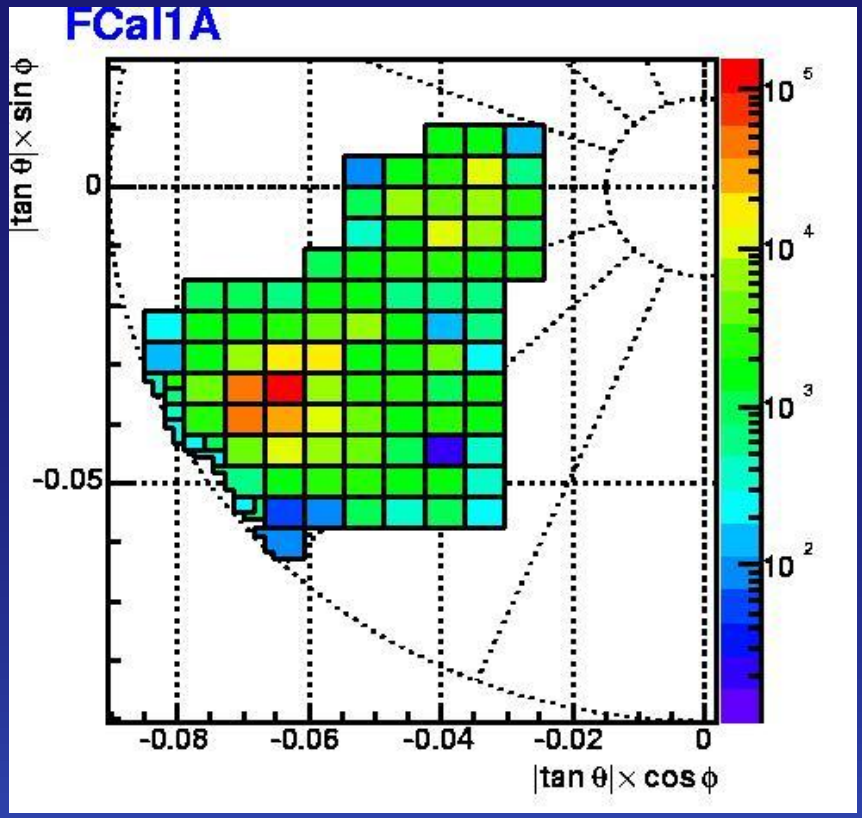
Topological Cluster Splitting & π^+/π^--Puzzle Solved

MPI Lar Meeting Sven Menke, MPI München 28. May 2004, MPI München

- `CaloTopoClusterSplitter`: the new topological cluster splitter
  - Motivation
  - Implementation in athena `8.2.0`
  - Example events
- π^+/π^--Puzzle
  - π^+-beam is really `p`-beam with some pions
  - New plots for the NIM paper (thanks Hendrik!)



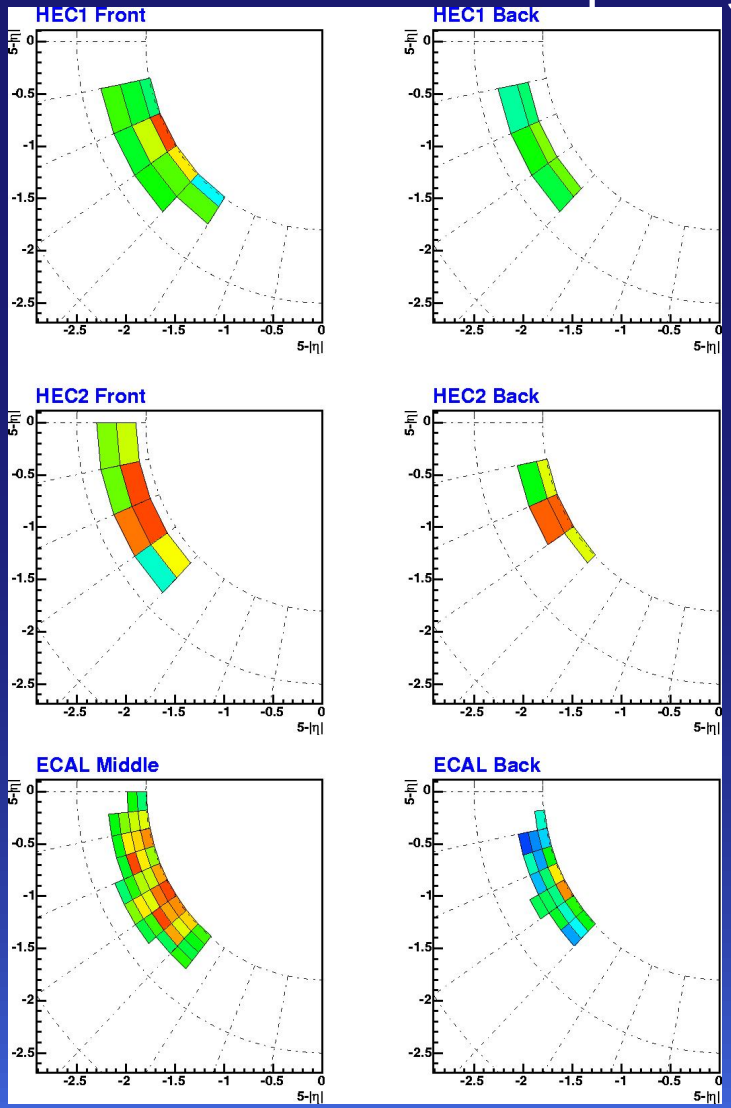
- `CaloTopoClusterMaker` makes clusters across all Calorimeters (`LArNeighbourOption::super3D`)
  - based on Signal over Noise thresholds
  - and topological neighbors
- Classification requires identification of “Hot-Spots”
  - need to split clusters around local maxima in real physical observable
  - transverse cell energy density $\rho_\perp = E_\perp / V$ seems best
- `CaloTopoClusterSplitter` re-clusters existing cluster into one or more clusters
  - around the local maxima above a seed threshold
  - with same (or different) topological neighbors
  - without cell or neighbor thresholds
  - keeping local maxima in separate clusters
  - with $\rho_\perp$ ordered seeds in every iteration

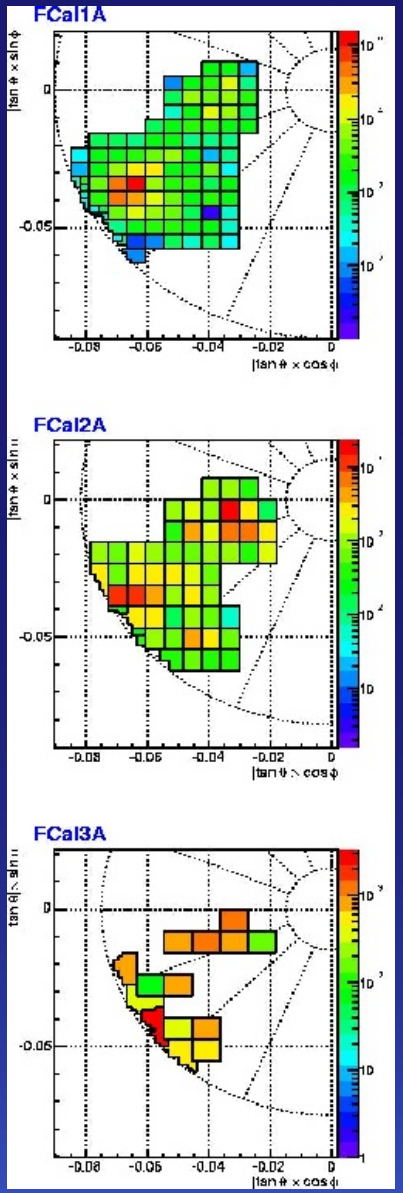
Topological Cluster Splitter ► Code

- released in `CaloRec-02-02-19` in time for athena `8.2.0`
- `CaloTopoClusterSplitter` is a `CaloClusterMakerTool` like `CaloTopoClusterMaker`
  1. loop over all `CaloCell` members of all previously made `CaloClusters`
     a) store all cells as potential neighbor cells for topological clustering; the parent cluster is kept as a reference such that only cells within the same parent cluster can be re-clustered together
     b) create a proto-cluster for each cell
     c) keep as seed cells those which are a local max ($\rho_\perp > 500\,\mathrm{MeV}/600000\,\mathrm{mm}^3$, $\rho_\perp > \max\{\rho_{\perp,\mathrm{neighbors}}\}$, $N_{\mathrm{neighbors}} \geq 4$)
  2. sort current seed cells in descending order in $\rho_\perp$ and mark them used
  3. loop over the current seed cells
     a) loop over the neighbors of the current seed cell
        i. include the neighbor cell in current proto-cluster if it is not a local max itself, does not belong to a proto-cluster of size > 1, and does belong to the same parent cluster
        ii. add the neighbor cell to the list of next seed cells if it is not marked used and mark it used
  4. copy the list of next seed cells to the current list
  5. iterate (starting at step 2) until list of current seed cells is empty
  6. copy all cells of parent clusters not re-clustered in separate clusters (one per parent cluster)
  7. remove all original `CaloClusters` and create new `CaloClusters` from the local max proto-clusters and the rest proto-clusters
- switched on by default as specified in `CaloRec/CaloTopoCluster_jobOptions.{txt,py}`

Topological Cluster Splitter ► Example Event

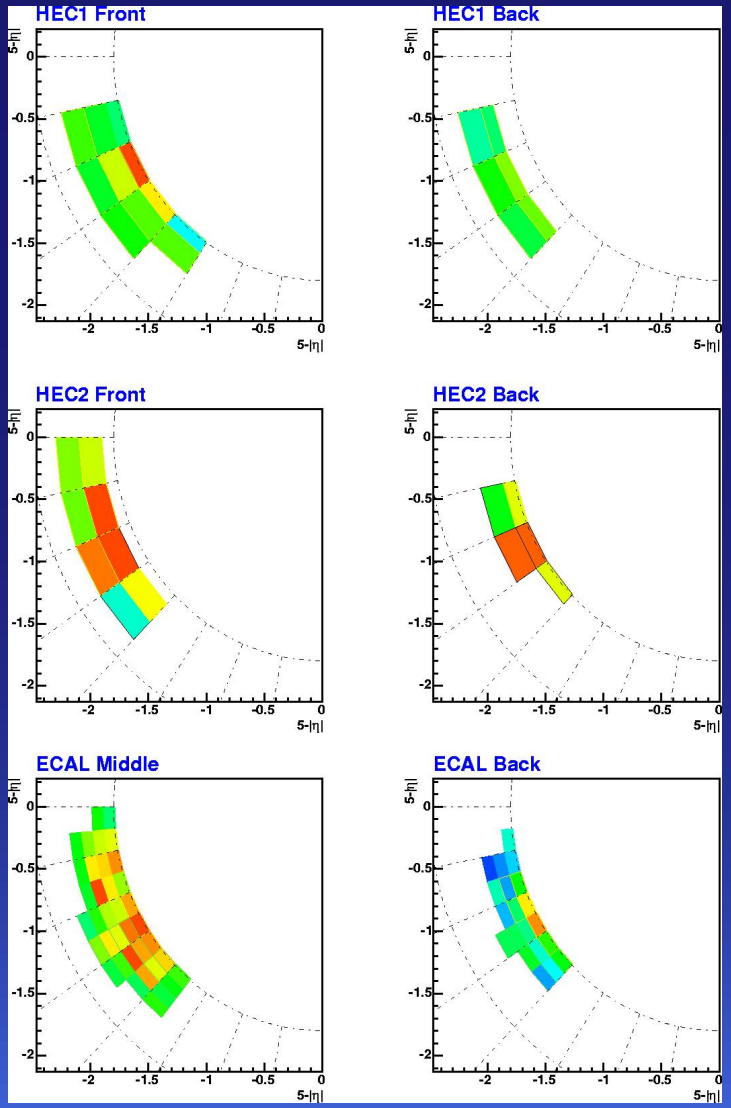
- Jet with $p_\perp > 70\,\mathrm{GeV}$, $|\eta| < 5$ in EM, HEC, FCal
- Parent Cluster before splitting

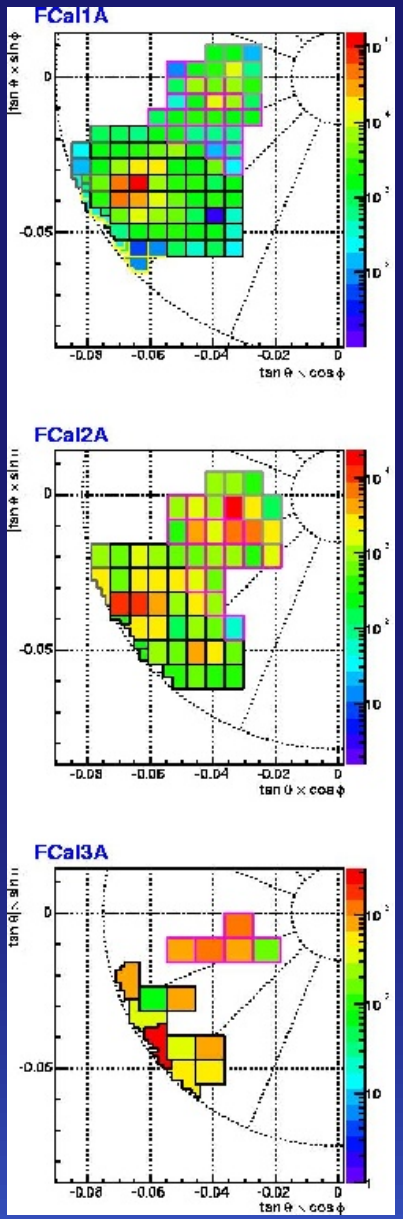




- EMEC has only 2 layers in this region
- EMEC3 neighbors HEC1
- HEC1 overlaps with the front of FCal1
- rear faces of FCal1 and 2 neighbor HEC3 and 4
- all 9 layers belong to the same cluster
- at least 4 potential local maxima visible

- same Cluster after splitting

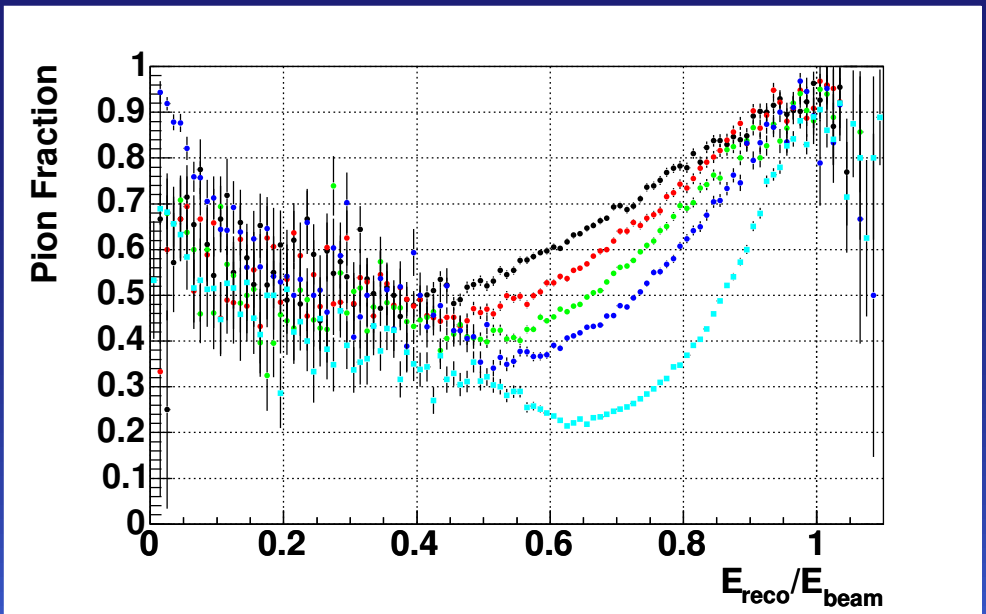


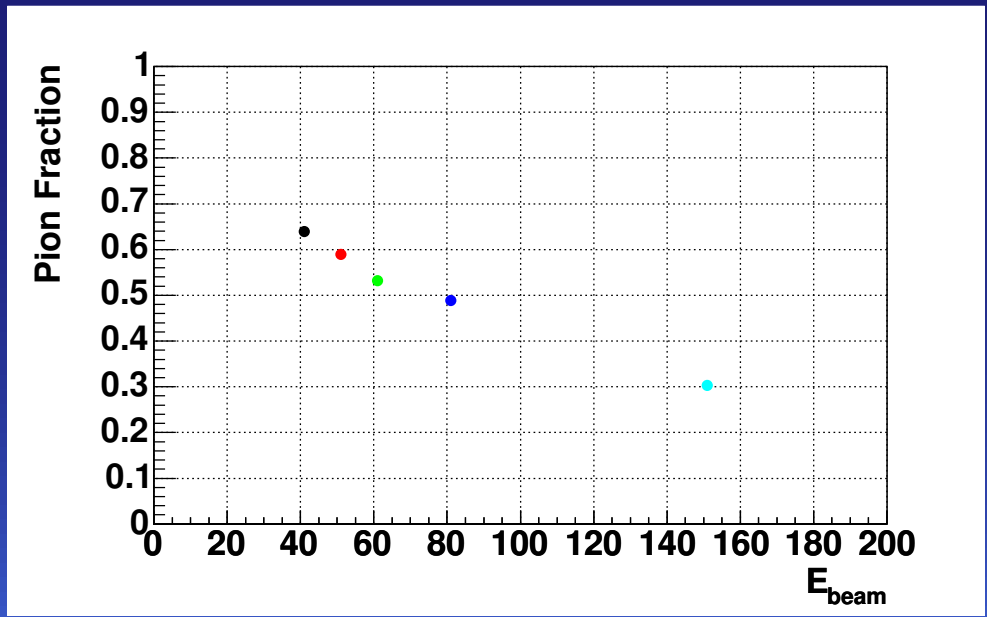


- different sub-clusters denoted by different box colors
- 7 local maxima were found in the parent cluster
- sub-clusters are also crossing system boundaries
- single γ clusters remain un-splitted

π^+/π^--Puzzle ► π^+-beam is mainly p-beam

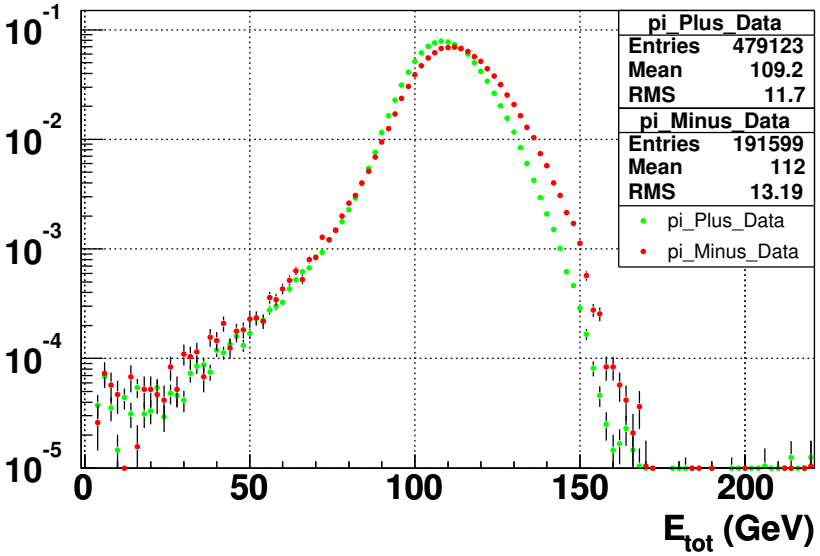
- some π^+-runs have useful CEDAR information
- CEDAR threshold for standard points at 40, 50, 60, and 80 GeV and the horizontal scan at 150 GeV such that electron-trigger selects pions, pion-trigger selects protons
- pion fraction as function of reconstructed energy shows the different response to protons and pions best
- pion fraction falls from 64 % at 40 GeV to 30 % at 80 GeV

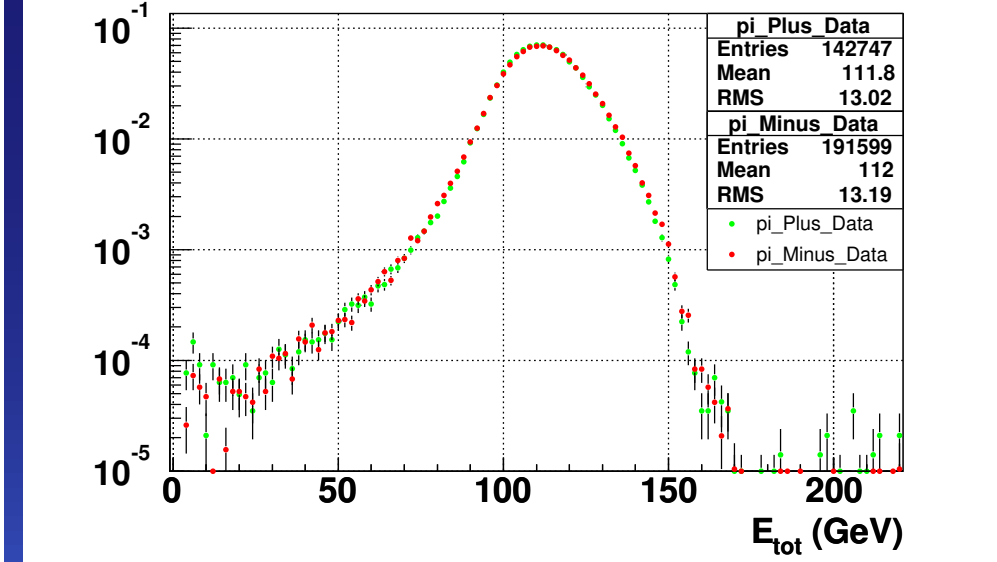




π^+/π^--Puzzle ► comparison to π^-

- comparison of π^+ horizontal scan at 150 GeV to π^- at all standard points at 150 GeV
- left plot without pion/proton separation
- right plot with protons removed
- the difference in the mean drops from 2.5 % to 0.2 %





π^+/π^--Puzzle ► new NIM paper plots

- thanks to Hendrik we have replaced all relevant NIM paper plots
- π^+ and π^- have still different symbols
- all fits to data are updated and without separating the two charges
- new draft is on the web: NIM paper: Draft 2.2