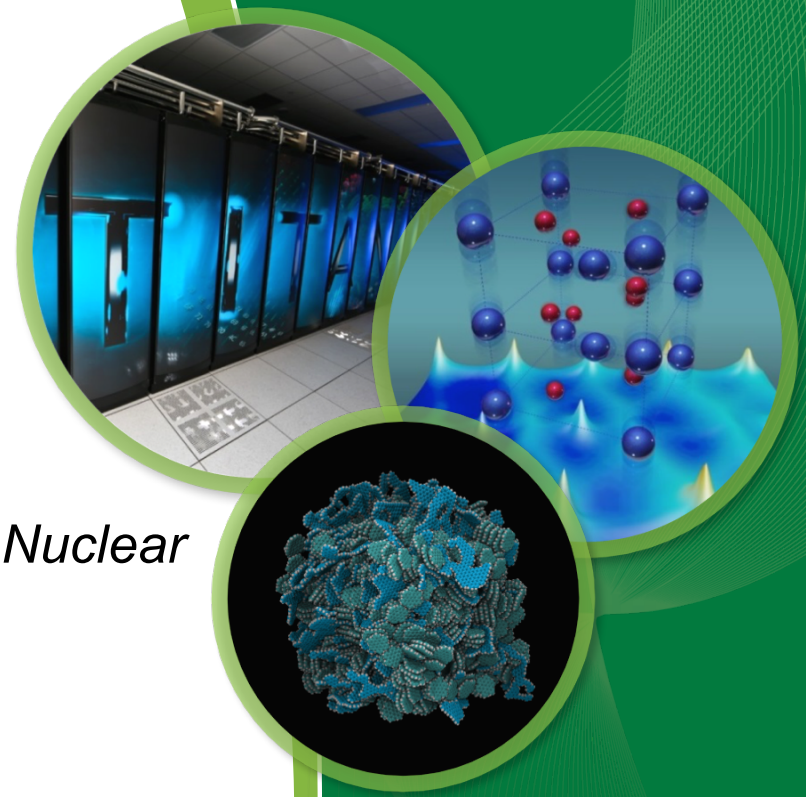
Finalizing the ^{63}Cu and ^{65}Cu Resonance Evaluation for the ENDF/B-VIII Release



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ANS Winter Meeting & Expo
November 6-10, 2016
Caesars Palace
Las Vegas, NV

Recent Nuclear Criticality Safety Program Technical Accomplishments

ORNL is managed by UT-Battelle
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Resolved Resonance Region Evaluation of ^{63}Cu and ^{65}Cu

Physics Improvement

1. Experimental thermal cross section measurement
2. Upper limit of resonance evaluation extended from 99.5 keV to 300 keV
3. Experimental capture data analyzed
4. Angular distribution updated
5. Resonance parameter covariance matrix calculated

Neutron Transport Motivation

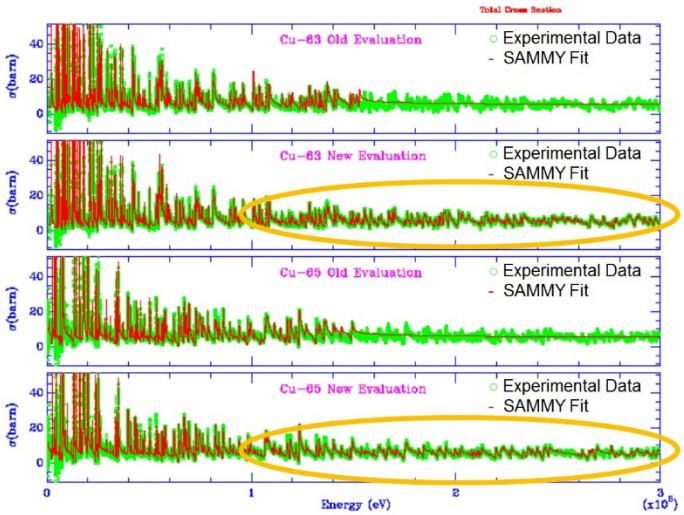
1. Improve the shape of the cross section in the thermal region
2. Extend resonances into harder neutron spectrum
3. Set the capture/scattering ratio based on experimental data
4. Important for reflector efficiency
5. Enables studies of propagation of nuclear data uncertainty for applications

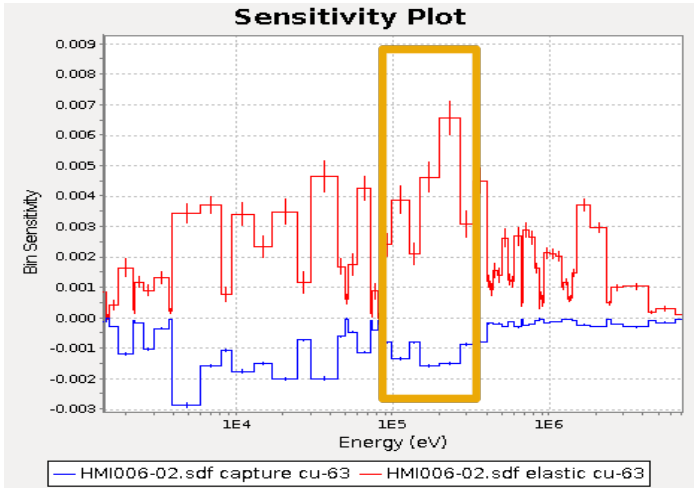
Experimental Data Used in the New Evaluation

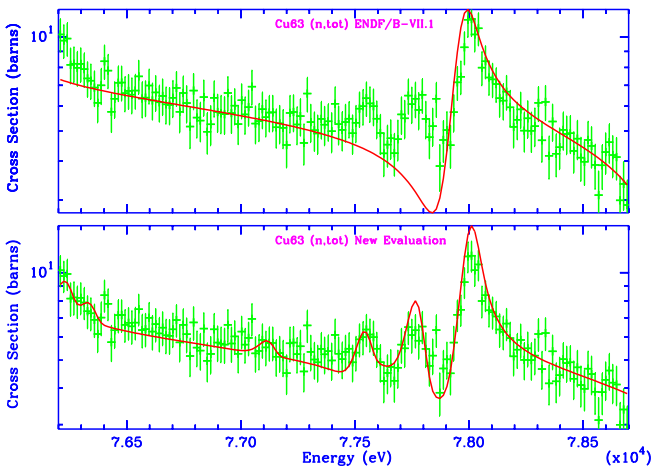
Reference	Energy Range (eV)	Facility	Measurement
Pandey et al.	32 – 185 000	ORELA	Trans. at 78 m
Pandey et al.	1 000 – 1 400 000	ORELA	Trans. at 78 m
Guber et al.	100 – 90 000	GELINA	Cap. at 58 m
Guber et al.	100 – 2 200 272	GELINA	Cap. at 58 m
Sobes et al.	0.01 – 0.1	MITR	Trans. at 1.2 m

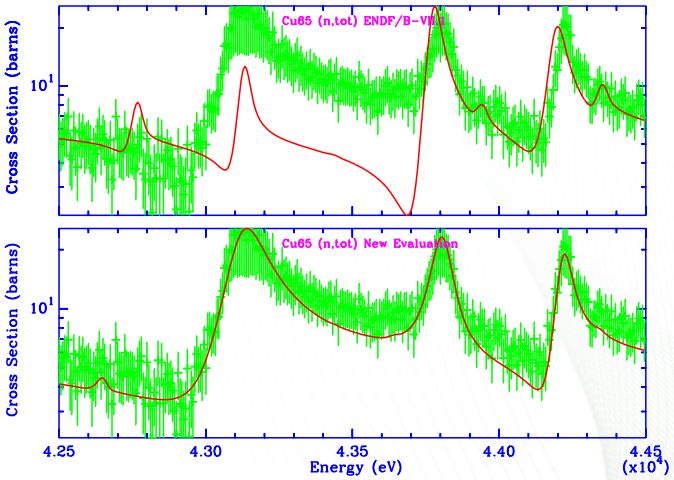
Extending the Resolved Resonance Region

Resolved resonance region of both copper isotopes, has been extended from 99.5 keV to 300 keV.

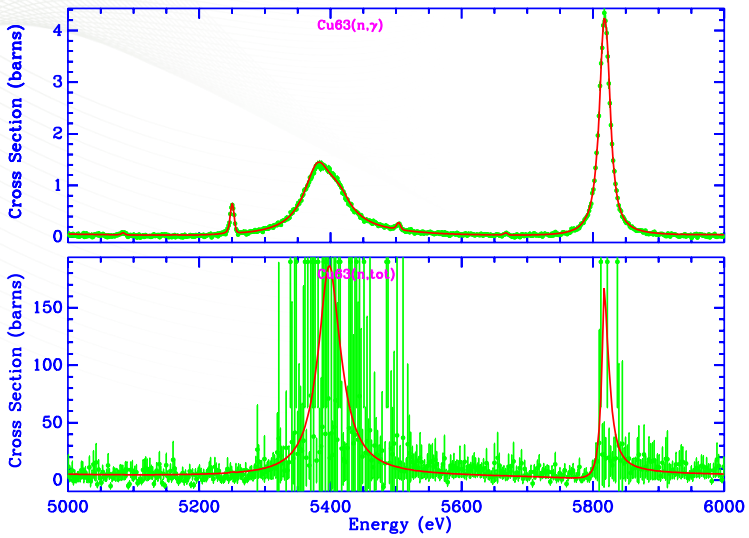


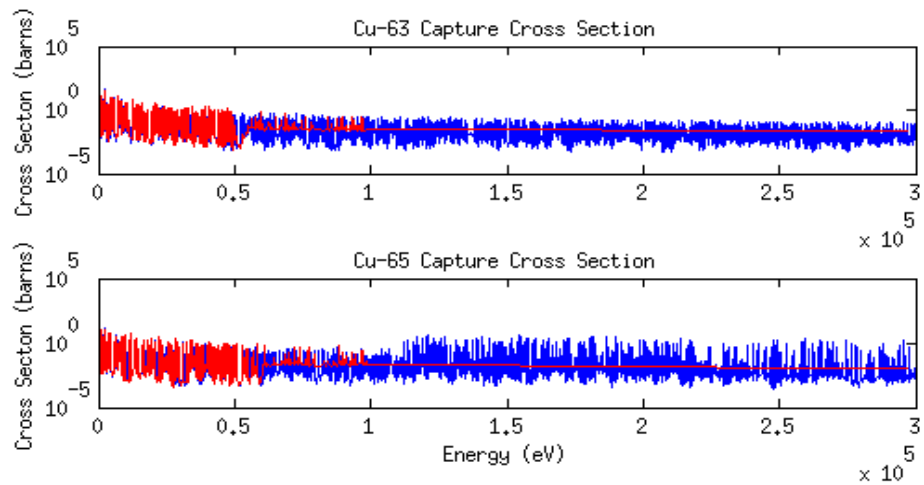


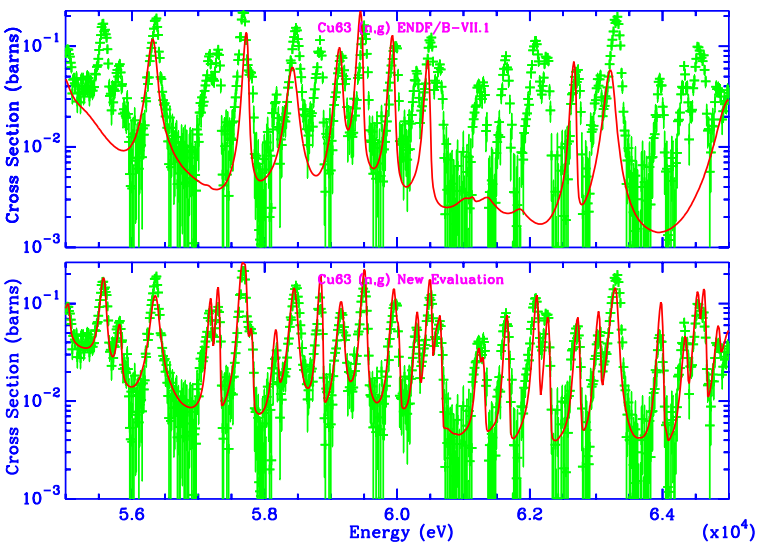


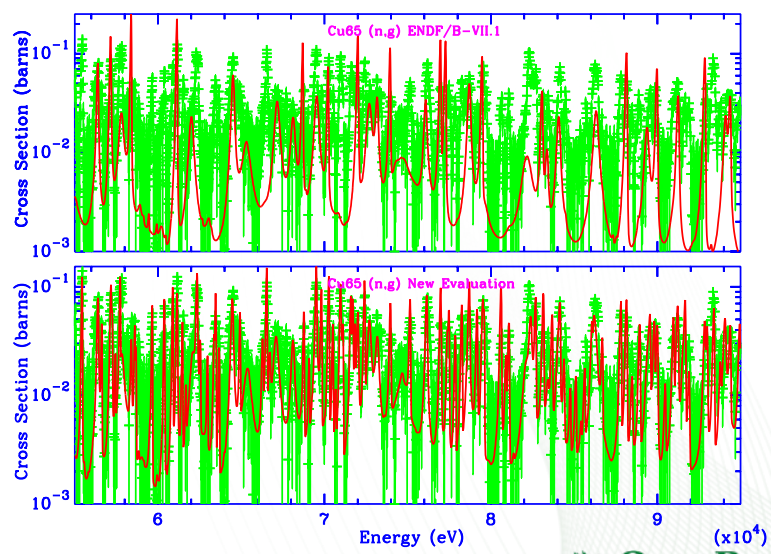


New Capture Measurements to set Capture to Scattering Ratio









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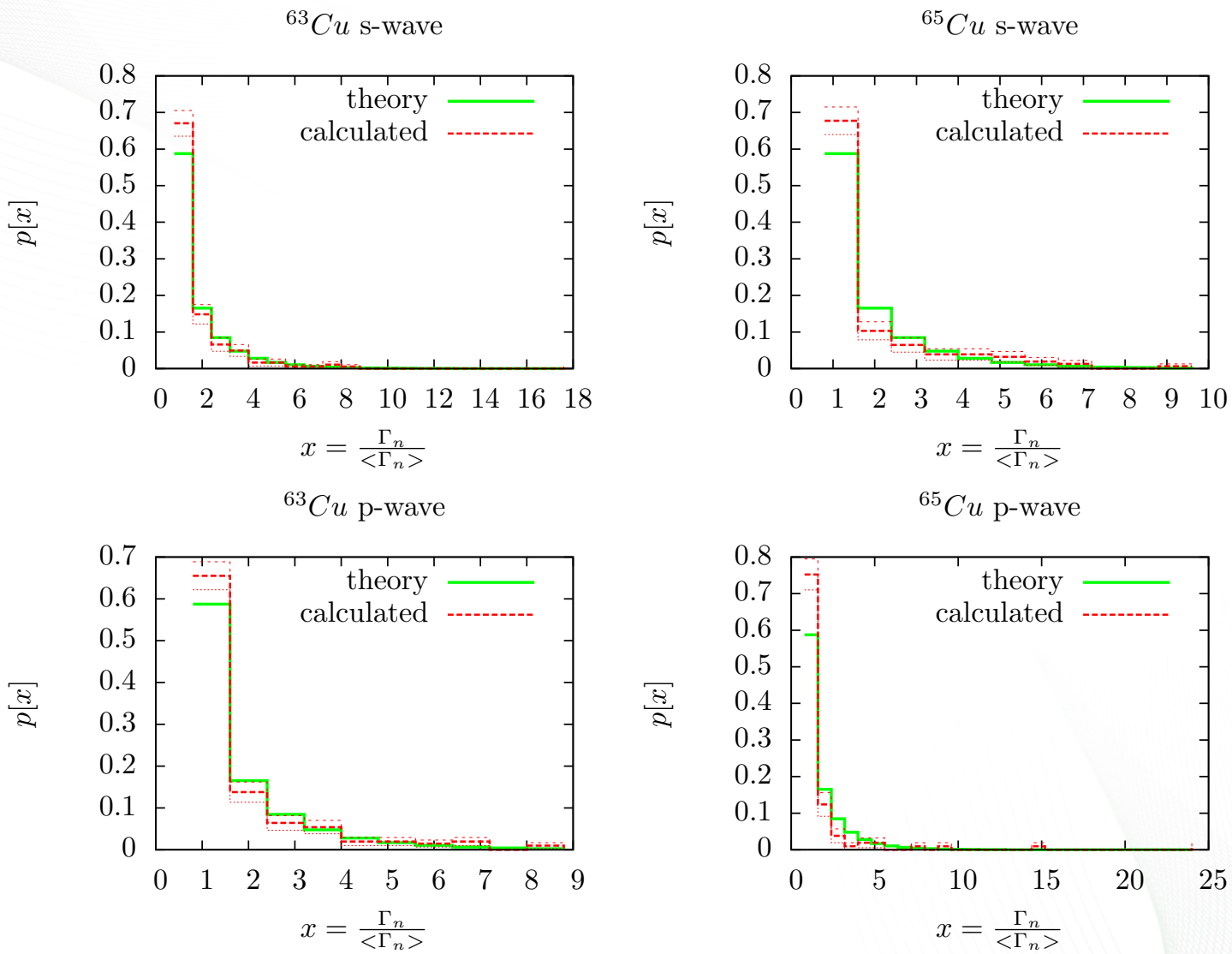
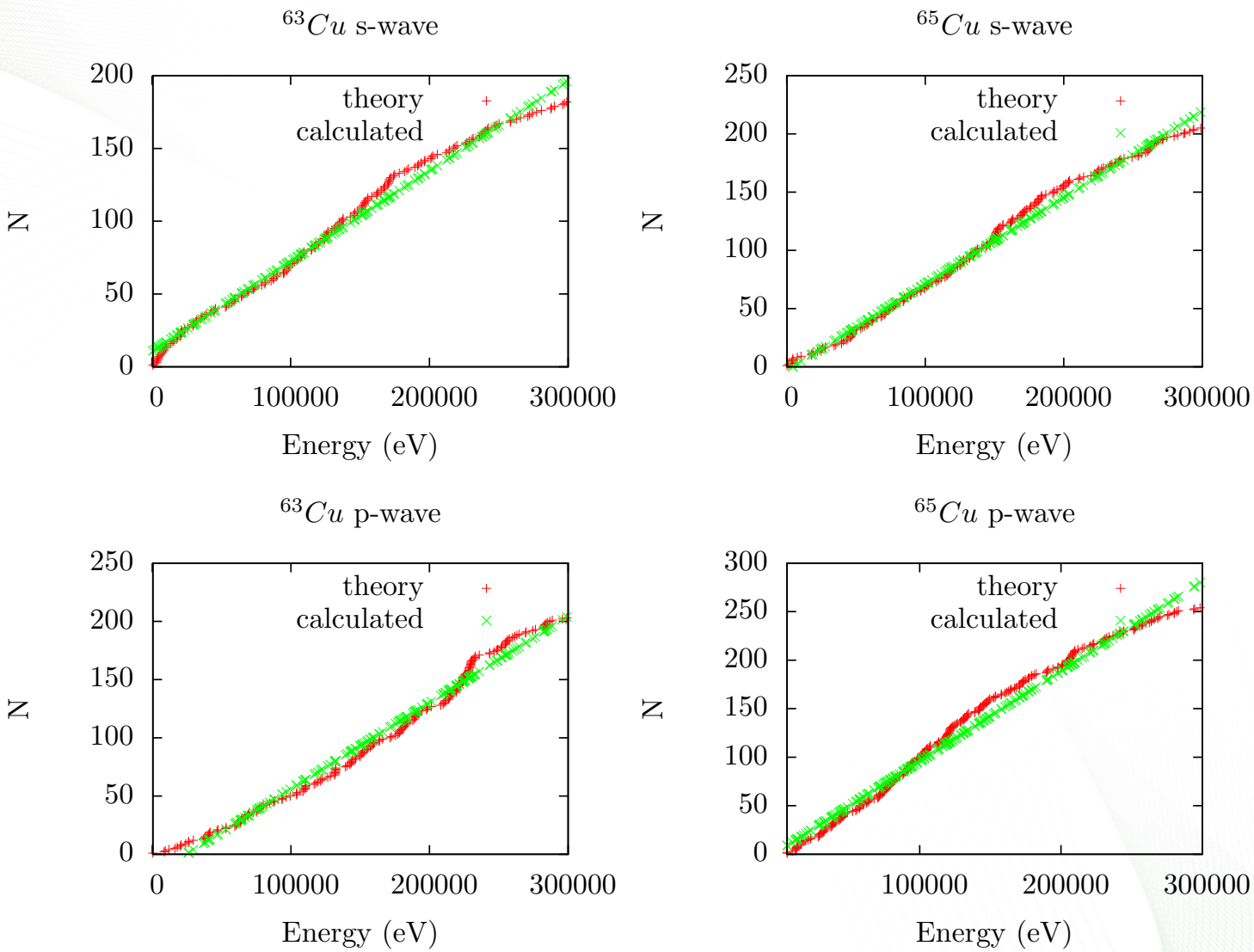
Resonance Statistics

	^{63}Cu		^{65}Cu	
	Atlas of N. Res.	New Evaluation	Atlas of N. Res	New Evaluation
Thermal capture	4.50 b	4.47 b	2.17 b	2.14 b
Scattering radius	6.7 fm	6.7 fm	6.7 fm	6.7 fm
Avg. Lv. Spacing, s-wave	722 eV	563 eV	1520 eV	835 eV
Avg. Lv. Spacing, p-wave	404 eV	543 eV	628 eV	506 eV
Avg. Cap. Width, s-wave	0.500 eV	1.140 eV	0.395 eV	0.534 eV
Avg. Cap. Width, p-wave	0.260 eV	0.532 eV	0.370 eV	0.432 eV
Resonance Capture Integral	4.8 b	4.85 b	2.18 b	2.14 b

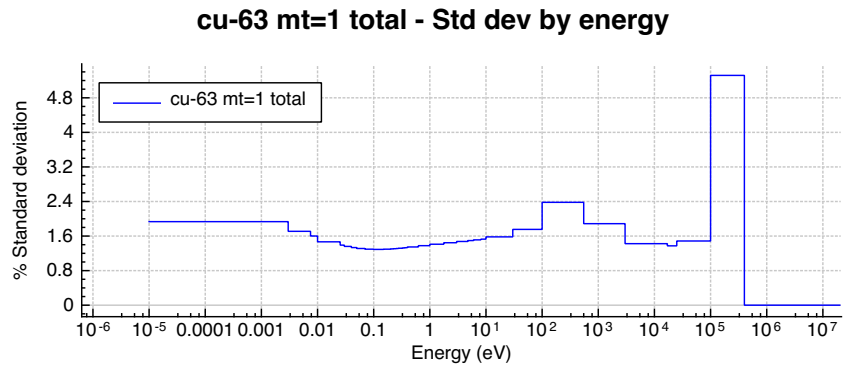
Porter-Thomas Distribution

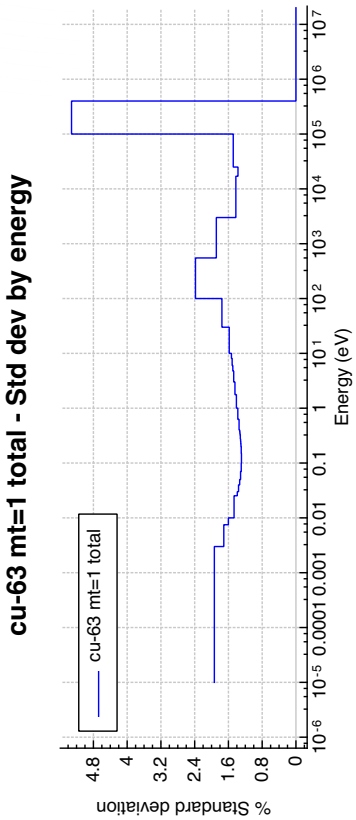


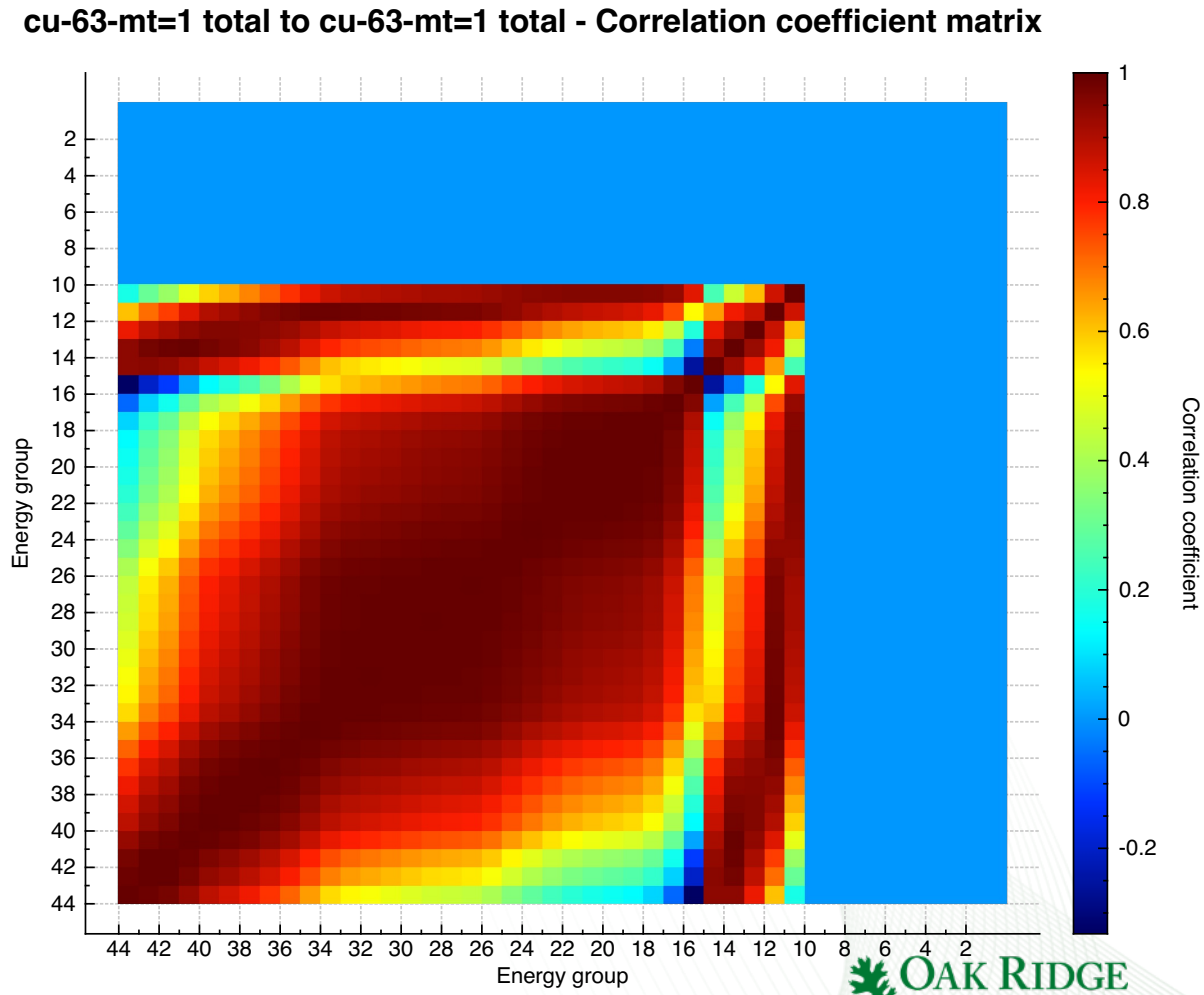
Cumulative Number of Levels



Resonance Parameter Covariance Propagated to Cross Section







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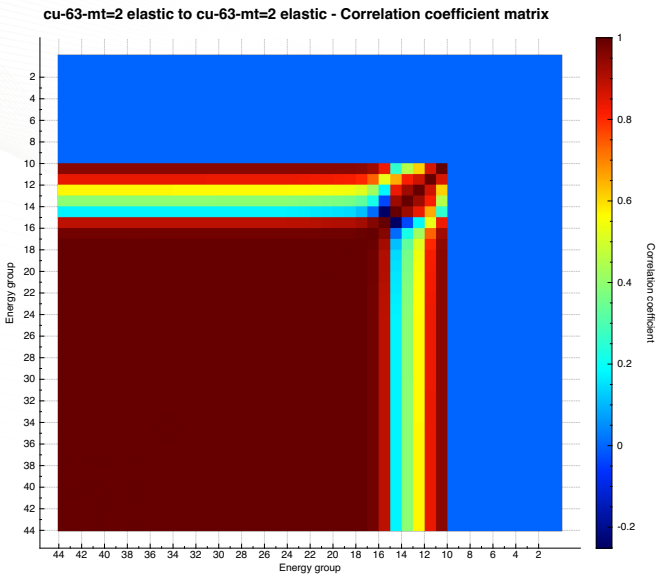
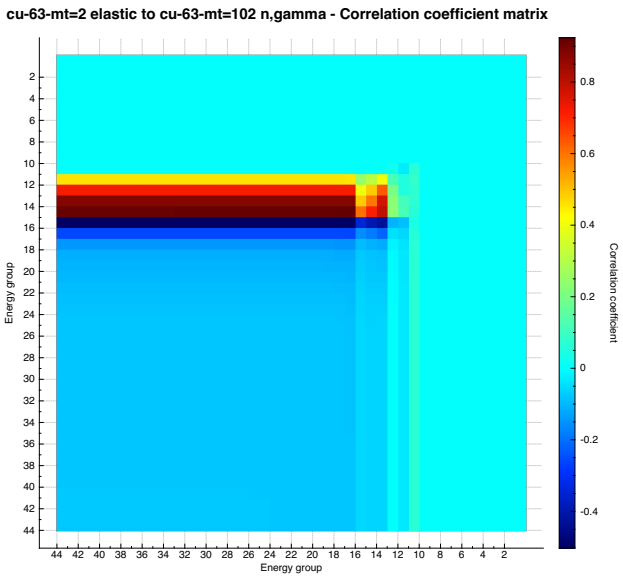
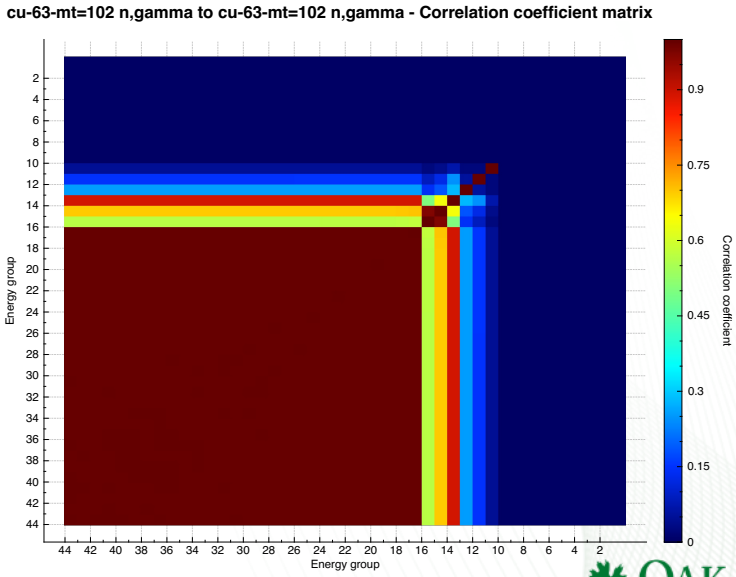
Cross-reaction Correlation Matrices

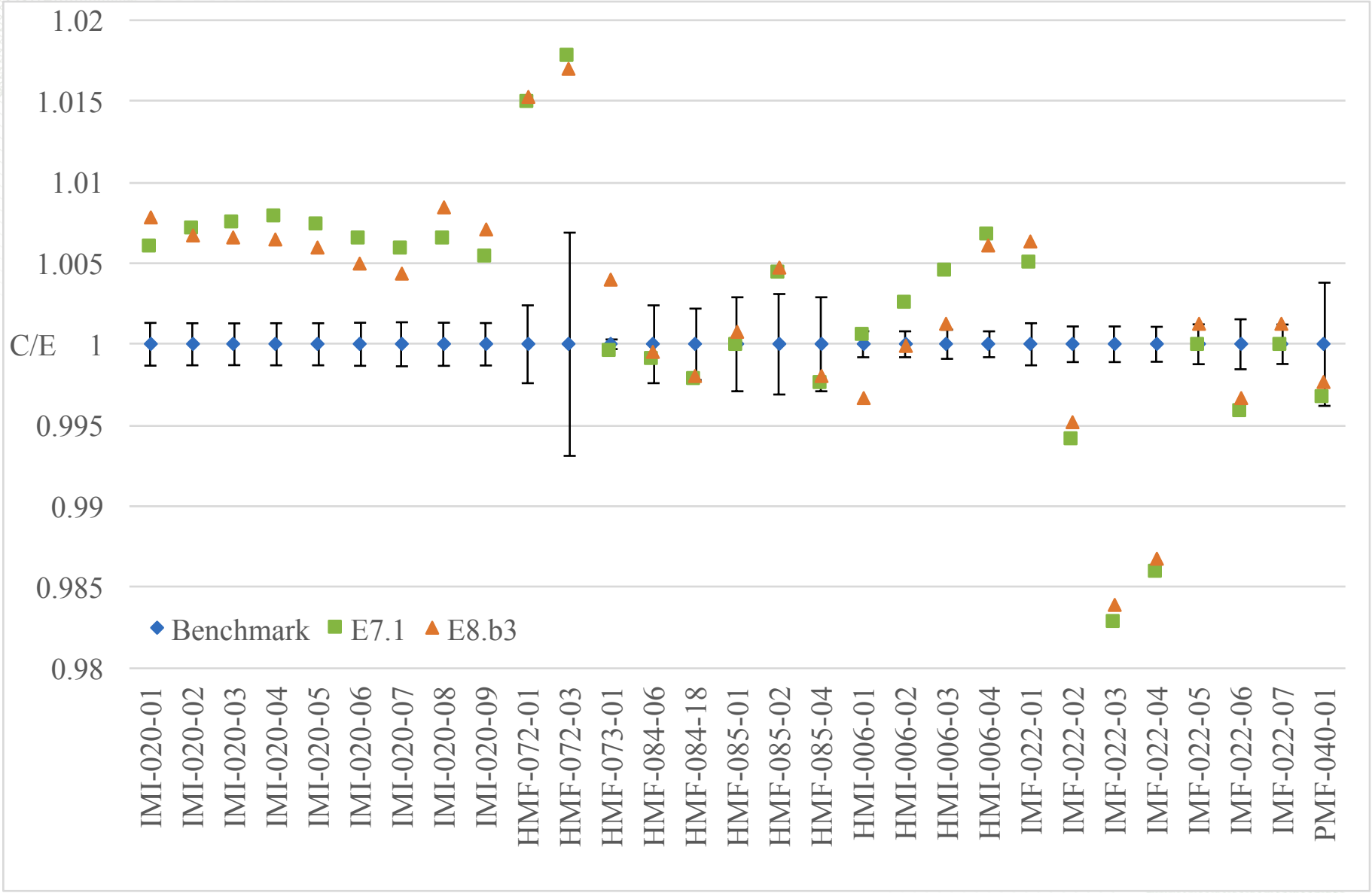




- Resonance parameter covariance matrix enables computation of energy-wise correlations for all pairs of reactions in the RRR



ICSBEP Benchmark Results



Conclusions

1. New RRR evaluation fits experimental measurements up to 300 keV

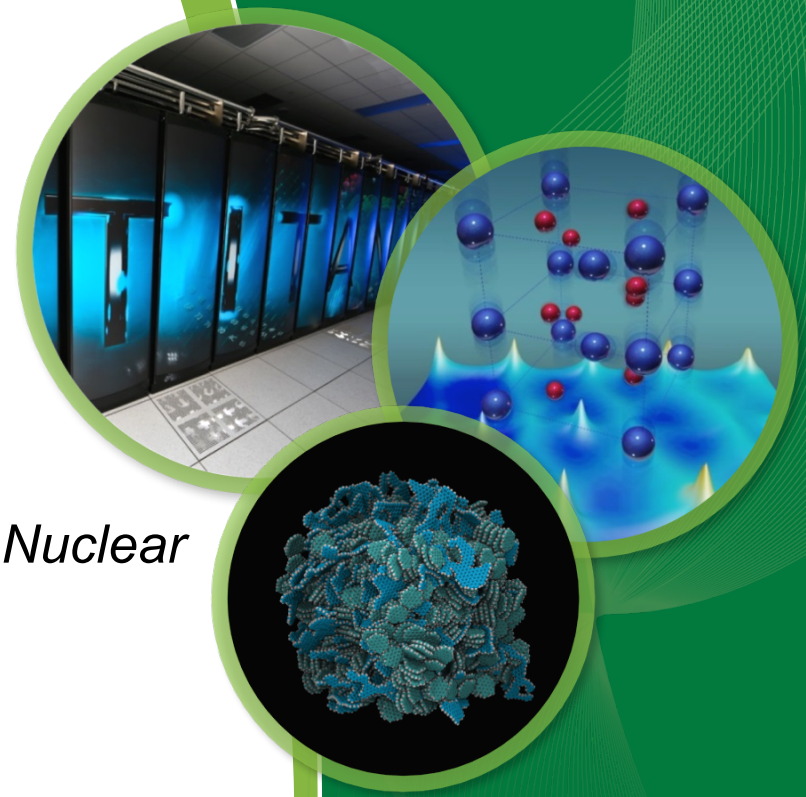
2. Resonance parameter statistics confirmed/updated with increased upper RRR energy

3. Resonance Parameter Covariance Matrix calculated enables propagation of nuclear data uncertainty

4. Improvement in ICSBEP benchmark results over ENDF/B-VII.1 Cu evaluations.

5. Thanks to the NCSP for continued support!

Finalizing the ^{63}Cu and ^{65}Cu Resonance Evaluation for the ENDF/B-VIII Release



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