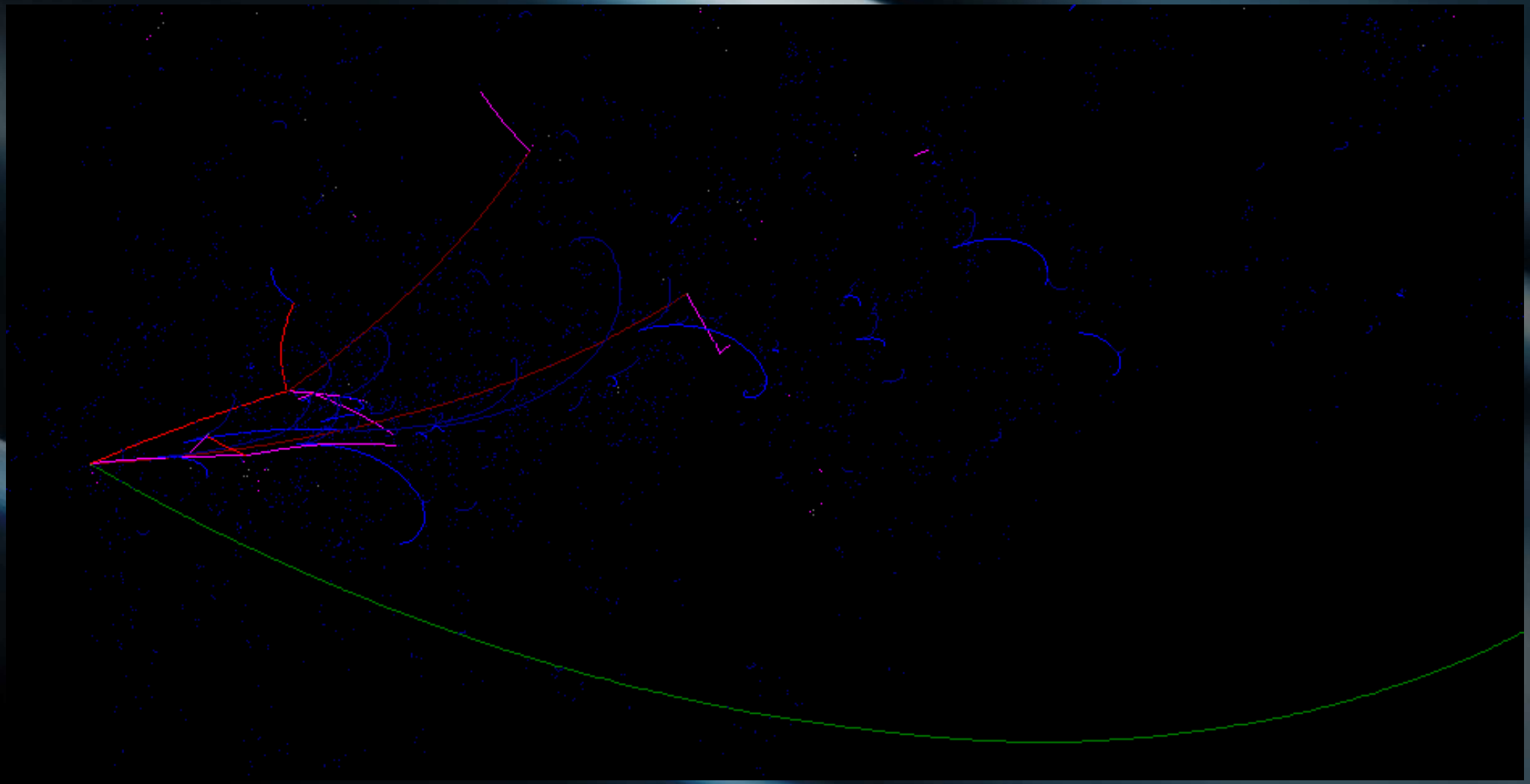
TASD Analysis



Malcolm Ellis - 27th April 2011

Outline

- Software work
  - MINDG4
  - Digitization
  - Reconstruction
- TASD model
- TASD performance
  - Detector response
  - Resolution

Next steps

Software Work

- Since the end of 2010, have been working on taking the existing software used in the MIND simulation and analysis and modifying it to make TASD an option.
- First two phases of work completed.
- Third phase almost ready, report to be delivered in the coming weeks.
- Work will be continued at Glasgow

MINDG4

- GEANT4 application for simulation of the MIND detector.
- Developed by Anselmo Cervera, Andrew Laing.
- Simulates isolated particles, or can read in GENIE or NUANCE format neutrino events and use G4 to simulate the detector response.
- Hosted on SVN repository at University of Valencia.

  User control via configuration text file, G4 UI accessible as well.

Digitization

- Separate package, also hosted at Valencia.
- Read in BHEP format ROOT file.
- Simulates readout electronics and low level reconstruction (hit finding, cluster finding, space point reconstruction).
- Passes a list of reconstructed space points associated to the simulated particle in another BHEP format ROOT file to the reconstruction code.

Reconstruction

- Reads in Digitizaton output and finds and fits tracks using the RecPack Kalman fitting package.
- Has a number of options including fitting single particles and looking for and reconstructing neutrino events (primary lepton, hadronic jet).
- Optimized for MIND, but can now perform single particle fits for TASD as well.
- Needs more work to remove use of Monte Carlo information in reconstruction process.

TASD Model

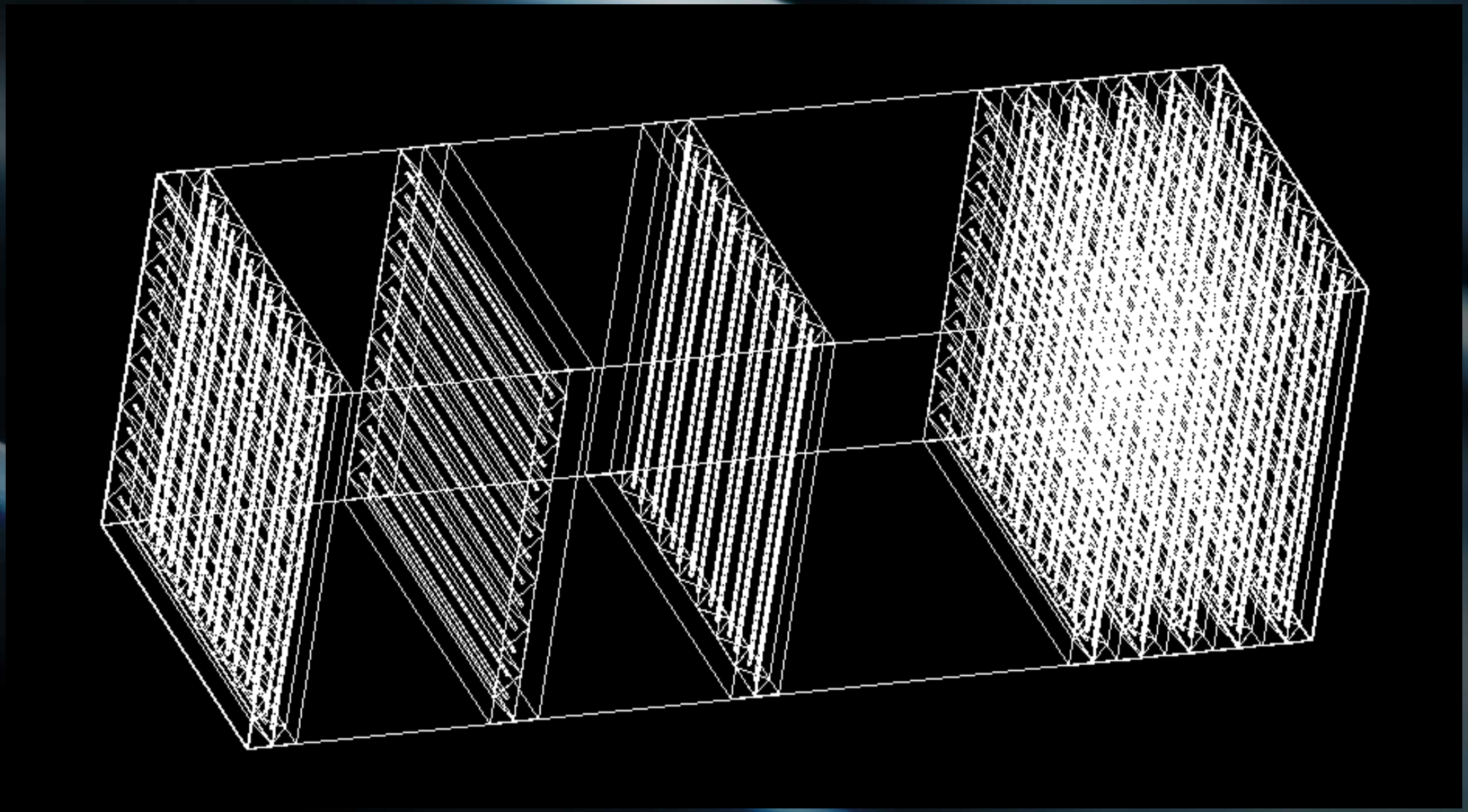
- Parametrized GEANT4 volumes added that model:
  - Individual triangular or rectangular cross-section extruded scintillator bars.
  - WLS fibre inside each bar.
  - Planes made up of a layer (or two, with alternating orientation, as appropriate) of bars.
  - Modules made up of an 'X' and 'Y' orientation plane.
  - Complete detector made up of required number of modules.
  - Various options to control detector shape and size.

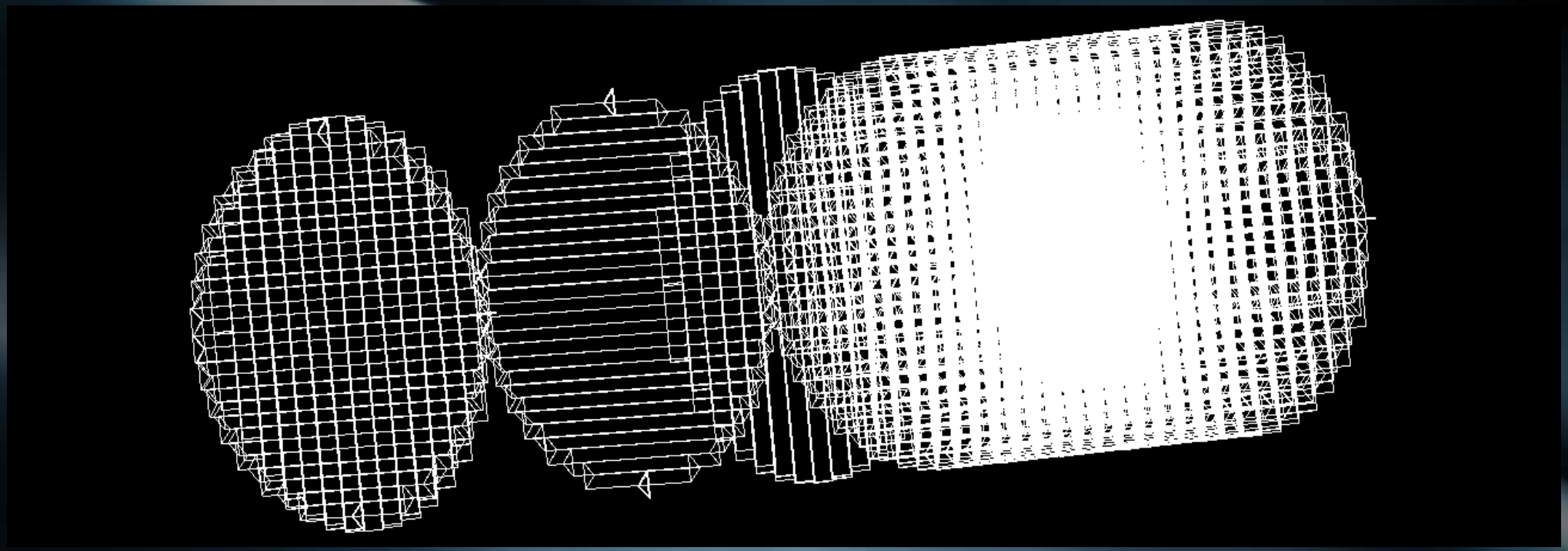
TASD Model Options

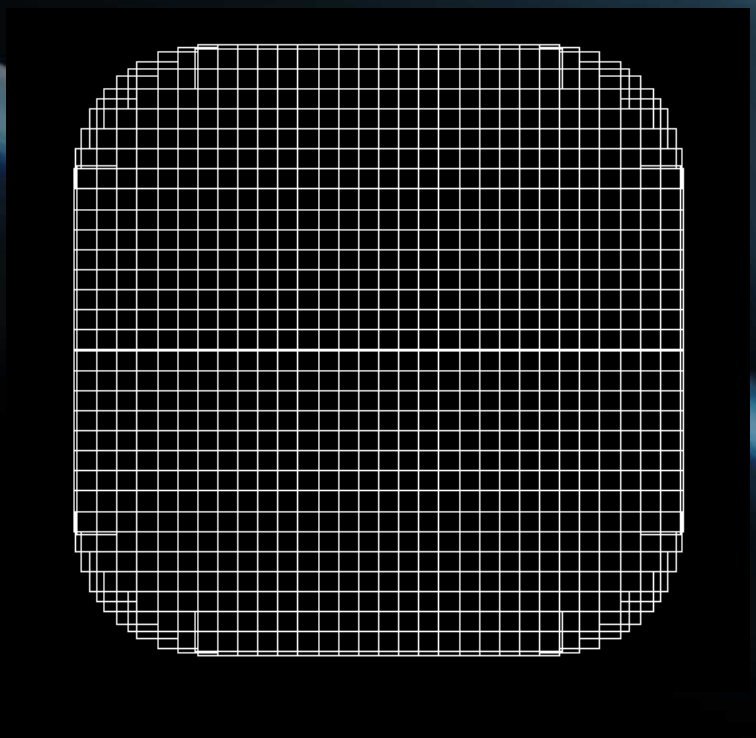
- MindTasd – 0 = MIND, 1 = TASD
- PrismWidth – Width of the base (mm)
- PrismHeight – Height of the bar (mm)
- RectBar – Trianglur or rectangular cross-section
- PrismLength – Length of the extrusion
- FibreRadius – Radius of the WLS fibre
- FibreOffset values control location with respect to centre of bar.

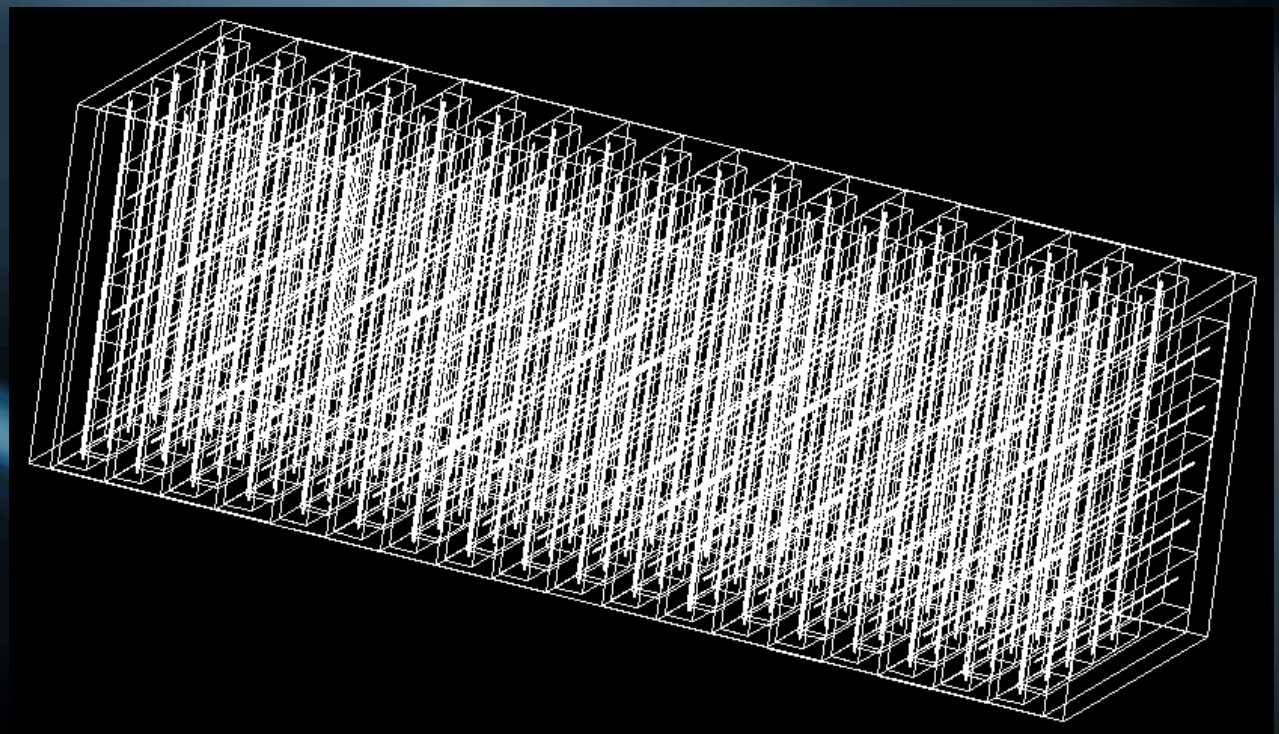
  Other options control detector shape, visualization of components, etc...

TASD Models





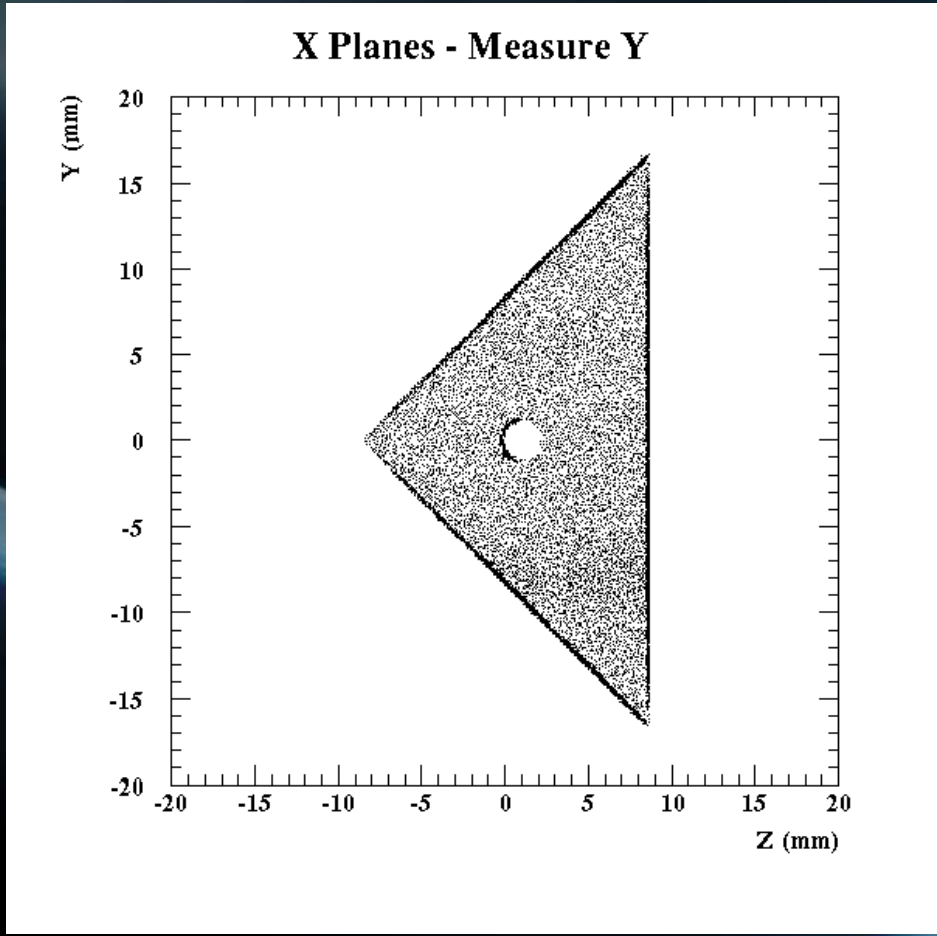


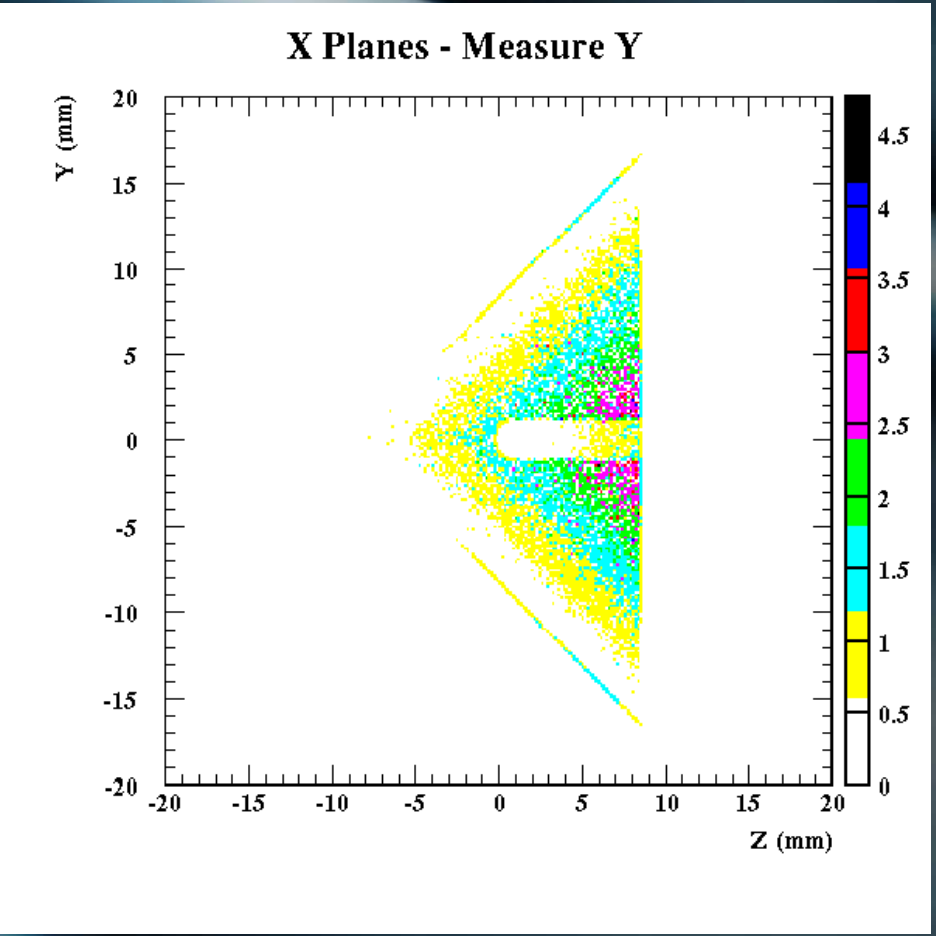


TASD Performance

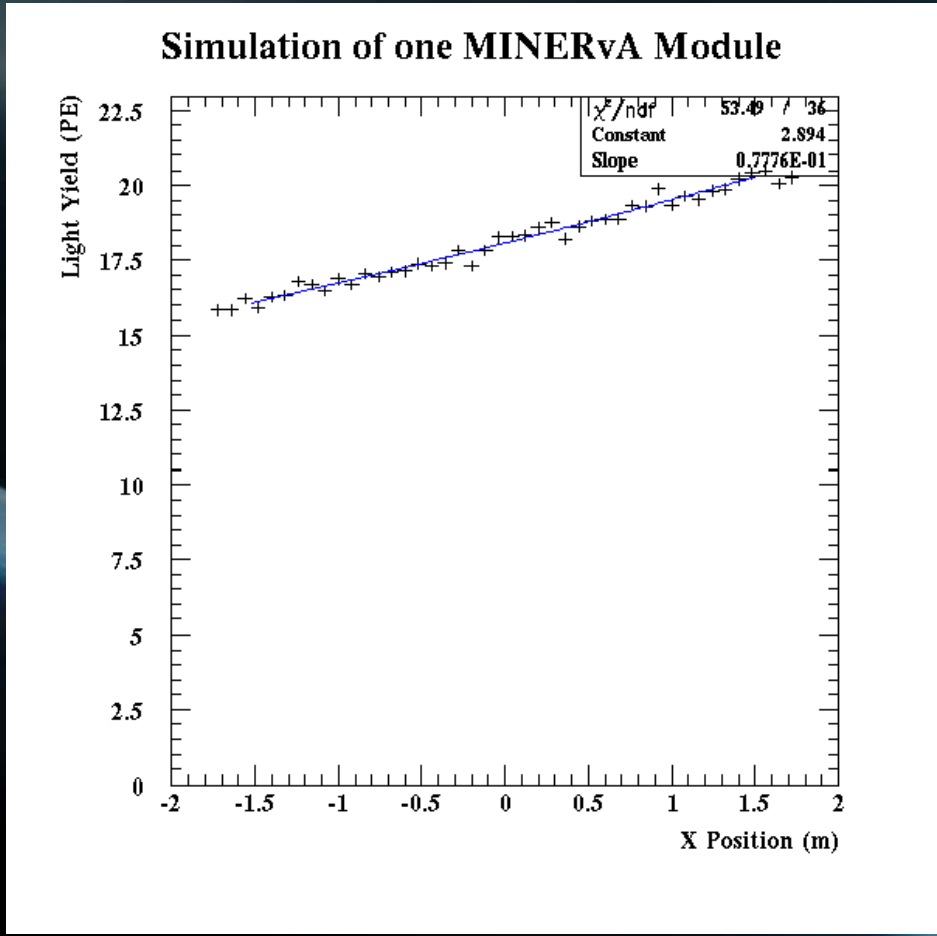
- GEANT4 Hits
- Digitization
- Hit reconstruction
- Tracking
  - Tracking efficiency
  - Momentum resolution
  - Charge ID
  - Particle ID

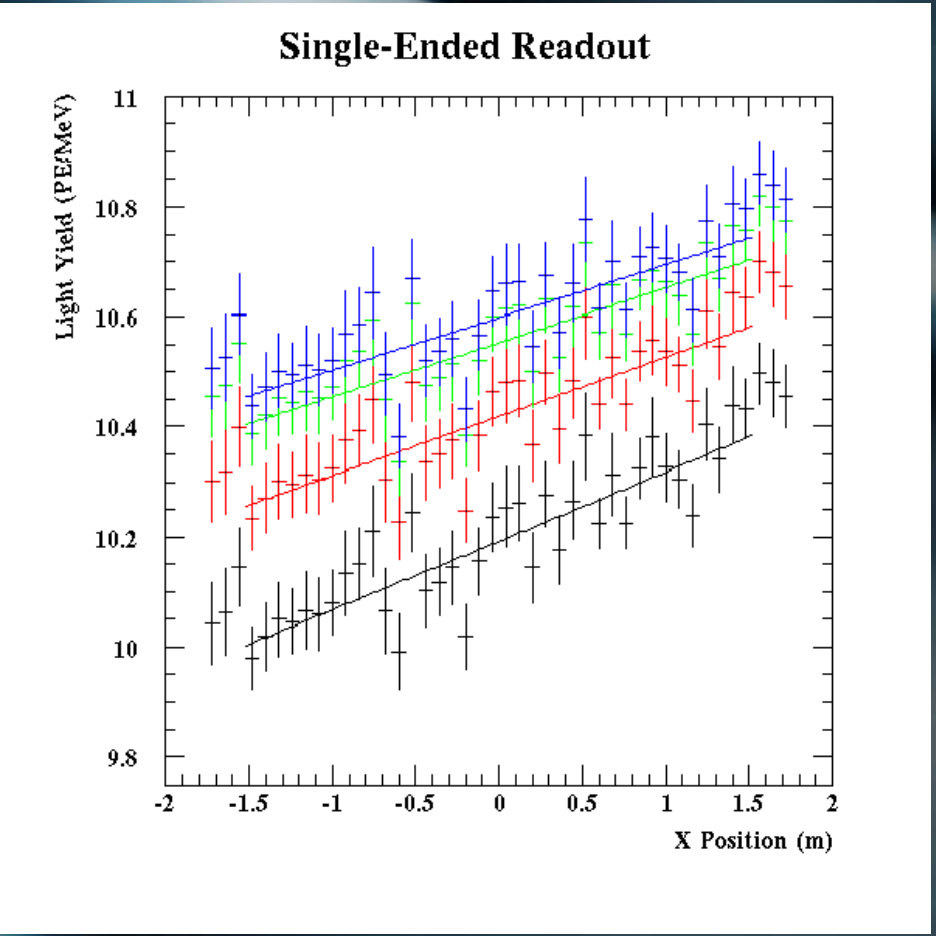
GEANT4 Hits


X Planes - Measure Y
Y (mm)
Z (mm)
20
15
10
5
0
-5
-10
-15
-20

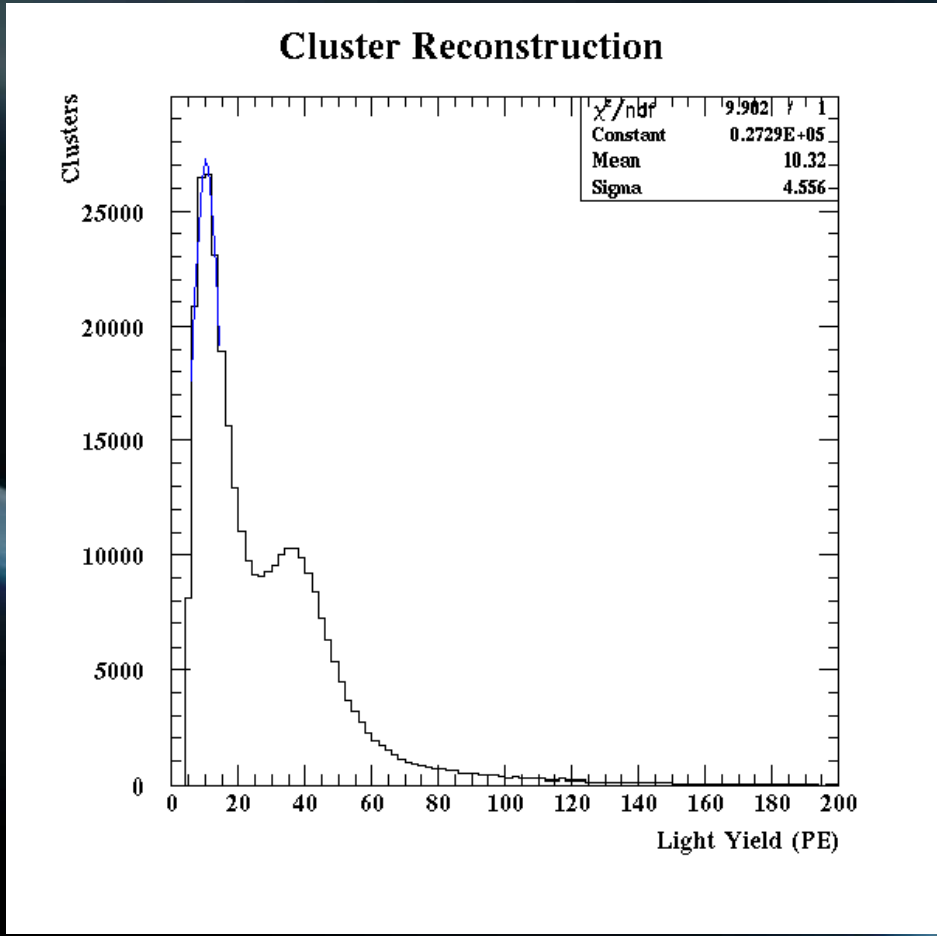

X Planes - Measure Y
Y (mm)
Z (mm)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0

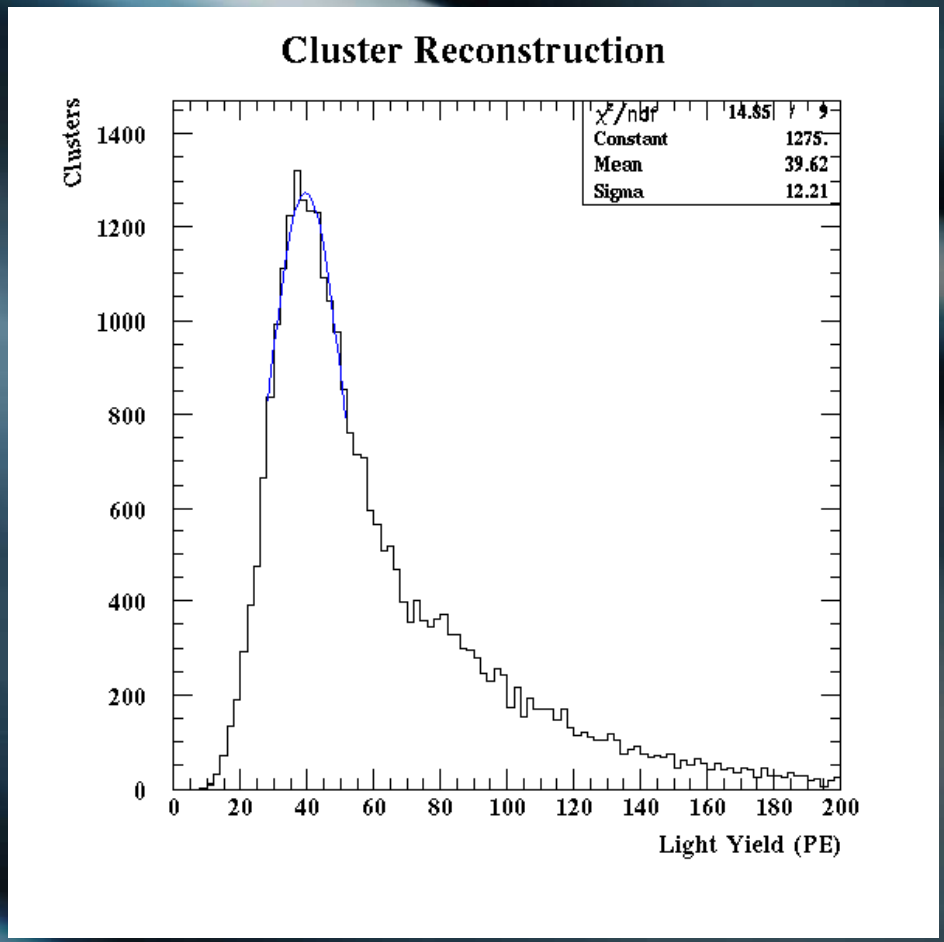
Digitization



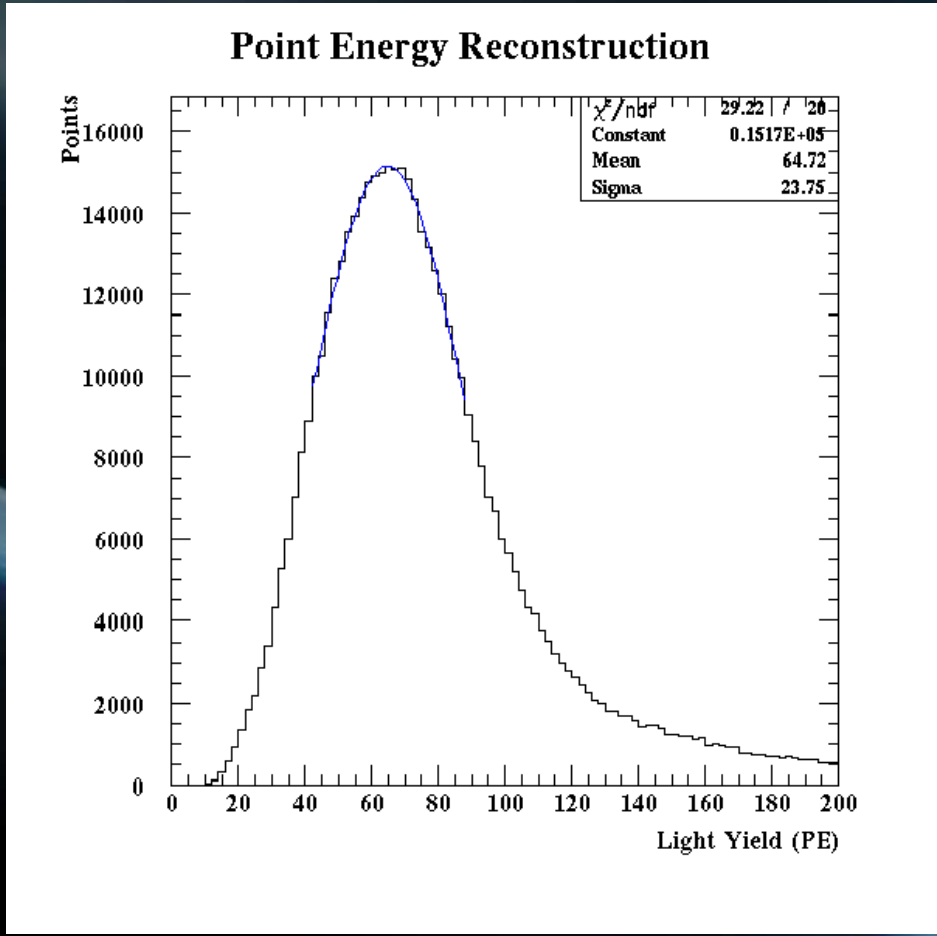


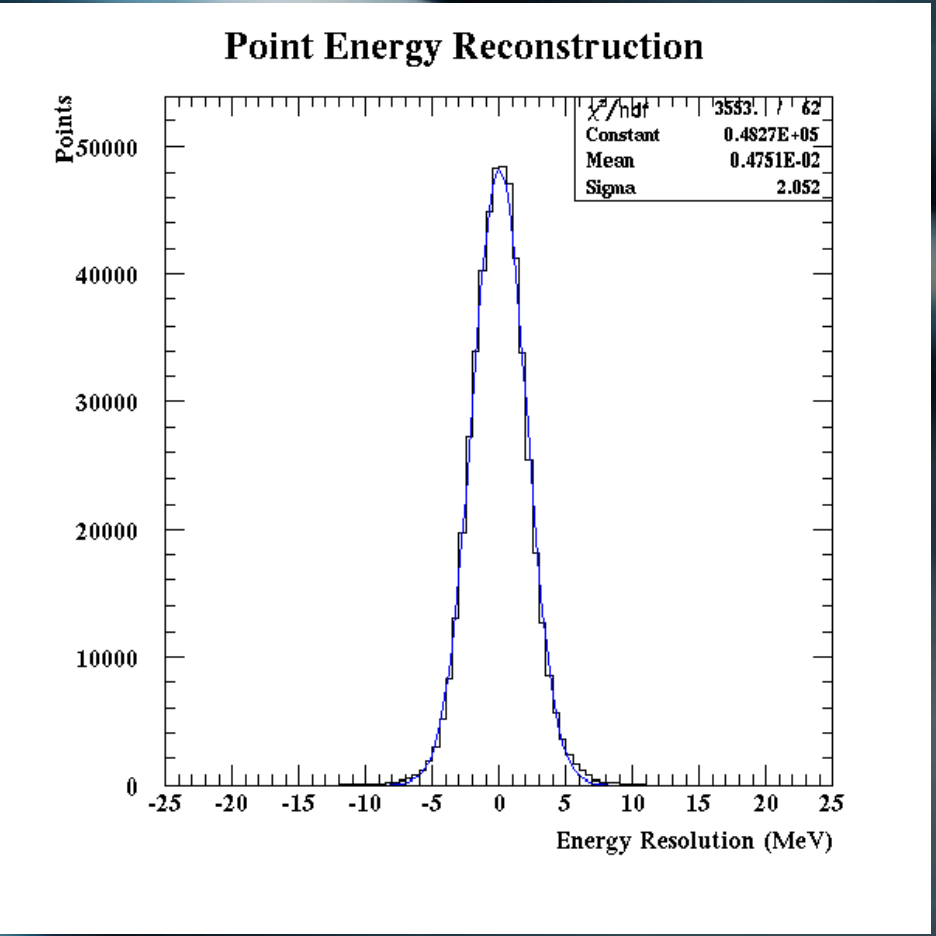
Cluster Reconstruction



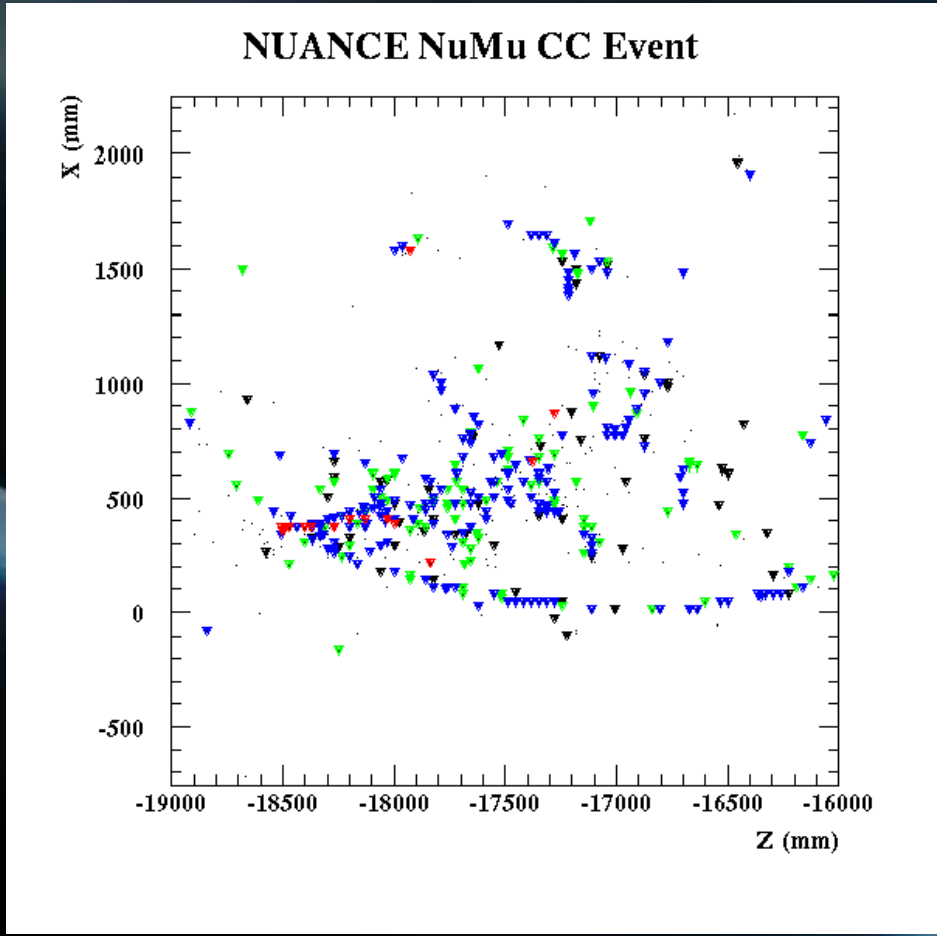


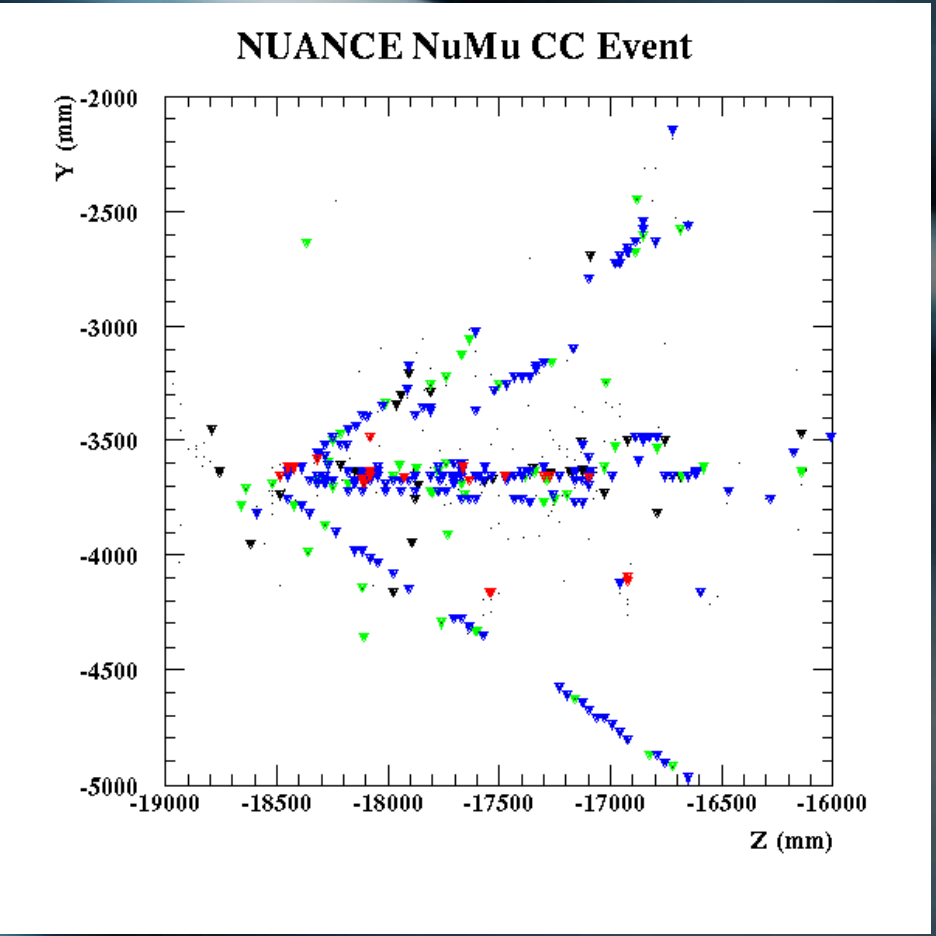
Point Reconstruction



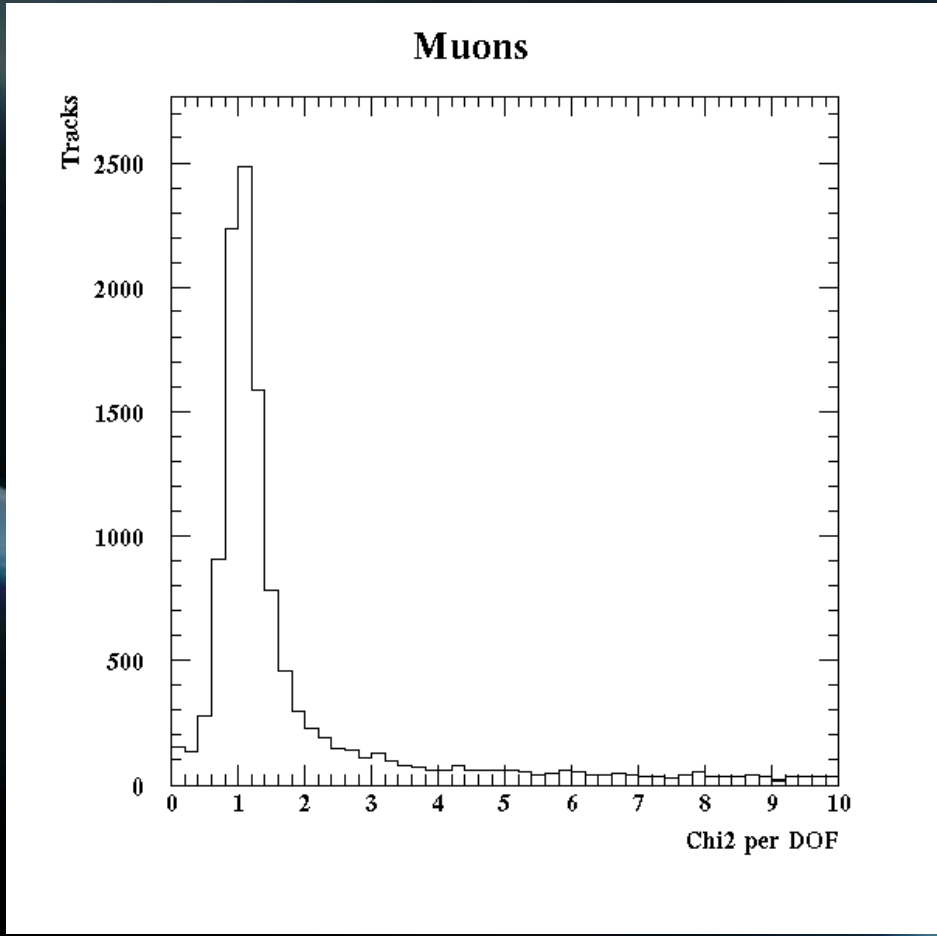


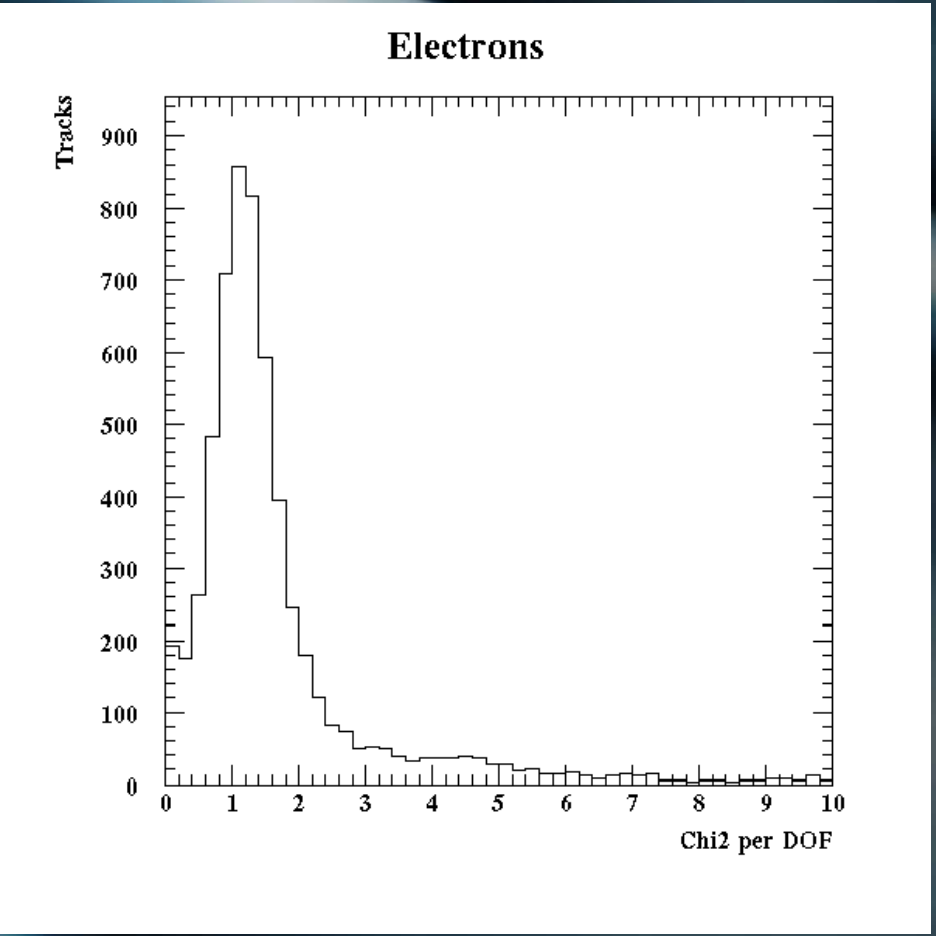
Reconstructed Event



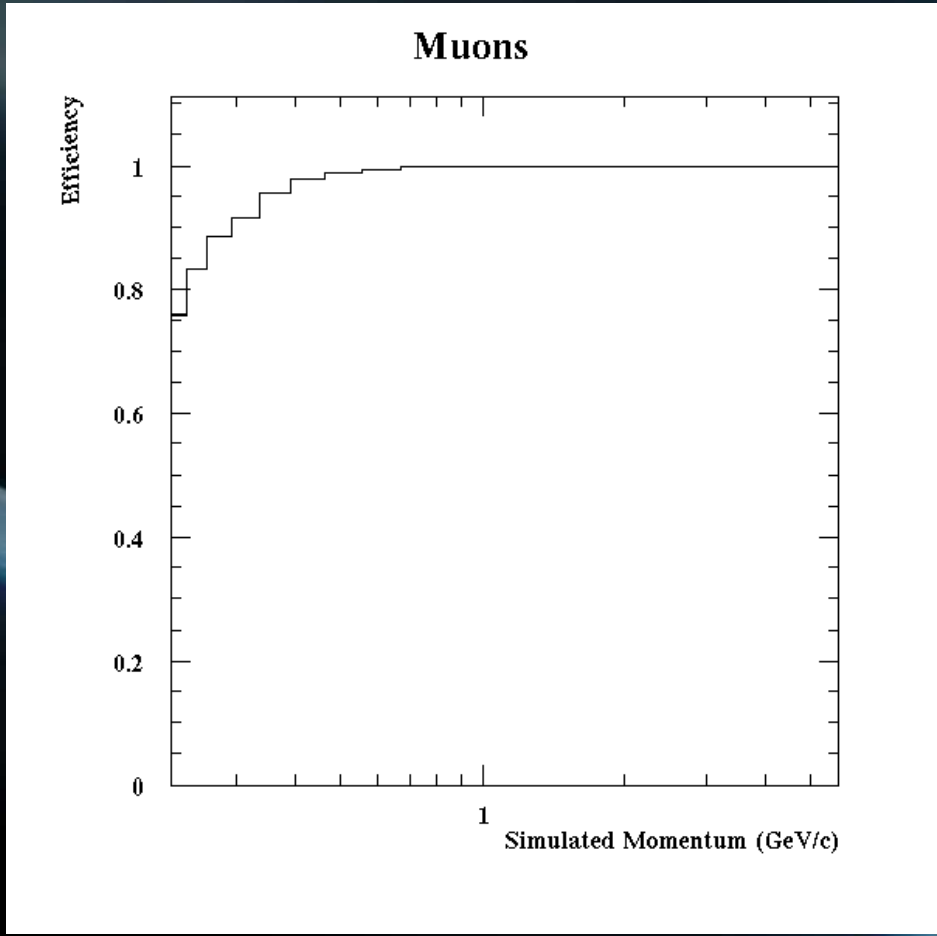


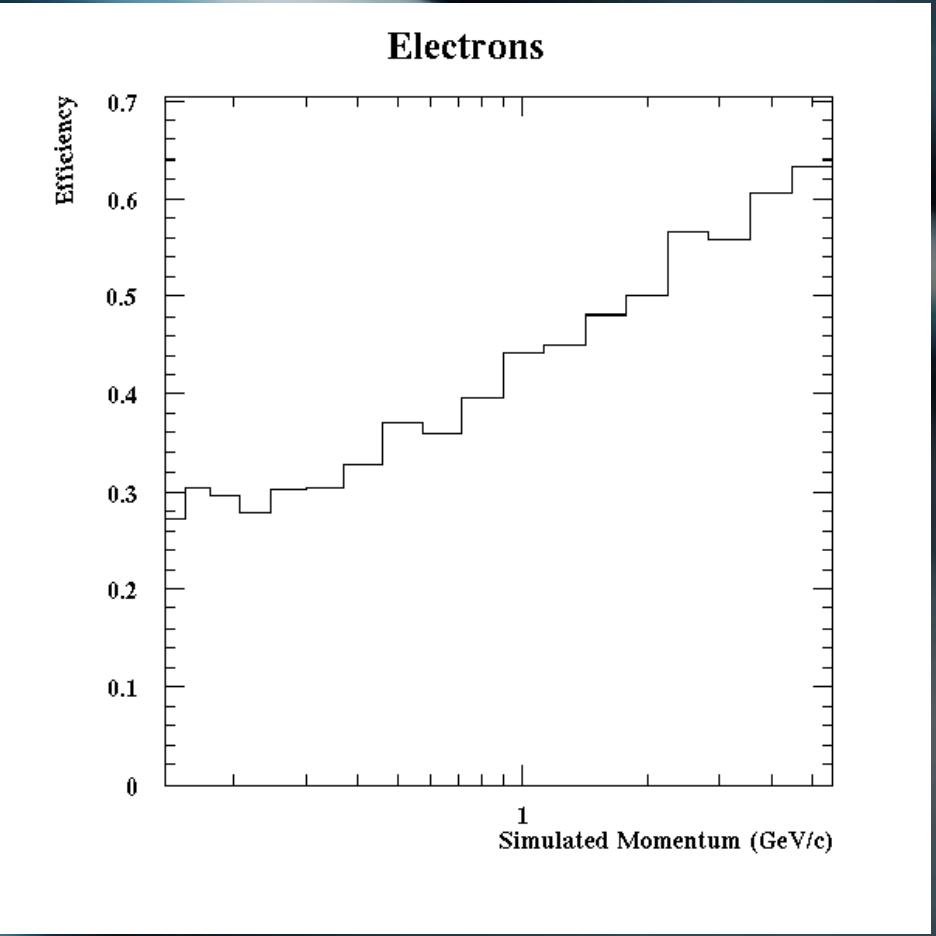
Track Reconstruction



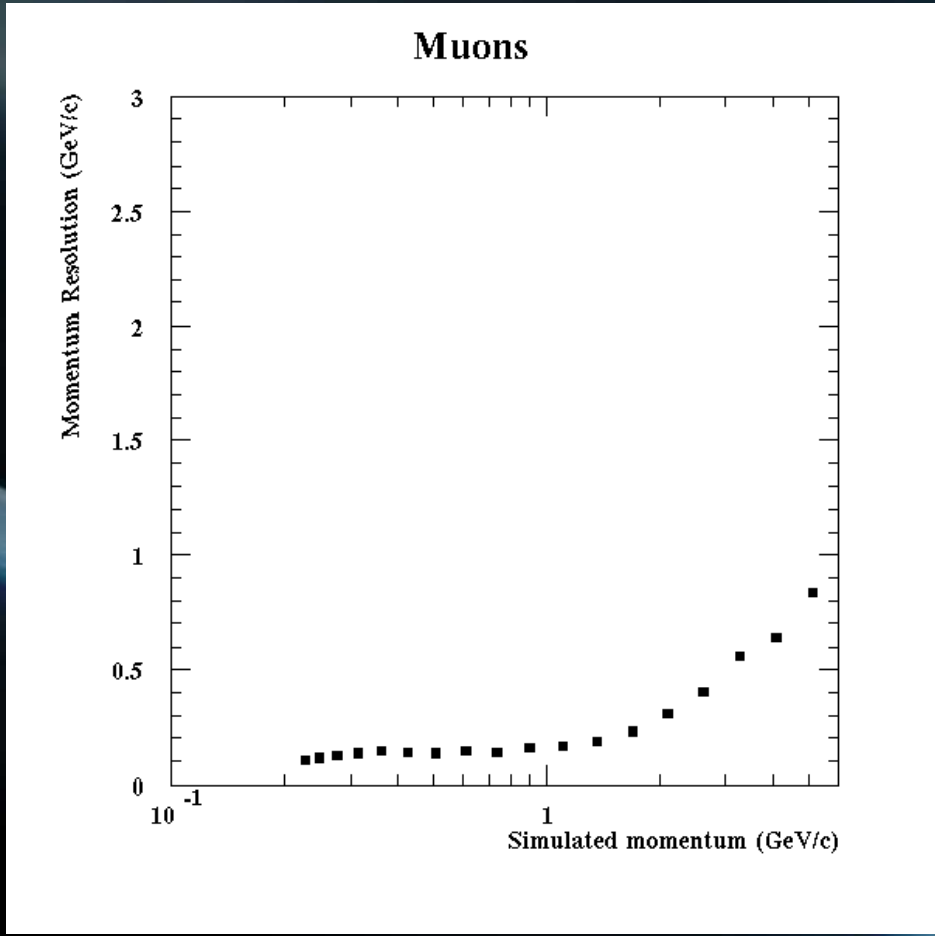


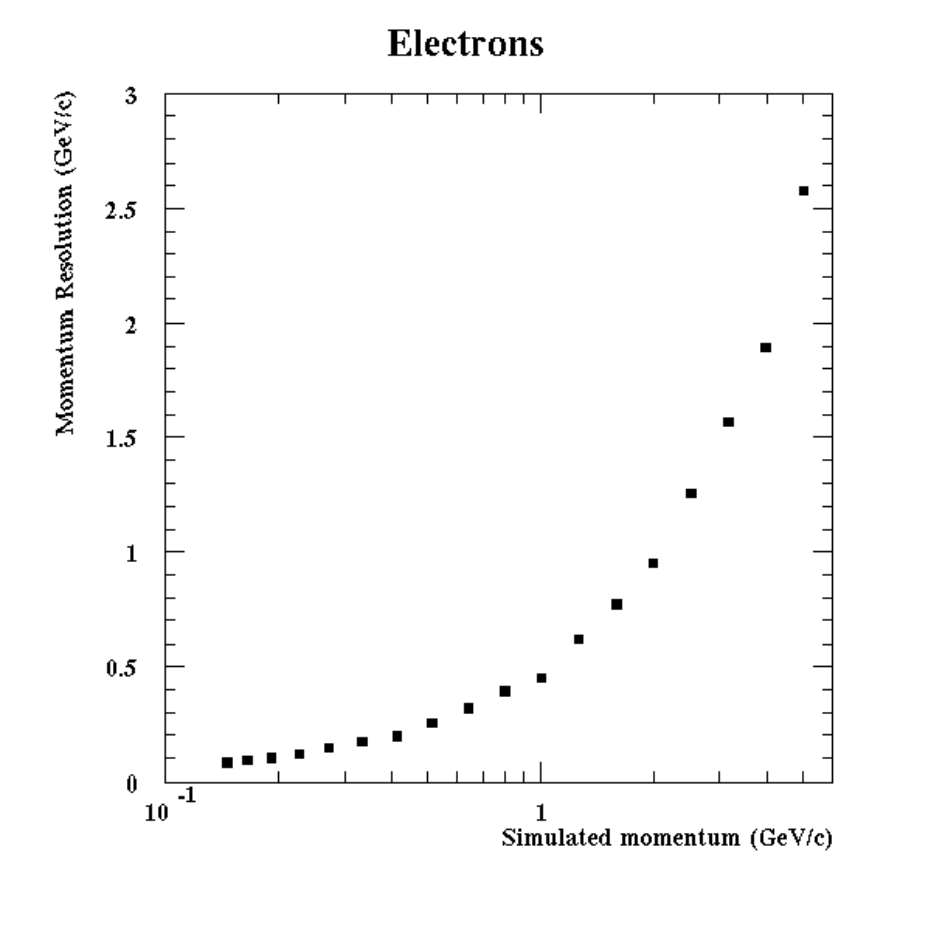
Efficiency


Muons
Efficiency
1
0.8
0.6
0.4
0.2
0
1
Simulated Momentum (GeV/c)

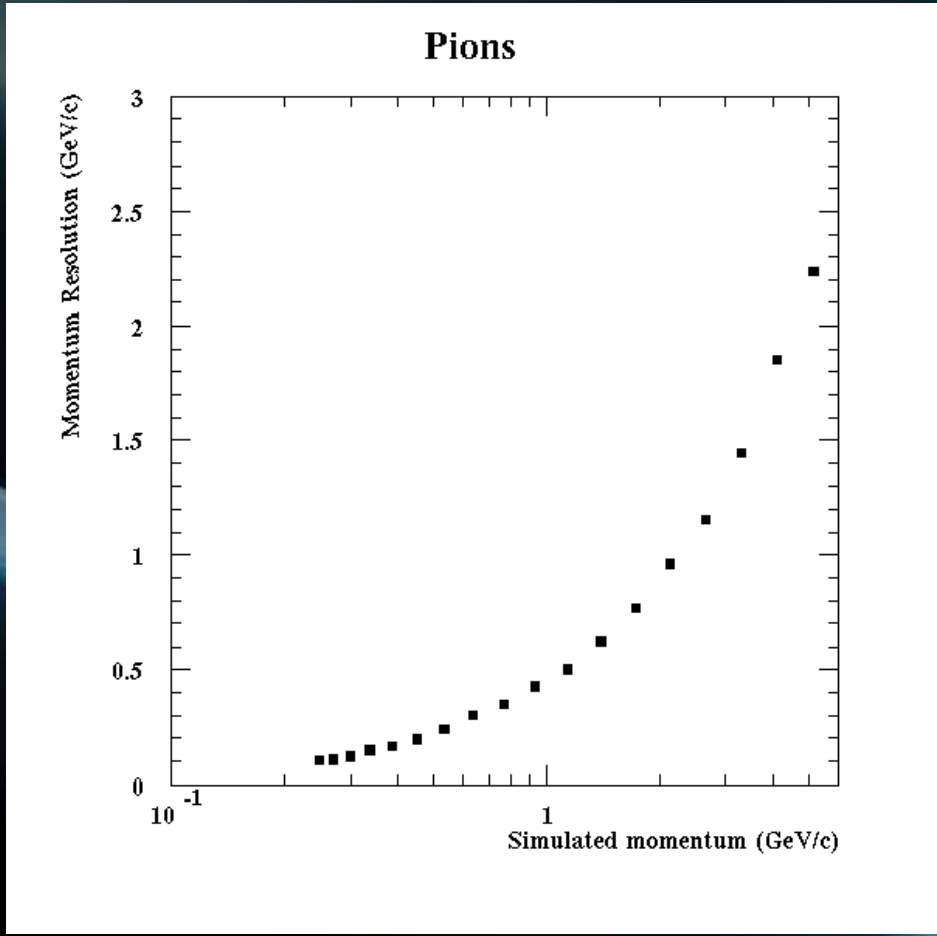

Electrons
Efficiency
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
Simulated Momentum (GeV/c)

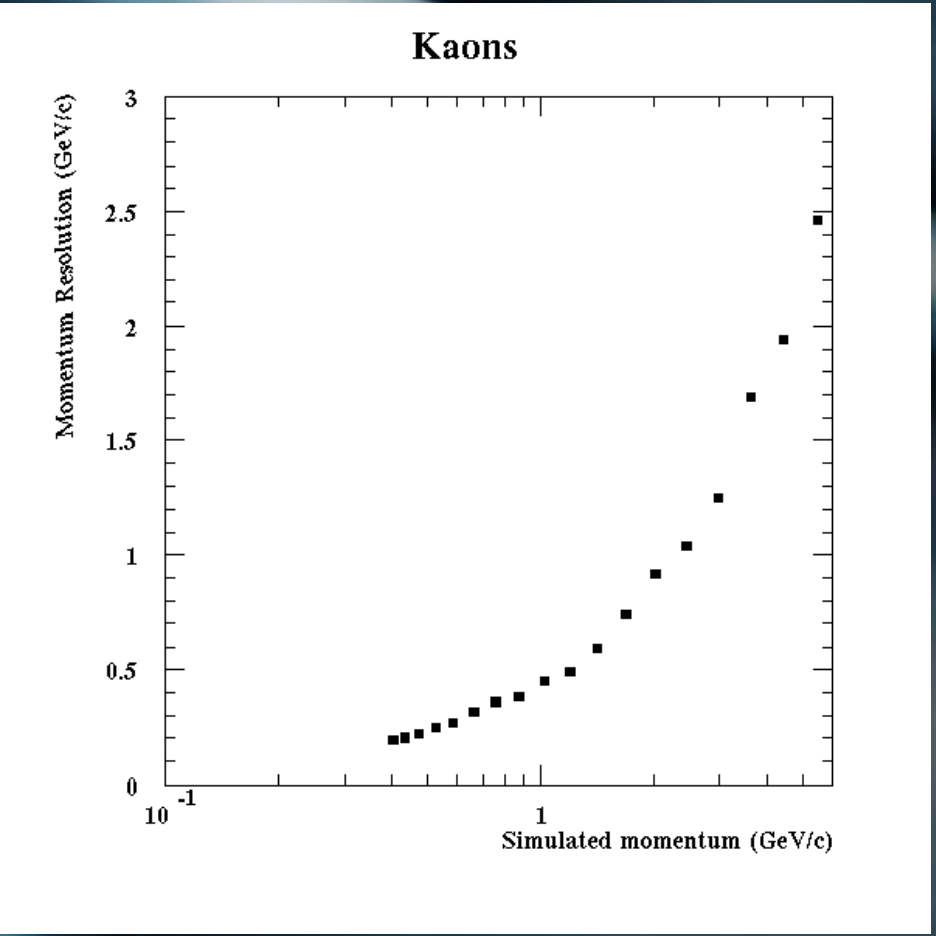
Momentum Resolution



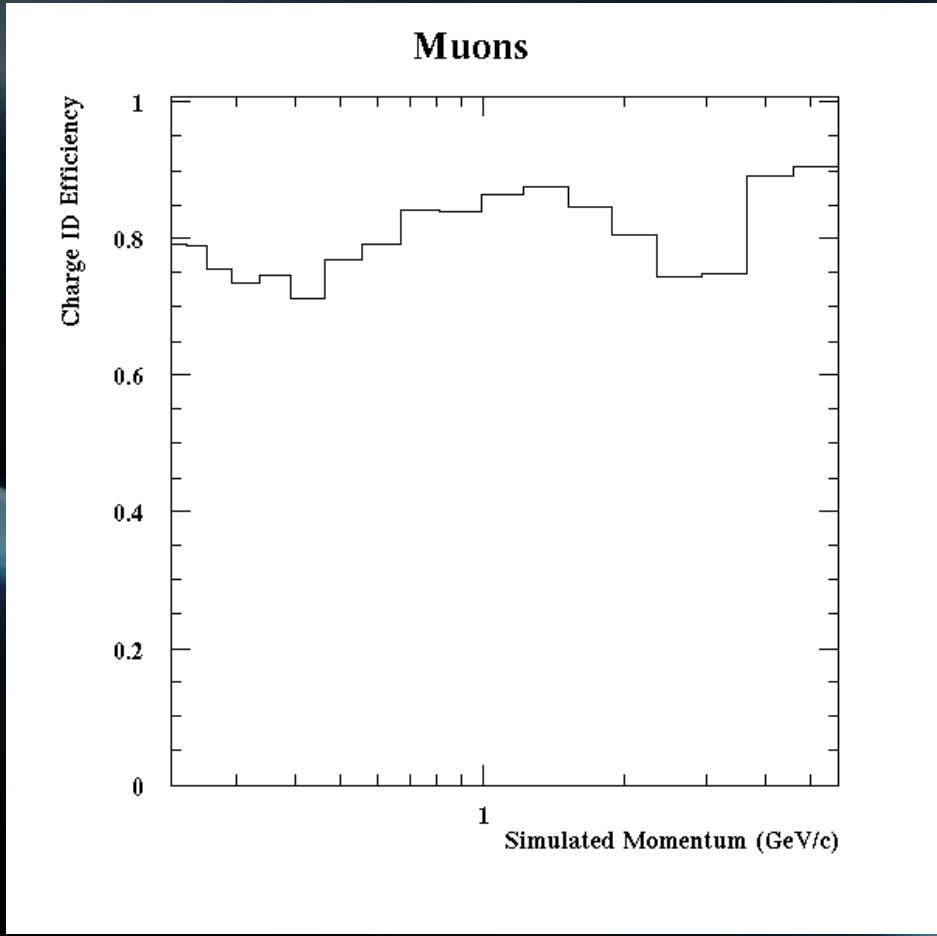


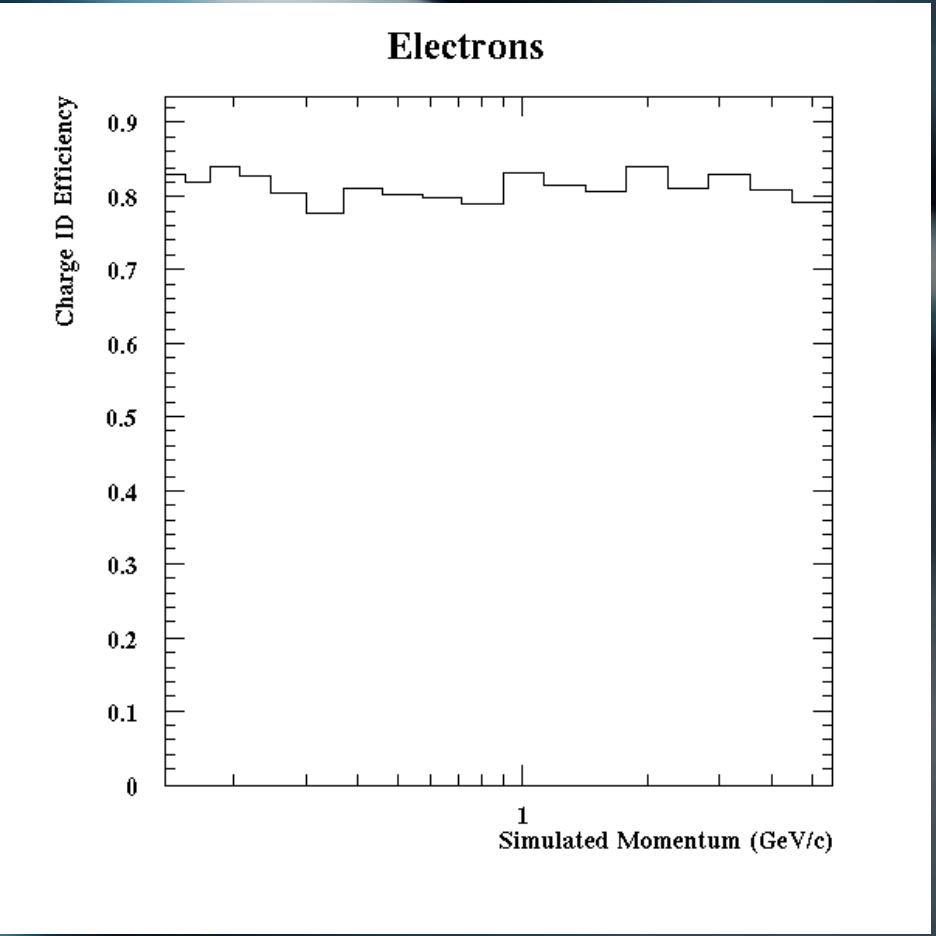
Momentum Resolution



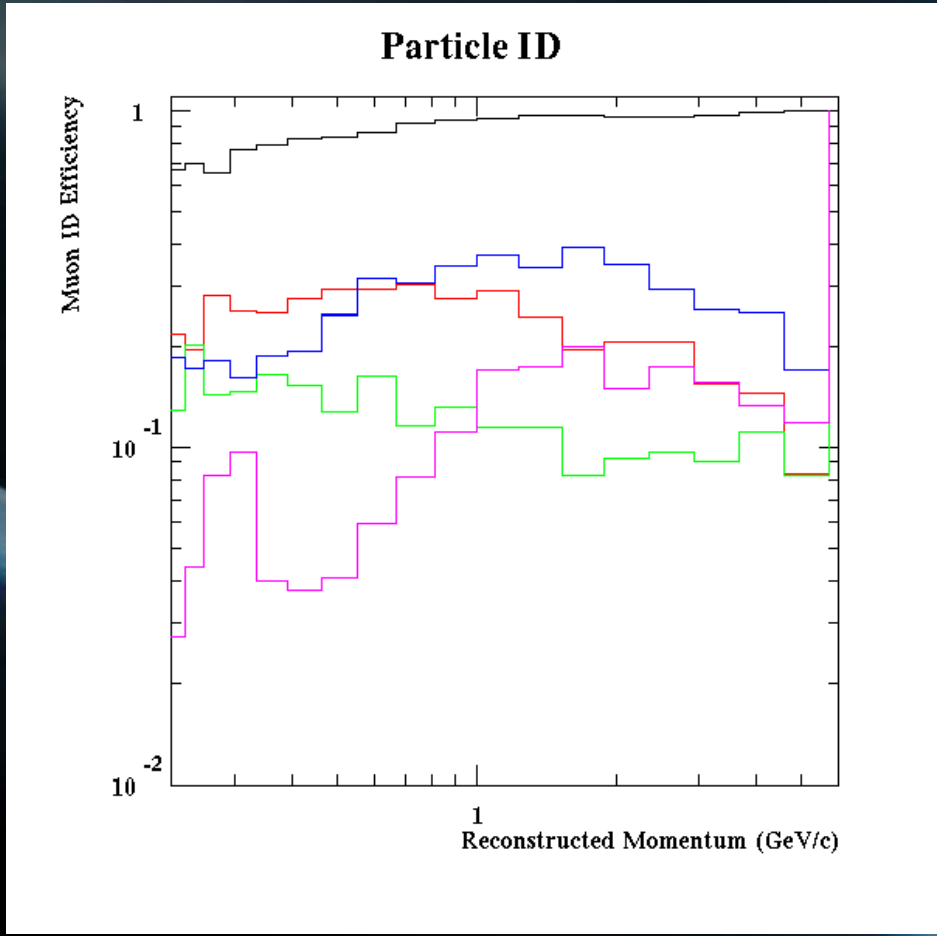


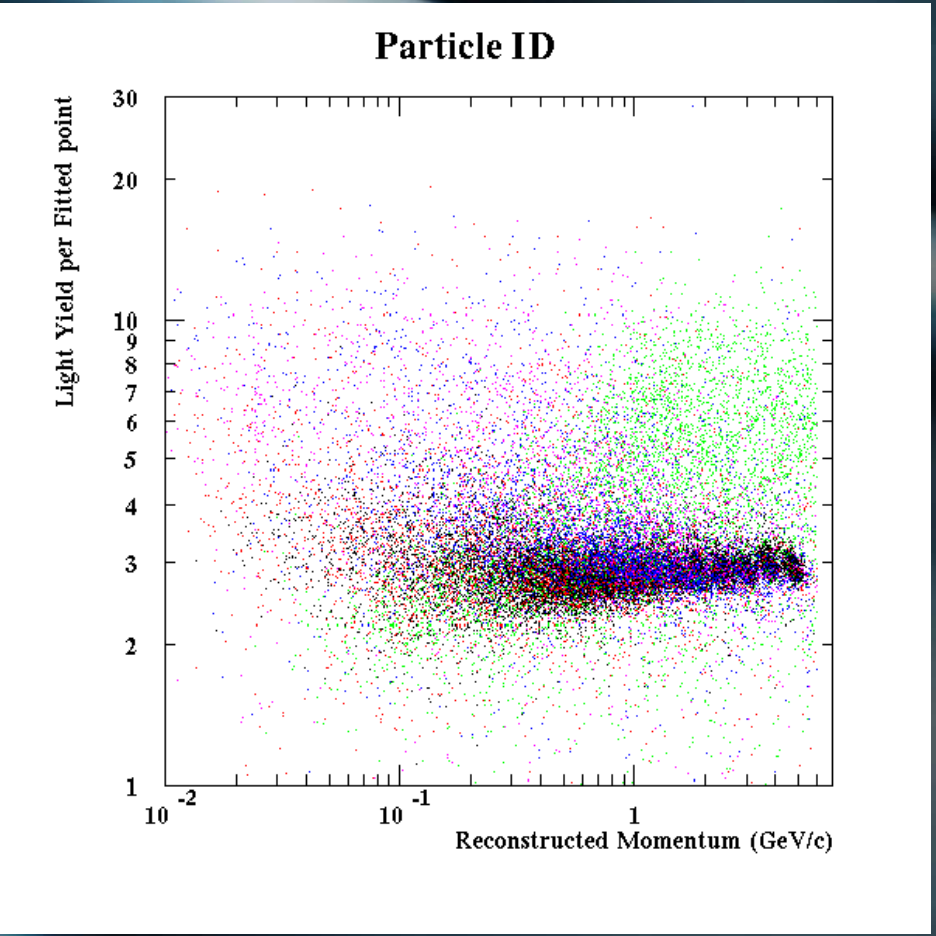
Charge ID


Muons
Charge ID Efficiency
1
0.8
0.6
0.4
0.2
0
1
Simulated Momentum (GeV/c)


Electrons
Charge ID Efficiency
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
Simulated Momentum (GeV/c)

Particle ID


Particle ID
Muon ID Efficiency
1
10^-1
10^-2
1
Reconstructed Momentum (GeV/c)


Particle ID
Light Yield per Fitted point
30
20
10
9
8
7
6
5
4
3
2
1
10^-2
10^-1
1
Reconstructed Momentum (GeV/c)

Next Steps

- Complete detailed write-up of modified code and current status of performance.
-
- Hand over software to Glasgow for continuing work:
  - Further improvements to code.
  - High statistics study of TASD performance.
  - First comparison of TASD on MIND based on full reconstruction using the same software framework.