Beam Energy-Loss measurement

Rhys Gardener

CM42
RAL

Intro/outline

- Preliminary look at the energy loss measurement – very early thoughts with a couple of simulations to assist.

- Energy loss in beam
  - LH2 absorber

- MC study
  - Simulation Details
  - Analysis
  - Plots
  - Conclusions

Beam Energy-loss

- Ionisation Cooling of a Muon beam is achieved by passing the beam through an absorber of low-Z material.
  - In our case LH2 or LiH.

- Energy-loss is an interesting measurement that will help our understanding of the beam.

- There are few (if any) instances of the muon beam energy loss being measured.
  - MUSCAT measured scattering angle distributions.

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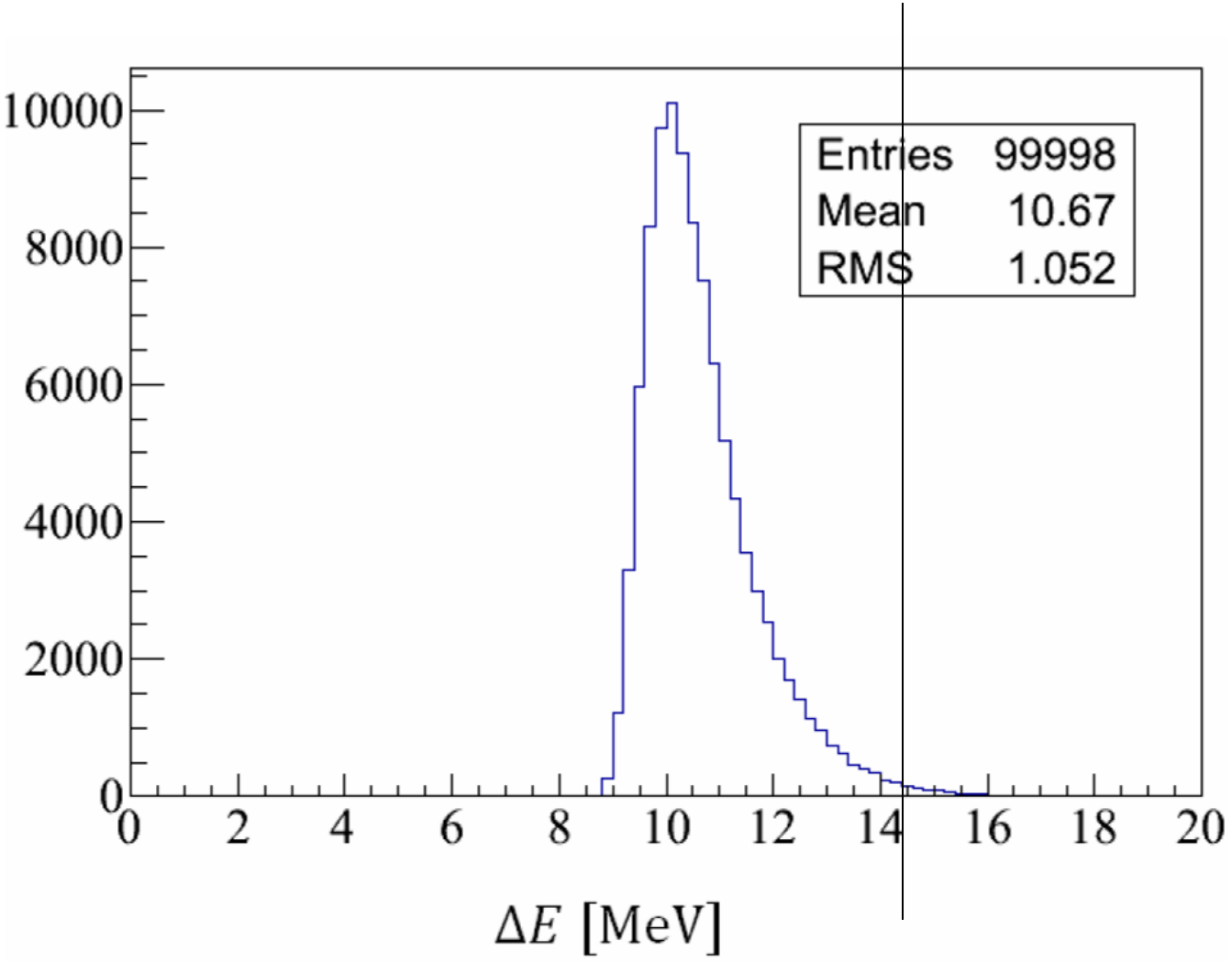
- Will initially use the trackers to measure the momentum either side of the absorber.
  - Likely all detectors will be needed to make a good measurement.



Simulated Energy loss distribution for 200MeV muons in 35cm LH2.

(from Tim Carlisle's Thesis.)

MAUS MC simulation

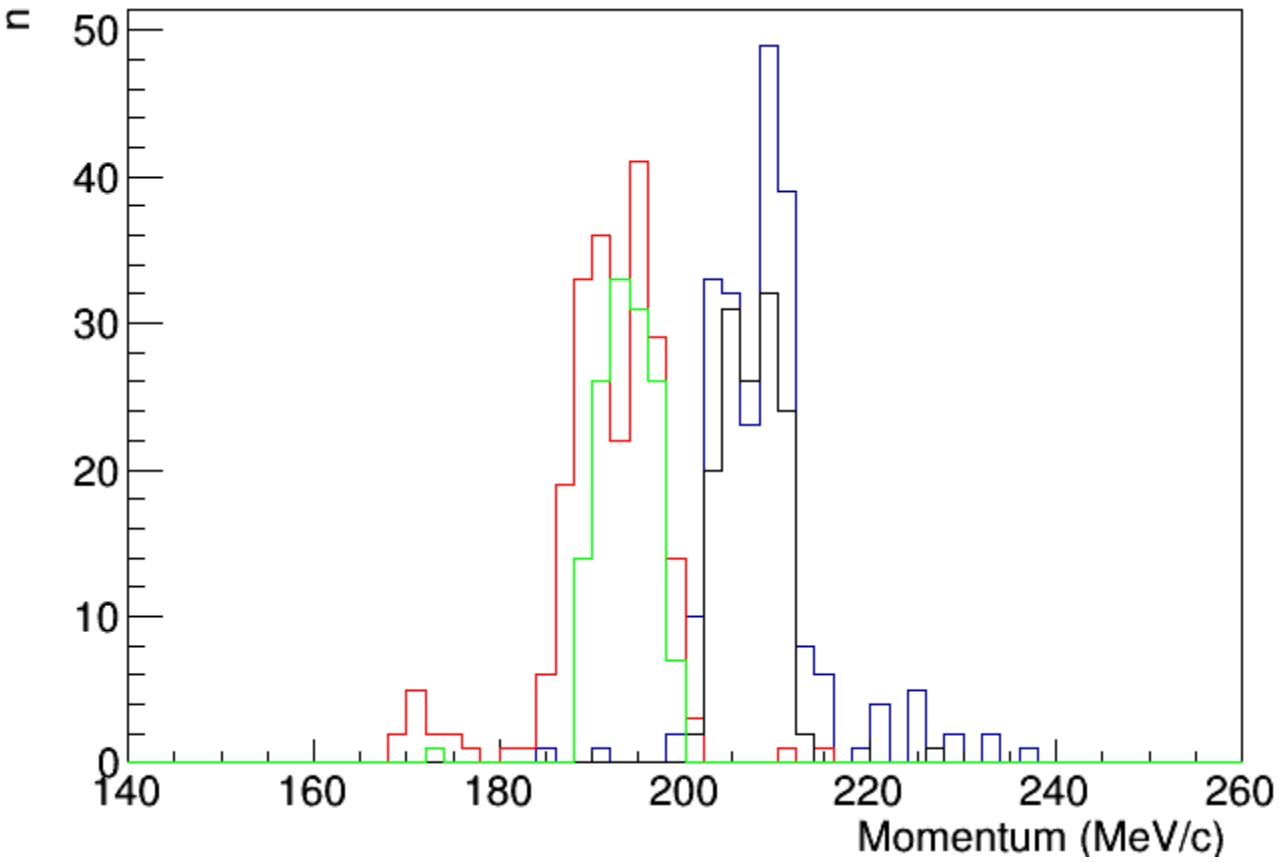
- Using Step IV geometry (42) with LH2 absorber.
- 100k events simulated at 200MeV/c at beginning of channel.
  - Particle decay enabled (should disable later?)
  - 22042 spills produce space points in TOF detectors.

Initial MC analysis

- Use difference between TOF1 and TOF0 to select muon tracks
  - 42-48ns
  - End up with 3904 tracks reconstructed through both trackers. (4% of simulated events)

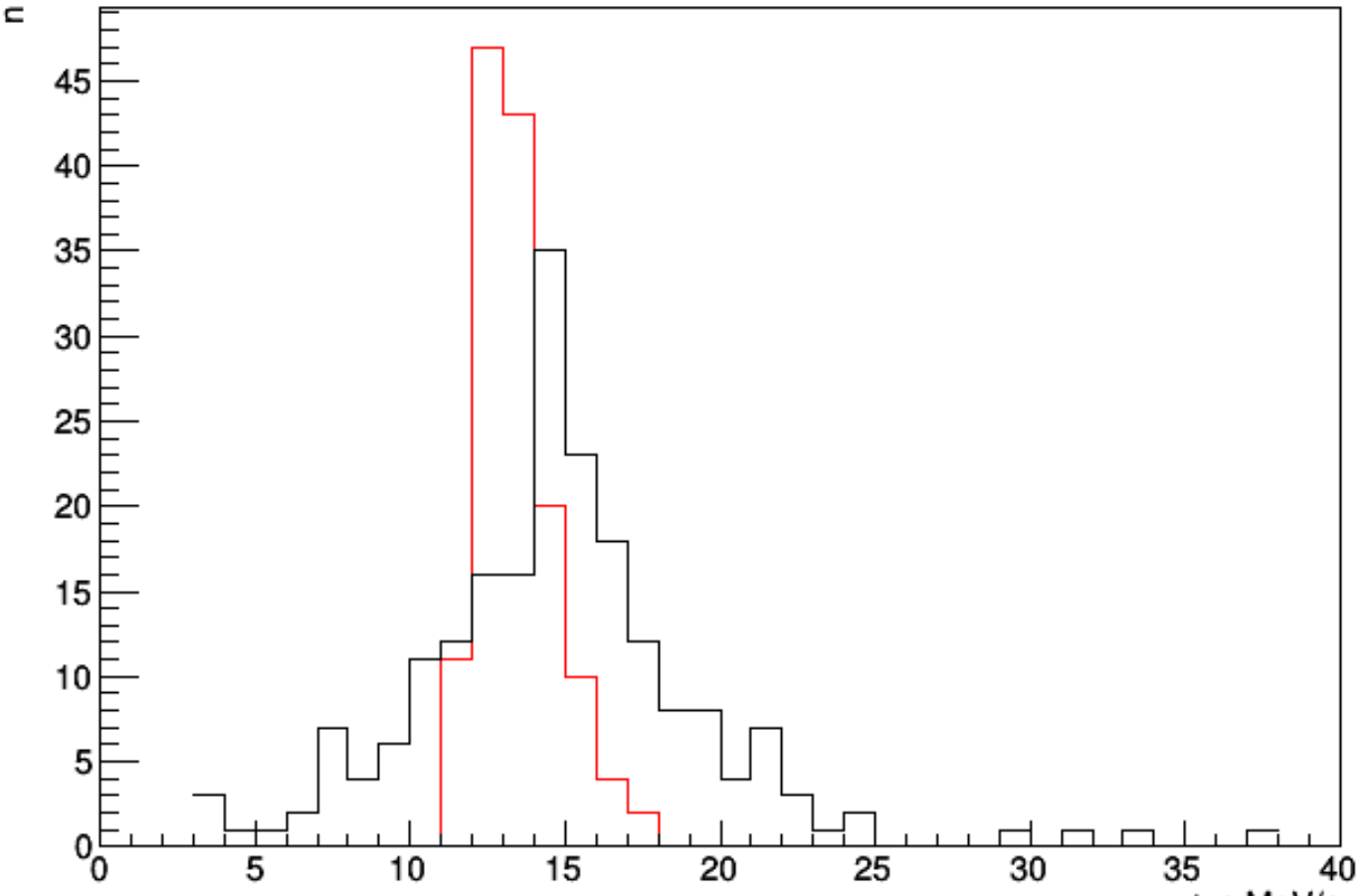
- Momentum range of muons can be flexible. I have chosen 200±5MeV at the absorber.
  - Results in selecting only ~300 reconstructed events

- Make a comparison of reconstructed momenta in upstream&downstream trackers.
  - Quick and easy, not final solution..



Blue – US reconstructed MC. Mean = 208.475 MeV/c, RMS = 6.252
Red – DS reconstructed MC. Mean = 191.643 MeV/c, RMS = 6.430
Black – US MC data Mean = 207.263 MeV/c, RMS = 3.249
Green – DS MC data Mean = 193.546 MeV/c, RMS = 3.251

Energy Loss plots

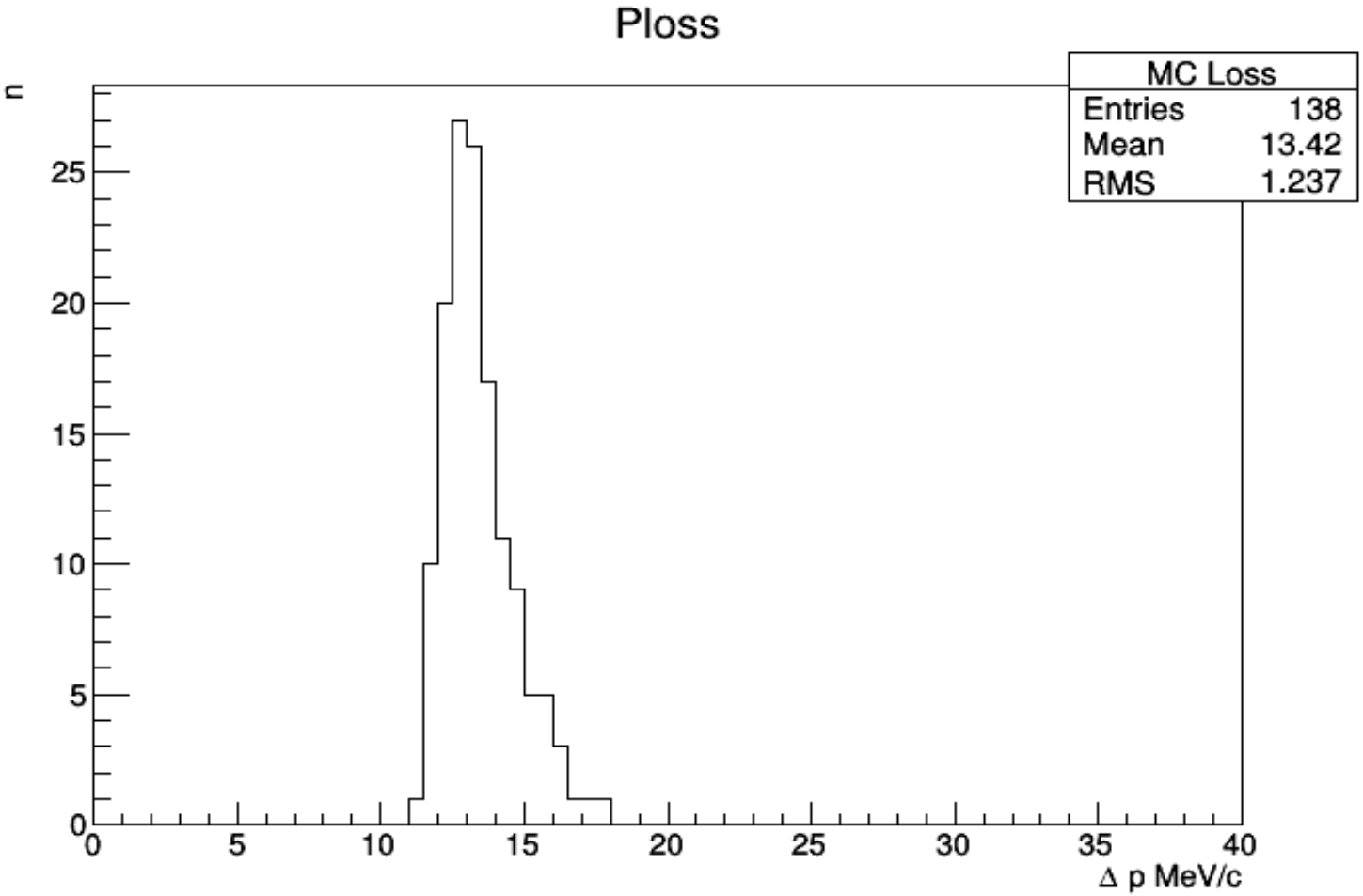


Black – Reconstructed MC data Mean = 14.8661, RMS = 4.7137

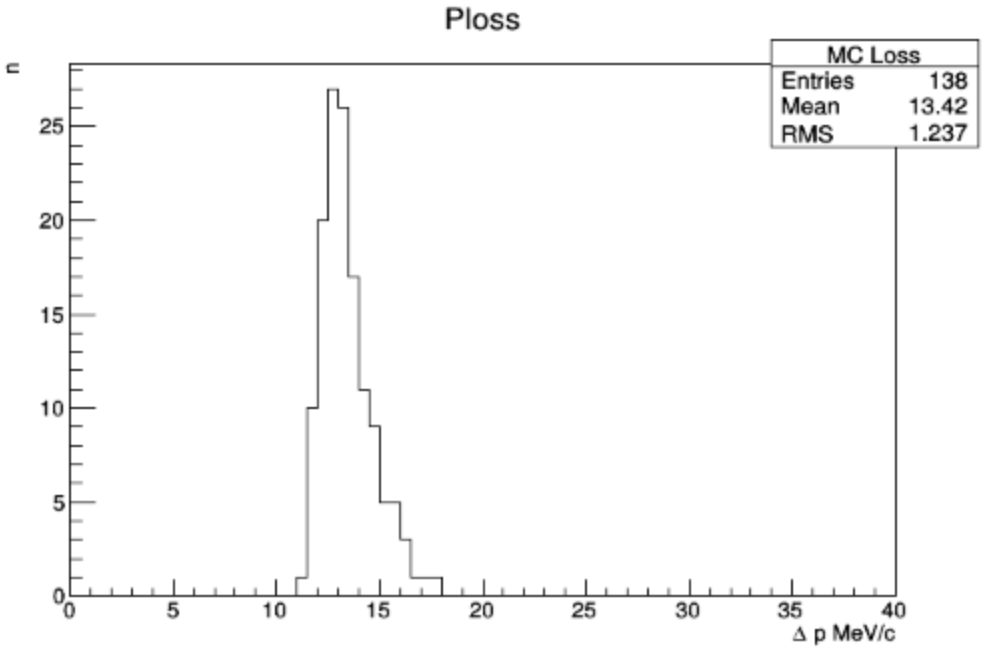
Red – MC data Mean = 13.4228, RMS = 1.237

- Mean (roughly) in agreement.

Monte-Carlo

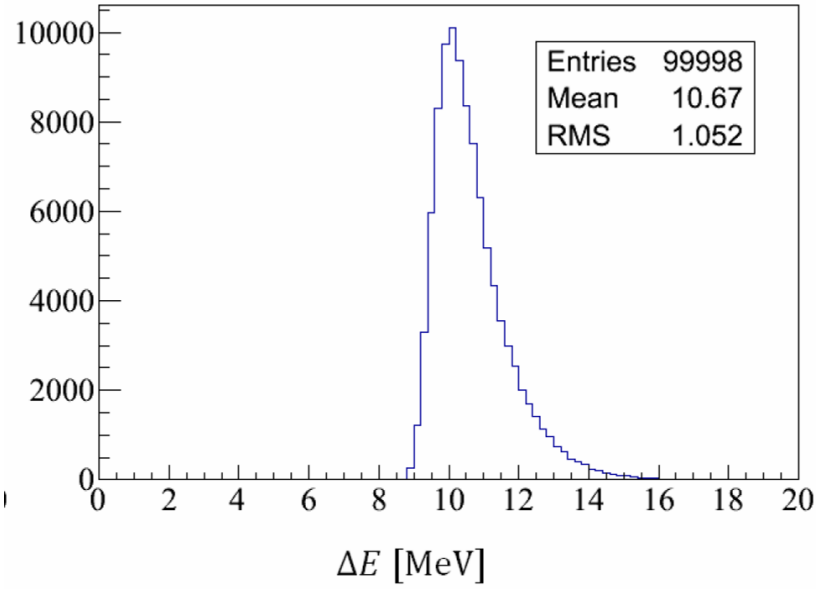


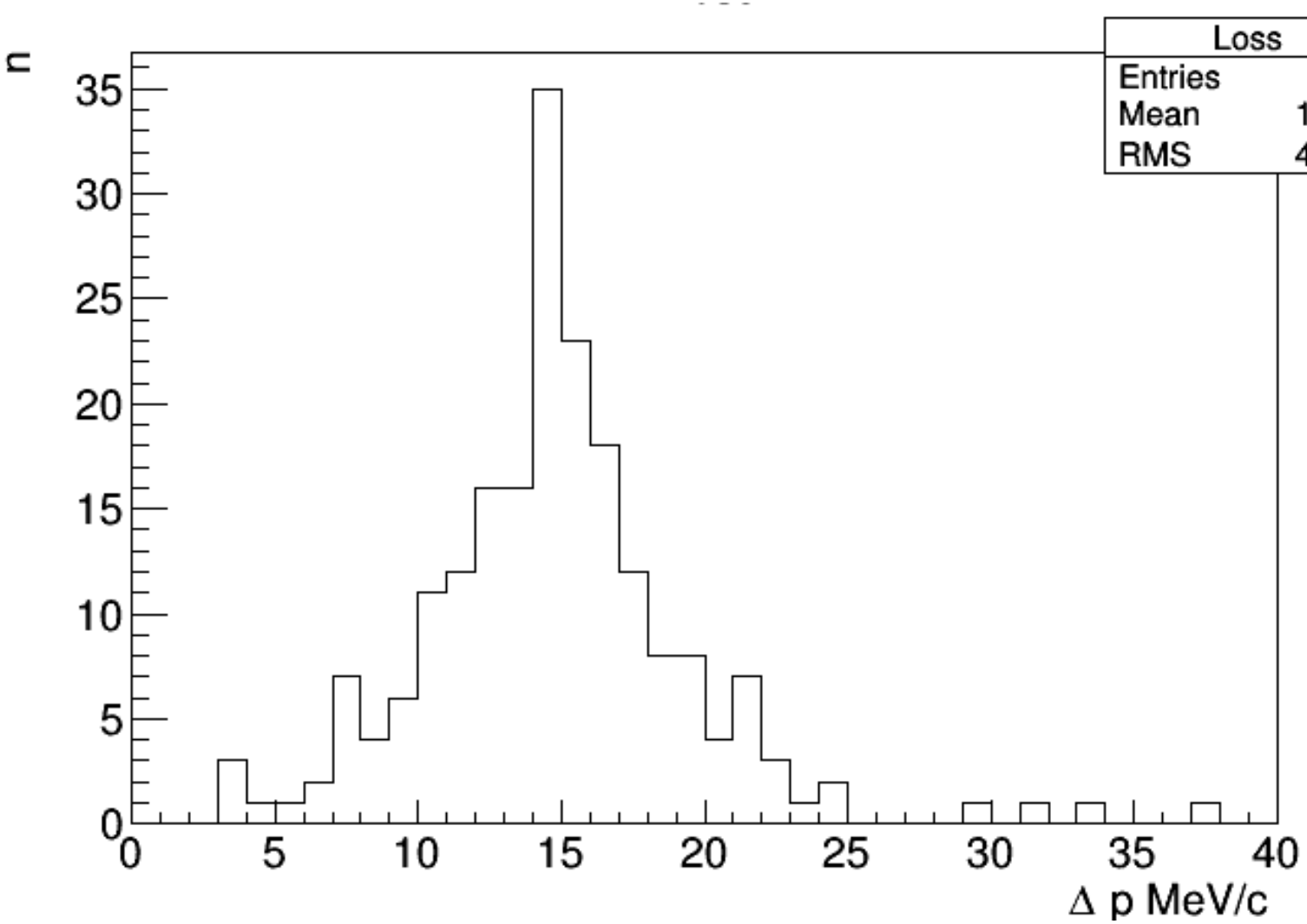
- MC data only – good comparison with T. Carlisle's MC results above.
  - Slightly higher mean.
- Clear landau distribution, will be easy enough to make a fit.

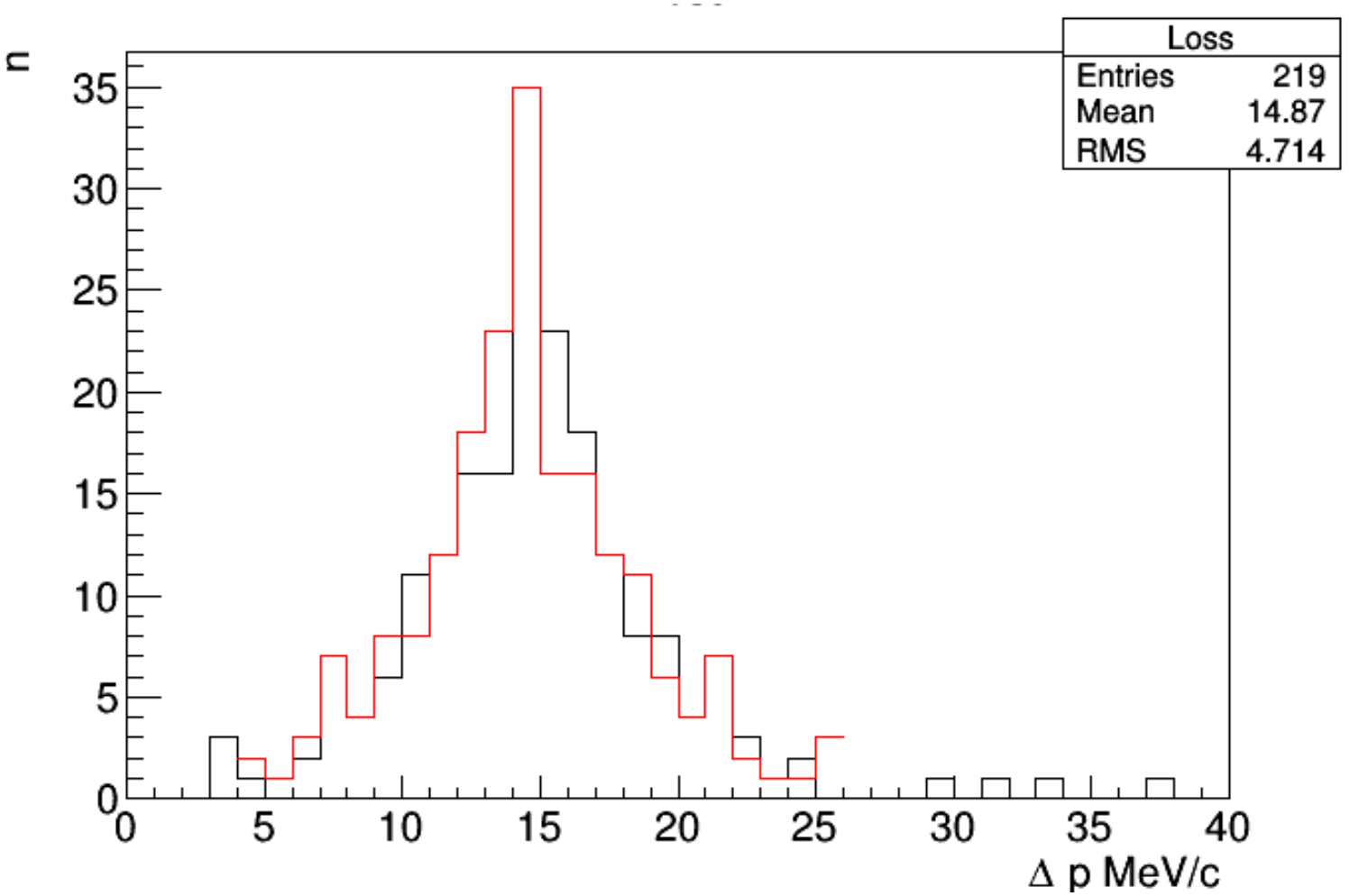


← My Monte Carlo

Tims Monte-Carlo -->

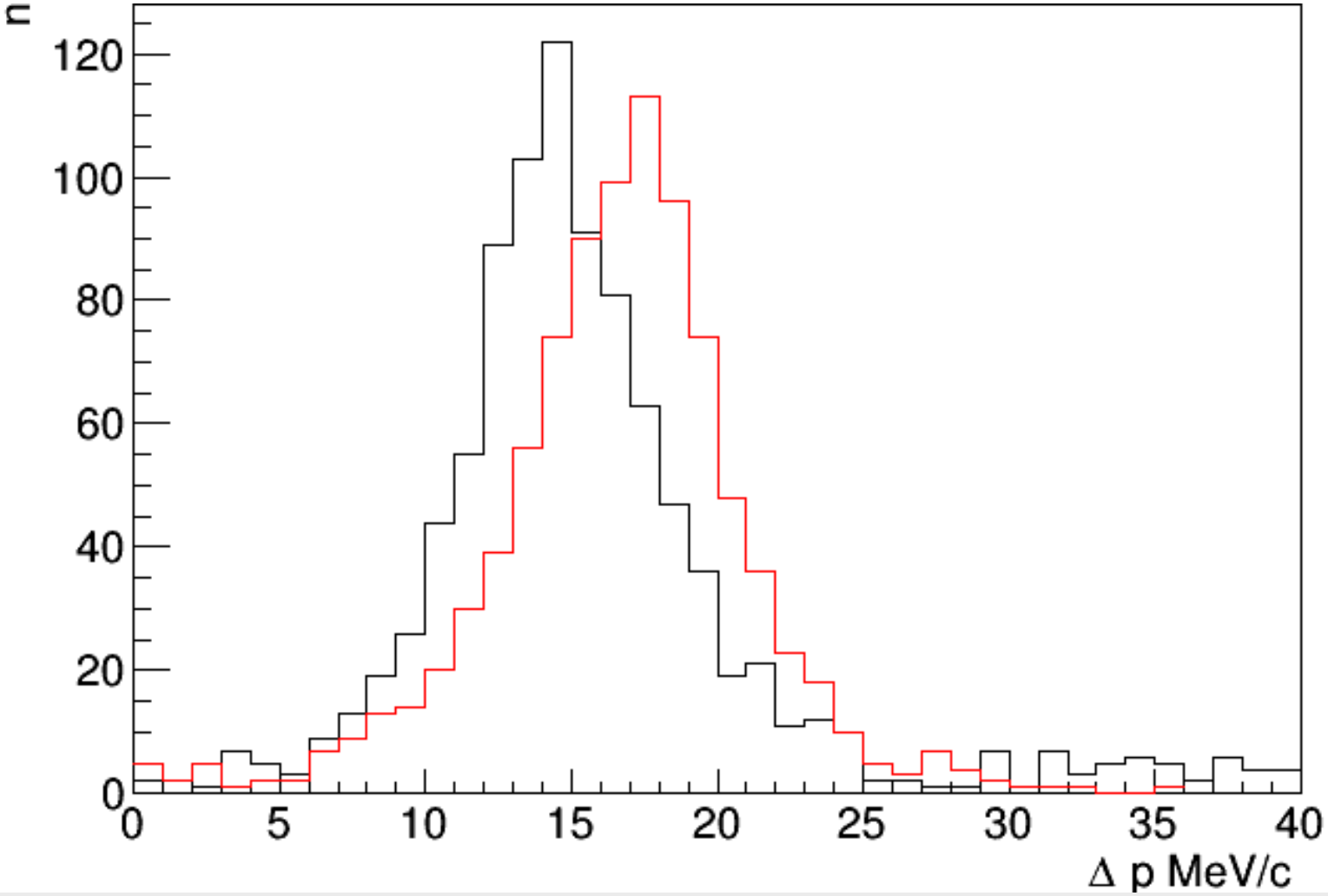



Loss
Entries 219
Mean 14.87
RMS 4.714
n
0
5
10
15
20
25
30
35
40
Δ p MeV/c



Distribution reflected around maximum.
- Could be possible to see landau asymmetry with more events..

- Increased momentum selection range to 200±20 MeV.
- Reflect distribution around mean. (Red is reflected)
- Landau distribution now more clear..



Comments/Conclusions

- Difference in mean momenta in Upstream and Downstream tracker is around 14MeV, but large error

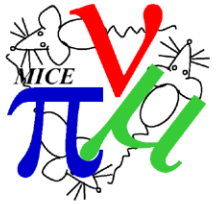
- Reflecting distribution of energy loss potentially indicates landau, good to compare with MC.
  - More stats needed – redo MC with muon tracks only.

- Resolution on Energy loss measurement will be an issue
  - Tracker resolution ~ 3MeV (improvements coming?)

- Can potentially improve measurement by using other detectors:
  - TOF can measure momentum with resolution ~ 4MeV
  - EMR ~2MeV?
  - KL?

- <u>Lots of work to do!</u>

Thank you – Questions?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