

Geant4 Simulations

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Current Status

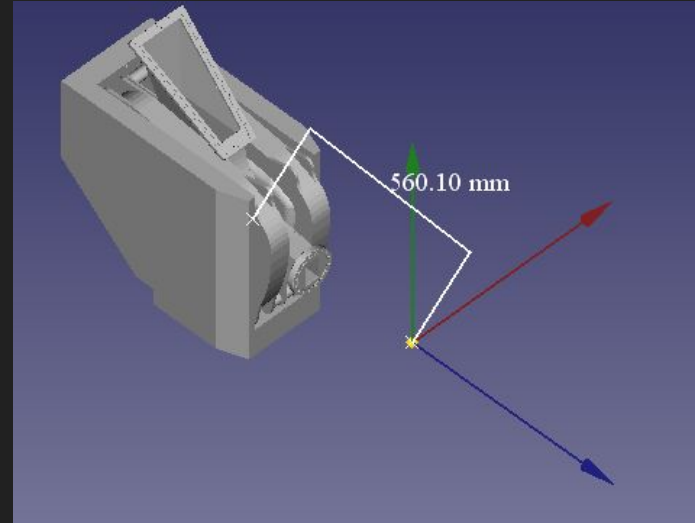
- The current geometry and magnetic field of the spectrometers is implemented.
- A simplified model of the GEMs is being used to collect hit data.
- Background rates are collected from firing 30MeV electrons at a random angle into the window of each spectrometer.

Implementing New Geometries

- Geant4 has a three step process for adding physical objects into the simulation.
 - The object's shape is created using one of several types of shape
 - The shape is placed into a logical volume in which the material is specified
 - The logical volume is placed in a physical volume in which its orientation and location in a mother volume is specified
- The volumes form a hierarchy with the highest level being the world volume.
- Geant4 does not have a built in method for importing complicated CAD objects.
- We rely on Standard Triangle/Tessellation Language (STL) files which break down a CAD object into a set of triangles that define the surface of the object.
- This provides a layer of translation between CAD programs such as SolidWorks and Geant4.

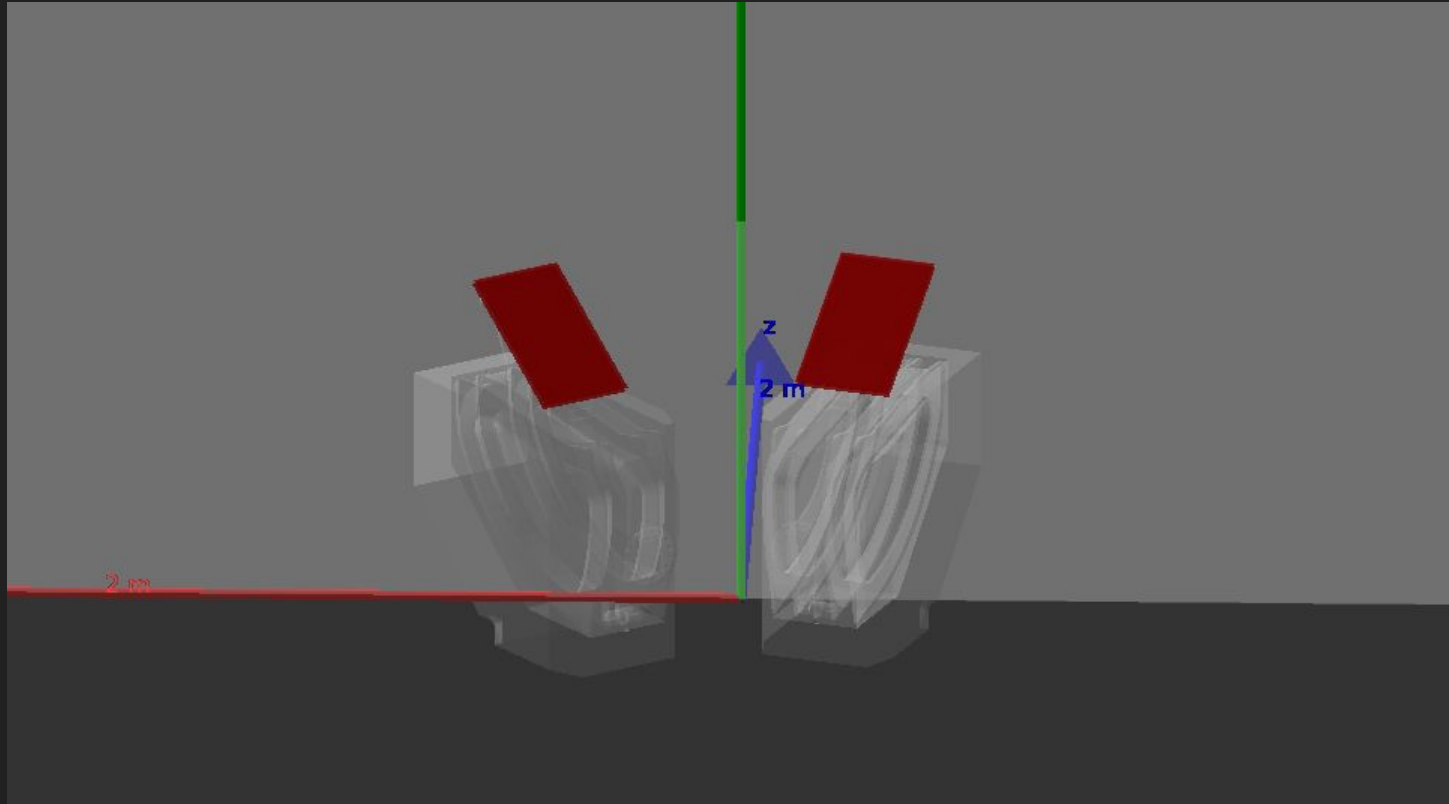
Inputting STL Files into Geant4

- The spectrometer CAD drawing must be separated into individual files based on material.
- Each part is exported as its own STL file and loaded into Geant4 separately.
- Using FreeCAD, the relative locations of the parts was verified to be correct.



> P1	[0.00 0.00 0.00]
> P2	[-125.58 218.95 -500.00]
Distance	560.10 mm

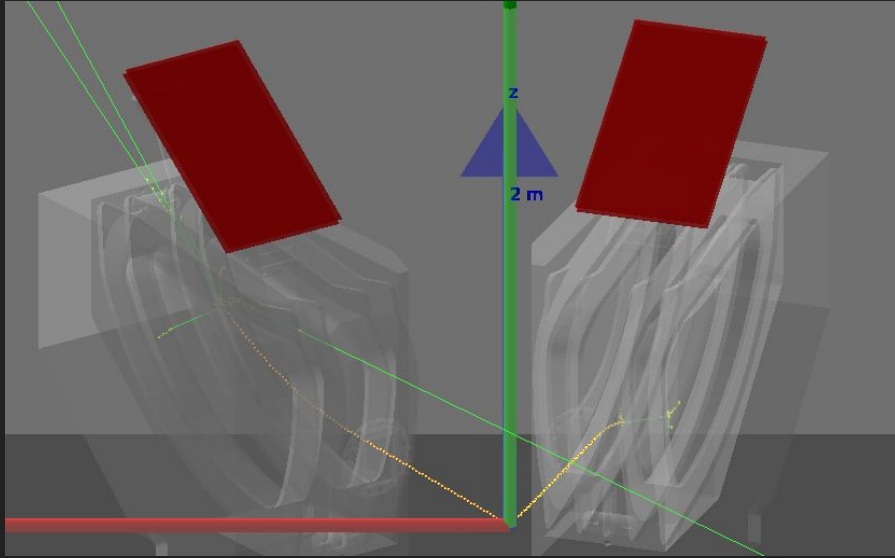
Placement in Geant4



Field Map

- The magnetic field is loaded in from either the plain text field data file provided or a binary file generated from the plain text file.
- The binary file is preferred because it takes significantly less time to load when starting the simulation.
- The field values are tuned for 31MeV electrons and scaled by the appropriate amounts for each spectrometer.
- Interpolation is used to get the field value at a specific point

Single Event with new Geometry and Field



A 30MeV electron is fired into each spectrometer, the same configuration used for the background study.

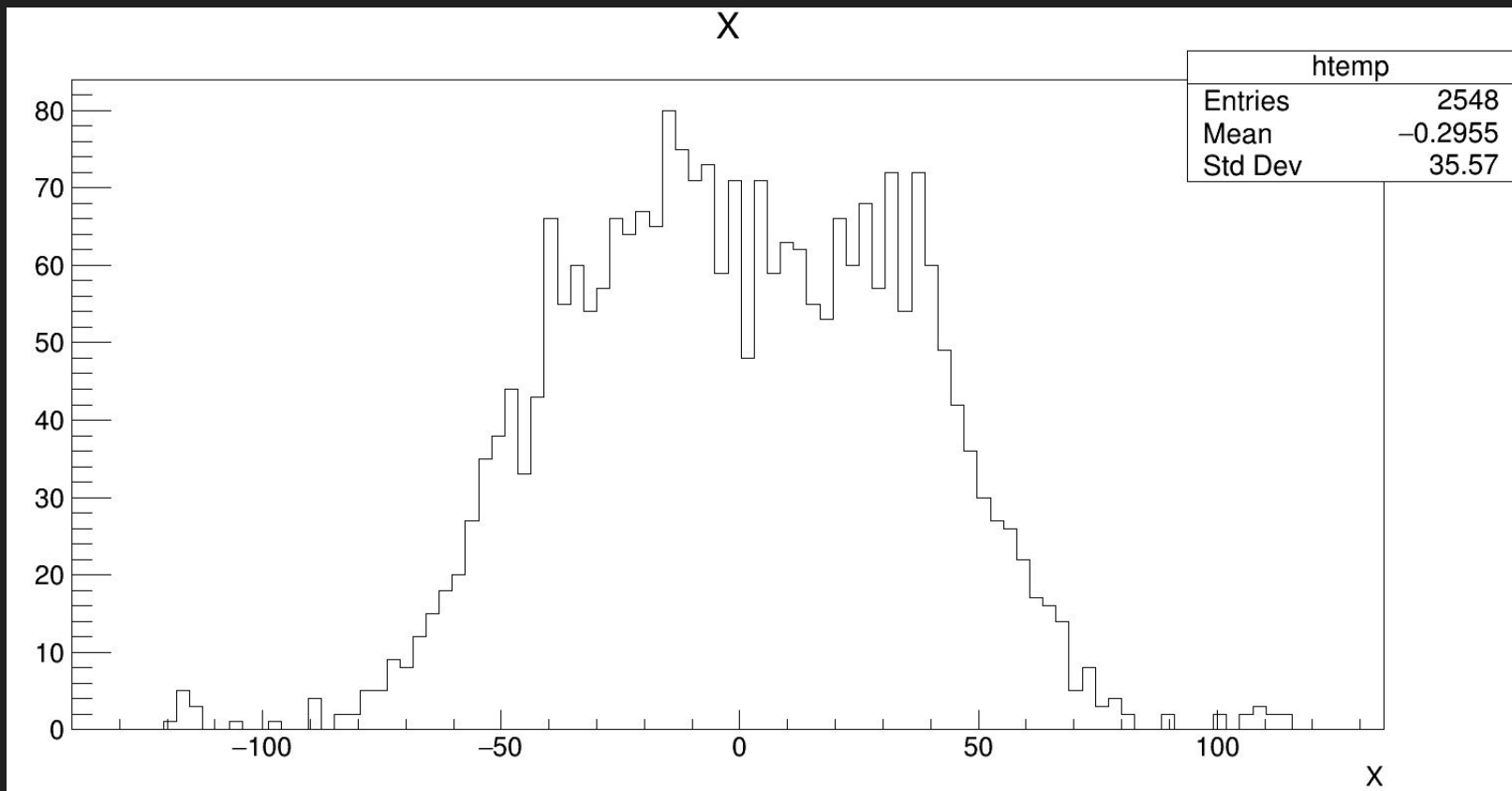
On the electron side, the particle strikes the back of the chamber and scatters.

On the positron side, the particle is directed downwards and strikes the bottom of the chamber.

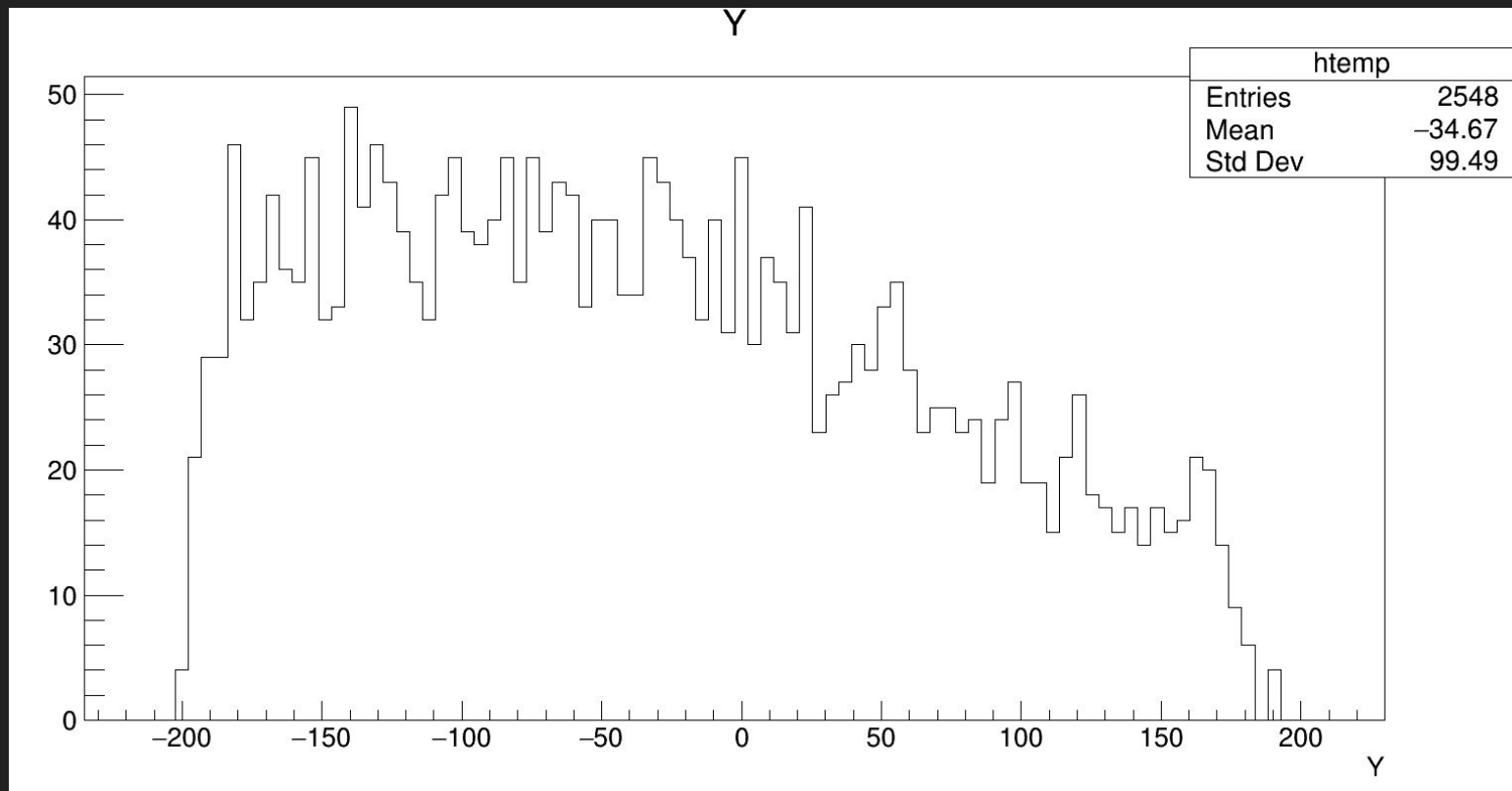
Background Rates

- To measure the background rates with the new geometry and field, 30MeV electrons are fired into the window of each spectrometer.
- The hits are recorded if they strike both sensitive detector planes at the exit of the chamber.
- These planes are placed in the same location as the GEMs and will be replaced later with the actual GEM material and geometry.
- For some events, there are multiple particles which strike both detectors in the same event.

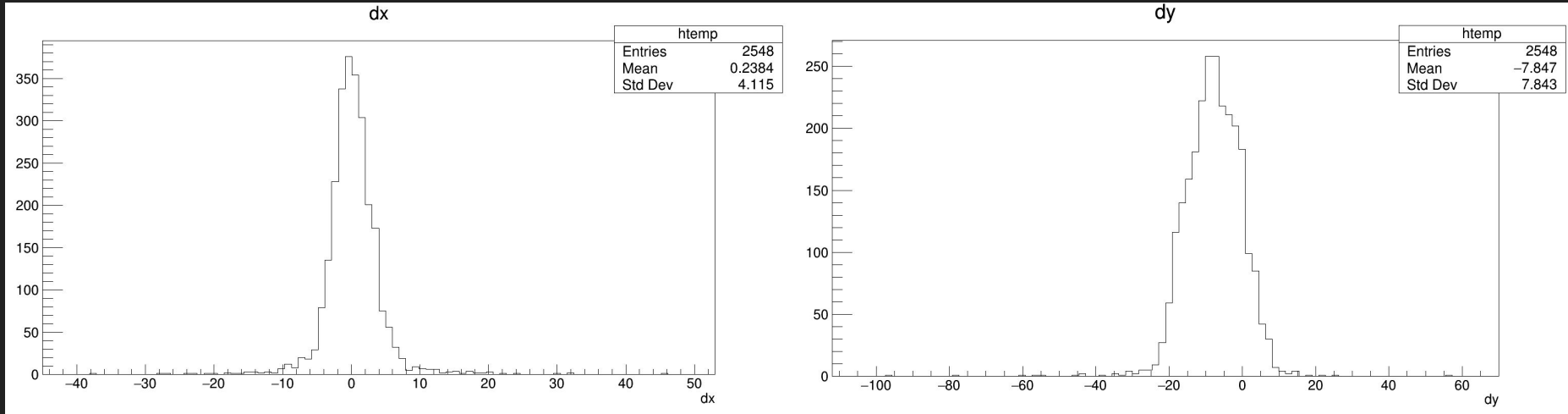
Background Rates (Electron Spectrometer)



Background Rates (Electron Spectrometer)

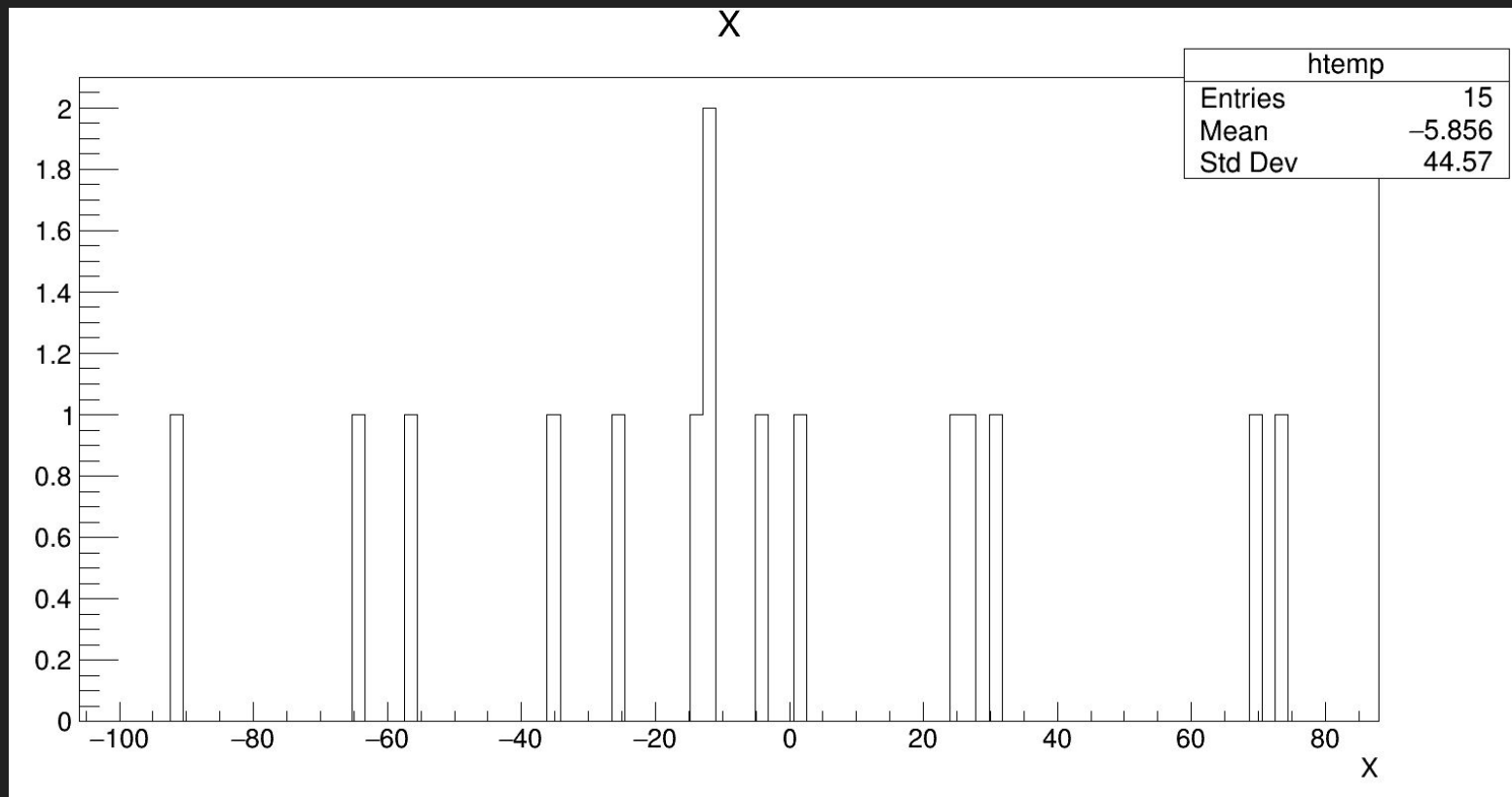


Background Rates (Electron Spectrometer)

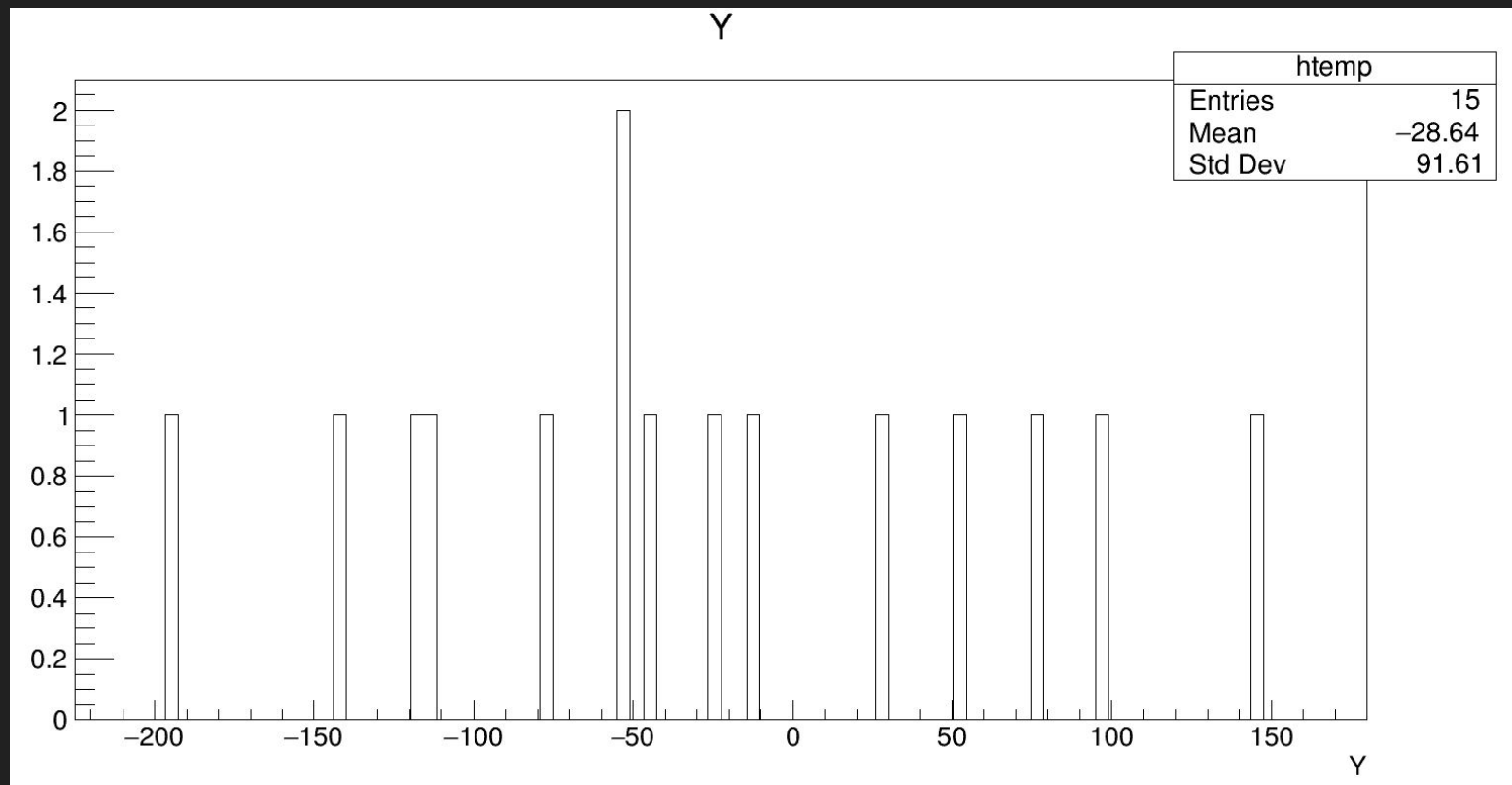


Differences in hit location between each sensitive detector

Background Rates (Positron Spectrometer)



Background Rates (Positron Spectrometer)



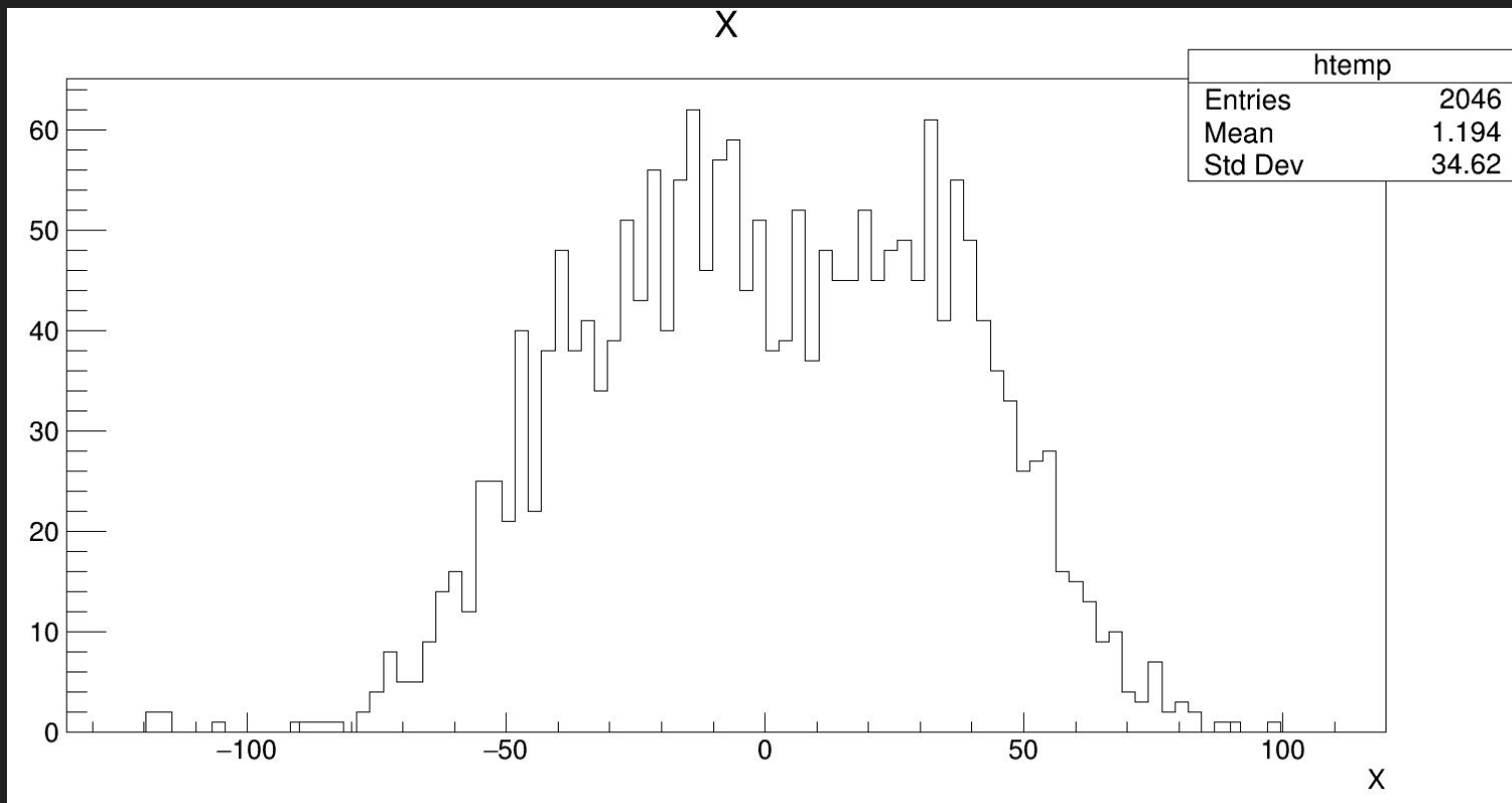
Summary

- For 100,000 events, there were 2548 hits on the electron side and 15 hits on the positron side.
- There were 57 events in which multiple particles were in the acceptance on the electron side and 0 on the positron side.

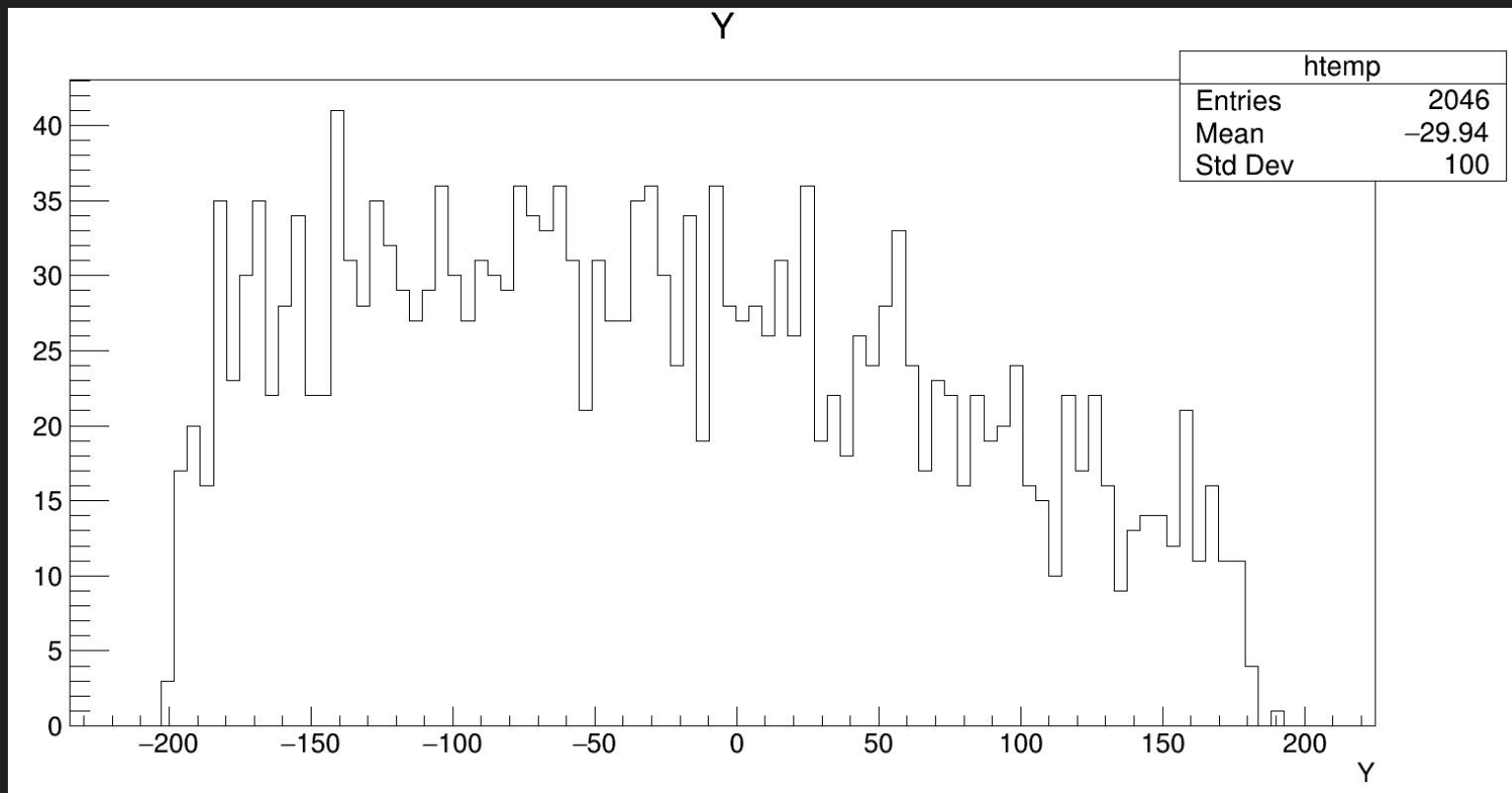
Only Counting Primary Particles

- In the previous run, all electrons and positrons that hit the detectors were recorded.
- In a second run, hits were only recorded for the original 30MeV electrons hitting the target.
- 2046 hits were recorded on the electron side, 1 hit on the positron side.

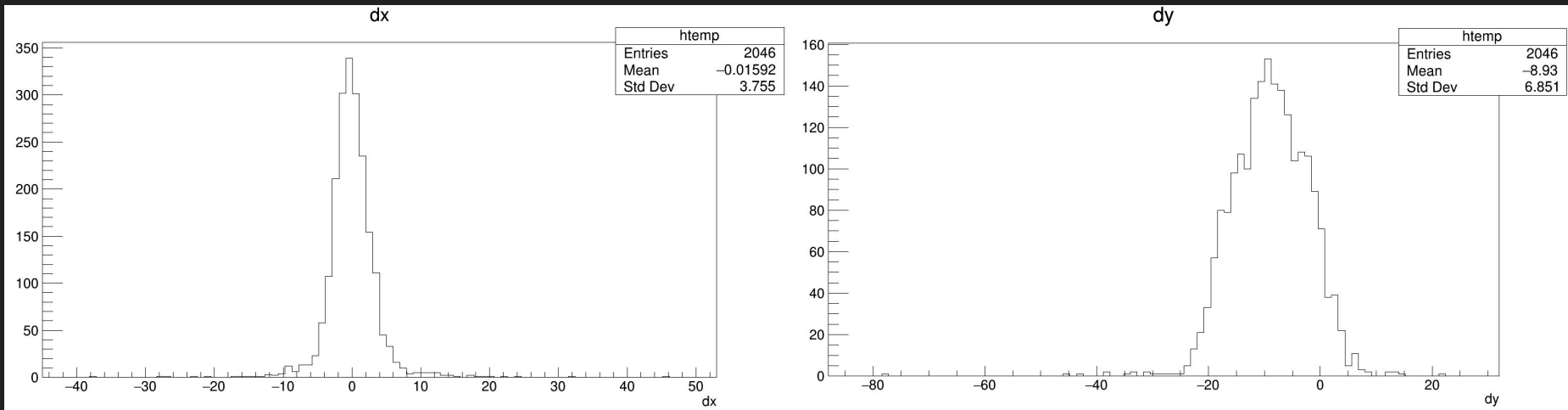
Background Rates (Primary Only) Electron Side



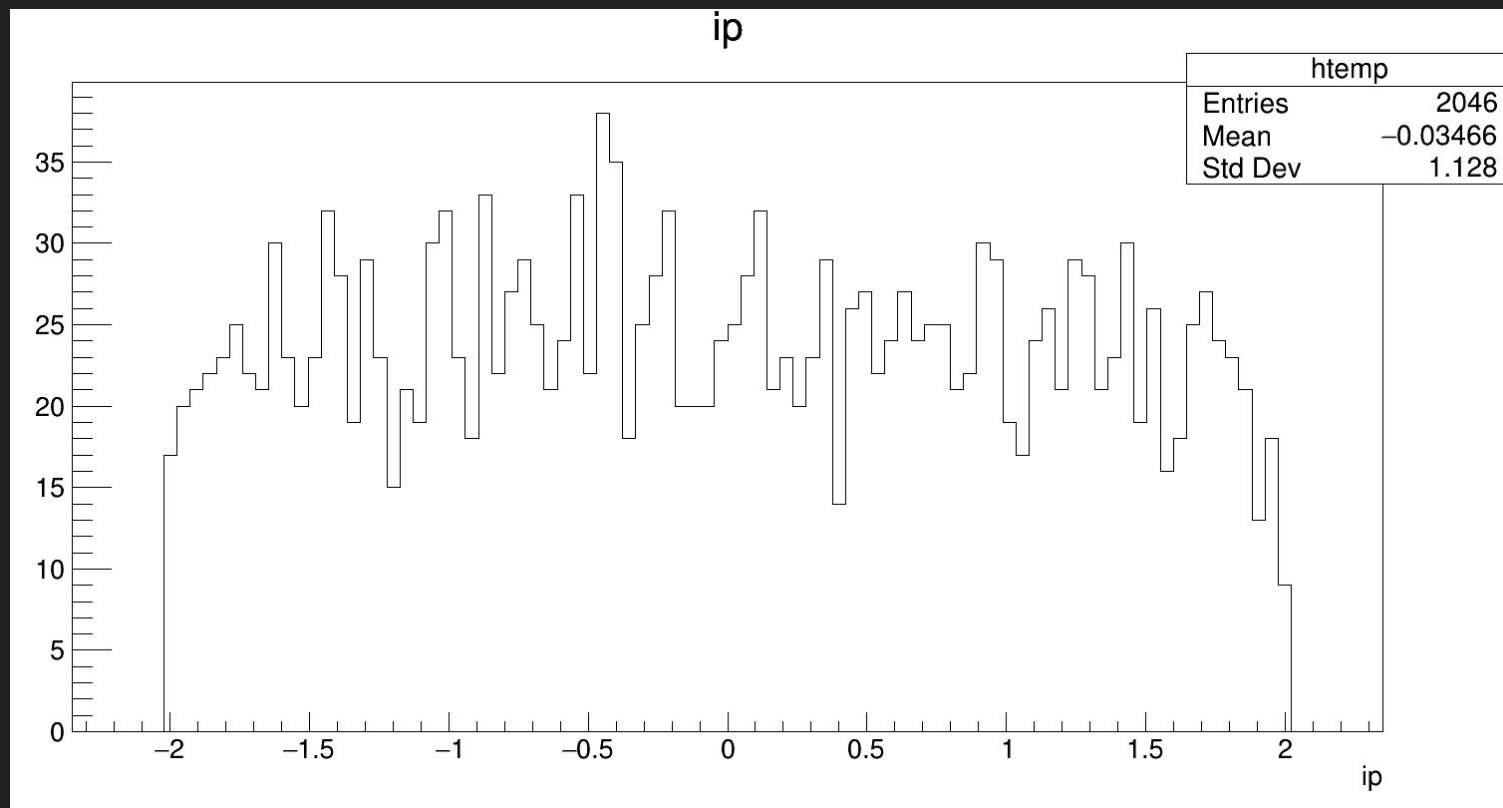
Background Rates (Primary Only) Electron Side



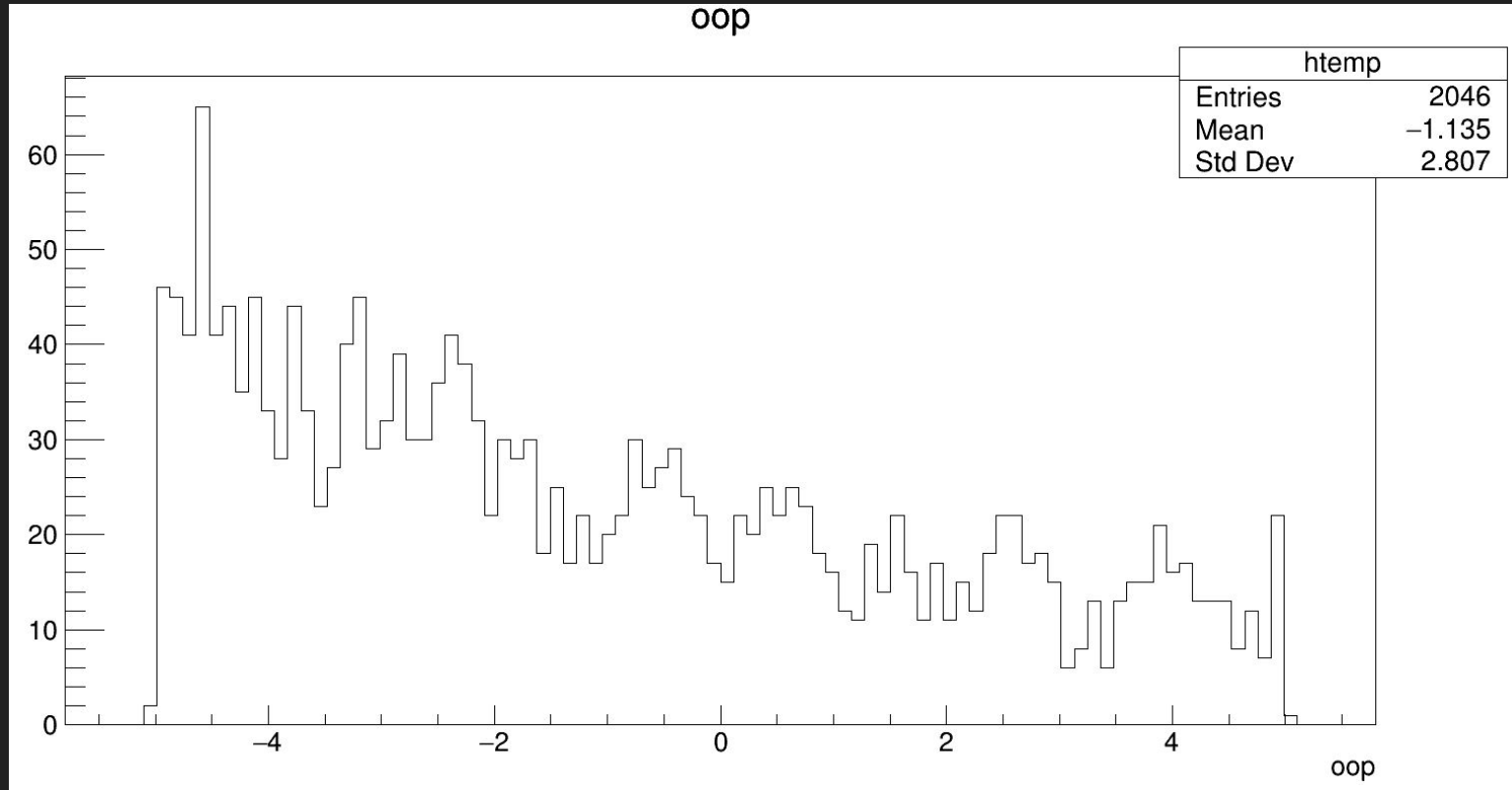
Background Rates (Primary Only) Electron Side



In-plane Angle (at particle creation, primary only)



Out-of-plane Angle (at particle creation, primary only)



Next Steps

- Implementing a more accurate model of the GEMs
- Fixing the recording of event seeds to recreate events for visual analysis
- Fix file output formatting for python scripts