# Update on H2 TB2007 data analysis

## Outline

- HE response and resolution with and without the ECAL (EE+ES) in front.
- Noise and mip studies in EE.

CaloTaskForce Meeting , October 31, 2008

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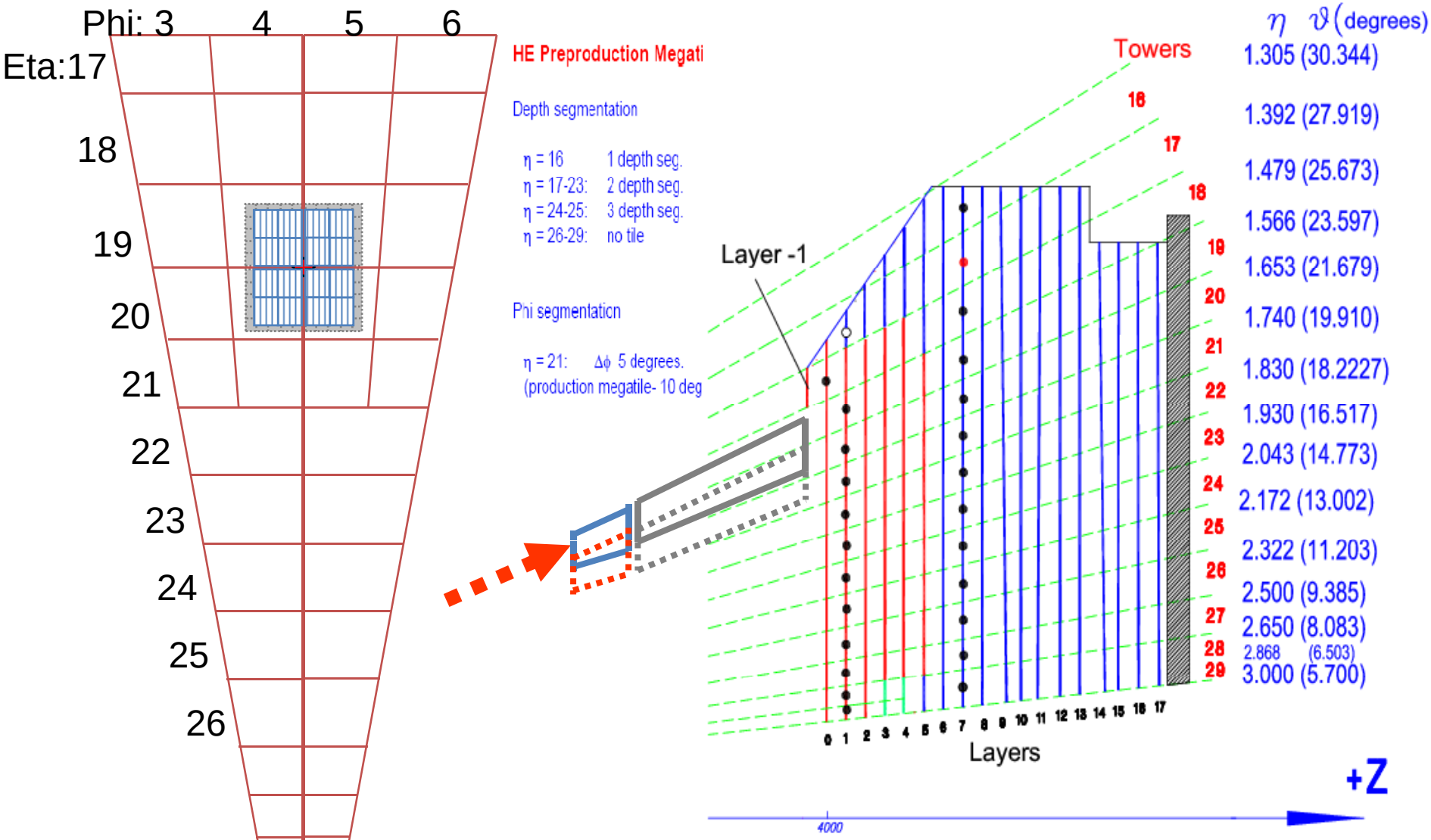
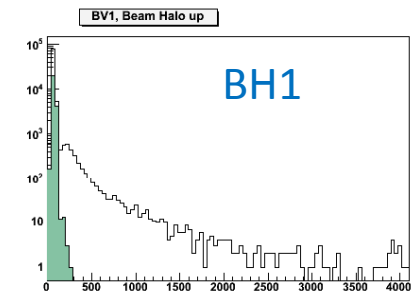
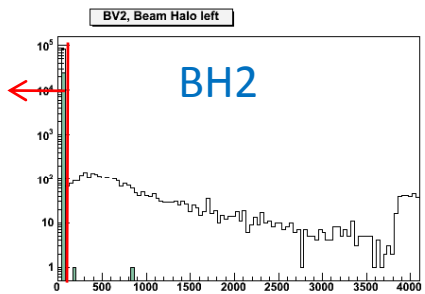
# TestBeam 2007 calorimeter set up

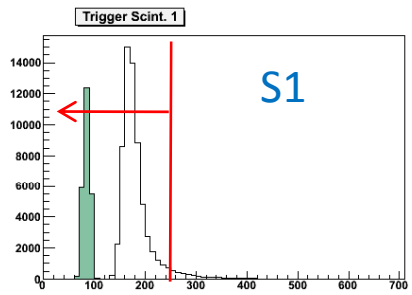


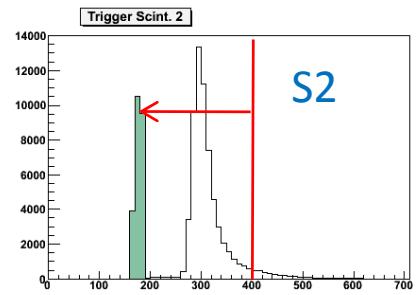

The longitudinal and transverse segmentation of the HE calorimeter

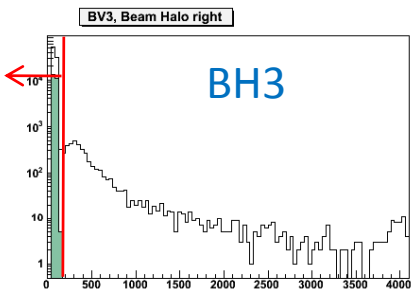
# Various beam cleanings used

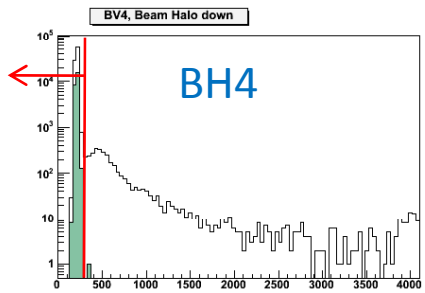


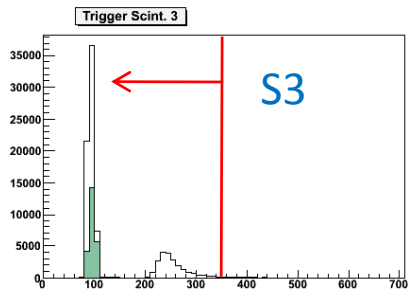



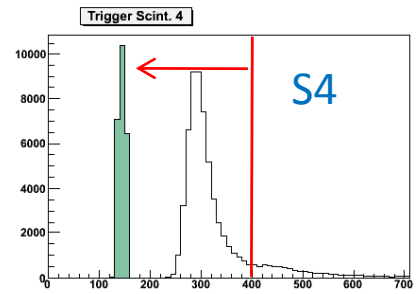




**Definitions used :**

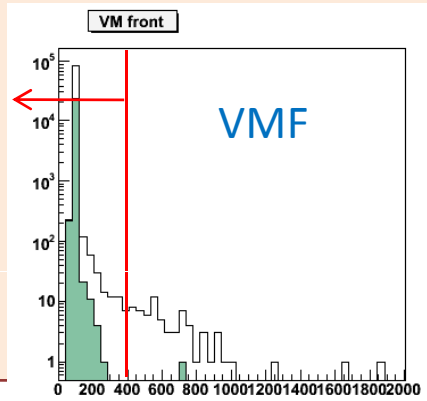
**tagged** : if(S1>250 || S2>400 || S3>350 || S4>400 || BH2>80 || BH3>120 || BH4>280)

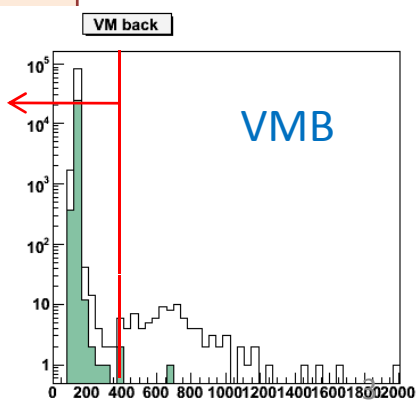
**muon** : if( (! tagged) AND (VMB>400 || VMF>400))

**electron**: if( (! tagged) AND (! muon) AND CK2>100)

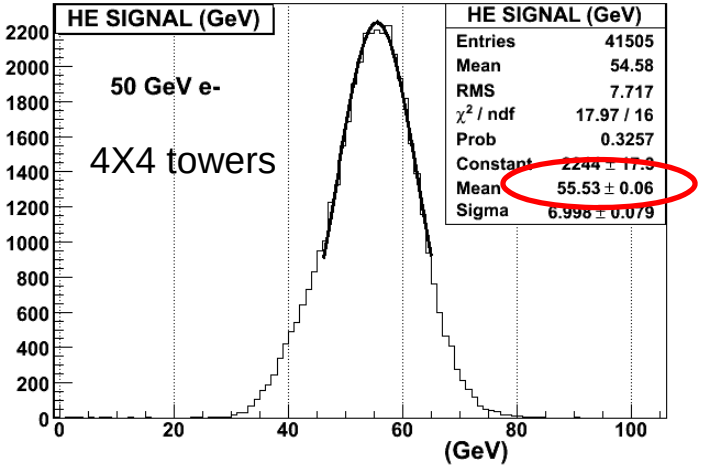
**pions** : if( hadron AND CK3>500) *

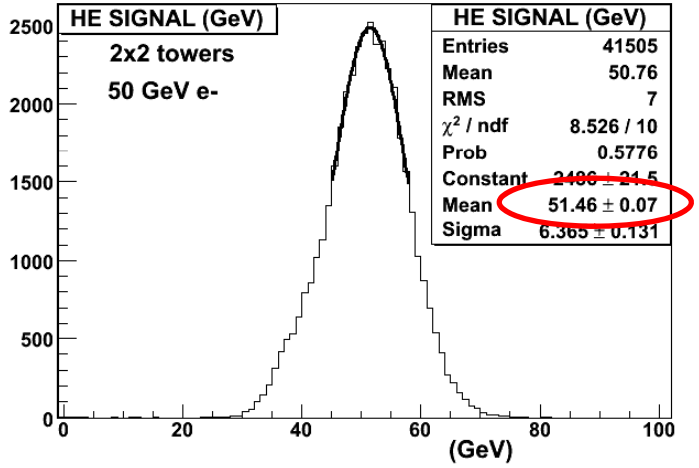
*For clean events in high energy runs we use beam clean up and Muon veto back.*



# Calibrating HE energy with 50 GeV e-




HE energy is summed over 4X4 towers (2 depths) The scale is obtained by fitting the distribution with a Gaussian function to find the peak position.
The scale thus obtained is: **50/55.53 = 0.90**

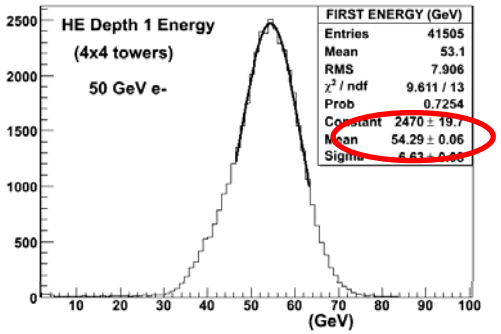
**Hence total(HE+EE) = $EE_{5x5}$ + HE x 0.90**

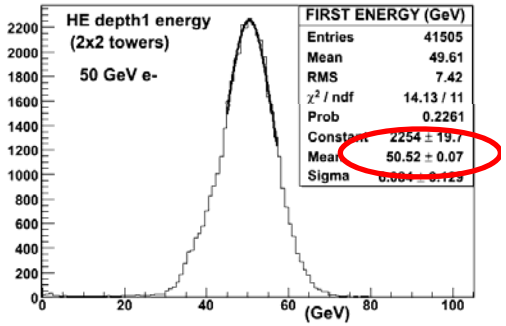
- If we look at HE energy only from the depth 1 then we see that for 50 GeV e- beam 98% energy is deposited in the depth 1, as expected.

(These will lead to systematic studies in future.)

❖ If HE energy is summed over 2X2 towers (2 depths) then we observe a lower mean.

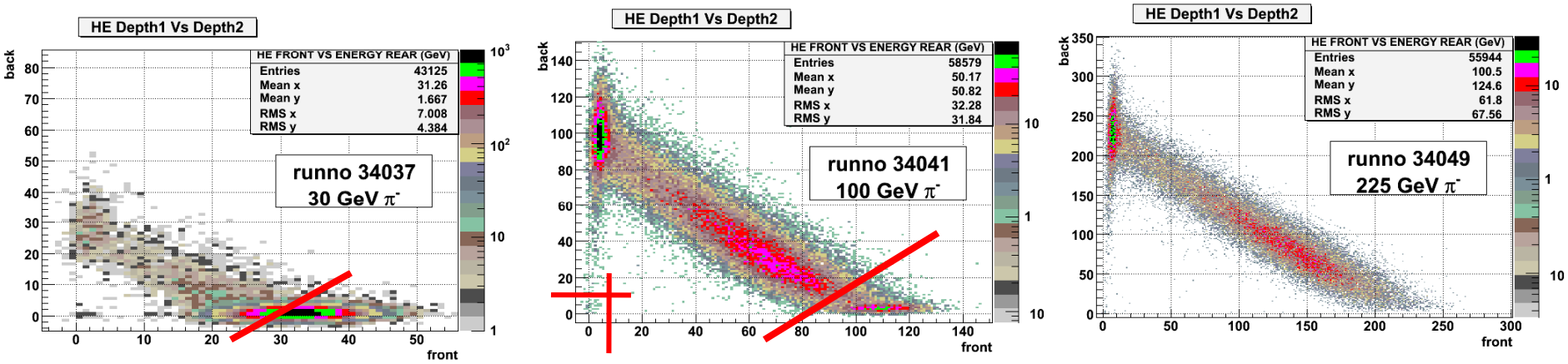
✓ Higher mean in 4x4 is probably due to noise coming from 16 extra towers.



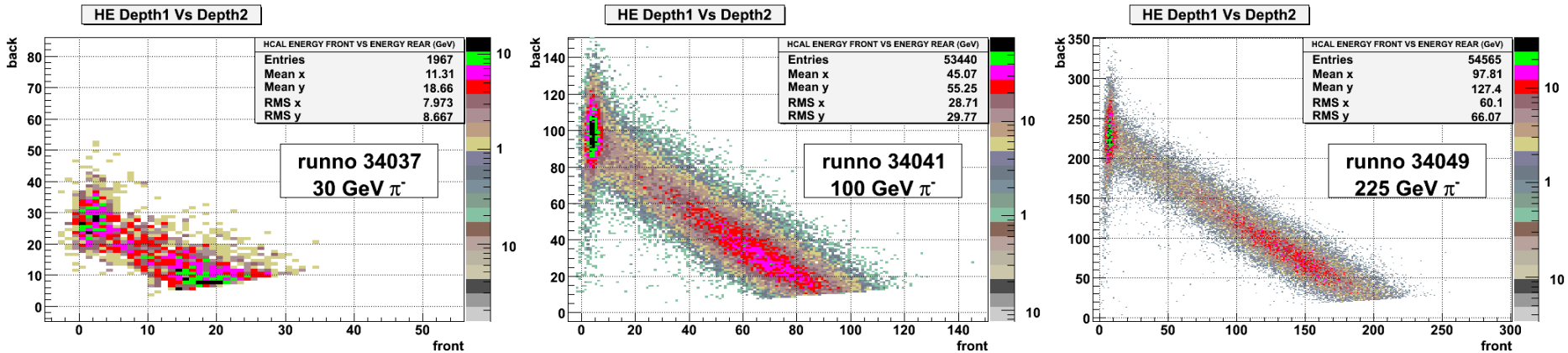



# HE standalone energy distributions in two depths

HE has two depths – these distributions look at energy deposited in depth 1 and 2.




Cuts applied to get rid of (i) electrons present in the beam and (ii) contamination due to beamline interactions. After those cuts the distributions look like the following:

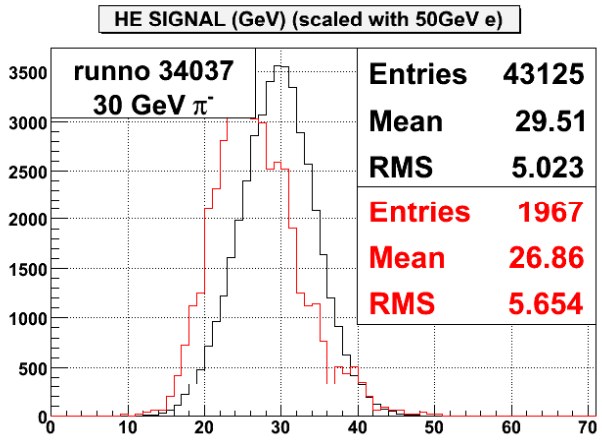


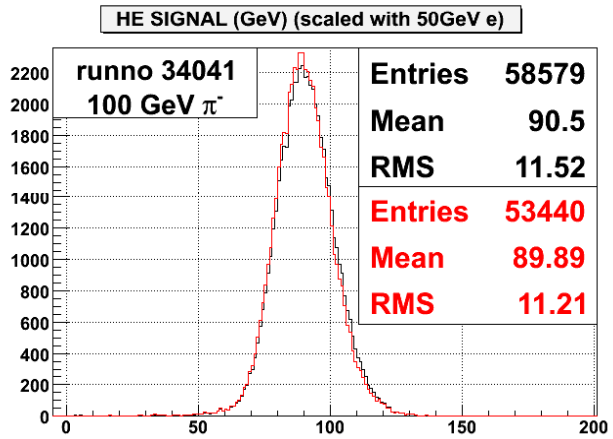
# Energy deposited in HE 4x4 towers (depth1+2)

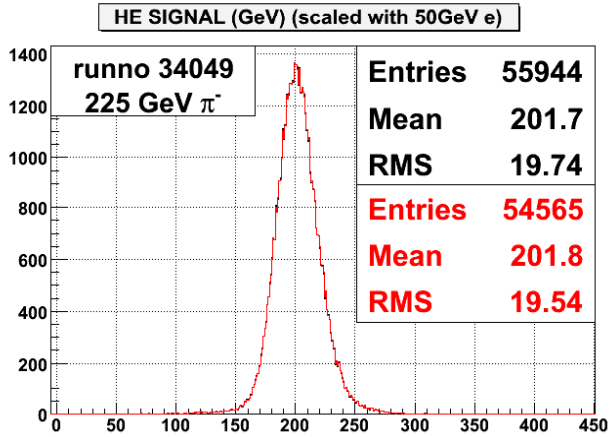
HE energy is summed over 4X4 towers (2 depths).

Plots show the total energy in 4x4 towers before and after the cut.

We notice that apart from the 30 GeV point the cuts do not affect higher distributions much.



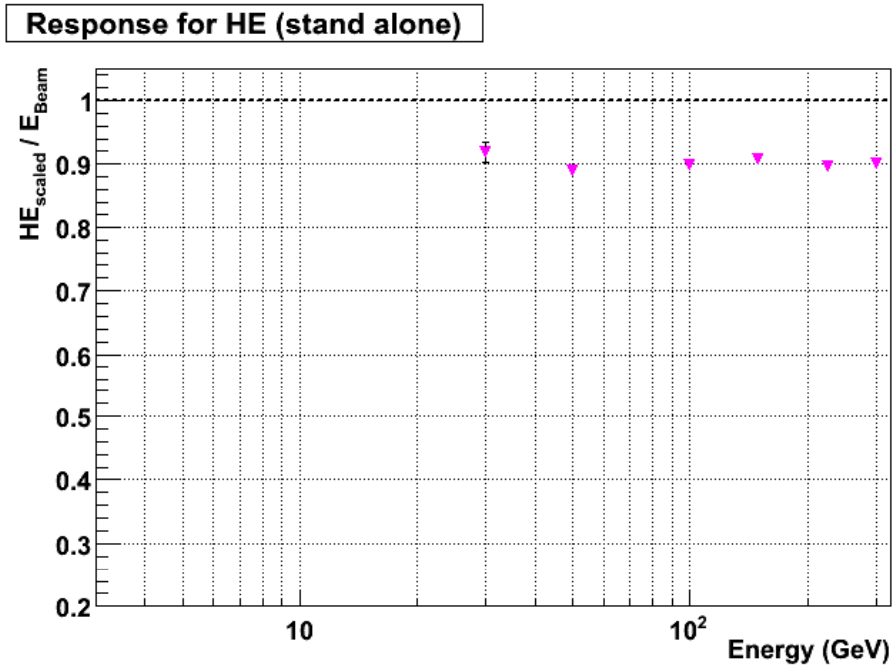



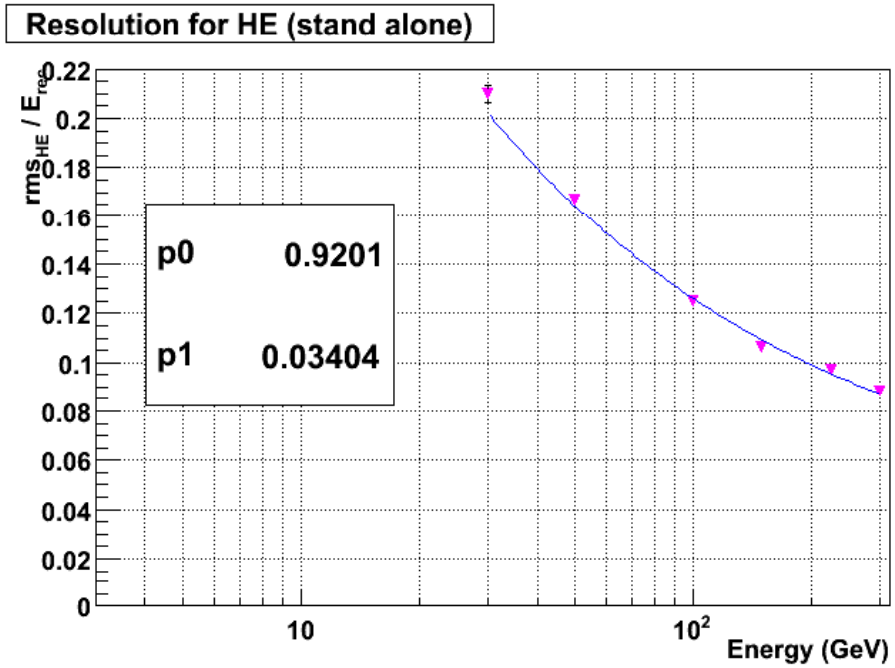

Energy after cut

Energy before cut

# Response and Resolution of HE stand alone

- For HE standalone case, we don't have reasonable data for very low energies. TDC / Cerenkov were not working for those runs, hence particle identification is not possible.
- For high energy runs 20 GeV is excluded, it having mostly electrons.
- So we use high energy data with 30, 50, 100, 150, 225, 300 GeV pion runs to obtain these plots.




**We notice response of HE stand alone is almost linear around 0.9.**

$$\frac{\sigma}{E} = \frac{92.0\%}{\sqrt{E}} + 3.4\%$$

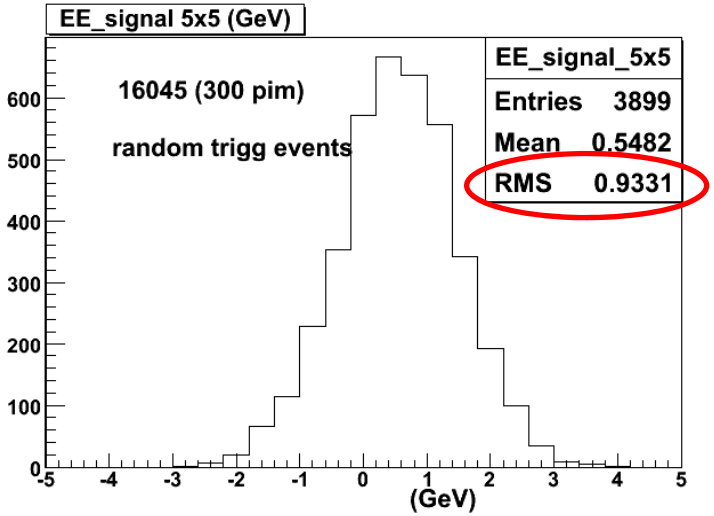
✓ Resolution is around 9% for 300 GeV and 20% for 30 GeV.

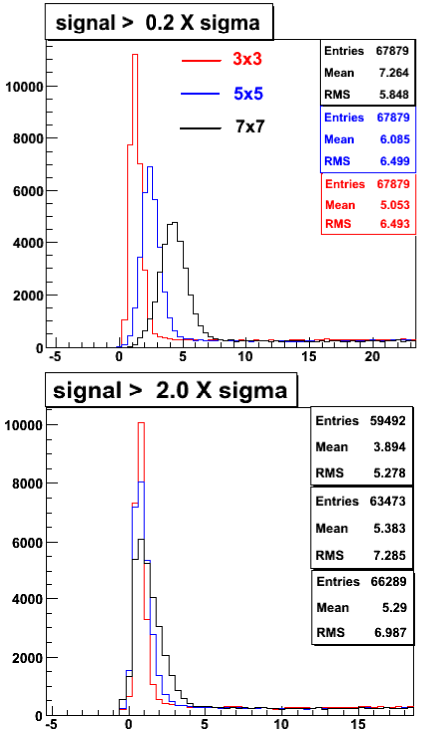
# Issue with EE noise

In TestBeam 06 we had EB where noise/crystal was 40 MeV.
In TestBeam 07 we have EE, which has noise/cry = 180 MeV.

✓ We establish that from the EE5x5 distribution for random trigger events. Noise/cry = 0.933/sqrt(25) = 0.180 GeV(approx).

- Average pedestal rms for EE is 2 ADC counts (while in EB is 1.2 ADC counts)
- In EE matrix (at H2) is roughly 90 MeV per ADC counts (while it is on average 37 for EB)

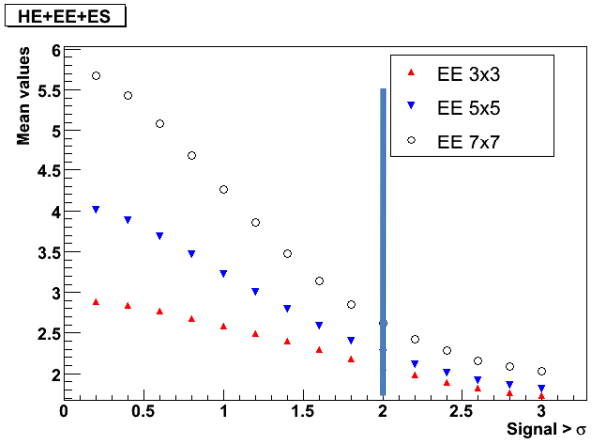



Due to this *high noise in EE* we need the consider signals only above a certain threshold.

We varied this thershold and studied the effect for different cluster sizes, namely 3x3, 5x5, 7x7.

We see that around 2 sigma the signals for various clusters are coming close.



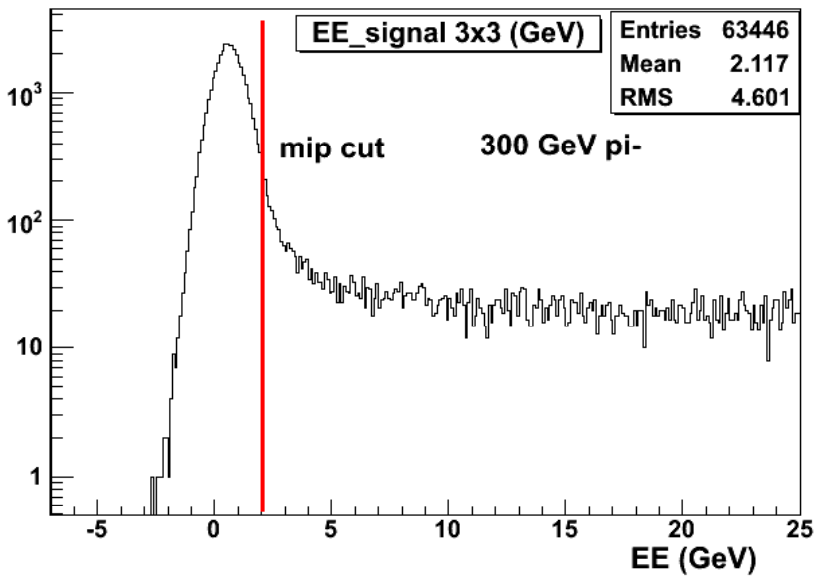

**We decided to consider signal events only above 2 sigma.**

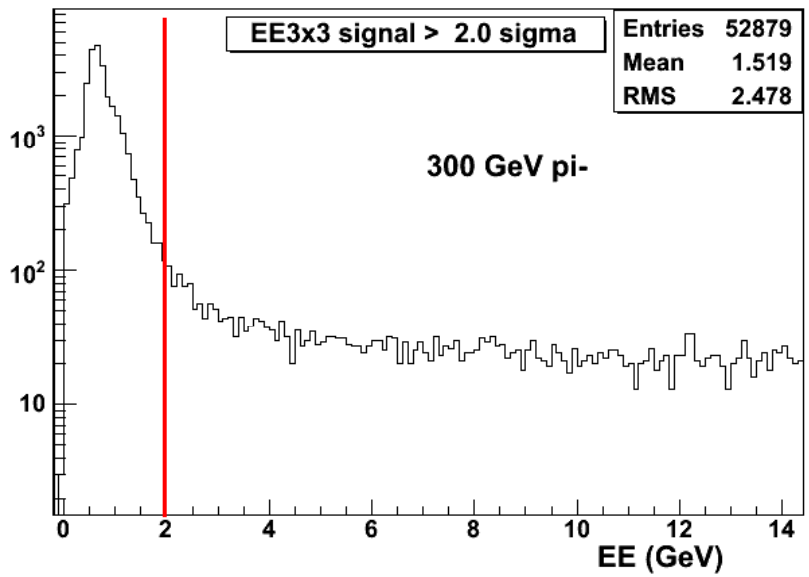
# MIP in EE

How to decide mips in Ecal?

We study the 3x3 signal distribution for 300 GeV pion run. We also try to see the same distribution with Our chosen 2 sigma cut.

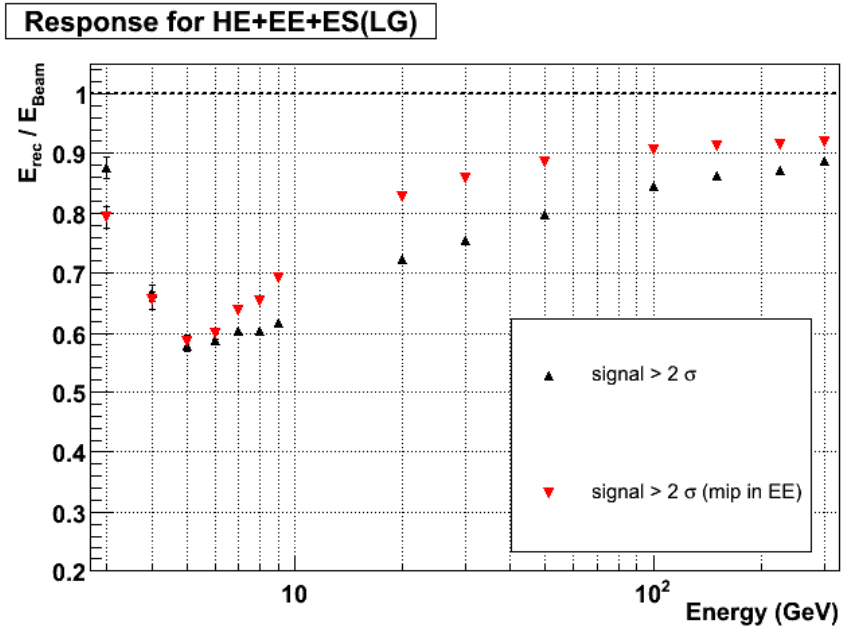
We see a tail starting to form at around 2 GeV.

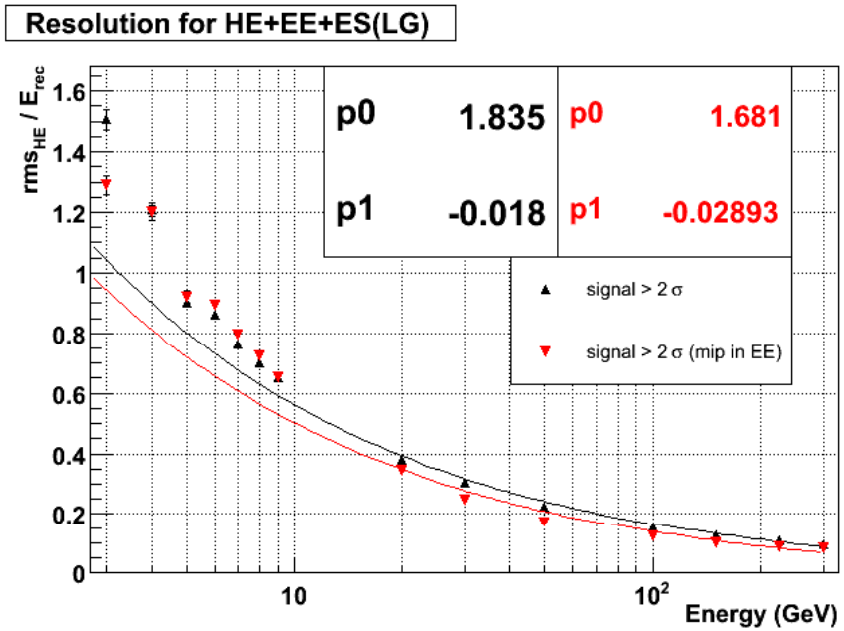



We decided to cut for mip around 2 GeV from these figures.

# Response & Resolution for combined HE+EE+ES




$$\frac{\sigma}{E} = \frac{183.5\%}{\sqrt{E}} + 1.8\%$$

$$\frac{\sigma}{E} = \frac{168.1\%}{\sqrt{E}} + 2.9\%$$

(mip in EE)

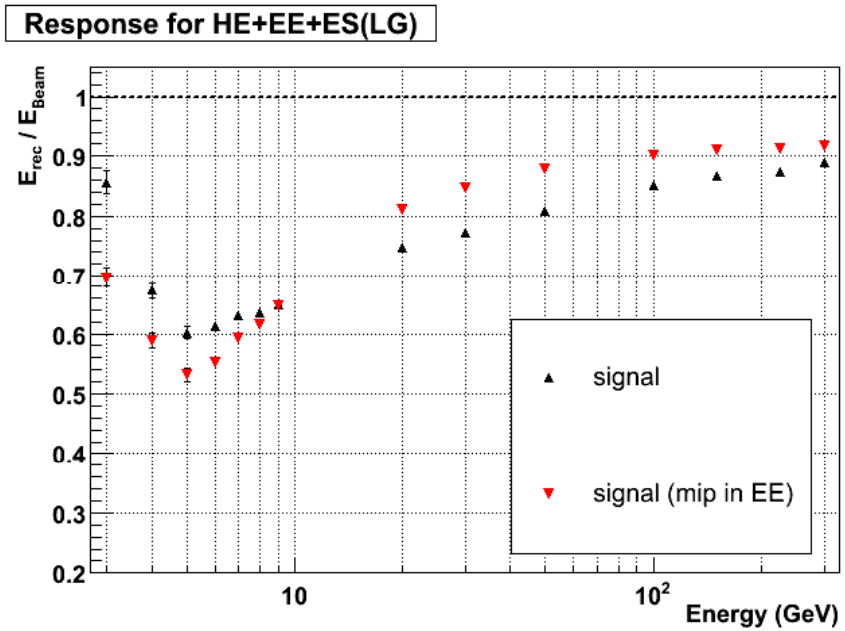
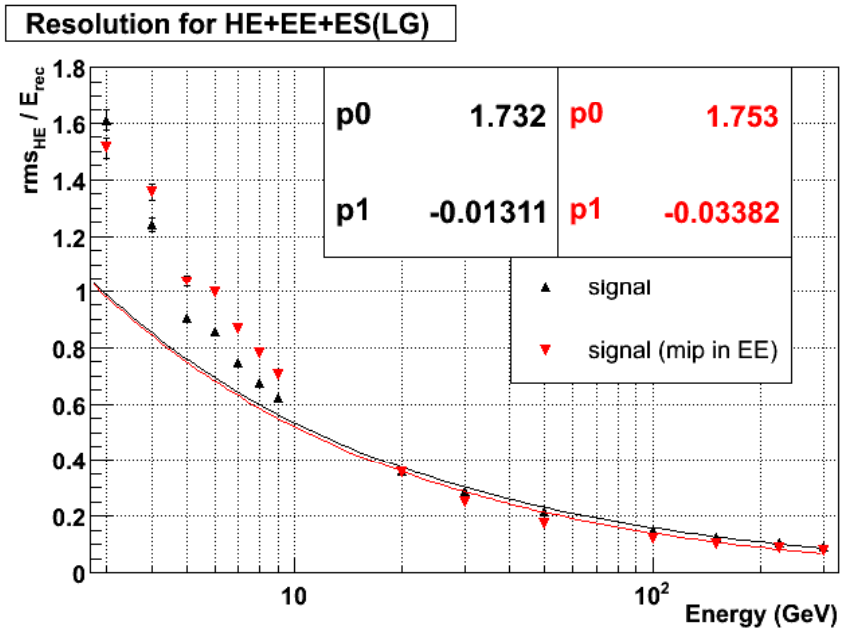
- We clearly see the non-linearity in the combined response.
- The resolution worsens as compared to HE stand alone case.

✓ Resolution is around 10% for 300 GeV and 30% for 30 GeV.

# Conclusions and Outlook

- We studied the response and resolution of hadron endcap calorimeter with and without the ECal (EE + Preshower).
- Due to high noise in EE crystals (4 times that in EB) we consider signals only above a threshold.
- We decide on the mip in ECal events and mip threshold is applied at 2 GeV.
- We see that with the presence of ECal in front the resolution worsens compared to HE stand alone.
- For very low energies the response in HE is increasing after 5 GeV. This effect needs further investigation.
- We shall look at single particle response for protons and kaons as well.
- We have to study the systematic coming from the scaling of HE with 50 GeV e- (eg. Considering 2x2 tower and only depth 1 instead of 4x4 towers (with 2 depths).

# Back up

Response & Resolution for combined HE+EE+ES when **no** 2 sigma cut is applied.

We still see similar behaviour but in mip in EE we have lower response in very low energies.