Nuclear Data Adjustment with SAMMY Based on Integral Experiments

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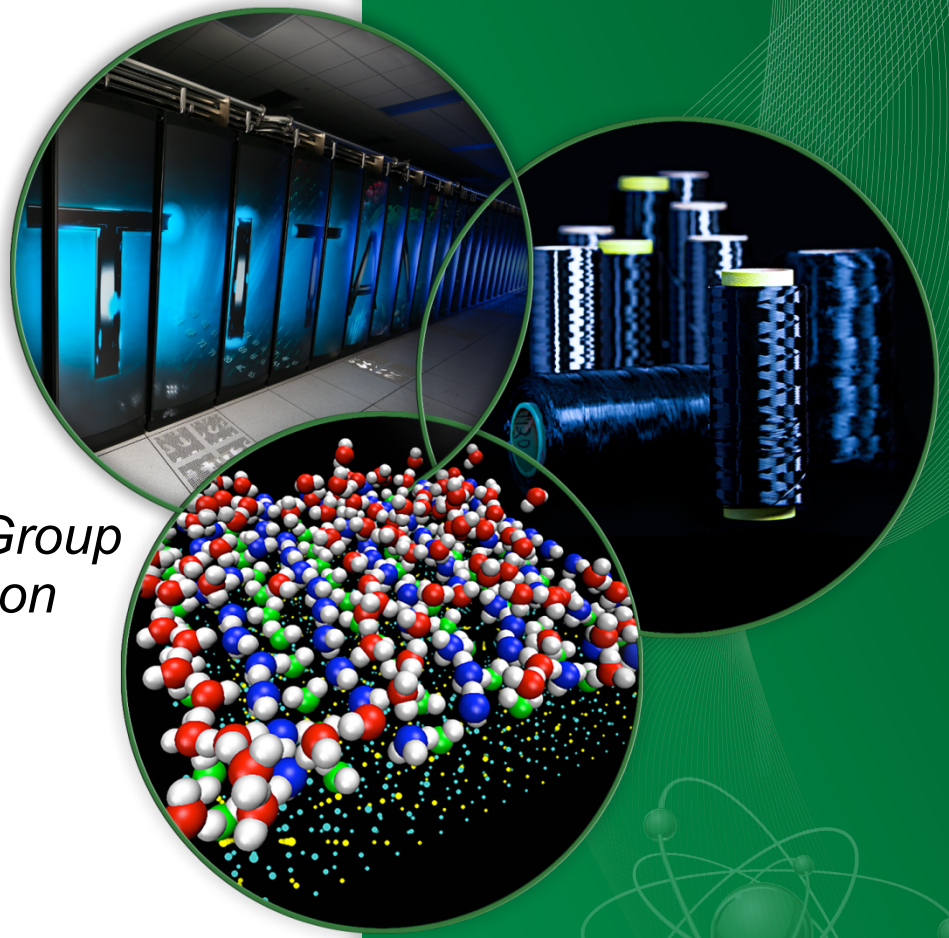

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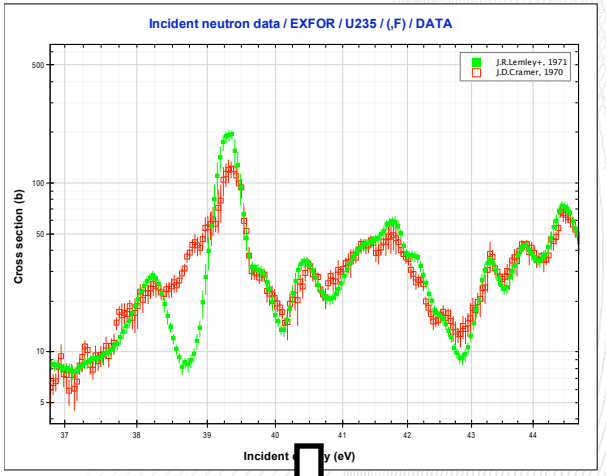
SAMINT: A Code for Nuclear Data Adjustment with SAMMY Based on Integral Experiments

- Allow coupling of differential and integral data evaluation in a continuous-energy framework
- Update the parameters of a resolved resonance region evaluation directly based on integral benchmark experiments

Traditional SAMMY Evaluation

- Traditionally SAMMY has used differential experimental data ($\sigma(E_i)$ vs E_i) to adjust nuclear data parameters:
  - Resonance energies
  - Resonance widths
  - Number of prompt neutrons per fission
  - Etc…
- Integral experimental data, such as ICSBEP benchmarks, have remained only a tool for validation of completed nuclear data evaluations.



SAMMY

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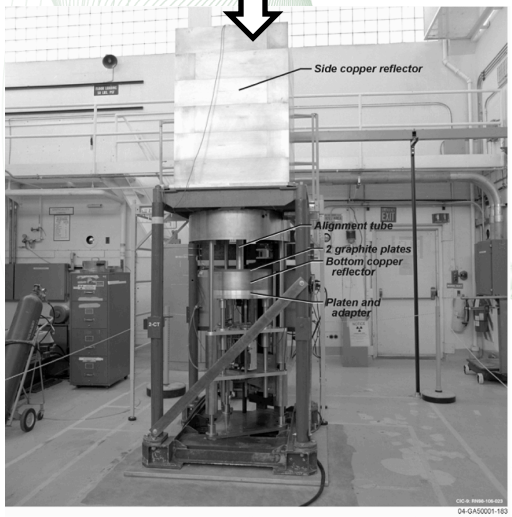

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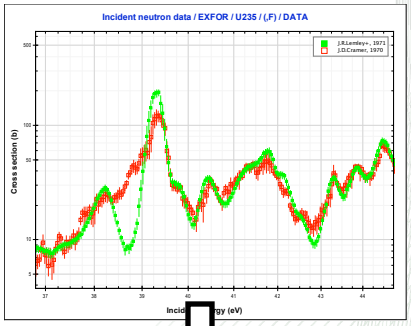
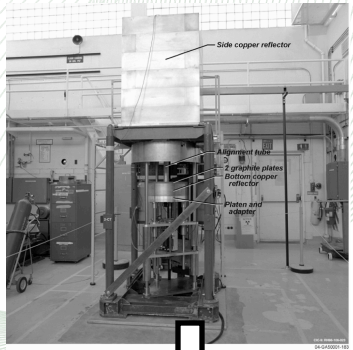
Integral Experiments to Aid Nuclear Data Evaluation

- SAMINT can be used to extract information from integral benchmarks to aid the nuclear data evaluation process.
- Near the end of the evaluation based on differential experimental data, integral data can be used to:
  - Resolve remaining ambiguity between differential data sets
  - Guide the evaluator to troublesome energy regions
  - Inform the evaluator of the most important nuclear data parameters to integral benchmark calculations
  - Improve the nuclear data covariance matrix evaluation





SAMMY

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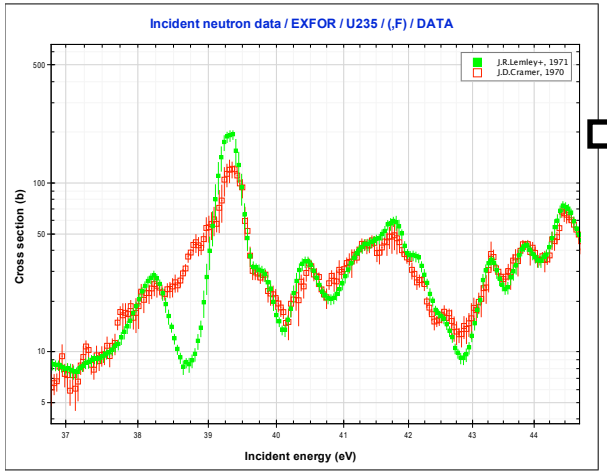
SAMINT
Proper Uses

- SAMINT **is not intended** to bias the nuclear data towards fitting a certain set of integral experiments
- SAMINT should be used to **supplement** evaluation of differential experimental data
- Using the GLLS methodology ensures that the update nuclear data parameters respect the original fit of the differential data

Using SAMINT with SAMMY

Differential Experimental Data



Integral Experimental Data

SAMMY → dσ(E)/dP → SAMINT → dk/dP → SAMMY → Updated P and δP → ENDF

SAMINT ← dk/dσ(E) ← CE TSUNAMI MCNP-6

P stands for all resonance parameters: E_λ, Γ_γ , Γ_n , Γ_f , etc.

SAMINT Today and Tomorrow

Current Capabilities

- Adjusting resolved resonance parameters and associated covariance
- Adjusting number of prompt neutrons per fission
- Calculating continuous energy cross sections and eta values (reactor physics) to satisfy integral benchmarks
- Works with both CE TSUNAMI and MCNP-6 k-eigenvalue sensitivities
- Iteration for non-linearity

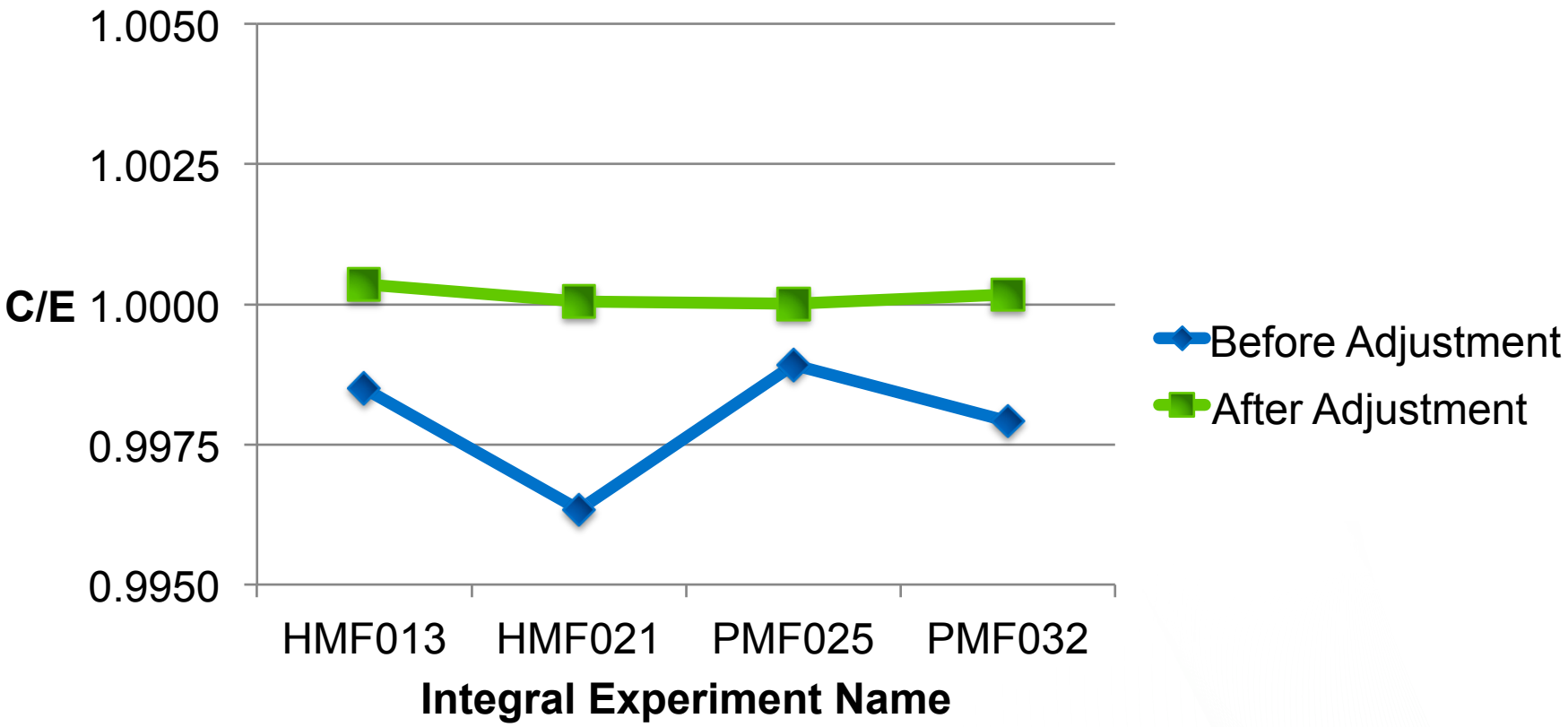
Future Developments

- Near term:
  - Expansion to the unresolved resonance region
- Long term:
  - Expansion to high energy region
  - Adjustment of angular distribution data and associated covariance
  - Support for future TSUNAMI generalized sensitivity theory developments

Results and Analysis

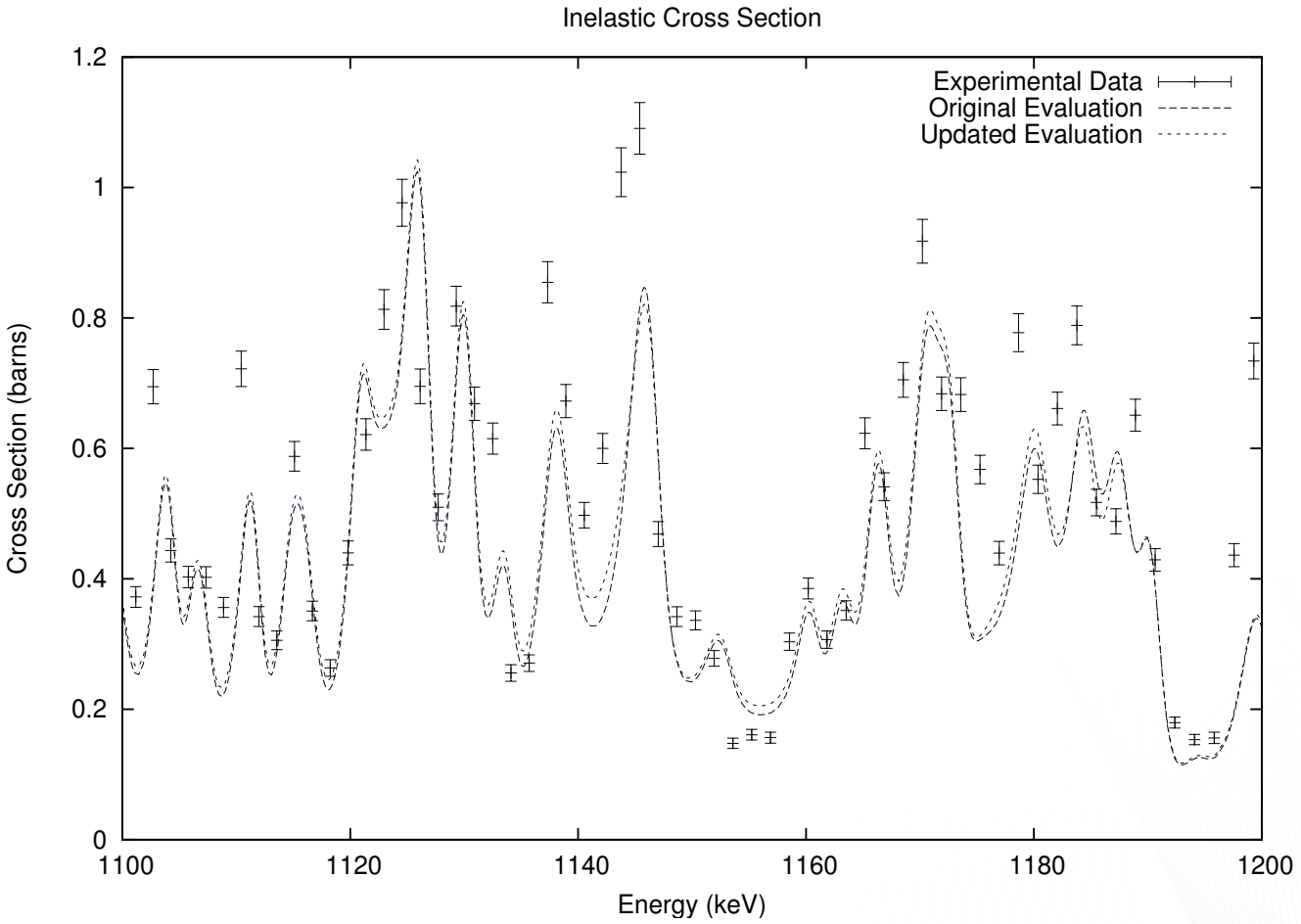
- SAMINT used to improve resolved resonance region evaluation of ^{56}Fe which had previously given discrepant results.
- Four integral experiments from the ICSBEP were selected.
- Energy region of evaluation: 1e-5 eV to 2 MeV.
- 1190 resonance parameters varied:
  - Γ_{γ}: 450 keV – 2MeV
  - $\Gamma_{(n,n'),1}$ and $\Gamma_{(n,n'),2}$: 846 keV – 2MeV

^{56}Fe Results



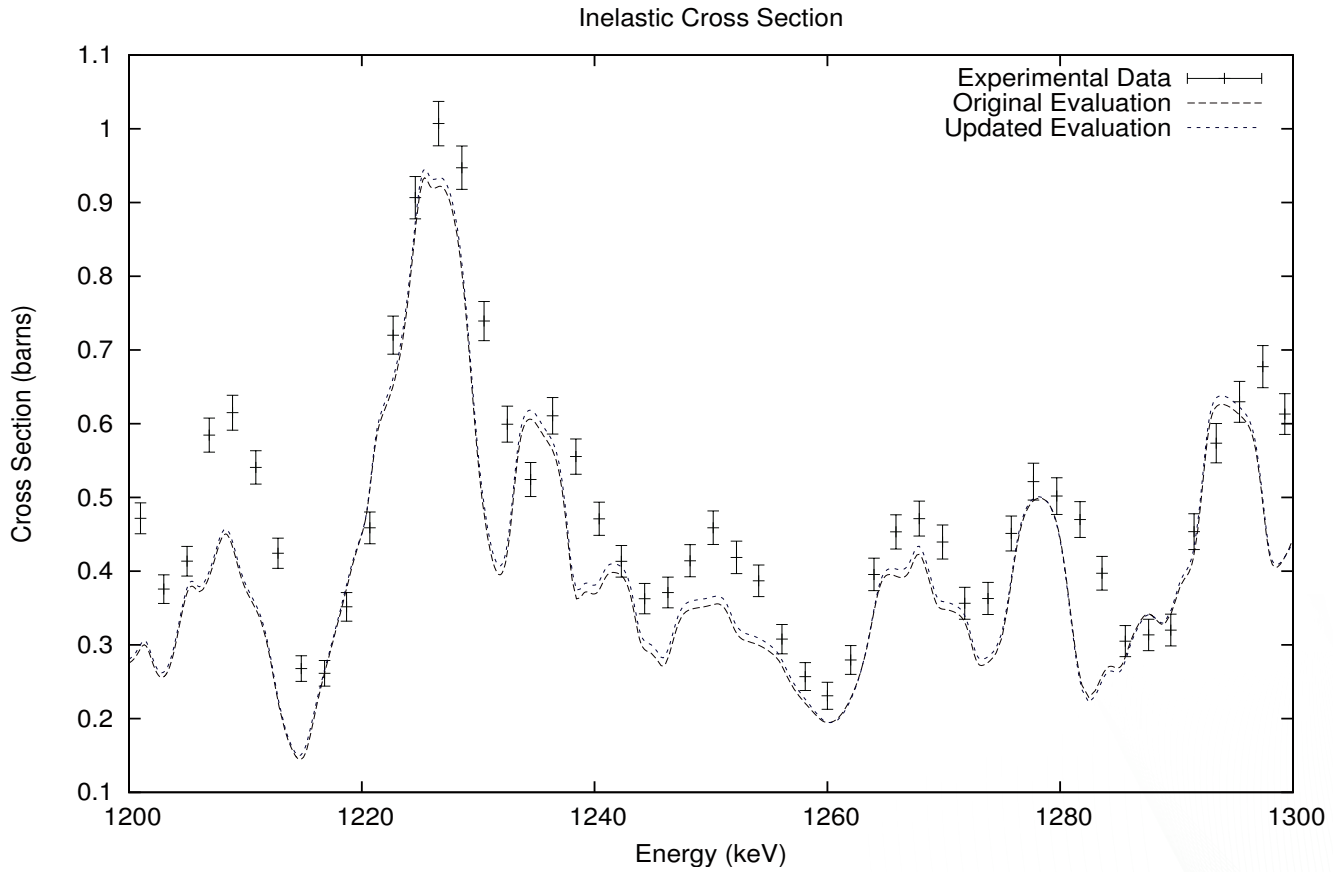
- **C/E**: $\frac{\text{Computed Value}}{\text{Experimentally Measured Value}}$

Cross Section Changes: Finer Scale than Differential Experimental Data



Inelastic cross section of ^{56}Fe before (χ^2 = 73.3382) and after (χ^2 = 73.6877) the adjustment based on integral experimental data plotted on top of differential experimental data of Plompen, presented with one standard deviation error bars.

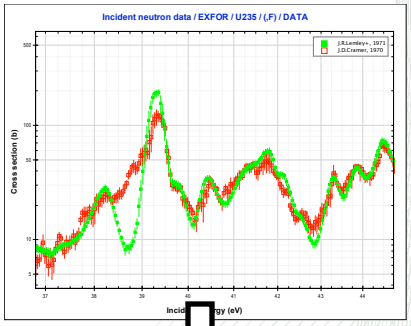
Cross Section Changes: Finer Scale than Differential Experimental Data

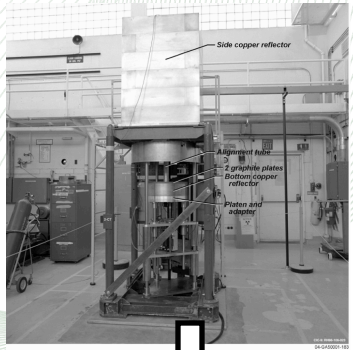


Inelastic cross section of ^{56}Fe before (χ^2 = 23.6023) and after (χ^2 = 22.9036) the adjustment based on integral experimental data plotted on top of differential experimental data of Perey, presented with one standard deviation error bars.

Summary

- SAMINT should be used to **supplement** evaluation of differential experimental data.
- SAMINT will also improve the nuclear data covariance matrix evaluation.
- Plans to extend the SAMINT methodology to the unresolved resonance region and the high energy region.
- Support for this work was provided by the US DOE Nuclear Criticality Safety Program.





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