NJOY-ERRORJ

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Introduction

Covariance Processing in the Resonance Region

- Covariances of grouped cross sections generated from a covariance matrix of resonance parameter
  - Reich-Moore resonance parameter covariance (SAMMY)
  - Compact format
- ERRORJ and PUFF can handle them

New Development of ERRORJ

- Originally ERRORJ was started with the ERRORR module in NJOY
- ERRORJ was a stand-alone code. Users must use it with NJOY
- We remodeled ERRORJ such that one can used as a NJOY module
- Users can simply replace ERRORR in NJOY by ERRORJ
  - Covariance data in the entire energy range can be processed
- New version — more accurate and faster

Error Propagation from Resonance Parameters

Covariances of resonance parameters V_{ij} are given in the ENDF files, where i, j are the indices for the resonance parameters, p. The error propagation from the resonance parameter covariance to the grouped cross section covariance is given by:

$$\mathrm{Cov}(\sigma_a, \sigma_b) = \sum_{ij} \frac{\partial \sigma_a}{\partial p_i} \frac{\partial \sigma_b}{\partial p_j} V_{ij}$$

The sensitivity $\partial\sigma/\partial p$ can be calculated:

- With an analytical method — PUFF-IV
  - The SAMRML code was incorporated
- Numerical derivatives — ERRORJ
  - We stuck the same technique as before. However, the accuracy was checked against SAMRML.
  - The reasons are: more freedom for future development, and we do not expect any speed-up.

Revised Algorithm

Calculation Acceleration

The most time-consuming part is not a sensitivity calculation it self, but an energy integration over the energy grid.

Old algorithm

$$\frac{\partial \sigma_g}{\partial p_i} = \frac{\sigma'_g - \sigma_g}{\delta p_i}, \qquad \sigma_g = \frac{1}{\delta E}\int_{E\in g} \sigma(E) dE$$

New algorithm

$$\frac{\partial \sigma_g}{\partial p_i} = \frac{1}{\delta E}\int_{E\in g} \frac{\sigma'_g(E) - \sigma_g(E)}{\delta p_i} dE$$

where the perturbed g-th group cross section σ'_g is calculated with the perturbed resonance parameter, $p'_i = p_i + \delta p_i$.

The revised algorithm is much faster than the old one, since $\sigma'_g(E) \simeq \sigma_g(E)$ when the i-th resonance is outside the group energy bin.

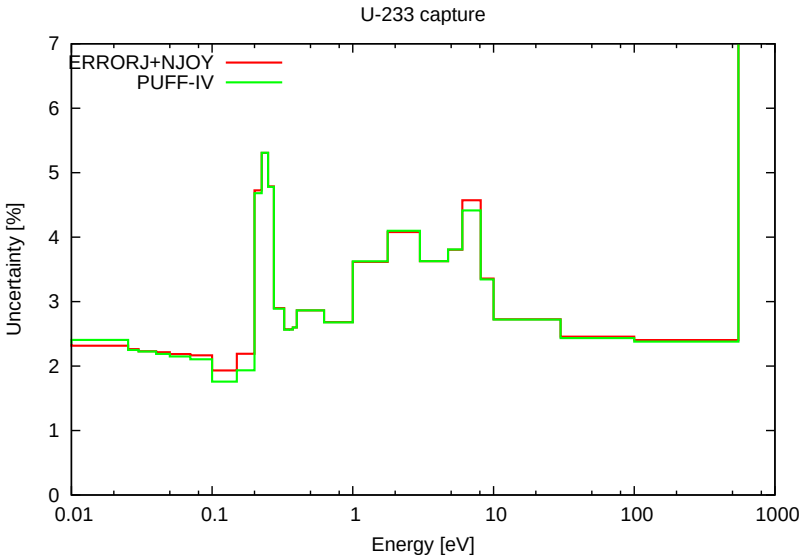
Results

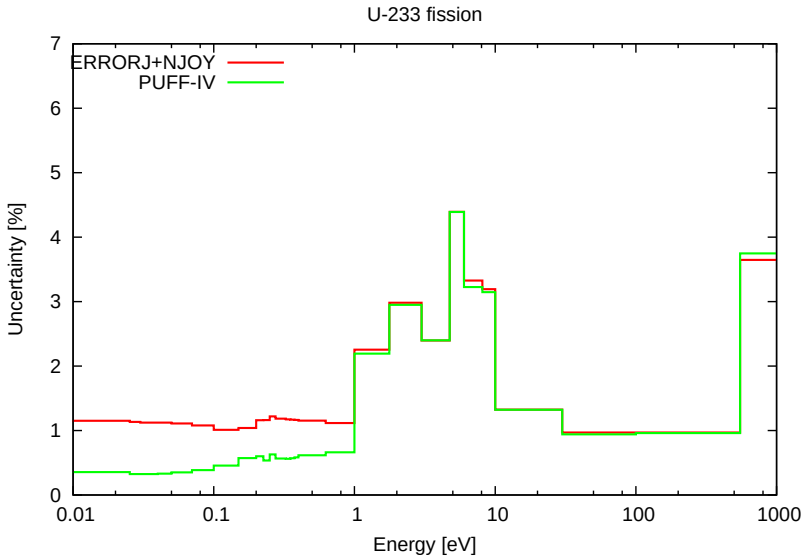
How fast ?

Processed nuclide	Original ERRORJ	Revised ERRORJ
U-235 (JENDL-3.2)	2 hours	40 min
Pu-239 (JENDL-3.3)	3 hours	50 min
U-238 (JENDL-3.3)	12 min	a cup of espresso
U-233 (ENDF/B-VII)	Forever	5 hours

(Linux on Core Duo Laptop)

Comparisons with PUFF-VI





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Conclusion

- The ERRORJ code, which is a covariance processing code, has been renewed
  - much faster than the previous version
  - parameters tuned
- The ERRORJ can be used as the ERRORR module in NJOY
  - just replace ERRORR by the new ERRORJ code
  - compatible with NJOY ver.99.120 and later
- The code is available on your request — Go Chiba (JAEA)
- and will be available through RSICC and NEA Databank soon