

Update on Test Beam Results Using an RPC Semi-Digital HCAL



Outline

- **Introduction**

- The sDHCAL prototype
 - Mini sDHCAL
 - 1 m² prototype
- Beam Tests history.

Key characteristics
for the energy reconstruction
in a digital calorimeter

- **Mini sDHCAL:**

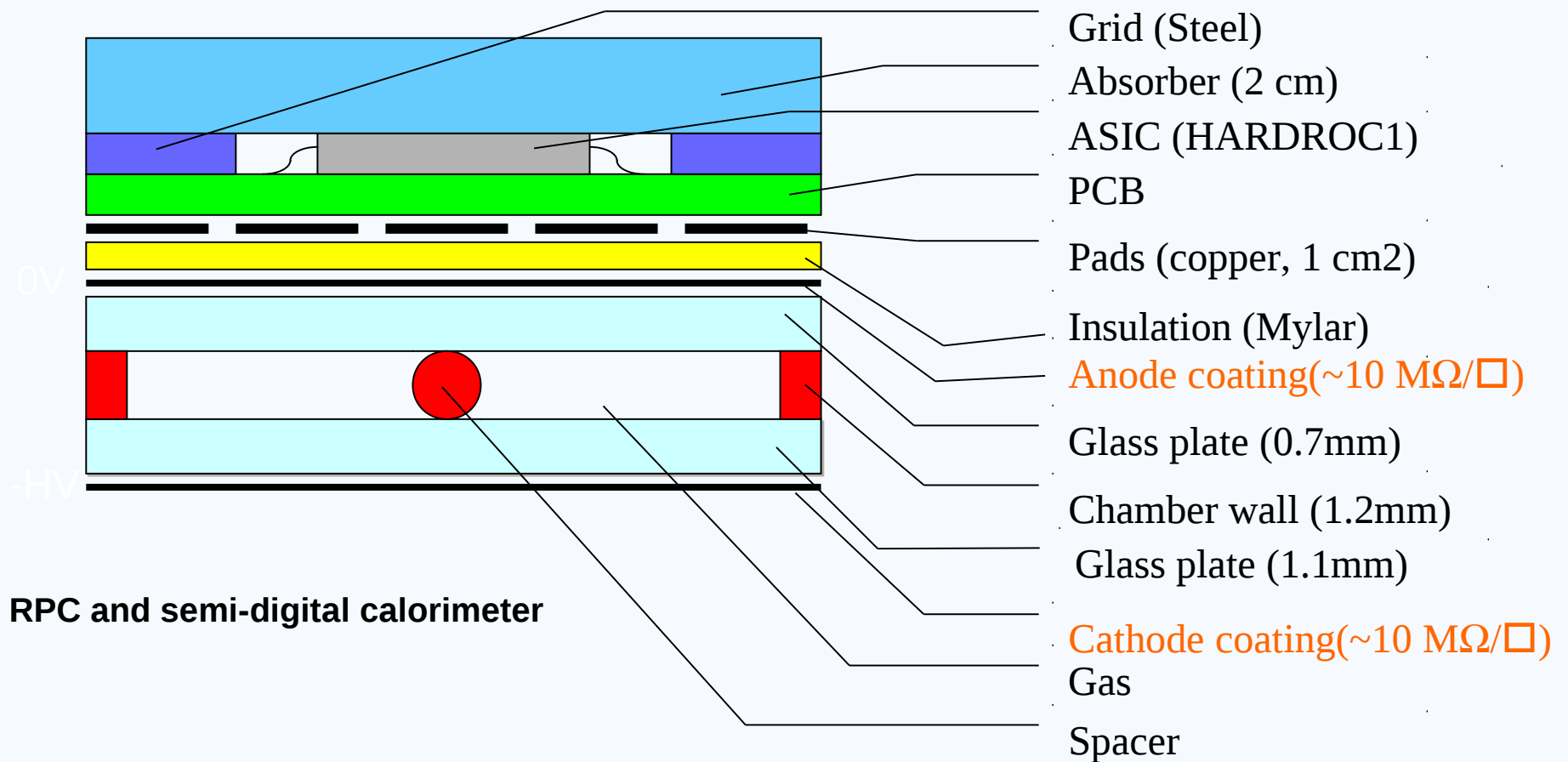
- Efficiency and Multiplicity.
- Uniformity and Stability in time

- **1 m² performances**

- Data selection
- Efficiency results
- Tracking system

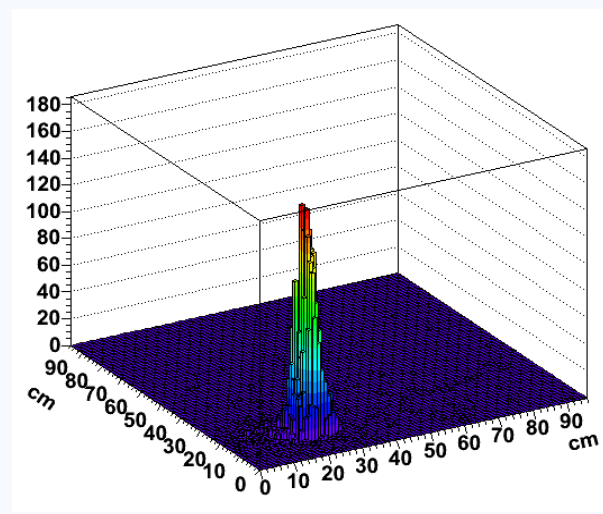
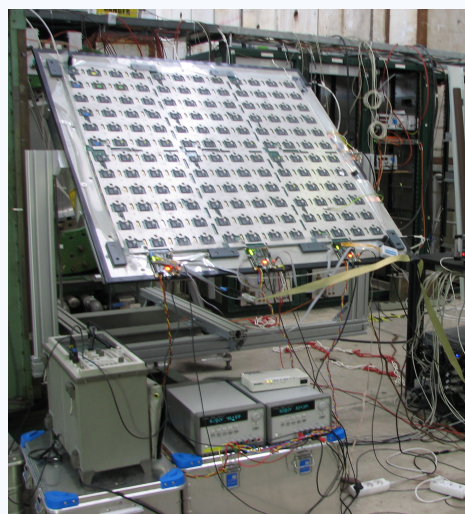
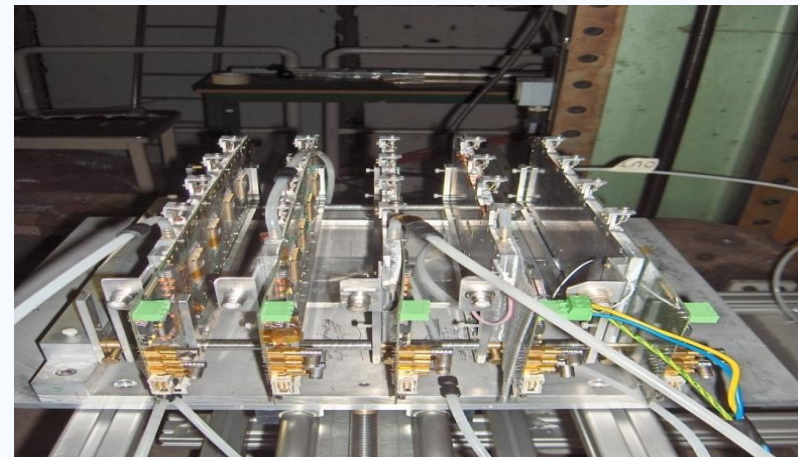
- **Conclusion**

Introduction



Introduction

- SDHCAL prototype
 - Mini sDHCAL
 - RPC: 4 Asics and 8*32 of 1 cm² cells
 - Asic: 64 Channels
 - Trigger = 2 scintillators
 - 1 M² :
 - 144 Asics
 - Same triggering system



Beam tests and List Of Participants

2008	July/August Mini sDHCAL 3-12 GeV Pions PS@CERN	November Mini sDHCAL 6 GeV Pions PS@CERN
2009	June July Mini sDHCAL + 1 M ² 3-12 GeV Pions PS@CERN	August Mini sDHCAL + 1 M ² with Absorber 10-150 GeV Pions&Muons SPS@CERN

IPNL (France): C. Combaret, I. Laktineh, R. Kieffer, M. Vander Docket

LLR (France): K. Belkadhi, V. Boudry, D. Decotigny, M. Ruan

CIMAP (Spain): M-C. Fouz, J. Puerta Pelayo

CP3 (Belgium): E. Cortina, S. Manai

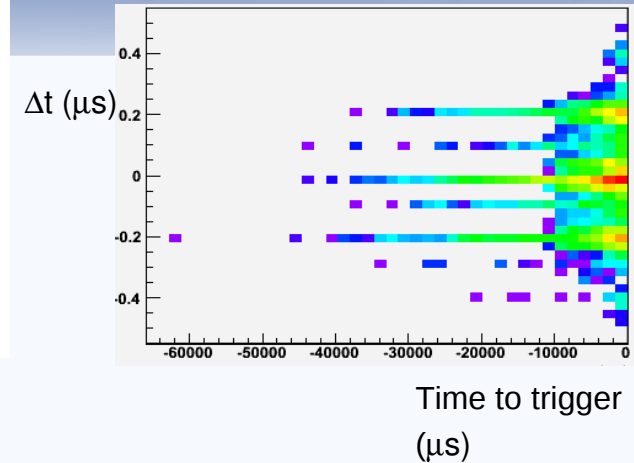
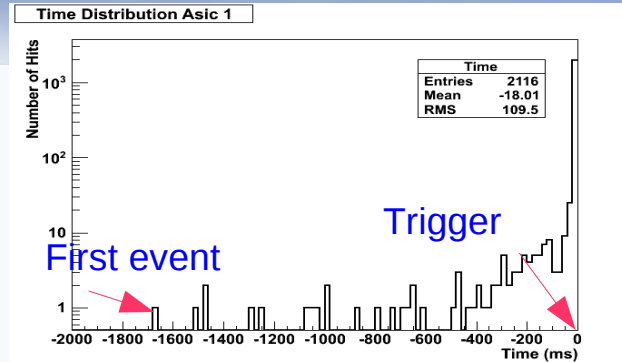
FST (Tunisia): K. Manai

Time reconstruction

- Time structure:

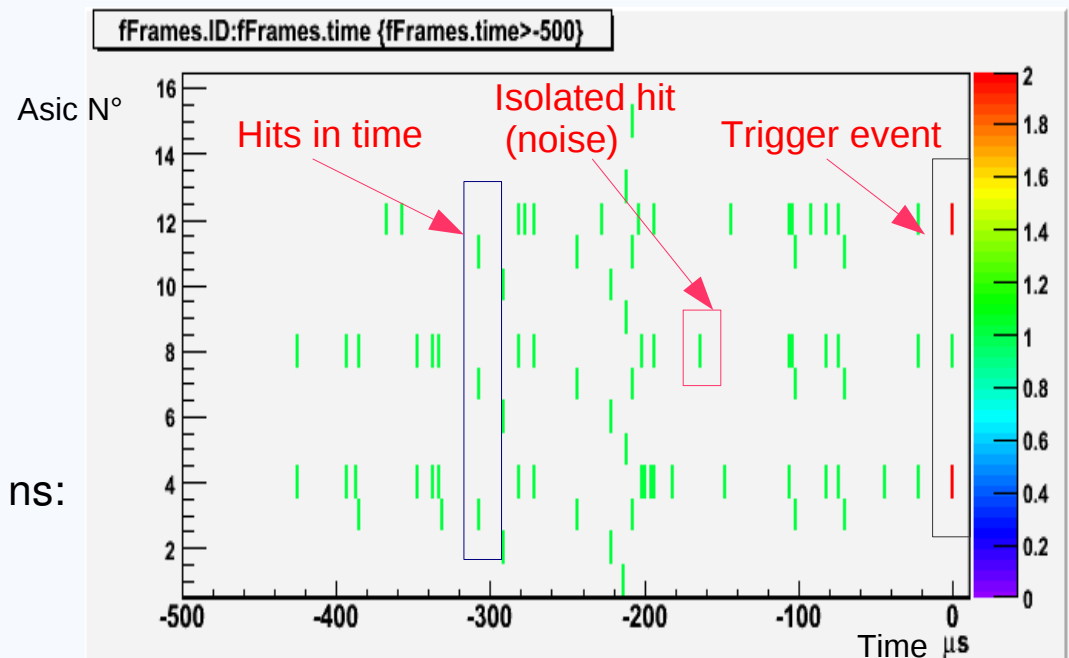
Acquisition

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



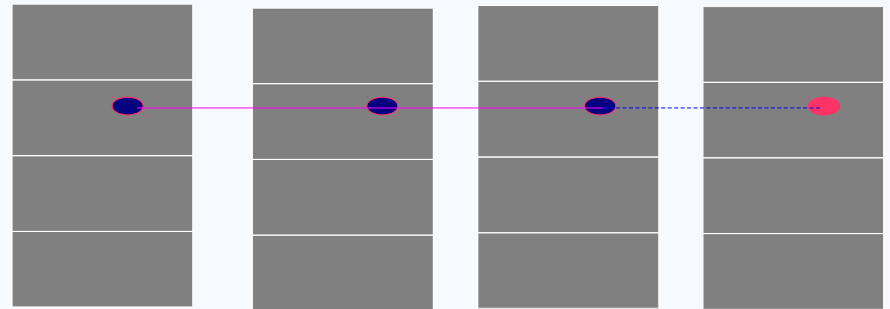
Tracks Reconstruction

- Efficiency/Multiplicity determination:

- **Tracking method:**

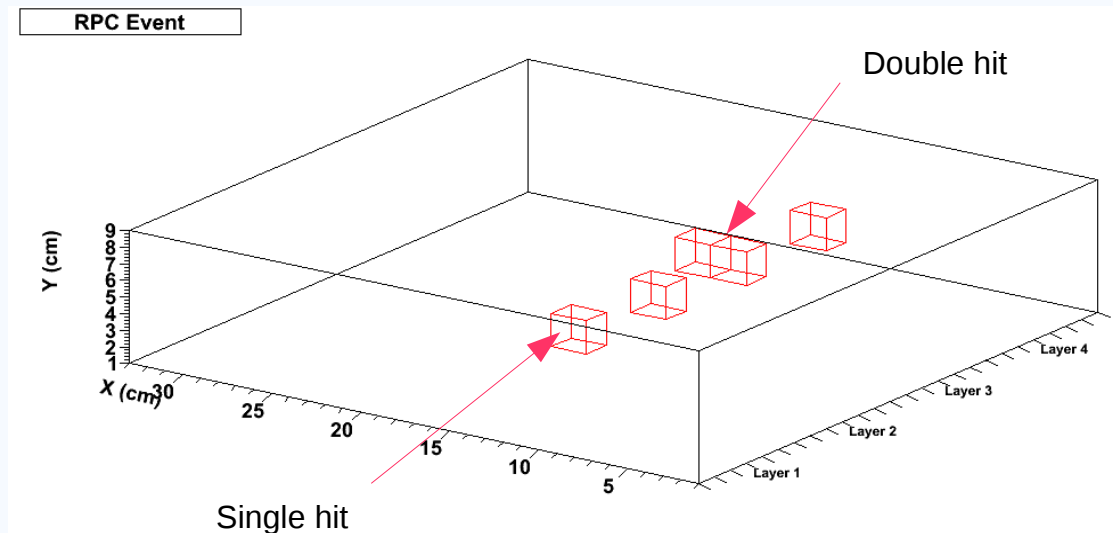
- Use hits belonging to the remaining RPCs with a time selection to build a track
 - Search hits in the studied layer around the expected impact

Layer1 Layer2 Layer3 Layer4



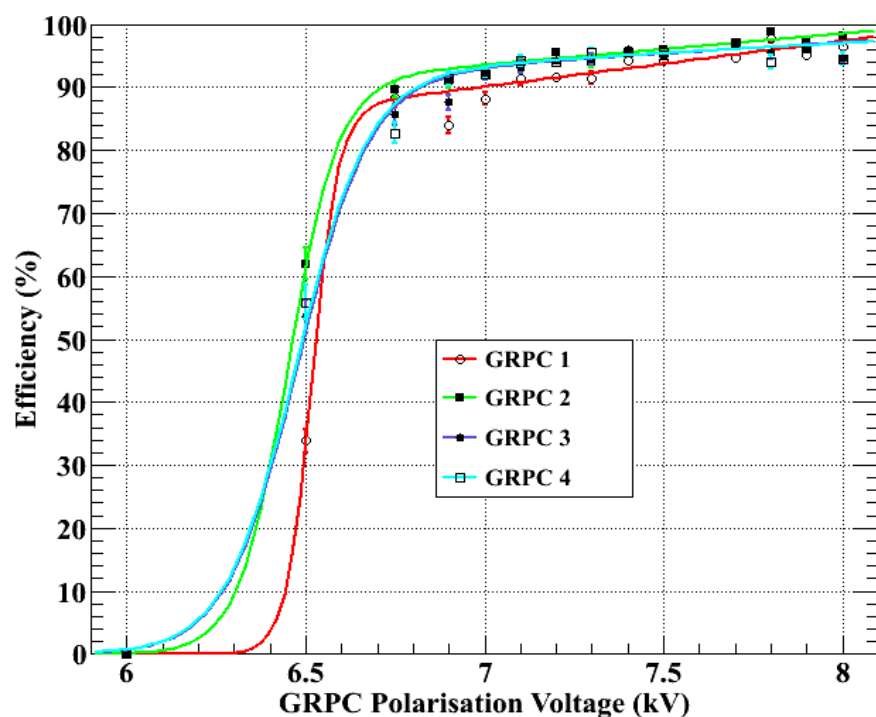
- Event Selection:

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

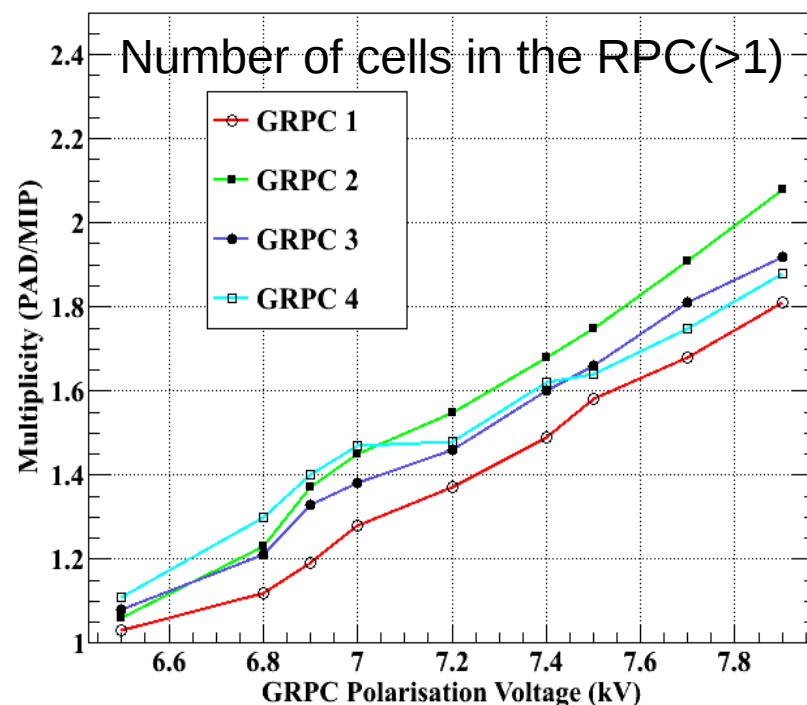


Efficiency and Multiplicity Vs HV

Reference setup: 4 Russian RPCs, Triggered event data sample

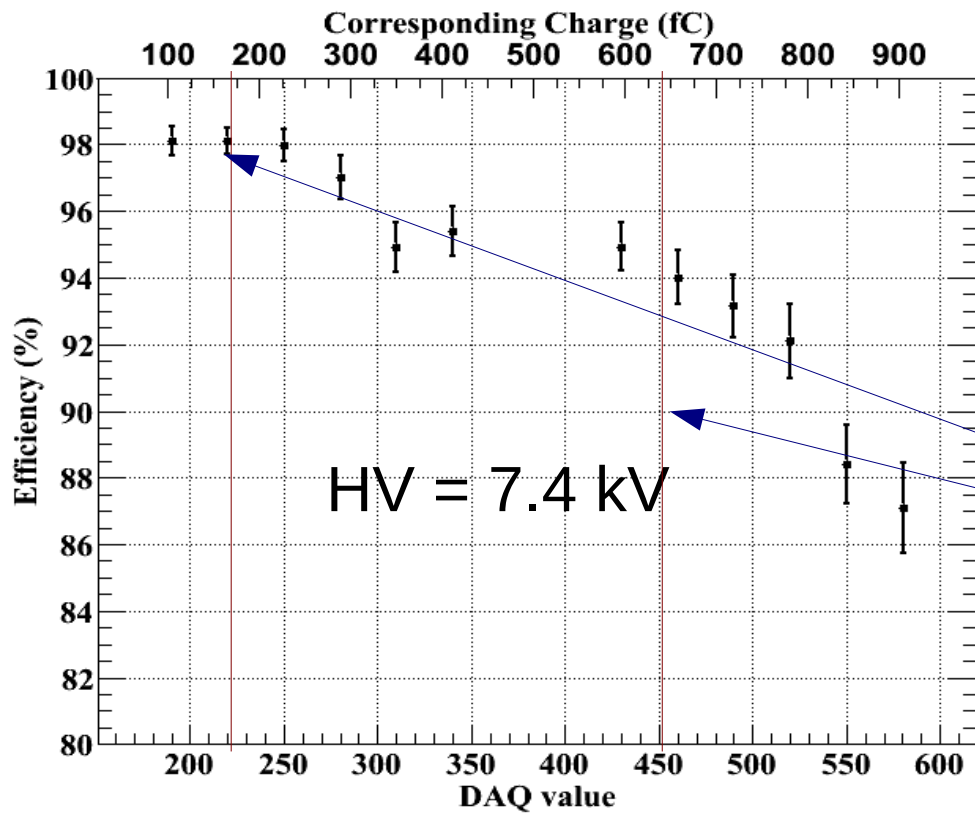


- ✓ HV scan
- ✓ Threshold 220/450 DAQ value
- ✓ 6 GeV pions beam



- ✓ Uniform behaviour for the 4 RPCs
- ✓ 95% of efficiency reached at 7.4 kV
- ✓ Multiplicity of ~ 1.6 at 7.4 kV

Efficiency Vs Threshold



SDHCAL with 1st version of Asics
= 2 thresholds

****Start of signal distribution
More to be seen with the 2nd version
of Asics

- Working thresholds chosen:
- Low threshold 220 DAQ value
 - High threshold 450 DAQ value

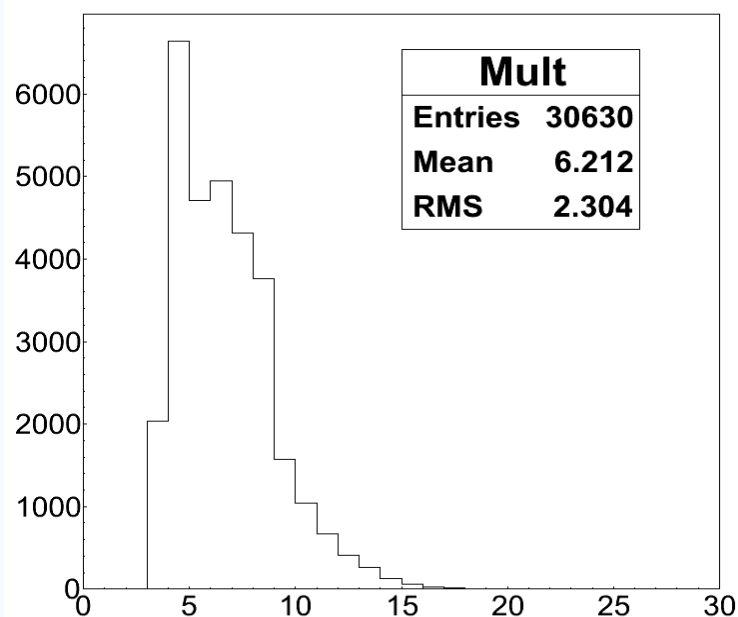
Multiplicity distribution

Full Train Sample: reconstructed multiplicity

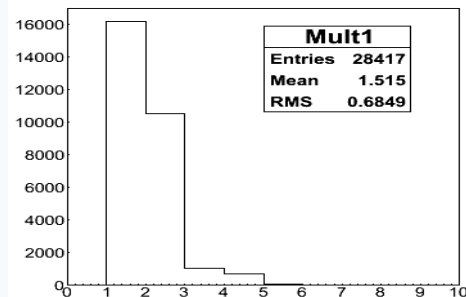
Global Multiplicity

Multiplicity per layer
(thr = 220; HV=7.4kV)

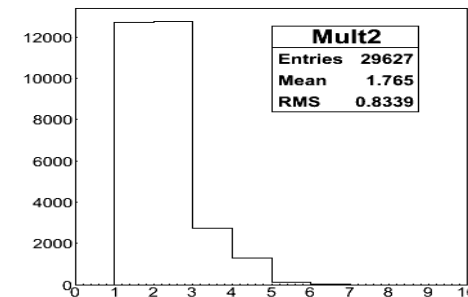
Multiplicity all layers RUN102



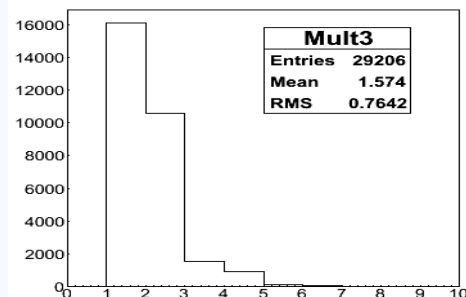
Multiplicity layer 1 RUN102



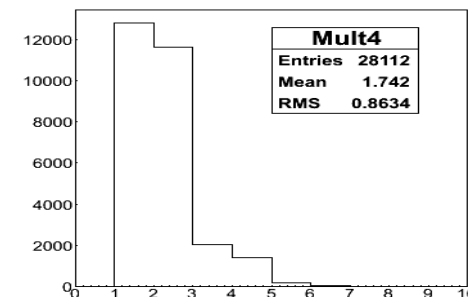
Multiplicity layer 2 RUN102



Multiplicity layer 3 RUN102

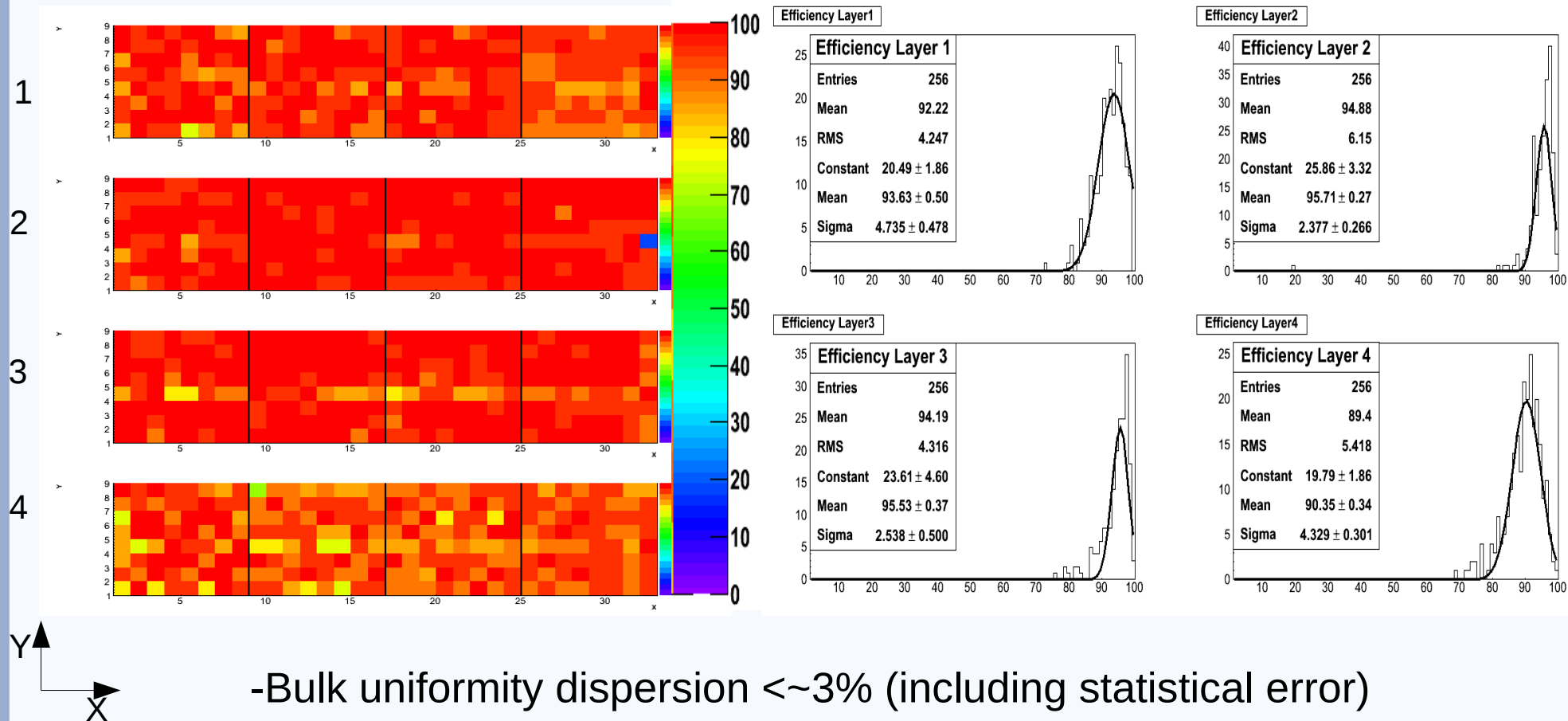


Multiplicity layer 4 RUN102



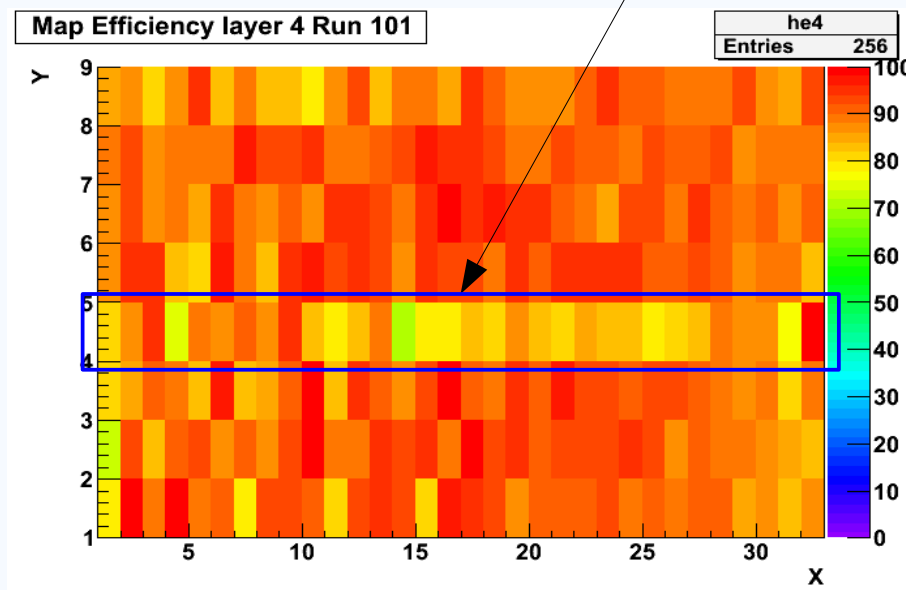
Detector Uniformity

Efficiency 2D map RUN 102, HV=7.4 kV



Systematical Effects

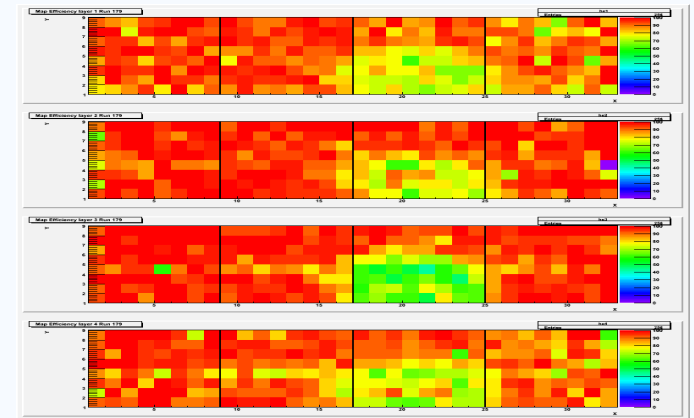
Fish line between the two plates



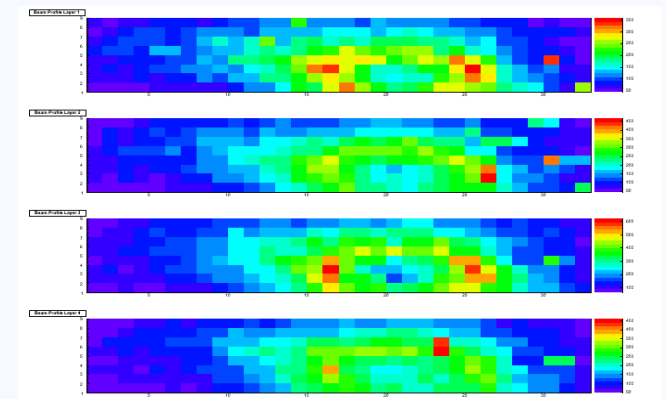
Fish line will be replaced by ceramic balls to reduce contact surface

High rate areas (19 kHz/cm^2)

Efficiency map RUN 179

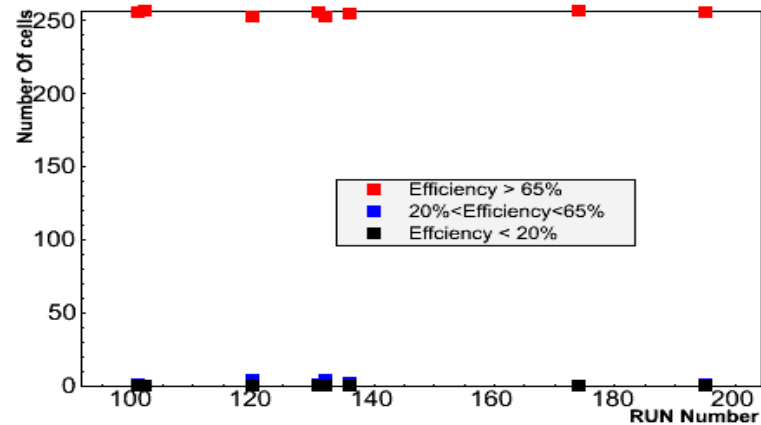


Beam profile

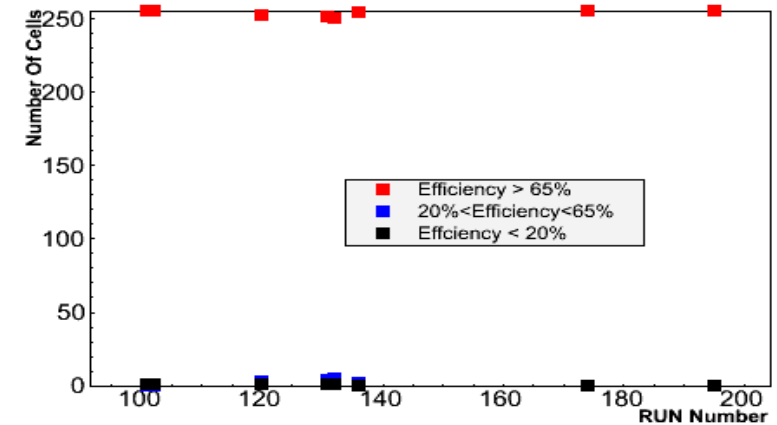


Stability in time HV =7.4 kV

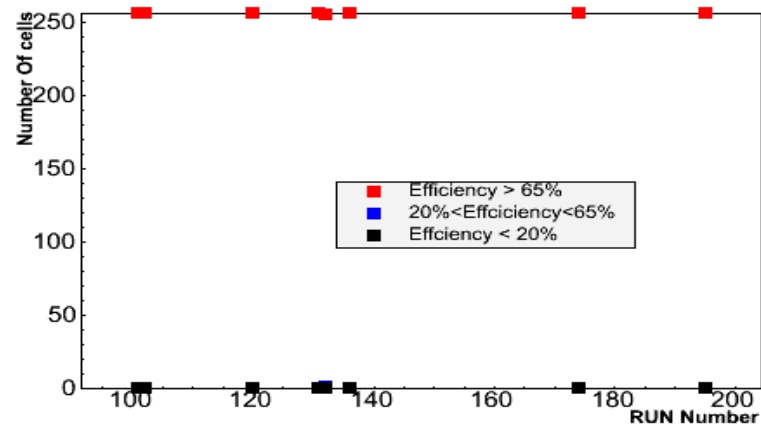
Layer #1



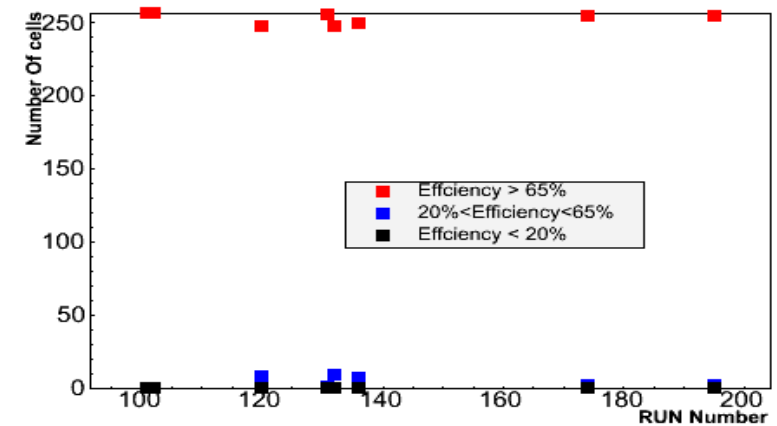
Layer #2



Layer #3



Layer #4



1 M² prototype

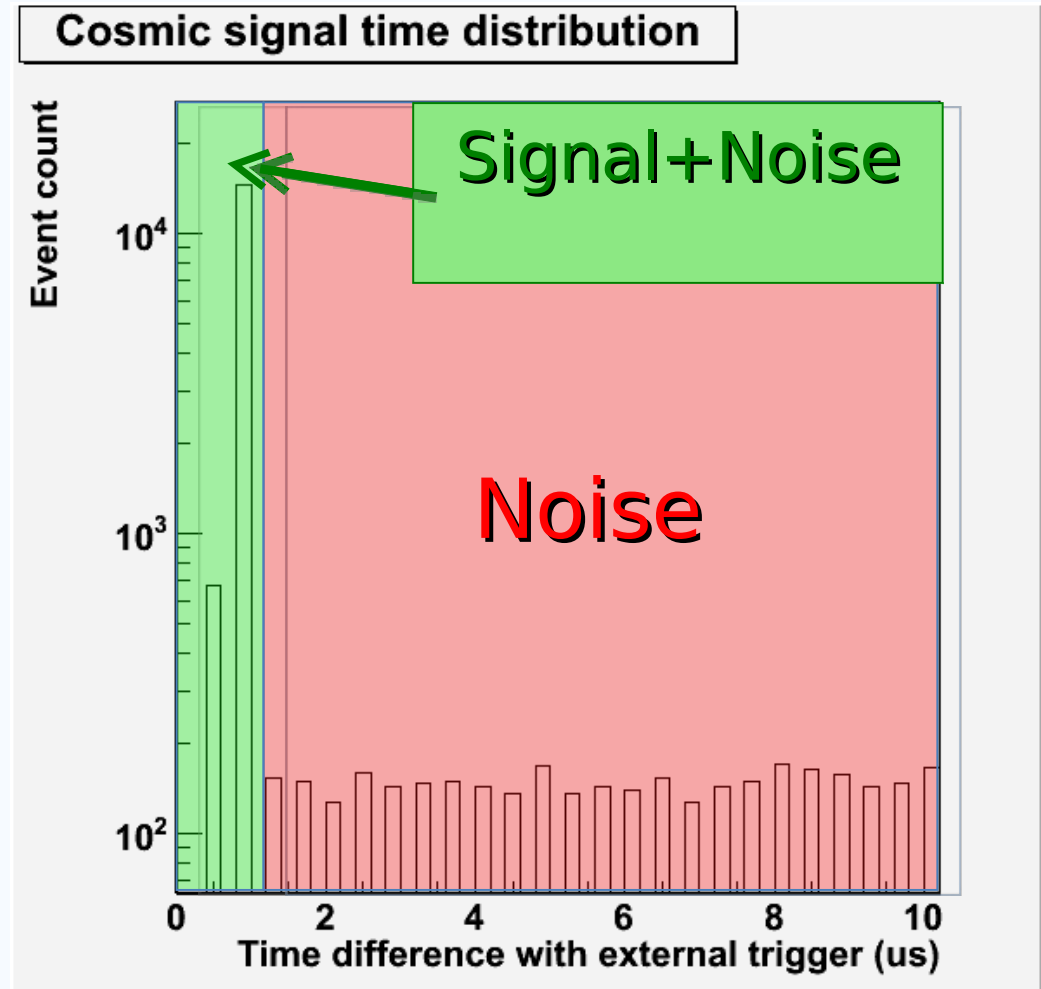


1 M² data Structure

Time selection for cosmic related events:

$0 < \text{EventTime} < 1.2 \mu\text{s}$

Noise contamination ratio: 1%

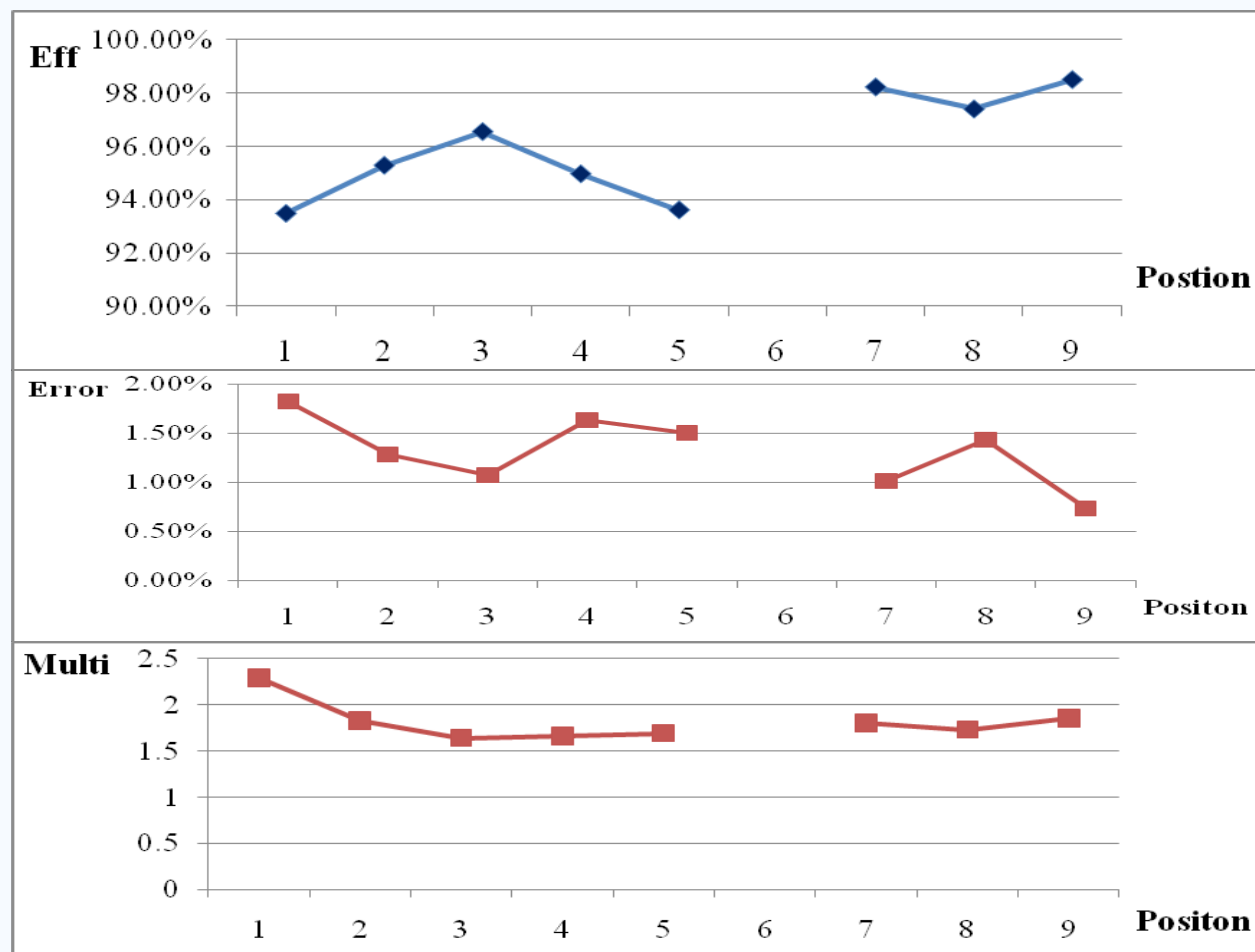


Efficiency and Multiplicity results

Position scan

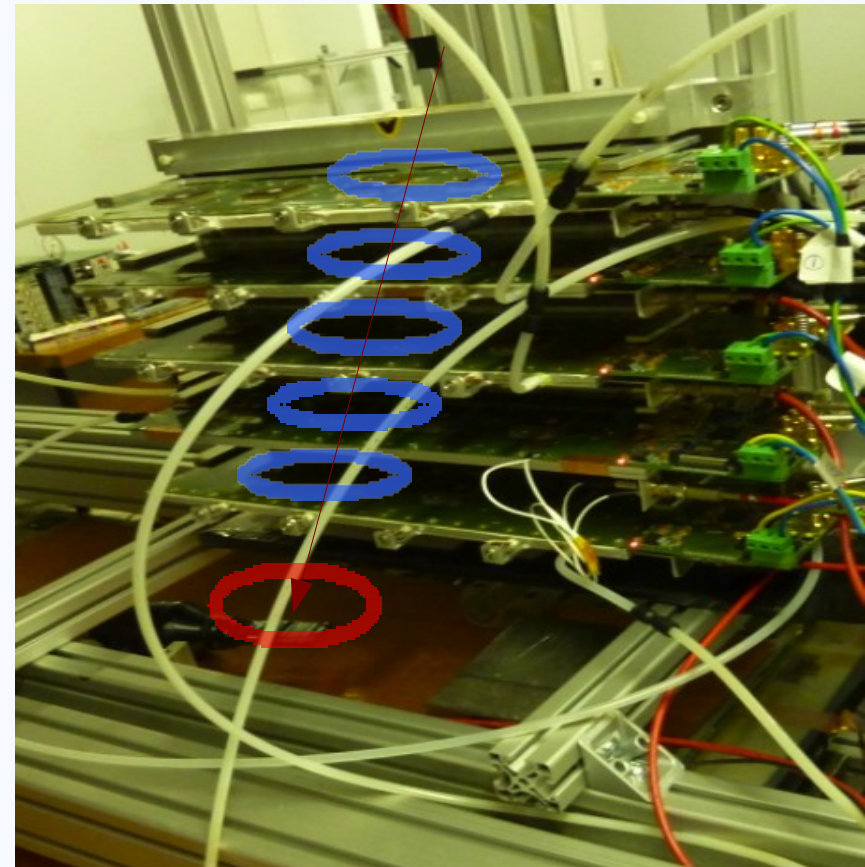
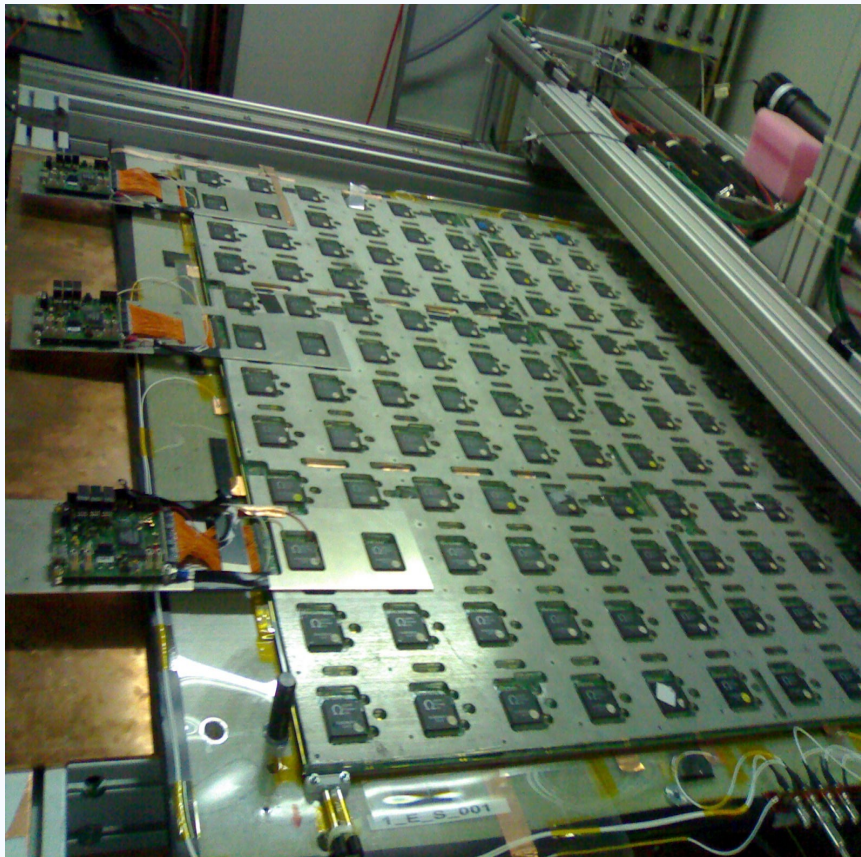
1	4	7
2	5	8
3	6	9

Results without gain correction
and at different T,P,H (to be
controlled in next beam tests)



Tracking System

Small set-up (mini-DHCAL) used as tracking device for the large chamber

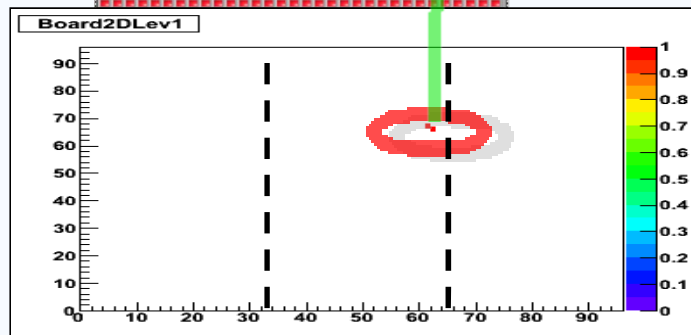


Tracking System

Offline reconstruction:

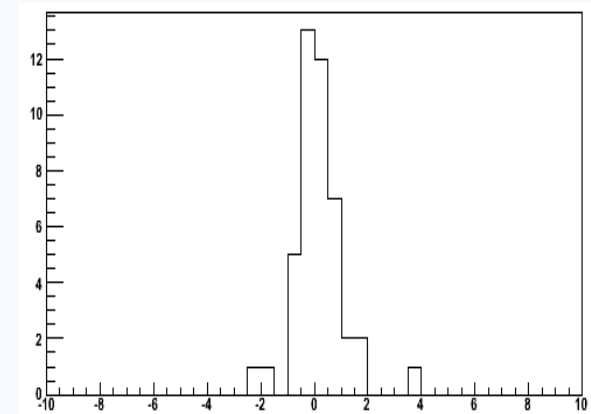
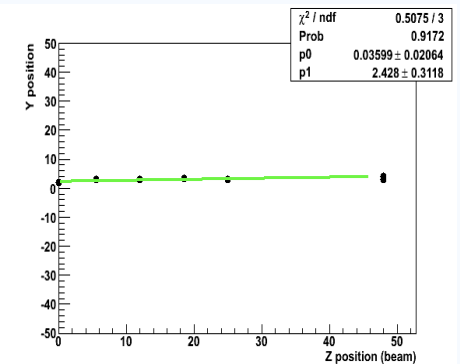
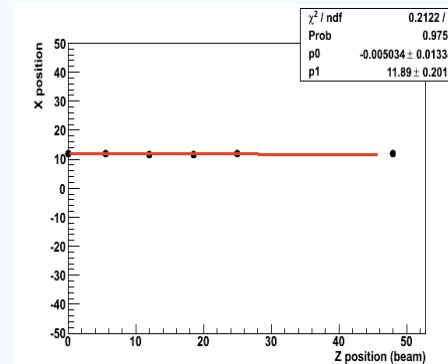
- Clustering in small chambers
- Fit track in small chambers
- Project track in Large chamber
- Check hit presence.

Small
Setup



Large Chamber

100x
100
cm²



Distance between expected and found hits

Good synchronisation and alignment between the two detectors

Conclusion

- Study of efficiency and multiplicity of the detector confirms the high performances with the optimal parameters:
 - Efficiency ~ 95%
 - Multiplicity ~ 1.5
- Study of stability and uniformity of the detector.
- 1 M² RPC: everything is working now (efficiency >94%).
- Next:
 - Two additional large RPCs being assembled
 - Two scheduled beam tests:
 - May: 2 weeks PS beam
 - July: 11 days SPS beam