Towards a 1m^3 Glass RPC HCAL prototype with multi-threshold readout

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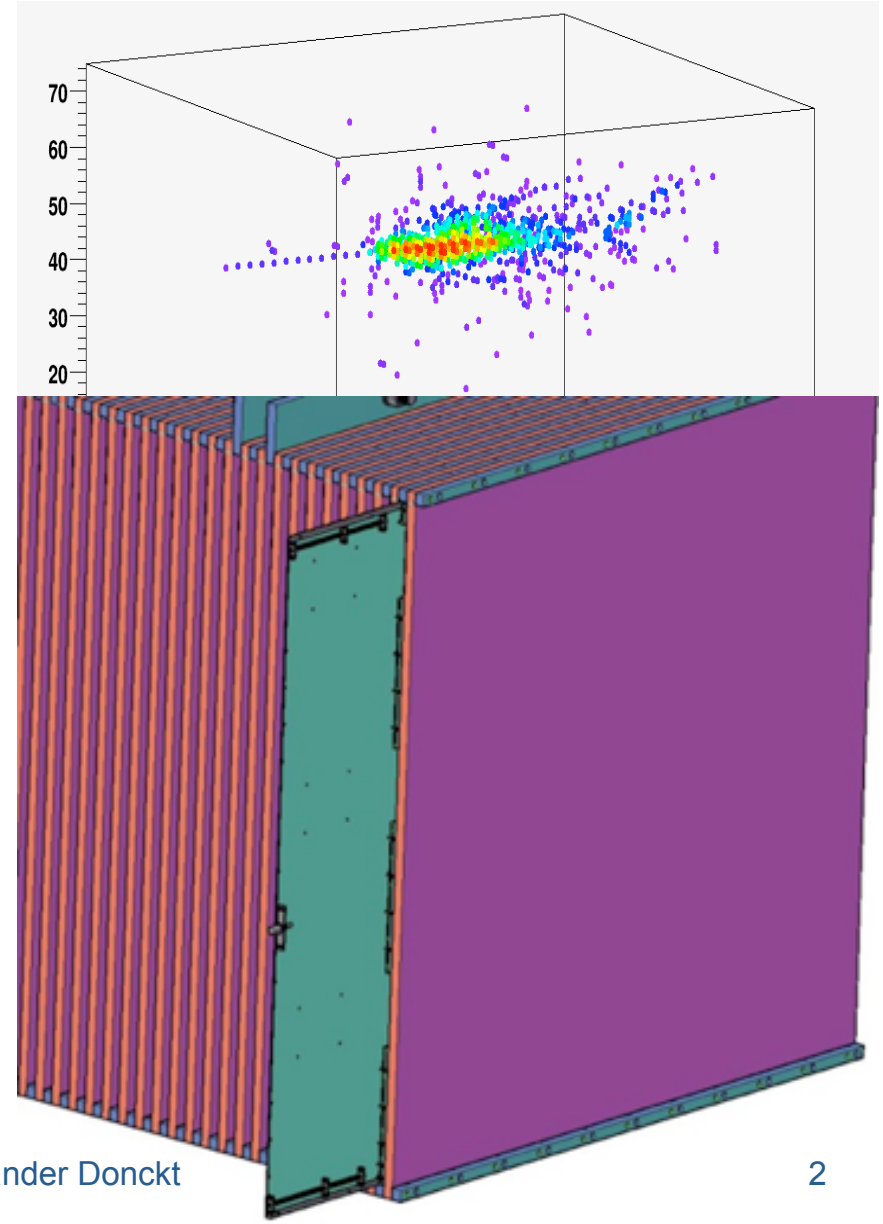
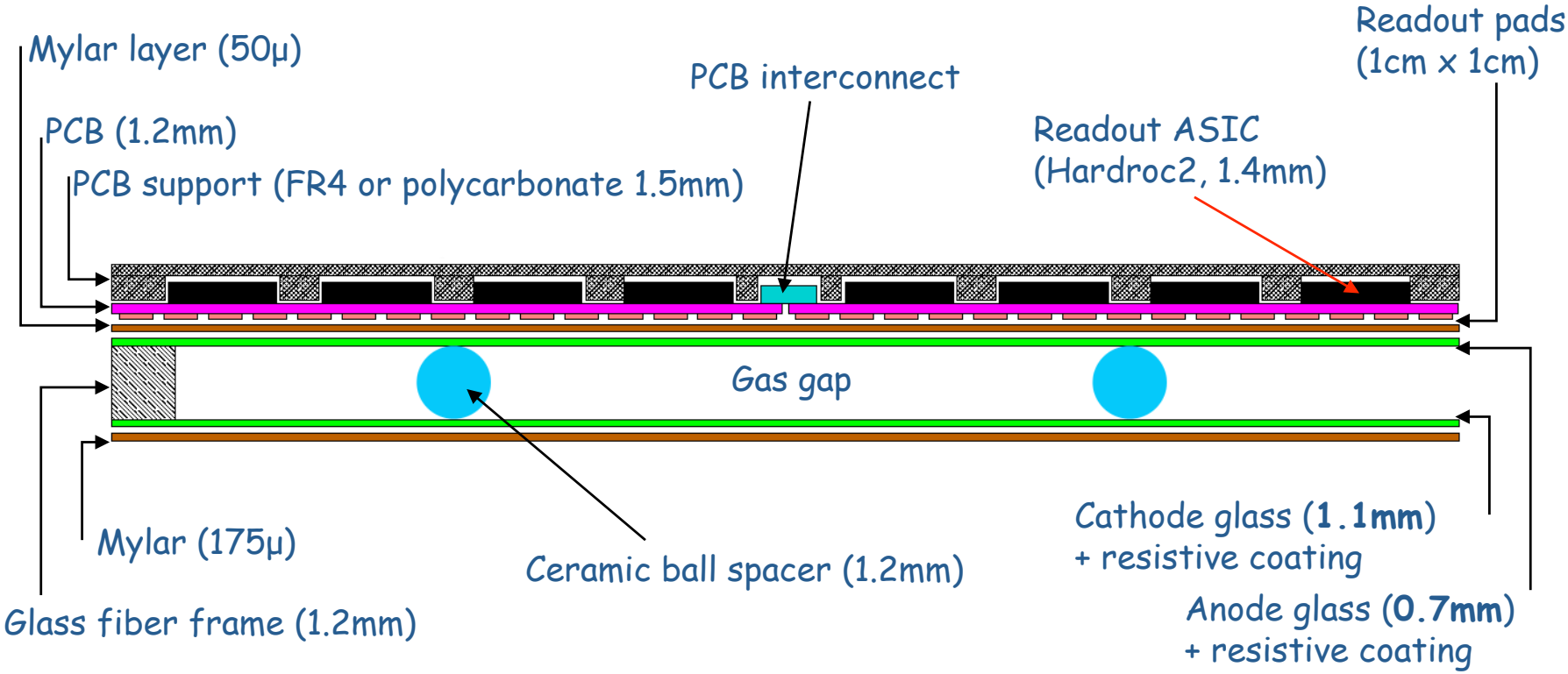
The Glass RPC SDHCAL prototype

- 40 1m^2 layers of
  - steel absorber (1,5cm)
  - 6mm thick glass RPCs in 5mm thick steel cassettes
- Total of $5\lambda_I$
- Avalanche mode TFE (94.5% Isobutane (5%), SF6 (0.5%)
- Multiple thresholds to allow for the recognition of the dense shower center.
- 1 cm^2 charge collectors with 3 thresholds
- Power-pulsed electronics
- Requires no cooling !



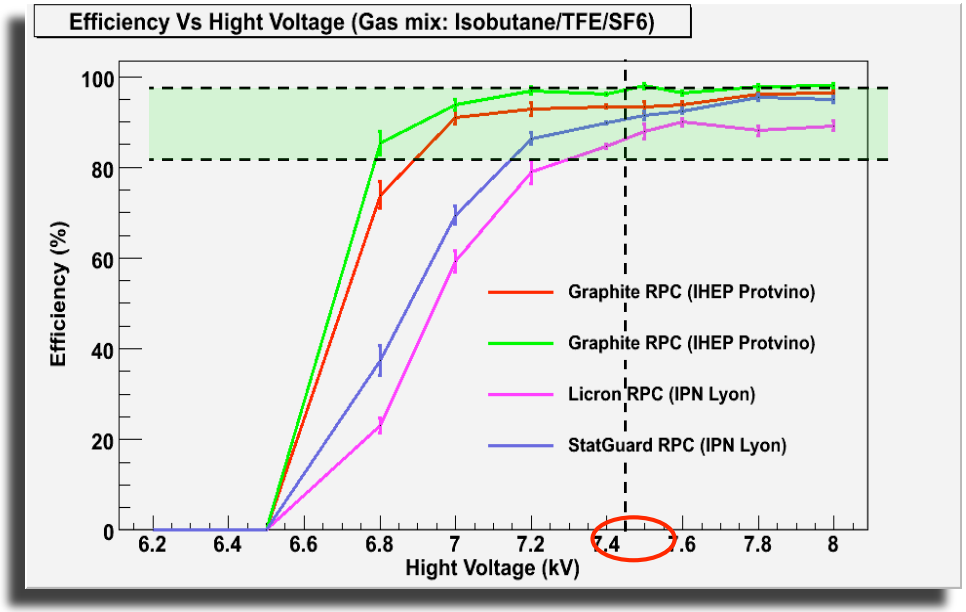
Cross-section of GRPCs

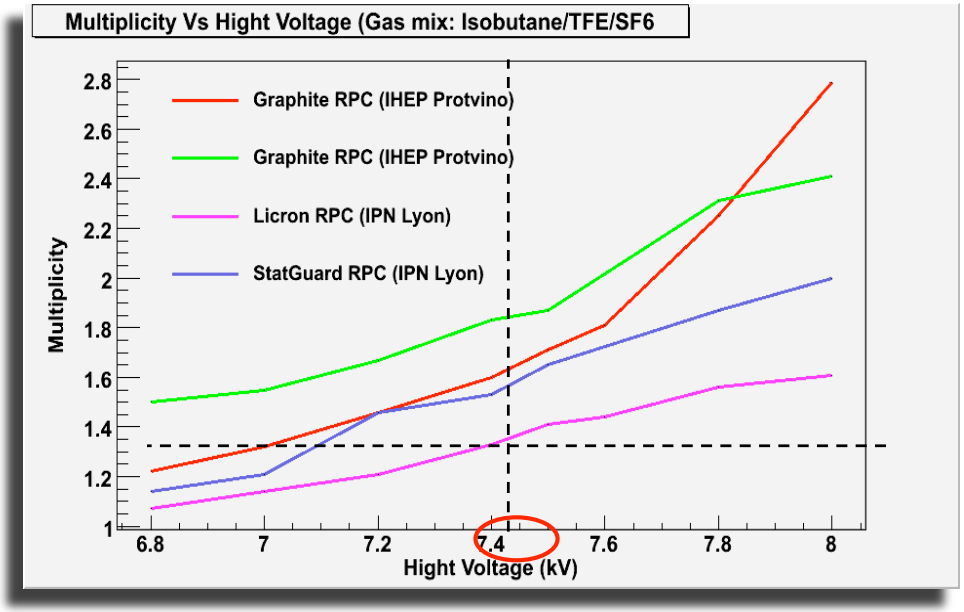


Total thickness including embedded electronics: **5.925mm**

Resistive coating

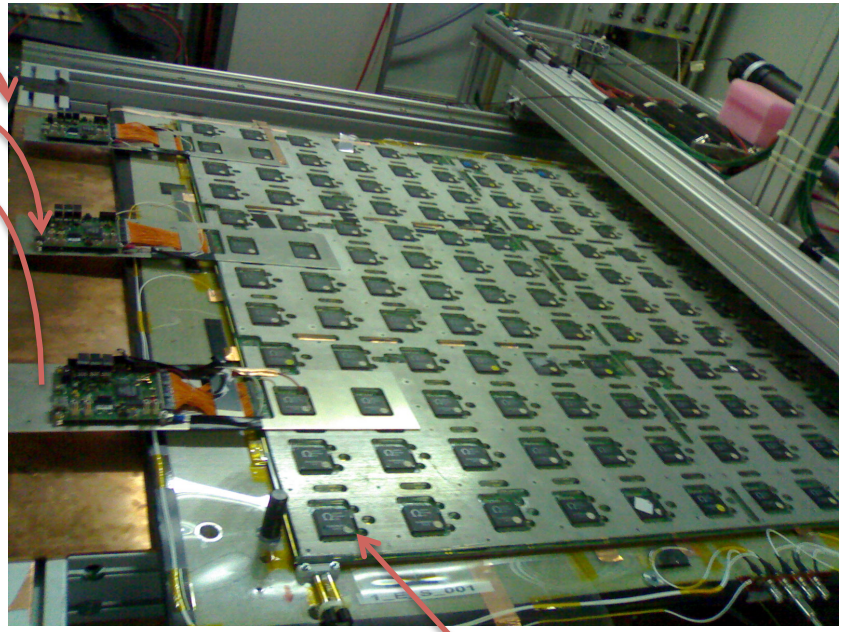
Coating	Resistivity	Multiplicity	HV Connection	Application
Graphite	400 kΩ/□	>1.6 @ 7.4 kV	✓	
Licron	>20 MΩ/□	✓	✗ Lost	Spray
Statguard	few M Ω/□	✓	✓	Roll (liquid paint)
Colloidal graphite	few M Ω/□	✓	✓	Silk screen printing

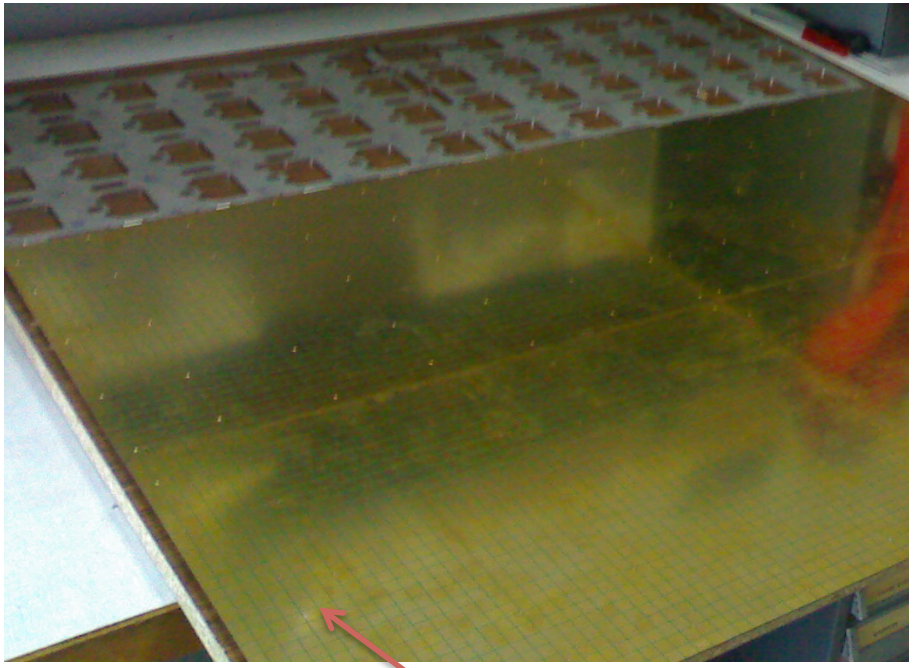




GRPC read-out

3 DIFs (Detector InterFace boards)

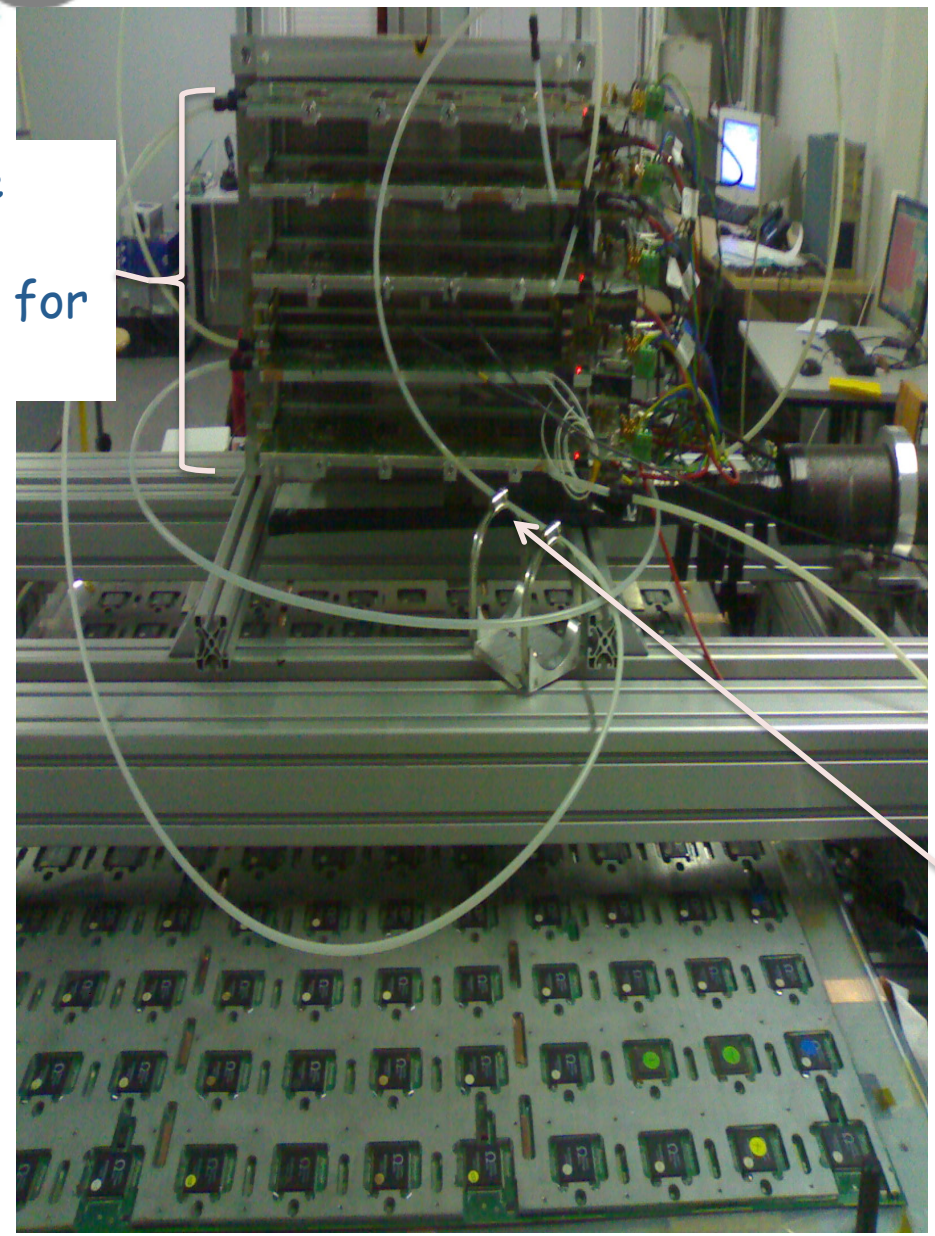




144 ASICs (HARDROC2 chips) reading 64 1cm^2 PADs each

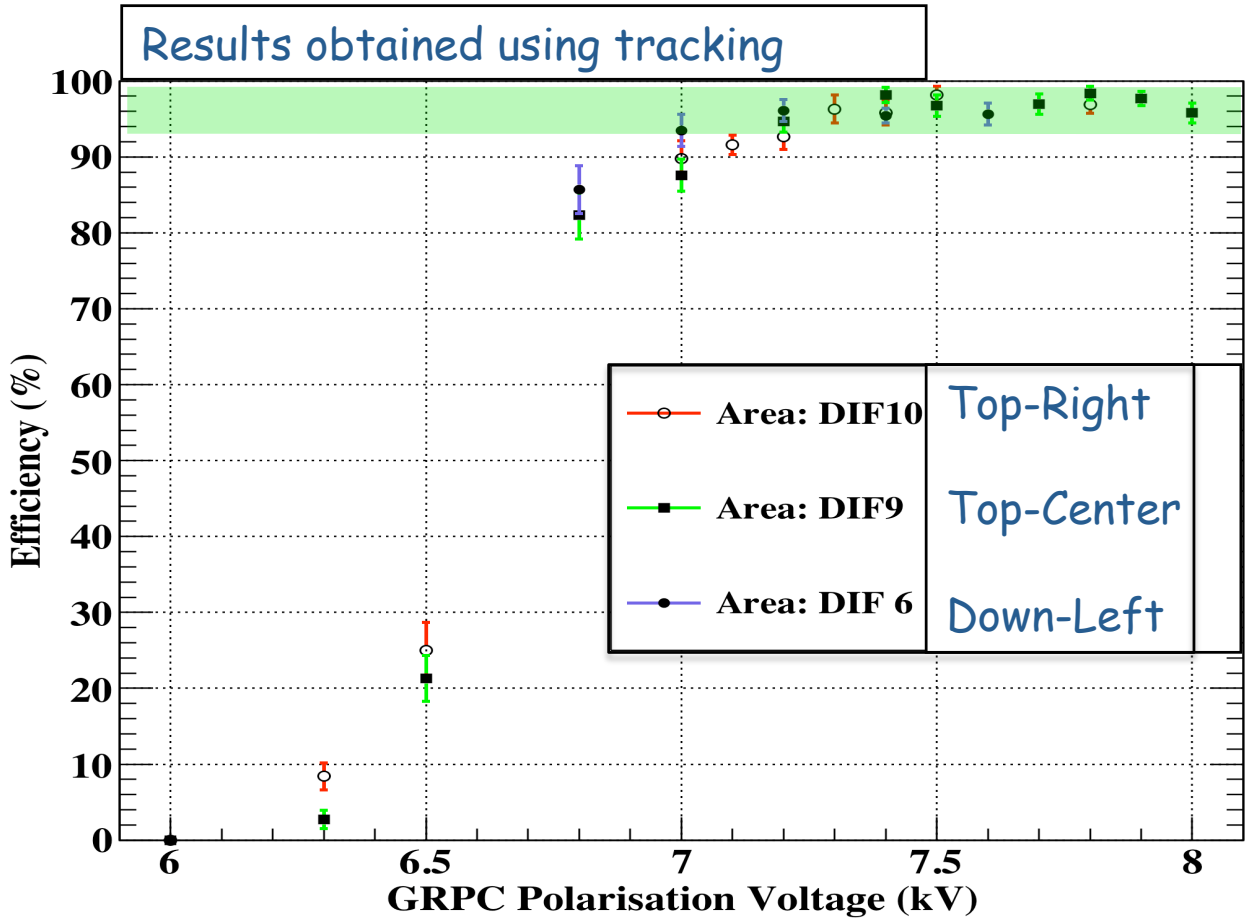
Cosmic test bench

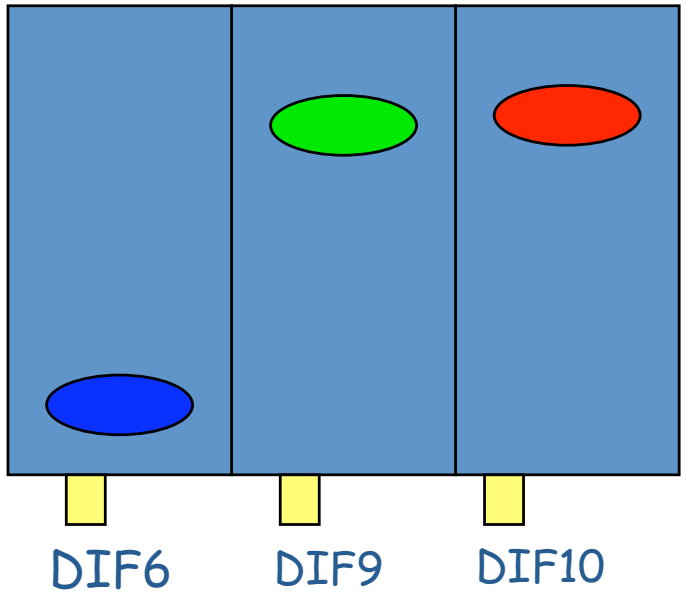
Up to five 8x32 cm Chambers for tracking



Trigger scintillator

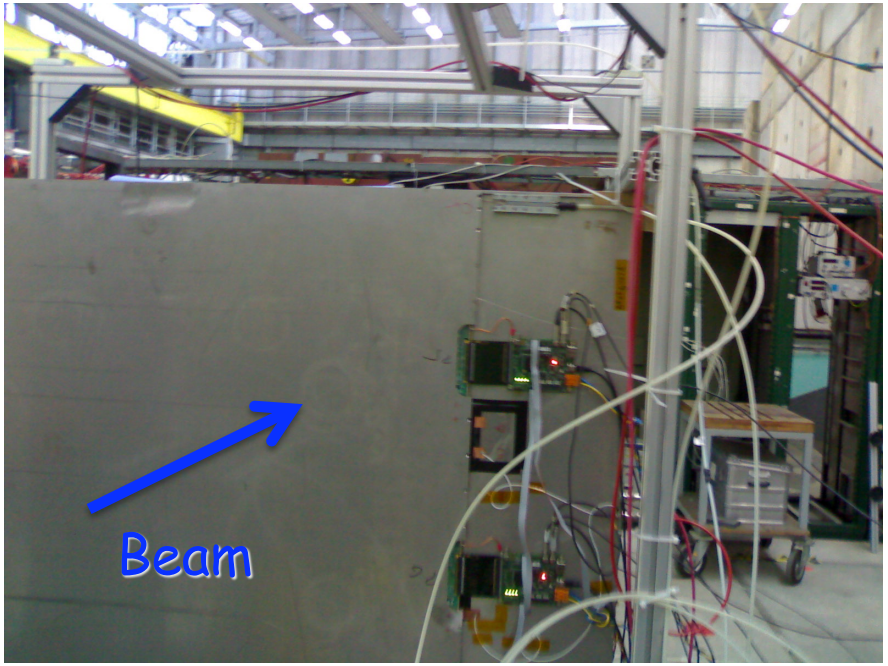
Efficiency homgeneity vs HV scan





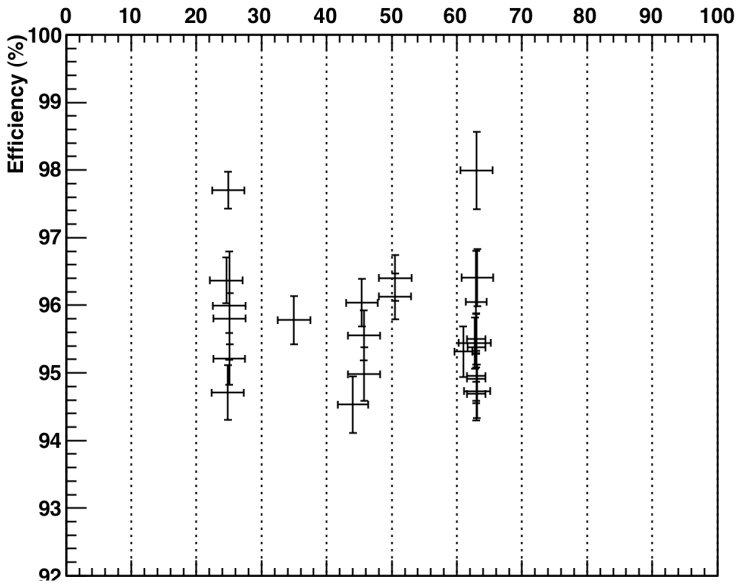
HV scan on **3 different areas**.
Statguard coated chamber.

Beam tests

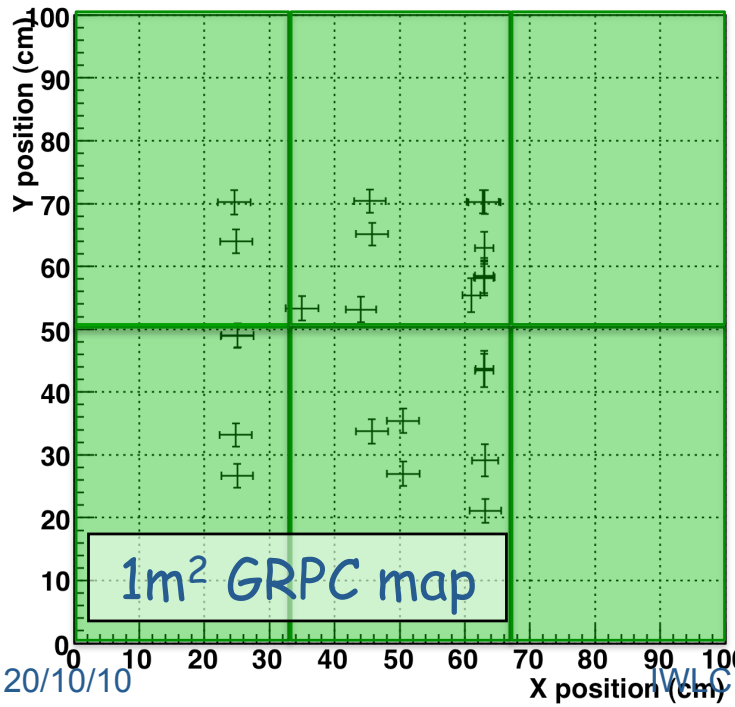


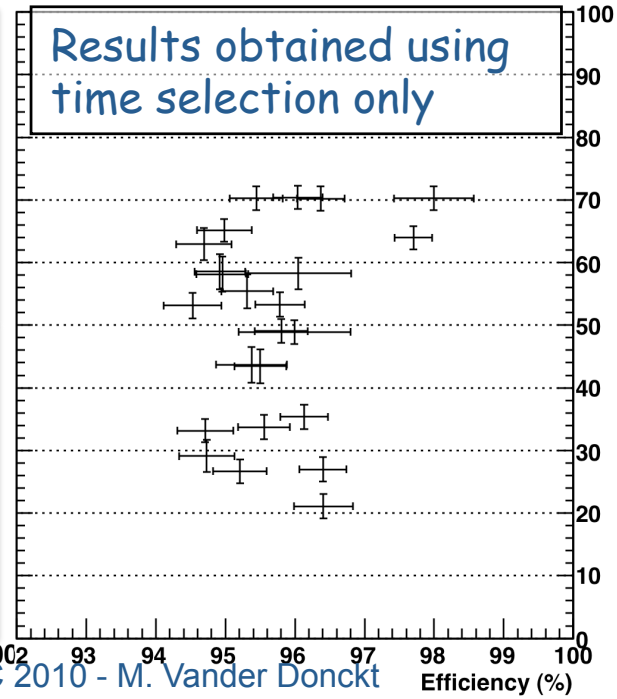
- 1 m^2 Statguard chamber tested @ CERN-PS in May 2010 – 10 GeV π
- 2 1m^2 colloidal graphite chambers inserted @SPS H4 (150 GeV π) in September 2010

Efficiency homogeneity studies

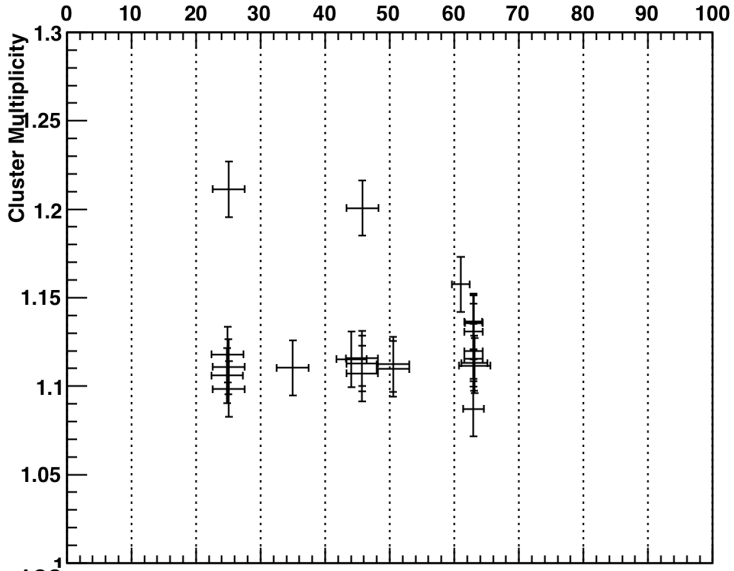


- HV: 7.5 kV
- Position scan area
- Homogeneous
- >95%

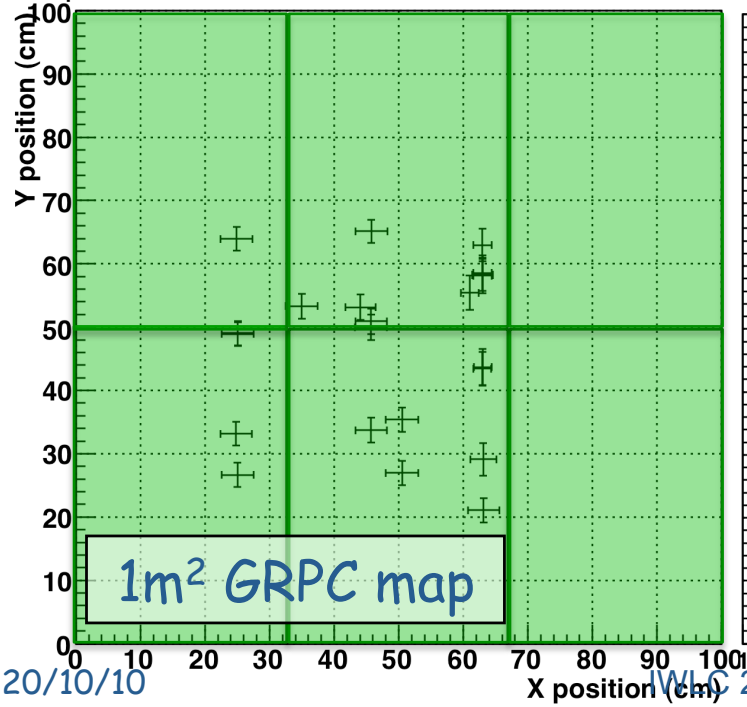


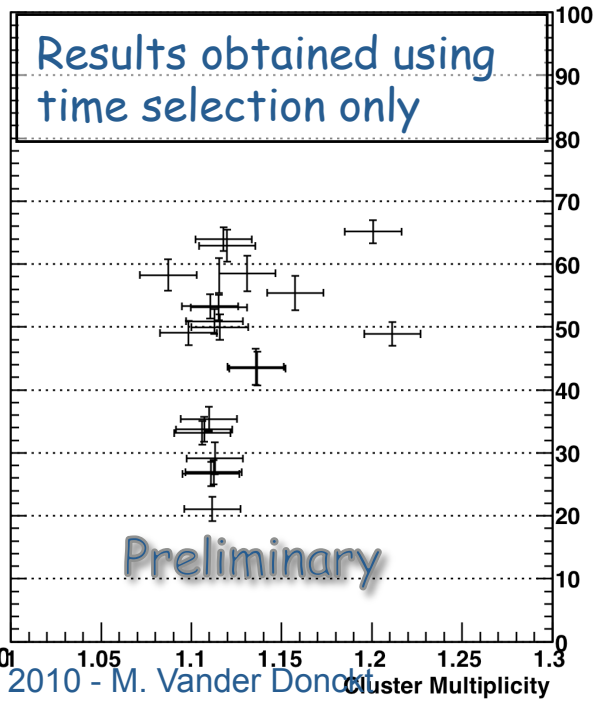


Multiplicity homogeneity studies

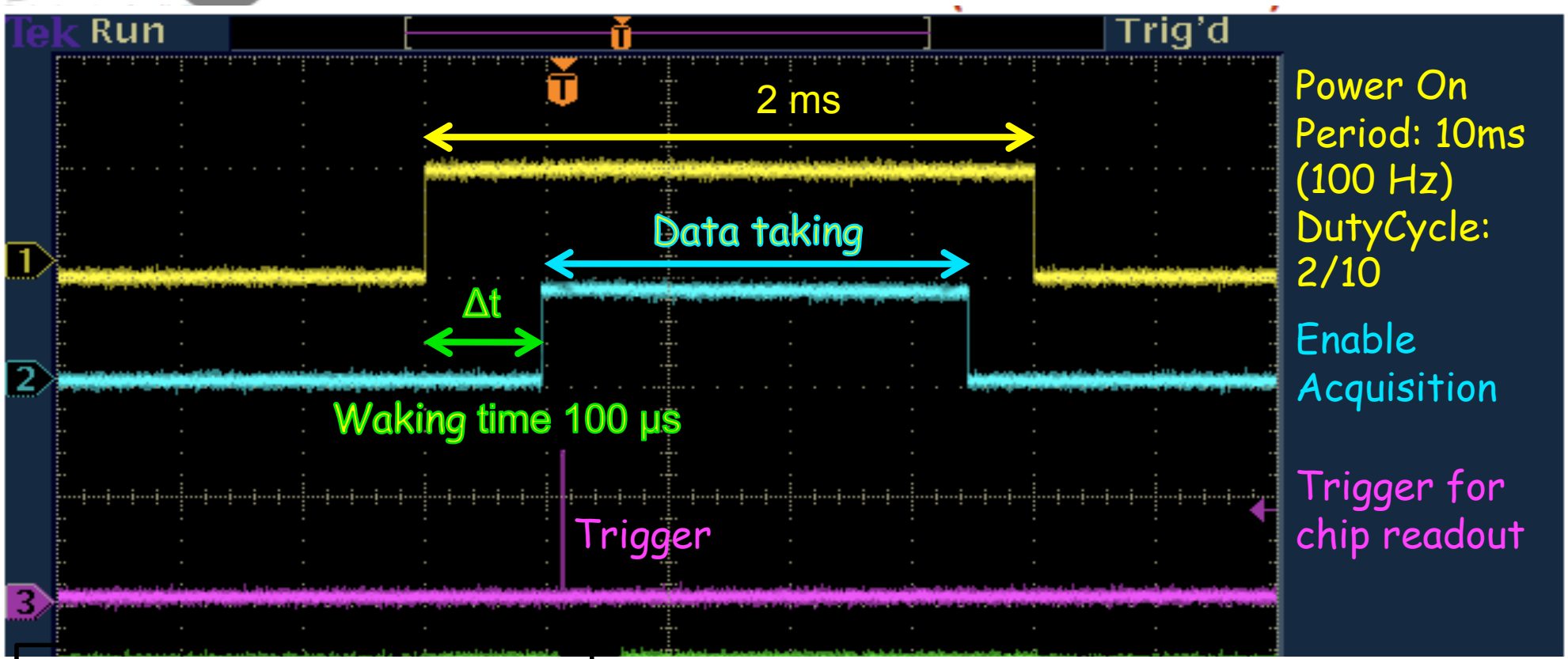


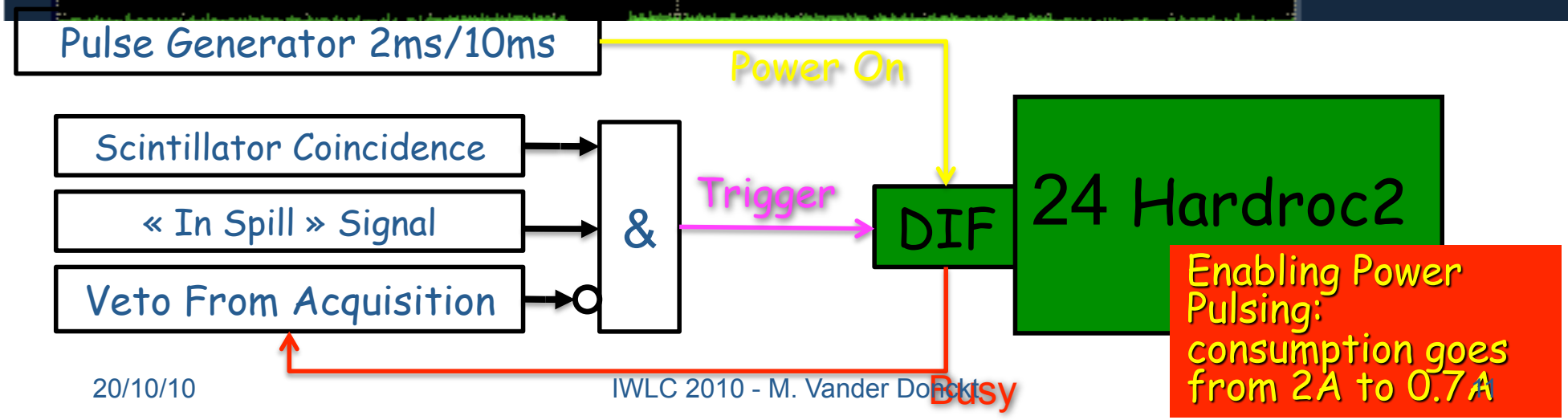
- HV: 7.5 kV
- Multiplicity highly depends on threshold level
- Homogeneous
- <1.3 for threshold ~0.25 MIP





Principle of power pulsing

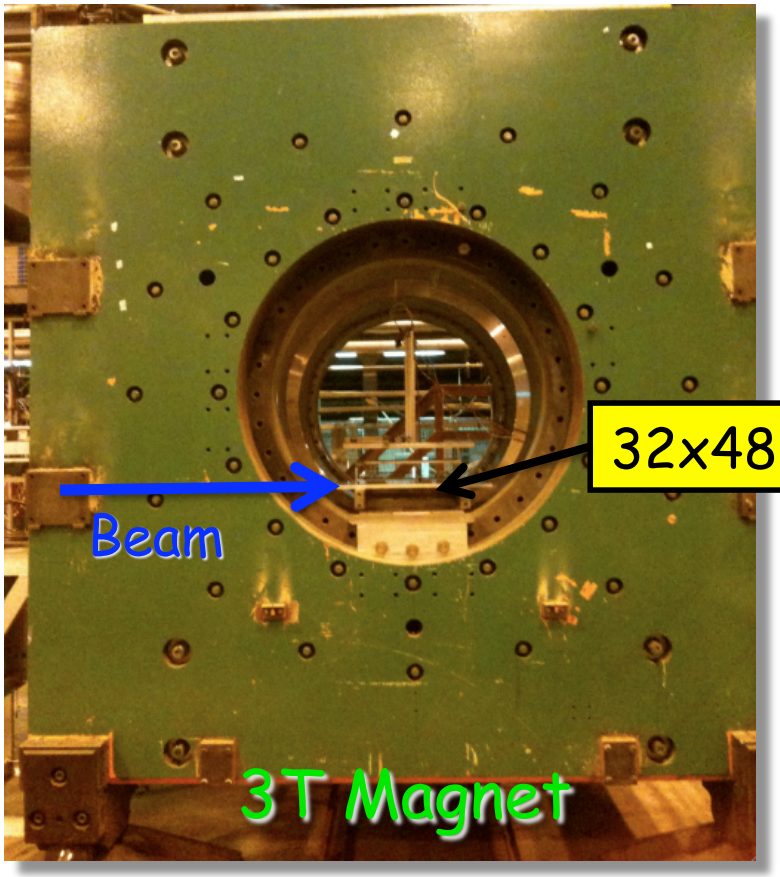


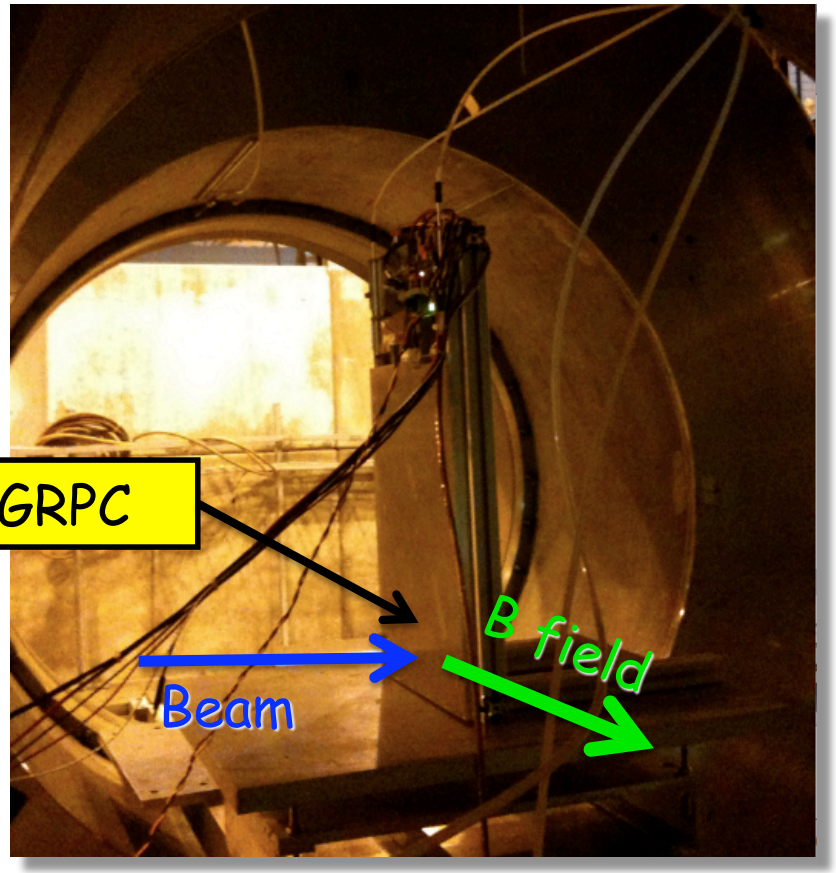


Power Pulsing Test Beam

Beam conditions: 80GeV @ High Rate

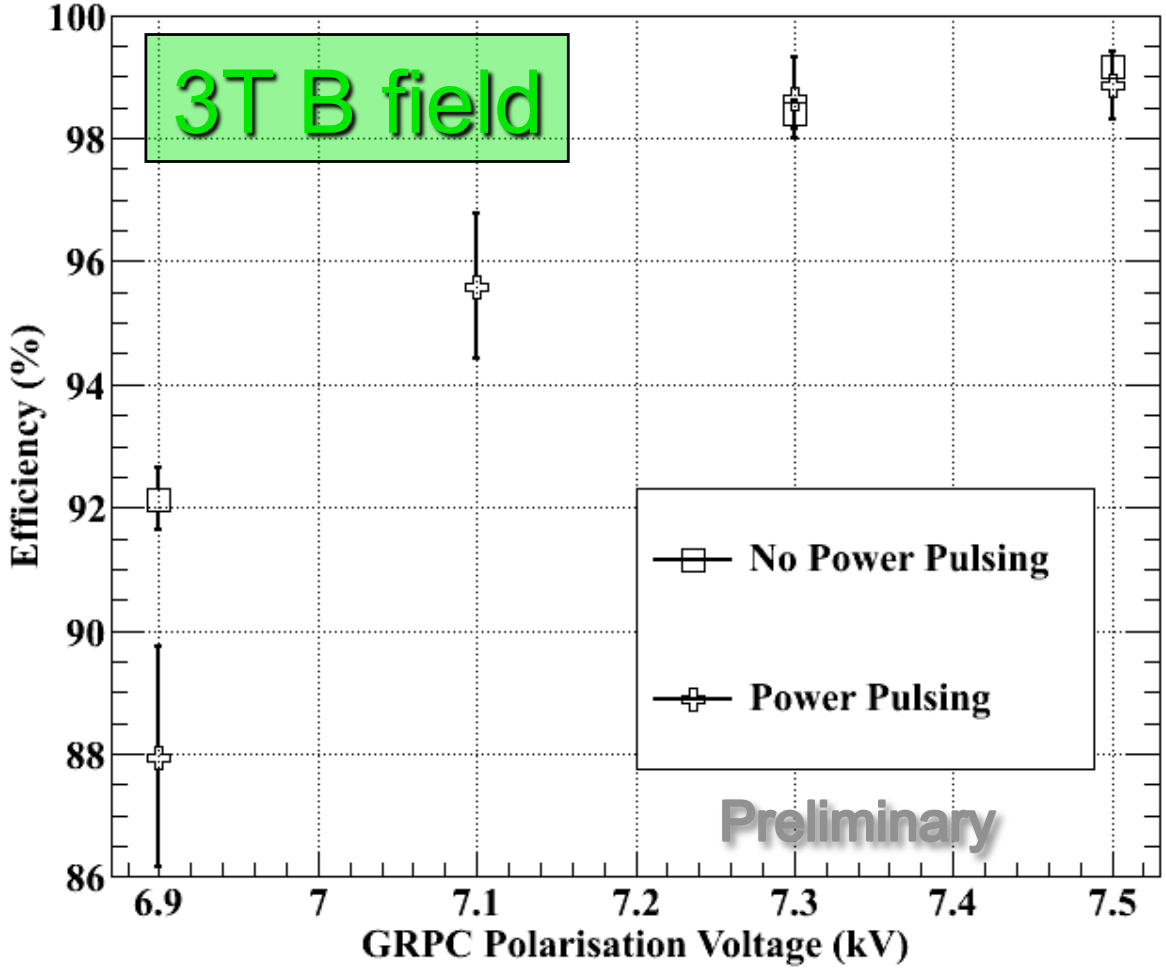
Aim: PowerPulsing tests using B field.





32x48 cm² GRPC

Power Pulsing



1ms after power-ON : no efficiency loss.

Studies are still ongoing to reduce waiting time to 0.1 ms

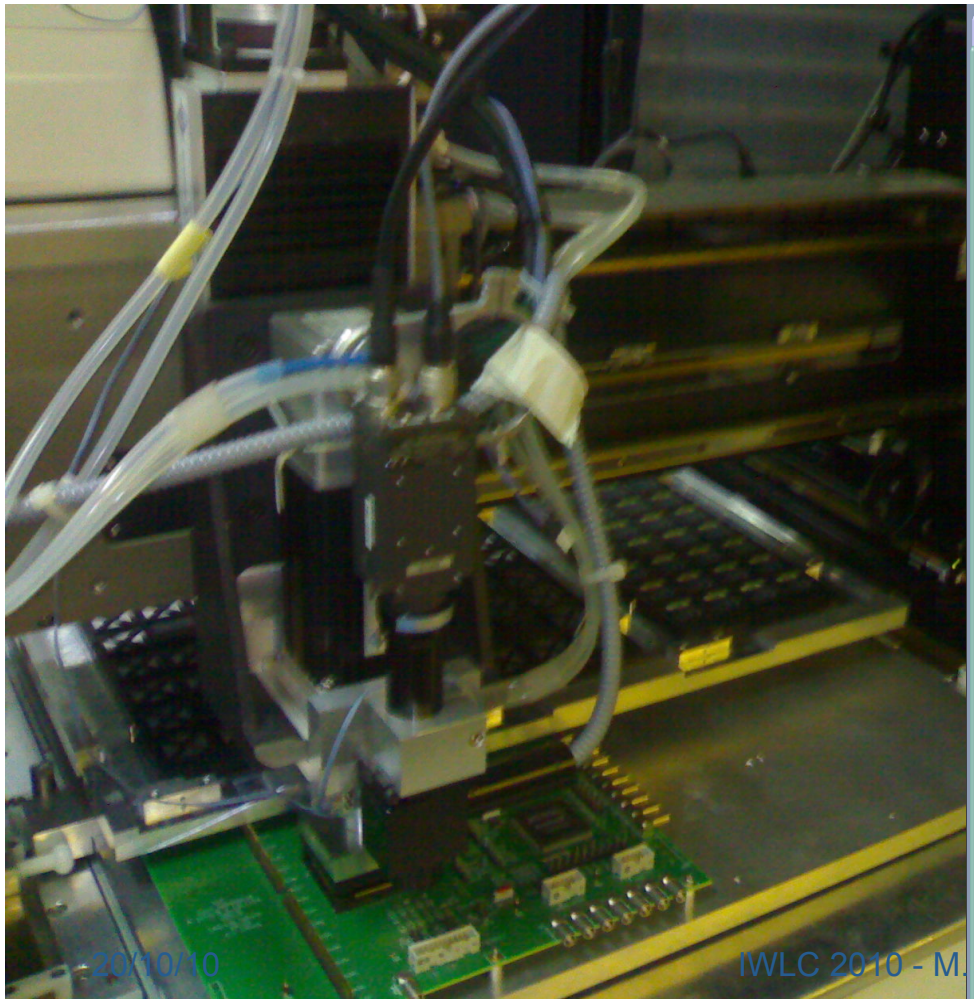
Analysis Summary

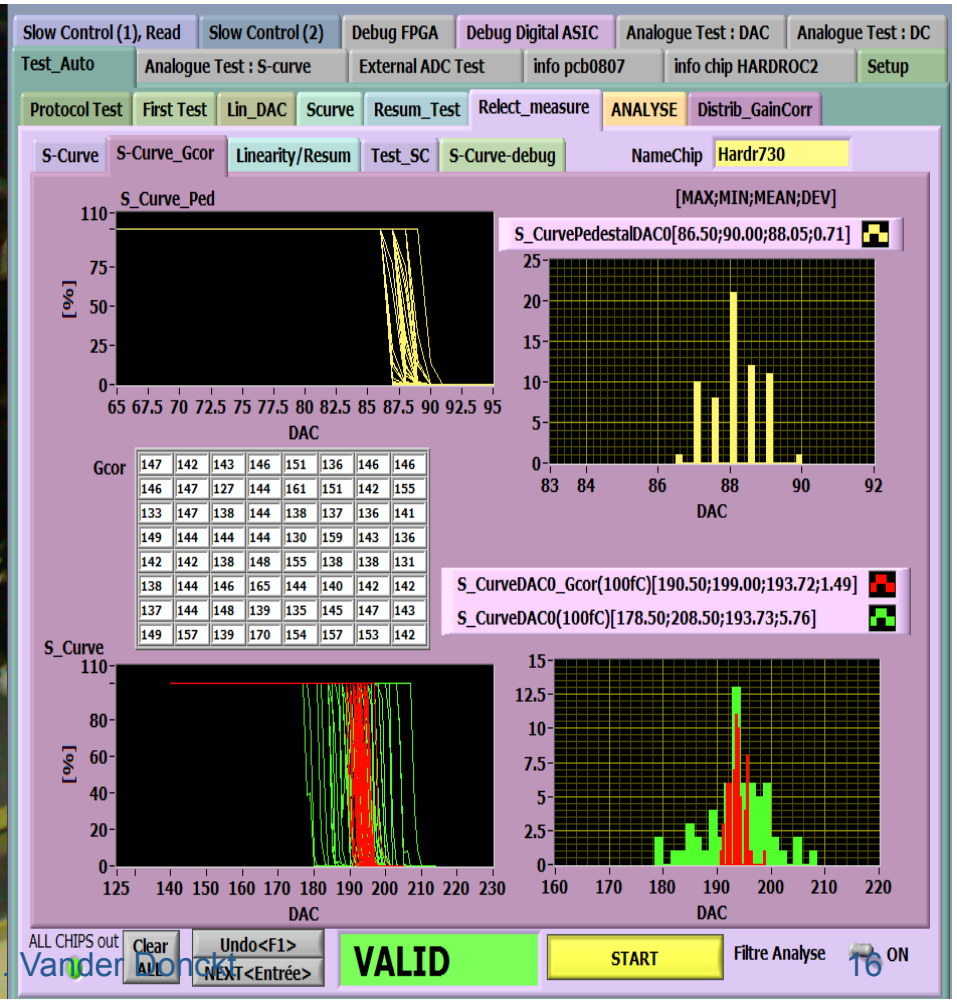
- ✓ Efficiency more than 95%.
- ✓ Multiplicity < 1.3 Pad/MIP (must be re-defined using the 3 thresholds)
- ✓ Detection rate: Steady up to 100 Hz/PAD
- ✓ Noise rate: ~0.1 Hz/cm^2
- ✓ Detector working in a 3 Telsa field
- ✓ Good efficiency/multiplicity homogeneity on large chamber
- ✓ Validity of power pulsing concept proven.

Towards $1m^3$

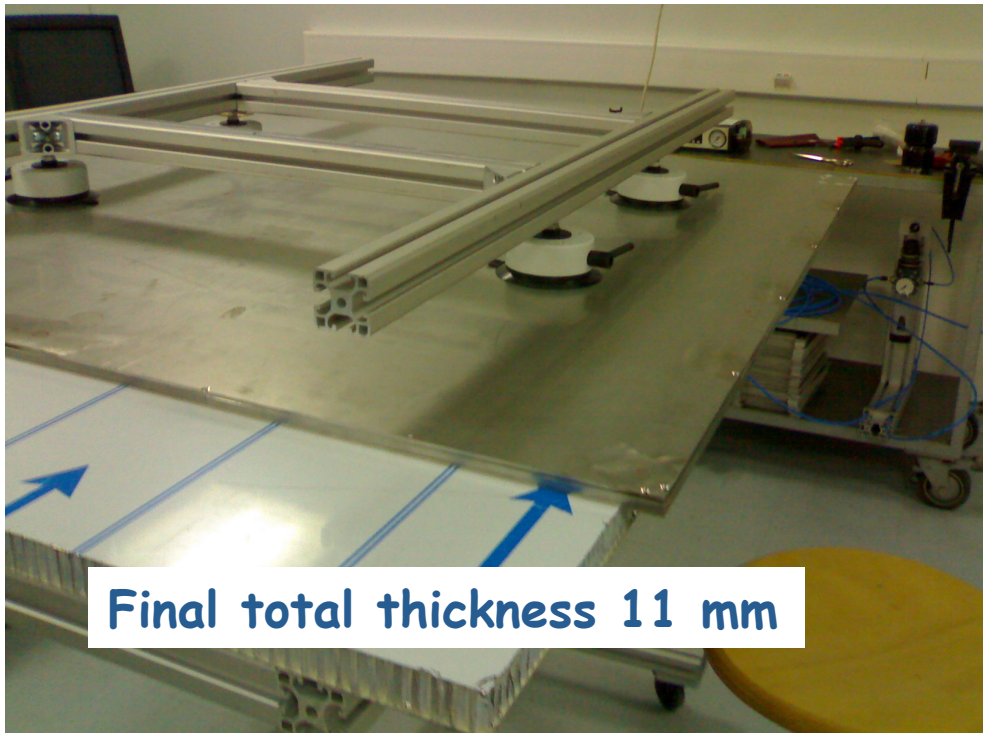
Electronics: ASICs test facility

The ASICs are ready for the 40 layers.
Currently under test, using a robot.
Max test time : 10 minutes/ASIC using Labview-based application

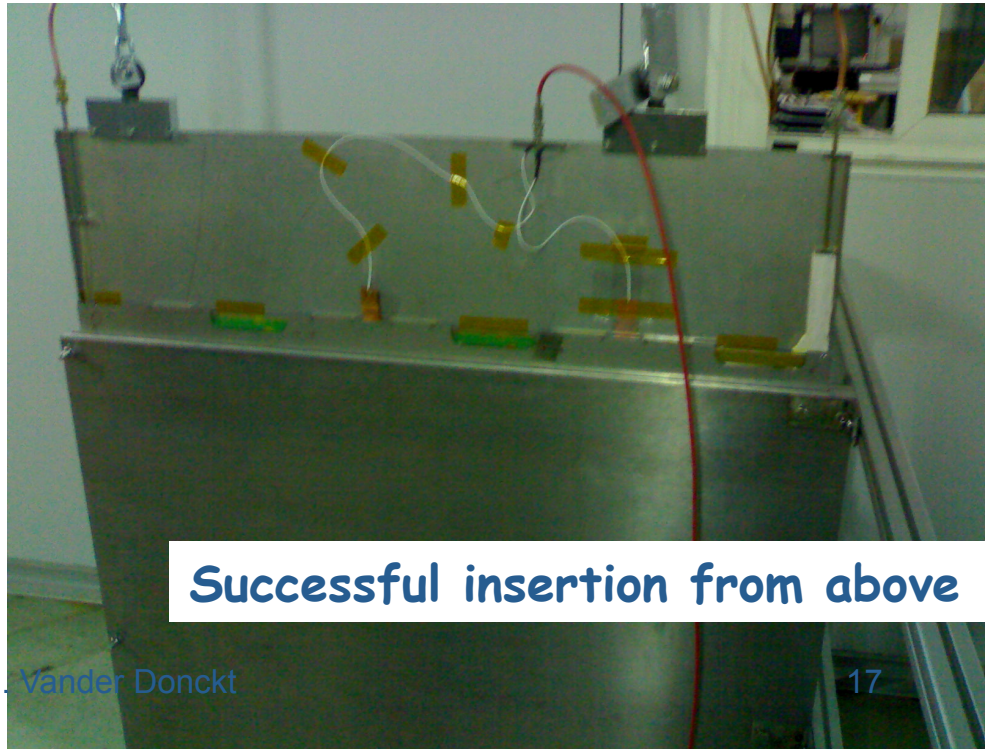





Chamber assembly going on

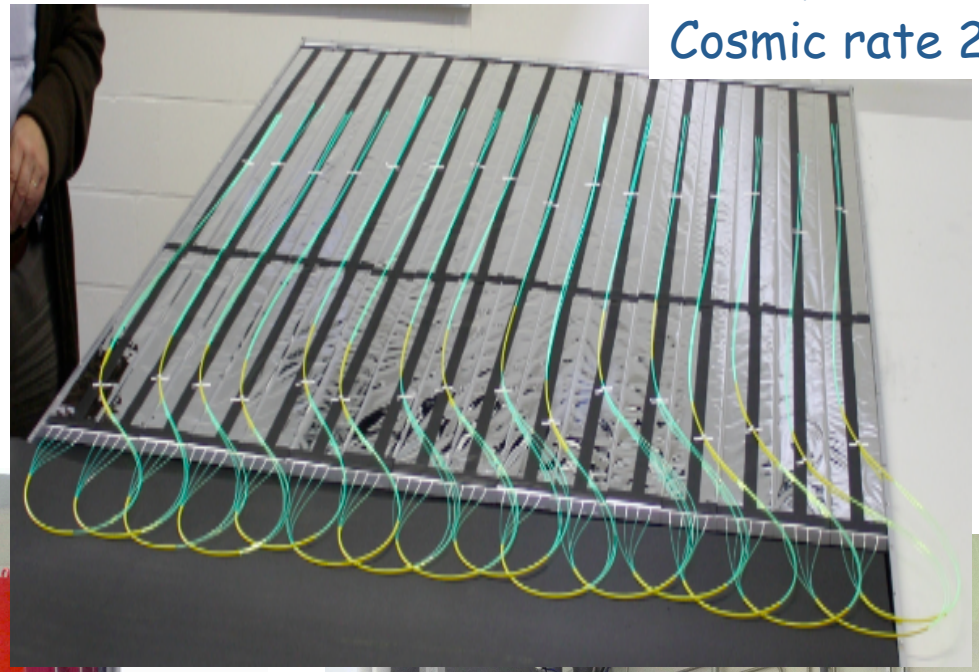

Final total thickness 11 mm


aperture 12.5 mm


Successful insertion from above

Test bench for production

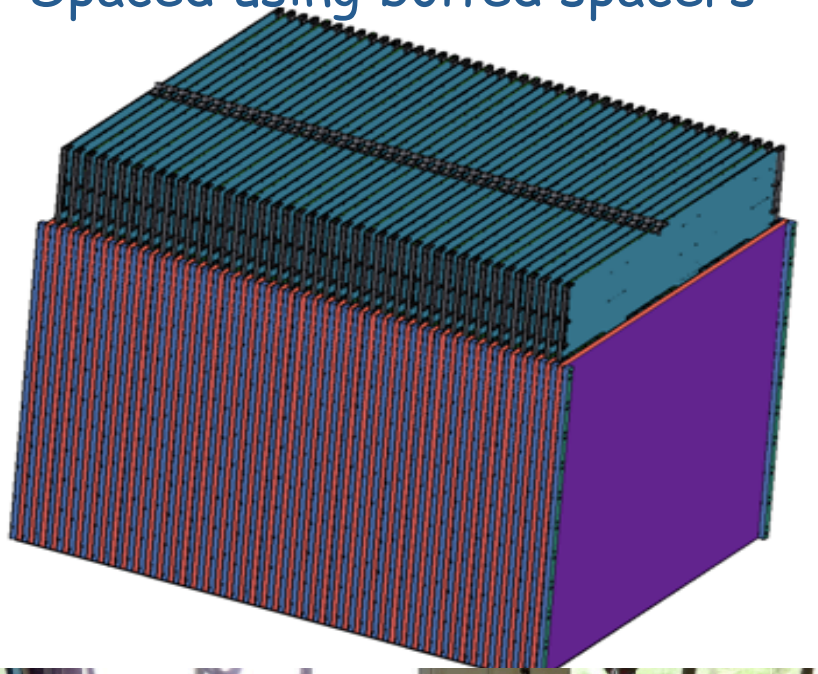
2x2 X-Y scintillator planes
Cosmic rate 200Hz

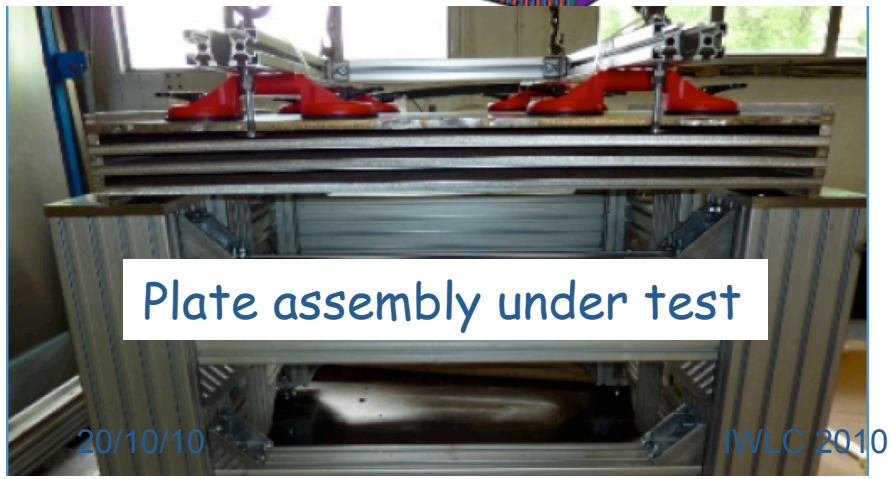


Gas+HV/LV supplies for up to 7 gRPCs that can be tested in few hours

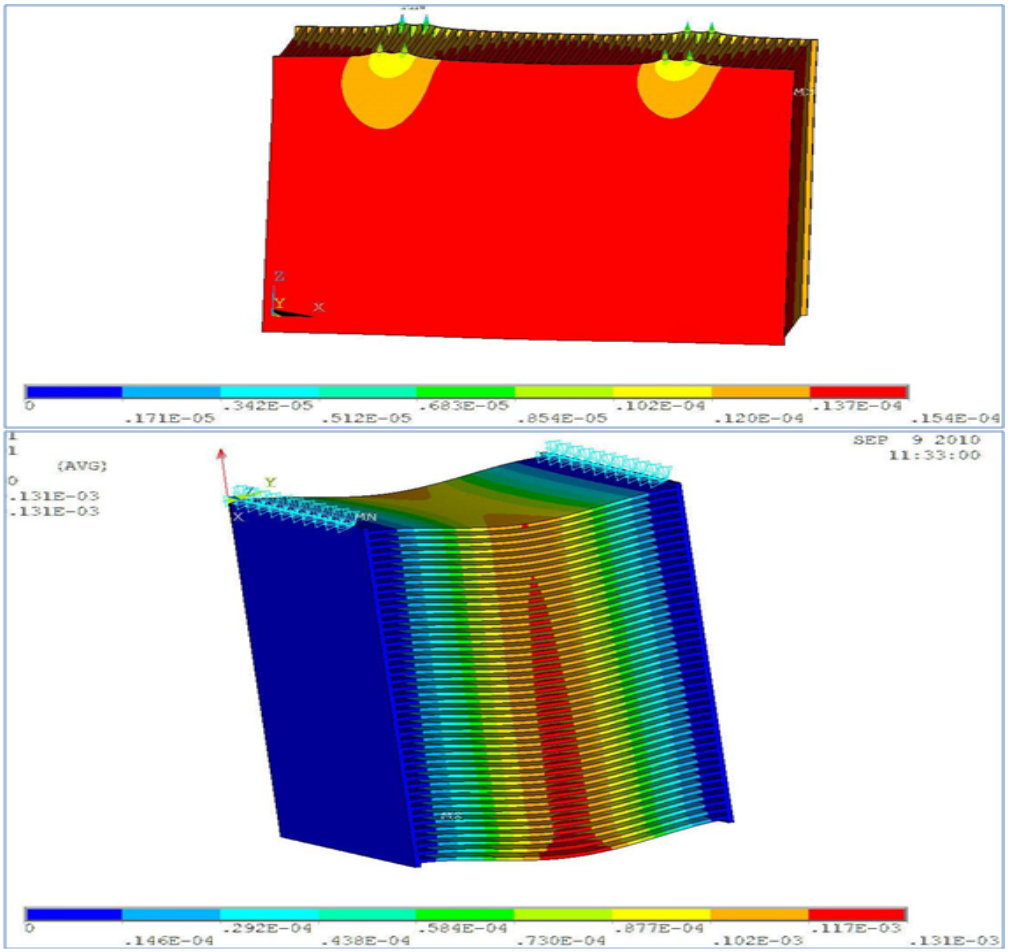
Mechanics

Self supporting structure
Spaced using bolted spacers





ANSYS simulation of stress
and deformation : <150μm



Summary

- 1 m^2 glass RPCs have good efficiency, multiplicity, power pulsing works.
  - Not detailed but under control: ageing, gas flow, HV & gas services
- 1 m^3 construction ongoing to be finished first term 2011
- Ongoing;
  - threshold calibration using charge injection
  - Latest Colloidal graphite testbeam result analysis