

# Progress on E/p for low energy pions

N. Davidson



THE UNIVERSITY OF  
MELBOURNE

# E/p method

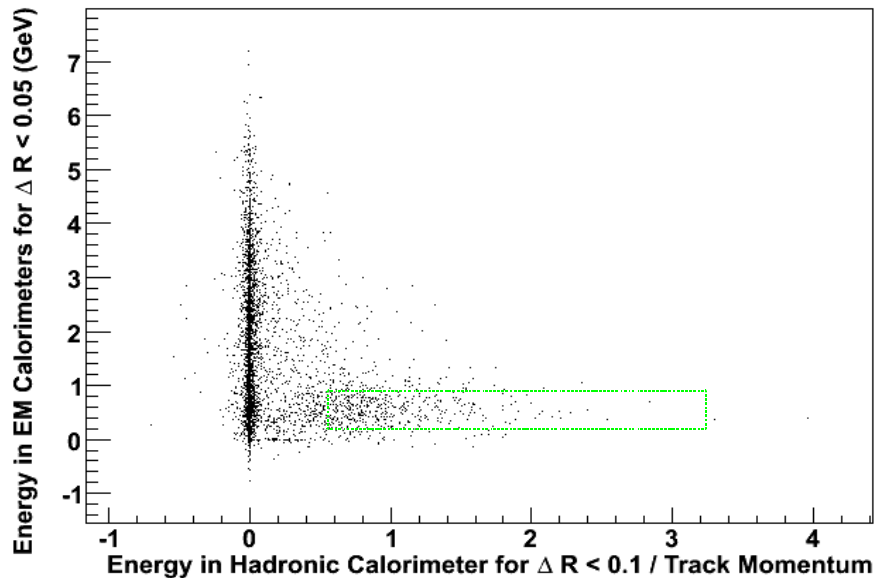
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- Recall: E/p is a method to check the energy scale calibration.
- Minimum bias events have been studied to find isolated pions and check the low energy ( $P_t < 15\text{GeV}$ ) range of the single hadron calibration.
- P – taken from track momentum (precise)
- E – taken as the sum of caloTopoClusters energies within a cone of  $\Delta R=0.4$  centered on the track position when extrapolated to the 2nd layer of the EM calorimeter.
  - Only tracks with matching cluster within  $\Delta R < 0.05$  are considered
  - Only clusters with  $|\eta| < 2.5$  are used.
- Previous work was done with csc datasets reconstructed with Athena 11.0.4
- Now looking at 12.0.6 MC
- 400k minbias events:
  - `trig1_misal1_csc11.005001.pythia_minbias.recon.v12000601`
- 25k single pions with  $\eta=1\text{GeV}$ 
  - `trig1_misal1_mc12.007421.singlepart_singlepi_et1.recon.v12000601`
- 15k single pions with  $\eta=10\text{GeV}$ 
  - `trig1_misal1_mc12.007422.singlepart_singlepi_et10.recon.v12000601`
- Many sample have 1mm problem and will be compared to 30 micron datasets when available.

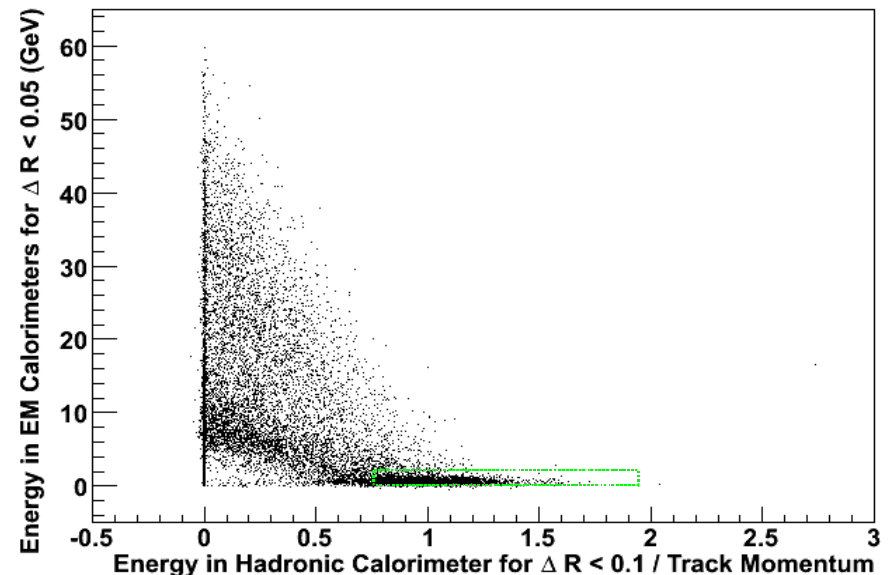
# First look at contamination subtraction

- Method to estimate background energy in the EM calorimeter:
  - Identify pions which shower late depositing minimal energy in the EM Calorimeter.
    - EM calo energy in  $R < 0.05$  around track is between 200-800 MeV
    - Energy in cone 0.1 in Hadronic Calorimeter  $> 0.6 \times$  Track P

Single Pt=1GeV Pion sample



Single Pt=10GeV Pion sample



# Estimate of contaminating energy

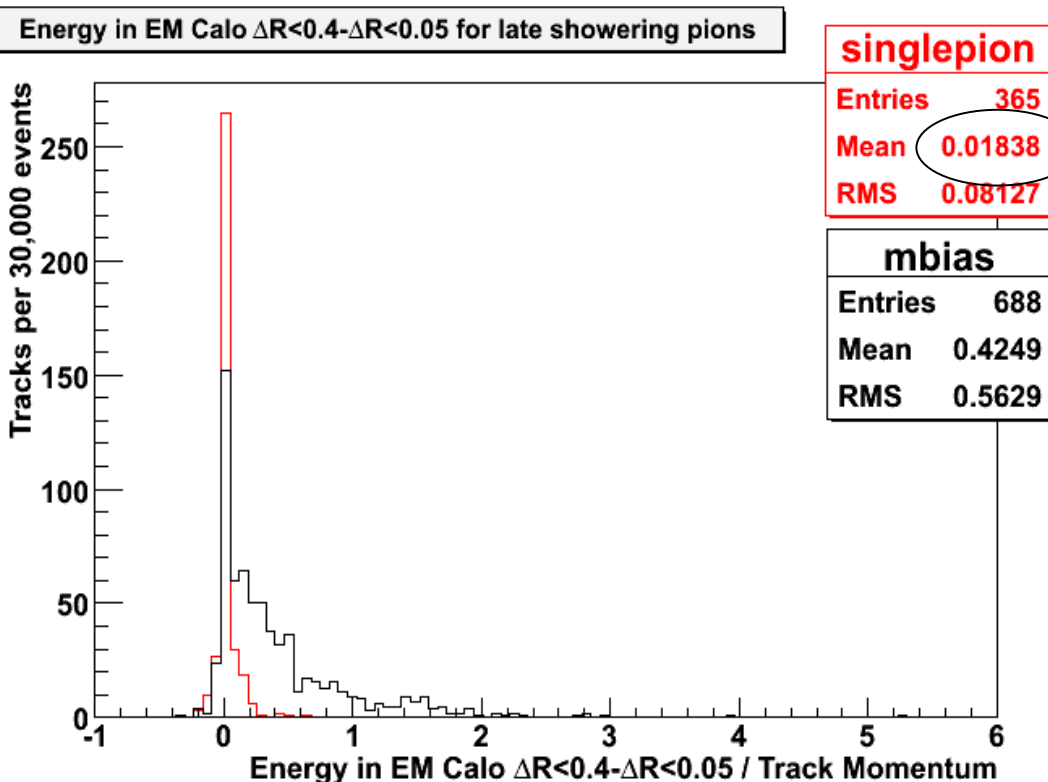
- Take the EM energy contamination as the energy difference between a cone of 0.4 and 0.05. Plot shows such an estimate for  $p_t=1\text{ GeV}$ .

Late showering pions in minimum bias selected as described on the pervious slide. Plus cuts on

Track Isolation  $> 0.4$   
and at least one hit in the B layer

For 1GeV pions there will be an overestimate of the contam. due to pion EM energy outside  $R<0.05$

For 10GeV pions this appears to be less than 0.005



# Estimate of contaminating energy (cont.)

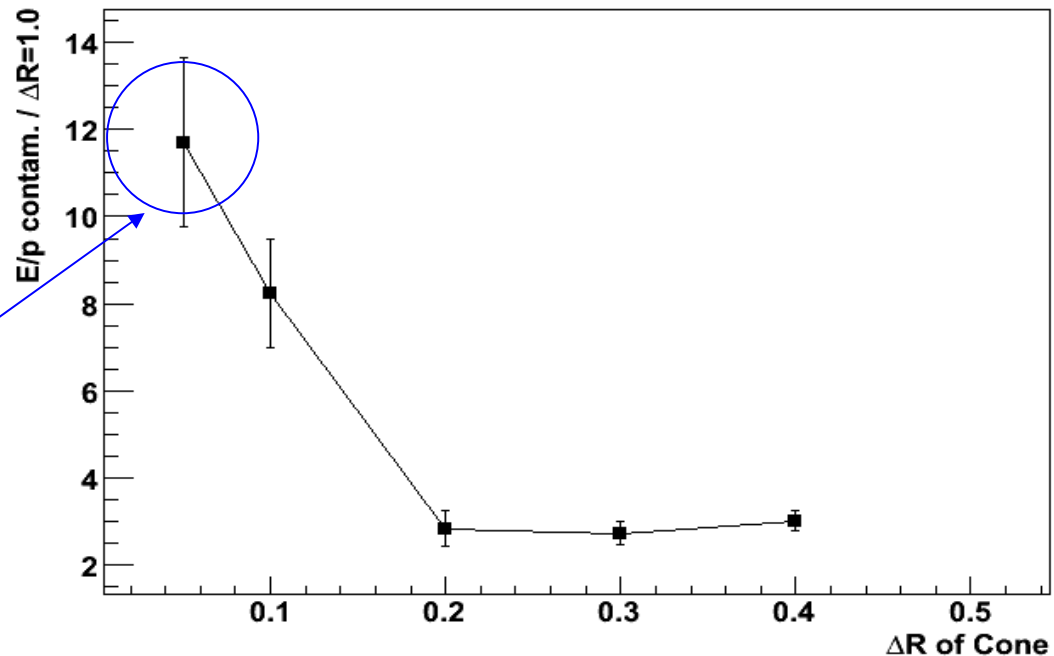
- Estimate the contaminating energy density in the 0.05 cone as the same density as that is  $R < 0.1 - R < 0.05$ .

plot shows the difference in E/p between the single sample and minimum bias per unit of Delta R.

In this example an estimate for the 0.05 cone would be incorrect by approx.

$$(12-8) \cdot 0.05^2 = 0.01$$

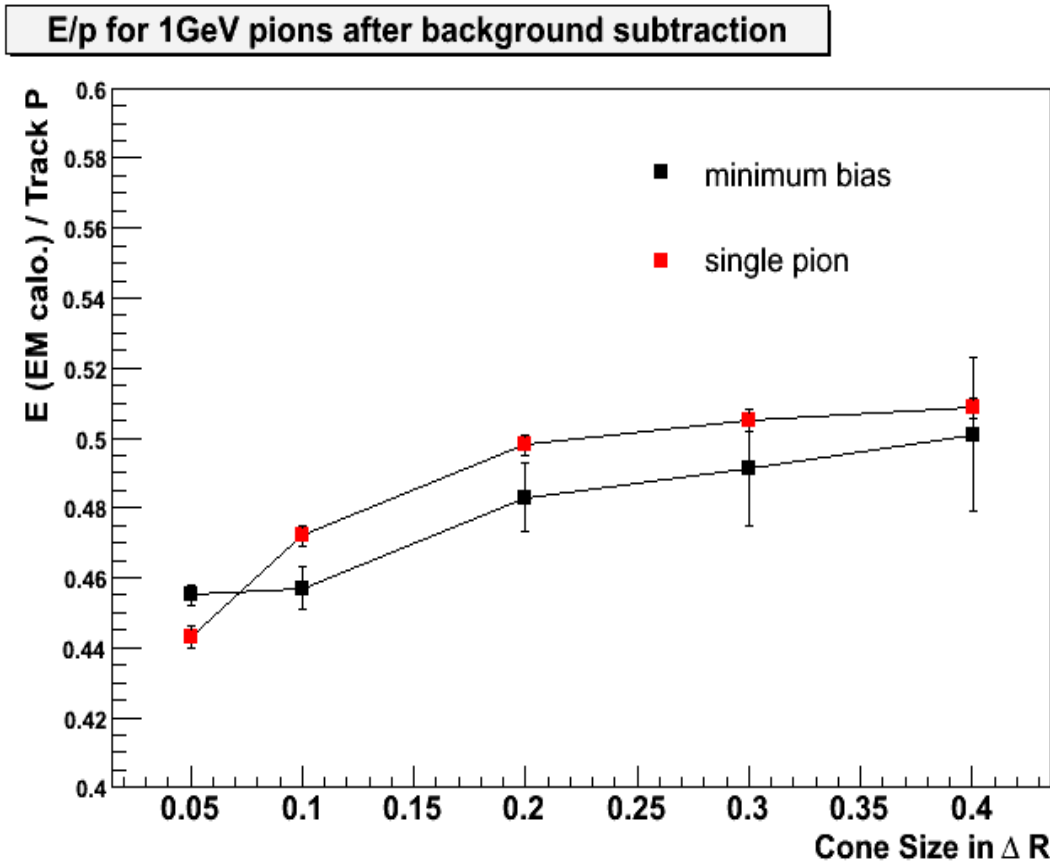
Contam. E/p density for pt=1GeV pions in minimum bias



- More cuts may be needed to reduce the background until this approximation is valid.

# EM Calo. energy subtraction results

- Result of subtracting the measured background energies:



For 30k minimum bias events

Only statistical error shown here.

Differences may be explained by the reasons outlined before:

- Overestimate of contam outside 0.05 cone due to pion energy
- Underestimate of contam inside 0.05

More study required but looks interesting for very preliminary work.

# Background in hadronic calorimeter

- Also need to estimate the contamination in the hadronic calorimeter:
  - This can be measured in the area between  $R < 0.4$  and  $R < 0.2$  from the track as very little of the pions energy is deposited here on average.
  - Below  $R < 0.2$  contam. should be small (approx 0.02, but still needs to be accounted for.
  - More investigation is required into this.
- In general more work will be done to see if this method can be used for pions where the cuts method can not be used.

# 10GeV pions in J2 sample

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- Could not find ESDs for the 500k minbias events reconstructed with 12.0.6.1
  - should be 3000 tracks with  $8 < Pt < 12 \text{ GeV}$
  - only 450 with track isolation of  $R > 0.4$
  - so even less that shower late
  - will still try to study this once some ESDs are found.
- First looks at dijet samples
  - J2 studied to get a feel for what we might expect
    - many very low energy tracks ( $< 5 \text{ GeV}$ )
    - close separation between tracks

# 10 GeV pions in J2 dataset

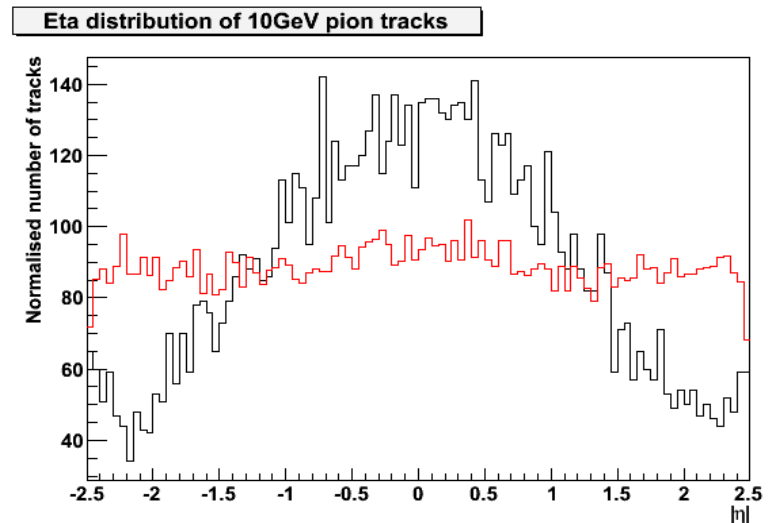
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- From about 350k J2 events:
  - approx. 9,000 tracks with  $8 < P_t < 12 \text{ GeV}$ , matching cluster within  $R < 0.05$  and isolation from other tracks of  $R > 0.2$ .
  - approx. 500 of these are late showering.
  - approx. 100 with track isolation of  $R > 0.4$
- 10 GeV single pions sample shows little energy outside of 0.05 cone for late showing pions (Unlike 1 GeV case).
  - results in an underestimate of the e/p of less than 0.003

# Results cont.

- Early comparison shows a difference between the measured contamination and 'real' contamination.
  - Estimate of EM calo e/p contam from late showing pions
    - $0.91 \pm 0.04$
  - Estimate of 'real' contam to e/p using single pions
    - $0.98 \pm 0.01$

- But I have not weighted the single pion sample with the eta distribution of the tracks in J2!



- Need to weight the tracks in eta and also study the error due to incorrect estimate of energy within the cone of  $R < 0.05$