LA-UR-22-20570

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Title: LANL ``What Do We Get'' Report

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Intended for: Collaboration meeting with LBNL and BNL on 238U inelastic scattering analysis.

Issued: 2022-01-24

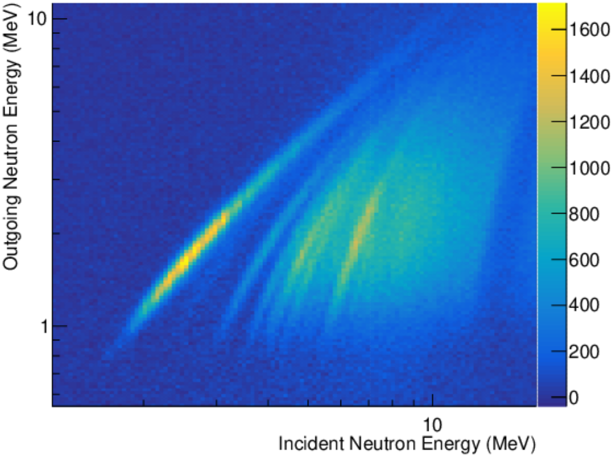
LANL “What Do We Get” Report

^{238}U GENESIS Meeting

HPGe at Chi-Nu Team

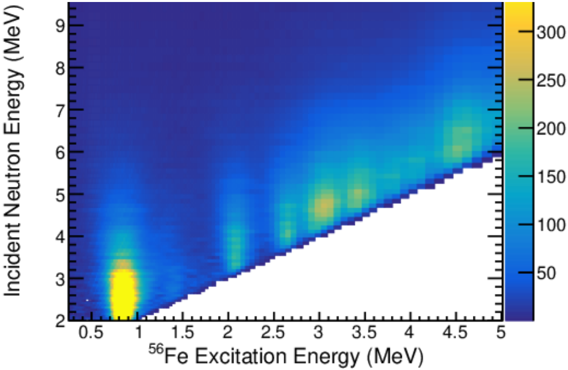
n-γ Coinc. $\rightarrow$ Excitation Energies (Fe ex.)

- n-γ with liquid-liquid and liquid-HPGe
- Random n-γ coinc. removal
- Fission removal
- Correction for n flux
- Correction for γ decay, efficiency, and ang. dist.



Convert Corrected n-γ Coincs to Missing Mass

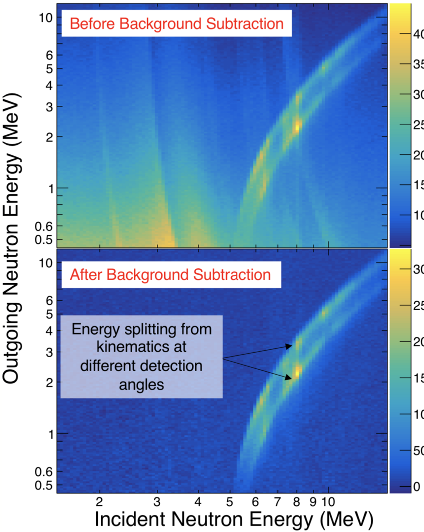
- Correct at each n-det angle
- Sum over all angles in E_n^{inc} vs excitation energy



Unfold / Correct for n Response using ^{12}C(n,n')

- ^{12}C(n,n') reaction gives clean measure of environmental neutron response
- Correct into n response matrix
- Then use iterative unfolding to give n-response-corrected yield:

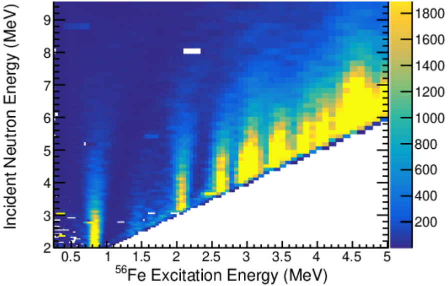
$$m^{(n+1)}_{\alpha|\beta}(E) = \frac{m^{(n)}_{\alpha|\beta}(E)c_\alpha(E)}{\sum_{i=1}^{N}\mathcal{R}(E,E_i)m^{(n)}_{\alpha|\beta}(E_i)}$$

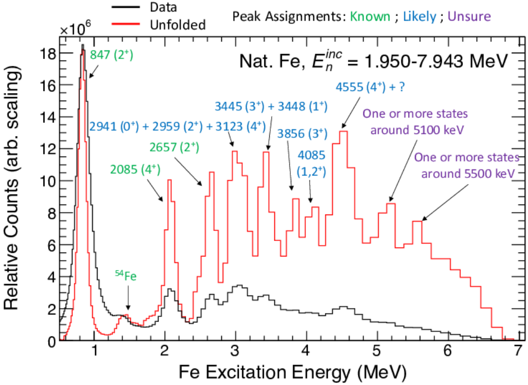


Report E_n^{inc}-binned XS

- Example of resolution improvement from Fe data

- ^{238}U is more complicated, but same general processes should apply





Slides Added After Meeting

Random Coincidence Backgrounds Eliminated

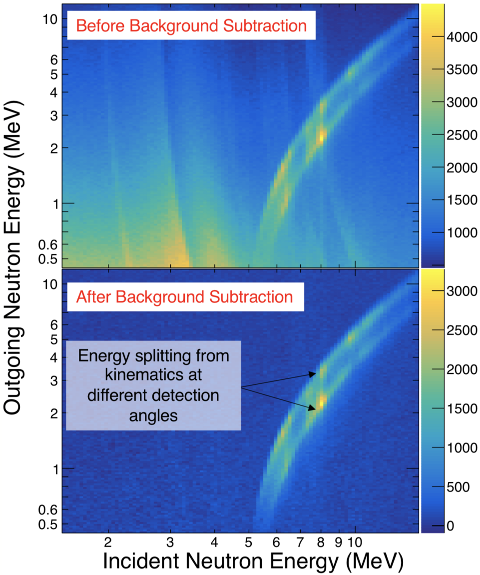
- Random coincidence rates derived form Poisson probabilities for *uncorrelated* detection rates †
  - true coincidence rate must be low
- Calculate the total probability for:
  1. Detecting a γ at time t_γ
  2. Not detecting n over coinc. time $t_n - t_\gamma$
  3. Detecting n at time t_n

$$\text{Coinc. Rate} \quad = \quad r_b = r_\gamma r_n \Delta_t$$

$$\Rightarrow \quad b = \frac{\gamma n}{N_{t0}}$$

$$\text{with} \quad \gamma, n = \text{counts}$$

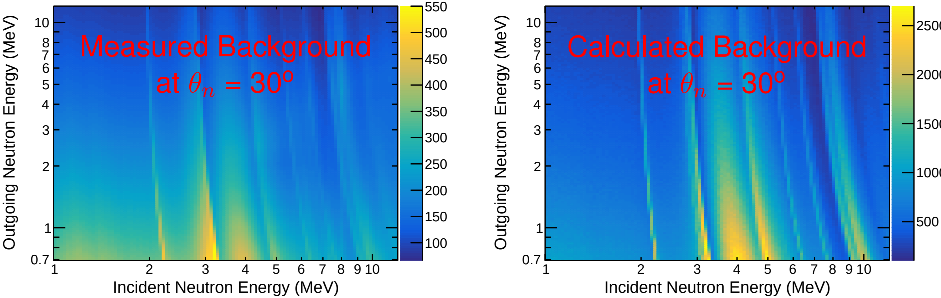
- Works remarkably well here, but what are the backgrounds?



†O'Donnell, NIMA **805** (2016) 87

Backgrounds from γ-Anticoincident Neutrons

- The elastic scattering ^{12}C(n,n) reaction is a likely source
- Do a simple Monte Carlo calculation for this background:
  - Sample incident neutrons from WNR FP15L flux shape
  - Calculate E_n^{out} from sample E_n^{inc}, convert to TOFs
  - Vary TOFs according to random γ timing, recover new $E_n^{inc'}$ and $E_n^{out'}$
  - Fill histogram with counts = $\sigma(E_n^{inc})$
- Possible to extract cross sections from this background?...maybe...



References for More Information

- Original Background Method Paper
  - J.M. O'Donnell, NIMA **805** (2016) 87
- Application to PFNS with more details:
  - K.J. Kelly, M. Devlin, J.M. O'Donnell, *et al.*, PRC **102** (2020) 023615
- Application to scattering, with other details
  - K.J. Kelly, M. Devlin, J.M. O'Donnell, E.A. Bennett, PRC **104** (2021) 064614
- Citation for Iterative Unfolding Method "Re-discovery"
  - K.J. Kelly, M. Devlin, J.M. O'Donnell, E.A. Bennett, NIMA **1010** (2021) 165552