MUSE Simulation

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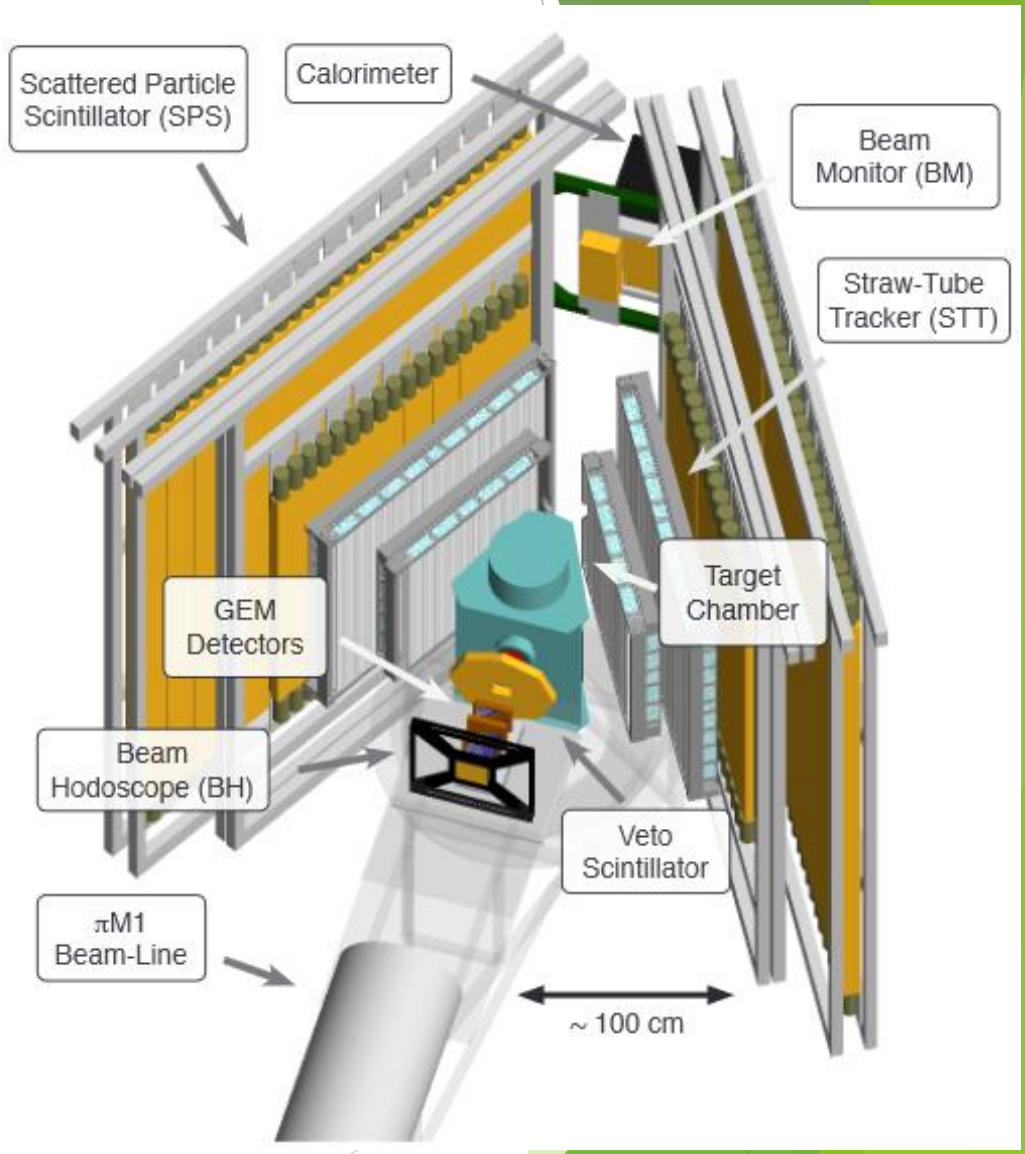
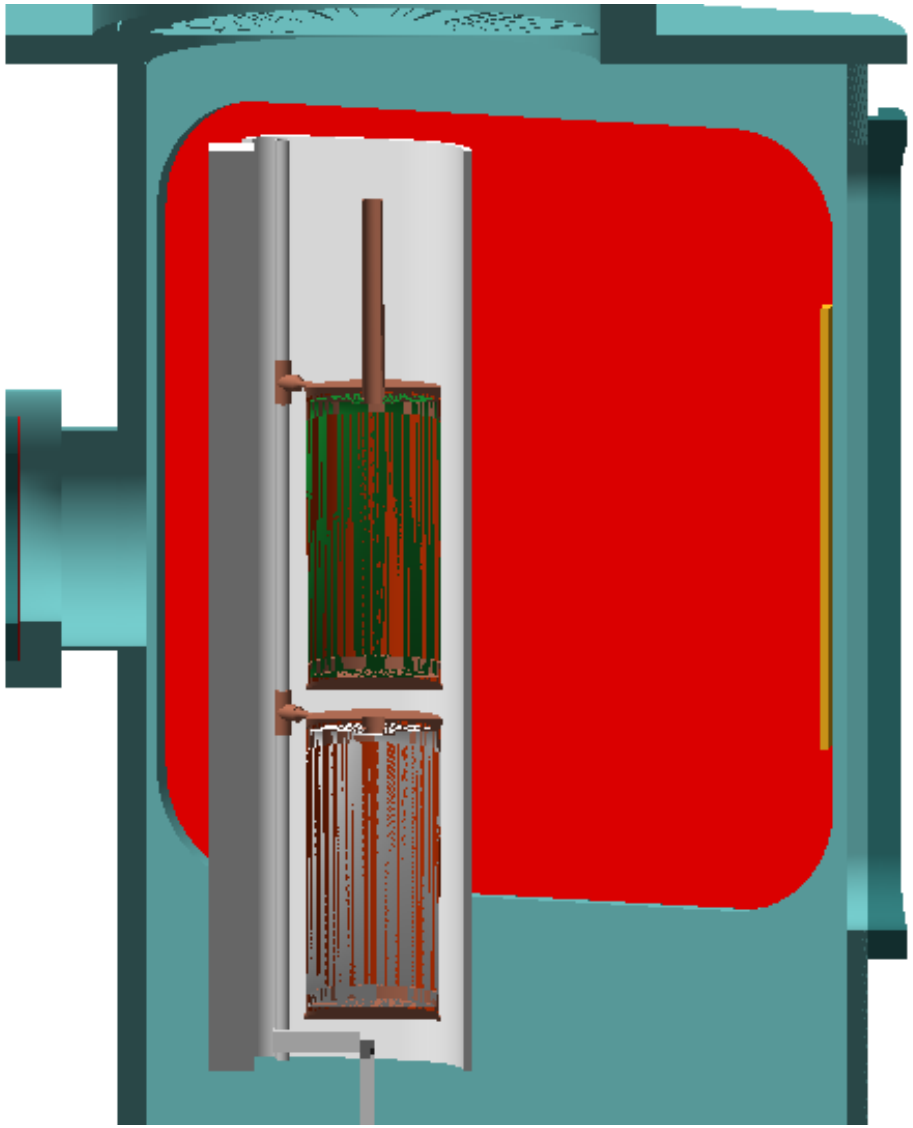
Overview

- Addition of detector components
- Continuous geometry updates
- Species-dependent beam parameterisation
- Rare event simulation
- Timing updates



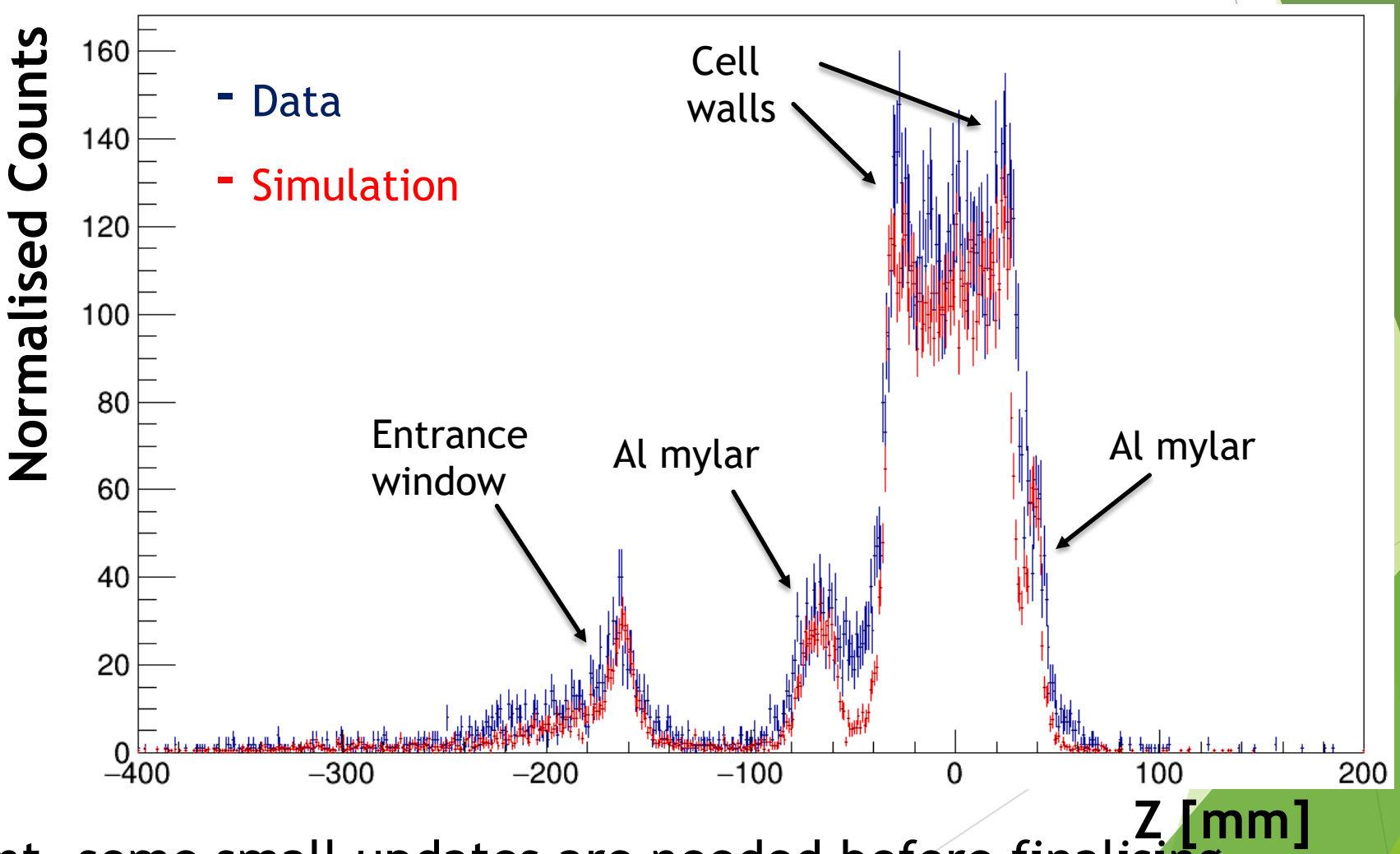
Addition of aluminized mylar



- Simple shapes implemented in simulation
- Tuning to data
- Needs updating for different run periods and target cells

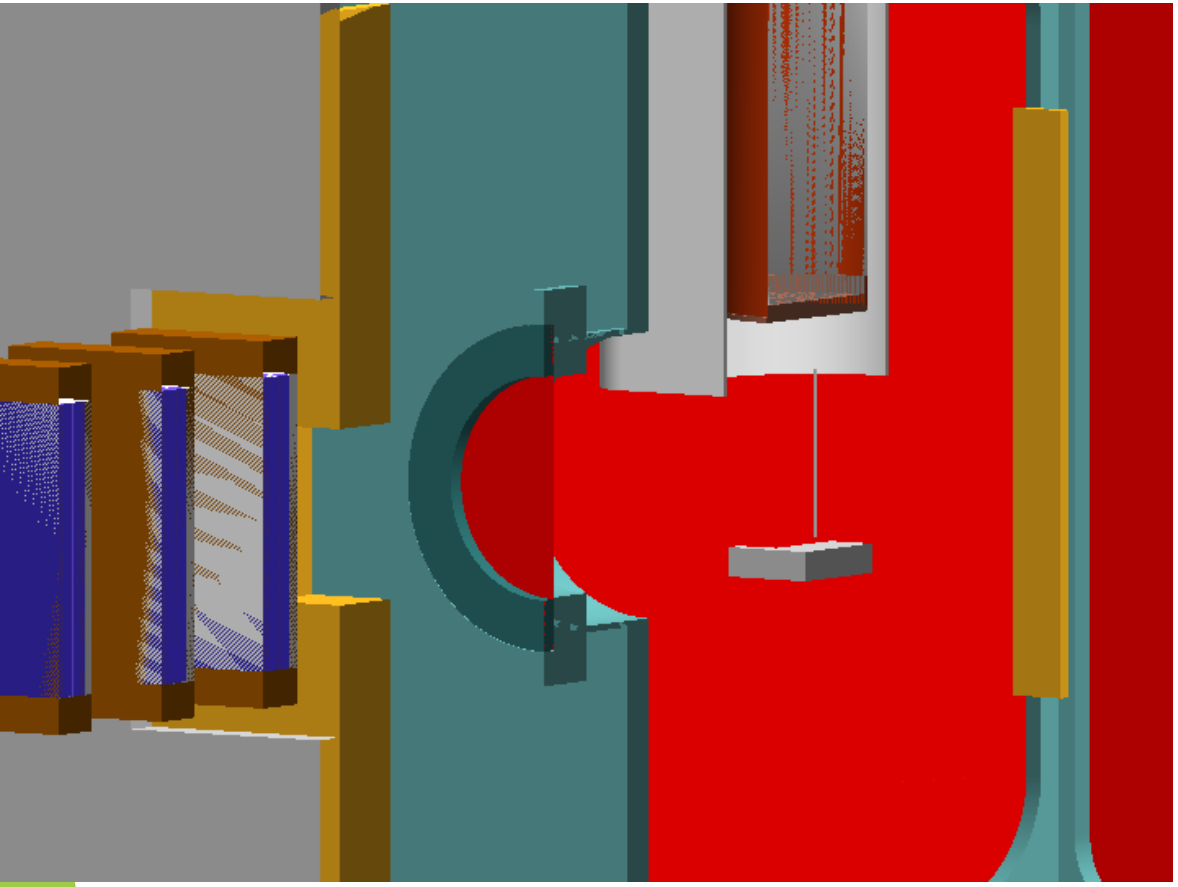
Addition of aluminized mylar (new since report)

Z vertex reconstruction for data and simulation of 160 MeV/c π^+



Good agreement, some small updates are needed before finalising

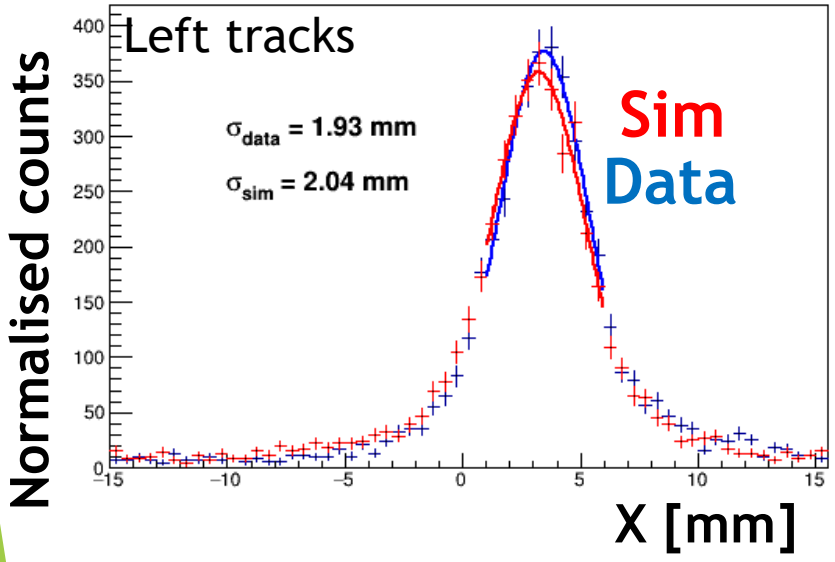
Implementation of rod target

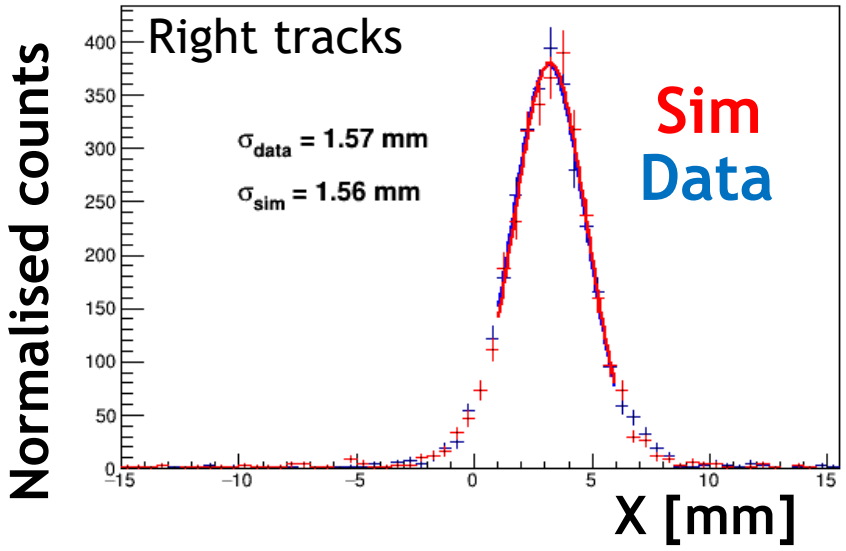


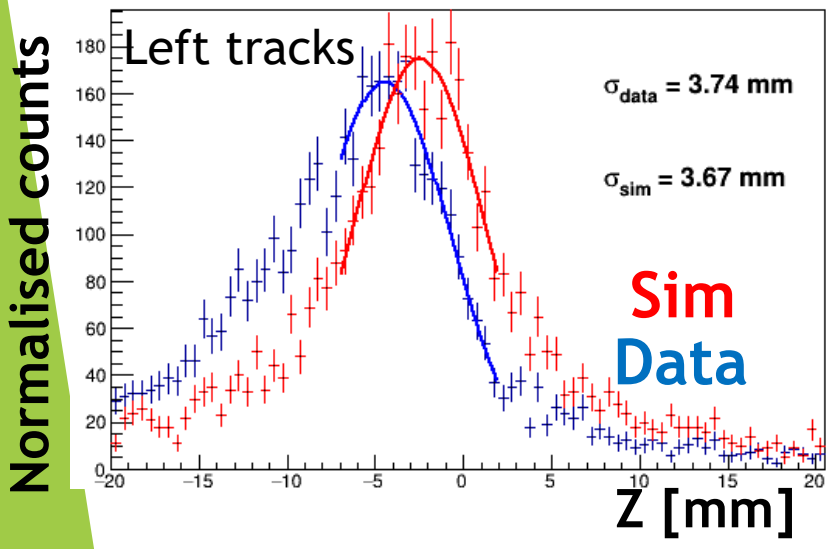
- Rod target used to check the resolution
  - Good for comparison of simulation and data
- Look at misalignments
  - Can easily test this in the simulation
- Rod target frame transparent for visualisation

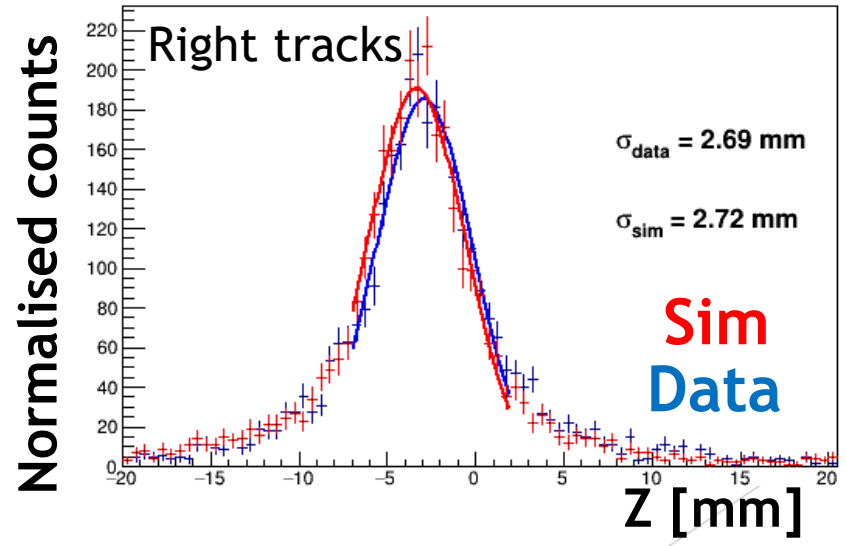
Implementation of rod target (new since report)

Vertex reconstruction for 210 MeV/c π^- Dec 2023









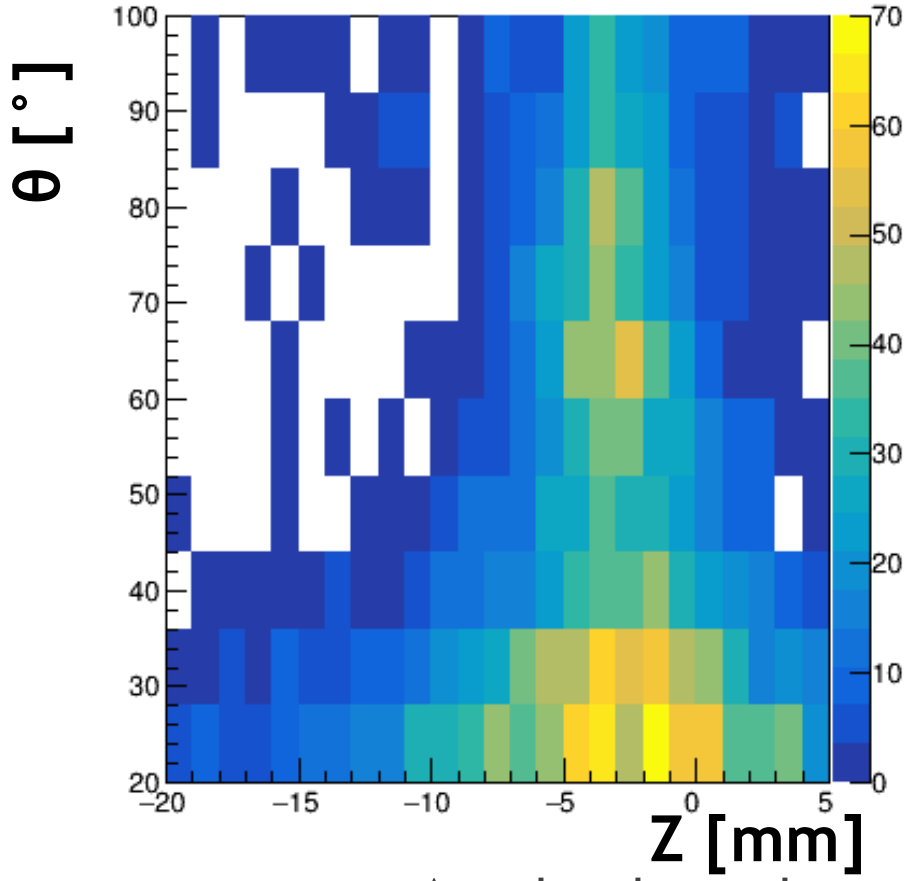
- General agreement between data and simulation
- Disagreement in Z vertex for left side tracks

Implementation of rod target (new since report)

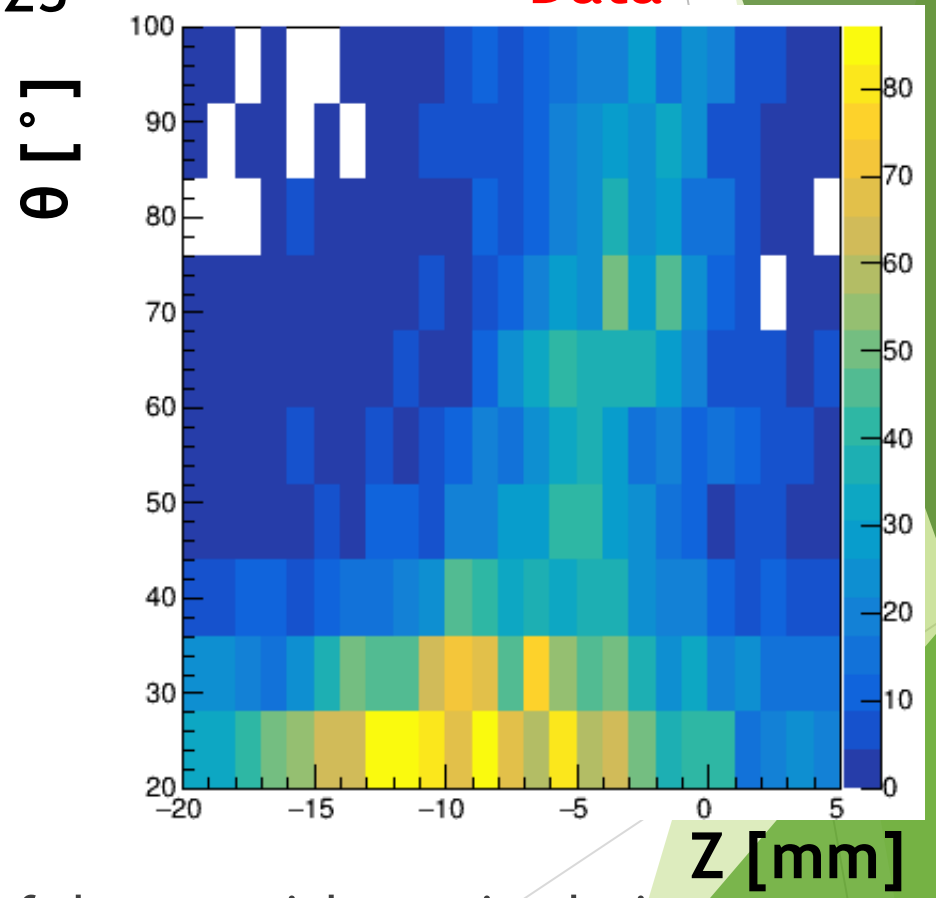
Angular dep. of Z vertex for 210 MeV/c π^- from left tracks

Dec 2023

Sim



Data



- Angular dependence for data on left but not right or simulation
- Difference between nominal geometry and experiment found
- After survey geometry will be updated in analysis

Geometry

- Geometry implemented using design specifications
- Survey experiment
- Modify simulation geometry to fit survey data
- Export geometry as GDML for use in data analysis

Example fit result

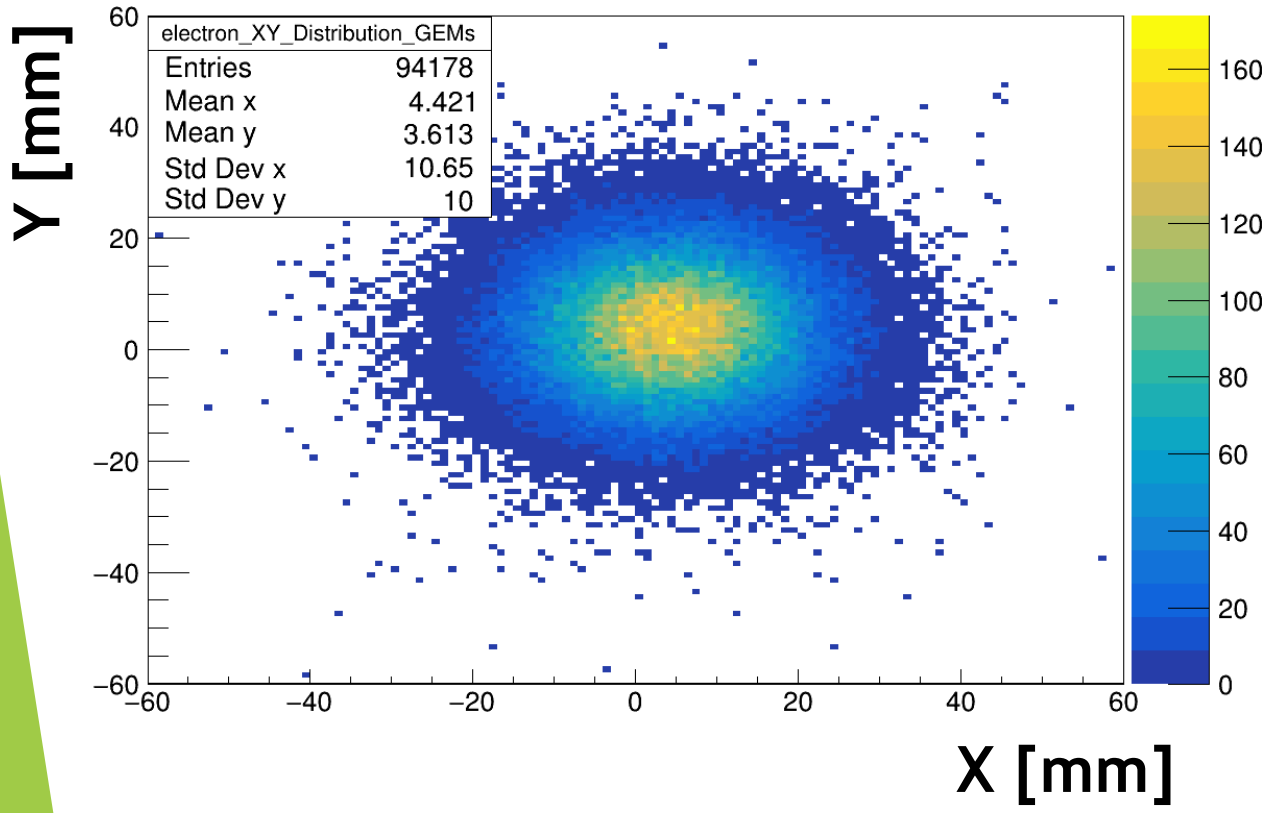
```
/g4PSI/det/trans GEM0    -0.511     0.106    -0.008 mm
/g4PSI/det/trans GEM1    -1.034     1.020    -4.803 mm
/g4PSI/det/trans GEM2    -0.754     0.246     0.937 mm
/g4PSI/det/trans GEM3    -1.151     0.304     0.065 mm

/g4PSI/det/rot GEM0       0.036     0.018    -0.541 deg
/g4PSI/det/rot GEM1      -0.666    -0.233    -6.706 deg
/g4PSI/det/rot GEM2      -0.075     1.132    -1.290 deg
/g4PSI/det/rot GEM3       0.032    -0.164    -0.223 deg
```

fit translational and rotational offsets

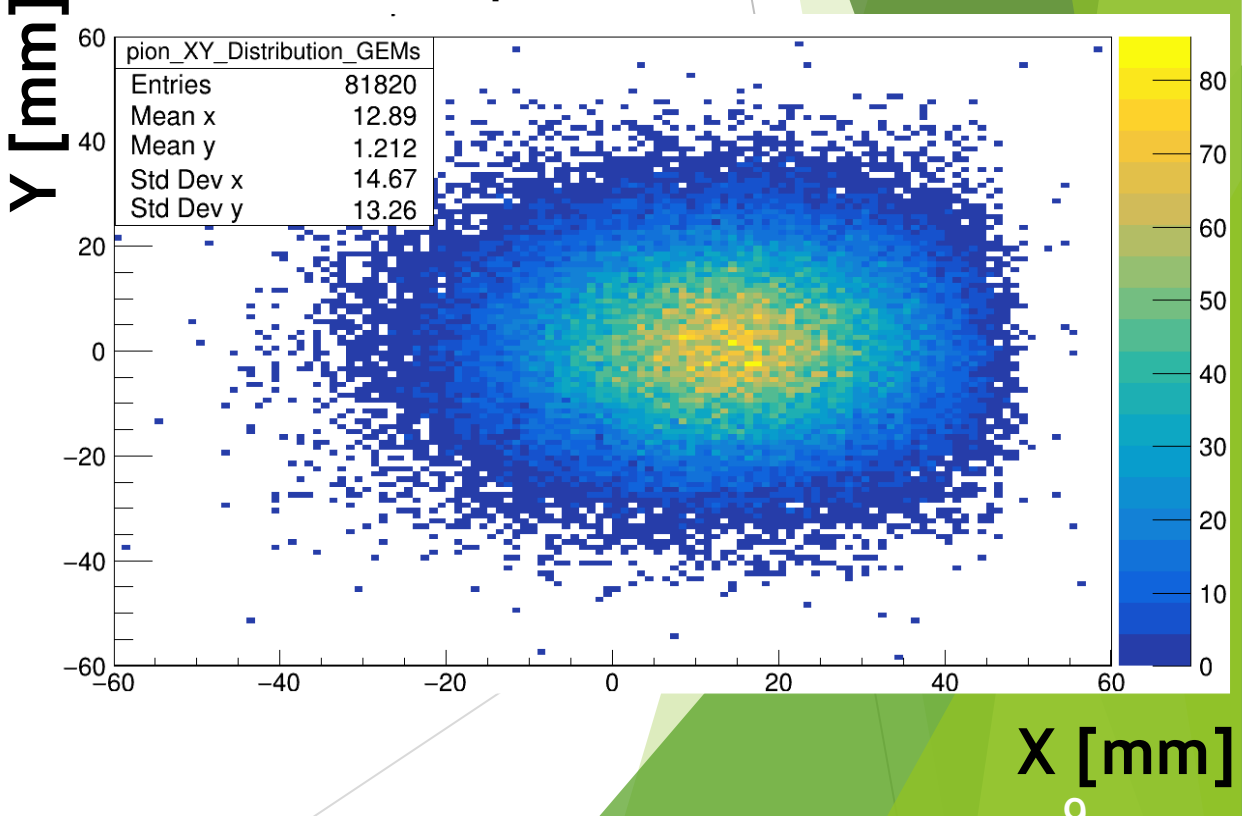
Beam Parameterisation

- GEM tracks projected to GEM0 z position
- Energy losses in Intermediate Focal Point → Different beam deflection between particle species

210 MeV/c e^- position from GEM data



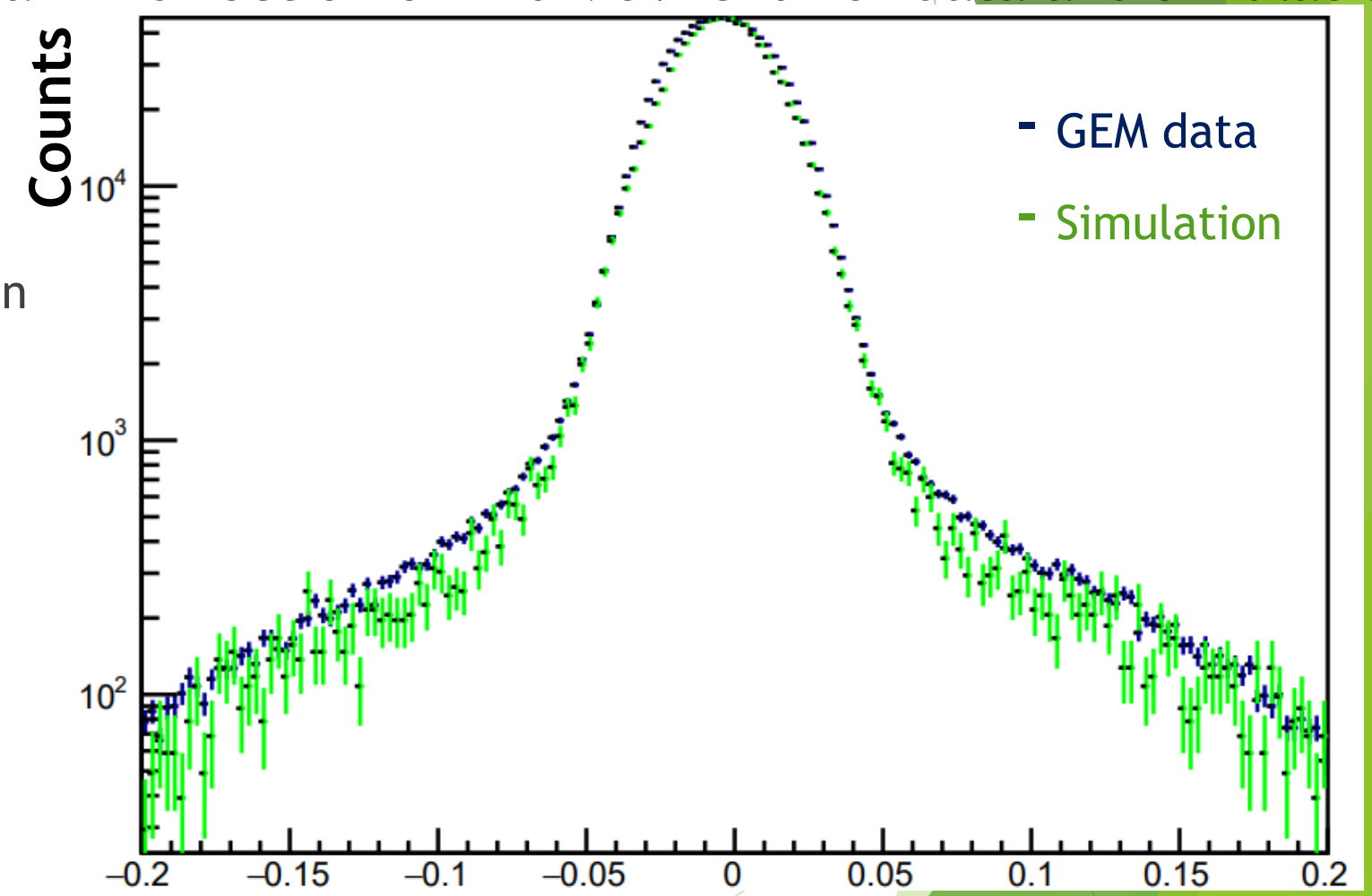
210 MeV/c π^- position from GEM data



Beam Parameterisation

- Species determined by BH
- GEM tracks compared between data and sim
- Beam tuned iteratively

Beam Y direction of 210 MeV/c π^- for data and simulation



Much better agreement after separating particle species
Tails need to be well understood for background contributions

Rare-Event Simulation

Move from ESEPP to Olympus event generator for radiative corrections

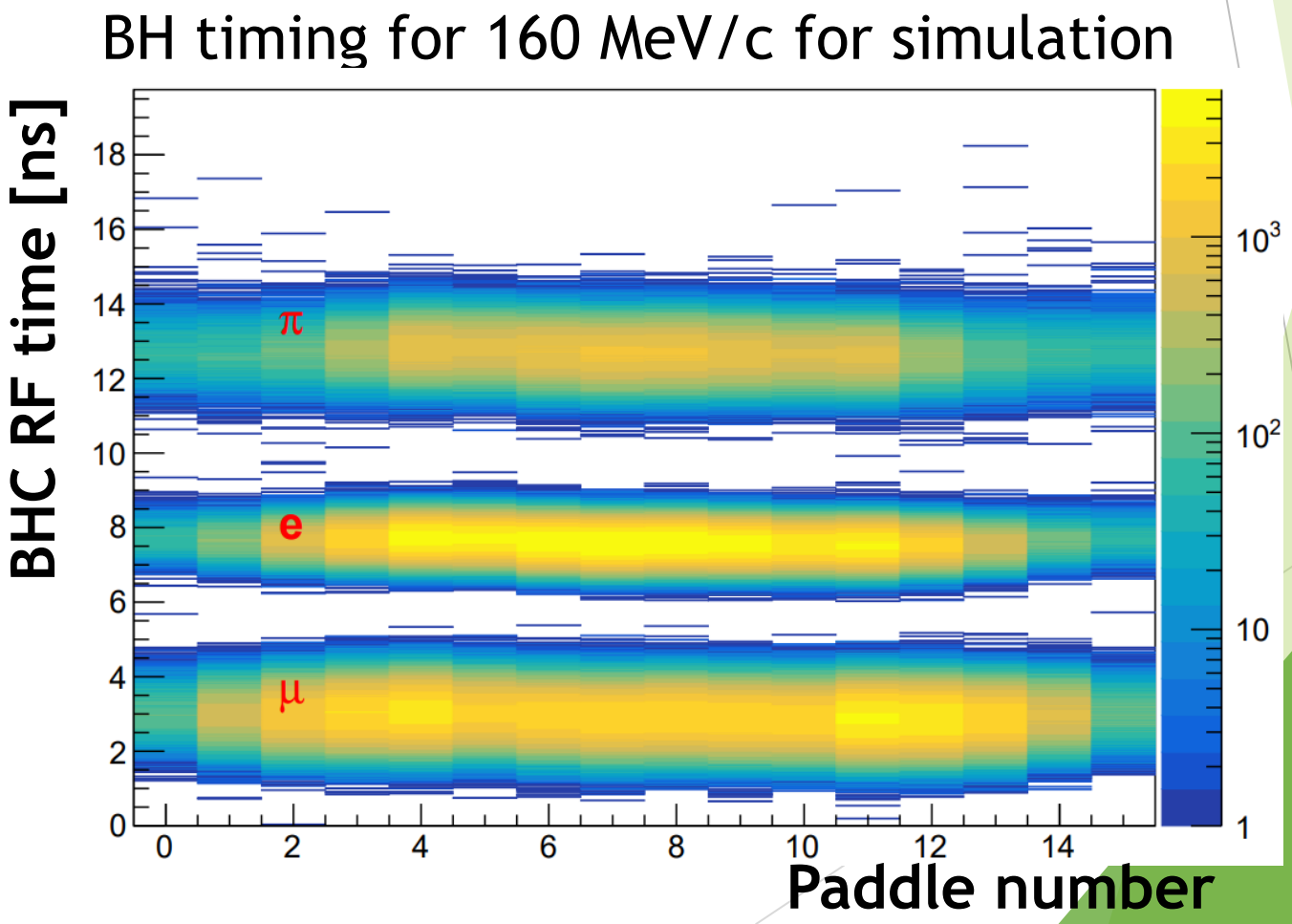
- Very fast setup time
  - Can be run during the simulation
- Can use incoming particle information
- Angular dependence in weight
  - Can run uniformly – quickly gain statistics at larger angles

Rare-Event Simulation

- Add physics process using Olympus
- Only implemented in the target cell
  - Possibly in the chamber as well (background contributions)
- Give a high probability for the Olympus process
  - Record cross-section determined by Olympus

Timing Updates

- Initial implementation of consistent trigger time in the simulation



Still to do

- Setup and alignment (run-time dependent)
- Tune detector parameters (run-time dependent)

- Rare-event simulation

- Implement trigger conditions in simulation
- Slow control data in simulation