Development of large GRPC at IPNL

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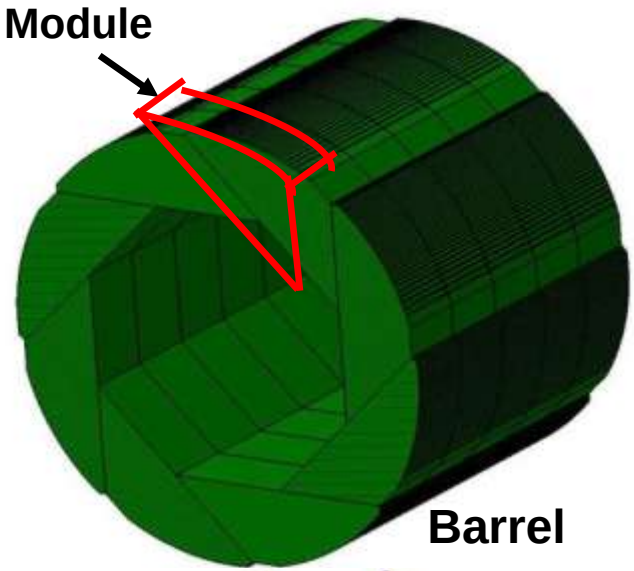
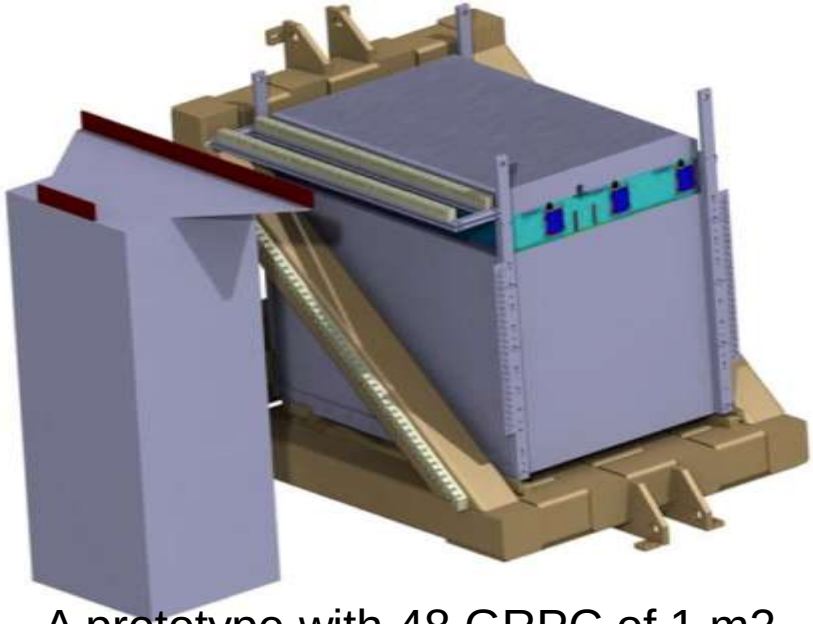
Motivation

-The Semi-Digital HCAL is one of two options proposed in the ILD LOI. It uses gaseous detectors as sensitive medium with embedded readout electronics providing 1cm2 lateral segmentation.
-A genuine mechanical structure is proposed for the SDHCAL.

GRPC was chosen as the baseline :
-Cost-effective
-High efficiency
-Adequate resolution

Challenges
-homogeneity for large surfaces
-Thickness of only few mms
-Services from one side
-Embedded electronics





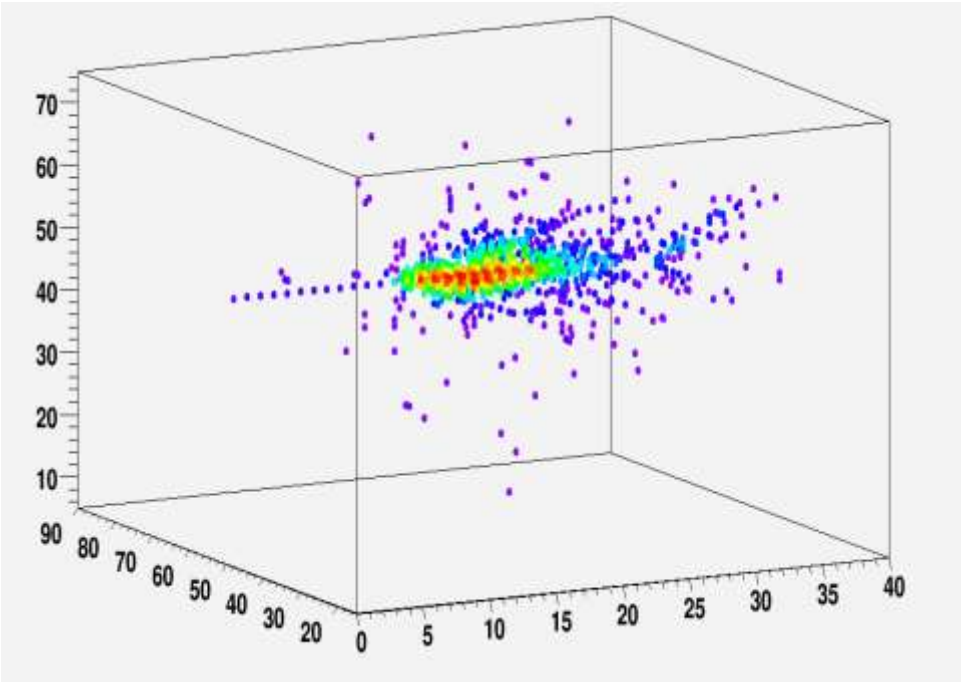
A prototype with 48 GRPC of 1 m2 was conceived as a demonstrator

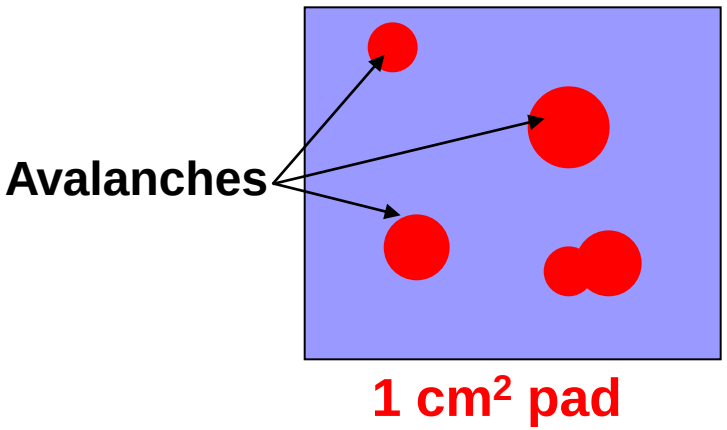
Motivation

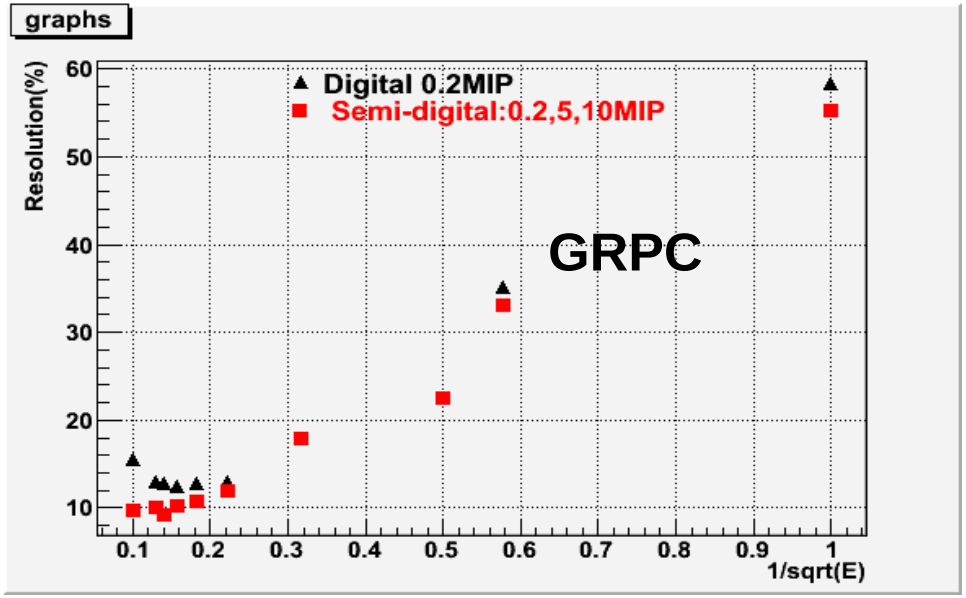
Electronics readout choice

At high energy the shower core is very dense→ simple binary readout will suffer saturation effect

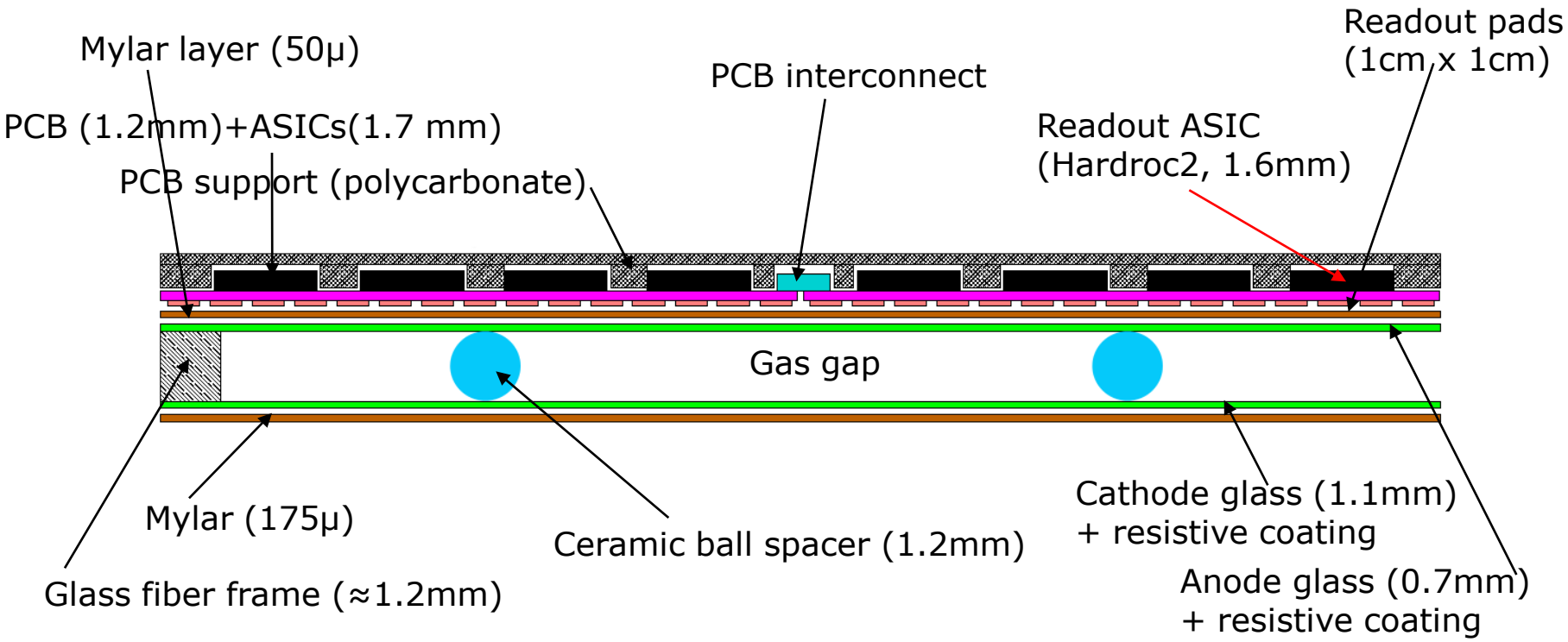
→ semi-digital readout (2-bit) can improve the energy resolution.







Cross-section of Lyon 1m^2 glass RPCs

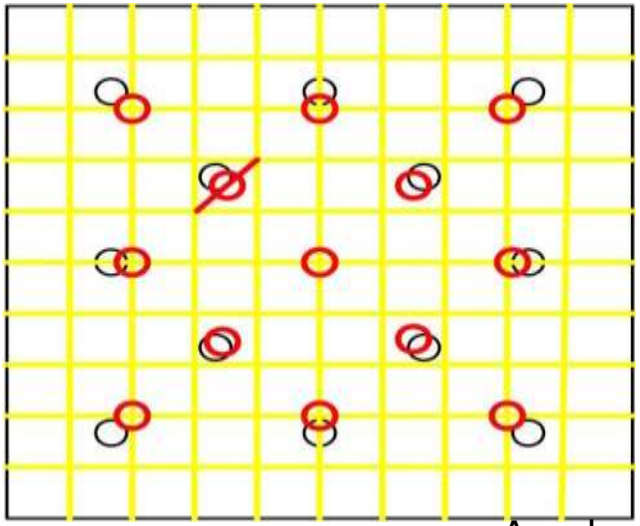


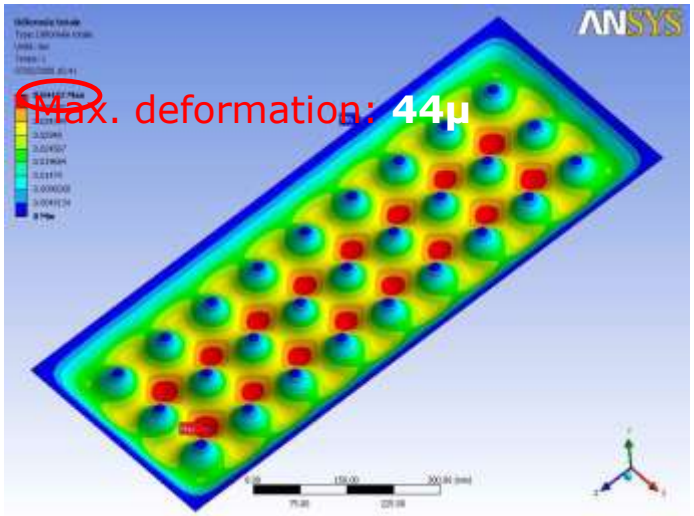
Total thickness: 6.0mm

The choice of ceramic balls rather than fishing lines aims at reducing both dead zones and noise.

Homogeneity study

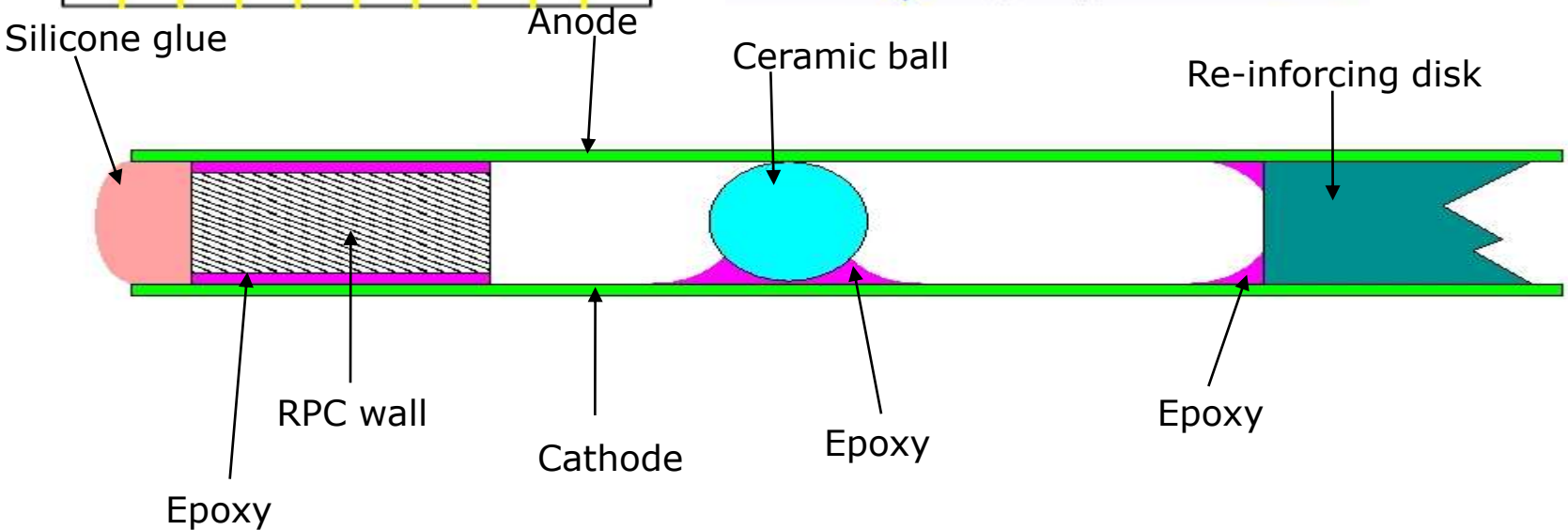
To maintain the same distance between the two glass plates, spacer are used every 10 cm : 68 ceramic balls+ 13 fiber glass disks.





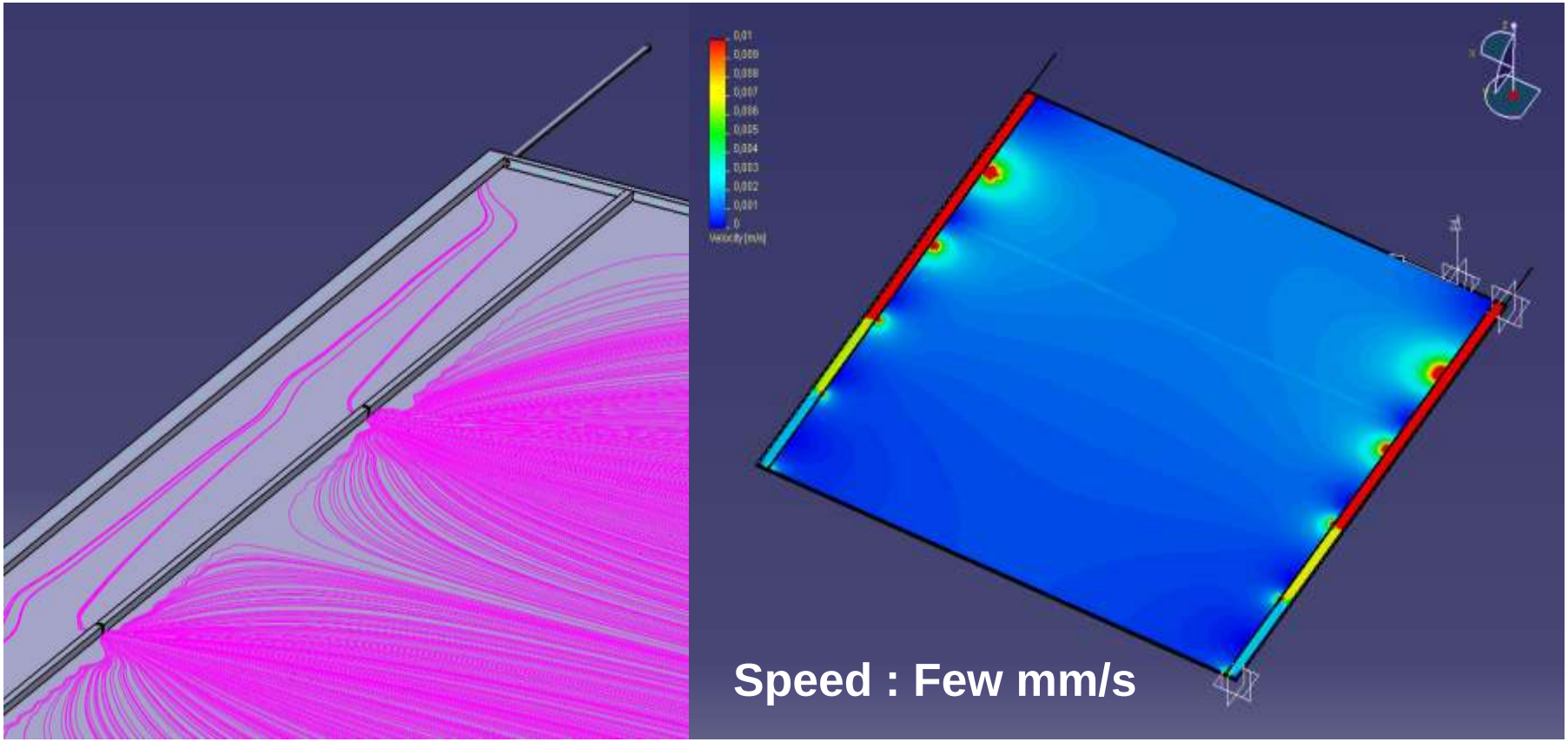
Included
- glass weigh
- electrostatic force

Not included
- Gas pressure



Gas distribution system

The services being on one side of the detector, a new gas distribution design is used. It allows to distribute the gas uniformly in the large chamber.



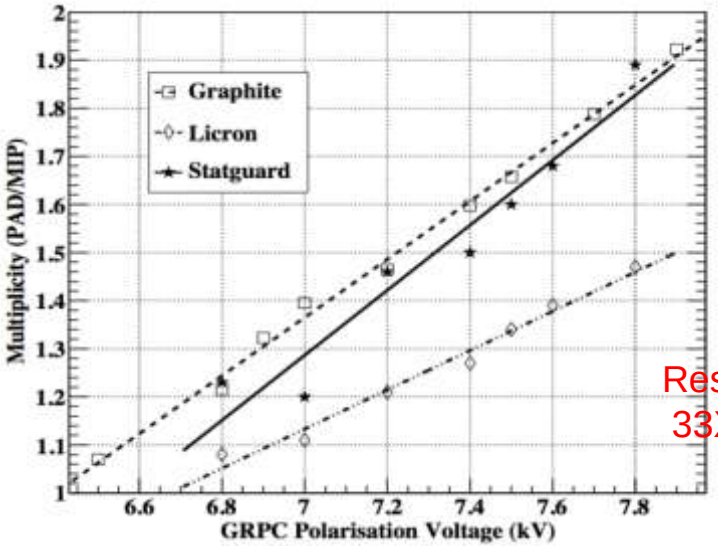
When diffusion is included→ Homogeneity is expected to be even better

A test using Kr83m radioactive gas is scheduled to monitor online the gas distribution

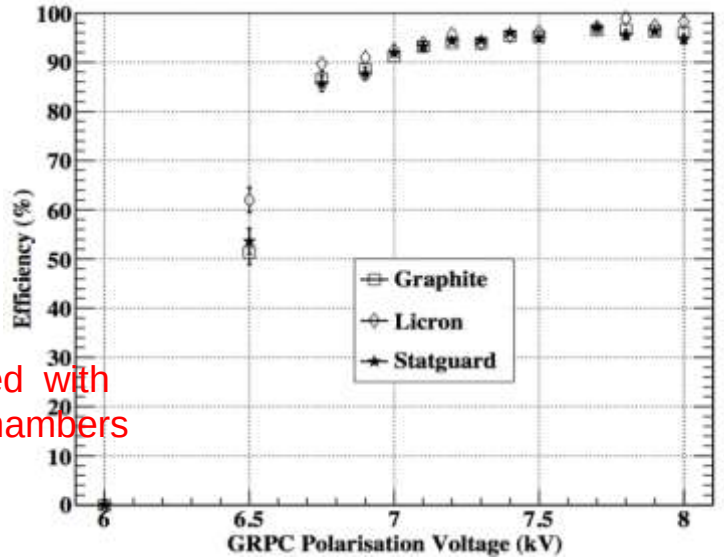
Resistive coating study

The resistive coating is needed to apply the HV on the two glass plates (electrodes). The resistivity value of this coating plays an important rôle of the pad multiplicity. The higher the resistivity the lower the multiplicity
Three kinds of coatings were tested :

	Licron	**Statguard**	**Colloidal Graphite type I**	**Colloidal Graphite type II**
Surface resistivity (MΩ/□)	~20	1-10	~0.5	Depends on mix ratio; choose ~0.7
Best application method	Spray	Brush	Silk screen printing	Silk screen printing



Results obtained with 33X8.3 cm2 chambers

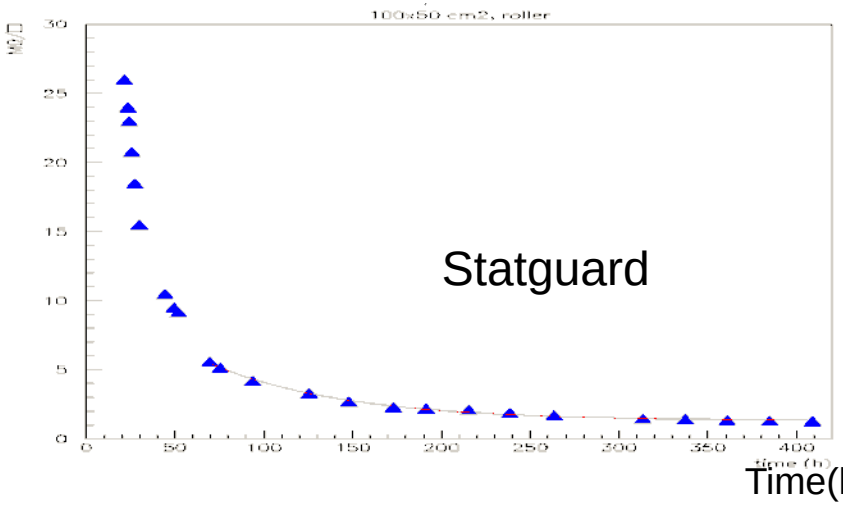


Resistive coating study

Licron and Statguard are more appropriate for low pad multiplicity. However :

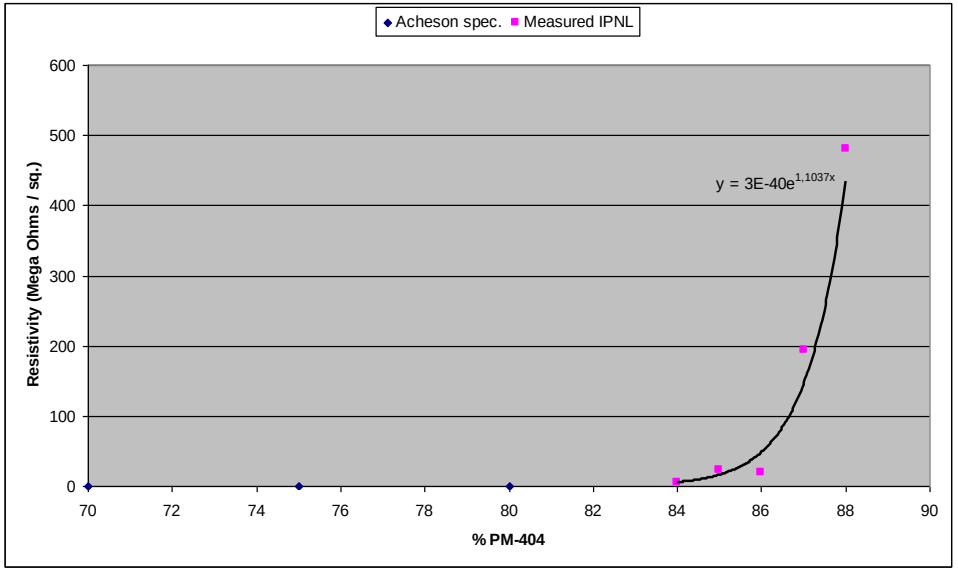
Licron : Loss of HV connection over time (1-2 months)

Statguard : long time constant for stable resistivity (2 weeks), poor homogeneity



Time(h)

The colloidal graphite of type II is less expensive and allows to choose the needed resistivity even if this is a delicate operation



Measured resistivity as a function of the mix ratio

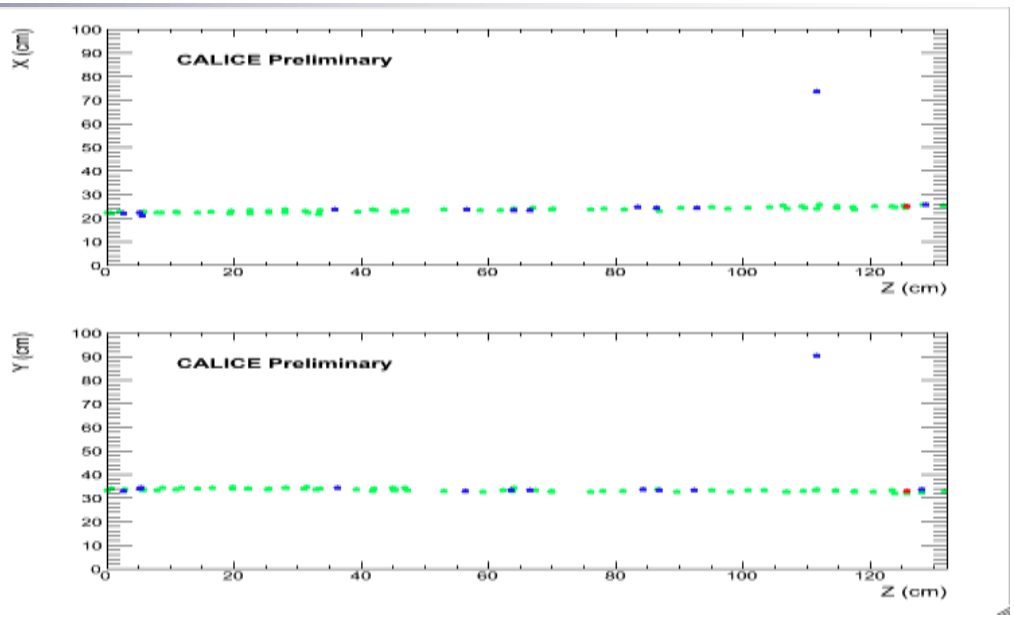
/tmp/PreviewPasteboardItems/LCWS11 - SDHCAL (glissé(e)s) 2.pdf

The SDHCAL prototype was assembled at CERN and then exposed to pion beam at H2-SPS in June 2011

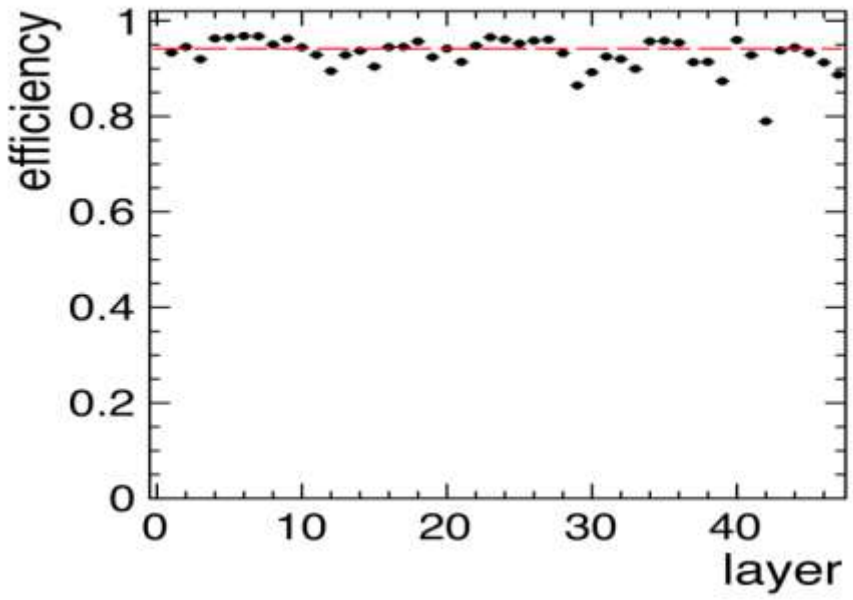
Prototype data acquisition

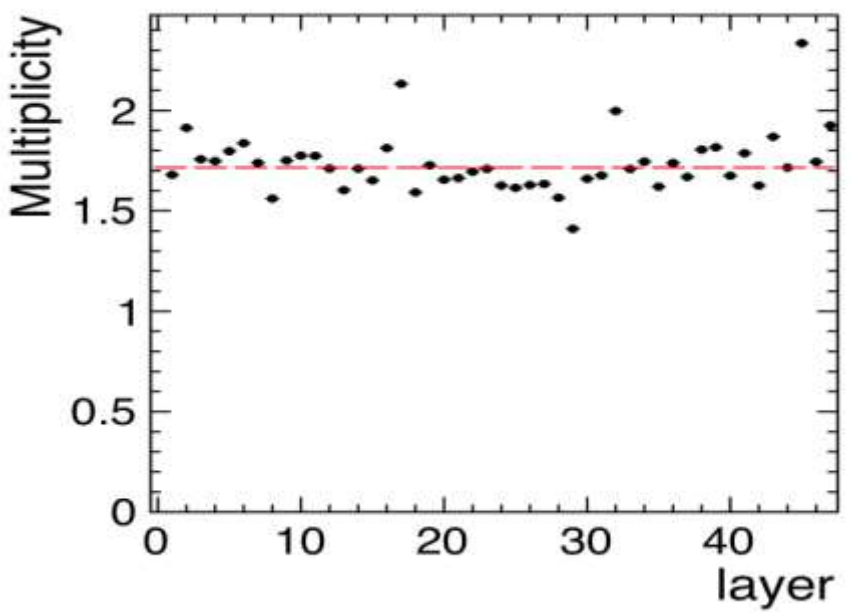
Muons are used to study the GRPCs behaviour during the TB

HV : 6.9 kV
Gas flow : 2 l/h
Gas mixture:
93% R134A, 5% CO_2, 2% SF_6



Colours correspond to the three thresholds: Green (100 fC), Blue (5 pC), Red (15 pC)



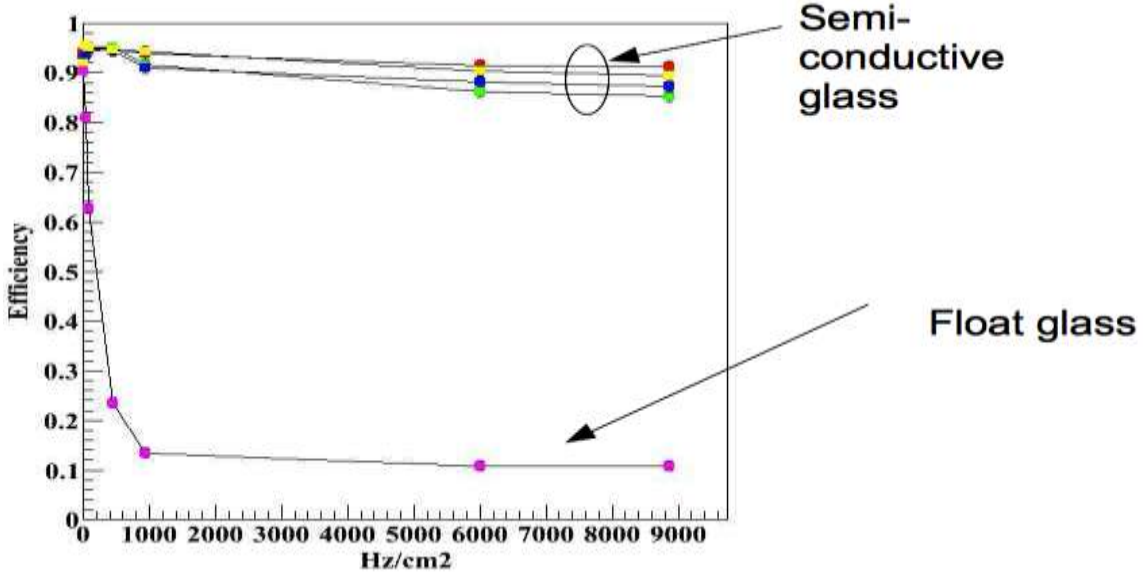


High-Rate GRPC

High-Rate GRPC may be needed in the very forward region

✓Semi-conductive glass (10^{10} Ω.cm) produced by our collaborators from Tsinghua University was used to build few chambers.
✓4 chambers were tested at DESY as well as standard GRPC (float glass)

Performance is found to be excellent at high rate for GRPCs with the semi-conductive glass and can be used in the very forward region if the rate > 100 Hz/cm
This is proposed for the High eta region of CMS



Perspective

1- Build few large GRPC (2-3 m^2) equipped with new ASIC HR3 developed by Omega. To completely demonstrate the SDHCAL option for ILD

2- Build few chambers with the CMS scheme using semi-conductive glass (single and multi-gap) and develop/adapt the readout electronis