Clustering and PFA plans

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NORTHERN ILLINOIS
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Snowmass Workshop
August 14-27, 2005

Clustering and PFA

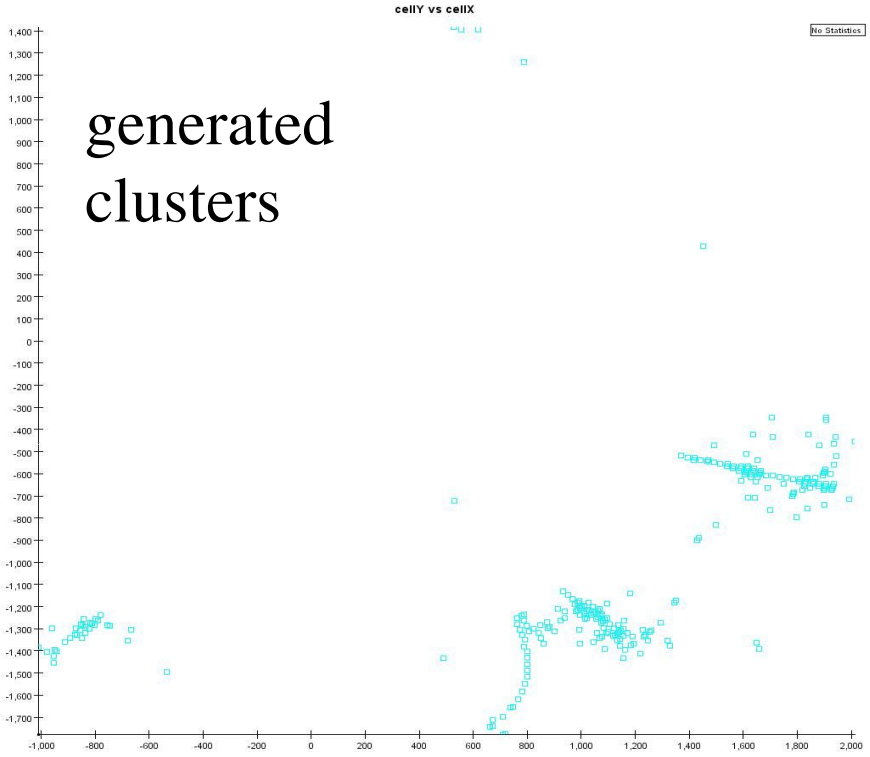
- Goal: develop yet another complete Particle Flow Algorithm based on a calorimeter-only clustering algorithm (Vishnu Zutshi).
- Participate in the detector optimization effort
- Development has been based on SiD and non-projective geometries, but algorithm is in no way restricted to these characteristics
  SDNPHOct04 is based on SDJan03, steel/scintillator, with non-projective HCal barrel and replacing 34 1cm-thick with 41 0.5cm-thick scintillator layers, simulated by LCDG4
- Plans to consider digitization effects in the detector optimization (DigiSim)

Directed Tree Algorithm

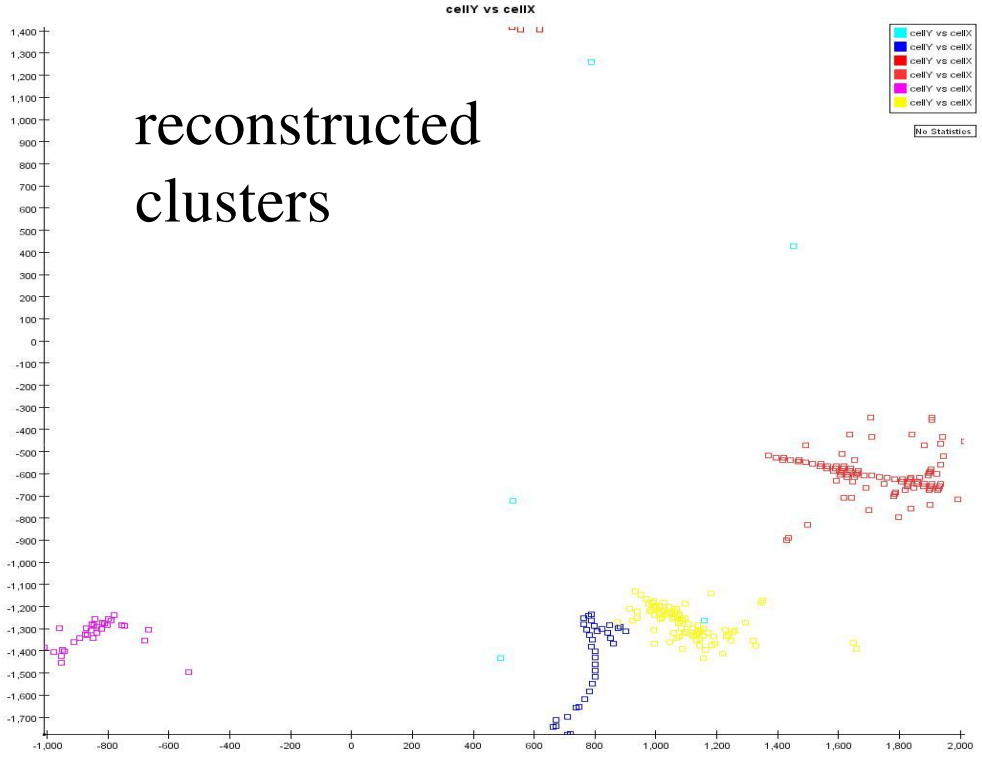
- Define a cell neighborhood
- Discard low-energy hits (¼ MIP cut)
- Calculate density for each hit, based on number of hits on neighborhood
- calculate Distance-Weighted Density Differences, $(D_j - D_i)/d_{ij}$, for all hits *j* in the *i*'s neighborhood
- Find *i*,*j* pair of hits (*i*,*j*) with maximum DDWD
  - negative max: *i* is the seed of a new cluster
  - positive max: *i* is attached to *j*, which may be a seed or become attached to some other seed

Single particle events

generated clusters

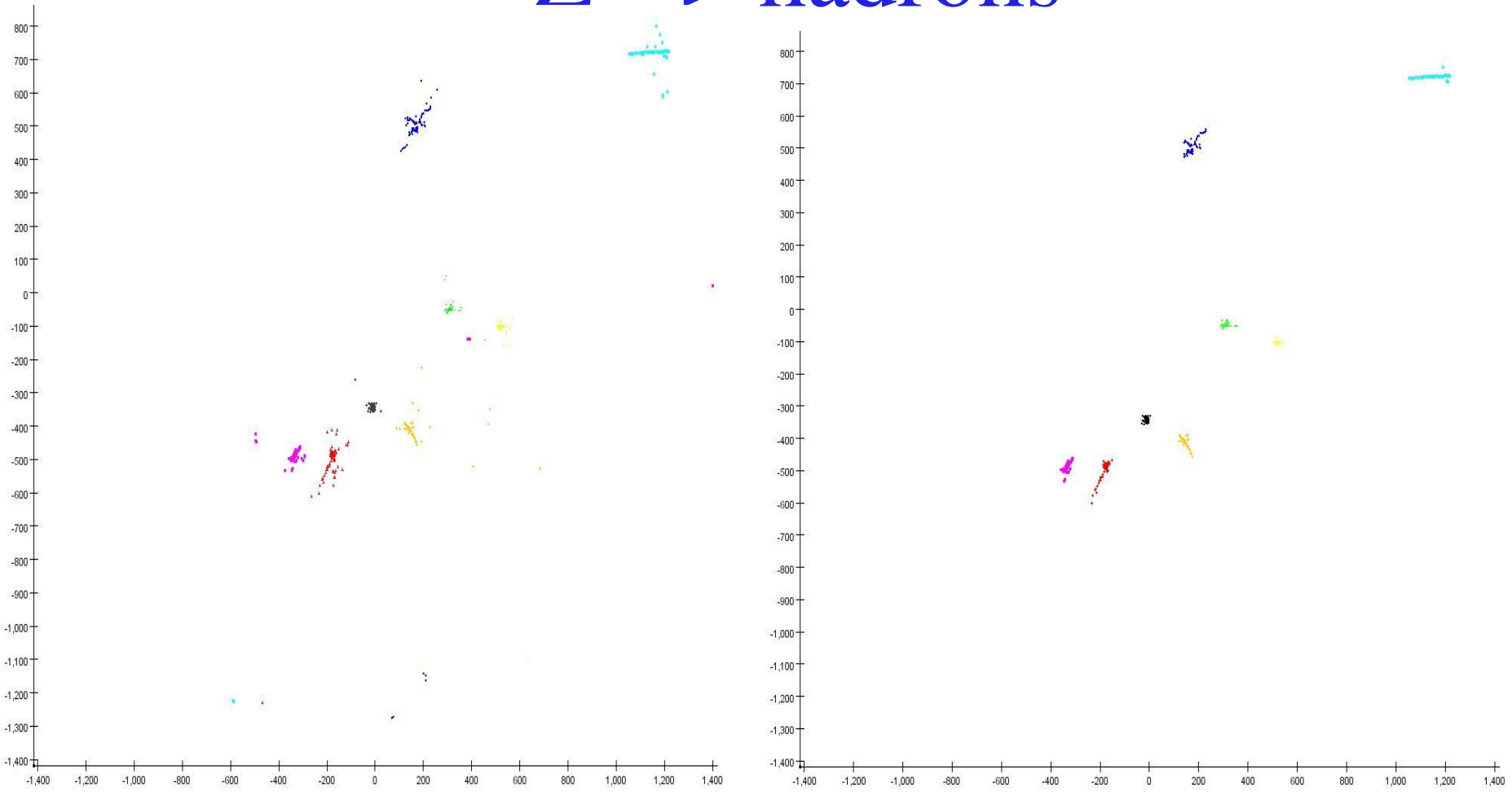


reconstructed clusters



No problem to reconstruct the clusters from single hadrons.
Some fragments are clear though.

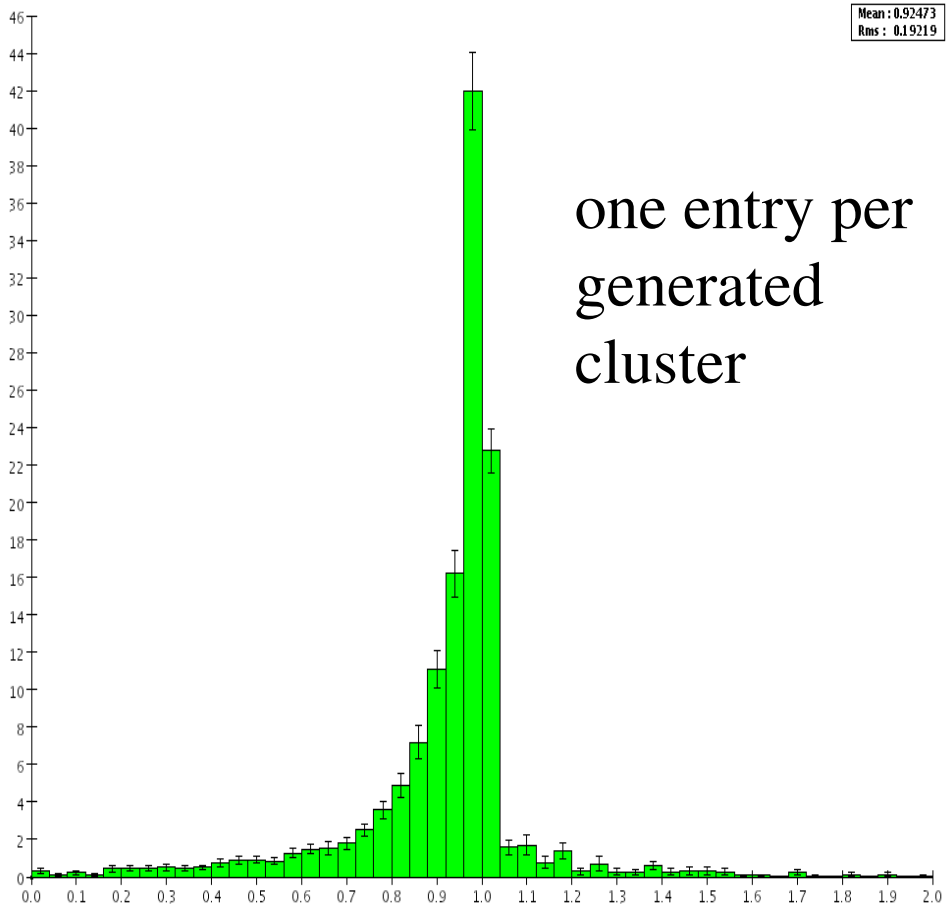
Z --> hadrons



Seems to be doing a good job, but one needs to quantify the performance

Algorithm performance

- Calorimeter only
- Compare reconstructed to generated cluster energies after cluster matching
- Calculate E_{rec} / E_{gen} for each generated cluster
- Enter into histogram with weight E_{gen} / E_{total}
- Ideal: spike at 1



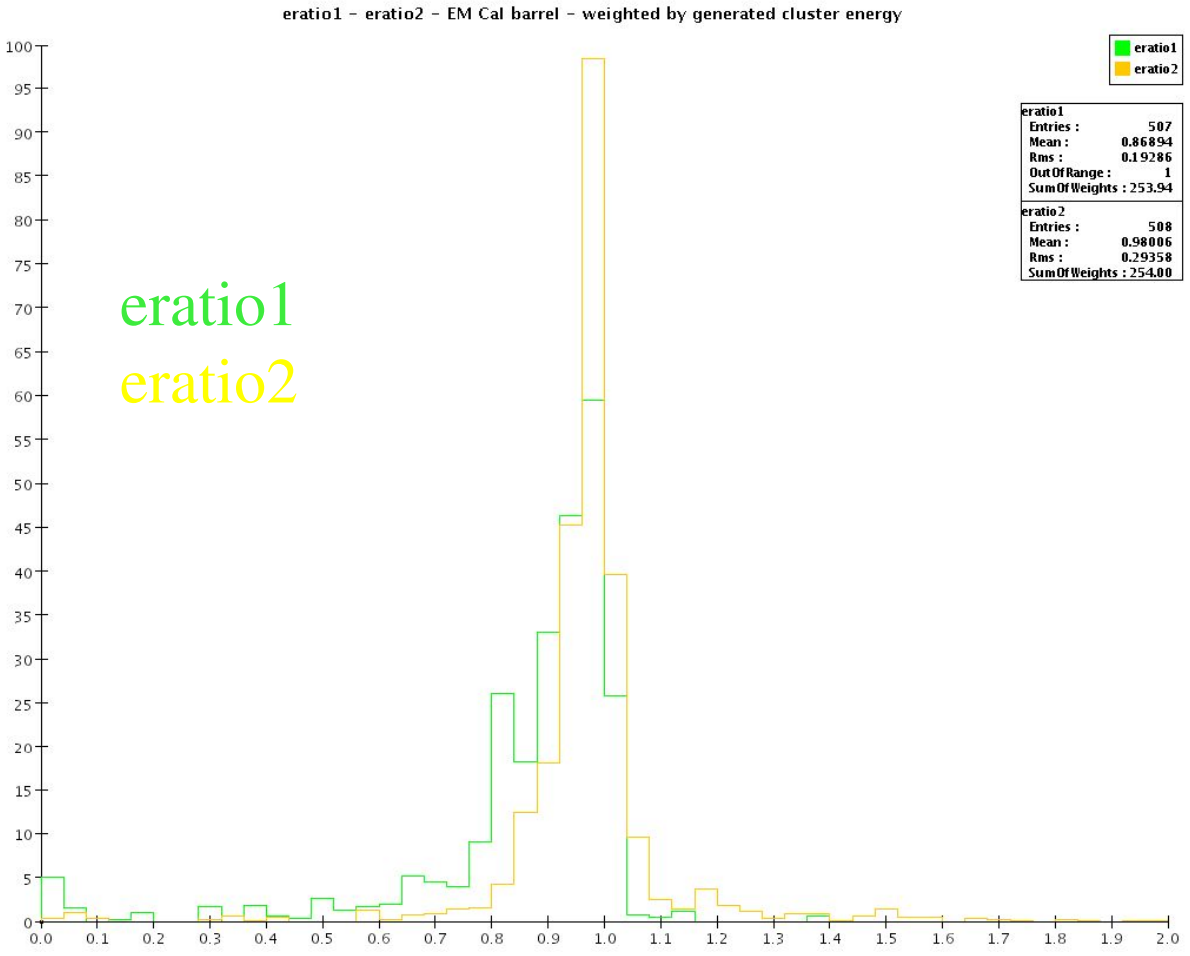
one entry per generated cluster

Cluster matching and merging algorithms

- Stage 1: one-to-one gen-reco matching, based on distances (3D or angular)
  --> several remaining clusters (“satellites”)
- Stage 2: attach satellites to reco clusters, based on angular distances
  possible cuts on angular separation, satellite energies, #hits

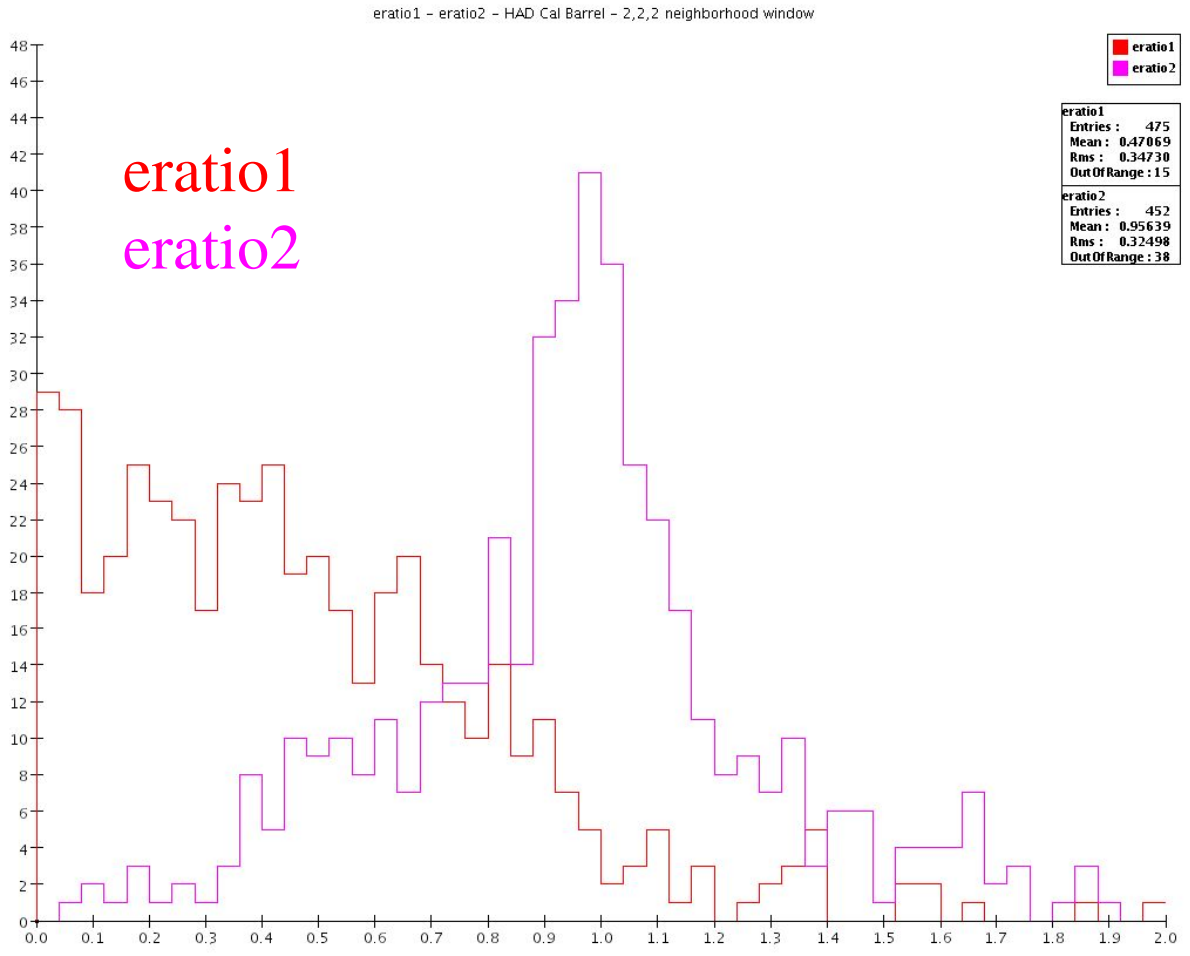
Preliminary ECal analysis

- 500 events, with 2-pions 10cm apart at Ecal face, using SDNPHOct04 detector
- neighborhood definition: (dphi=5, dZ=5, dlayer=9)
- discard events with decays or interactions before Ecal
- Look at:
  - eratio1: Erec/Egen after stage 1 (matching)
  - eratio2: Erec/Egen after stage 2 (merge satellites)



Preliminary HCal analysis

- 500 events, with 2-pions 10cm apart at Ecal face, using SDNPHOct04 detector
- neighborhood definition: (dphi=2, dZ=2, dlayer=2)
- discard events with decays or interactions before Ecal
- Look at:
  - eratio1: Erec/Egen after stage 1 (matching)
  - eratio2: Erec/Egen after stage 2 (merge satellites)



Current status

- Analysis of complex events shows some problems with too many isolated satellites
  satellites are isolated reconstructed clusters, too far from the main shower (how to connect them?)
- Clustering algorithm converted to org.lcsim, to be certified. Committed to LCSim CVS repository
- More manpower for the PFA development effort
- This is work in progress, there is a lot of work to do!...

Things to do

- Some more parameter optimization (HCal)
- Add other tools for a complete PFA algorithm
  - track matching
  - photon ID
  - cluster shape
  - MIP tracking in calorimeters (to help connecting satellites?)
  - digitization effects