MiniFoCal in ALICE

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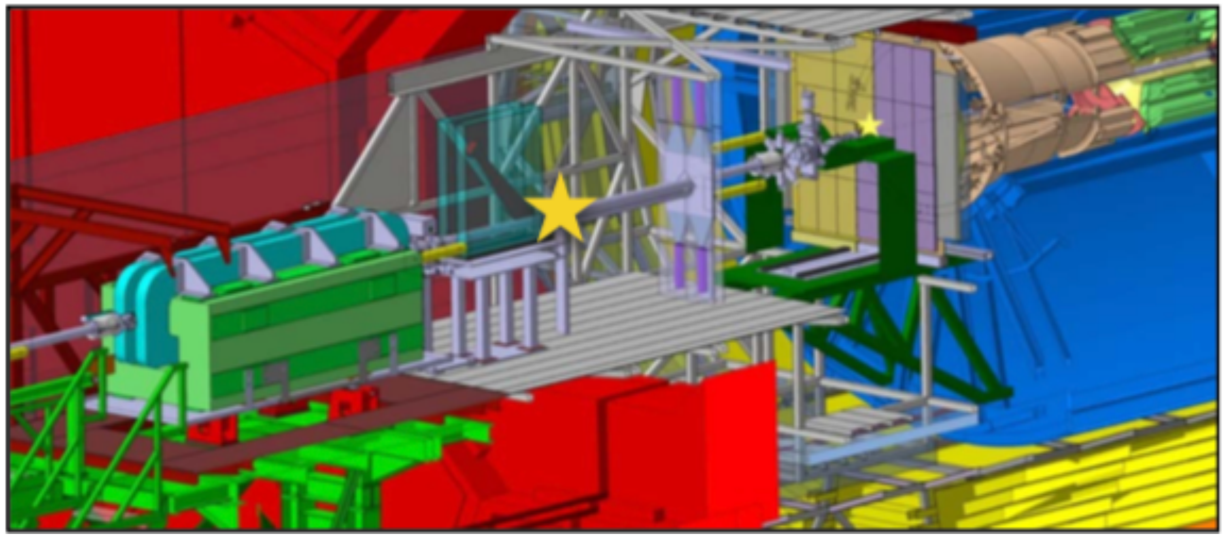
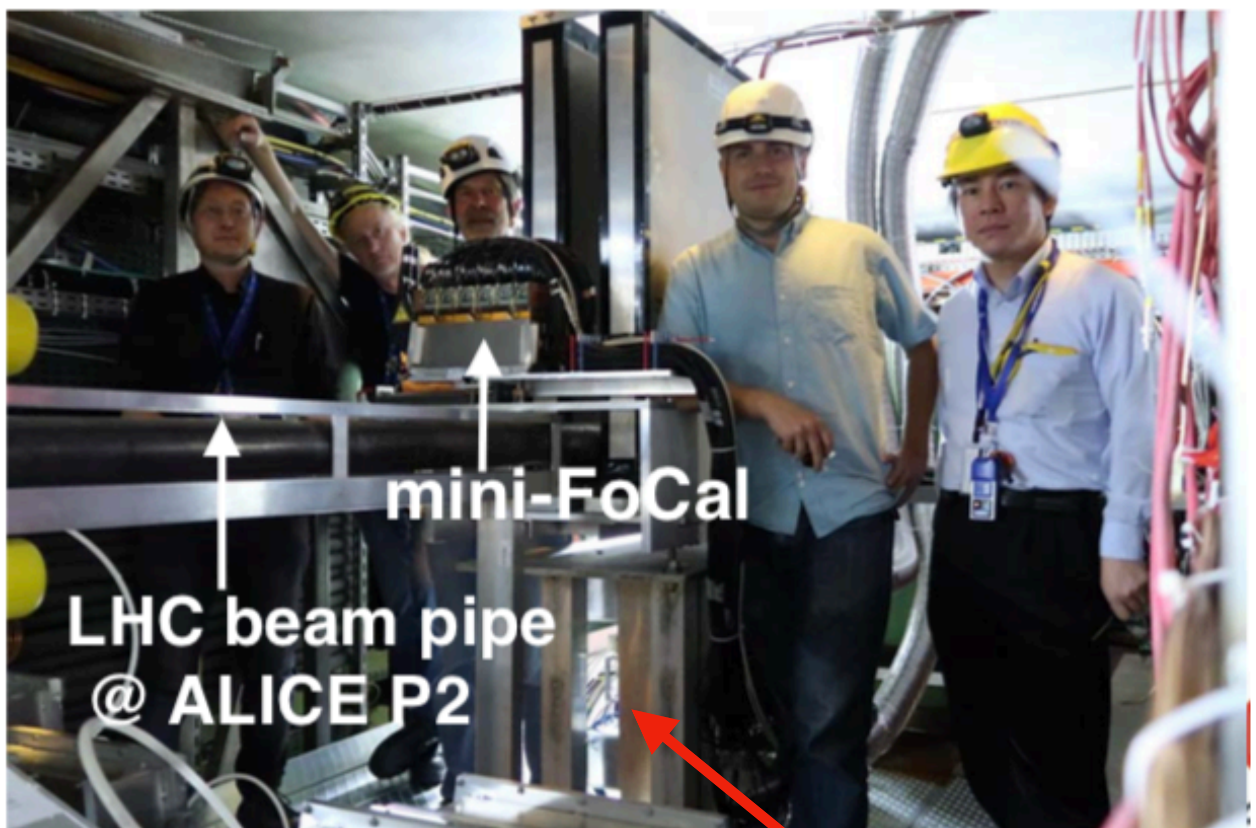
Work in progress…

ALICE Cavern



Location in the cavern:

- Approximately 7.3 m from the interaction point
- The PMD detector was fully installed in front, this will create a large number of background
- The SRS and APV readout was located near the beam pipe:
  - Some components are not RadHard



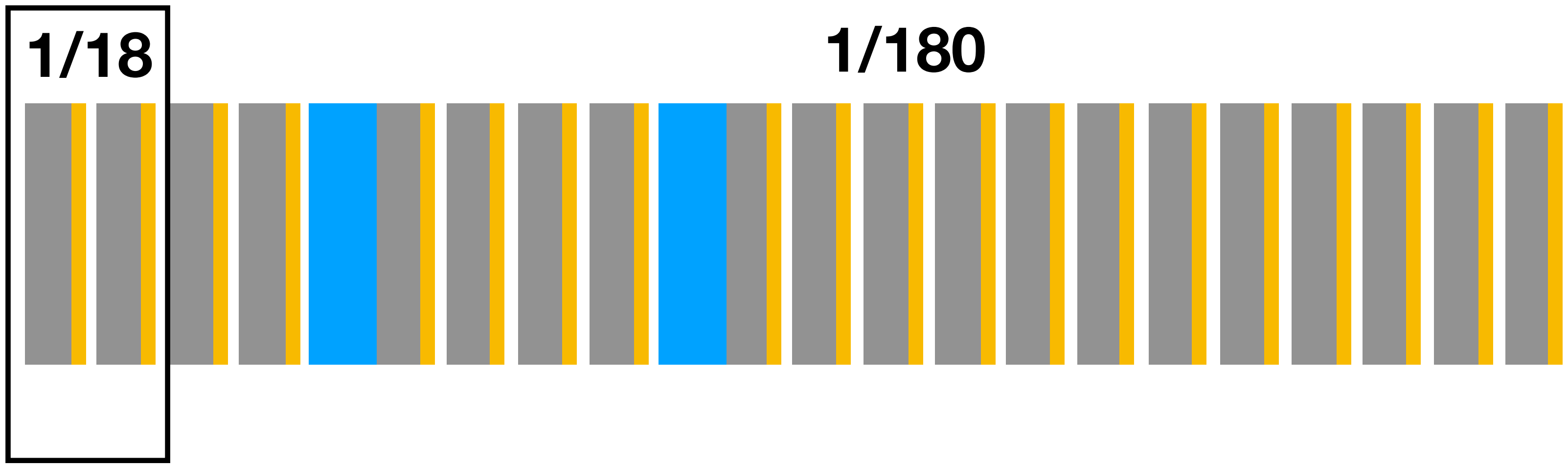
SRS system under the table

The testbeam setup was modified for the ALICE cavern:

- Only the really essential components were installed in the miniFrame:
  - Detector, readout system
- The low voltage operation, switches for data collection, etc. was installed outside of the miniFrame

This test can be repeated in Run-3 with a more final designed prototype of the miniFoCal

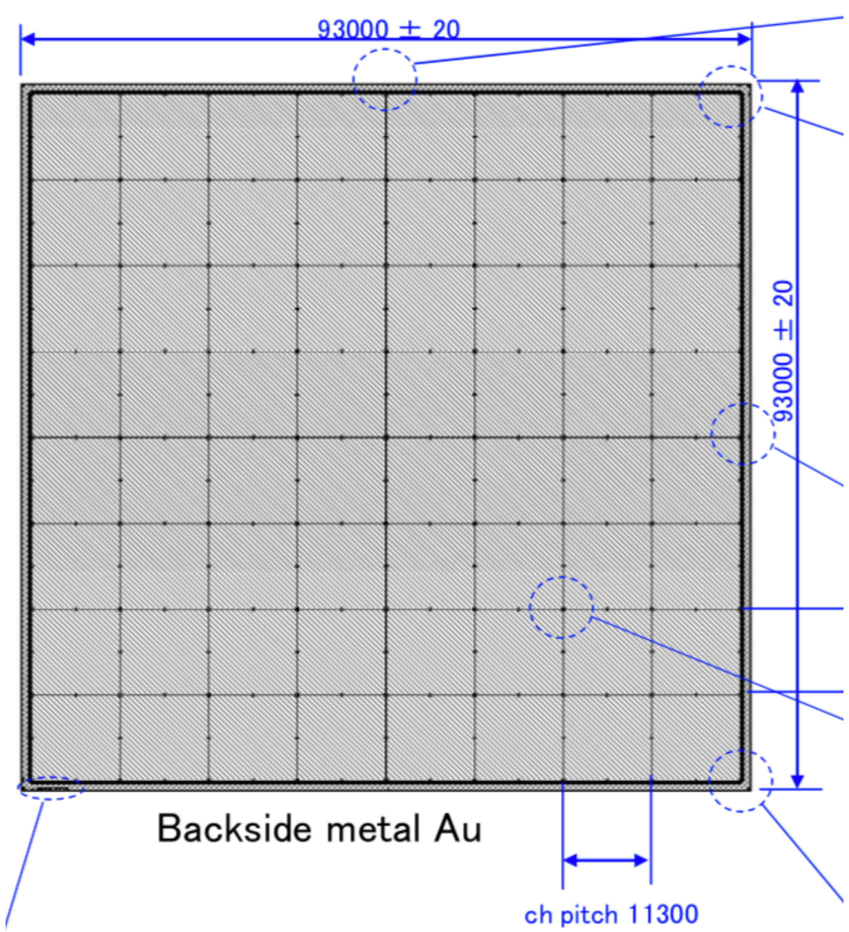
miniFoCal Layer Geometry



W layer 3.5 mm ~ 1X_0
94 % purity (4% Ni, 2% Cu)

Si Layer, 320 μm
1.125cmx1.125cm active

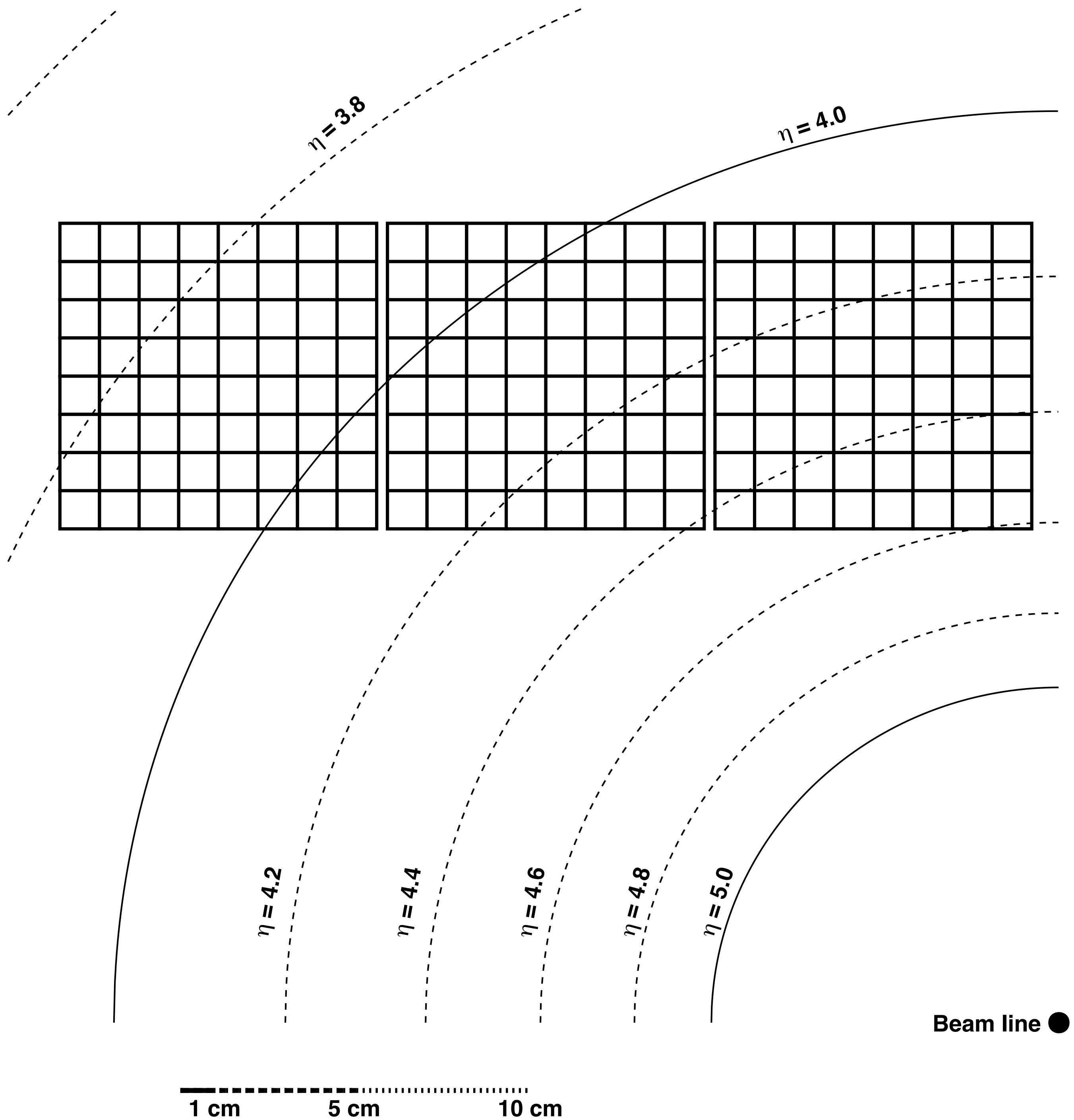
Plastic Scintillator
0.5cm thickness
Necessary for triggering on showers



Cutout from Hamamatsu data sheet

Trigger provided by the scintillator:
From testbeam we tried to set the scintillator threshold for E_{shower} > 50 GeV
Magnetic field effect of the PMT response could be ~20 % reduction
Due to magnetic field (100 mT horizontally at the location) we had to modify the initial setup

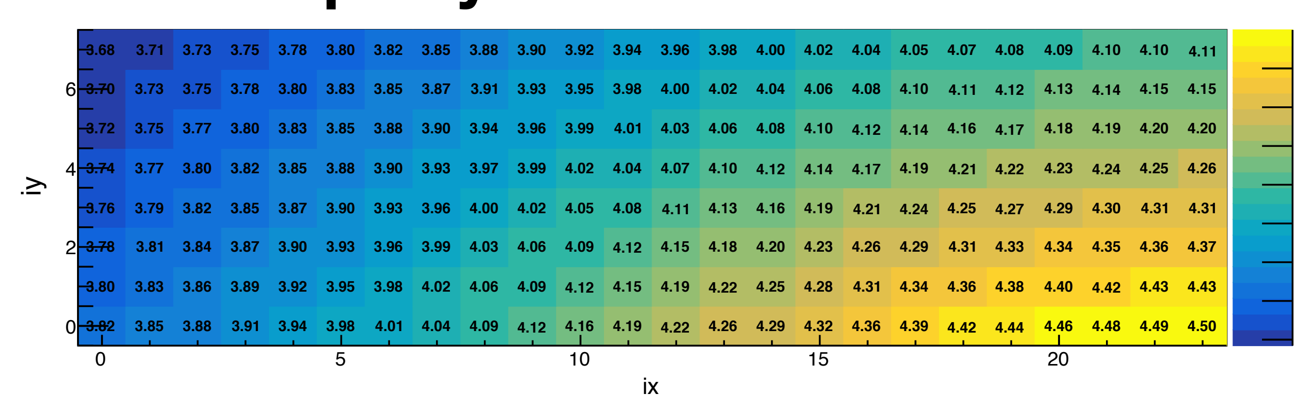
Geometry of the miniFoCal in ALICE



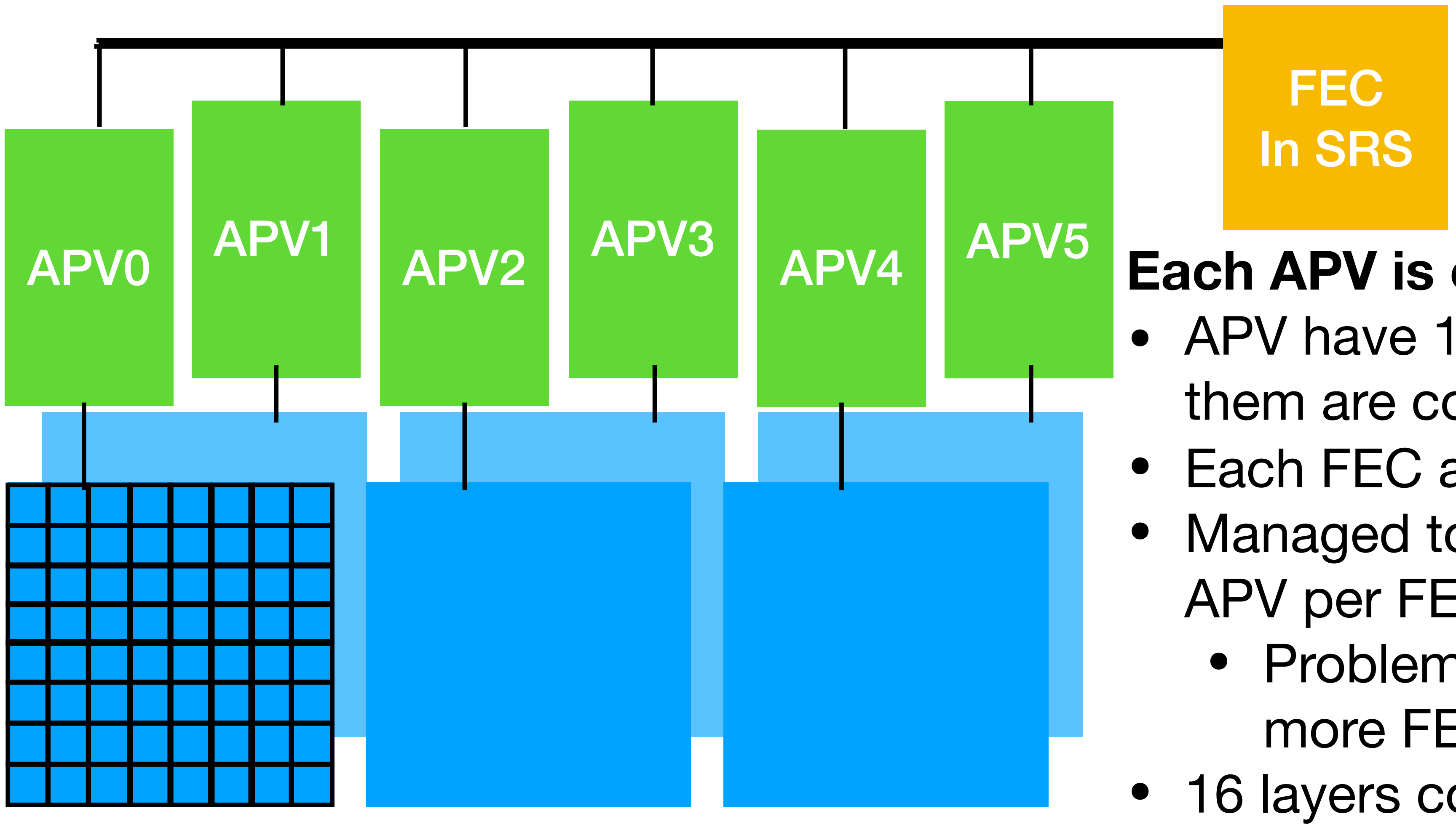
The miniFoCal rapidity distribution in ALICE:

- The acceptance is from η = [3.7,4.5]
- Calculated with the x,y,z positions from Ton and Rene

Pseudorapidity for the center of the PADs



ALICE miniFoCal mapping



Each APV is connected to one single PAD:

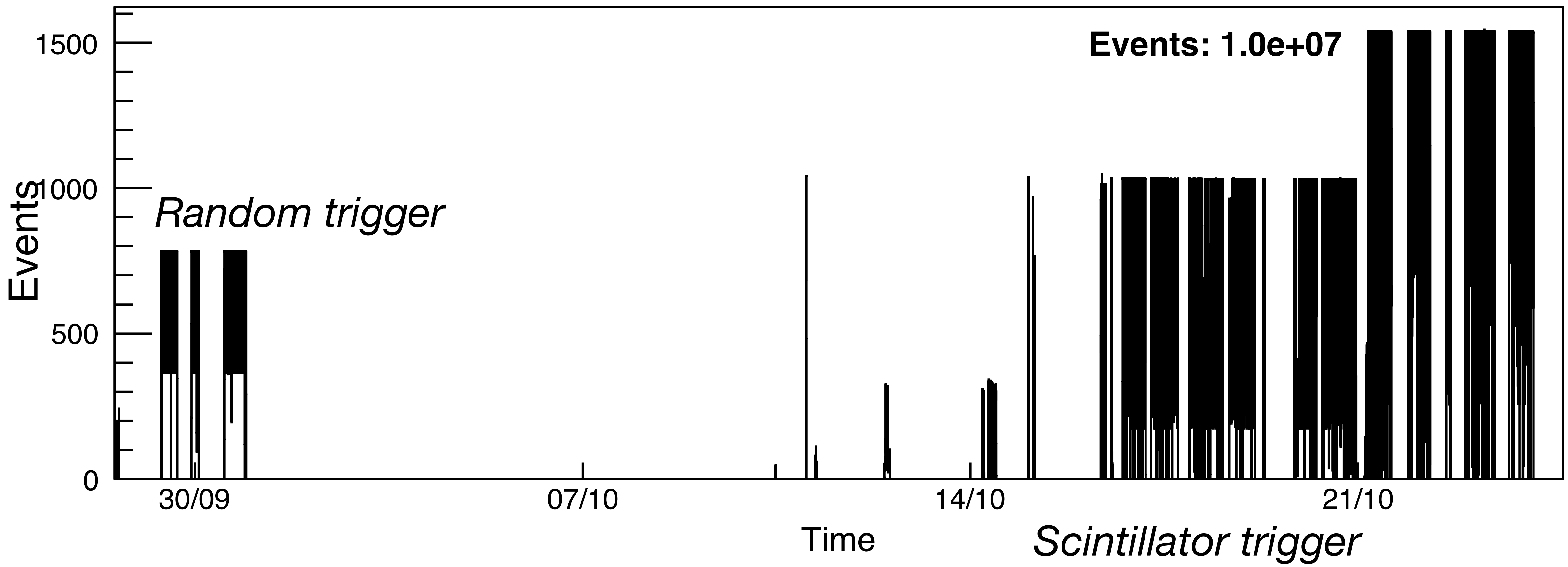
- APV have 128 channels, but only half of them are connected to the pads
- Each FEC at the SRS handles 2 layers
- Managed to set the readout with only 6 APV per FEC (out of 8):
  - Problems with the DATE stability for more FECs
- 16 layers could be operational

FEC mapping of the layers and locations from the IP point of view:

- Layers 1 (front) to Layer 20 (back)
- Left, Middle and Right from the front view
- Only 60/64 connection were used
- During the run we also experienced some looses of communicating to the FEC's

	FEC0	FEC1	FEC2	FEC3	FEC4	FEC5	FEC6	FEC7
APV0	20R	16R	12R	10R	8R	6R	4R	2R
APV1	19R	15R	11R	9R	7R	5R	3R	1R
APV2	20M	16M	12M	10M	8M	6M	4M	2M
APV3	19M	15M	11M	9M	7M	5M	3M	1M
APV4	20L	16L	12L	10L	8L	6L	4L	2L
APV5	19L	15L	11L	9L	7L	5L	3L	1L
APV6	13R		13M	13L	17R	17M	17L	
APV7	14R		14M	14L	18R	18M	18L	

Event statistics



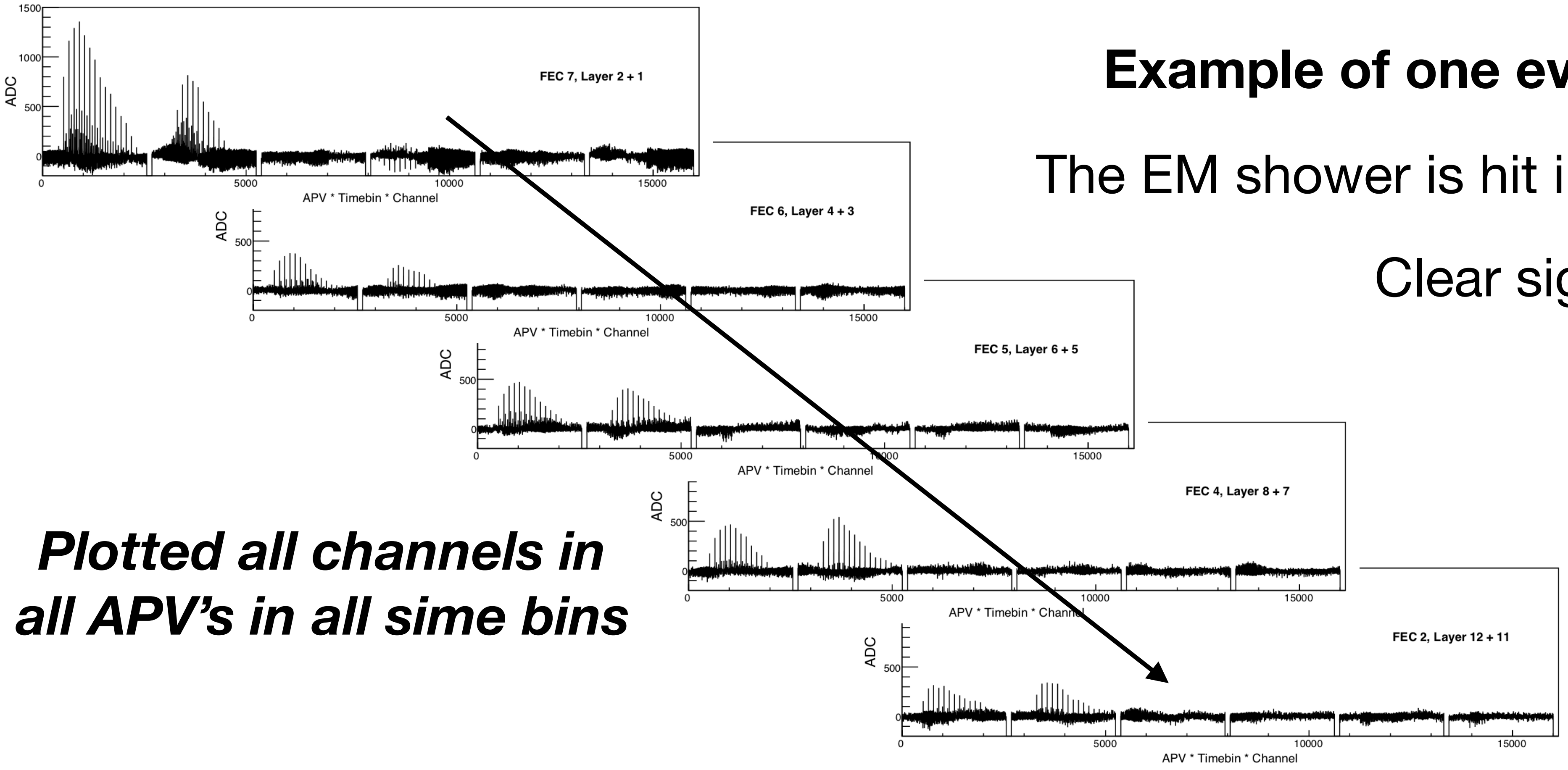
We took little bit over 10M events in the data taking period:

- 13 TeV p+p running
- Self triggering setup
- No zero suppression was implemented (completely new firmware)
- We lost one additional FEC communication ~22/10, increased the data taking rate

Currently analyzing only ~200k events

- In order to have a manageable statistics
- After debugging the code, we would move to the full data

Typical event readout



Example of one event display

The EM shower is hit in the left side of the detector

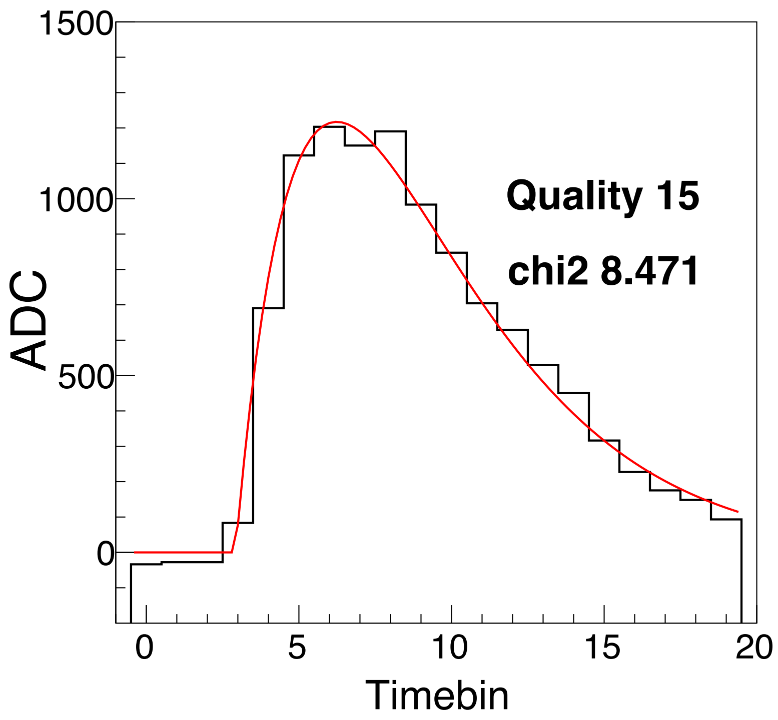
Clear signal is observed in all layers

Plotted all channels in all APV's in all sime bins

The first two layers have higher sensitivity (by factor of 10). The shower max is expected around 9-10 layer

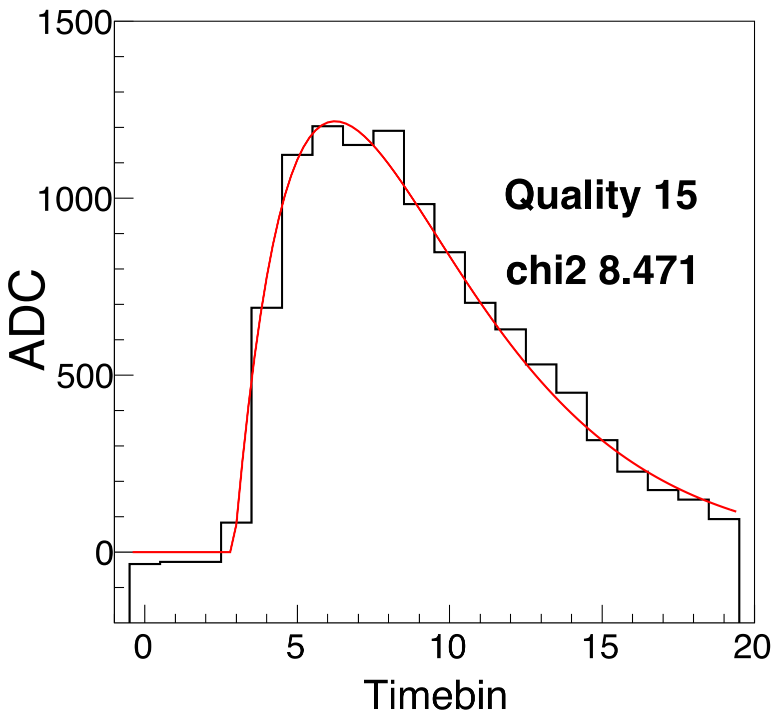
Typical signal from the APV:

- Timed that the first three time bins will be the pedestals
- Signal rise in 3-6 time bins
- The the signal end is not always fully captured in the 20 time bins (from 30), but it reduces the data length by 1/3.
- Trying to find a quality-insurance of the signal, fit with a APV signal functional form (gauss*error function combination)

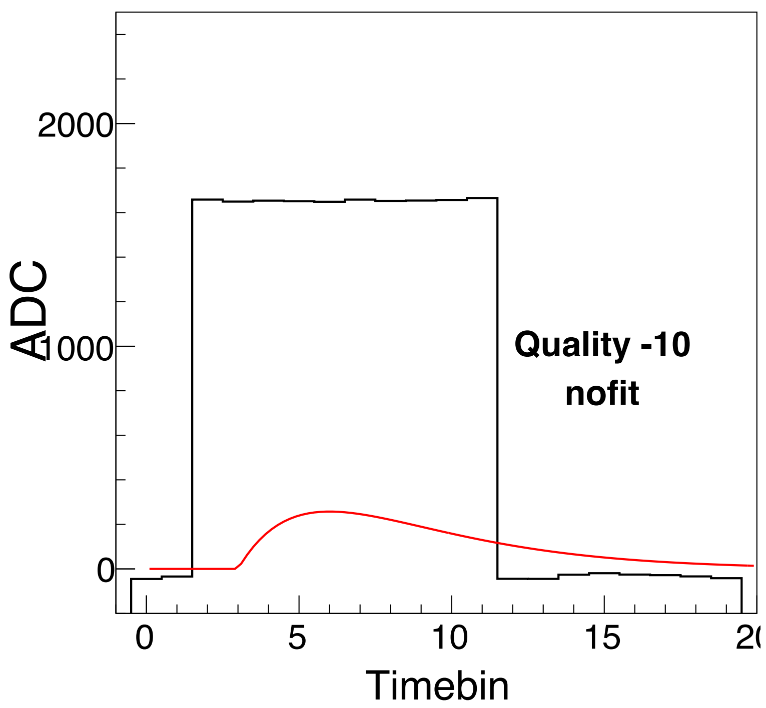


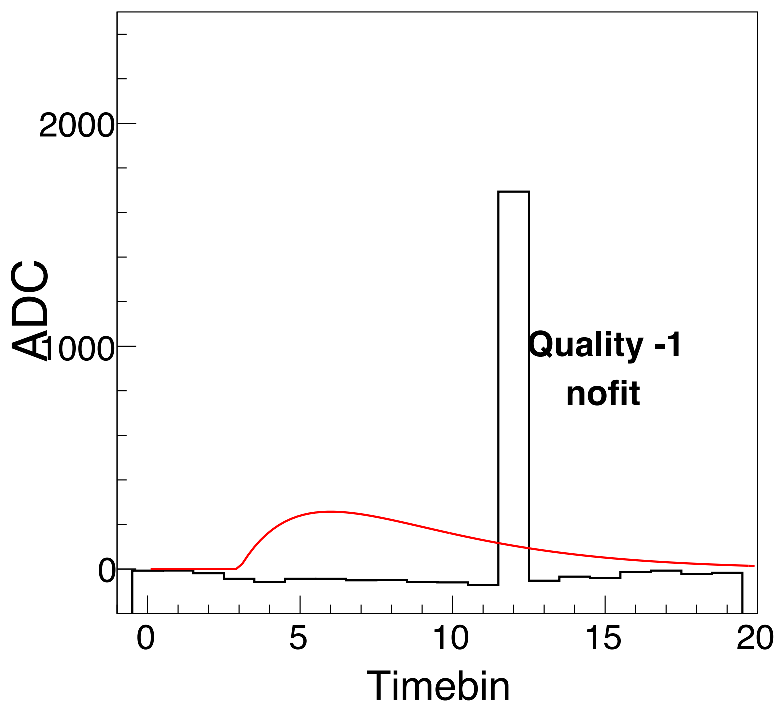
Classification of hits

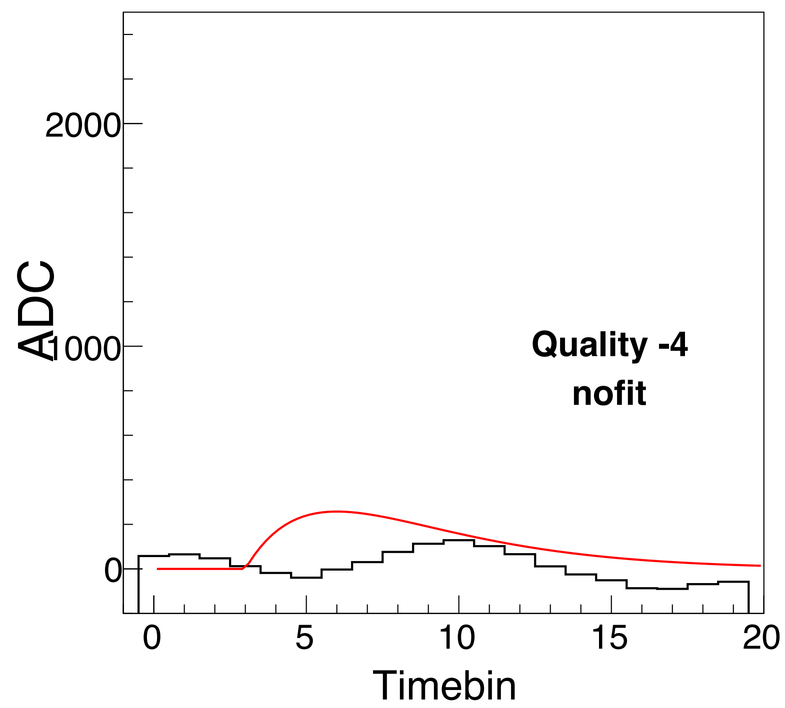
- **The maximum of the histogram has to be > 5σ of the pedestal**
- **Classify the event with its quality definition:**
  - First 3 time bins are pedestals < 5σ
  - Find the maximum of the histogram around 5-10 time bin:
    - Penalty of late or early signals (not timed correctly)
  - Three monotonic increase of values before the maximum bin
    - Steep rise strengthen the quality assurance
  - Five monotonic decrease of values after the maximum bin
  - Some penalty on quality for obvious (frequent) bad signals



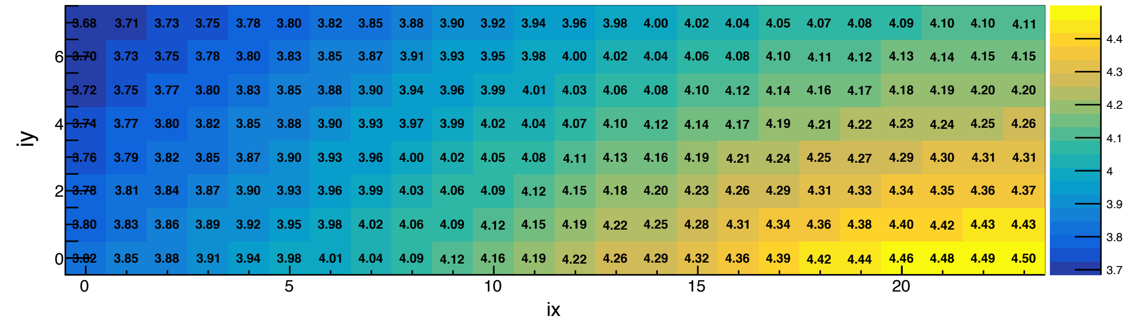
Some obvious bad 'hits'

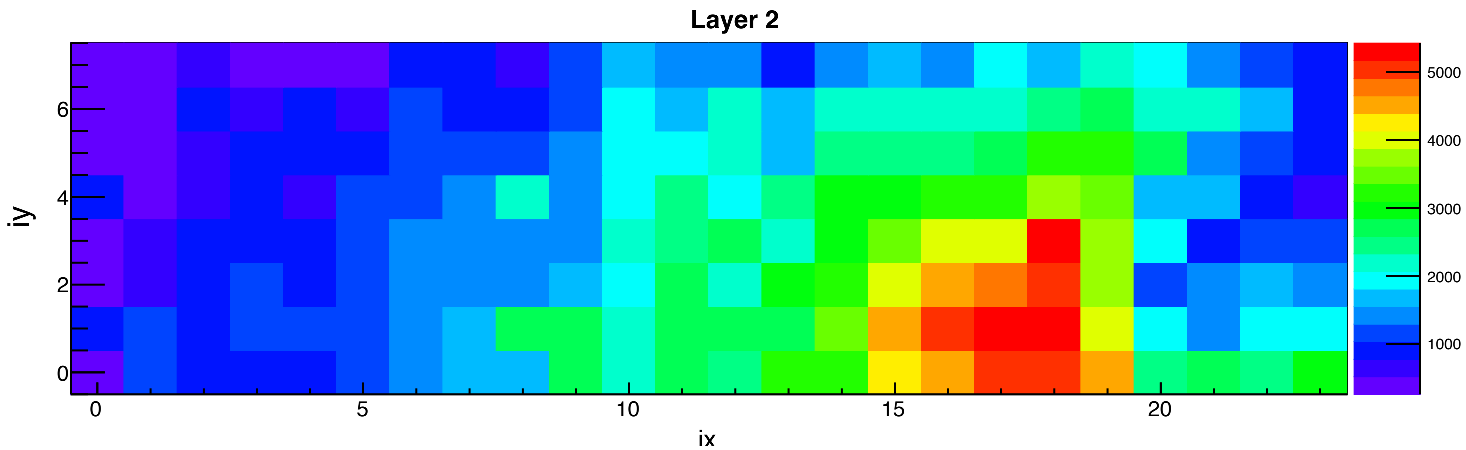


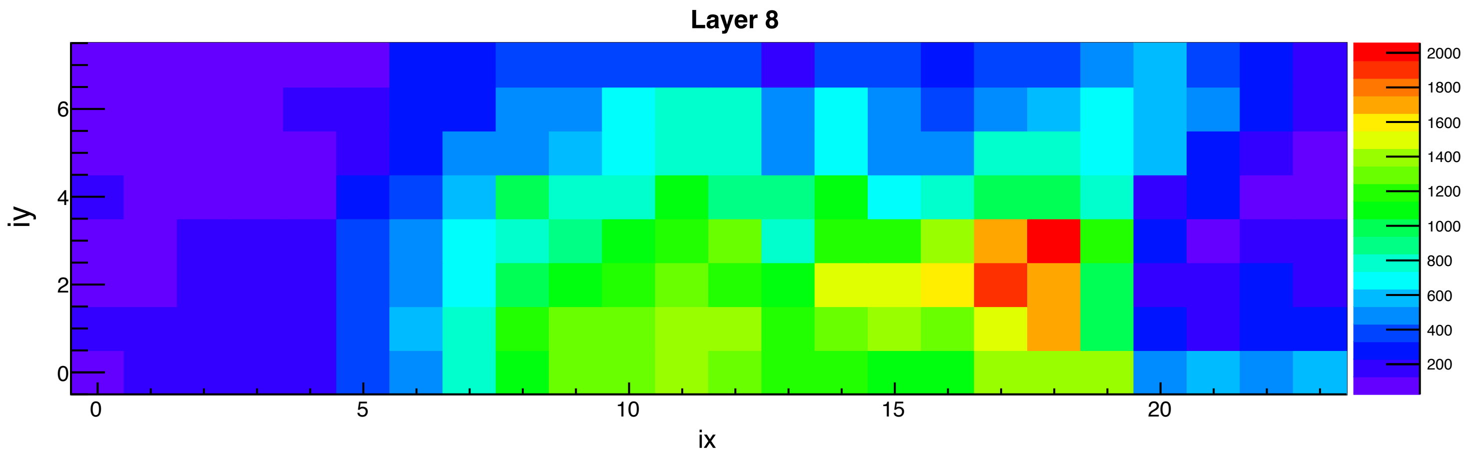


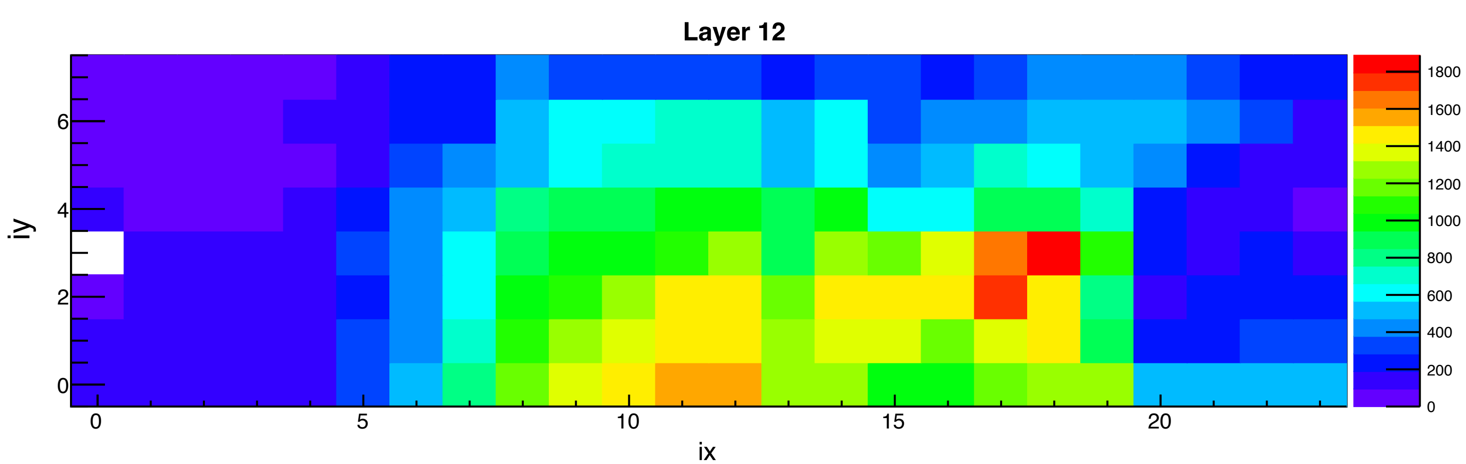


Hit distribution in different layers



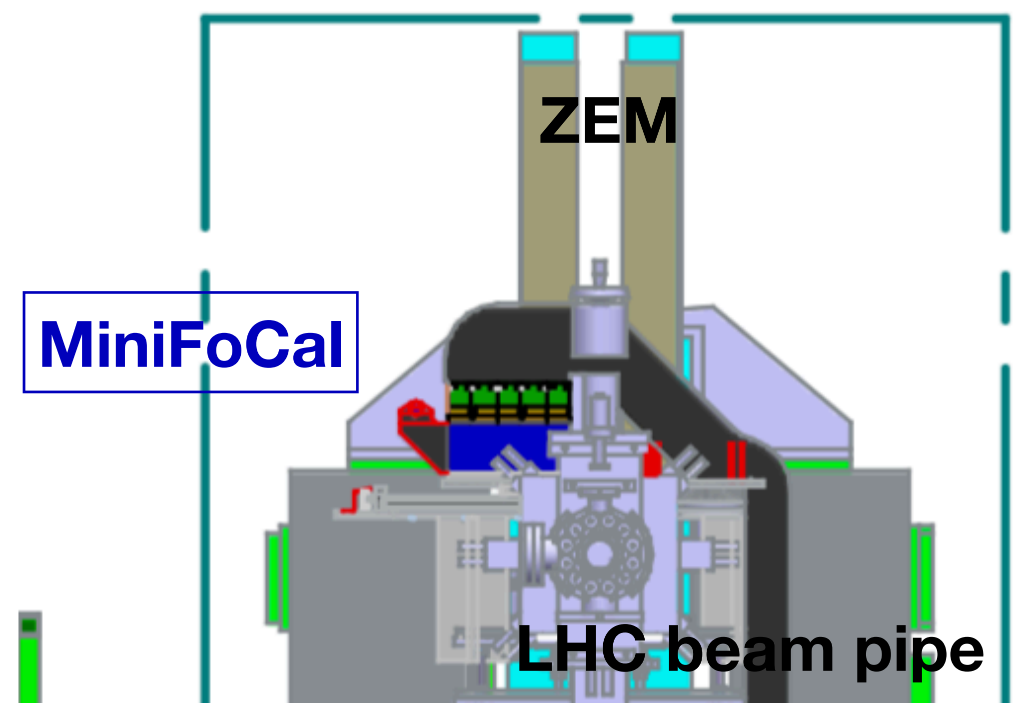




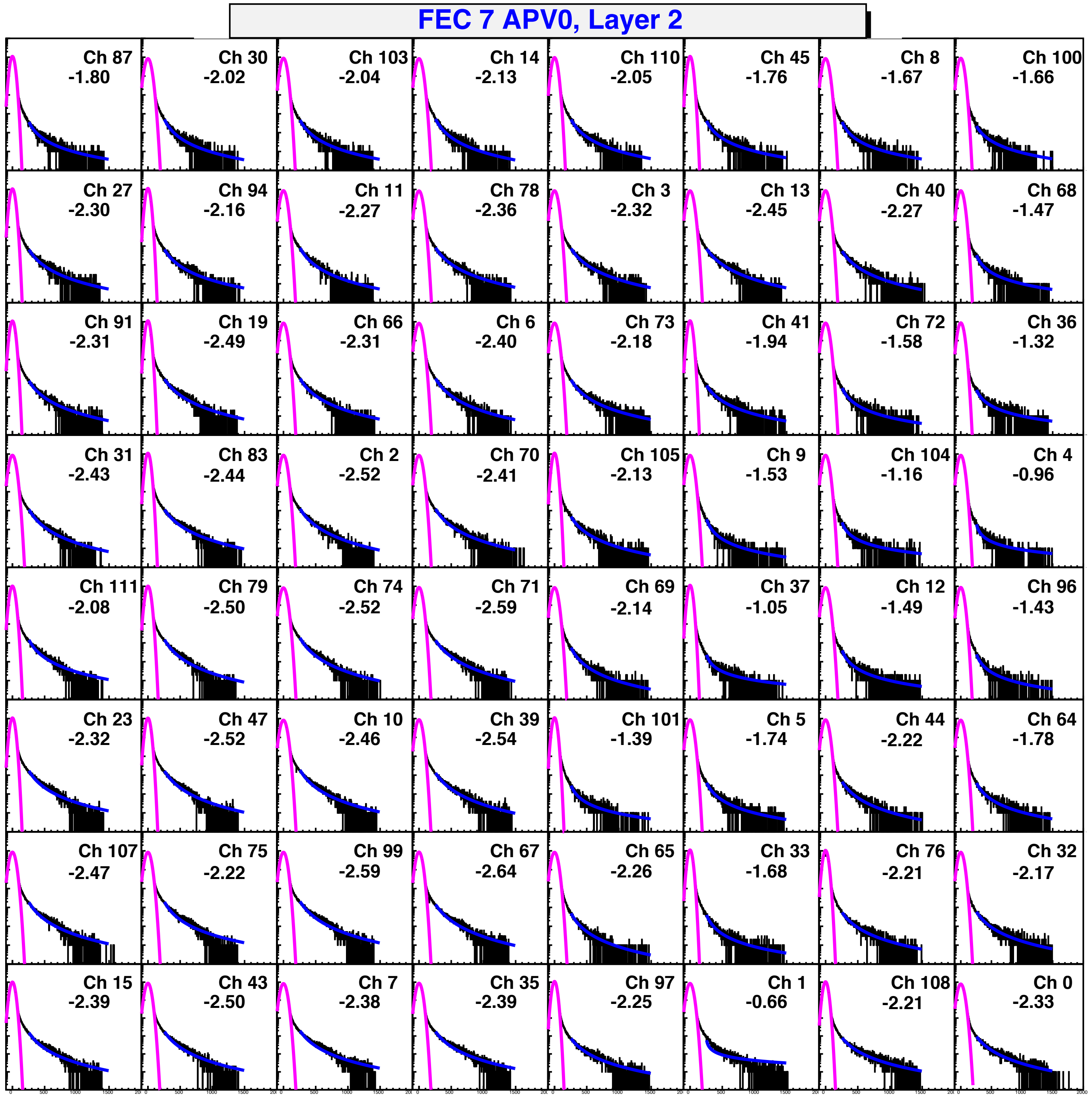


Hit distribution revealed dead and hot channels:
We found one dead channel near the edge in L12 and one hot channel (not shown in this slide)

The expected rapidity distribution is observed, only there is a hole in the right hand side of the detector, consistent in all layers



Calibration procedure

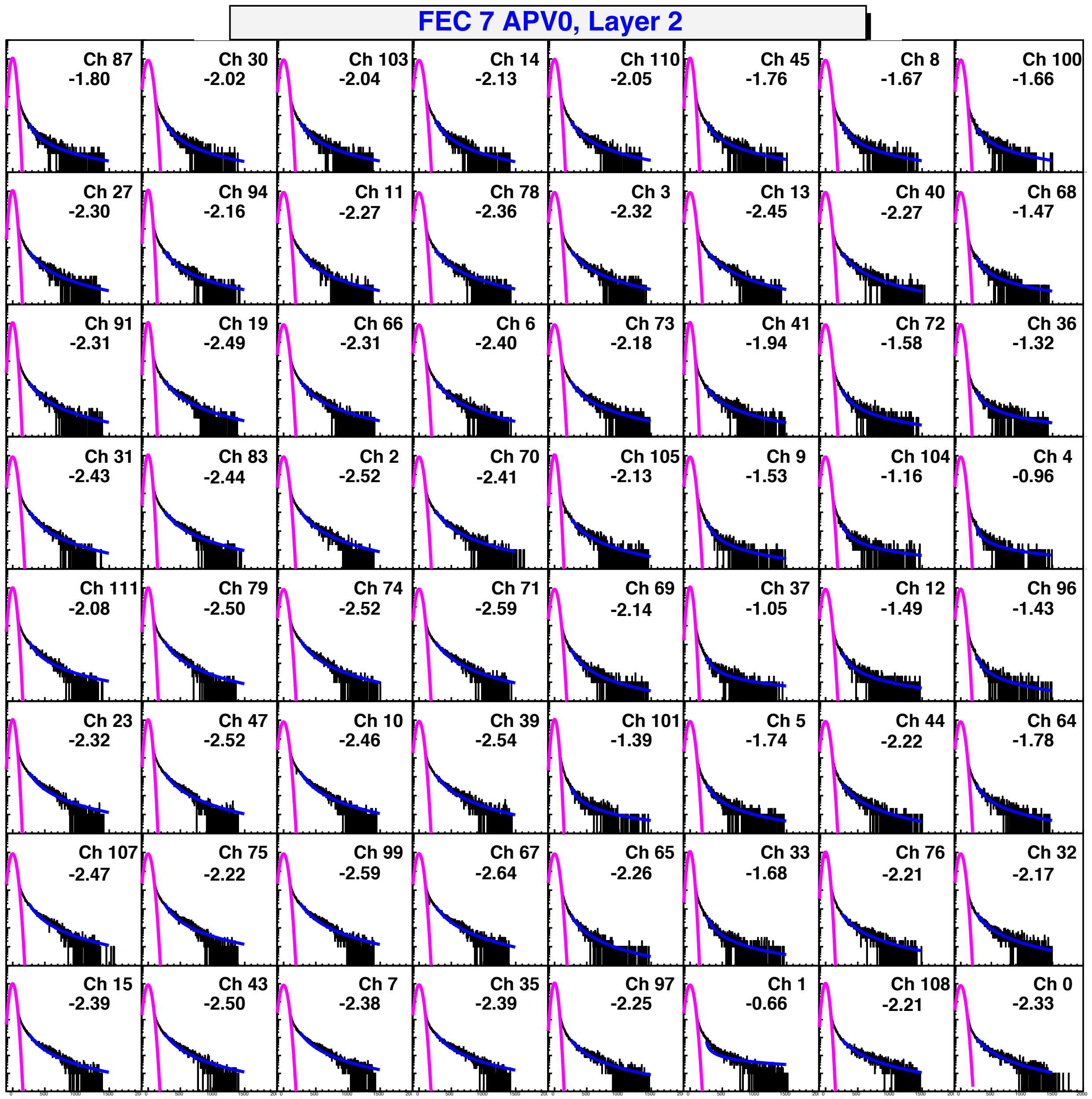


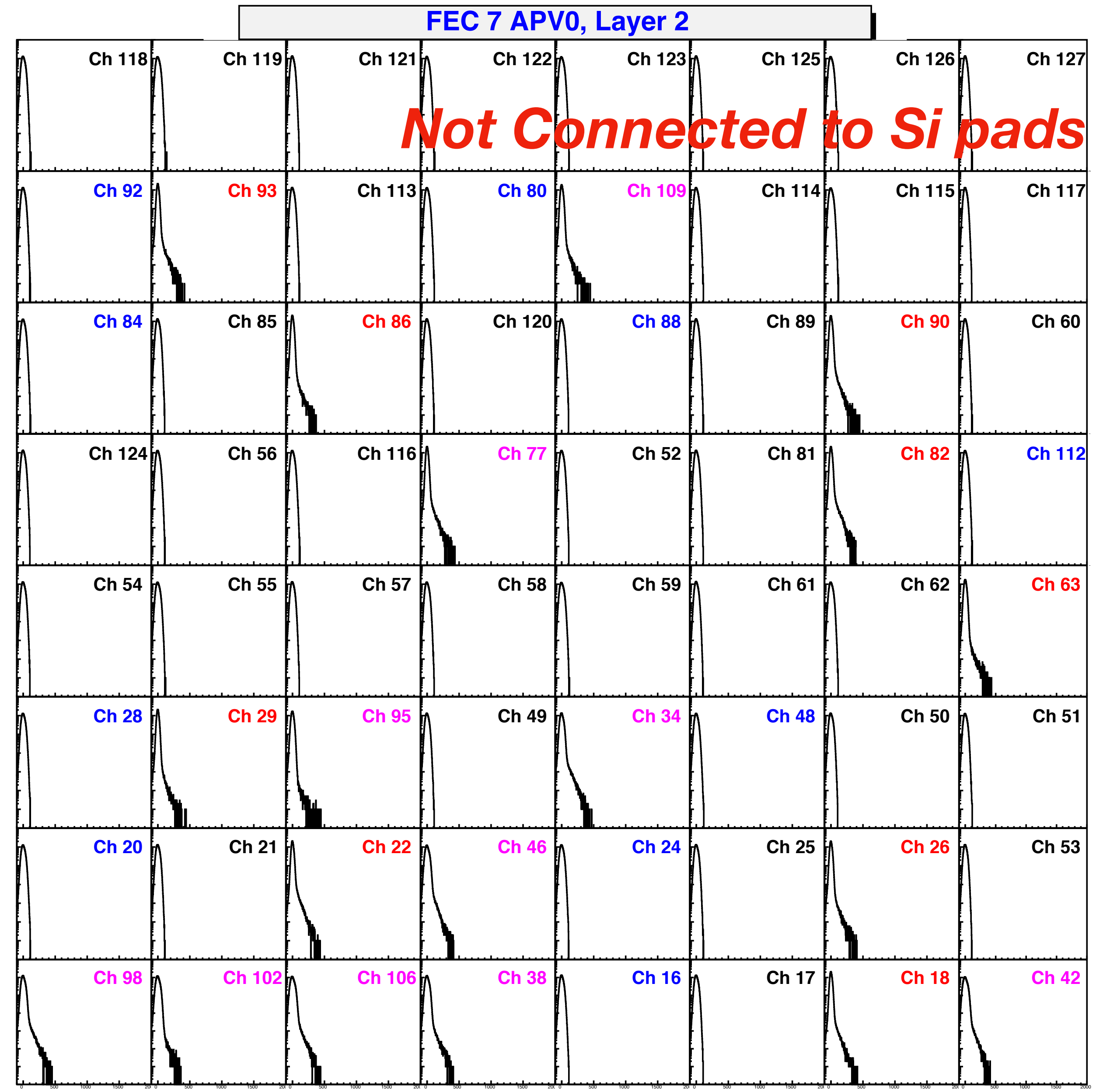
Fit each channel with gaussian and power law function:

- Gaussian for the pedestal
- Power law for the hits

The channel number and slope is shown in each pad corresponding to a single Si pad.

Complication from cross-talk between channels



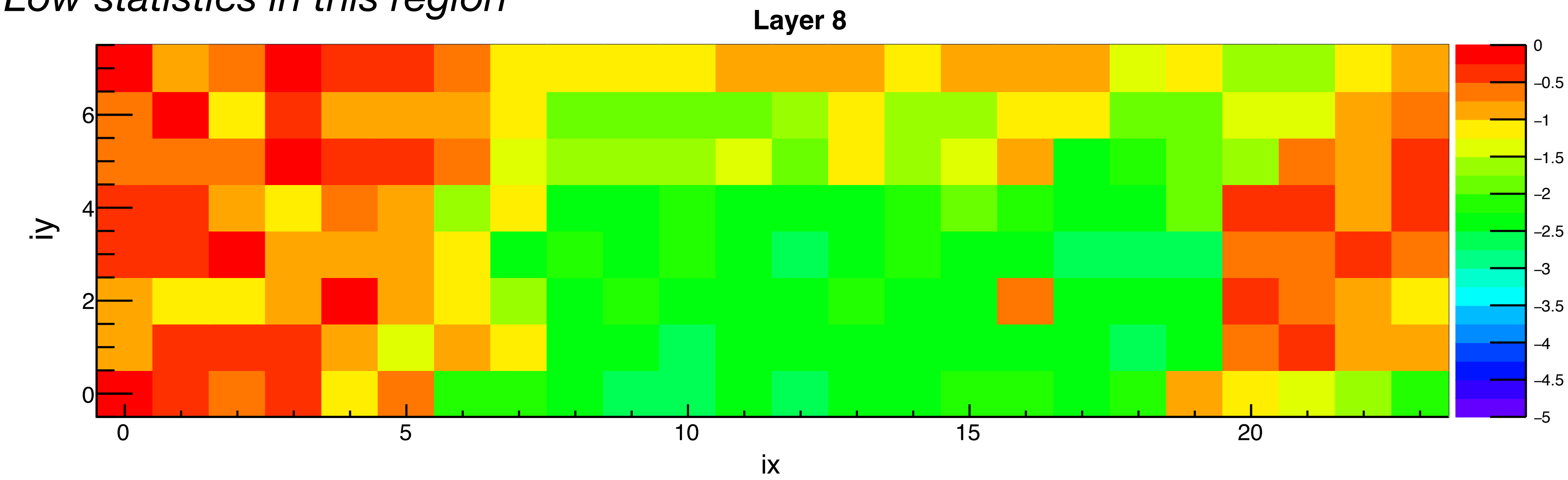


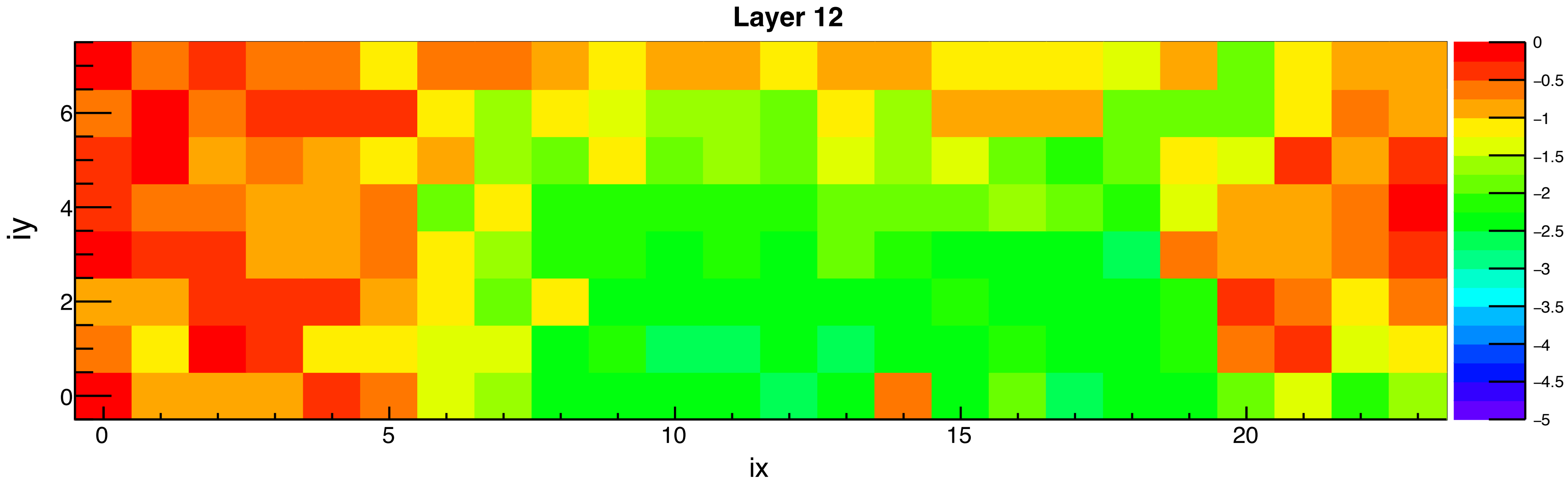
There is a clear observation of cross talk between channels:

- When one of the channel ADC overflows… the signal appear in “some” of the neighboring channels
- It cross-talks between the connected channels, so it will be a challenge to identify and correct for this effect

Calibration constant distribution

Low statistics in this region





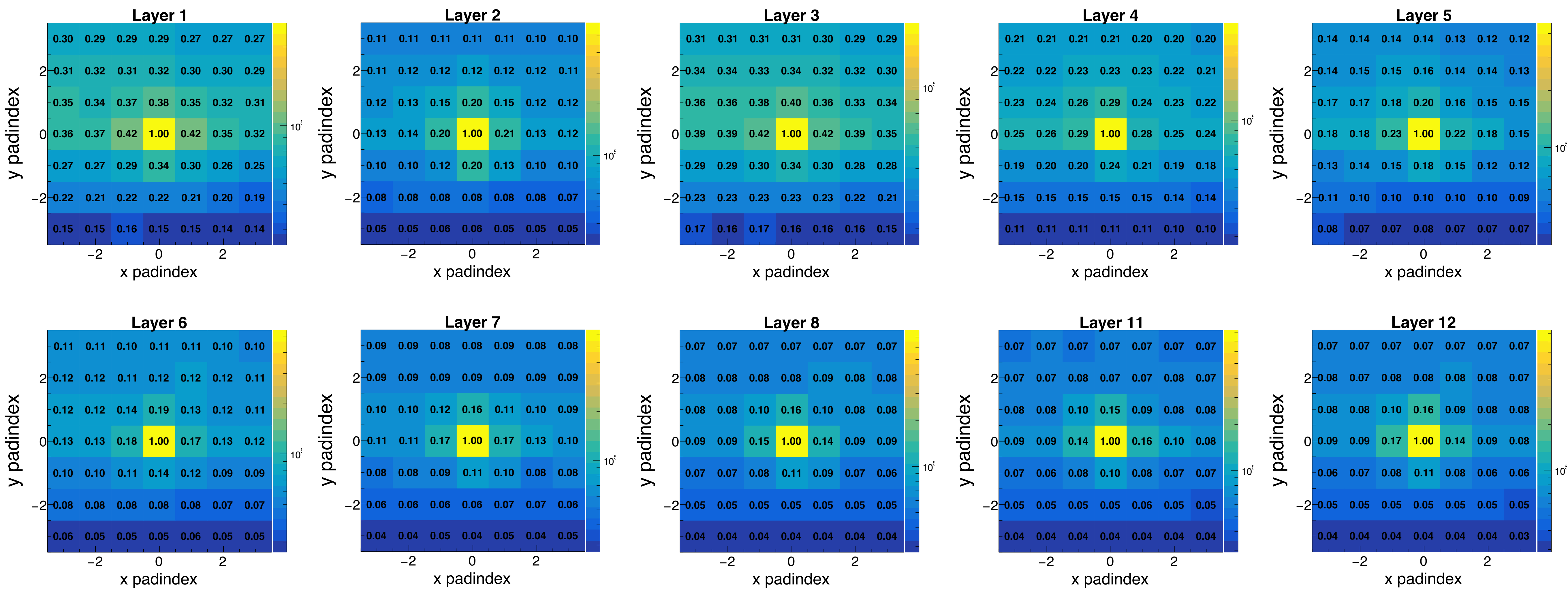
Similarly follows the hit distribution

Need more events to analyze in order to have enough hits collected

Red means very small (or 0 slopes) - that is more related to the statistics than the actual physics slopes

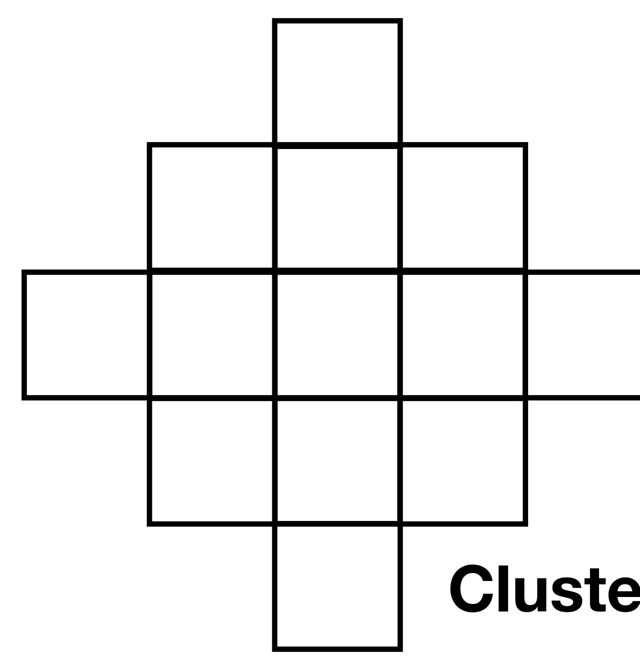
The slopes are expected to be around -2 to -2.5.

Clusterization Process



The distribution of the maximum values of hits around largest hit in the layer:

- Require only one cluster at most (no other hit in detector outside of the 7x7 area)
  - This can introduce biases for merged π^0
- The EM shower is within the 3x3 area of the main hit
- Non-symmetric distribution because of the geometry of the detector



Cluster object

Cluster center finding

For simplicity I use the ‘usual’ EMCal cluster position finding

$$[x, y] = \frac{\sum [x_i, y_i] \cdot w_i}{\sum w_i}$$

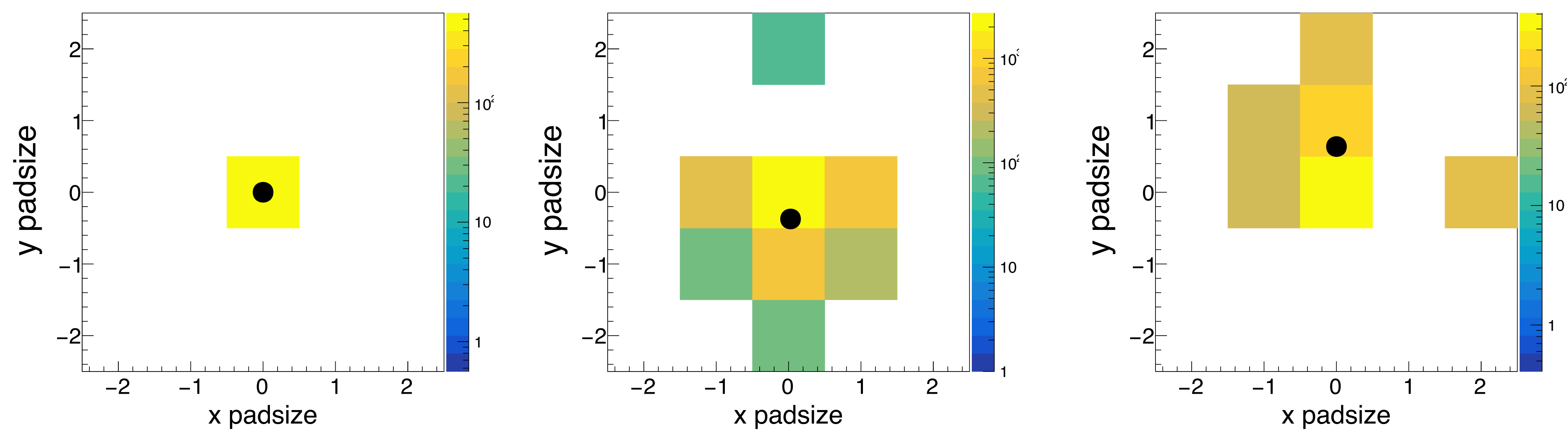
where $w_i = \ln E_i, \text{ when } E_i > E_{\text{th}}$

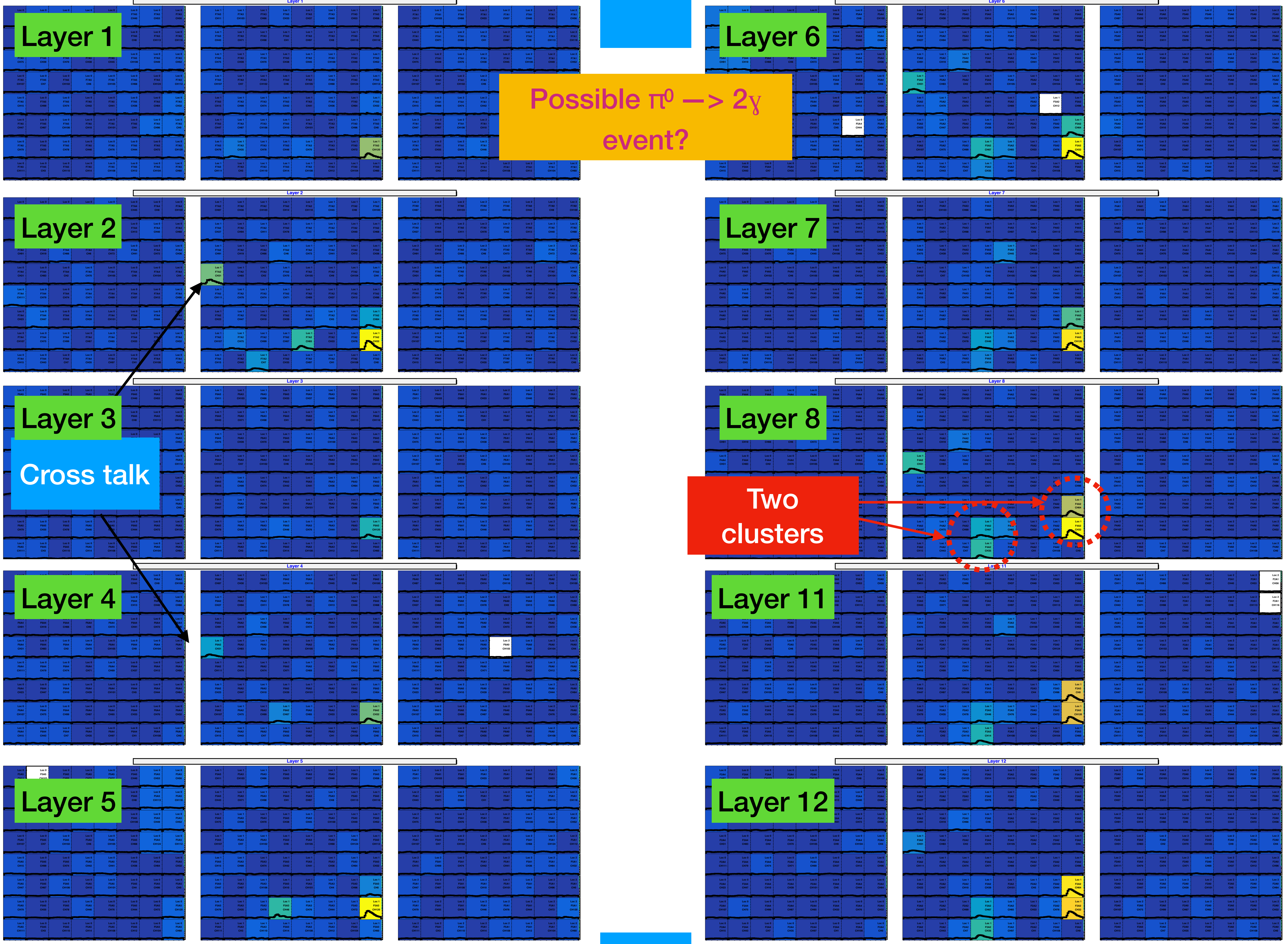
Using logarithmic weight as a start, to increase the contribution of the lower hits around the main hit.

The position is set after summing up all the layer hits:

- Reminder the first two layers has 10 times more sensitivity
  - Shower is not developed here yet - no tail
- It can be improved putting a weight on the layer also
  - Later layers probably would have increase weight

Examples




Layer 1
Layer 2
Layer 3
Cross talk
Layer 4
Layer 5
Layer 6
Possible π⁰ —> 2γ event?
Layer 7
Layer 8
Two clusters
Layer 11
Layer 12

Summary

- Very quick look in the ALICE cavern data
- Calibration of pad:
  - Pad-by-pad calibration ongoing
  - Si-by-Si calibration?
  - Layer calibration
- Classification of signals with a quality cut:
  - Trying to find a good-enough description
- These informations can feed back to simulation
  - Then back to data for energy calibration
  - Confirm with testbeam results (Saori's and Yoko's work)
- Still lot of things to do on these data
  - SRS system is good for testbeam, but it is not stable in radiation and data taking

Outlook: Run-3

Goal of the test:

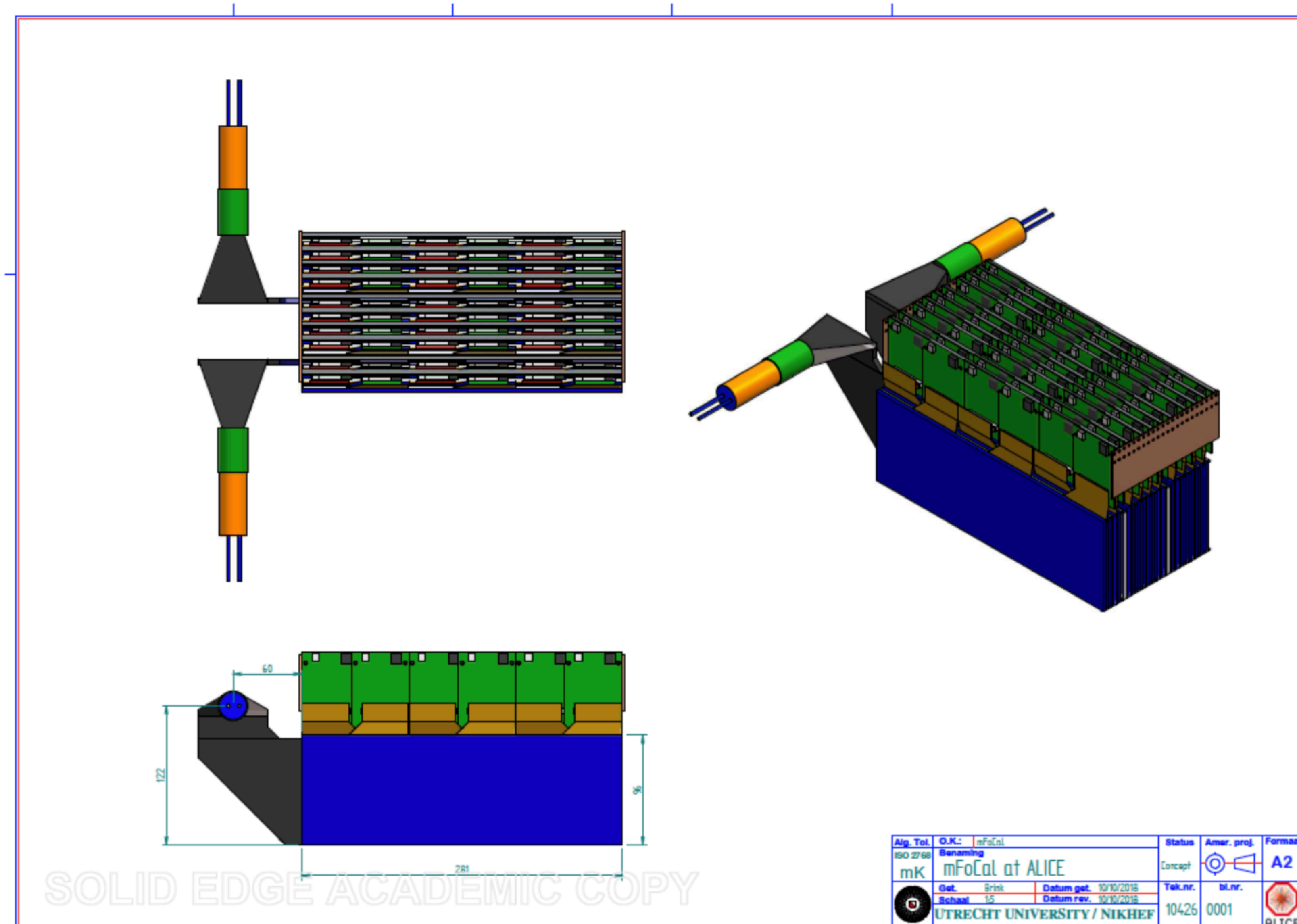
- Physics observables: π^0 yield in p+p collisions
- First look in the direct photon measurement performance

What would be needed:

- At least one or two pixel layers
- The PAD layers can be reused (20 layers):
    - Attenuation on the flexible boards can be removed
    - It is possible to upgrade the electronics (see morning sessions)
- Common readout scheme for the PAD+PIX layers
    - Why not implement the O^2 readout
    - Triggering can be also as before (scintillator), or continuous readout
- Much more sophisticated online monitoring and analysis software
- Test-bench, then test-beam before installation

Thank you

Triggering setup



The final scintillator triggering