Neutron Cross-Section Measurements Activities at ORNL

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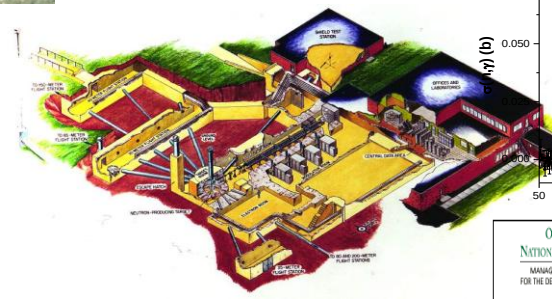
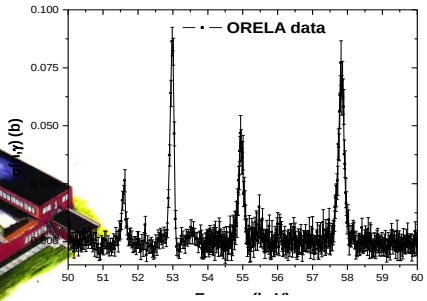
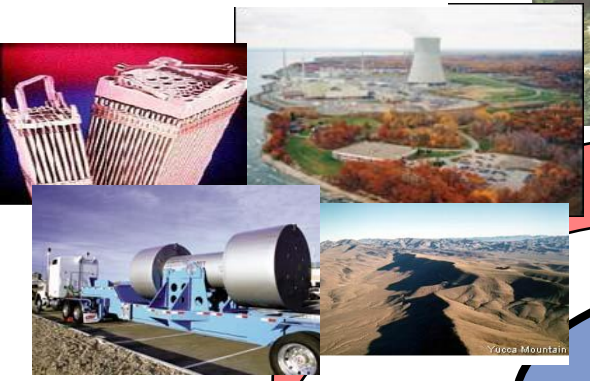
Nuclear Astrophysics

ORELA



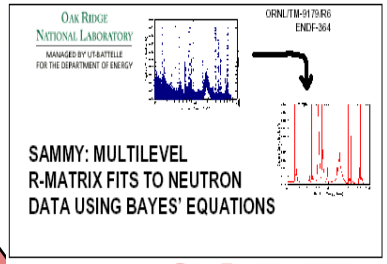




Basic Science

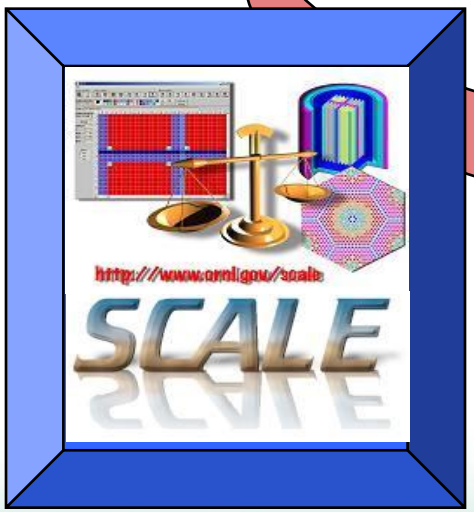
Applications

ORNL Data Support for Nuclear Applications

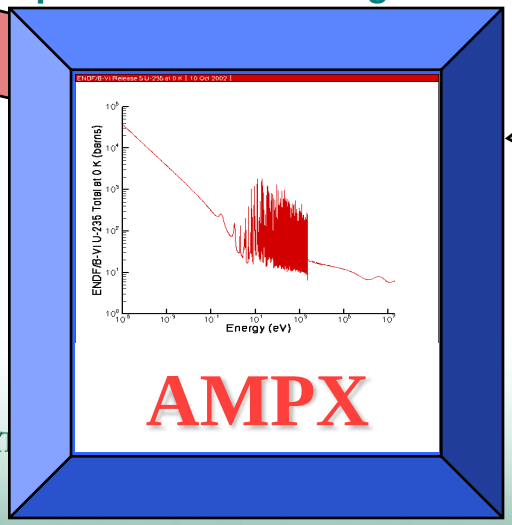


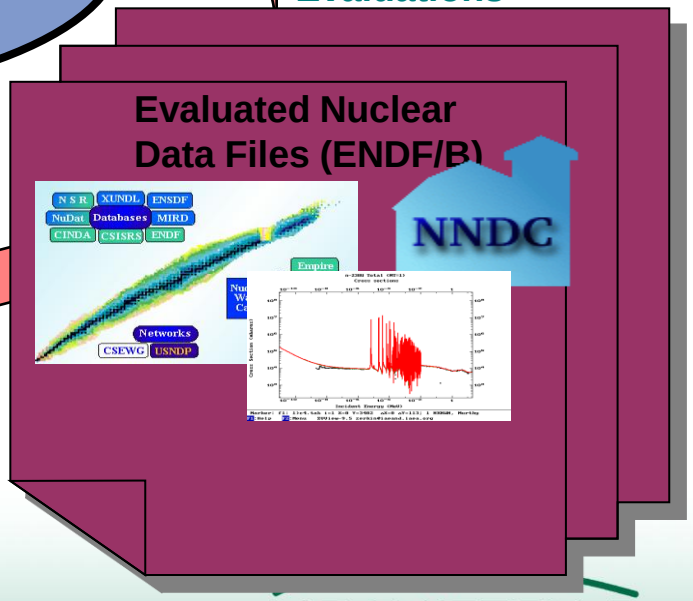
SAMMY

Cross-Section Evaluations



Computational modeling





OAK RIDGE NATIONAL LABORAT
U. S. DEPARTMENT OF ENERGY

UT-BATTELLE

ORELA Operation suspended for FY09

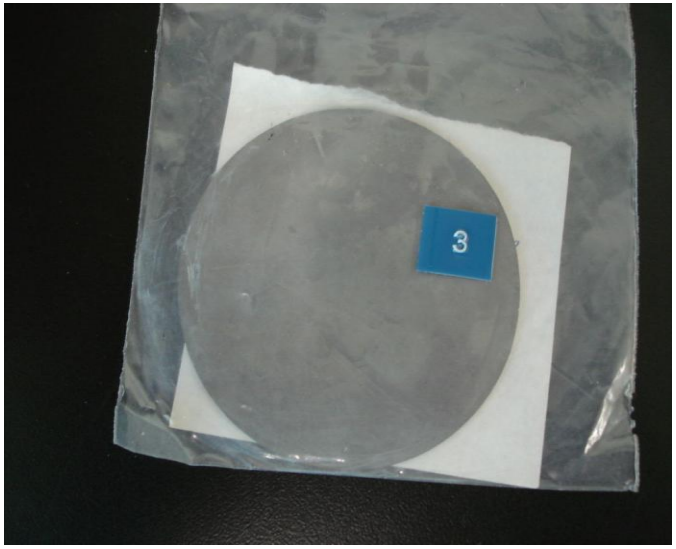
- Due to old/incomplete Safety Analysis Document (SAD) ORELA operation was suspended in FY09. New SAD is DOE requirement.
- ORELA operations manager and accelerator safety personnel form ORNL are working on new SAD.
- Until new and approved SAD document, ORELA stays in stand-by mode.

ORNL Measurement Activities in FY09

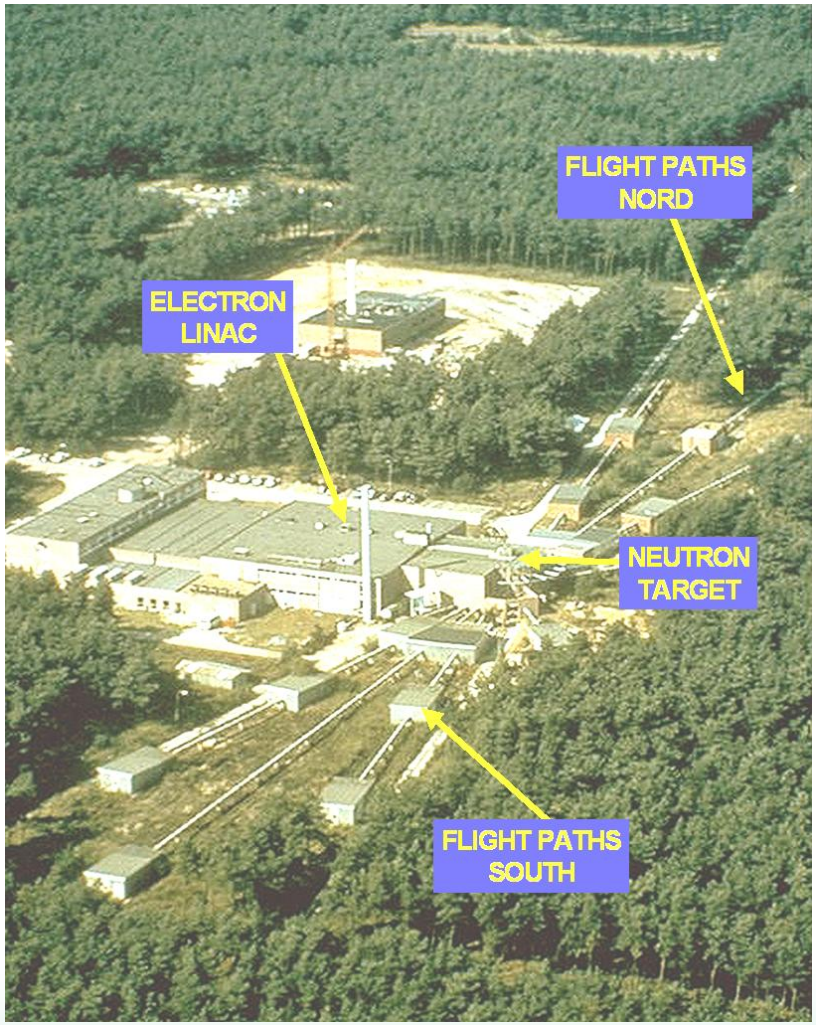
- Measurements of the stable W isotopes for the NCSP using enriched samples.
- No good high resolution data available in nuclear data libraries.
- New experiments with oxide samples exist but unclear physical condition of the samples, since samples changed during experiment, i.e. at/b unknown.
- Collaboration with IRMM in Geel to salvage this data by redoing experiments.

W samples

- Metallic samples are preferred over oxide samples. Oxide is usually the inventory form of the provider.
  - The oxide produces unwanted background due to scattering of neutrons from oxygen.
  - Oxide are hygroscopic, need to be pressed into a selfsupporting disk and need to be encapsulated (additional background from canning).
- Old metallic samples were found in the material storage at ORNL.
  - Metallic disks with 1mm thickness and 70mm diameter.
  - Several disk for each isotope with enrichment of up to 95%, so different sample thickness could be achieved.



GELINA

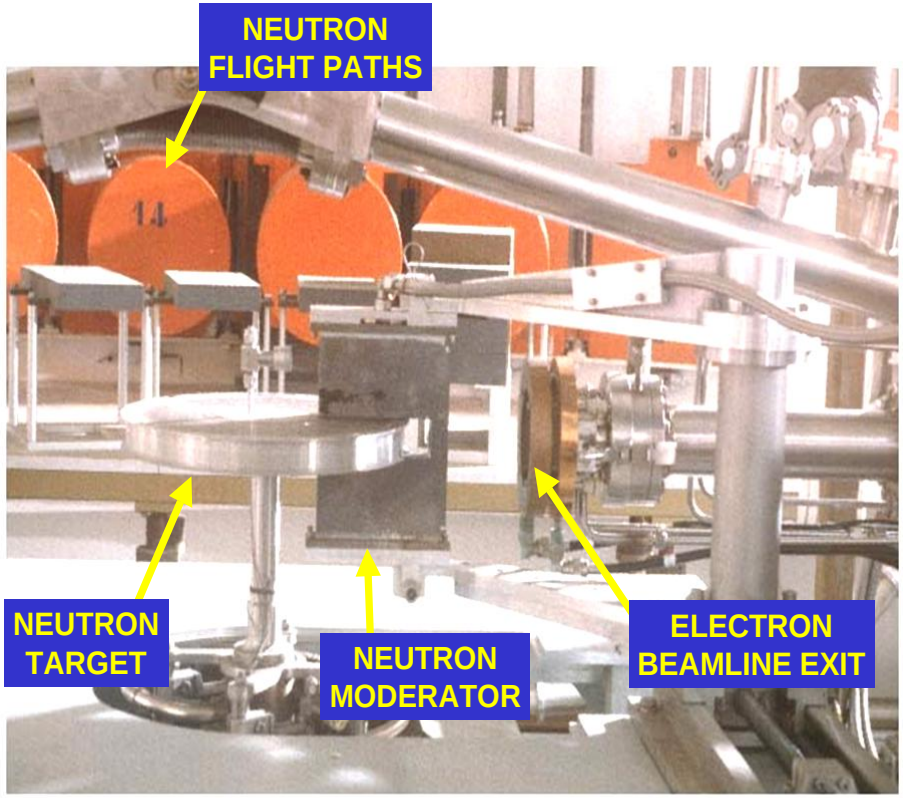


- Time-of-flight facility
- Pulsed white neutron source

  (10 meV < E_n < 20 MeV)
- Multi-user facility with 10 flight paths (10 m - 400 m)
- The measurement stations have special equipment to perform:
  - Total cross section measurements
  - Partial cross section measurements

Pulse Width	: 1ns		
Frequency Hz	: 40 Hz	-	800
Average Current	: 4.7 μA	-	75 μA
Neutron intensity n/s	: 1.6 10^{12} n/s	-	2.5 10^{13}

Neutron Production



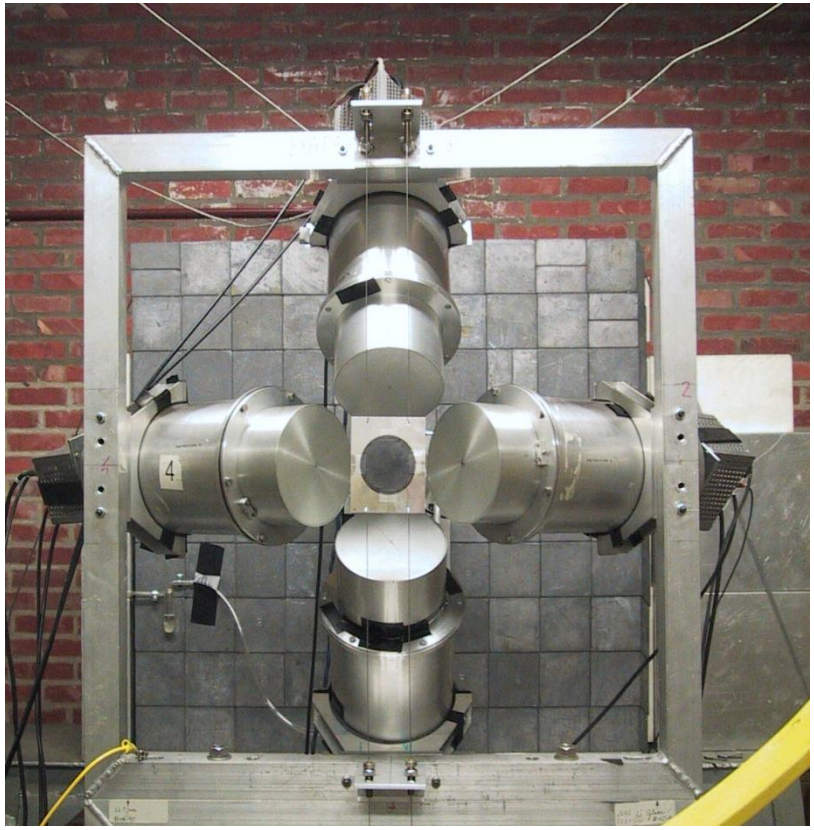
- e^- accelerated to $E_{e^-,max} \approx$ 140 MeV
- (e^-, γ) Bremsstrahlung in U-target (rotating & cooled with liquied Hg)
- (γ,n) , (γ ,f) in U-target
- Low energy neutrons by water moderator in Be-canning

Capture cross section measurements at GELINA

Total energy detection

- C_6D_6 liquid scintillators
  - 125°
  - PHWT
- Flux measurements (IC)
  - $^{10}B(n,\alpha)$
  - $^{235}U(n,f)$

L = 10 m, 30 m and 60 m

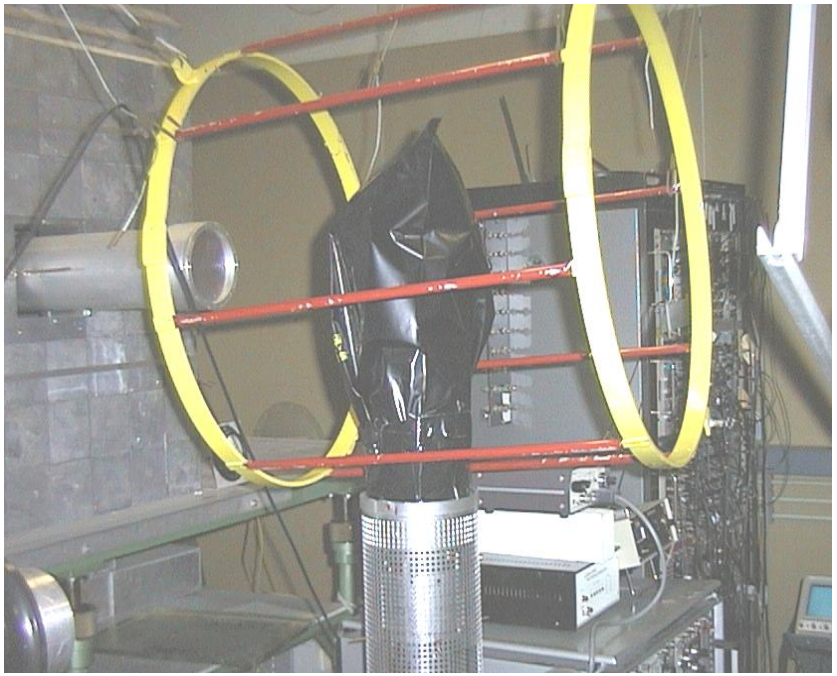


$$Y_{exp} = N\sigma_{\varphi}\frac{C_w - B_w}{C_{\varphi} - B_{\varphi}}$$

Transmission Measurements

Sample & Background Filters

Detector



Detector stations
Moderated: L= 30 m,50 m,(100 m,200 m)
Fast : L= 400 m

Low energy : $^{6}Li(n,t)\alpha$ Li-glass

High energy : H(n,n)H Plastic scintillator

$$T = \frac{C_{in}}{C_{out}} \cong e^{-n\sigma_{tot}}$$

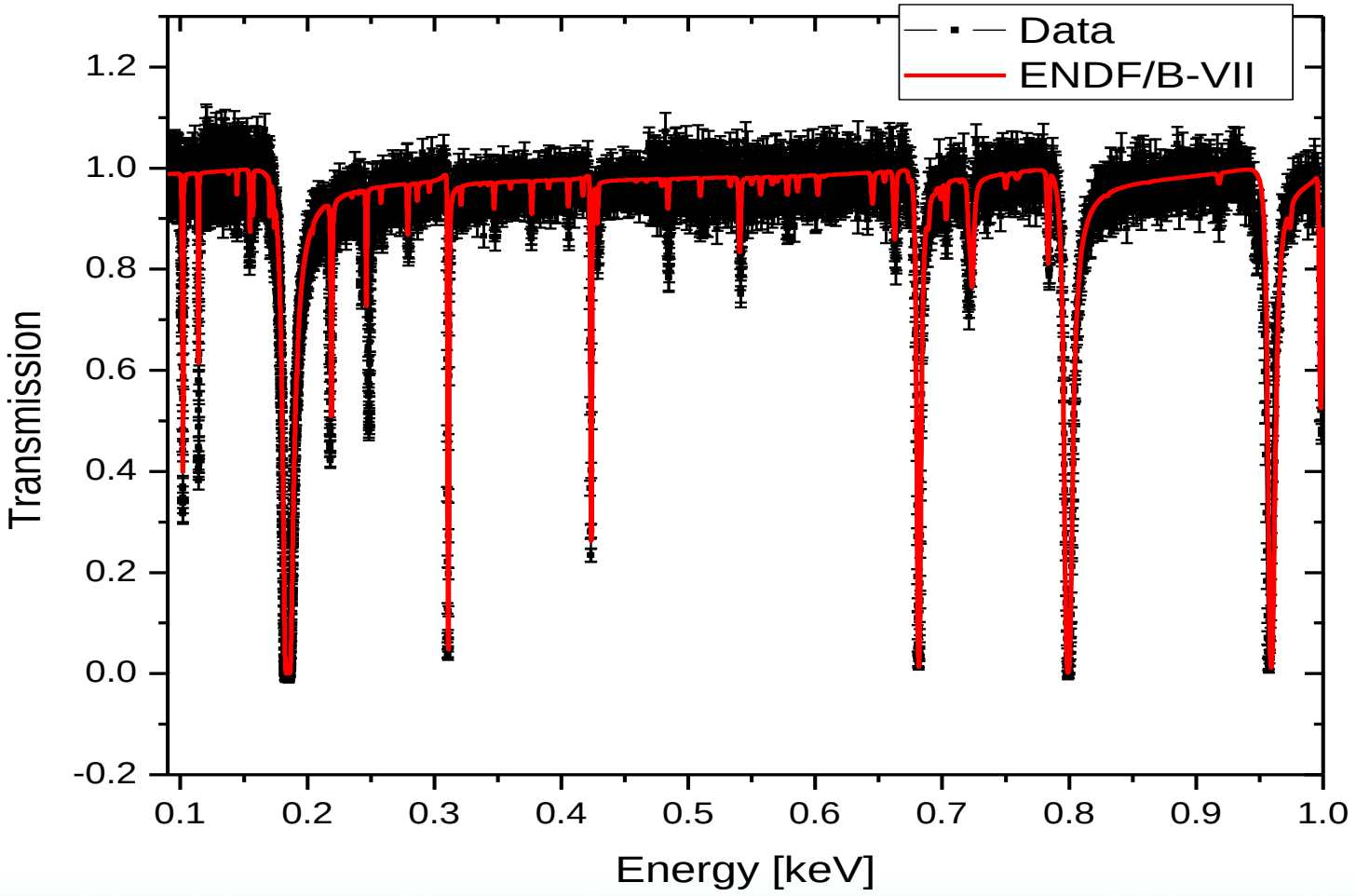
Experiments at GELINA

- Since ORELA was not operating all experiments were done in collaboration with GELINA.
- Neutron capture was performed at FP14 (60m) and FP15 (30m) with 1nsec pulse width and rep rate of 800Hz. By combining various disks, different sample thickness were achieved.
- Neutron transmission was measured at FP4 (50m) using a ^{6}Li glass detector. Different sample thickness were used.
- Additional runs are planned to measure the unresolved region.
- Additional experiments are planned at 40 Hz rep rate to measure the cross section down to thermal energies.

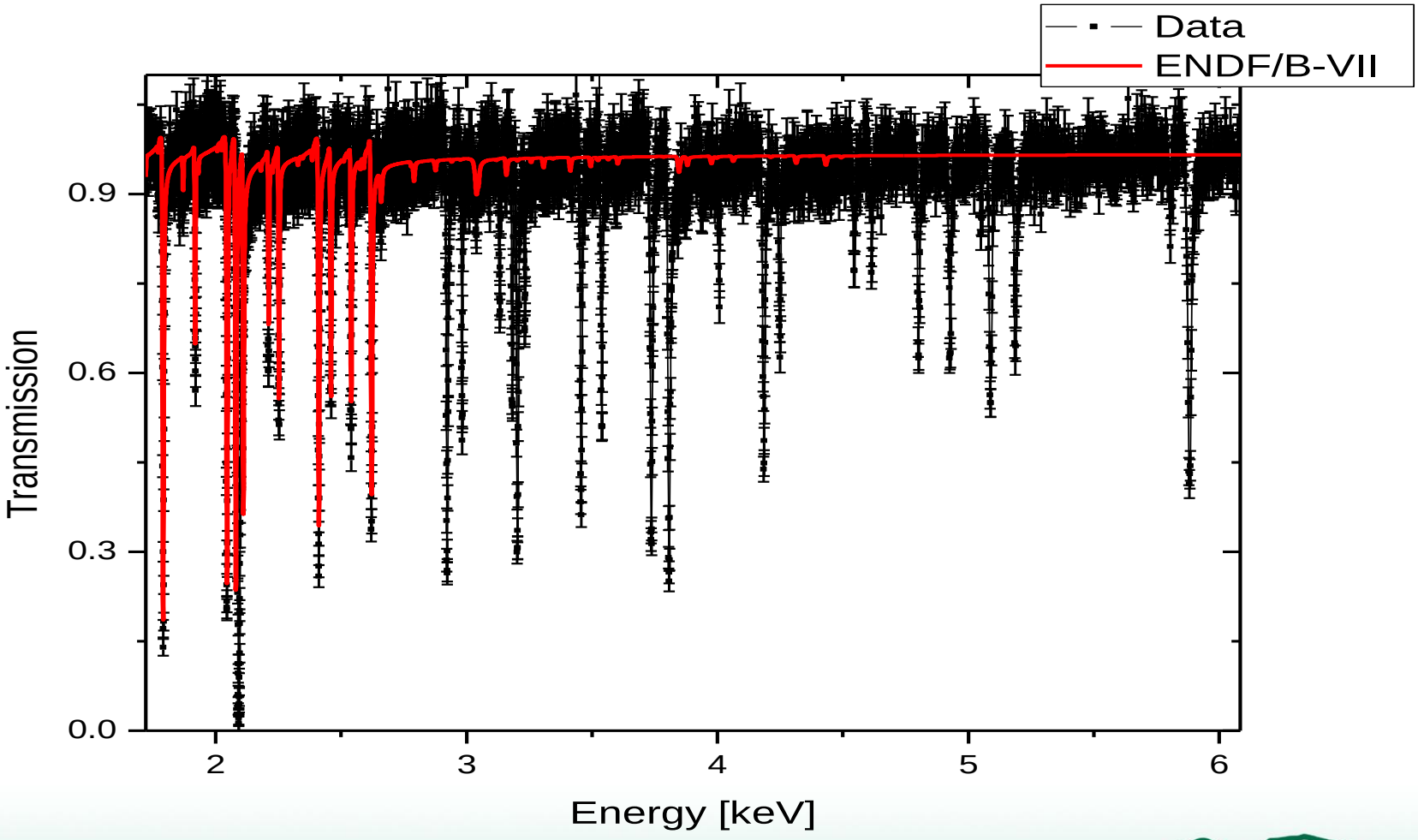
W Data Reduction

- Data are written in list-mode for each ADC and TDC.
- GELINA specific programs (AGL and AGS) are used for data reduction.
- AGL to produce spectra which are corrected for gain and checked for consistency.
- AGS used AGL data to produce yield, transmission or capture data propagating all experimental uncertainties.
- Output are experimental data with complete covariance matrix.

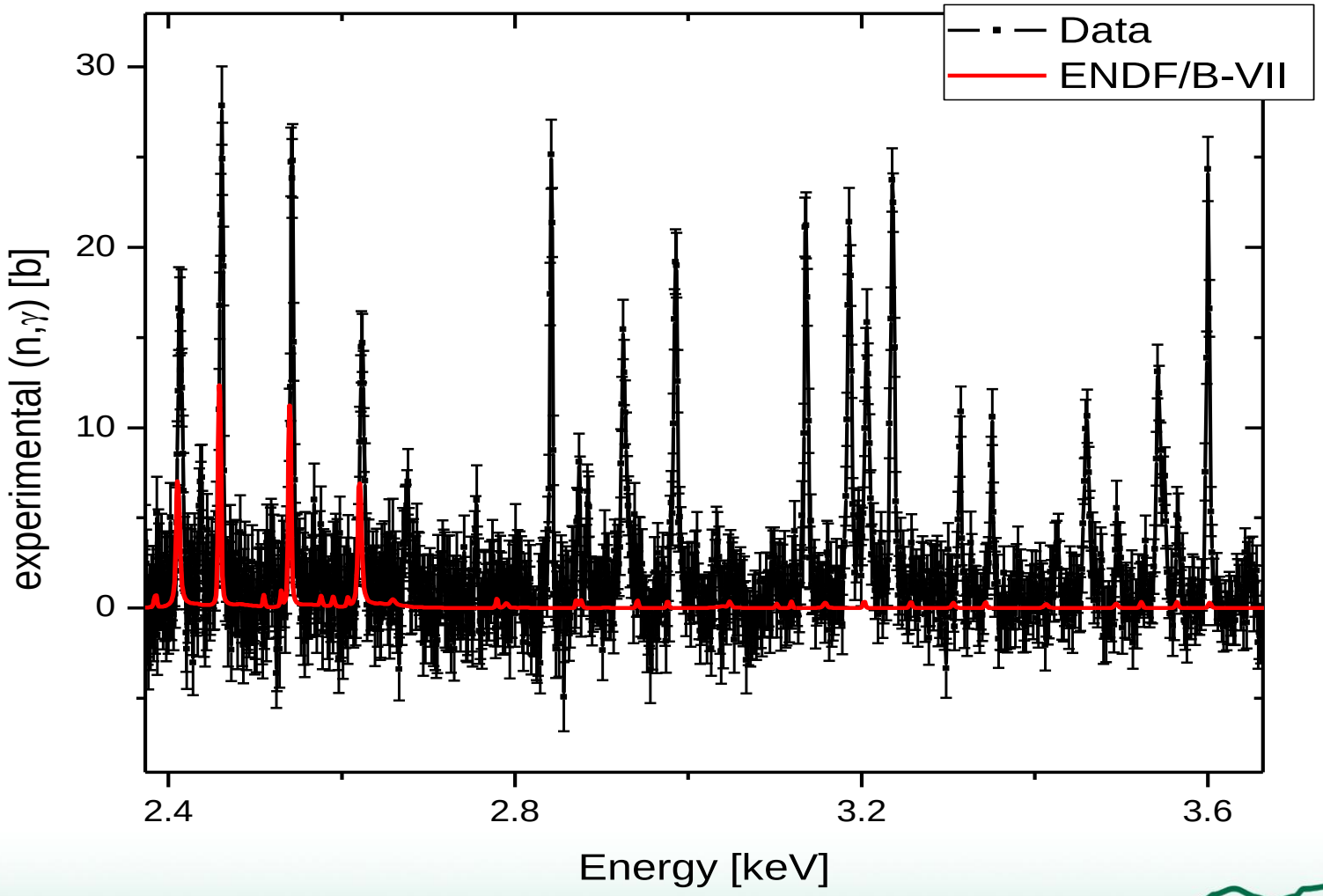
Transmission Data for 1mm ^{184}W compared to ENDF/B-VII

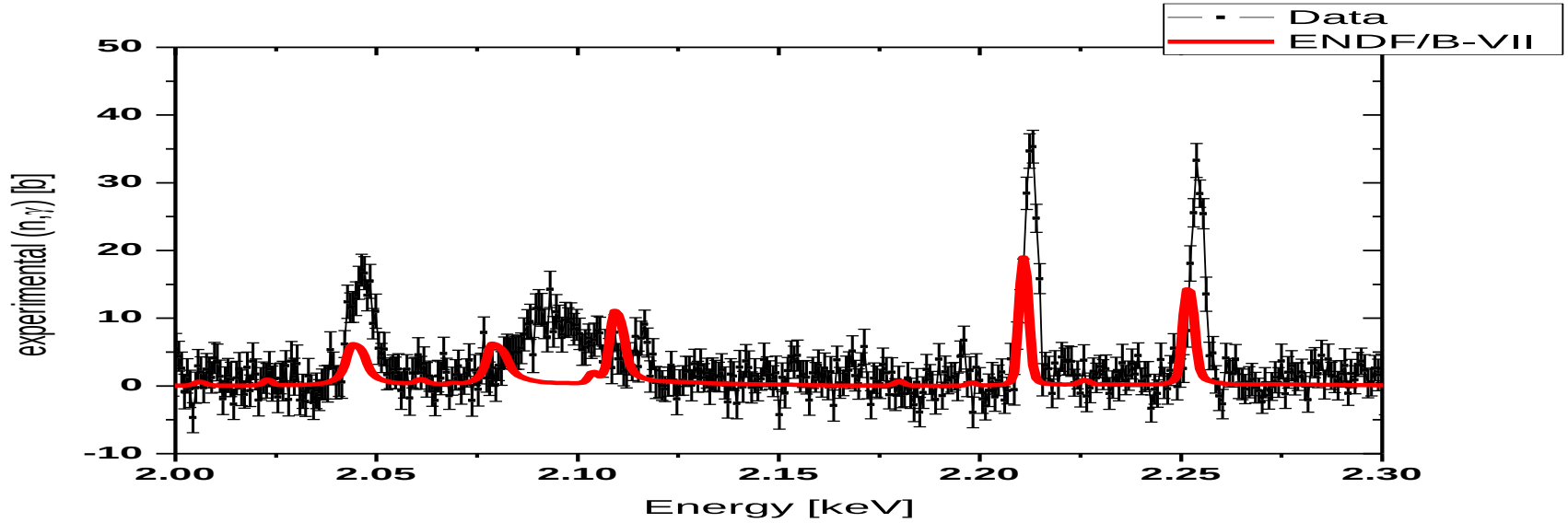


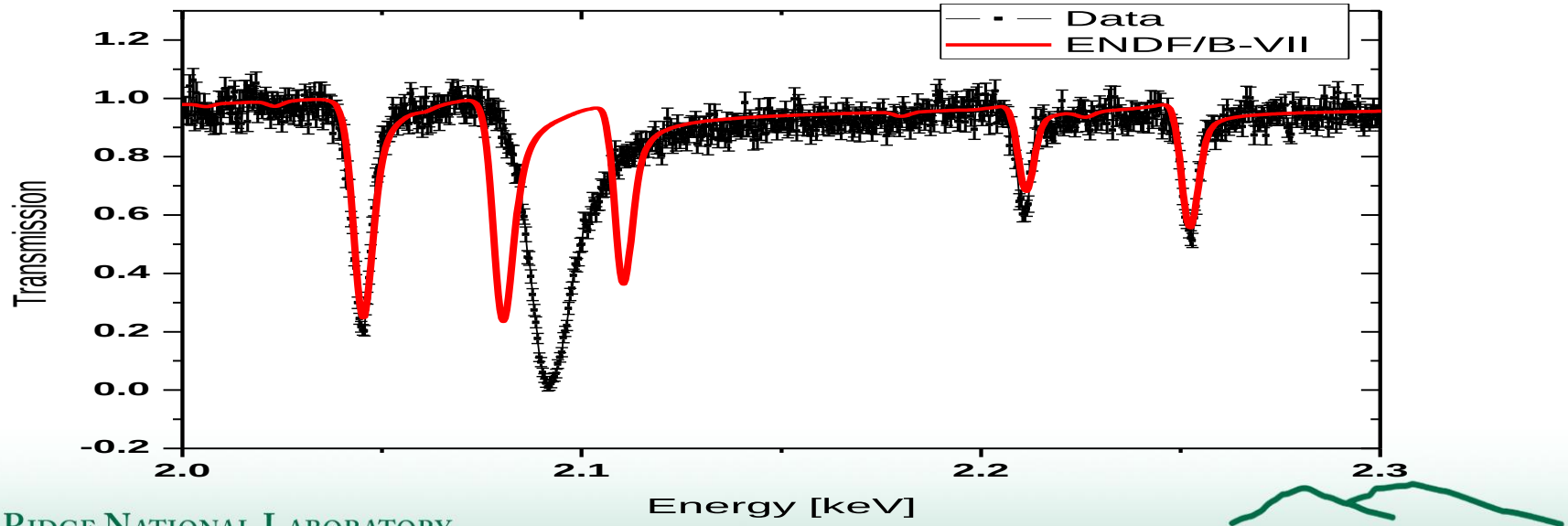
Transmission Data for 1mm ^{184}W compared to ENDF/B-VII: Terra Incognita



(n,γ) Data for 2mm ^{184}W compared to ENDF/B-VII




Data
ENDF/B-VII
experimental (n,γ) [b]
50
40
30
20
10
0
-10
2.00
2.05
2.10
2.15
2.20
2.25
2.30
Energy [keV]


Data
ENDF/B-VII
Transmission
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
2.0
2.1
2.2
2.3
Energy [keV]

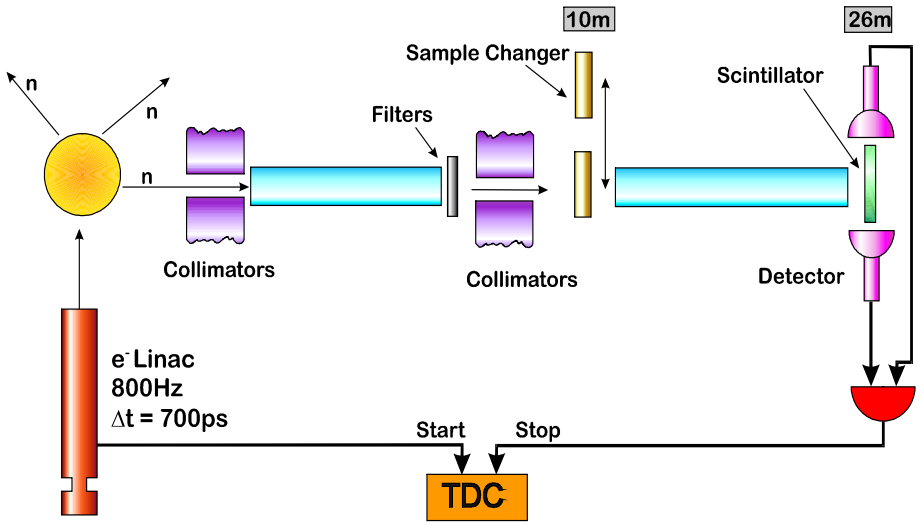
Summary FY09

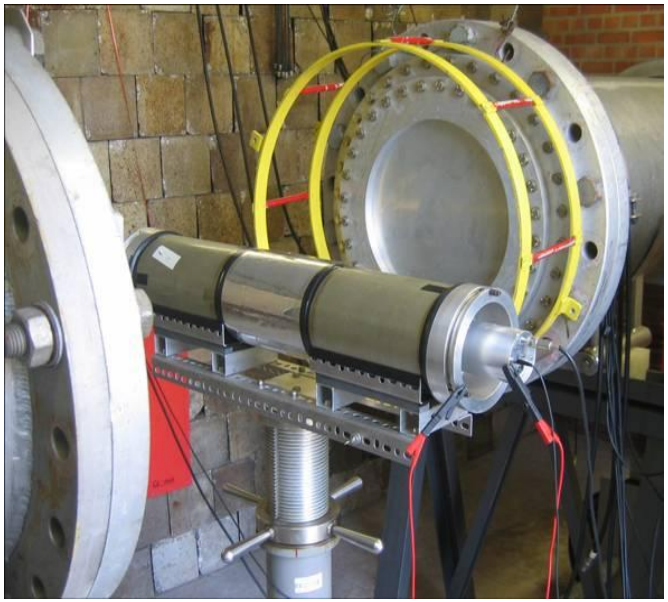
- ORELA is in stand-by mode.
- Experiments performed at GELINA
- Neutron Capture:
  - Natural W, ^{182,183,184,186}W, thin and thick sample at different FP-length
- Neutron Transmission:
  - Natural W, ^{184}W thin and thick sample
- Data for ^{184}W are reduced to cross section.

People involved in the Experiments

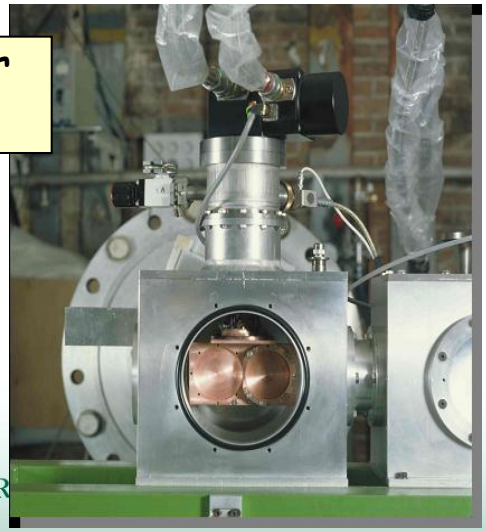
- Christos Lampoudis, IRMM
- Peter Schillebeeckx, IRMM
- Stefan Kopecky. IRMM
- Peter Siegler, IRMM
- Clint Ausmus, ORNL

Transmission Setup @25m





cryostat sample changer
temp. range 10K - 350K



^{6}Li glass (NE912)
diam.: 10cm
thickness 1cm
2 * 5" PM tube