ORNL Neutron Cross-Section Measurements Activities

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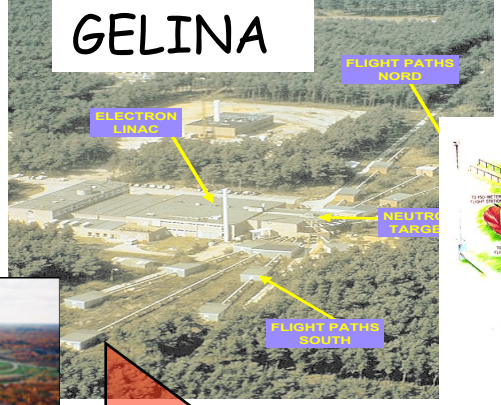
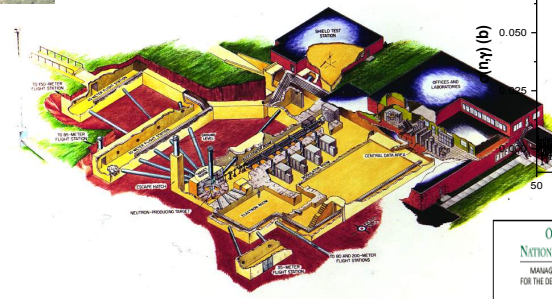
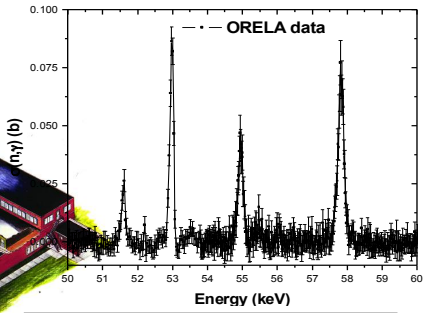
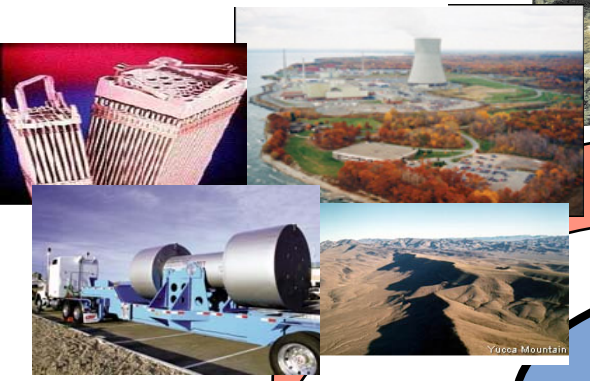
Nuclear Astrophysics



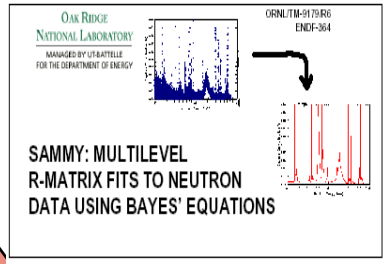
ORELA







Basic Science



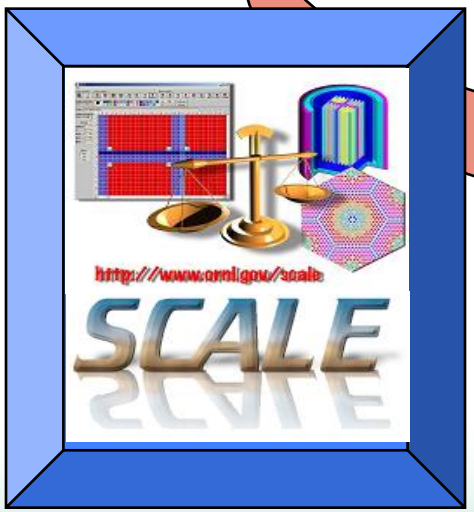
SAMMY

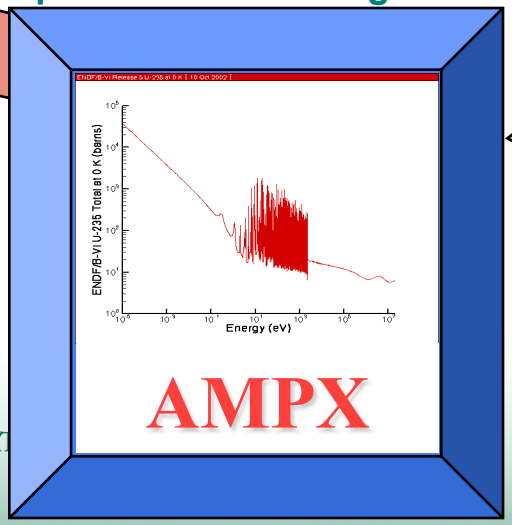
Cross-Section Evaluations

ORNL Data Support for Nuclear Applications

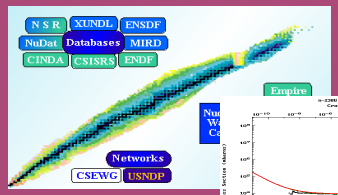
Applications

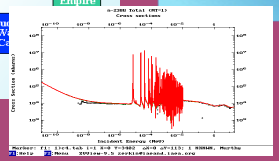
Computational modeling





Evaluated Nuclear Data Files (ENDF/B)

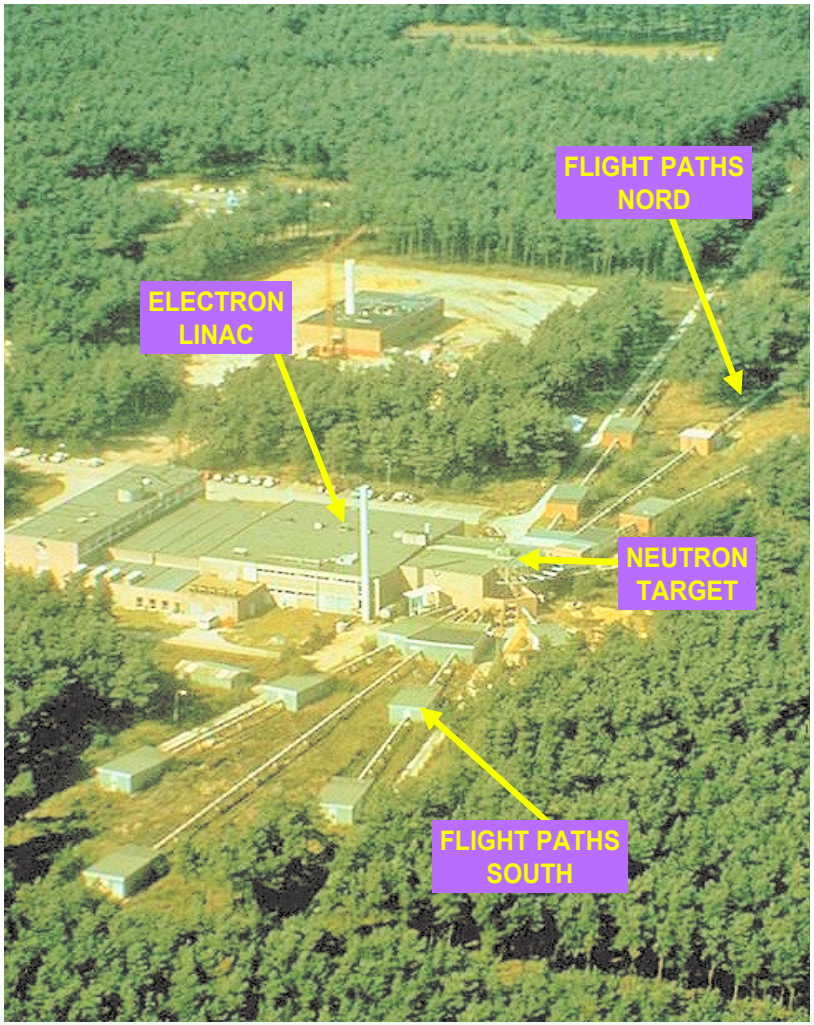




OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

UT-BATTELLE

GELINA

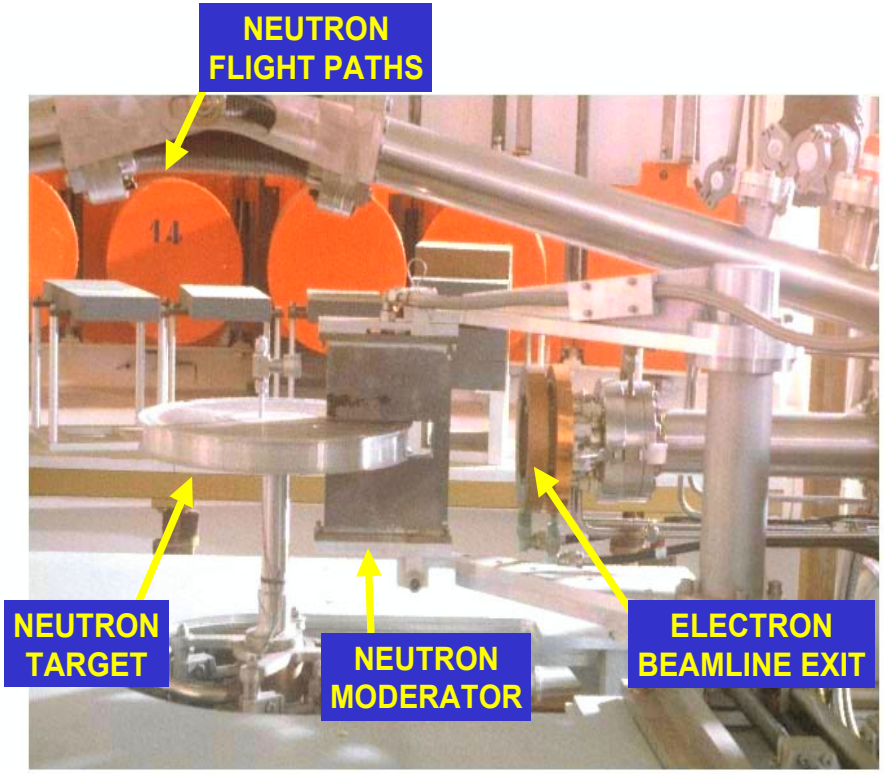


- Time-of-flight facility
- Pulsed white neutron source

  (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

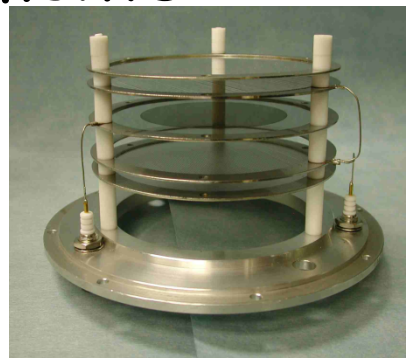
Major Upgrades to GELINA

- Over the last couple of years major upgrades of GELINA
  - New modulators
  - New control room, all settings of the accelerator are now computer controlled
  - New process water cooling
  - Upgrade and renovation of the flight station

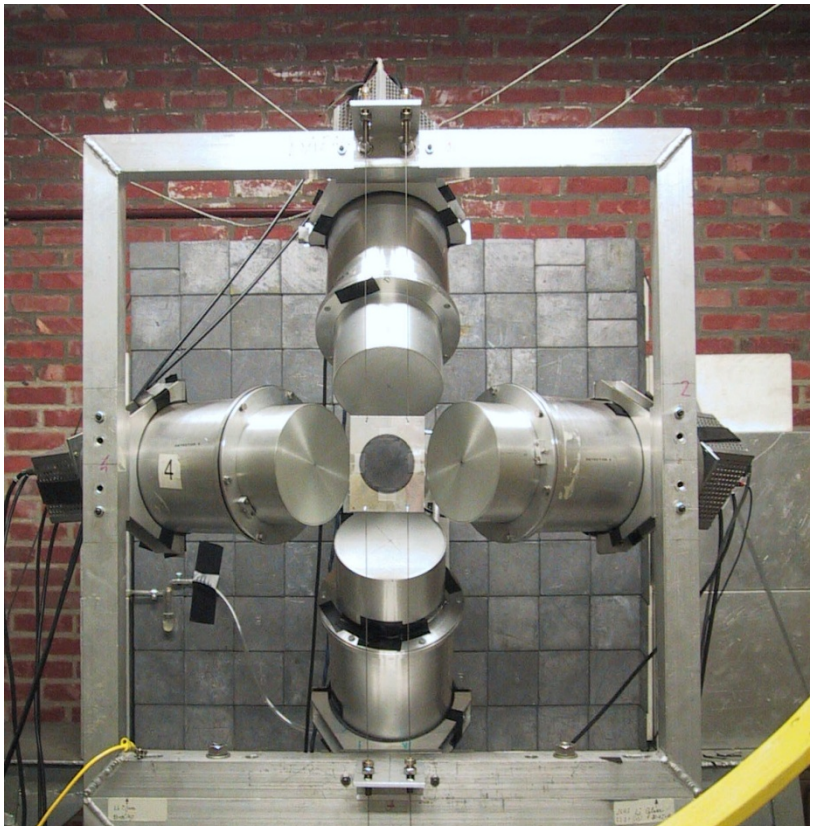
Capture cross section measurements at GELINA

Total energy detection

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



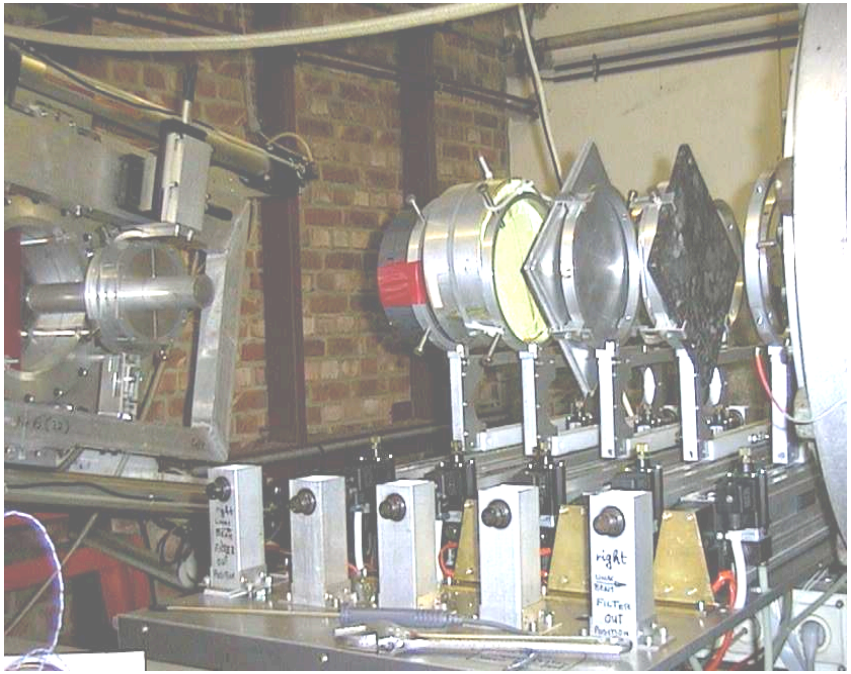
L = 10 m, 30 m and 60 m



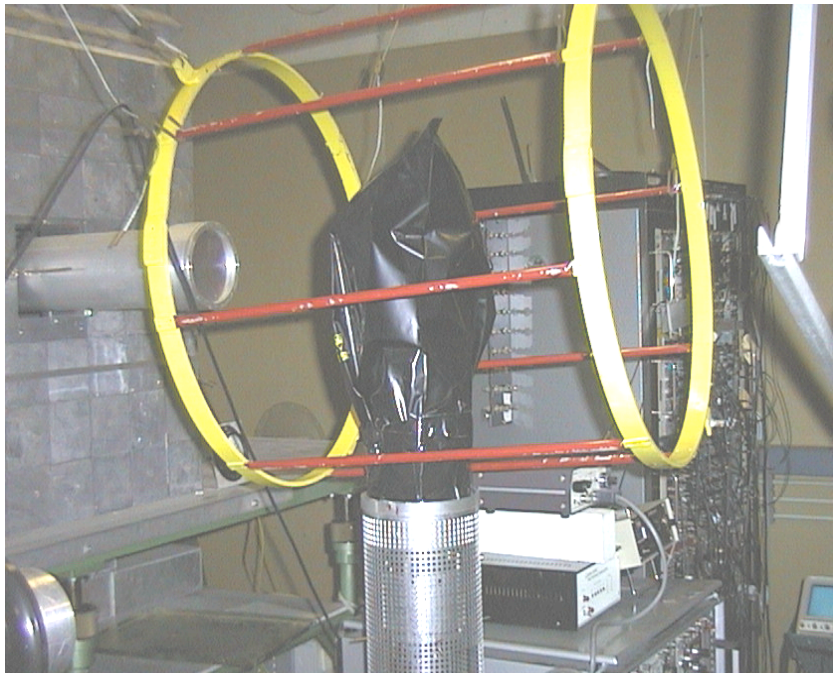
$$Y_{exp} = N\sigma_{\varphi}\frac{C_w - B_w}{C_{\varphi} - B_{\varphi}}$$

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

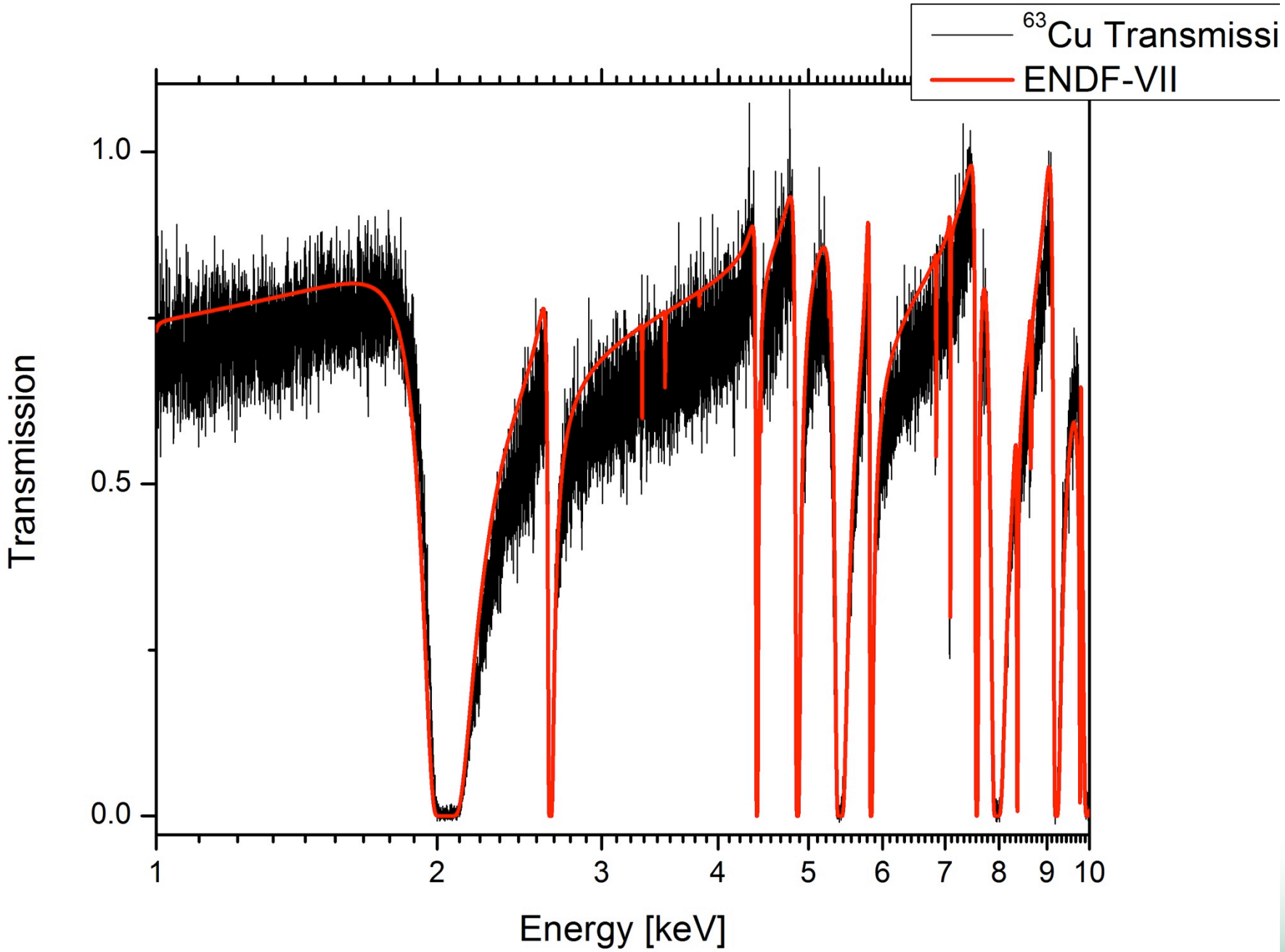
$$T = \frac{C_{in}}{C_{out}} \cong e^{-n\sigma_{tot}}$$

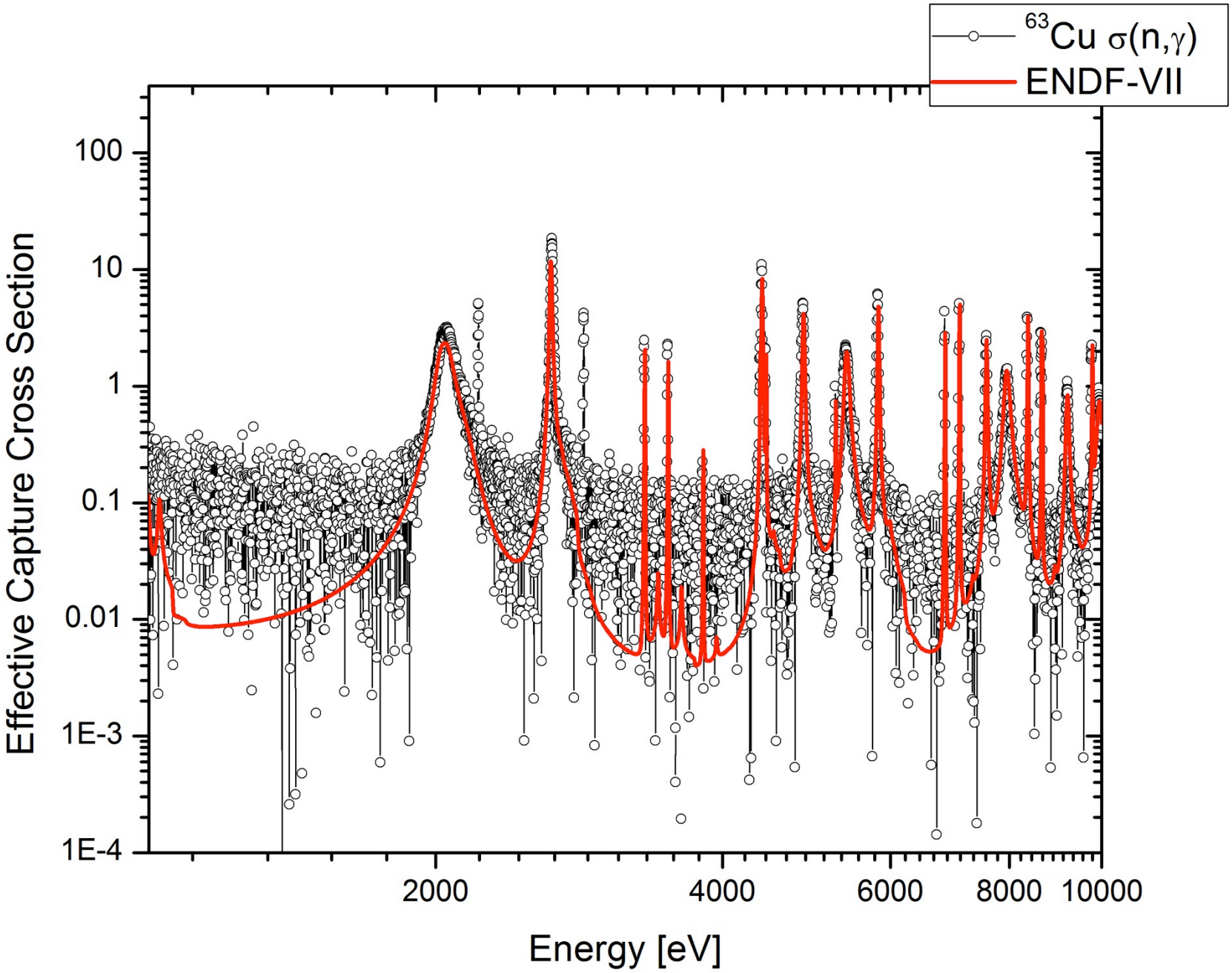
ORNL Measurement Activities in FY11 I

- Use of metallic Cu samples, >99% isotopic enrichments. 8cm diameter disks with 1mm thickness.
- Finalized Neutron Capture measurements for ^{63,65}Cu at GELINA using set up at FP14, 60m station.
- Performed measurements with ^{235}U fission chamber to determine flux at high energies.
- Include old ORELA transmission data in evaluation.

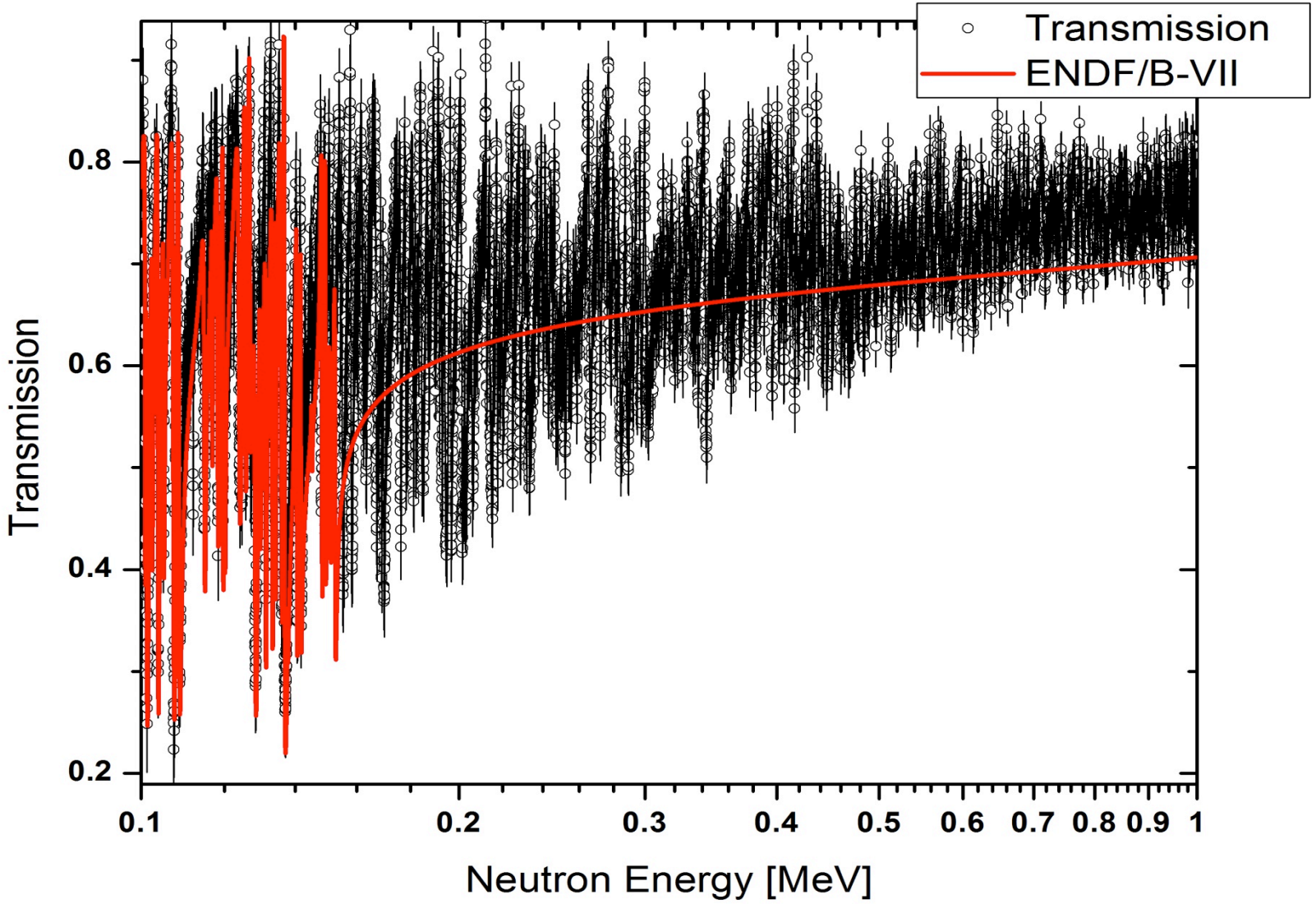
Data Taking and Reduction

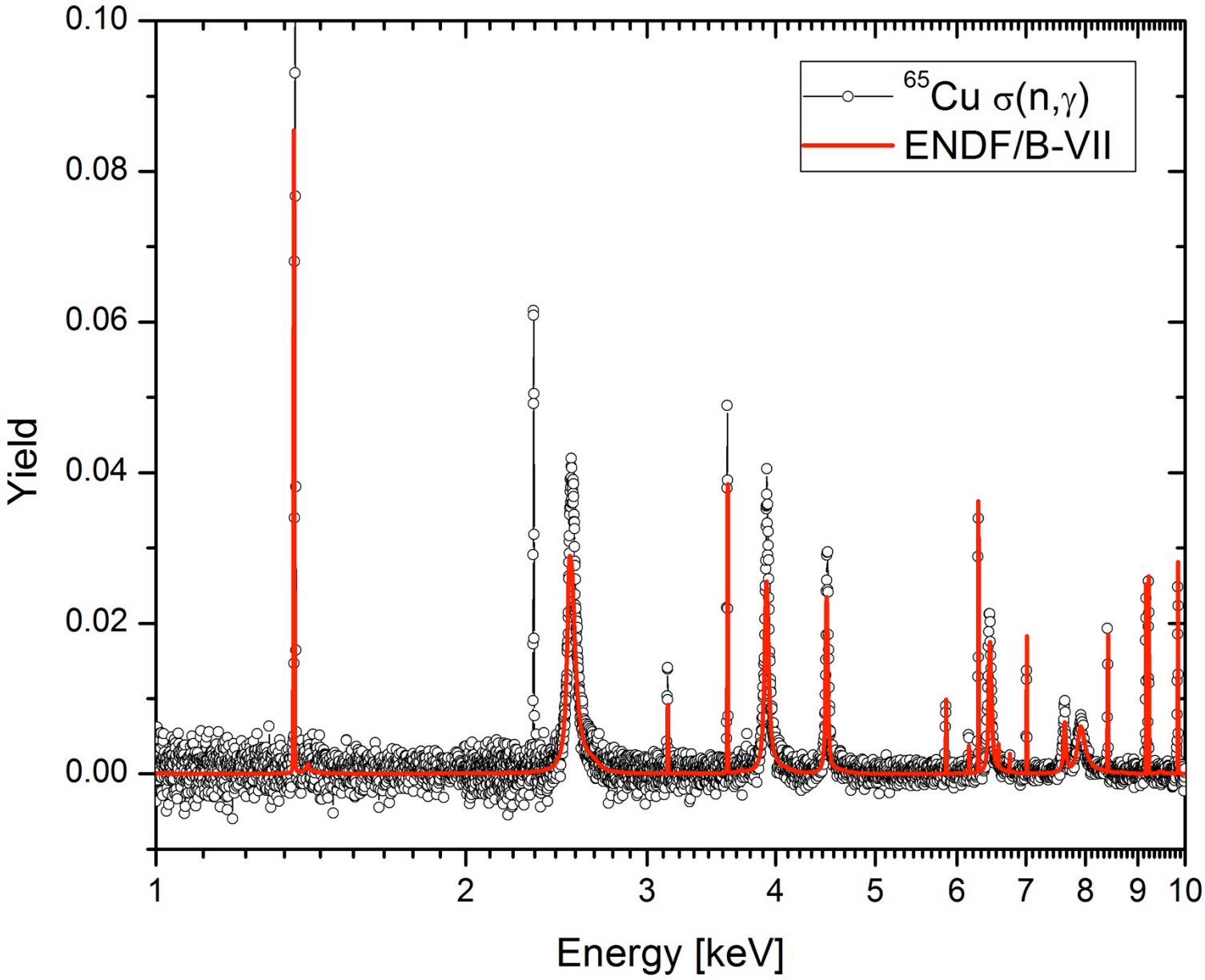
- Data are taken in list mode: TOF and pulse-height for detector(s) and flux monitor.
- Usually at least 2 experiments are performed for each isotope. For example 4 isotopes translate to at least 8 experiments over the time frame of a couple of weeks each, depending on the nucleus.
- Data are sorted into spectra using the program package AGL, which includes also stability and consistency test of the raw data.
- The resulting spectra are then converted to cross section applying all background corrections using the AGS code. A full propagation of the uncertainties is performed including covariance.

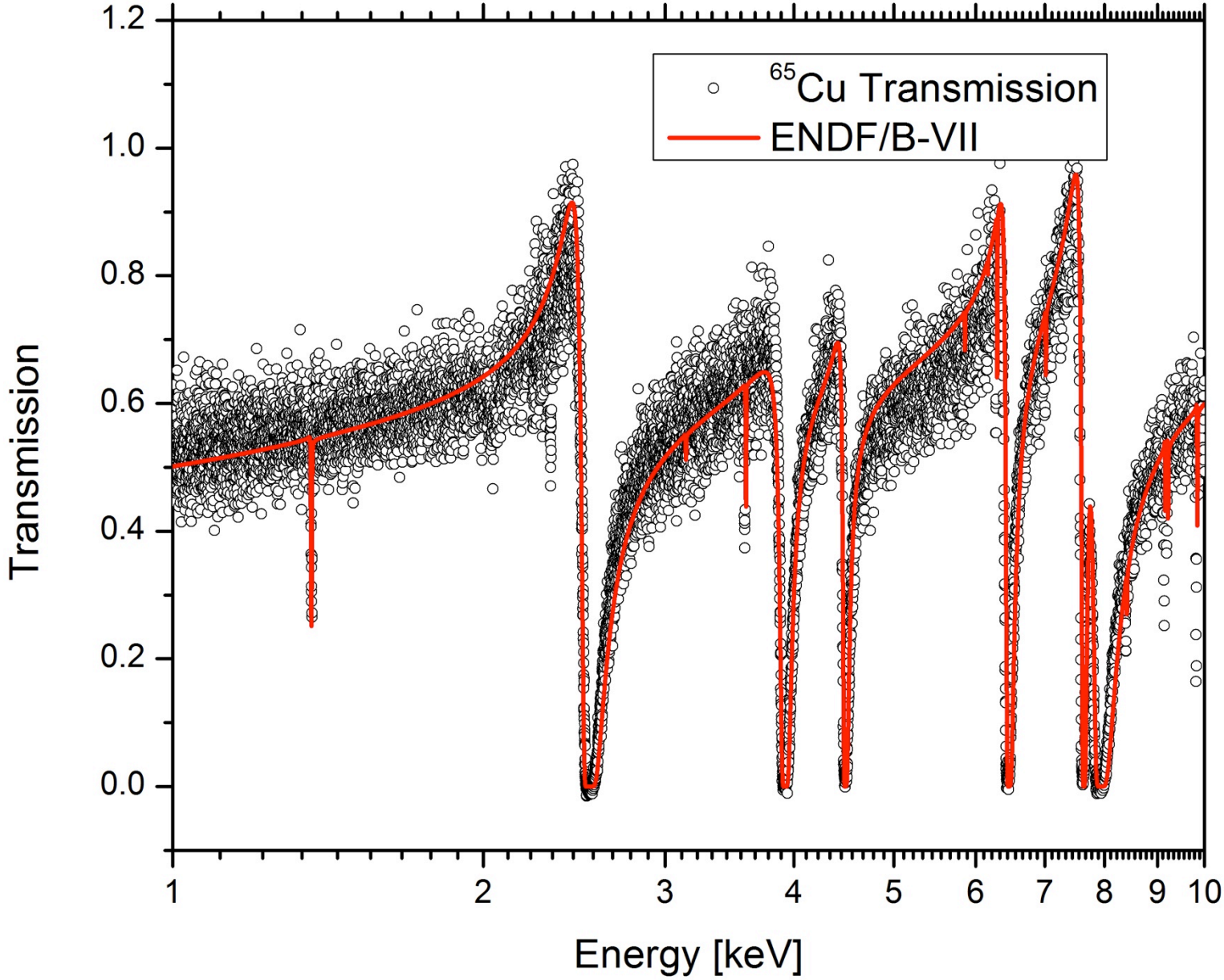

^{63}Cu Transmissi
ENDF-VII
Transmission
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
Energy [keV]


^{63}Cu σ(n,γ)
ENDF-VII
Effective Capture Cross Section
100
10
1
0.1
0.01
1E-3
1E-4
2000
4000
6000
8000
10000
Energy [eV]

^{63}Cu: no resonance data in ENDF at high energies




0.10
0.08
0.06
0.04
0.02
0.00
Yield
1
2
3
4
5
6
7
8
9
10
Energy [keV]
^{65}Cu σ(n,γ)
ENDF/B-VII


^{65}Cu Transmission
ENDF/B-VII
Transmission
Energy [keV]
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
4
5
6
7
8
9
10

ORNL Measurement Activities in FY11 II

- Measurements of Ca using metallic samples.
- The samples are in Al canning due to reactivity with air.
- Transmission experiments with different sample thickness available using FP4, 50 m.
- Neutron Capture using detector system at FP14, 60m.
- Data not yet reduced to cross section.

Ca samples

People involved in the Experiments

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