Gd Isotopes and Covariances in Fast Region

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Evaluation & Covariance

The key to finding the right Technology

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$^{152-160}$Gd(n,*) evaluations for ENDF/B-VII

- **Material for control rods (very large thermal capture cross section)**

- **Current evaluations taken from ENDF/B-V for ^{156,158,160}Gd**

- **Current evaluations taken from JENDL-2 or 3.2 for ^{152,154}Gd**

- **No evaluation of ^{153}Gd in libraries**

- **New resonance parameters for $^{152-160}$Gd**

- **Test case for covariances generation with EMPIRE**
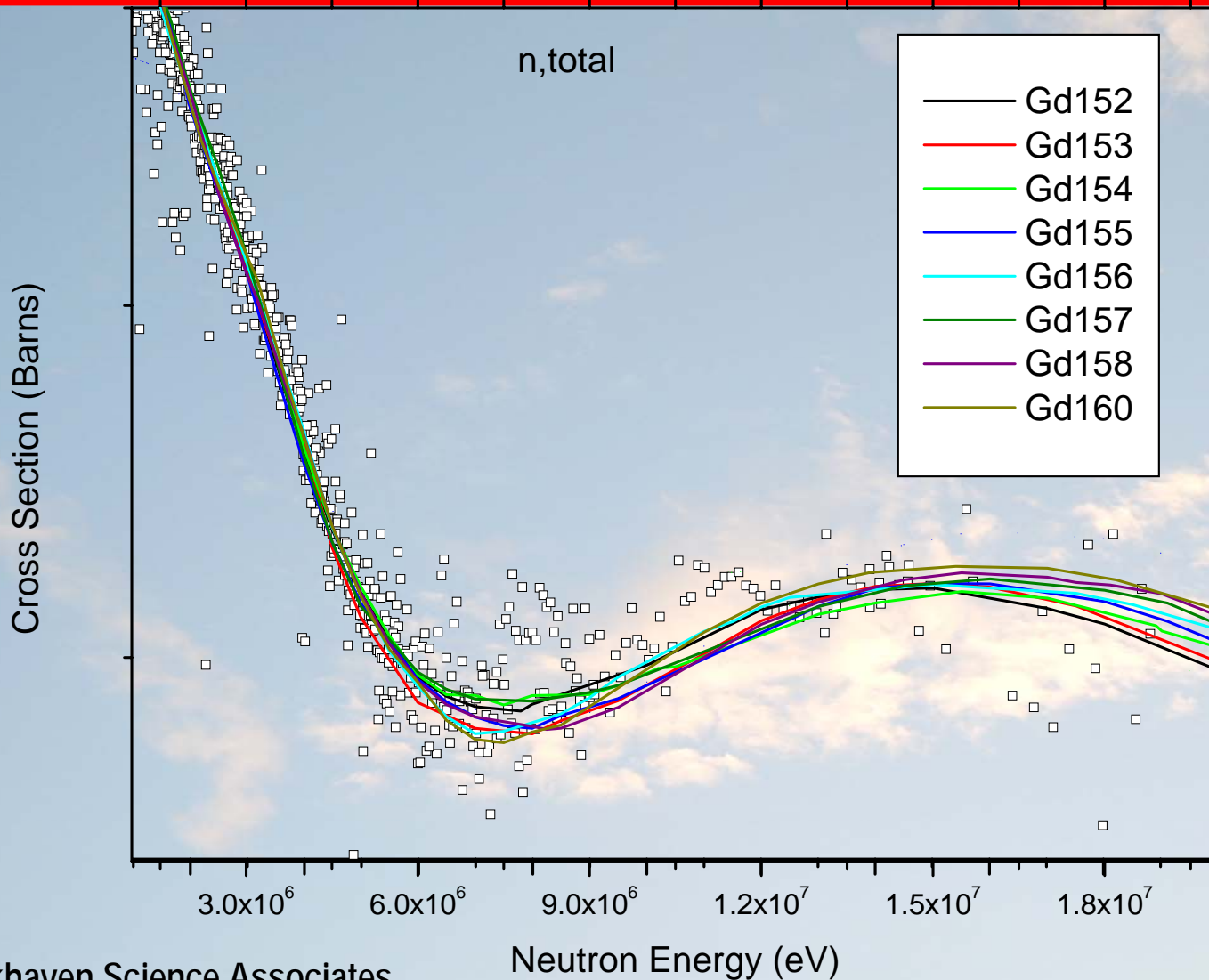
Gd 64
gadolinium

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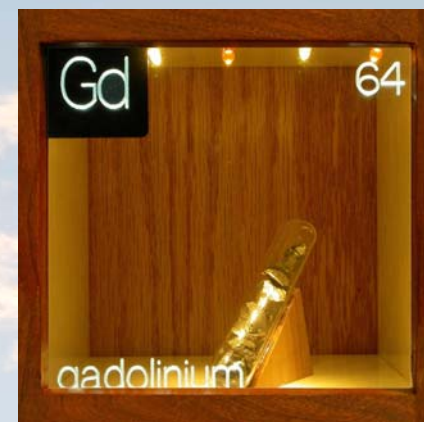
Gadolinium: Fitting the Optical Potential

-New capability: fitting up to 9 OM parameters together to total, elastic cross section (radius, depth, deformation…)

-Example for ^{158}Gd : Vibrational Optical potential from F. Dietrich, for Sm
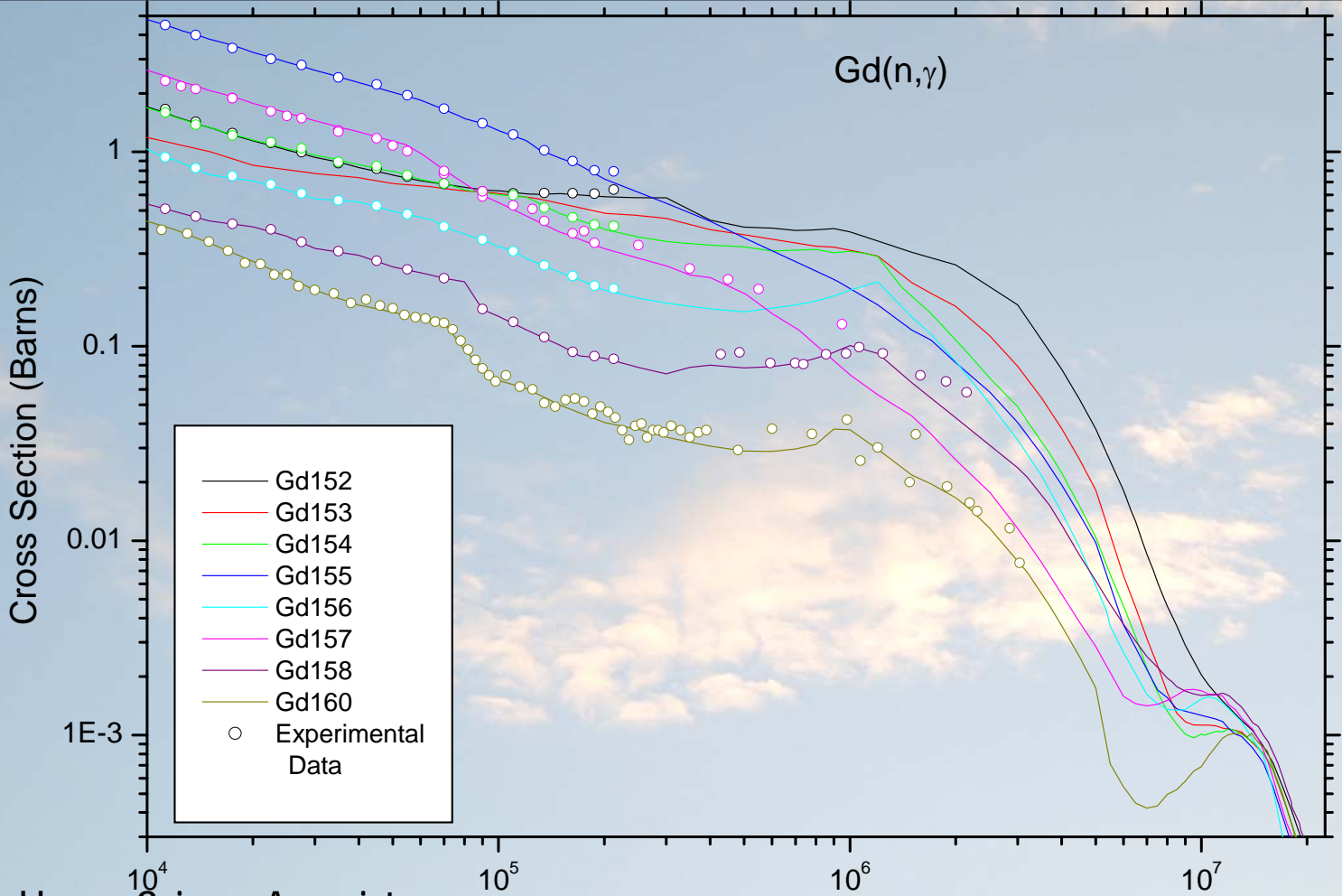

Original potential
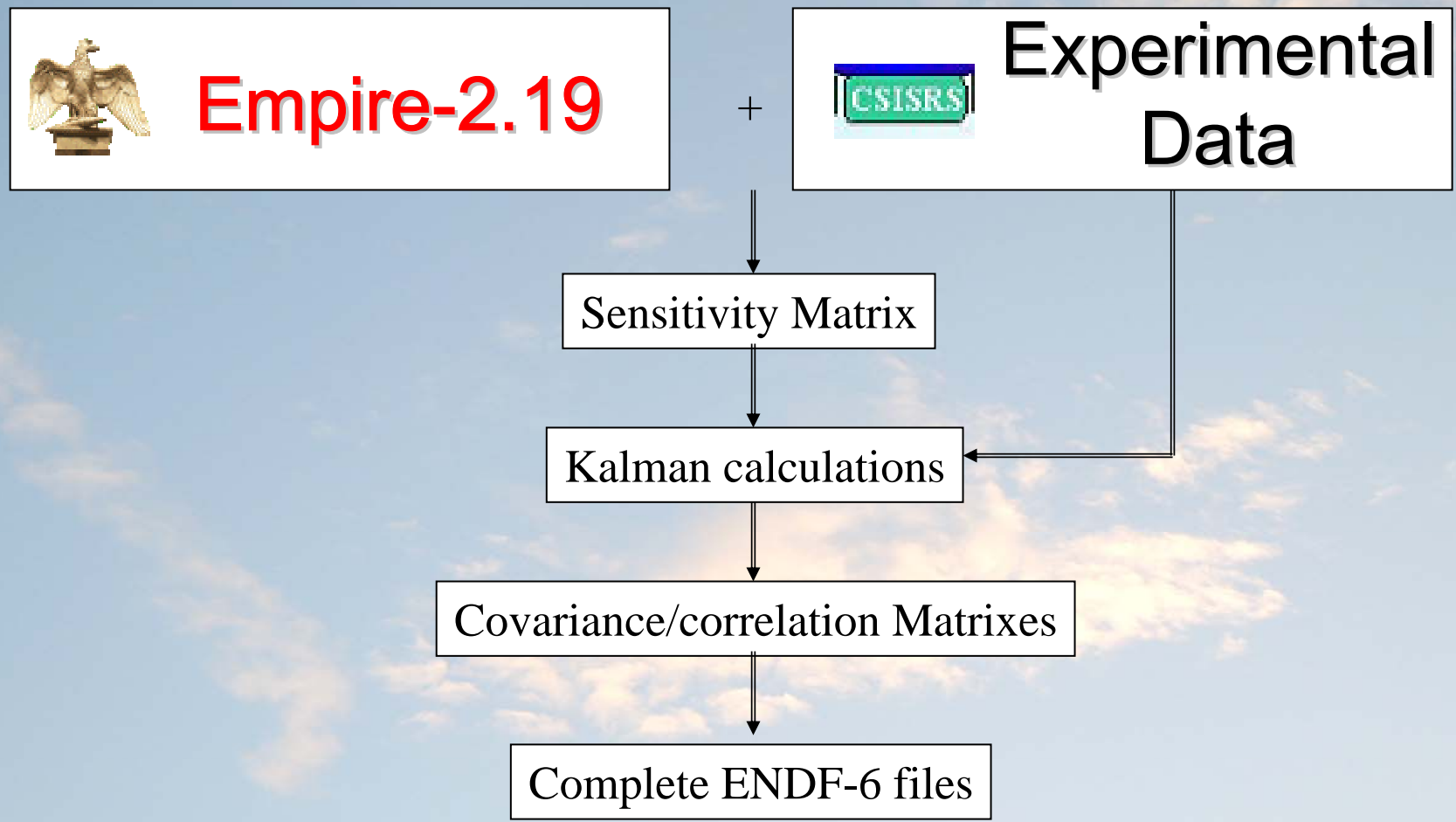
After fitting

^{158}Gd(n,tot)
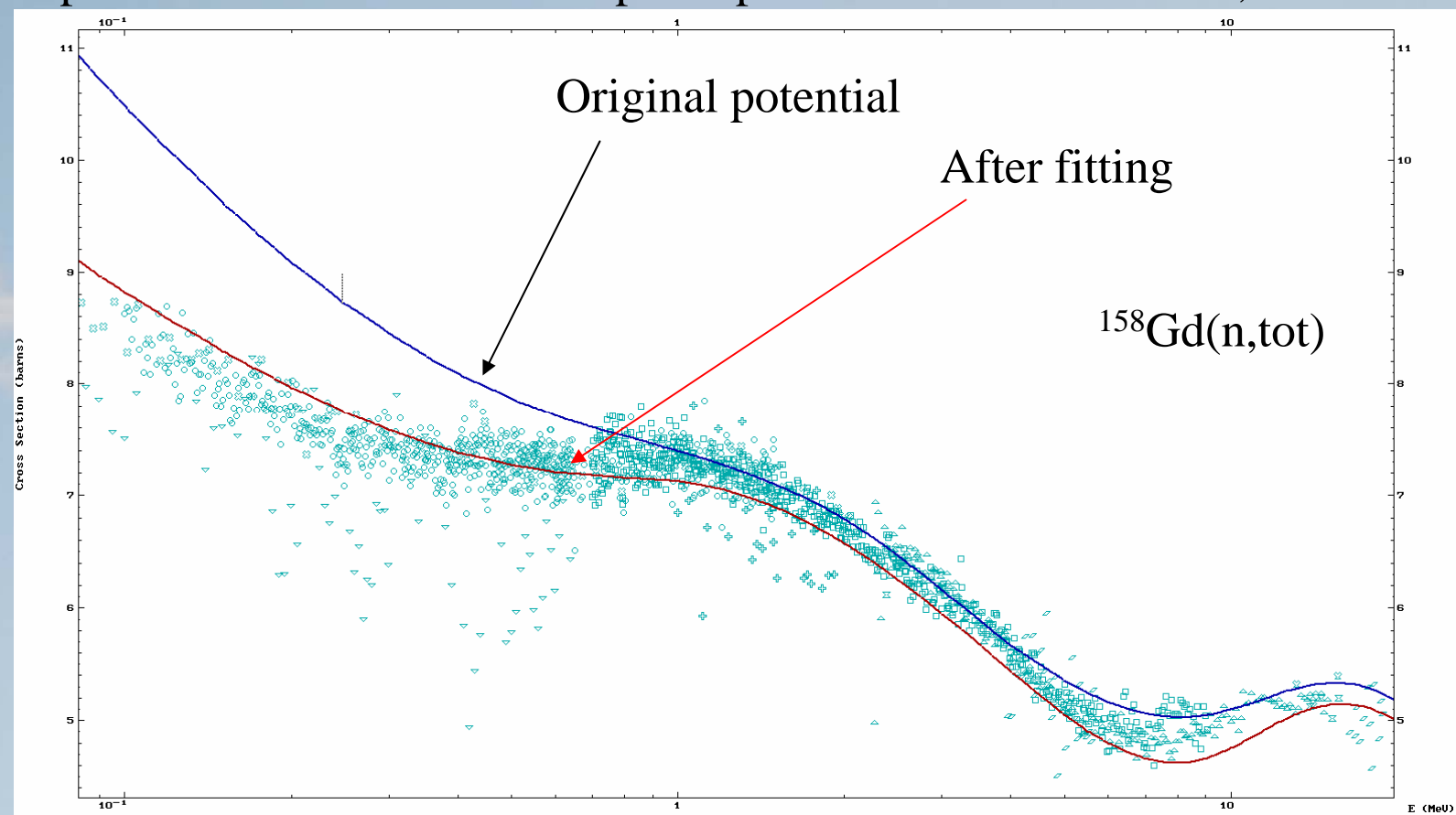
Gadolinium: Total Cross Sections

Gadolinium: Capture Cross Sections

-Selection of the Gamma strength function to follow experimental data

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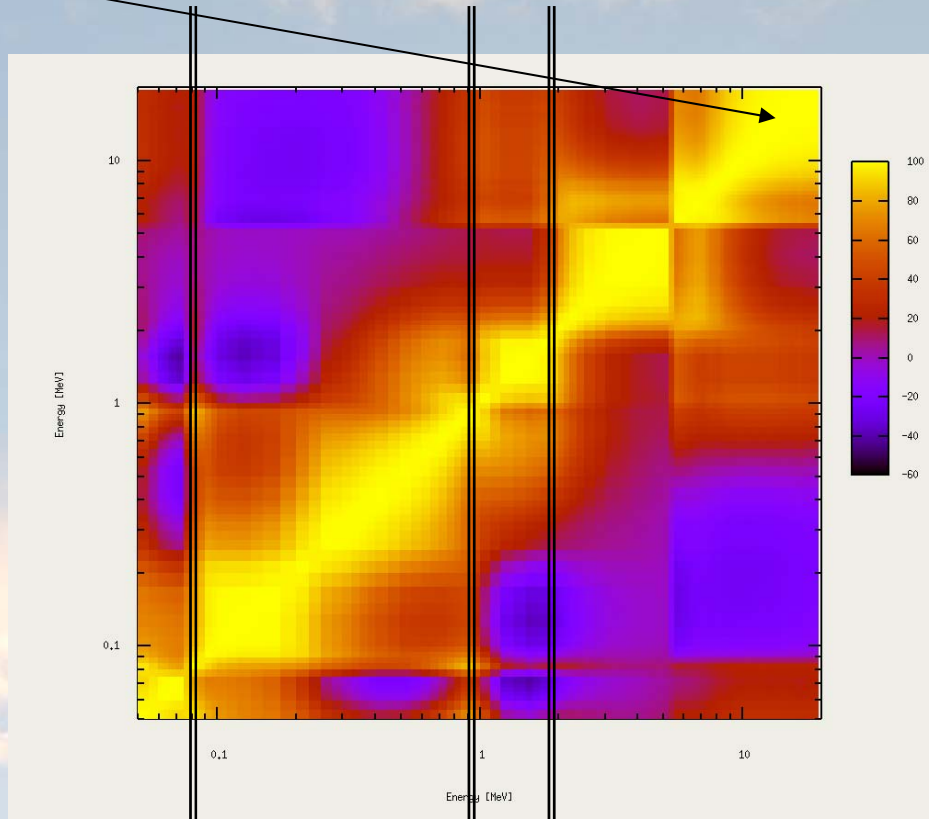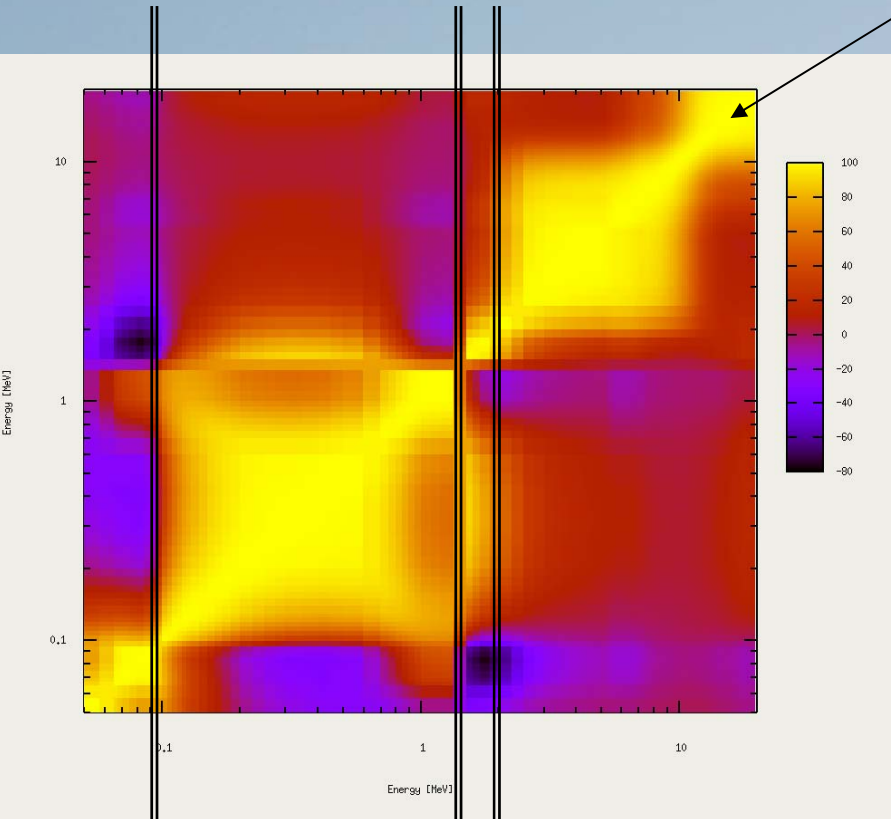U.S. Department of Energy

From EMPIRE-2 to Covariances

Empire-2.19 + Experimental Data

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Sensitivity Matrix

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Kalman calculations

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Covariance/correlation Matrixes

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Complete ENDF-6 files

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Example on even-n: ^{156}Gd(n,γ)-^{160}Gd(n,γ)

^{156}Gd(n,γ)

^{160}Gd(n,γ)

Giant resonance

(2$^+$)

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Uncertainty on ^{160}Gd(n,γ) from Kalman calculations

^{160}Gd(n,γ)

Legend:
- ENDF/B-VII β1
- Kalman
- ○ Bohkovko
- ☆ Kononov

Y-axis: Cross Section (Barns)
X-axis: Neutron Energy (eV)

20 %   40 %   30 %

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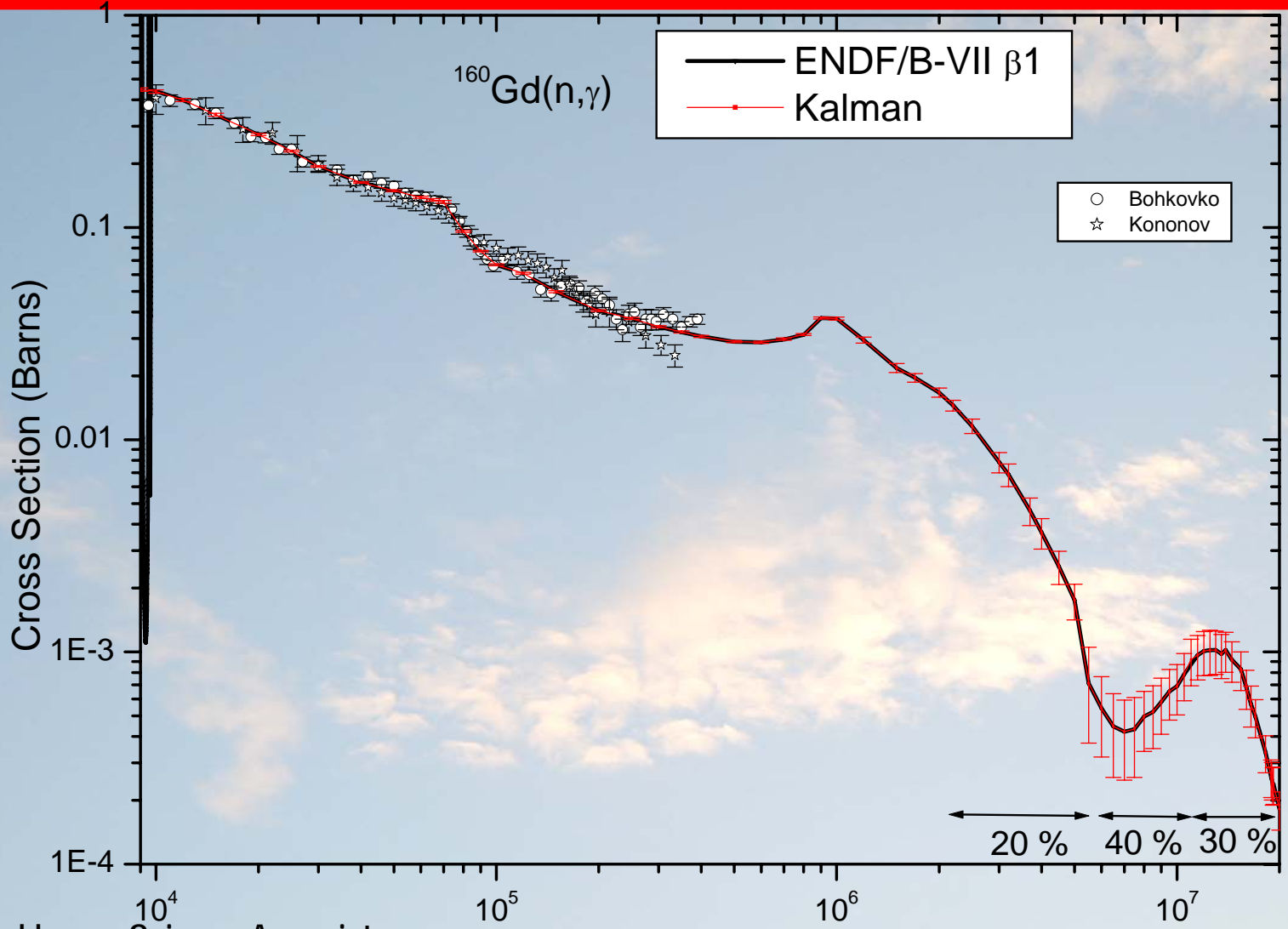
Conclusion

- **Go online at www.nndc.bnl.gov for ENDF/B-VII beta1**
- **EMPIRE allows complete evaluation in the fast region for:**
  - **Complete mass chain**
  - **From cross sections to covariances**

-More study is necessary to fully understand structures in covariance matrix
-Add a module for Resonance evaluations & analysis
-Covariances for resonance region