



# Status and plans of the SDHCAL-GRPC

Imad Laktineh

# Outline

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- Reminder of R&D activities
- Status of the 1m<sup>2</sup>
- Preparation of the 1m<sup>3</sup> technological prototype

# Reminder : Mini-SDHCAL

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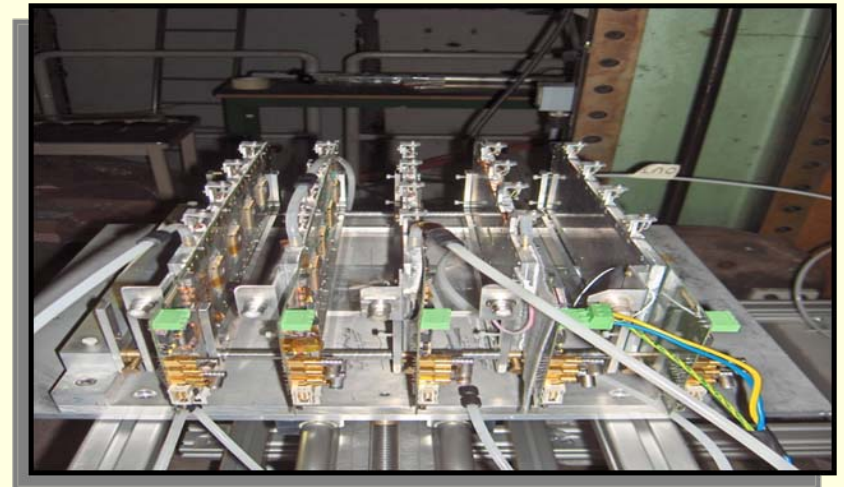
- HR1 ASIC designed and produced in 2007
- Numerical card based on FPGA-USB architecture was conceived in 2007.
- Electronics boards hosting 4 HR1 and the numerical card were produced in 2007: 8-layer, 800 $\mu$ , 6 class
- Small GRPC detectors (32X8) were produced in 2007-2008:
  - Simple Gap: Graphite (Protvino), Licron and Statguard (IPNL)
  - Multigap GRPC (Bologna)
- whole system successfully tested with cosmics and TB at CERN in 2008.



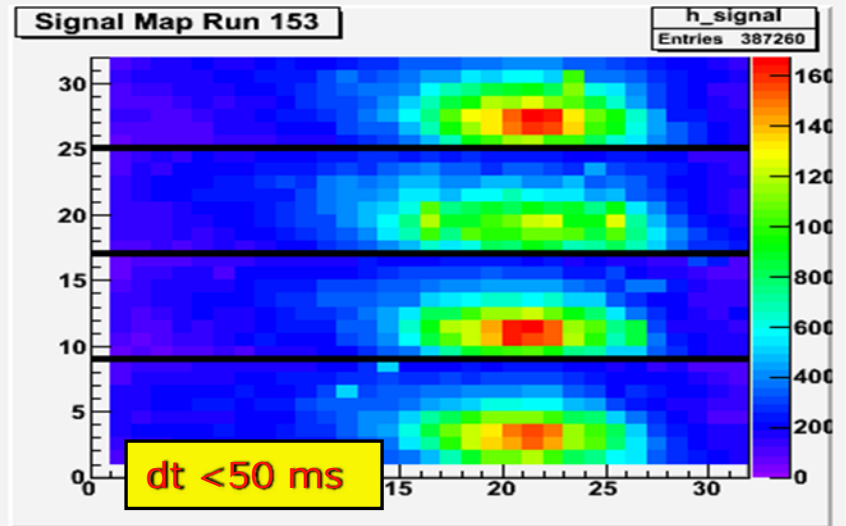
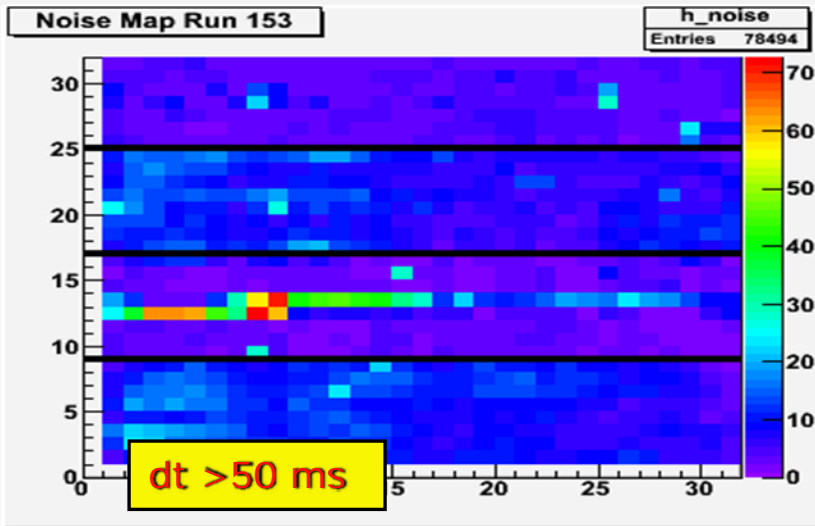
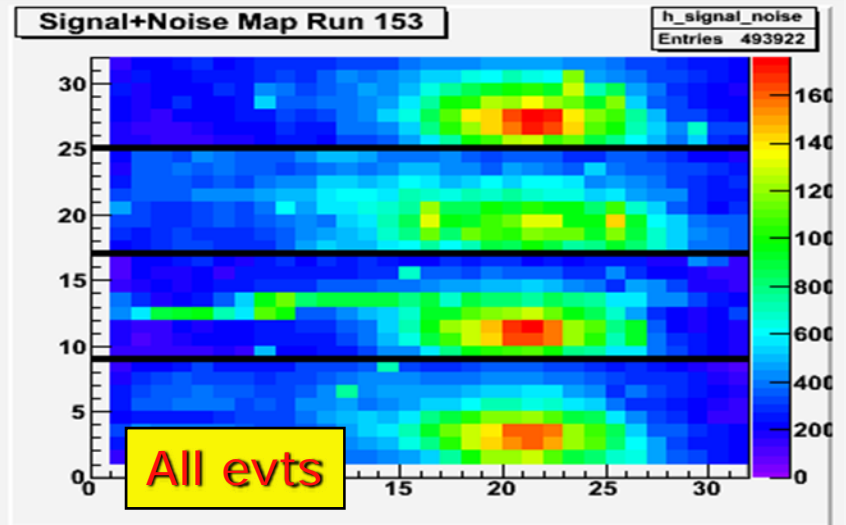
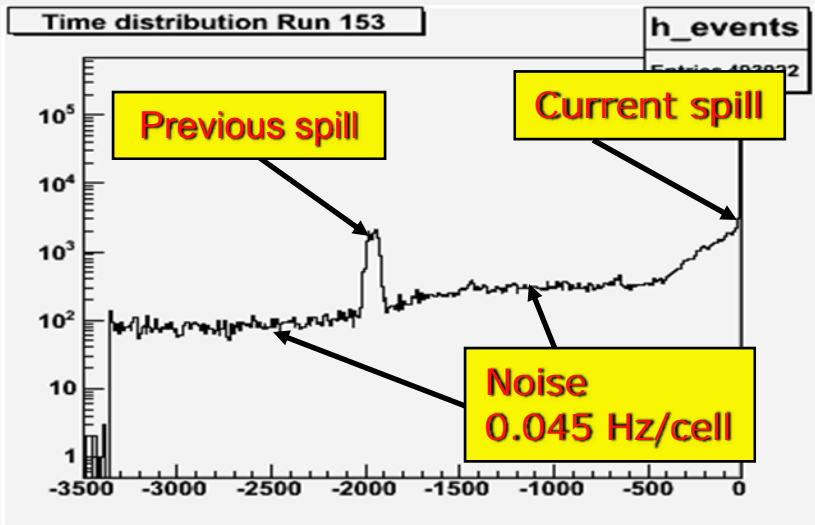
# Reminder: Test Beam @PS-CERN

June-July and November  
2008 TB Goals

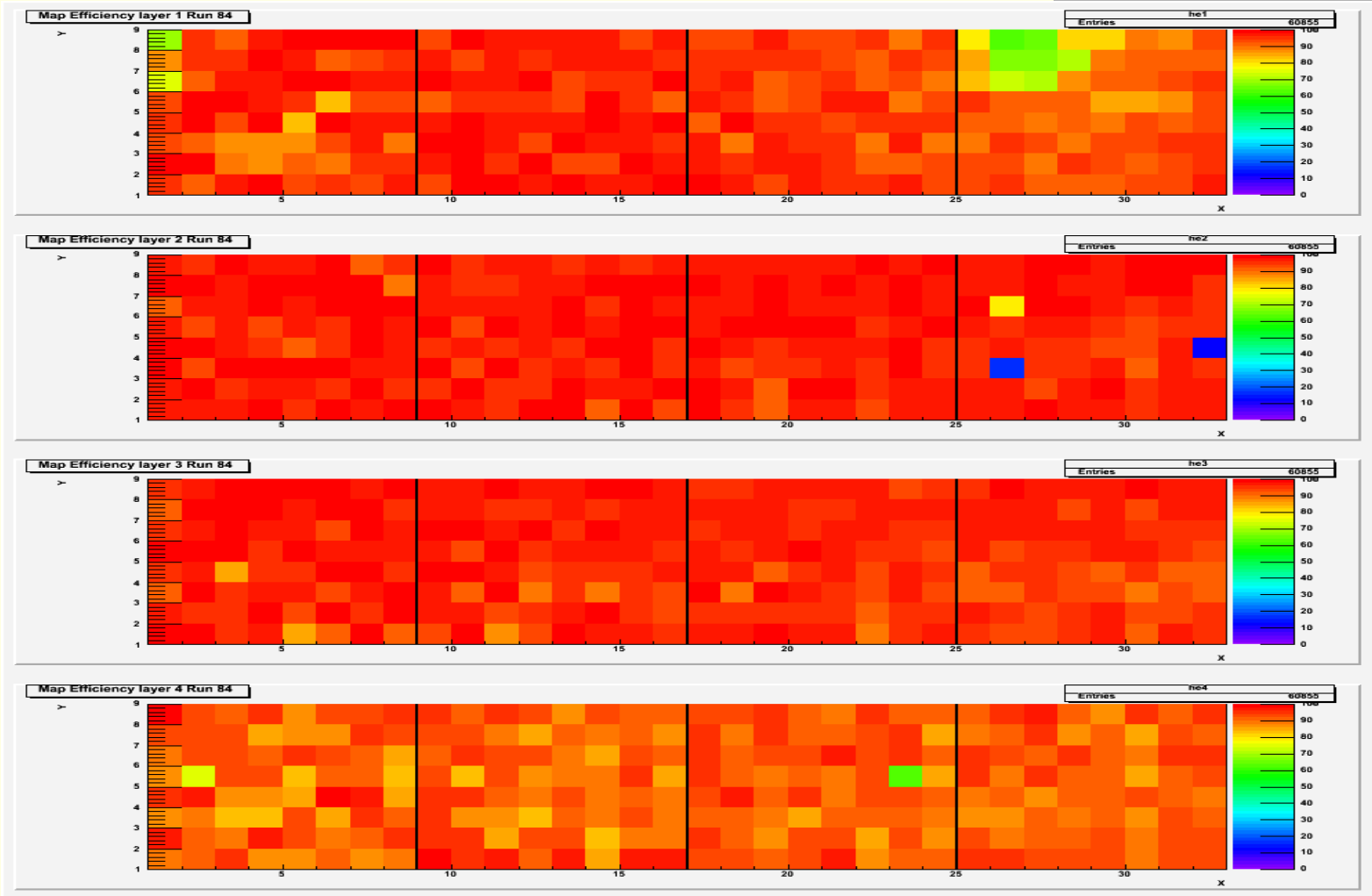
- Validate the semi-digital electronics readout system in beam conditions
- Evaluate the performance of different kinds of GRPCs
- Study first phase of hadronic showers



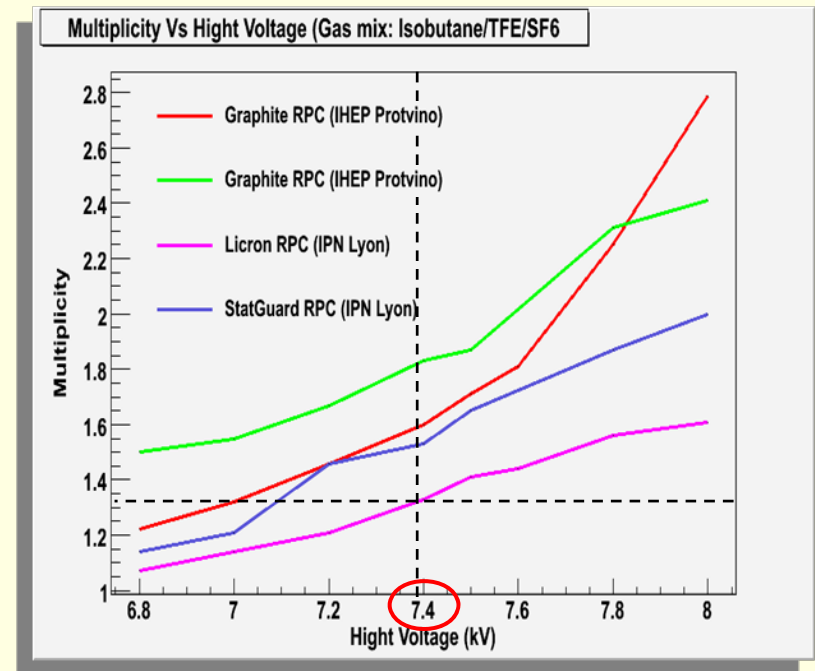
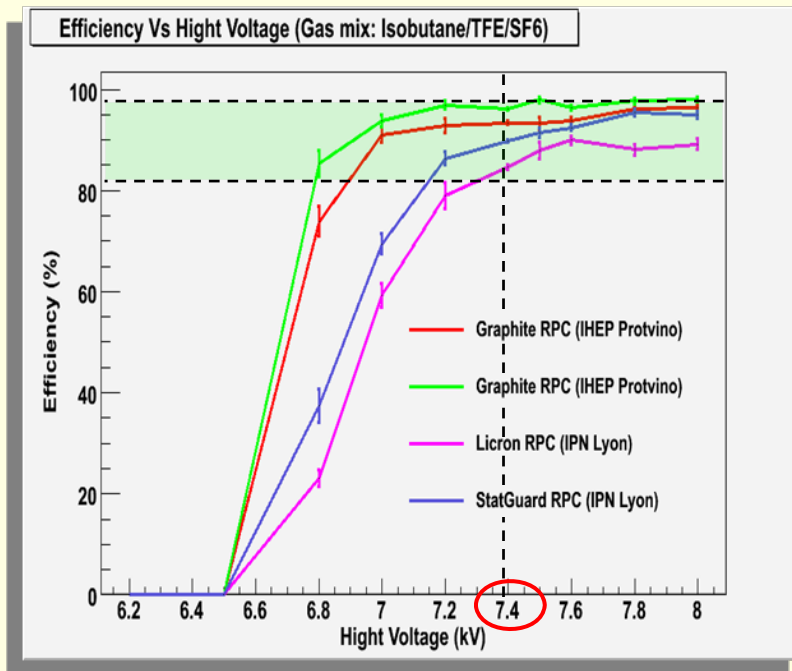
# Reminder: Test Beam @PS-CERN



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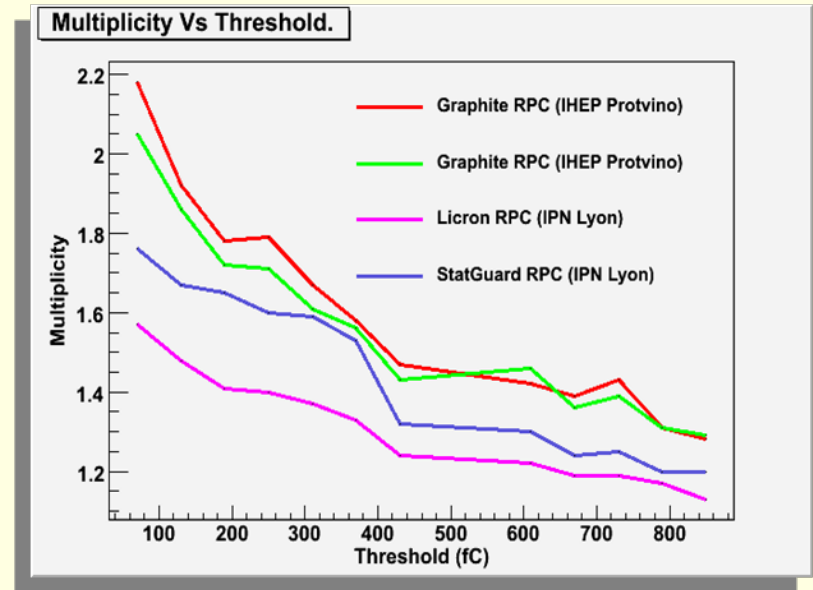
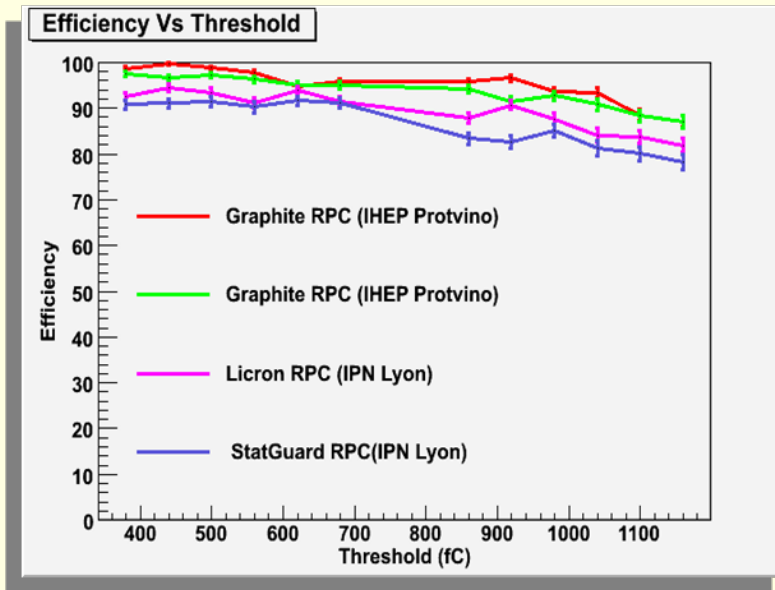


# Reminder : GRPC performance



➤ Efficiency and multiplicity behavior versus H.V

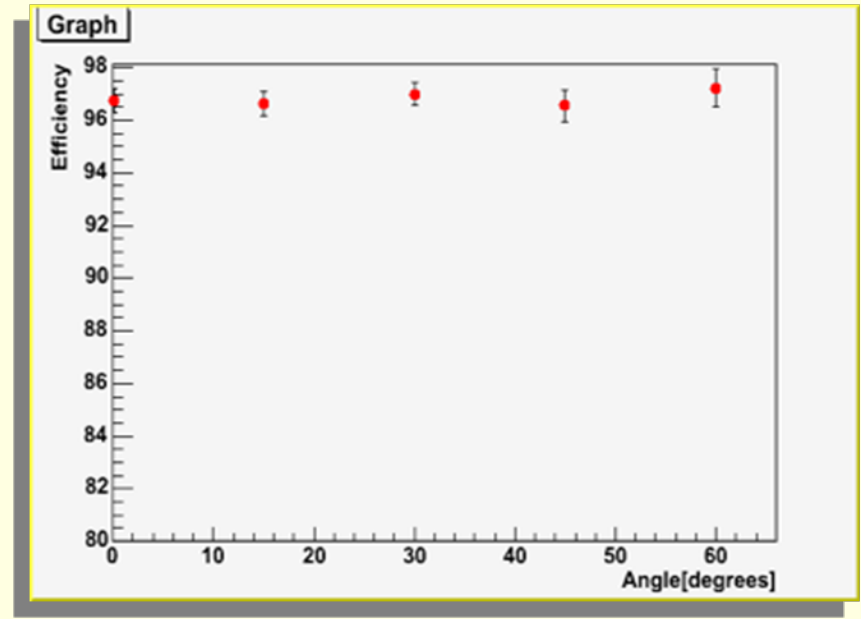
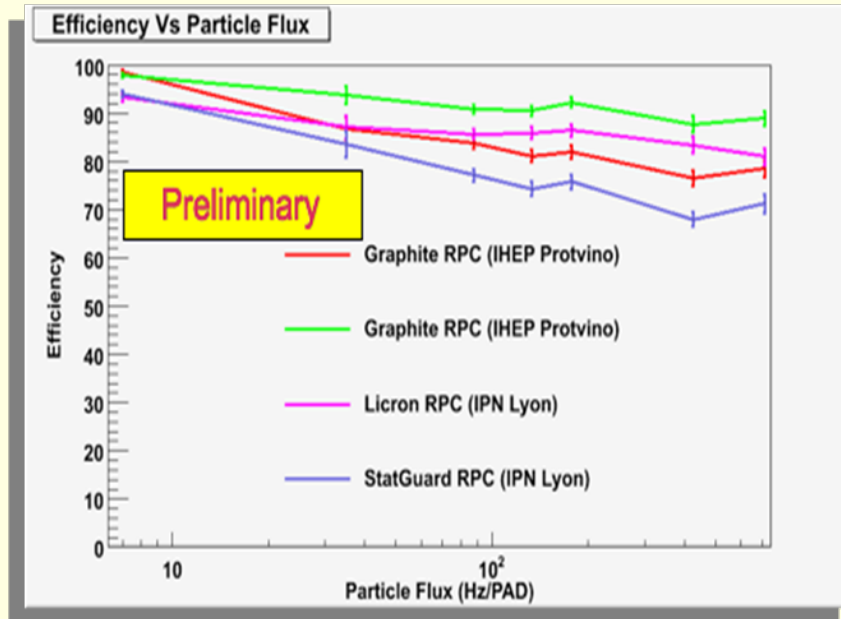
# Reminder : GRPC performance



➤ Efficiency and multiplicity behavior versus threshold

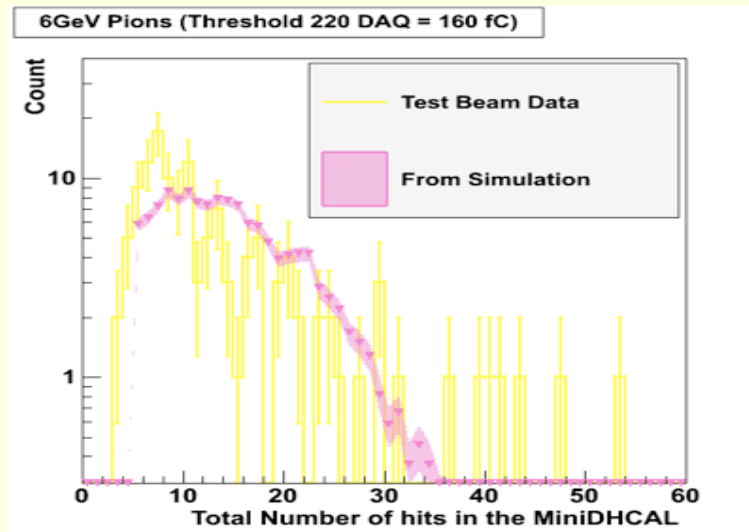
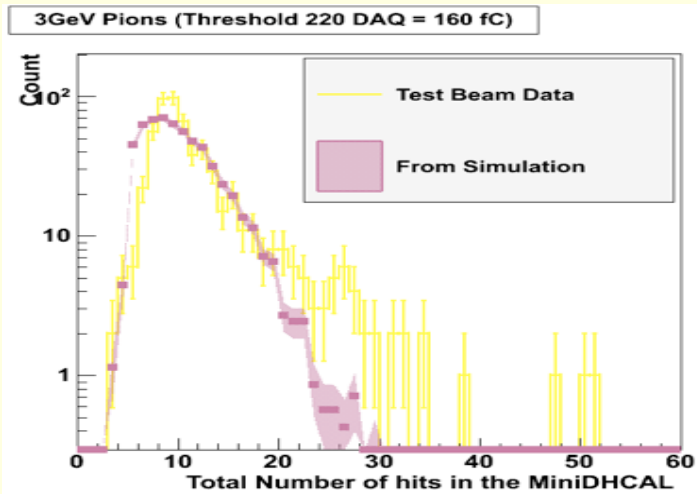
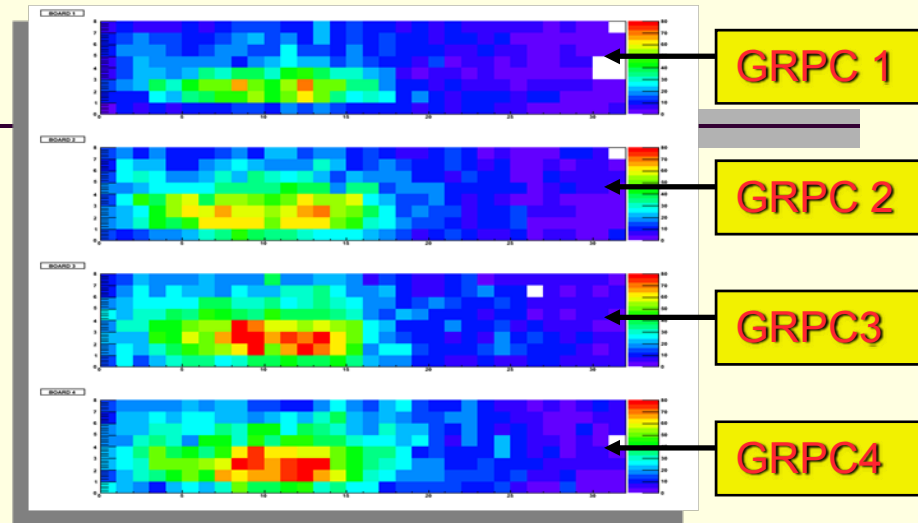
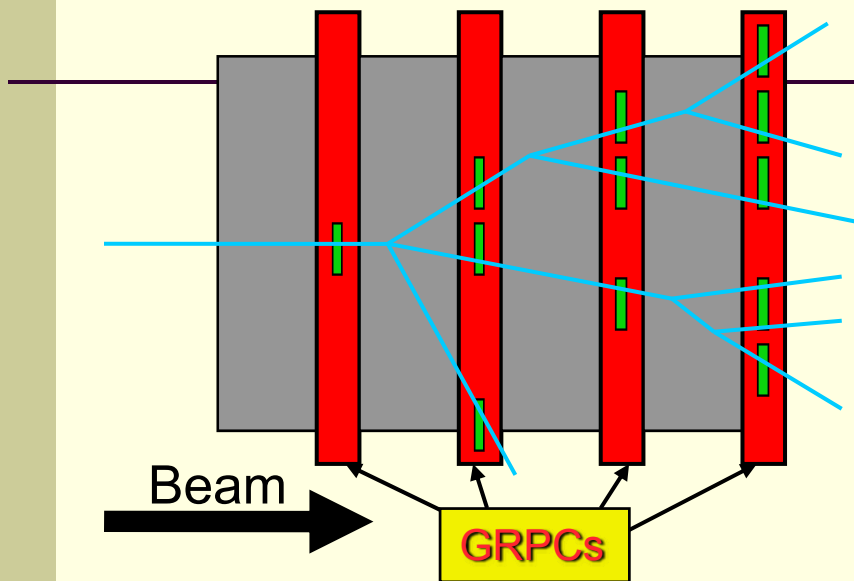


# Reminder : GRPC performance



- Efficiency and multiplicity behavior versus flux, angle

# Reminder : Hadronic Showers



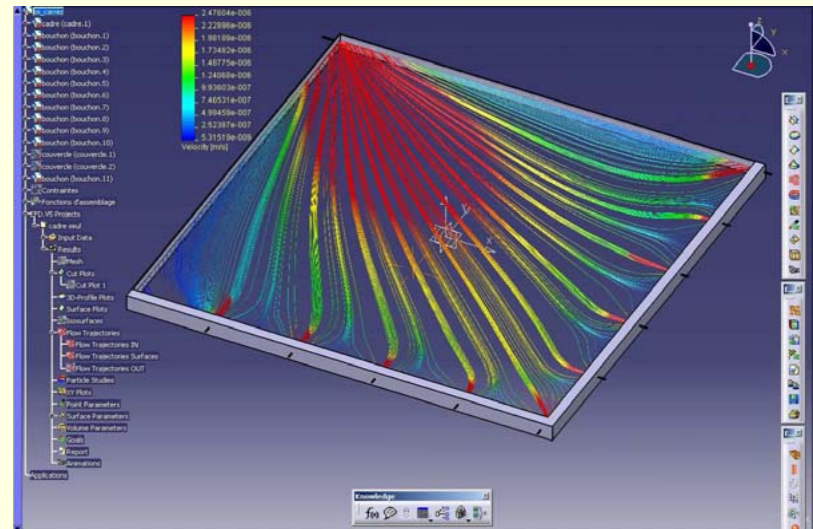
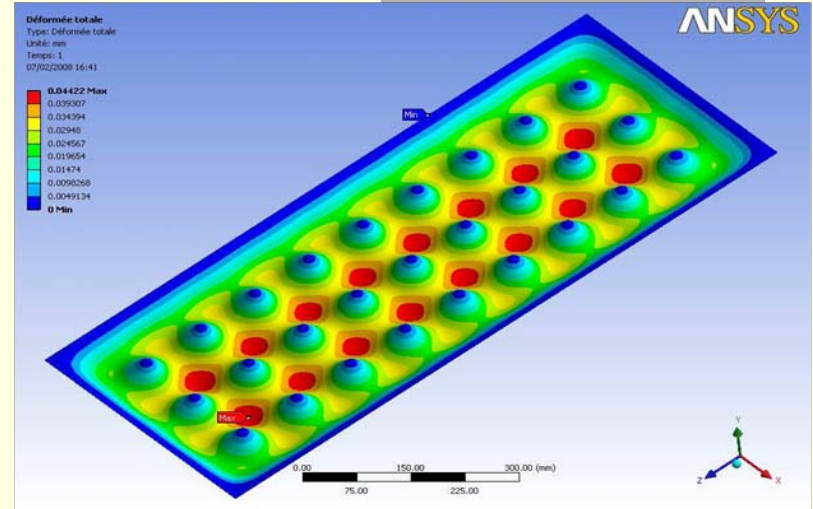
# Status : 1m<sup>2</sup> detector R&D

## ■ Spacers:

Tiny ceramics balls to reduce dead zones. Number optimized to reduce deformation

## ■ Gas distribution

Few scenarios are proposed for better distribution → to reduce gas renewal



# Status : 1m<sup>2</sup> detector R&D

## ■ Resistive paintings:

higher resistivity →

lower multiplicity

Candidates: Licron, Statguard

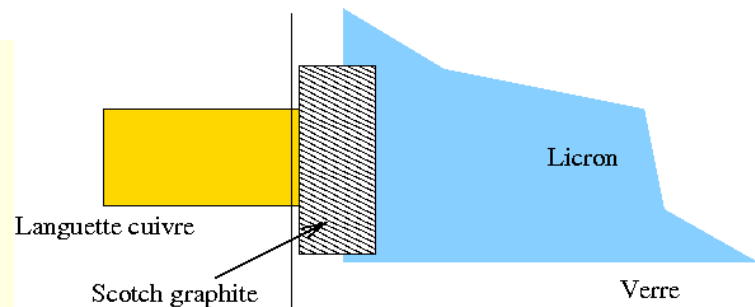
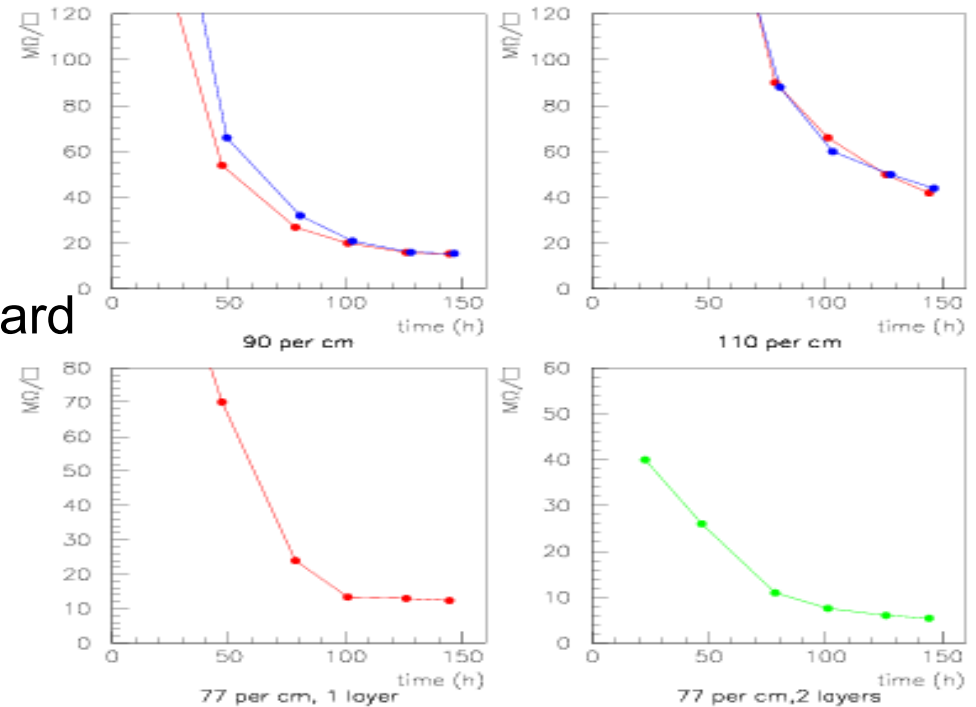
## Silk screen printing

Allows better homogeneity  
and resistivity control

## ■ High Voltage :

Stability Problems.

Solution found using  
a special epoxy glue



# Status : 1m<sup>2</sup> detector R&D



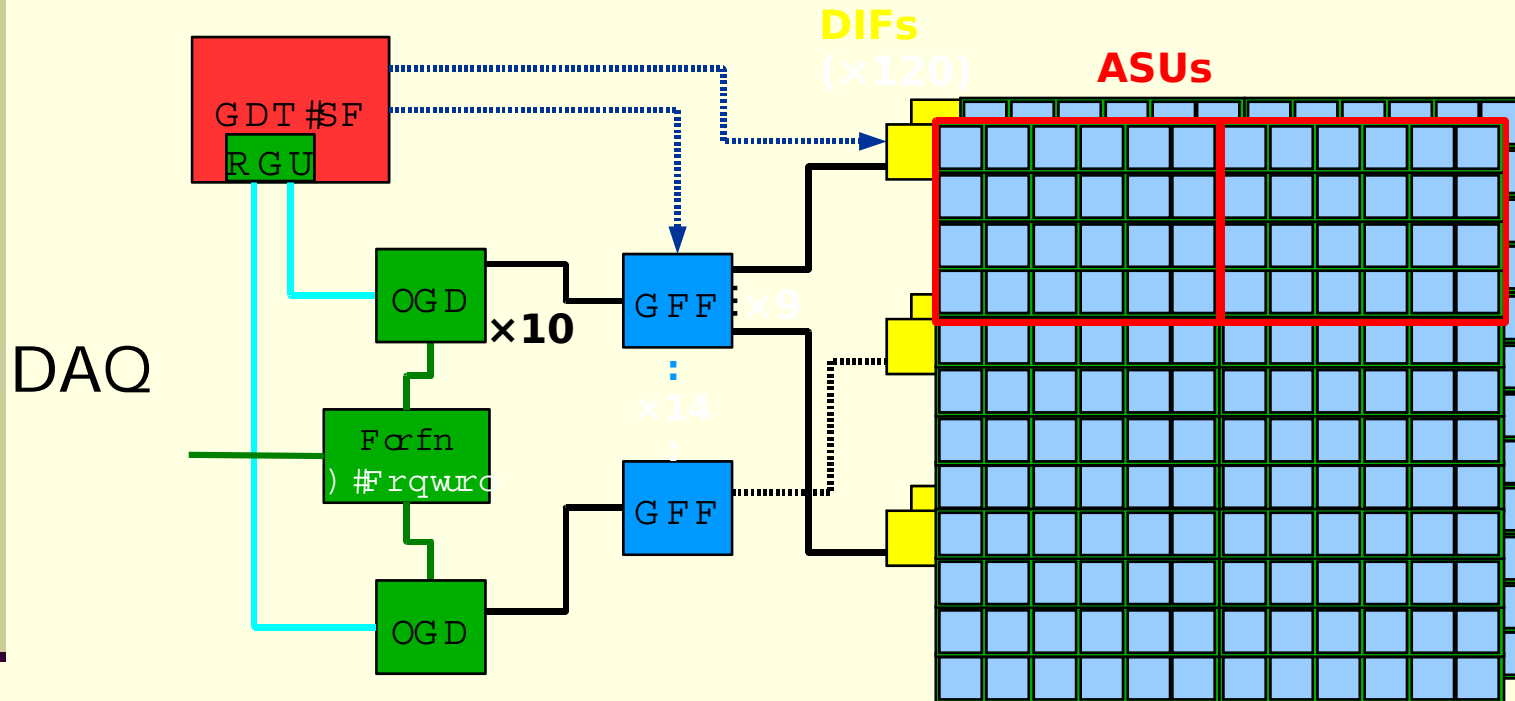
GRPC: IPNL



MGRPC: Bologna-CERN

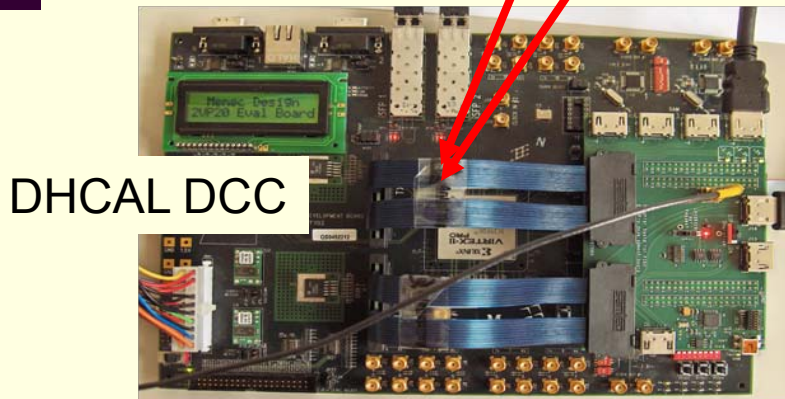
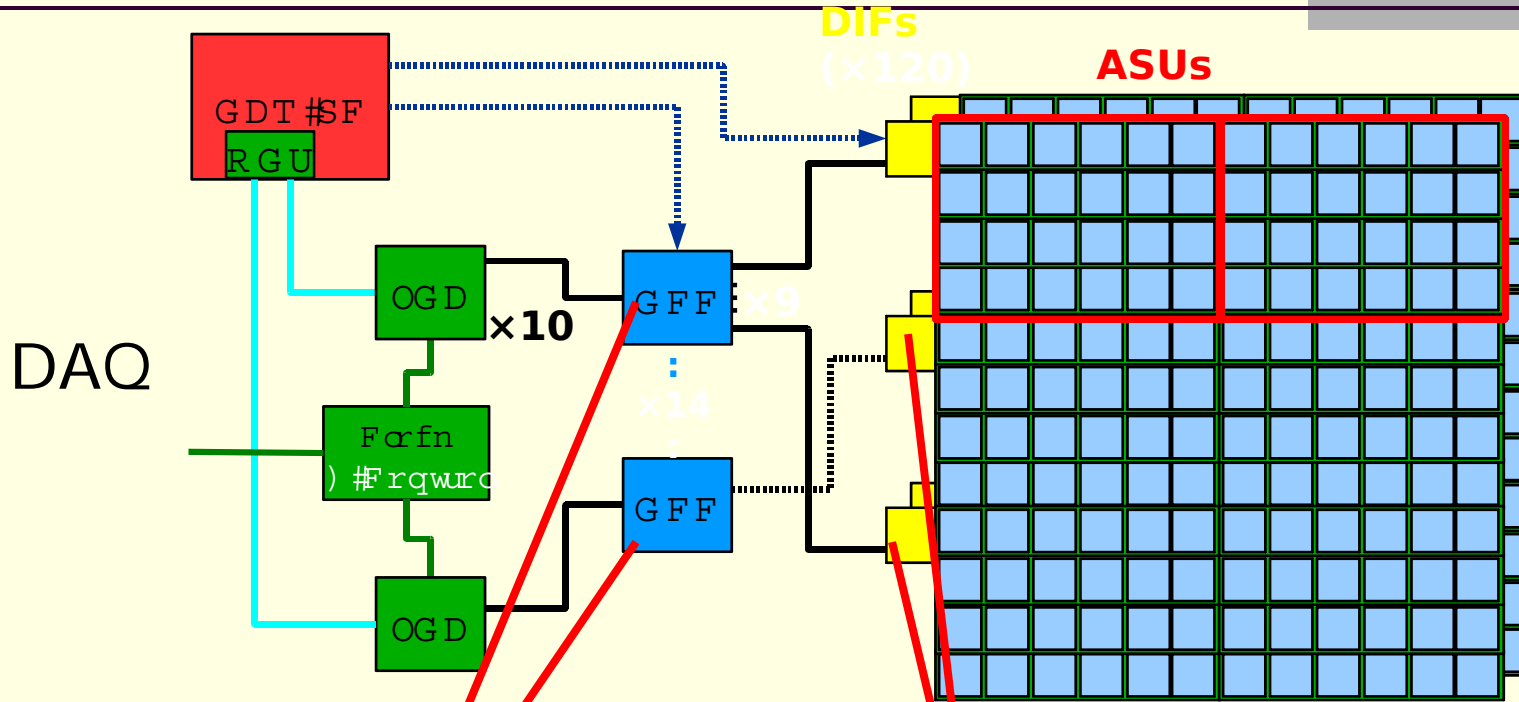


# Status: 1m<sup>2</sup> electronics readout R&D



Proposed readout scheme

# Status: 1m<sup>2</sup> electronics readout R&D



# Status: 1m<sup>2</sup> electronics readout R&D

1 M



DIF

Slab 1

Slab 2

PCBs  
connected with  
0 ohms  
resistors

Track length = 4 M

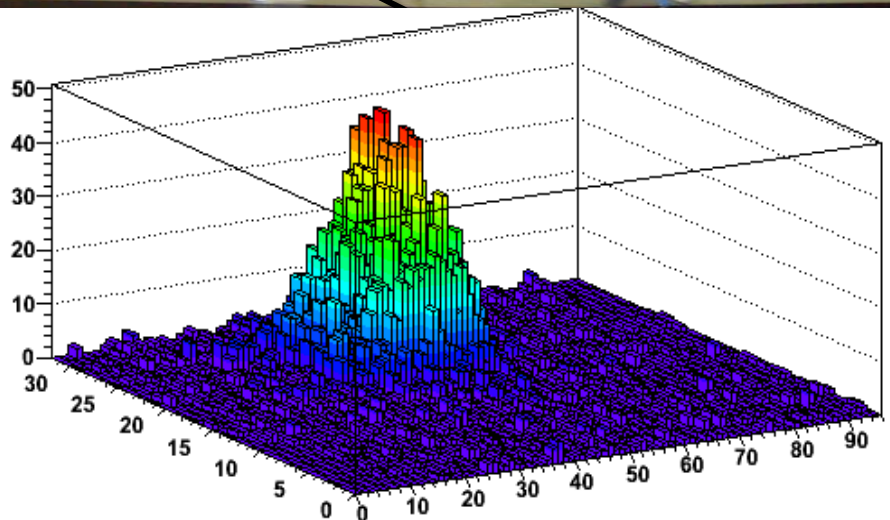
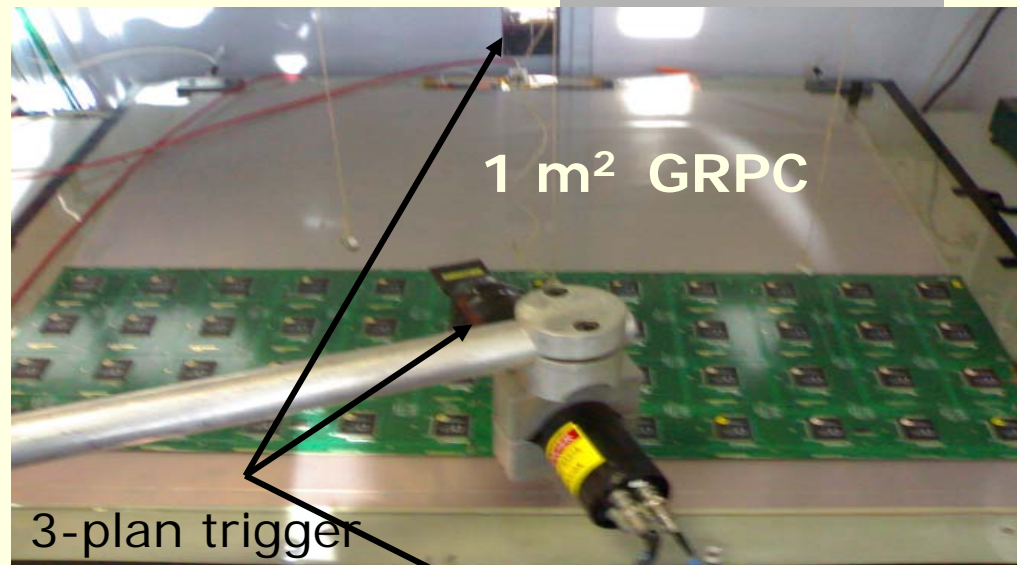
48 HARDROC1

# Status: 1m<sup>2</sup> electronics readout R&D

1m<sup>2</sup> GRPC chambers were tested with the small electronics board (4HR1)

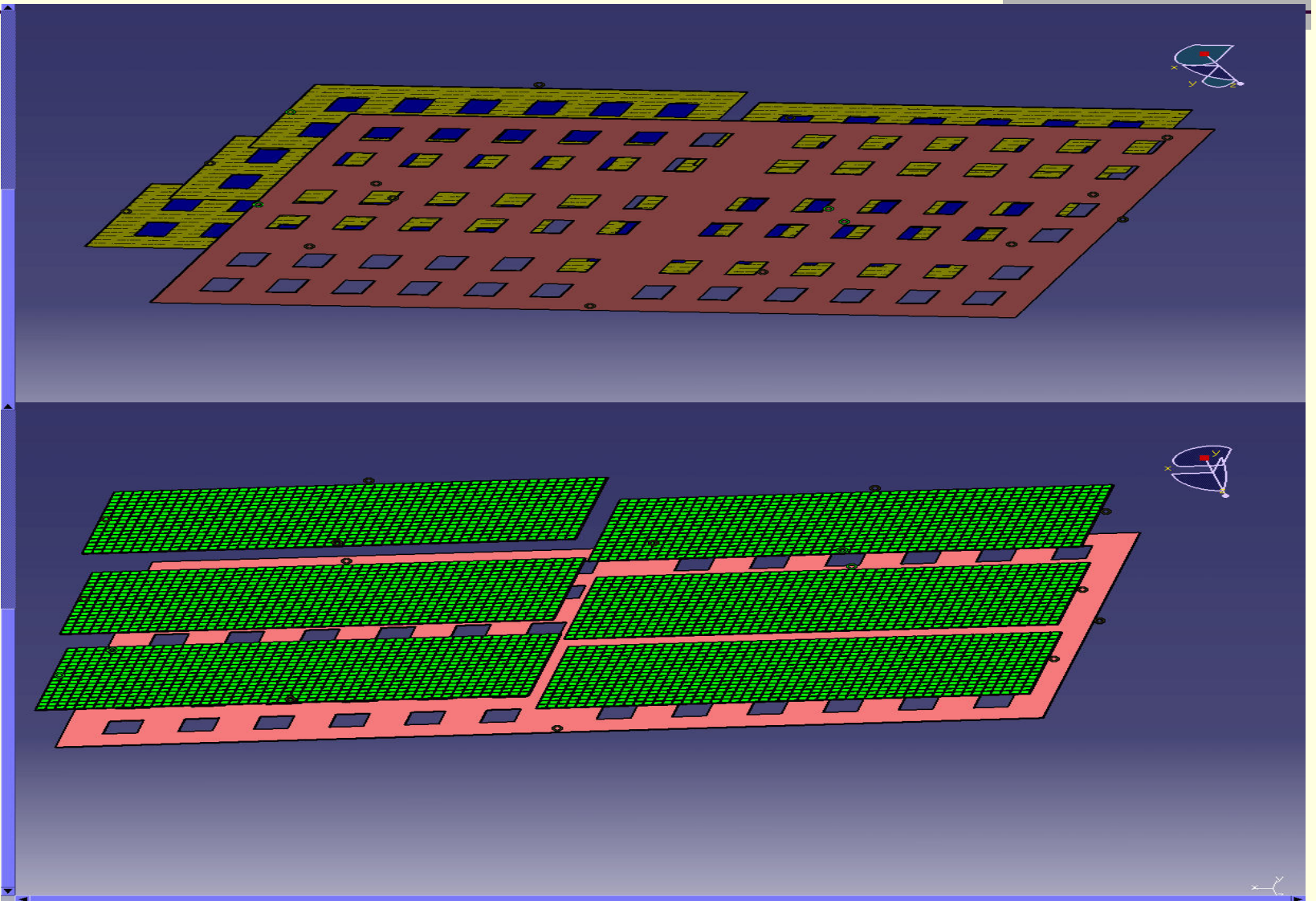
PCB-doublets (3072 c) are tested independently

Problems with DIF firmware were found and fixed





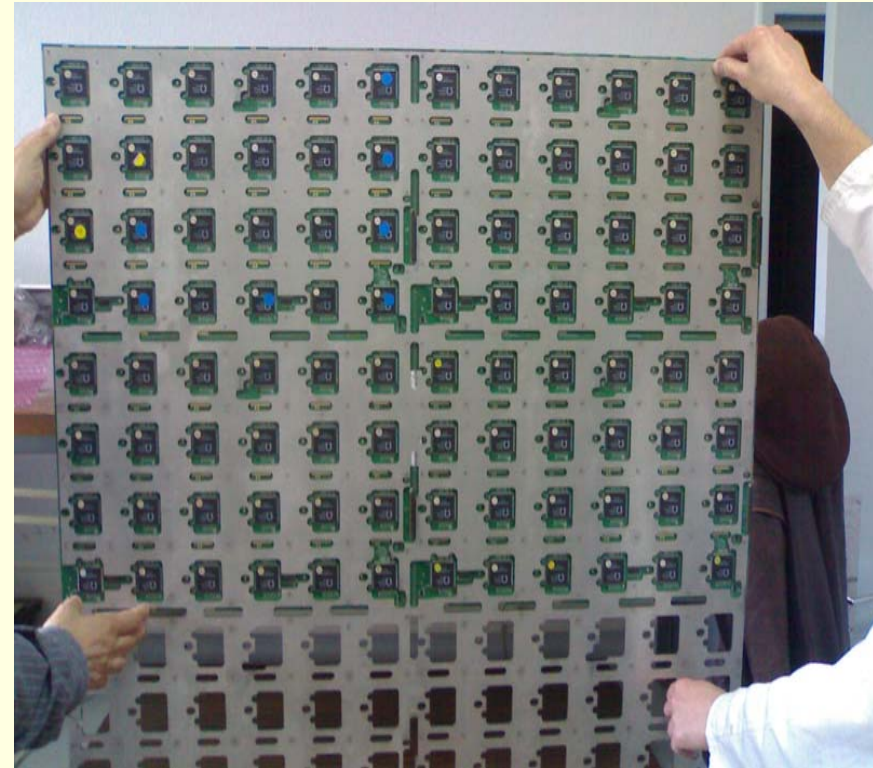
# Status: 1m<sup>2</sup> electronics readout R&D





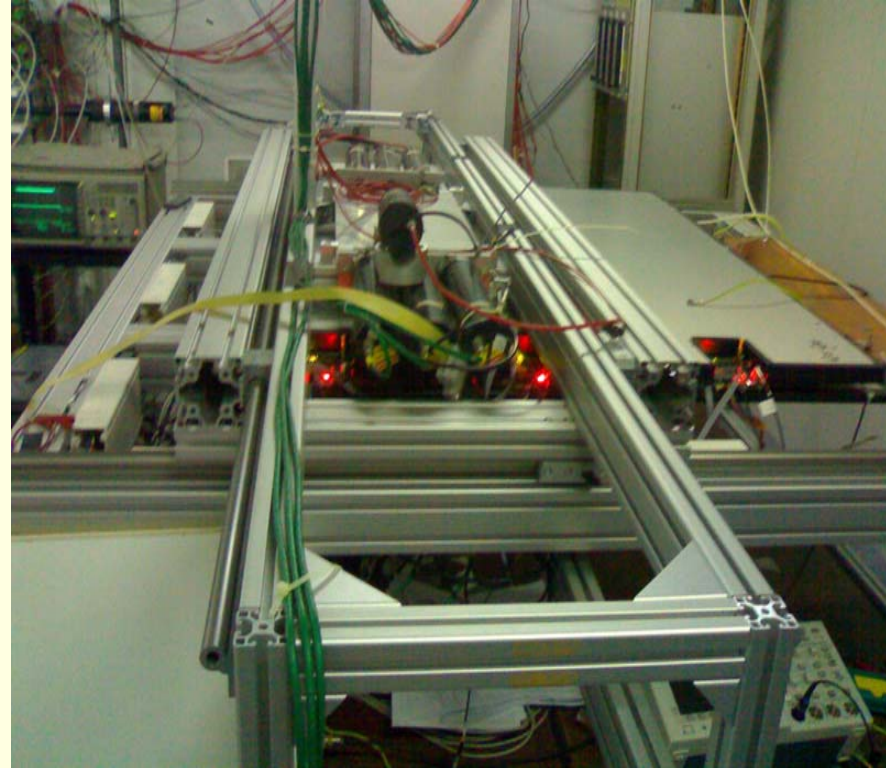
# Status: 1m<sup>2</sup> electronics readout R&D

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The 3X2 PCBs were mounted on the S.Steel support

# Status: 1m<sup>2</sup> electronics readout R&D



Cosmic Rays bench for 1m<sup>2</sup> GRPC

# Test Beam at CERN

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Two periods : 18 June-3 July, 1-7 August

More than 23 shifters

## Aims:

- Test the different 1m<sup>2</sup> GRPC (Licron S.G, Statguard S.G , M.G) in beam conditions
- Study hadronic showers development by placing 1,2....6 Lead walls 5 cm each in front of the 1m<sup>2</sup>

In addition

- Test the high-rate GRPC built
- using semi-conductive glass ( $10^{10}$   $\Omega$ .cm) provided by Tsinghua group

# Status: 1m<sup>2</sup> electronics readout R&D

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New 1m<sup>2</sup> electronics board is under construction with HARDROC2 ASIC → 3 thresholds, masks, optimized power pulsing

PCB are designed and will be produced within 1 month  
The new design is intended to avoid problems met with the previous version (transmission lines impedance) which was solved by adding few buffers.

The 144 HARDROC2 will be tested using a semi-automatic procedure

Aims :

Have a final version before the 1m<sup>3</sup> prototype

With the power pulsing scheme tested at the large scale level



# Preparation for the 1M<sup>3</sup> technological prototype

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Technological prototype :

40 planes of 1M<sup>2</sup> :

16mm s.steel absorber

4mm s.steel support

6mm GRPC

## Important points:

- Mechanical structure and cooling system
- Detector construction and quality control
- ASIC production and quality control
- High voltage system
- Gas distribution system
- DAQ system

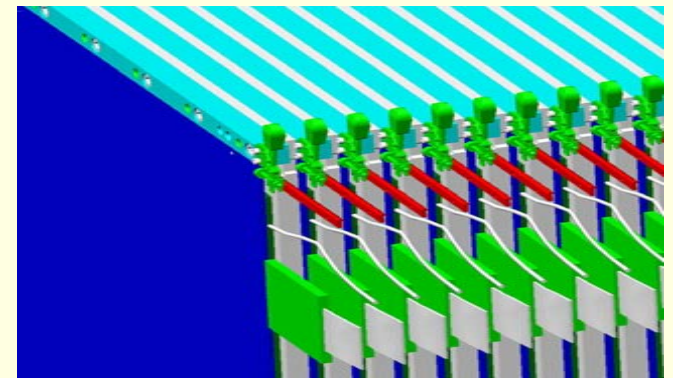
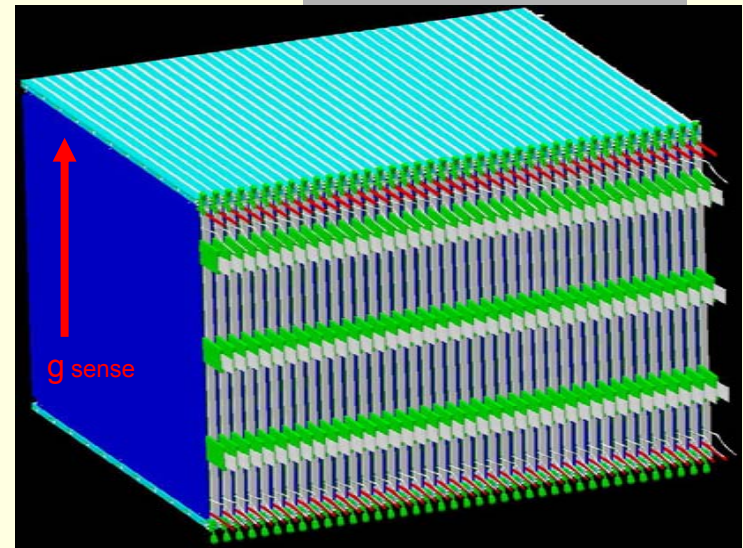


# Towards the 1m<sup>3</sup> technological prototype

A mechanical structure design was proposed by CIEMAT group  
It will be finalized in the near future

**CIEMAT** will fund the construction of the mechanical structure as well as the S.Steel plates

Cooling system study has started.  
**Louvain-la-neuve** will be in charge of this



# Towards the 1m3 technological prototype

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Detectors will be built by  
IPNL and Protvino and tested in IPNL

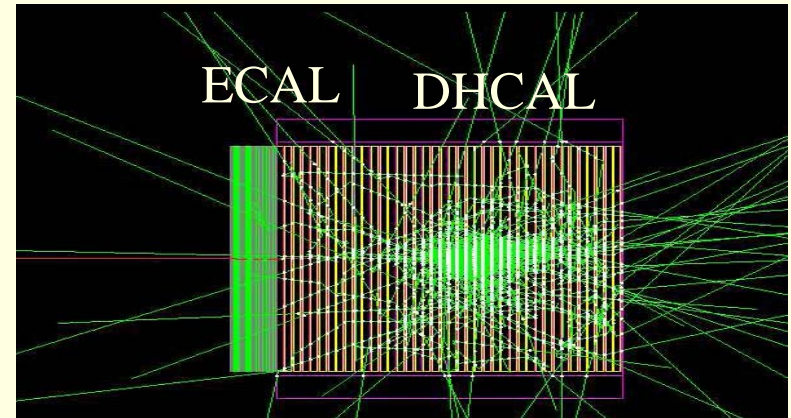
ASICs will be controlled in fully automatic  
way using a robotic system used for CMS trackers  
IPNL, LAL

DIF, DCC control by LLR in collaboration with LAPP  
High voltage system: Cockcroft –Walton technology  
Gent group required funding for this purpose

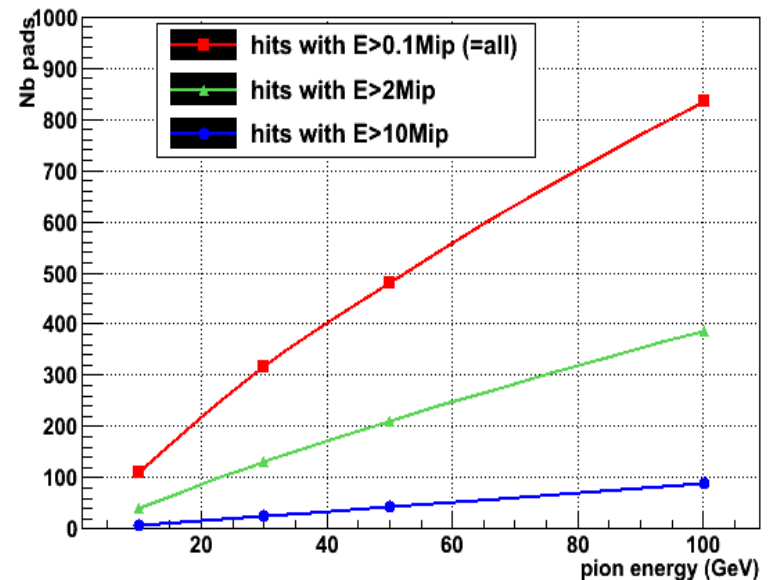
Gas distribution system: a simple one already exists.  
More sophisticated one is maybe needed →  
Babar drift chamber gas system?

# Towards the 1m3 technological prototype

- Pions with different energies were simulated to better understand the containment
- Digitization was developed.
- Algorithms for energy reconstruction using the 3 thresholds are under development



Number of pads vs pion energy



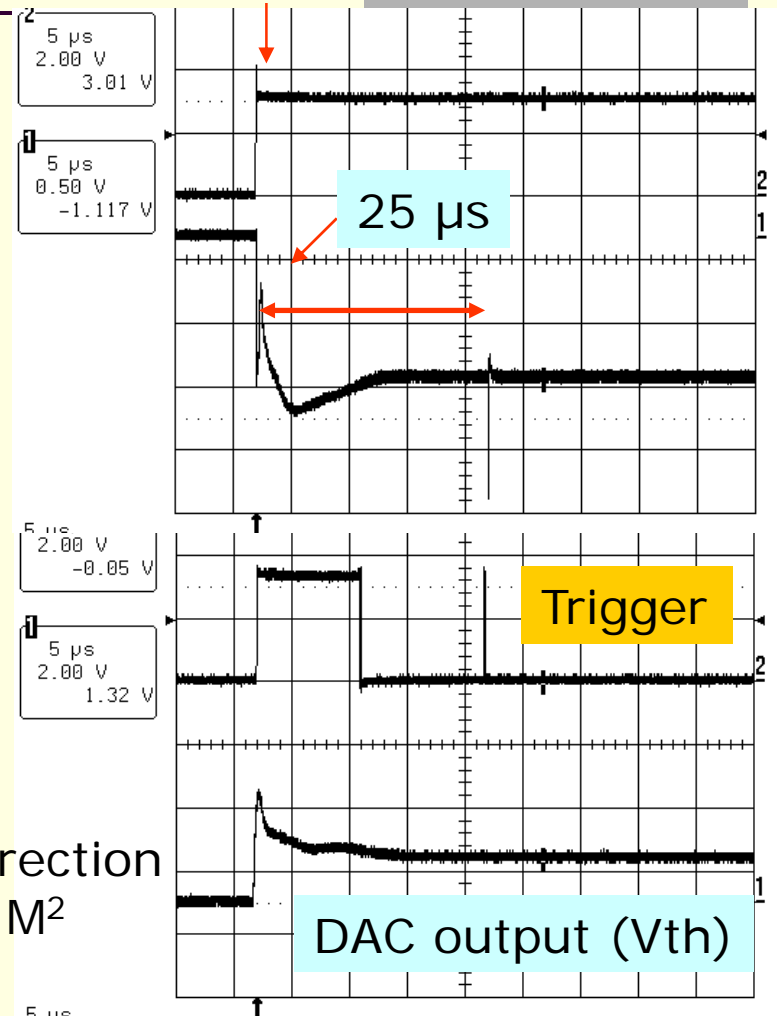
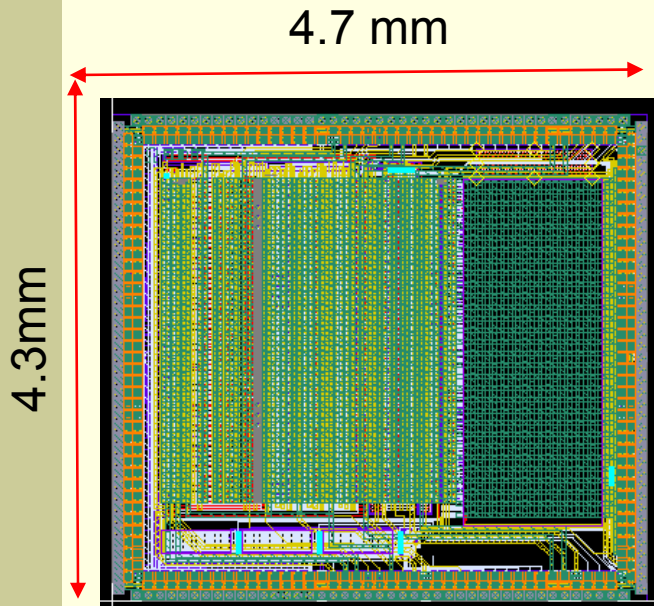
# Conclusion

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- Our project is progressing as scheduled
- Many problems were fixed
- Decision to build the detectors and to produce the ASICs will be taken before Septembre
- Construction will start in Octobre 2009
- Prototype expected July-Octobre 2010

# Readout electronics

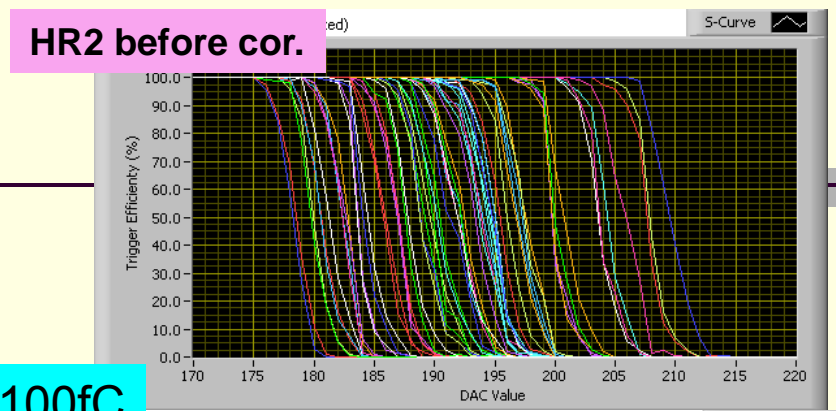
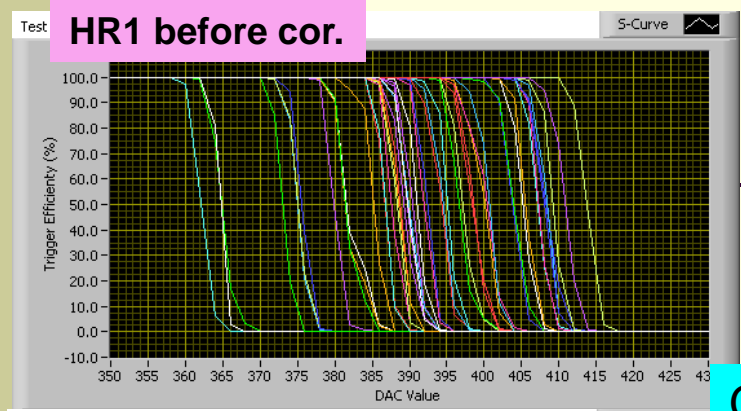
PWR ON



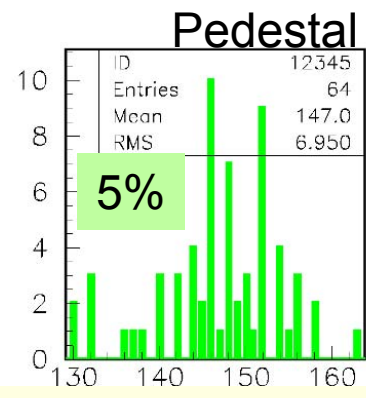
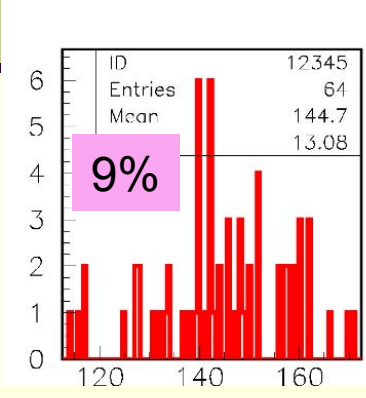
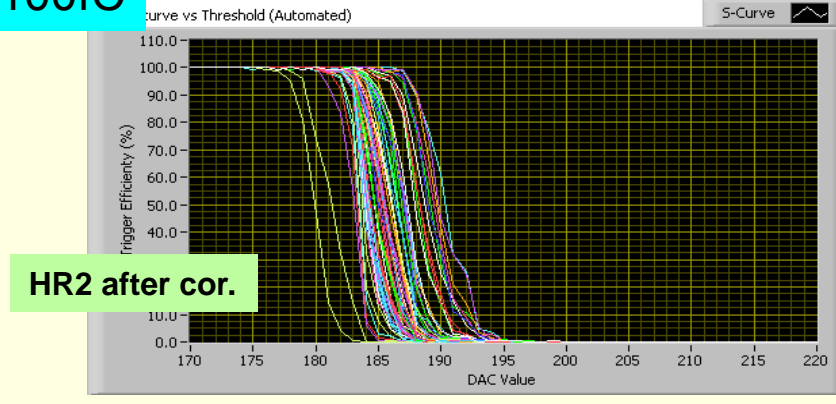
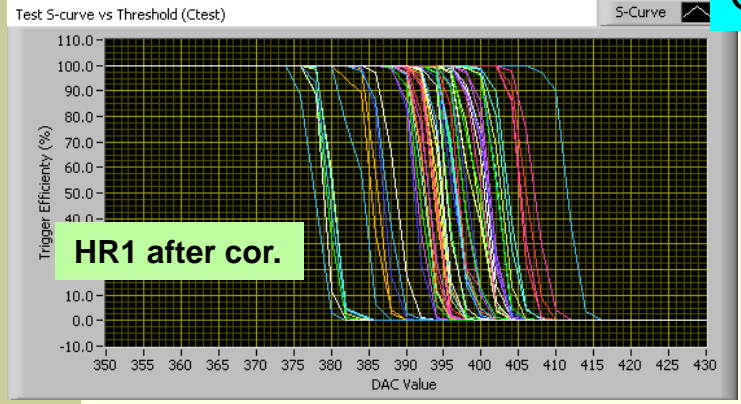
3 thresholds with "independent" gain correction  
New PCBs are under design for a second M<sup>2</sup>



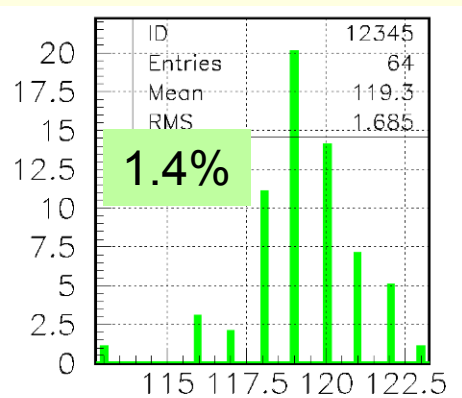
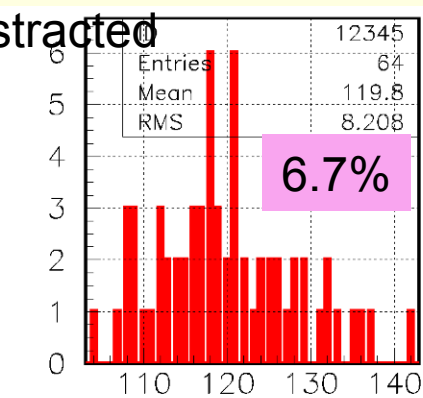
# FSB0 scurves: HR1 /HR2 before and after gain correction



**Qinj=100fC**



**Pedestal subtracted**



# Semiconductive glass and ceramics

Semiconductive glass

210mm\*70mm\*0.7mm

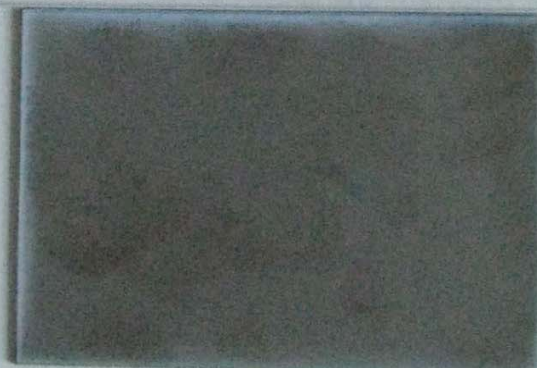
$\sim 10^{10} \Omega \cdot \text{cm}$



Semiconductive ceramics

80mm\*50mm\*1mm

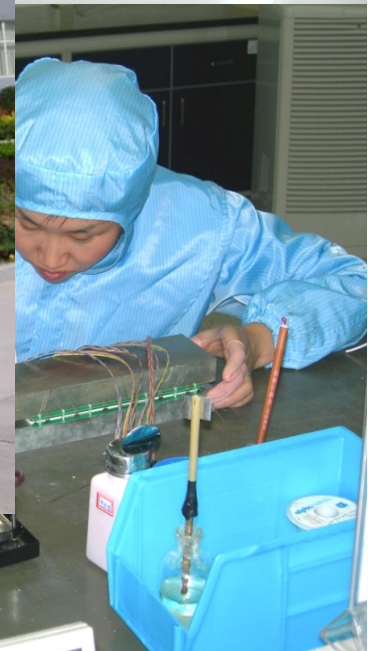
$10^6 \sim 10^9 \Omega \cdot \text{cm}$





# STAR MRPC workshop @

Outer scene of the workshop





# 1.- Ciemat mechanical workshop.

## Milling Machines:

- 1 CNC machine of aprox 4x1 m<sup>2</sup> working table. Accuracy of aprox 0.03 mm/m, with temperature compensation.



This is the machine that can be used to produce the plates for the HCAL prototype.