New neutron-induced cross-section measurements for improved nuclear data

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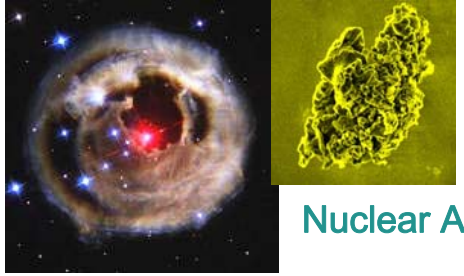
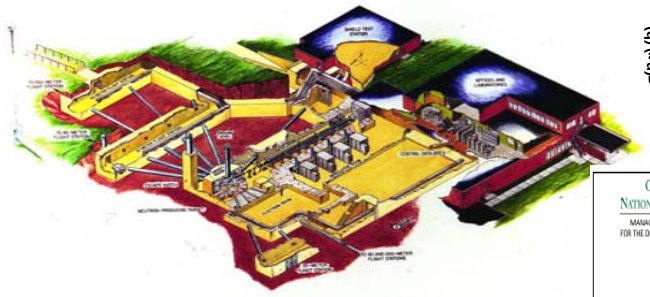
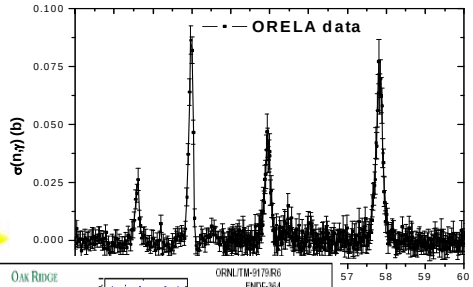
ORELA

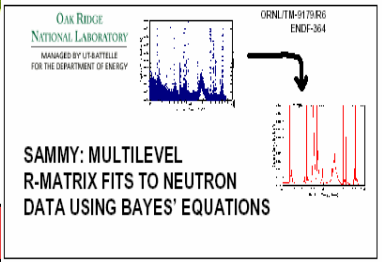


Nuclear Astrophysics





Basic Science



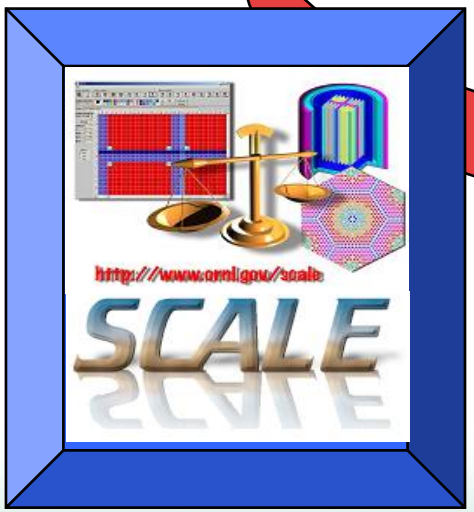
SAMMY

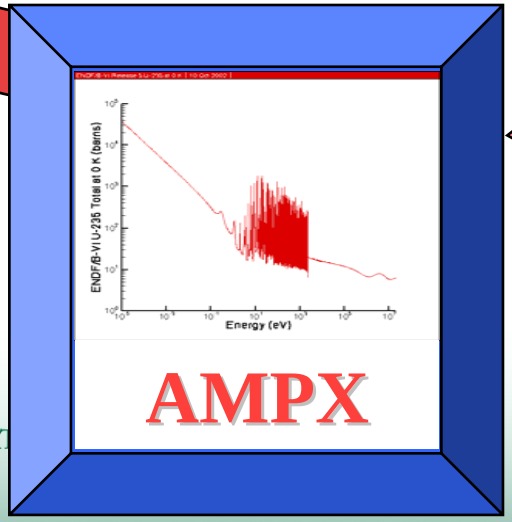
Applications

ORNL Data Support for Nuclear Applications

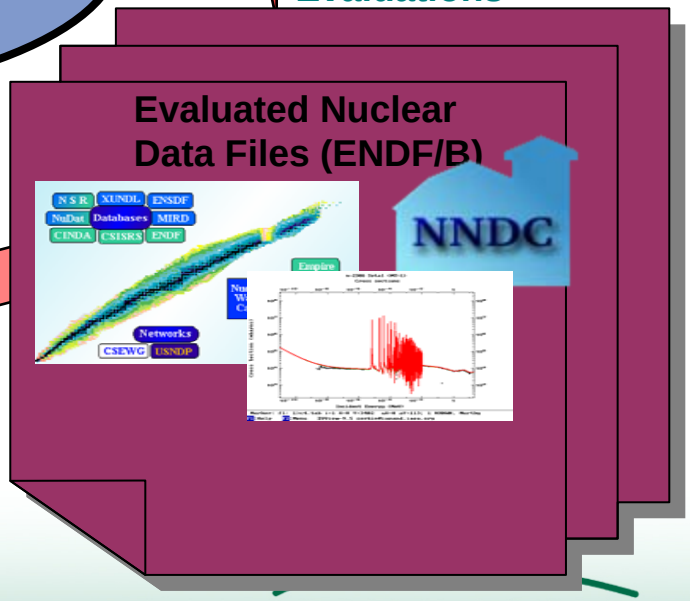
Cross-Section Evaluations

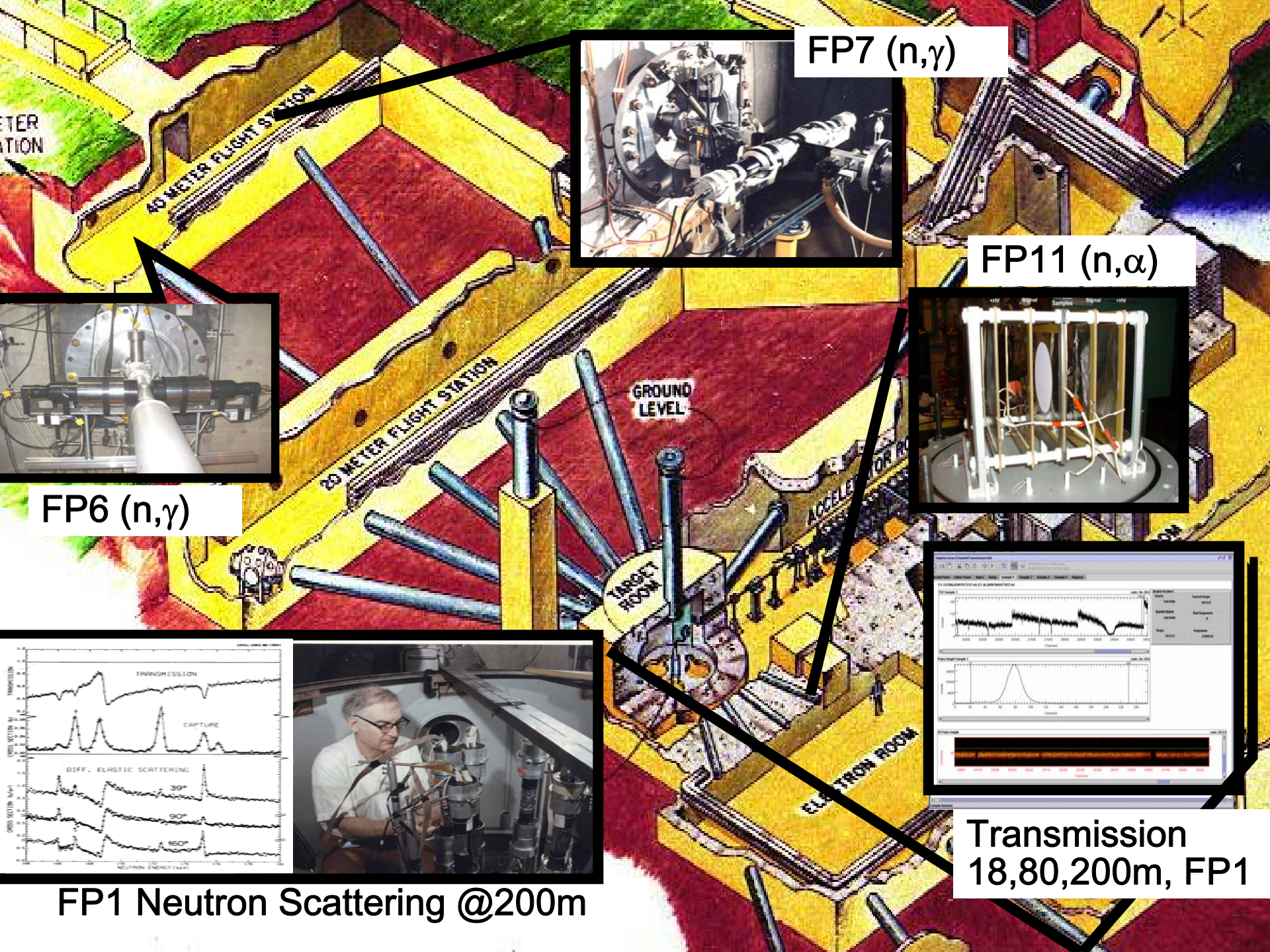
Computational modeling





AMPX

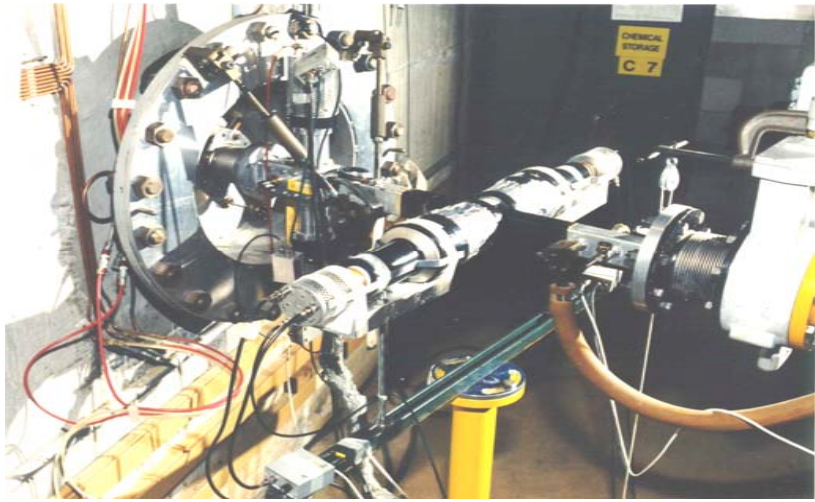


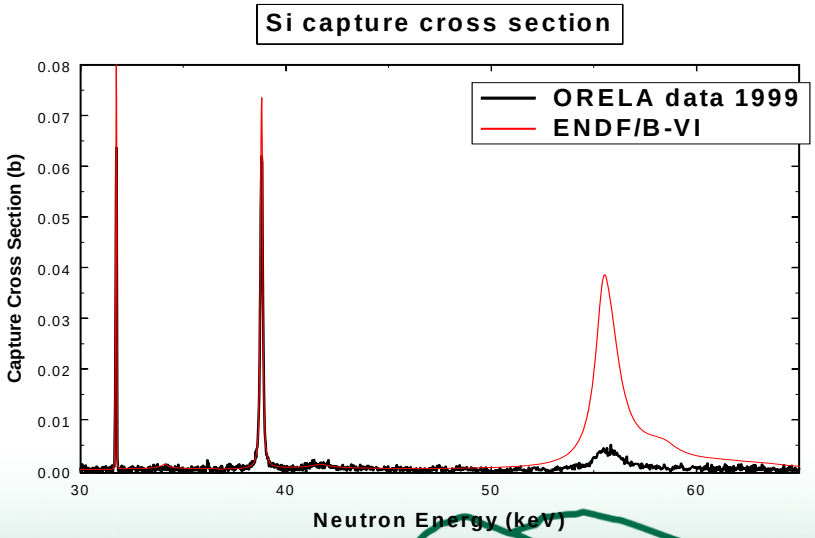

40 METER FLIGHT STATION
20 METER FLIGHT STATION
GROUND LEVEL
TARGET ROOM
ELECTRON ROOM
FP7 (n,γ)
FP11 (n,α)
FP6 (n,γ)
TRANSMISSION
CAPTURE
DIFF. ELASTIC SCATTERING
39°
90°
160°
Transmission
18,80,200m, FP1
FP1 Neutron Scattering @200m

Modified capture set up at FP7

- Some problems with the old data:
  - Underestimated neutron sensitivity correction, new set up has significantly less structure
  - Low-energy cut off of 3 keV
  - No high energy (>100 keV) data
  - Incorrect weighting function
- New set up overcome these problems.

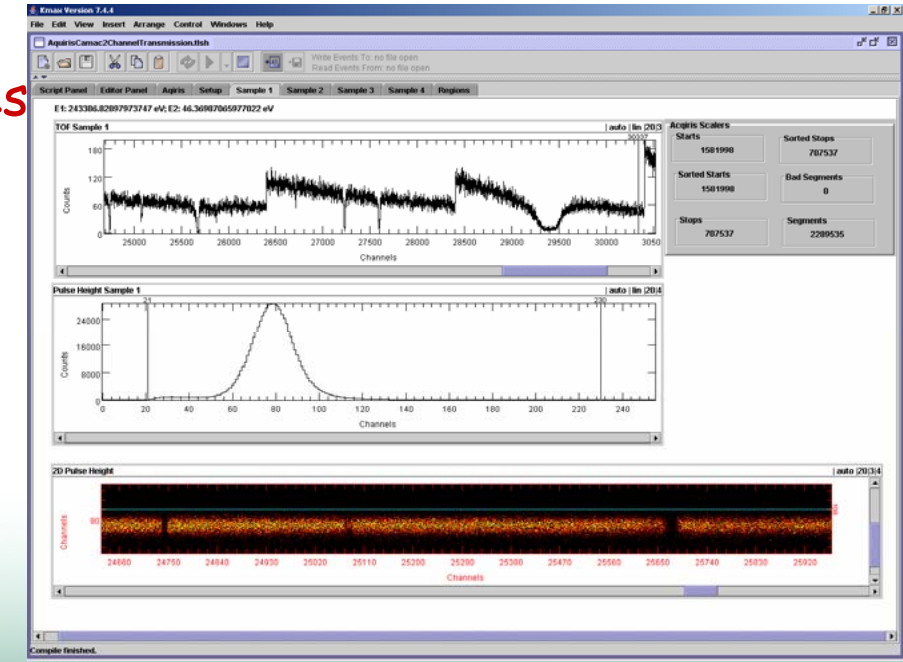
Ex: Large neutron sensitivity of older measurements led to many erroneously-large resonance areas in current evaluations



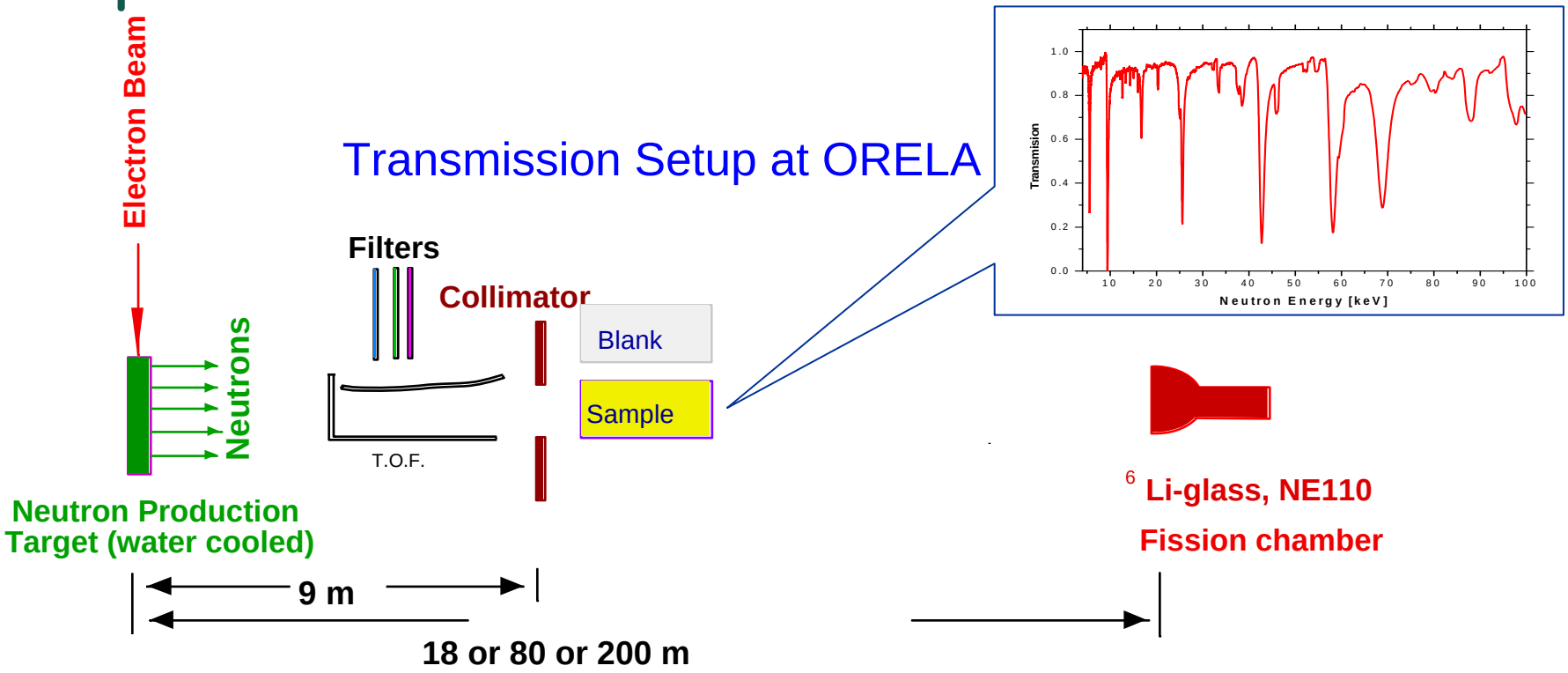


New & Improved ORELA Transmission Apparatus

- Transient digitizer (Acqiris DC-270) replaced old CAMAC TDC and several NIM modules.
- Allows simultaneous measurement of time of flight and pulse height
  Previous system for ^{6}Li-glass detector was 1-D (TOF only), and for NE-110 detector had only 4 pulse-height channels.
  Allows simultaneous use of both types of detectors.
- Unlimited stops per start
  Previous system limited to 8 stops/start (LeCroy 4208 TDC)
- Fewer NIM and CAMAC modules
  Simpler and more reliable



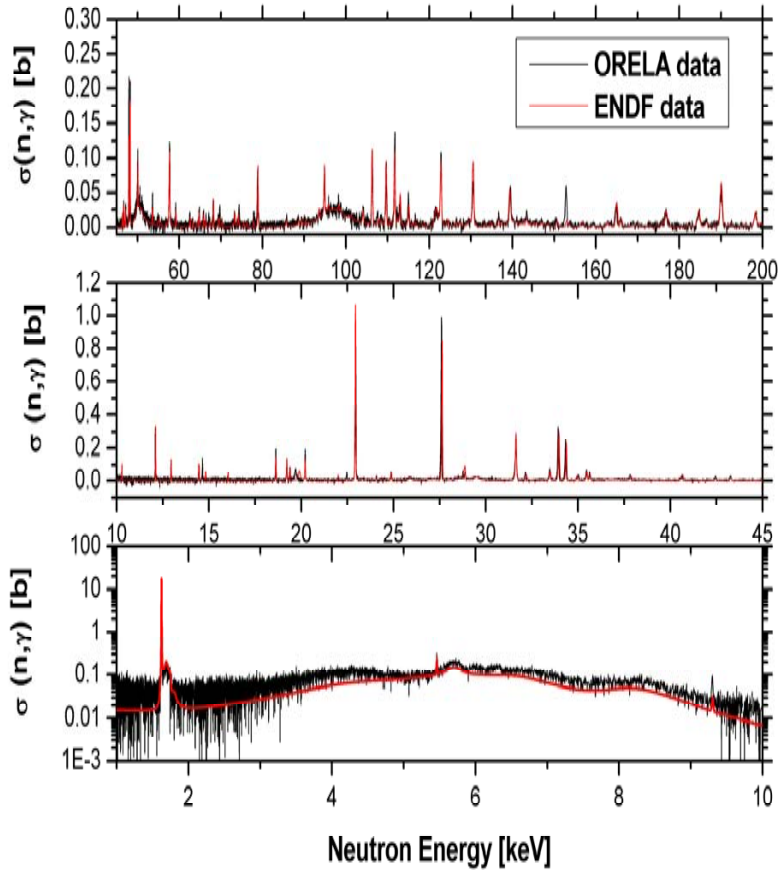
Simplified schematic of neutron transmission

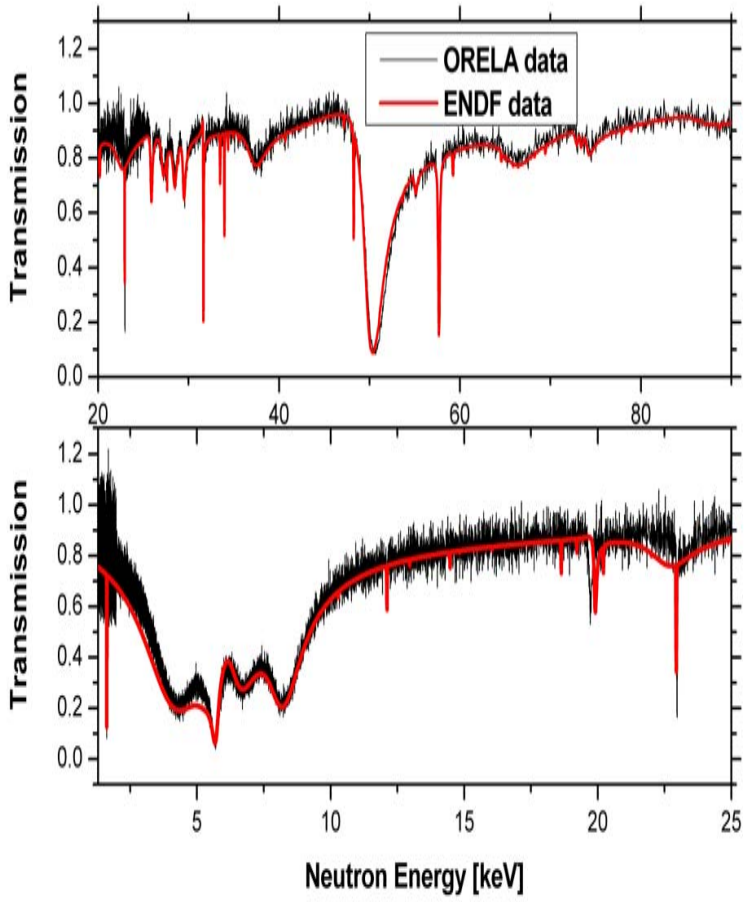


- For transmission, separate measurements of sample in and sample out

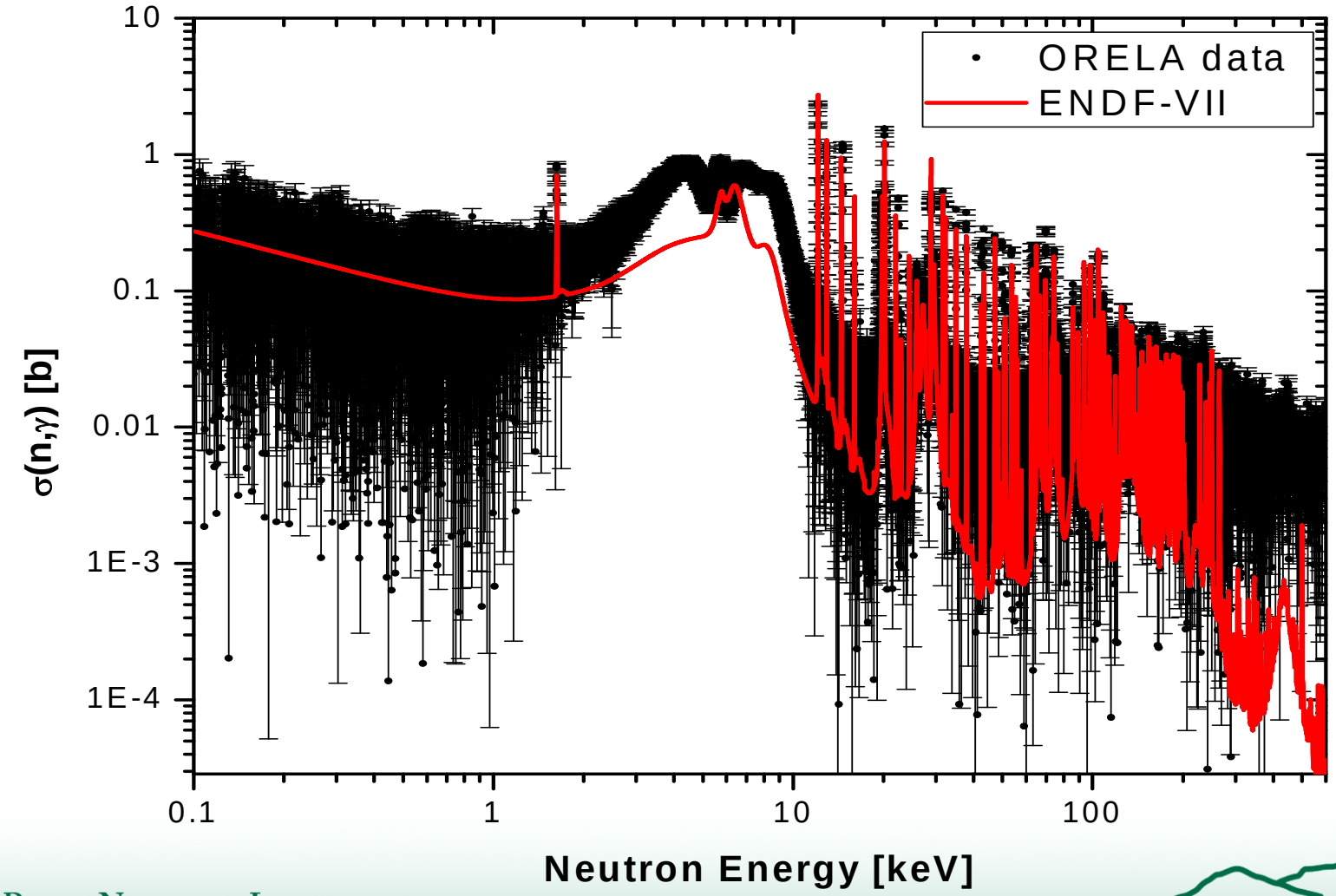
$$T = e^{-N\sigma_T d}$$

Neutron Capture and Transmission Data for Natural Cr compared to ENDF/B-VII

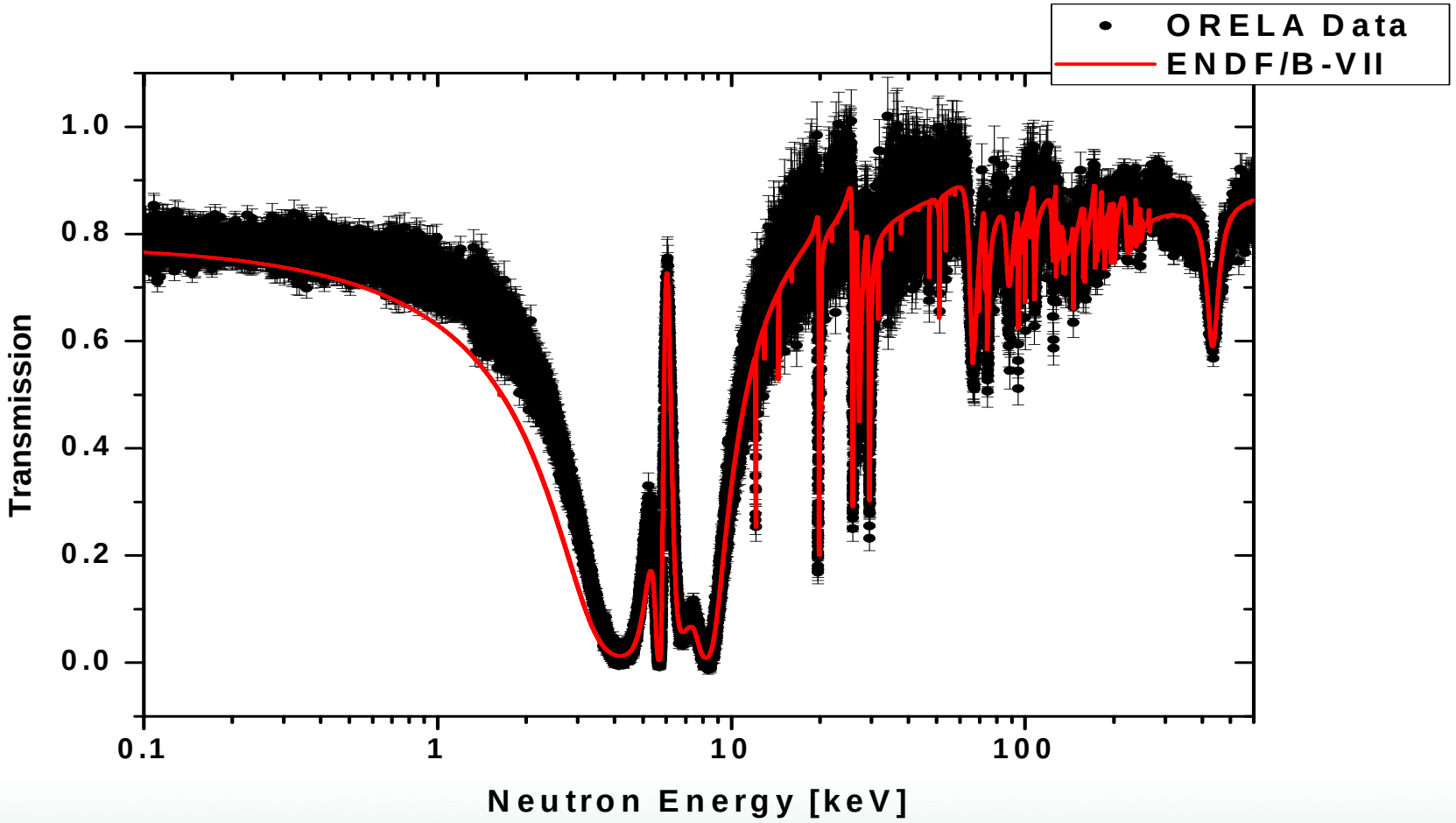




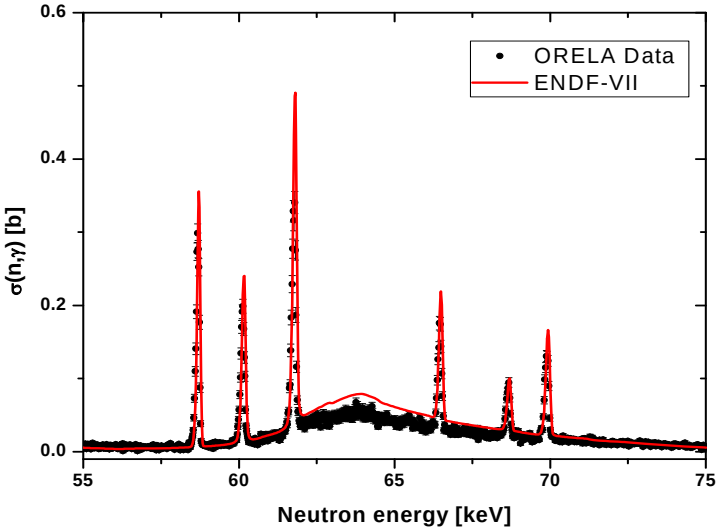
^{53}Cr Data compared to ENDF/B-VII Parameters

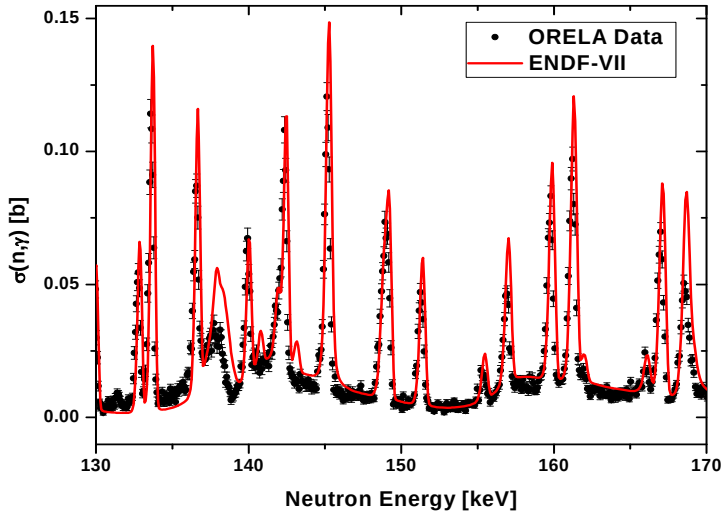


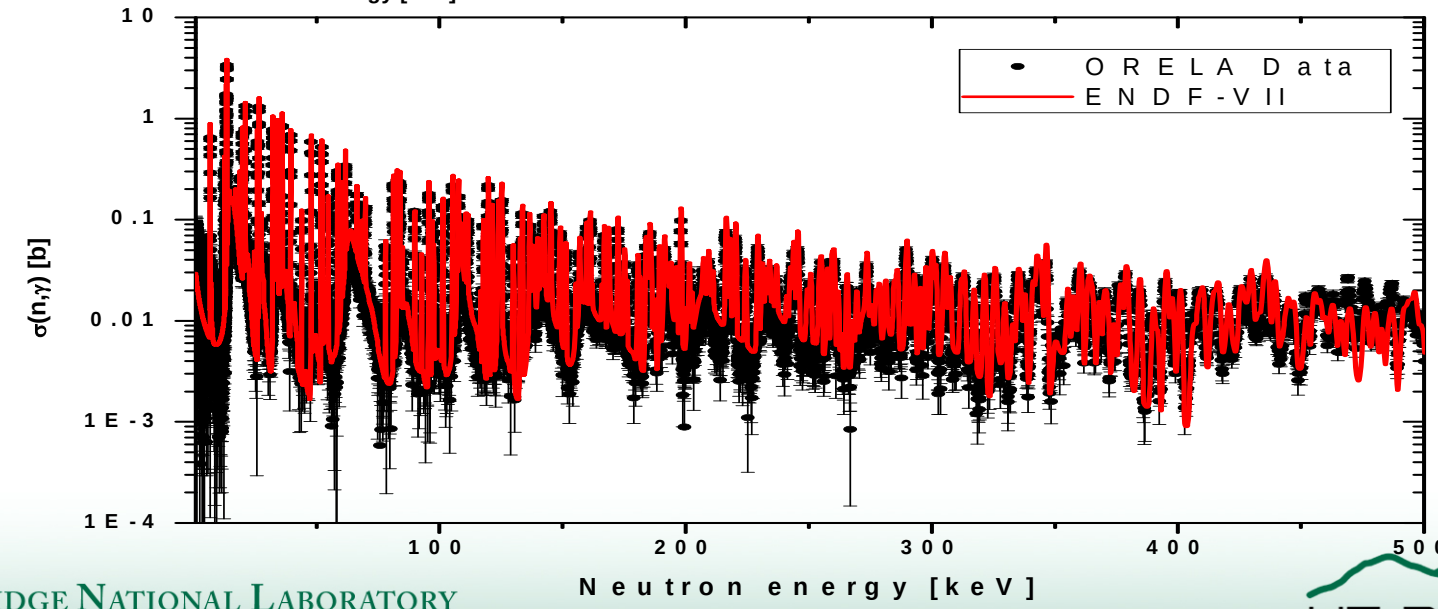
ORELA $^{53}CrO_2$ Transmission Data compared to ENDF/B-VII



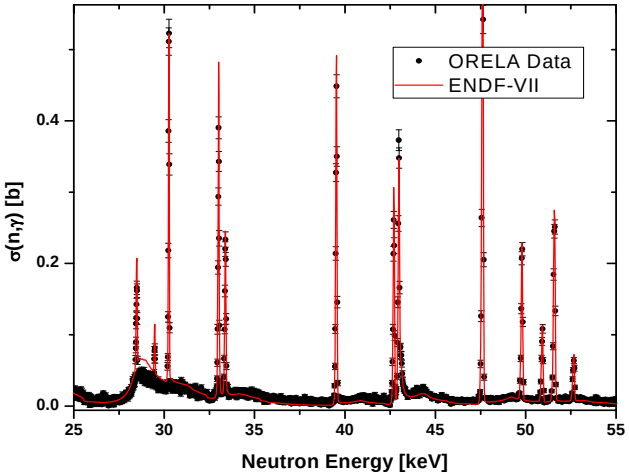
^{58}Ni Data compared to ENDF/B-VII Parameters

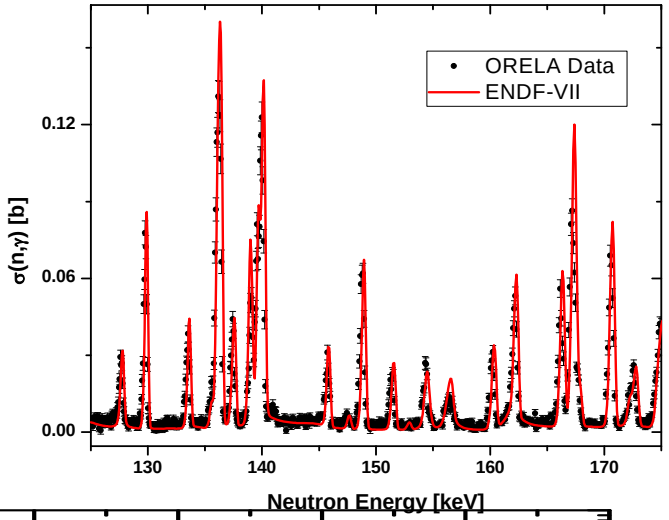


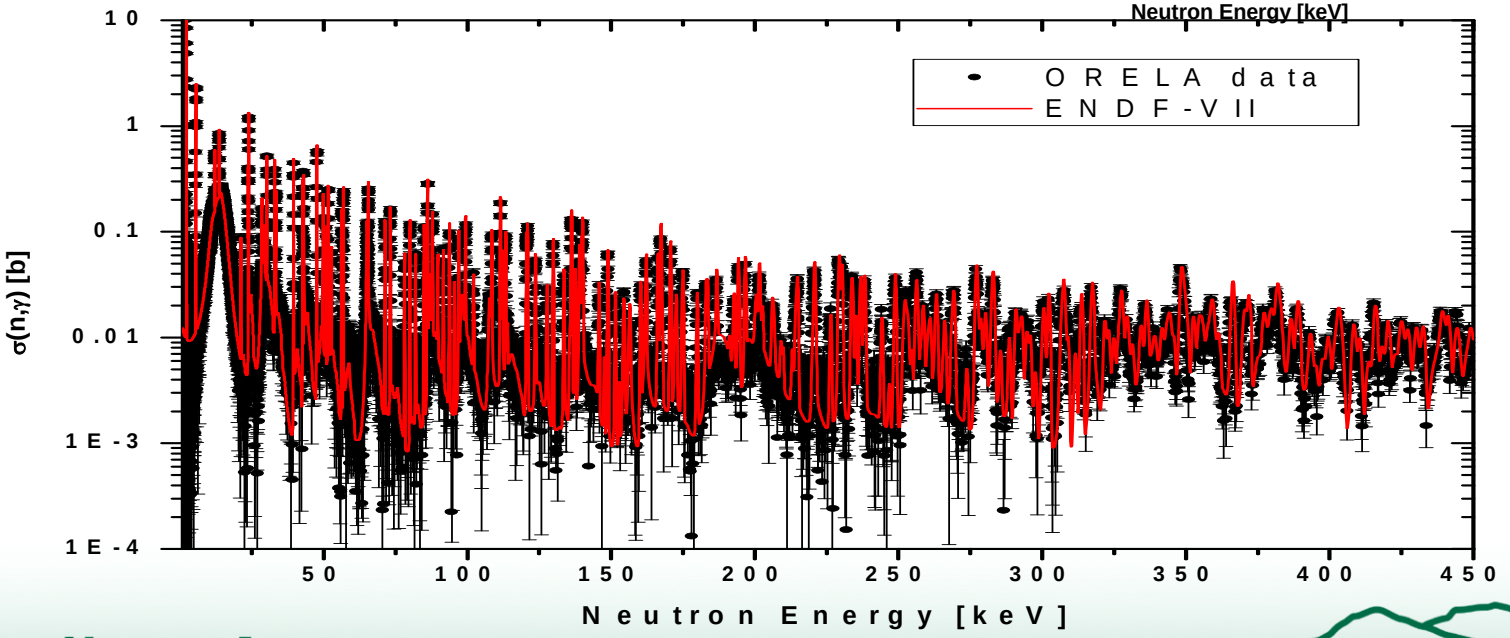




^{60}Ni Data compared to ENDF/B-VII Parameters







New $^{95}Mo(n,\gamma)$ and σ_t Measurements at the Oak Ridge Electron Linear Accelerator (ORELA)

- $^{95}Mo(n,\gamma)$ measured using new apparatus on F.P. 6 at 40 m.
  C_6D_6 using PHWT.
  ^6Li-glass flux monitor.
  Separate background measurements.
  Modified to measure coincidence PH data.

- ^{95}Mo σ_t measured on F.P. 1 at 80 m.
  ^6Li-glass detector.
  Separate sample-out, CH_2, and Bi measurements.
  Transmission.

"CINDORELA"

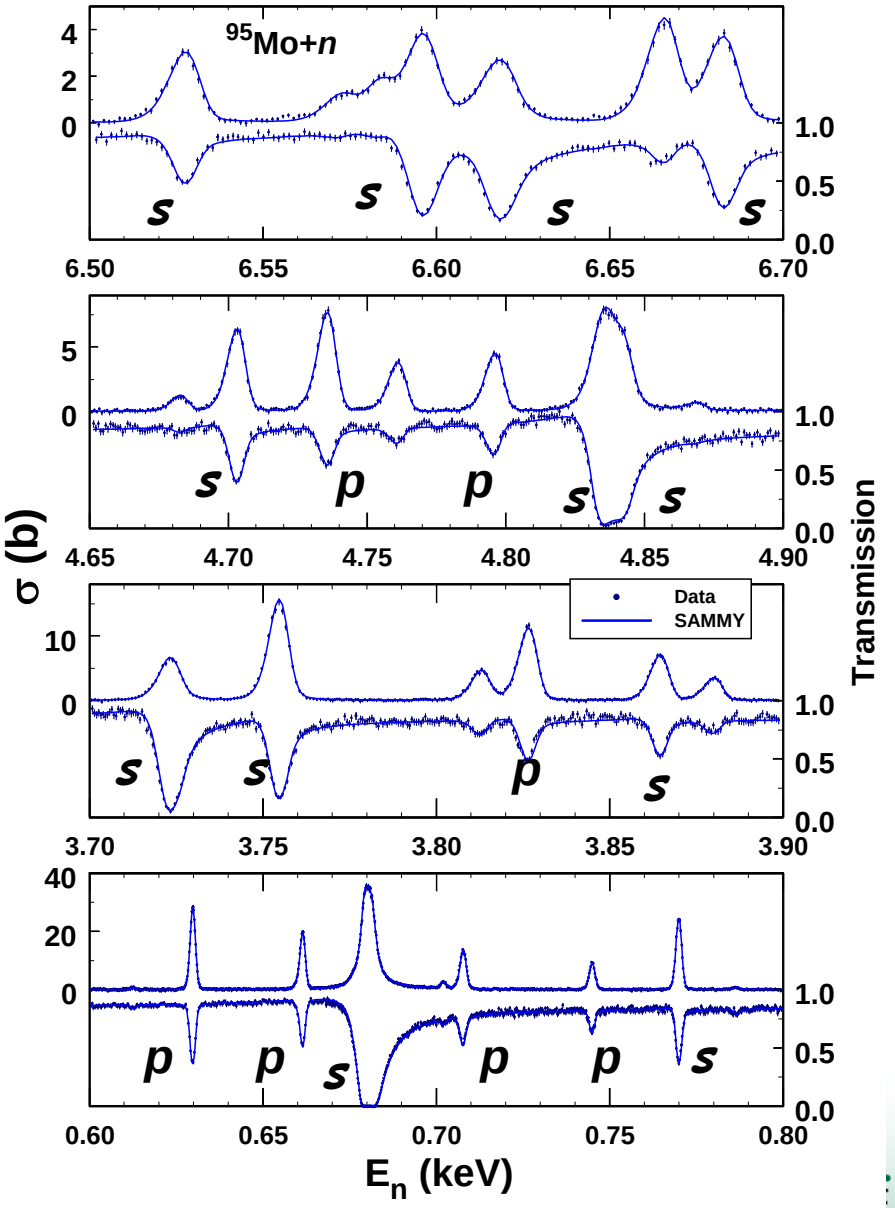
Capture of Incident Neutrons Detector at ORELA

New ^{95}Mo(n,γ) and σ_t Data from ORELA

Resonance analysis using SAMMY.
318 resonances to 10 keV.
Only 106 previously known.
Only 32 previous firm J^{π} assignments.

- Transmission data yield parity of resonance if neutron width is large enough.

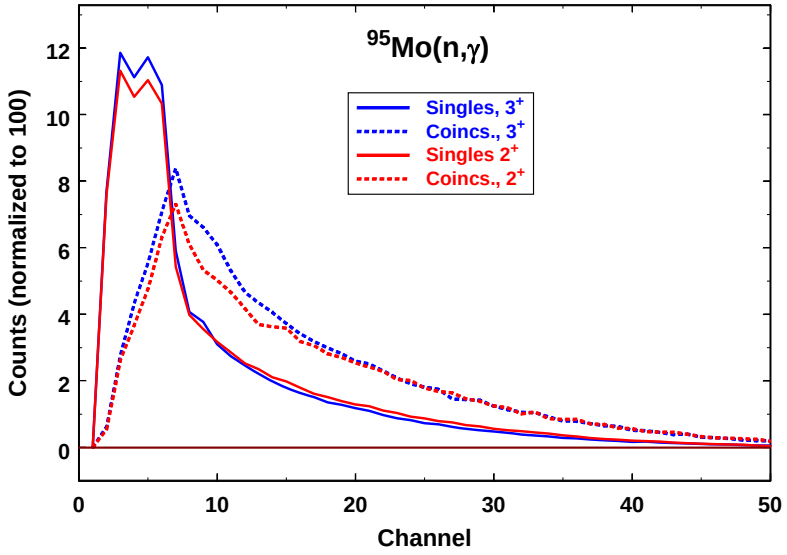
Transmission = $\exp(-n\sigma_t)$

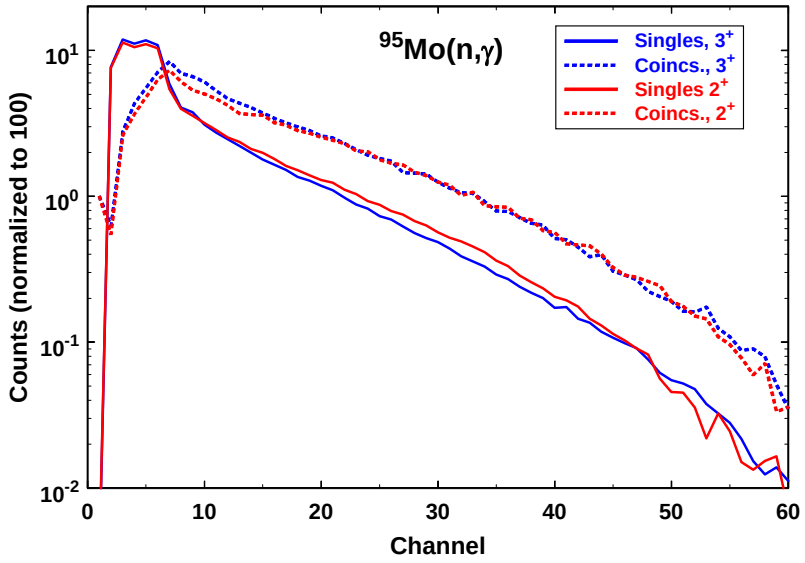


New Method for Determining J^{π} Values

- Uses information contained in capture γ-ray cascade. Higher spins expected to have higher γ-ray multiplicity. Higher spin => more coincidences and softer singles spectrum.
- Use several "off-line" gates on singles and coincidence pulse-height data to construct ratios maximizing J and π differences.

Pulse-height spectra: 2^+ vs. 3^+



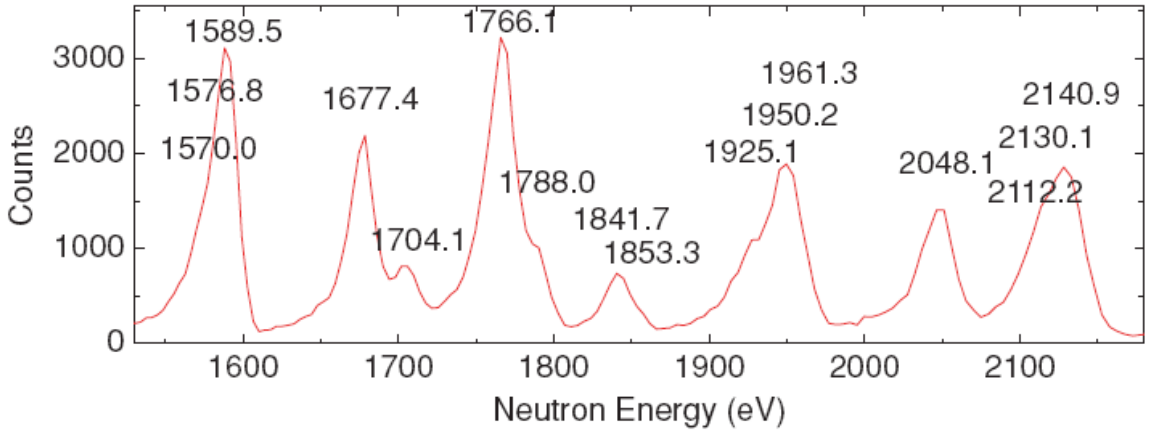


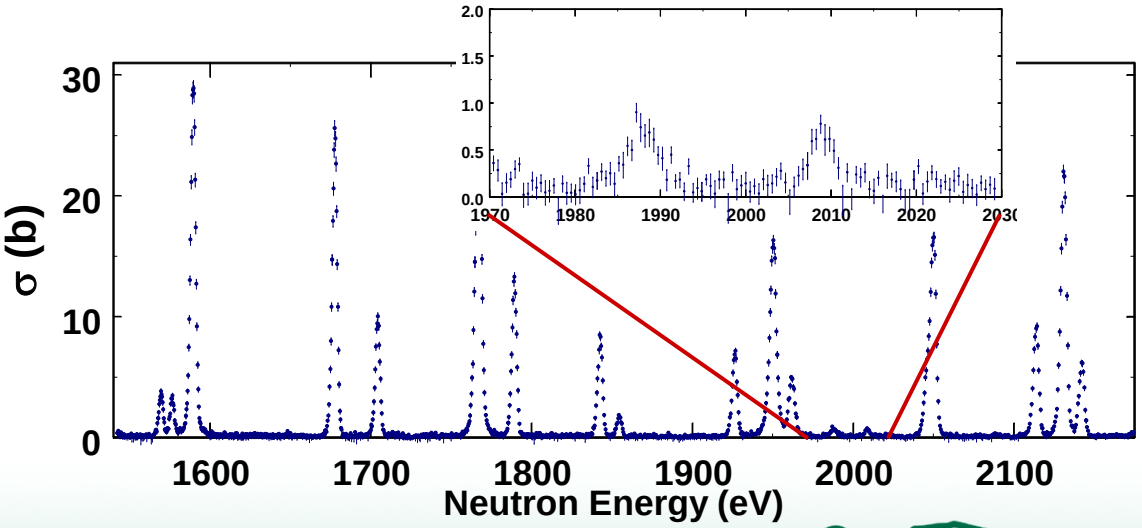
Comparison of Recent ^{95}Mo(n,γ) Experiments

- DANCE @ Lujan

- CINDORELA

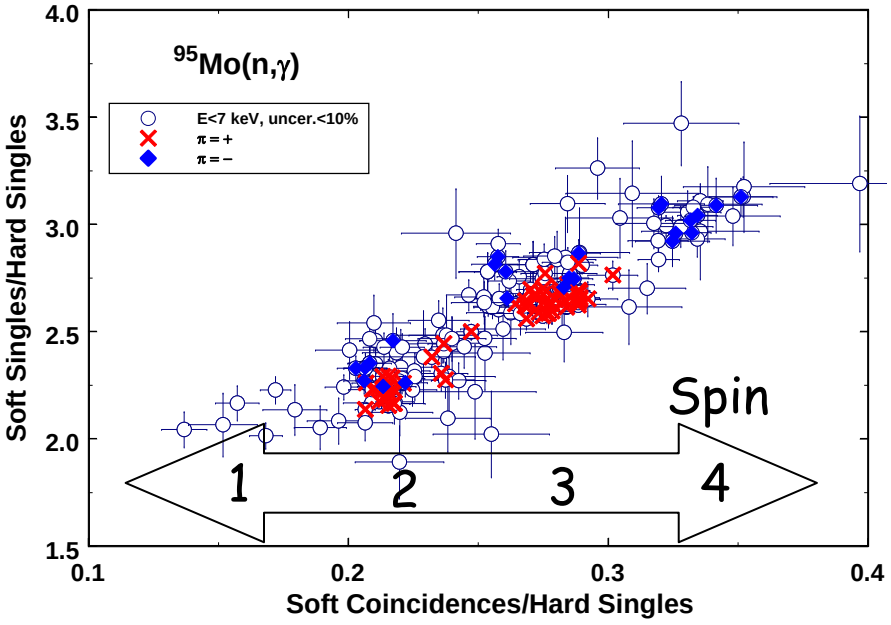
Sheets *et al*., Phys. Rev. C 76, 064317

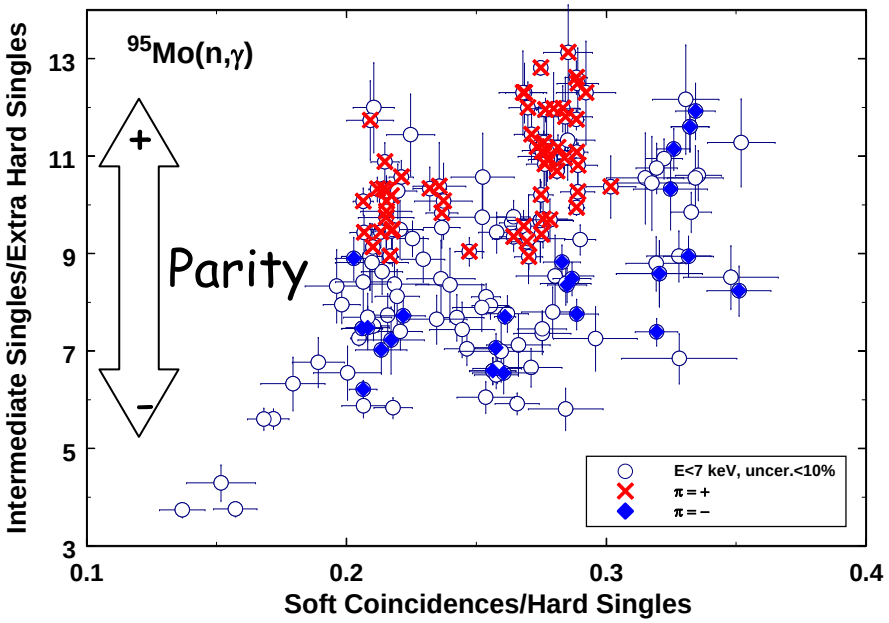




New Method for Determining Resonance Jπ's: Results

- Some combinations separate π as well as J.





^{95}Mo+*n* Resonance J$^{\pi}$'s: Results So Far

What	Previous	Present
E_n range (keV)	0 – 2.14, 3.13 – 4.96	0 – 10
Resonances	106	318 178 to 5.4 keV
Firm J	33	146
Firm π	37	144
Firm J$^{\pi}$	32	134

Summary FY08

- ORELA delivered 1720 hours of beam in FY08 with an average power of 5 kW.
- Neutron Capture:
  - Natural Cr, ^{53}Cr, ^{58}Ni, ^{60}Ni, Natural Ti, ^{48}Ti
- Neutron Transmission:
  - Natural Cr, ^{53}Cr for thin and thick sample
  - Natural Ti, ^{48}Ti for thin and thick sample
- Data for Cr, ^{53}Cr, ^{58}Ni, ^{60}Ni are reduced to cross section and being analyzed.
- New FP6 capture set up allows to determine J and π. Example: ^{95}Mo