Translating ENDF/B-VIII.0 into GND

Mini CSEWG, May 5 2017

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GND specification is nearing completion

- FUDGE is being modified to match GND specifications

- U.S. nuclear data community plans to release ENDF/B-VIII in both ENDF and GND

  — Estimated release date is mid-December 2017

  — ENDF ⇔ GND translation needs to be nearly one-to-one

    – A little work to do still

  — New version of Fudge will be released at the same time as ENDF/B-VIII

    – same version used to translate ENDF-VIII into GND

  — After the release, further changes to GND specifications will need to be approved by new format governance board, EG-GNDS (part of WPEC).

- GND translation is also being tested on other libraries including JEFF-3.2, JENDL-4 and TENDL-2015

# Current status of ENDF-VIII to GND translation

- Sub-libraries currently being translated:

  - Incident n, p, d, t, He3, alpha, gamma and electron data

  - standards

  - photo-atomic

  - atomic relaxation   (except writing back to ENDF-6 is currently broken)

  - thermal_scattering

- Not yet translated (Dave Brown is working on these: likely as I speak)

  - Neutron-induced and spontaneous fission yields

    - nfy and sfy translation is simple, but need to finalize how to store them in GND

  - Decay sub-library

Some files have "problem" data

- The translator complains about some data issues, but can "recover" from them with the proper flags

- Fission cross section stored in MF10
  - New W evaluations use unofficial ENDF format modification to store fission cross section
  - Affects W182-186. Crashes unless option --ignoreMF10Fission used

- Missing evaluation date in MT451
  - GND requires evaluation date. n + Pu239 fails without '--skipBadDate'

- Unnormalizable continuum gammas in MF6
  - GND stores gammas similar to the MF12,15 forms, thus MF6 gamma data must be converted to MF12,15 like data
  - At some incident energies, the continuum gamma spectrum has 0 area and cannot be normalized as needed for MF12 like data.
  - Translator crashes unless option --continuumSpectraFix is set
  - Affected isotopes:
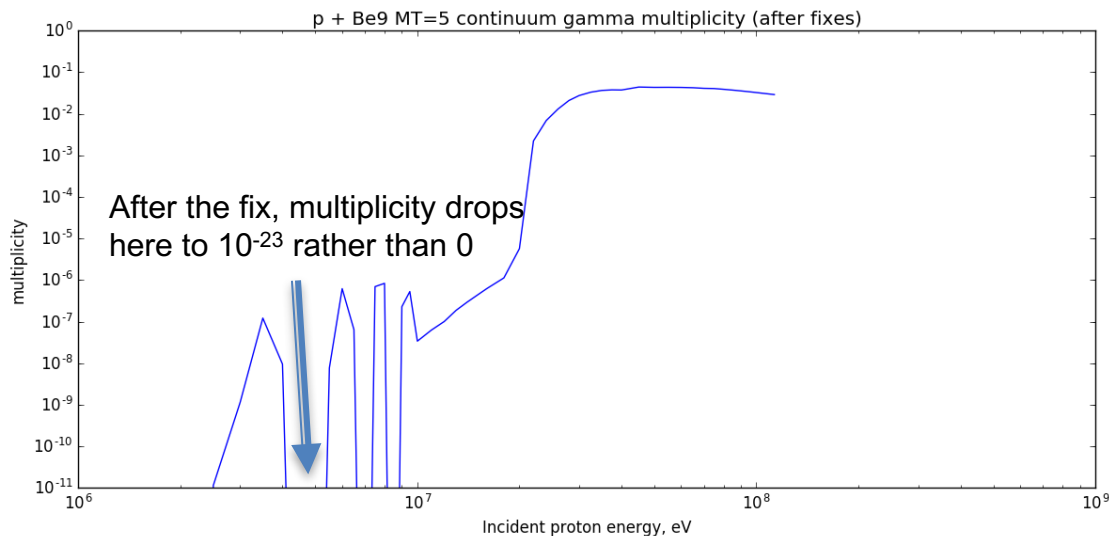   — n + Cl35, Ca42-46, As73, Pb204-207
    — p + Be9

More detail on continuum gamma problem

- In MF6, continuum, primary and discrete gammas are all listed together for each incident energy, along with total multiplicity for all gammas
  - Each primary & discrete has a probability, continuum has a spectrum
  - Some continuum spectra are all 0s
    — probability distribution at these incident energies cannot be normalized
  - Probability can go from non-zero to zero and back multiple times:
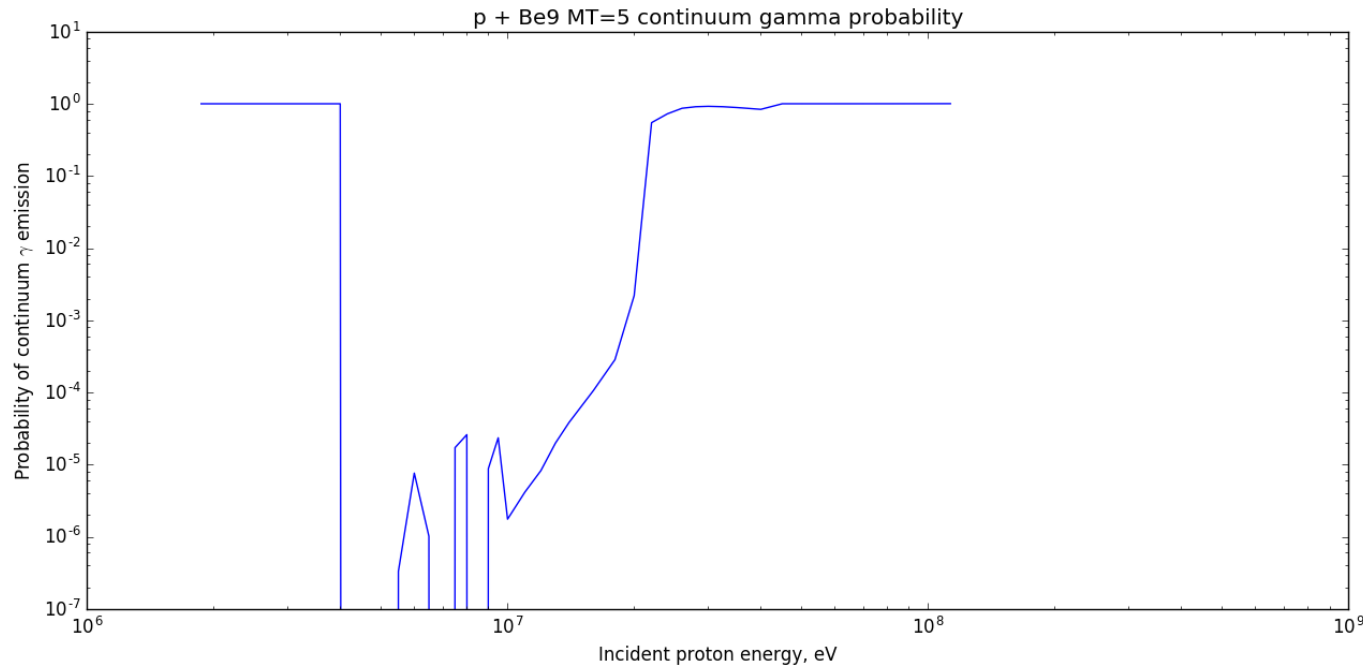
Patching continuum gamma problems

- When option --continuumSpectraFix is supplied, the translator replaces 0-norm continuum spectra with a delta function, weighted by total gamma multiplicity

p + Be9 MT=5 continuum gamma multiplicity (after fixes)

After the fix, multiplicity drops here to 10^{-23} rather than 0

multiplicity

Incident proton energy, eV

- This is just a temporary work-around. Gamma spectra need more attention!

We often 'verify' translation by converting back to ENDF-6

- Run 'rePrint.py' to translate and ENDF-6 file to GND and back to ENDF-6

- We xxdiff the original ENDF-6 and GND $\rightarrow$ ENDF-6 files or simply count the number of lines that differences
  - First remove line numbers to simplify comparison

- 222K (out of 11.5M) lines differ in neutron sub-library
  - Worst culprits (>2000 diffs): Be9, Cl35, Ca, Ni, Ge, Zr91, Mo, Sn, W, Pb, Th232

- 46K (out of 2.8M) lines differ in gamma sub-library
  - Dominated by U234, U236, Pu238, Pu241

- Most differences do not matter

Common reasons for differences after rePrint.py

- When duplicate (x,y) points appear in TAB1, the translator drops the second point where possible. Can result in many diffs that are not important!

- ENDF stores mass (AWR) many times, GND picks the most frequently-used value and only stores that.

- Small (few eV) domain mismatch between cross section and multiplicity/distribution
  - Re-written file uses MF3 domain everywhere
  - Larger mismatch is treated as an error

- INTG records in MF32 are inconsistent: some files store 0 correlations explicitly, others leave them blank

Other checks

- Beyond translation, LLNL is doing other tests on ENDF-VIII:

  - All test on GND data
    — ENDF/B-VII.1 and ENDF/B-VIII
    — LLNL ENDL2009.3 and ENDL2011.3

  - Physics checks: are distributions normalized? Energy balanced? Can resonances be reconstructed? Do cross sections sum to total?
    — Still run into lots of warnings at this step, especially about energy balance. Worst cases are getting reported to authors

  - Processing neutron evaluations for Monte Carlo and Sn codes, running V&V benchmark suite
    — LLNL codes Mercury (MC) and Ardra (Sn) can now read processed data from GND
    — ENDF/B-VII.1
    — LLNL ENDL2009.3 and ENDL2011.3
    — Will be adding ENDF/B-VIII any day

Tasks before the ENDF-VIII release

- **Finalize GND specifications**

- **Start translating nfy, sfy and decay sub-libraries**

- **More testing**

- **We have released sample GND files translated from ENDF/B-VII.1 for feedback.**

  - If you have not received and email about them and would like to see them, send me an email.