

DHCAL Response To Positrons And Pions

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Analysis Strategy - I

1. Event selection:

- Look at DHCAL only.
- Only one cluster in Layer 1 with at most four hits.
- At least 3 active layers.
- No hits in the outer two pads in any layer.

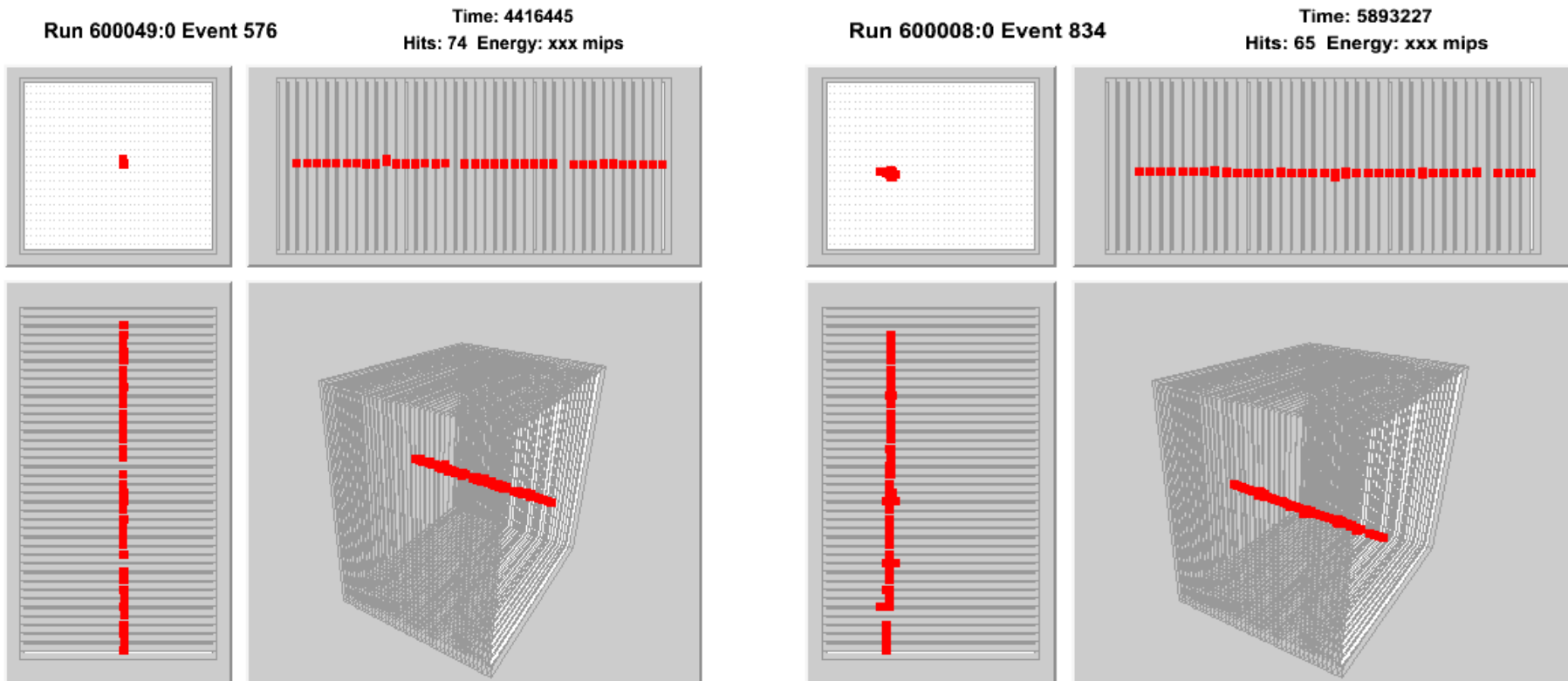
2. Muon ID:

- Pick the cluster in Layer 1 and another cluster starting from the last layer and running towards Layer 1.
- Look at the layers in between the picked layers. Find the maximum number of layers (NMaxinLine) with clusters that lie within 2 cm of the points predicted by the line joining the picked clusters. There should be no hits in this layer from 1.5 cm to 25 cm from the predicted point (isolation criteria).

Analysis Strategy - II

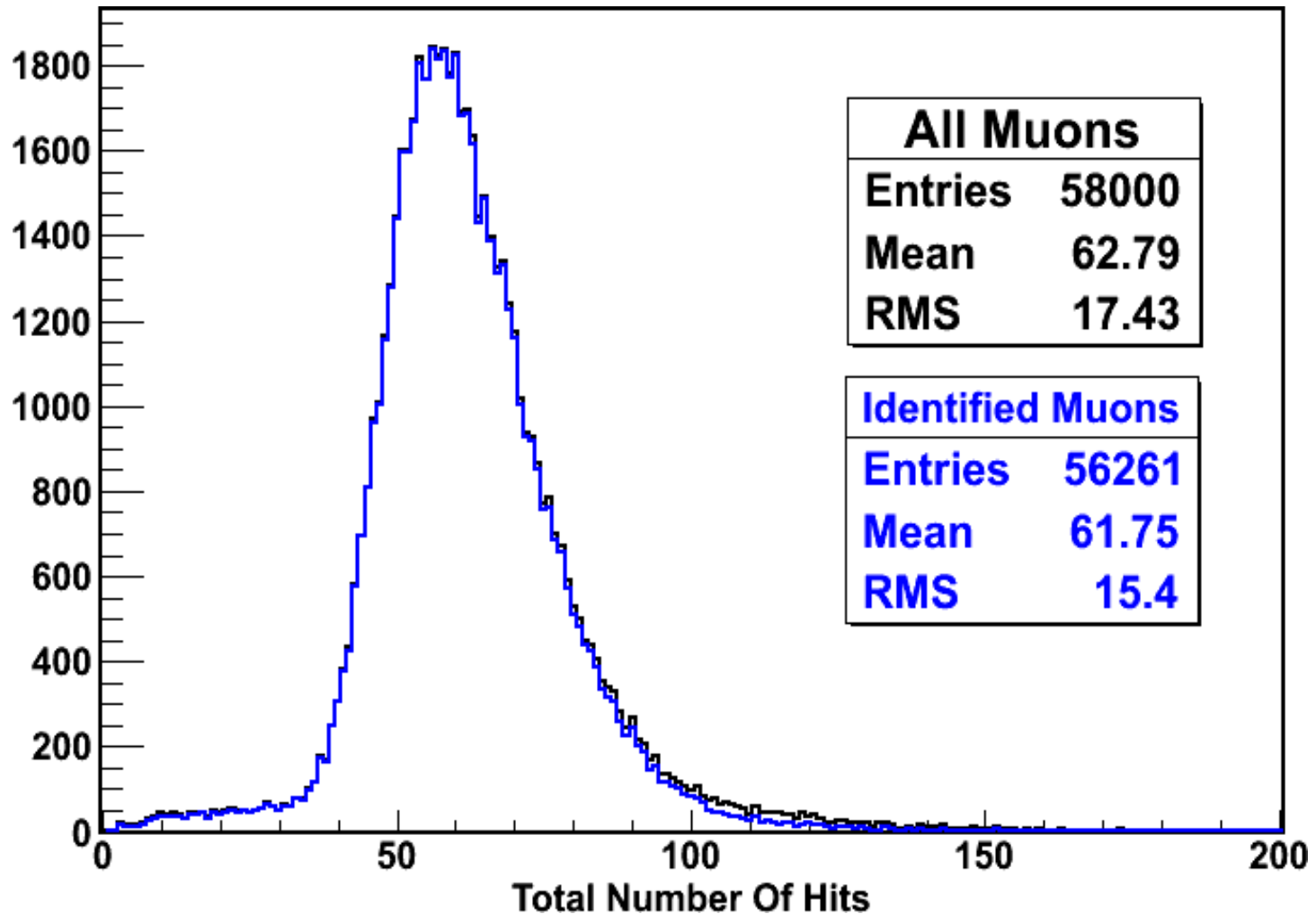
2. Muon ID:

- Eventually, there will be “ $N_{\text{maxinLine}}+2$ ” layers that have clusters lying along a line. If this is equal to the number of active layers, identify as a muon.
- If “ $N_{\text{maxinLine}}+2$ ” is more than 80% of the number of active layers, identify as a muon required that no two consecutive layers violate the isolation criteria mentioned before (this is to include muon tracks with higher multiplicities in a few layers due to knocked out particles while avoiding interactions).



Muon ID

Muon Run 600008 Oct 2010



- Muon ID efficiency $\sim 97\%$.
- $\sim 95\%$ of unidentified muons are eliminated in pion and positron analysis with the requirement of no hits in Layers 37-38 (last two layers).

Analysis Strategy - III

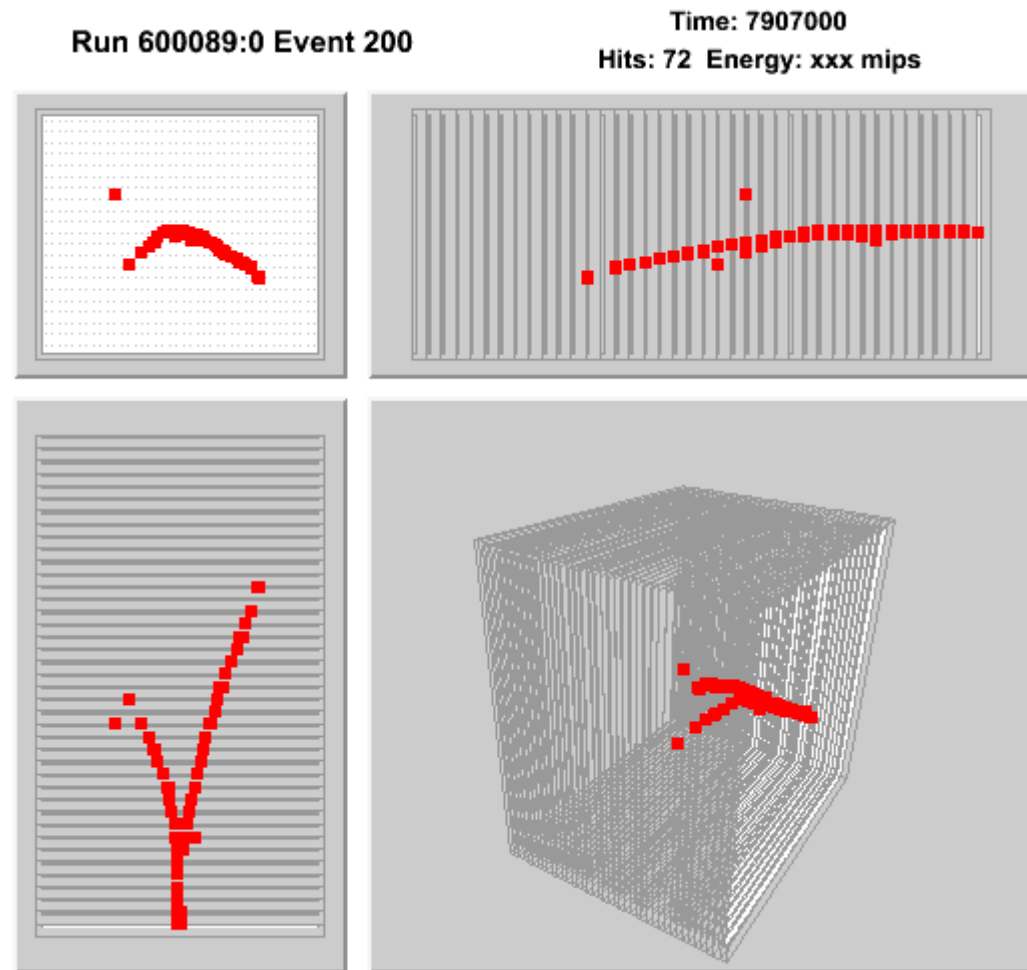
2. Pion ID:

- Identify the MIP section with an algorithm similar to Muon ID, but this time going from Layer 1 to last layer.

- Pick the cluster in the last MIP layer and another cluster starting from the last layer and running towards the MIP section.

- If these two picked clusters are aligned with hits in more than two intermediary layers, identify as pion.

- If the picked clusters are aligned with hits in at least one intermediary layer, the direction vectors from the last MIP layer are recorded. If the angle between any two such vectors is more than 20° , identify as pion.



4 GeV pion

5

Analysis Strategy - IV

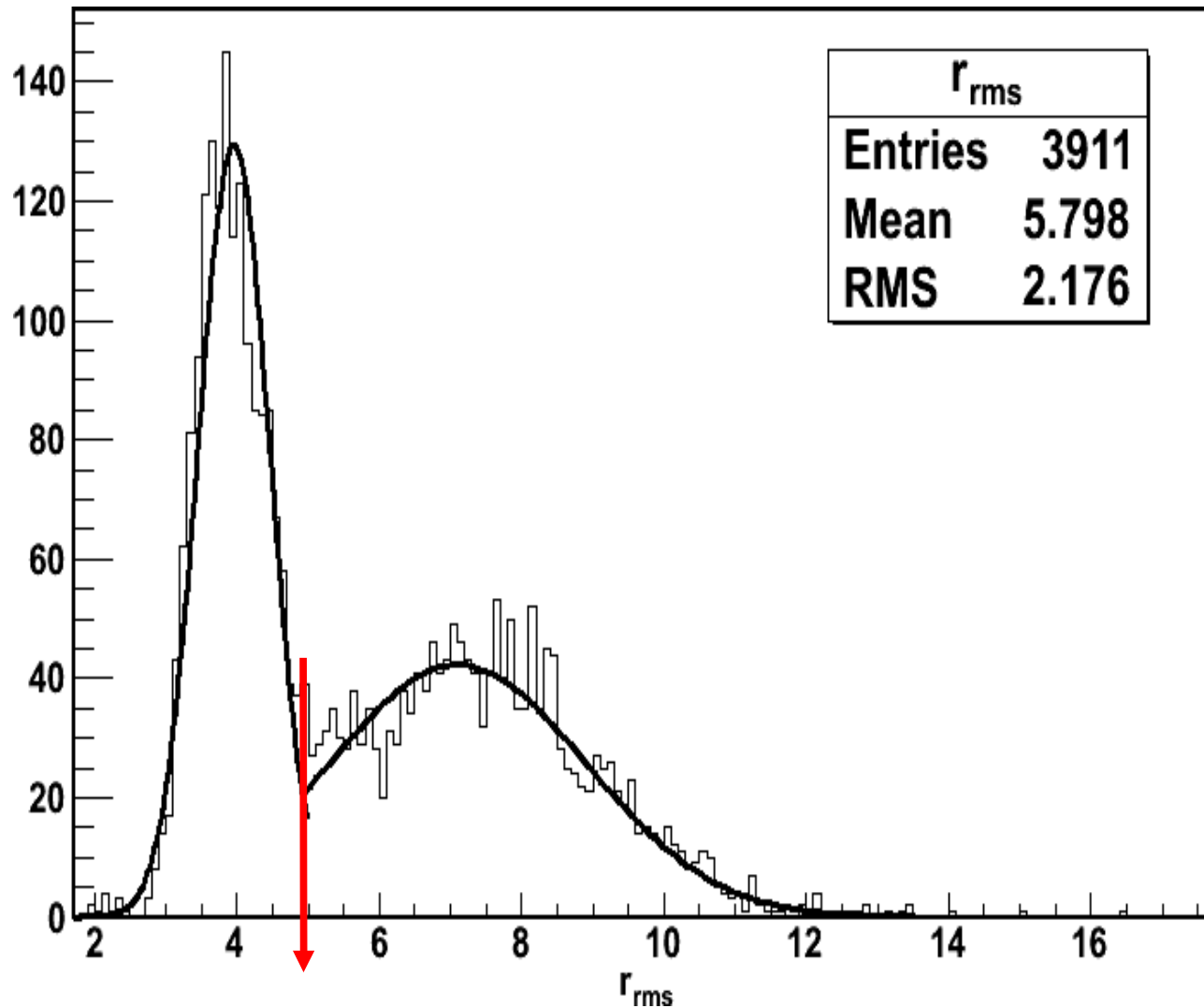
2. Pion And Positron ID:

- For the not-yet identified pion-positron mixture, the below variable is defined:

$$r_{rms} = \sqrt{\frac{\sum r_i^2}{N_{Hits}}}$$

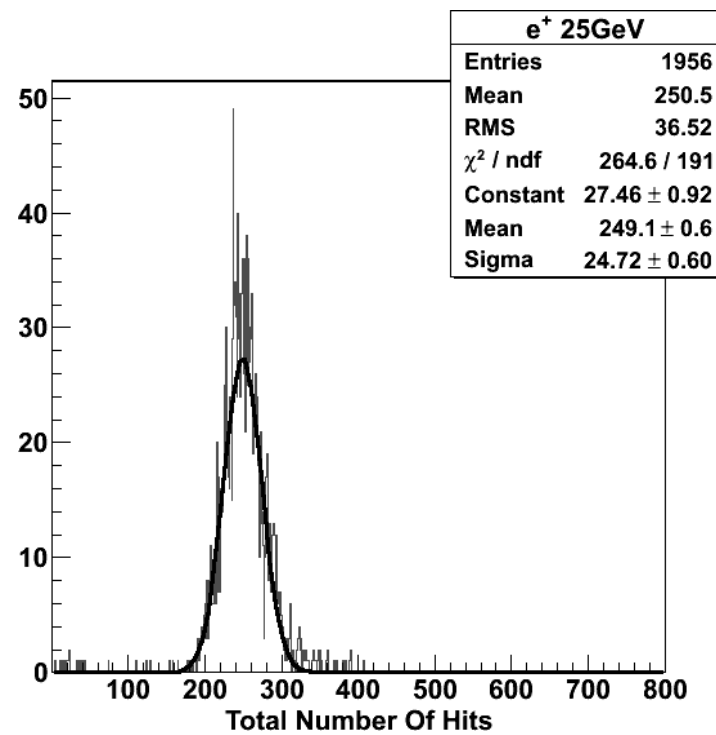
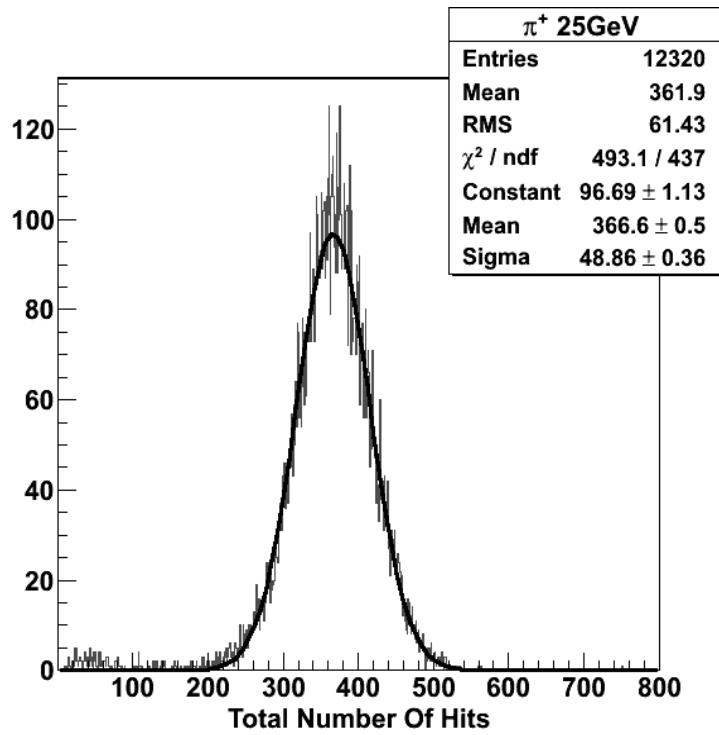
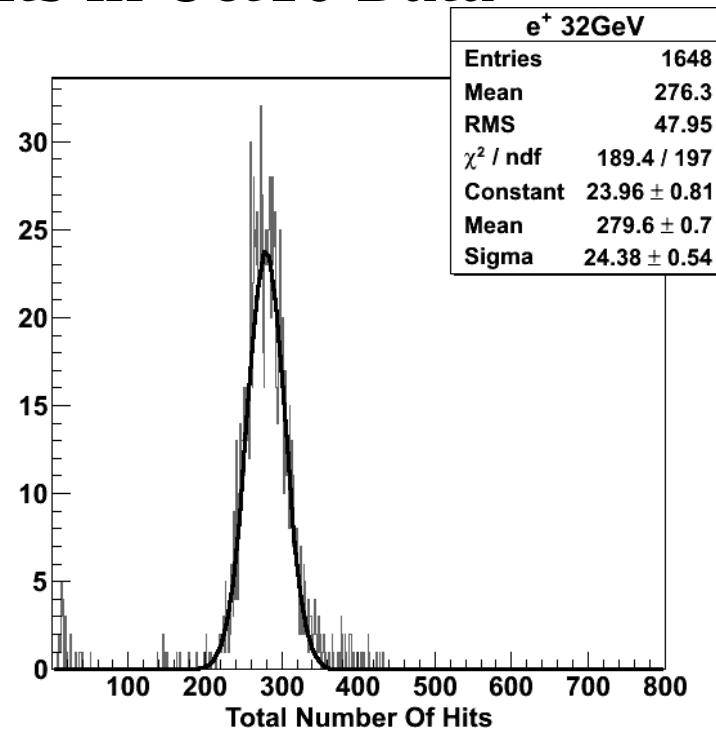
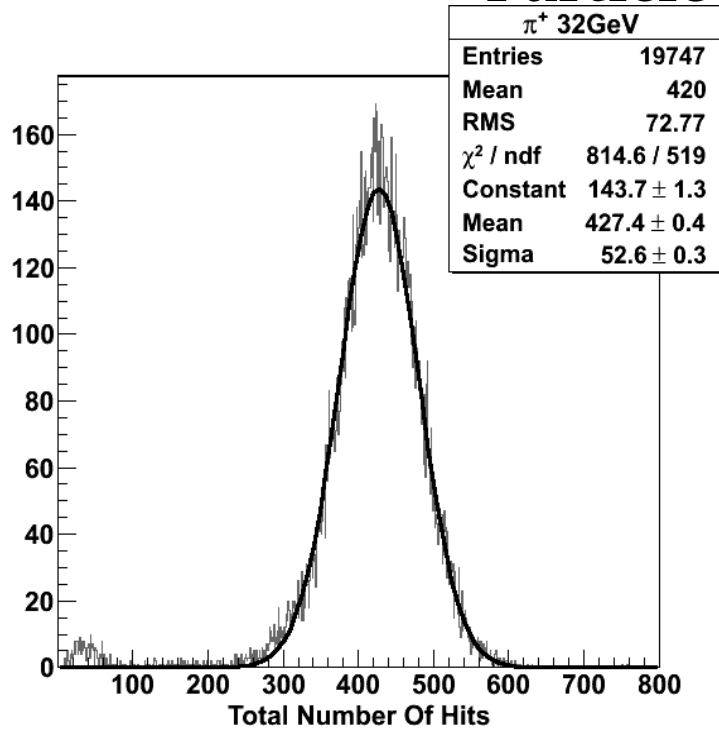
where r_i is the distance of each hit to the x-y center of all the hits in the corresponding layer and N_{Hits} is the total number of hits.

Pion And Positron ID

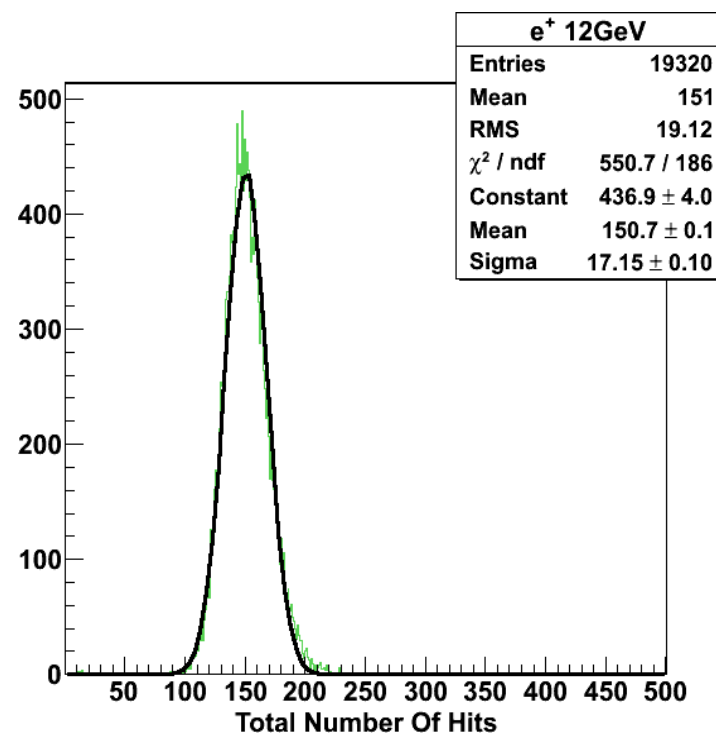
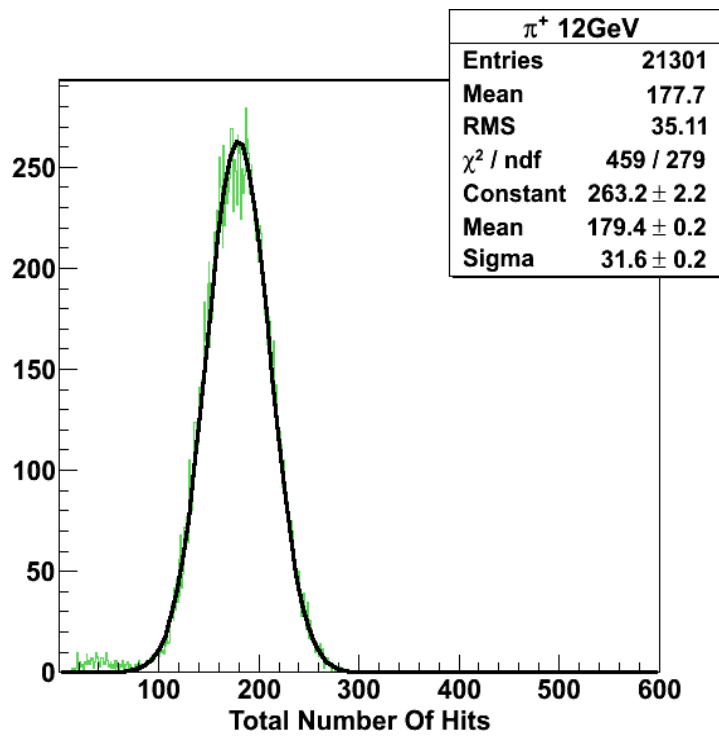
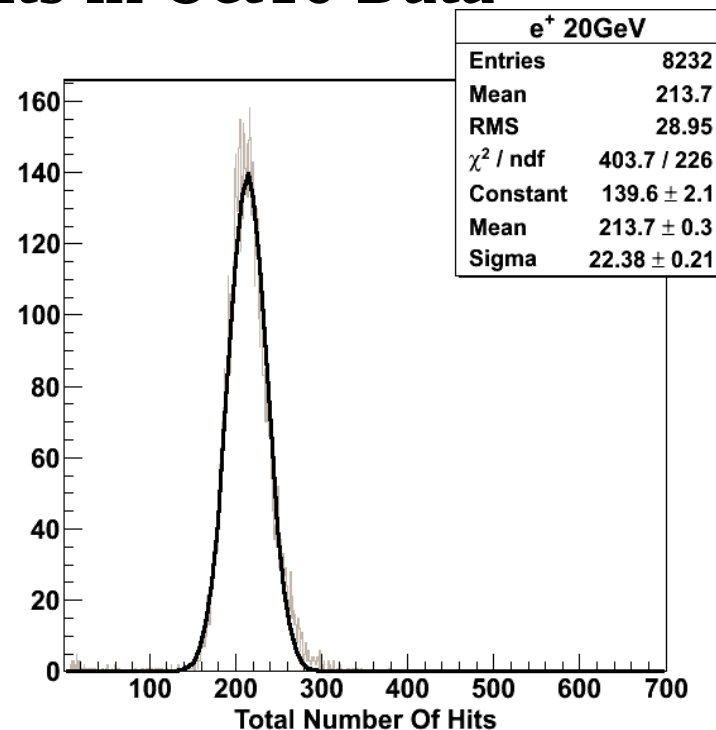
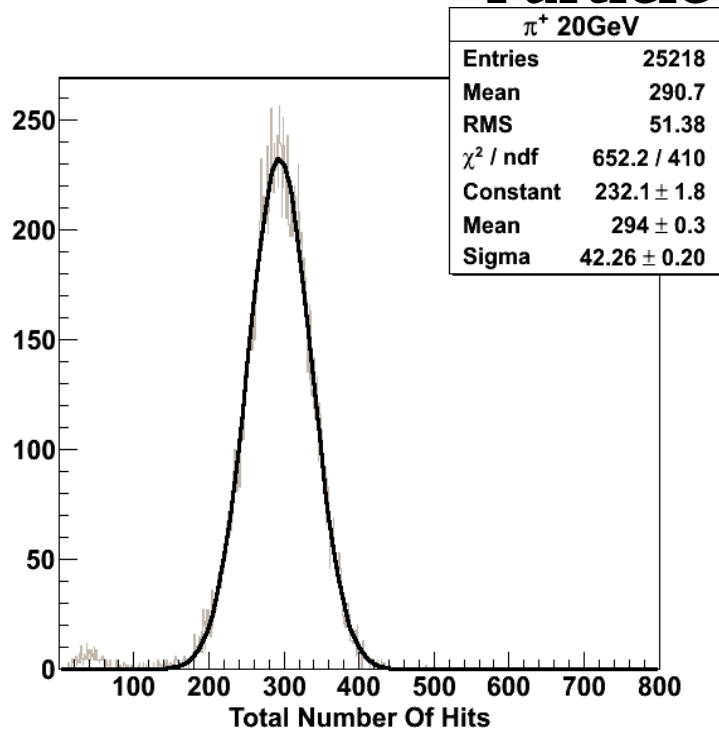


r_{rms} for 20 GeV runs. A cut at 5 is applied to distinguish pions ($r_{rms} > 5$) and positrons ($r_{rms} < 5$). Estimated mixing is 20%. The fraction of pion events that require this selection is $\sim 4\%$.

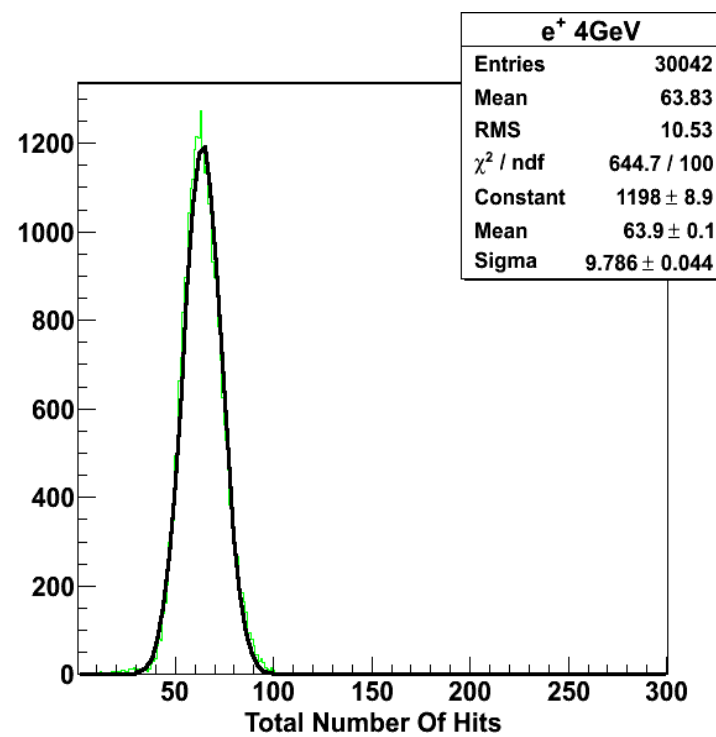
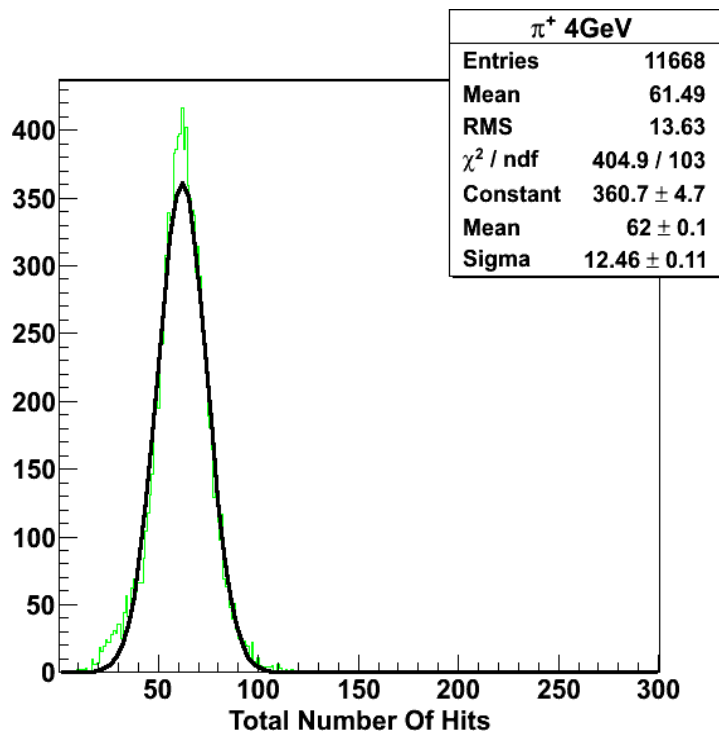
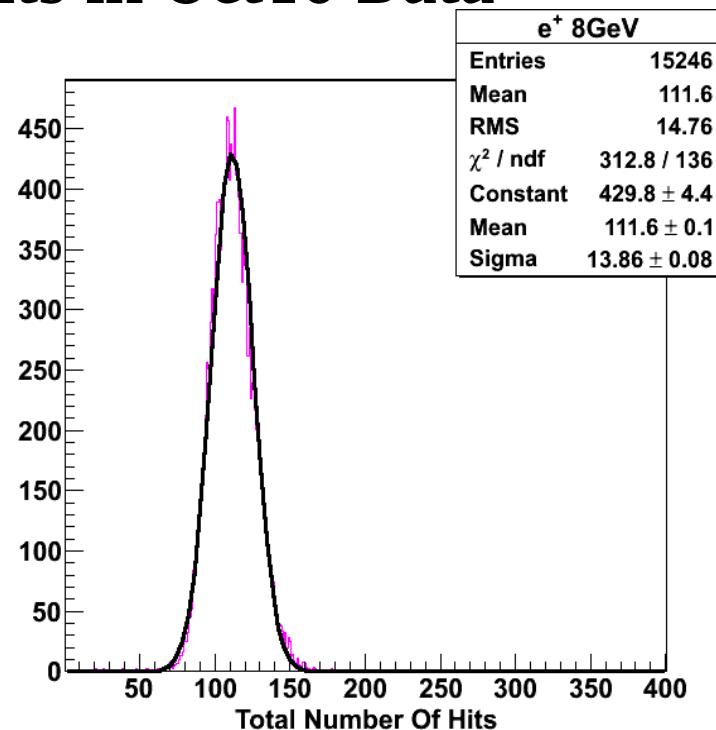
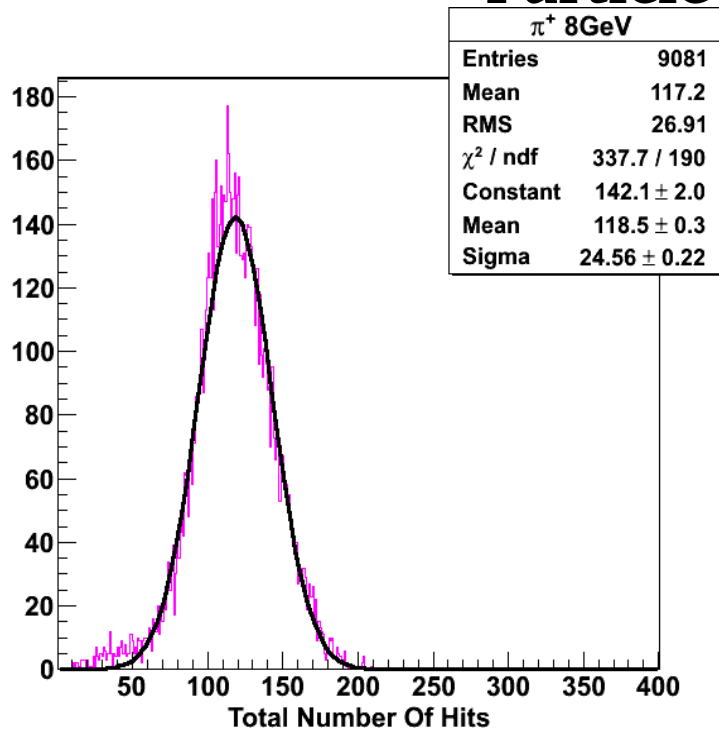
Particle ID Results in Oct10 Data



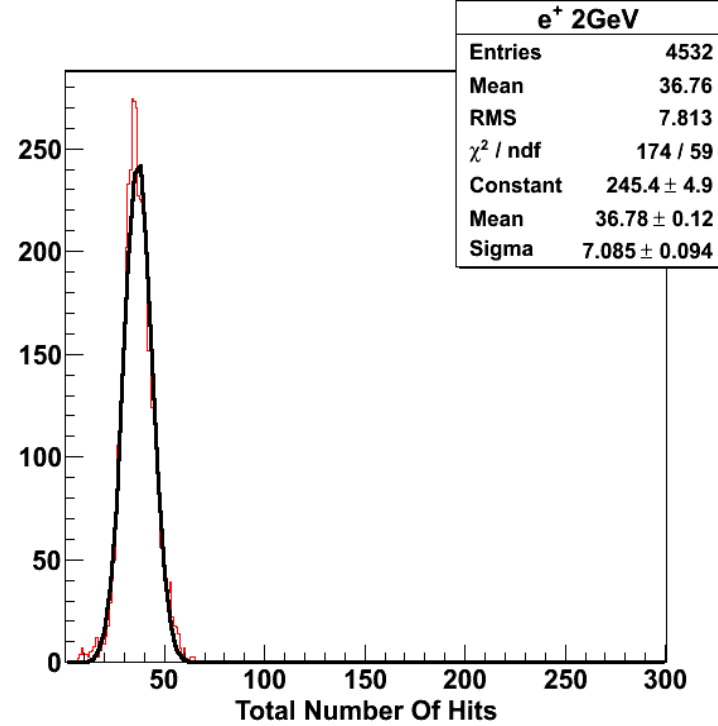
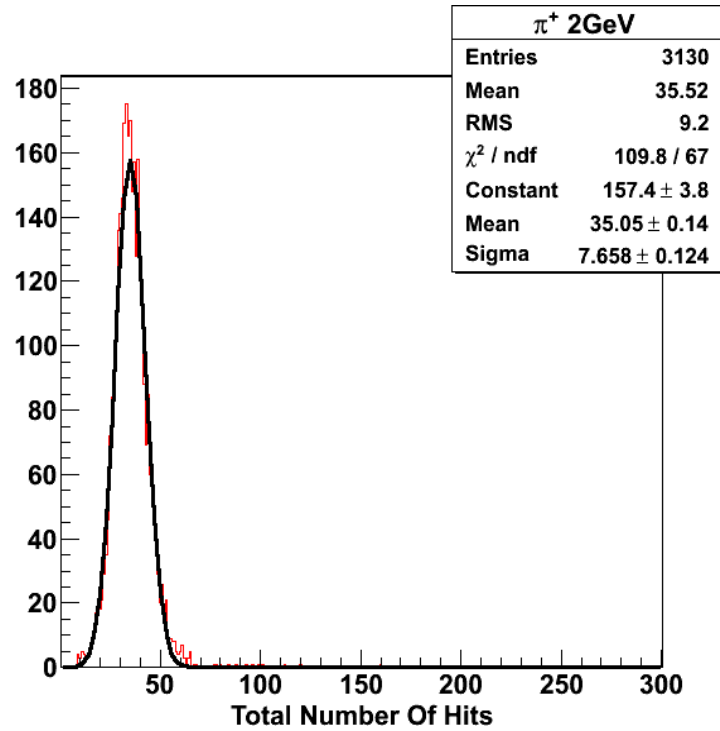
Particle ID Results in Oct10 Data



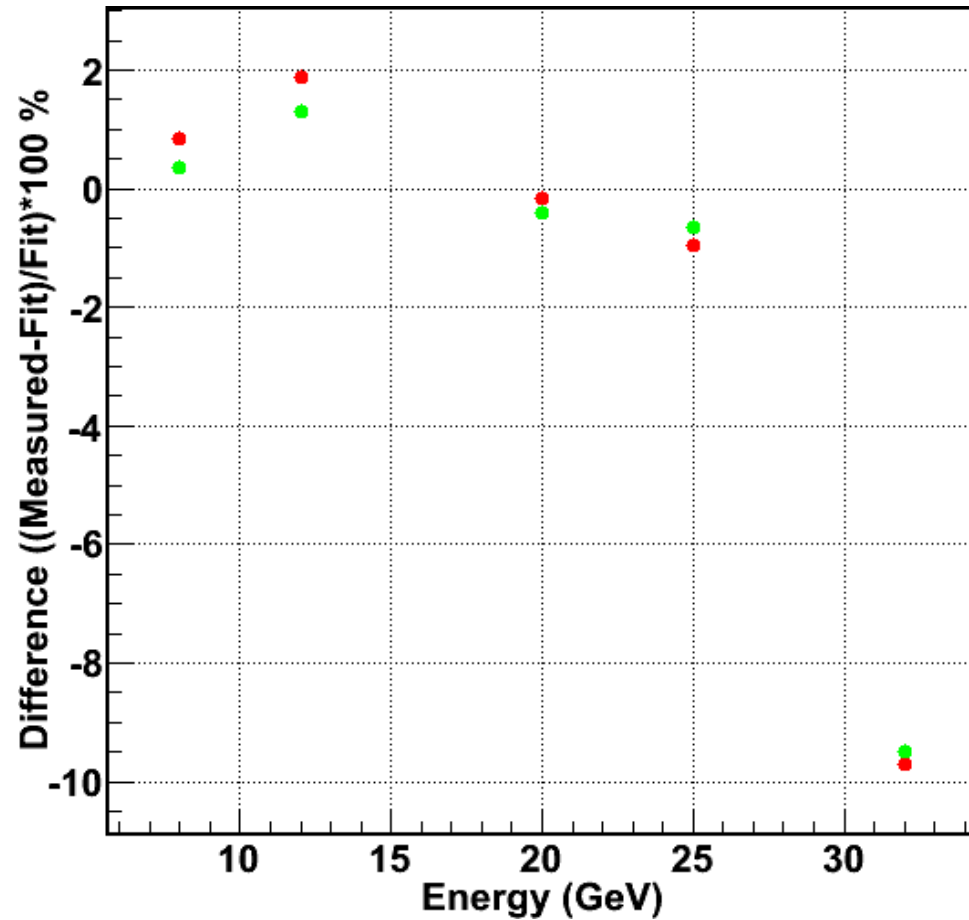
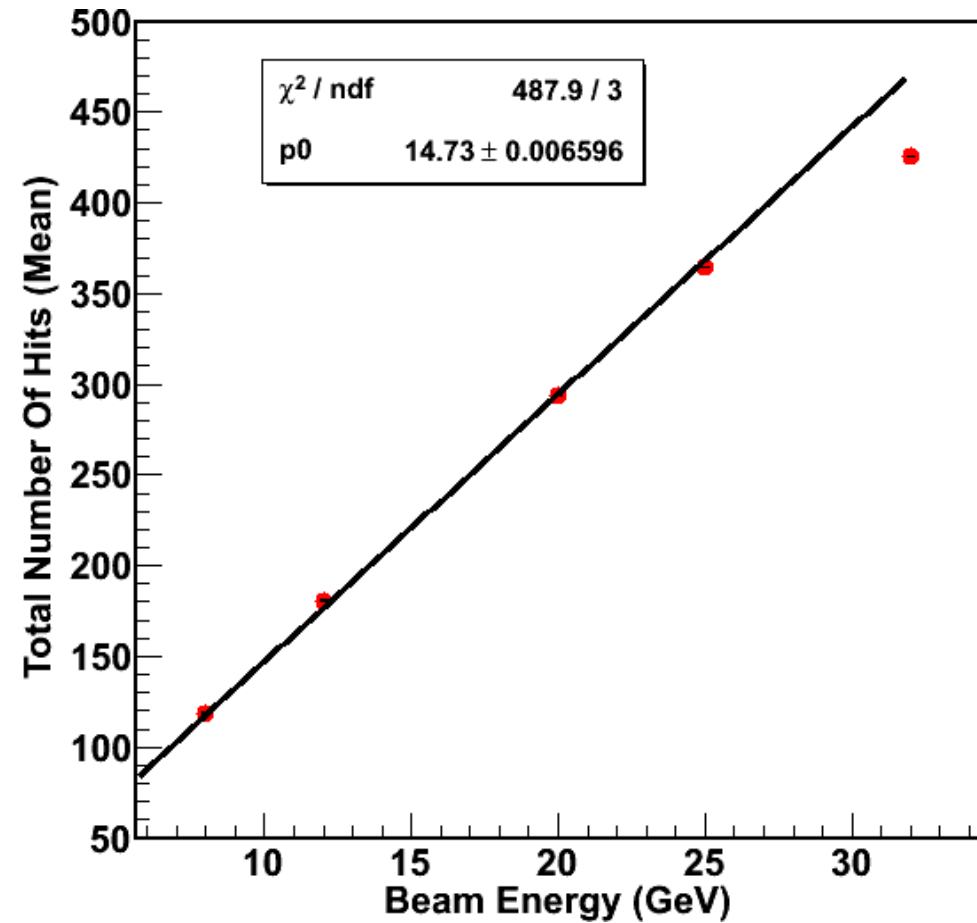
Particle ID Results in Oct10 Data



Particle ID Results in Oct10 Data



Pion Results (Oct10 Data)



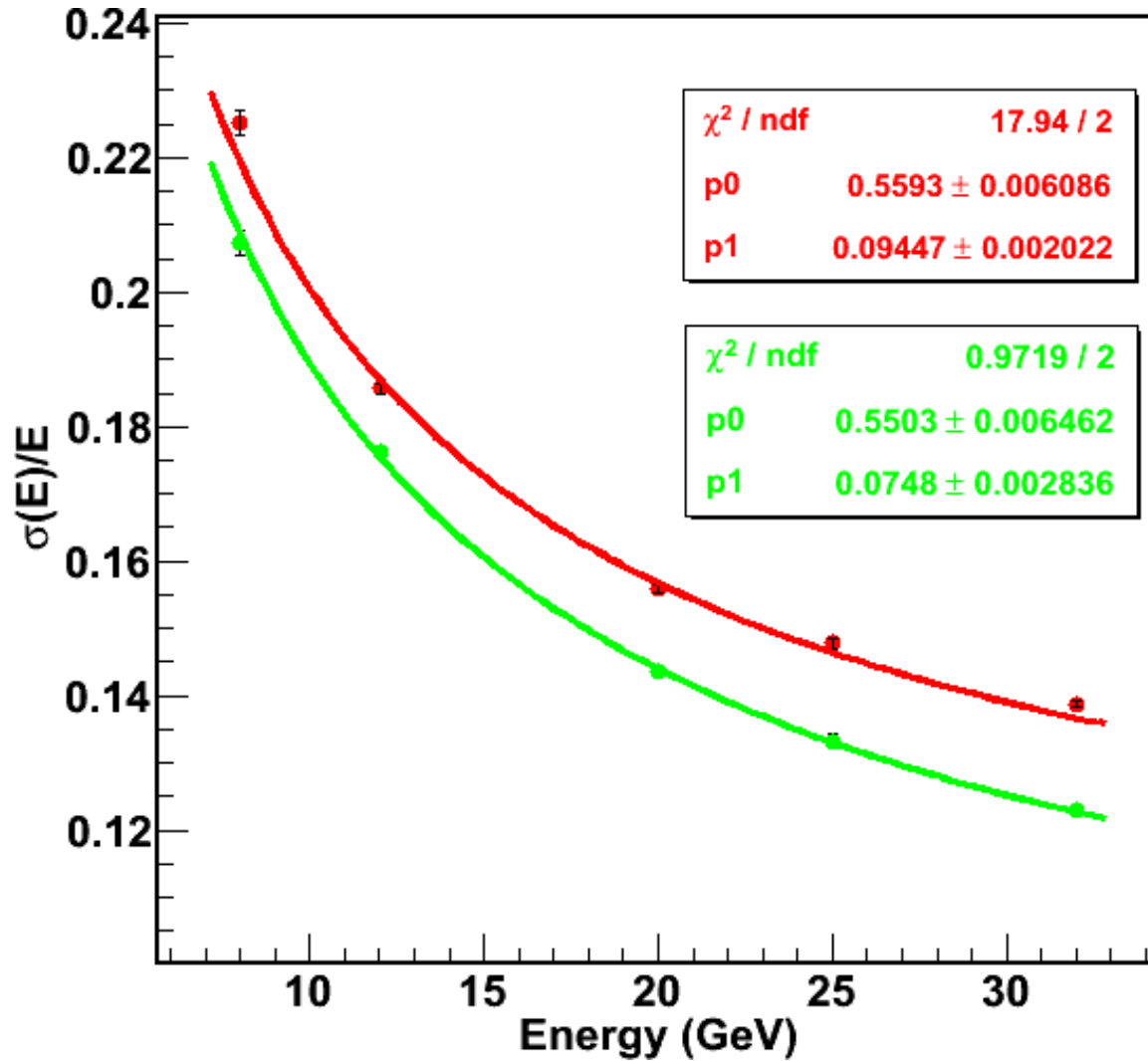
$$N = p0 * E$$

32 GeV data point is not included in the fit.

No Selection

No Hits in last two layers

Pion Results (Oct10 Data)



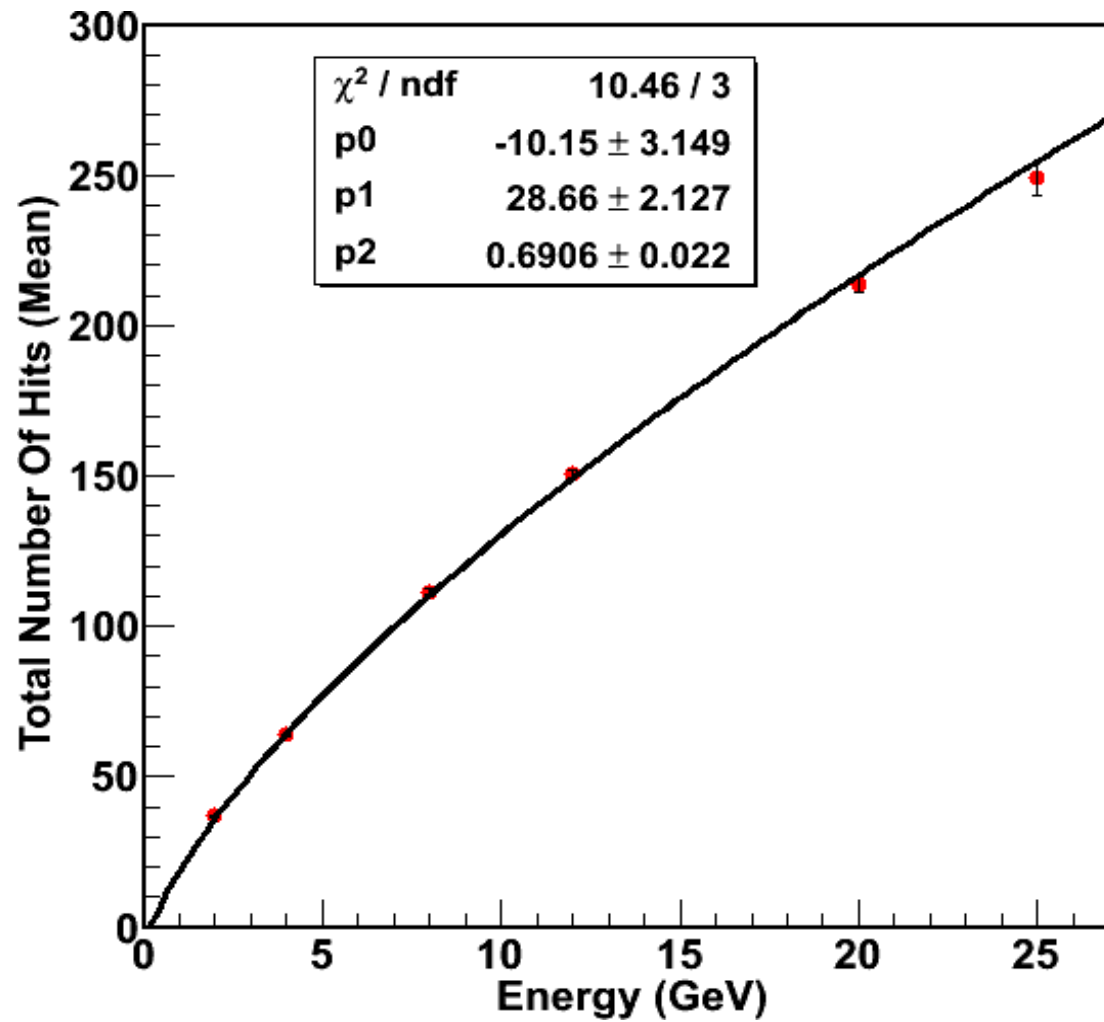
$$\frac{\sigma}{E} = \frac{p0}{\sqrt{E}} + p1$$

32 GeV data point is not included in the fit.

No Selection

No Hits in last two layers

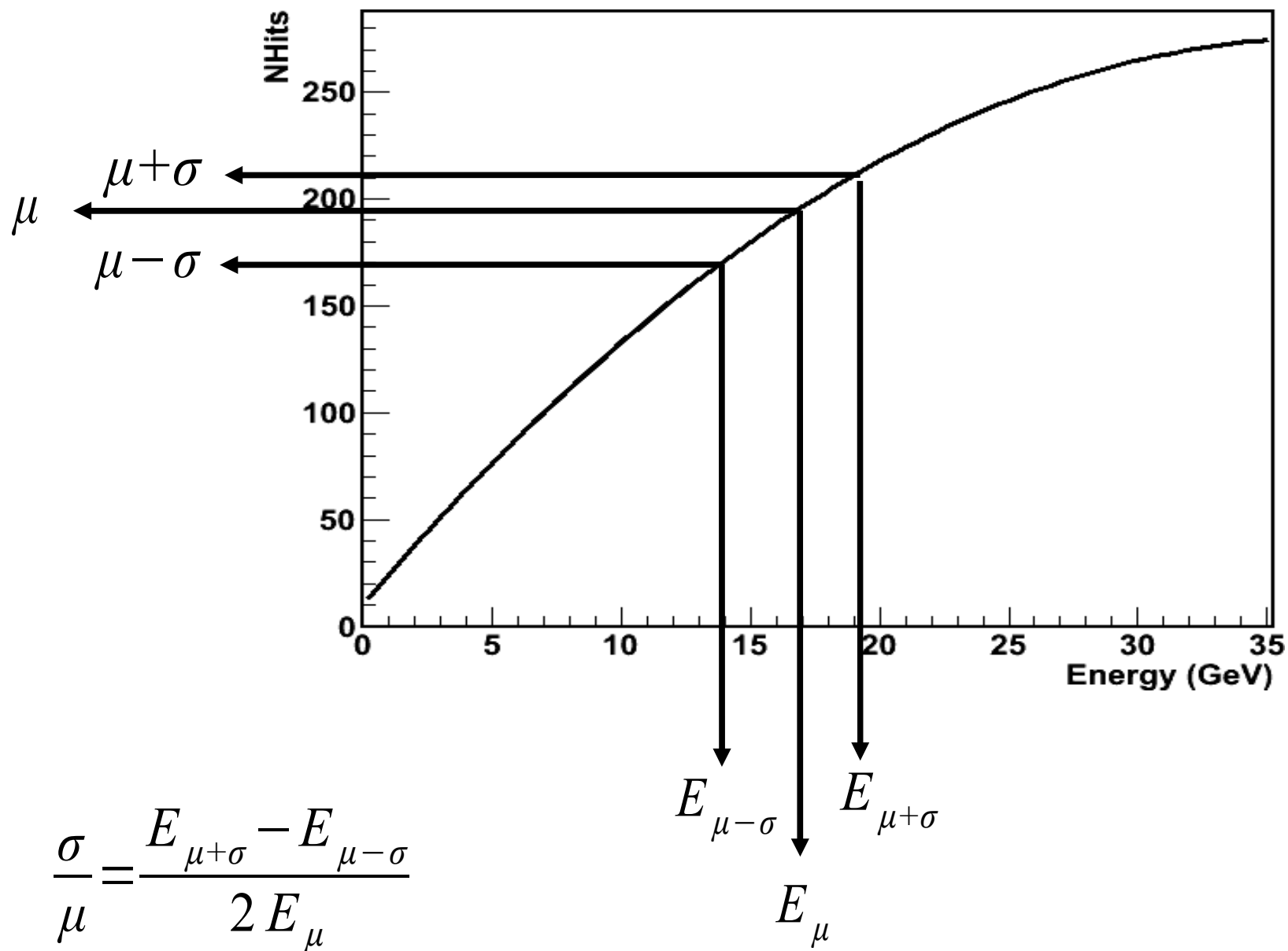
Positron Results (Oct10 Data)



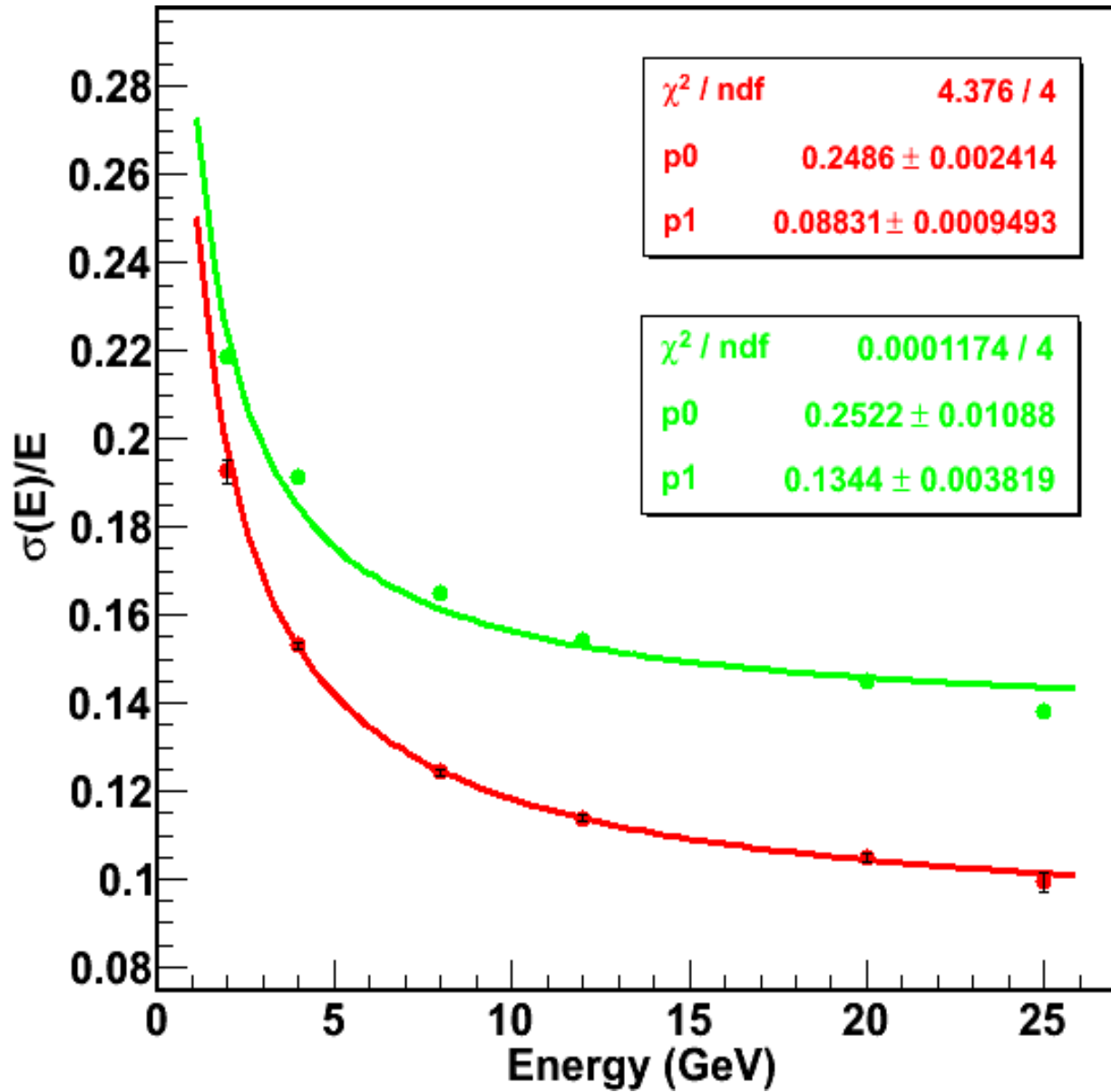
$$N = p_0 + p_1 * E^{p_2}$$

Positron Results (Oct10 Data)

Resolution Correction For Non-Linear Response



Positron Results (Oct10 Data)



$$\frac{\sigma}{E} = \frac{p0}{\sqrt{E}} \oplus p1$$

No processing

Corrected for non-linearity

Conclusions

1. We have a large volume of data from two successful beam test campaigns.
2. The Digital Hadron Calorimeter concept is being validated.
3. Current measurements show 55% hadronic and 25% electromagnetic energy resolutions.
4. Analysis ongoing.