News and preparation of the Semi-Digital Hadronic CALorimeter prototype

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

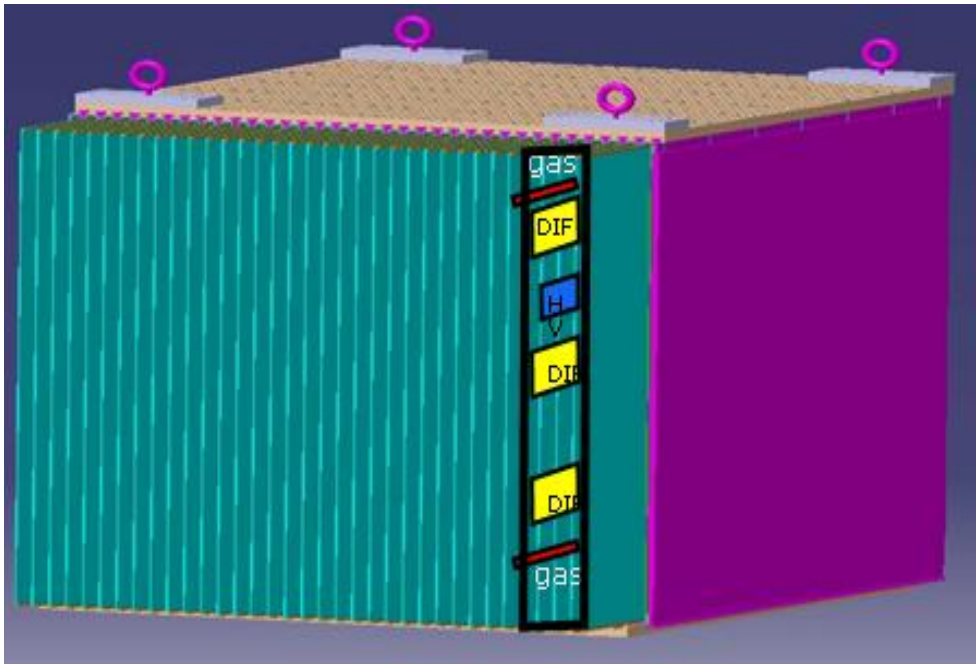
Outline

- Preparation for the prototype construction

The Technological prototype

We intend to validate the **SDHCAL concept** by building a prototype which is as close as possible to the proposed SDHCAL for ILD

→ Self-supporting mechanics
→ Minimized dead zone
→ Minimized thickness
→ One-side services
→ Power pulsed electronics



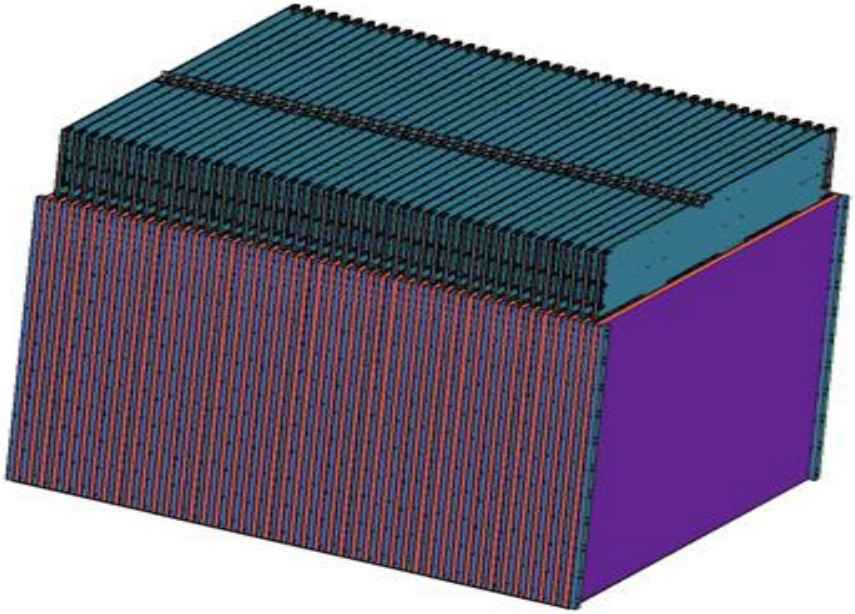
The prototype will be made of 40 units. Each unit is made of :

2 cm absorber
+ **0.6 cm sensitive medium**

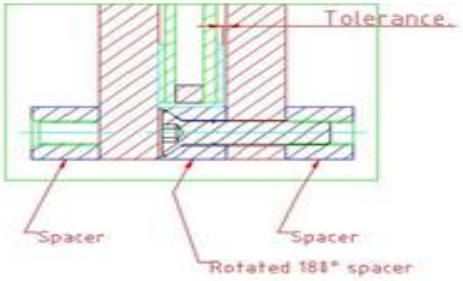
1 cm^2 transversal granularity
This is about **5 λ_I**
and **368640** channels

The modular structure we propose makes it possible to increase the number of units up to 48

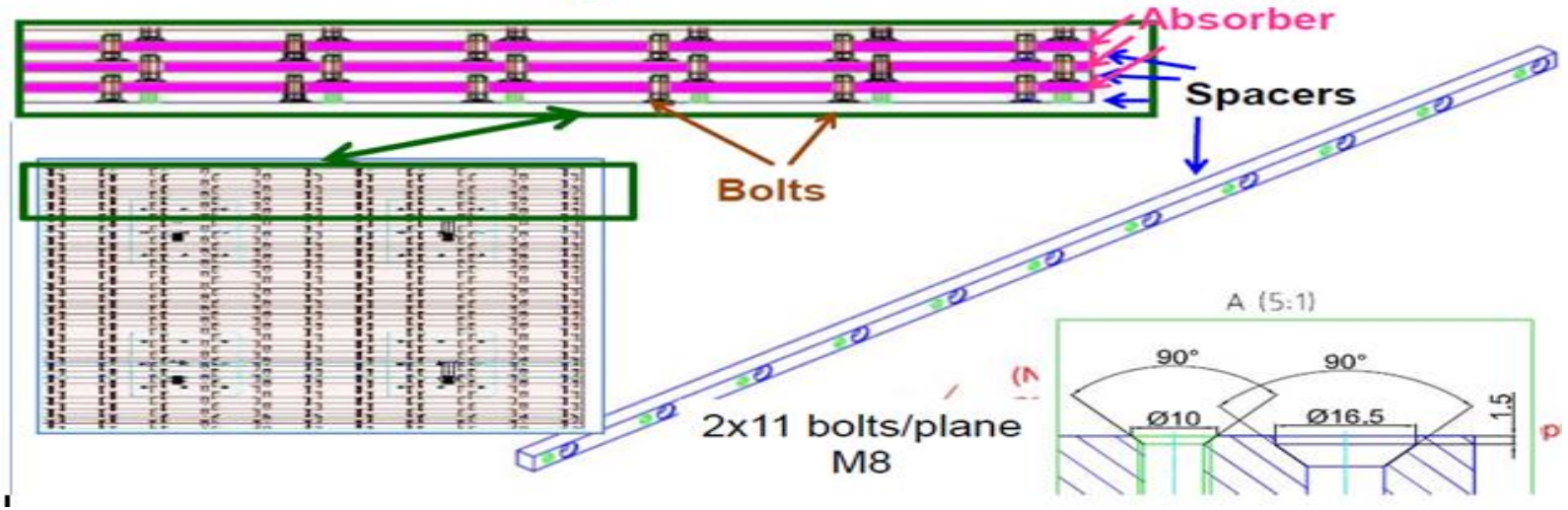
Mechanical structure : Self-supporting

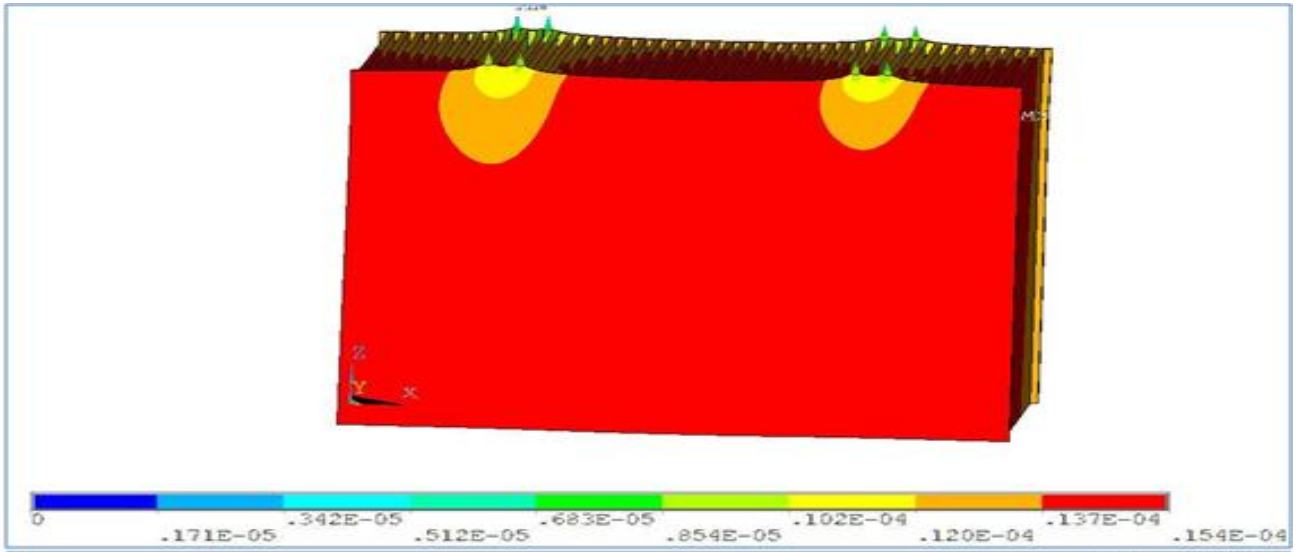


The structure is built using the absorbers. Each of them is 1.5cm thick and with lateral dimensions of 101.1 x 105.4 cm2



Spacer thickness: 13 mm

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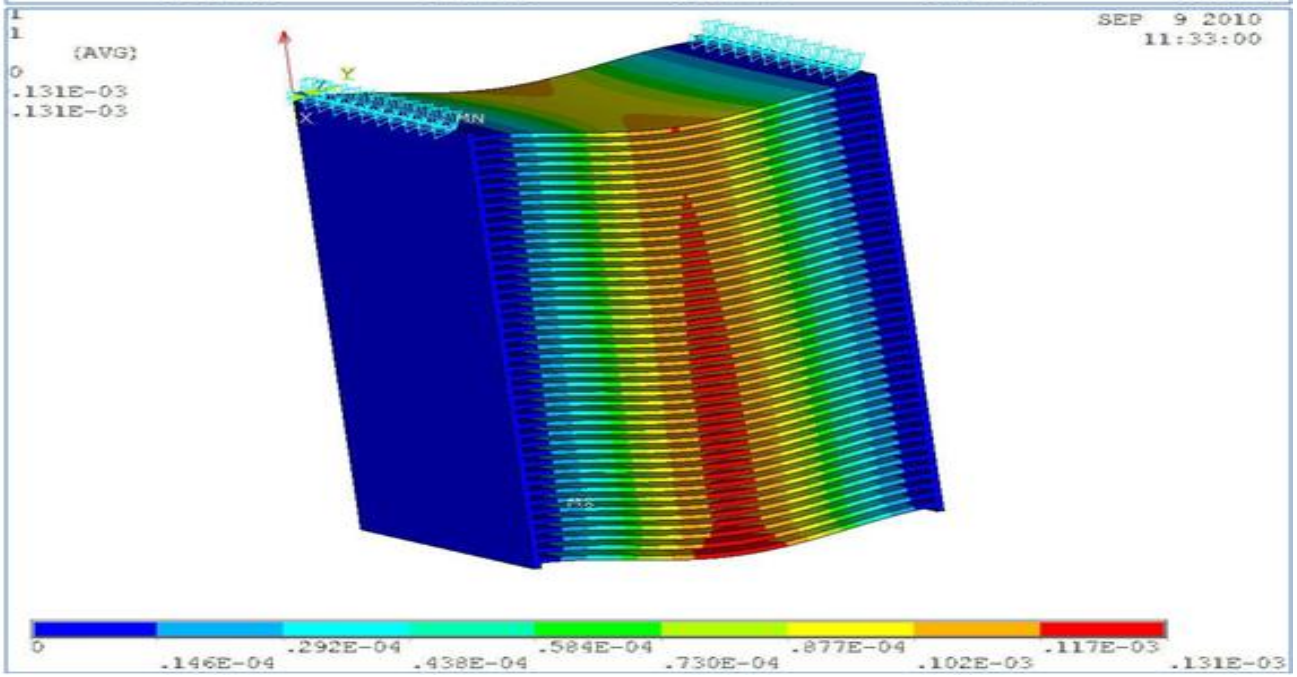
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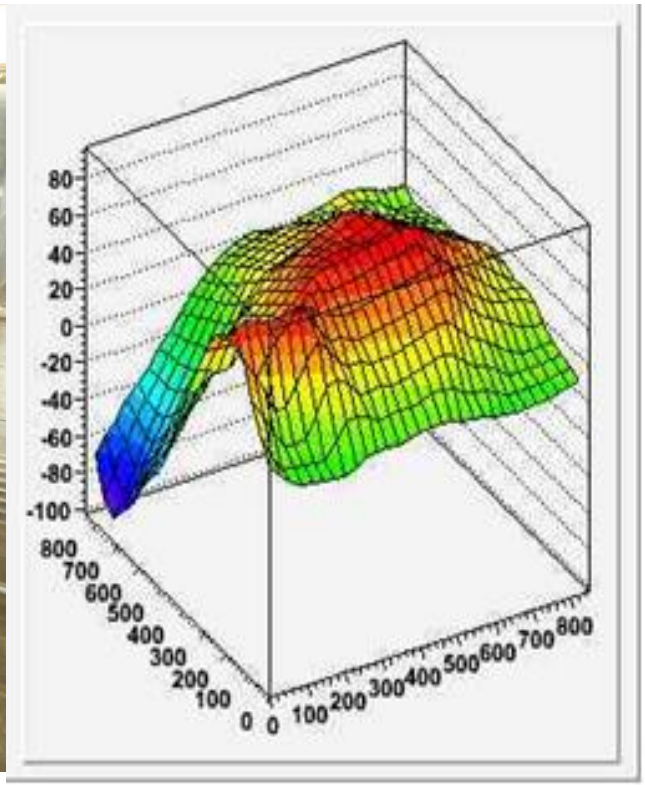
.117E-03
.131E-03

Mechanical structure

The material type : stainless steel **304L** (measured permeability had a maximum value of **1.5** → This allows to use the SDHCAL prototype in 4-Tesla magnet

Tolerance : ± 50 µm on the thickness and **250µm** maximum on the planarity of the surface.

Quality control during the mass production of the plates will include verification by the company, both of the thickness and the planarity, and then a crosscheck will be performed at CIEMAT by using a laser interferometer system ((Precision of the system about the 30-40 µm for the planarity measurement).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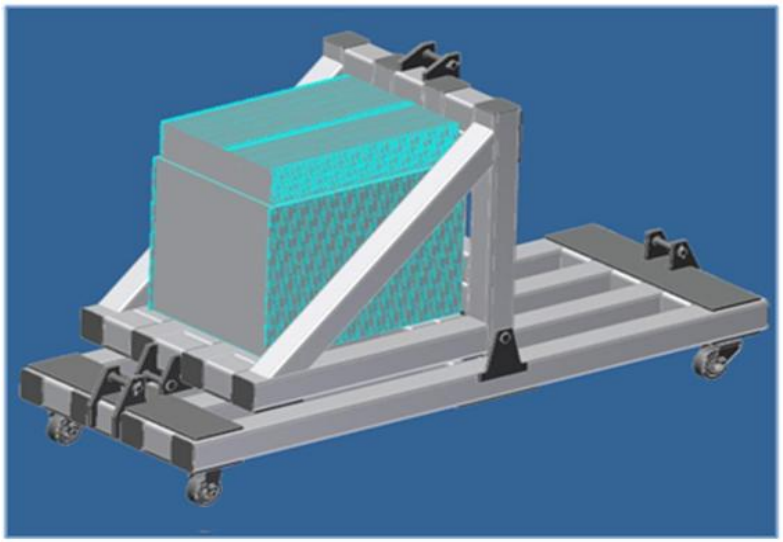
800

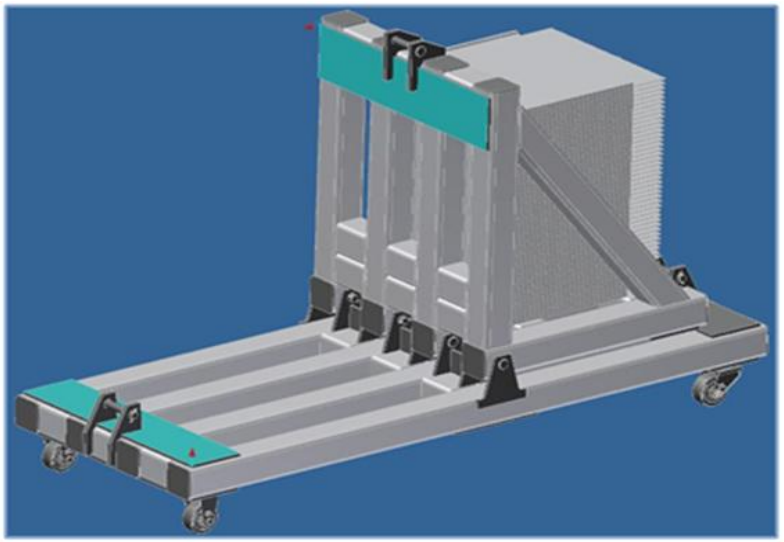
Mechanical structure

A first assembly test has been performed at CIEMAT using bare and specific tools for the handling of the plates. Some prototypes have been already built and others are under the final design.

Mechanical structure

The 1m3 prototype is a heavy structure (~8500 Kg) that we need to move and eventually rotate (for cosmic tests at the lab for example). The design of the needed tooling is being finalized and will be built at CIEMAT in the next months.

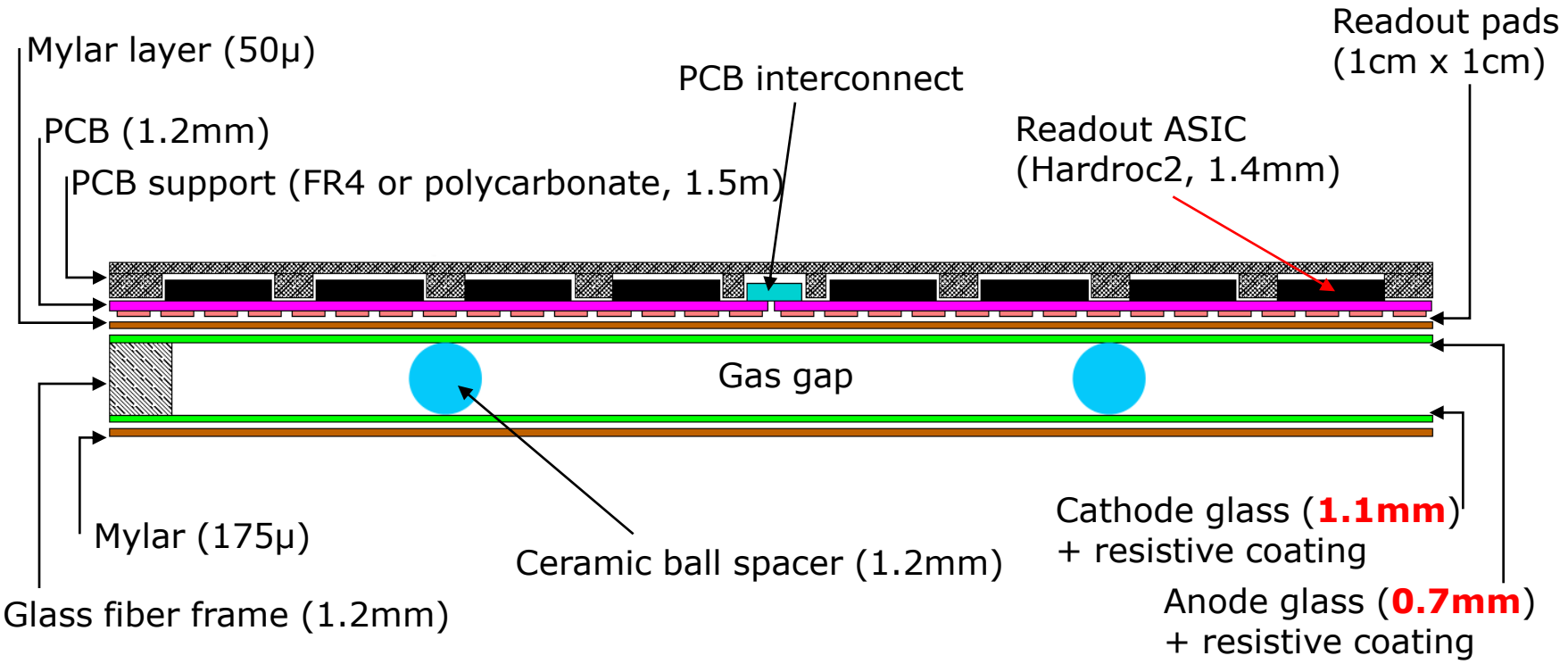




Mechanical structure

We expect the mechanical structure to be ready by March 2010

Cross-section of GRPCs

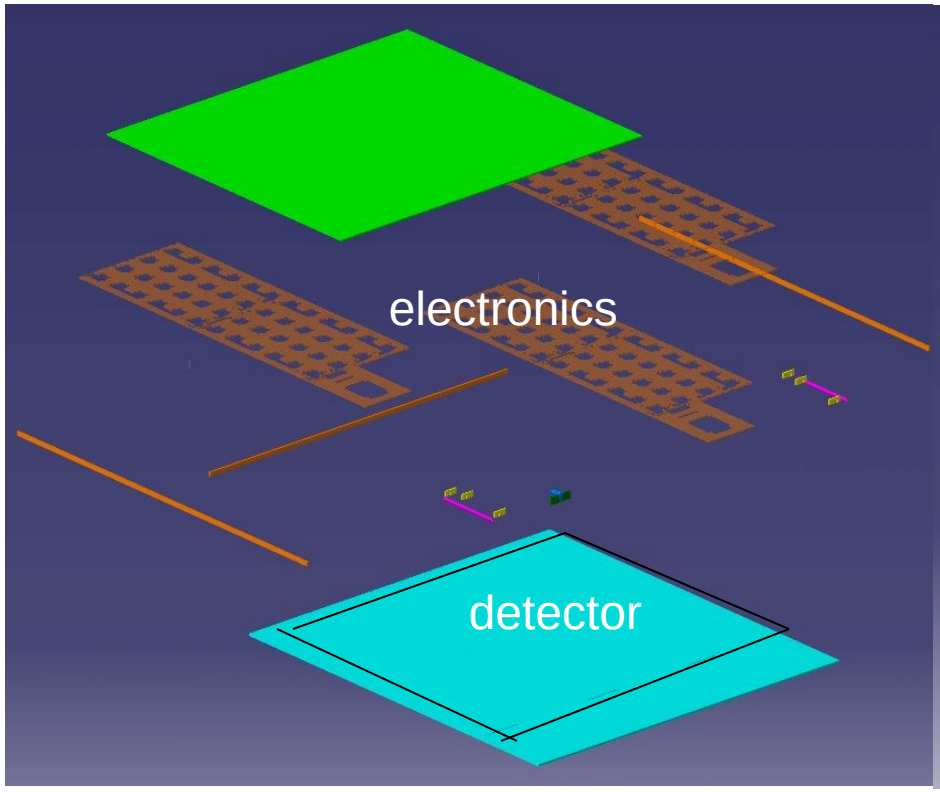


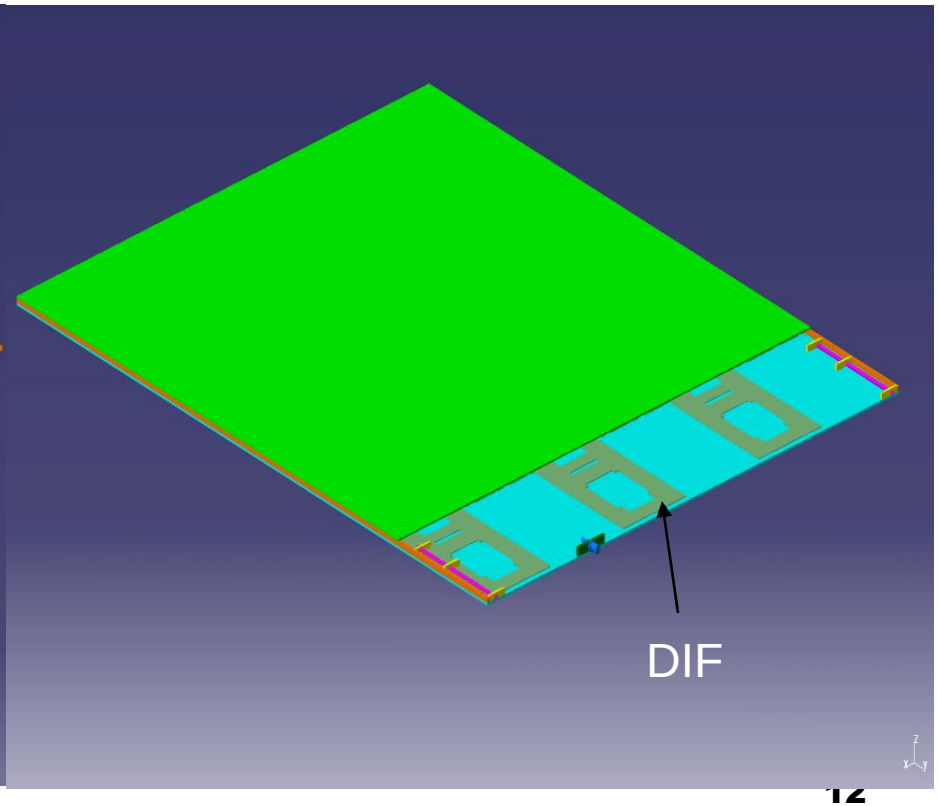
Total thickness including embedded electronics: **5.925mm**

We want to put this in a robust cassette whose walls are part of the absorber

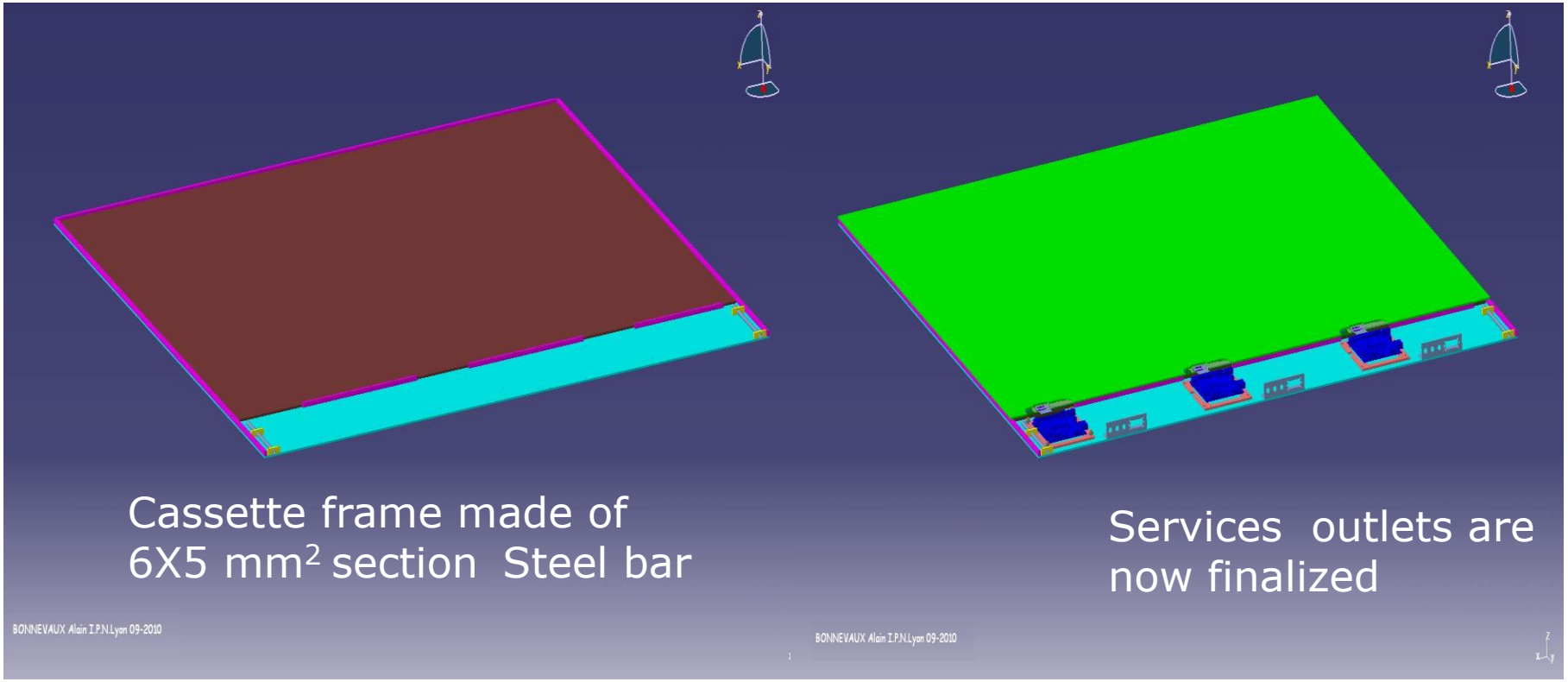
Cassette structure

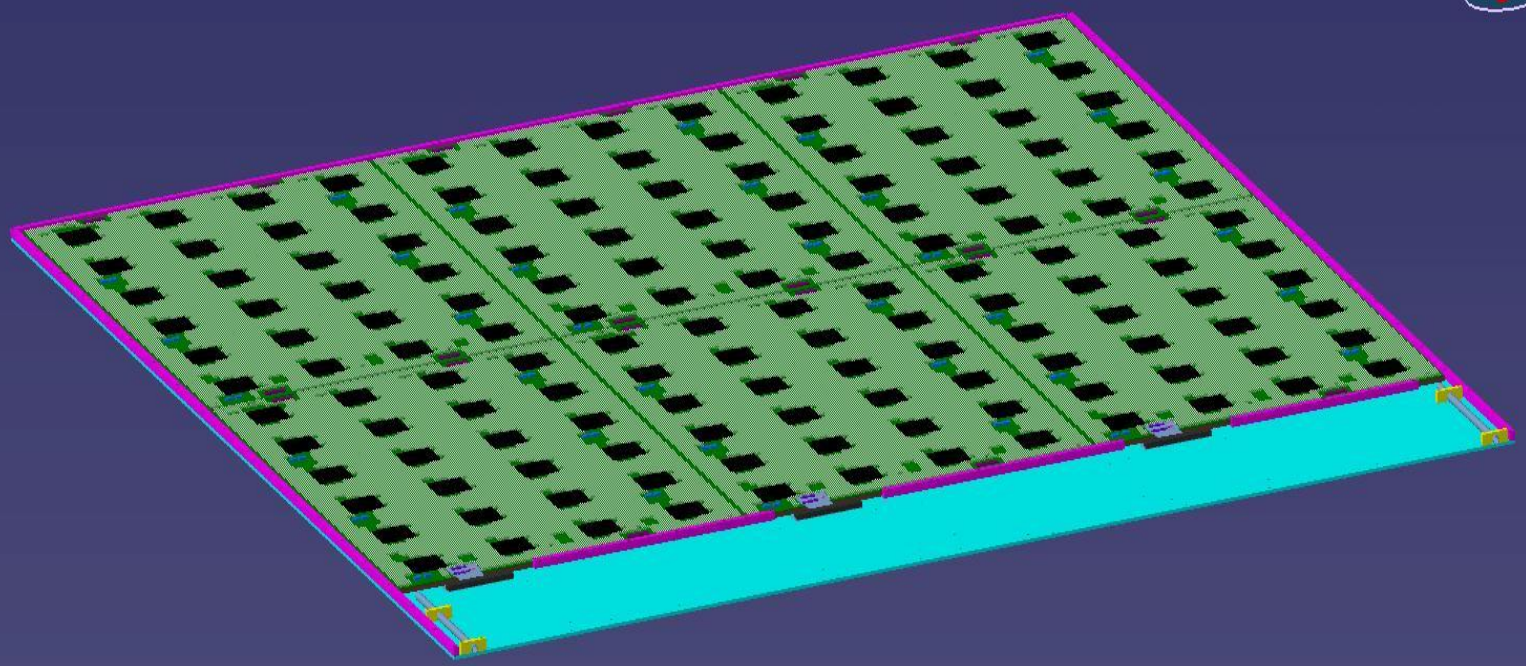
Cassette forms the elementary unit. It Includes the GRPC detector and associated electronics. It allows to fix the electronics on one plate (cover) and the detector on the other plate. The two plates (2+3 = 5 mm) are a part of the absorber
The total thickness of a cassette is 5 mm + 6 mm (sensitive medium)





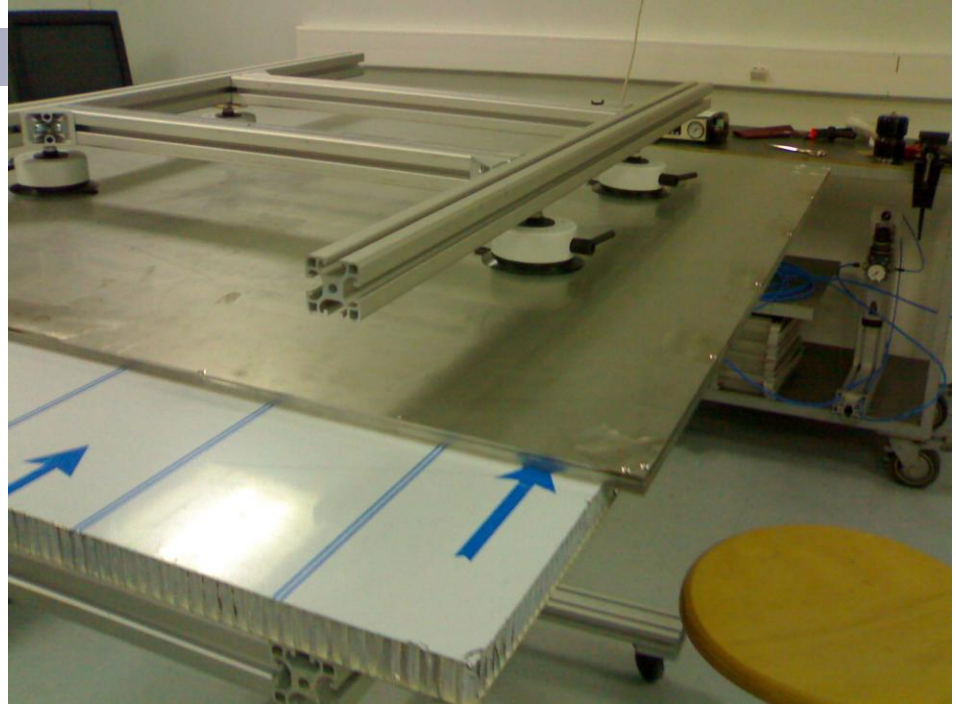
Cassette structure





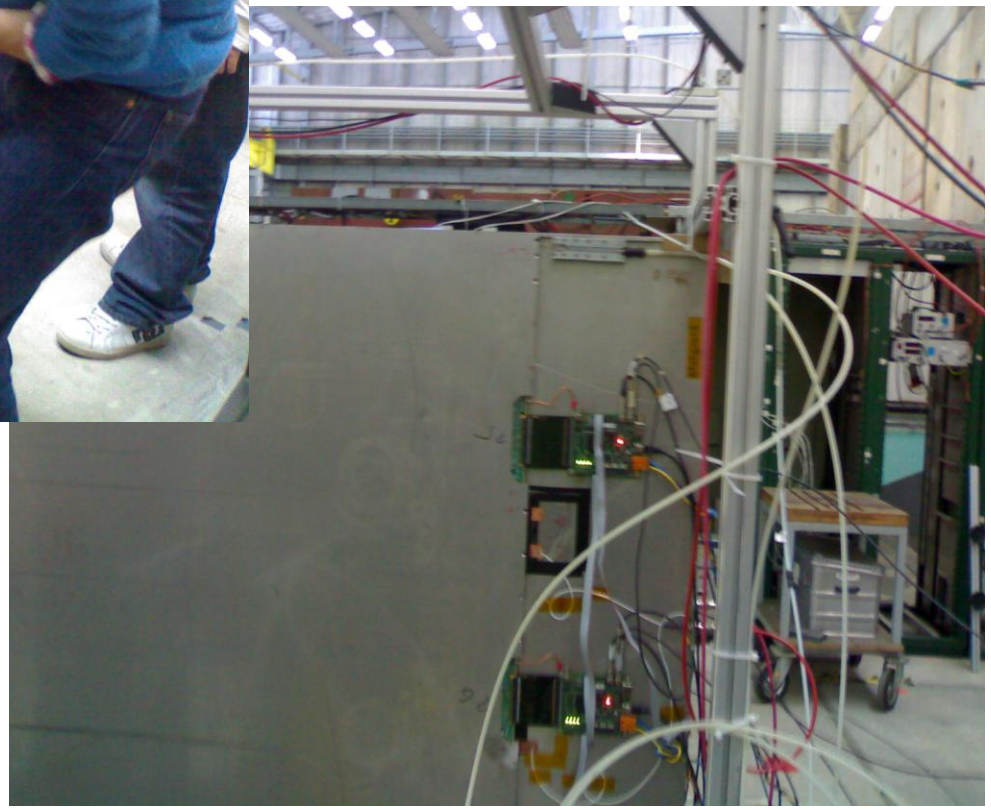
Distance from detector to edge = 2 mm

Assembling procedure



Clearance : 2 mm in Z
4 mm in X

Full cassette was successfully tested at T9-PS
May 17- 29



Cassette structure

We expect full production of all components of the cassettes before the end of November 2010

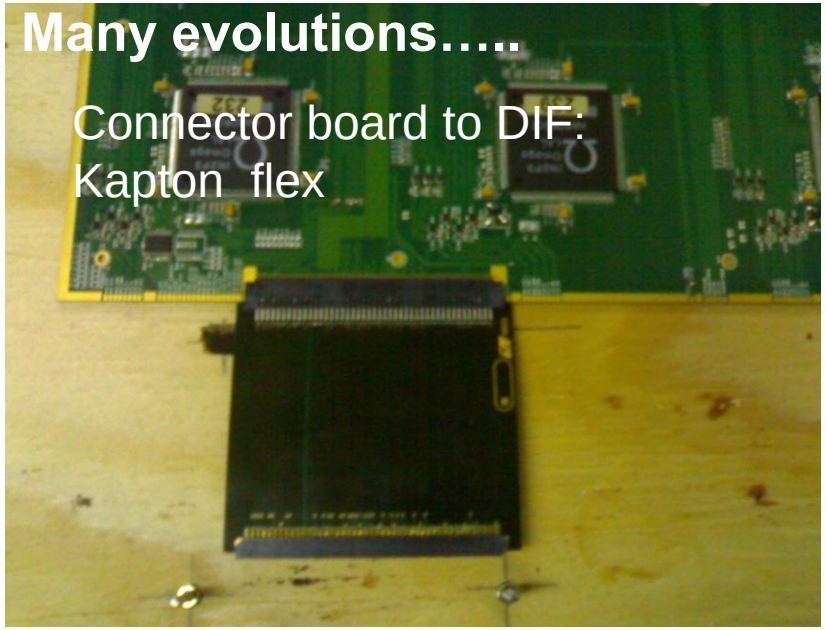
Electronics

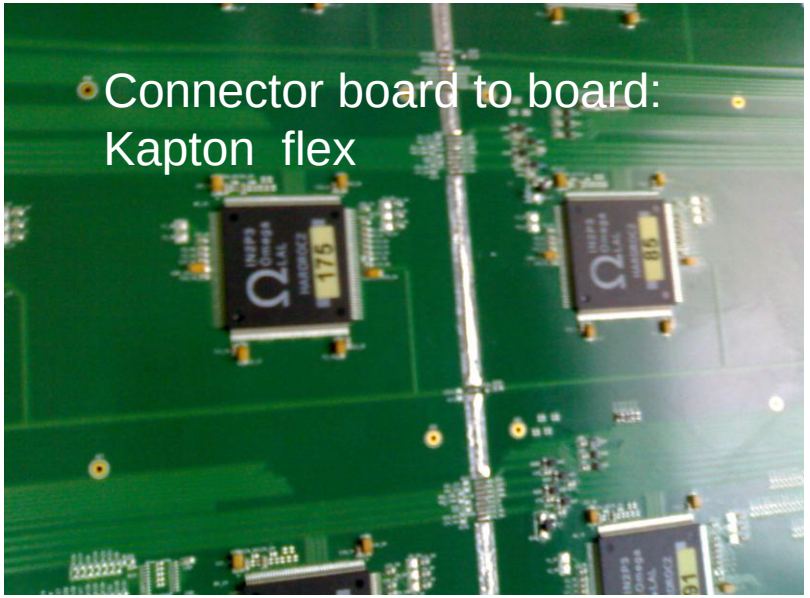
1- ASIC : Produced and being tested and calibrated (9000 ASICs)

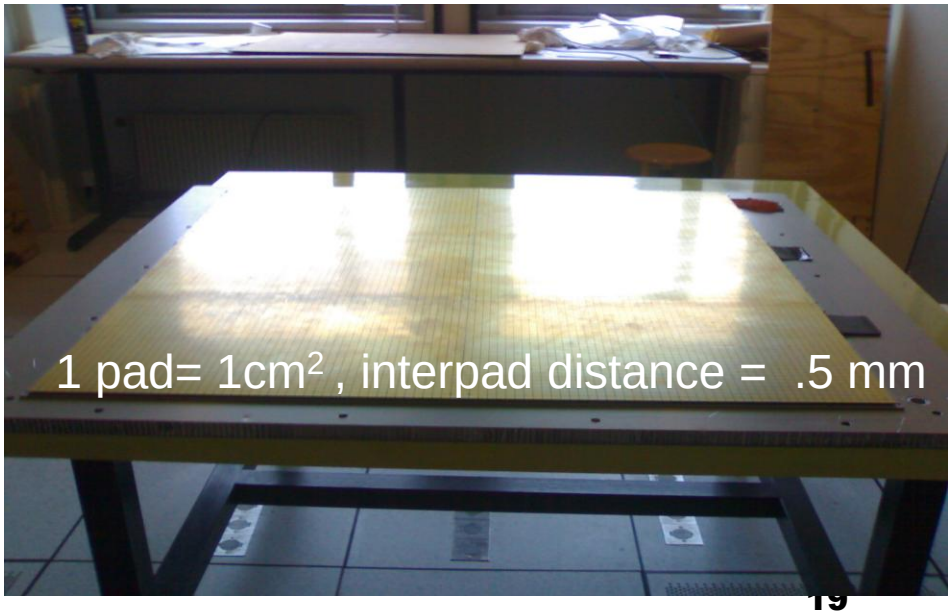
2- DIF : Produced and tested 165 available

3- ASU : Being finalized. 300 to be produced and cabled by end of November

Many evolutions…..

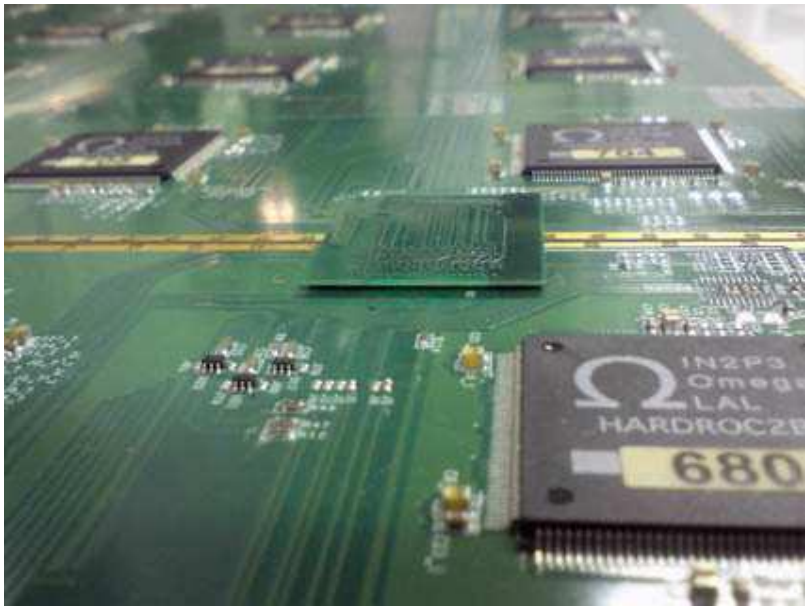




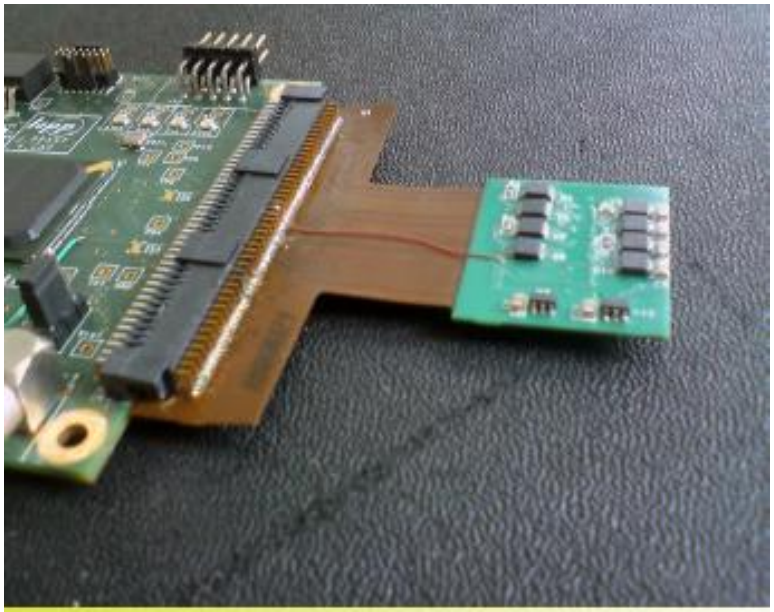


Electronics

A big effort is made on the connectors
1- More robust
2- Easily plugged



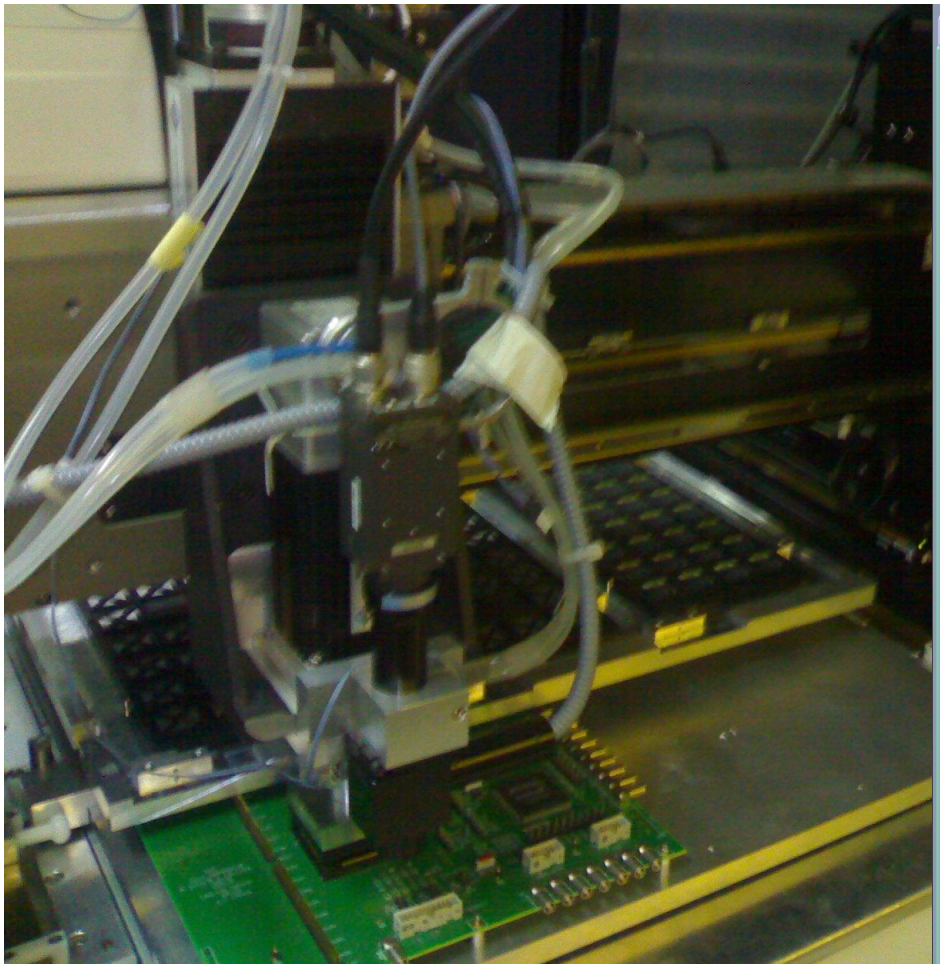
ASU-ASU connector
seems ok.

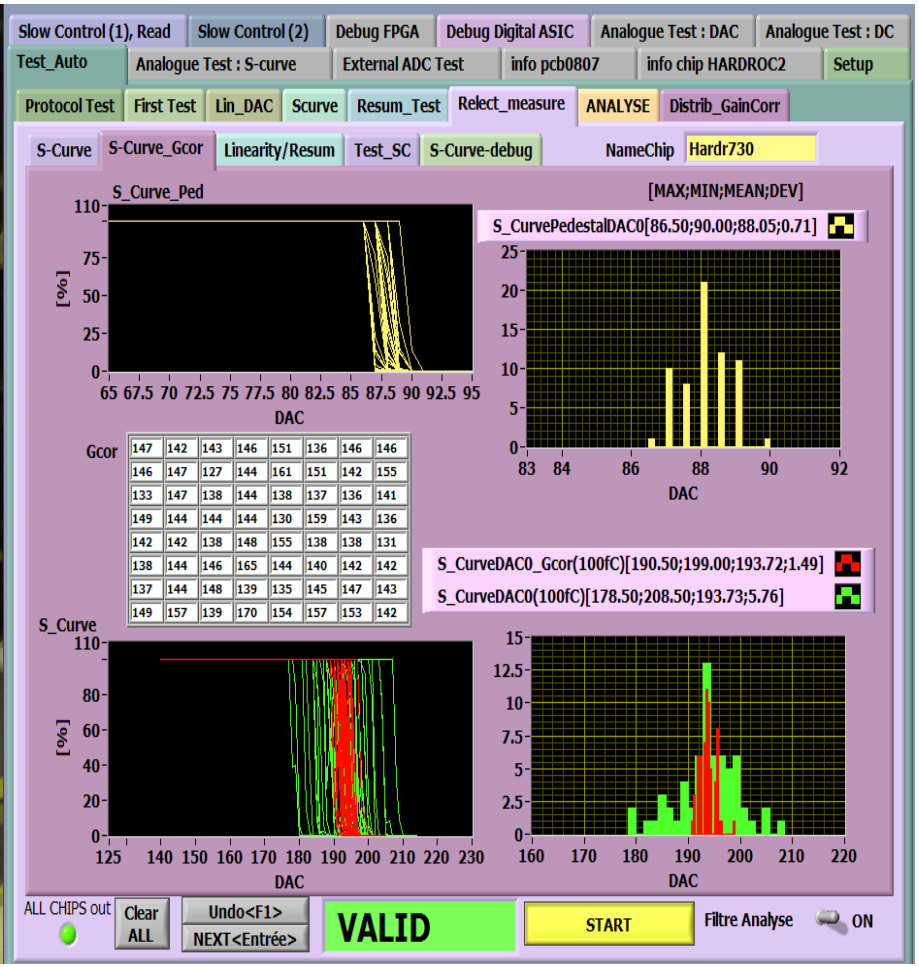


We will slightly modify
the ASU-DIF connector
Rigid-Flex to Rigid-Flex-Rigid

Electronics

A robot is being used to test the ASICs
Max test time : 10 minutes/ASIC using Labview-based application





Electronics

Electronics assembling will start as soon as the ASUs are cabled. First $1m^2$ will be completed starting from December 2010

Detectors

Components to build 60 chambers are at hand
Painting of 16 plates with semi-automatic silk screen print machine was performed.

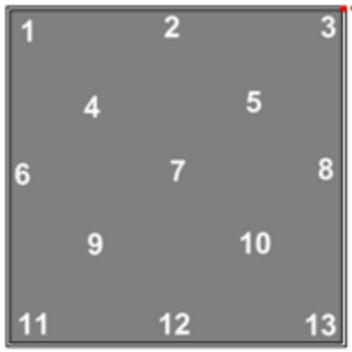
1- Painting area : 2-3 mm far from the edge was respected important to limit sparks with the cassette edges

2- Painting homogeneity : very good

1	0,53	2,6	0,18	0,29	0,17	0,25	0,16	0,32	0,16	0,36	0,18	0,33	0,18	0,42	0,25	0,22
2	0,7	2,3	0,22	0,33	0,21	0,32	0,16	0,34	0,18	0,47	0,24	0,4	0,23	0,52	0,23	0,27
3	0,7	2,5	0,15	4,7	0,18	0,23	0,15	0,37	0,19	0,33	0,17	0,36	0,18	0,37	0,18	0,23
4	0,82	3,5	0,27	0,38	0,22	0,37	0,2	0,45	0,29	0,46	0,24	0,47	0,26	0,52	0,34	0,35
5	0,97	3,8	0,23	0,45	0,19	0,37	0,25	0,45	0,23	0,42	0,23	0,47	0,26	0,46	0,29	0,33
6	0,67	3,5	0,29	0,31	0,18	0,25	0,19	0,36	0,21	0,36	0,2	0,4	0,21	0,53	0,24	0,25
7	0,97	3,2	0,26	0,42	0,22	0,37	0,22	0,41	0,25	0,44	0,23	0,46	0,26	0,62	0,28	0,31
8	0,77	52	0,21	0,3	0,18	0,29	0,22	0,34	0,27	0,36	0,17	0,4	0,18	0,5	0,19	0,28
9	0,97	∞	0,31	0,47	0,24	0,35	0,25	0,4	0,27	0,49	0,25	0,47	0,27	0,59	0,27	0,34
10	0,97	3,4	0,22	0,44	0,2	0,38	0,25	0,45	0,25	0,46	0,25	0,5	0,32	0,51	0,3	0,35
11	0,85	4	0,28	0,4	0,26	0,25	0,18	0,45	0,17	0,41	0,21	0,43	0,19	0,43	0,23	0,35
12	0,97	5,4	0,19	0,43	0,23	0,4	0,16	0,45	0,22	0,59	0,26	0,54	0,23	0,62	0,23	0,59
13	0,9	3,2	0,14	0,26	0,16	0,3	0,2	0,34	0,48	0,42	0,26	0,43	0,28	0,61	0,23	0,73
Valeur Min	0,53	2,3	0,14	0,26	0,16	0,23	0,15	0,32	0,16	0,33	0,17	0,33	0,18	0,37	0,18	0,22
Valeur Max	0,97	52	0,31	4,7	0,26	0,4	0,25	0,45	0,48	0,59	0,26	0,54	0,32	0,62	0,34	0,73
Valeur Moy	0,83	########	0,23	0,71	0,20	0,32	0,20	0,39	0,24	0,43	0,22	0,44	0,23	0,52	0,25	0,35
Rapport Max/Min	1,83	22,61	2,21	18,08	1,63	1,74	1,67	1,41	3,00	1,79	1,53	1,64	1,78	1,68	1,89	3,32
Epaisseur Verre	1,1	1,1	0,7	1,1	0,7	1,1	0,7	1,1	0,7	1,1	0,7	1,1	0,7	1,1	0,7	0,7

Verre N°2 et N°4 => Manque de Peinture

Not enough painting



POINTS DE CONTROLE RESISTIVITES

Detectors

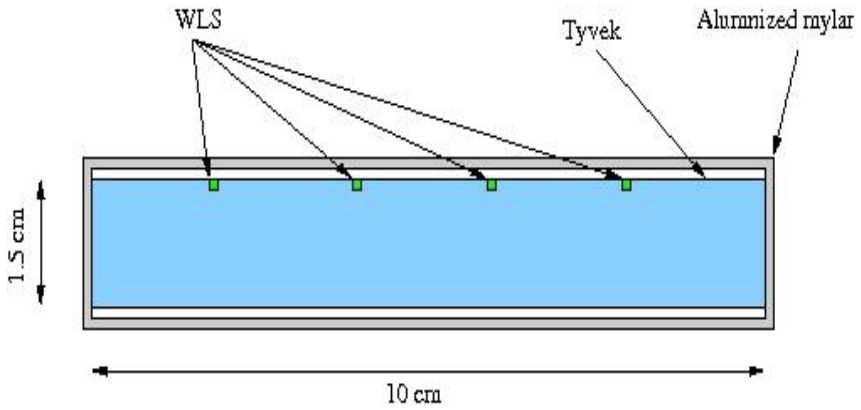
Painting of additional 100 plates will take place next month. Il takes 2 days.

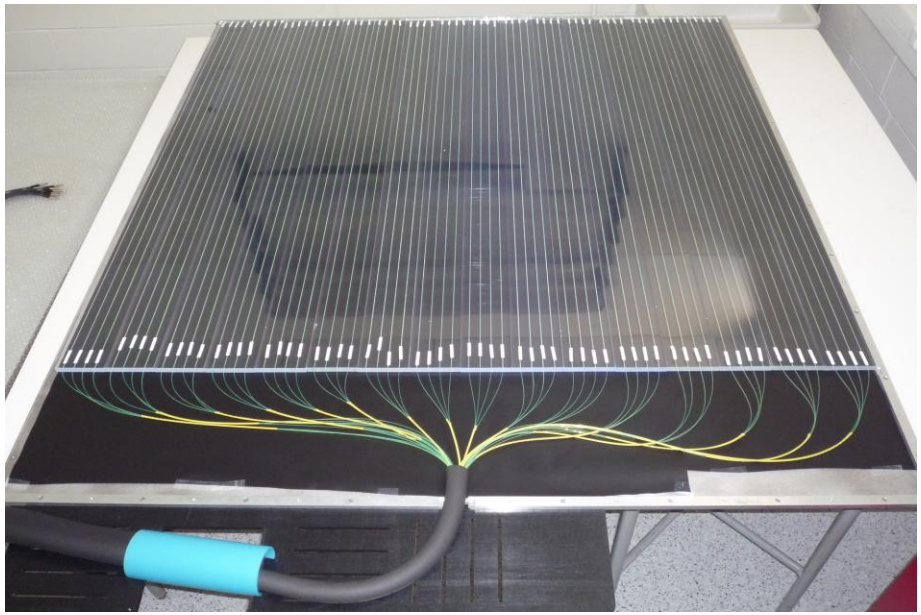
Construction of detectors has already started
We expect to build 2 chambers/week

Validation test

We intend to test our chambers and validate them using a cosmic ray stand developed by the group of Louvain.

The stand is made of 4 planes of scintillators 160X160 cm^2 each two X-Y doublets





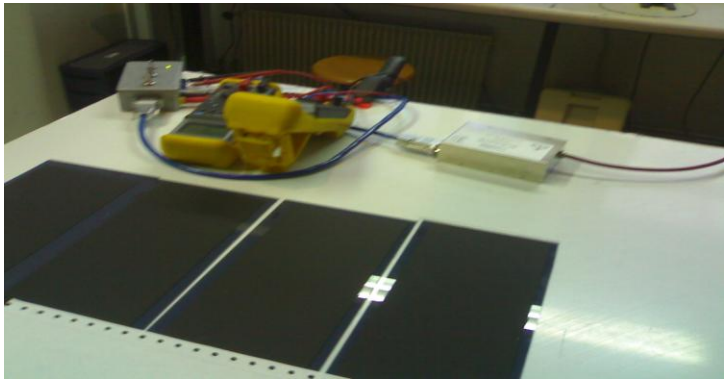
Validation tests

The two doublets will be separated By .9 m.
Up to 3 GRPC can be tested at the same time.
4 hours are enough to study the Efficiency of each pad of the GRPC chamber.

Gas system is already installed and fully functional.

GRPCs will be transported from Lyon to Louvain by a group of 6

Services: High Voltage

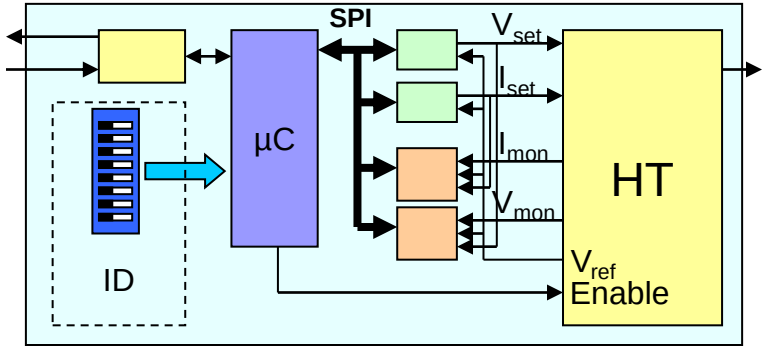


Cockcroft-Walton system

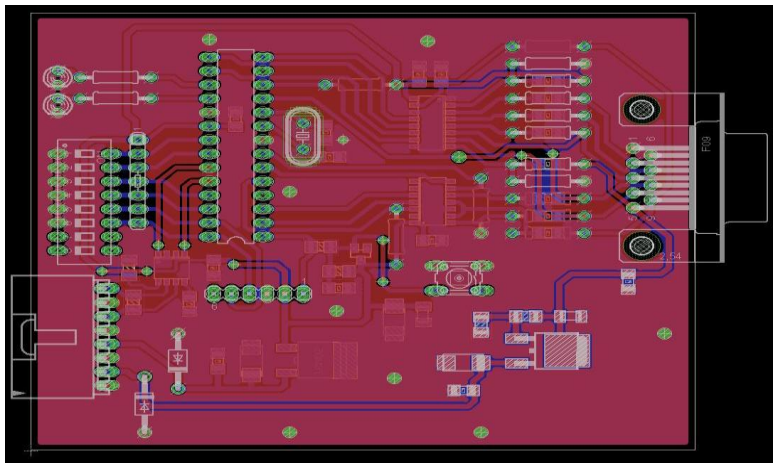
is selected as the baseline
for the technological prototype.
It satisfies safety requirement
and ILD volume limitation.
A module was developed in
collaboration with ISEG
Characteristics:

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

Still we are working to
To reduce its thickness to 21mm

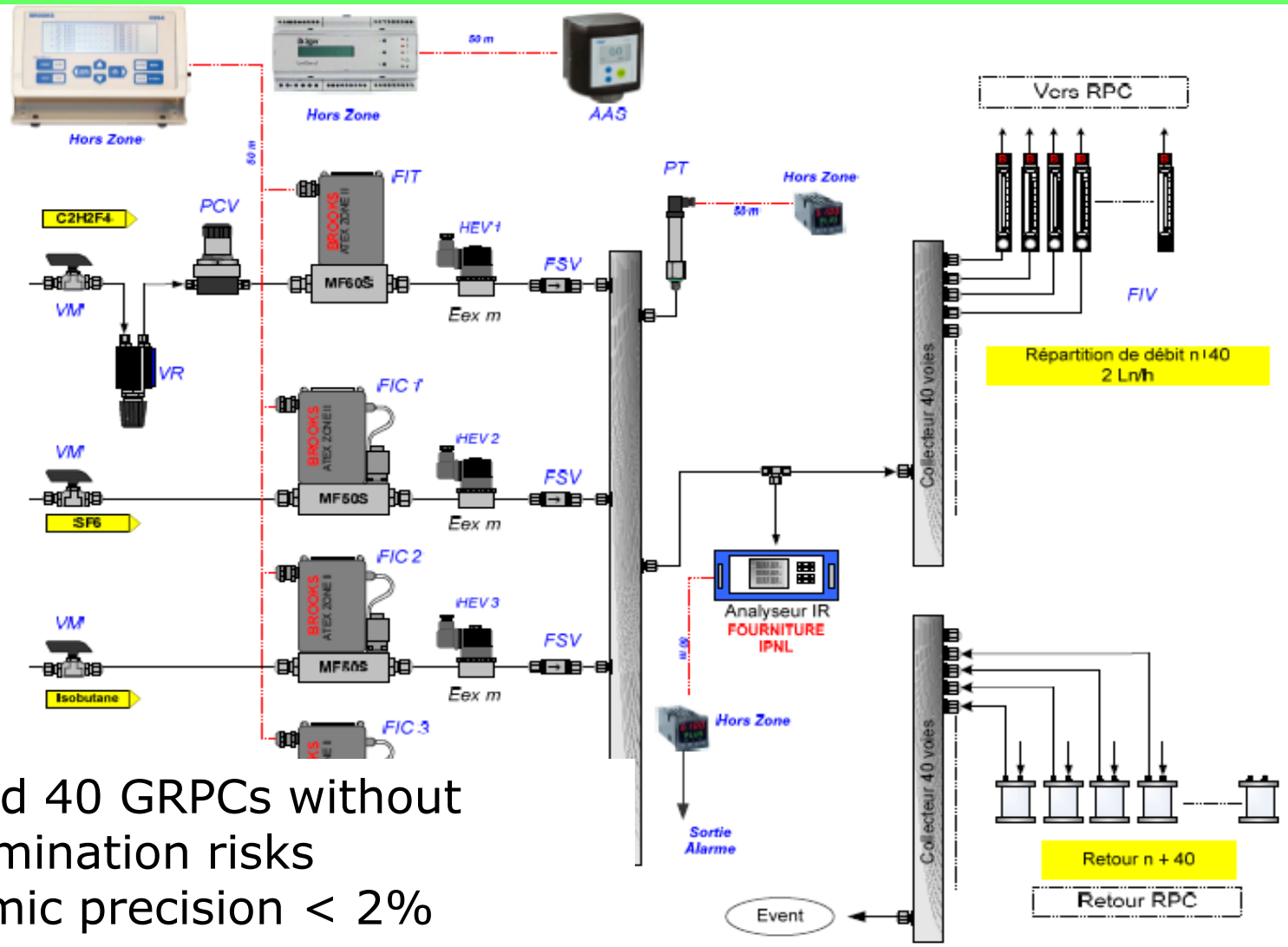


CAN Transceiver | ADC | DAC



A card to control/monitor
the voltage/current of the
40 modules independently
was conceived and being
produced

Services: Gas distribution system

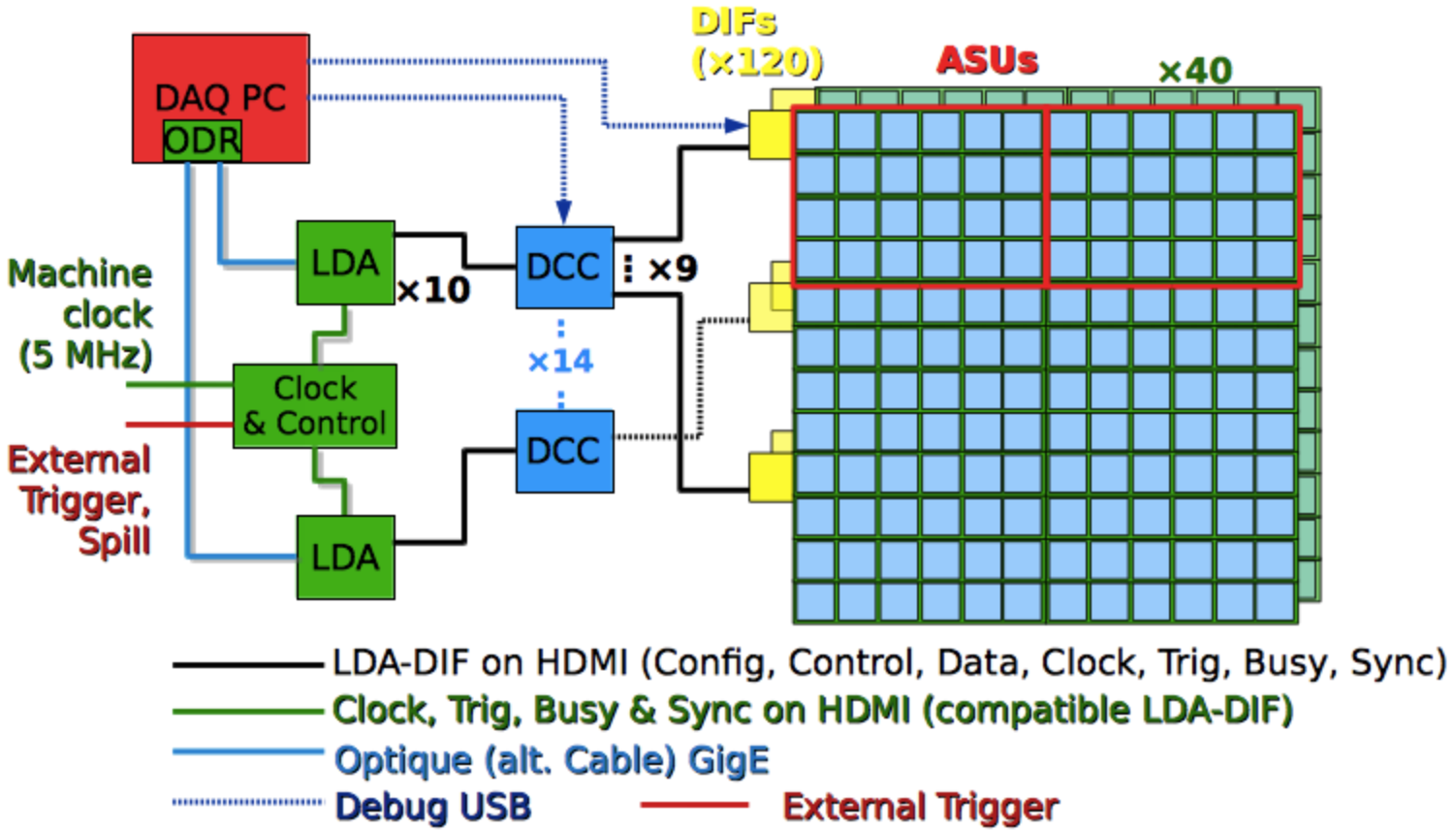


To feed 40 GRPCs without contamination risks
Dynamic precision < 2%

To be delivered soon

Acquisition system and Software

Situation is much happier now than 3 months ago
See talks of Vincent and Laurent



We think we will have the system ready by February 2011

The prototype construction schedule

- ASICs are produced and packed LAL
- and then tested using the CMS adapted Robot IPNL
- DIFs are produced and tested LAPP
- DCC, LDA and other DAQ related boards are produced and being tested by LLR
- PCBs are being finalized and production is expected soon IPNL
- Cabling will start after (IPNL)
- RPCs production will start soon (2/week) (IPNL+Gent+LPC)
- Cassettes designed and should be built by a private company and PNL,LLR..
- Assembling units (detector+cassette+electronics) will take place starting from November (IPNL)
- Testing units : Louvain-La-Neuve
- Mechanical structure will be ready by the February 2010: CIEMAT

Conclusion

- Many components are ready
- Tests are still ongoing
- Mass production has already started
- DAQ HW and SW are in advanced phase
- Realistic simulation is ongoing

We hope to be ready before March 2011

Simulation and performance study

Simulation should be as realistic as possible :

1- Including dead zones and edge effects

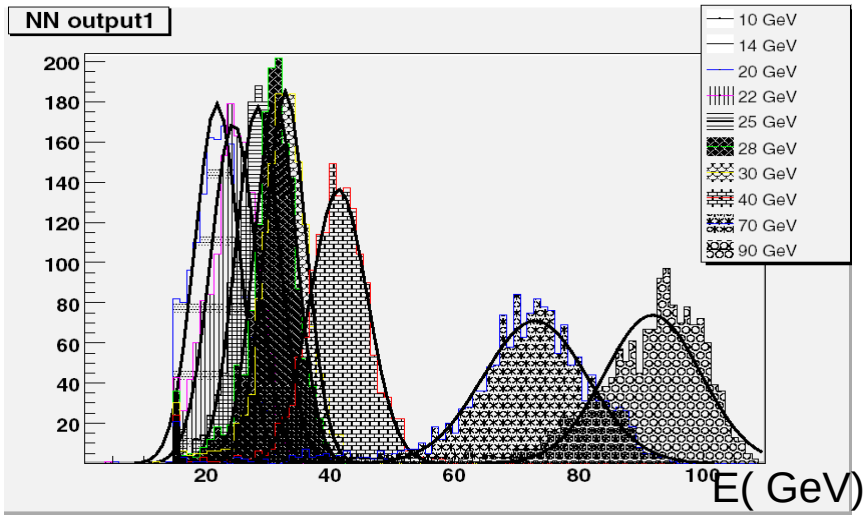
2- Obtaining the same efficiency and multiplicity as for data see R.Han talk

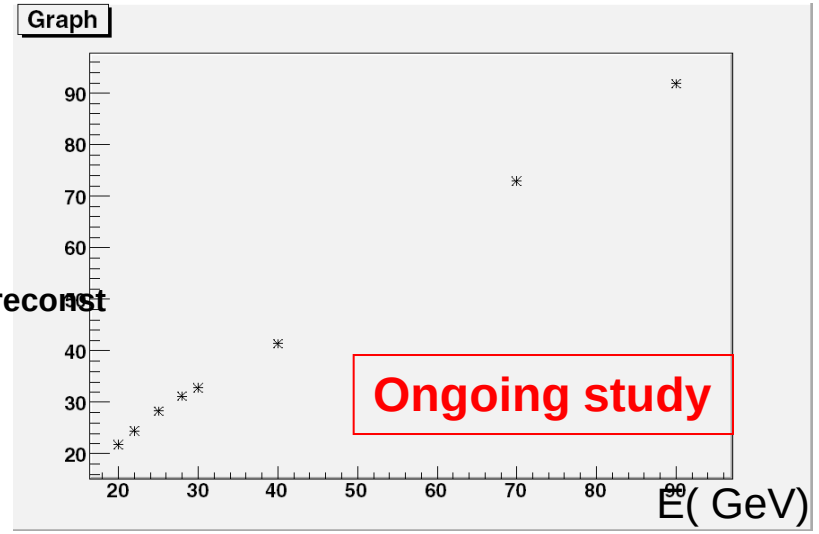
Performance study

3- Developing new algorithms to improve on energy resolution and PFA: Neural Network, Hough Transform, Minimum Spanning Tree…..

Energy resolution

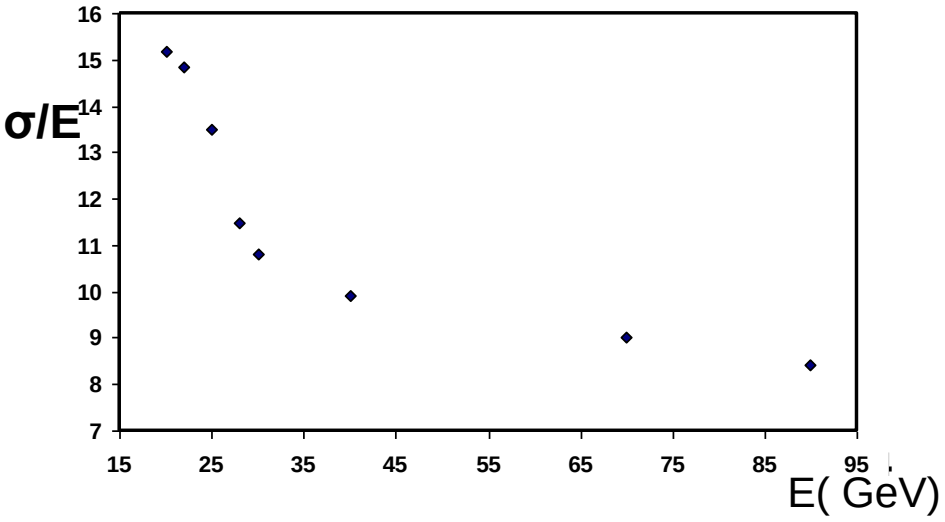
To determine the energy a Neural Network can be very helpful





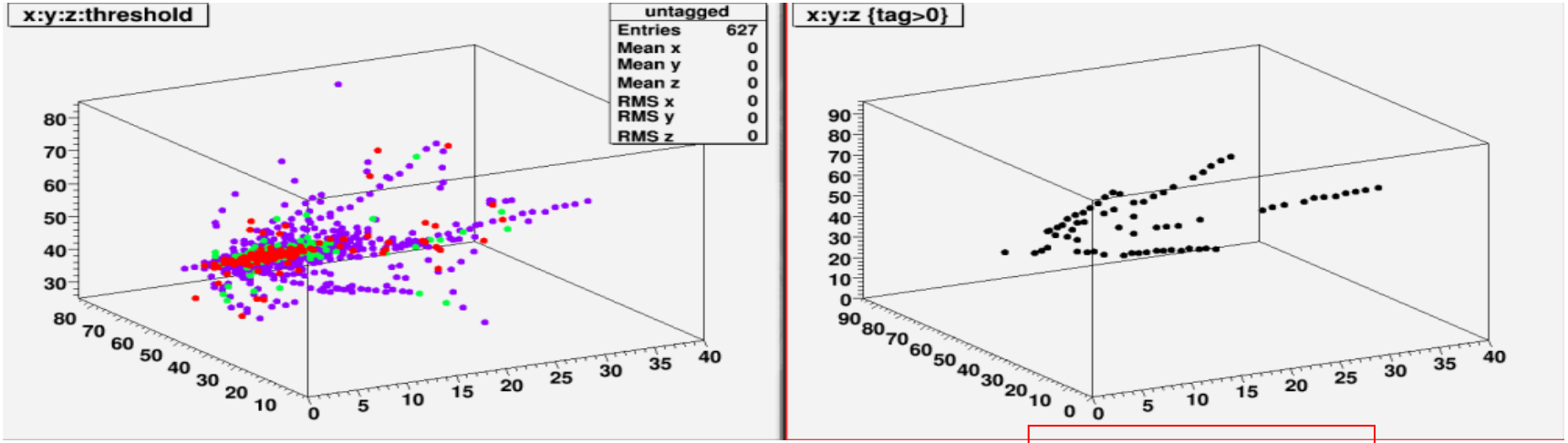
INPUTS : Number of pads with 1st,2d and 3d threshold (N_1,N_2,N_3)

Additional inputs taking into account the shower shape and its extension as well as shower density distribution are being studied



Tracking, clustering algorithms

Hough Transform : find MIP inside the hadronic shower and use them to calibrate/control the detector



Ongoing study

Minimum Spanning Tree :

→Powerful tool to connect clusters into appropriate branches.

→Useful to separate electromagnetic from hadronic contribution