Considerations for Centrality Analysis

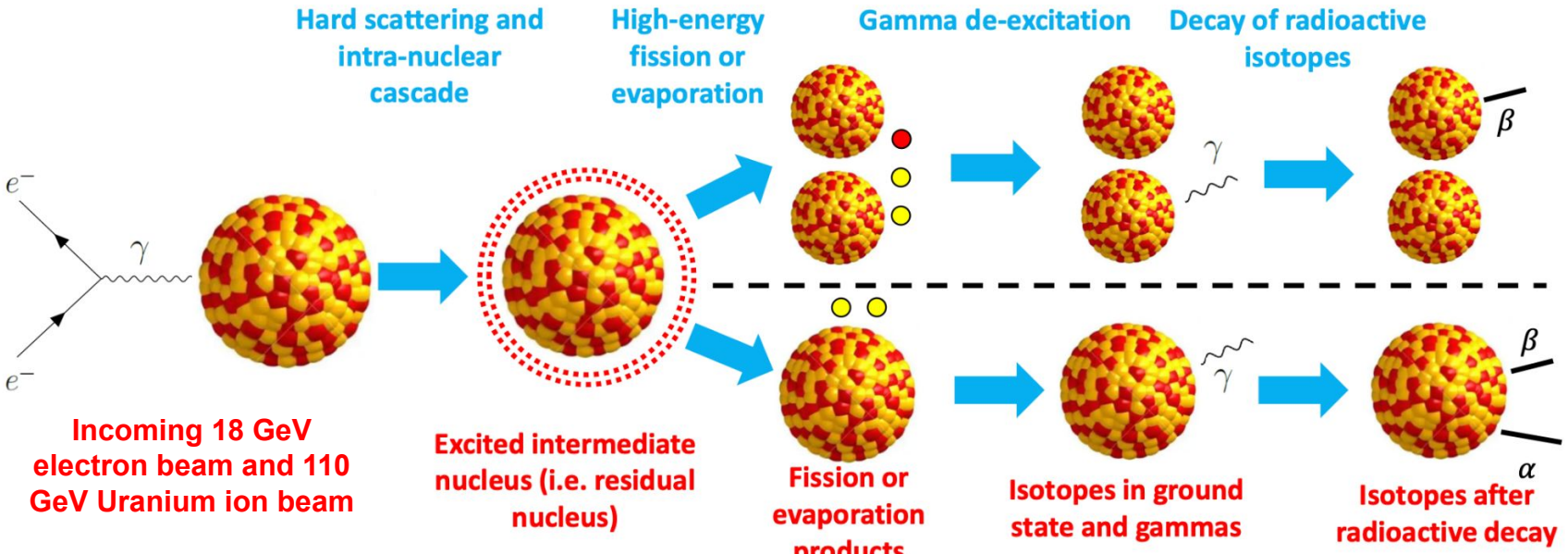
Chase Owen

Motivation For Study

- In electron-nucleus collision, possible for electrons to scatter from more than one nucleon in the nucleus
    - Number of participants in collision studied using centrality classes, determined by forward neutron production
- Used BeAGLE event generator to study effectiveness of ZDC for defining experimentally useful centrality classes
- Focus will be reconstruction of event energies and defining centrality classification limitations

Made by Barak S

Nuclear fragment production at the EIC



Simulation Information

- Used BeAGLE event generator, developed for EIC related physics
- Consists of several components:
  - Pythia 6 to model initial scattering process
  - DPMJet describes intranuclear cascade/fragment formation
  - FLUKA and ABLA07 simulate decay of excited pre-fragments
- Collisions simulated with 18 GeV electron beam and 110 GeV Uranium beam.

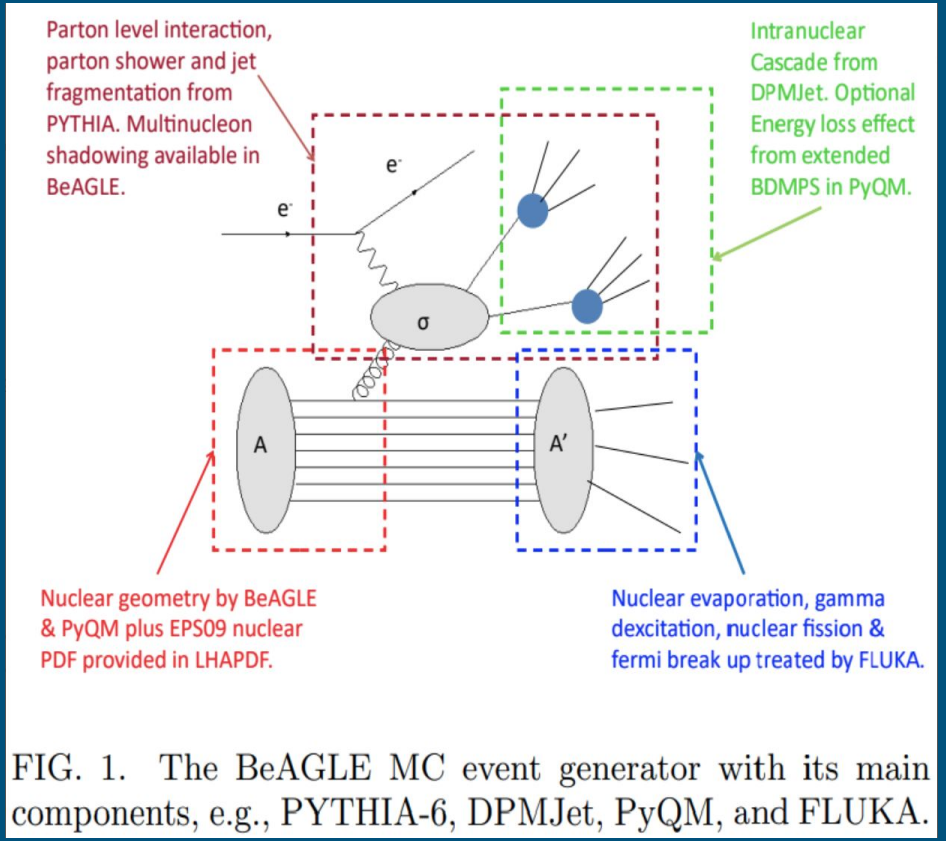
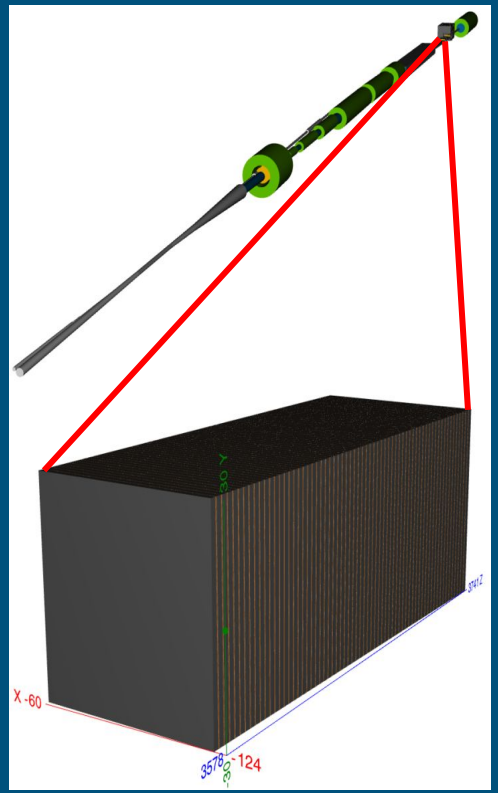
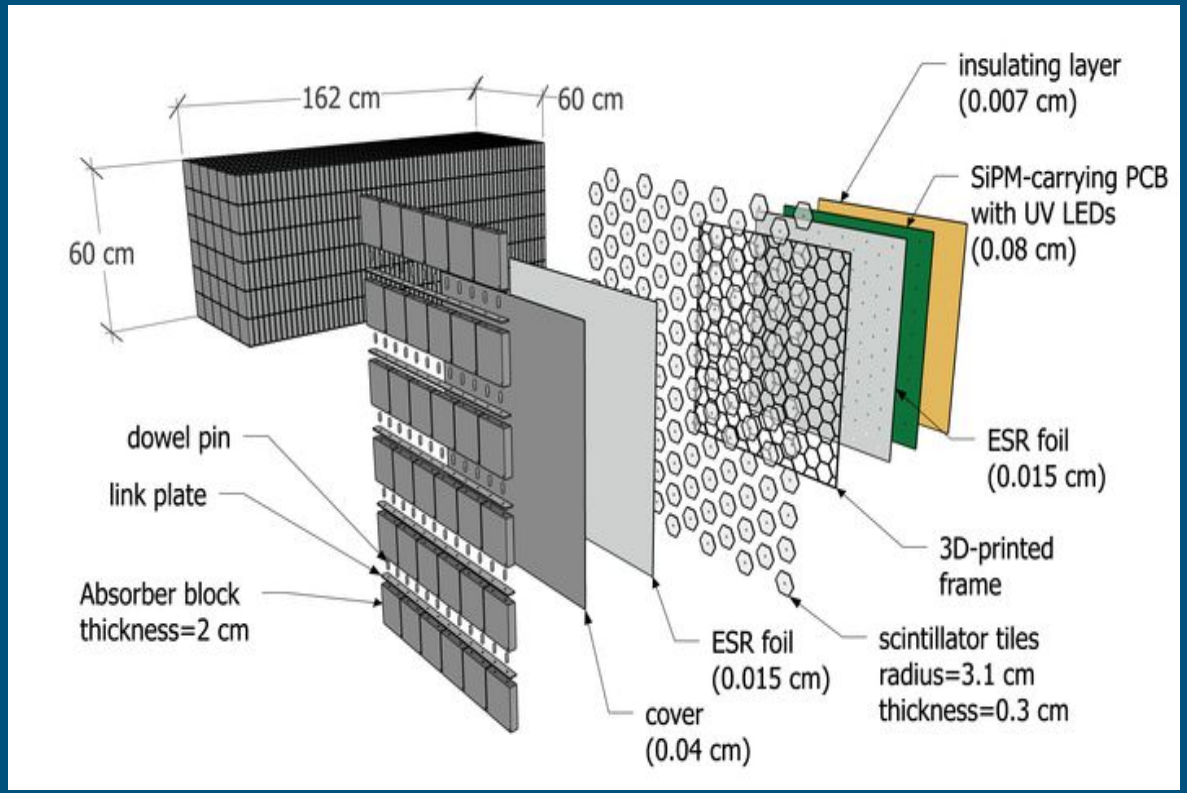


FIG. 1. The BeAGLE MC event generator with its main components, e.g., PYTHIA-6, DPMJet, PyQM, and FLUKA.

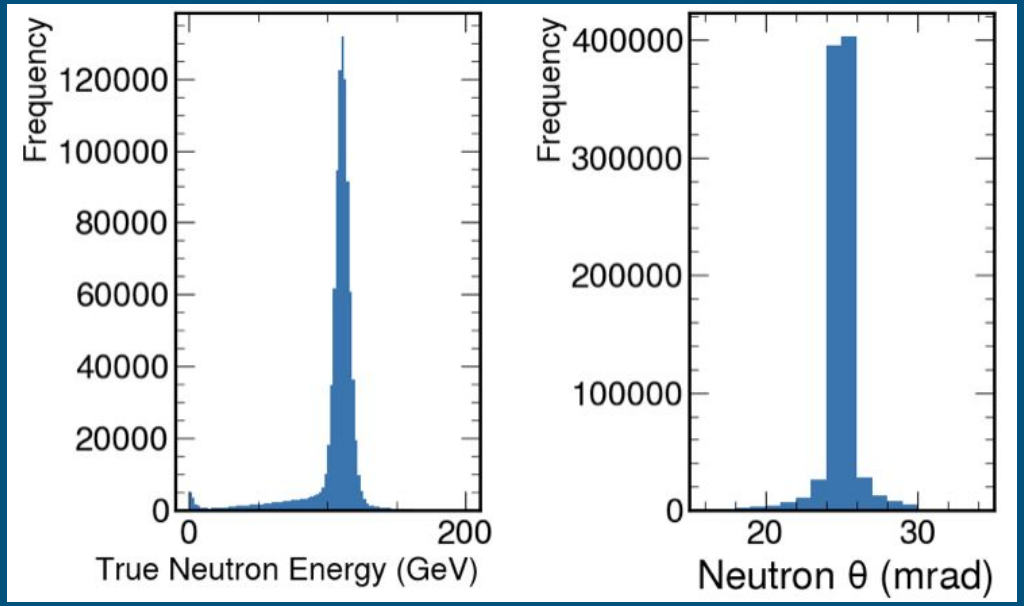
Figure from: https://arxiv.org/pdf/2204.11998

Simulated Far Forward Region (Not including LYSO ECal)



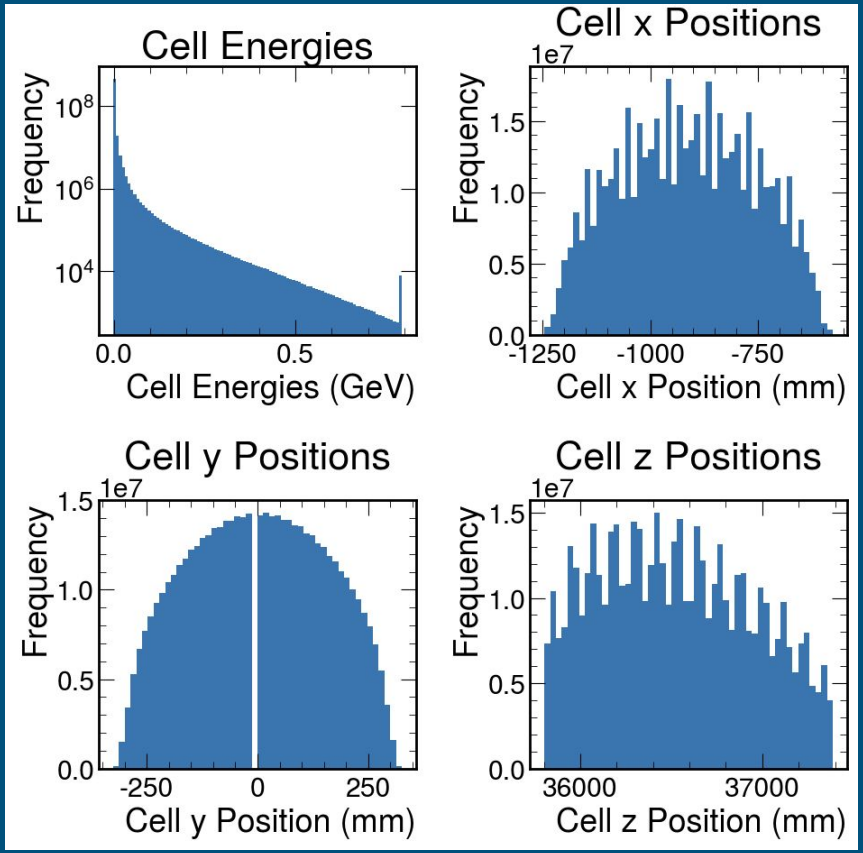


Truth Level Neutron Kinematics



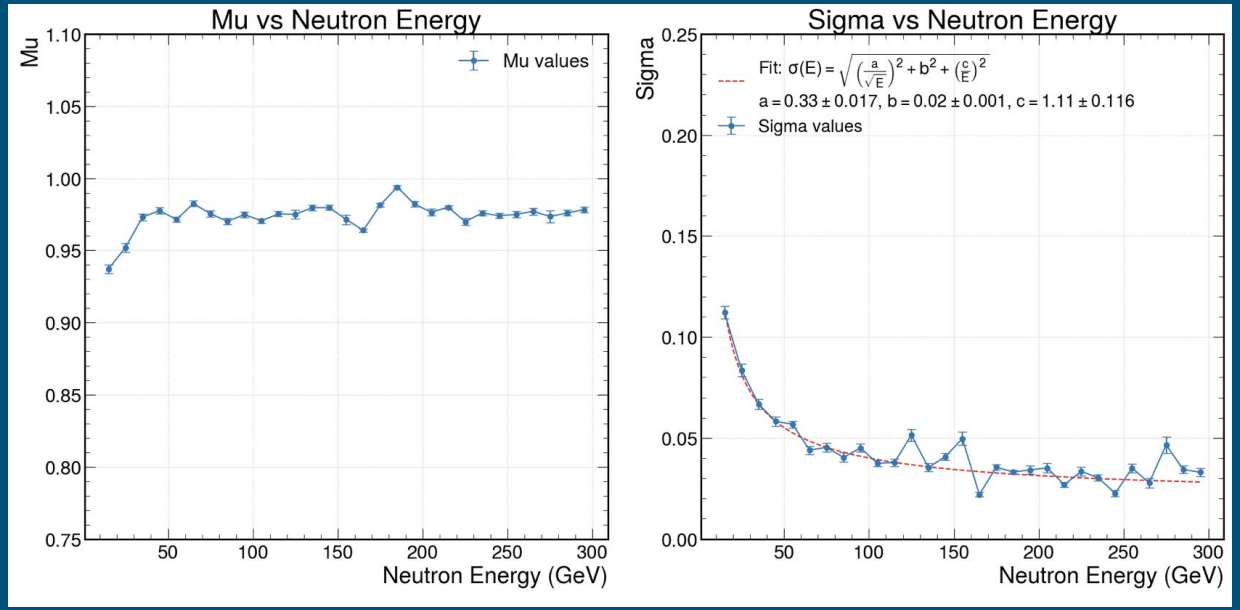
- Most neutron energies are around 110 GeV
- Incident angle is around 25 milliradians (Result of crossing angle)

Reconstructing ZDC Energies



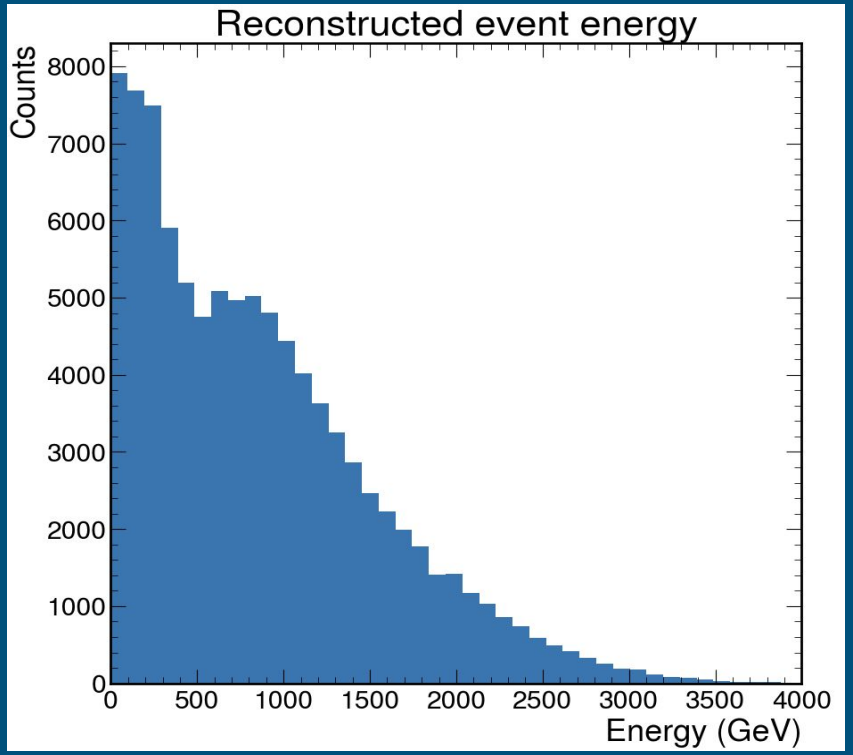
- ZDC meant to measure neutron energy in far forward region
- Computes ZDC energy by summing individual calorimeter cells

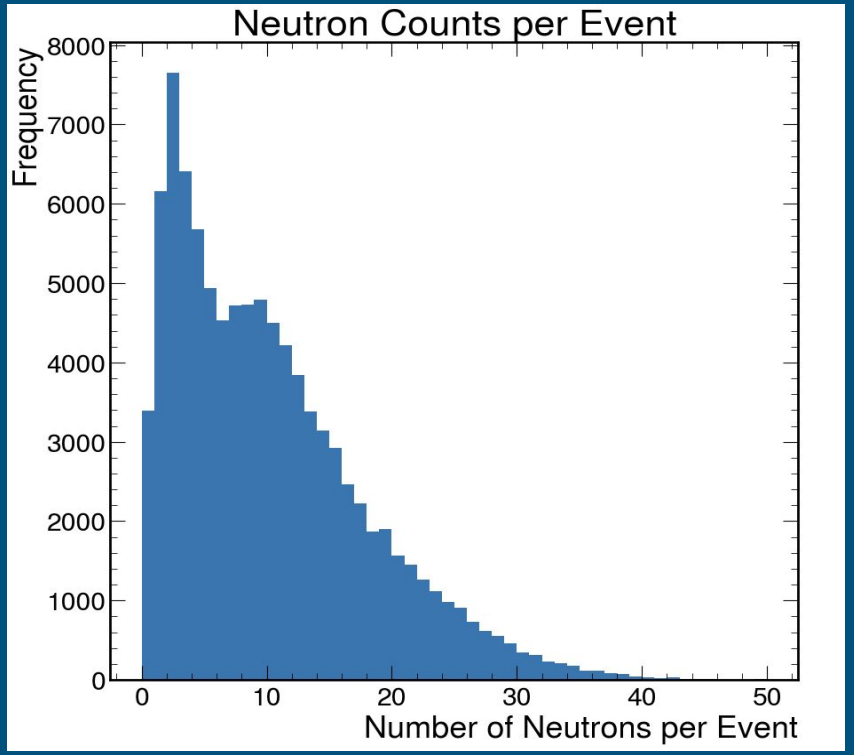
Single Neutron Response (See Mia's presentation for more info)



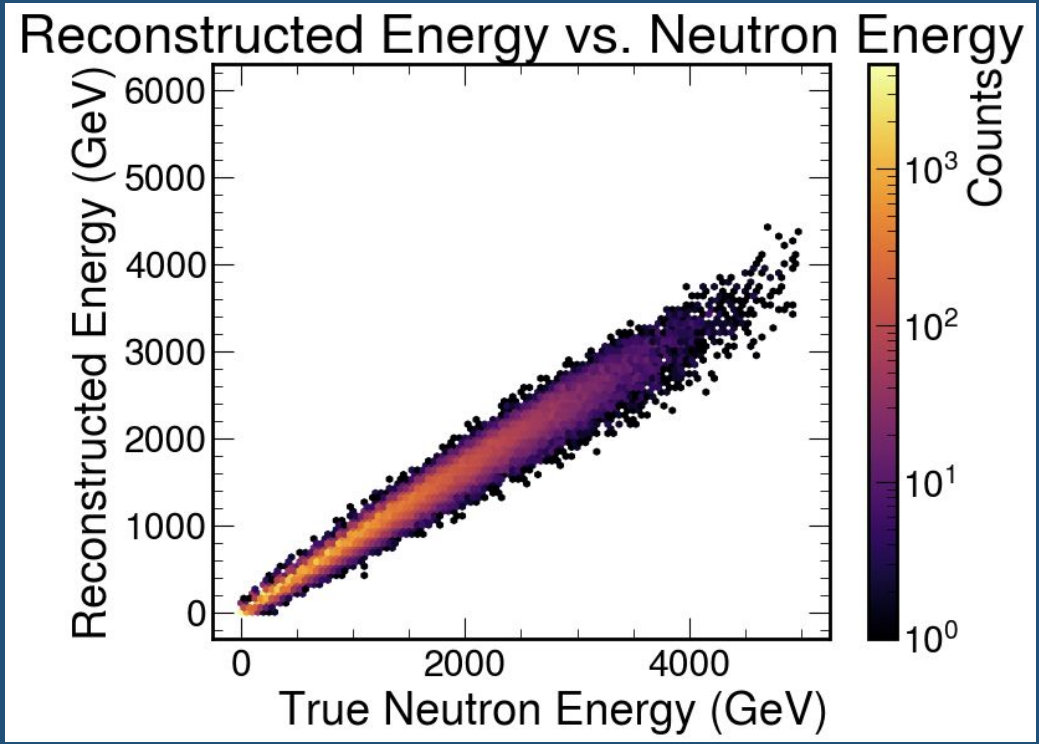
- Mean and Sigma values given by fitting over Reconstructed/True energy
- The single neutron reconstruction is quite precise
    - These capabilities should help with measuring multiple neutrons

Correspondence Between ZDC Energy and Neutron Multiplicity



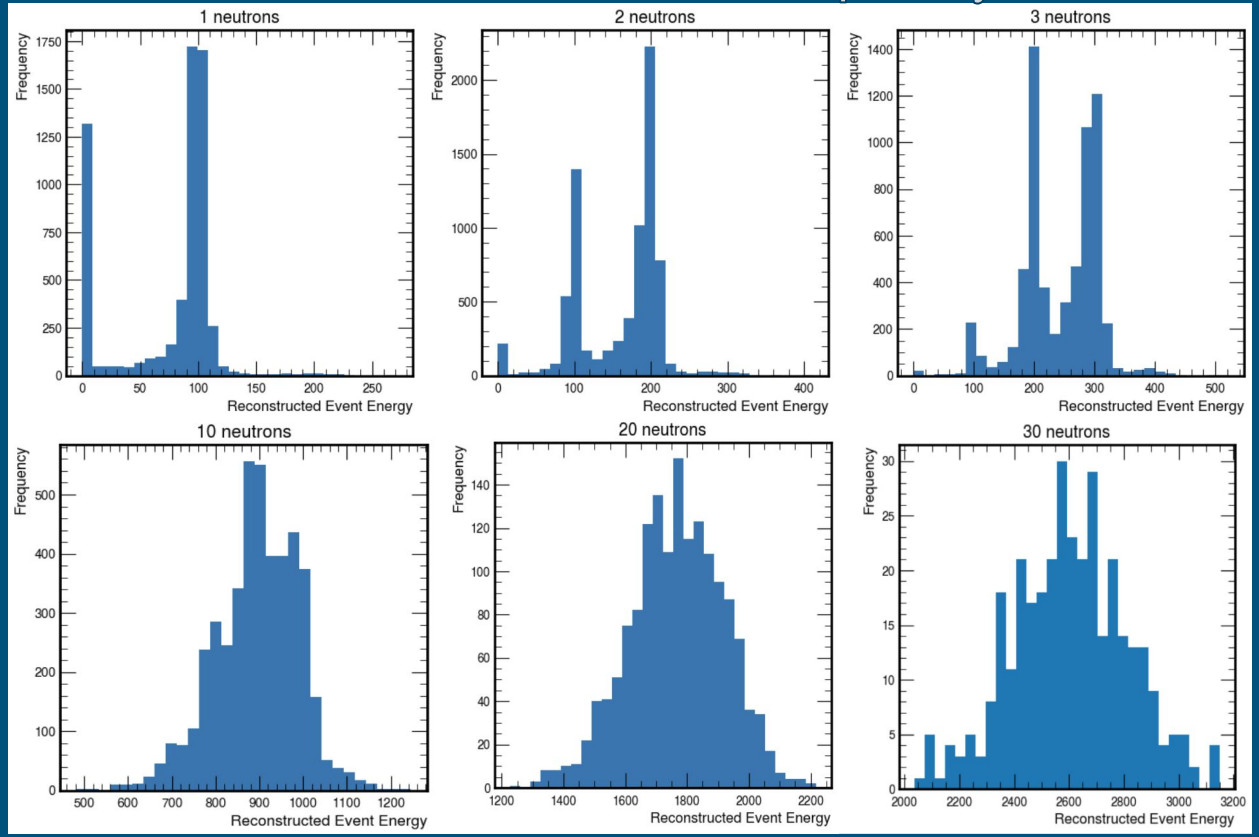


Correspondence Between ZDC Energy and Neutron Multiplicity



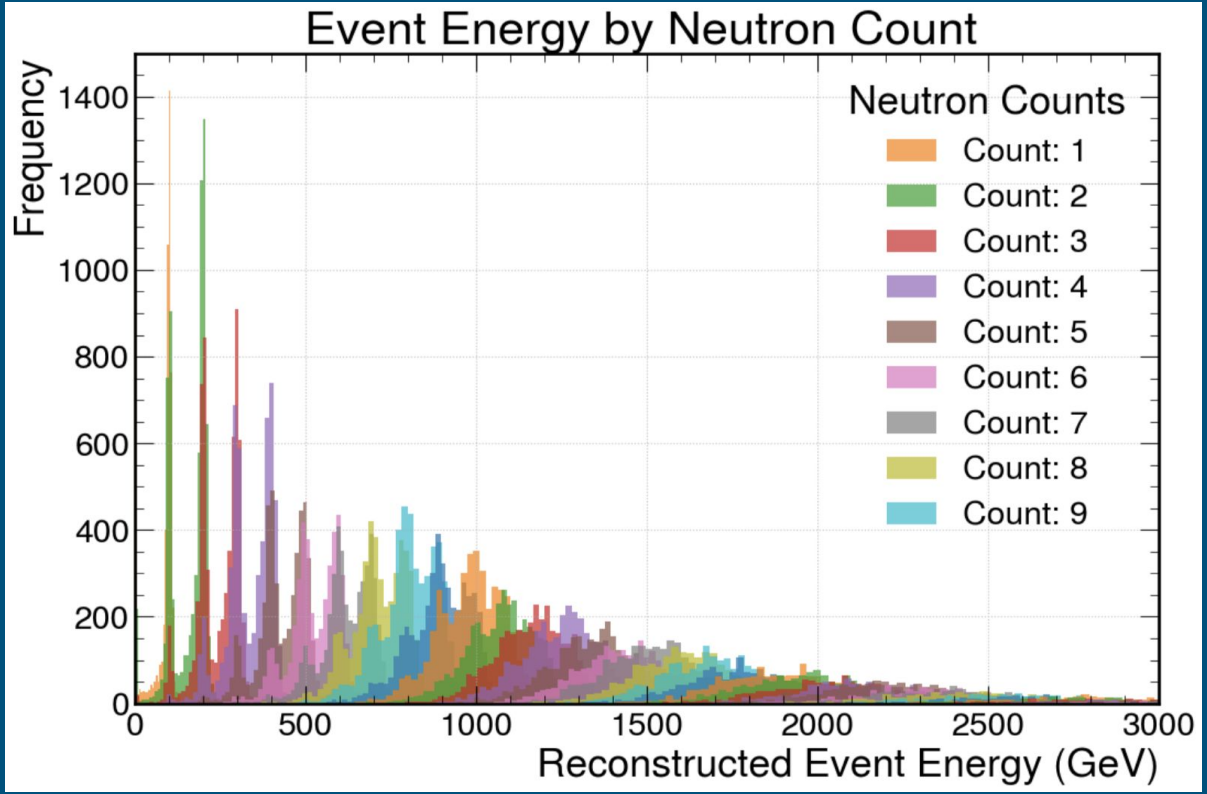
- Linear response is ideal

Reconstructed Neutron Multiplicity Slices



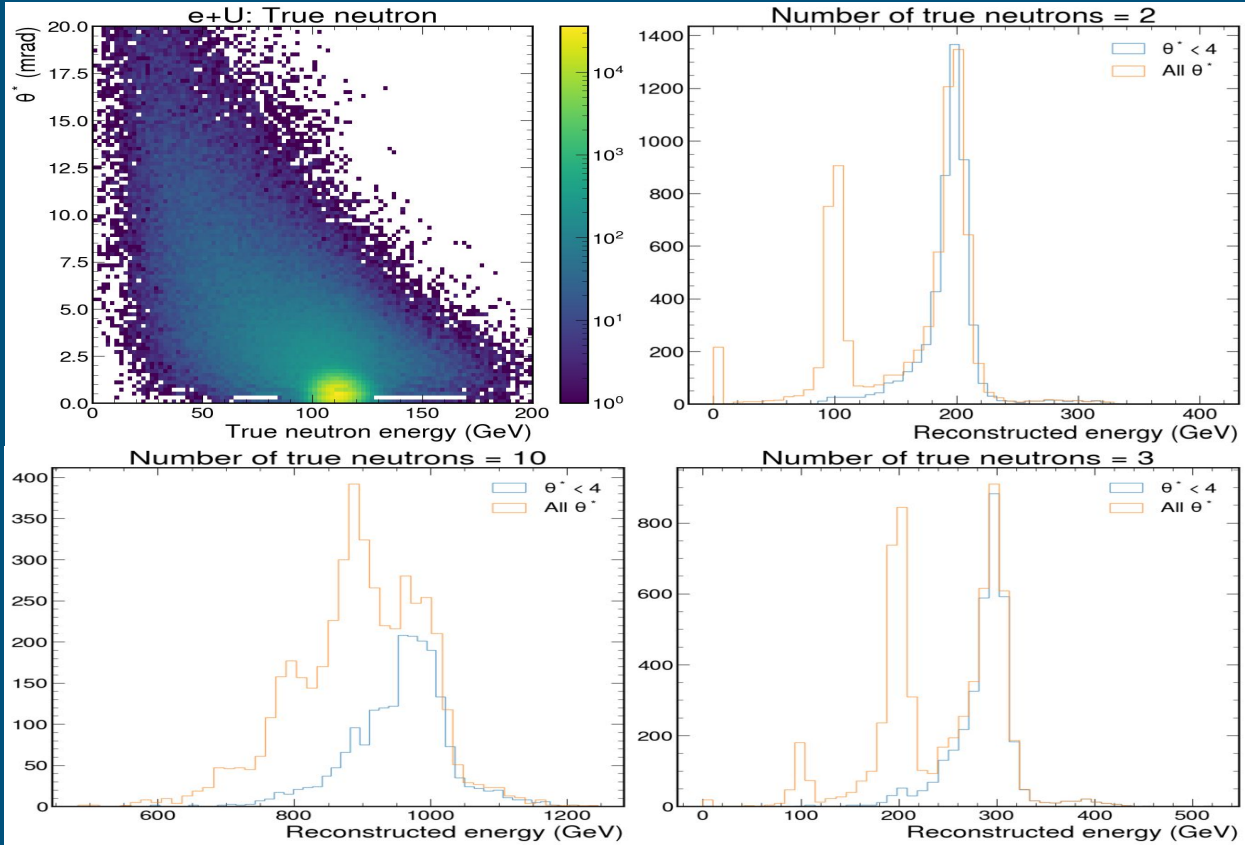
- Lower energies have the double peak
- Higher energies exhibit less bimodal structure.
- Structure unexpected

Neutron Multiplicities



- The sharp peaks for individual neutron multiplicities is ideal
    - Reflects good ZDC energy resolution for single neutrons

ZDC Acceptance



- ZDC has an acceptance up to 4 mrad due to magnets in the far forward region
  - Theta is along the proton axis (ZDC aligned)
- Conclusion: Around 30% neutrons miss ZDC causing bimodal distributions

Conclusion

- The acceptance of the ZDC causes centrality classifications to be challenging, requires larger intervals
- Centrality analyses still possible using ZDC, but effects limit precision
- If 30% of neutrons miss the ZDC, presents challenges for measurements requiring tagging that the struck nucleus did or did not break up