

The logo for IRSN, featuring the letters 'IRSN' in a bold, sans-serif font. The 'I', 'R', and 'S' are red, while the 'N' is blue.

INSTITUT  
DE RADIOPROTECTION  
ET DE SÛRETÉ NUCLÉAIRE

*Faire avancer la sûreté nucléaire*

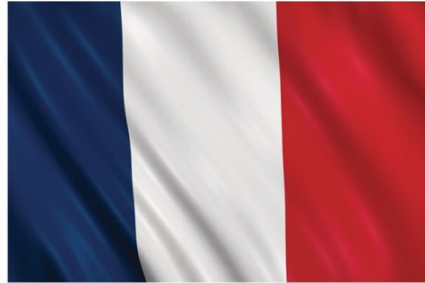
# Nuclear Data Evaluation Work at IRSN (NCSP)

**CSEWG Meeting  
Brookhaven National  
Laboratory**

**IRSN / PSN-EXP/SNC  
November 2017  
Luiz LEAL  
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# OUTLINE

1. Gd evaluations
2. Evaluations Performed at IRSN:  $^{103}\text{Rh}$ ,  
 $^{233}\text{U}$ ,  $^{54}\text{Fe}$
3. Concluding remarks



# IRSN missions

*French Institute for Radiological Protection and Nuclear Safety*

- Provide support for the public authorities competent in nuclear safety and radiation protection for civil and defense activities, and **safety of nuclear facilities and materials;**
- Define and implement national and international **research programs;**



# Resonance Evaluations and deliverables

Isotope	Energy Range	Resonance Covariance Evaluation
$^{103}\text{Rh}$	Thermal to 8 keV	RP + CV
$^{233}\text{U}$	Thermal to 2.0 keV	RP + CV
$^{155}\text{Gd}$ , $^{157}\text{Gd}$	Thermal to 500 eV	RP + CV
$^{54}\text{Fe}$	Thermal to 1.2 MeV	RP + CV
Pb and Mo	Assessment of existing evaluations	-

# $^{155}\text{Gd}$ and $^{157}\text{Gd}$ Resonance Evaluation

## ■ Motivation:

- Issues with benchmark calculations with Gd concentration;
- Extension of the resonance region from 300 eV to 500 eV;
- SAMMY R-matrix analysis;
- Transmission, capture data from RPI;
- Improve benchmark integral representation;
- Uncertainty information and resonance parameter;
- Covariance generation;

# General Information

## Atlas of Neutron Resonances (ANR)

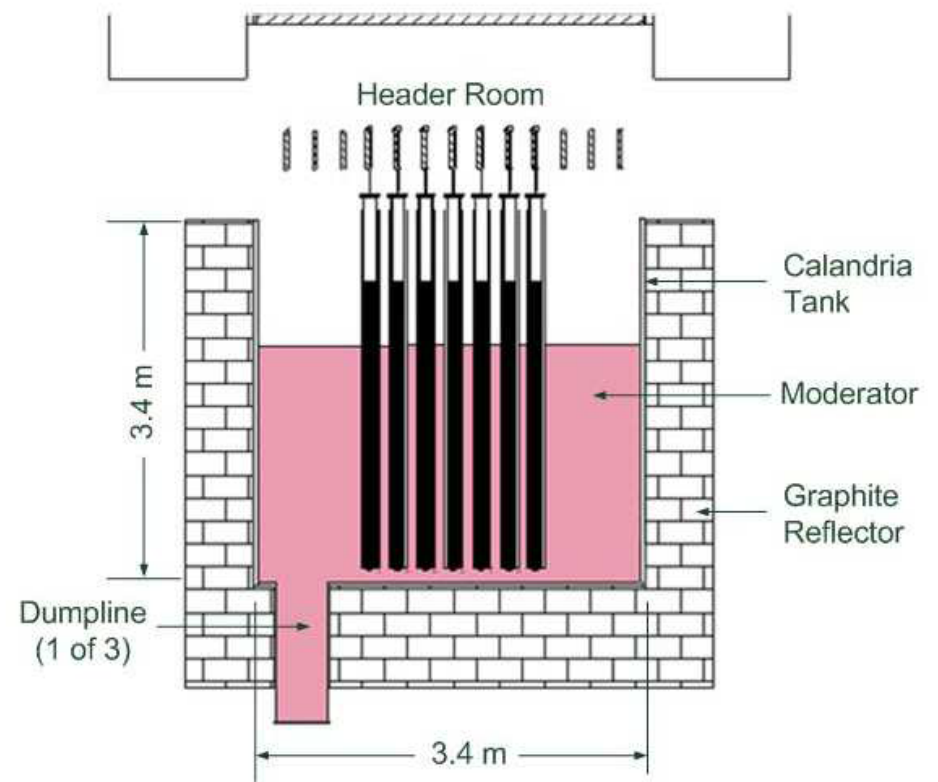
	Thermal Cross Section (barns)	Capture Resonance Integral (barns)	Westcott's Factor
$^{155}\text{Gd}$	$60900 \pm 500$	$1537 \pm 100$	0.83899
$^{157}\text{Gd}$	$254000 \pm 815$	$754 \pm 20$	0.84715

# Benchmark Results: Issues

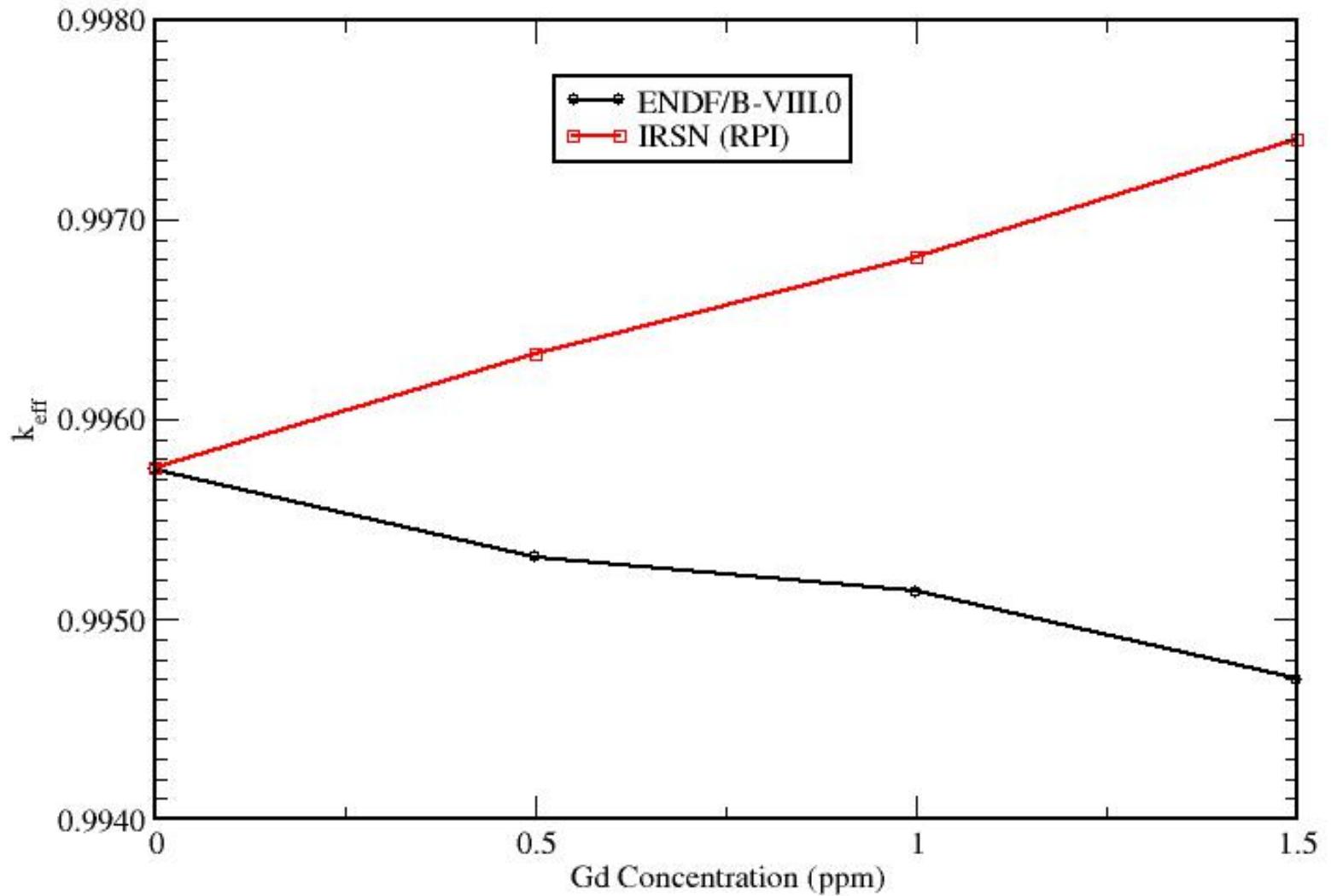
## ZED-II (Zero Energy Deuterium) Research Reactor

### Issues with benchmark calculations with Gd concentration

*Note: Dan Roubtsov kindly shared his MCNP input decks*

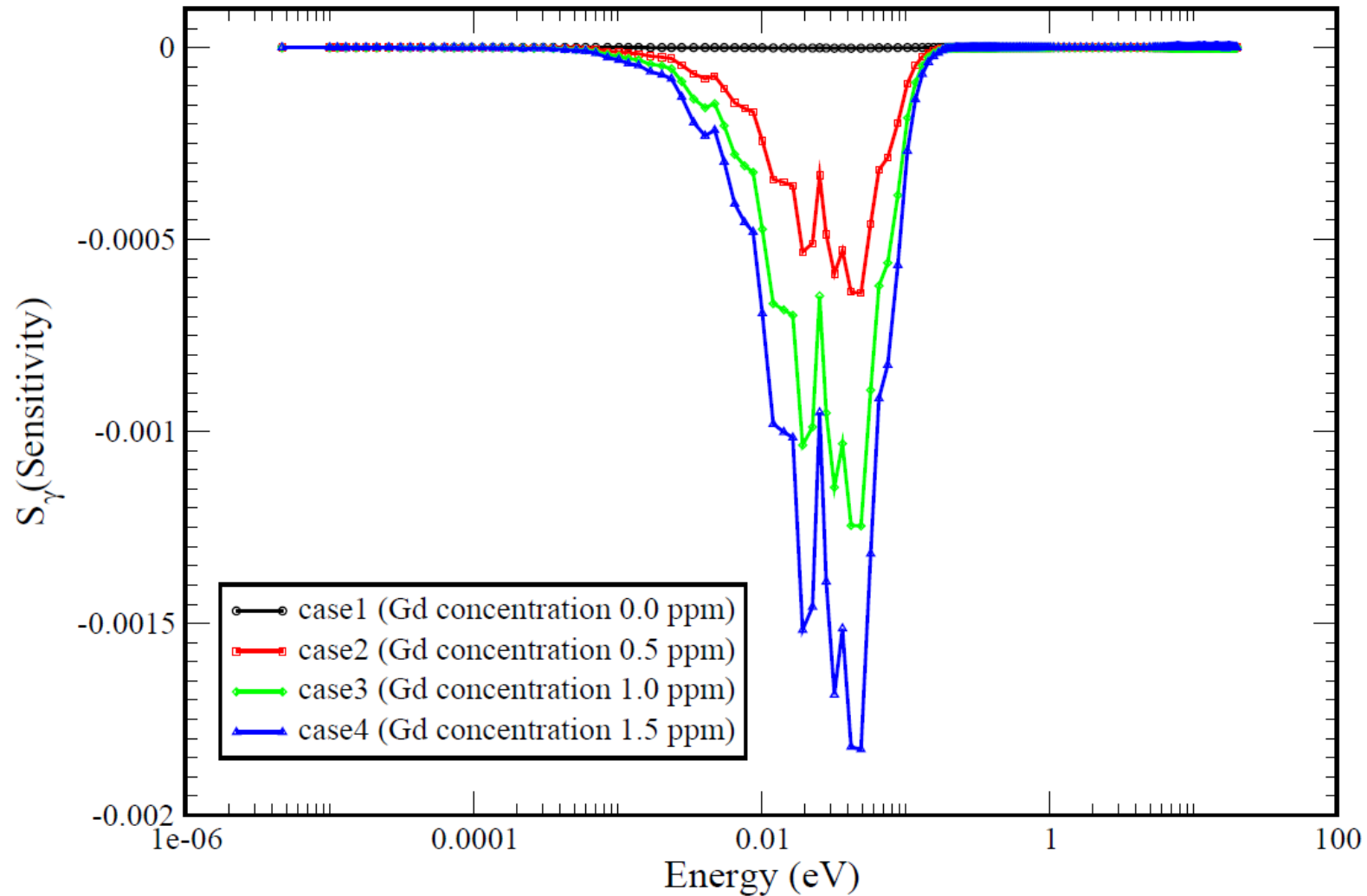


# Issue:





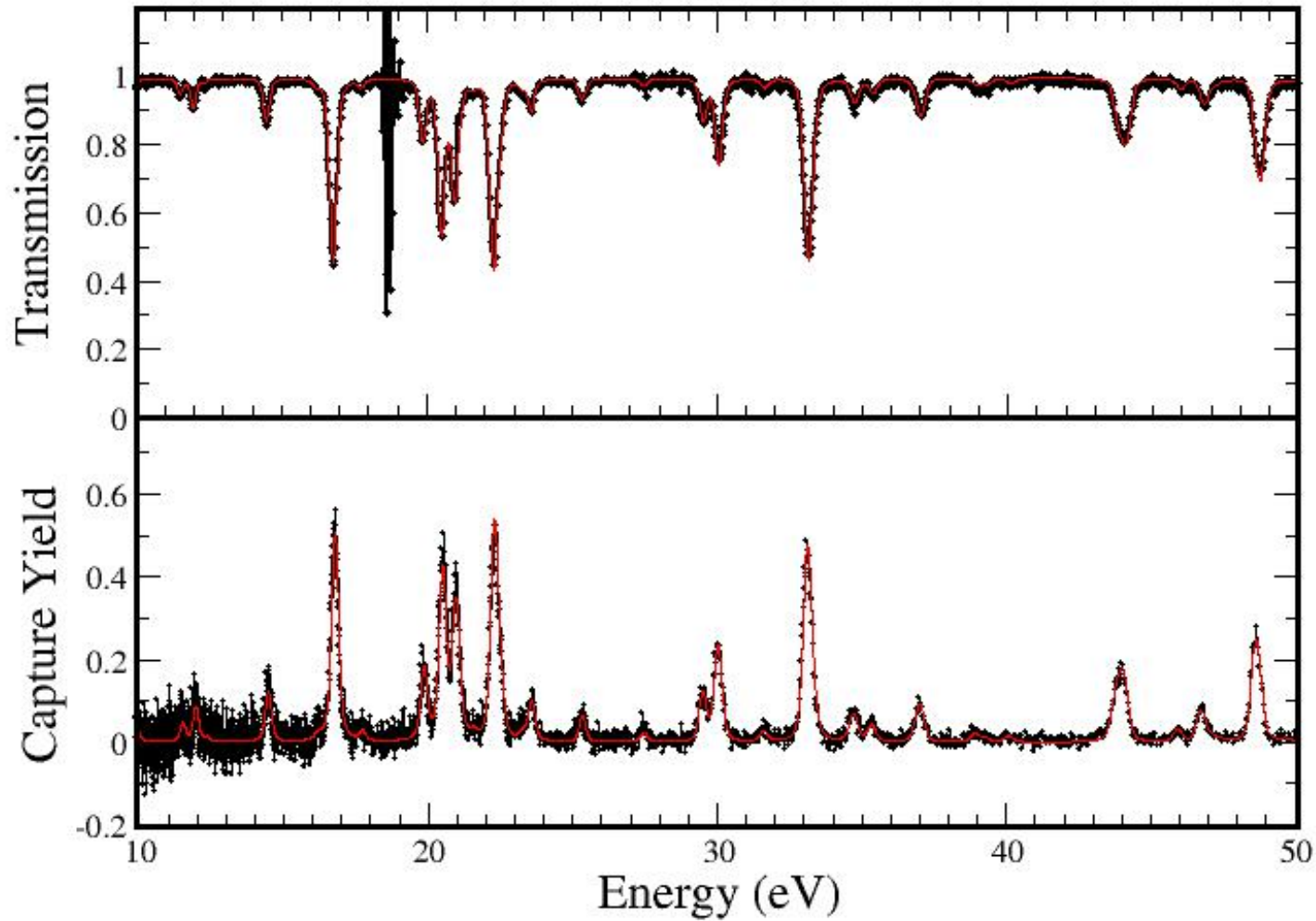
# $K_{eff}$ Sensitivity to the Capture Cross Section



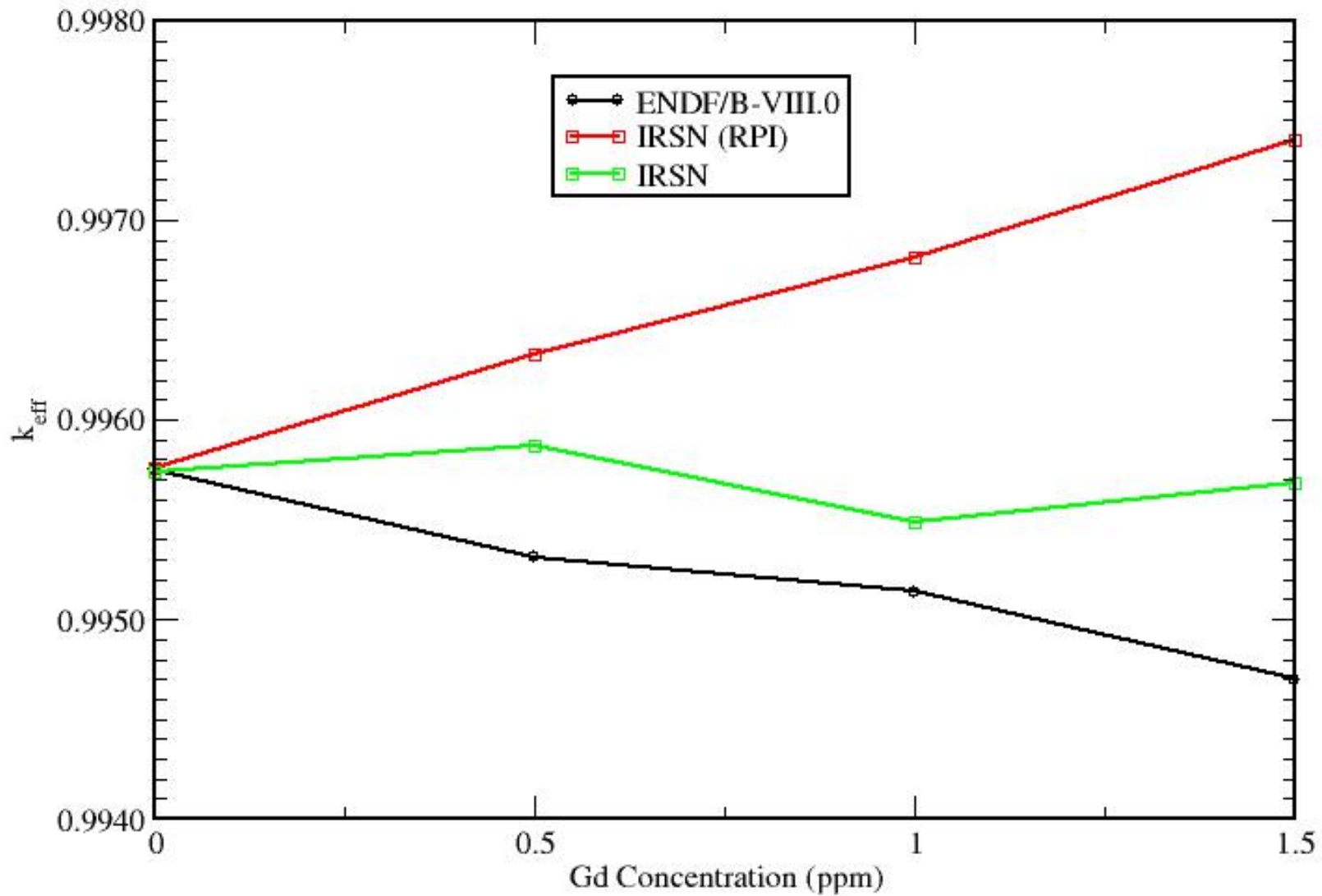
# SAMMY Fitting (RPI)

RPI Experimental Data

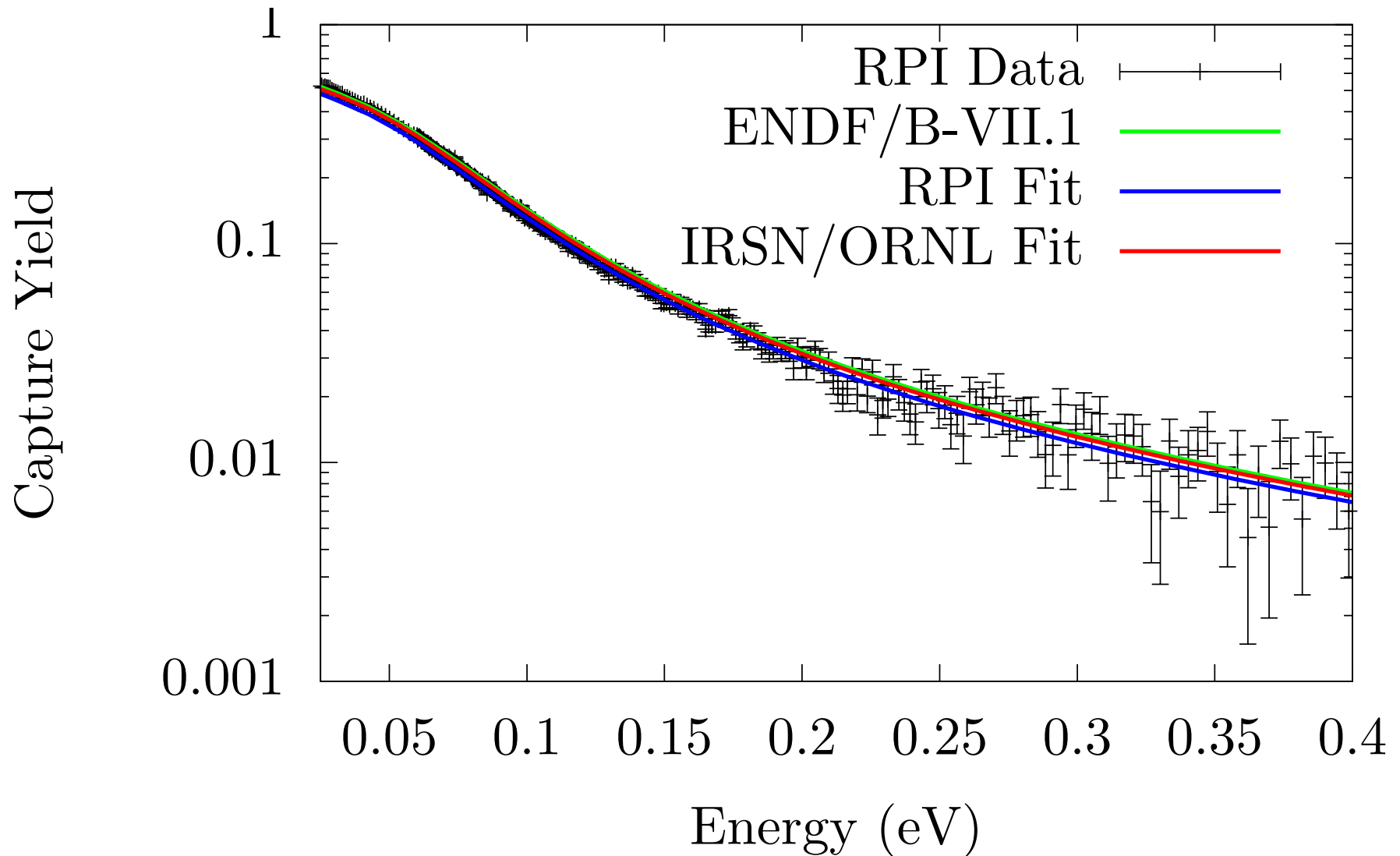
Natural Gd



# Resolution: use of SAMMY and SAMINT



# SAMMY Fitting (RPI)



# $^{157}\text{Gd}$ Results

Evaluation	Thermal Cross Section (barns)	Capture Resonance Integral (barns)	Westcott's Factor
ENDF/B-VIII.0	252892.2	759.26	0.85305
IRSN (RPI)	225629.8	778.32	0.76287
IRSN	244071.5	806.62	0.82467
ANR	254000 $\pm$ 815	754 $\pm$ 20	0.84715

## Moving Forward:

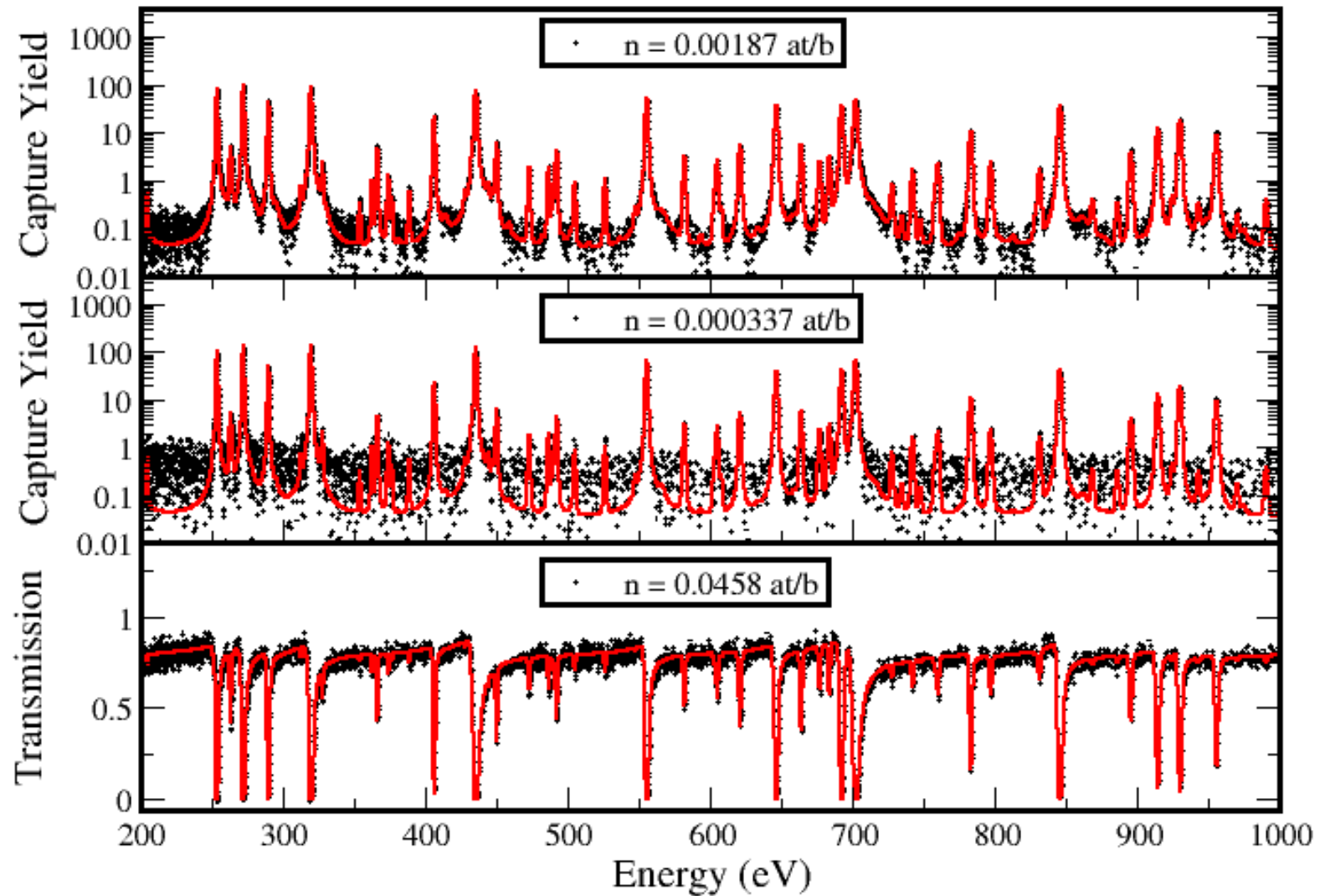
- Include new cross-section measurements performed at n\_TOF;
- Include new thermal cross-section measurements (work underway in Hungary);
- Verify contribution of other Gd isotopes, mainly  $^{155}\text{Gd}$ ;
- Include IRSN Gd benchmark in the integral fitting;
- Covariance generation;

# $^{103}\text{Rh}$ Resonance Evaluation

## ■ Motivation:

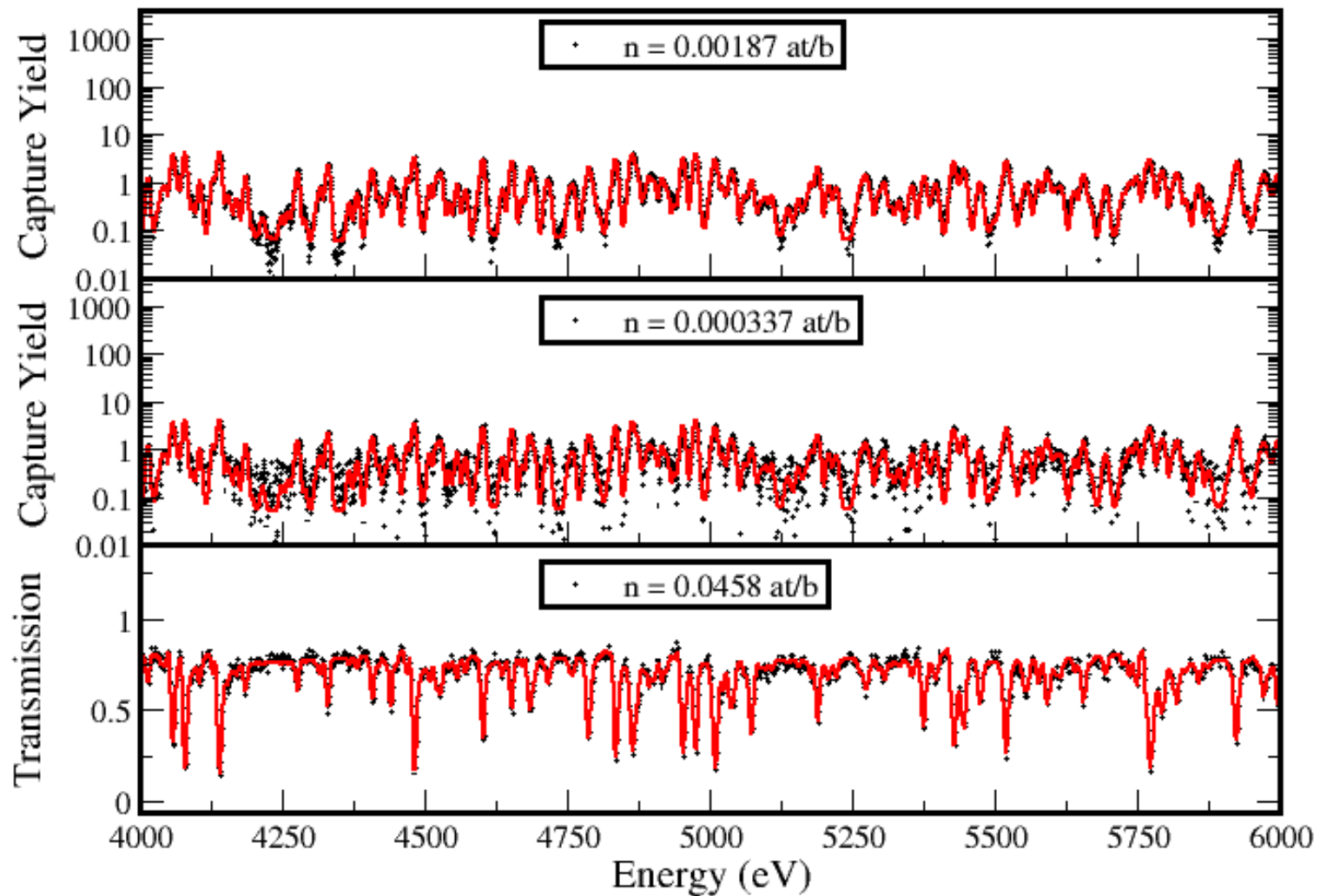
- Issues with resonance spin representation;
- No capture data used on previous evaluations;
- Extension of the resonance region from 4 keV to 8 keV;
- SAMMY R-matrix analysis;
- Transmission, capture data from GELINA used to extend the evaluation up to 8 keV;
- Improve benchmark integral representation;
- Uncertainty information and resonance parameter;
- Covariance generation.

# $^{103}\text{Rh}$ SAMMY Fitting (GELINA)

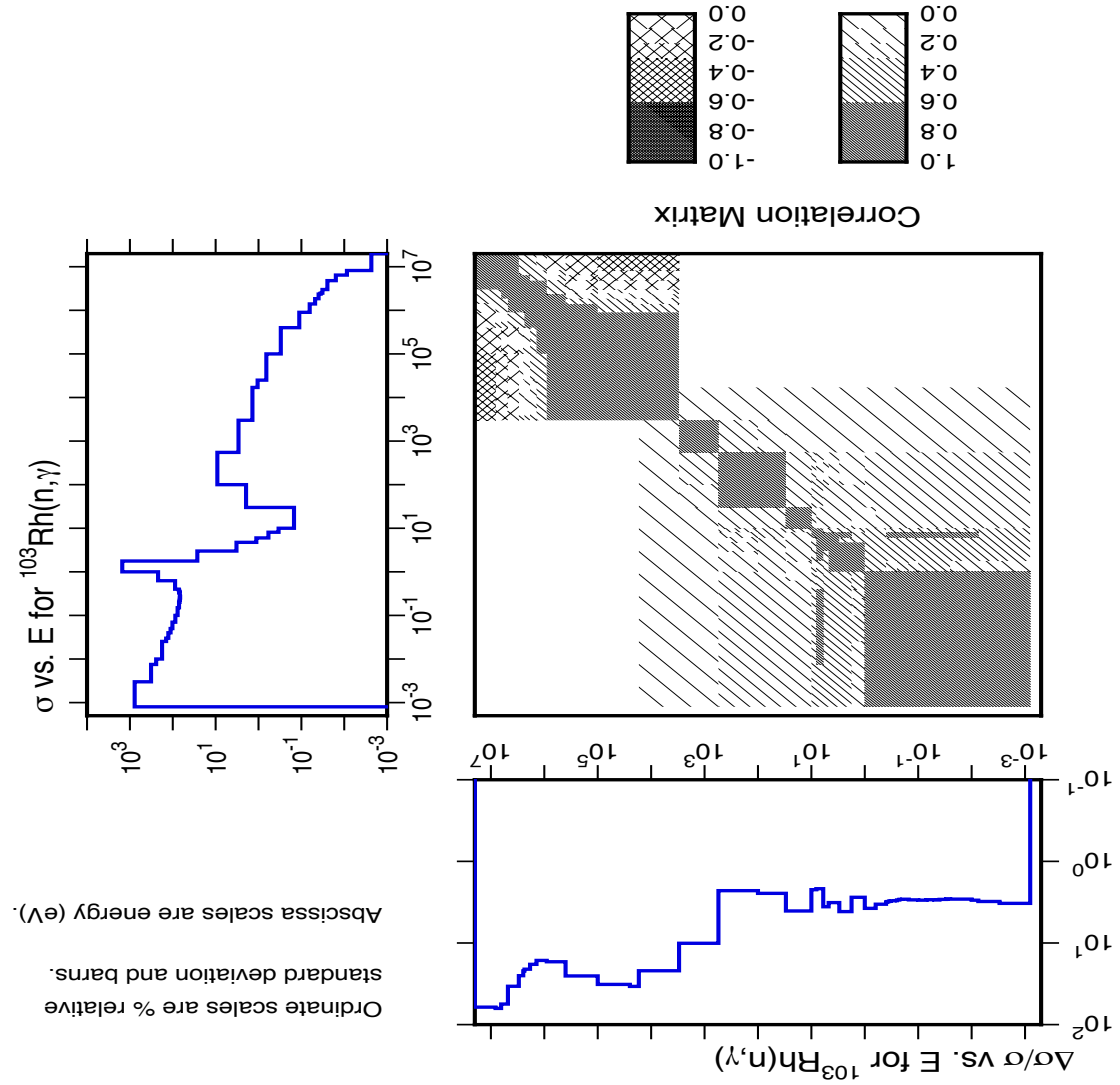




# $^{103}\text{Rh}$ SAMMY Fitting



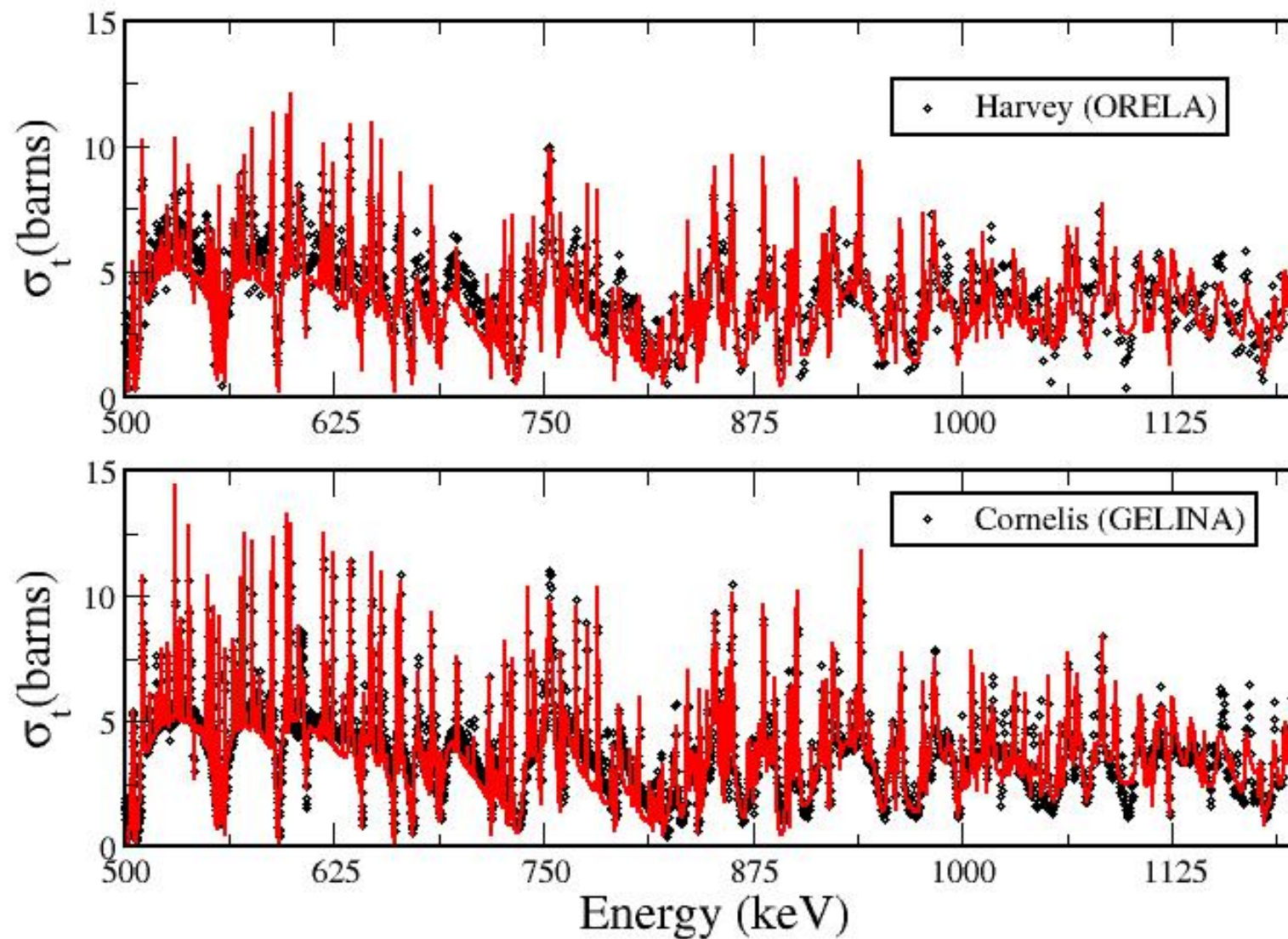
# $^{103}\text{Rh}$ Covariance



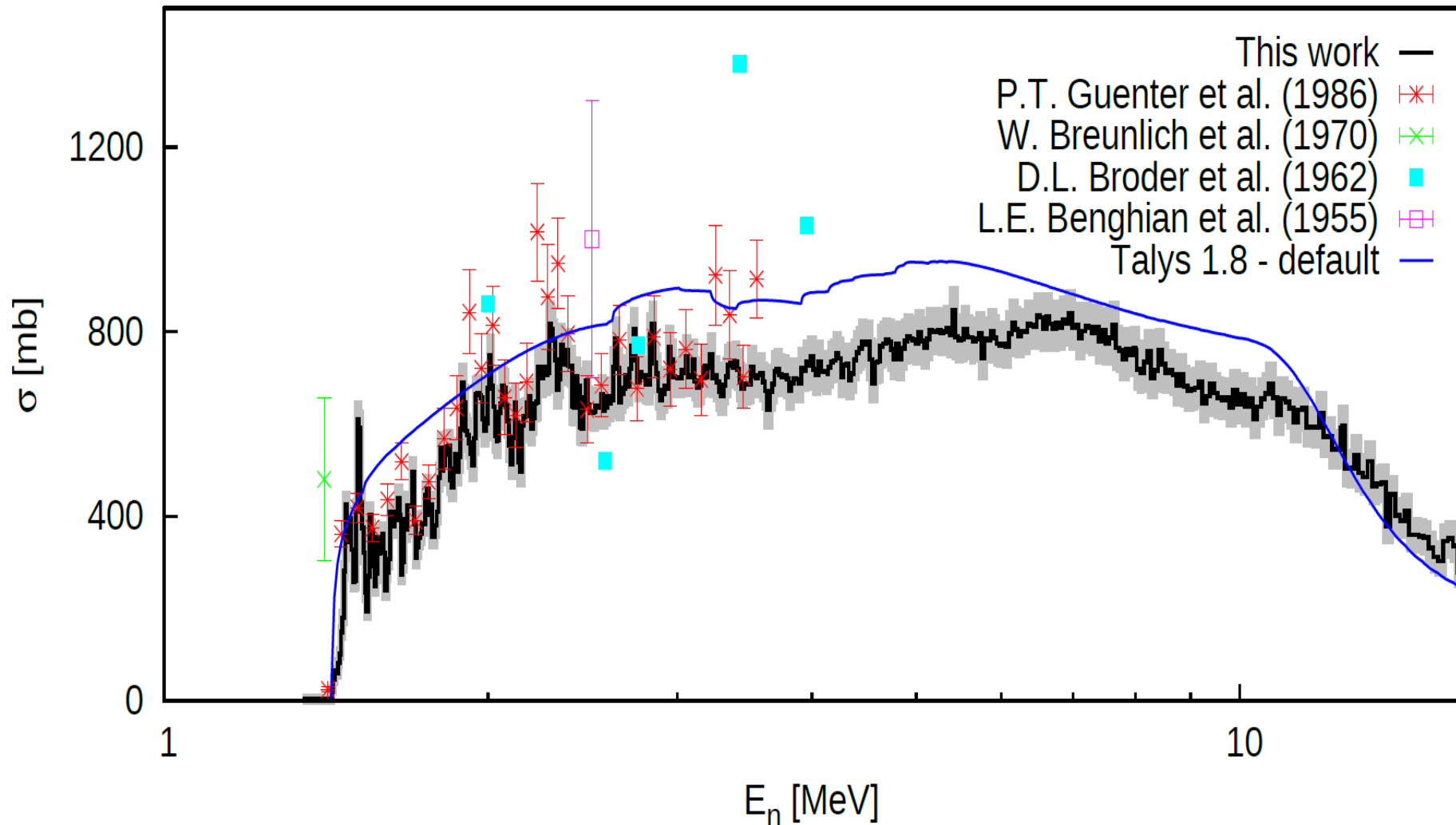
# $^{54}\text{Fe}$ Evaluation in the Resolved Resonance

- Natural Iron:  $^{56}\text{Fe}$ (91.75 %),  $^{54}\text{Fe}$ (5.85 %) and  $^{57}\text{Fe}$ (2.12 %);
- Resonance region extended from 700 keV to 1.2 MeV;
- High resolution transmission data of Cornelis (GELINA) and Harvey (ORELA);
- Capture and DDX Scattering cross section needed;
- First inelastic channel opens 1.434 MeV;
- Inelastic cross section data measurements going on at GELINA;

# $^{54}\text{Fe}$ Resolved Resonance



# $^{54}\text{Fe}$ GEEL inelastic cross section



# $^{233}\text{U}$ Resonance Evaluation

## ■ Motivation :

- Address issues with thermal and epithermal energy benchmark ;
- Extend resonance energy from 600 eV to 2 keV;
- High resolution transmission and fission data taken;
- Very little information on capture data;
- SAMMY R-matrix analysis;
- Improve benchmark integral representation;
- Uncertainty information and resonance parameter
- Covariance generation;

# $^{233}\text{U}$ Resonance Measurements

■  $^{233}\text{U}$  fission and transmission measurements done at ORNL

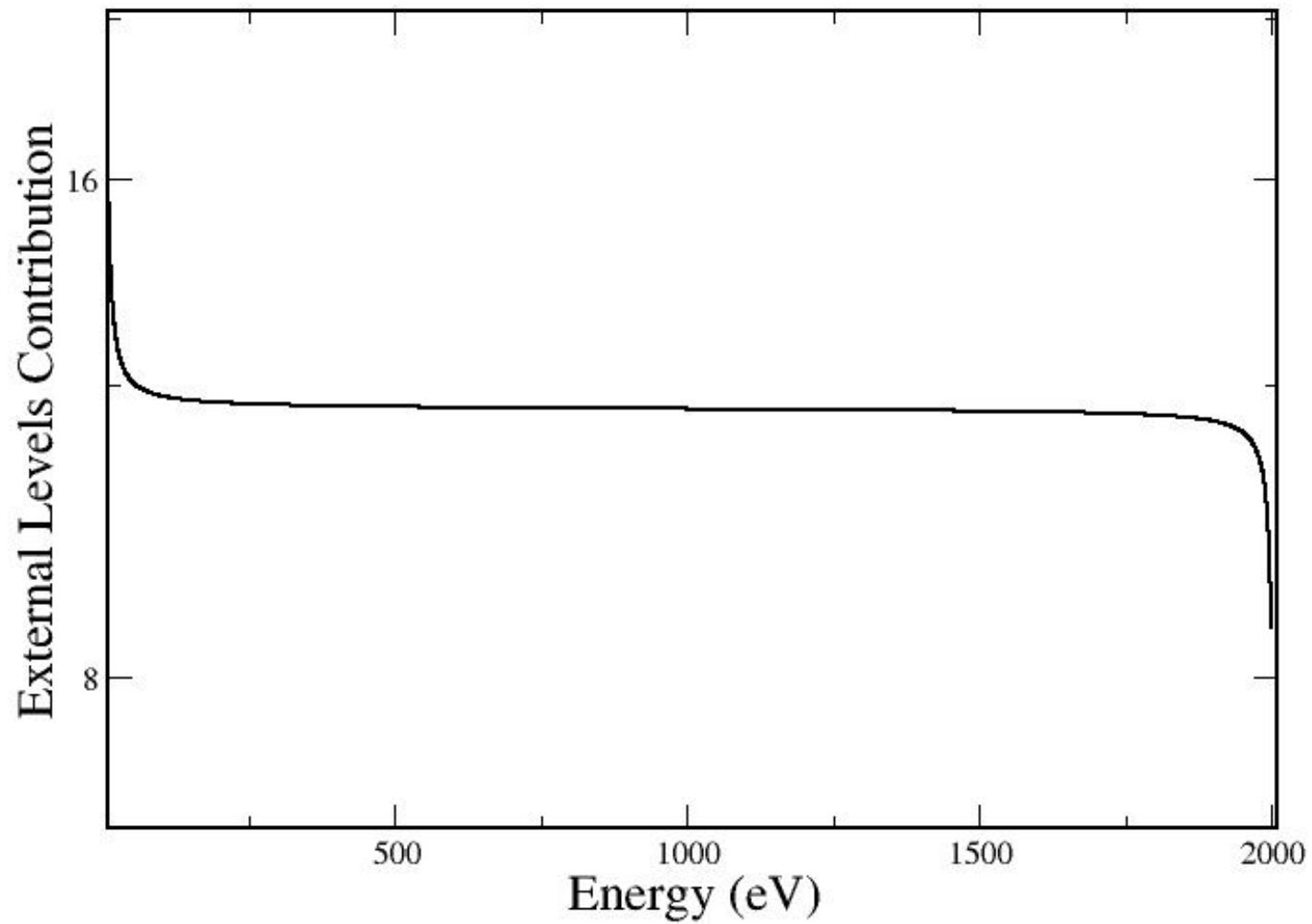
➤ Fission Measurement:

- $^{233}\text{U}$  fission chamber (2.11 grams Uranium)
- 99.997% enriched  $^{233}\text{U}$
- Energy range from 0.4 eV to 700 keV

➤ Transmission Measurement:

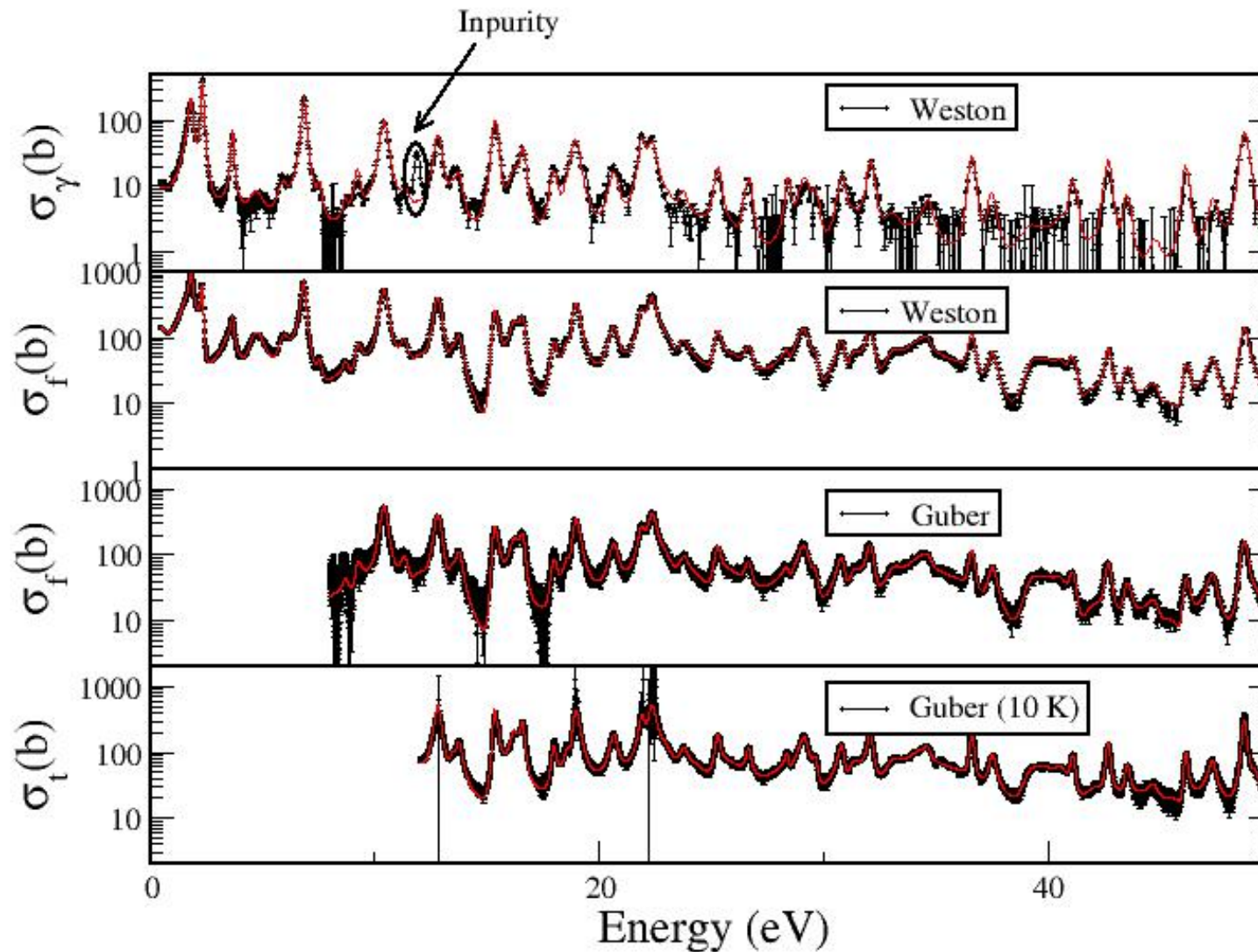
- ~35 and ~73 gram-metal samples
- 99.76 %  $^{233}\text{U}$
- Cryogenically cooled to  $T=11\text{ K}$
- Energy range from 0.5 eV to 600 keV

# External Levels

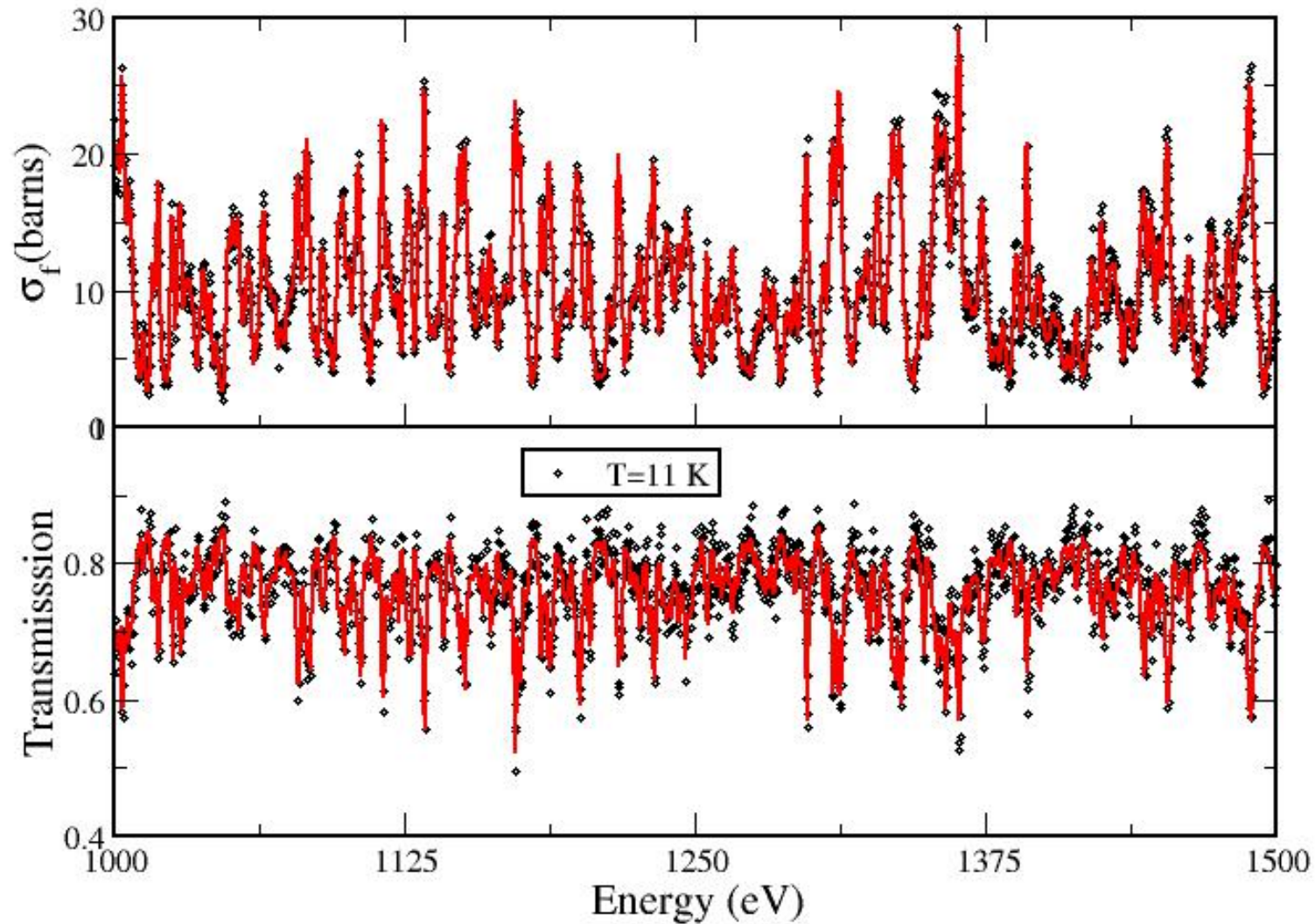




# Data Fitting



# Data Fitting



# Concluding Remarks

- IRSN continues to work close to the NCSP agenda on differential data evaluation;
- Various tasks have been accomplished following the NCSP schedule;
- Final evaluation includes resonance parameters and resonance parameter covariance;
- *Capture data for  $^{233}\text{U}$  is needed to finish the evaluation effort;*
- *Some work on the NJOY processing of resonance parameter covariance is needed !!*