R&D for GRPC SDHCAL

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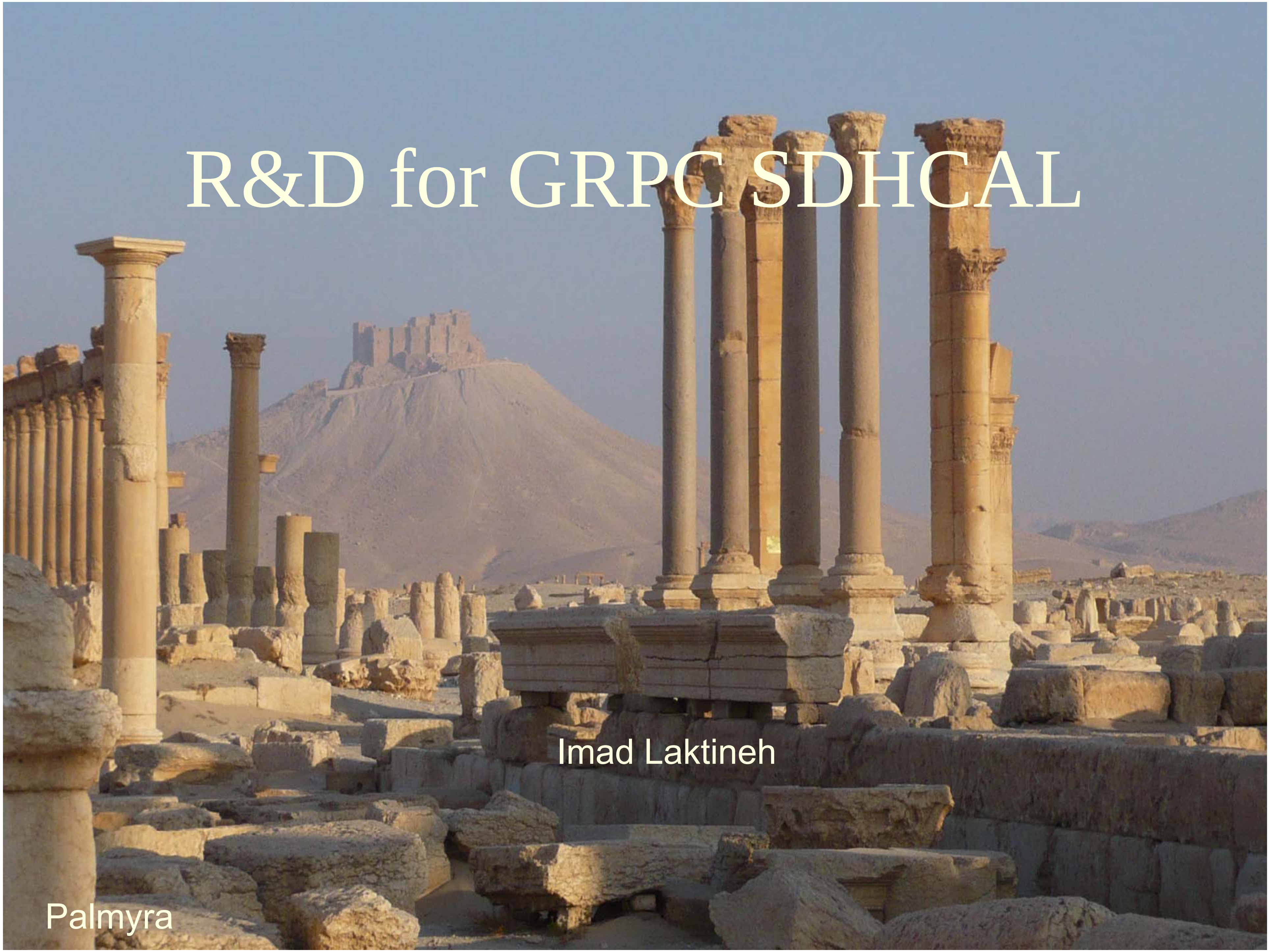


Palmyra

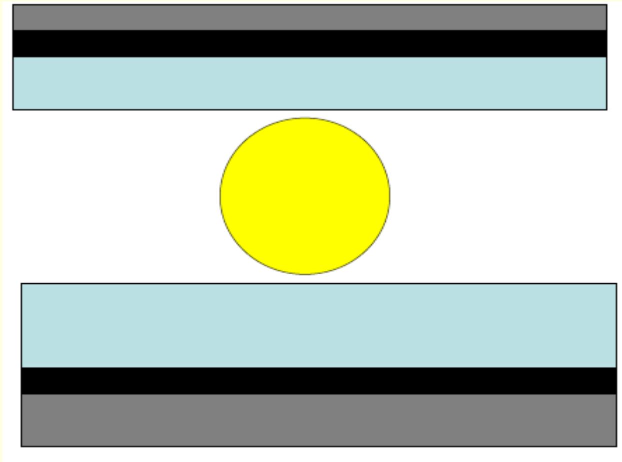
Contents

- Status of $1M^2$ GRPC R&D
- Preparation for the $1M^3$ prototype

$1M^2$ for the technological prototype

Technology drivers :

- Closed chamber design – no external gas-tight box
- Reduce the dead zones: spacers, frame
- uniform resistive coating
- Low cost
- Scalable



Components

Borosilicate glass

Anode: 0.7 mm

Cathode: 1.1 mm

Resistive layer (~ 20μ)

Graphite, Licron' (polymer), Statguard' (oxides of Fe, Ti)

Insulation layers – mylar:

175 μ cathode side (HV ~7.5 kV)

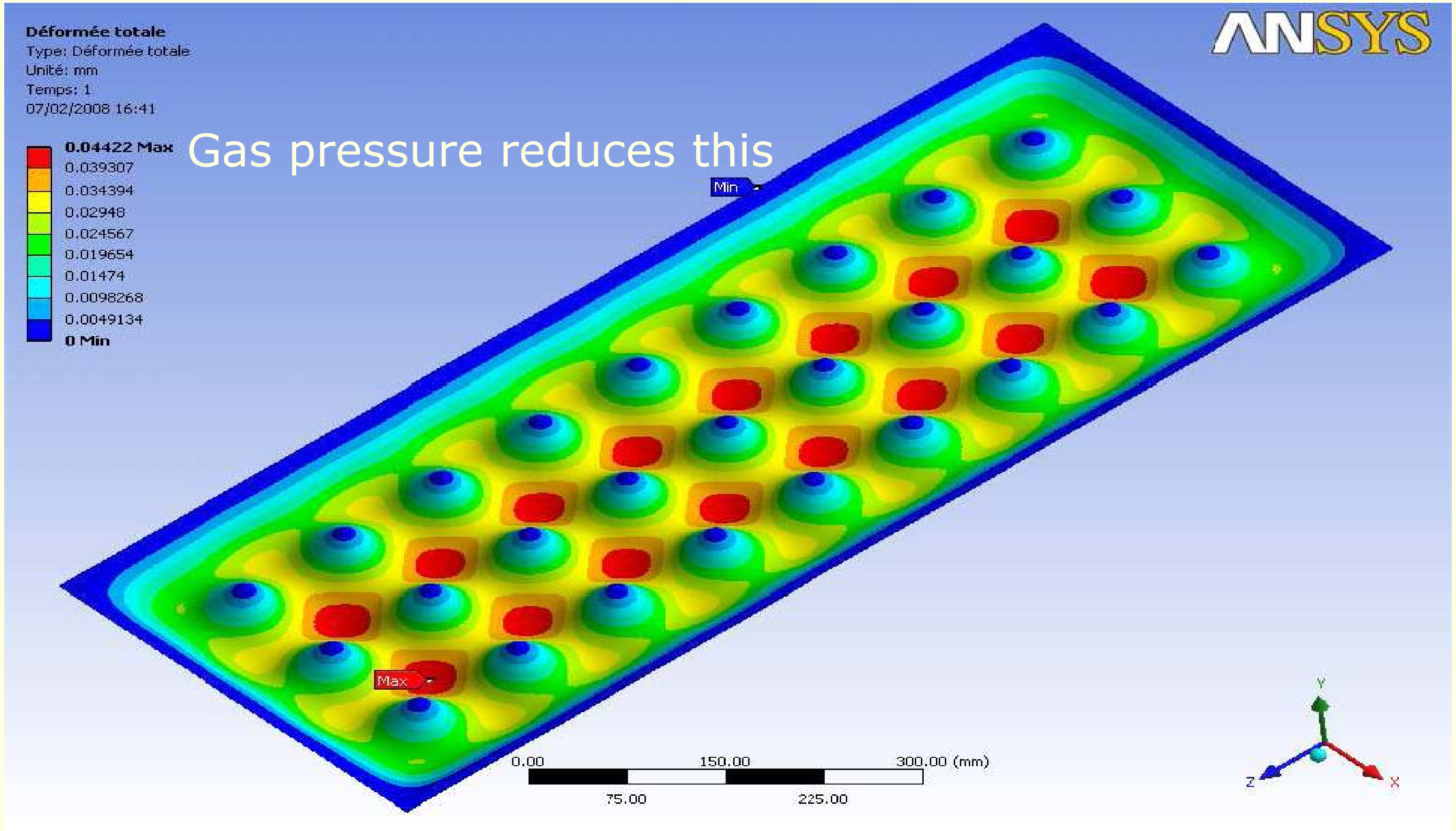
50 μ anode side (0 V)

$1M^2$ for the technological prototype

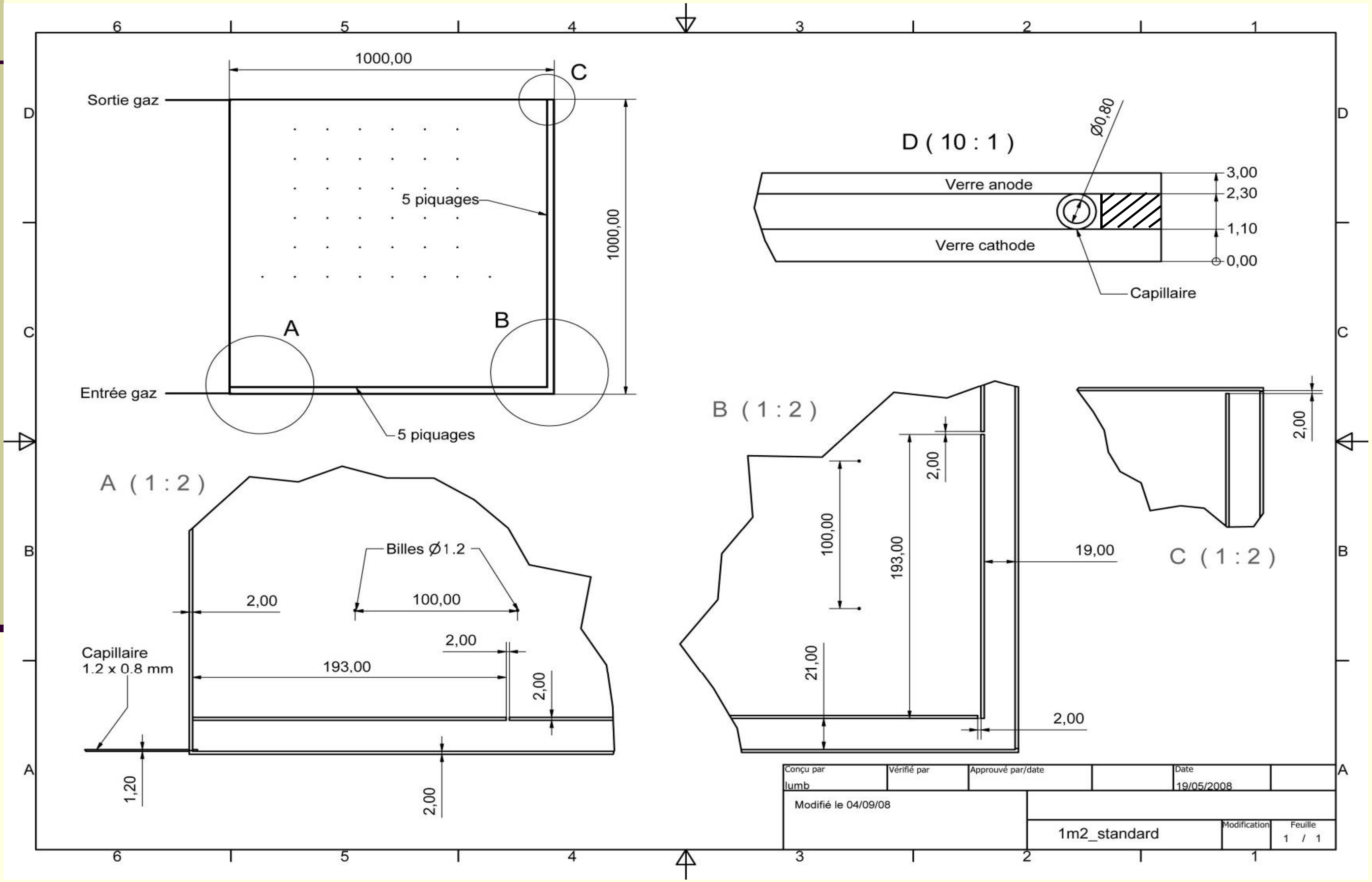
- Two types of chamber:
  - ‘Standard’ chamber
    - Frame in G10, thickness 1.2 mm, width 3 mm
    - ‘Channelled’ gas distribution – ‘2 fishing lines’ (PMMA)
  - ‘Capillary’ chamber
    - Capillary tube frame 1.2X.8 mm
    - Frame used to distribute gas (0.3 mm holes drilled in capillary walls)
    - Advantage: reduction of dead zones
- Support between glass planes:
  - Ceramic balls diam. 1.2 +/- 0.02 mm
  - Distance between balls optimized (ANSYS):
    100 mm (max. deformation 44 μ – 81 balls / m2)

Mechanical deformation of the detector

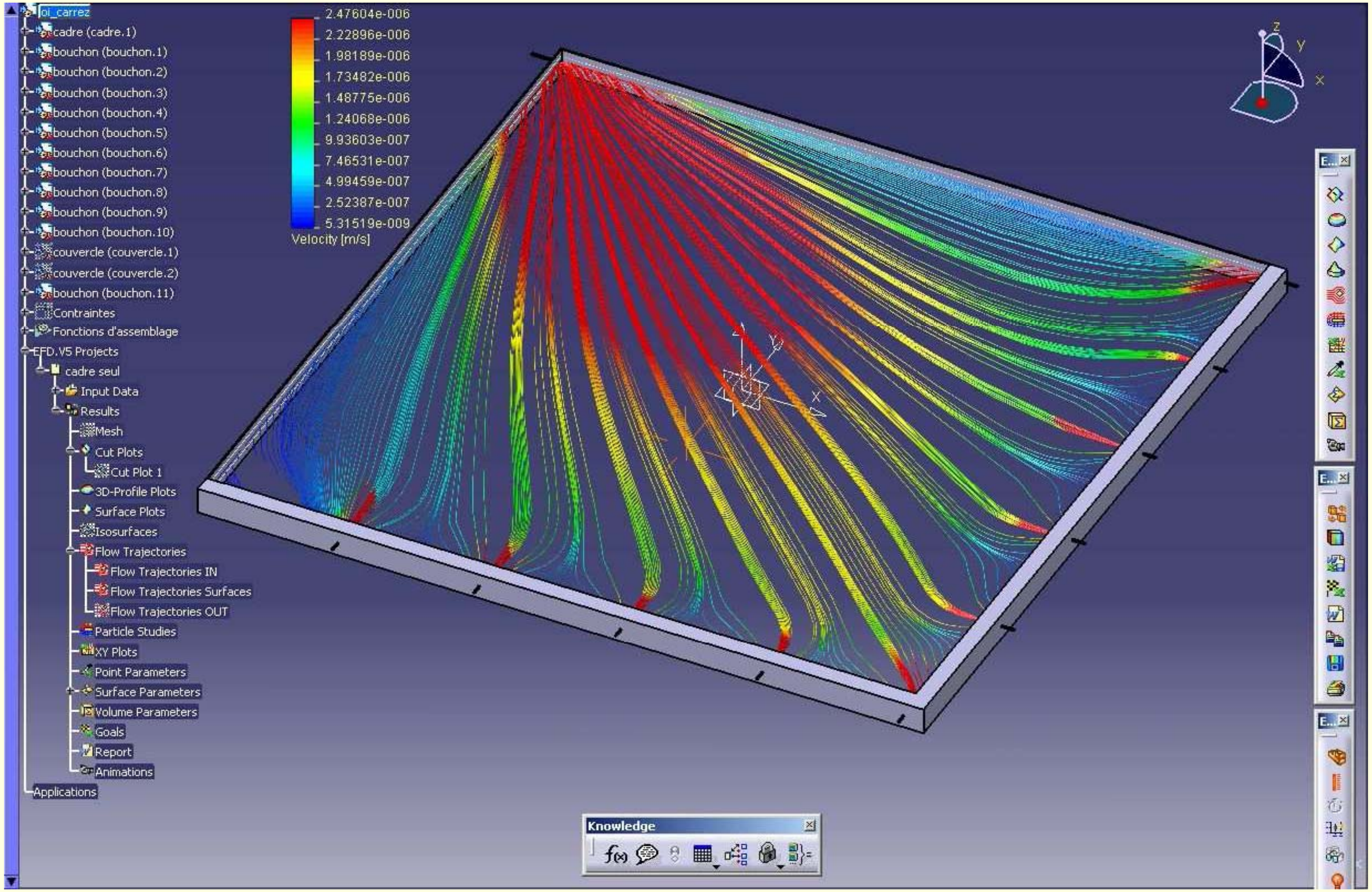
Deformation with HV and ceramics balls



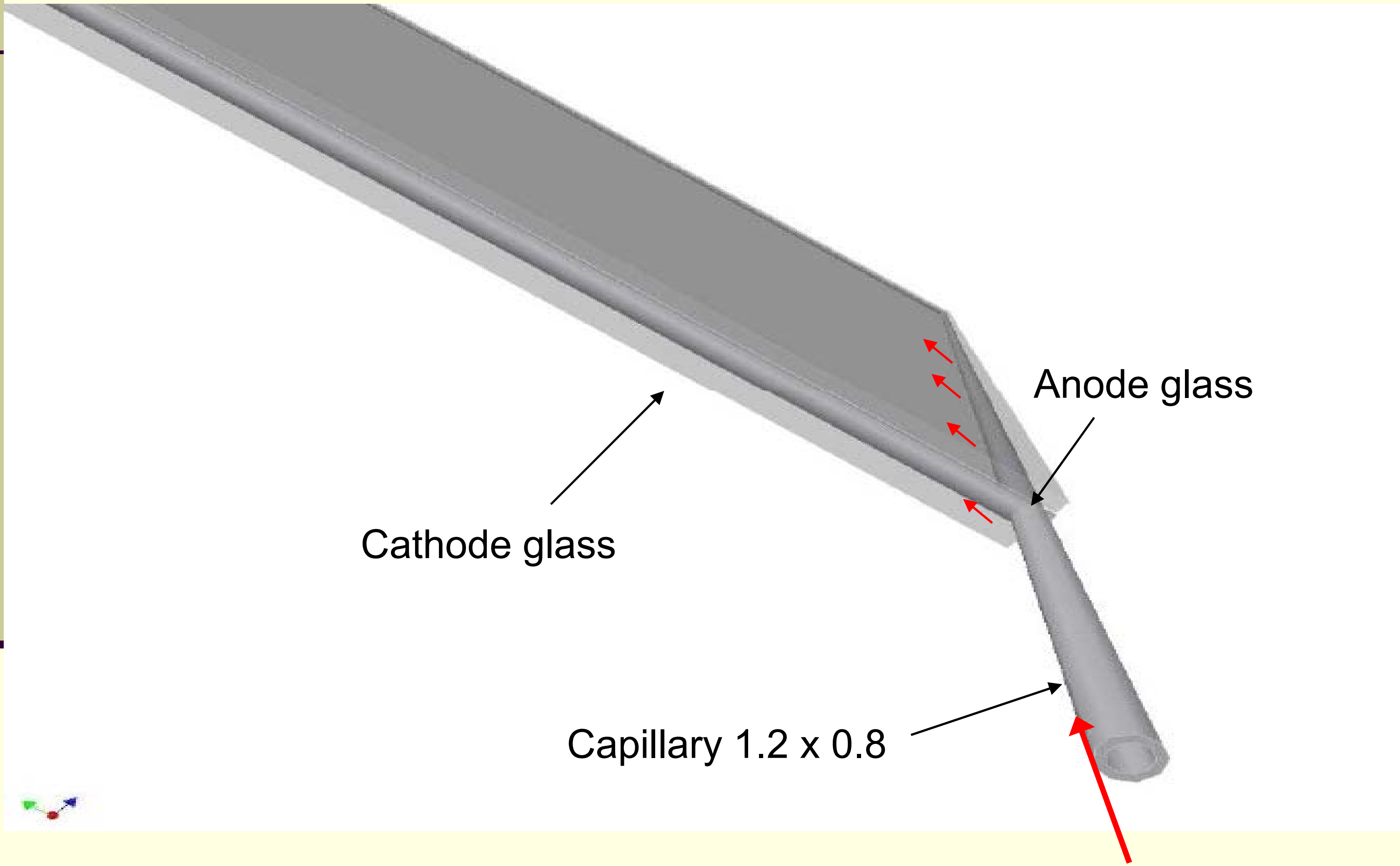
Gas distribution, ‘standard’ chambers



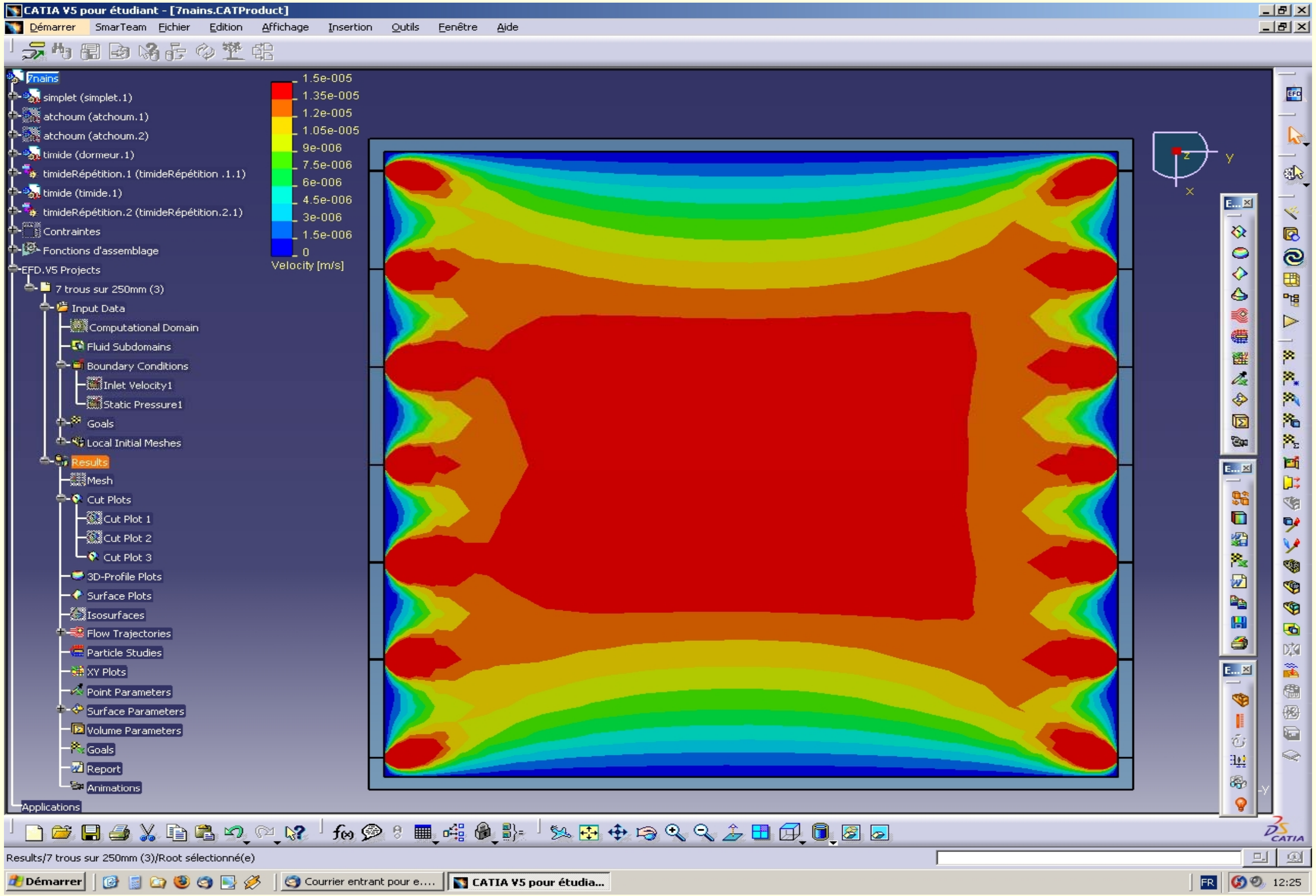
Simulation – gas circulation in standard chamber



Gas distribution,‘capillary’ chambers



Simulation – gas circulation in capillary chamber



M^2 GRPC Status

4 chambers of $1M^2$ were built up to now in Lyon

- All with the standard gas distribution system
- 2 with Licron (aerosol ,ρ_s ~ 30 MΩ/□)
- 1 with Statguard (liquid, 500 MΩ/□ !!!!!)
- 1 to be coated with Statguard (silk screen printing)

Two kinds of problems were encountered and solved:

- Gas tightness
- High voltage connection
- Resisitivity control

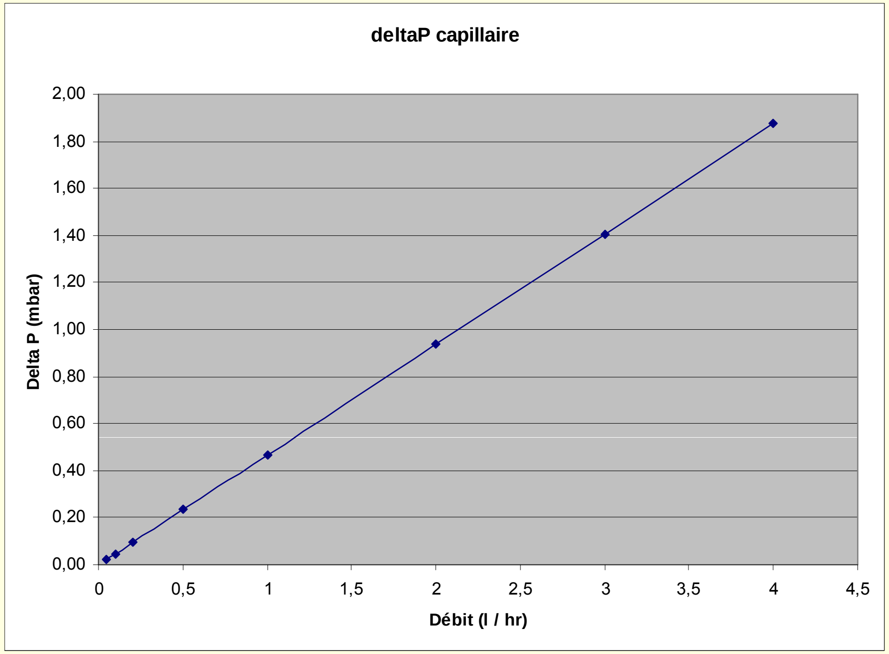
Construction steps

- Clean glass and cover with resistive coating
- Glue micro-balls, frame, gas spacers and capillary tubes to cathode glass on gluing table
- Add glue to upper surfaces of balls and gas spacers
- Turn table to vertical position
- Introduce anode glass
- Turn table to horizontal position
- Deposit glue lines between glass and frame to make gas-tight
- Glue 6mm gas connectors to capillaries and solder HV connectons
- Transfer to honeycomb support

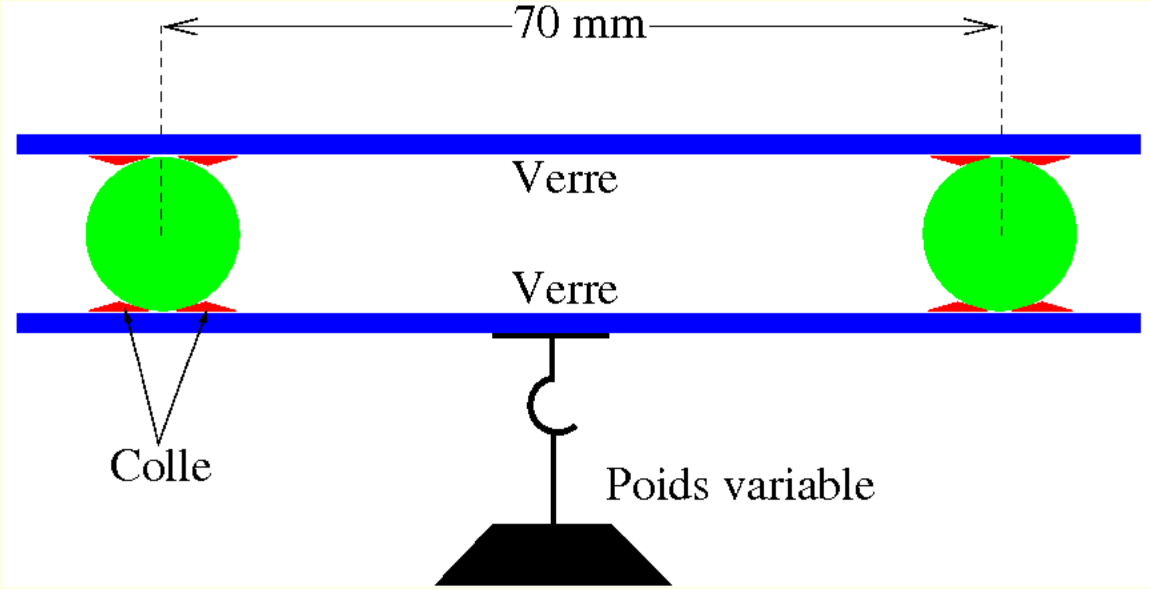



Gas tightness

- First chambers inflated under gas pressure!
- Glue failure caused balls to become detached from upper glass
- Subequent failure of glue around perimeter → gas leaks
- Over-pressure in chamber not excessive (Δp_{exit} ~2.5 mbar ≡ 250g / ball max.)

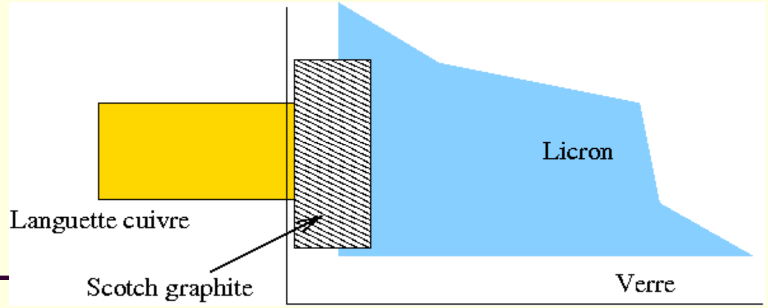


Glue test



- Usual glue – two-component epoxy AY103 + HY951: 2.7g/cm2
- Dow Corning RTV Silicone 3140: 5.0g/cm2
- Araldite epoxy 2011 / 2012: 108 g/cm2

HV connections



- Recurring problem – loss of HV connection on Licron chambers
- Apparent thinning of Licron layer near the copper strip glued to the glass
- Occurred using: After short time (few days to a couple of weeks)
  - Copper Scotch with conductive adhesive
  - Copper strips glued with silver-loaded varnish

- Solutions found:
  - Graphite Scotch
  - Epotek EE129 conductive epoxy

  Both solutions seem to work up to now

Statguard resistivity (1)

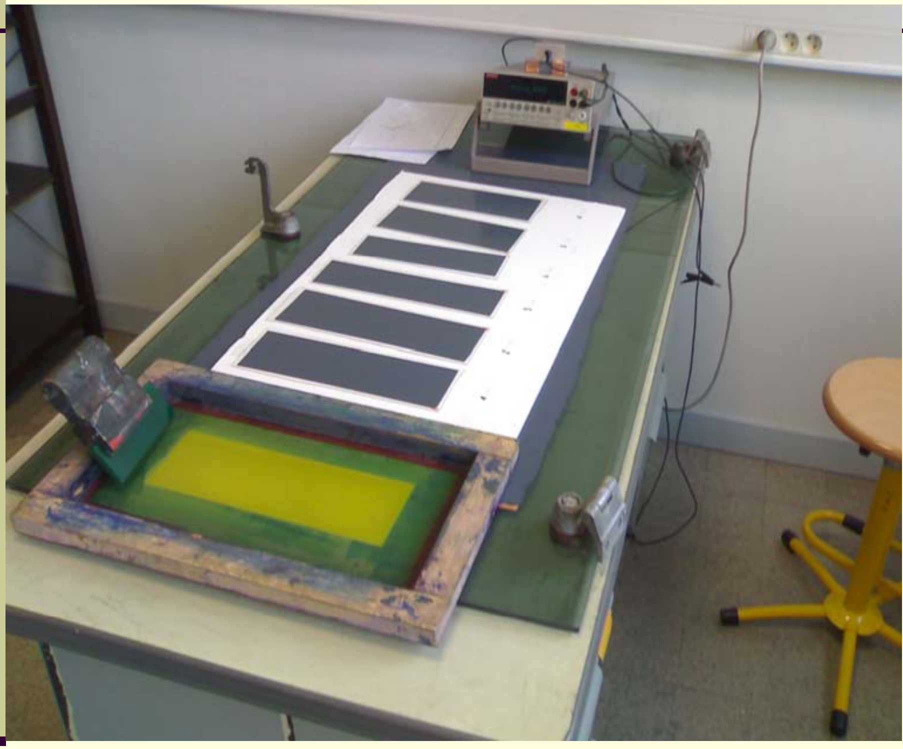
- Commercial product used for ESD protection of floor surfaces
- Potential to silk-screen print onto glass
- Relatively inexpensive
- Good surface finish
- Small chamber in Nov. 08 test beam performed reasonably well (efficiency, multiplicity) →Vincent talk
- 1M^2 Statguard chamber in same test beam had static build-up problem → few HARDROCs damaged due to charge breakdown

  This is due most probably to the very high Statguard resistivity (500MΩ/□)

Statguard resistivity (2)

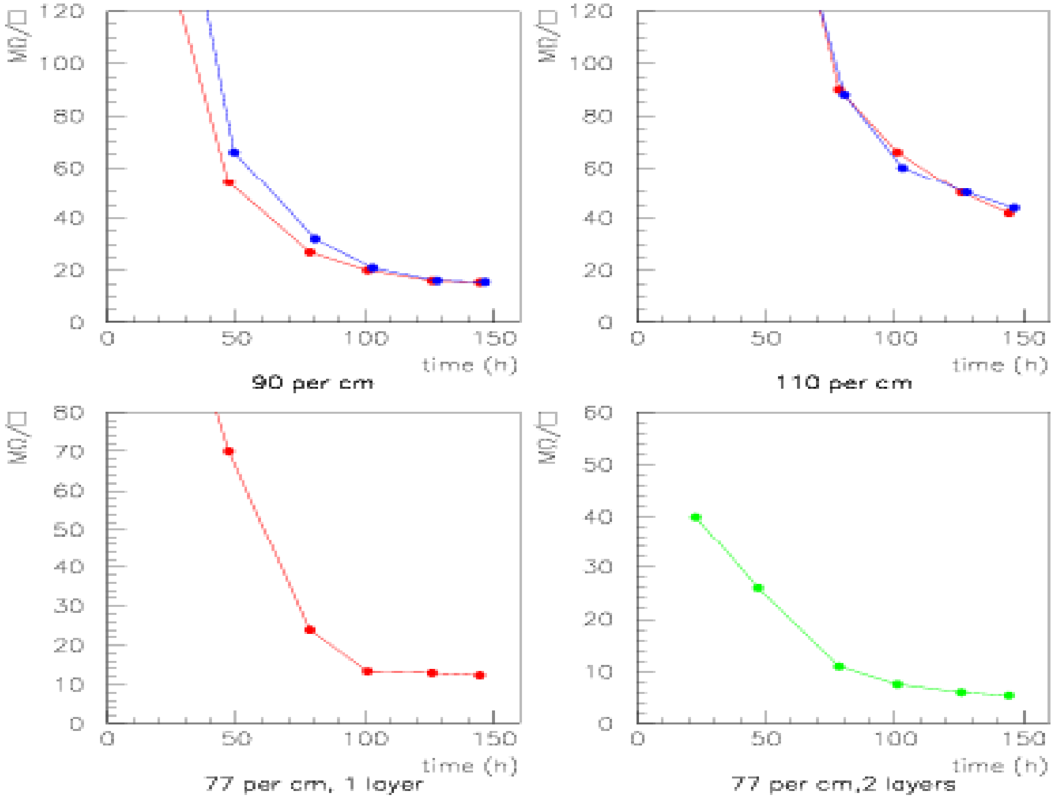
- Resistivity not easily controllable:
  - Varies from 10 MΩ/□ to >500 MΩ/□ for no apparent reason
  - Same glass cleaning procedure
  - Same method of deposition (roller)
  - Same number of layers and approximate layer thickness
- Recent tests indicate roller may be to blame
- Consistent results (~25 MΩ/□ for 1 coat) with paint brush or skimmer
- Silk-screen printing method has been investigated

Silk-screen printing method



- Silk-screen printing method provides a uniform thickness.
- Suitable for coating of large surface detectors
- Different screen configurations were tested using Statguard to obtain the needed resistivity
- other coatings will be tested (colloidal graphite)

Resistivity evolution with time after silk-screen painting



Statguard painting

- Resistivity depends on the layer thickness (up to some extent)
- Using the screen structure allows to determine the thickness (less fibers/cm→ more painting→thicker layer→less resistivity)

Readout electronics status for M^2 detector

- 8 PCB of 50X33.3 cm^2 were conceived and produced
- 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 Slab 1 Slab 2

Readout electronics status for M^2 detector

Problems found and fixed :

- Slow control and data readout failure:
  "Clock signal arriving before data signal after few ASICs"

  → buffers added (2/24 asics)
  → critical line were adapted to avoid reflections

- DIF firmware failures

  → state machines "latched"
  → external trigger system correctly implemented

Data taking with cosmics started last week with one PCB-doublet
If ok→ we equip one $1M^2$

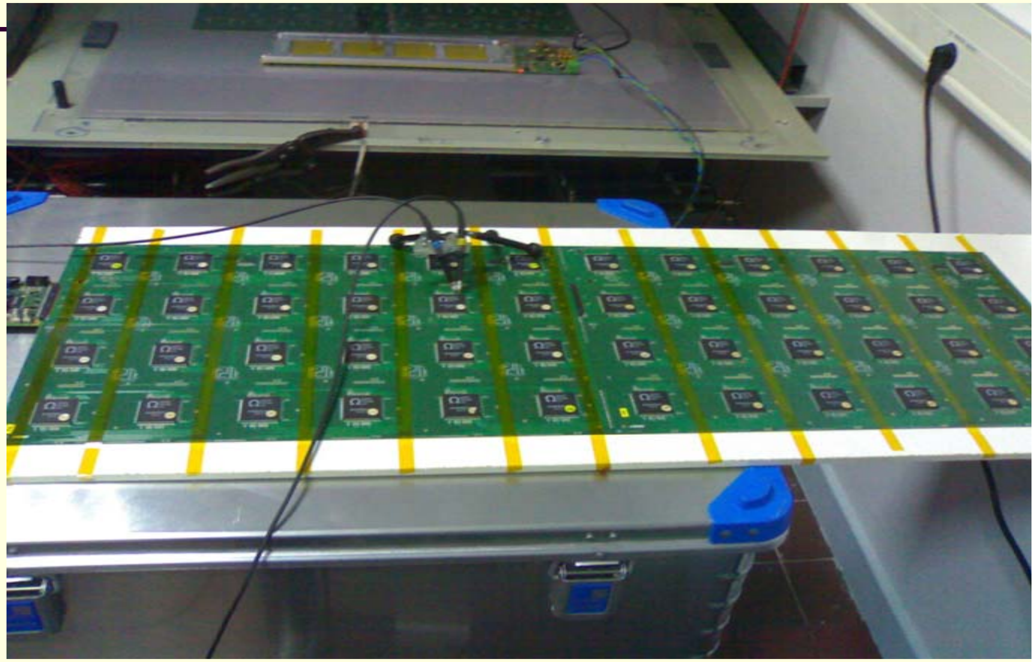
Status for M² detector

Big chamber was tested with small electronics board

PCB-doublet was tested

PCB-doublet on large detector is being tested

Fully equipped large detector to be soon tested



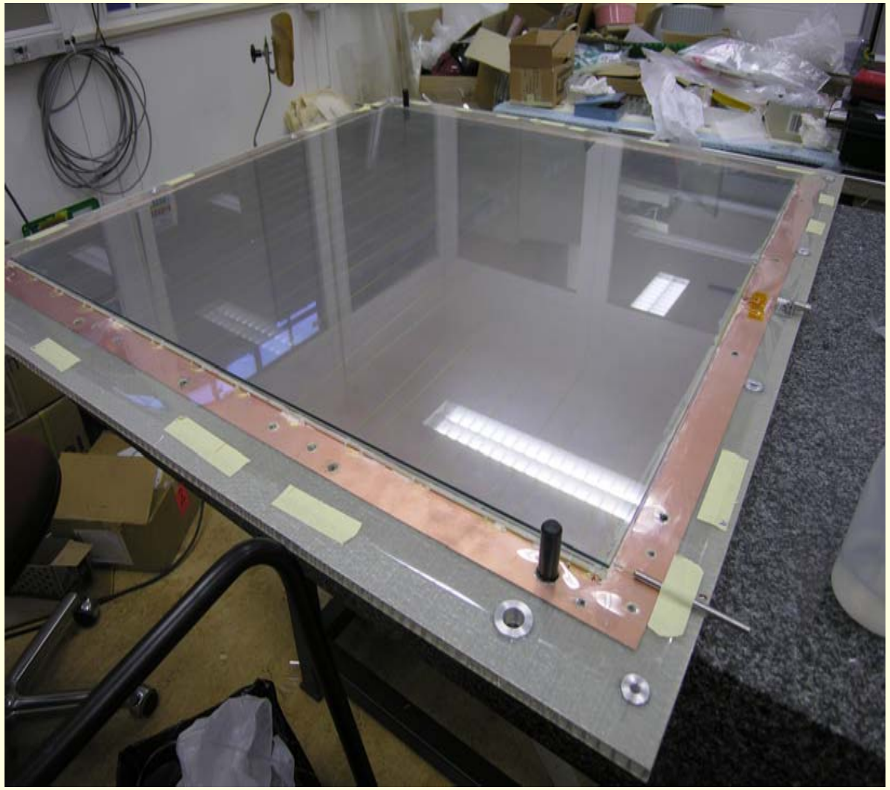
GRPC activities

Bologna-CERN

MGRPC
5 glass plates of 400 μ each
4 gaps of 250 μ
using fishing line as spacers
and Licron as resistive coating

32X8 cm^2 MGRPC was built
and tested with the SDHCAL
electronics: see Vincent talk

1M^2 multigap GRPC was
built and will be tested with
the same 1M^2 SDHCAL
electronics



GRPC activities

Tsinghua University

Semiconductive glass

210mm*70mm*0.7mm

$\sim 10^{10}\Omega$.cm

Rate: 26 k HZ/cm^2

Semiconductive ceramics

80mm*50mm*1mm

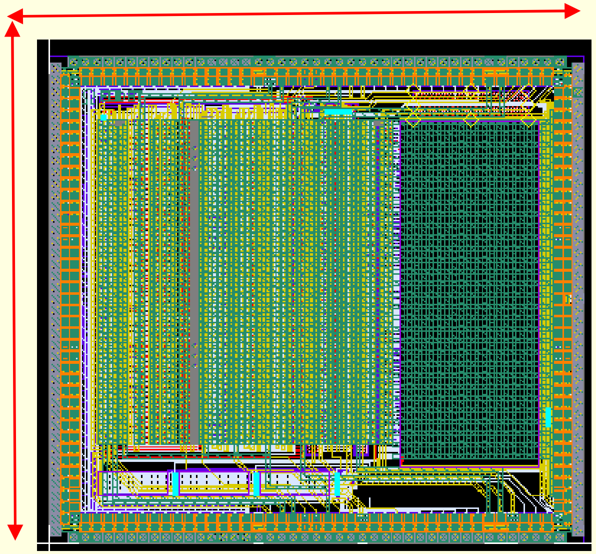
$10^6 \sim 10^9\Omega$.cm

Few small chambers will be tested with the SDHCAL
In the next TB at cern.

Readout electronics

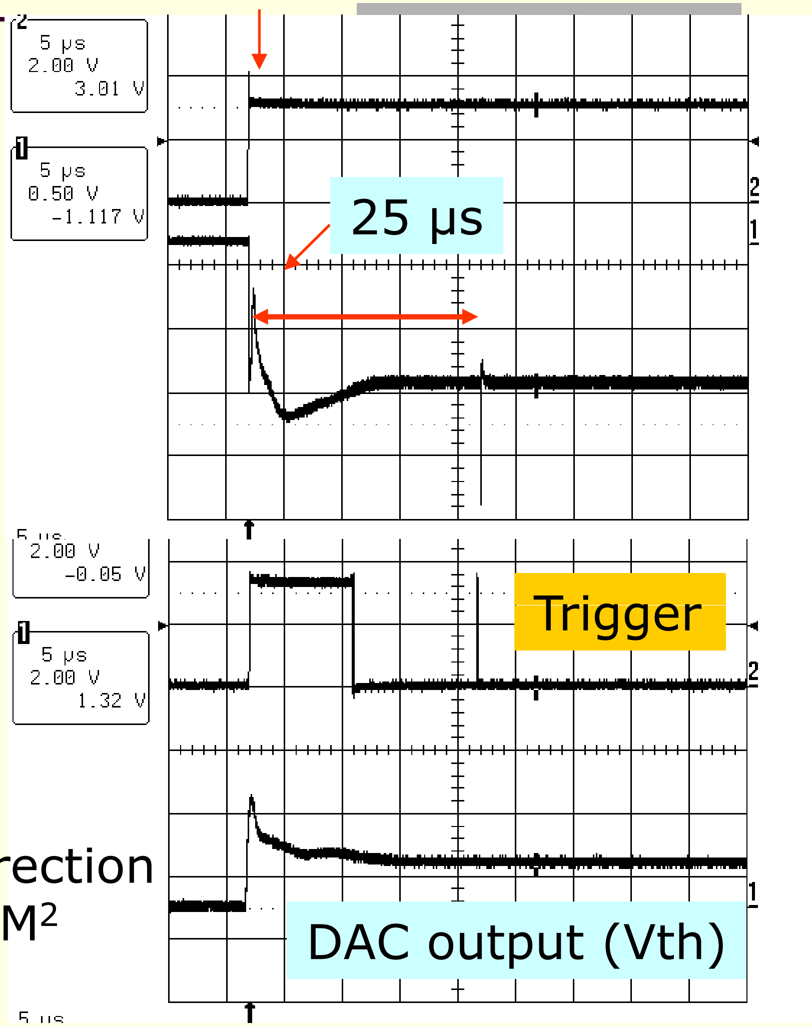
4.7 mm

4.3mm



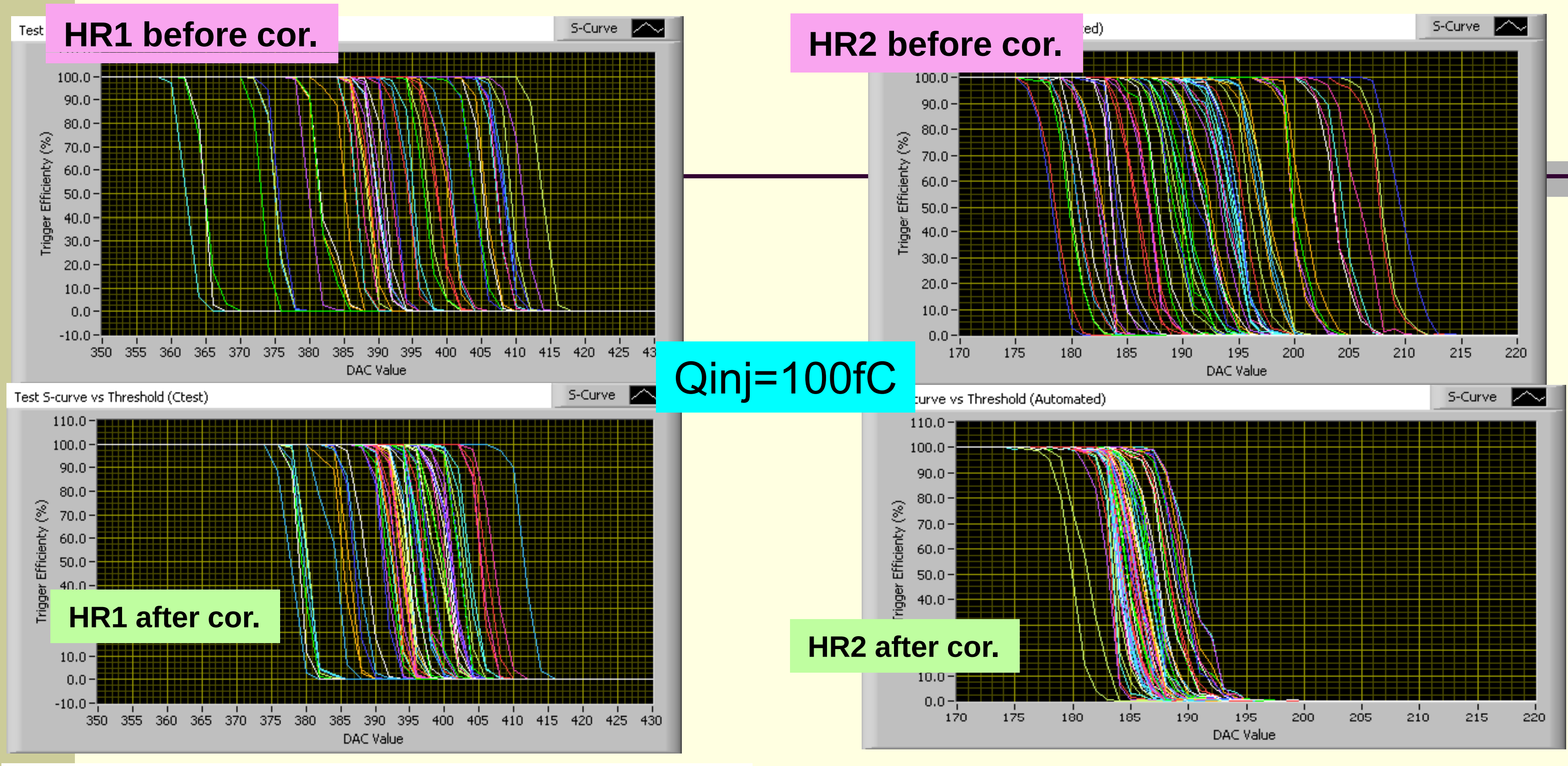
HR2

PWR ON



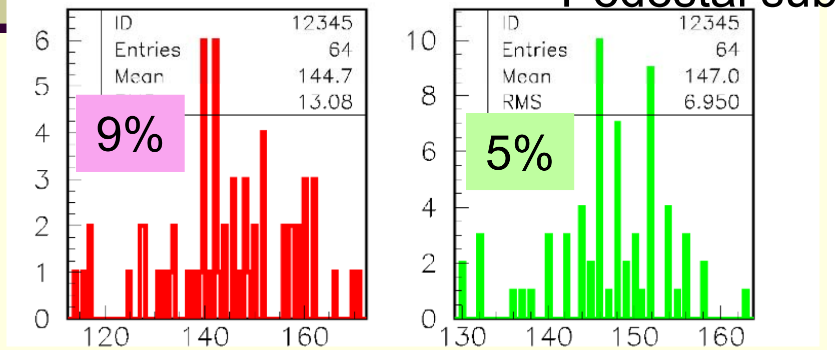
3 thresholds with "independent" gain correction
New PCBs are under design for a second M^2

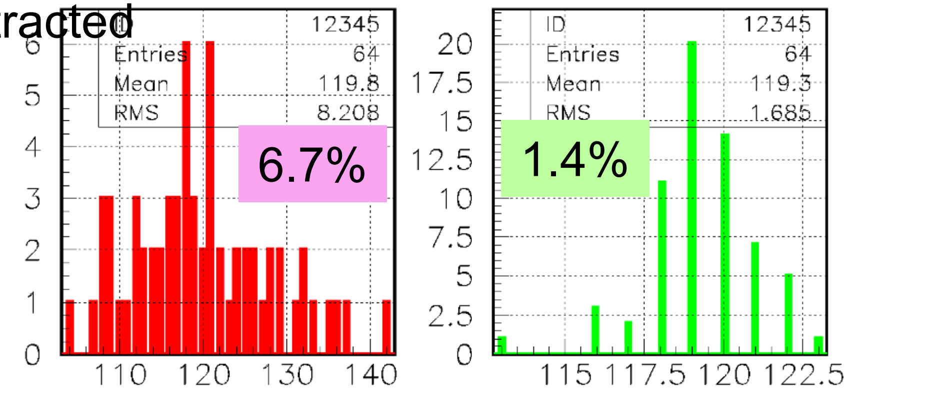
FSB0 scurves: HR1 /HR2 before and after gain correction



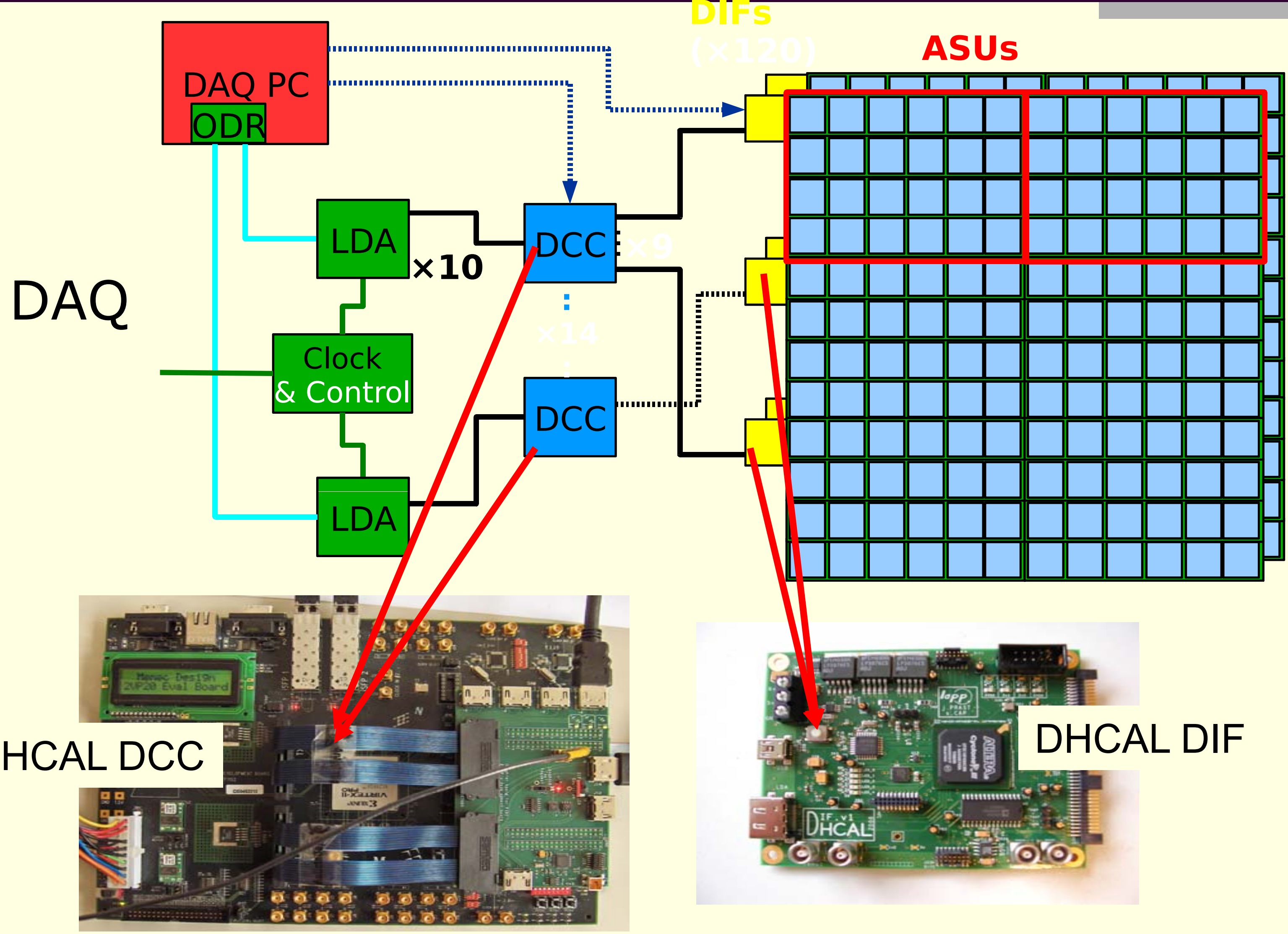
Qinj=100fC

Pedestal substracted

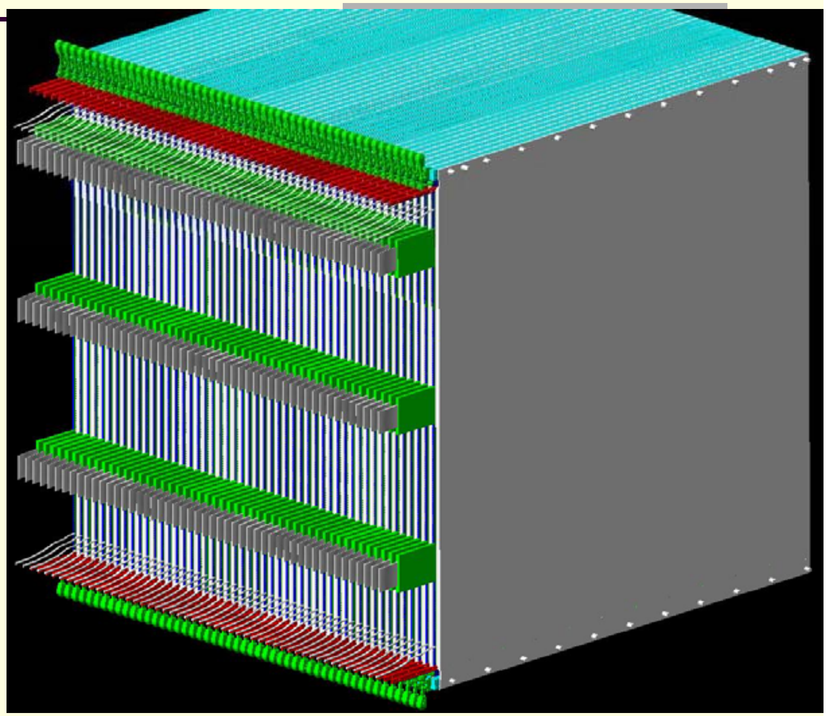




Readout electronics



Preparation for the $1M^3$ technological prototype



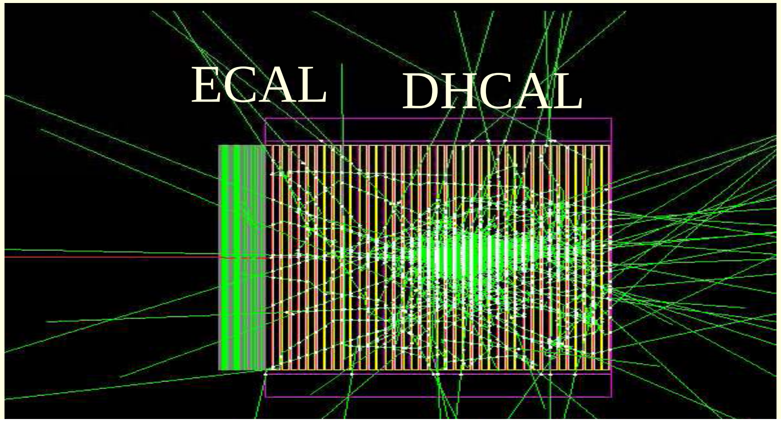
The aim is to come as close as possible to what we would like to have for ILC.

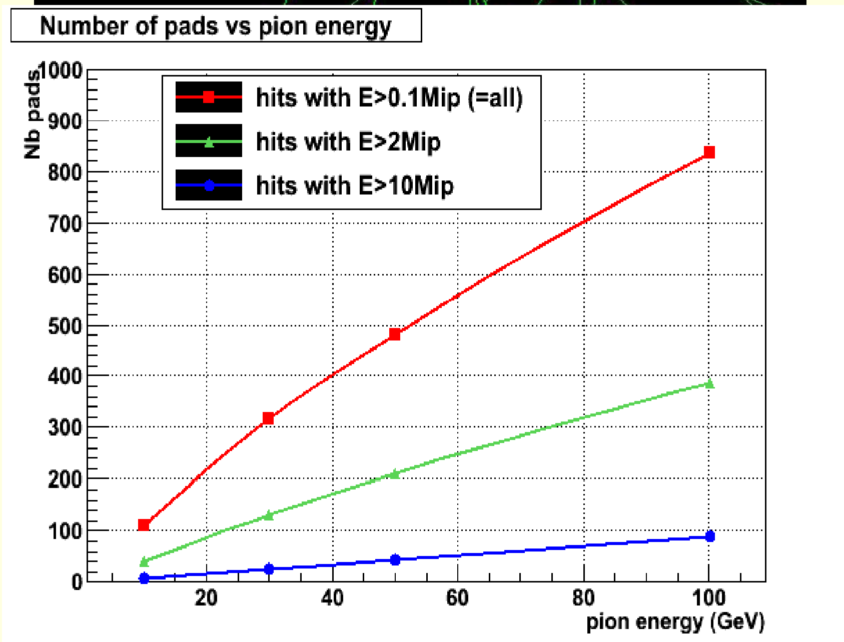
Technological prototype :
40 plans of $1M^2$:
16mm s.steel absorber
4mm s.steel support
6mm GRPC

Important points:
Semi-digital readout, mechanical structure, gas system
DAQ, event building, data storage.

Preparation for the 1M^3 technological prototype

- Pions with different energies were simulated to better understand the containment
- Analyses to exploit the three thresholds have started by having an idea of the energy/particles going in one pad
- Work has started to develop algorithms for energy reconstruction using the 3 thresholds
- Digitization should be worked out.





Preparation for the 1M3 technological prototype

Important issues:

- Mechanical structure: see Enrique talk, thermal study
- Gas system :
  → Possibility to use BaBar drift chambers gas system
  → Recycling and purification system are also worked out in collaboration with CMS-RPC (R.Guida)
- Software, data format : →ongoing work to have the 1M3 in mokka for the simulation
  → developing the needed tools for clustering

Conclusion

- Building ILC-like large GRPCs is now a controlled technique
- Electronics readout for $1M^2$ is debugged and is almost ready
- Mechanical structure to hold GRPC+ equipped PCB is ready
- Another equipped $1M^2$ with HR2 is in preparation
- The preparation for the $1M^3$ is ongoing and construction should be start in second half of 2009.