IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Faire avancer la sûreté nucléaire

Nuclear Data Evaluation Work at IRSN

TPR Meeting
Oak Ridge National Laboratory

IRSN / PSN-EXP/SNC
March 2018
Luiz LEAL

OUTLINE

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

Resonance Evaluations and deliverables

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

^{155}Gd and ^{157}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;

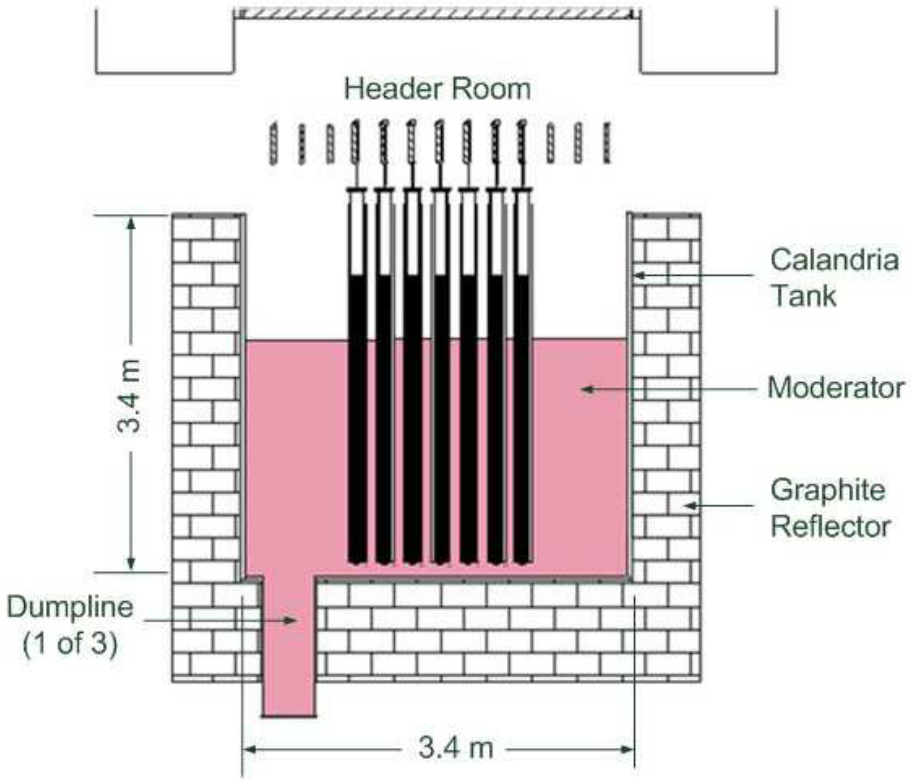
General Information

Atlas of Neutron Resonances (ANR)			
	Thermal Cross Section (barns)	Capture Resonance Integral (barns)	Westcott's Factor
^{155}Gd	60900 ± 500	1537 ± 100	0.83899
^{157}Gd	254000 ± 815	754 ± 20	0.84715

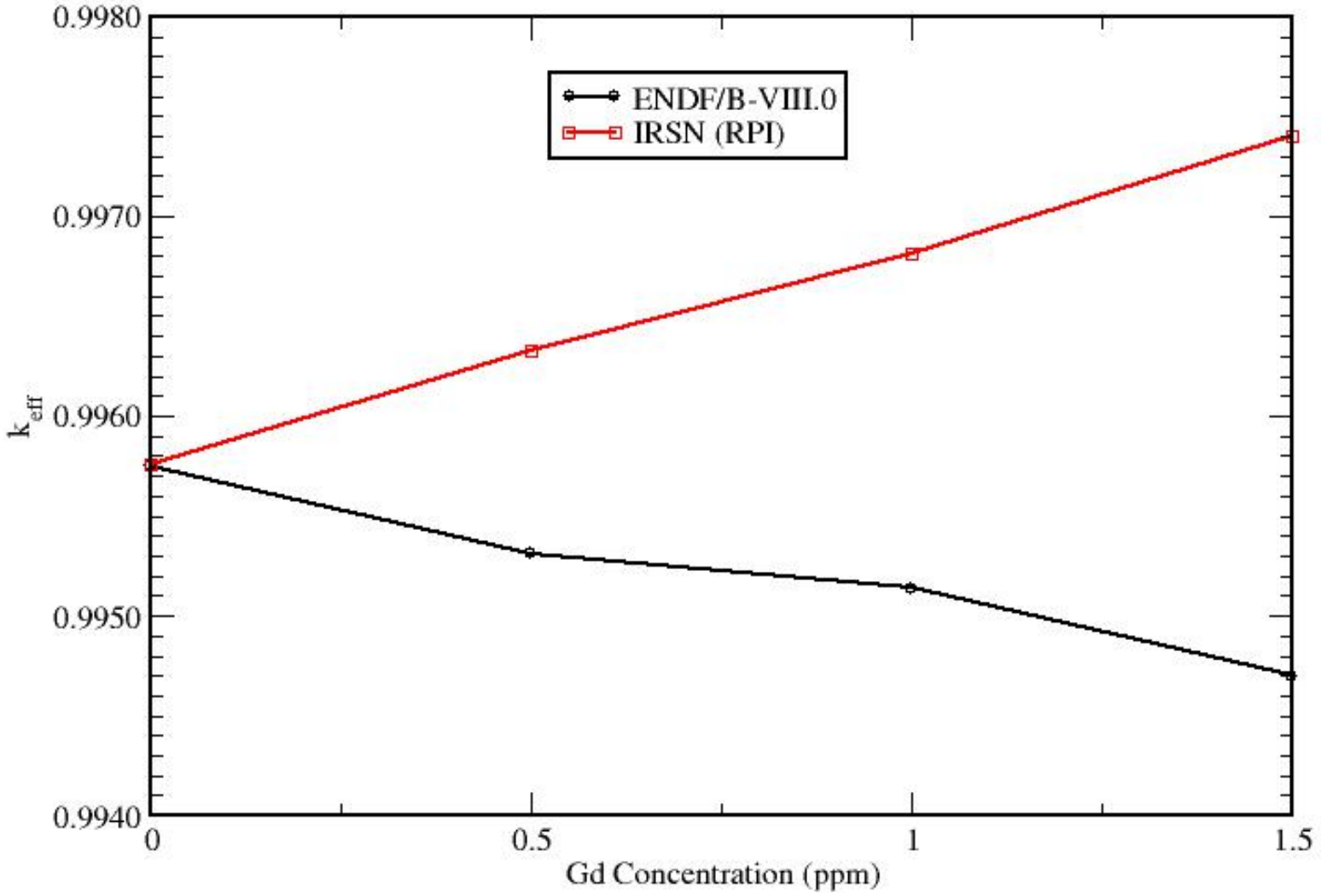
Benchmark Results: Issues

- ZED-II (Zero Energy Deuterium) Research Reactor
- Issues with benchmark calculations with Gd concentration

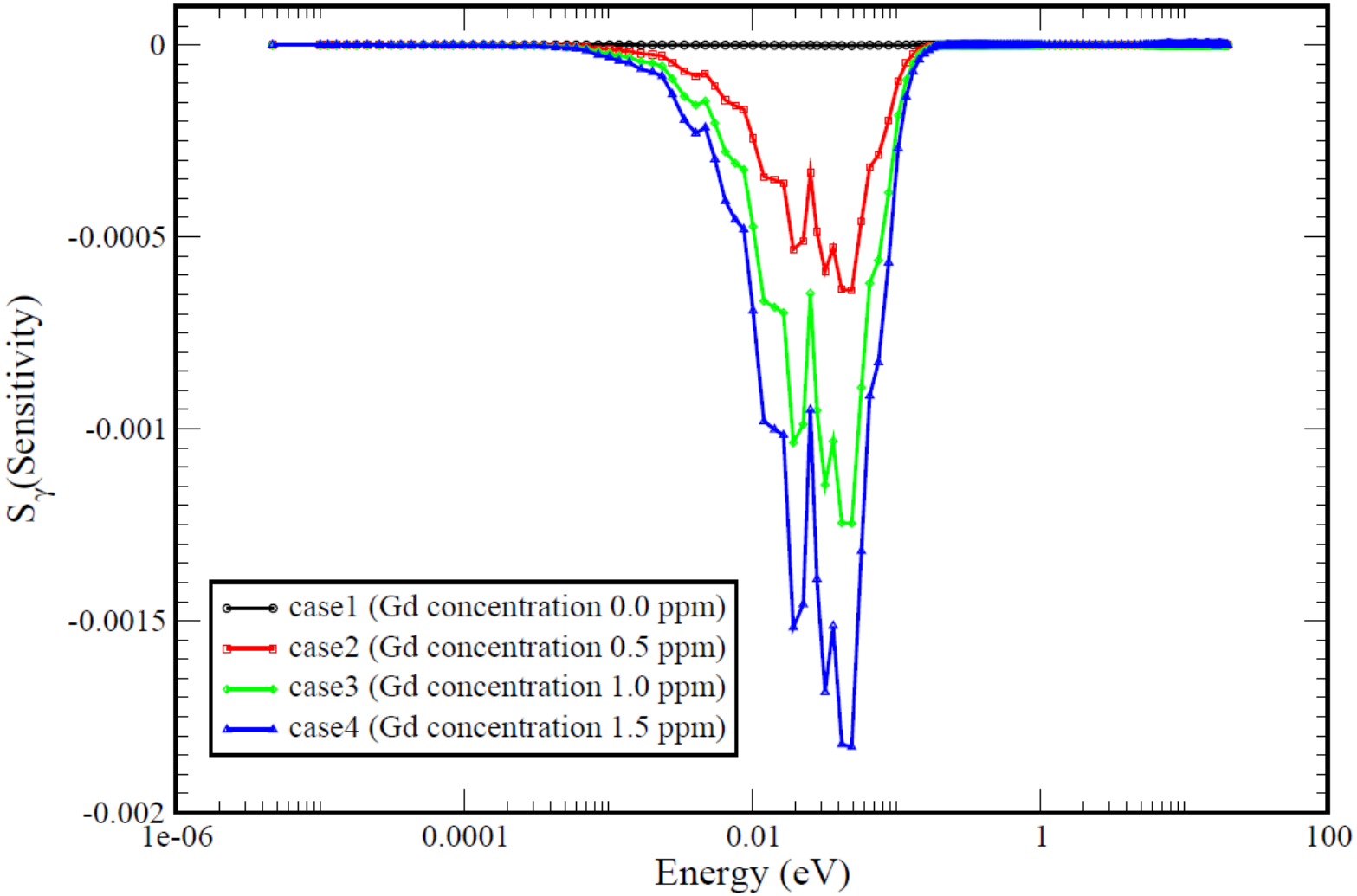
Note: Dan Roubtsov kindly shared his MCNP input decks



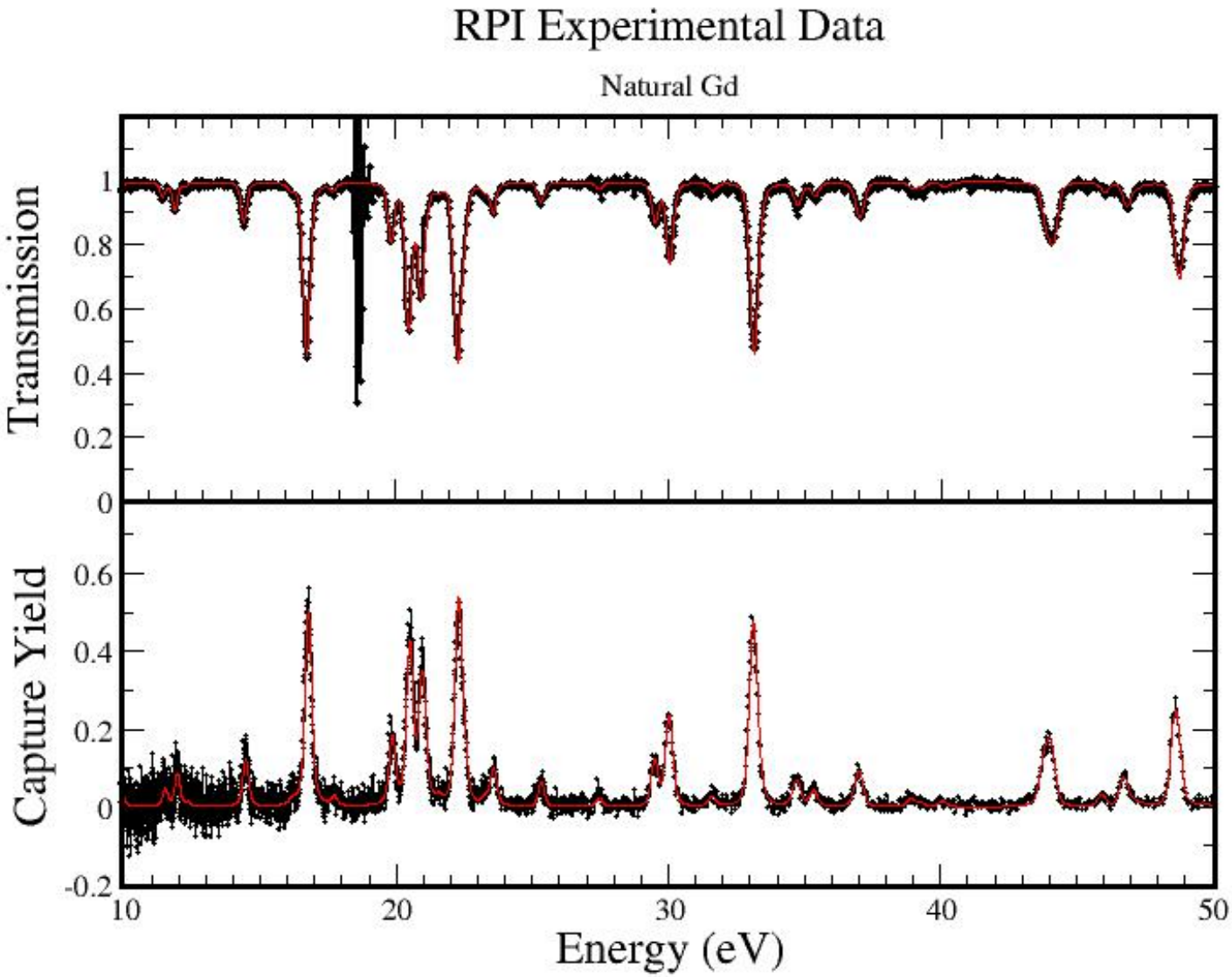
Issue:


0.9980
0.9970
0.9960
0.9950
0.9940
k_{eff}
ENDF/B-VIII.0
IRSN (RPI)
0
0.5
1
1.5
Gd Concentration (ppm)

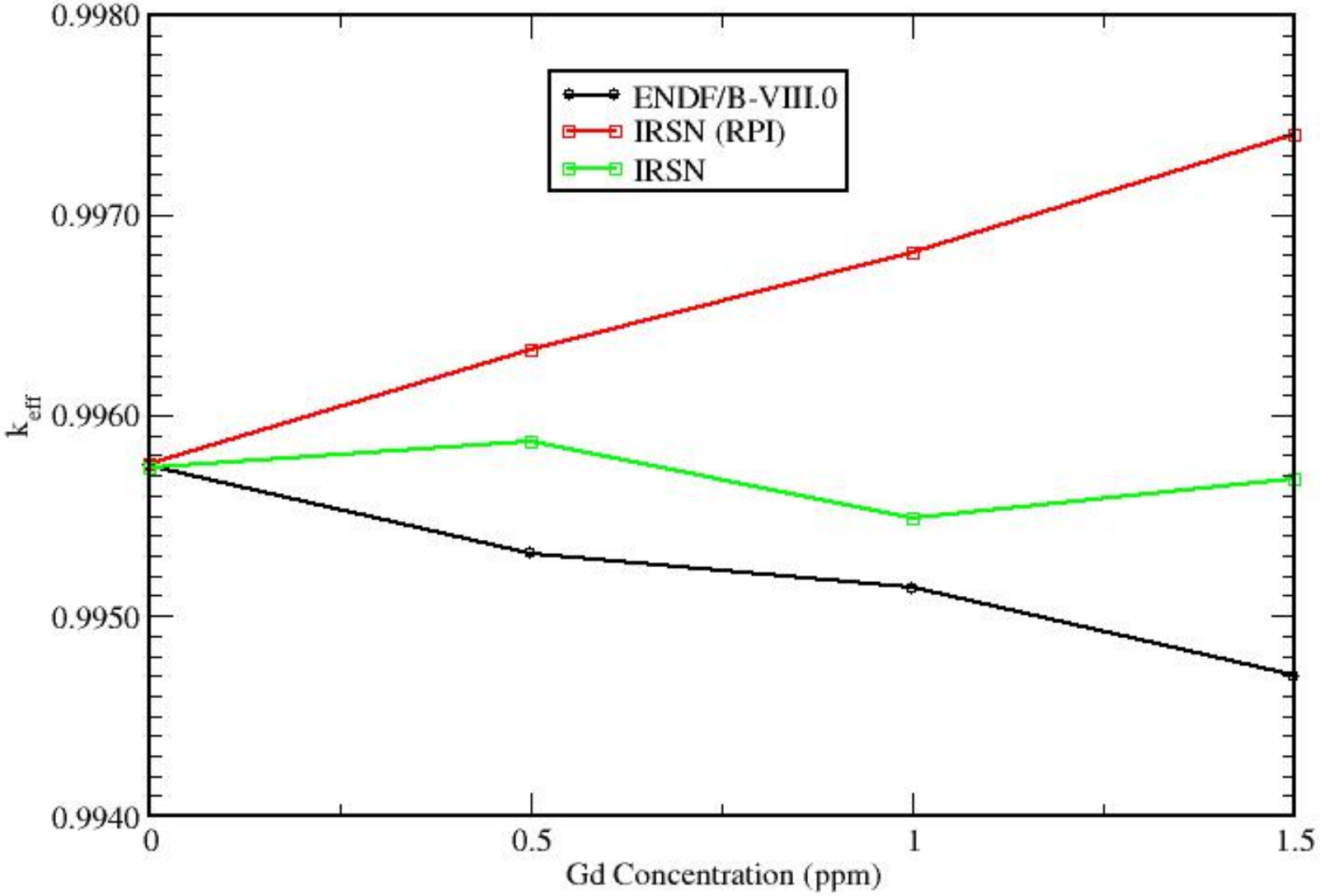
K_{eff} Sensitivity to the Capture Cross Section



SAMMY Fitting (RPI)



Resolution: use of SAMMY and SAMINT



^{157}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 ± 815	754 ± 20	0.84715

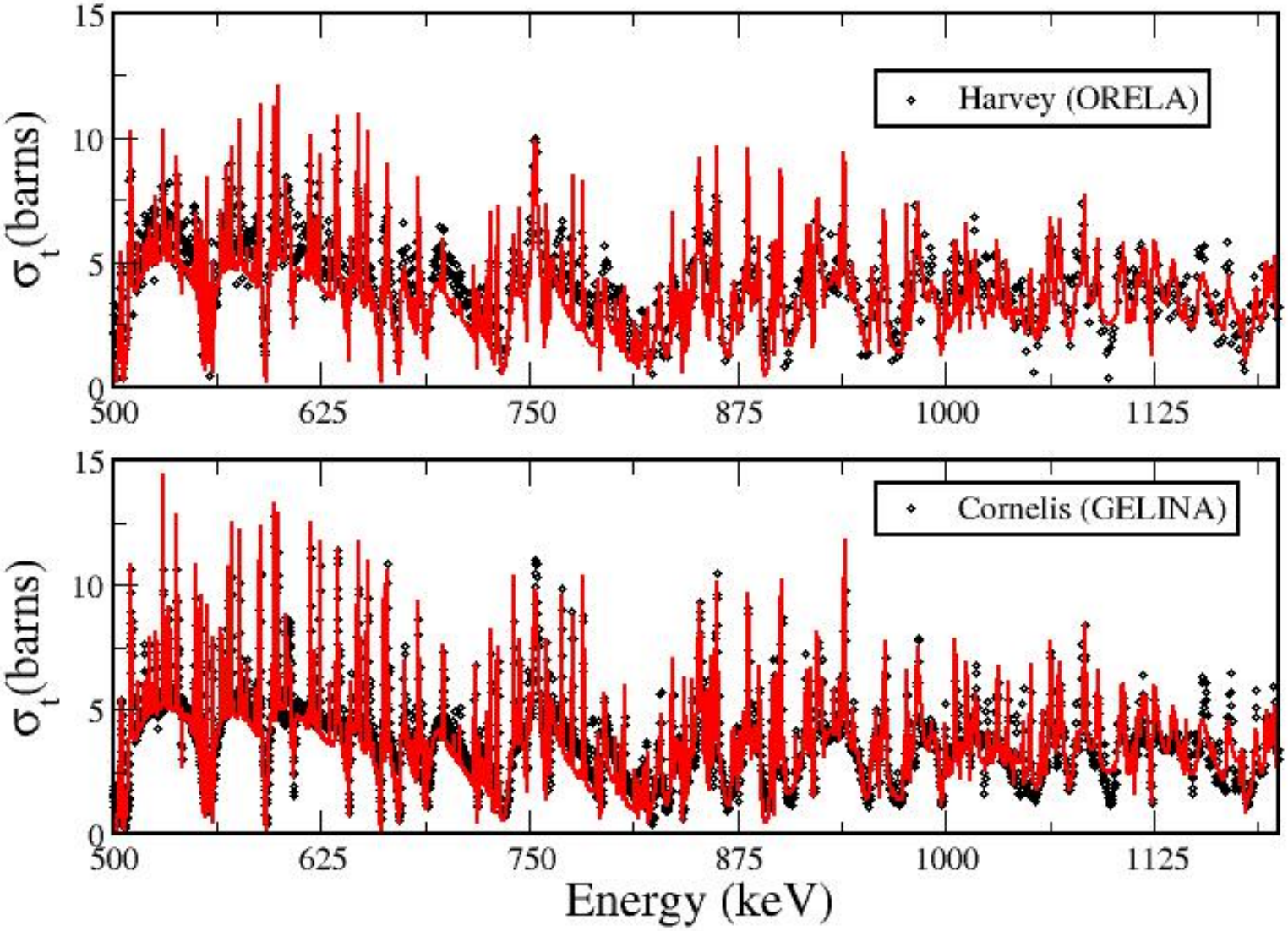
Moving Forward:

- Include new capture 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}Gd;
- Include IRSN Gd benchmark in the integral fitting;
- Covariance generation;

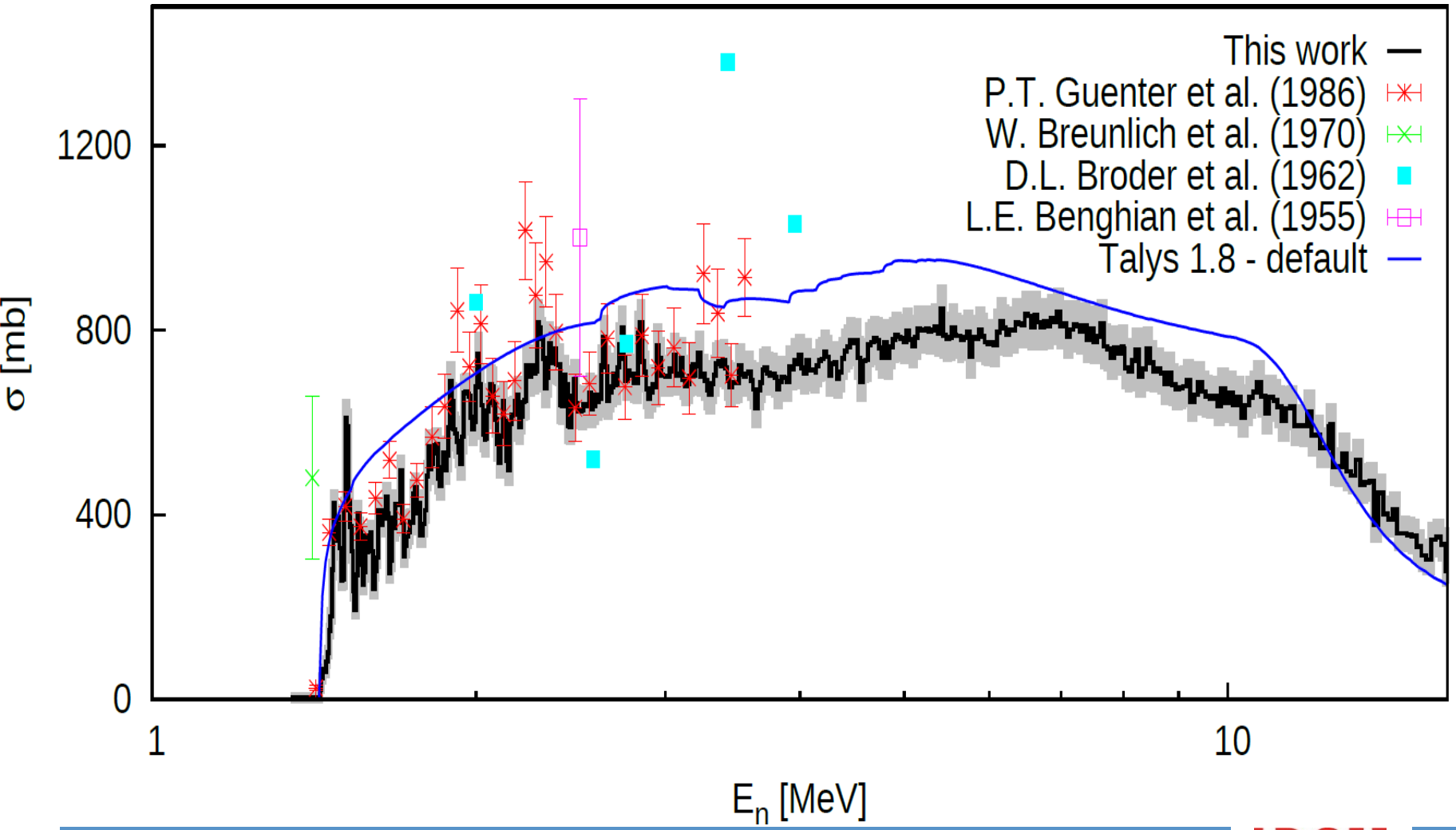
^{54}Fe Evaluation in the Resolved Resonance

- Natural Iron: ^{56}Fe(91.75 %), ^{54}Fe(5.85 %) and ^{57}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}Fe Resolved Resonance



^{54}Fe GEEL inelastic cross section



^{233}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;

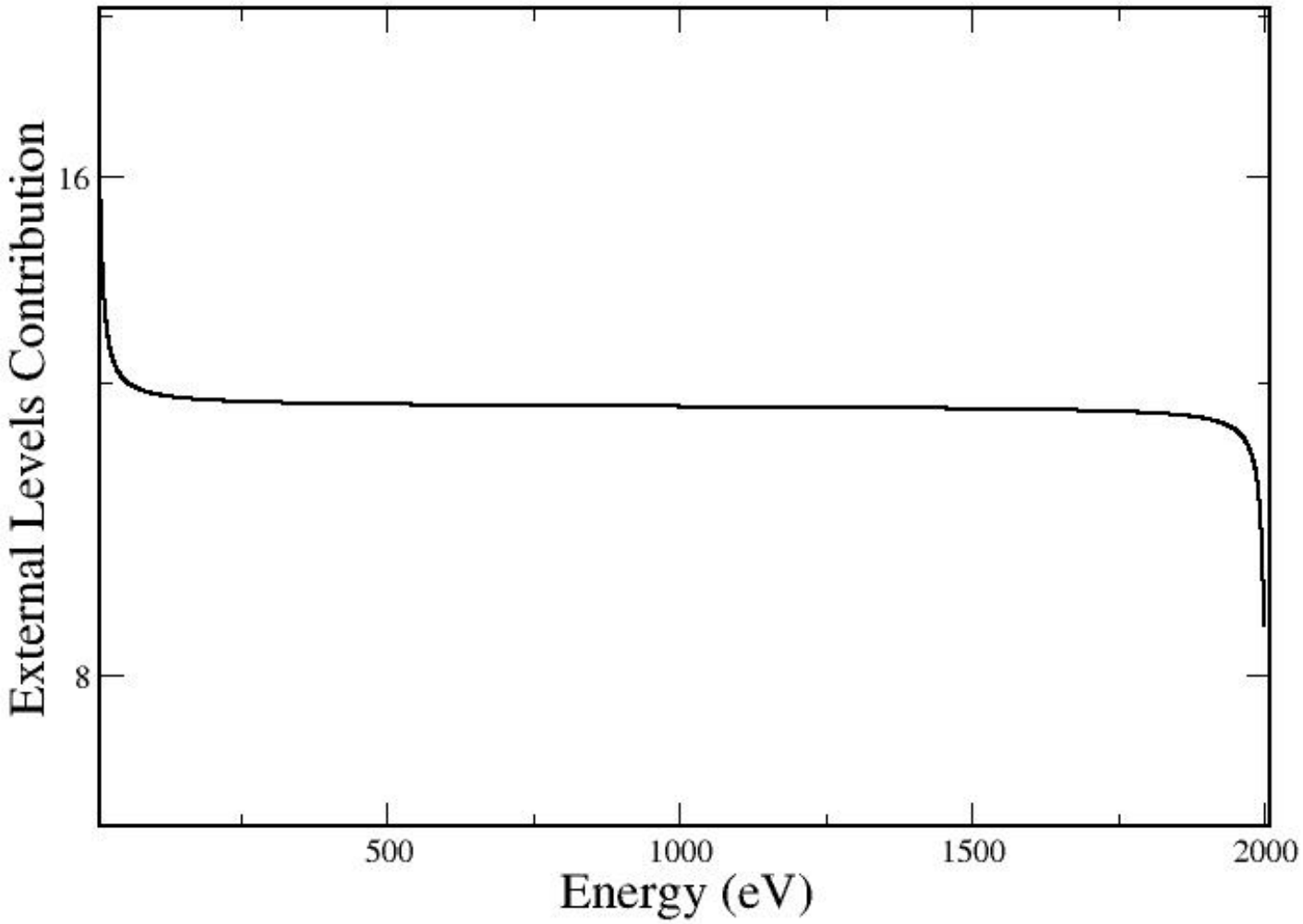
^{233}U Resonance Measurements

- ^{233}U fission and transmission measurements done at ORNL

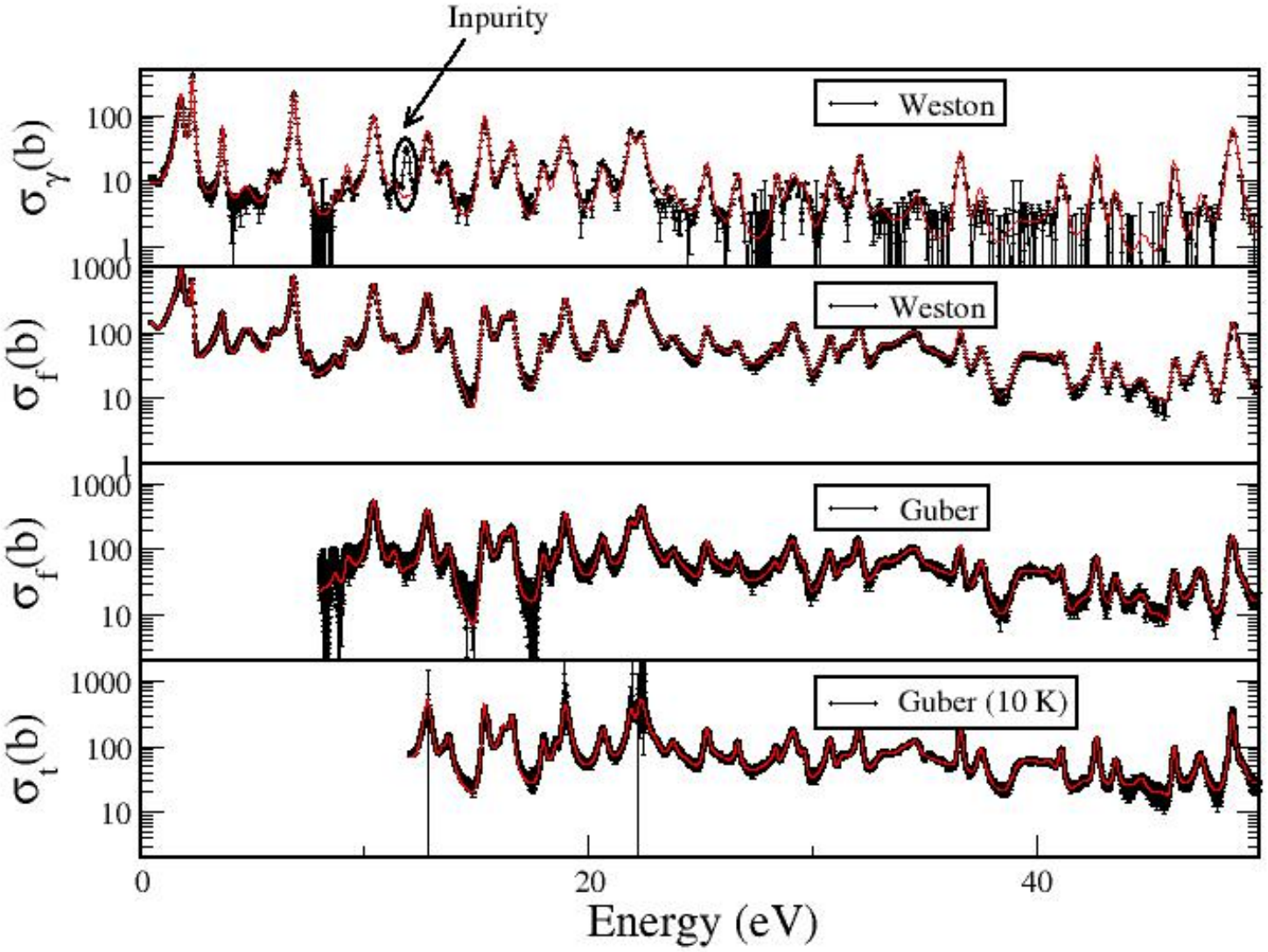
  - Fission Measurement:
    - ^{233}U fission chamber (2.11 grams Uranium)
    - 99.997% enriched ^{233}U
    - Energy range from 0.4 eV to 700 keV

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

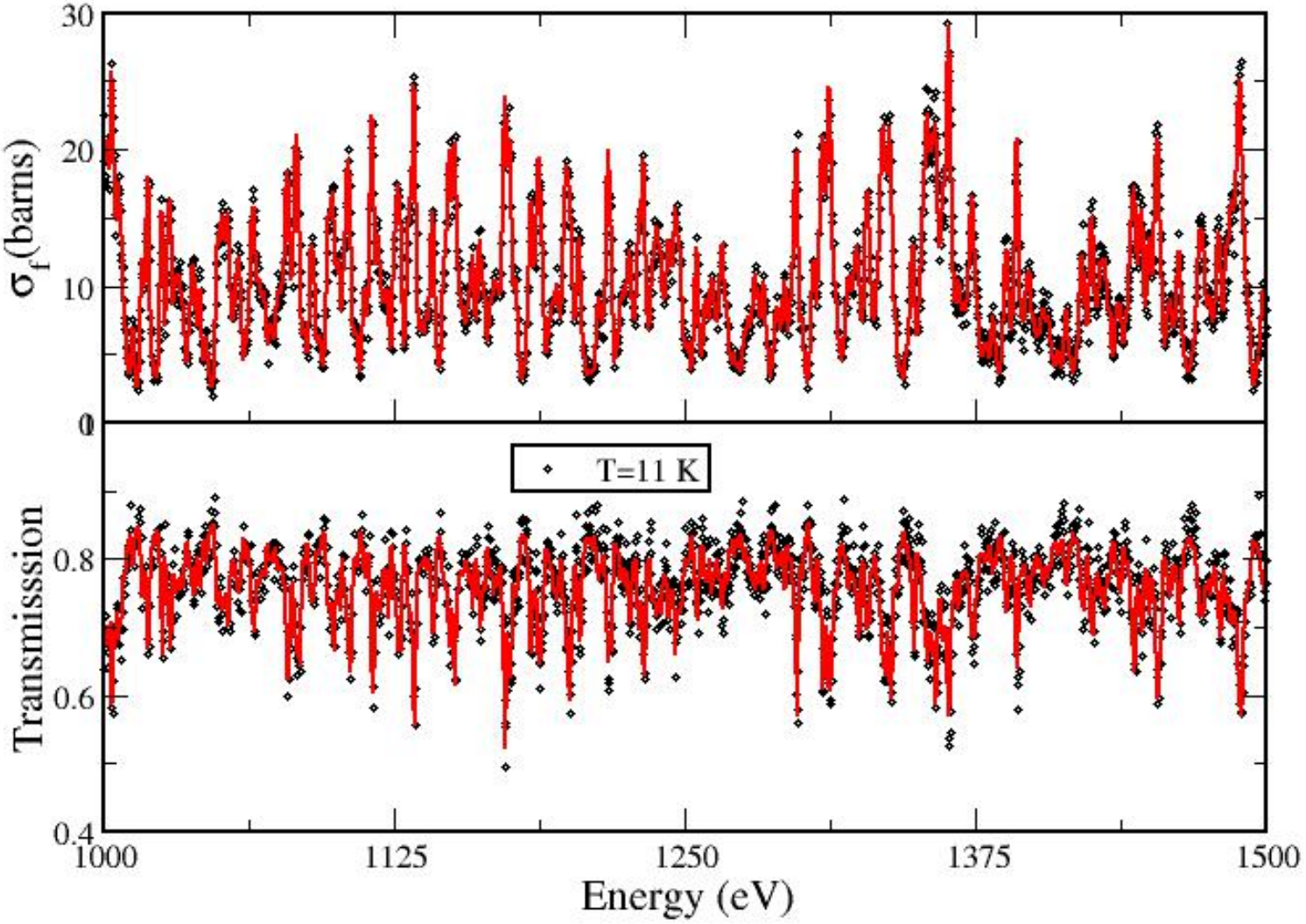
External Levels



Data Fitting



Data Fitting



Concluding Remarks

- IRSN continues to work close to the NCSP agenda on differential data evaluation;
- Final evaluation includes resonance parameters and resonance parameter covariance;