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NJOY's processing steps and processed forms

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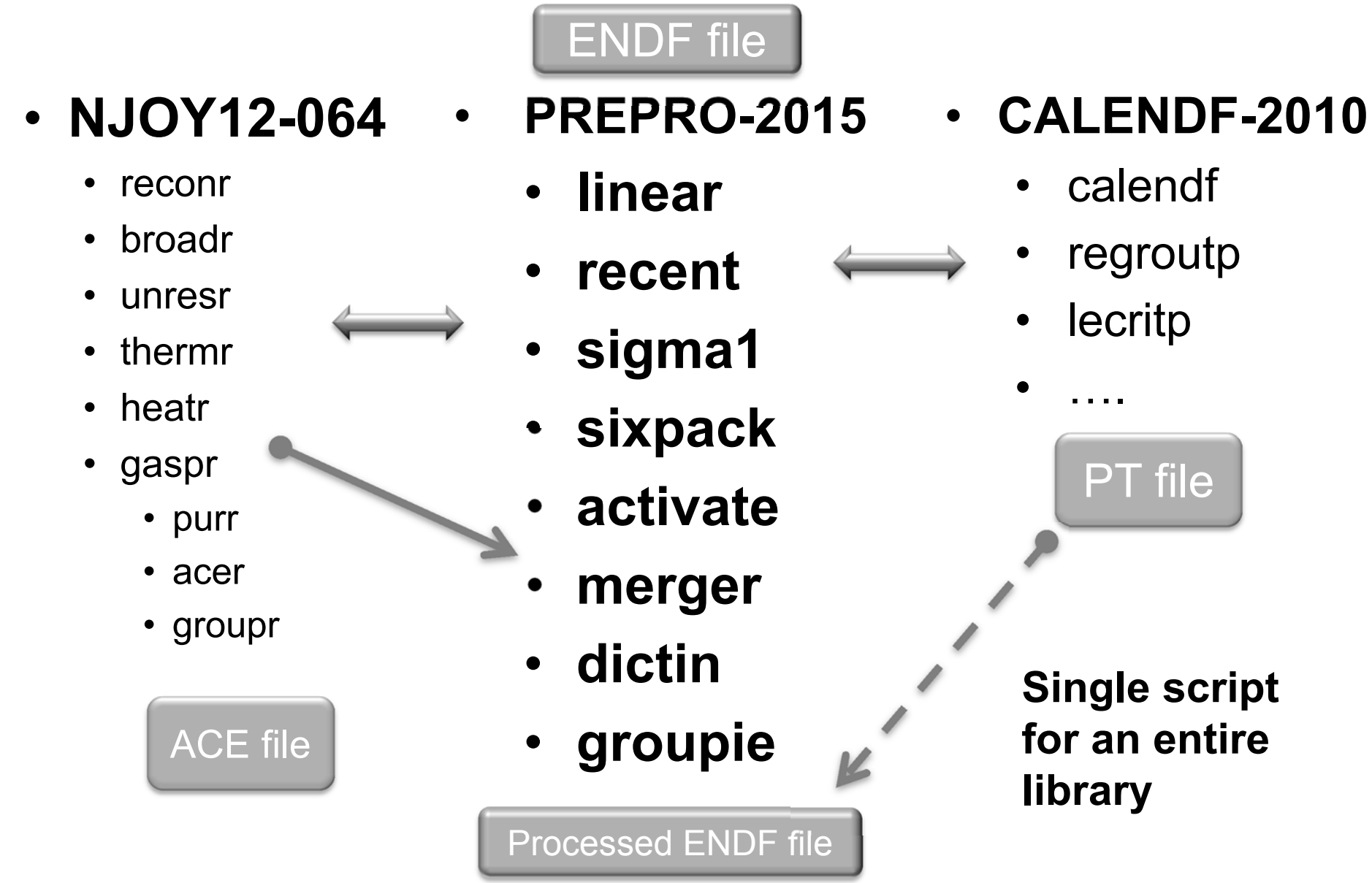
Processing: physics observable to engineering

- Raw ENDF-6 formatted nuclear data files are pretty cumbersome and not flexible enough for modern applications ! Let us hope that the GND one will be better
- Nuclear data processing is a necessity: to feed the many nuclear codes that require processed nuclear data forms
- These data are used by particle transport and time-evolution/inventory codes such as TRIPOLI and FISPACT-II
- The physics of interaction probabilities, emitted spectra, decays/heat/activity, *etc.* are taken from nuclear data
- Processing bridges the gap between the physics and the simulation codes

Processing steps

- Uniquely, uses three processing codes to prepare, shape nuclear data:
  - NJOY – kerma, dpa, matrix, gas production & crosschecking
  - PREPRO – ENDF data file preparation, high energy
  - CALENDF – probability table & crosschecking
- Advantages
  - Robustness, completeness
  - Redundancy
  - Portability, repeatability
  - Legacy and maturity
- Remarks: not all observables need processing to be usable

Processing steps: three codes



Processing steps: three codes

- **NJOY-12.064**
  - 0 Kelvin run
  - Single temperature pendf
  - Two *heatr* runs (7 + 4 responses, gamma local)
  - *Groupr* 1025 groups @ 30 MeV; p, d, t, alpha and he-3 + residual nucleus (A>4) production matrix
  - *thermr*, free gas
  - Two more *heatr* run (7 + 4 responses, gamma transported)
  - *purr* (nbin=20, ladders=64)
  - Two *acer* (new cumulative angle distribution (law 61) and one for checking and ace data forms display)

Processing steps: three codes

- **PREPRO-2015-3**
  - 0 Kelvin run
  - Single temperature pendf, 294 Kelvin to… 100 KeV
  - *SIXPACK*: unique mf-3/mt5-mf6 high energy processing
  - *ACTIVATE*: unique mf9 processing
  - Merge NJOY-12 dpa, kerma pendf responses
  - *GROUPIE* to: 1102 gprs @ 1 GeV
    1067 gprs @ 200 MeV
    1025 gprs @ 30 MeV
    162 gprs @ 200 MeV (Charge particles)
  - mf-2 processed, but also kept in for further usage

The resulting pendf “tape” fully comply to the ENDF-6 format frame and many utilitarian process (display, merge, concatenate, etc.) can be performed on such data forms

HEATR inputs instruction

```
heatr
-21 -24 -26 30
$isma[$c2] 7 0 0 0 2/   or 7 0 0 1 2/
302 303 304 318 402 442 443/
heatr
-21 -26 -27 33
$isma[$c2] 4 0 0 0 2/
444 445 446 447/
```

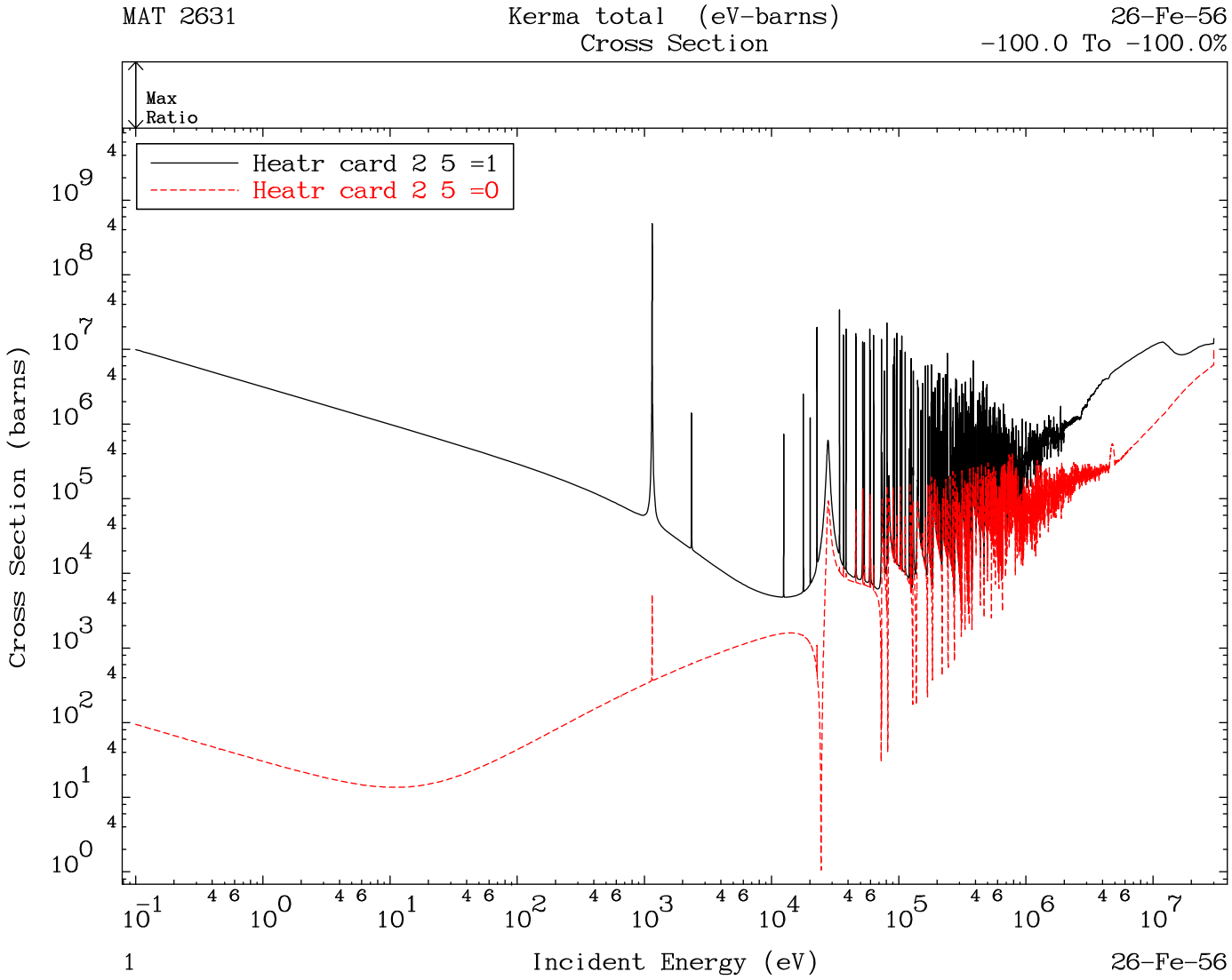
0/1 = gamma rays transported/deposited locally (default=0)

402 = 300 + 102

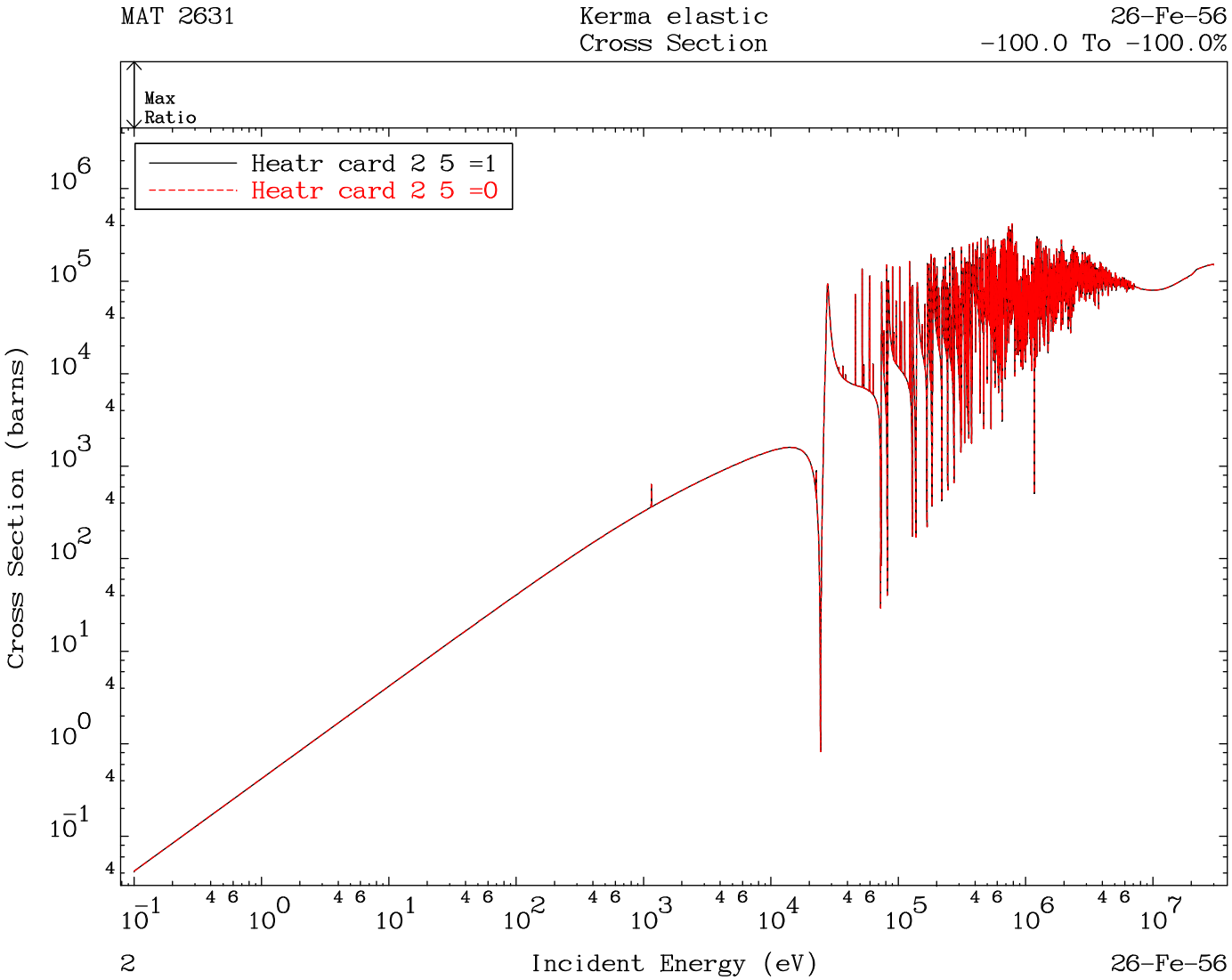
qa user specified q values

qbar variable qbar for reactions with qa flag only

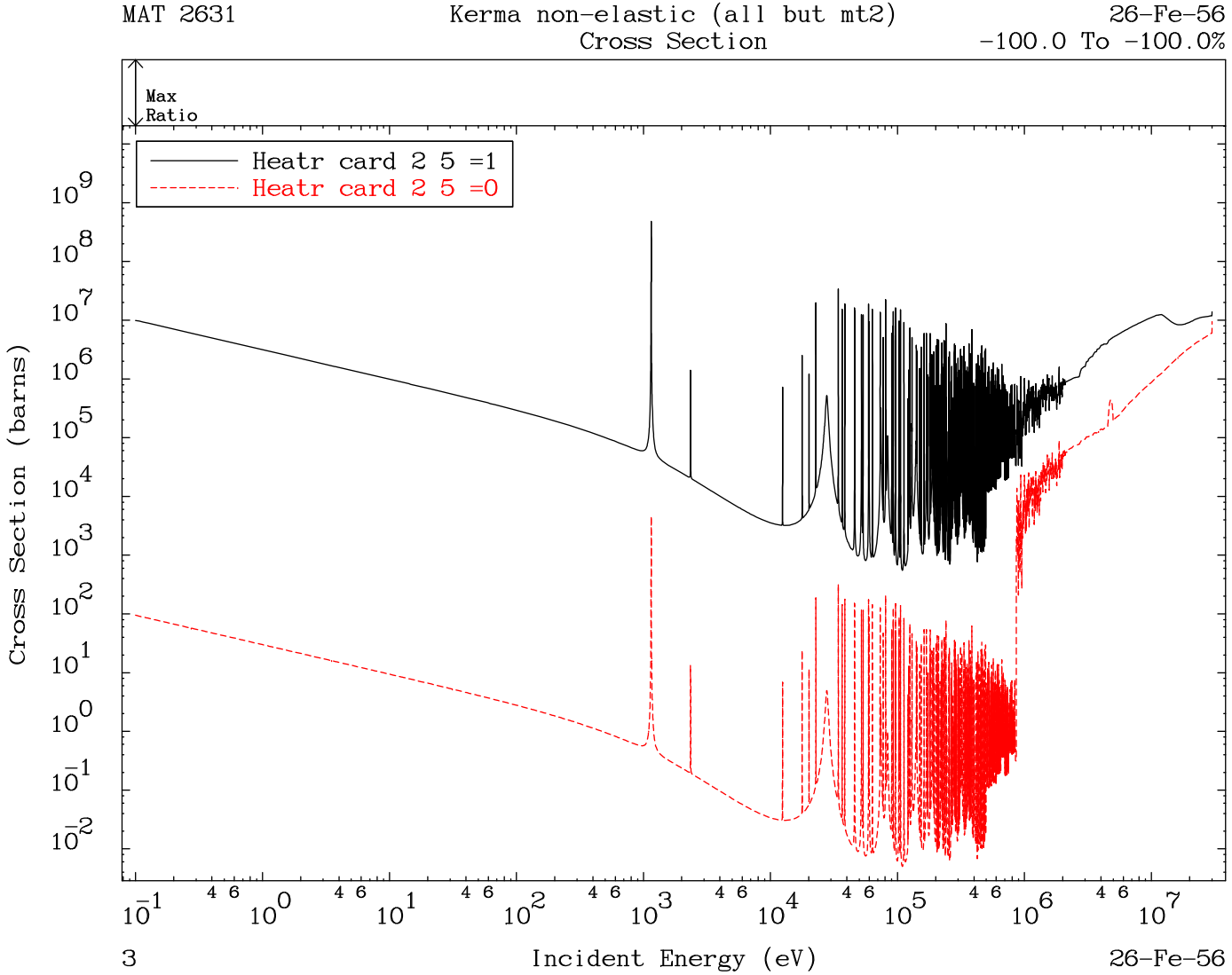
Heatr inputs



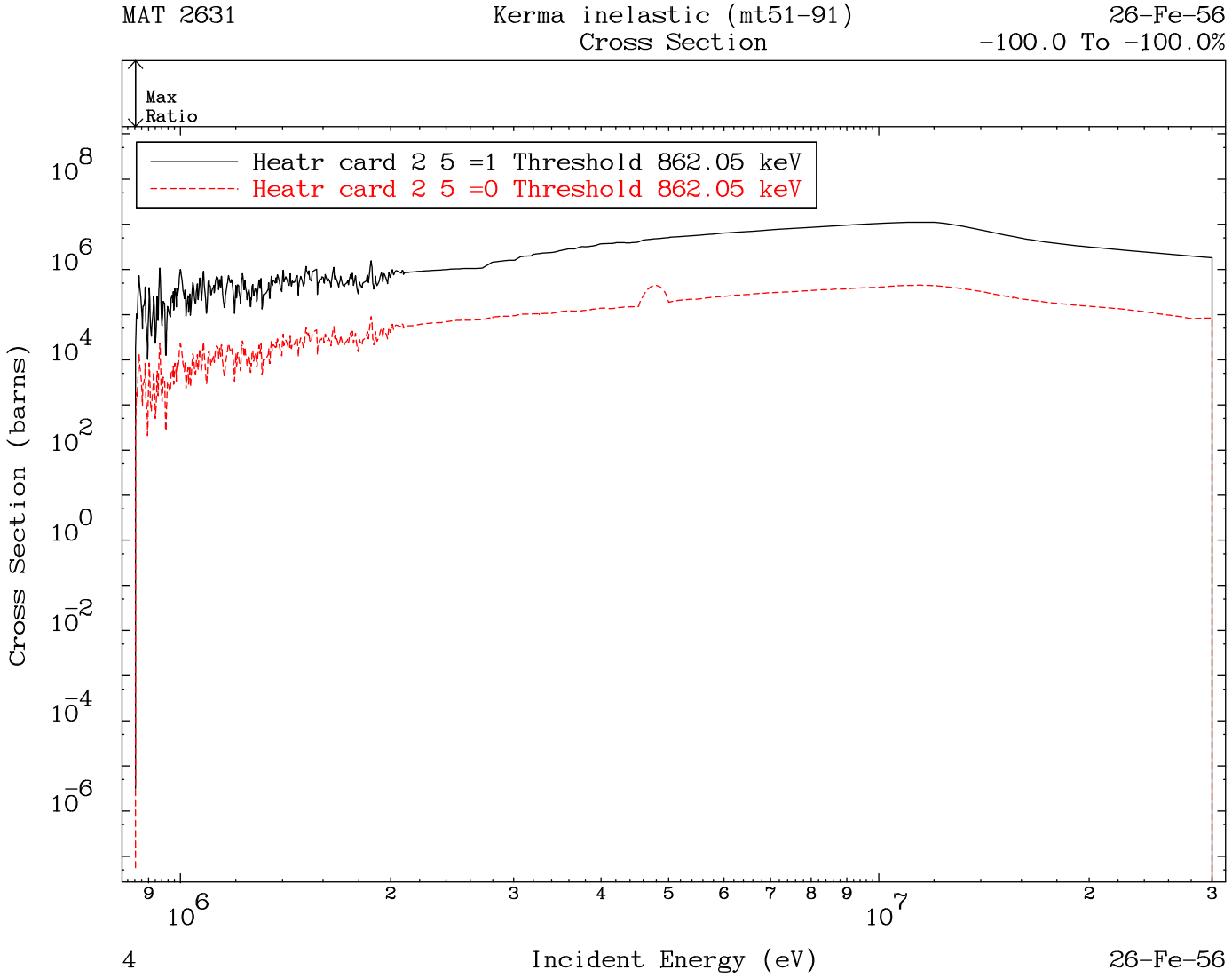
Heatr inputs



Heatr inputs



Heatr inputs



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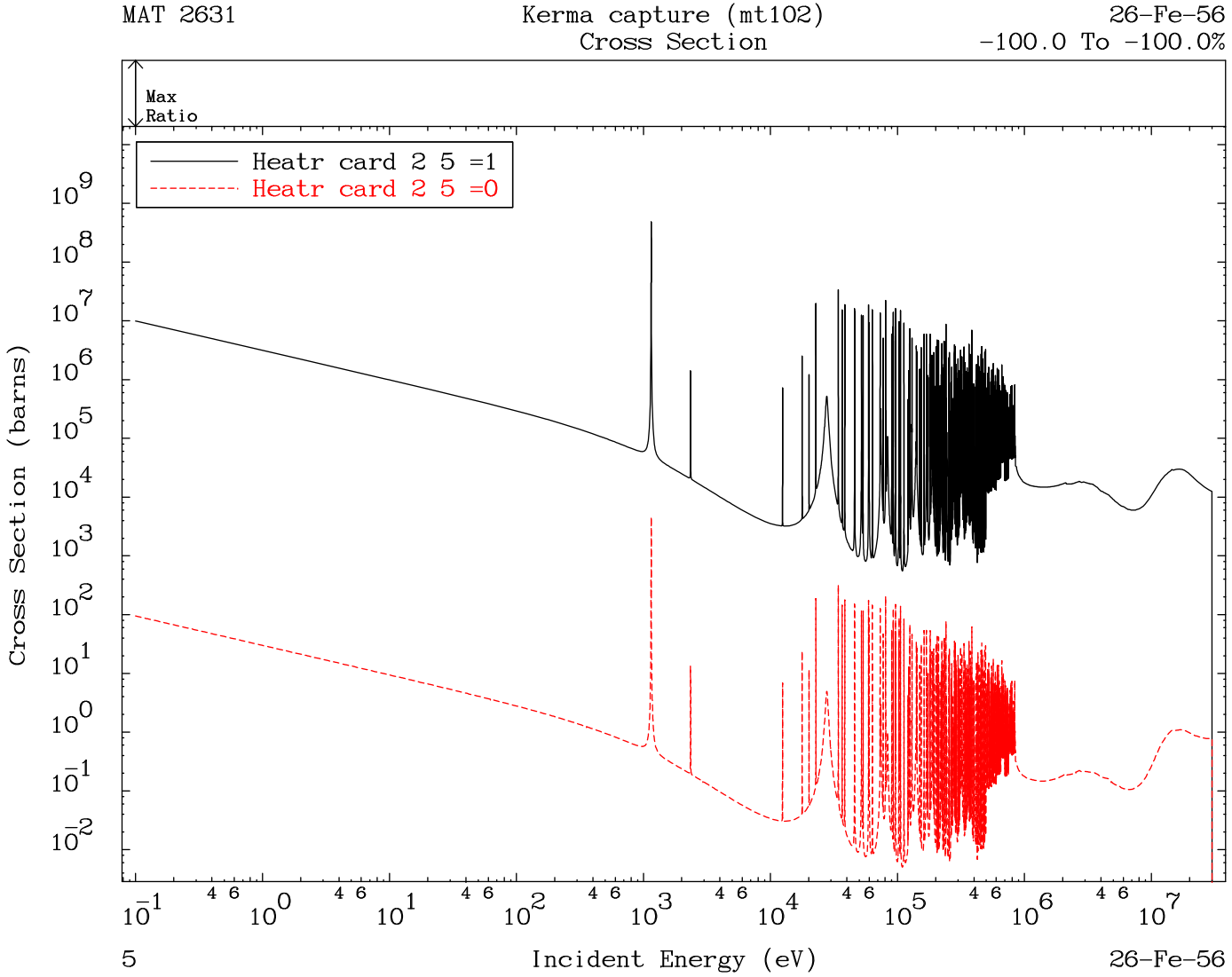
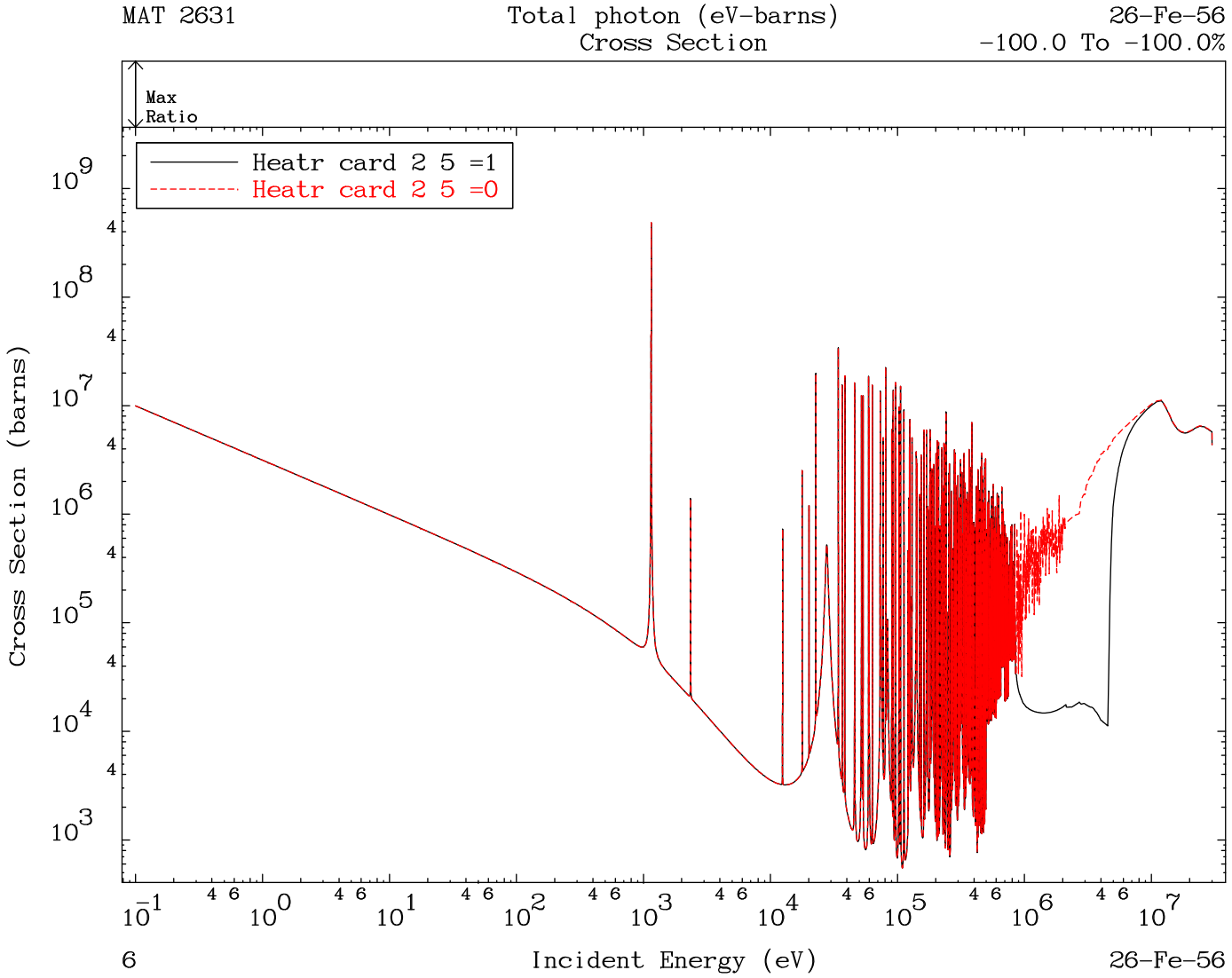
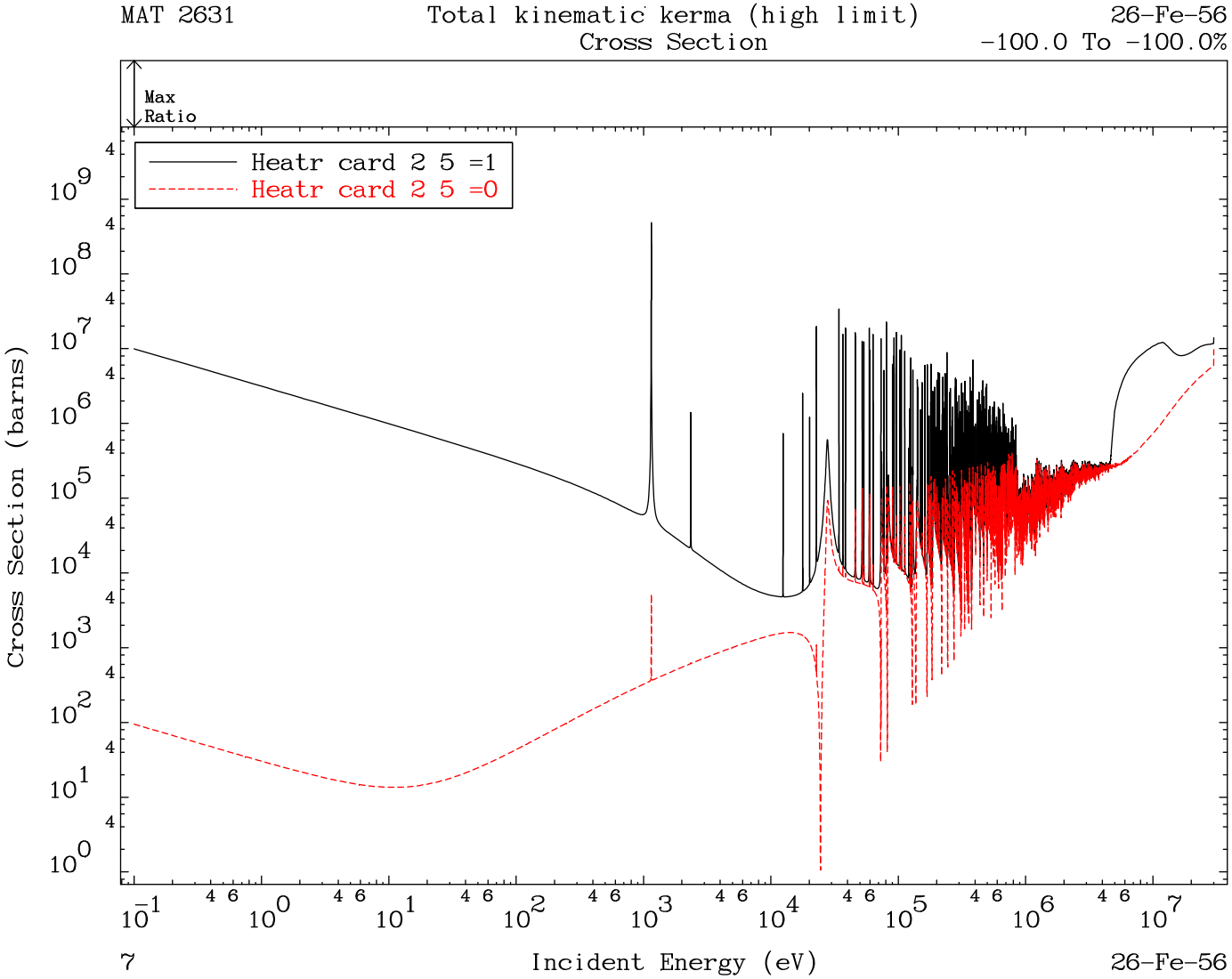
Heatr inputs



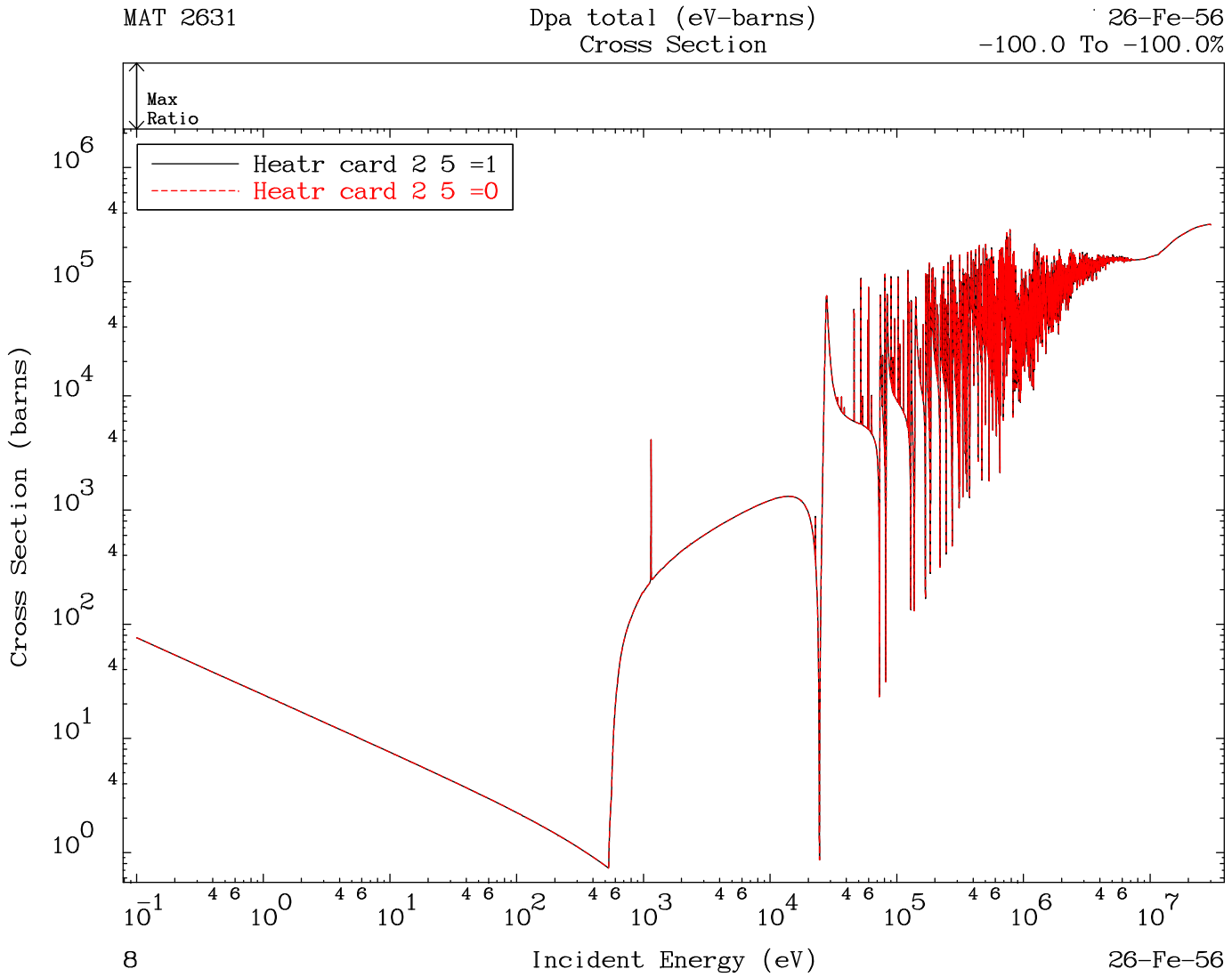
Heatr inputs



Heatr inputs

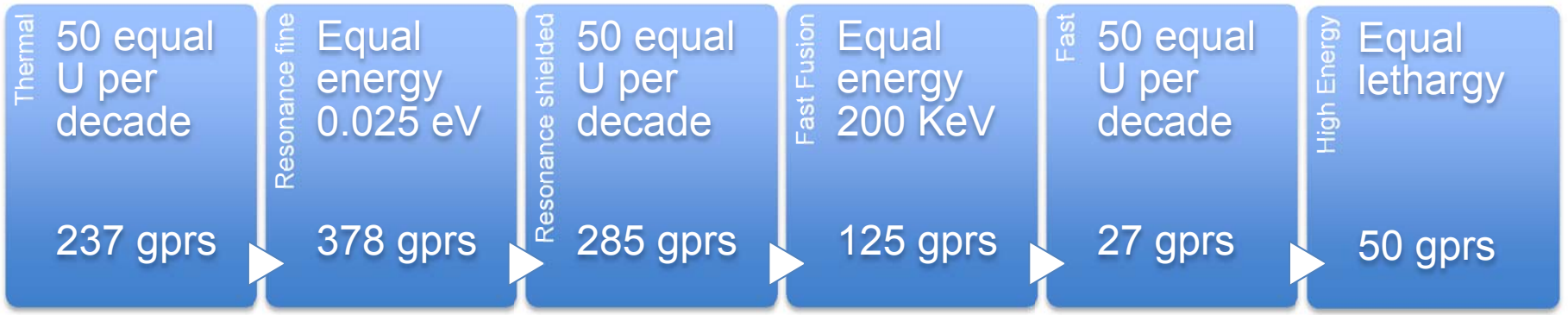


Heatr inputs



Group structures

- For all 558 target nuclides
- 1102 energy groups for all applications alike



1e-5 eV 0.55 eV 10 eV 5 MeV 30 MeV 100 MeV 1 GeV

615 groups 1025 groups

- 378 fine groups in the resonance range
- Resonance shielded data available in the RRR (0.1 eV) up to the end of the URR for all nuclides IDs
- Fast fine structure for accurate threshold reaction rate

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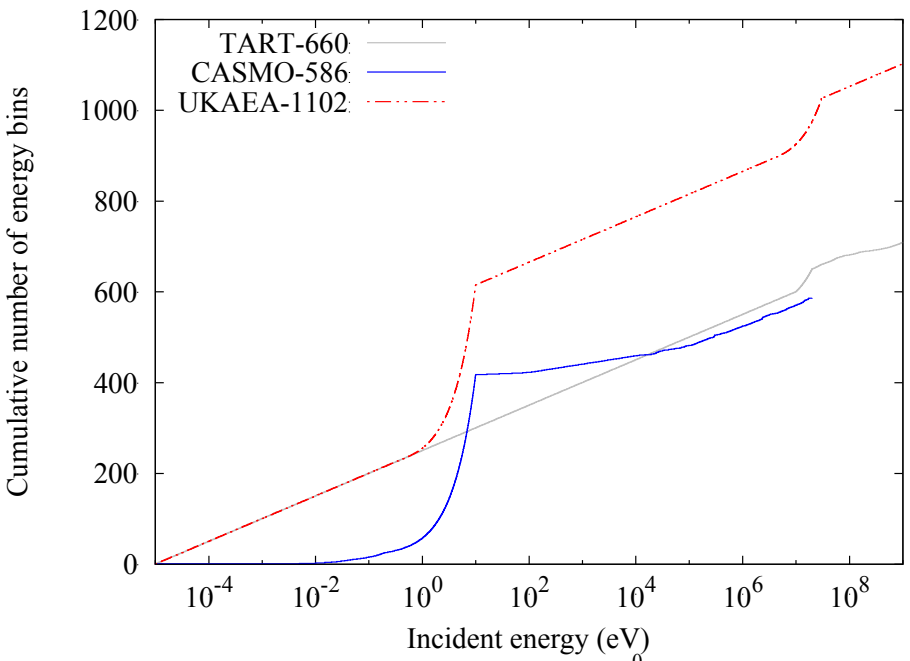
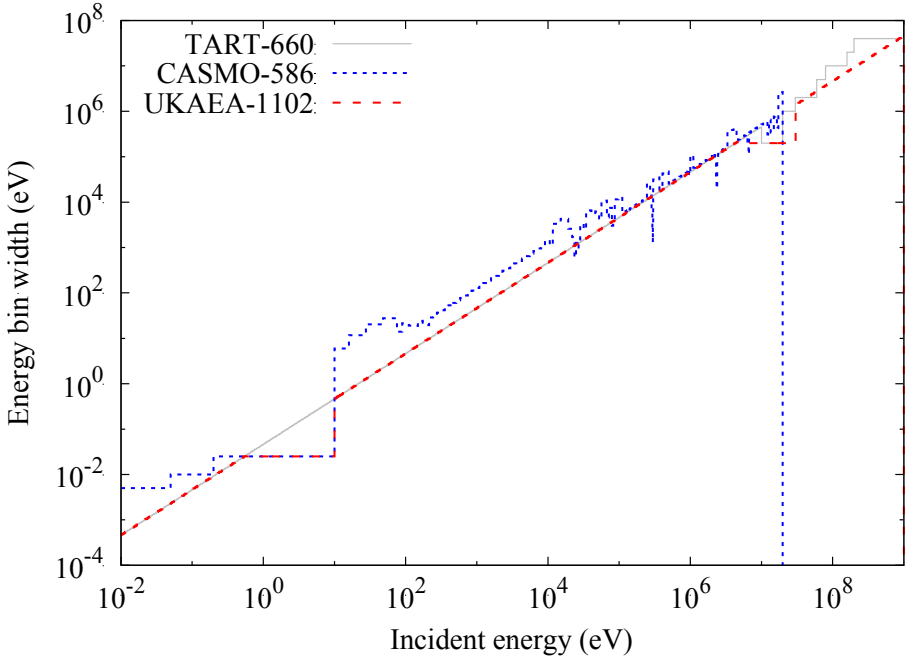
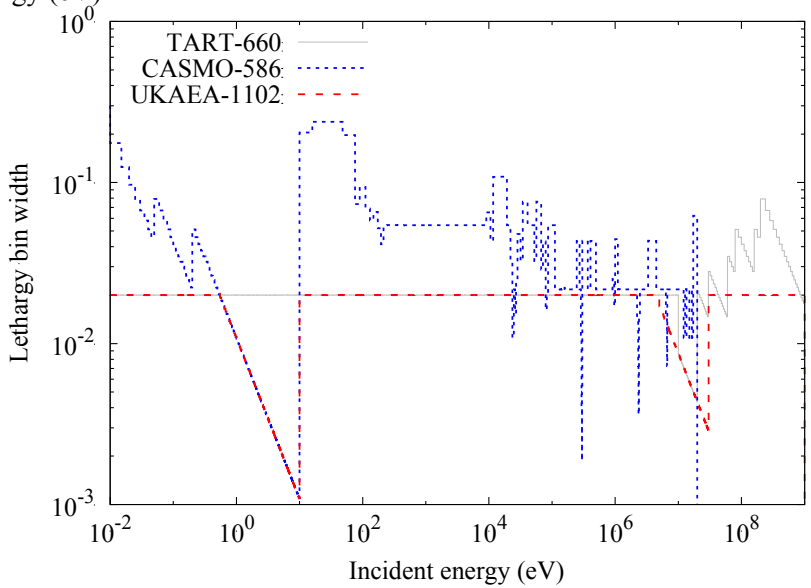
Group structure







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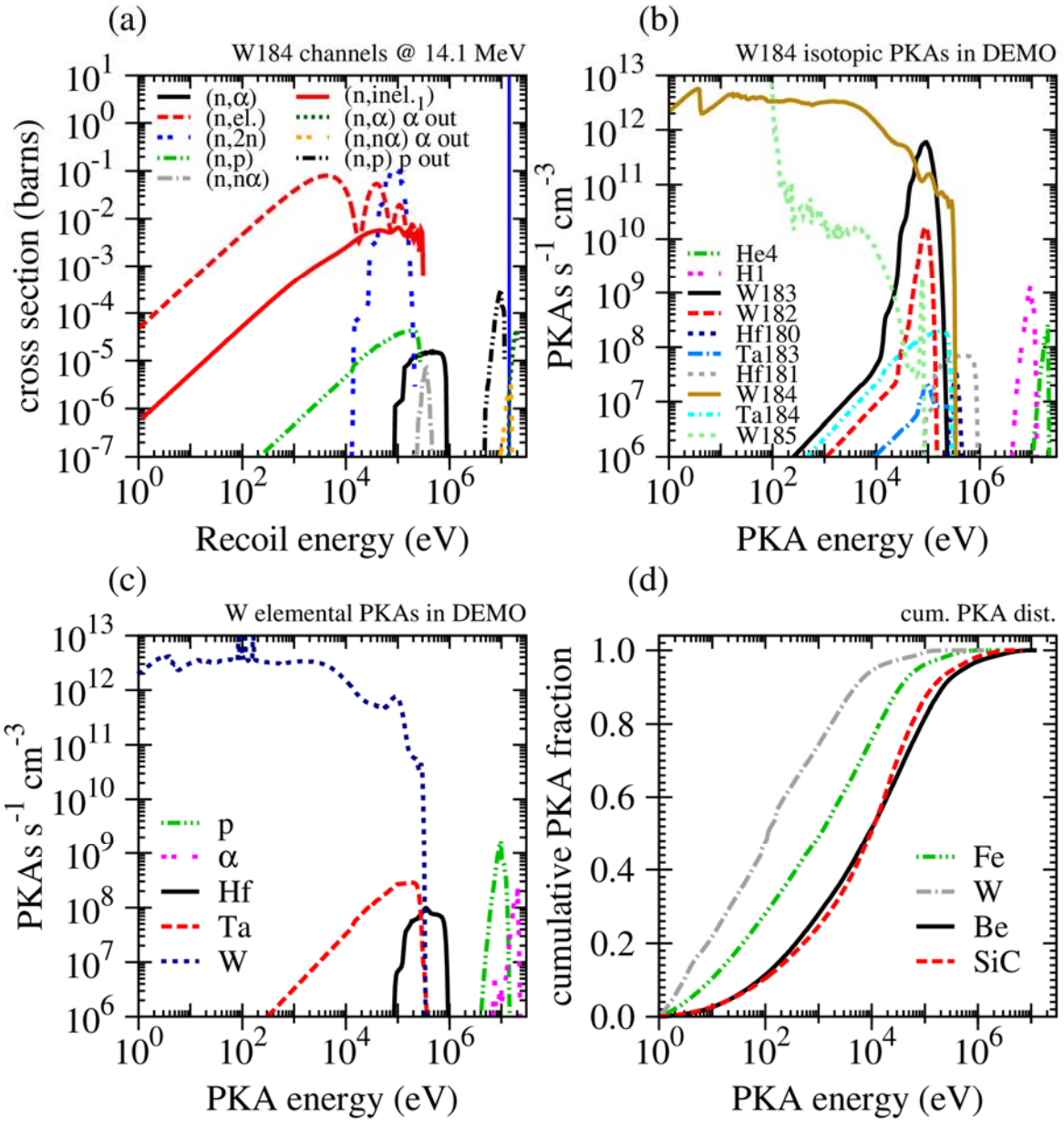
Applications forms

- Pointwise forms, Temperature dependent
- Groupwise, T and sigma zeroes dependent
- Matrices: n-n, n-g, n-prod and recoil
- All partials and total Kerma (7), dpa (4), gas production (5)

- FISPACT-II & SPECTRA-PKA forms, groupwise with PT tables, uncertainty, n-prod-recoil matrices, responses

- MCNP-6 Ace forms (Law 61) (SERPENT-2)
- TRIPOLI-4 forms (xdr, aniso, photonuc, Qfission…)

More than just xs; pka spectra for material sciences



(a) shows the raw n-prod matrices from njoy-12 for W184

(b) shows the isotopic results for W184 collapsed with a DEMO spectrum.

(c) Shows the elemental results for W – i.e. summed over 180/182 /183/184/186

(d) Shows cumulative distributions for four different materials (summed over heavy recoils).