



Status of $n+^{239}\text{Pu}$ Evaluation & Covariances

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- One more thing...

“Calibration”? “Adjustment”? “Lucky Draw”?

- A proof of principle: Using knowledge of Jezebel k_{eff} to constrain fission cross section (in fact, $\nu\sigma_f$)
- Kawano et al, NSE **153**, 1 (2006)
- No change to mean values (already “adjusted”) but strong impact on covariance matrix

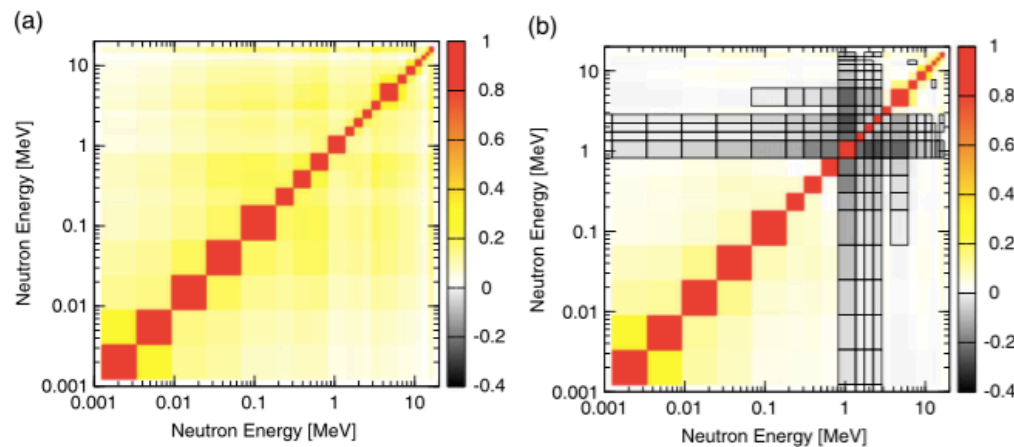
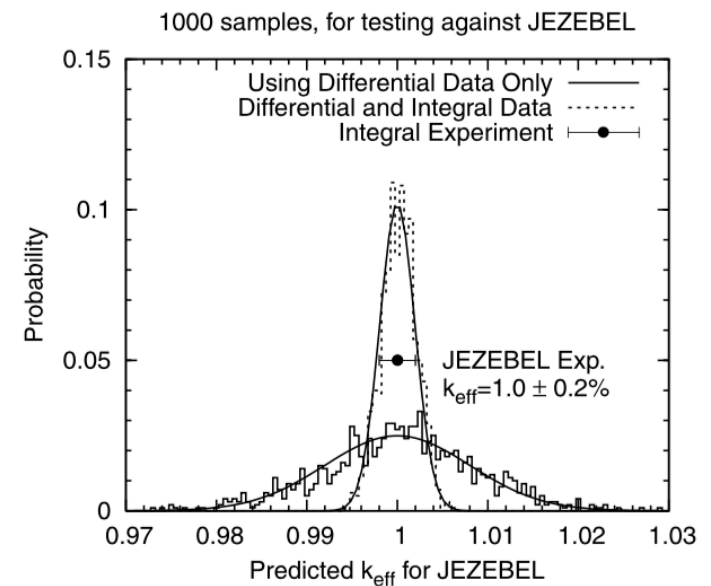


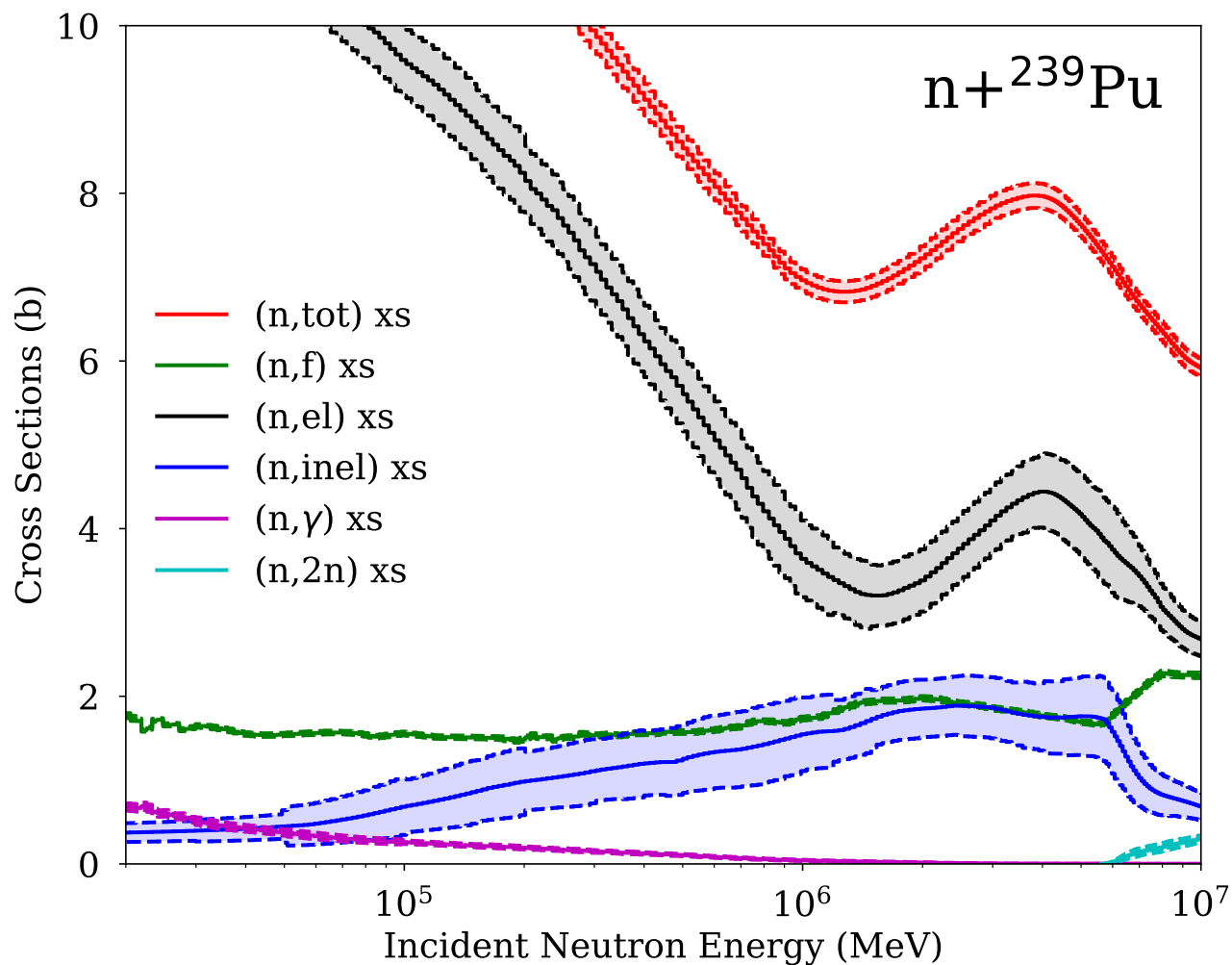
Figure 8. The correlation matrix associated with the evaluated neutron-induced fission cross section of ^{239}Pu changes dramatically if the integral benchmark data from the Jezebel ^{239}Pu critical assembly is included (b) or not (a) in the evaluation. In the posterior correlation plot (b), the blocks surrounded by a solid line indicate negative correlation regions. For more information, see [70].



Main Updates from ENDF/B-VII.1

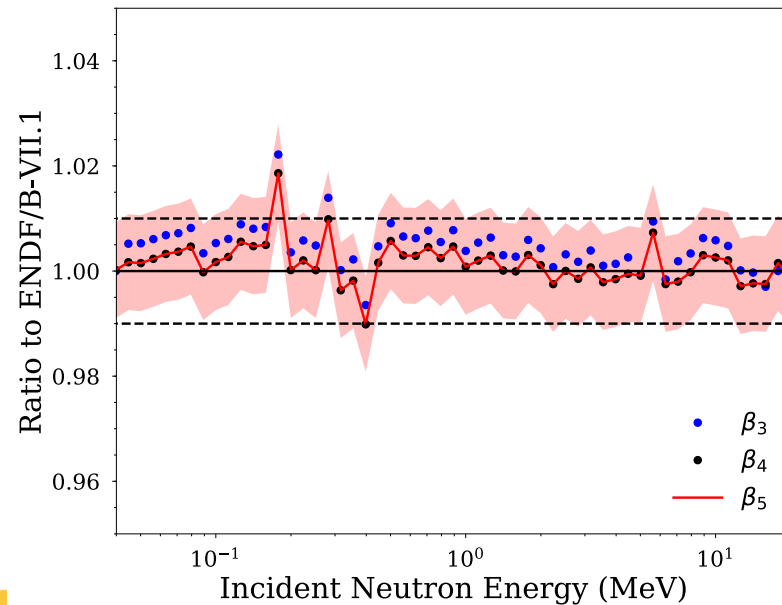
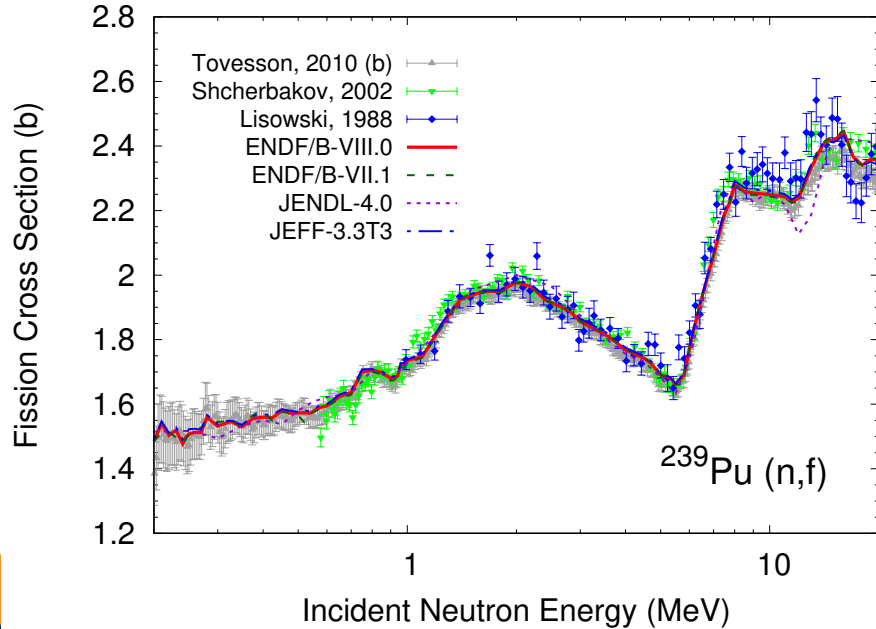
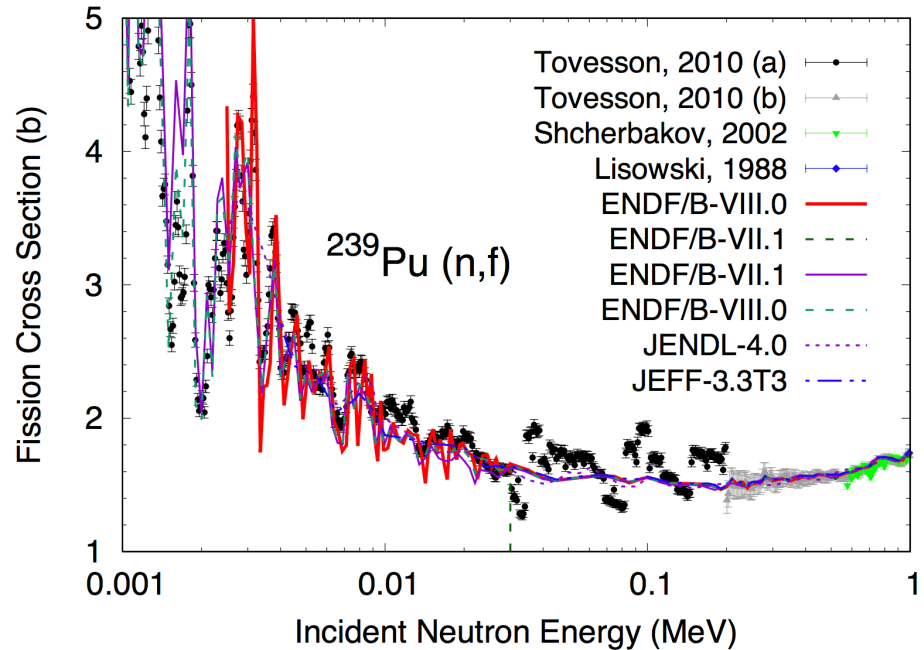
- Resonance region
 - Adoption of **WPEC SG-34** results up to 2.5 keV
 - New resonance parameters and nubar values
- Fast region: **not** a new full-blown evaluation!
 - Capture
 - Experimental data by Mosby et al. (DANCE, LANL)
 - Theoretical advances (Kawano)
 - Fission
 - Adoption of new IAEA standards result
 - Prompt Fission Neutron Spectrum
 - Chi-nu data (cf. Kelly's talk) still preliminary
 - New evaluation above 5 MeV incident neutron energy
 - **Updated covariances**

618-gps NJOY-processed File



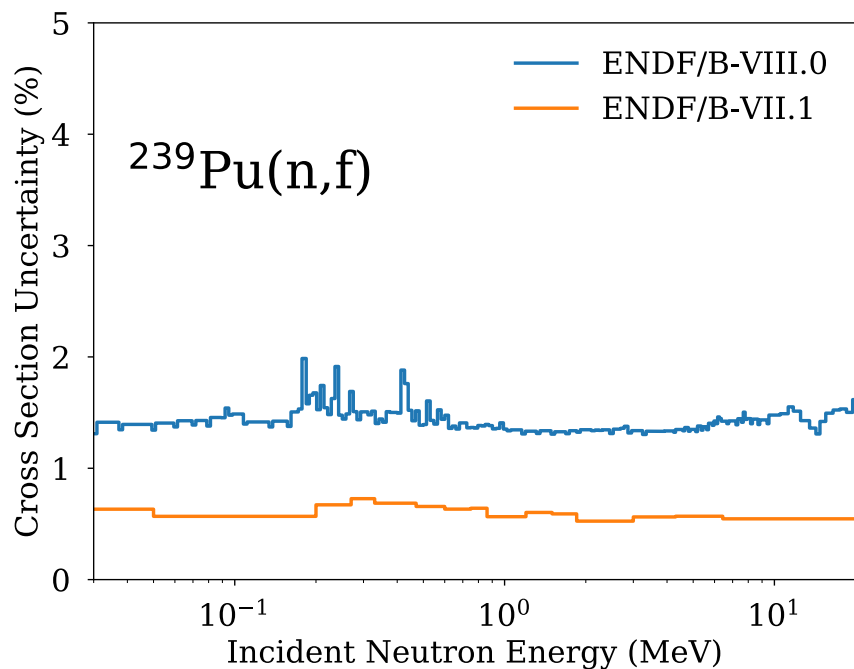
Fission Cross Section

- Adoption of new IAEA standard results above 30 keV
- New covariance, including a 1.2% fully correlated component

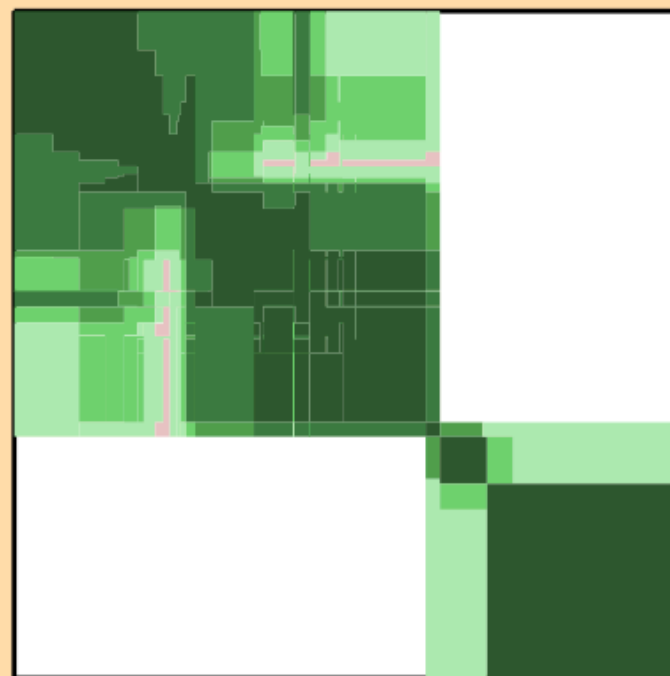
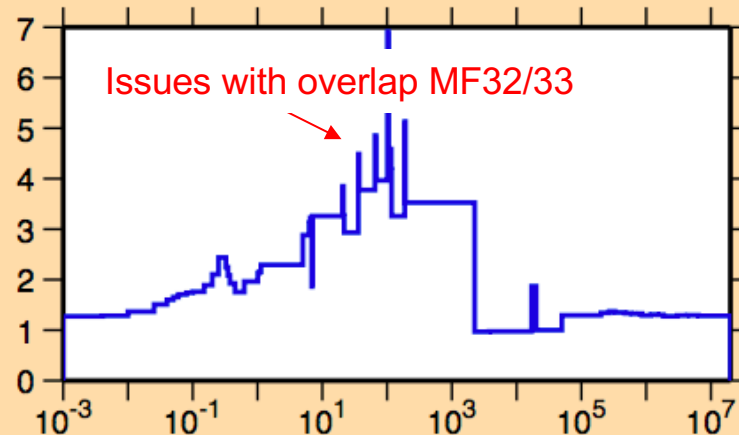


New uncertainties

- Added 1.2% fully correlated component for unrecognized systematic errors.



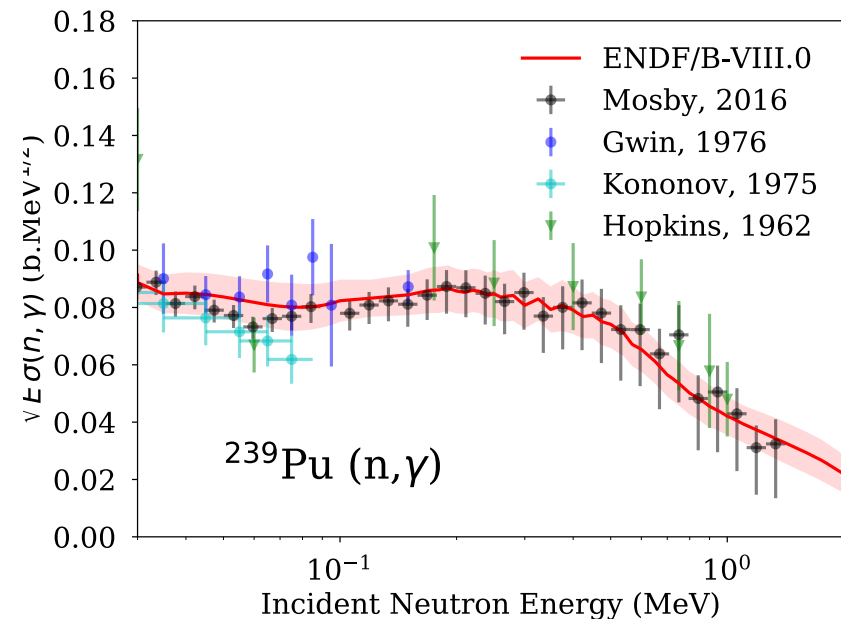
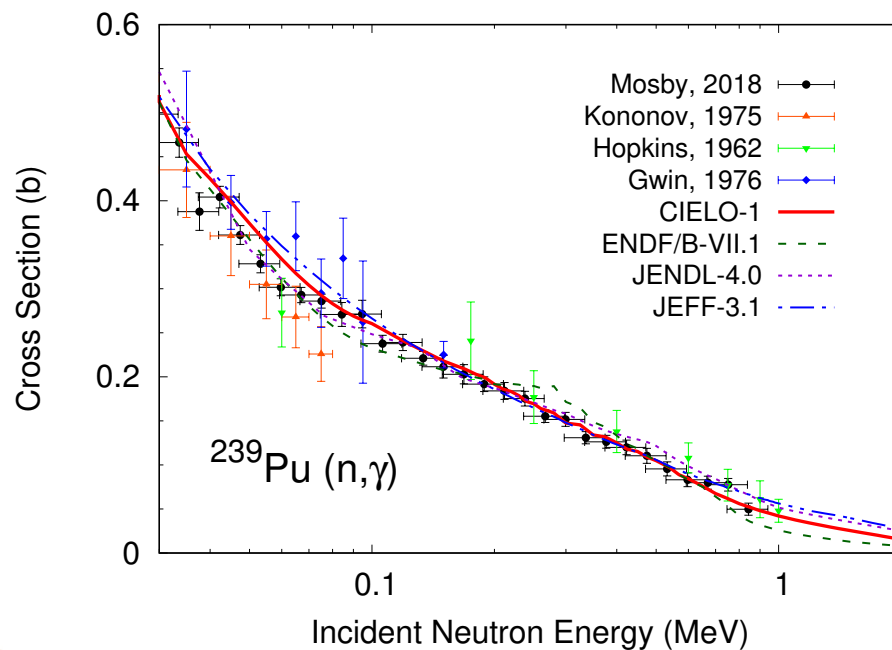
$\Delta\sigma/\sigma$ vs. E for $^{239}\text{Pu}(n,f)$



Correlation Matrix

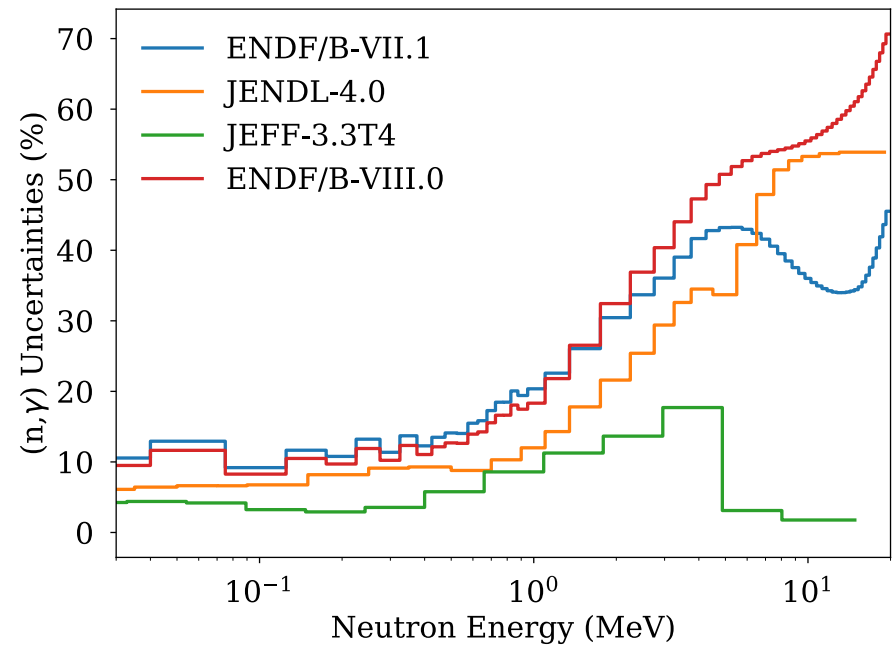
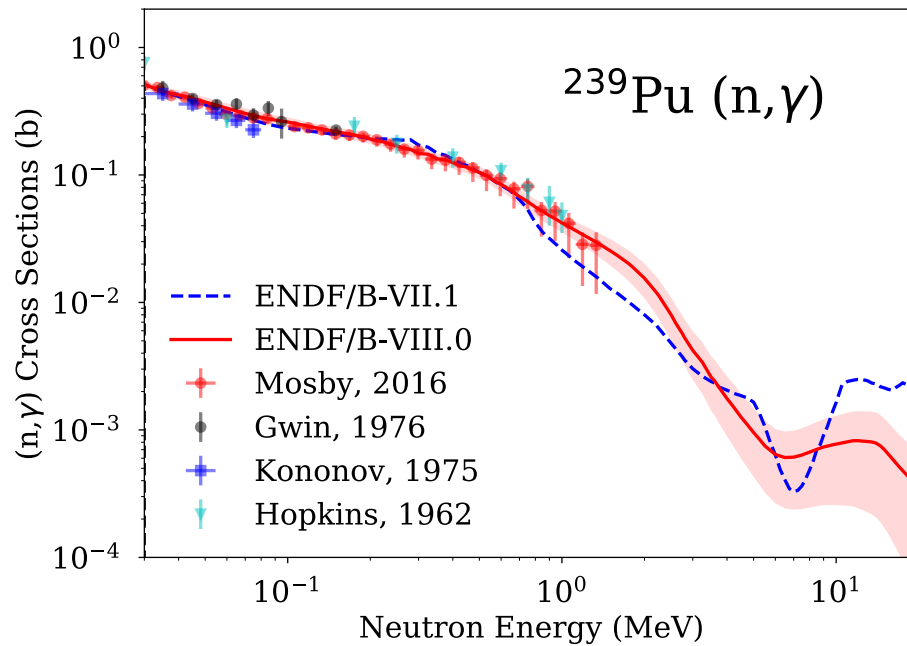
(n, γ) Cross Section

- New experimental results from DANCE measurement (**Mosby et al.**)
- New theoretical work (**Kawano, CoH₃**), including M1 “scissors” mode (also, **Ullmann et al.**)

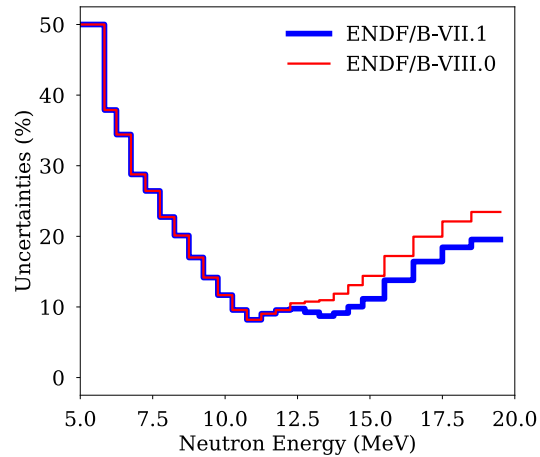
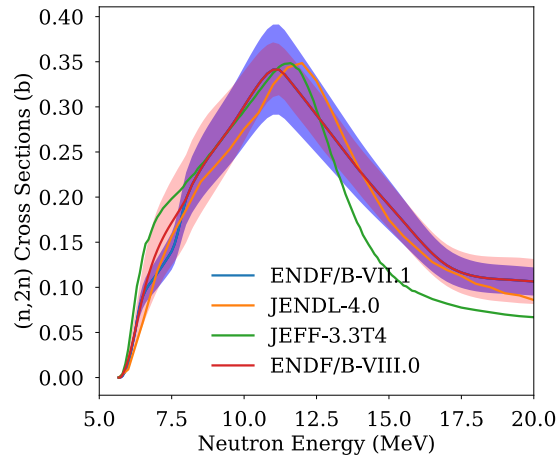


Uncertainties on (n,γ)

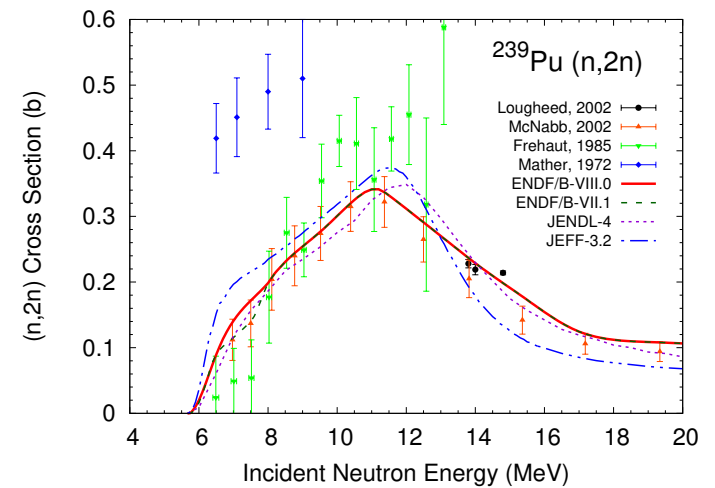
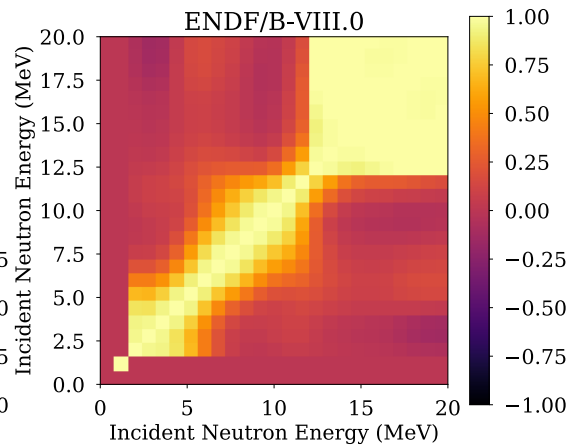
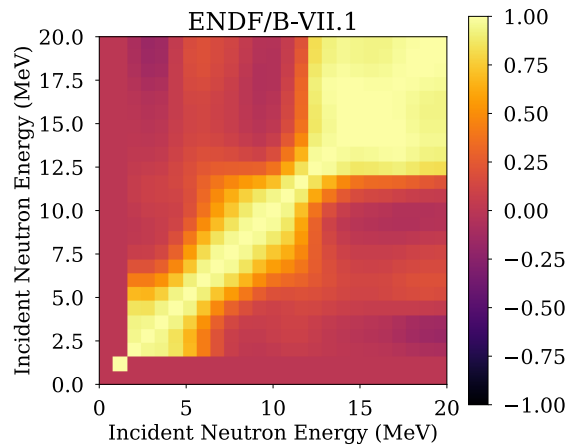
- Slight reduction of uncertainties below 1 MeV but increase at higher energies



(n,2n) Cross Section

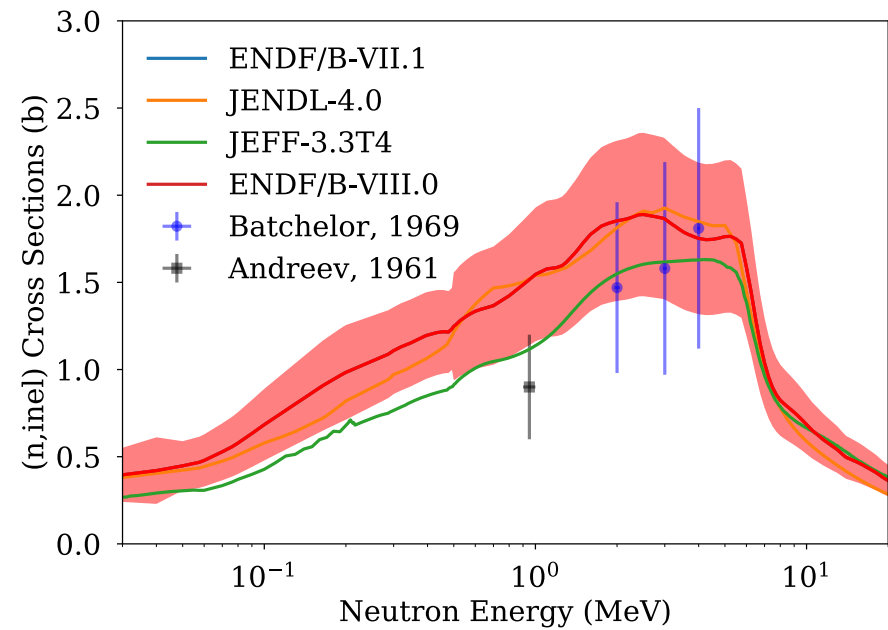
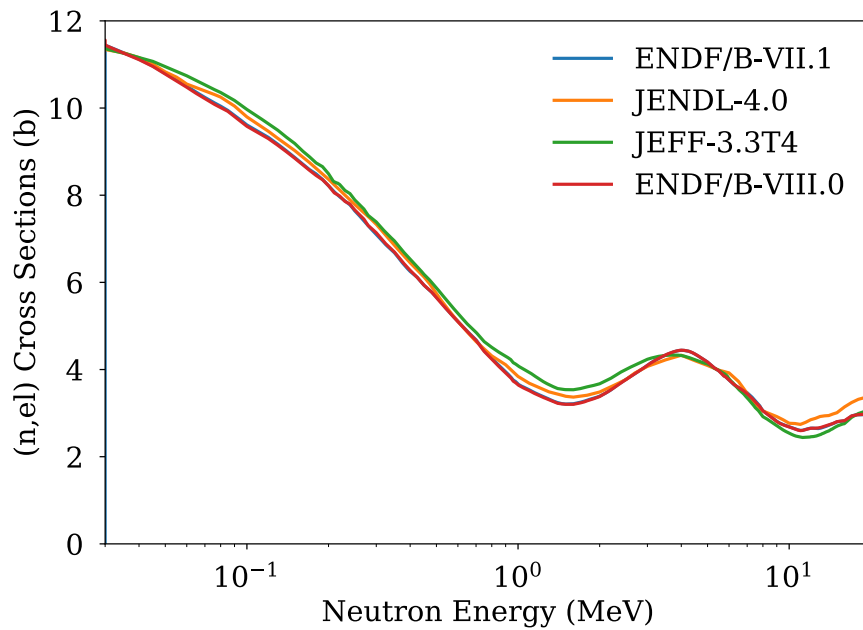
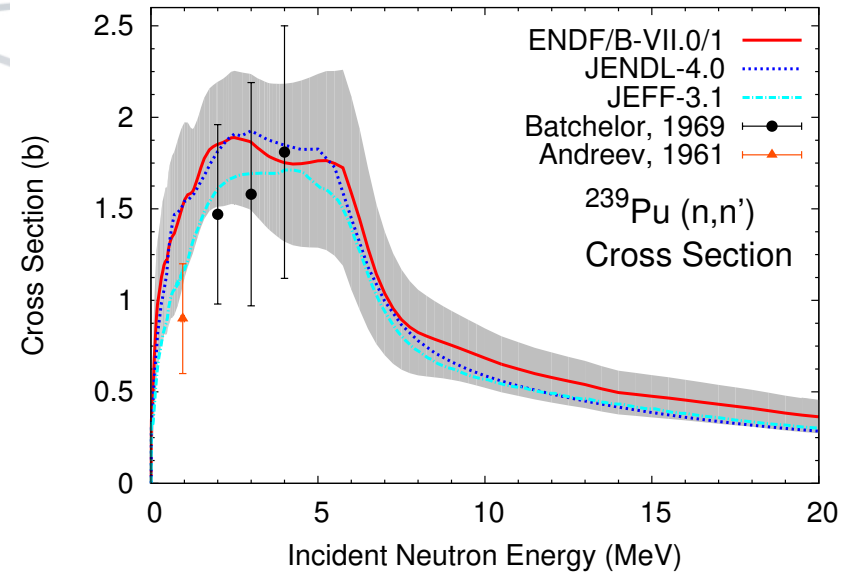


- Modest change near threshold, below 7.5 MeV



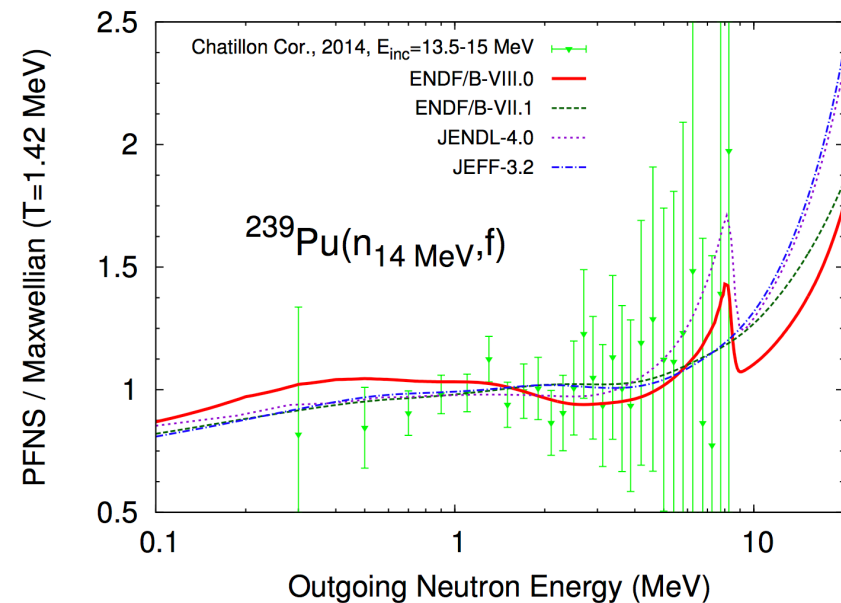
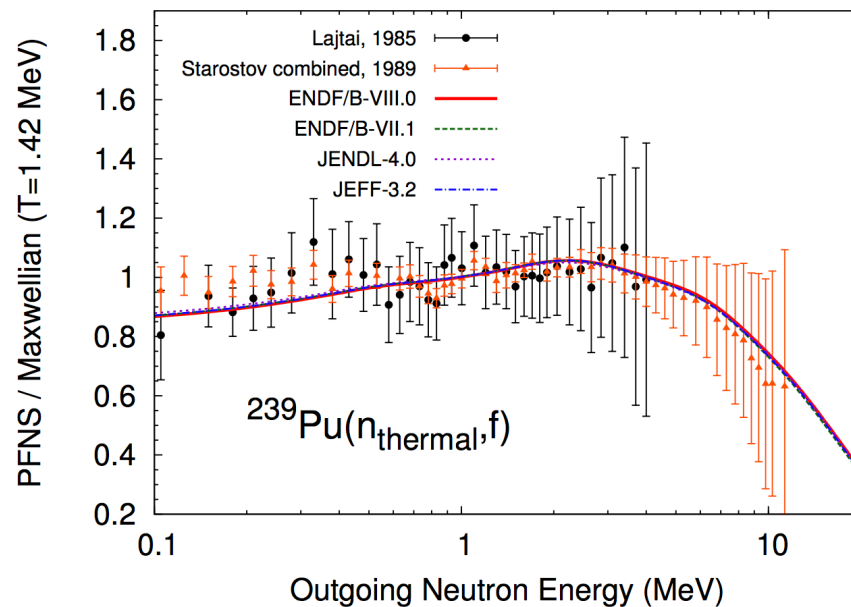
Elastic/Inelastic Cross Sections

- No change
- Study P_1 uncertainties before the final release of the library?



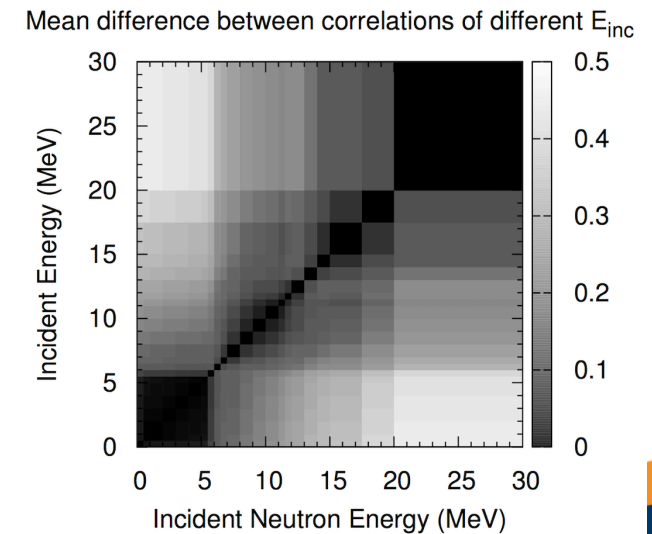
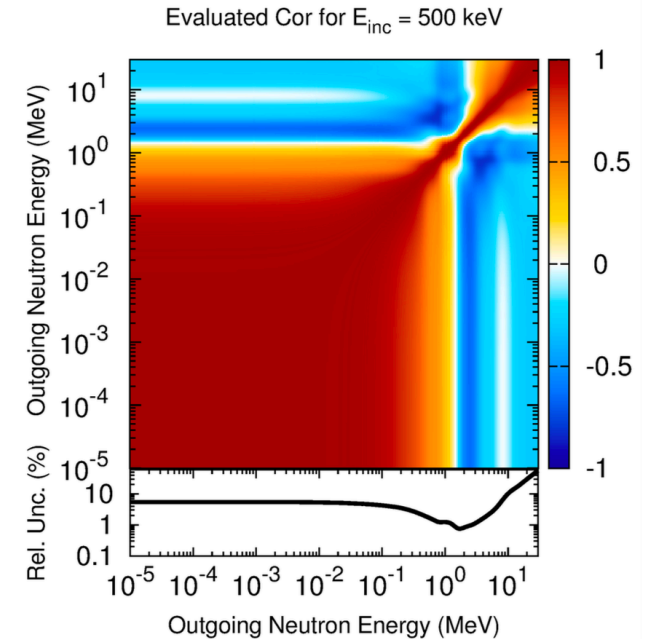
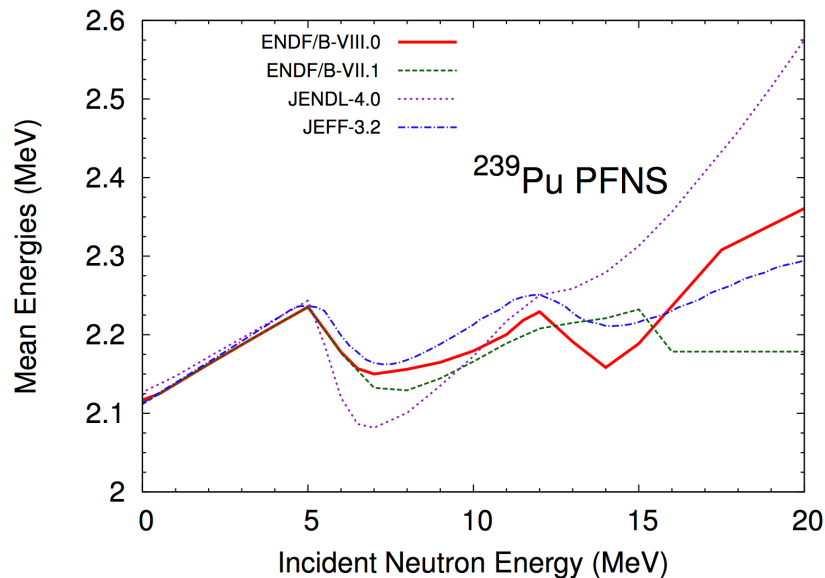
Prompt Fission Neutron Spectrum

- Small tweak for thermal PFNS to improve modeling of Plutonium thermal solution benchmarks
- Unchanged from B-VII.1 from 0.5 to 5 MeV
- New evaluation (**Neudecker et al.**) above 5 MeV
- Preliminary chi-nu data (**Kelly et al.**)



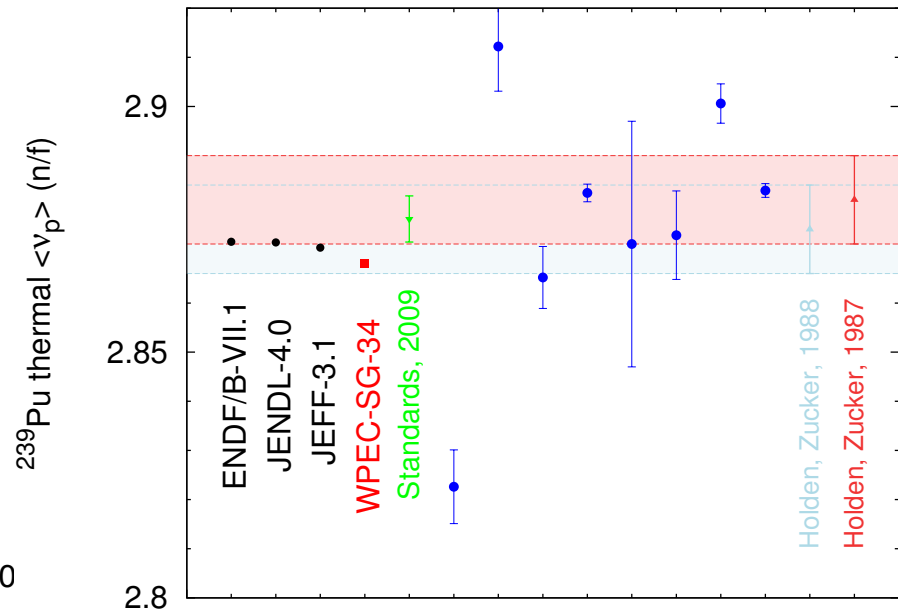
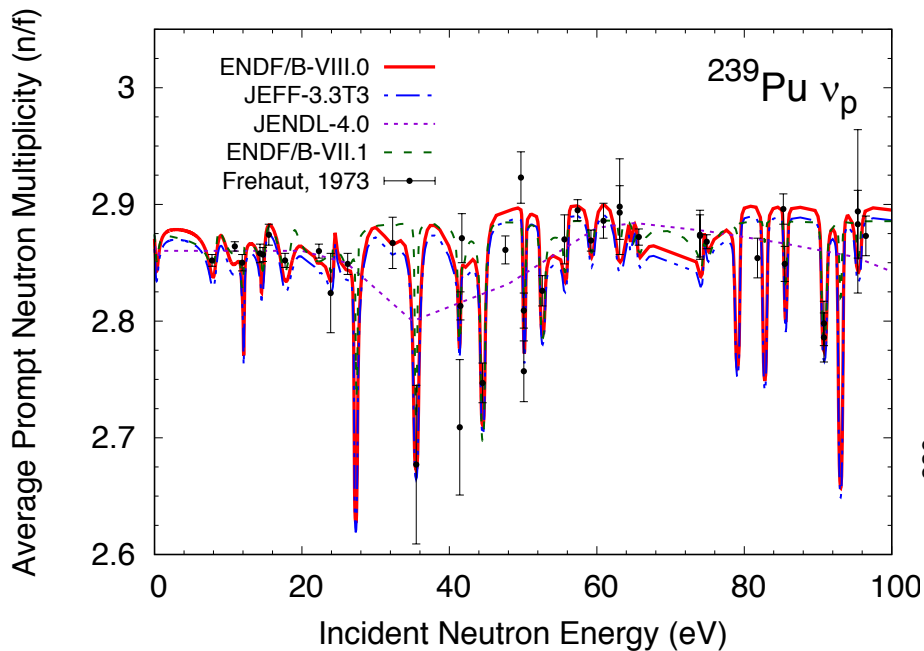
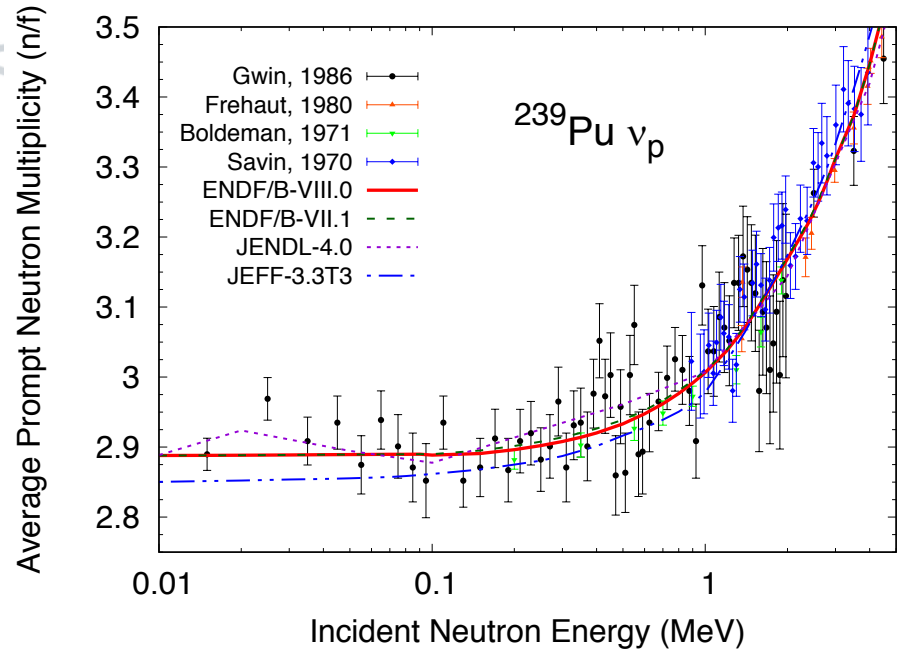
PFNS Uncertainties

- Better handling of experimental errors
- Large effort as part of chi-nu experimental and simulation work → revisit many past experiments for unrecognized systematic biases
- Thermal: $\langle E_{out} \rangle = 2.116 \pm 0.037$ MeV
- D. Neudecker et al., NDS (2017)



Average Prompt Fission Neutron Multiplicity

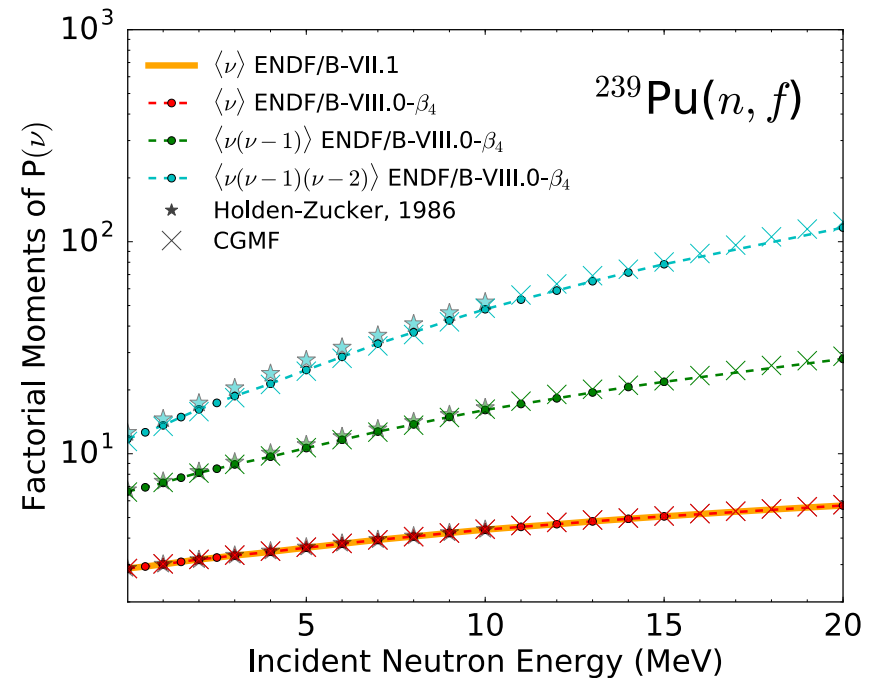
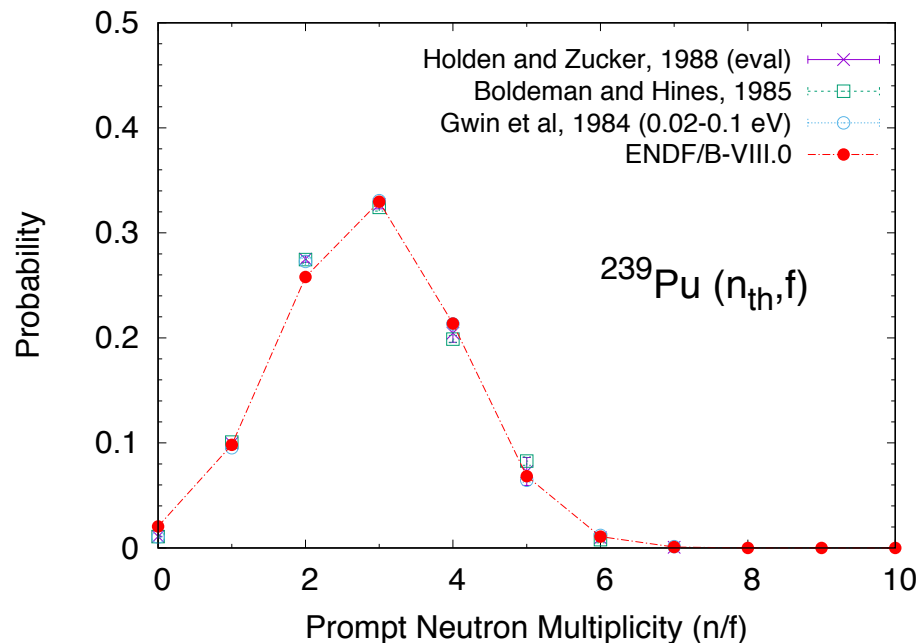
- WPEC SG-34 results adopted
- (n,γf) process invoked to interpret fluctuations < 100 eV



Neutron Multiplicity Distribution $P(\nu)$

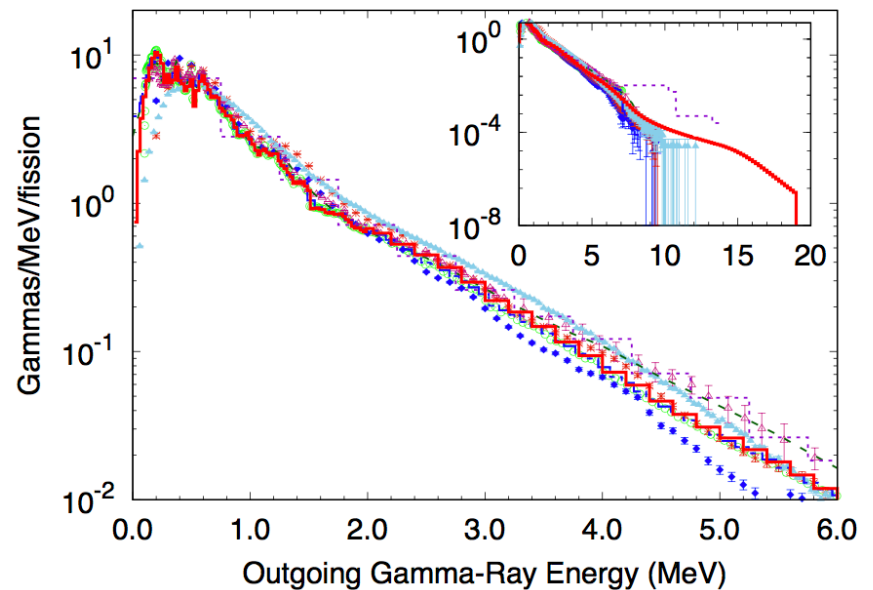
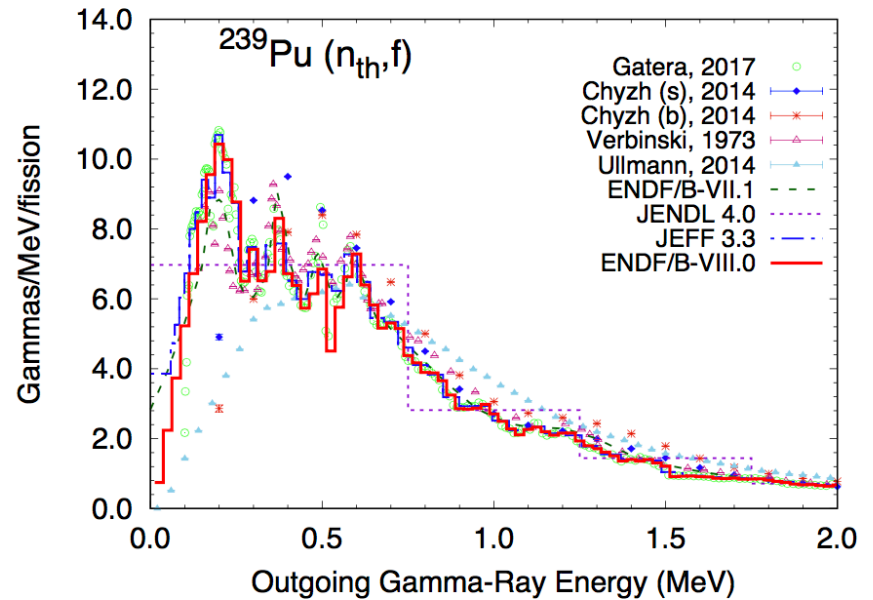
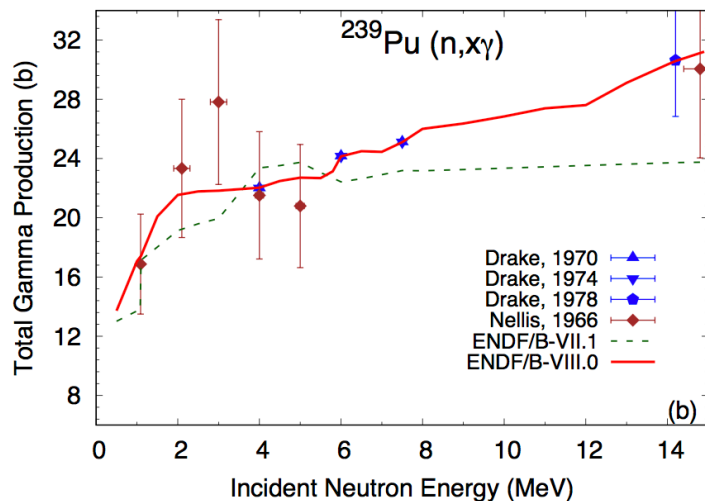
- Terrell's formulation, supported by CGMF calculations
- New format, but does not include covariance information

$$\sum_{\nu} P(\nu) = 1 \text{ and } \sum_{\nu} \nu P(\nu) = \bar{\nu}$$



Prompt Fission γ Rays

- New evaluation (**Stetcu, Chadwick**)
 - Hauser-Feshbach calculations
 - New experimental data by Oberstedt (Geel), Ullmann and Chyzh (LANSCCE)
- *New N_γ -dependent spectra in progress*
- No ENDF format for uncertainties



Summary & Perspectives

	CIELO-1 Jezebel k-eff Unc. (pcm)	B-VII.1 Jezebel k-eff Unc. (pcm)	JEFF-3.3 Jezebel k-eff Unc. (pcm)	JENDL-4.0u1 Jezebel k-eff Unc. (pcm)
fission	903	331	305	434
nubar	241	81	413	209
PFNS E_{av}	185	186	443	286
elastic	463	438	90	198
inelastic	797	797	150	250
capture	67	74	30	59
Summed	1025	562	645	648
Exp. unc.	110	110	110	110
$C-E$	15	12	68	185

- In the next few weeks:
 - Finalize all uncertainties and covariances
 - Possible tweak to PFNS uncertainties
 - Fix “double-counting” issue with ORNL
 - Revisit nu-bar uncertainties
 - Include P_1 uncertainties?

Impact of ^{239}Pu covariances on Jezebel
(Chadwick et al, CIELO NDS paper)