Weighting procedure for CERN test beam data and simulations

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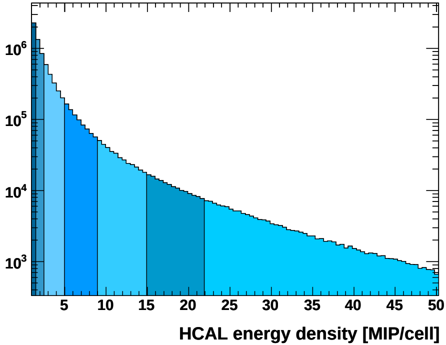
Reminder

Idea:

- Non-compensated calorimeter: $\frac{e}{h} > 1$
- Different weights for em. and had. showers/subshowers
- Em. showers/subshowers tend to be denser than had. showers/subshower

Method:

- Calculate energy density of each cell $\frac{\text{cell energy}}{\text{cell volume}}$
- Define bins in density spectrum $\rightarrow$ weights for the different bins
- Each cell is weighted due to it's density



Analysis

In AHCAL contained showers

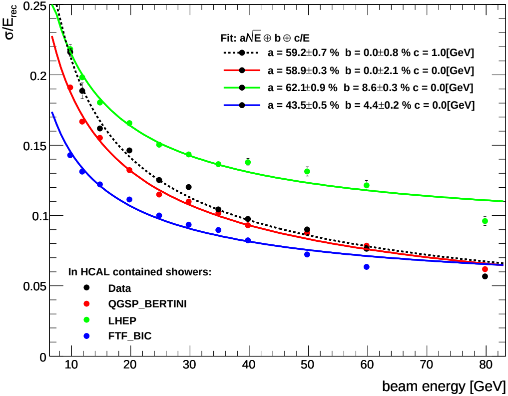
- temperature corrected data: Ecal Hits < 50, HcalEnergy > 100 MIP, TcmtEnergy < 5 MIP
- simulation without Ecal and TailCatcher
  Cuts on Hcal Energy in first and last layer

Physics lists:

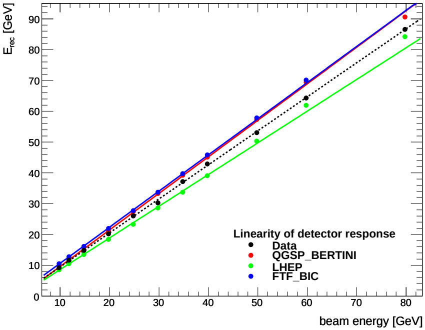
- QGSP_BERTINI
- LHEP
- FTF_BIC

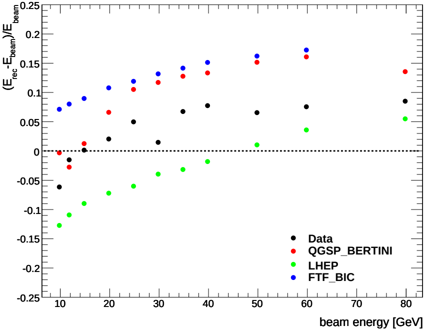
Single weight: $\omega = 0.03$

$E_{rec} = \sum_i E_i \omega$



linearity





QGSP_BERTINI
LHEP
FTF_BIC

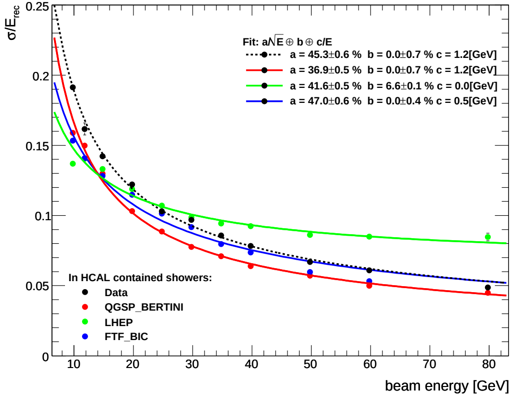
Weights from data

Weighted energy: $E_{\text{weighted}} = \sum_i E_i \omega_i$

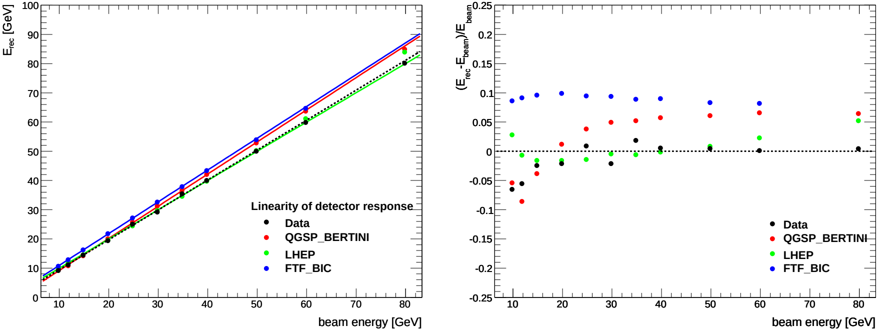
$$\omega_i(x, E) = a(E) \cdot \exp\left(b(E) \cdot x_i\right) + c(E)$$

x_i - middle if energy density bin

input: E of event without weighting



linearity

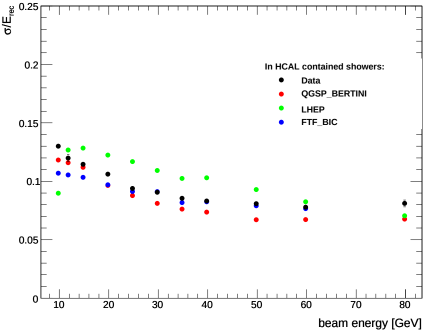


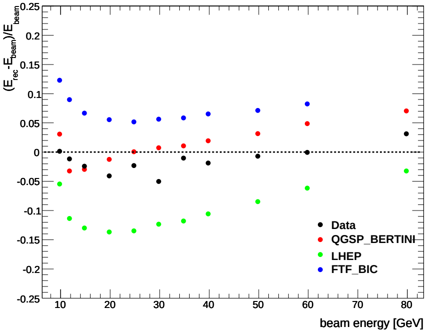
Parameterization $a(E), b(E)$ and $c(E)$ found with data sample.

Weights from data work pretty well for all simulations.

Weights from simulation (QGSP_BERTINI)

Parameterization $a(E), b(E)$ and $c(E)$ found with QGSP_BERTINI simulation sample.





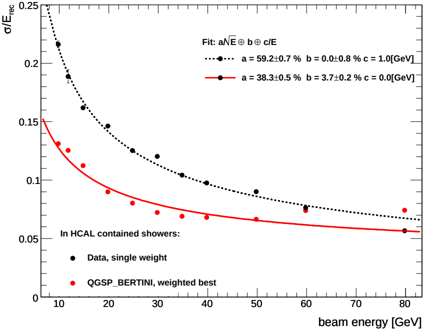
Does not work at all!
Same for weights from LHEP.

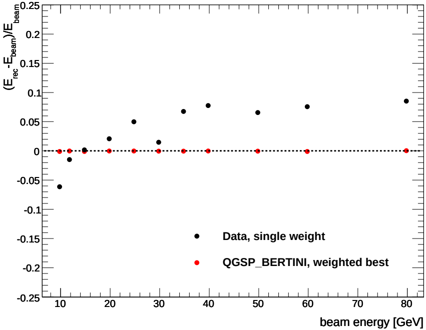
Reason

Difference between E_{rec} and E_{beam} to high.

- All weights free, no parameterization
- Beam energy as input to find individual weights for each energy

$\Rightarrow$ Does not work, too.
$\longrightarrow$ same for LHEP





Clustering

Idea:

- Develop cluster algorithm
- Devide each cluster into electromagnetic and hadronic components
- Apply weighting approch to cluster components

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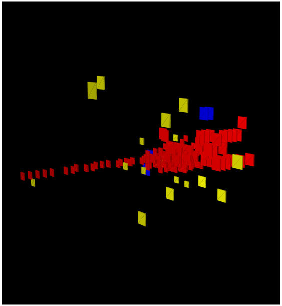
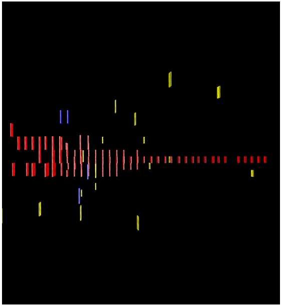
Algorithm:

- project all hits and all energy on the front of calorimeter
- look for local maxima in both sets
- take maxima as seeds for the clustering algorithm
- go through layers and look for neighbours in all layer for seed with fixed i, j value
- iteration to look for neighbours of neighbours

Clustering algorithm

- Hits in cluster
- Isolated hits
- Hits with neighbour





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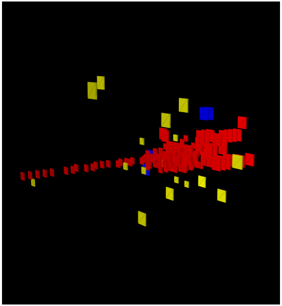
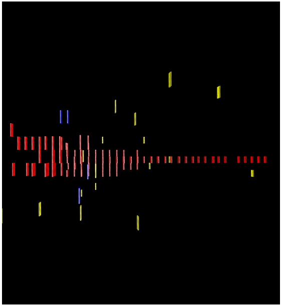




Issue:

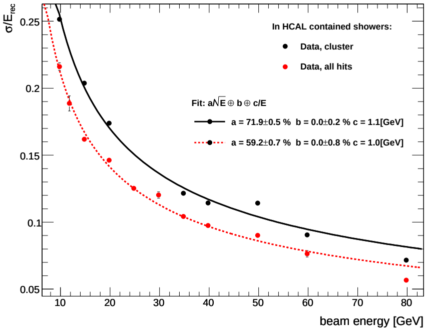
How to handle and/or define noise in the AHCAL?

- in shown analysis: all hits are collected for the energy reconstruction
- every way of noise definition declined the energy resolution
  - treat all isolated cells as noise
  - treat cells as noise for which the energy density (with 3D neighbours) is below 0.8 MIP
  - treat cells as noise which are not containded in a cluster

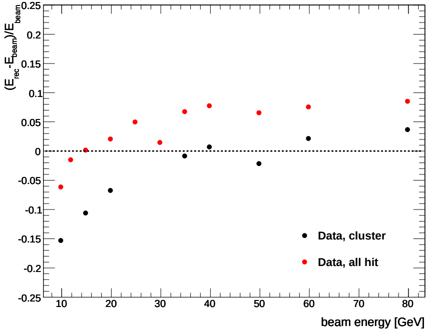
Some results

In AHCAL contained showers.

Energy resolution

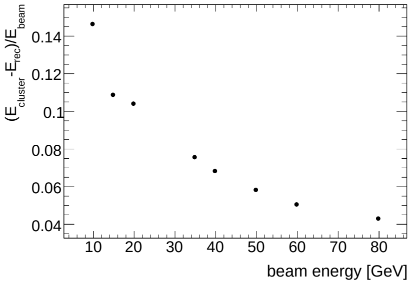


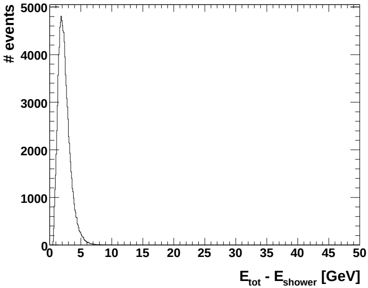
Linearity (same single weight $\omega = 0.03$)

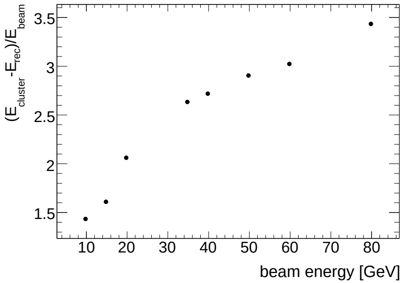


Not counted energy

Difference between cluster energy and reconstructed energy of all hits in calorimeter

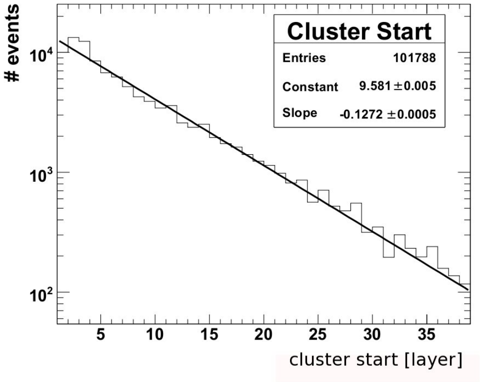






More results:

Position of shower start:
20GeV: $\rightarrow$ 8 layers
No cut on tail catcher



Outlook

- compare data with new updated simulation (temperature effects, steels plate thickness)

- further development of clustering algorithm
- find best variables to distinguish between em. and had. subclusters
- apply weighting procedure on em. and had. subclusters

- try to implement weighting procedure in PandoraPFA

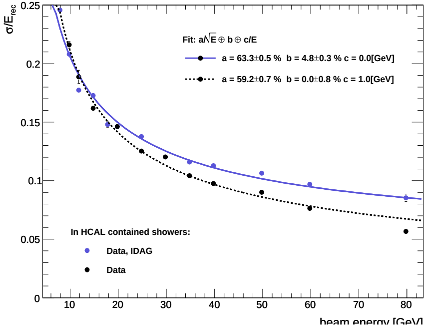
IDAC and old calibration

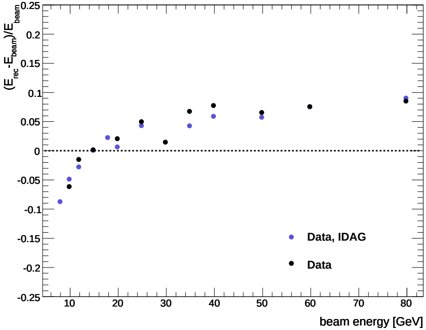
Two types of recontructed data

- Older reconstruction (with temperature correction)
  No bad channel filter
- Official IDAG CERN reconstruction
  New calibration values for MIP and Gain

Results:

- Linearity nearly the same for both sets
- Energy resolution about 3% worse in the IDAG case





Reason

Recontruction of 80GeV Run 331280

1. recontruction with "old" calibration values (temperature corrected)
   energy resolution $\frac{\sigma}{E_{rec}} = 4.902 \pm 0.187$
   reconstructed energy $E_{rec} = 86.99 \pm 0.15$
2. reconstruction with "old" calibration values (temperature corrected) and with BadChannelFilter
   energy resolution $\frac{\sigma}{E_{rec}} = 5.265 \pm 0.211$
   reconstructed energy $E_{rec} = 86.02 \pm 0.16$
3. reconstruction with "IDAG" calibration values (temperature corrected) and with BadChannelFilter
   energy resolution $\frac{\sigma}{E_{rec}} = 7.696 \pm 0.351$
   reconstructed energy $E_{rec} = 87.5 \pm 0.3$