Trackwise Clustering

- Photon finding / ID is the crucial step of Pflow
- Make use of spatial continuity and high density of EM showers to find and ID Photons
- Trackwise Clustering seems to be a promising choice

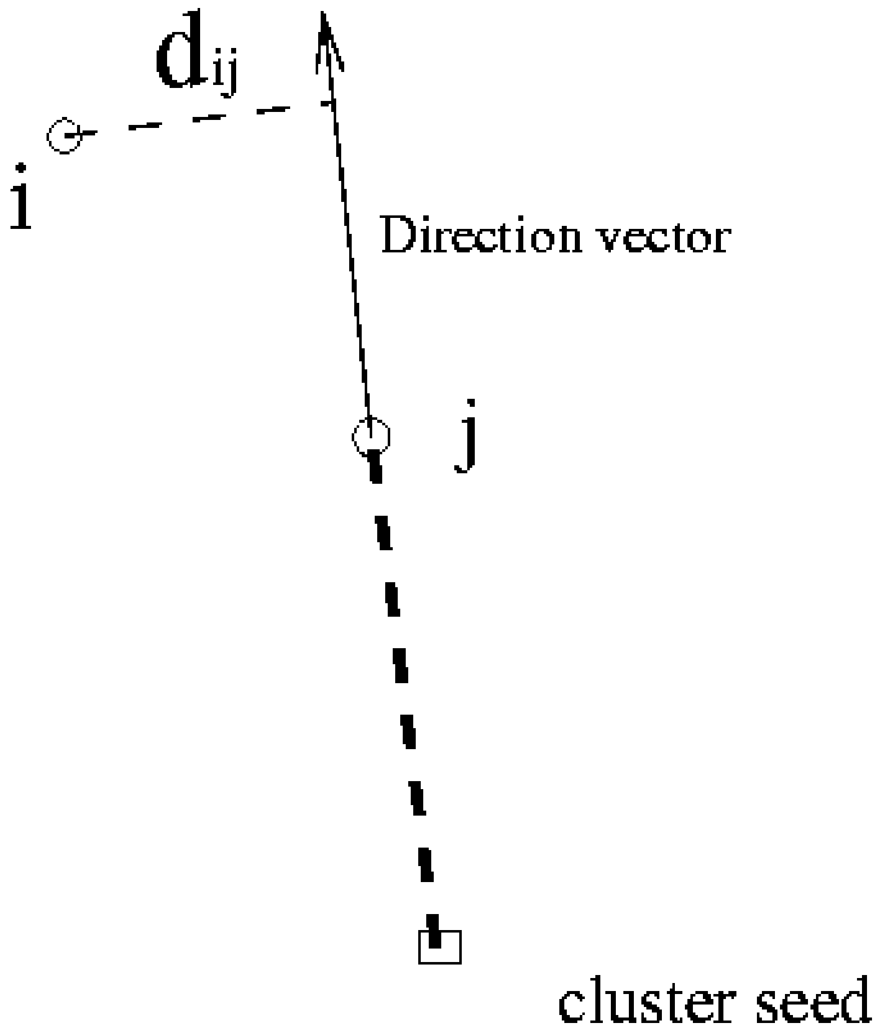
Clustering Algorithm

- Use information from tracking system: intersection point of each TPC-track with calorimeter-front face seeds a “charged” cluster
- Sort all calorimeter hits in ascending order of their distance to IP
- Start clustering from the first hit in this sorted array and proceed with increasing index
- At each step of clustering the hit is assigned a direction vector (explanation follows)

Clustering Algorithm (cont.)

- Step "i" of clustering: handling of hit "i":
  - If hit "i" is in proximity to any track intersection point with calorimeter then the hit is assigned to that "charged" cluster. Proxymity criterion: distance between position and track intersection point < 1.5cm. Assign direction vector for "i" parallel track momentum vector at calorimeter ront face.
  - Fot each hit "j" (j < i, allready assigned to a cluster), with $R_{ij} < R_{thres}$ compute the distance of hit "i" to the direction vector of "j"
  - R_{thres} = 2.5cm for ECAL / R_{thres} = 10cm for HCAL

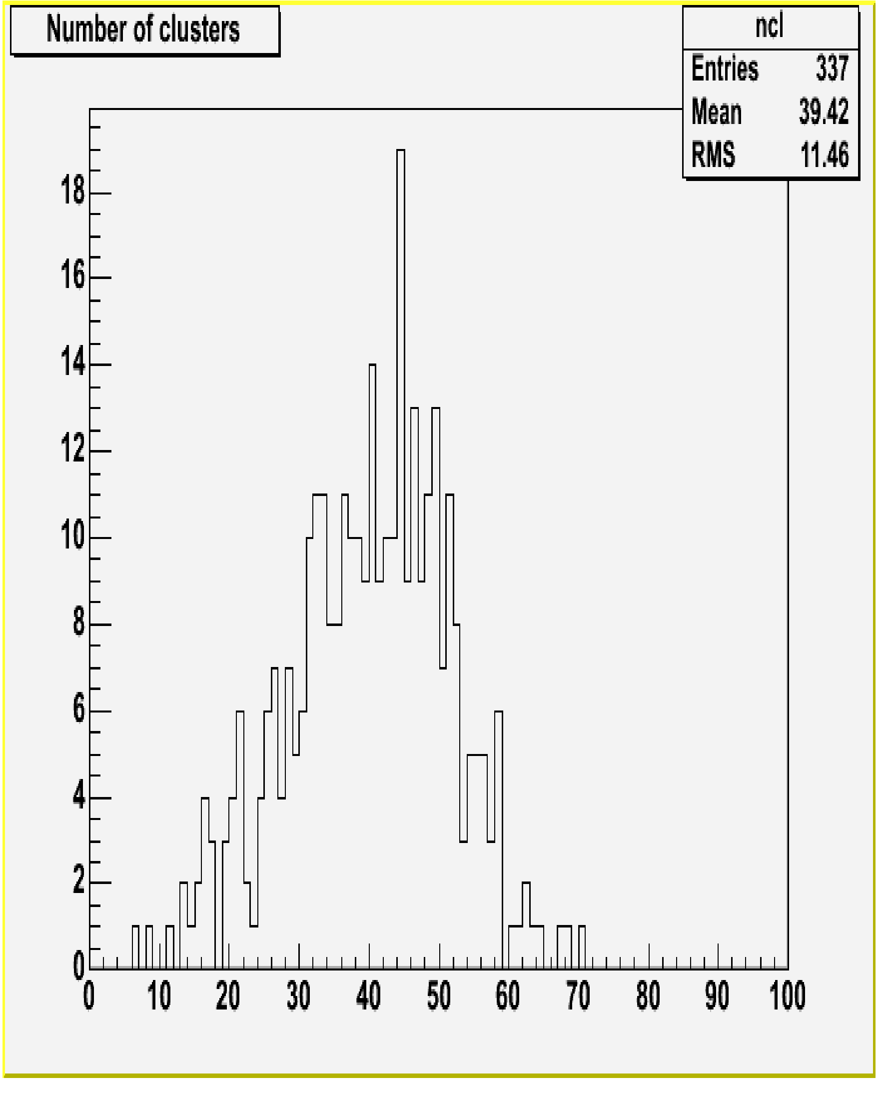
Clustering Algorithm (cont.)



- Find minimal d_{ij}
- if $\min(d_{ij}) < d_{thres}$ then assign hit “i” to the cluster which “j” belongs to.
- Assign direction vector for hit “i” along the line connecting the seed with hit “j”

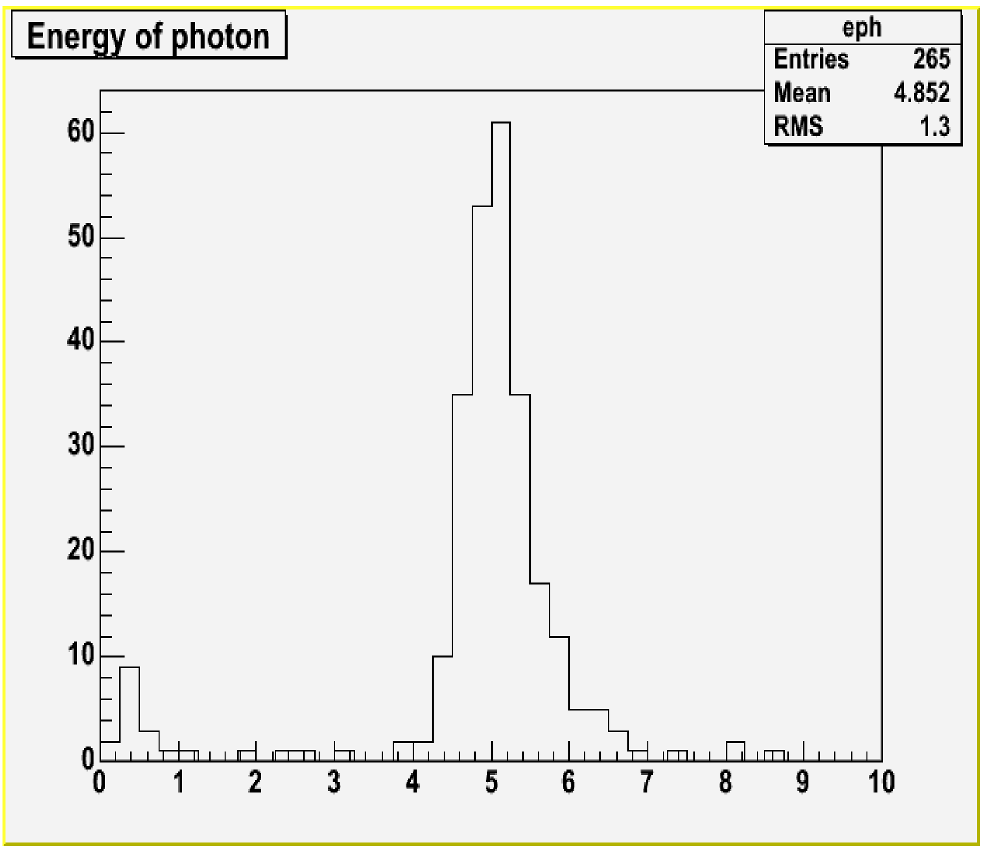
Clustering Algorithm (cont.)

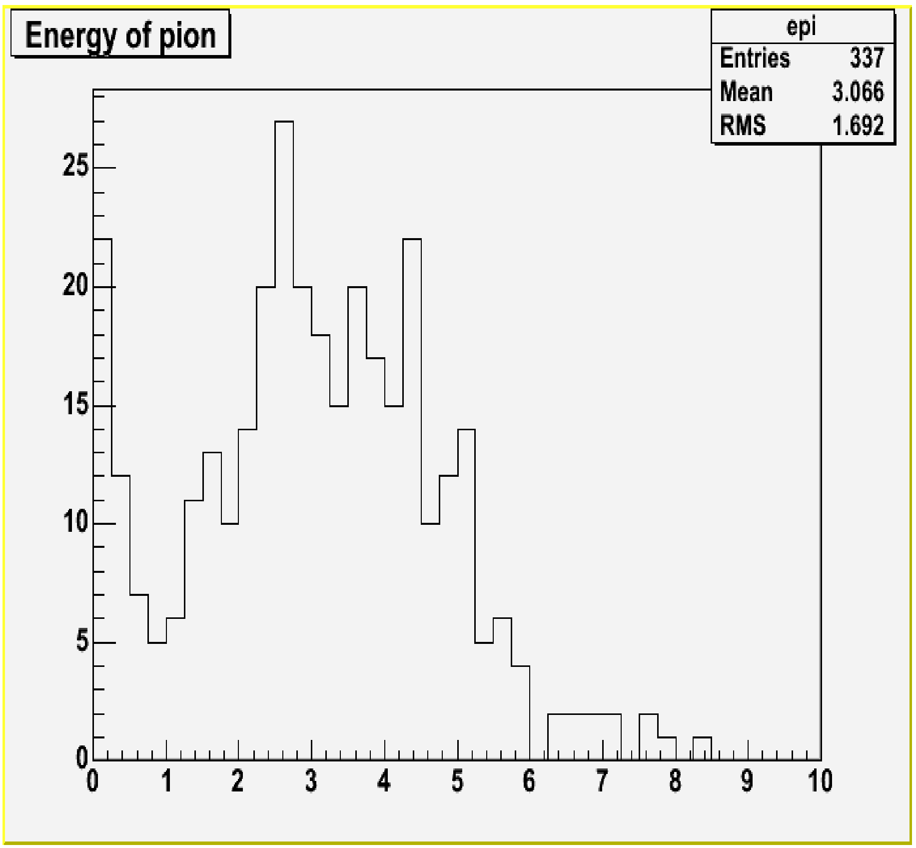
- if $\min(d_{ij}) > d_{thres}$ then hit "i" seeds a new "neutral" cluster. In this case hit "i" is assigned a direction vector connecting hit "i" and IP
- d_{thres} = 2.0cm for ECAL
- d_{thres} = 5.0cm for HCAL
- Increment "i"
- Procedure results in several high-hit-multiplicity clusters and many low-hit multiplicity clusters



Control plots

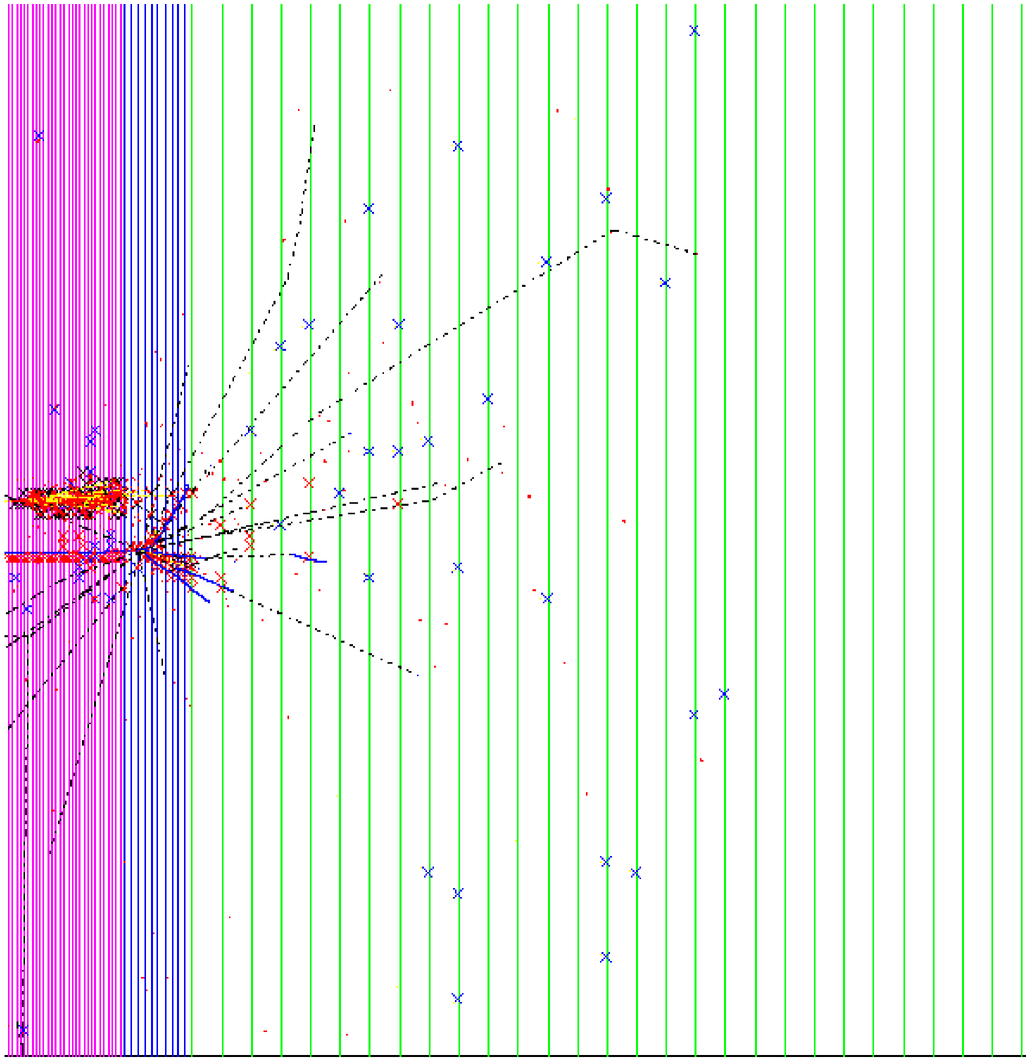
- Two closeby particles: 5GeV γ and 5 Gev π^+ at 5cm distance





Event display

- Two closeby particles: 5GeV γ and 5 Gev π^+ at 5cm distance



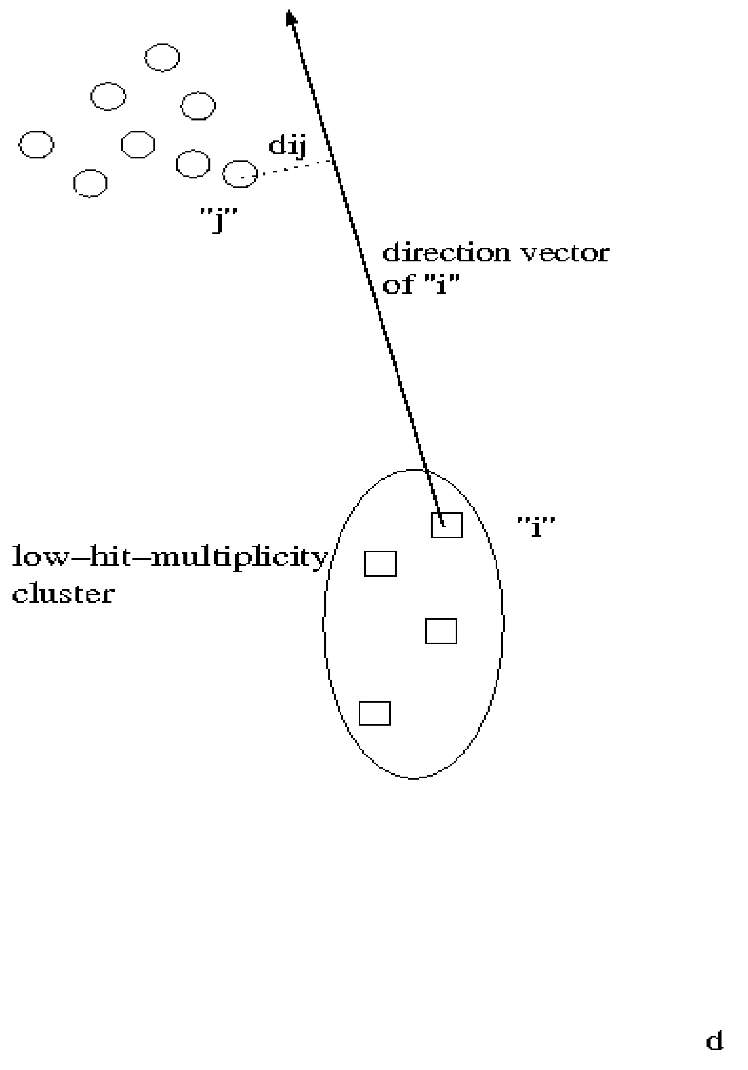
Next step: Merging low multiplicity clusters to big ones

- Merge low-hit-multiplicity clusters (Nhit < 10) to the spatially nearest big cluster (Nhit >= 10)

- But there is a danger to merge hits from hadron showers to photon-clusters thus overestimating photon energy

Merging

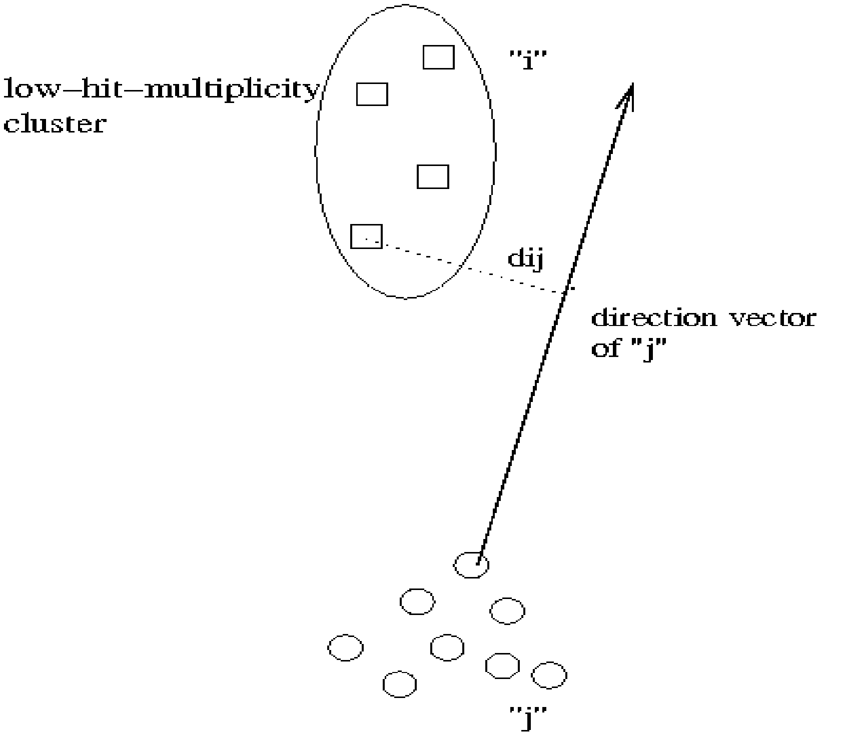
- For each cluster with less than N_{min} hits:
  - Take hit “i” with maximum distance to IP
  - calculate d_{ij} for every hit “j” in forward direction, within a certain radius of R_{merge} = 40cm (direction vector is taken from “i”)



Merging (cont.)

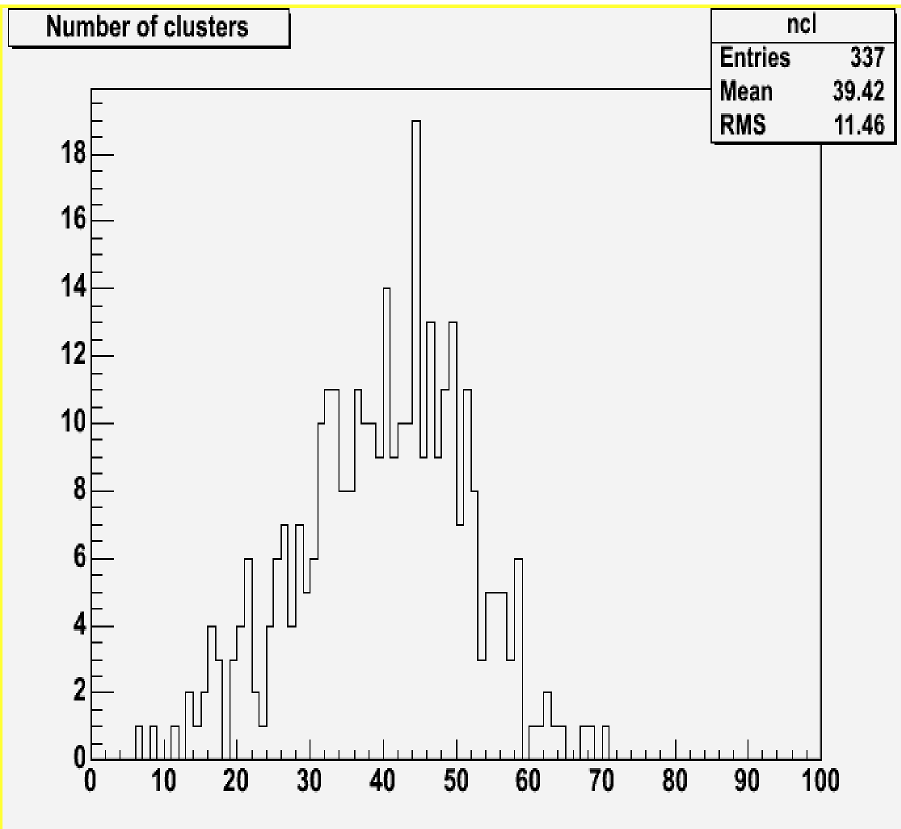
- Take hit "i" with minimal distance to IP
- calculate d_{ij} for every hit "j" in backward direction, within a certain radius of R_{merge} = 40cm (direction vector is taken from "j")

• Find minimal d_{ij} and merge the low-hit-multiplicity cluster to the cluster, which the hit with minimal d_{ij} belongs to.

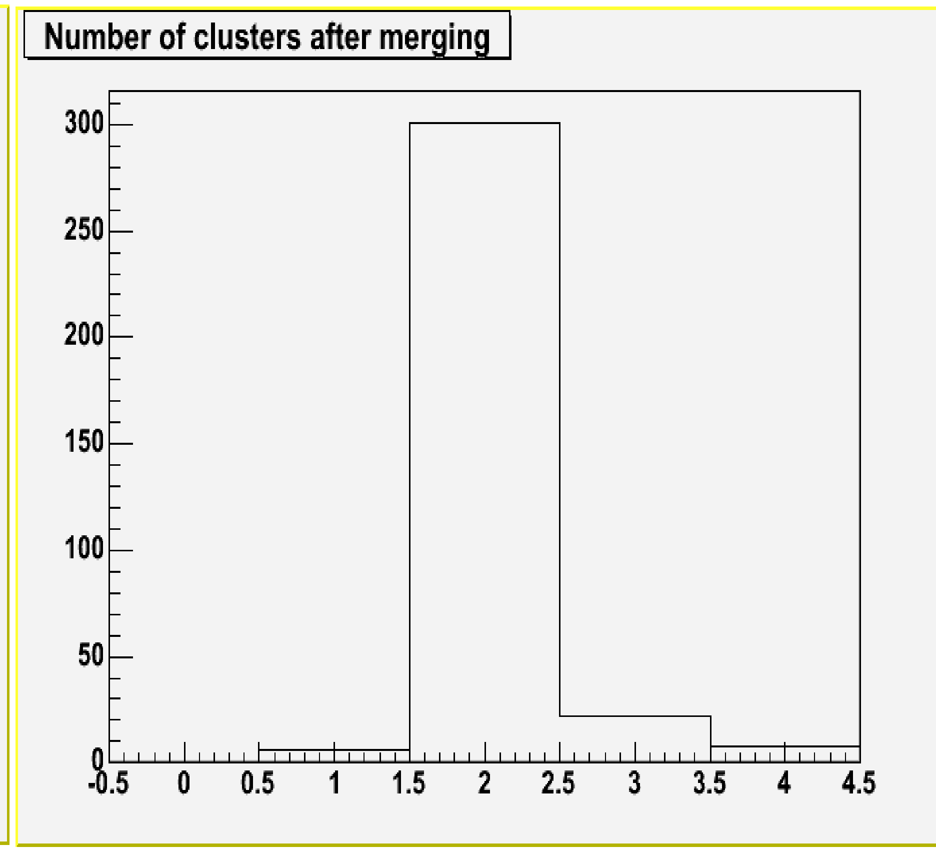


Control plots

- Two closeby particles: 5GeV γ and 5 Gev π^+ at 5cm distance



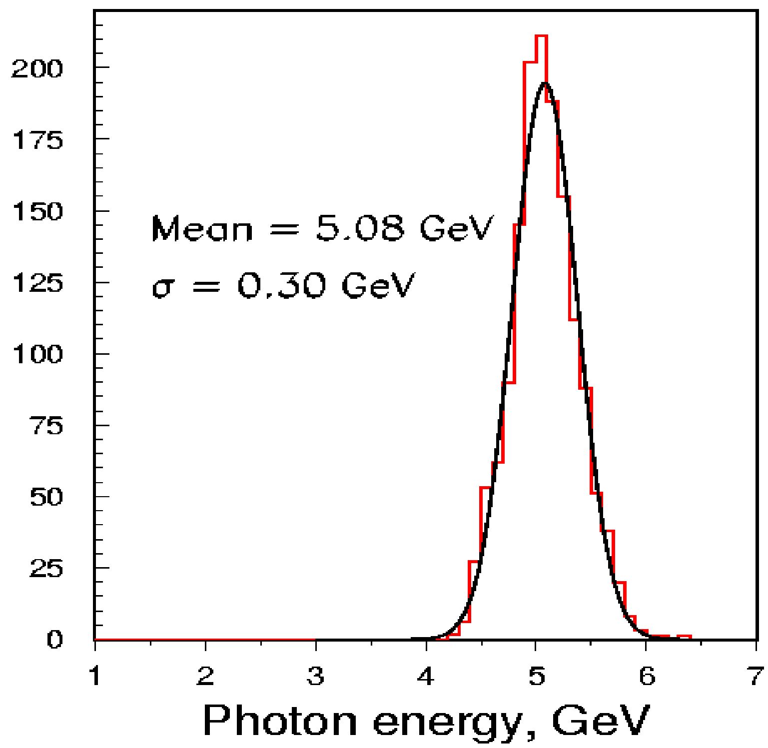
Before Merging



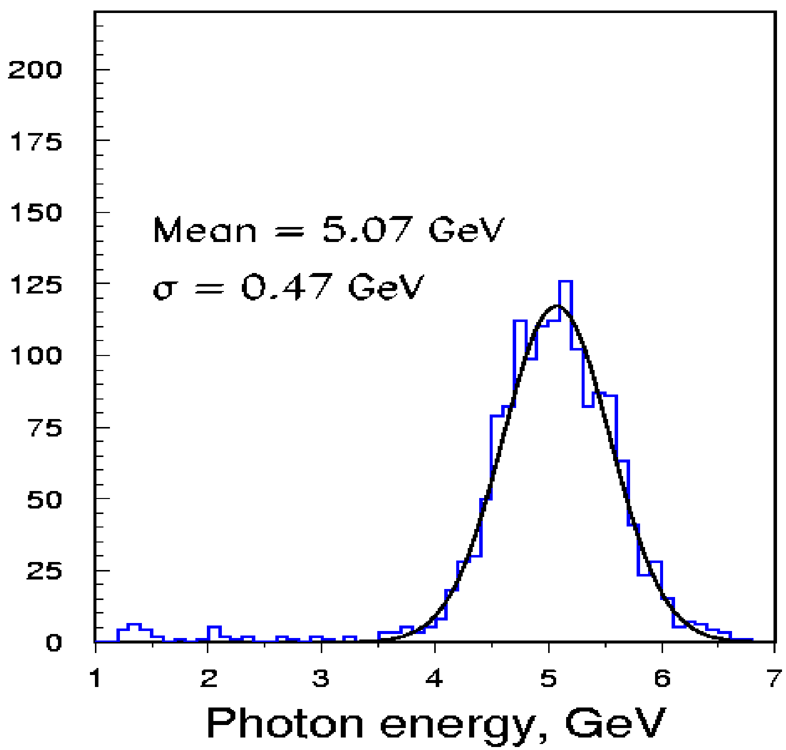
After Merging

Control plots (energy resolution)

Photon only (5GeV)



Photon and π^0



Outlook and conclusion

- Trackwise clustering seems to be a good way for clustering in the calorimeter
- ID of photons could be done by fiting the long. profile of the neutral clusters: $A \cdot x^B \cdot \exp(-Cx)$
- Its reasonable to preform photon ID before merging to prevent merging of distant hits to photon clusters
- Algorithm fully implemented in Marlin