GRPC TestBeam results

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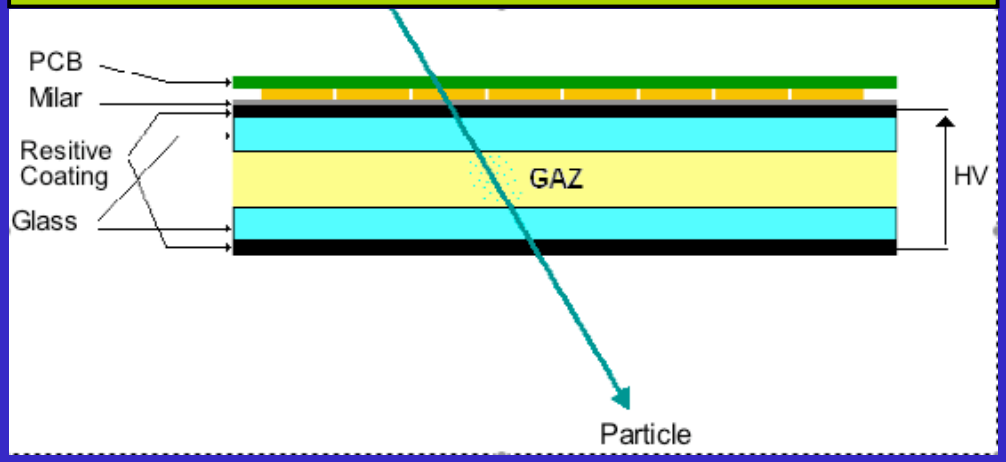
Overview

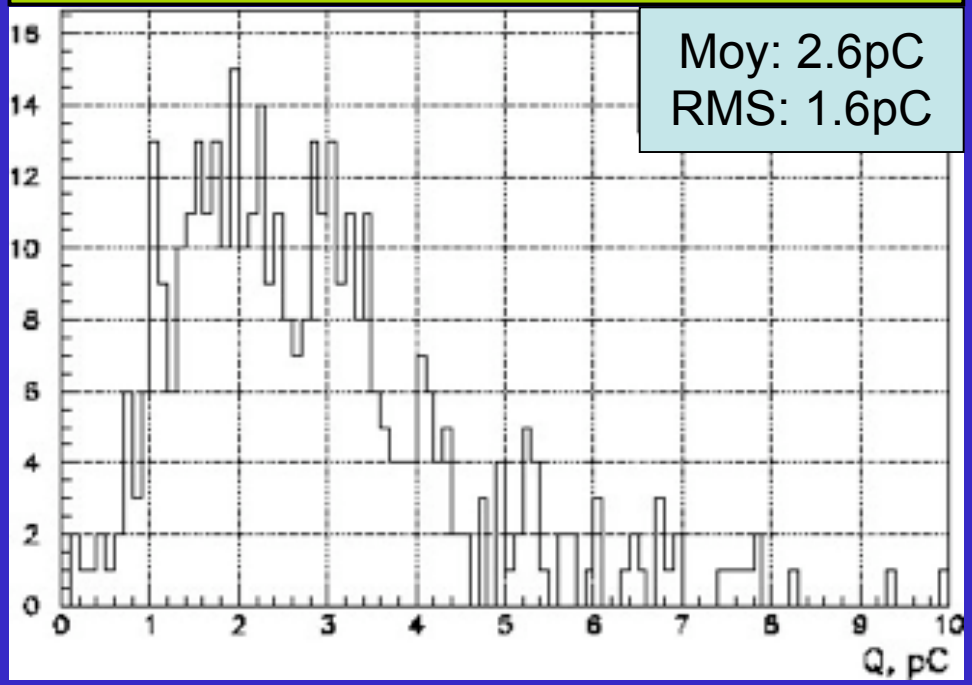
- Detector & readout
- GRPC R&D
- TestBeam Results
- Large detector devoppment
- Conclusions & perspectives

GRPC principle (Glass Resistive Plate Chamber)

Schematical view of the GRPC

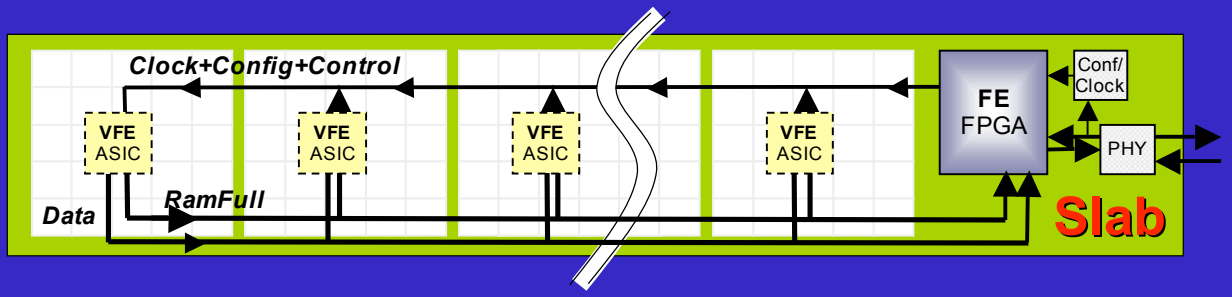


GRPC specta (From Protvino laboratory)



- Hight Voltage: 6.5kV - 8kV
- Avalanche mode
- Gas mix: 93% TFE, 5% Isobutene, 2% SF_6
- Inductive readout.
- Advantages : robust, good efficiency, very thin detector, cheap.
- Noise rate less than: 1Hz/cm^2

GRPC readout (Used for the lasts TestBeams)



Readout circuit board have been devlopped in collaboration with LLR and LAL:

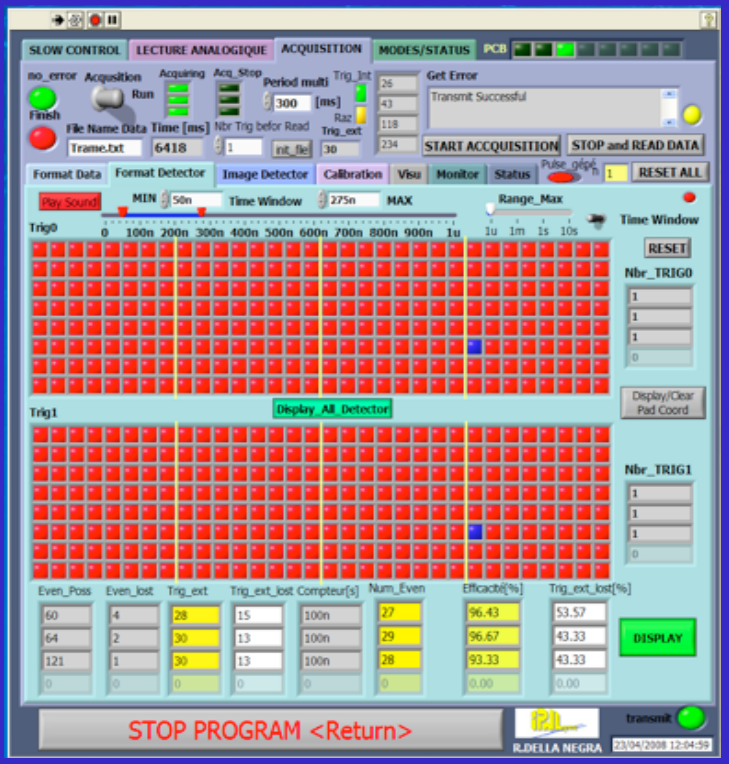
-> 8 layers PCB, total thickness 800µm

-> ASICs: HARDROC (64 semi digital channels)

-> 4 DaisyChained ASICs on board

-> 256 sensitiv Pads (1 cm2)

-> LabView aquisition



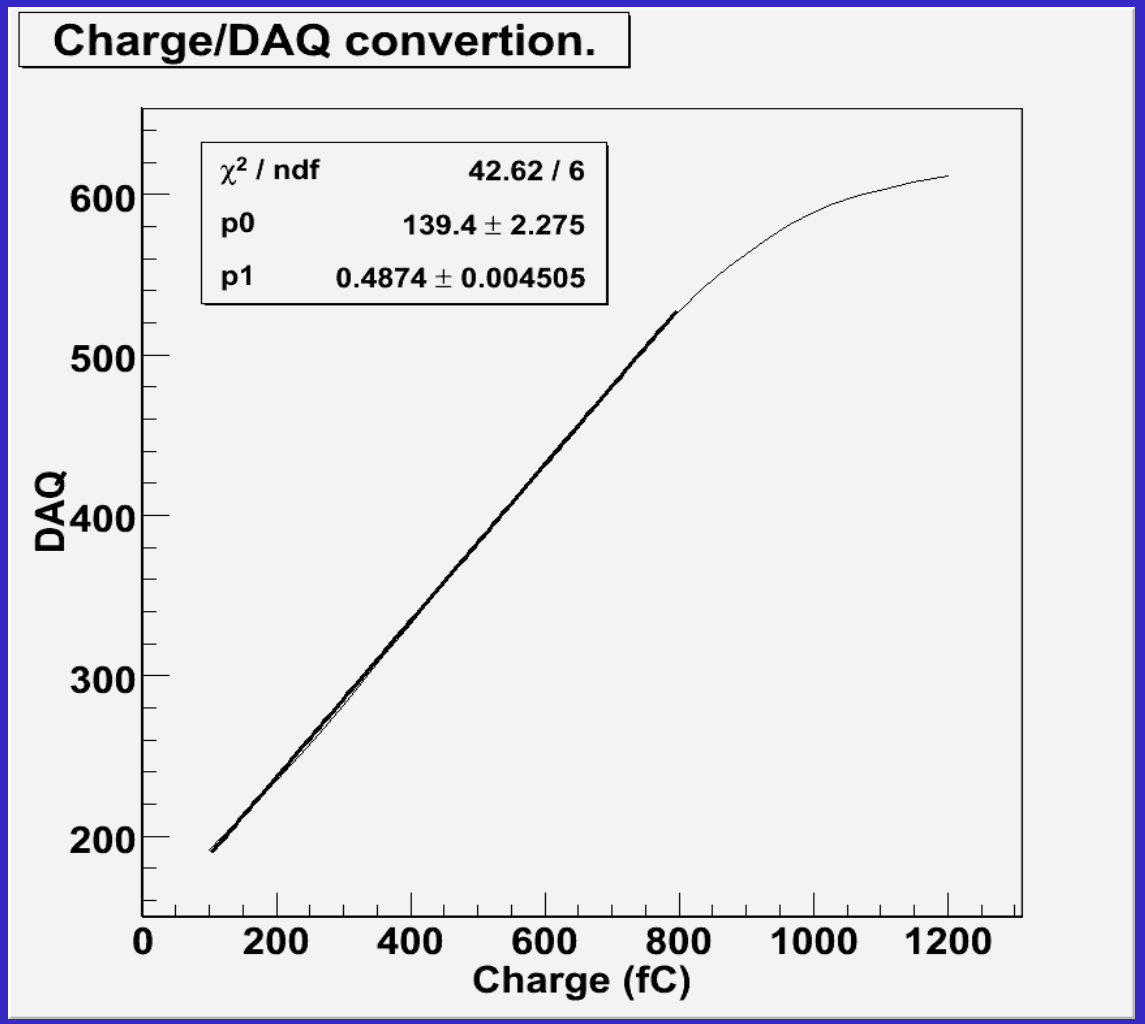
HARDROC's slow Control parameters:

- Adjustable gain for each channel to calibrate
- Two threshold (Set for the whole asic as a DAQ value)

Signal format:

- For each triggered channel: Timing Flag + Threshold(s) reached

Equivalence between digital threshold and charge



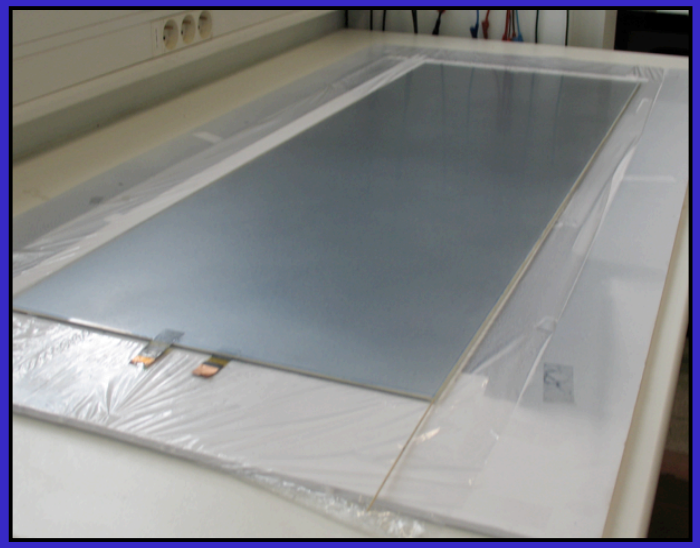
Mean value: 1DAQ= 2±0,1 fC

Linear dynamic range: 800fC

Electrodes optimisation

Glass caracteristics:

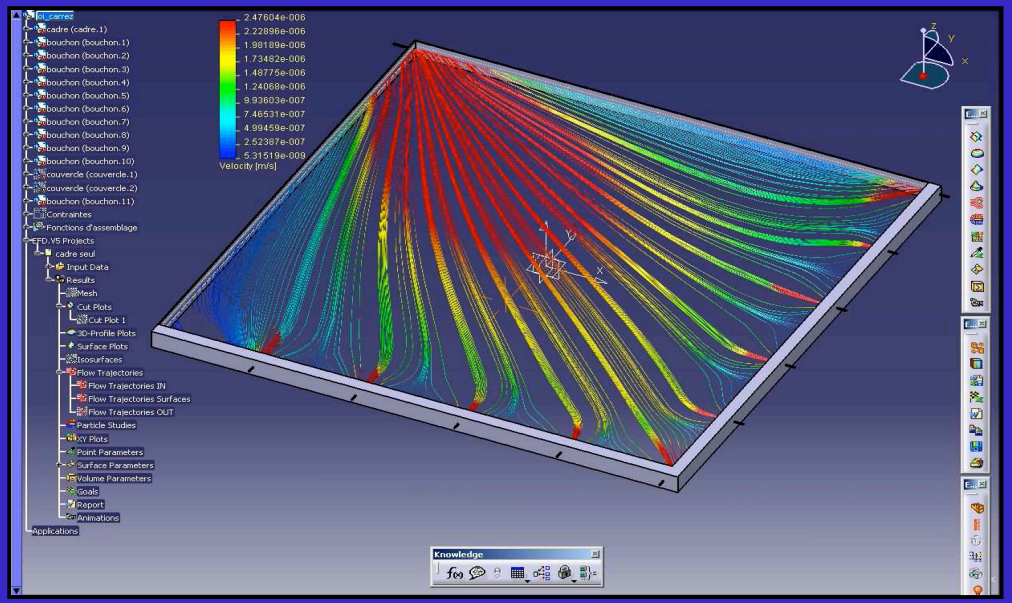
- Glass thickness: 1,07 and 0,7 mm.
- Hight resitivity; Detection rate about 100 Hz/cm2.
- Glass flatness permit to avoid noise sparks.

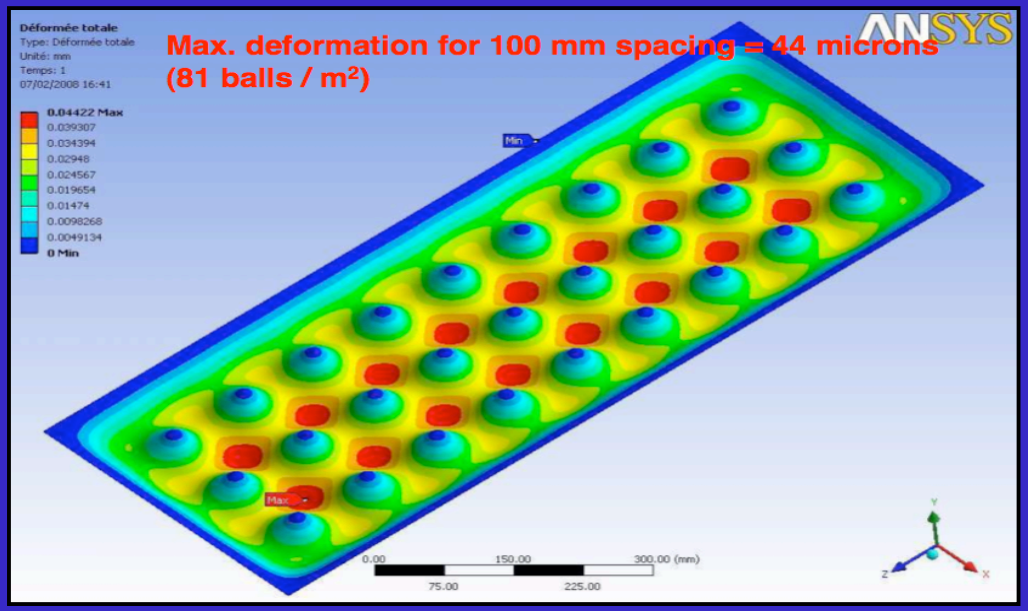


Resistive material coating and connexion:

- Differents electrode's coating solutions have been under study (Statguard, Graphite, Licron).
- Resistive coating play an imporant role in hit multiplicity.
- An important R&D job has been done concerning the HV connexion with the thin resistive coating, in order to reduce the noise generated by this interface.
- Connexion life time was also a critical point under test.

Gas flux optimisation





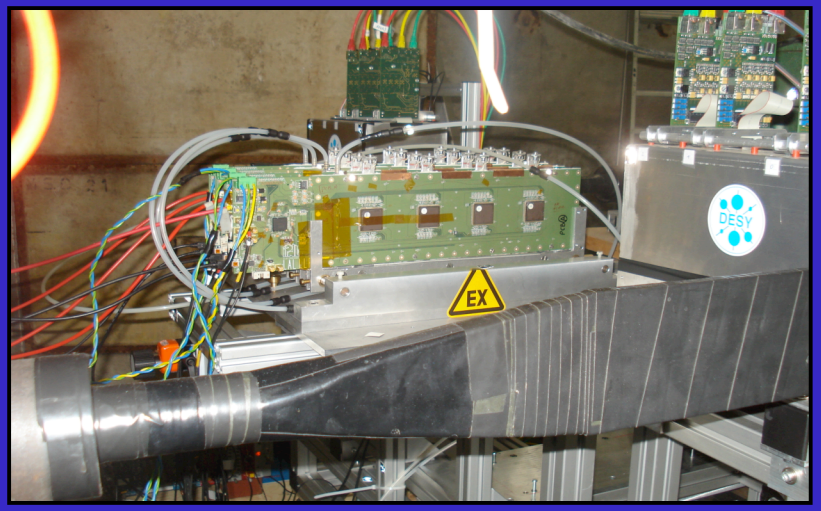
Needs:

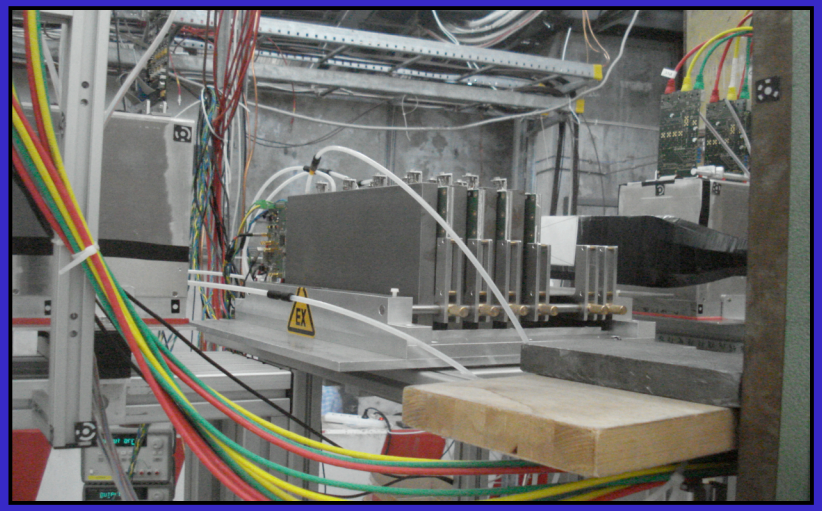
- Improvement of the gas renewal (Ensure a stable ionization process)
- Minimisation of dead zones dues to spacers.

Two solution was proposed:

- Use of ceramic balls as « ponctual » spacers.
- Chamber's frame used as gas distributor.

TestBeams @ CERN (Jully & November 2008)





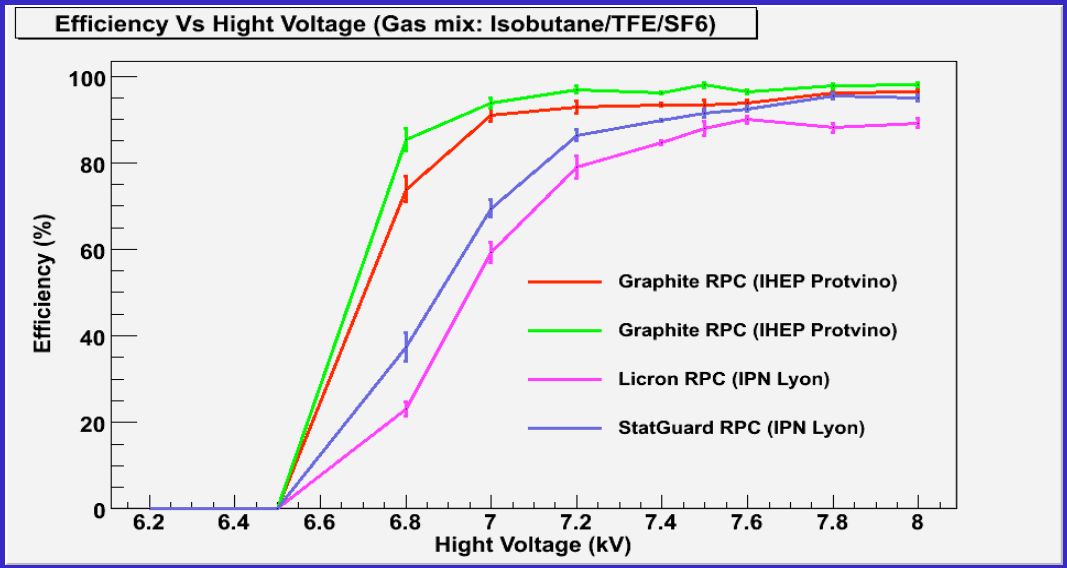
Main goals:

- Test small GRPC performances (32x8 PADs):
  - Differents energies (1-12Gev), and particles kind (Pions, muons, electrons)
  - Differents beam rates.
  - Scan of impact angles.
  - Use of EUDET pixel telescope.

- Test of the electronique readout:
  - Under realistic flux conditions.
  - Evaluation of detector's response according to the daq's threshold level.

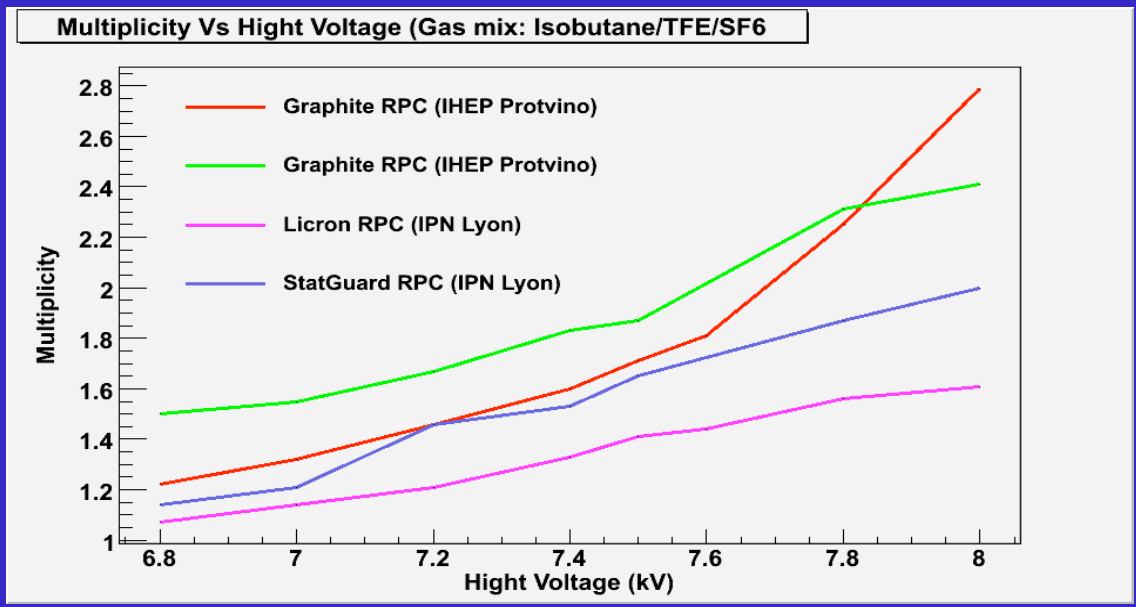
- First record of hadronic shower putting iron slab between detectors.

Performance of the detectors moving Hight Voltage

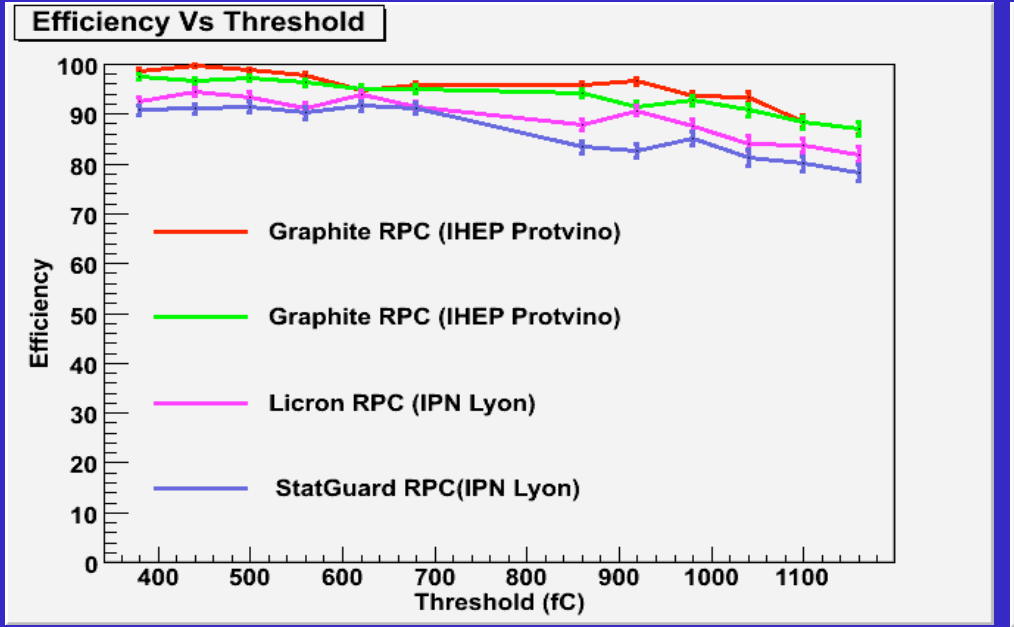


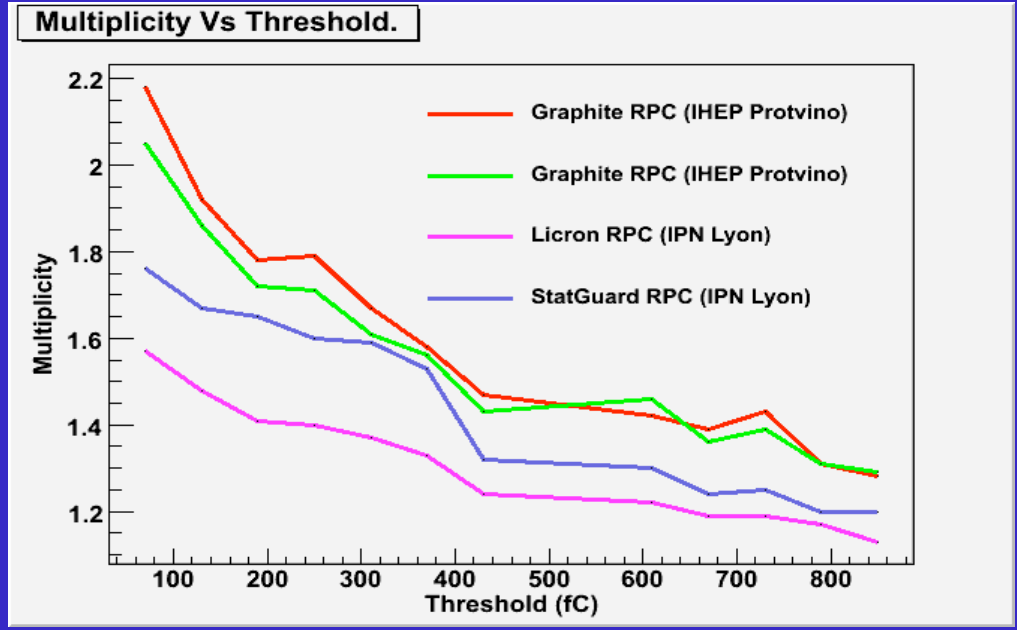
Threshold: 120 fC
Plateau: 7.2 to 8 kV
Efficiency between 80 and 98%
Best ratio multiplicity/Efficency: @ 7.4 kV

The licron detector seems to be the best candidate, it got the lower multiplicity, and shows acceptable efficiency performances.



Performance of the detectors moving ASIC's Threshold



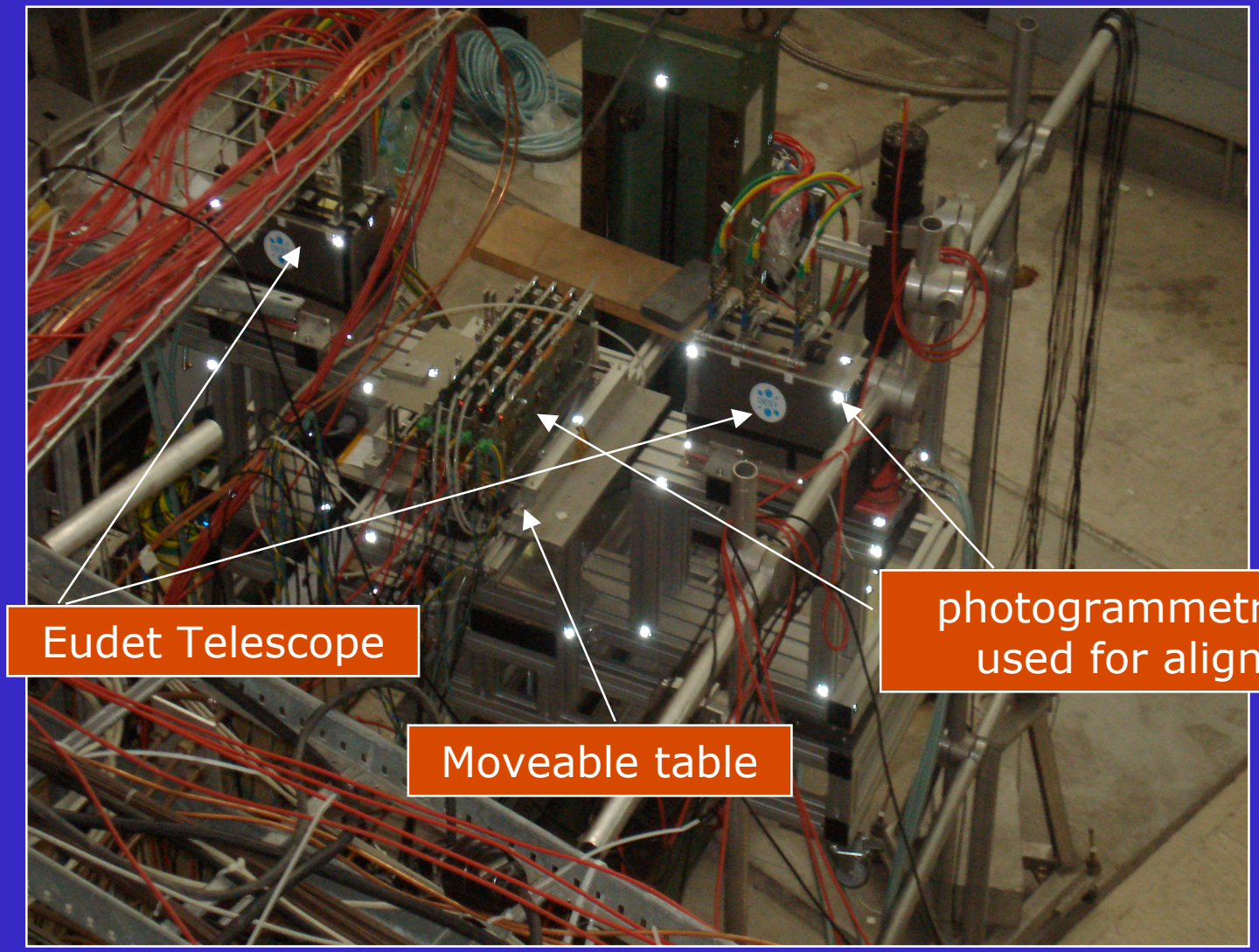


Moving ASIC's threshold we wanted a kind of pseudo-spectra.

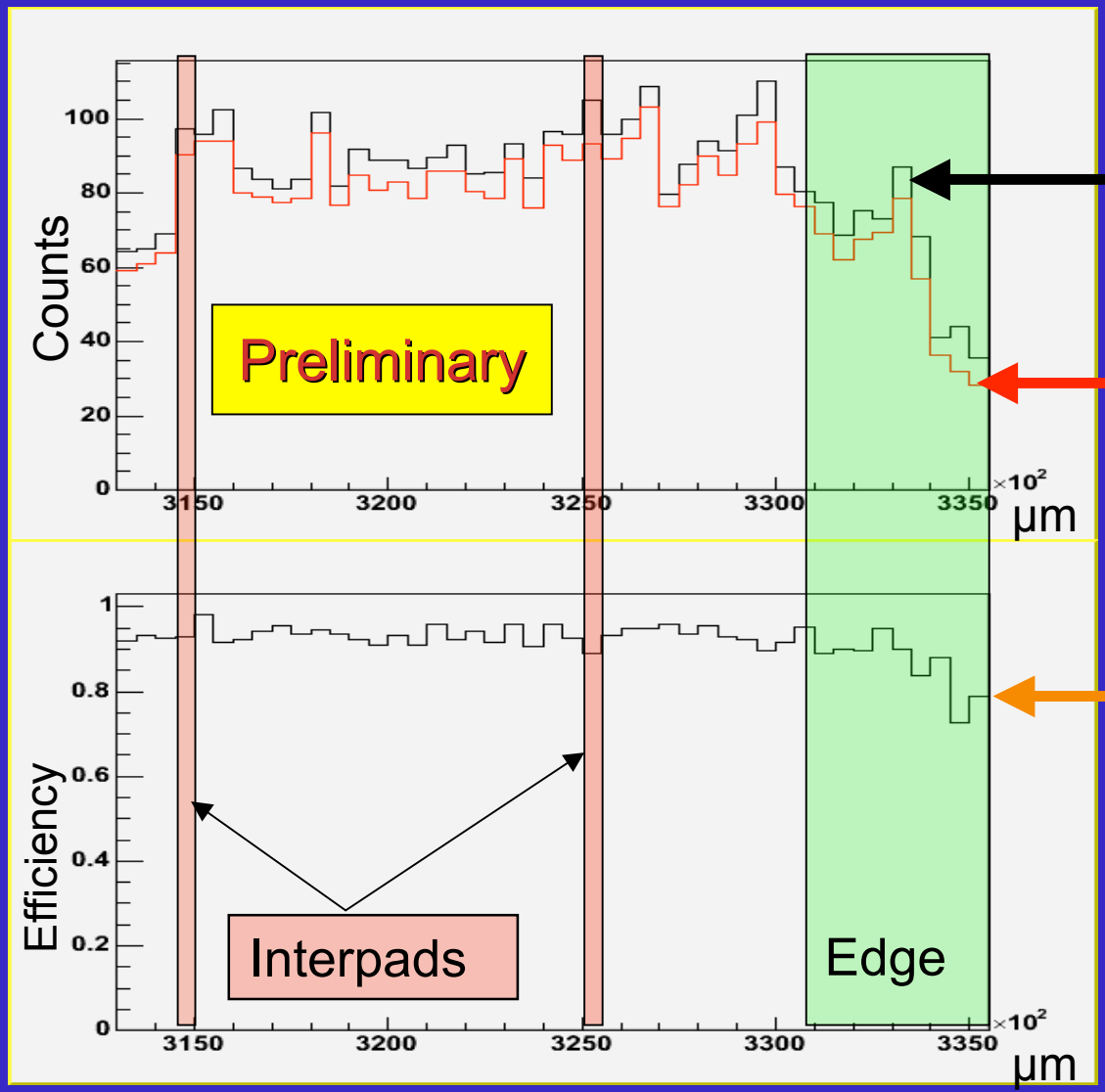
But the ASIC's dynamic range was to small, the next ASIC version will have a larger dynamic range, we will do this measurement again.

Concerning multiplicity the effect of threshold is as expected.

Use of Eudet Pixel telescope (@ CERN)



Spatial efficiency using EuTel track reconstruction



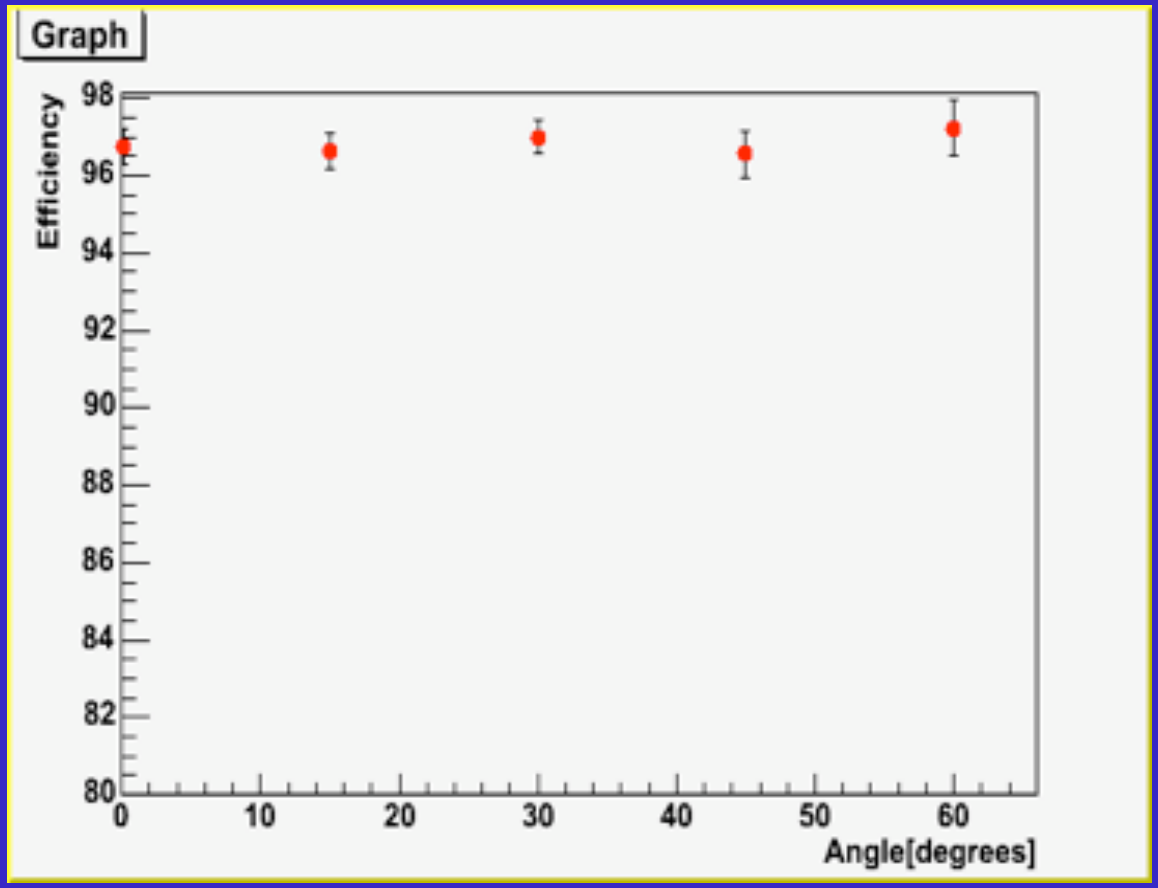
Black (Trigger): spatial prediction of hits in GRPC, from EuTel.

Red : matched digital hits (EuTel + GRPC)

Efficiency: Red/Black

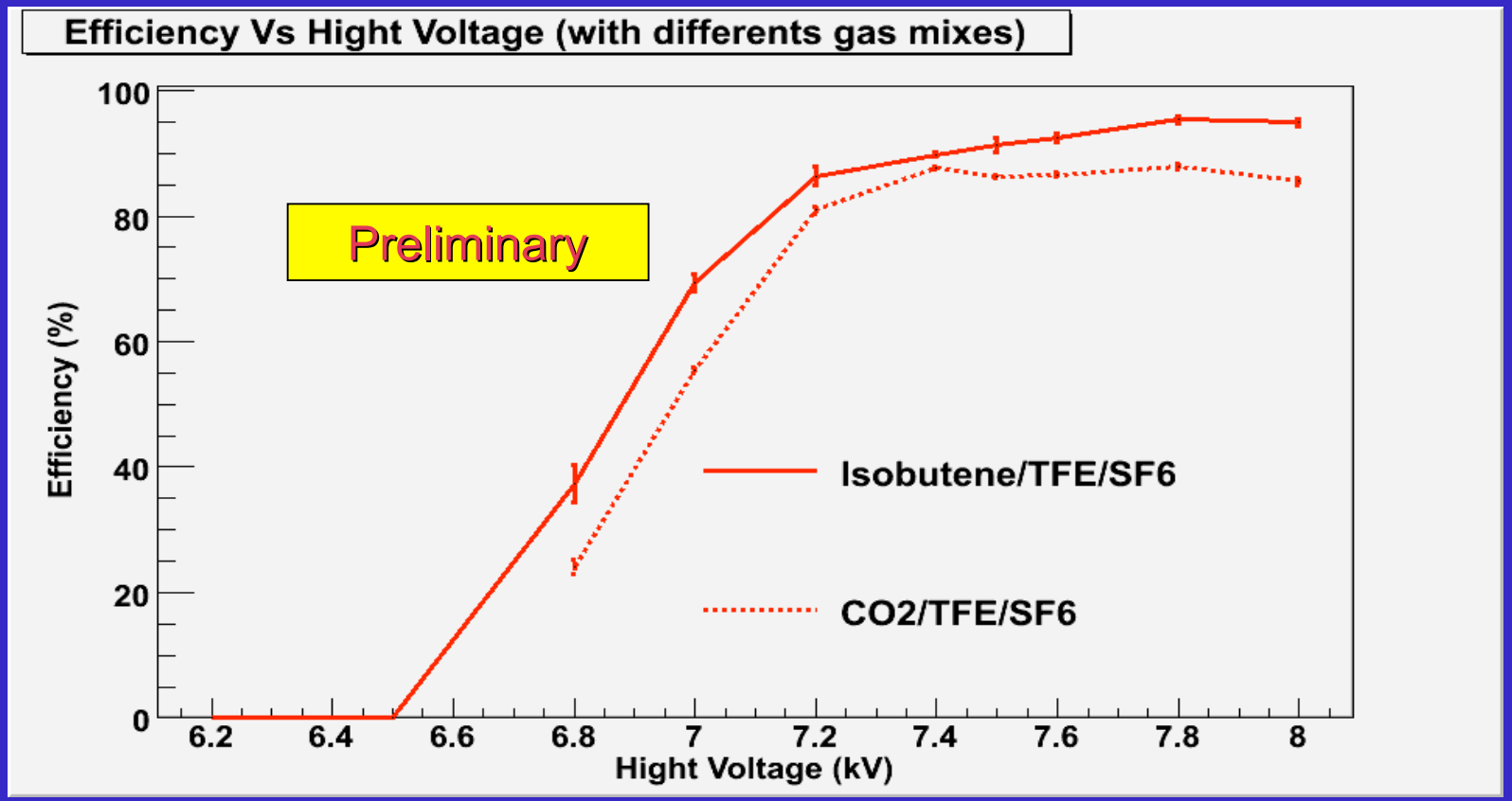
Using EuTel, we can evaluate efficency on the detector edges, and between two Pads.

Efficiency Vs Angle of incident particles.



Efficiency is quite constant, even for large angles.
It promises a good particle detection in the end caps of the future experiment.

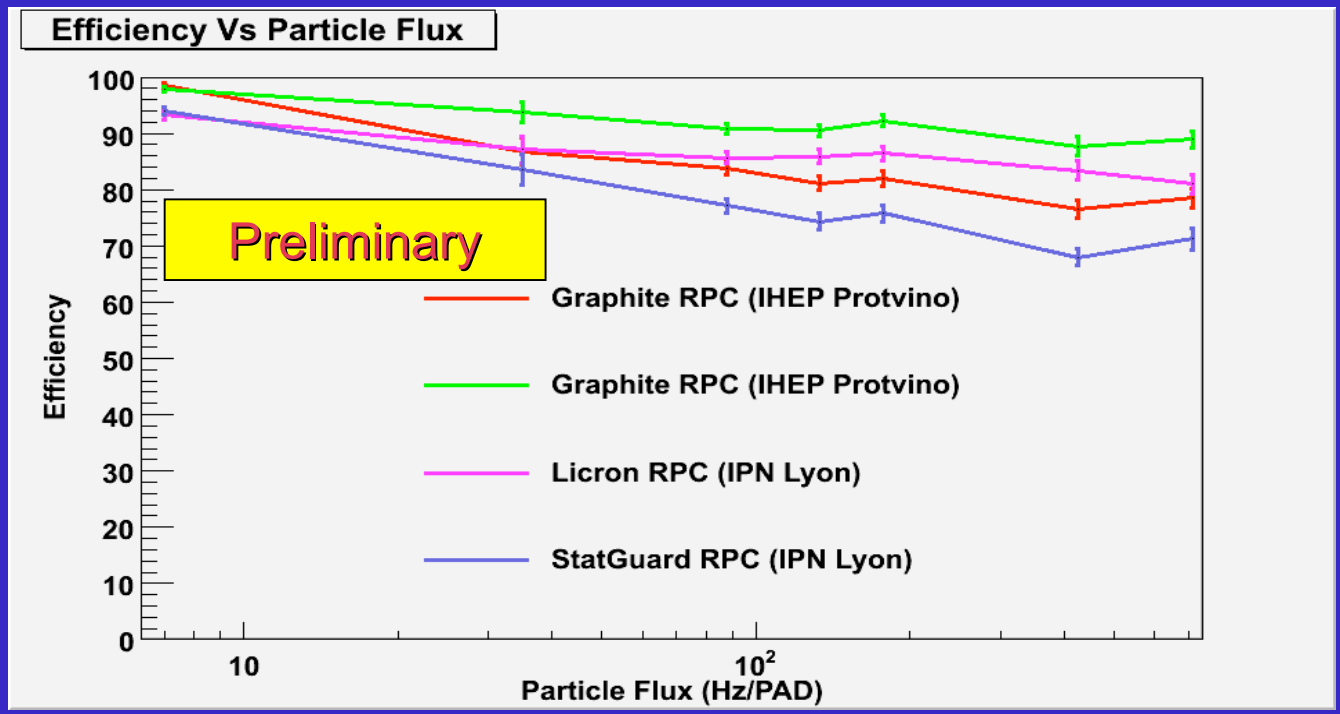
Performances obtained replacing isobutene by CO_2



These firsts tests using CO_2 , are quite promising.

Note: Complementary measurements have to be done to comfirm these results.

Evolution of performances with particle flux

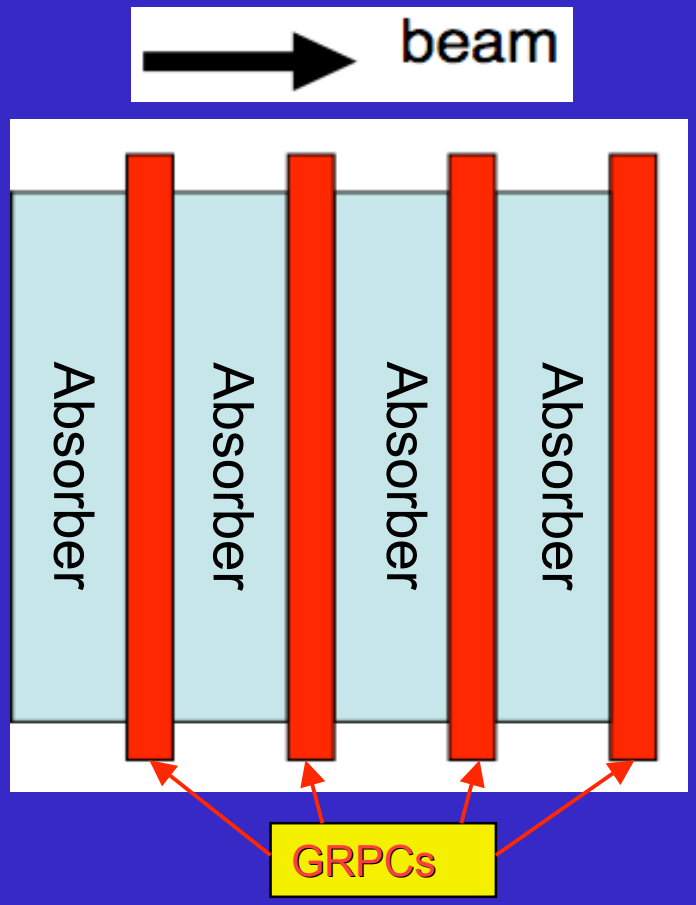


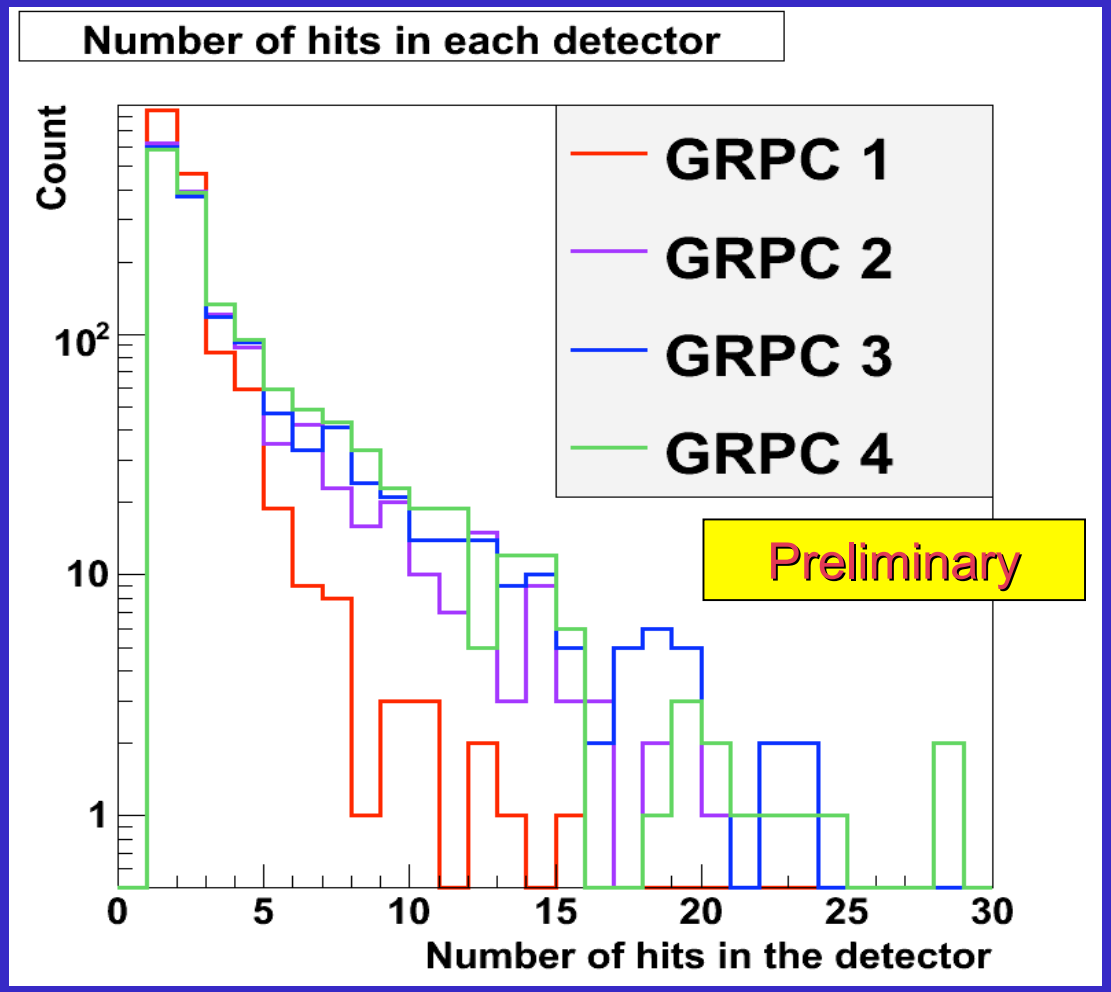
We made some correlations between flux measurment done with scintillators, and efficiency of the chambers.

It gives us some preliminary results about GRPC running in real beam conditions.

Note: The flux measurement was not very precise, we have to make some complementary measurements to confirm these results.

Hadronics showers

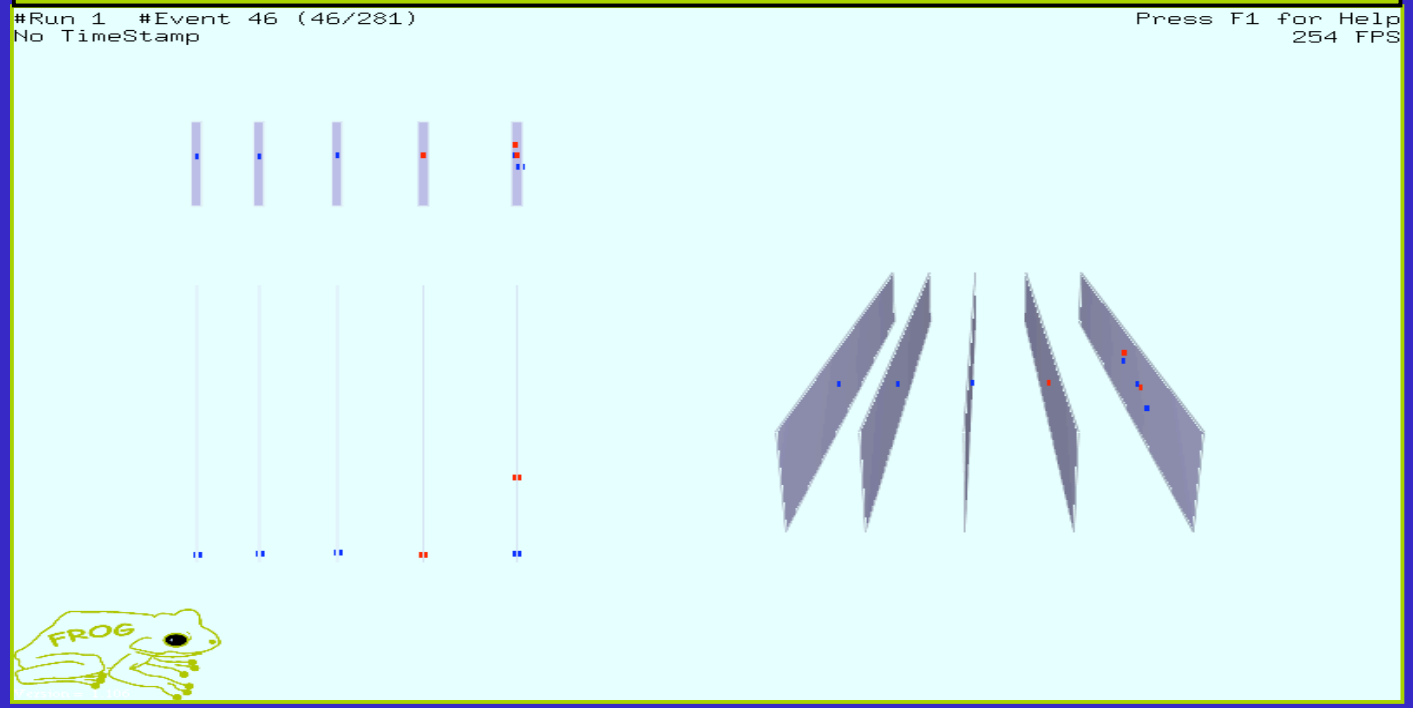




Hadronic shower are mostly uncontained in MiniDHCAL but these profiles gives a first idea of shower devloppment and energy deposition.

TestBeam results summary

FROG event display used for our SmallDHCAL



- More than 400 kEvents recorded (DAQ's rate: 20Hz).
- The most part of the data have been analysed.
- We now try to fit simulation with TestBeam events.

The 1m^2 prototype

Detection chamber:

- 1m^2 chambers have been built, with licron and statguard coating.

Readout:

- 144 ASICs/m^2 providing 9126 chanels/m^2
- New DIF board driving 48 DaisyChained HARDROCs.
- Hight aquisition rate

(See C.Combaret's talk).

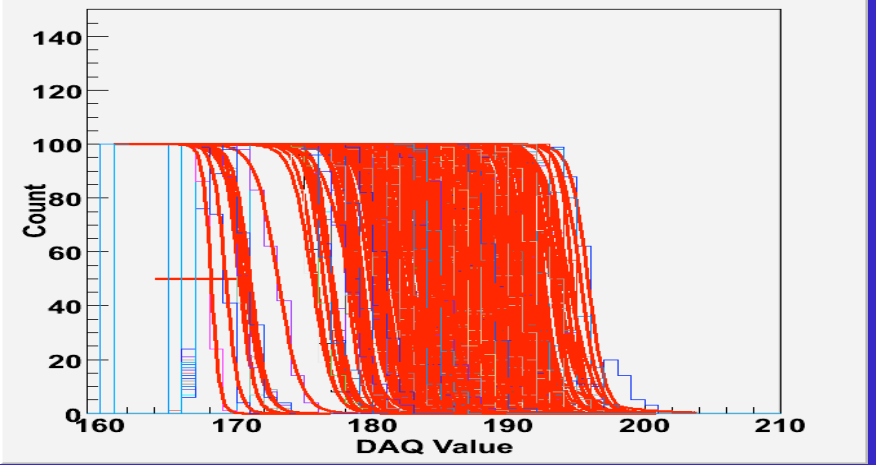
Conclusions & Perspectives

- These BeamTests permit us to validate our GRPC's technologie.
- The readout gives us promising results.
- End of data is still being analysed.
- We are now preparing the next TestBeam, with the idea of putting $1m^2$ GRPC fully equiped on beam in a few weeks.

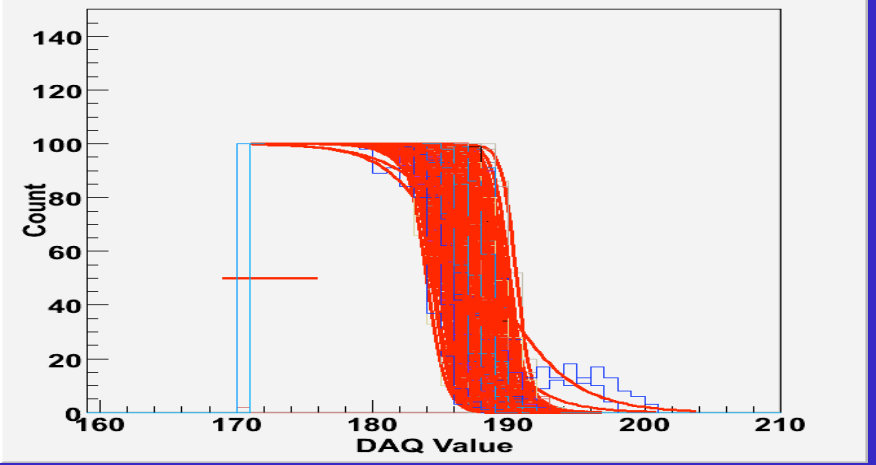
Thanks

Readout Callibration

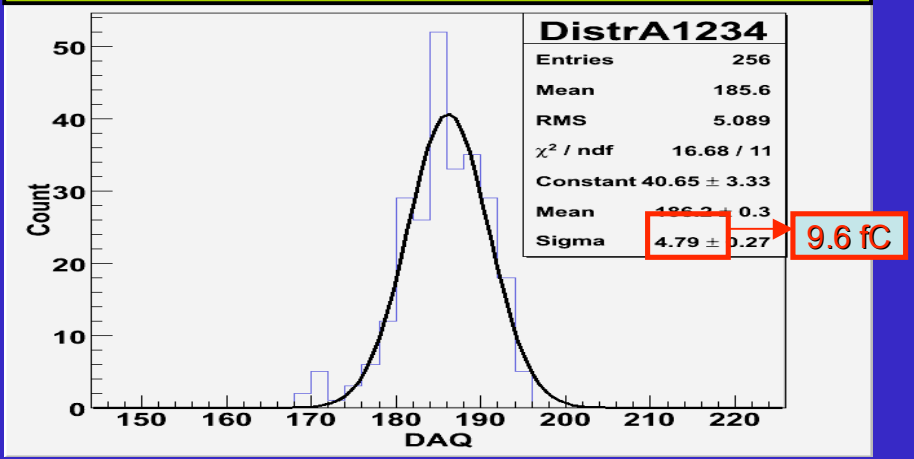
256 channel's SCurves (before correction)



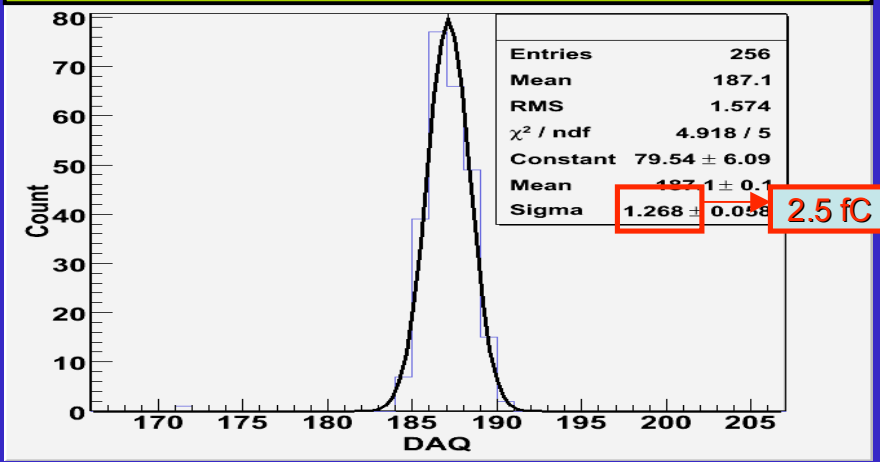
256 channel's SCurves (after correction)



Threshold distribution (before correction)



Threshold distribution (after correction)



Injected charge: 100 fC

Reduction of the channel's dispersion by a factor 3

Channels dispersion : 2.5 fC