DHCAL Meeting 20/01/09

GRPC development in Lyon

Overview

- Part 1 – technology choices
- Part 2 – constructed chambers and problems encountered

Part 1: Technology

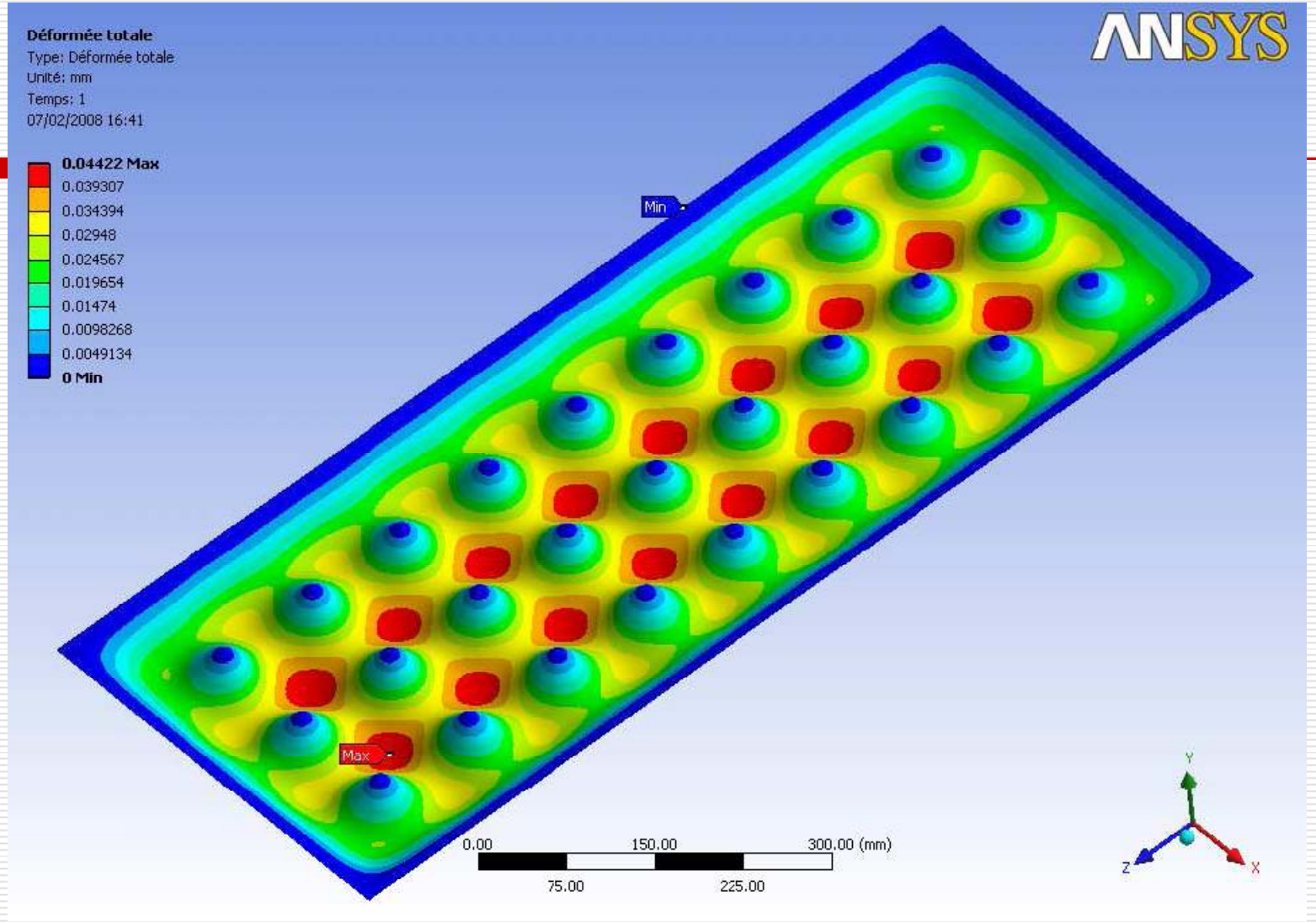
- Technology drivers
  - Minimize dead zones
    - Closed chamber design – no external gas-tight box
    - Reduce area of spacers inside gas volume
  - Low cost
  - Scaleable to 2500 m^2 of detector
    - Semi-industrialized production possible

GRPCs 'Lyonnaise' – technology (1)

- Borosilicate glass
  - Anode: 0.7 mm
  - Cathode: 1.1 mm
- Resistive layer (~ 20μ)
  - Graphite: $\rho_s \sim 2$ kΩ/□
    → Very high multiplicity!
  - 'Licron' (polymer): $\rho_s \sim 30$ MΩ/□
  - 'Statguard' (oxides of Fe, Ti): $\rho_s > 100$ MΩ/□
- Insulation layers – mylar
  - 175 μ cathode side (HV ~7.5 kV)
  - 50 μ anode side (0 V)

GRPCs 'Lyonnaise' – technology (2)

- Two types of chamber:
  - 'Standard' chamber
    - Frame in G10, thickness 1.2 mm, width 3 mm
    - 'Channelled' gas distribution – 'fishing line' (PMMA)
  - 'Capillary' chamber
    - Capillary tube frame 1.2 x 0.8 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)


Déformée totale
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Unité: mm
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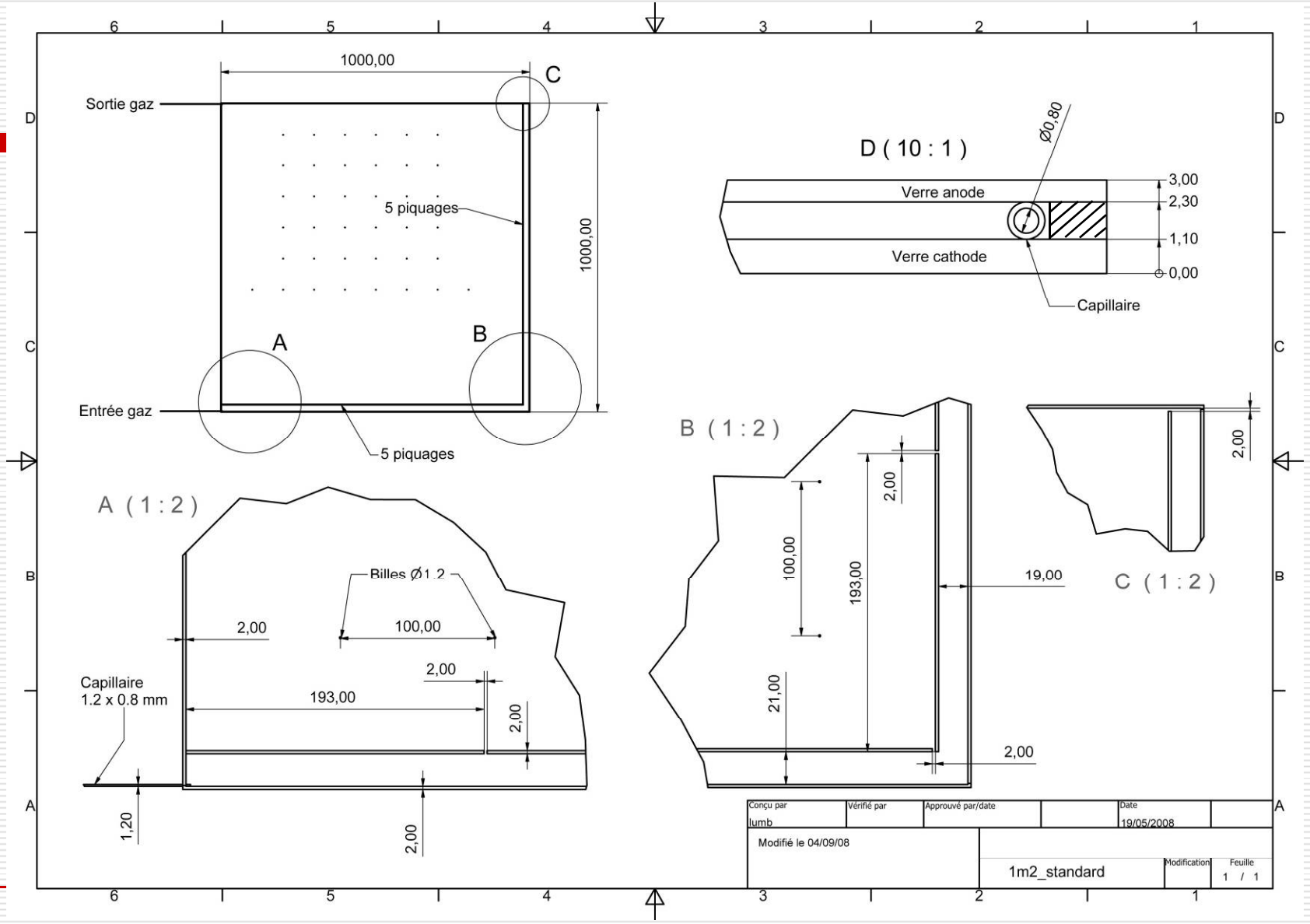
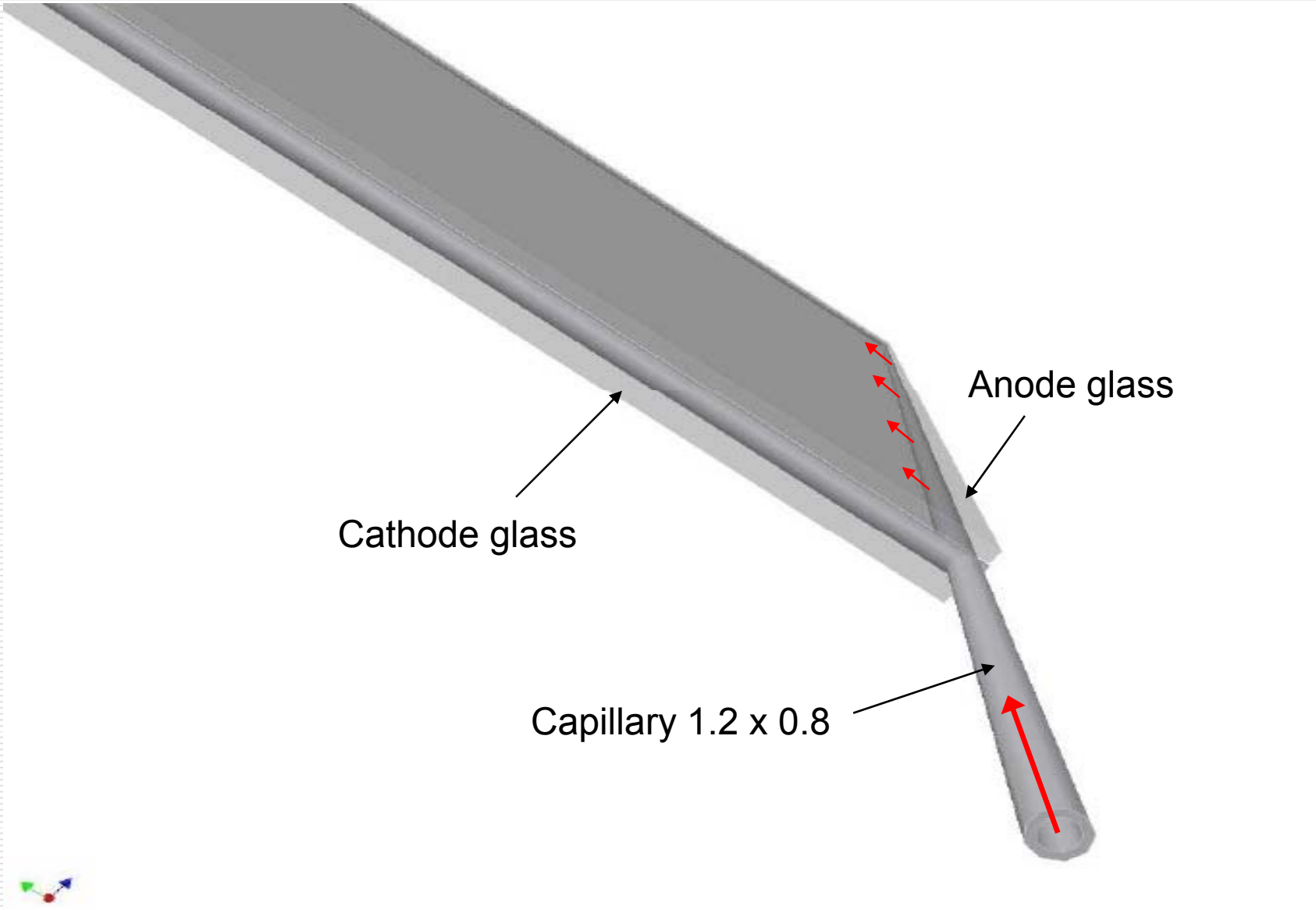
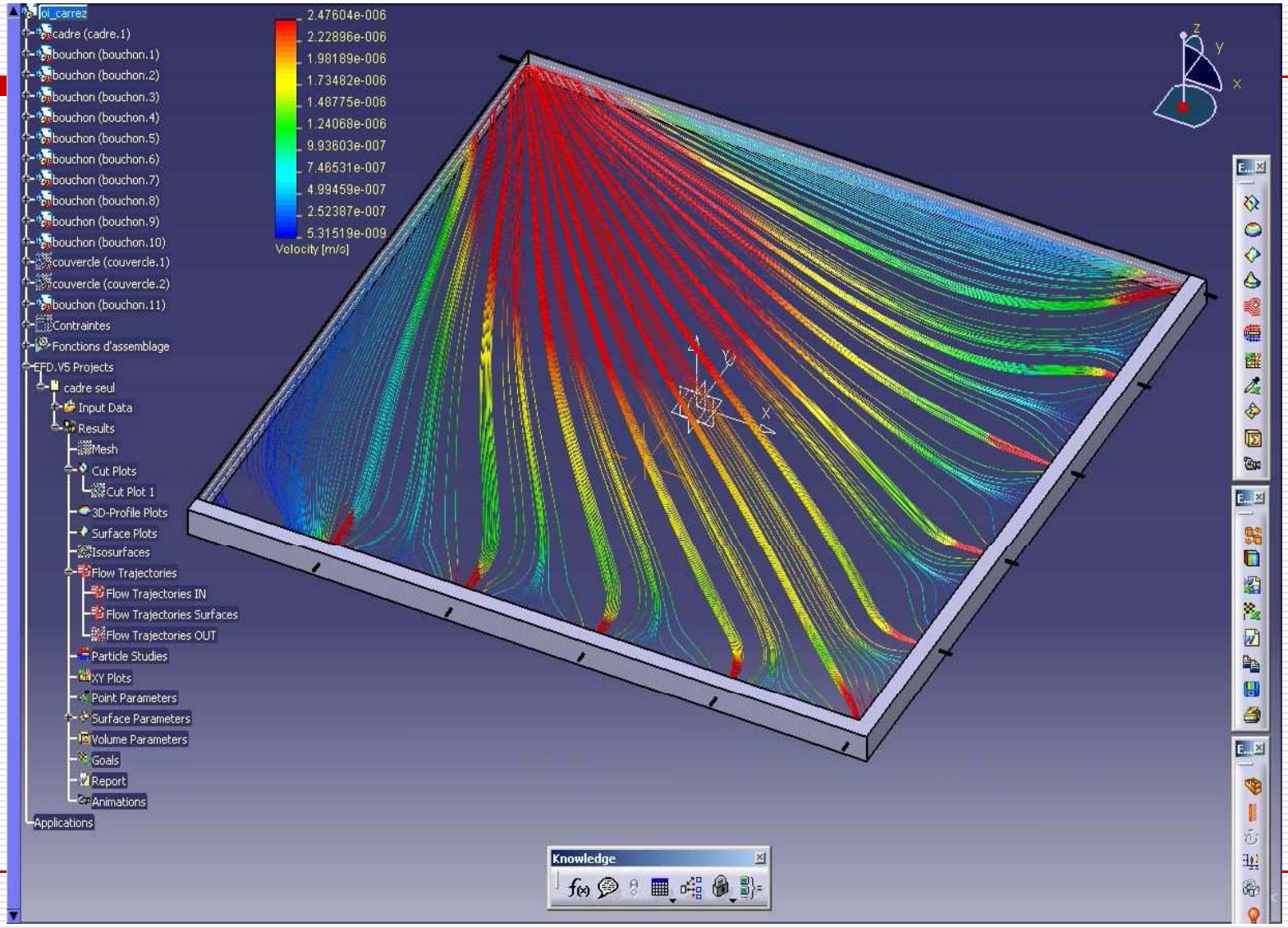
Gas distribution, ‘standard’ chambers



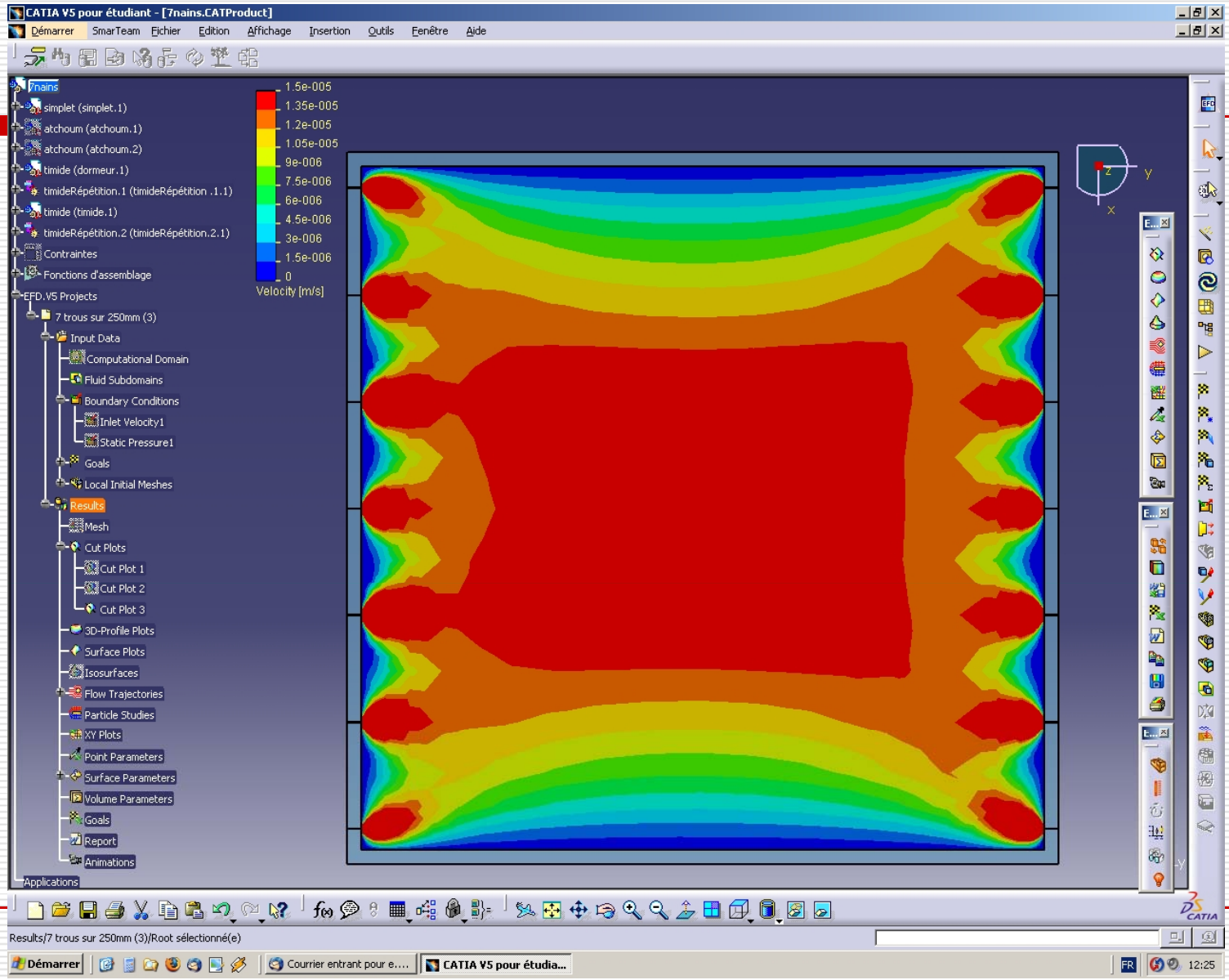
Gas distribution,‘capillary’ chambers



Simulation – gas circulation in standard chamber



Simulation – gas circulation in capillary chamber



Resistive layer

- Application:
  - Statguard: paint roller
  - Graphite / Licron: aerosol
- Quality control:
  - Surface quality: visual inspection
  - Electrical continuity / voltage distribution
  - Homogenity: measure ρ_s

Connections HV / ground

Part 2: Constructed chambers

- Three chambers 1m x 1m produced:
  - 2 x “Licron” chambers
  - 1 x “Statguard” chamber
  - All with standard gas distribution
- Construction steps:
  - Clean glass and cover with resistive cloating
  - 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
  - Add weights to anode glass and wait for glue to dry
  - 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

Gluing table

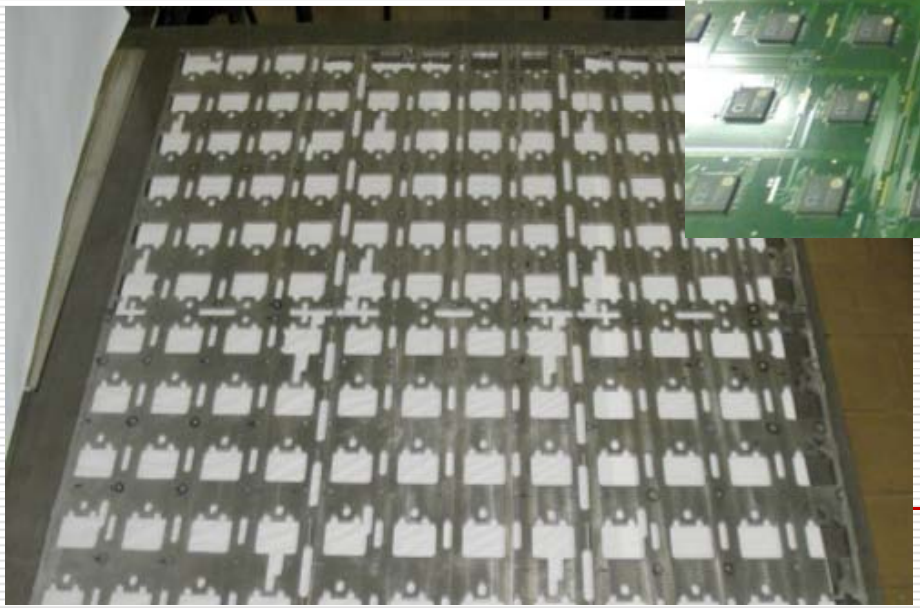
Gluing the gas channel spacers

Statguard chamber + Honeycomb Support

Vacuum pick-up system

Large area read-out

144 ASICS/m2 → 9472 channels/m2
(chamber is underneath!)



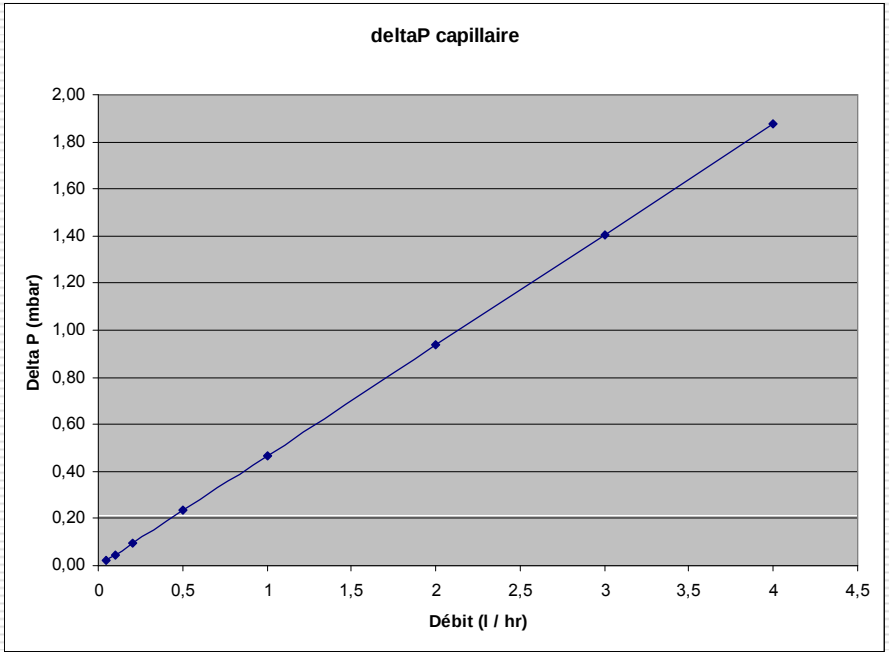
Stainless steel PCB support (CEIMAT)

Problems encountered

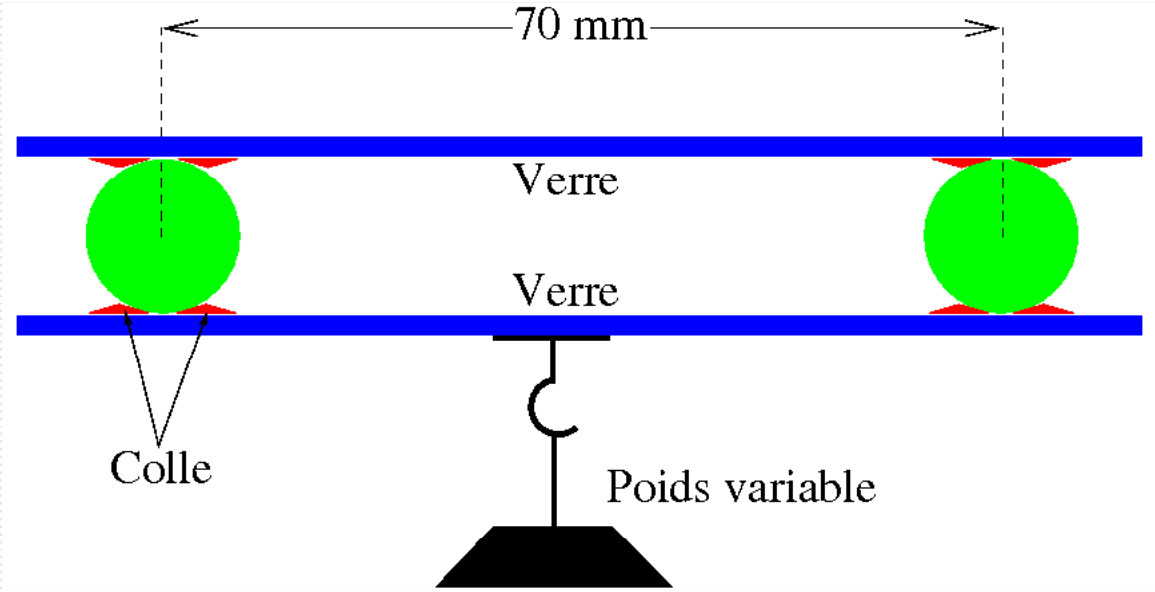
- Gas tightness
- HV connection reliability
- Statguard resistivity

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.)

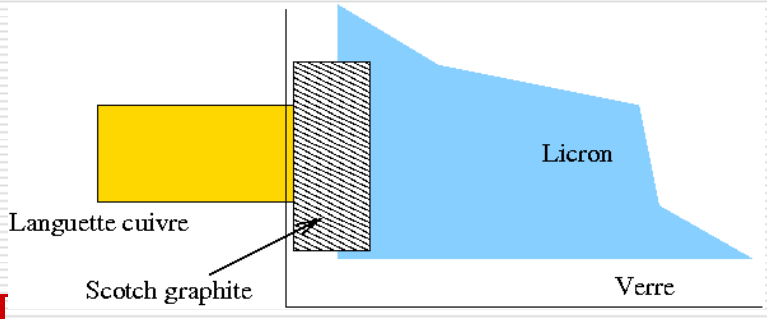


Glue test



- 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:
  - Copper Scotch with conductive adhesive
  - Copper strips glued with silver-loaded varnish
  - Loss of electrical contact after just a few days
- Solutions found:
  - Graphite Scotch
  - Epotek EE129 conductive epoxy
- Long-term reliability unknown

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) → see Keiffer talk
- 1m2 Statguard chamber in same test beam had static build-up problem → damage to HARDROCs
- Thought to be caused by very high Statguard resistivity (~500MΩ/□)
- Static accumulation much less for 1m2 Licron chambers (~20 MΩ/□)

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

Current status and future plans

- Three 1m2 chambers have been built
- One of these under volts and taking data for several weeks in the lab
- Short-term plans
  - Investigate other resistive coatings (colloidal graphite, 'Isovic', …)
  - Read out whole surface with large PCBs
  - Characterize whole surface
- Longer-term
  - Move to dedicated construction / testing facility
  - Industrialization of construction: silk screen printing, glue robot, vacuum picking,…
  - Optimization of gas distribution, gas re-cycling
  - Study of mechanical integration issues