

Proton Update

rb - LArIAT - 2k16

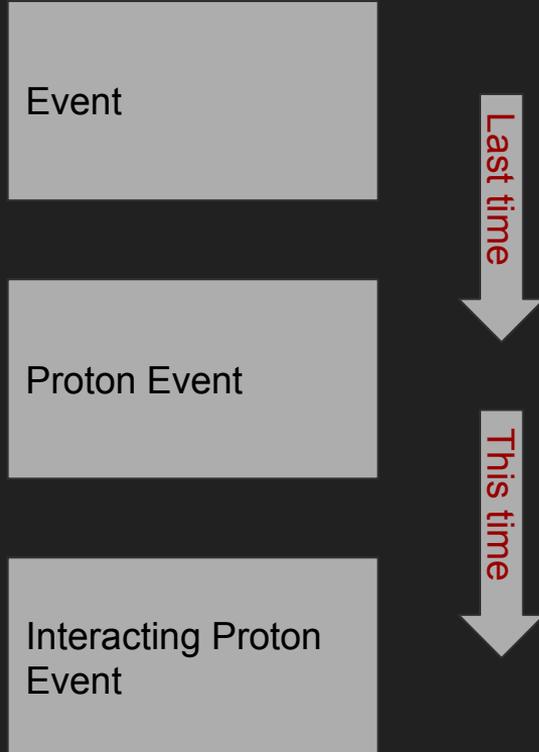
Last Time

- I went over the first part of the xs game: if I want to fill two plots on data for protons, I need to be able to find the protons.
- I looked at the purity of “proton” samples using track length to motivate a fiducial cut.
- Ultimately further understanding of impurities will be done by using Run I (the smaller AND less clean sample) to estimate the purity of Run II (the larger AND cleaner sample).

Today - More MC Studies!

- Overview of *brief* mc studies:
- Track behaviour study (angles and such)
- Calo study (looking at dE/dX near kinks/end of tracks)

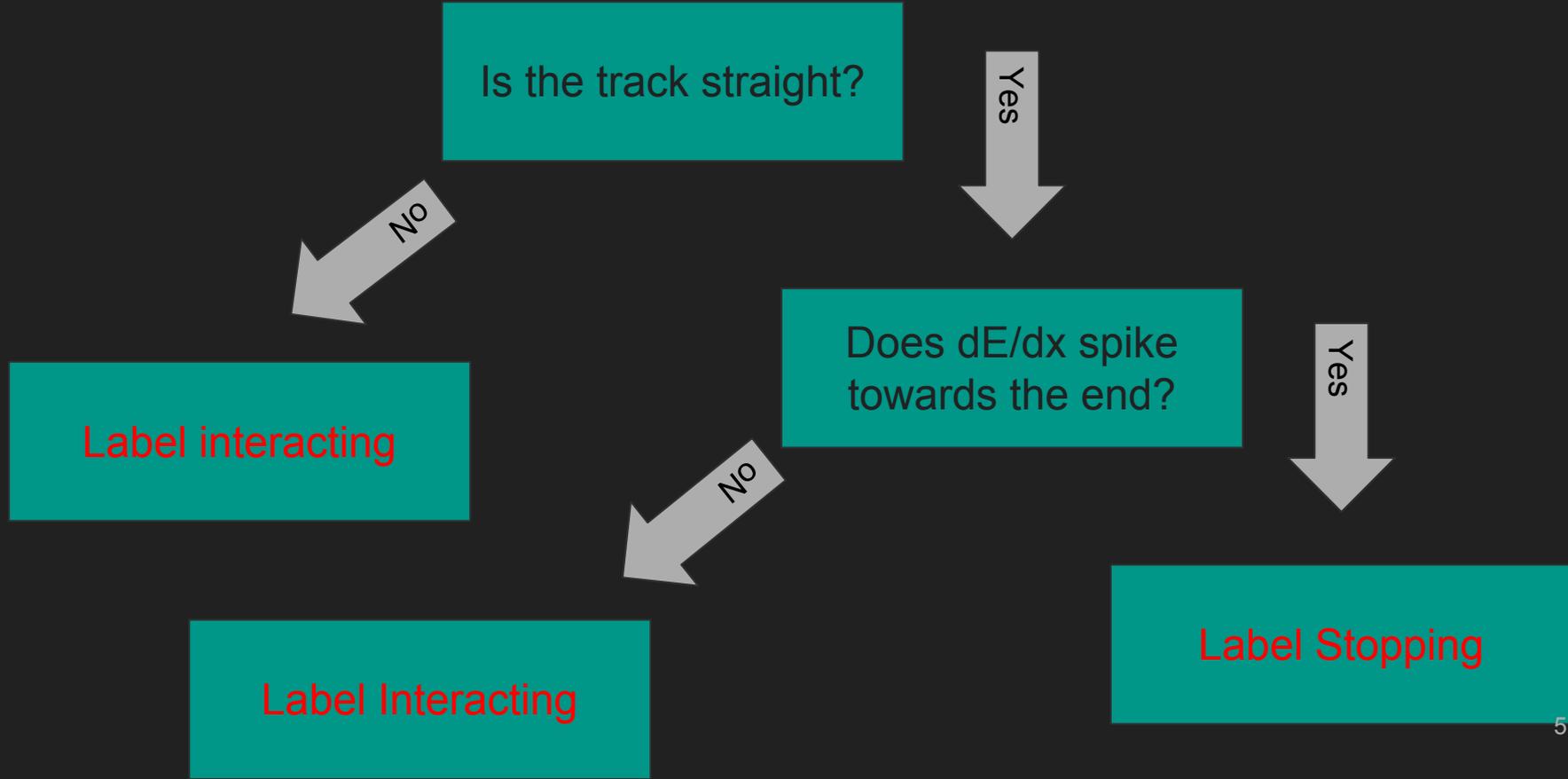
Cross-section strategy (i.e. MC study motivation)



The goal is to identify observables to use in separating between stopping and interacting protons.

This is a work in progress! A better understanding of some of the pathologies shown will require further investigation.

Cross-section strategy

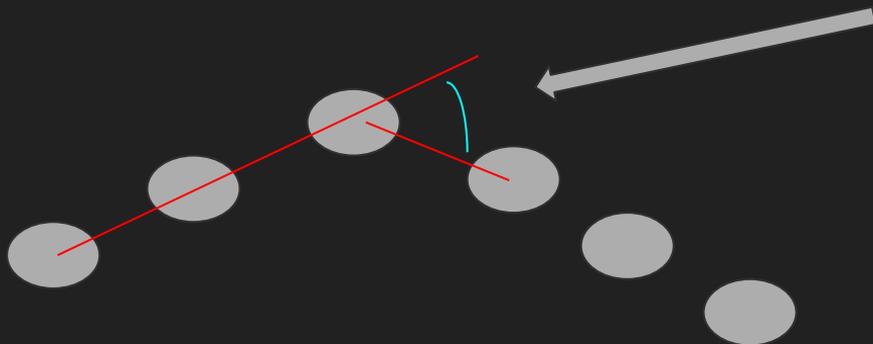


Track behaviour study

- With this overall strategy in mind for separating stopping and interacting protons (not caring at the moment about lifting back up specific channels, just total cross section) I had a couple goals in mind.
- If geant thinks a particle is stopping (no TrajectoryProcess), how straight is the track?
- If geant thinks a particle is interacting (inelastic/elastic/coulomb), how “not-straight” is the track?

Parameter of interest

- I want to associate straightness of a MC truth trajectory with what geant thinks the process is.
- I chose maximum angle in a trajectory as the parameter of choice.



Here this would be the maximum angle for this trajectory. (for straight going particle should be near 0)

Evaluating this parameter

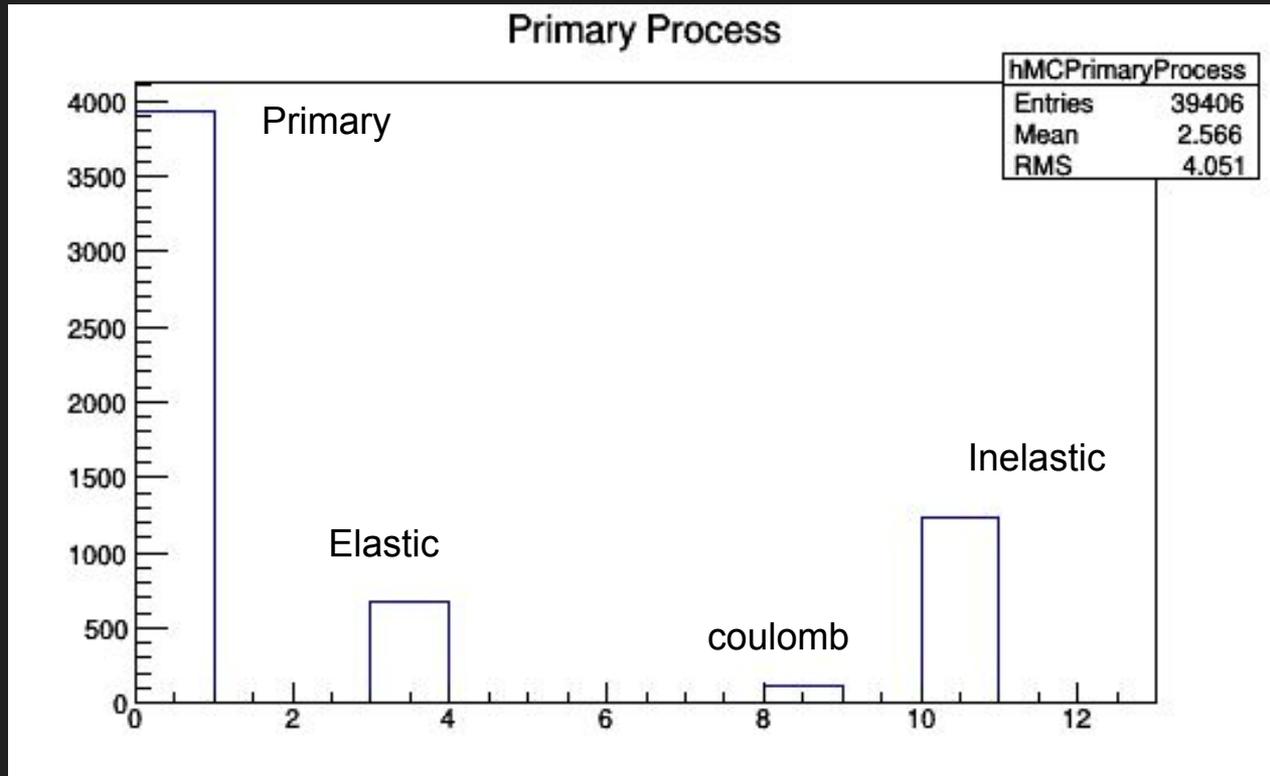
- In an actual interaction study this isn't the correct parameter to look at because in the (unlikely) event a particle scatters first with a small angle, then with a large angle we would only look at the larger angle.
- However for the purposes of studying the association in monte carlo between geant trajectory process and an observable (a kink) this parameter works just fine.

Quick blurb about the MC sample before the physics

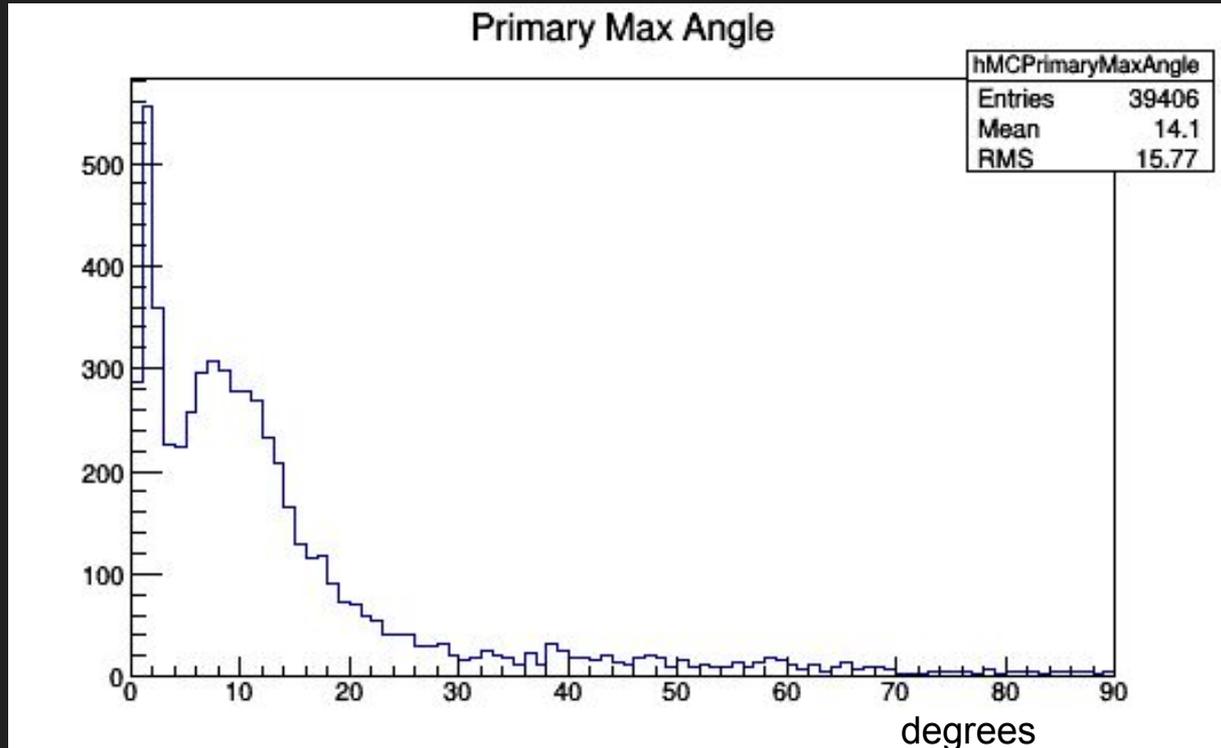
- Weighted by momentum to match data spectrum.
- I will be (throughout this talk) matching MC truth particle to MC reco so that I can associate process, do this momentum weighting, etc.
- I do this by matching an initial reconstructed vector with a truth vector (once the particle reaches the TPC) with some tolerance of position and angle. Very similar to what the Pion folks did (there's a talk somewhere on the docdb).

The following plots are all MC truth

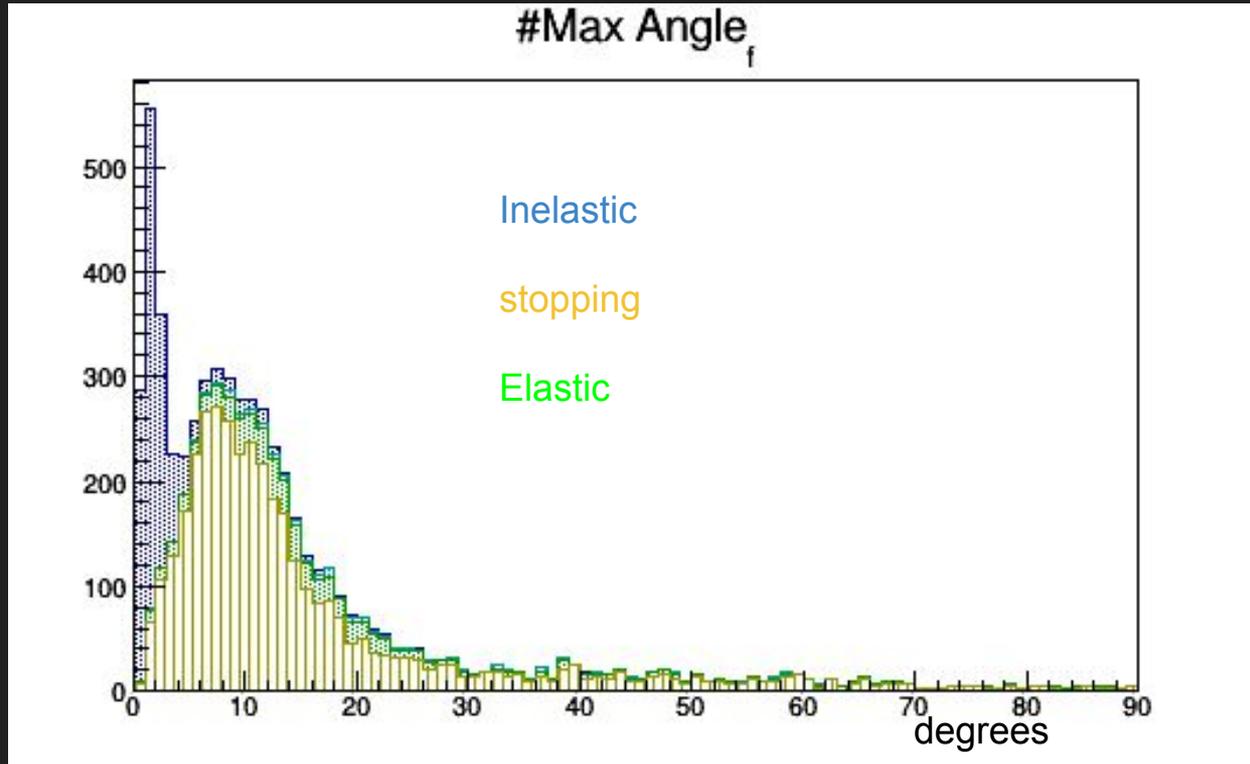
Trajectory Process



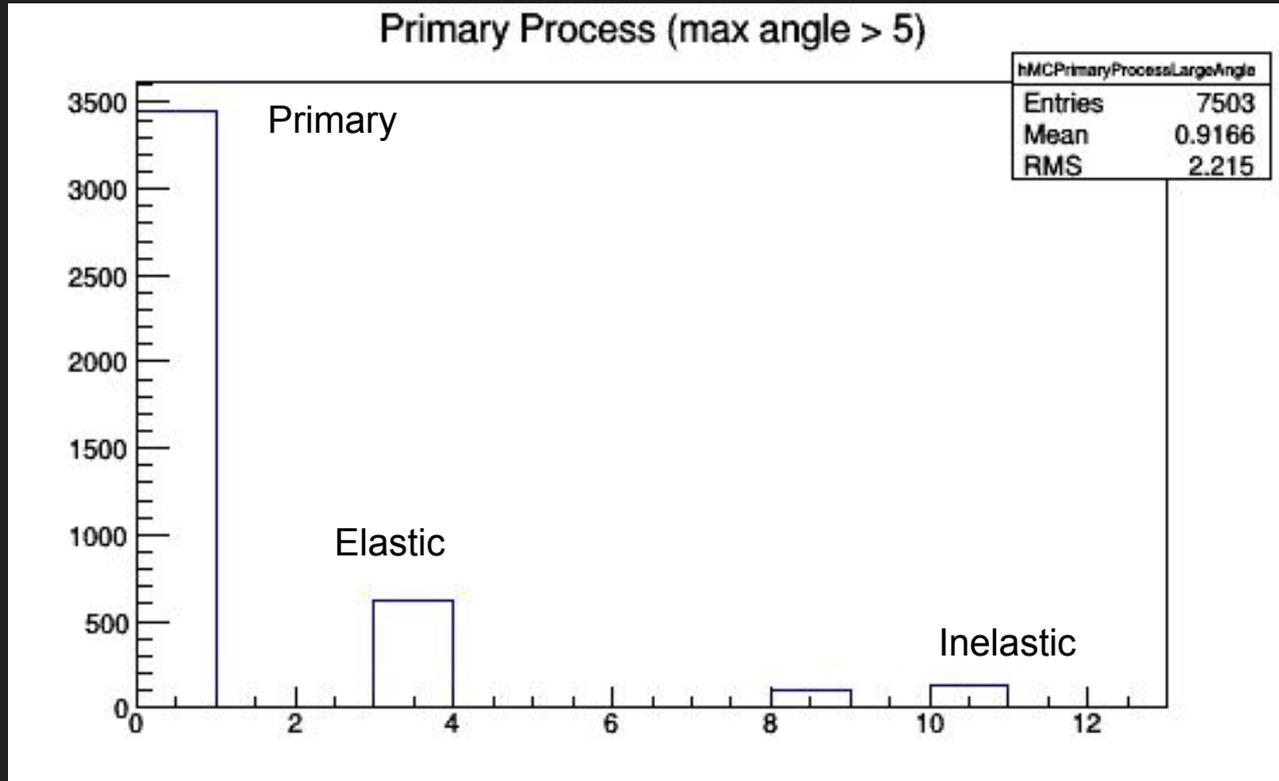
Primary Trajectory Maximum Angle



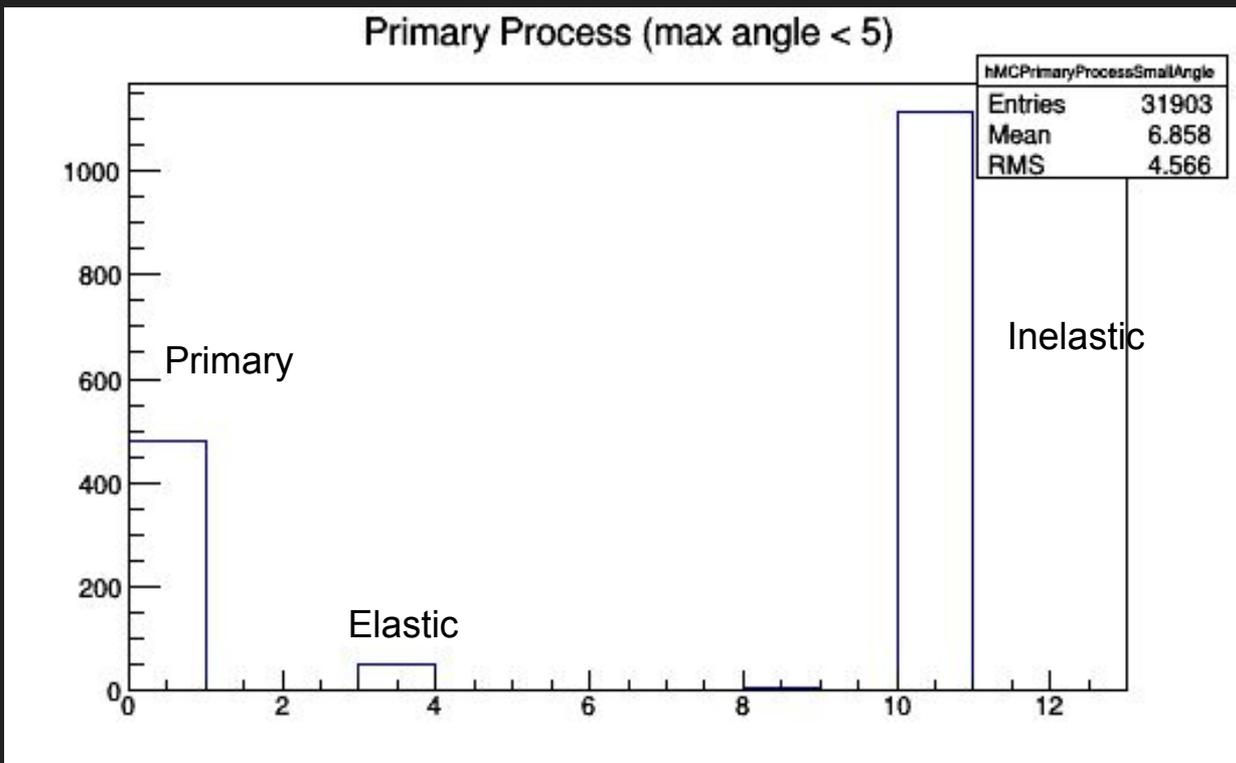
Primary Trajectory Maximum Angle (with process)



Process for trajectories with max angle > 5 degrees



Process for trajectories with max angle < 5 degrees

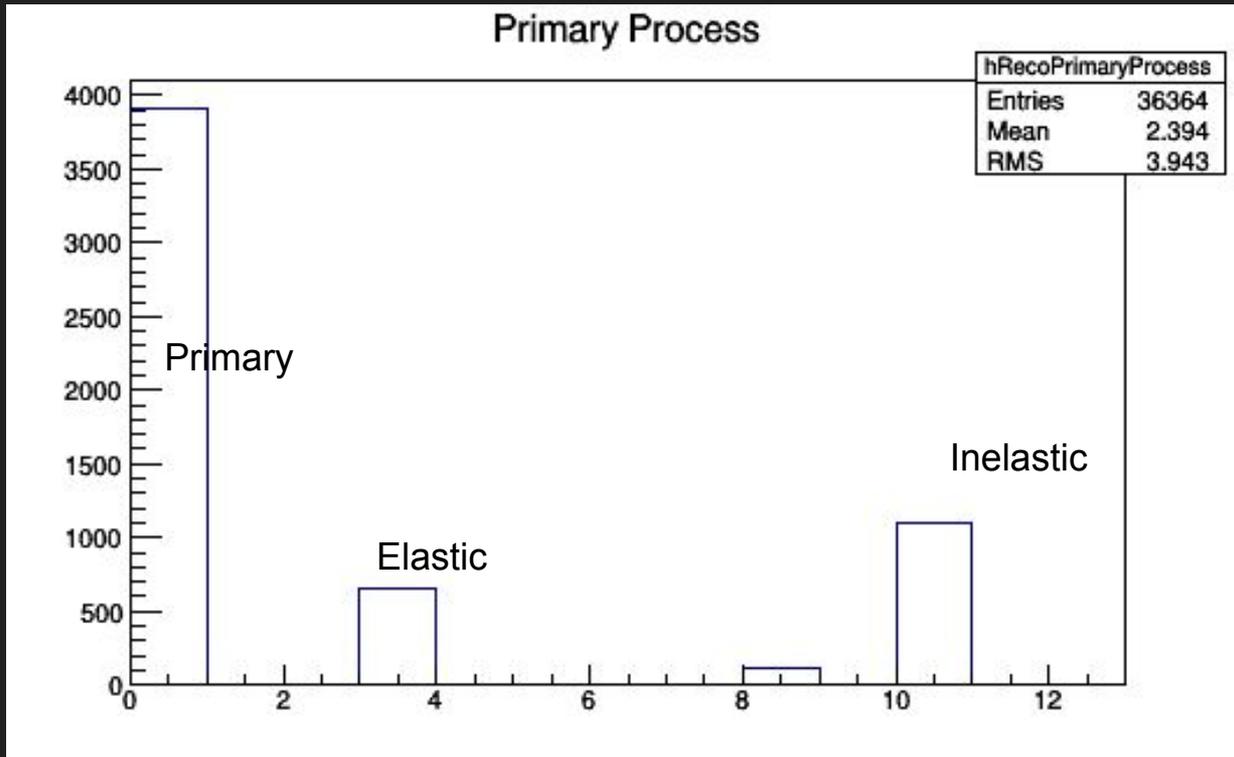


Choosing this observable

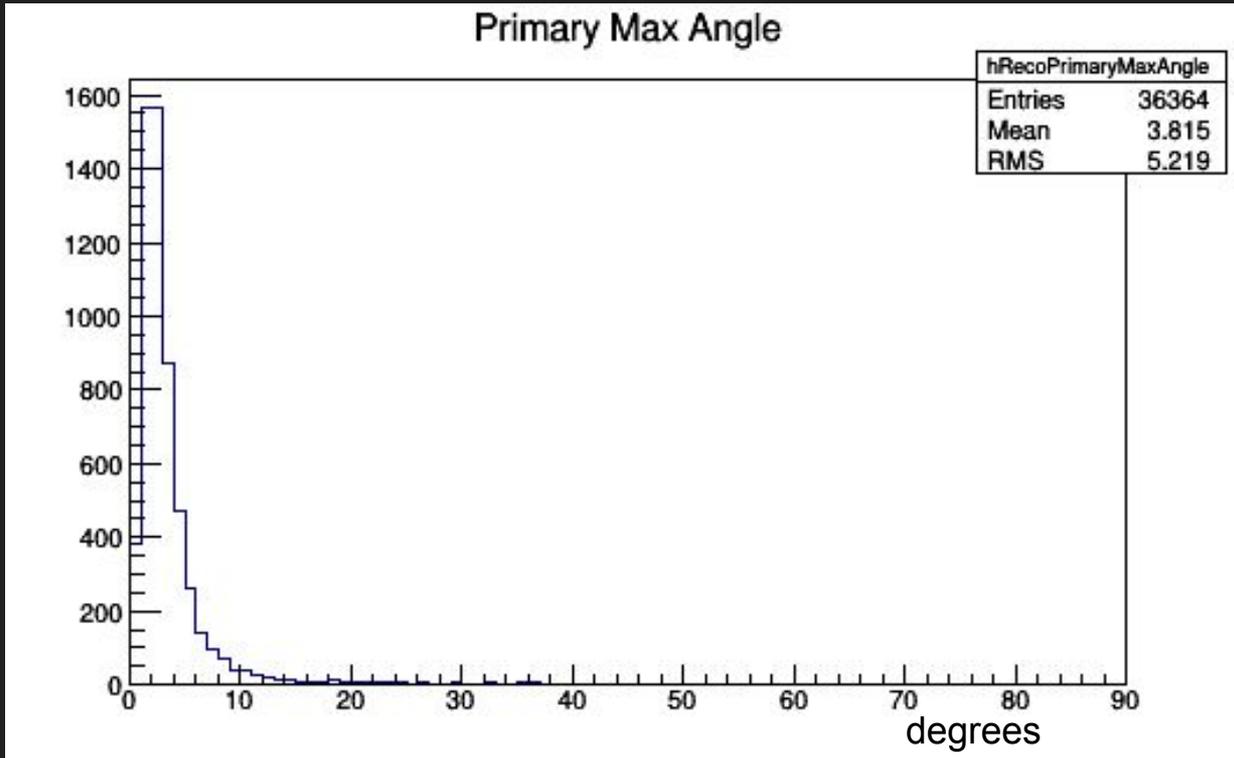
- The goal - ideally - is to maximize signal and minimize noise. In our context this means we want to pick an angle so that everything less than that angle is either **stopping** or **inelastic scatter**, so that we can separate further using calorimetry.
- However this optimization is tricky to do since as we can see there is still some loss between g4 and larsoft (what we have labeled as having no process but with a maximum angle indicating otherwise).
- At the end of the day this is an eyeball choice and **NOT FINAL**, I will eventually come back and try to study this further.

The following plots are all MC reco

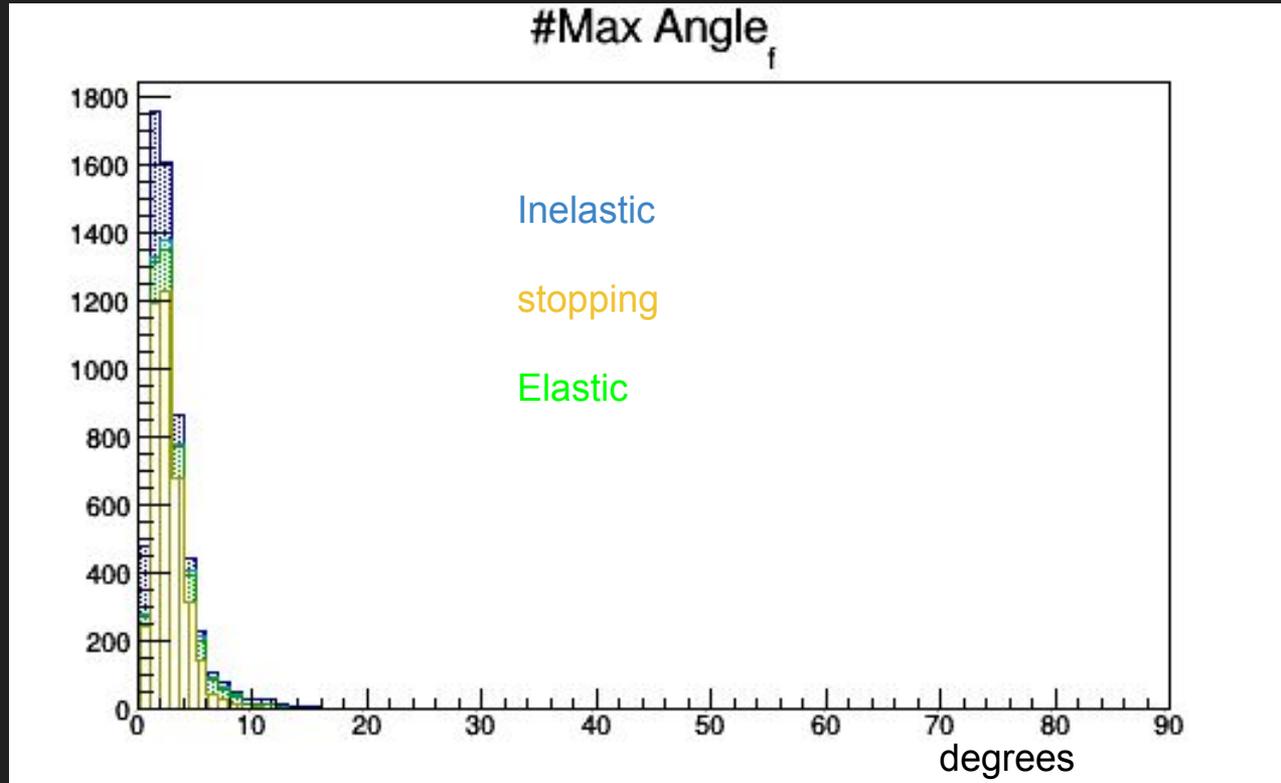
Trajectory Process



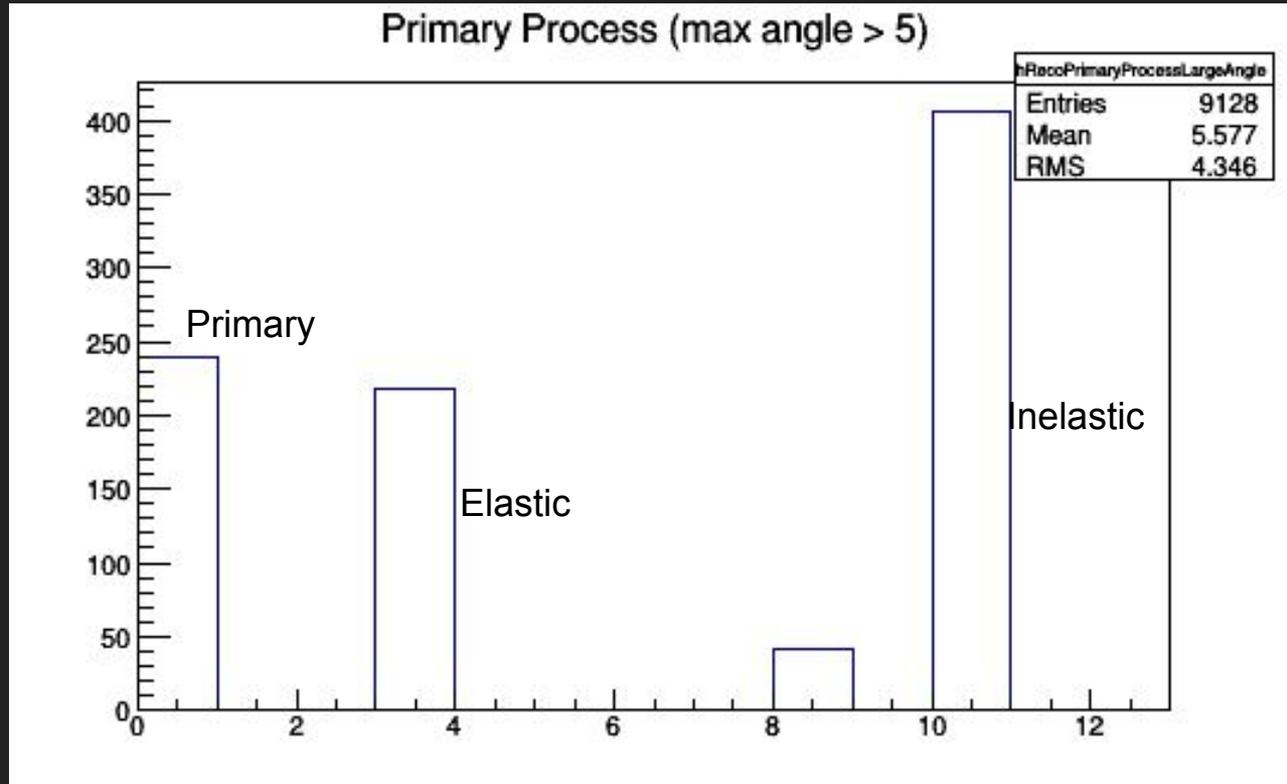
Primary Trajectory Maximum Angle



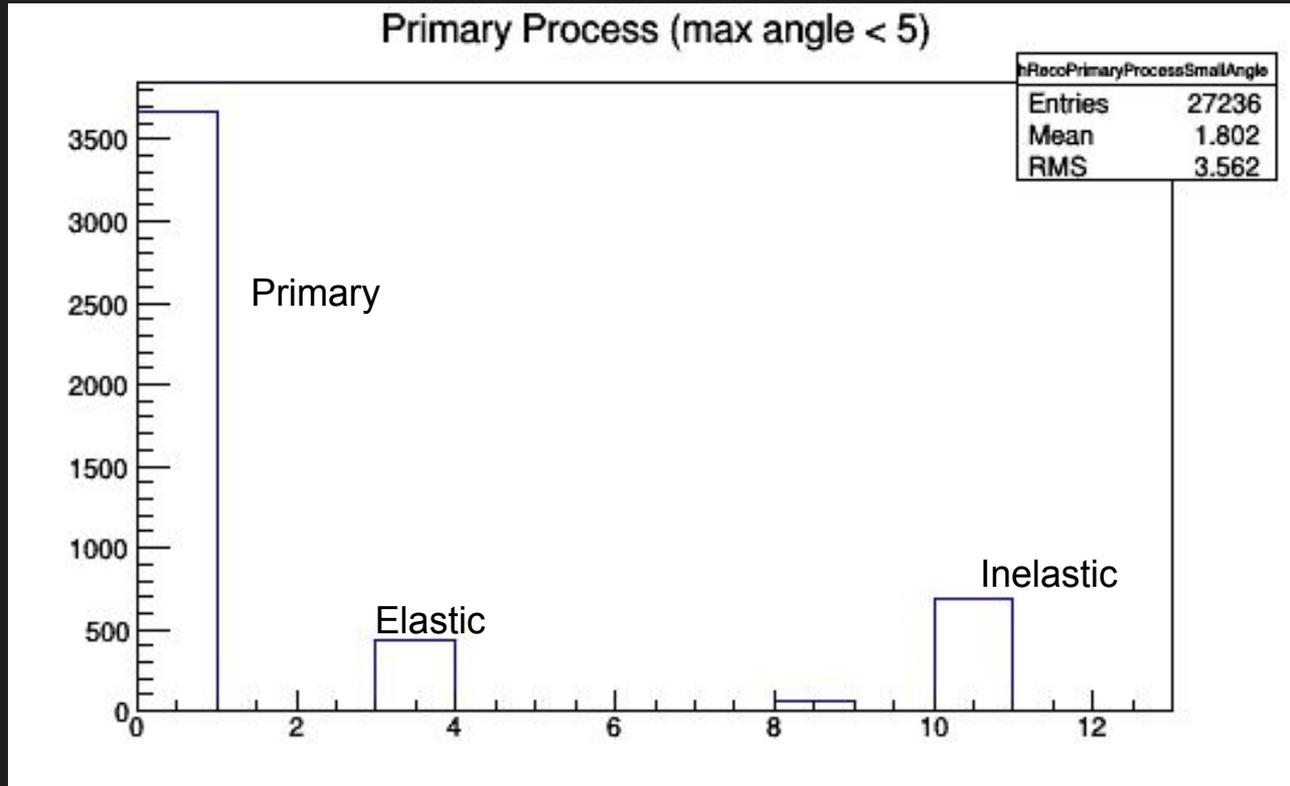
Primary Trajectory Maximum Angle (with processes)



Process for trajectories with max angle > 5 degrees



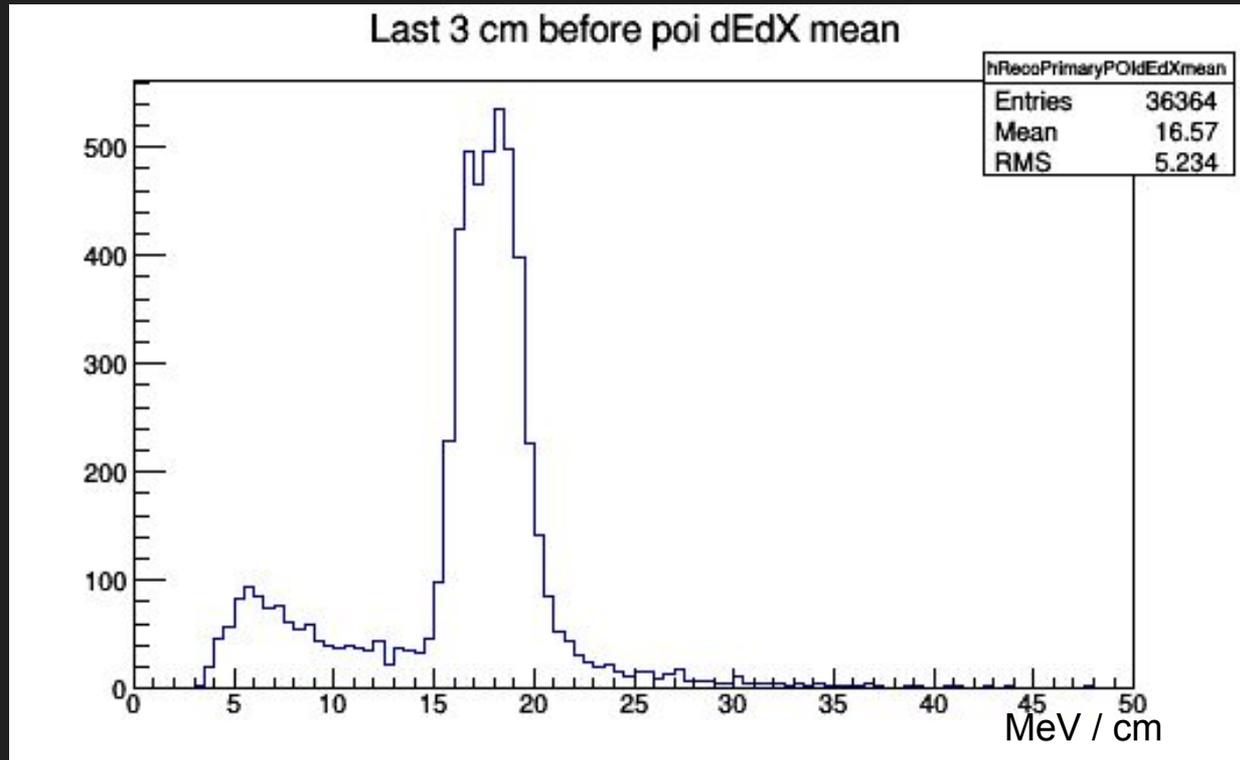
Process for trajectories with max angle < 5 degrees



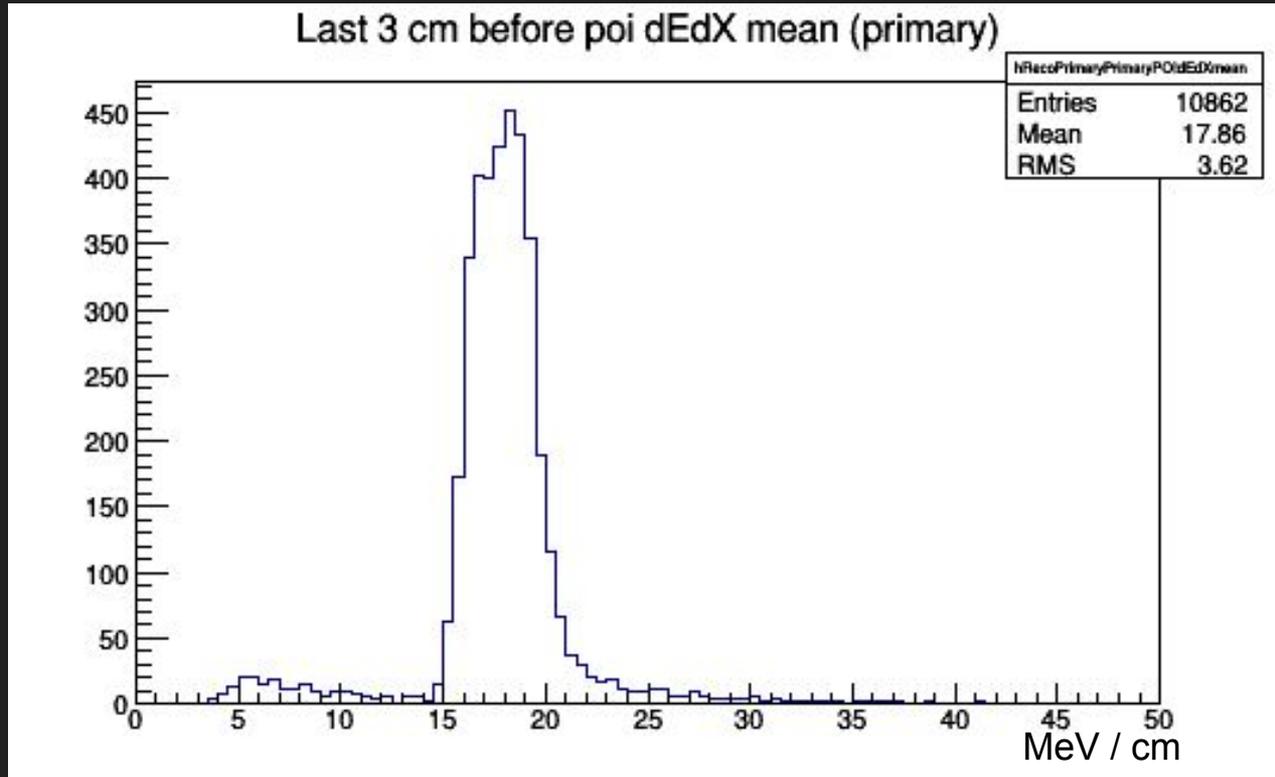
Brief look at the calorimetry

- After looping over each space point for a track I label a point of interest (POI) as being **either** a kink (if there is a change in trajectory greater than 5 degrees) **or** the end of a track (if the track is straight)
- Once this POI is chosen, I calculate the mean dE/dx for 3cms of track before it
- We expect straight and stopping tracks to have a different signature than straight and interacting tracks
- The rest of the plots are all MC reco...

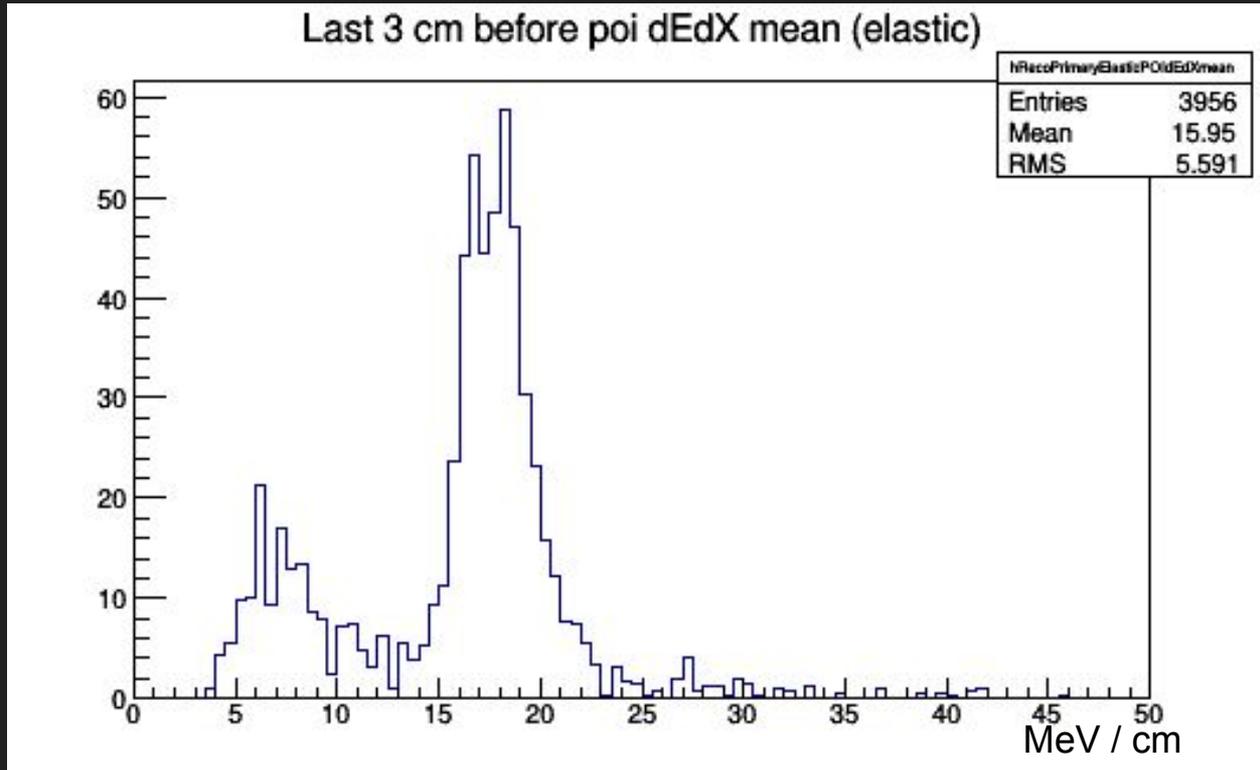
$\langle dE/dx \rangle$ 3 cm before POI



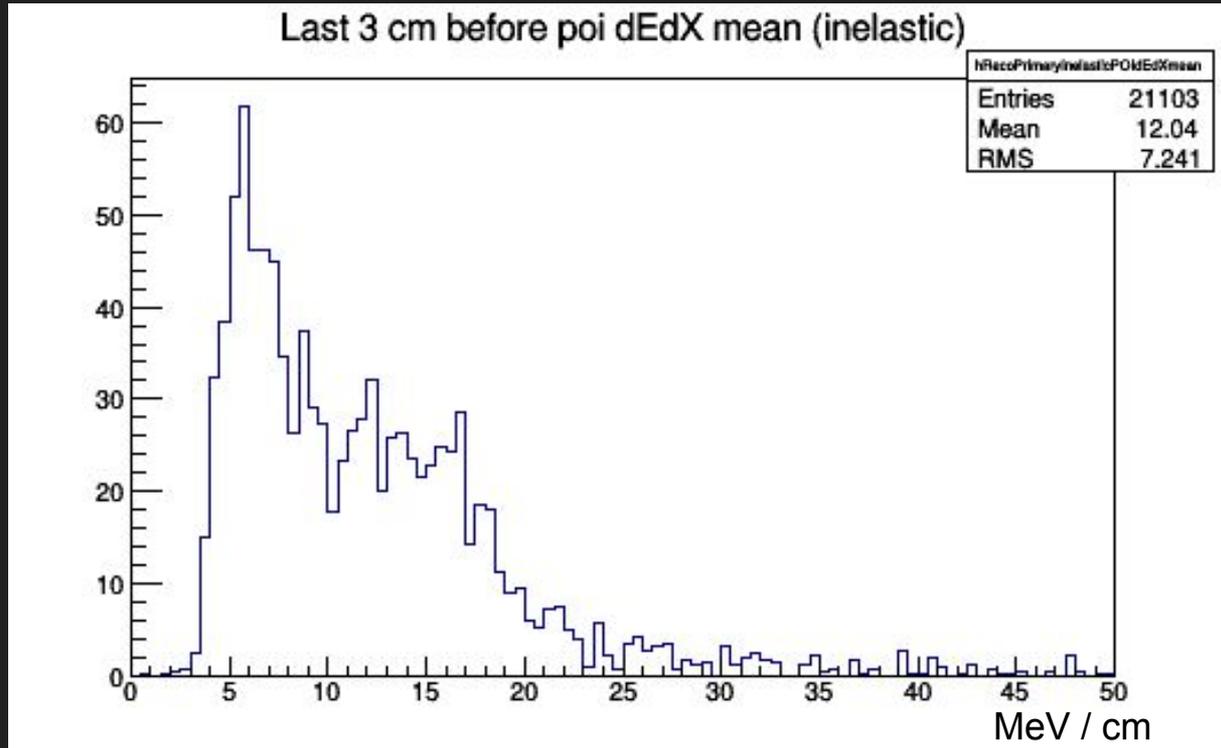
$\langle dE/dx \rangle$ 3 cm before POI for “stopping”



$\langle dE/dx \rangle$ 3 cm before POI for elastic



$\langle dE/dx \rangle$ 3 cm before POI for inelastic



Some notes about kinks and $\langle dE/dX \rangle$

- Something I have not yet done is look at the residual range for kinks. This would help further indicate exactly how well or poorly the reconstruction is doing.
- Also this **might** explain the elastic plot I just showed. If a particle elastic scatters right before stopping, the mean dE/dX right before the scatter may be skewed with some of this stopping behaviour.
- I need to study it further to know for sure however.

Takeaways for the cross-section

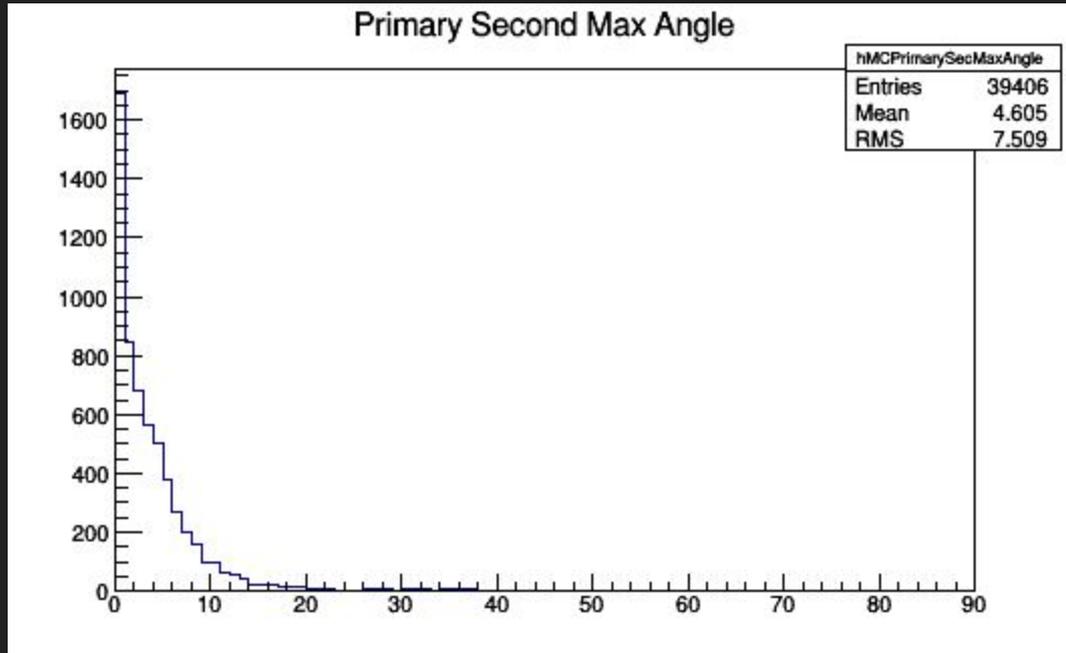
- The goals were to take away from these two studies two parameters that are usable in identifying interactions: a minimum scatter angle, and a minimum stopping dE/dX signature before a POI.
- This first pass over I picked two numbers by eye, trying to minimize background in each case (pruning out straight tracks, then pruning out stopping particles).
- I plan on going back over and trying to come up with a way to quantitatively optimize these, but there may be limitations in geant 4 mislabels.

Moving forward

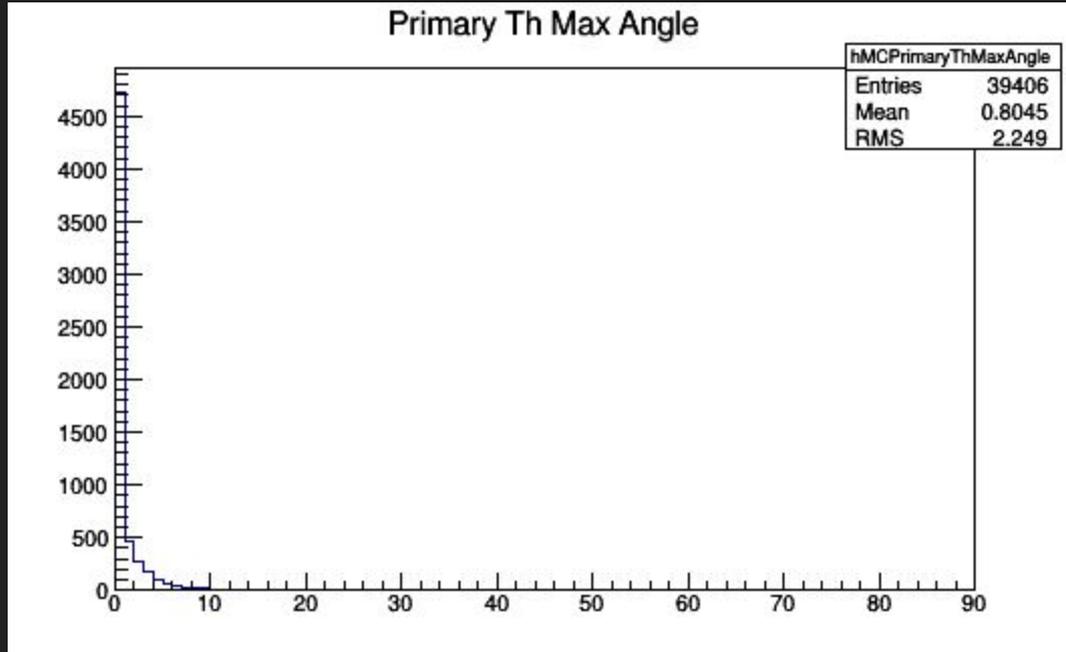
- Turning the crank and getting an early look at the MC reco Cross section
- Going back and optimizing these parameters (as much as this makes sense to do)
- (potential intermediate step: studying the calorimetry further to try and lift back up specific channels of the cross-section)
- Opening the box on data
- Go back from the beginning and estimate uncertainty every step of the way!

Thank you!

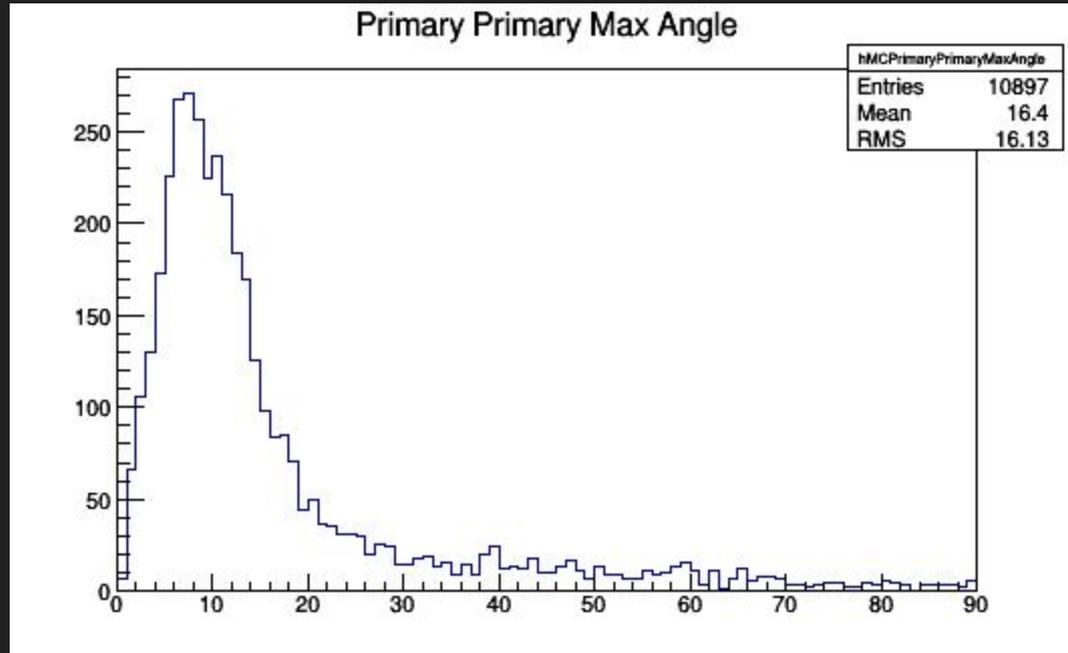
Backups Truth



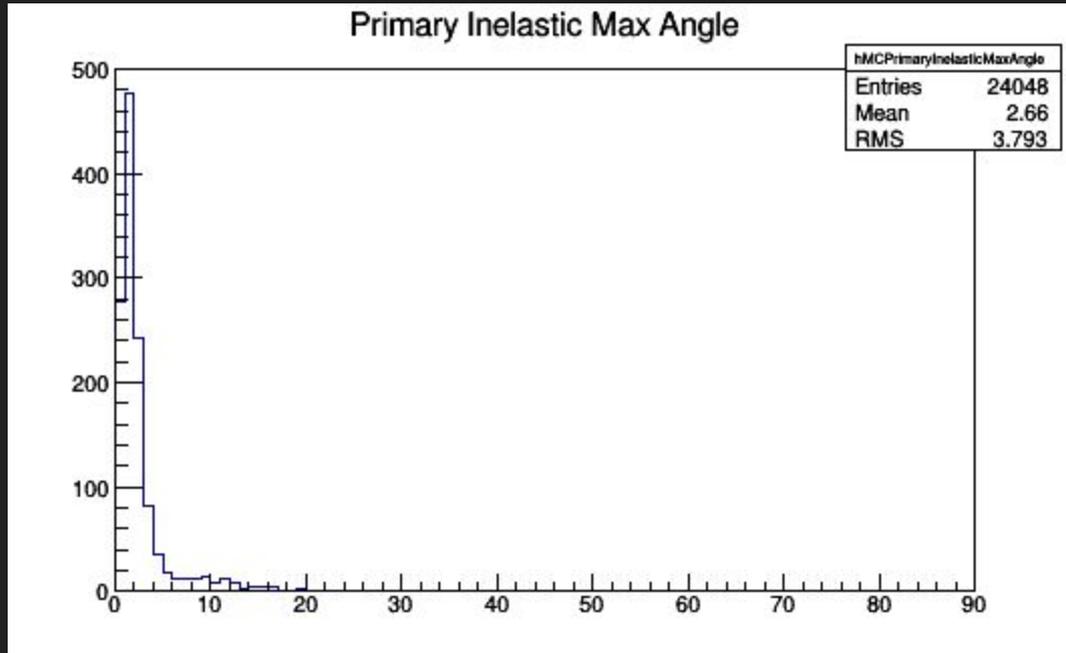
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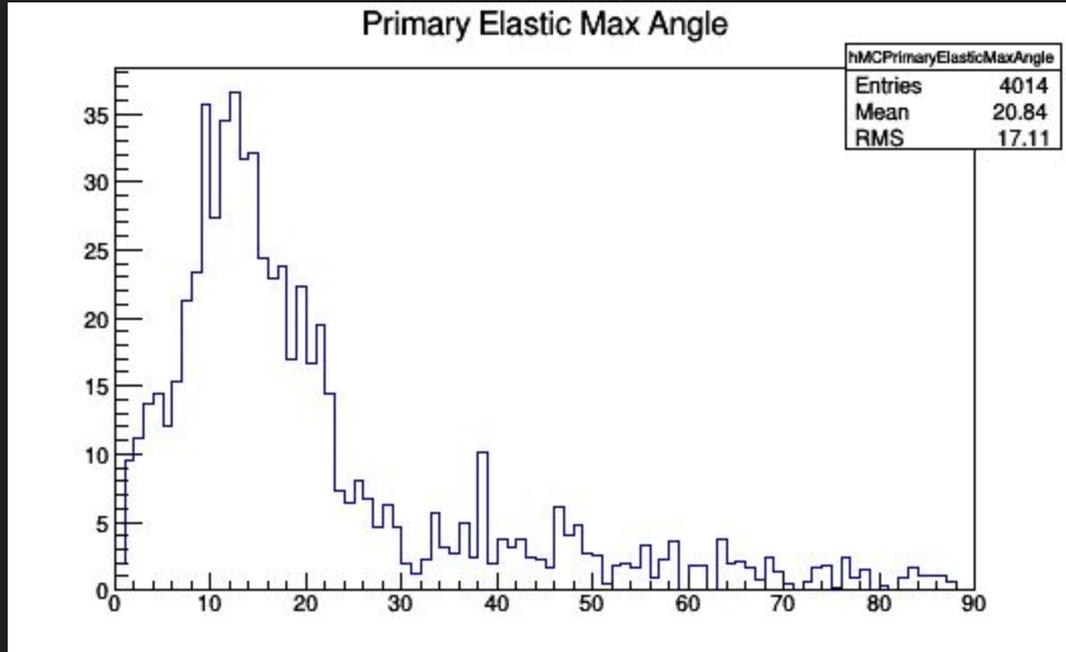
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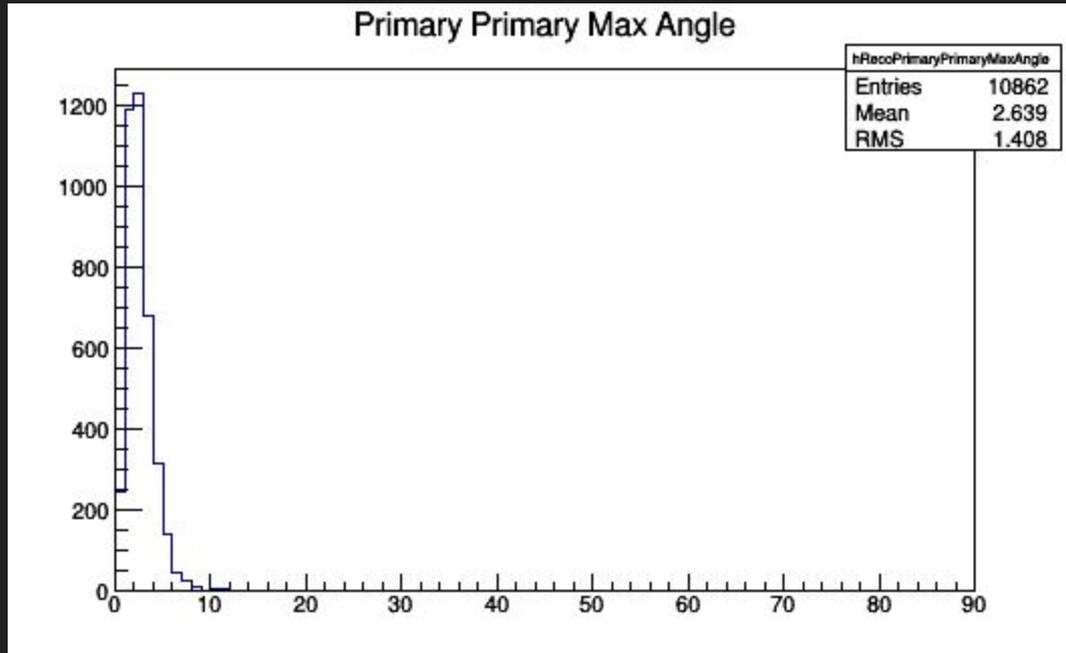
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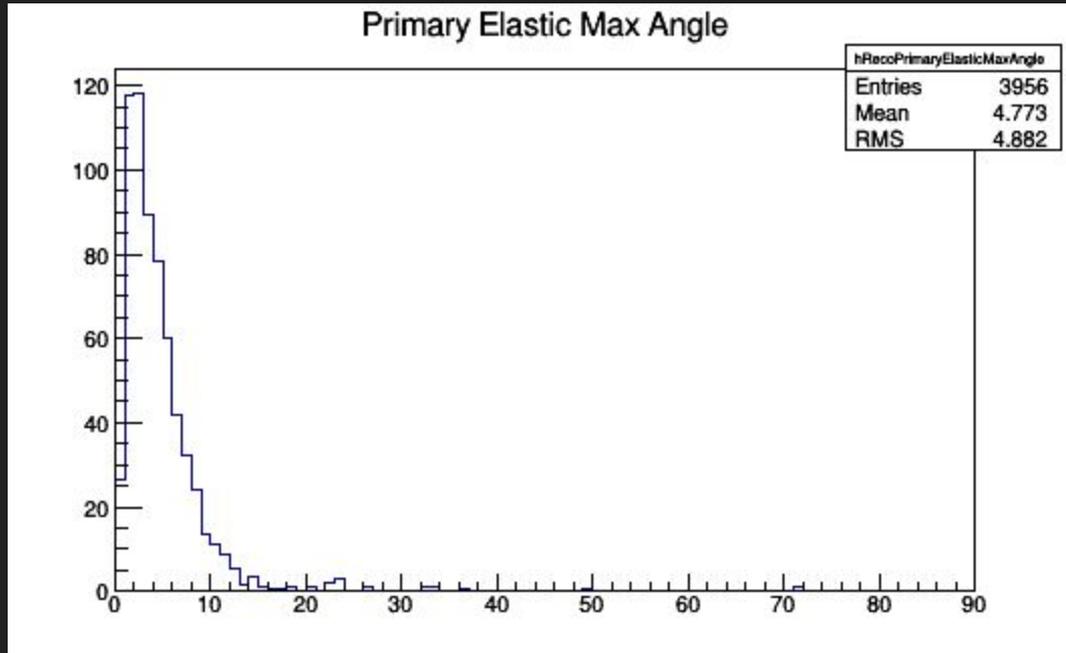
Backups Truth



Backups Reco



Backups Reco



Backups Reco

