The VETO system of the OPERA experiment

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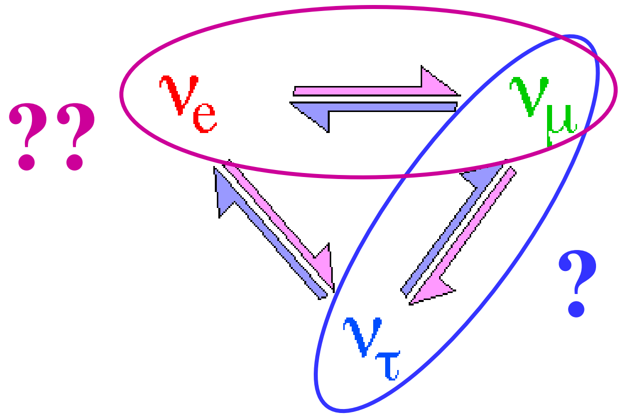
Outline:

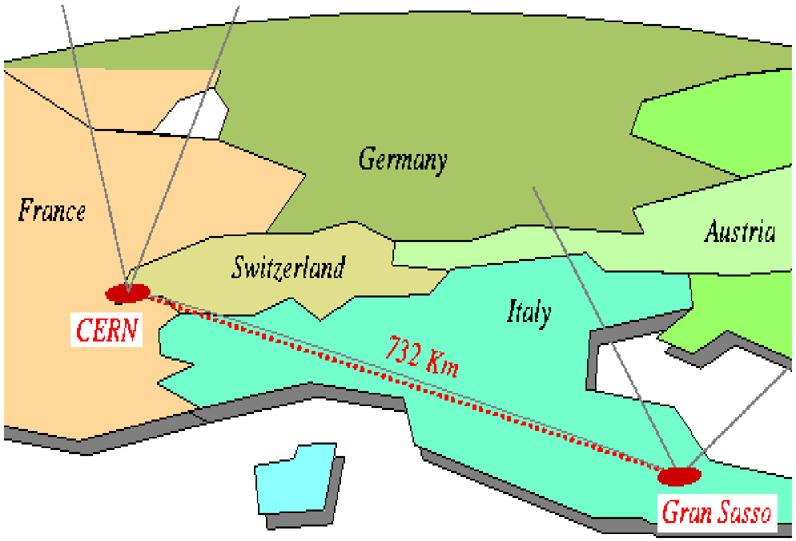
- **Mechanical Structure**
- **Tests on glass RPC**
- **System monitoring**
- **GRPCs status**

Physics motivation ***and*** *conceptual design*

- **Provide unambiguous evidence for $\nu_\mu \rightarrow \nu_\tau$ oscillations in the atmospheric neutrino region ($\Delta m^2 = 1.5\text{–}3.0 \times 10^{-3}\, eV^2$) through the appearance of ν_τ in a pure ν_μ beam**
- **Search for the sub-leading $\nu_\mu \rightarrow \nu_e$ oscillations (θ_{13})**

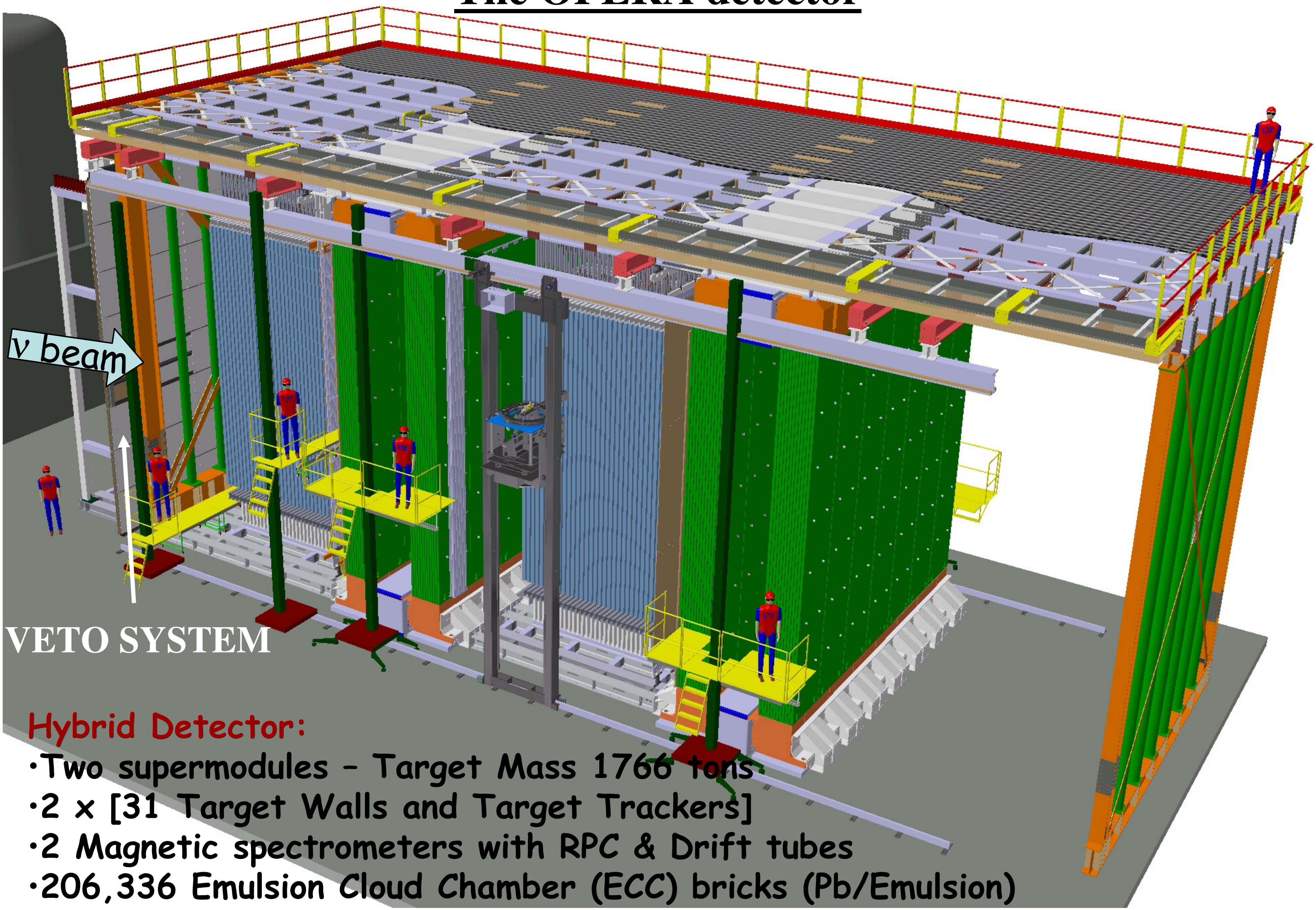


- **ν_μ beam produced at CERN and sent to Gran Sasso (*$E_{CM} >> m_\tau$, L ~ 730 km*)**
- **Weak neutrino interactions → kton mass and low background**
- **Observation of τ lepton decays → High spatial granularity**



Mechanical Structure

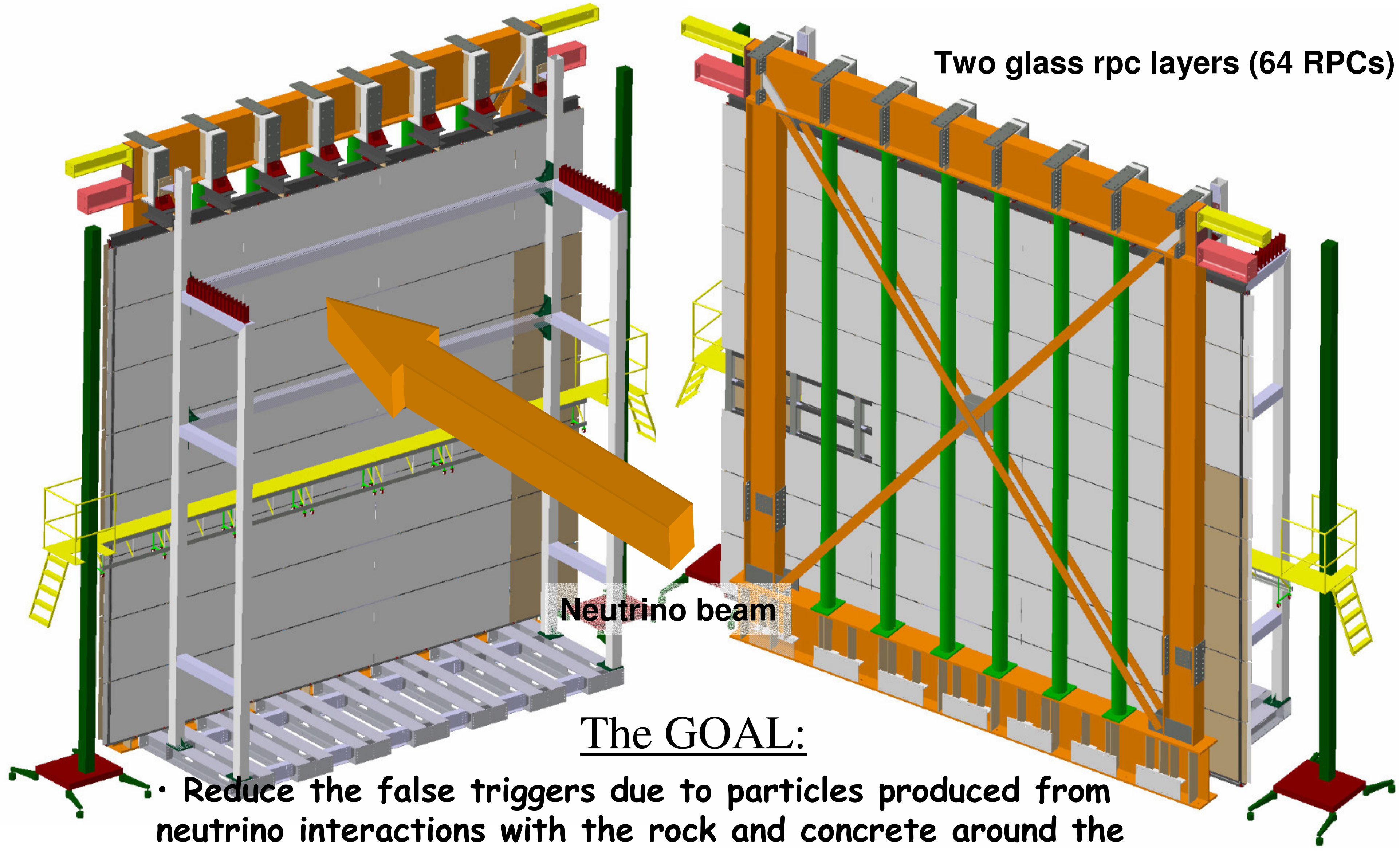
The OPERA detector



Hybrid Detector:

- Two supermodules – Target Mass 1766 tons
- 2 x [31 Target Walls and Target Trackers]
- 2 Magnetic spectrometers with RPC & Drift tubes
- 206,336 Emulsion Cloud Chamber (ECC) bricks (Pb/Emulsion)

Veto mechanical structure: system layout

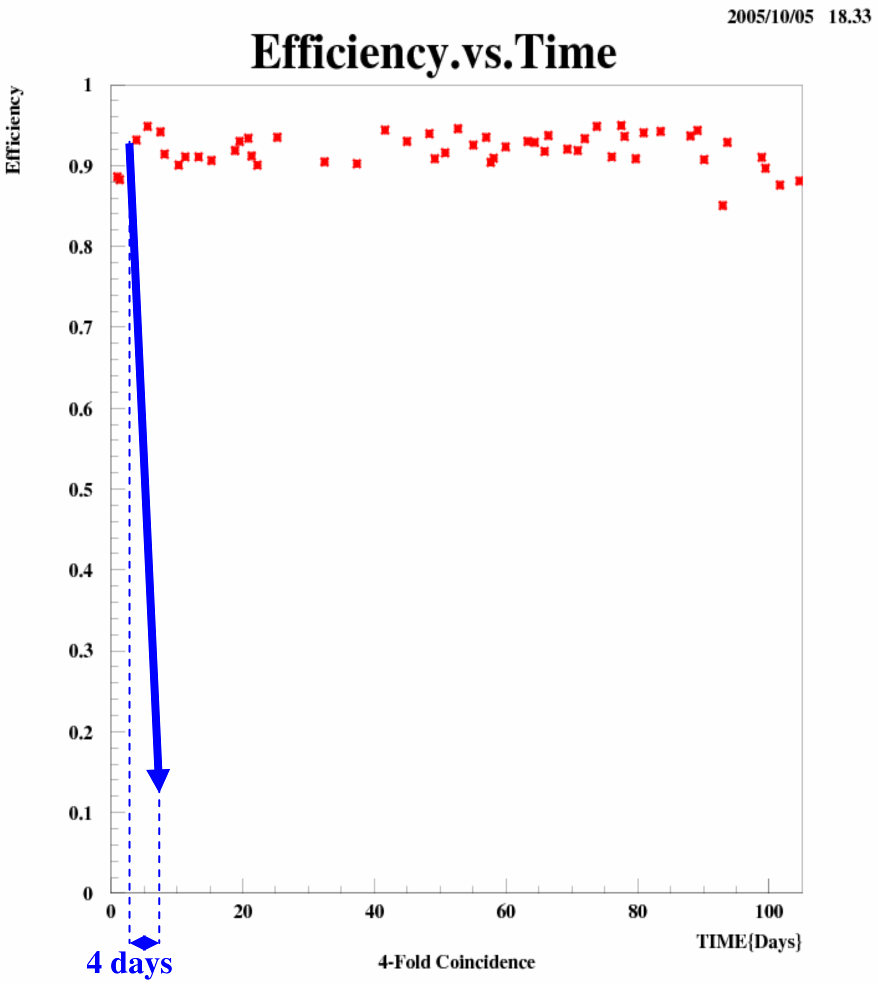


The GOAL:

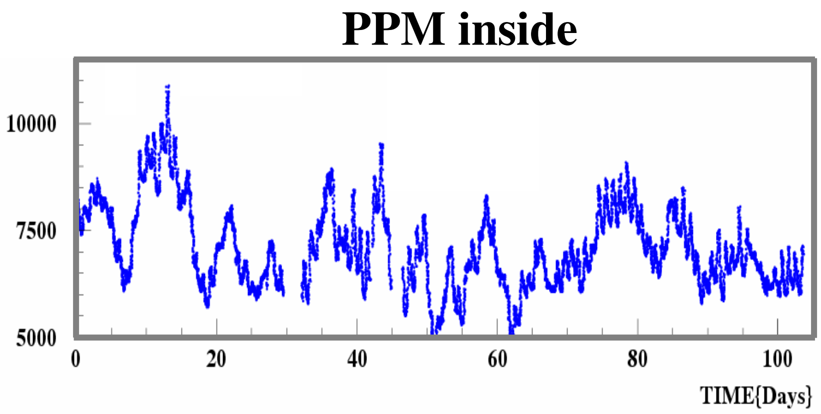
- Reduce the false triggers due to particles produced from neutrino interactions with the rock and concrete around the detector.
- Beam monitor from muon rate.

Tests on Glass RPC

Water vapour ageing



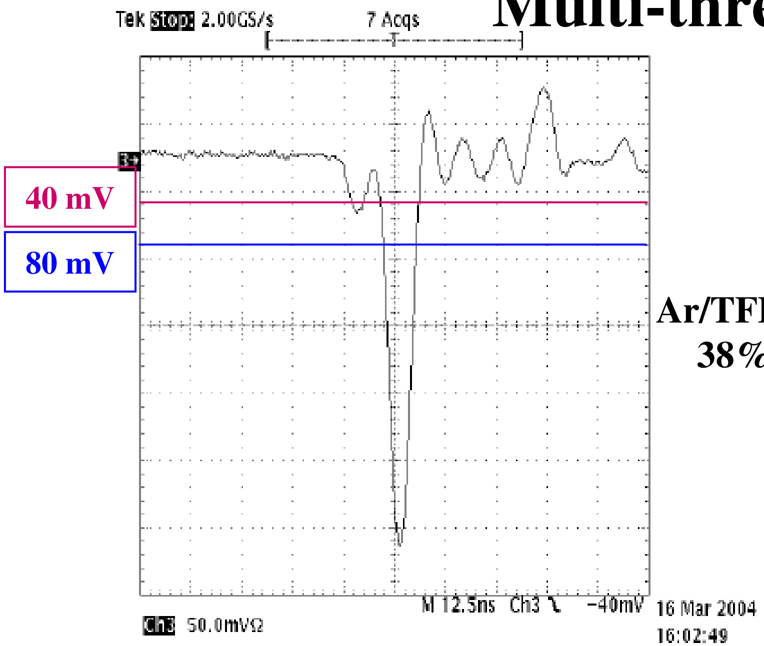
$Ar/TFE/SF_6/iso\text{-}C_4H_{10}=38\%/4\%/1\%/57\ \%$



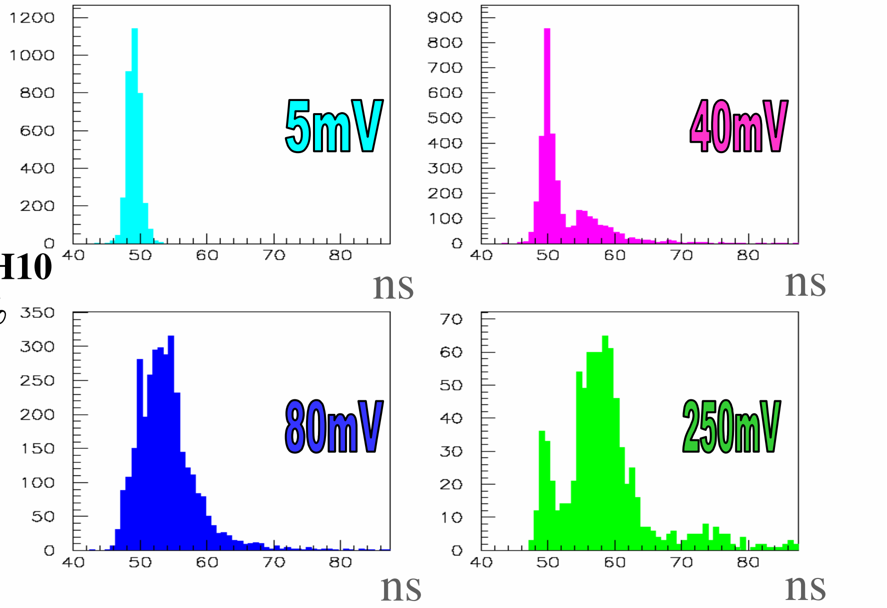
In RPC 2003 we showed the quick (4 days,see the blue arrow) efficiency drop, when the standard mixture ($Ar/TFE/SF6/iso\text{-}C_4H_{10}=38\%/57\%/1\%/4\%$) is polluted by water vapour.

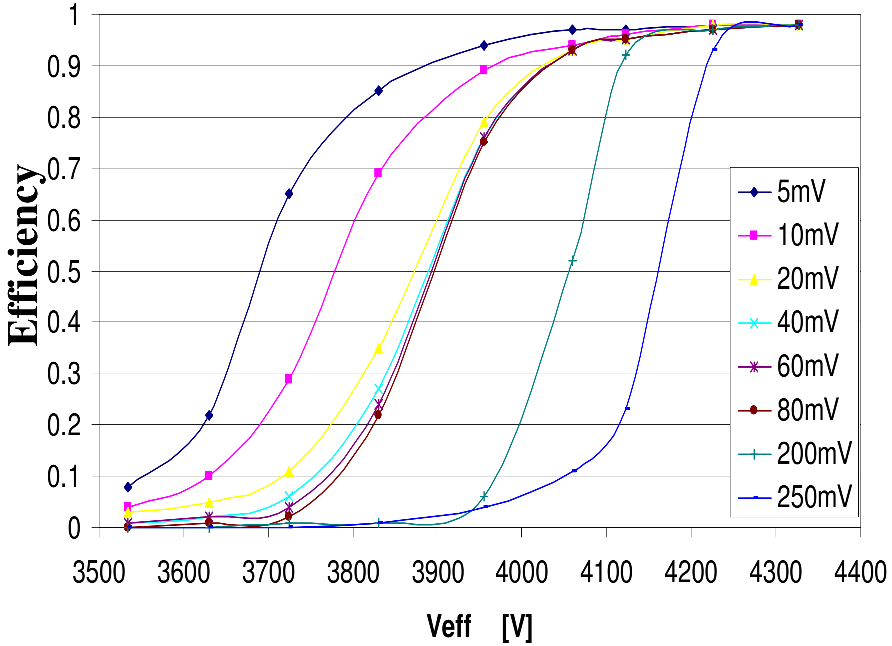
In this case no critical efficiency drop is observed. This result suggests that the water pollution is critical when we work with great amount of freons (hydrofluoric acid production hypothesis).

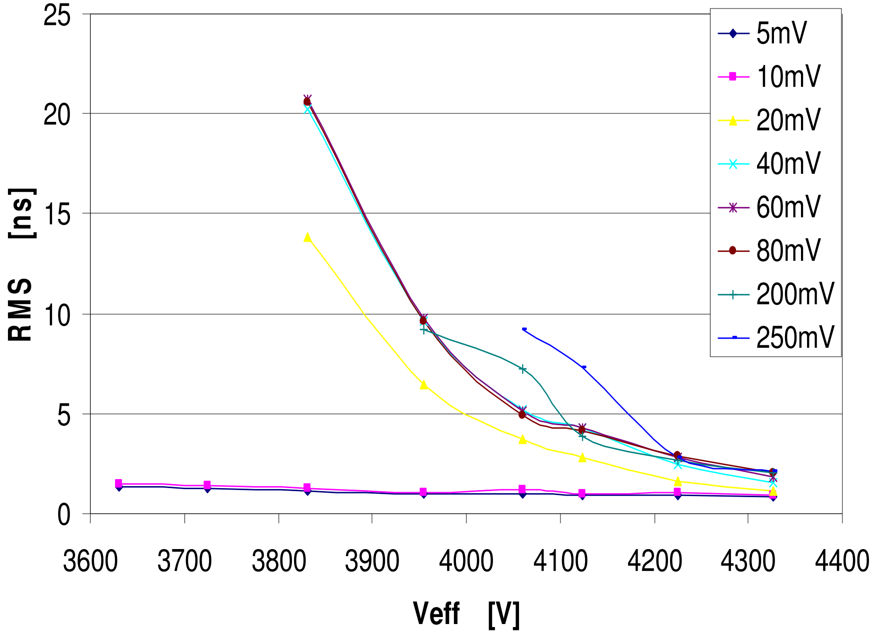
Multi-threshold measurement



Ar/TFE/SF6/iso-C4H10
38%/57%/1%/4%







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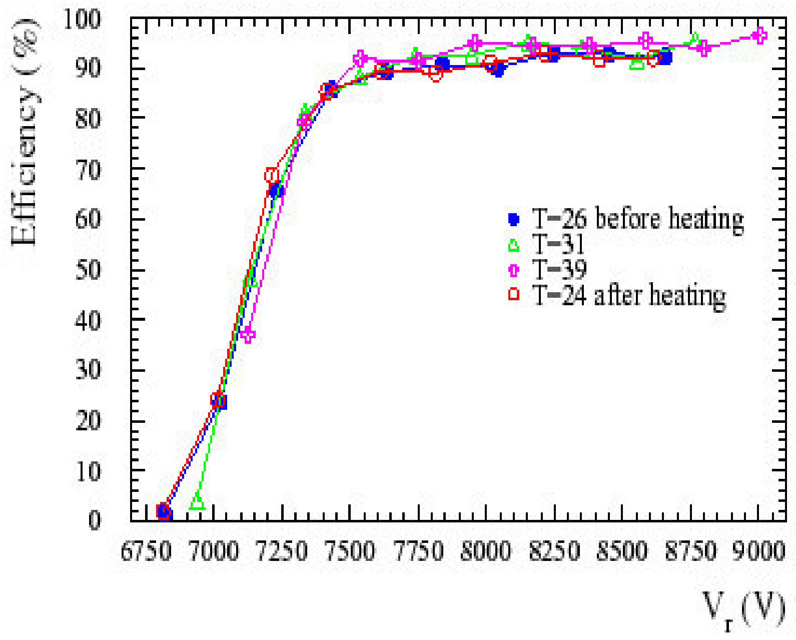
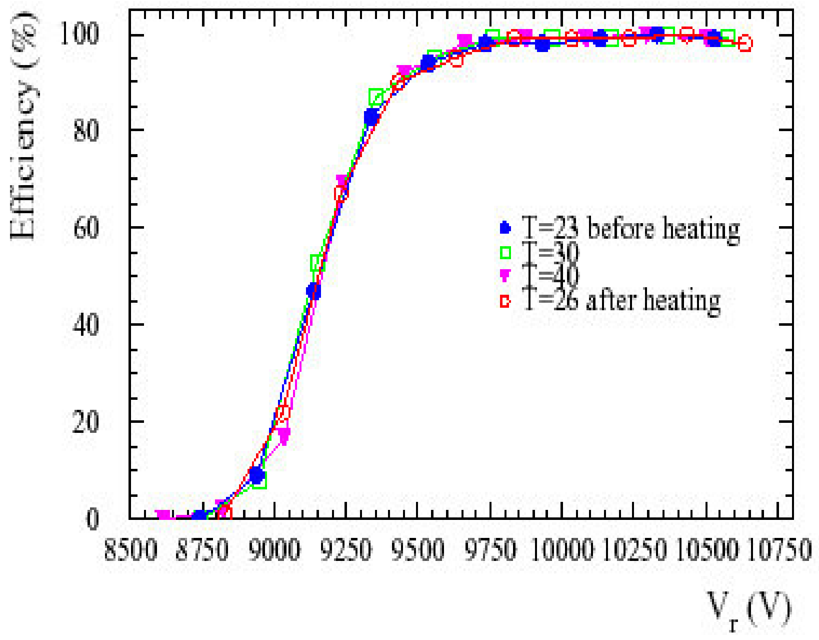
Avalanche vs Streamer test (final design glass RPC)





Streamer mode

Ar/TFE/C_4H_{10}/SF_6= 48/47/4/1

Efficiency @ working point ~ 97%

- **Big signals**
- **Very low H_2O contamination is needed**

Avalanche mode

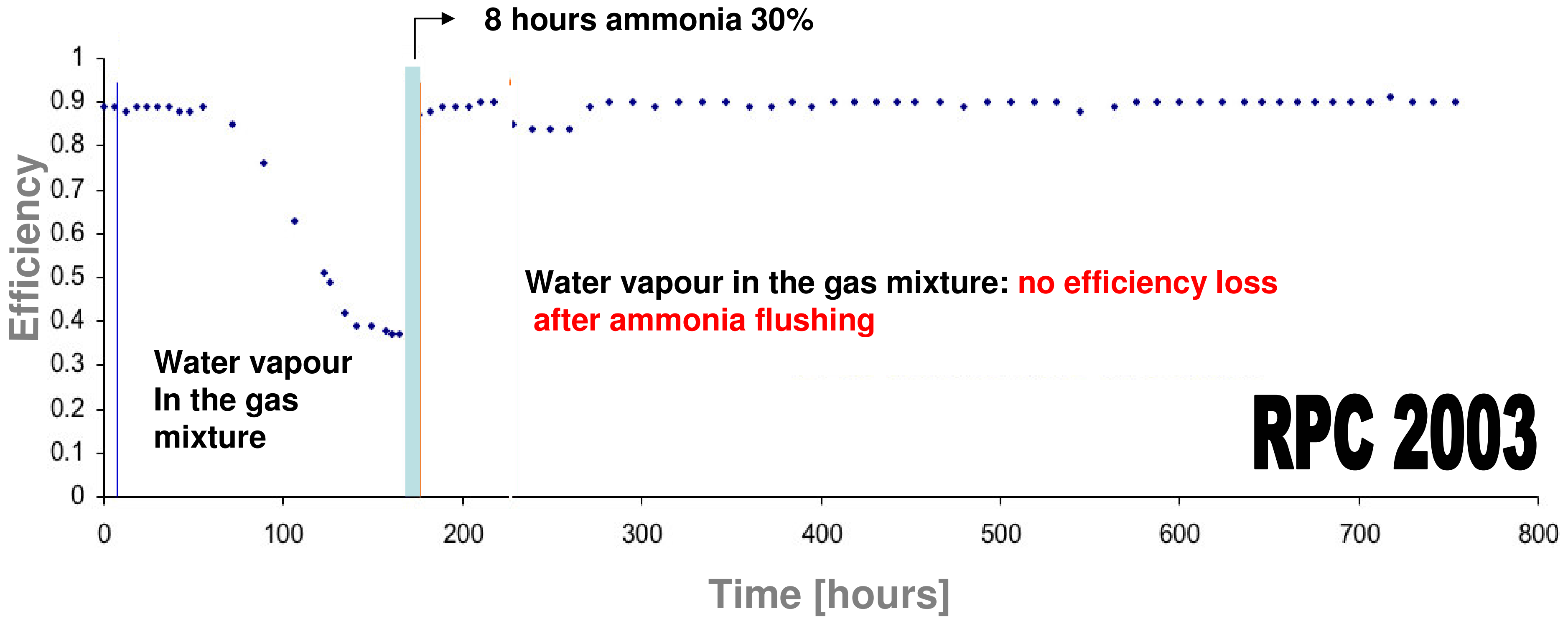
TFE/C_4H_{10}/SF_6= 95/4/1

Efficiency @ working point ~ 99%

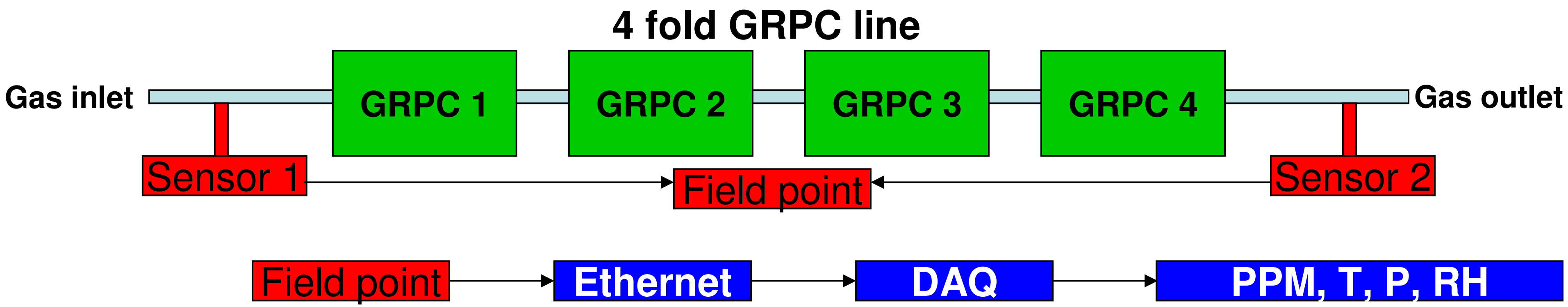
- **Smoother operation.**
- **Higher efficiency value with respect to the streamer mode.**
- **Small signals**

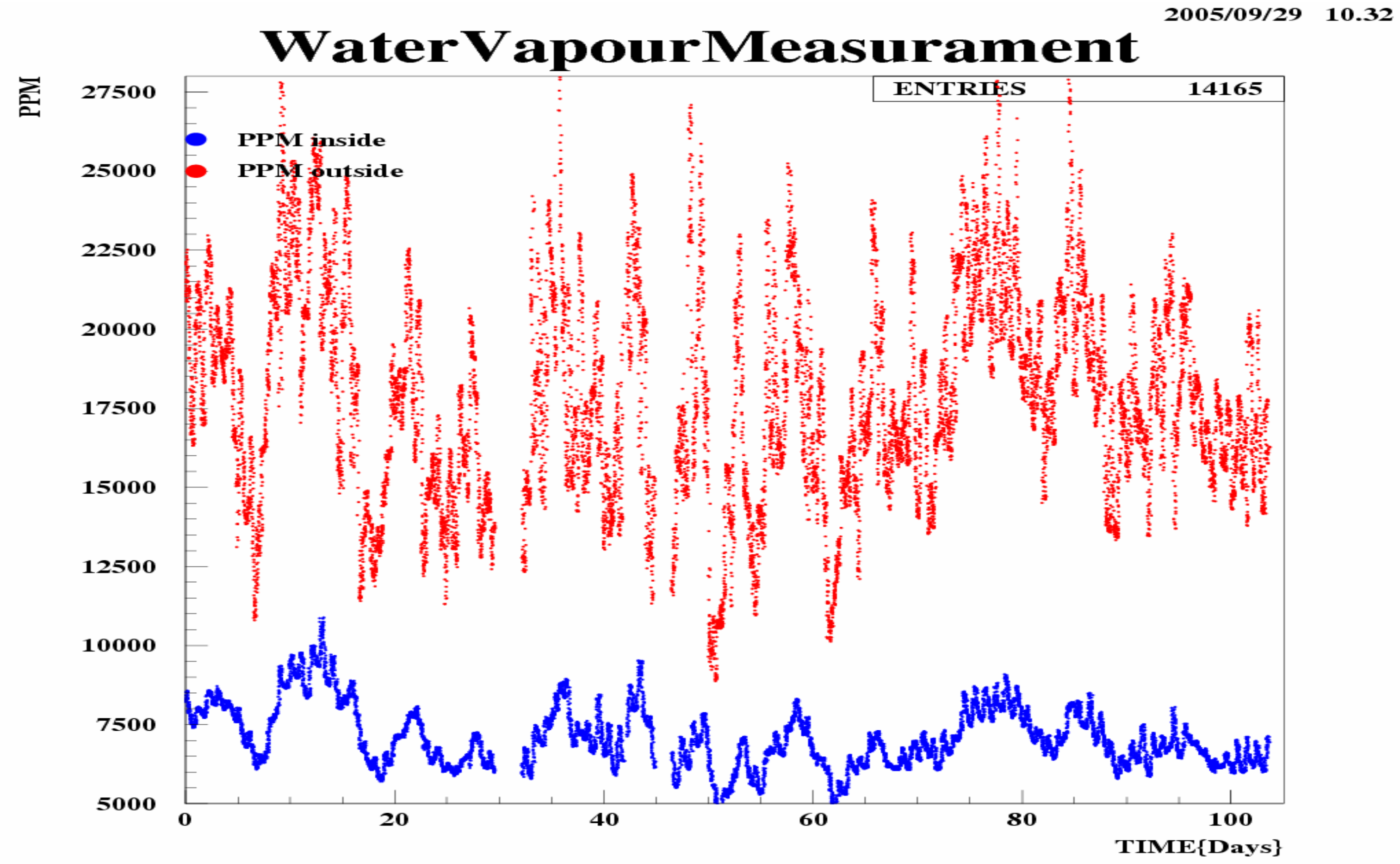
System monitoring

System monitoring



A water vapour monitor has been developed in order to be used in the OPERA VETO system.

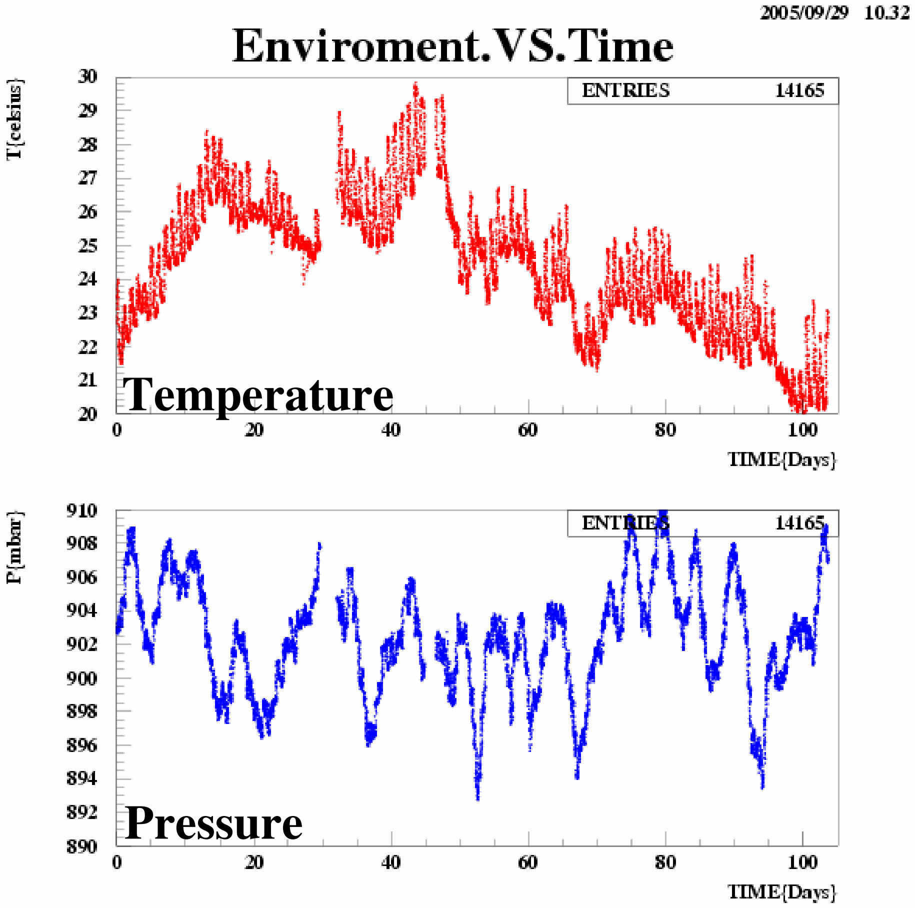


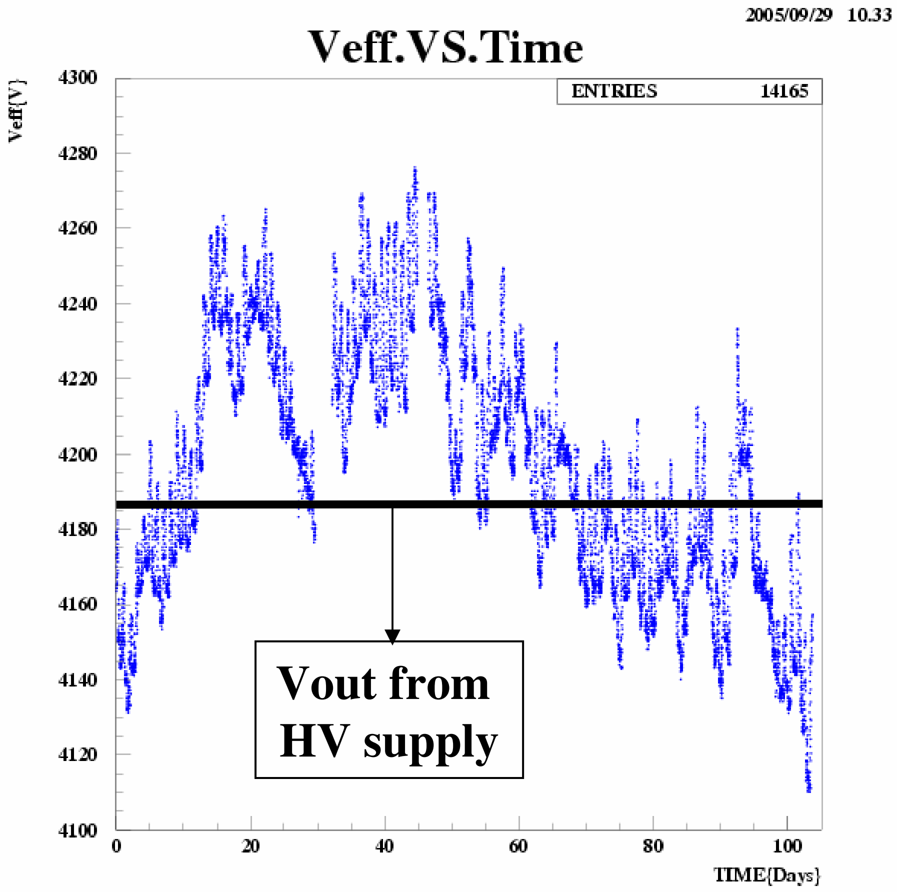


Using plastic connections for the gas system and GRPC with the noryl box (see Gustavino's talk in RPC2003), the PPM inside the chamber are in the range beetween 5000 and 10000

NB: PPM is a function of T,P,RH

Effective voltage monitoring





With the monitoring system we are able to control the electric effective field inside the chamber.

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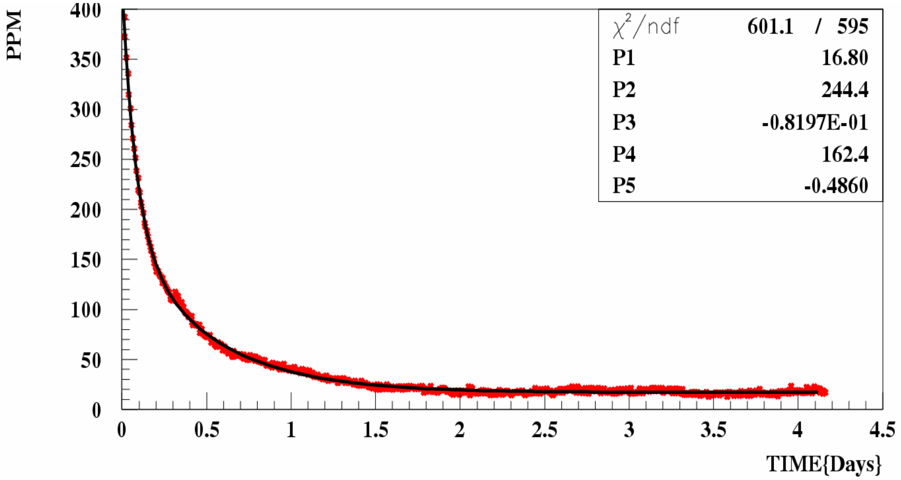
Hygroscopy on gas system connection

The humidity inside the line is strongly dependent on the flux rate, on the pipeline material and on its length. The r2075 Tygon tube is the best choice as shown in the table. The values are referred to 1 meter connection.

FLUX[cc/min]	Tygon r2075 Water ppm	Tygon r3603 Water ppm
20	30	280
40	20	150
60	-	130
100	5	55



$$PPM(t)=PPM(\infty)+A[\exp(-t/\tau_{fast})]+B[\exp(-t/\tau_{slow})]$$

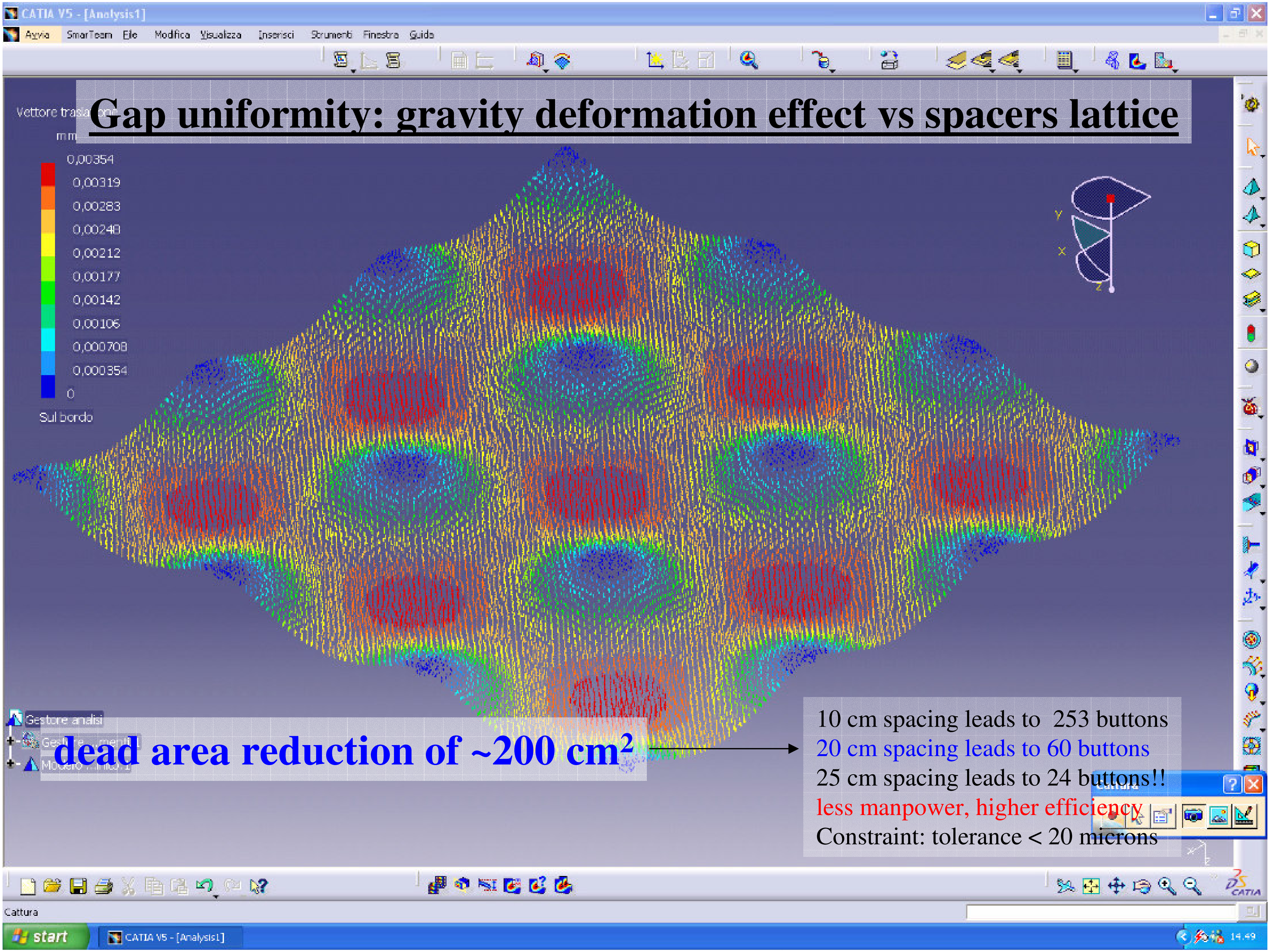
$\tau_{fast}\sim$ 2 hours

$\tau_{slow}\sim$ 12 hours

This test is performed using a flushing rate of about 40 cc/min instead 75 cc/min inside 1 meter of tubing. Using these special connectors, the water vapour contamination is limited at 20 PPM

Glass RPC status

Gap uniformity: gravity deformation effect vs spacers lattice



dead area reduction of ~200 cm^2 →

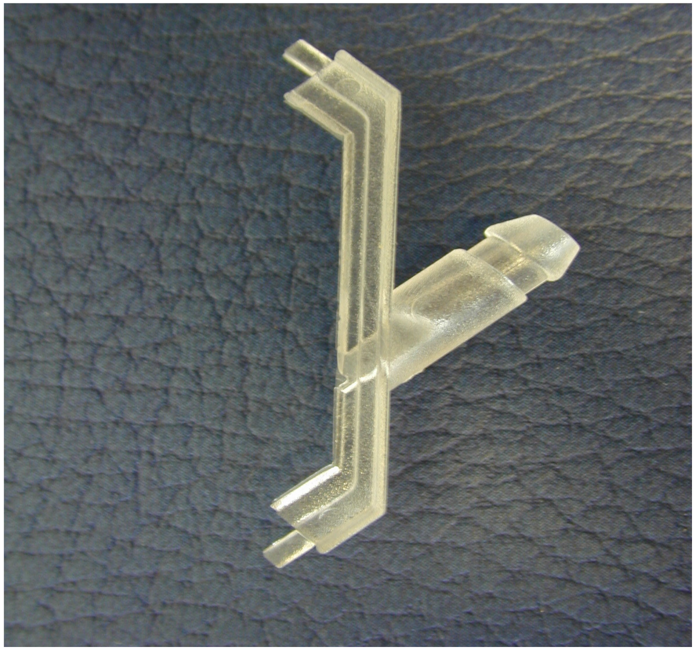
10 cm spacing leads to 253 buttons

20 cm spacing leads to 60 buttons

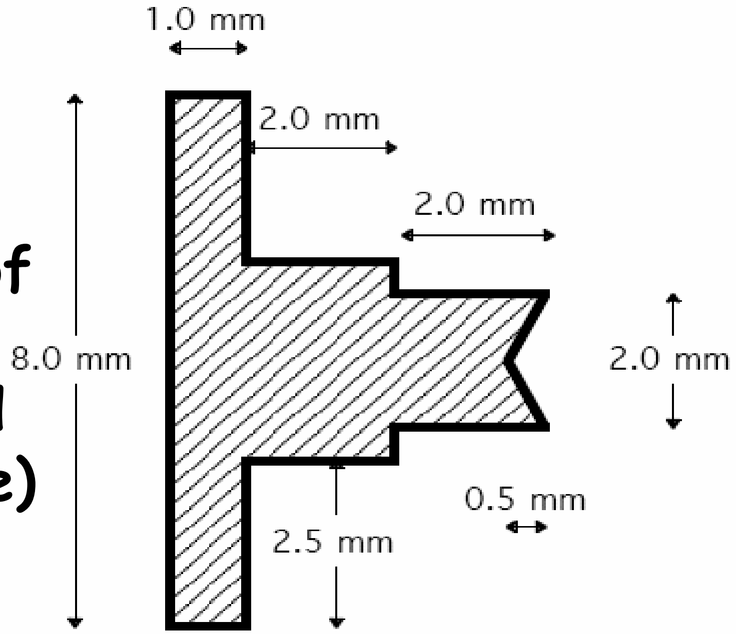
25 cm spacing leads to 24 buttons!!

less manpower, higher efficiency

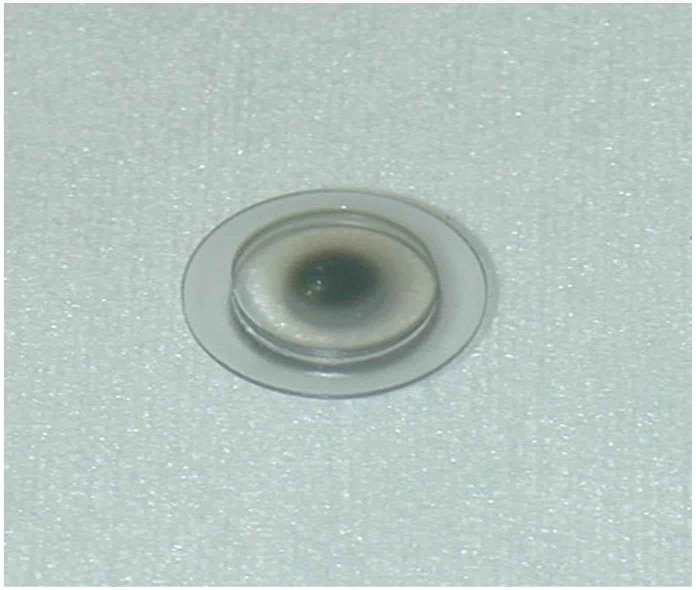
Constraint: tolerance < 20 microns



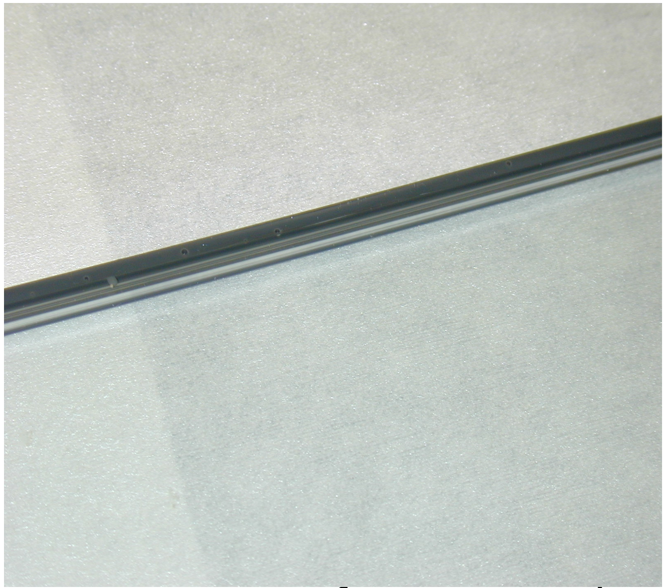
New polycarbonate frame : dead area reduction of ~300 cm^2(with respect the old bakelite-like one)



Mechanical devices



Each polycarbonate element is glued on the glass electrode using a digital dispenser in order to have the same tickness.



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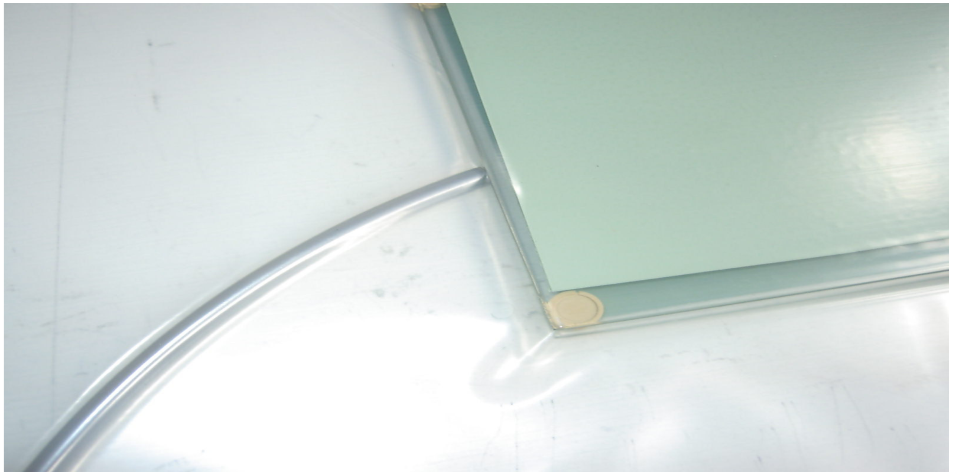
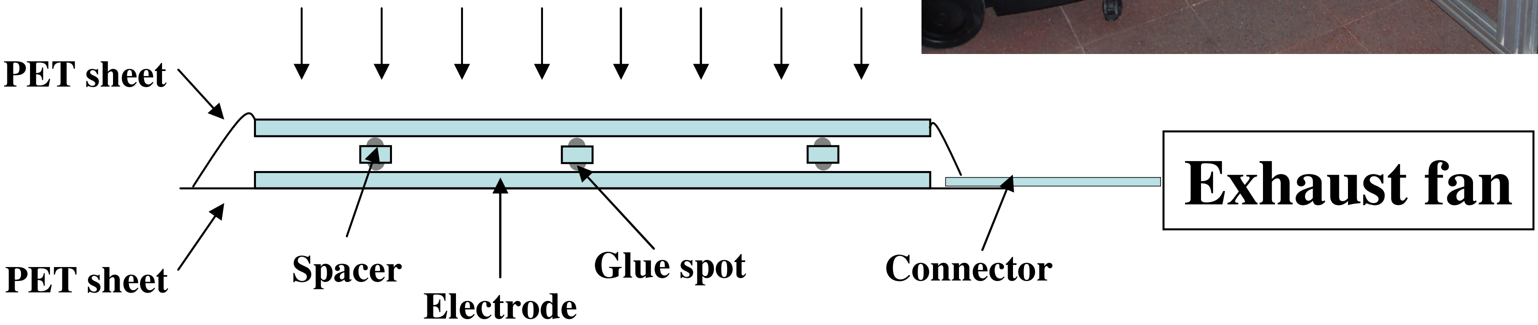
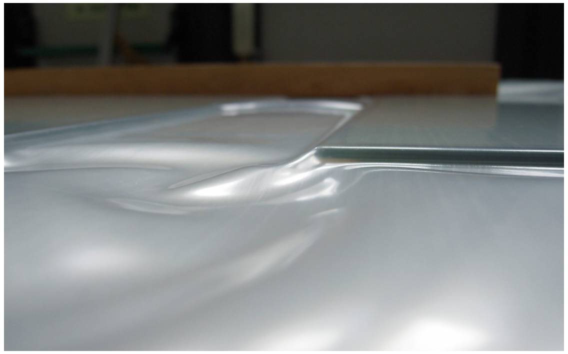
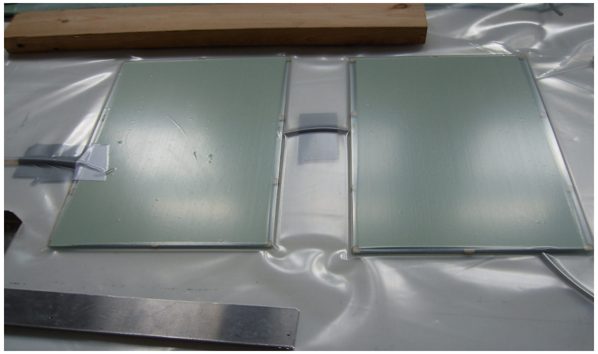
Vacuum gluing system on Glass Electrodes



100 mbar = 1 ton/m^2







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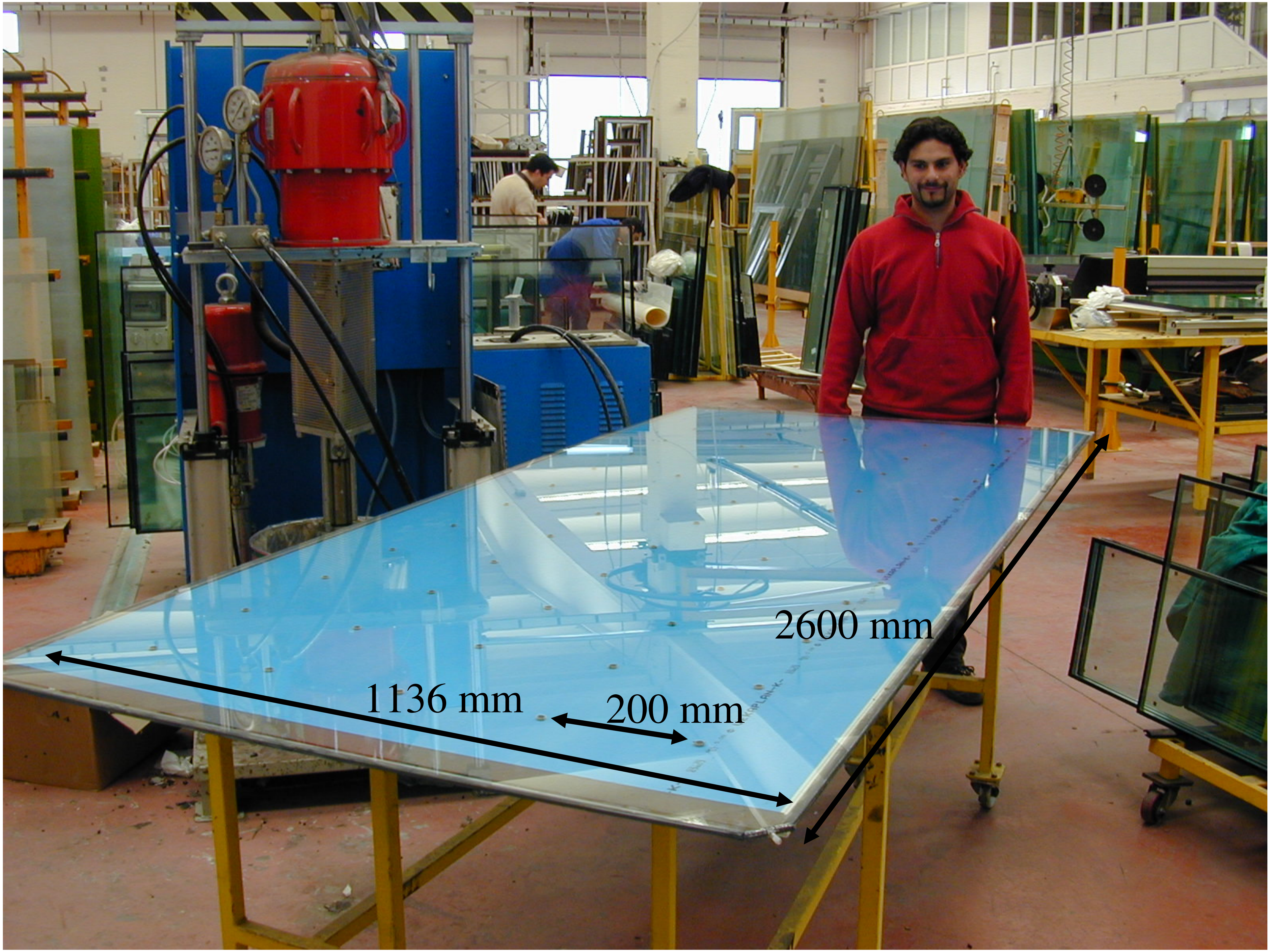
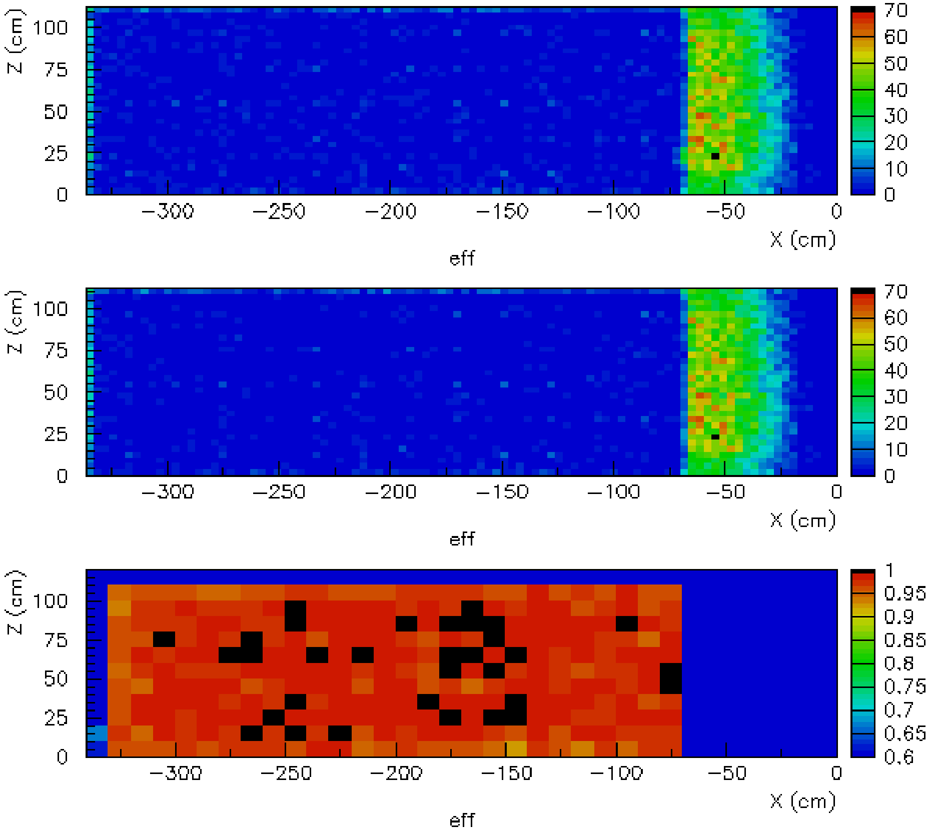
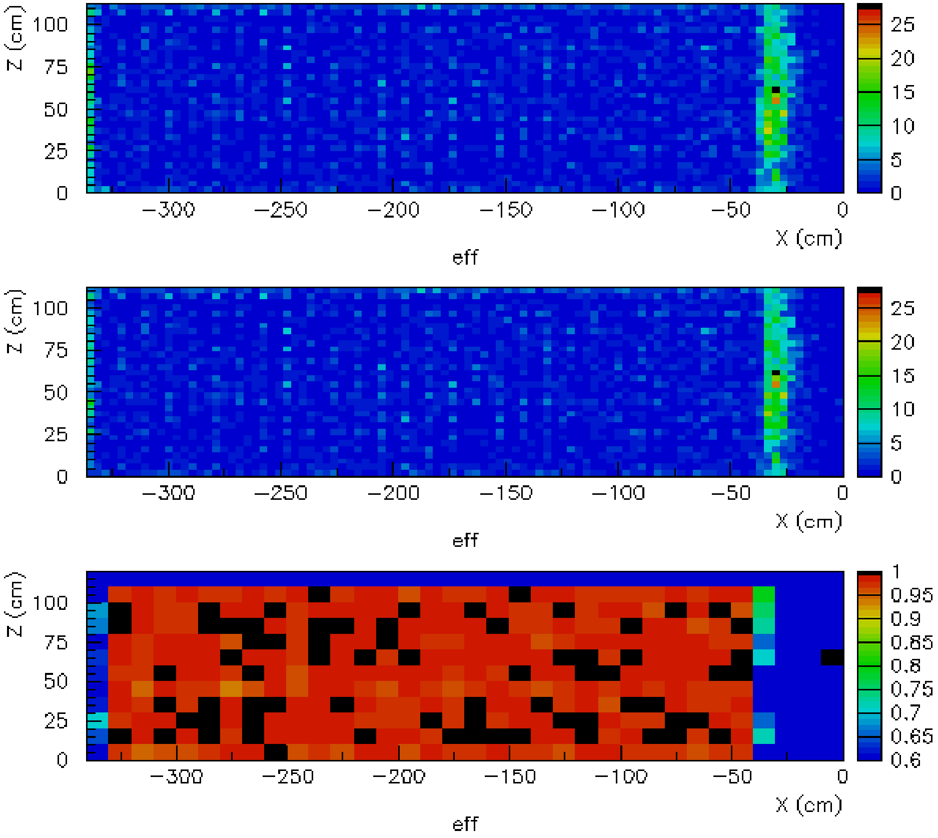

2600 mm
1136 mm
200 mm

Preliminary!



Glass RPC prototype
(raw data, no conditioning, low statistic)



"First class" bakelite RPC

Conclusions

- **Construction and validation of Glass RPCs for the OPERA VETO system will finish on February 2006 (200 m^2 of glass RPCs are needed)**
- **Detector design is optimized to minimize the geometrical dead zone**
- **Monitor system to prevent ageing**
- **We will use for the gas system only steel tubing**

(copper is not a good solution for ammonia recovering)