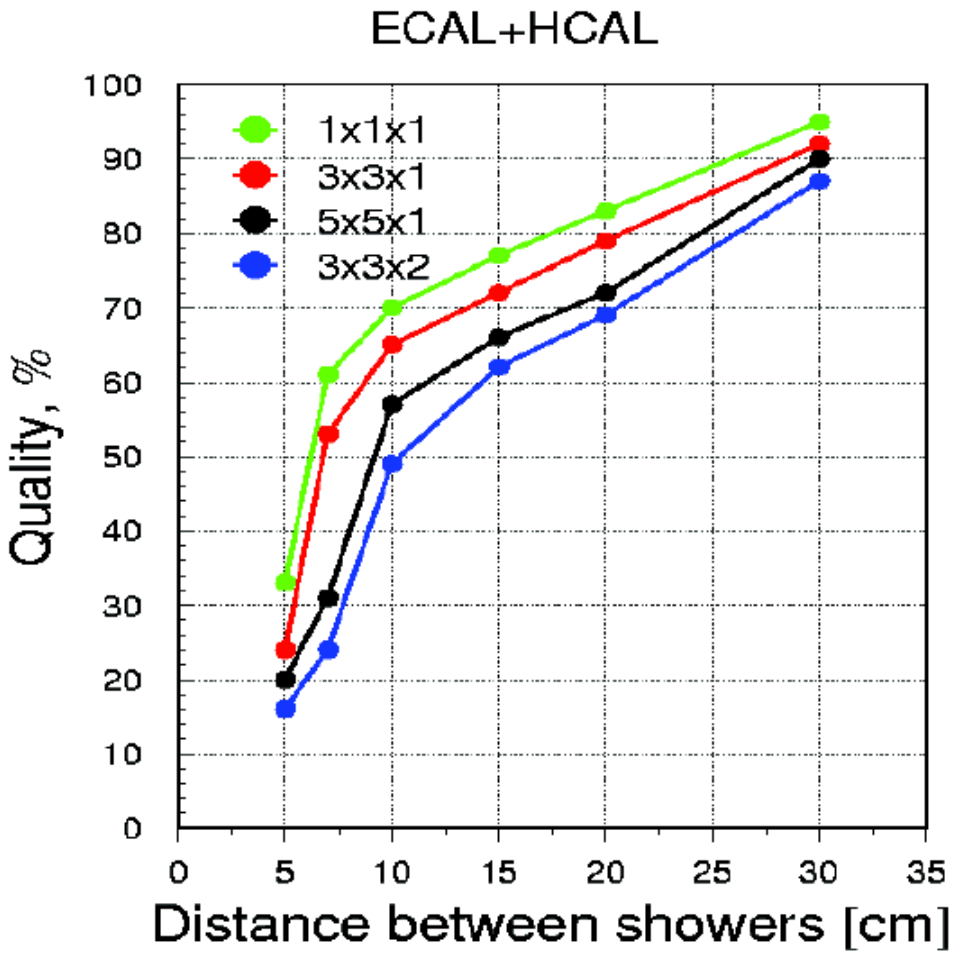
Particle Separation

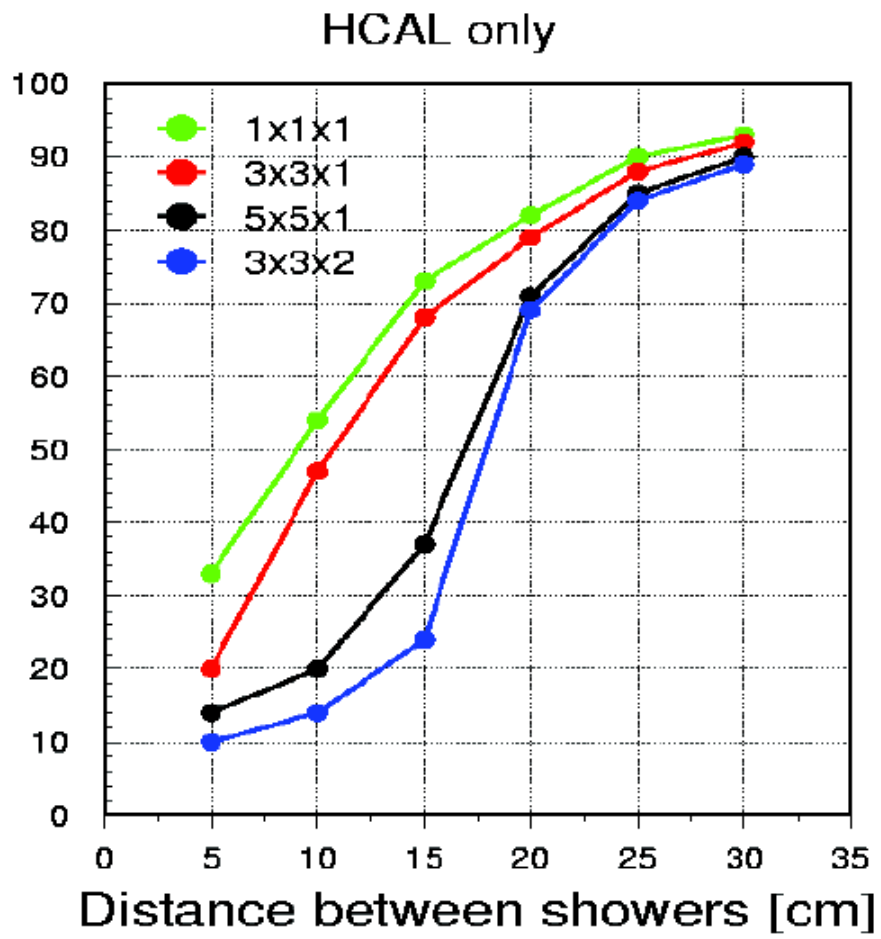
Jörgen Samson

HCAL main meeting

19th December 2007

Motivation

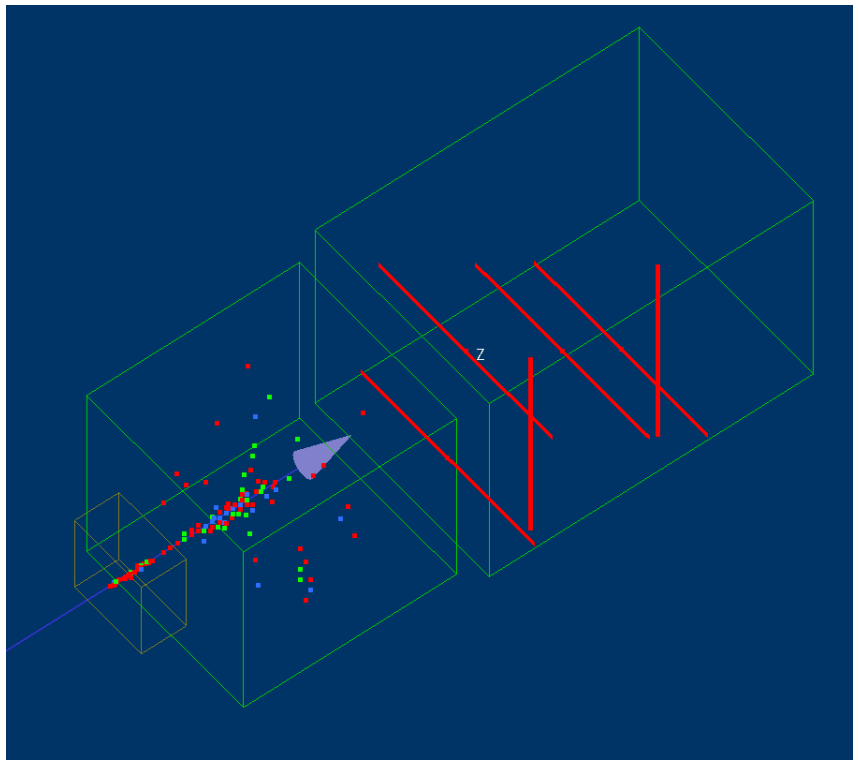




Alexei Raspereza, 2004

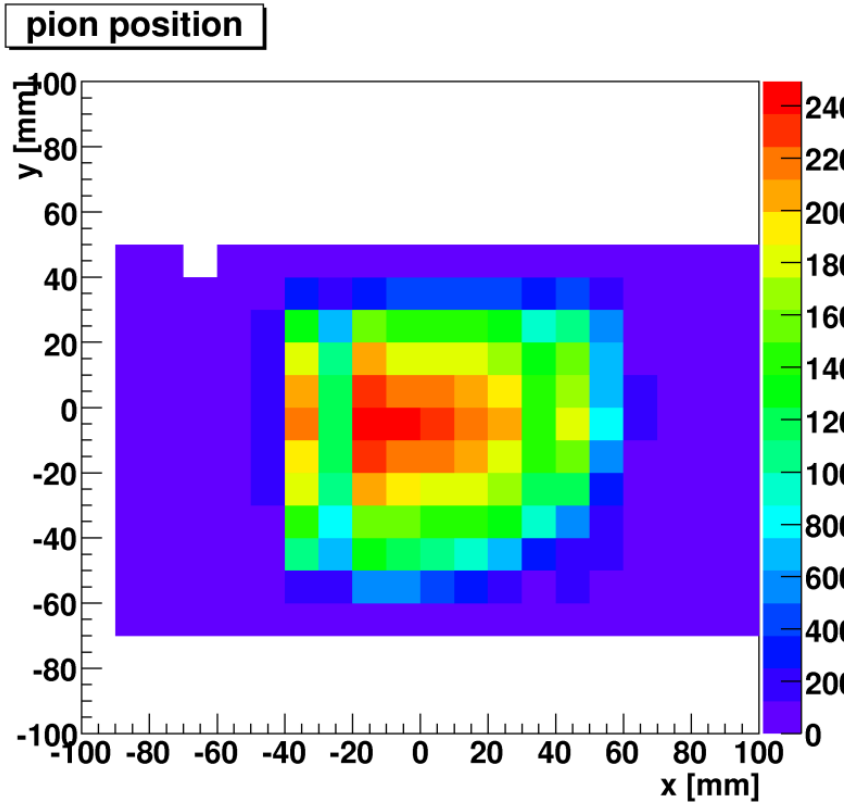
EventSelection

- October 2006
- π^-. In this talk 8 GeV and 12 GeV.
- hadronic shower contained in HCAL
  - MIP like track in ECAL
  - low number of low energetic hits in TCMT (compatible with noise)
- *track* in ECAL used for position information



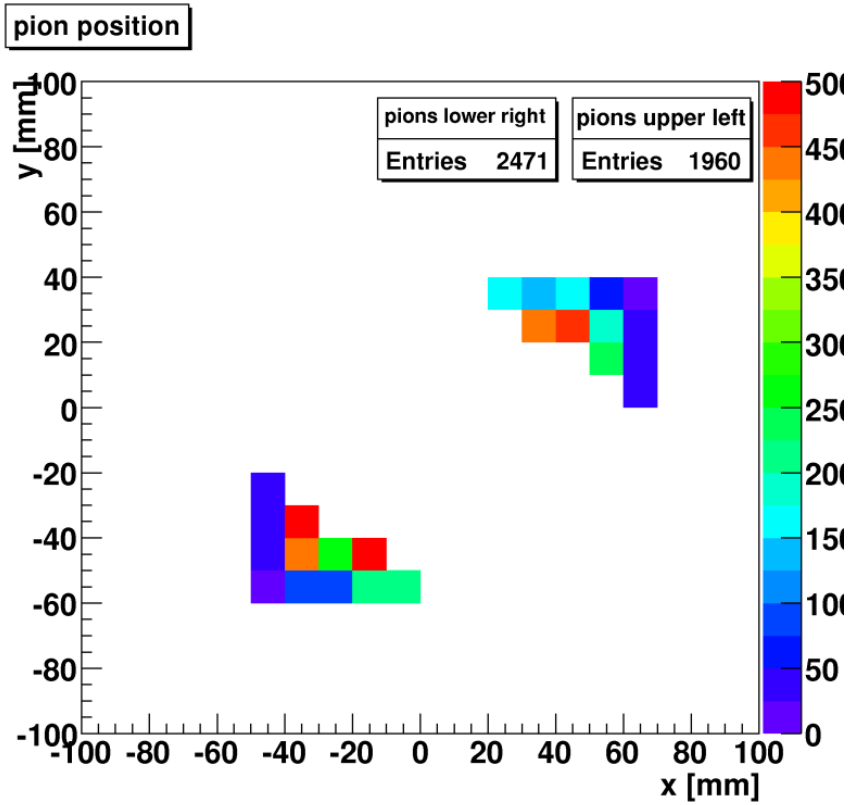
Impact Position

- 10cm x 10cm conincidence trigger
- decreasing number of events at edges
- max distance at opposite corners
  - cannot shift events $\leftrightarrow$ diff. tile sizes
- can get some statistics of overlayed events with 10cm *track* distance



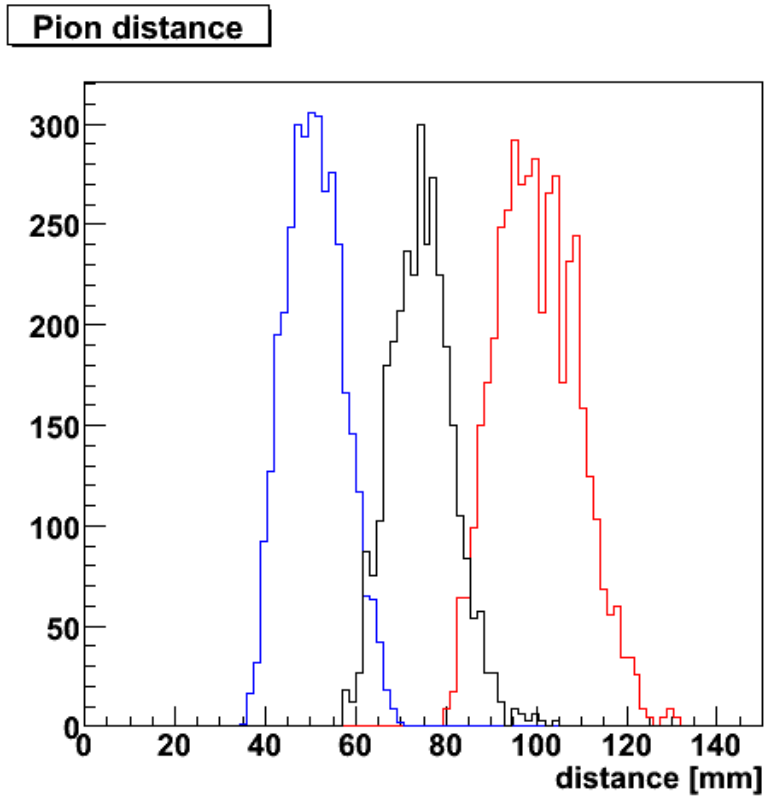
Impact Position

- 10cm x 10cm conincidence trigger
- decreasing number of events at edges
- max distance at opposite corners
  - cannot shift events $\leftrightarrow$ diff. tile sizes
- can get some statistics of overlayed events with 10cm *track* distance
- select events in opposite corners
- $\approx$ 1000 pairs per run



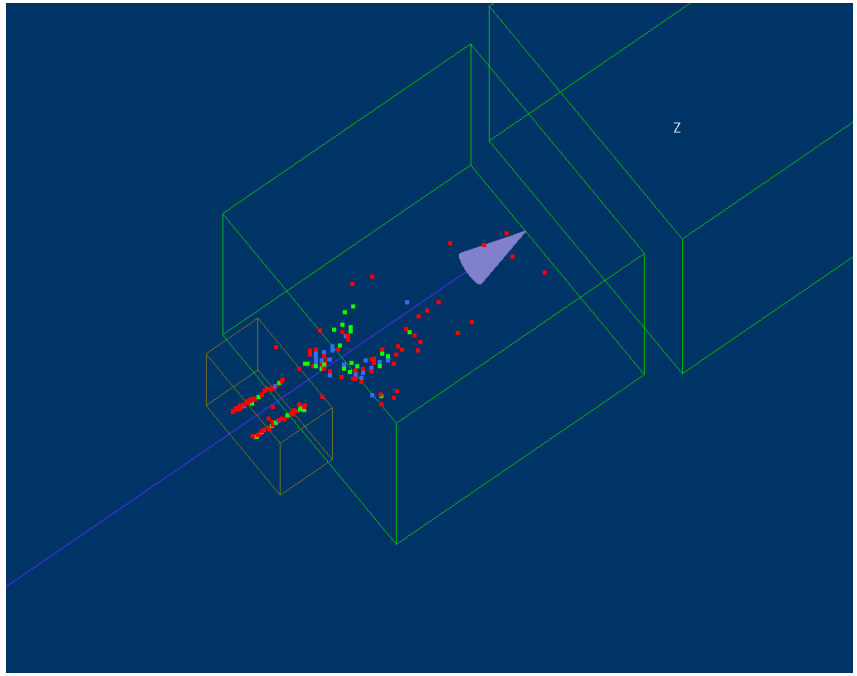
Event Pairing

- mip stub position determined by ECAL only
- position only known worse than $1 \times 1\, cm^2$
- subsamples of events pairs with mean particle distance of 10 cm , 7.5 cm and 5 cm



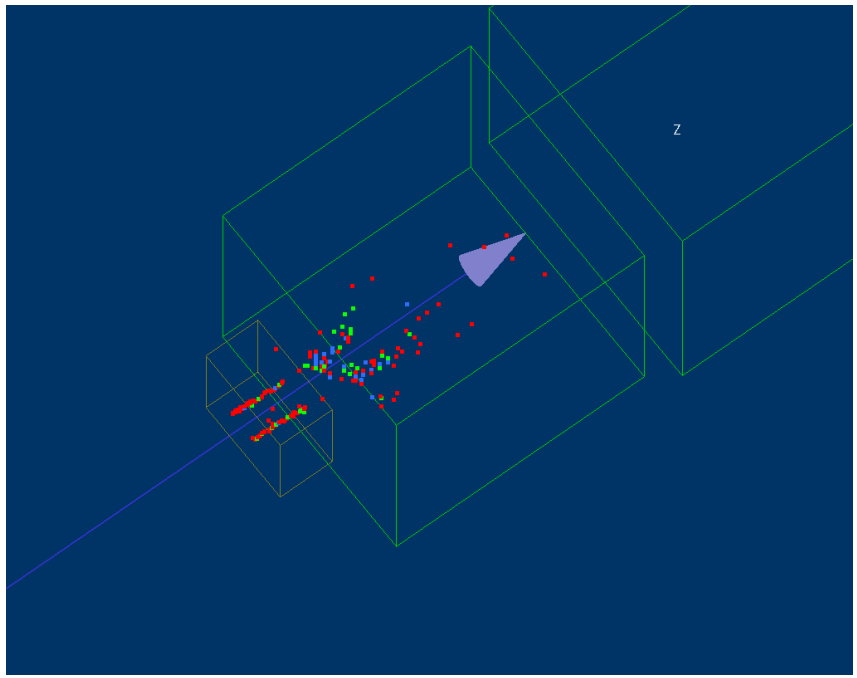
Event Overlay

- energy summation:
  - sum of cell energy (currently) after zero suppression
    - doubles number of noise hits
  - sum of cell energy after saturation correction
    - saturation correction applied for each (original) event separately
    - corrected amplitudes are added and cut off is applied ⇒ "emulate" saturation



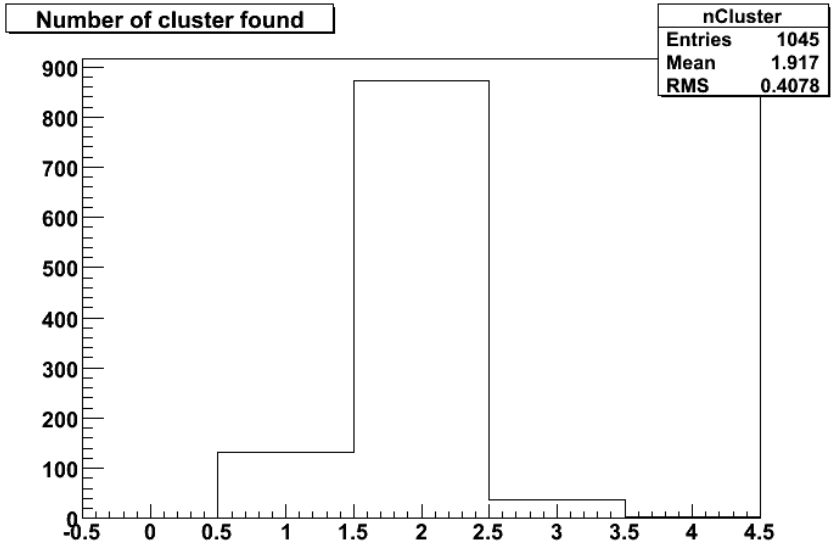
Event Overlay

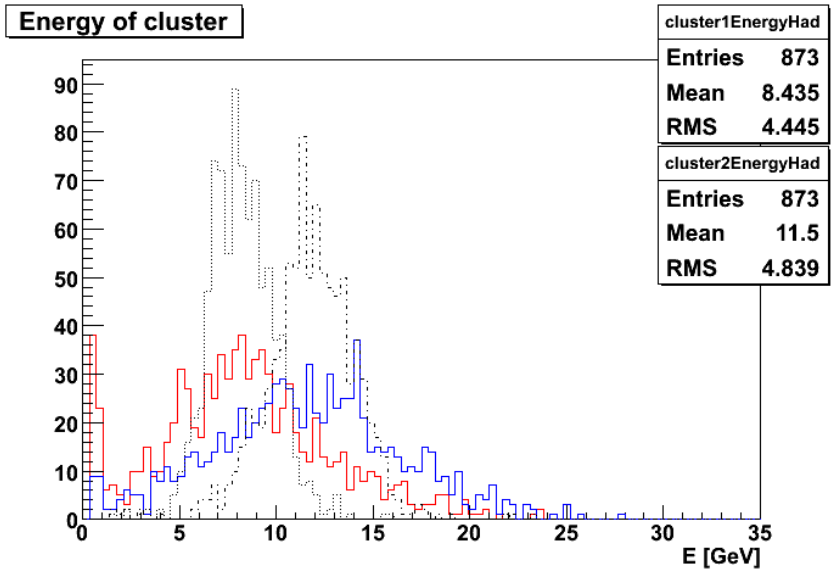
- low energetic hits
  - number of noise hits affected ($\times 2$ vs. integral of tails of broadened noise)
  - signal definition stays the same
- high energetic hits
  - saturation
  - virtual dynamic range of cell increased
- clustering algorithm
  - Trackwise Clustering
  - weakly depends on hit energy
  - signal definition $\leftrightarrow$ pattern recognition?



Application of Clustering

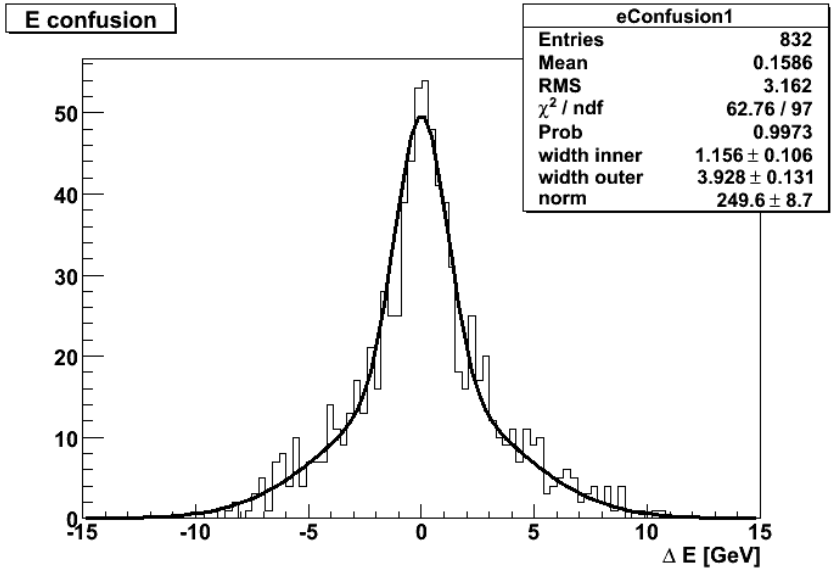
- apply clustering algorithm on two particle event
- you get:
  - a number of clusters found
  - the energy of each cluster





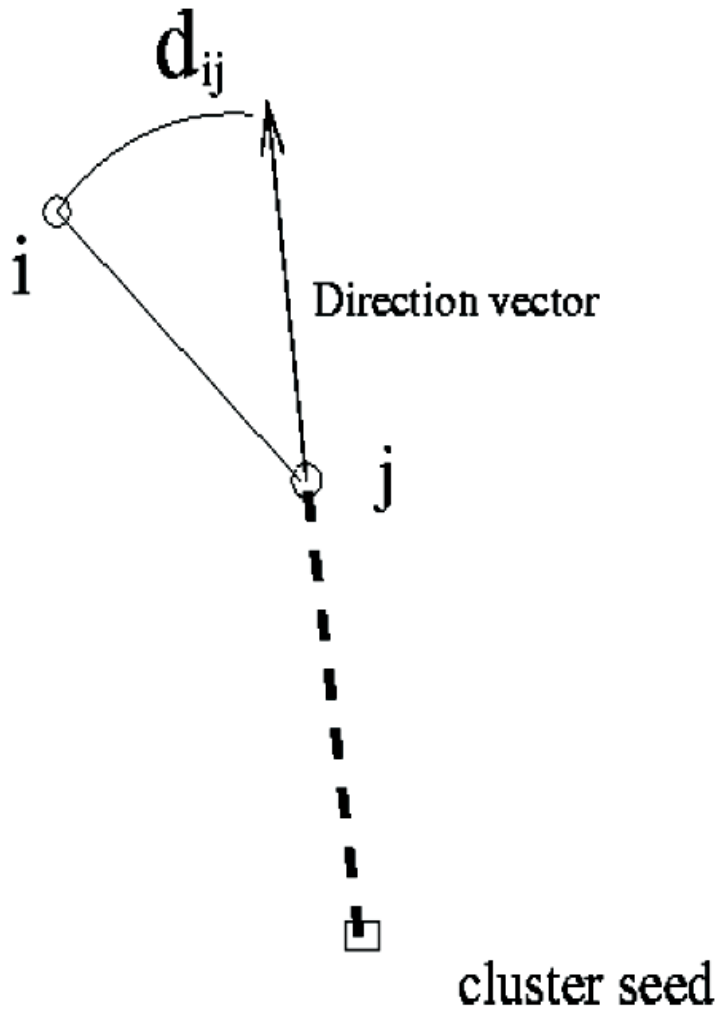
Application of Clustering

- apply clustering algorithm on two particle event
- you get:
  - a number of clusters found
  - the energy of each cluster
- we know more
  - detector response to single particle
  - energy wrongly associated



Clustering Algorithm (2)

- Step "i" of clustering: handling hit "i" :
  - For each hit "j" already assigned to one of the clusters, j < i, and distance between two hits R_{ij} < **RCut** compute the length of arc (d_{ij}) defined by vector connecting "j" and "i" and by directional vector of "j" . Define merging parameter as weighted sum $s_{ij} = (1-w)R_{ij}+wd_{ij}$
  - Find minimal s_{ij}
  - If min(s_{ij}) < **sCut** then assign hit "i" to the cluster to which hit "j" belongs
  - Assign direction vector for hit "i" along line connecting cluster seed with hit "i"

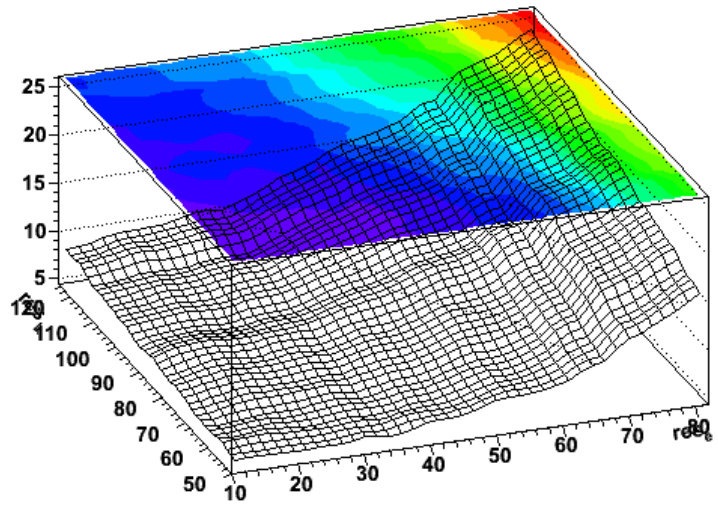


Alexei Raspereza, October 13 2005

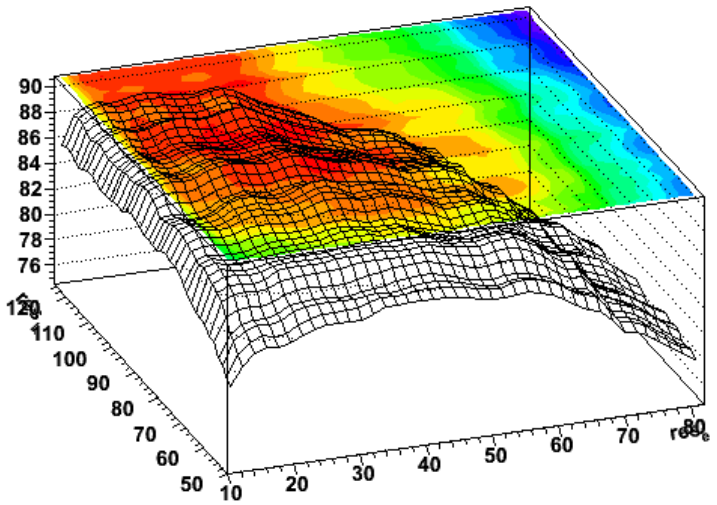
5

Parameter Scan

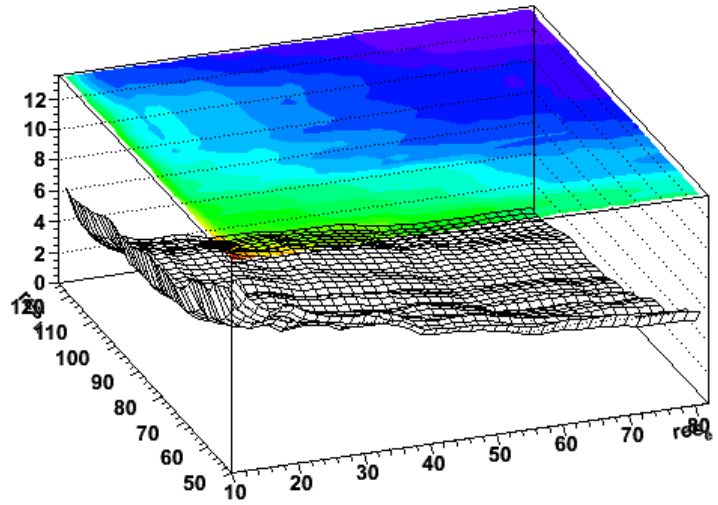
Eff. 1 cluster



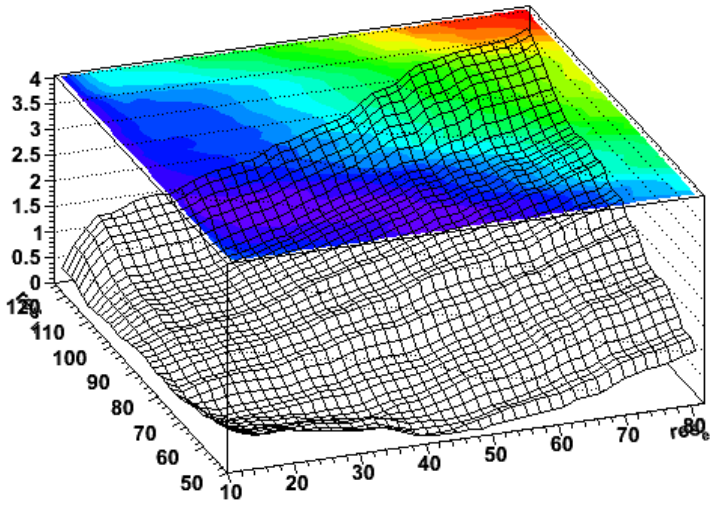
Eff. 2 cluster



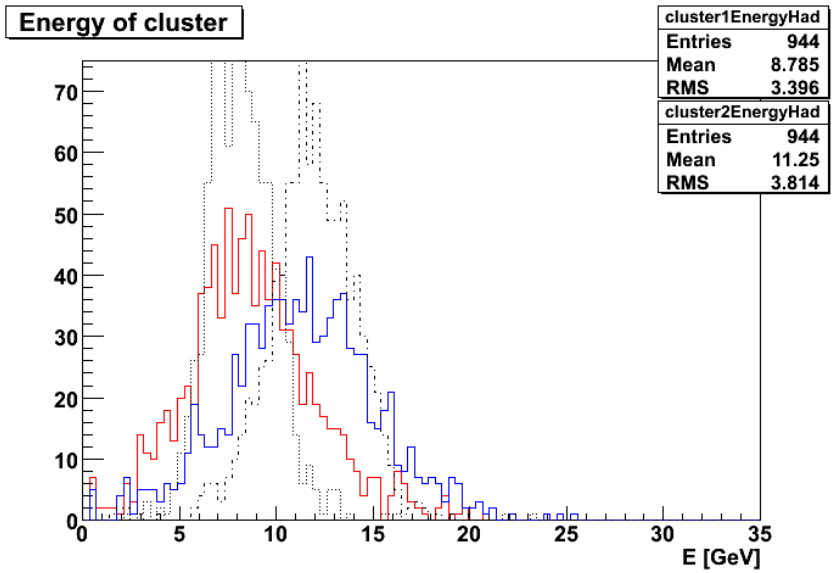
Eff. 3 cluster



Eff 1 clu / Eff clu

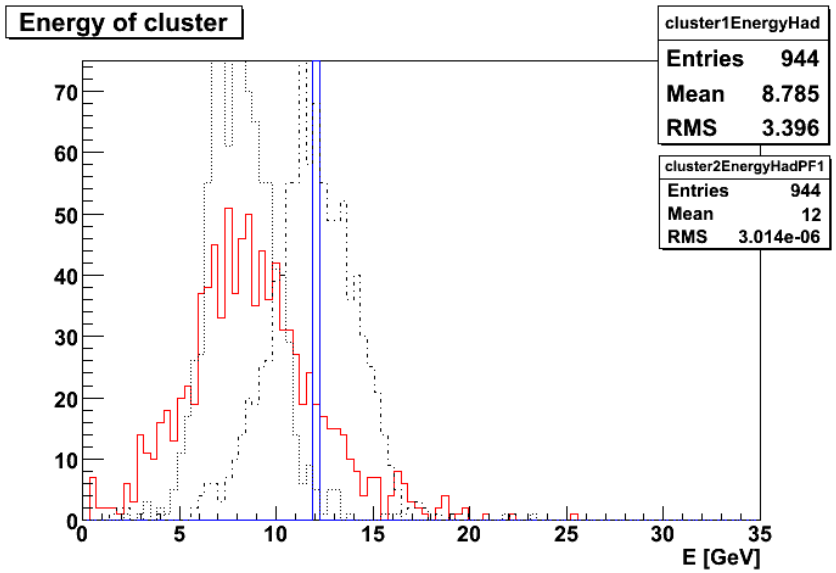


Naïve Particle Flow



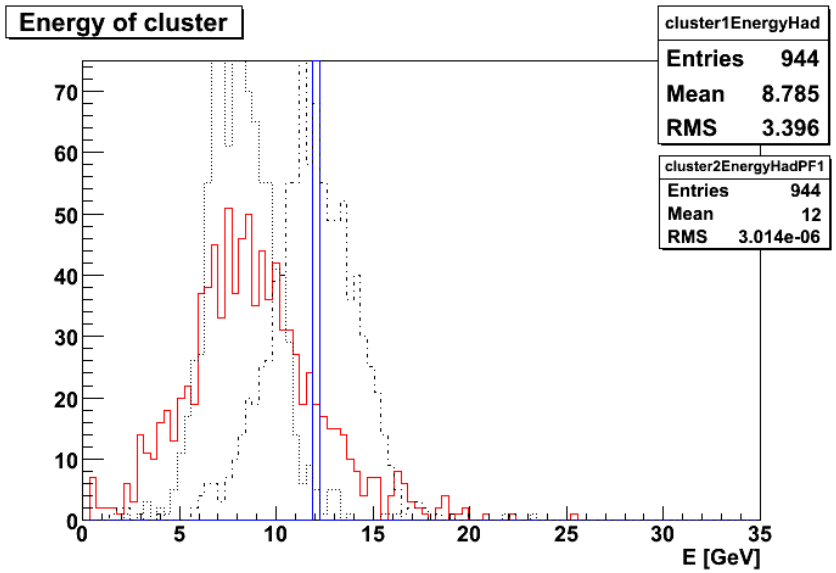
- start with reconstructed clusters

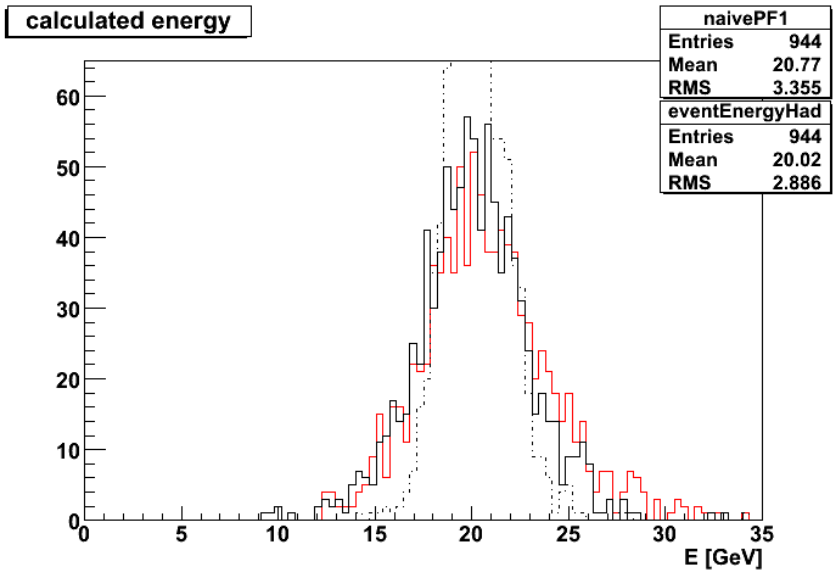
Naïve Particle Flow



- start with reconstructed clusters
- assume one cluster has an associated track/momentum measurement

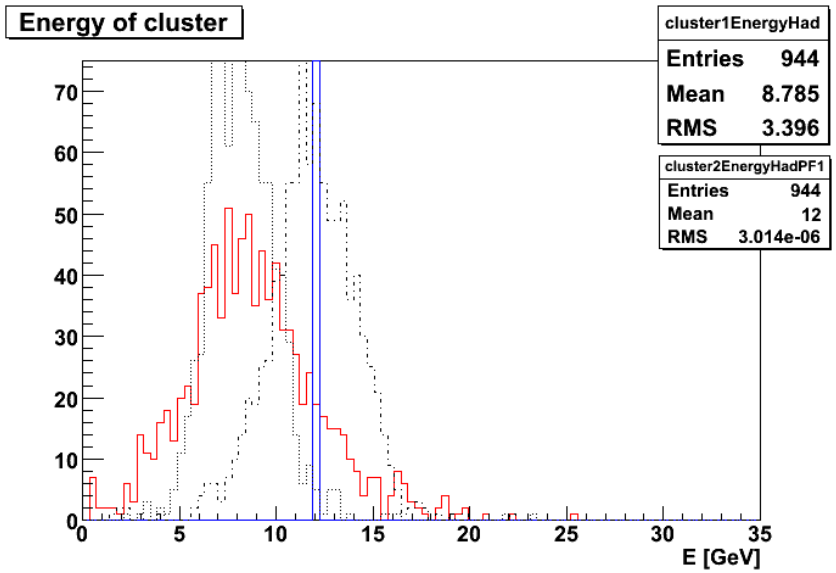
Naïve Particle Flow

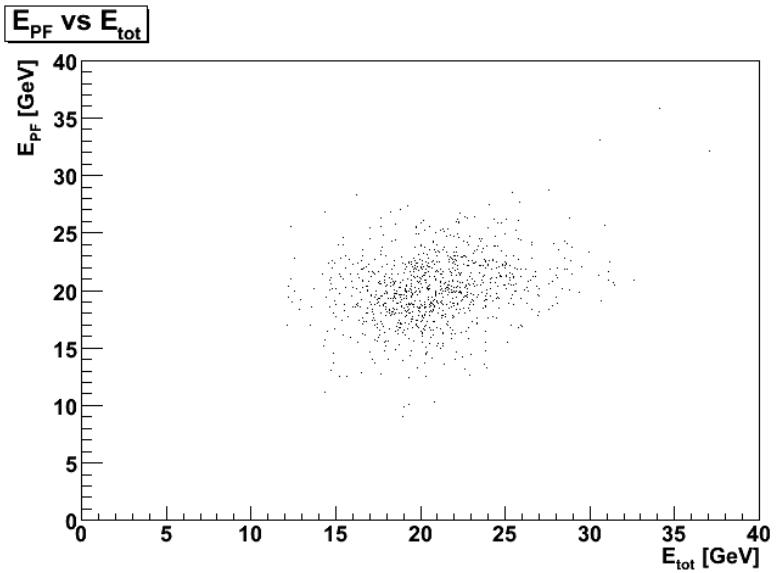




- start with reconstructed clusters
- assume one cluster has an associated track/momentum measurement
- discard this cluster and add (known) energy of second cluster to first
- compare with total energy

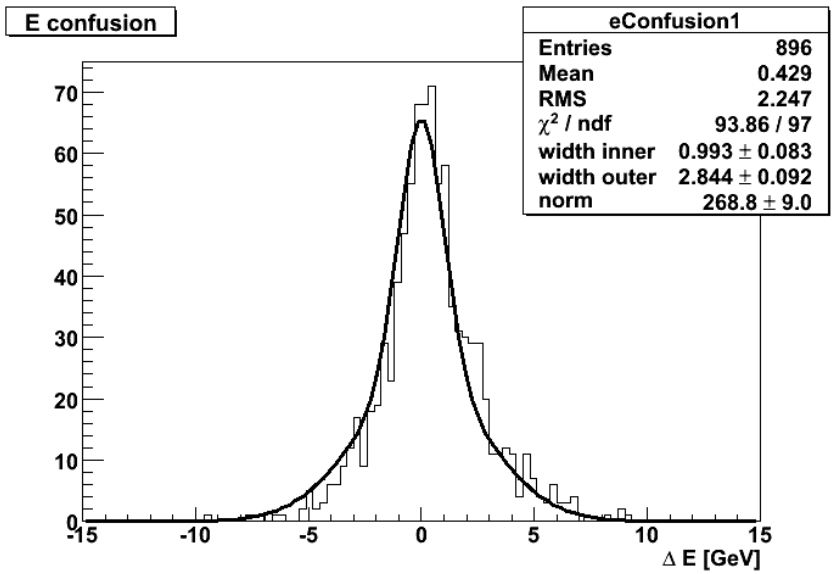
Naïve Particle Flow

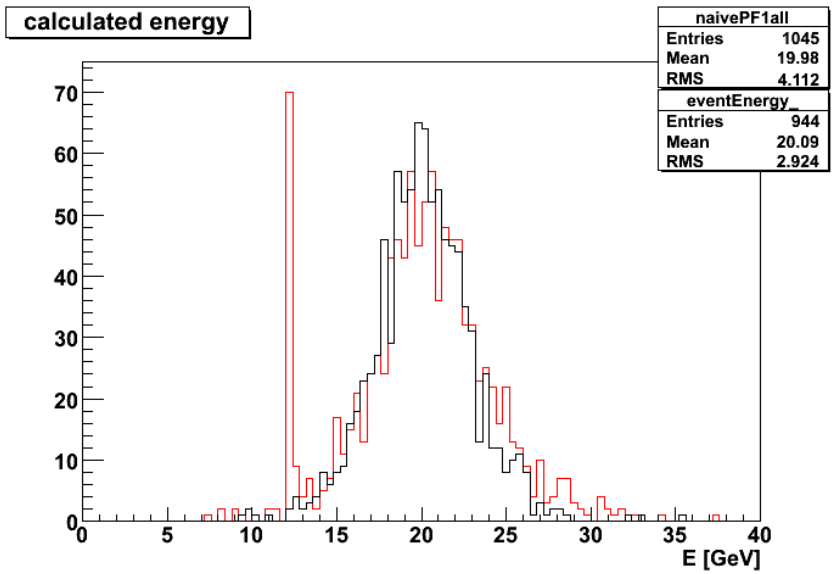




- start with reconstructed clusters
- assume one cluster has an associated track/momentum measurement
- discard this cluster and add (known) energy of second cluster to first
- compare with total energy
- really different to just summing up the energy

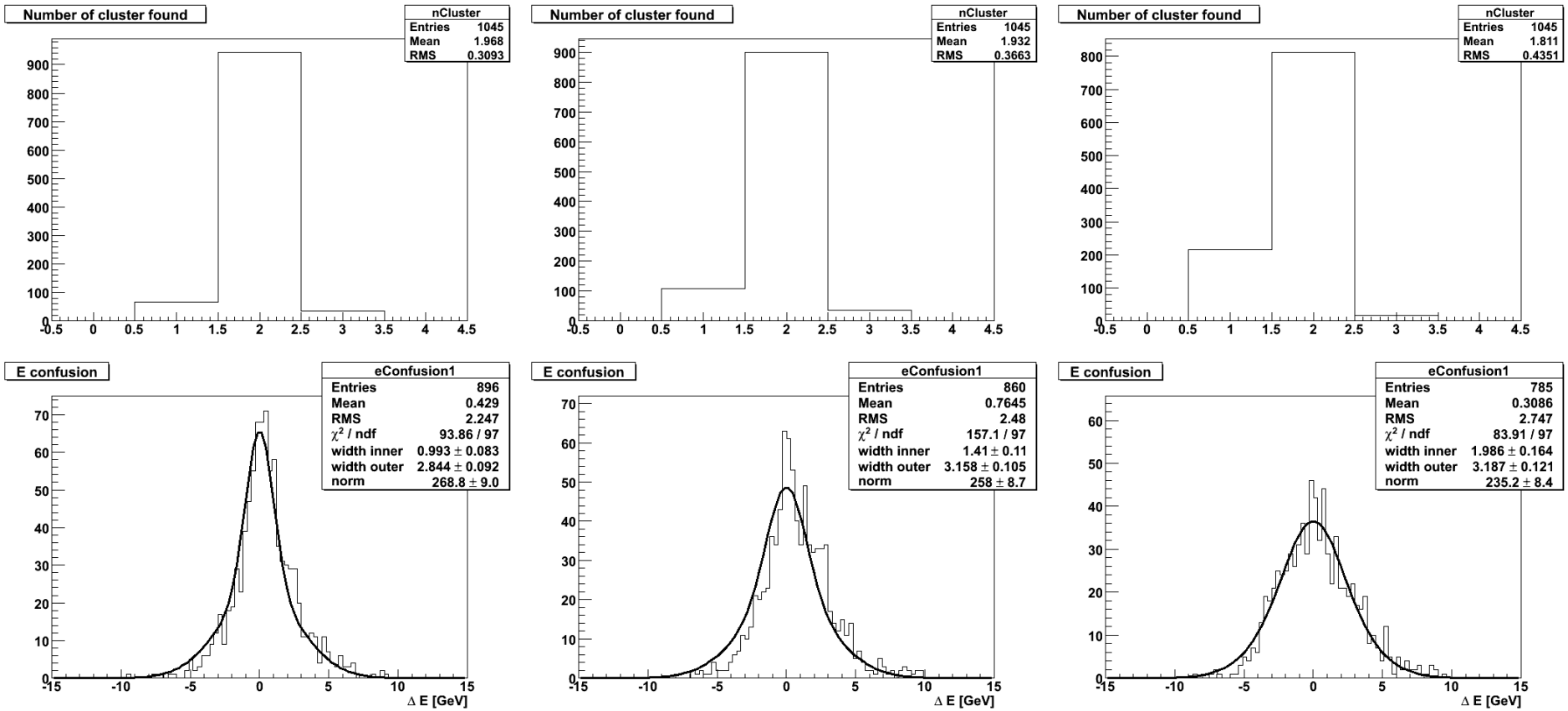
Figure of Merit





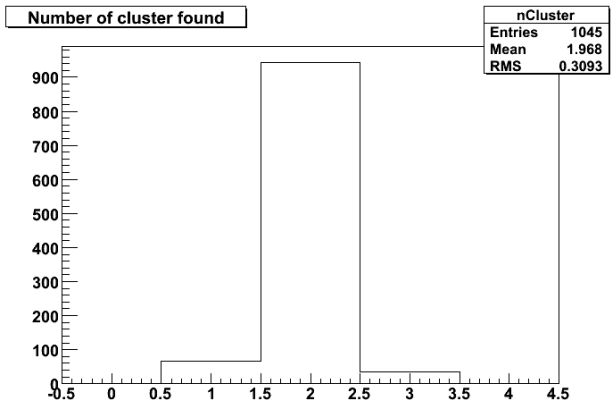
- How well is this example (in numbers)?
- only one distribution to judge
- but: double Gauss plus singular peak for "one cluster found" plus bump for "more clusters found"

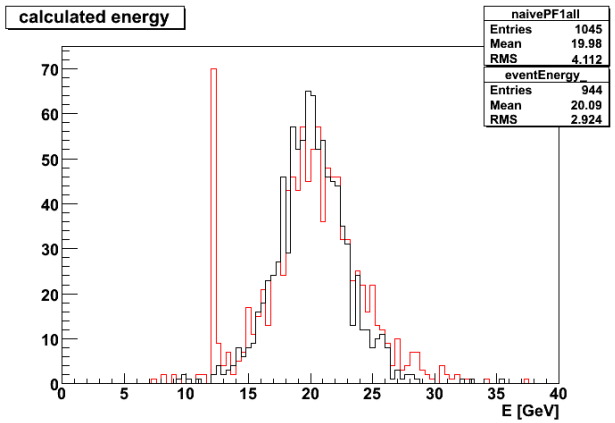
Different Distances



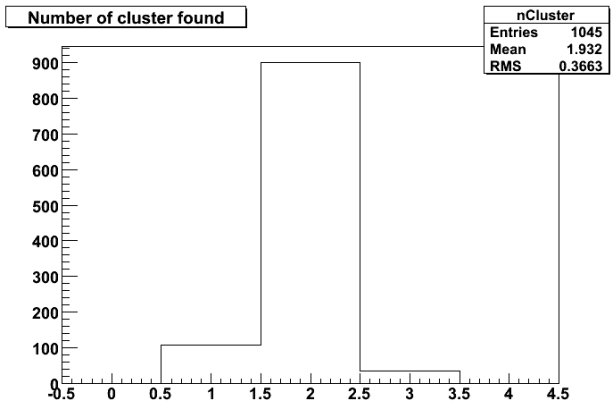
10 cm 7.5 cm 5 cm

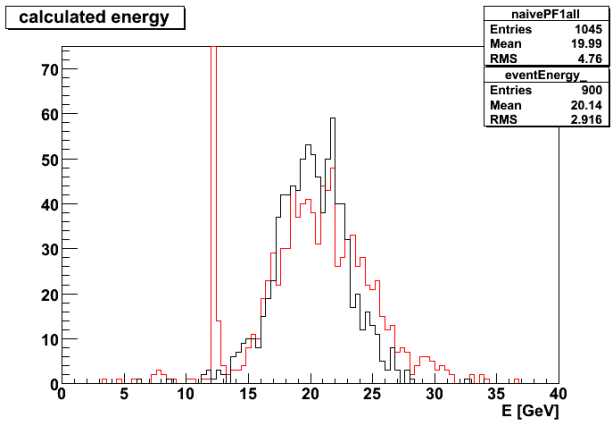
Different Distances



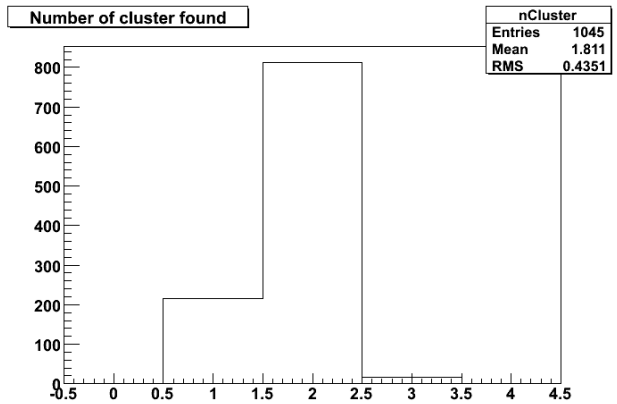


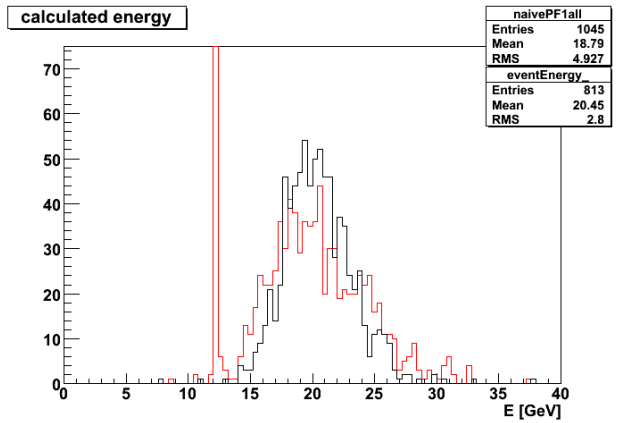
10 cm





7.5 cm





5 cm

The Usual Warnings

- simple overlay method; clustering algorithm only depends weakly on hit energy
- 10 cm distance is the point where confusion eats up the advantage of par ticle flow for this example

- fact that both particles have mip like stub helps the clustering algorithm (i.e. pattern recognition)
- selection of pions (shower contained in HCAL) might bias the result
- choice of clustering algorithm
- real particle flow much more complex; no direct prediction of particle flow performance

Conclusions & Outlook

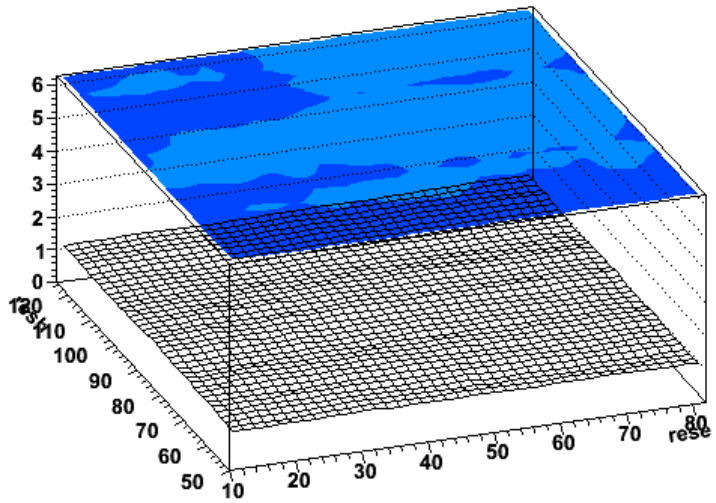
- at 10 cm: confusion eats up advantage of particle flow
- worsening of shower separation with decreasing distance can be seen

- agree on a figure of merit to compare similar studies (different clustering algorithms)
- more energies
- comparison with MC
- removal of MIP stub for to simulate neutral hadrons
- probably much more

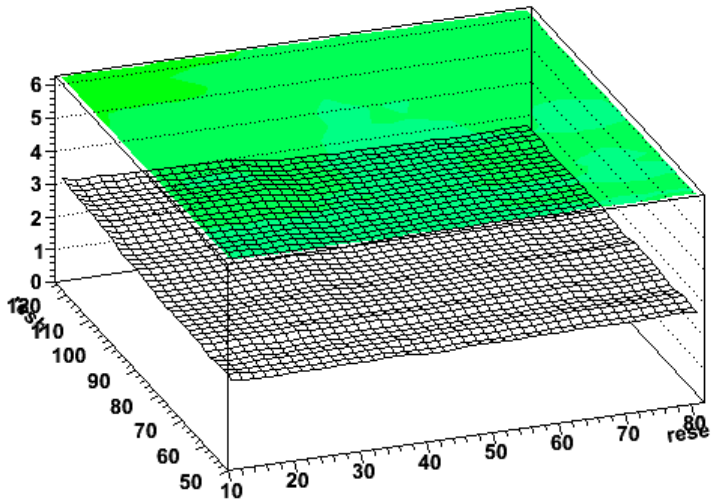
BACKUP

BACKUP:

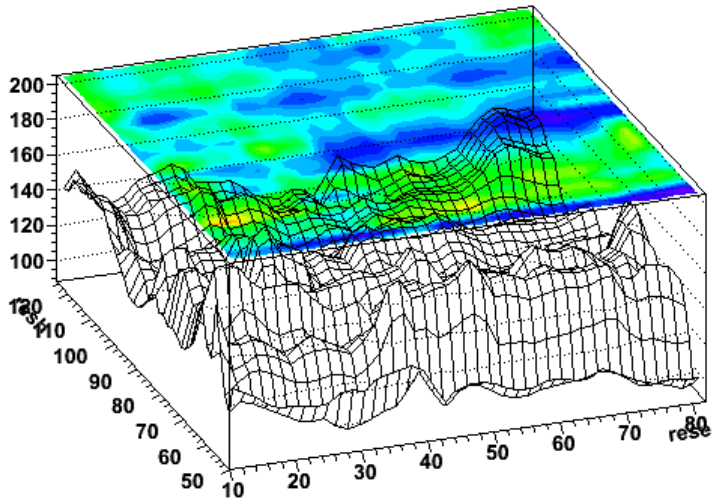
Inner width



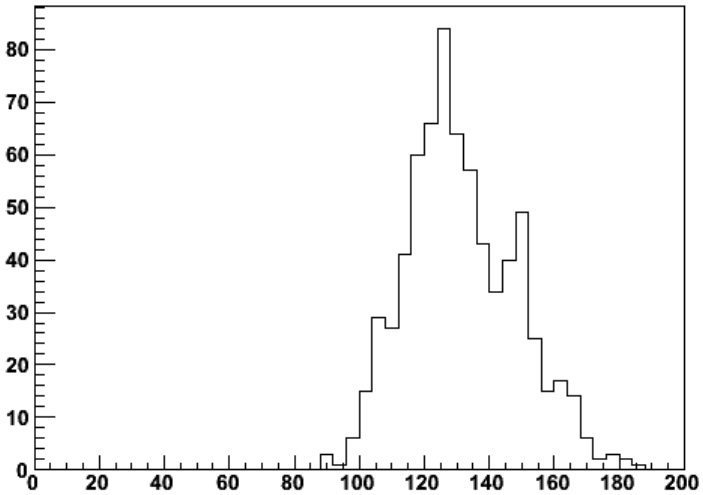
Outer width



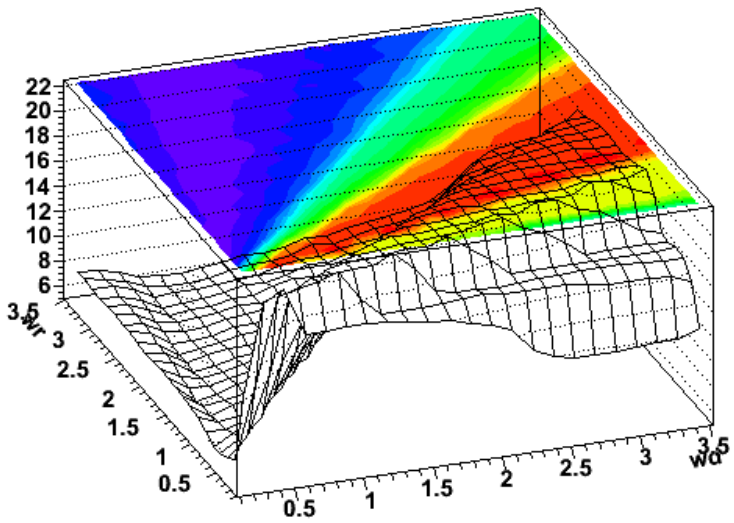
X^2



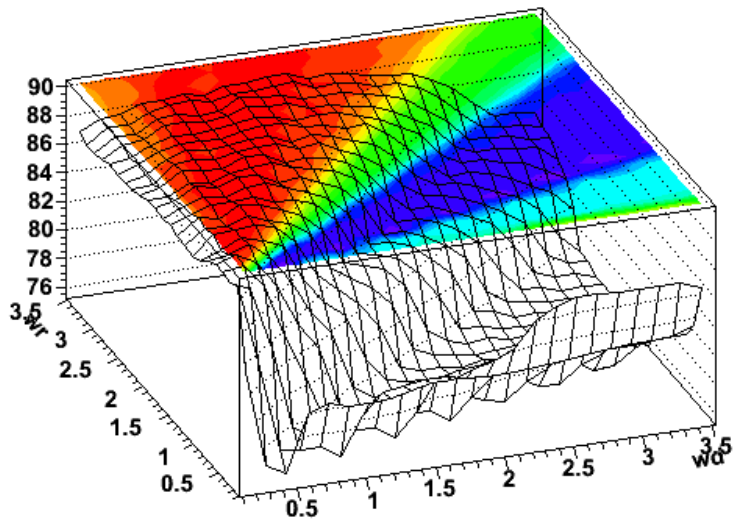
X^2



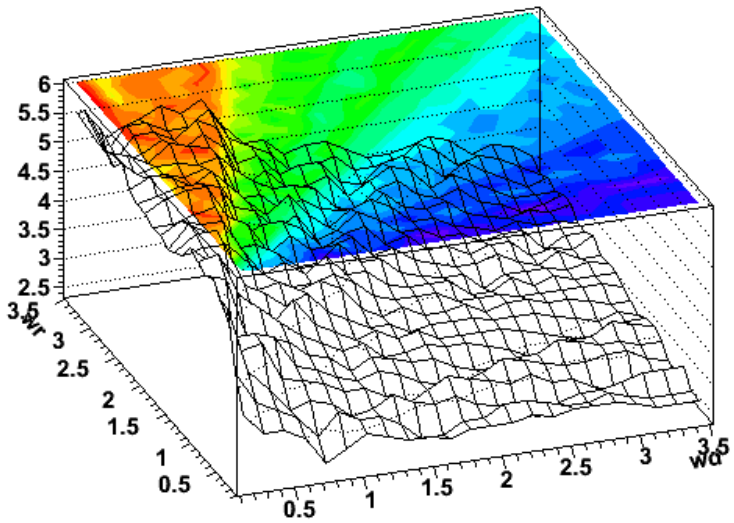
Eff. 1 Cluster



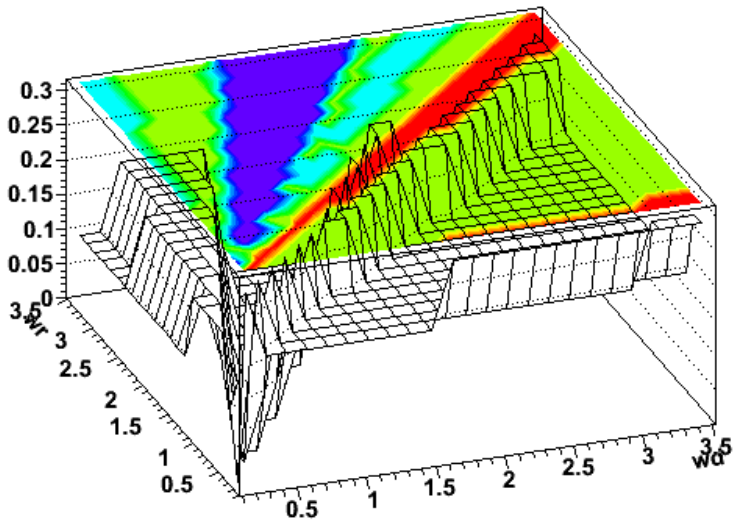
Eff. 2 Cluster



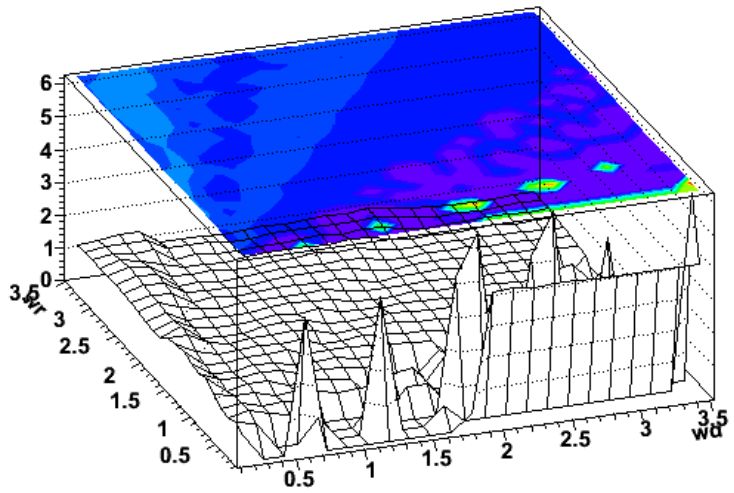
Eff. 3 Cluster



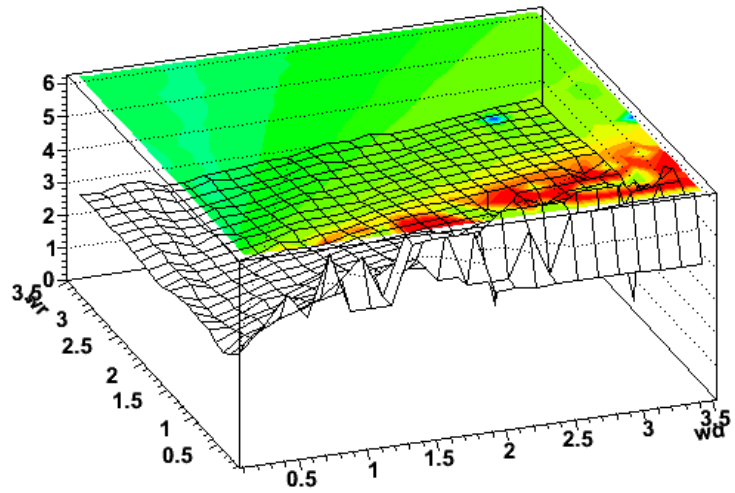
Eff. 4+ Cluster



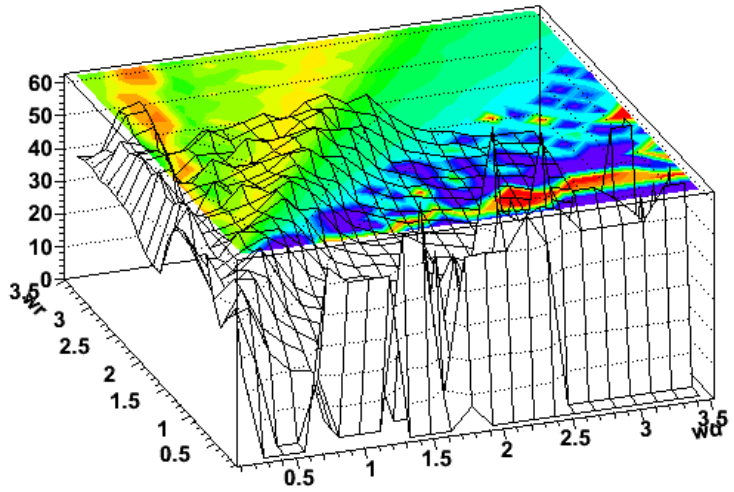
Inner width



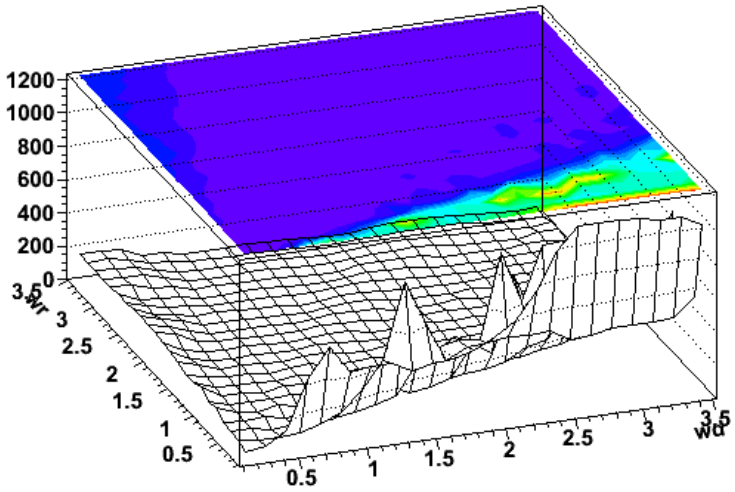
Outer width

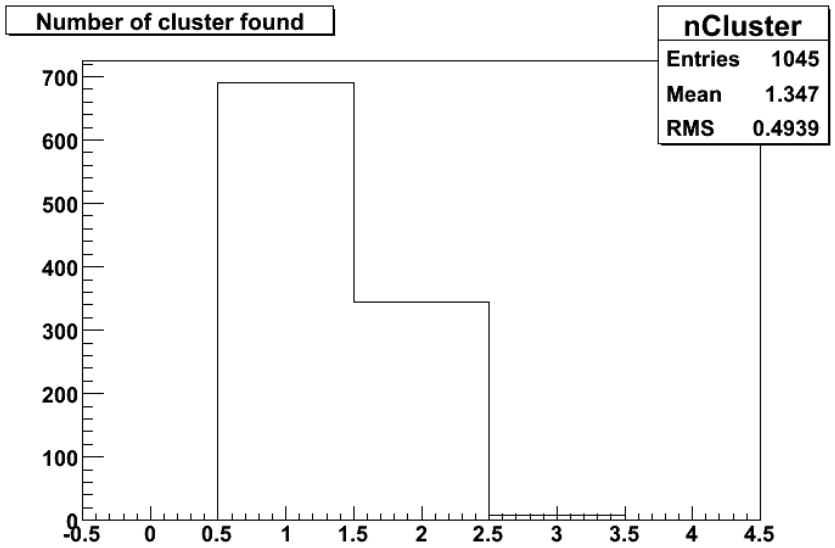


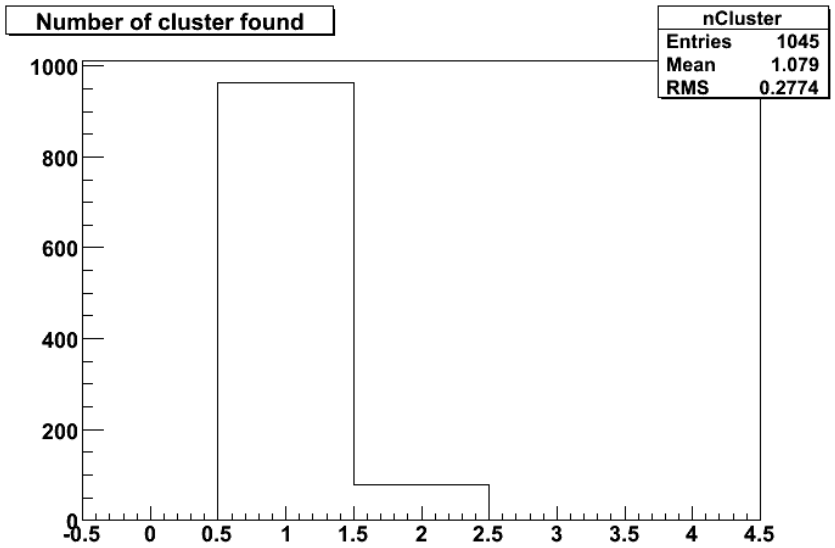
Area inner

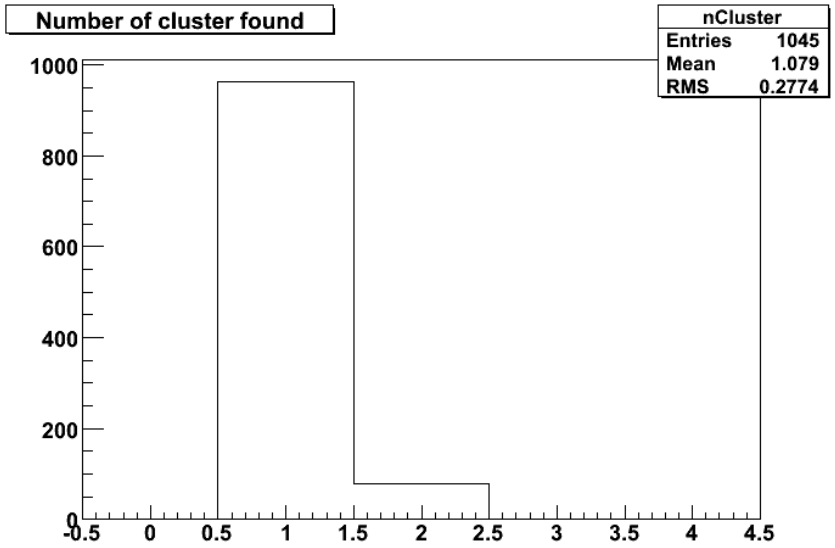


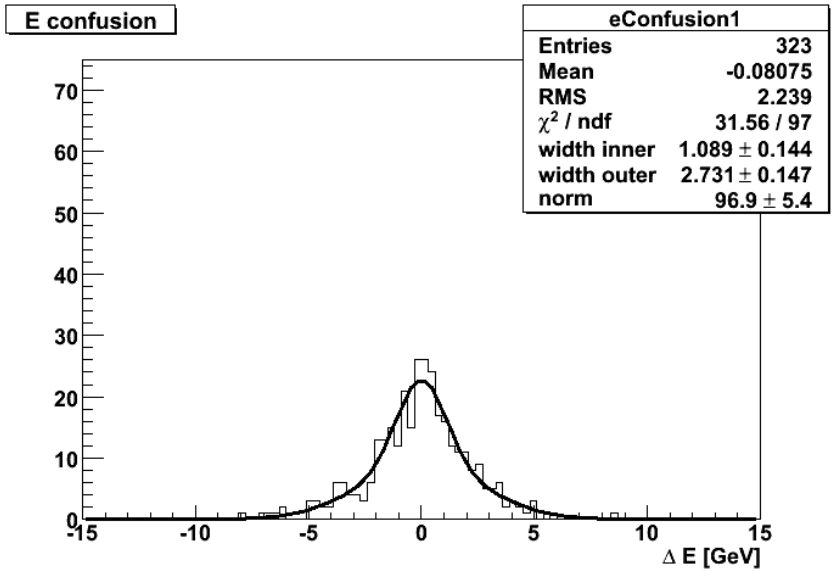
X^2

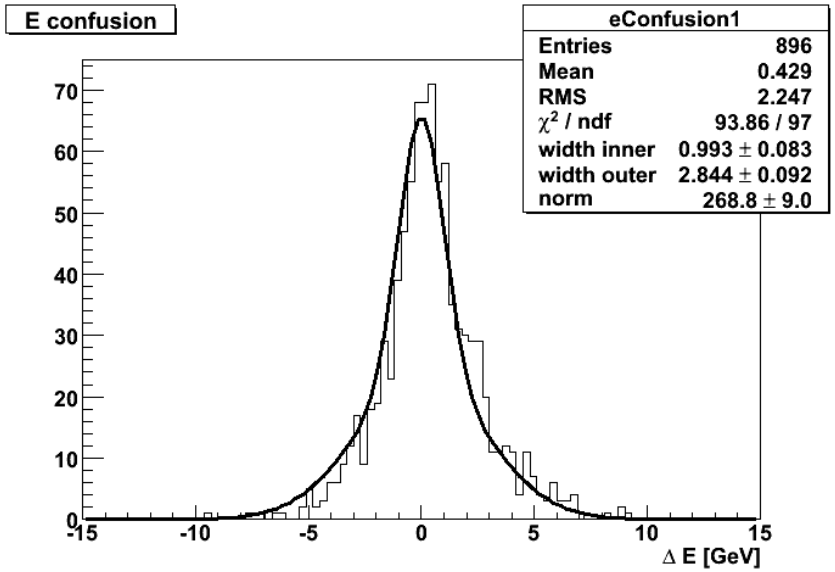



Number of cluster found
nCluster
Entries 1045
Mean 1.347
RMS 0.4939
700
600
500
400
300
200
100
0
-0.5 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5


Number of cluster found
nCluster
Entries 1045
Mean 1.079
RMS 0.2774
1000
800
600
400
200
0
-0.5 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5


Number of cluster found
nCluster
Entries 1045
Mean 1.079
RMS 0.2774
1000
800
600
400
200
0
-0.5 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5


E confusion
eConfusion1
Entries 323
Mean -0.08075
RMS 2.239
χ² / ndf 31.56 / 97
width inner 1.089 ± 0.144
width outer 2.731 ± 0.147
norm 96.9 ± 5.4
Δ E [GeV]


E confusion
eConfusion1
Entries 896
Mean 0.429
RMS 2.247
χ² / ndf 93.86 / 97
width inner 0.993 ± 0.083
width outer 2.844 ± 0.092
norm 268.8 ± 9.0
Δ E [GeV]