Two Particle Separation with tile HCAL

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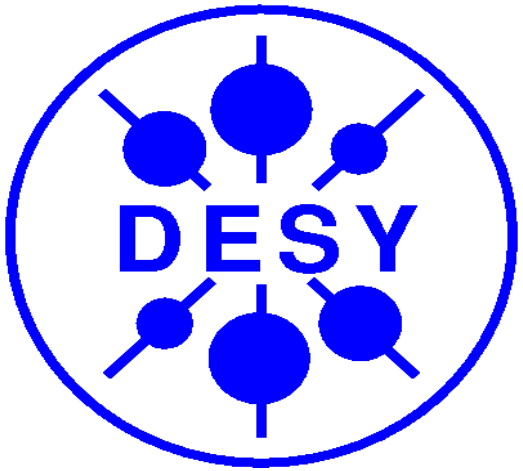
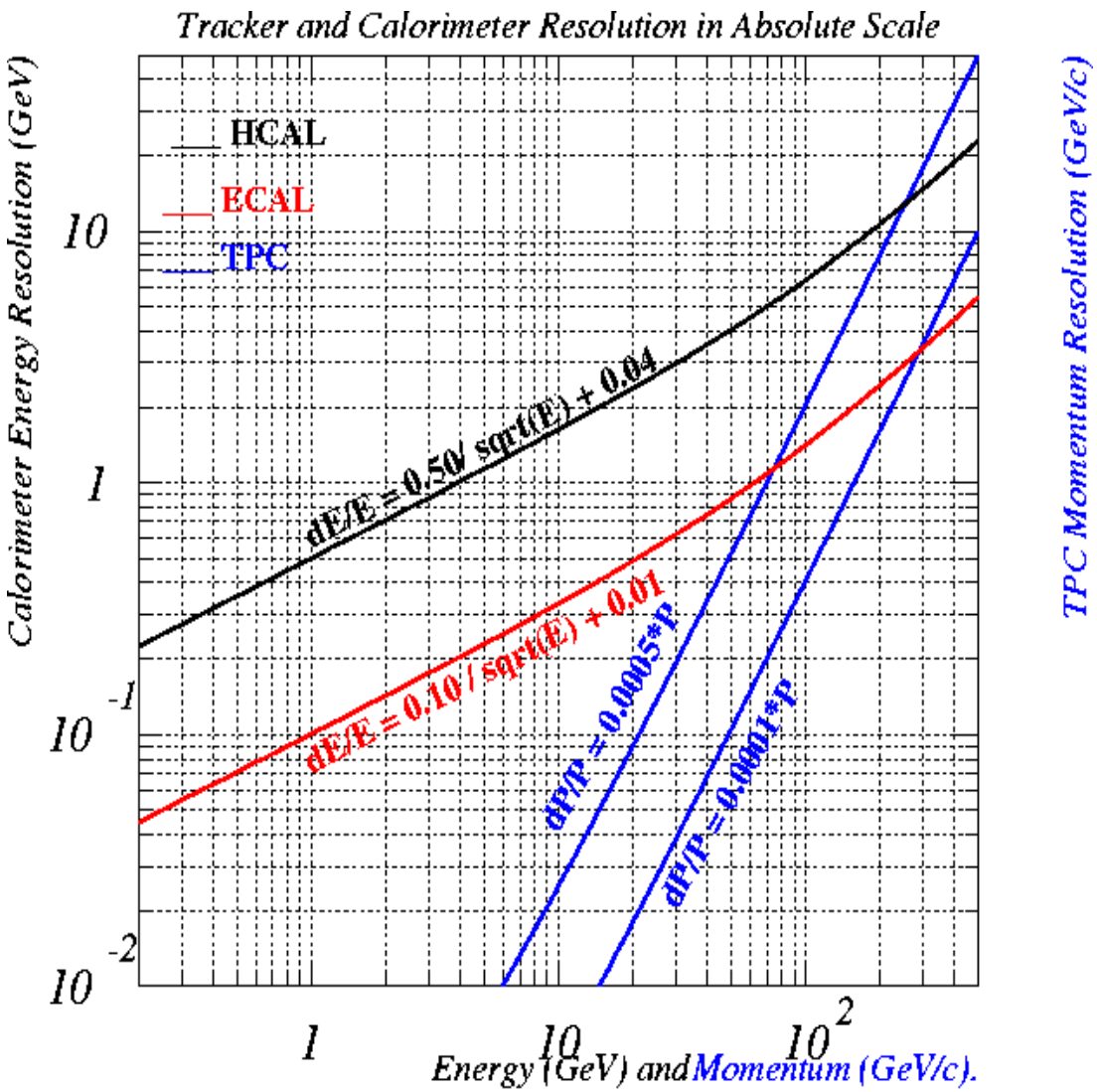


LC Workshop, Paris 20/4/2004

Particle Flow Concept

- P-flow concept : attempt to reconstruct every single particle in event
- Tracker information → 4P vectors of charged objects
- Ecal → 4P vectors of photons
- Ecal + HCal → 4P vectors of neutral hadrons (contain ~ 14% of jet energy)
- Efficient separation of neutral and charged objects is an issue → highly granulated calorimeters are required



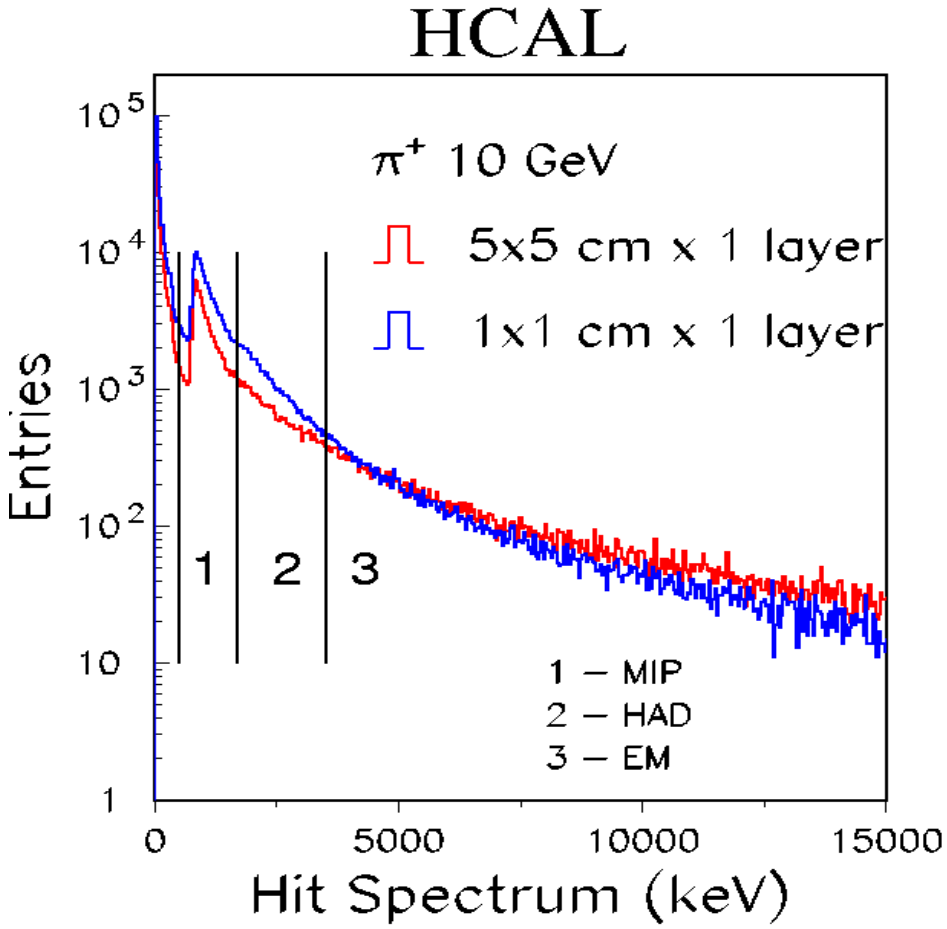
Simulation (Setup and Goals of Study)

- Goals
  - Develop shower reconstruction/separation procedure
  - Investigate shower separation capability of algorithm in dependence of calorimeter granularity, distance between showers, particle energies
- Simulation setup (closely follows envisaged prototype geometry)
  - 40 layers of ECAL
    layers 1-30 : 1.4mm W, 1mm G10, 0.5mm Si, 1mm G10
    layers 31-40 : 4.2mm W, 1mm G10, 0.5mm Si, 1mm G10
  - 40 layers of tile HCAL (analog)
    each layer : 20mm Fe, 5mm Scintillator
- Studied tile size options / readout schemes :
  $1x1cm^2$ x 1lay, $3x3cm^2$ x 1lay, $3x3cm^2$ x 2lay, $5x5\ cm^2$ x 1lay
- Simulation is done with GEANT3, FLUKA+MICAP

Reconstruction
Step #1 : Clustering

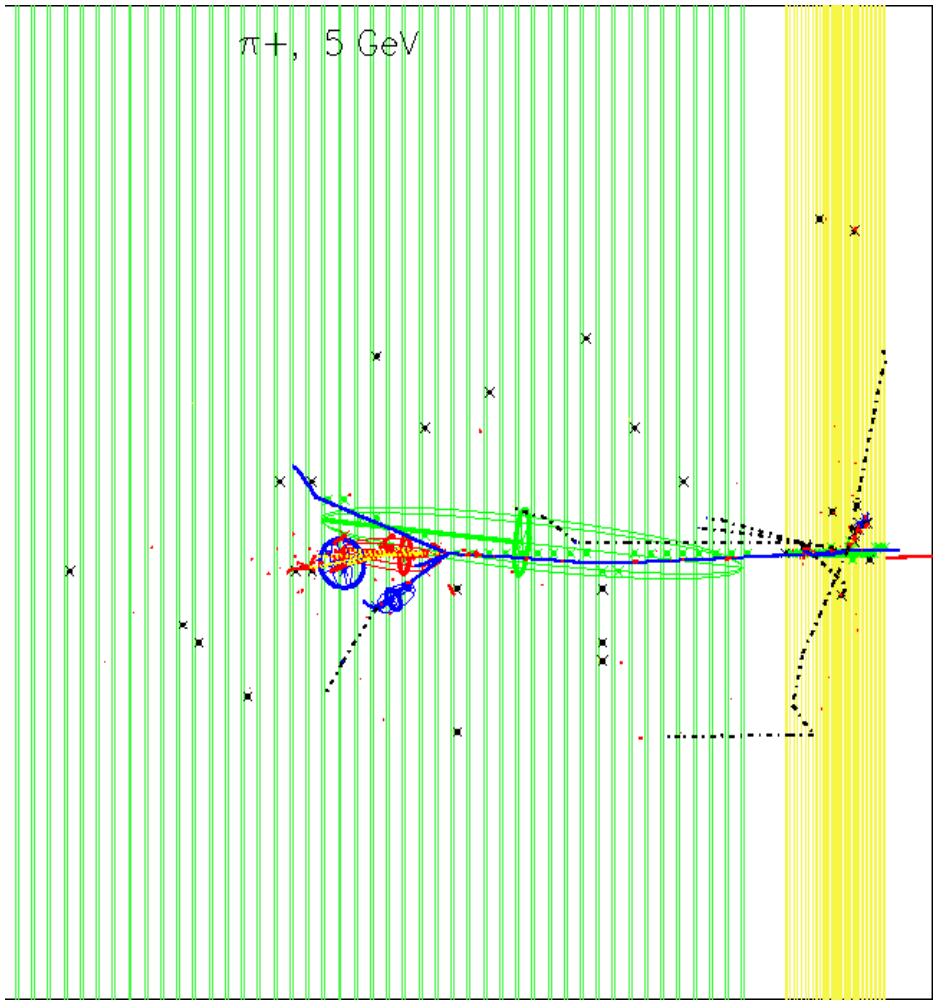
Two steps of reconstruction
1. Clustering
2. Shower building

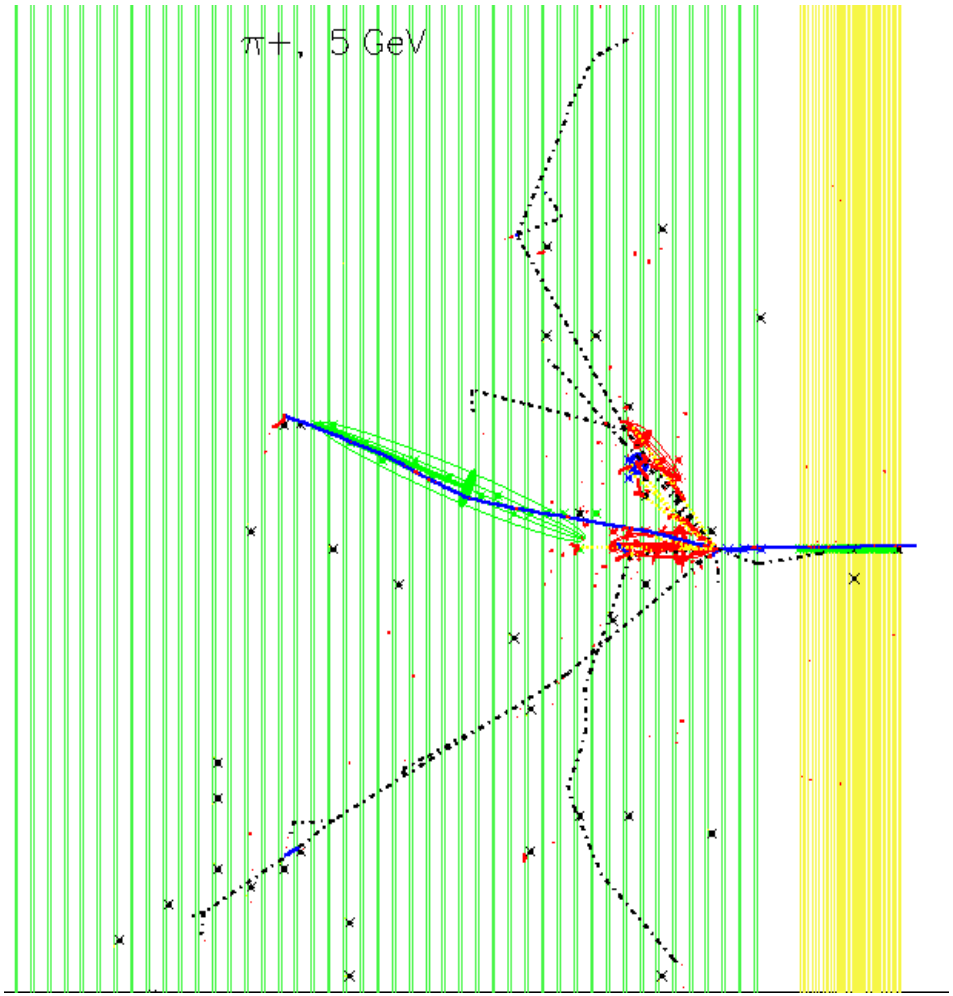
- Clusters : structures inside shower
- Hits are classified into 3 categories:
  - MIP : hits from single tracks
  - EM : high density hits
  - HAD : hits produced by group of close-by tracks in vicinity of nuclear interaction
- Clustering is performed separately on each category (clustering algorithm from V.Morgunov)
- Fourth hit category after clustering :
  - Neutron hits (spatially separated from reconstructed clusters)



Clustering (Event Displays)

CLUSTERS : MIP EM HAD NEUT



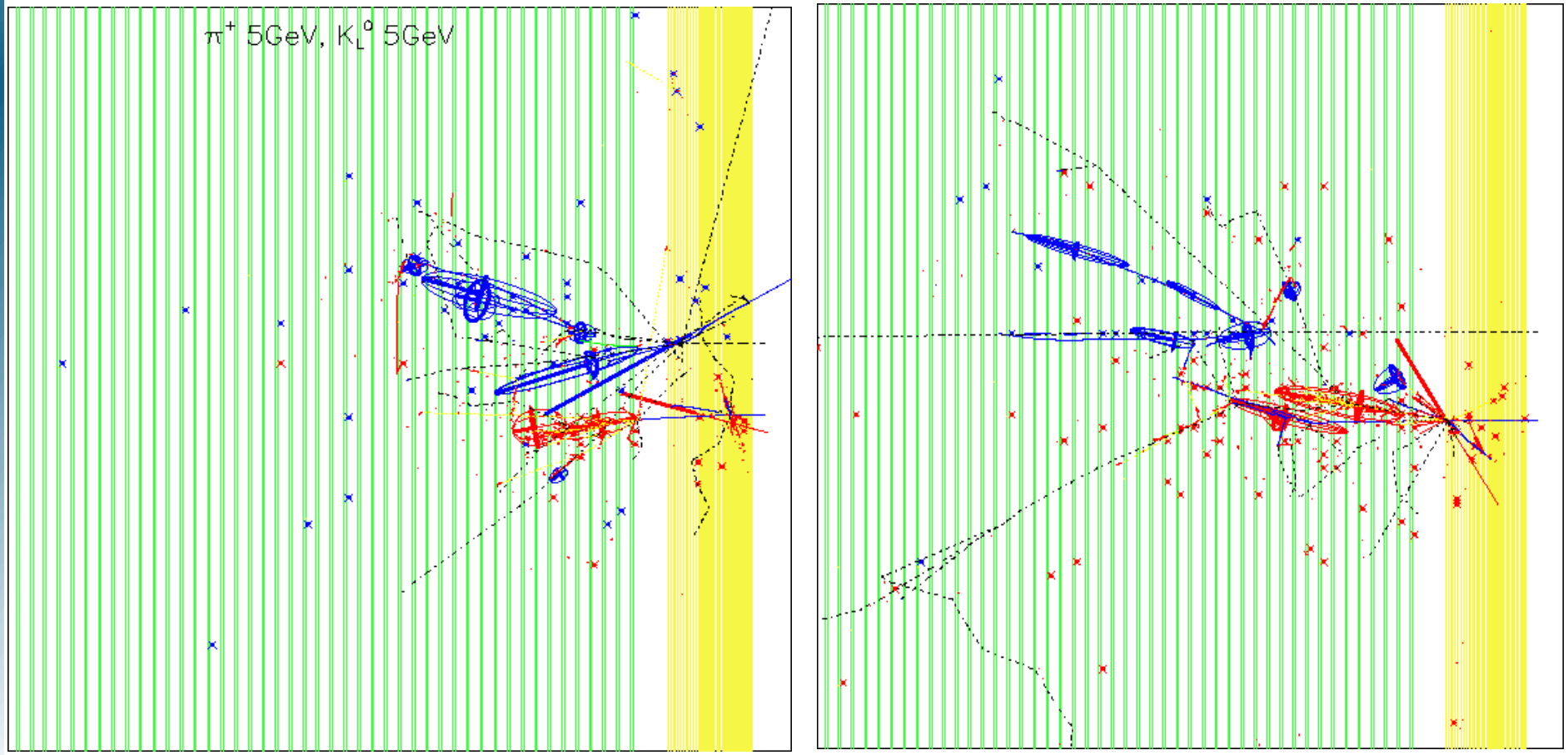


Step #2 : Shower Reconstruction

- Shower – tree of HAD and EM clusters topologically connected by tracks (MIP clusters) + initiated by neutrons (spatially disconnected from tree) hits/clusters
- Track reconstructed with tracking system seeds shower : find starting cluster (cluster closest to track intersection point with ECAL front plane)
- Reconstruction of total shower by collecting clusters into tree and adding close neutron hits/clusters (iterative procedure : parameters governing shower reconstruction are iteratively adjusted till E_{shower} fits best P_{track}) $\rightarrow$ algorithm is self-adaptive to HCAL segmentation
- Remaining clusters/hits are assigned to neutral objects
- Initial study : analysis of simple situation of two close by showers (neutral and charged)

Showers (Event Displays)

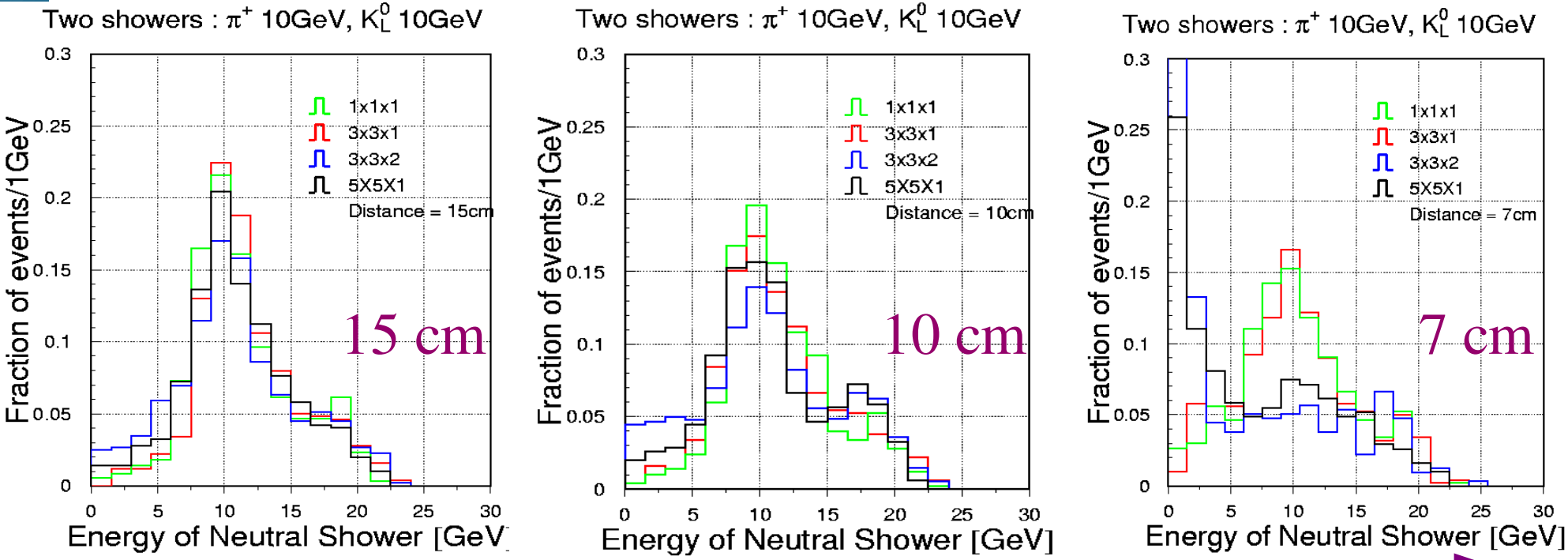
Two showers from 5GeV π^+ and 5GeV K^0
Distance – 15cm



Shower Separation

Criterion to estimate performance :

Energy spectrum of neutral shower as a function of distance between initial particles and HCAL tile size

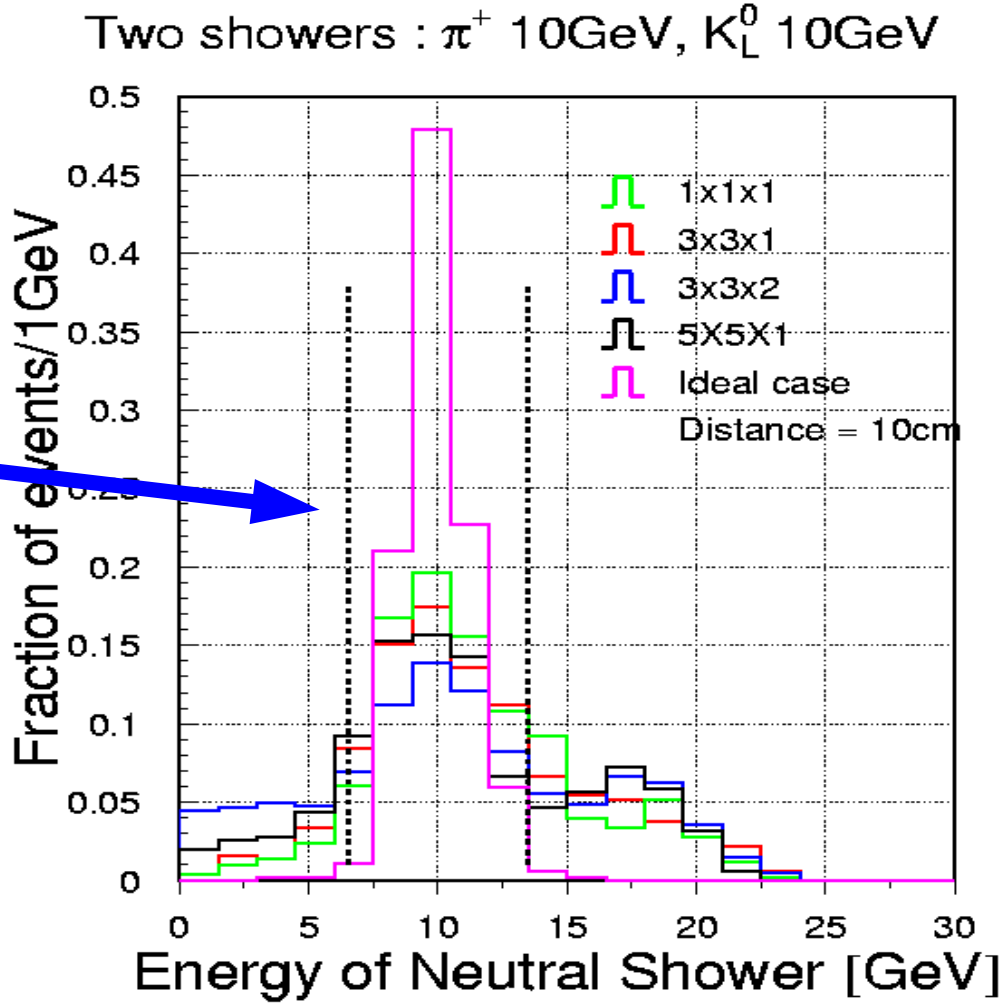


Distance between particles

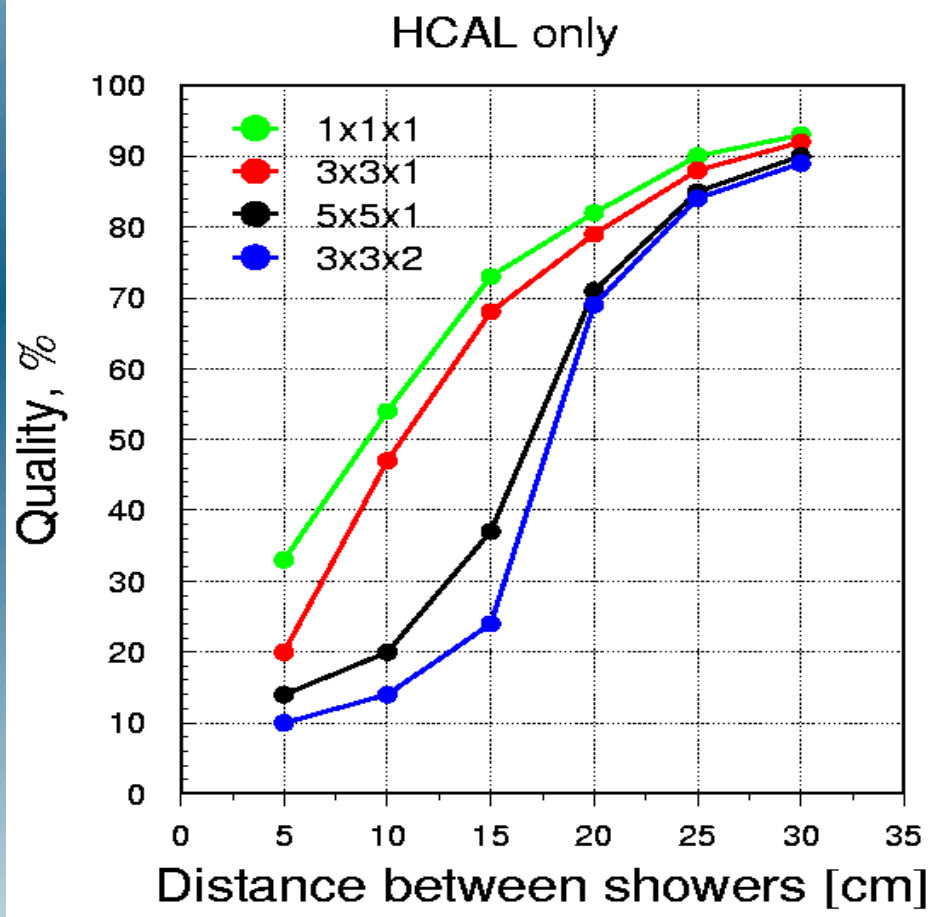
Definition of Shower Separation Quality

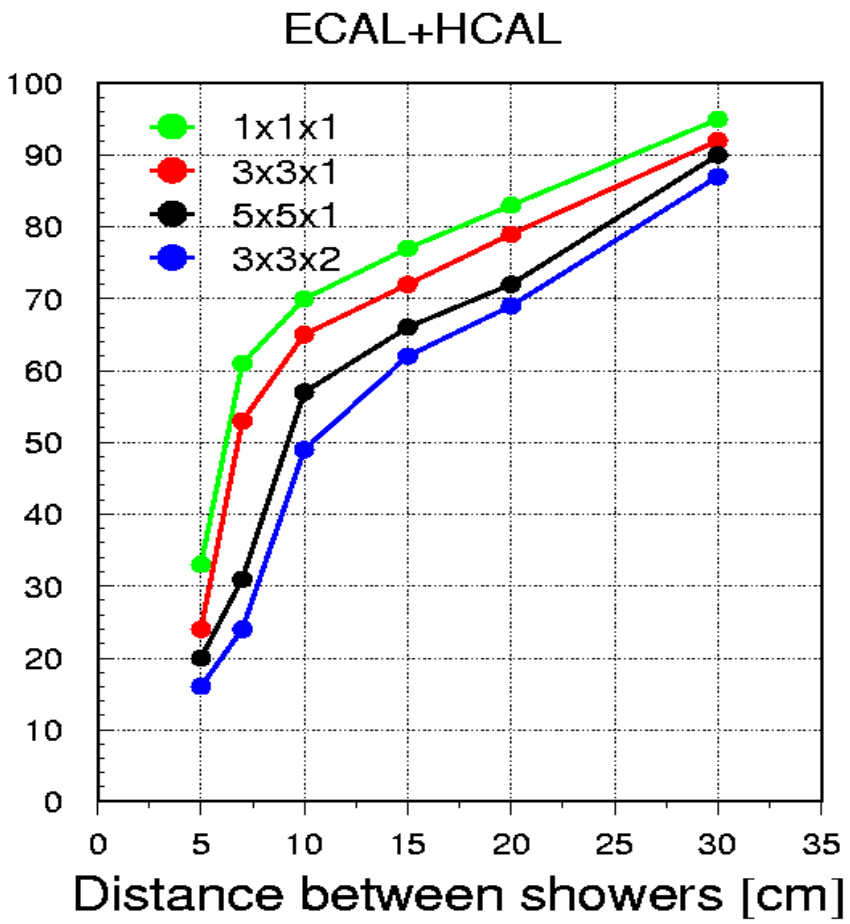
Separation quality = fraction of events in which reconstructed energy of neutral shower lies in the range E_{true} +/- 3σ,

σ – nominal energy resolution of neutral shower (no close by shower)

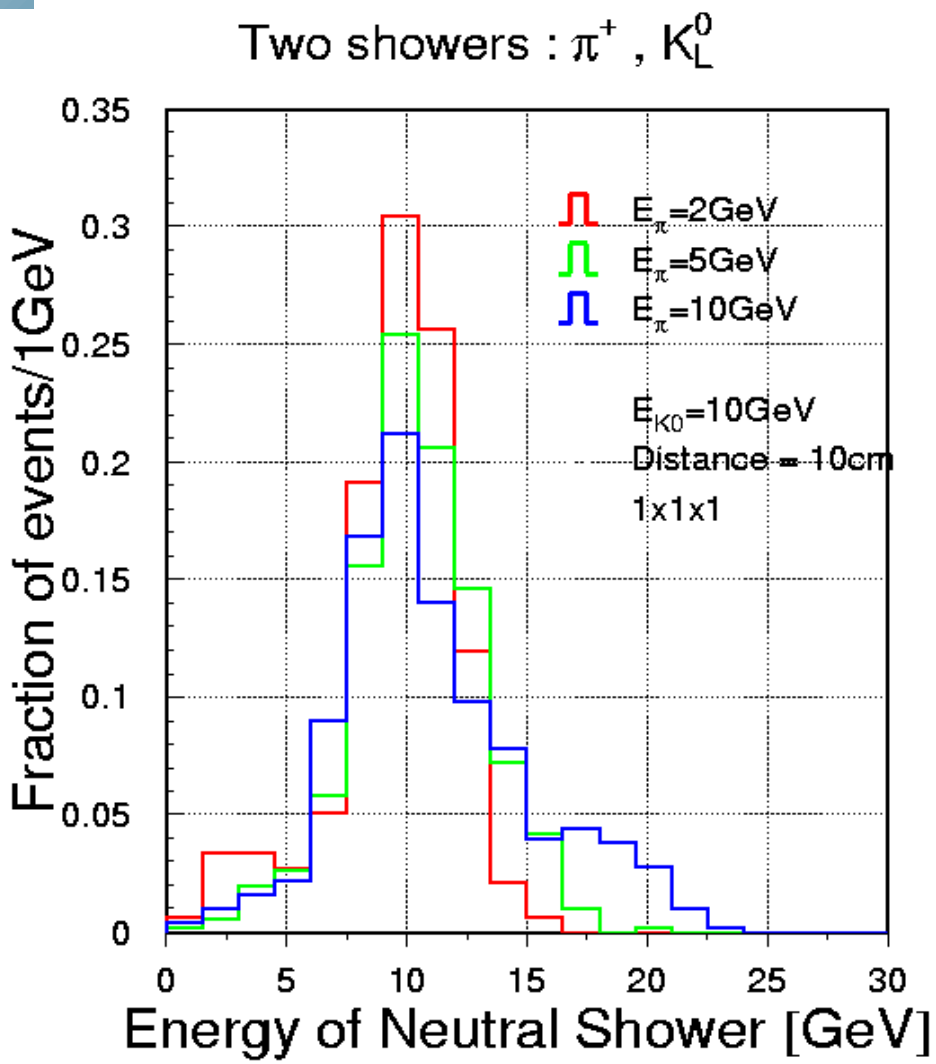


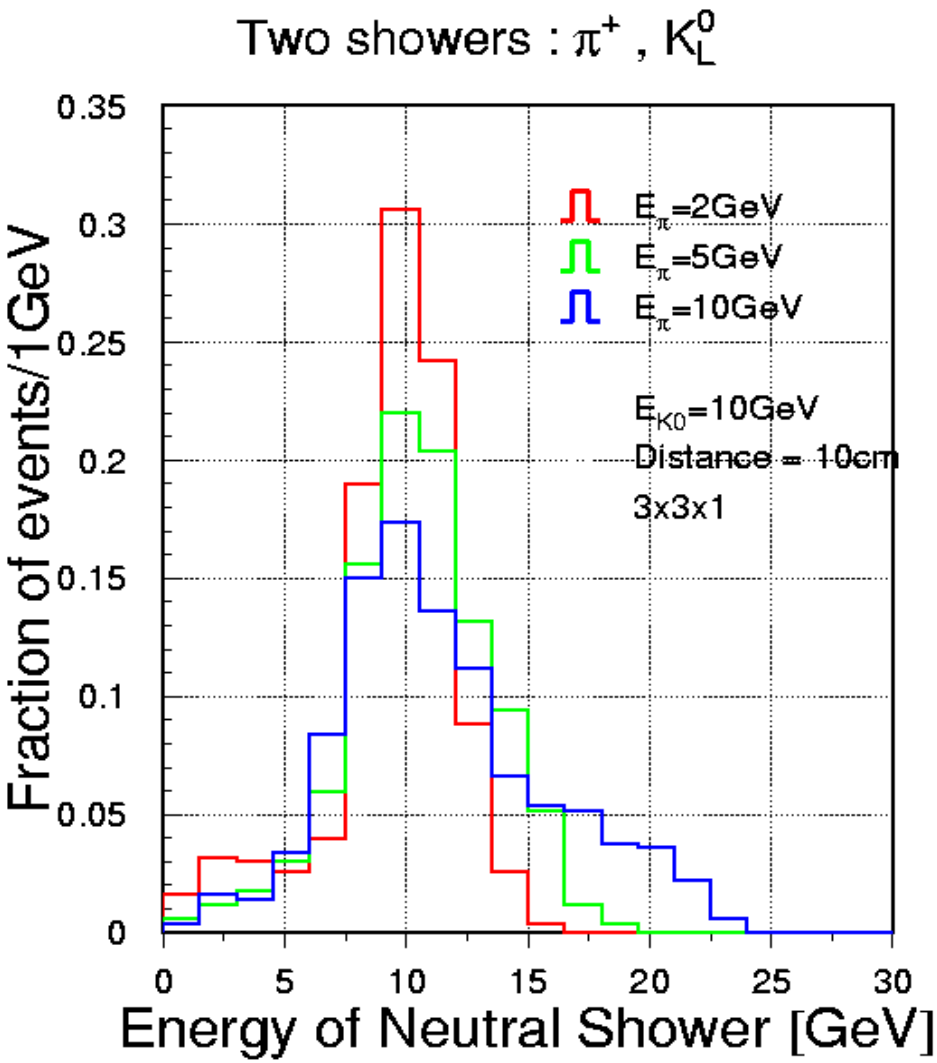
Separation Quality vs Transversal and Longitudinal Segmentation





Energy Dependence of Shower Separation Quality





Summary and Outlook

- Algorithm of shower separation / reconstruction is being developed within DESY CALO group
- First results showed that reconstruction quality is sensitive to transversal and longitudinal segmentation of tile HCAL
- Quality of reconstruction gets worse with increasing tile size and going to readout scheme when layers are joined in depth
- Further development/tuning of algorithm and more detailed study are planned (from simple two particle case to realistic jets)