Status of Topo Clustering Splitting and Moments

Hadronic Calibration Workshop Sven Menke, MPI München 3. May 2006, MPI München

- Introduction
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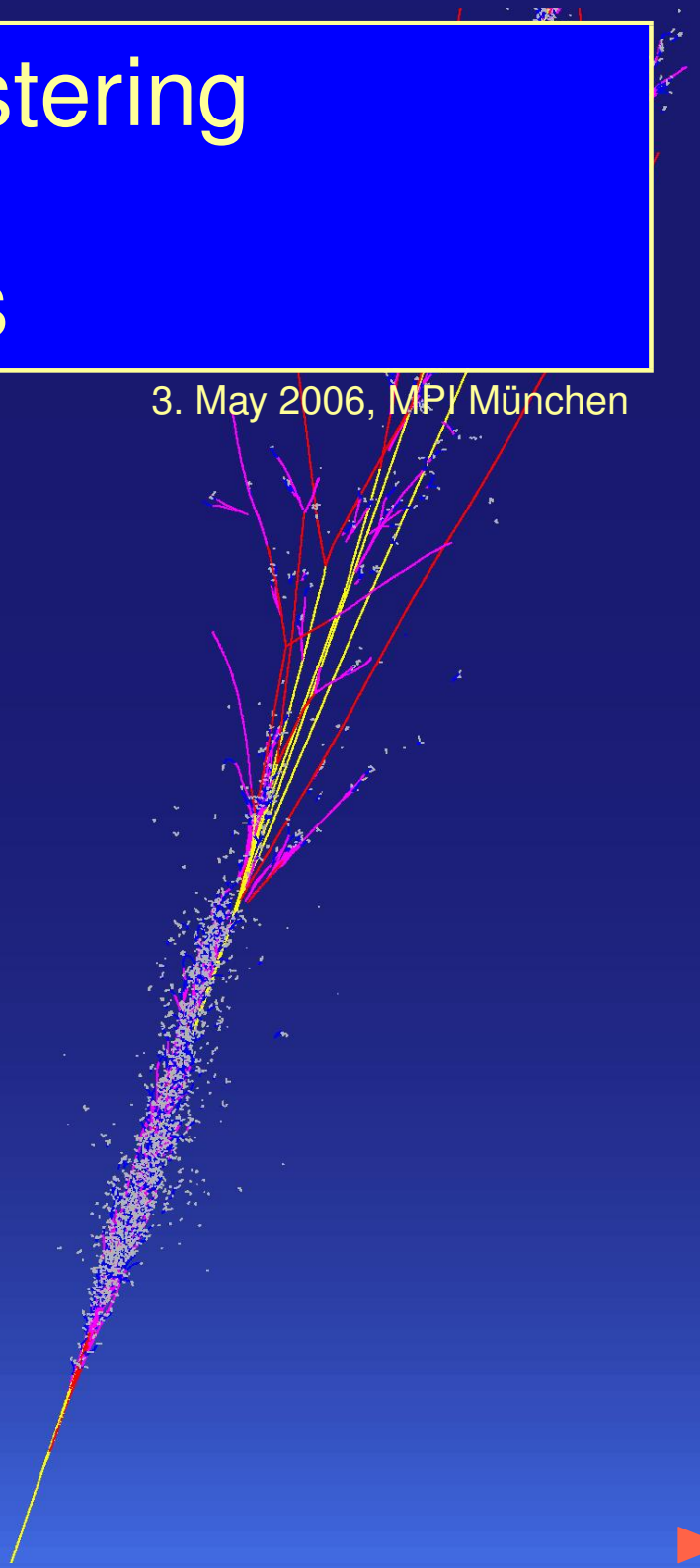
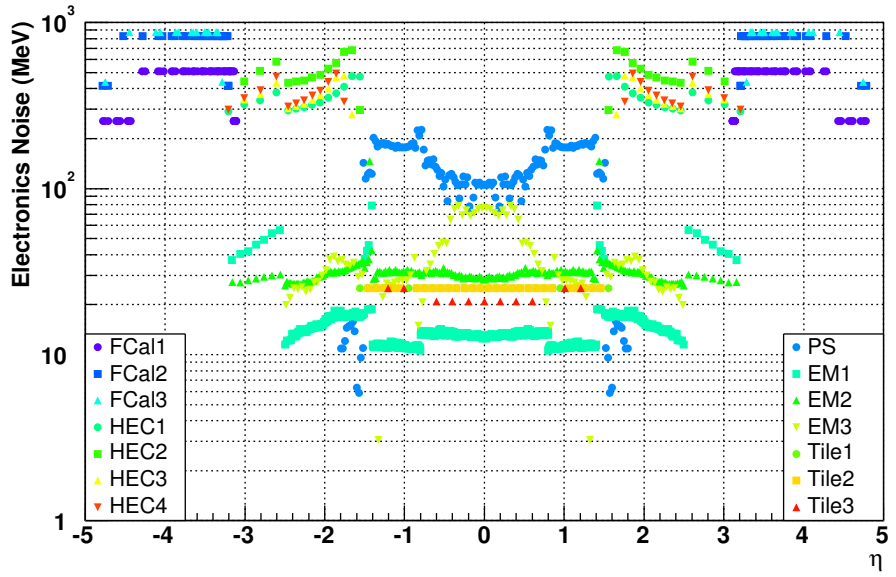


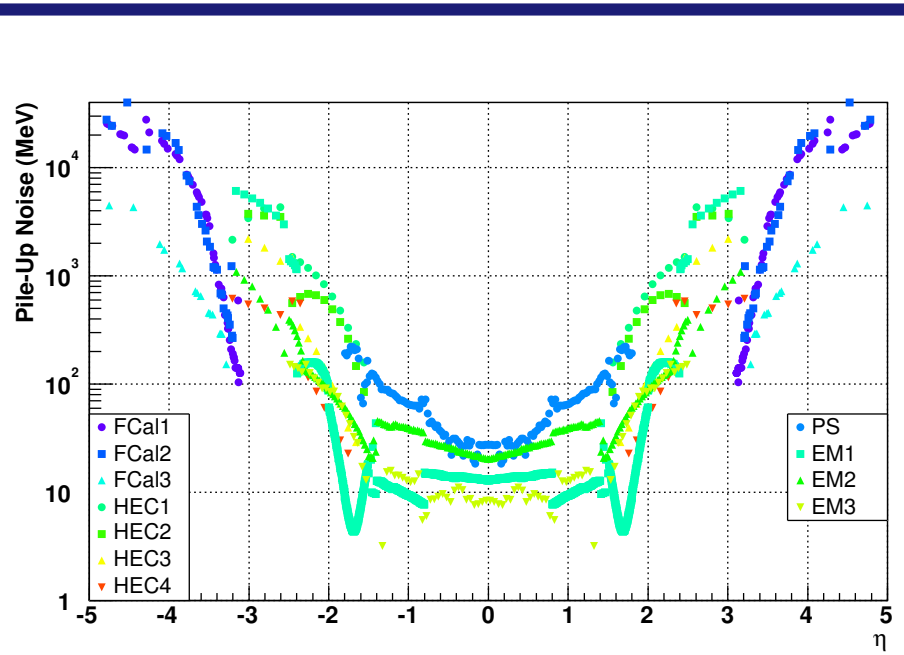
Introduction

- Topo Cluster Making/Splitting in a nutshell
- Cluster Making
  - start with all calorimeter cells and select seeds based on signal over noise thresholds
  - expand clusters in 3D around seeds with a lower signal over noise threshold and merge those with common neighbors
  - include finally all cells on the cluster perimeter with yet a lower signal over noise threshold
- Cluster Splitting
  - find local maxima in transverse energy density and above a threshold in clustered cells
  - expand clusters in 3D around maxima without threshold and share common neighbors
- Moments
  - calculate global cluster quantities based on cell constituents prior to calibration

Status of Clustering

- `CaloTopoClusterMaker`
  - thresholds `4/2/0` are used for the `TopoCluster`
  - thresholds `6/3/3` are used for the `EMTopoCluster`
  - units are in noise σ with the quadratic sum of electronics noise RMS and pile-up RMS by default
  - individual samplings can be excluded from forming seeds – useful for muonic clusters
- plots show electronics noise (top) and pile-up noise (bottom) for $L = 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-2}$

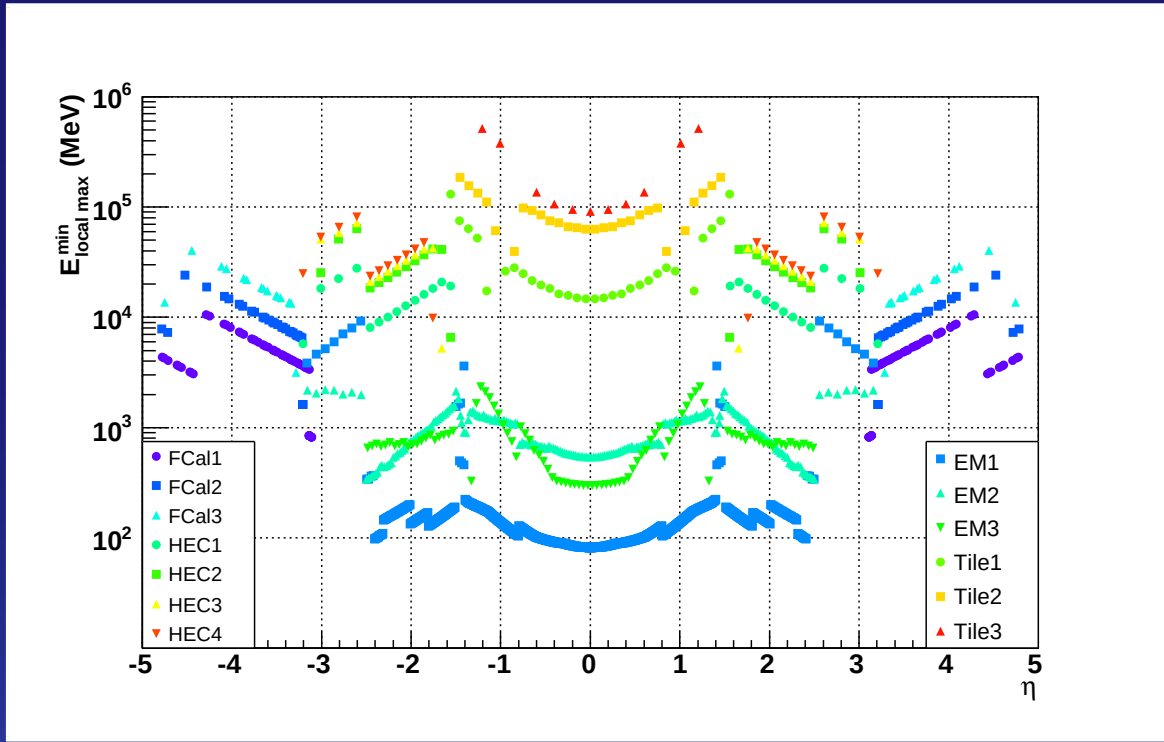




Status of Clustering

CaloTopoClusterSplitter

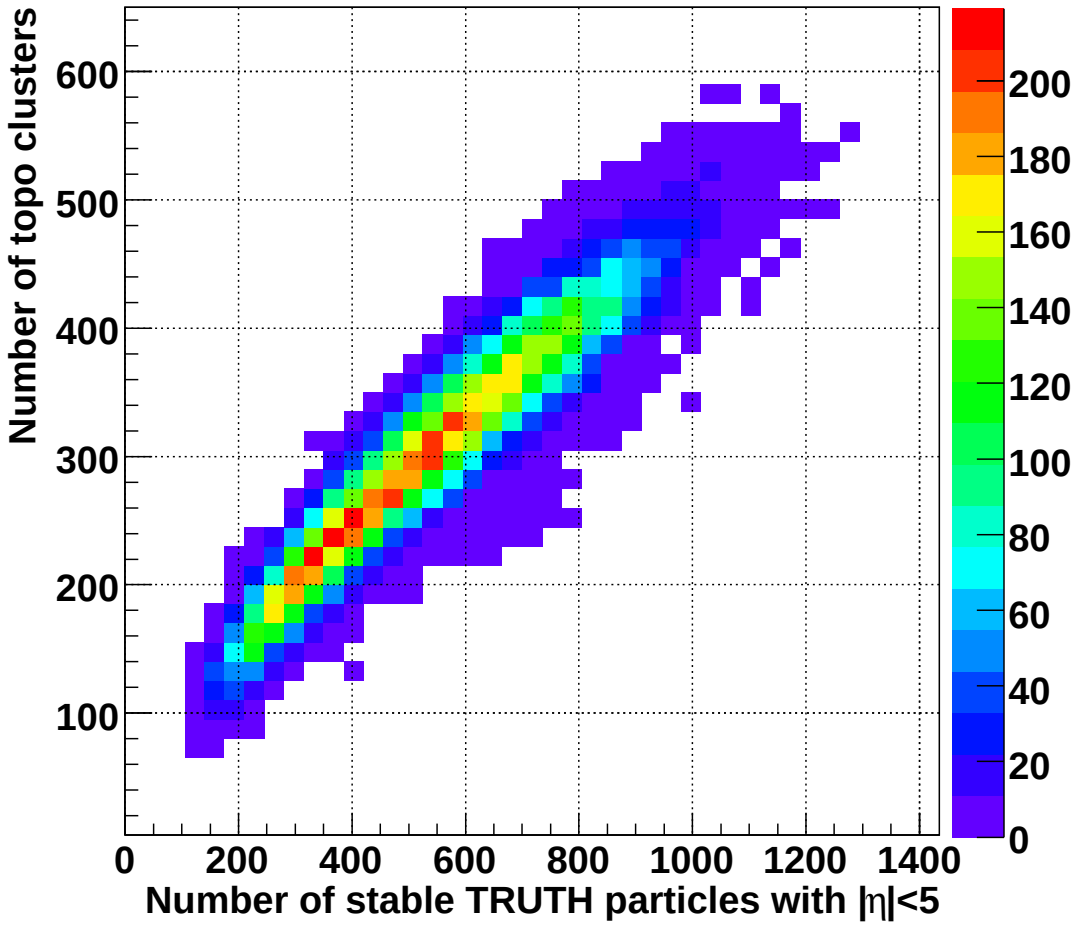
- clusters are re-arranged around local maxima with $E_{\perp}/V > 500\,\mathrm{MeV}/6\,10^{6}\,\mathrm{mm}^{3}$
- individual samplings can be excluded from forming local maxima – by default the presamplers, strips, and the gap scintillators are excluded
- if two cells are claimed by two local maxima during the same step in re-clustering, they are first excluded from both and in the end shared between both with distance and energy dependent weights
- biggest issue is perhaps the definition of the threshold for local maxima – cells in hadronic calorimeters are too big to get a chance to form local maxima



plot shows splitter threshold

Status of Clustering

- Things to discuss
- What do we expect the splitter to do?
  - currently it splits mainly in the EM calorimeter – i.e. two or more electromagnetic showers are split
  - pion showers are not currently split, since the em component likely forms the only local maximum
  - On the particle scale the current situation is shown in the plot to the right – the number of clusters vs. the number of stable particles reaching the calorimeters in a postrome dijet sample (J4)
  - we get on average 2 particles per cluster

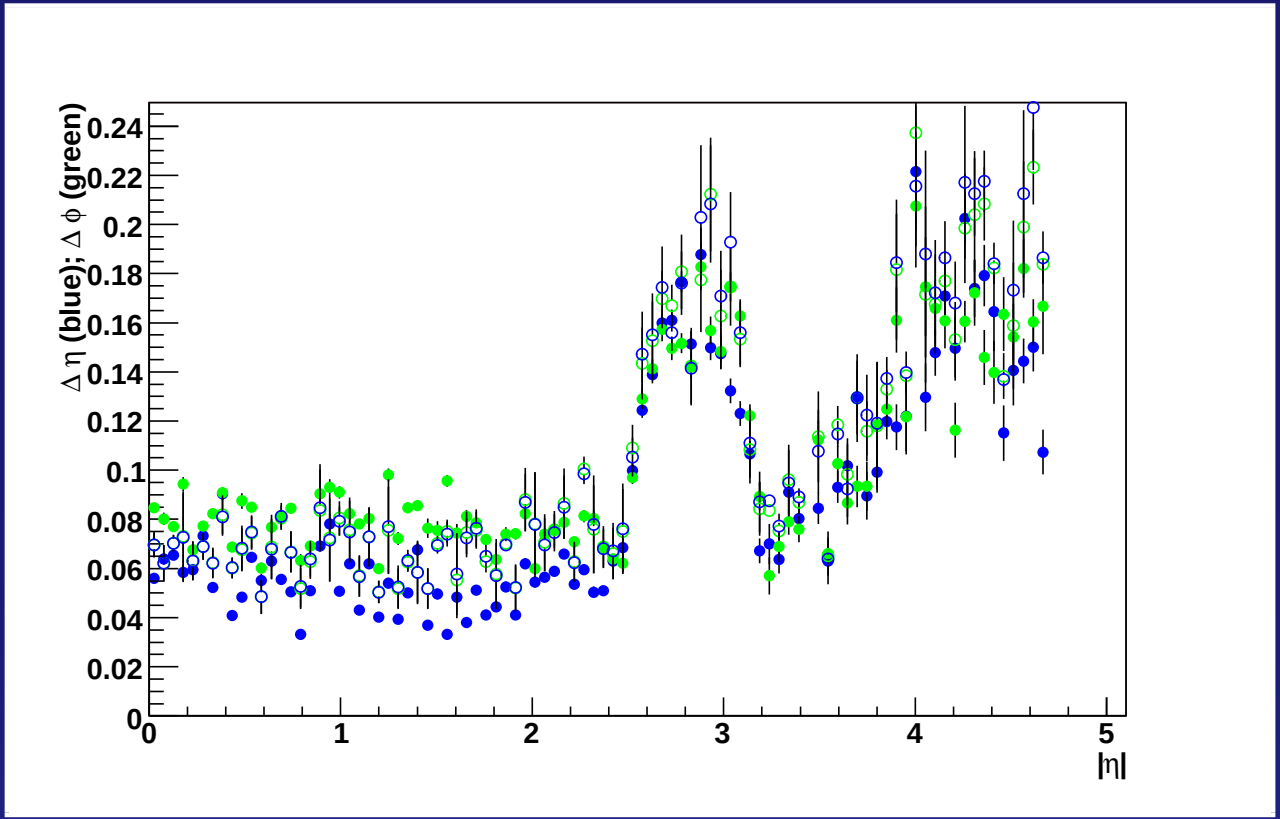


- Alternative definition for local maxima?
  - we could try transverse area density ► $E_\perp/(\Delta\eta \times \Delta\phi)$
  - do we actually want pion showers to be split (early em component and later hadronic component)?

Status of Moments

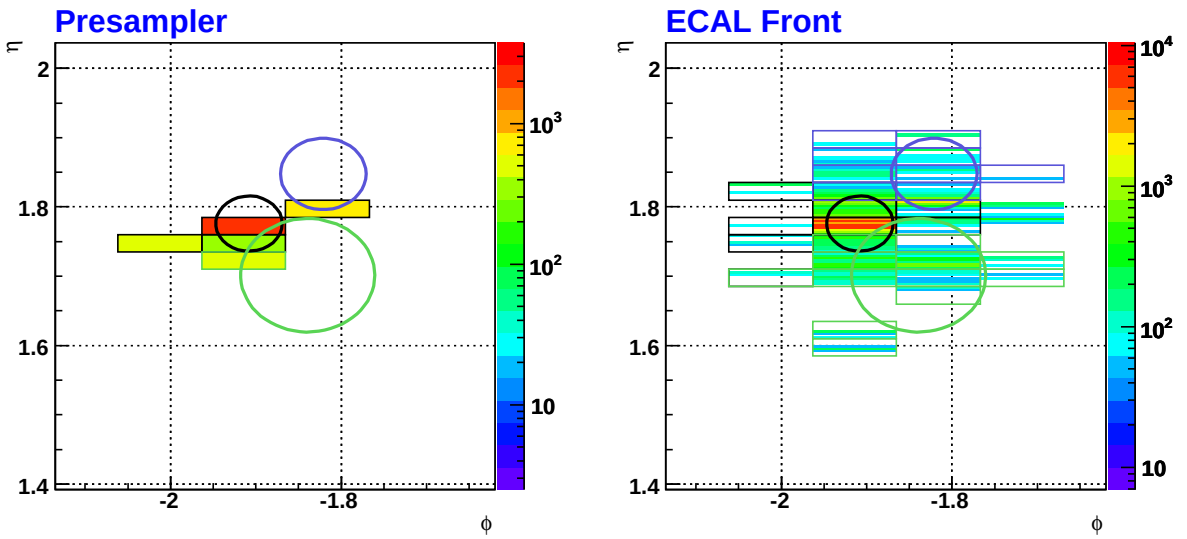
- 5 most popular moments are on AOD
  - $\langle\eta\rangle$, $\langle\phi\rangle$, $\langle r^2\rangle$, $\langle\lambda^2\rangle$, $\langle E/V\rangle$
  - with $\langle r^2\rangle$ one can calculate the core size of the cluster:
    - $\Delta\phi = \text{atan}\left(\sqrt{\frac{\langle r^2\rangle}{x_{\text{cent}}^2 + y_{\text{cent}}^2}}\right)$
    - $\Delta\eta =$

$$\left|\langle\eta\rangle + \log\left(\tan\left(\frac{2\,\text{atan}(\exp(-\langle\eta\rangle)) - \text{atan}\left(\sqrt{\frac{\langle r^2\rangle}{x_{\text{cent}}^2+y_{\text{cent}}^2+z_{\text{cent}}^2}}\right)}{2}\right)\right)\right|$$



- plot shows that the so calculated sizes (open circles) are very close to simple averages of $|\Delta\eta|$ and $|\Delta\phi|$ over the cell constituents (closed circles)
- also $\Delta\eta$ and $\Delta\phi$ are almost identical
- the simpler formula of $\Delta\phi$ can be used for $\Delta\eta$ too

Status of Moments ► Cluster Size Example



- plot shows example of three clusters in a QCD jet with circles indicating the calculated core size
- clusters can extend beyond the calculated sizes
- core circles can overlap

Persistency Issues

- Cell weights, calibration, cluster quantities etc.
  - current cluster making updates the cluster energy, η and ϕ and the corresponding sampling quantities whenever the weight of a cell is changed or a cell is added/subtracted to/from the cluster
  - geometrical weights and calibrations are not separated
  - lots of people would like to get access to em quantities i.e. cells and sampling info with geomterical weights only
  - this is not possible in the current design
  - exceptions are the cluster moments, which are calculated once on the em scale after splitting
- do we want sampling data on em scale or with calibration constants?
- do we want sampling data on the AOD?
- do we want sampling data to be treated like moments?
- some people even want to have cell weights on the em scale on the ESD/AOD

Conclusions

- Topo Cluster Maker
  - latest code change 6 months ago – new feature to exclude certain samplings from seed finding
  - are we happy with the thresholds?
- Topo Cluster Splitter
  - latest code change 6 months ago – shared cells take distance to cluster centers into account
  - is current definition of local maxima sufficient?
- Moments
  - core size estimates as an example of moments application
  - more/less/other moments to be implemented?
- Persistency
  - lots of requests to get cells or at least layer sums on EM scale on AOD
  - no easy task for technical reasons, size constraints and AOD purpose