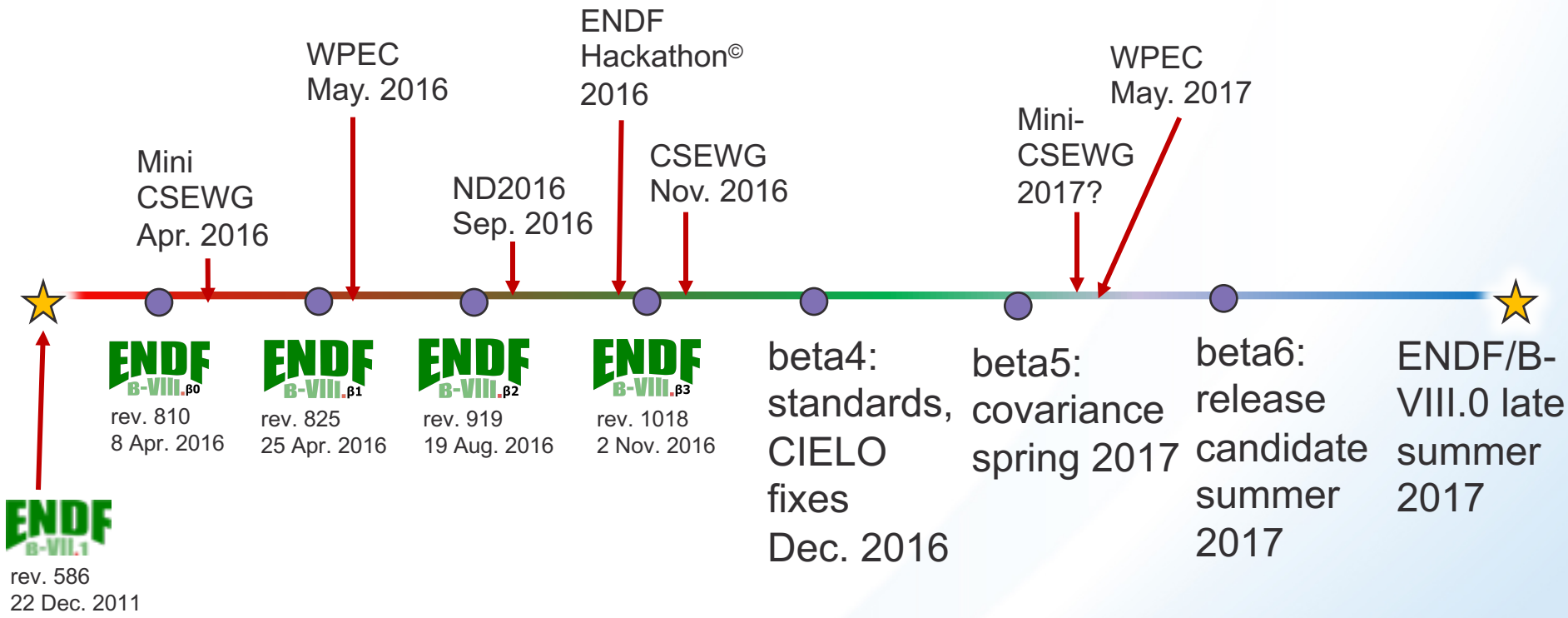
Status of the ENDF/B-VIII beta3 library

D. Brown



Timeline not to scale

Beta0 highlights (2011-2015):

- **CIELO evaluations:**
  - ^{16}O
  - ^{56}Fe
  - ^{235}U
  - ^{238}U
  - ^{239}Pu
- **Non-CIELO:**
  - ^{54}Fe, ^{57}Fe, ^{58}Fe
  - n
  - Yb, Dy, Os (JENDL4)
  - ^{18}O (RUSFOND)
  - $^{63,65}Cu$
  - $^{182,183,184,186}W$
  - ^{40}Ar
  - $^{236m1}Np$
  - $^{58-61}Ni$
  - EGAF gammas
  - Bug fixes
- **EPICS2014:**
  - photoat
  - electrons
  - atomic_relax
- **Decay data:**
  - $^{93,95,96}Rb$
  - ^{95}Sr
  - $^{82,83}Ge$
  - $^{95,98,98m,99}Y$
  - $^{88,89,90,91}Br$
  - ^{90}Kr
  - $^{140,141}Cs$
  - ^{143}Ba
  - $^{143,144,145}La$
  - ^{134}Sb
  - ^{138}I
- **Thermal Scattering:**
  - MAT fixes
  - SiO_2 (x2)
  - SiC
  - Lucite
  - H_2O
  - D_2O (x2)

Beta1 highlights
(corrections after mini-CSEWG Apr. 2016)

- **CIELO**:
  - ^{56}Fe
  - ^{235}U
  - ^{238}U
- **Non-CIELO:**
  - ^{7}Be
  - $^{12,13}C$
  - $^{54,57}Fe$
  - Bug fixes

Beta2 highlights
(so we all have something to present at ND2016...)

- **CIELO**:
  - ^{56}Fe
  - ^{235}U
  - ^{238}U
  - ^{239}Pu
- **Non-CIELO**:
  - ^{7}Be
  - ^{54}Fe
  - ^{40}Ca
  - Bug fixes
- **Thermal scattering**:
  - BeO (x2)
  - Polyethyline

Beta3 highlights

- **CIELO**:
  - ^{56}Fe
  - ^{239}Pu
- **Non-CIELO**:
  - $^{54,57}Fe$
  - $^{35,37}Cl$
  - ^{59}Co
  - $^{73,74}As$
  - ^{78}Kr
  - ^{132}Te
  - ^{124}Xe
  - $^{174,176,178,179,180}Hf$
  - ^{7}Be
  - RQ Wright's nubars
- **Charged particles**:
  - p+^{7}Li, p+a, p+^{13}C
  - d+7Li
  - t+a, t+^{7}Li
  - ^{3}He+a, ^{3}He+^{3}He
  - a+a
- **Thermal scattering**:
  - D_2O (x2) new temps
  - Be(metal)
  - UO_2 (x2)
  - Graphite
  - Reactor graphite

Late things

- ^{235}U (arrived after beta3)
- ^{238}U (arrived after beta3)
- Standards (not arrived yet)

- Working though bug lists supplied by
  - Kent Parsons (LANL)
  - Cedric Jouanne (CEA)

ADVANCE feedback available on all evaluations

- Please see http://www.nndc.bnl.gov/endf/b7.dev/qa/index.html

- If you have questions about a report, I can walk you through it

ENDF Hackathon© 2016

D. Brown, T. Kawano,
S. Mughabghab, G. Nobre,
V. Sobes,
I. Thompson (remotely)

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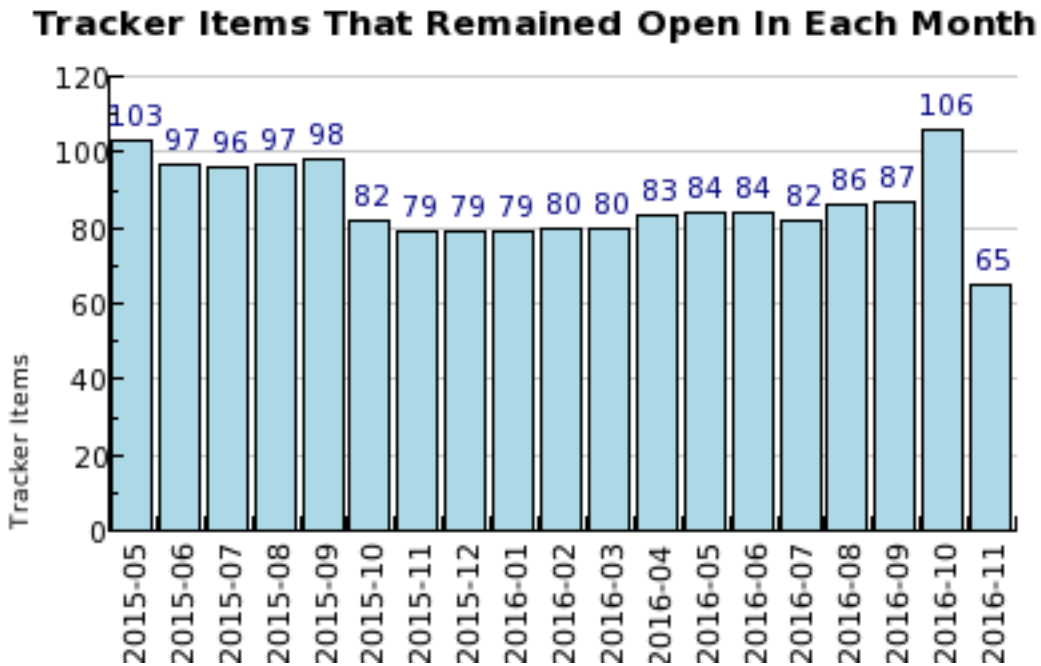
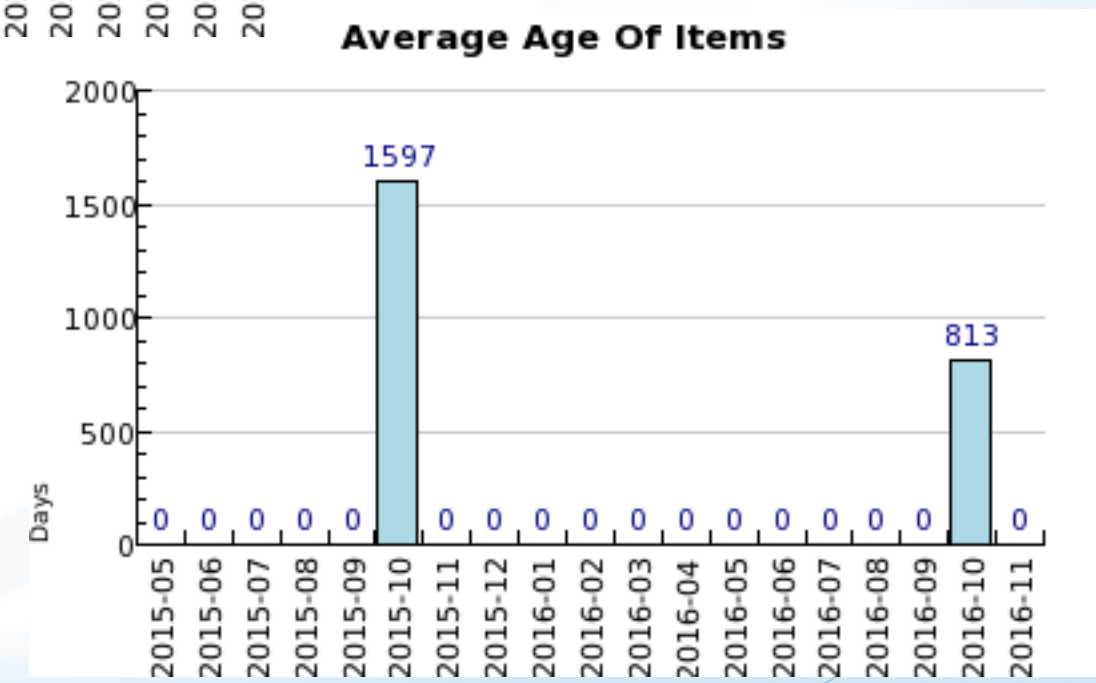
What's all this about?

- **Clean up as many ENDF evaluations as possible using whatever evaluation tools you have**
- **Donuts and coffee provided…**
- **Schedule:**
  - Monday-Thursday — kill bugs
  - Friday — review changes, make sure OK



40% reduction in open trackers



Lots of old bugs have been fixed

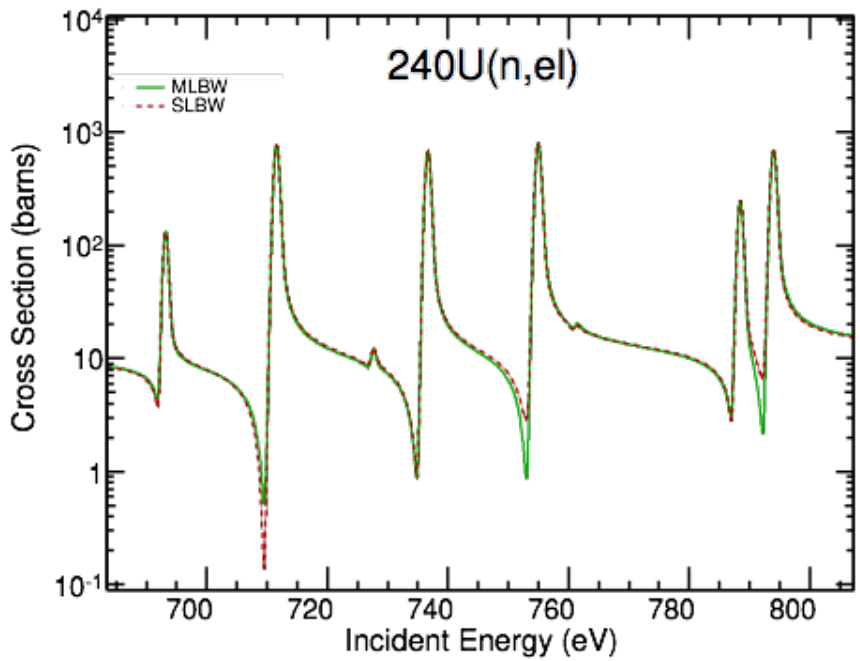
This year's winner of the golden bug, for most dead bugs

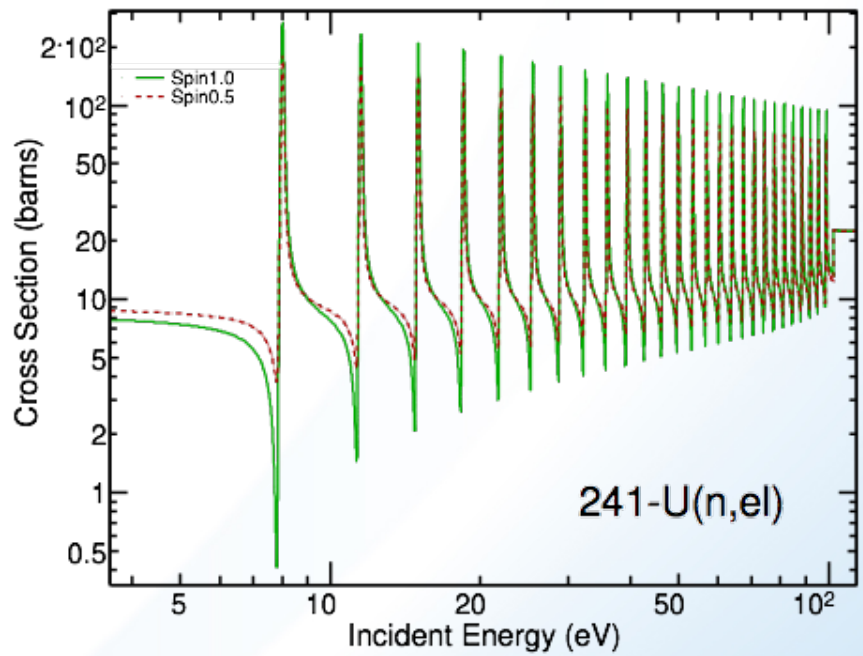
- **Champion: Toshihiko Kawano!**
  - 19 commits (including a 2 self-inflicted bug penalty)
- **Reserve champion: Dave Brown**
  - 9 commits + 1 bonus commit for being organizer and donut purchaser

Big Changes

- ^{63,65}Cu finalized (VS+TK)
- R.Q. Wright's nubar evaluations added to all MA (TK)
- Death to SLBW format, plus other minor RRR fixes (DB+GN)
- Proper extension of ^{7}Be to 20 MeV, preserving Page's evaluation (IT)
- ^{239}U RRR (IT)
- Hf fixes (TK): new fast for 174,176-180
- ^{154}Eu thermal cross section fix (TK+SM)
- Zr cleaned up (DB+SM)
- ^{73,74}As evaluations recalculated in fast region (TK)
- ^{93}Nb RR updated (TK)
- ^{35,37}Cl capture cross sections fixed (TK)
- ^{76}Kr redo fast region, JENDL-4 RRR (TK)
- ^{124}Xe redo fast region (TK)
- ^{132}Te redo fast region (TK)
- ECPL translated to ENDF (IT)

SLBW format eliminated in ENDF library & messed up RRR J^{Π} assignments corrected





Bad J^{Π}: ^{105}Rh, ^{148m1}Pm, ^{241}U, ^{243}Pu

SLBW->MLBW: ^{105}Rh, ^{135}Xe, ^{148m1}Pm, ^{241}U, ^{243}Pu

Wish we could have gotten to these…

- ^{12}C discrete gamma's added for use in assays
- ^{240}Pu thermal cross sections tweaked to resolve PU-SOL-THERM
- deuteron masses
- removal of all pseudo-levels
- energy balance
- Reduce signal/noise for FUDGE errors

Automated fixes?

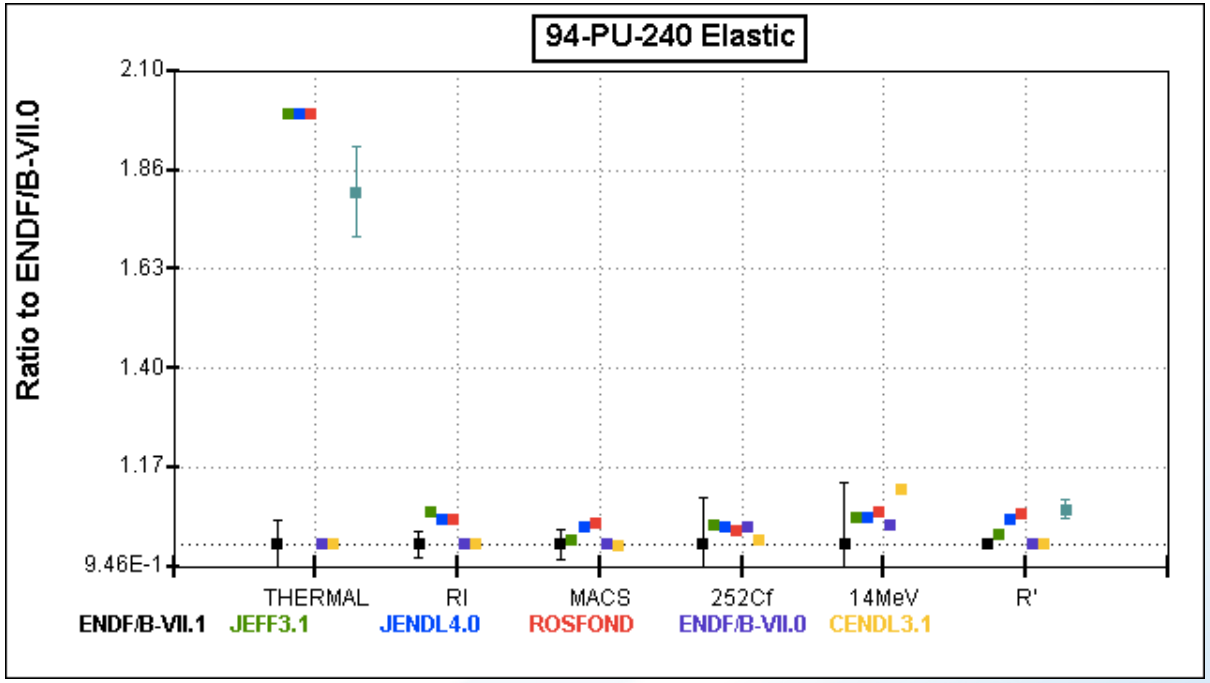
- Zeros in Legendre moment data
- Norms of all PDFs set to 1.0000000000
- BR's all sum to 1.0000000
- Tweak Q's & Thresholds

“Minor tweak” to 240Pu?

Background

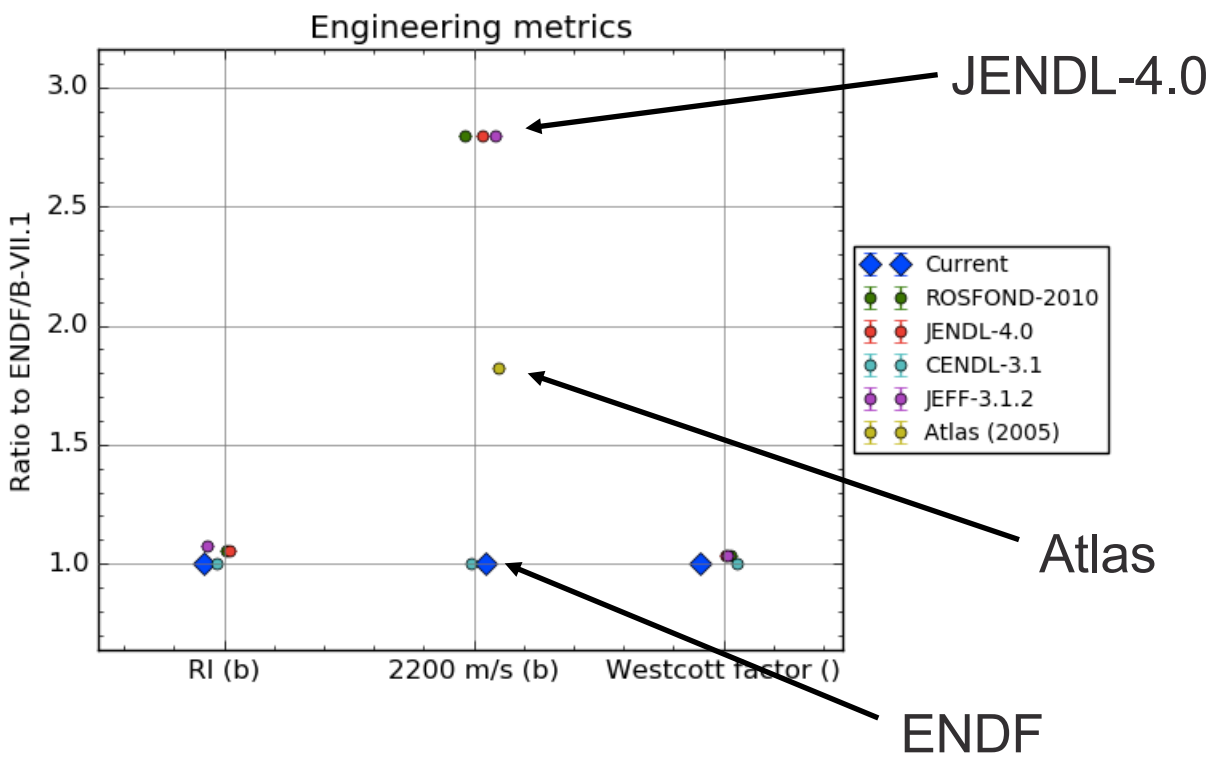
- **We always do terrible with PU-SOL-THERM assemblies (some ZPRs too)**
  - Is it 239Pu or 240Pu?
  - New CIELO evaluation of 239Pu did not fix
- **In 2010 revision [#111] a new ORNL+LANL evaluation was submitted for 240Pu**
  - It made PU-SOL-THERMs worse (See Skip's 2010 CSEWG validation talk)
  - We reverted to ENDF/B-VII.0 RRR in revision [#175]
- **JENDL-4.0 adopted new ORNL RRR**

Tracker [#633]: ^{240}Pu(n,el) thermal cross section is very low



Thanks Boris!

Here's a similar plot, including the Atlas value

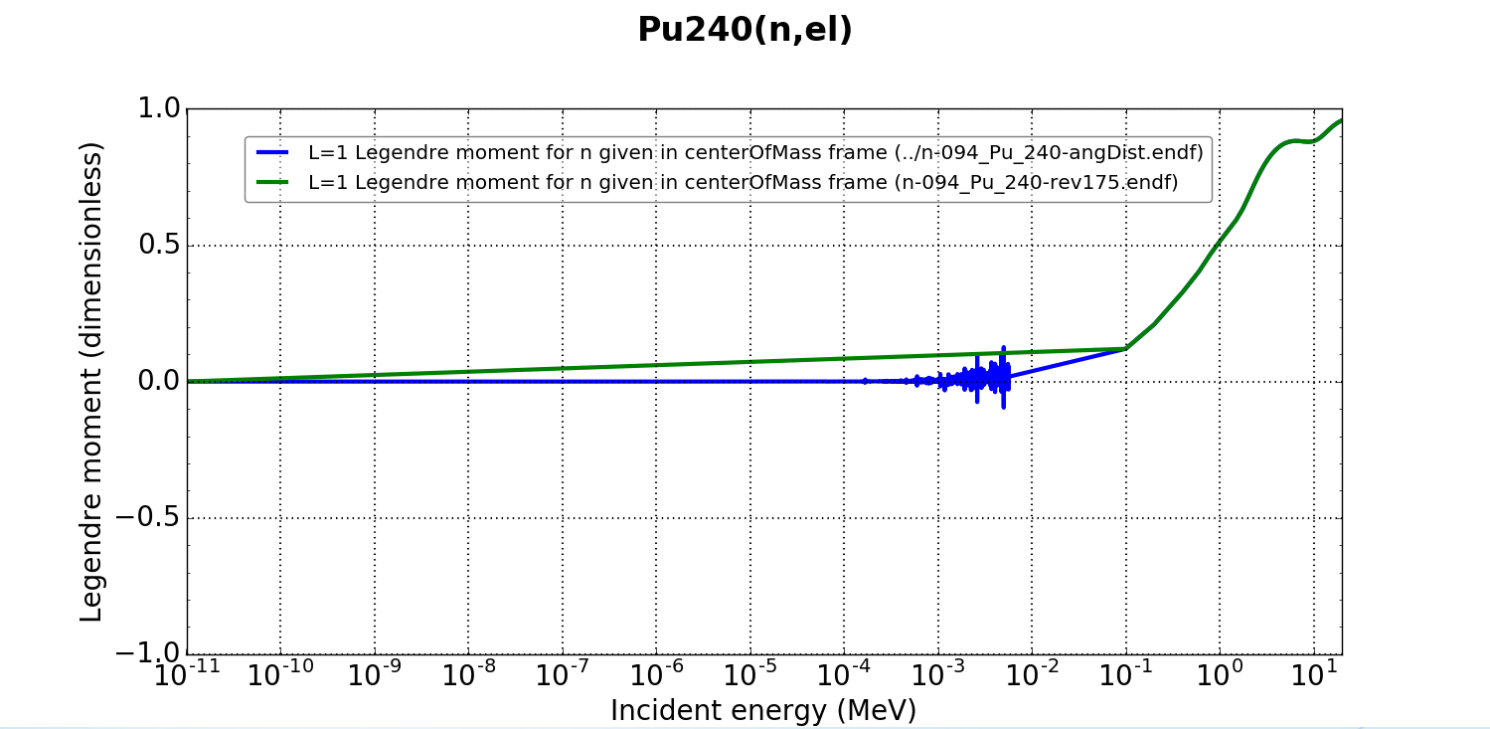


About the Atlas evaluation

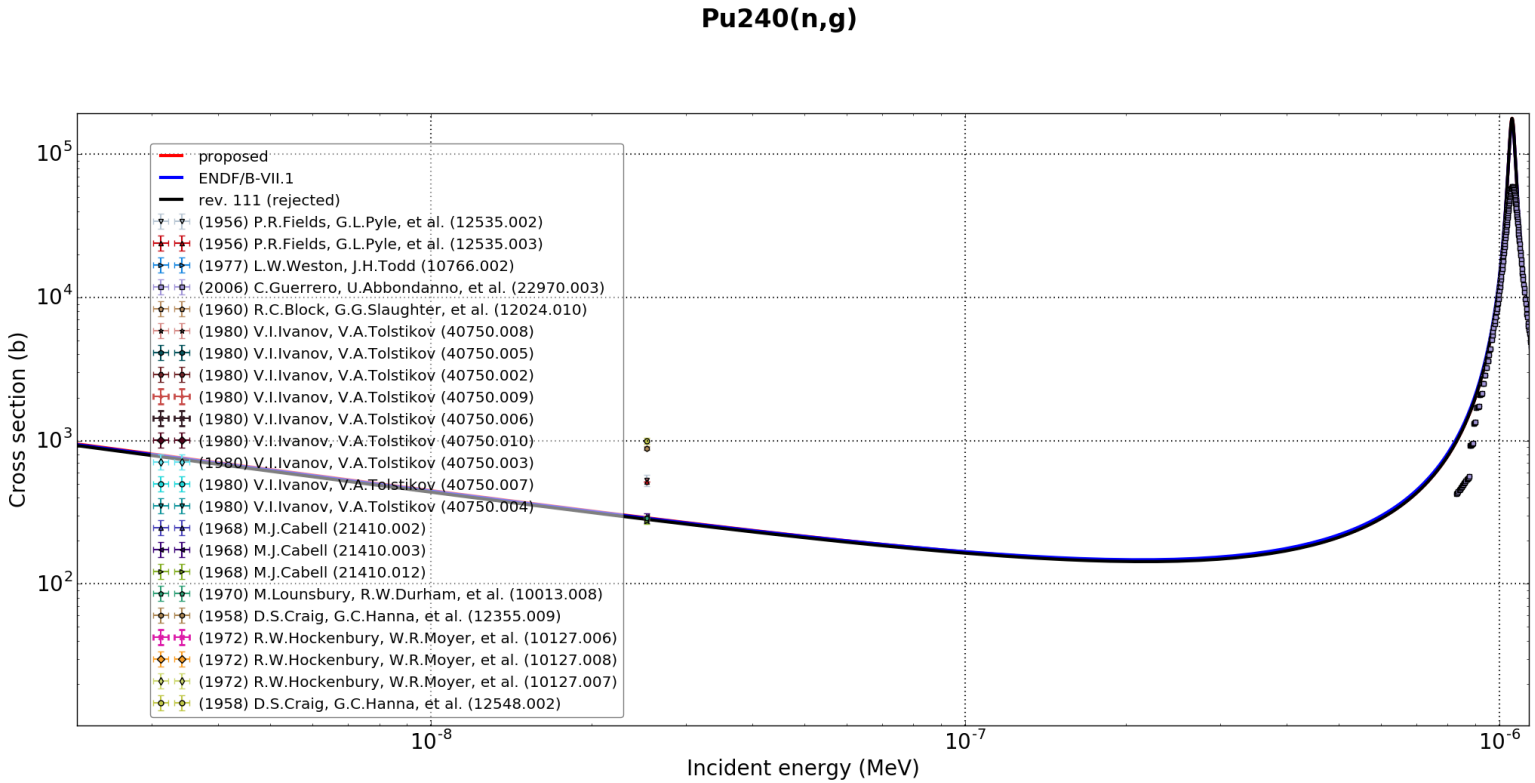
- $\sigma_s = 1.73 \pm 0.10$ b
  $= \sigma_{coh} = 4\pi(g_+a_+ + g_-a_-)^2$ since $J^\Pi = 0^+$
- "Can be determined very accurately" – S. Mughabghab
- Determined from pair of neutron diffraction experiments
  - (ANL) G.H. Lander, M.H. Mueller, ACR/B 27, 2284 (1971)
  - (LANL) J.L. Green et al., JNM, 34, 281 (1970)

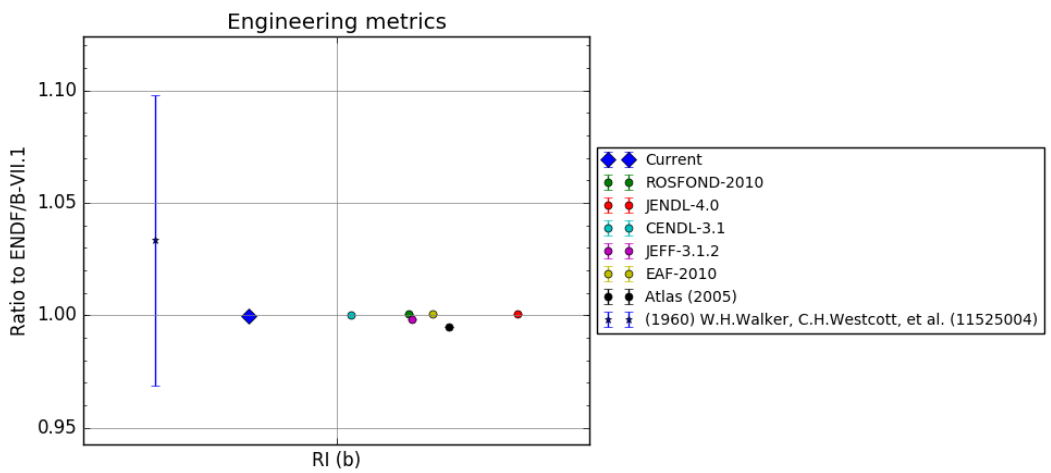
Things we tried

- Rework bound levels to match Atlas values for thermal elastic, capture and fission (carefully, there is MT32 data to go with it)
- Reconstruct angular distribution using FUDGE (better physics, but doesn't do anything to benchmarking)



Changed bound resonances





Capture preserved

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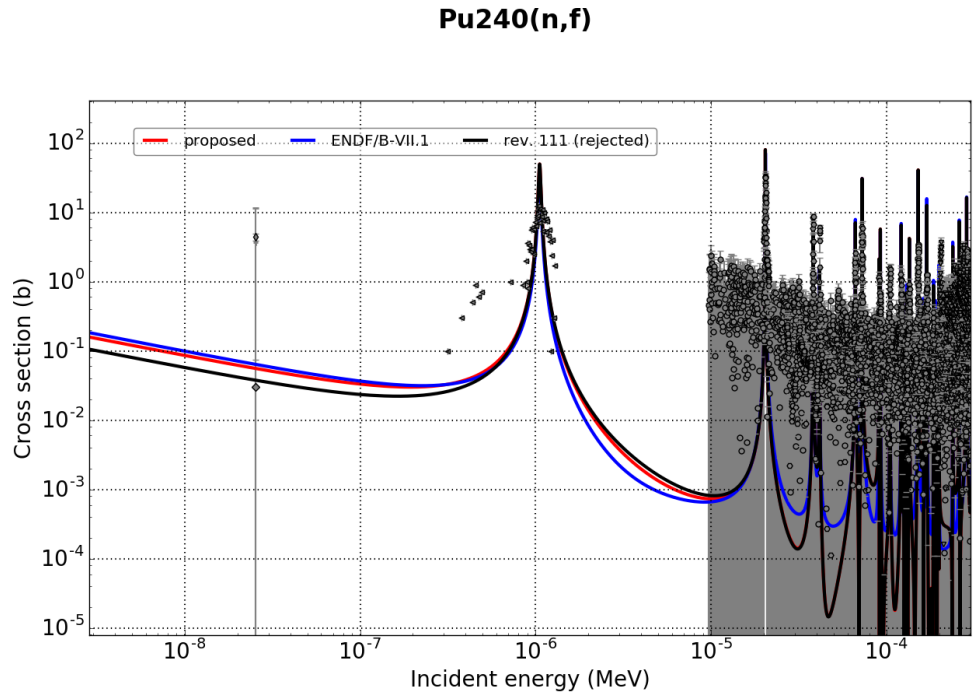
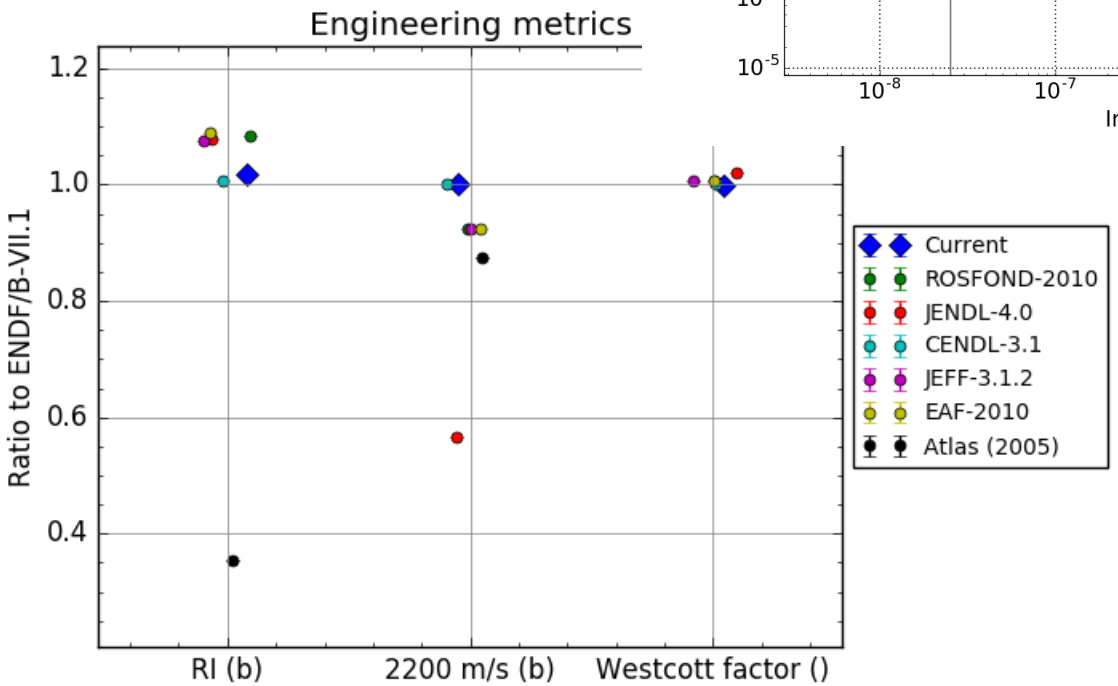
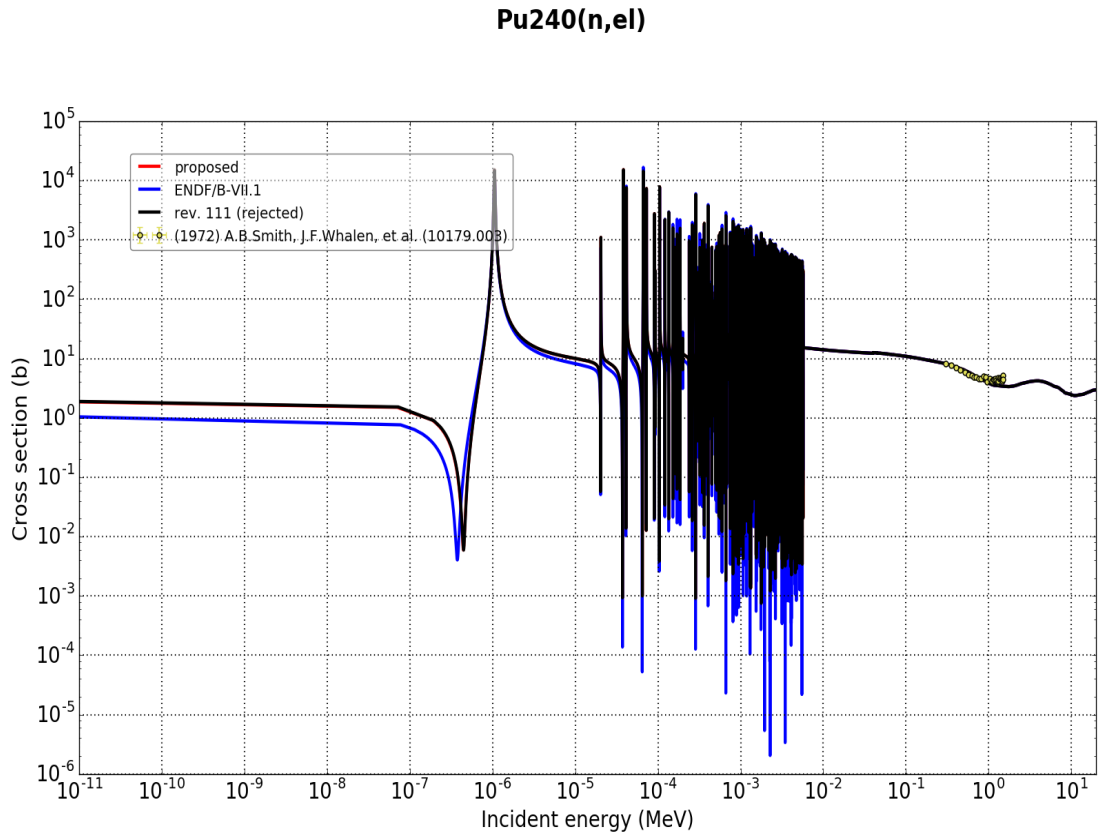
Fission lowered a little from B7.1

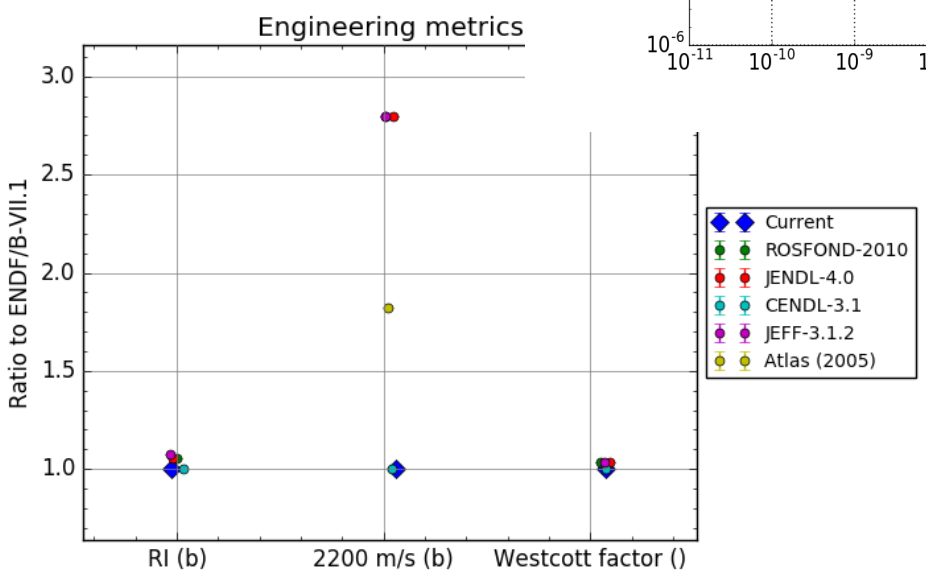




It was difficult to match Atlas exactly by hand

ORNL resonances already agreed with Atlas





Testing

	ICSBEP	ENDF/B-VII.1 == ENDF/B-VIII.b2	ENDF/B-VIII.b2+rev111 (ORNL)	ENDF/B-VIII.b2+bd level fix	ENDF/B-VIII.b2+bd level fix, angDist
PMF002 ("dirty Jezebel")	1.000(2)	0.99999(8)	0.99997(8)	1.00002(8)	0.99995(8)
MCF002 (ZPR6/7 "high 240Pu")	0.9874(22)	0.98003(7)	0.97944(7)	0.97985(7)	0.97955(7)
PST18.2	1.0000(34)	1.01173(9)	1.01474(12)	1.01053(12)	1.01078(12)
PST18.9	1.0000(34)	0.99815(10)	1.00223(10)	0.99836(10)	0.99830(10)

performance comparable to B7.1