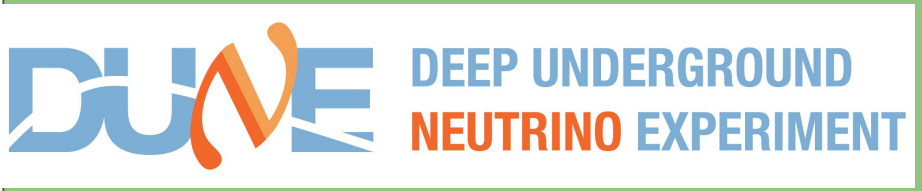
1 GeV Beam dE/dx Study

ProtoDUNE Analysis Meeting- 02/21/2019

Owen Goodwin

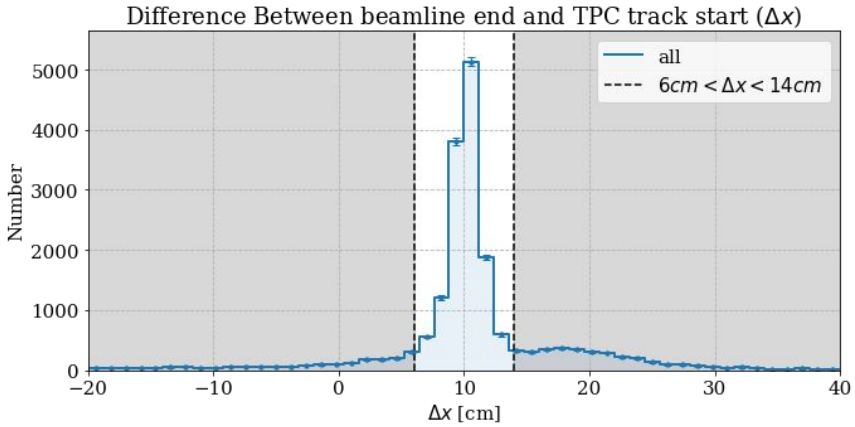


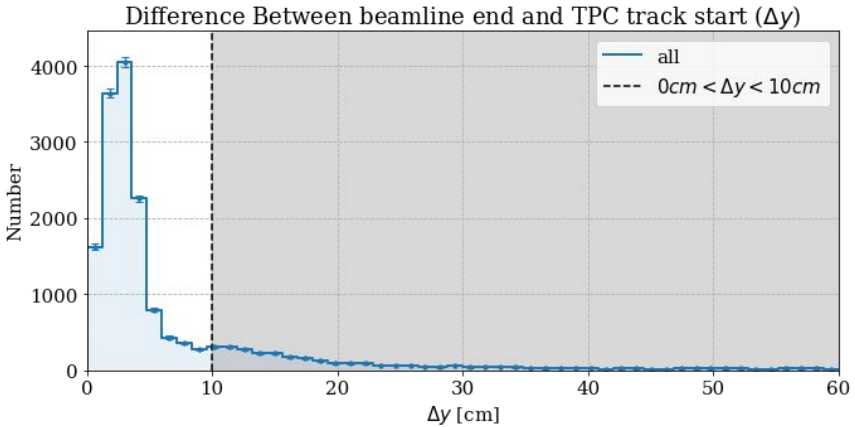
Introduction

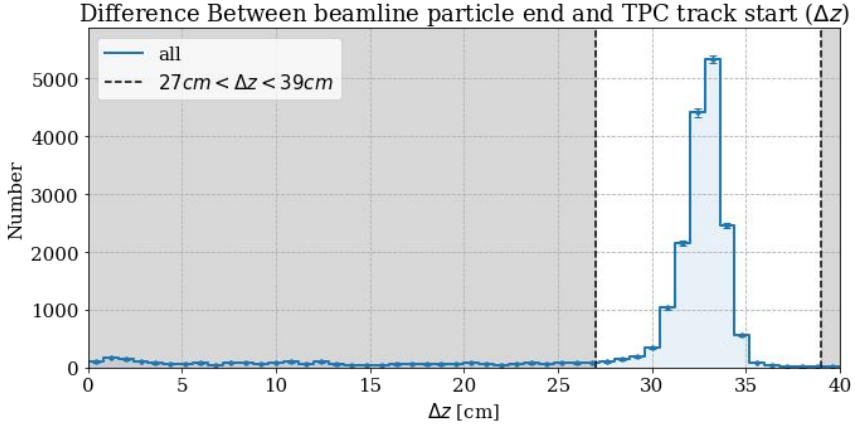
- Looking at dE/dx of reconstructed 1 GeV candidate tracks.
- Using all of Run 5387 (defname `runset-5387-reco-unified-hv-180kV-beam-1GeV-v0`);
  - 1 GeV Beam Momentum
  - 180 kV drift field
  - Hadron Trigger
- Use Justin Hugon's beamline filter to select 1 GeV Pion events. Details here https://indico.fnal.gov/event/19185/contribution/2/material/slides/0.pdf
- Then use protoana::ProtoDUNEPFParticleUtils to get reconstructed TPC beam particle

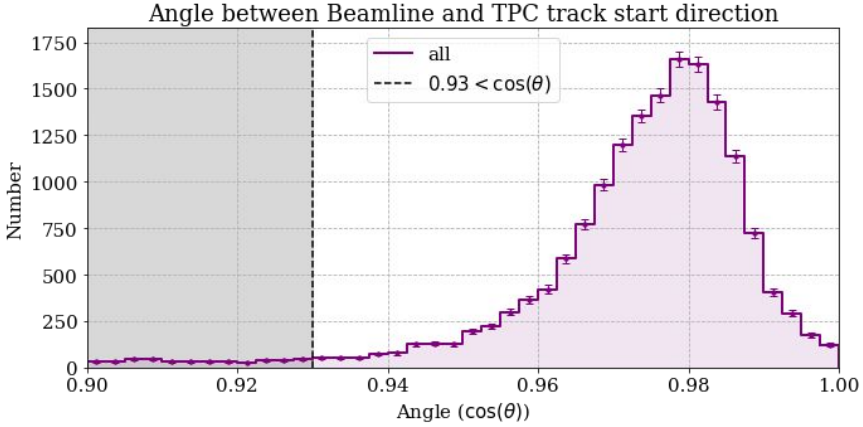
Selection Cuts

Owen Goodwin 02/21/2019







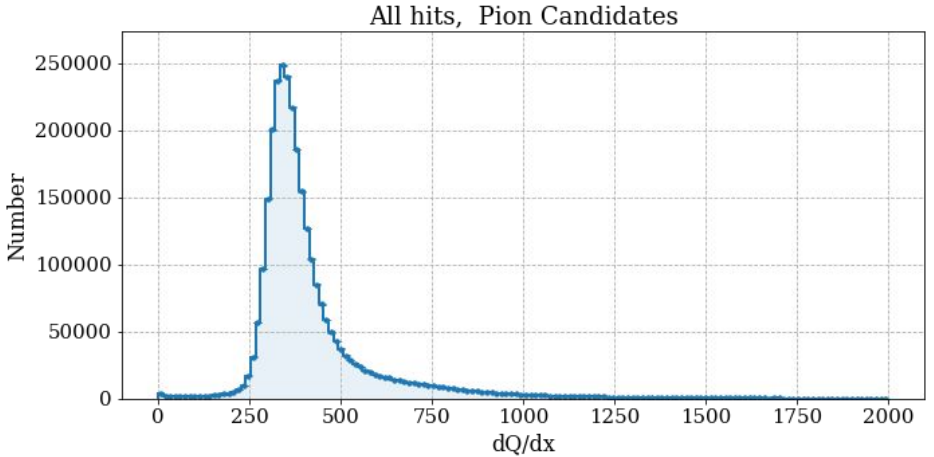


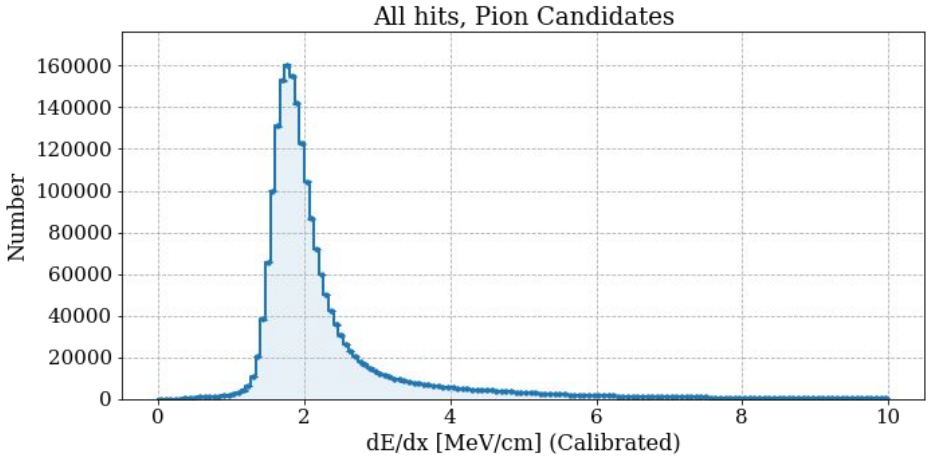
Calorimetry

Owen Goodwin 02/21/2019

MANCHESTER 1824
The University of Manchester

- Use Ajib's calorimetry correction to calibrate, described here. https://docs.dunescience.org/cgi-bin/private/RetrieveFile?docid=12997&filename=Stopping_muon_calibration.pdf&version=1
- Uses cathode crossing T0 tagged stopping muons. Calibration is for collection plane.
- Done for run 5387 (this run)

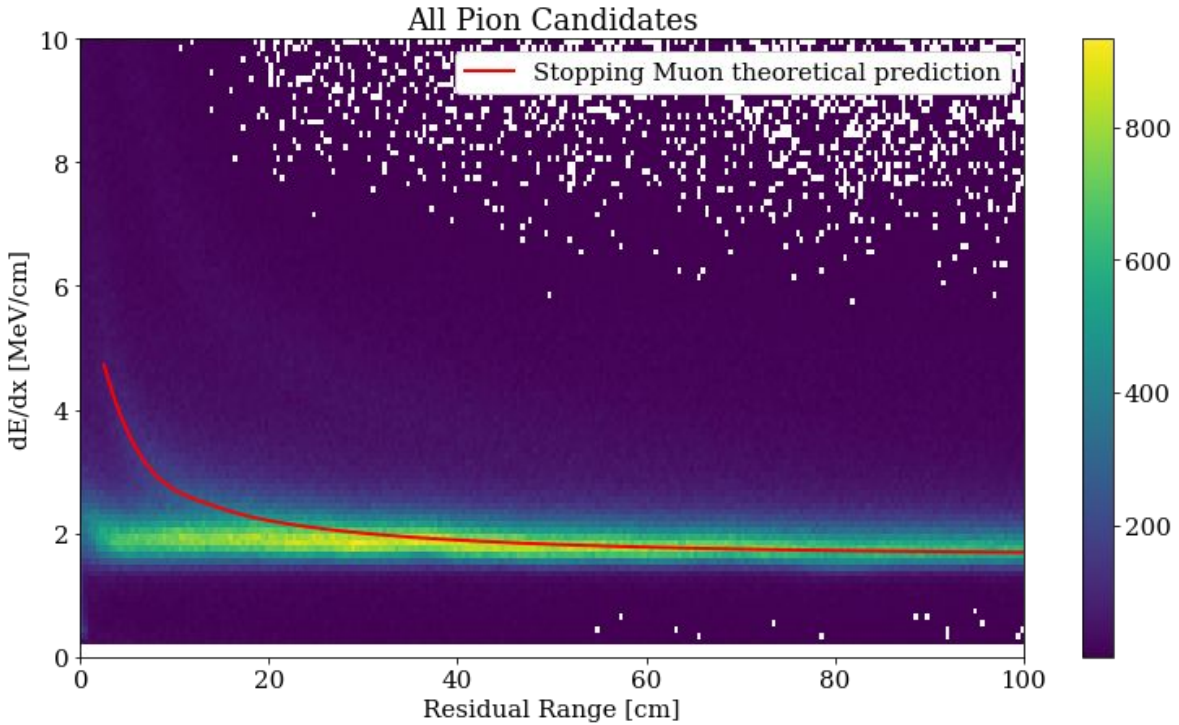




Residual Range vs dE/dx

Owen Goodwin 02/21/2019

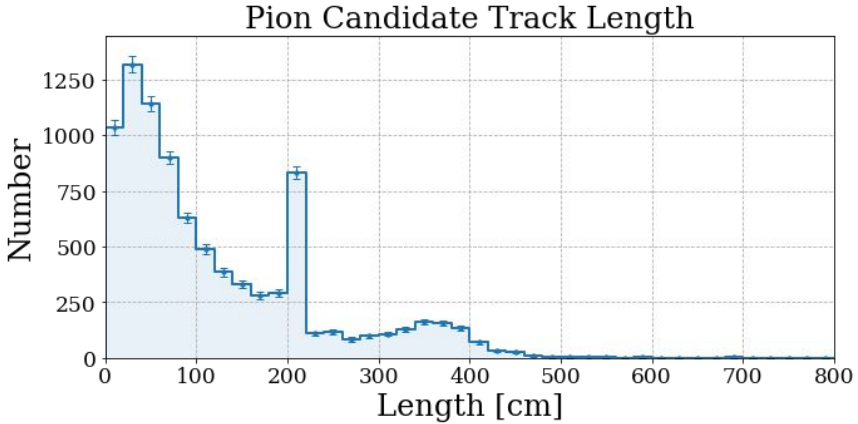
- Clear MIP region.
- Most Particles don't stop, as expected, Pions will interact

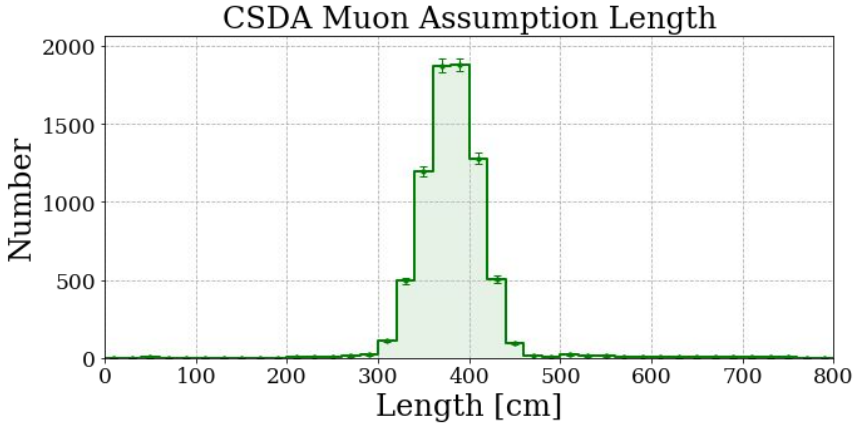


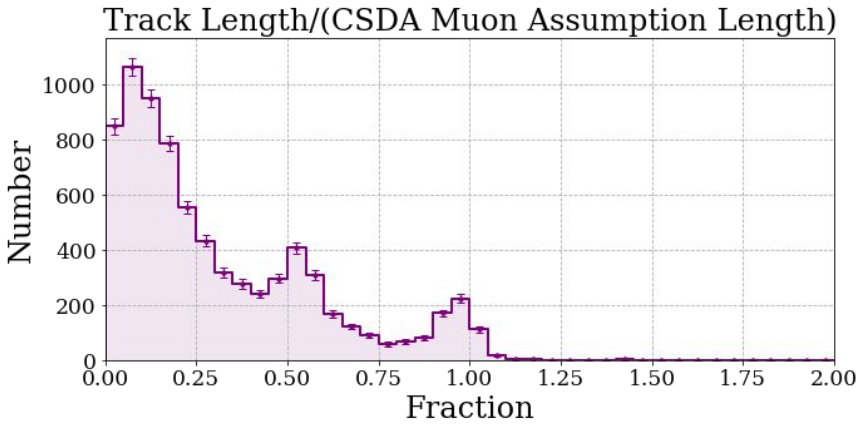
Selecting Beam Stopping Muons

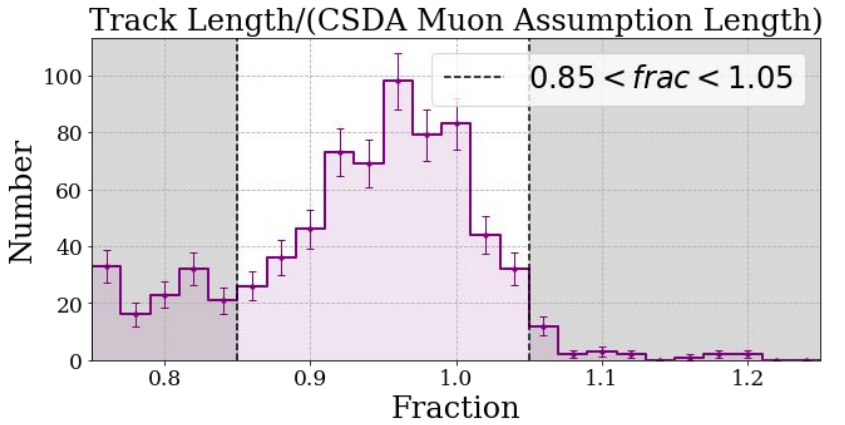
Owen Goodwin 02/21/2019

MANCHESTER 1824
The University of Manchester









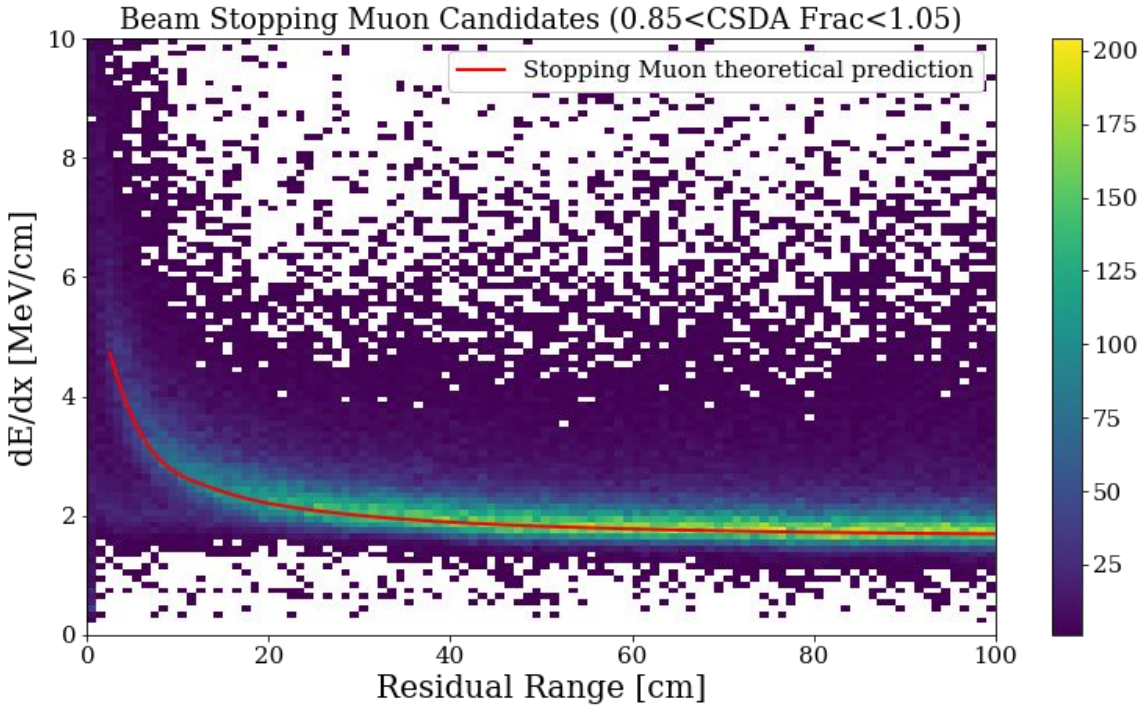
Stopping muons

Owen Goodwin 02/21/2019

Selecting tracks with track length compatible with Stopping Muon.

Clear Muon like bragg peak shown, matches prediction.

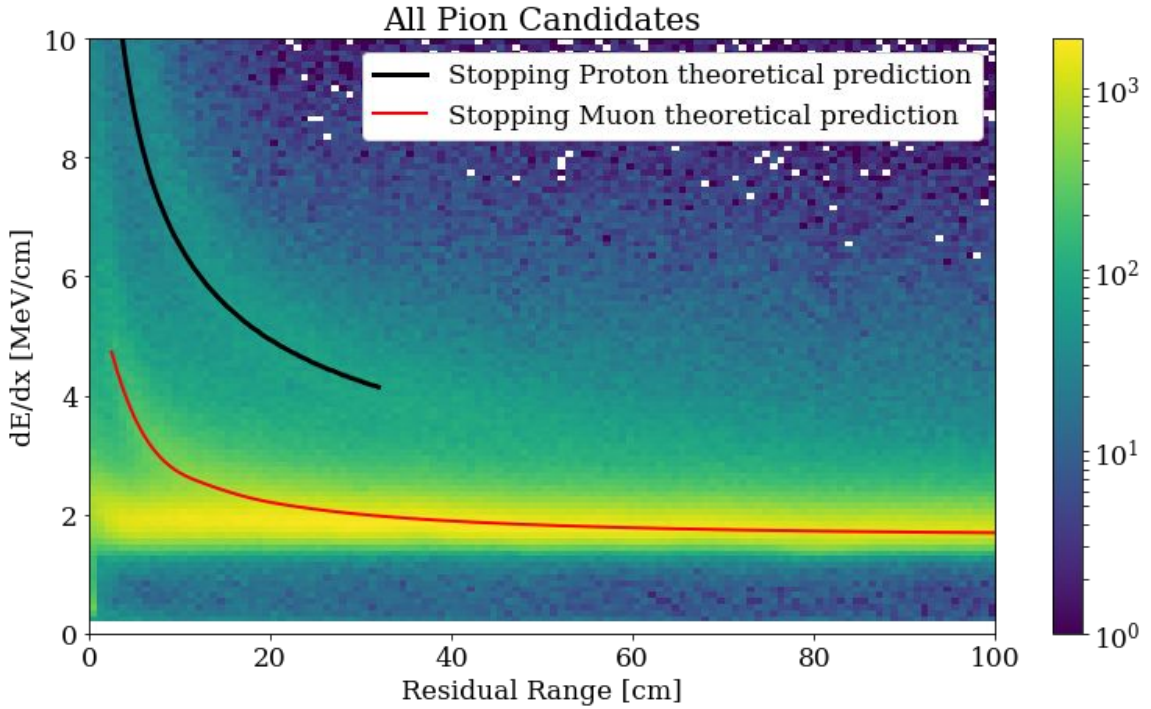
Beam cross check of cosmic calibration



Plotting all candidates with a logarithmic Z scale show, small component consistent with stopping proton Bragg peak.

Possibly protons produced by beam Pion interactions?

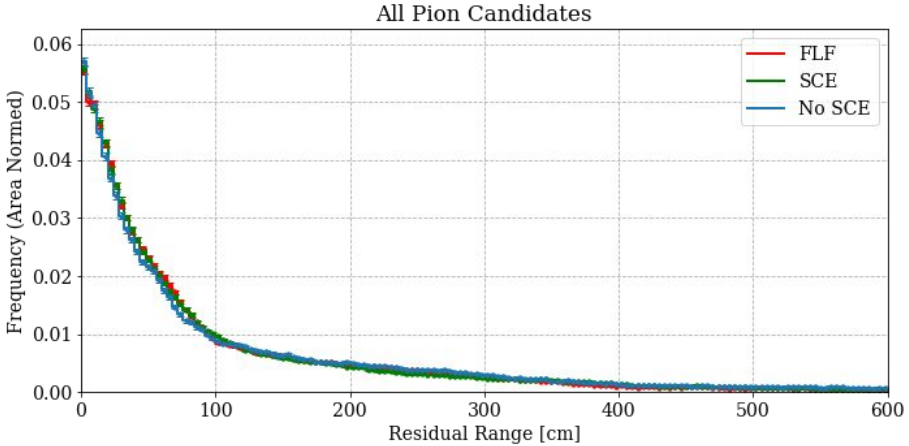
Going to look at some event dispays

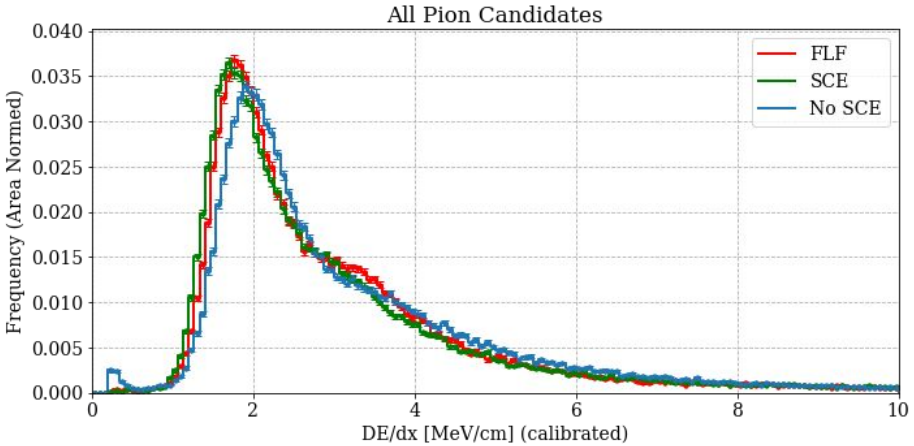


Monte Carlo

Owen Goodwin 02/21/2019

- 1 GeV Beam MC.
- Select events where beam particle is true pion
- Use Ajib's calibration for each MCC11 sample (No SCE, SCE, SCE+FLF)

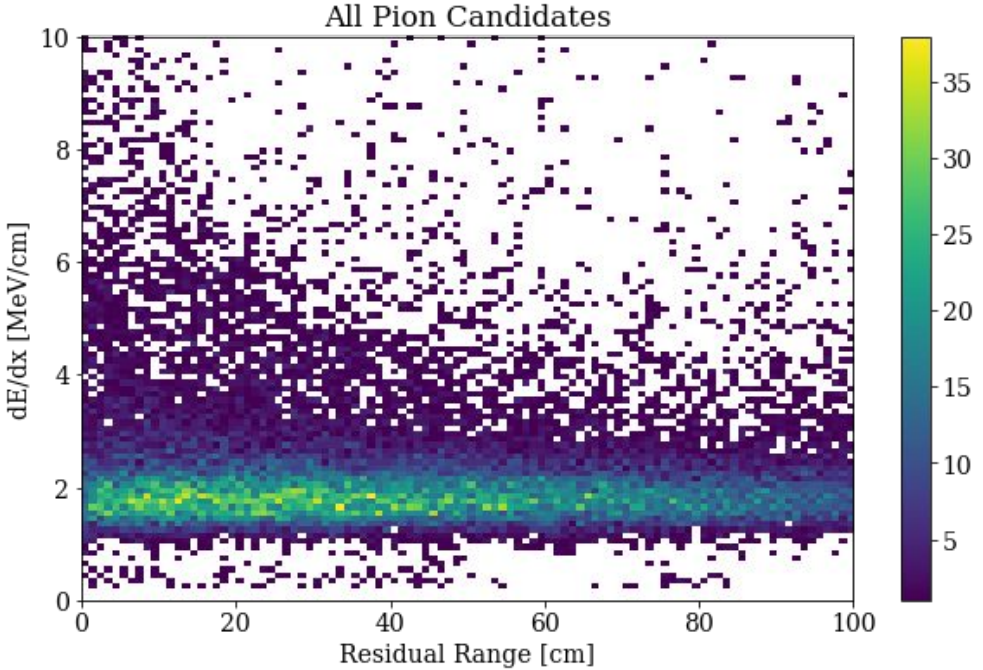




Residual Range vs dE/dx (FLF MC)

Owen Goodwin 02/21/2019

MANCHESTER 1824
The University of Manchester



Very low stats (~300 true pions events in each sample)

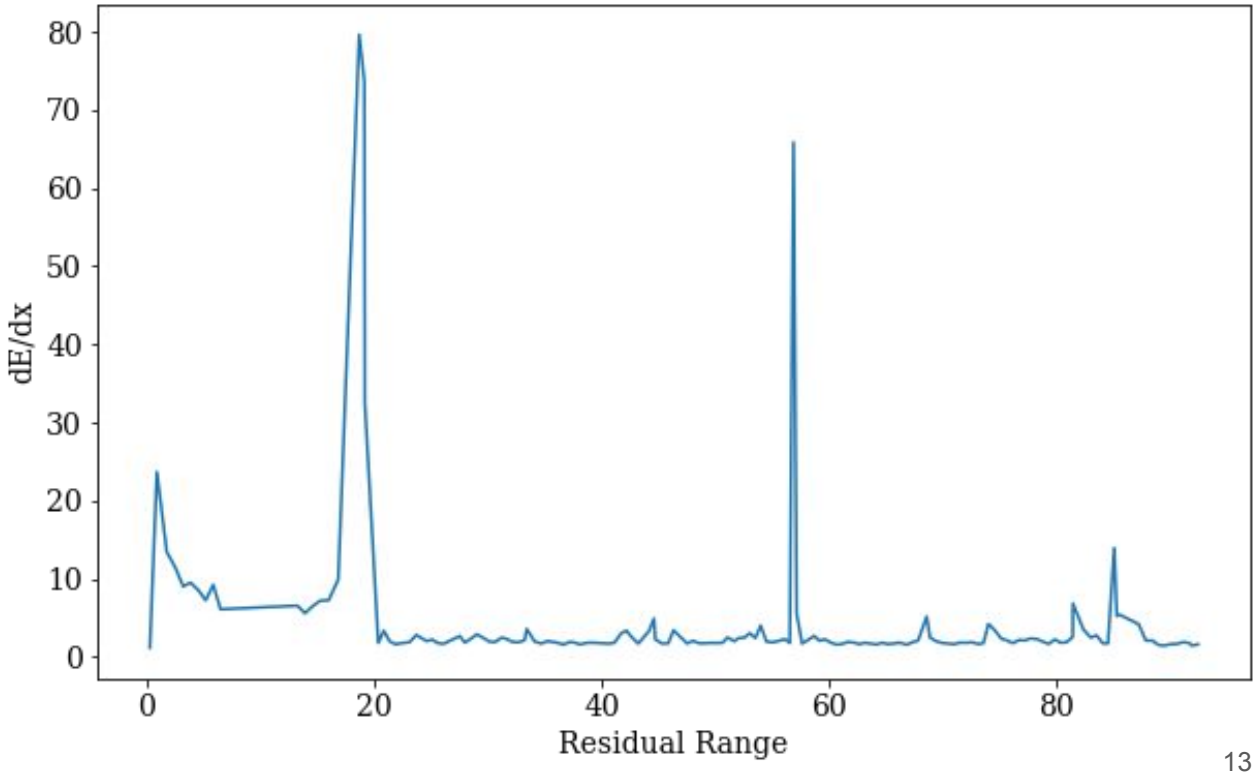
4 true pion events in stopping region

Plans

- Would like to run data/MC comparisons with higher stats MC.
- Longer term goal to reconstruct energy spectrum of Michel electrons from selected beam muons

BACKUP

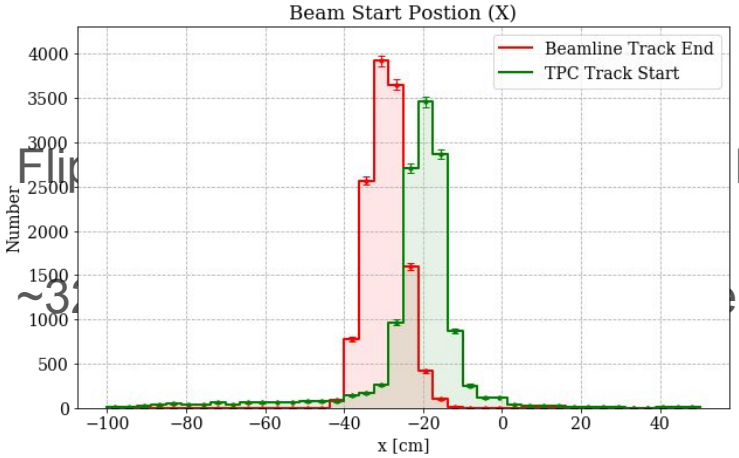
Rough PID. Interacting pion->proton?

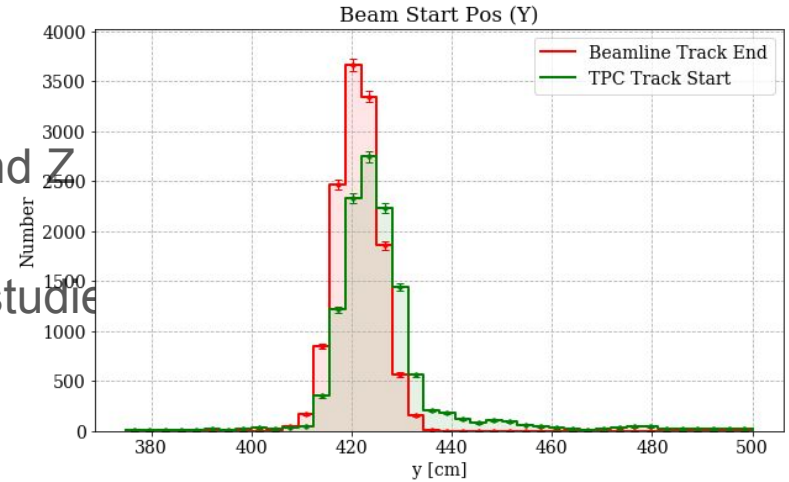


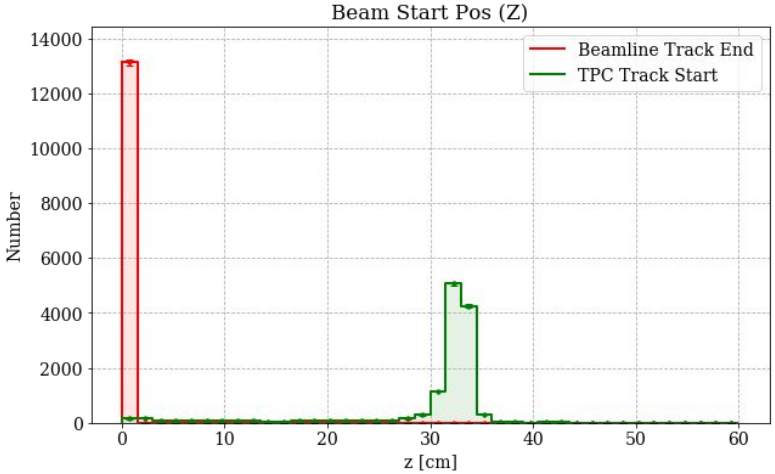
Beam Start Position

Owen Goodwin 02/21/2019

MANCHESTER 1824
The University of Manchester



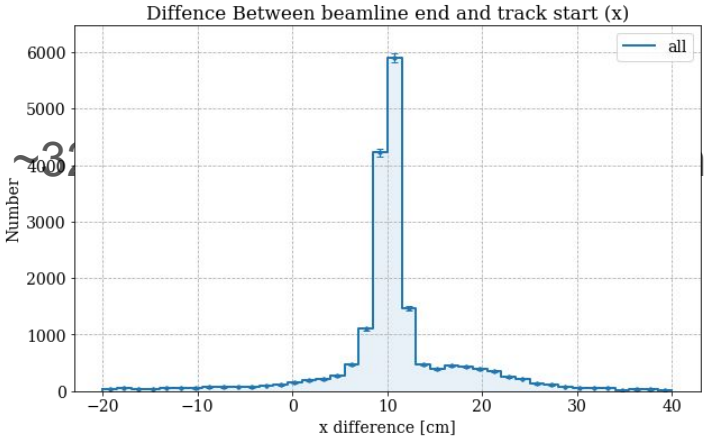


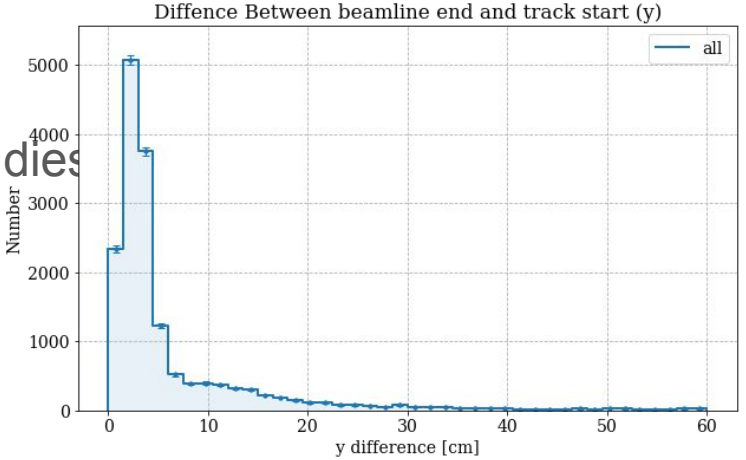


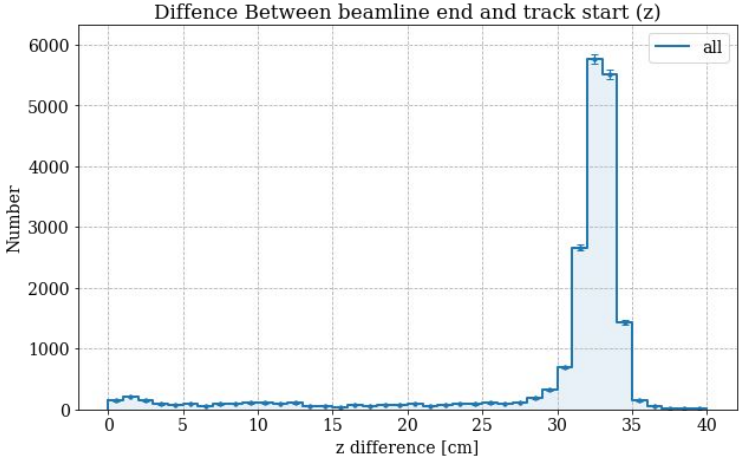
Beam Start Position

Owen Goodwin 02/21/2019

~3[illegible]er studies

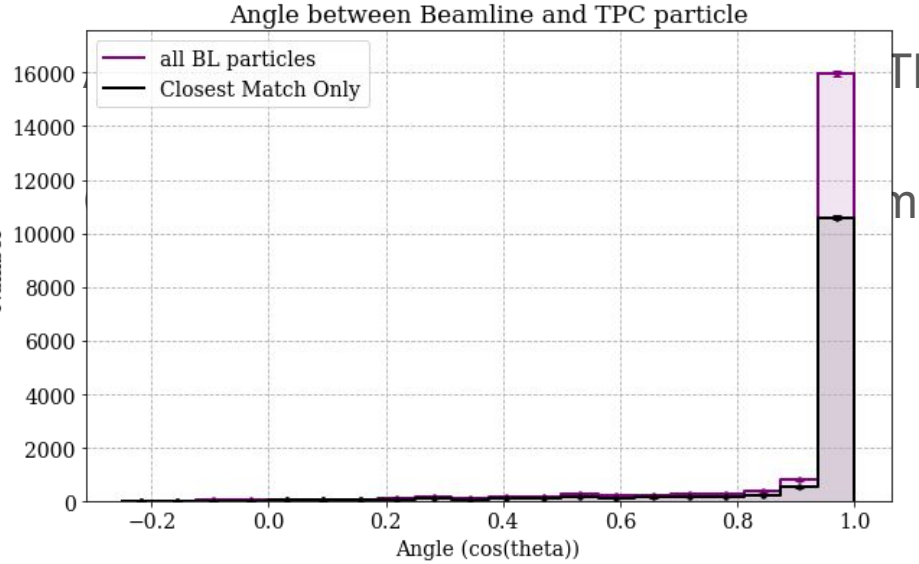


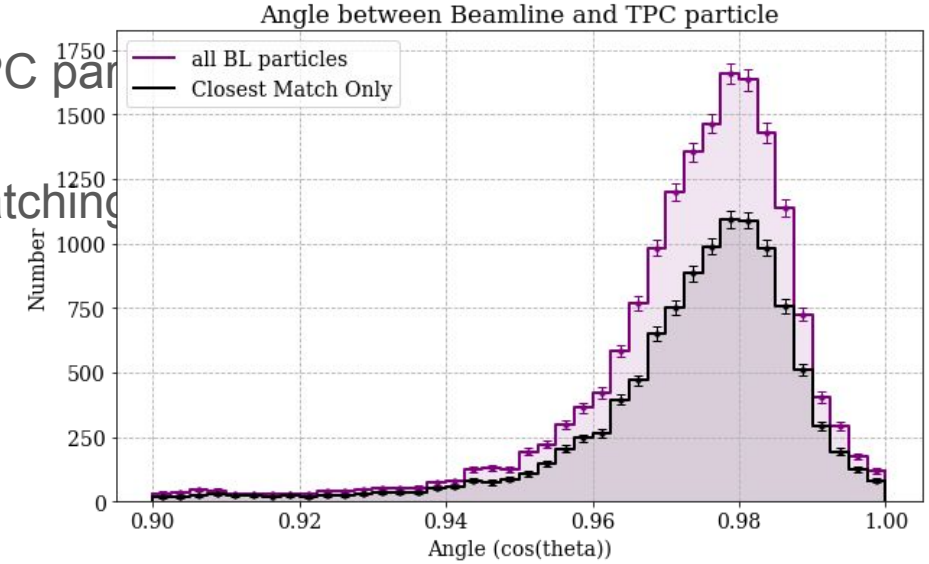




Directional Match

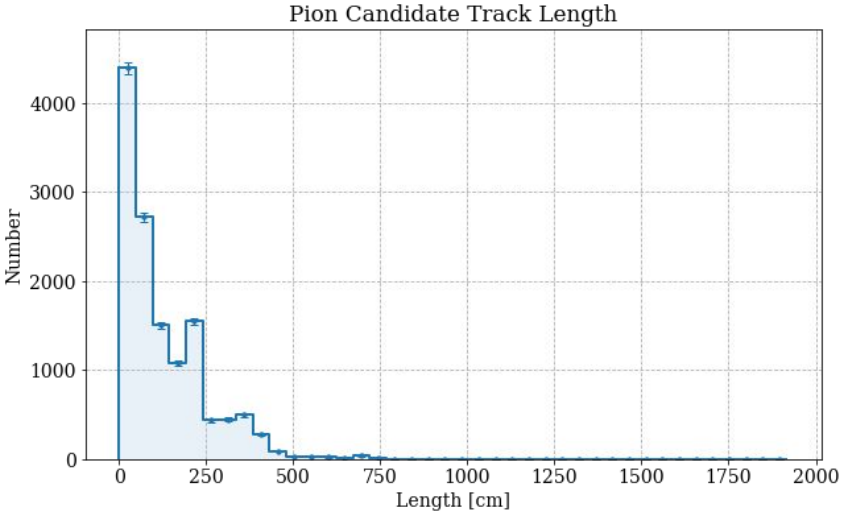
Owen Goodwin 02/21/2019

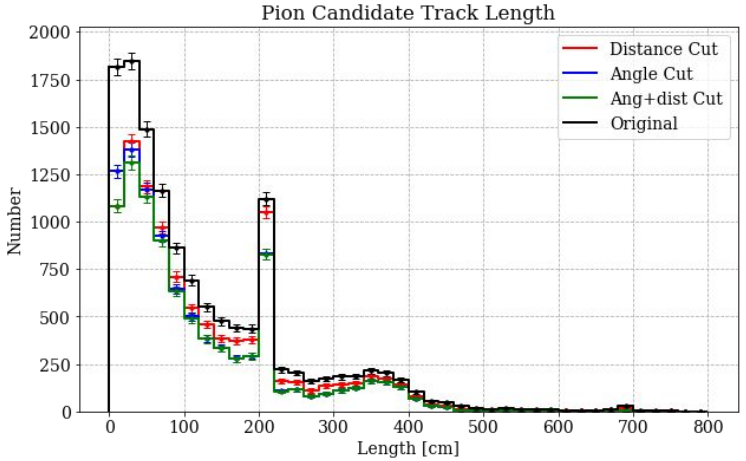


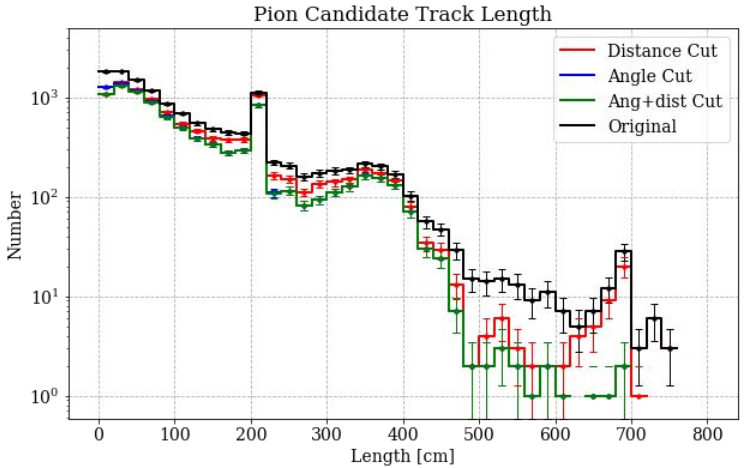


Track Length

Owen Goodwin 02/21/2019







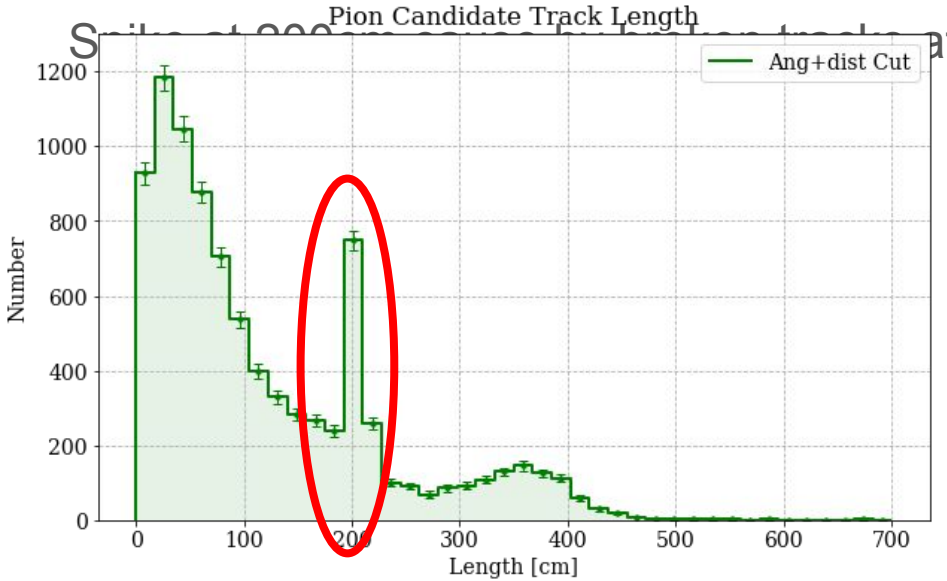
Distance Cuts: 6cm< x diff < 14cm and y diff < 10cm and 29cm<z diff <36 cm
Angle cut: Cos(theta)>0.9
Both Cuts remove extreme high length tail.

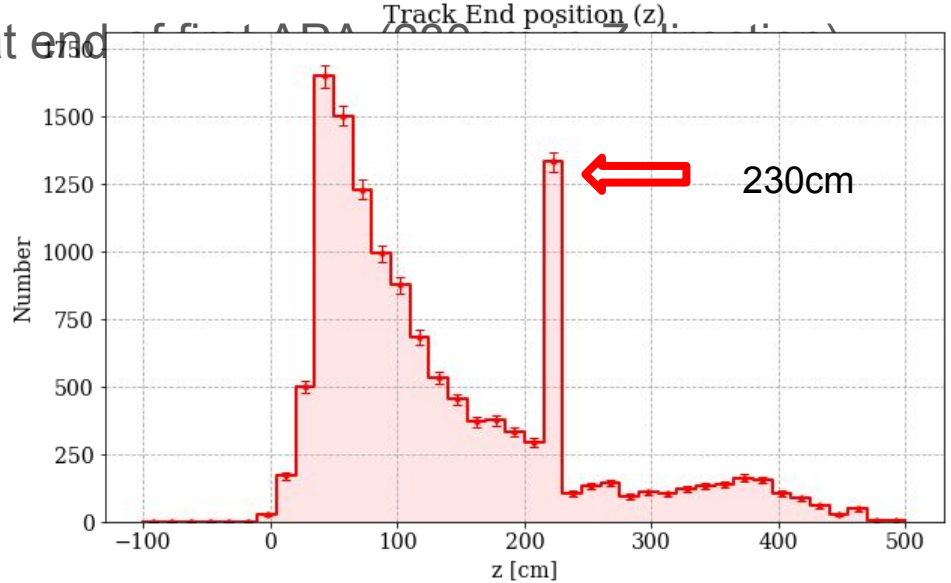
Track Length

Owen Goodwin 02/21/2019

MANCHESTER 1824
The University of Manchester

Spike at 200cm caused by broken tracks at end of first APA (600 cm in Z direction)

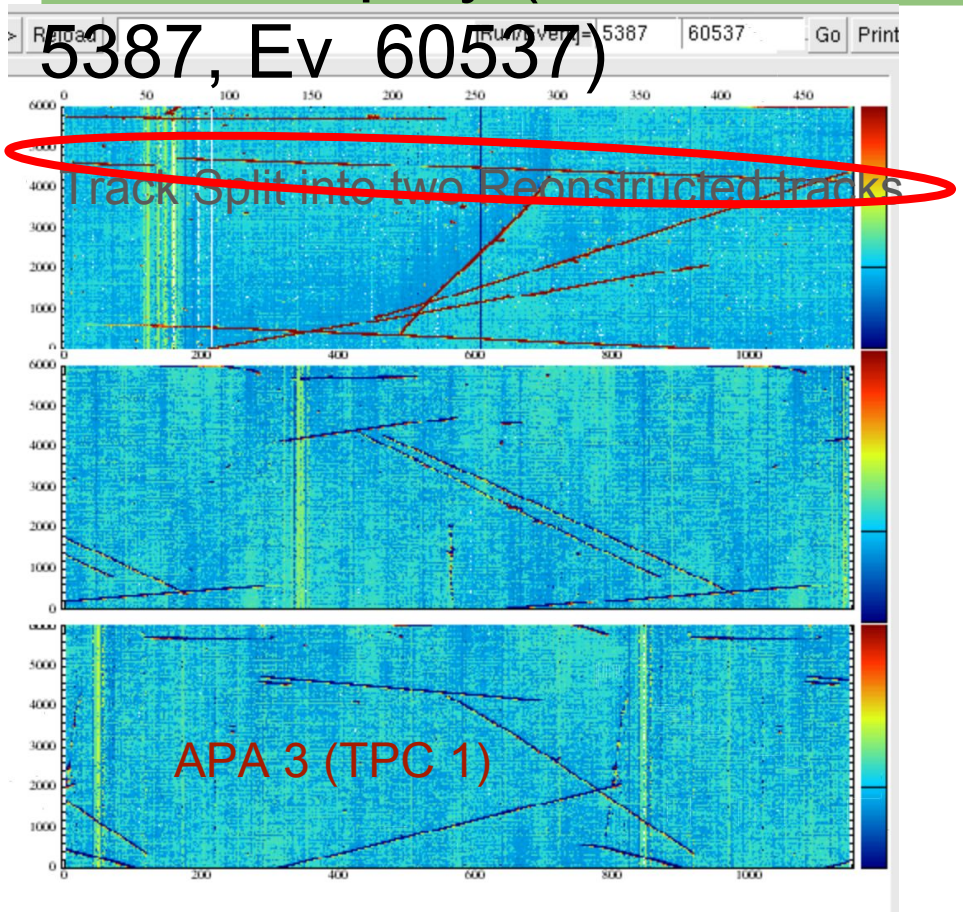


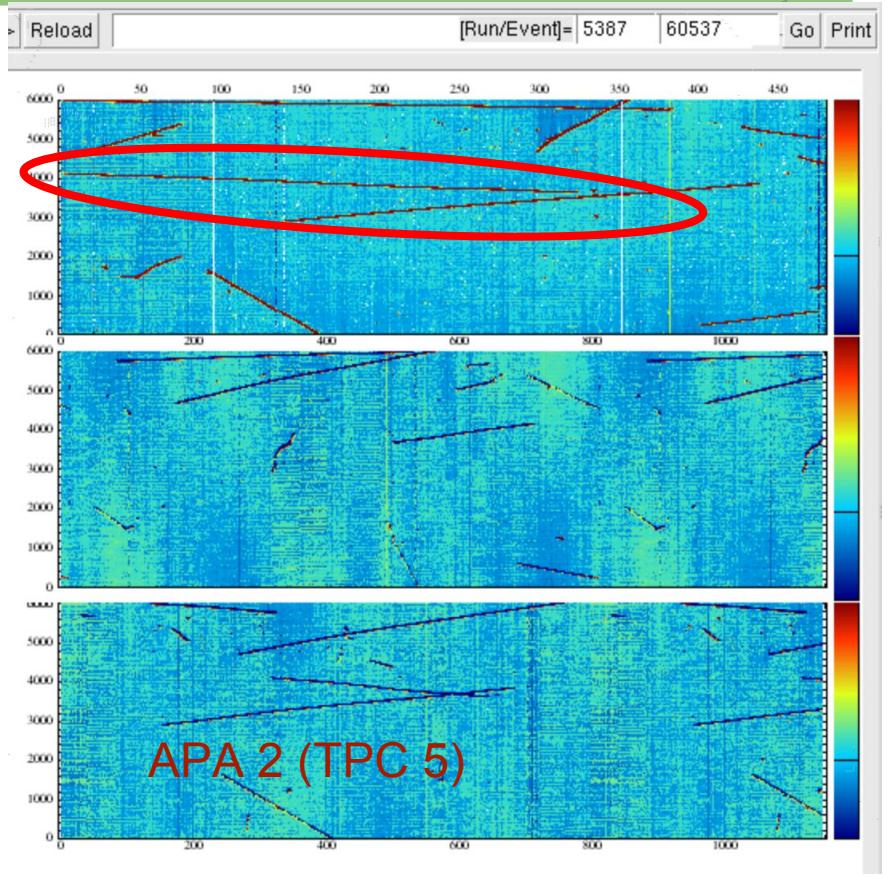


Event Display (Run 5387, Ev 60537)

Owen Goodwin 02/21/2019

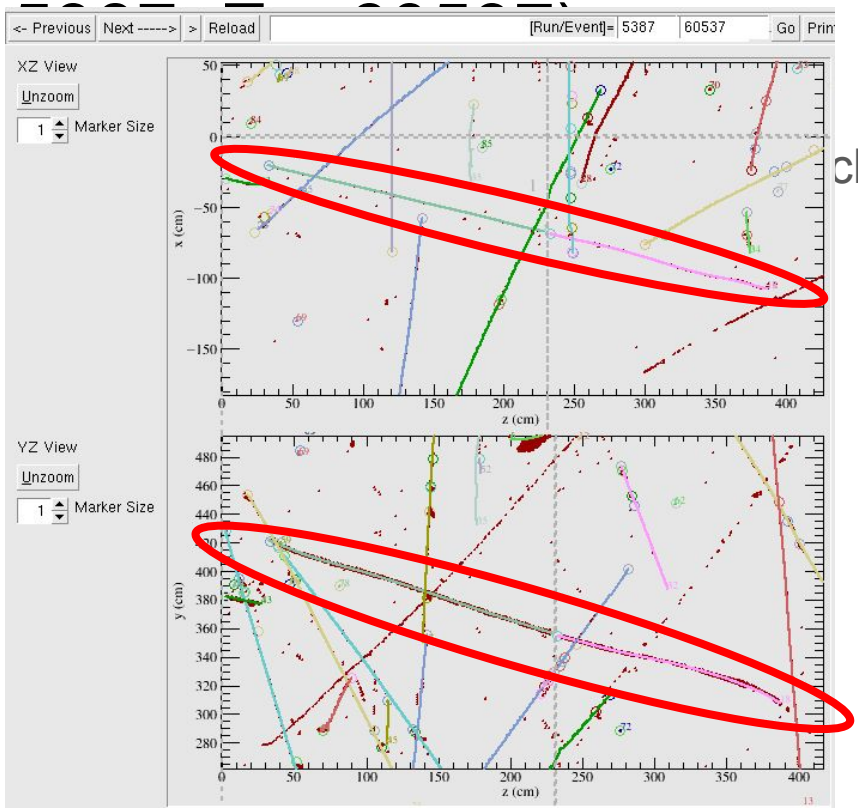
MANCHESTER 1824
The University of Manchester

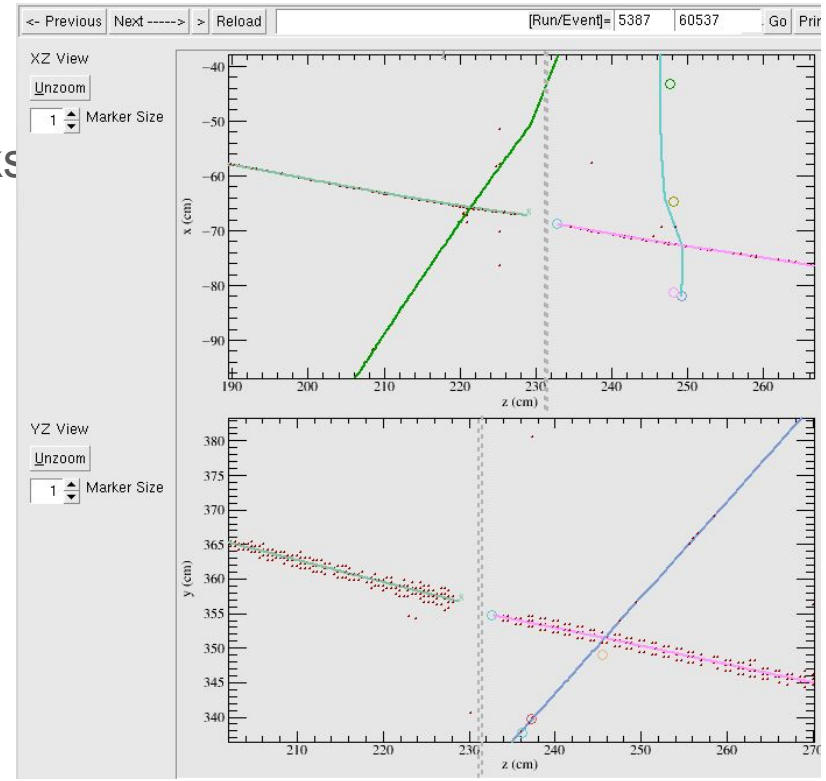




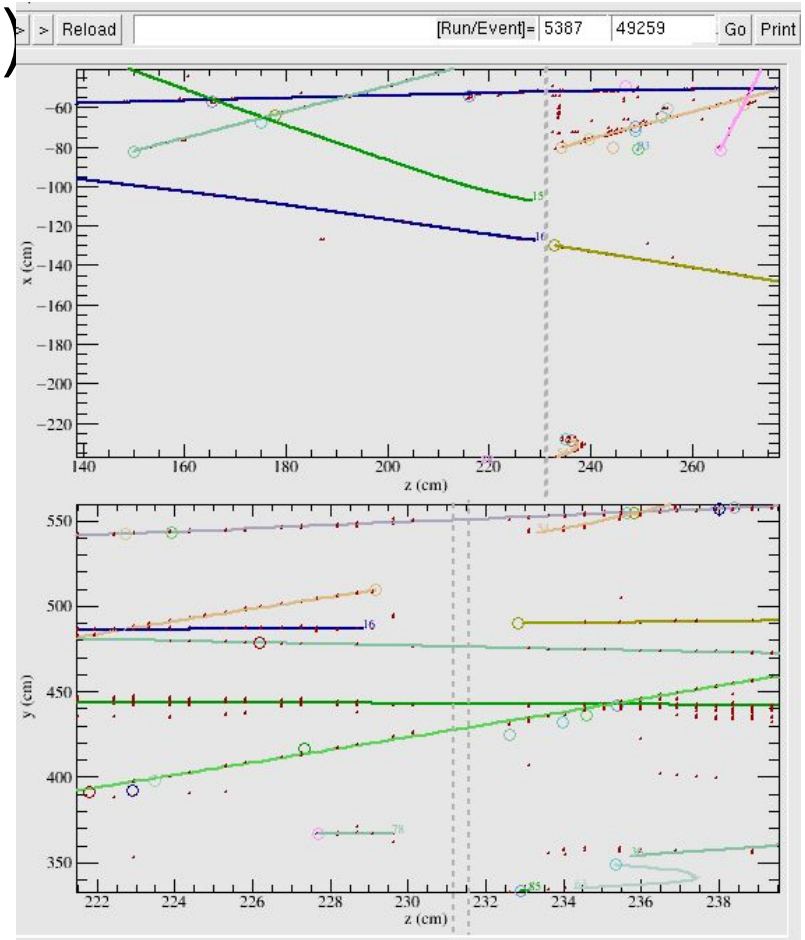
Event Display (Run

Owen Goodwin 02/21/2019

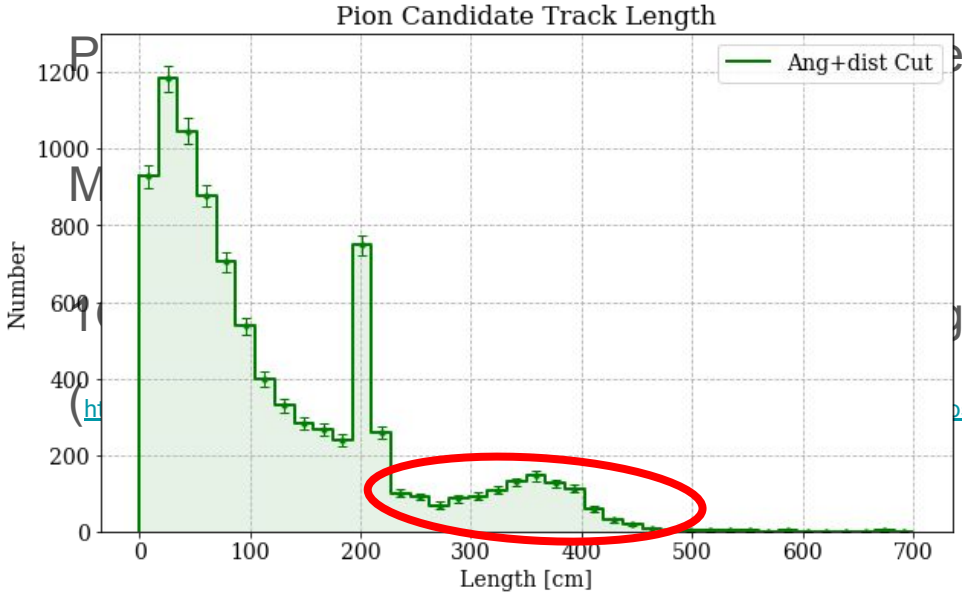




(Run 5387, Ev 49259)



Track Length



P ength at 1 GeV (<1m)

M

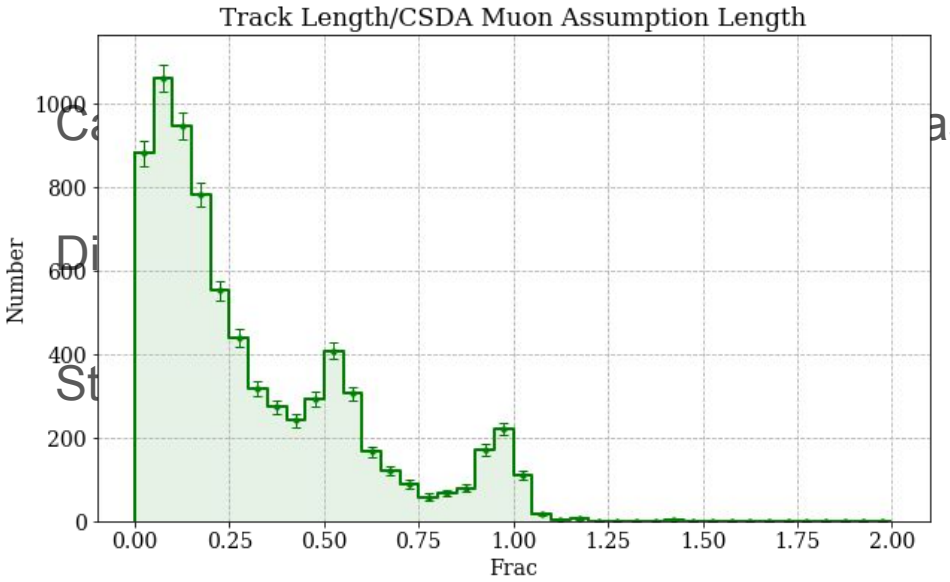
T ge using CSDA tables

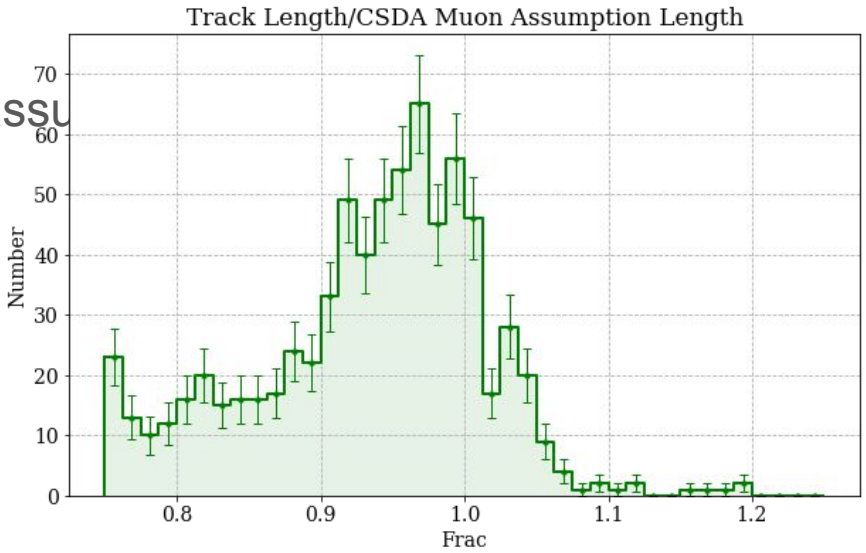
(oss_289.pdf) is ~395cm

Track Length

Owen Goodwin 02/21/2019

MANCHESTER 1824
The University of Manchester

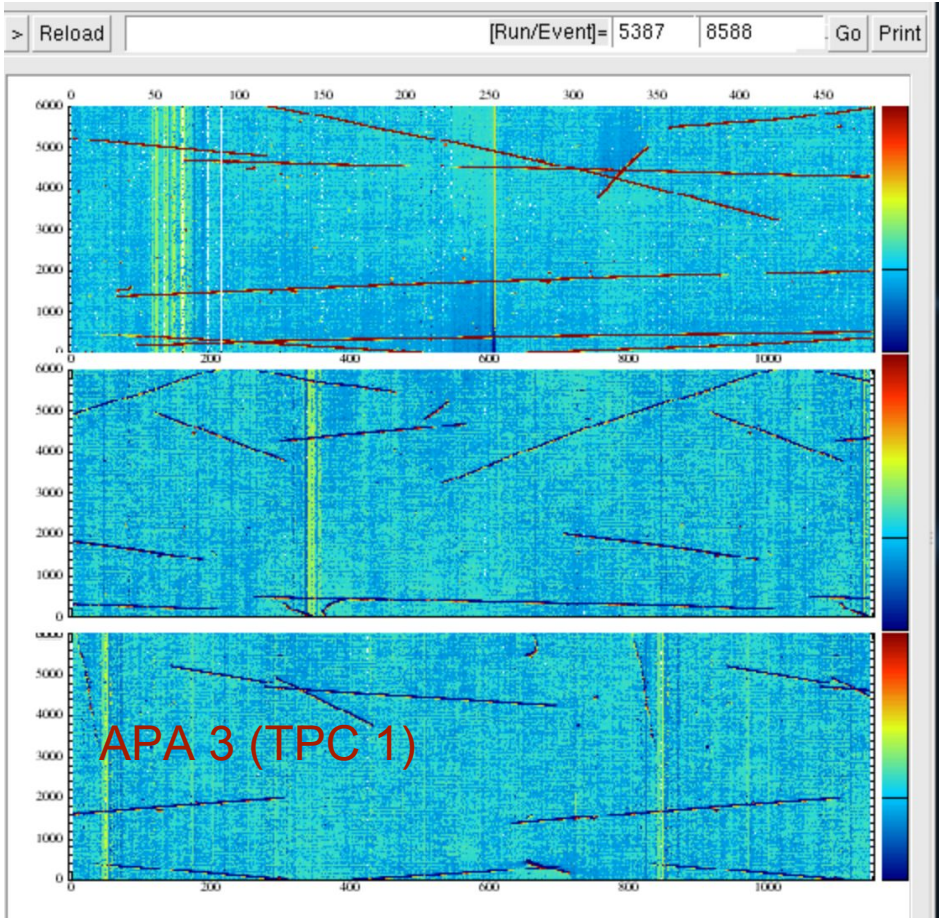


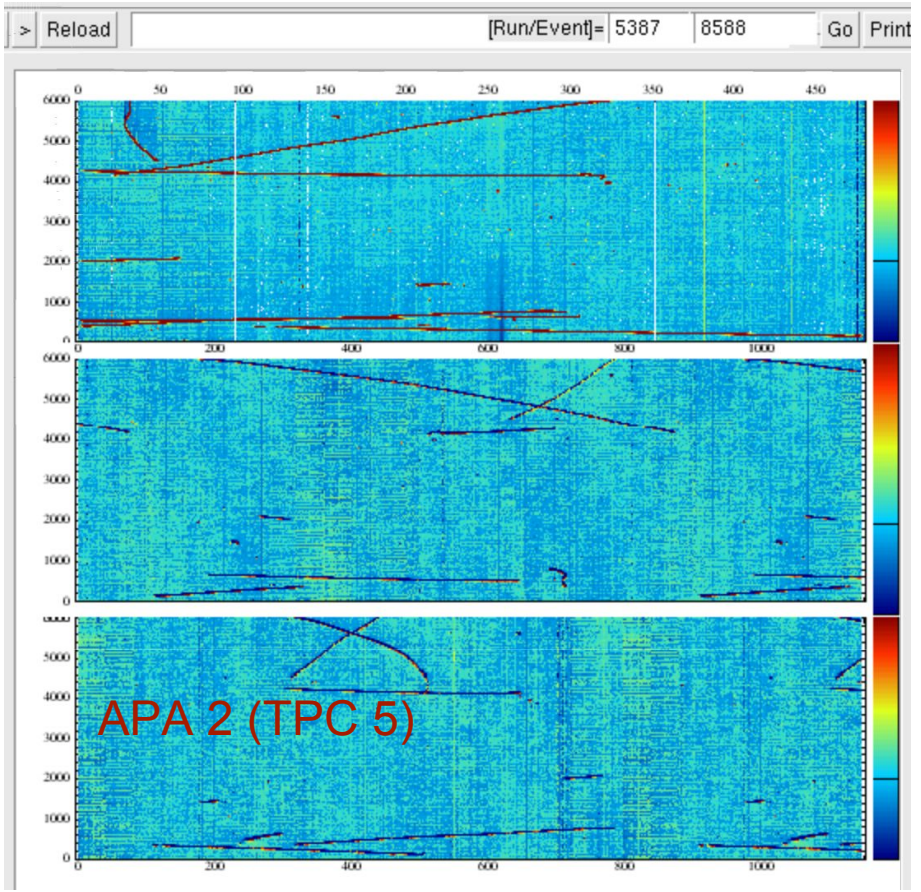


Run 5387, Ev 8588

Owen Goodwin 02/21/2019

MANCHESTER 1824
The University of Manchester

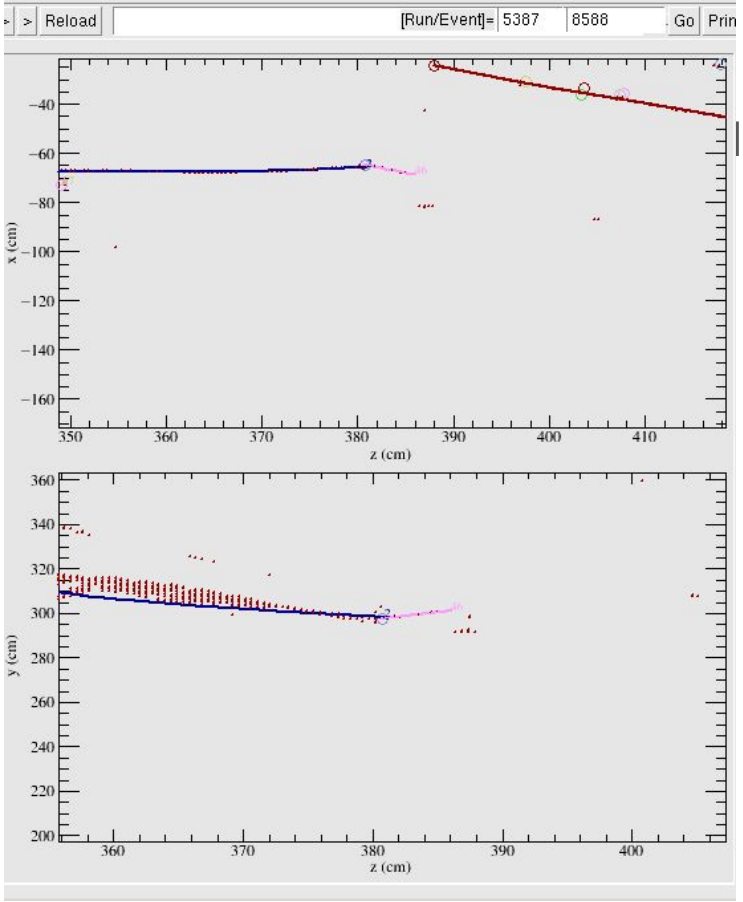




Run 5387, Ev 8588

Owen Goodwin 02/21/2019

MANCHESTER 1824
The University of Manchester



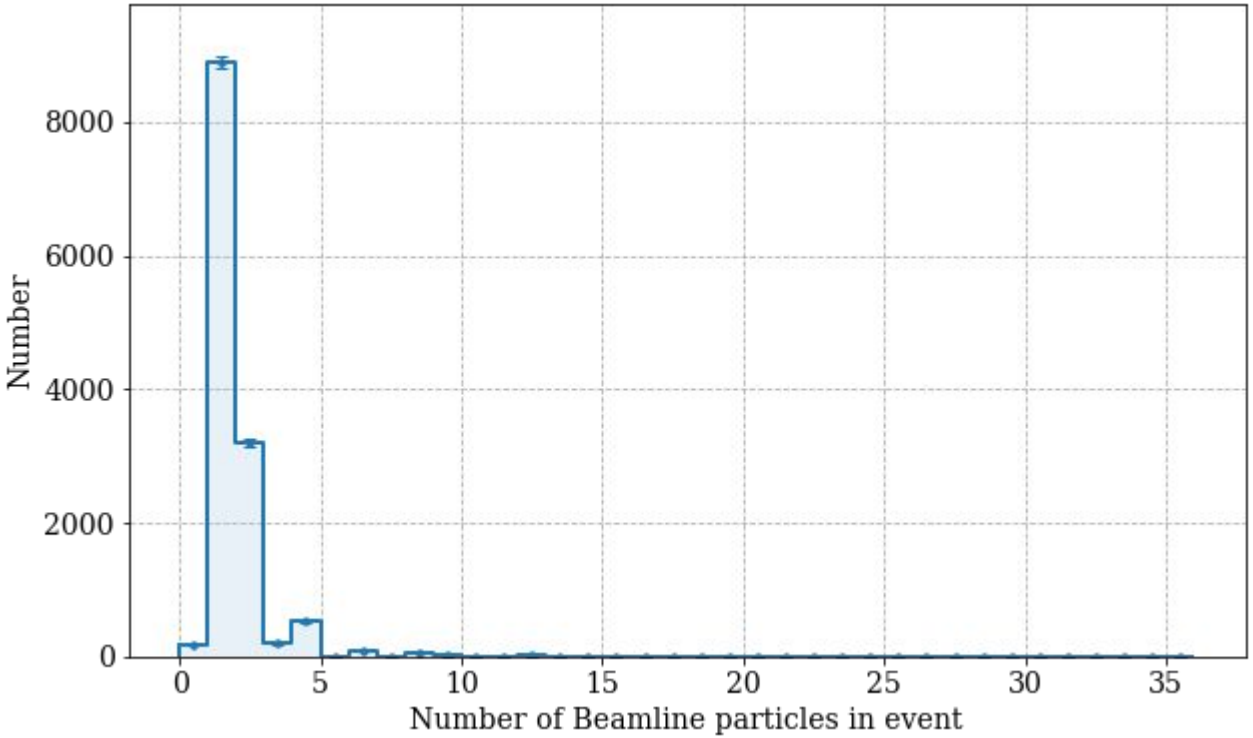
- Michel electron?

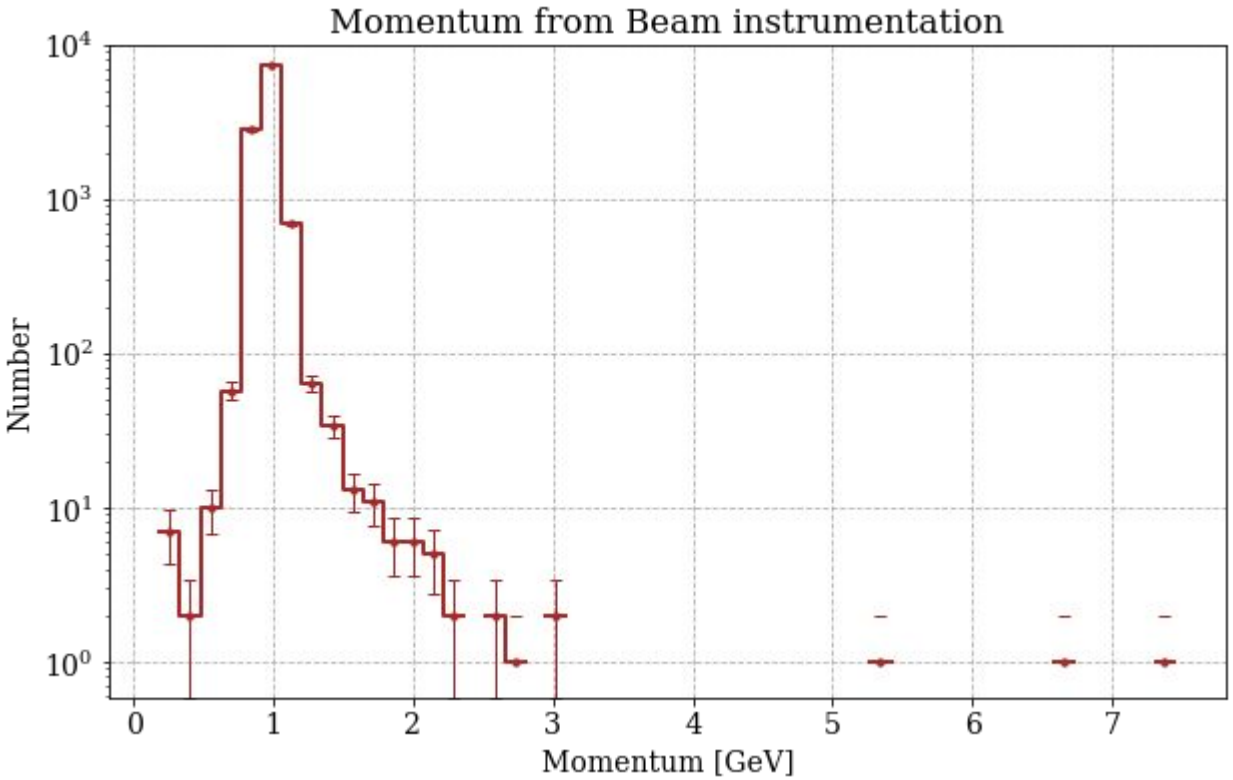
Summary + Possible Next Steps

Study variables separated by track end processes

Matching broken tracks

Muons?


Number
8000
6000
4000
2000
0
0
5
10
15
20
25
30
35
Number of Beamline particles in event

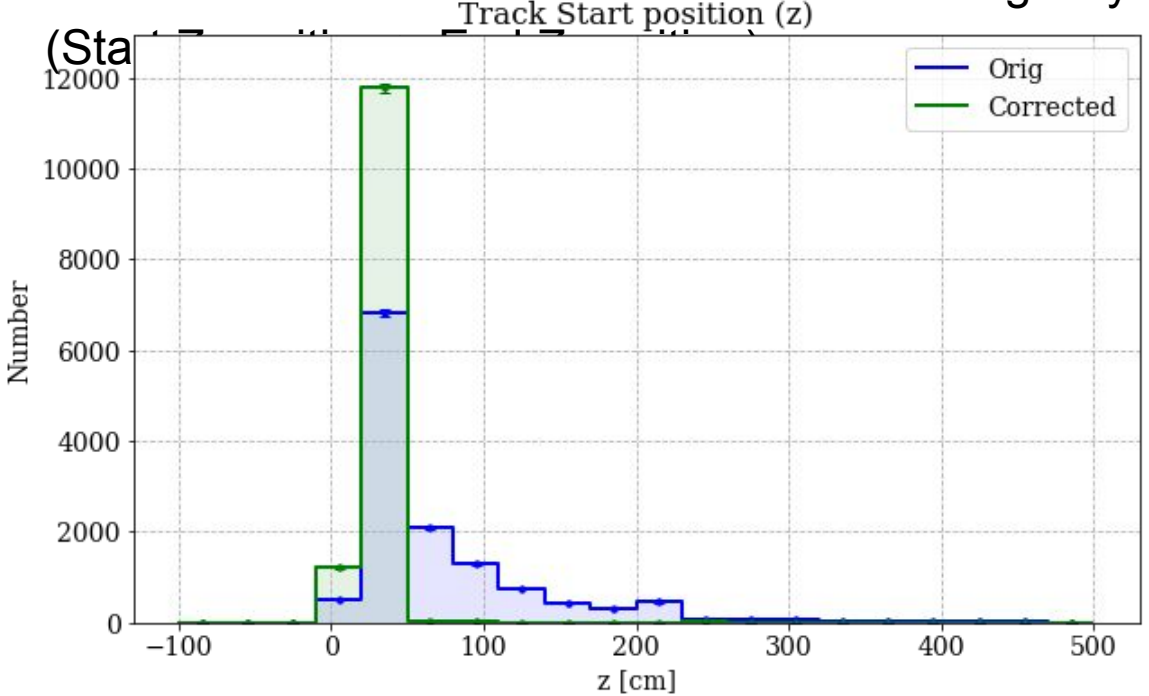

Momentum from Beam instrumentation
Number
10^4
10^3
10^2
10^1
10^0
0
1
2
3
4
5
6
7
Momentum [GeV]

Track Reco Wrong way

7594/13122 = 57.8%

of Pion Candidate tracks reconstructed “wrong way” round.

(Sta

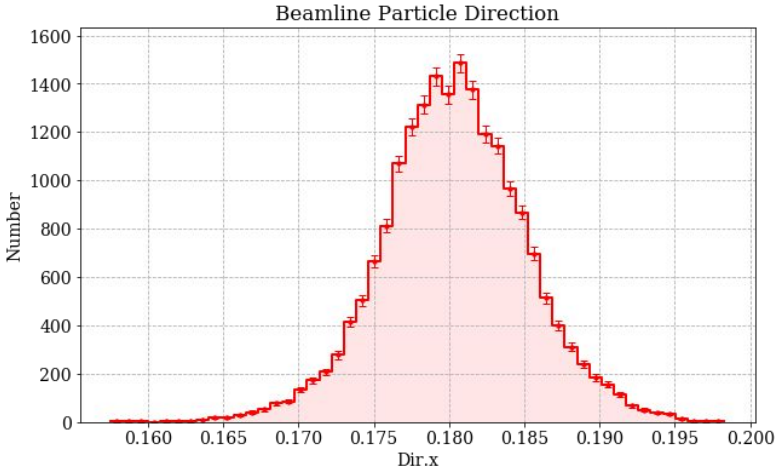


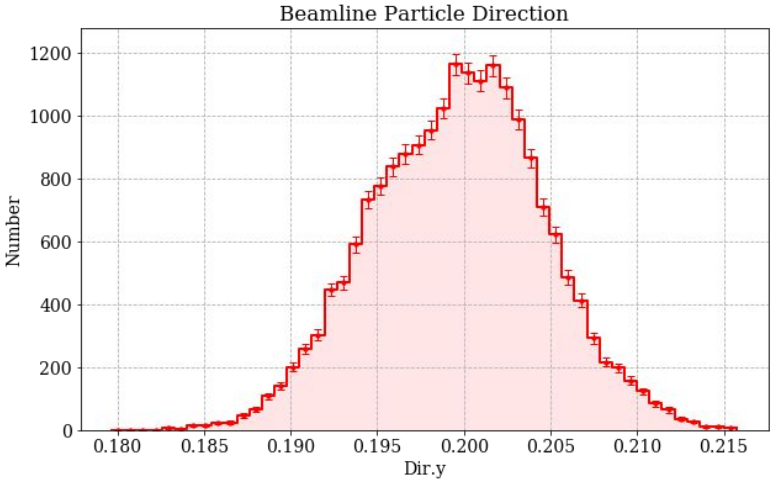
I flip the tracks the wrong way round.

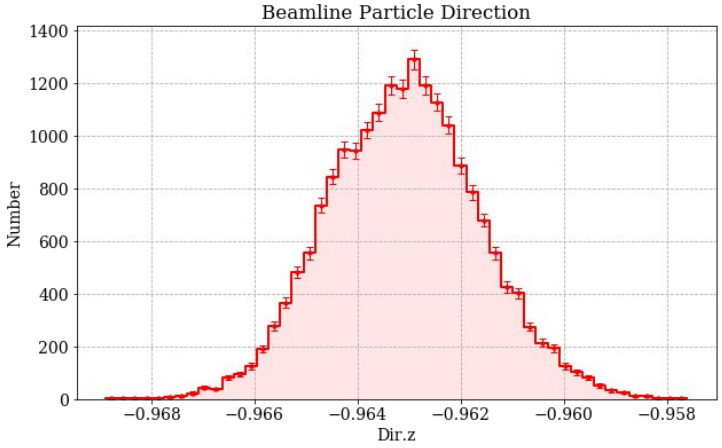
Plots shows z start position before and after flipping

Beamline Particle info

Owen Goodwin 02/21/2019



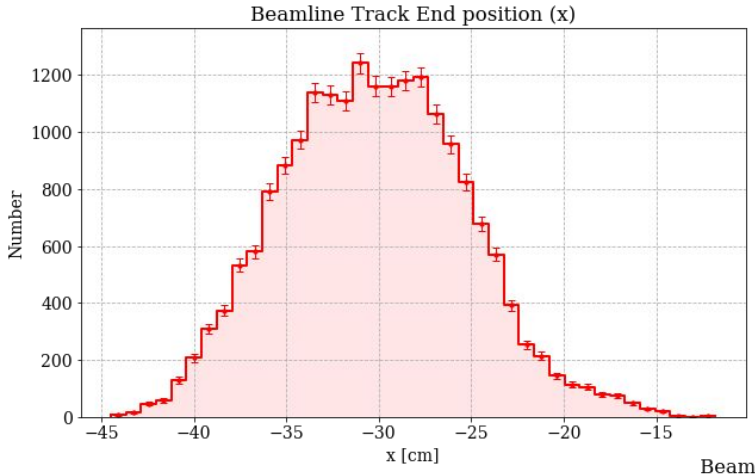


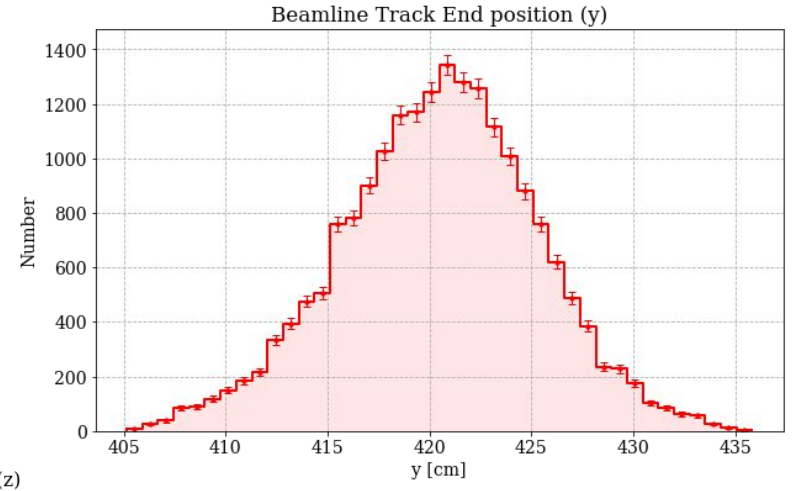


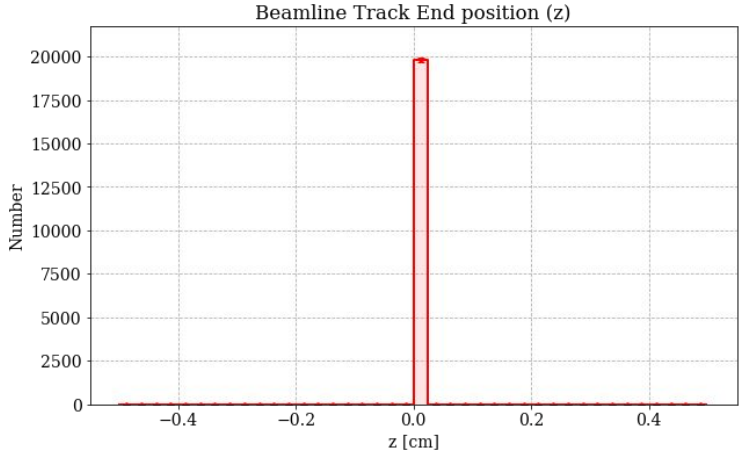
Beamline particles have opposite direction to expected? Going in negative Z direction

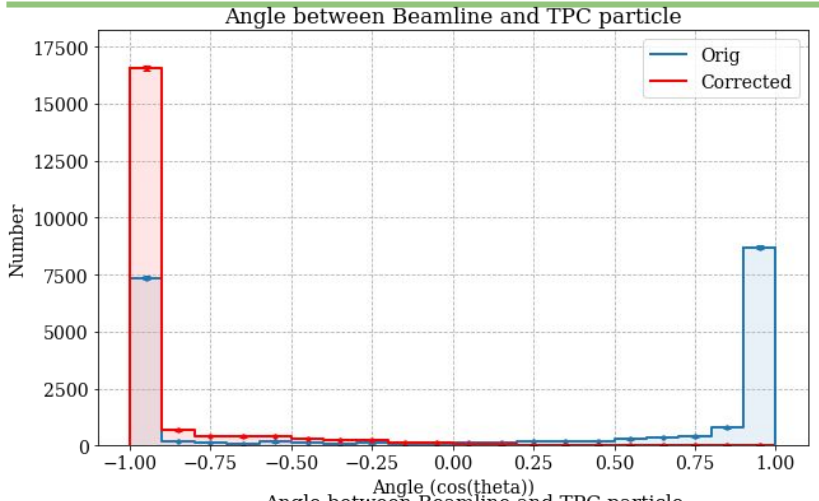
Beamline Particle info

Owen Goodwin 02/21/2019







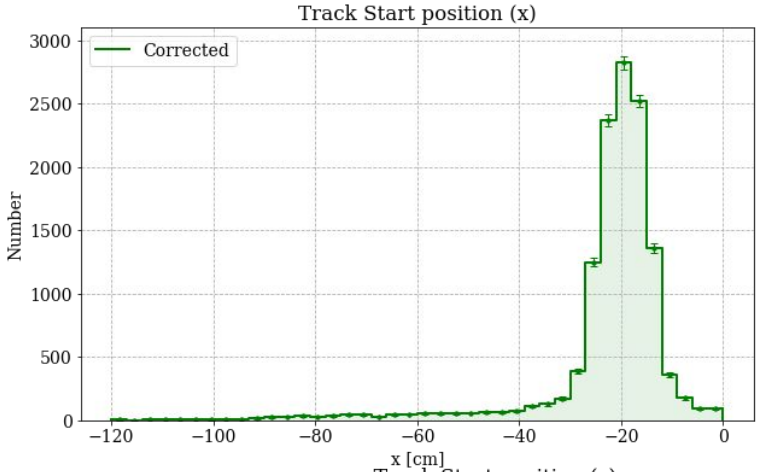


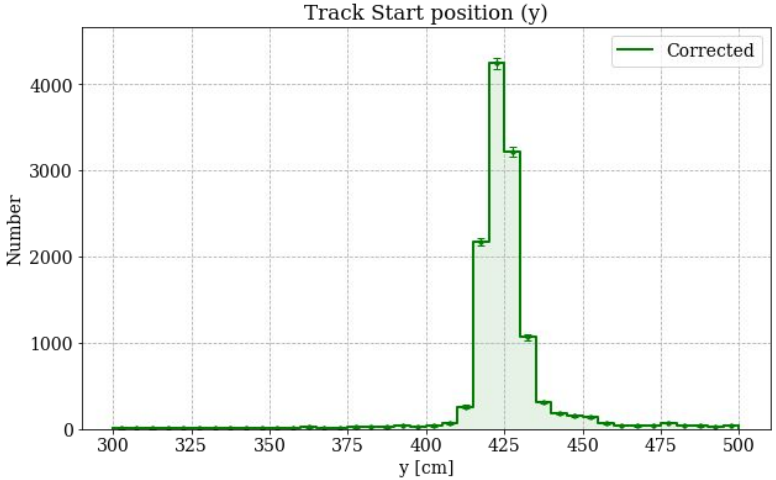
Orig is before I flip the backwards going TPC tracks
Corrected after.

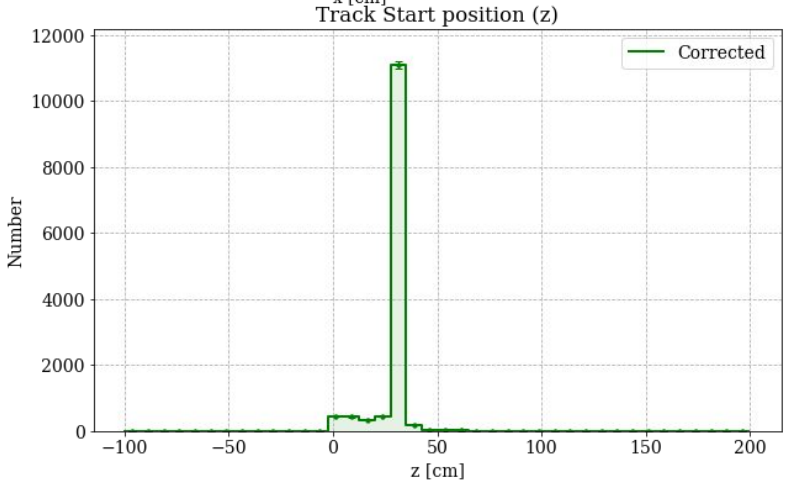
Corrected and flipped is after I also flip direction of all beamline particles

Pion Cand StartPos

Owen Goodwin 02/21/2019



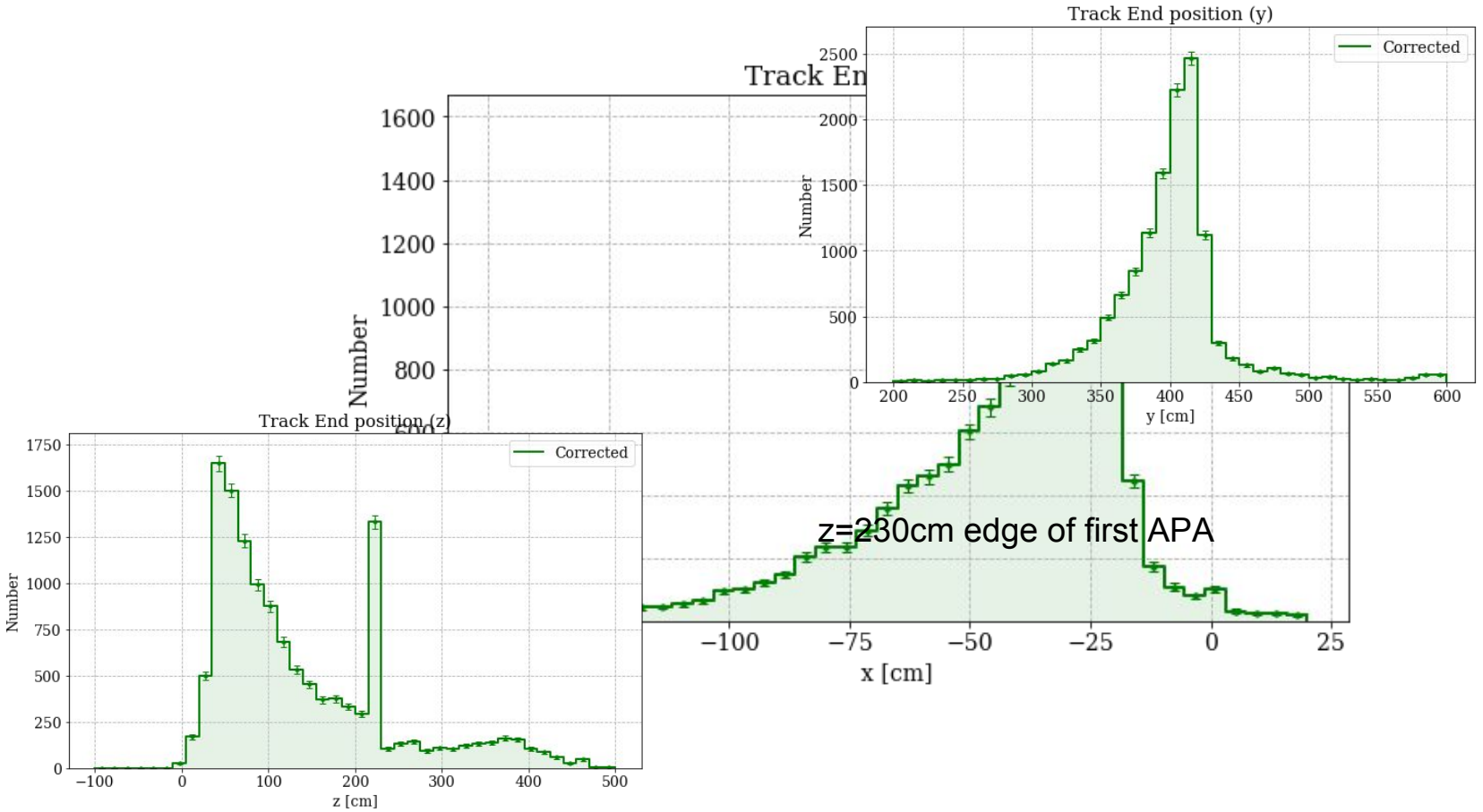


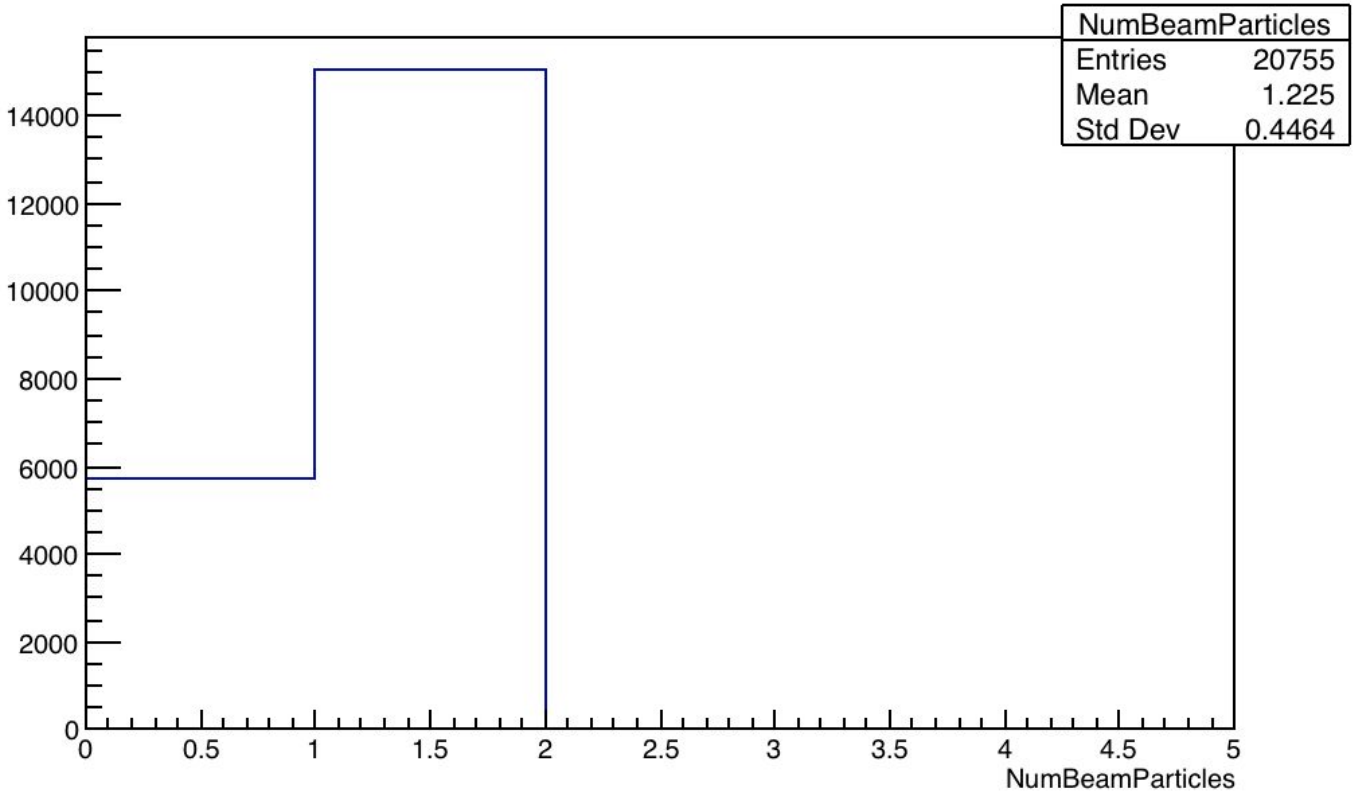


Pion Cand EndPos

Owen Goodwin 02/21/2019

MANCHESTER 1824
The University of Manchester




NumBeamParticles
Entries 20755
Mean 1.225
Std Dev 0.4464
14000
12000
10000
8000
6000
4000
2000
0
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
NumBeamParticles