ENDF/B-VII.1: What we have Accomplished

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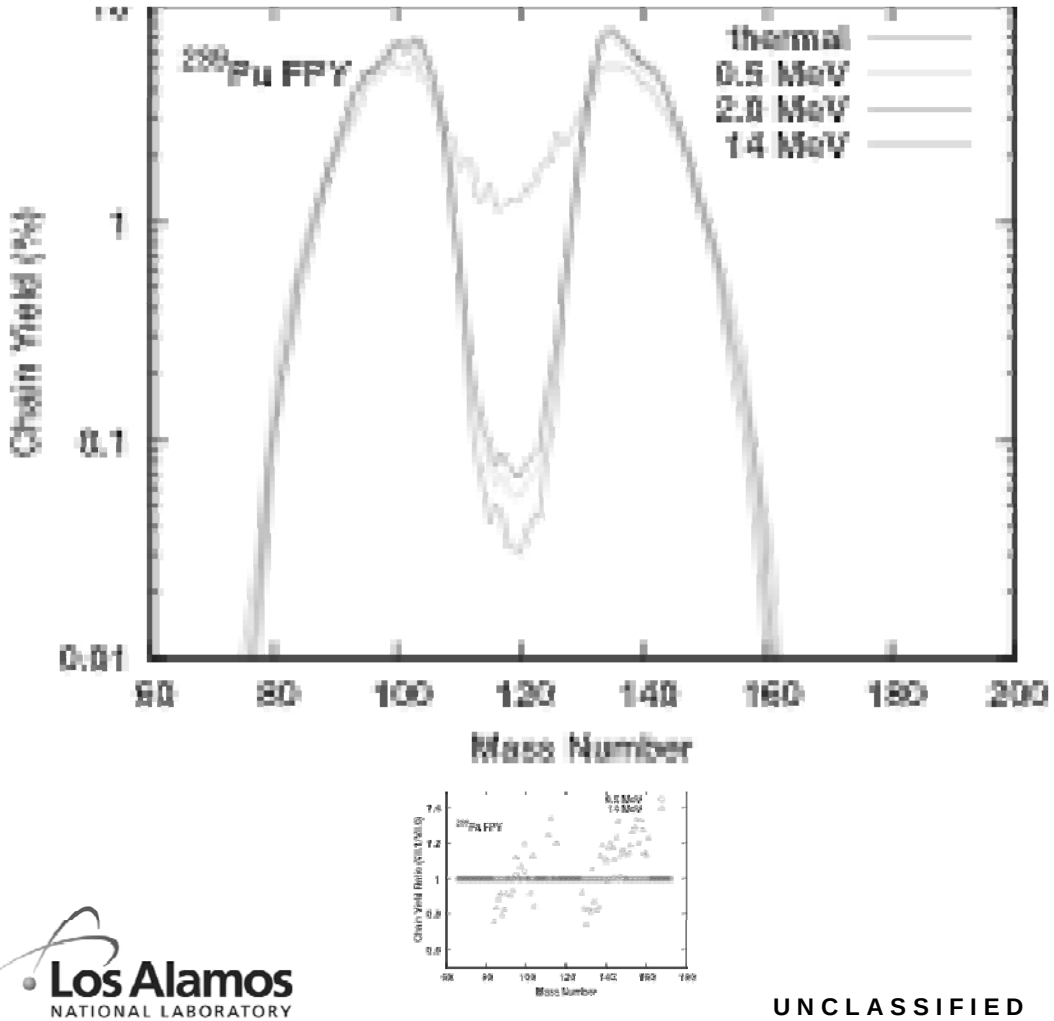
Highlights of New ENDF/B-VII.1 Library – Released December 2011, together with Nuclear Data Sheets article

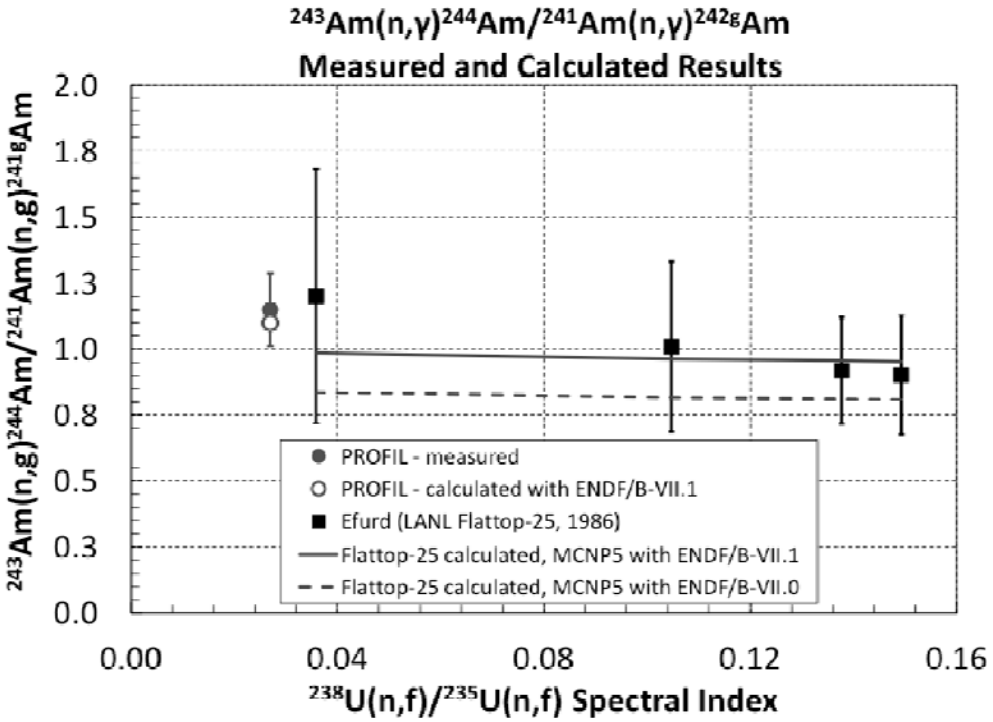
- **Covariances for 190 of the most important nuclides (All labs)**
- **Actinide advances – mainly minor actinide upgrades (LANL, JENDL4, LLNL)**
- **Light nucleus improved R-matrix analyses (3He, 6Li, 9Be) - LANL**
- **Structural materials (Ti, V, Mn, Cr, Ni, Zr, W) + Cl, K (ORNL, LANL, BNL, IAEA)**
- **Dosimetry reactions : Ta, Xe, As. Kr, Y, Tl, Tm (LLNL, BNL, LANL)**
- **n + Fission Product advances (BNL), especially thermal & resonance range capture (Mo, Tc, Rh, Ag, Cs, Nd, Sm, Eu)**
- **FPY for n+^{239}Pu, for fast and 14 MeV energies, LANL; Fission energy release (LANL, LLNL)**
- **Expansion from 393 to 423 nuclides**
- **Decay data (BNL, LANL)**
- **Expanded & improved validation – k-eff, beta-eff, Rossi-alpha, MACS, and LANL, CEA (PROFIL,COSMOS), IPPE transmutation reaction rates**
- **Much cleaned up library (BNL)**

FPY work



- New FPYs at 0.5, 2 MeV, and 14 MeV
- Energy dependence from 0.5-2 MeV included for first time – facilitating <1-2% accuracy for key FPs
- 14 MeV changes substantial (>10% in some cases, guided by LANL and LLNL accelerator experiments)
- Kawano has now created individual FPY tables too

Actinide cross sections for transmutation: n,g n,2n and n,f reaction rates



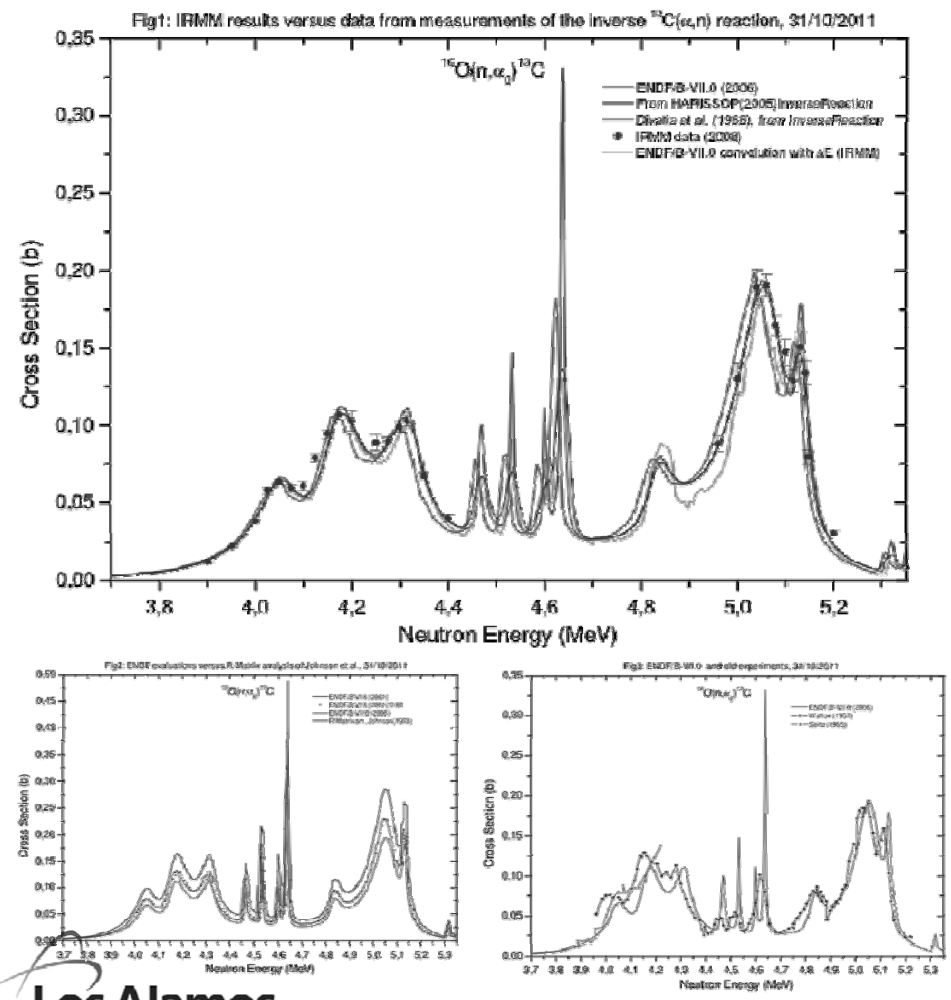
LANL has data that helped alidate Mughabghab's change to 43Am(n,g), that was motivated y PROFIL

Also, see Kahler's paper that hows many reaction rate testing gainst:

- PROFIL data
- LANL crit assemblies
- IPPE fast reactor data
- Wallner mass-spec

(supports 238U n,g; suggests 235U n,g a bit high)? But this contradicts PROFIL?

16O : We are staying with VII.0 (except for capture changes supporting astrophysics)



At the peak at 4.18 meV:

VII.1=VII.0 & JEFF,JENDL, BROND, CENDL, have 112 mb

Geel has 108mb as measured, 112 mb corrected for energy resolution (Georginis)

Harissopoulis (PRC, 2006) has 106 mb, 112 mb corrected for energy resolution (priv. comm. Georginis)

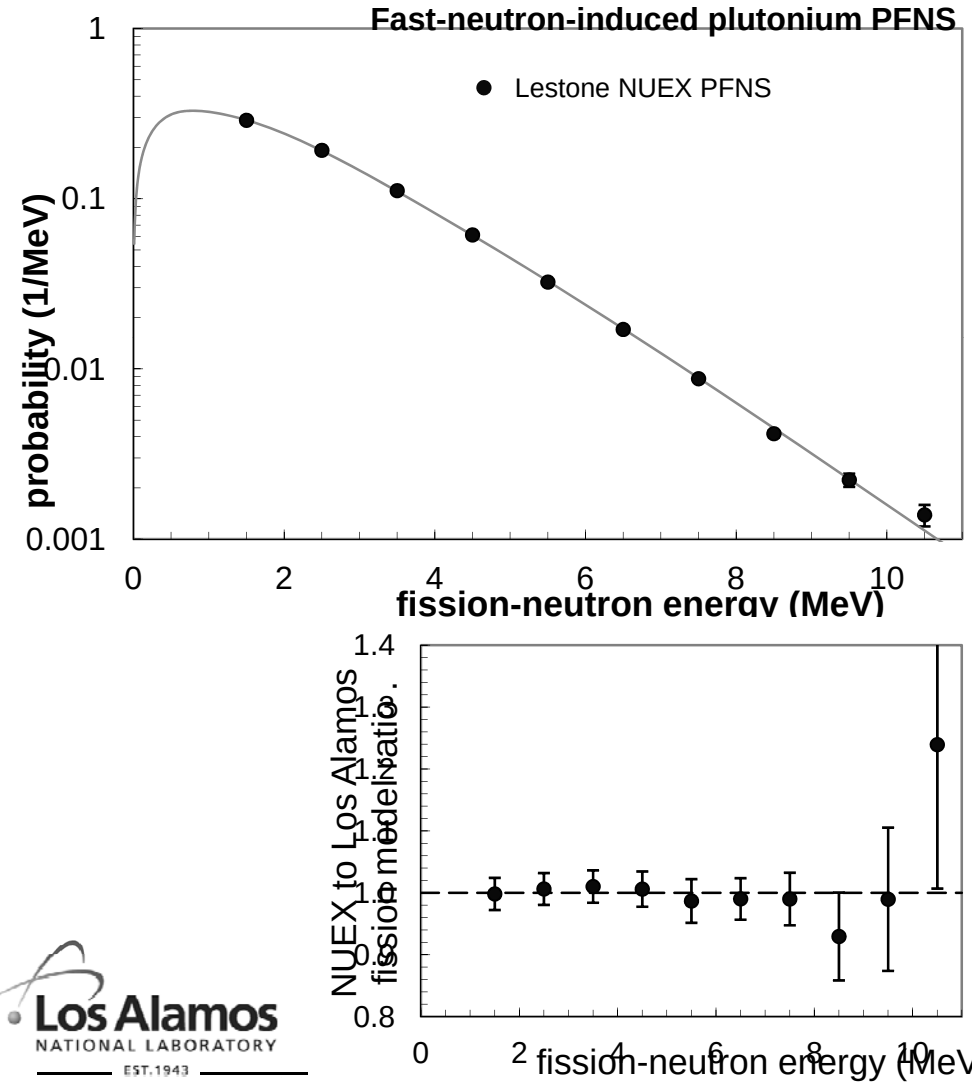
Johnson R-matrix in Exfor (rediced Bair by ~20% has ~ 130mb)

Seitz has 114 mb

Divatia has 107 mb

(But Hale's analysis was giving >150 mb)

Lestone's PFNS for 2 MeV n+239Pu. Perhaps the most accurate data ever presented



Documented in LAUR-03167 (2011)

Data only available for Eout > 1.5 MeV

(we will hope to get precise data below 1 MeV from LANSCE)

Note our dosimetry (n,2n) data from Jezebel, and recent IPPE Pu fast reactor data, suggest that above 6-7 MeV the ENDF spectrum is too hot

Some LANL ENDF Priorities in the Coming Years

- **Big 3: ^{235,8}U and ^{239}Pu**
  - Remove compensating errors likely present in current ENDF, JEFF, ENDL evaluations (between fission, PFNS, inelastic, capture, nubar … reactions)
  - ~ 1 keV ^{235}U capture: resolve 25%+ differences between JENDL4 and ENDFVII, with help from new measurements from LANSCE & RPI
  - Use of dosimetry reactions
- **Continue improvements of minor actinides; neutron+ FPs, & FPYs**
  - Capture and fission rates
- **Make progress on other important light nuclides:**
  - ^{16}O, ^{12}C, … + ^{56}Fe and other structural materials
- **Exploit new measurement capabilities coming on-line (PFNS, TPC, SPIDER fission fragments, critical assembly experiments at DAF…)**
- **Refine covariances**
  - After user community builds experience on using this capability

Lessons Learned for Future ENDF Releases (A Partial List)

Better coordinate efforts across the labs

Avoid large substantial changes/improvements coming in at last minute

Ensure we test the final library version!

When a new evaluation is delivered:

- "first, do no harm"
- phase 1 review by peers is needed
- must test against the crits to ensure no adverse impact

etc.

Backup viewgraphs – a Future World Evaluated File?

But First…
Arguments Against Moving to Developing an ENDF/I

- **Countries want to "own" the data, and don't want to loose control**
- **Perhaps developing own databases better maintains in-house expertises**
- **Independent databases help mitigate against a "common failure"**
- **Independence drives competition, often driving innovation**
- **Our customers have neutronics simulation codes calibrated to our existing database – we risk loosing calibrated predictive capability in the short term**
- **Practically, it would be a challenge to make this happen**
  - the task is large: ~ a decade
  - international coordination is a pain; national coordination is bad enough
  - resources – staffing, funding, are ambiguous & no "customer" is pushing for this yet

Why We Should Move to Developing an ENDF/I (1)

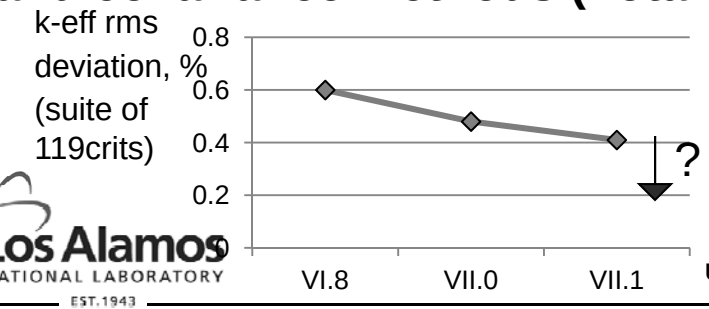
- **We should strive for lasting impacts. Creation of ENDF/I might be the most important capability we can create for future generations**
- **Nuclear data are physical constants – there's only one correct answer!**
  - Existing ENDF, JENDL, JEFF, …. have reached a level of maturity to enable us to contemplate this next step – *they're already converging!*
  - ENDF already increasingly uses international advances (FPs, MA, …)
  - LLNL is an interesting case study – they moved from ENDL to fully joining ENDF; also in Russia, ROSFOND uses many international evaluations
- **Pool our resources – the golden age of nuclear science is over**
- **Build on initial steps already taken**
  - IAEA/WPEC/CSEWG standards
  - IAEA CRPs, & WPEC subgroups (FPs, U8, … Photonuclear, dosimetry, … RIPL, FENDL)

Why We Should Move to Developing an ENDF/I (2)

- **Quality: new advances will benefit from being a collaborative product from the world's best experts**
- **Less risk of one "expert" making a bad evaluation decision – peer review from the world's experts will help prevent this**
- **The leading experts are getting older, and retiring**
  - New generation is not as skilled, I'm afraid to say
  - We're rapidly loosing capability
- **Each current database – ENDF, JEFF, JENDL, BROND, CENDL, …. is increasingly vulnerable to poor decisions because of lost expertise**

Why We Should Do it Now

- **We have mid-career experts with 20 years to shepherd this project through**
  - Herman, Kawano, Talou, Kahler (US), + equivalents from other countries
- **We still have senior and retired experts we can draw upon**
  - These folk come from the truly great generation in nuclear science
  - Ignatyuk, Vonach,Young, Oblozinsky, Katakura, …
  - Perhaps some can be engaged to help/consult
- **Because current databases are mature and fairly well-validated, and probably satisfy most immediate concerns, we have an opportunity to step back to create a new capability**
- **Computational & intellectual advances enable a "step function" in improvement, *e.g.* exploring the large phase space of solutions using new UQ and covariance methods (Total Monte Carlo, Bayesian Methods, …)**



How to Make it Happen

- **Use international coordination, e.g. IAEA**
- **Establish a group comprised of leaders from the main evaluation projects to discuss:**
  - what each of us wants to get out of the project?
  - What resources can be devoted?
  - How can it be coordinated? Leaders must be passionate & embody the highest standards/expectations
- **What would the next steps be?**
  - Assemble a starting I-ENDF from the “best” databases presently available?
  - Coordinated efforts on improving priority nuclides
  - Continual validation calculations
  - Integration of optimization and uncertainty quantification (covariances) from the start

Be Bloody, Bold, and Resolute

Conclusions

- **Let's seriously discuss whether there is an interest in this**
  - Let's all consult with our national evaluation projects, and our sponsors
- **IAEA/WPEC would be obvious coordinating bodies**
- **A lesser goal, but a valuable objective, would be to discuss with the IAEA how future CRPs on focused topics might advance this objective**