Plutonium-239 Advances for ENDF/B-VIII.beta3

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Major Changes to plutonium in the fast region (>40 keV) based on new IAEA Standards fission results & LANL data

- **Preliminary fission cross section from standards analysis increased significantly**
  - Increased by 0.5% or more
  - We implemented above 40 keV in fast range, but not <40 keV URR
  - Largely increases Jezebel criticality – but compensated by other improvements:

- **Latest capture using DANCE data (Mosby *et al.*) is higher – adopt**
- **Latest PFNS evaluation (Neudecker) is softer – adopt**
- **Covariance evaluation of nubar is lower – adopt (& remove the tweak)**

Jezebel changes

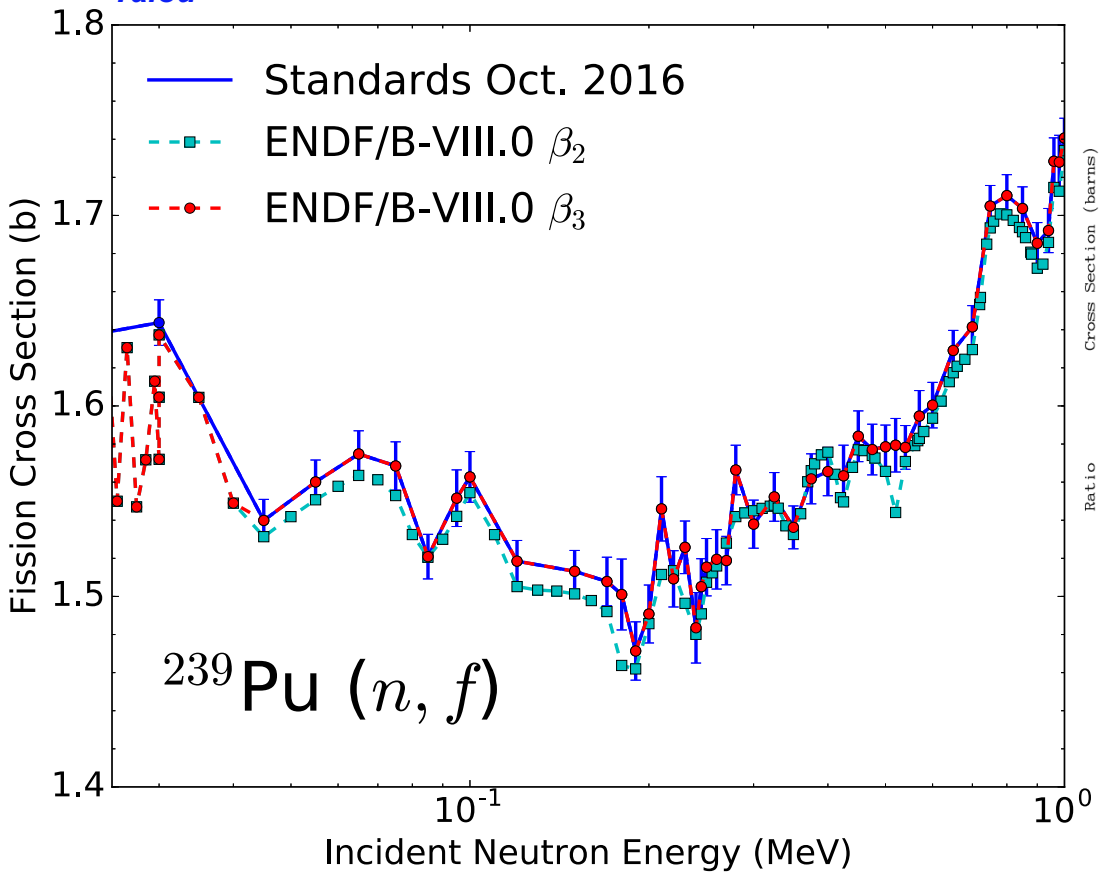
n,f	n,nu	n,pfns	n,capture
↑ 273 pcm	↓ -67 pcm -67 pcm	↓ -134 pcm	↓ -59 pcm
k=1.00088			

Overall:	beta2	beta3	vii.1
Jezebel, rev4	1.00088	->1.00086	(1.00069)
Jezebel, rev2			(0.99988)
Falttop-Pu	0.99951	->0.99959	(1.00093)

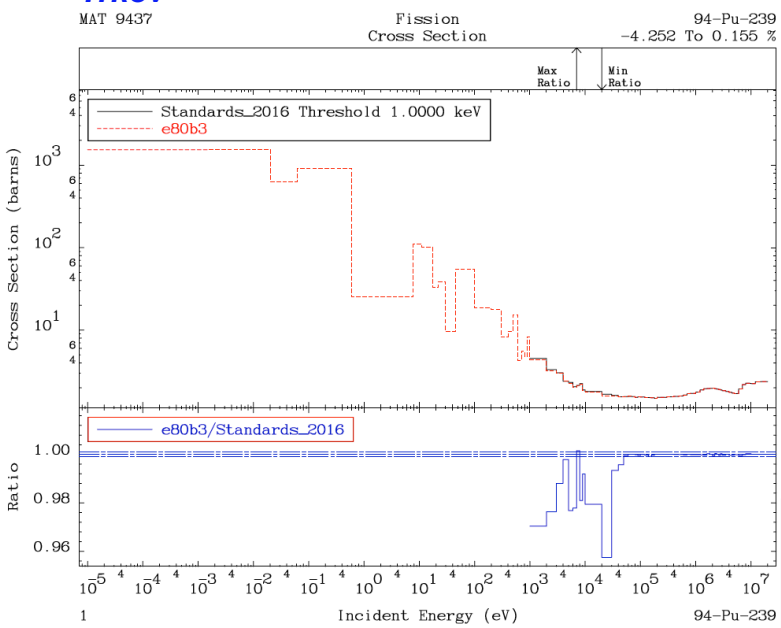
Kahler MCNP6 calcs.

^{239}Pu (n,f) cross section increased to match new standard

Talou

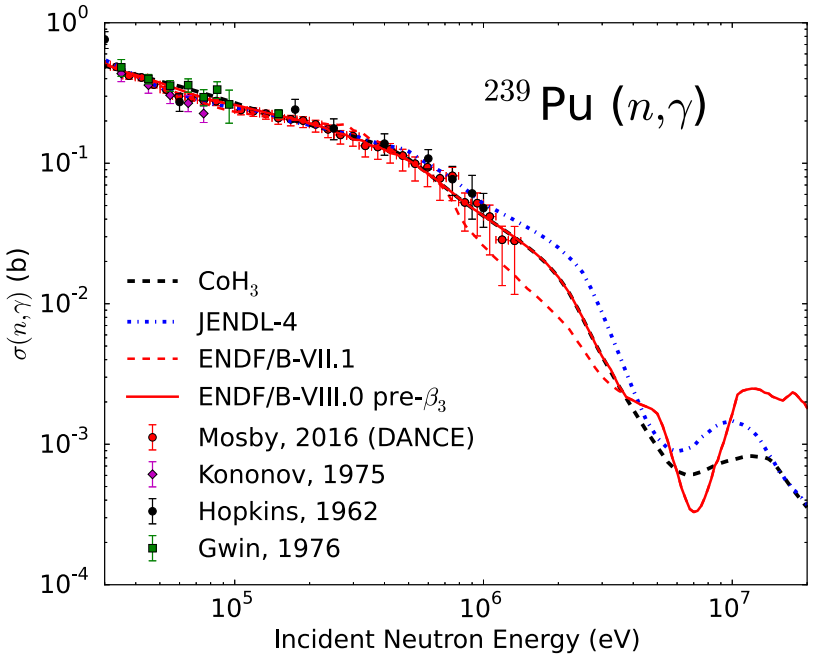


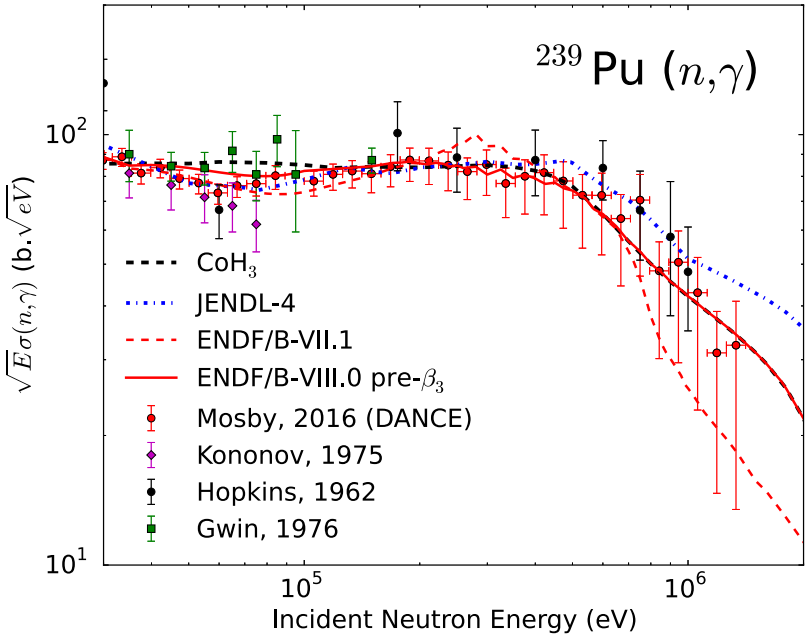
Trkov



- **But note, the beta3 URR are ~2% lower than the standard from 1-40 keV**
- **Accommodating this in time for B-VIII will be difficult**

^{239}Pu (n,γ) cross section increased at higher energies matching new DANCE data & Kawano calculation

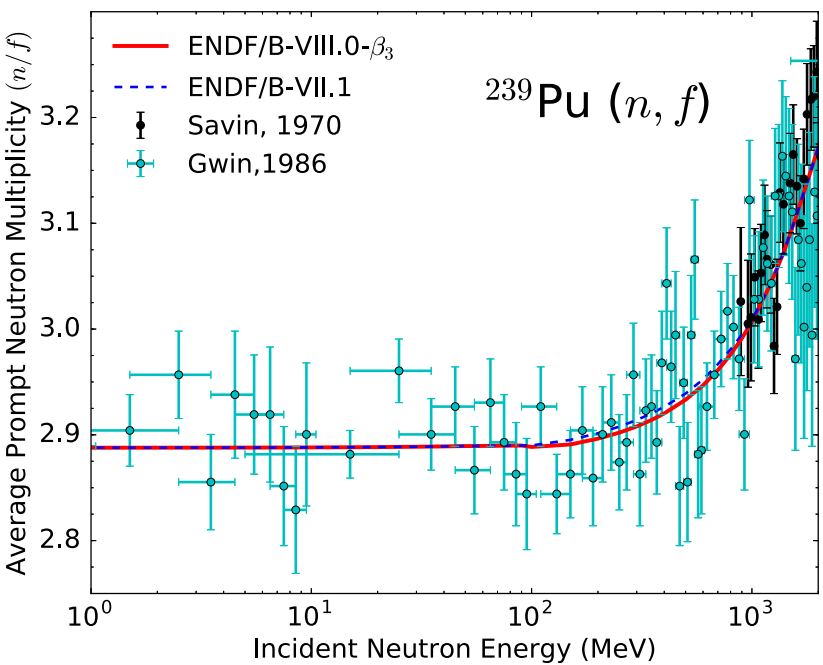


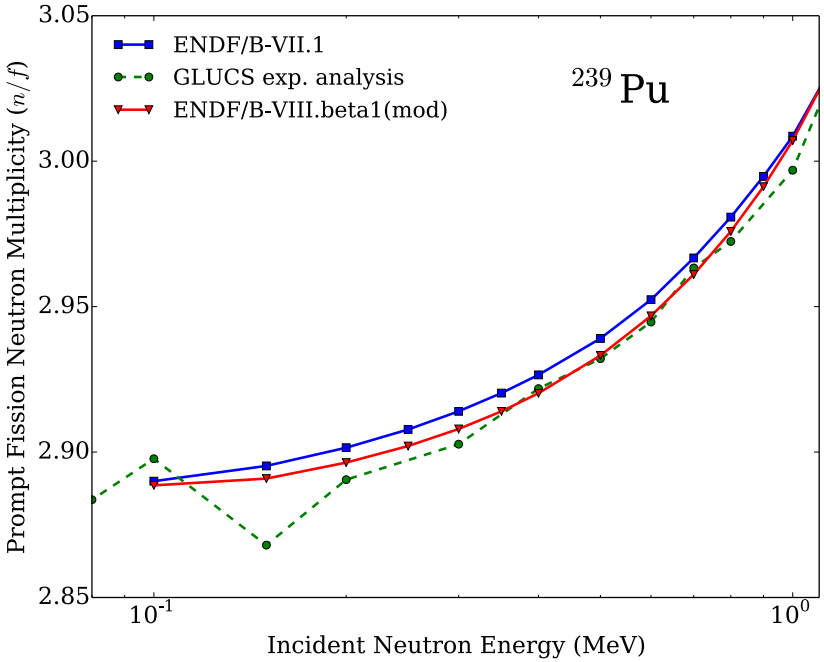


Chadwick, Kawano, Mosby

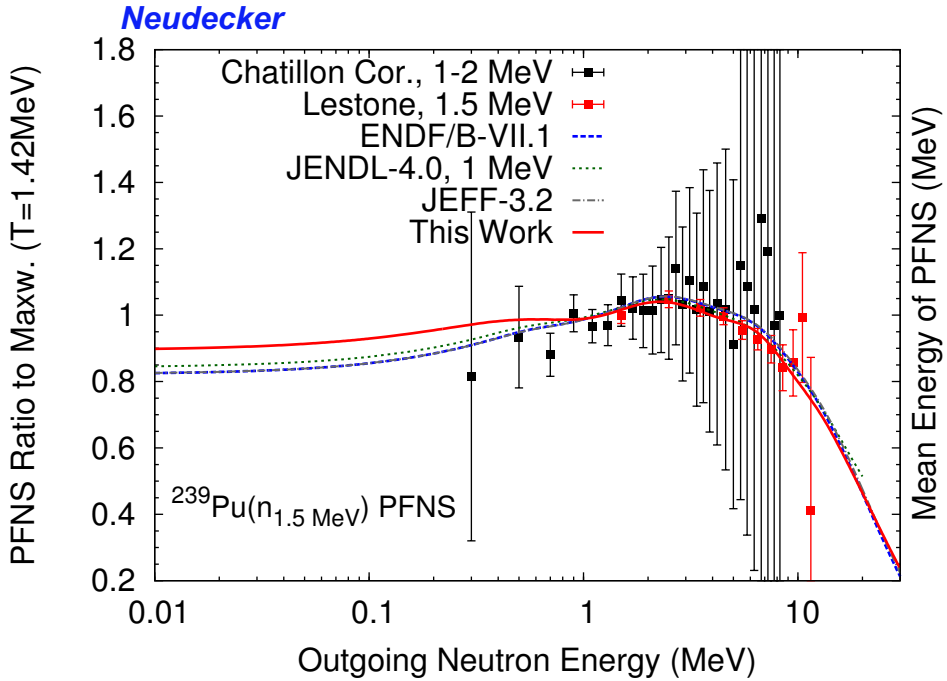
^{239}Pu prompt neutron multiplicity reduced to match data (covariance analysis) – previous tweak removed

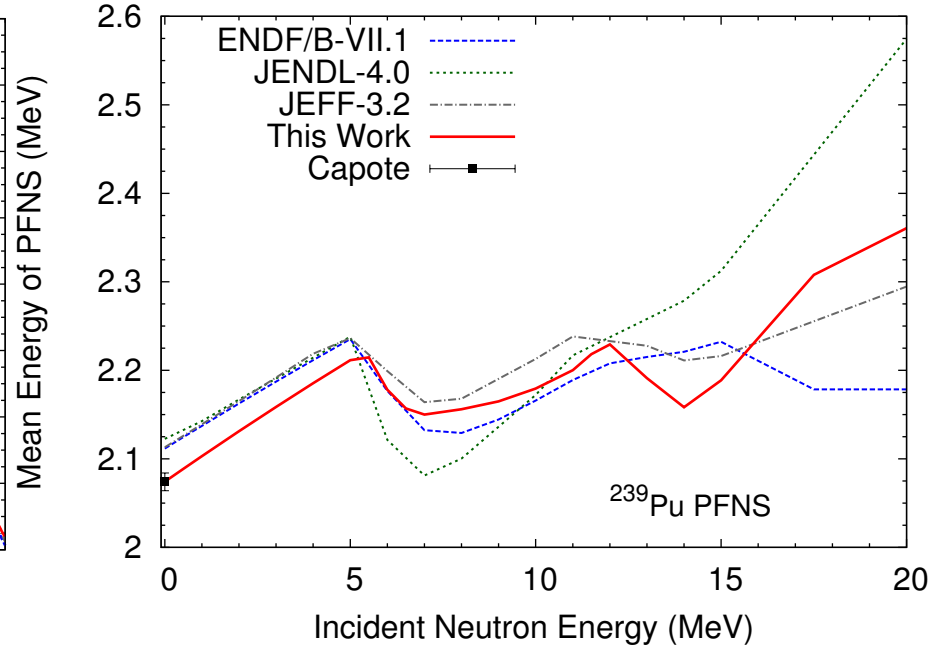
Talou





^{239}Pu prompt neutron spectrum
Adopted Neudecker's evaluation, softer in fast range



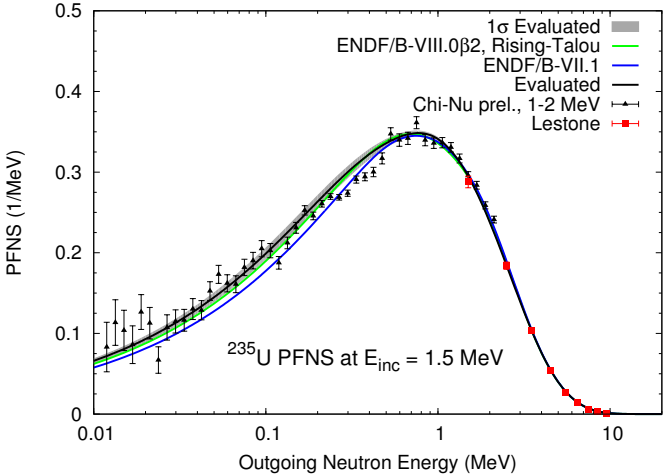


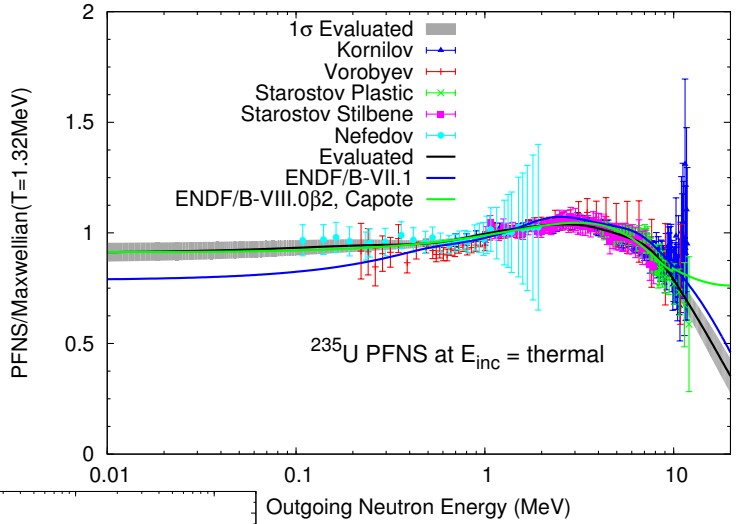
- **We await Chi-nu PFNS data (next year)**
- **But Chi-nu 235U data suggested a softer spectrum, so this change is consitent with that trend**

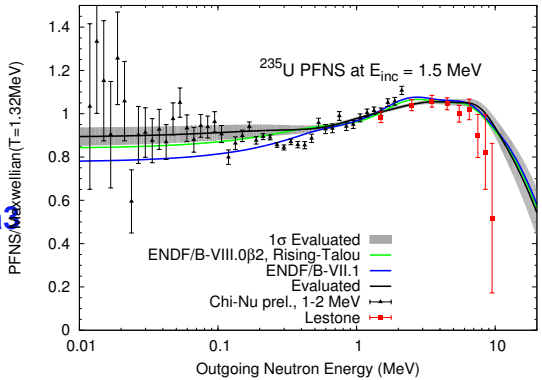
- **But note, the thermal average energy is kept from beta2**
- **Much work is needed before we change Pu thermal VIII.1 !**

^{235}U prompt neutron spectrum, for comparison
Adopted Neudecker's evaluation except at thermal

Neudecker



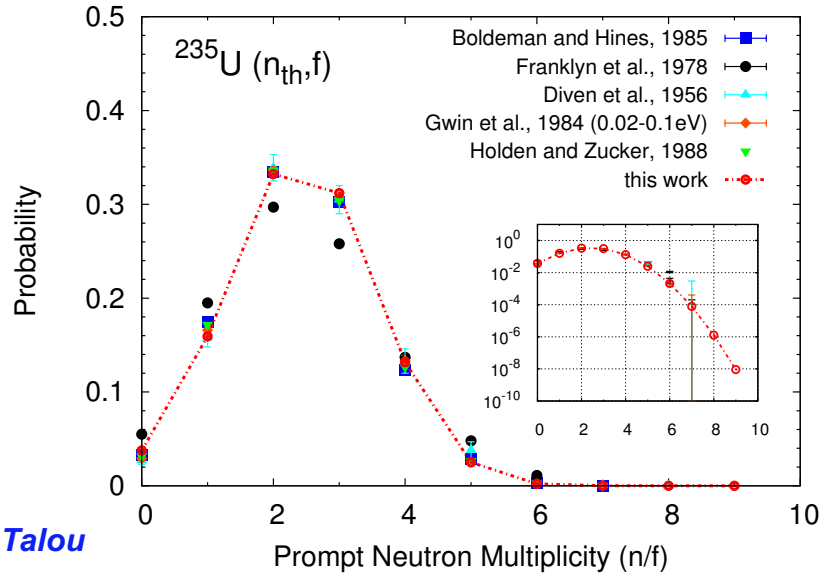




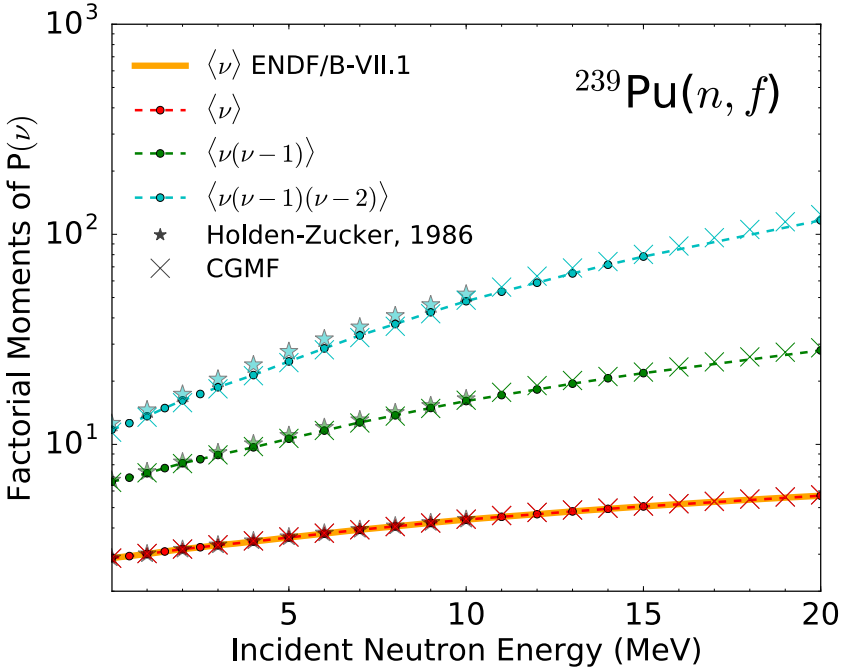
- **Chi-nu PFNS 235U data suggested a softer spectrum- used in the 235U beta3**

Prompt fission neutron multiplicity distribution P(ν) for next beta4 release (doesn't impact criticality)

- $P(\nu;E_{inc})$ evaluations based on Terrell's formula
- CGMF calculations in good agreement
- Factorial moments <ν>,<ν (ν-1)>, <ν (ν-1)(ν-2)>
- New ENDF format accepted last year
- Results for $^{235,238}U$ and ^{239}Pu from 0 to 20 MeV



Talou



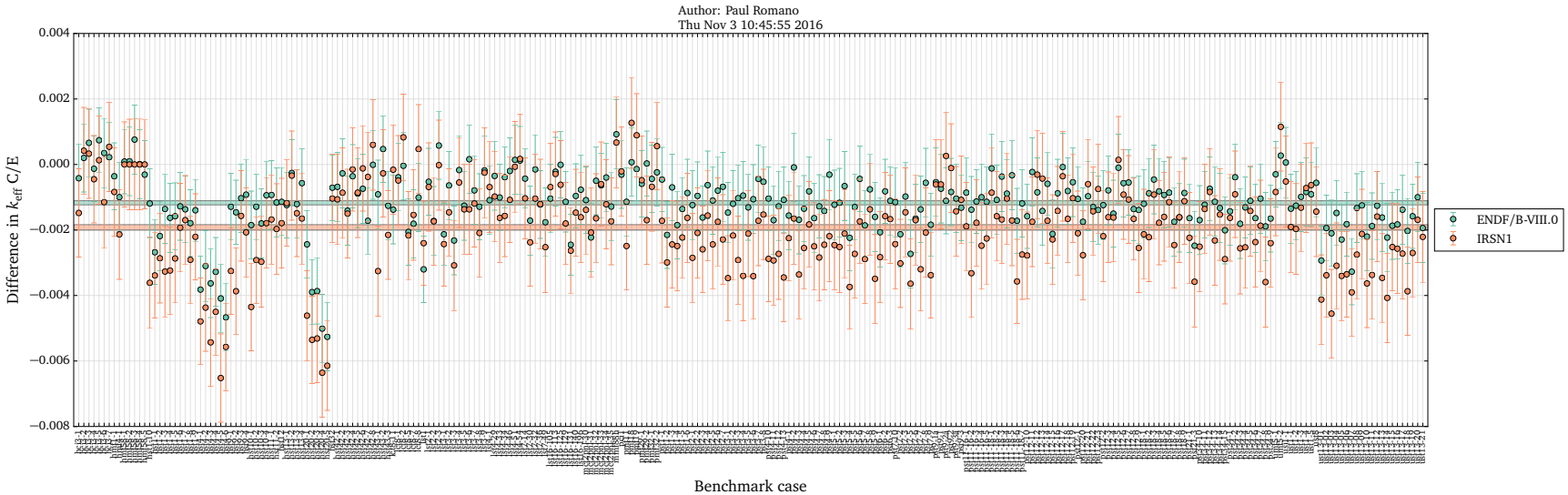
However it remains difficult to get ν-dependent spectra renormalized exactly to evaluated average spectrum…

Next steps for ENDF/B-VIII - beta4

- **Beta3 appears to perform well, like beta2**
  - But when ^{235,8}U change in beta4, updates may be needed (*e.g*. when considering Flattop-Pu performance)
  - Study possible fission increases in 1-40 keV URR range
- **Fission gamma-ray & total gamma production fixes need to be included –Stetcu, Talou, *et al.***
- **FPY update at 14 MeV to acount for recent TUNL data**
- **Include, and test, P(nu) data from Talou**
  - For fission neutrons
  - For fission gammas too?
- **Covariance evaluation updates**

Backup

Backup – Romano O16 testing



I wanted to revive this discussion from half a year ago about benchmarking of O16. I have been doing some comparisons of the ENDF/B-VIII.0 beta2 O-16 file and Luiz's IRSN1 evaluation and have attached some preliminary results. I had three sets of runs:

1. O16 from ENDF/B-VII.1, H2O/D2O from ENDF/B-VII.1, all other nuclides from ENDF/B-VIII.0
2. O16 from ENDF/B-VIII.0, H2O/D2O from CAB, all other nuclides from ENDF/B-VIII.0
3. O16 from IRSN1, H2O/D2O from CAB, all other nuclides from ENDF/B-VIII.0

The green series in the plot is the difference 2 - 1 and the red series is the difference 3 - 1. We see that overall Gerry's new O16 results in about a 100 pcm average decrease in keff and the IRSN1 evaluation results in closer to a 200 pcm drop. Probably of interest to Danila will be hst4 and hst20 which are D2O benchmarks, both of which show **big** changes.

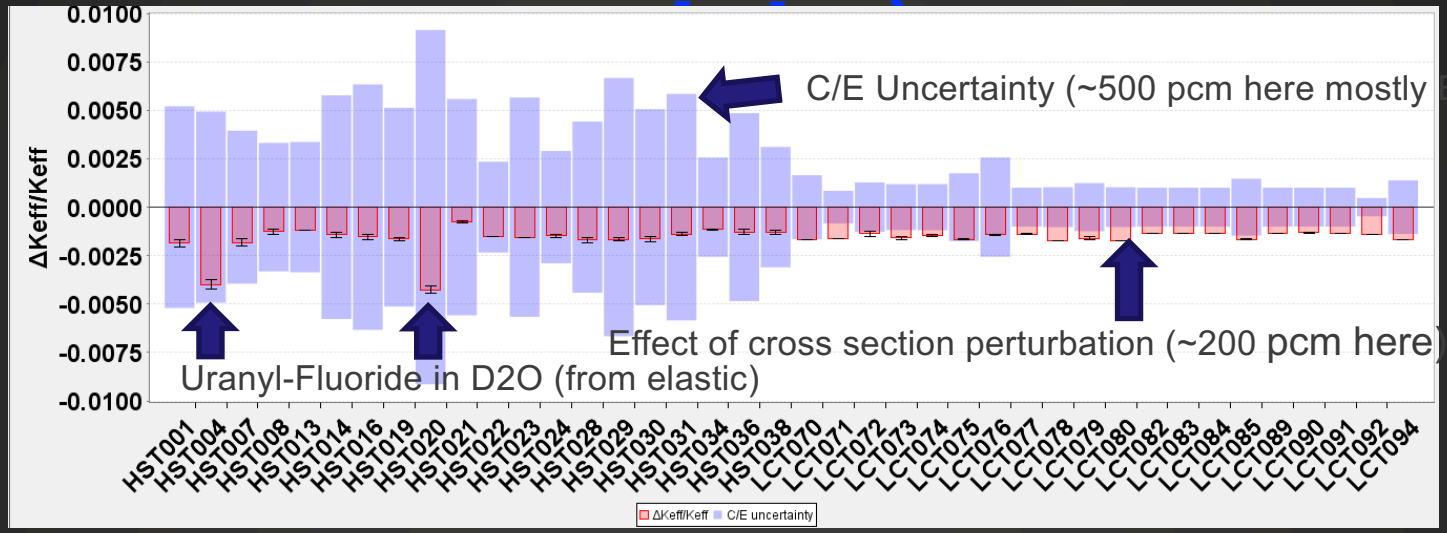
Luiz has pointed out to me that his O16 evaluation should be coupled with his other new U235 evaluation, so I'm going to run that as well. In fact, I'm going to re-run everything since ENDF/B-VIII.0 beta3 just came out, but I did want to share the preliminary results with you all to get some feedback.

Best regards,

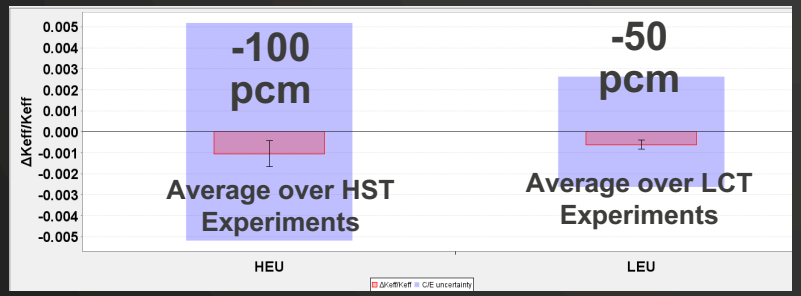
Paul

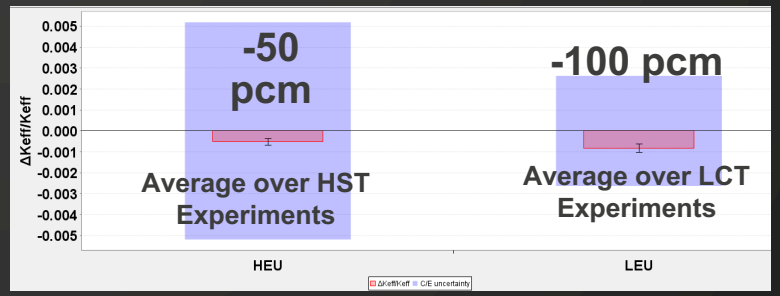
Hill NDaST Sensitivity Tool: O^{16}(elastic +

Sample HST and LCT Cases—perturbation X Sensitivity dk/dΣ



O^{16}(elastic) O^{16}(n,alpha)





(Using http://www.oecd-nea.org/ndast/)