LANL Updates on Chi-Nu and Neutron Scattering

CSEWG 2021

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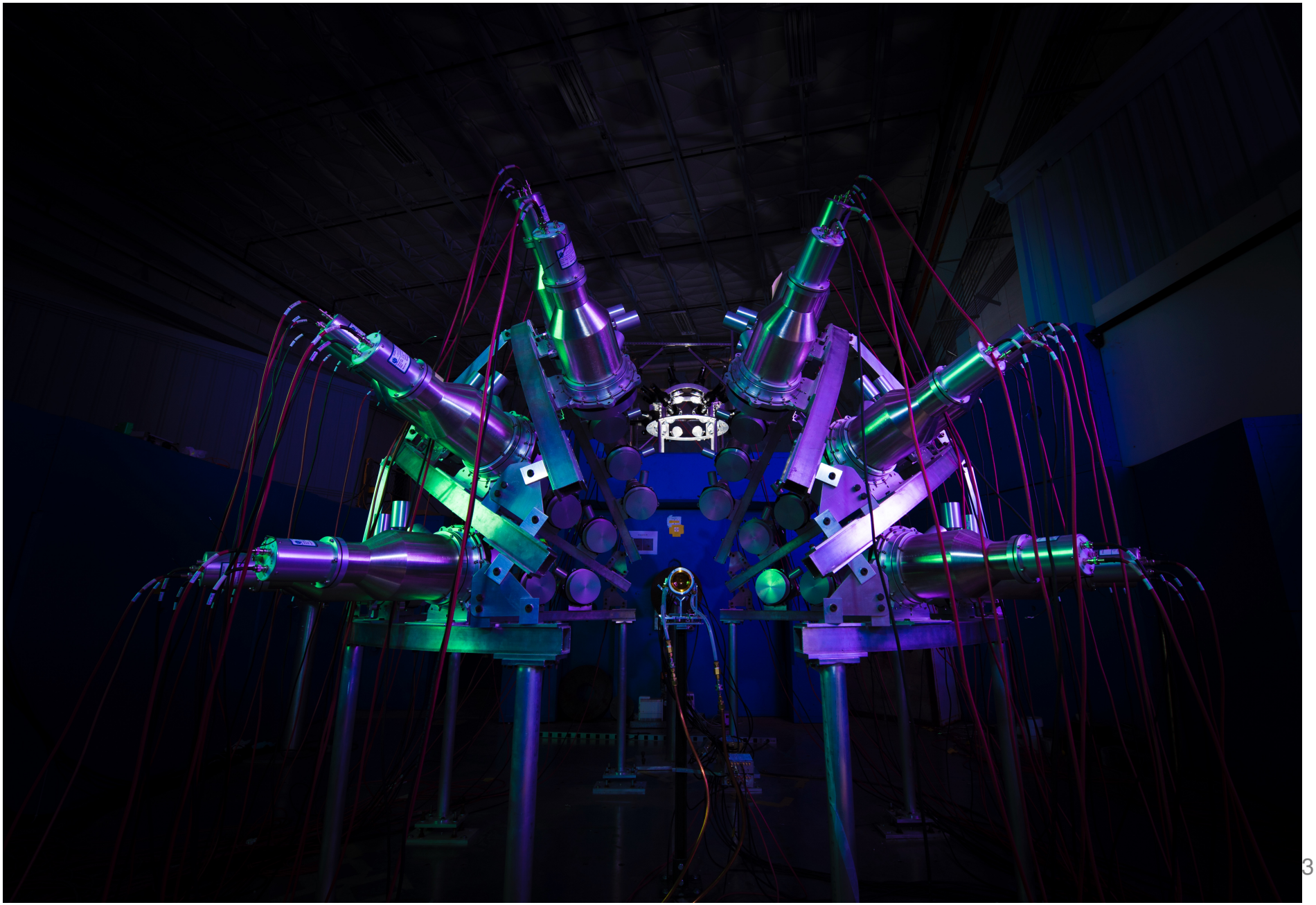
Outline

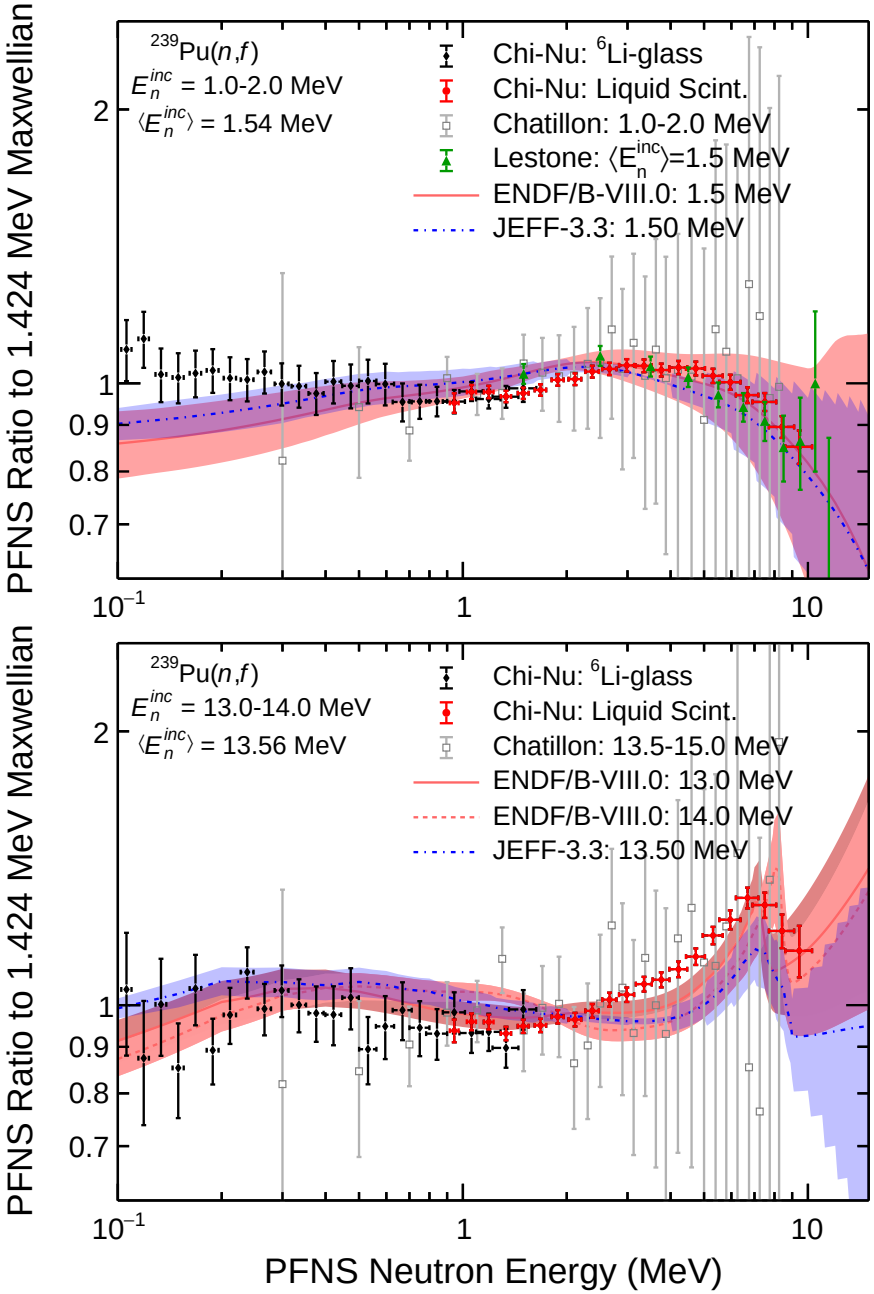
- Chi-Nu Prompt Fission Neutron Spectrum (PFNS):
  - Revisit ^{239}Pu
  - Updates on ^{235}U, ^{238}U, and ^{240}Pu

- Neutron Scattering at LANL
  - Revisit n-γ technique with liquid scintillators
  - Results from carbon measurements
  - Extension to CLYC scintillators

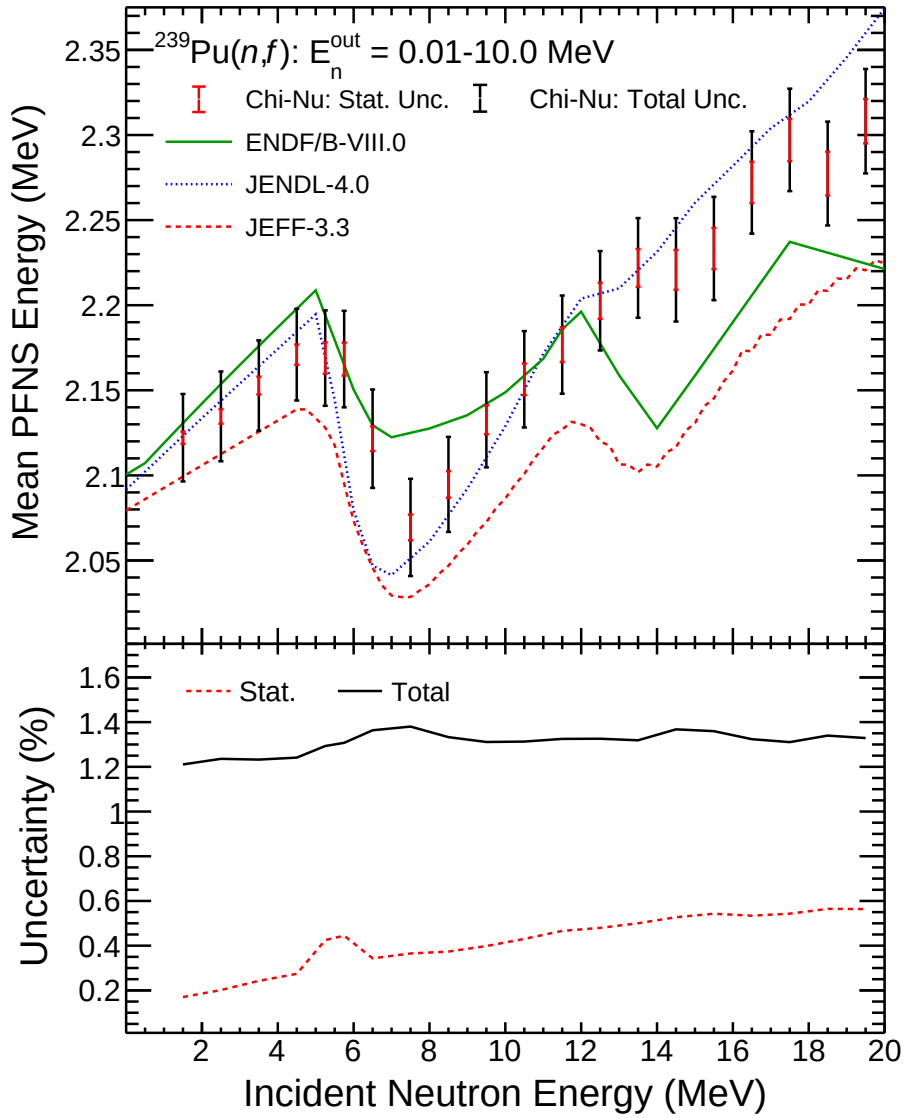
The Chi-Nu Arrays



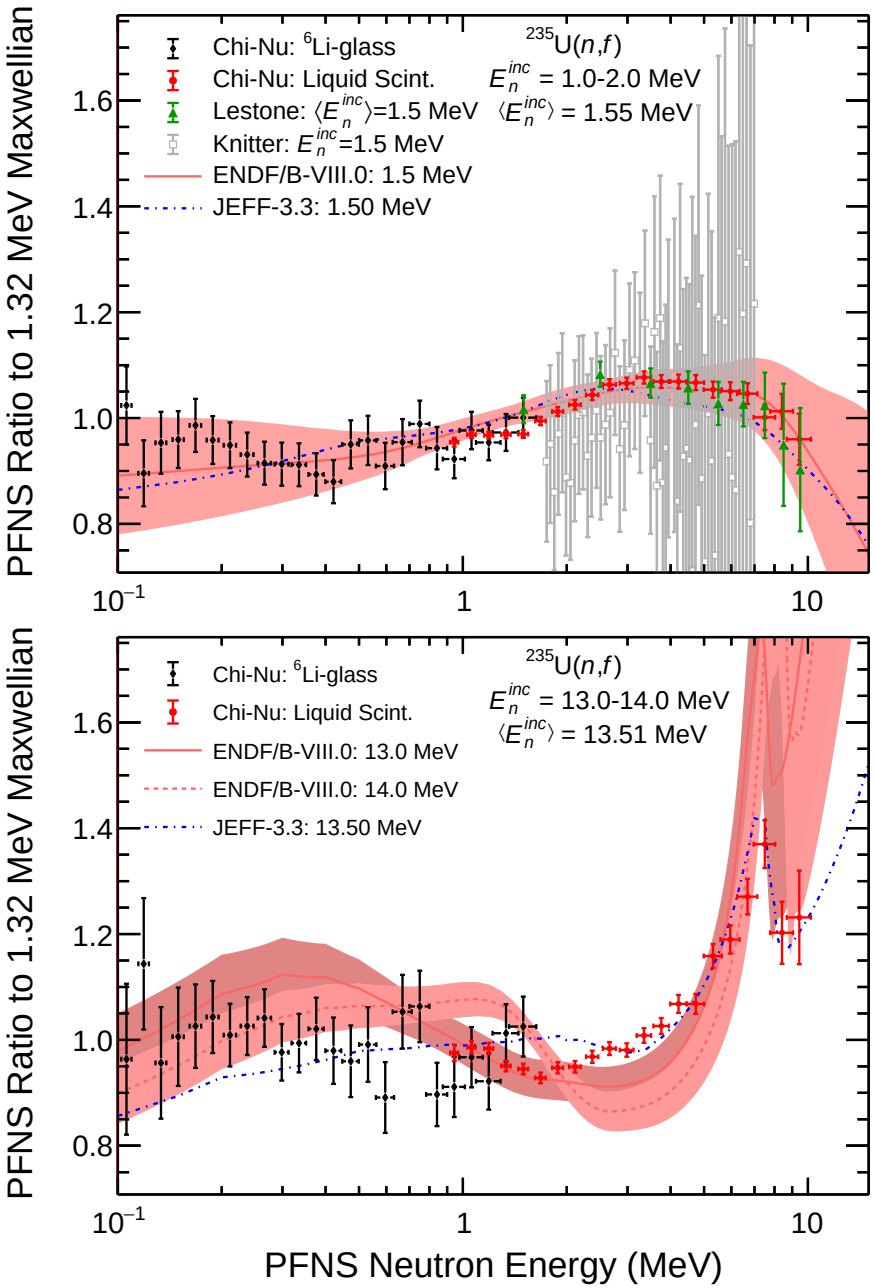
Recall ^{239}Pu PFNS: Published in 2020



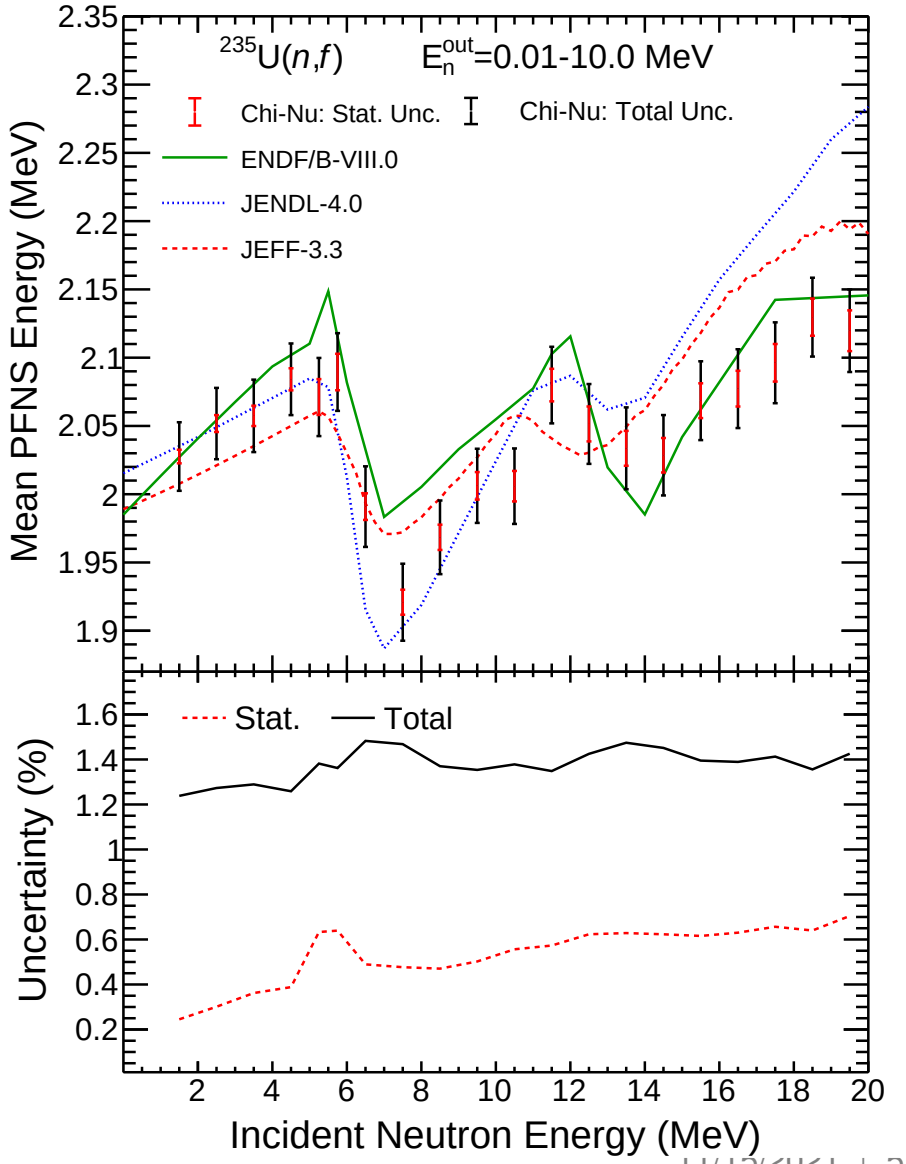
- Kelly, *et al.* PRC **102** 034615 (2020)
- Kelly, Marini, *et al.* NDS **173** 42 (2021)



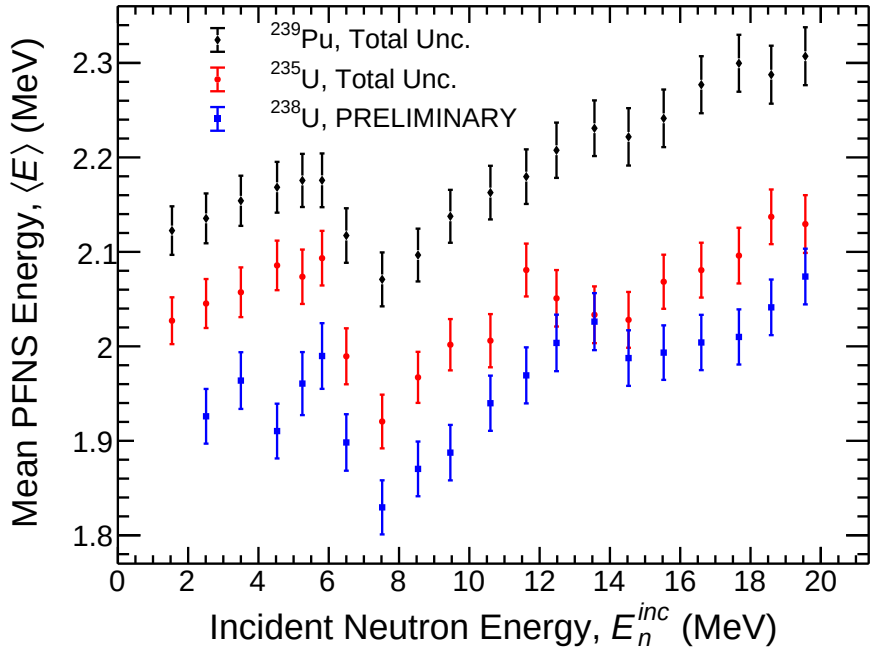
^{235}U PFNS: Results Finalized, Pub. in Prep.



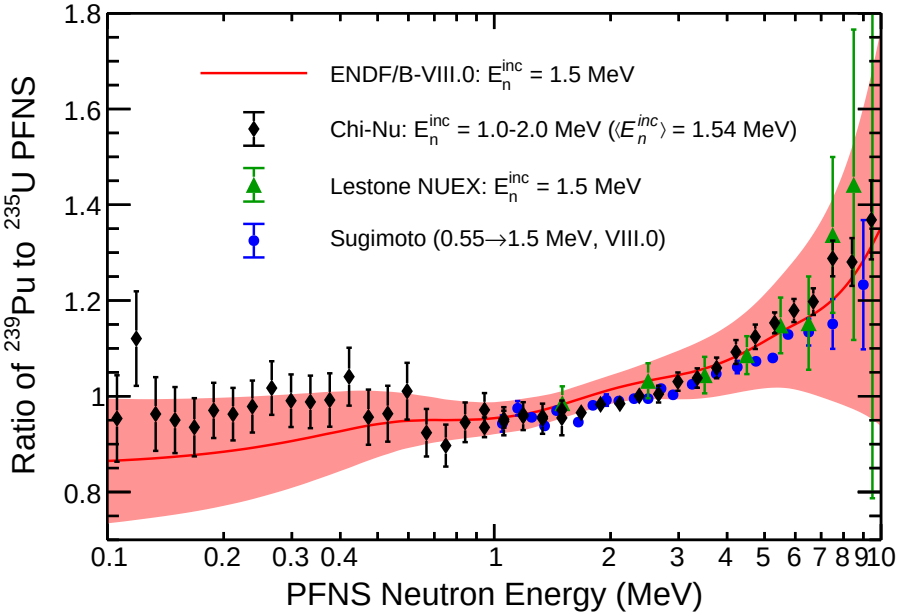
- Kelly, *et al.* PRC in prep

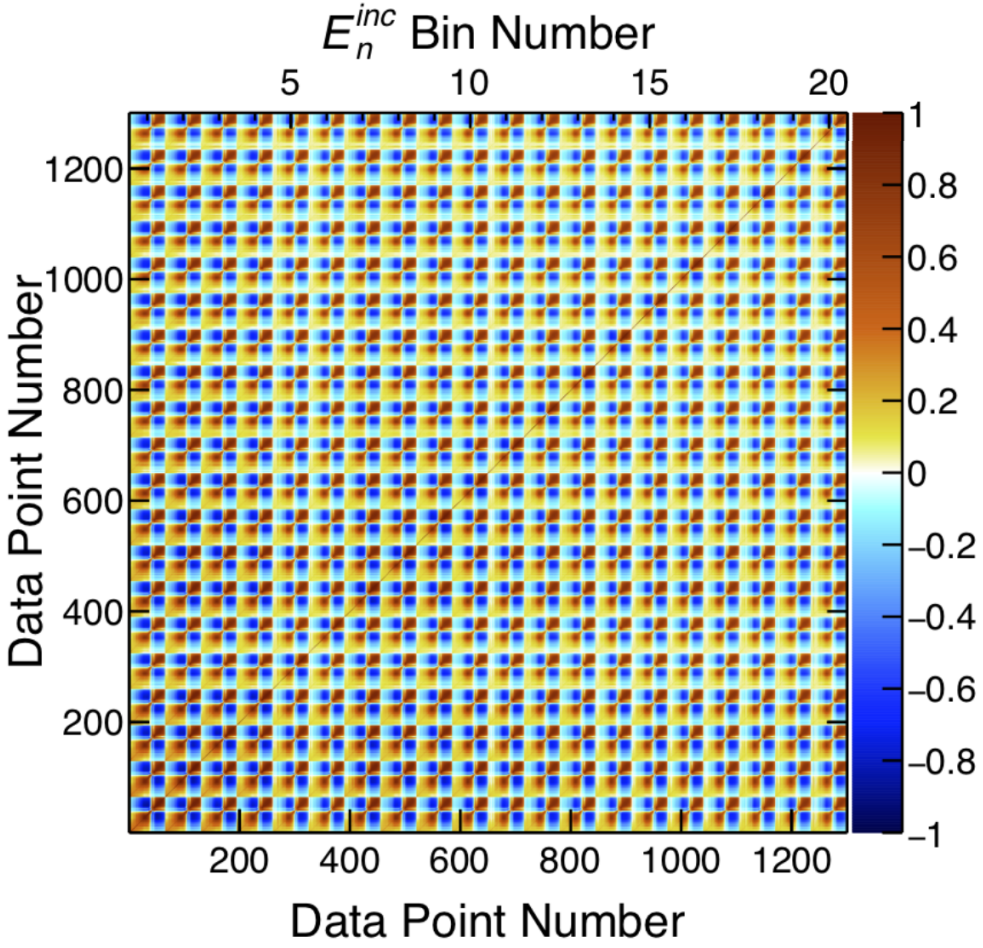


^{238}U PFNS: All DAQ Completed; Prelim. Analysis



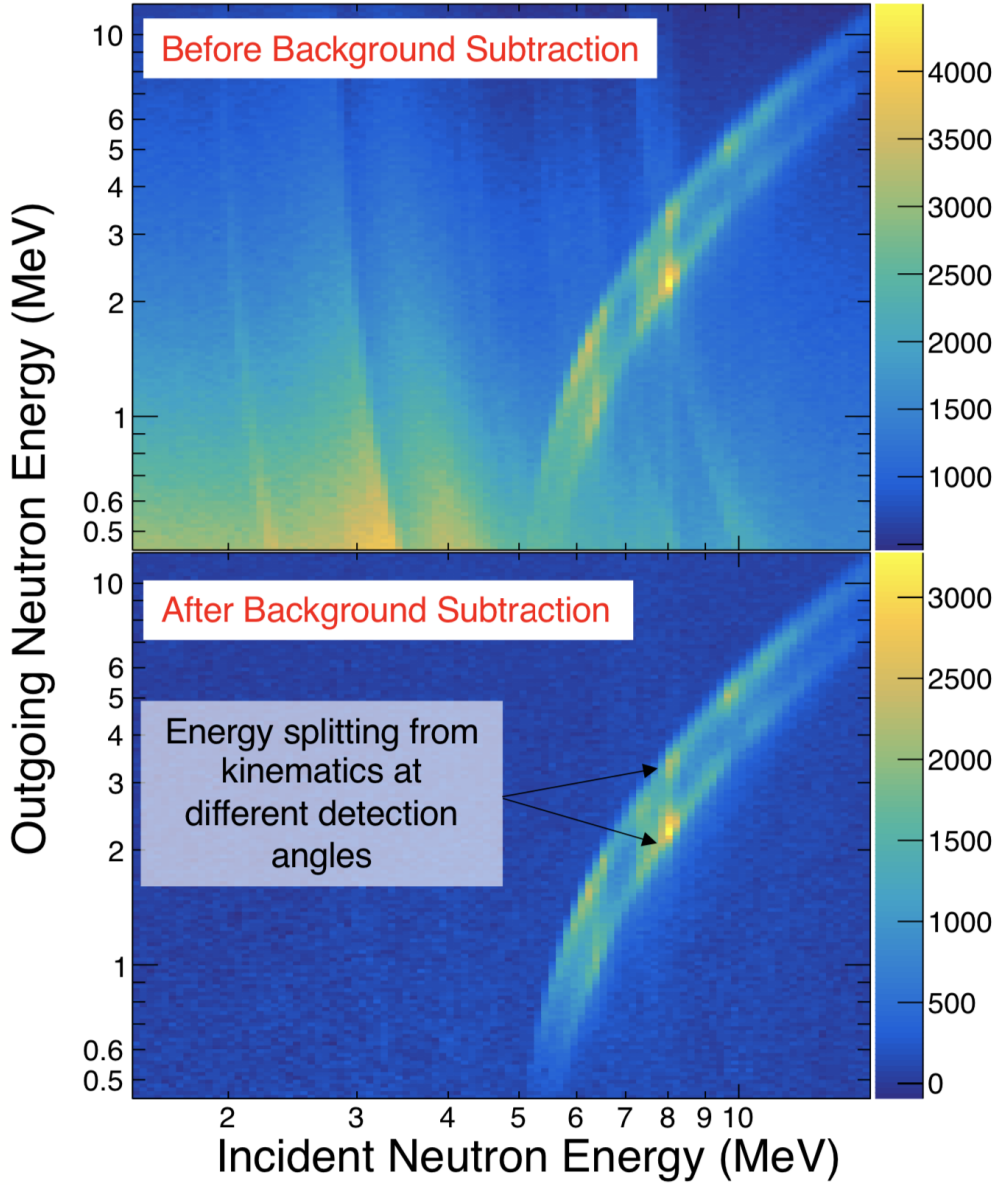
- ^{238}U to be finalized next year
- Able to consider comparisons of ^{239}Pu, ^{235}U, ^{238}U, ..., across wide E_n^{inc} range





Scattering: Liq. Scint. n-γ Coincidence Analysis

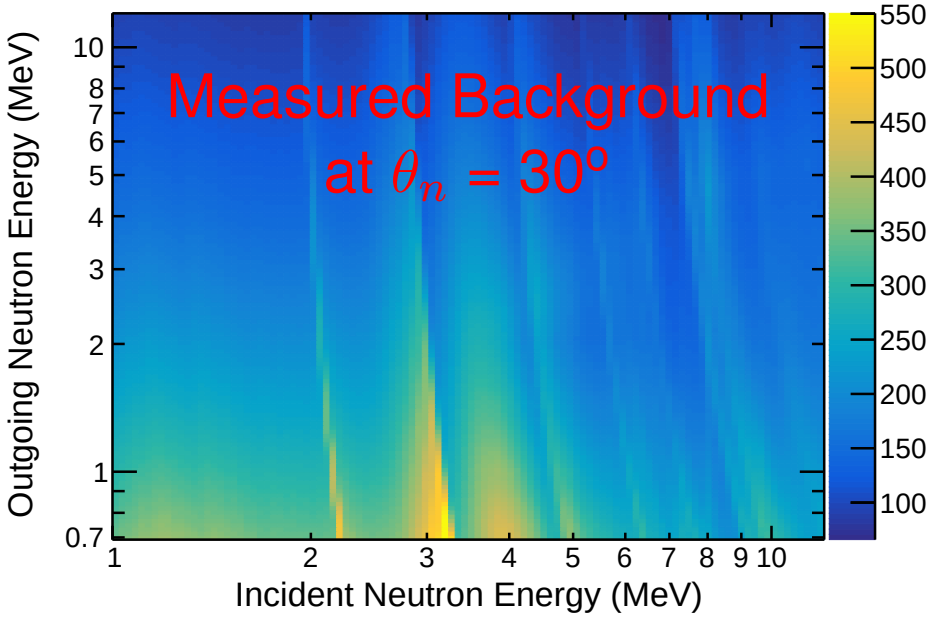
- γ-tag for E_n^{inc} and E_n^{out}
- Good liq. Scint. timing reveals inelastic level structure
- Simple case: carbon
  - shown last year
  - also measured Fe and Pt
- Random coincidences are easily removed†
- What are the backgrounds?

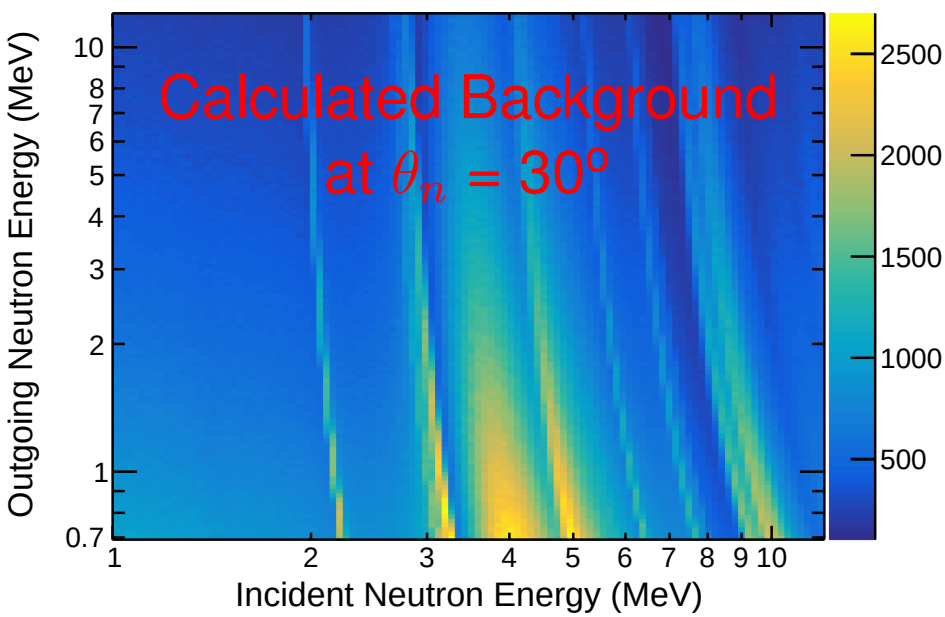


†O'Donnell, NIMA **805** (2016) 87

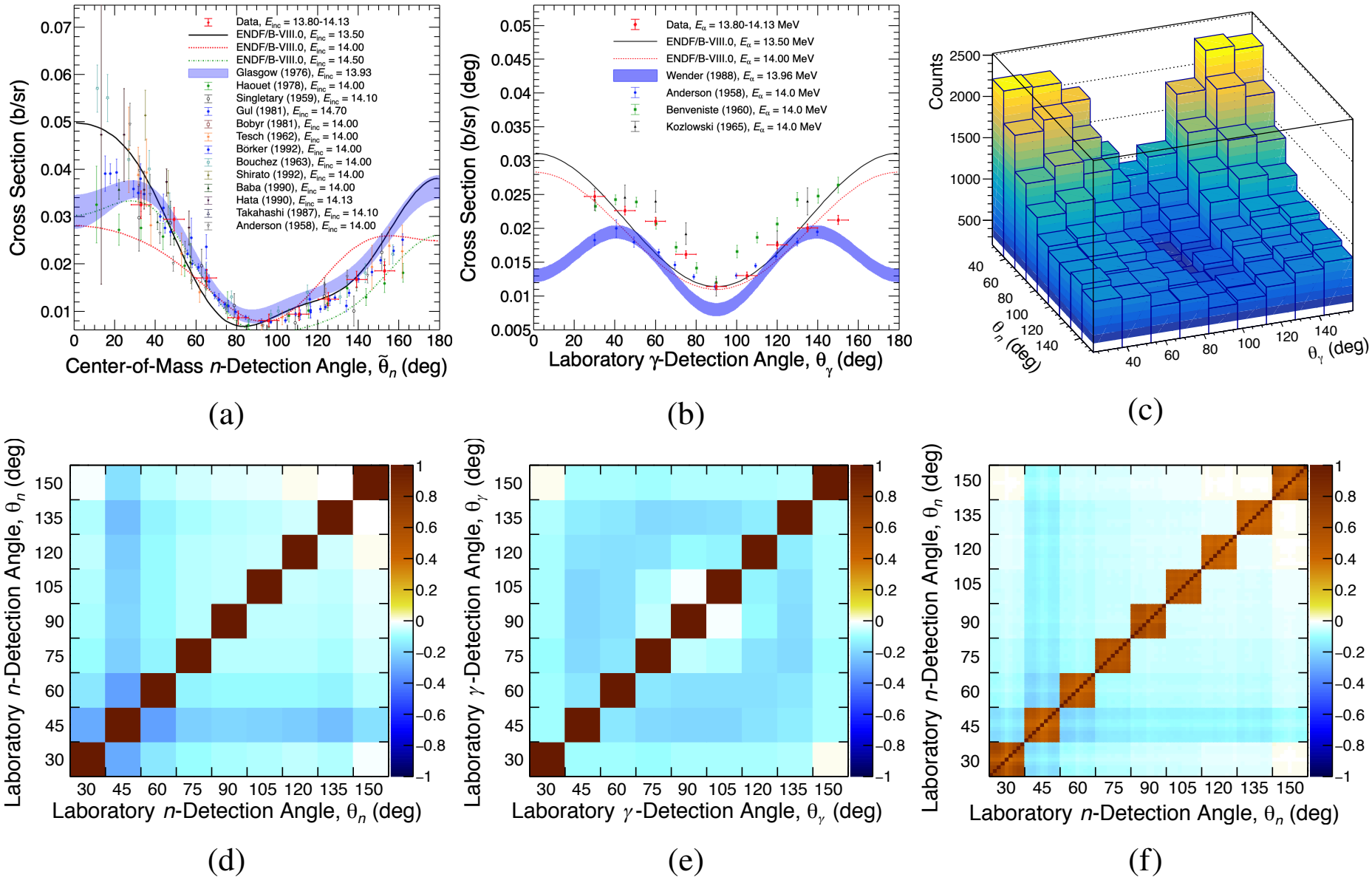
Backgrounds from γ-Anticoincident Neutrons

- 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...

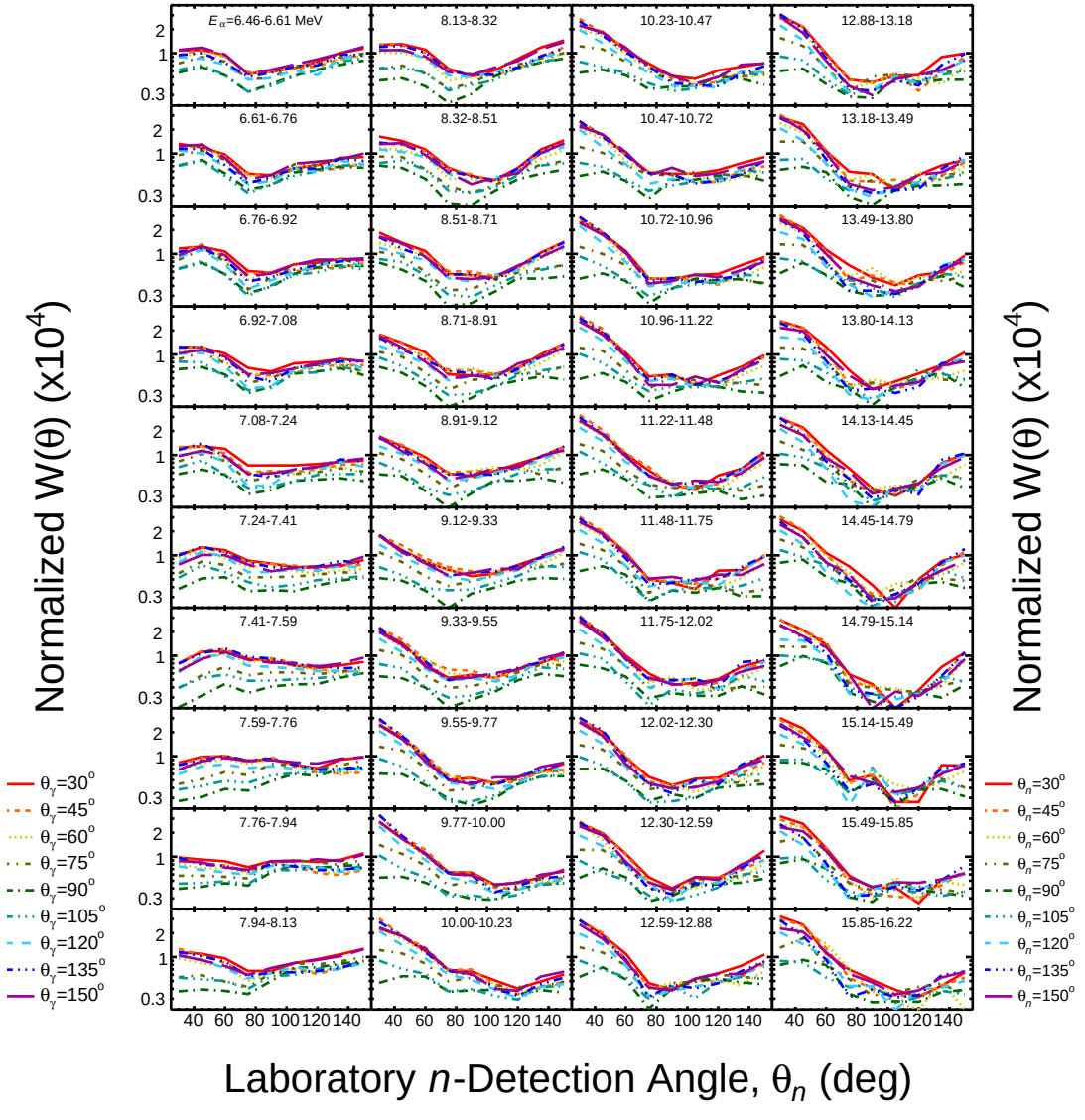


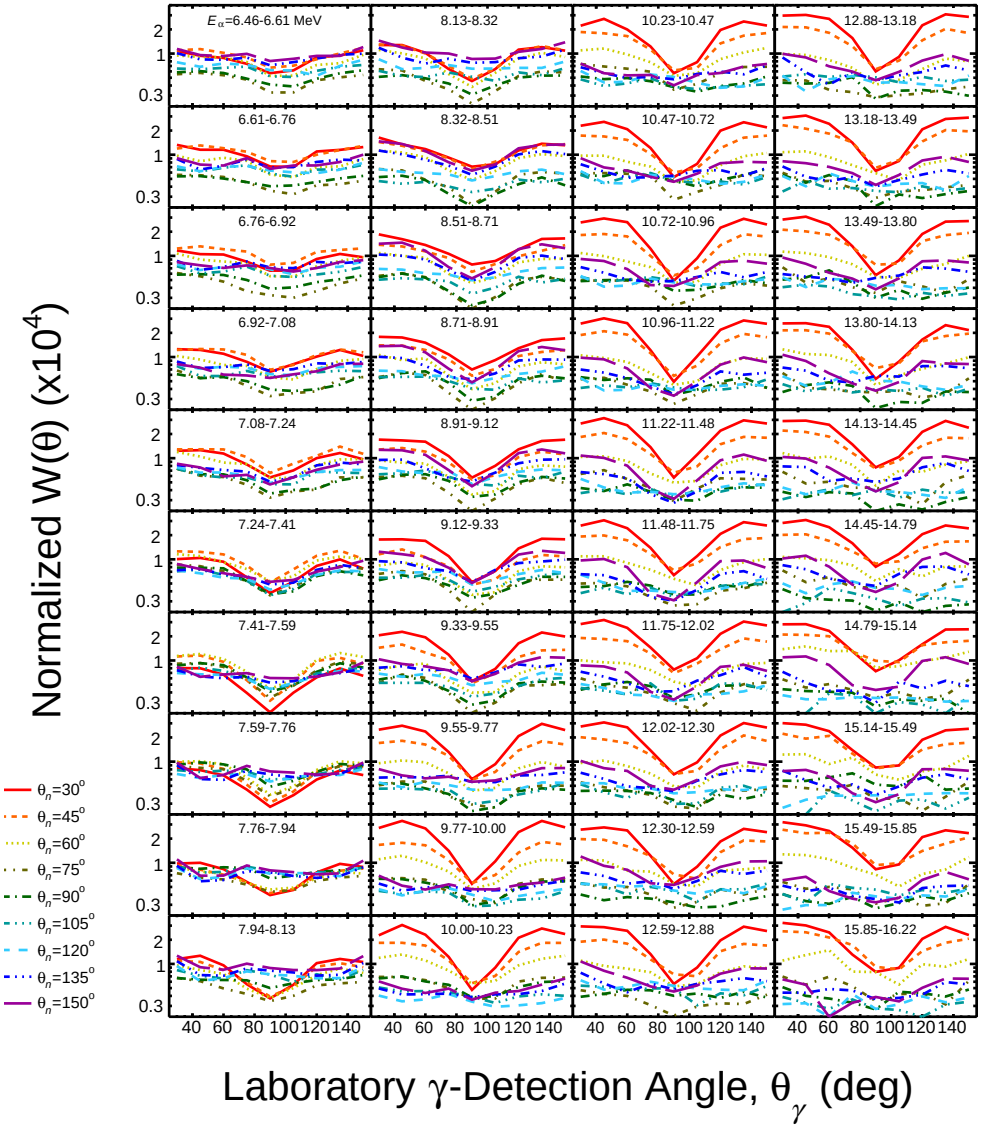


Extract n, γ, and Correlated n-γ Distributions



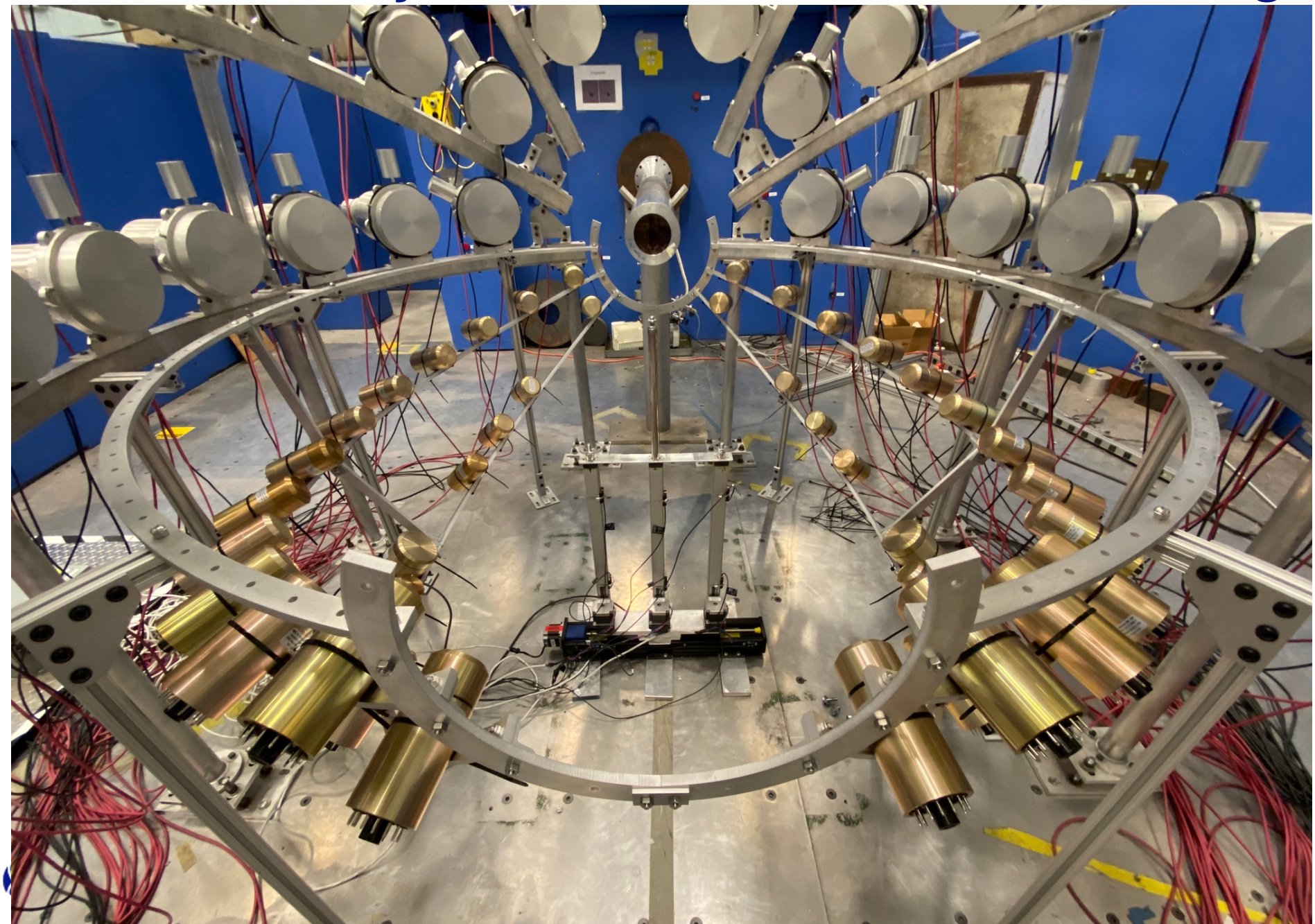
Corr. n-γ Distributions for Wide Range of E_n^{inc}



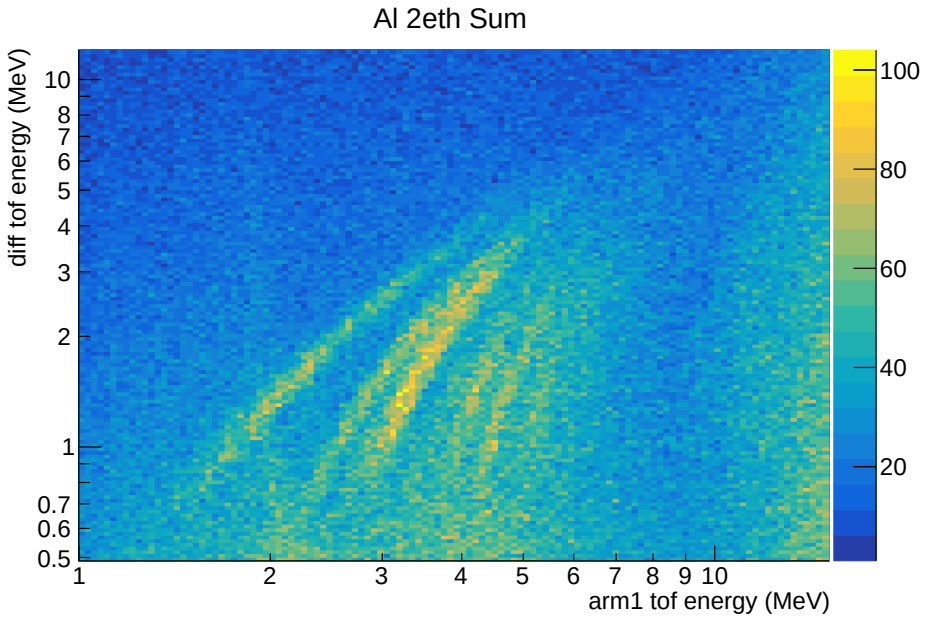


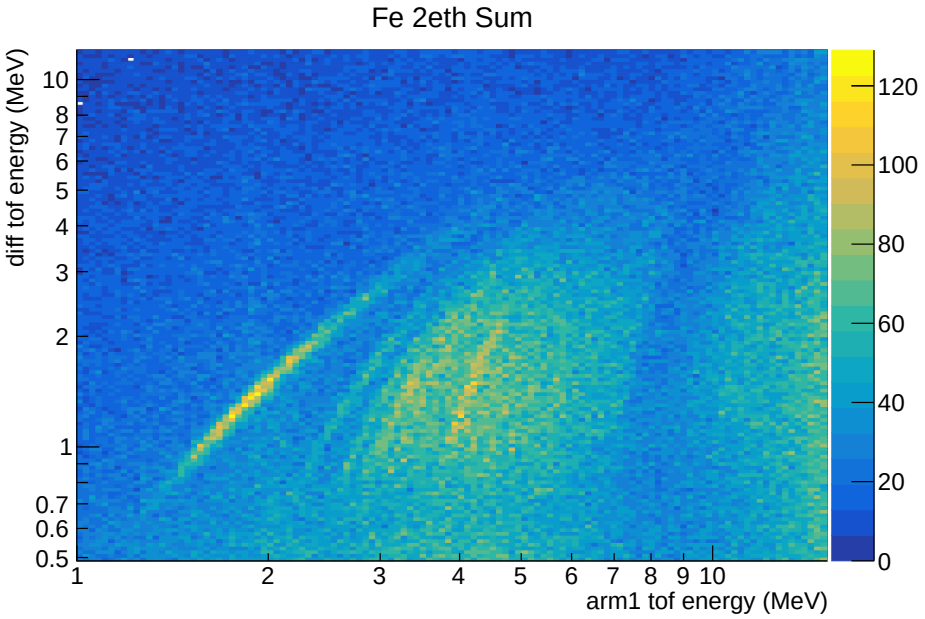
Recently accepted to PRC

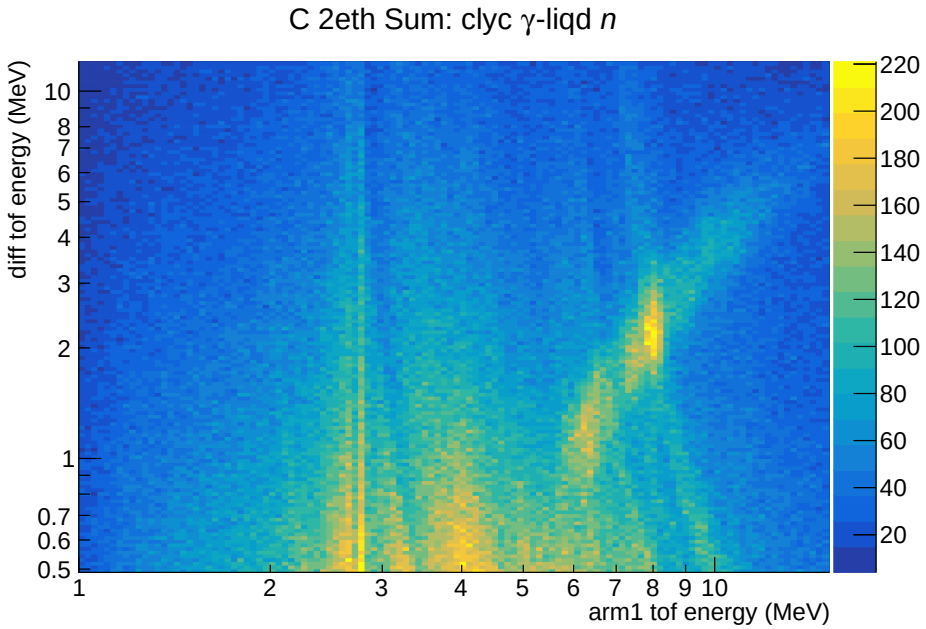
CoGNAC Array of CLYC Detectors for Scattering

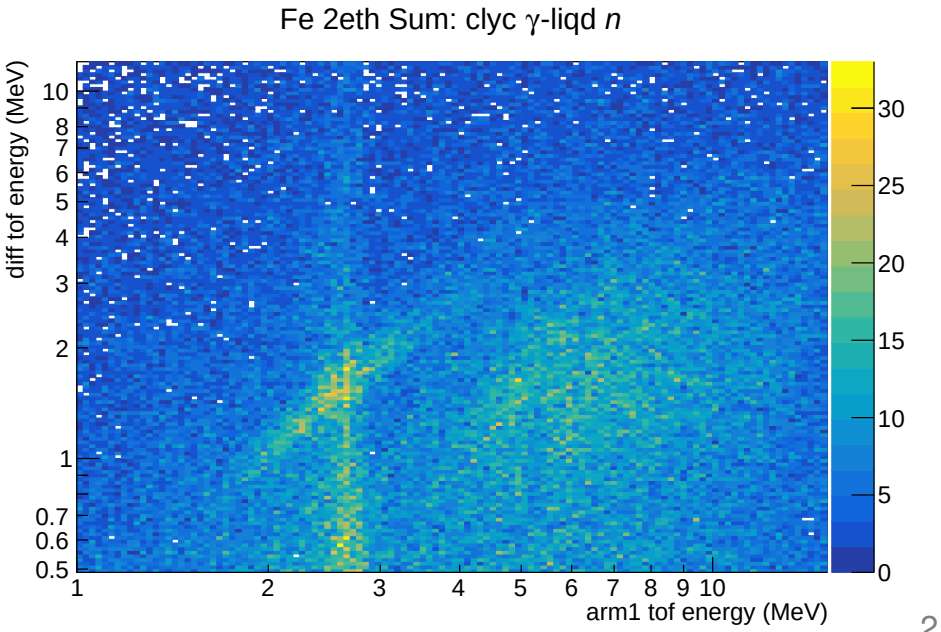


Very Early Data from CoGNAC + Liq. Scint.









Summary

- Scattering measurements this run cycle:
  - Al, Fe, and Be, with C for calibration
- CoGNAC array of CLYCs in progress
- More to come in the future!

- Chi-Nu Results and Future:
  - ^{239}Pu PFNS full results published in PRC in 2020
  - ^{235}U PFNS finalized and publication in progress
  - ^{238}U full data set collected, and preliminary analysis has been applied
  - ^{240}Pu(sf) PFNS collected with liquid scint.
    - In-beam PFNS delayed due to PPAC delays and beam loss

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- Initial scattering work funded by LDRD Project 20190588ECR
- Meas. and Dev. funded by LDRD Project 20210329ER
- γ-production cross section measurements funded by NA-22