Simulating the Coordinate Detector in the Context of Hall A

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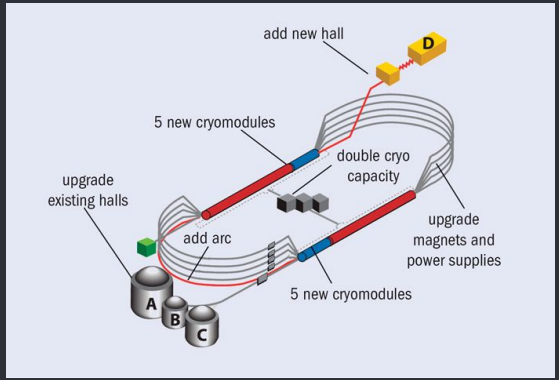
Advised by Dr. Edward Brash

Introduction

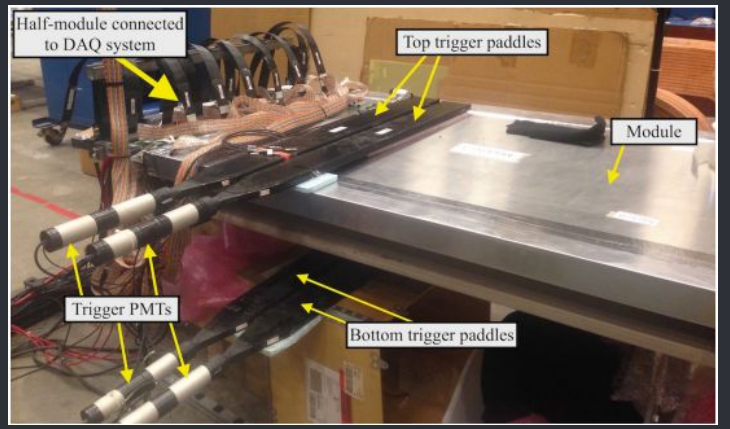
- Barriers to Nuclear Physics progress:
  - Time
  - Energy

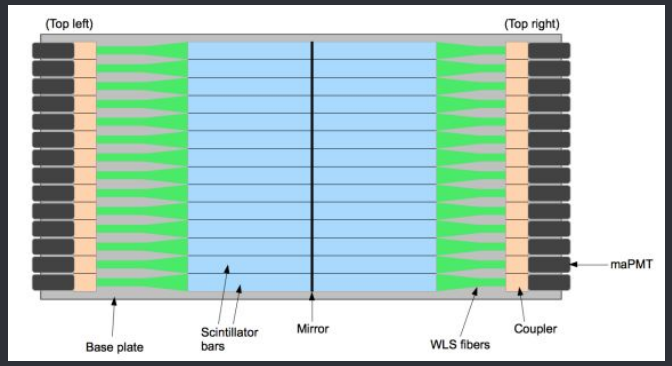


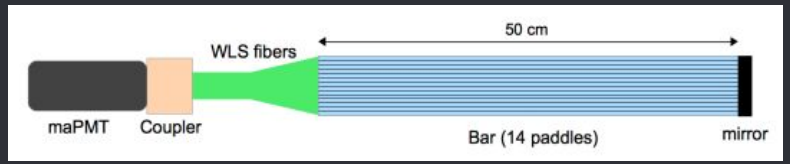
Rigorous approval process ➡ Simulations

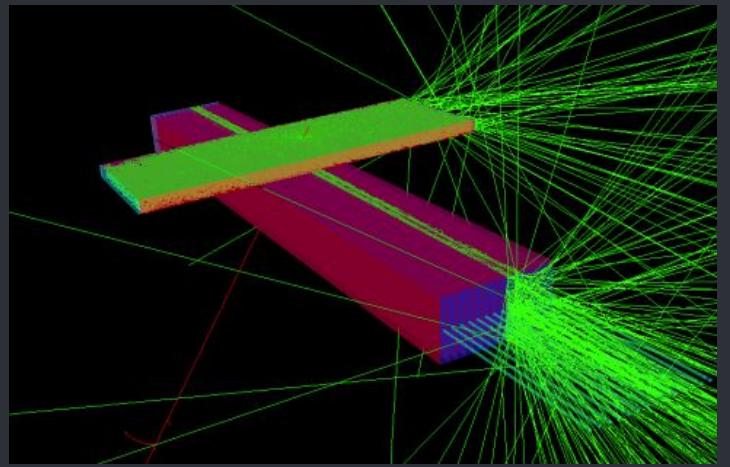
Introduction

- Coordinate Detector (CDet)
- Tracking info or charge veto



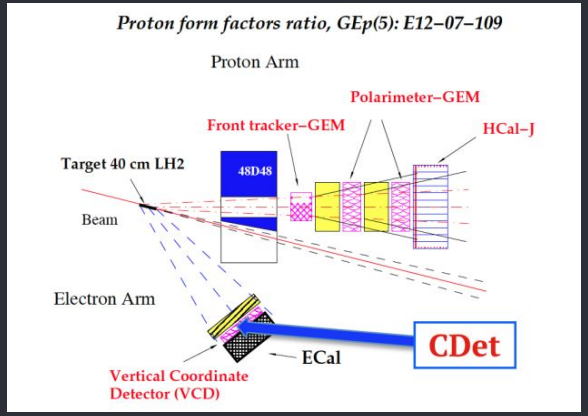


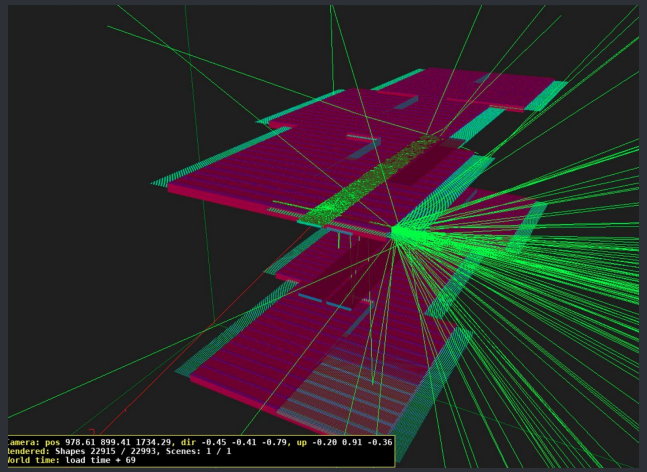




Theory

- Use G4SBS simulation
  - Pass to CDet sim





Simulations use:

- ROOT
- GEANT4

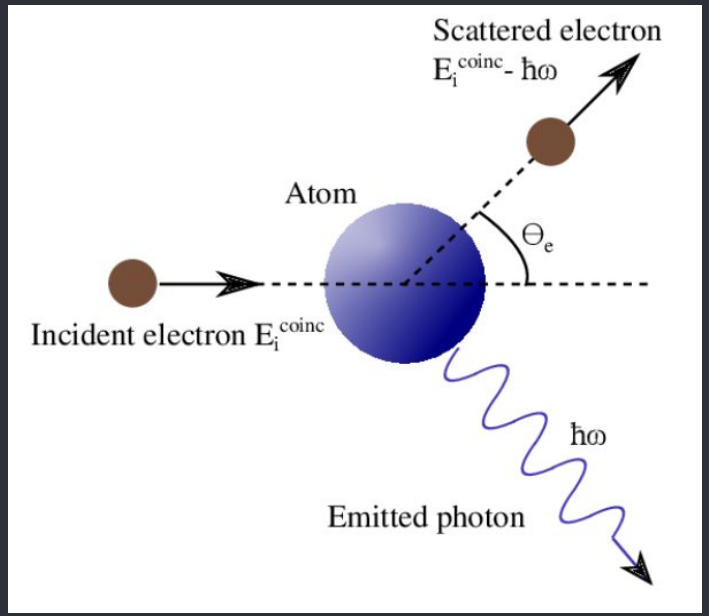
Energy deposited by scattered particle	∝	Scintillation yield	∝	Photon signal at PMT	∝	Photoelectron yield inside PMT	∝	Electronic signal produced by PMT	∝	Final ADC channel

Theory Cont.

- Elastic scattering:

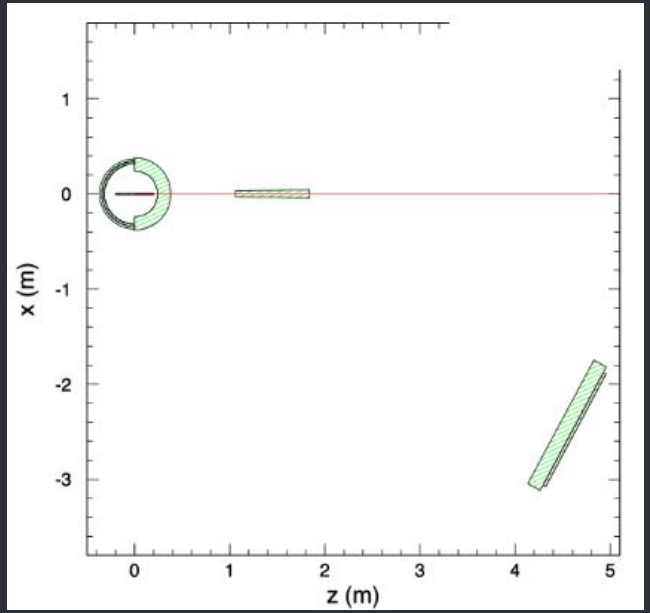
$$\theta_{polar} = \arccos\left(\frac{-x\sin(\theta_0) + z\cos(\theta_0)}{\sqrt{x^2+y^2+z^2}}\right)$$

$$energy = \frac{e_{beam} m_p}{m_p + e_{beam}(1-\cos\theta_{polar})}$$



Use simplified model

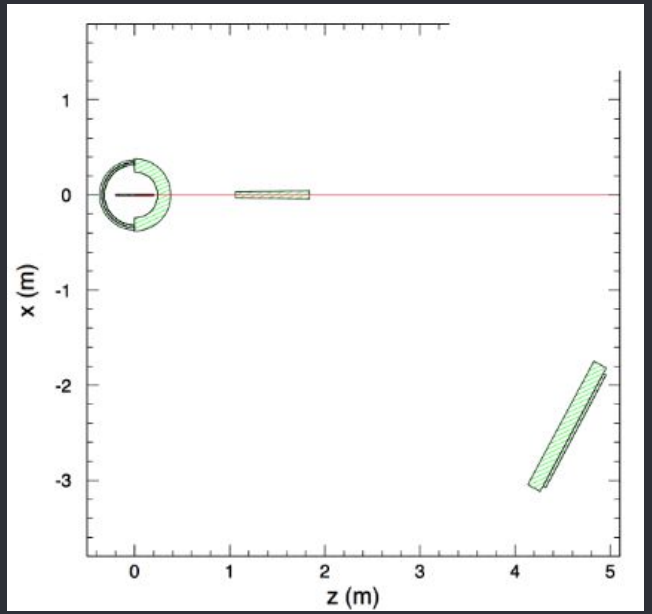
Methods

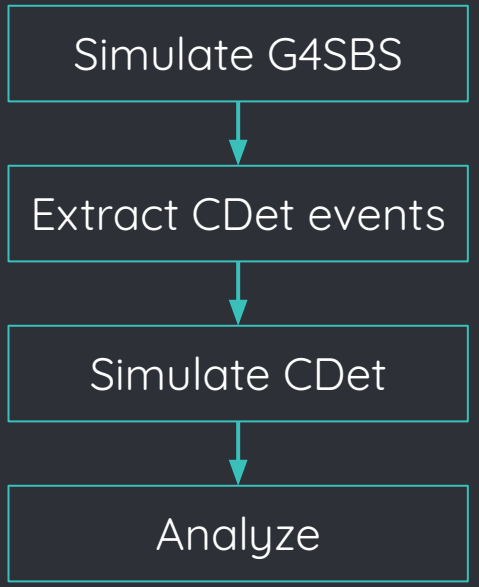


Main Challenge: coordinate transformations

Analysis in Python

Methods

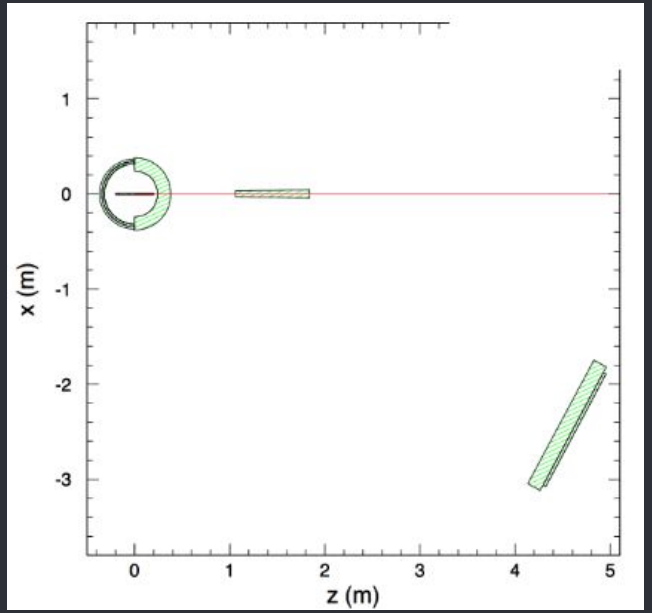


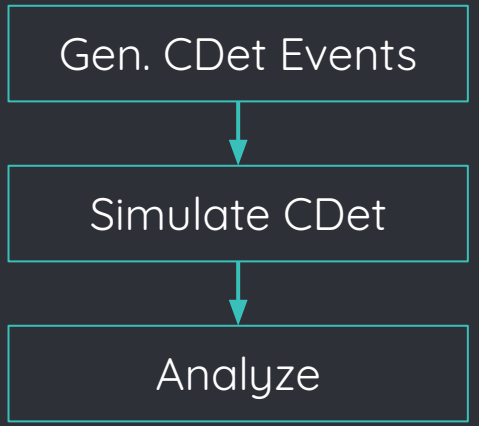


Main Challenge: coordinate transformations

Analysis in Python

Methods



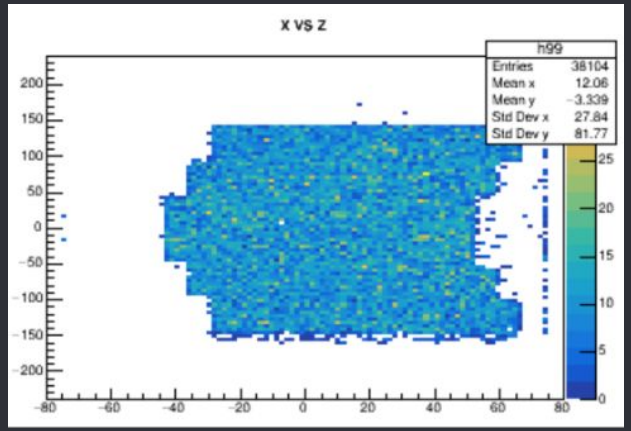


Main Challenge: coordinate transformations

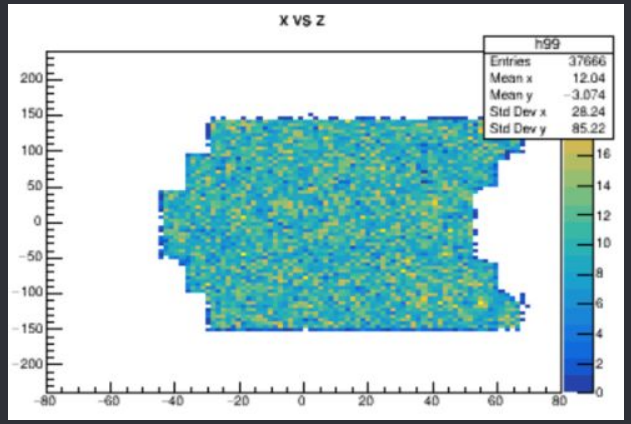
Analysis in Python

Methods

- Choose position
- Calculate angle
- Calculate energy
- Pass events to CDet



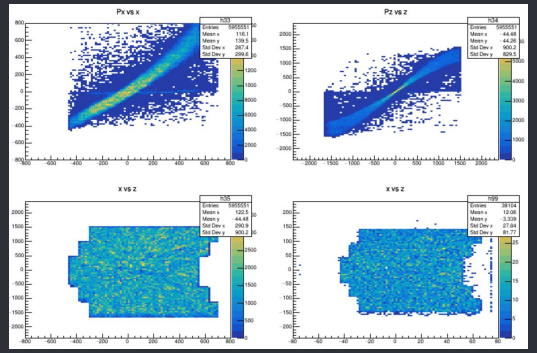
G4SBS

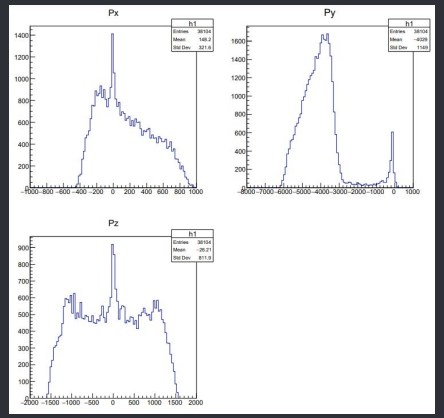


Model

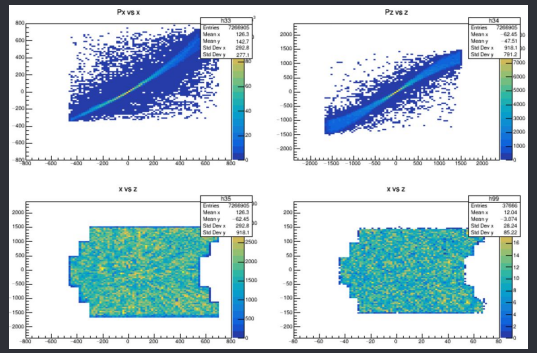
Data

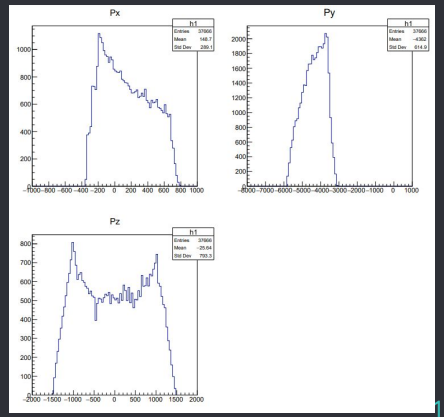
- Data generated from G4SBS generator



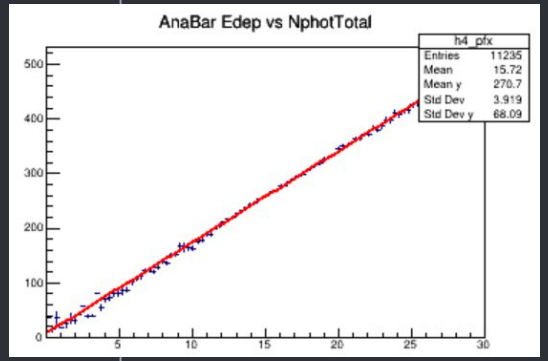


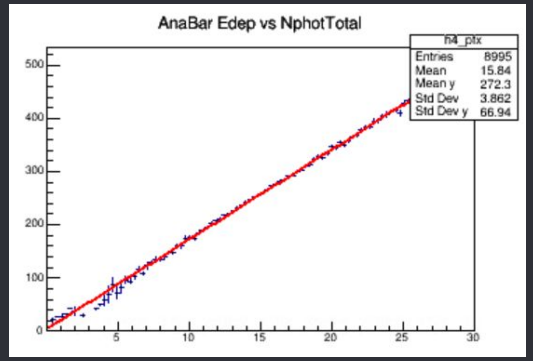
- Data generated from simplified model



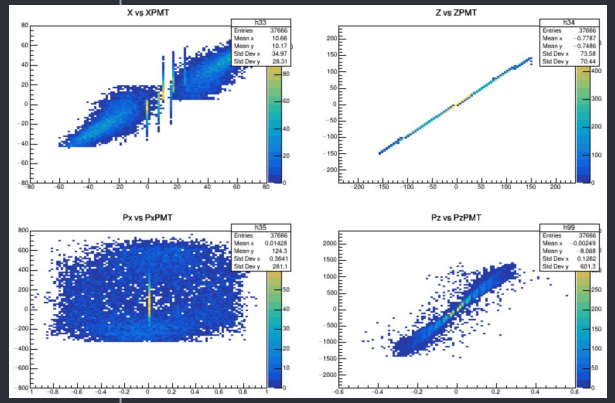


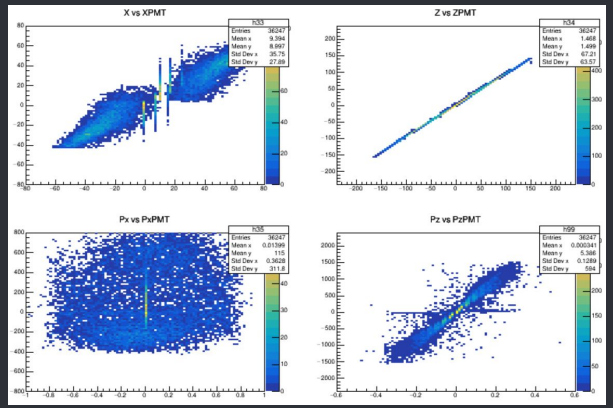
Results and Discussion





	Model	G4SBS
E dep (MeV)	15.72	15.84
# photons	279.7	272.3





Theoretical Model vs G4SBS

References

Brash, E. (2023). “AnaBarMC.” https://github.com/brash99/CDetOptical.

JeffersonLab (2021). “Super bigbite simulation.” https://github.com/JeffersonLab/g4sbs.

Khandaker, M., Jones, M.K., Pentchev, L., Punjabi, V., Sarty, A.,, Wojtsekhowski, B. (2012). “Coordinate Detector Conceptual Design.” Jefferson Lab: SBS Program.

Lorenti, L. (2019). “Calibration and performance studies of the coordinate detector for the super bigbite spectrometer in jefferson lab’s hall a via geant4 simulation and root analysis.” M.S. thesis, Christopher Newport University, Christopher Newport University.

Thank You!

ANY QUESTIONS?