

Report on Status of SG39

WPEC/SG39

May 15, 2014

G. Palmiotti, M. Salvatores

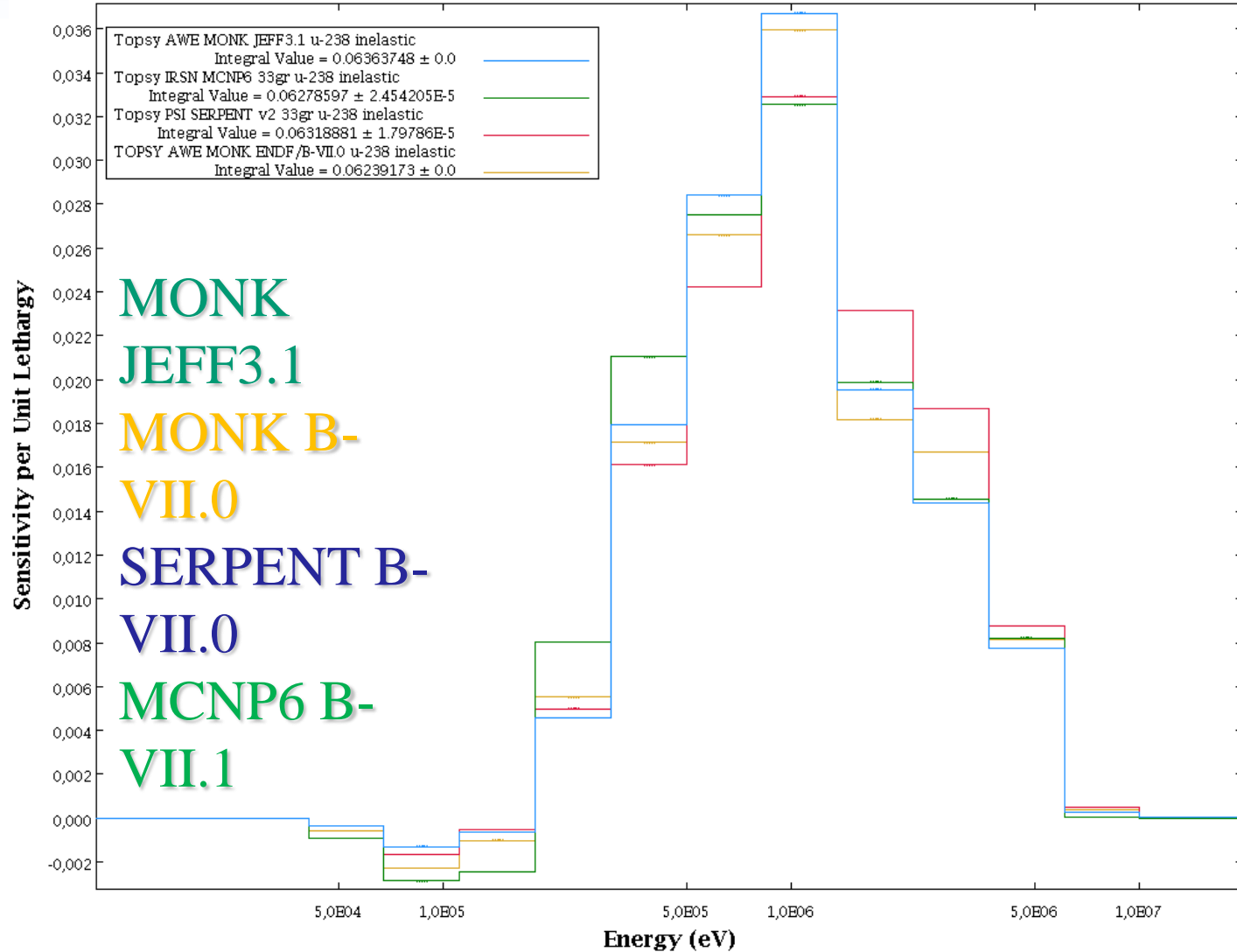
www.inl.gov



- Title: “Methods and approaches to provide feedback from nuclear and covariance data adjustment for improvement of nuclear data files”
- Goals, Mandate, Working Method:
 - Mandate for this WPEC subgroup is to provide criteria and practical approaches to use effectively the results of sensitivity analyses and cross section adjustments for feedback to evaluators and differential measurement experimentalists in order to improve the knowledge of neutron cross sections, uncertainties, and correlations to be used in a wide range of applications.
 - Review issues and summarize findings on methodologies used to provide feedback to evaluated data files (e.g. reactor physics experiment accuracies, adjustment methodologies etc.).
 - Select and define test cases for application.
 - Based on obtained results, recommend a general methodology and practices for providing feedback to evaluators both on nuclear data and on associated covariance data, based on specific examples.
 - Actual feedback will be provided to evaluation projects (e.g. CIELO initiative) on the specific examples indicated in the previous point.

- **First meeting held in November 2013**
- **Second meeting held May 13, 2014**
- **Investigation on method issues to assess reliability of adjustments, and sensitivity computation tools**
- **Exploring alternative way of adjustments (directly on nuclear parameters instead of multigroup cross sections)**
- **Selected 5 isotopes to focus in a first phase: 4 of interest of CIELO (^{56}Fe , ^{235}U , ^{238}U , ^{239}Pu), and ^{23}Na**
- **Selected three major “global” adjustments (ENDF/B-VII.0, JENDL-4, and JEFF3.1) for providing initial feedbacks**
- **Identification and adoption of experiments for providing specific information on the target isotopes**
- **Joint meeting with CIELO held on May 14, 2014**
- **Preliminary feedback coming from major adjustments (JENDL-4, ENDF/B-VII.0) together with trends on ^{239}Pu covariance data (from CEA) provided to CIELO**

Topsy: U-238 Inelastic Profile



- **Assessment of adjustments.**
- **Definition of criteria to accept new central values of cross sections after adjustments.**
- **Avoid compensation among different input data in the adjustments.**
- **Validation of the “a priori” and use of the “a posteriori” covariance matrix.**
- **Issues related to the presence of negative eigenvalues in the “a priori” covariance matrix.**

Adjustment Potential

Potential is calculated as well as *motive force* by using

$$(\Delta T/T)'_{i,j} = M_j G_{i,j}^T [G_{i,j} M_j G_{i,j}^T + V_i]^{-1} [J - \overline{R_{c,I}} / \overline{R_{e,I}}]$$

in place of

$$(\Delta T/T)_{i,j} = M_j G_{i,j}^T [G_{i,j} M_j G_{i,j}^T + V_i]^{-1} [J - R_{c,i} / R_{e,i}]$$

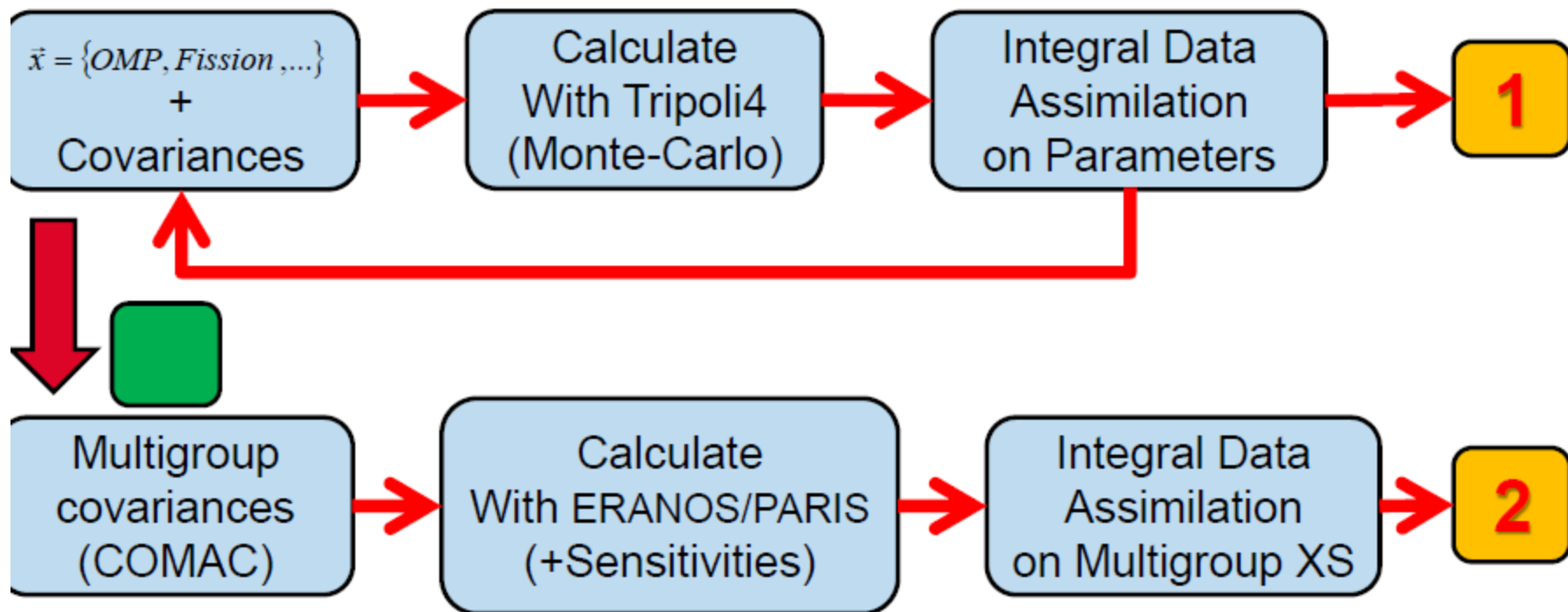
Average of $1 - C/E$
over a set of
core parameters
related to i

$1 - C/E$ of
the core parameter i

- *Motive force* becomes **null in two cases**:
 - Not sensitive to the integral experiment: $G \sim 0.0$
 - There is *no motive force*
 - Sensitive but not necessary to adjust the cross sections: $G \gg 0.0$ and $C/E \sim 1.0$
 - There is *force that keeps the present values*, or *frictional force*
- Therefore, *Potential* is needed to distinguish the two cases.
- The amplitude of *Potential* is comparable with that of a different kind of integral experiments, such as criticality and Na void reactivity



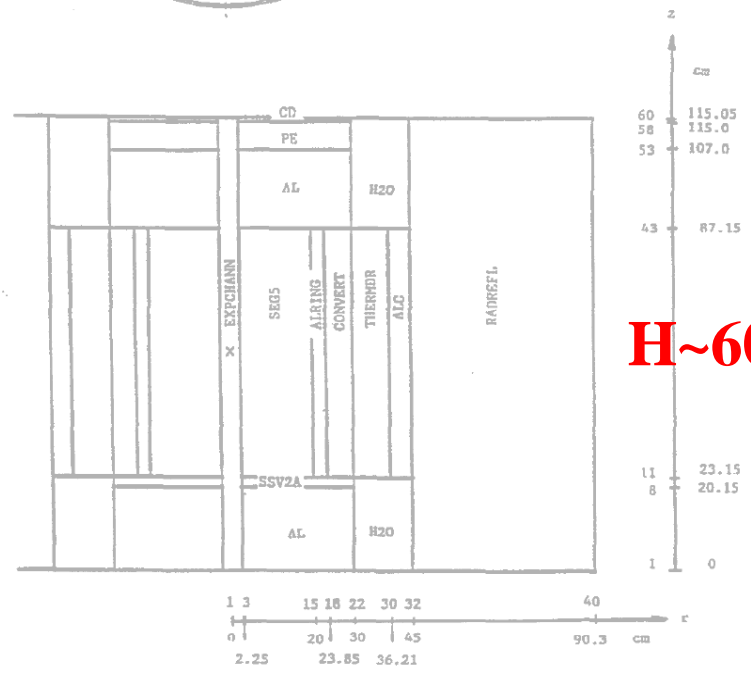
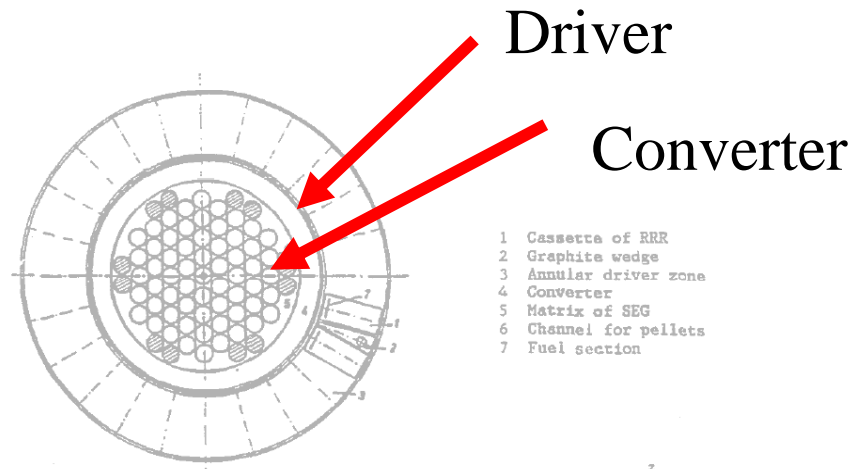
■ JEZEBEL → define a consistent benchmark



- A. Only Cross sections and related model parameters
- B. Investigate results
- C. Add other nuclear data (PFNS, nu, etc...)
- D. Propagate to a Fast Reactor

The ROSSENDORF experiments include sample reactivity measurements at the central position of the fast-thermal coupled system RRR/SEG, well described and documented now in /2/. The measurements are based on the pile-oscillator method developed to a high perfection.

SEG: Experiment with flat or steep adjoint for separation of inelastic from absorption

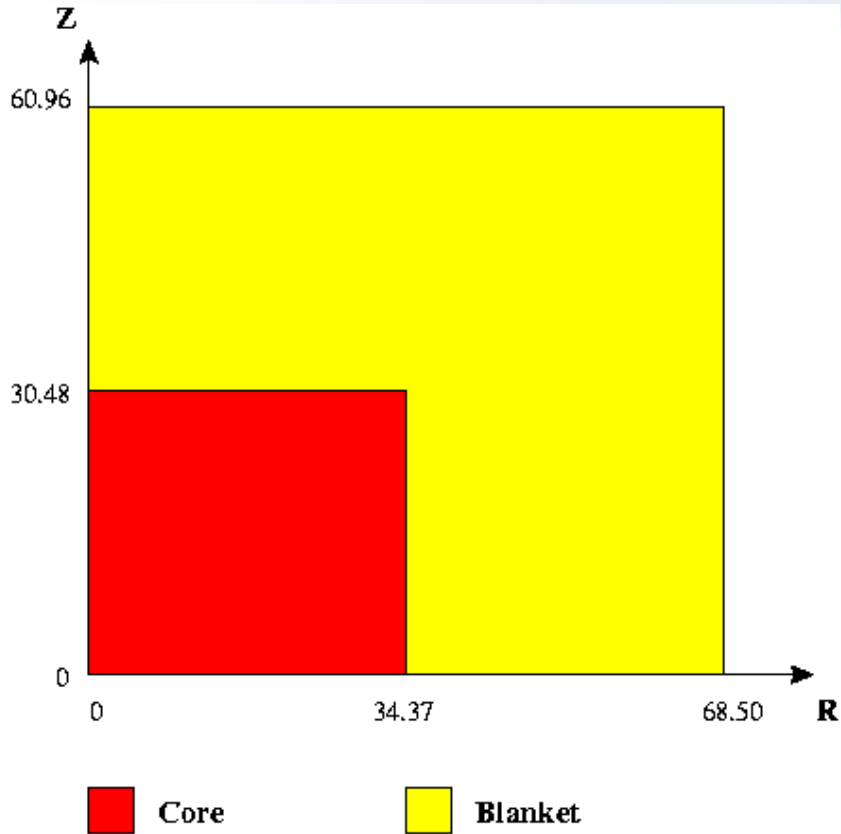


H~60 cm

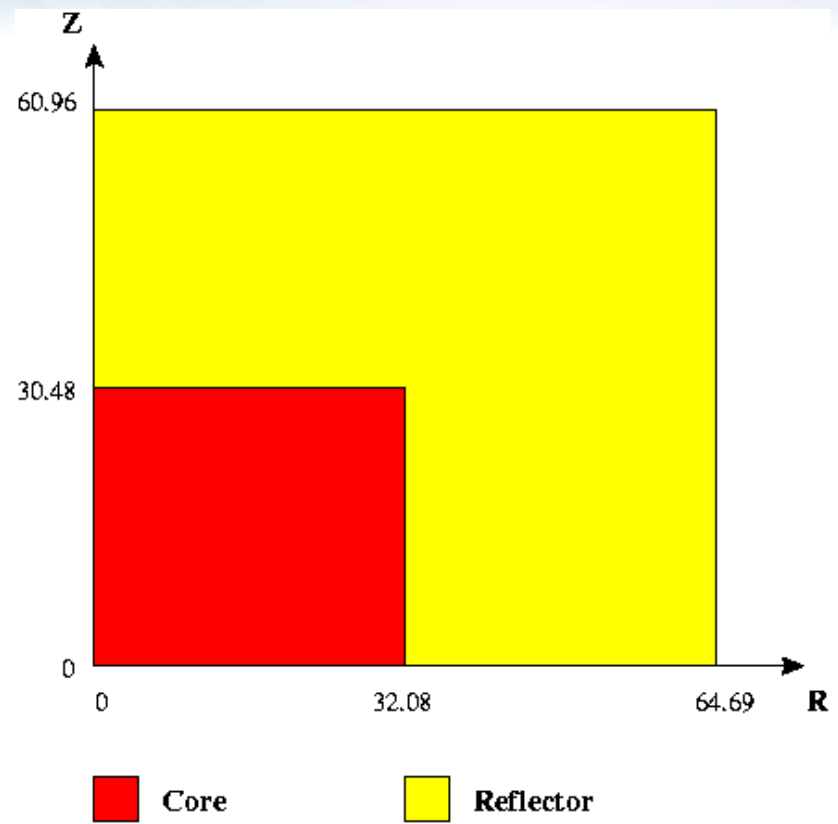
SINBAD Index – Reactor Shielding

- Winfrith Iron Benchmark (ASPIS)
- Winfrith Iron 88 Benchmark (ASPIS)
- Winfrith Water/Iron Benchmark (ASPIS-PCA REPLICA)
- Winfrith Neutron-Gamma Ray Transport through Water/Steel Arrays (ASPIS)
- NESDIP-2 Benchmark (ASPIS)
- NESDIP-3 Benchmark (ASPIS)
- JANUS Phase I (Neutron Transport Through Mild and Stainless Steel)
- JANUS Phase VIII (Neutron Transport Through Sodium Mild Steel)
- Ispra Iron Benchmark (EURACOS)
- Karlsruhe Iron Sphere
- Wuerenlingen Iron Benchmark (PROTEUS)
- Gamma Production X-Sections from Thermal Neutron Capture in 14 elements & SS
- Gamma Production X-Sections from Fast Neutron Capture in 14 elements & SS
- ORNL TSF Iron Broomstick
- ORNL TSF Stainless Steel Broomstick
- ORNL Neutron Transport Through Iron and SS - Part I
- University of Illinois Iron Sphere (CF-252)
- University of Tokyo-YAYOI Iron Slab
- Snezynsk Photon Leakage Spectra from Al, Ti, Fe, Cu, Zr, Pb, U238 Spheres
- NAÄADE 1 Iron Benchmark (60cm)

ZPR-3 Configurations

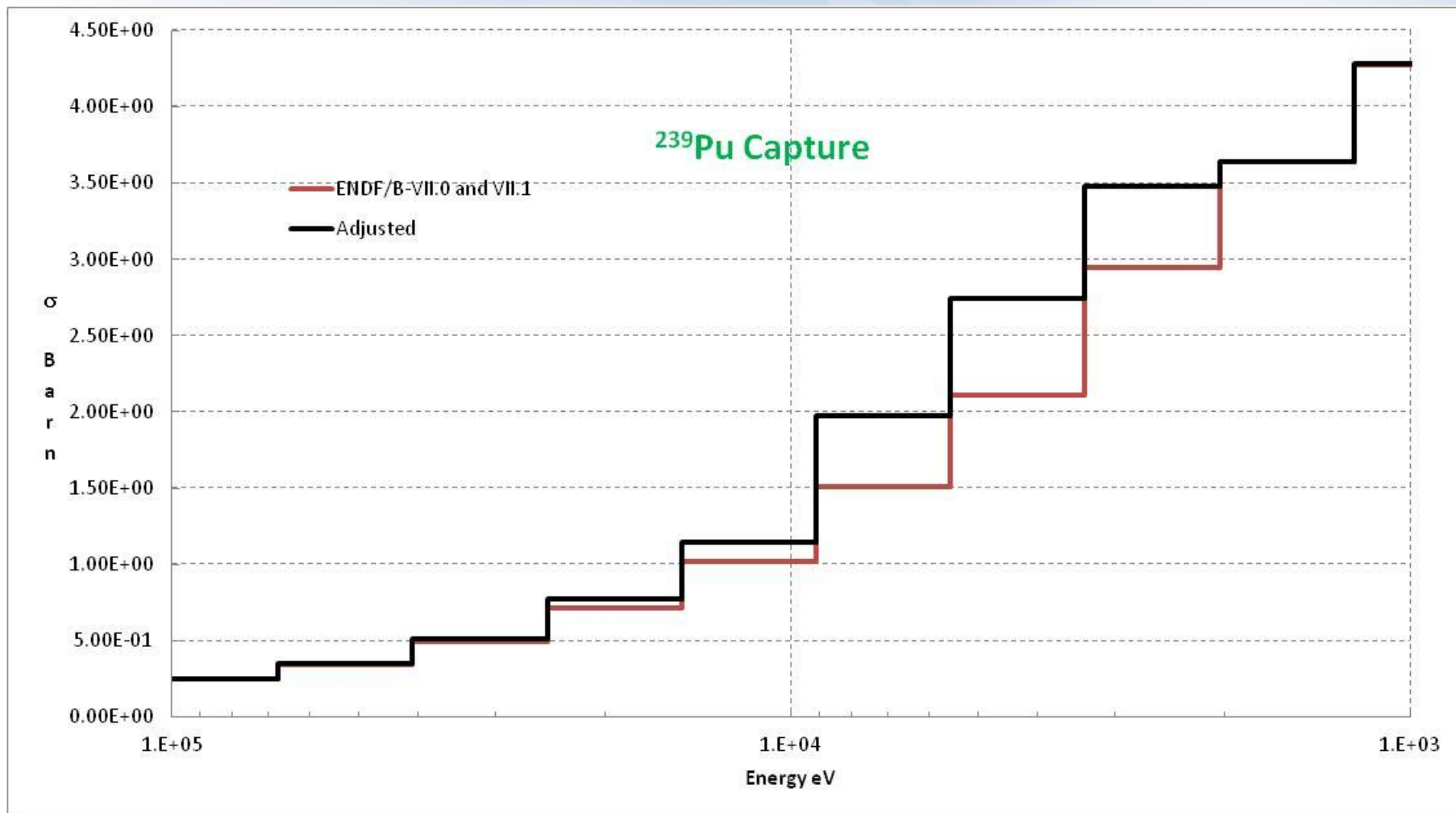


ZPR-3 Assembly 53

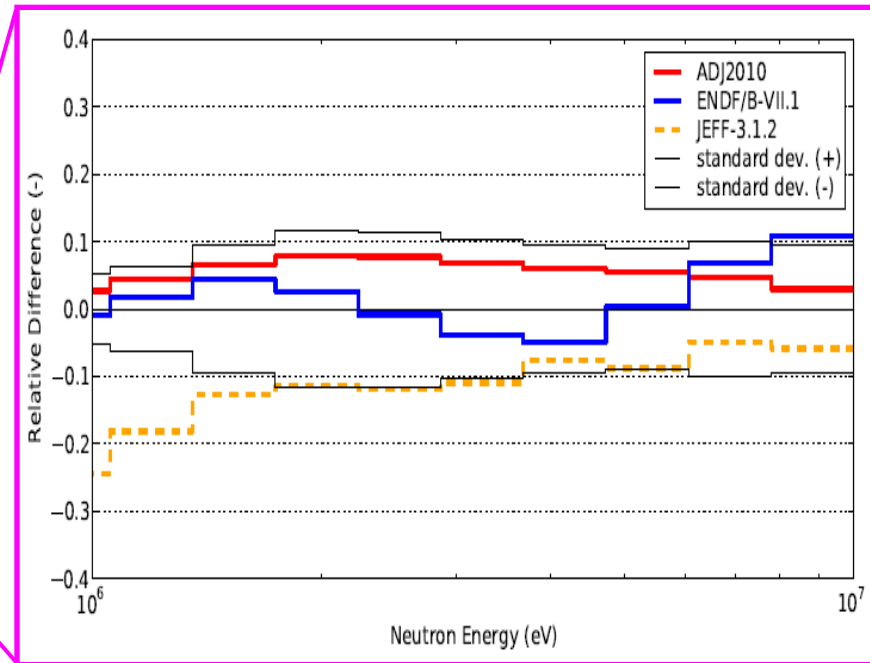
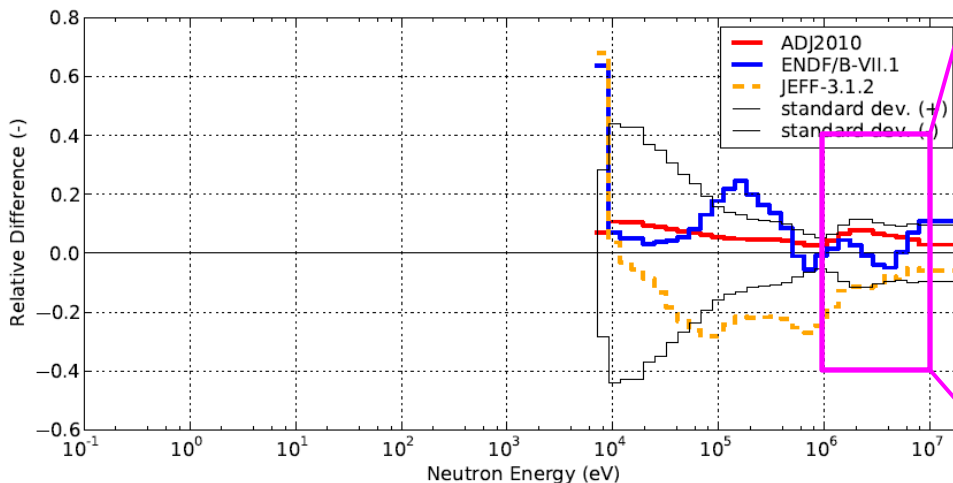
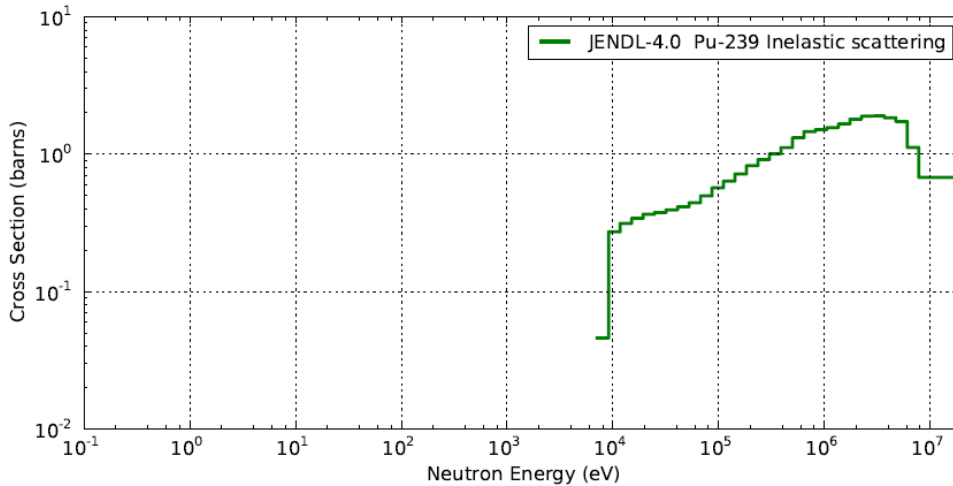


ZPR-3 Assembly 54

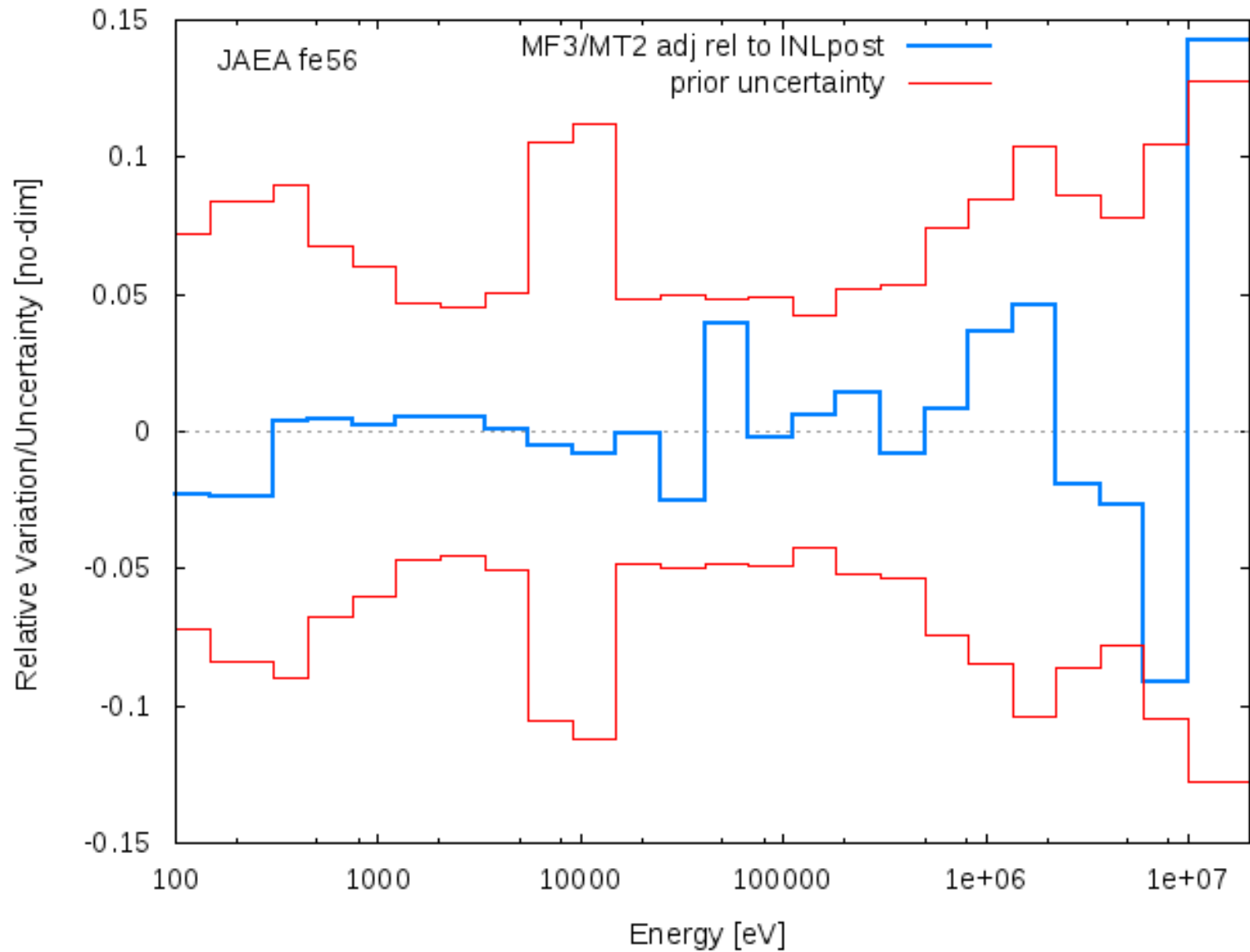
Feedback on ENDF/B-VII.0



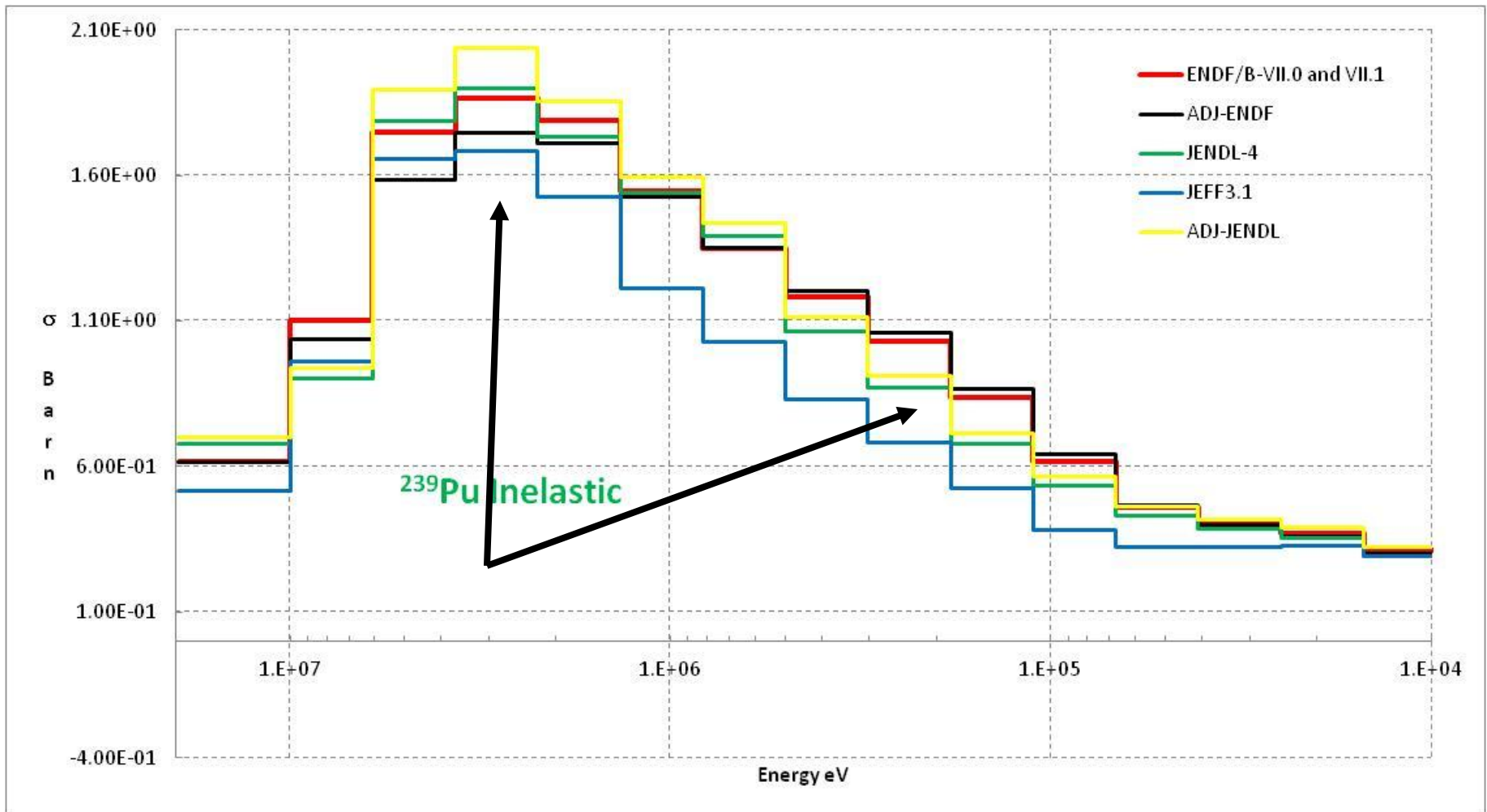
Inelastic scattering



- ADJ2010 **increases** Pu-239 inelastic scattering cross-section by **10% at the maximum**. This alteration is **within the variance** of JENDL-4.
- Increase of inelastic scattering **compensates** the effect of the Pu-239 fission spectrum hardening on **Na void reactivity**, but the **mechanism** of increase is **NOT known**.



www.oecd-nea.org/science/wpec/sg39/adjustment/results
INL and JAEA results and plots' comparison E. Dupont

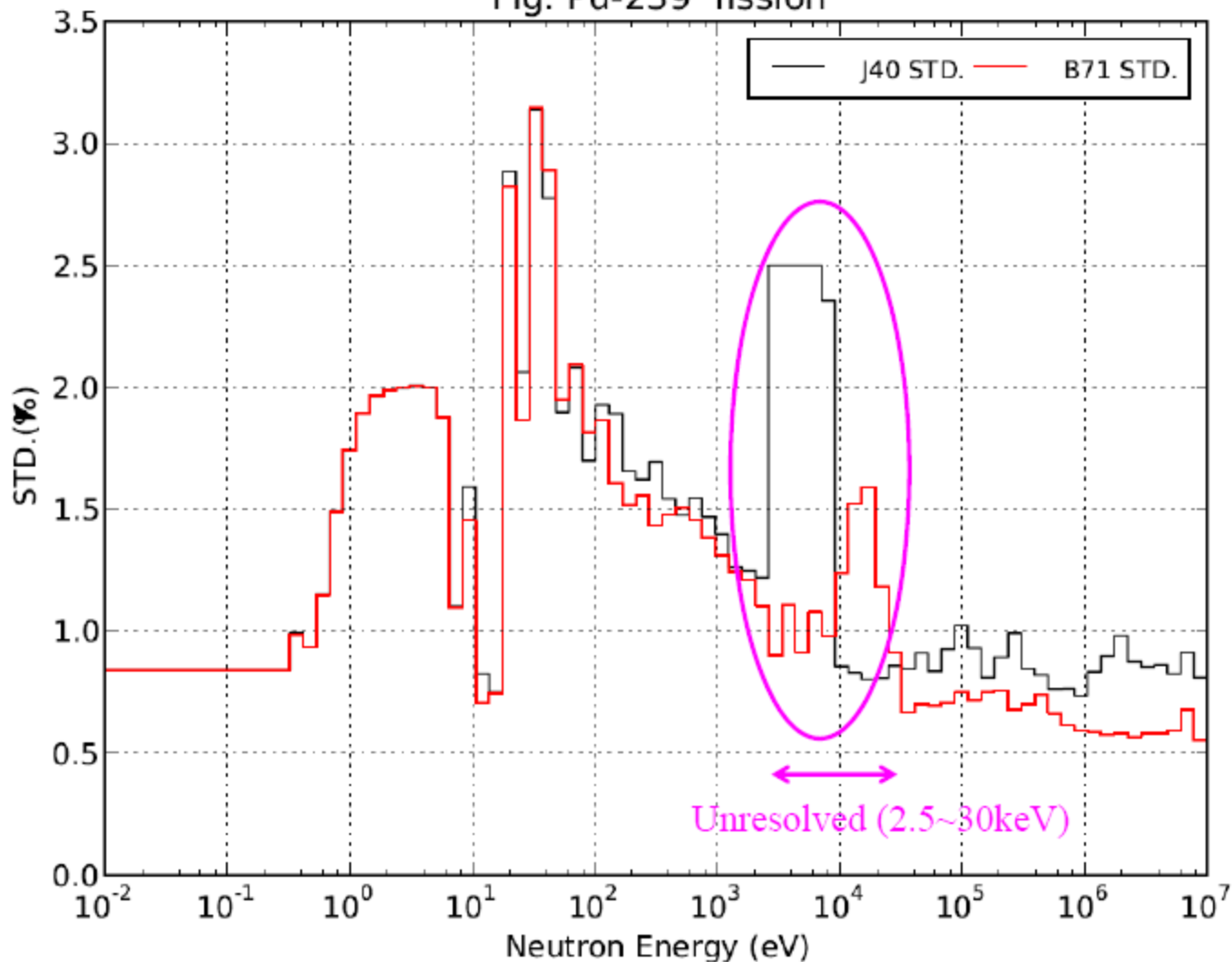


- JEFF Values often discrepant with respect to ENDF and JENDL
- After adjustment, significant discrepancies between ENDF and JENDL in the range
 - 2-3MeV (adjustments in opposite directions) and ~300-600 keV
- Probably need of specific integral experiments (flat or steep adjoint flux etc)

Comparison of Covariances

Pu-239 Fission (2/3)

Fig. Pu-239 fission



Summary

- **Several topics under way:**
 - **Establishing and coping with methodology issues.**
 - **Identifying new experiments useful to improve cross**
 - **Exploring alternative way of adjustment**
- **First feedback have been provided to CIELO from ENDF and JENDL adjustments (some trends on ^{239}Pu covariance data from CEA)**
- **However, at this stage major concerns come from existing compensations of different type (reactions, experiments, etc.)**
- **Next step is focusing on experiments of elemental type so that compensations can be avoided.**
- **Expecting feedback from CIELO in terms of more complete and reliable covariance data**