

1 GeV beam MC Study

ProtoDUNE Analysis Meeting 03/28/2019
Owen Goodwin

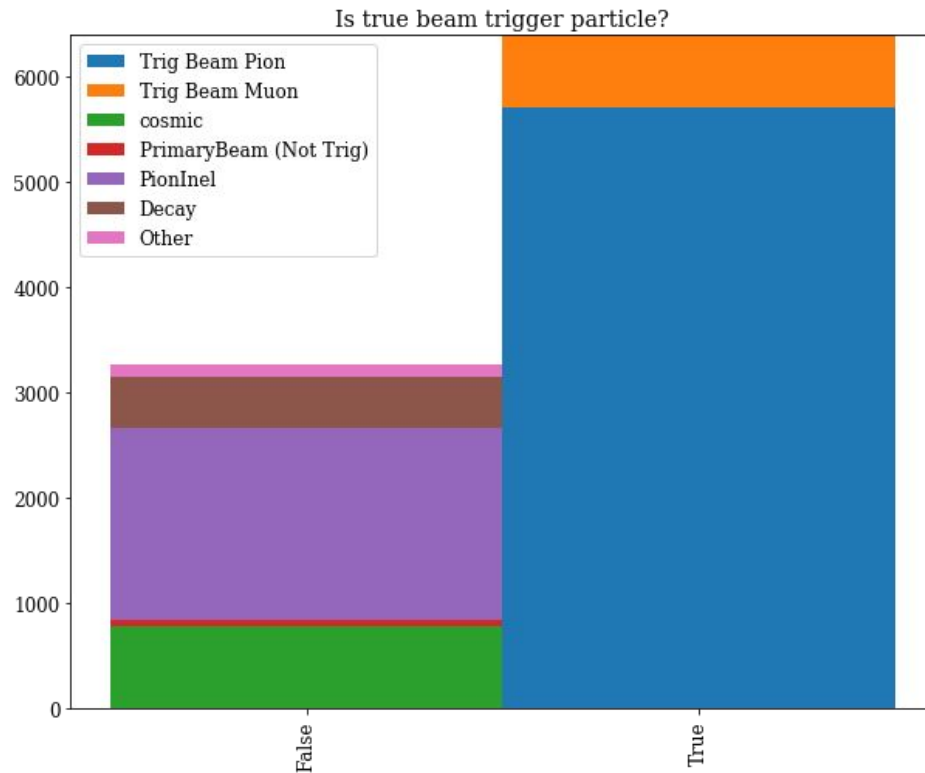


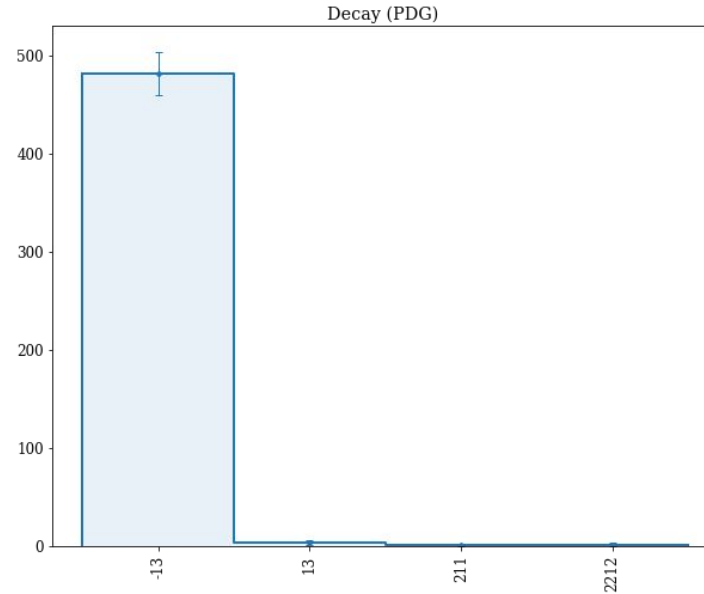
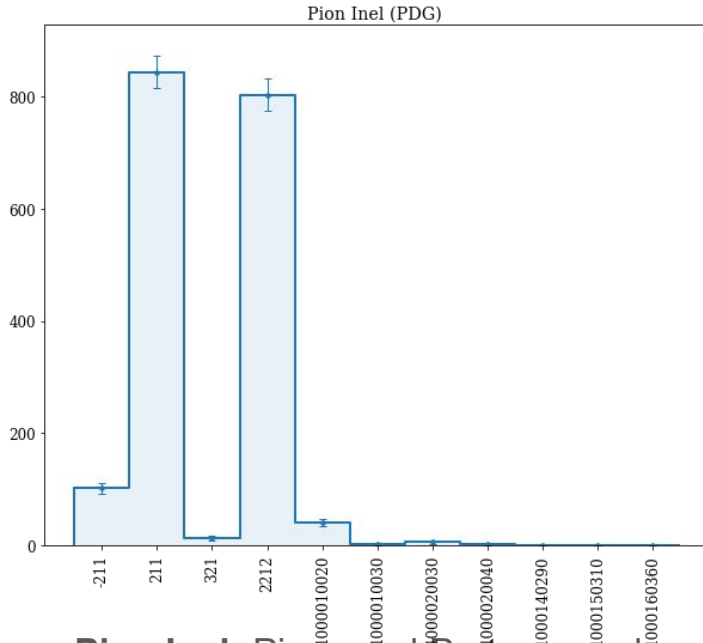
- New 1 GeV MC samples available with higher stats
- Looking at SCE, no flf sample here(74529 total events)
- Select MC events using true beam particle being pion or muon.
- Look at comparisons with run 5387 (1 GeV)
 - Beamline 1 GeV Pion filter
 - Unstable HV filter
 - Inactive FEMB filter

Monte Carlo	# true beam events	# events with reco beam track
Muons	734	719
Pions	9860	8936

Data Run 5387	# Events after filters with Pion trig	# events with reco beam track
Pions/Muons	20991	13122

- Take the reco track pandora assigns as beam particle and backtrack to MC particle that created the track
- Can check if the backtracked MC particle matches the true beam particle.
- The Plot is split based on start process of the MCparticle that created the reco track selected as the beam particle.

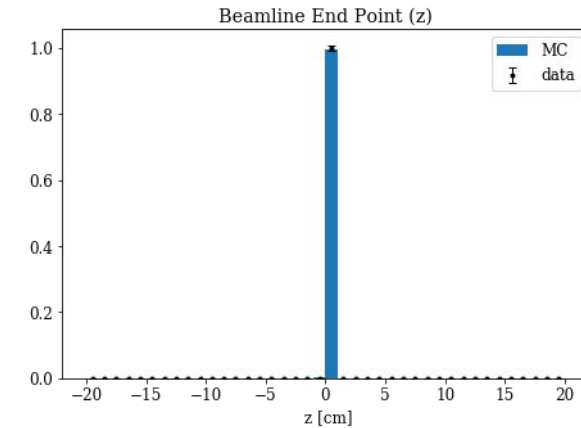
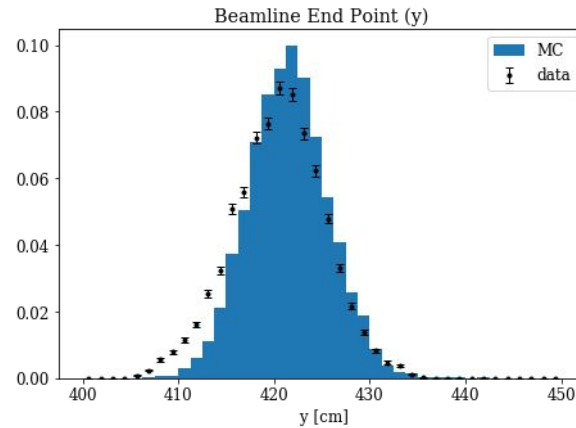
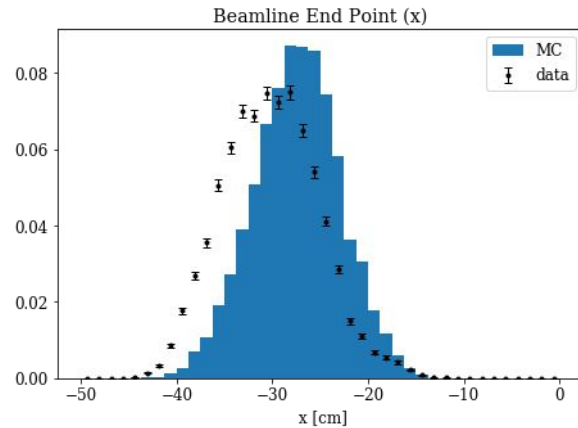


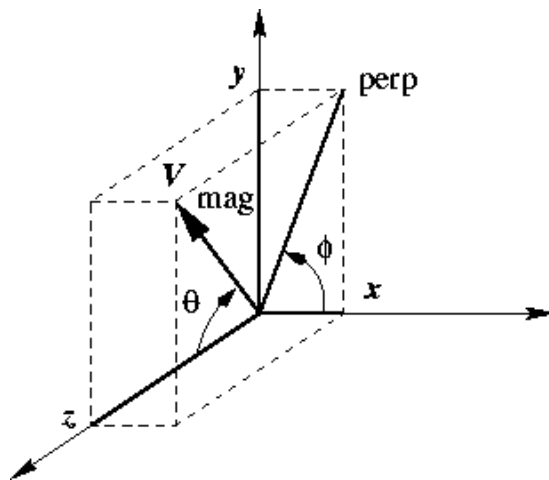
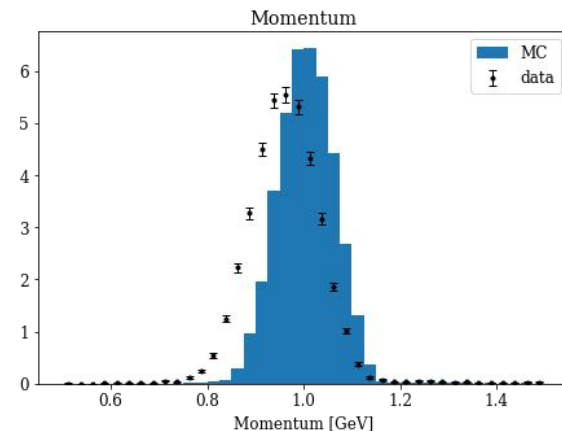
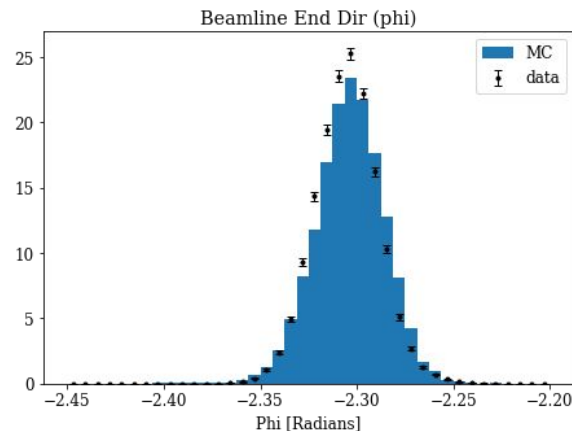
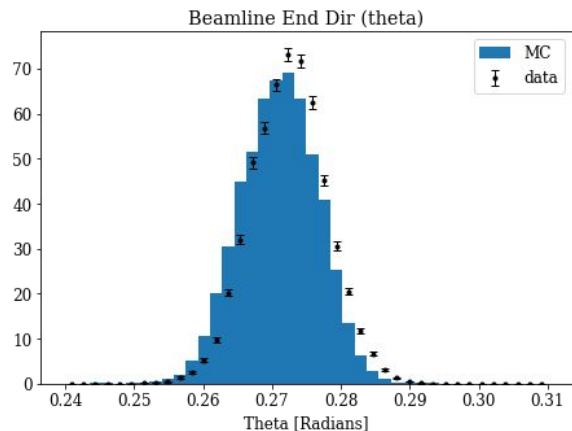


- **Pion Inel**; Pions and Protons produced from the pion interacting.
- **Decay**; Mainly muons from pion decay.
- **Primary Beam (Not trig)**; particles coming from beamline but not the one that triggered the event.
- **Others**; predominantly protons from secondary interactions (proton/neutron/pi- inelastic)

Replicate Beamline instrumentation position measurement in Monte Carlo by projecting the beam MC particle direction to plane the plane $z=0$.

Data is from beamline reconstruction

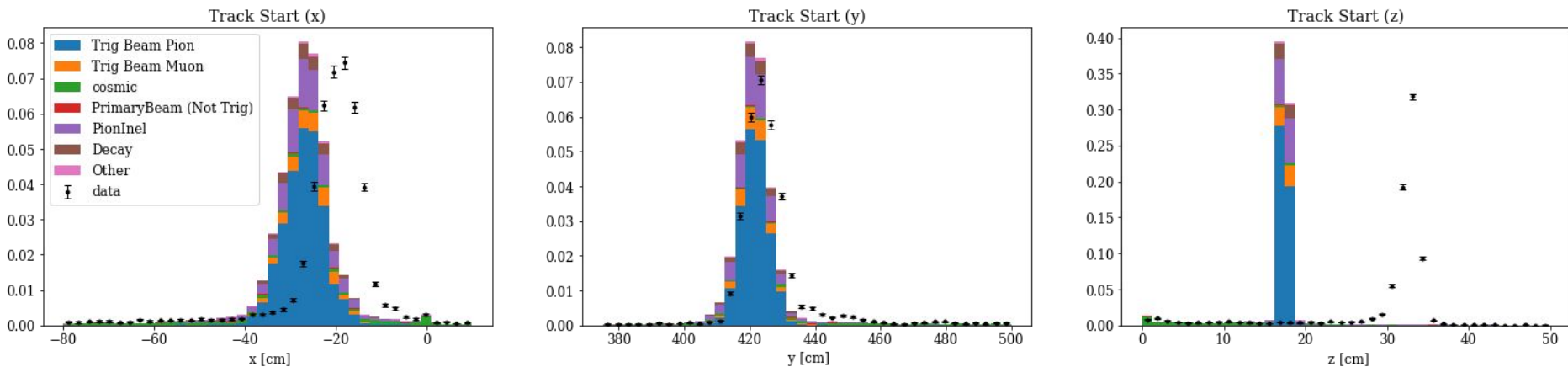




- Haven't updated to the new beamline reconstruction. Expect new data momentum to be shifted up by $\sim 5\%$
- Neither Data or MC Mom has energy loss before TPC

Reco Track Position.

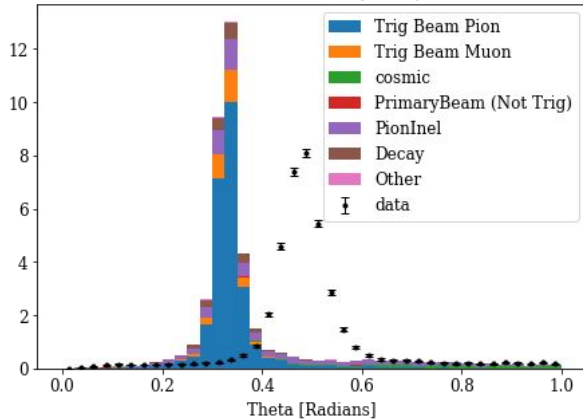
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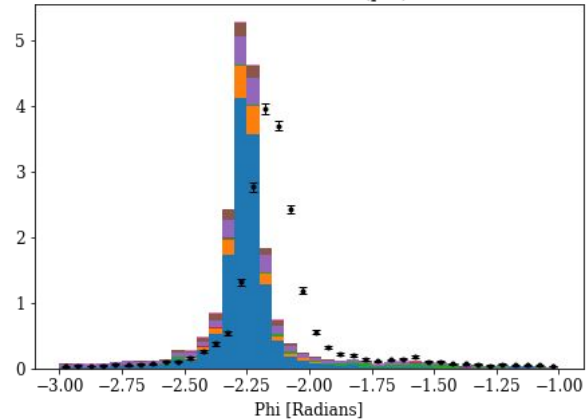
Offsets between track start position between Data and MC as seen before.

This is sce only sample, distributions for no sce and flf are in backup.

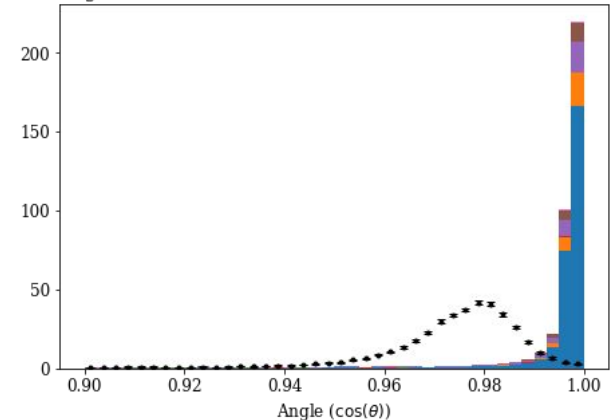
Track Start Dir (theta)



Track Start Dir (phi)



Angle between 'beam direction' and track start direction

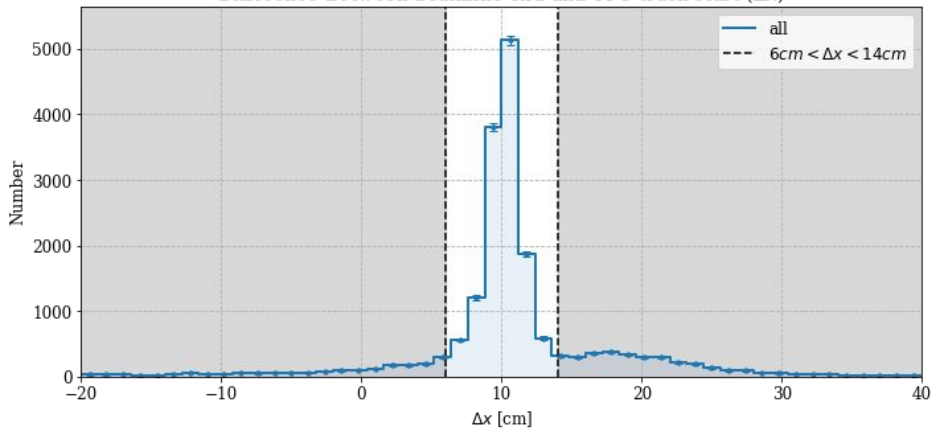


- Large difference in theta direction of track.
- Compare track direction with average beamline direction.

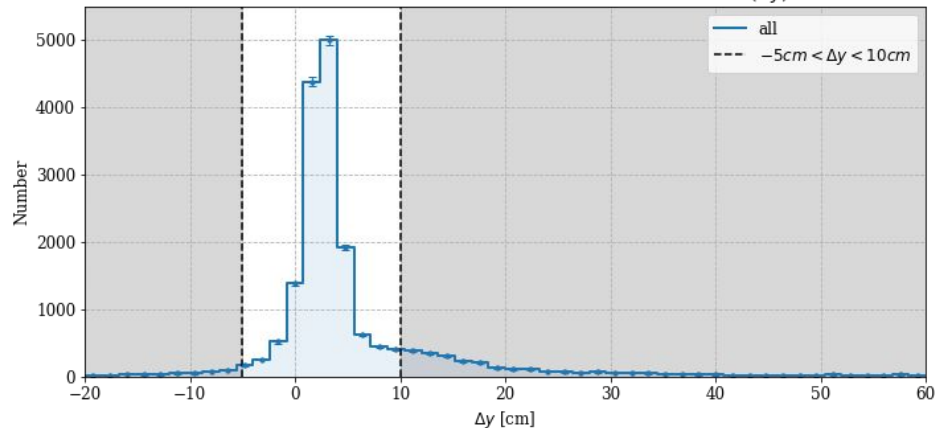
Data Quality Cuts

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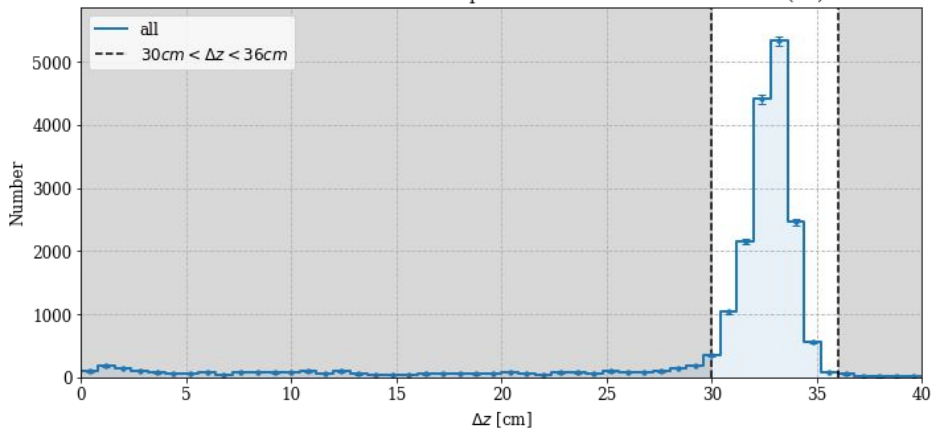
Difference Between beamline end and TPC track start (Δx)



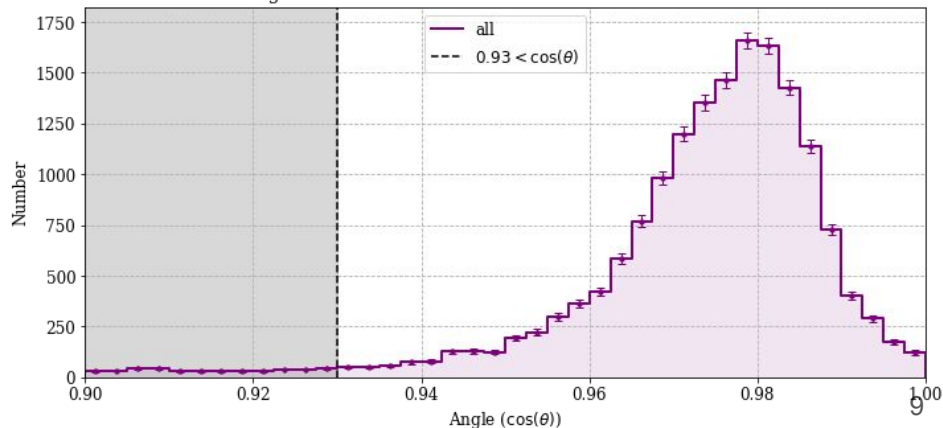
Difference Between beamline end and TPC track start (Δy)



Difference Between beamline particle end and TPC track start (Δz)

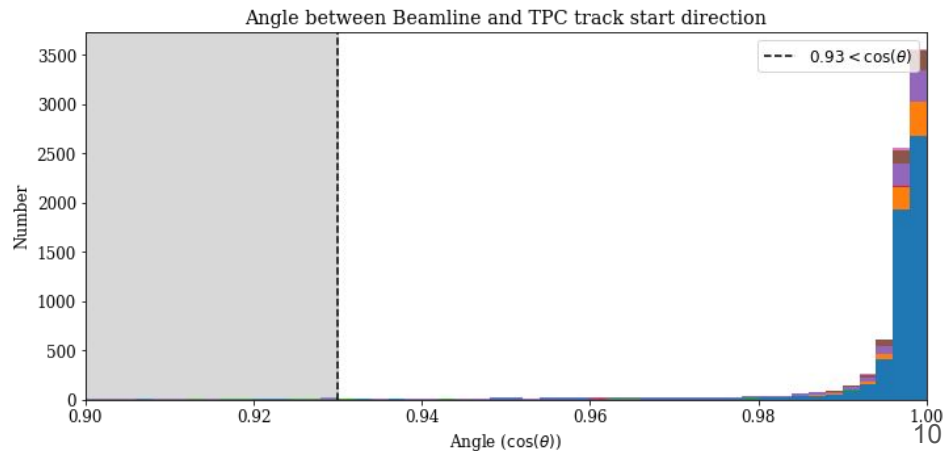
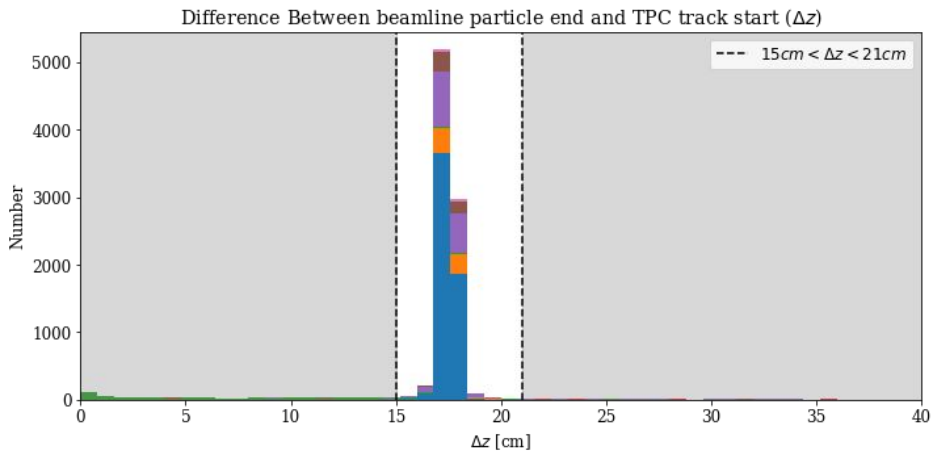
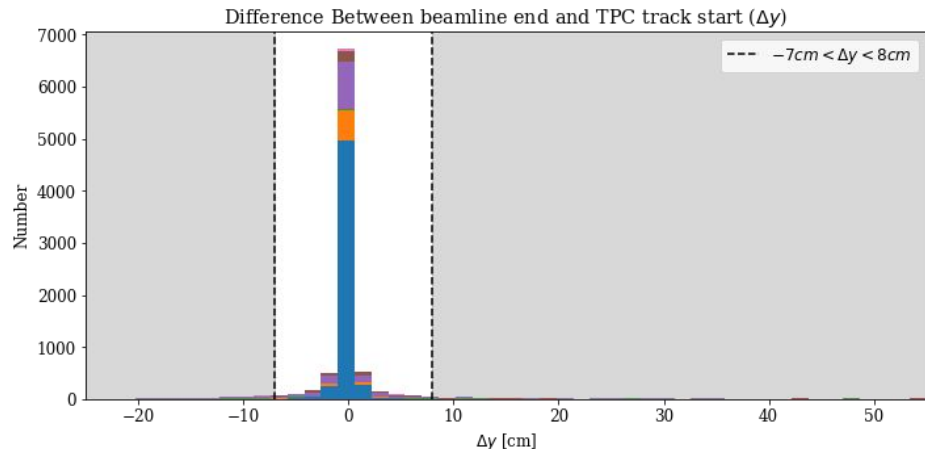
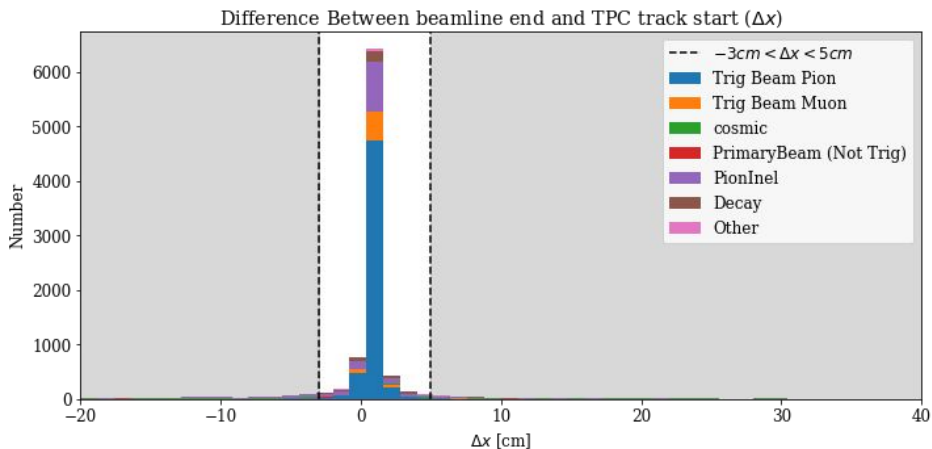


Angle between Beamline and TPC track start direction



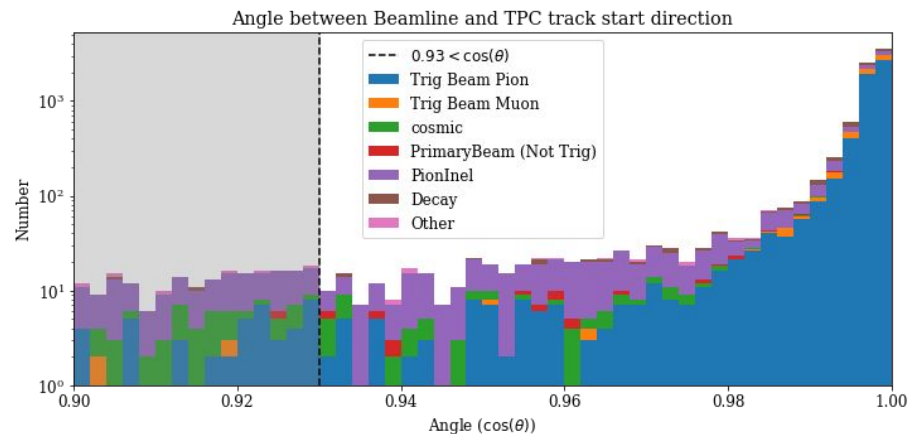
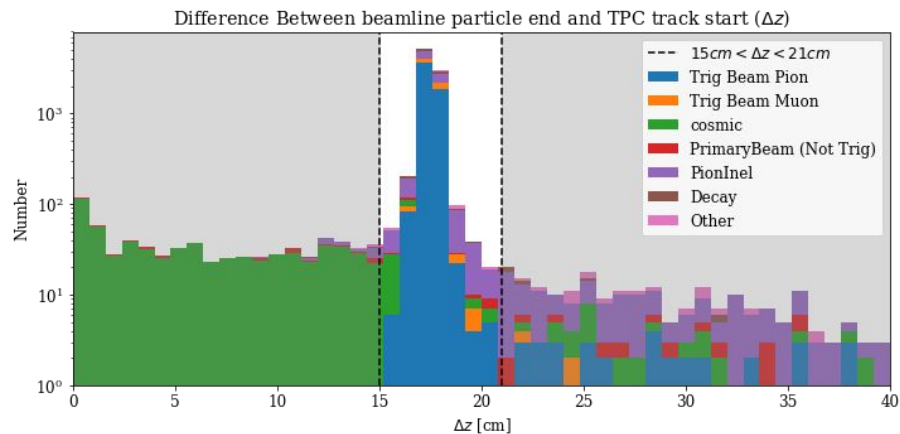
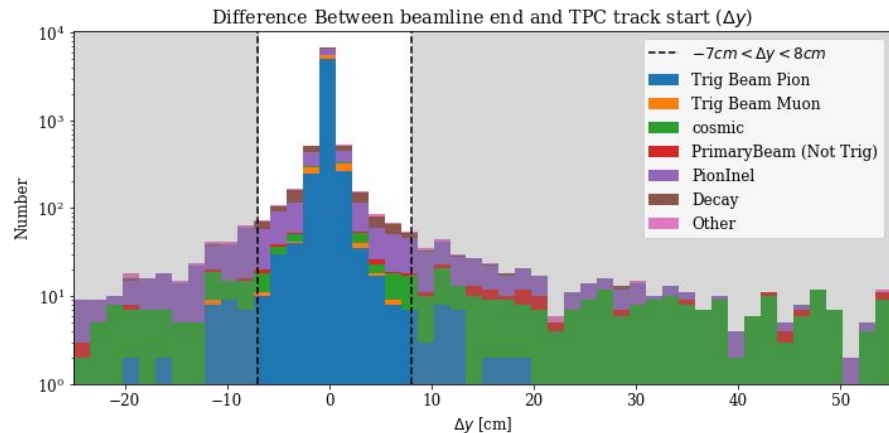
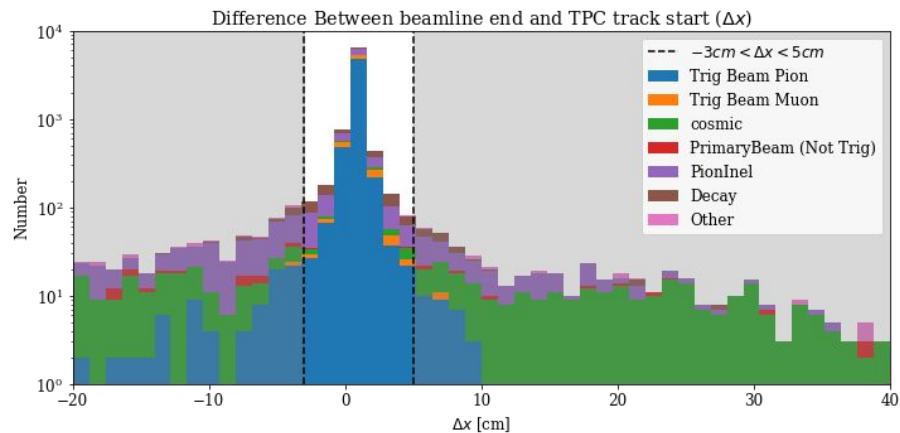
MC Quality Cuts

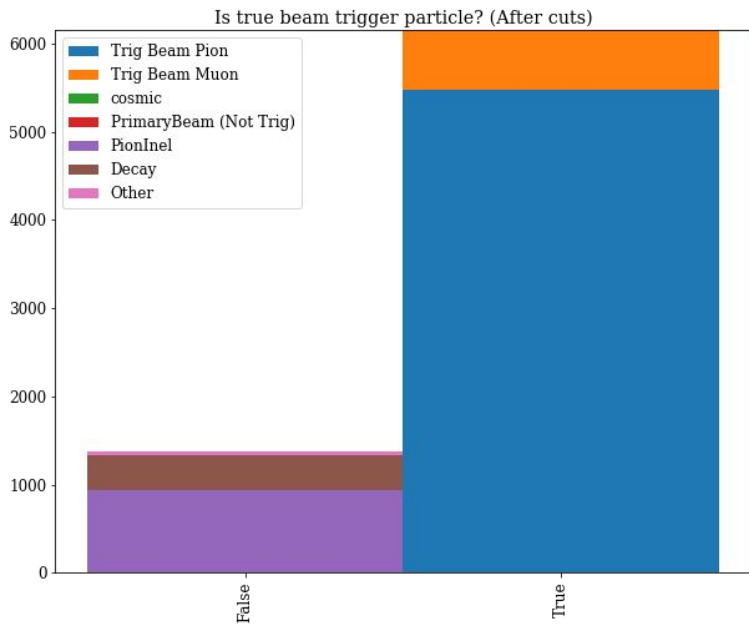
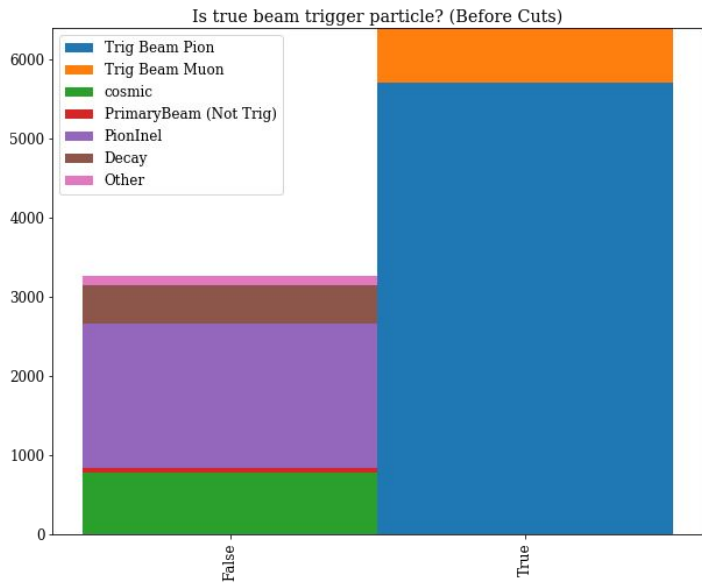
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MC cuts (log)

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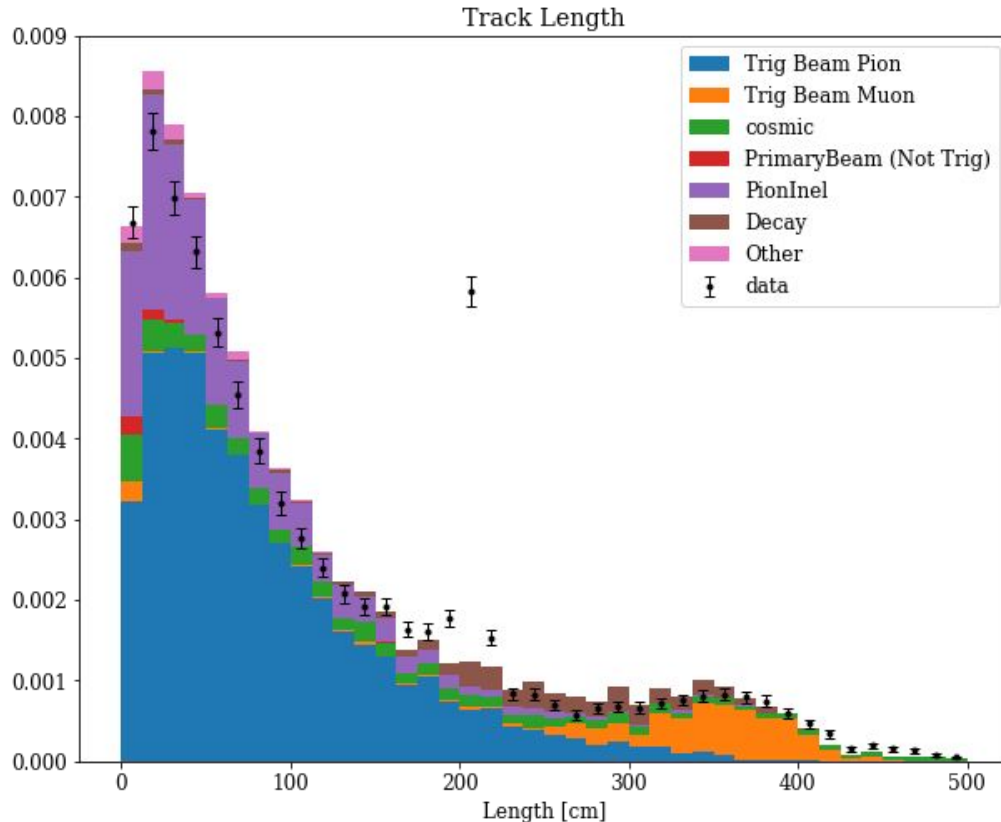




	# events before cuts	# after cuts
MC	9655	7521
Data	133111	9171

Track Length (Before cuts)

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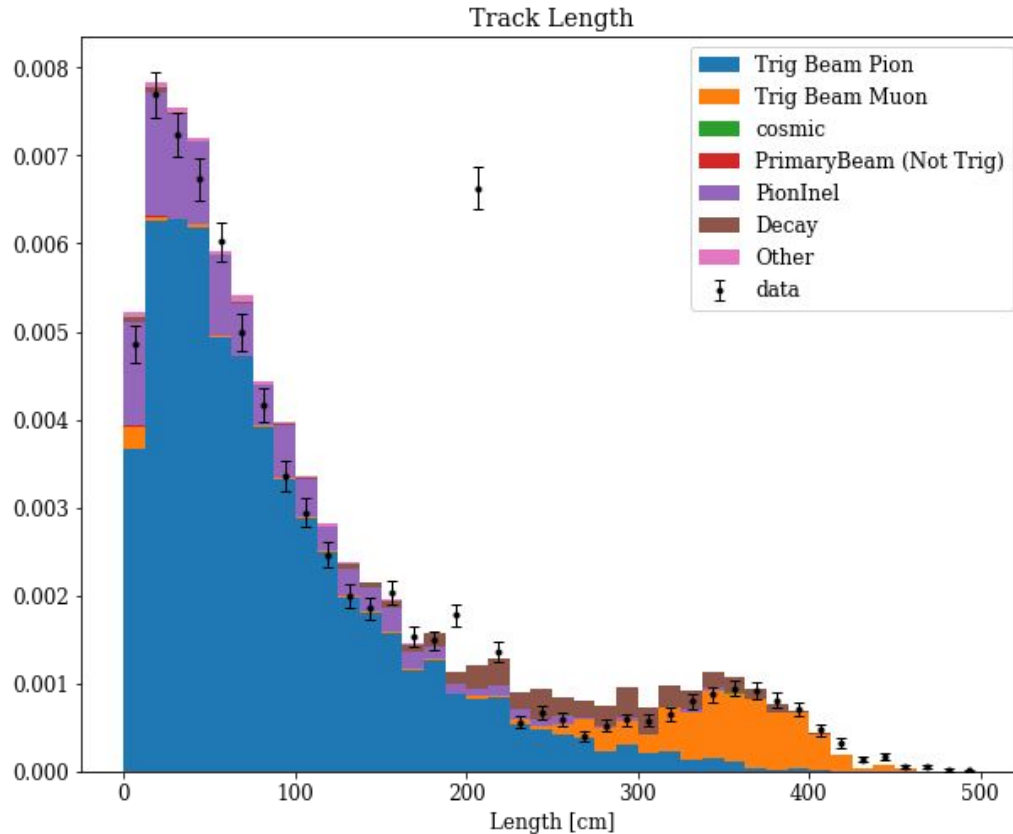


Total MC area normalised to data area.

Broken tracks at edge of APA (230 cm). Haven't yet implemented Jake's track stitcher

Track Length (After cuts)

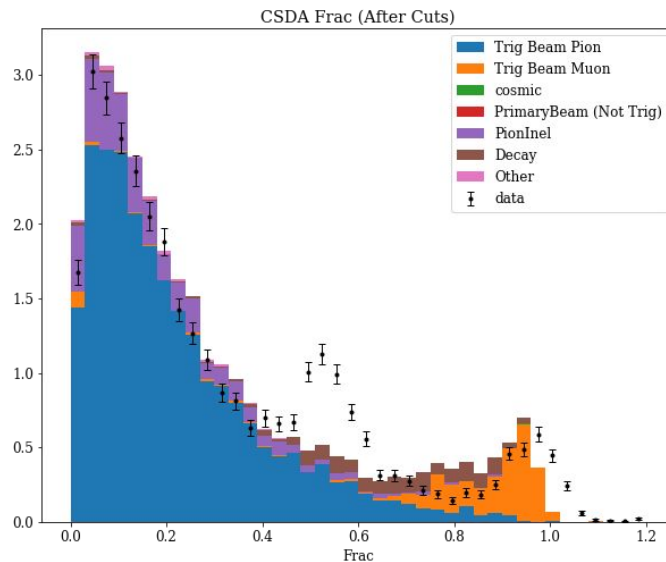
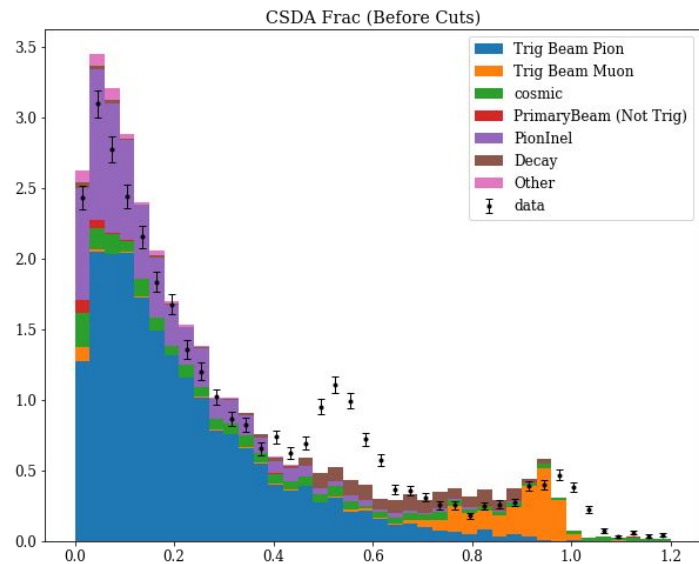
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After beam quality cuts.

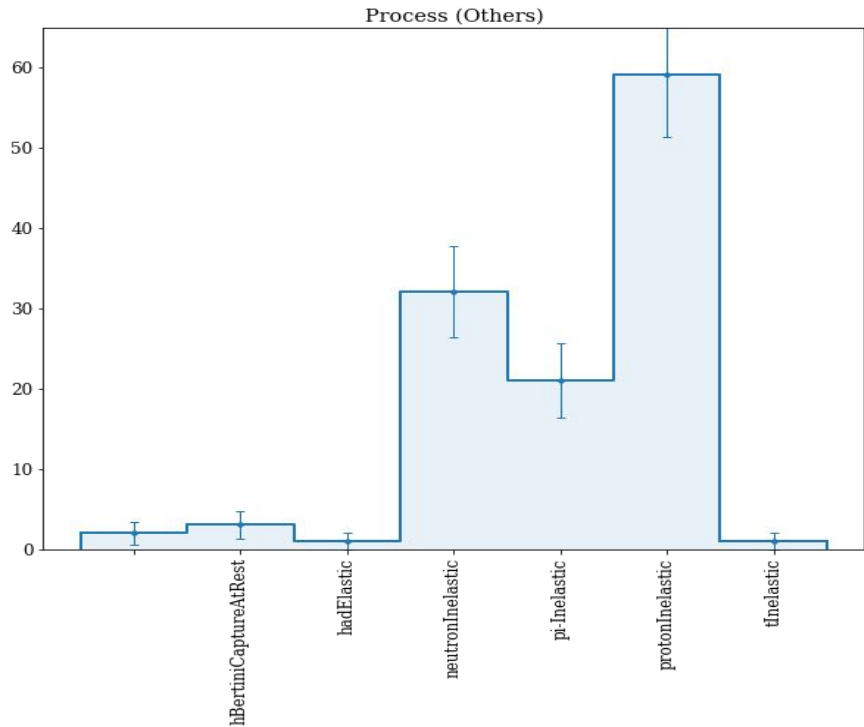
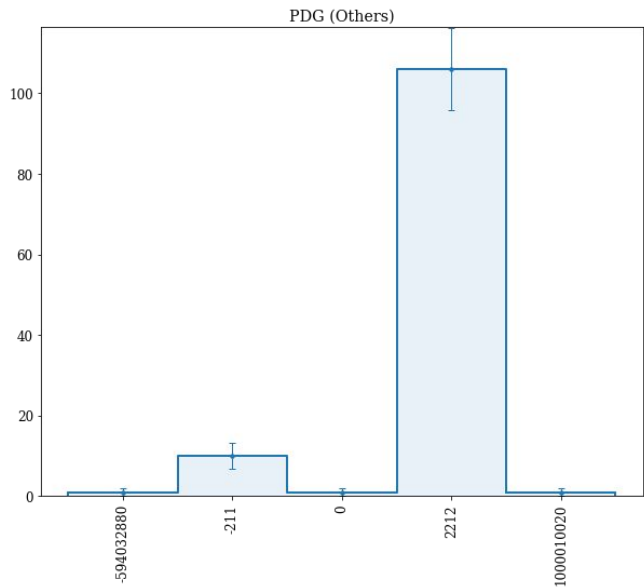
Use beamline momentum (or MC truth mom) to calculate range CSCA range under muon assumption.

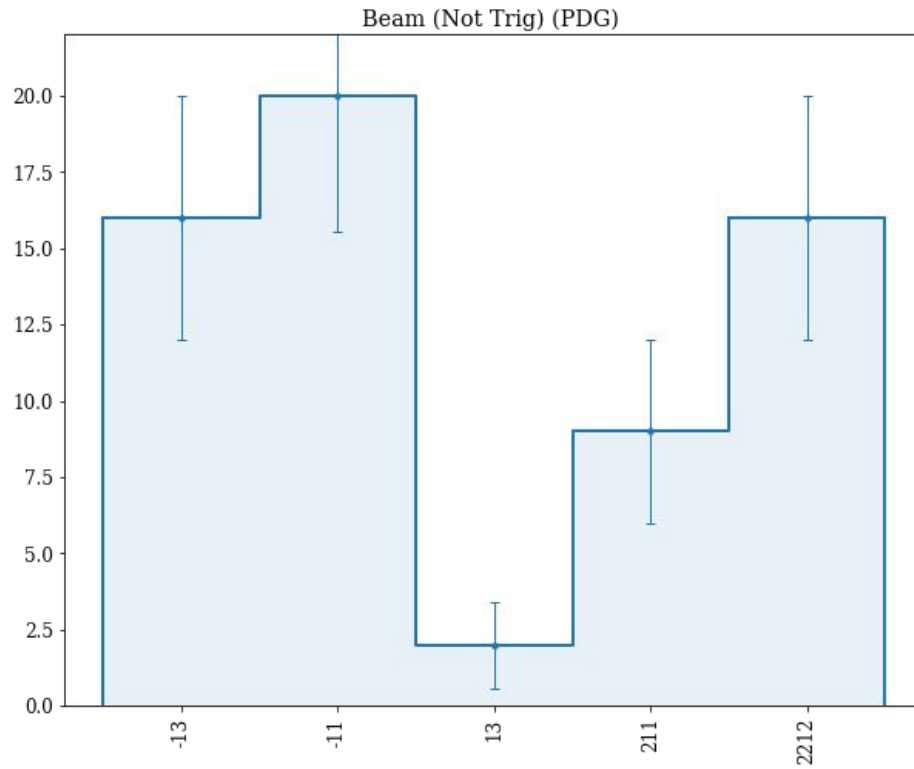
Divide track length by this. Peak around 1 from stopping muons.



- Implement track stitcher
- Use updated beamline reconstruction. Look at effect on stopping bump.
- Look at stopping muon events in more detail, now there are more stats.

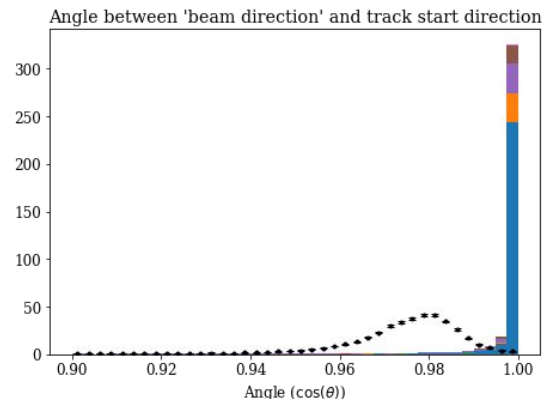
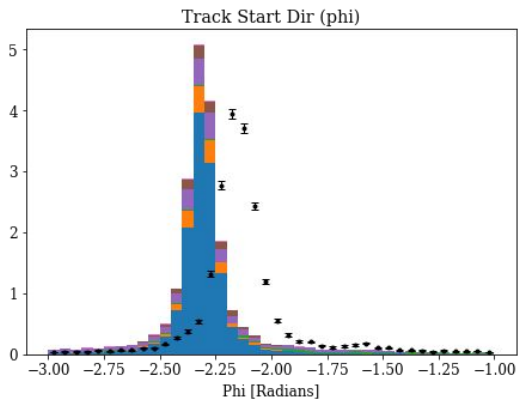
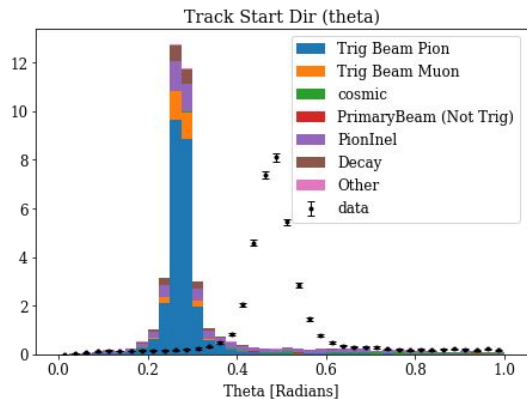
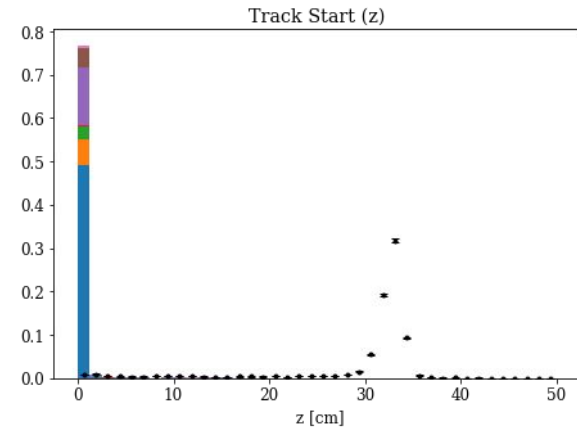
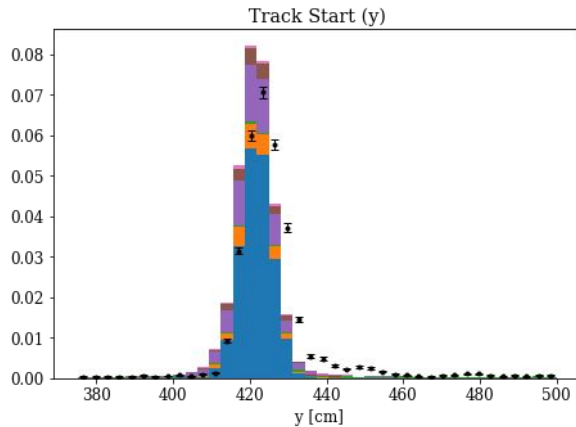
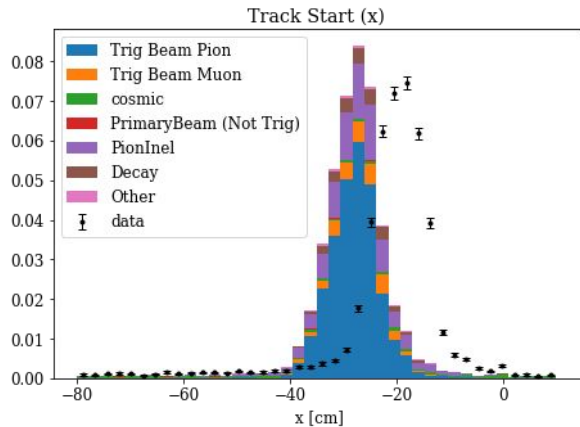
Back up





No SCE sample

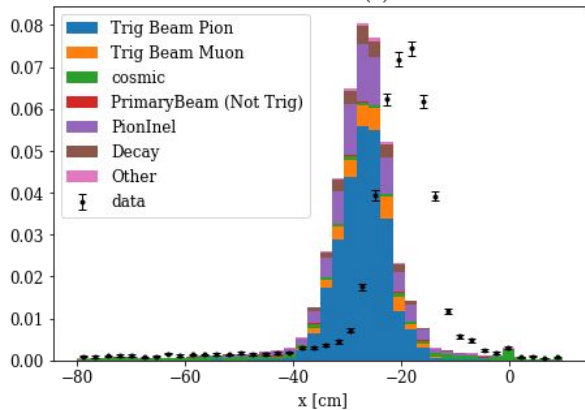
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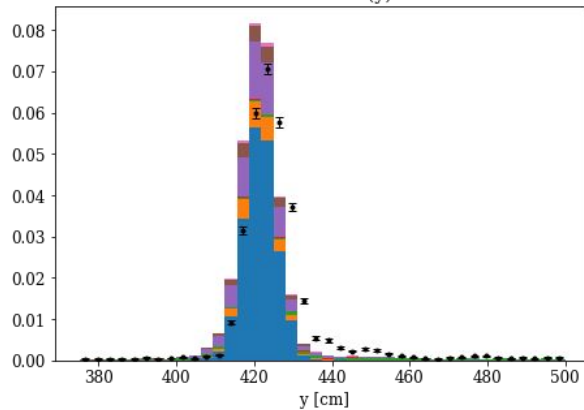
SCE sample.

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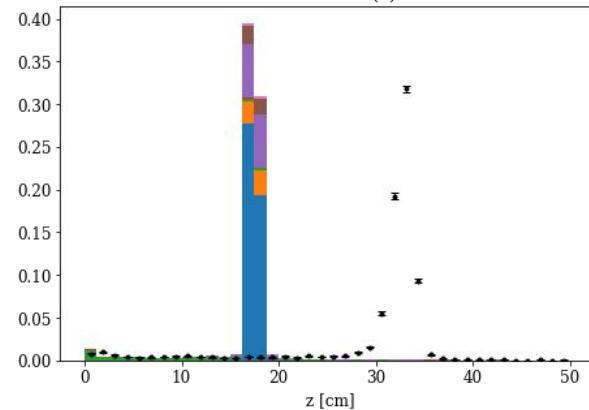
Track Start (x)



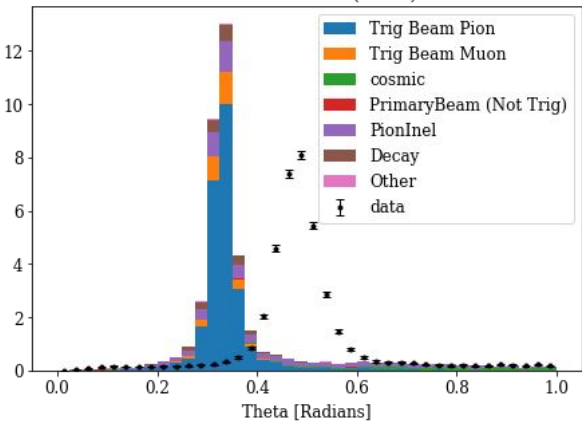
Track Start (y)



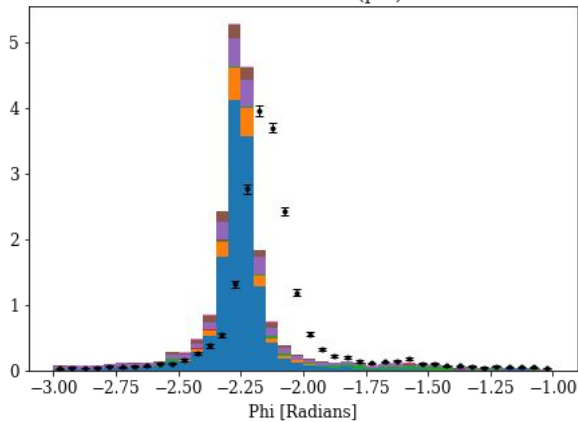
Track Start (z)



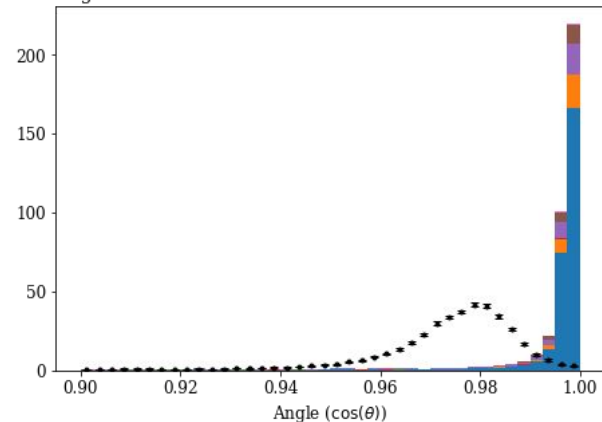
Track Start Dir (theta)



Track Start Dir (phi)

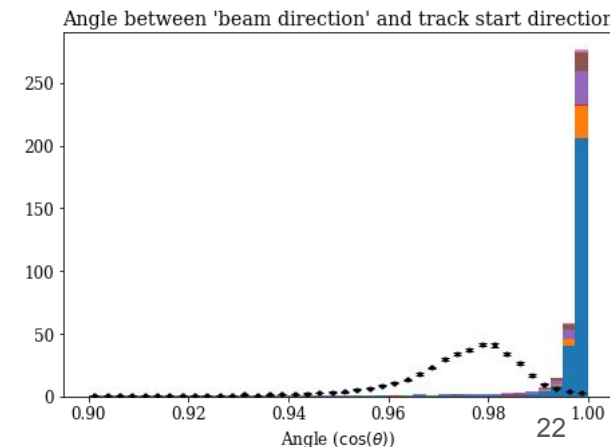
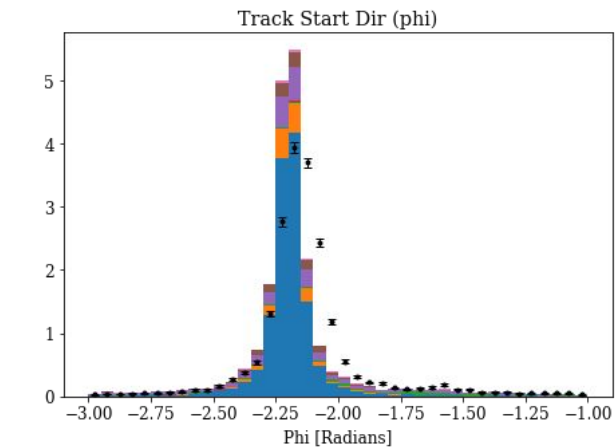
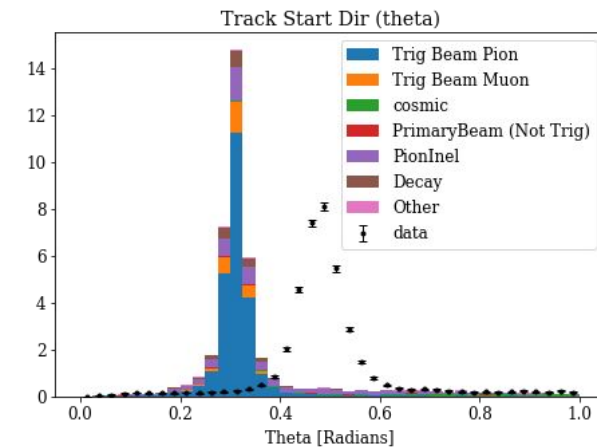
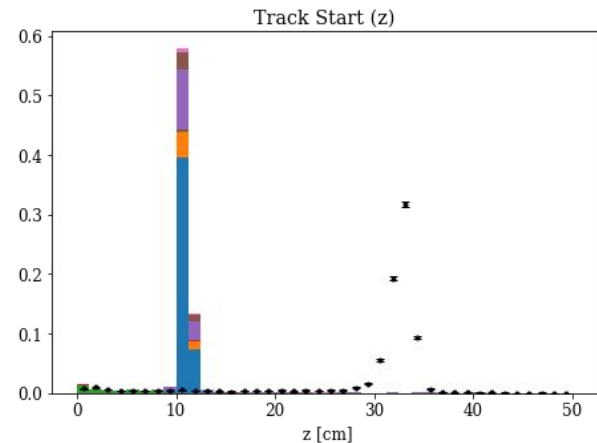
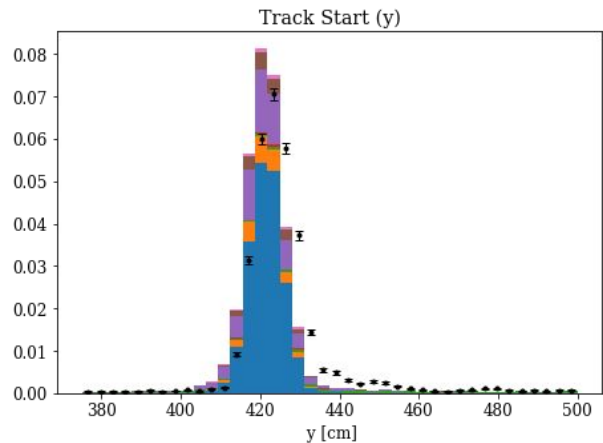
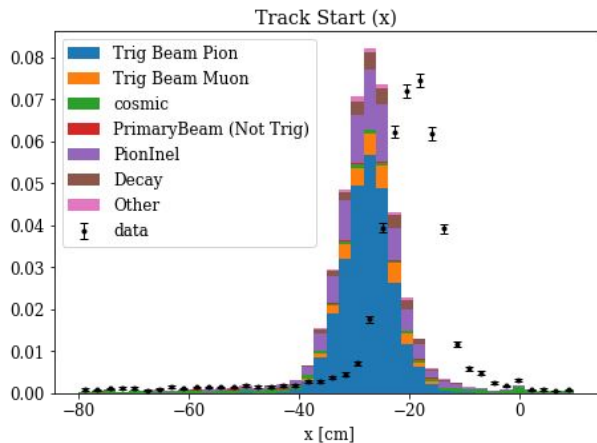


Angle between 'beam direction' and track start direction

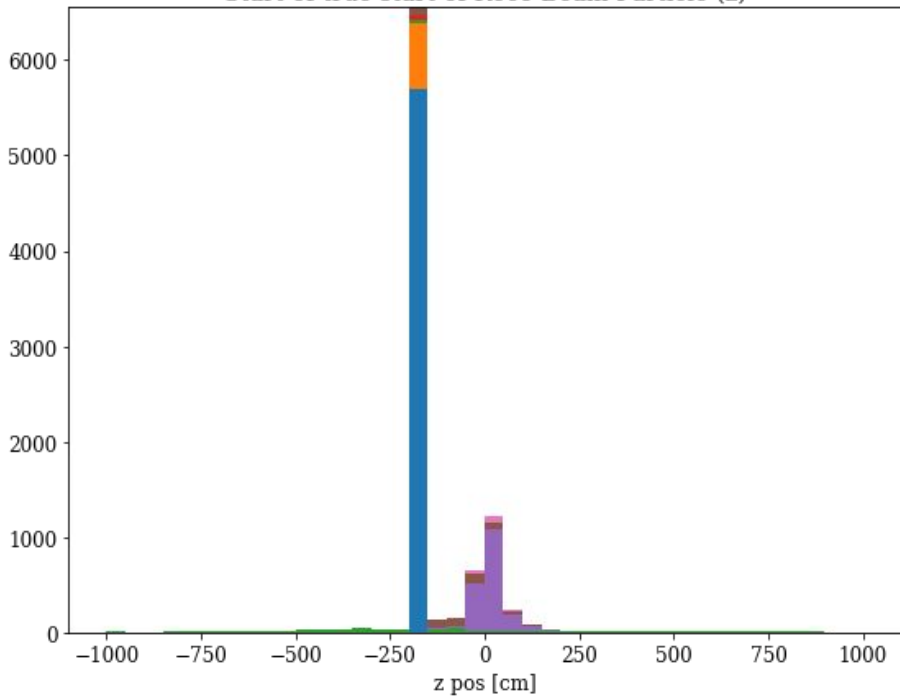


FLF sample

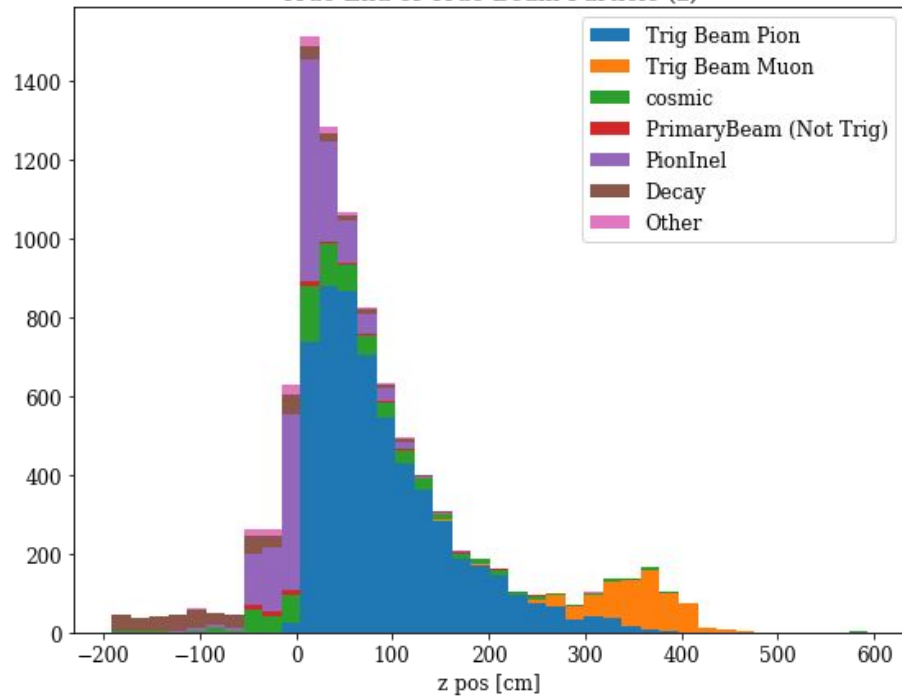
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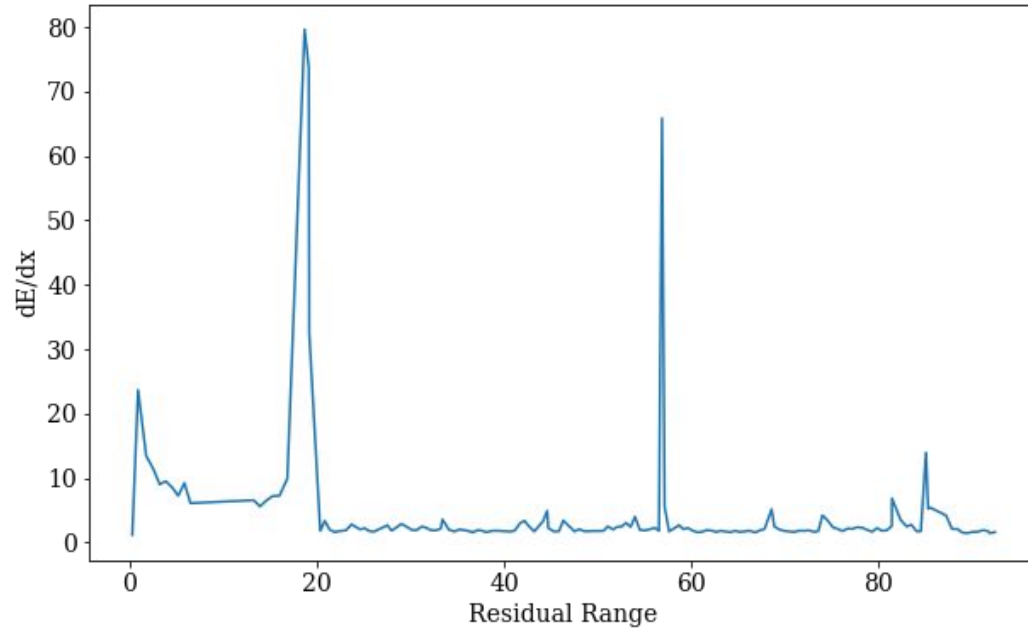
Start of true start of Reco Beam Particle (z)



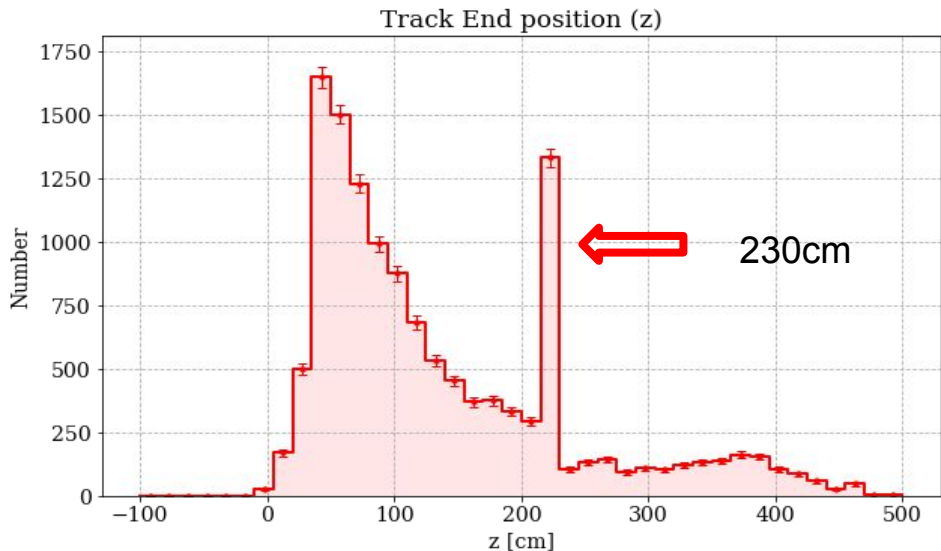
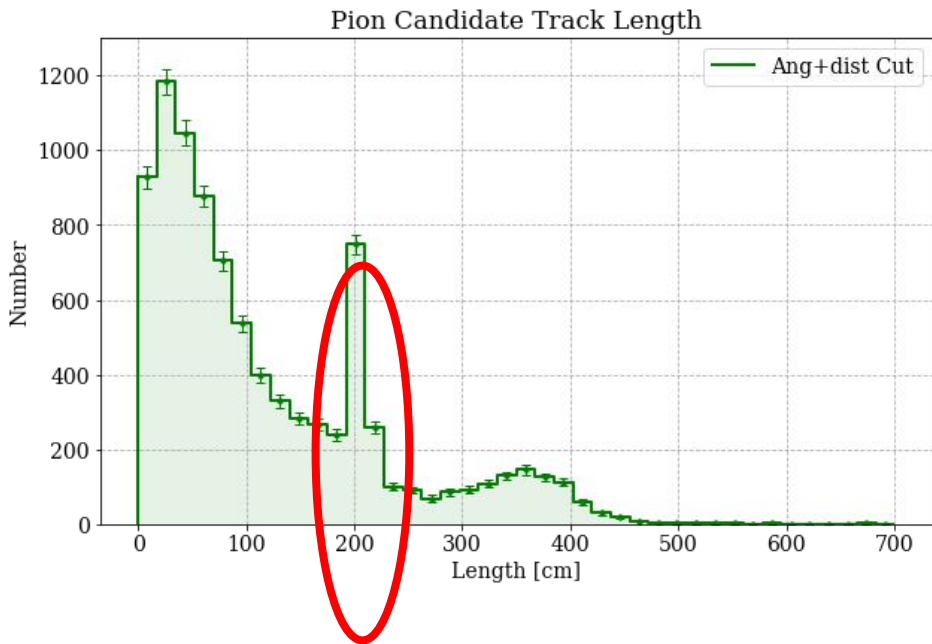
True End of True Beam Particle (z)



Rough PID. Interacting pion->proton?

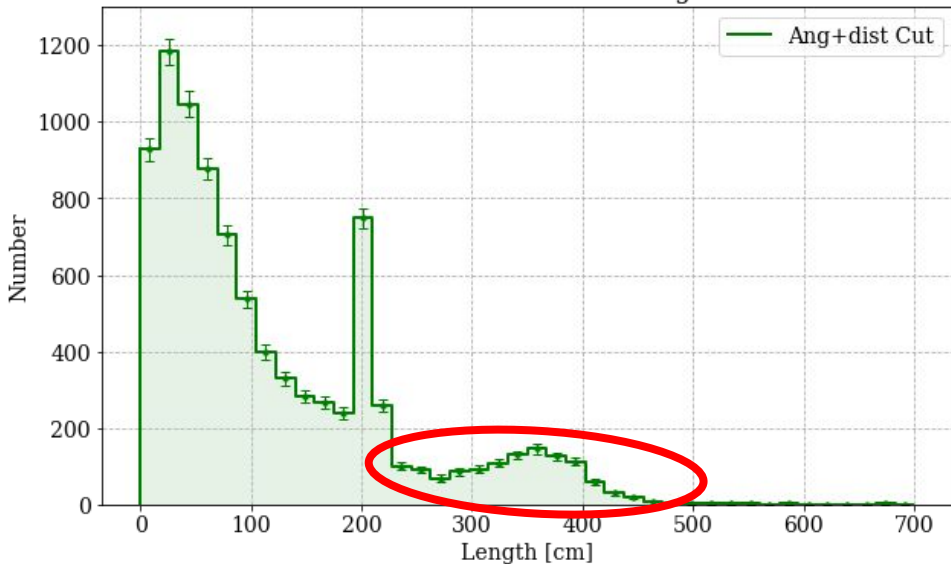


Track Length



Spike at 200cm cause by broken tracks at end of first APA (230cm in Z direction)

Pion Candidate Track Length



Peak much beyond Pion-LAr
interaction length at 1 GeV (<1m)

Muon Contamination

1GeV mom Stopping Muon
expected range using CSDA tables

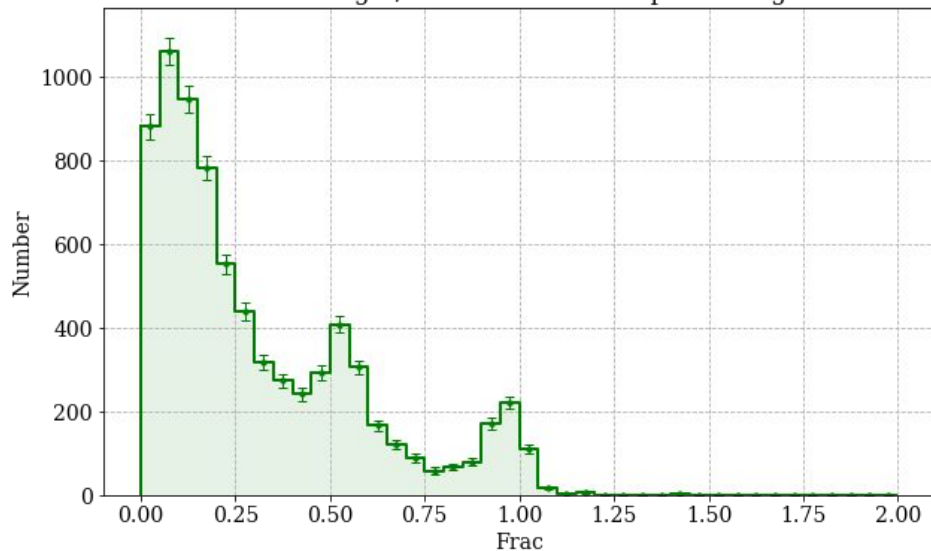
(http://pdg.lbl.gov/2012/AtomicNuclearProperties/MUON_ELOSS_TAB
[LES/muonloss_289.pdf](http://pdg.lbl.gov/2012/AtomicNuclearProperties/MUON_ELOSS_TAB)) is ~395cm

Calculate CSDA range of particle (muon assumption) using Beamline momentum.

Divide Track Length by this.

Stopping muon peak just below 1.

Track Length/CSDA Muon Assumption Length



Track Length/CSDA Muon Assumption Length

