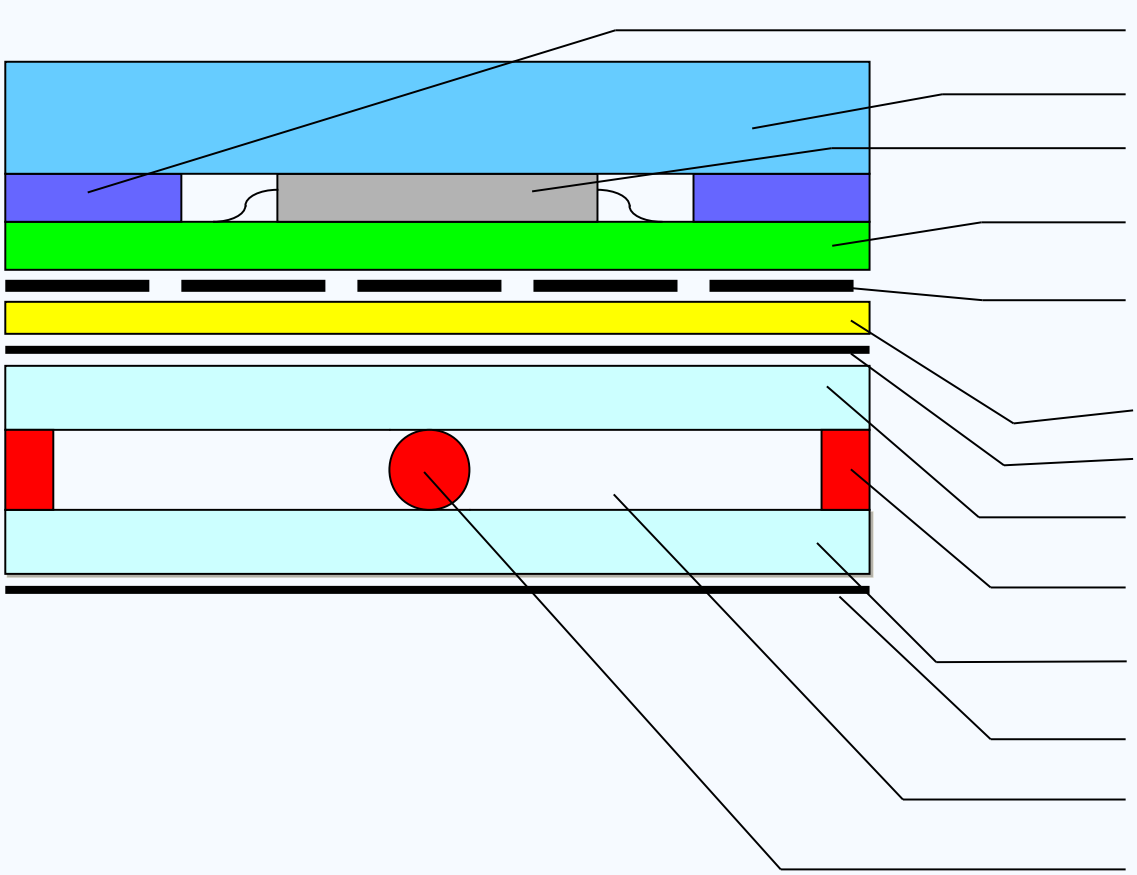
Noise and multiplicity analysis of RPC Semi-Digital HCAL

Khaled Belkadhi
LLR-École polytechnique
belkadhi@llr.in2p3.fr

Outline

- **Introduction** The sDHCAL prototype.
- **Noise analysis:**
  - Data.
  - Noise map and fishing line effect.
- **Multiplicity results using test beam data**
  - Tracks reconstruction.
  - Multiplicity map and uniformity.
  - Multiplicity map using 3 mm bin size.
- **Conclusion & perspectives**

The RPC sDHCAL prototype

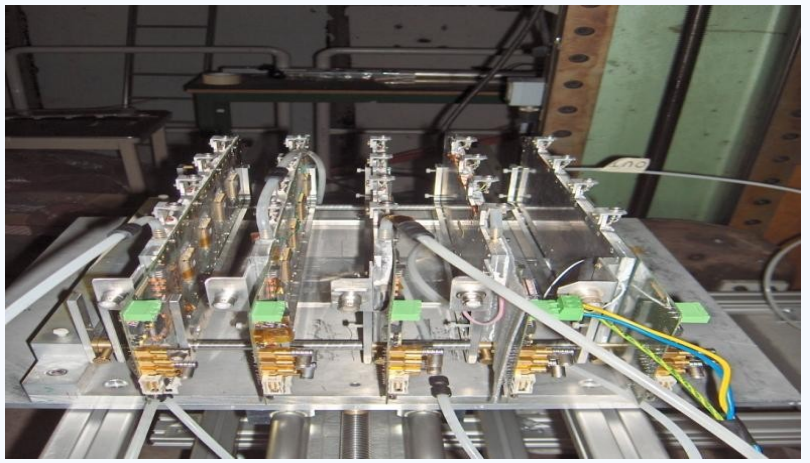


Grid (Steel)
Absorber (2 cm)
ASIC (HARDROC1)
PCB
Pads (copper, 1 cm2)
Insulation (Mylar)
Anode coating(~10 MΩ/□)
Glass plate (0.7mm)
Chamber wall (1.2mm)
Glass plate (1.1mm)
Cathode coating(~10 MΩ/□)
Gas
Spacer

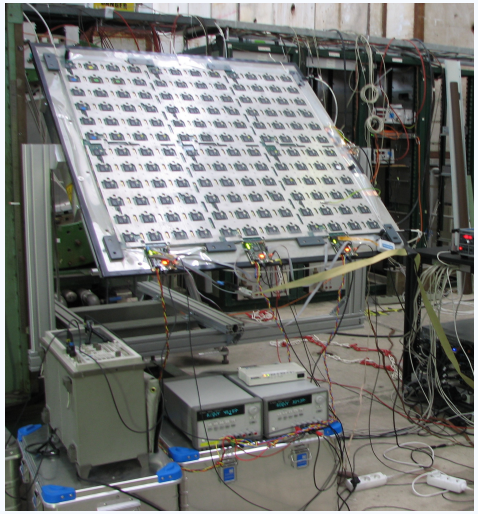
RPC and semi-digital calorimeter

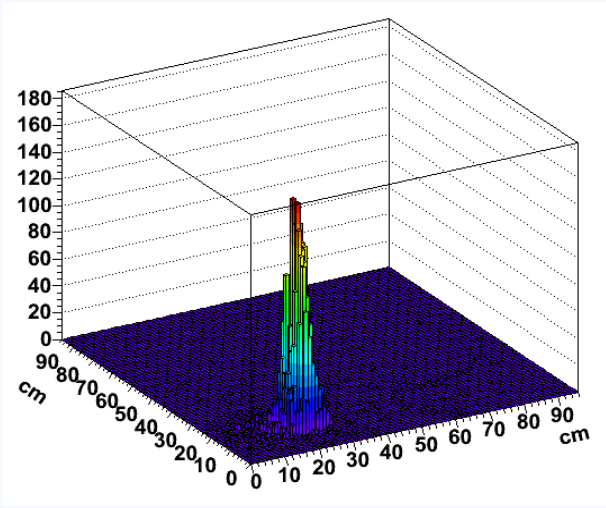
The RPC sDHCAL prototype

- SDHCAL prototype
  - **Mini sDHCAL**
    - RPC: 4 Asics and 8*32 of 1 cm² cells
    - Asic: 64 Channels
    - Trigger (test beam) = 2 scintillators



  - **1 M² :**
    - 144 Asics
    - Same triggering system

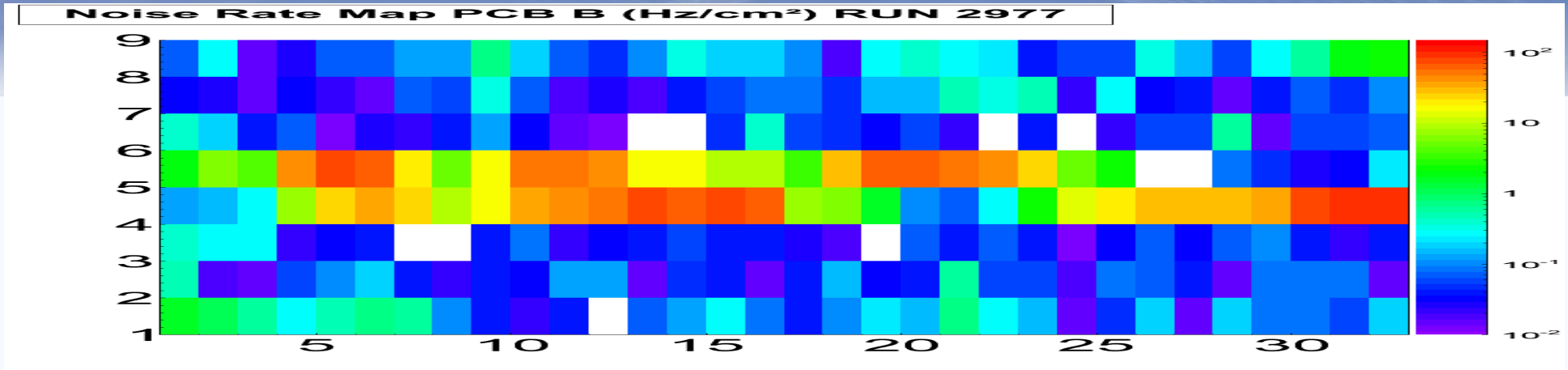




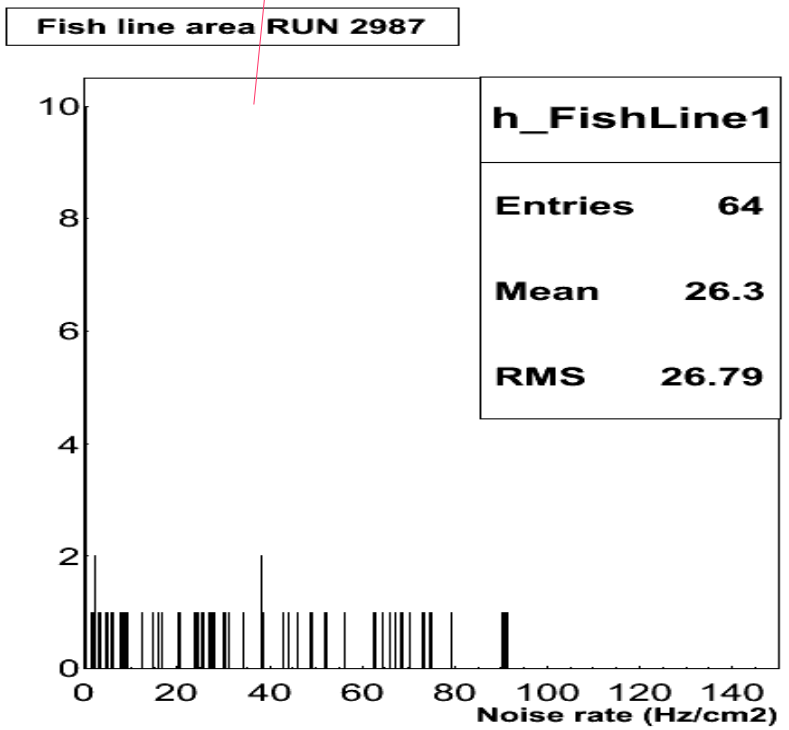
Noise analysis: data (off beam)

- External trigger @ 10 Hz.
- Threshold scan : 200 – 500 DAC value.
- One mini RPC (32 cm * 8cm) with fishing line spacer.
- 1000 to 30000 events (depending on runs).
- Same conditions (temp., gas flux, humidity,..)

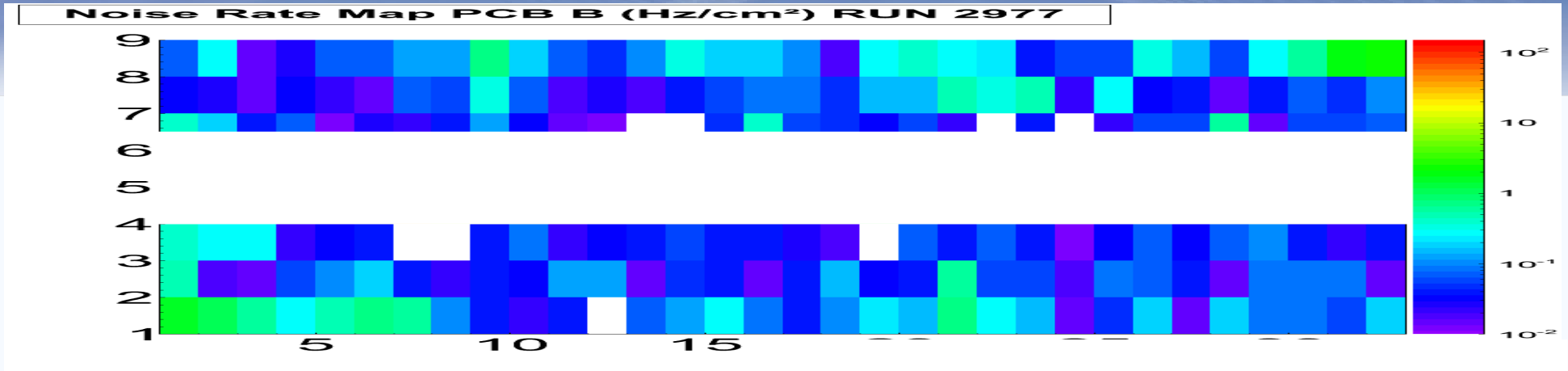
Noise map RUN 2977: threshold=200 DAC value (150 fC)

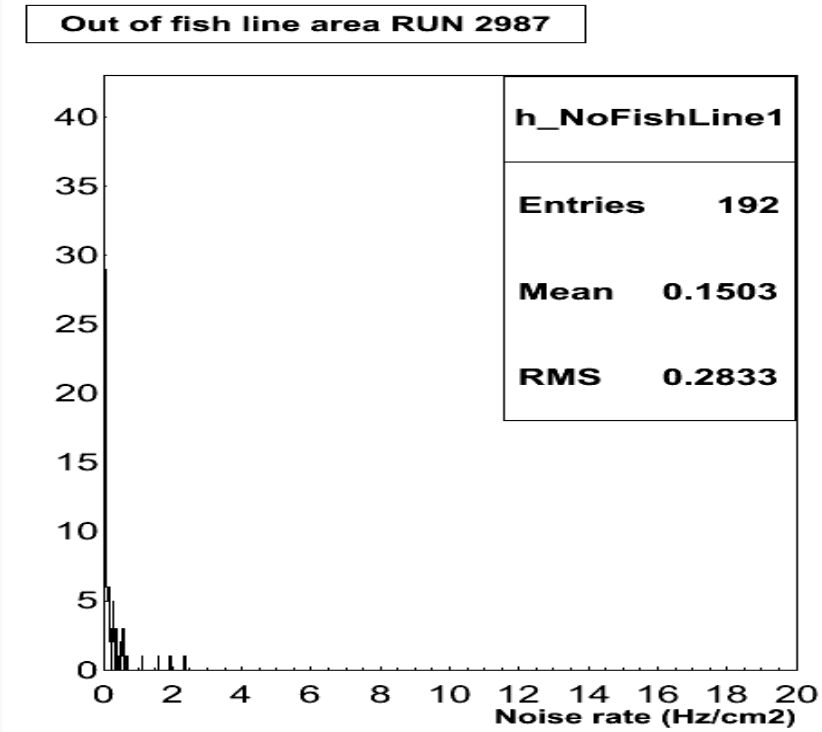


Noise map RUN 2977: threshold=200 DAC value (150 fC)

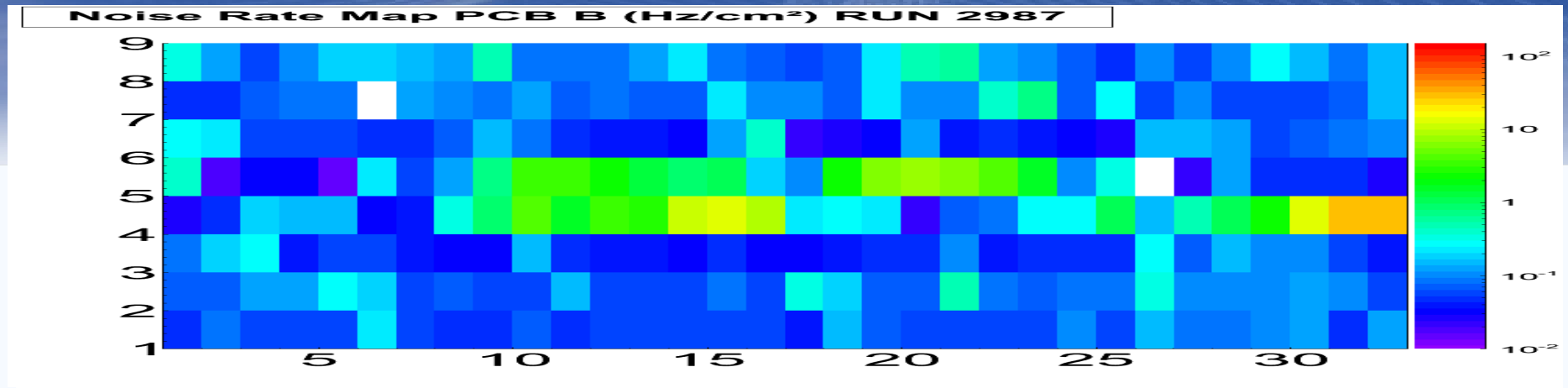


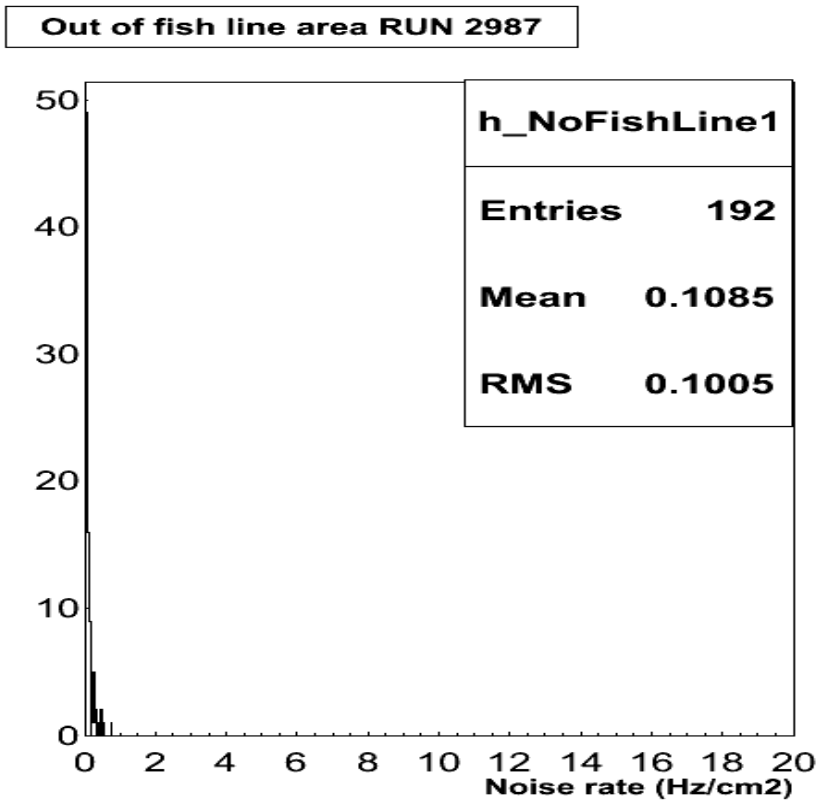
Noise map RUN 2977: threshold=200 DAC value (150 fC)

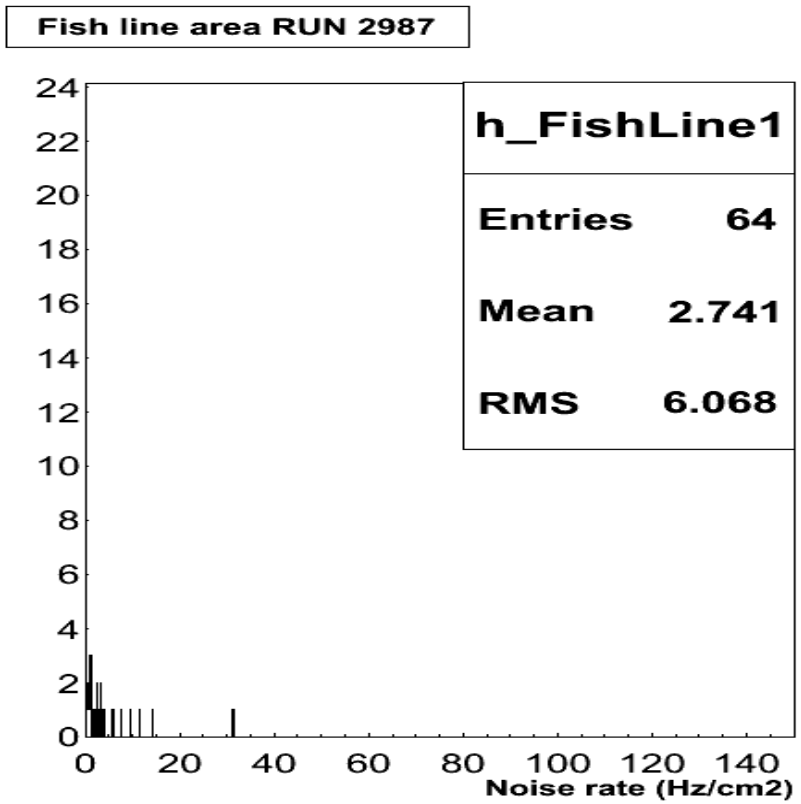




Noise map RUN 2987: threshold=500 DAC value



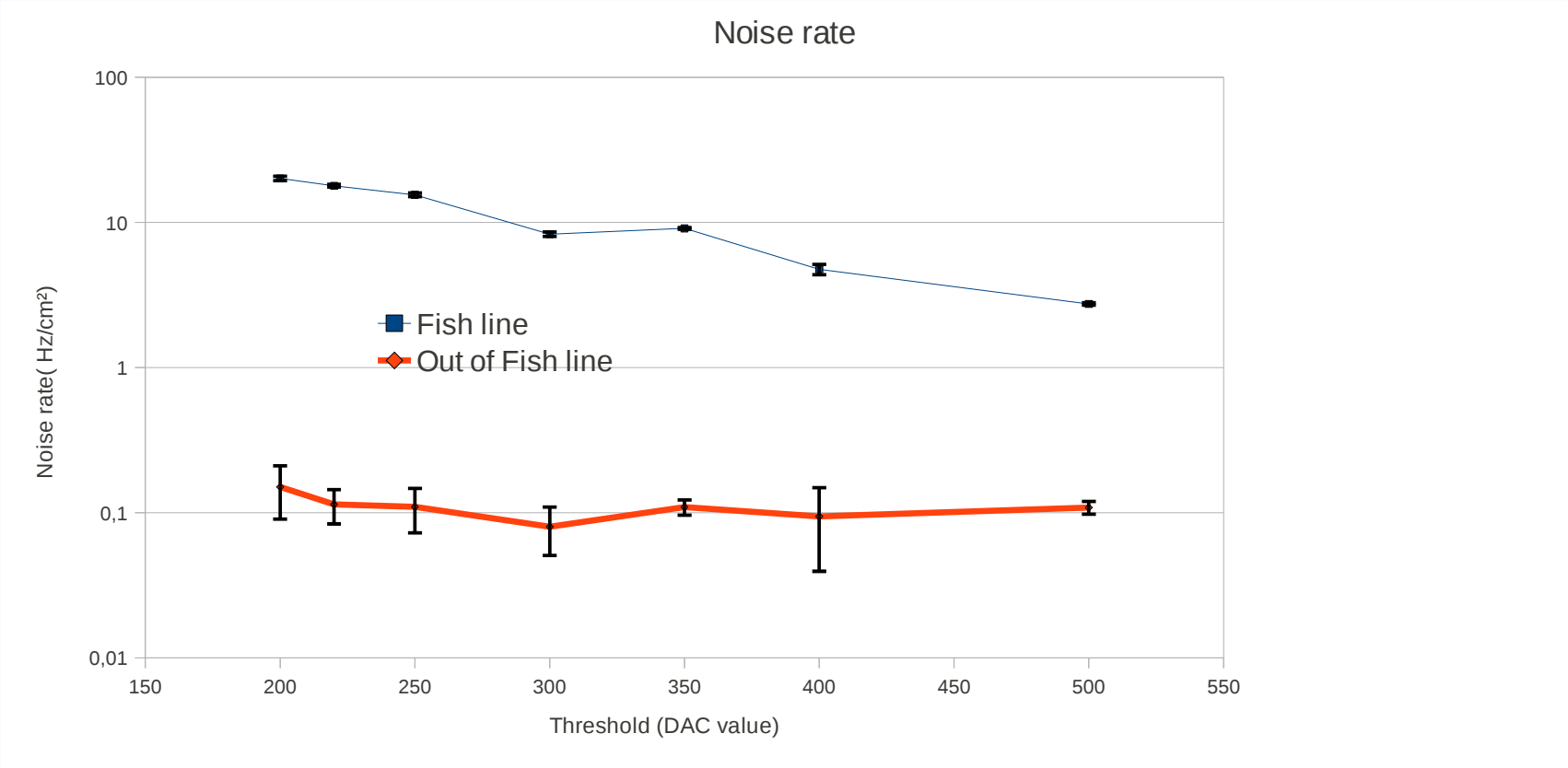




Noise rate: threshold scan

RUN N°	N° events	DAC value	Fish line (Hz/cm²)	Out of Fish line (Hz/cm²)
2977	1421	200	26.3	0.1503
2978	4260	220	17.88	0.1139
2979	2697	250	15.5	0.1097
2980	3164	300	8.31	0.0801
2981	21787	350	9.09	0.1093
2985	1073	400	4.75	0.0941
2987	30484	500	2.74	0.1085

Noise rate: threshold scan



-Fish line area: noise rate decrease from 26 to 2.7 Hz/cm²
-Free area: stable noise rate(~0.1 Hz/cm²) 6 times higher than cosmics rate

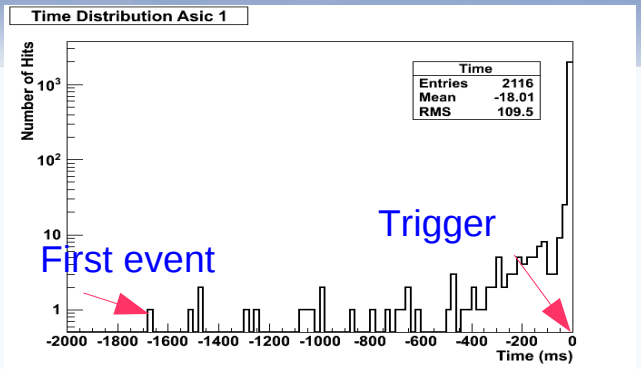
Some issues

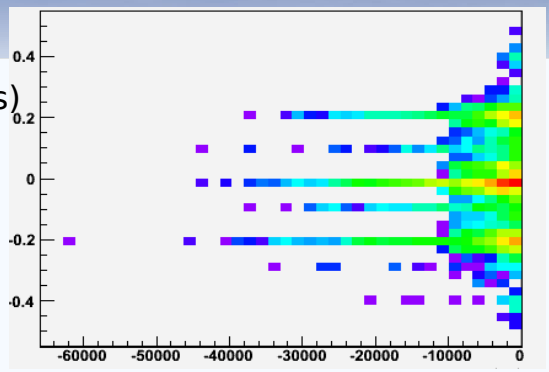
- Noise rate in the RPCs is linked to the size of the spacer : ceramic balls surface is 100 times less then fishing line.

- New generation of ASICs (HARDROC2) allows control of individual channels (noisy channels can be masked).

Multiplicity results using test beam data and train reconstruction sample

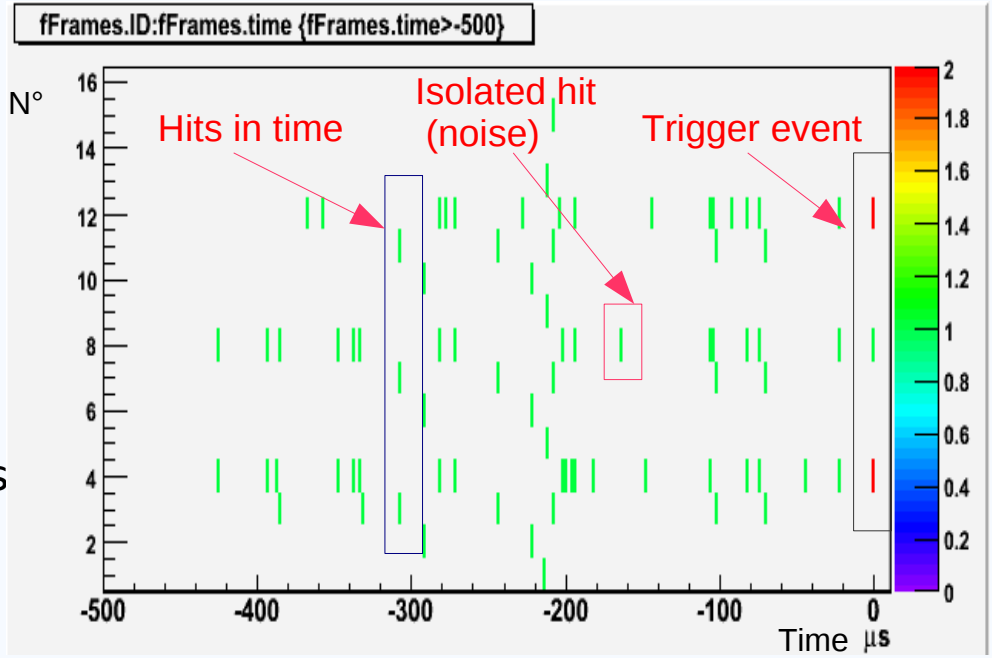
- Time structure:





Acquisition

1. Starts acquisition
2. Events are recorded in the memory with corresponding time and channel ID
3. Trigger from scintillators: stops acquisition
4. Read the memory

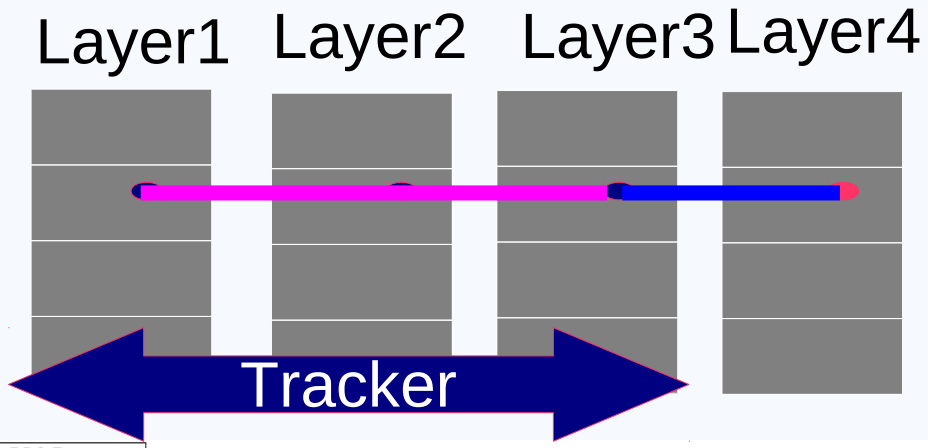


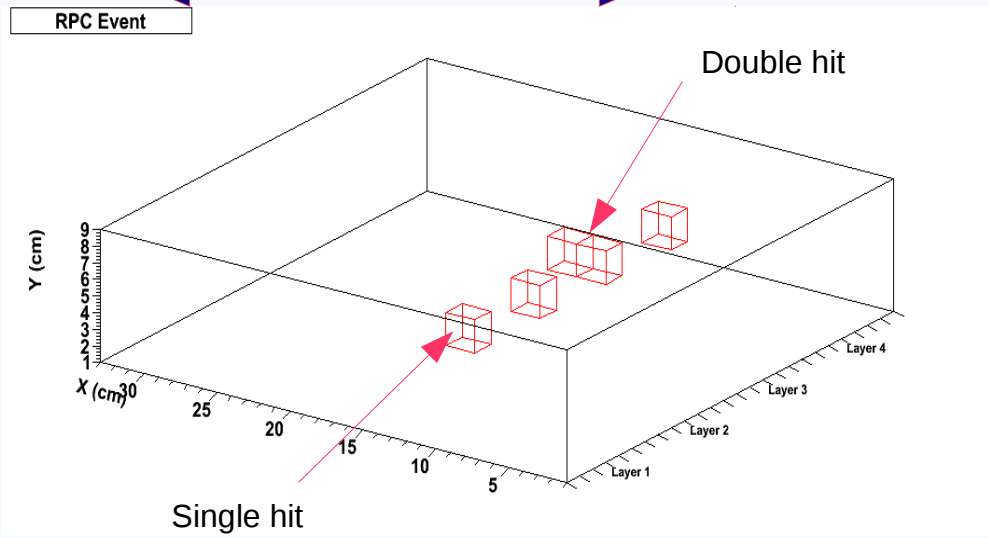
Time reconstruction

Hits belonging to the same event have $|\Delta t| < 200$ ns selection criteria for tracks reconstruction

Tracks Reconstruction

- Efficiency/Multiplicity determination:
  - **Tracking method:**
    - Use hits belonging to the remaining RPCs with a time selection to build a track candidate
    - Search hits in the studied layer around the expected impact

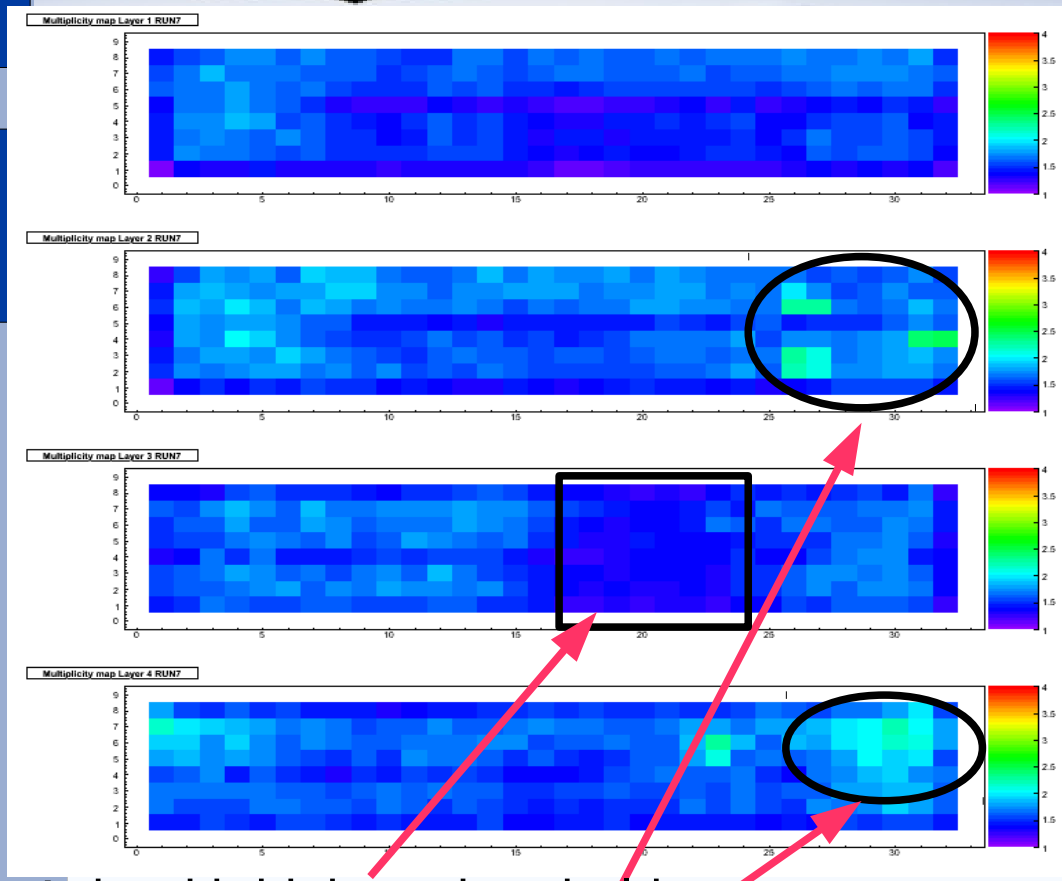


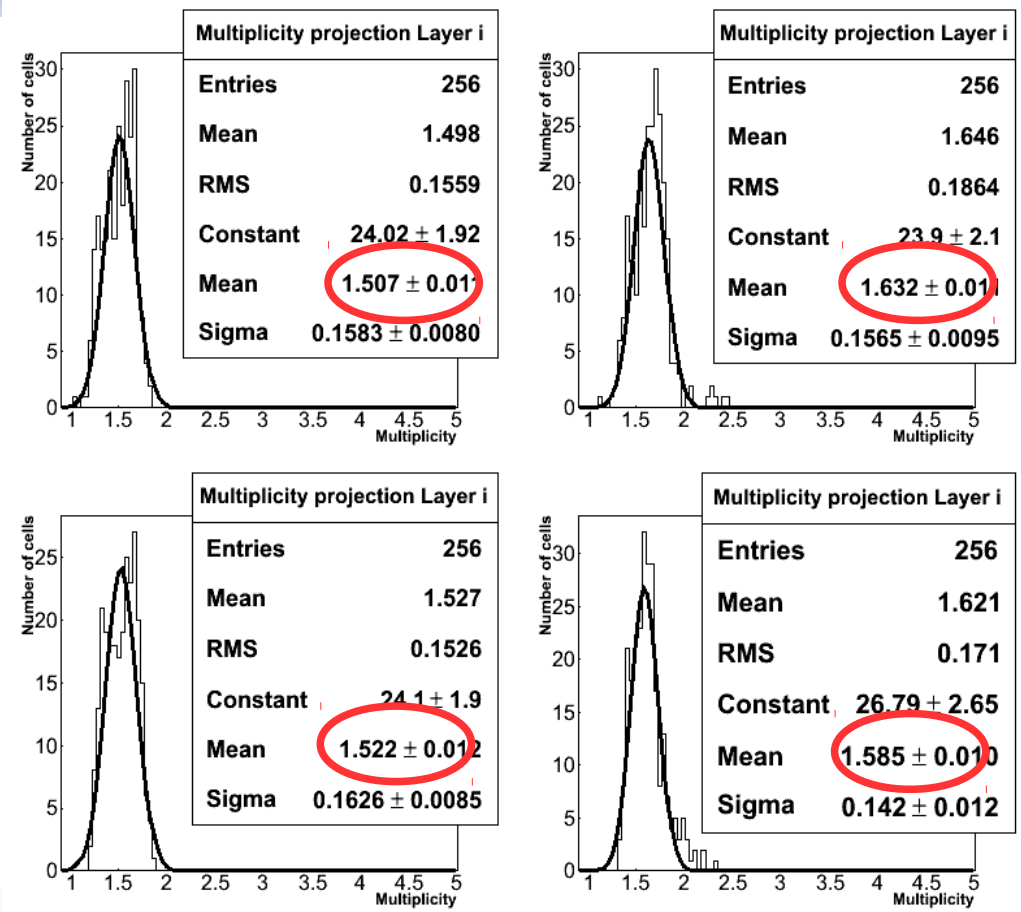


- Event Selection:
  - $\Delta t < 200$ ns
  - ≥ 1 hit per selection layer
  - ΔX & $\Delta Y = \pm 1$ cm on all layers

Multiplicity uniformity using 1cm (1 cell) bin size

6 GeV Pions, HV=7.4 kV, Threshold=220 DAC (165 fC)



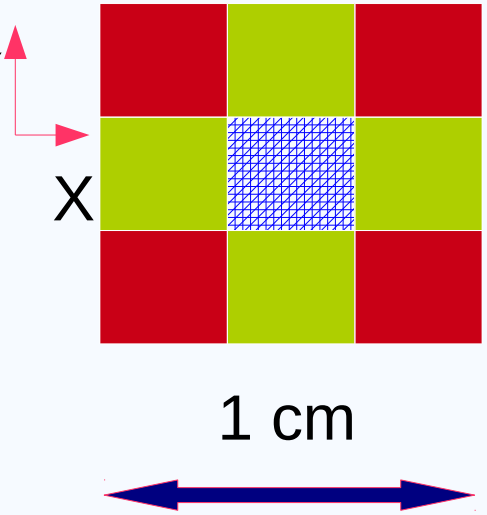


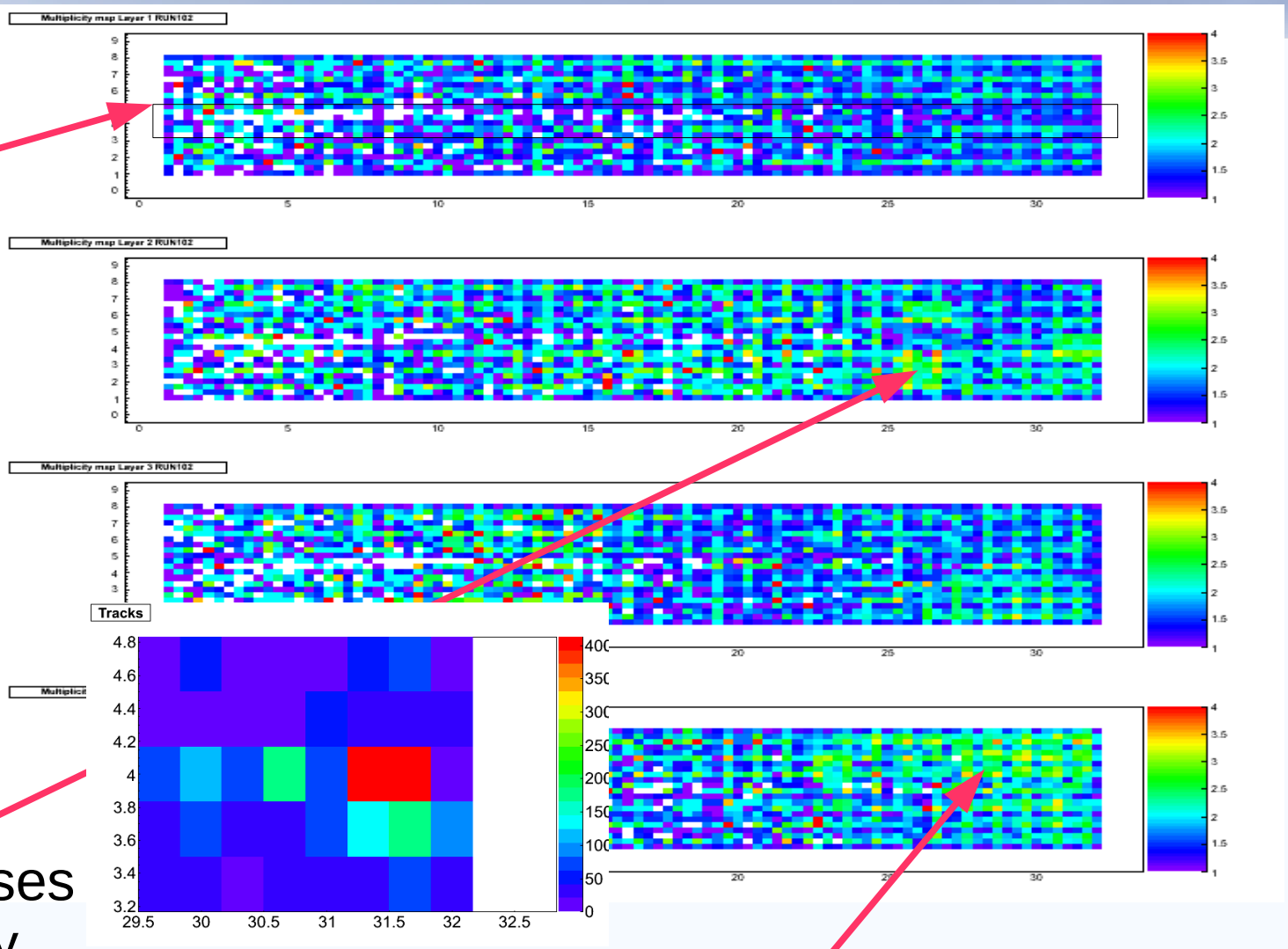
Asic with highest threshold

Strange areas: need a smallest binning to be understood

Multiplicity map using 3mm bin size

Fishing line area





Linked cells causes higher multiplicity (confirmed by EUDET telescope scan)

Problem with PCB fixation

Conclusions & perspectives

- Noise study confirms low noise rate in free area (out of spacers) → better results with ceramic balls.
- Study of efficiency and multiplicity of the detector confirms the high performances with the optimal parameters:
  - Efficiency ~ 95%
  - Multiplicity ~ 1.5
- 1 M^2 RPC: everything is working now (efficiency >94%).
- New results of power-pulsing test beam (see Robert's talk).
- Next:
  - Two additional large RPCs being assembled
  - Scheduled beam tests with 2 M^2 in end of september (SPS beam).