Status of ECAL analysis

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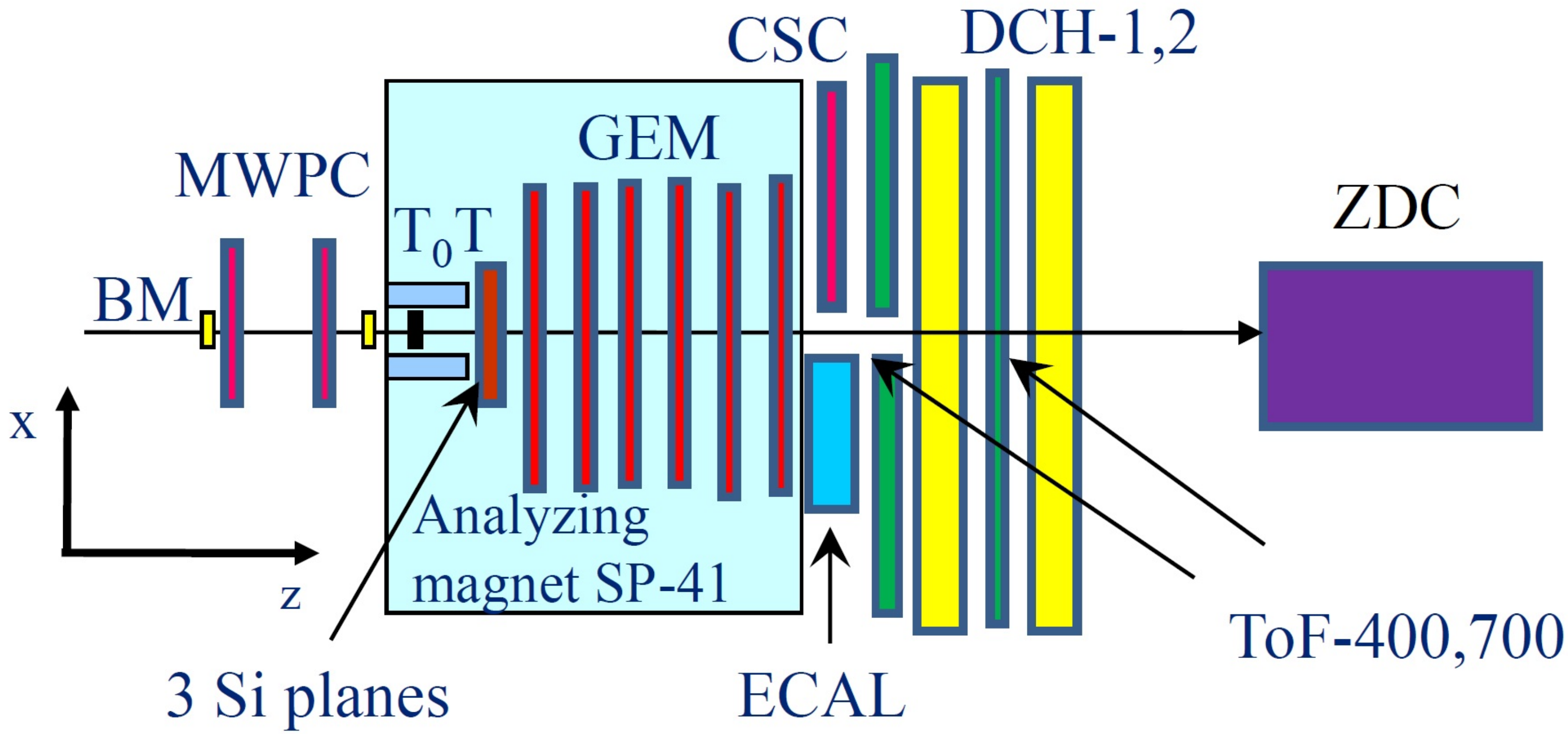
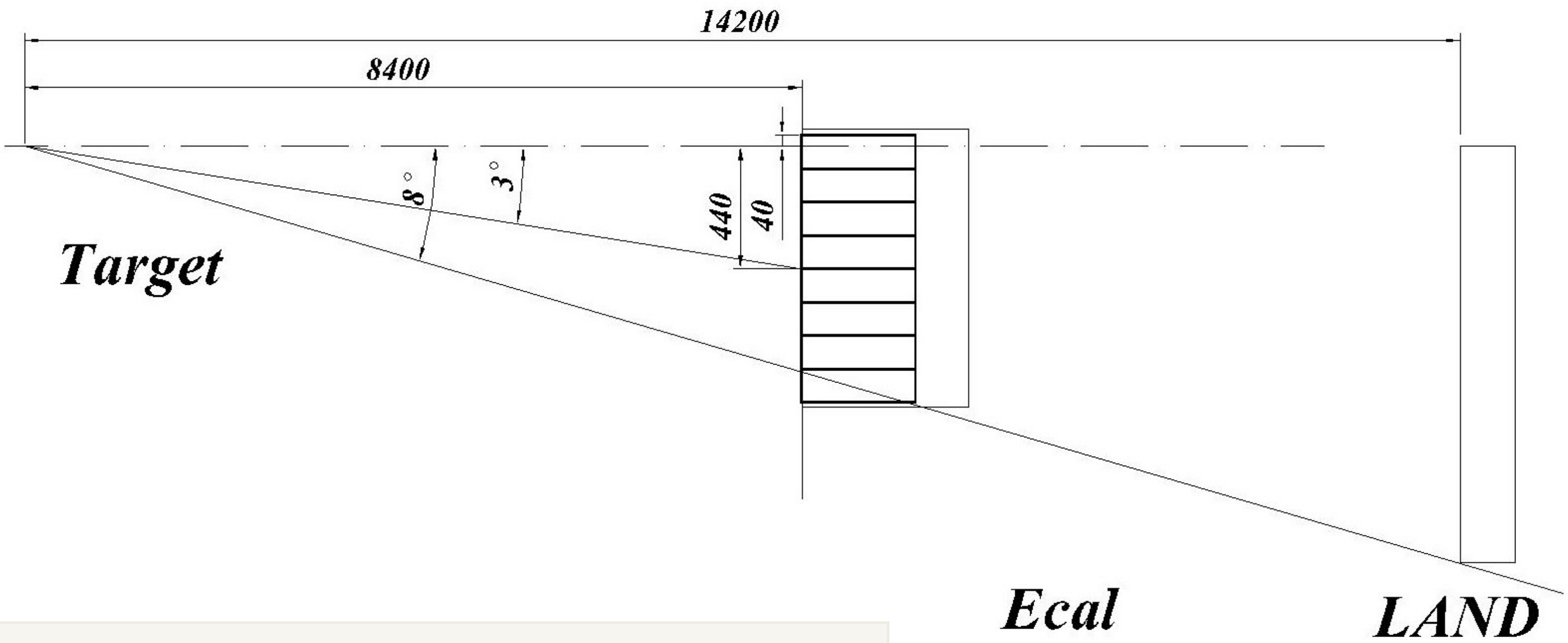


DCH-1,2 – drift chambers
ToF-400,700 – time-of-flight
ECAL – electromagnetic calorimeter
ZDC – zero degree calorimeter
T0T – T0 + trigger

Si plane – silicon detector
GEM – gas electron multipliers
BM – beam monitors
MWPC – multi wire proportional chamber
CSC – cathode strip chambers

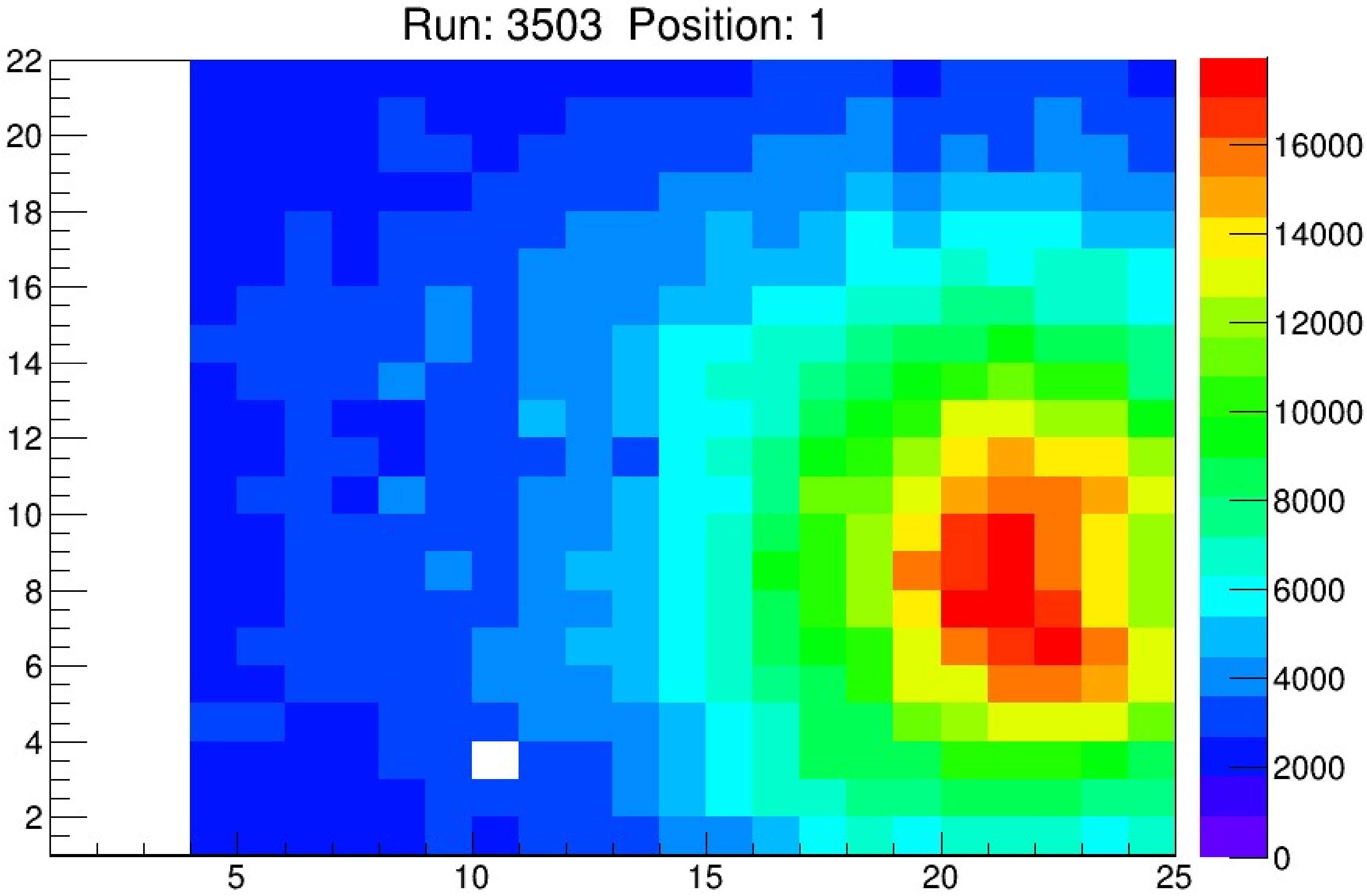
Block-scheme of the BM@N spectrometer - Run 55

The position of the ECAL during calibration, the beam of carbon.



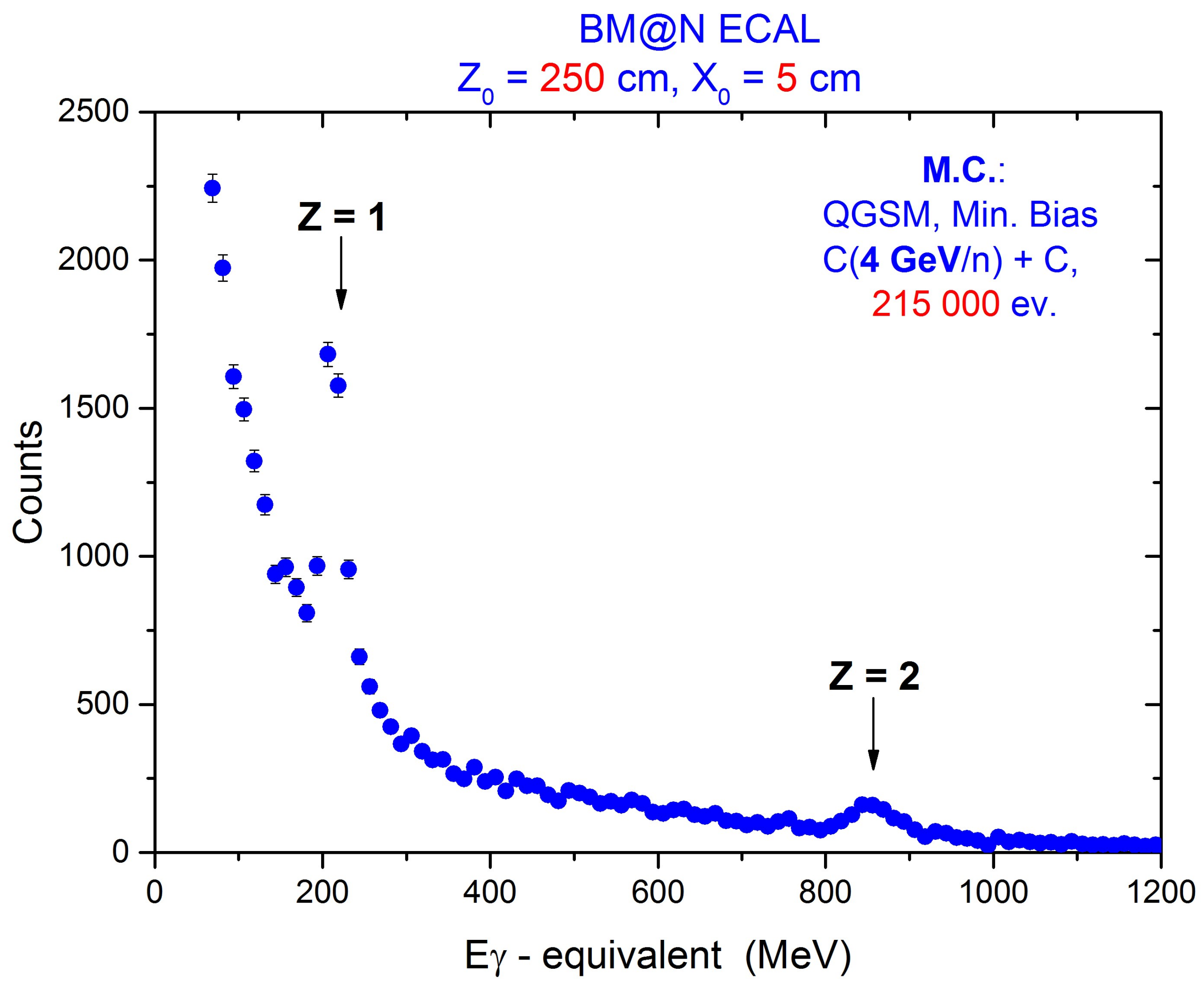
Calibration runs (3503 – 3513)	
Beam	C, 3.17 GeV/nucleon
Target	Pb
Events (B = 0)	9 x 200k
Events (B = 0.18 T)	200k

The density distribution of events by area of the ECAL



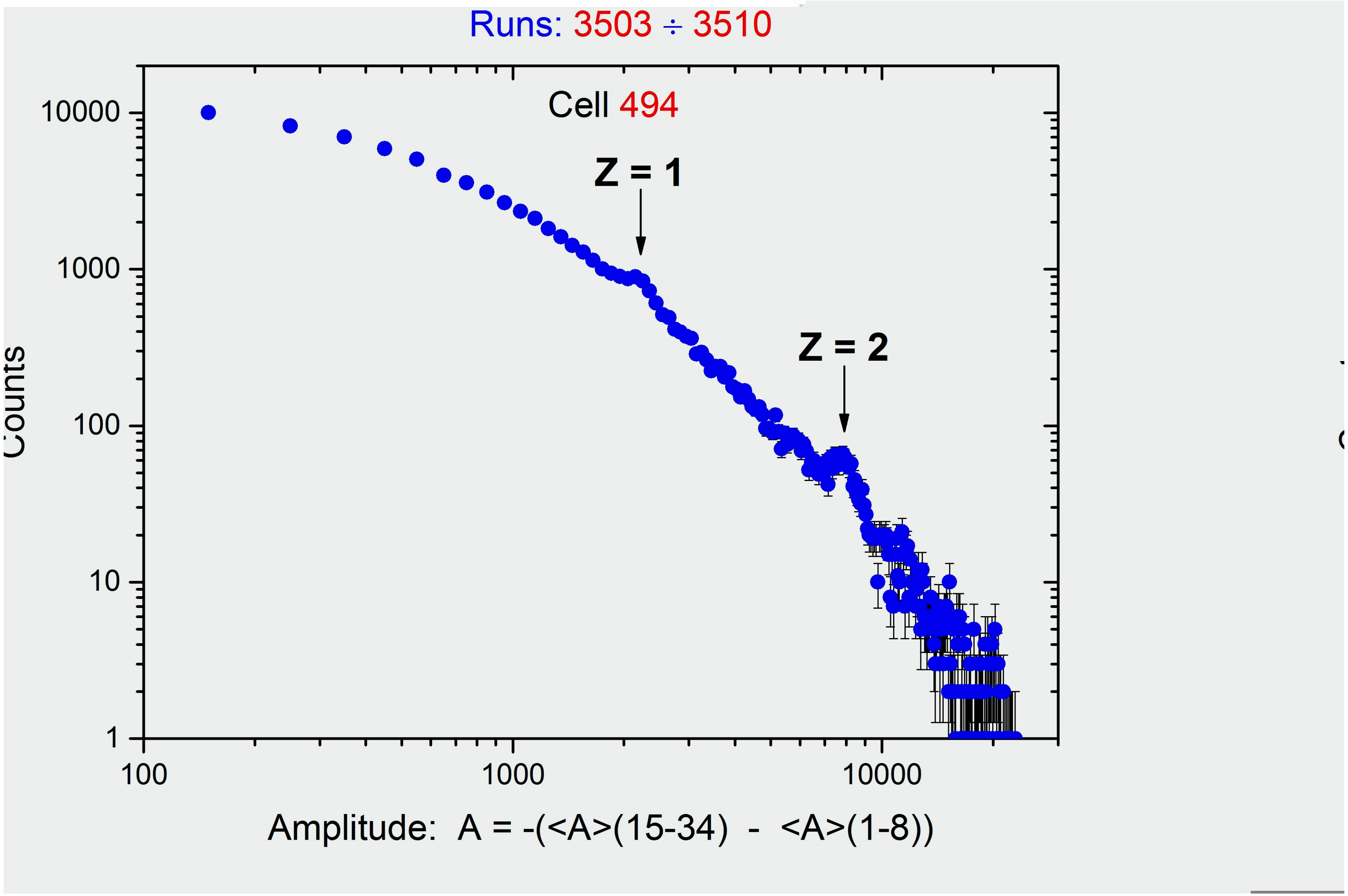
Monte Carlo simulation BM@N ECAL

Presents the amplitude distribution of signals in a single calorimeter cell, in units of photon energy equivalents. Distance of the cell edge to the beam axis, X_0=5cm



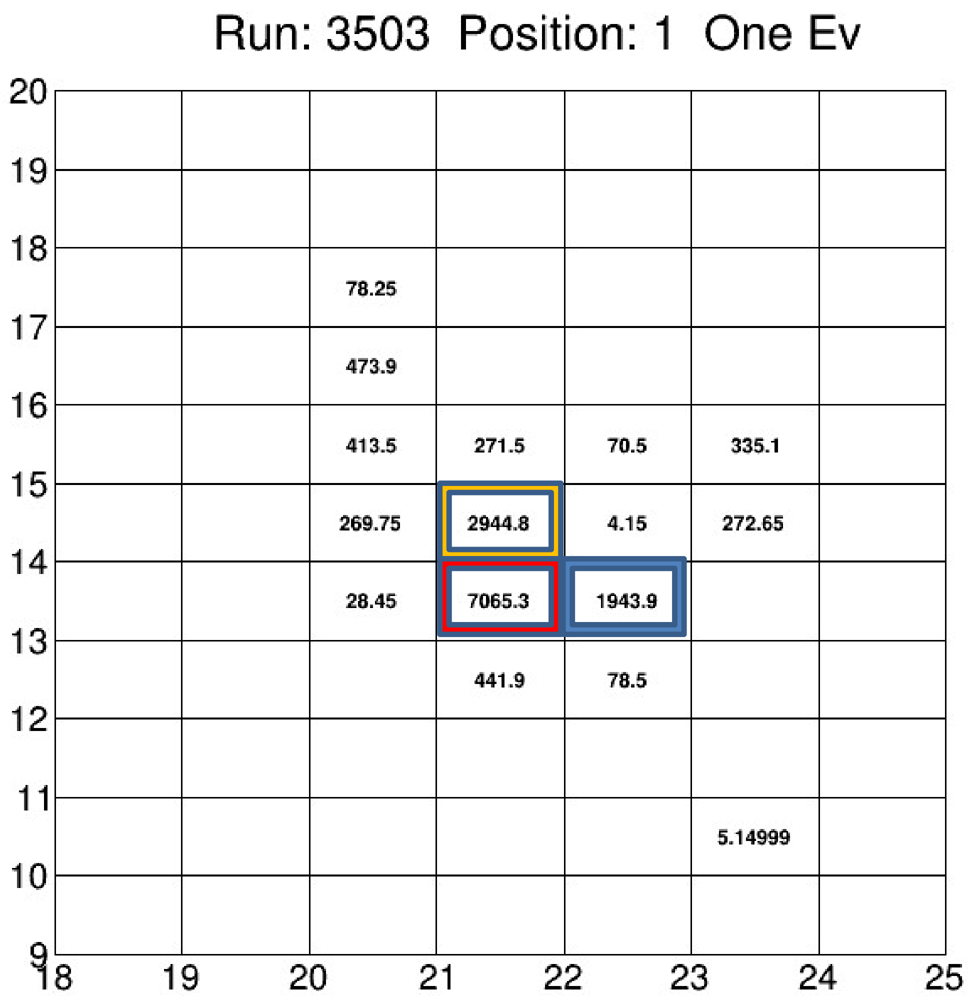
Experimental data

Amplitude spectrum of a cell over the events in the calibration runs



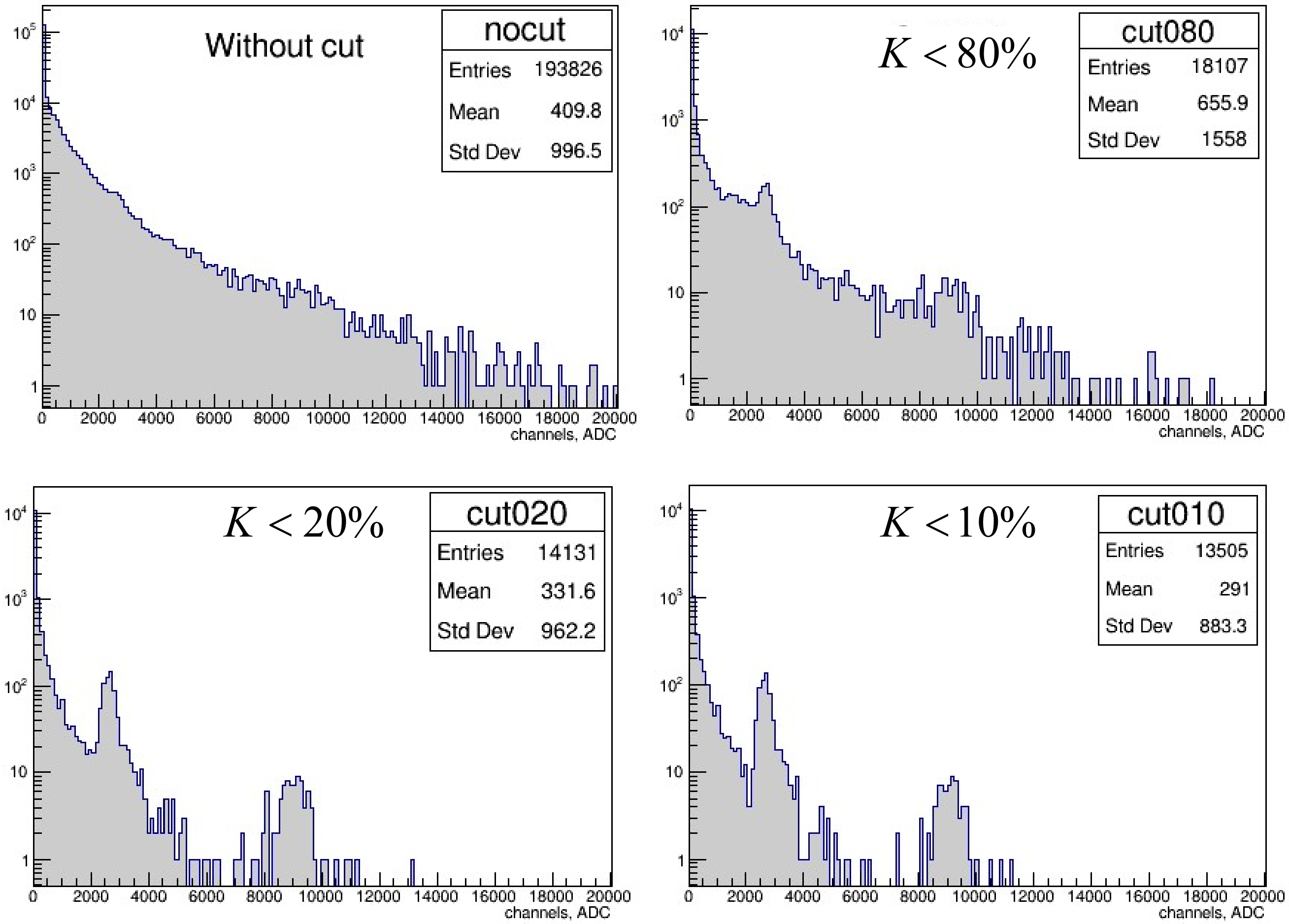
Explanation of the calibration technique

Analysis of energy distribution in the cluster – separation of non-MIP cells



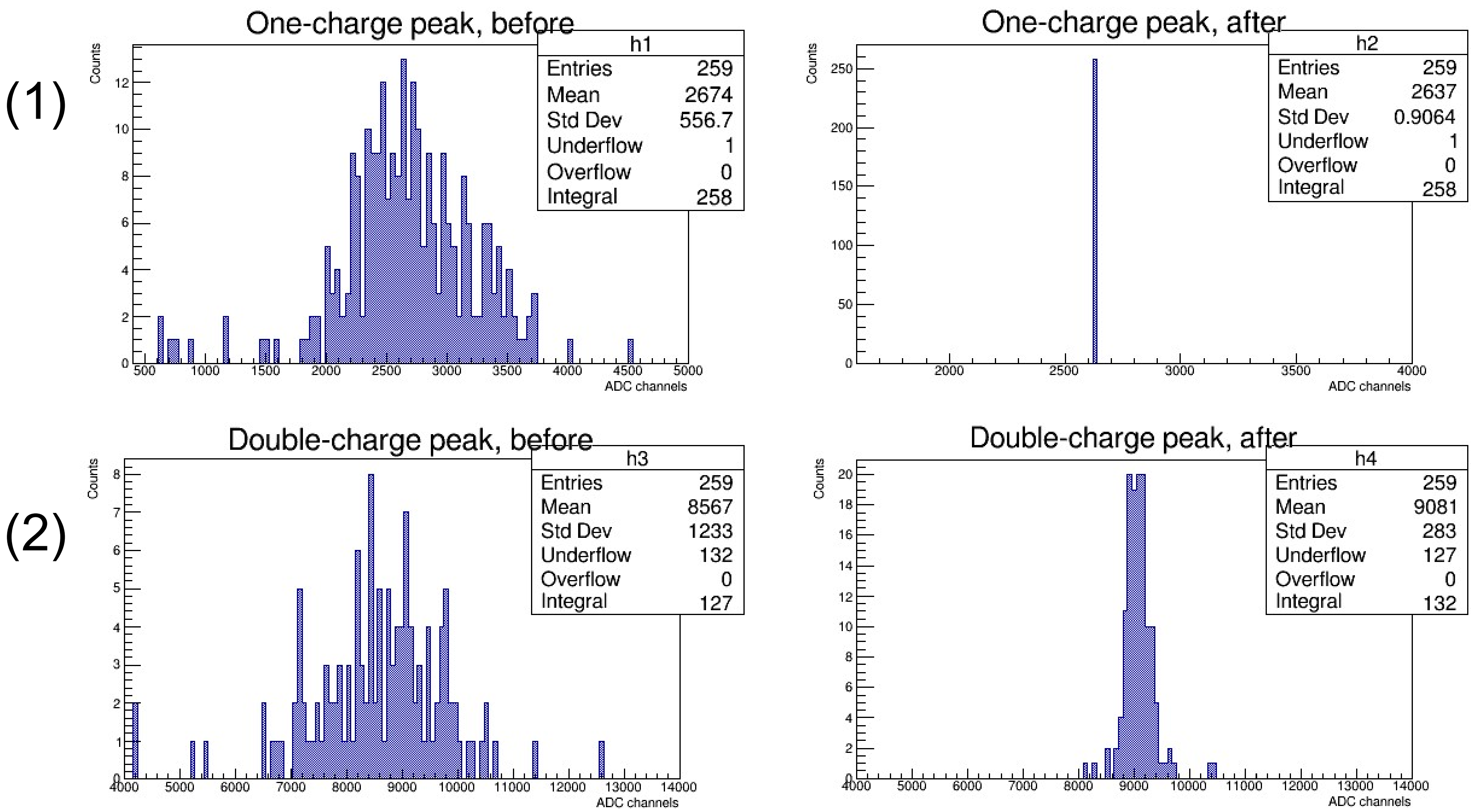
$$K = \frac{\sum_{i=1}^{8} A_i}{A_0}$$

Cells are filtered by the amplitude of the neighbors



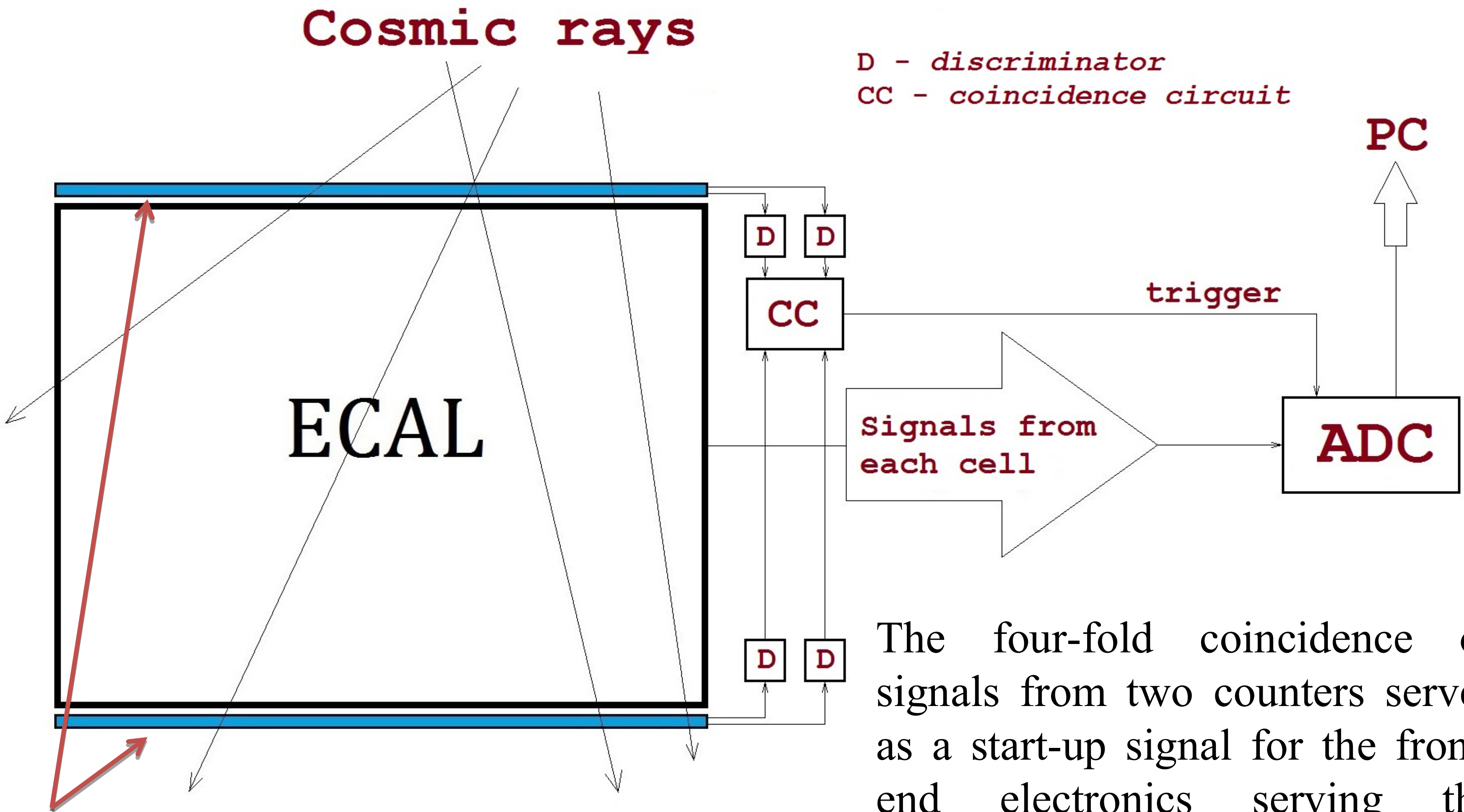
Run	3503…3511
Events	8 x 200k
ECAL cell	411

Illustration of the calibration by the position of single-charge peak



Stage 1. Calibration coefficients has been calculated
Stage 2. The results has been applied to the double-charge peak

ECAL monitoring system based on cross-scanning of cells by cosmic rays.



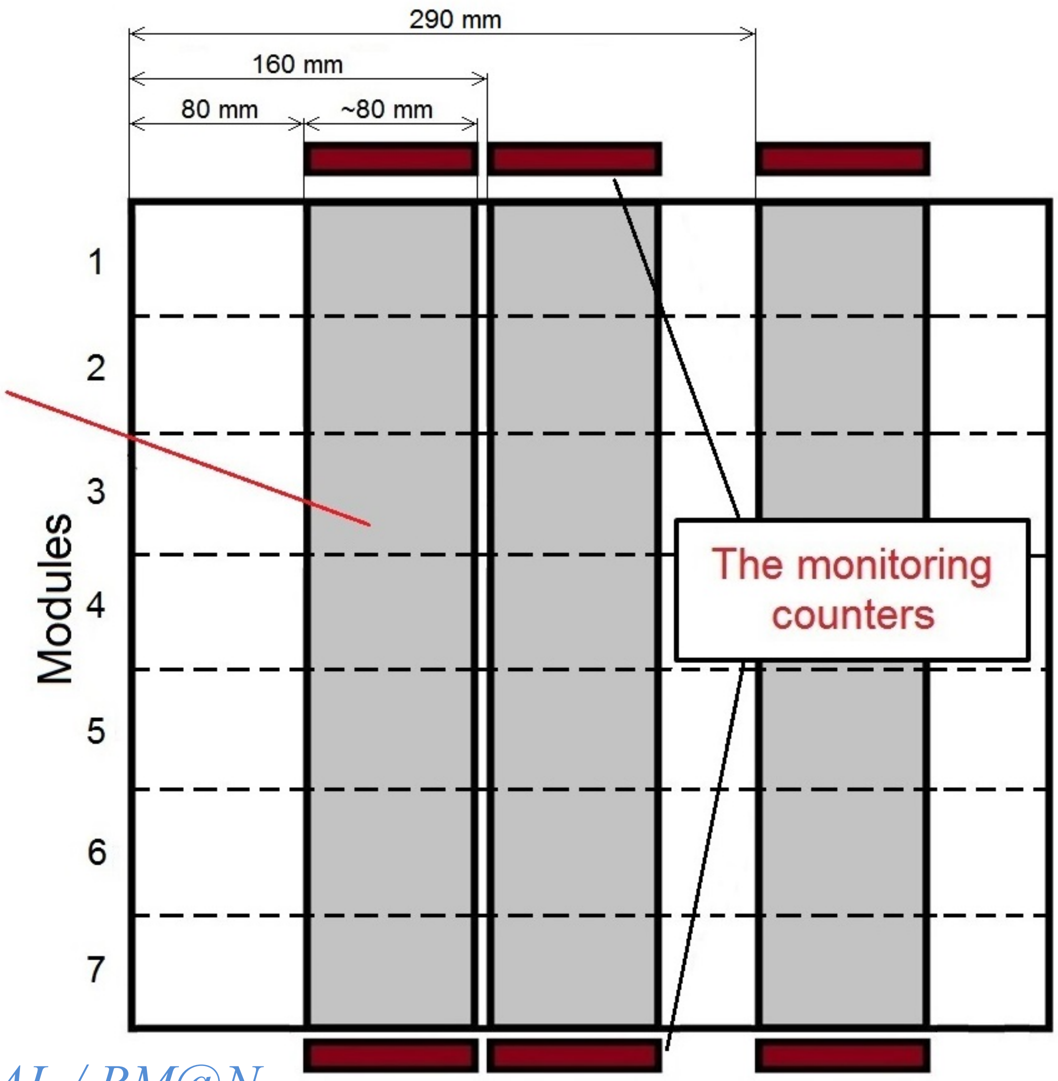
The monitoring counters

The four-fold coincidence of signals from two counters serves as a start-up signal for the front-end electronics serving the calorimeter. Other events are not taken into account.

Block diagram of the monitoring system placement on the calorimeter 8 x 7 modules (24 x 21 cells)

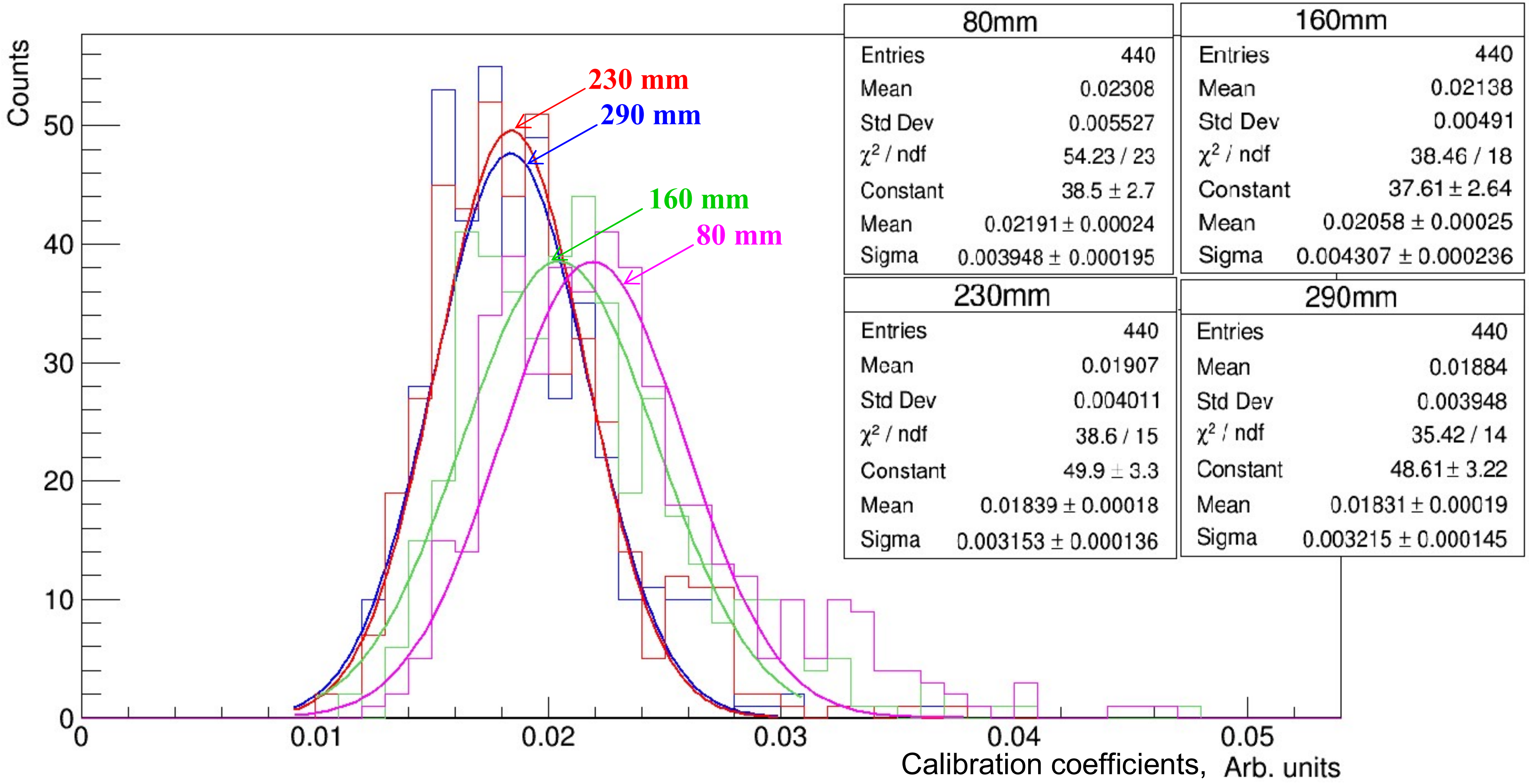
The installation of
ECAL 8 x 7 modules
(967 x 843 x 515 mm^3)

The area of passage of cosmic muons, which corresponds to the maximum energy release of electromagnetic shower, developing in the module of the calorimeter at a distance of ~5-6 radiation lengths, and occupying about 1-2 radiation lengths.

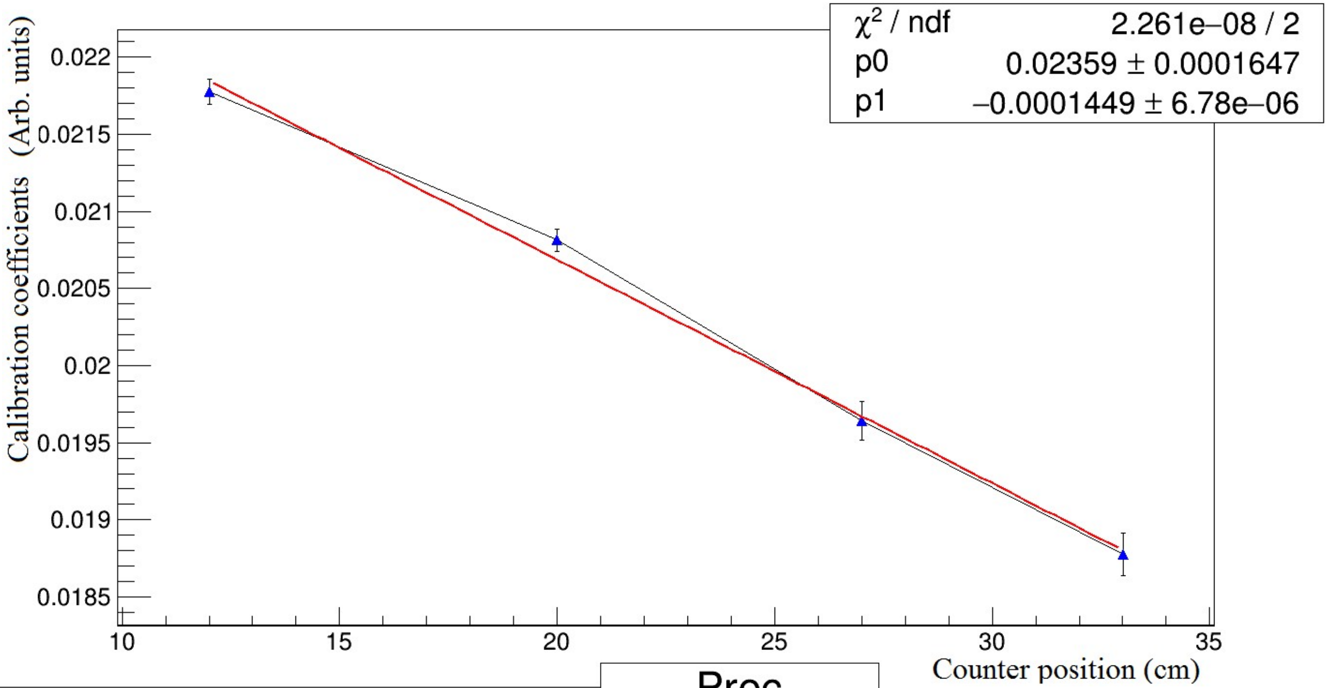


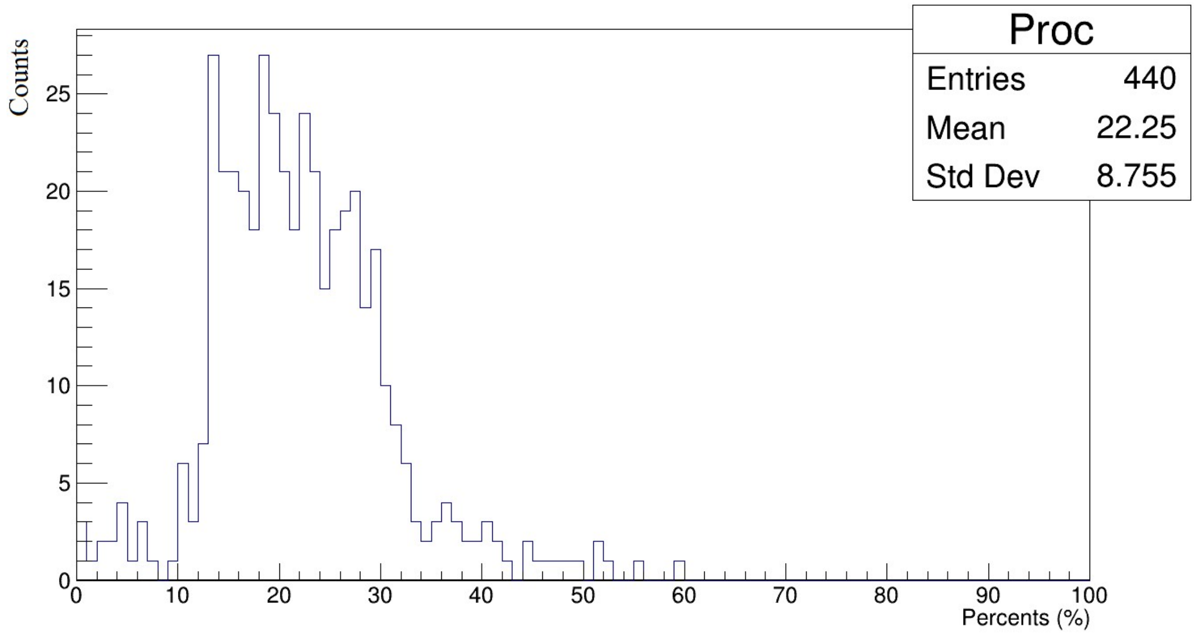
Side view of the assembly *ECAL / BM@N*
with the location of the monitoring counters

Calibration coefficients



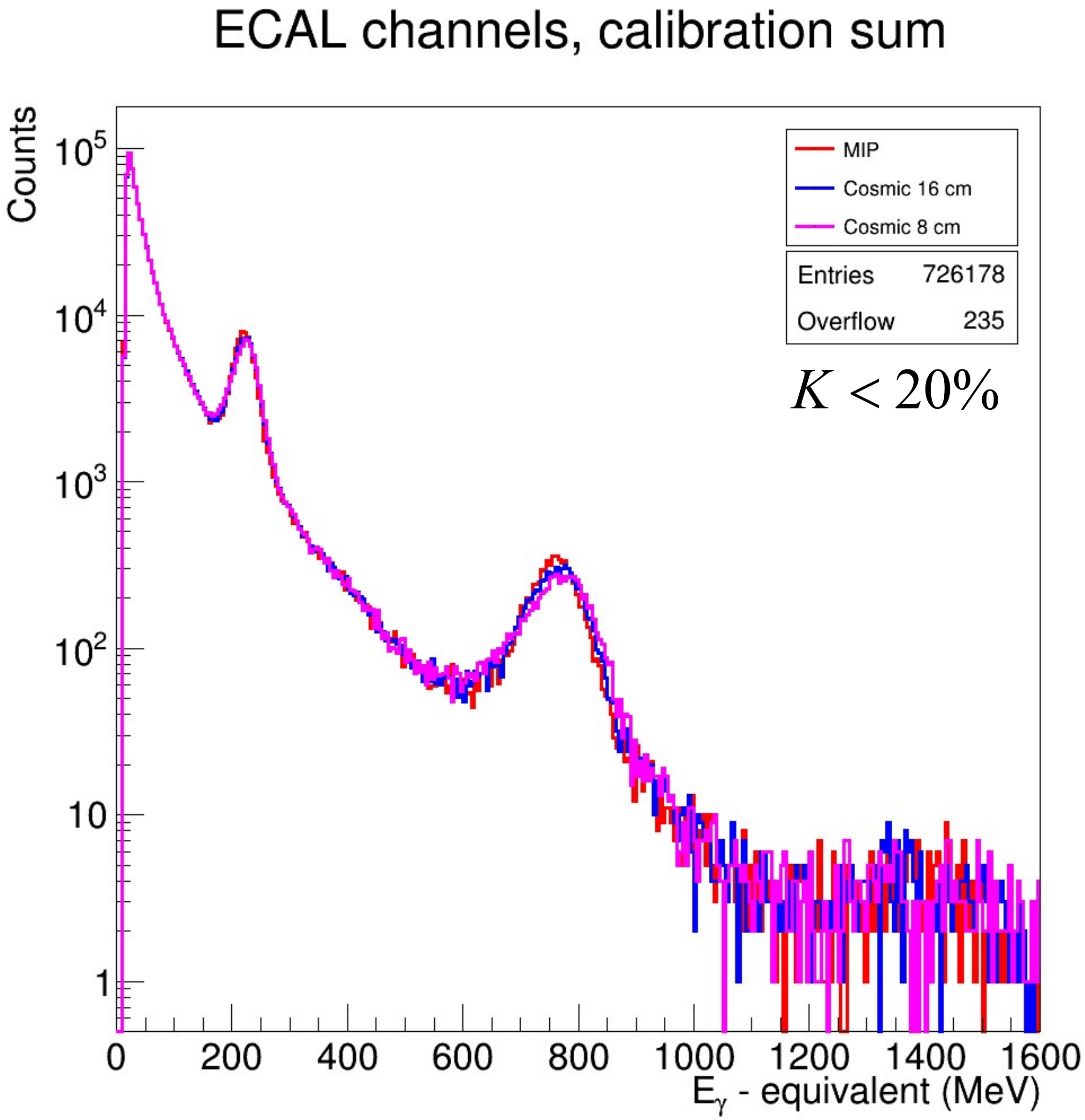
Determination of light attenuation coefficients in the cells





Difference between 80 mm and 290 mm in %

Comparison of the calibrations



Verification of the algorithm on the Monte-Carlo data

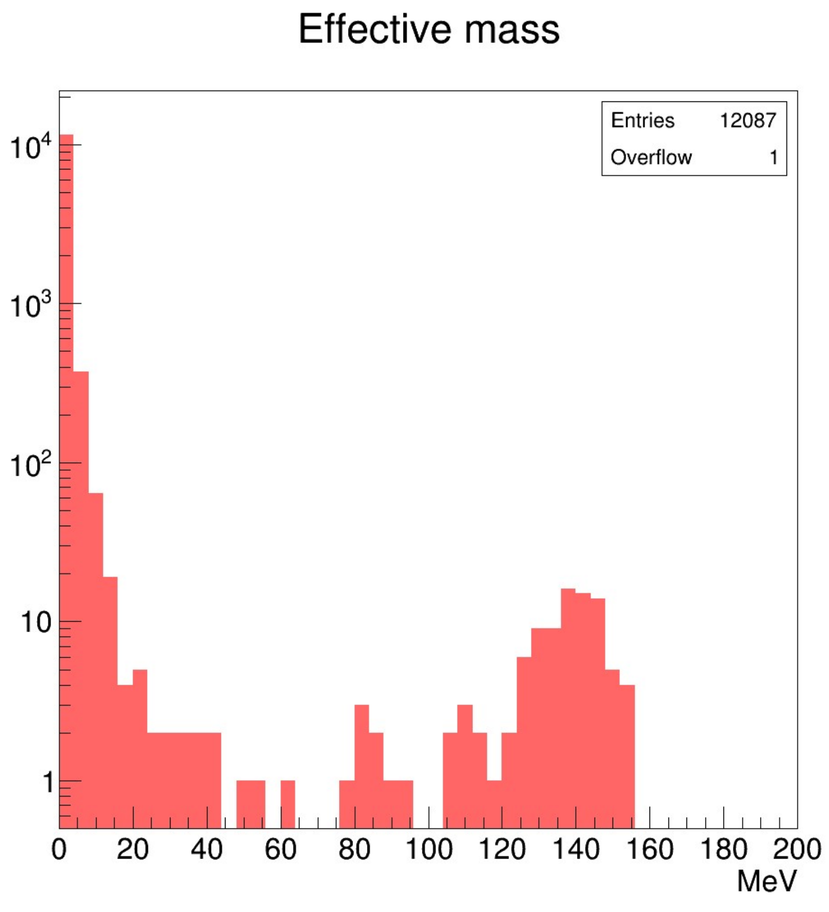
- Simulation results file mc_CC_ecal_1.root with ECAL included. Thanks to Alexander Zinchenko.

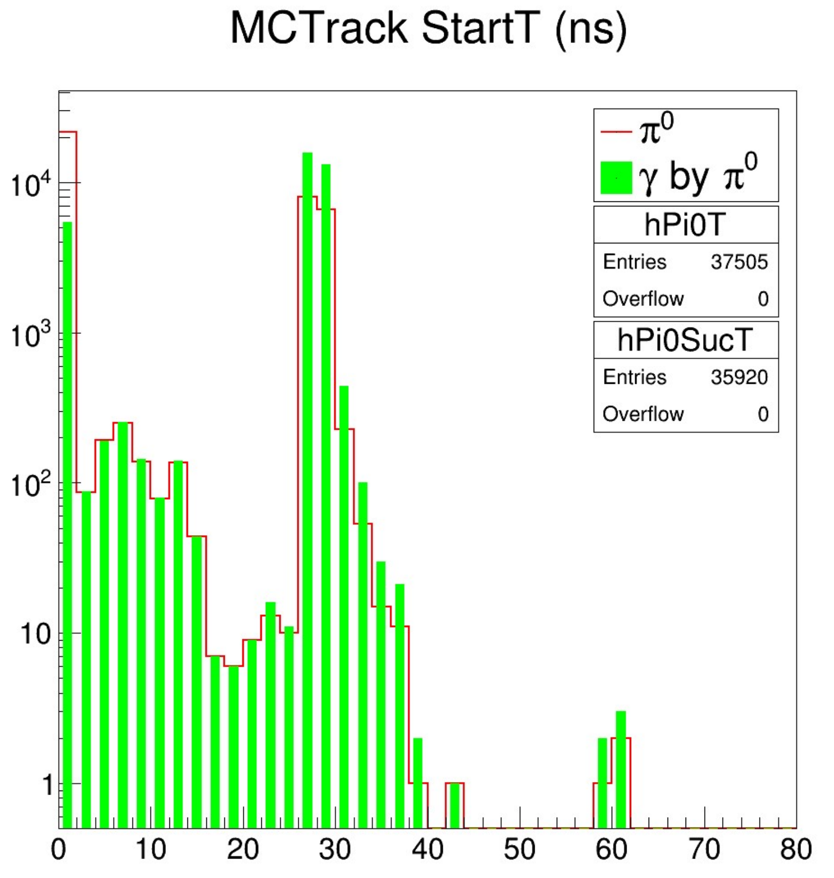
- Initial data file analysis procedure
  - The total energy loses in the scintillator for showers formed by photons from the π_0 decay is calculated
  - Photons energy reconstructed
  - The effective mass for each pair of the photons is calculated

- Generation of digi-files
  - Calculated the total energy losses in each cell of the calorimeter for each event
  - A number of digi.root files with different particle selection settings are created

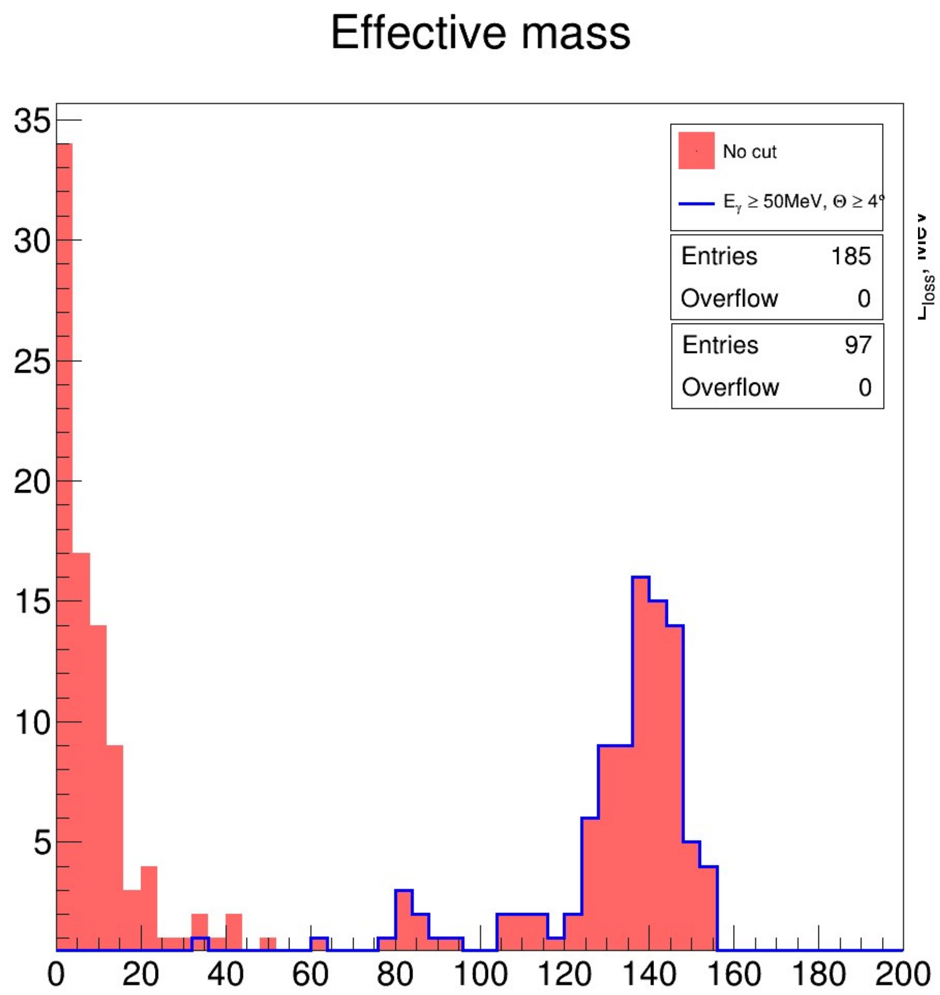
- Generated digi analyzed with the algorithm

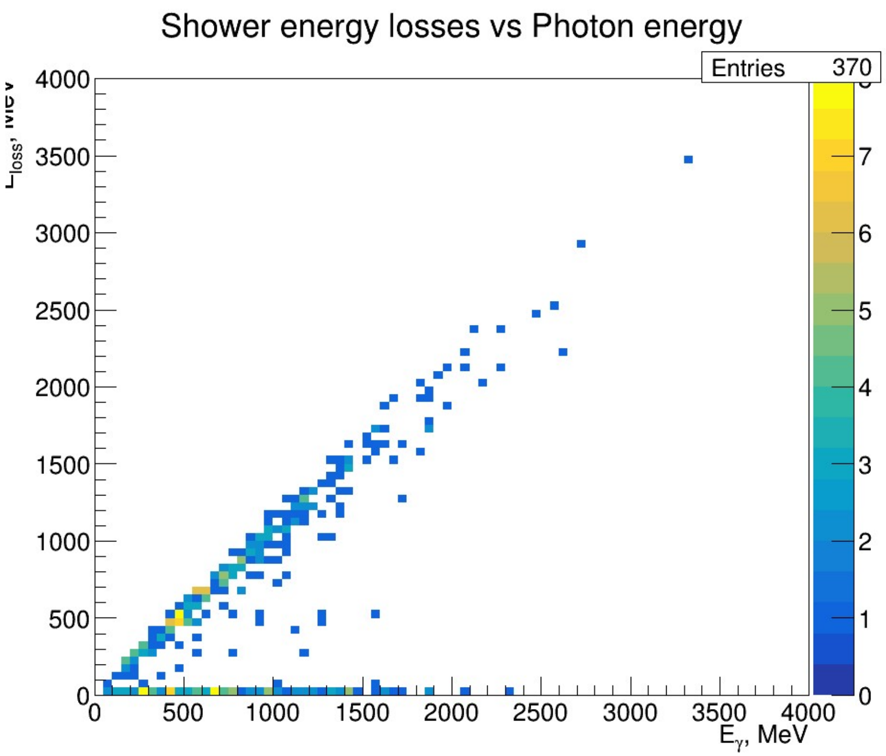
Reconstruction of the simulated π_0 by use of MCTrack data



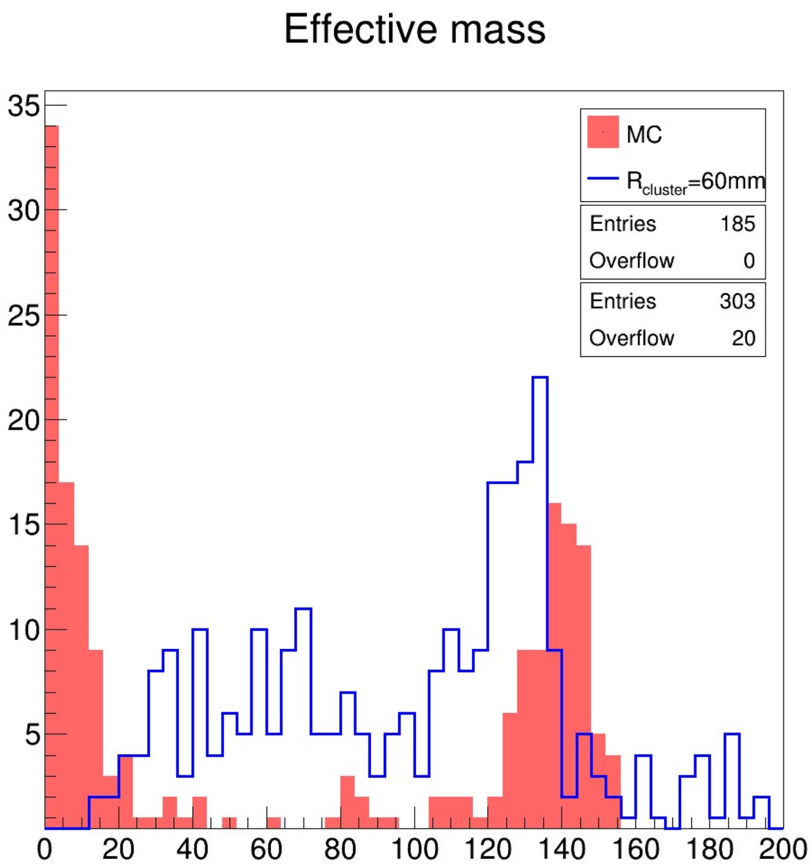


Reconstruction of the simulated π_0 by use of MCTrack data

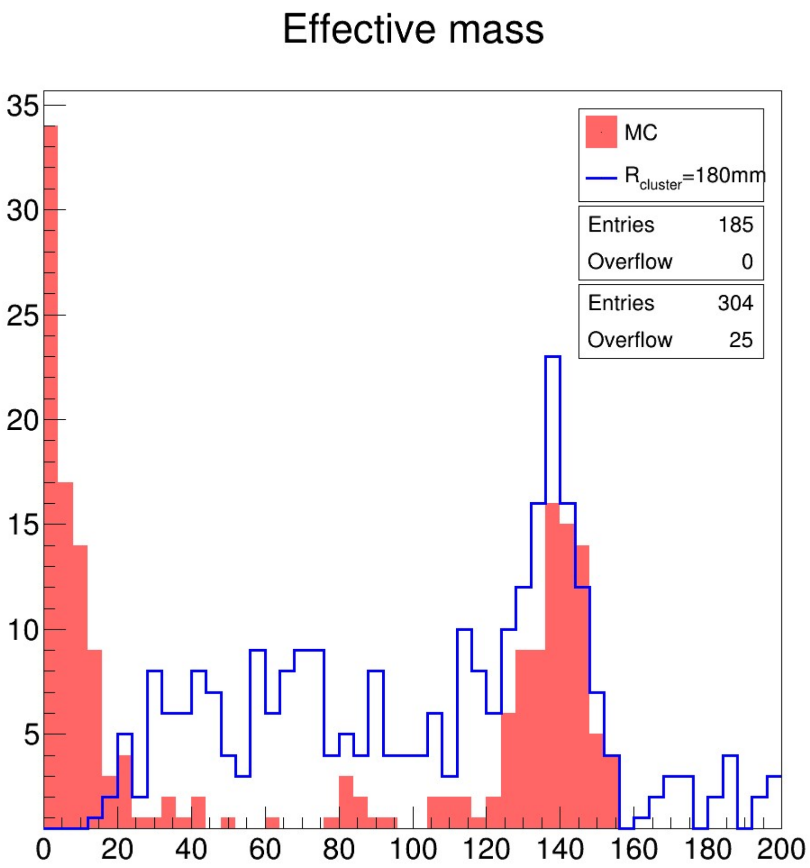




Cluster size

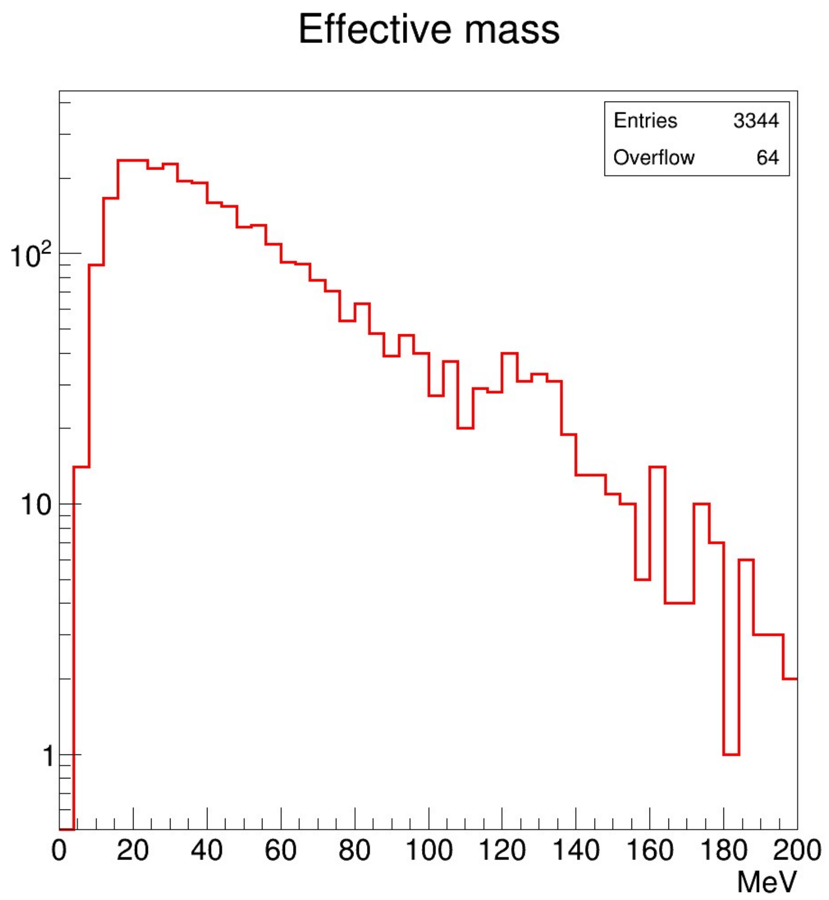


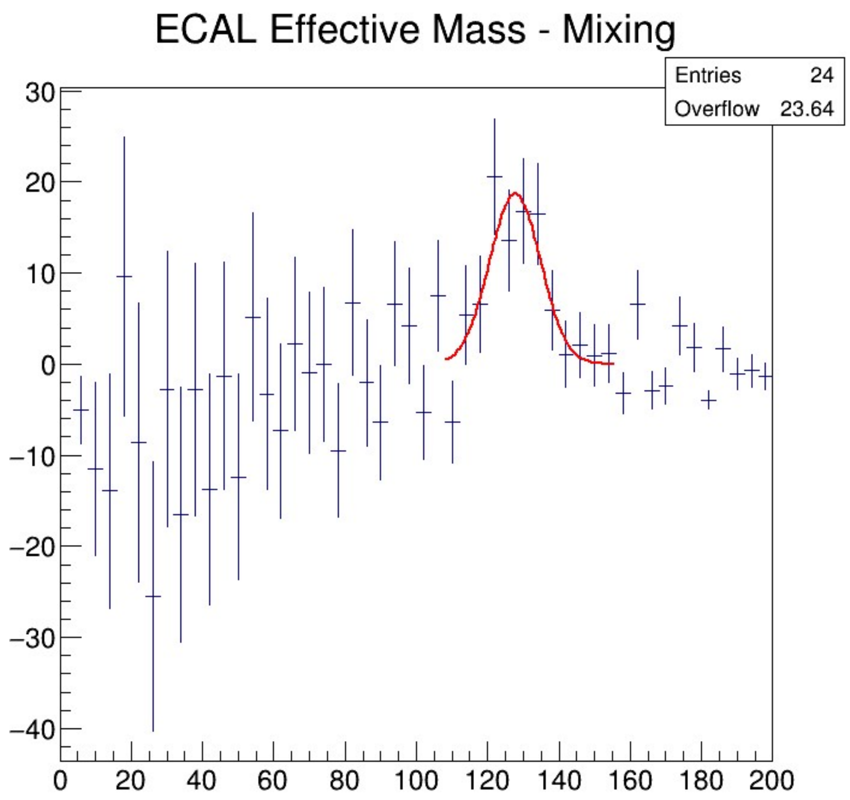
$R_{clusetr}$= 60mm (3x3)



$R_{clusetr}$= 180mm (7x7)

Pion + background (simulation)

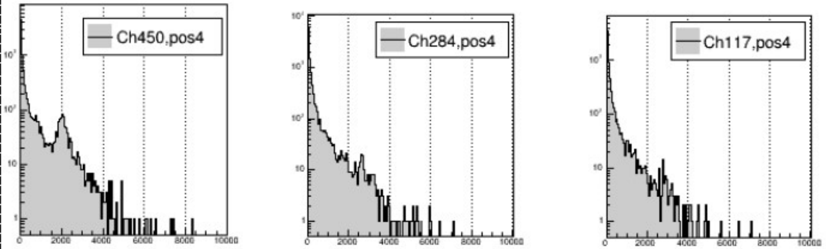




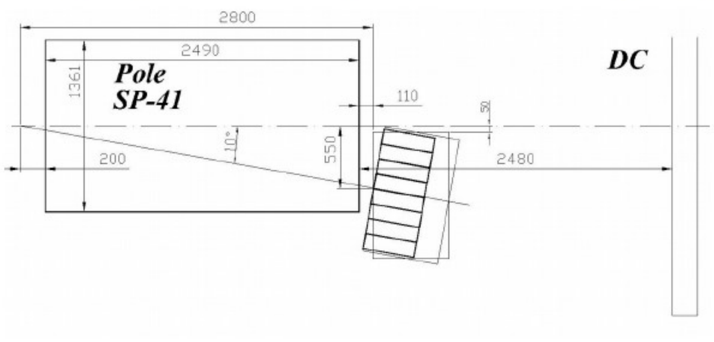
Ecal krypton data (BM@N)

- Kr-Cu run, T_0=2.6 GeV/n
- Two ecal position, 4th-closer to beam, 5th- far from the beam

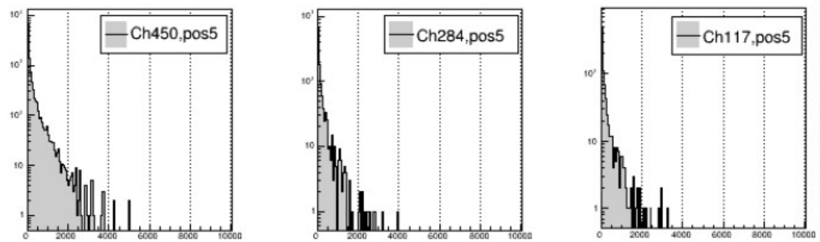
- Position 4



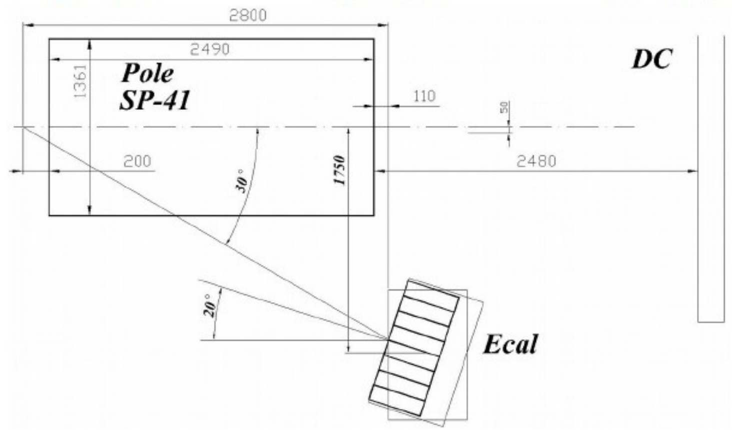
- α~2°
- α~10°
- α~16°



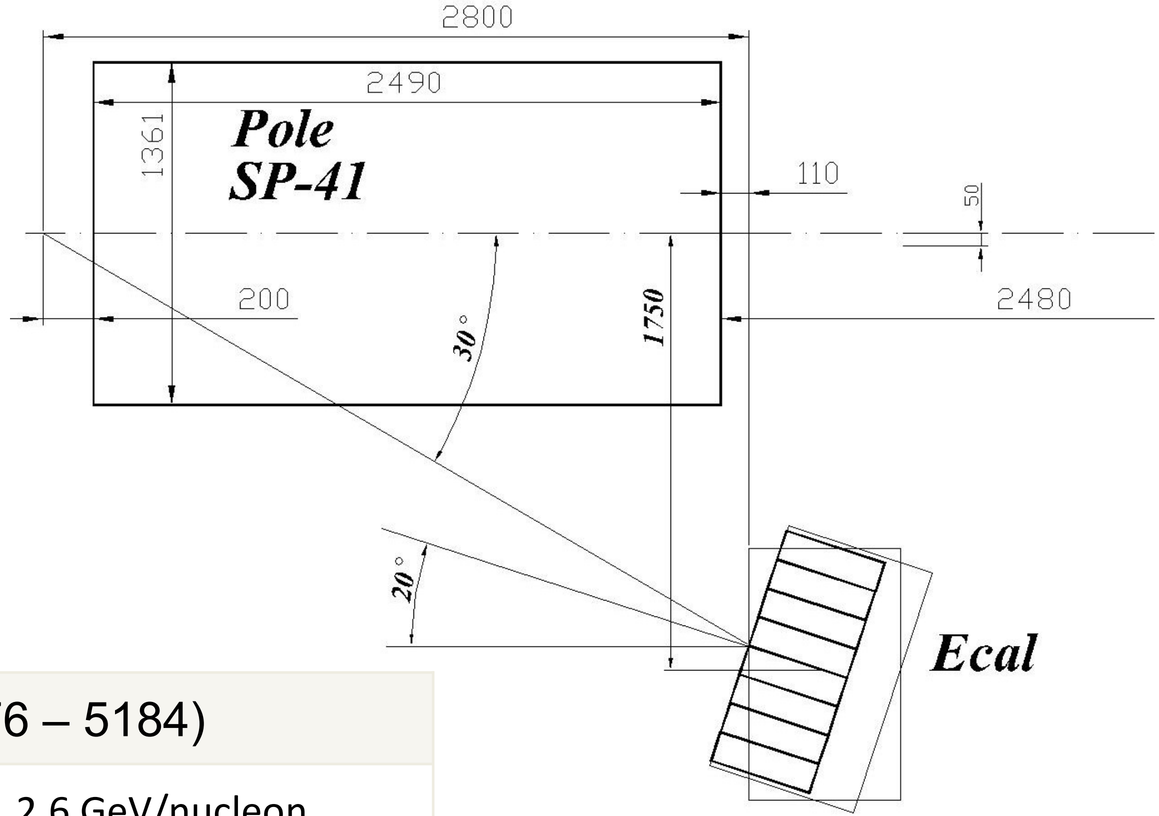
- Position 5



- α~22°
- α~30
- α~36°

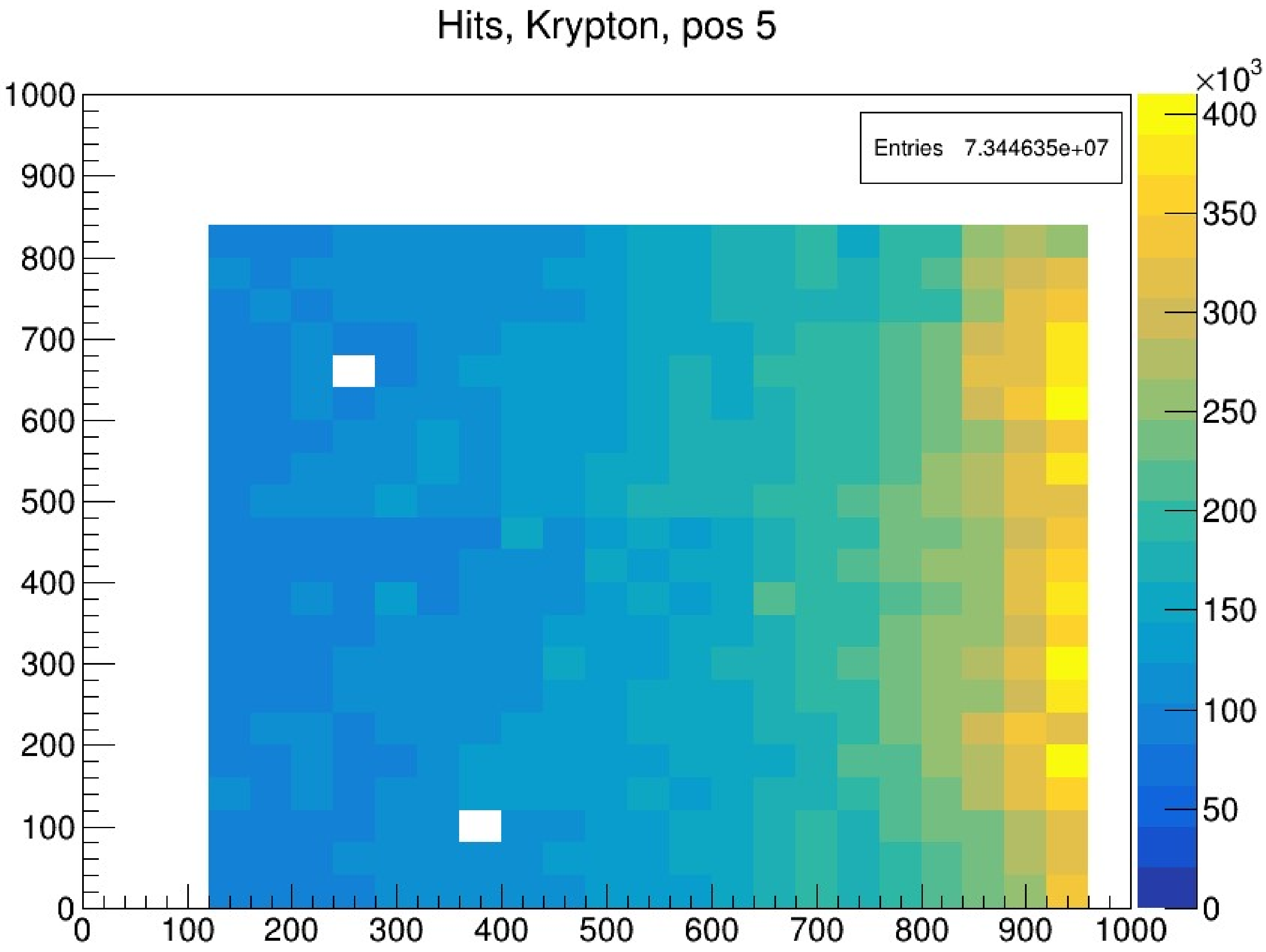


The position of the ECAL during the dataset on the krypton beam.

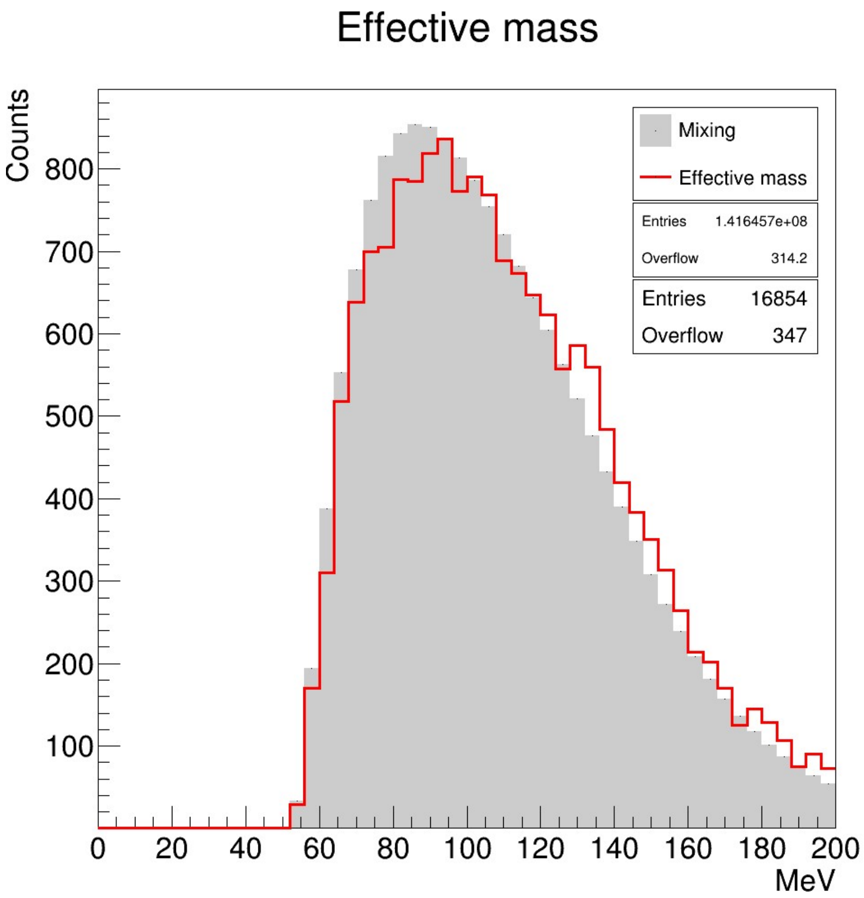


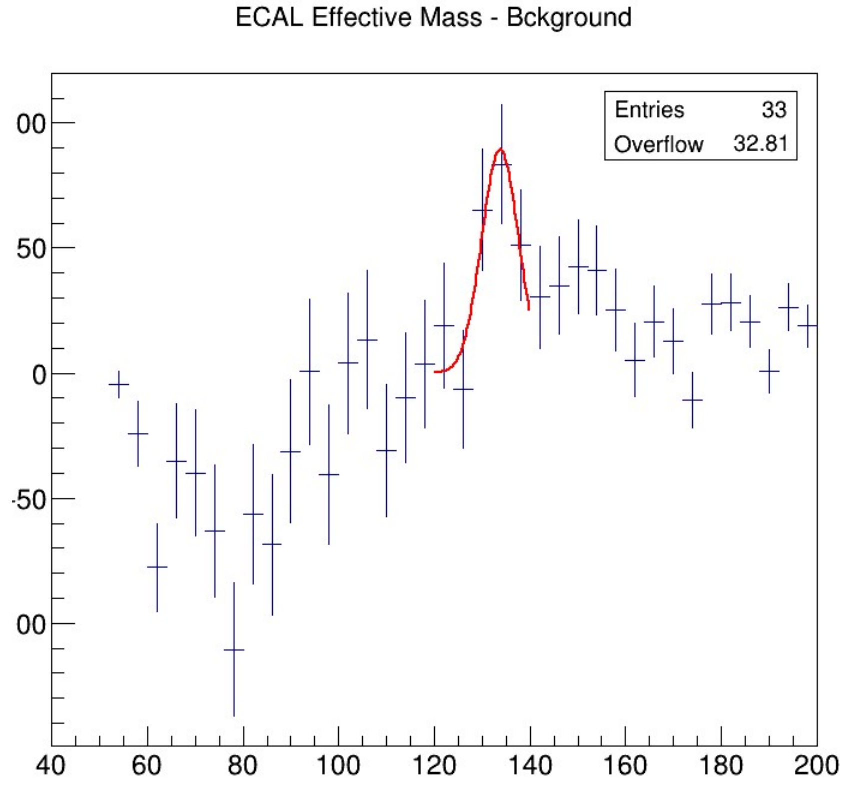
Krypton runs, pos. 5 (4976 – 5184)	
Beam	Kr, 2.6 GeV/nucleon
Target	Cu
Field	1152 gauss
Events (with ECAL)	~3×10^7 (~1.1×10^7)

The density distribution of events by area of the ECAL



Pion + background (Kr data)





Cluster size 3x3 cells,

Minimal cluster energy 500MeV, minimal angle $\Theta_{min} = 6°$

TODO List

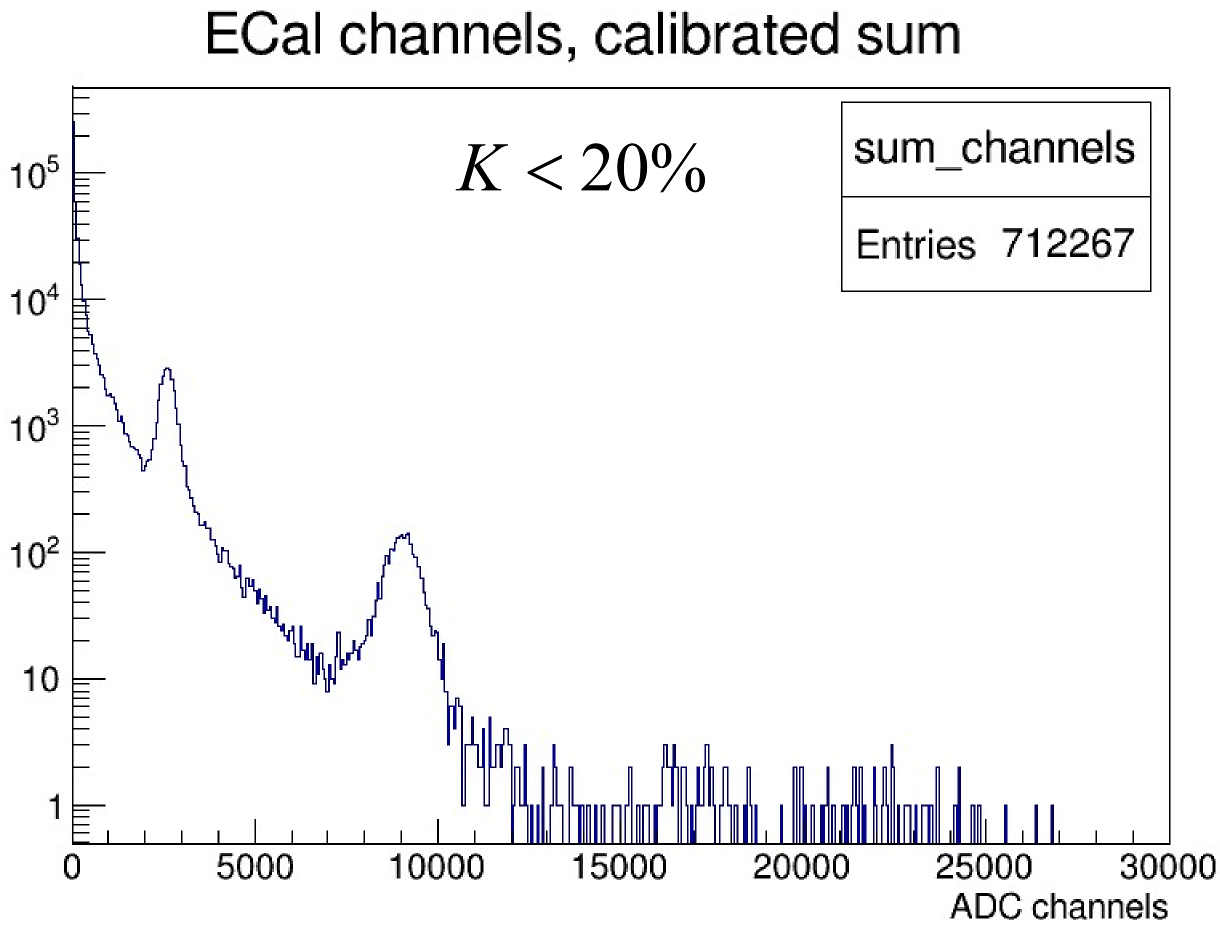
- Analysis of existing data continues
  - Calibration procedure improvement
  - Cuts optimization
  - Cluster shape consideration
  - Accounting for information from charged particles tracking
- For future experiments
  - Replacement of ECAL modules with nonstandard properties
  - Online monitoring
  - Two arms ECAL configuration to increase effective mass range and statistics

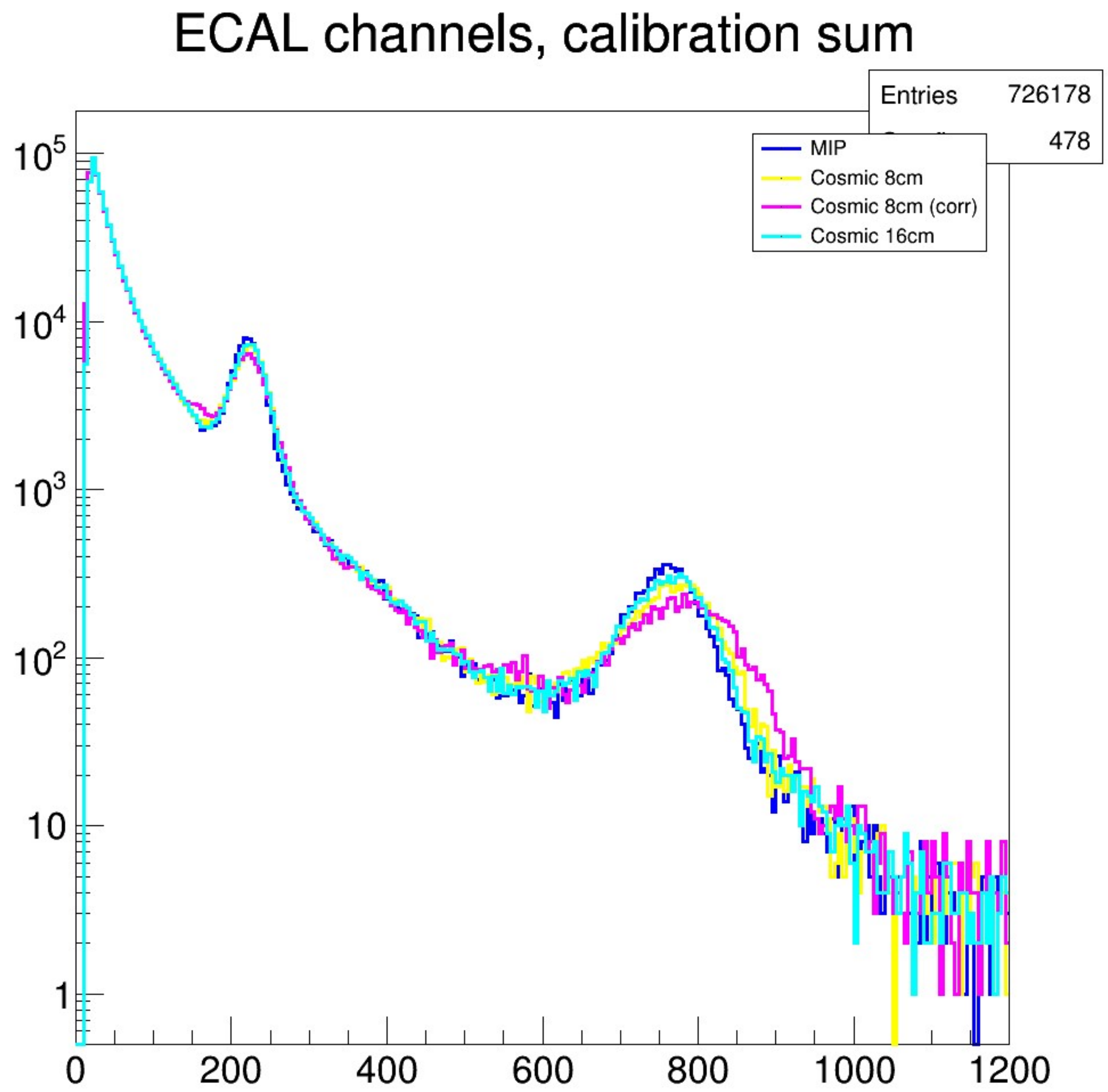
Thanks for your attention

BACKUP

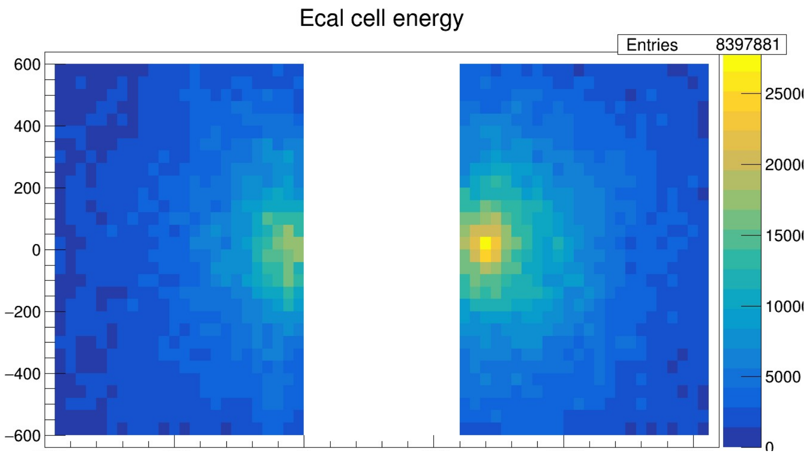
The «**Shashlyk**» module is a lead-scintillator sandwich which read out by means of wavelength shifting fibers passing through the holes in scintillator and lead. The module consist of nine towers. Tower consist of 220 alternating tiles of Pb (0.3 mm) and plastic scintillator (1.5 mm). Each scintillator tile is optically isolated from the neighbor tiles. Detection of light is carried out by silicon photodetectors MPPC.

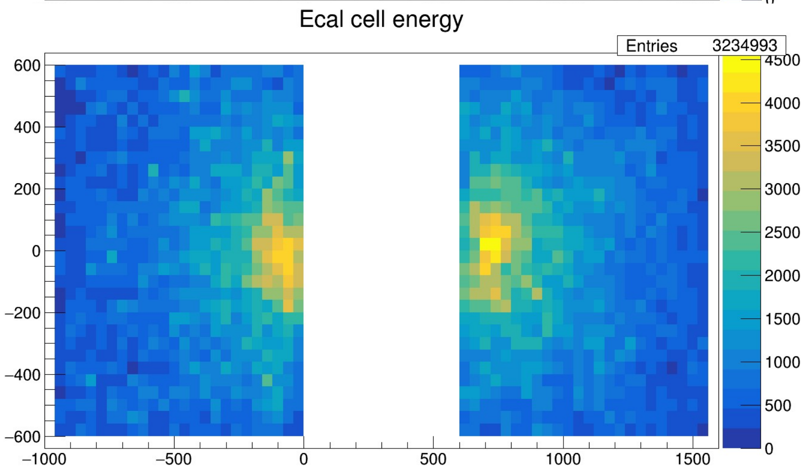
Aggregate amplitude spectrum of the overall calibrated cells

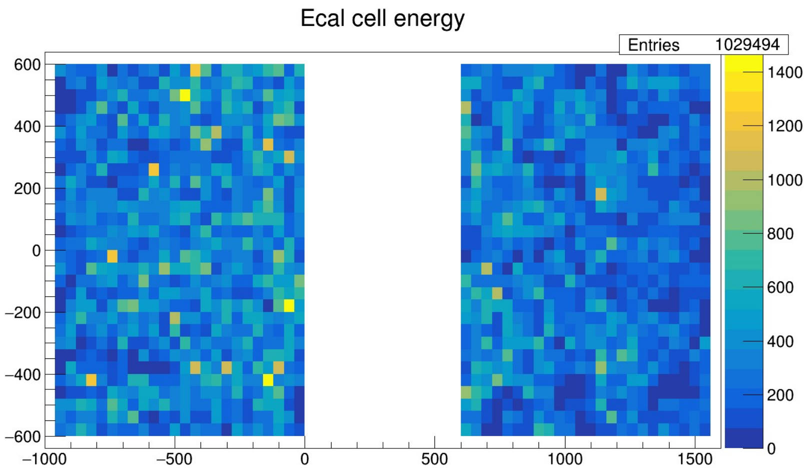




ECAL channels, calibration sum
Entries 726178
478
MIP
Cosmic 8cm
Cosmic 8cm (corr)
Cosmic 16cm
10^5
10^4
10^3
10^2
10
1
0
200
400
600
800
1000
1200


Ecal cell energy
Entries 8397881
600
400
200
0
−200
−400
−600
5000
0

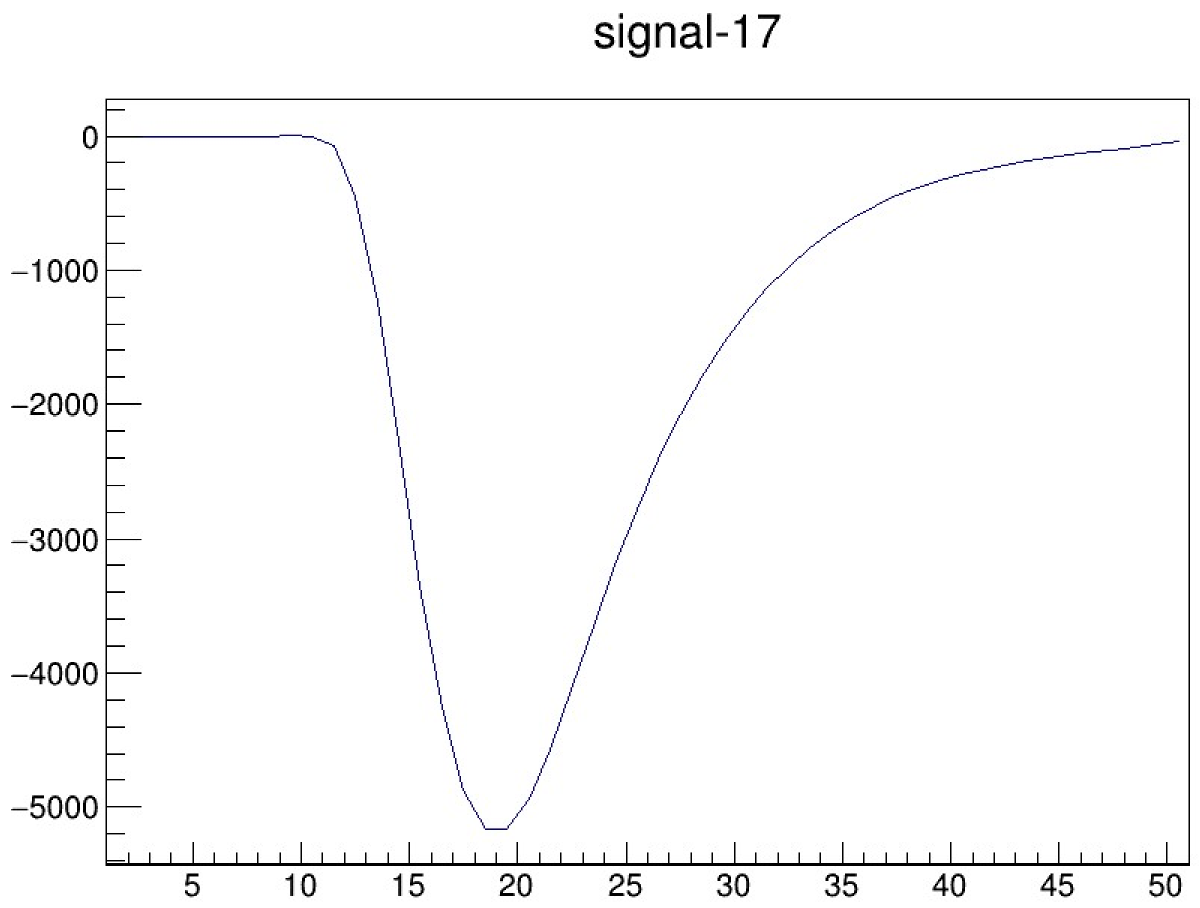

Ecal cell energy
Entries 3234993
600
400
200
0
−200
−400
−600
−1000
−500
0
500
1000
1500
4500
4000
3500
3000
2500
2000
1500
1000
500
0


Ecal cell energy
Entries 1029494
600
400
200
0
−200
−400
−600
−1000
−500
0
500
1000
1500
1400
1200
1000
800
600
400
200
0

Algorithm for cluster analysis

For each event in the run

- Ignore cells with low energy deposit
- Compose clusters from the cells that has common sides
- Find cell with maximum amplitude in the cluster – it's center
- For all cells inside R (the parameter) calculate the photon energy loss and center of mass
- Apply cuts (number of cells inside R, cluster energy, center cell energy etc.)
- Collect all such clusters in the event
- Calculate effective mass for each pair of clusters in the event (applayng the angel cut)
- Calculate mixing with previously collected clusters


signal-17
0
−1000
−2000
−3000
−4000
−5000
5
10
15
20
25
30
35
40
45
50