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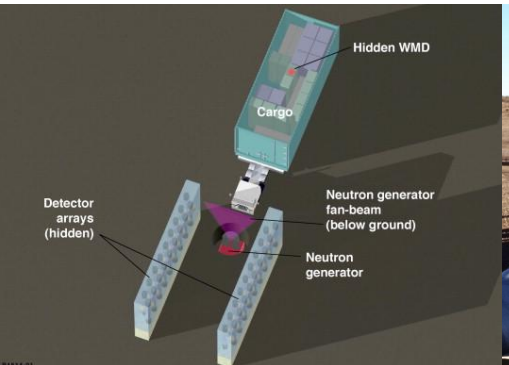
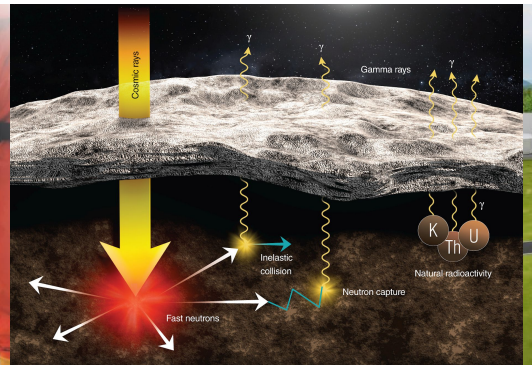
Gamma-ray Production Cross Sections for Active Neutron Interrogation with GENESIS

Josh Brown
Department of Nuclear Engineering, University of California, Berkeley

February 29, 2024

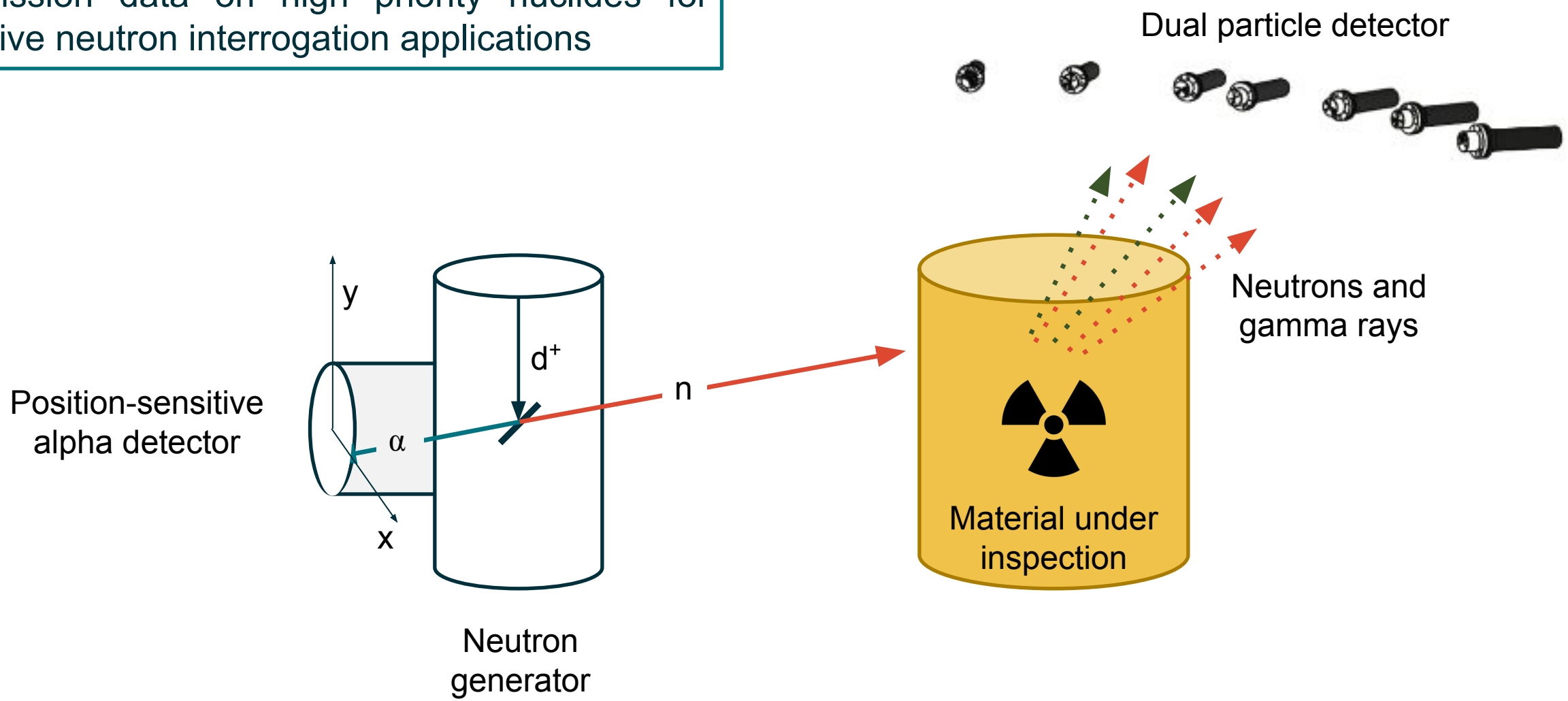




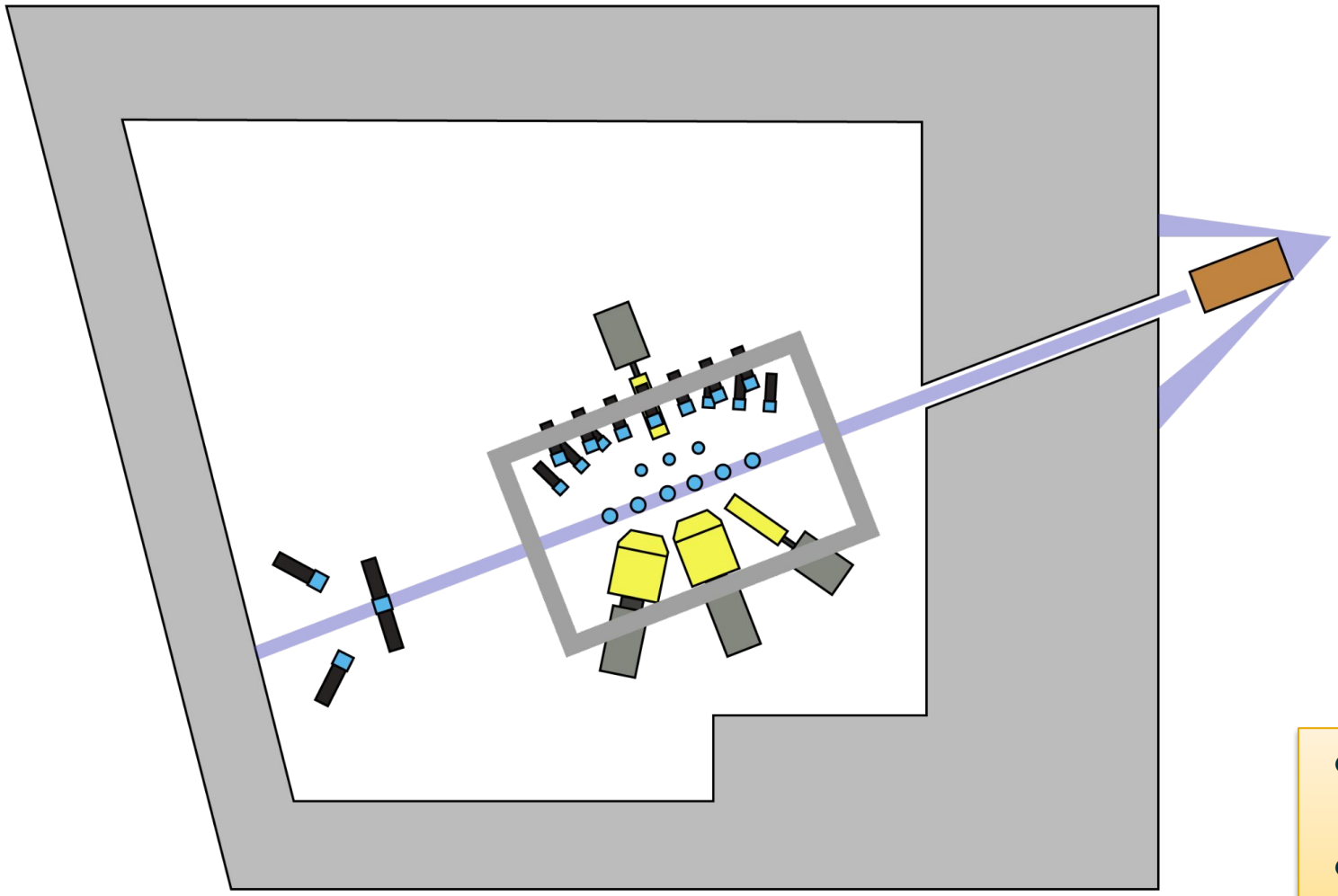


GENESIS Mission Problem

Goal: Provide partial gamma-ray cross sections and correlated gamma/neutron emission data on high priority nuclides for active neutron interrogation applications

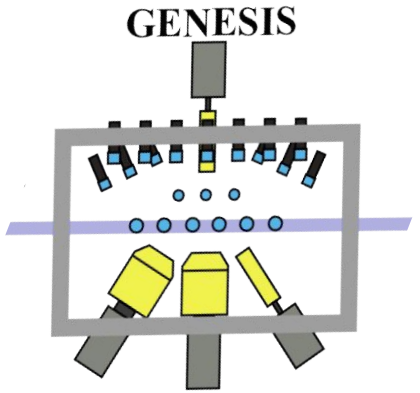


GENESIS at the 88-Inch Cyclotron



- Array commissioned under prior DOE-NE project led by Bernstein
- Beamtime supported through DOE-NP Nuclear Data Program!

Nuclear Data Needs for Active Neutron Interrogation



New neutron-induced inelastic scattering cross section data and gamma/neutron emission probabilities are needed

Priority	Elements
First	C, N, O, Na, Al, Si, Fe, Cu, Pb, W, U, Pu
Follow-up	He, Li, Be, B, Cl, Cr, Mn, Ni, Ge, Br, Cd, I, Cs, La
Remaining	F, Mg, P, S, Ar, K, Ca, Ti, As, Kr, Mo, Sn, Sb, Xe, Gd, Bi, Np, Am, Tm

S. McConchie, et al., Technical Report No. ORNL/TM-2021/1900, 2021.

GENESIS Activities

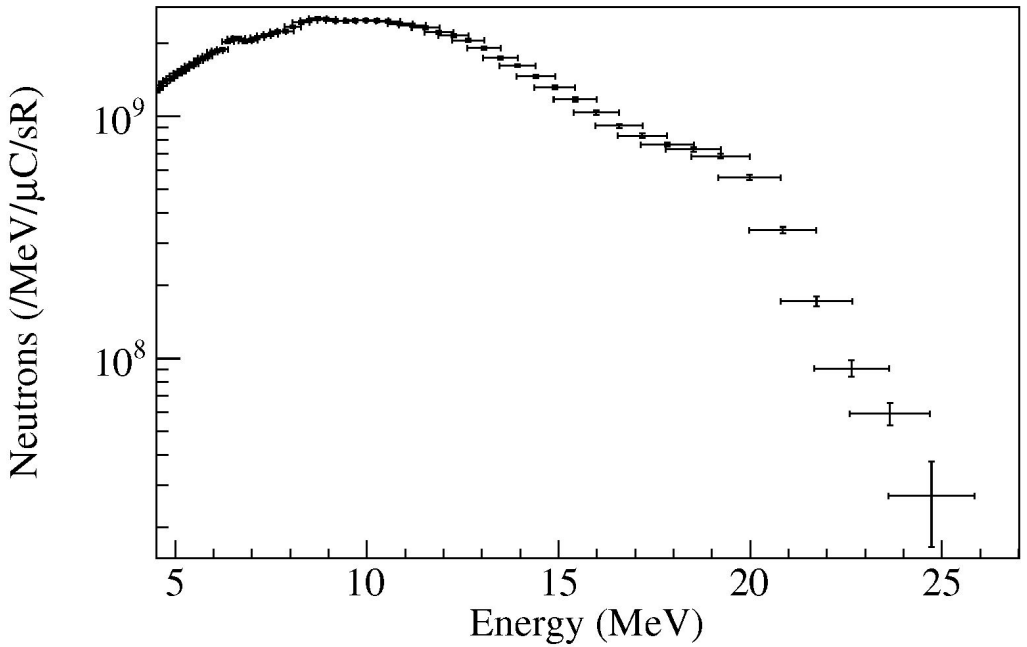
- ▮ data sets that have been produced and are under investigation
- ◯ focus of this project

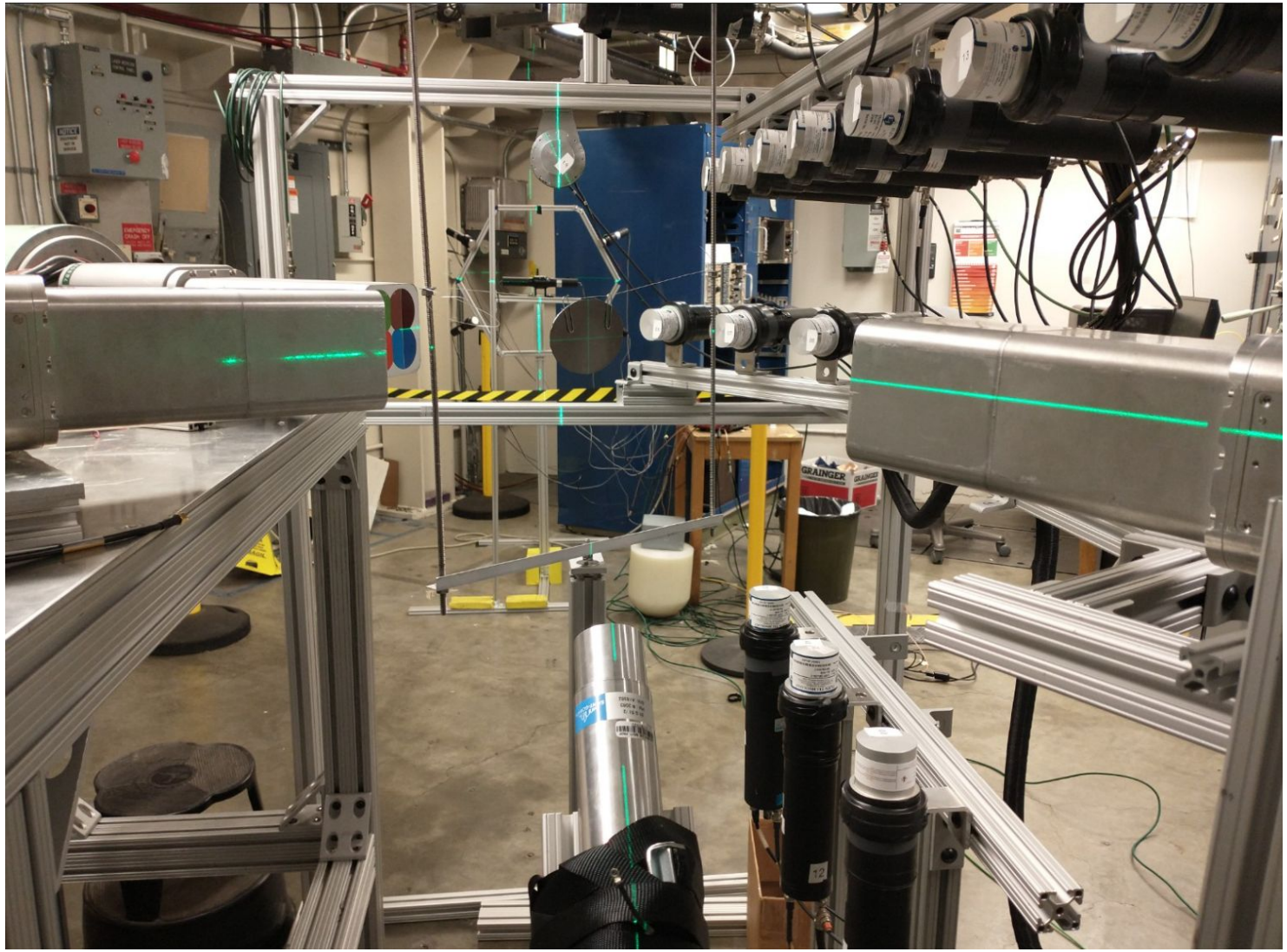
Collaboration/Strategic Partnerships

- Stockpile Stewardship Academic Alliance (Bernstein)
- Coordinated DT-API measurement program with NASA/JHUAPL Goddard team (Peplowski, Ayllon)
- NA-113 at LLNL (Bleuel)
- Air Force Institute of Technology (Manfredi)

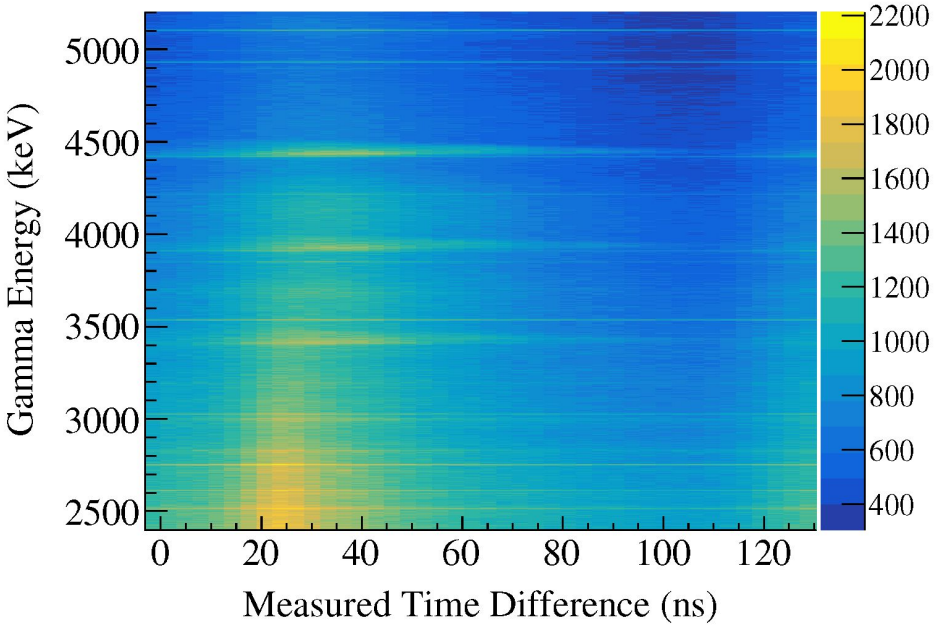
Carbon Experiment

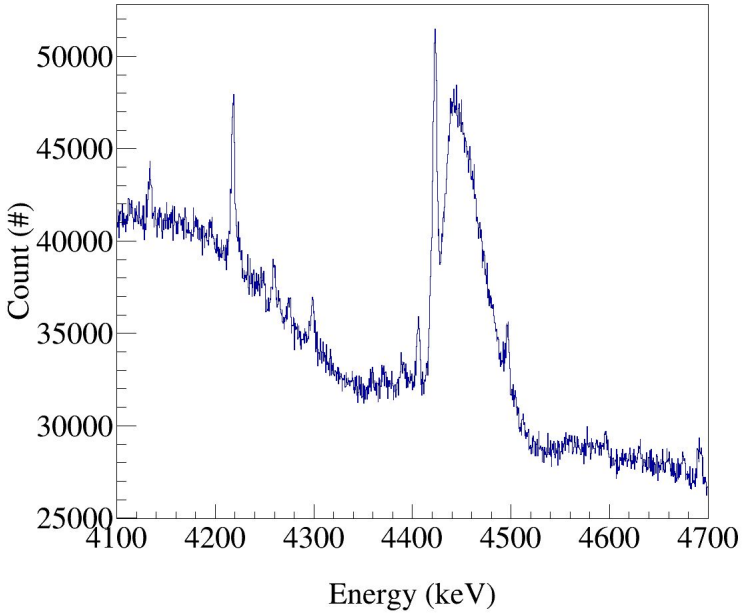
- 3 Eurosys clovers
- 26 EJ-309 liquid scintillators
- 25 MeV deuteron beam
- 4 days with beam on target
- 2 days of background data

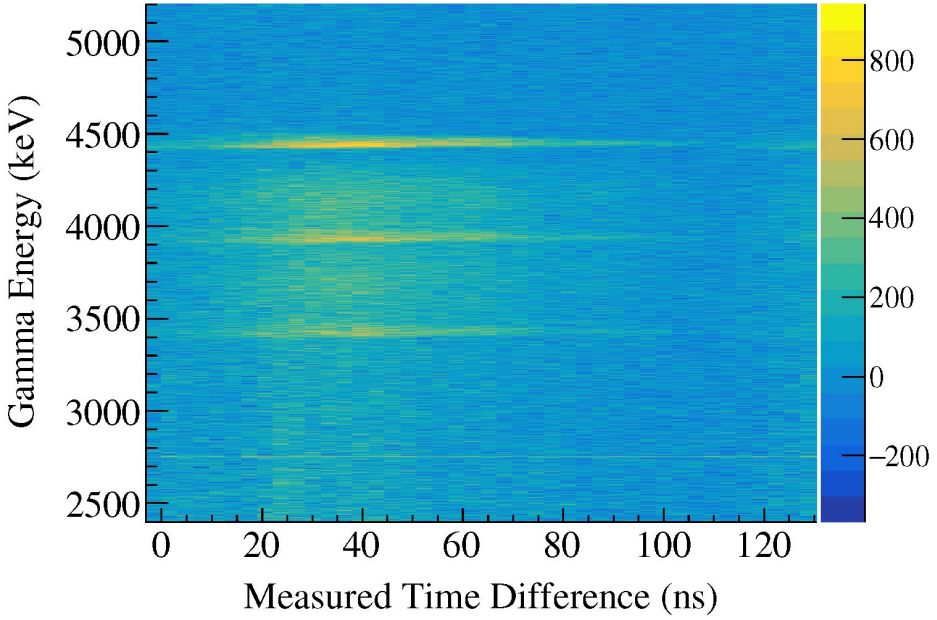


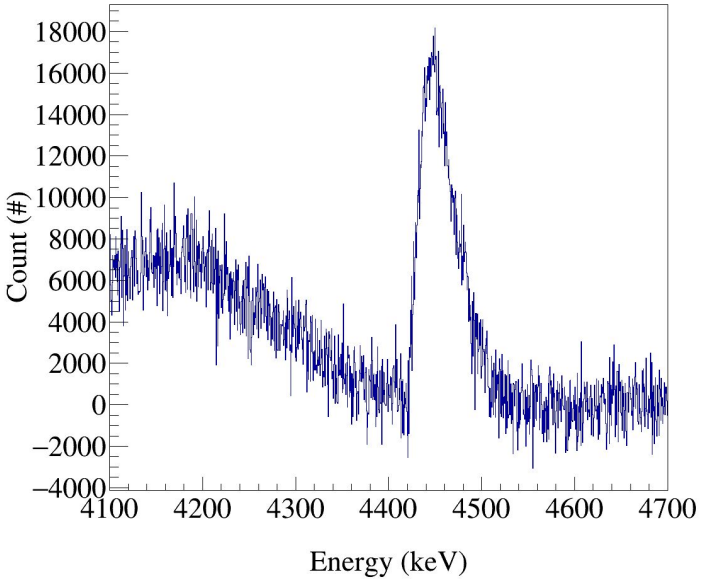


Carbon Analysis









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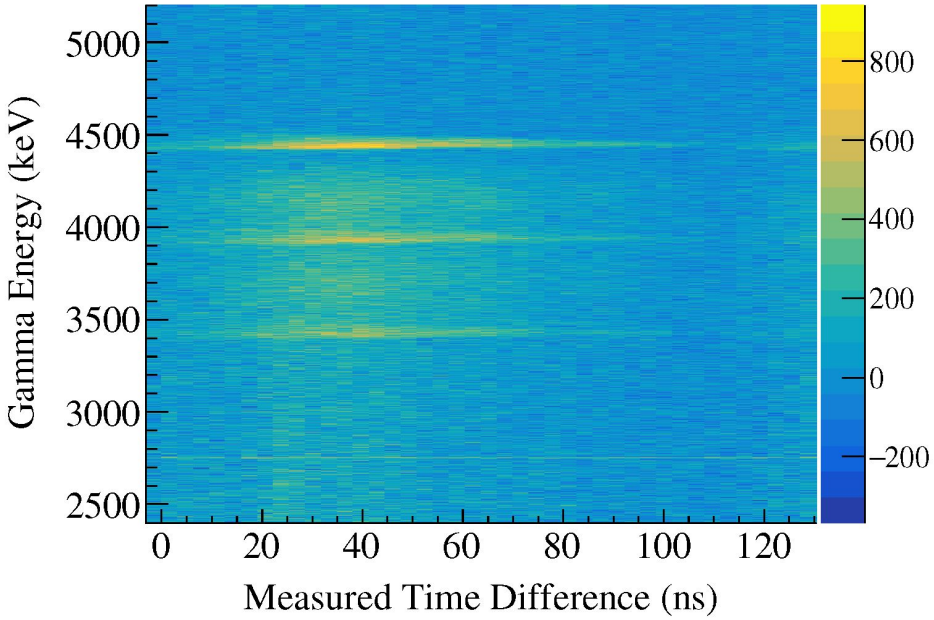
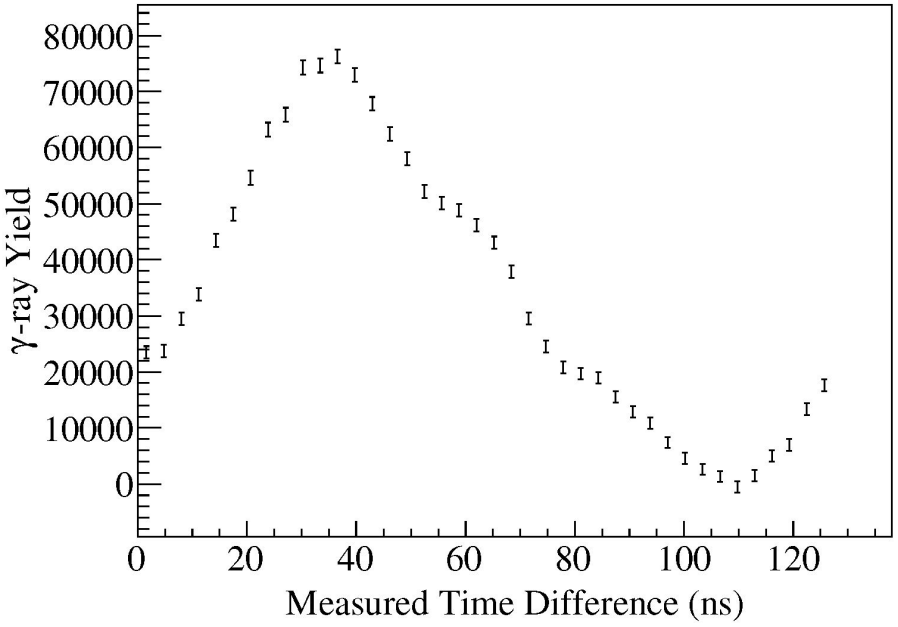
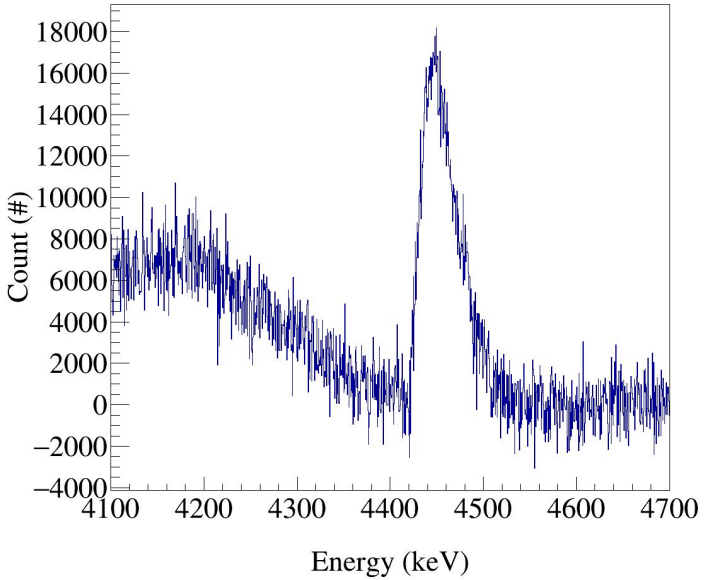
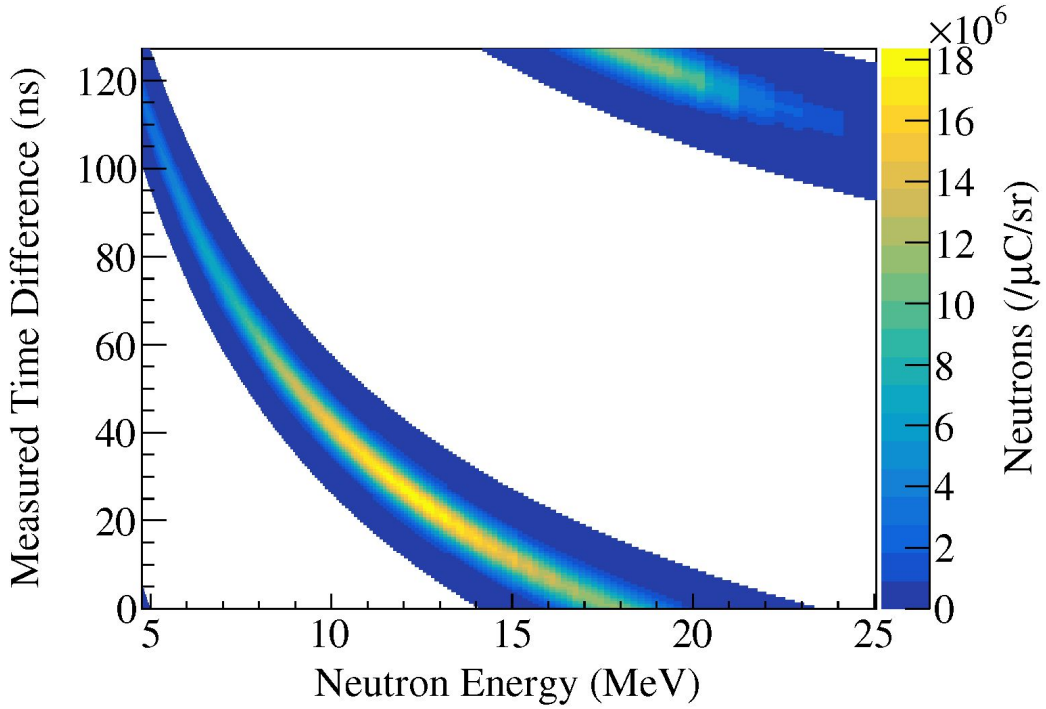


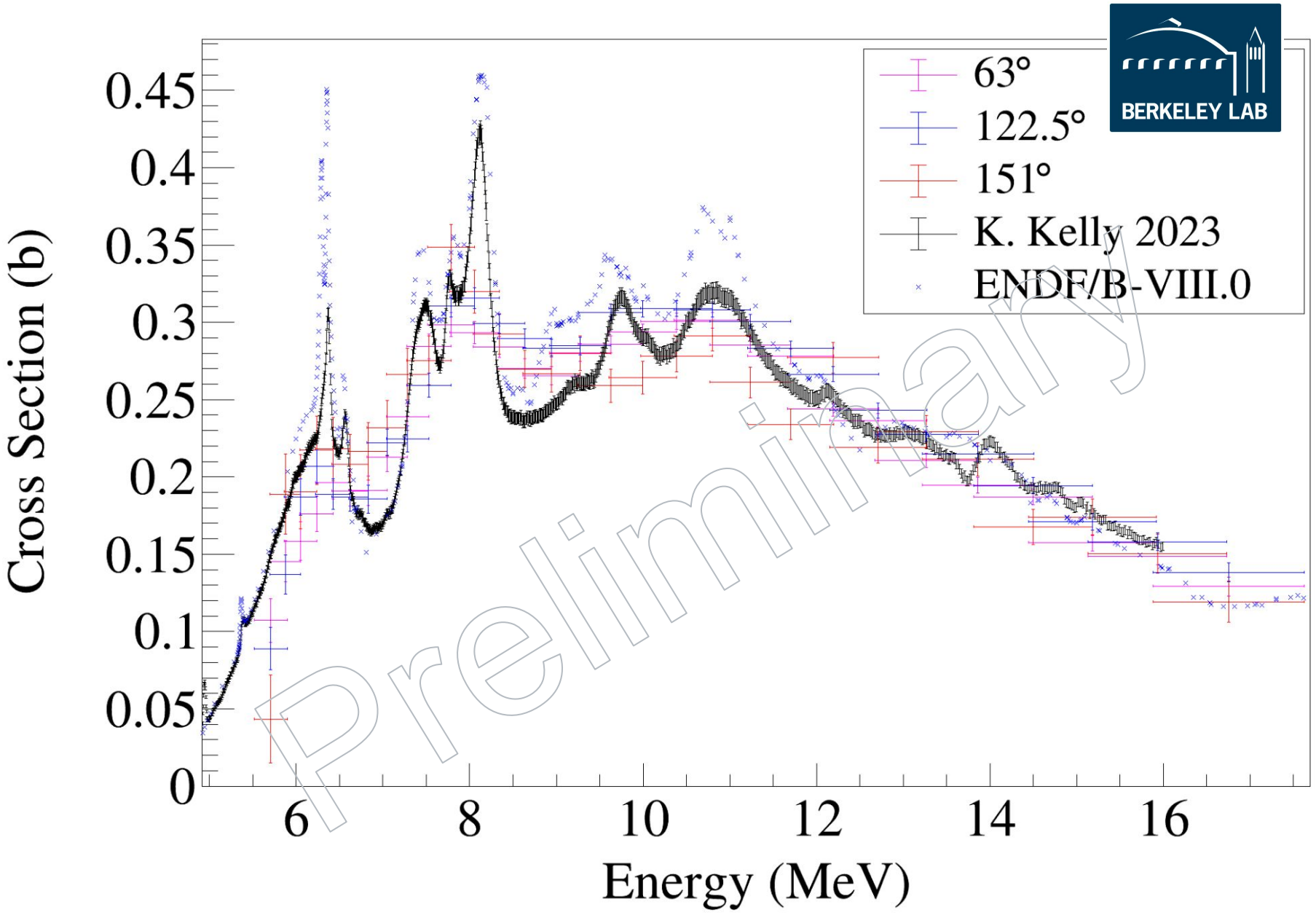






Carbon Results

- Absolutely normalized results
- Agree well with shape from K. Kelly normalized per his recommendation
- Working on covariances
- Working on neutron observables



Accomplishments and Future Work

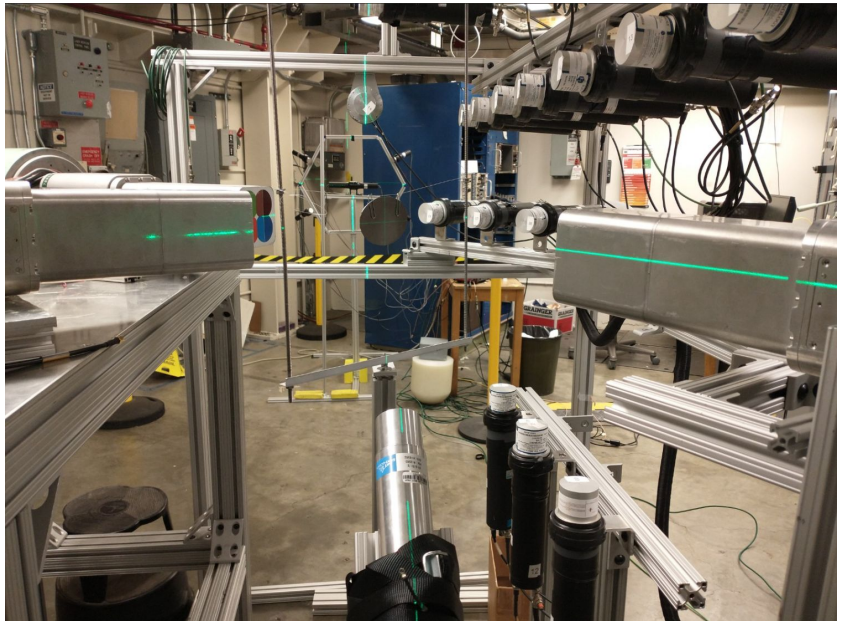
- Publication on Array Characterization

Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment
Volume 1061, April 2024, 169120

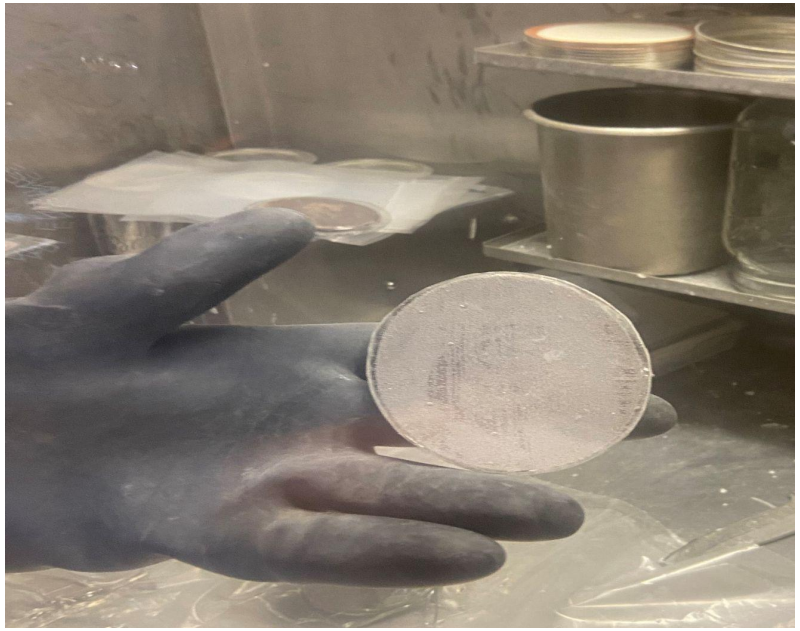
Full Length Article

GENESIS: Gamma Energy Neutron Energy Spectrometer for Inelastic Scattering

J.M. Gordon [a], J.C. Batchelder [a], L.A. Bernstein [a b], D.L. Bleuel [c], C.A. Brand [a c], J.A. Brown [a], B.L. Goldblum [a b], B.G. Frandsen [d], T.A. Laplace [a], T. Nagel [a]

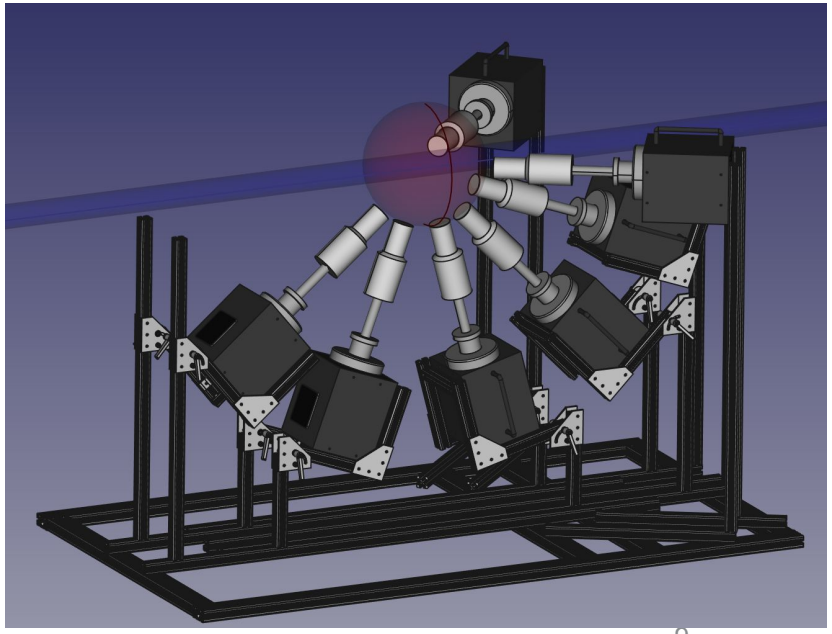


- Conducted an experiment with a natural carbon target
  - Preliminary gamma results
  - Neutron results in progress



- Array Expansion
  - 7 new HPGe detectors

- Plan for metallic Na target
  - Calendared end of March



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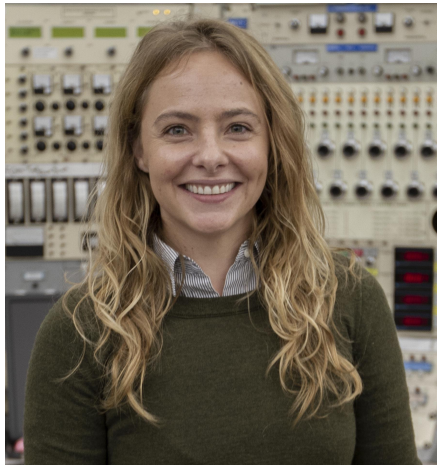

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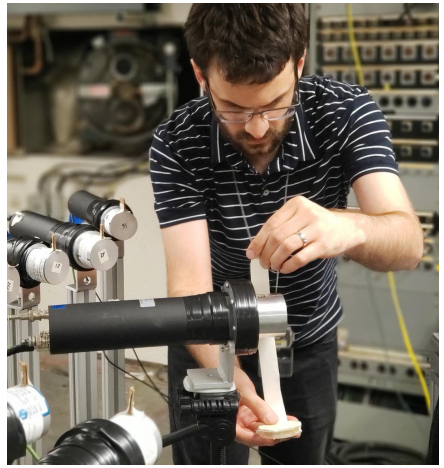
PhD Nuclear Physicist with 25+ years experience in experimental nuclear physics

Josh Brown
Tech Lead, UC Berkeley

PhD Nuclear Engineer and lead architect of the GENESIS array



Thibault Laplace
Res. Engr, UC Berkeley

PhD Nuclear Engineer with expertise in nuclear reactions and neutron detection

Joseph Gordon
Postdoc, UC Berkeley

PhD Nuclear Engineer Thesis work focused on establishing the GENESIS array

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