Report on GRPC/DHCAL
in Europe

CIEMAT,IHEP,IPNL,LAL,LAPP,LLR,"Bologna"

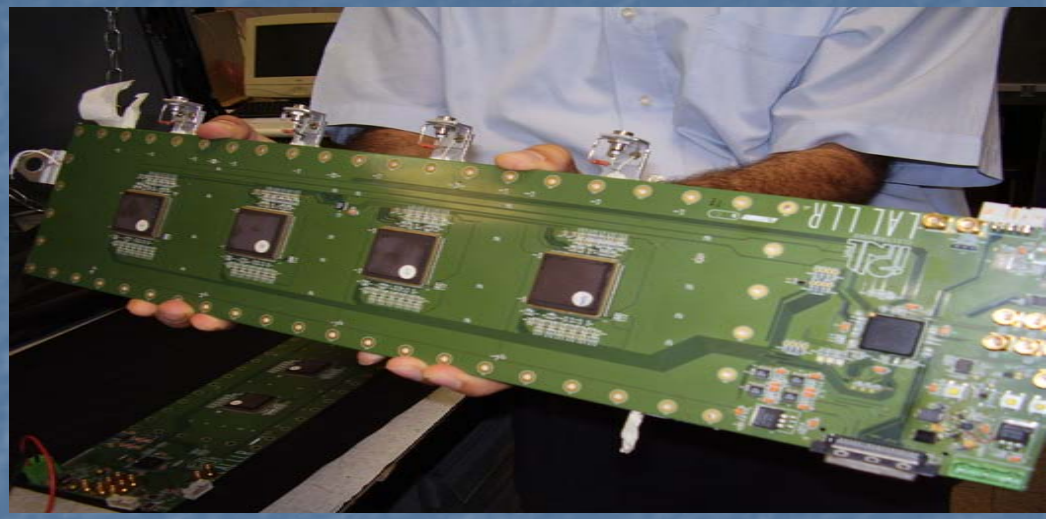
I. Laktineh
IPN-Lyon

Outline

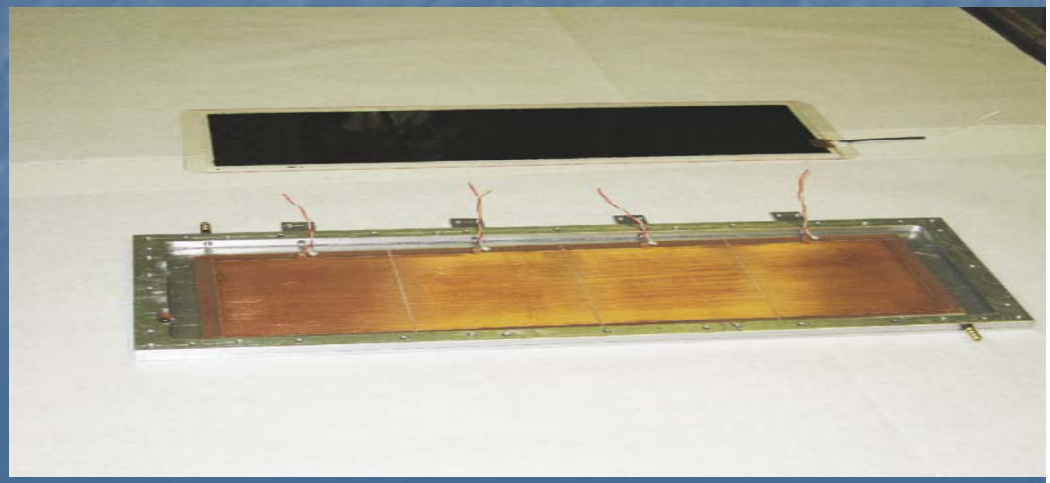
- Mini DHCAL
- Towards the 1 m² project
- Perspectives

Mini DHCAL

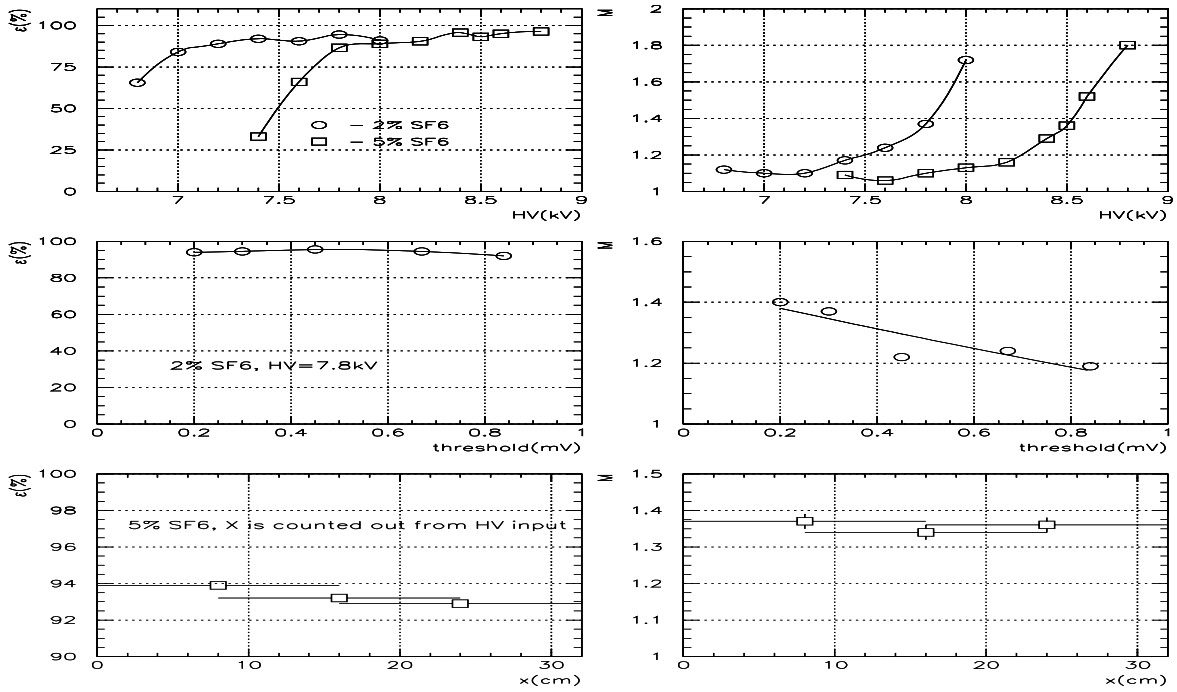
PCBs equipped with
4 hardroc1+FPGA+USB
IPNL+LAL+LLR



Standard RPCs
(graphite +fishing lines)
IHEP

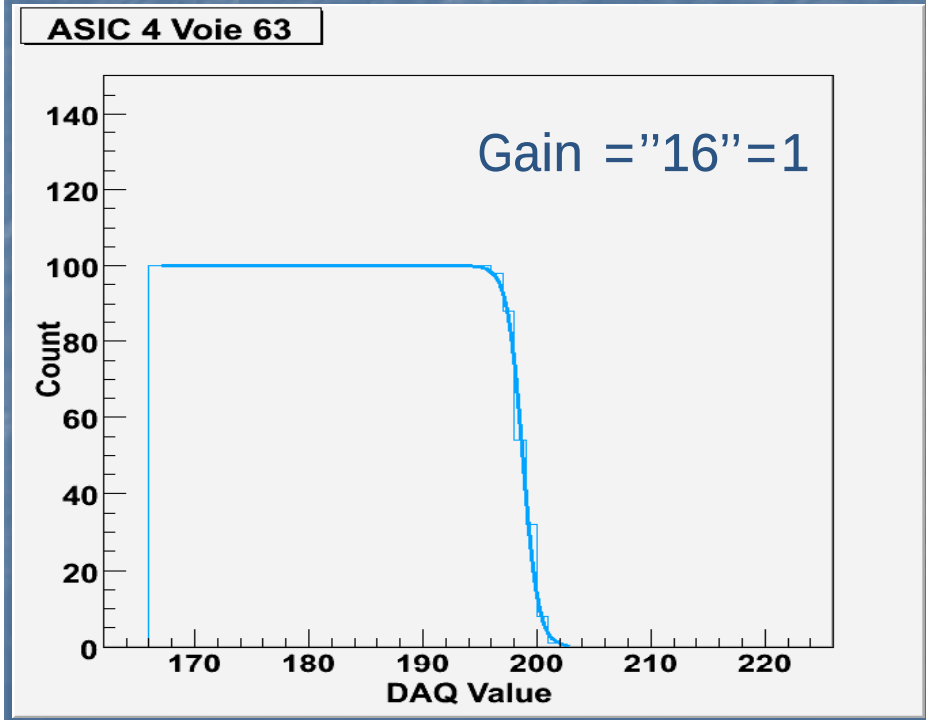


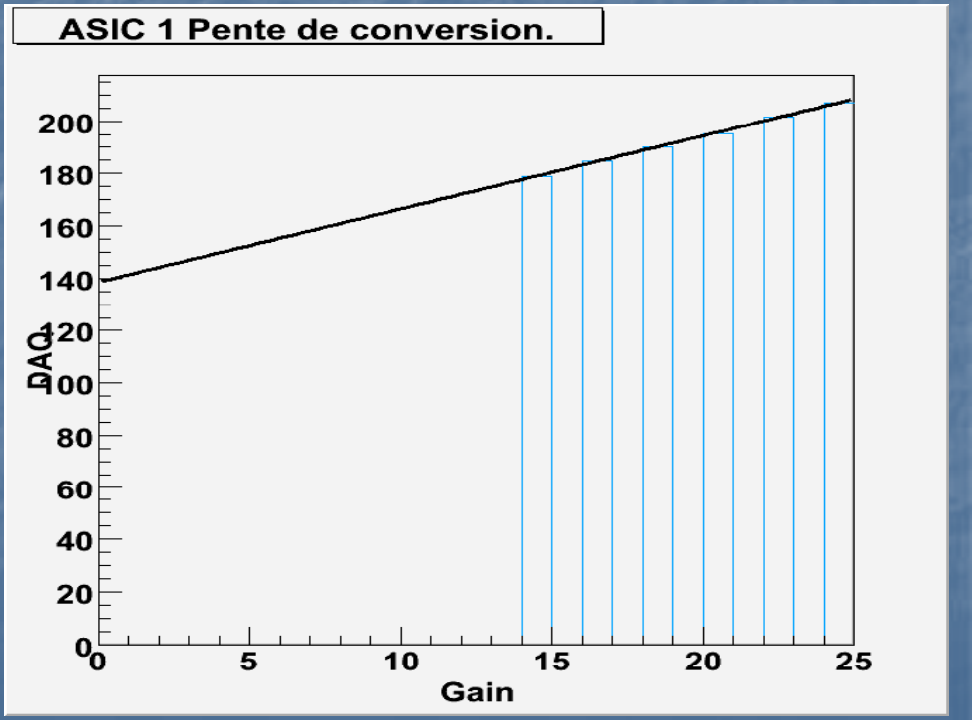
GRPC were tested at IHEP with standard electronics and then sent to IPNL



Read-Out calibration

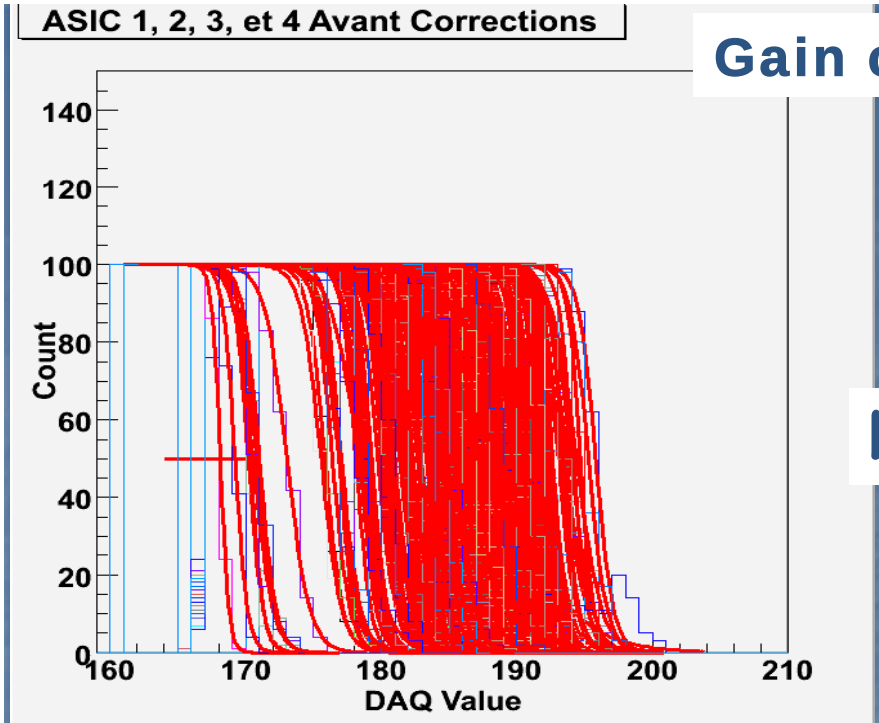
The purpose of the calibration is to have a homogeneous response of the electronics.

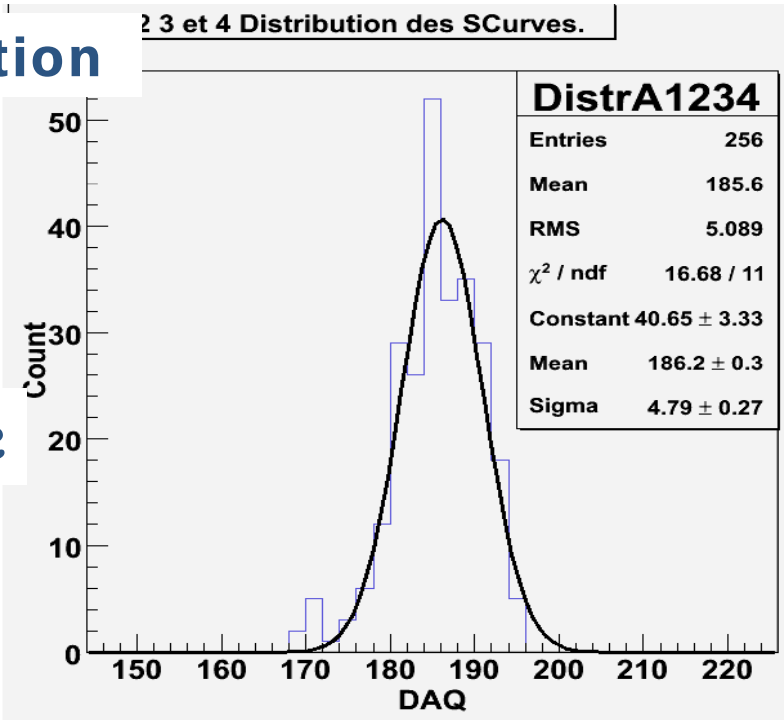




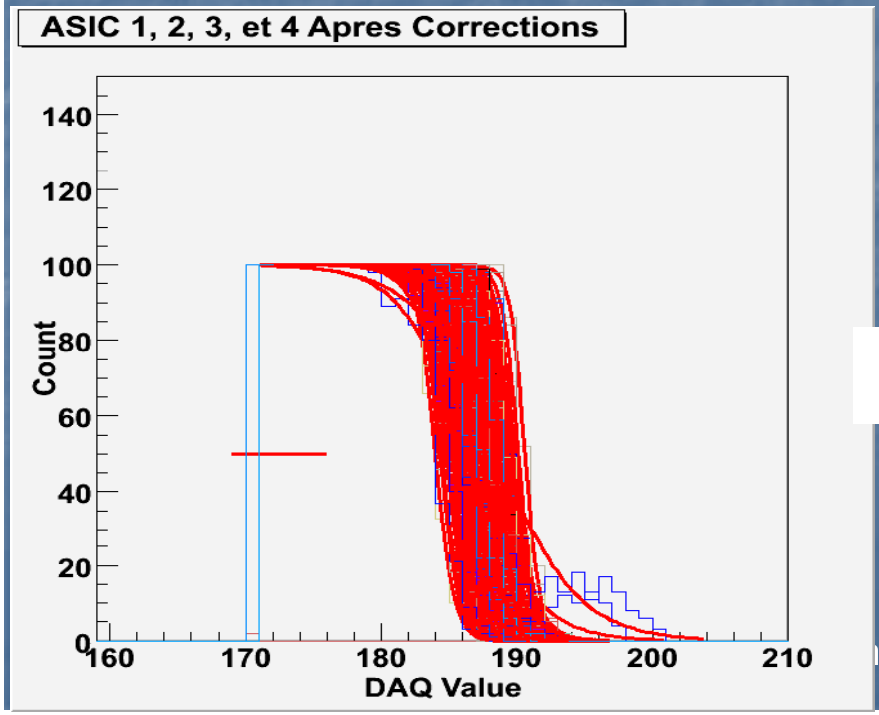
Gain correction

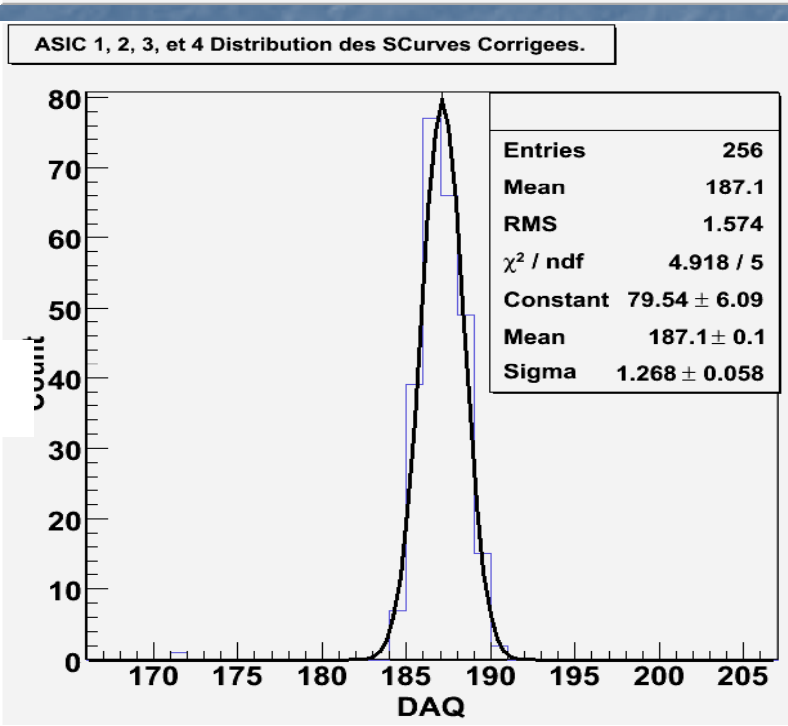
before



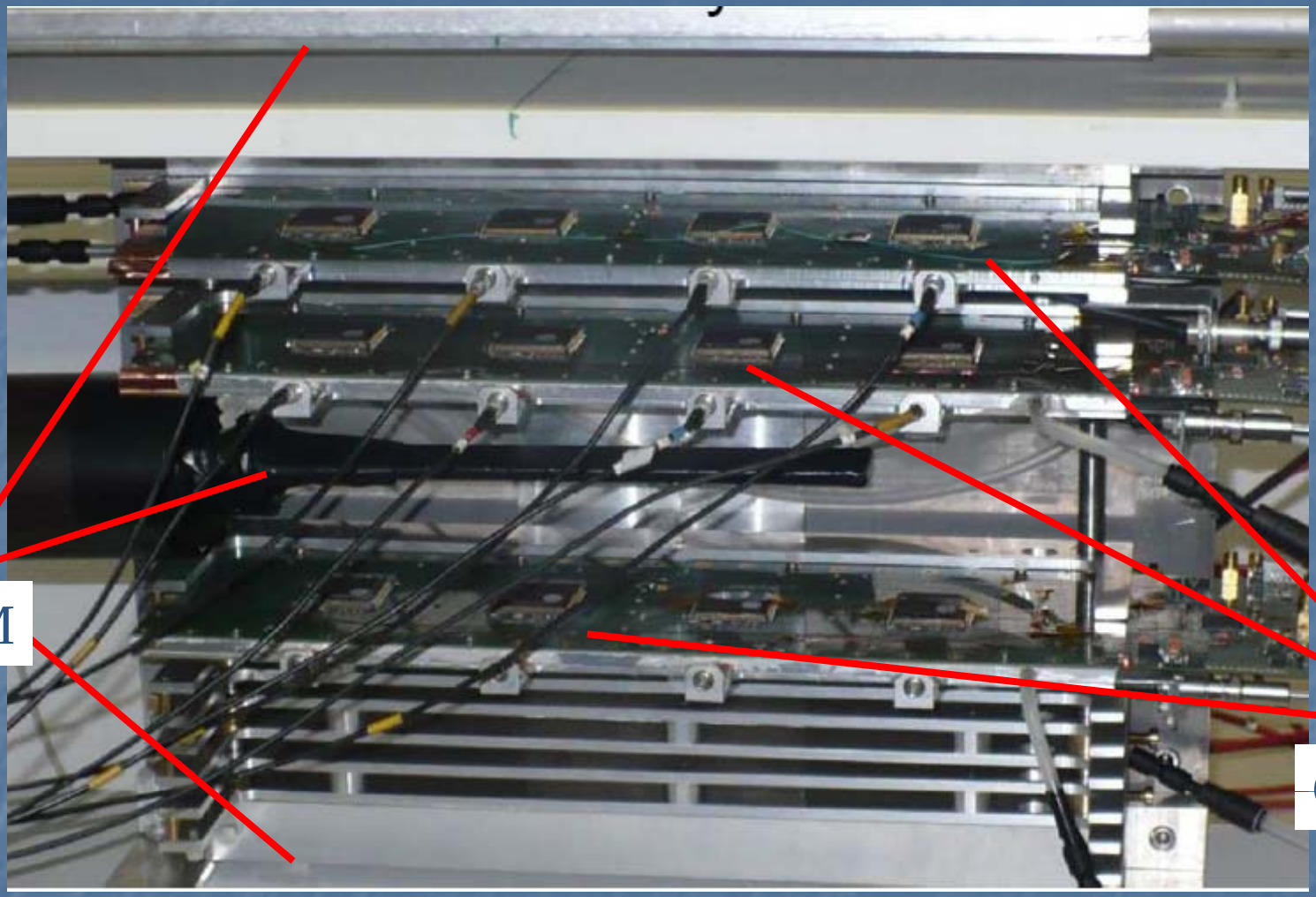


after



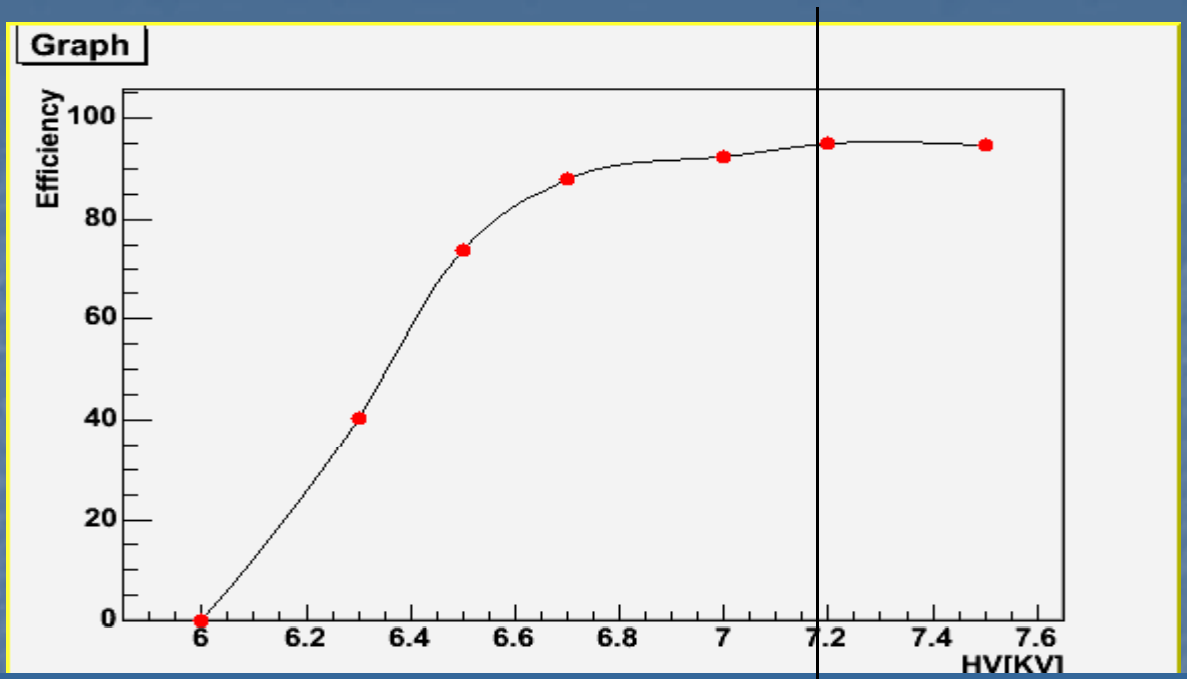


Calice-Ma



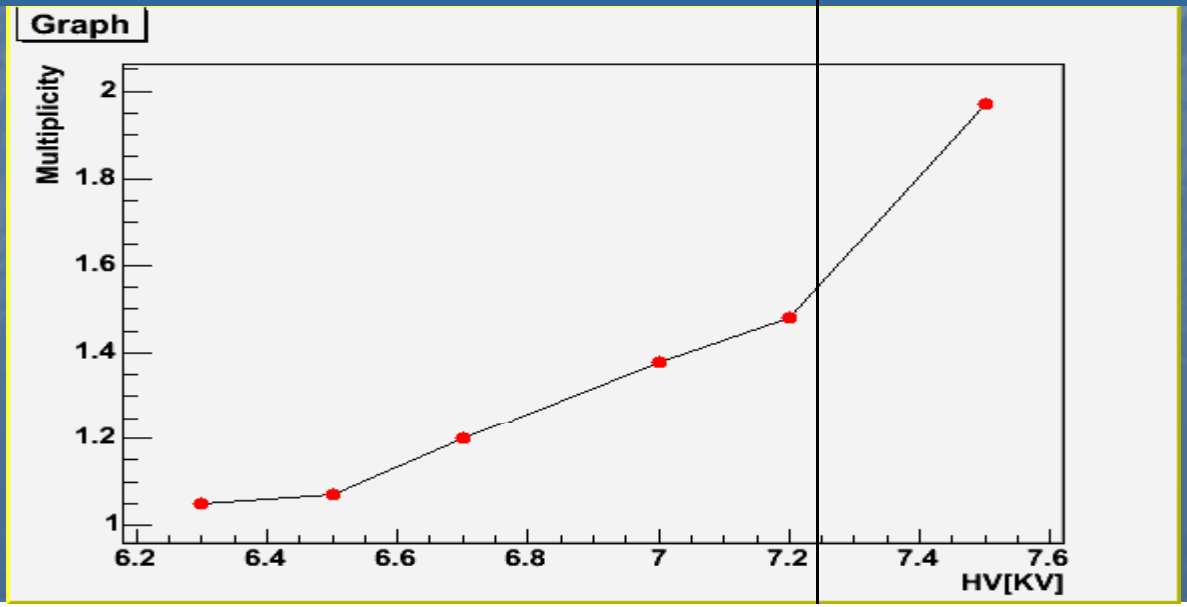
Cosmics bench

GRPC
32X8 pads
graphite



TFE 93%
Isobutene 5%
SF6 2%

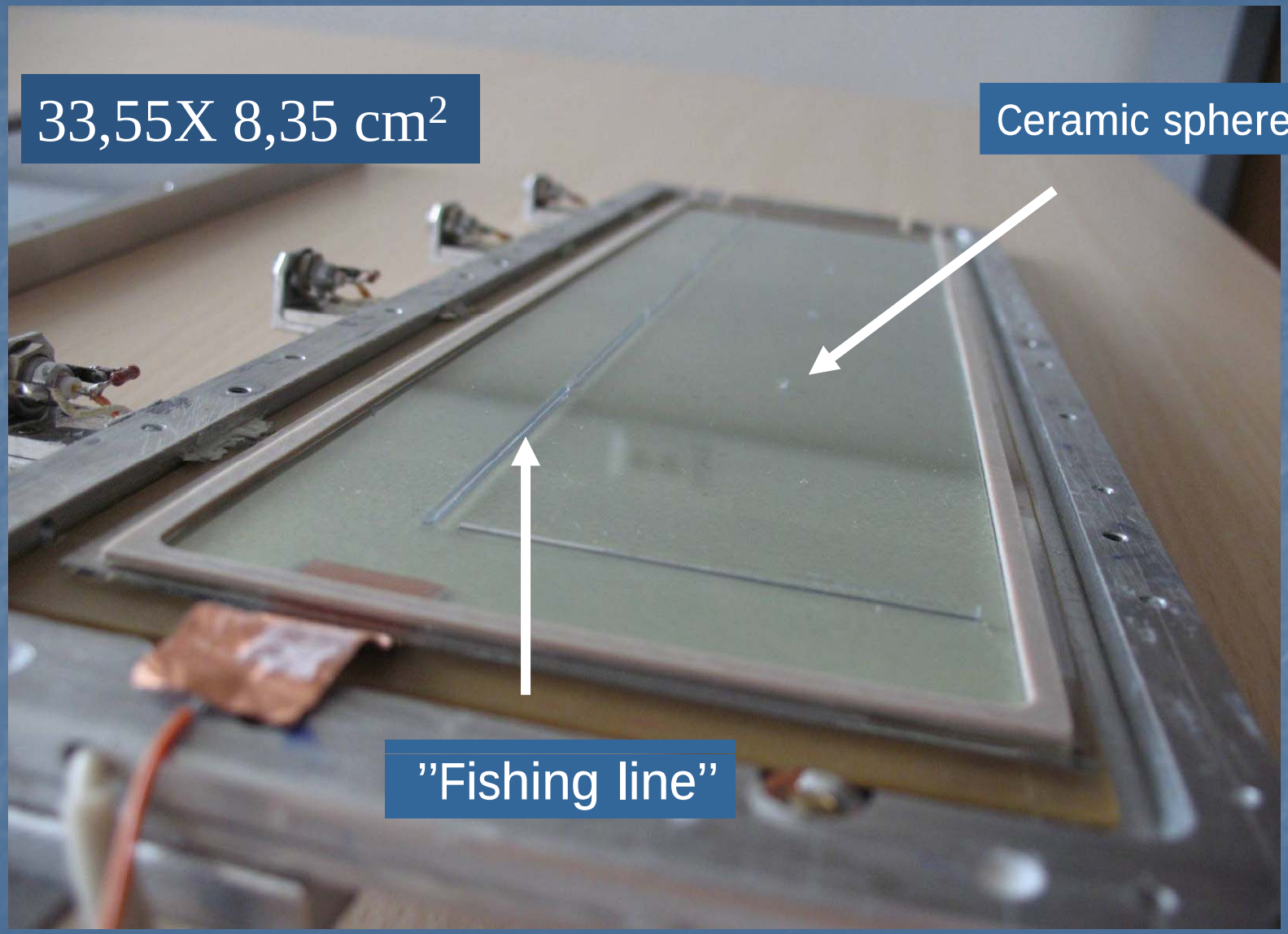
Threshold= 190 DAQ.U ≈ 100 fc

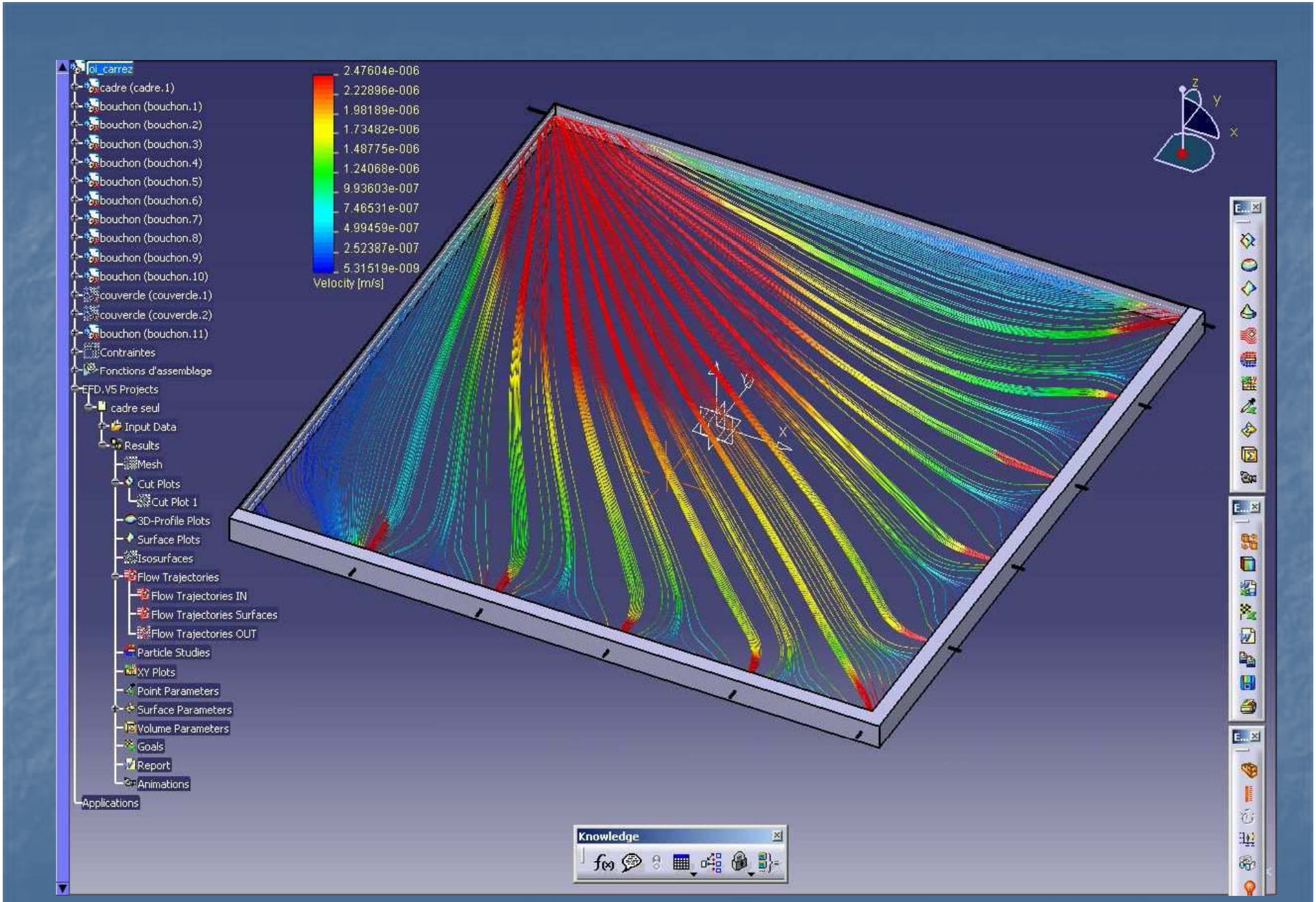


New GRPC developments

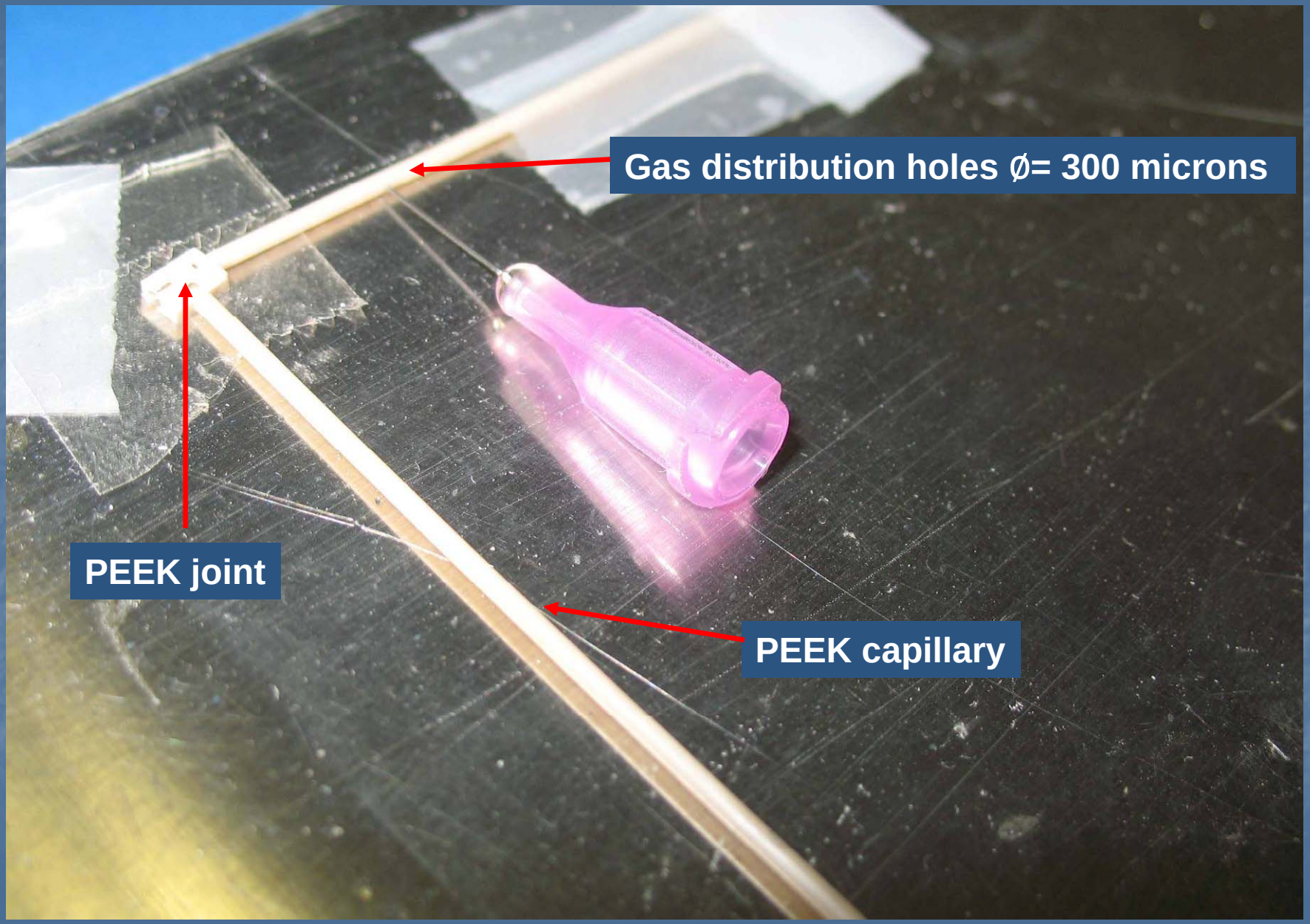
- Try new resistive paintings : Licron, statguard to reduce cross-talk
- Try new gas distribution systems : to improve gas distribution
- Try new spacers/frame to reduce dead zone
- Try new HV connection system to reduce related noise

solution1

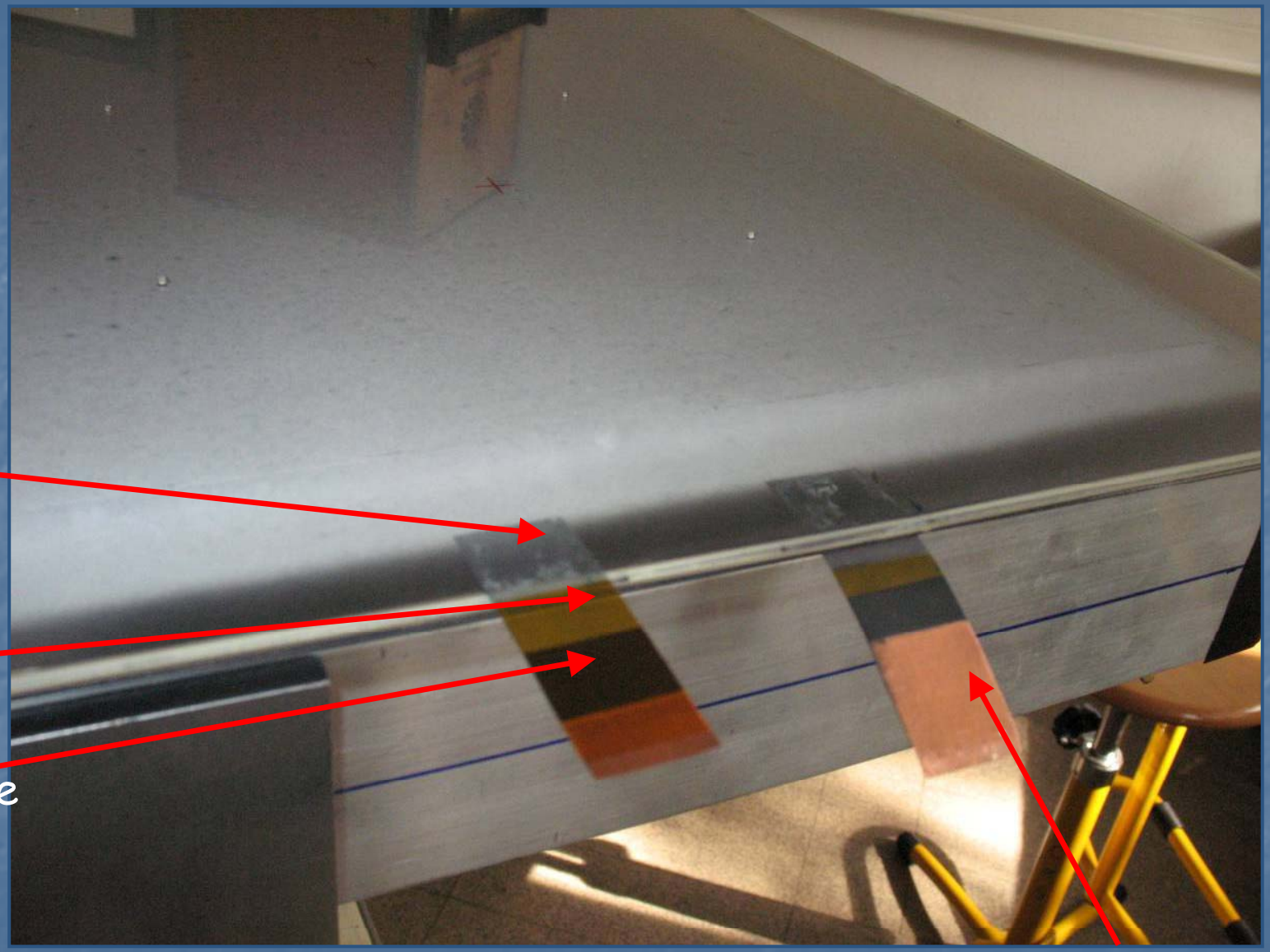




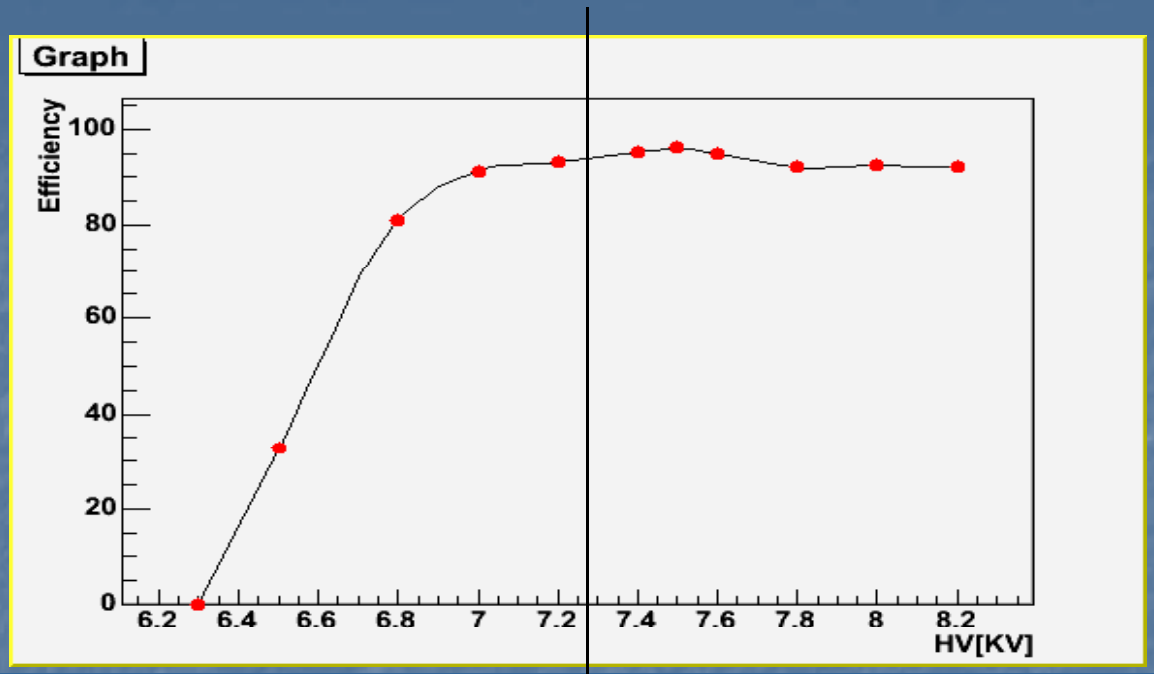
Gas circulation simulation for solution1


Gas distribution holes ∅= 300 microns
PEEK joint
PEEK capillary

HV connection

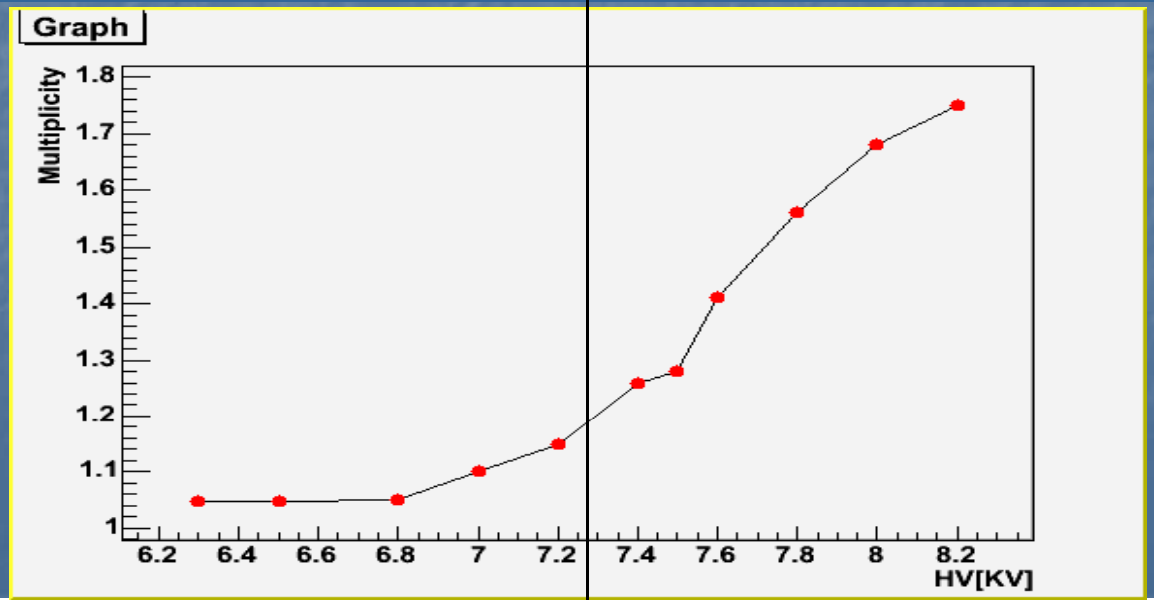


GRPC
32X8 pads
licron



TFE 93%
Isobutene 5%
SF6 2%

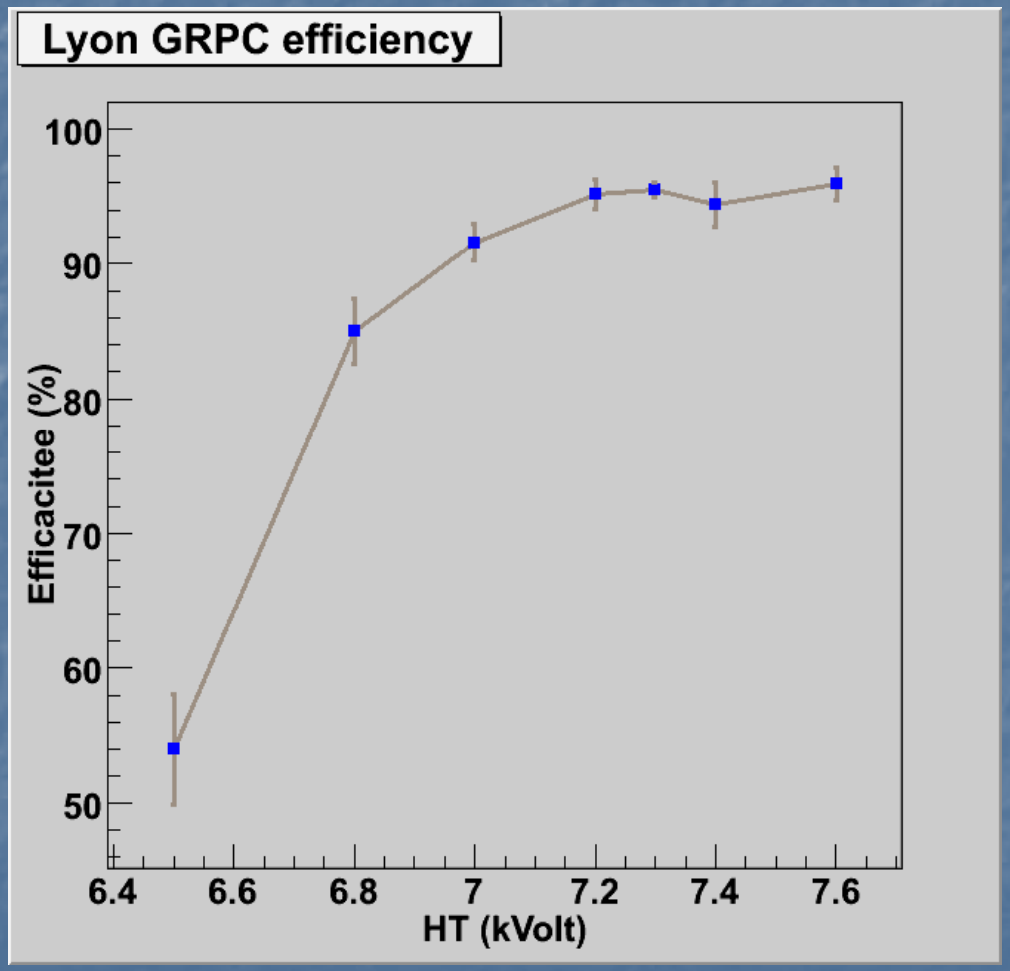
Threshold= 190 DAQ.U ≈ 100 fc



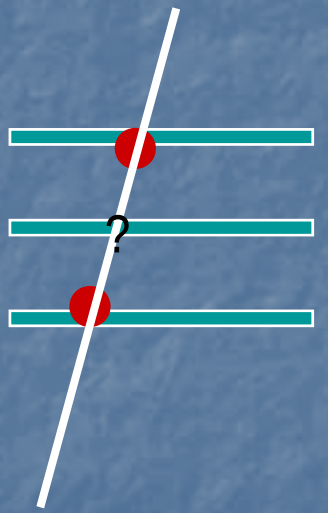
Noise 2-3 times lower

Efficiency obtained using tracks built with the other GRPCs

GRPC
32X8 pads
licron



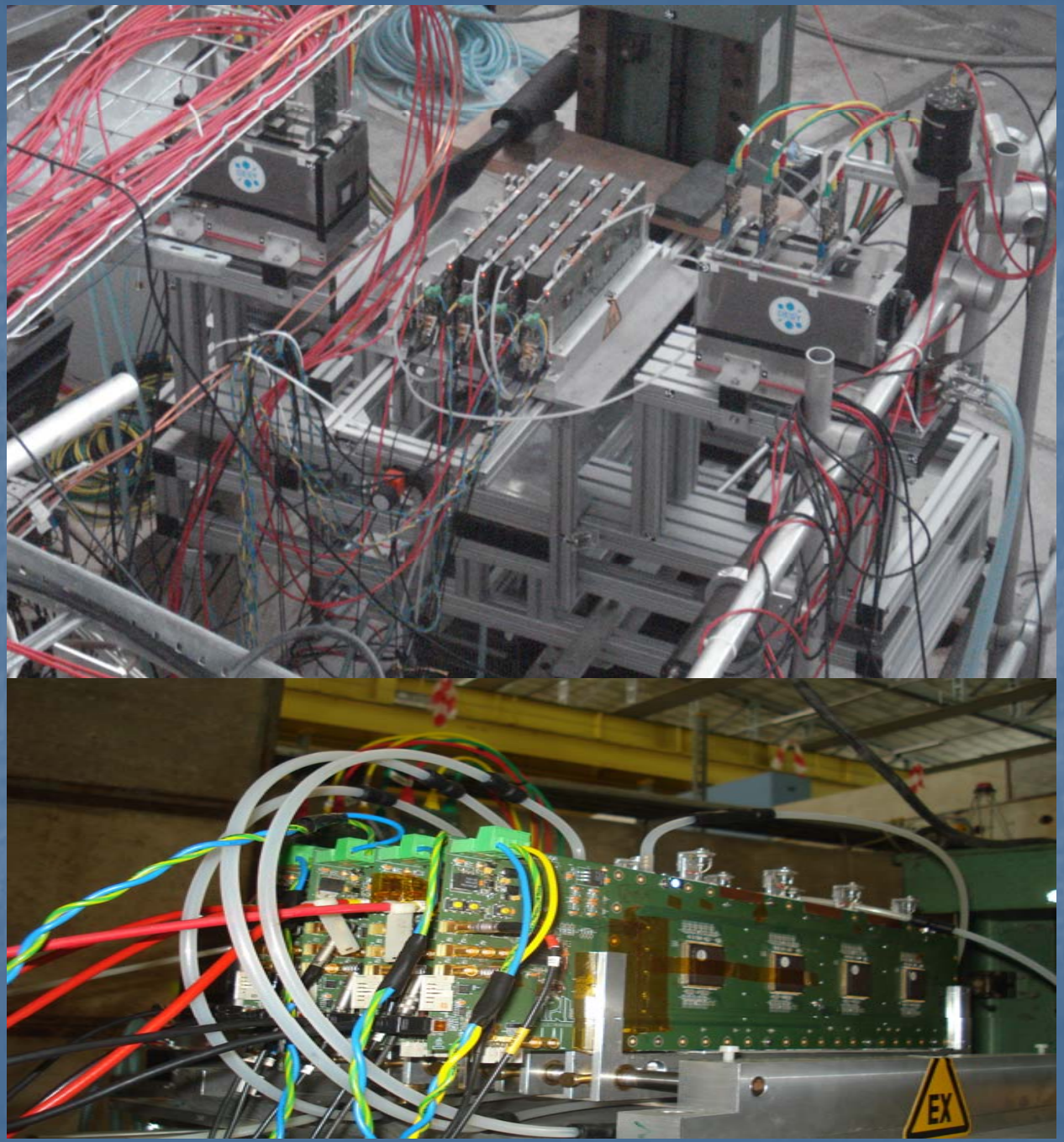
TFE	93%
Isobutene	5%
SF6	2%

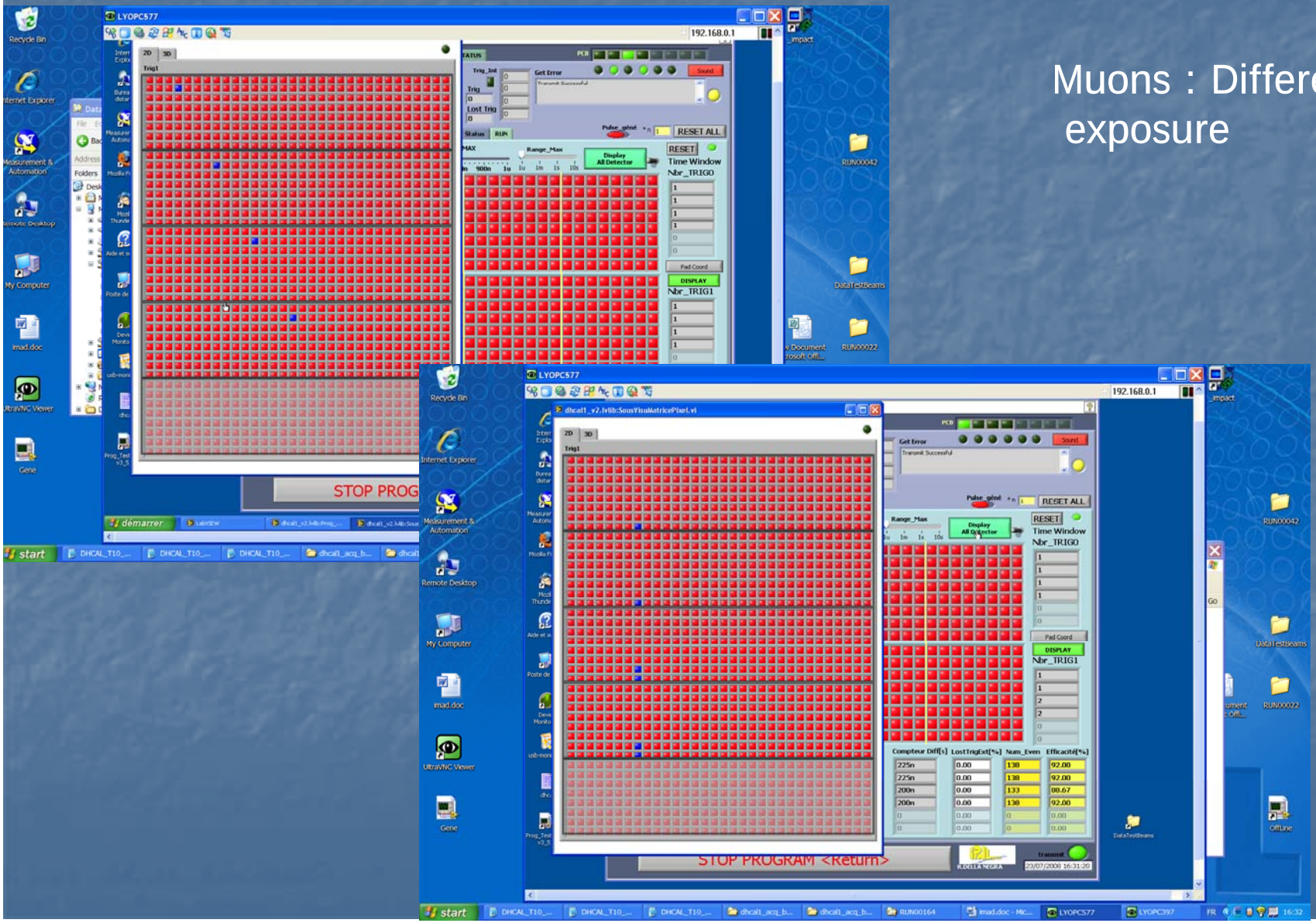


Threshold= 190 DAQ.U ≈ 100 fc

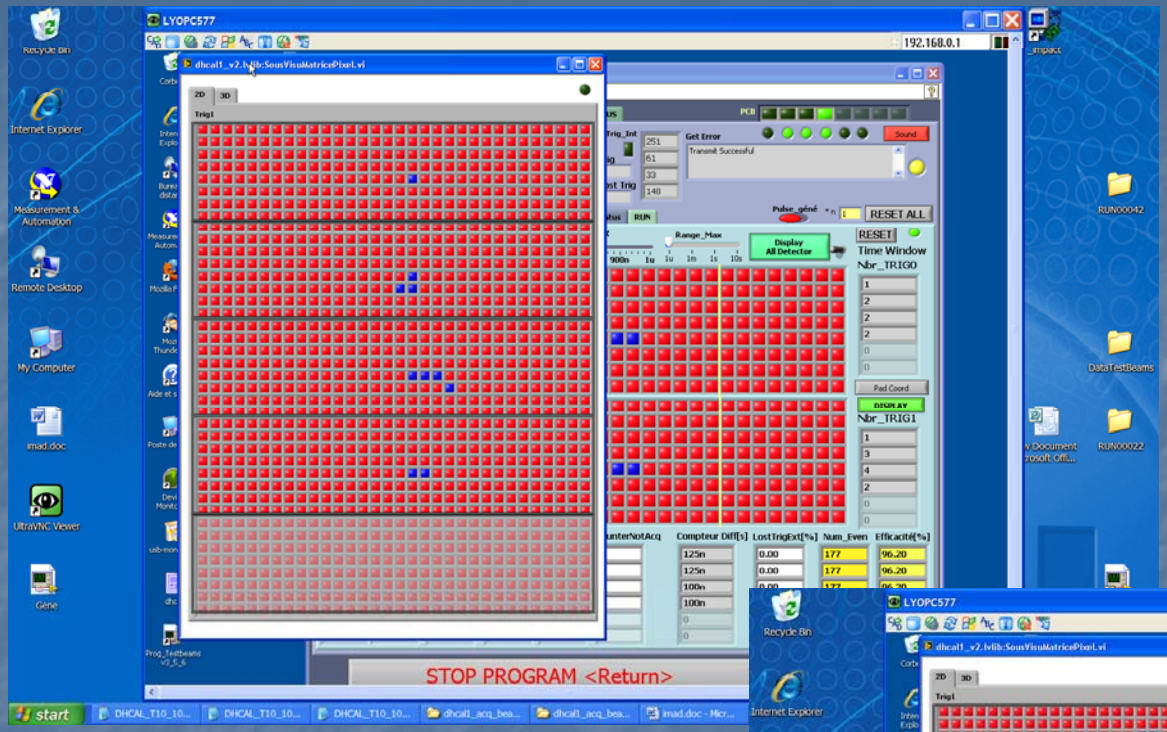
Mini DHCAL

- 4/5 GRPCs with/without steel slabs
- Common readout through a USB-hub
- Muons, pions, different energies, different angles
- Triggers: Eudet telescope setup/Scintillator-PM

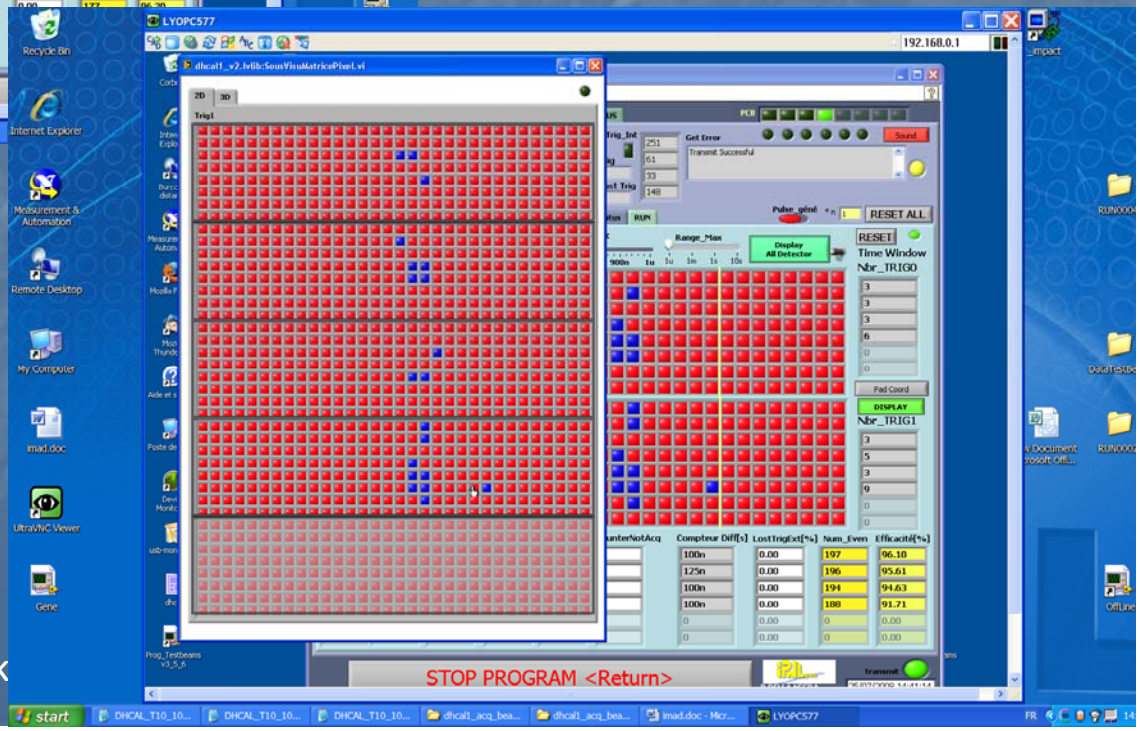

EX



Muons : Different angle exposure



Pion: no absorber in front of the first GRPC

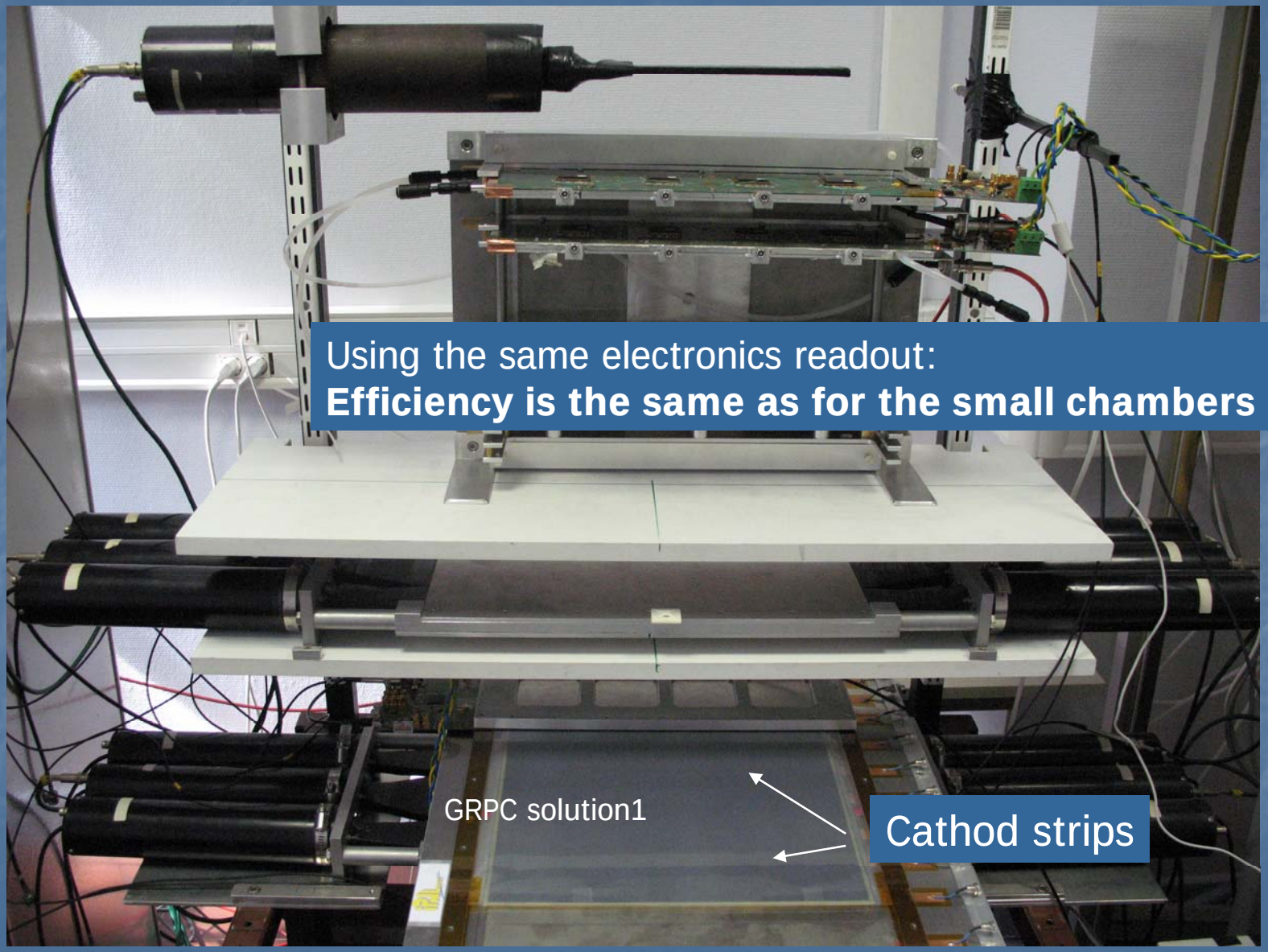


Pion: absorber in front of the first GRPC

I.Lak

Toward the 1M^2 prototype

50 X 32-pad prototype

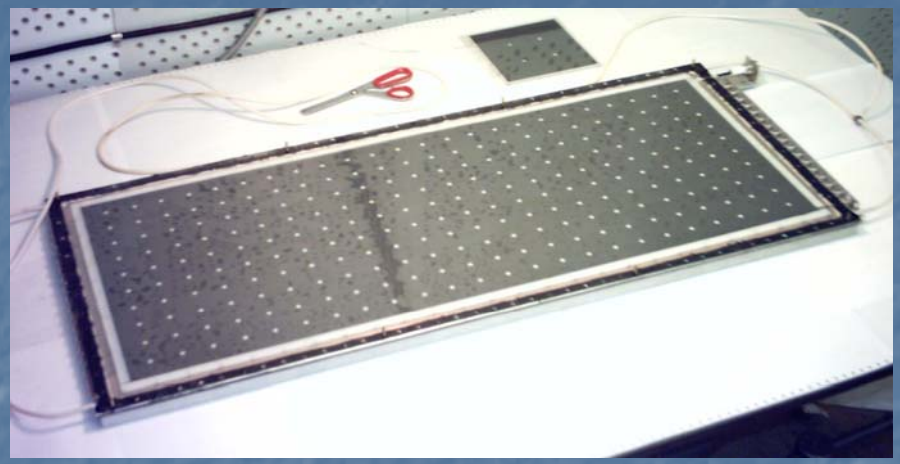


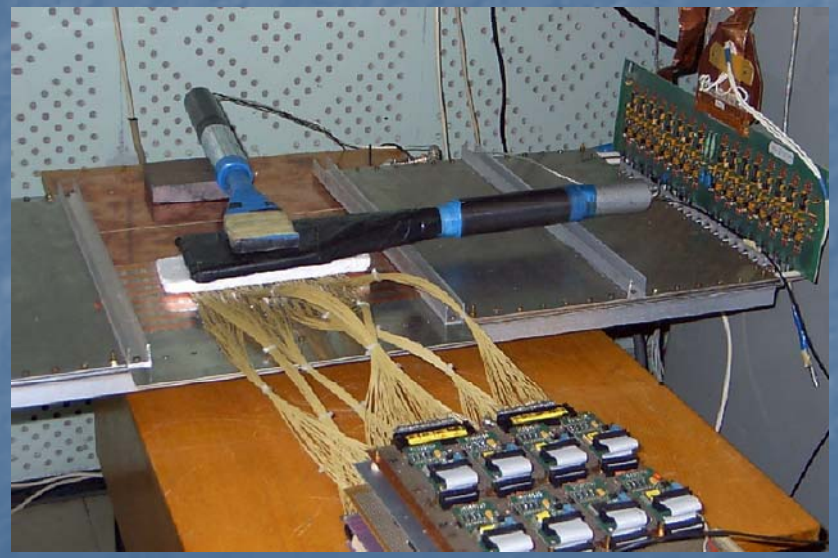
40x100-pad prototype

RPC with sensitive area of 36x96 cm2 was produced to incorporate 32x32 =1024 pads of 1 cm2 area.

For read-out the 2 anode PBs with 16x32=512 pads were used. Connections between pads and the 64 ch. FEE are made by microcoax 50 ohm cables.

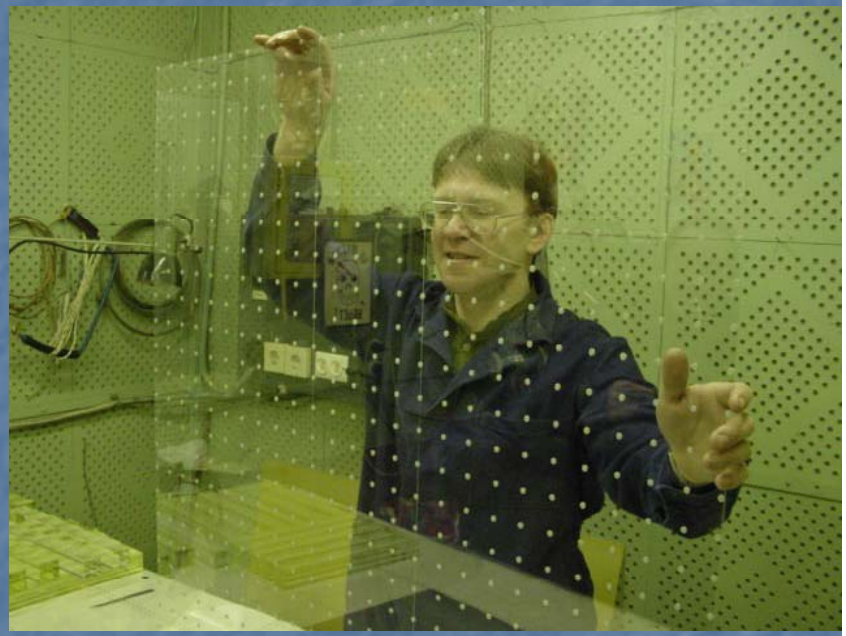
It was found that tightness between anode PB and RPC gas volume is needed.





1 m2 prototype with strips

16x and 16 y strips of 6 cm width



Detailed study of the plane was performed in cosmic rays.

In general :

- the plane is robust and hermetic;
- inefficiency of about 6% is compatible with the geometrical one due to spacers;
- uniformity of efficiency on the large scale is (94+/-2)%;
- current in HV circuit is 1 μA;
- noise at the plateau knee of about 0.45 Hz/cm2 is acceptable.

How to readout large surface GRPC?

- Building a large size GRPC: ok
- New generation electronics readout : ok
- Associated readout electronics to large size GRPC should be demonstrated.

How to read out large surface GRPC?

Solution:

- Conceive and realize large PCB
- Connect PCBs together to build large size anode
- Rigidify the anode using a part of the absorber
- Fix the detector on the anode
- Connect anode to DIF → Signal

Conception of Large PCB :

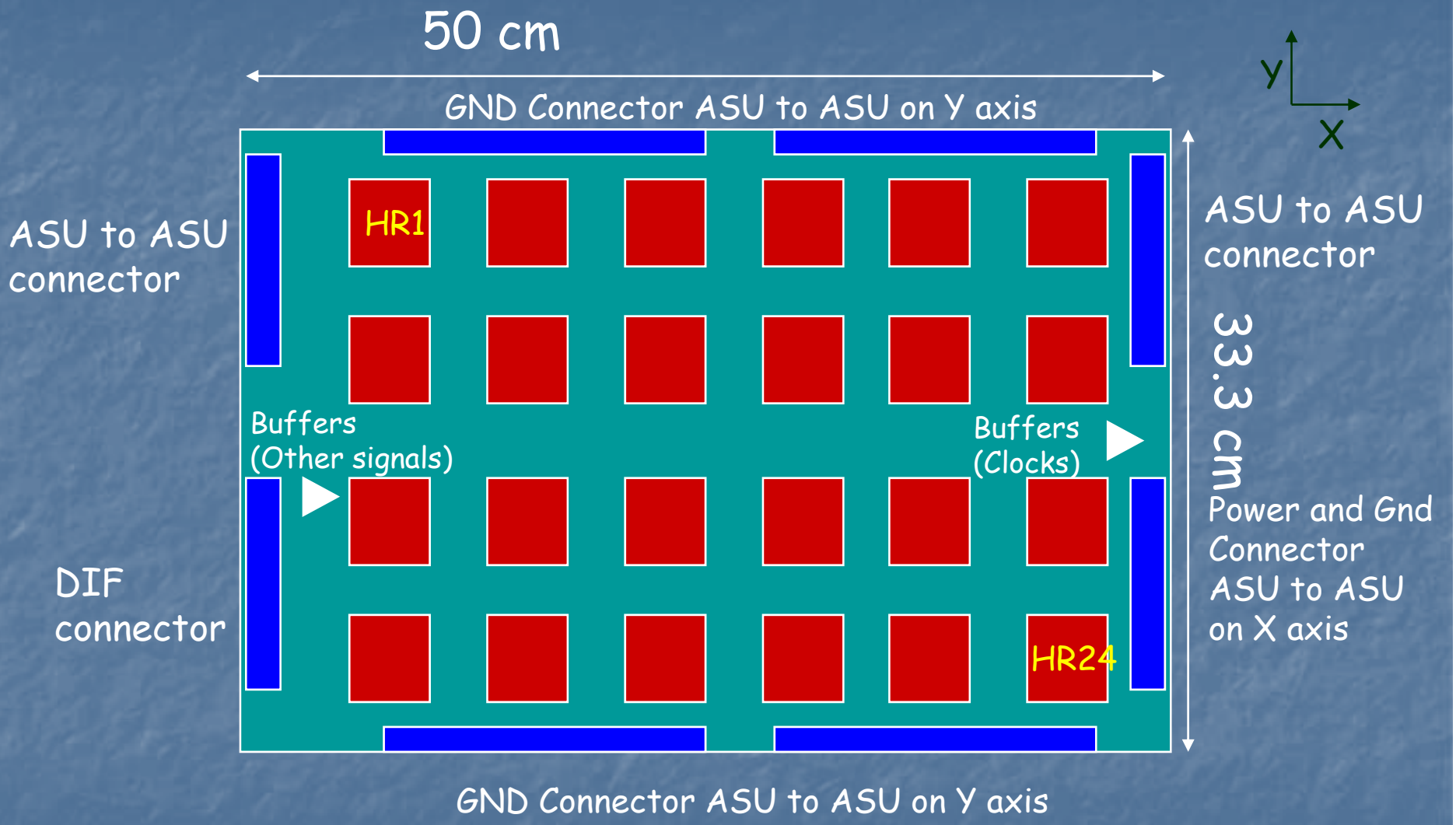
- An important point to determine the PCB size was the industry capacity to produce high class PCBs (buried vias...)
- The PCB design was based on

1- using the same layer structure as the one of the previous 4-chip board

2- optimizing the signal transmission between the different asics on the same PCB

3- taking into account the connection between two adjacent PCB and connection between the PCB and the DIF

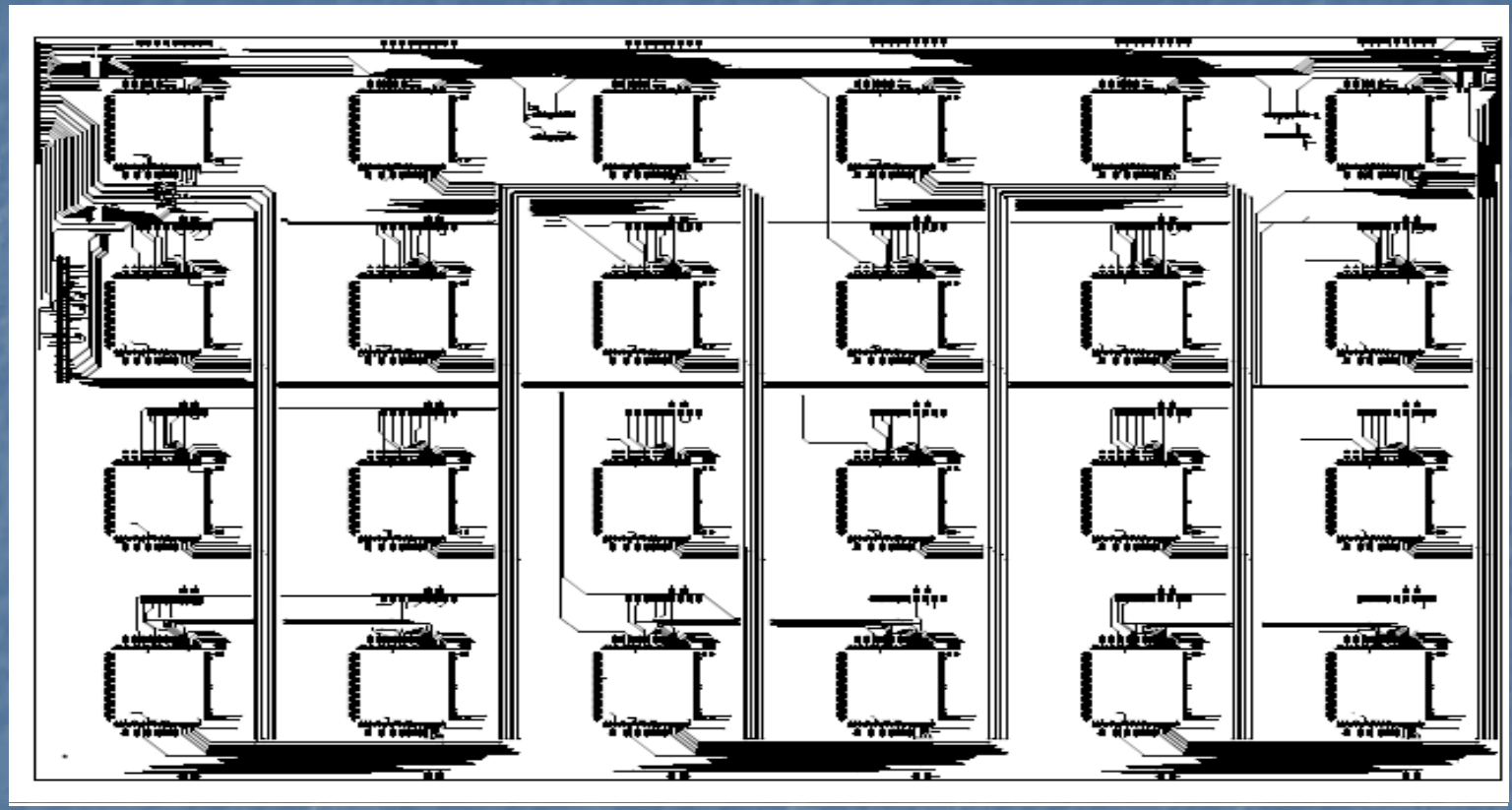
PCB DESIGN



1536 pads on Bottom Layer

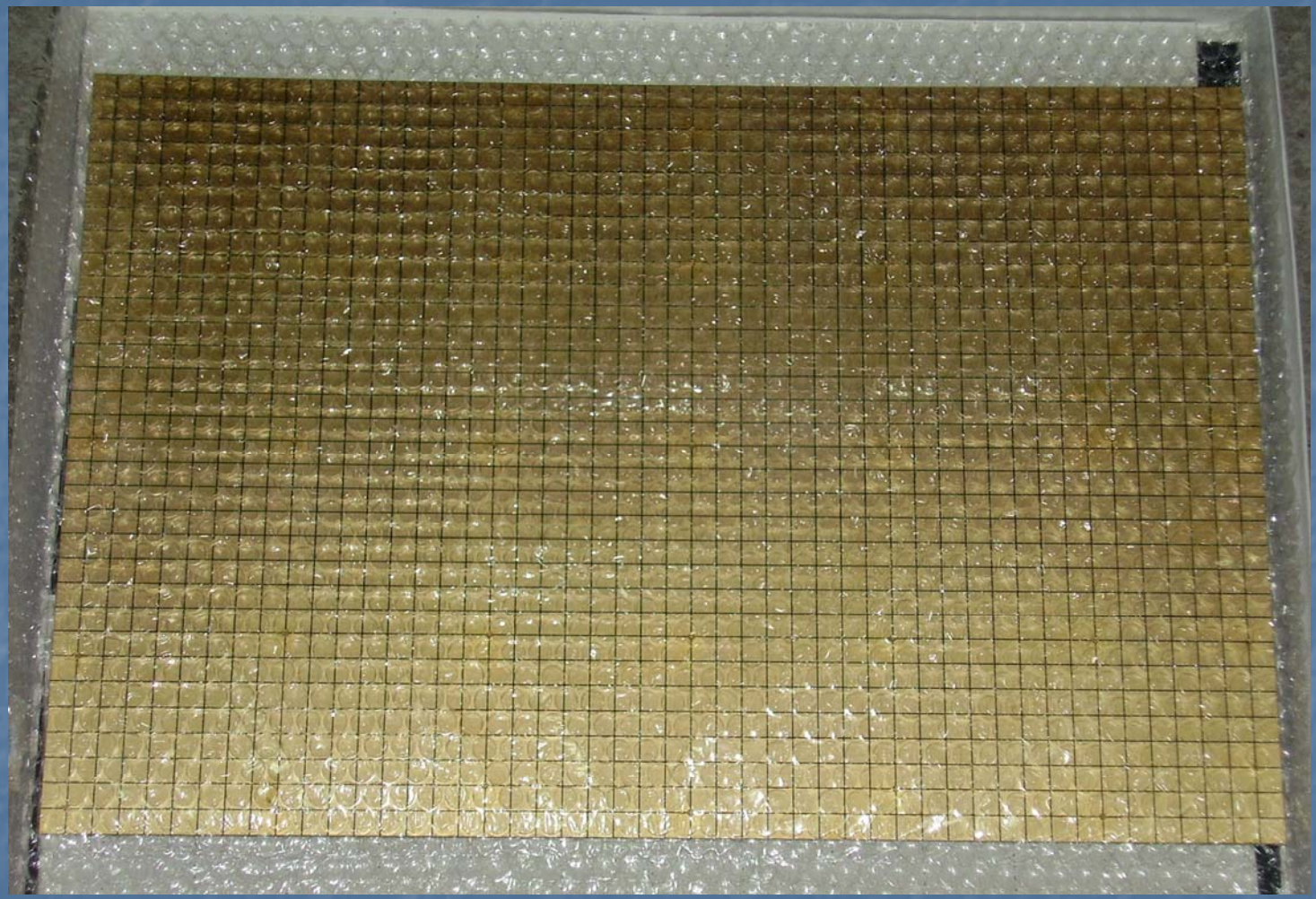
Buried and Blind Vias (Same as the last PCB with 4 HR)

24-asic PCB design

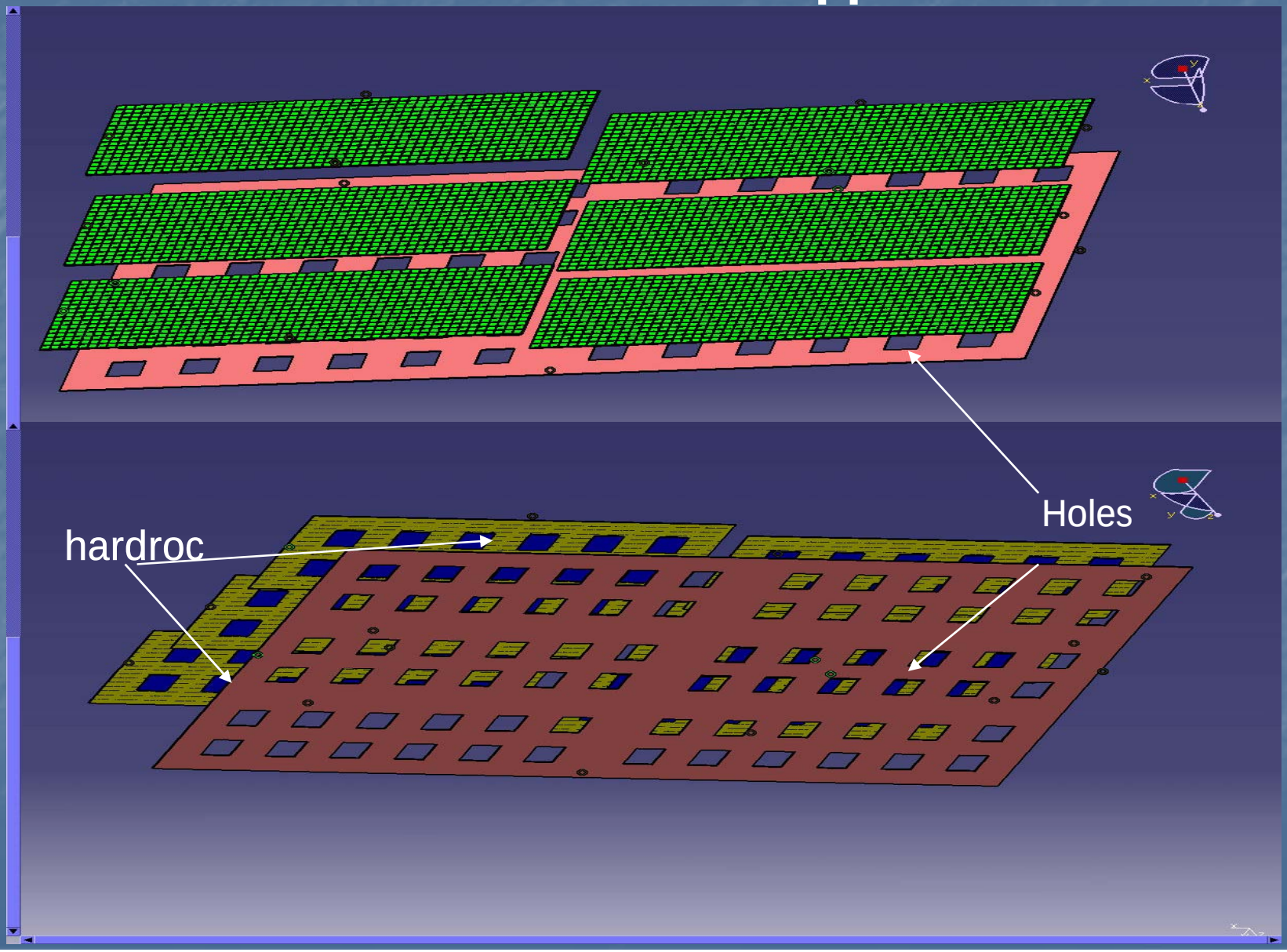


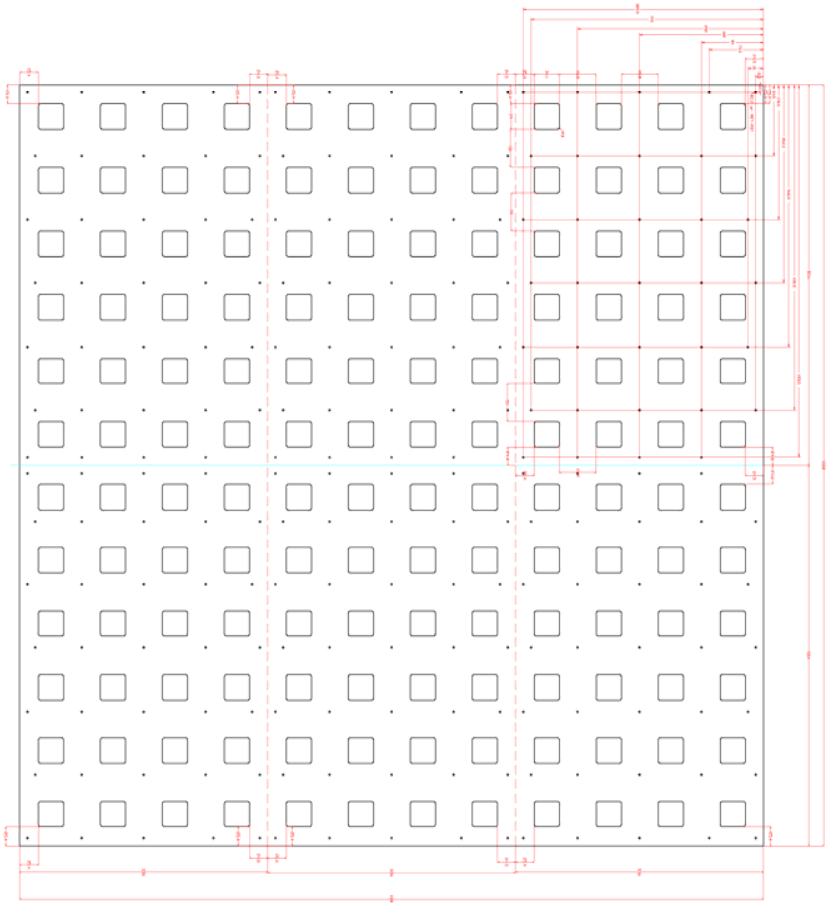
30 holes for M1 screws were distributed on the PCB for fixation on the absorber

6+2 PCBs were recently produced (end of August)

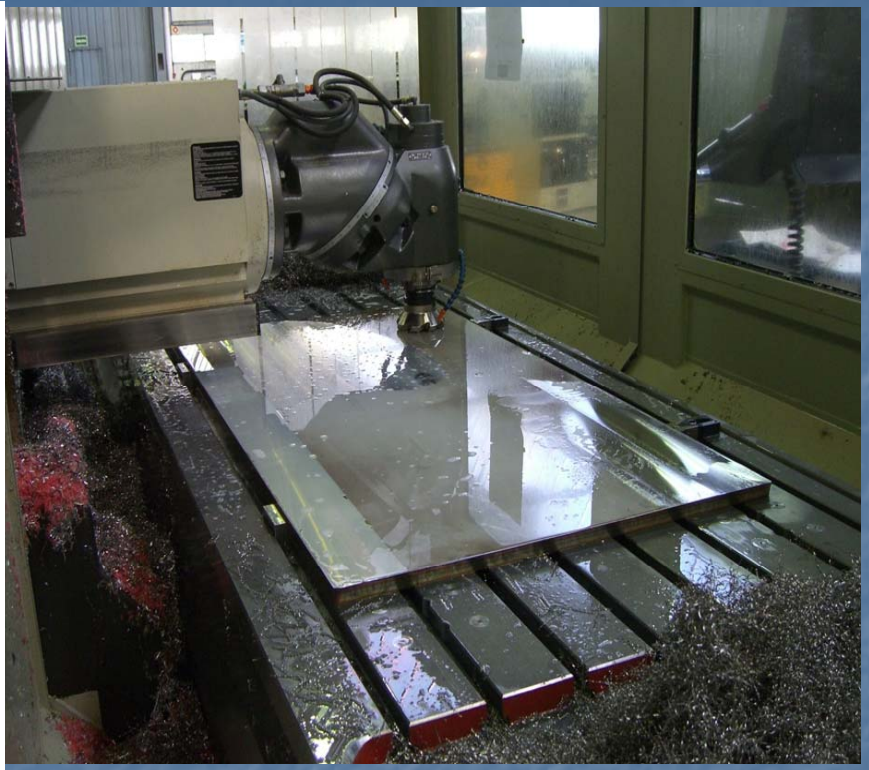


PCB connection :
Assemble 2 X 3 PCBs on 1M² Support





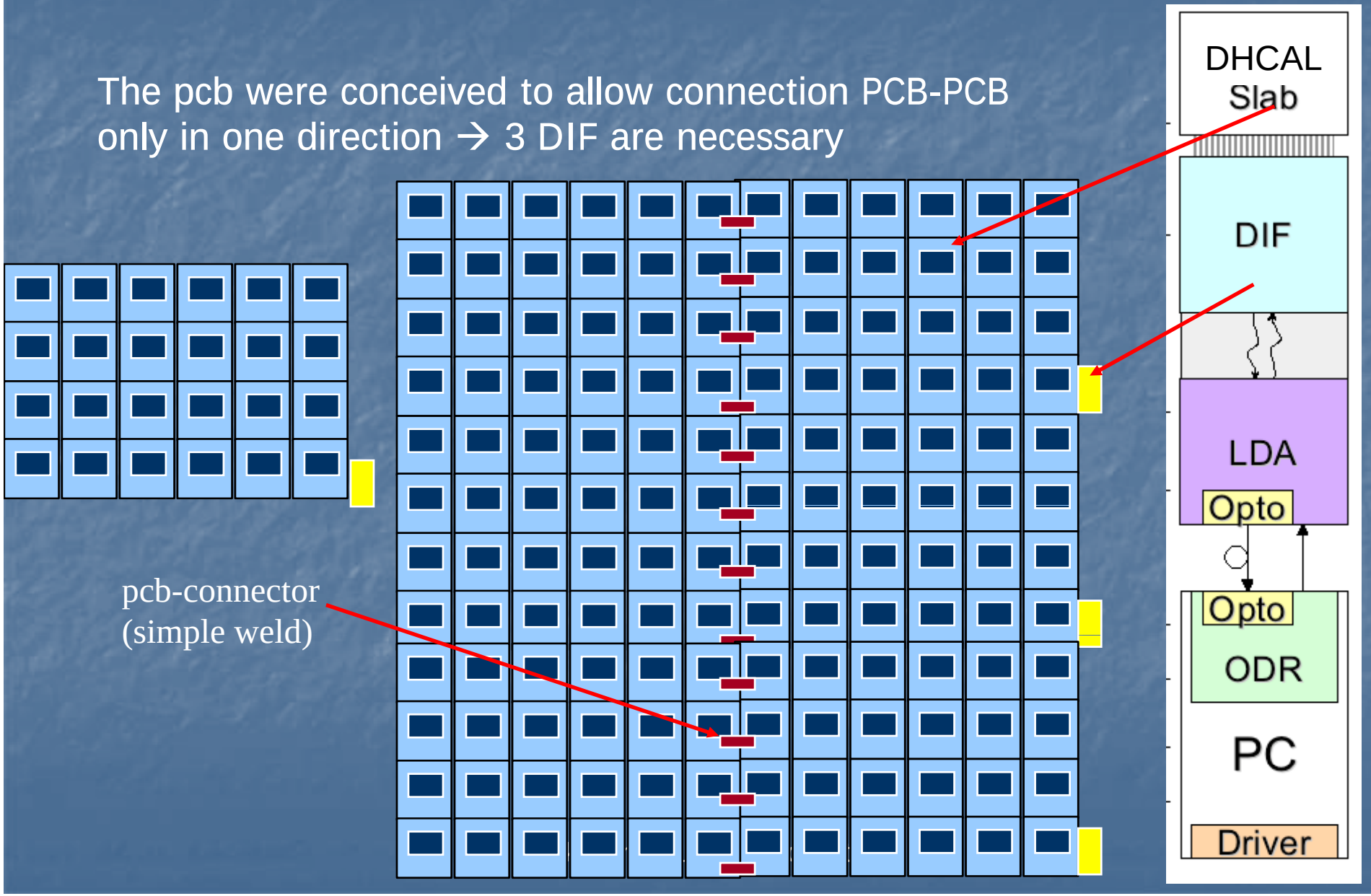
Support thickness = 2 mm



1M2 Support is designed and will be produced soon by ciemat

Connection to DIF

The pcb were conceived to allow connection PCB-PCB only in one direction → 3 DIF are necessary



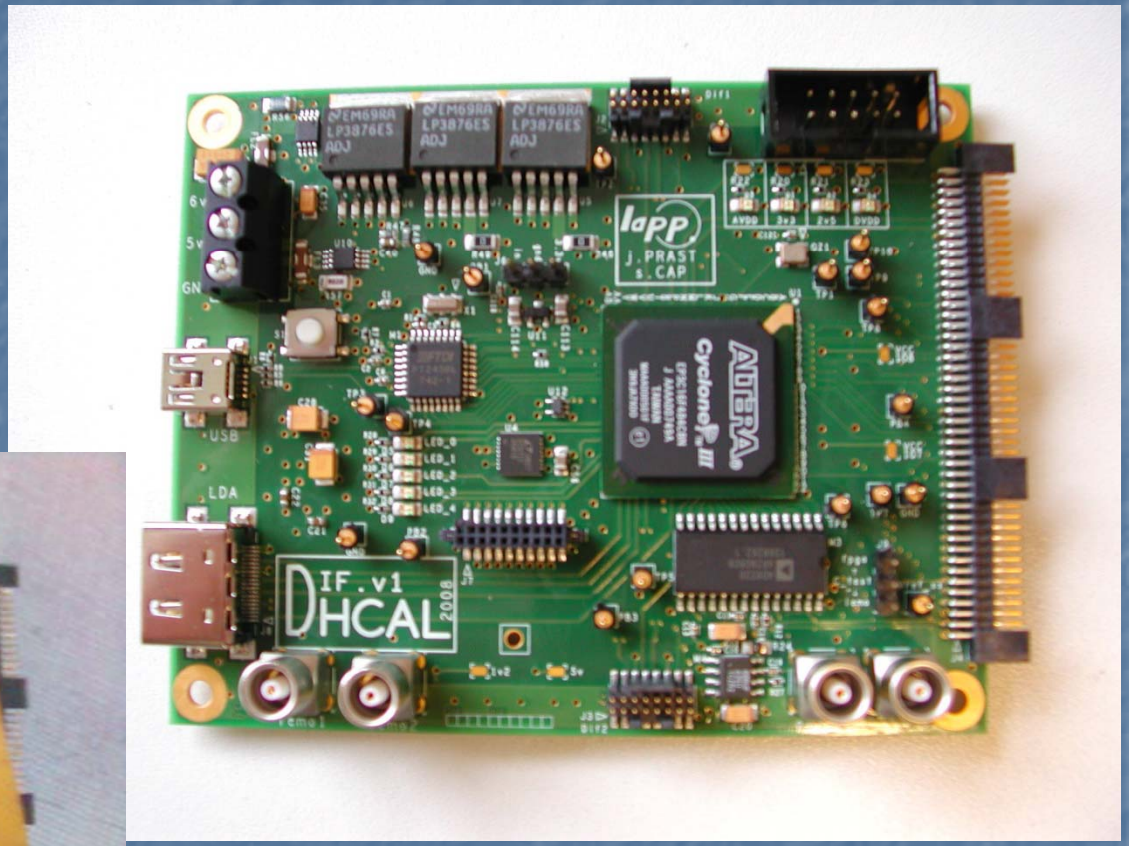
DIF
(LAPP)

10 DIF were produced

DIF :

8 cm *10 cm *1.6 mm

10 layers (6 for signals)



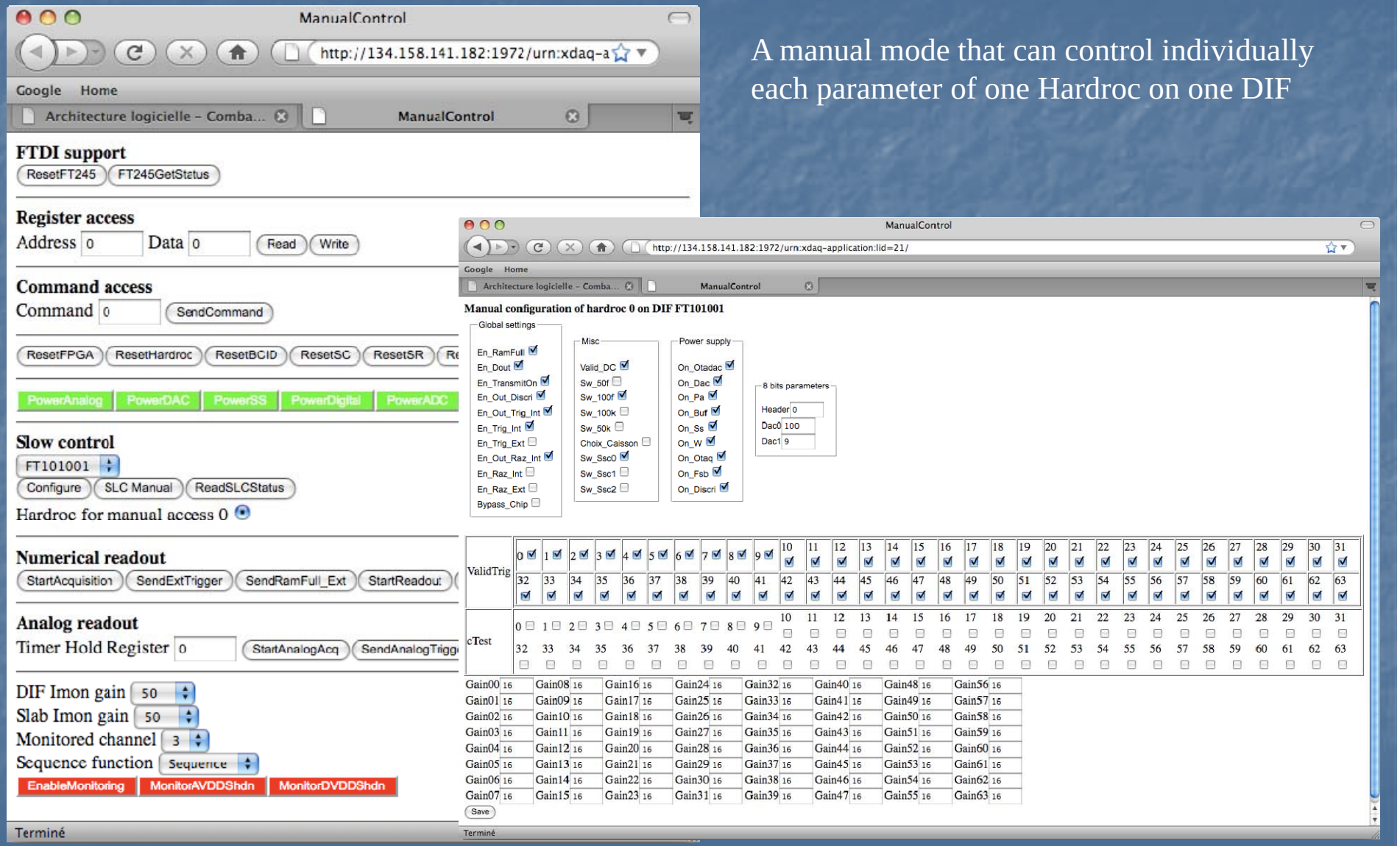
Firmware was developed and tested :
slow control+ digital readout

DIF

A specific software acquisition readout based on Xdaq/usb is developed in phase with the firmware development

- DIF low level access : OK
- Slow control : tested
- Digital acquisition : individual functions tested, integration in progress
- Event builder : in progress
- Analog Acquisition : in progress
- Monitoring : Developed , tests in progress with real DIFs

Some screenshots…



A manual mode that can control individually each parameter of one Hardroc on one DIF

PCB connection to detector

Temporary solution:

Use spacers to press electronics board against the detector inside a box. This allows to replace one detector with other avoiding the risk to harm the electronics board

Longtime solution : Glue? Solution should be the ILC one

We are open to suggestions and collaboration

Summary for the 1M^2 project

Hardroc1 chips are produced and currently under test

PCB are produced

Cabling will be performed by the end of September

DIF are produced and under test

Software is being developed

Detectors: Three kinds of 1M^2 GRPC detectors will be produced
IHEP,IPNL,INFN-Bologna

Connection between electronics board and detector is investigated

Beam test in November at CERN if things go as expected

Toward the 1M^3 prototype

- Electronics :
  Hardroc2 was designed and submitted
  return expected for October
- Detector :
  The November beam test will allow us to
  choose the better GRPC detector
- Absorbers : Some tests were done in CIEMAT workshop
  Production of high surface quality Steel
  absorbers is possible and will be scheduled

1.- Ciemat mechanical workshop.

Milling Machines:

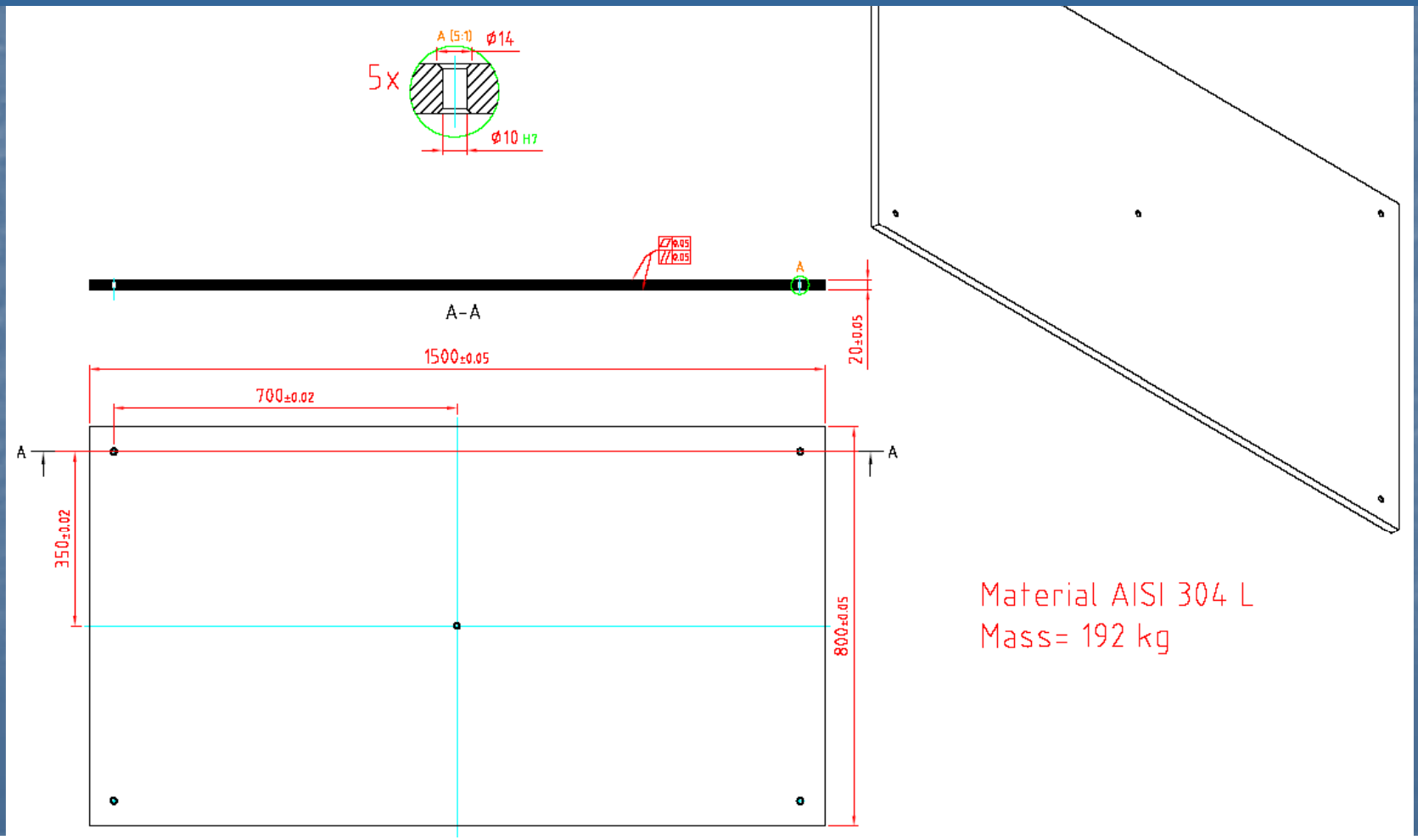
- 1 CNC machine of aprox 4x1 m2 working table. Accuracy of aprox 0.03 mm/m, with temperature compensation.

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

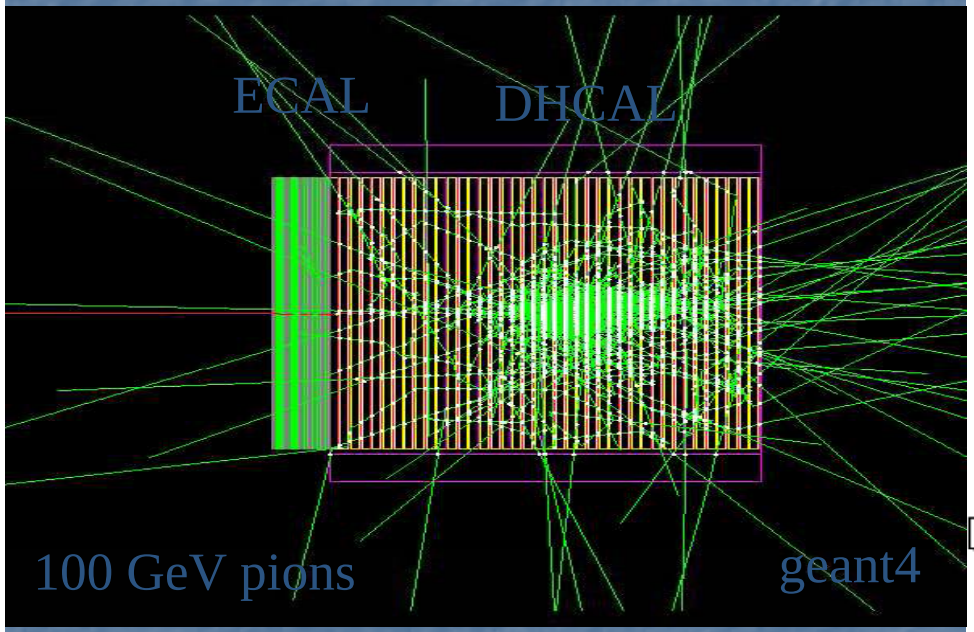
2.-Test on a plate of 1510x810x25 mm3

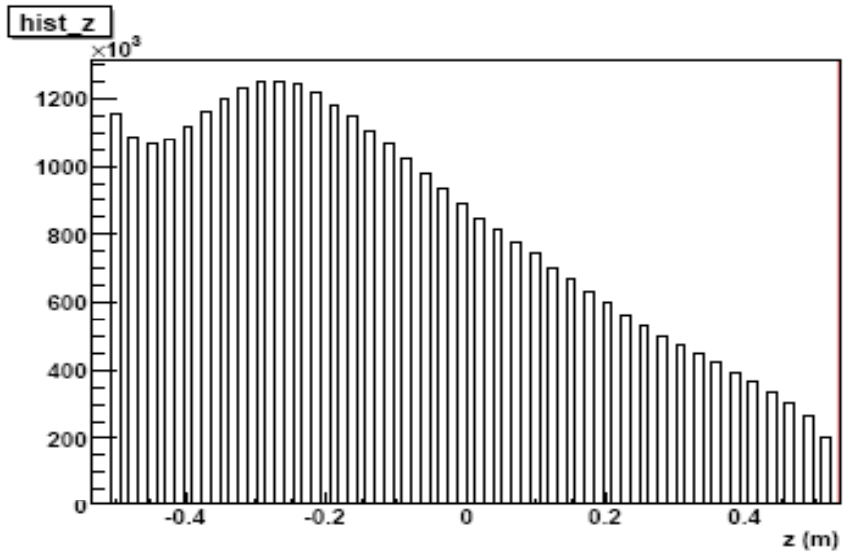
To study the capacity and posibilities of the Ciemat workshop to produce the prototype:

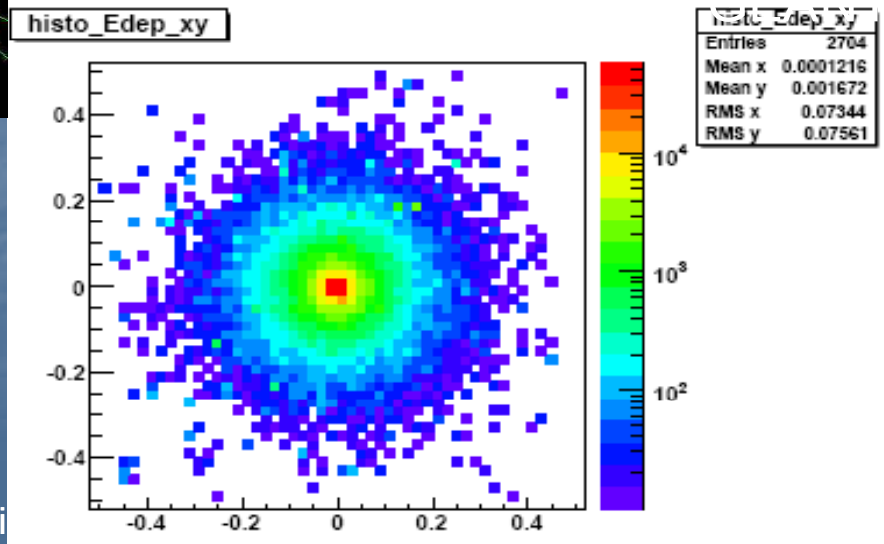
- To verify the planarity of the plate we was used a comparator on the CNC machine. And to verify the CNC machine we will use interferometer measurements (not yet finished). The final planarity of the plate will be measure by the interferometer, if this is considered necessary.
- We was machining a plate of AISI 304 L, to obtain the following plate:



Which dimensions for the prototype?







Longitudinal and transverse develop. of hadronic showers associated to 100 GeV pion in DHCAL(4,5 λ) behind ECAL (24 X_0)

Preliminary :
95% of the showers are included in 70×70 cm²

Toward the 1M^3 prototype

Although 70X70 X 100 cm^3 prototype is ok for hadronic shower studies with GRPCs, we think to go to 100X100 X 100 cm3 one if the additional cost is not too high.

In any case this will be subject to results obtained with the 1M^2 detectors (GRPC/MICROMEGAS)

Conclusion

- A mini DHCAL/GRPC was built and successfully operated using the new generation of readout electronics
- New design GRPC detectors were tested and interesting results obtained
- The GRPC 1M^2 is almost completed and beam test is expected before the end of 2008.
- The EuDHCAL is enriched by new comers (Bologna-Italy)
- Important work was done for DHCAL/GRPC for ILD (M.Anduze) but more work is expected soon...

Multigap GRPC

Advantages :

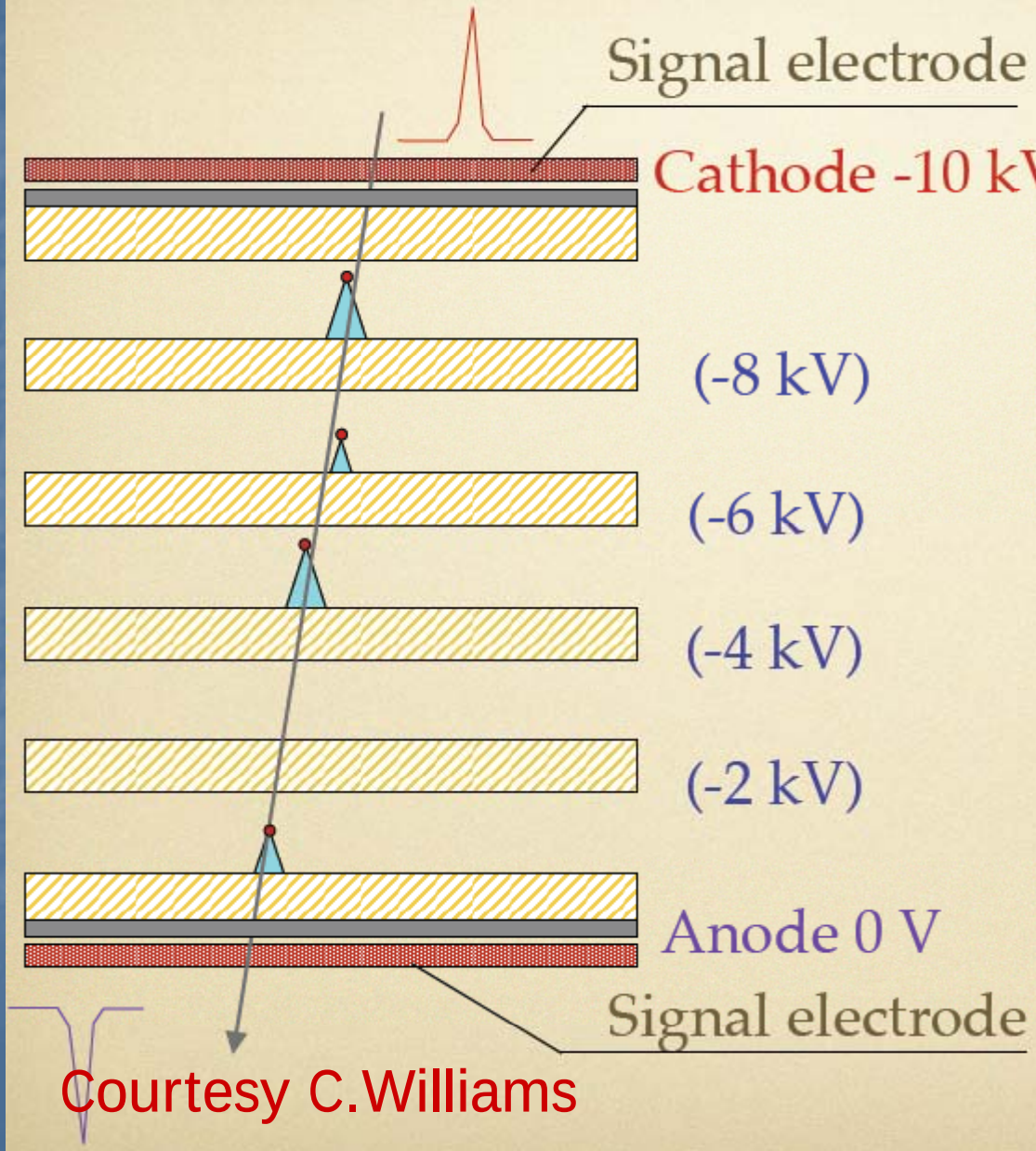
- 1 mip spectrum is les spread

(very good for semi-digital readout)

- Higher efficiency

We would like to test it....

MULTIGAP RESISTIVE PLATE CHAMBER



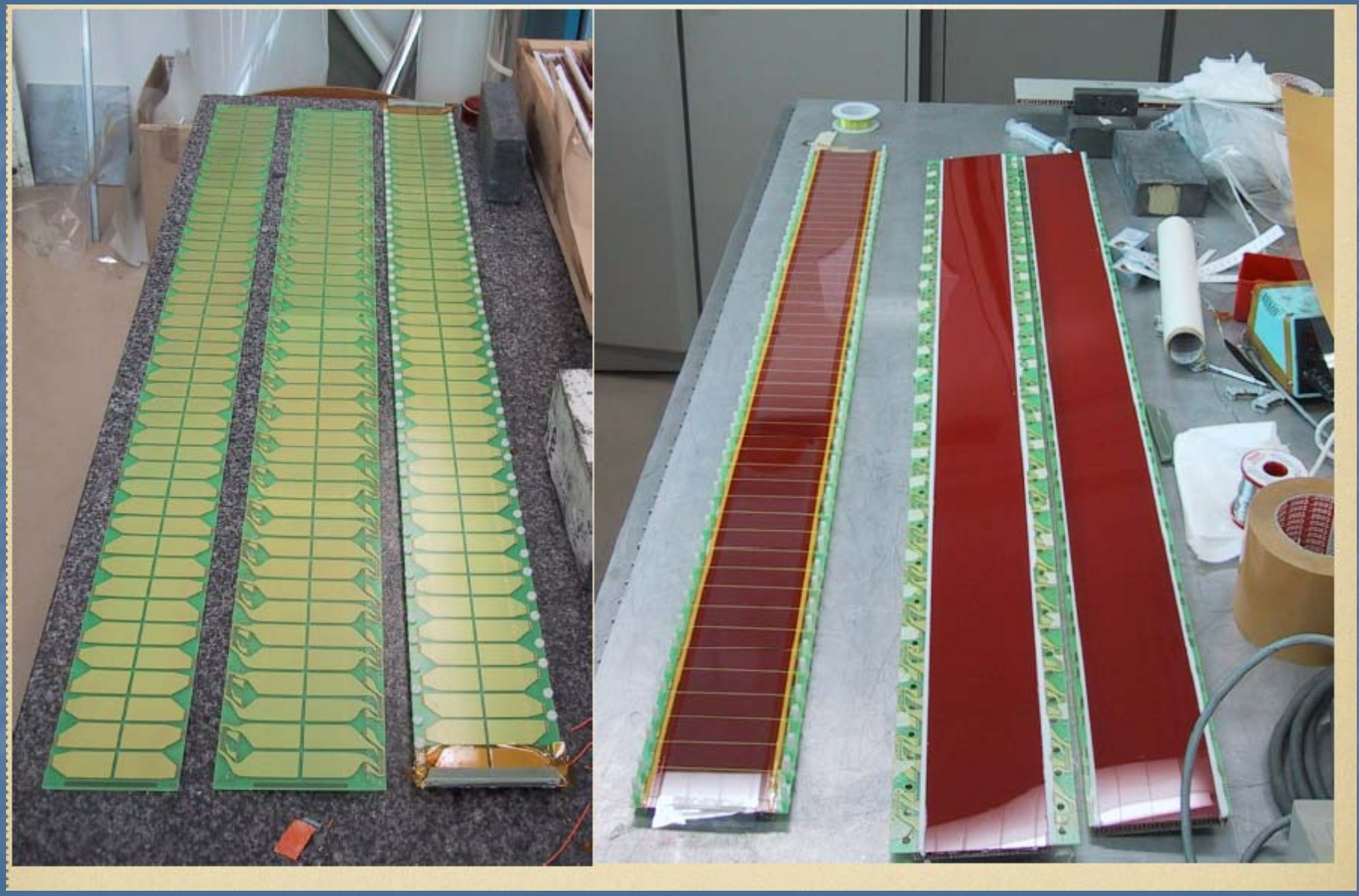
Courtesy C.Williams

Stack of equally-spaced resistive plates with voltage applied to external surfaces (all internal plates electrically floating)

Pickup electrodes on external surfaces (resistive plates transparent to fast signal)

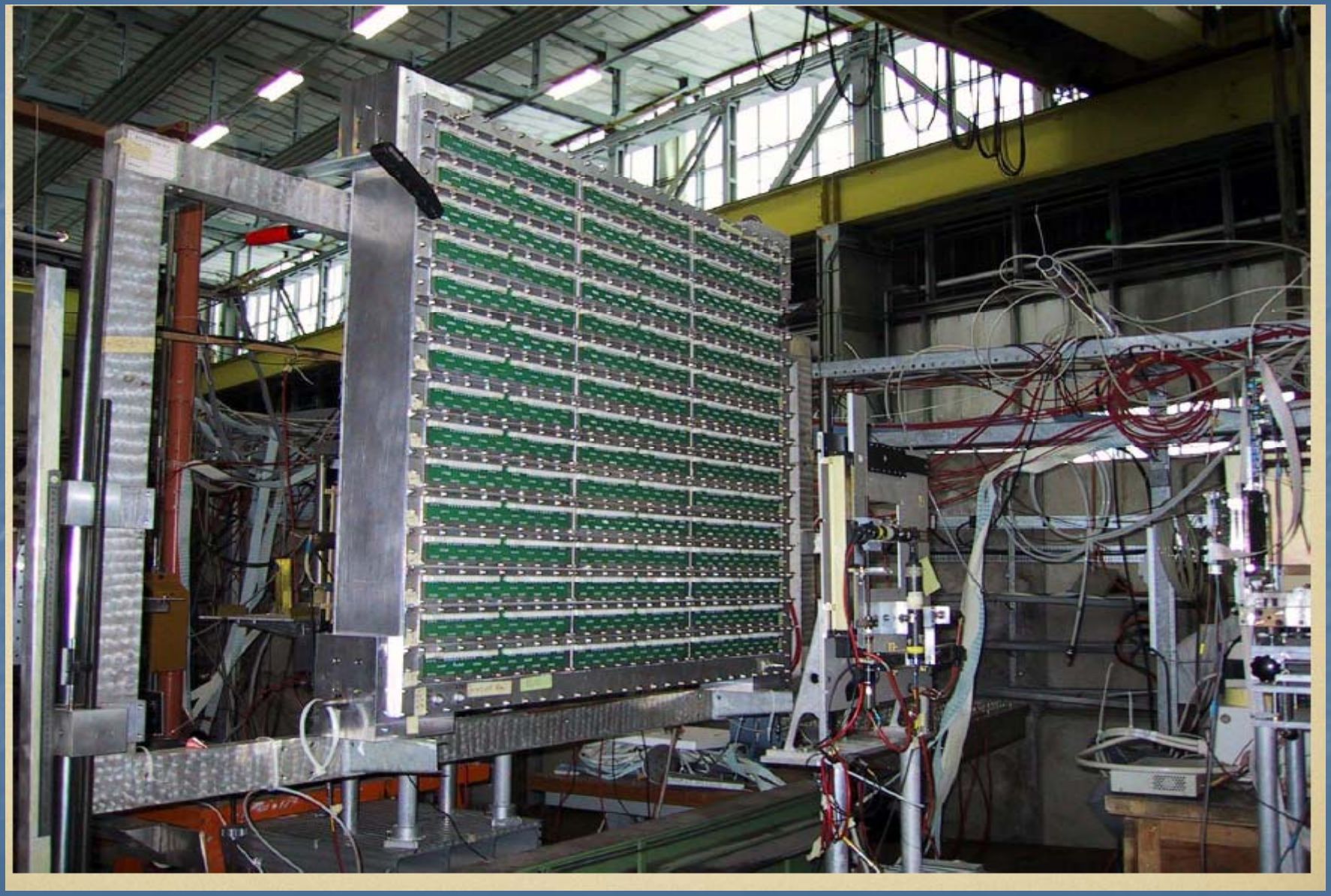
Internal plates take correct voltage - initially due to electrostatics but kept at correct voltage by flow of electrons and positive ions - feedback principle that dictates equal gain in all gas gaps

Alice TOF



Courtesy C.Williams

Alice TOF



Courtesy C.Williams