Improved Calibration of Nuclear Resonance Parameters

MTV Kickoff Meeting

May 20th, 2019

Chris Perfetti
University of New Mexico

Introduction and Motivation

- High-fidelity nuclear cross section data is vital to the accuracy of modeling and simulation tools in various nonproliferation applications (fissile material quantification, criticality, etc.)
- Significant uncertainties (more than 50%) exist in key actinide neutron cross sections.
- Critical experiments have been performed to help data scientists verify the accuracy of their evaluations.

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- Our goal is to use integral benchmark experiment data to improve the fidelity of nuclear data evaluations and nuclear data uncertainty estimates.
- This goal will be accomplished by using data assimilation methods to "calibrate" nuclear data evaluations.

Mission Relevance

- High-fidelity nuclear data (in particular for fission cross sections) is necessary for the detection, characterization and tracking of nuclear materials and equipment.

- This work will improve the accuracy of cross section data using already existing experimental data.
  - Potential exists to extend these methods to other nuclear data.

Technical Work Plan: Data Assimilation

TSURFER: *T*ool for *S*/*U* analysis of *R*esponse *F*unctionals using *E*xperimental *R*esults

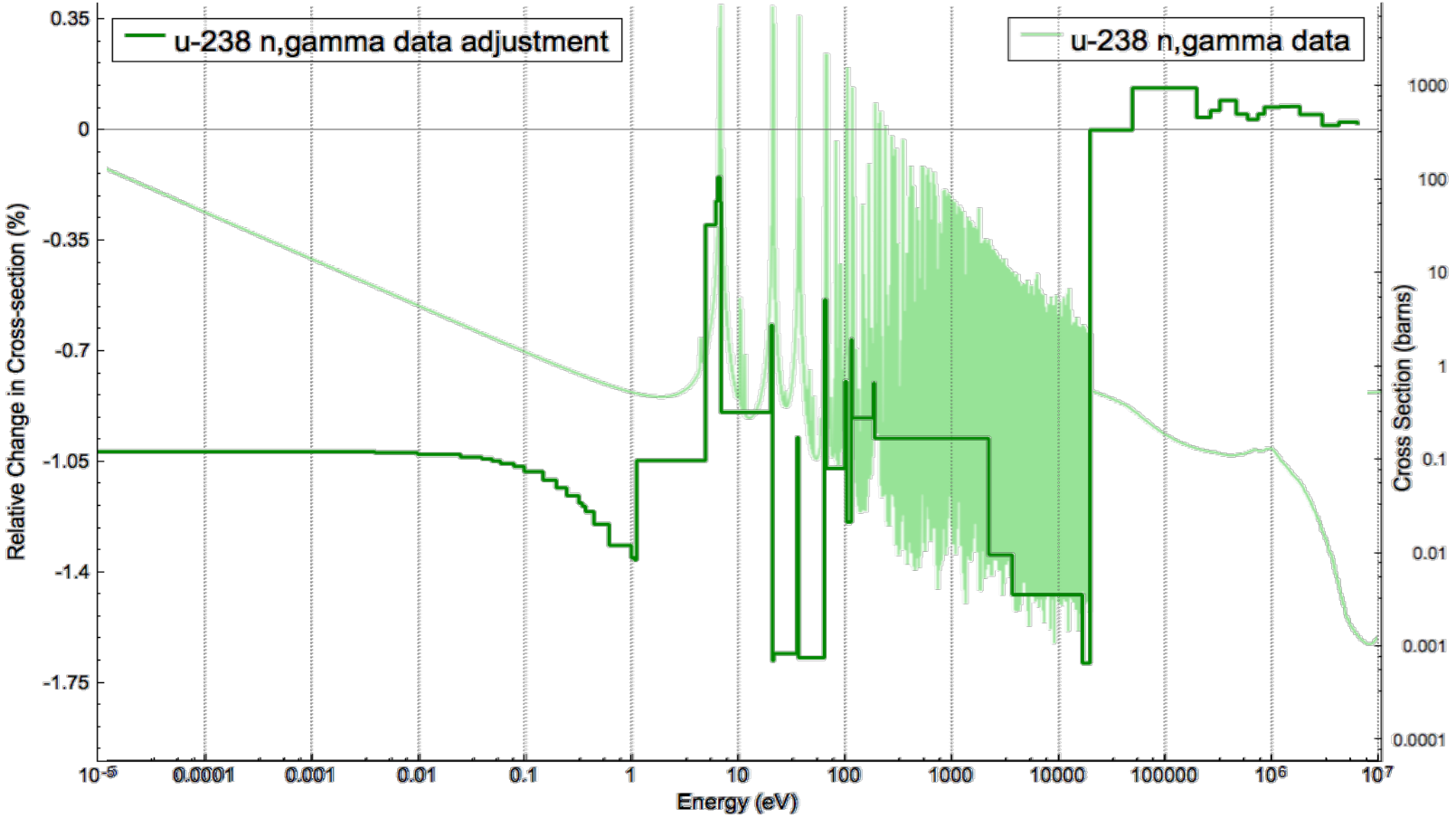
Uses sensitivity information to **consistently** adjust nuclear cross section data and reconcile biases between integral experiment results and computational predictions.

$$S_{f(x),\,x} = \frac{\partial f(x) / f(x)}{\partial x / x}$$

Modified cross section and cross section uncertainty data is used to anticipate computational biases in criticality safety applications.

Technical Work Plan:
Realistic Cross Section Adjustments?

- TSURFER adjusts multigroup (i.e. energy-averaged) cross sections.
- This approach cannot generate usable nuclear data evaluations.



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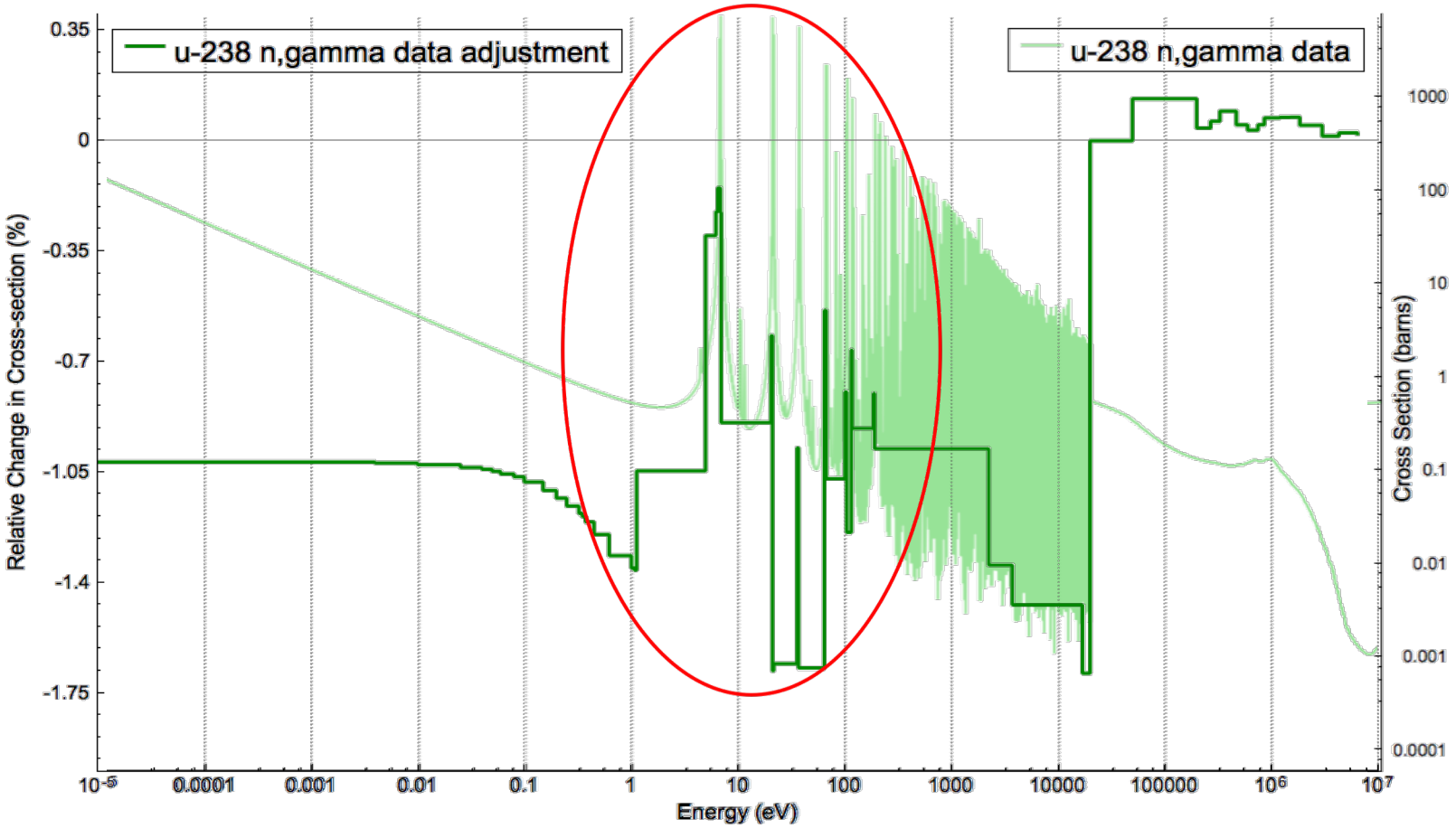

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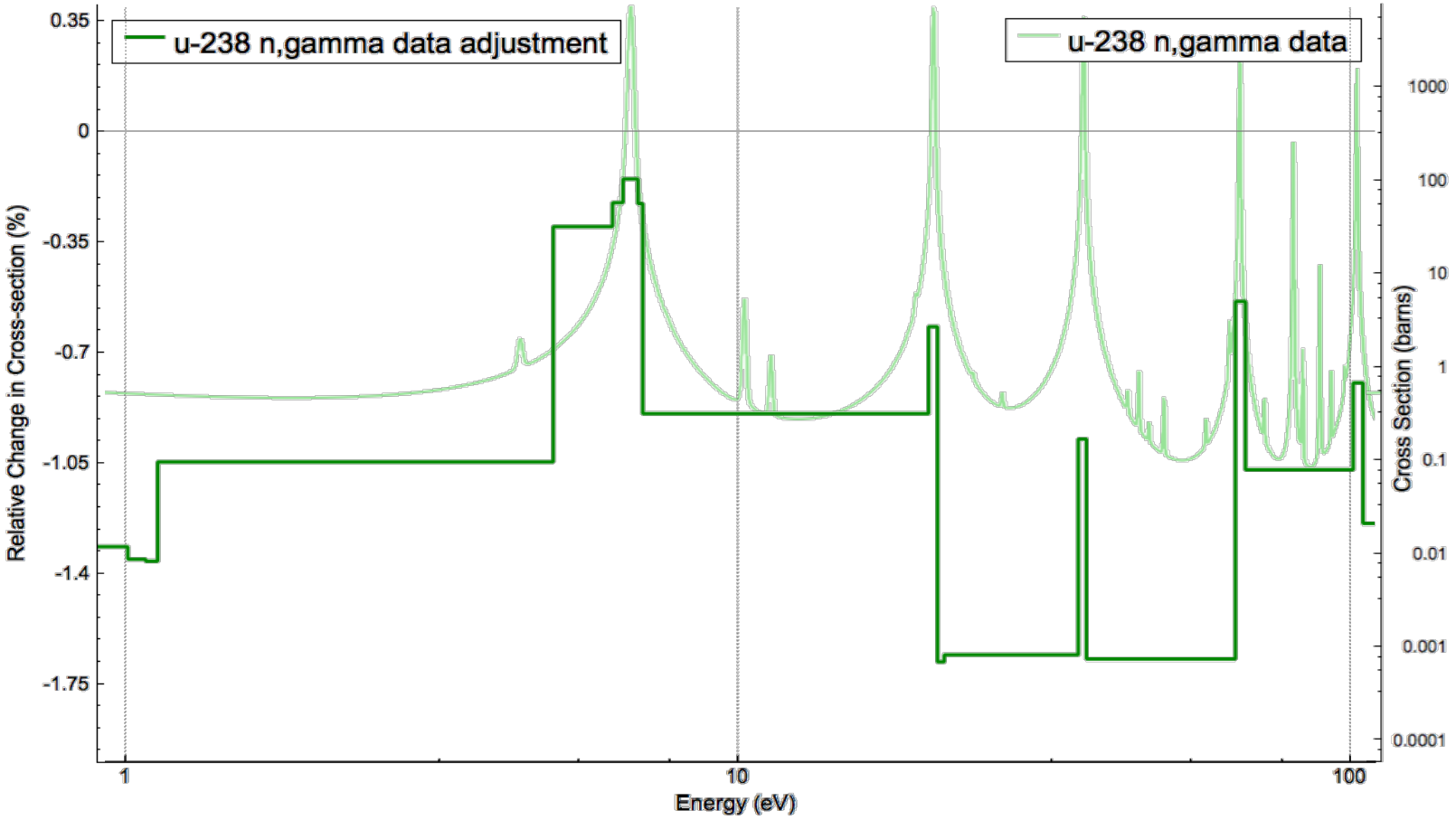


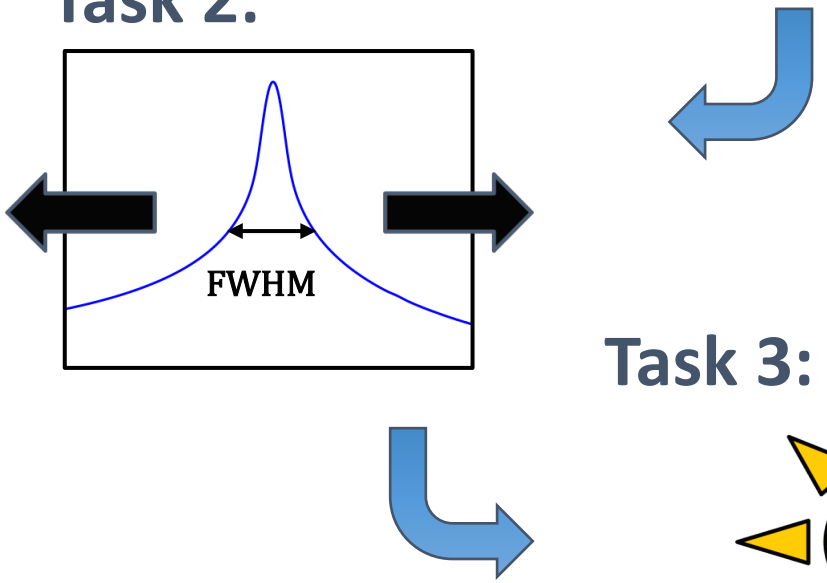
Technical Work Plan

- **Task 1:** Develop a resonance parameter sensitivity capability.
- **Task 2:** Modify TSURFER to assimilate experimental data by adjusting fundamental nuclear data.
- **Task 3:** Evaluate the accuracy of nuclear data and nuclear covariance adjustments.

Task 1:

$$S_{f(x),\,FWHM} = \frac{\partial f(x) / f(x)}{\partial FWHM / FWHM}$$

Task 2:



Task 3:

Technical Work Plan

Year 1:

- Develop resolved resonance sensitivity capability.

Year 2:

- Modify TSURFER to allow resolved resonance data adjustment.
- Demonstrate capability.

Year 3:

- Develop unresolved resonance sensitivity capability.

Year 4:

- Develop sensitivity capability for fast energy model parameters.

Year 5:

- Modify TSURFER to allow adjustment of all nuclear data parameters.
- Demonstrate capability.

Technical Work Plan

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- Develop resolved resonance sensitivity capability.

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- Develop sensitivity capability for fast energy model parameters.

Year 5:

- Modify TSURFER to allow adjustment of all nuclear data parameters.
- Demonstrate capability.

- All work will be performed in cooperation with **Oak Ridge National Laboratory** and **Los Alamos National Laboratory**.

Expected Impact + MTV Impact

If successful, this work will produce:

- More accurate nuclear data evaluations.
- More accurate nuclear data covariance (uncertainty) estimates.
- The first methodology for consistently evaluating nuclear data while considering the results of integral experiments.
- Potential for improving the accuracy of non-cross section nuclear data.

This work will continue to develop research opportunities and personnel pipelines between UNM, ORNL, and LANL.

Conclusions - Recap on Mission Relevance

- High-fidelity nuclear data (in particular for fission cross sections) is necessary for the detection, characterization and tracking of nuclear materials and equipment.

- This work will improve the accuracy of cross section data using already existing experimental data.

Acknowledgements

The Consortium for Monitoring, Technology, and Verification would like to thank the NNSA and DOE for the continued support of these research activities.

This work was funded by the Consortium for Monitoring, Technology, and Verification under Department of Energy National Nuclear Security Administration award number DE-FOA-0001875