



SDHCAL Cosmics ray Analysis

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Reconstruction steps

- Use Trivent to Select the candidates events with parameters :
 - Time cluster size = $5 * 200\text{ns}$
 - Noise cut ≥ 5 hits (on full detector)
 - Nbr of fired layer ≥ 5
- Cleaning and Clustering
- Calibration.
- Run nbr: 710515 (Cosmic run taken before CERN TB)

Cleaning

Cleaning :

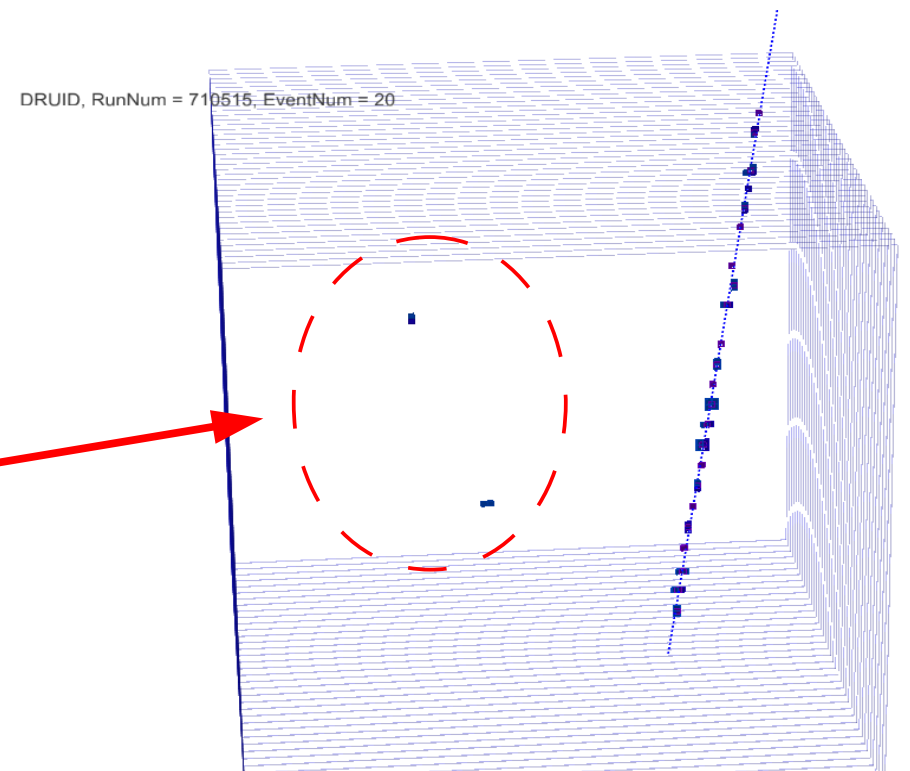
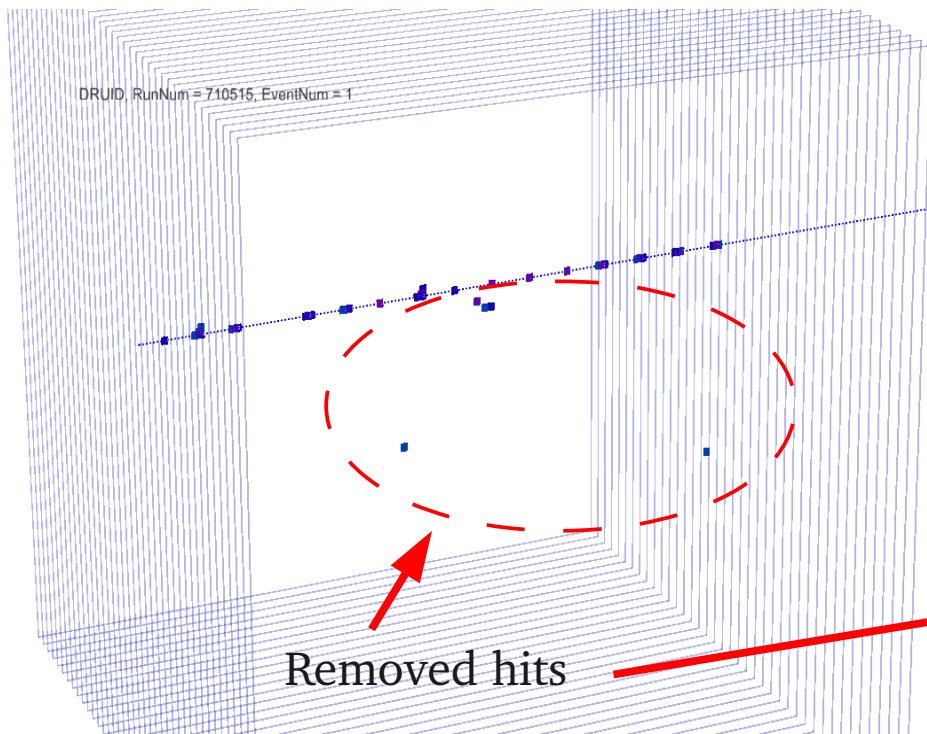
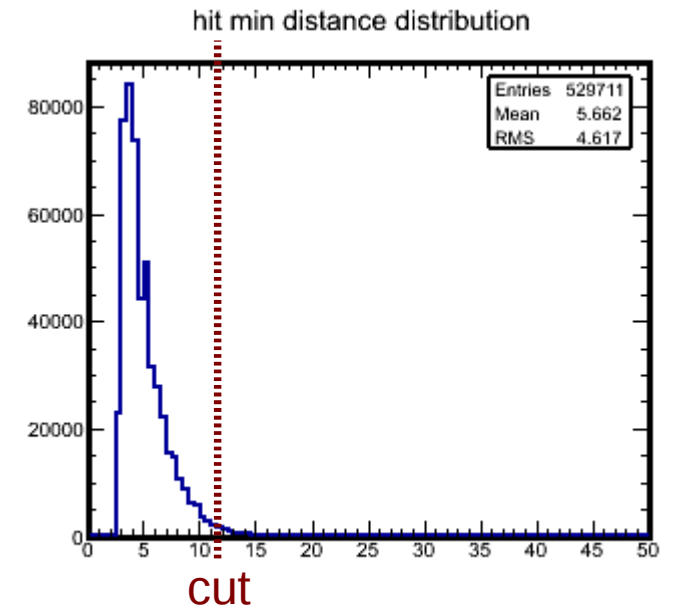
Remove the far hits $\min(\text{Euclidean_dist}(\text{hits}, \text{set of hits})) > 12\text{cm}$

Clustering (neighbor clustering next slide)

Do the fit excluding layer with $N_{\text{cluster}} > 1$

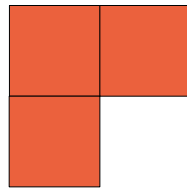
Remove the furthest clusters from the reconstructed track.

Repeat the fit with selected clusters.

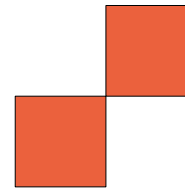


Neighbor clustering

- The hits are grouped by neighbor clustering which consist in appending the hits sharing a common side.
 - The hits joined only by vertex will be not added in the same cluster.
- The center of gravity of the hits ($\text{thr} \geq 1$) is taken as position of the cluster.
- The error of the position is calculated as X and Y spread divided by $\sqrt{12}$



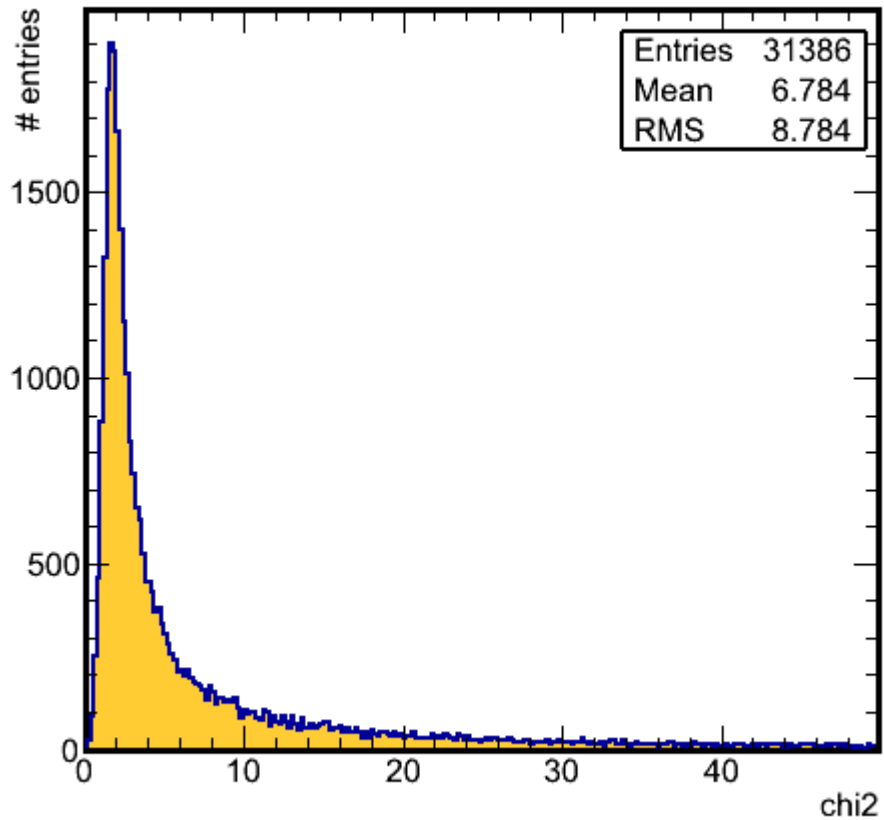
**1 cluster
with 3 hits**



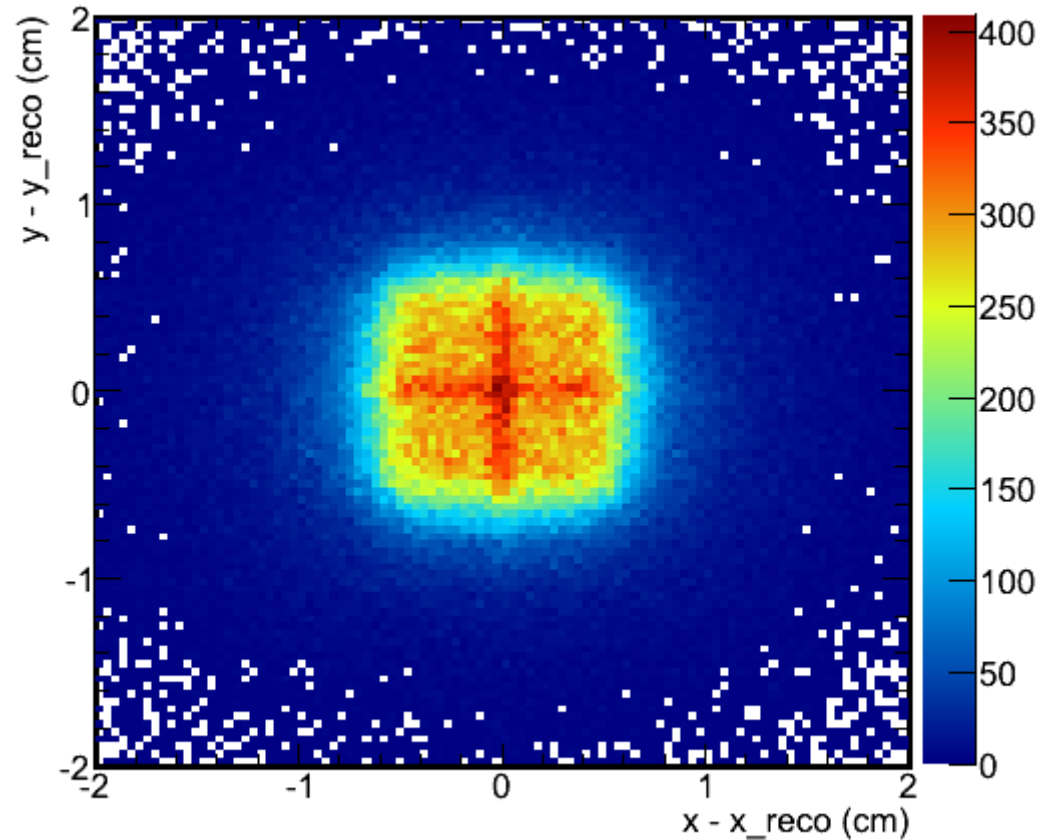
**2 cluster with
1 hit each**

Track reconstruction

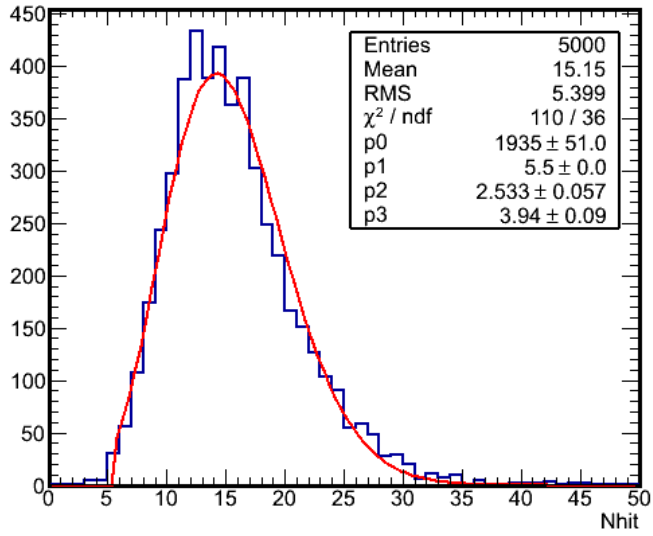
chi2 distribution



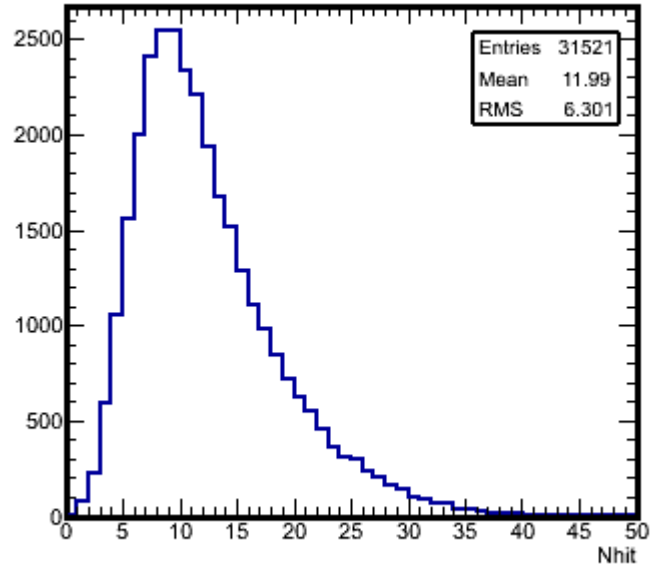
- The straight line is fitted by χ^2 minimisation.



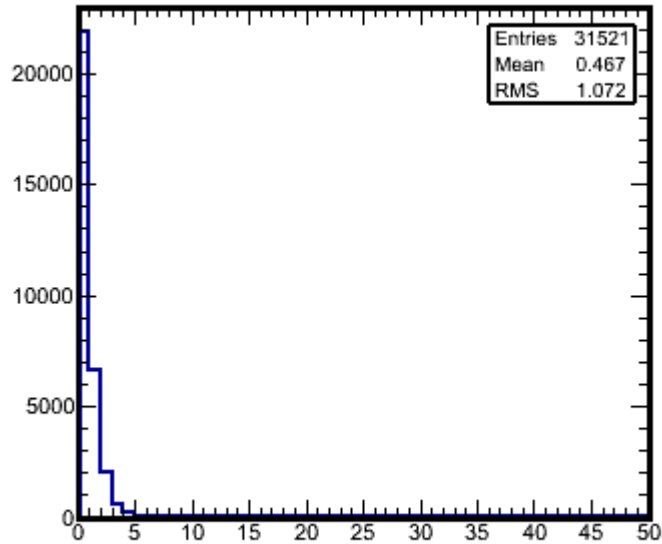
Nhit distribution or thr 0



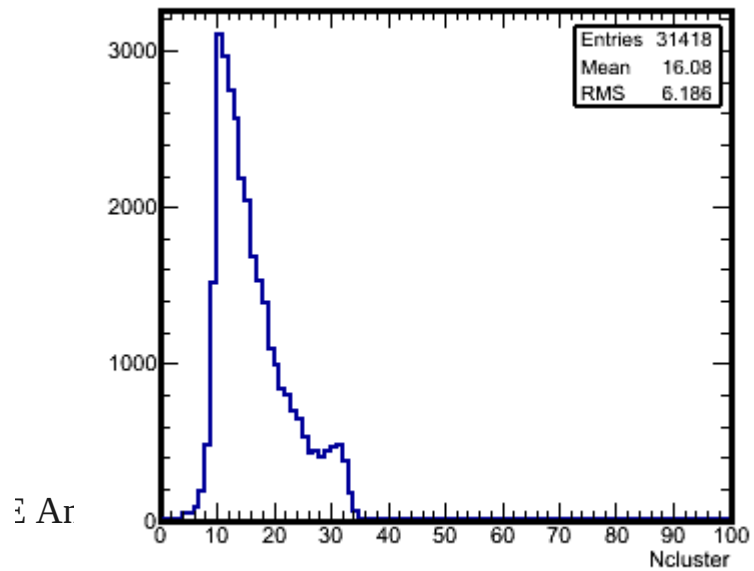
Nhit distribution for thr 2



Nhit distribution for thr 3



Ncluster distribution



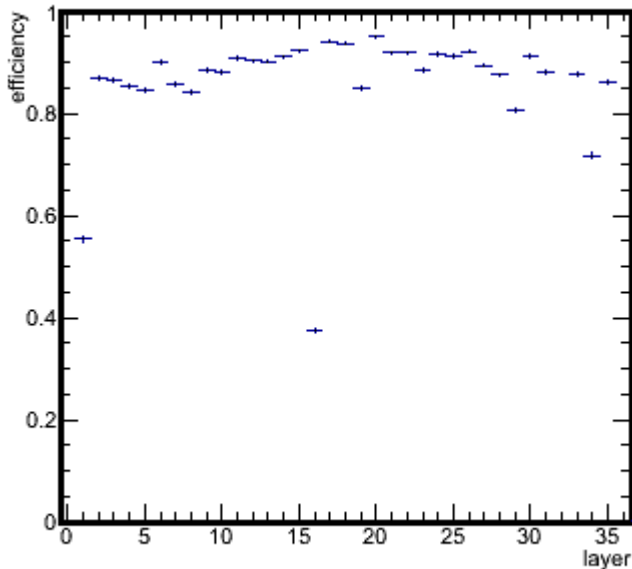
Efficiency & Multiplicity

- The efficiency of one layer is the probability to find at least 1 hit within 5 cm of reconstructed track using other layers.

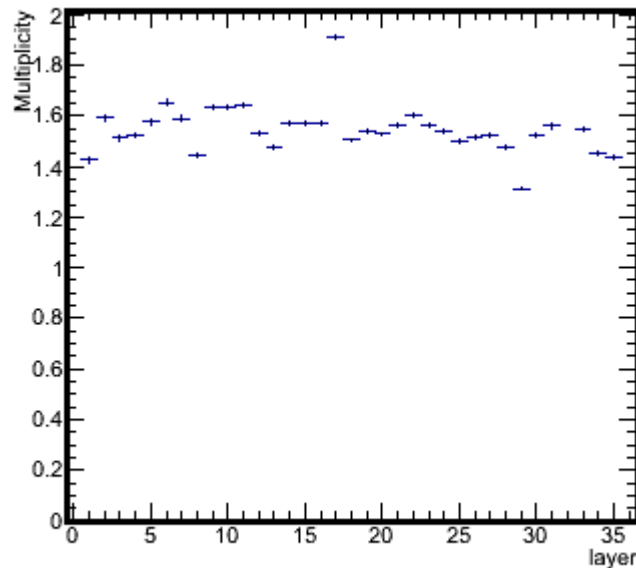
$$\varepsilon_i = \frac{\sum_{\text{track } i} (1_{N_{\text{hit}} > 0})_i}{N_{\text{track}}}$$

- Track i = reconstructed track excluding layer i
- Multiplicity = number of hits in each layer (on responding layer).
- For this study only the cluster with $N_{\text{hit}}/\text{Cluster} < 5$ are taken for reconstruction.
- The track with $\chi^2 < 20$ are taken as good track.

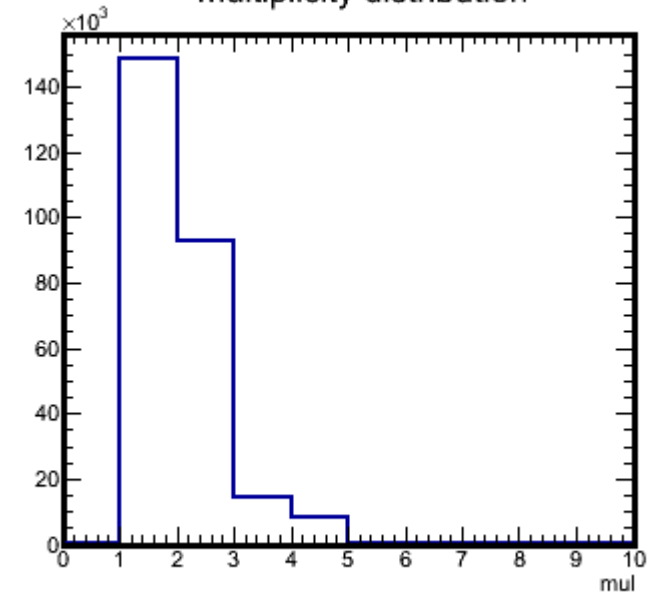
Hit efficiency vs Z



Multiplicity by Layer

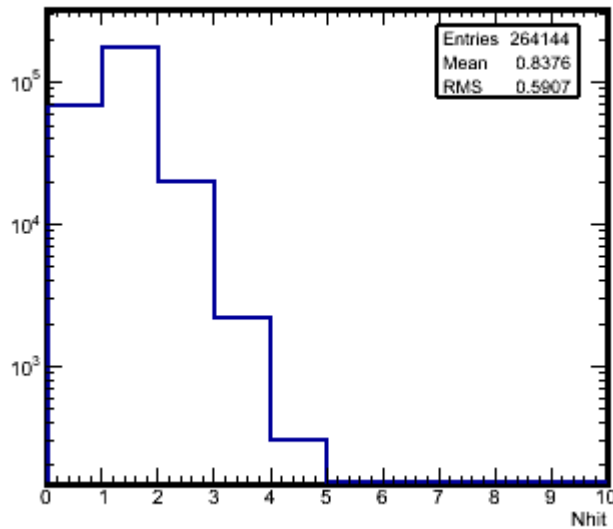


multiplicity distribution

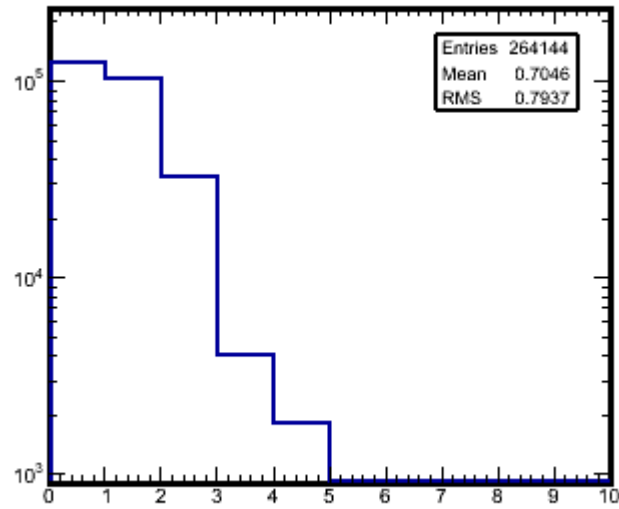


Number of hit distribution on clusters

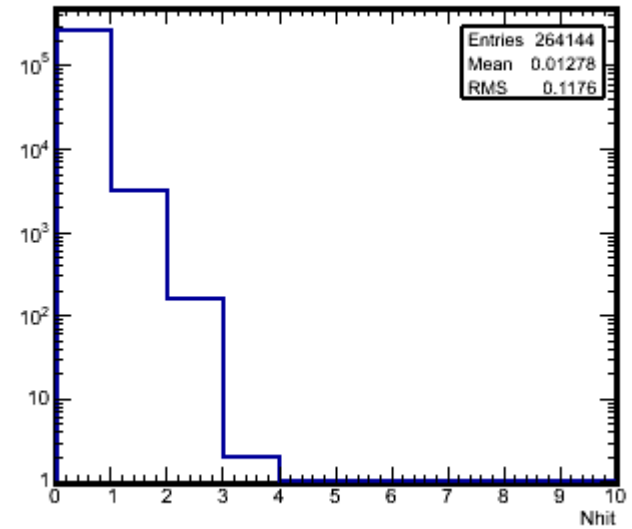
Nhit/Cluster for thr 1



Nhit/Cluster for thr 2

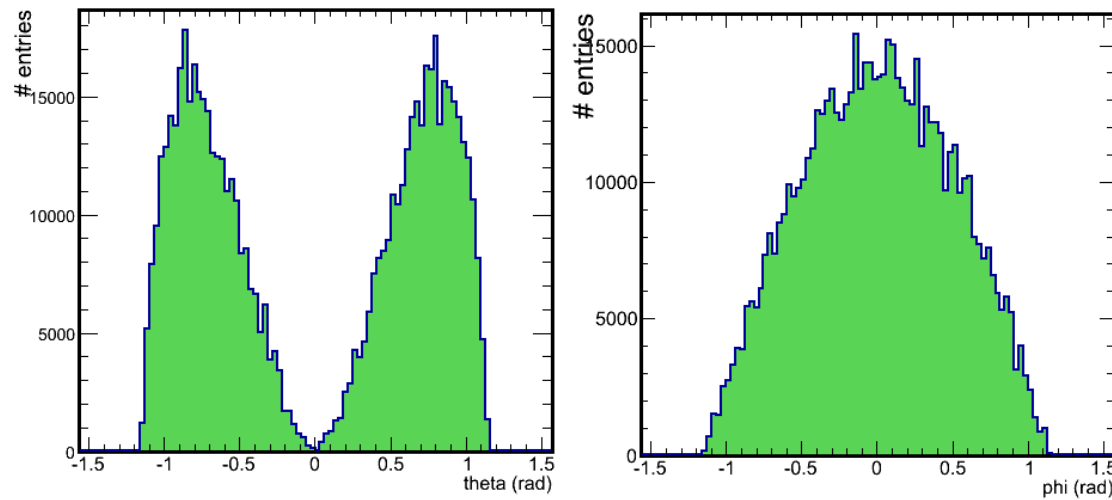


Nhit/Cluster for thr 3

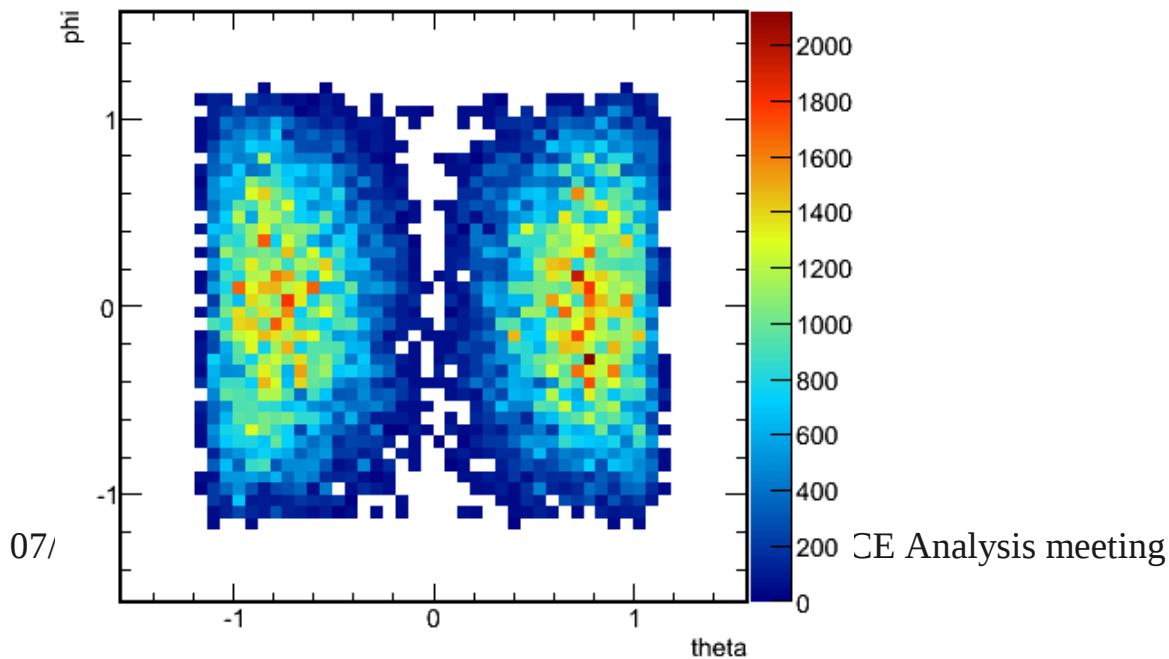
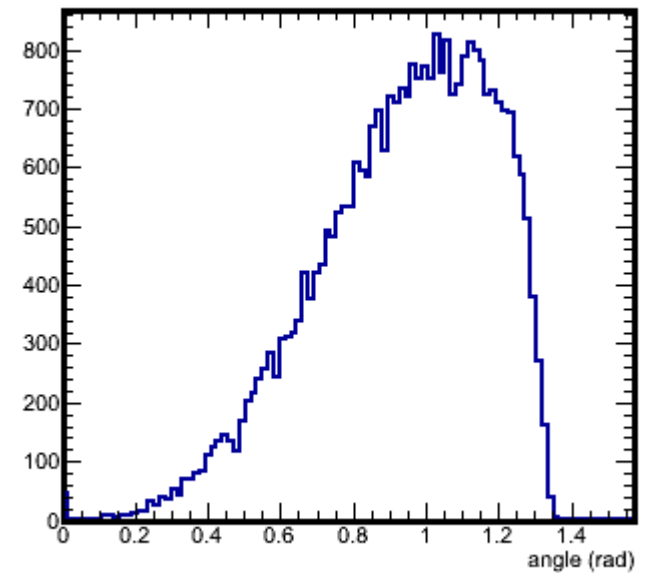


Angular distribution

- Angle distribution :
 - Theta = angle on (Y,Z) plan
 - Phi = angle on (X,Z) plan

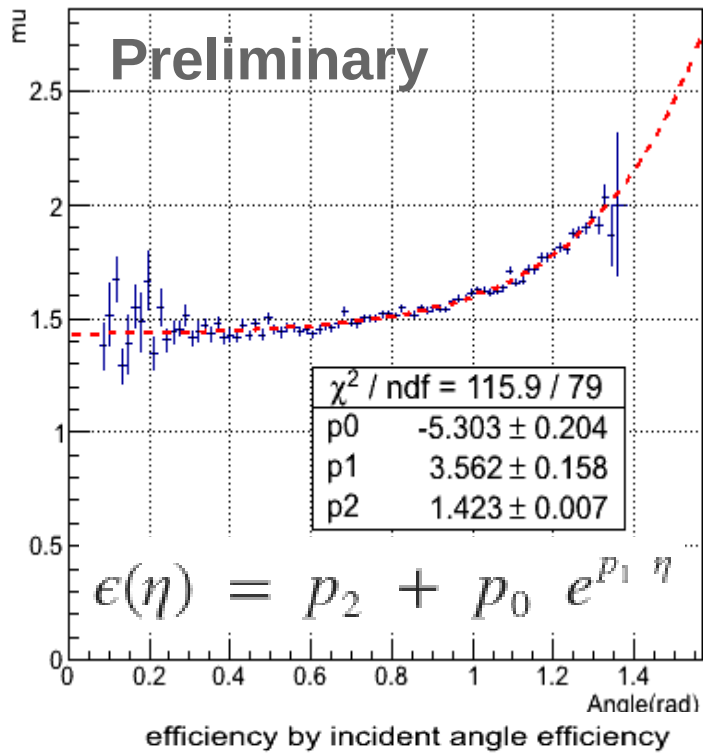


incident angle distribution



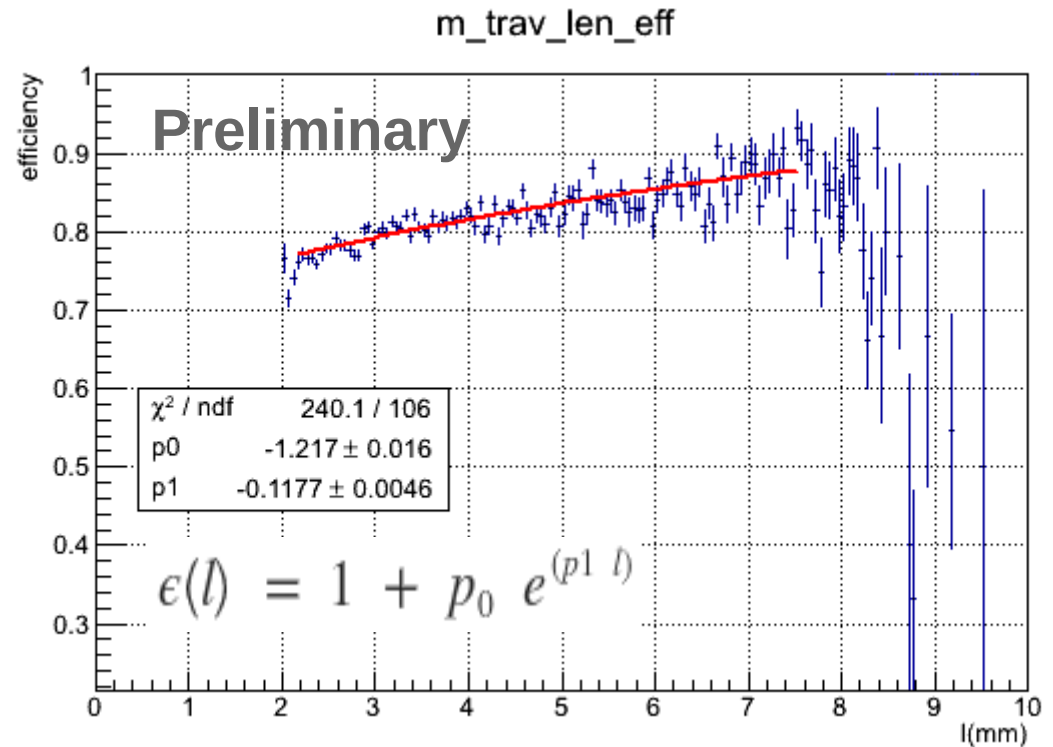
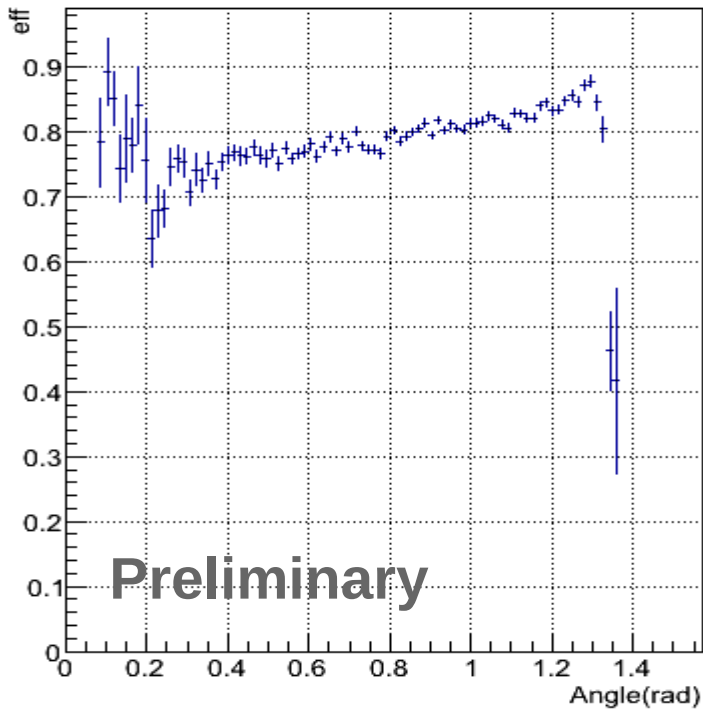
- The angle between the normal direction for the plan and reconstructed track is called incident angle (η)

multiplicity vs incident angle

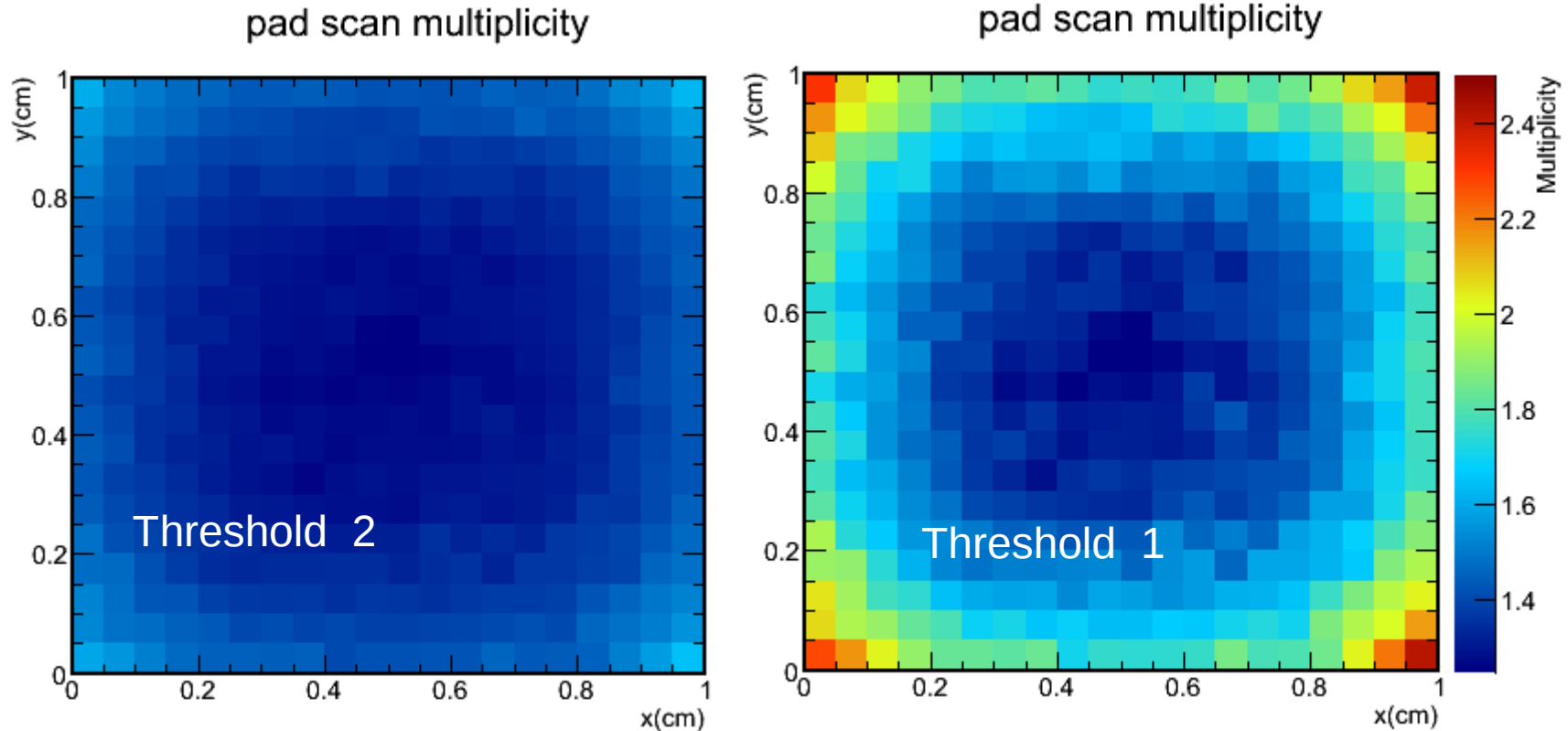


- The traveling length is the passage distance of the cosmic ray on the gas gap.

$$l = \frac{\text{gas gap}}{\cos(\eta)}$$



Scan over the pad



- The spatial multiplicity distribution depend the the shape of electronic avalanche on the gas.
- $\eta < 0.8$ rad (46°)
- Stat on thr3 is too low...

Summary

- Preliminary results on Cosmic Ray data from February 2012 show :
 - a clean distributions of Nhits for thr1,2,3
 - a clear angular dependance of the efficiency and multiplicity (large angle analysis require specific treatment {to be done})
 - a smooth distribution of multiplicity in pads (used for digitization).
- The same studies of the cosmic runs taken during the test beam are under studies and the results are coming soon.