SDHCAL Technological prototype Where we are?

Imad Laktineh

CIEMAT, Gent, IPNL, LAL, LAPP, LLN, LLR, LPC, Protvino,Tsinghua,Tunis

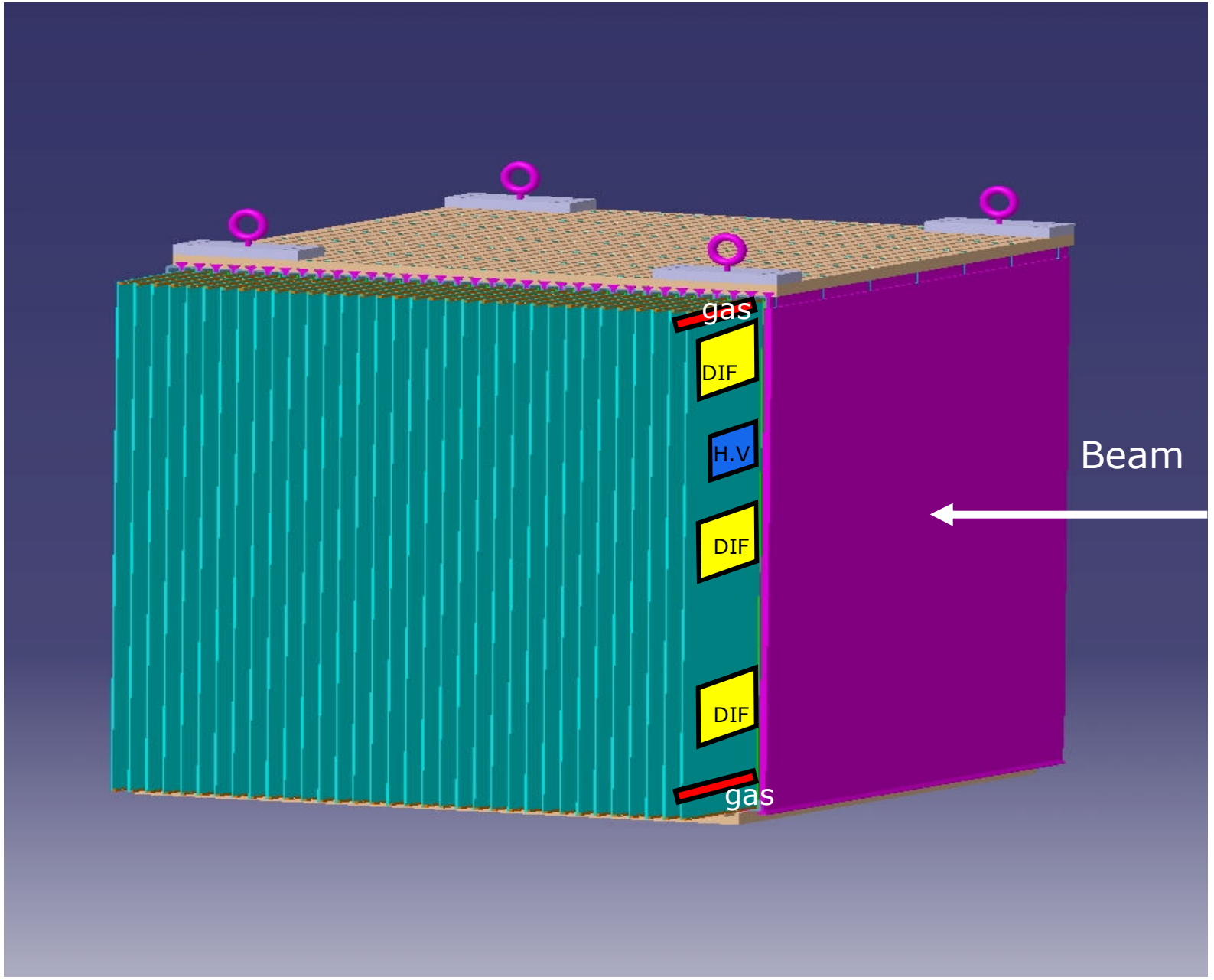
In memoriam

Vladimir Ammosov

10. Feb. 1945 - 11. Jan. 2010

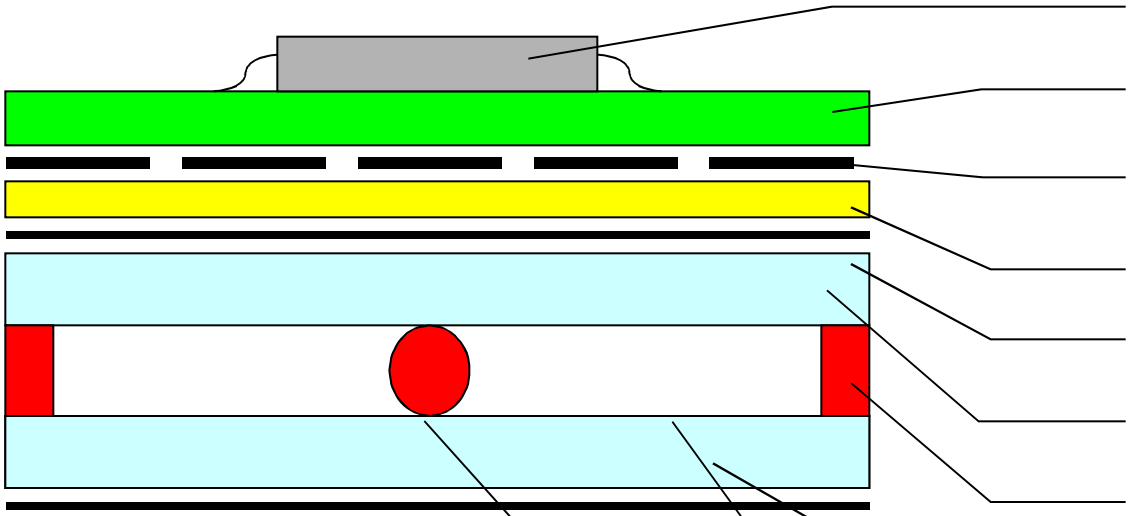
Ingredients of a technological prototype

- Detector
- Electronics
- Mechanical structure
- Services
- Simulation
- Conclusion


gas
DIF
H.V
DIF
DIF
gas
Beam

Detector

Thickness : 3.225 mm



ASIC
PCB
Pads (copper, **1 cm2**)
Insulation (Mylar)
Anode coating
Glass plate (**0.7mm**)
Chamber wall (1.2mm)
Glass plate (1.1mm)
Cathode coating
Gas
Spacer

Almost no dead zone : replace fishing lines by Ceramics tiny ball

Detector

Homogeneity :

within the same detector but also from one detector to another

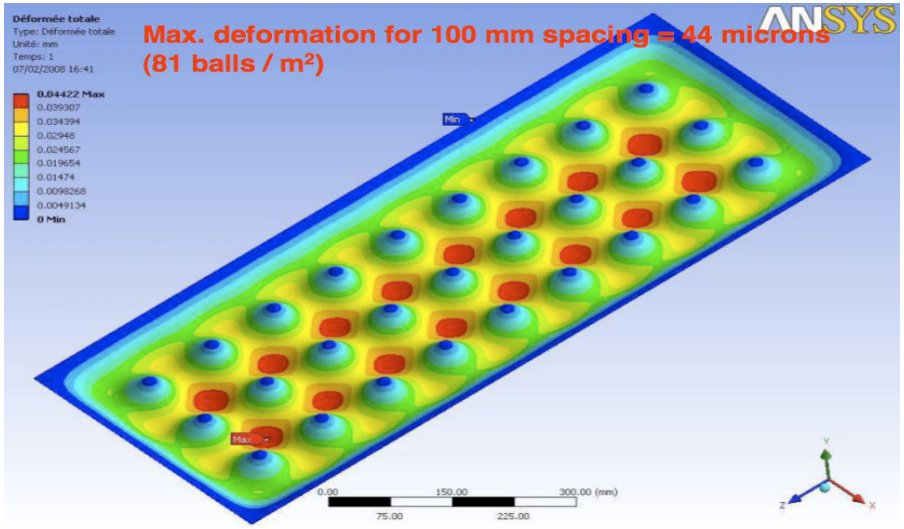
→Glass : ok

→Mylar : ok

→Painting : This is an issue but using the silk screen painting technique this is ok

→Distance between the two plates : This is vey Important (E=ΔV/d)

almost ok



Resistive coating

The problem is to have homogenous paining for large surface:

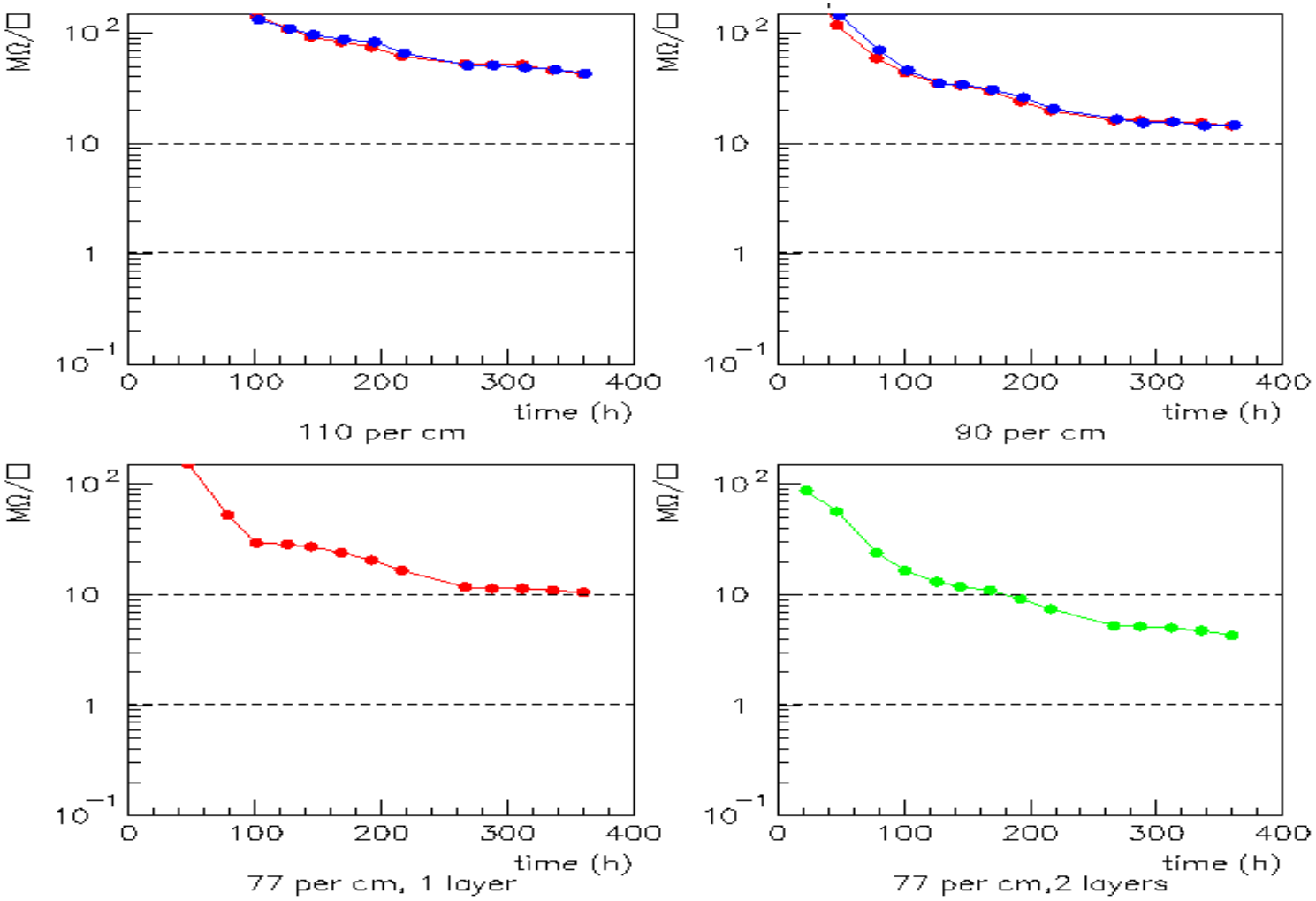
Graphite: (400 K Ω/□) Standard but rather high multiplicity (1.6 pads/mip at 7.4 kV), no HV connection problem
Licron : (> 20 M Ω/□) : Spray, good multiplicity, HV long-term connection problems (HV lost after few months)

Statguard : (few M Ω/ □) : Liquid painting, stable, no HV connection problem observed so far but homogeneity is not good when painted with a roll → Silk Screen Printing

Silk Screen Printing :

The technique is well known, it provides homogenous and well controlled coating. Used in OPERA GRPCs.
Simple tools are needed (reduced cost)

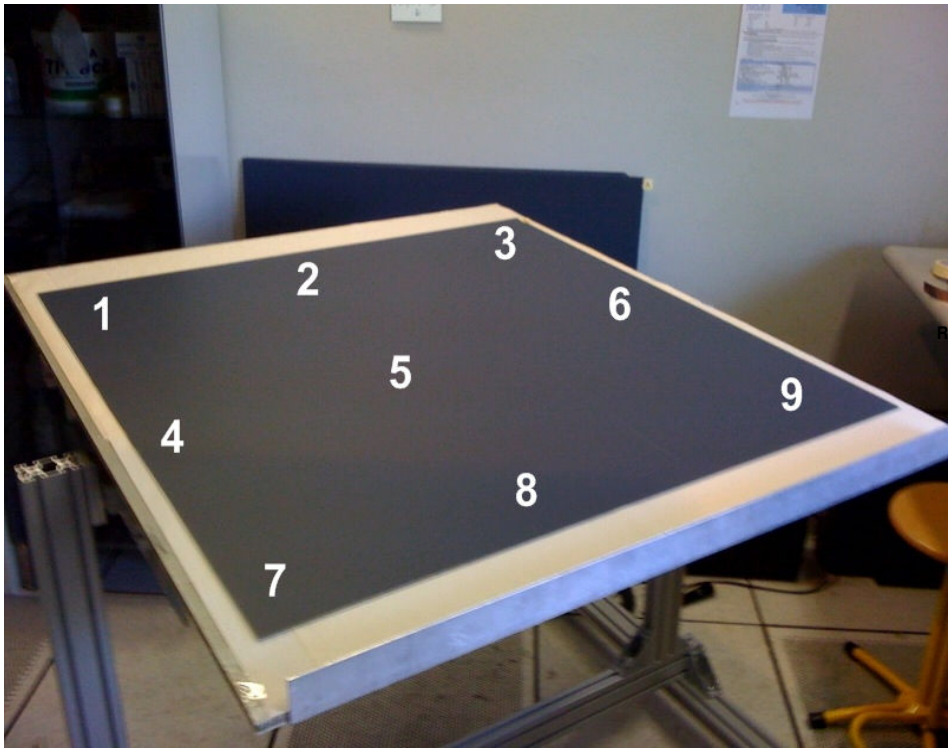
Resistivity control using SSP technique

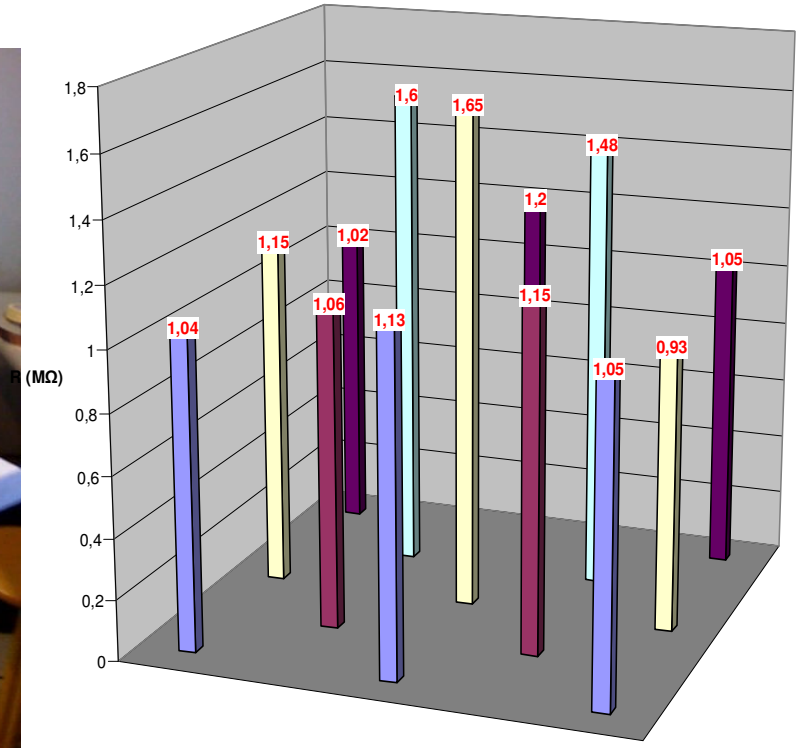


Silk Screen Printing :

Statguard is not really adapted to Silk Screen Printing. It dries quickly

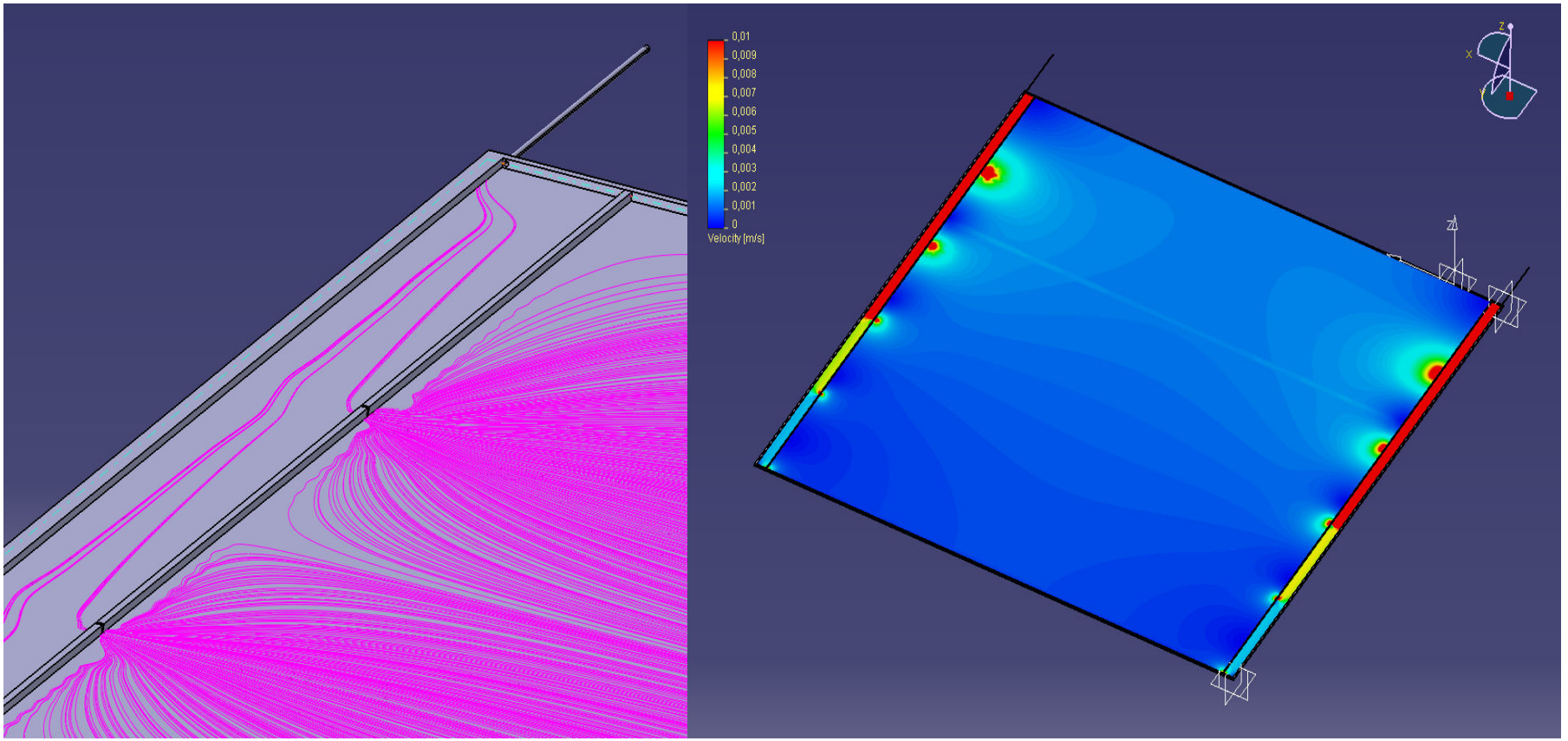
Colloidal graphite (~1 M Ω/ □) is well suited for Silk Screen Printing but drying at high temperature (180°) is needed





Ratio MAX/MIN = 1.77

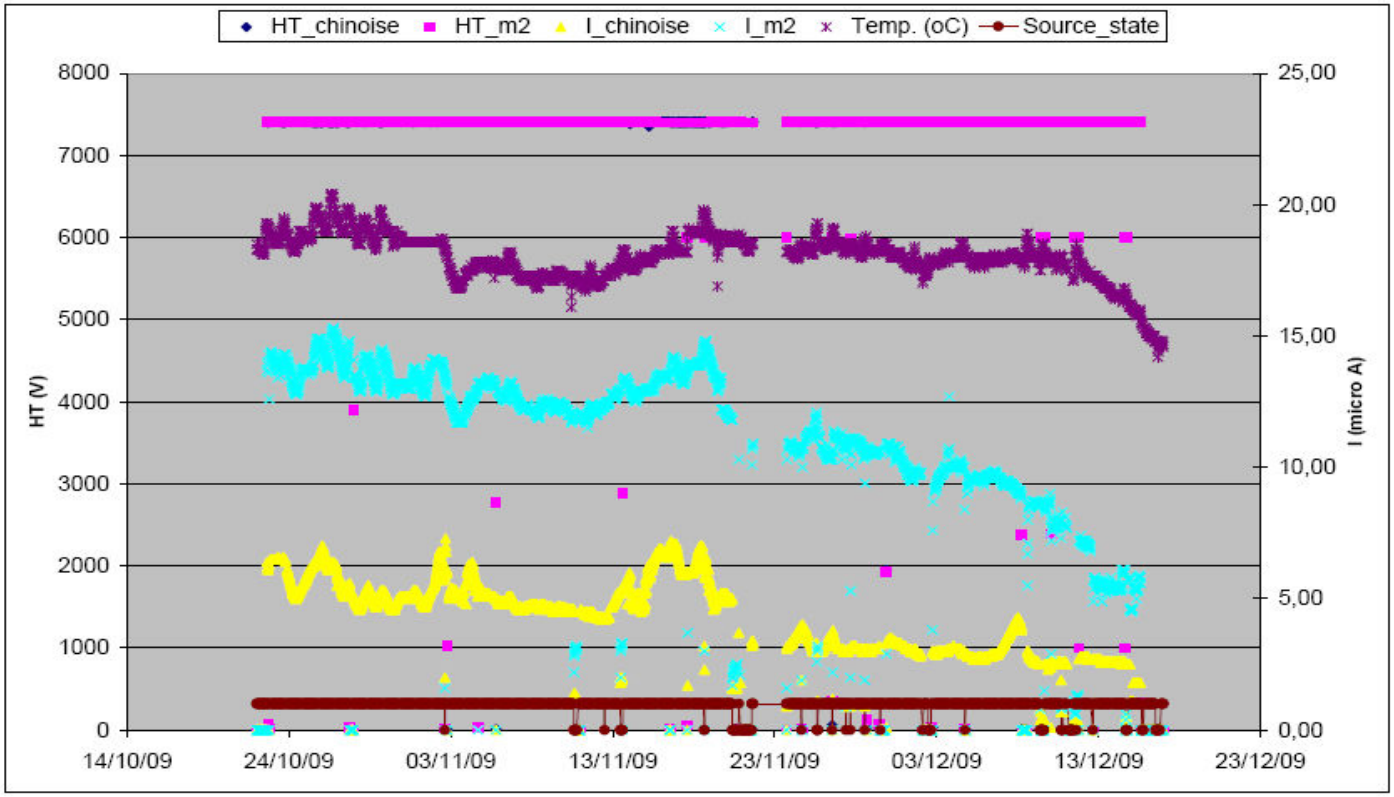
Gas circulation system was conceived and checked with sophisticated simulation tools with the aim to reduce gas consumption and to guarantee a well distributed gas
→ Homogeneity



Ongoing aging study

We have 2 GRPCs (standard 1m^2, semi-conductive small GRPC) in the GIF facility since October 2010). Correlation between gain, temperature, pressure and humidity is currently under study so the pure irradiation effect can be deduced.

10^3 Hz/cm^2



Electronics

All Test Beams were done using HR1(2 thr.)

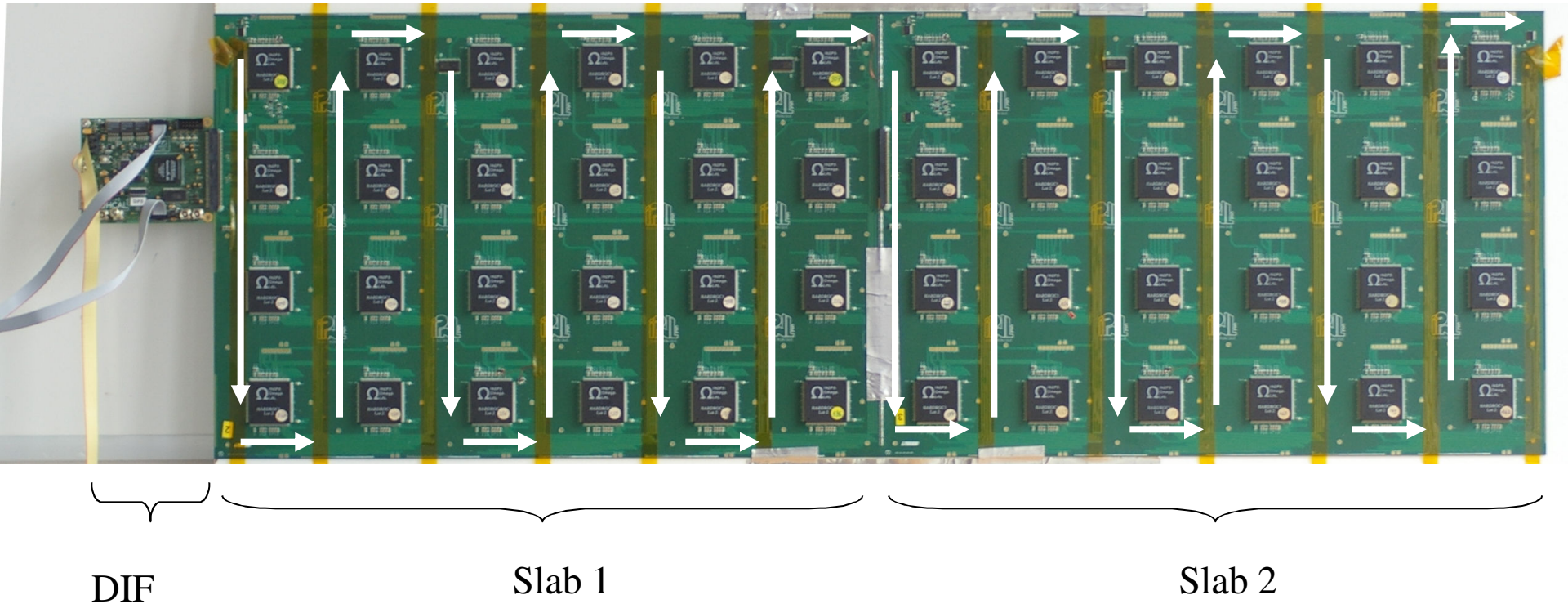
Few bugs with HR1 : ineffective mask, partial P.P

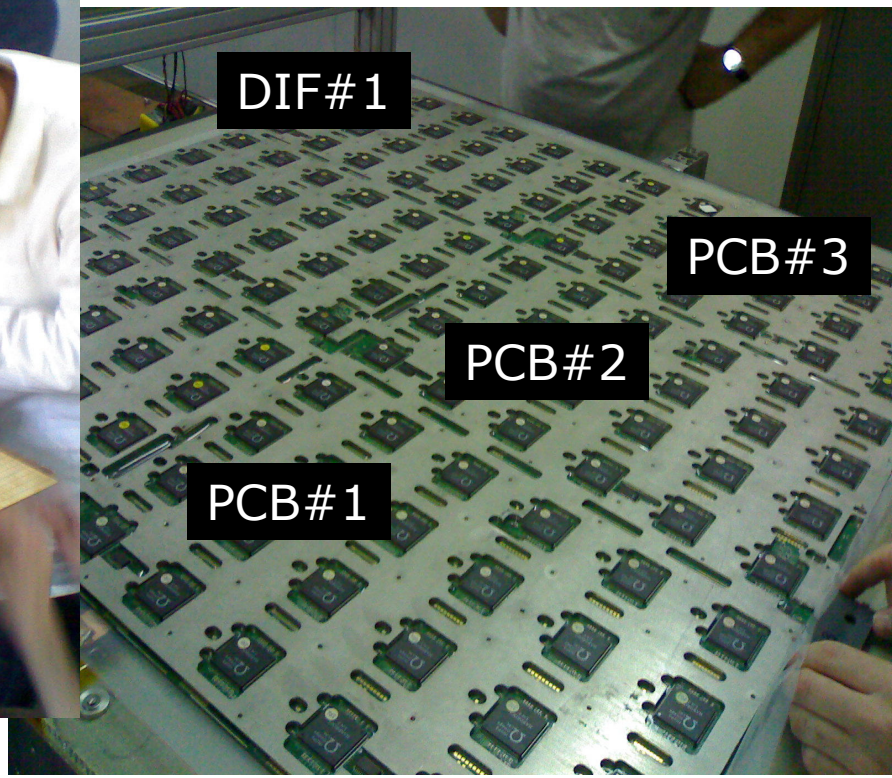
HR1 → HR2(3 thr.): but problems with some configurations loading

HR2→HR2b : bugs free

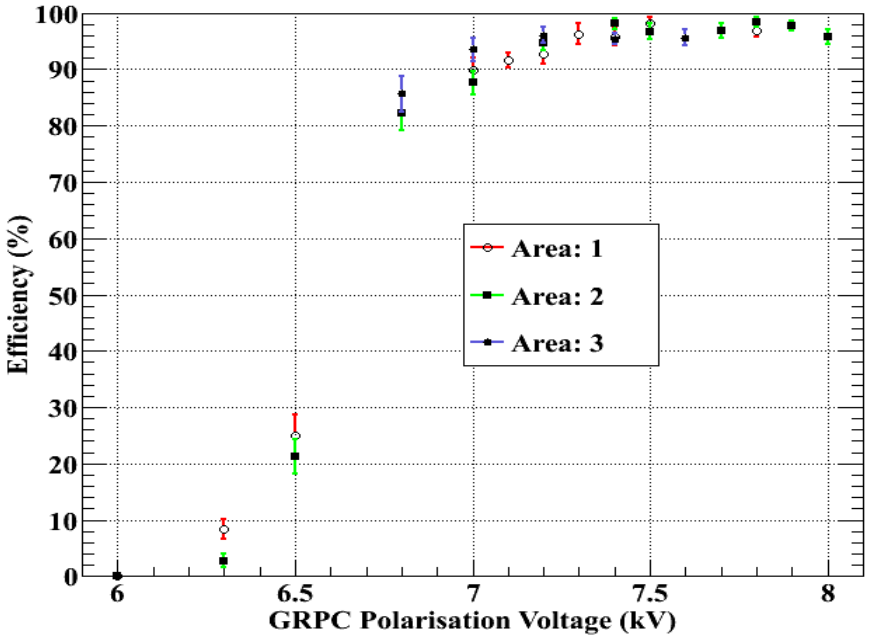
First structure

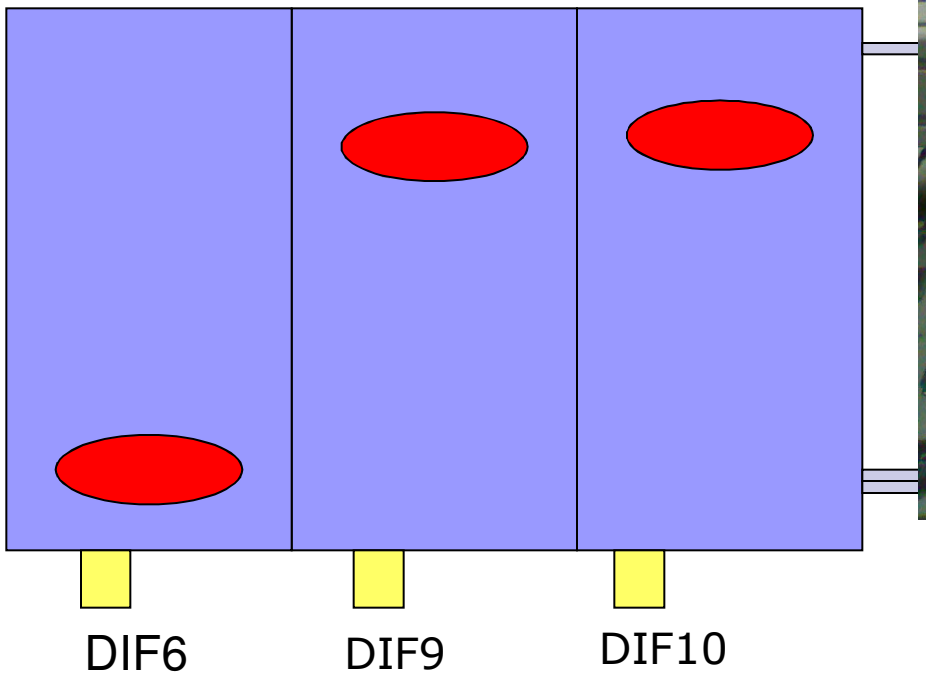
- PCB of 50X33.3 cm^2 8-layer, class 6 (buried vias)
- 6 were equipped with hardroc1 (plastic packaging)→ 144 ASICs
- PCB are connected 2 by 2 using zero resistor
- DIF connected directly to PCB
- PCB fixed to a mechanical structure to make a flat 1m^2 PCB

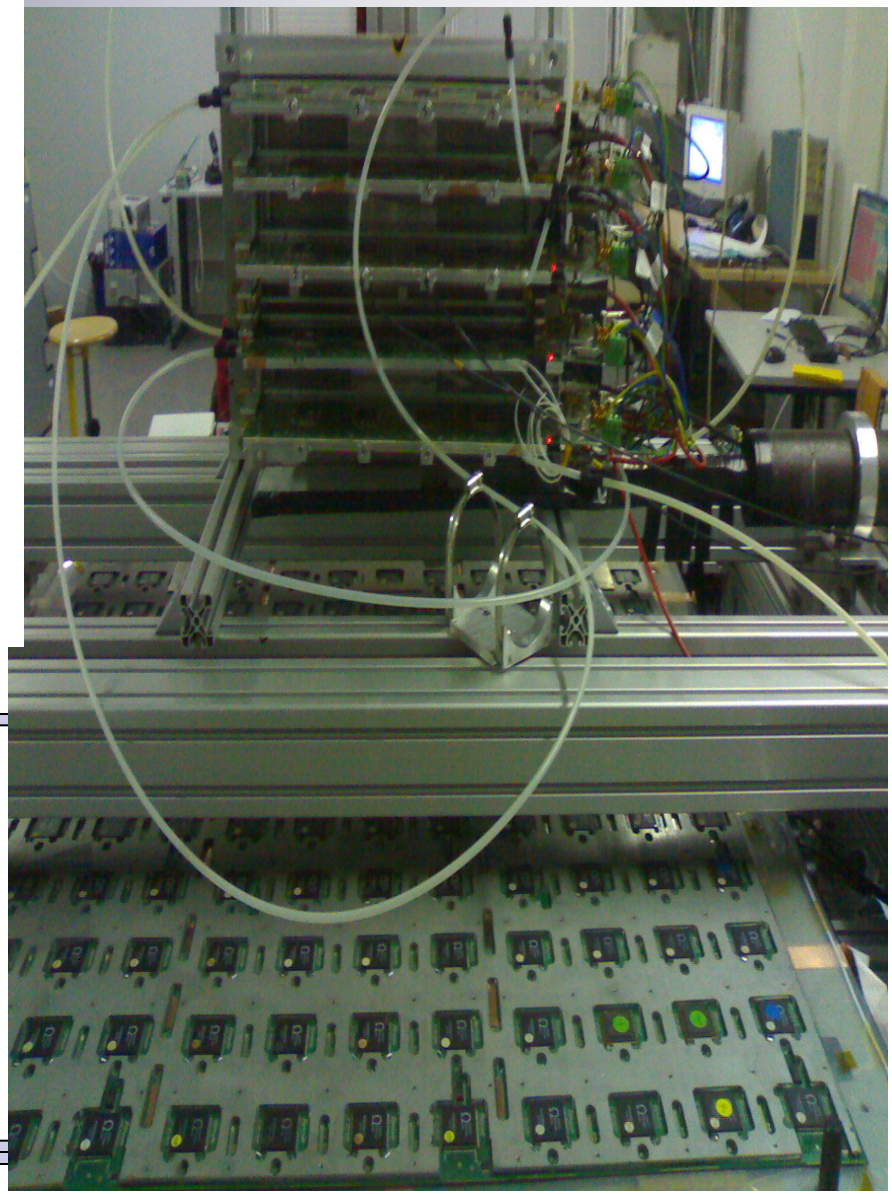




144 ASICs, 9216 channels





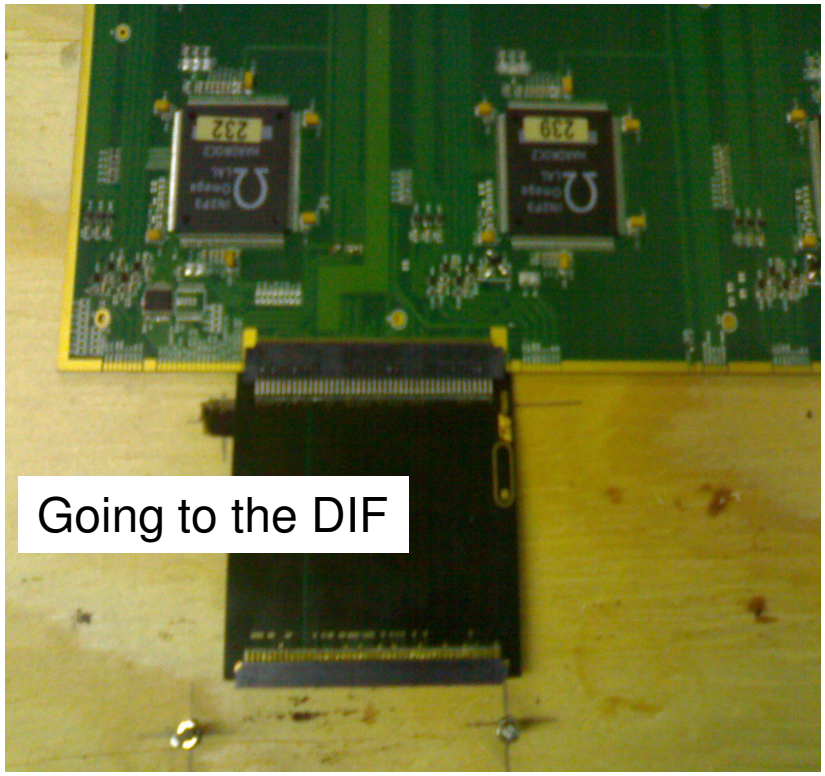


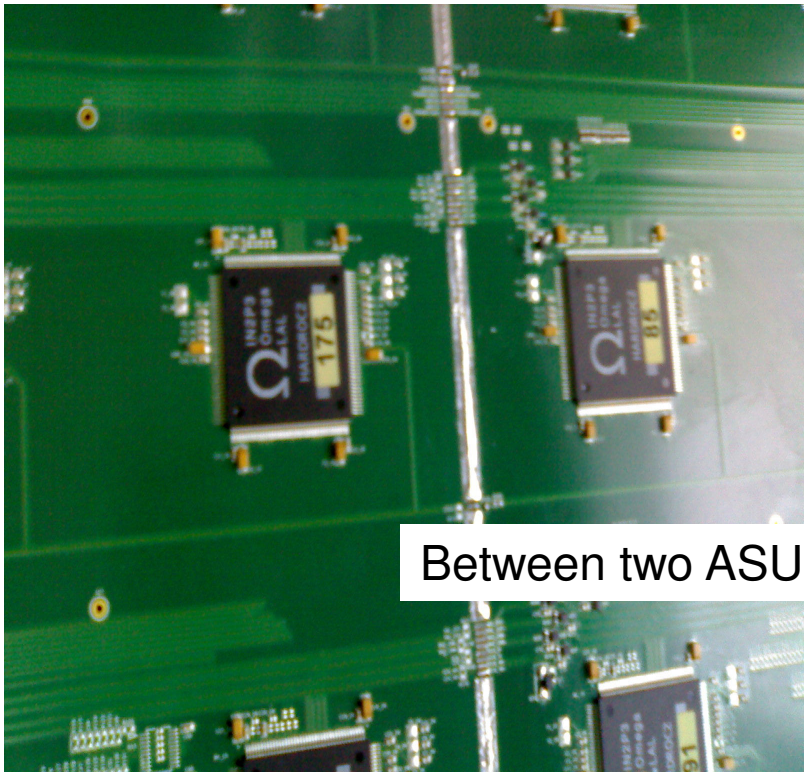
See Imad and Christophe talks

New structure

Learning from TB experience we improved our scheme :

Connections problems were fixed using flex (kapton)





New structure

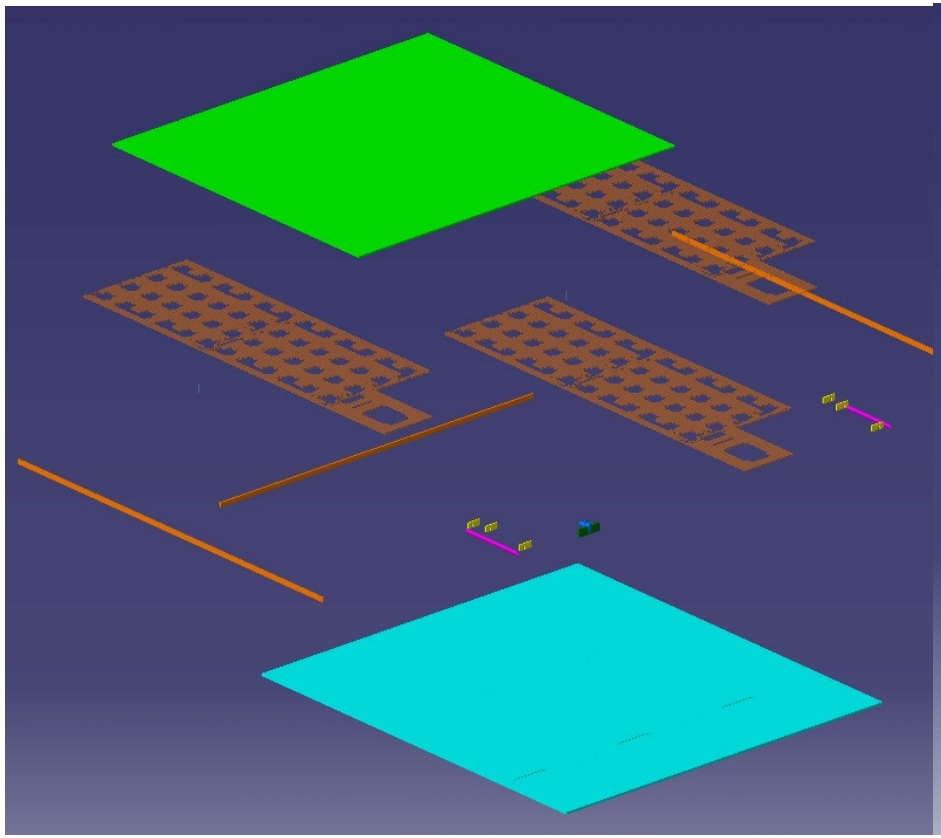
15 PCB equipped with
HR2 and HR2b were produced
→
2 additional fully equipped
1m^2 GRPC are being assembled
using the new scheme

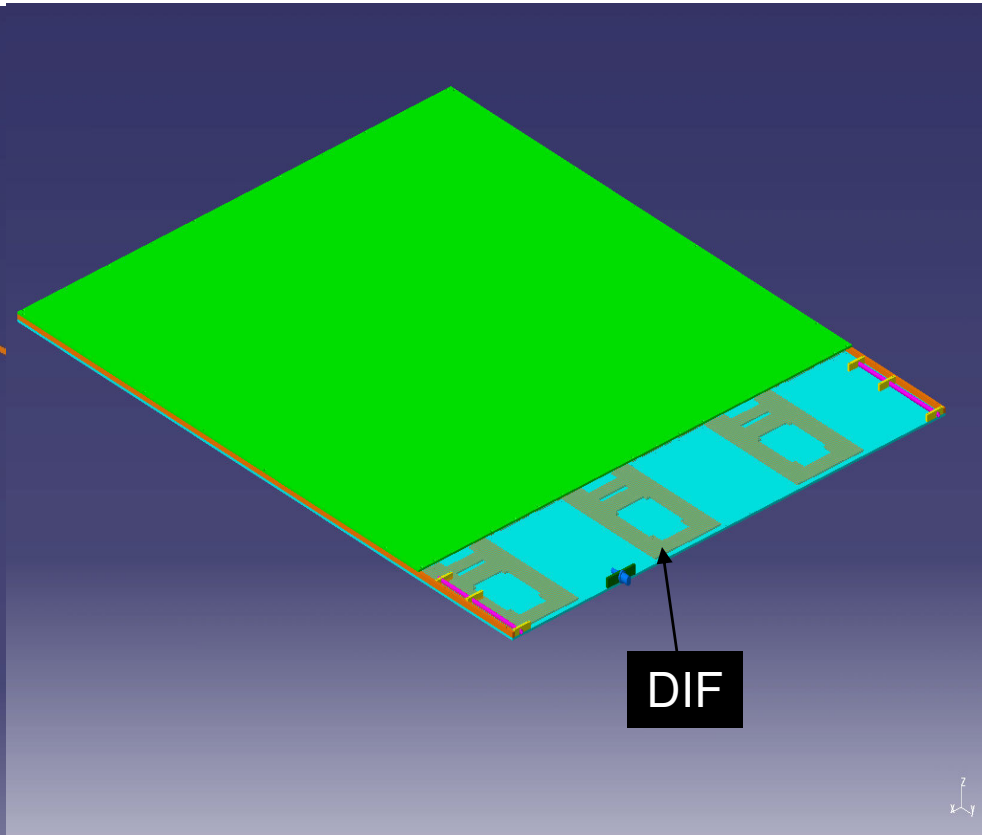
ASICs were tested using
Labview-based system

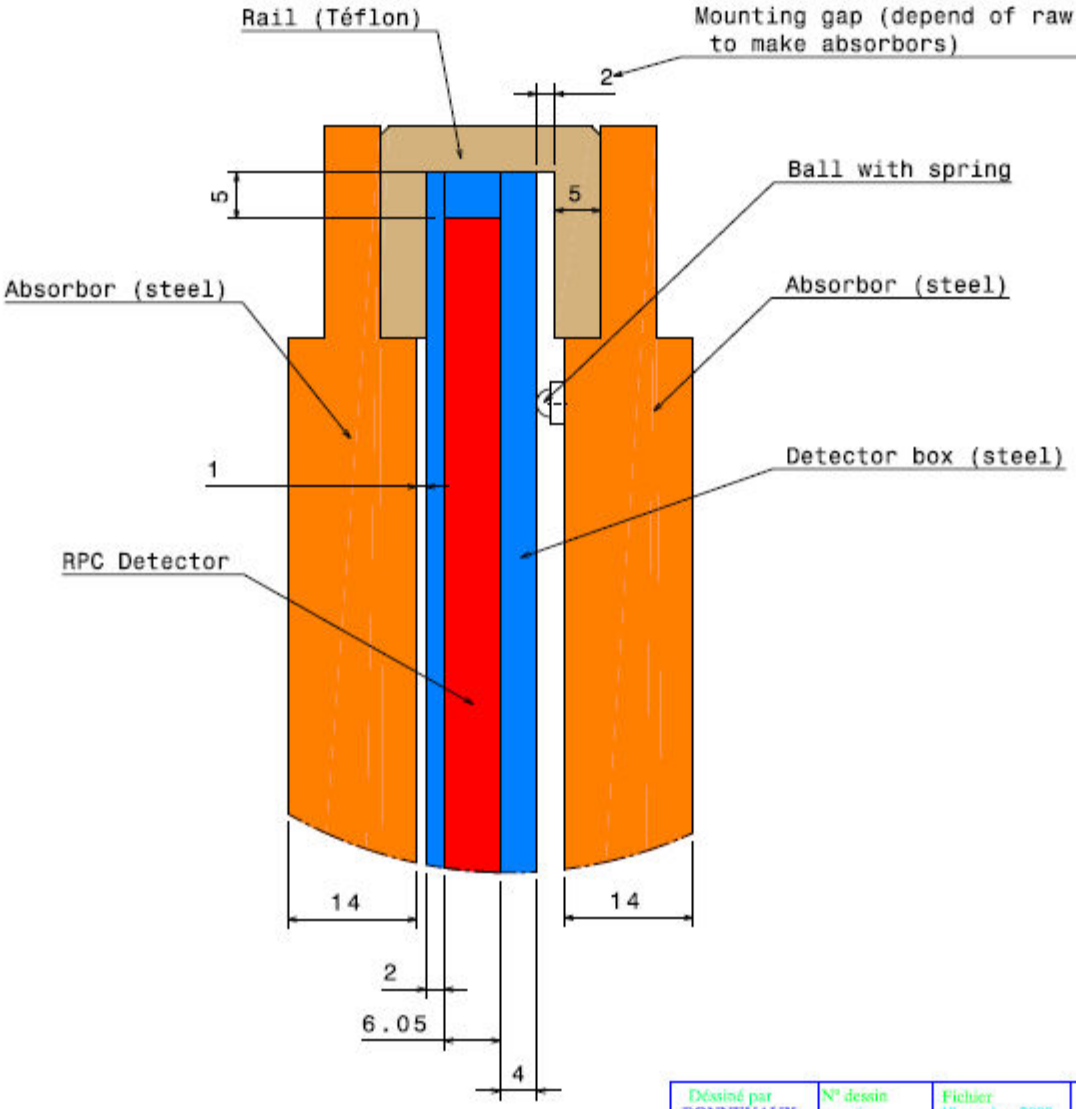
Slabs are tested after the ASICs
Are plugged using Xdaq-based
system.

New structure

Cassette to include the GRPC detector and associated electronics was designed.
It allows to fix the electronics on one of the cassette wall using screws+ special glue.







Rev Nb	Note de révision	Date	Signature

Dessiné par	N° dessin	Fichier		Date	Echelle
BONNEVAUX	numéro	19 octobre 2009		16-10-2009	

CALICE DHCAL

PROTOTYPE M3	Edition	Feuille
	01	01

Services

→High voltage service

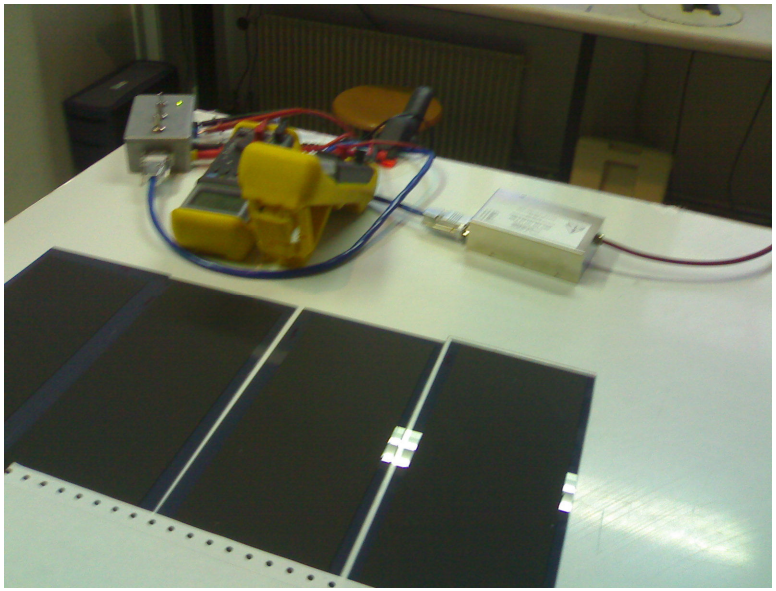
→Gas distribution system

High Voltage

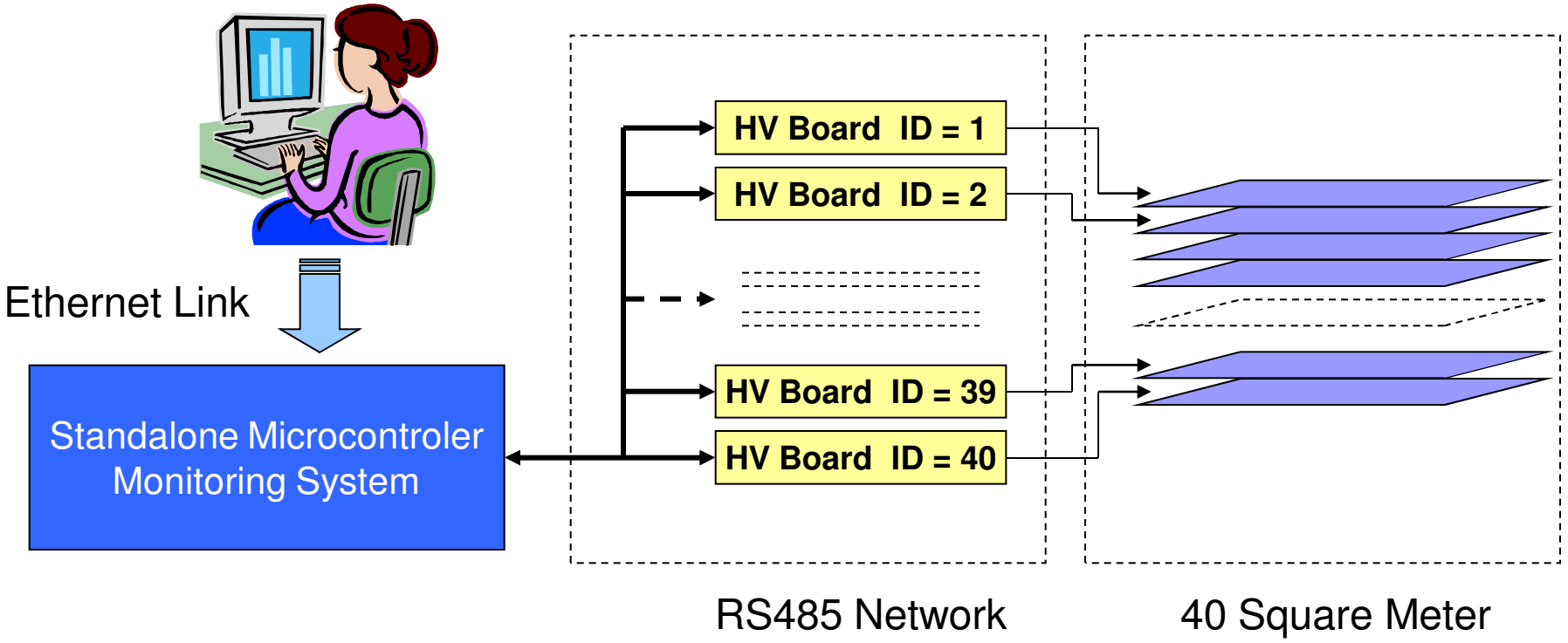
Cockcroft-Walton system
is selected as the baseline
for the technological prototype.
It satisfies safety requirement
and ILD volume limitation.

This was developed in
collaboration with ISEG company.
Characteristics:

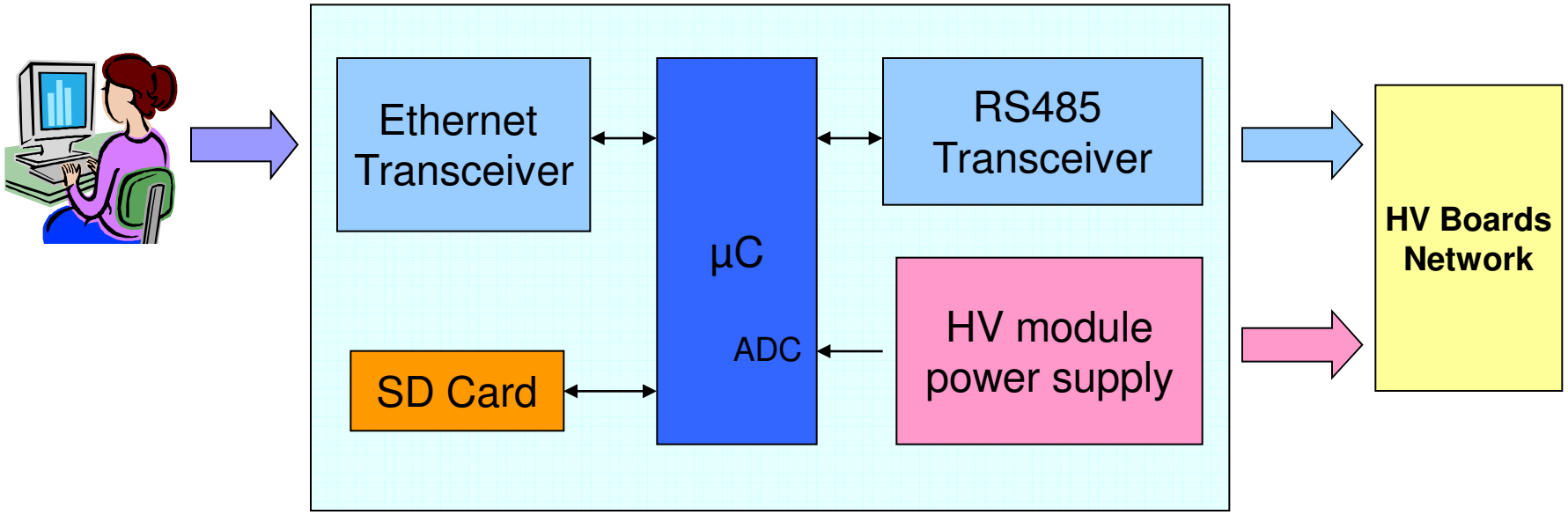
- 0-5 V → 0-10 kV
- I <10μA
- I,V monitoring
- Residual noise 50 mV



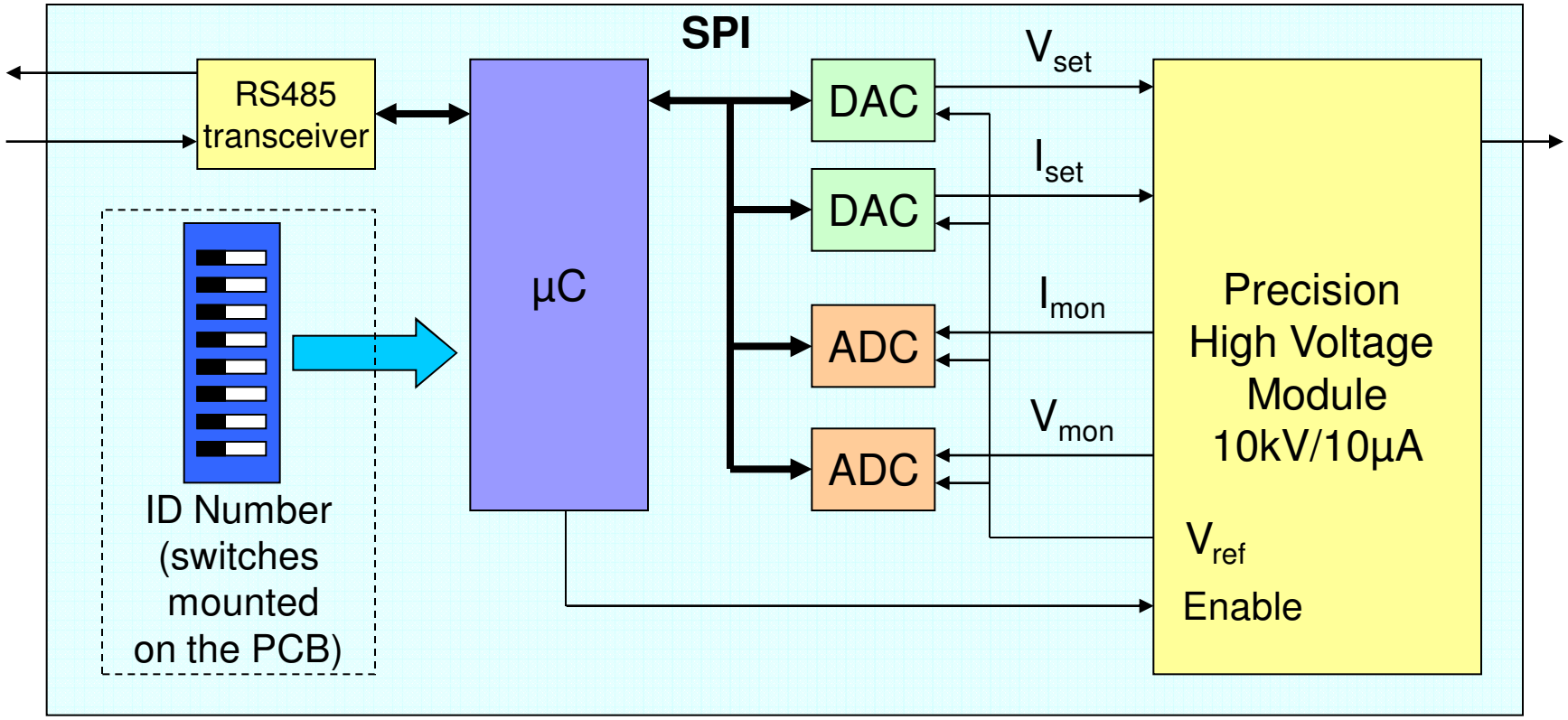
HV Network


Ethernet Link
Standalone Microcontroler Monitoring System
HV Board ID = 1
HV Board ID = 2
HV Board ID = 39
HV Board ID = 40
RS485 Network
40 Square Meter

Standalone Microcontroler Monitoring System



HV Board Overview Diagram

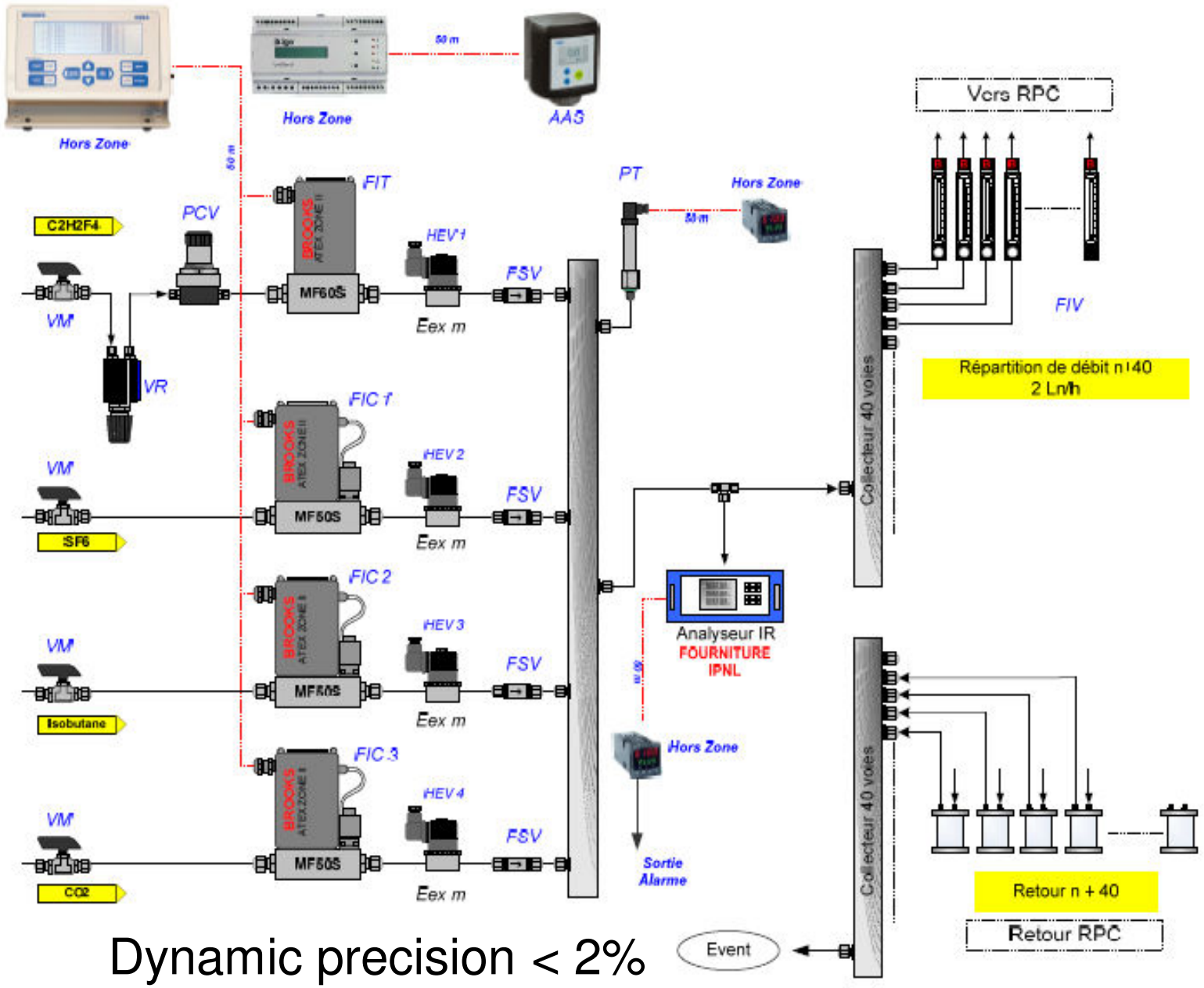


Gas distribution system

A system able to feed 40 detectors in parallel is being designed in collaboration with a French company

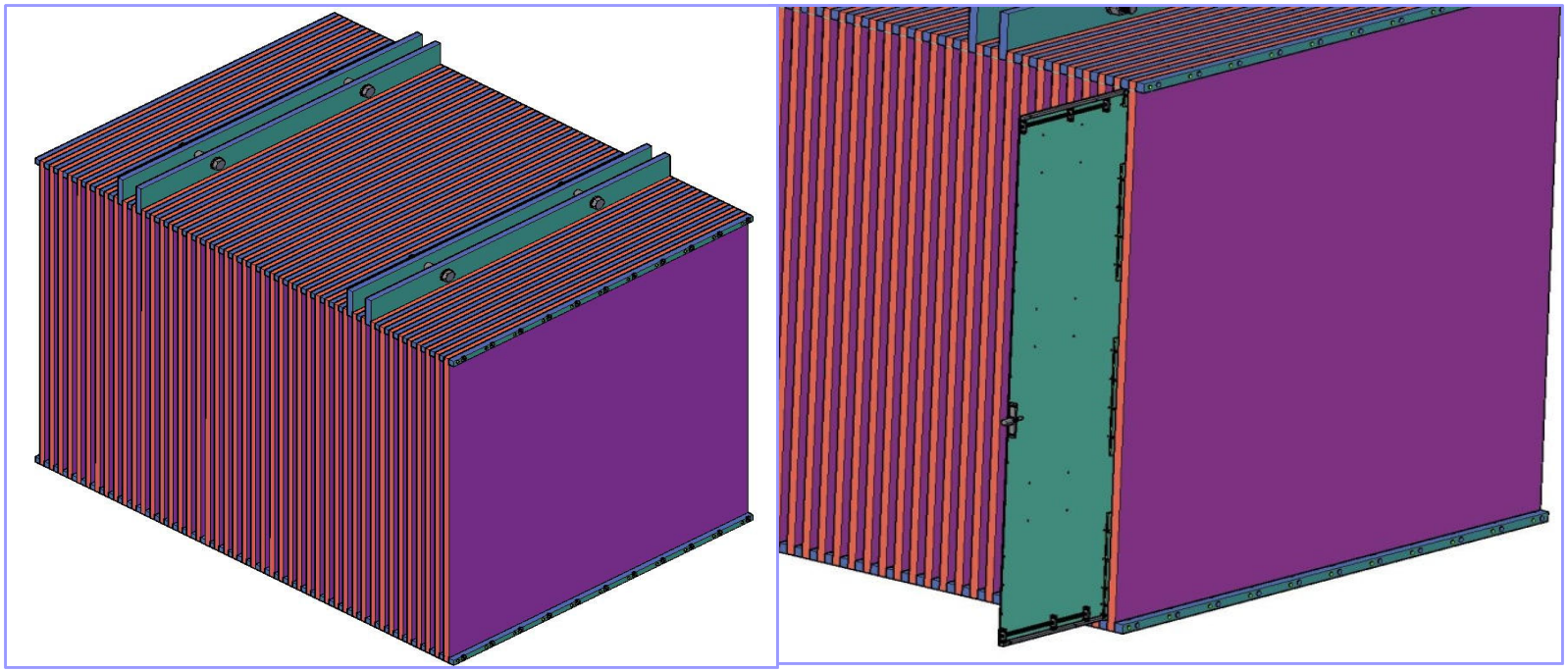
It is conceived to reduce contamination risk and to guarantee a good control of the gas mixture components

It satisfies CERN safety rules (very important)

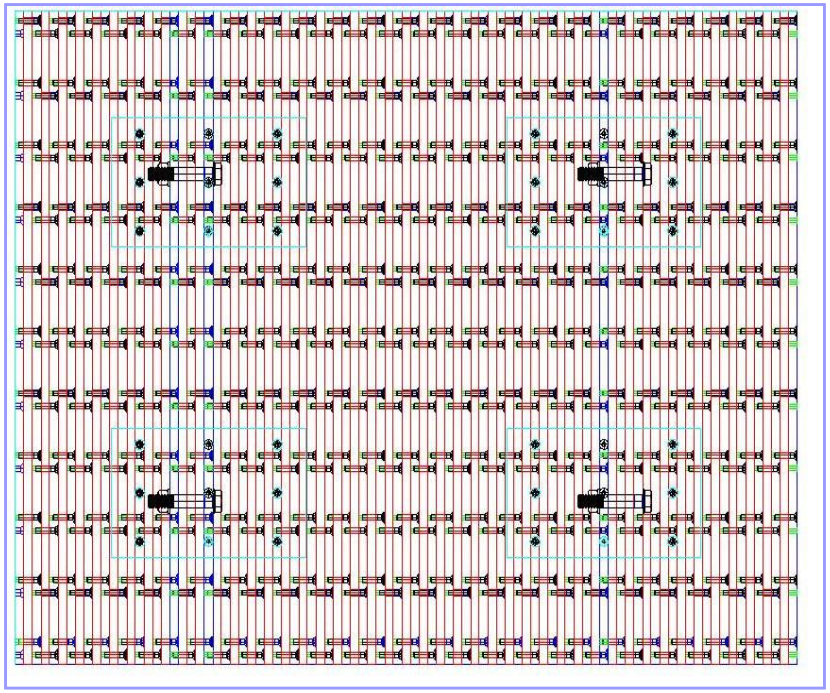


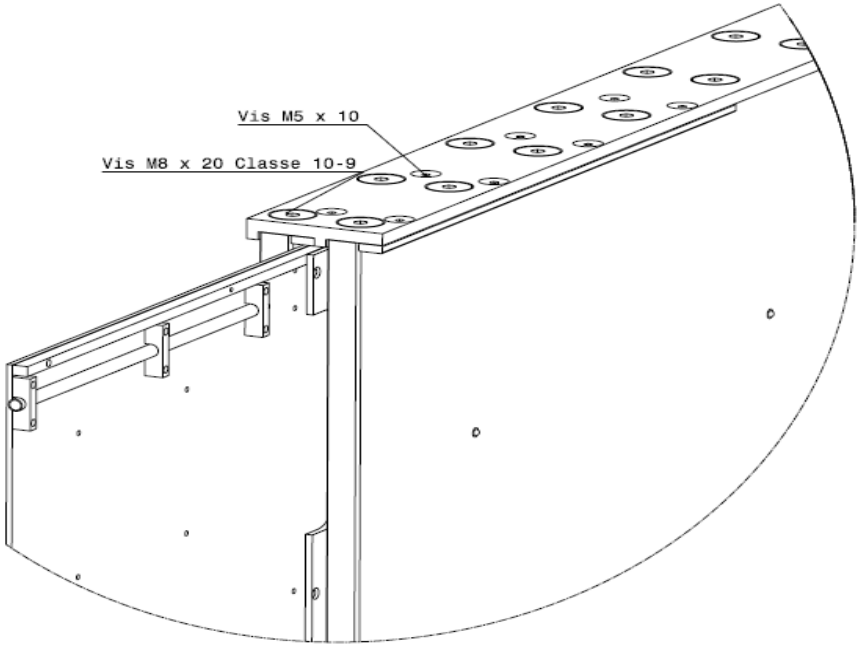
Dynamic precision < 2%

Mechanical structure



See Enrique talk





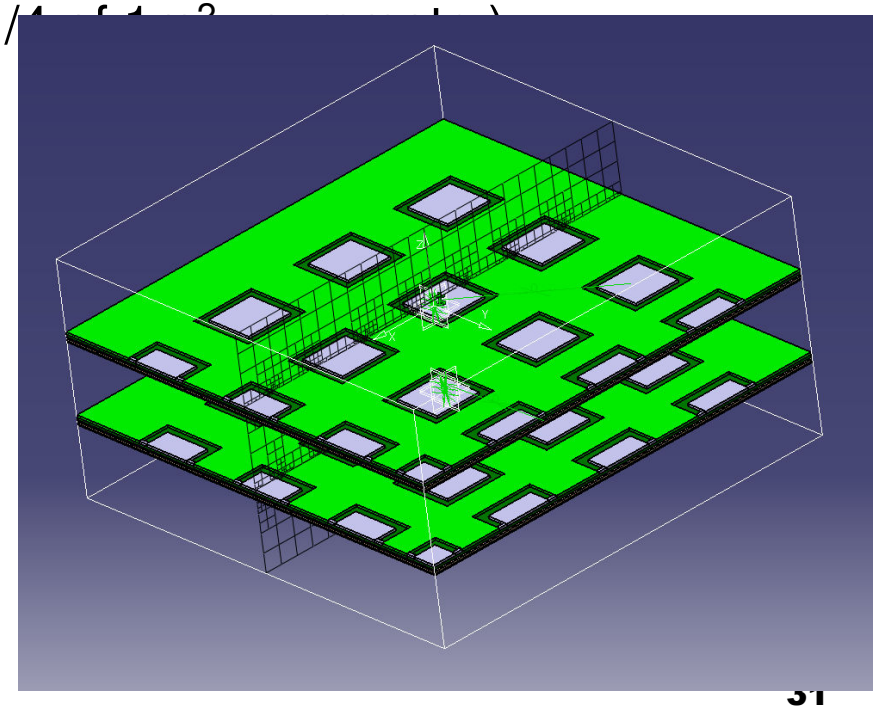
Fixation solutions

Thermal Study

- **Model**
  - 100 mW chips (no power pulsing)
  - No cooling , thermal dissipation by convection only,

    T(hall) = 20°c

    (still we should include the DIF effect in the future)
  - 3 absorbers et 2 detecteurs (1/
  - Cubic grid



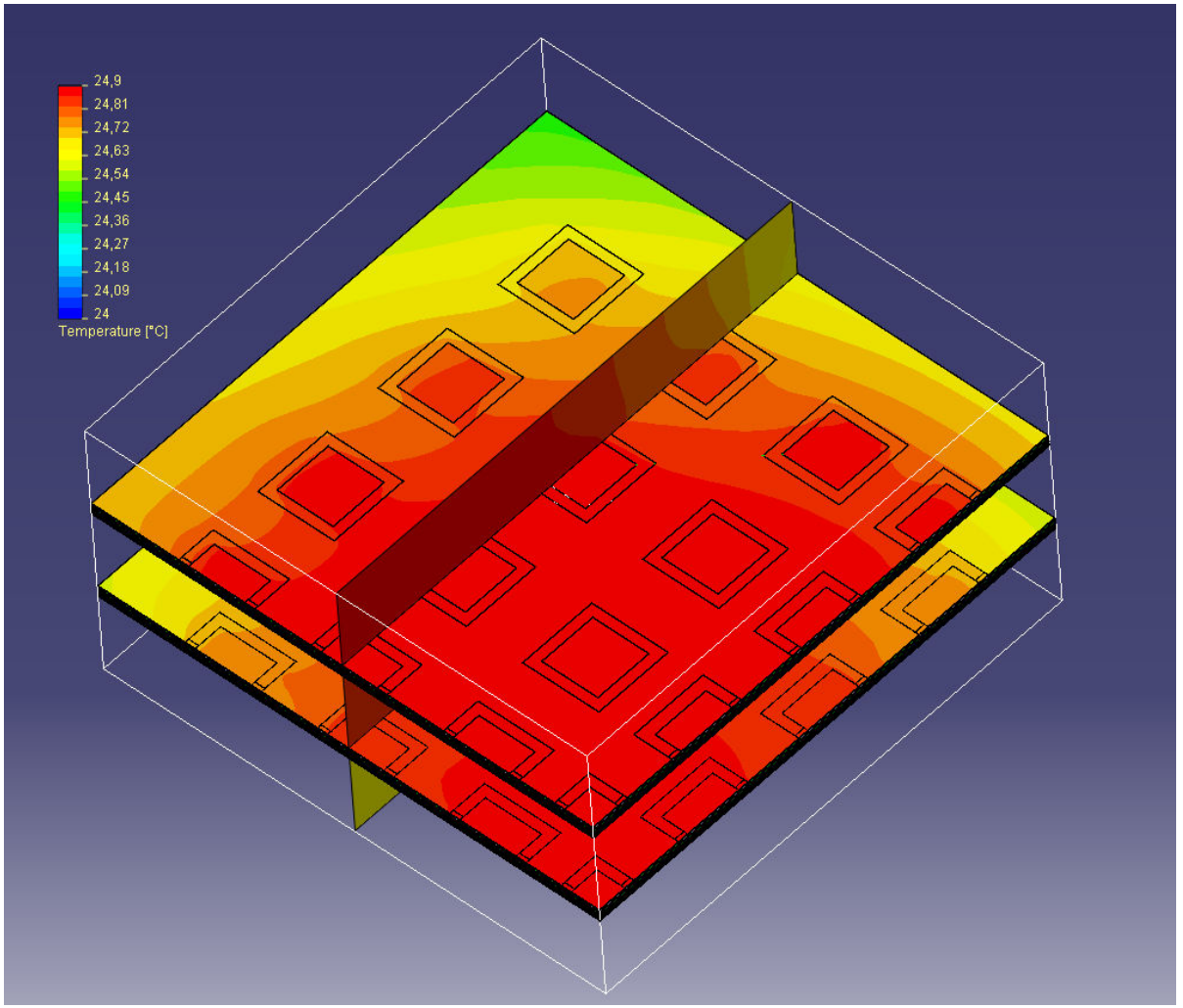
- **Codes**
  - Catia V5
  - EFD flomerics

Thermal Study

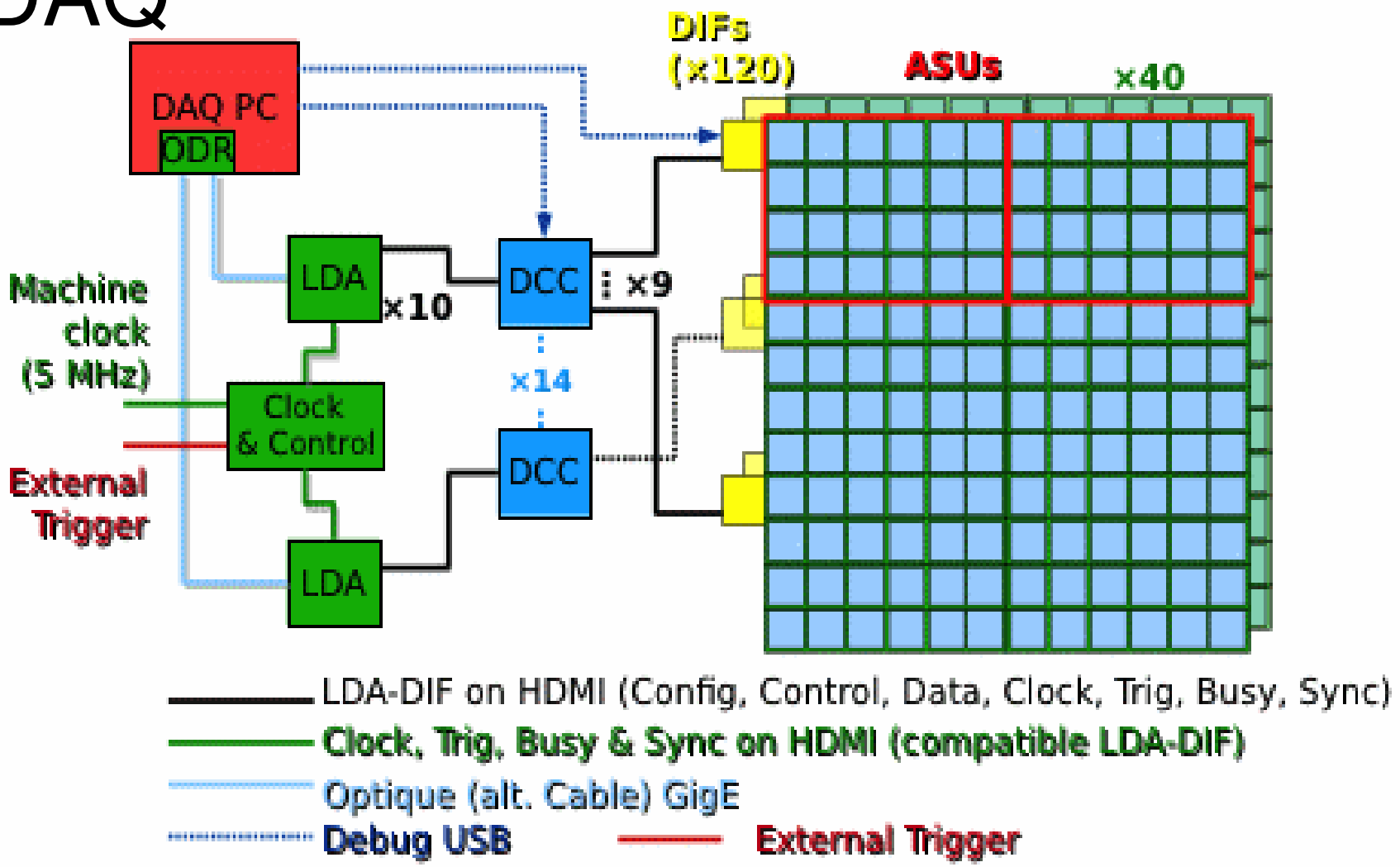
- **Resultats**

$T_{max} = 25℃$

No cooling needed



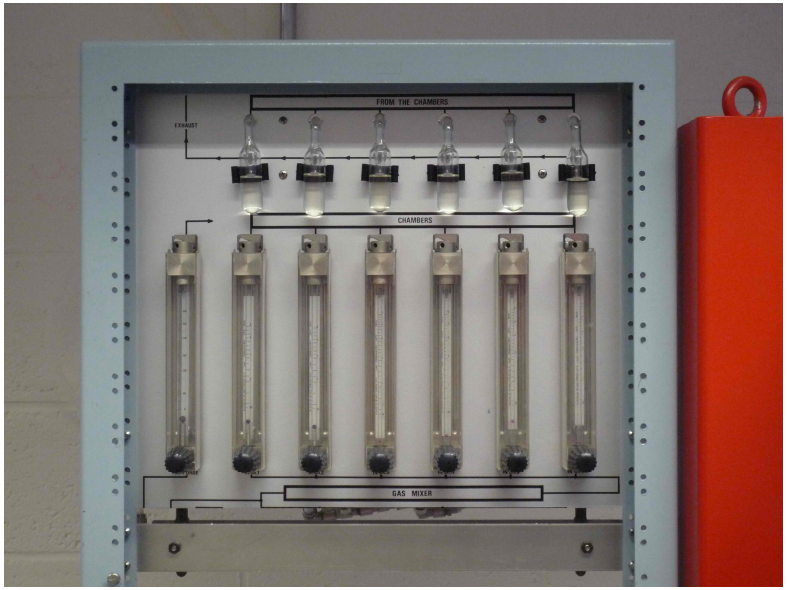
DAQ

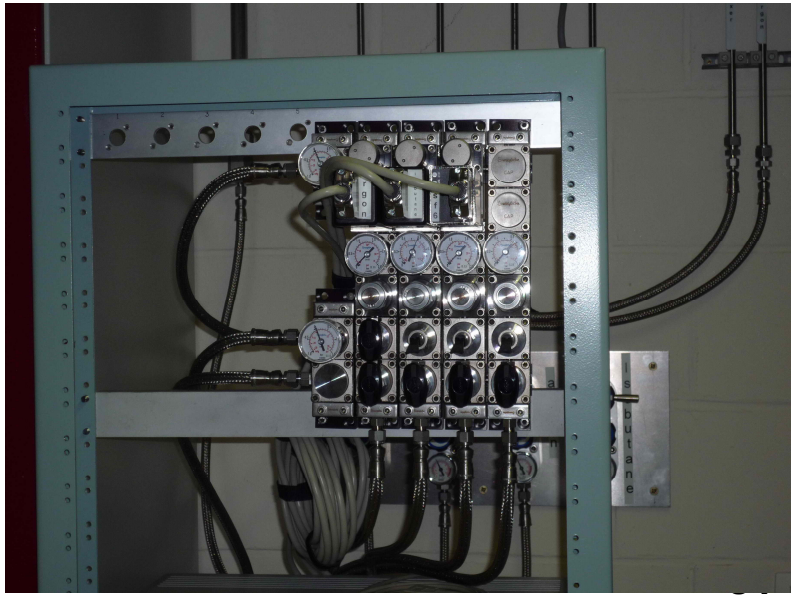


See Vincent and Julie talks

Cosmic Test Bench in LLN

A teststand under preparation in Louvain-la-Neuve laboratory using (scintillators+fibers+PMT) Will be used to test the detectors

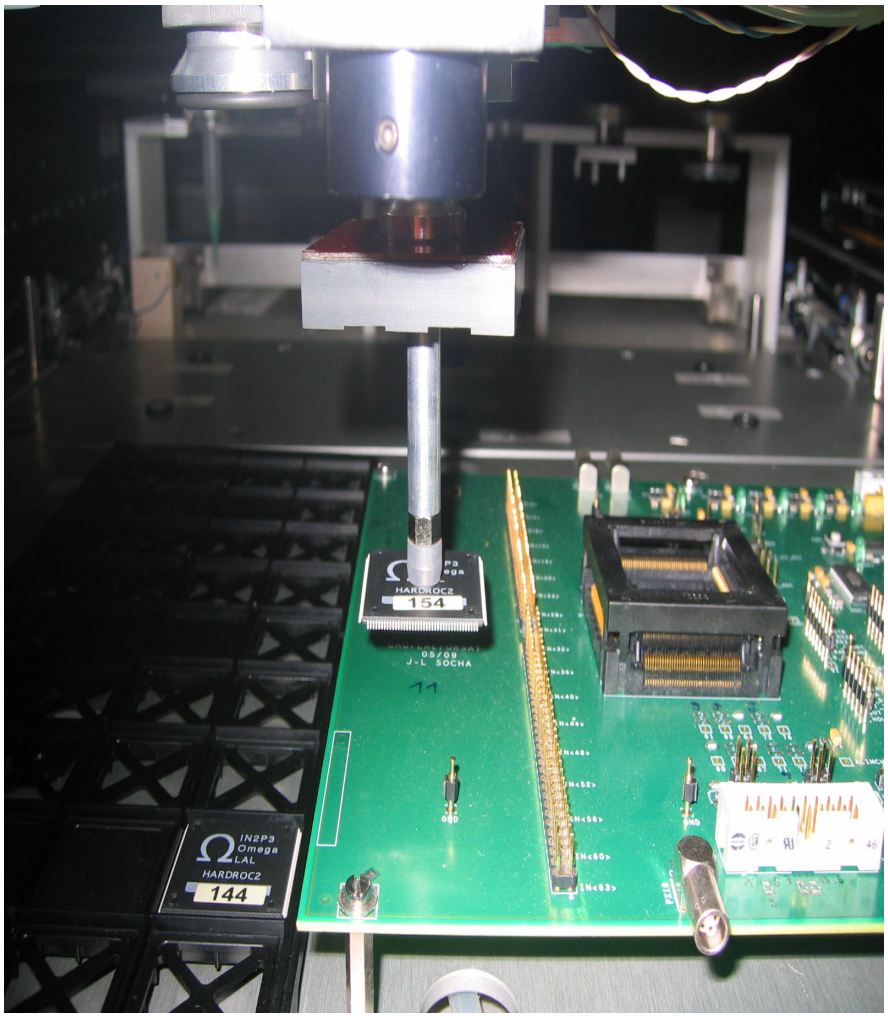


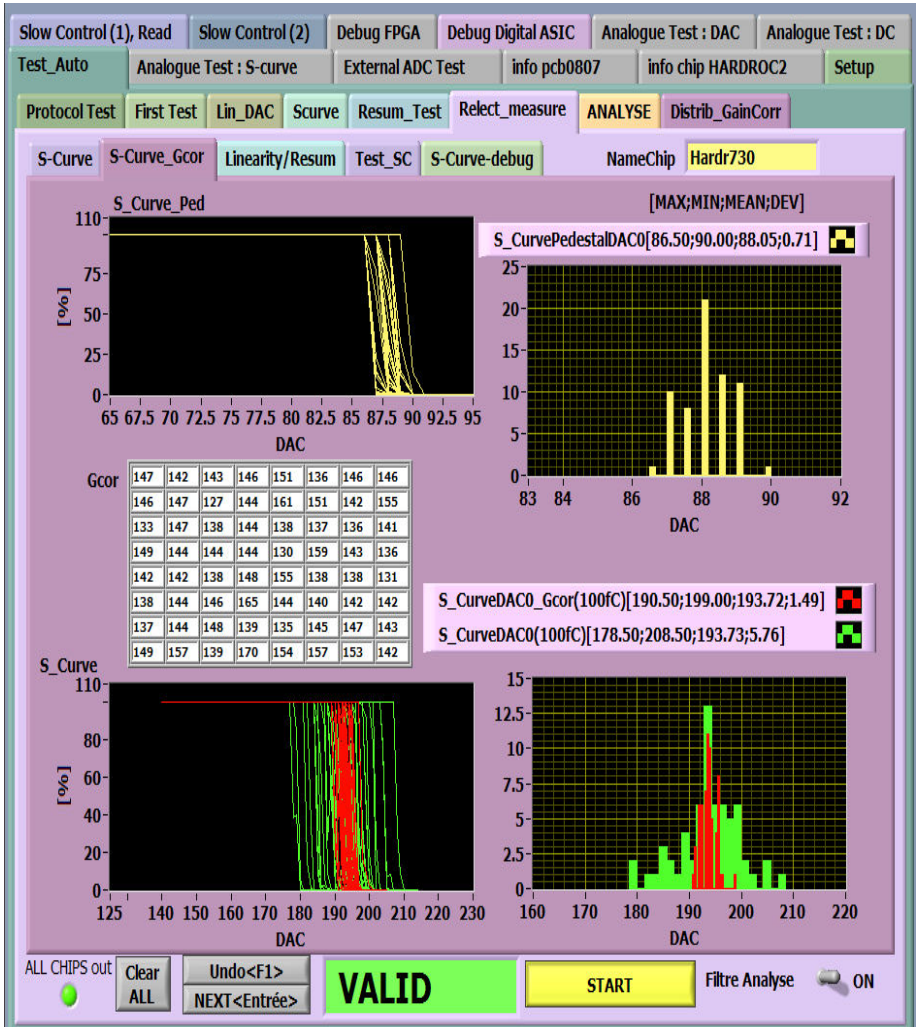


Chips test bench in Lyon

A CMS robot is being adapted to test the ASICs

Max test time : 10 minutes/ASIC using Labview-based application





Simulation and performance study

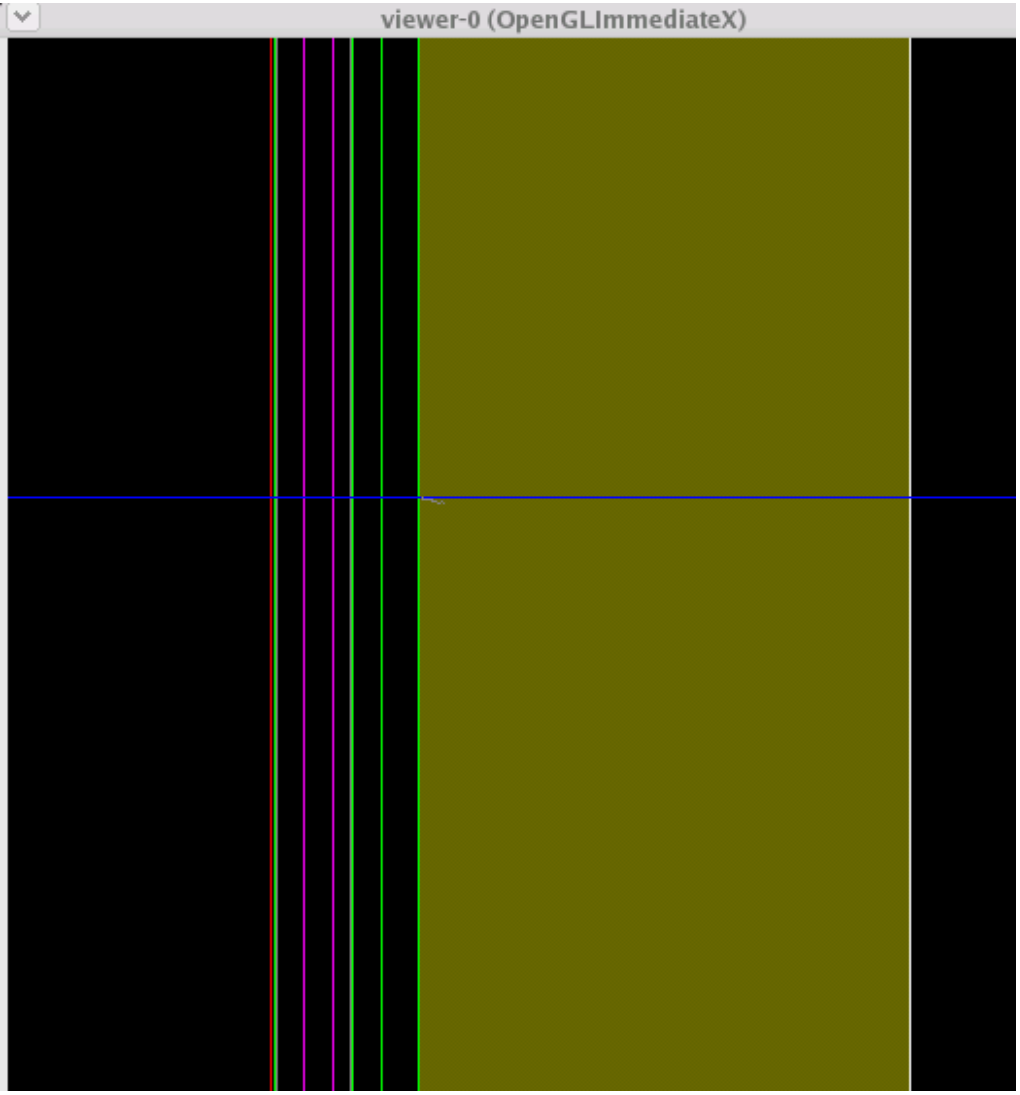
Simulation should be as realistic as possible

This means :

1- Including dead zones and edge effects

2- Obtaining the same efficiency and multiplicity as for data

The structure of one layer

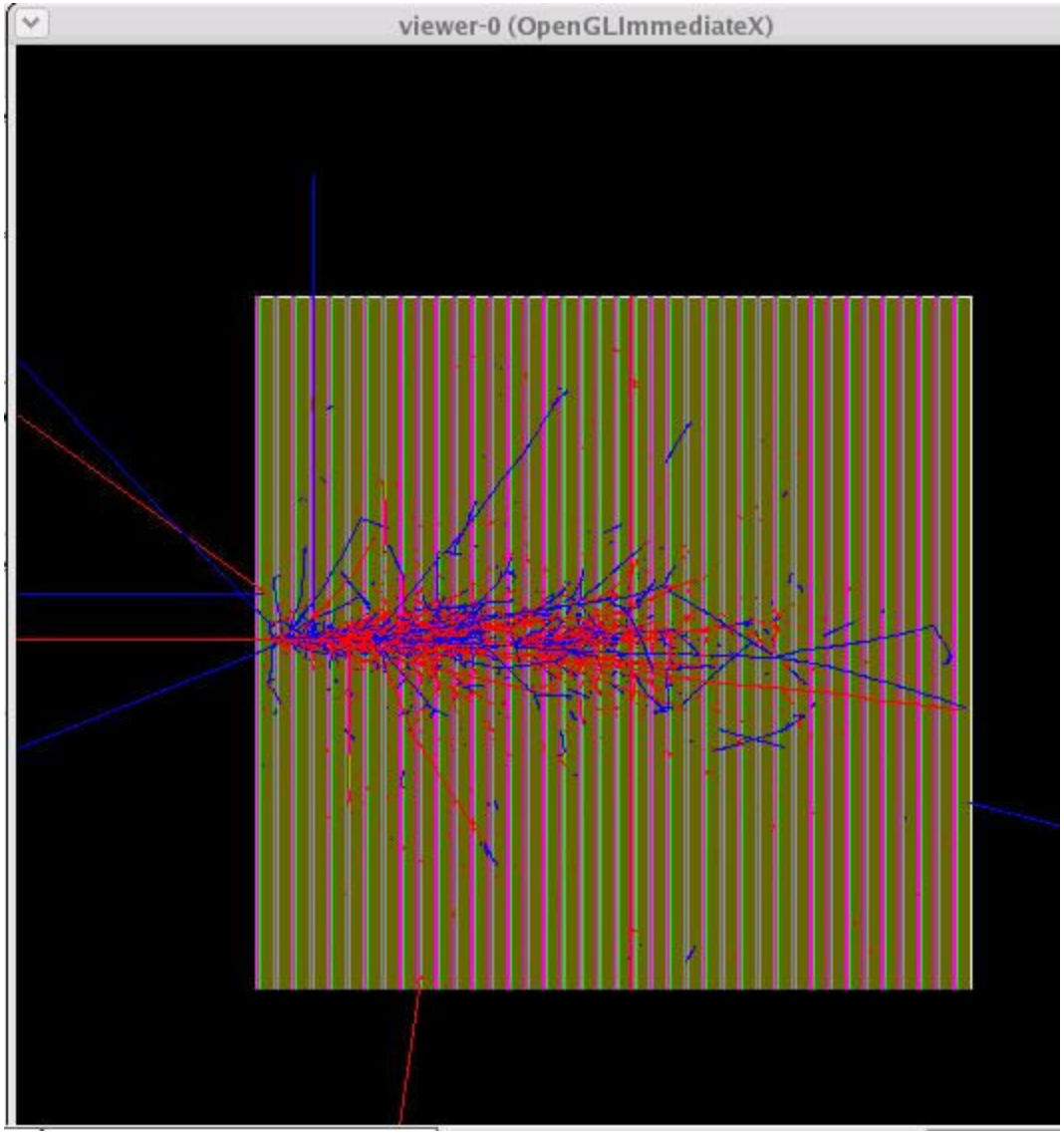


- PCB=1.20*mm;
- Mylar_Anode =0.05*mm; (Red)
- Mylar Cathode =0.18*mm;
- Graphite_Anode= 0.05*mm; (Green)
- Graphite Cathode=0.05*mm; (Green)
- Thin Glass=0.700*mm; (Gray)
- Gap =1.200*mm;
- Thick Glass =1.10*mm;
- ChipPackageThickness =1.50*mm;
- Absorber =2.00cm (Yellow)

- TFE:SF6:ISO(V)=94.5: 0.5: 5
- TFE:SF6:ISO(M)=96.4: 0.7: 2.9

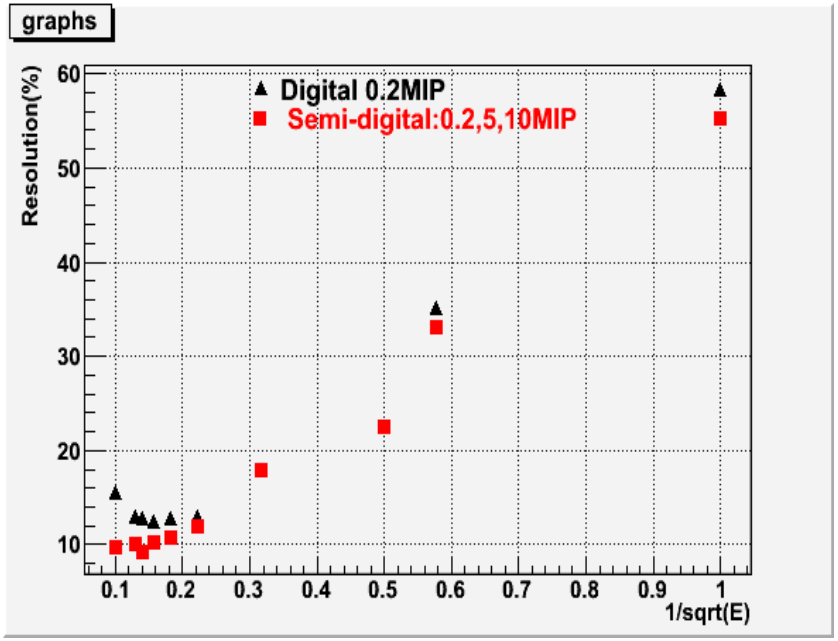
- Beam Direction: from –Z to +Z, from electronics to absorber

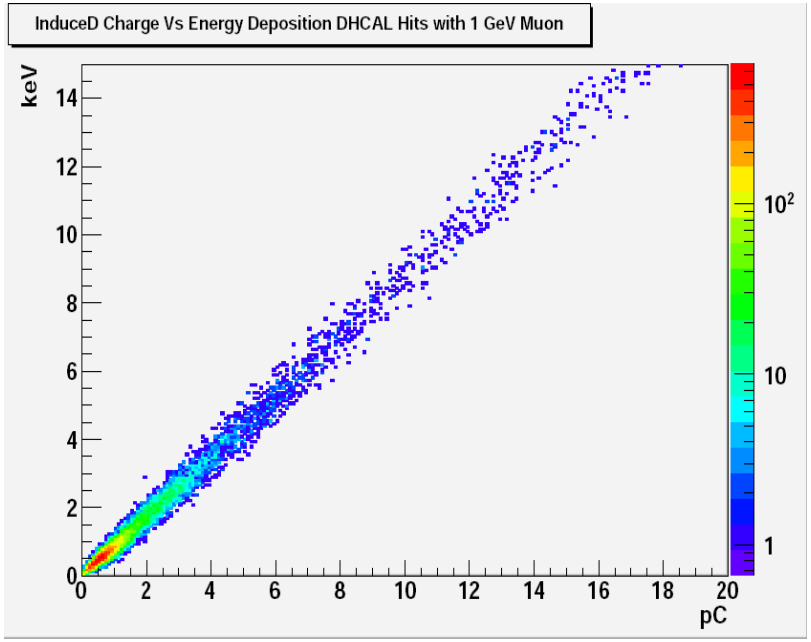
40-layer prototype with 100 GeV pion event



Selection of the threshold values and the weight of each threshold was made using a Chi2 optimization.

"Weights are energy dependent"

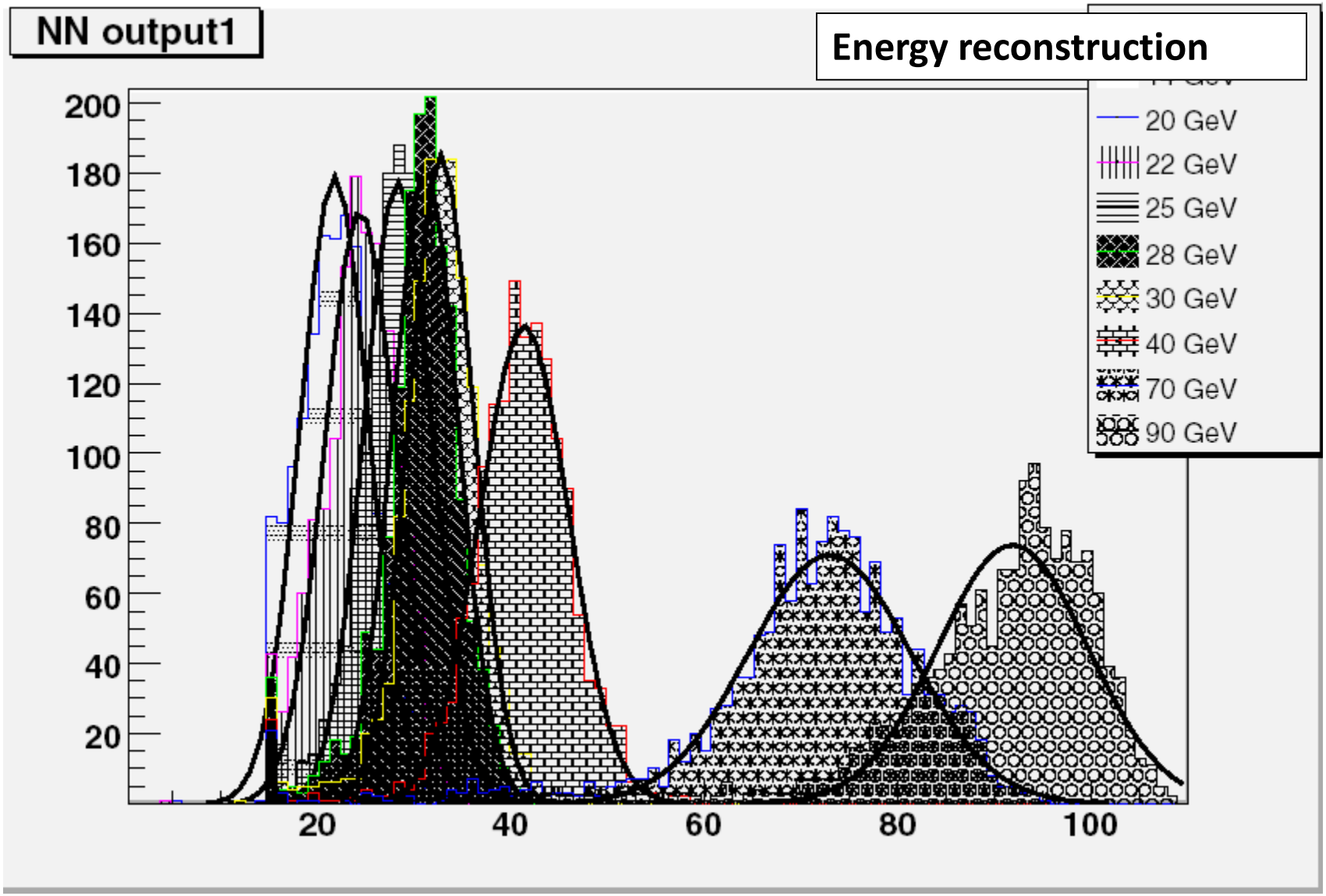




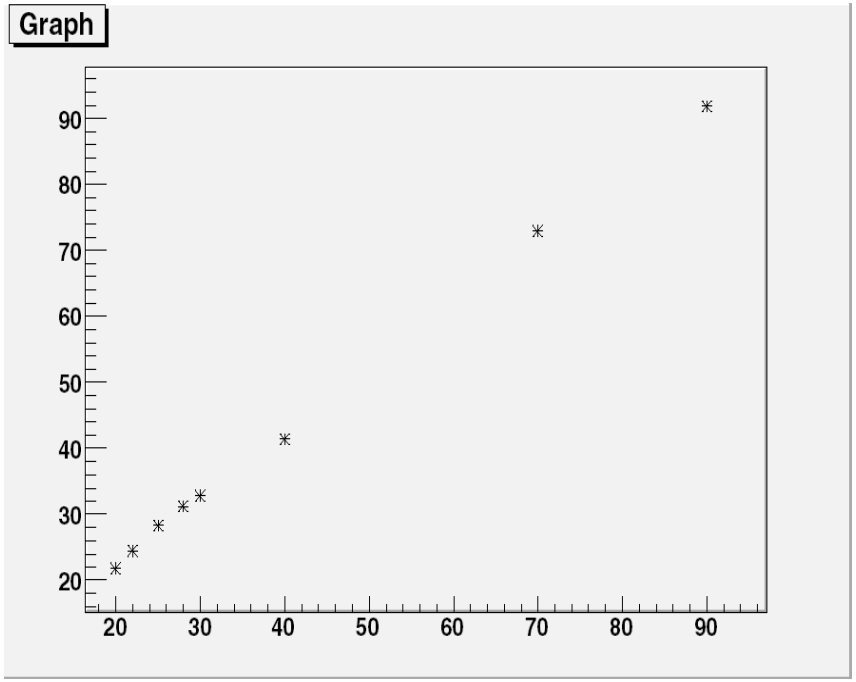
Based on accumulated dE/dX in each cell. We are reproducing the same study based on the accumulated charged

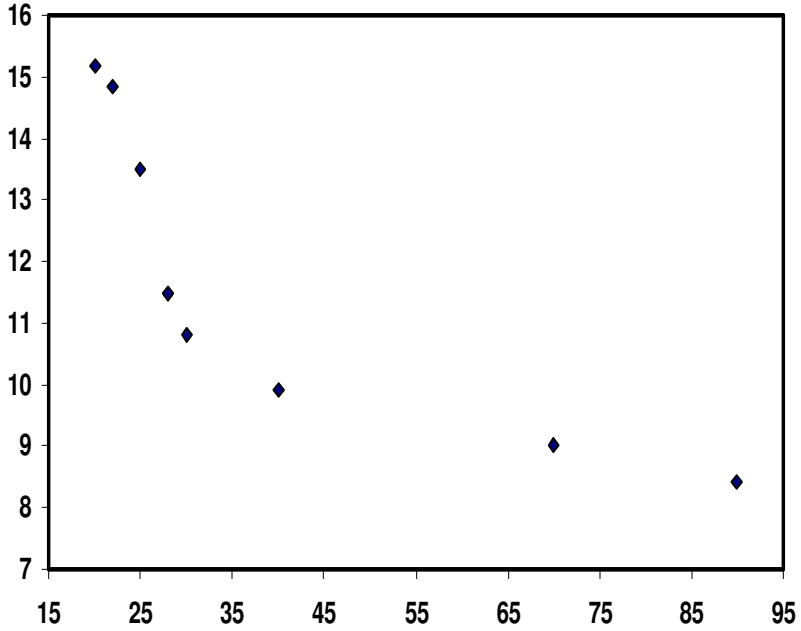
However, using a polya function to convert energy into charge There is a linearity

To determine the energy a NN can be very helpful



Linearity, resolution Vs Beam Energy: Semi-Digital (0.2,5,10MIP) using NN





Only semi-digital information taken into account. Work to include the shower shape and hits density is ongoing

Conclusion

- A lot of progress has been made in different fields in the technological SDHCAL prototype
- We are almost ready to start the mass production
- We think we can have our technological prototype ready for TB in 2011
- We intend to replace our standard RPCs by MGRPCs in a second step and probably with semi-conductive GRPCs.