Subgroup 20:
Covariance Matrix Evaluation and Process in the Resolved/Unresolved Resonance Regions
Status Report 2004

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ORNL/LANL meeting at Oak Ridge (Jul, 2003)

- MF32, A new ENDF format — **Compact Format**.

    - The compact format enables us to store the full covariance matrix within a reasonable file size.

    - The format is really needed to store the huge covariance of ^{235}U resonance parameters evaluated with SAMMY.

    - This format is still pending as a part of ENDF-6.

- Generation of covariance data for existing libraries.

    - Larson implemented "**Retroactive Method**" to estimate a covariance matrix of resonance parameters in SAMMY.

    - We recommend to use this capability for generation of resonance parameter covariance.

    - SAMMY generates the covariance both in the original ENDF-6 format and in the new compact format.

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Evaluations for Gd and Rh Isotopes

ORNL/LANL collaboration on Criticality Safety and Space Reactor

The evaluated covariance files (ENDF-6 format) are complete, therefore the data are good examples to show our capability of covariance evaluation and processing.

- For the criticality safety study
  - We have evaluated covariance data of ^{152,154,155,156,157,158,160}Gd.
  - The quantities included are resolved and unresolved resonance parameters, cross sections of total, elastic, inelastic, neutron capture, $(n, 2n)$, and $(n, 3n)$ reactions.
  - For the resonance parameters, SAMMY's retroactive method was used at ORNL.
  - For the cross sections above the resonance range, covariance data were evaluated with the KALMAN and SOK codes at LANL.
  - These two parts were combined at ORNL, and processed with ERRORJ.
- For JIMO (Jupiter Icy Moons Orbiter) Space Reactor
  - Covariance matrices were given for ^{185}Re and ^{187}Re.
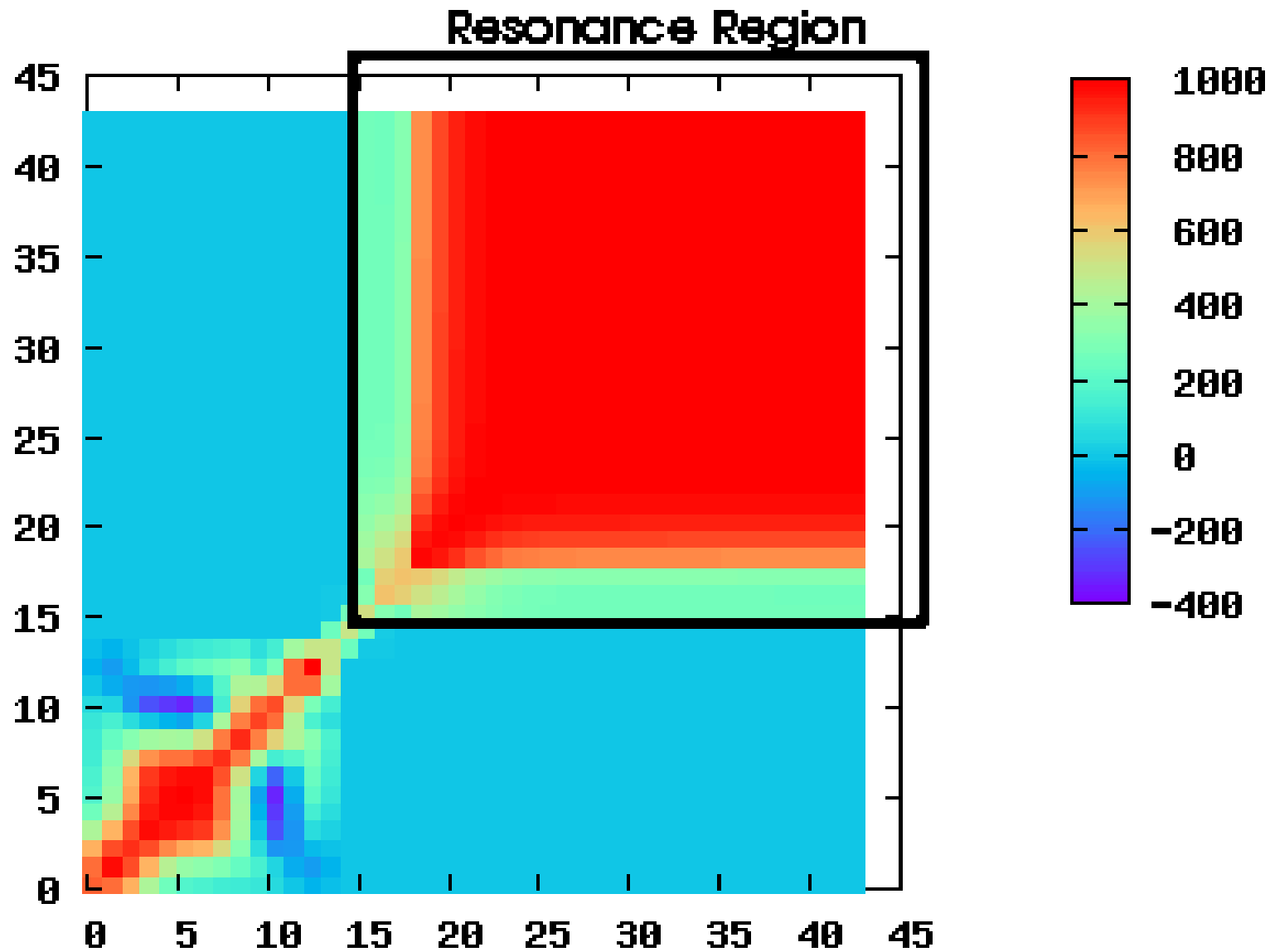 - The same evaluation method as for Gd isotopes was adopted.

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Gd-158 Uncertainties

Total and Capture Cross Section
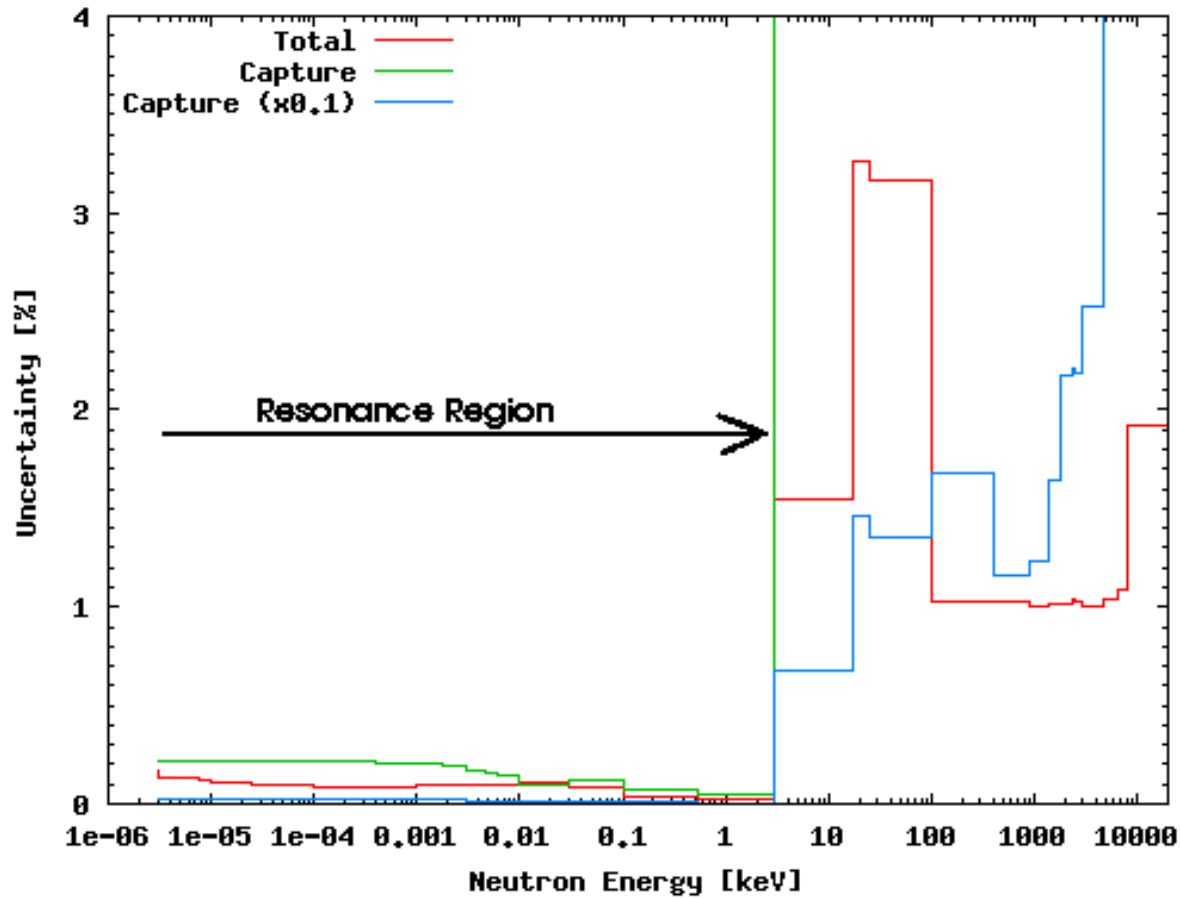
Gd-158 Total Cross Section, Correlation
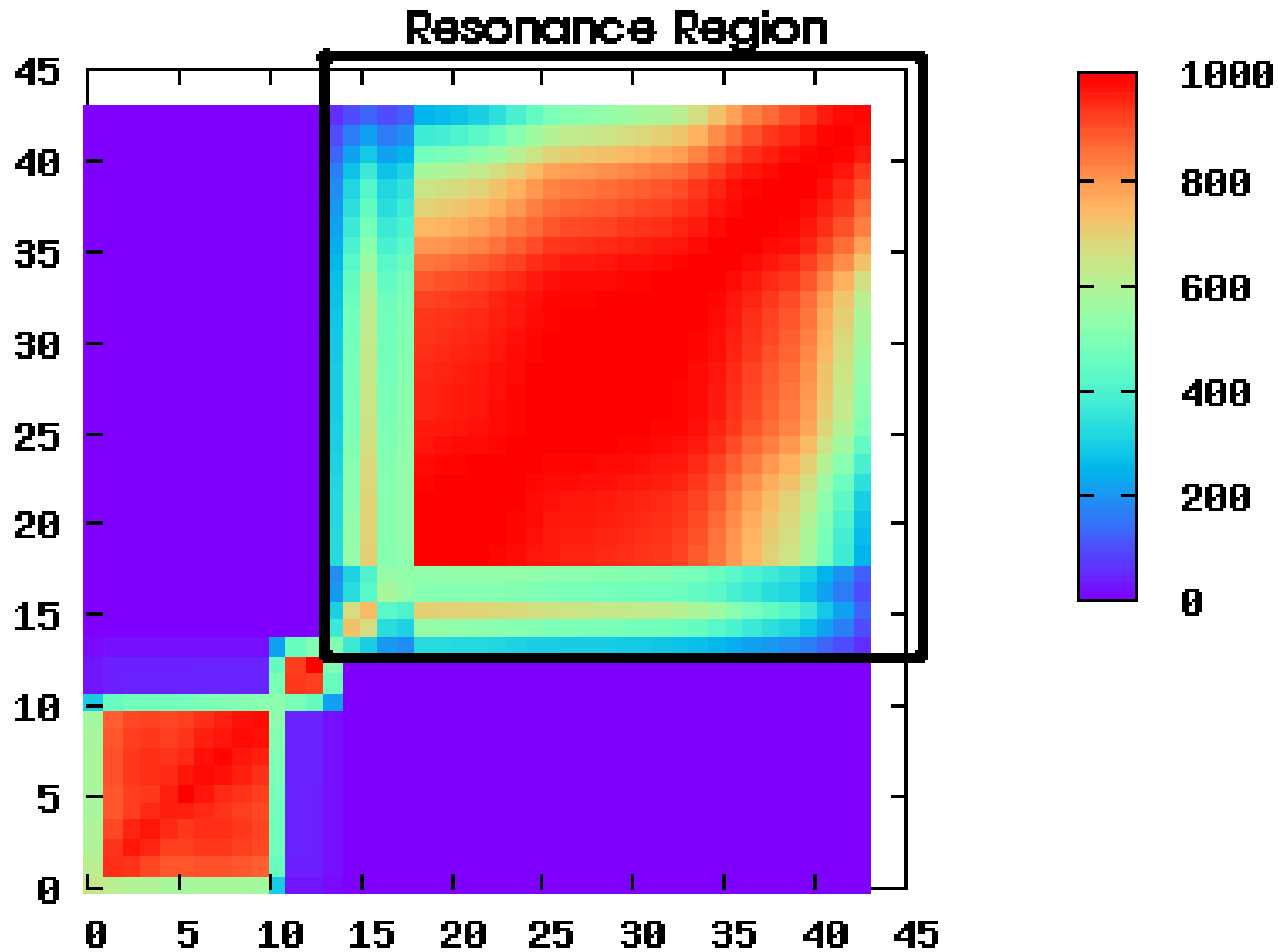
Gd-158 Capture Cross Section, Correlation

Resonance Region
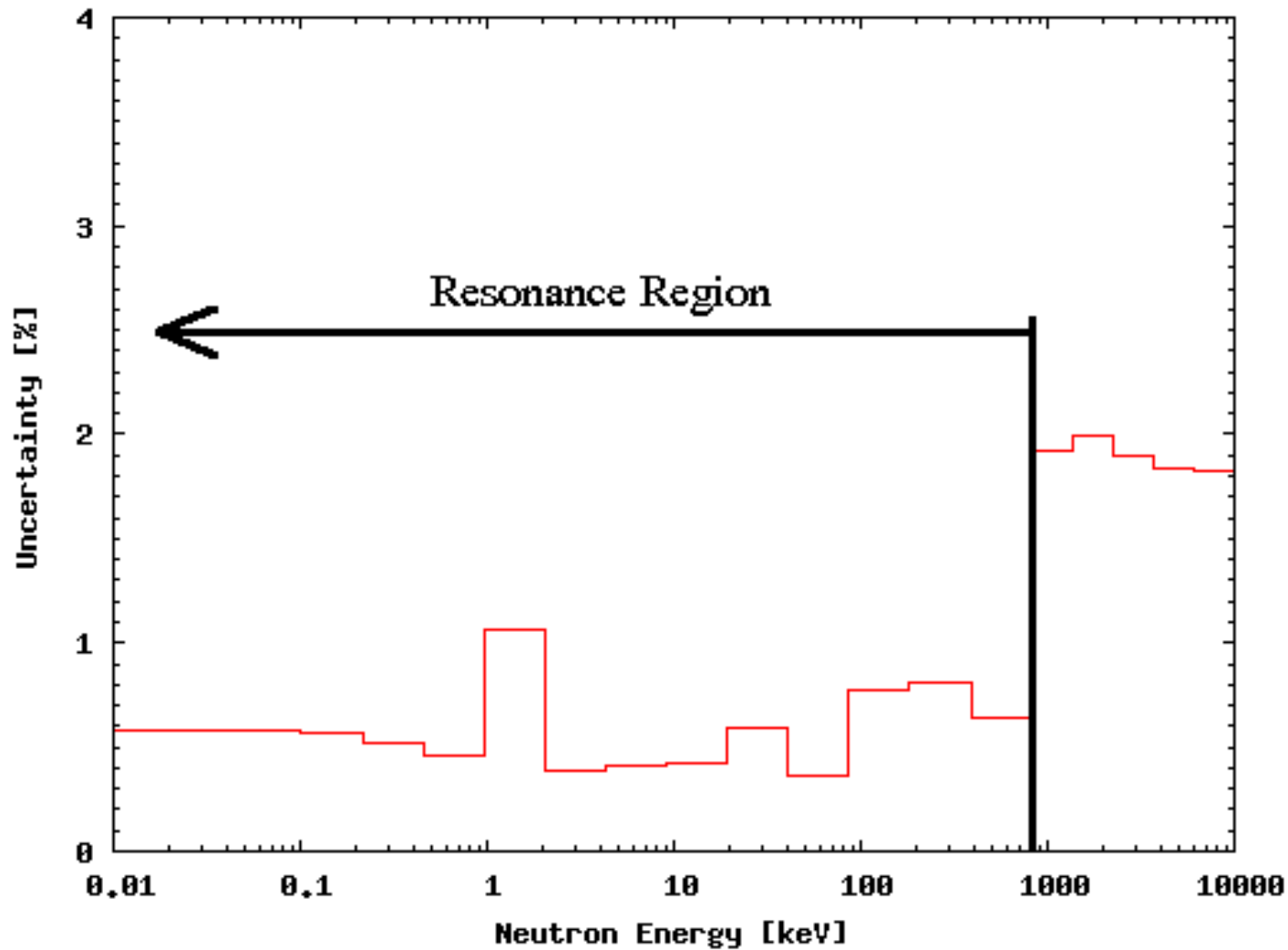
Development of SAMMY

How believable or accurate are the covariance matrices being created for the resonance region.

- Evaluated covariances should include all the known uncertainties in the experimental data and in the model calculation.

- For example:

  - If the resolution-broadening function is known to have a certain form with certain parameter values, with uncertainties on those values, one might wish to use those parameter values (not allow them to vary) but also include the effect of the uncertainties.

  - Similarly for many other parameters (normalization, backgrounds, sample thickness, detector efficiencies, etc.).

- SAMMY will have the ability to propagate uncertainties for virtually any parameters.

- The final covariance matrix will then properly reflect all uncertainty information available to the evaluator.

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Development of ERRORJ at JNC

- The ERRORJ code that processes Reich-Moore covariance data can be used with NJOY, AMPX, and PUFF-2 data processing systems.

- Chiba and Ishikawa of JNC maintain the code. The new version (ver.2.0) was released in May, 2003.

- ERRORJ will be extended in order to read the compact covariance format generated by SAMMY.

- ERRORJ still has some limitations; for example, it cannot calculate covariance data for a self-shielding factor.

- The code has been distributed to Sumitomo Atomic Energy Industries, JAERI Nuclear Data Center, JAERI ADS Project, Toshiba, ORNL, ANL, LANL, NEA Databank, and IPPE.

Fe-56 Total Cross Section Uncertainties

Resonance Region
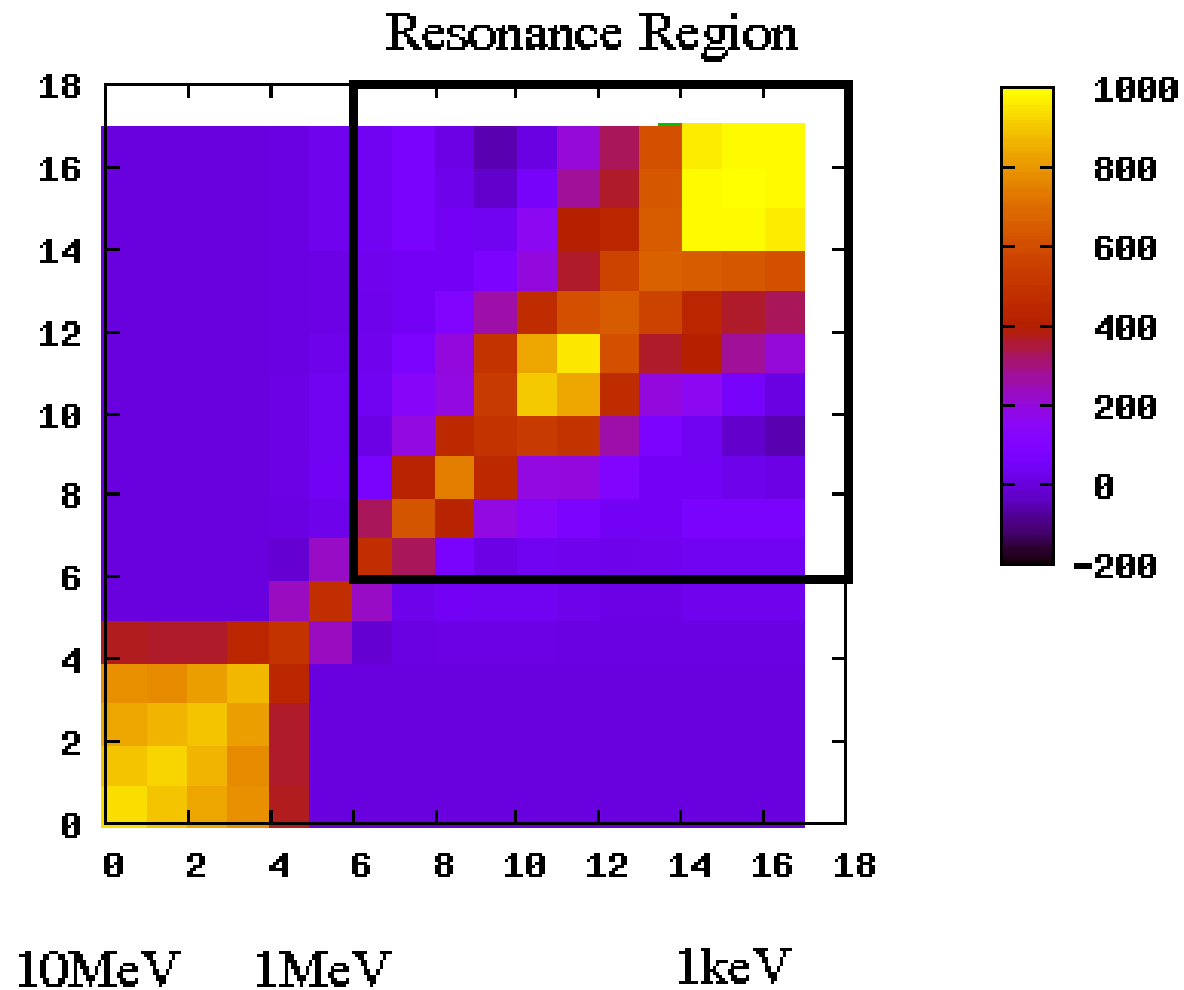
Processing Codes, LANL and ORNL

NJOY (LANL)

- Larson provided a subroutine that calculates derivatives of R-matrix theory (not numerical but analytical). This subroutine will be incorporated into NJOY to process resonance covariances. With this code, it may enable NJOY to calculate covariances of self-shielding factors.

SAMMY (ORNL)

- Although SAMMY is not a processing code, it also has a capability to generate group-averaged cross sections and their covariance. This would help us to check the generated group constant covariance.

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