

# Clustering and PFA plans

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# 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

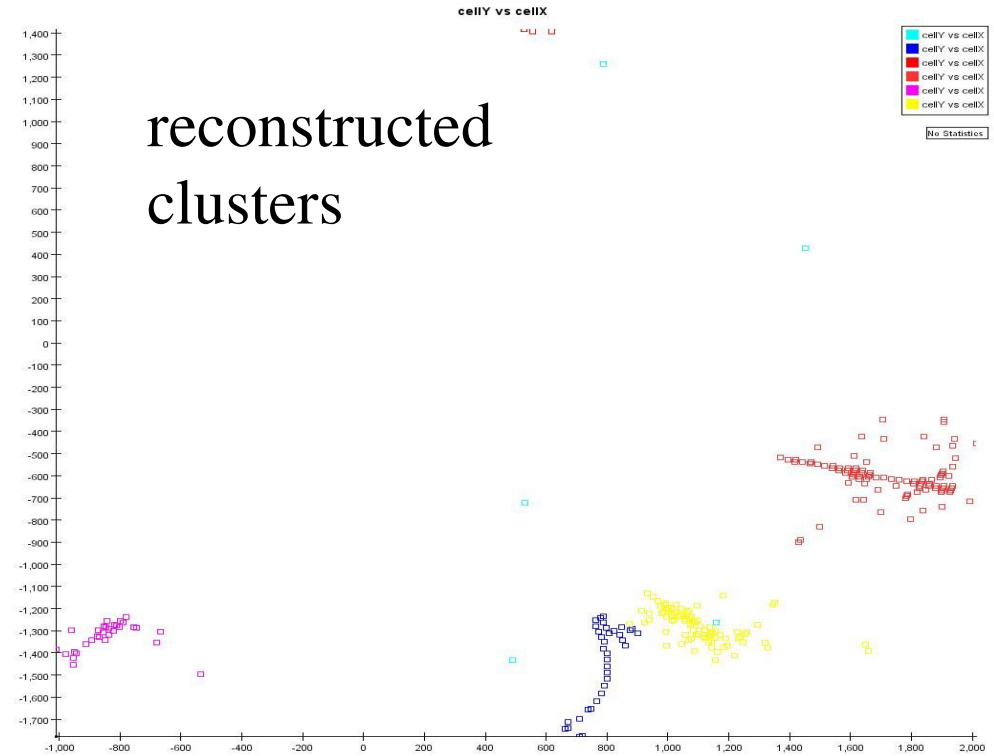
- Define a cell neighborhood
- Discard low-energy hits ( $1/4$  MIP cut)
- Calculate density for each hit, based on number of hits on neighborhood
- calculate Distance-Weighted Density Differences,  $(D_j - D_i)/d_{ij}$ , for all hits  $j$  in the  $i$ 's neighborhood
- Find  $i,j$  pair of hits  $(i,j)$  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

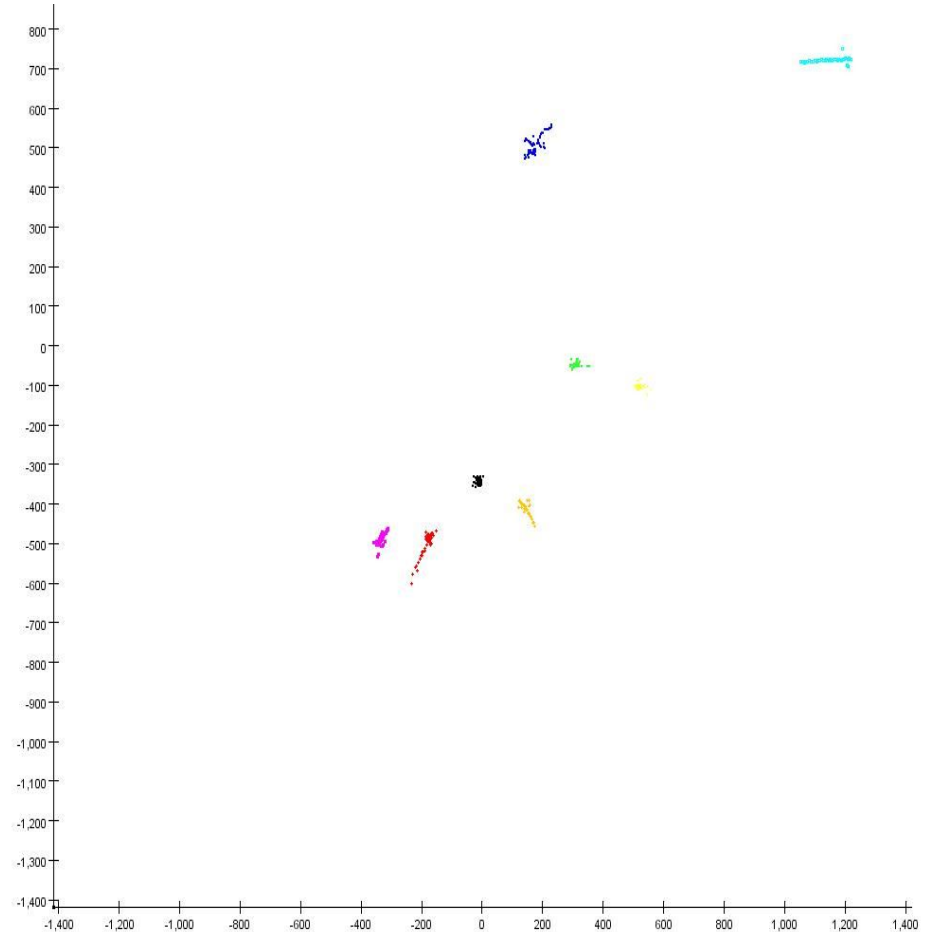
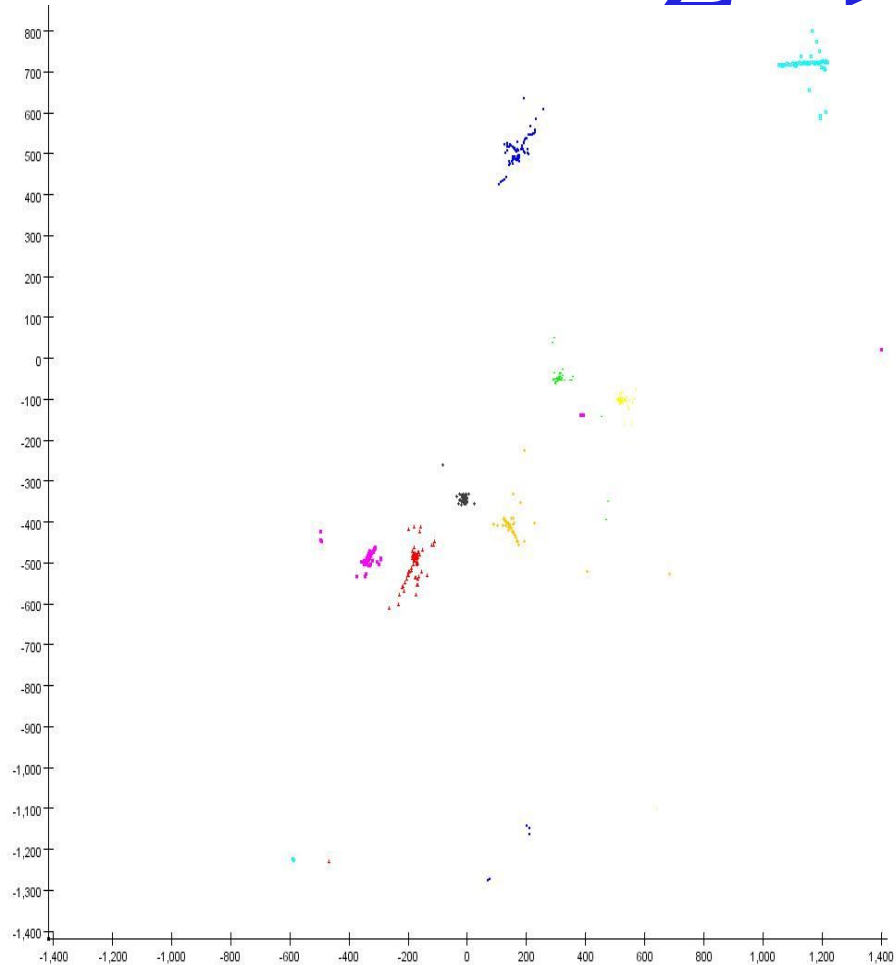


reconstructed  
clusters



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

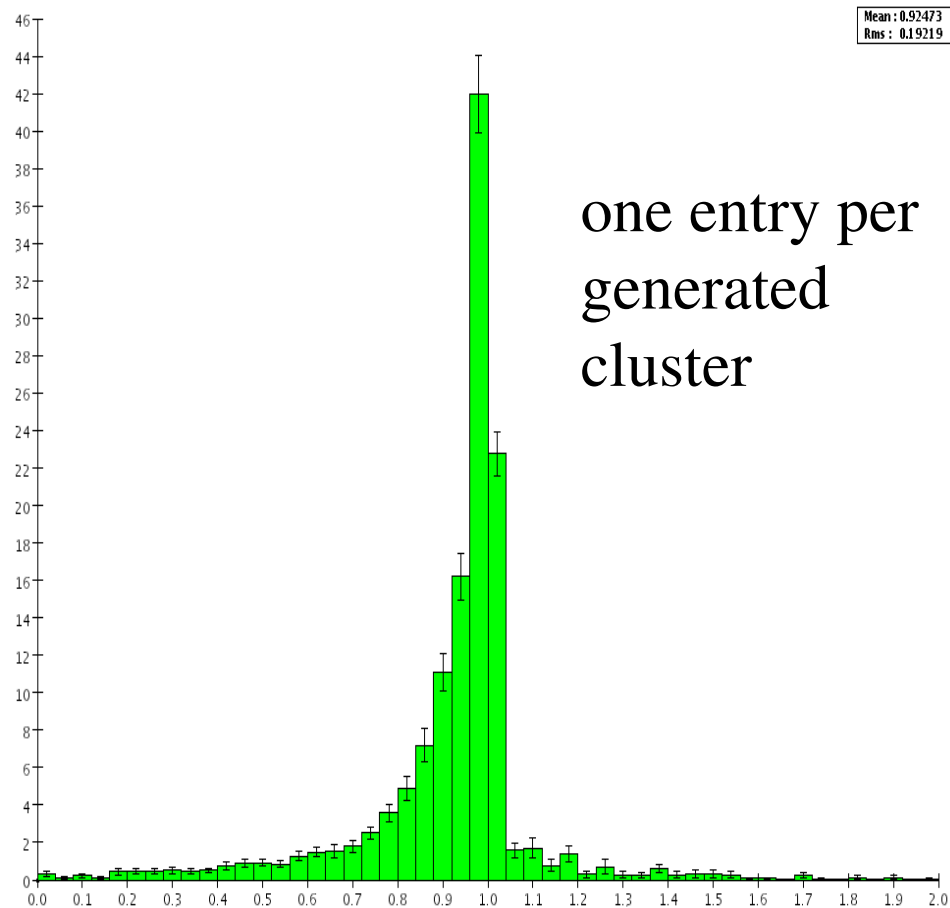
# $Z \rightarrow \text{hadrons}$



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  $E_{\text{rec}} / E_{\text{gen}}$  for each generated cluster
- Enter into histogram with weight  $E_{\text{gen}} / E_{\text{total}}$
- Ideal: spike at 1

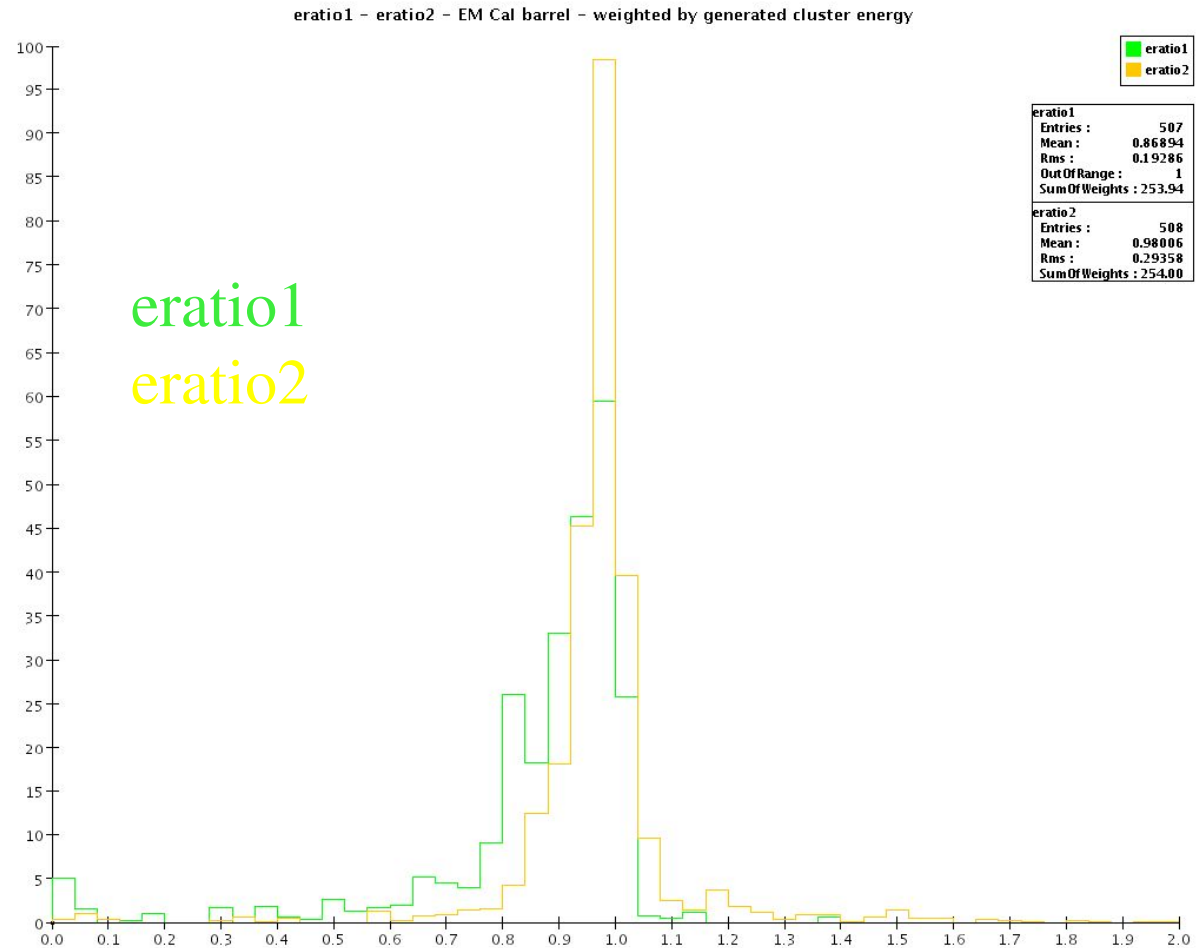


# Cluster matching and merging algorithms

- 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

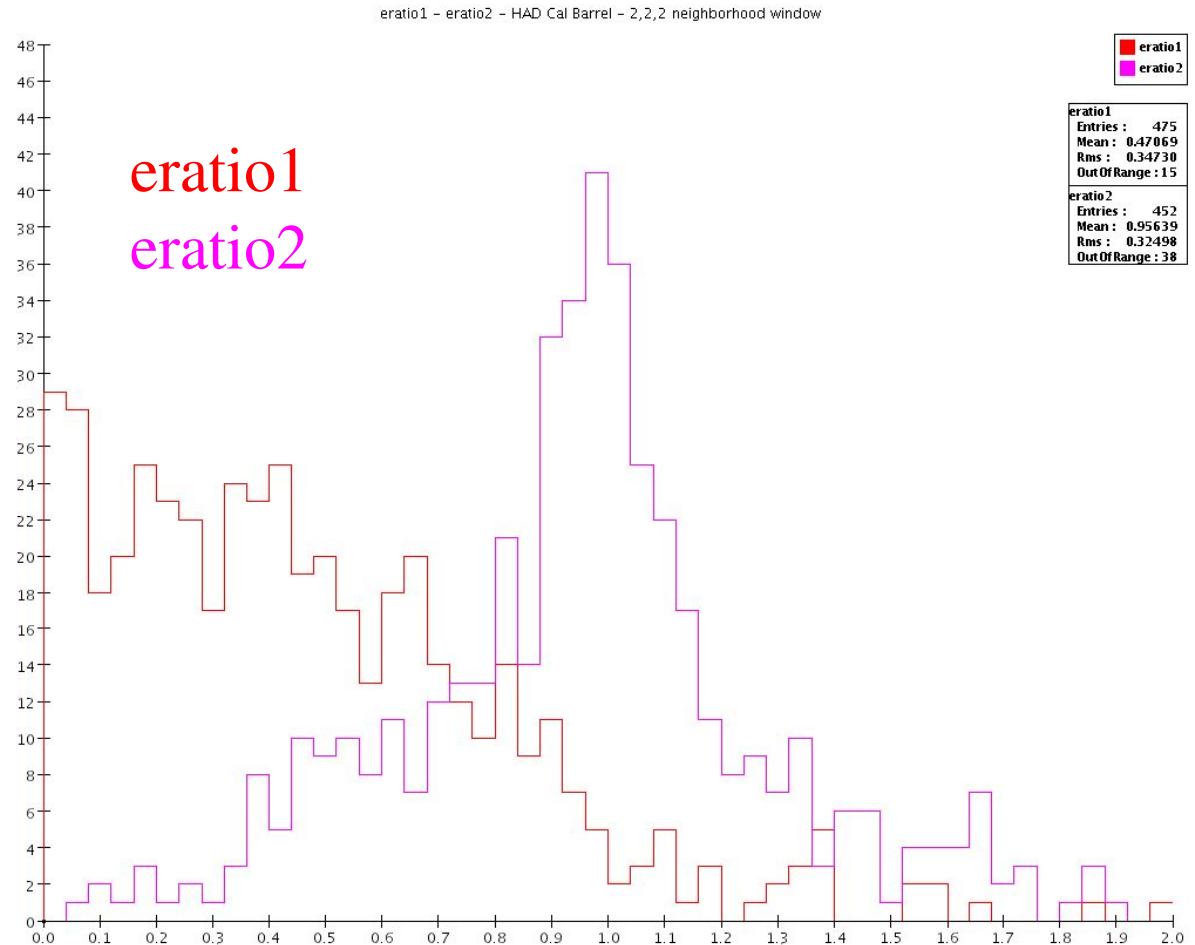
# Preliminary ECal analysis

- 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