Update on E/p for Single Isolated Hadrons from Minimum Bias

N. Davidson

THE UNIVERSITY OF MELBOURNE

Basic idea...

- Motivation behind work is to check the hadronic energy scale in situ by looking at the ratio of momentum from the inner detector (should be close to actual) to the calorimeter energy.
- Current work for single pions from taus does not cover the low E range (below 20GeV). We need to see if minimum bias event can do this.

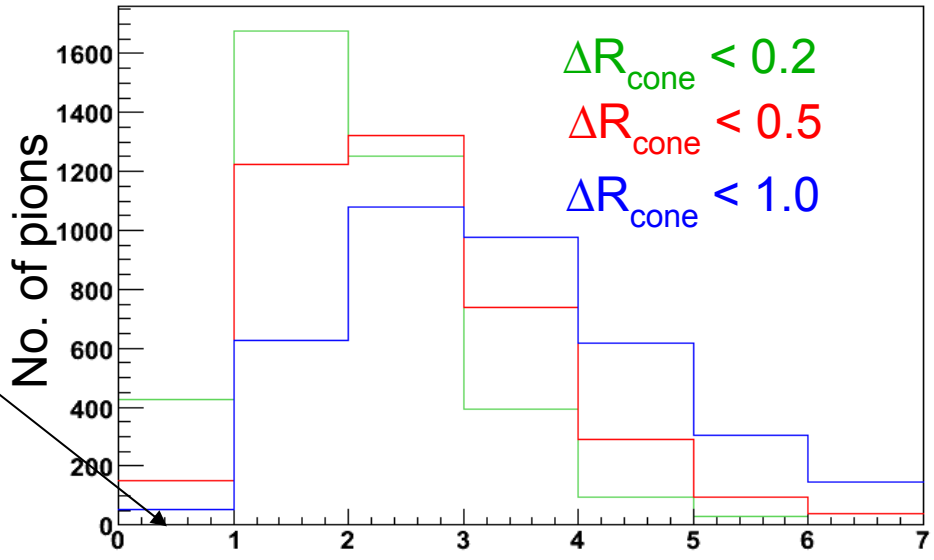
Update on what I've been doing...

- The track is extrapolated to the calorimeter using the TrackToCaloExtrapolation tool. (To fixed depth currently).
- E is taken as sum of CaloTopoCluster energies within some ΔR_{cone} (= 0.2, 0.5 and 1) of track. (Uncalibrated)
- I looked at cluster-track matching efficiencies and E/p for ideal case: 3GeV single pion sample:
  - csc11.007401.singlepart_singlepi2.recon.ESD.v11004103
  - 8,000 events (only small to get a feel for what's going on).
  - Approx. 4,000 pion tracks
- Then looked at minimum bias events with momentum range 400MeV – approx. 5GeV and studied the effect of contamination to the cluster energies from charged and neutral sources within the event.
  - csc11.005001.pythia_minbias.recon.ESD.v11004201
  - 11,000 events
  - Approx. 230,000 tracks

Matching for 3GeV Single Pions

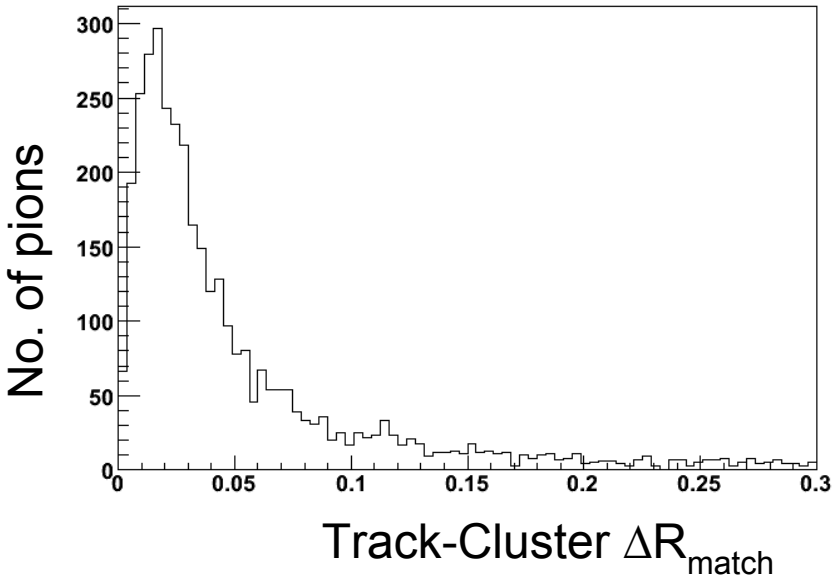
- Number of clusters around track

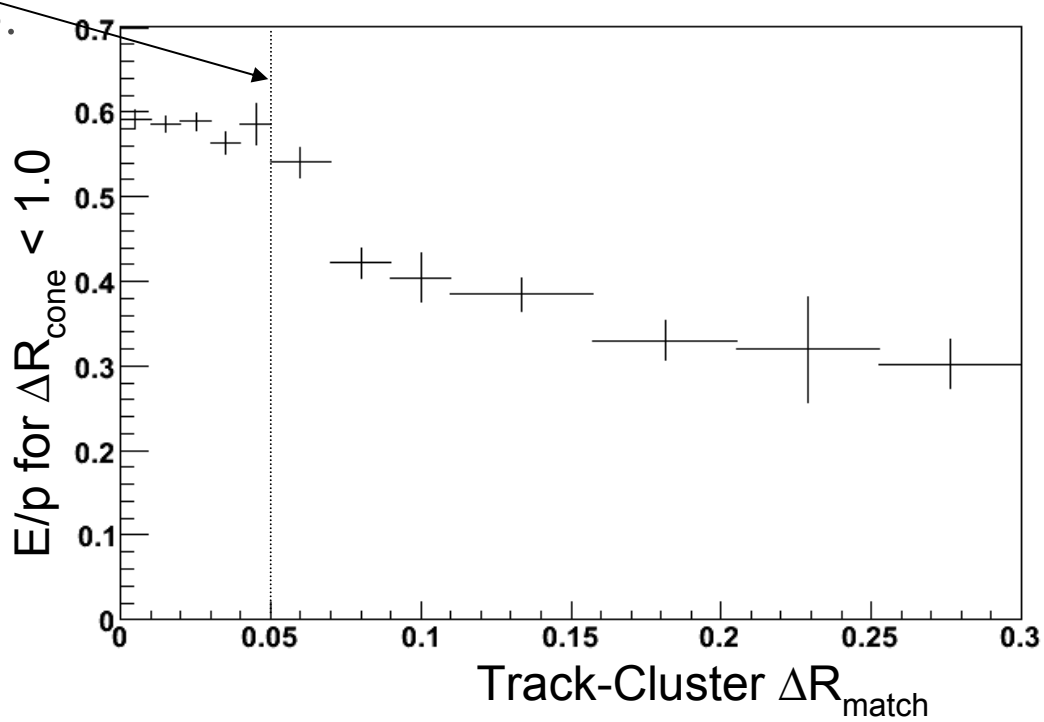
Efficiency of any cluster being found within ΔR is above 0.9 for all values of ΔR_{cone}. However, some clusters may be incorrectly matched.



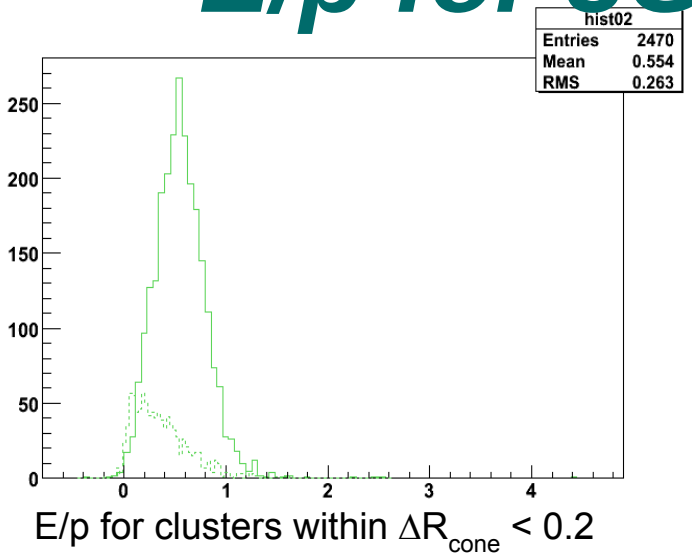
- Distance between track and closest cluster

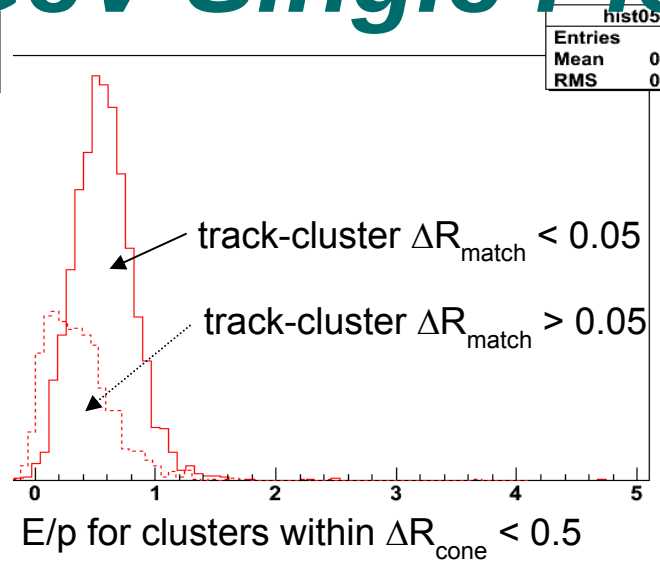
Mismatched clusters could cause decrease in E/p with Track-Cluster ΔR_{match}. Need to remove effect by selecting below $\Delta R_{match} < 0.05$.

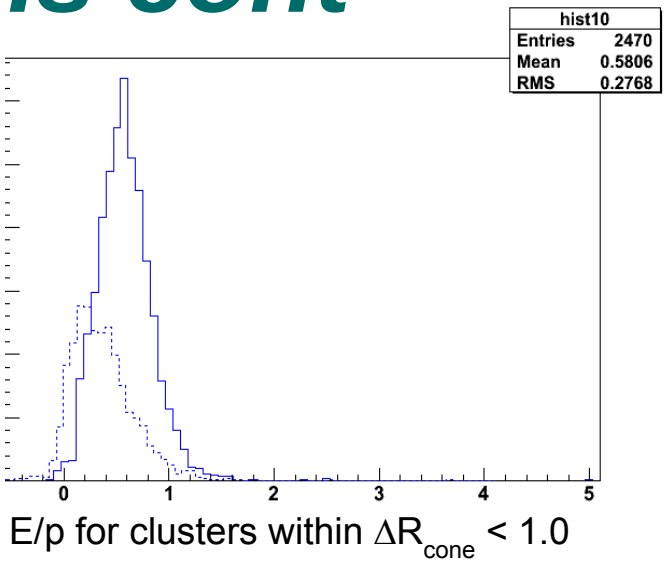




E/p for 3GeV Single Pions cont





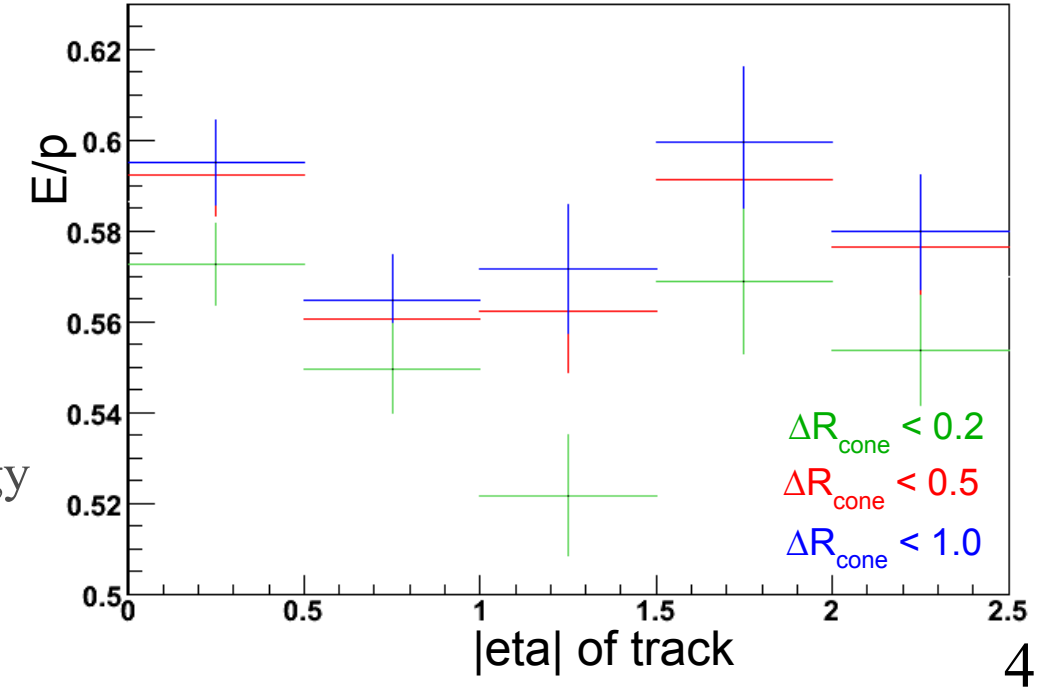


3% Shift in mean between 0.2 and 1.0 cones. Only 0.5% between 0.5 and 1.0

- E/p vs. |eta|
(with $\Delta R_{match} < 0.05$ matching criteria)

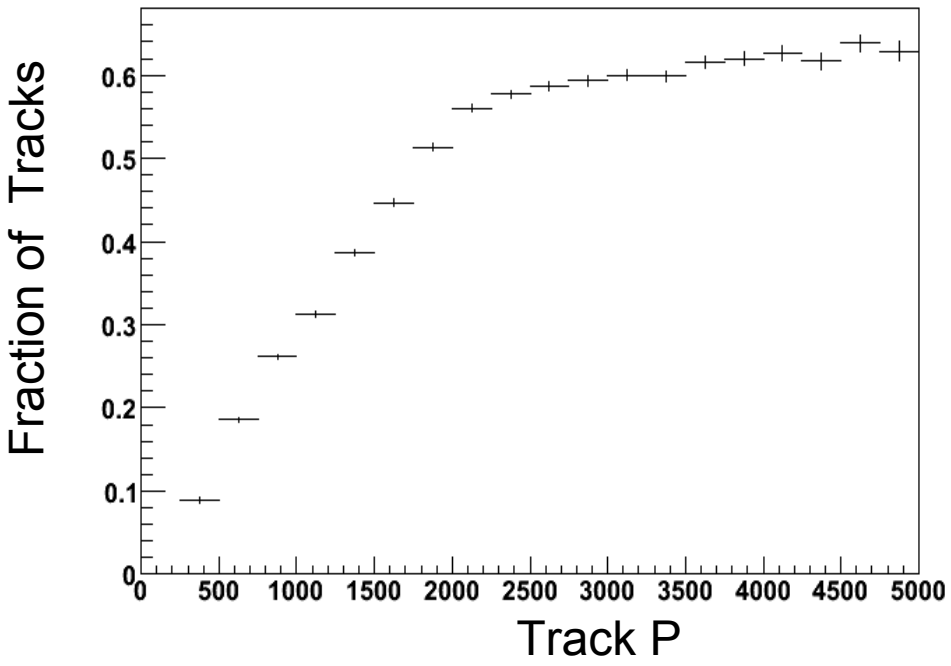
Not enough statistics, but it's clear there is a variation over |eta|.

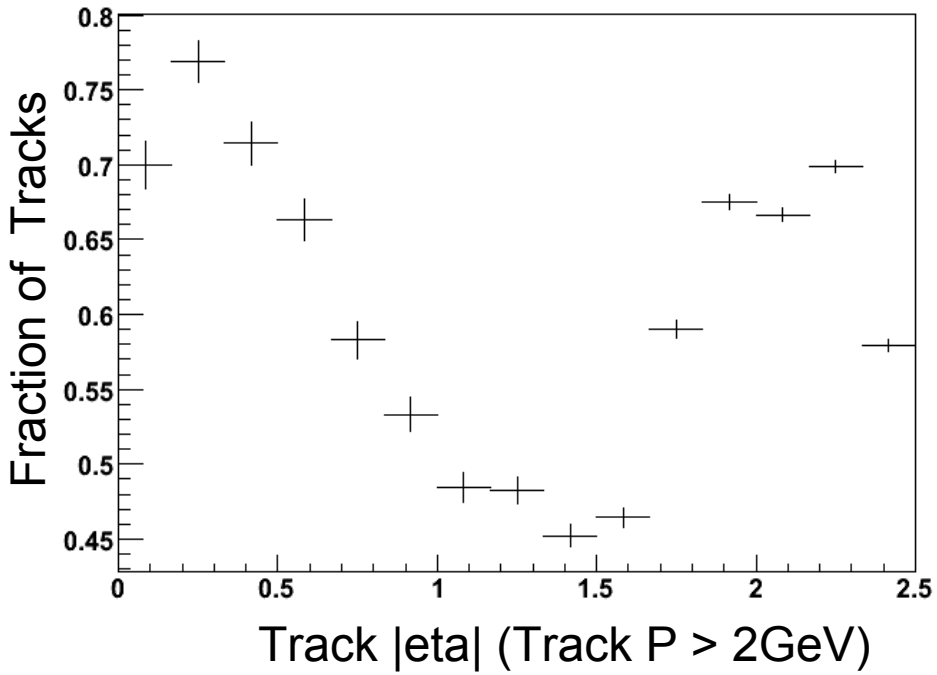
I plan to study calibration hits to see energy losses in dead material, crack region etc. Also plan to study 1GeV Pions.



Matching for Minimum Bias Tracks

Plots show the fraction of tracks that have at least one cluster within $\Delta R_{match} < 0.05$





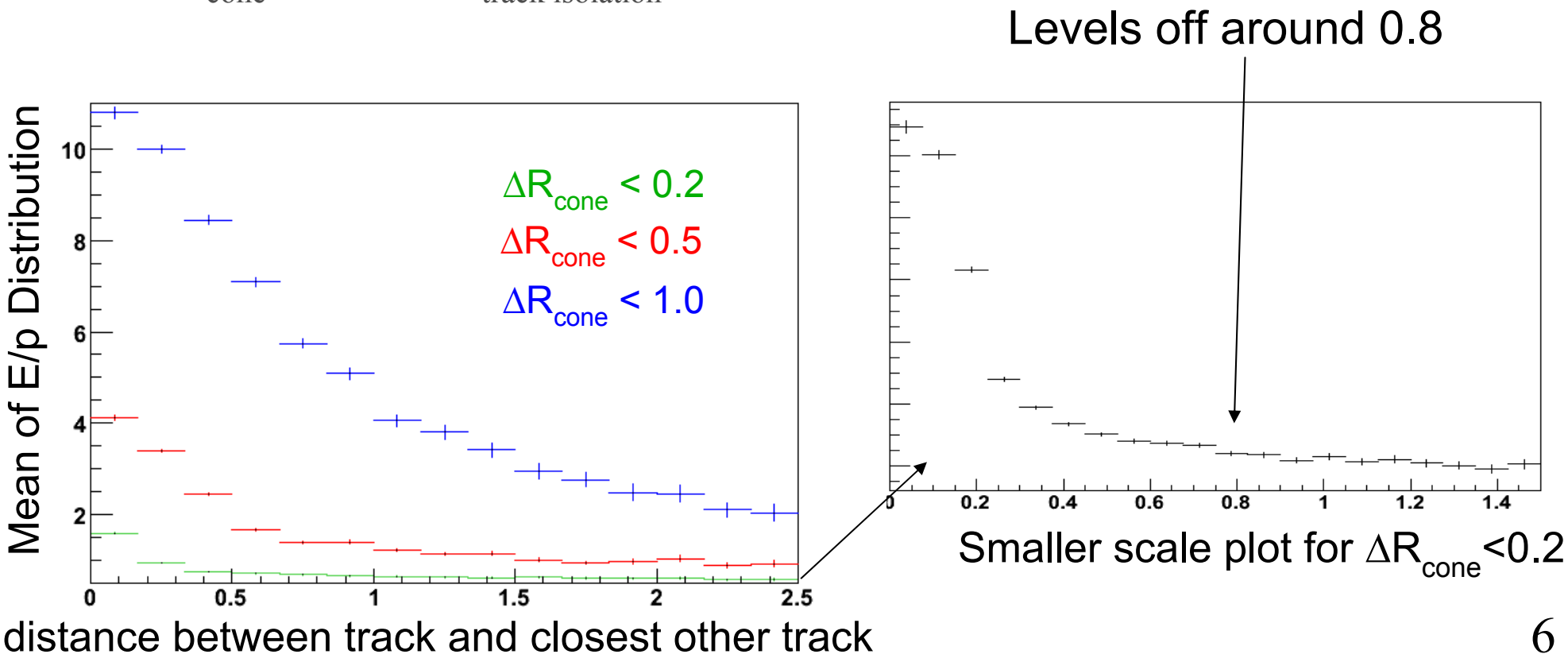
- Fewer matched clusters for low P tracks. Not surprising considering method of cluster reconstruction and dead material losses.

- I plan to see what the lower limit is with calibration hits data.

- For now, just look at particles with P > 2 GeV.

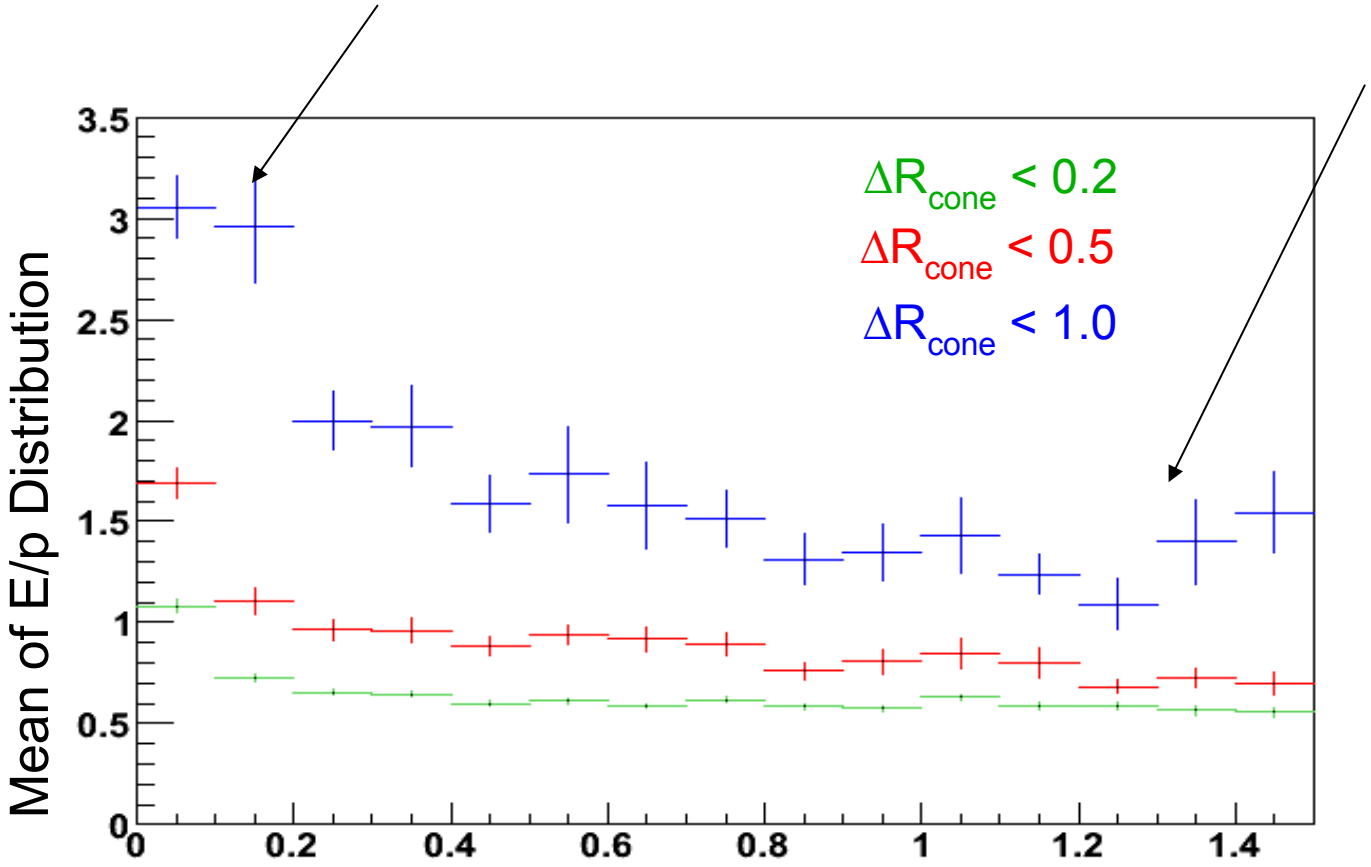
Impact of Extra Charged Particles on E/p

- I looked at the distance (at calorimeter) between tracks and the effect on E/p
- Track isolation is dependent on ΔR_{cone}. This is not surprising, however, the isolation required seems a bit too large for the larger cones. I need to investigate this further but for the moment take isolation cuts as:
  - $\Delta R_{cone} < 0.2 : \Delta R_{track\ isolation} > 0.8$
  - $\Delta R_{cone} < 0.5: \Delta R_{track\ isolation} > 1.5$
  - $\Delta R_{cone} < 1.0: \Delta R_{track\ isolation} > 2$



Impact of Neutral Particles on E/p

- Using truth data, I looked at neutral contamination of clusters.
- The closest distance was defined to be $\Delta R_{neutral}$ between any neutral particle and cluster within the cone of the track.
- For close neutrals, the E/p mean is biased high (as expected)



$\Delta R_{neutral}$ between cluster and neutral particle after track isolation cut

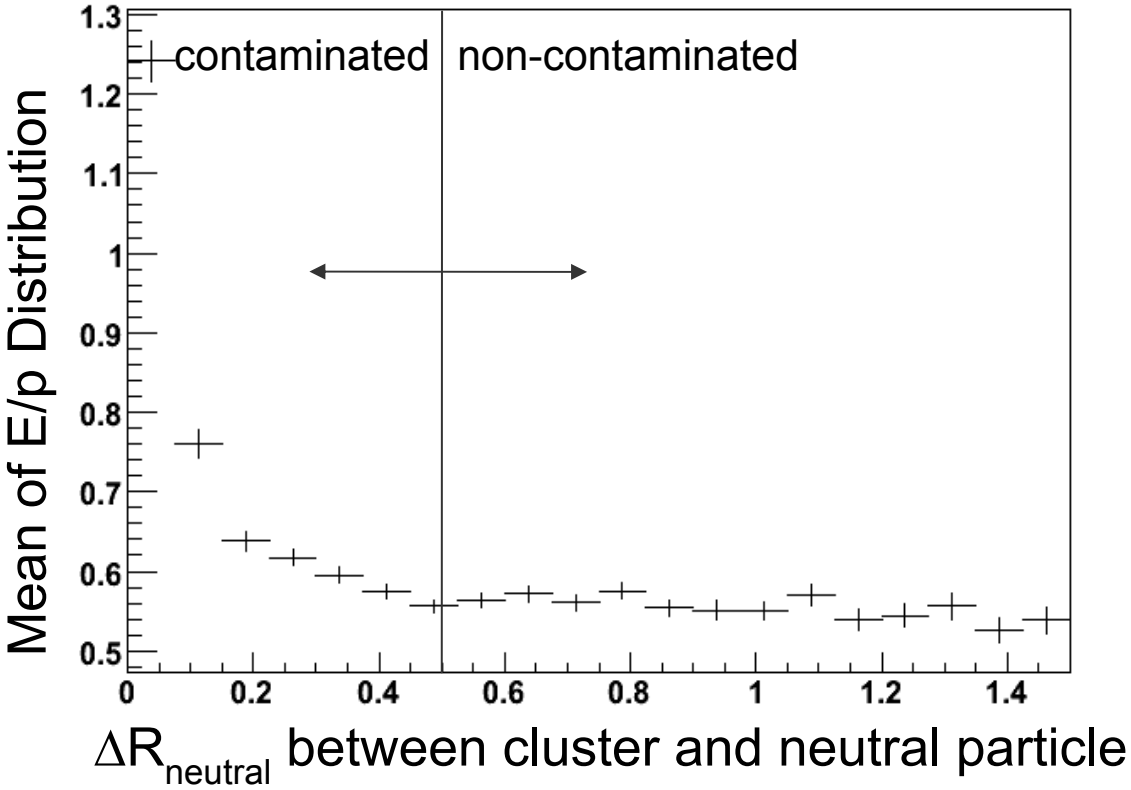
Of concern is when neutrals are further away.

E/p mean should not differ by so much for the various cone sizes. This is not consistent with result from single pions.

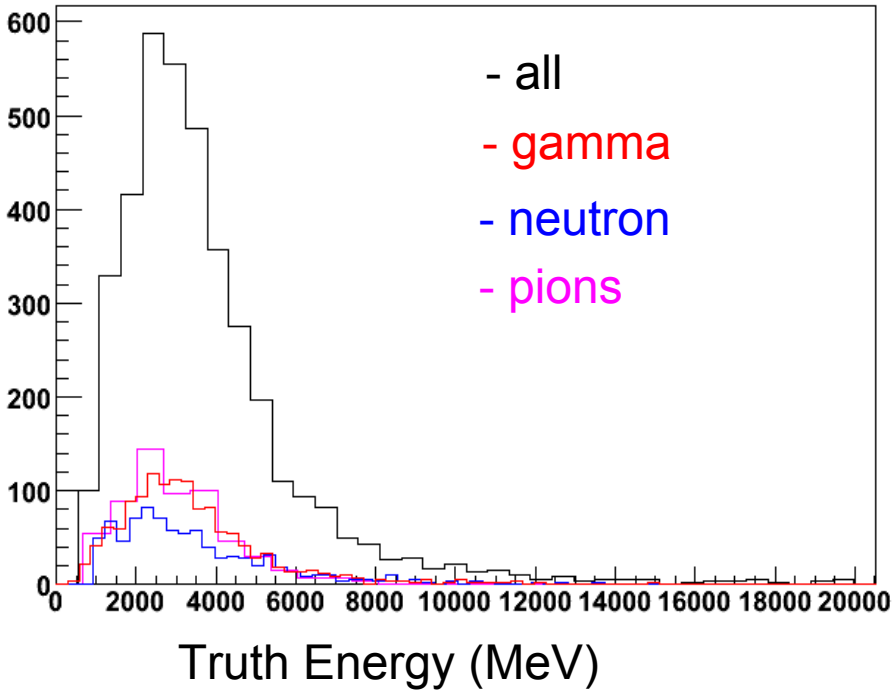
Potentially due to adding in extra background clusters. Need to investigate.

Impact of Neutral Particles on E/p cont.

- So for now, just using $\Delta R_{cone} < 0.2$.
- Define contaminated and non-contaminated clusters in this way (as the mean levels off around 0.5)



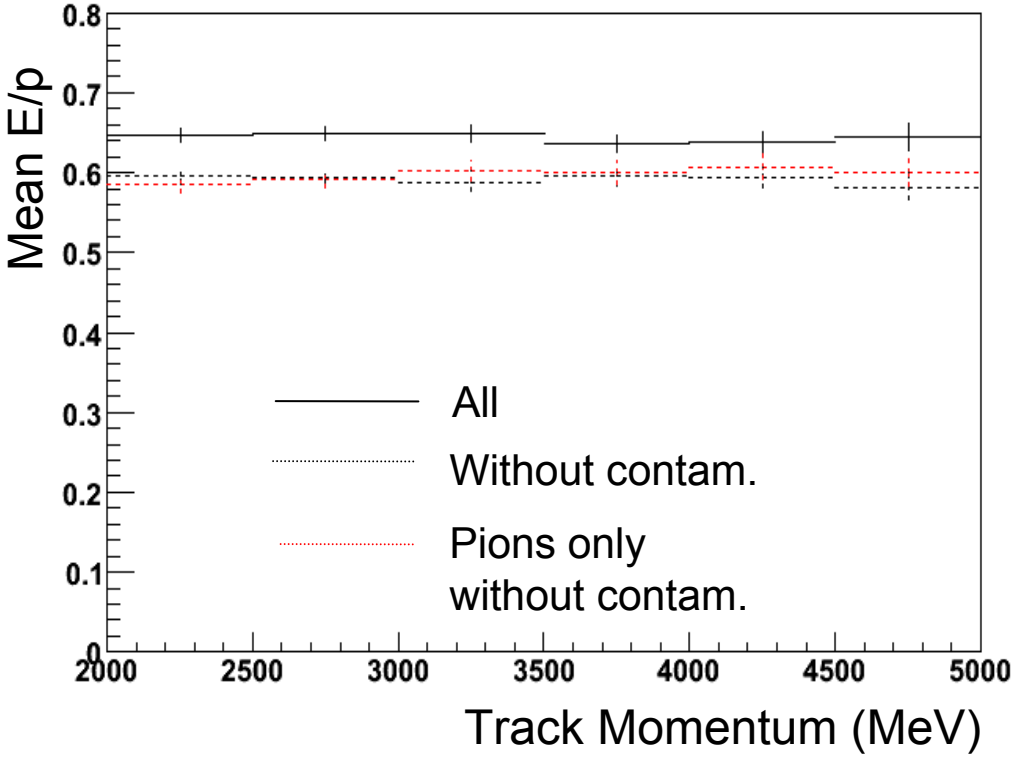
Neutral particle energy spectrum

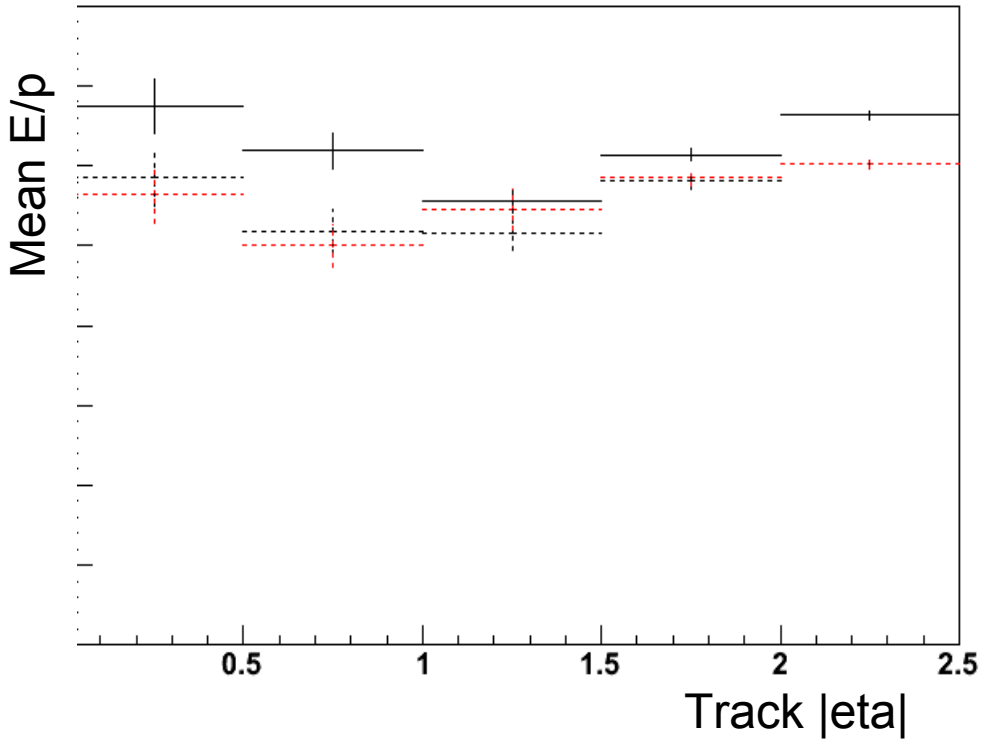


- The neutral particles which make up the contamination in the left region of the above plot are:
  - gamma - 35 % neutron - 23%
  - pion - 15% K_S^0 - 9 %
  - K_L^0 - 8%

Bias from Neutral Contamination

- Plots of E/p vs P and Eta





- Bias from neutrals is about 5 %
  - Will be considerable with pile up (2.3 or 23 similar event!)
- Bias from non-pions only around 1%
- Looking similar to single pion results for 3GeV

Separation variable

- Already removed some contamination incidentally with track isolation cut
  - Fraction of contaminants went from 0.65 to 0.40
- I plan to look at this correlation in more depth as well as the track matching requirement.
- Other variable to look at:
  - No. of clusters in cone
  - Depth of energy deposited within calorimeter
  - Cluster radius
  - Fraction EM energy vs. hadronic energy

Plans

- Soon:
  - Look at calibration hits
  - Include pile up (important)
  - Examine trigger effects
  - Use more statistics
  - Use calibrated CaloTopoClusters
- Later:
  - Repeat using jets for the calorimeter energy. (default cut on jets is 10GeV)
  - Repeat for 900GeV
  - Compare effect of minimum bias generators