GENESIS Measurement of Delayed-Neutron Emission from Actinide Targets

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Nuclear Science & Security Consortium

The State of βn Nuclear Data

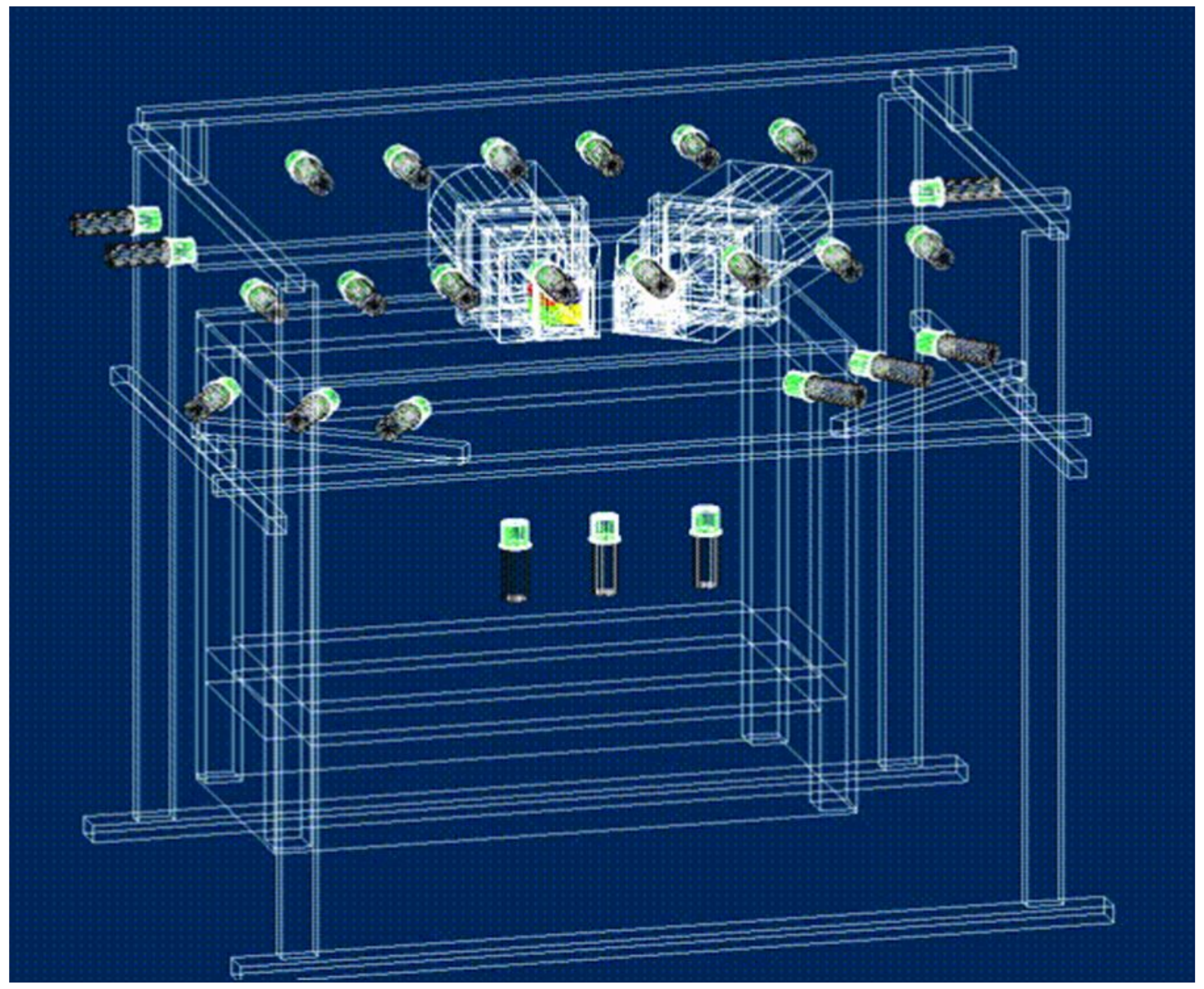
- There is sparse data for fission product yields (FPY) of fast neutrons on U-238. [2,5,6]
- There exists significantly less nuclear data on beta-delayed neutron branching ratios and half-lives, and where there is; it is highly discrepant. [3]
- There are few measurements for FPY with half-lives of around 250ms. [1,4]
- There exists a large gap in the data for beta-delayed neutron emitters in the quarter-second half-life regime and thus serves as a strong thesis topic to prepare Awedisean for a lifelong career in national security.
- There is a need for improved beta-delayed neutron data for a wide range of application including:
  - reactor decay heat,
  - advanced reactor design
  - anti-neutrino spectral calculations for reactors,
  - r-process nucleosynthesis, and
  - nuclear structure physics. [7]

Yield Optimization Regression

- Awedisean's current focus is on maximizing beta-delayed production yield while optimizing beam-time in order to obtain high peak-to-background ratios
- To do so, the following modeling tools will be used:
  - FIER
  - MCNP
  - GEANT-4
- A regression on numerous FIER inputs will be used with a range of irradiation and counting times.
- The numerous FIER outputs will be input to a GEANT-4 model.

GENESIS Detector Array

- Dr. Joshua Brown developed and deployed GENESIS (**G**amma **E**nergy **N**eutron **E**nergy **S**pectrometer for **I**nelastic **S**cattering) and is comprised of up to 28 liquid scintillators that allow neutron and gamma pulse shape discrimination.
- Neutrons are produced via deuteron breakup at the 88-Inch Cyclotron at LBNL and then collimated into Cave 5 where GENESIS resides.
- Cave 5 is ideal as low beam currents are used in conjunction with a neutron-absorbing beamstop to reduce contaminants from other experiments.
- The concrete walls far from the detector setup in Cave 5 also decreases neutron background from scatter off the concrete.
- The neutron flux is characterized using a separate neutron time-of-flight flux monitor.



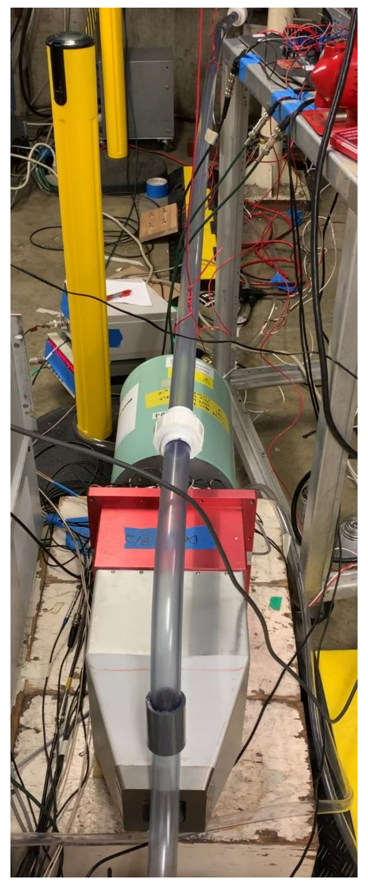
- Joseph Gordon has replicated the GENESIS setup in GEANT-4 that will serve as a final modeling-and-simulation step.
- The GEANT simulation will give more-realistic detector responses as a function of fission data.
- A "best case" will emerge and serve as the computational underpinning to run beam at the 88 and get experimental data this coming up this summer.
- GENESIS also uses an in-beam irradiation scheme eliminating the need for transporting actinide samples thus allowing the detection of short lived fission products
- The neutron and high-resolution gamma-ray spectrometry capabilities of GENESIS at LBNL serves as the ideal tool for active interrogation data studies.

FIER

- The FIER (**F**ission **I**nduced **E**lectromagnetic **R**esponse) code is a Bateman solver written by Dr. Eric Matthews to analytically predict delayed gamma-ray spectra following fission.
- This code base has been extended to include delayed neutrons in the calculation.
- FIER is used in the Pu-239 data analysis and will also be critical to Awedisean's thesis experiment.

FLUFFY

- The **F**ast **L**oading **U**ser **F**acility for **F**ission **Y**ields is a pneumatic transport system that allows for the measurement of short-lived fission product yields (with half-lives <1s) if an actinide sample is loaded in the capsule
- The ~1s transport time serves as a limiting factor that GENESIS will address.



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