Beam Energy-Loss measurement

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CM43
RAL
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Outline

- Aiming to demonstrate that it will be possible to make the first muon beam energy loss measurement.

- Quick look at the past.

- Overview of MC analysis with reconstruction.
    - large effort to overcome reconstruction errors.

Past Measurements

- No measurement of muon energy loss in LH2 done before
  - Some Bubble chamber studies have used Bethe approximation to measure muon mass, not vice versa
  - Simon Holmes thesis on MuScat touched on energy loss measurement briefly
    - Measured end-of-beam energy vs x-axis as an attempt to measure energy-loss/scattering correlation. No conclusive results gained.

Past Measurements

So, MICE will be the first experiment to measure the mean energy loss of a Muon beam in Liquid Hydrogen (and LiH).

MC Analysis

Simulating muons with 200MeV in US tracker, 6mm beam.

- 500k muon events (need larger data sets because of stats loss)
- TOF2 triggers: 186961
- Full field in DS (for now)

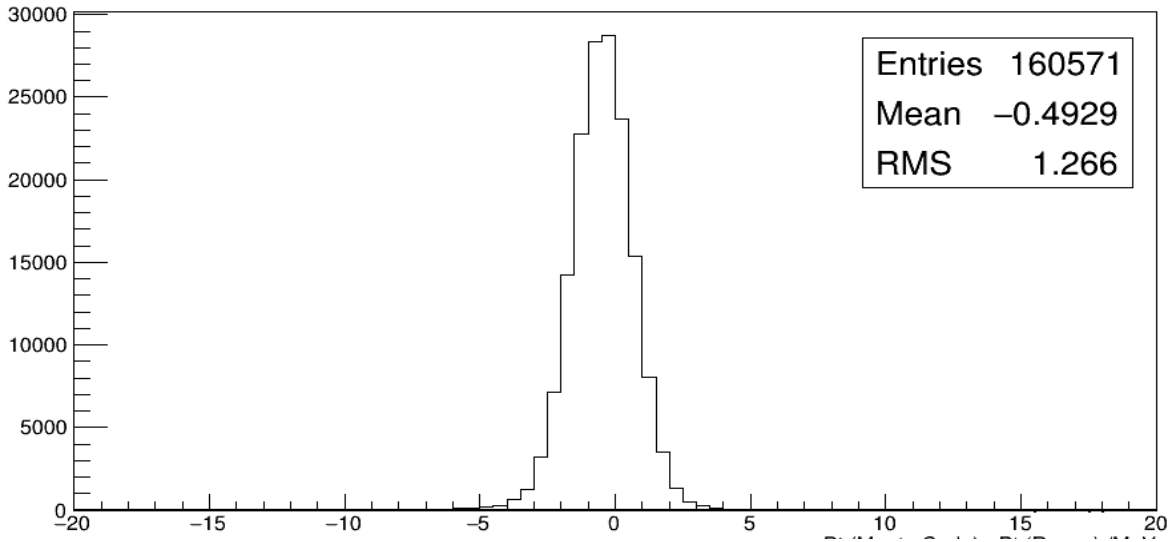
Using MAUS v1.1.0, test geometry w. LH2 absorber (#673)

- Analysis is taking a momentum measurement in upstream tracker, subtracting momentum in downstream tracker to get momentum loss in absorber on particle-by-particle basis.

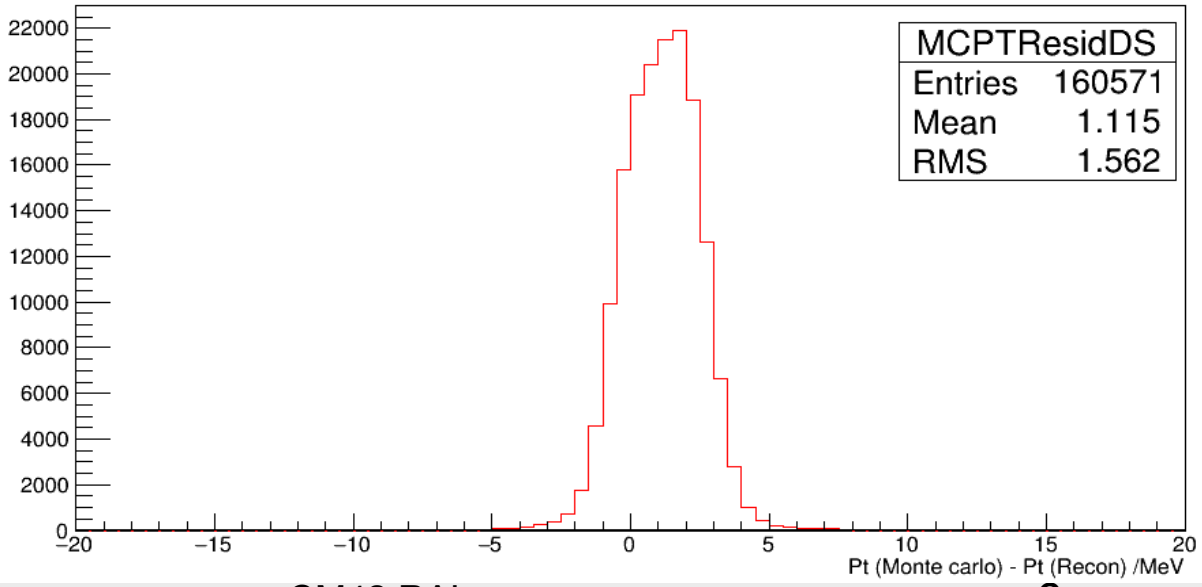
- Errors in mean energy loss dominated by Pz reconstruction resolution errors in the residuals.

Pt Residuals

US

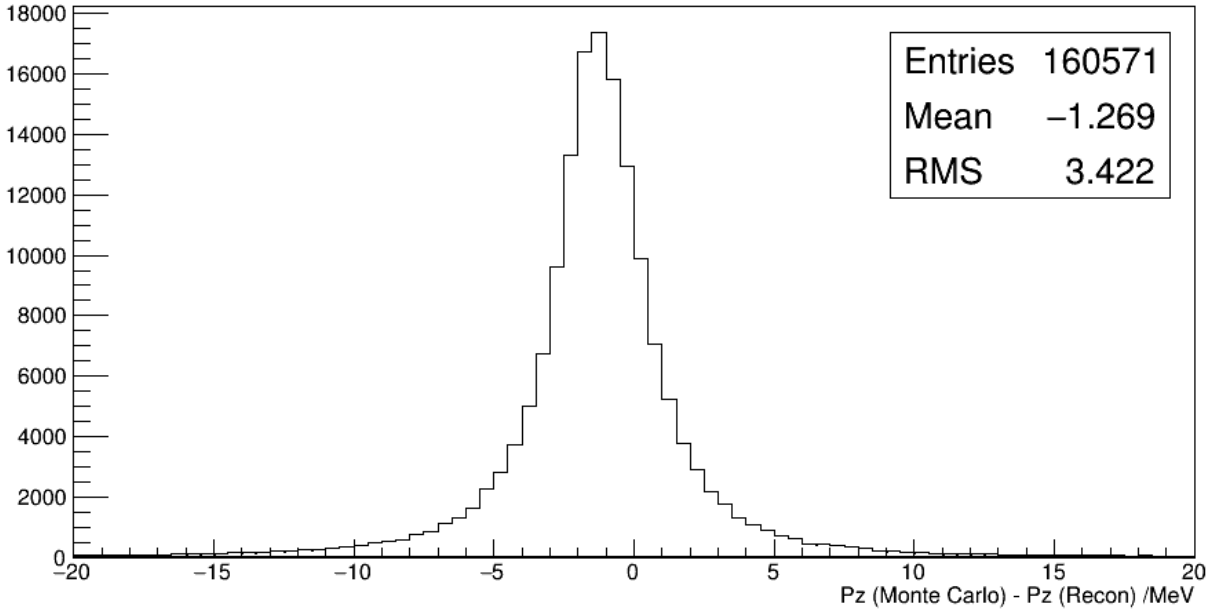


DS

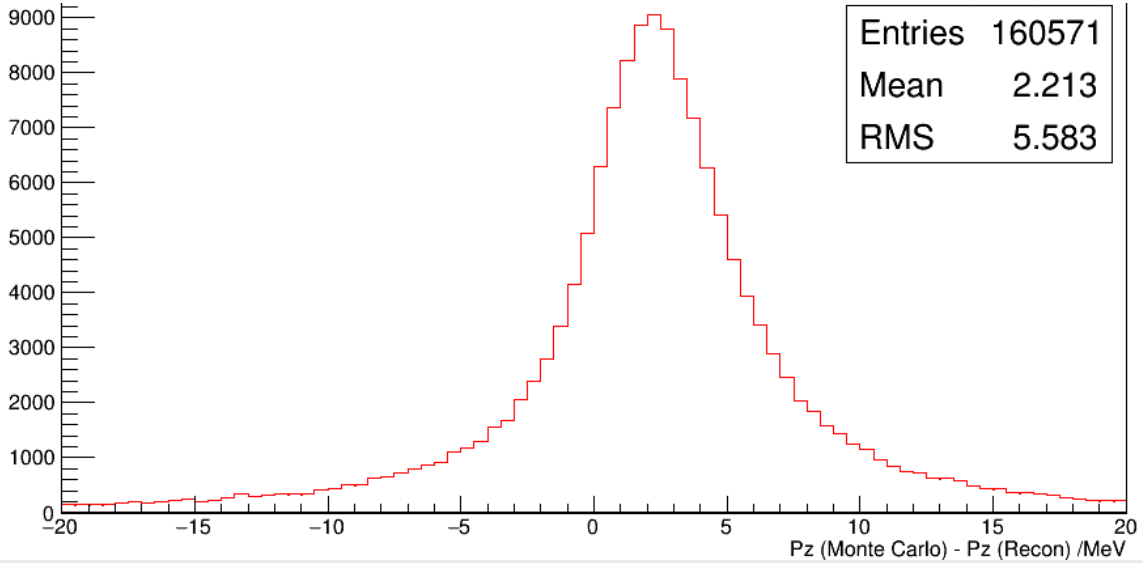


Pz Residuals – without cuts

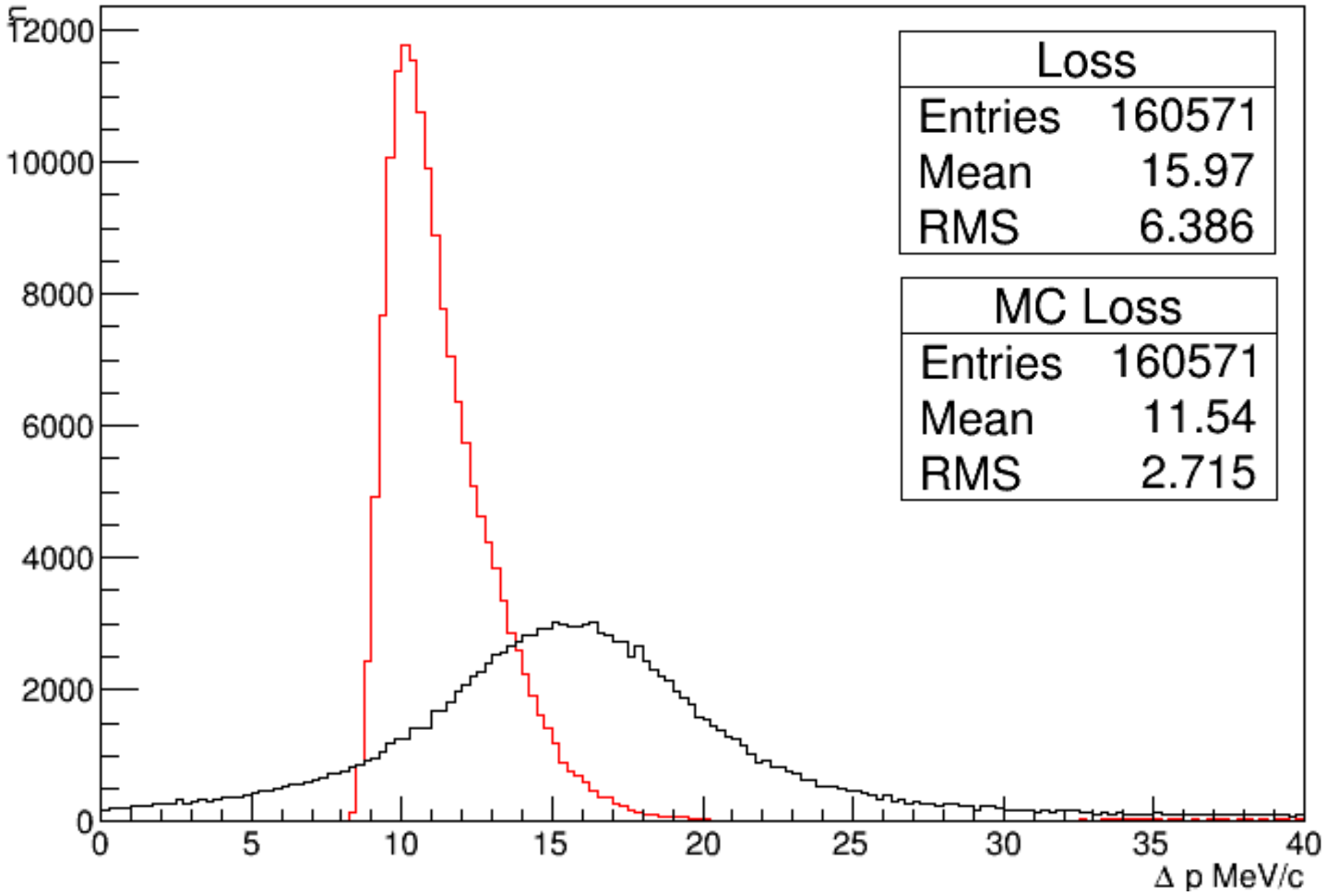
US



DS



MC Energy loss vs Energy loss (without selection cuts)



So...

- Off-center residuals in US and DS trackers result in overestimating the energy loss.
  - Mean recon. energy loss is 4.43MeV larger.

- Need a method of selecting region of well-reconstructed tracks with mean residual closer to 0.

- Create distribution of PT vs PZ for tracks that have poor PZ residuals
- Subtract from this the distribution of all selected events.

  - Result is a “pattern” which shows regions where there is an excess of well reconstructed events.

  - Can do a “by eye” selection from messing around with these plots

PT vs PZ event selection in DS

Poor Residuals

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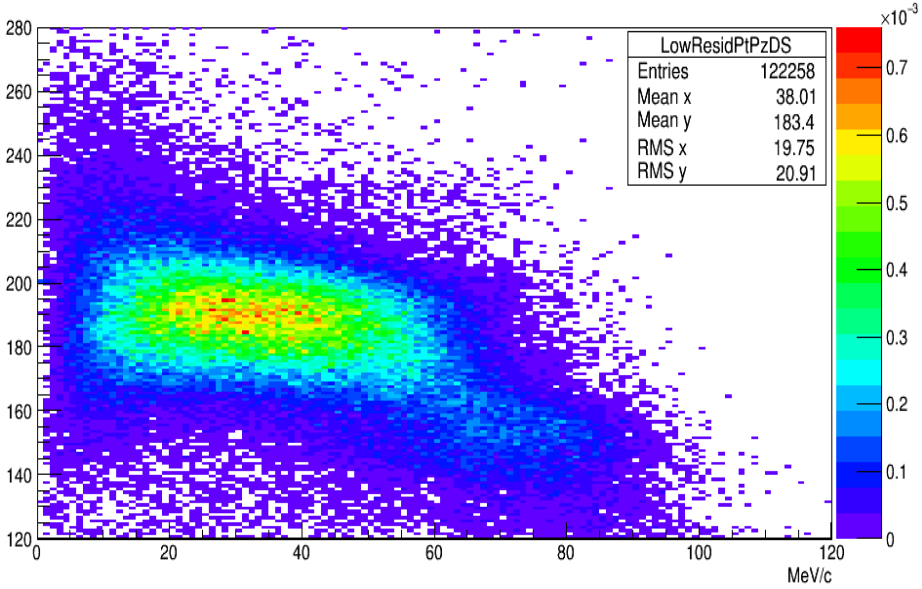
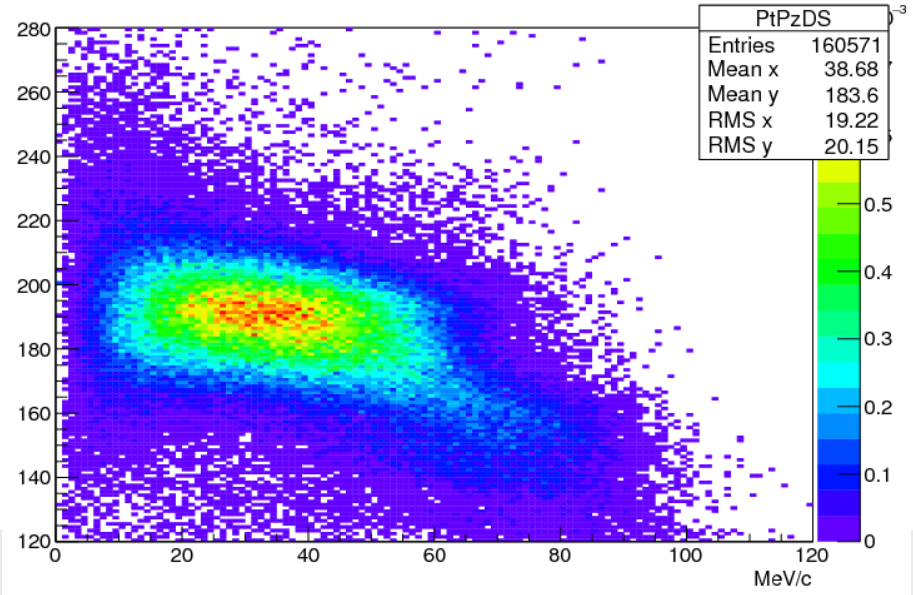
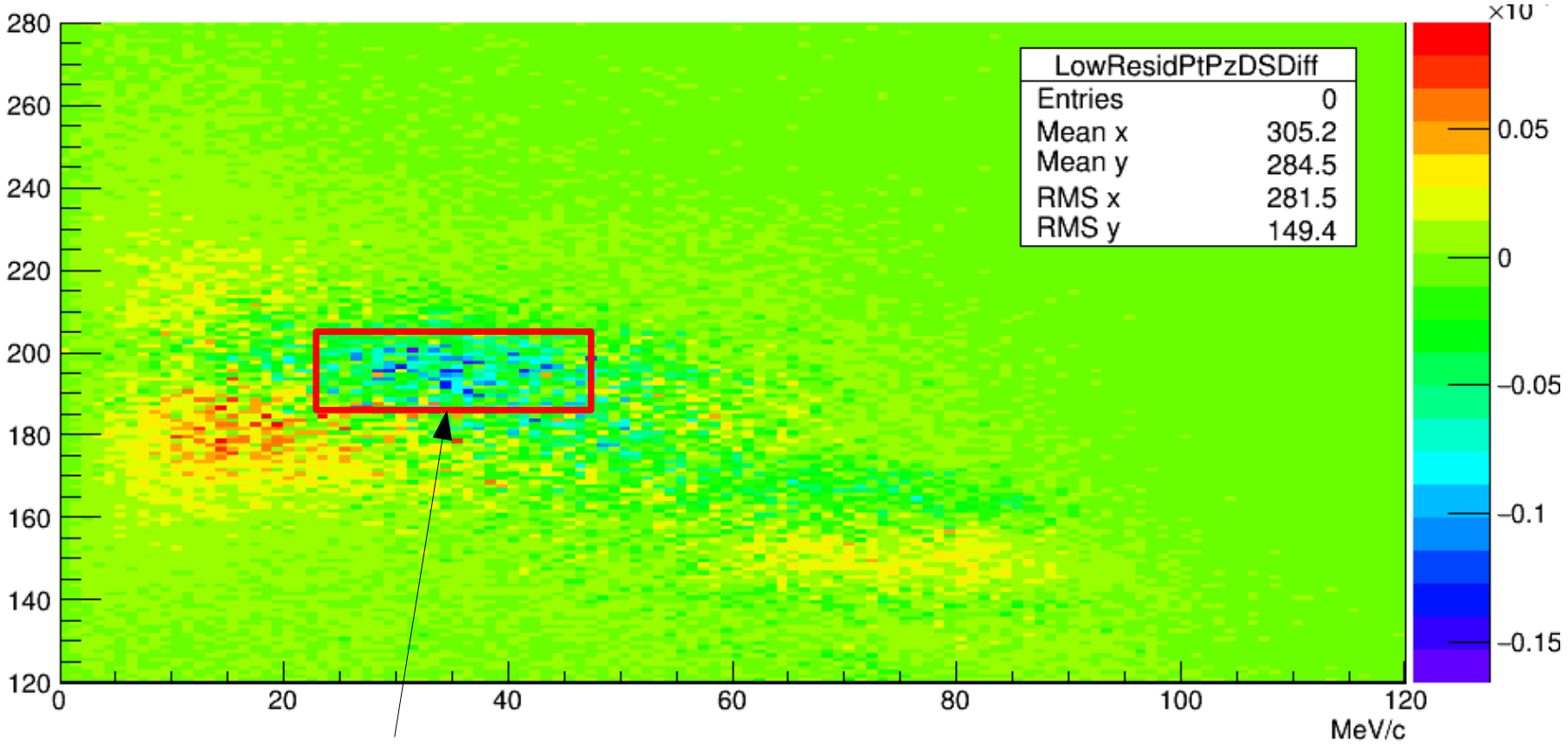


All events





Excess of well-reconstructed events in DS tracker

Cuts on Pt and Pz

In US tracker:

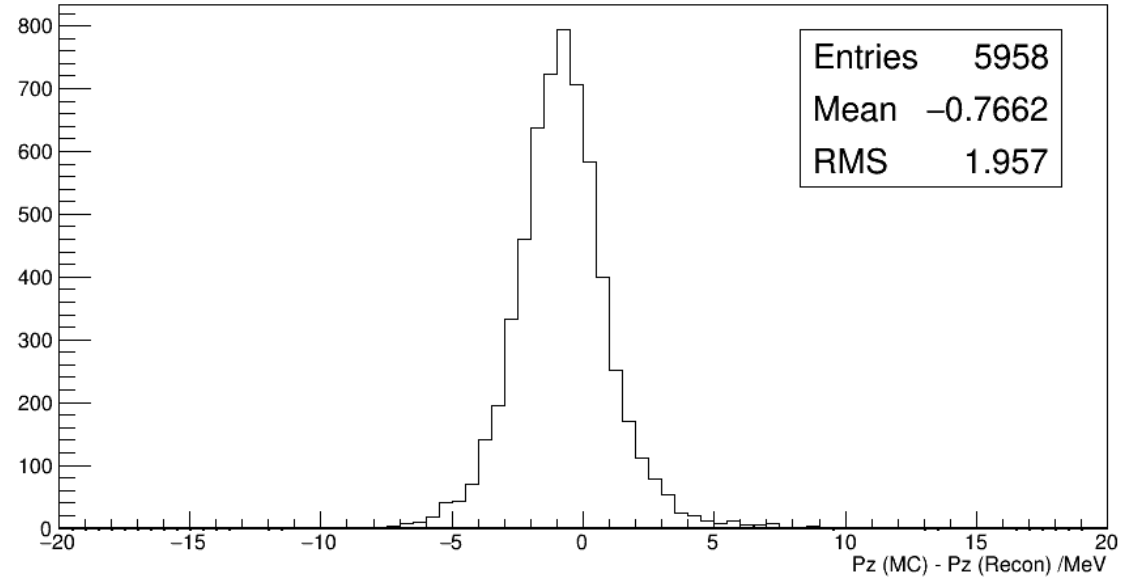
- Pt > 30MeV
- Pz < 210MeV

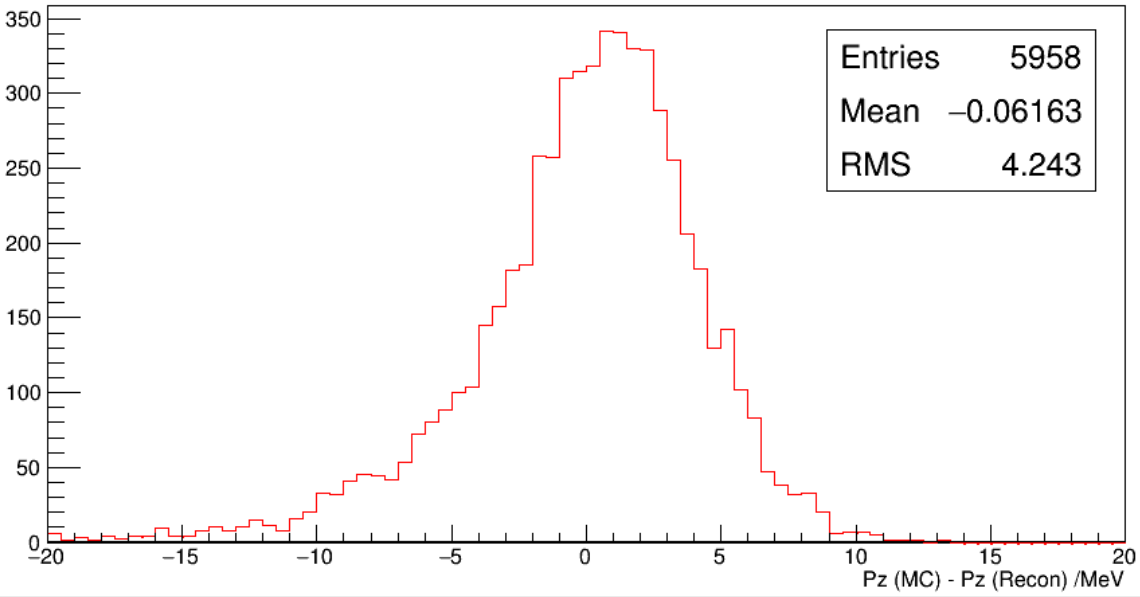
In DS tracker:

- 30MeV < Pt < 40MeV
- 185MeV < Pz < 202MeV

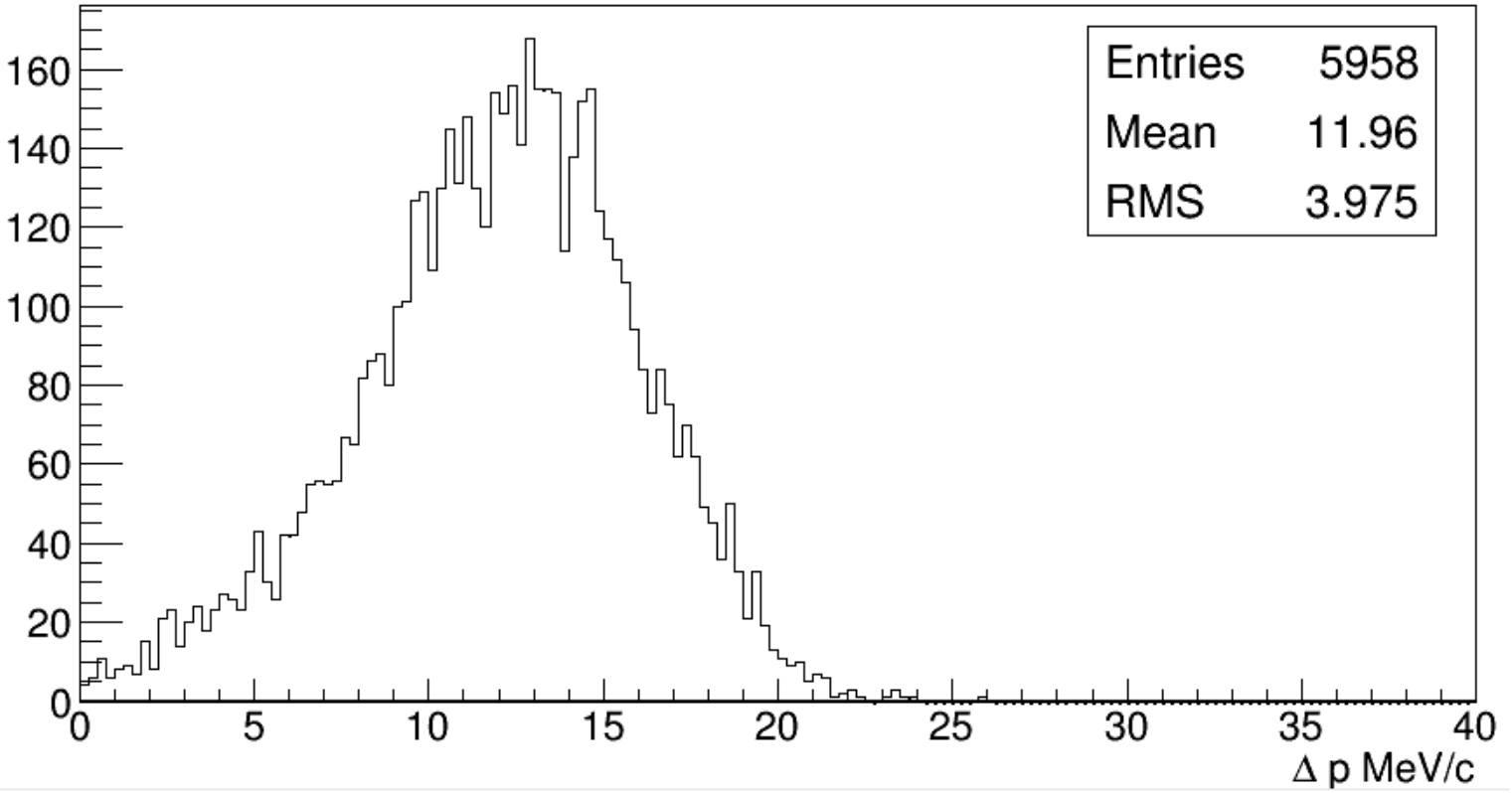
- These cuts take away a lot of potentially useable events
- But do improve at least the mean residuals...

Pz residuals (after cuts)





Energy loss with cuts:



Mean energy loss is now comparable to the MC mean..

Comments

- Attempting to find well-reconstructed events with this method is clearly not perfect.
  - Losing ~96% of TOF2 triggers
  - Very wasteful.
  - At least find a defined region of events that provide OK residuals.
  - Only really useful to show that if more events were reconstructed well, then the mean energy loss is measurable.

- Some flag in reconstruction which could indicate whether an event is usable would be a good solution.
  - More usable events!

- Need to test this with an empty absorber

- Most likely will need to see some improvement in the reconstruction to carry out the measurement in this fashion.