Evaluation and Validation of the n+^{63,65}Cu Cross Sections

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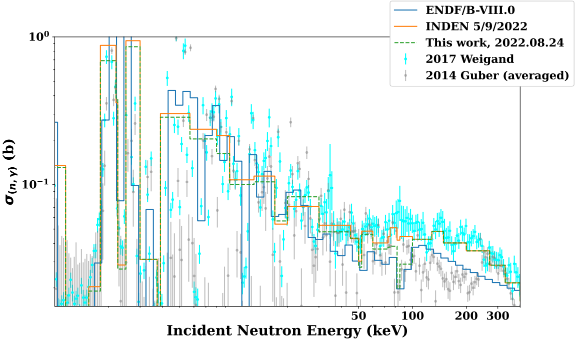
INTRODUCTION

Objective	Update n+^{63,65}Cu cross section evaluations with recently measured data to resolve discrepancies in benchmark performance
Model	*R*-matrix analysis; analysis of angular distribution coefficients
Validation	Rez shielding benchmark; ICSBEP criticality benchmarks

RESOLVED RESONANCE REGION

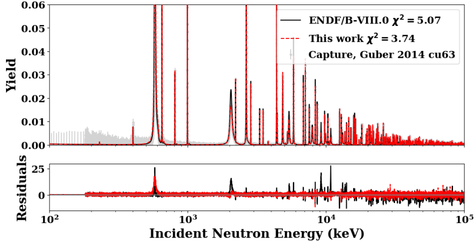
The primary challenge in the resolved resonance region was to resolve the discrepancy between the available measurements for ^{63}Cu(n,γ). The high resolution GELINA measurements (Guber, 2014) have a much lower capture yield above 20 keV than the lower resolution LANL measurements (Weigand, 2017).

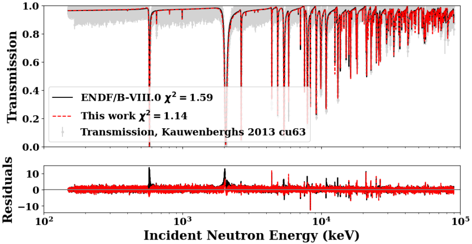
In this work, we normalized Guber's ^{63}Cu(n,γ) measurements above 20 keV by a factor of 20% to improve alignment with Weigand's measurements.



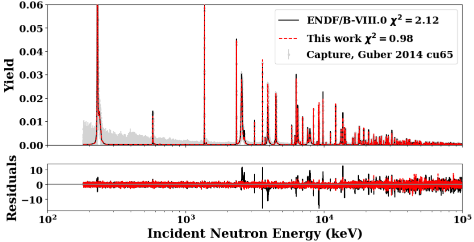
RESOLVED RESONANCE REGION

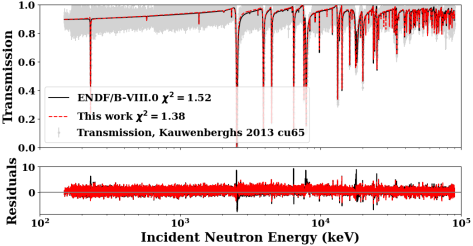
^{63}Cu





^{65}Cu

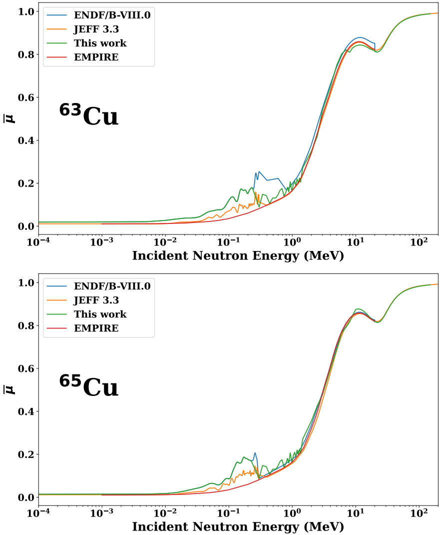




ANGULAR DISTRIBUTION PARAMETERS

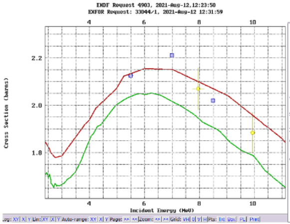
Our past work has demonstrated that the criticality benchmarks are highly sensitive to the $^{63,65}Cu$ angular distributions. Additionally, the ENDF/B-VIII.0 Legendre coefficients exhibited a discontinuity at the transition from the RRR to the fast region.

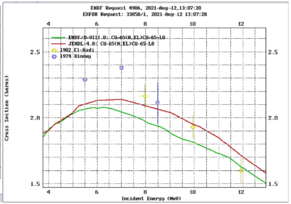
In this work, Legendre coefficients from experimental measurements by Popov (1986) and Smith (1967) are adopted from 100 keV to 1 MeV for both isotopes.



VALIDATION – SHIELDING BENCHMARK

In the fast region, ENDF/B-VIII.0 cross sections agree well with measurements up to 4 MeV, but deviate above 4 MeV.





The JENDL-4.0 cross sections agree with measurements above 4 MeV. Adopting the JENDL-4.0 above 4.0 MeV improves performance in the Rez shielding benchmark.

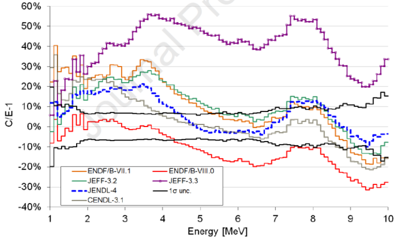
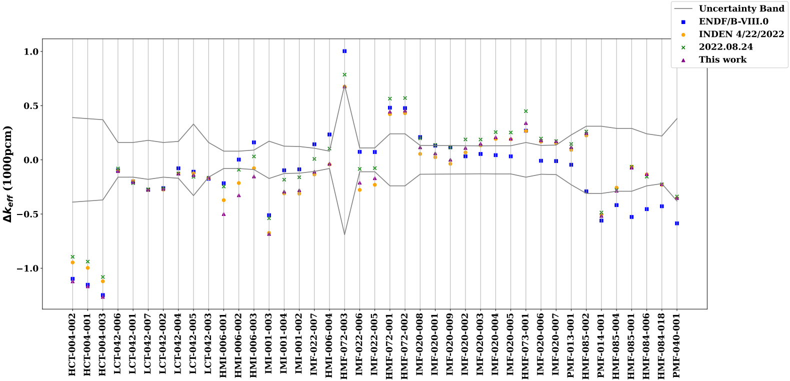


Figure 7: Neutron leakage spectra comparison for different libraries.

VALIDATION – REACTIVITY BENCHMARKS

The evaluation of this work leads to improved agreement between measured and calculated k_{eff} in ICSBEP criticality benchmarks. The adjustment to the Legendre coefficients contributes to overall agreement, and the increase in the ^{63}Cu capture cross section reduces the trend in the ZEUS (HMI-006) series with respect to EALF.



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CONCLUSION

- The $n+^{63,65}Cu$ cross sections have been updated via *R*-matrix analysis up to 100 keV.
- An increased average capture cross section and the adoption of experimentally-based Legendre coefficients lead to improved performance in reactivity benchmarks.
- In the fast region, the adoption of the JENDL-4.0 cross sections above 4.0 MeV improves the performance in shielding benchmarks.
- The $n+^{63,65}Cu$ ENDF files will be submitted to ENDF/B-VIII.1.

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