Los Alamos NATIONAL LABORATORY

WANDA 2023 Update: White Source n-γ Measurements of γ-Production Cross Sections at LANSCE

K. J. Kelly, M. Devlin (presenting), E.A. Bennett, J.M. O'Donnell, M. Paris

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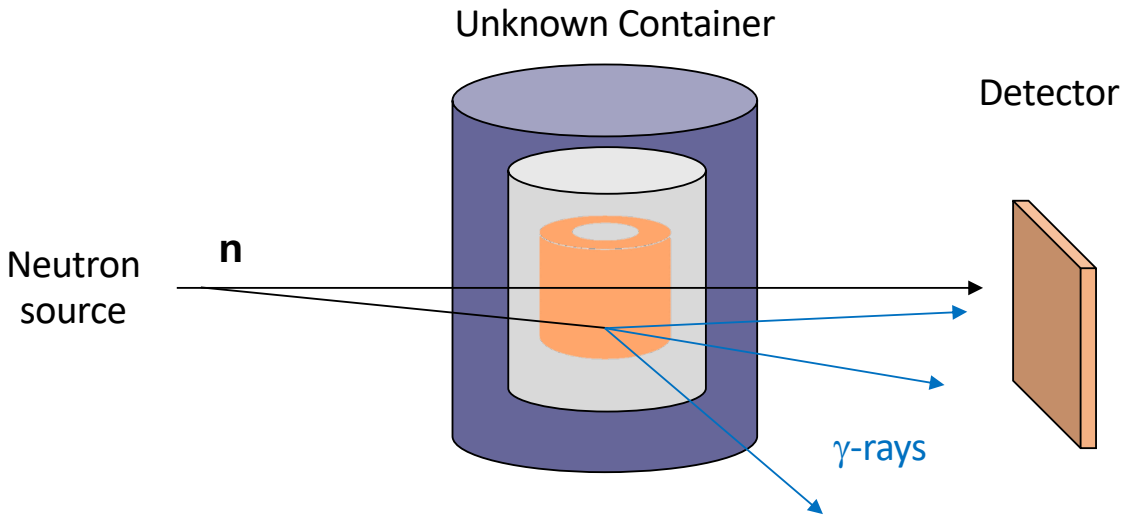
Outline

- Project Motivation
- Analysis Methods
- ^{27}Al and ^{16}O Measurements, and ^{12}C
- Future Work

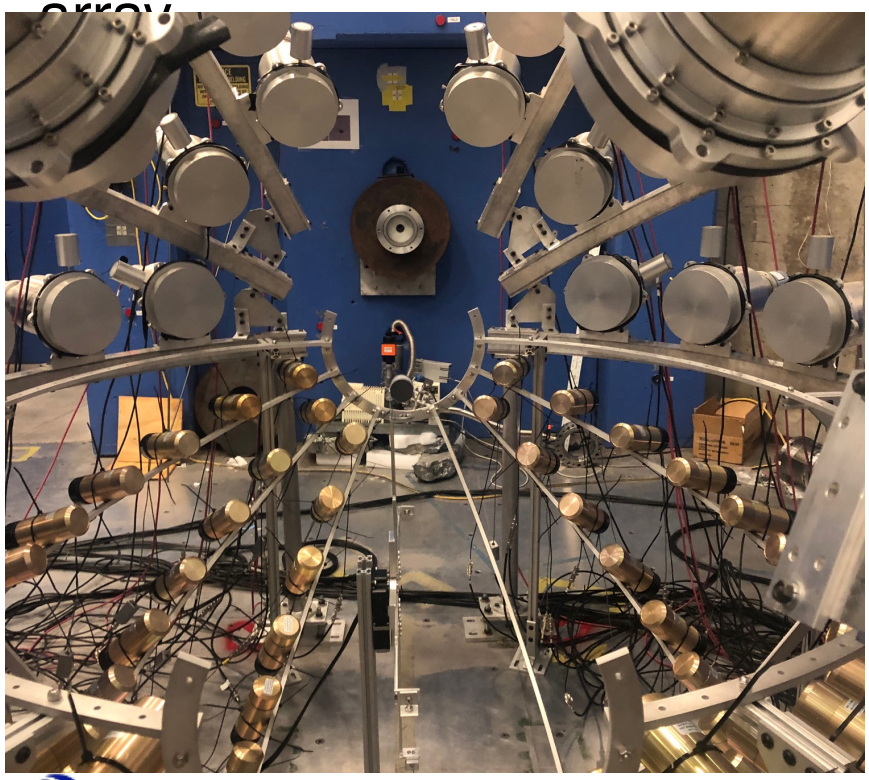
Motivation: Active Interrogation

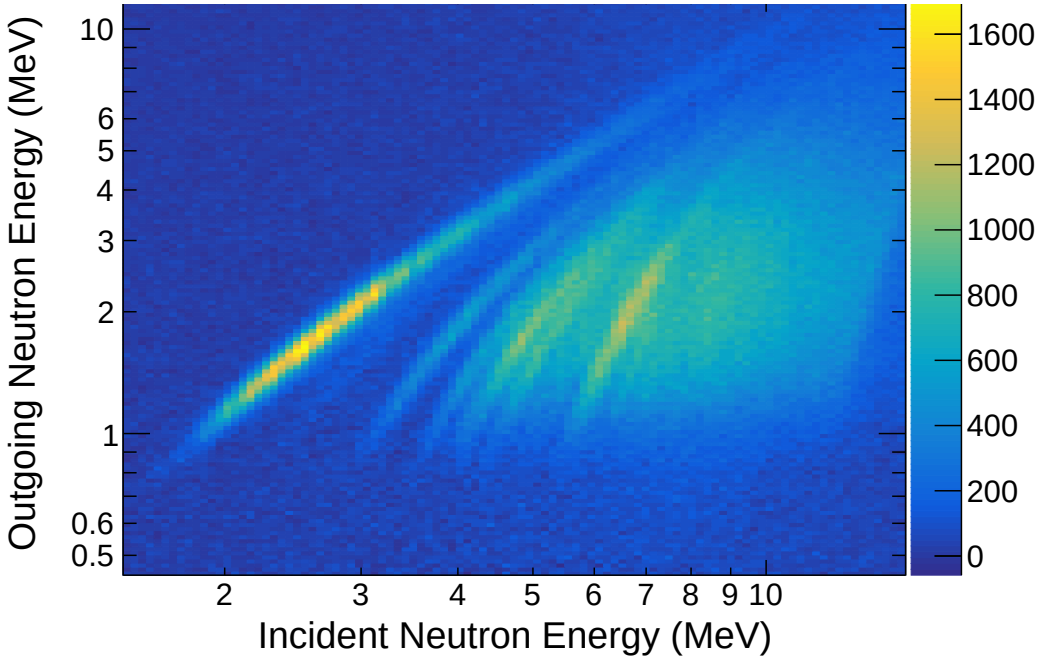
- Identify contents of a container via neutron irradiation
- γ-ray emission used for ID
- Requires knowledge of γ-prod. XS
  - Effectively equal to $(n,n'\gamma)$ XS for many nuclei
- Also require understanding of neutron transport



CoGNAC n-γ Approach to Scattering

- PSD n-γ separation $\Rightarrow$ treat each detector as both n and γ detector
  - Incident Neutron Energy, E_n^{inc}, from t_0-t_γ time difference
  - Outgoing Neutron Energy, E_n^{out}, from t_γ-t_n time difference
- Chi-Nu liquid scintillator array and nearly complete CLYC-6 detector array





Iterative Unfolding of Neutron Spectra

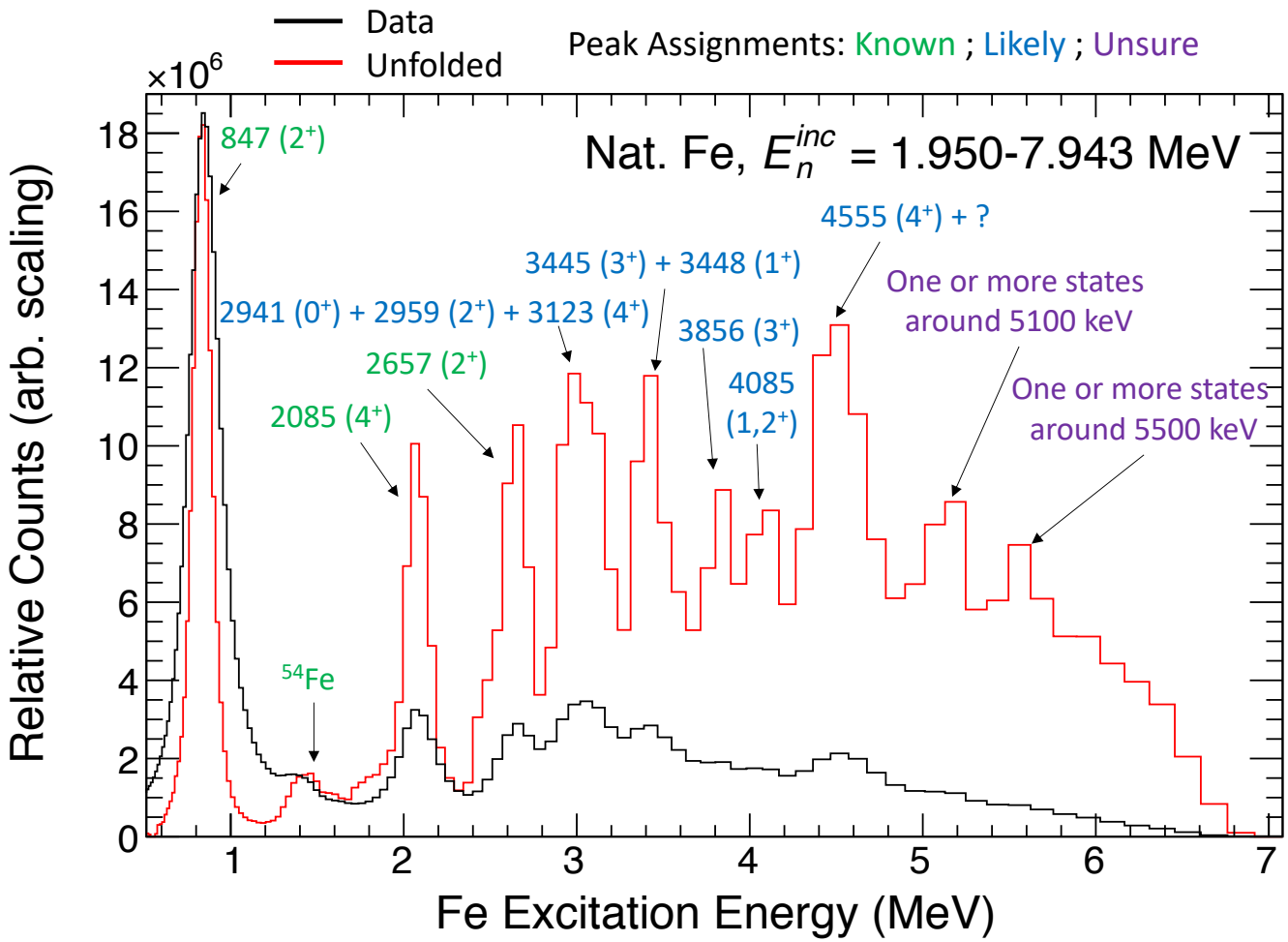
$$m_{\alpha|\beta}^{(n+1)}(E) = \frac{m_{\alpha|\beta}^{(n)}(E) c_\alpha(E)}{\sum_{i=1}^{N} \mathcal{R}(E, E_i) m_{\alpha|\beta}^{(n)}(E_i)}$$

Kelly *et al.*, NIMA **1010** (2021) 165552

Kelly *et al.*, NIMA **866** (2017) 182

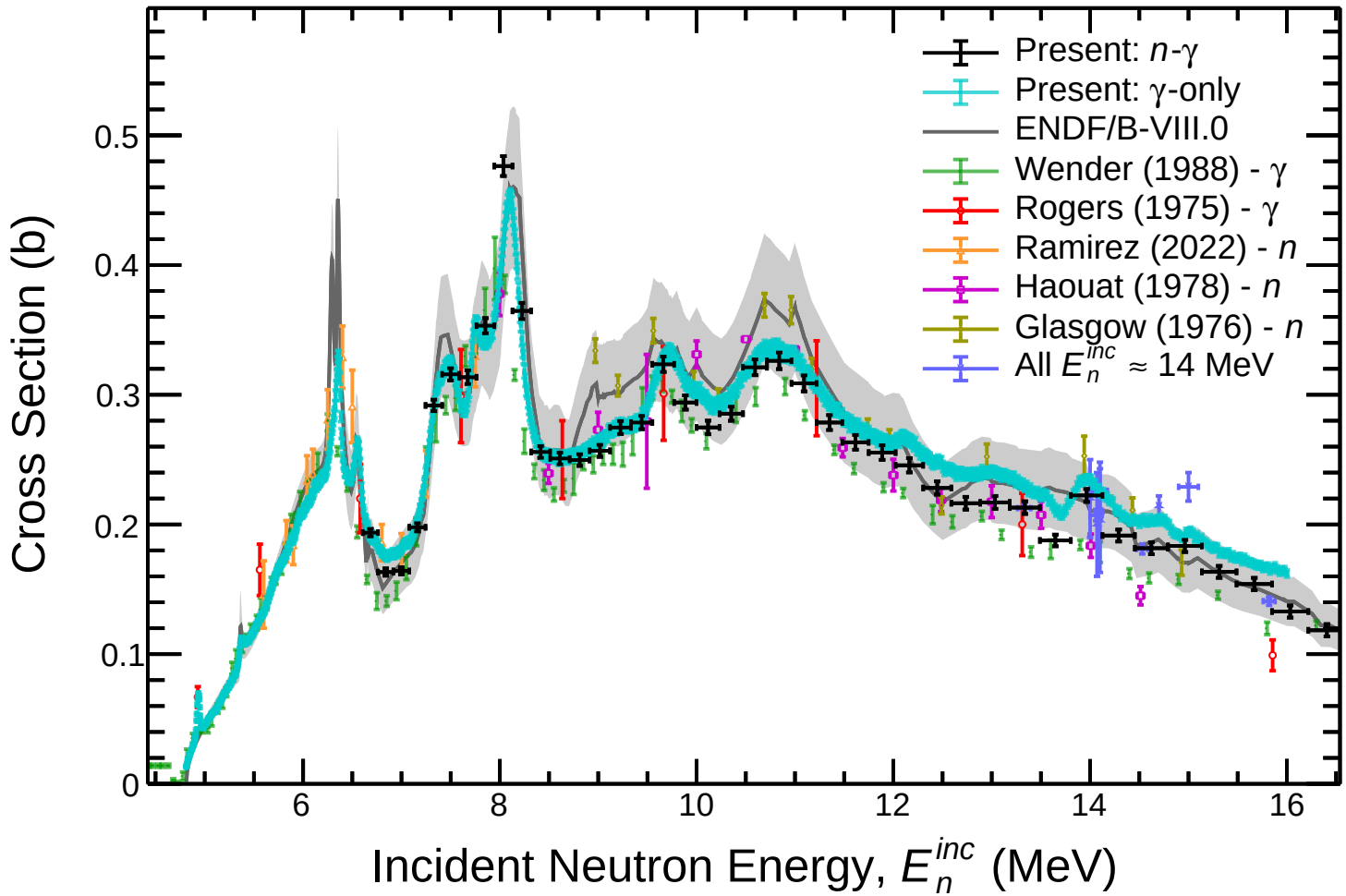
Gold, Report ANL-6984 (1964)

- Improves resolution of state excitations
- Corrects for environmental n scattering effects
- Extract full strength of each excited state
  - Demonstrated with continuous PFNS in MCNP



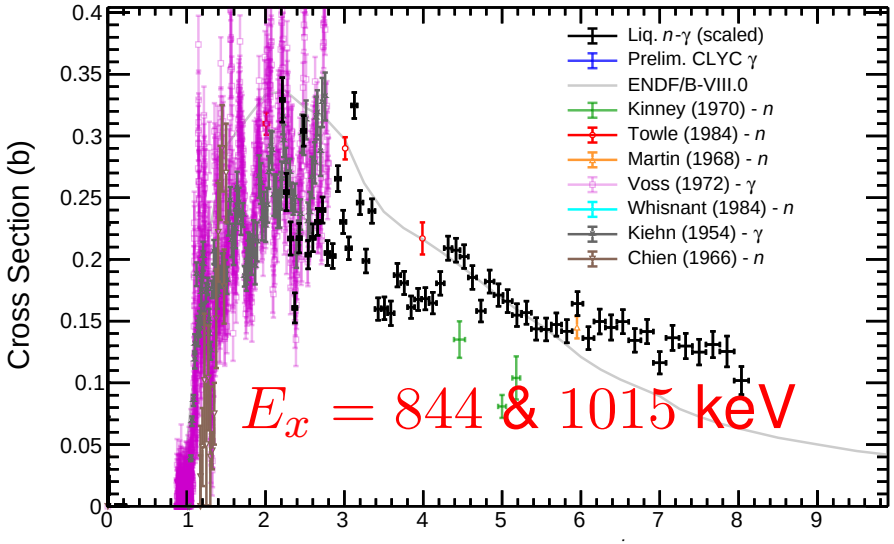
Preliminary $^{12}C(n,n'\gamma)$ Cross Section

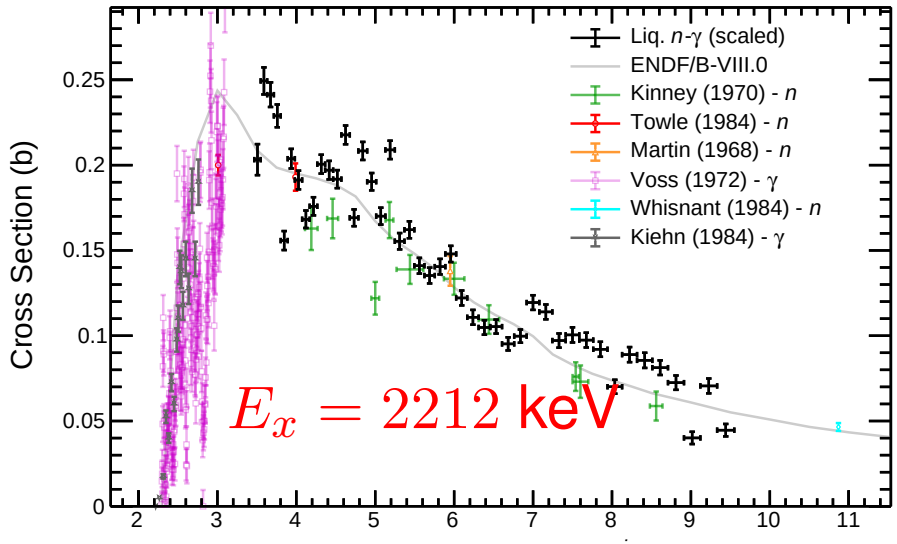
- Correlated n-γ Distributions: Kelly *et al.*, PRC **104** (2021) 064614
- γ-Production XS motivated liq. scint. γ-ray Investigations
- No competing γ rays $\Rightarrow$ high-res, high-stats $^{12}C(n,n'\gamma)$ XS

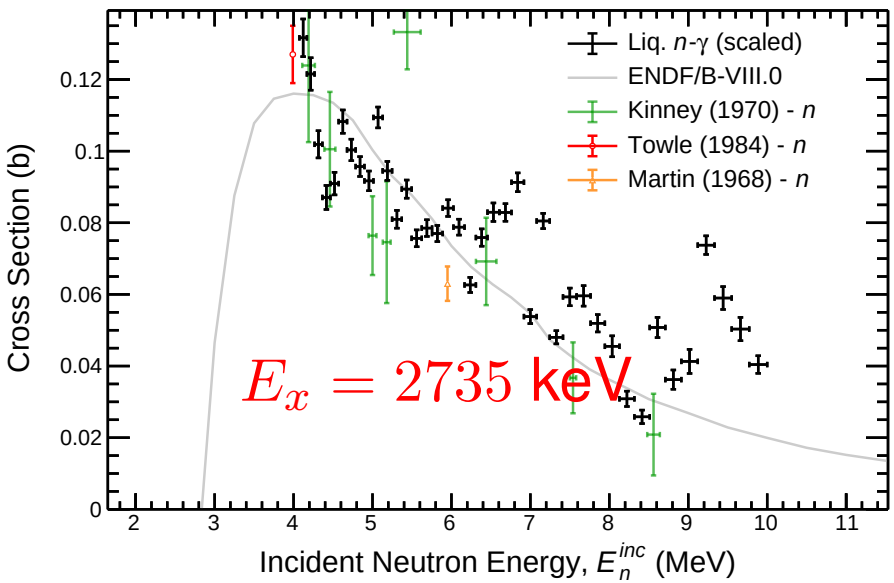


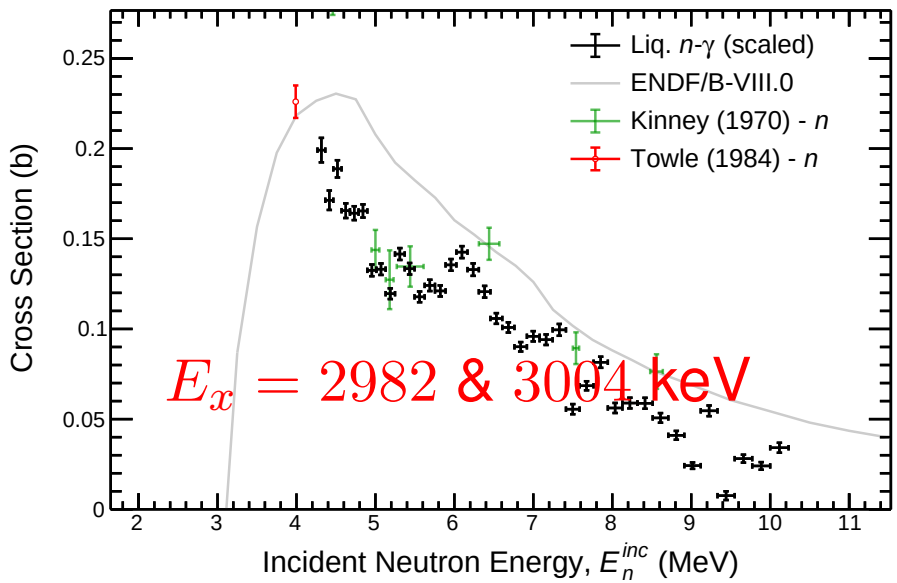
^{27}Al$(n,n'\gamma)$ Cross Sections

- All data normalized to 4.0 MeV data point at $E_x = 2212$ keV

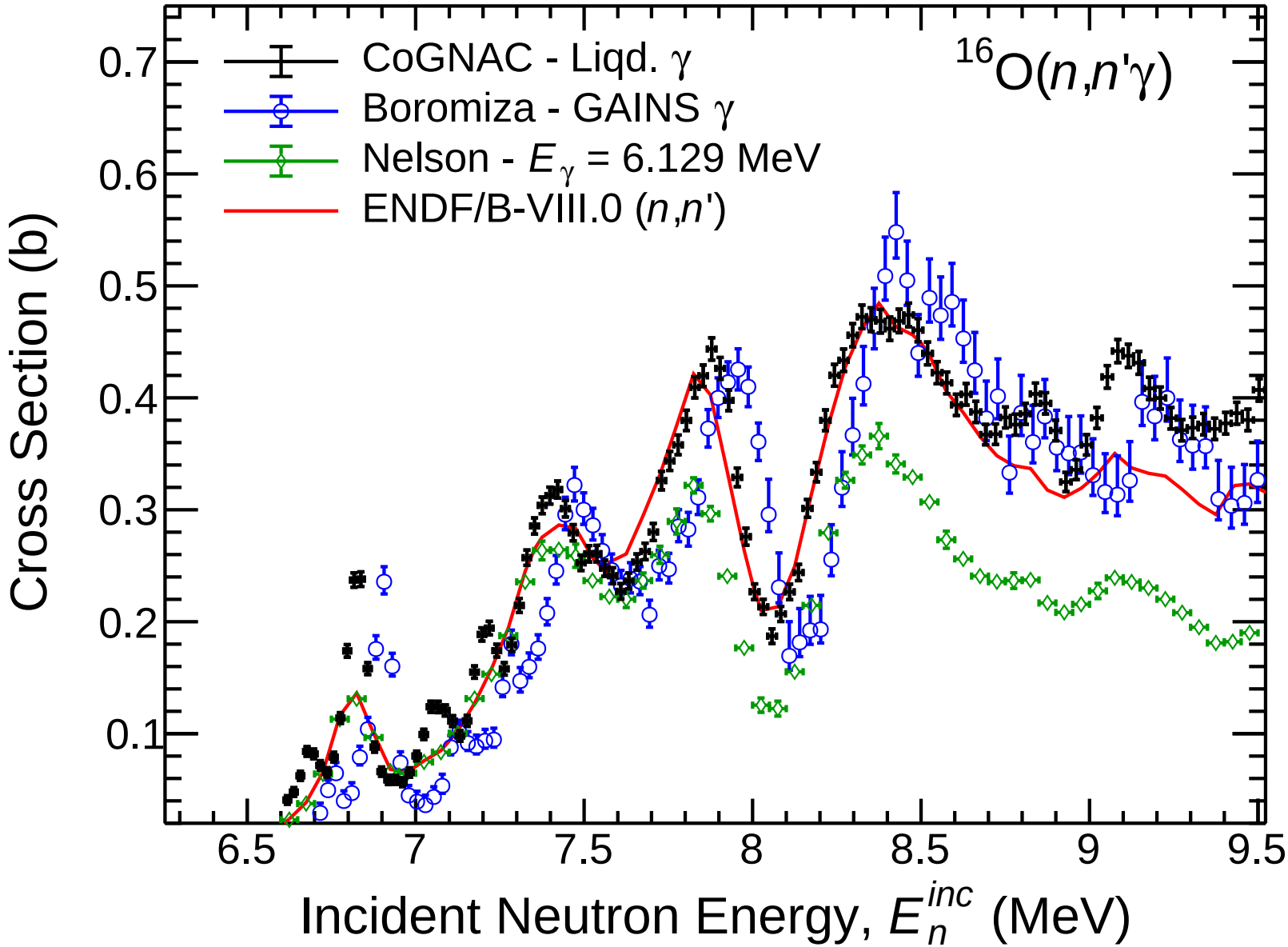








Preliminary Results for $^{16}O(n,n'\gamma)$



Future Work

- ^{27}Al(n,$n'\gamma$) data under review
- ^{16}O(n,$n'\gamma$) results preliminary, but promising
- ^{28}Si(n,$n'\gamma$) data, and likely more ^{16}O data, to be collected during the 2023 run cycle