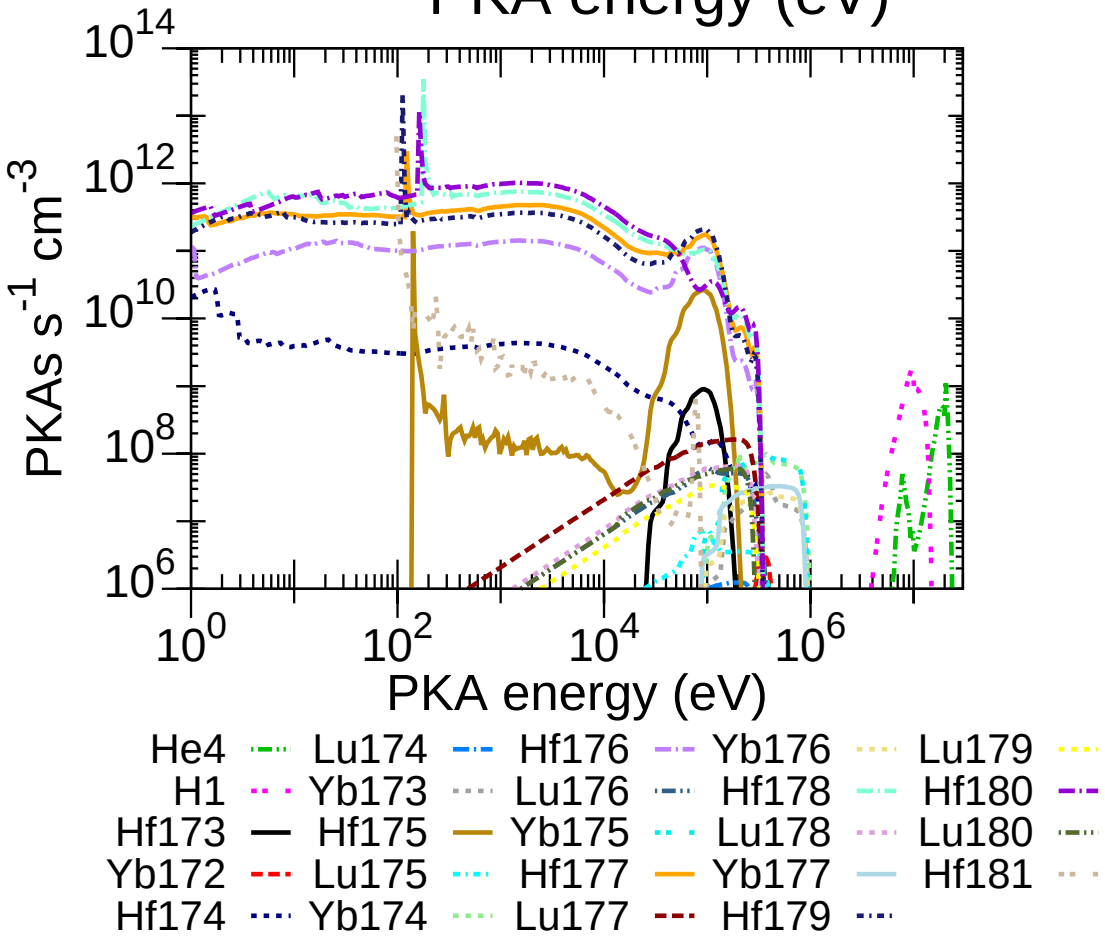
6 appm He & 12 appm H after 1 year

14 dpa/year



Hafnium FW PKA distributions





Hafnium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hf178m	4.00s	Hf176(n,γ)Hf177(n,γ)Hf178m	97.0	1.0		
		Hf174(n,γ)Hf175(β^+)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178m	1.7			
		Hf174(n,γ)Hf175(n,γ)Hf176(n,γ)Hf177(n,γ)Hf178m	1.1			
		Hf177(n,γ)Hf178m		99.0	81.3	
		Hf178(n,n′)Hf178m			18.3	17.5
		Hf179(n,2n)Hf178m				59.3
		Hf180(n,2n)Hf179(n,2n)Hf178m				13.9
		Hf180(n,2n)Hf179m(IT)Hf179(n,2n)Hf178m				6.6
		Hf179(n,2n)Hf178(n,n′)Hf178m				1.0
Hf179m	18.67s	Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m	54.7			
		Hf178(n,γ)Hf179m	23.1	93.9	10.4	
		Hf177(n,γ)Hf178(n,γ)Hf179m	20.2	6.1		
		Hf179(n,n′)Hf179m			89.0	1.6
		Hf180(n,2n)Hf179m				97.6
Lu176m	3.63h	Hf174(n,γ)Hf175(β^+)Lu175(n,γ)Lu176m	100.0	100.0	98.5	
		Hf174(n,γ)Hf175(β^+)Lu175(n,γ)Lu176(n,n′)Lu176m			1.5	
		Hf176(n,p)Lu176m				54.9
		Hf177(n,2n)Hf176(n,p)Lu176m				26.7
		Hf177(n,d)Lu176m				7.4
		Hf177(n,np)Lu176m				3.4
		Hf178(n,2n)Hf177(n,2n)Hf176(n,p)Lu176m				2.6
		Hf178(n,2n)Hf177(n,d)Lu176m				1.5
Hf180m	5.50h	Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180m	34.8	2.5		
		Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180m	26.2			
		Hf179(n,γ)Hf180m	12.2	96.3	62.0	
		Hf178(n,γ)Hf179(n,γ)Hf180m	9.1	1.1		
		Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180m	8.2			
		Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180m	6.9			
		Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180m	2.2			
		Hf180(n,n′)Hf180m			37.3	99.5
Hf171	12.11h	Hf174(n,2n)Hf173(n,2n)Hf172(n,2n)Hf171				81.6
		Hf174(n,2n)Hf173(n,2n)Hf172(n,2n)Hf171m(IT)Hf171				14.9
		Hf176(n,2n)Hf175(n,2n)Hf174(n,2n)Hf173(n,2n) Hf172(n,2n)Hf171				2.6
Ta183	5.09d	Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182(n,γ)Ta183	26.4	61.2	39.1	
		Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183	15.0	34.8	27.1	
		Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182(n,γ)Ta183	9.3			
		Hf180(n,γ)Hf181(n,γ)Hf182(n,γ)Hf183(β^-)Ta183	7.6	3.0	32.7	
		Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182(n,γ)Ta183	7.5			
		Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182(n,γ)Ta183	5.9			
		Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183	5.3			
		Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT) Ta182(n,γ)Ta183	4.2			
		Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183	3.3			
		Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ) Hf182(n,γ)Hf183(β^-)Ta183	2.6			
		Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ) Ta182(n,γ)Ta183	2.4			
		Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182(n,γ)Hf183(β^-)Ta183	2.1			
		Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(n,γ)Hf182(n,γ)Hf183(β^-)Ta183	1.7			
		Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182(n,γ)Ta183	1.5			
		Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ) Ta182m(IT)Ta182(n,γ)Ta183	1.4			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Lu172	6.70d	Hf174(n,2n)Hf173(β^+)Lu173(n,2n)Lu172				63.4
		Hf174(n,2n)Hf173(β^+)Lu173(n,2n)Lu172m(IT)Lu172				26.4
		Hf176(n,2n)Hf175(β^+)Lu175(n,2n)Lu174(n,2n) Lu173(n,2n)Lu172				2.1
		Hf176(n,2n)Hf175(n,2n)Hf174(n,2n)Hf173(β^+) Lu173(n,2n)Lu172				2.1
		Hf176(n,2n)Hf175(β^+)Lu175(n,2n)Lu174m(n,2n) Lu173(n,2n)Lu172				1.0
Hf179n	25.10d	Hf176(n,γ)Hf177(n,γ)Hf178m(n,γ)Hf179n	89.3			
		Hf176(n,γ)Hf177(n,γ)Hf178n(n,γ)Hf179n	7.7			
		Hf174(n,γ)Hf175(β^+)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178m(n,γ)Hf179n	1.5			
		Hf174(n,γ)Hf175(n,γ)Hf176(n,γ)Hf177(n,γ) Hf178m(n,γ)Hf179n	1.0			
		Hf177(n,γ)Hf178n(n,γ)Hf179n		95.4		
		Hf178(n,γ)Hf179n		2.5		
		Hf177(n,γ)Hf178m(n,γ)Hf179n		1.5		
		Hf179(n,n′)Hf179n			98.4	10.9
		Hf180(n,2n)Hf179n				85.1
		Hf180(n,2n)Hf179(n,n′)Hf179n				2.4
		Hf180(n,2n)Hf179m(IT)Hf179(n,n′)Hf179n				1.2
Hf181	42.38d	Hf180(n,γ)Hf181	33.7	97.9	99.9	99.8
		Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	22.9			
		Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	15.4			
		Hf179(n,γ)Hf180(n,γ)Hf181	14.7	2.0		
		Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181	6.0			
		Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181	4.0			
		Hf176(n,γ)Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180(n,γ)Hf181	1.7			
Hf175	70.00d	Hf174(n,γ)Hf175	100.0	100.0	100.0	
		Hf176(n,2n)Hf175				68.5
		Hf177(n,2n)Hf176(n,2n)Hf175				28.8
		Hf178(n,2n)Hf177(n,2n)Hf176(n,2n)Hf175				2.5
Ta182	114.71d	Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	31.0	63.2	58.1	1.4
		Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	17.6	35.9	40.3	1.4
		Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182	11.0			
		Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	8.8			
		Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182	7.0			
		Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182m(IT)Ta182	6.3			
		Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	5.0			
		Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(β^-)Ta181(n,γ)Ta182m(IT)Ta182	4.0			
		Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ)Ta182	2.9			
		Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182	1.8			
		Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-)Ta181(n,γ) Ta182m(IT)Ta182	1.6			
		Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(β^-) Ta181(n,γ)Ta182m(IT)Ta182	1.0			
		Hf180(n,γ)Hf181(n,γ)Hf182m(β^-)Ta182				57.4
		Hf180(n,γ)Hf181(n,γ)Hf182m(β^-)Ta182m(IT)Ta182				23.1
		Hf180(n,γ)Hf181(n,γ)Hf182m(β^-)Ta182n(IT)Ta182m(IT)Ta182				14.2
		Hf180(n,γ)Hf181(n,γ)Hf182(n,n′)Hf182m(β^-)Ta182				1.1
Lu173	1.34y	Hf174(n,2n)Hf173(β^+)Lu173				89.7
		Hf176(n,2n)Hf175(β^+)Lu175(n,2n)Lu174(n,2n)Lu173				3.0
		Hf176(n,2n)Hf175(n,2n)Hf174(n,2n)Hf173(β^+)Lu173				3.0
		Hf176(n,2n)Hf175(β^+)Lu175(n,2n)Lu174m(n,2n)Lu173				1.4
		Hf176(n,2n)Hf175(β^+)Lu175(n,2n)Lu174m(IT) Lu174(n,2n)Lu173				1.2

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Lu174	3.56y	Hf174(n,p)Lu174			98.4	
		Hf174(n,p)Lu174m(IT)Lu174			1.3	
		Hf176(n,2n)Hf175(β^+)Lu175(n,2n)Lu174				57.4
		Hf176(n,2n)Hf175(β^+)Lu175(n,2n)Lu174m(IT)Lu174				27.1
		Hf177(n,2n)Hf176(n,2n)Hf175(β^+)Lu175(n,2n)Lu174				8.6
		Hf177(n,2n)Hf176(n,2n)Hf175(β^+)Lu175(n,2n) Lu174m(IT)Lu174				3.4
		Hf176(n,2n)Hf175(β^+)Lu175(n,2n)Lu174m(n,E)Lu174				1.3
H3	12.33y	Hf177(n,t)H3				50.9
		Hf179(n,t)H3				22.5
		Hf178(n,t)H3				3.7
		Hf178(n,2n)Hf177(n,t)H3				5.0
		Hf180(n,2n)Hf179(n,t)H3				2.6
		Hf180(n,t)H3				2.0
		Hf180(n,2n)Hf179m(IT)Hf179(n,t)H3				1.3
		Hf176(n,t)H3				1.2
		Hf176(n,2n)Hf175(β^+)Lu175(n,t)H3				1.0
Hf178n	31.00y	Hf176(n,γ)Hf177(n,γ)Hf178n	96.7			
		Hf174(n,γ)Hf175(β^+)Lu175(n,γ)Lu176m(β^-)Hf176(n,γ) Hf177(n,γ)Hf178n	1.7			
		Hf174(n,γ)Hf175(n,γ)Hf176(n,γ)Hf177(n,γ)Hf178n	1.1			
		Hf177(n,γ)Hf178n		99.5	99.9	
		Hf179(n,2n)Hf178n				81.4
		Hf180(n,2n)Hf179(n,2n)Hf178n				9.9
		Hf180(n,2n)Hf179m(IT)Hf179(n,2n)Hf178n				4.7
		Hf178(n,n′)Hf178n				1.7
		Hf180(n,2n)Hf179n(n,2n)Hf178n				1.0
Ho166m	1.2 10^3y	no pathways found				
Ho163	4.6 10^3y	no pathways found				
Hf182	9.0 10^6y	Hf180(n,γ)Hf181(n,γ)Hf182	49.1	98.9	99.9	96.6
		Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	17.1			
		Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	13.8	1.0		
		Hf177(n,γ)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ) Hf181(n,γ)Hf182	10.9			
		Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	4.5			
		Hf177(n,γ)Hf178(n,γ)Hf179(n,γ)Hf180(n,γ)Hf181(n,γ)Hf182	2.8			
		Hf180(n,γ)Hf181(n,γ)Hf182m(IT)Hf182				3.2
Lu176	4.0 10^{10}y	Hf174(n,γ)Hf175(β^+)Lu175(n,γ)Lu176	100.0	99.8	99.9	
		Hf176(n,p)Lu176				60.8
		Hf177(n,2n)Hf176(n,p)Lu176				14.8
		Hf177(n,d)Lu176				11.5
		Hf177(n,np)Lu176				7.9
		Hf178(n,2n)Hf177(n,d)Lu176				1.1
		Hf178(n,2n)Hf177(n,2n)Hf176(n,p)Lu176				1.0

Tantalum

Isotope	Atom % abundance
Ta180m	0.01
Ta181	99.99

($T_{1/2}$ =1.8 10^{15}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.12E+15	2.41E+15	1.85E+15	1.99E+14	4.81E+06	1.47E+04
Ta182	57.1	73.8	94.0	98.1	0.2	49.9
Ta182m	22.5					
Ta180	15.1	19.4				
Ta183	4.1	5.3	4.2			
W181	0.6	0.8	1.0	1.2		
H3					83.2	
Hf178m					8.3	
Hf178n					8.3	
Hf182					0.2	49.9

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	4.52E-01	4.50E-01	4.27E-01	4.70E-02	1.61E-10	2.08E-12
Ta182	94.5	94.9	97.8	99.9	1.1	84.6
Ta183	2.9	2.9	1.9			
Ta180	1.8	1.8				
Hf178n					51.2	
Hf178m					45.3	
H3					2.3	
Hf182					0.2	15.3

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	5.63E+05	5.63E+05	5.50E+05	6.16E+04	8.63E-05	2.37E-06
Ta182	99.7	99.7	99.8	100.0	2.7	97.6
Hf178n					60.3	
Hf178m					36.9	
Hf182					0.1	2.4

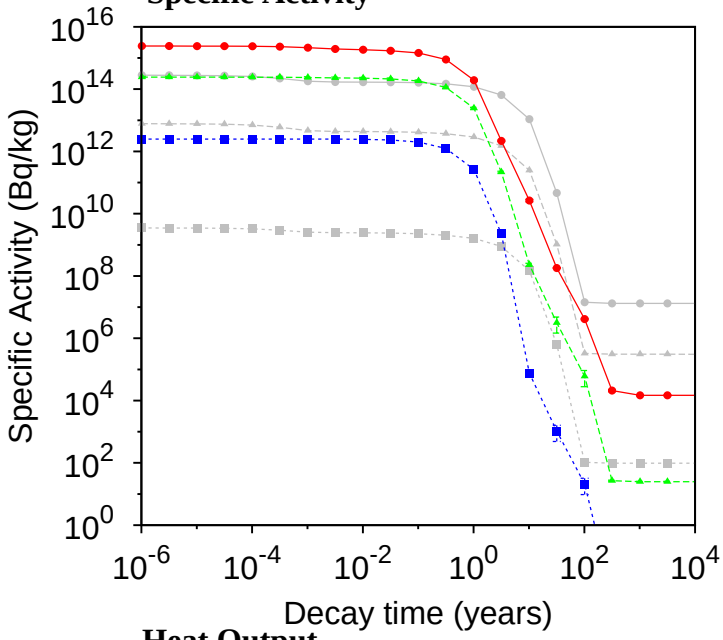
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.87E+06	2.87E+06	2.72E+06	2.94E+05	2.07E-03	3.31E-05
Ta182	92.9	92.9	95.9	99.9	0.5	33.3
Ta183	5.8	5.8	3.7			
Hf178n					90.3	
H3					8.1	
Hf182					1.1	66.6

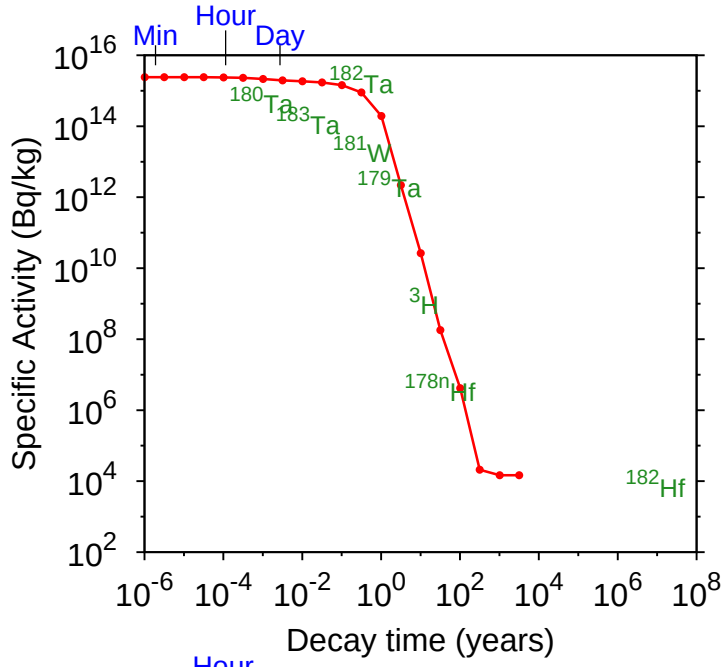
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.81E+07	1.81E+07	1.76E+07	1.96E+06	1.07E-01	2.35E-03
Ta182	98.2	98.2	98.8	100.0	0.1	3.1
Ta183	1.5	1.5	0.9			
Hf178n					96.8	
Hf182					2.1	96.9

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.79E+13	1.79E+13	1.74E+13	1.96E+12	1.01E+03	7.52E+01
Ta182	99.5	99.6	99.8	100.0	7.3	97.6
Hf178n					48.5	
Hf178m					40.1	
H3					4.0	
Hf182					0.2	2.4

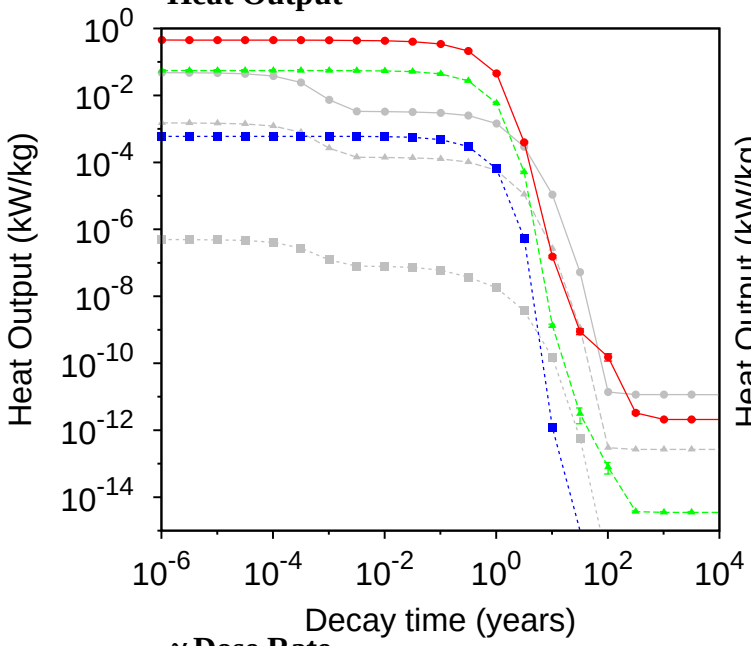
Tantalum activation characteristics

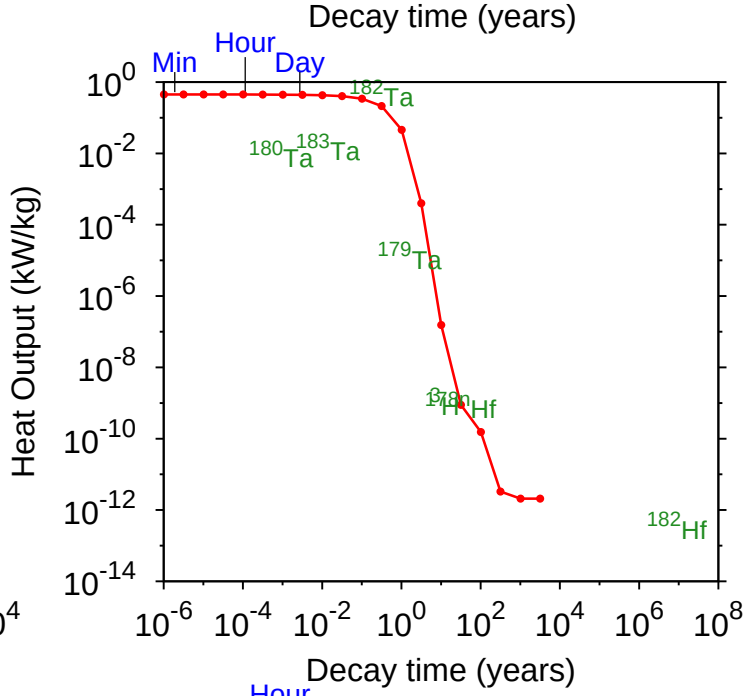
Specific Activity



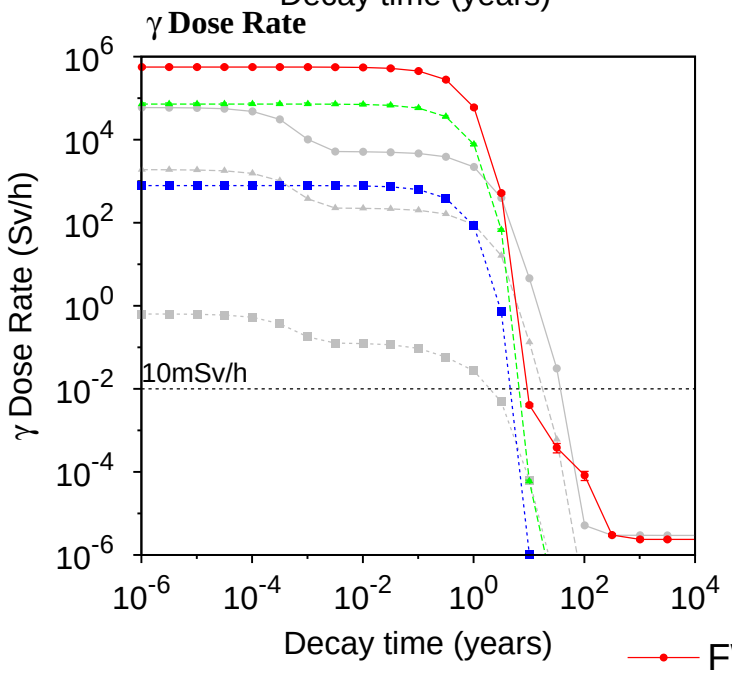


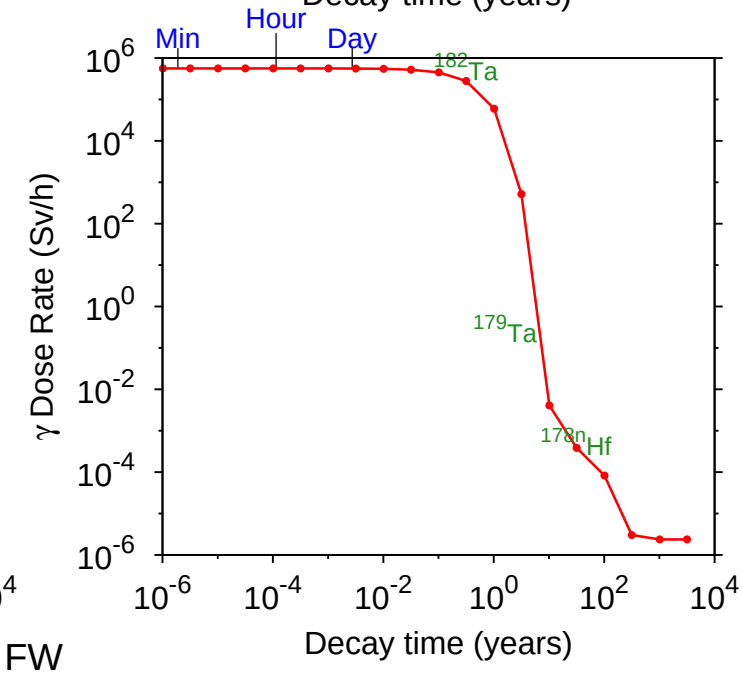
Heat Output





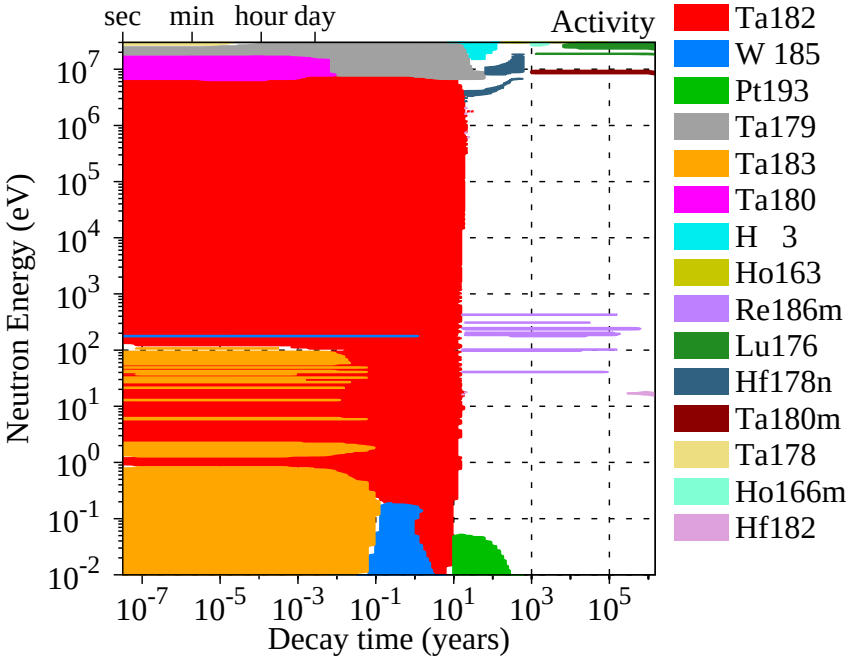
γ Dose Rate

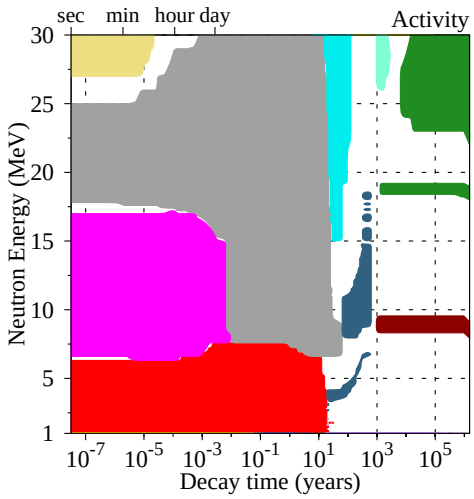


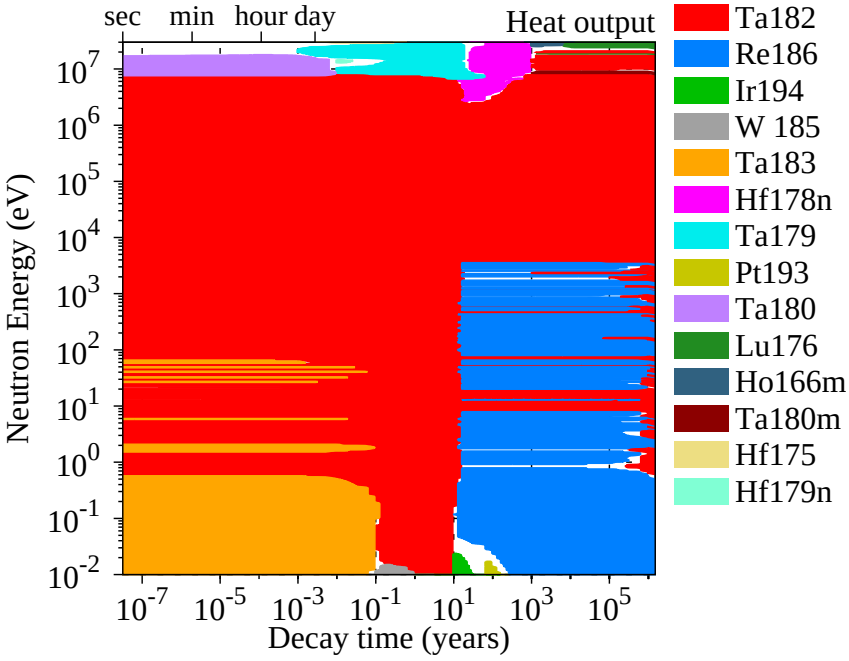


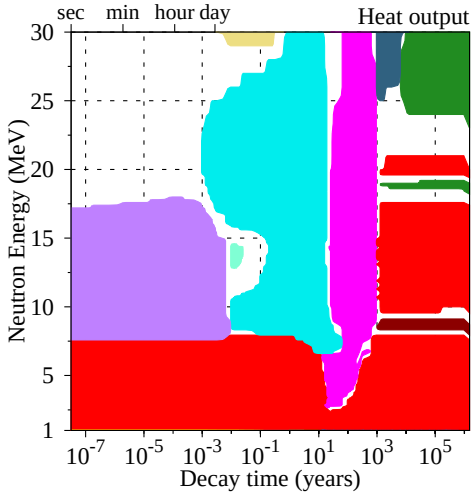
FW
Blanket
Manifold
Fe results

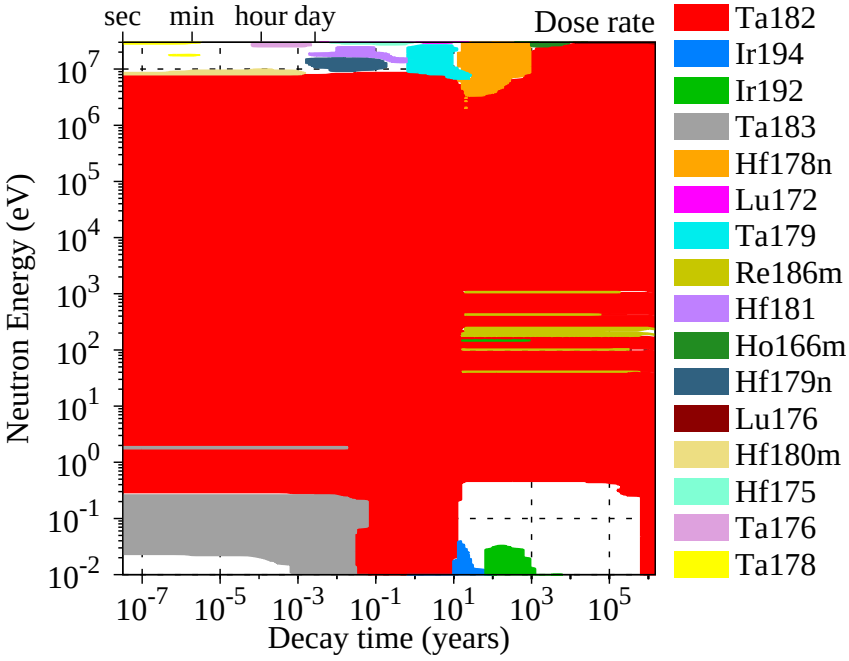
Tantalum Importance diagrams

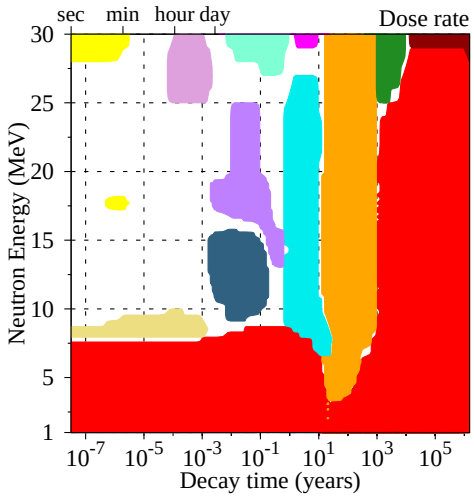




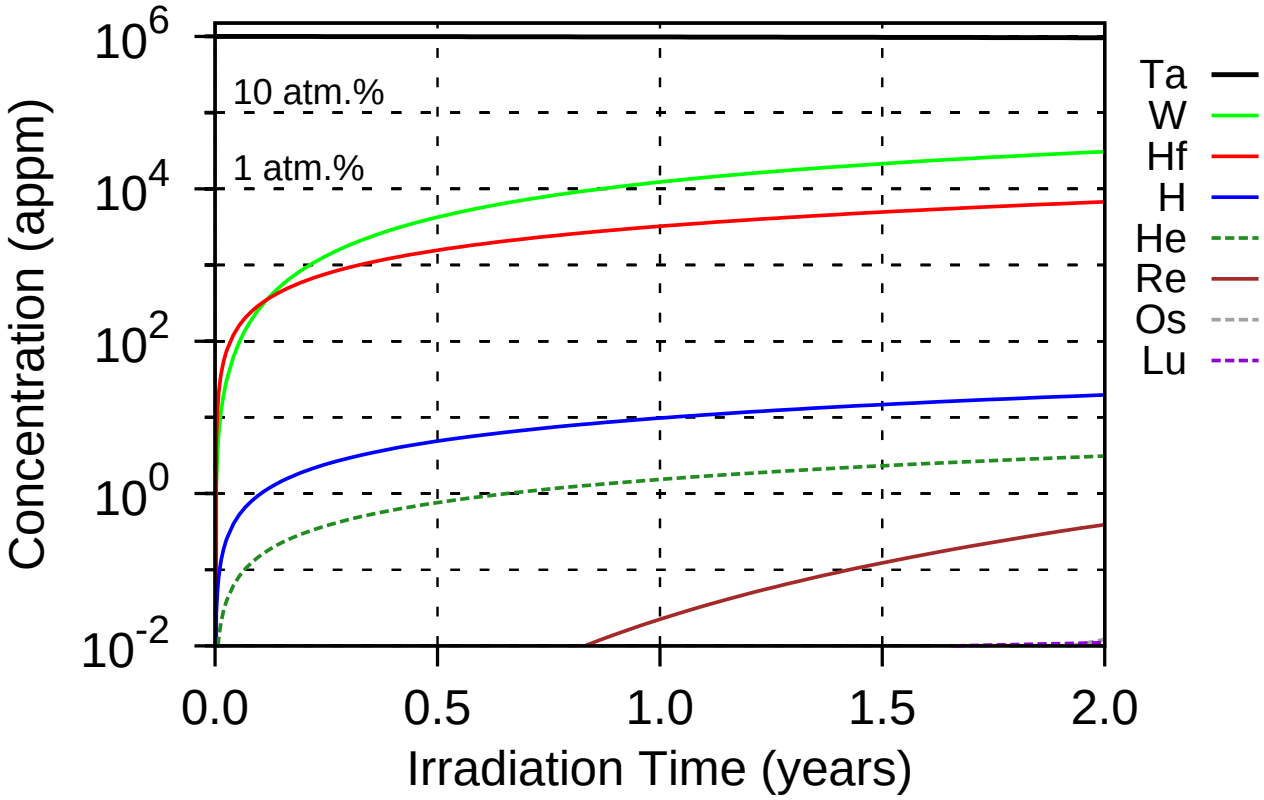






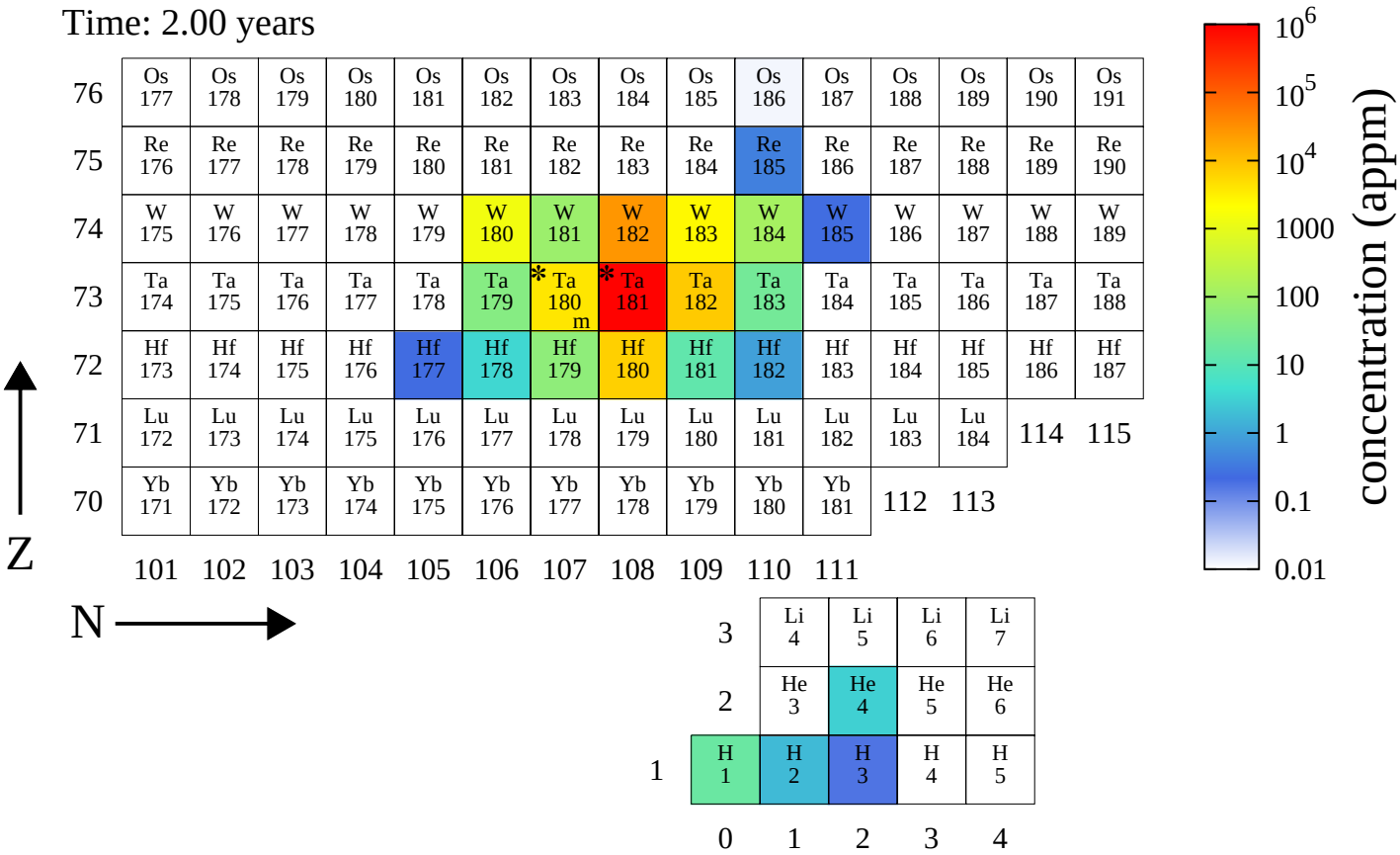


Tantalum FW Transmutation

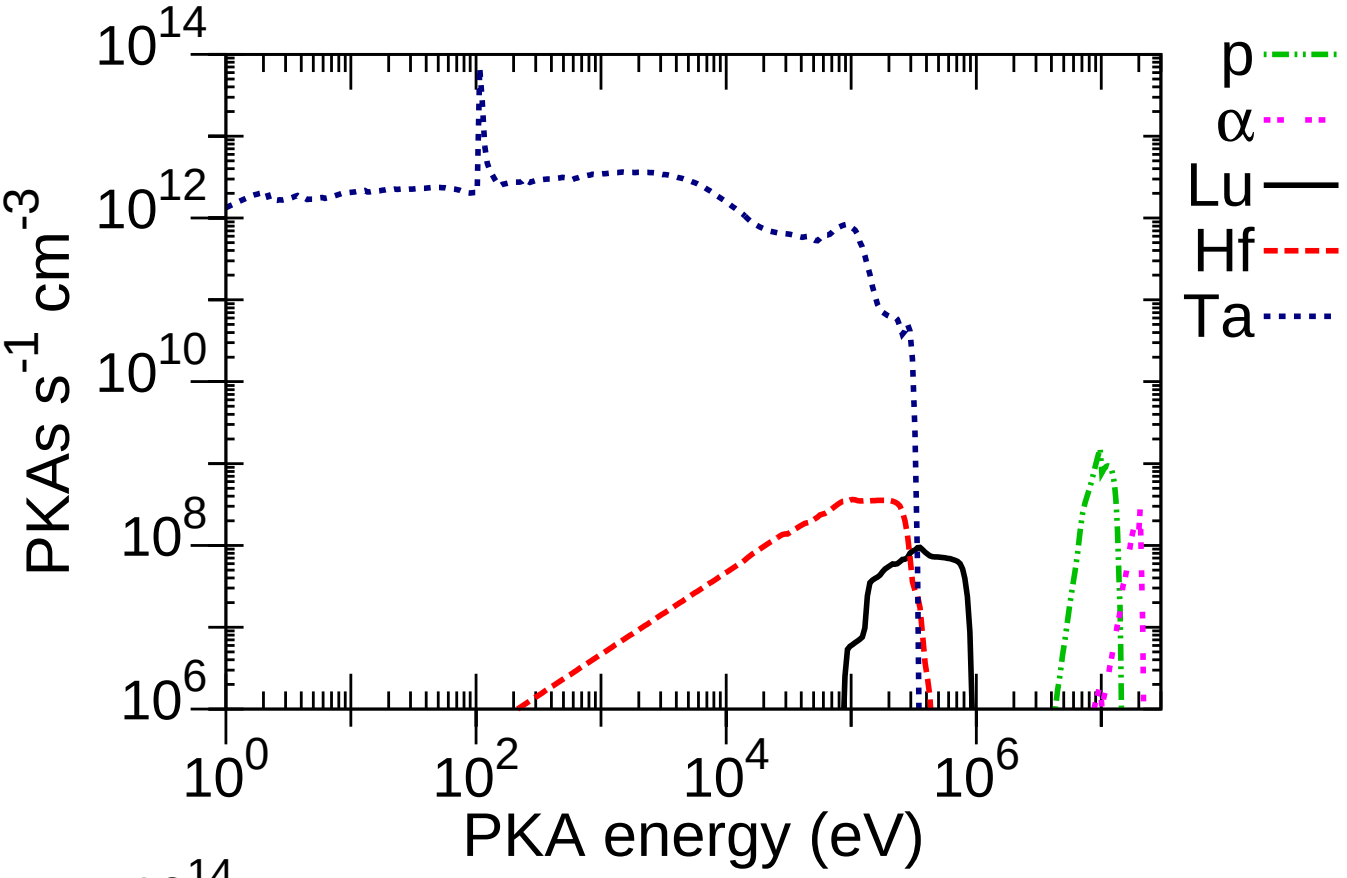


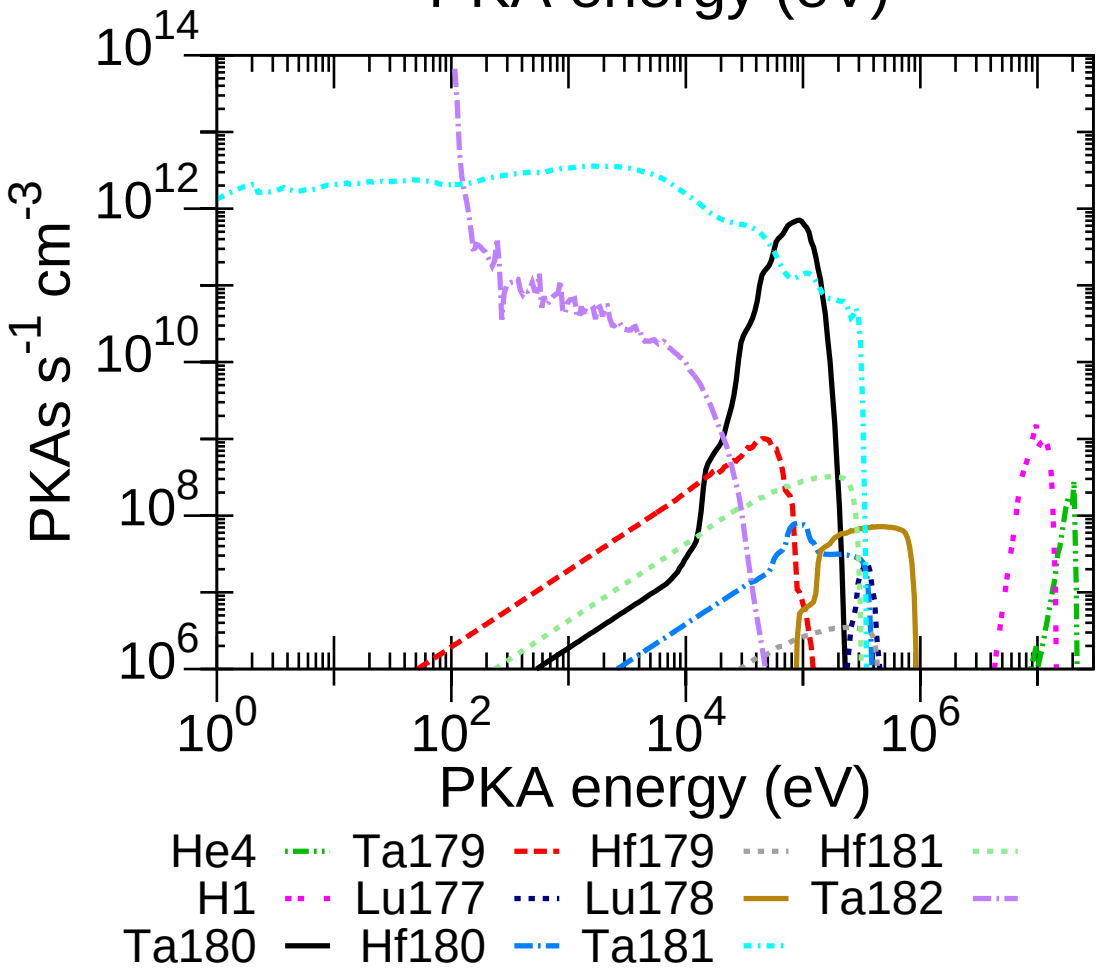
2 appm He & 10 appm H after 1 year

4 dpa/year



Tantalum FW PKA distributions





Tantalum Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ta182m	0.28s	Ta181(n,γ)Ta182m	100.0	99.8	96.6	
		Ta181(n,γ)Ta182n(IT)Ta182m			1.9	
		Ta181(n,γ)Ta182(n,n$'$)Ta182m			1.5	
Hf178m	4.00s	Ta180m(n,α)Lu177(β^-)Hf177(n,γ)Hf178m		88.2		
		Ta181(n,α)Lu178(β^-)Hf178(n,n$'$)Hf178m			76.5	
		Ta181(n,α)Lu178m(β^-)Hf178(n,n$'$)Hf178m			23.1	
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179(n,2n)Hf178m				47.5
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179m(IT) Hf179(n,2n)Hf178m				22.7
		Ta181(n,2n)Ta180m(n,2n)Ta179(β^+)Hf179(n,2n)Hf178m				15.4
		Ta181(n,3n)Ta179(β^+)Hf179(n,2n)Hf178m				3.3
		Ta181(n,2n)Ta180(β^-)W180(n,2n)W179(β^+)Ta179(β^+) Hf179(n,2n)Hf178m				2.7
		Ta181(n,2n)Ta180m(n,E)Ta180(β^+)Hf180(n,2n) Hf179(n,2n)Hf178m				2.1
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179n(IT) Hf179(n,2n)Hf178m				1.9
		Ta181(n,2n)Ta180m(n,E)Ta180(β^+)Hf180(n,2n)Hf179m(IT) Hf179(n,2n)Hf178m				1.0
Ta178	9.29m	Ta181(n,2n)Ta180m(n,2n)Ta179(n,2n)Ta178				70.9
		Ta181(n,2n)Ta180(β^-)W180(n,2n)W179(β^+)Ta179(n,2n)Ta178				12.7
		Ta181(n,3n)Ta179(n,2n)Ta178				9.7
		Ta181(n,2n)Ta180m(n,3n)Ta178				2.0
Hf180m	5.50h	Ta181(n,γ)Ta182(n,α)Lu179(β^-)Hf179(n,γ)Hf180m	33.5	40.4		
		Ta181(n,α)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180m	24.0	3.6		
		Ta181(n,γ)Ta182m(IT)Ta182(n,α)Lu179(β^-)Hf179(n,γ)Hf180m	19.0	23.0		
		Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183(n,α)Hf180m	7.2	7.8		
		Ta181(n,α)Lu178(β^-)Hf178(n,γ)Hf179(n,γ)Hf180m	6.3	1.6		
		Ta181(n,α)Lu178m(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180m	4.1			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(β^-)W183(n,α)Hf180m	4.1	4.4		
		Ta181(n,α)Lu178m(β^-)Hf178(n,γ)Hf179(n,γ)Hf180m	1.1			
		Ta181(n,γ)Ta182(β^-)W182(n,α)Hf179(n,γ)Hf180m		6.0		
		Ta181(n,γ)Ta182(β^-)W182(n,γ)W183(n,α)Hf180m		3.6		
		Ta181(n,γ)Ta182m(IT)Ta182(β^-)W182(n,α)Hf179(n,γ)Hf180m		3.4		
		Ta181(n,γ)Ta182m(IT)Ta182(β^-)W182(n,γ)W183(n,α)Hf180m		2.0		
		Ta181(n,γ)Ta182(β^-)W182(n,α)Hf179m(IT)Hf179(n,γ)Hf180m		1.8		
		Ta181(n,γ)Ta182m(IT)Ta182(β^-)W182(n,α)Hf179m(IT) Hf179(n,γ)Hf180m		1.0		
		Ta180m(n,E)Ta180(β^+)Hf180(n,n$'$)Hf180m			94.9	
		Ta180m(n,n$'$)Ta180(β^+)Hf180(n,n$'$)Hf180m			5.1	
		Ta181(n,2n)Ta180(β^+)Hf180(n,n$'$)Hf180m				87.4
		Ta181(n,2n)Ta180m(n,E)Ta180(β^+)Hf180(n,n$'$)Hf180m				5.7
		Ta181(n,2n)Ta180m(n,p)Hf180m				5.6
Ta180	8.08h	Ta180m(n,E)Ta180		100.0	94.9	
		Ta180m(n,n$'$)Ta180			5.1	
		Ta181(n,2n)Ta180				88.6
		Ta181(n,2n)Ta180m(n,E)Ta180				11.1
Ta176	8.09h	no pathways found				
Ir194	19.30h	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Re186	3.75d	Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183(n,γ)W184(n,γ)W185(β^-)Re185(n,γ)Re186	52.0	46.7		
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(β^-)W183(n,γ)W184(n,γ)W185(β^-)Re185(n,γ)Re186	29.6	26.5		
		Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(β^-)W184(n,γ)W185(β^-)Re185(n,γ)Re186	5.5	4.3		
		Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ)Ta185(β^-)W185(β^-)Re185(n,γ)Re186	4.2			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(n,γ)Ta184(β^-)W184(n,γ)W185(β^-)Re185(n,γ)Re186	3.1	2.4		
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ)Ta185(β^-)W185(β^-)Re185(n,γ)Re186	2.4			
		Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183m(IT)W183(n,γ)W184(n,γ)W185(β^-)Re185(n,γ)Re186	1.8	1.6		
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(β^-)W183m(IT)W183(n,γ)W184(n,γ)W185(β^-)Re185(n,γ)Re186	1.0			
		Ta181(n,γ)Ta182(β^-)W182(n,γ)W183(n,γ)W184(n,γ)W185(β^-)Re185(n,γ)Re186		10.4		
		Ta181(n,γ)Ta182m(IT)Ta182(β^-)W182(n,γ)W183(n,γ)W184(n,γ)W185(β^-)Re185(n,γ)Re186		5.9		
Ta183	5.09d	Ta181(n,γ)Ta182(n,γ)Ta183	63.7	63.7	58.6	
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183	36.2	36.2	40.6	
Lu172	6.70d	no pathways found				
Hf179n	25.10d	Ta181(n,γ)Ta182(β^-)W182(n,α)Hf179n	63.7		56.7	
		Ta181(n,γ)Ta182m(IT)Ta182(β^-)W182(n,α)Hf179n	36.2		39.3	
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179n				91.3
		Ta181(n,2n)Ta180m(n,E)Ta180(β^+)Hf180(n,2n)Hf179n				5.6
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179(n,n$'$)Hf179n				1.3
Hf181	42.38d	Ta180m(n,E)Ta180(β^+)Hf180(n,γ)Hf181	62.7	100.0	94.9	
		Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183(n,α)Hf180(n,γ)Hf181	18.2			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(β^-)W183(n,α)Hf180(n,γ)Hf181	10.4			
		Ta181(n,γ)Ta182(n,α)Lu179(β^-)Hf179(n,γ)Hf180(n,γ)Hf181	3.2			
		Ta181(n,γ)Ta182m(IT)Ta182(n,α)Lu179(β^-)Hf179(n,γ)Hf180(n,γ)Hf181	1.8			
		Ta181(n,α)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ)Hf180(n,γ)Hf181	1.7			
		Ta180m(n,n$'$)Ta180(β^+)Hf180(n,γ)Hf181			5.1	
		Ta181(n,p)Hf181				98.0
		Ta181(n,2n)Ta180(β^+)Hf180(n,γ)Hf181				1.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hf175	70.00d	Ta181(n,2n)Ta180m(n,α)Lu177(β^-)Hf177(n,2n) Hf176(n,2n)Hf175				14.3
		Ta181(n,nα)Lu177(β^-)Hf177(n,2n)Hf176(n,2n)Hf175				9.9
		Ta181(n,2n)Ta180m(n,2n)Ta179(n,2n)Ta178(β^+)Hf178(n,2n) Hf177(n,2n)Hf176(n,2n)Hf175				8.0
		Ta181(n,2n)Ta180(β^+)Hf180(n,3n)Hf178(n,2n)Hf177(n,2n) Hf176(n,2n)Hf175				6.7
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179(n,2n)Hf178(n,2n) Hf177(n,2n)Hf176(n,2n)Hf175				5.8
		Ta181(n,2n)Ta180m(n,2n)Ta179(n,α)Lu176m(β^-) Hf176(n,2n)Hf175				5.0
		Ta181(n,2n)Ta180(β^+)Hf180(n,α)Yb177(β^-)Lu177(β^-) Hf177(n,2n)Hf176(n,2n)Hf175				4.4
		Ta181(n,α)Lu178(β^-)Hf178(n,2n)Hf177(n,2n) Hf176(n,2n)Hf175				4.3
		Ta181(n,3n)Ta179(n,2n)Ta178(β^+)Hf178(n,2n)Hf177(n,2n) Hf176(n,2n)Hf175				3.2
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179m(IT)Hf179(n,2n) Hf178(n,2n)Hf177(n,2n)Hf176(n,2n)Hf175				2.8
		Ta181(n,2n)Ta180m(n,nα)Lu176m(β^-)Hf176(n,2n)Hf175				2.6
		Ta181(n,α)Lu178m(β^-)Hf178(n,2n)Hf177(n,2n) Hf176(n,2n)Hf175				2.3
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179(n,3n)Hf177(n,2n) Hf176(n,2n)Hf175				1.7
		Ta181(n,2n)Ta180(β^-)W180(n,2n)W179(β^+)Ta179(n,2n) Ta178(β^+)Hf178(n,2n)Hf177(n,2n)Hf176(n,2n)Hf175				1.4
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179(n,2n)Hf178m(IT) Hf178(n,2n)Hf177(n,2n)Hf176(n,2n)Hf175				1.3
		Ta181(n,3n)Ta179(n,α)Lu176m(β^-)Hf176(n,2n)Hf175				1.2
		Ta181(n,2n)Ta180m(n,α)Lu177m(β^-)Hf177m(IT)Hf177(n,2n) Hf176(n,2n)Hf175				1.1
		Ta181(n,2n)Ta180m(n,2n)Ta179(β^+)Hf179(n,2n)Hf178(n,2n) Hf177(n,2n)Hf176(n,2n)Hf175				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ir192	73.80d	Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ)Ta185(β^-) W185(β^-)Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ) Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	13.9			
		Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183(n,γ)W184(n,γ)W185(β^-) Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192	11.1			
		Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ)Ta185(β^-) W185(β^-)Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ) Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192	9.7			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ) Ta185(β^-)W185(β^-)Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ) Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	7.9			
		Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183(n,γ)W184(n,γ)W185(β^-) Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192	7.7			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(β^-)W183(n,γ) W184(n,γ)W185(β^-)Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ) Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	6.3			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ) Ta185(β^-)W185(β^-)Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ) Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192	5.5			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(β^-)W183(n,γ) W184(n,γ)W185(β^-)Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ) Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192	4.4			
		Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(β^-)W184(n,γ)W185(β^-) Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192	3.2			
		Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(β^-)W184(n,γ)W185(β^-) Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192	2.2			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(n,γ)Ta184(β^-) W184(n,γ)W185(β^-)Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ) Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	1.8			
		Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ)Ta185(β^-) W185(β^-)Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ) Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192	1.7			
		Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183(n,γ)W184(n,γ)W185(β^-) Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192	1.4			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(n,γ)Ta184(β^-) W184(n,γ)W185(β^-)Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ) Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192	1.3			
		Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ)Ta185(β^-) W185(β^-)Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ) Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192	1.2			
		Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ)Ta185(β^-) W185(β^-)Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ) Os188(n,γ)Os189m(IT)Os189(n,γ)Os190(n,γ)Os191m(IT) Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	1.1			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ir192	cont.	Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ) Ta185(β^-)W185(β^-)Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ) Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192	1.0			
W185	75.12d	Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183(n,γ)W184(n,γ)W185	54.0	45.6		
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(β^-)W183(n,γ) W184(n,γ)W185	30.7	25.9		
		Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(β^-)W184(n,γ)W185	4.8	2.9		
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(n,γ)Ta184(β^-) W184(n,γ)W185	2.8	1.7		
		Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ)Ta185(β^-)W185	2.7			
		Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183m(IT)W183(n,γ) W184(n,γ)W185	1.9	1.6		
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ) Ta185(β^-)W185	1.5			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(β^-)W183m(IT) W183(n,γ)W184(n,γ)W185	1.1			
		Ta181(n,γ)Ta182(β^-)W182(n,γ)W183(n,γ)W184(n,γ)W185		13.0		
		Ta181(n,γ)Ta182m(IT)Ta182(β^-)W182(n,γ)W183(n,γ) W184(n,γ)W185		7.4		
Ta182	114.71d	Ta181(n,γ)Ta182	63.7	63.7	58.6	45.1
		Ta181(n,γ)Ta182m(IT)Ta182	36.2	36.2	40.6	43.9
		Ta181(n,γ)Ta182n(IT)Ta182m(IT)Ta182				10.3
W181	120.99d	Ta180m(n,E)Ta180(β^-)W180(n,γ)W181	100.0	100.0	94.9	
		Ta180m(n,n$'$)Ta180(β^-)W180(n,γ)W181			5.1	
Ta179	1.61y	Ta181(n,2n)Ta180m(n,2n)Ta179				72.4
		Ta181(n,2n)Ta180(β^-)W180(n,2n)W179(β^+)Ta179				13.0
		Ta181(n,3n)Ta179				9.9
H3	12.33y	Ta181(n,t)H3				19.9
		Ta181(n,2n)Ta180m(n,t)H3				2.9
Hf178n	31.00y	Ta180m(n,α)Lu177(β^-)Hf177(n,γ)Hf178n		64.3	87.4	
		Ta180m(n,α)Lu177m(β^-)Hf177m(IT)Hf177(n,γ)Hf178n			2.4	
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179(n,2n)Hf178n				46.9
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179m(IT) Hf179(n,2n)Hf178n				22.4
		Ta181(n,2n)Ta180m(n,2n)Ta179(β^+)Hf179(n,2n)Hf178n				12.1
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179n(n,2n)Hf178n				7.2
		Ta181(n,3n)Ta179(β^+)Hf179(n,2n)Hf178n				3.5
		Ta181(n,2n)Ta180(β^-)W180(n,2n)W179(β^+)Ta179(β^+) Hf179(n,2n)Hf178n				2.1
		Ta181(n,2n)Ta180(β^+)Hf180(n,2n)Hf179n(IT) Hf179(n,2n)Hf178n				1.8
		Ta181(n,2n)Ta180m(n,E)Ta180(β^+)Hf180(n,2n) Hf179(n,2n)Hf178n				1.6
Pt193	50.00y	no pathways found				
Ho166m	1.2 10^3y	no pathways found				
Ho163	4.6 10^3y	no pathways found				
Re186m	2.0 10^5y	Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183(n,γ)W184(n,γ)W185(β^-) Re185(n,γ)Re186m	50.4			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(β^-)W183(n,γ) W184(n,γ)W185(β^-)Re185(n,γ)Re186m	28.6			
		Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(β^-)W184(n,γ)W185(β^-) Re185(n,γ)Re186m	5.9			
		Ta181(n,γ)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ)Ta185(β^-) W185(β^-)Re185(n,γ)Re186m	5.5			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(n,γ)Ta184(β^-) W184(n,γ)W185(β^-)Re185(n,γ)Re186m	3.3			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(n,γ)Ta184(n,γ) Ta185(β^-)W185(β^-)Re185(n,γ)Re186m	3.1			
		Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183m(IT)W183(n,γ)W184(n,γ) W185(β^-)Re185(n,γ)Re186m	1.8			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(β^-)W183m(IT) W183(n,γ)W184(n,γ)W185(β^-)Re185(n,γ)Re186m	1.0			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hf182	9.0 10^6y	Ta180m(n,E)Ta180(β^+)Hf180(n,γ)Hf181(n,γ)Hf182	81.5	100.0	94.7	
		Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183(n,α)Hf180(n,γ) Hf181(n,γ)Hf182	8.9			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(β^-)W183(n,α) Hf180(n,γ)Hf181(n,γ)Hf182	5.0			
		Ta181(n,γ)Ta182(n,α)Lu179(β^-)Hf179(n,γ)Hf180(n,γ) Hf181(n,γ)Hf182	1.8			
		Ta181(n,γ)Ta182m(IT)Ta182(n,α)Lu179(β^-)Hf179(n,γ) Hf180(n,γ)Hf181(n,γ)Hf182	1.0			
		Ta180m(n,n$'$)Ta180(β^+)Hf180(n,γ)Hf181(n,γ)Hf182			5.0	
Lu176	4.0 10^{10}y	Ta181(n,α)Lu178(β^-)Hf178(n,α)Yb175(β^-)Lu175(n,γ)Lu176	85.2	85.0	76.8	
		Ta181(n,α)Lu178m(β^-)Hf178(n,α)Yb175(β^-)Lu175(n,γ)Lu176	14.6	14.2	23.1	
Ta180m	1.8 10^{15}y	Ta181(n,γ)Ta182(n,α)Lu179(β^-)Hf179(n,γ)Hf180m(β^-)Ta180m	33.7			
		Ta181(n,α)Lu178(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180m(β^-)Ta180m	23.9			
		Ta181(n,γ)Ta182m(IT)Ta182(n,α)Lu179(β^-)Hf179(n,γ) Hf180m(β^-)Ta180m	19.2			
		Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183(n,α)Hf180m(β^-)Ta180m	7.1			
		Ta181(n,α)Lu178(β^-)Hf178(n,γ)Hf179(n,γ)Hf180m(β^-)Ta180m	6.3			
		Ta181(n,α)Lu178m(β^-)Hf178(n,γ)Hf179m(IT)Hf179(n,γ) Hf180m(β^-)Ta180m	4.1			
		Ta181(n,γ)Ta182m(IT)Ta182(n,γ)Ta183(β^-)W183(n,α) Hf180m(β^-)Ta180m	4.0			
		Ta181(n,α)Lu178m(β^-)Hf178(n,γ)Hf179(n,γ)Hf180m(β^-)Ta180m	1.1			

Tungsten

Isotope	Atom % abundance	
W180	0.12	
W182	26.50	
W183	14.31	($T_{1/2}$ =1.1 10^{17}y)
W184	30.64	($T_{1/2}$ =4.0 10^{17}y)
W186	28.43	($T_{1/2}$ =5.9 10^{17}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.01E+15	8.74E+14	4.96E+14	3.18E+13	2.96E+06	1.85E+06
W187	31.1	35.8	4.9			
W185	27.7	32.1	54.6	30.3		
W181	16.5	19.1	32.9	64.6		
W185m	6.9	0.9				
W183m	6.7					
Re188	4.4	5.1	0.3			
Re186	4.2	4.8	4.3		32.1	49.7
Ta182	1.1	1.3	2.2	3.9		
Re186m					32.1	49.7
H3					28.9	
Hf178m					3.3	
Hf178n					3.3	

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	6.19E-02	5.64E-02	1.44E-02	6.91E-04	1.13E-10	7.17E-11
W187	60.3	66.0	20.3			
Re188	9.7	10.6	1.3	0.1		
W185	9.2	10.1	38.3	28.3		
W183m	5.4					
Ta182	4.4	4.8	18.5	43.3		0.1
Re186	3.9	4.3	8.6		48.4	73.6
W185m	3.5	0.4				
W181	2.3	2.5	9.8	25.7		
Re184	0.6	0.6	2.4	1.5		
Hf178n					17.8	
Re186m					17.3	26.3
Hf178m					15.7	

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.52E+04	2.51E+04	5.56E+03	4.09E+02	2.05E-05	5.11E-07
W187	82.3	82.5	29.2			
Ta182	14.1	14.1	62.4	95.3	0.3	12.6
Re184	1.6	1.6	6.9	2.8		
Re188	1.2	1.2	0.2			
Hf178n					60.5	
Hf178m					37.0	
Re186m					1.2	44.8
Re186			0.1		1.1	42.2

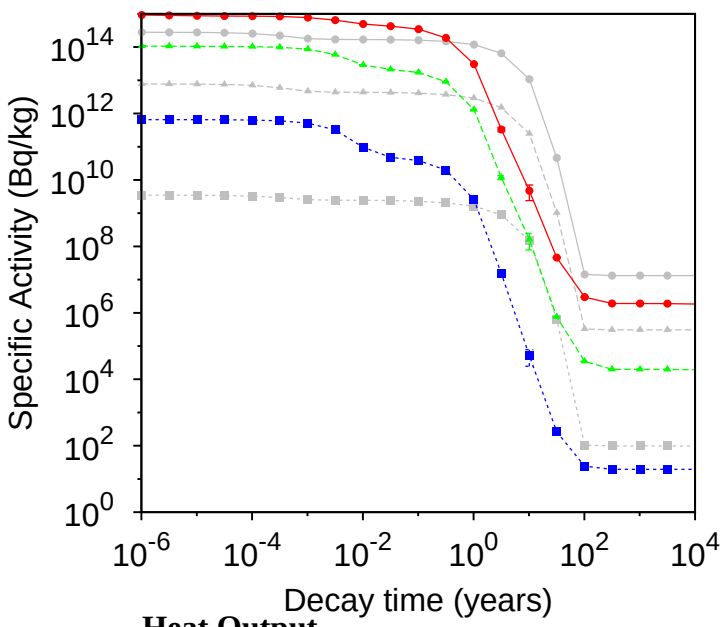
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.82E+05	4.81E+05	2.02E+05	7.87E+03	4.01E-03	3.40E-03
W187	41.1	41.0	7.7			
W185	25.6	25.6	59.0	53.8		
Re186	13.2	13.2	16.0		35.6	40.5
Re188	13.0	13.0	1.0	0.1		
Ta182	3.5	3.5	8.2	23.7		
W181	2.6	2.6	6.1	19.8		
Re184	0.5	0.5	1.1	0.8		
Re184m	0.1	0.1	0.2	1.3		
Re186m					52.2	59.5
Hf178n					11.3	

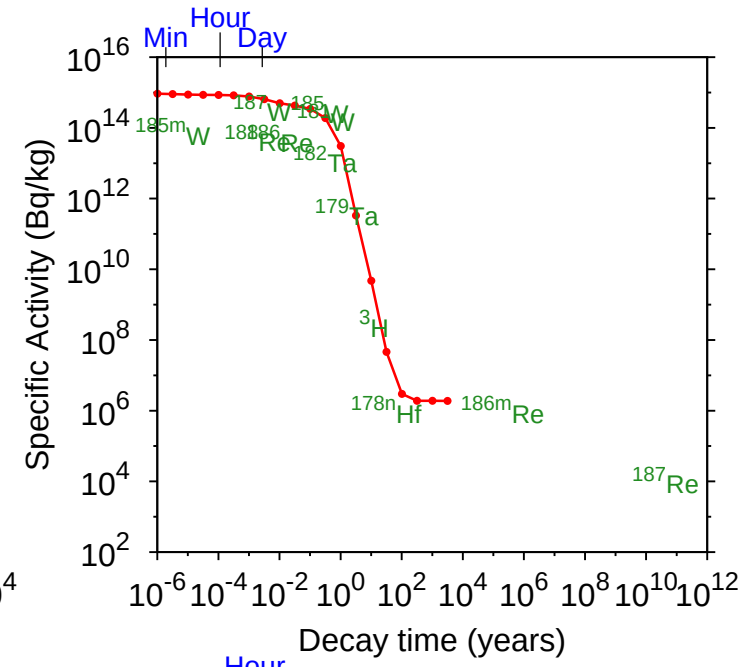
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.91E+05	2.91E+05	1.85E+05	1.49E+04	3.79E-02	1.21E-02
Ta182	38.9	38.9	59.8	83.7		
W187	20.5	20.4	2.5			
Re186	16.0	16.0	12.8		2.8	8.3
W185	11.5	11.5	17.6	7.8		
Re188	8.3	8.3	0.4			
W181	1.5	1.5	2.4	3.7		
Re184	1.5	1.5	2.3	0.8		
Re184m	0.7	0.7	1.1	3.0		
Hf178n					66.3	
Re186m					30.1	91.1

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.78E+11	1.66E+11	1.32E+11	1.46E+10	3.02E+02	7.37E+01
Ta182	63.5	68.3	83.7	85.2	0.7	2.8
W187	17.6	18.9	1.9			
W181	9.3	10.1	12.3	14.0		
W183m	5.4					
W185m	1.7	0.2				
Re184	1.2	1.3	1.5	0.4		
Hf178n					39.4	
Hf178m					32.6	
Re186m					21.0	83.2
Re187					3.1	12.7
H3					2.8	
Re186					0.3	1.2

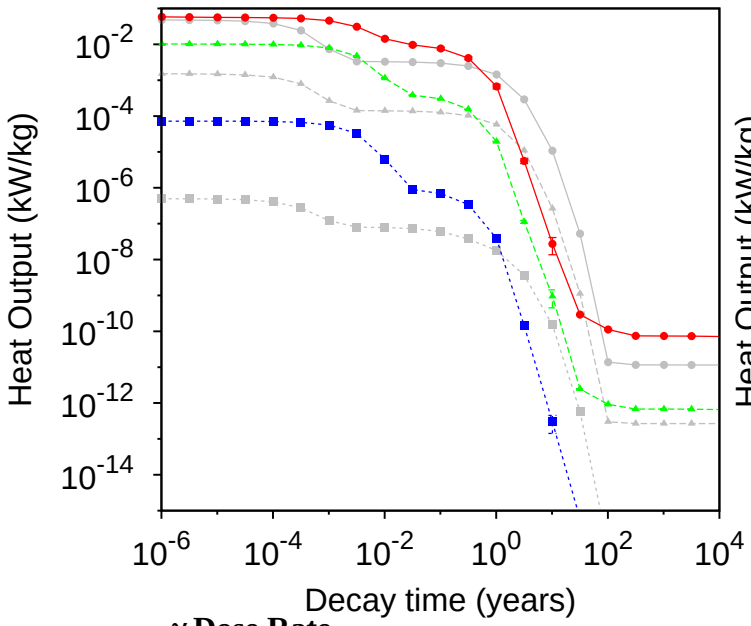
Tungsten activation characteristics

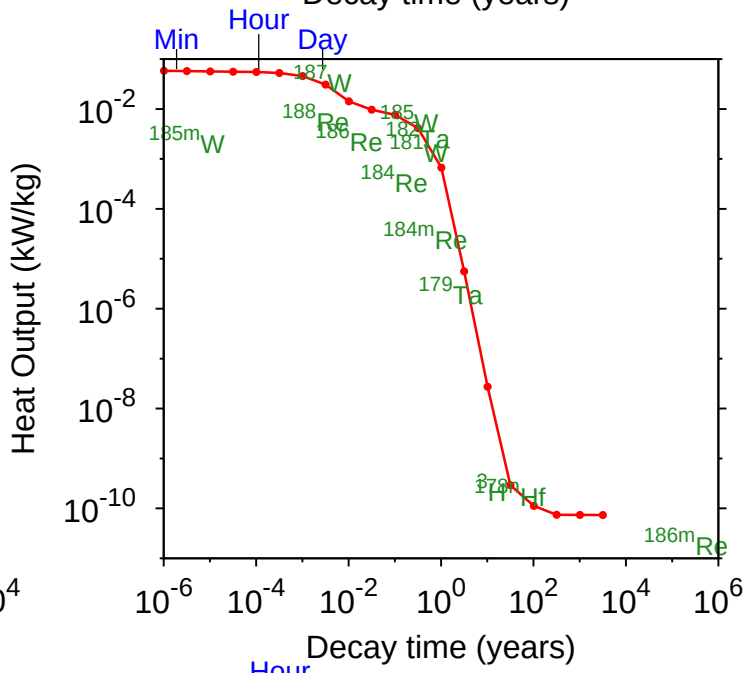
Specific Activity



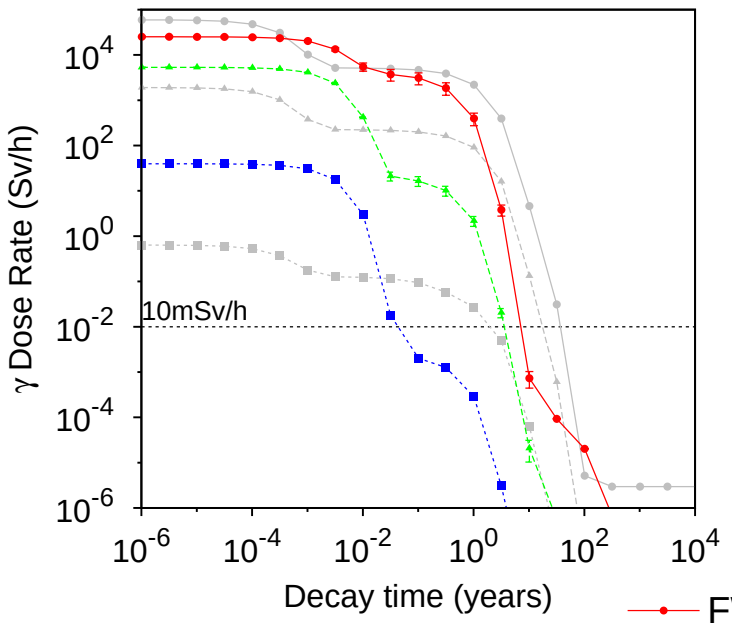


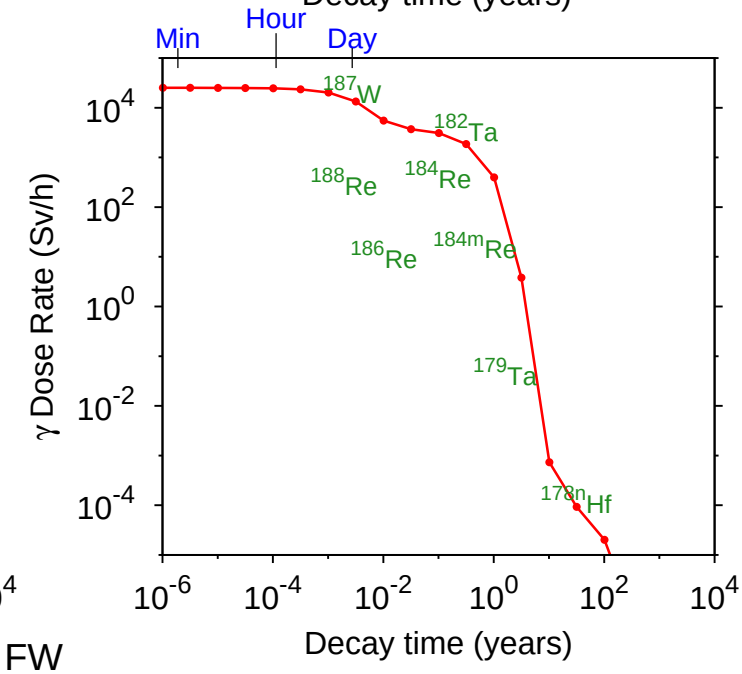
Heat Output





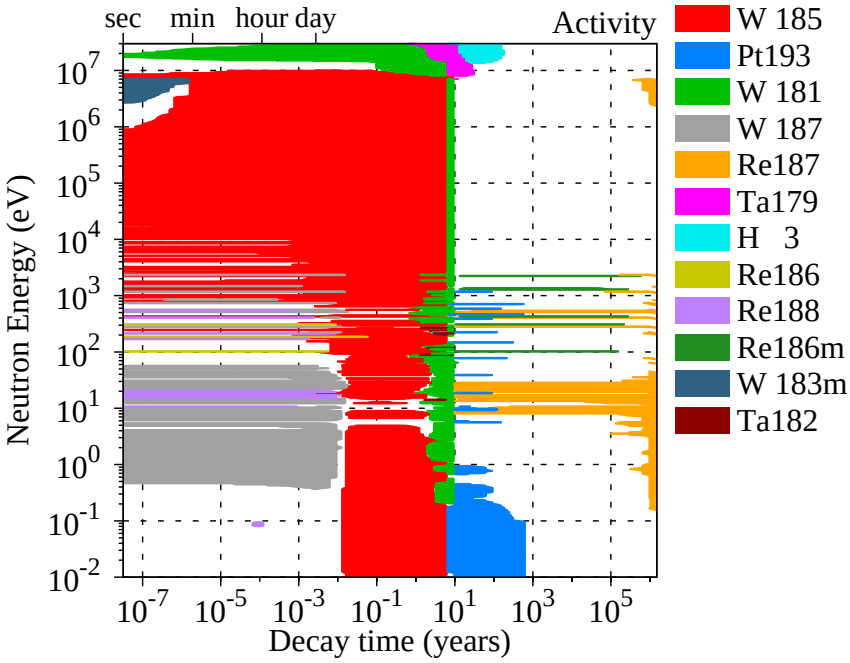
γ Dose Rate

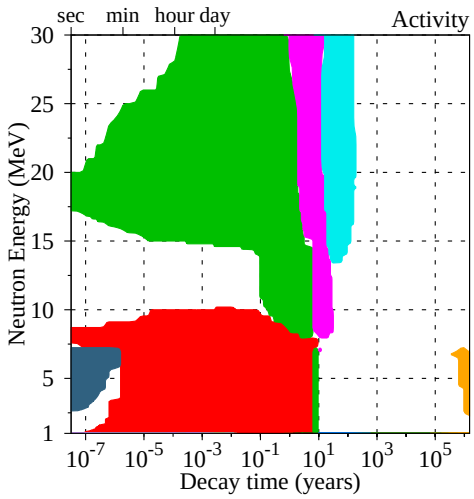


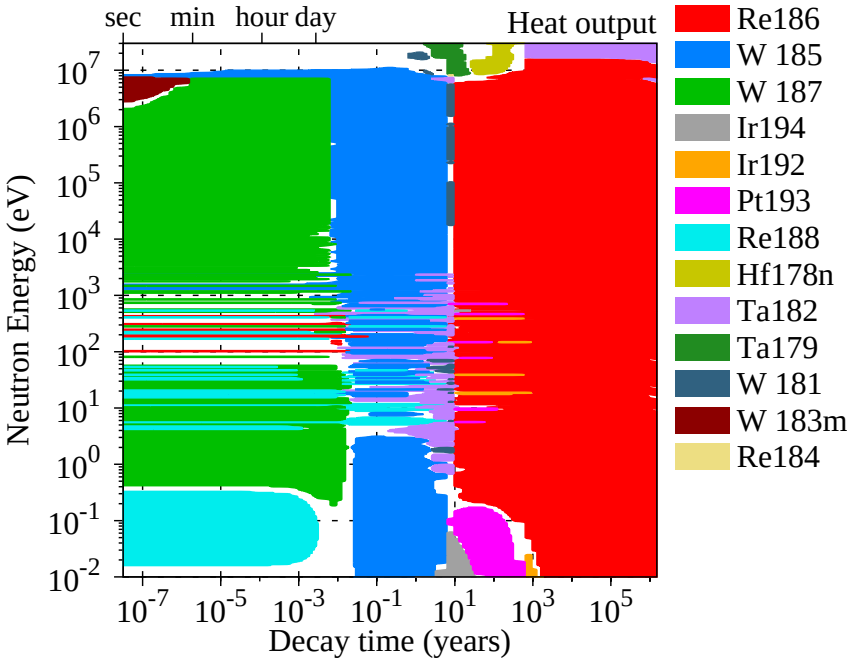


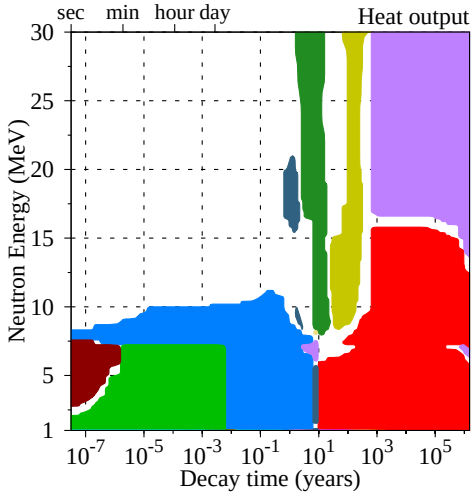
FW
Blanket
Manifold
Fe results

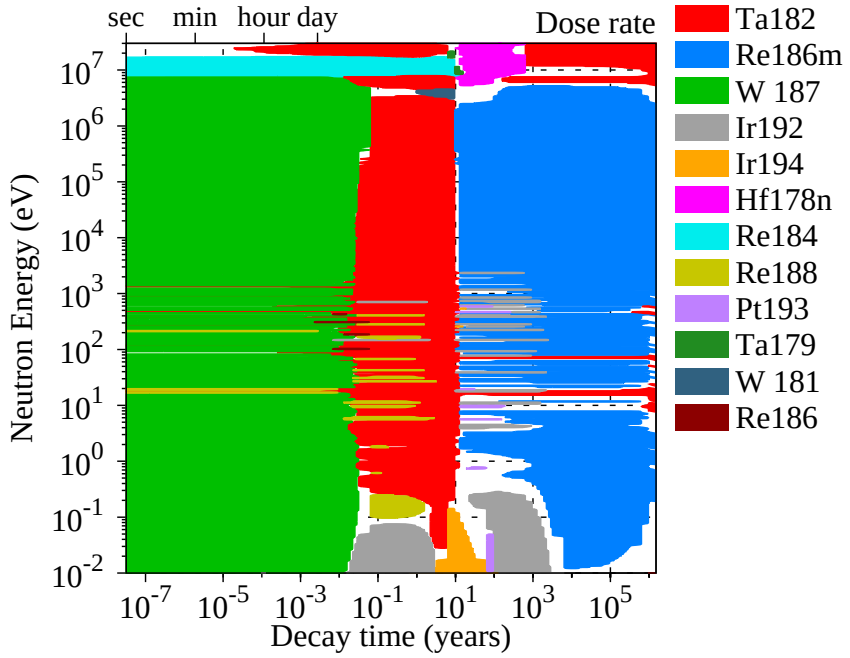
Tungsten Importance diagrams

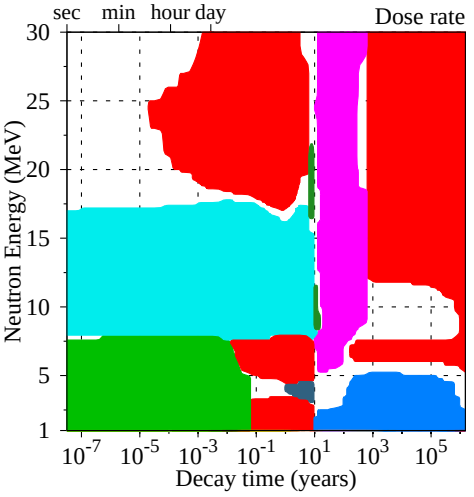




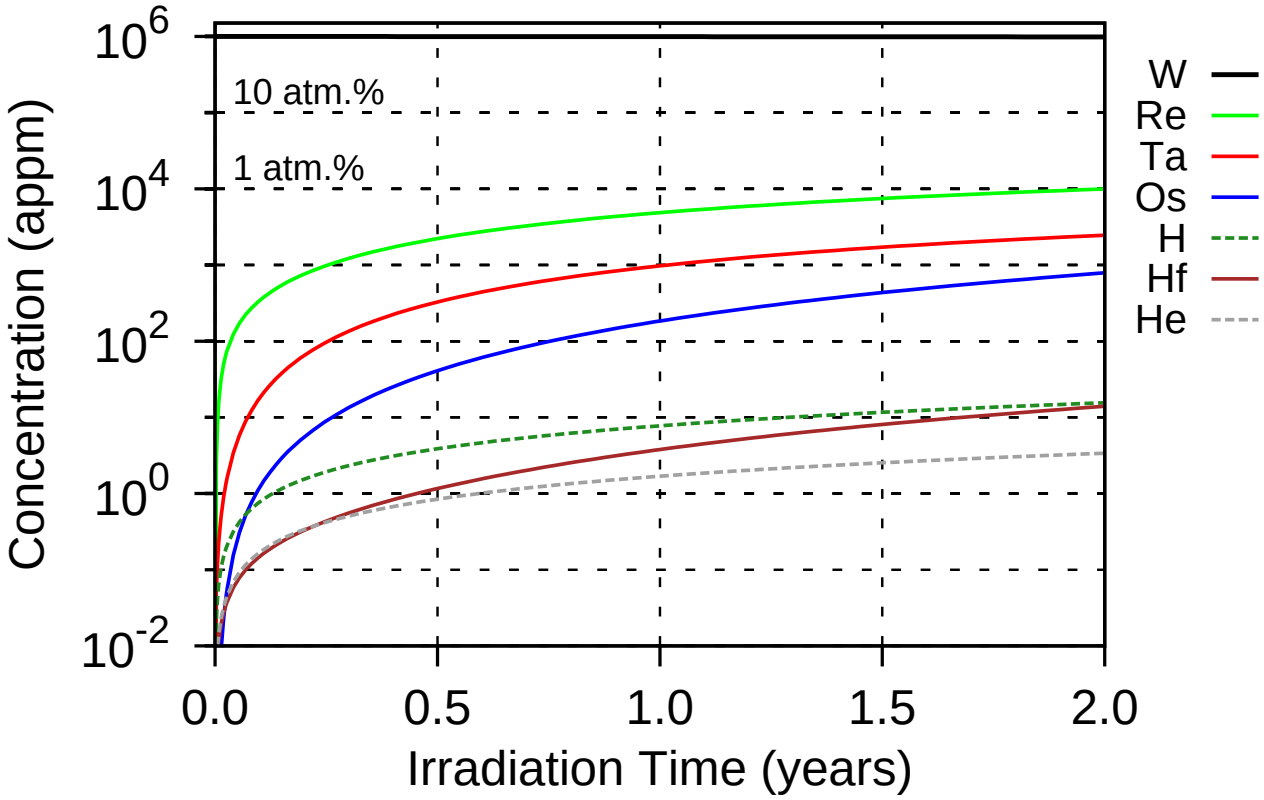






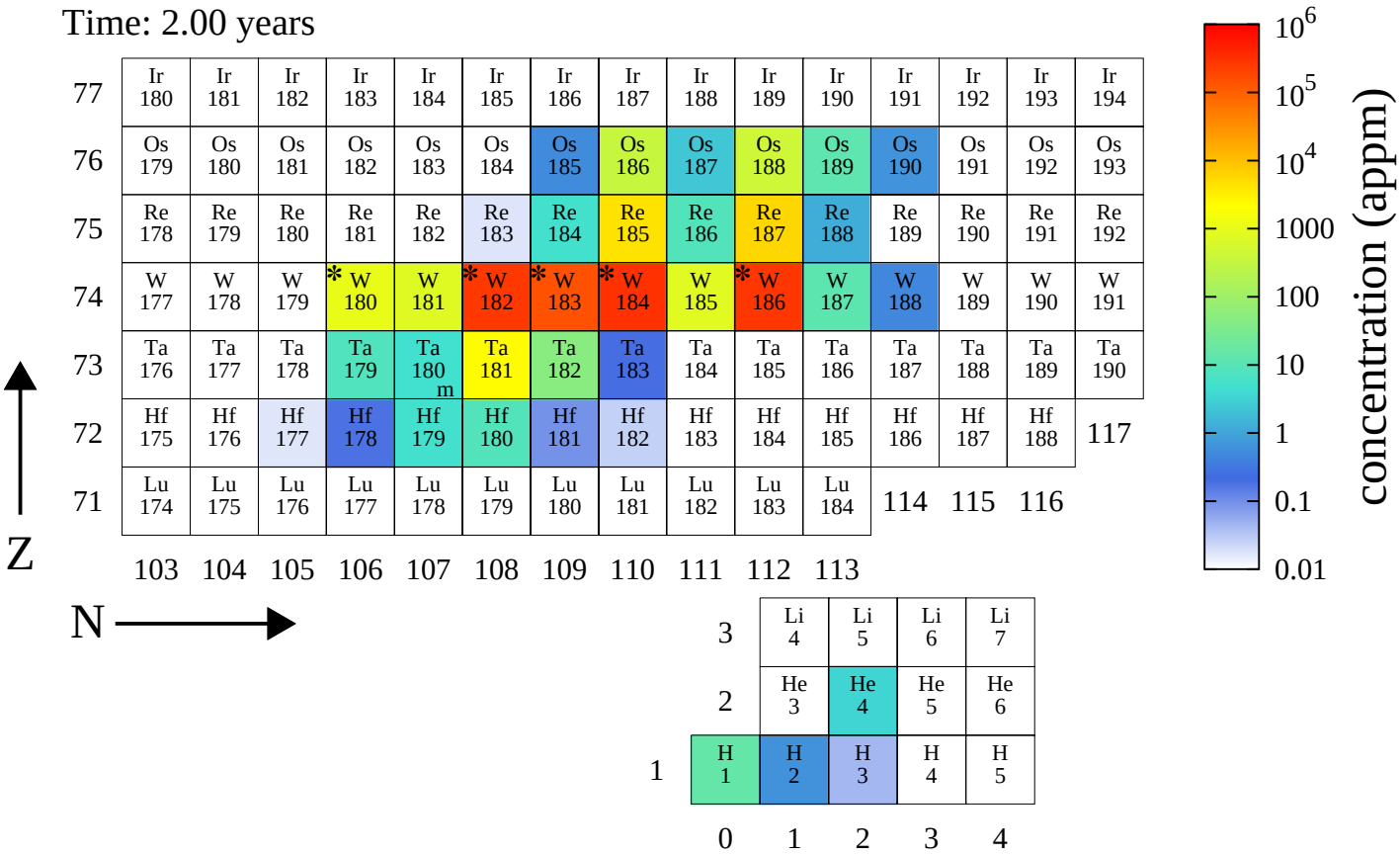


Tungsten FW Transmutation

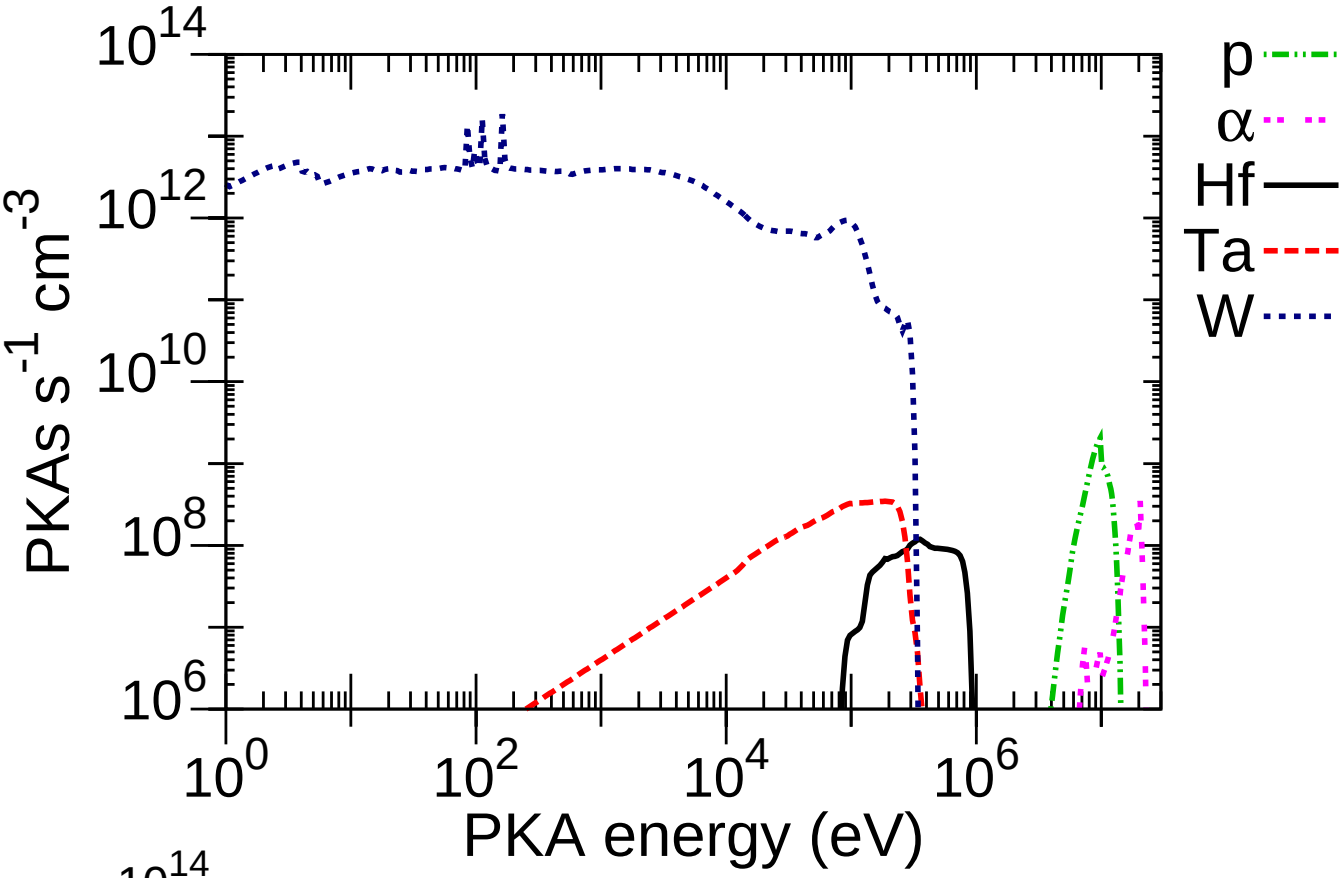


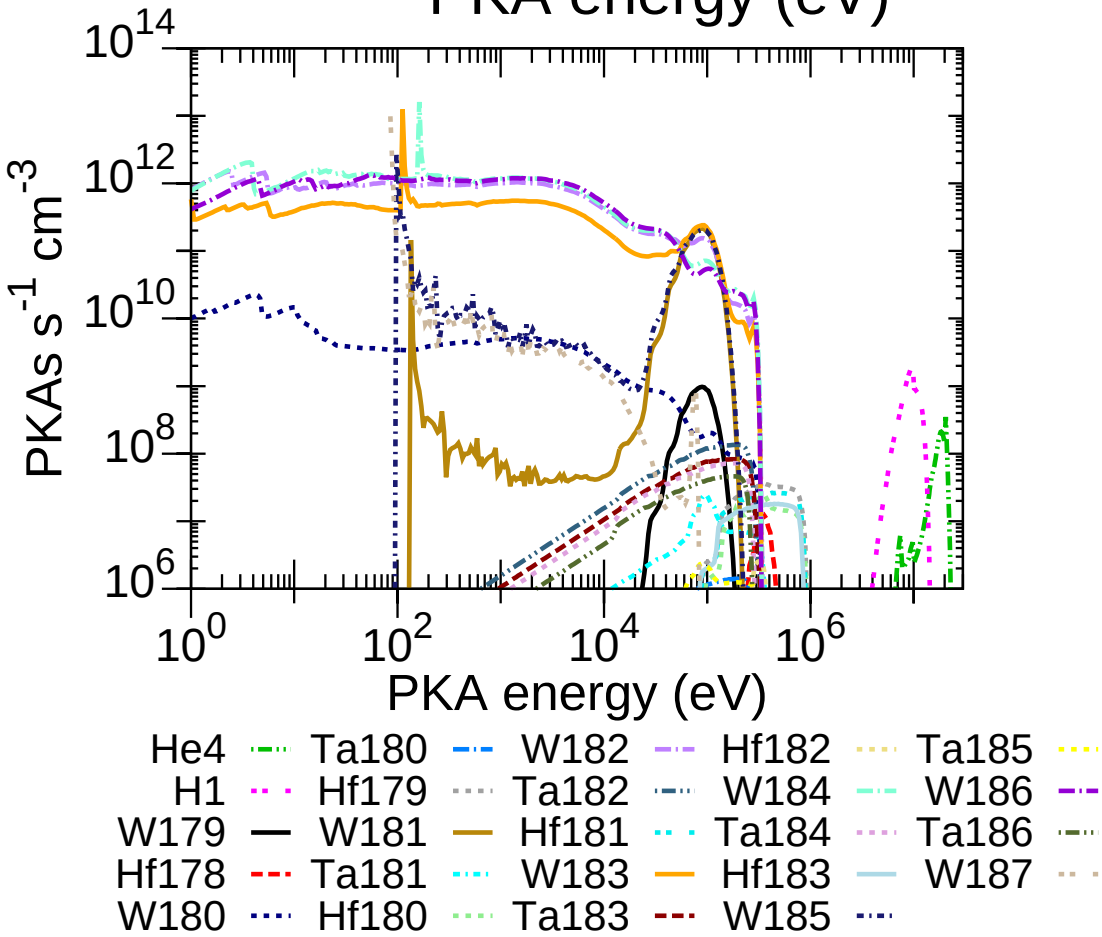
2 appm He & 8 appm H after 1 year

6 dpa/year



Tungsten FW PKA distributions





Tungsten Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hf178m	4.00s	W180(n,α)Hf177(n,γ)Hf178m		71.7	97.1	
		W180(n,γ)W181(n,α)Hf178m		28.3	2.7	
		W180(n,2n)W179(β^+)Ta179(β^+)Hf179(n,2n)Hf178m				33.7
		W180(n,2n)W179m(IT)W179(β^+)Ta179(β^+)Hf179(n,2n)Hf178m				9.2
		W182(n,α)Hf179(n,2n)Hf178m				7.3
		W182(n,2n)W181(n,2n)W180(n,2n)W179(β^+)Ta179(β^+) Hf179(n,2n)Hf178m				5.9
		W182(n,2n)W181(β^+)Ta181(n,2n)Ta180m(n,2n)Ta179(β^+) Hf179(n,2n)Hf178m				3.4
		W182(n,nα)Hf178m				3.0
		W182(n,2n)W181(n,α)Hf178m				2.9
		W182(n,2n)W181(n,2n)W180(n,2n)W179m(IT)W179(β^+)Ta179(β^+) Hf179(n,2n)Hf178m				1.6
		W182(n,α)Hf179m(IT)Hf179(n,2n)Hf178m				1.2
		W182(n,2n)W181(β^+)Ta181(n,3n)Ta179(β^+)Hf179(n,2n)Hf178m				1.2
W183m	5.25s	W182(n,γ)W183m	91.2	100.0	7.2	
		W180(n,γ)W181(β^+)Ta181(n,γ)Ta182(n,γ)Ta183(β^-)W183m	5.5			
		W180(n,γ)W181(β^+)Ta181(n,γ)Ta182m(IT)Ta182(n,γ) Ta183(β^-)W183m	3.1			
		W183(n,n$'$)W183m			91.5	1.4
		W184(n,2n)W183m				96.9
W185m	1.67m	W184(n,γ)W185m	71.4	98.2	98.8	
		W183(n,γ)W184(n,γ)W185m	15.7	1.8		
		W182(n,γ)W183(n,γ)W184(n,γ)W185m	12.9			
		W184(n,γ)W185(n,n$'$)W185m			1.0	
		W186(n,2n)W185m				99.8
Re188	16.98h	W186(n,γ)W187(β^-)Re187(n,γ)Re188	94.3	95.3	81.3	
		W186(n,γ)W187(β^-)Re187(n,γ)Re188m(IT)Re188	3.1	4.6	18.6	
Ir194	19.30h	W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	20.6			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194	20.2			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	14.3			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192(n,γ)Ir193(n,γ)Ir194	14.1			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ) Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT) Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	2.5			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ) Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT) Ir192(n,γ)Ir193(n,γ)Ir194	2.4			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ) Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192(n,γ) Ir193m(IT)Ir193(n,γ)Ir194	1.7			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ) Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192(n,γ) Ir193(n,γ)Ir194	1.7			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	1.7			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194	1.7			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	1.2			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194	1.2			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ir194	cont.	W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(n,E)Ir193(n,γ)Ir194	1.2			
W187	23.85h	W186(n,γ)W187	97.0	100.0	100.0	100.0
		W184(n,γ)W185(β^-)Re185(n,γ)Re186(β^+)W186(n,γ)W187	1.9			
Re186	3.75d	W184(n,γ)W185(β^-)Re185(n,γ)Re186	78.7	98.3	93.1	
		W183(n,γ)W184(n,γ)W185(β^-)Re185(n,γ)Re186	12.8			
		W182(n,γ)W183(n,γ)W184(n,γ)W185(β^-)Re185(n,γ)Re186	8.3			
		W184(n,γ)W185m(IT)W185(β^-)Re185(n,γ)Re186			6.2	
		W186(n,γ)W187(β^-)Re187(n,2n)Re186				82.7
		W186(n,2n)W185(β^-)Re185(n,γ)Re186				9.3
		W186(n,2n)W185m(IT)W185(β^-)Re185(n,γ)Re186				6.1
Re184	35.40d	W186(n,2n)W185(β^-)Re185(n,2n)Re184				54.5
		W186(n,2n)W185m(IT)W185(β^-)Re185(n,2n)Re184				35.9
		W186(n,2n)W185(β^-)Re185(n,2n)Re184m(IT)Re184				5.3
		W186(n,2n)W185m(IT)W185(β^-)Re185(n,2n)Re184m(IT)Re184				3.5
Ir192	73.80d	W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	45.1			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	31.5			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	5.5			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	3.8			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	3.7			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	2.6			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188m(IT)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	1.5			
		W186(n,γ)W187(β^-)Re187(n,γ)Re188m(IT)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	1.0			
W185	75.12d	W184(n,γ)W185	74.7	97.7	93.6	
		W183(n,γ)W184(n,γ)W185	14.4	1.5		
		W182(n,γ)W183(n,γ)W184(n,γ)W185	10.7			
		W184(n,γ)W185m(IT)W185			6.3	
		W186(n,2n)W185				60.2
		W186(n,2n)W185m(IT)W185				39.7
Ta182	114.71d	W180(n,γ)W181(β^+)Ta181(n,γ)Ta182	63.7	63.7	58.1	
		W180(n,γ)W181(β^+)Ta181(n,γ)Ta182m(IT)Ta182	36.2	36.2	40.3	
		W182(n,p)Ta182				47.3
		W182(n,p)Ta182m(IT)Ta182				38.0
		W182(n,p)Ta182n(IT)Ta182m(IT)Ta182				3.2
		W183(n,2n)W182(n,p)Ta182				2.7
		W183(n,2n)W182(n,p)Ta182m(IT)Ta182				2.2
W181	120.99d	W180(n,γ)W181	100.0	100.0	100.0	
		W182(n,2n)W181				93.8
		W183(n,2n)W182(n,2n)W181				5.3
Re184m	168.01d	W186(n,2n)W185(β^-)Re185(n,2n)Re184m				60.1
		W186(n,2n)W185m(IT)W185(β^-)Re185(n,2n)Re184m				39.6
Ta179	1.61y	W180(n,2n)W179(β^+)Ta179				47.7
		W182(n,2n)W181(n,2n)W180(n,2n)W179(β^+)Ta179				15.8
		W180(n,2n)W179m(IT)W179(β^+)Ta179				13.1
		W182(n,2n)W181(β^+)Ta181(n,2n)Ta180m(n,2n)Ta179				12.2
		W182(n,2n)W181(n,2n)W180(n,2n)W179m(IT)W179(β^+)Ta179				4.3
		W182(n,2n)W181(β^+)Ta181(n,3n)Ta179				3.1
		W182(n,2n)W181(β^+)Ta181(n,2n)Ta180(β^-)W180(n,2n)W179(β^+)Ta179				2.1
H3	12.33y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hf178n	31.00y	W180(n,γ)W181(n,α)Hf178n	99.9	89.1	17.5	
		W180(n,α)Hf177(n,γ)Hf178n		10.9	82.4	
Pt193	50.00y	no pathways found				
Re186m	2.0 10^5y	W184(n,γ)W185(β^-)Re185(n,γ)Re186m	81.0	98.6	93.6	
		W183(n,γ)W184(n,γ)W185(β^-)Re185(n,γ)Re186m	11.8			
		W182(n,γ)W183(n,γ)W184(n,γ)W185(β^-)Re185(n,γ)Re186m	7.0			
		W184(n,γ)W185m(IT)W185(β^-)Re185(n,γ)Re186m			6.3	
Re187	4.4 10^{10}y	W186(n,γ)W187(β^-)Re187	98.0	100.0	100.0	

Rhenium

Isotope	Atom % abundance
Re185	37.40
Re187	62.60

($T_{1/2}$ =4.4 10^{10}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.83E+15	3.81E+15	1.28E+15	1.61E+13	3.20E+08	3.02E+08
Re186	50.5	50.7	76.9		48.7	49.8
Re188	40.5	40.5	3.4			
Re184	5.4	5.4	15.2	44.8		
Re188m	1.6	1.3				
Re184m	0.9	0.9	2.6	46.3		
Os185	0.5	0.5	1.4	7.7		
W185	0.1	0.1	0.4	1.1		
Re186m					48.7	49.8
H3					2.3	

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.58E-01	3.57E-01	9.74E-02	1.90E-03	1.21E-08	1.17E-08
Re188	58.0	58.0	6.0			
Re186	30.9	31.0	57.9		73.6	73.6
Re184	8.9	8.9	30.8	58.5		
Re184m	0.8	0.8	2.9	33.4		
Os185	0.6	0.6	2.2	7.7		
Re186m					26.3	26.4

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	5.05E+04	5.04E+04	3.78E+04	1.76E+03	7.28E-05	7.04E-05
Re184	70.3	70.3	88.2	69.9		
Re188	20.0	20.0	0.7			
Os185	4.5	4.5	5.9	8.7		
Re184m	3.3	3.3	4.4	21.2		
Re186m					51.2	51.3
Re186	0.9	0.9	0.6		48.7	48.7

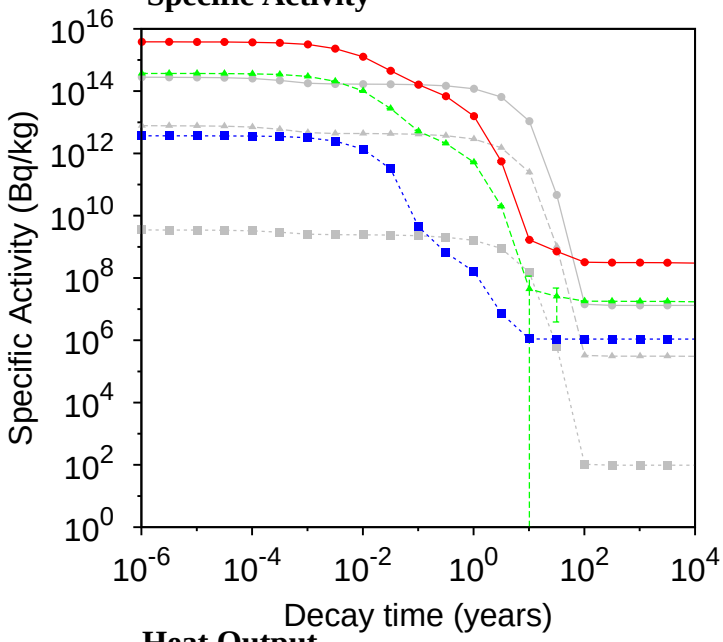
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	5.34E+06	5.33E+06	1.79E+06	1.91E+04	5.77E-01	5.57E-01
Re186	54.2	54.3	82.3		40.5	40.5
Re188	40.6	40.5	3.4			
Re184	3.9	3.9	10.9	37.7		
Re184m	0.9	0.9	2.8	58.5		
Os185	0.2	0.2	0.5	3.3		
Re186m					59.4	59.5

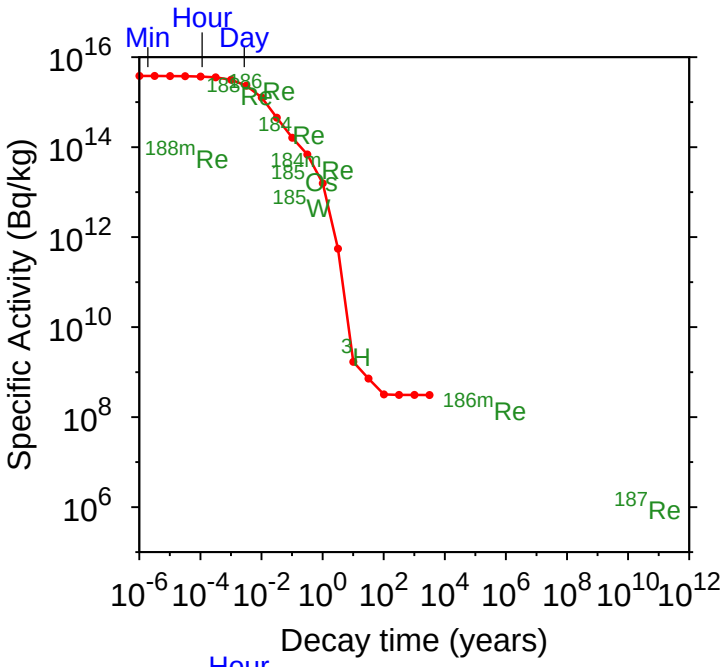
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.61E+06	3.60E+06	1.72E+06	6.43E+04	2.04E+00	1.97E+00
Re186	58.9	58.9	62.8		8.4	8.4
Re188	23.2	23.1	1.4			
Re184	10.9	10.9	21.5	21.3		
Re184m	6.1	6.1	12.5	75.4		
Os185	0.8	0.8	1.7	3.1		
Re186m					91.5	91.6

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.45E+11	2.44E+11	2.11E+11	1.09E+10	1.16E+04	1.11E+04
Re184	76.9	77.3	84.0	60.2		
Os185	7.5	7.5	8.5	11.3		
Re188	6.3	6.3	0.2			
Re184m	5.5	5.5	6.3	27.4		
Re188m	2.1	1.7				
Ta182	0.4	0.5	0.5	1.1		
Re186m					89.7	90.0
Re187					8.3	8.6
Re186	0.8	0.8	0.5		1.3	1.4

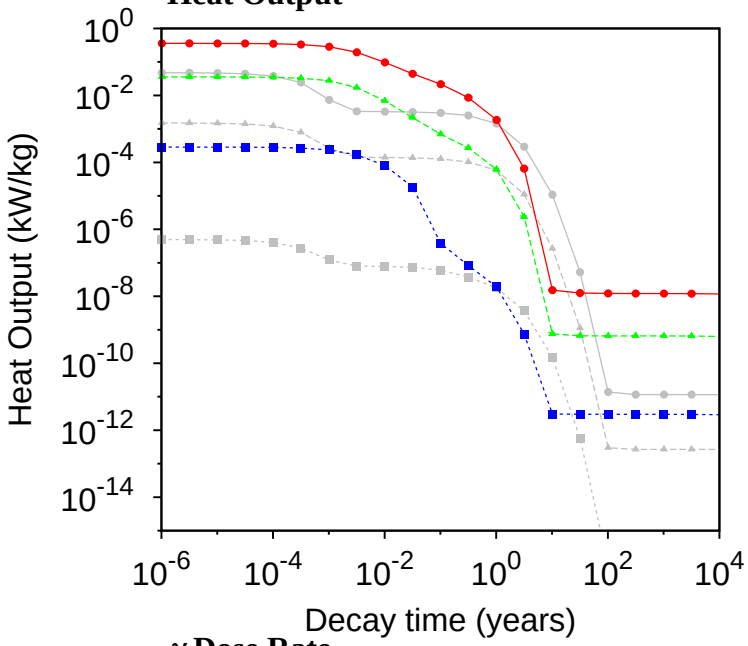
Rhenium activation characteristics

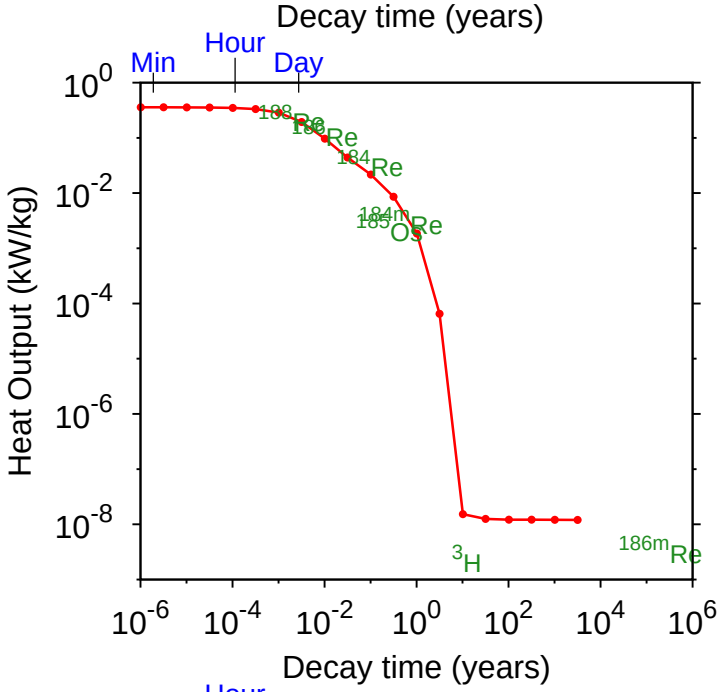
Specific Activity



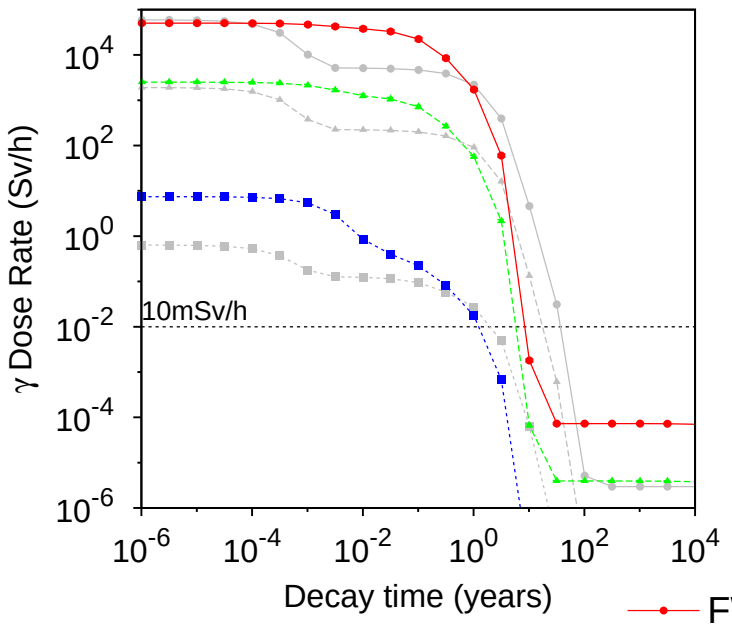


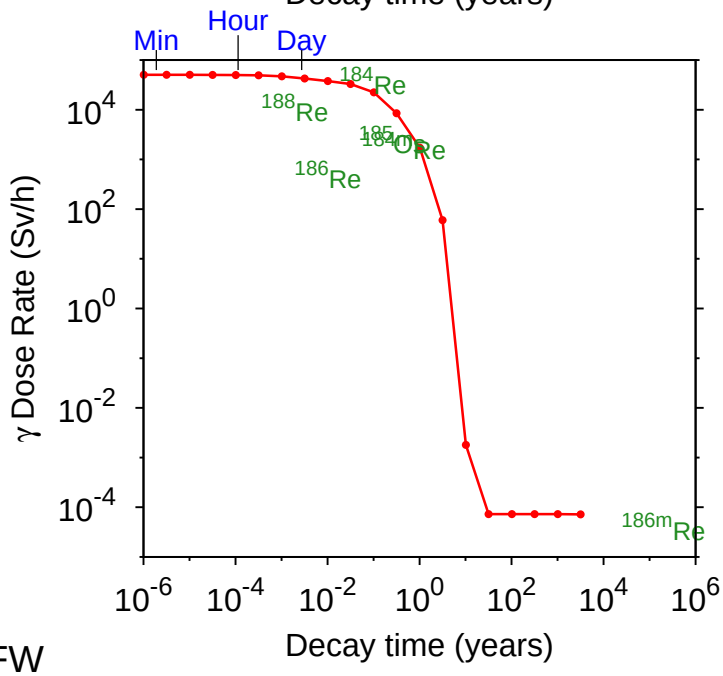
Heat Output





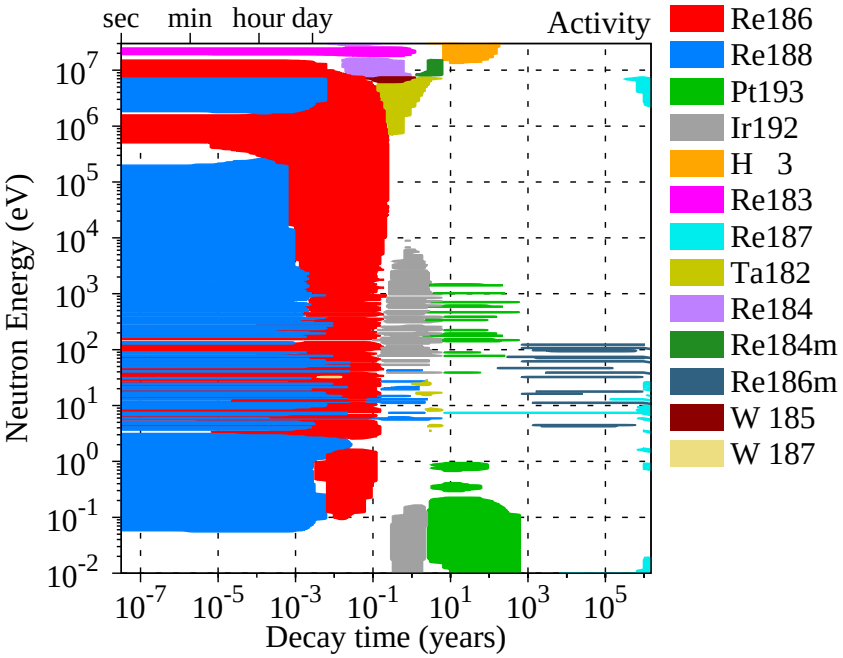
γ Dose Rate

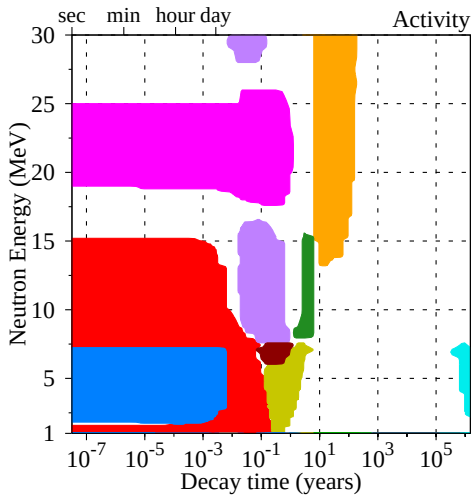


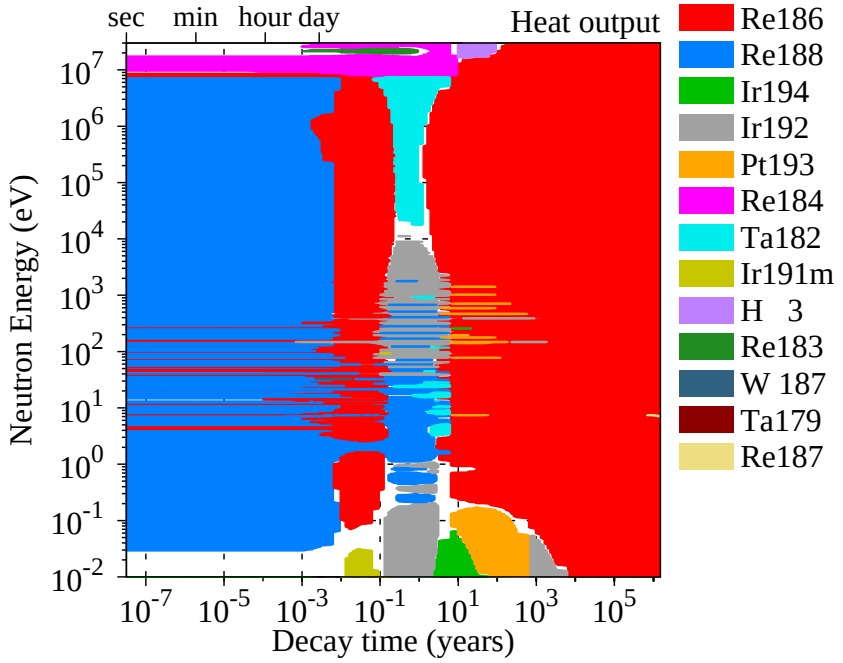


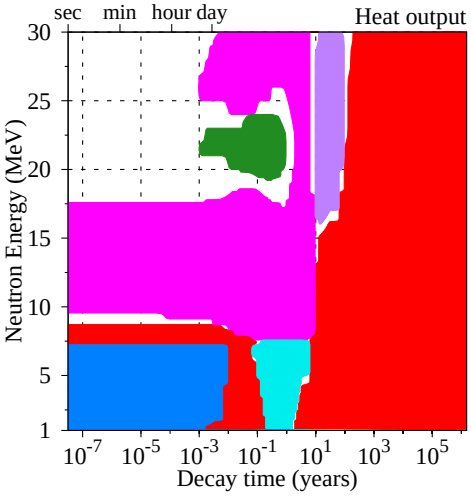
FW
Blanket
Manifold
Fe results

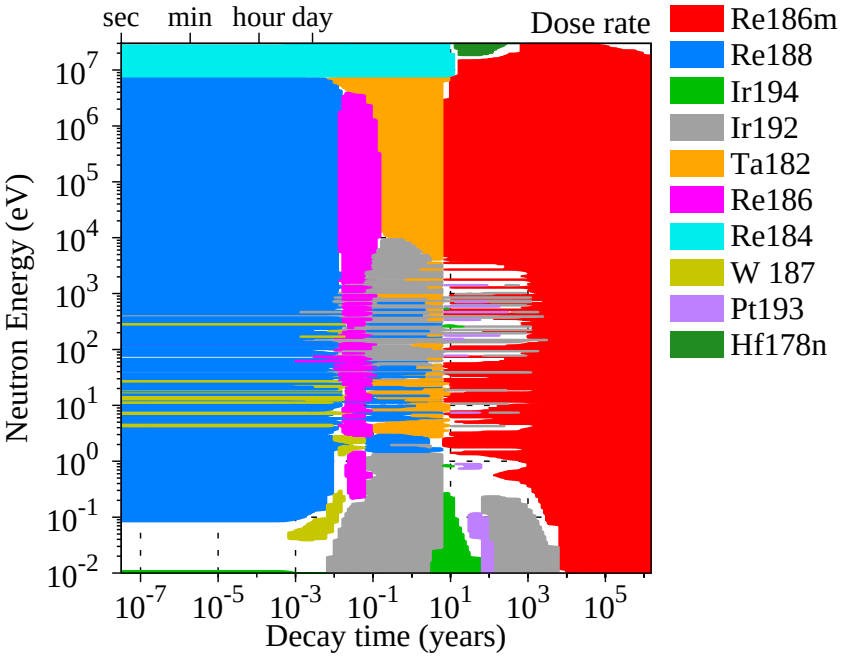
Rhenium Importance diagrams

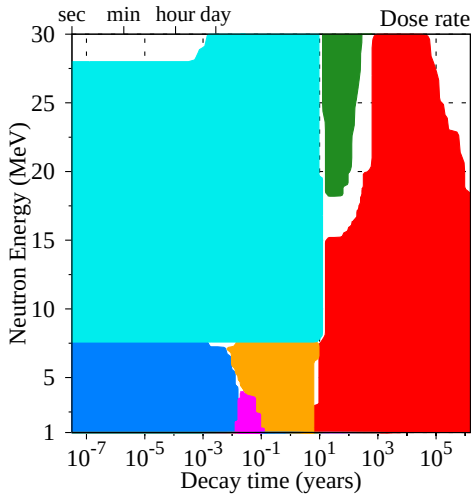




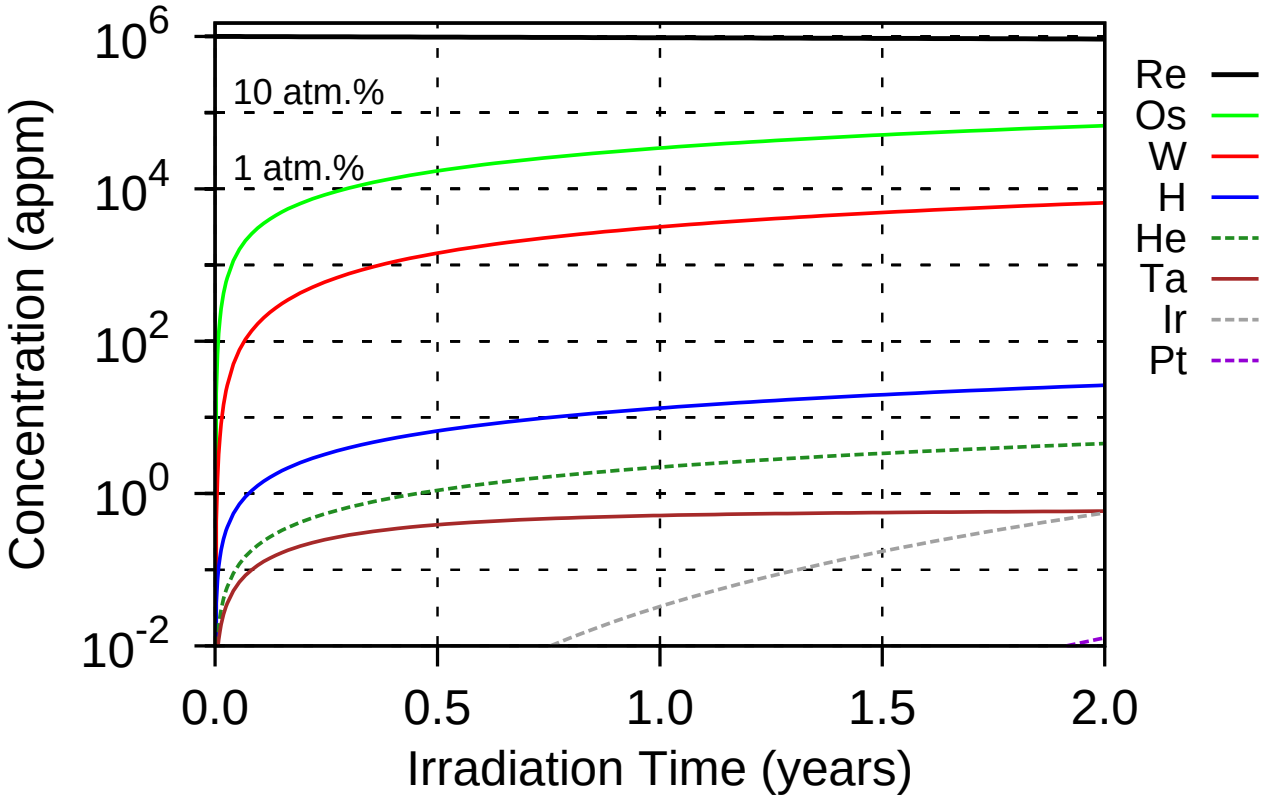






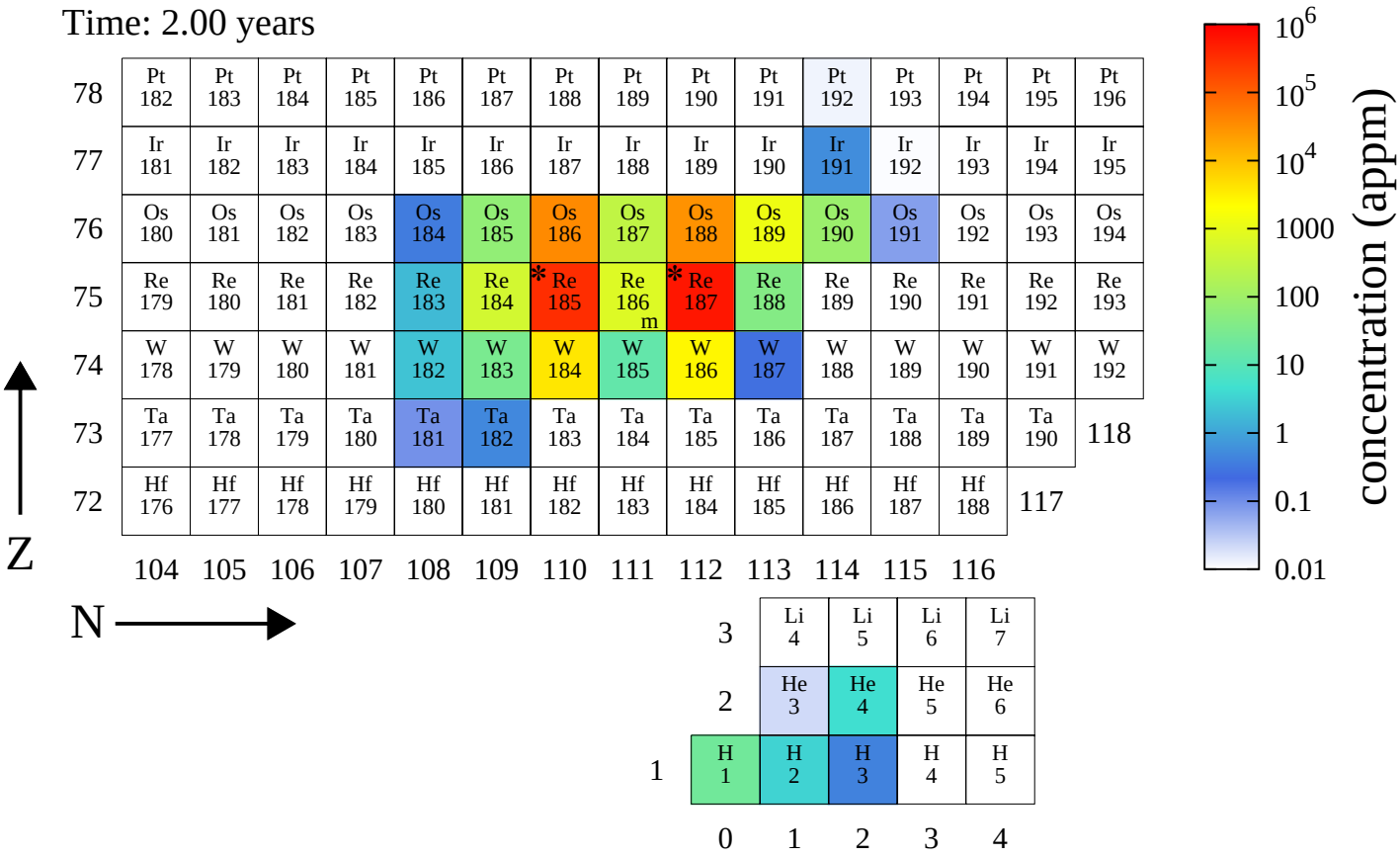


Rhenium FW Transmutation

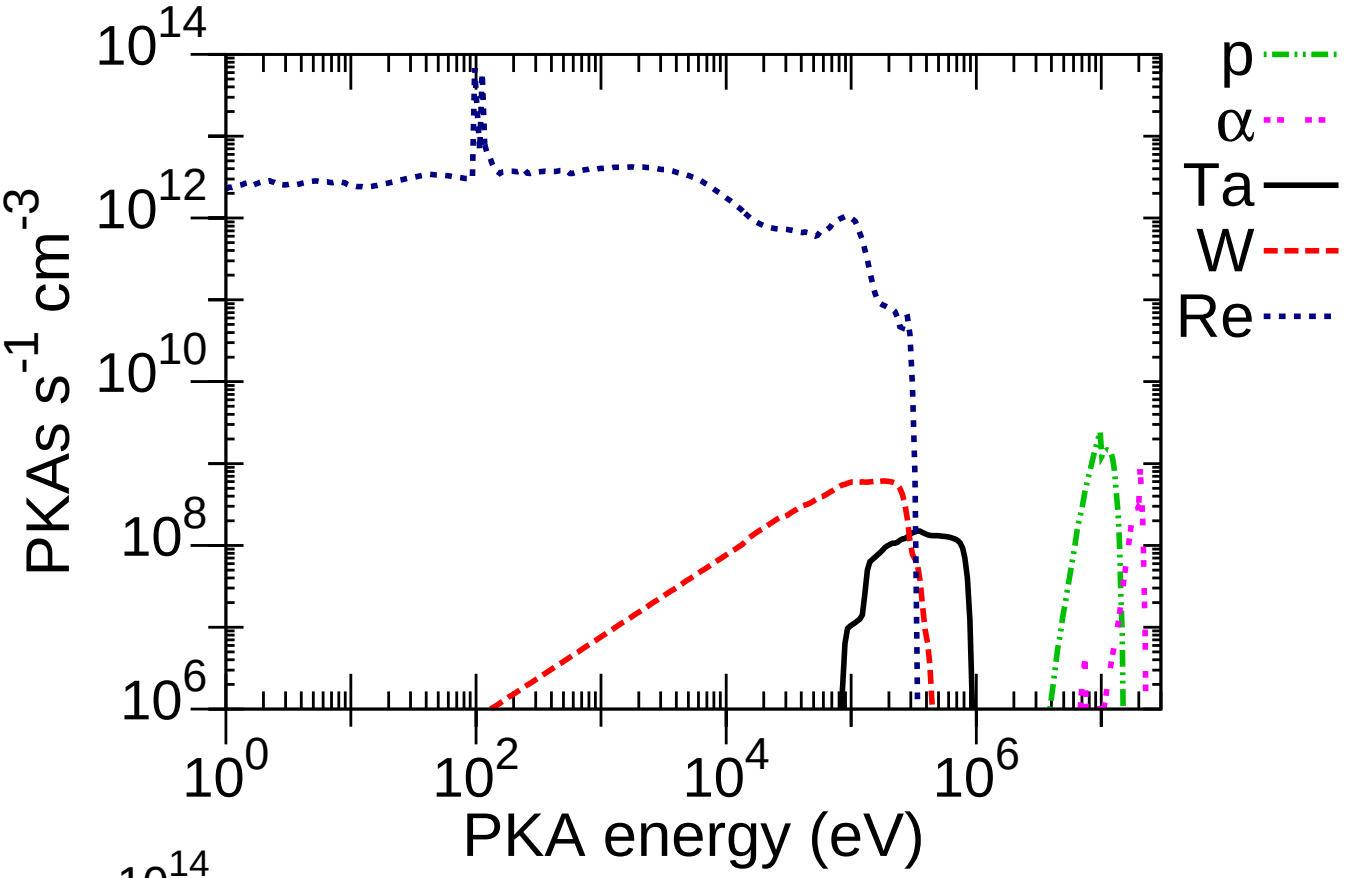


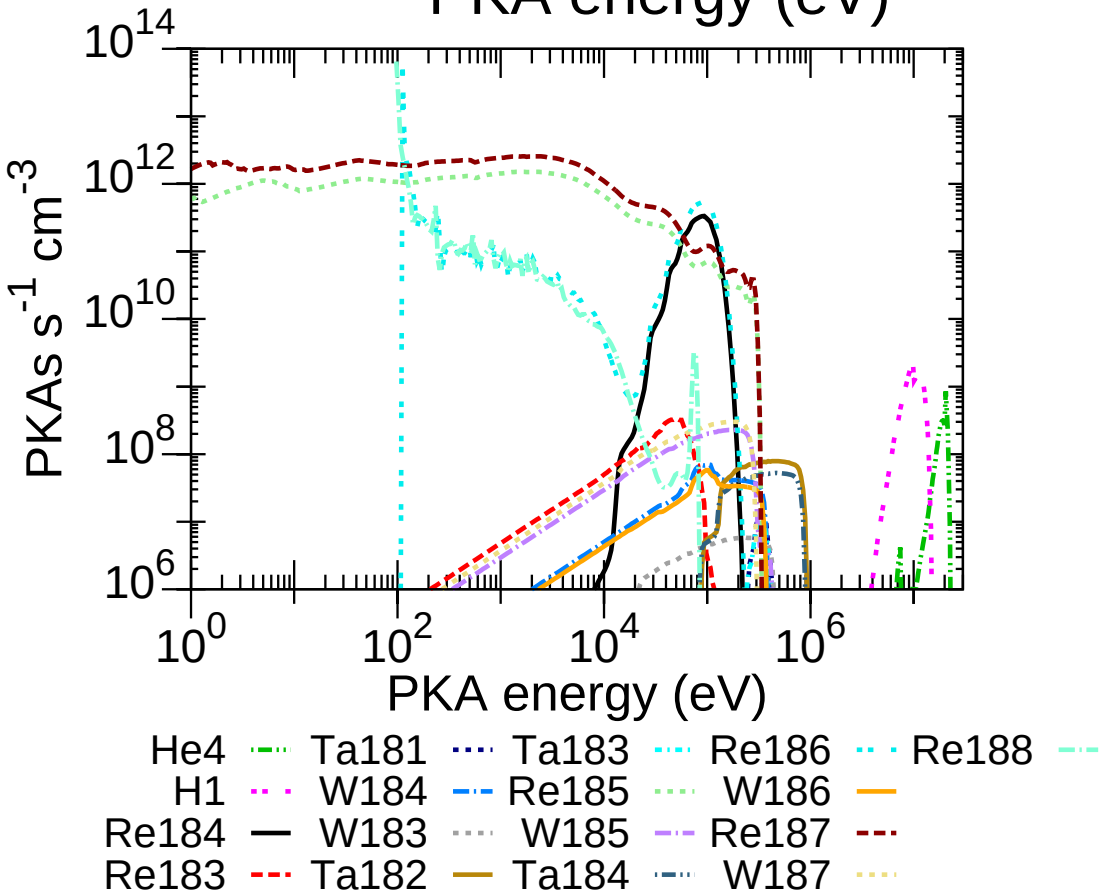
2 appm He & 13 appm H after 1 year

13 dpa/year



Rhenium FW PKA distributions





Rhenium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ir191m	4.90s	Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m	57.5	69.1		
		Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m	21.4			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191(β^-)Ir191m	7.0	12.7		
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m	4.7	9.3		
		Re187(n,γ)Re188m(IT)Re188(β^-)Os188(n,γ)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m	1.9	3.3		
		Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189m(IT)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m	1.8			
		Re187(n,γ)Re188(n,γ)Re189(β^-)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m		1.9		
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT)Os189(n,γ) Os190(n,γ)Os191(β^-)Ir191m		1.7		
Re188m	18.60m	Re187(n,γ)Re188m	67.4	100.0	100.0	100.0
		Re185(n,γ)Re186(β^+)W186(n,γ)W187(β^-)Re187(n,γ)Re188m	29.1			
		Re185(n,γ)Re186(n,γ)Re187(n,γ)Re188m	3.1			
Re188	16.98h	Re187(n,γ)Re188	65.3	95.4	81.4	8.1
		Re185(n,γ)Re186(β^+)W186(n,γ)W187(β^-)Re187(n,γ)Re188	28.1			
		Re185(n,γ)Re186(n,γ)Re187(n,γ)Re188	3.0			
		Re187(n,γ)Re188m(IT)Re188	2.2	4.6	18.6	91.8
Ir194	19.30h	Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT) Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	16.0			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT) Ir192(n,γ)Ir193(n,γ)Ir194	15.4			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192(n,γ) Ir193m(IT)Ir193(n,γ)Ir194	11.1			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192(n,γ) Ir193(n,γ)Ir194	10.8			
		Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	5.3			
		Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194	5.2			
		Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	3.7			
		Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194	3.6			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(n,γ)Os192(n,γ)Os193(β^-)Ir193(n,γ)Ir194	2.1			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192(n,γ) Ir193m(IT)Ir193(n,γ)Ir194	1.9			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192(n,γ) Ir193(n,γ)Ir194	1.9			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192(n,γ)Ir193m(IT) Ir193(n,γ)Ir194	1.3			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT) Ir192(n,γ)Ir193m(n,γ)Ir194	1.3			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	1.3			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ir194	cont.	Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194	1.3			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194	1.3			
W187	23.85h	Re185(n,γ)Re186(β^+)W186(n,γ)W187	100.0	99.9	99.4	
		Re187(n,p)W187				99.6
Re186	3.75d	Re185(n,γ)Re186	99.9	99.8	98.9	
		Re185(n,γ)Re186m(n,E)Re186			1.0	
		Re187(n,2n)Re186				98.9
		Re187(n,2n)Re186m(n,E)Re186				1.0
Re184	35.40d	Re185(n,2n)Re184				85.4
		Re185(n,2n)Re184m(IT)Re184				12.3
Re183	70.00d	Re185(n,2n)Re184(n,2n)Re183				39.6
		Re185(n,2n)Re184m(n,2n)Re183				37.2
		Re185(n,3n)Re183				15.5
		Re185(n,2n)Re184m(IT)Re184(n,2n)Re183				5.5
Ir192	73.80d	Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	34.0	38.9		
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	23.8	29.3		
		Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192	12.4			
		Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192	8.7			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	4.1	7.1		
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	2.9	5.4		
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192	2.8	5.2		
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	2.0	3.9		
		Re187(n,γ)Re188m(IT)Re188(β^-)Os188(n,γ)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192	1.1	1.9		
		Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189m(IT)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	1.0			
		Re187(n,γ)Re188(n,γ)Re189(β^-)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192		1.6		
		Re187(n,γ)Re188m(IT)Re188(β^-)Os188(n,γ)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192		1.4		
		Re187(n,γ)Re188(n,γ)Re189(β^-)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192		1.2		
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT)Os189(n,γ) Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192		1.0		
W185	75.12d	Re187(n,γ)Re188(β^-)Os188(n,α)W185	59.1	90.8	59.7	
		Re187(n,γ)Re188m(IT)Re188(β^-)Os188(n,α)W185	2.0	4.3	13.6	
		Re187(n,γ)Re188(β^-)Os188(n,α)W185m(IT)W185	1.5	3.0	5.4	
		Re185(n,p)W185			17.5	10.1
		Re185(n,p)W185m(IT)W185			1.3	4.5
		Re187(n,γ)Re188m(IT)Re188(β^-)Os188(n,α)W185m(IT)W185			1.2	
		Re187(n,α)Ta184(β^-)W184(n,γ)W185			1.0	
		Re187(n,2n)Re186(β^+)W186(n,2n)W185				50.5
		Re187(n,2n)Re186(β^+)W186(n,2n)W185m(IT)W185				33.3
Os185	93.80d	Re187(n,2n)Re186(β^-)Os186(n,2n)Os185				99.5
Ta182	114.71d	Re185(n,α)Ta182	66.7	66.0	61.1	36.6
		Re185(n,α)Ta182m(IT)Ta182	33.2	33.8	38.1	43.0
		Re185(n,α)Ta182n(IT)Ta182m(IT)Ta182				18.8
Re184m	168.01d	Re185(n,2n)Re184m				98.8
Ta179	1.61y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
H3	12.33y	Re185(n,t)H3				20.4
		Re187(n,t)H3				15.8
Hf178n	31.00y	no pathways found				
Pt193	50.00y	Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT) Ir192(β^-)Pt192(n,γ)Pt193	36.4			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192(β^-) Pt192(n,γ)Pt193	25.4			
		Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192(β^-)Pt192(n,γ)Pt193	9.7			
		Re185(n,γ)Re186(β^-)Os186(n,γ)Os187(n,γ)Os188(n,γ) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192(β^-)Pt192(n,γ)Pt193	6.7			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192(β^-) Pt192(n,γ)Pt193	4.4			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189(n,γ)Os190(n,γ) Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192(β^-)Pt192(n,γ)Pt193	3.1			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192(β^-)Pt192(n,γ)Pt193	3.0			
		Re187(n,γ)Re188(β^-)Os188(n,γ)Os189m(IT)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192(β^-)Pt192(n,γ)Pt193	2.1			
		Re187(n,γ)Re188m(IT)Re188(β^-)Os188(n,γ)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192(β^-)Pt192(n,γ)Pt193	1.2			
Re186m	2.0 10^5y	Re185(n,γ)Re186m	100.0	100.0	100.0	
		Re187(n,2n)Re186m				99.7
Re187	4.4 10^{10}y	Re185(n,γ)Re186(β^+)W186(n,γ)W187(β^-)Re187	29.1			
		Re185(n,γ)Re186(n,γ)Re187	3.1			

Osmium

Isotope	Atom % abundance	
Os184	0.02	($T_{1/2}$ =5.6 10^{13}y)
Os186	1.59	($T_{1/2}$ =2.0 10^{15}y)
Os187	1.60	
Os188	13.29	
Os189	16.21	
Os190	26.36	
Os192	40.93	

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.32E+15	1.28E+15	7.23E+14	2.68E+12	2.74E+09	6.14E+04
Ir191m	27.7	28.5	43.7			
Os191	27.5	28.5	43.7			
Os191m	16.1	16.5	0.3			
Os189m	10.3	10.6				
Os193	8.0	8.3	2.0			
Ir192	4.6	4.8	8.2	73.9	27.6	
Ir192m	3.2	0.3				
Ir194	1.0	1.0	0.1	0.1		
Os185	0.8	0.8	1.4	25.3		
Pt193				0.2	44.7	
Ir192n					27.6	
Re186	0.1	0.1	0.1			50.0
Re186m						50.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.83E-02	3.74E-02	2.34E-02	4.09E-04	1.54E-07	2.39E-12
Ir192	26.5	27.1	41.7	80.2	81.4	
Ir191m	26.2	26.8	36.9			
Os193	19.9	20.4	4.3			
Os191m	6.6	6.7	0.1			
Os191	5.7	5.9	8.1			
Ir194	5.0	5.1	0.3	0.1		
Os185	3.1	3.2	4.9	19.6		
Ir190	2.4	2.5	3.2			
Os189m	1.8	1.8				
Os192m	1.1					
Ir192m	1.0	0.1				
Ir192n					13.2	
Pt193					5.3	
Re186	0.2	0.2	0.2			73.6
Re186m						26.4

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	7.40E+03	7.38E+03	6.38E+03	2.31E+02	5.64E-02	1.41E-08
Ir192	61.3	61.4	68.6	63.6	99.5	
Os185	16.8	16.9	19.0	36.2		
Ir190	8.9	9.0	8.4			
Os193	6.9	6.9	1.1			
Ir191m	2.6	2.6	2.6			
Ir194	2.2	2.2	0.1			
Re186m						51.1
Re186						48.9

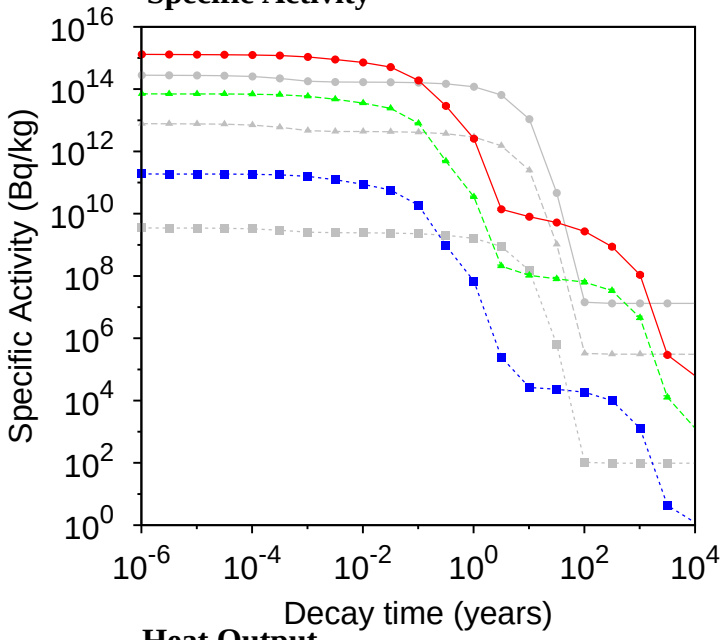
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.33E+05	4.32E+05	2.85E+05	3.14E+03	1.33E+00	1.14E-04
Os191	48.0	48.1	63.0			
Os193	19.9	19.9	4.0			
Ir192	19.8	19.8	29.0	88.4	79.5	
Os191m	4.7	4.7	0.1			
Ir194	3.9	3.9	0.3	0.1		
Os185	1.2	1.2	1.8	11.0		
Ir190	1.0	1.0	1.3			
Ir192n					17.6	
Pt193					2.9	
Re186m						59.4
Re186	0.5	0.5	0.4			40.5

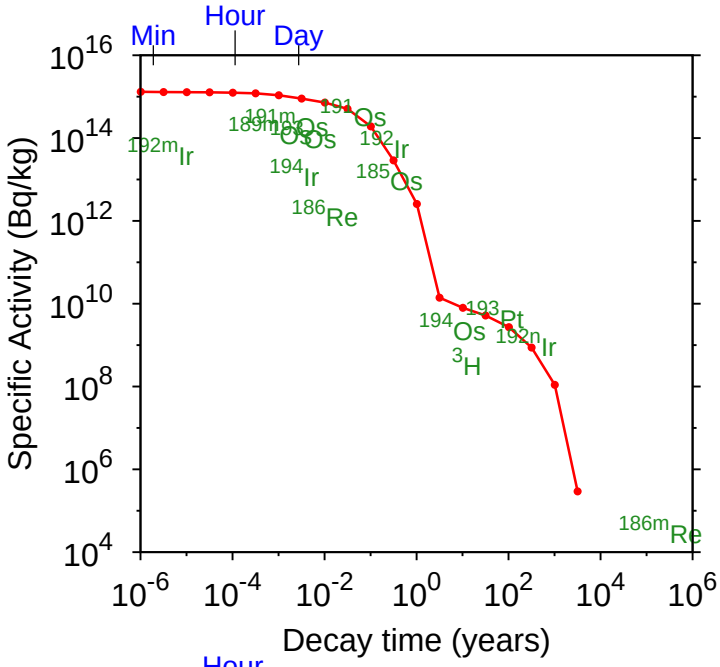
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.22E+06	1.22E+06	1.02E+06	1.44E+04	3.45E+01	4.13E-04
Os191	56.6	56.6	58.6			
Ir192	33.0	33.0	38.1	90.7	14.5	
Os193	4.5	4.5	0.7			
Os191m	2.8	2.8				
Os185	1.3	1.3	1.5	7.5		
Os194				1.3		
Ir192n				0.3	85.4	
Re186m						89.3
Re186	0.1	0.1	0.1			8.2
Os184						2.5

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.14E+11	1.11E+11	1.02E+11	2.66E+09	8.14E+05	2.08E+00
Ir192	53.3	54.8	58.1	74.4	93.0	
Ir191m	26.6	27.3	25.9			
Os185	8.8	9.1	9.7	25.5		
Ir190	3.2	3.3	3.0			
Os191	3.2	3.3	3.1			
Os192m	2.3					
Pt193					5.2	
Ir192n					1.8	
Re186m						98.4
Re186						1.5

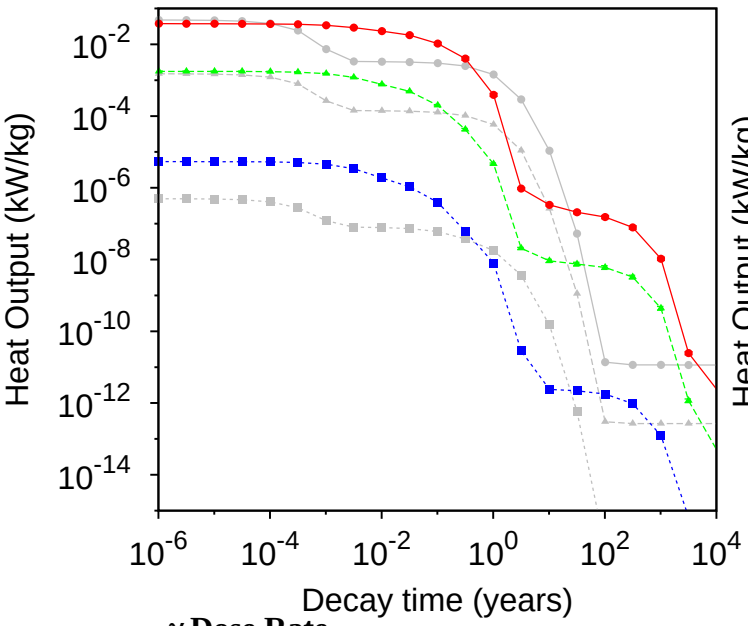
Osmium activation characteristics

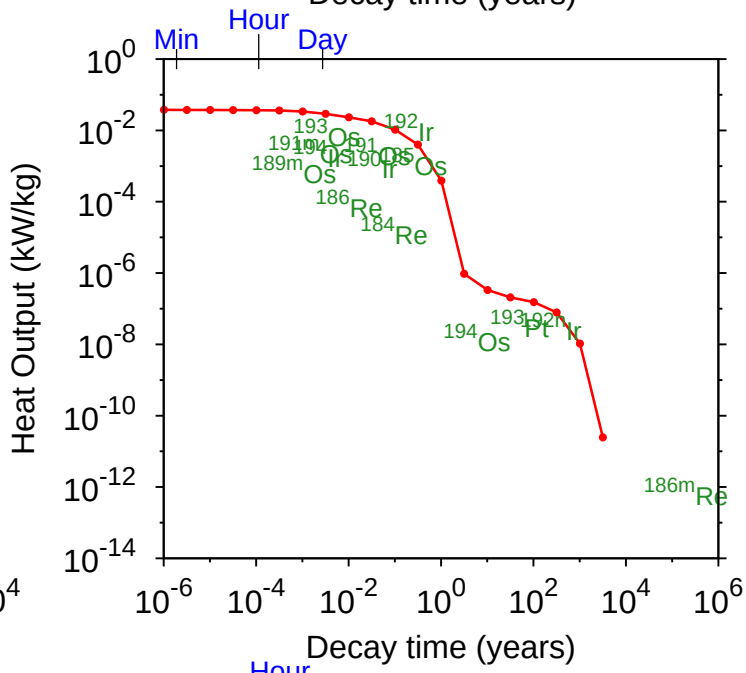
Specific Activity



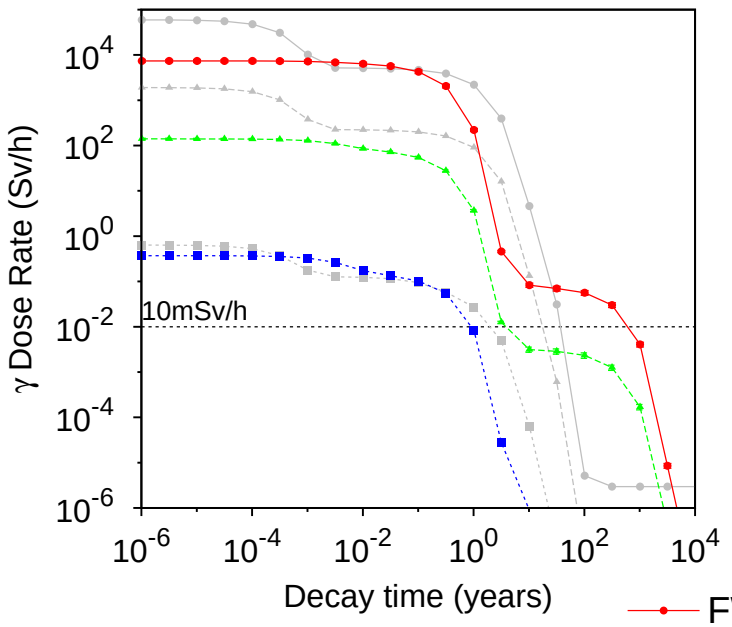


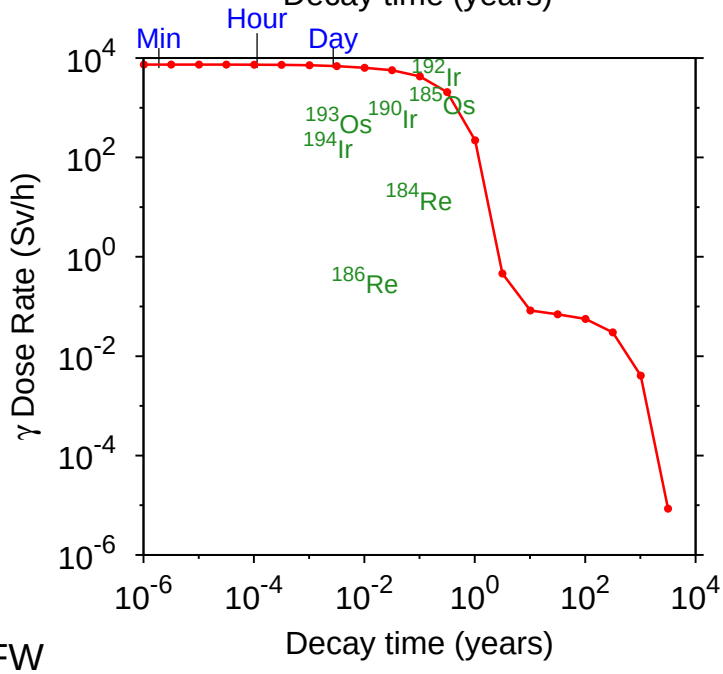
Heat Output





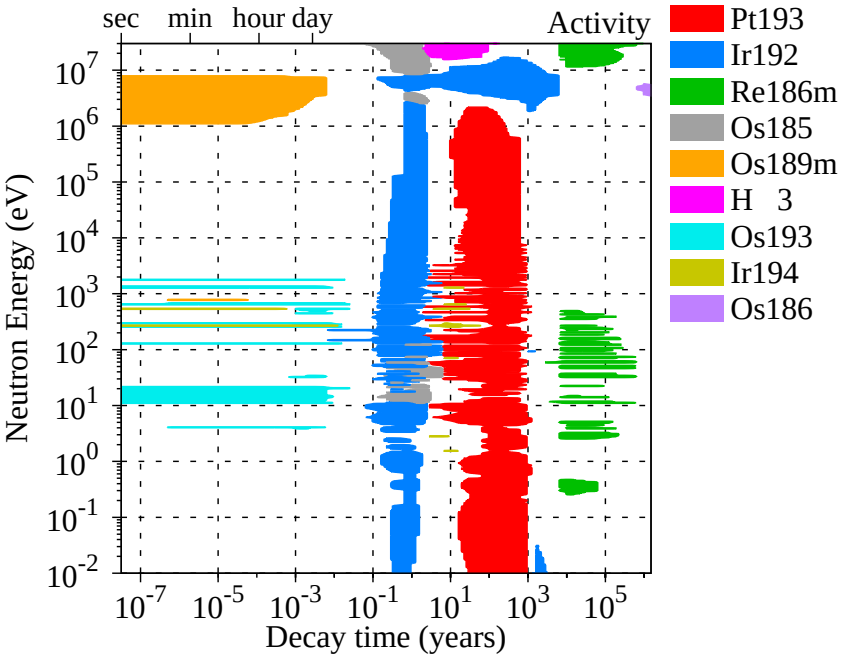
γ Dose Rate

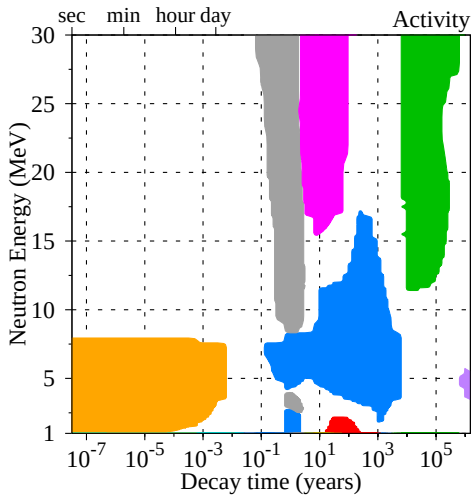


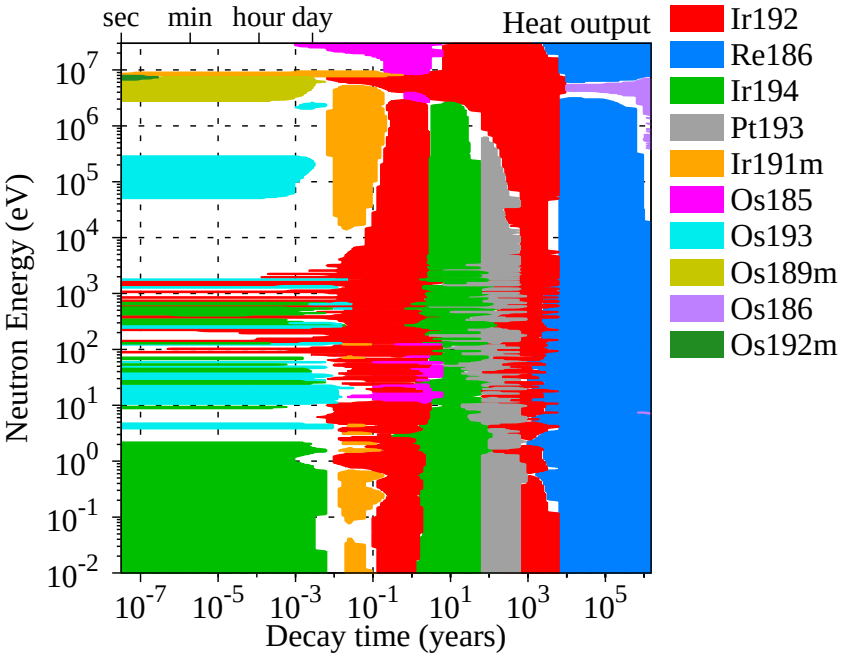


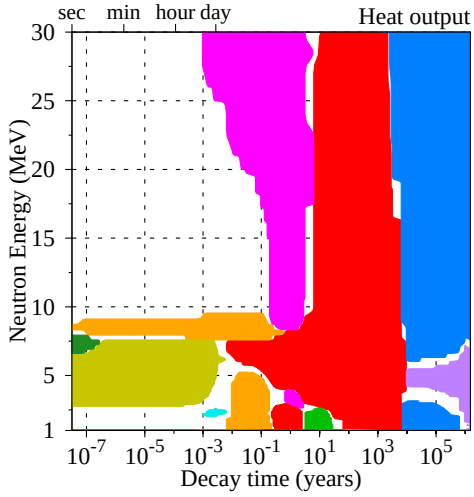
FW
Blanket
Manifold
Fe results

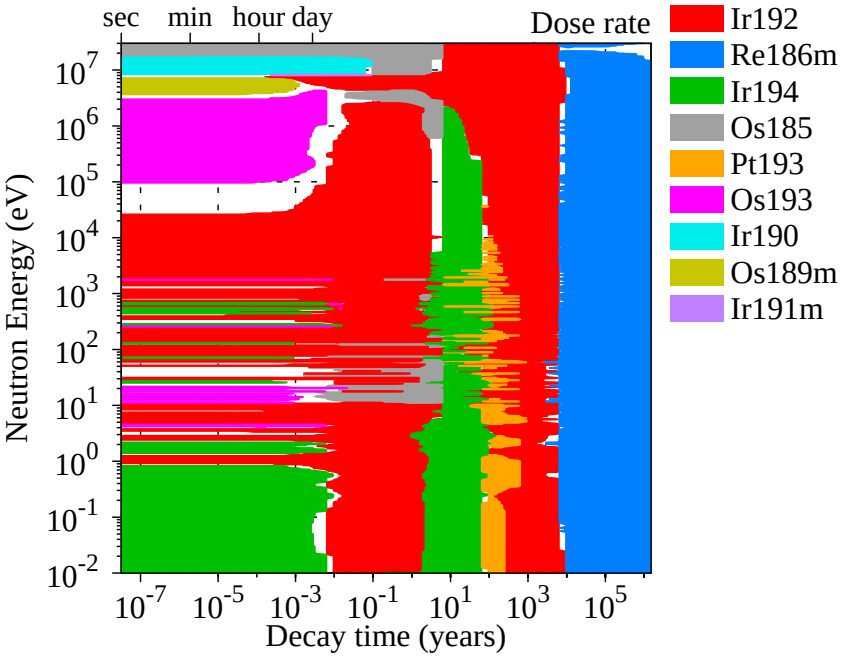
Osmium Importance diagrams

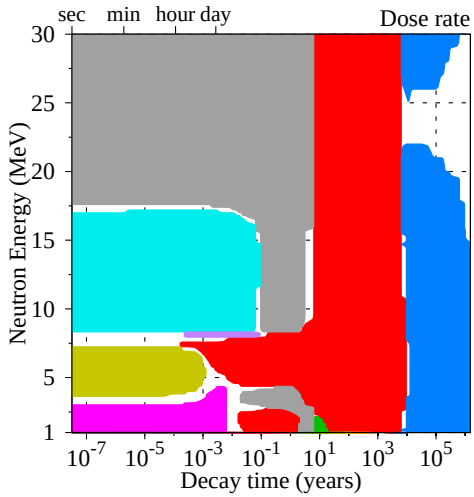




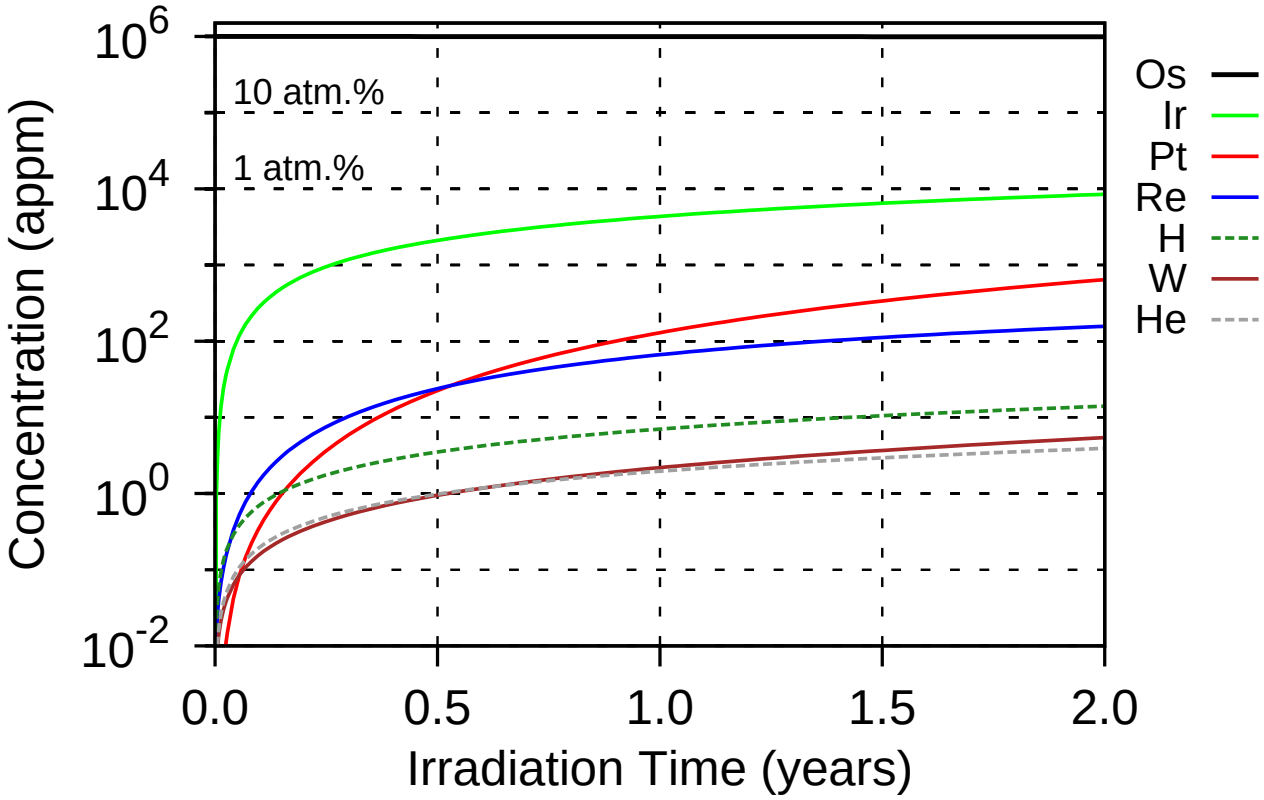






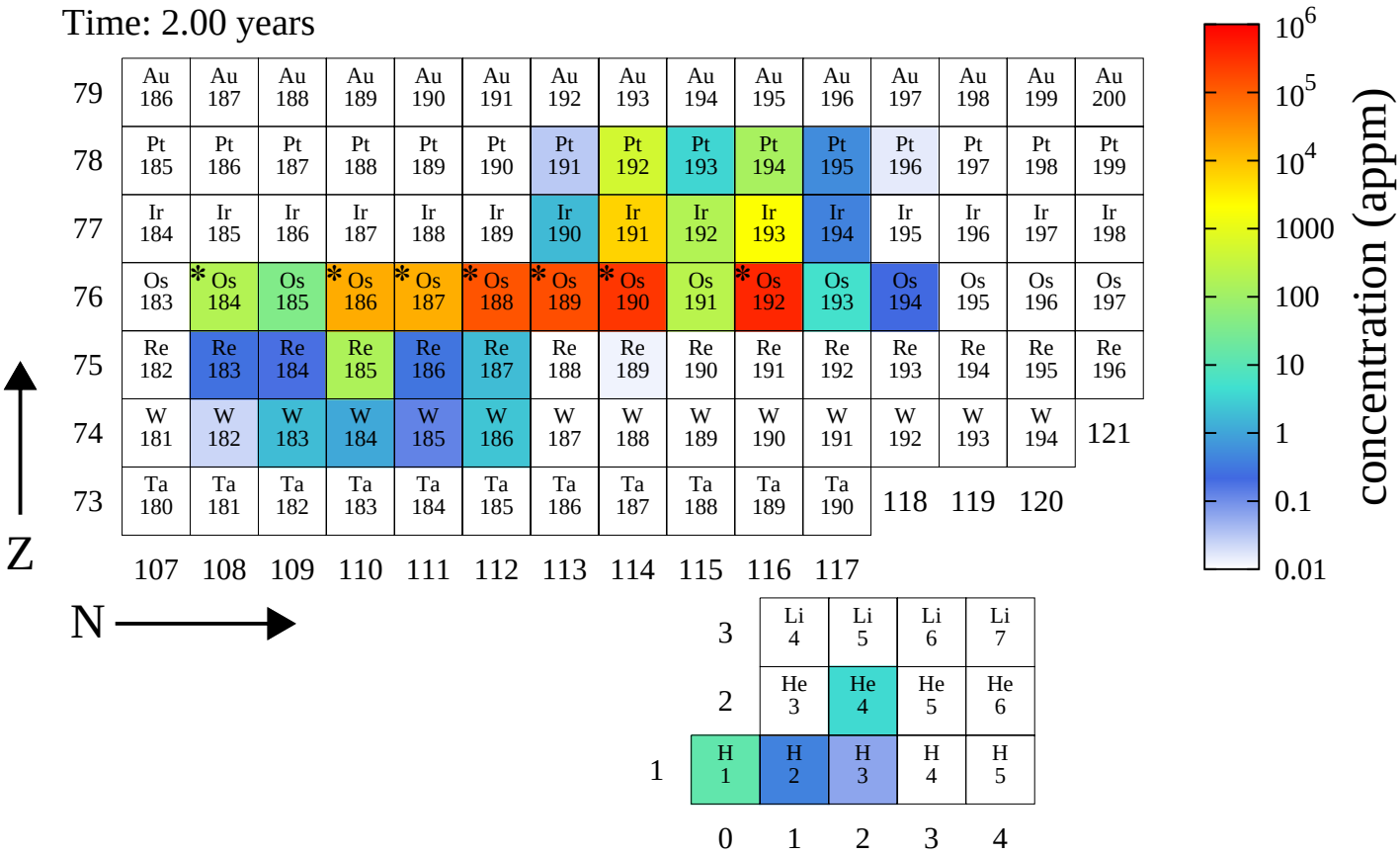


Osmium FW Transmutation

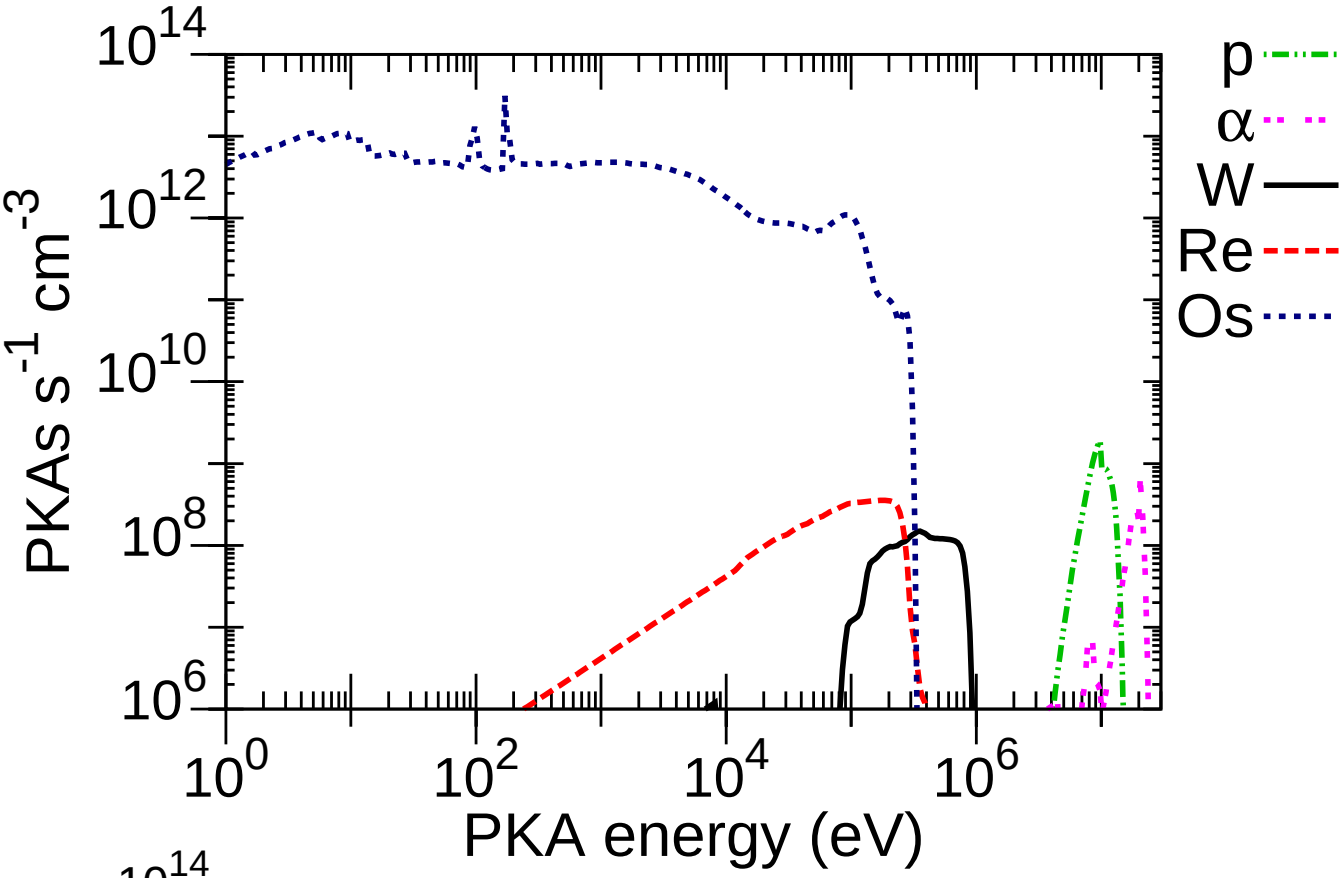


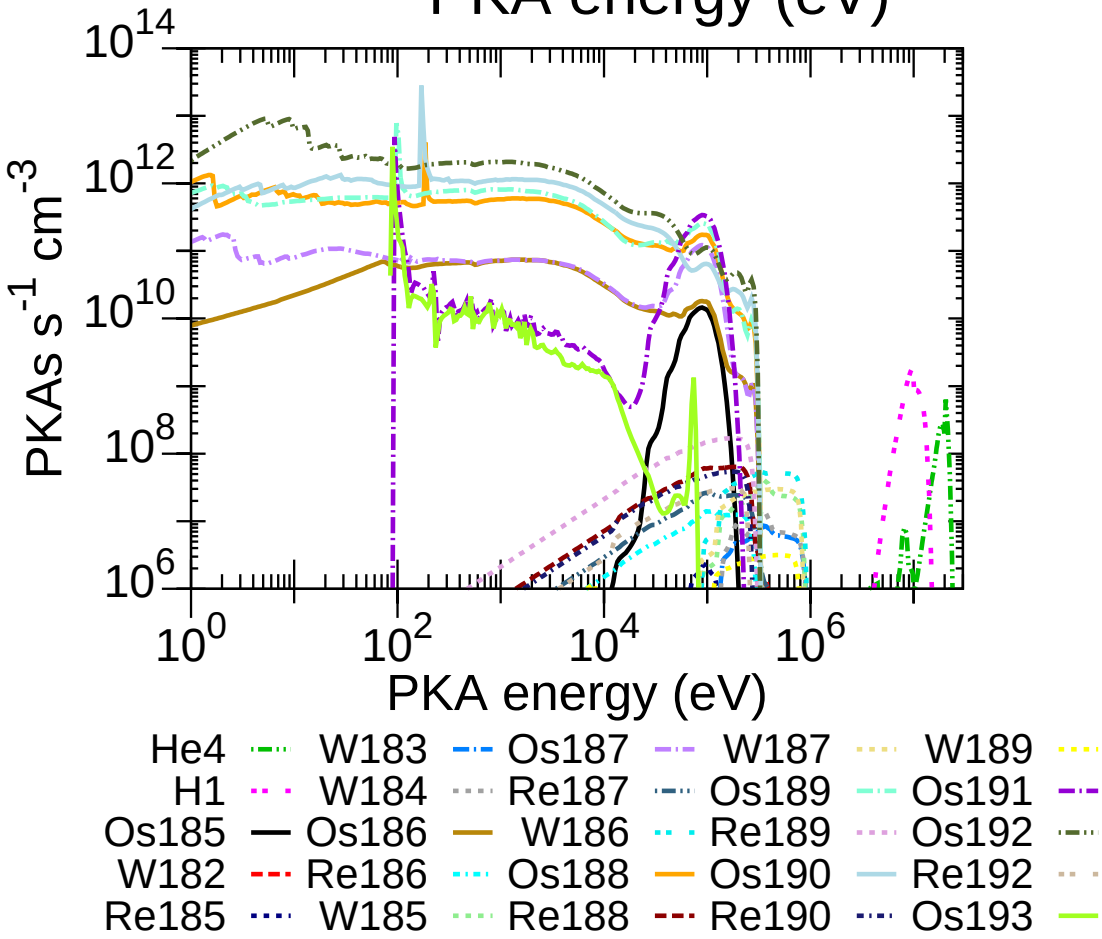
2 appm He & 7 appm H after 1 year

14 dpa/year



Osmium FW PKA distributions





Osmium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ir191m	4.90s	Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m	50.9	80.7	65.6	
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m	32.0	3.7		
		Os190(n,γ)Os191(β^-)Ir191m	6.1	14.8	34.1	
		Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m	4.9			
		Os189(n,γ)Os190(n,γ)Os191(β^-)Ir191m	3.9			
		Os192(n,2n)Os191(β^-)Ir191m				55.6
		Os192(n,2n)Os191m(IT)Os191(β^-)Ir191m				44.2
Os192m	5.90s	Os190(n,γ)Os191m(IT)Os191(n,γ)Os192m	50.9	80.7	6.3	
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(n,γ)Os192m	32.0	3.7		
		Os190(n,γ)Os191(n,γ)Os192m	6.1	14.8	3.3	
		Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(n,γ)Os192m	4.9			
		Os189(n,γ)Os190(n,γ)Os191(n,γ)Os192m	3.9			
		Os192(n,n′)Os192m			90.4	99.9
Ir192m	1.44m	Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m	51.3	82.5	65.1	
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m	31.8	1.9		
		Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m	6.2	15.1	33.9	
		Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m	4.7			
		Os189(n,γ)Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m	3.8			
		Os192(n,γ)Os193(β^-)Ir193(n,2n)Ir192m				24.0
Os189m	5.81h	Os188(n,γ)Os189m	79.5	97.2	1.7	
		Os186(n,γ)Os187(n,γ)Os188(n,γ)Os189m	10.2			
		Os187(n,γ)Os188(n,γ)Os189m	9.7			
		Os189(n,n′)Os189m		2.0	98.2	4.6
		Os190(n,2n)Os189m				93.0
Os191m	13.10h	Os190(n,γ)Os191m	56.6	95.4	99.8	
		Os189(n,γ)Os190(n,γ)Os191m	36.1	4.5		
		Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m	5.6			
		Os192(n,2n)Os191m				99.9
Ir194	19.30h	Os192(n,γ)Os193(β^-)Ir193(n,γ)Ir194	36.6	99.5	99.1	
		Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	9.2			
		Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194	8.4			
		Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	6.4			
		Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192(n,γ)Ir193(n,γ)Ir194	5.9			
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	4.8			
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194	4.4			
		Os190(n,γ)Os191m(IT)Os191(n,γ)Os192(n,γ)Os193(β^-) Ir193(n,γ)Ir194	4.0			
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	3.3			
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194	3.1			
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(n,γ)Os192(n,γ) Os193(β^-)Ir193(n,γ)Ir194	1.2			
		Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT) Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	1.1			
		Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT) Ir192(n,γ)Ir193(n,γ)Ir194	1.0			
Os193	1.25d	Os192(n,γ)Os193	83.3	100.0	100.0	99.9
		Os190(n,γ)Os191m(IT)Os191(n,γ)Os192(n,γ)Os193	10.6			
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(n,γ)Os192(n,γ)Os193	3.4			
		Os190(n,γ)Os191(n,γ)Os192(n,γ)Os193	1.3			

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Re186	3.75d	Os184(n,γ)Os185(β^+)Re185(n,γ)Re186	94.9	99.9	99.3	
		Os188(n,α)W185(β^-)Re185(n,γ)Re186	4.0			
		Os186(n,p)Re186				43.7
		Os190(n,α)W187(β^-)Re187(n,2n)Re186				12.8
		Os187(n,p)Re187(n,2n)Re186				11.2
		Os188(n,2n)Os187(n,p)Re187(n,2n)Re186				6.1
		Os187(n,2n)Os186(n,p)Re186				5.9
		Os188(n,2n)Os187(n,2n)Os186(n,p)Re186				3.2
		Os188(n,2n)Os187(n,np)Re186				2.7
		Os187(n,np)Re186				2.4
		Os188(n,2n)Os187(n,d)Re186				2.4
		Os187(n,d)Re186				2.2
		Os188(n,d)Re187(n,2n)Re186				1.5
		Os186(n,p)Re186m(n,E)Re186				1.3
Ir190	12.00d	Os192(n,2n)Os191(β^-)Ir191m(IT)Ir191(n,2n)Ir190				47.3
		Os192(n,2n)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,2n)Ir190				37.6
		Os192(n,2n)Os191(β^-)Ir191m(IT)Ir191(n,2n)Ir190m(IT)Ir190				8.0
		Os192(n,2n)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,2n) Ir190m(IT)Ir190				6.4
Os191	15.30d	Os190(n,γ)Os191m(IT)Os191	50.9	80.7	65.6	
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191	32.0	3.7		
		Os190(n,γ)Os191	6.1	14.8	34.1	
		Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191	4.9			
		Os189(n,γ)Os190(n,γ)Os191	3.9			
		Os192(n,2n)Os191				55.6
		Os192(n,2n)Os191m(IT)Os191				44.2
Ir192	73.80d	Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192	30.3	47.2	25.9	
		Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	21.2	35.5	38.9	
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192	18.7	1.0		
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192	13.0			
		Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	3.7	8.6	13.5	
		Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	2.7			
		Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	2.6	6.5	20.3	
		Os189(n,γ)Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192	2.3			
		Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192	1.9			
		Os189(n,γ)Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	1.6			
		Os192(n,n$'$)Os192m(β^-)Ir192n(n,E)Ir192				43.5
		Os192(n,γ)Os193(β^-)Ir193(n,2n)Ir192				17.8
		Os192(n,γ)Os193(β^-)Ir193(n,2n)Ir192m(IT)Ir192				2.3
		Os192(n,n$'$)Os192m(β^-)Ir192n(n,n$'$)Ir192				2.0
		Os192(n,n$'$)Os192m(β^-)Ir192n(IT)Ir192				1.4
Os185	93.80d	Os184(n,γ)Os185	100.0	100.0	100.0	
		Os186(n,2n)Os185				85.6
		Os187(n,2n)Os186(n,2n)Os185				9.5
		Os188(n,2n)Os187(n,2n)Os186(n,2n)Os185				4.5
Os194	5.99y	Os192(n,γ)Os193(n,γ)Os194	90.0	100.0	100.0	
		Os190(n,γ)Os191m(IT)Os191(n,γ)Os192(n,γ)Os193(n,γ)Os194	6.8			
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(n,γ)Os192(n,γ) Os193(n,γ)Os194	1.6			
H3	12.33y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Pt193	50.00y	Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192(β^-)Pt192(n,γ)Pt193	40.3	46.6	21.5	
		Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192(β^-)Pt192(n,γ)Pt193	28.1	35.1	32.2	
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192(β^-)Pt192(n,γ)Pt193	10.8			
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192(β^-)Pt192(n,γ)Pt193	7.5			
		Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT) Ir192(β^-)Pt192(n,γ)Pt193	4.9	8.6	11.2	
		Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192(β^-) Pt192(n,γ)Pt193	3.4	6.5	16.8	
		Os189(n,γ)Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192(β^-)Pt192(n,γ)Pt193	1.3			
		Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192(β^-)Pt192(n,γ)Pt193m(IT)Pt193		1.0	4.5	
		Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192(β^-)Pt192(n,γ)Pt193m(IT)Pt193			6.8	
		Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192(β^-) Pt192(n,γ)Pt193m(IT)Pt193			3.5	
		Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT) Ir192(β^-)Pt192(n,γ)Pt193m(IT)Pt193			2.4	
Ir192n	241.00y	Os190(n,γ)Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	51.0	63.9	2.8	
		Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	31.4	1.7		
		Os190(n,γ)Os191(n,γ)Os192m(β^-)Ir192n	6.2	11.7	1.5	
		Os188(n,γ)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(n,γ) Os192m(β^-)Ir192n	4.6			
		Os189(n,γ)Os190(n,γ)Os191(n,γ)Os192m(β^-)Ir192n	3.8			
		Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192n		18.5	34.4	
		Os190(n,γ)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192n		3.4	17.9	
		Os192(n,n′)Os192m(β^-)Ir192n			41.2	
Re186m	2.0 10^5y	Os184(n,γ)Os185(β^+)Re185(n,γ)Re186m	97.7	100.0	99.8	
		Os188(n,α)W185(β^-)Re185(n,γ)Re186m	1.8			
Os184	5.6 10^{13}y	no pathways found				
Os186	2.0 10^{15}y	Os184(n,γ)Os185(β^+)Re185(n,γ)Re186(β^-)Os186	3.4			
		Os184(n,γ)Os185(n,γ)Os186	1.0			

Iridium

Isotope	Atom % abundance
Ir191	37.30
Ir193	62.70

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	5.57E+15	4.41E+15	2.54E+15	7.28E+13	3.69E+11	3.33E+01
Ir192	39.8	50.3	84.4	98.8	24.6	0.3
Ir194	29.7	37.4	2.8			
Ir192m	20.9	2.0				
Ir190	3.5	4.4	6.3			
Ir193m	3.1	3.9	5.3			
Ir191m	1.5	0.2	0.3			
Pt193				1.0	50.9	
Ir192n				0.2	24.5	0.3
Re186						49.4
Re186m						49.4

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	6.72E-01	6.59E-01	4.07E-01	1.19E-02	1.87E-05	1.31E-15
Ir192	54.7	55.7	87.1	99.9	80.3	1.4
Ir194	35.5	36.1	2.5			
Ir190	7.2	7.4	9.7			
Ir192m	1.6	0.1				
Ir192n					13.0	0.2
Pt193					6.7	
Re186						72.4
Re186m						25.9

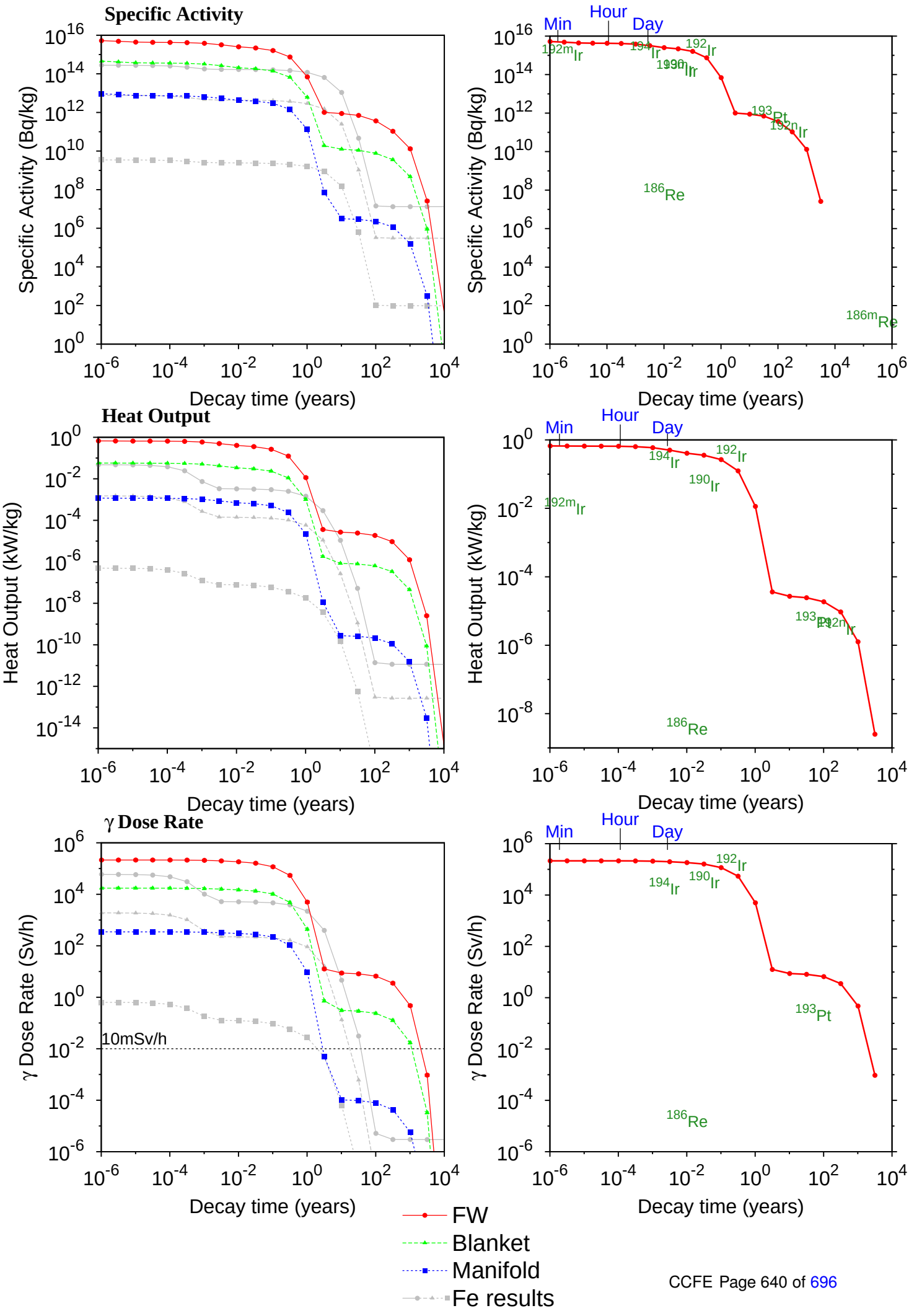
Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	2.15E+05	2.15E+05	1.84E+05	5.21E+03	6.63E+00	2.09E-11
Ir192	74.6	74.7	84.3	100.0	99.0	38.7
Ir190	15.9	15.9	15.1			
Ir194	9.2	9.2	0.5			
Re186m						41.6
Re186						19.6

Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	5.56E+06	5.55E+06	3.33E+06	1.01E+05	1.61E+02	6.11E-08
Ir192	55.9	55.9	90.1	99.9	78.9	0.3
Ir194	38.7	38.6	2.8			
Ir190	4.2	4.2	5.7			
Ir193m	0.8	0.8	1.1			
Ir192n					17.5	0.1
Pt193					3.6	
Re186m						59.3
Re186						40.4

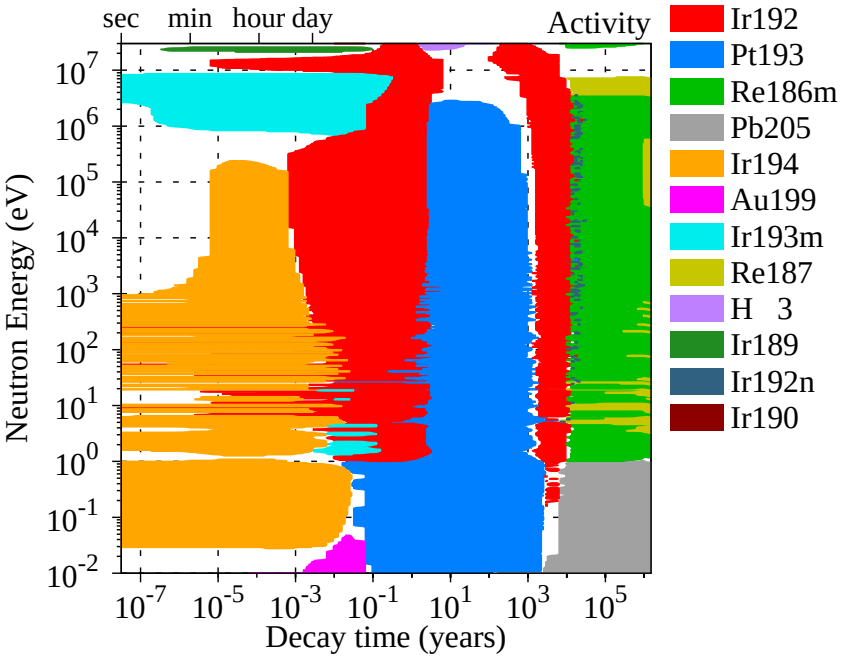
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.63E+07	1.63E+07	1.48E+07	4.80E+05	4.13E+03	2.21E-07
Ir192	89.9	89.9	95.8	99.0	14.5	0.3
Ir194	5.7	5.7	0.3			
Ir190	2.9	2.9	2.6			
Ir193m	1.4	1.4	1.2			
Ir192n				1.0	85.4	2.0
Re186m						89.4
Re186						8.2

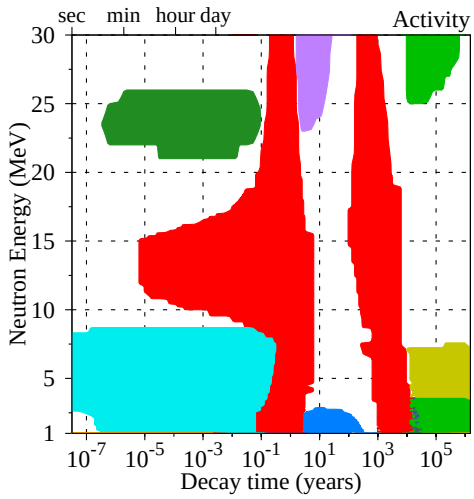
Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.45E+12	2.43E+12	2.30E+12	7.20E+10	9.89E+07	1.40E-03
Ir192	90.5	91.0	93.0	100.0	91.7	8.0
Ir190	8.0	8.1	6.9			
Pt193					6.6	
Ir192n					1.8	0.2
Re186m						78.4
Re187						12.2
Re186						1.2

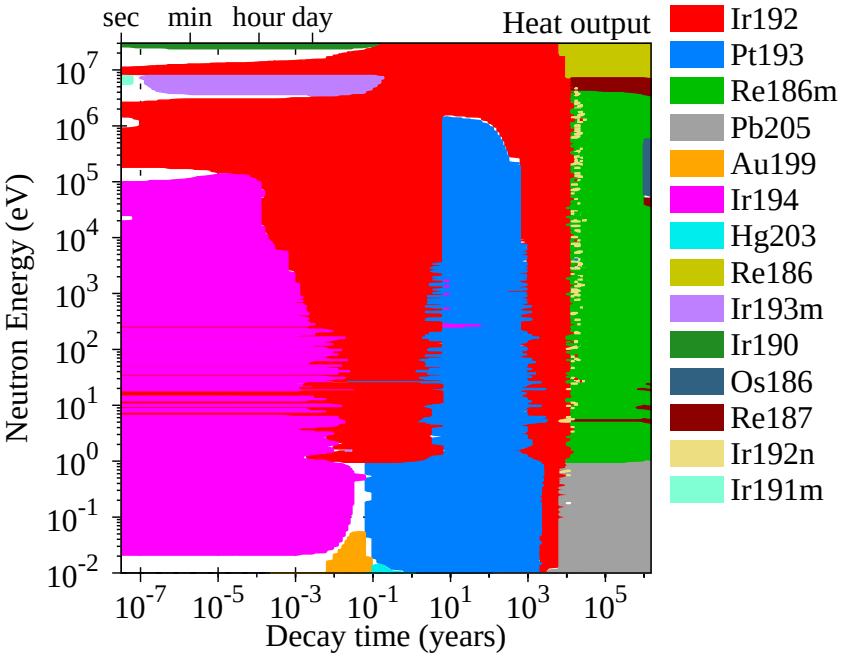
Iridium activation characteristics

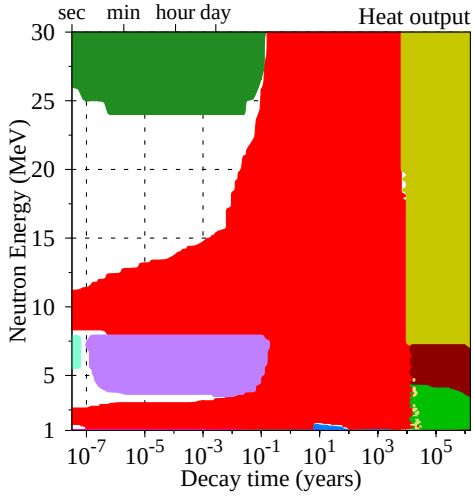


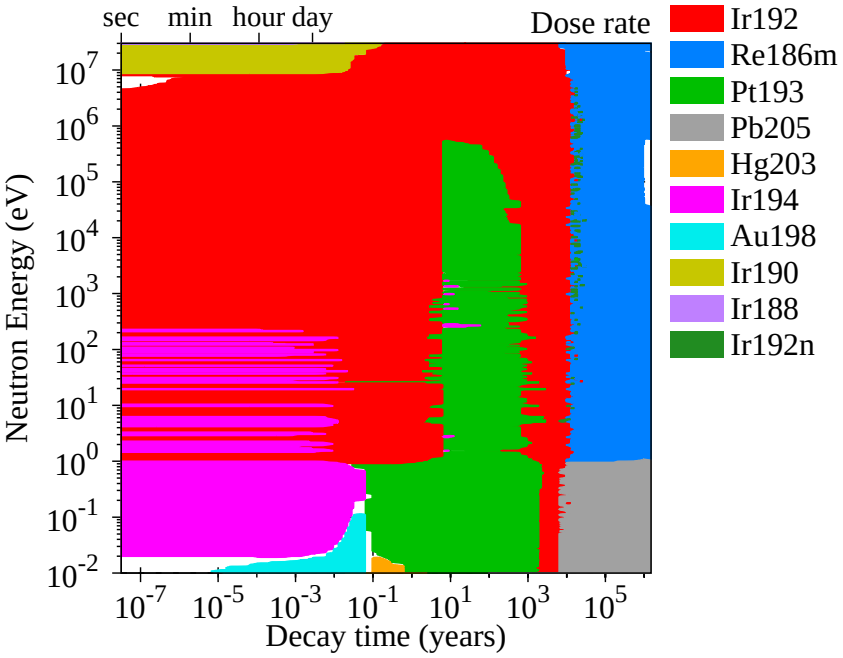
Iridium Importance diagrams

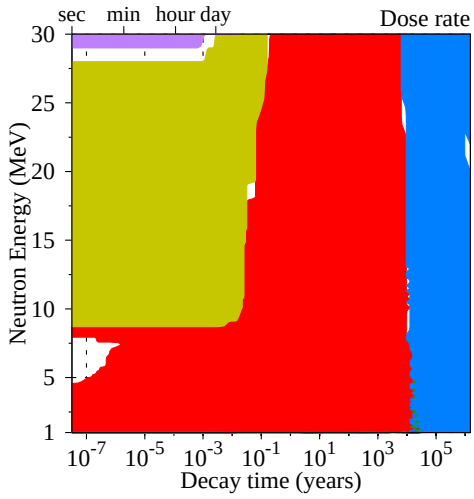




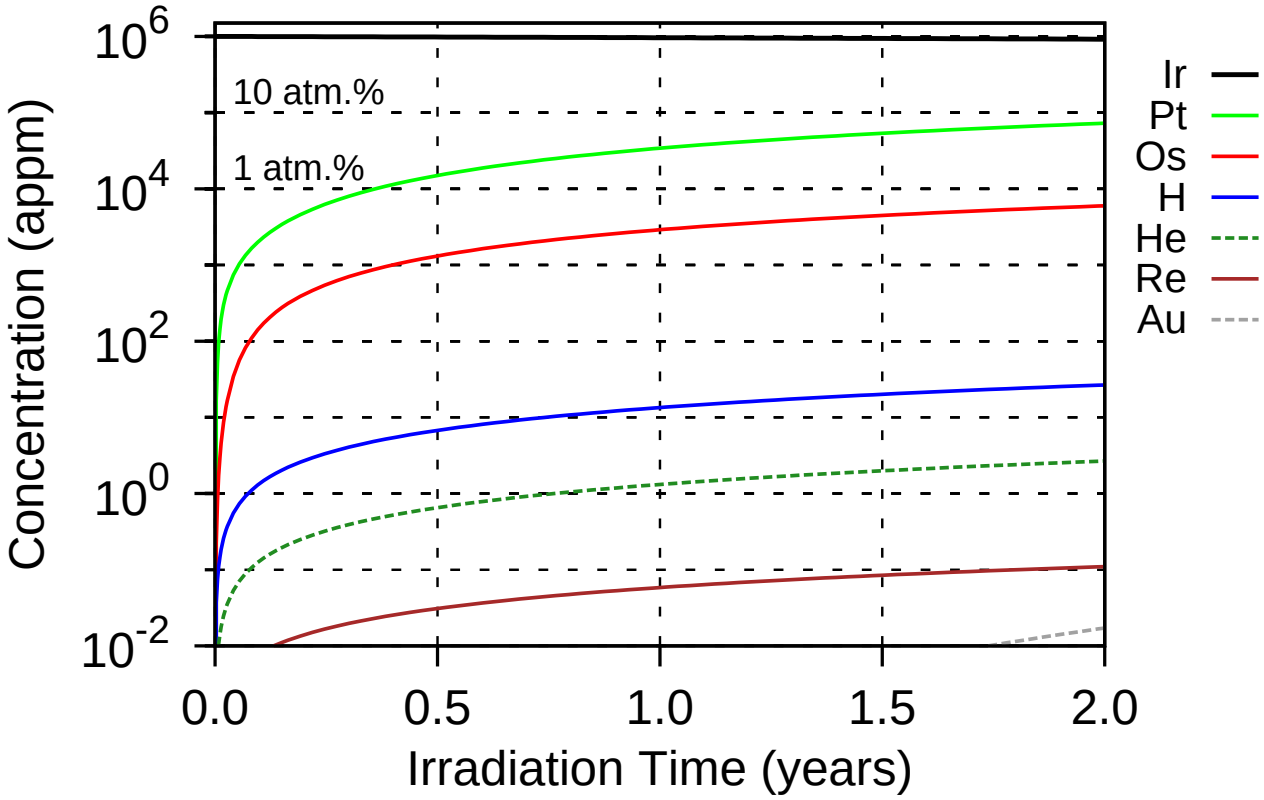




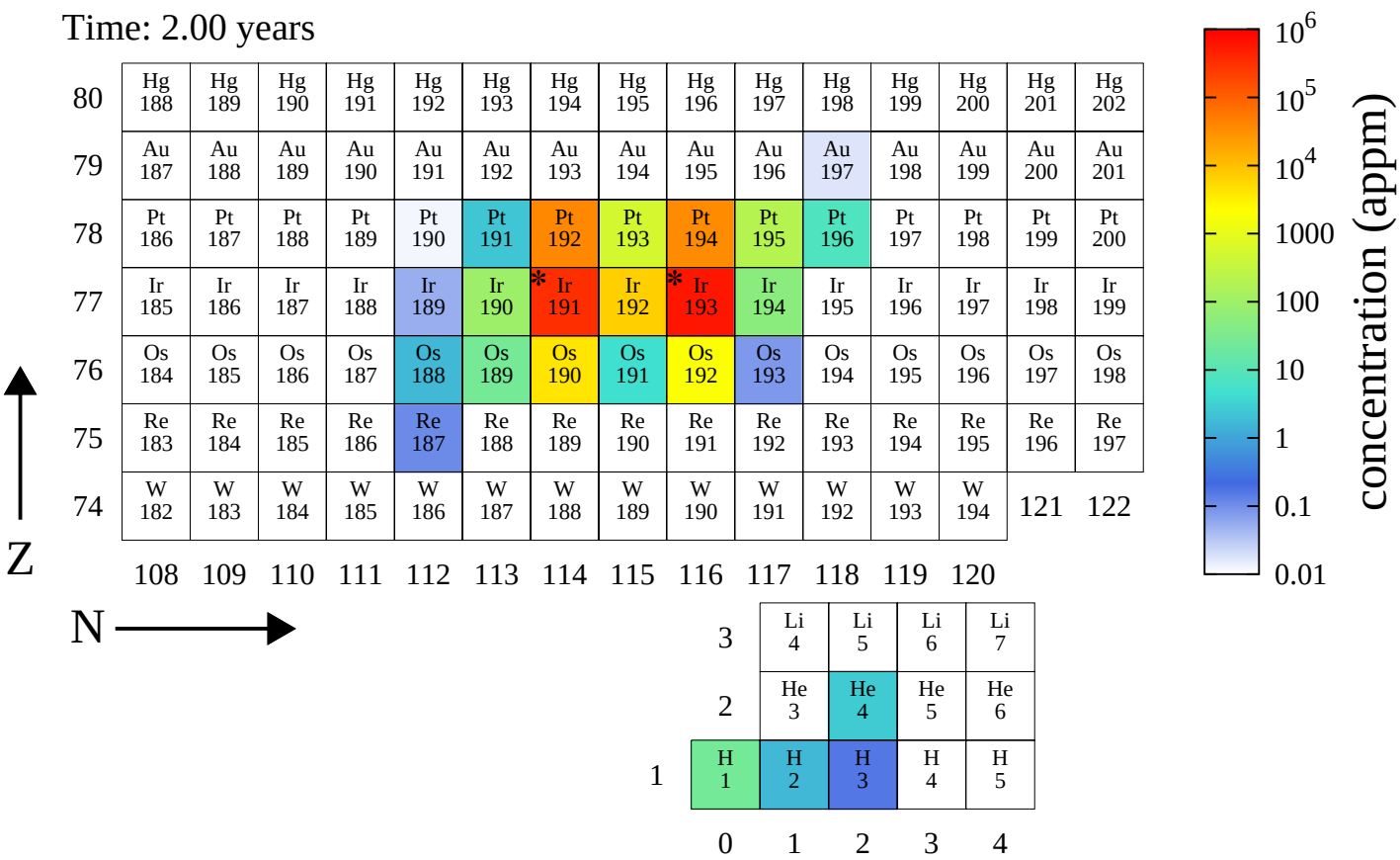




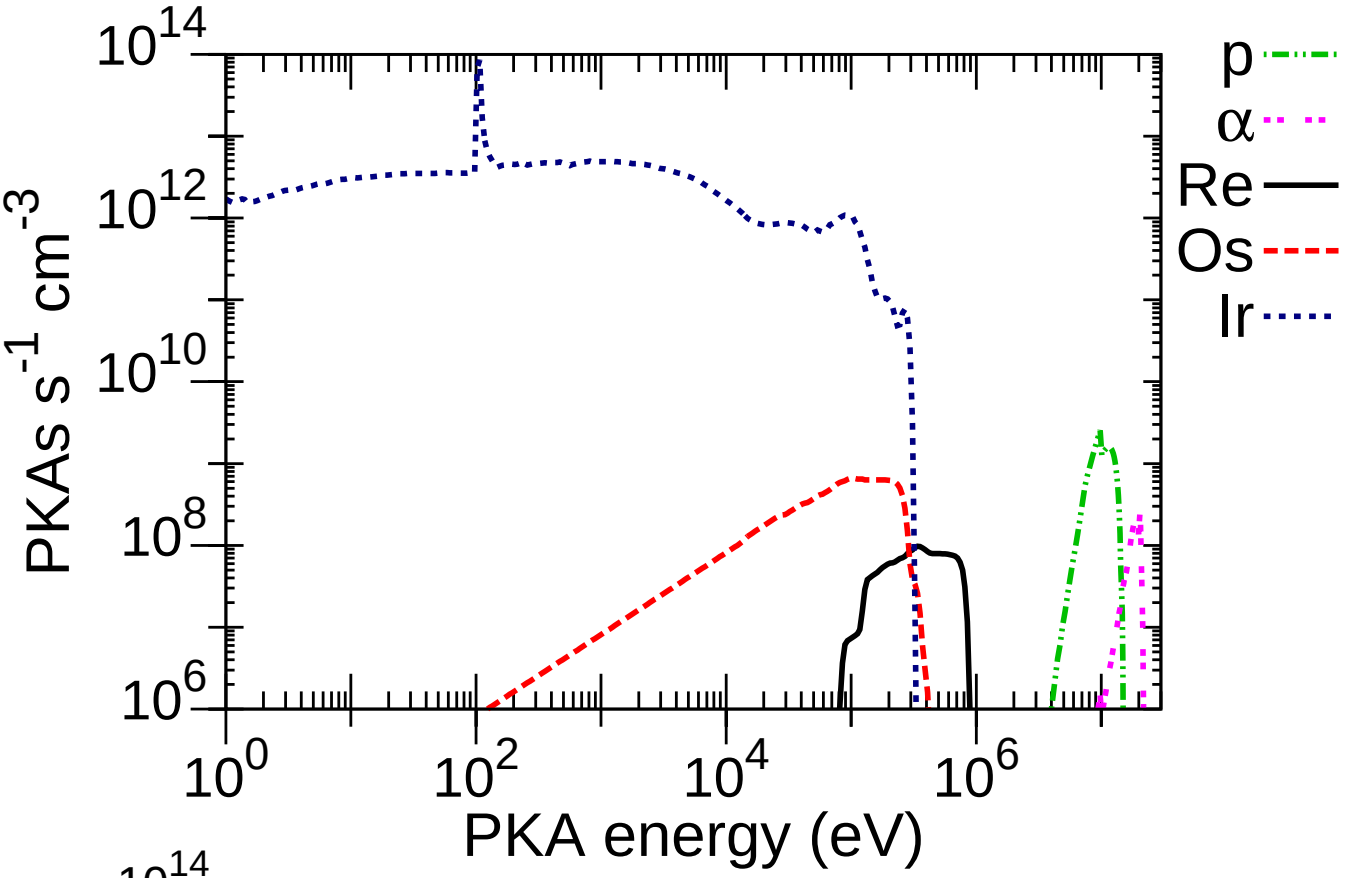
Iridium FW Transmutation

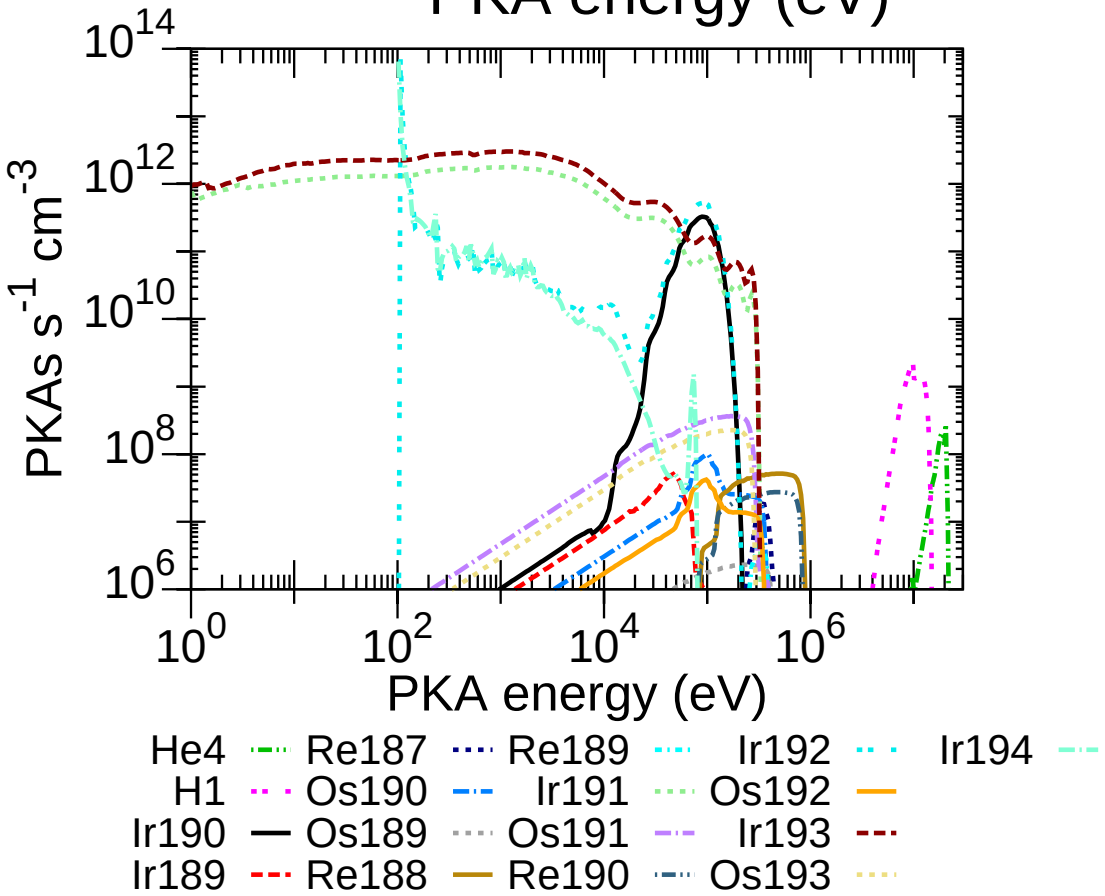


1 appm He & 13 appm H after 1 year 14 dpa/year



Iridium FW PKA distributions





Iridium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ir191m	4.90s	Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191(β^-)Ir191m	27.4	63.8		
		Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191m(IT)Os191(β^-)Ir191m	13.2	30.9		
		Ir191(n,γ)Ir192m(IT)Ir192(β^+)Os192(n,α)W189(β^-)Re189(β^-) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m	9.3			
		Ir191(n,γ)Ir192m(IT)Ir192(β^-)Pt192(n,α)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m	6.7			
		Ir191(n,γ)Ir192(β^+)Os192(n,α)W189(β^-)Re189(β^-)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m	6.5			
		Ir191(n,γ)Ir192(β^-)Pt192(n,α)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(β^-)Ir191m	4.6			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ) Ir194(β^-)Pt194(n,α)Os191(β^-)Ir191m	4.4			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194(β^-) Pt194(n,α)Os191(β^-)Ir191m	4.1			
		Ir191(n,γ)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194(β^-) Pt194(n,α)Os191(β^-)Ir191m	3.1			
		Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194(β^-)Pt194(n,α) Os191(β^-)Ir191m	2.8			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ) Ir194(β^-)Pt194(n,α)Os191m(IT)Os191(β^-)Ir191m	2.1			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194(β^-) Pt194(n,α)Os191m(IT)Os191(β^-)Ir191m	2.0			
		Ir191(n,γ)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194(β^-) Pt194(n,α)Os191m(IT)Os191(β^-)Ir191m	1.5			
		Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194(β^-)Pt194(n,α) Os191m(IT)Os191(β^-)Ir191m	1.4			
		Ir191(n,γ)Ir192m(IT)Ir192(β^-)Pt192(n,α)Os189m(IT) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m	1.3			
		Ir191(n,γ)Ir192m(IT)Ir192(β^+)Os192(n,α)W189(β^-)Re189(β^-) Os189(n,γ)Os190(n,γ)Os191(β^-)Ir191m	1.1			
		Ir191(n,γ)Ir192m(IT)Ir192(β^+)Os192(n,α)W189(β^-)Re189(β^-) Os189m(IT)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m	1.1			
		Ir191(n,n$'$)Ir191m			99.4	69.0
		Ir193(n,2n)Ir192(n,2n)Ir191m				10.1
		Ir193(n,2n)Ir192n(n,2n)Ir191m				4.6
		Ir193(n,2n)Ir192(β^+)Os192(n,2n)Os191(β^-)Ir191m				3.1
		Ir193(n,2n)Ir192(β^+)Os192(n,2n)Os191m(IT)Os191(β^-)Ir191m				2.5
		Ir191(n,p)Os191(β^-)Ir191m				2.3
		Ir193(n,3n)Ir191m				1.6
		Ir193(n,2n)Ir192m(IT)Ir192(n,2n)Ir191m				1.3
		Ir193(n,2n)Ir192(β^-)Pt192(n,2n)Pt191(β^+)Ir191m				1.1
Ir192m	1.44m	Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m	27.7			
		Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m	13.3			
		Ir191(n,γ)Ir192m		100.0	99.0	
		Ir193(n,2n)Ir192m				98.2
Ir194	19.30h	Ir193(n,γ)Ir194	57.4	99.9	99.6	91.9
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	12.6			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194	10.3			
		Ir191(n,γ)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194	8.8			
		Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194	7.2			
		Ir191(n,γ)Ir192m(IT)Ir192(β^+)Os192(n,γ)Os193(β^-) Ir193(n,γ)Ir194	1.0			
		Ir193(n,γ)Ir194m(IT)Ir194				7.2
Ir188	1.73d	Ir191(n,2n)Ir190(n,2n)Ir189(n,2n)Ir188				74.8
		Ir191(n,2n)Ir190m(IT)Ir190(n,2n)Ir189(n,2n)Ir188				12.7
		Ir191(n,3n)Ir189(n,2n)Ir188				8.8
		Ir191(n,2n)Ir190(n,3n)Ir188				1.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Au198	2.69d	Ir193(n,γ)Ir194(n,γ)Ir195(β^-)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	48.6			
		Ir193(n,γ)Ir194(β^-)Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	13.7			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194(n,γ)Ir195(β^-)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	7.4			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194(n,γ)Ir195(β^-)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	7.0			
		Ir191(n,γ)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194(n,γ)Ir195(β^-)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	5.2			
		Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194(n,γ)Ir195(β^-)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	4.9			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194(β^-)Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	2.0			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194(β^-)Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	1.9			
		Ir191(n,γ)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194(β^-)Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	1.4			
		Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194(β^-)Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	1.3			
Au199	3.14d	Ir193(n,γ)Ir194(n,γ)Ir195(β^-)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199	48.3			
		Ir193(n,γ)Ir194(β^-)Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199	13.5			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194(n,γ)Ir195(β^-)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199	7.4			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194(n,γ)Ir195(β^-)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199	7.0			
		Ir191(n,γ)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194(n,γ)Ir195(β^-)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199	5.2			
		Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194(n,γ)Ir195(β^-)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199	4.9			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194(β^-)Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199	1.9			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194(β^-)Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199	1.9			
		Ir191(n,γ)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194(β^-)Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199	1.4			
		Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194(β^-)Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199	1.3			
Re186	3.75d	Ir191(n,α)Re188(β^-)Os188(n,α)W185(β^-)Re185(n,γ)Re186	94.2			
		Ir191(n,α)Re188m(IT)Re188(β^-)Os188(n,α)W185(β^-)Re185(n,γ)Re186	3.2			
		Ir191(n,α)Re188(β^-)Os188(n,α)W185m(IT)W185(β^-)Re185(n,γ)Re186	2.4			
		Ir191(n,nα)Re187(n,2n)Re186				54.5
		Ir191(n,2n)Ir190(β^+)Os190(n,α)W187(β^-)Re187(n,2n)Re186				31.0
		Ir191(n,2n)Ir190m(IT)Ir190(β^+)Os190(n,α)W187(β^-)Re187(n,2n)Re186				5.3
		Ir191(n,2n)Ir190(n,α)Re187(n,2n)Re186				4.9
		Ir191(n,2n)Ir190(n,nα)Re186				1.2

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ir193m	10.53d	Ir191(n,γ)Ir192m(IT)Ir192(β^+)Os192(n,γ)Os193(β^-)Ir193m	50.1			
		Ir191(n,γ)Ir192(β^+)Os192(n,γ)Os193(β^-)Ir193m	35.0			
		Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m	2.5			
		Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192(n,γ)Ir193m	1.7			
		Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m	1.2			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m		57.0		
		Ir191(n,γ)Ir192(n,γ)Ir193m		43.0		
		Ir193(n,n$'$)Ir193m			100.0	99.1
Ir190	12.00d	Ir191(n,2n)Ir190				84.4
		Ir191(n,2n)Ir190m(IT)Ir190				14.3
Ir189	13.20d	Ir191(n,2n)Ir190(n,2n)Ir189				76.6
		Ir191(n,2n)Ir190m(IT)Ir190(n,2n)Ir189				13.0
		Ir191(n,3n)Ir189				9.0
Hg203	46.62d	no pathways found				
Ir192	73.80d	Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192	16.4			
		Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192	11.4			
		Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	7.9			
		Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192	5.5			
		Ir191(n,γ)Ir192m(IT)Ir192		57.0	39.8	
		Ir191(n,γ)Ir192		43.0	59.8	
		Ir193(n,2n)Ir192				86.9
		Ir193(n,2n)Ir192m(IT)Ir192				11.0
		Ir193(n,2n)Ir192n(n,E)Ir192				1.2
H3	12.33y	Ir193(n,t)H3				9.3
		Ir191(n,t)H3				25.2
Pt193	50.00y	Ir191(n,γ)Ir192m(IT)Ir192(β^-)Pt192(n,γ)Pt193	58.3	55.8	32.5	
		Ir191(n,γ)Ir192(β^-)Pt192(n,γ)Pt193	40.7	42.1	48.9	
		Ir191(n,γ)Ir192m(IT)Ir192(β^-)Pt192(n,γ)Pt193m(IT)Pt193		1.2	6.9	
		Ir191(n,γ)Ir192(β^-)Pt192(n,γ)Pt193m(IT)Pt193			10.4	
		Ir193(n,2n)Ir192(β^-)Pt192(n,γ)Pt193m(IT)Pt193				30.2
		Ir193(n,γ)Ir194(β^-)Pt194(n,2n)Pt193m(IT)Pt193				23.3
		Ir193(n,2n)Ir192(β^-)Pt192(n,γ)Pt193				21.0
		Ir193(n,γ)Ir194(β^-)Pt194(n,2n)Pt193				15.0
		Ir193(n,2n)Ir192m(IT)Ir192(β^-)Pt192(n,γ)Pt193m(IT)Pt193				3.8
		Ir193(n,2n)Ir192m(IT)Ir192(β^-)Pt192(n,γ)Pt193				2.6
		Ir193(n,γ)Ir194m(IT)Ir194(β^-)Pt194(n,2n)Pt193m(IT)Pt193				1.8
		Ir193(n,γ)Ir194m(IT)Ir194(β^-)Pt194(n,2n)Pt193				1.2

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Ir192n	241.00y	Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191(n,γ)Os192m(β^-)Ir192n	27.6			
		Ir193(n,γ)Ir194(β^-)Pt194(n,α)Os191m(IT)Os191(n,γ) Os192m(β^-)Ir192n	13.2			
		Ir191(n,γ)Ir192m(IT)Ir192(β^+)Os192(n,α)W189(β^-)Re189(β^-) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	9.0			
		Ir191(n,γ)Ir192m(IT)Ir192(β^-)Pt192(n,α)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	6.4			
		Ir191(n,γ)Ir192(β^+)Os192(n,α)W189(β^-)Re189(β^-)Os189(n,γ) Os190(n,γ)Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	6.3			
		Ir191(n,γ)Ir192(β^-)Pt192(n,α)Os189(n,γ)Os190(n,γ) Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	4.5			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ) Ir194(β^-)Pt194(n,α)Os191(n,γ)Os192m(β^-)Ir192n	4.4			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194(β^-) Pt194(n,α)Os191(n,γ)Os192m(β^-)Ir192n	4.1			
		Ir191(n,γ)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194(β^-) Pt194(n,α)Os191(n,γ)Os192m(β^-)Ir192n	3.1			
		Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194(β^-)Pt194(n,α) Os191(n,γ)Os192m(β^-)Ir192n	2.9			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m(IT)Ir193(n,γ) Ir194(β^-)Pt194(n,α)Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	2.1			
		Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193(n,γ)Ir194(β^-) Pt194(n,α)Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	2.0			
		Ir191(n,γ)Ir192(n,γ)Ir193m(IT)Ir193(n,γ)Ir194(β^-) Pt194(n,α)Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	1.5			
		Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194(β^-)Pt194(n,α) Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	1.4			
		Ir191(n,γ)Ir192m(IT)Ir192(β^-)Pt192(n,α)Os189m(IT) Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	1.2			
		Ir191(n,γ)Ir192m(IT)Ir192(β^+)Os192(n,α)W189(β^-)Re189(β^-) Os189(n,γ)Os190(n,γ)Os191(n,γ)Os192m(β^-)Ir192n	1.1			
		Ir191(n,γ)Ir192m(IT)Ir192(β^+)Os192(n,α)W189(β^-)Re189(β^-) Os189m(IT)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(n,γ) Os192m(β^-)Ir192n	1.0			
		Ir191(n,γ)Ir192n		100.0	96.3	
		Ir191(n,γ)Ir192(n,n$'$)Ir192n			2.2	
		Ir191(n,γ)Ir192m(IT)Ir192(n,n$'$)Ir192n			1.5	
		Ir193(n,2n)Ir192n				99.1
Re186m	2.0 10^5y	Ir191(n,α)Re188(β^-)Os188(n,α)W185(β^-)Re185(n,γ)Re186m	94.2			
		Ir191(n,α)Re188m(IT)Re188(β^-)Os188(n,α)W185(β^-) Re185(n,γ)Re186m	3.2			
		Ir191(n,α)Re188(β^-)Os188(n,α)W185m(IT)W185(β^-) Re185(n,γ)Re186m	2.4			
		Ir191(n,nα)Re187(n,2n)Re186m				51.2
		Ir191(n,2n)Ir190(β^+)Os190(n,α)W187(β^-)Re187(n,2n)Re186m				19.4
		Ir191(n,2n)Ir190(n,nα)Re186m				15.5
		Ir191(n,2n)Ir190(n,α)Re187(n,2n)Re186m				4.5
		Ir191(n,2n)Ir190m(IT)Ir190(β^+)Os190(n,α)W187(β^-) Re187(n,2n)Re186m				3.3
		Ir191(n,2n)Ir190m(IT)Ir190(n,nα)Re186m				2.6
Pb205	1.5 10^7y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Re187	4.4 10^{10}y	Ir191(n,γ)Ir192m(IT)Ir192(β^+)Os192(n,α)W189(β^-)Re189(β^-) Os189(n,α)W186(n,γ)W187(β^-)Re187	9.9			
		Ir191(n,γ)Ir192m(IT)Ir192(β^-)Pt192(n,α)Os189(n,α) W186(n,γ)W187(β^-)Re187	7.1			
		Ir191(n,γ)Ir192(β^+)Os192(n,α)W189(β^-)Re189(β^-)Os189(n,α) W186(n,γ)W187(β^-)Re187	6.9			
		Ir191(n,γ)Ir192(β^-)Pt192(n,α)Os189(n,α)W186(n,γ) W187(β^-)Re187	5.0			
		Ir191(n,γ)Ir192m(IT)Ir192(β^-)Pt192(n,α)Os189m(IT) Os189(n,α)W186(n,γ)W187(β^-)Re187	1.4			
		Ir191(n,γ)Ir192m(IT)Ir192(β^+)Os192(n,α)W189(β^-)Re189(β^-) Os189m(IT)Os189(n,α)W186(n,γ)W187(β^-)Re187	1.1			
		Ir191(n,γ)Ir192(β^-)Pt192(n,α)Os189m(IT)Os189(n,α) W186(n,γ)W187(β^-)Re187	1.0			
		Ir191(n,n$'$)Ir191m(n,nα)Re187			42.0	
		Ir193(n,α)Re190(β^-)Os190(n,α)W187(β^-)Re187			40.6	
		Ir193(n,α)Re190m(β^-)Os190(n,α)W187(β^-)Re187			8.1	
		Ir193(n,α)Re190m(IT)Re190(β^-)Os190(n,α)W187(β^-)Re187			6.6	
		Ir191(n,nα)Re187				55.6
		Ir191(n,2n)Ir190(β^+)Os190(n,α)W187(β^-)Re187				31.9
		Ir191(n,2n)Ir190m(IT)Ir190(β^+)Os190(n,α)W187(β^-)Re187				5.4
		Ir191(n,2n)Ir190(n,α)Re187				5.0
Os186	2.0 10^{15}y	Ir191(n,α)Re188(β^-)Os188(n,α)W185(β^-)Re185(n,γ) Re186(β^-)Os186	94.2			
		Ir191(n,α)Re188m(IT)Re188(β^-)Os188(n,α)W185(β^-) Re185(n,γ)Re186(β^-)Os186	3.2			
		Ir191(n,α)Re188(β^-)Os188(n,α)W185m(IT)W185(β^-)Re185(n,γ) Re186(β^-)Os186	2.4			
		Ir191(n,nα)Re187(n,2n)Re186(β^-)Os186				20.6
		Ir191(n,2n)Ir190(β^+)Os190(n,α)W187(β^-)Re187(n,2n) Re186(β^-)Os186				7.6
		Ir191(n,2n)Ir190(n,α)Re187(n,2n)Re186(β^-)Os186				1.8
		Ir191(n,2n)Ir190m(IT)Ir190(β^+)Os190(n,α)W187(β^-) Re187(n,2n)Re186(β^-)Os186				1.3

Platinum

Isotope	Atom % abundance
Pt190	0.01
Pt192	0.78
Pt194	32.97
Pt195	33.83
Pt196	25.24
Pt198	7.16

($T_{1/2}$ =6.5 10^{11}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	4.45E+14	4.39E+14	1.64E+14	5.38E+12	1.36E+12	1.33E+01
Pt193m	27.3	27.6	41.3			
Pt195m	27.2	27.6	39.4			
Pt197	20.8	21.0	2.7			
Au199	7.1	7.2	8.6			
Pt199	7.1	6.4				
Pt197m	4.8	4.7				
Au198	2.2	2.2	2.3			
Pt193	1.2	1.2	3.3	99.5	100.0	
Pt191	1.0	1.1	1.1			
Pt190						99.6

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.01E-02	1.95E-02	5.71E-03	4.02E-05	9.05E-06	6.90E-15
Pt195m	23.7	24.3	44.3			
Pt197	20.6	21.1	3.5			
Pt199	18.8	17.2				
Pt193m	14.6	14.9	28.5			
Pt197m	6.7	6.6				
Au199	6.1	6.2	9.6			
Au198	5.7	5.8	7.8			
Pt191	1.3	1.4	1.9			
Ir192	0.7	0.7	2.4	11.2		
Au196	0.4	0.4	1.0			
Pt193	0.2	0.2	0.6	88.8	100.0	
Pt190						100.0

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.60E+03	1.52E+03	3.77E+02	3.59E+00	4.21E-01	1.86E-14
Pt199	43.9	41.2				
Au198	28.4	30.0	47.1			
Pt191	5.7	6.0	9.7			
Pt195m	5.6	5.9	12.6			
Ir192	3.7	3.9	15.3	53.9	0.1	
Pt197m	3.7	3.8				
Au199	2.2	2.4	4.3			
Au196	1.9	2.0	5.4			
Pt197	1.5	1.5	0.3			
Pt193m	1.2	1.3	2.8			
Ir190	0.5	0.6	1.9			
Pt193	0.1	0.1	0.4	46.1	99.9	
Re186m						68.0
Re186						32.0

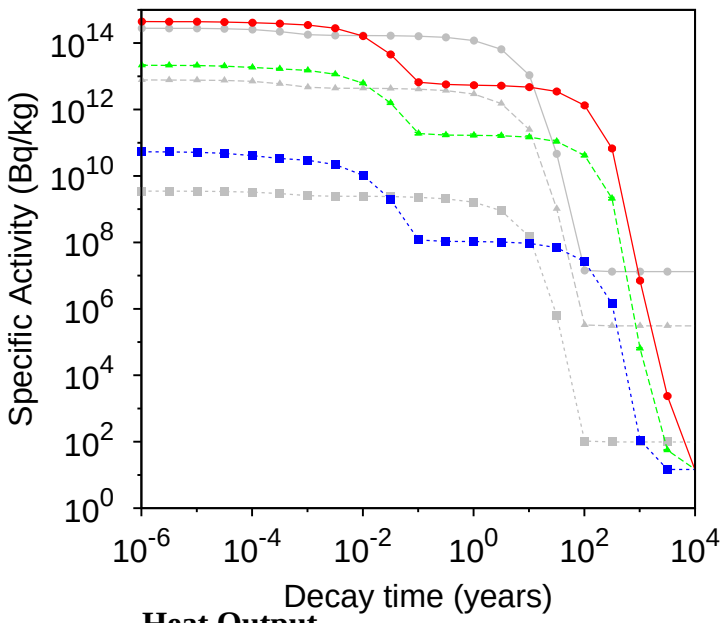
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.99E+05	1.99E+05	8.53E+04	2.04E+02	4.21E+01	1.09E-07
Pt195m	38.3	38.4	47.6			
Pt193m	27.4	27.5	35.7			
Pt197	18.6	18.6	2.1			
Au199	7.0	7.0	7.3			
Au198	4.9	4.9	4.5			
Ir192	0.6	0.6	1.3	18.7		
Pt193	0.1	0.1	0.2	81.3	100.0	
Pt190						99.9

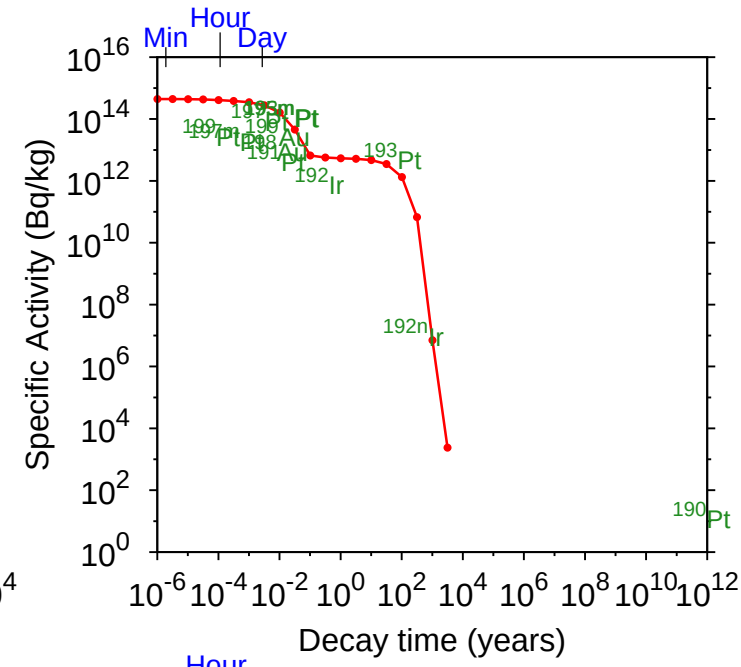
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	8.60E+04	8.57E+04	4.09E+04	2.93E+02	2.89E+01	3.04E-06
Au199	29.0	29.0	27.4			
Pt195m	25.4	25.4	28.4			
Pt193m	16.9	17.0	19.9			
Au198	9.8	9.8	8.1			
Pt197	9.2	9.2	0.9			
Ir192	6.5	6.5	13.1	61.4	0.2	
Pt193	0.1	0.1	0.3	38.3	98.7	
Ir192n				0.1	1.1	
Pt190						100.0

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.33E+10	2.23E+10	8.04E+09	2.12E+08	4.68E+07	1.32E-02
Pt195m	47.2	49.4	72.9			
Pt199	34.6	32.2				
Au198	4.2	4.4	4.8			
Ir192	3.6	3.8	10.1	12.9		
Au196	2.2	2.3	4.3			
Pt191	2.0	2.1	2.3			
Au199	1.4	1.4	1.8			
Pt193	0.8	0.8	2.3	87.1	100.0	
Pt190						100.0

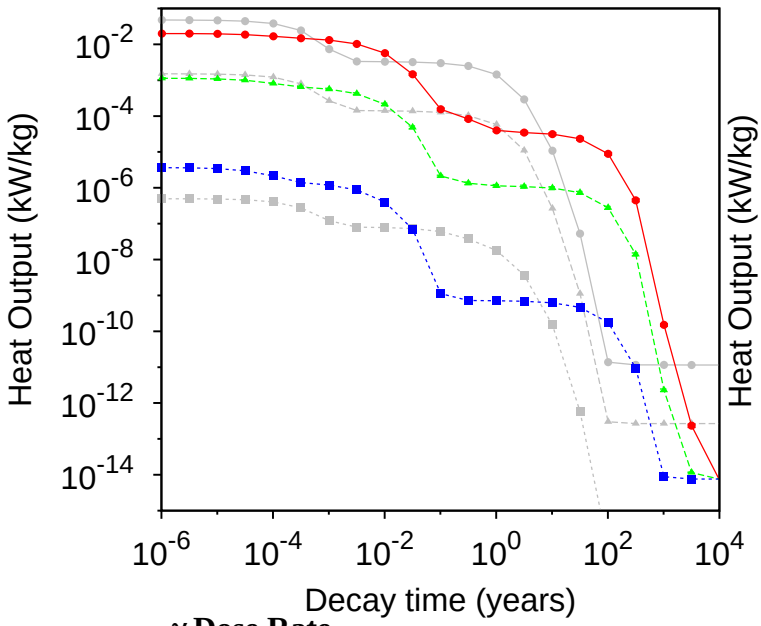
Platinum activation characteristics

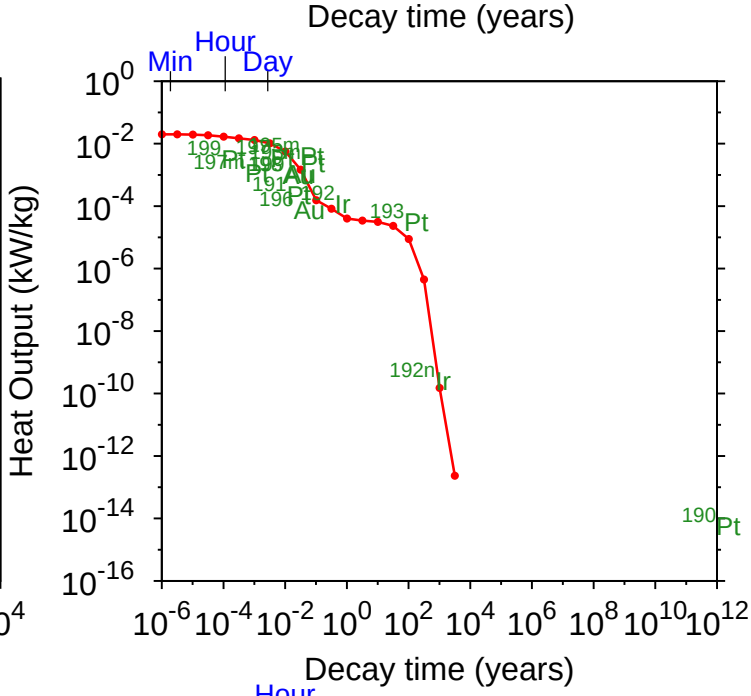
Specific Activity



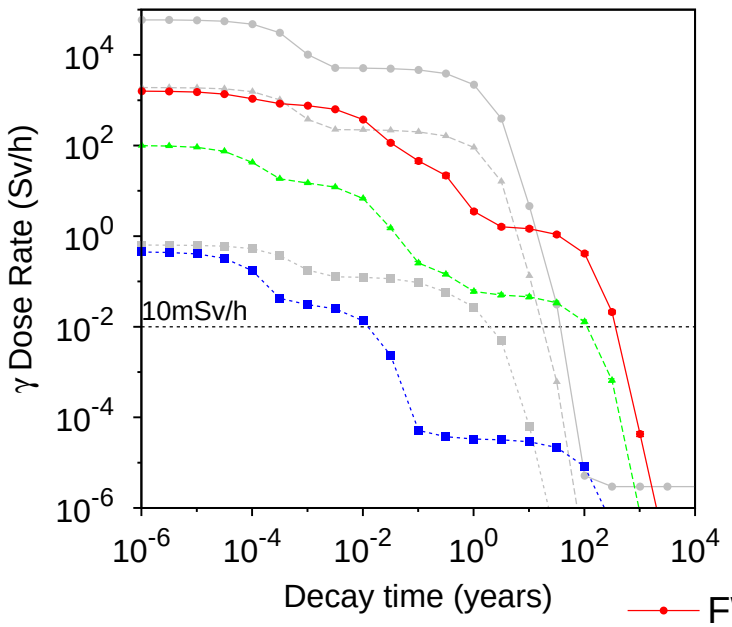


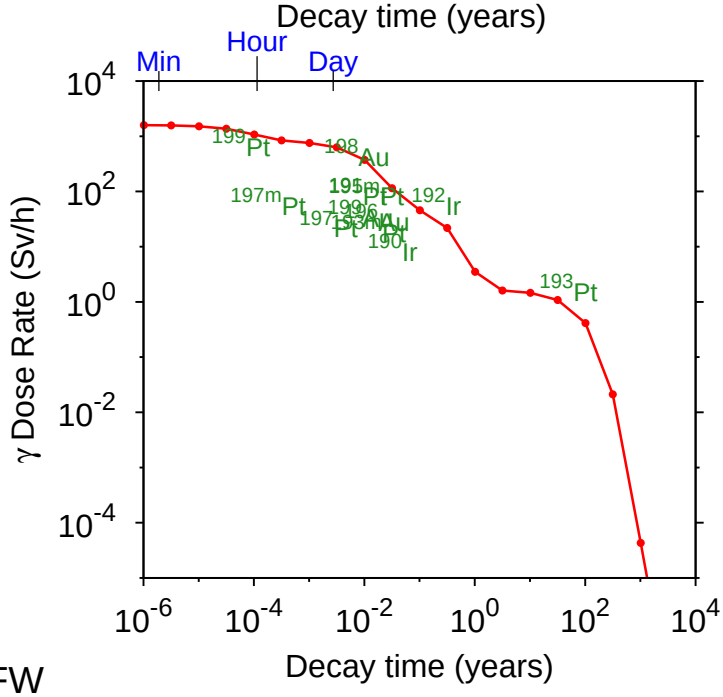
Heat Output





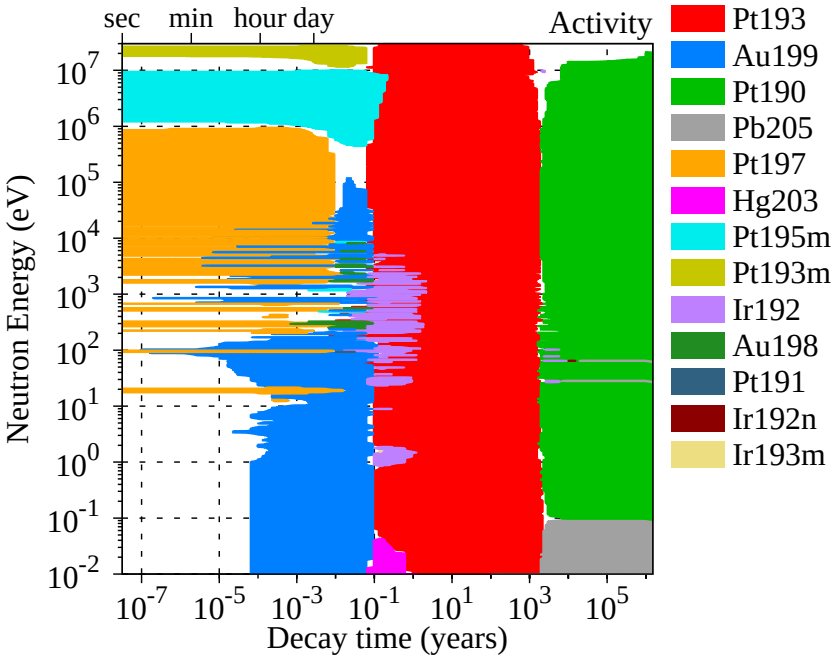
γ Dose Rate

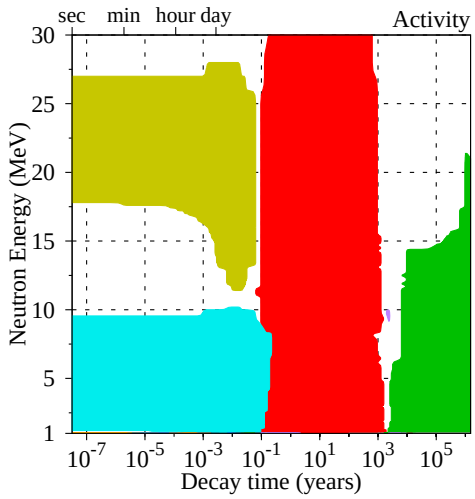


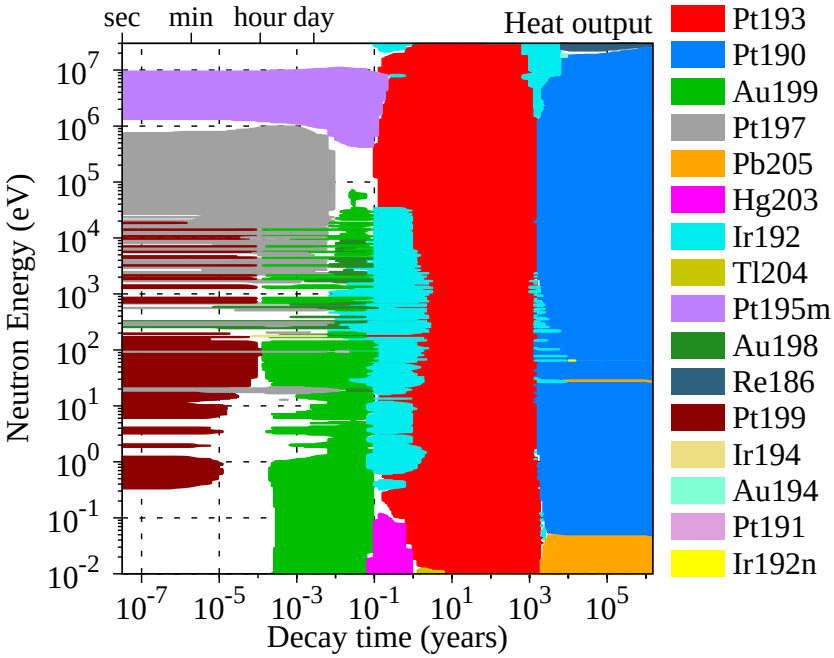


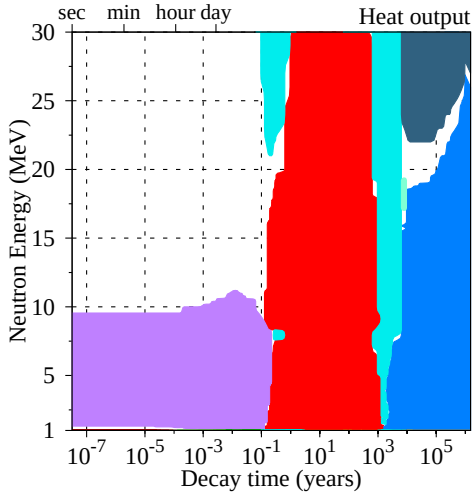
FW
Blanket
Manifold
Fe results

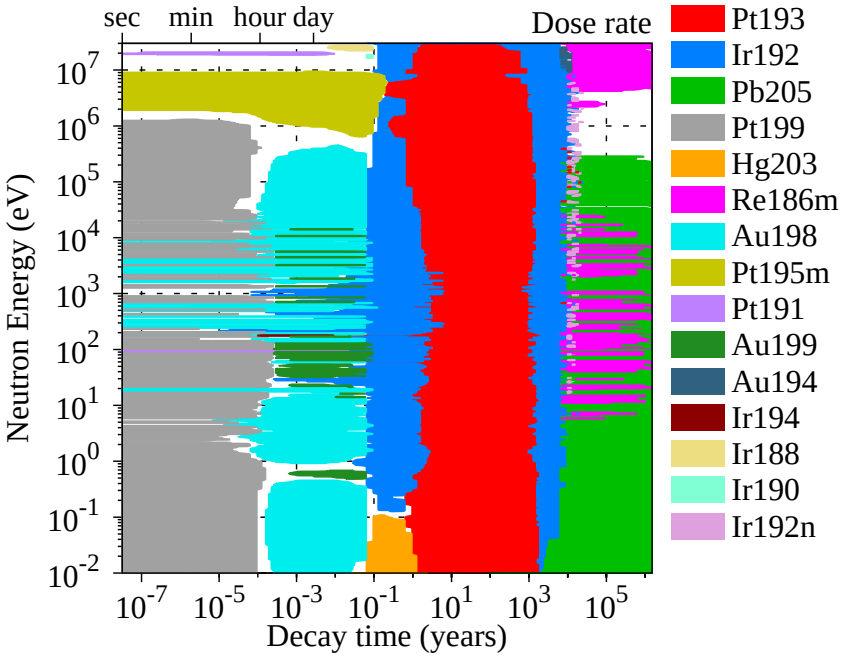
Platinum Importance diagrams

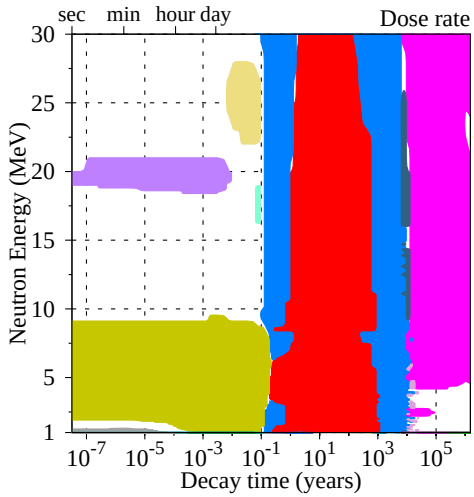




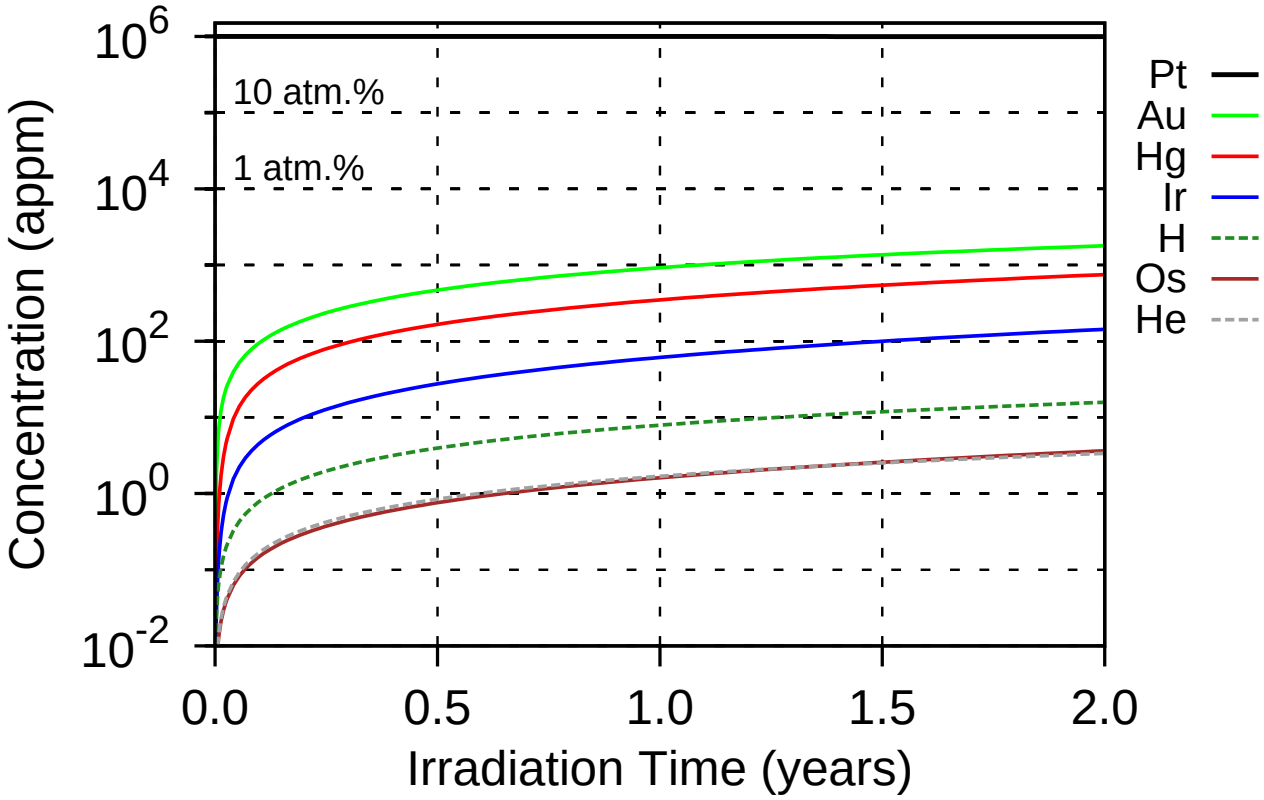






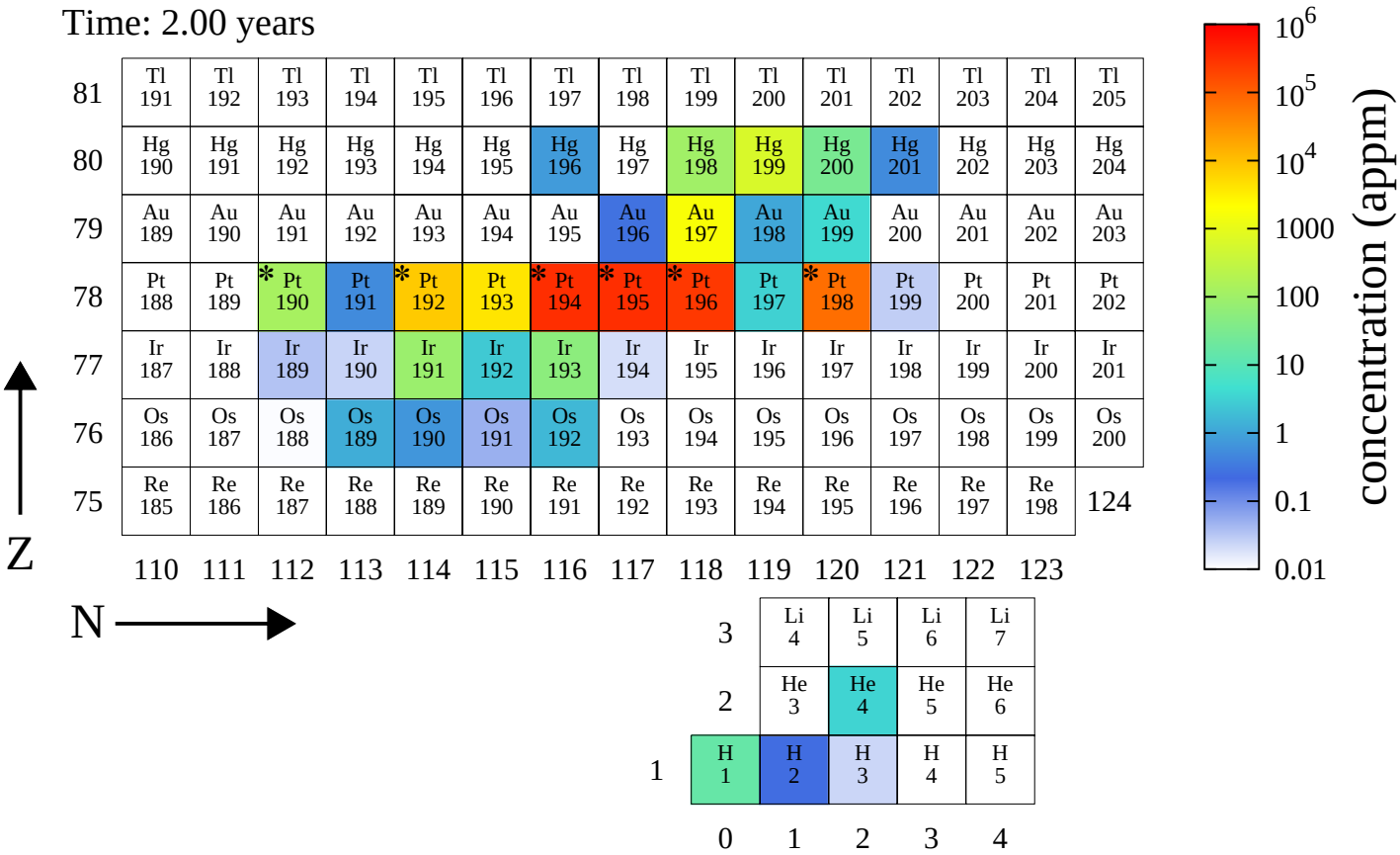


Platinum FW Transmutation

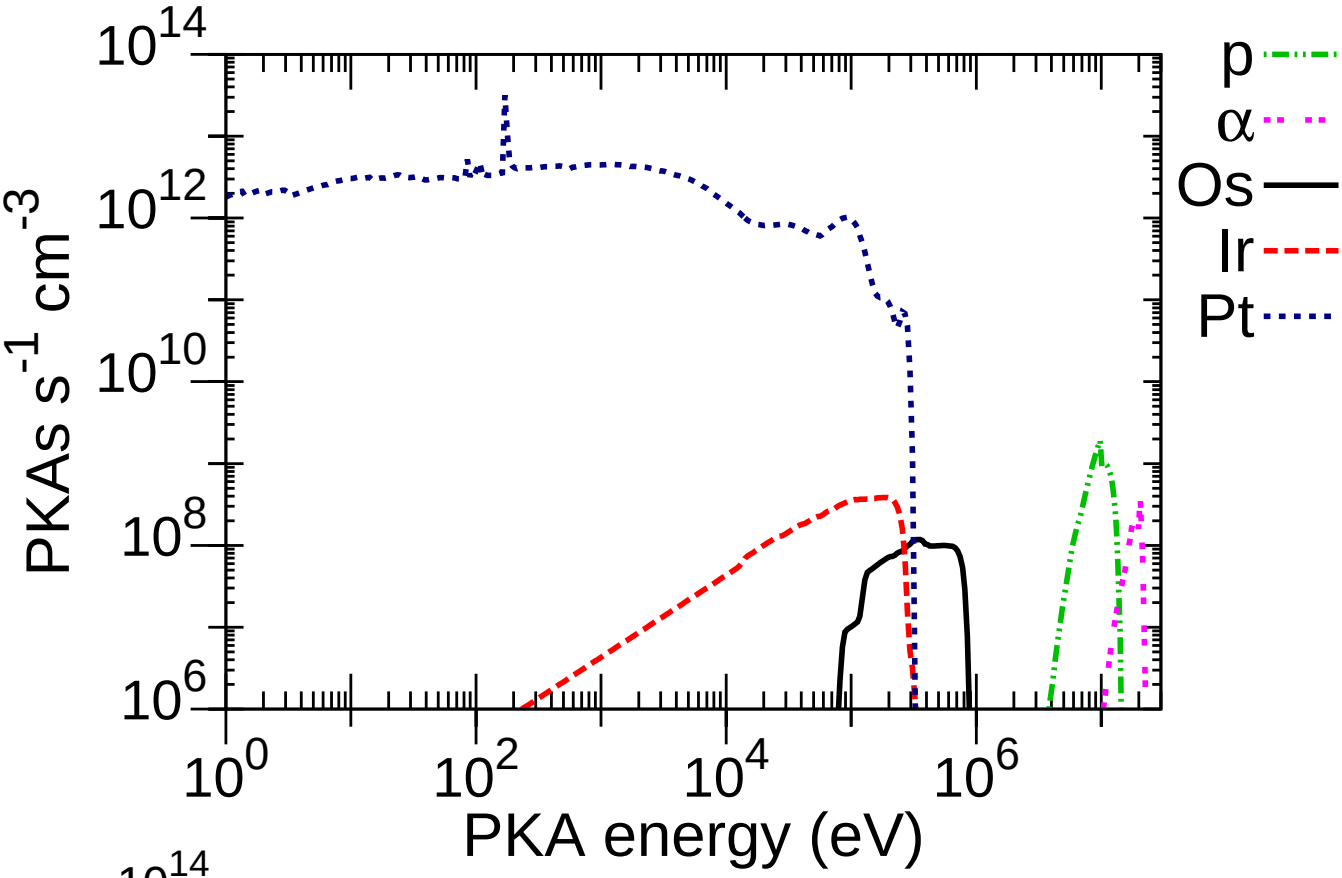


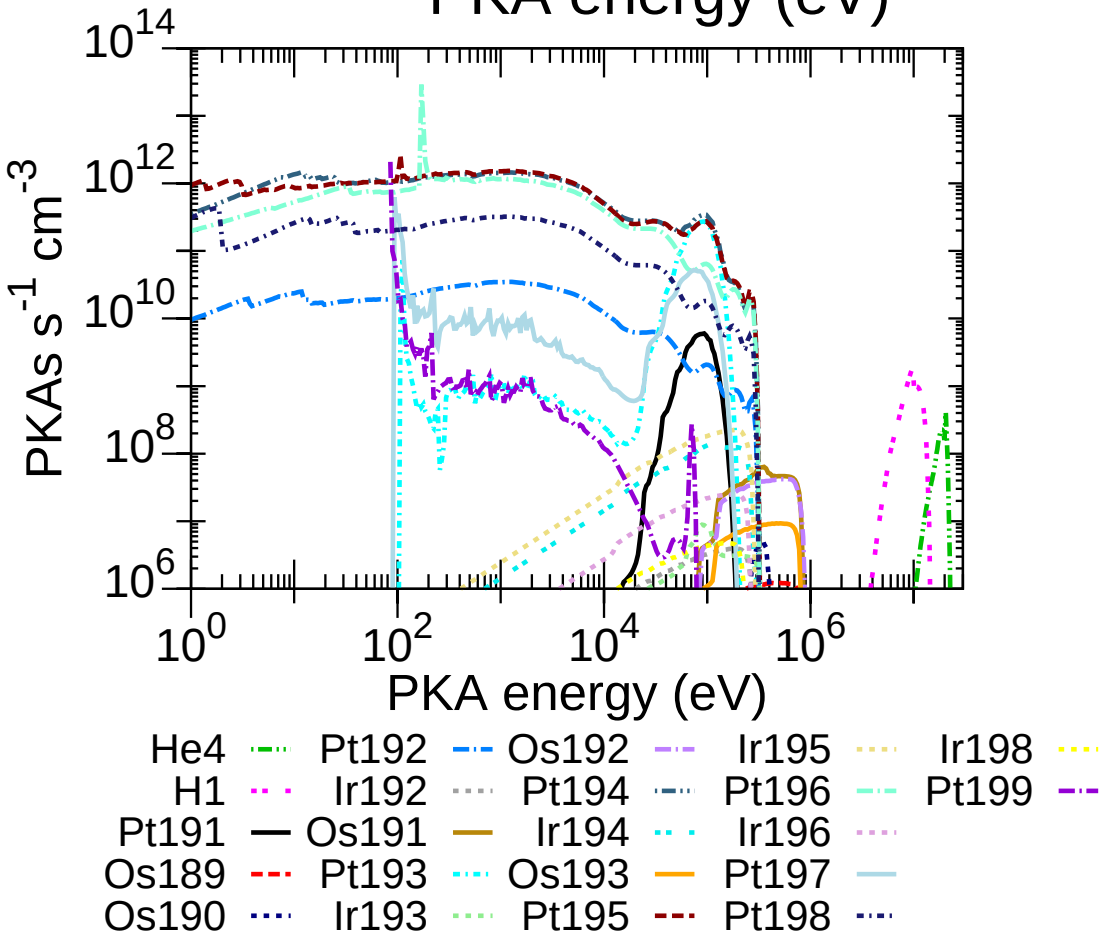
2 appm He & 8 appm H after 1 year

14 dpa/year



Platinum FW PKA distributions





Platinum Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Pt199	30.80m	Pt198(n,γ)Pt199	98.6	99.9	95.4	65.0
		Pt198(n,γ)Pt199m(IT)Pt199			4.6	35.0
Pt197m	1.59h	Pt195(n,γ)Pt196(n,γ)Pt197m	50.6	5.6		
		Pt196(n,γ)Pt197m	46.9	94.3	99.7	
		Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197m	2.5			
		Pt198(n,2n)Pt197m				99.8
Ir194	19.30h	Pt192(n,γ)Pt193(β^+)Ir193(n,γ)Ir194	81.5	97.5	82.1	
		Pt190(n,γ)Pt191(β^+)Ir191(n,γ)Ir192m(IT)Ir192(n,γ) Ir193m(IT)Ir193(n,γ)Ir194	5.3			
		Pt190(n,γ)Pt191(β^+)Ir191(n,γ)Ir192m(IT)Ir192(n,γ) Ir193(n,γ)Ir194	4.4			
		Pt190(n,γ)Pt191(β^+)Ir191(n,γ)Ir192(n,γ)Ir193m(IT) Ir193(n,γ)Ir194	3.7			
		Pt190(n,γ)Pt191(β^+)Ir191(n,γ)Ir192(n,γ)Ir193(n,γ)Ir194	3.0			
		Pt192(n,γ)Pt193m(IT)Pt193(β^+)Ir193(n,γ)Ir194		2.1	17.4	
		Pt194(n,p)Ir194				78.8
		Pt195(n,2n)Pt194(n,p)Ir194				10.3
		Pt195(n,np)Ir194				3.8
		Pt194(n,p)Ir194m(IT)Ir194				3.6
		Pt195(n,d)Ir194				1.5
Pt197	19.89h	Pt195(n,γ)Pt196(n,γ)Pt197	49.9	5.4		
		Pt196(n,γ)Pt197	46.2	91.4	88.8	
		Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197	2.5			
		Pt196(n,γ)Pt197m(IT)Pt197		2.9	10.9	
		Pt198(n,2n)Pt197				55.3
		Pt198(n,2n)Pt197m(IT)Pt197				44.5
Au194	1.58d	Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196m(IT)Au196(β^-) Hg196(n,2n)Hg195m(IT)Hg195(β^+)Au195(n,2n)Au194m(IT)Au194				5.3
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196m(IT)Au196(n,2n) Au195m(IT)Au195(n,2n)Au194m(IT)Au194				4.7
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196m(IT)Au196(β^-) Hg196(n,2n)Hg195m(β^+)Au195(n,2n)Au194m(IT)Au194				4.6
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196m(IT)Au196(β^-) Hg196(n,2n)Hg195(β^+)Au195(n,2n)Au194m(IT)Au194				4.6
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196m(IT) Au196(β^-)Hg196(n,2n)Hg195m(IT)Hg195(β^+)Au195(n,2n) Au194m(IT)Au194				4.3
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196m(IT) Au196(n,2n)Au195m(IT)Au195(n,2n)Au194m(IT)Au194				3.8
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196m(IT) Au196(β^-)Hg196(n,2n)Hg195m(β^+)Au195(n,2n)Au194m(IT)Au194				3.7
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196m(IT) Au196(β^-)Hg196(n,2n)Hg195(β^+)Au195(n,2n)Au194m(IT)Au194				3.7
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196(β^-)Hg196(n,2n) Hg195m(IT)Hg195(β^+)Au195(n,2n)Au194m(IT)Au194				3.2
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196(n,2n)Au195m(IT) Au195(n,2n)Au194m(IT)Au194				2.8
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196(β^-)Hg196(n,2n) Hg195m(β^+)Au195(n,2n)Au194m(IT)Au194				2.8
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196(β^-)Hg196(n,2n) Hg195(β^+)Au195(n,2n)Au194m(IT)Au194				2.7
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196(β^-) Hg196(n,2n)Hg195m(IT)Hg195(β^+)Au195(n,2n)Au194m(IT)Au194				2.6
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196m(IT)Au196(β^-) Hg196(n,2n)Hg195m(IT)Hg195(β^+)Au195(n,2n)Au194				2.3
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196(n,2n) Au195m(IT)Au195(n,2n)Au194m(IT)Au194				2.2
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196m(IT)Au196(n,2n) Au195(n,2n)Au194m(IT)Au194				2.2
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196(β^-) Hg196(n,2n)Hg195m(β^+)Au195(n,2n)Au194m(IT)Au194				2.2
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196(β^-) Hg196(n,2n)Hg195(β^+)Au195(n,2n)Au194m(IT)Au194				2.2
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196m(IT)Au196(n,2n) Au195m(IT)Au195(n,2n)Au194				2.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Au194	cont.	Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196m(IT)Au196(β^-) Hg196(n,2n)Hg195m(β^+)Au195(n,2n)Au194				2.0
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196m(IT)Au196(β^-) Hg196(n,2n)Hg195(β^+)Au195(n,2n)Au194				2.0
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196m(IT) Au196(β^-)Hg196(n,2n)Hg195m(IT)Hg195(β^+)Au195(n,2n)Au194				1.8
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196m(IT) Au196(n,2n)Au195(n,2n)Au194m(IT)Au194				1.8
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196m(IT) Au196(n,2n)Au195m(IT)Au195(n,2n)Au194				1.6
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196m(IT) Au196(β^-)Hg196(n,2n)Hg195m(β^+)Au195(n,2n)Au194				1.6
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196m(IT) Au196(β^-)Hg196(n,2n)Hg195(β^+)Au195(n,2n)Au194				1.6
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196(β^-)Hg196(n,2n) Hg195m(IT)Hg195(β^+)Au195(n,2n)Au194				1.4
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196(n,2n)Au195(n,2n) Au194m(IT)Au194				1.3
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196(n,2n)Au195m(IT) Au195(n,2n)Au194				1.2
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196(β^-)Hg196(n,2n) Hg195m(β^+)Au195(n,2n)Au194				1.2
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196(β^-)Hg196(n,2n) Hg195(β^+)Au195(n,2n)Au194				1.2
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196(β^-) Hg196(n,2n)Hg195m(IT)Hg195(β^+)Au195(n,2n)Au194				1.1
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196(n,2n) Au195(n,2n)Au194m(IT)Au194				1.1
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196(n,2n) Au195m(IT)Au195(n,2n)Au194				1.0
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196m(IT)Au196(n,2n) Au195(n,2n)Au194				1.0
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196(β^-) Hg196(n,2n)Hg195m(β^+)Au195(n,2n)Au194				1.0
Ir188	1.73d	Pt190(n,2n)Pt189(β^+)Ir189(n,2n)Ir188				93.8
		Pt190(n,2n)Pt189(n,2n)Pt188(β^+)Ir188				3.2
		Pt192(n,2n)Pt191(β^+)Ir191(n,2n)Ir190(n,2n) Ir189(n,2n)Ir188				1.6
Au198	2.69d	Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	48.9	94.0	87.8	
		Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	47.7	2.8		
		Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198	1.9			
		Pt196(n,γ)Pt197m(IT)Pt197(β^-)Au197(n,γ)Au198		3.0	10.8	
		Pt198(n,2n)Pt197(β^-)Au197(n,γ)Au198				50.3
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,γ)Au198				40.5
		Pt198(n,2n)Pt197(β^-)Au197(n,γ)Au198m(IT)Au198				3.7
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,γ)Au198m(IT)Au198				3.0
		Pt198(n,2n)Pt197m(β^-)Au197m(IT)Au197(n,γ)Au198				1.4
Pt191	2.80d	Pt190(n,γ)Pt191	100.0	100.0	100.0	
		Pt192(n,2n)Pt191				73.9
		Pt194(n,2n)Pt193m(IT)Pt193(n,2n)Pt192(n,2n)Pt191				14.9
		Pt194(n,2n)Pt193(n,2n)Pt192(n,2n)Pt191				9.6
Au199	3.14d	Pt198(n,γ)Pt199(β^-)Au199	46.4	99.9	95.4	65.0
		Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199	26.0			
		Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199	25.2			
		Pt194(n,γ)Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ) Au198(n,γ)Au199	1.0			
		Pt198(n,γ)Pt199m(IT)Pt199(β^-)Au199			4.6	34.9

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Re186	3.75d	Pt190(n,α)Os187(n,γ)Os188(n,α)W185(β^-)Re185(n,γ)Re186	95.3			
		Pt190(n,α)Os187(n,γ)Os188(n,α)W185m(IT)W185(β^-) Re185(n,γ)Re186	2.5			
		Pt190(n,α)Os187(n,α)W184(n,γ)W185(β^-)Re185(n,γ)Re186	1.9			
		Pt192(n,2n)Pt191(β^+)Ir191(n,nα)Re187(n,2n)Re186				49.7
		Pt192(n,2n)Pt191(β^+)Ir191(n,2n)Ir190(β^+)Os190(n,α) W187(β^-)Re187(n,2n)Re186				18.2
		Pt190(n,2n)Pt189(β^+)Ir189(n,α)Re186				9.6
		Pt192(n,2n)Pt191(β^+)Ir191(n,2n)Ir190(n,α) Re187(n,2n)Re186				4.4
		Pt192(n,2n)Pt191(β^+)Ir191(n,2n)Ir190m(IT)Ir190(β^+) Os190(n,α)W187(β^-)Re187(n,2n)Re186				3.1
		Pt192(n,2n)Pt191(β^+)Ir191(n,2n)Ir190(n,nα)Re186				2.1
		Pt194(n,2n)Pt193m(IT)Pt193(n,2n)Pt192(n,2n)Pt191(β^+) Ir191(n,nα)Re187(n,2n)Re186				1.6
		Pt194(n,2n)Pt193(n,2n)Pt192(n,2n)Pt191(β^+)Ir191(n,nα) Re187(n,2n)Re186				1.1
Pt195m	4.02d	Pt194(n,γ)Pt195m	99.1	100.0	6.6	
		Pt195(n,n′)Pt195m			92.5	13.5
		Pt196(n,2n)Pt195m				84.7
Pt193m	4.34d	Pt192(n,γ)Pt193m	99.8	100.0	94.7	
		Pt192(n,γ)Pt193(n,n′)Pt193m			4.4	
		Pt194(n,2n)Pt193m				87.4
		Pt195(n,2n)Pt194(n,2n)Pt193m				11.2
Au196	6.18d	Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196m(IT)Au196				32.3
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196m(IT)Au196				26.0
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196				19.3
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196				15.5
		Pt198(n,2n)Pt197(β^-)Au197(n,2n)Au196n(IT)Au196m(IT)Au196				2.7
		Pt198(n,2n)Pt197m(IT)Pt197(β^-)Au197(n,2n)Au196n(IT) Au196m(IT)Au196				2.2
Ir193m	10.53d	Pt190(n,γ)Pt191(β^+)Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m	47.7	56.4		
		Pt190(n,γ)Pt191(β^+)Ir191(n,γ)Ir192(n,γ)Ir193m	33.3	42.5		
		Pt194(n,α)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT) Ir192(n,γ)Ir193m	5.8			
		Pt194(n,α)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192(n,γ)Ir193m	4.1			
		Pt194(n,α)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192m(IT)Ir192(n,γ)Ir193m	2.8			
		Pt194(n,α)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ) Ir192(n,γ)Ir193m	2.0			
		Pt192(n,α)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192(n,γ)Ir193m	1.3			
		Pt192(n,γ)Pt193(β^+)Ir193(n,n′)Ir193m			82.4	
		Pt192(n,γ)Pt193m(IT)Pt193(β^+)Ir193(n,n′)Ir193m			17.3	
		Pt194(n,2n)Pt193m(IT)Pt193(n,p)Ir193m				34.8
		Pt194(n,2n)Pt193(n,p)Ir193m				22.2
		Pt194(n,2n)Pt193m(IT)Pt193(β^+)Ir193(n,n′)Ir193m				17.1
		Pt194(n,2n)Pt193(β^+)Ir193(n,n′)Ir193m				11.0
		Pt194(n,d)Ir193m				4.0
		Pt195(n,2n)Pt194(n,2n)Pt193m(IT)Pt193(n,p)Ir193m				2.2
		Pt194(n,np)Ir193m				2.2
		Pt195(n,2n)Pt194(n,2n)Pt193(n,p)Ir193m				1.4
Ir190	12.00d	Pt190(n,p)Ir190			54.7	
		Pt190(n,p)Ir190m(IT)Ir190			45.3	
		Pt192(n,2n)Pt191(β^+)Ir191(n,2n)Ir190				74.3
		Pt192(n,2n)Pt191(β^+)Ir191(n,2n)Ir190m(IT)Ir190				12.6
		Pt194(n,2n)Pt193m(IT)Pt193(n,2n)Pt192(n,2n)Pt191(β^+) Ir191(n,2n)Ir190				4.8
		Pt194(n,2n)Pt193(n,2n)Pt192(n,2n)Pt191(β^+) Ir191(n,2n)Ir190				3.1
		Pt194(n,α)Os191(β^-)Ir191m(IT)Ir191(n,2n)Ir190				1.1

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Hg203	46.62d	Pt198(n,γ)Pt199(β^-)Au199(β^-)Hg199(n,γ)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203	68.4	95.9	83.0	
		Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199(β^-)Hg199(n,γ)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203	21.5			
		Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199(β^-)Hg199(n,γ)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203	8.1			
		Pt198(n,γ)Pt199(β^-)Au199(n,γ)Au200(β^-)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203		4.0	12.1	
		Pt198(n,γ)Pt199m(IT)Pt199(β^-)Au199(β^-)Hg199(n,γ)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203			4.0	
Ir192	73.80d	Pt190(n,γ)Pt191(β^+)Ir191(n,γ)Ir192m(IT)Ir192	46.1	56.4	39.0	
		Pt190(n,γ)Pt191(β^+)Ir191(n,γ)Ir192	32.2	42.5	58.6	
		Pt194(n,α)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	6.8			
		Pt194(n,α)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	4.7			
		Pt194(n,α)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	3.2			
		Pt194(n,α)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	2.3			
		Pt192(n,α)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	1.6			
		Pt192(n,α)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	1.1			
		Pt194(n,2n)Pt193m(IT)Pt193(β^+)Ir193(n,2n)Ir192				47.7
		Pt194(n,2n)Pt193(β^+)Ir193(n,2n)Ir192				30.9
		Pt194(n,2n)Pt193m(IT)Pt193(β^+)Ir193(n,2n)Ir192m(IT)Ir192				6.0
		Pt194(n,2n)Pt193(β^+)Ir193(n,2n)Ir192m(IT)Ir192				3.9
		Pt192(n,p)Ir192				2.3
		Pt195(n,2n)Pt194(n,2n)Pt193m(IT)Pt193(β^+)Ir193(n,2n)Ir192				1.8
		Pt195(n,2n)Pt194(n,2n)Pt193(β^+)Ir193(n,2n)Ir192				1.2
Tl204	3.79y	Pt198(n,γ)Pt199(β^-)Au199(β^-)Hg199(n,γ)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204	74.4	94.1		
		Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199(β^-)Hg199(n,γ)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204	18.7			
		Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199(β^-)Hg199(n,γ)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204	5.2			
		Pt198(n,γ)Pt199(β^-)Au199(n,γ)Au200(β^-)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204		5.7		
Pt193	50.00y	Pt192(n,γ)Pt193	98.9	97.9	81.9	
		Pt192(n,γ)Pt193m(IT)Pt193		2.1	17.6	
		Pt194(n,2n)Pt193m(IT)Pt193				56.7
		Pt194(n,2n)Pt193				36.3
		Pt195(n,2n)Pt194(n,2n)Pt193m(IT)Pt193				3.7
		Pt195(n,2n)Pt194(n,2n)Pt193				2.4
Ir192n	241.00y	Pt194(n,α)Os191(n,γ)Os192m(β^-)Ir192n	52.1			
		Pt194(n,α)Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	25.0			
		Pt192(n,α)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	12.0			
		Pt190(n,γ)Pt191(β^+)Ir191(n,γ)Ir192n	4.0	99.0	94.7	
		Pt192(n,α)Os189m(IT)Os189(n,γ)Os190(n,γ)Os191m(IT)Os191(n,γ)Os192m(β^-)Ir192n	2.3			
		Pt192(n,α)Os189(n,γ)Os190(n,γ)Os191(n,γ)Os192m(β^-)Ir192n	1.5			
		Pt190(n,γ)Pt191(β^+)Ir191m(IT)Ir191(n,γ)Ir192n		1.0	1.0	
		Pt190(n,γ)Pt191(β^+)Ir191(n,γ)Ir192(n,n′)Ir192n			1.9	
		Pt190(n,γ)Pt191(β^+)Ir191(n,γ)Ir192m(IT)Ir192(n,n′)Ir192n			1.3	
		Pt194(n,2n)Pt193m(IT)Pt193(β^+)Ir193(n,2n)Ir192n				48.5
		Pt194(n,2n)Pt193(β^+)Ir193(n,2n)Ir192n				31.6
		Pt195(n,α)Os192m(β^-)Ir192n				10.4
		Pt192(n,p)Ir192n				2.3
		Pt195(n,2n)Pt194(n,2n)Pt193m(IT)Pt193(β^+)Ir193(n,2n)Ir192n				1.6
		Pt195(n,2n)Pt194(n,2n)Pt193(β^+)Ir193(n,2n)Ir192n				1.0

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Re186m	2.0 10^5y	Pt190(n,α)Os187(n,γ)Os188(n,α)W185(β^-)Re185(n,γ)Re186m	95.4			
		Pt190(n,α)Os187(n,γ)Os188(n,α)W185m(IT)W185(β^-) Re185(n,γ)Re186m	2.5			
		Pt190(n,α)Os187(n,α)W184(n,γ)W185(β^-)Re185(n,γ)Re186m	1.9			
		Pt190(n,2n)Pt189(β^+)Ir189(n,α)Re186m				53.6
		Pt192(n,2n)Pt191(β^+)Ir191(n,nα)Re187(n,2n)Re186m				20.4
		Pt192(n,2n)Pt191(β^+)Ir191(n,2n)Ir190(n,nα)Re186m				9.2
		Pt192(n,2n)Pt191(β^+)Ir191(n,2n)Ir190(β^+)Os190(n,α) W187(β^-)Re187(n,2n)Re186m				5.6
		Pt192(n,2n)Pt191(β^+)Ir191(n,2n)Ir190(n,α) Re187(n,2n)Re186m				1.7
		Pt192(n,2n)Pt191(β^+)Ir191(n,2n)Ir190m(IT) Ir190(n,nα)Re186m				1.6
Pb205	1.5 10^7y	Pt198(n,γ)Pt199(β^-)Au199(β^-)Hg199(n,γ)Hg200(n,γ) Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204(β^-) Pb204(n,γ)Pb205	78.8			
		Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ)Au199(β^-) Hg199(n,γ)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203(β^-) Tl203(n,γ)Tl204(β^-)Pb204(n,γ)Pb205	16.2			
		Pt195(n,γ)Pt196(n,γ)Pt197(β^-)Au197(n,γ)Au198(n,γ) Au199(β^-)Hg199(n,γ)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ) Hg203(β^-)Tl203(n,γ)Tl204(β^-)Pb204(n,γ)Pb205	3.4			
Pt190	6.5 10^{11}y	no pathways found				

Gold

Isotope	Atom % abundance
Au197	100.00

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.83E+15	3.38E+15	1.45E+15	1.07E+11	3.97E+06	3.92E-03
Au198	69.9	79.1	72.0			
Au196	14.7	16.7	25.9			
Au196m	9.5	0.8				
Au197m	2.9					
Hg197	0.9	1.0	1.1			
Au195				99.8		
Pt193					80.4	
H3				0.2	18.7	
Hg194					0.3	99.4

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.75E-01	3.63E-01	1.53E-01	2.20E-06	2.53E-11	1.67E-20
Au198	83.3	86.0	79.7			
Au196	12.1	12.5	19.7			
Au197m	1.9					
Au196m	1.2	0.1				
Au195				100.0		
Pt193					84.1	
Au194					9.1	
Ir192					3.4	
H3					2.7	
Hg194					0.2	82.3
Hg196						17.7

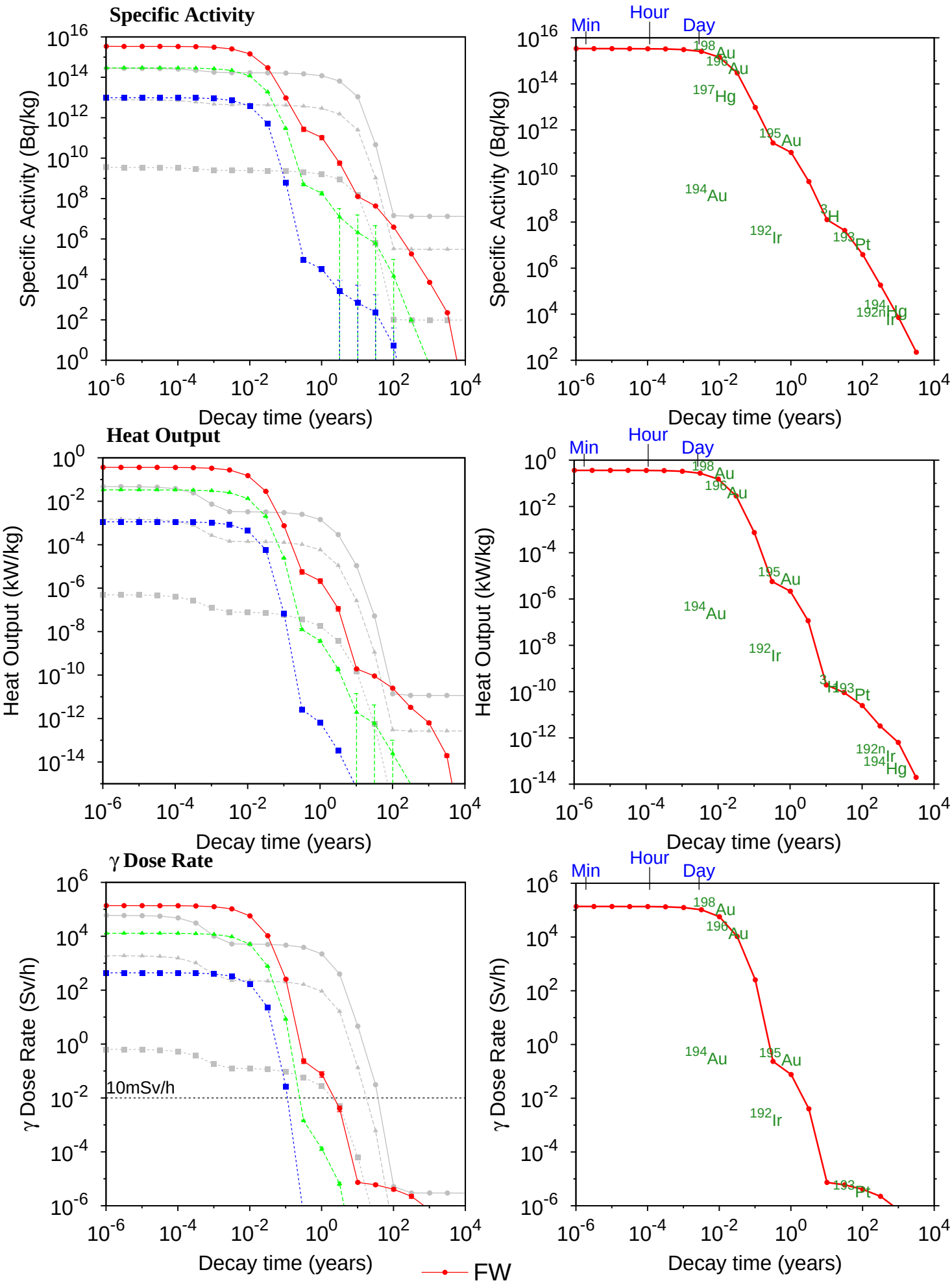
Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.37E+05	1.37E+05	5.77E+04	7.78E-02	4.10E-06	6.91E-16
Au198	88.0	88.5	82.0			
Au196	11.3	11.4	18.0			
Au195				99.9		
Au194					68.2	
Pt193					23.0	
Ir192				0.1	8.7	
Hg194					0.1	100.0

Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.97E+06	2.96E+06	1.22E+06	2.67E+01	8.29E-04	1.99E-10
Au198	90.1	90.1	85.6			
Au196	8.4	8.4	13.6			
Au195				100.0		
Hg194					82.6	99.9
Pt193					11.9	
H3					3.8	

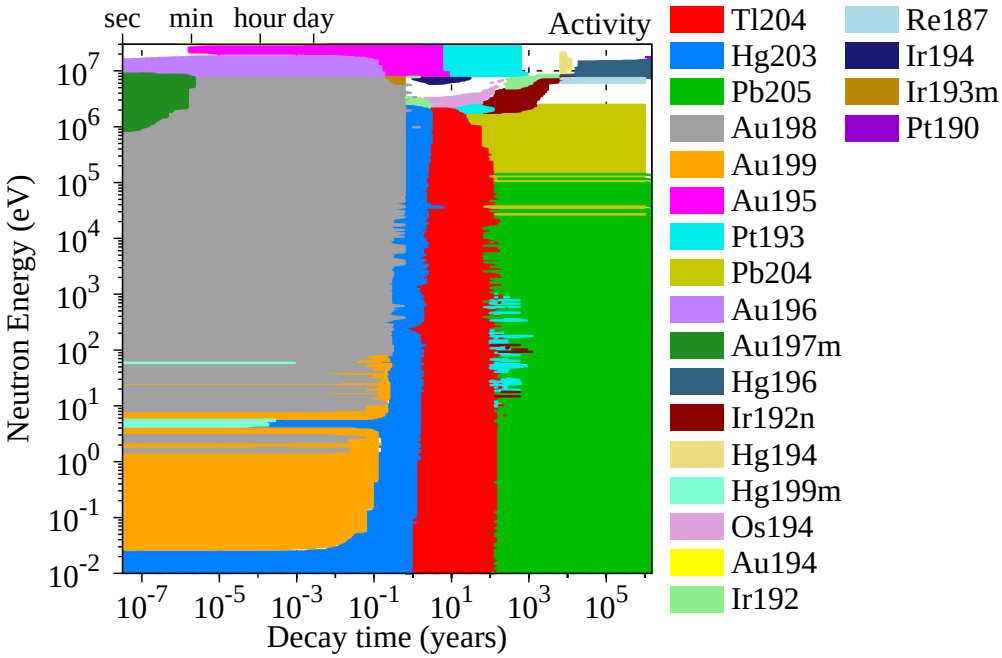
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.57E+06	2.57E+06	1.05E+06	1.82E+02	6.86E-04	5.47E-11
Au198	89.5	89.5	85.4			
Au196	8.1	8.1	13.2			
Au195			0.1	100.0		
Ir192n					29.2	
H3					28.2	
Hg194					27.4	99.7
Pt193					9.8	
Ir192					5.0	

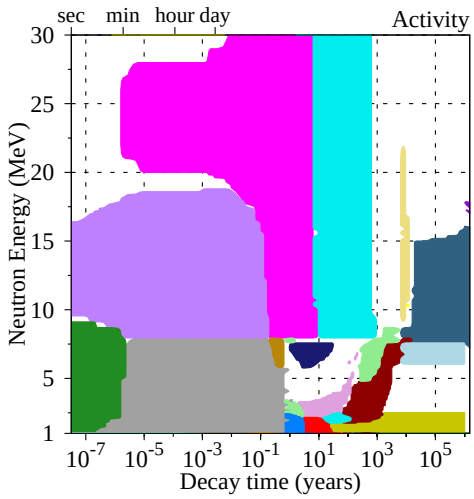
Clear	0s	5.3m	3.7d	1y	100y	10^4y
	5.76E+11	5.45E+11	2.84E+11	9.71E+06	1.37E+02	6.18E-08
Au196	46.6	49.2	63.0			
Au198	46.4	49.0	36.8			
Au197m	4.7	0.1				
Au196n	1.3	1.4				
Au195				100.0		
Pt193					80.5	
Au194					10.1	
H3					5.4	
Ir192					3.8	
Hg194					0.2	97.0
Hg196						3.0

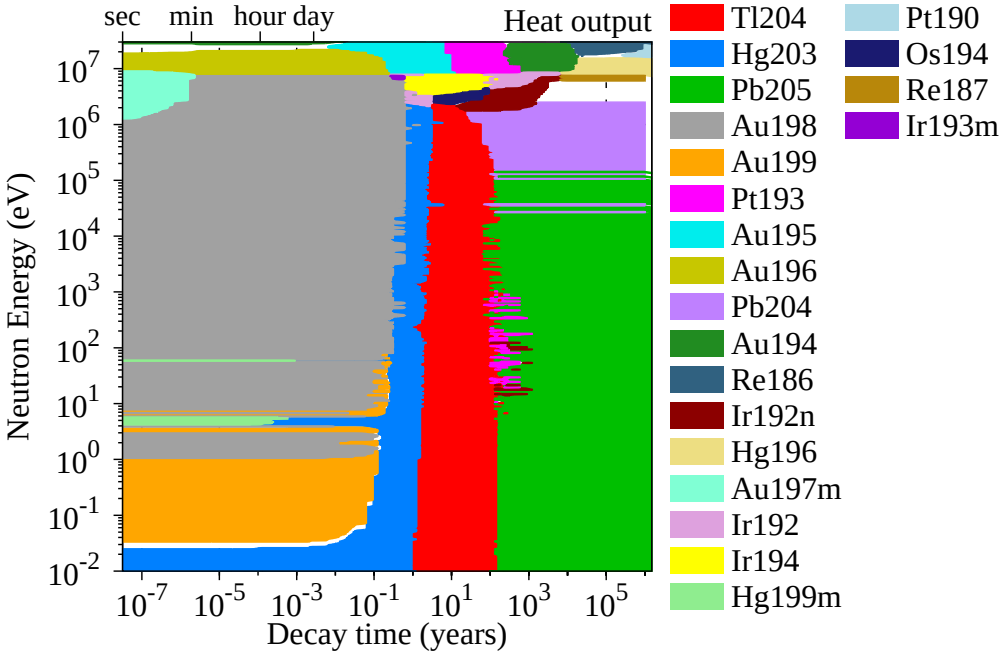
Gold activation characteristics

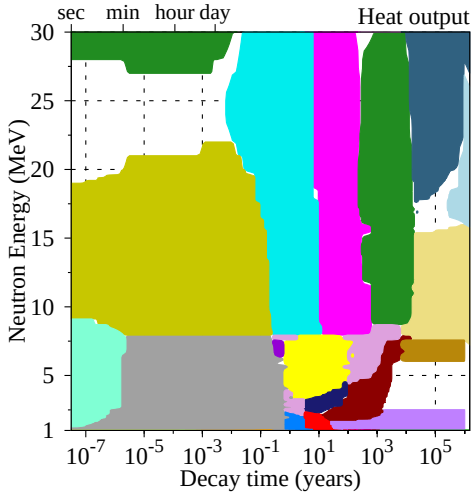


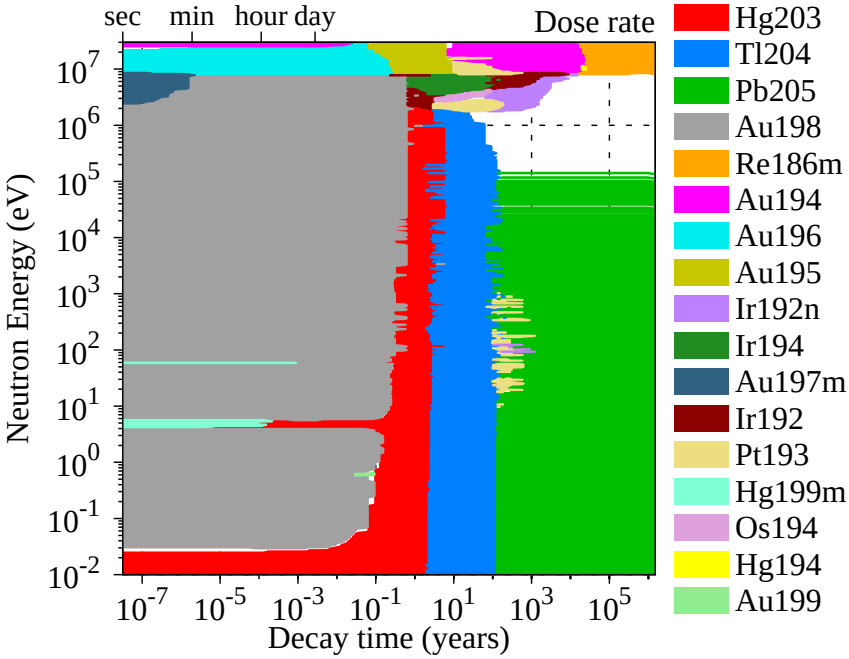
Gold Importance diagrams

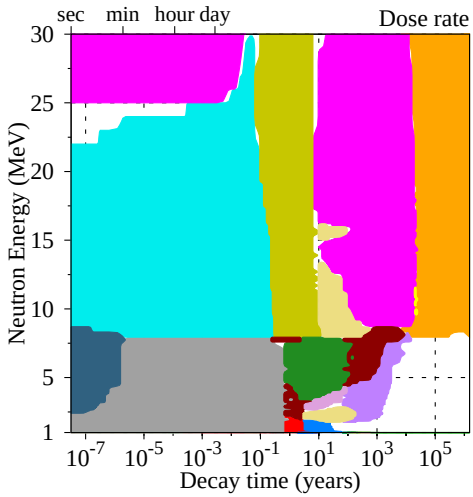




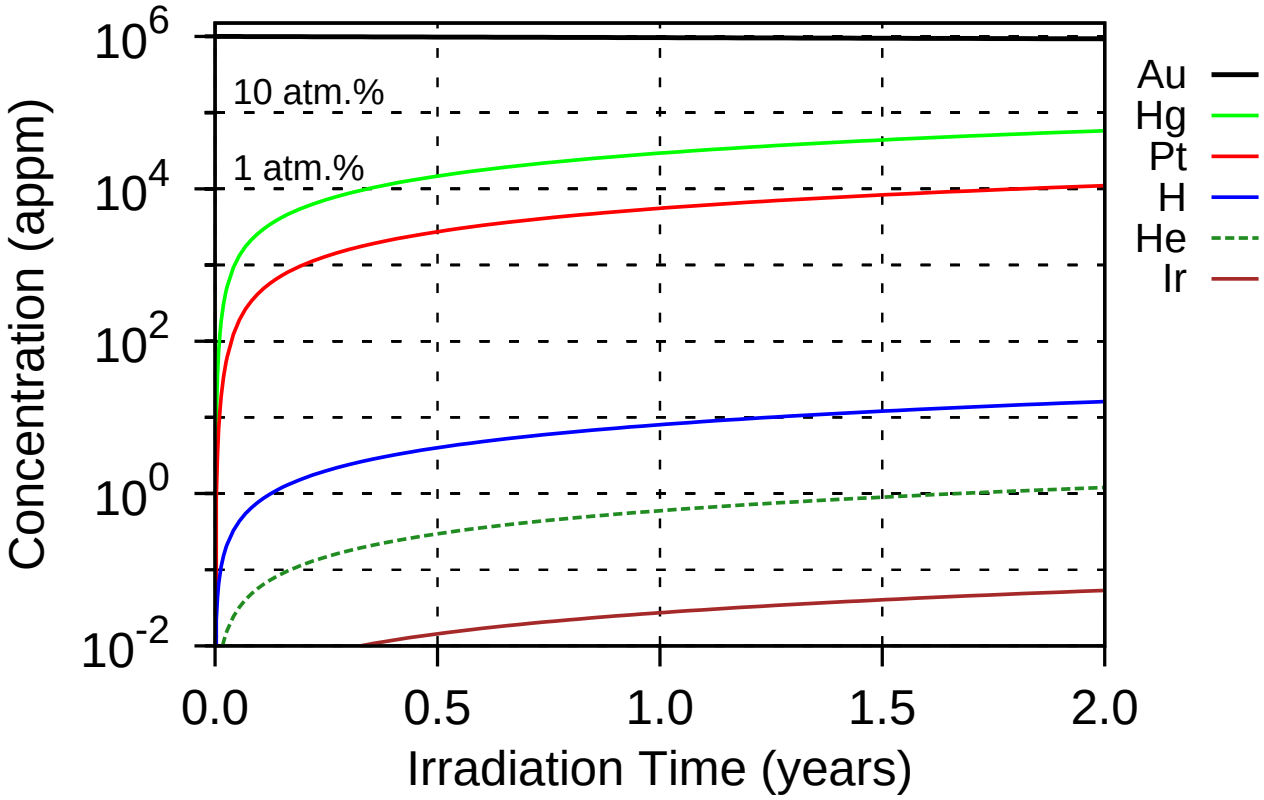








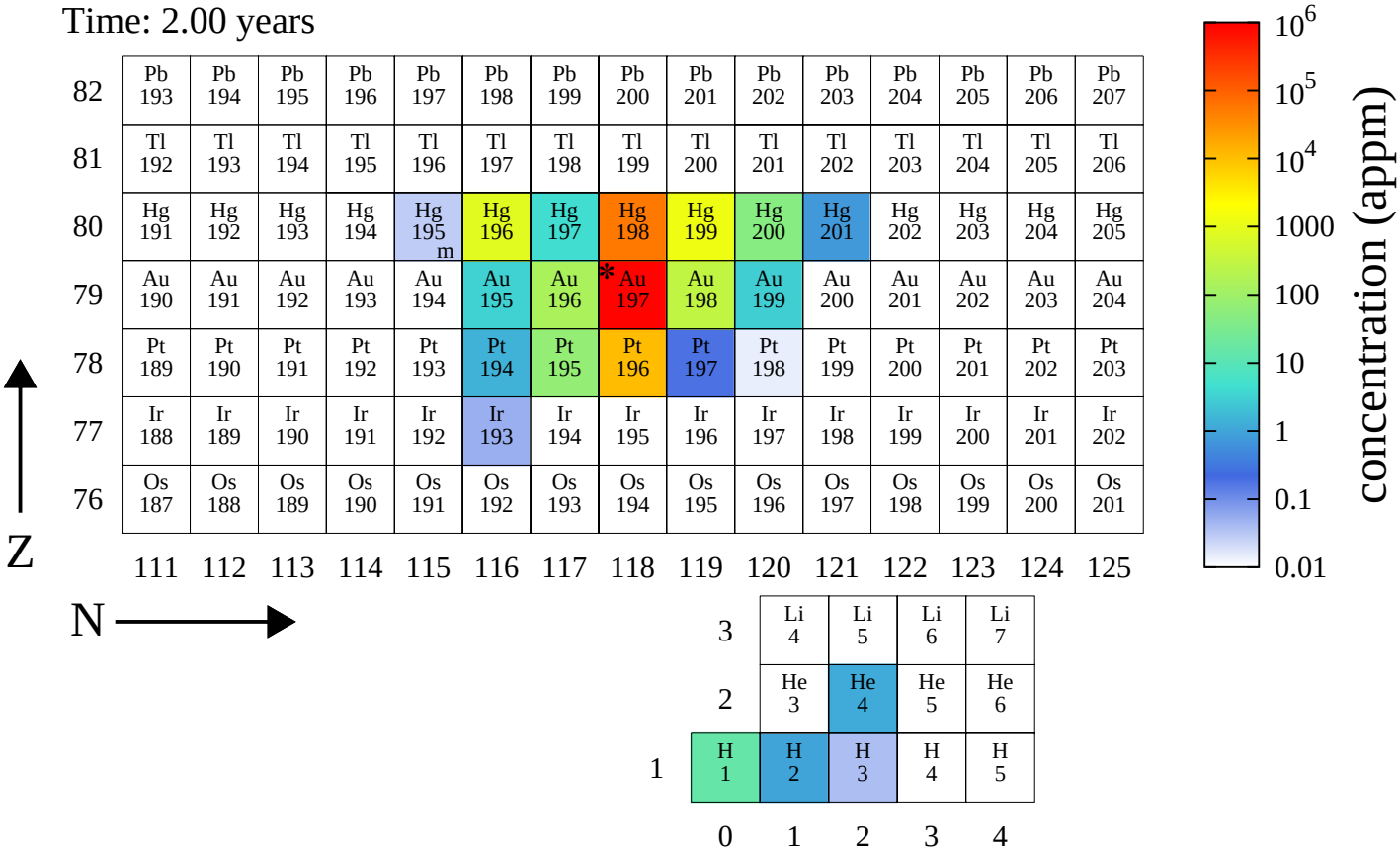
Gold FW Transmutation



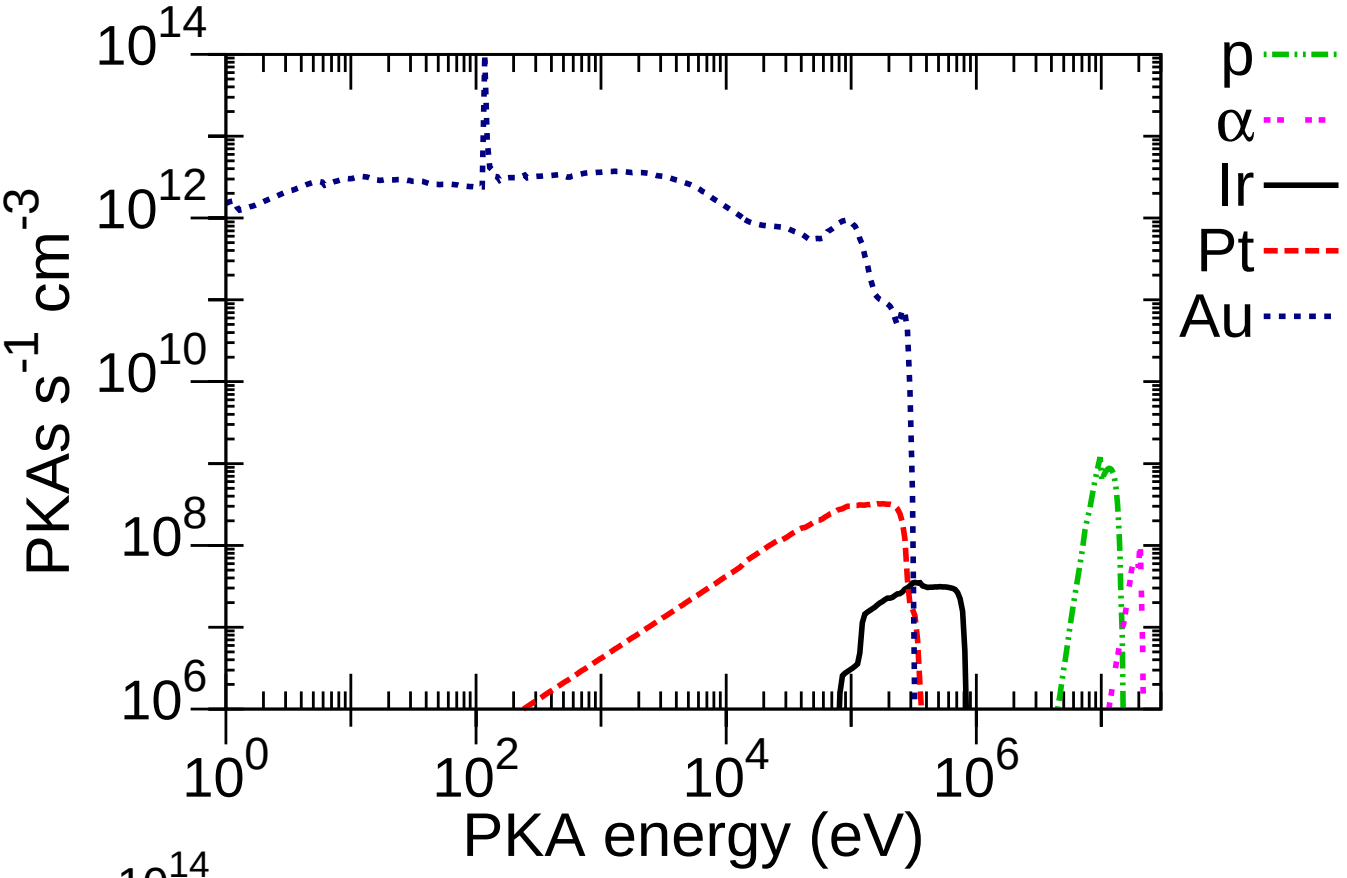
1 appm He & 8 appm H after 1 year

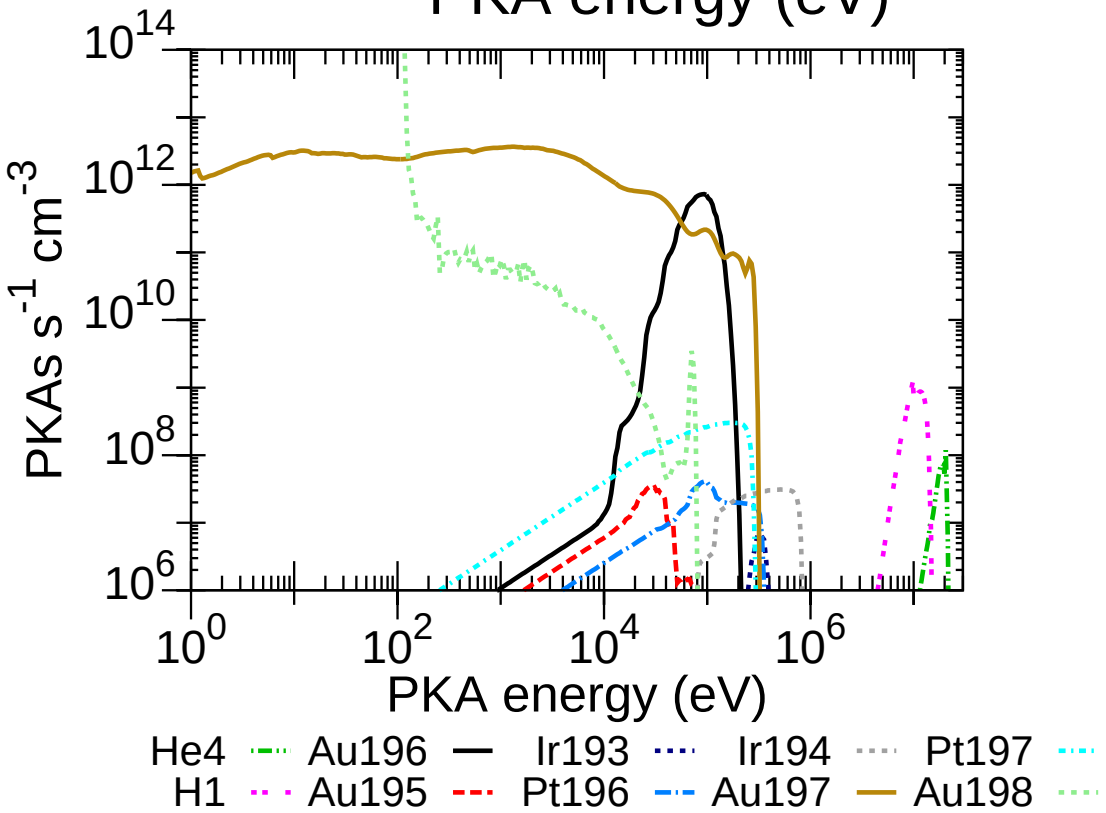
11 dpa/year

Time: 2.00 years



Gold FW PKA distributions





Gold Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Au197m	7.74s	Au197(n,γ)Au198(n,γ)Au199(β^-)Hg199(n,α)Pt196(n,γ) Pt197m(β^-)Au197m	97.4			
		Au197(n,γ)Au198(n,α)Ir195(β^-)Pt195(n,γ)Pt196(n,γ) Pt197m(β^-)Au197m	1.2			
		Au197(n,γ)Au198(β^-)Hg198(n,γ)Hg199(n,α)Pt196(n,γ) Pt197m(β^-)Au197m	1.1			
		Au197(n,n′)Au197m			100.0	99.4
Au196m	8.10s	Au197(n,2n)Au196m				91.8
		Au197(n,2n)Au196n(IT)Au196m				7.7
Hg199m	42.10m	Au197(n,γ)Au198(β^-)Hg198(n,γ)Hg199m	100.0	100.0	93.5	
		Au197(n,γ)Au198(β^-)Hg198(n,γ)Hg199(n,n′)Hg199m			6.3	
Au196n	9.60h	Au197(n,2n)Au196n				99.5
Ir194	19.30h	Au197(n,α)Ir194	100.0	100.0	99.3	90.1
		Au197(n,α)Ir194m(IT)Ir194				8.2
Au194	1.58d	Au197(n,2n)Au196m(IT)Au196(β^-)Hg196(n,2n)Hg195m(IT) Hg195(β^+)Au195(n,2n)Au194m(IT)Au194				11.4
		Au197(n,2n)Au196m(IT)Au196(β^-)Hg196(n,2n)Hg195m(β^+) Au195(n,2n)Au194m(IT)Au194				9.9
		Au197(n,2n)Au196m(IT)Au196(β^-)Hg196(n,2n)Hg195(β^+) Au195(n,2n)Au194m(IT)Au194				9.7
		Au197(n,2n)Au196(β^-)Hg196(n,2n)Hg195m(IT)Hg195(β^+) Au195(n,2n)Au194m(IT)Au194				6.8
		Au197(n,2n)Au196(β^-)Hg196(n,2n)Hg195m(β^+)Au195(n,2n) Au194m(IT)Au194				5.9
		Au197(n,2n)Au196(β^-)Hg196(n,2n)Hg195(β^+)Au195(n,2n) Au194m(IT)Au194				5.8
		Au197(n,2n)Au196m(IT)Au196(n,2n)Au195m(IT)Au195(n,2n) Au194m(IT)Au194				5.6
		Au197(n,2n)Au196m(IT)Au196(β^-)Hg196(n,2n)Hg195m(IT) Hg195(β^+)Au195(n,2n)Au194				4.9
		Au197(n,2n)Au196m(IT)Au196(β^-)Hg196(n,2n)Hg195m(β^+) Au195(n,2n)Au194				4.2
		Au197(n,2n)Au196m(IT)Au196(β^-)Hg196(n,2n)Hg195(β^+) Au195(n,2n)Au194				4.2
		Au197(n,2n)Au196(n,2n)Au195m(IT)Au195(n,2n) Au194m(IT)Au194				3.3
		Au197(n,2n)Au196(β^-)Hg196(n,2n)Hg195m(IT)Hg195(β^+) Au195(n,2n)Au194				2.9
		Au197(n,2n)Au196m(IT)Au196(n,2n)Au195(n,2n) Au194m(IT)Au194				2.7
		Au197(n,2n)Au196(β^-)Hg196(n,2n)Hg195m(β^+) Au195(n,2n)Au194				2.5
		Au197(n,2n)Au196(β^-)Hg196(n,2n)Hg195(β^+)Au195(n,2n)Au194				2.5
		Au197(n,2n)Au196m(IT)Au196(n,2n)Au195m(IT) Au195(n,2n)Au194				2.4
		Au197(n,2n)Au196(n,2n)Au195(n,2n)Au194m(IT)Au194				1.6
		Au197(n,2n)Au196(n,2n)Au195m(IT)Au195(n,2n)Au194				1.4
		Au197(n,2n)Au196m(IT)Au196(n,2n)Au195(n,2n)Au194				1.1
		Au197(n,2n)Au196n(IT)Au196m(IT)Au196(β^-)Hg196(n,2n) Hg195m(IT)Hg195(β^+)Au195(n,2n)Au194m(IT)Au194				1.0
Hg197	2.69d	Au197(n,γ)Au198(β^-)Hg198(n,2n)Hg197m(IT)Hg197				46.1
		Au197(n,γ)Au198(β^-)Hg198(n,2n)Hg197				39.9
		Au197(n,γ)Au198m(IT)Au198(β^-)Hg198(n,2n)Hg197m(IT)Hg197				3.4
		Au197(n,γ)Au198m(IT)Au198(β^-)Hg198(n,2n)Hg197				3.0
		Au197(n,2n)Au196m(IT)Au196(β^-)Hg196(n,γ)Hg197m(IT)Hg197				2.2
		Au197(n,2n)Au196m(IT)Au196(β^-)Hg196(n,γ)Hg197				2.1
		Au197(n,2n)Au196(β^-)Hg196(n,γ)Hg197m(IT)Hg197				1.3
		Au197(n,2n)Au196(β^-)Hg196(n,γ)Hg197				1.3
Au198	2.69d	Au197(n,γ)Au198	100.0	100.0	99.8	92.5
		Au197(n,γ)Au198m(IT)Au198				6.9
Au199	3.14d	Au197(n,γ)Au198(n,γ)Au199	100.0	100.0	97.8	
		Au197(n,γ)Au198m(n,γ)Au199			2.0	
Re186	3.75d	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Au196	6.18d	Au197(n,2n)Au196m(IT)Au196				59.1
		Au197(n,2n)Au196				35.3
		Au197(n,2n)Au196n(IT)Au196m(IT)Au196				5.0
Ir193m	10.53d	Au197(n,nα)Ir193m				84.3
		Au197(n,2n)Au196m(IT)Au196(n,α)Ir193m				5.5
		Au197(n,2n)Au196(n,α)Ir193m				3.3
Hg203	46.62d	Au197(n,γ)Au198(n,γ)Au199(β^-)Hg199(n,γ)Hg200(n,γ) Hg201(n,γ)Hg202(n,γ)Hg203	98.5	9.1		
		Au197(n,γ)Au198(n,γ)Au199(n,γ)Au200(β^-)Hg200(n,γ) Hg201(n,γ)Hg202(n,γ)Hg203	1.1			
		Au197(n,γ)Au198(β^-)Hg198(n,γ)Hg199(n,γ)Hg200(n,γ) Hg201(n,γ)Hg202(n,γ)Hg203		90.0		
Ir192	73.80d	Au197(n,α)Ir194(β^-)Pt194(n,α)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192	39.8			
		Au197(n,α)Ir194(β^-)Pt194(n,α)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192	27.8			
		Au197(n,α)Ir194(β^-)Pt194(n,α)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	19.1			
		Au197(n,α)Ir194(β^-)Pt194(n,α)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192	13.3			
		Au197(n,2n)Au196m(IT)Au196(β^+)Pt196(n,α)Os193(β^-) Ir193(n,2n)Ir192				24.5
		Au197(n,nα)Ir193m(IT)Ir193(n,2n)Ir192				22.6
		Au197(n,2n)Au196(β^+)Pt196(n,α)Os193(β^-)Ir193(n,2n)Ir192				14.6
		Au197(n,nα)Ir193(n,2n)Ir192				9.5
		Au197(n,2n)Au196m(IT)Au196(β^+)Pt196(n,α)Os193(β^-) Ir193(n,2n)Ir192m(IT)Ir192				3.1
		Au197(n,nα)Ir193m(IT)Ir193(n,2n)Ir192m(IT)Ir192				2.8
		Au197(n,2n)Au196n(IT)Au196m(IT)Au196(β^+)Pt196(n,α) Os193(β^-)Ir193(n,2n)Ir192				2.1
		Au197(n,2n)Au196(β^+)Pt196(n,α)Os193(β^-)Ir193(n,2n) Ir192m(IT)Ir192				1.8
		Au197(n,2n)Au196m(IT)Au196(n,α)Ir193m(IT) Ir193(n,2n)Ir192				1.5
		Au197(n,nα)Ir193(n,2n)Ir192m(IT)Ir192				1.2
Au195	186.09d	Au197(n,2n)Au196m(IT)Au196(β^-)Hg196(n,2n)Hg195m(IT) Hg195(β^+)Au195				16.9
		Au197(n,2n)Au196m(IT)Au196(β^-)Hg196(n,2n)Hg195m(β^+)Au195				14.6
		Au197(n,2n)Au196m(IT)Au196(β^-)Hg196(n,2n)Hg195(β^+)Au195				14.4
		Au197(n,2n)Au196(β^-)Hg196(n,2n)Hg195m(IT)Hg195(β^+)Au195				10.1
		Au197(n,2n)Au196(β^-)Hg196(n,2n)Hg195m(β^+)Au195				8.7
		Au197(n,2n)Au196(β^-)Hg196(n,2n)Hg195(β^+)Au195				8.6
		Au197(n,2n)Au196m(IT)Au196(n,2n)Au195m(IT)Au195				8.2
		Au197(n,2n)Au196(n,2n)Au195m(IT)Au195				4.9
		Au197(n,2n)Au196m(IT)Au196(n,2n)Au195				3.9
		Au197(n,2n)Au196(n,2n)Au195				2.3
		Au197(n,2n)Au196n(IT)Au196m(IT)Au196(β^-)Hg196(n,2n) Hg195m(IT)Hg195(β^+)Au195				1.4
		Au197(n,2n)Au196n(IT)Au196m(IT)Au196(β^-)Hg196(n,2n) Hg195m(β^+)Au195				1.2
		Au197(n,2n)Au196n(IT)Au196m(IT)Au196(β^-)Hg196(n,2n) Hg195(β^+)Au195				1.2
Tl204	3.79y	Au197(n,γ)Au198(n,γ)Au199(β^-)Hg199(n,γ)Hg200(n,γ) Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204	98.6	12.0		
		Au197(n,γ)Au198(n,γ)Au199(n,γ)Au200(β^-)Hg200(n,γ) Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204	1.1			
		Au197(n,γ)Au198(β^-)Hg198(n,γ)Hg199(n,γ)Hg200(n,γ) Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204		86.8		
Os194	5.99y	no pathways found				
H3	12.33y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Pt193	50.00y	Au197(n,2n)Au196m(IT)Au196(β^+)Pt196(n,2n)Pt195m(IT) Pt195(n,2n)Pt194(n,2n)Pt193m(IT)Pt193				15.5
		Au197(n,2n)Au196m(IT)Au196(β^+)Pt196(n,2n)Pt195(n,2n) Pt194(n,2n)Pt193m(IT)Pt193				12.7
		Au197(n,2n)Au196m(IT)Au196(β^+)Pt196(n,2n)Pt195m(IT) Pt195(n,2n)Pt194(n,2n)Pt193				10.2
		Au197(n,2n)Au196(β^+)Pt196(n,2n)Pt195m(IT)Pt195(n,2n) Pt194(n,2n)Pt193m(IT)Pt193				9.3
		Au197(n,2n)Au196m(IT)Au196(β^+)Pt196(n,2n)Pt195(n,2n) Pt194(n,2n)Pt193				8.3
		Au197(n,2n)Au196(β^+)Pt196(n,2n)Pt195(n,2n)Pt194(n,2n) Pt193m(IT)Pt193				7.6
		Au197(n,2n)Au196(β^+)Pt196(n,2n)Pt195m(IT)Pt195(n,2n) Pt194(n,2n)Pt193				6.1
		Au197(n,2n)Au196(β^+)Pt196(n,2n)Pt195(n,2n) Pt194(n,2n)Pt193				5.0
		Au197(n,α)Ir194(β^-)Pt194(n,2n)Pt193m(IT)Pt193				3.3
		Au197(n,α)Ir194(β^-)Pt194(n,2n)Pt193				2.1
		Au197(n,2n)Au196n(IT)Au196m(IT)Au196(β^+)Pt196(n,2n) Pt195m(IT)Pt195(n,2n)Pt194(n,2n)Pt193m(IT)Pt193				1.3
		Au197(n,2n)Au196n(IT)Au196m(IT)Au196(β^+)Pt196(n,2n) Pt195(n,2n)Pt194(n,2n)Pt193m(IT)Pt193				1.1
Ir192n	241.00y	no pathways found				
Hg194	444.00y	no pathways found				
Re186m	2.0 10^5y	no pathways found				
Pb205	1.5 10^7y	Au197(n,γ)Au198(n,γ)Au199(β^-)Hg199(n,γ)Hg200(n,γ) Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204(β^-) Pb204(n,γ)Pb205	98.7			
		Au197(n,γ)Au198(n,γ)Au199(n,γ)Au200(β^-)Hg200(n,γ) Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204(β^-) Pb204(n,γ)Pb205	1.1			
Re187	4.4 10^{10}y	no pathways found				
Pt190	6.5 10^{11}y	no pathways found				
Pb204	1.4 10^{17}y	Au197(n,γ)Au198(n,γ)Au199(β^-)Hg199(n,γ)Hg200(n,γ) Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204(β^-)Pb204	98.7			
		Au197(n,γ)Au198(n,γ)Au199(n,γ)Au200(β^-)Hg200(n,γ) Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204(β^-)Pb204	1.1			
Hg196	2.5 10^{18}y	no pathways found				

Mercury

Isotope	Atom % abundance
Hg196	0.15
Hg198	9.97
Hg199	16.87
Hg200	23.10
Hg201	13.18
Hg202	29.86
Hg204	6.87

($T_{1/2}$ =2.5 10^{18}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	2.46E+14	2.36E+14	8.45E+13	6.34E+11	2.55E+06	8.56E+00
Hg199m	35.4	33.9				
Hg197	23.2	24.2	32.6			
Hg203	21.3	22.2	58.7	36.2		
Hg197m	12.7	13.2	2.9			
Au198	2.6	2.7	3.0			
Hg205	1.9	1.0				
Au197m	1.1	1.1	0.3			
Tl204	0.1	0.1	0.3	34.0	0.3	
Au195	0.3	0.3	0.9	29.9		
Pt193					89.0	
H3					7.3	
Au194					1.7	0.2
Hg194					1.7	0.2
Pb205						93.6
Tl202	0.2	0.2	0.5			3.0
Pb202						3.0

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	1.45E-02	1.37E-02	3.83E-03	2.45E-05	2.33E-11	1.14E-16
Hg199m	51.1	49.8				
Hg203	19.4	20.6	69.8	50.5		
Hg197m	9.6	10.2	2.9			
Hg197	9.0	9.5	16.4			
Au198	5.1	5.5	7.6			
Hg205	2.7	1.4				
Au197m	1.3	1.3	0.4			
Tl204	0.1	0.1	0.3	33.6	1.4	
Au195	0.1	0.1	0.4	16.0		
Pt193					65.0	
Au194					32.0	2.6
Pb205						77.0
Tl202	0.3	0.3	0.8			17.5
Pb202						2.8

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.12E+03	1.08E+03	4.85E+02	1.61E+00	9.75E-06	1.81E-11
Hg199m	31.1	29.5				
Hg203	29.9	31.0	65.6	91.5		
Au198	25.3	26.2	22.9			
Hg197	3.2	3.3	3.5			
Tl202	2.0	2.1	3.8			63.0
Au196	1.7	1.8	2.7			
Hg197m	1.5	1.6	0.3			
Au197m	1.5	1.5	0.3			
Hg195	1.1	1.2	0.4			
Au195			0.1	8.3		
Au194	0.1	0.1			93.1	19.5
Pt193					6.7	
Pb205						16.8

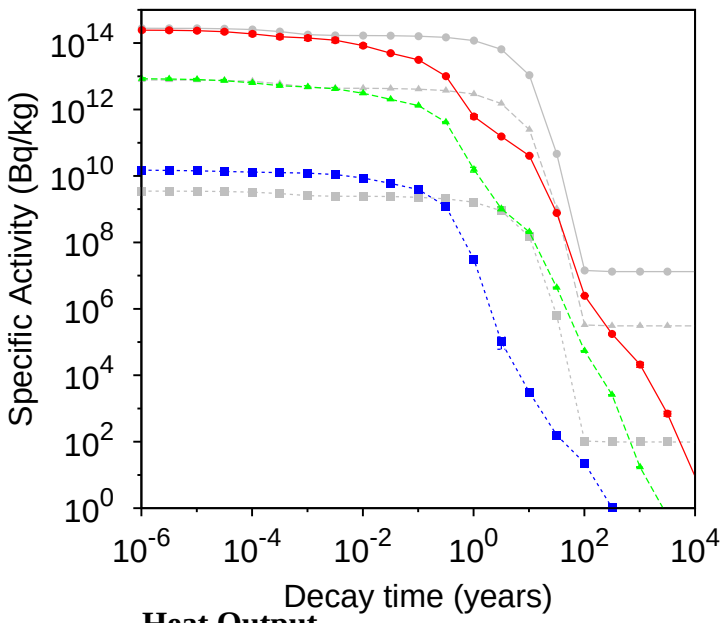
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.38E+05	1.38E+05	1.05E+05	7.41E+02	2.33E-03	5.48E-09
Hg203	72.1	72.2	89.5	58.8		
Hg197m	10.7	10.6	1.1			
Hg197	9.5	9.5	6.0			
Au198	4.6	4.6	2.4			
Hg199m	2.0	1.8				
Tl204	0.2	0.2	0.3	34.8	0.4	
Au195	0.1	0.1	0.2	6.4		
Hg194					95.4	15.9
Pt193					3.0	
Pb205						41.0
Pb202						40.9
Tl202	0.2	0.2	0.2			2.1

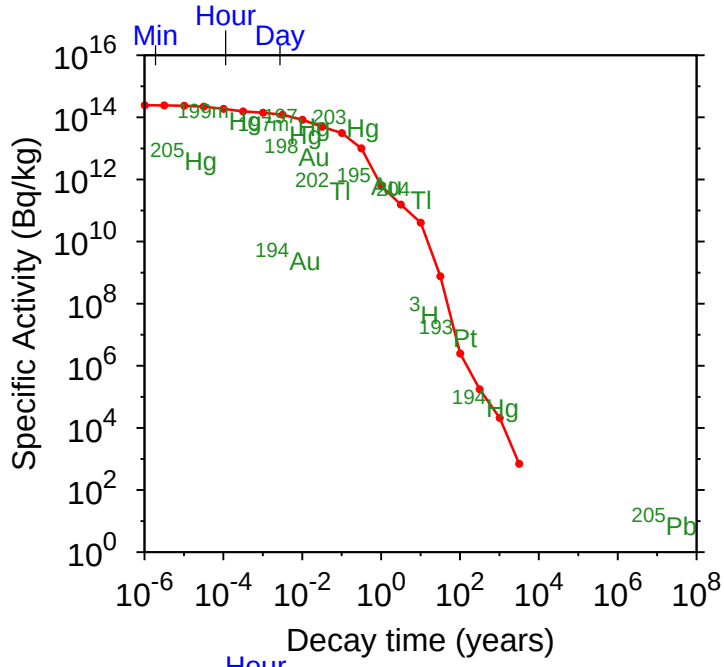
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.70E+05	1.70E+05	1.33E+05	9.56E+02	7.30E-04	1.02E-08
Hg203	73.9	74.0	89.8	57.6		
Hg197	10.1	10.1	6.2			
Hg197m	9.8	9.7	1.0			
Au198	3.2	3.2	1.6			
Hg199m	1.6	1.5				
Au195	0.7	0.7	0.9	33.6		
Tl204	0.1	0.1	0.1	8.8	0.5	
Hg194					83.7	2.3
H3					6.6	
Pt193					6.5	
Au194					1.4	
Ir192n					1.0	
Pb205						67.0
Pb202						30.1

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.78E+10	2.60E+10	6.21E+09	2.55E+08	1.35E+02	5.33E-04
Hg199m	68.2	66.9				
Hg203	18.8	20.1	79.9	9.0		
Au197m	2.5	2.5	0.8			
Au198	2.3	2.5	4.0			
Hg197	2.1	2.2	4.4			
Au196	1.2	1.3	3.7			
Hg197m	1.1	1.2	0.4			
Tl204	0.9	1.0	4.2	84.3	6.3	
Au195	0.2	0.3	1.1	6.7		
Pt193					58.3	
Au194					33.5	3.3
H3					1.4	
Pb205						88.5
Tl202	0.2	0.2	0.7			4.8
Pb202						3.4

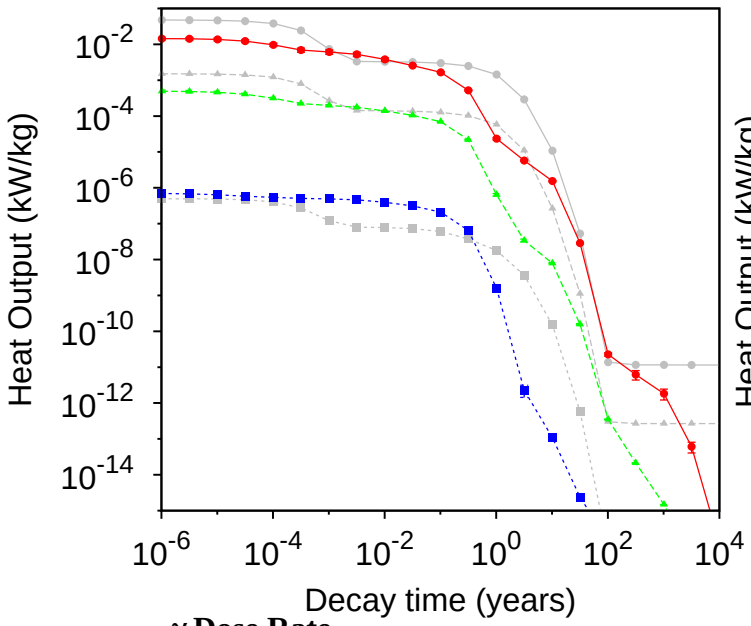
Mercury activation characteristics

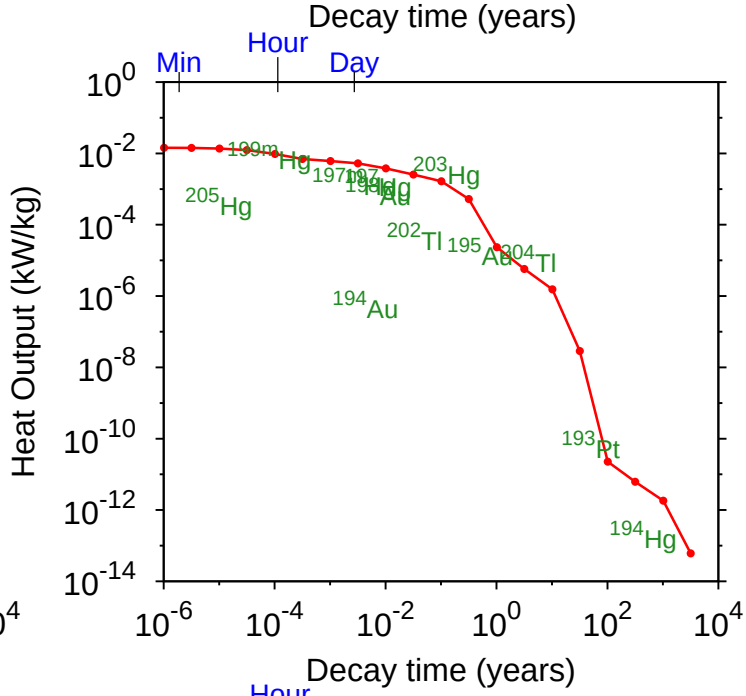
Specific Activity



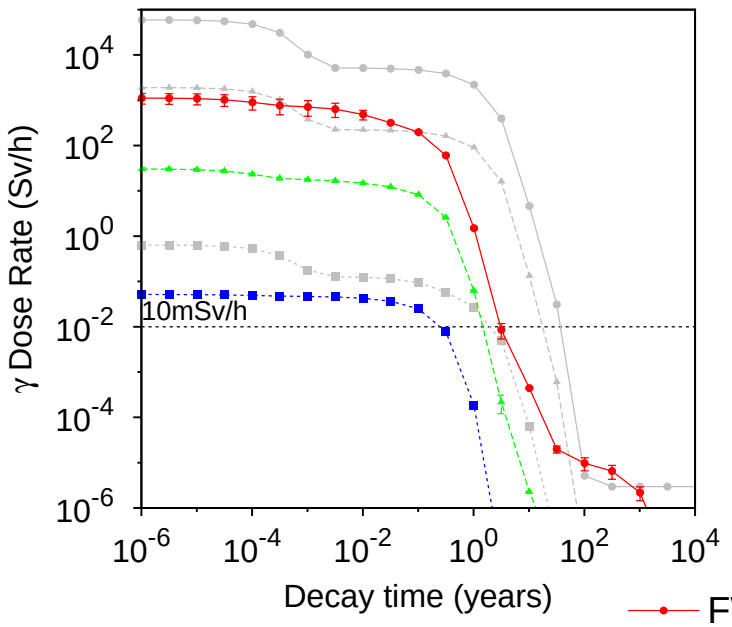


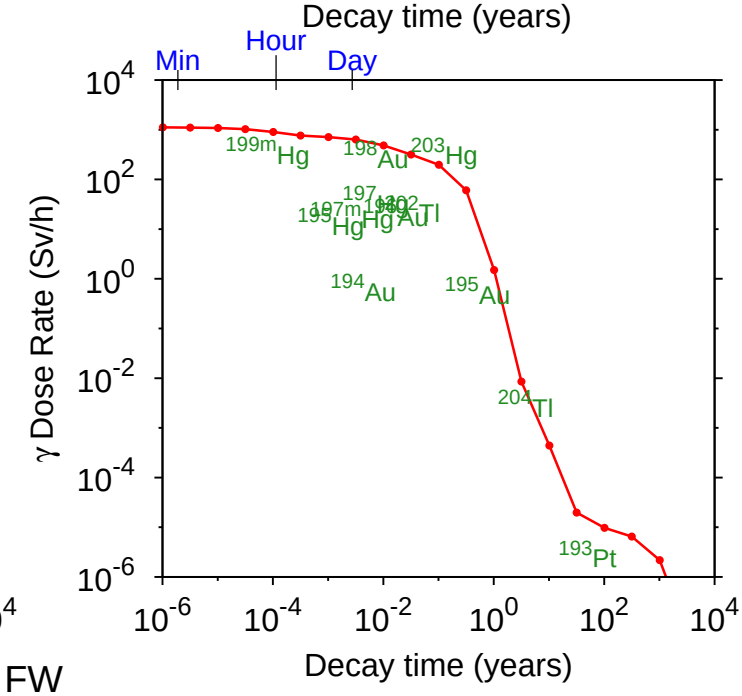
Heat Output





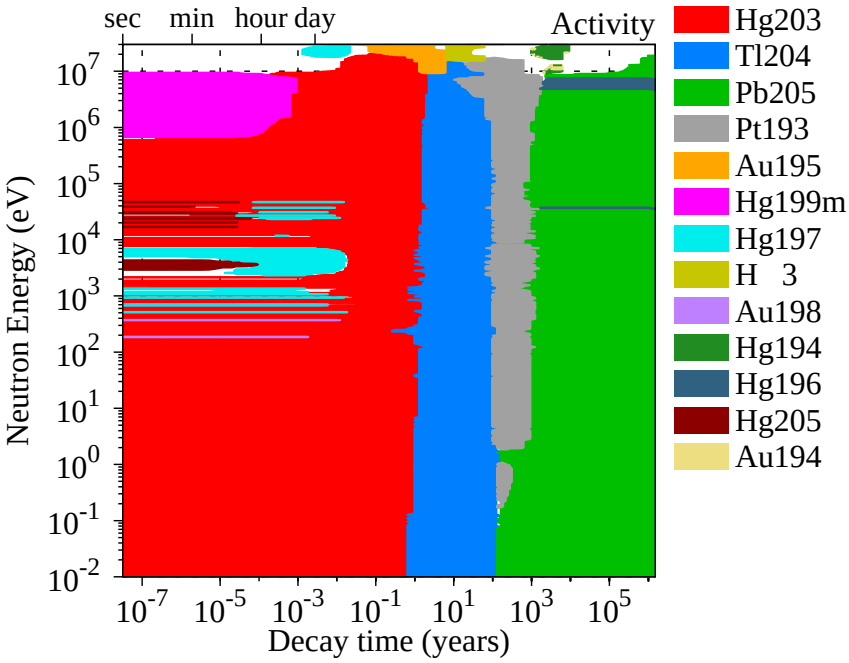
γ Dose Rate

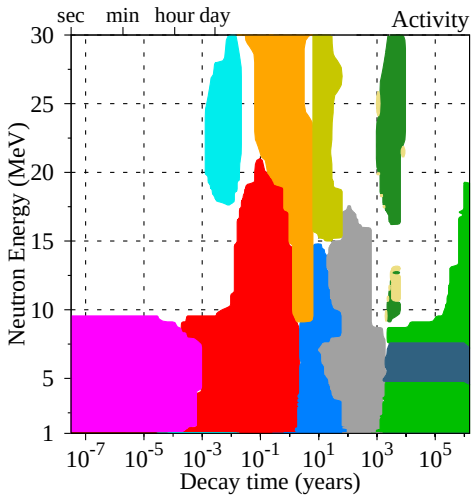


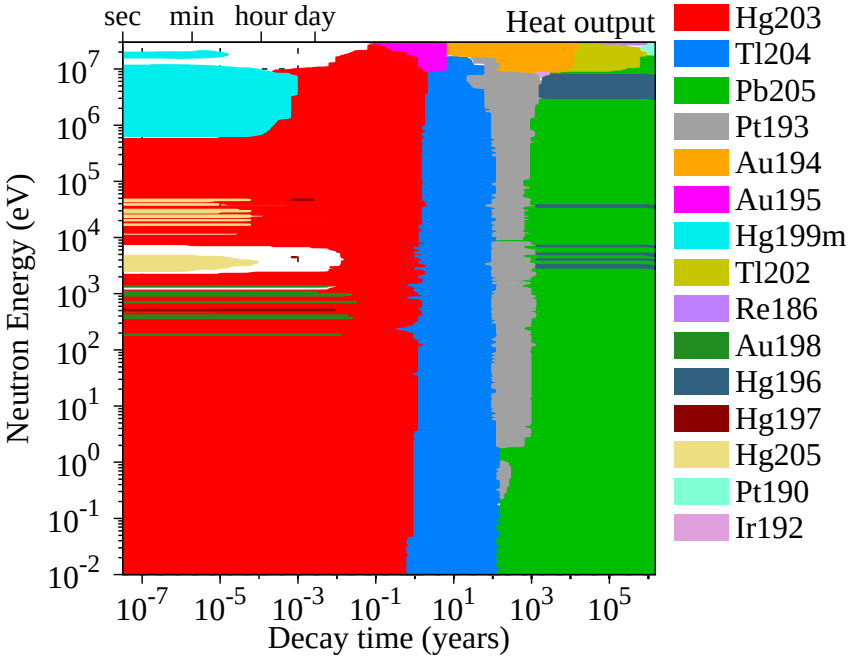


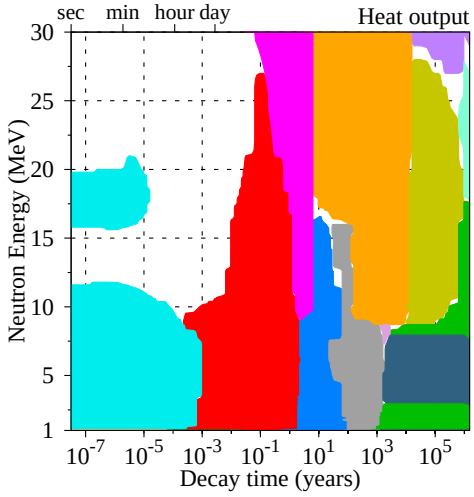
FW
Blanket
Manifold
Fe results

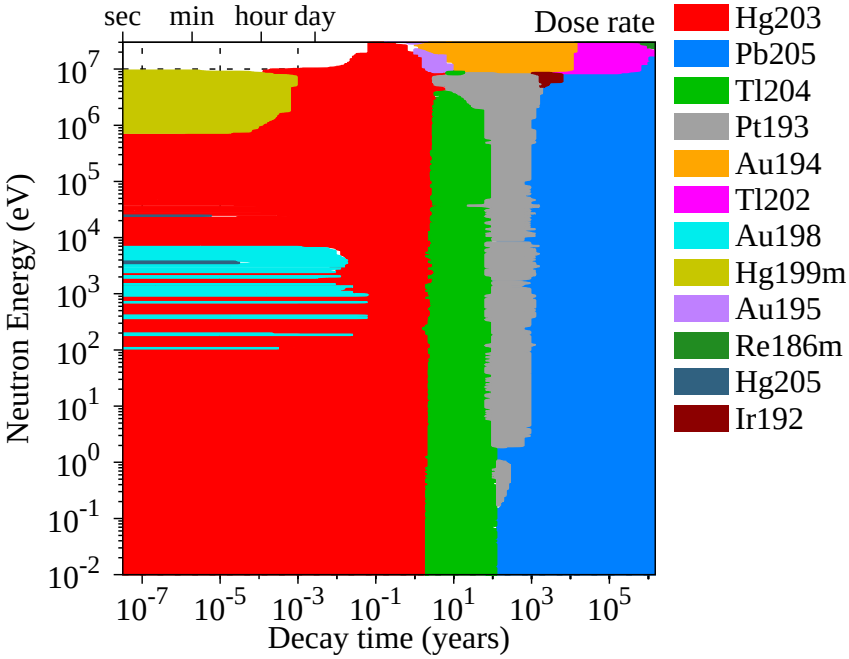
Mercury Importance diagrams

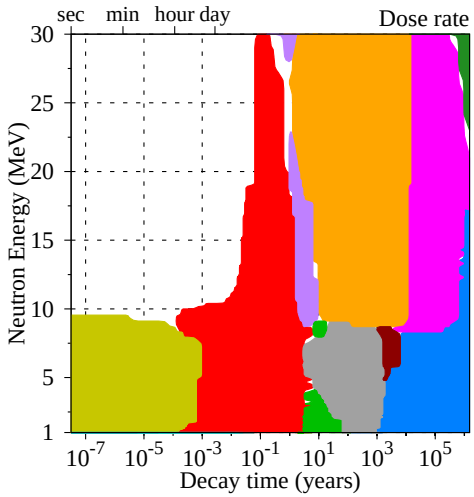




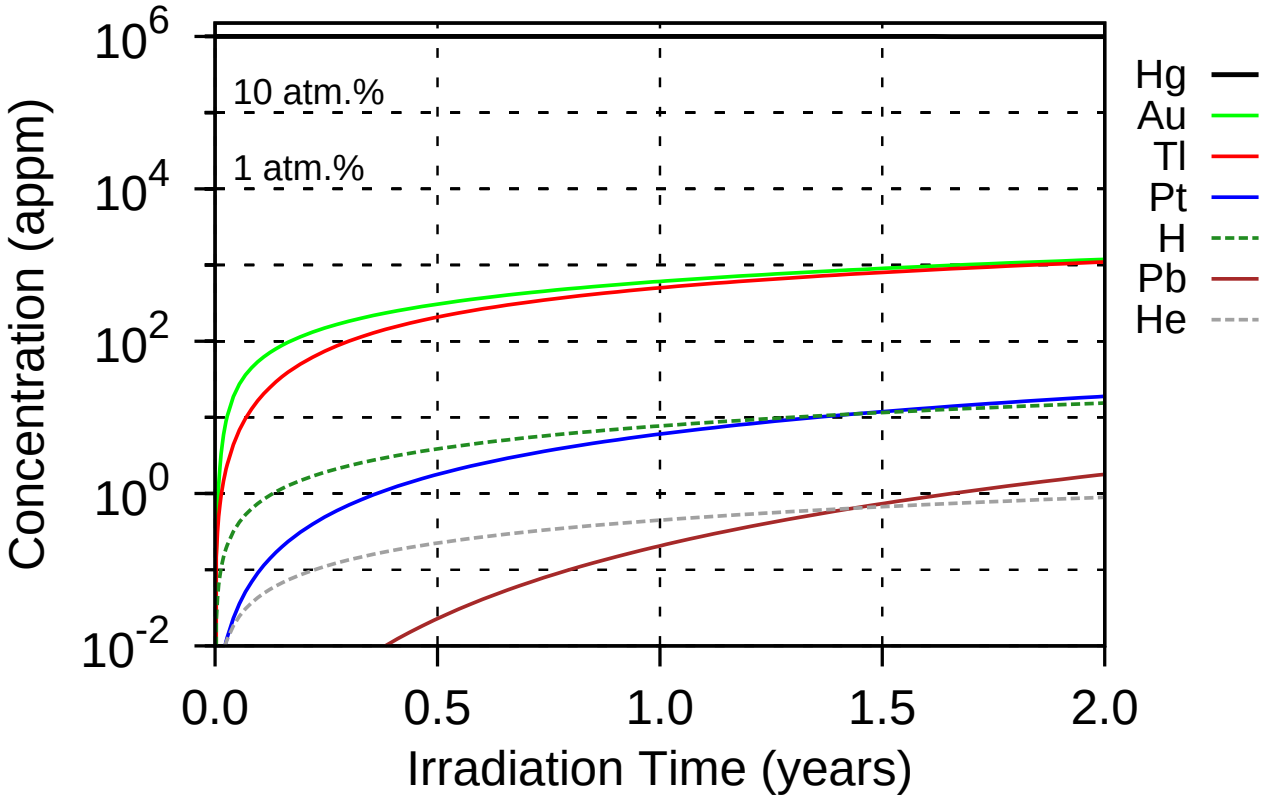




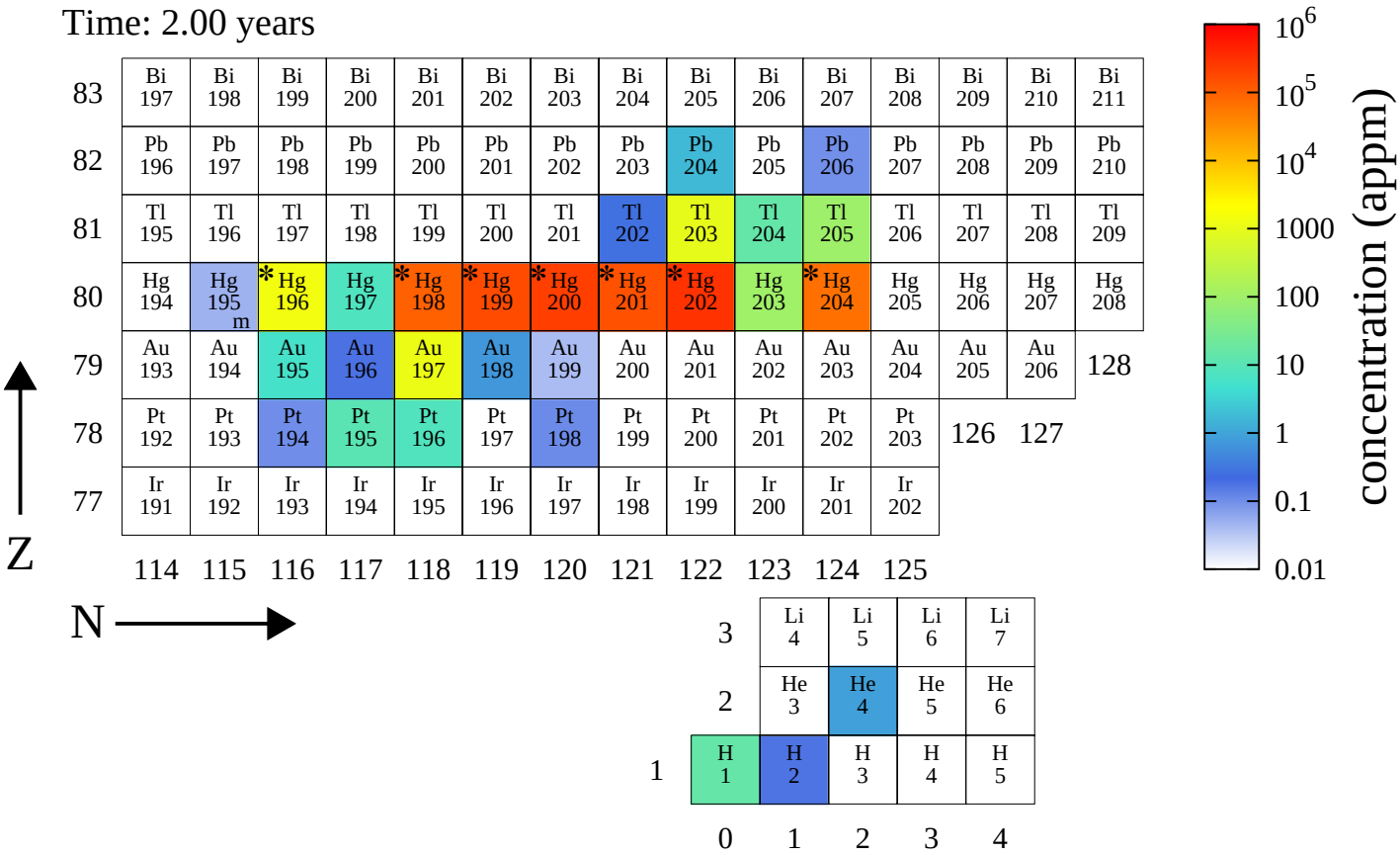




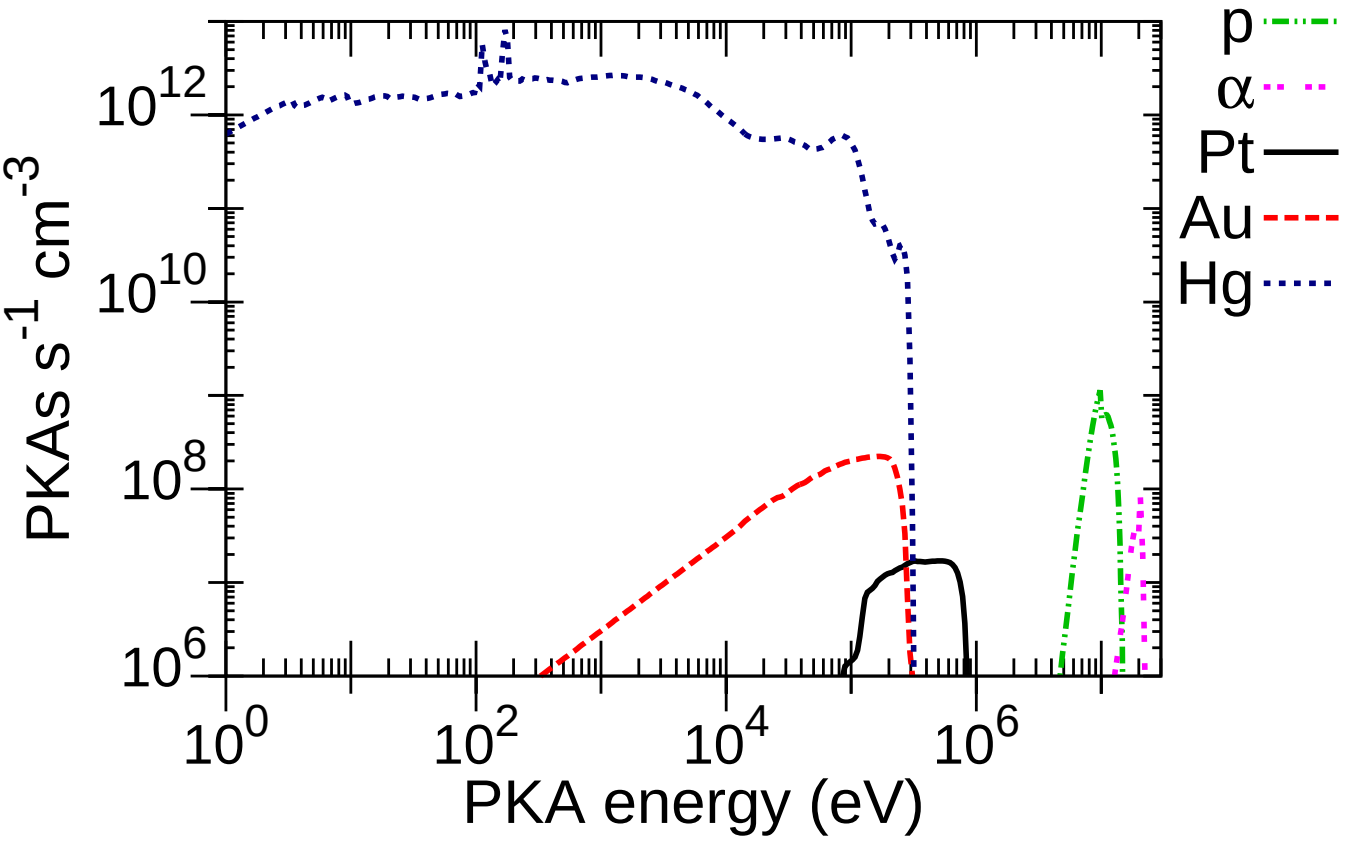
Mercury FW Transmutation

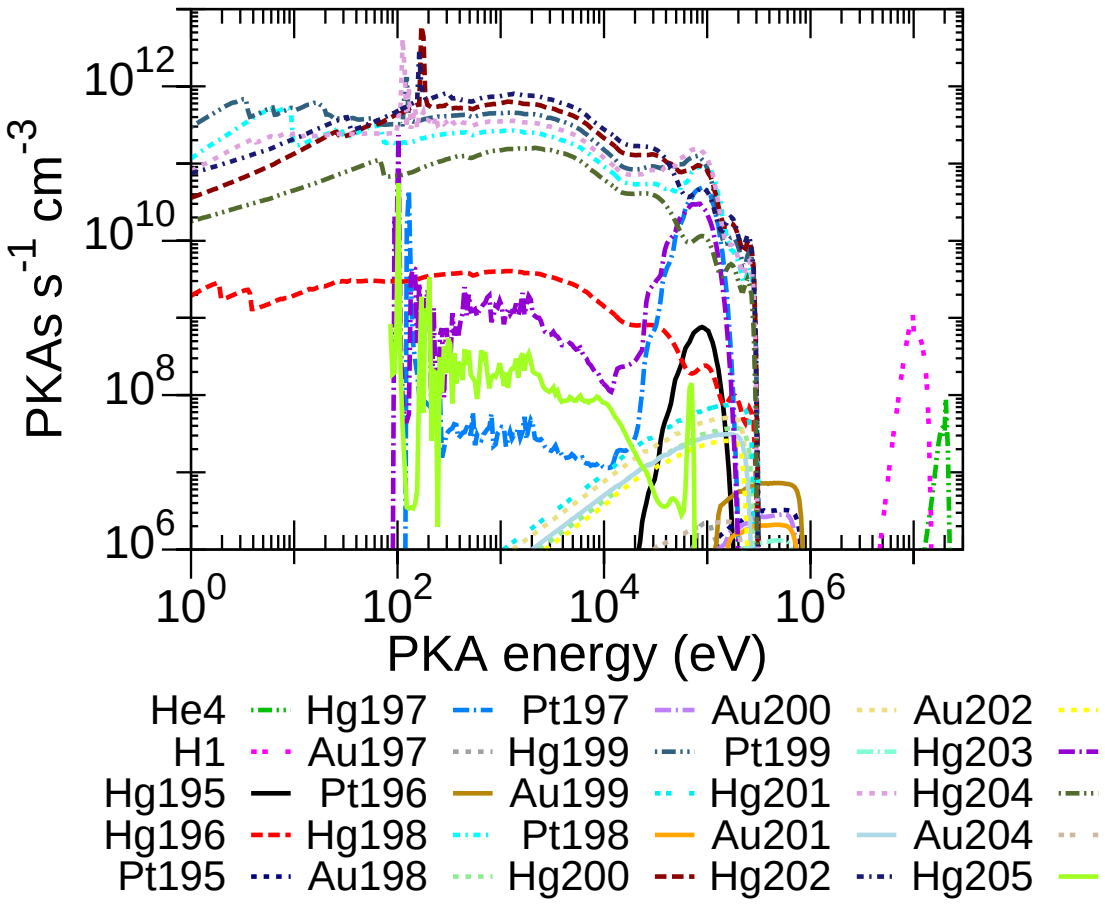


0 appm He & 8 appm H after 1 year 13 dpa/year



Mercury FW PKA distributions





Mercury Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Au197m	7.74s	Hg199(n,α)Pt196(n,γ)Pt197m(β^-)Au197m	93.1			
		Hg198(n,γ)Hg199(n,α)Pt196(n,γ)Pt197m(β^-)Au197m	6.0			
		Hg196(n,γ)Hg197m(β^+)Au197m		100.0	51.5	
		Hg196(n,γ)Hg197(β^+)Au197(n,n′)Au197m			40.7	
		Hg196(n,γ)Hg197m(IT)Hg197(β^+)Au197(n,n′)Au197m			7.5	
		Hg198(n,2n)Hg197m(β^+)Au197m				73.9
		Hg198(n,2n)Hg197m(IT)Hg197(β^+)Au197(n,n′)Au197m				3.9
		Hg198(n,2n)Hg197(β^+)Au197(n,n′)Au197m				3.3
Hg205	5.20m	Hg204(n,γ)Hg205	60.8	100.0	100.0	100.0
		Hg202(n,γ)Hg203(n,γ)Hg204(n,γ)Hg205	34.8			
		Hg201(n,γ)Hg202(n,γ)Hg203(n,γ)Hg204(n,γ)Hg205	2.0			
		Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203(n,γ)Hg204(n,γ)Hg205	1.4			
		Hg199(n,γ)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203(n,γ) Hg204(n,γ)Hg205	1.0			
Hg199m	42.10m	Hg198(n,γ)Hg199m	99.8	100.0	2.5	
		Hg199(n,n′)Hg199m			97.1	9.9
		Hg200(n,2n)Hg199m				81.0
		Hg201(n,2n)Hg200(n,2n)Hg199m				6.2
		Hg202(n,2n)Hg201(n,2n)Hg200(n,2n)Hg199m				1.0
Hg195	9.90h	Hg196(n,2n)Hg195m(IT)Hg195				51.7
		Hg196(n,2n)Hg195				43.7
Hg197m	23.90h	Hg196(n,γ)Hg197m		100.0	100.0	
		Hg198(n,2n)Hg197m				80.8
		Hg199(n,2n)Hg198(n,2n)Hg197m				17.5
Au194	1.58d	Hg196(n,2n)Hg195m(IT)Hg195(β^+)Au195(n,2n)Au194m(IT)Au194				23.5
		Hg196(n,2n)Hg195m(β^+)Au195(n,2n)Au194m(IT)Au194				20.3
		Hg196(n,2n)Hg195(β^+)Au195(n,2n)Au194m(IT)Au194				19.9
		Hg196(n,2n)Hg195m(IT)Hg195(β^+)Au195(n,2n)Au194				10.1
		Hg196(n,2n)Hg195m(β^+)Au195(n,2n)Au194				8.7
		Hg196(n,2n)Hg195(β^+)Au195(n,2n)Au194				8.6
		Hg196(n,2n)Hg195m(IT)Hg195(β^+)Au195(n,2n)Au194n(IT)Au194				1.2
		Hg196(n,2n)Hg195m(β^+)Au195(n,2n)Au194n(IT)Au194				1.0
		Hg196(n,2n)Hg195(β^+)Au195(n,2n)Au194n(IT)Au194				1.0
Hg197	2.69d	Hg196(n,γ)Hg197		99.0	84.4	
		Hg196(n,γ)Hg197m(IT)Hg197		1.0	15.6	
		Hg198(n,2n)Hg197m(IT)Hg197				43.4
		Hg198(n,2n)Hg197				37.5
		Hg199(n,2n)Hg198(n,2n)Hg197m(IT)Hg197				9.4
		Hg199(n,2n)Hg198(n,2n)Hg197				8.1
Au198	2.69d	Hg196(n,γ)Hg197(β^+)Au197(n,γ)Au198	99.7	98.9	82.5	
		Hg196(n,γ)Hg197m(IT)Hg197(β^+)Au197(n,γ)Au198		1.0	15.2	
		Hg196(n,γ)Hg197m(β^+)Au197m(IT)Au197(n,γ)Au198			1.4	
		Hg198(n,p)Au198				70.2
		Hg199(n,2n)Hg198(n,p)Au198				15.2
		Hg198(n,p)Au198m(IT)Au198				5.4
		Hg199(n,d)Au198				1.6
		Hg198(n,2n)Hg197m(IT)Hg197(β^+)Au197(n,γ)Au198				1.5
		Hg198(n,2n)Hg197(β^+)Au197(n,γ)Au198				1.3
		Hg199(n,2n)Hg198(n,p)Au198m(IT)Au198				1.2
Re186	3.75d	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Au196	6.18d	Hg196(n,p)Au196			93.7	
		Hg196(n,p)Au196m(IT)Au196			6.3	
		Hg198(n,2n)Hg197m(IT)Hg197(β^+)Au197(n,2n)Au196m(IT)Au196				27.1
		Hg198(n,2n)Hg197(β^+)Au197(n,2n)Au196m(IT)Au196				23.5
		Hg198(n,2n)Hg197m(IT)Hg197(β^+)Au197(n,2n)Au196				16.2
		Hg198(n,2n)Hg197(β^+)Au197(n,2n)Au196				14.0
		Hg199(n,2n)Hg198(n,2n)Hg197m(IT)Hg197(β^+)Au197(n,2n) Au196m(IT)Au196				2.9
		Hg198(n,2n)Hg197m(β^+)Au197m(IT)Au197(n,2n) Au196m(IT)Au196				2.6
		Hg199(n,2n)Hg198(n,2n)Hg197(β^+)Au197(n,2n) Au196m(IT)Au196				2.5
		Hg198(n,2n)Hg197m(IT)Hg197(β^+)Au197(n,2n)Au196n(IT) Au196m(IT)Au196				2.3
		Hg198(n,2n)Hg197(β^+)Au197(n,2n)Au196n(IT)Au196m(IT)Au196				2.0
		Hg199(n,2n)Hg198(n,2n)Hg197m(IT)Hg197(β^+) Au197(n,2n)Au196				1.7
		Hg198(n,2n)Hg197m(β^+)Au197m(IT)Au197(n,2n)Au196				1.5
		Hg199(n,2n)Hg198(n,2n)Hg197(β^+)Au197(n,2n)Au196				1.5
Tl202	12.24d	Hg204(n,2n)Hg203(β^-)Tl203(n,2n)Tl202				99.7
Hg203	46.62d	Hg202(n,γ)Hg203	75.9	99.1	99.9	
		Hg201(n,γ)Hg202(n,γ)Hg203	9.0			
		Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203	8.6			
		Hg199(n,γ)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203	6.2			
		Hg204(n,2n)Hg203				99.7
Ir192	73.80d	Hg196(n,α)Pt193(n,α)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	24.4			
		Hg196(n,α)Pt193(n,γ)Pt194(n,α)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192	17.2			
		Hg196(n,α)Pt193(n,α)Os190(n,γ)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192	17.1			
		Hg196(n,α)Pt193(n,γ)Pt194(n,α)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192	12.0			
		Hg196(n,α)Pt193(n,γ)Pt194(n,α)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	8.2			
		Hg196(n,α)Pt193(n,γ)Pt194(n,α)Os191m(IT)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192	5.8			
		Hg196(n,α)Pt193(n,α)Os190(n,γ)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192	3.0			
		Hg196(n,α)Pt193(n,α)Os190(n,γ)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192	2.1			
		Hg196(n,α)Pt193m(IT)Pt193(n,α)Os190(n,γ)Os191m(IT) Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	1.8			
		Hg196(n,α)Pt193m(IT)Pt193(n,γ)Pt194(n,α)Os191(β^-) Ir191m(IT)Ir191(n,γ)Ir192m(IT)Ir192	1.3			
		Hg196(n,α)Pt193m(IT)Pt193(n,α)Os190(n,γ)Os191m(IT) Os191(β^-)Ir191m(IT)Ir191(n,γ)Ir192	1.3			
		Hg196(n,γ)Hg197(n,α)Pt194(n,α)Os191(β^-)Ir191m(IT) Ir191(n,γ)Ir192m(IT)Ir192	1.2			
Au195	186.09d	Hg196(n,2n)Hg195m(IT)Hg195(β^+)Au195				34.8
		Hg196(n,2n)Hg195m(β^+)Au195				30.0
		Hg196(n,2n)Hg195(β^+)Au195				29.4
Tl204	3.79y	Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204	91.6	99.7	100.0	
		Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204	4.1			
		Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204	2.5			
		Hg199(n,γ)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203(β^-) Tl203(n,γ)Tl204	1.8			
H3	12.33y	no pathways found				
Pt193	50.00y	Hg196(n,α)Pt193	93.0	91.9	74.7	
		Hg196(n,α)Pt193m(IT)Pt193	7.0	8.1	24.8	
Ir192n	241.00y	no pathways found				
Hg194	444.00y	no pathways found				
Pb202	5.3 10^4y	no pathways found				
Re186m	2.0 10^5y	no pathways found				

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Pb205	1.5 10^7y	Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204(β^-)Pb204(n,γ)Pb205	95.9	99.8	100.0	
		Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204(β^-) Pb204(n,γ)Pb205	2.4			
		Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ) Tl204(β^-)Pb204(n,γ)Pb205	1.0			
Pt190	6.5 10^{11}y	no pathways found				
Hg196	2.5 10^{18}y	no pathways found				

Thallium

Isotope	Atom % abundance
Tl203	29.52
Tl205	70.48

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	3.89E+14	3.66E+14	3.21E+14	1.65E+14	6.11E+06	3.44E+04
Tl204	50.9	54.1	61.6	100.0	59.0	
Tl202	38.5	40.8	37.9			1.4
Tl206	9.7	4.3				
H3					40.4	
Pb205					0.5	97.2
Pb202						1.4

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	2.28E-02	2.08E-02	1.71E-02	6.29E-03	1.40E-10	4.09E-13
Tl202	51.3	56.3	55.6			9.1
Tl204	33.1	36.3	44.0	100.0	98.1	
Tl206	14.3	6.6				
H3					1.6	
Pb205					0.3	89.4
Pb202						1.5

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	6.79E+03	6.68E+03	5.40E+03	1.72E+00	7.35E-08	3.37E-08
Tl202	97.5	99.1	99.8		32.6	62.6
Pb203m	1.2					
Tl204				98.3	50.2	
Hg203	0.1	0.1	0.1	1.7		
Pb205					16.8	36.7

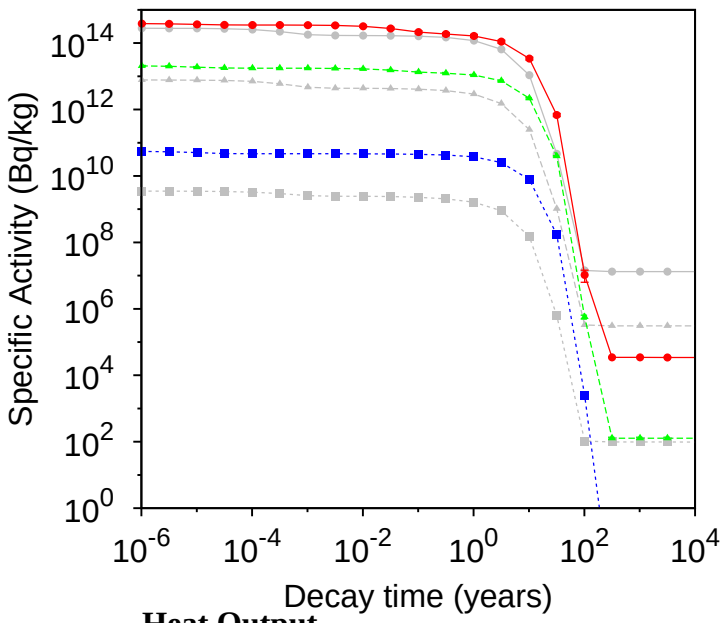
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	3.07E+05	3.07E+05	2.94E+05	1.98E+05	4.45E-03	1.38E-05
Tl204	77.3	77.3	80.7	100.0	97.3	
Tl202	21.9	21.9	18.6			1.6
H3					2.3	
Pb205					0.2	67.9
Pb202					0.1	30.5

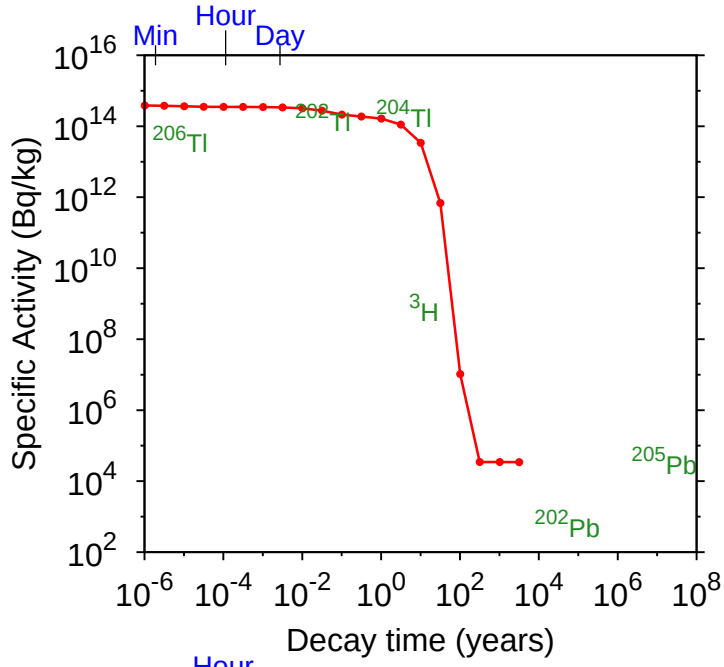
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.09E+05	1.09E+05	1.03E+05	6.43E+04	2.08E-03	3.42E-05
Tl204	71.1	71.2	75.0	100.0	67.5	
Tl202	26.2	26.2	22.5			0.3
Hg203	2.4	2.4	2.4			
H3					30.8	
Pb205					1.4	83.0
Pb202					0.3	16.7

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.52E+11	2.29E+11	2.10E+11	1.65E+11	3.64E+03	2.05E+00
Tl204	78.7	86.4	94.1	100.0	99.3	
Tl206	15.0	6.9				
Tl202	5.9	6.5	5.8			2.3
Pb205					0.1	96.0
Pb202						1.7

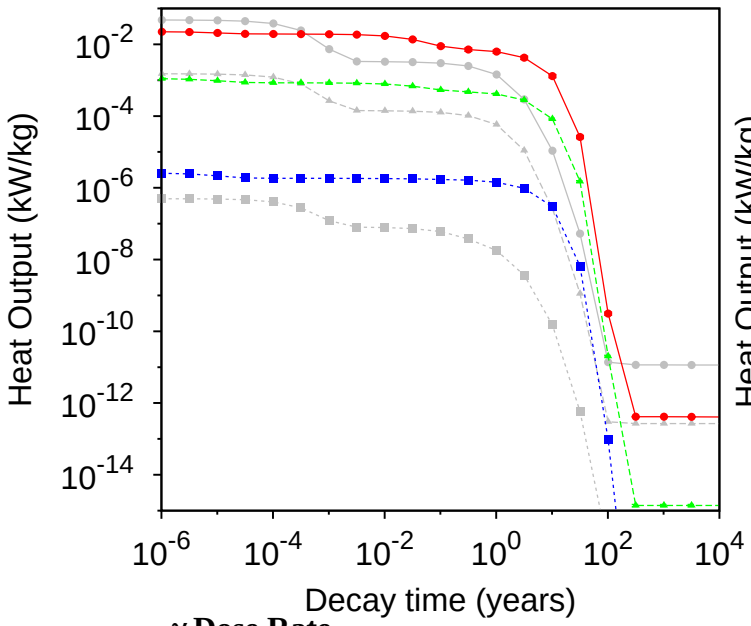
Thallium activation characteristics

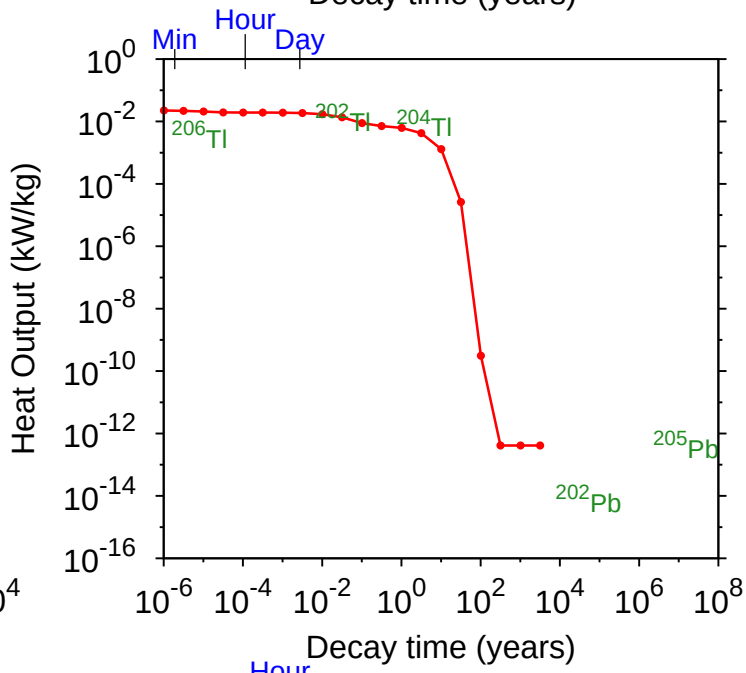
Specific Activity



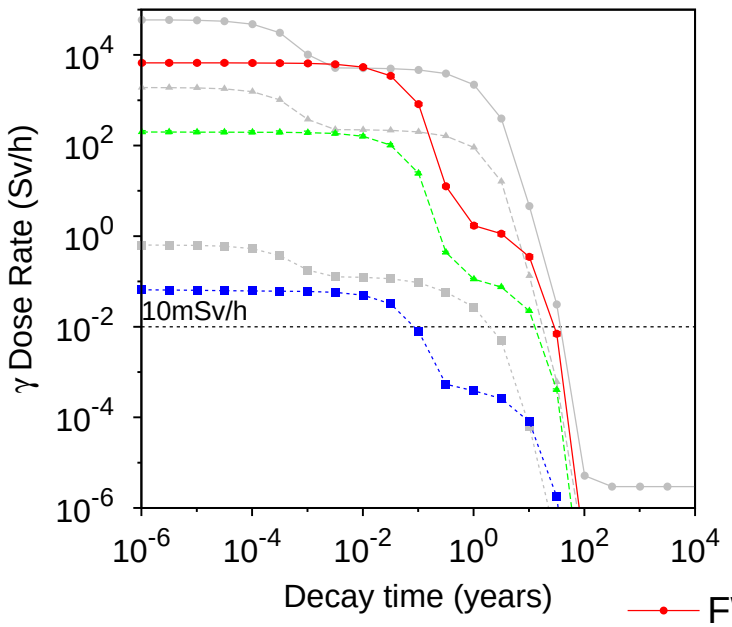


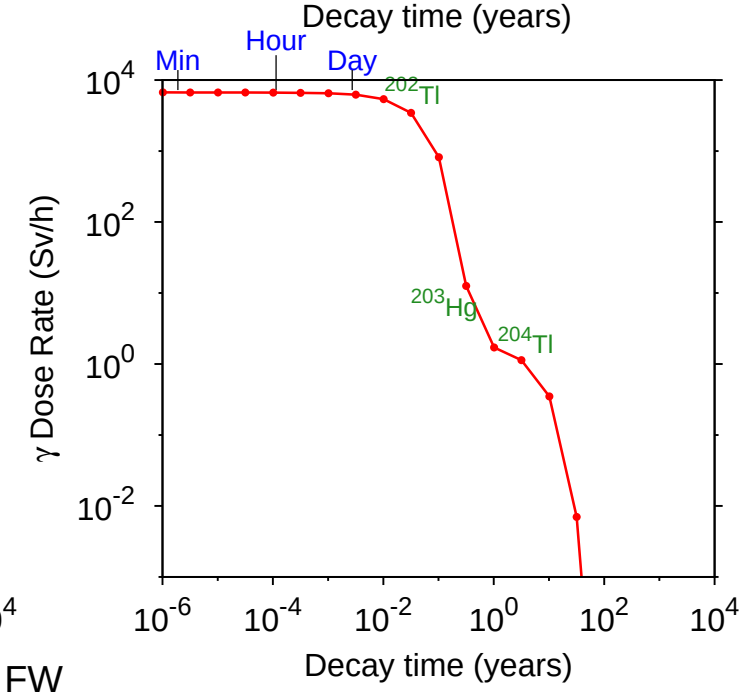
Heat Output





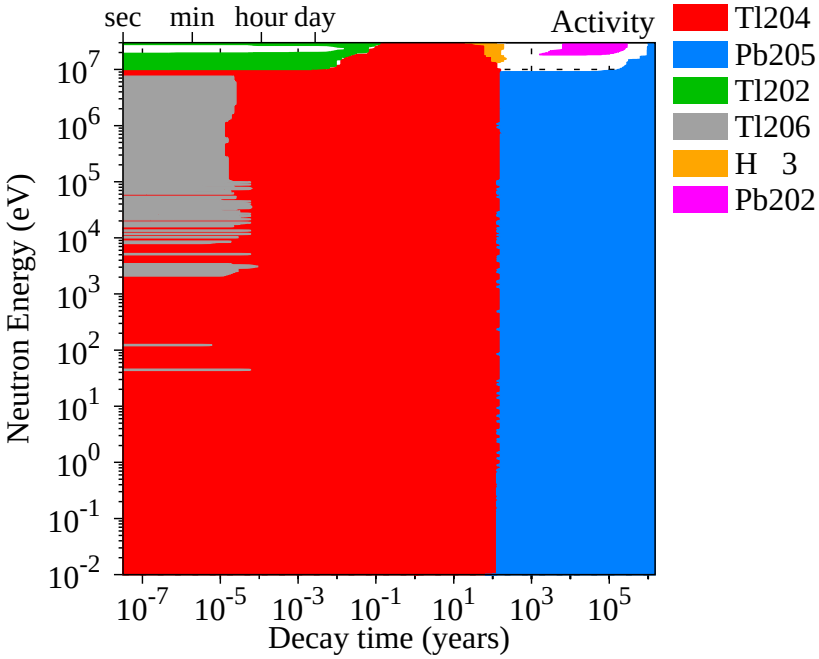
γ Dose Rate

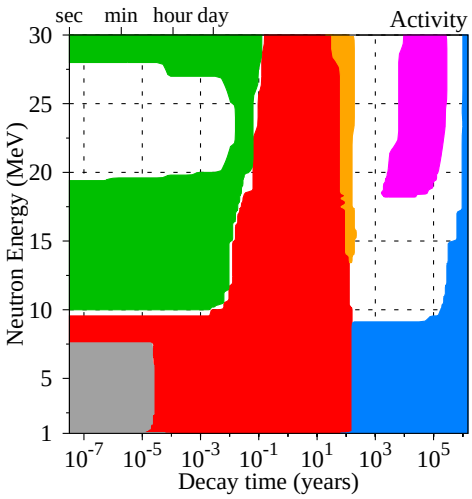


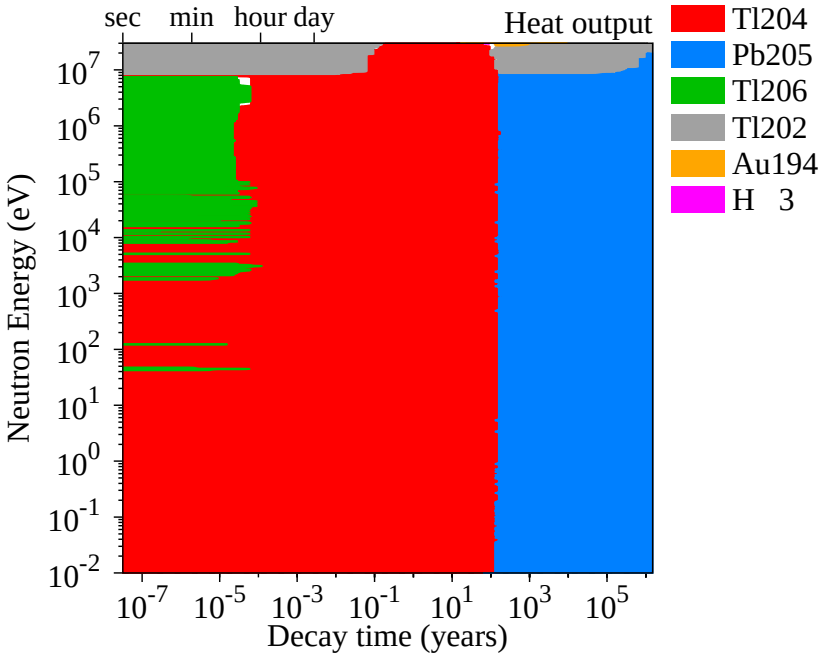


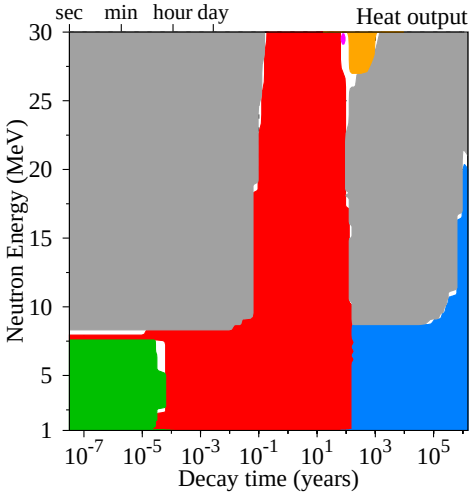
FW
Blanket
Manifold
Fe results

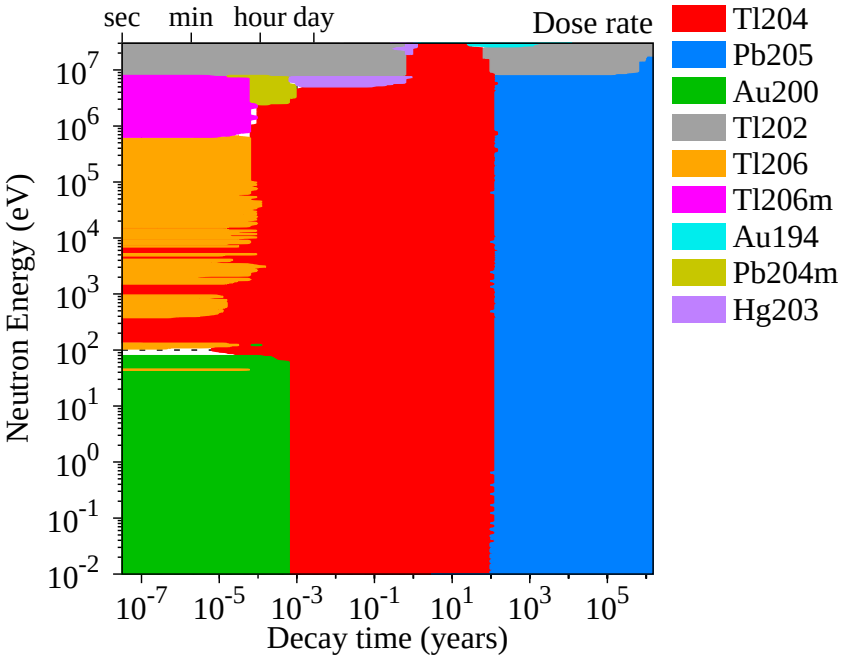
Thallium Importance diagrams

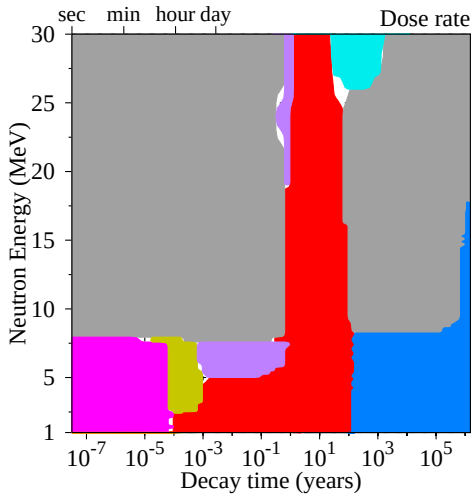




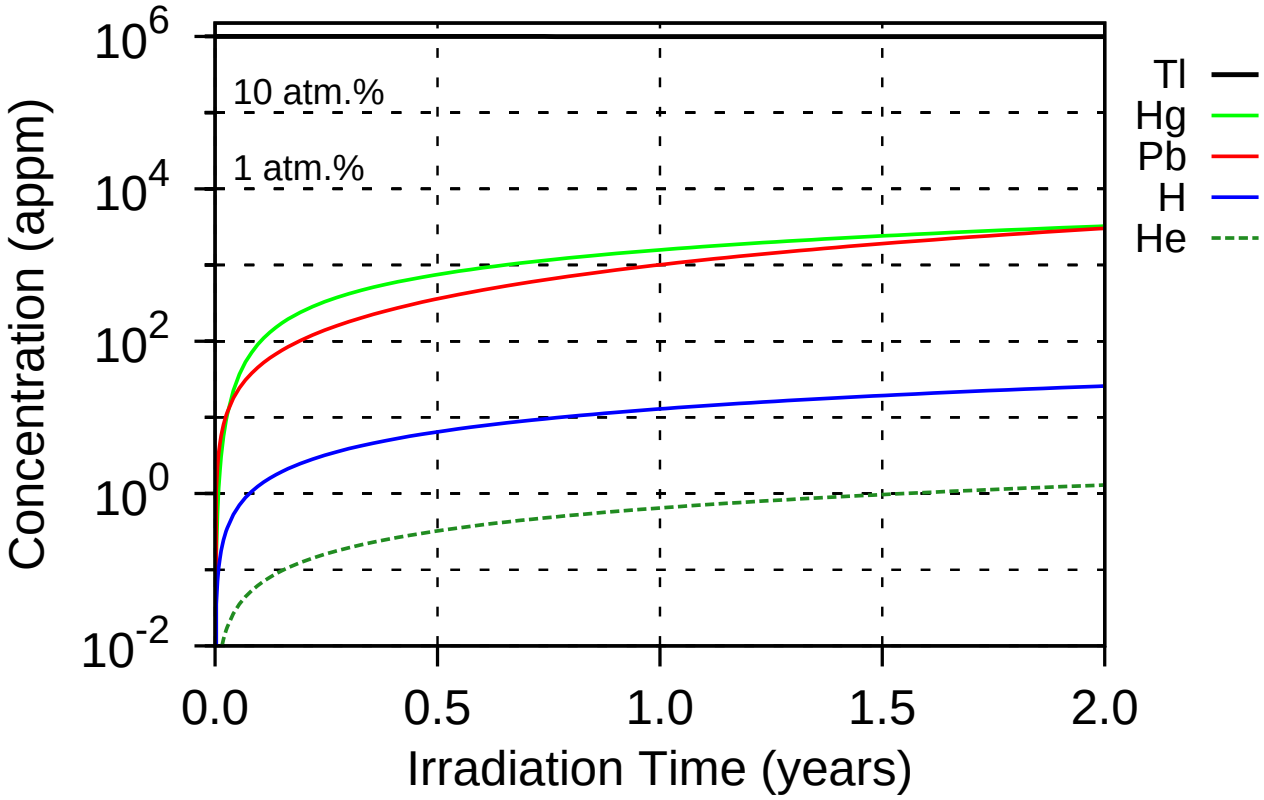




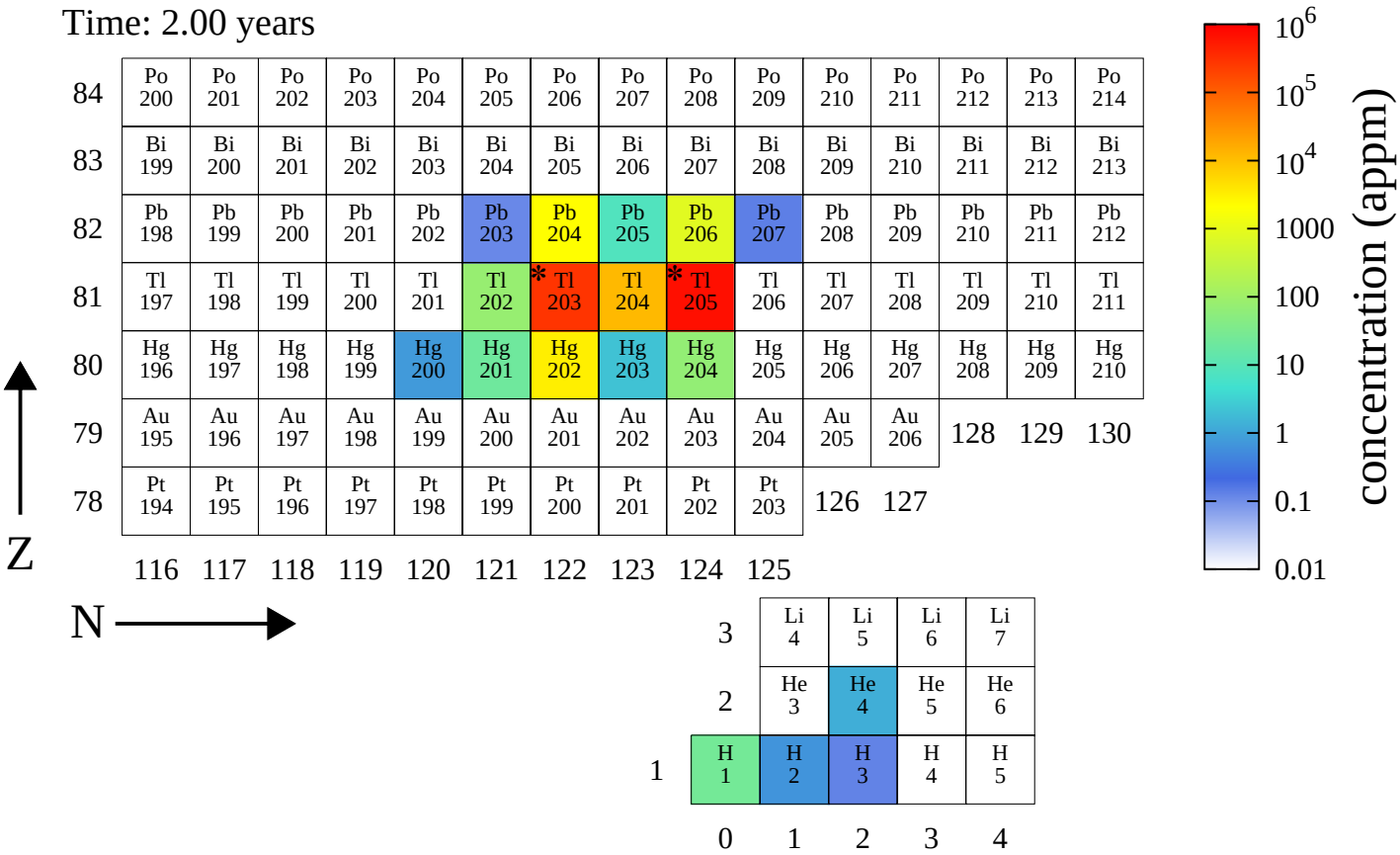




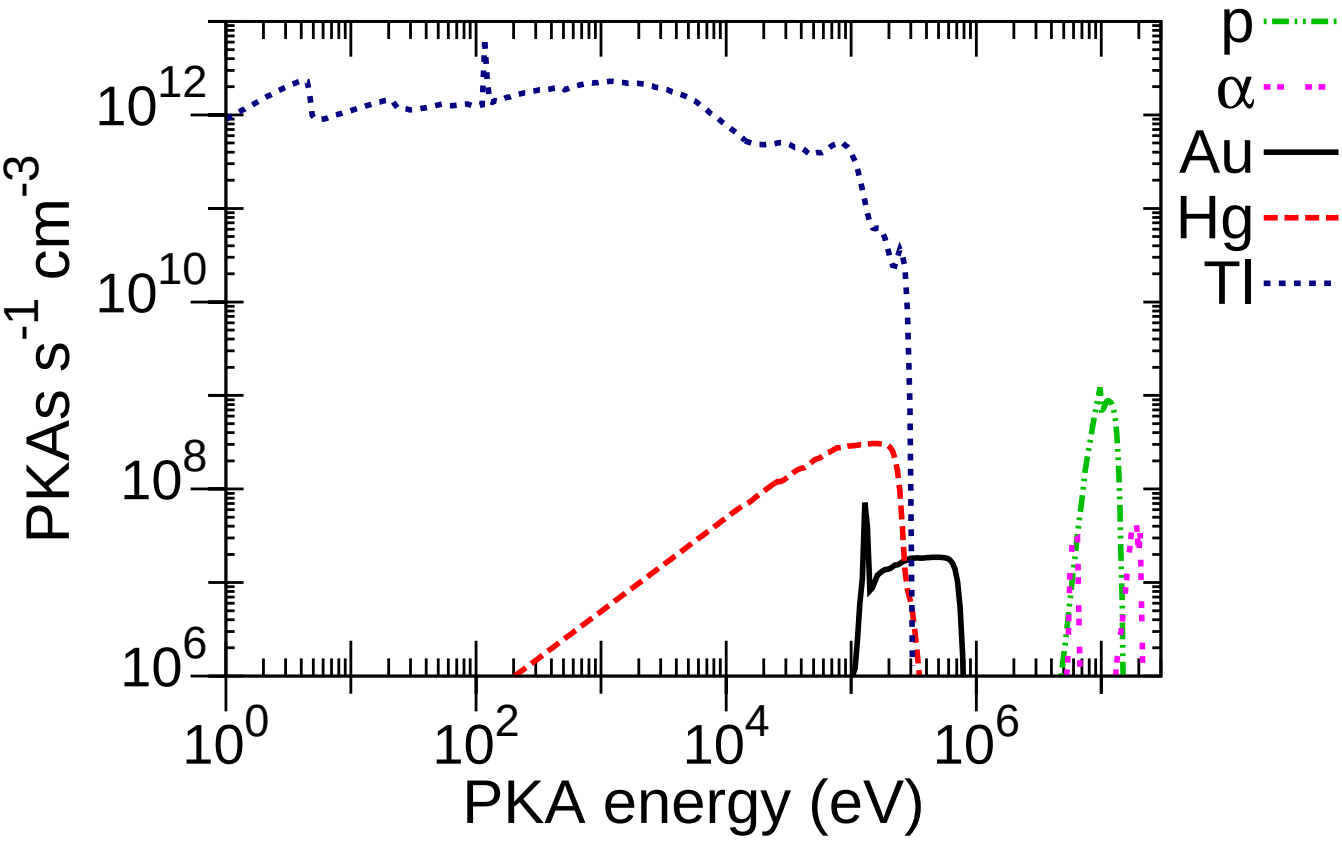
Thallium FW Transmutation

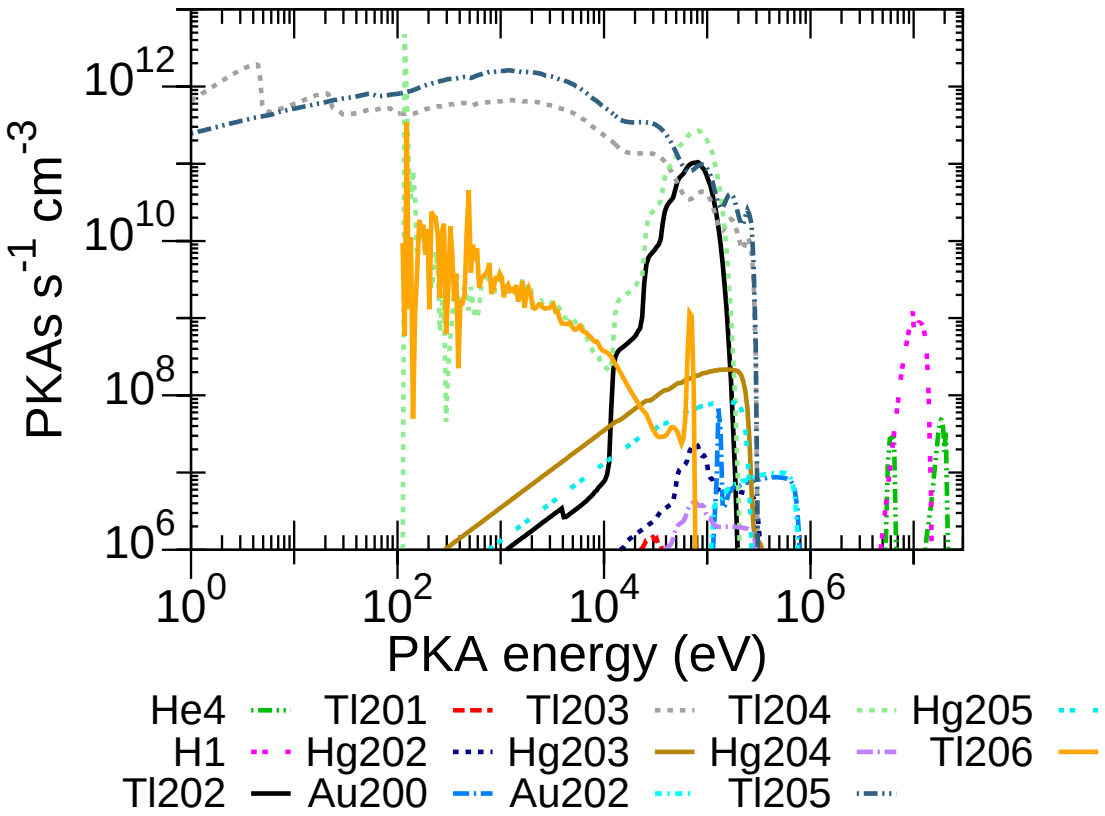


1 appm He & 13 appm H after 1 year 13 dpa/year



Thallium FW PKA distributions





Thallium Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Pb203m	6.29s	Tl205(n,2n)Tl204(β^-)Pb204(n,2n)Pb203m				98.1
		Tl205(n,2n)Tl204(β^-)Pb204(n,2n)Pb203n(IT)Pb203m				1.7
Tl206m	3.76m	Tl205(n,γ)Tl206m	92.1	100.0	100.0	100.0
		Tl203(n,γ)Tl204(n,γ)Tl205(n,γ)Tl206m	7.9			
Tl206	4.20m	Tl205(n,γ)Tl206	92.1	100.0	99.6	88.1
		Tl203(n,γ)Tl204(n,γ)Tl205(n,γ)Tl206	7.9			
		Tl205(n,γ)Tl206m(IT)Tl206				11.9
Au200	48.40m	Tl203(n,α)Au200	100.0	100.0	100.0	95.2
		Tl203(n,α)Au200m(IT)Au200				2.0
		Tl205(n,2n)Tl204(n,2n)Tl203(n,α)Au200				1.8
Pb204m	1.13h	Tl203(n,γ)Tl204(β^-)Pb204(n,n$'$)Pb204m			100.0	
		Tl205(n,2n)Tl204(β^-)Pb204(n,n$'$)Pb204m				99.6
Au194	1.58d	no pathways found				
Tl202	12.24d	Tl203(n,2n)Tl202				97.9
		Tl205(n,2n)Tl204(n,2n)Tl203(n,2n)Tl202				1.8
Hg203	46.62d	Tl203(n,α)Au200(β^-)Hg200(n,γ)Hg201(n,γ)Hg202(n,γ)Hg203	100.0			
		Tl205(n,γ)Tl206(β^-)Pb206(n,α)Hg203		100.0	2.2	
		Tl203(n,p)Hg203			97.8	75.8
		Tl205(n,2n)Tl204(β^+)Hg204(n,2n)Hg203				20.1
		Tl205(n,2n)Tl204(n,2n)Tl203(n,p)Hg203				1.2
		Tl203(n,2n)Tl202(β^+)Hg202(n,γ)Hg203				1.0
Tl204	3.79y	Tl203(n,γ)Tl204	100.0	100.0	100.0	
		Tl205(n,2n)Tl204				99.9
H3	12.33y	Tl205(n,t)H3				85.7
		Tl203(n,t)H3				13.5
Pb202	5.3 10^4y	Tl205(n,2n)Tl204(β^-)Pb204(n,2n)Pb203(n,2n)Pb202				38.7
		Tl205(n,2n)Tl204(β^-)Pb204(n,2n)Pb203m(IT) Pb203(n,2n)Pb202				38.3
		Tl205(n,2n)Tl204(β^-)Pb204(n,2n)Pb203(n,2n) Pb202m(IT)Pb202				10.9
		Tl205(n,2n)Tl204(β^-)Pb204(n,2n)Pb203m(IT)Pb203(n,2n) Pb202m(IT)Pb202				10.8
Pb205	1.5 10^7y	Tl203(n,γ)Tl204(β^-)Pb204(n,γ)Pb205	100.0	100.0	100.0	
		Tl205(n,γ)Tl206(β^-)Pb206(n,2n)Pb205				80.2
		Tl205(n,γ)Tl206m(IT)Tl206(β^-)Pb206(n,2n)Pb205				10.8
		Tl205(n,2n)Tl204(β^-)Pb204(n,γ)Pb205				9.0

Lead

Isotope	Atom % abundance
Pb204	1.40
Pb206	24.10
Pb207	22.10
Pb208	52.40

($T_{1/2}$ =1.4 10^{17}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	1.77E+14	9.24E+12	2.51E+12	3.91E+10	1.31E+07	1.29E+07
Pb207m	92.4					
Pb203	4.3	82.7	94.5			
Pb203m	2.2					
Pb204m	0.4	8.0				
Pb209	0.3	5.8				
Tl202		0.9	2.7		0.1	0.1
Tl204		0.5	1.9	99.6		
Pb205					98.2	99.8

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	4.42E-02	7.56E-04	1.46E-04	1.51E-06	1.75E-10	1.47E-10
Pb207m	96.9					
Pb203m	1.2					
Pb203	1.0	58.6	94.3			
Pb204m	0.6	34.2				
Pb209		2.3				
Tl208	0.1	1.4				
Tl202		0.8	3.6		0.4	0.4
Tl204		0.2	1.2	98.6		
Pb205					80.6	95.4
Bi207					13.0	
Bi208					3.5	4.1
Po210			0.1	0.9	1.7	

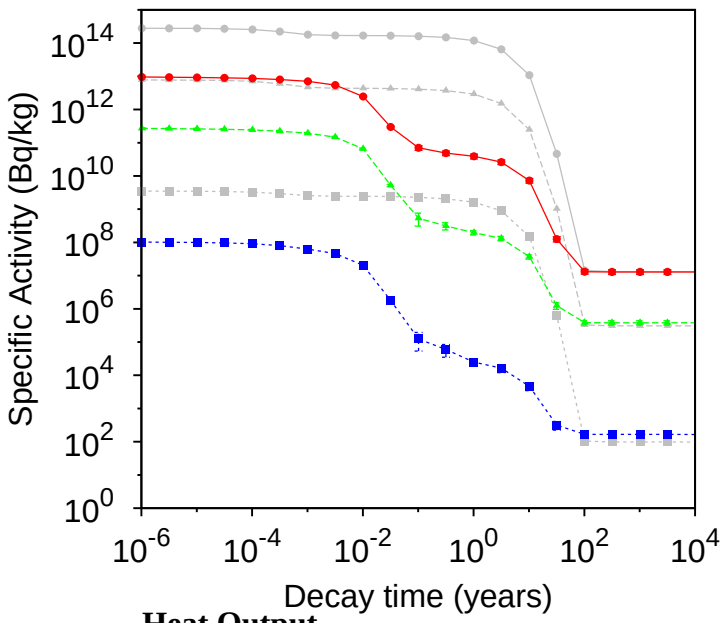
Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	4.84E+04	3.70E+02	2.36E+01	1.28E-03	4.06E-05	1.55E-05
Pb207m	98.0					
Pb203m	1.1					
Pb204m	0.6	76.0				
Pb203	0.1	17.9	87.1			
Tl208	0.1	3.8				
Tl206m		1.3				
Tl202		1.0	12.3		1.0	2.4
Hg203			0.6	51.9		
Tl204				30.1		
Bi207				16.8	61.2	
Bi208				0.8	26.2	67.4
Pb205				0.4	11.5	30.2

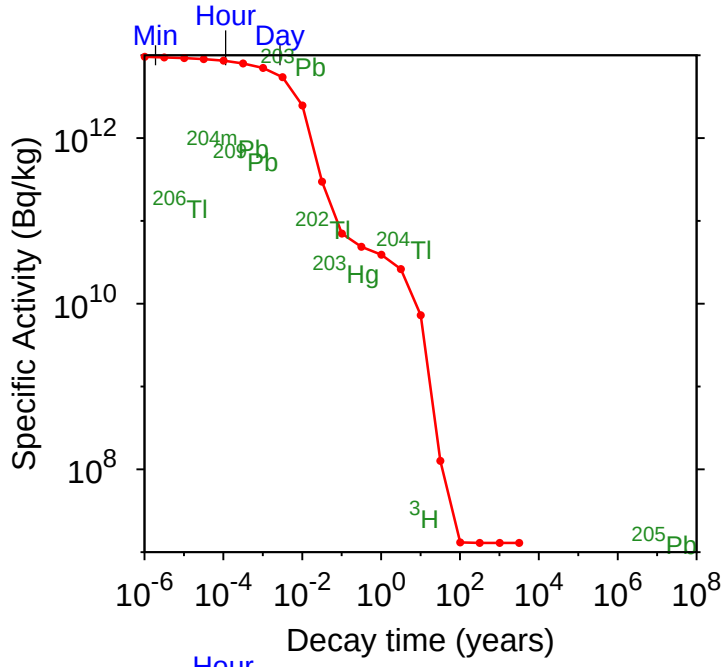
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.17E+03	2.16E+03	8.15E+02	6.65E+01	1.09E-02	3.70E-03
Pb203	84.8	85.0	69.9			
Po210	5.3	5.3	14.2	29.4	37.2	
Tl204	2.6	2.6	6.9	70.2		
Hg203	2.2	2.2	5.4	0.3		
Pb204m	1.8	1.7				
Tl202	1.7	1.7	3.7			0.1
Pb209	1.4	1.4				
Pb205					33.0	97.4
Pb210				0.1	21.0	
Po209					6.6	
Bi207					1.0	
Pb202					0.8	2.0

Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	2.26E+03	2.26E+03	1.03E+03	8.60E+01	4.74E-02	1.11E-02
Pb203	74.4	74.5	50.7			
Po210	18.3	18.3	40.2	81.5	30.7	
Hg203	2.6	2.6	5.4	0.3		
Pb209	1.5	1.5				
Pb204m	1.1	1.0				
Tl204	0.8	0.8	1.8	17.7		
Tl202	0.7	0.7	1.2			
Pb210				0.5	39.3	
Pb205					23.1	98.3
Po209					4.8	
Bi207					1.0	

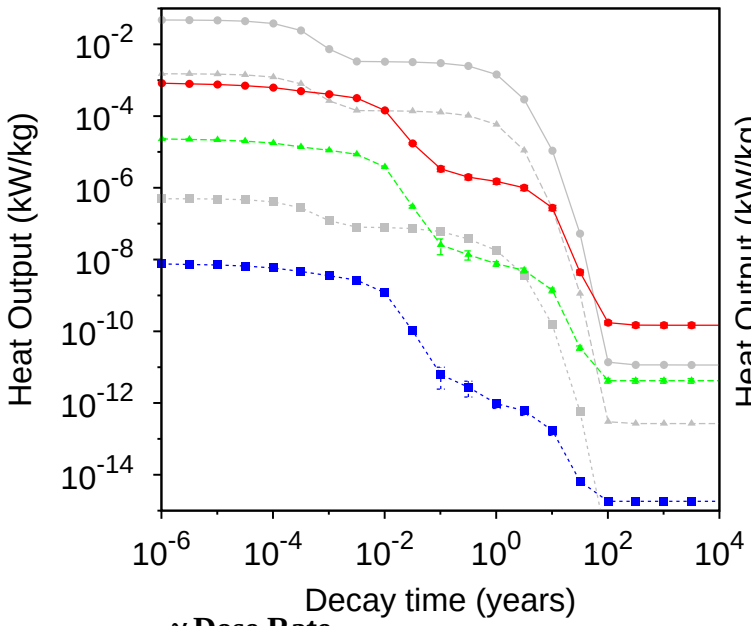
Clear	0s	5.3m	3.7d	1y	100y	10^4y
	2.54E+11	3.03E+09	2.93E+08	3.90E+07	1.67E+03	7.95E+02
Pb207m	97.6					
Pb203m	1.0					
Pb204m	0.6	50.9				
Pb203	0.3	25.2	81.0			
Pb209	0.2	17.8				
Tl206	0.1	2.5				
Tl204		1.5	15.9	99.9	0.1	
Tl206m		1.1				
Tl202		0.3	2.3		0.1	0.1
Bi207					51.4	
Pb205					45.4	95.2
Bi208					2.3	4.6

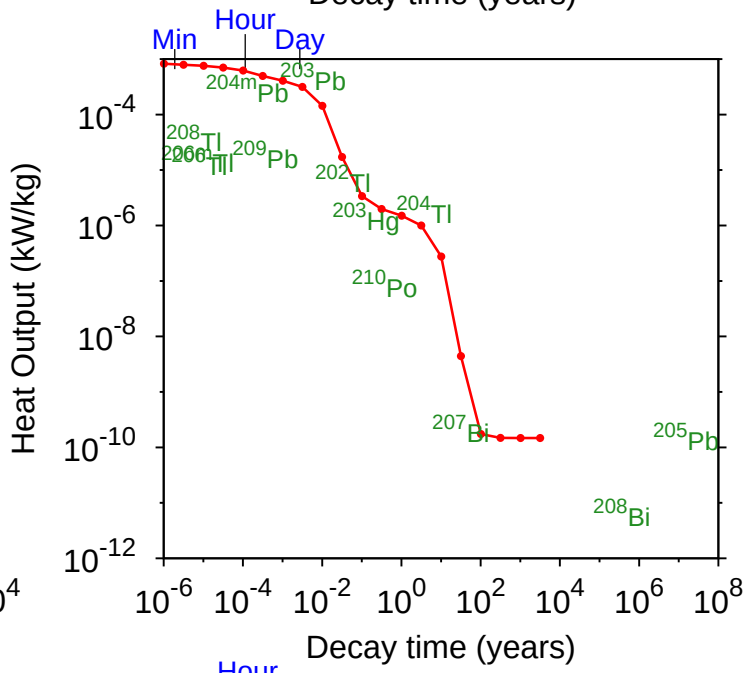
Specific Activity



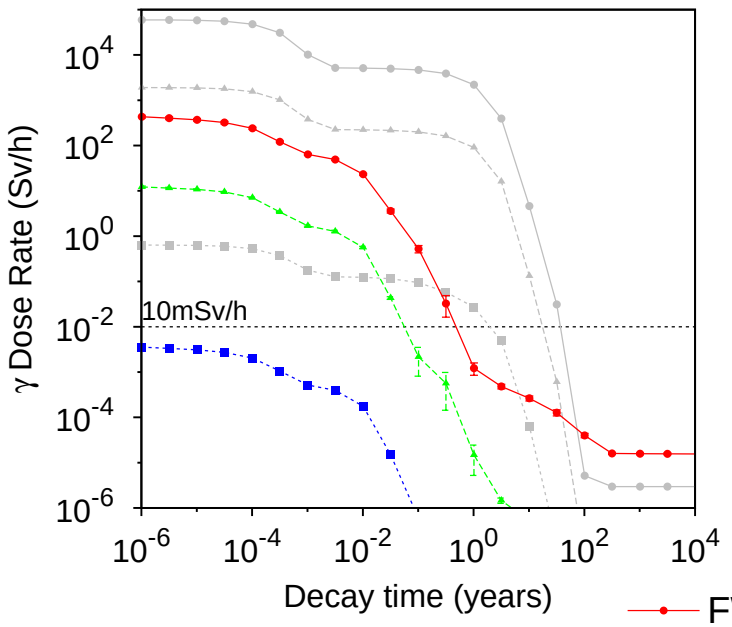


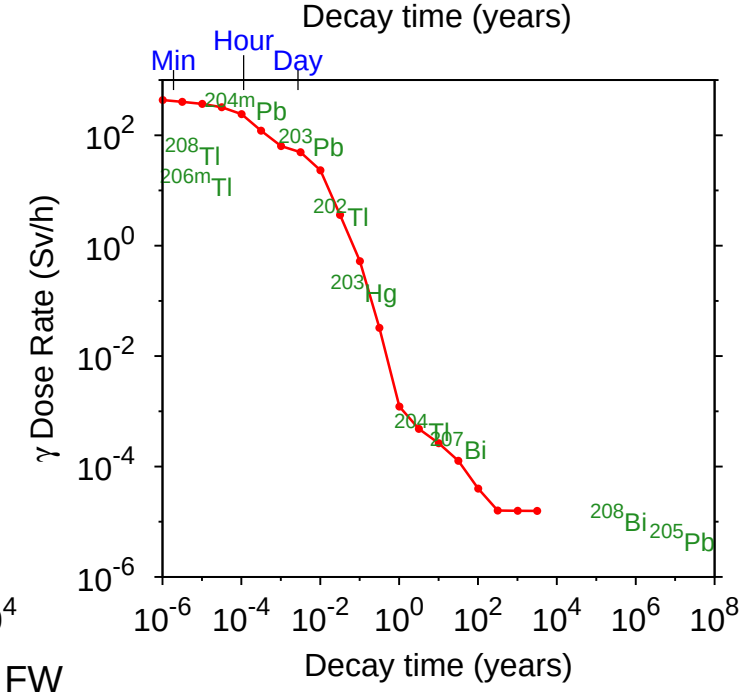
Heat Output





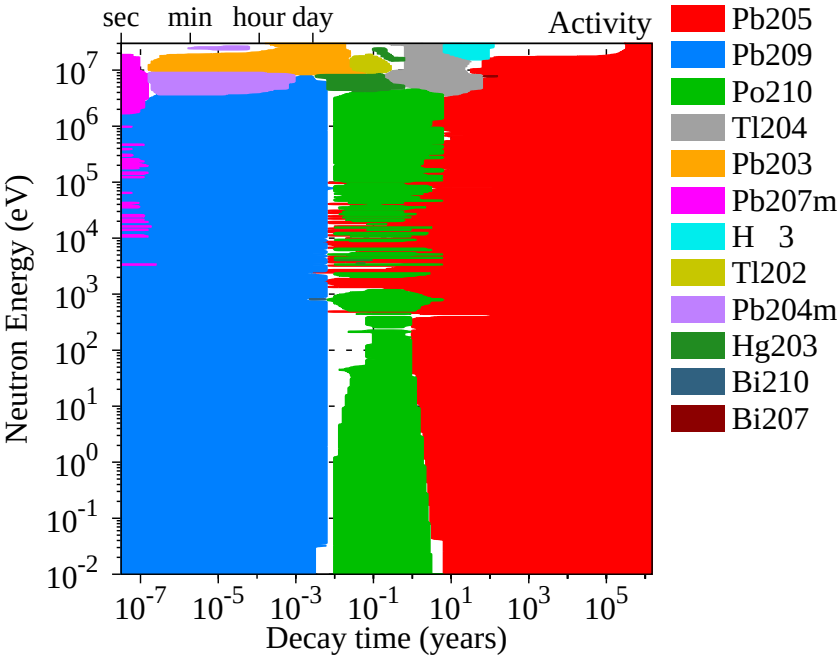
γ Dose Rate

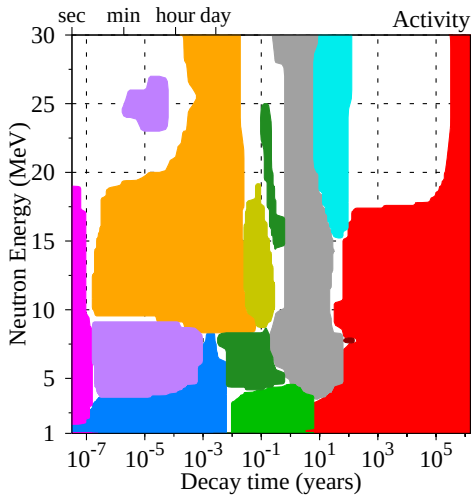


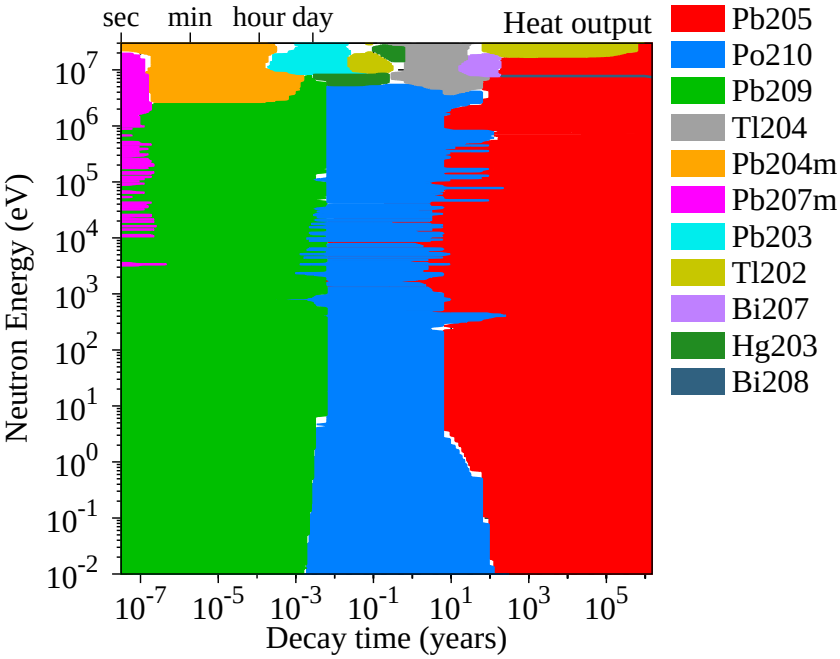


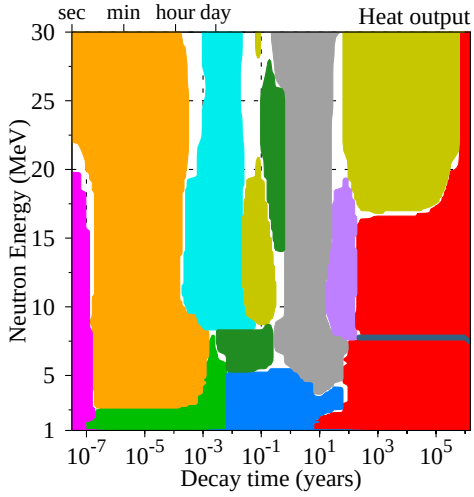
FW
Blanket
Manifold
Fe results

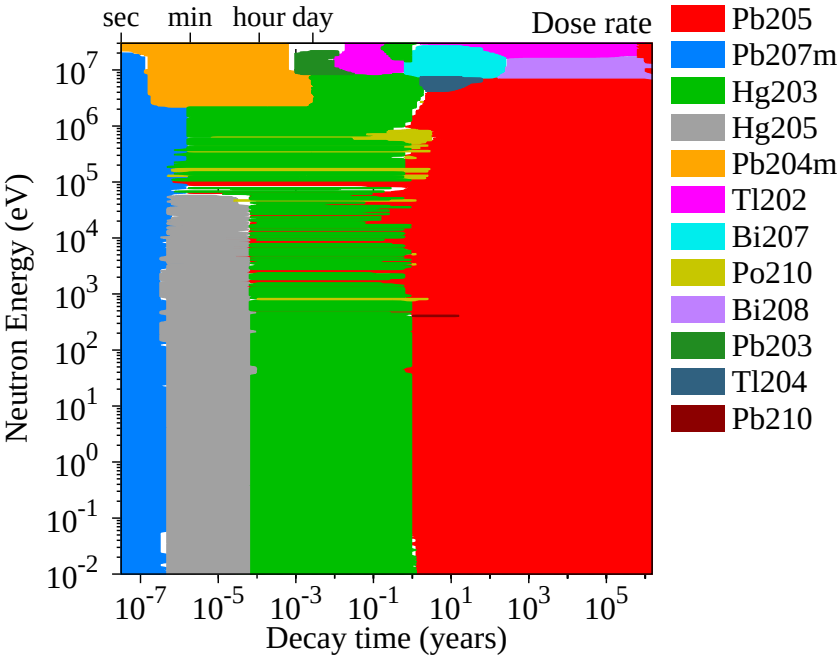
Lead Importance diagrams

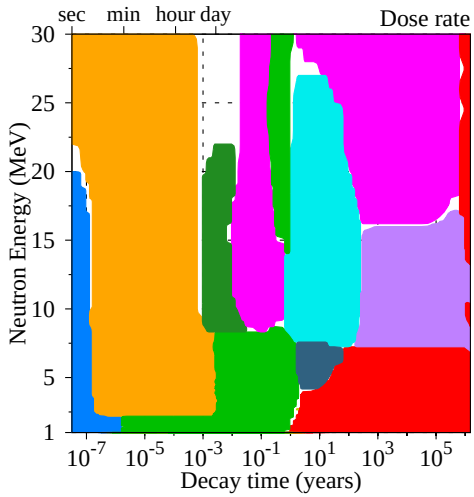




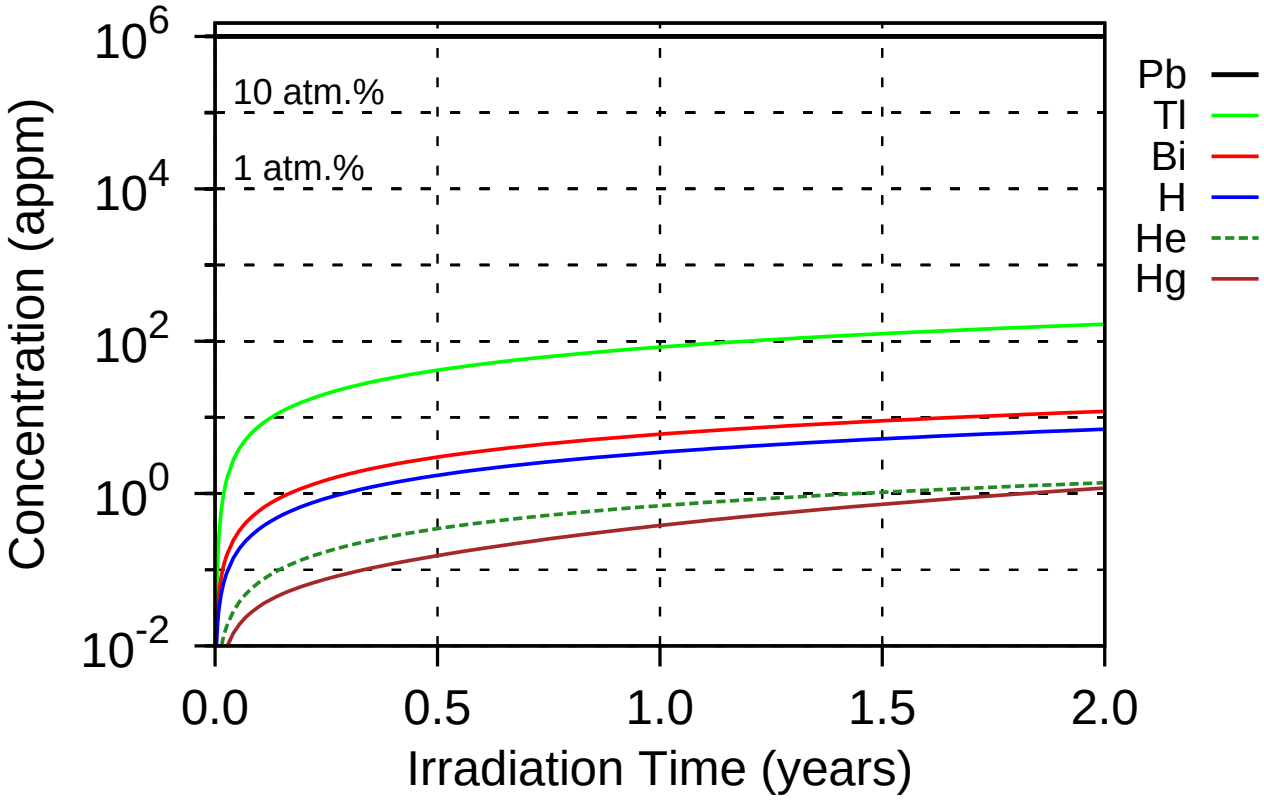




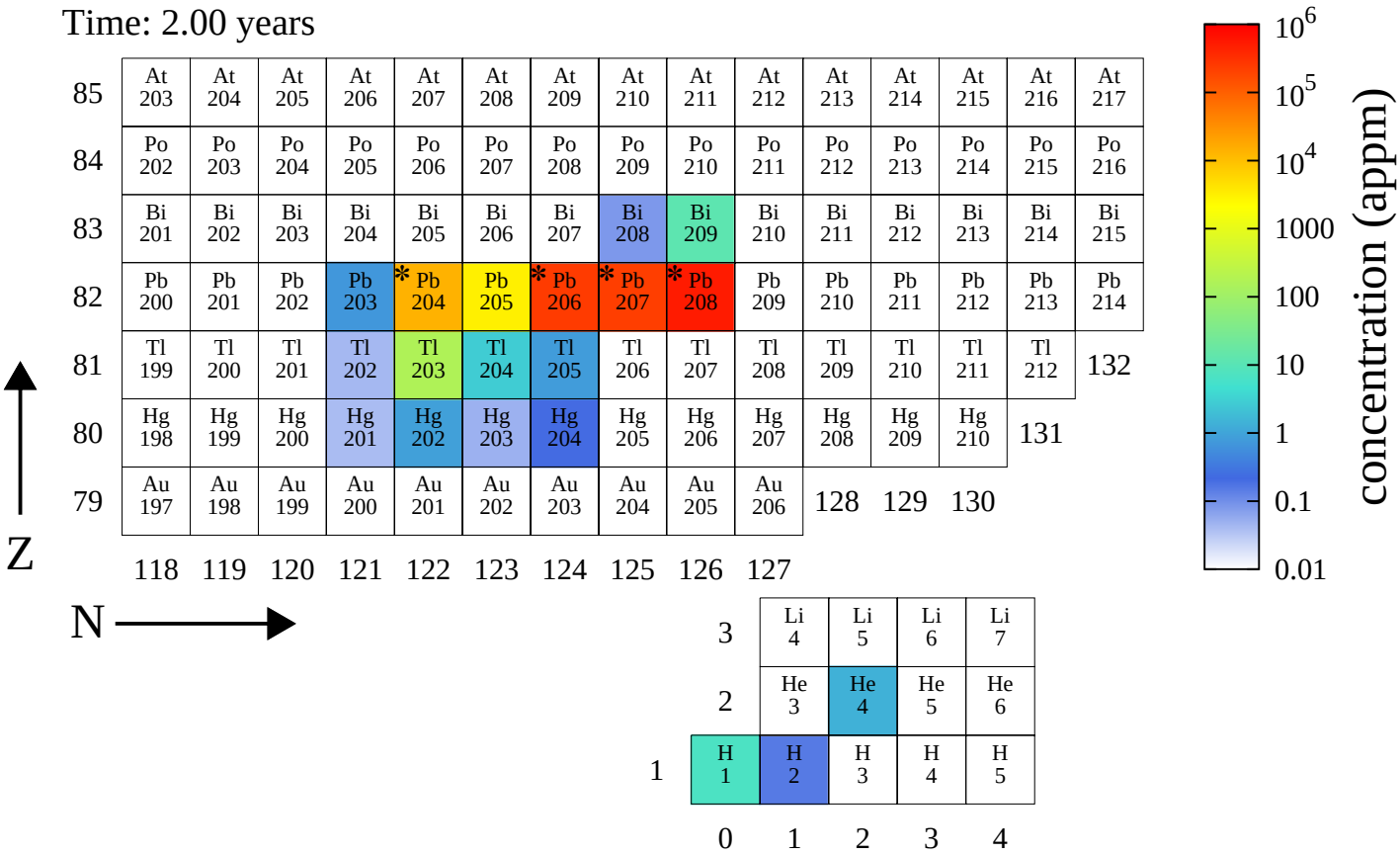




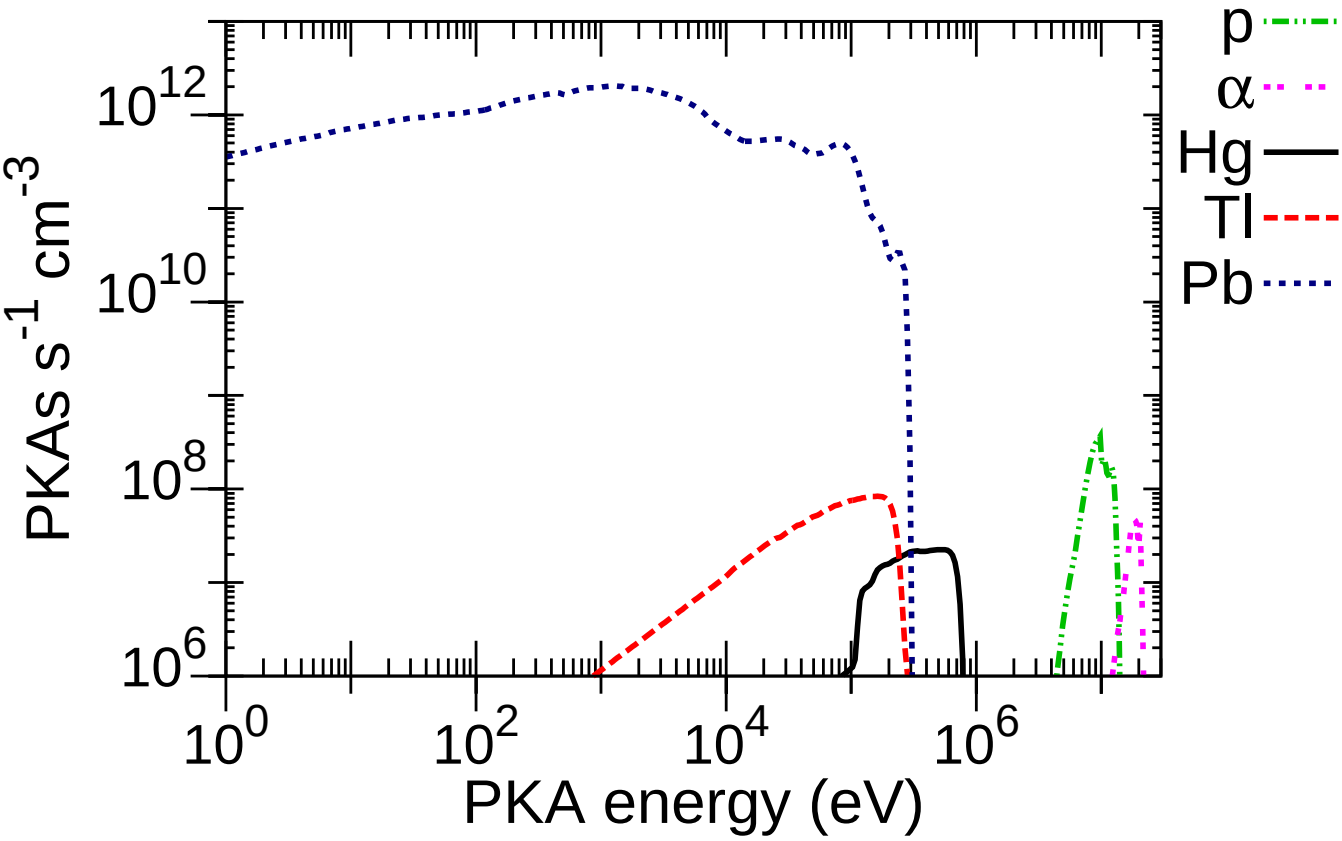
Lead FW Transmutation

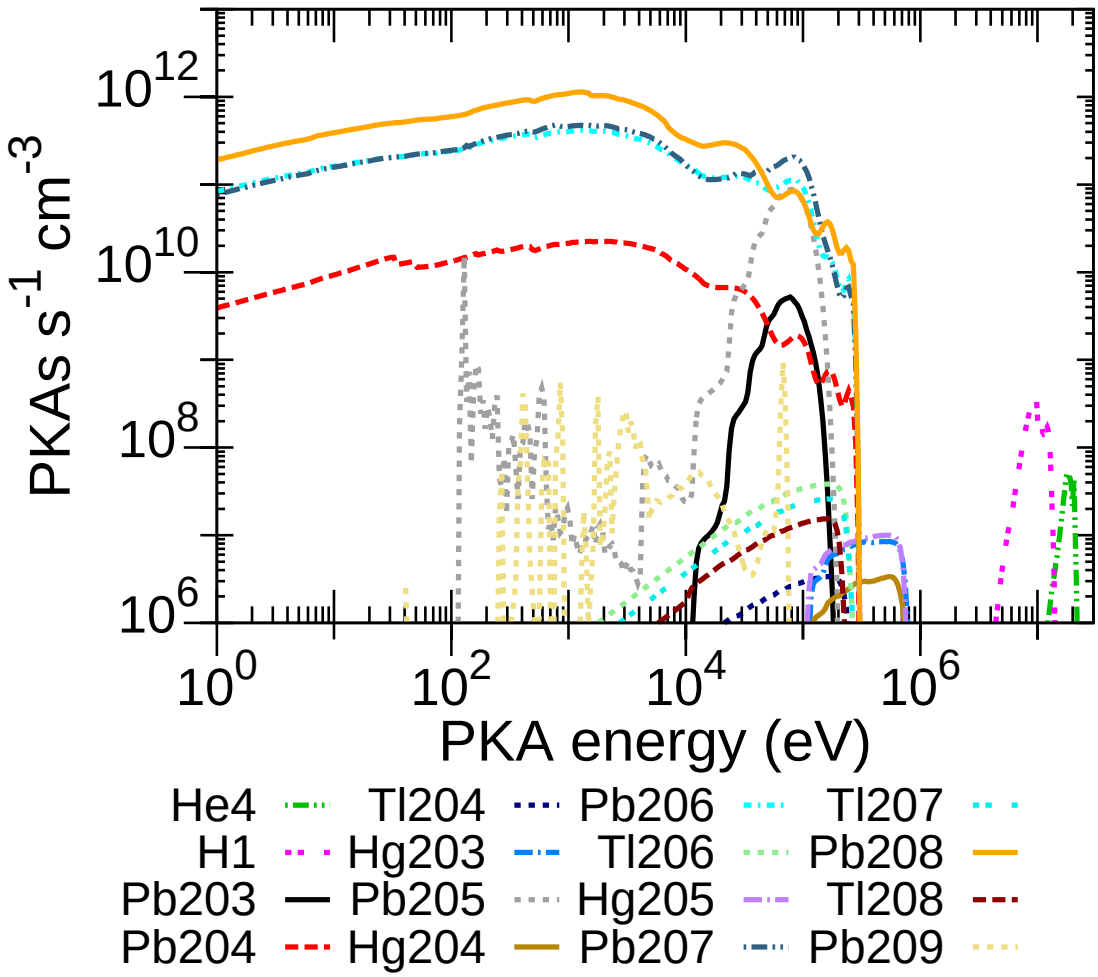


1 appm He & 3 appm H after 1 year 13 dpa/year



Lead FW PKA distributions





Lead Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Pb207m	0.81s	Pb206(n,γ)Pb207m	100.0	100.0	2.6	
		Pb207(n,n$'$)Pb207m			97.2	3.2
		Pb208(n,2n)Pb207m				95.7
Pb203m	6.29s	Pb204(n,2n)Pb203m				84.0
		Pb206(n,2n)Pb205(n,2n)Pb204(n,2n)Pb203m				10.8
		Pb206(n,2n)Pb205(n,2n)Pb204m(IT)Pb204(n,2n)Pb203m				2.4
		Pb204(n,2n)Pb203n(IT)Pb203m				1.4
Tl208	3.05m	Pb208(n,p)Tl208				100.0
Tl206m	3.76m	Pb208(n,α)Hg205(β^-)Tl205(n,γ)Tl206m	99.0			
		Pb208(n,γ)Pb209(β^-)Bi209(n,α)Tl206m			99.4	
		Pb206(n,p)Tl206m				86.8
		Pb207(n,2n)Pb206(n,p)Tl206m				11.0
Tl206	4.20m	Pb208(n,α)Hg205(β^-)Tl205(n,γ)Tl206	99.0	98.8		
		Pb204(n,γ)Pb205(β^+)Tl205(n,γ)Tl206		1.1		
		Pb208(n,γ)Pb209(β^-)Bi209(n,α)Tl206			99.2	
		Pb206(n,p)Tl206				66.2
		Pb206(n,p)Tl206m(IT)Tl206				19.9
		Pb207(n,2n)Pb206(n,p)Tl206				8.4
		Pb207(n,2n)Pb206(n,p)Tl206m(IT)Tl206				2.5
Hg205	5.20m	Pb208(n,α)Hg205	98.1	100.0	99.6	100.0
		Pb207(n,γ)Pb208(n,α)Hg205	1.5			
Pb204m	1.13h	Pb204(n,n$'$)Pb204m			100.0	7.7
		Pb206(n,2n)Pb205(n,2n)Pb204m				85.0
		Pb207(n,2n)Pb206(n,2n)Pb205(n,2n)Pb204m				5.4
		Pb206(n,2n)Pb205(n,2n)Pb204(n,n$'$)Pb204m				1.0
Pb209	3.25h	Pb208(n,γ)Pb209	98.5	100.0	100.0	100.0
		Pb207(n,γ)Pb208(n,γ)Pb209	1.5			
Pb203	2.16d	Pb204(n,2n)Pb203				42.7
		Pb204(n,2n)Pb203m(IT)Pb203				42.2
		Pb206(n,2n)Pb205(n,2n)Pb204(n,2n)Pb203				5.5
		Pb206(n,2n)Pb205(n,2n)Pb204(n,2n)Pb203m(IT)Pb203				5.4
		Pb206(n,2n)Pb205(n,2n)Pb204m(IT)Pb204(n,2n)Pb203				1.2
		Pb206(n,2n)Pb205(n,2n)Pb204m(IT)Pb204(n,2n) Pb203m(IT)Pb203				1.2
Bi210	5.01d	Pb208(n,γ)Pb209(β^-)Bi209(n,γ)Bi210	95.8	91.0	84.4	91.1
		Pb208(n,γ)Pb209(β^-)Bi209(n,γ)Bi210m(n,E)Bi210	3.4	9.0	14.5	8.7
		Pb208(n,γ)Pb209(β^-)Bi209(n,γ)Bi210m(n,n$'$)Bi210			1.1	
Tl202	12.24d	Pb204(n,2n)Pb203(β^+)Tl203(n,2n)Tl202				47.2
		Pb204(n,2n)Pb203m(IT)Pb203(β^+)Tl203(n,2n)Tl202				46.6
		Pb206(n,2n)Pb205(n,2n)Pb204(n,2n)Pb203(β^+) Tl203(n,2n)Tl202				1.9
		Pb206(n,2n)Pb205(n,2n)Pb204(n,2n)Pb203m(IT)Pb203(β^+) Tl203(n,2n)Tl202				1.9
Hg203	46.62d	Pb204(n,α)Hg201(n,γ)Hg202(n,γ)Hg203	85.6			
		Pb206(n,α)Hg203	14.3	100.0	100.0	71.0
		Pb207(n,2n)Pb206(n,α)Hg203				8.2
		Pb204(n,2n)Pb203(β^+)Tl203(n,p)Hg203				6.8
		Pb204(n,2n)Pb203m(IT)Pb203(β^+)Tl203(n,p)Hg203				6.7
		Pb207(n,α)Hg204(n,2n)Hg203				3.0
		Pb207(n,nα)Hg203				1.2
Po210	138.39d	Pb208(n,γ)Pb209(β^-)Bi209(n,γ)Bi210(β^-)Po210	96.5	92.3	86.7	92.6
		Pb208(n,γ)Pb209(β^-)Bi209(n,γ)Bi210m(n,E)Bi210(β^-)Po210	2.8	7.7	12.3	7.2
Tl204	3.79y	Pb204(n,α)Hg201(n,γ)Hg202(n,γ)Hg203(β^-)Tl203(n,γ)Tl204	58.5			
		Pb206(n,α)Hg203(β^-)Tl203(n,γ)Tl204	41.4	100.0	39.3	
		Pb204(n,p)Tl204			60.7	68.4
		Pb208(n,α)Hg205(β^-)Tl205(n,2n)Tl204				11.1
		Pb206(n,2n)Pb205(n,p)Tl205(n,2n)Tl204				6.4
		Pb206(n,2n)Pb205(n,2n)Pb204(n,p)Tl204				3.2
		Pb206(n,2n)Pb205(n,d)Tl204				3.1
		Pb204(n,2n)Pb203(β^+)Tl203(n,γ)Tl204				1.7
		Pb204(n,2n)Pb203m(IT)Pb203(β^+)Tl203(n,γ)Tl204				1.7
		Pb206(n,2n)Pb205(n,np)Tl204				1.4

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
H3	12.33y	Pb207(n,t)H3				49.5
		Pb208(n,t)H3				27.7
		Pb206(n,t)H3				8.2
		Pb208(n,2n)Pb207(n,t)H3				4.2
		Pb208(n,2n)Pb207m(IT)Pb207(n,t)H3				3.9
		Pb206(n,2n)Pb205(n,t)H3				2.9
		Pb204(n,t)H3				1.2
Pb210	22.16y	Pb208(n,γ)Pb209(n,γ)Pb210	99.2	100.0	100.0	96.6
		Pb208(n,γ)Pb209(β^-)Bi209(n,γ)Bi210m(n,p)Pb210				3.2
Bi207	31.76y	Pb208(n,γ)Pb209(β^-)Bi209(n,2n)Bi208(n,2n)Bi207				99.5
Po209	102.02y	Pb208(n,γ)Pb209(β^-)Bi209(n,γ)Bi210(β^-)Po210(n,2n)Po209				94.7
		Pb208(n,γ)Pb209(β^-)Bi209(n,γ)Bi210m(n,E)Bi210(β^-) Po210(n,2n)Po209				5.2
Pb202	5.3 10^4y	Pb204(n,2n)Pb203(n,2n)Pb202				36.7
		Pb204(n,2n)Pb203m(IT)Pb203(n,2n)Pb202				36.2
		Pb204(n,2n)Pb203(n,2n)Pb202m(IT)Pb202				10.3
		Pb204(n,2n)Pb203m(IT)Pb203(n,2n)Pb202m(IT)Pb202				10.2
		Pb206(n,2n)Pb205(n,2n)Pb204(n,2n)Pb203(n,2n)Pb202				1.6
		Pb206(n,2n)Pb205(n,2n)Pb204(n,2n)Pb203m(IT) Pb203(n,2n)Pb202				1.5
Bi208	3.7 10^5y	Pb208(n,γ)Pb209(β^-)Bi209(n,2n)Bi208				100.0
Pb205	1.5 10^7y	Pb204(n,γ)Pb205	100.0	100.0	100.0	
		Pb206(n,2n)Pb205				93.4
		Pb207(n,2n)Pb206(n,2n)Pb205				5.9

Bismuth

Isotope	Atom % abundance
Bi209	100.00

($T_{1/2}$ =1.9 10^{19}y)

FW Activation properties

Act	0s	5.3m	3.7d	1y	100y	10^4y
Bq kg^{-1}	9.40E+12	9.29E+12	7.00E+12	8.76E+11	2.31E+10	2.30E+09
Bi210	46.5	47.0	37.7			
Po210	44.1	44.6	59.1	79.0		
Pb209	4.8	4.8				
Bi207	2.0	2.0	2.6	20.5	89.5	
Tl206	1.5	0.8				
Bi208				0.3	10.1	99.9

Heat	0s	5.3m	3.7d	1y	100y	10^4y
kW kg^{-1}	3.99E-03	3.97E-03	3.81E-03	6.48E-04	6.55E-06	9.81E-07
Po210	90.1	90.5	93.9	92.5		
Bi210	6.8	6.9	4.3			
Bi207	1.2	1.2	1.3	7.4	83.9	
Bi208				0.2	15.2	99.9

Dose	0s	5.3m	3.7d	1y	100y	10^4y
Sv h^{-1}	1.06E+02	9.53E+01	7.81E+01	5.29E+01	7.63E+00	1.70E+00
Bi207	49.4	54.9	67.0	96.7	77.4	
Bi206	34.1	37.8	30.8			
Tl206m	12.4	5.4				
Pb207m	2.4					
Bi208	1.6	1.8	2.2	3.3	22.6	100.0

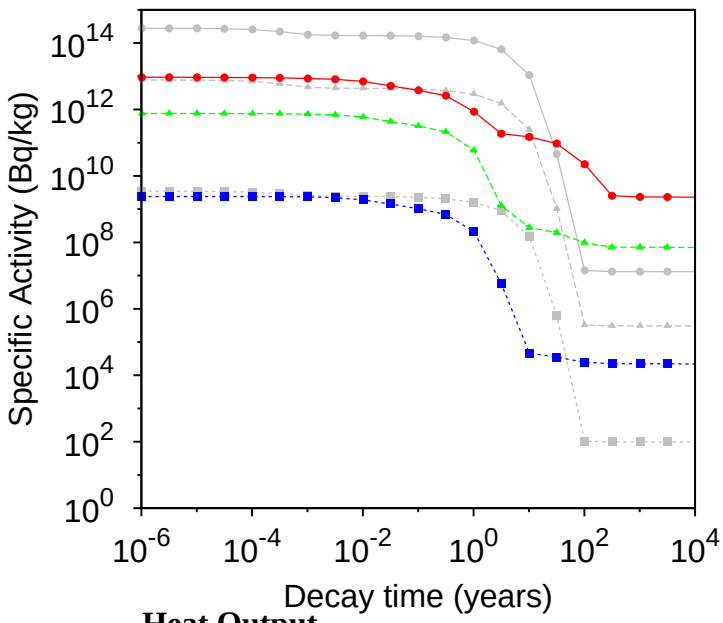
Ing	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	4.98E+06	4.98E+06	4.96E+06	8.30E+05	8.59E+01	3.22E+00
Po210	99.9	99.9	99.9	100.0	0.1	
Po209					64.8	
Bi207					31.3	
Bi208					3.8	99.7

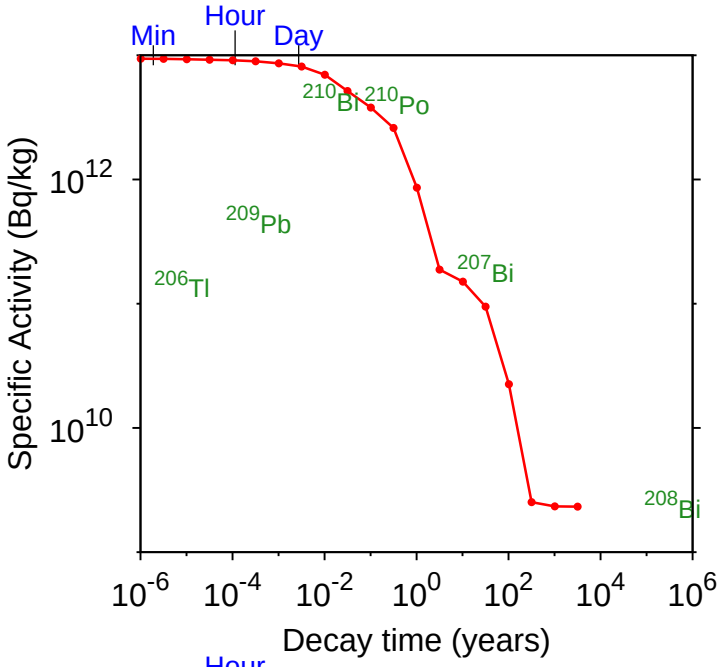
Inh	0s	5.3m	3.7d	1y	100y	10^4y
Sv kg^{-1}	1.82E+07	1.82E+07	1.80E+07	2.98E+06	3.01E+02	1.11E+01
Po210	97.7	97.8	98.6	100.0	0.1	
Bi210	2.2	2.2	1.4			
Po209					57.6	
Bi207					38.5	
Bi208					3.1	82.4
Bi210m					0.7	17.6

Clear	0s	5.3m	3.7d	1y	100y	10^4y
	1.11E+10	1.10E+10	8.65E+09	2.49E+09	2.13E+08	6.04E+06
Bi210	39.4	39.9	30.5			
Po210	37.3	37.8	47.8	27.7		
Bi207	16.5	16.7	21.2	72.0	97.1	
Pb209	4.1	4.1				
Tl206	1.2	0.7				
Bi208	0.1	0.1	0.1	0.2	2.9	100.0

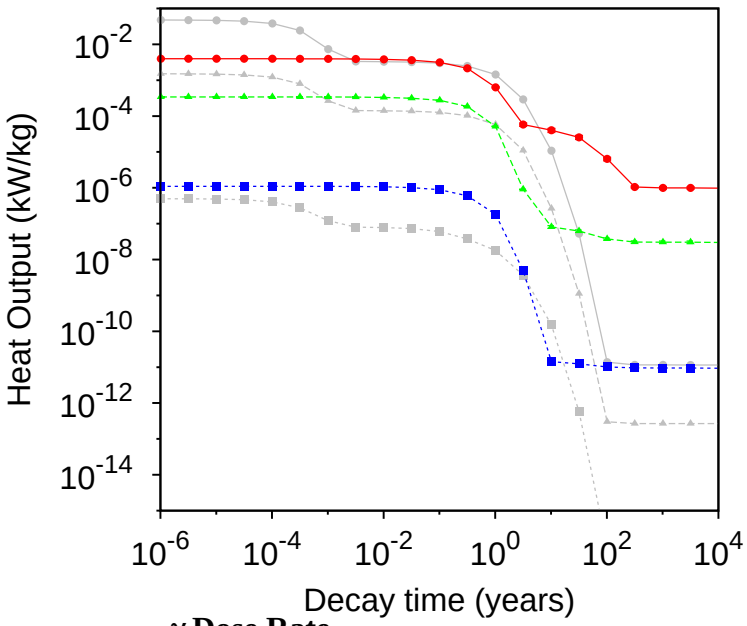
Bismuth activation characteristics

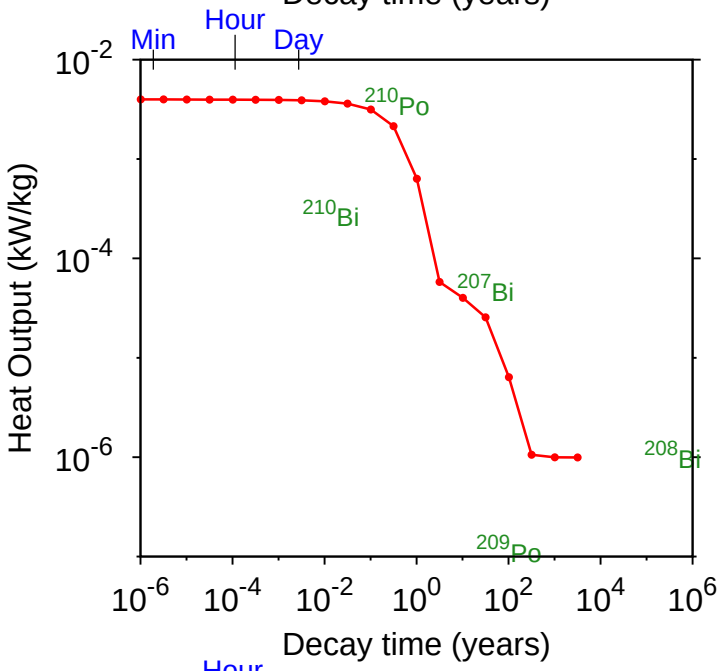
Specific Activity



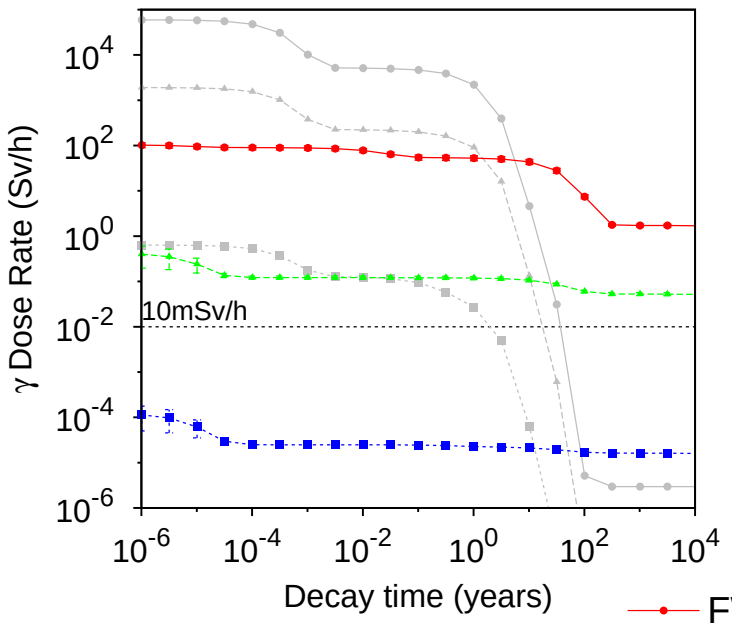


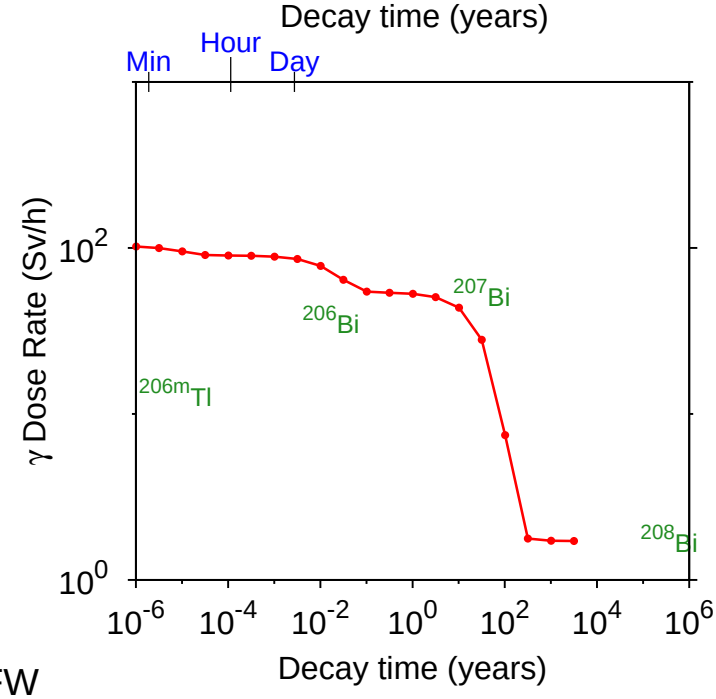
Heat Output





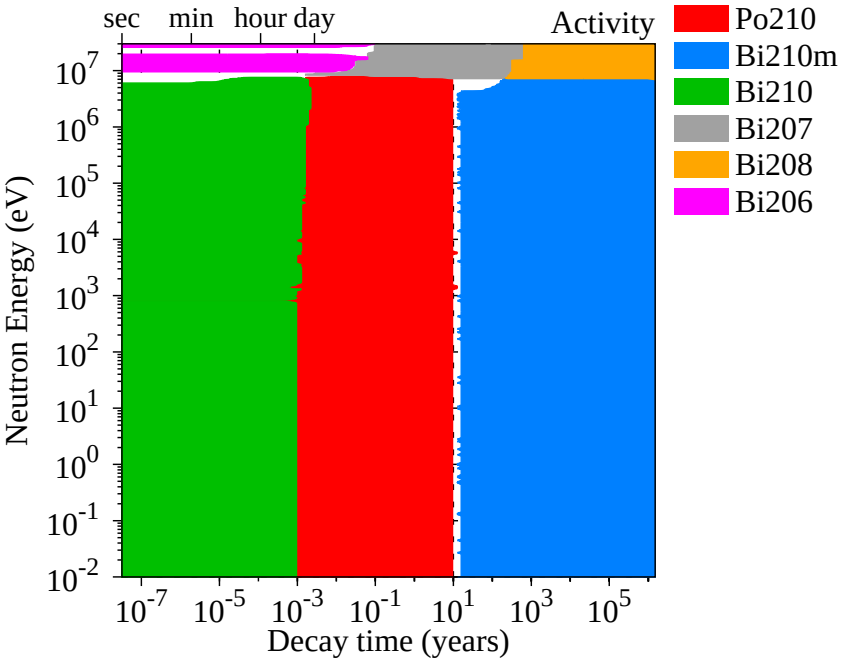
γ Dose Rate

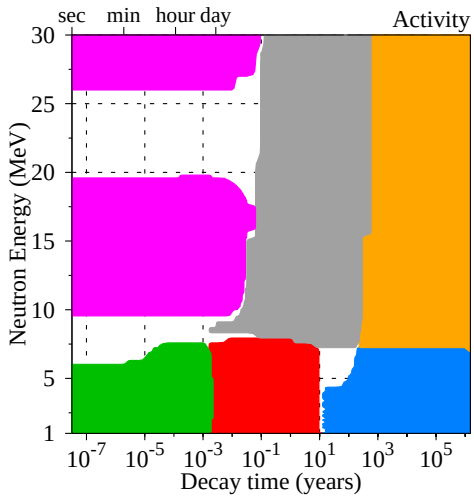


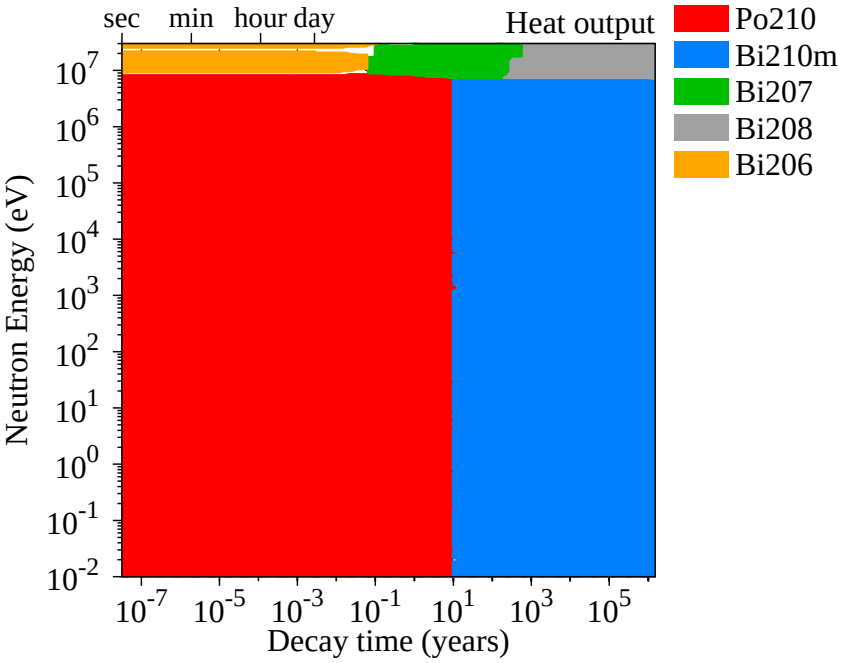


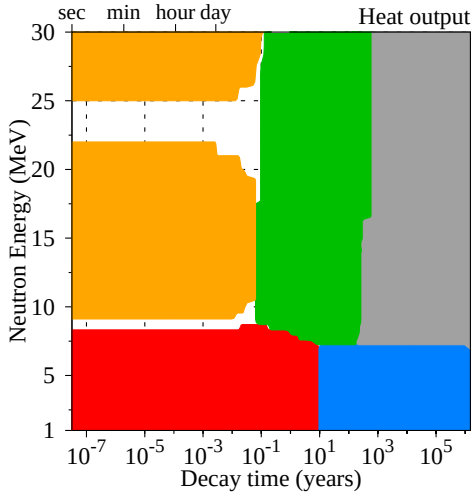
FW
Blanket
Manifold
Fe results

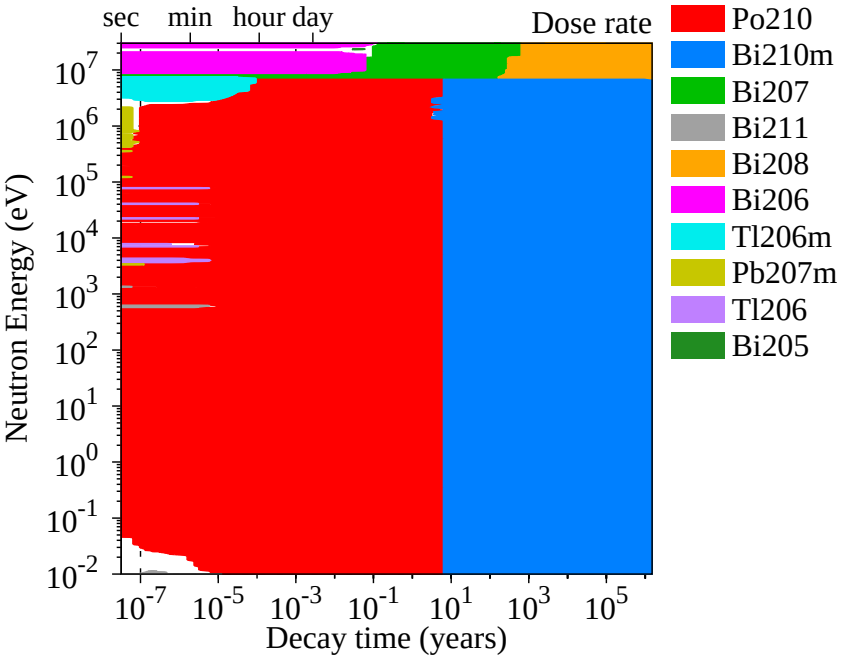
Bismuth Importance diagrams

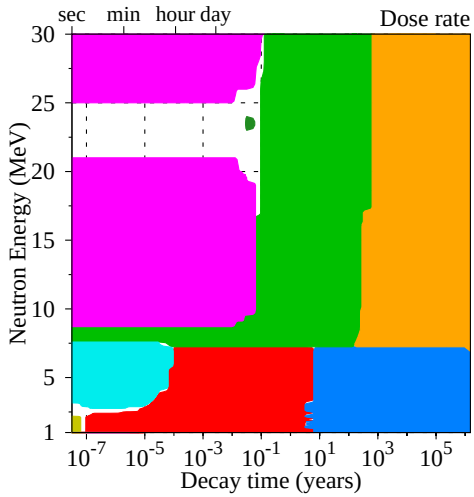




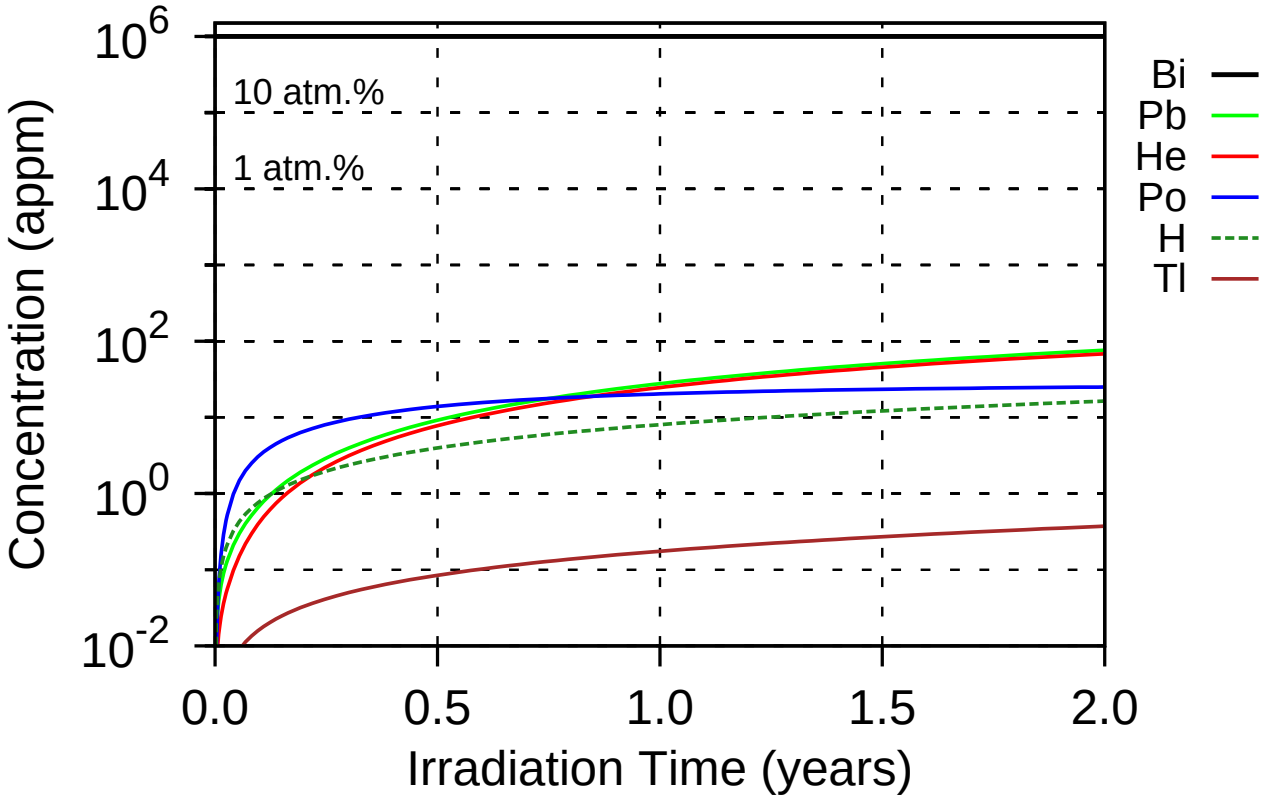






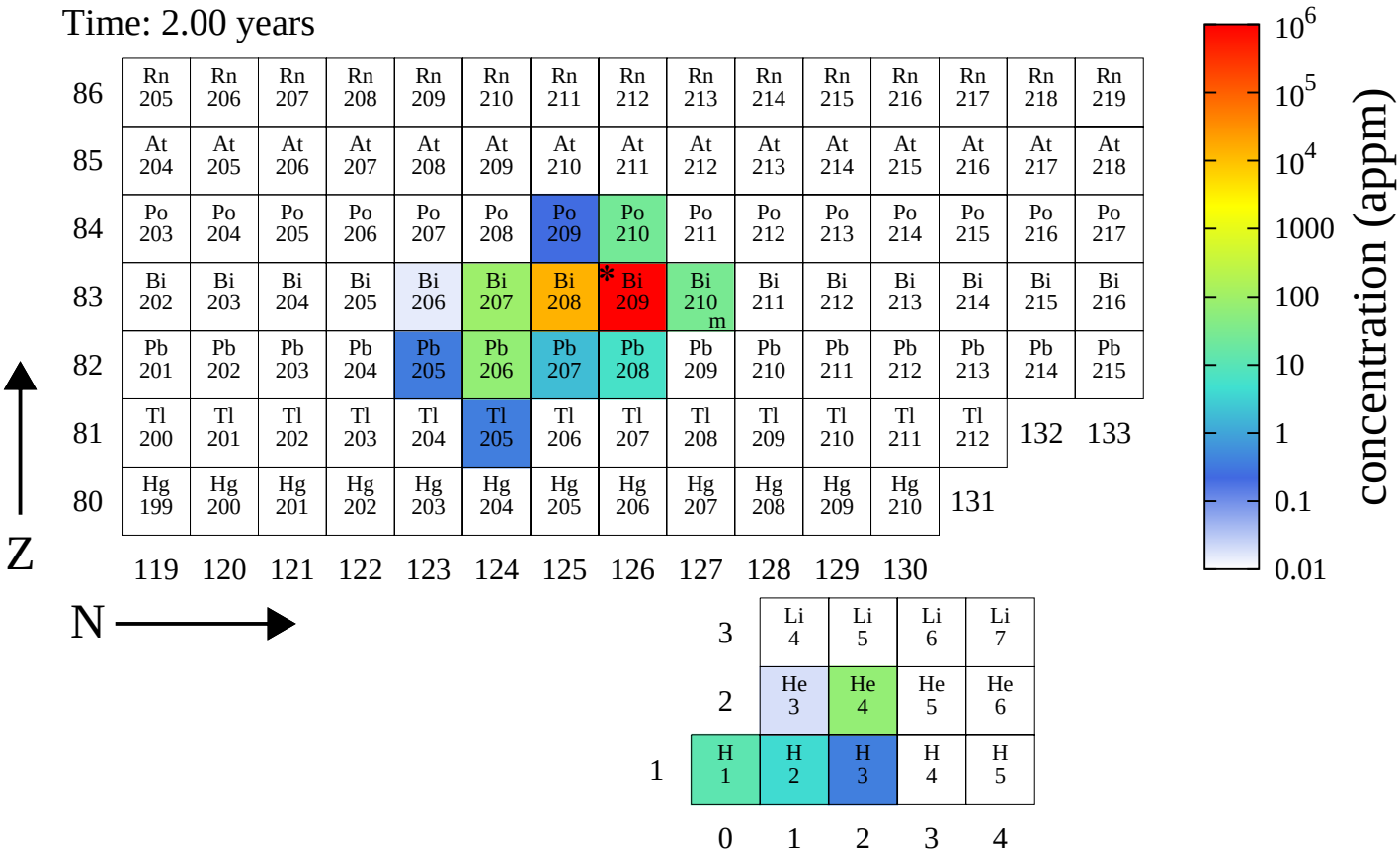


Bismuth FW Transmutation

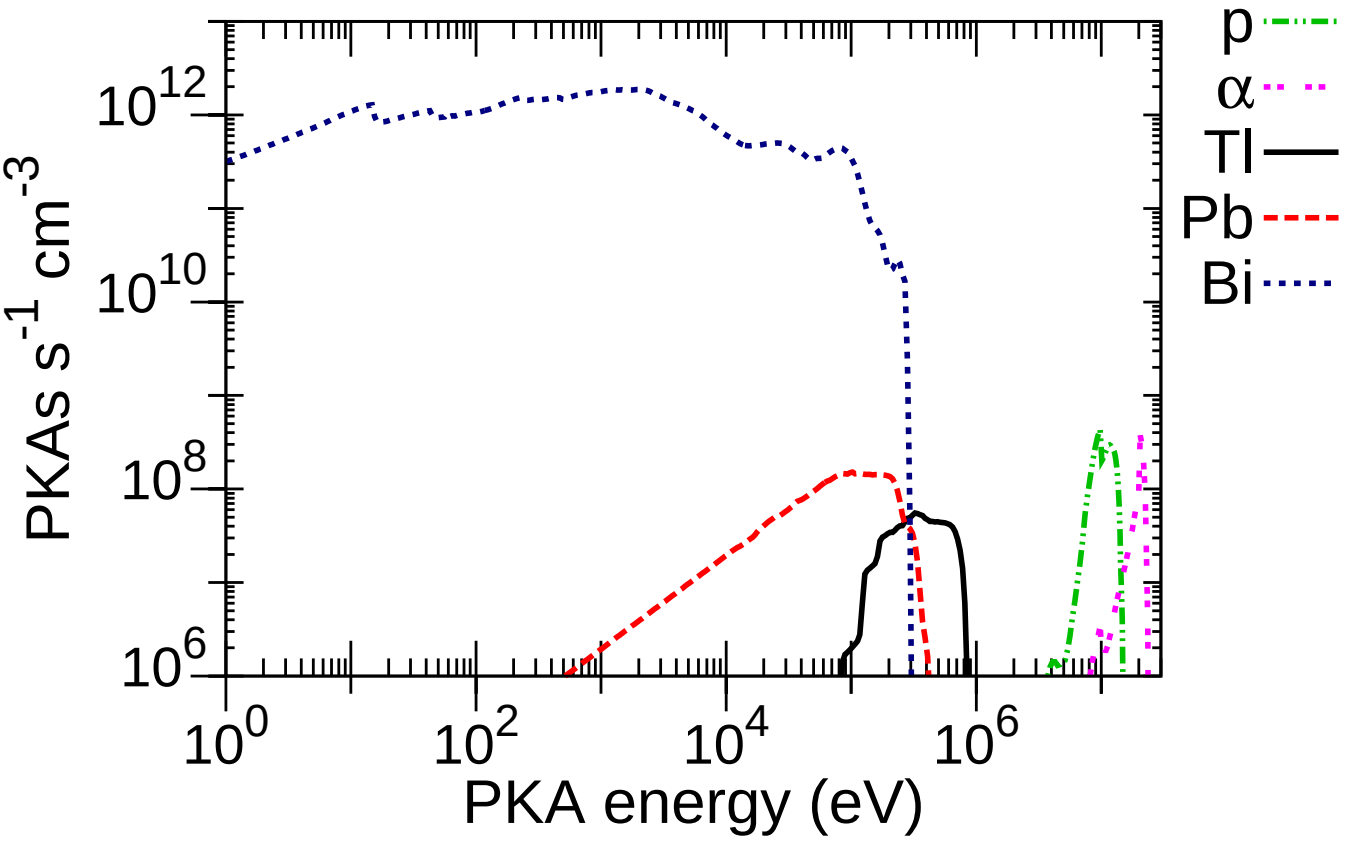


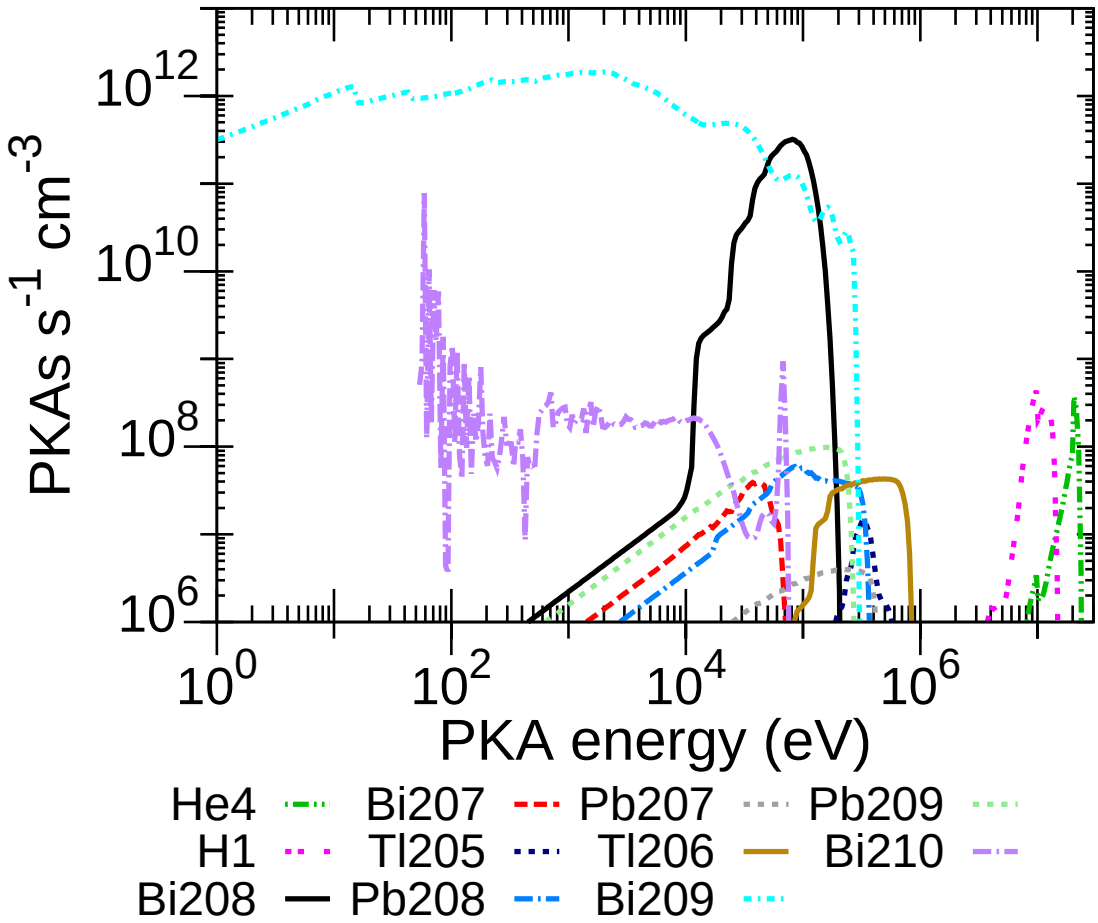
25 appm He & 8 appm H after 1 year

14 dpa/year



Bismuth FW PKA distributions





Bismuth Pathways analysis

Nuclide	$T_{1/2}$	Pathway	0.02–0.05 eV	20–40 keV	1–3 MeV	13–15 MeV
Pb207m	0.81s	Bi209(n,γ)Bi210(β^-)Po210(α)Pb206(n,γ)Pb207m	96.4	91.5	85.2	
		Bi209(n,γ)Bi210m(n,E)Bi210(β^-)Po210(α)Pb206(n,γ)Pb207m	2.8	7.7	12.1	
		Bi209(n,2n)Bi208(n,p)Pb208(n,2n)Pb207m				23.7
		Bi209(n,2n)Bi208(n,d)Pb207m				21.4
		Bi209(n,2n)Bi208(n,2n)Bi207(n,p)Pb207m				19.3
		Bi209(n,d)Pb208(n,2n)Pb207m				13.0
		Bi209(n,2n)Bi208(n,np)Pb207m				9.9
		Bi209(n,t)Pb207m				4.6
		Bi209(n,np)Pb208(n,2n)Pb207m				3.6
		Bi209(n,2n)Bi208(n,2n)Bi207(β^+)Pb207(n,n$'$)Pb207m				3.6
Bi211	2.17m	Bi209(n,γ)Bi210m(n,γ)Bi211	94.9	97.3	99.6	98.8
		Bi209(n,γ)Bi210(n,γ)Bi211	4.8	2.3		1.0
Tl206m	3.76m	Bi209(n,α)Tl206m			100.0	99.8
Tl206	4.20m	Bi209(n,α)Tl206	87.8	98.7	99.6	73.6
		Bi209(n,γ)Bi210(α)Tl206	10.7	1.1		
		Bi209(n,α)Tl206m(IT)Tl206				26.2
Pb209	3.25h	Bi209(n,γ)Bi210(β^-)Po210(α)Pb206(n,γ)Pb207(n,γ) Pb208(n,γ)Pb209	41.0			
		Bi209(n,γ)Bi210m(n,γ)Bi211(α)Tl207(β^-)Pb207(n,γ) Pb208(n,γ)Pb209	32.3			
		Bi209(n,γ)Bi210(β^-)Po210(n,γ)Po211(α)Pb207(n,γ) Pb208(n,γ)Pb209	20.1			
		Bi209(n,γ)Bi210(n,γ)Bi211(α)Tl207(β^-)Pb207(n,γ) Pb208(n,γ)Pb209	4.4			
		Bi209(n,p)Pb209			100.0	100.0
Bi210	5.01d	Bi209(n,γ)Bi210	93.8	85.1	73.9	84.1
		Bi209(n,γ)Bi210m(n,E)Bi210	6.2	14.9	24.3	15.5
		Bi209(n,γ)Bi210m(n,n$'$)Bi210			1.9	
Bi206	6.24d	Bi209(n,2n)Bi208(n,2n)Bi207(n,2n)Bi206				99.7
Bi205	15.31d	Bi209(n,2n)Bi208(n,2n)Bi207(n,2n)Bi206(n,2n)Bi205				99.7
Po210	138.39d	Bi209(n,γ)Bi210(β^-)Po210	95.1	87.7	78.6	87.4
		Bi209(n,γ)Bi210m(n,E)Bi210(β^-)Po210	4.9	12.3	19.9	12.3
		Bi209(n,γ)Bi210m(n,n$'$)Bi210(β^-)Po210			1.5	
Bi207	31.76y	Bi209(n,2n)Bi208(n,2n)Bi207				99.7
Po209	102.02y	Bi209(n,γ)Bi210(β^-)Po210(n,2n)Po209				92.6
		Bi209(n,γ)Bi210m(n,E)Bi210(β^-)Po210(n,2n)Po209				7.3
Bi208	3.7 10^5y	Bi209(n,2n)Bi208				100.0
Bi210m	3.0 10^6y	Bi209(n,γ)Bi210m	100.0	100.0	100.0	100.0

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