Adjusting ^{235,238}U and ^{239}Pu nuclear data with a Monte Carlo technique

D. Rochman and A.J. Koning

Nuclear Research and Consultancy Group,

NRG, Petten, The Netherlands

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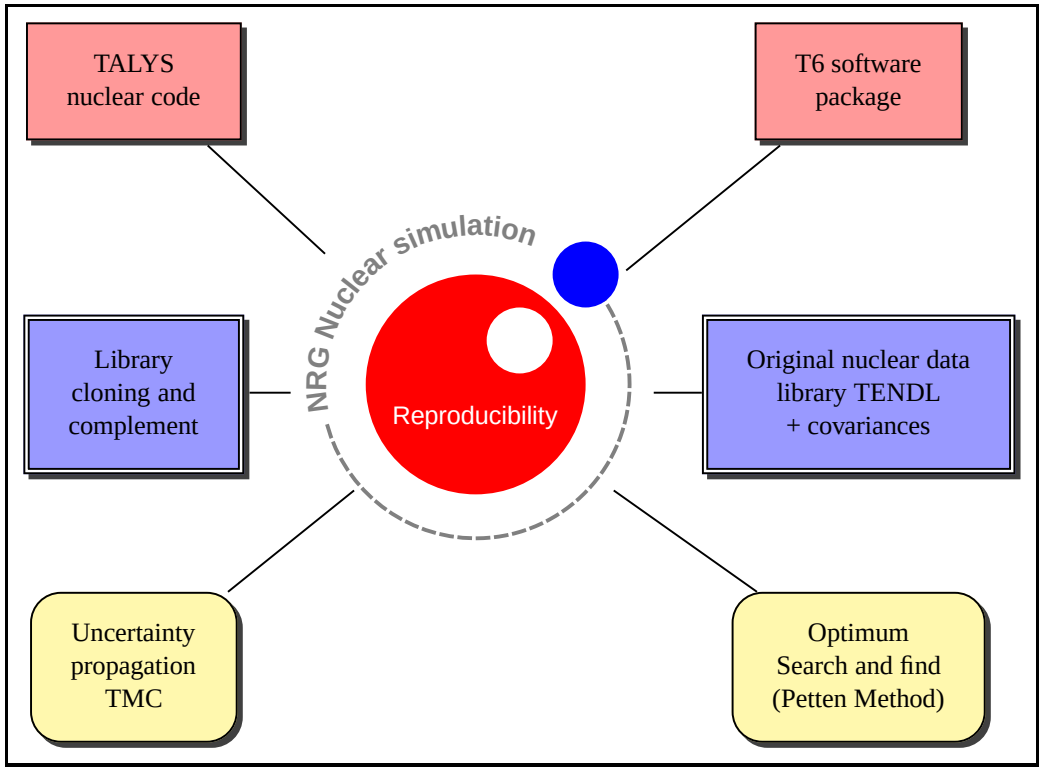
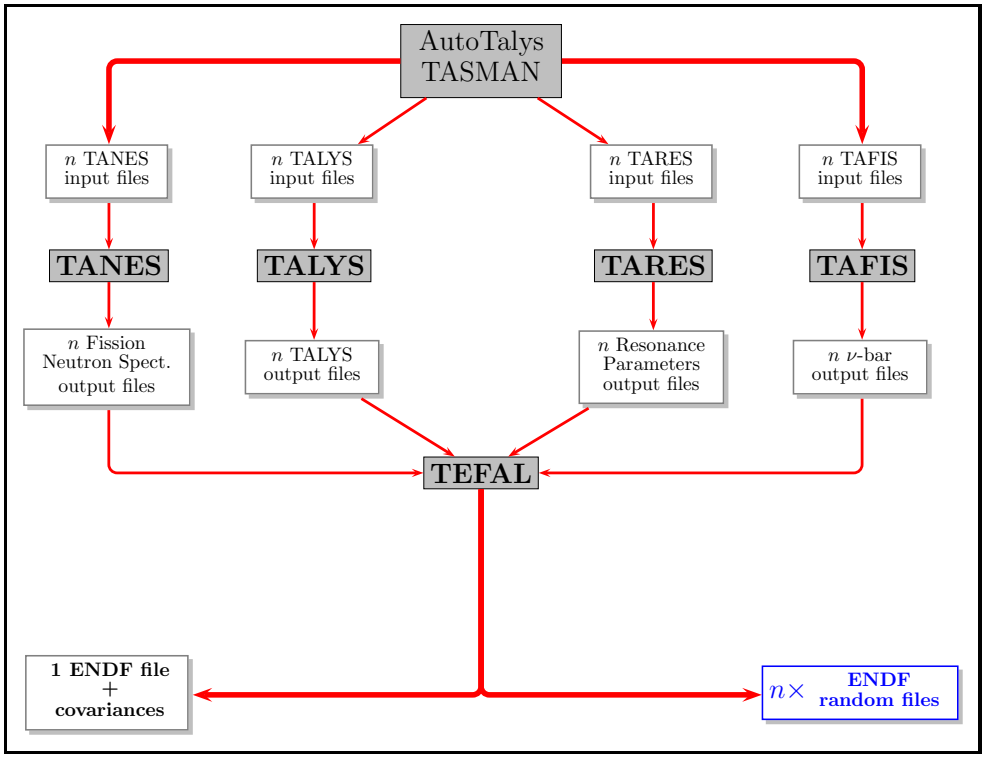
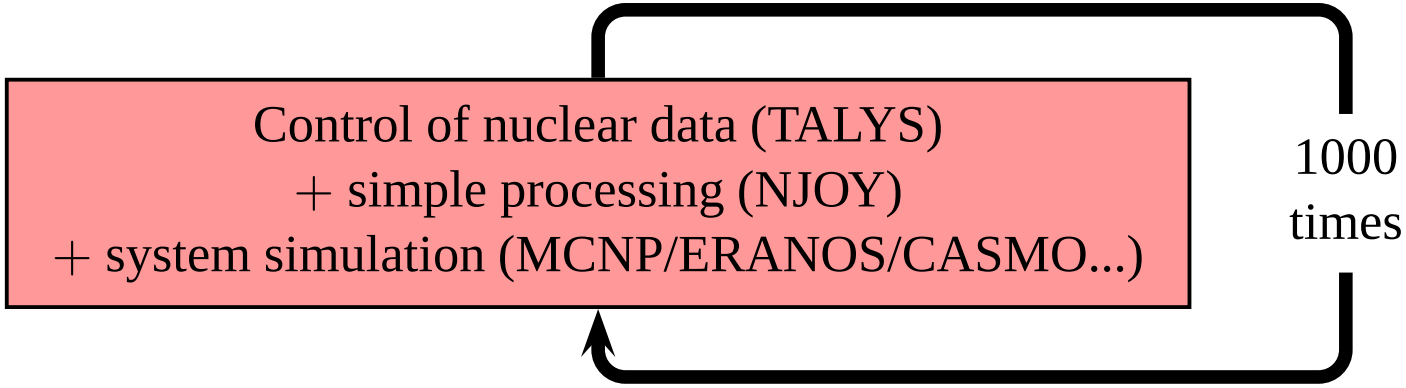
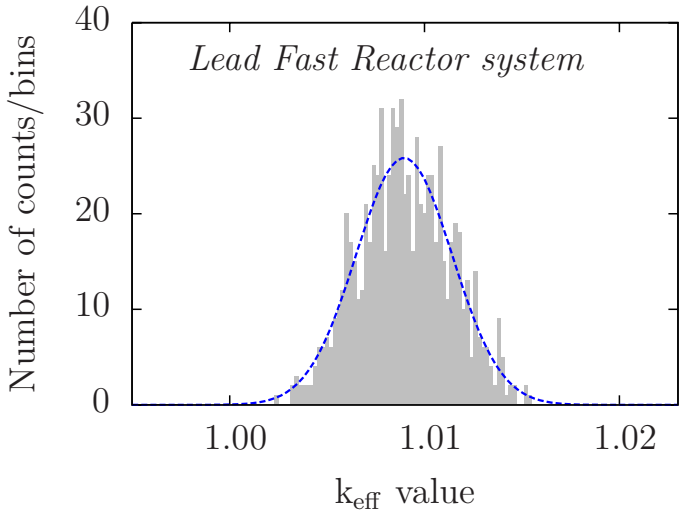


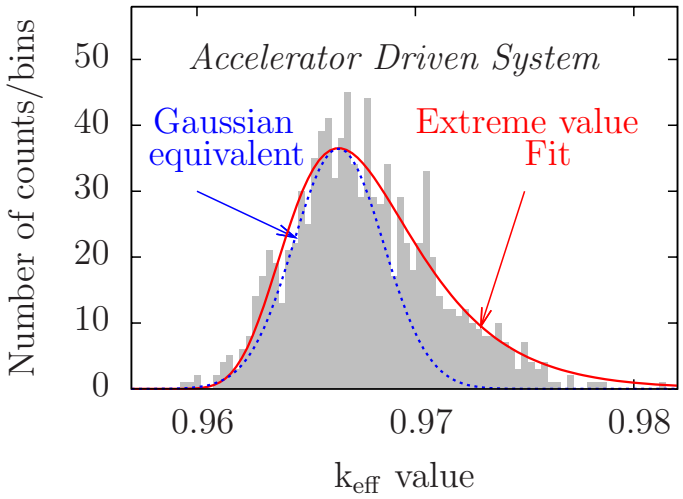


TMC: Total Monte Carlo

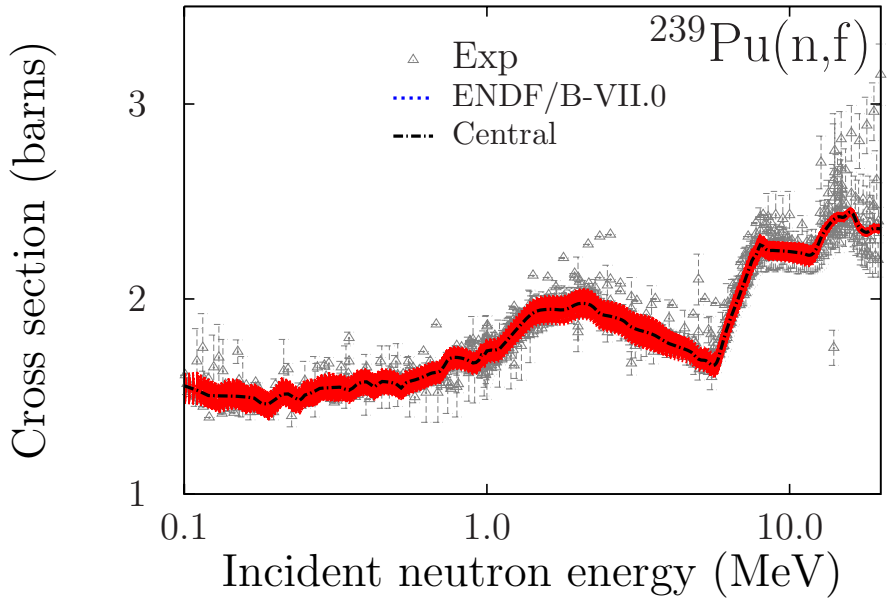


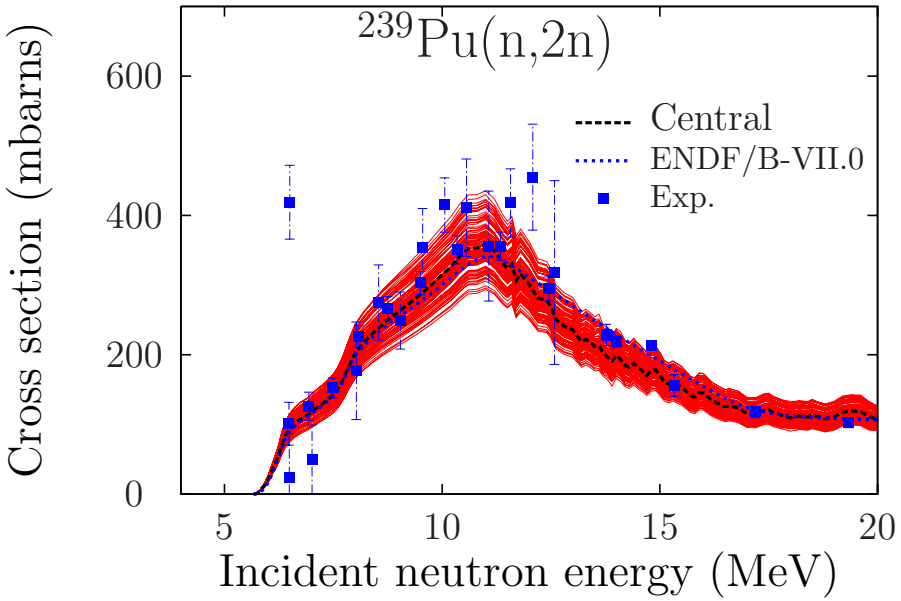
For each random ENDF file, the benchmark calculation is performed with MCNP. At the end of the *n* calculations, *n* different k_{eff} values are obtained. In the obtained probability distribution of k_{eff}, the standard deviation σ_{total} reflects two different effects: $\sigma^2_{total} = \sigma^2_{statistics} + \sigma^2_{nuclear\ data}$.

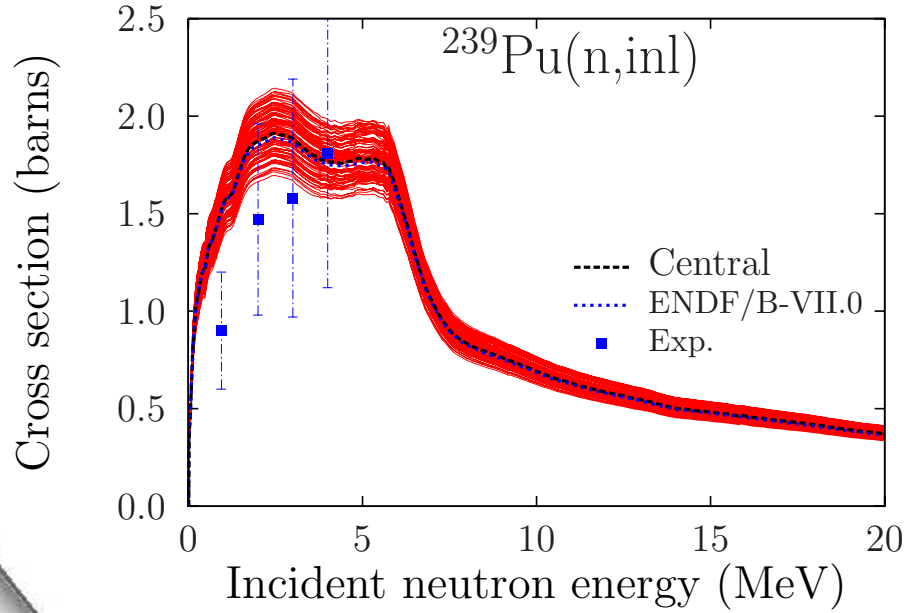


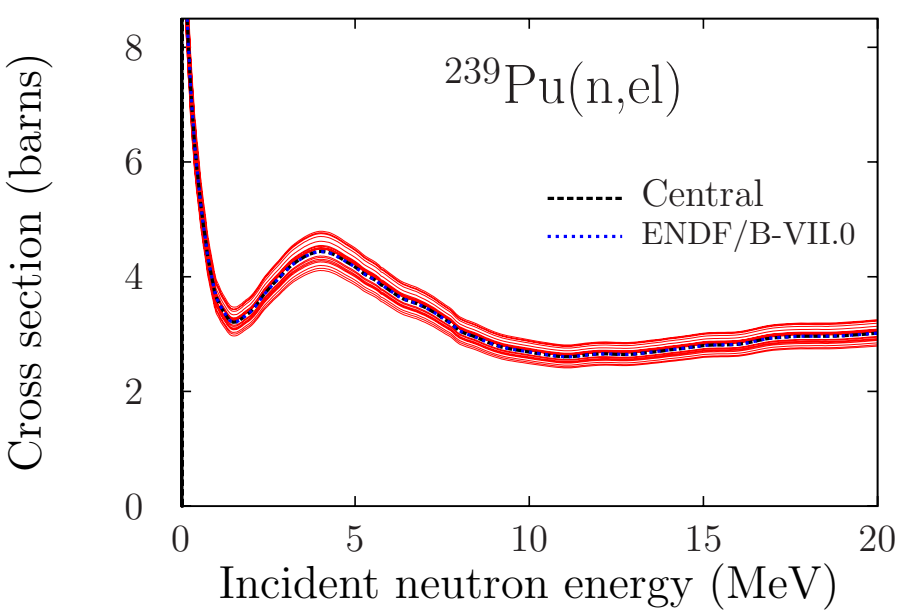


Example of random nuclear data for ^{239}Pu









Inverse TMC (Petten method) on ^{235,238}U and ^{239}Pu

Total Monte Carlo + selection
$\Longrightarrow \frac{1}{TMC}$

① Use TALYS to create ^{235,238}U, ^{239}Pu evaluations close or equal to ENDF/B-VII.1 or JEFF-3.1.2
② Randomize all model parameters (resonances, nubar, fission neutron spectrum, TALYS parameters) to create 1000 random ^{235,238}U, ^{239}Pu evaluations
③ Benchmarks the $n \geq 1000$ files with the same set of criticality benchmarks
④ Select the best random files

$$\alpha = \sum_{i=0}^{n} \frac{(C_i - E_i)^2}{C_i}, \tag{1}$$

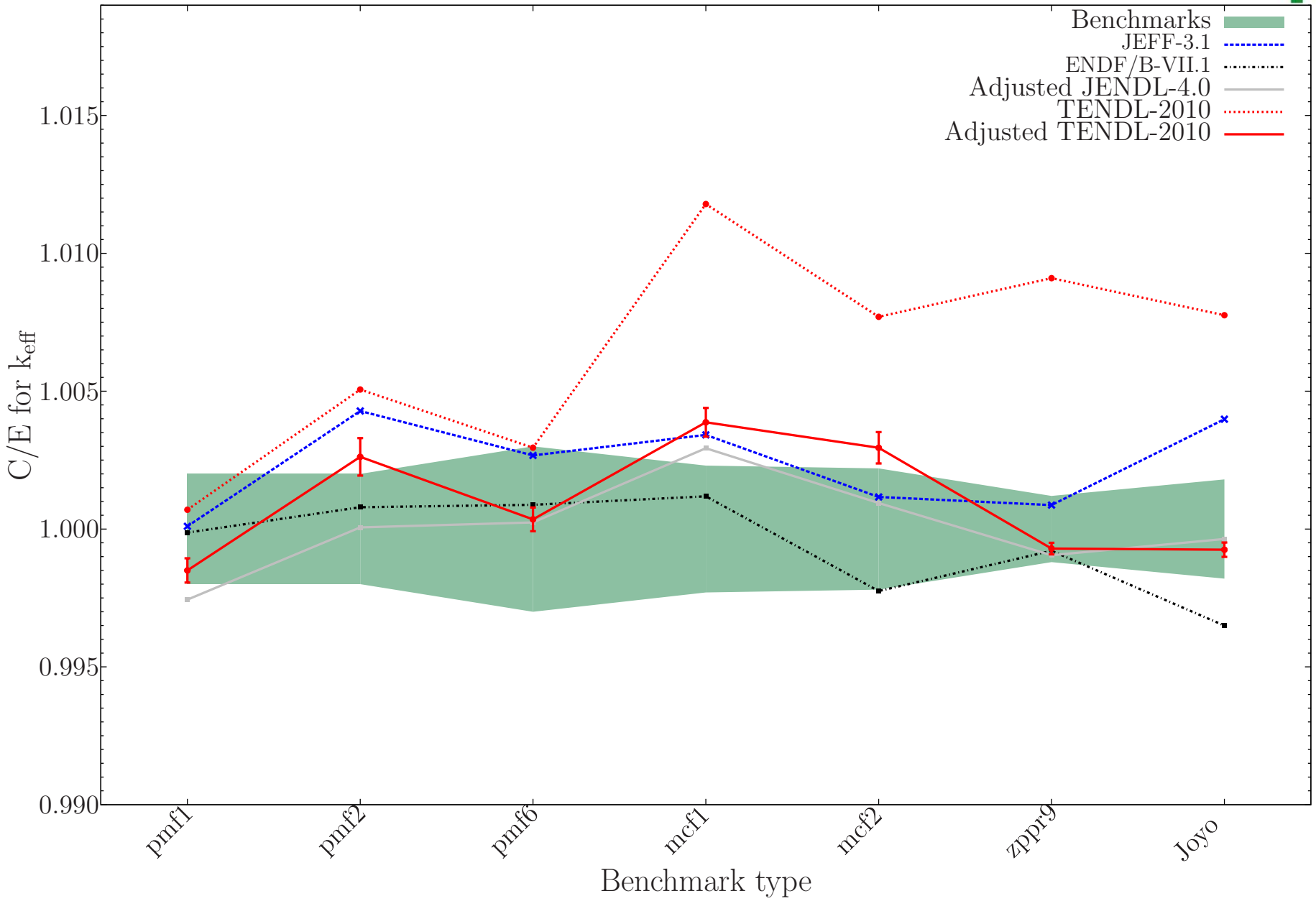
Results independent of the type of factor α, χ^2... or

$$F = 1 - 10^{\sqrt{\frac{1}{N}\Sigma(\log(E_i) - \log(C_i))^2}} \tag{2}$$

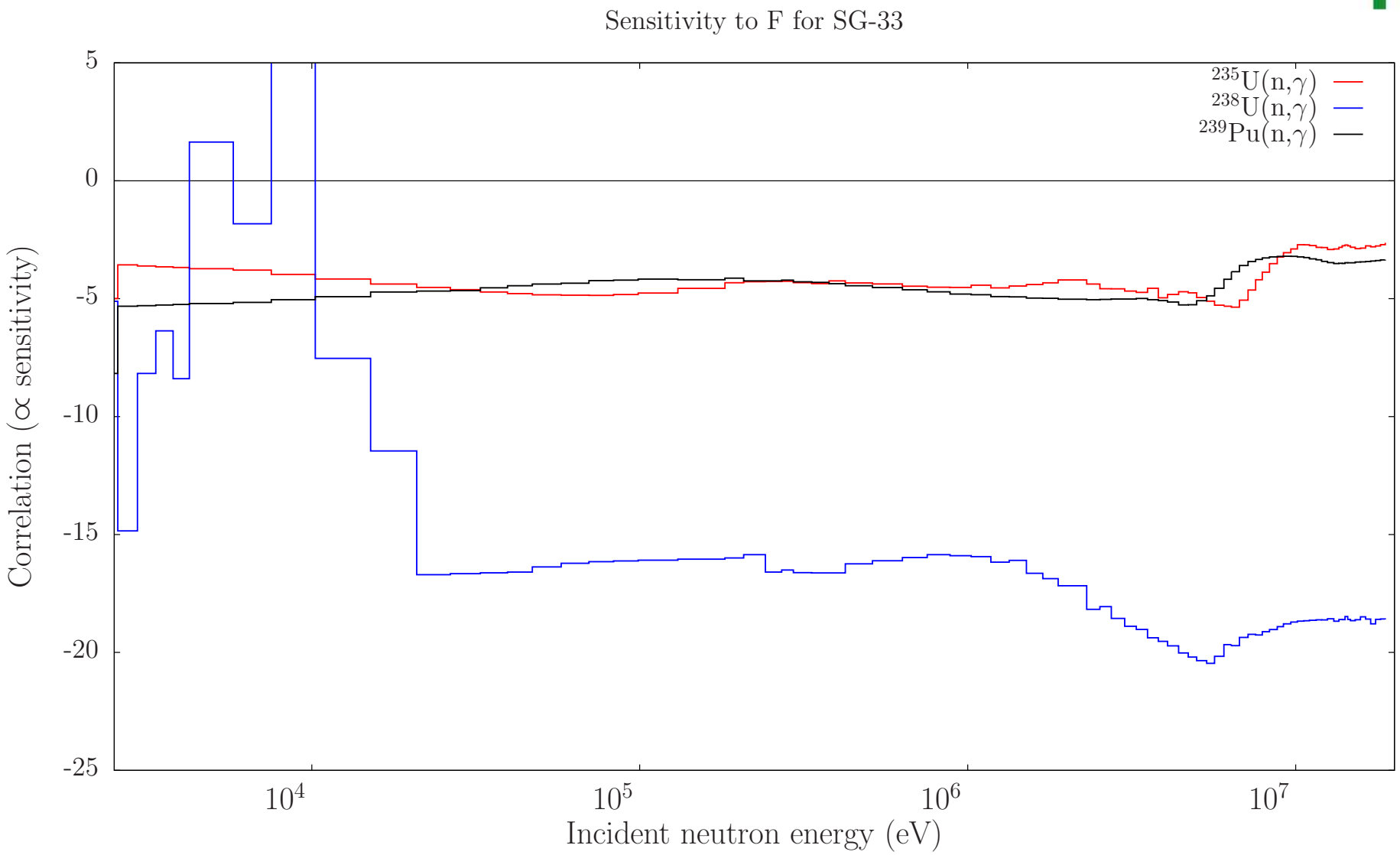
Inverse TMC (Petten method) on ^{235,238}U and ^{239}Pu

① Data for ^{235,238}U, ^{239}Pu taken from TENDL-2011,
② No other nuclides taken into account,
③ Only 7 benchmarks considered with k_{eff},
④ No covariance files involved, therefore no covariance updates,
⑤ no sensitivities needed,
⑥ Complete ENDF-6 files randomly varied (MF1-12),
⑦ Sensitivities can be obtained from the Monte Carlo calculations.

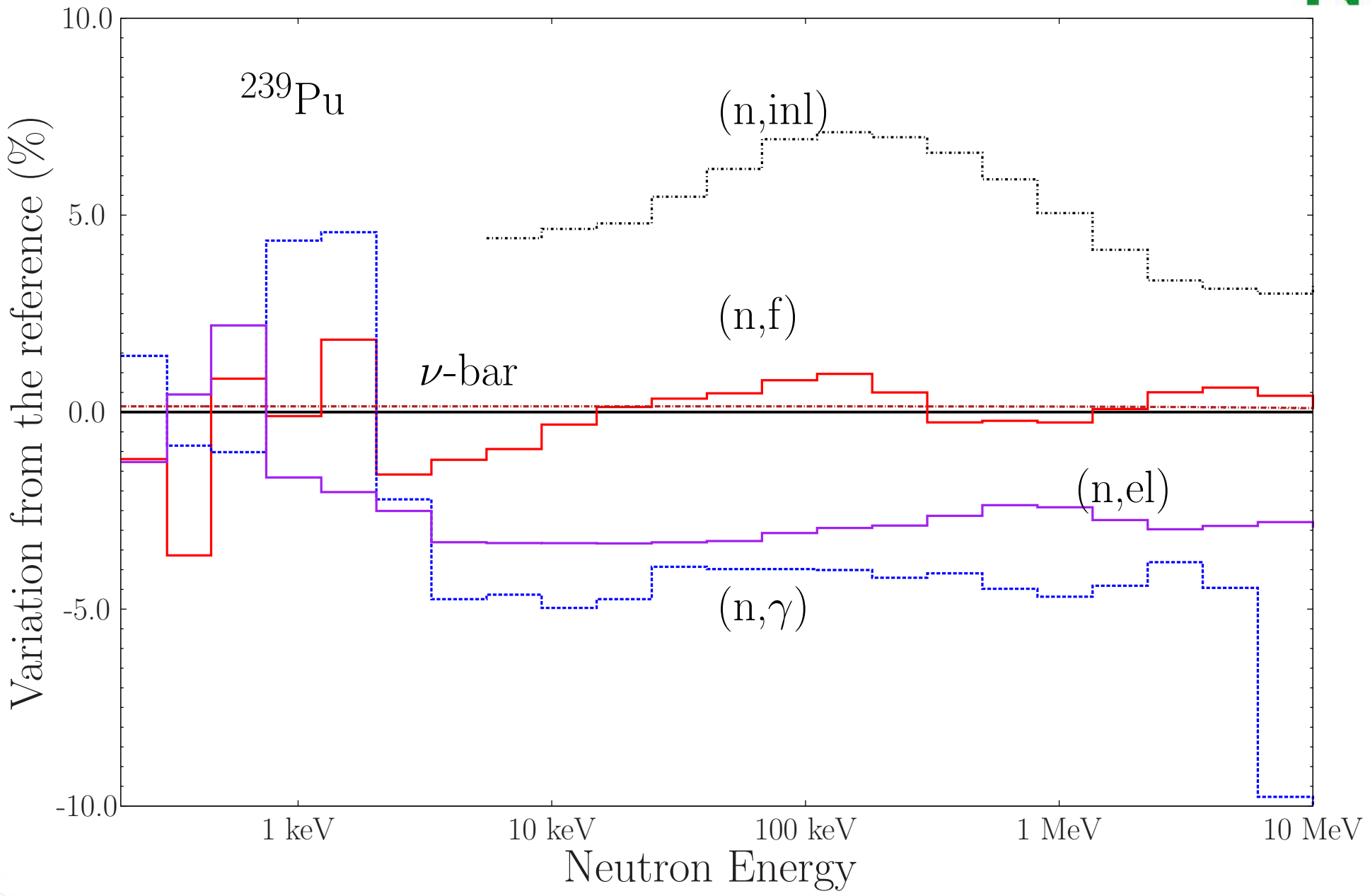
Results for k_{eff} for the SG-33 benchmarks



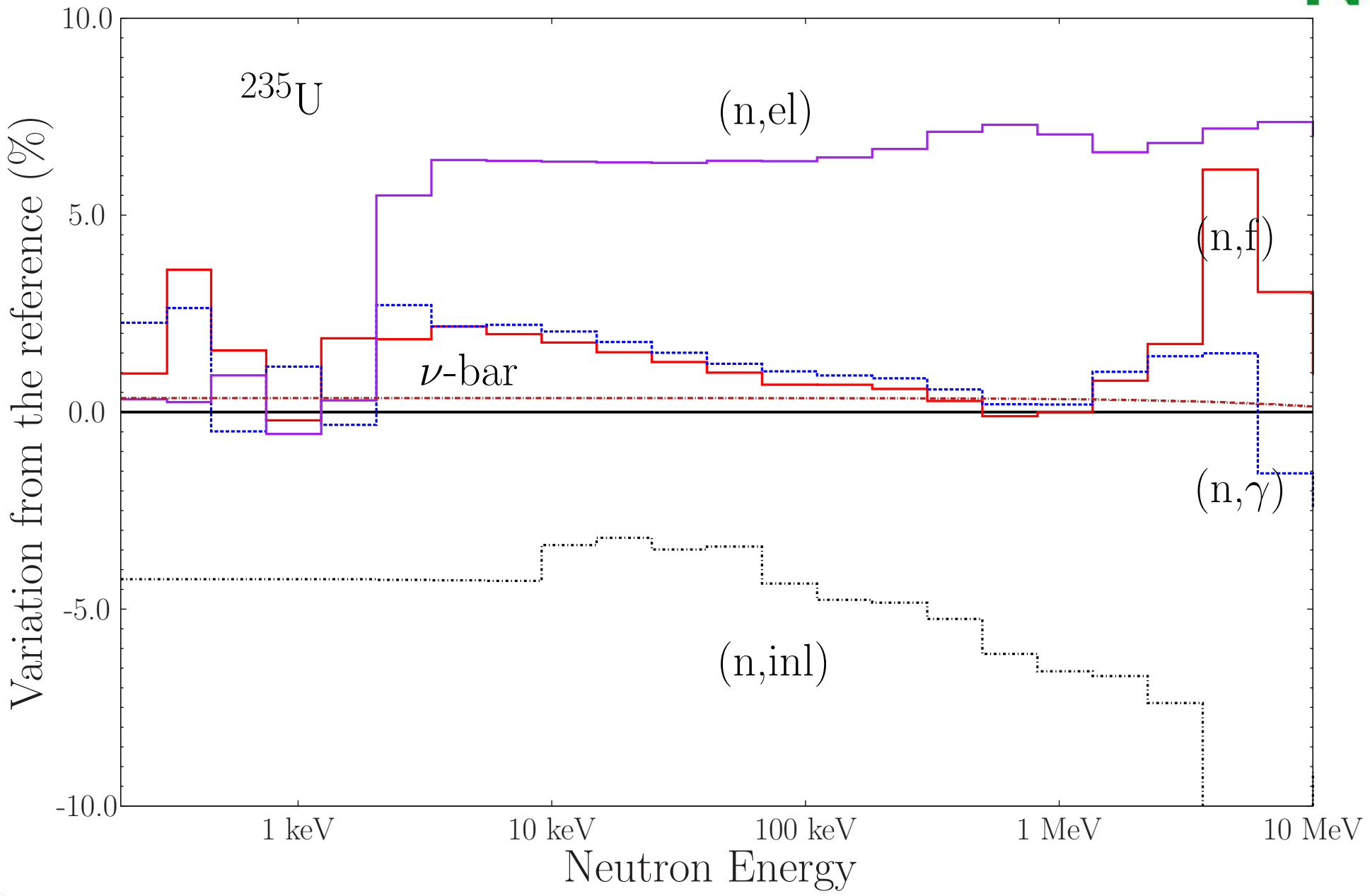
Example of Monte Carlo sensitivity



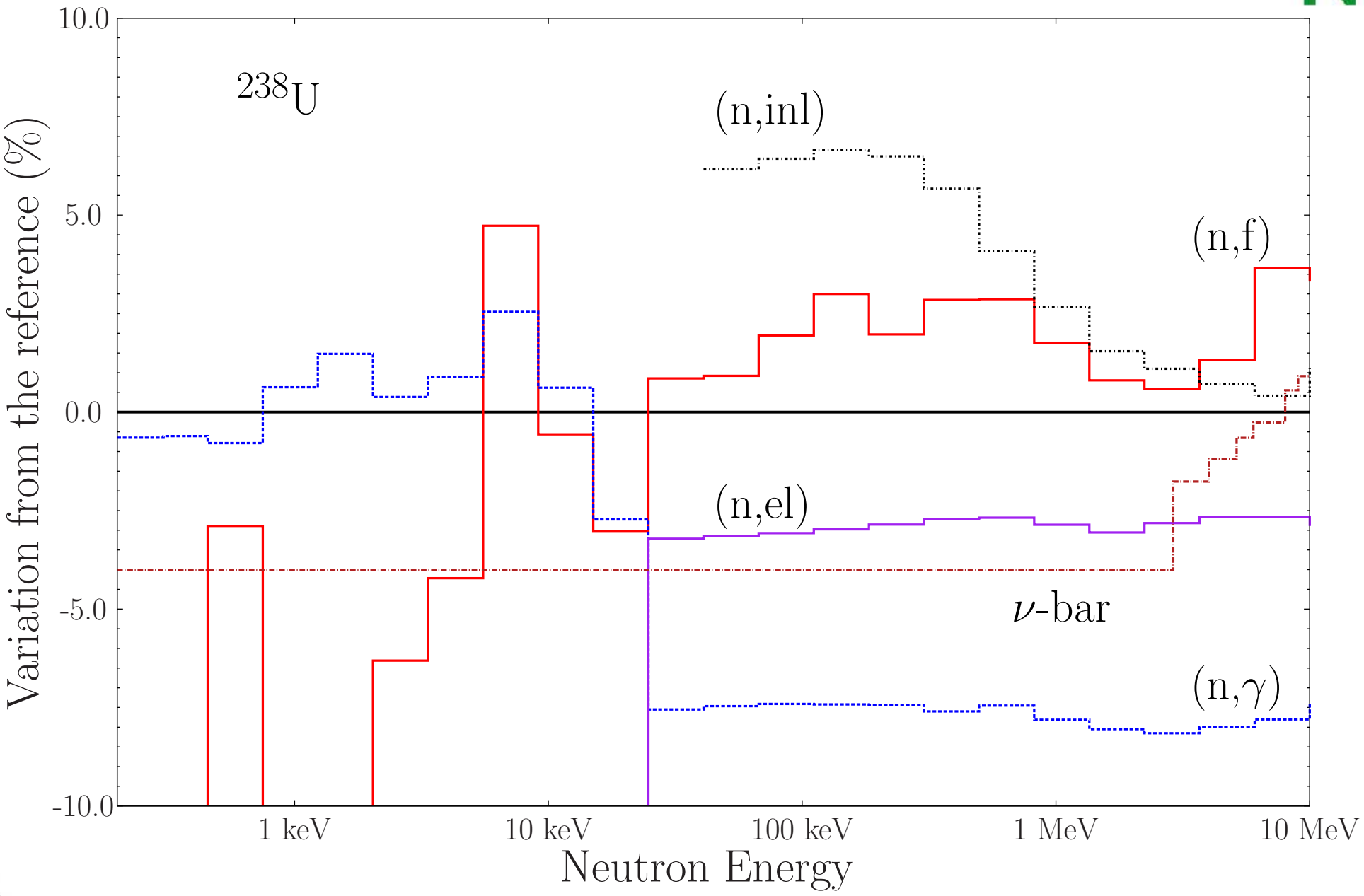
Variations for ^{239}Pu important cross sections



Variations for ^{235}U important cross sections



Variations for ^{238}U important cross sections



Conclusion

- Adjustment of ^{235,238}U and ^{239}Pu nuclear data with a Monte Carlo method,
- These three isotopes are enough to adjust k_{eff},
- In principle, no need of covariance files, therefore no adjustments on covariances,

1. method already tested on ^{63,65}Cu, ^{239}Pu, thermal scattering,
2. but how to combine many isotopes in an efficient way (as ^{235}U, ^{238}U and ^{239}Pu) ?

☺Long term goal:

Apply this method to a large number of isotope for the TENDL library

together with world domination (and world peace)