

Proposed updates to Pu evaluation for ENDF/B-VIII.0 β_2

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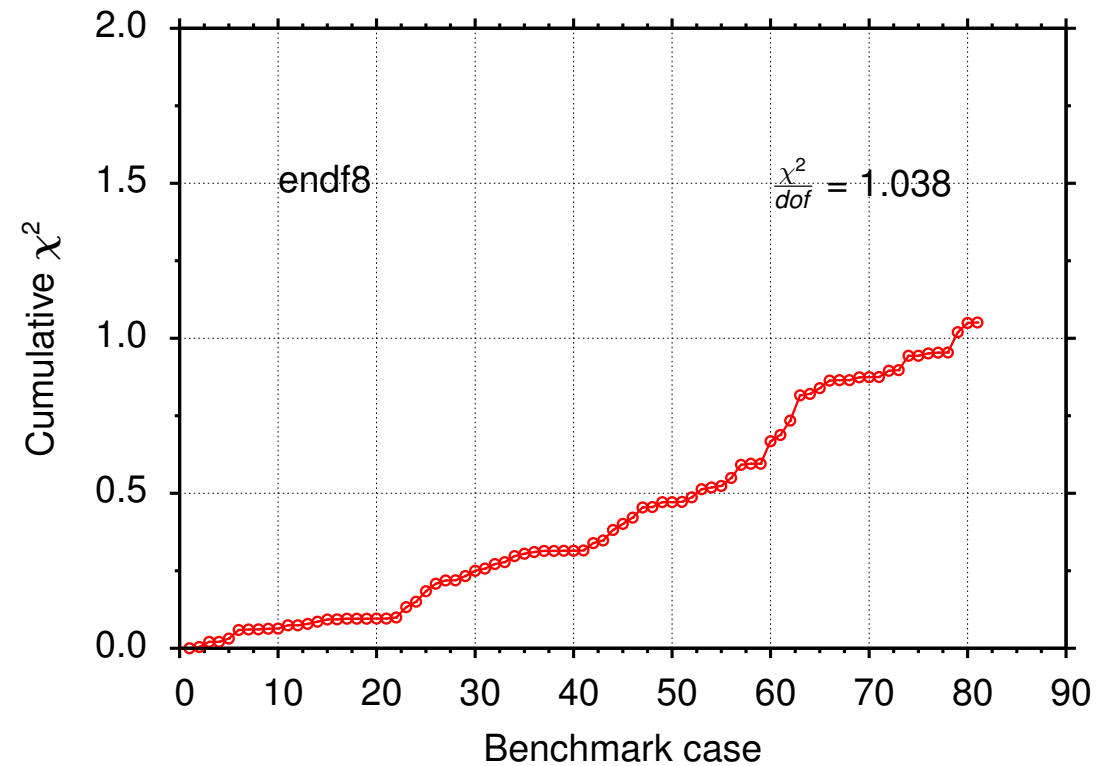
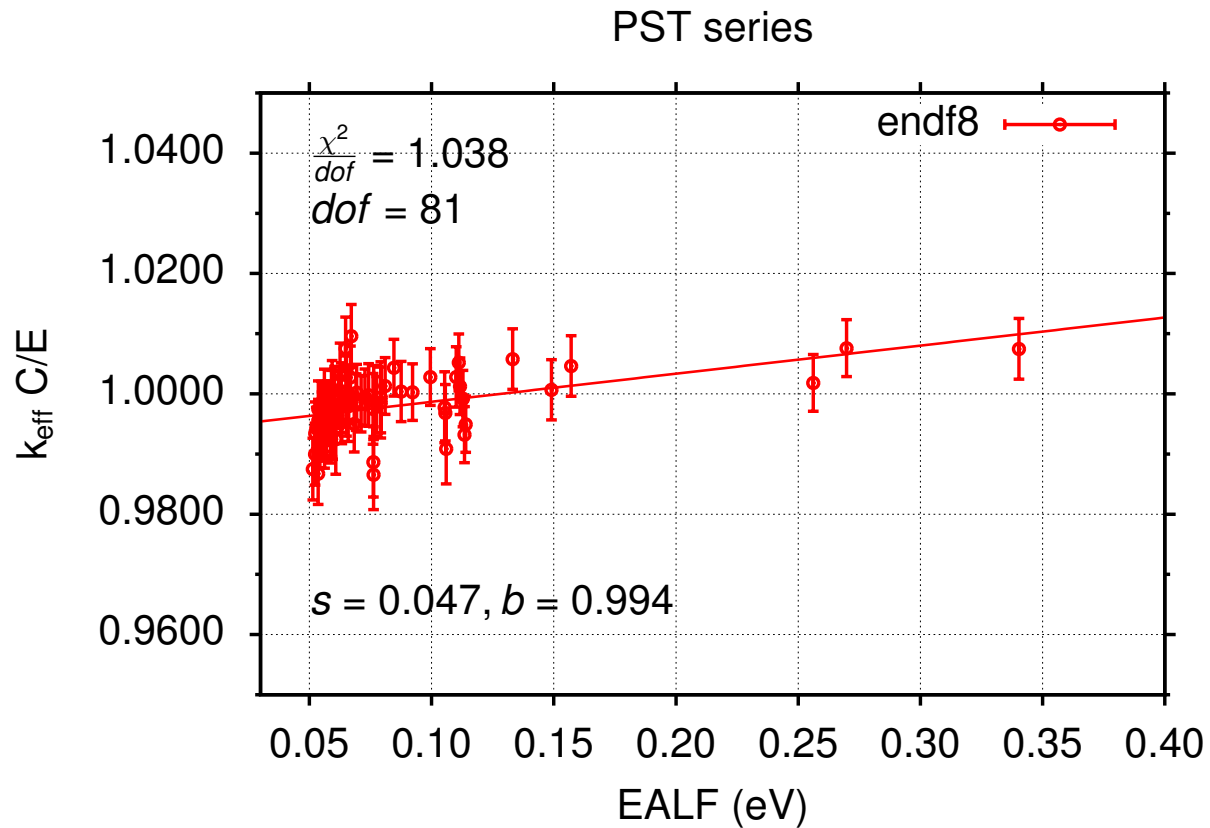
OVERVIEW: plutonium

- Current status of in ENDF/B-VIII.0 and ENDF/B-VIII.0 β_1 Pu evaluations¹
- Focus on the Pu thermal solutions (PST) and sanity check on fast metal assemblies (PMF)
 - Pu ENDF β_1 file in the low-energy region included updates in RRR (up to 2.5 keV), TNC and PFNS
 - Improvements over ENDF/B-VIII.0 in the C/E benchmarks (PST 81 cases)
 - Preliminary ν_p and cross section covariance generation for the resolved resonance energy range up to 2.25 keV
- Proposed updates for ENDF β_2
 - Extension of the RRR evaluation up to 5 keV
 - Inclusion of Mosby's data including proper resolution function (thanks to Marian J.)
 - Particular focus on η energy dependence from thermal up to 10 eV
 - * Impact of the capture-to-fission ratio at 0.29 eV
 - Updated ν_p and cross section covariance generation for the resolved resonance energy range up to 5 keV
 - Additional validation to test performance at about 2 eV and in the keV region

¹Pu ENDF files tested within ENDF/B-VIII.0.

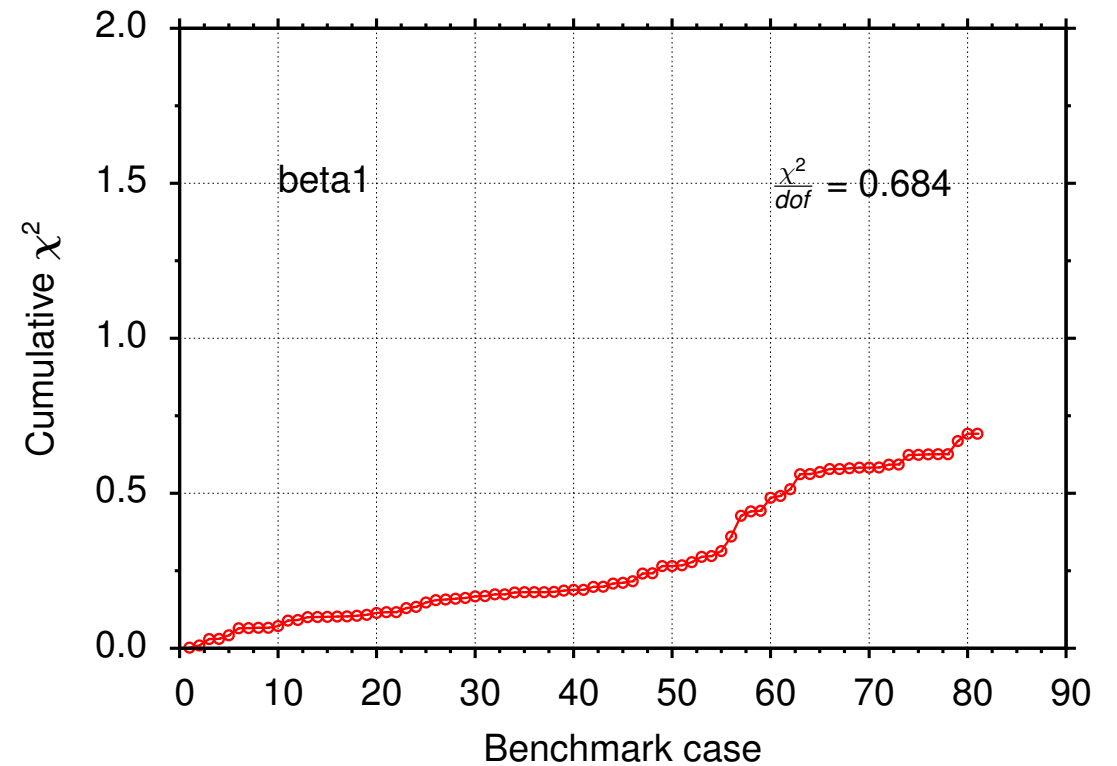
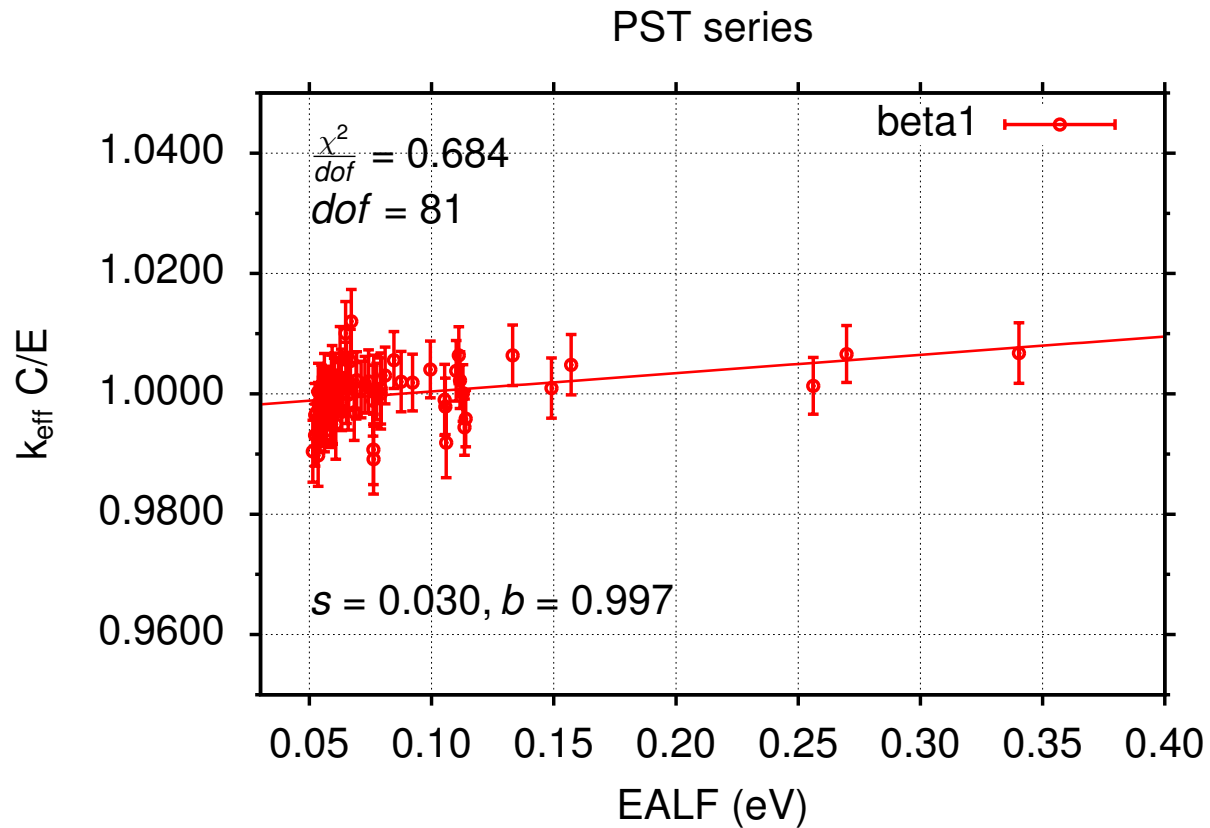
ENDF/B-VIII.0 benchmark performance (PST)

- Smooth cumulative χ^2 behavior with slightly positive slope



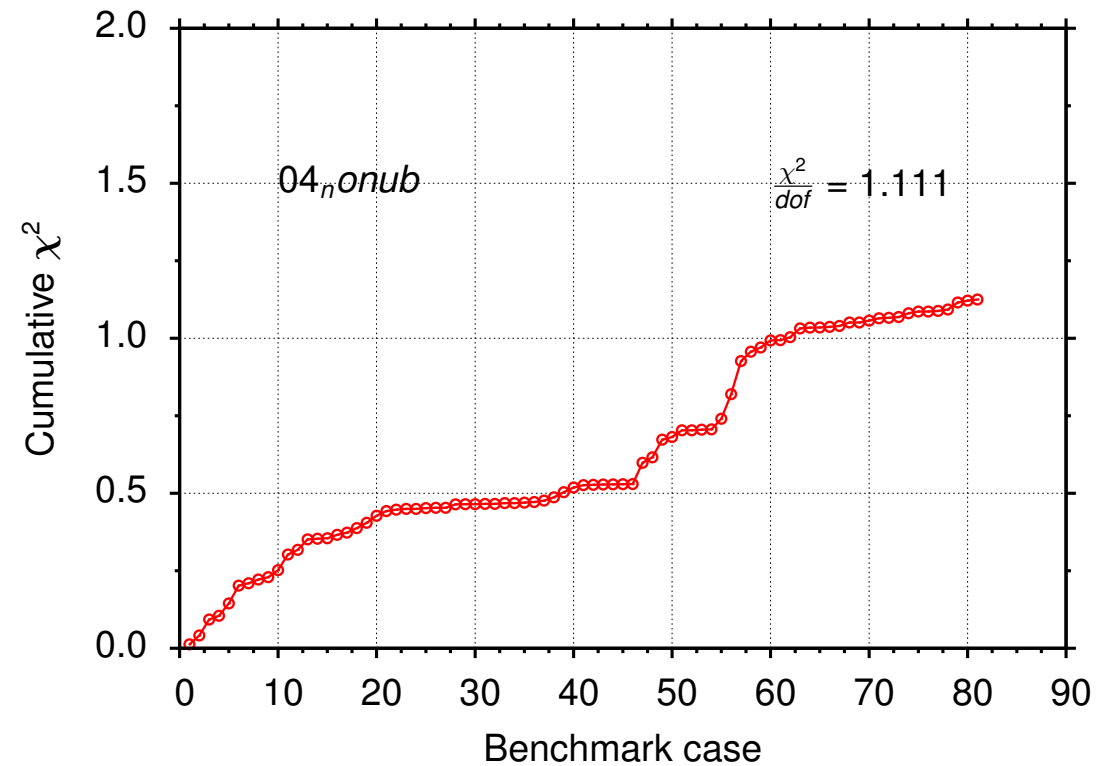
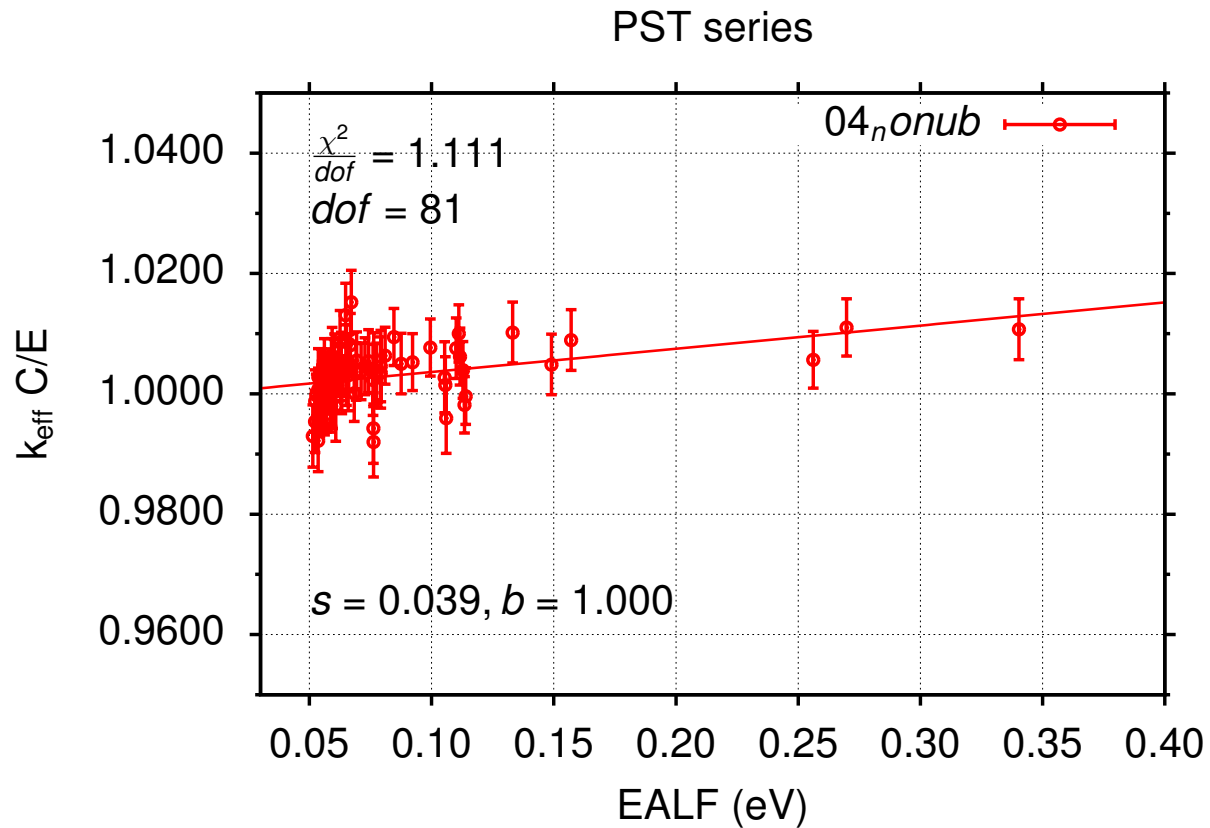
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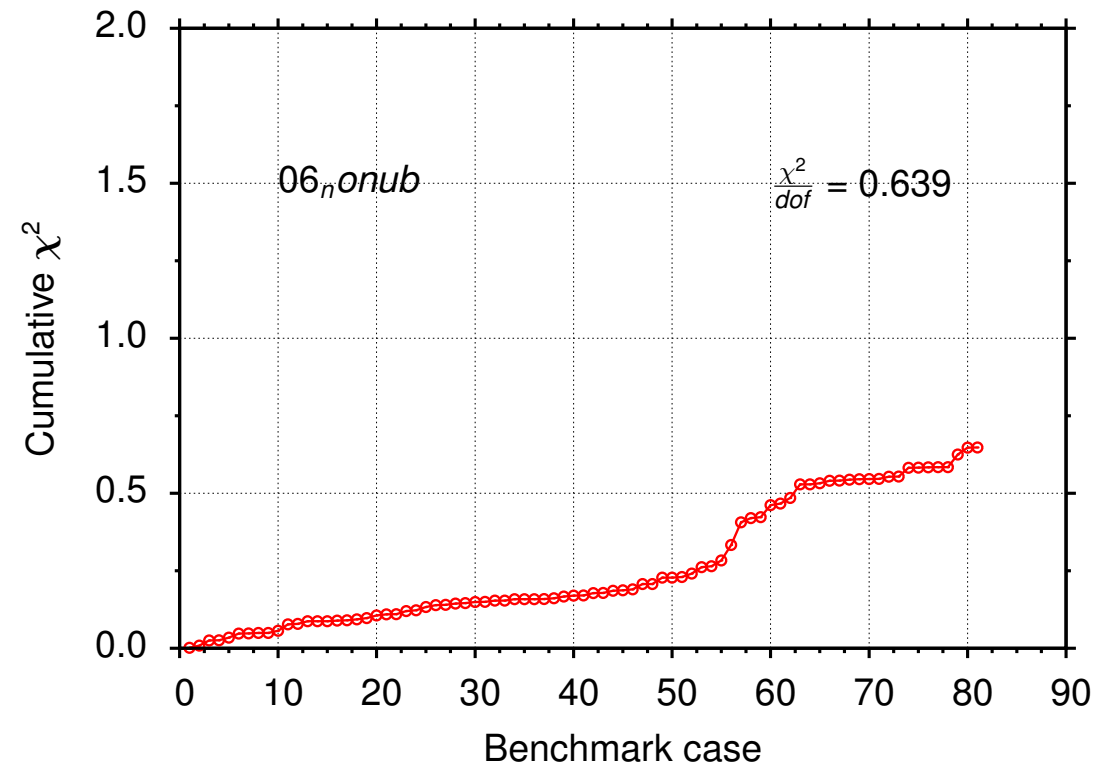
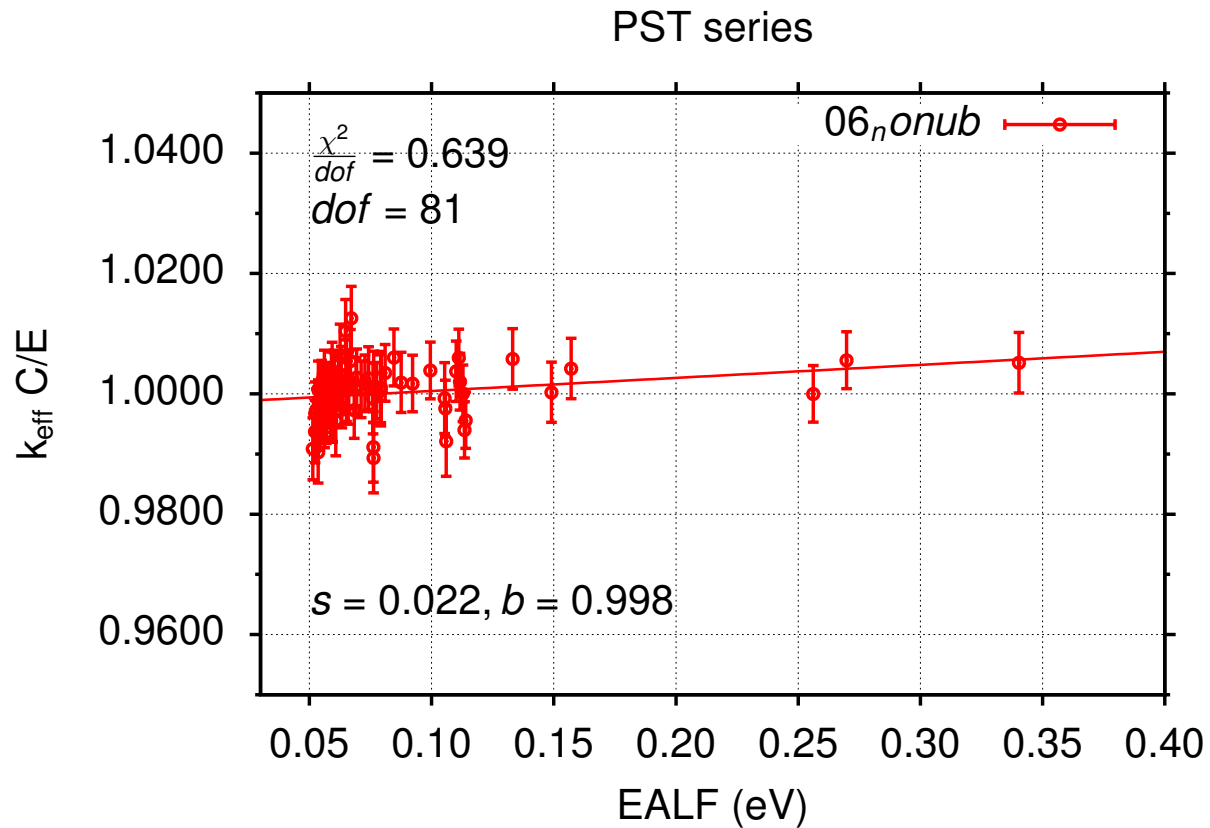
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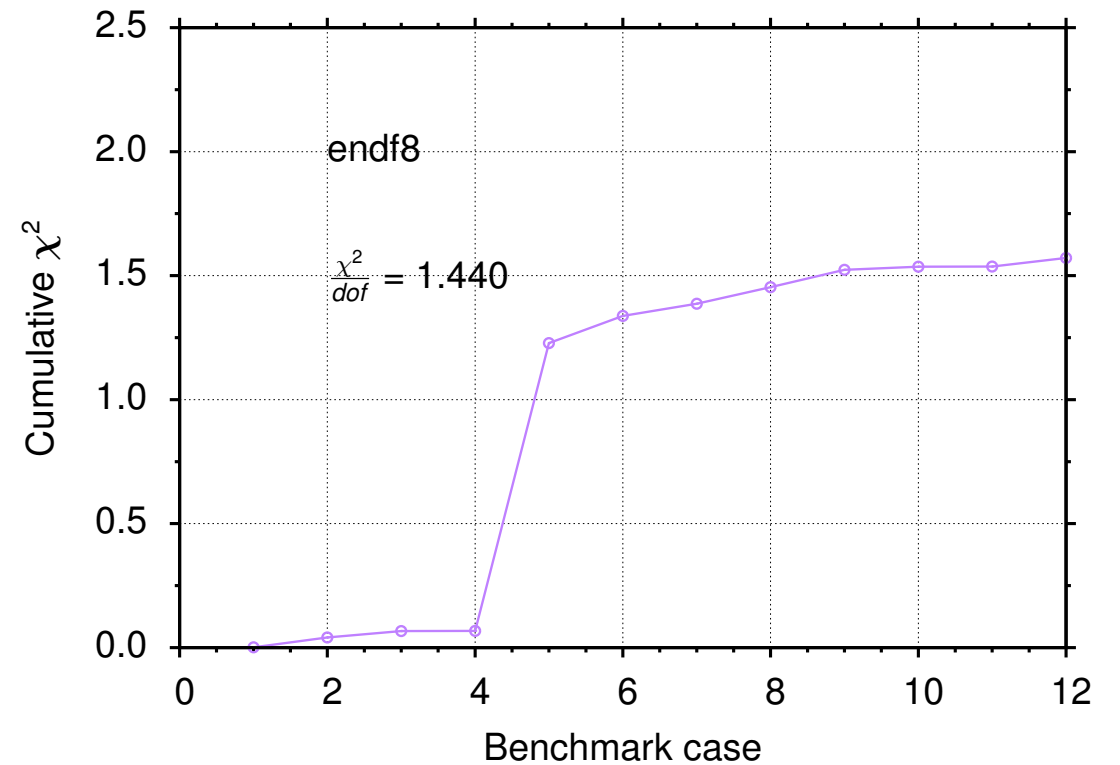
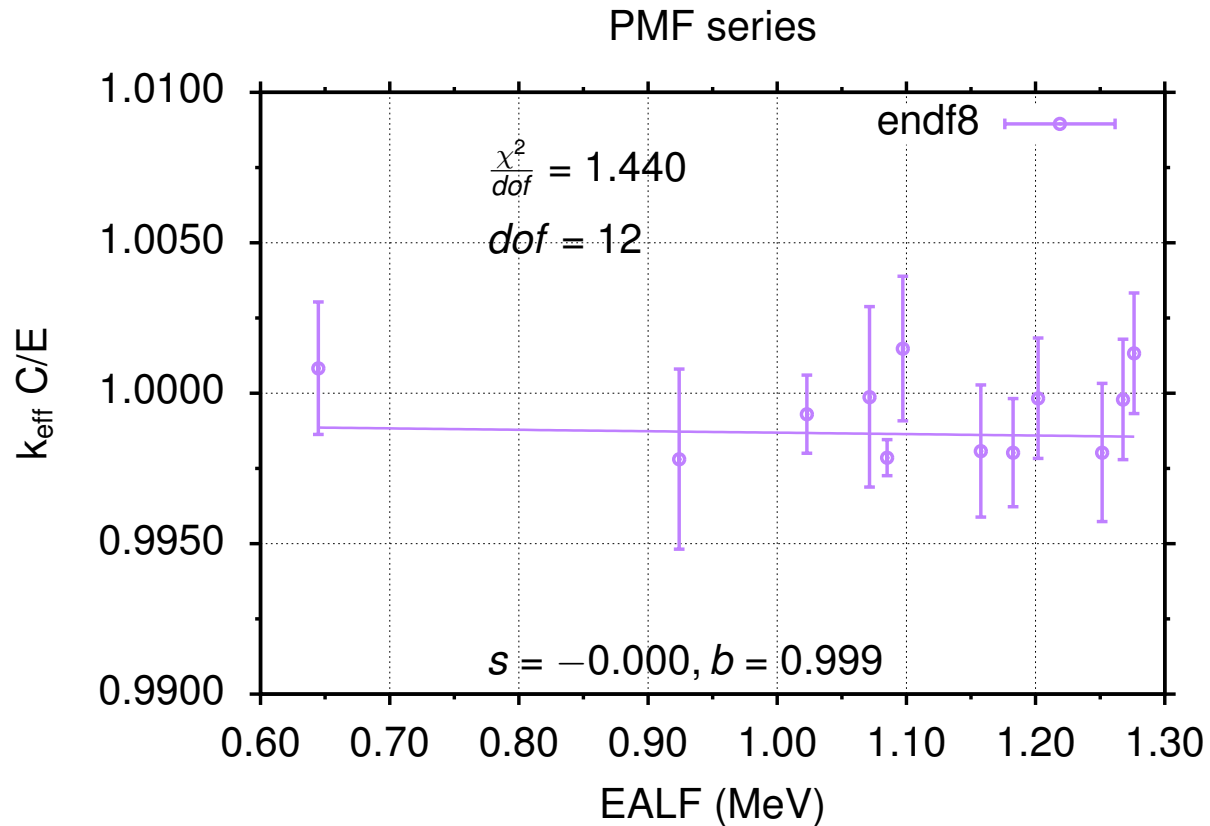
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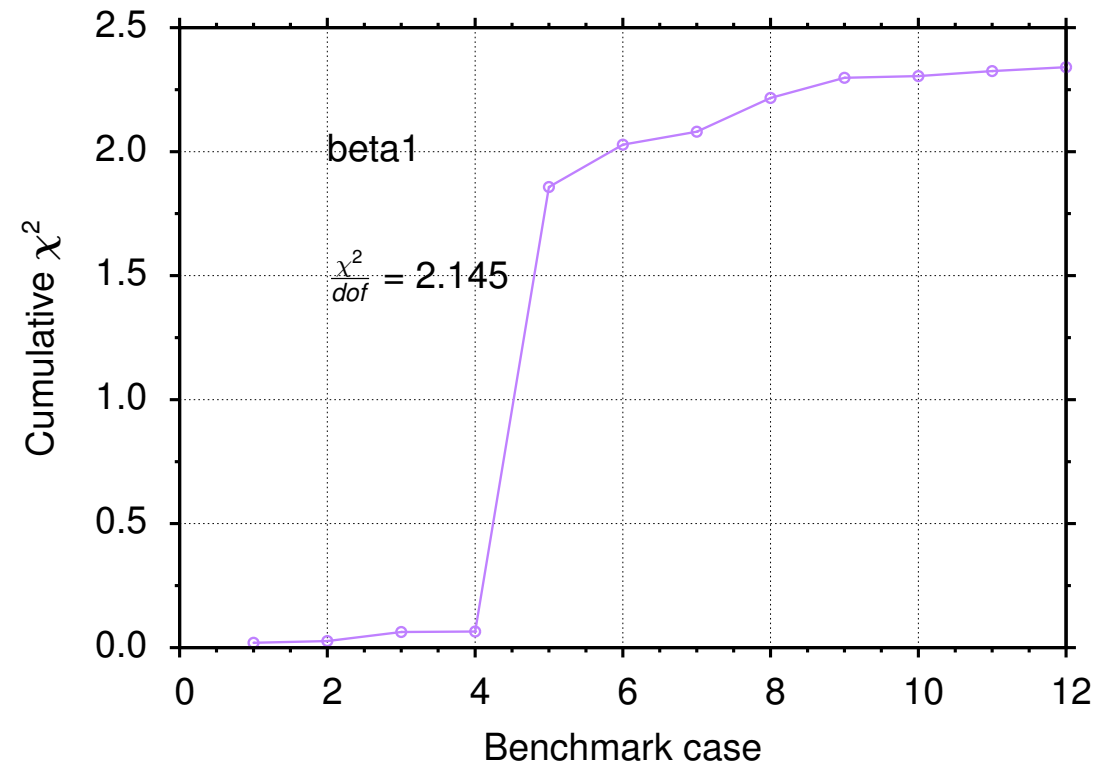
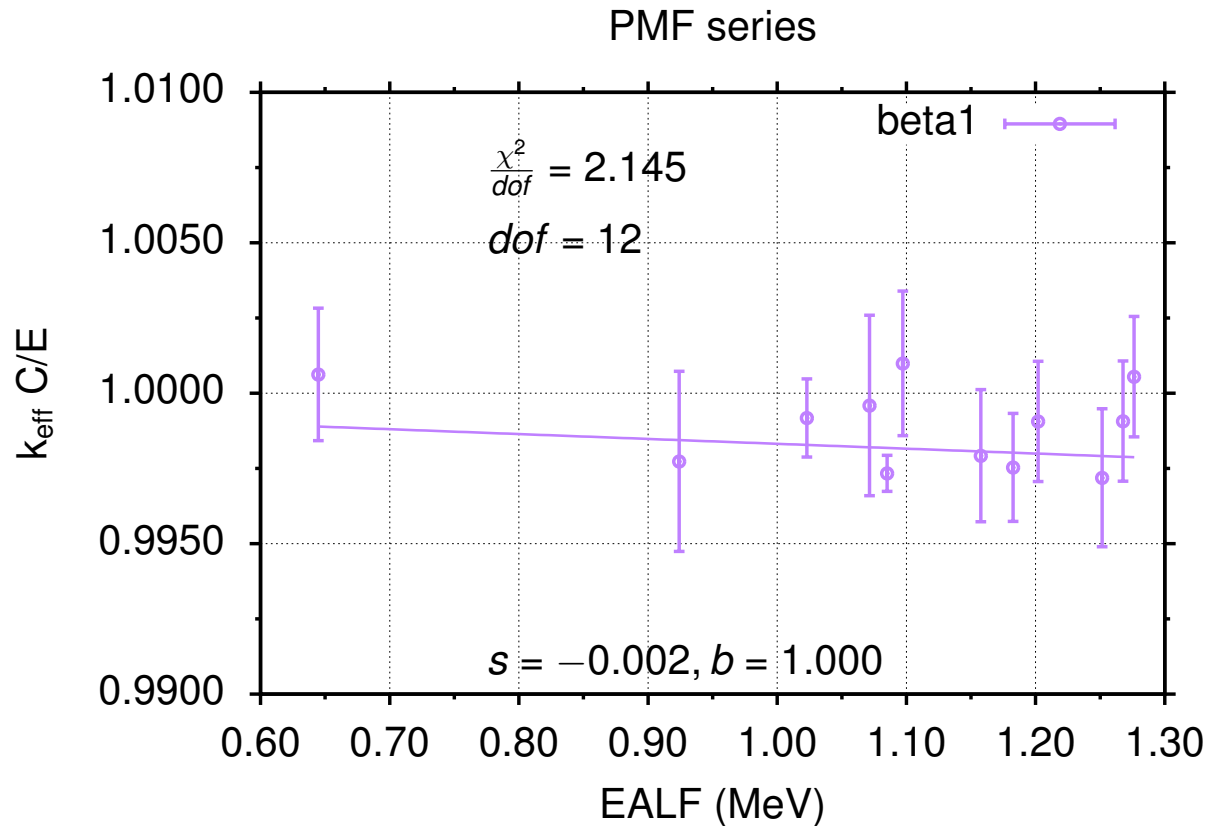
ENDF/B-VIII.0 benchmark performance (PMF)

- Smooth cumulative χ^2 behavior except for case PU-MET-FAST-008-001. Very low uncertainty 60 pcm
- Flat slope with slight underestimated reactivity



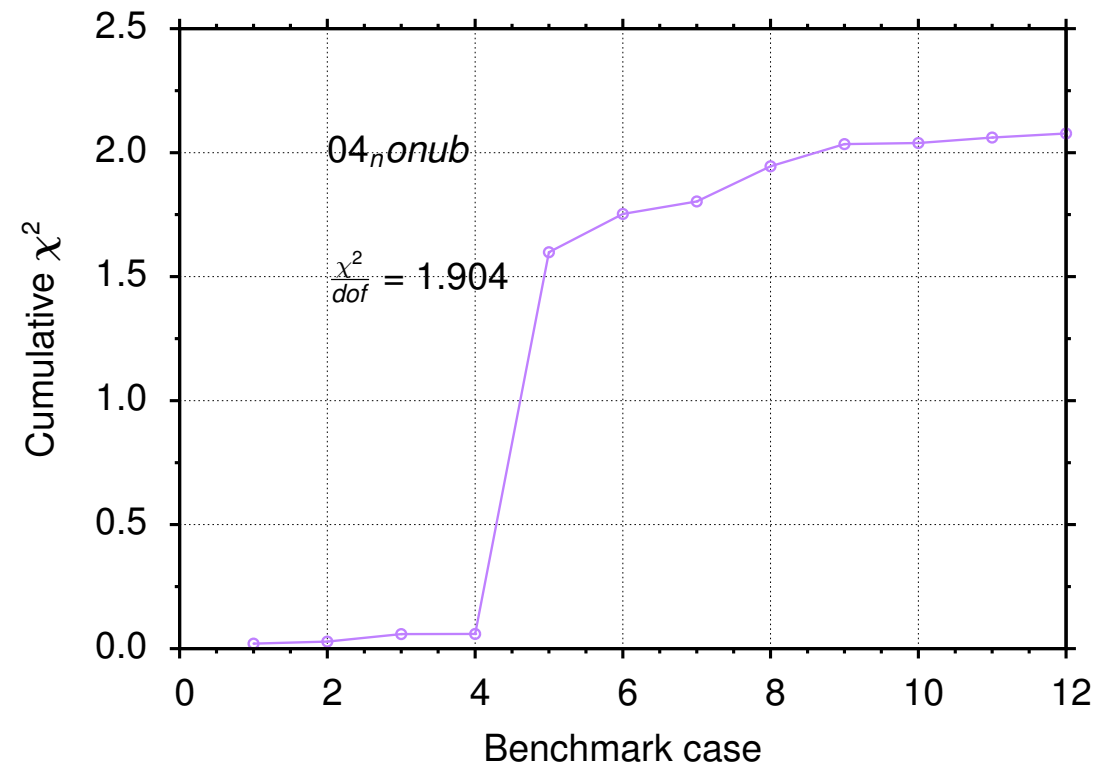
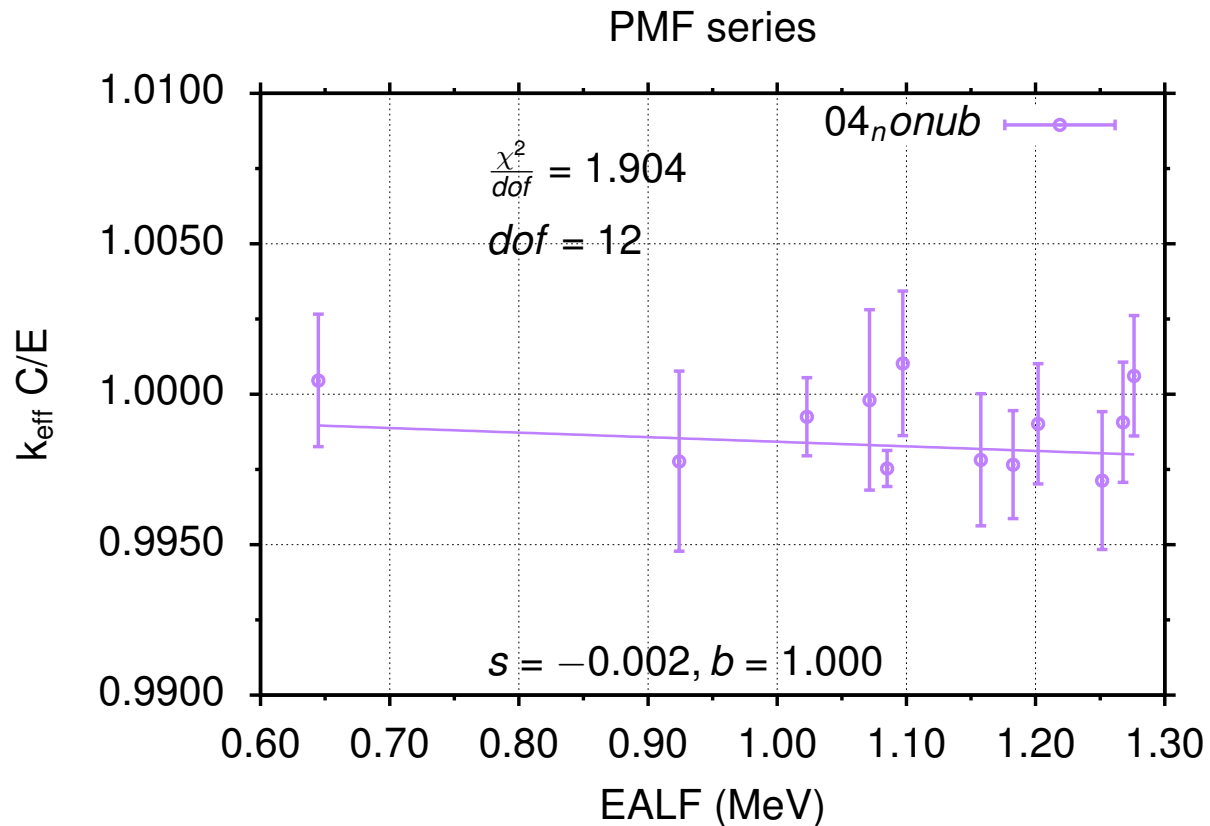
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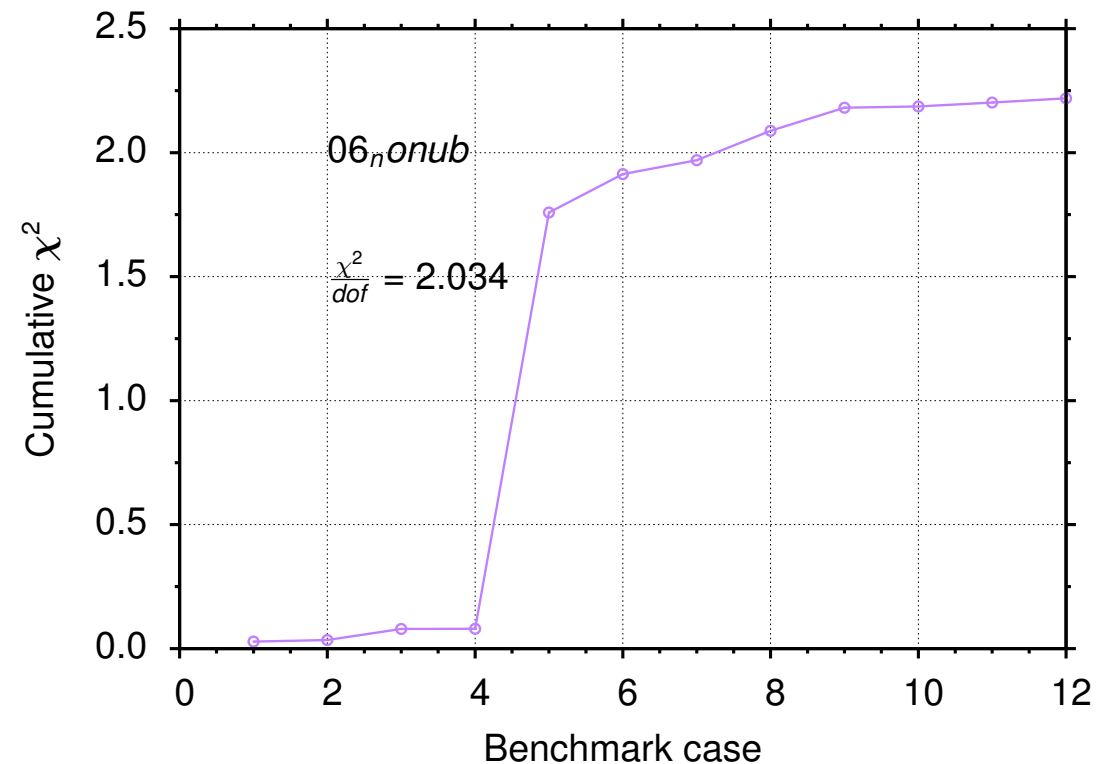
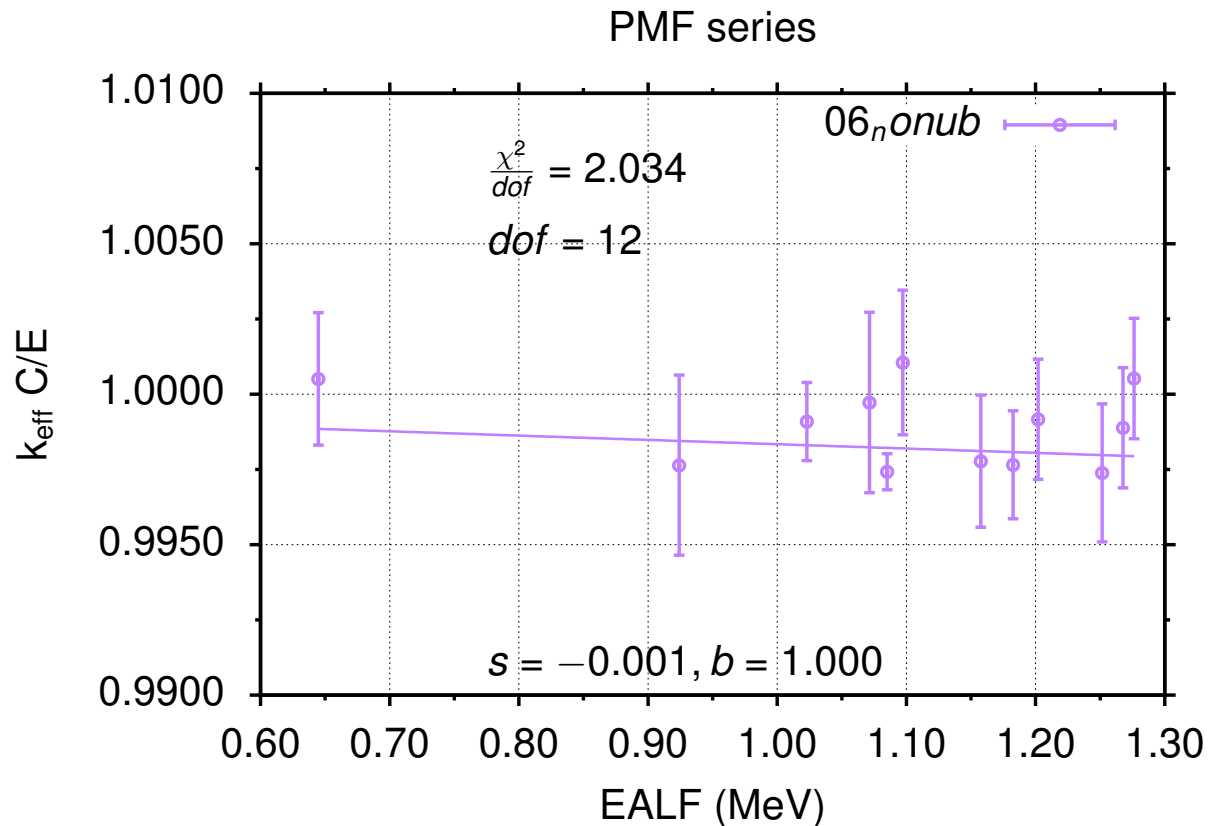
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- Cumulative χ^2 behavior similar to ENDF/B-VIII.0
- Slight underestimated reactivity and slight gradient. This shows possible correlations between changes in PST to PMF series



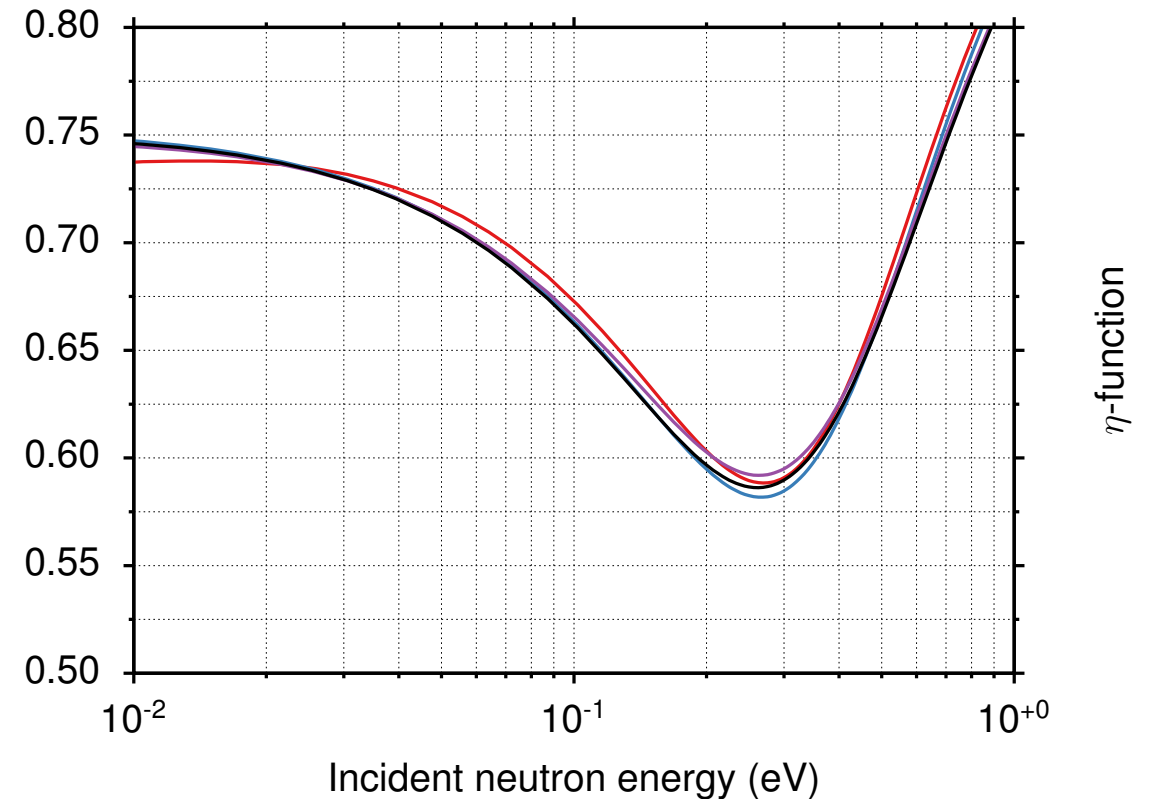
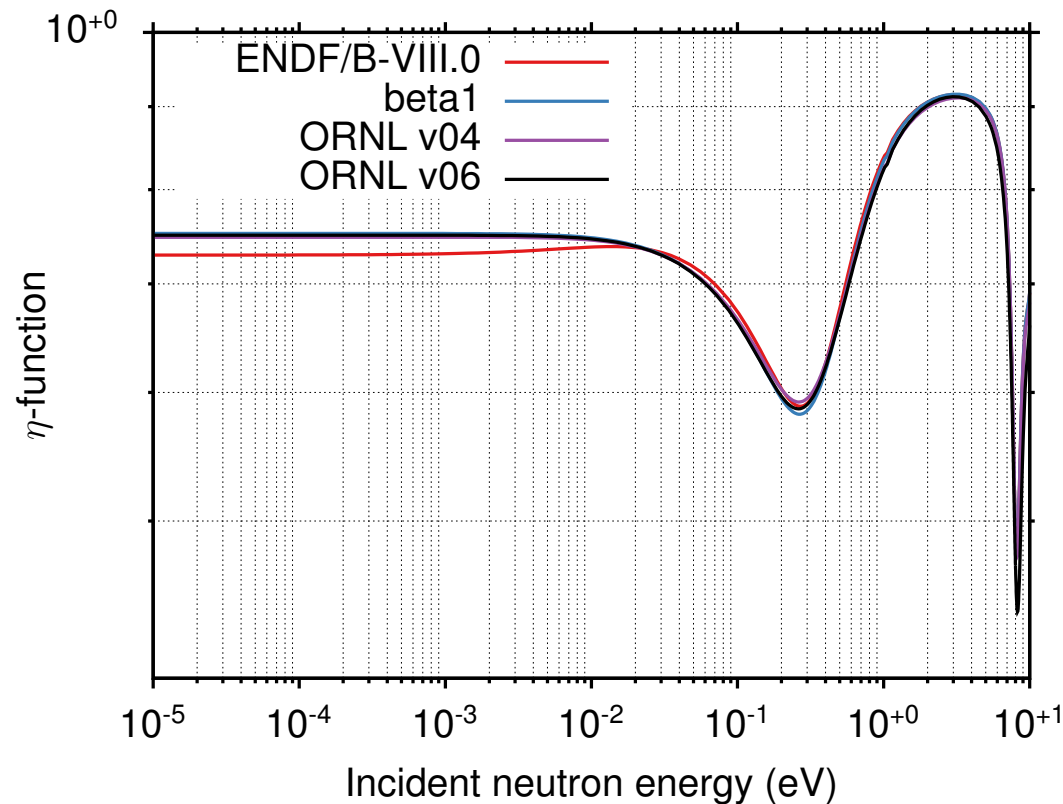
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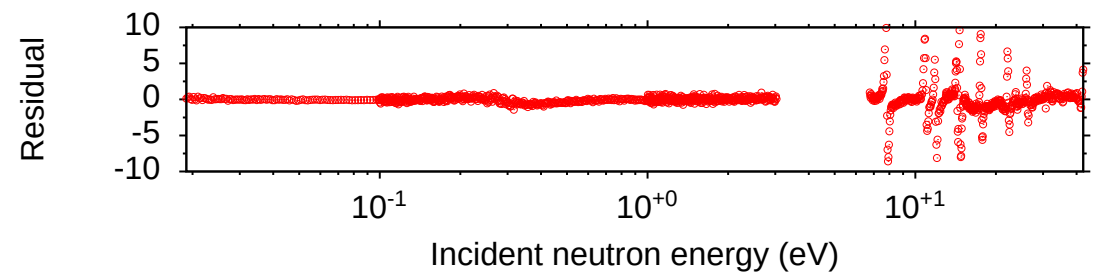
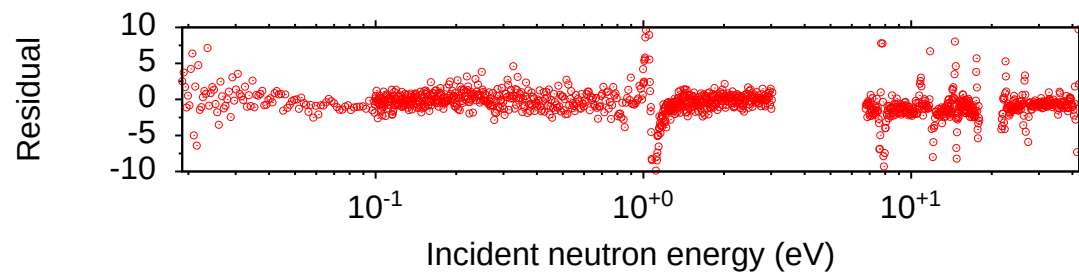
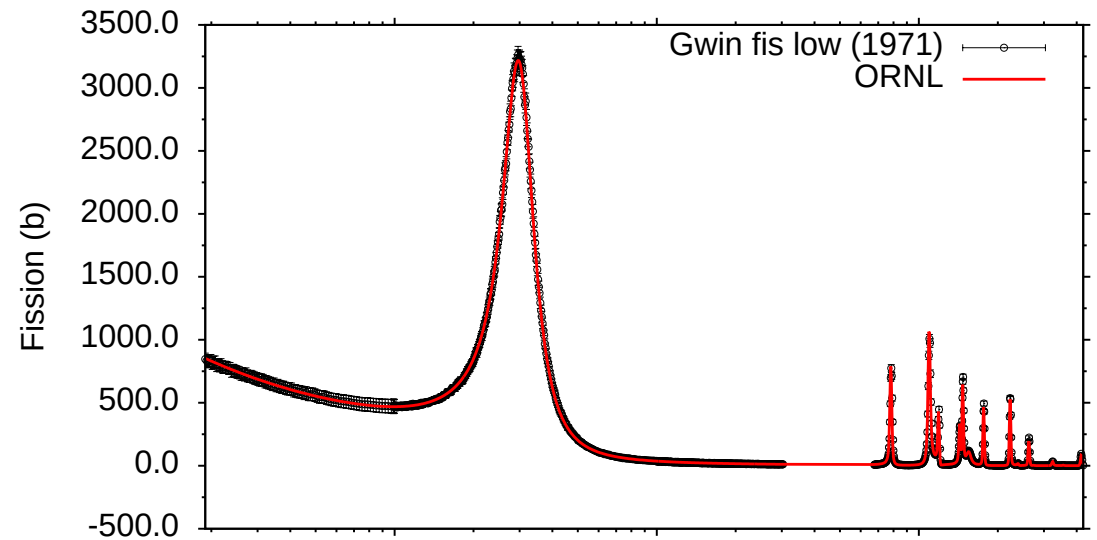
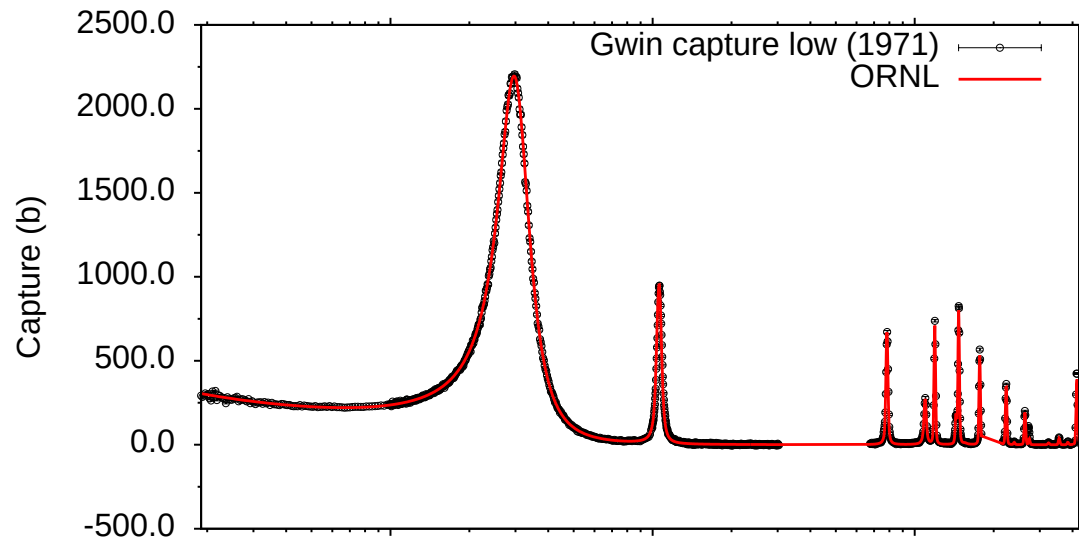
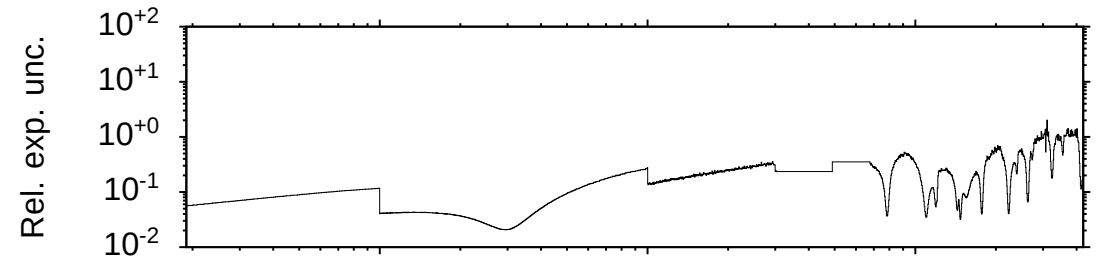
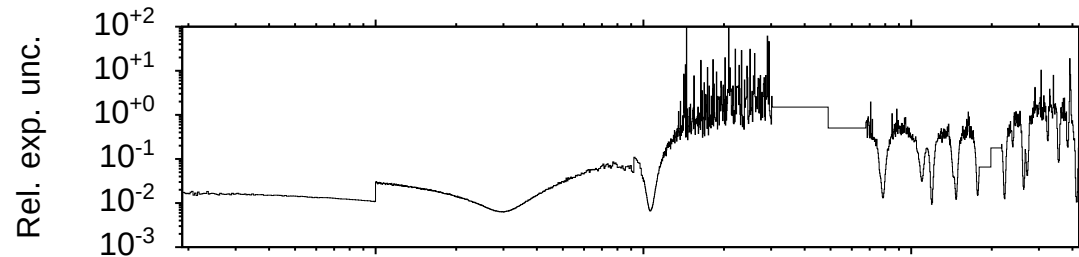


PST performance and η -function

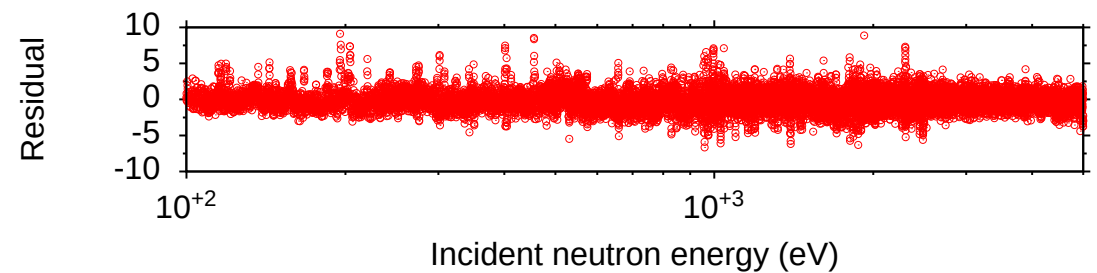
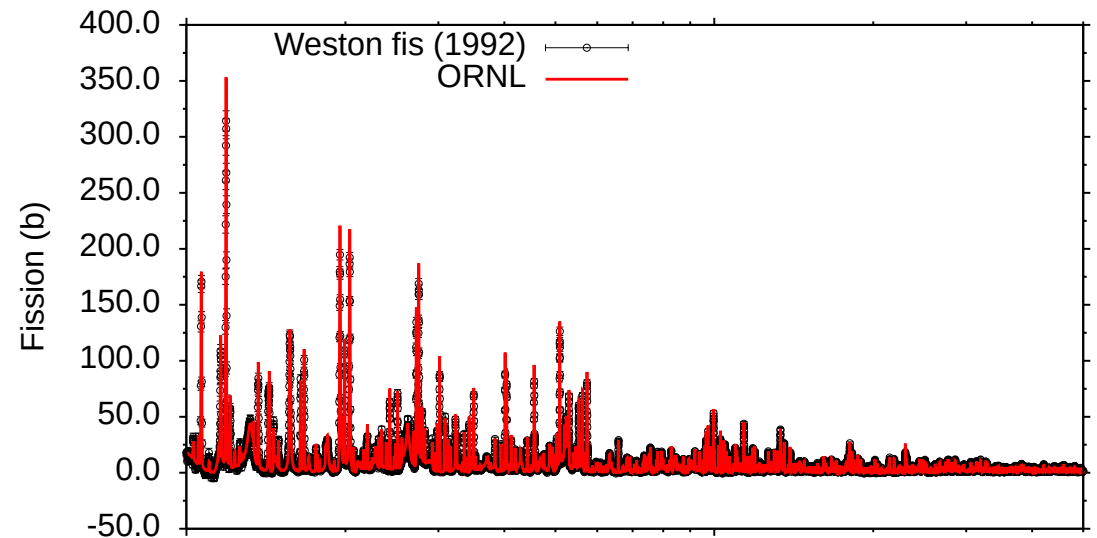
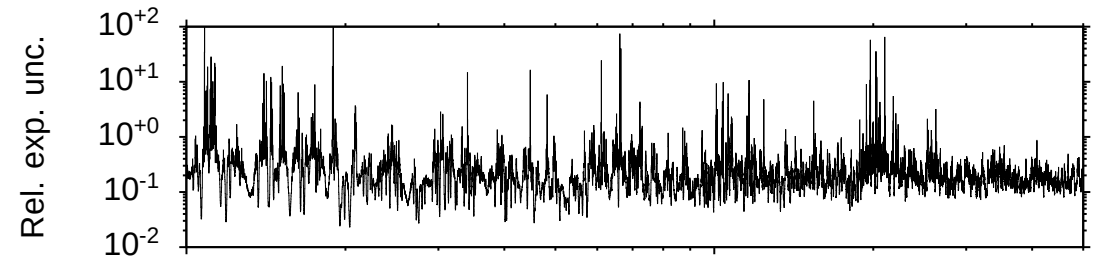
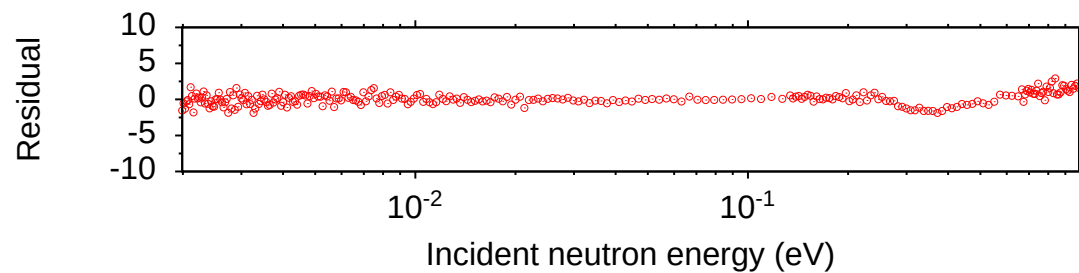
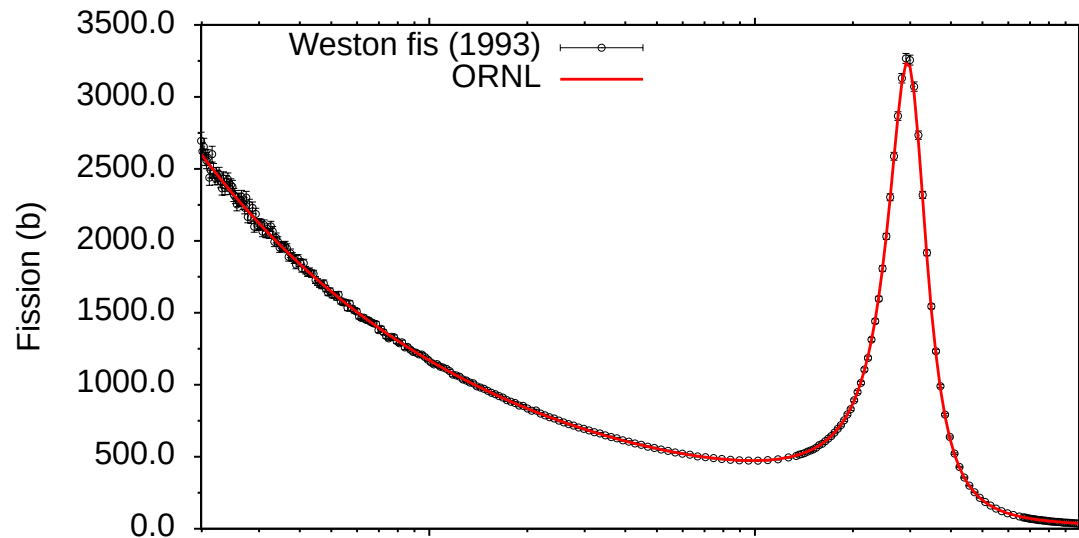
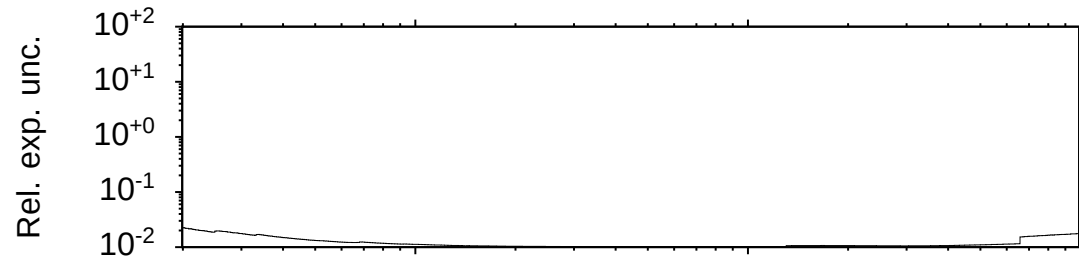
- Reactivity coefficients closely related to the capture-to-fission ratio α or the function $\eta = (1 + \alpha)^{-1}$
- Performance for EALF < 0.5 eV depending from thermal values together with 0.29 eV resonance level
- ...and neutron multiplicities, of course!



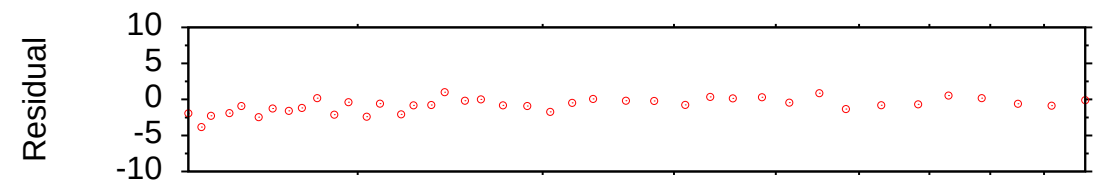
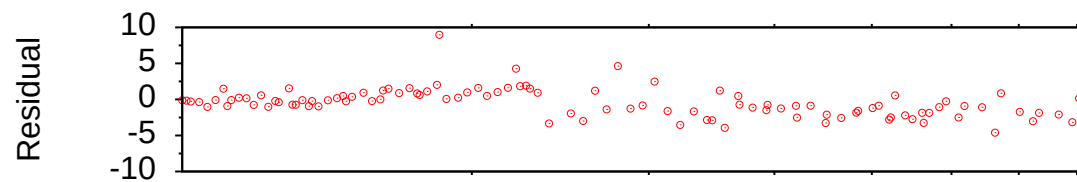
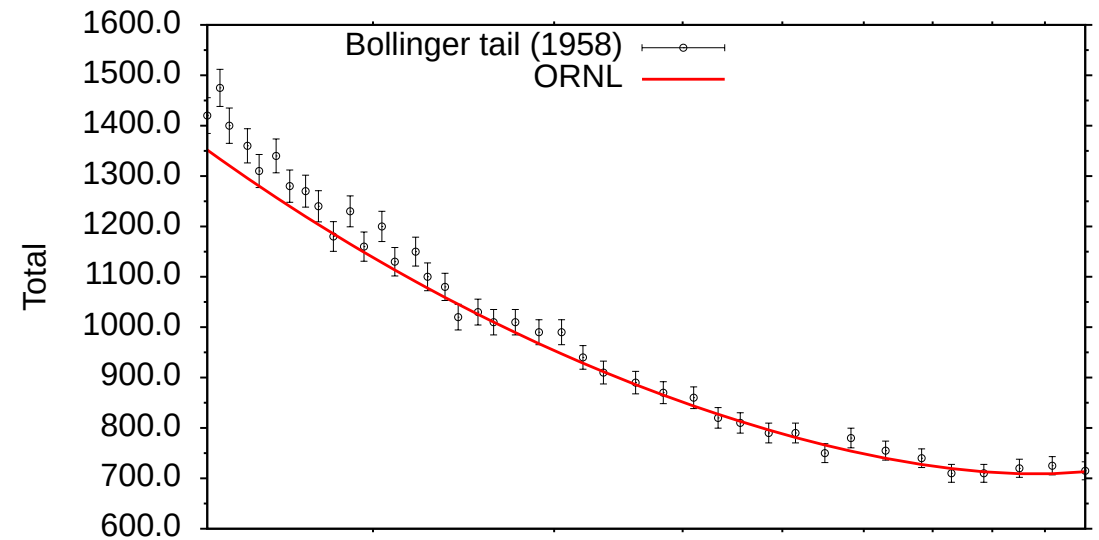
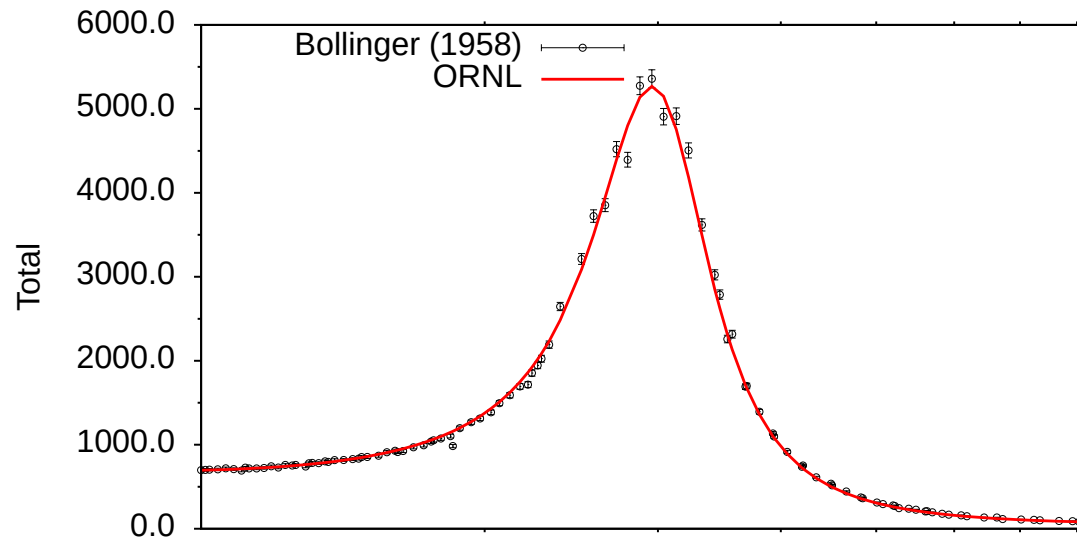
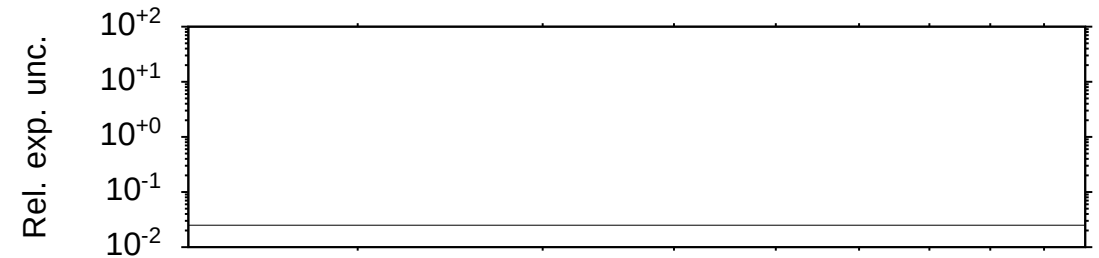
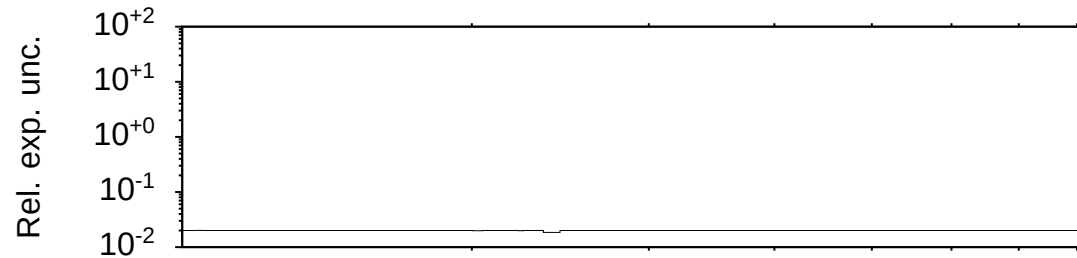
Fitting results (beta2)



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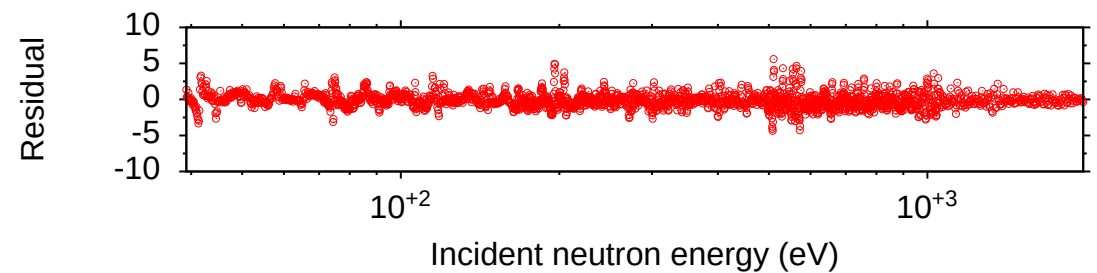
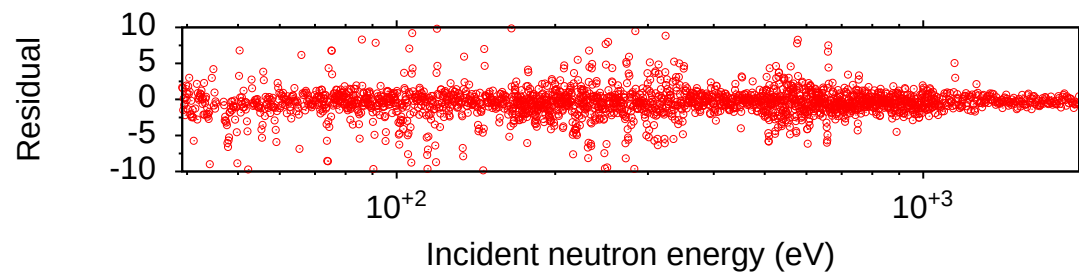
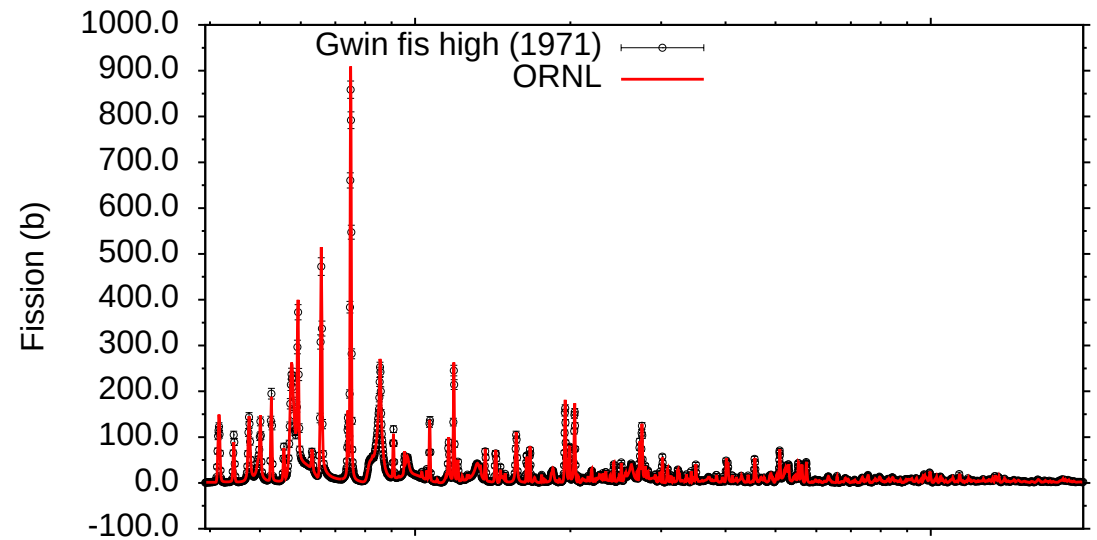
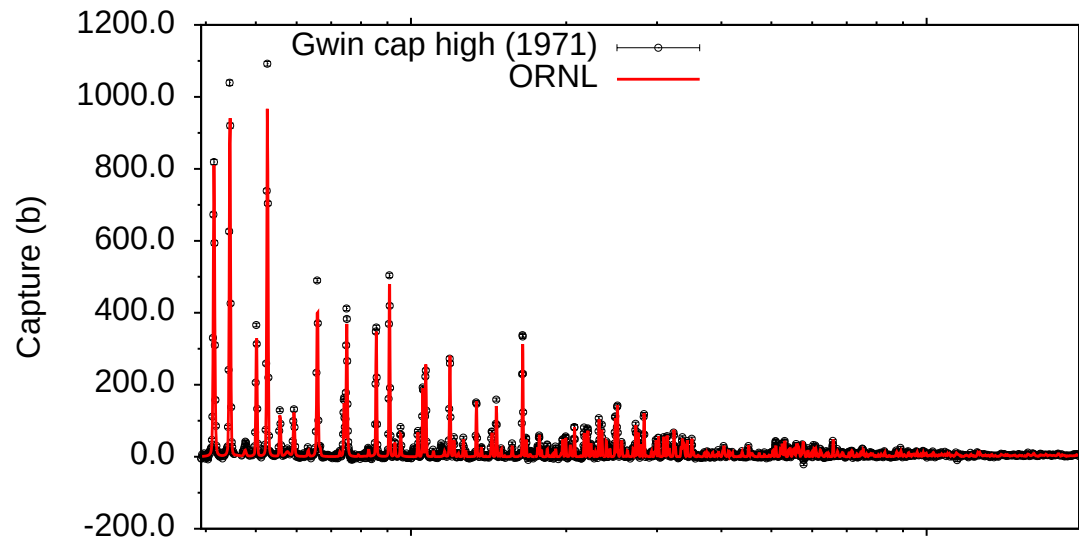
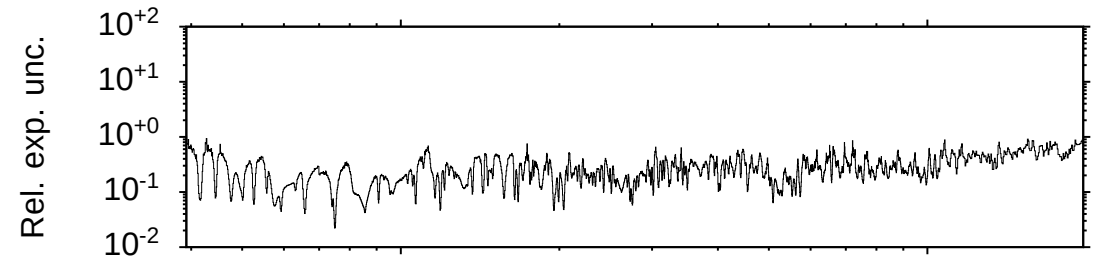
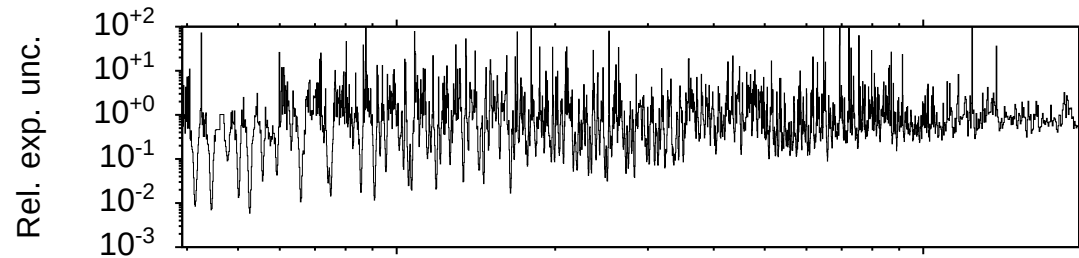
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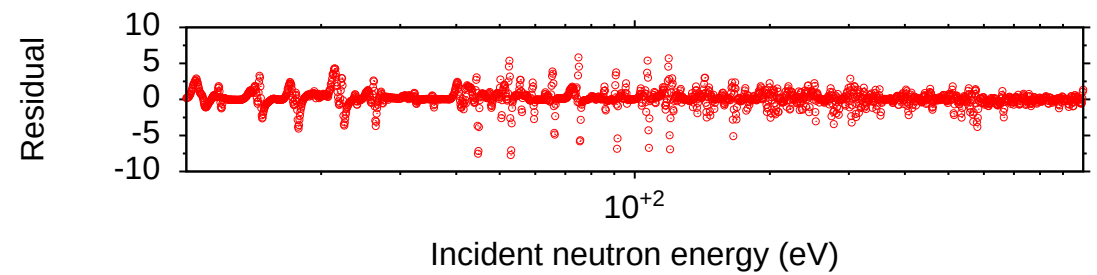
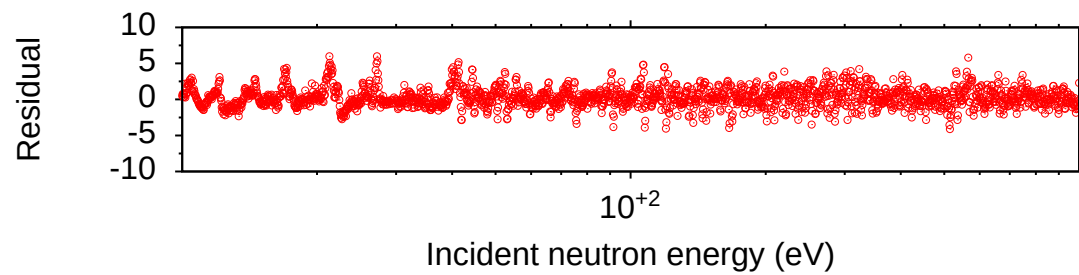
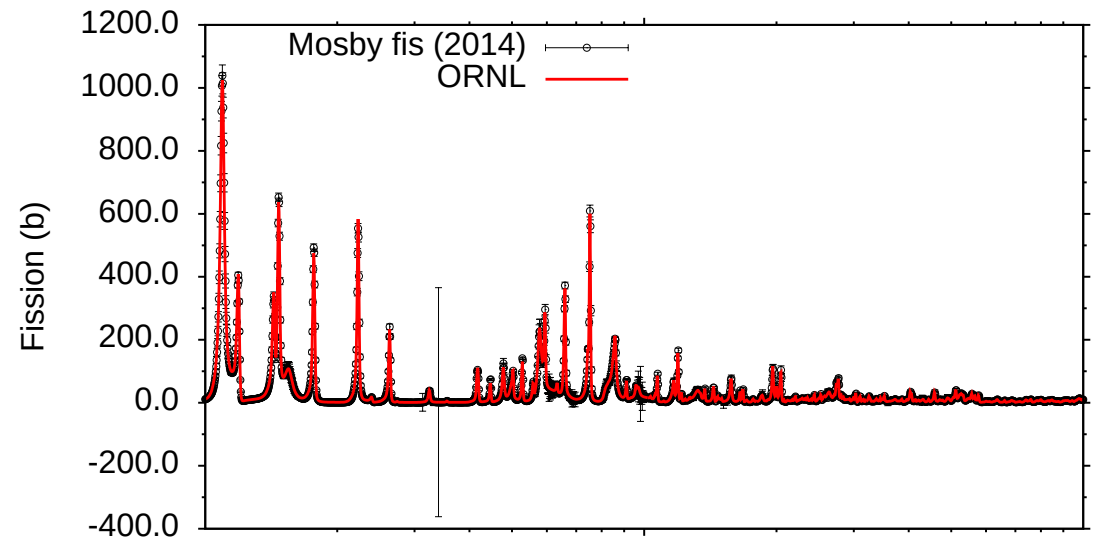
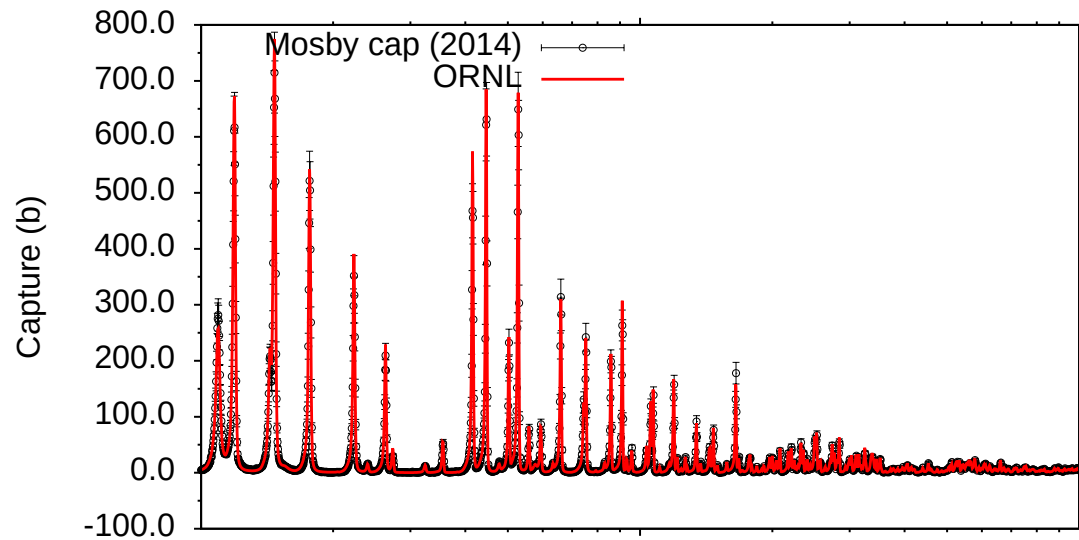
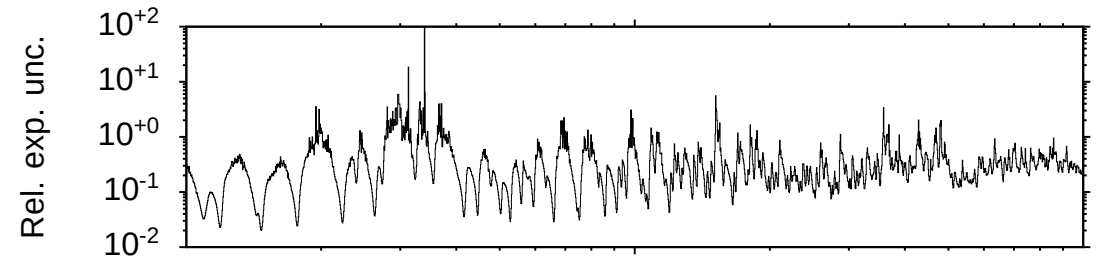
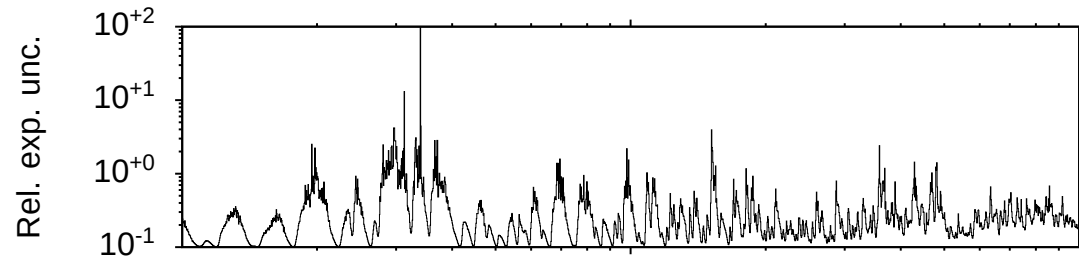
Incident neutron energy (eV)

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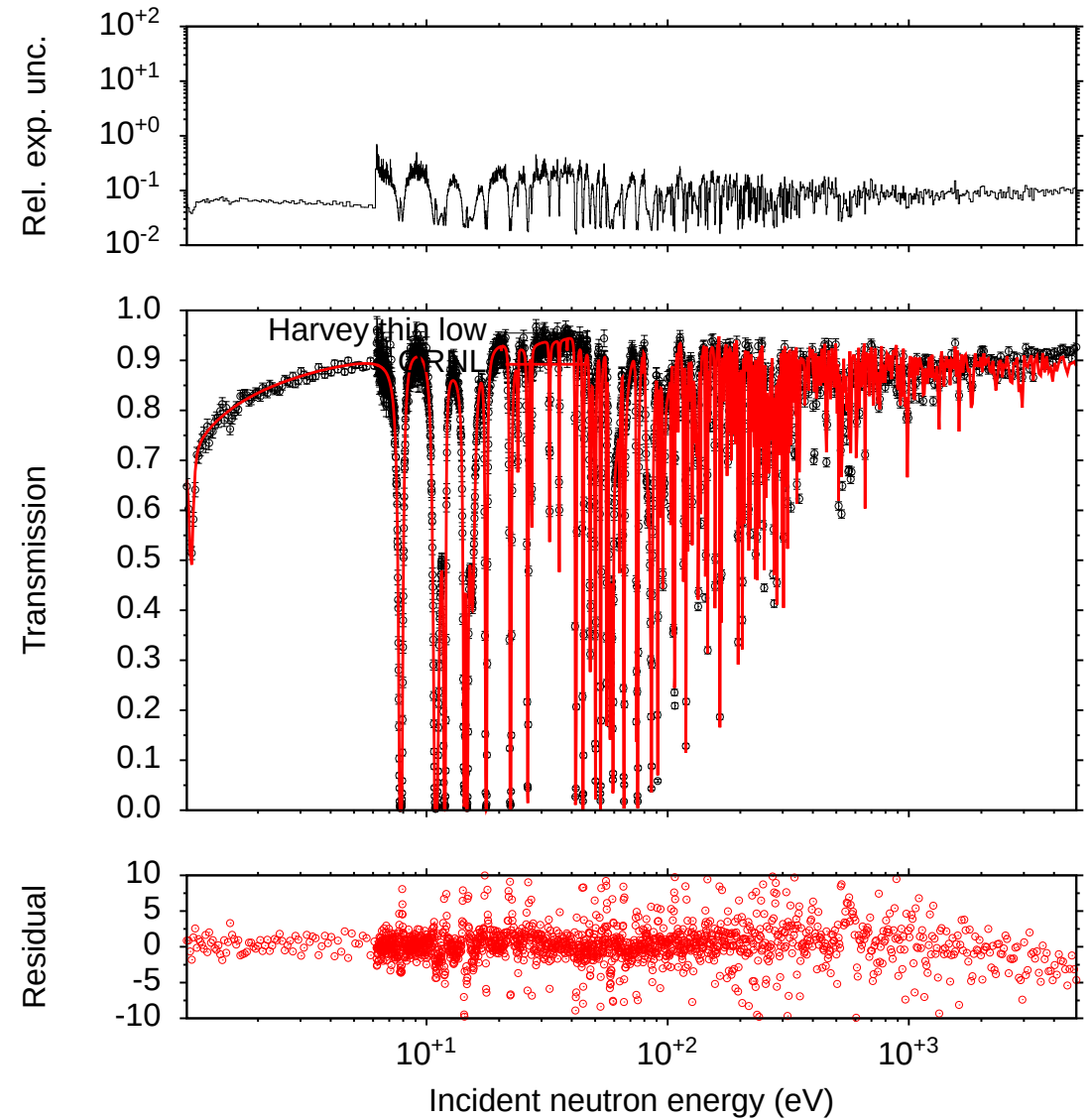
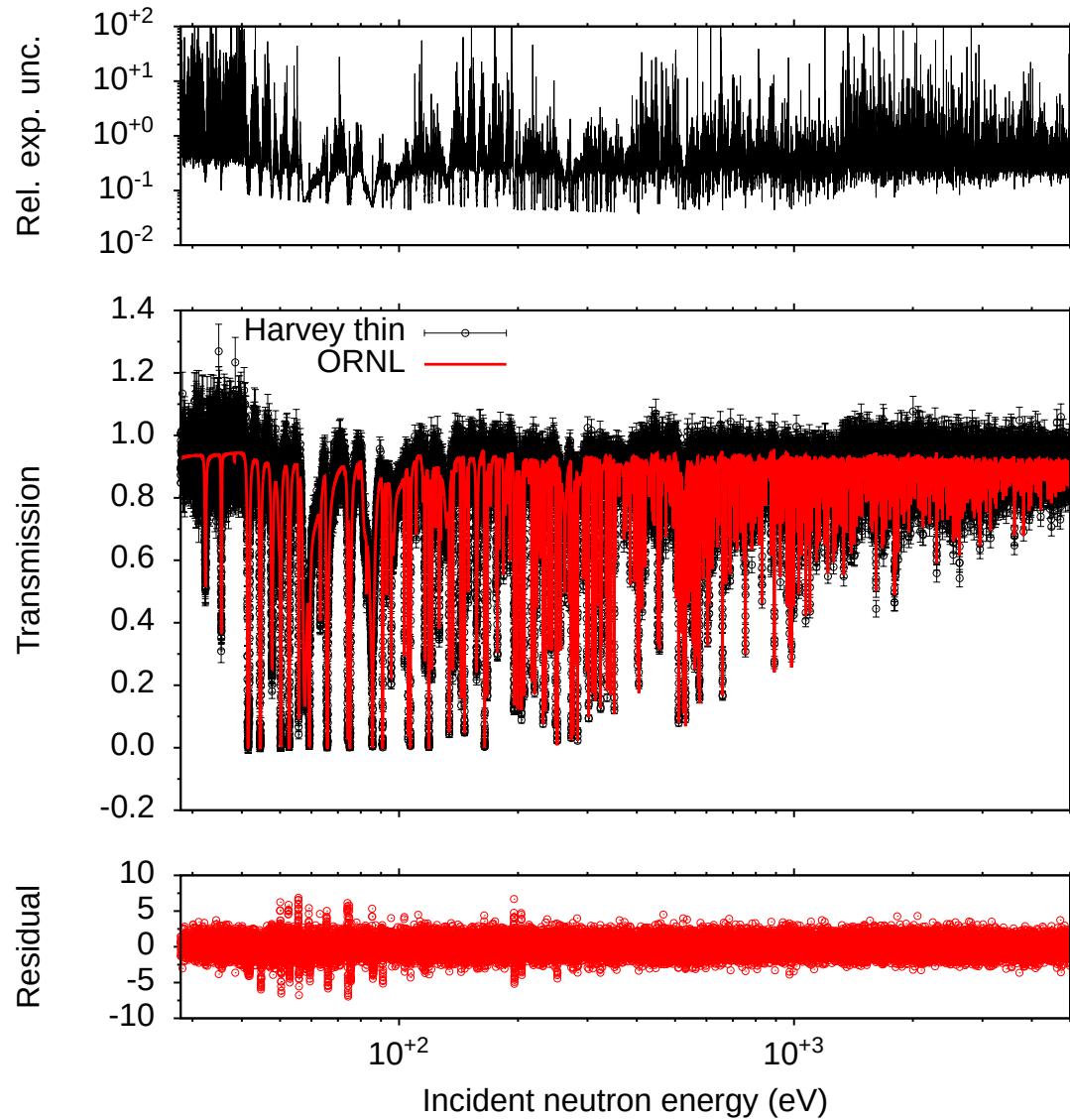
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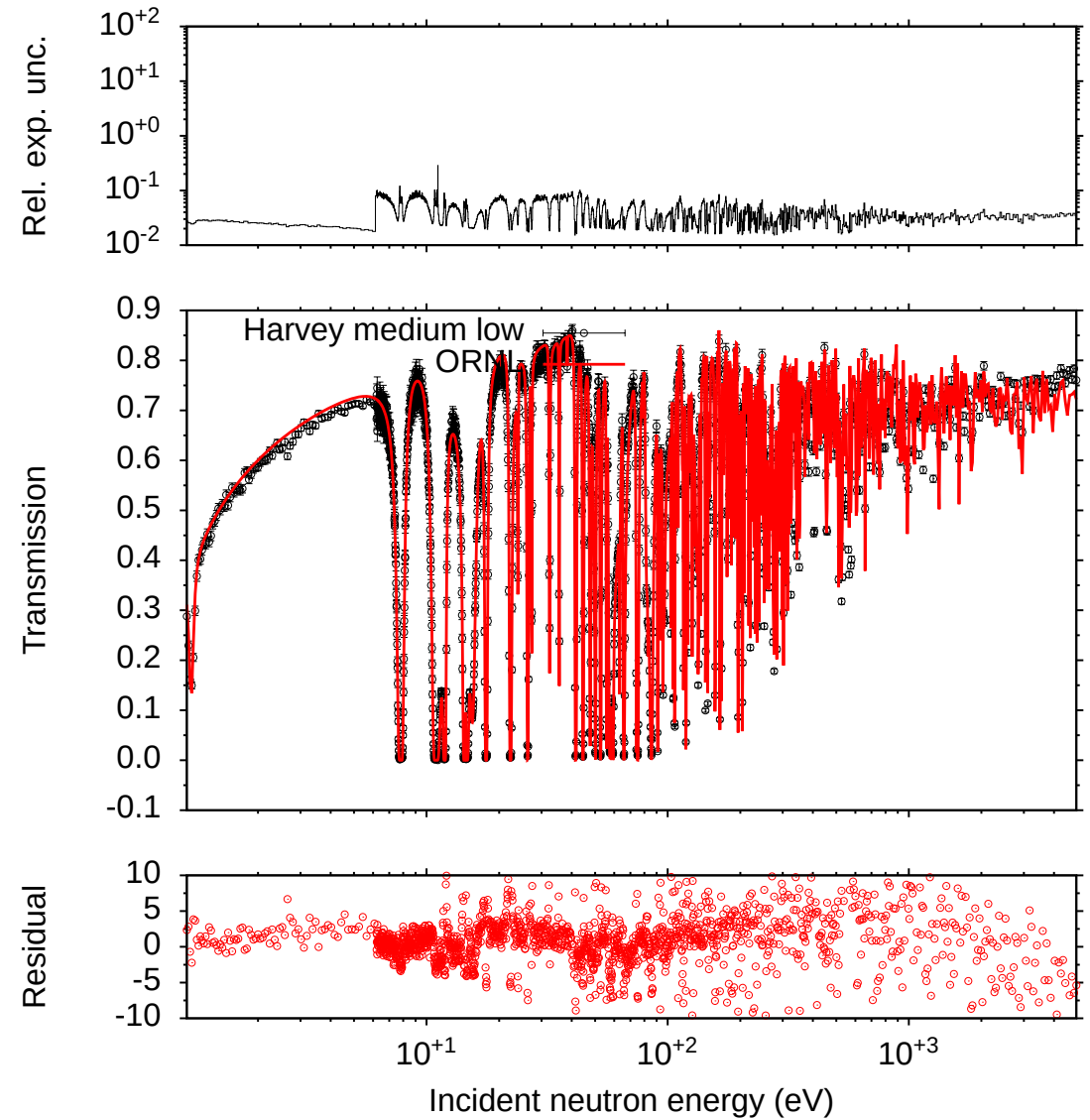
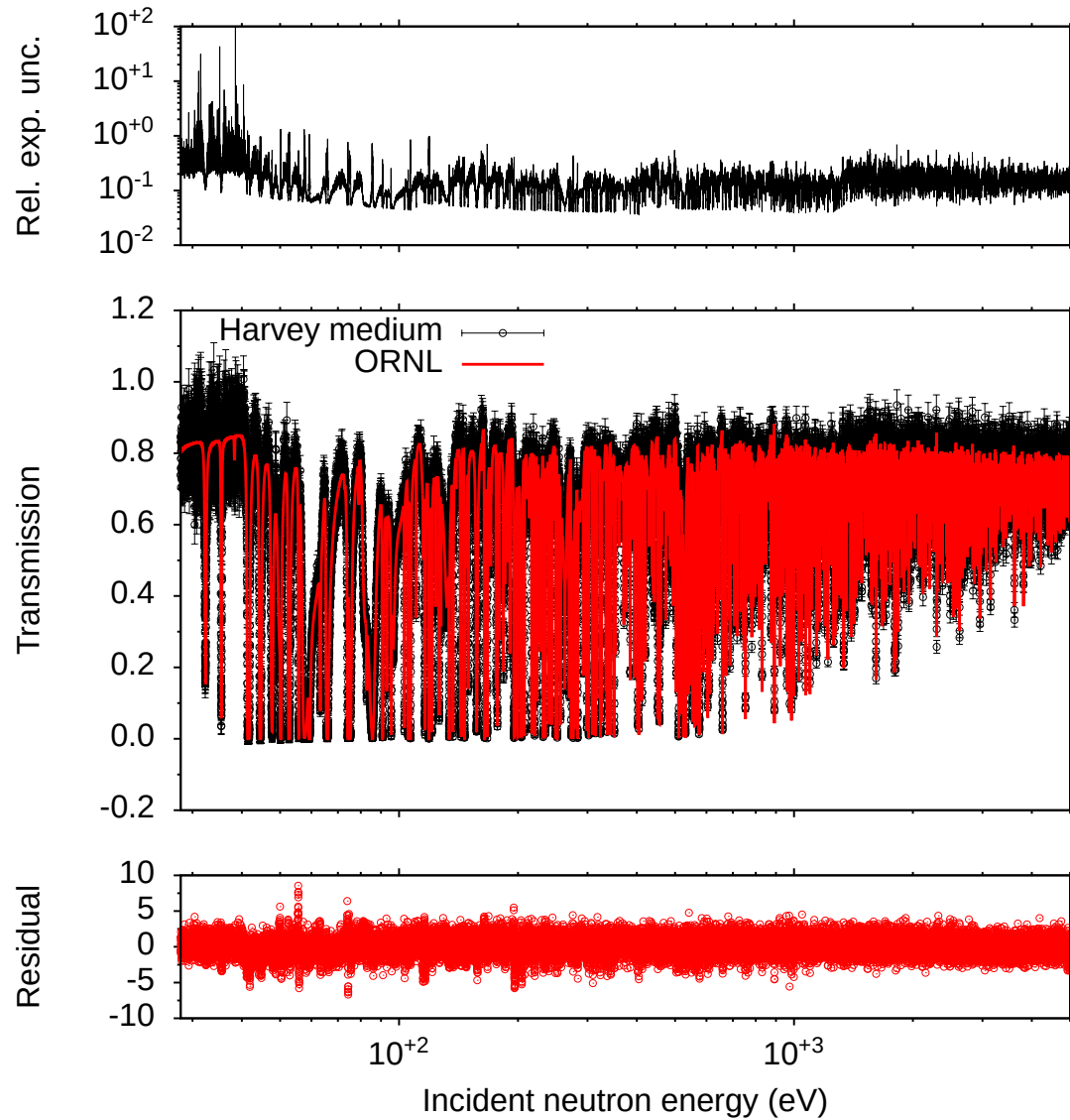
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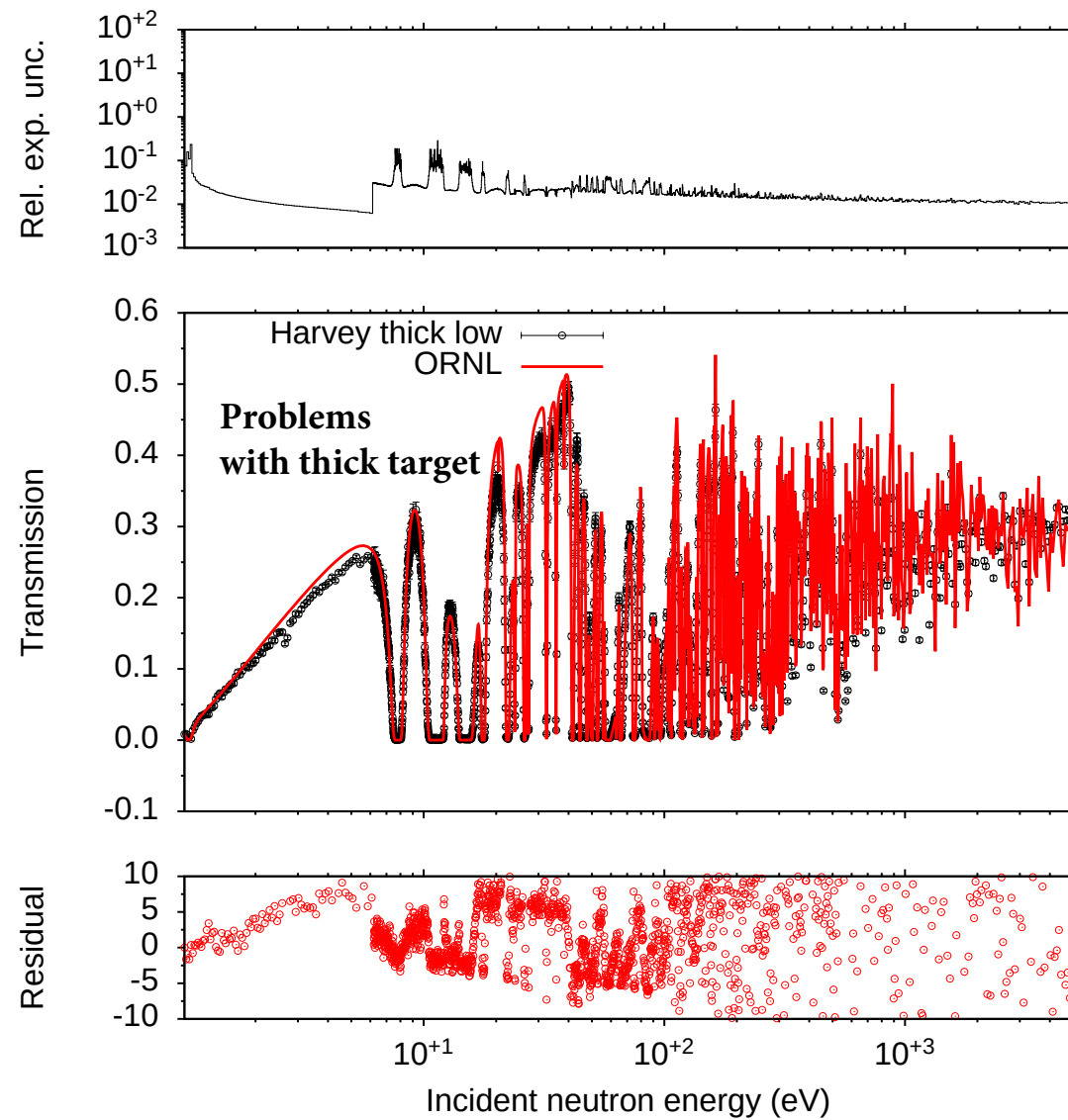
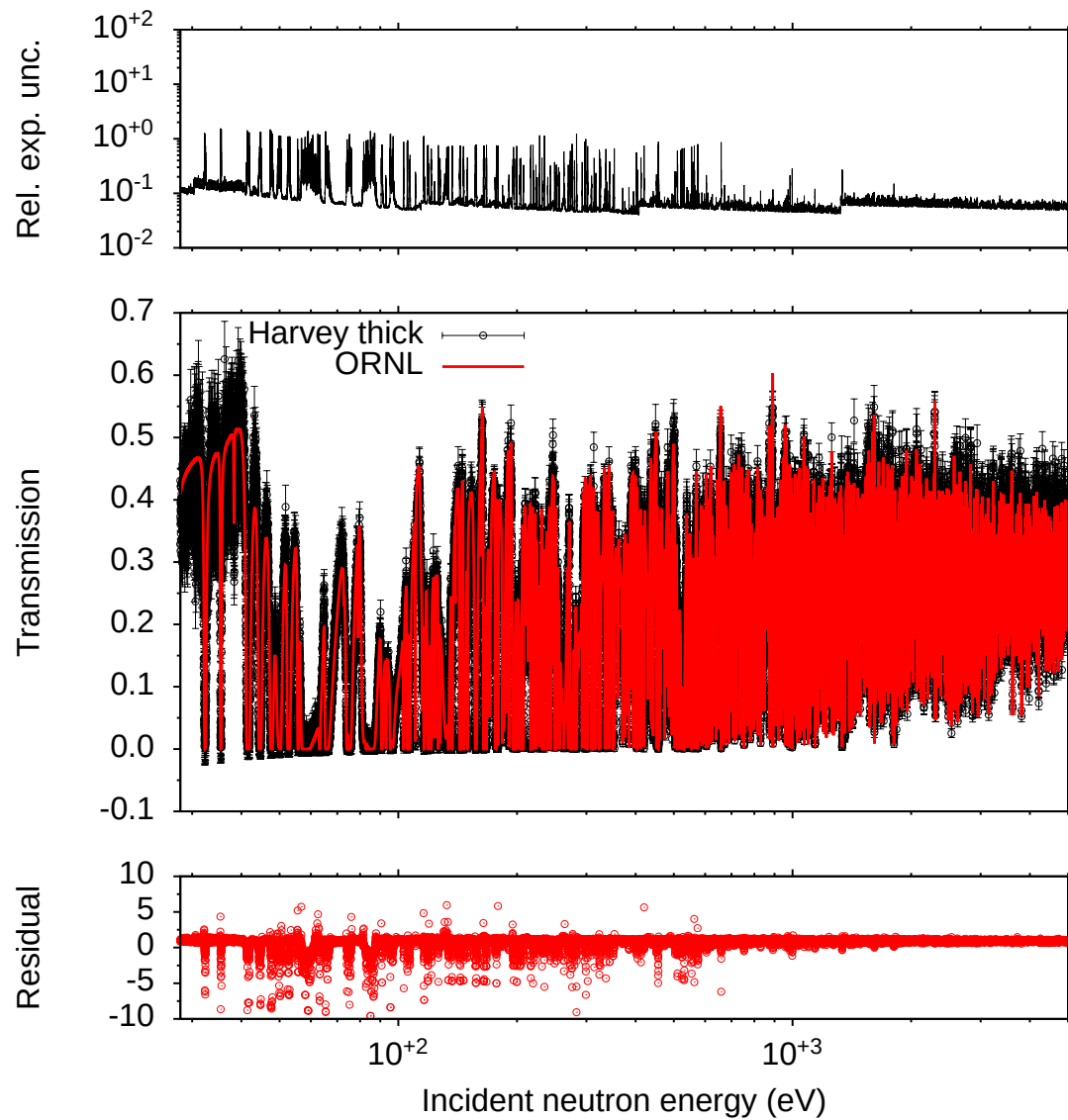
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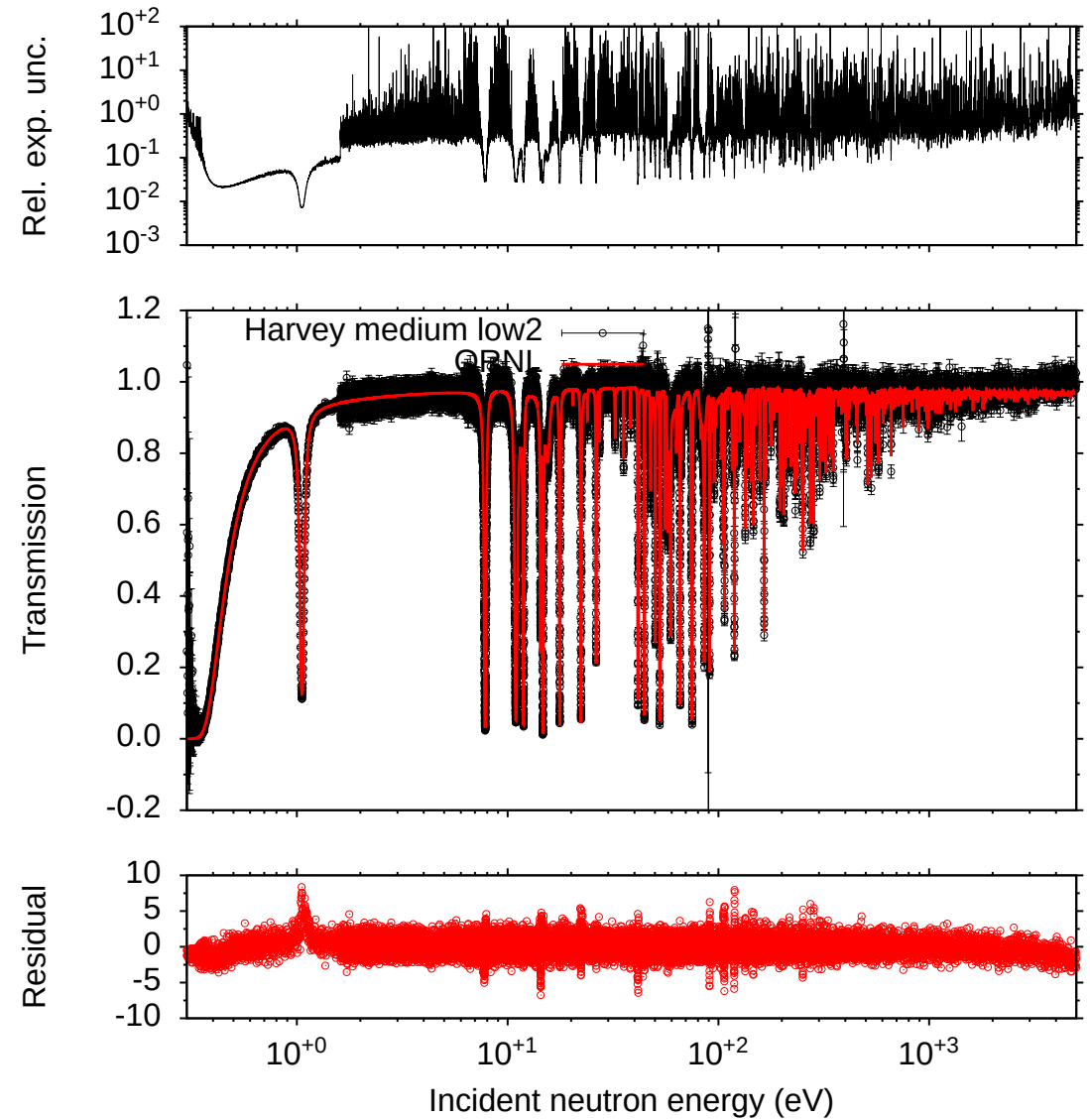
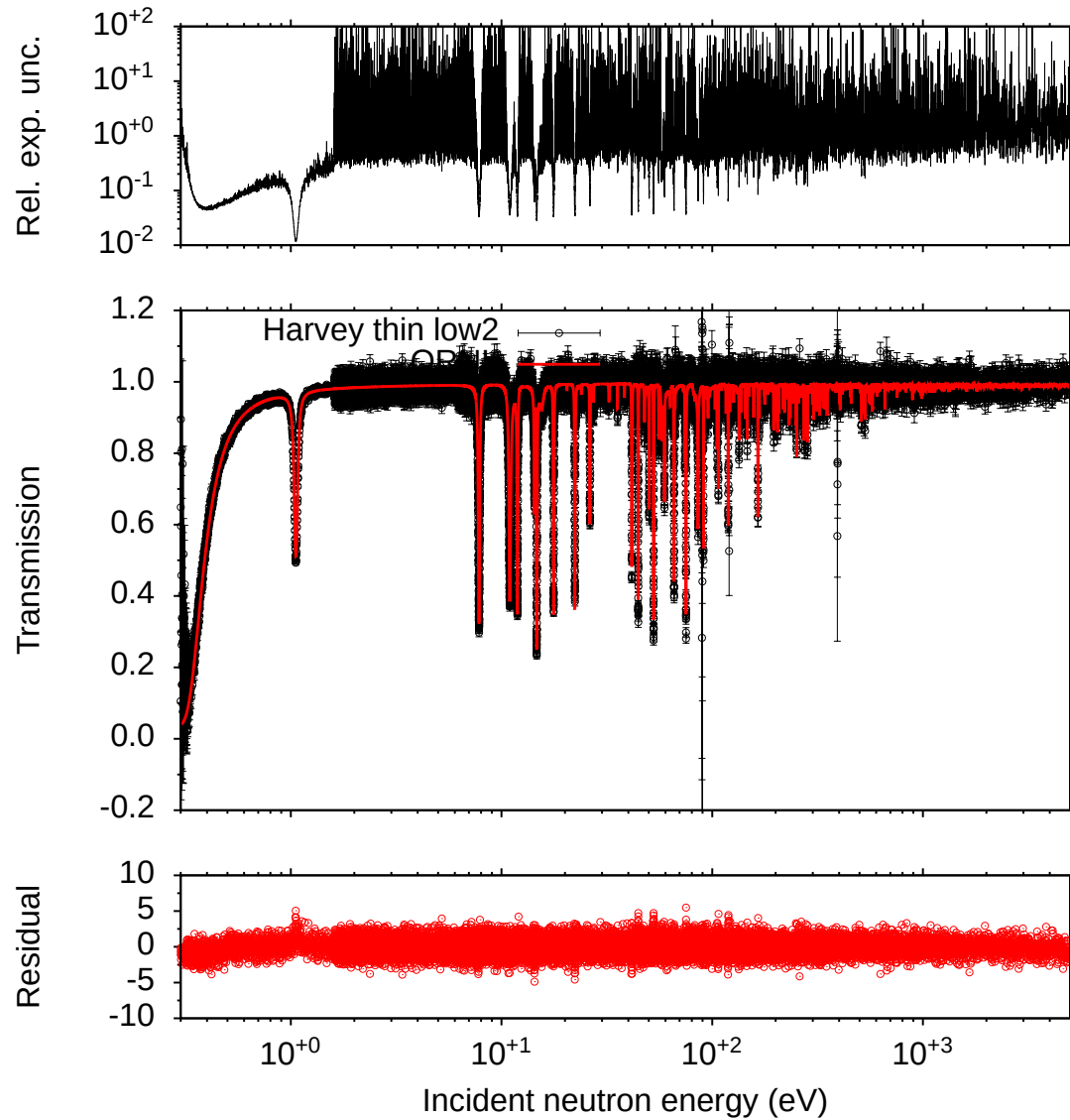


Fitting results (beta2)²



²Possible background subtraction problem for the thick transmission measurement on the right.

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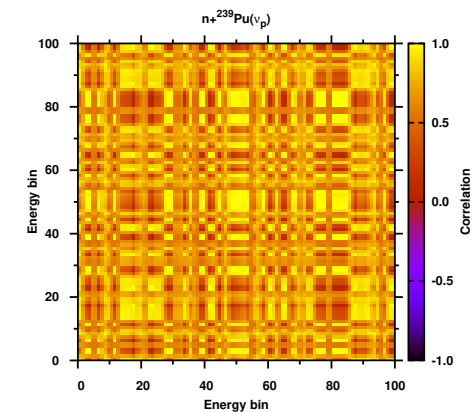
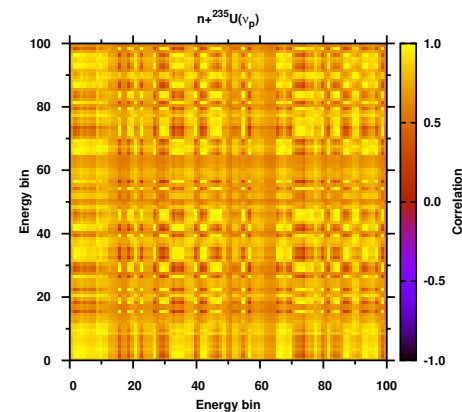
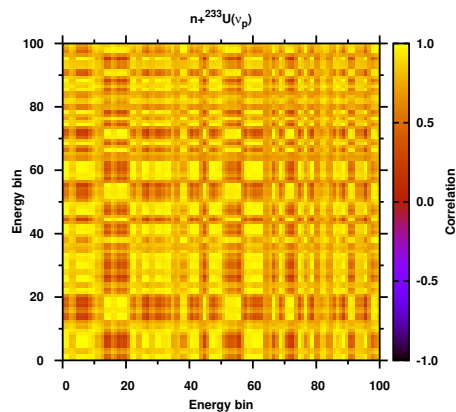
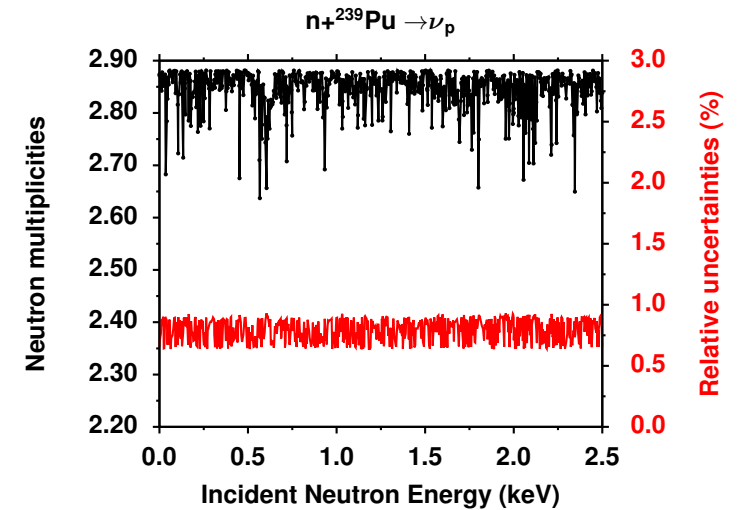
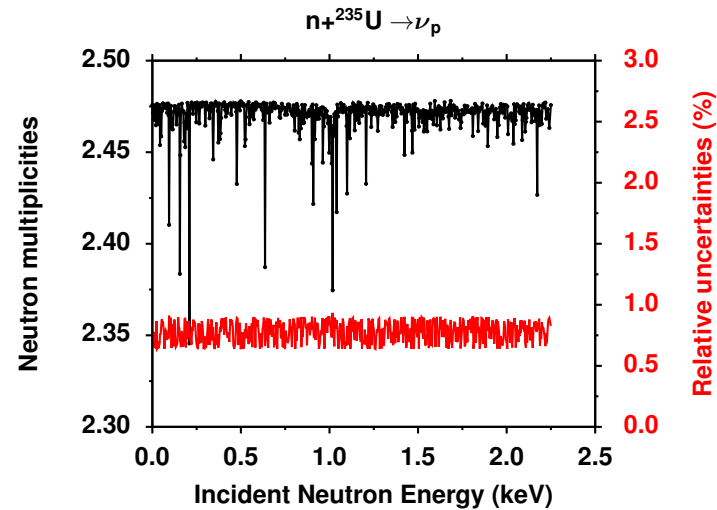
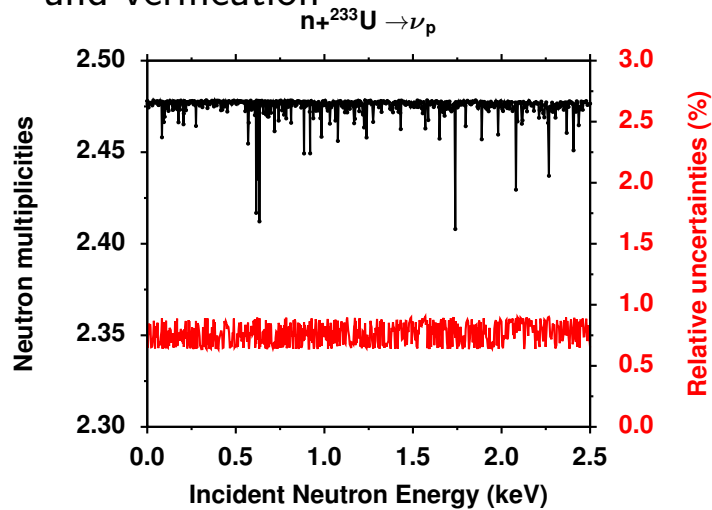


Uncertainty quantification

- Due to the large number of parameters, $^{233,235}\text{U}$ and ^{239}Pu covariance information was generated by a two-step procedure by SAMMY and AMPX
- The generated covariance information was reported in a pre-definite energy grid as a relative covariance matrix
- Energy dependent uncertainty systematically showing $\lesssim 1\%$ from thermal up to 10 eV and up to about 10% at high energies
- Neutron multiplicity uncertainty and correlations were calibrated to an average uncertainty of 0.75% by propagating model parameter uncertainty
- Covariance matrix exhibits correlation pattern related to fluctuating neutron multiplicities although overall correlations are close to unity
- For ENDF/B-VIII.0 β_2 release, refinement to the cross section uncertainties including a customized energy grid for each nucleus is planned

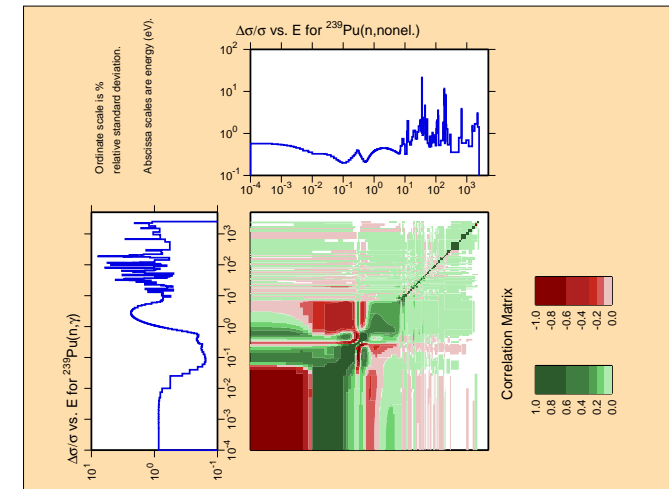
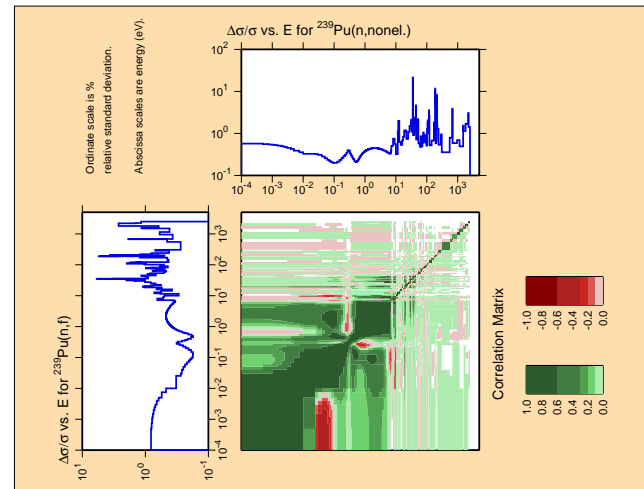
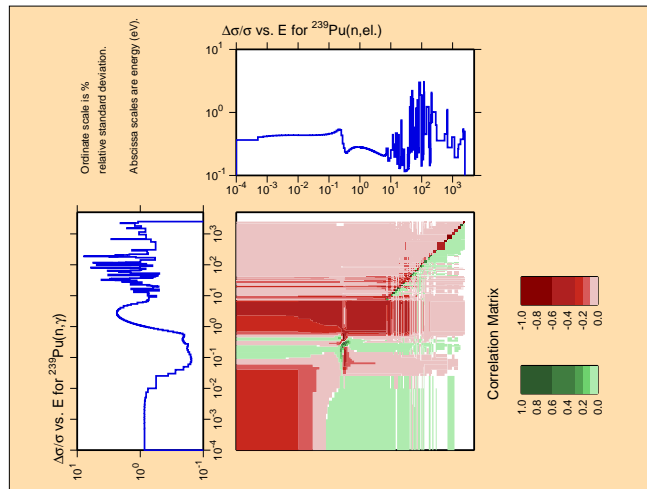
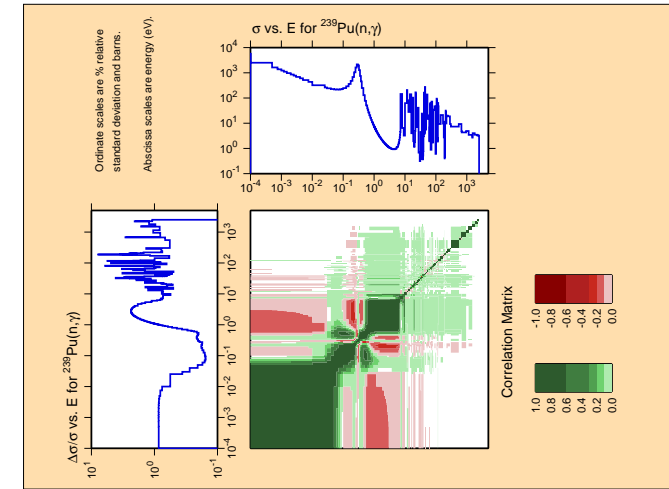
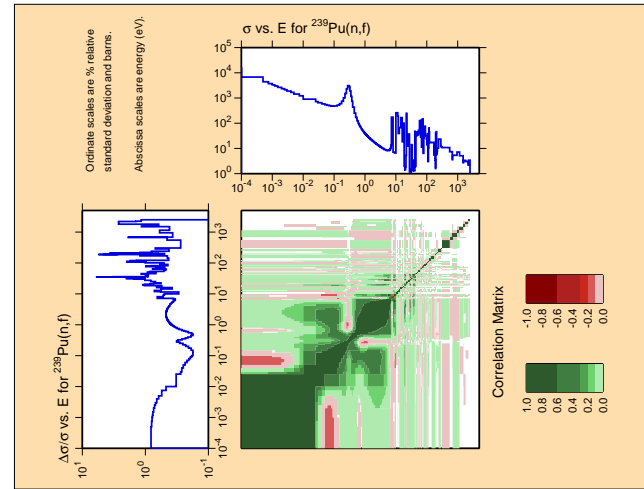
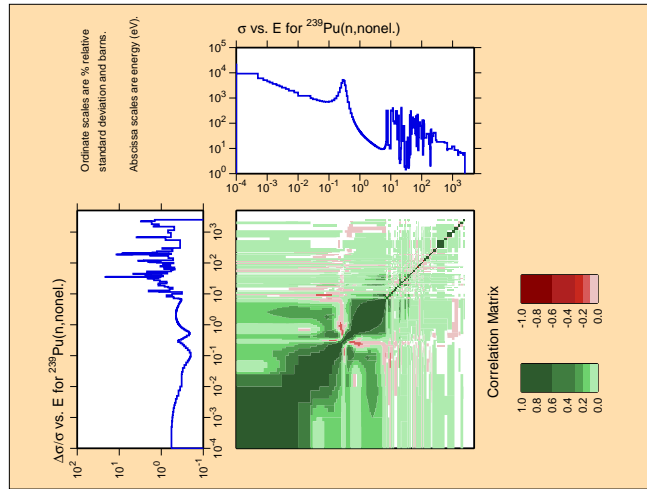
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Conclusions

- Analysis of energy dependence behavior of the η -function linked to benchmark performance
- Proposed updates of Pu RRR evaluation to ENDF β_2 consists of
 - RRR Extension up to 5 keV including Mosby's data
 - Comparable or improved performance to ENDF/B-VIII.0
 - A variation of about 1% in the η -function at 0.29 eV induces 40-50% variation in the PST series cumulative χ^2
 - Updates to the covariance information
- Full validation still in progress for extended PST series

ACKNOWLEDGMENTS

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ORNL TEAM: D. Wiarda, J. McDonnell, K. Ramic, K. Guber, T. Green, C. Chapman, J. Brown, G. Arbanas

Thank you!