Cluster reconstruction in the FCAL

March. 23, 2010

Mihajlo Kornicer

Indiana University

Short overview of clustering mechanism

- Iterative procedure uses fcal-hits sorted by energy
- Each iteration is two-step process
  1. find seeds for new clusters based on seed-threshold function, calculated from all existing clusters for a given seed-candidate
  2. assign hits to clusters based on shower-profile function that estimates expected energy from each cluster
- Iteration terminates when cluster-topology does not change from previous assignment of energies and positions
- details in NIM **A** 570 (2007) 384

Cluster functions

New coordinates (u, v) rotated by cluster azimuth:

- cluster center (u_0, v_0) = (r_0, 0) where r_0 is radial distance from z-axis

$$u = x\cos\phi + y\sin\phi,$$
$$v = -x\cos\phi + y\sin\phi.$$

Expected energy from a cluster with energy E_C:

- σ_v = Molier radius (~ 3.7 cm)
- $\sigma_u = \sigma_v + (8 \cdot \theta)^4$

$$f_E(\theta, u, v) = E_C \cdot \exp\left\{-\frac{1}{2}\left[\left(\frac{u-u_0}{\sigma_u}\right)^2 + \left(\frac{v-v_0}{\sigma_v}\right)^2\right]^2\right\}$$

Seed-threshold function from a cluster seeded by E_s:

- $a_v = 4.5 + 0.9 \log(E_C + 0.05)$
- $a_u = a_v + (10 \cdot \theta)^2$

core

$$f_T(u,v) = 2E_s \exp\left\{-\frac{1}{2}\left[\left(\frac{u-u_0}{\sigma_u}\right)^2 + \left(\frac{v-v_0}{\sigma_v}\right)^2\right]^2\right\}$$

tail

$$+ \; [0.2 + 0.5\log(E_s+1)] \exp\left\{-\frac{1}{2}\left[\left(\frac{u-u_0}{a_u}\right)^2 + \left(\frac{v-v_0}{a_v}\right)^2\right]^{\frac{1}{2}}\right\}$$

prevents large-distance off-shoots from creating split-off cluster

Parameters

- **MIN_CLUSTER_BLOCK_COUNT (default 2)**
- **MIN_CLUSTER_SEED_ENERGY (default 35 MeV)**
- **MAX_CLUSTER_RADIUS (default 25 cm)**
- **transverse and longitudinal widths (σ_v , σ_u) and (a_v , a_u)**

Important notes:

- seed-threshold and expectation functions are not meant to reproduce exact shower shape
- clustering mechanism designed in all-neutral environment of the RADPHI

$$\gamma p \rightarrow pX \rightarrow \pi^- b_1 \rightarrow \pi^+ \omega \rightarrow \pi^0 \rho \rightarrow \pi^+ \pi^-$$