

Providing “reasonable” ^{239}Pu and ^{235}U PFNS covariances for ENDF/B-VIII.0

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Aim of this work:

- **Provide reasonable evaluated uncertainties of the ^{235}U and ^{239}Pu PFNS given the evaluation input.**
- **Provide evaluated ^{235}U and ^{239}Pu PFNS covariances in ENDF-6 format such that evaluated information is preserved and benchmarks are affected little.**

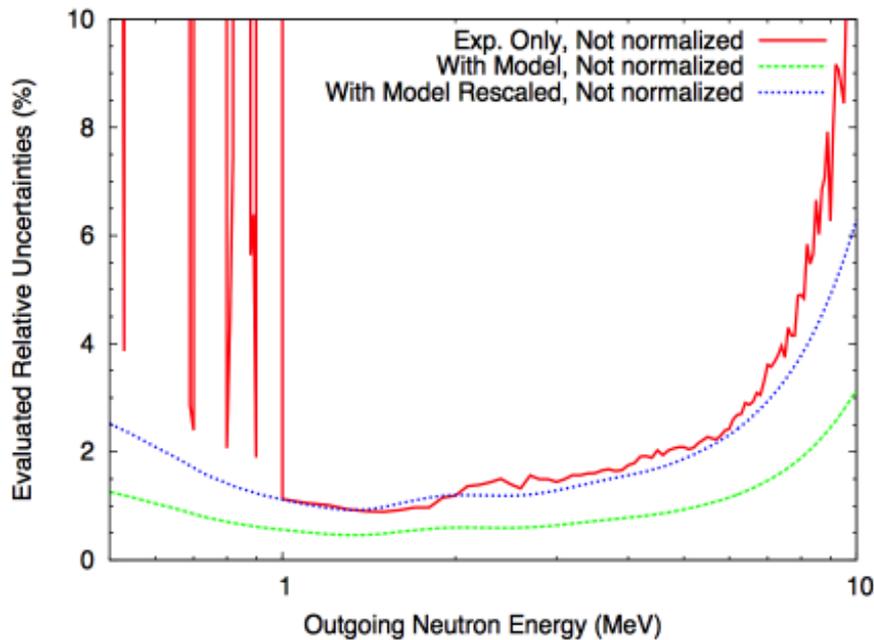
ENDF/B-VIII.0β4 ²³⁹Pu and ²³⁵U PFNS:

E_{inc} (MeV)	²³⁵ U	²³⁹ Pu
Thermal	Capote et al. [1]	Demi-Romano tweak of ENDF/B-VII.1
0.5-5	Neudecker et al. [2], without Chi-Nu data	ENDF/B-VII.1
> 5	Neudecker et al. [2], with Chi-Nu data	Neudecker et al. [2]

- [1] A. Trkov, R. Capote, Phys. Procedia 64, 48–54 (2015).
[2] D. Neudecker et al., Nuclear Data Sheets, in preparation.

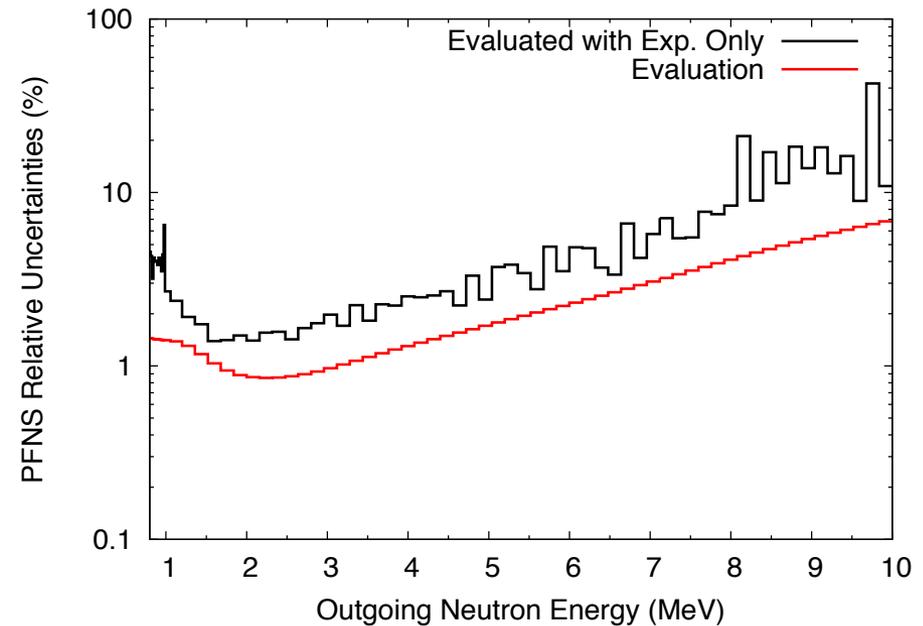
Evaluated unc. should be guided by combined exp. unc. where exp. data are well-known.

^{235}U



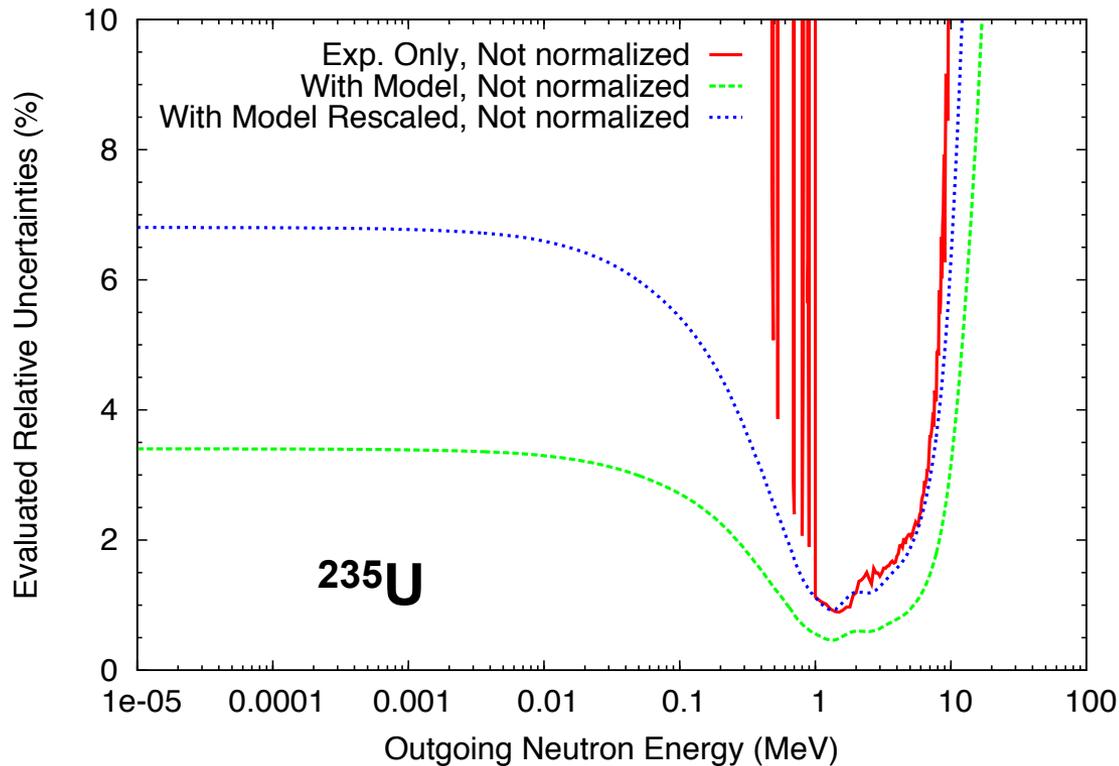
Rescaled with factor 2.0.

^{239}Pu

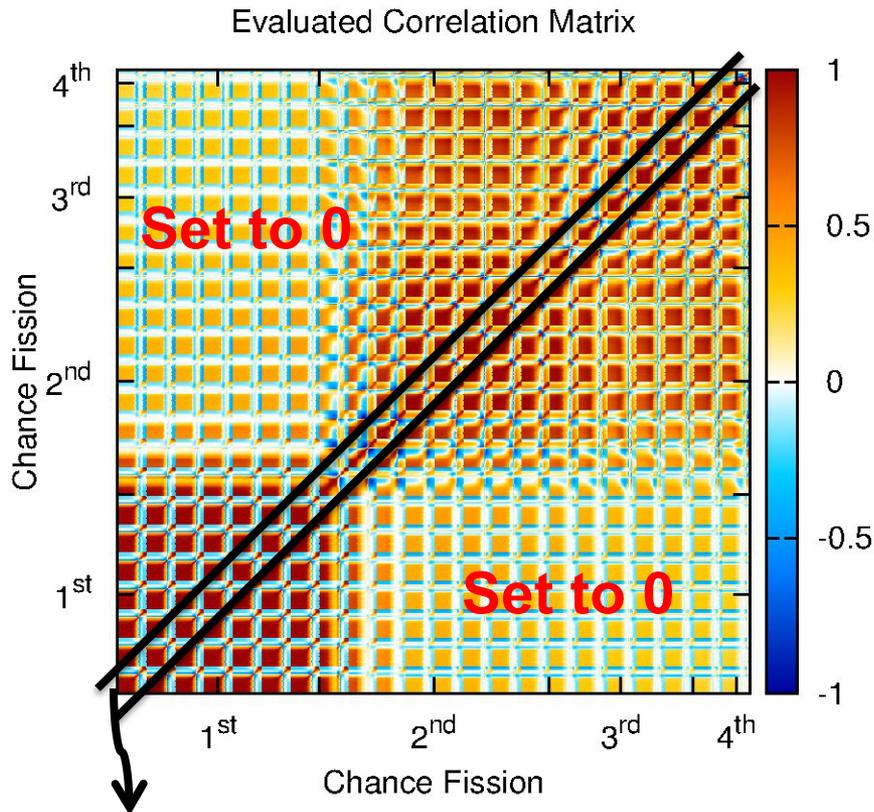


Rescaled with factor 1.6.

But are unc. of 7% at lowest E_{out} reasonable??



ENDF-6 MF35 format does not allow to store covariances between PFNS of different E_{inc} .



Can be stored in ENDF-6 format

Only correlations between the black bands can be stored, *all other correlations would be implicitly set to zero.*

→ Pu-240 Jezebel k_{eff} unc. distinctly decreased
M.E. Rising, et al., LANL report LA-UR15-24045 (2015).

ENDF-6 MF35 format recommendation:

“It is proposed that only a few covariances be used in each MT values in File 35 to cover the complete incident energy range. Each covariance matrix applies to the complete secondary energy distributions for the broad incident energy range specified. [...] No covariances between the different incident energy ranges are allowed.”

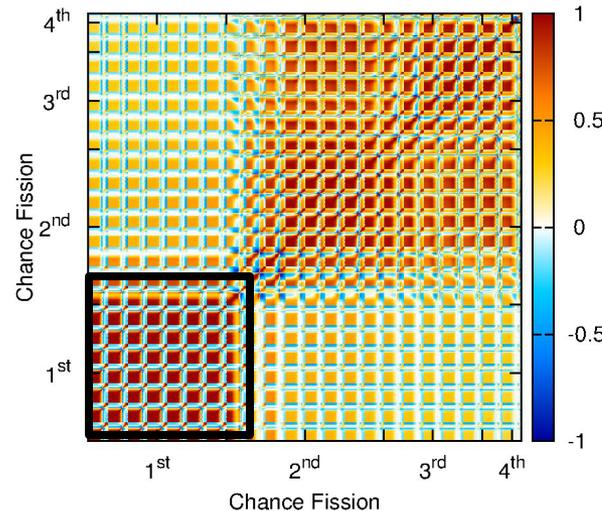
from ENDF-6 formats manual version 2012, page 284, section 35.1

Grouping of covariances for ^{235}U PFNS

E_{inc} (MeV)	Used
≤ 5	1.5 MeV
5-7	6 MeV
7-12	10 MeV
12-20	14 MeV

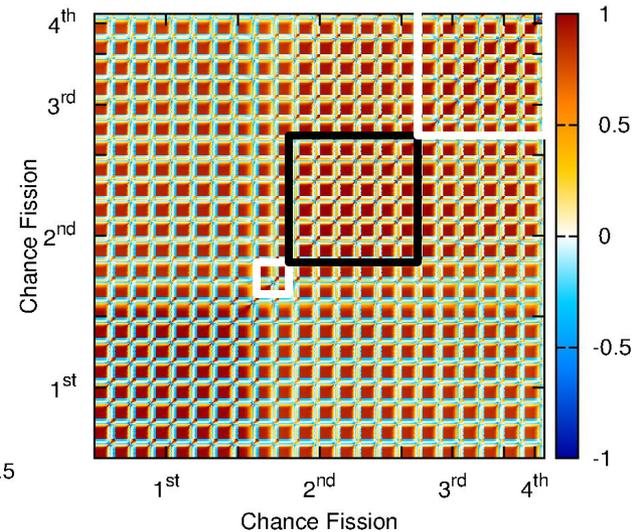
$E_{\text{inc}} \leq 5 \text{ MeV}$

Evaluated Correlation Matrix



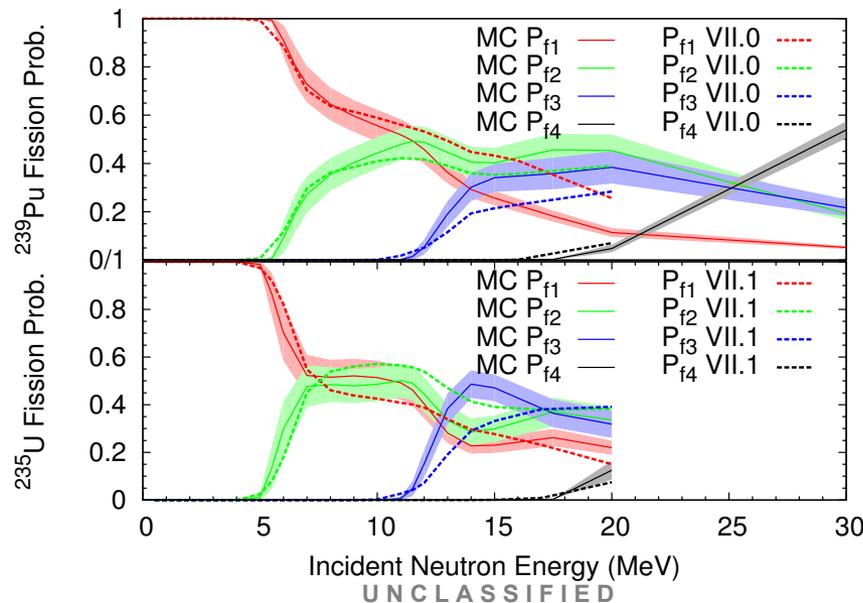
$E_{\text{inc}} > 5 \text{ MeV}$

Evaluated Correlation Matrix



Grouping of covariances for ^{235}U PFNS is motivated by different physics processes

E_{inc} (MeV)	Reasoning
≤ 5	Only 1 st chance fission (c.f.) processes contribute.
5-7	1 st and 2 nd c.f., 1 st c.f. dominates.
7-12	Similar 1 st and 2 nd c.f., pre-equilibrium contribution small
12-20	Mixing of 1 st , 2 nd , 3 rd c.f., pre-equilibrium component

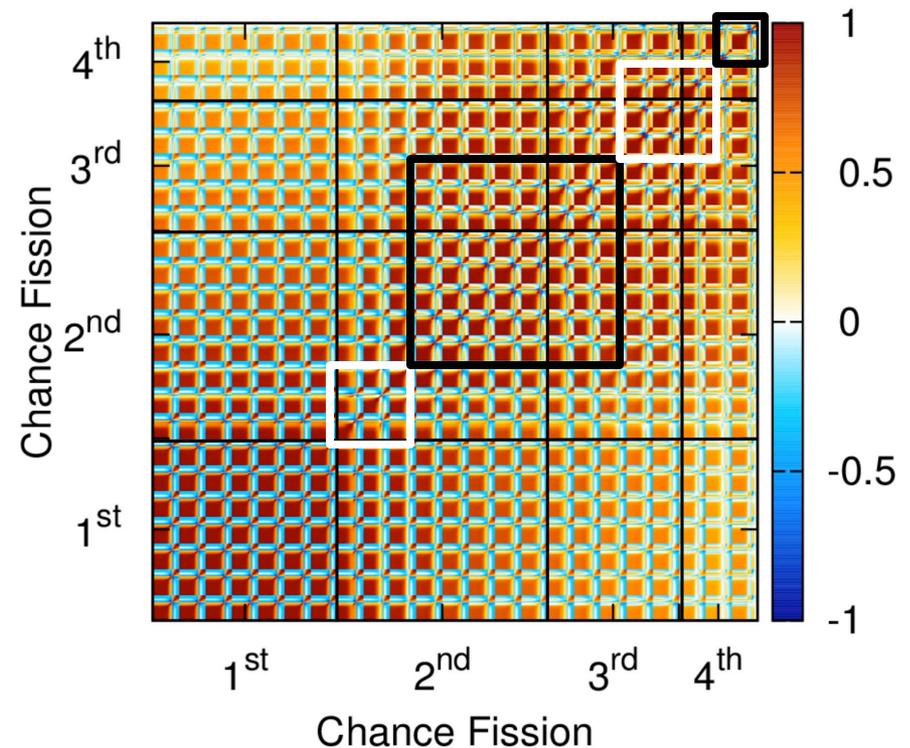


Grouping of covariances for ^{239}Pu PFNS

$$E_{\text{inc}} > 5 \text{ MeV}$$

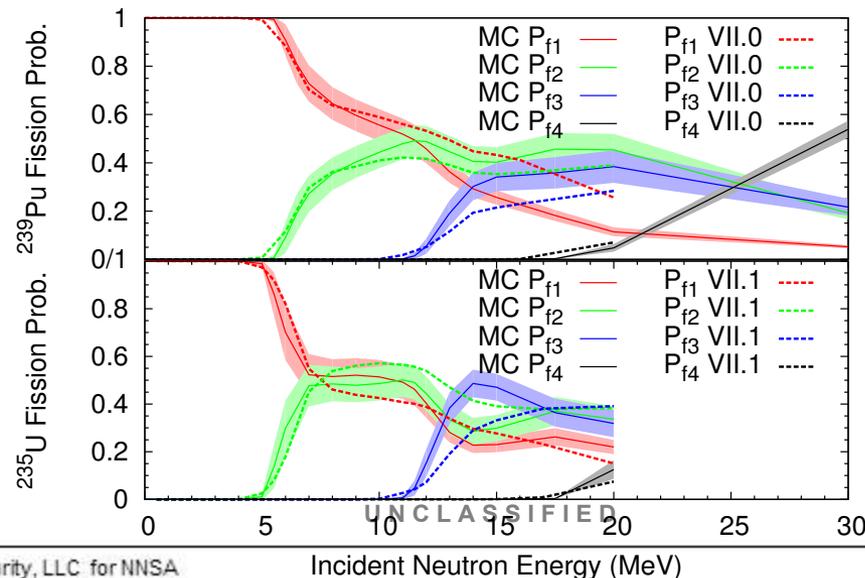
Evaluated Correlation Matrix

E_{inc} (MeV)	Used
≤ 5	0.5 MeV
5-6.5	6 MeV
6.5-13	10 MeV
13-30	14 MeV
30	30 MeV

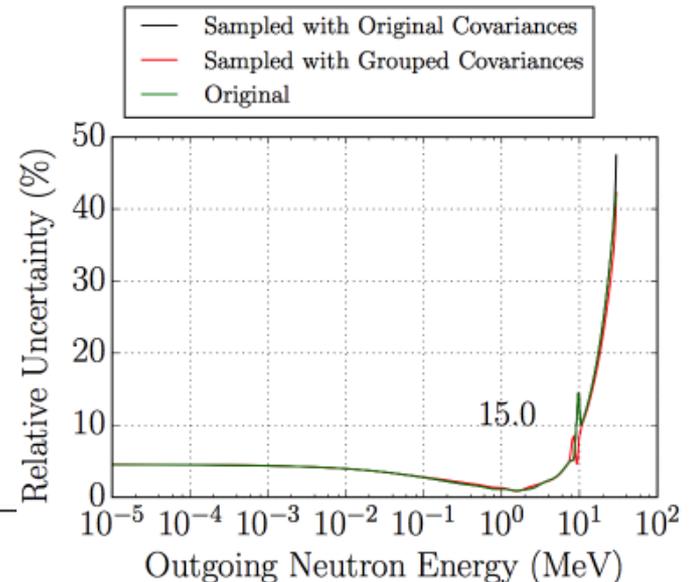
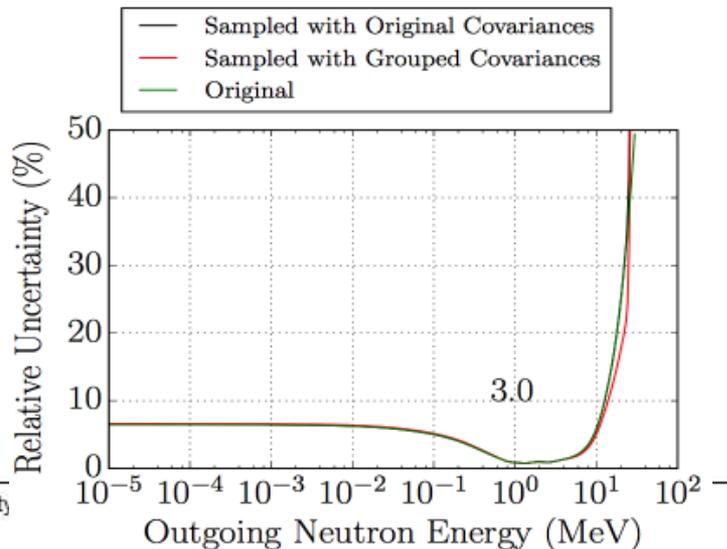
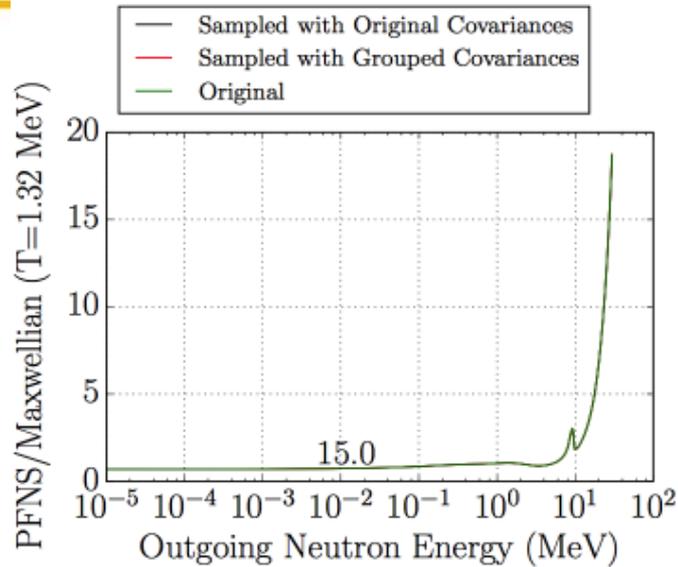
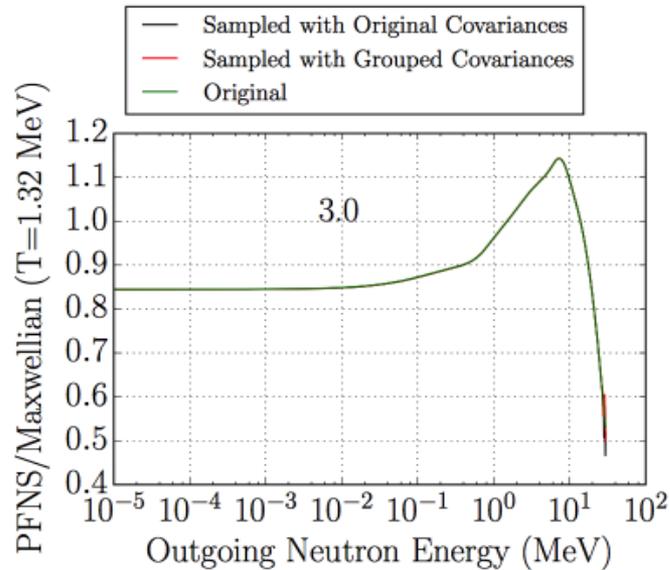


Grouping of covariances for ^{239}Pu PFNS

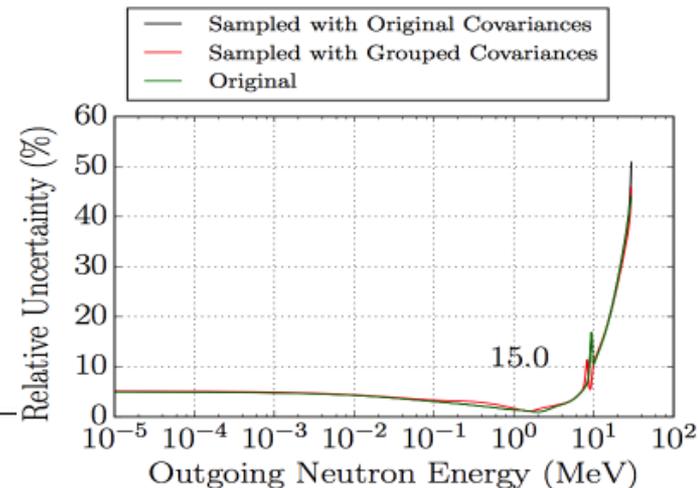
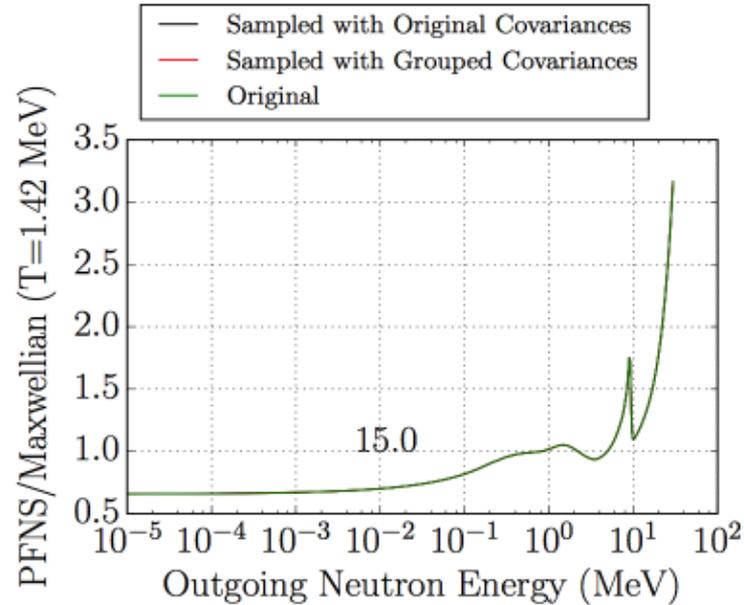
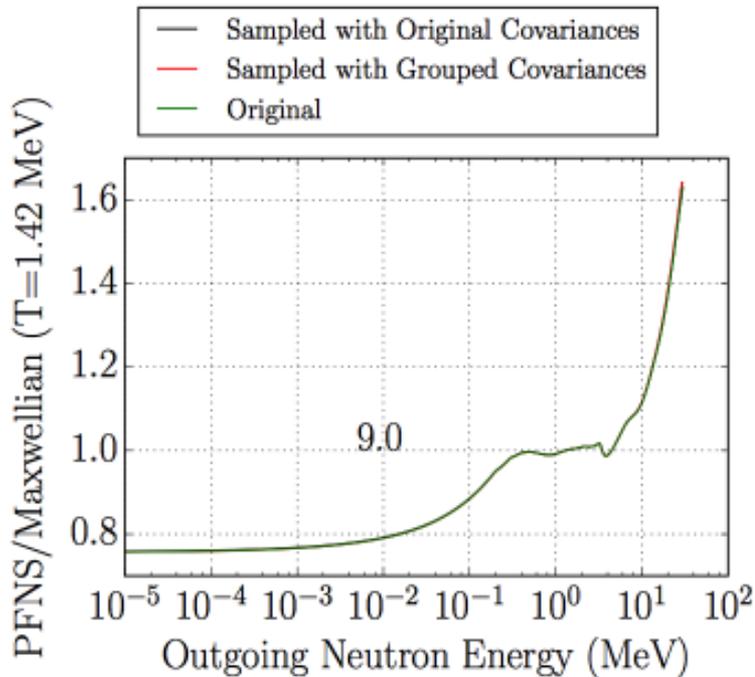
E_{inc} (MeV)	Reasoning
≤ 5	ENDF/B-VII.1 covariances
5-6.5	1 st and 2 nd c.f., 1 st c.f. dominates.
6.5-13	Similar 1 st and 2 nd c.f., pre-equilibrium contribution small
13-30	Mixing of 1 st , 2 nd , 3 rd c.f., pre-equilibrium component
30	Dominant 4 th c.f.



Sampling from grouped cov. reproduces original mean values and unc. well for ^{235}U .



Sampling from grouped cov. reproduces original mean values and unc. well for ^{239}Pu .



Jezebel and Godiva simulated k_{eff} unc. change negligibly if grouped vs original cov. are used.

Godiva k_{eff} unc. with original covariances: 51.2 pcm

Godiva k_{eff} unc. with grouped covariances: 51.7 pcm

→ **bias of 0.9%**

Jezebel k_{eff} unc. with original covariances for $E_{\text{inc}} > 5$ MeV: 5.0 pcm

Jezebel k_{eff} unc. with grouped covariances for $E_{\text{inc}} > 5$ MeV: 4.8 pcm

Approximate total Jezebel k_{eff} unc.: 73 pcm

→ **bias of 0.4%**

Summary

- Provide reasonable evaluated uncertainties of the ^{235}U and ^{239}Pu PFNS given the evaluation input.
Evaluated uncertainties were rescaled with constant factor.
- Provide evaluated ^{235}U and ^{239}Pu PFNS covariances in ENDF-6 format such that evaluated information is preserved and benchmarks are affected little.
Evaluated covariances were grouped into broad E_{inc} -bins. This grouping preserves mean values and unc. when sampling from grouped cov. and biases Jezebel and Godiva k_{eff} unc. negligibly.