Consortium
Nuclear Science & Security
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There exists significantly less nuclear data on advanced reactor design
There are few measurements for FPY with reactor decay heat,
There is sparse data for fission product yields
There is a need for improved beta-delayed
There exists a large gap in the data for nuclear structure physics. \[7\]

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.

The State of $\beta n$ 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.

• Dr. Joshua Brown developed and deployed GENESIS (Gamma Energy Neutron Energy Spectrometer for Inelastic Scattering) 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.

• The FIER (Fission Induced Electromagnetic Response) 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
FLUFFY
The Fast Loading User Facility for Fission Yields 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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