ILD studies:
ECAL end cap mechanics

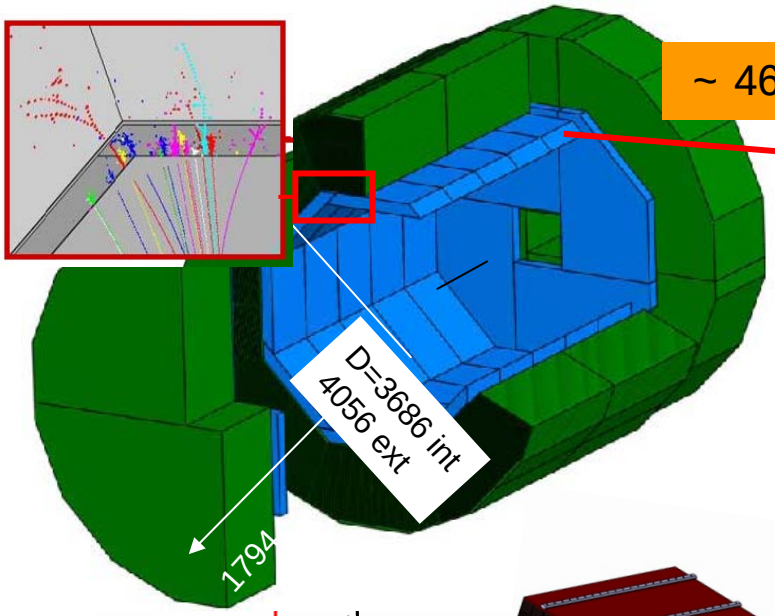
SiW ecal meeting@ Desy

Denis Grondin – Julien Giraud – Denis Jaussaud – July 5th, 2010

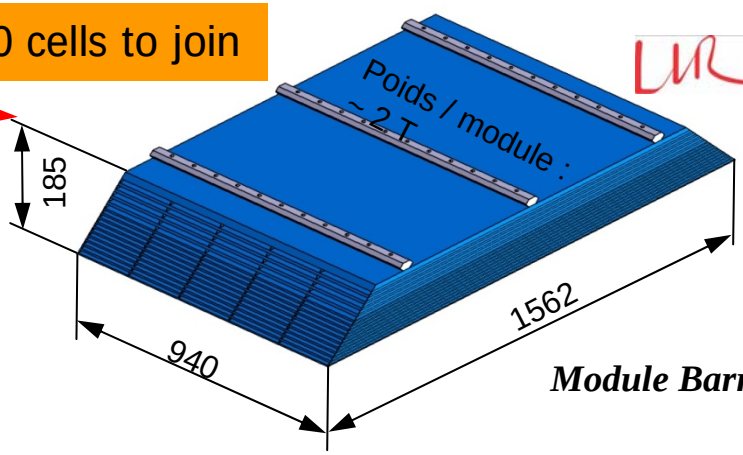
Si-W ECAL – Current baseline

W/Si – ECAL weight:
~ 112 T (80 barrel+32 End-Cap)

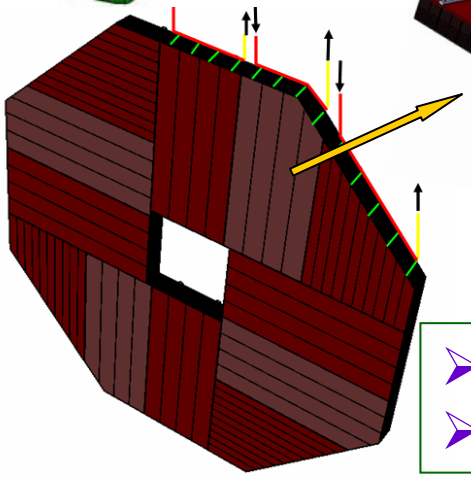
- No dead zone, compactness
- 40 identical trapezoidal modules

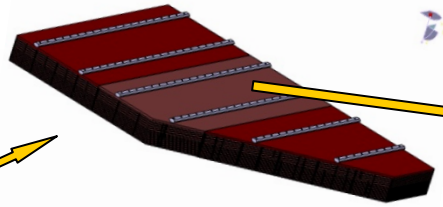


~ 4600 cells to join

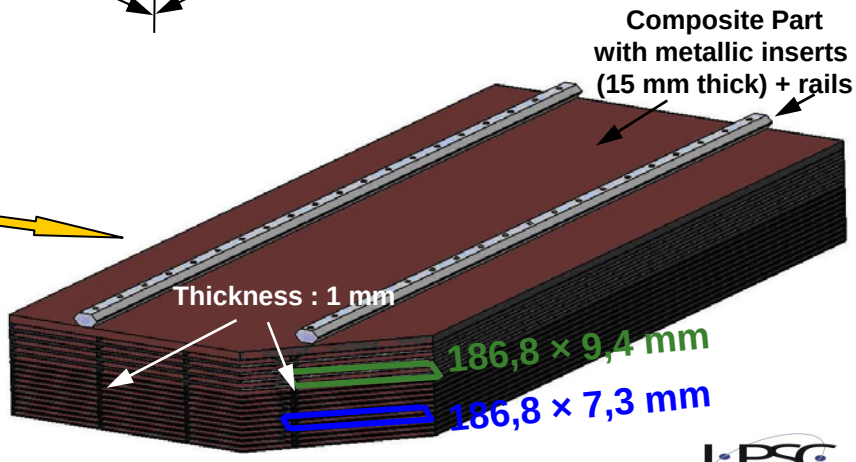


Module Barrel





Multi-module End-Cap

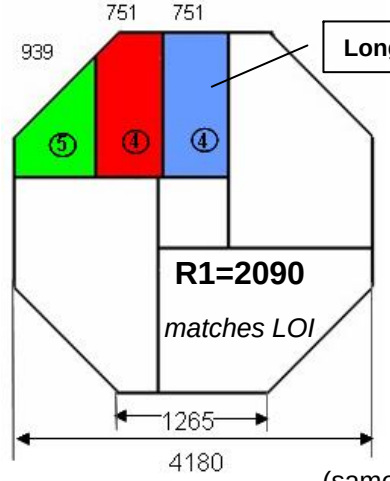


Module End-Cap n°2

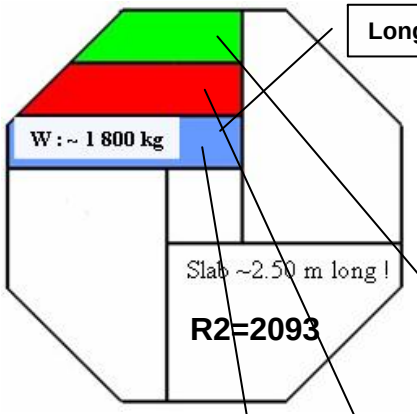
- 12 modules-3 distinct types
- Compactness, no dead zone if…

End-Caps structure: baseline

- Today, with the barrel's demonstrator and EUDET, the process for composite structure has been validated, with a built layer module width based on 182.1 mm for EUDET, and 1,50 m long…



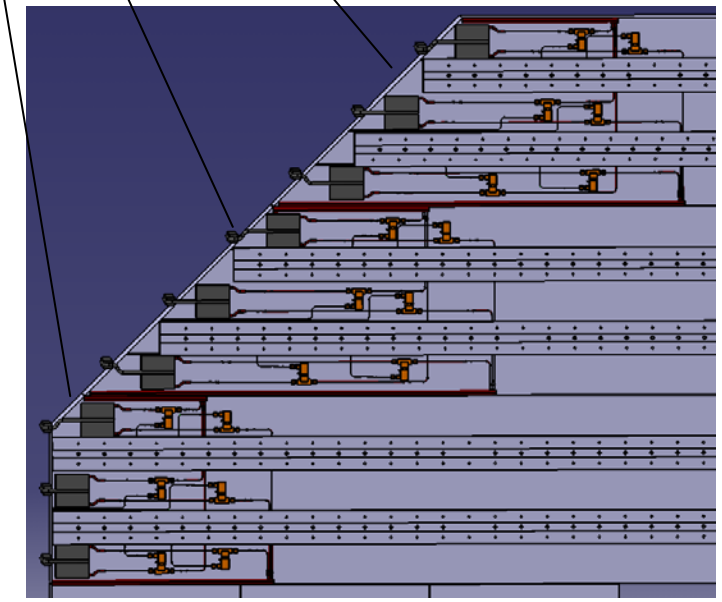
Design 1
(same width of alveoli / barrel)



Construction of 2.5 m long composite alveoli

Design 2 width of alveoli:186,8

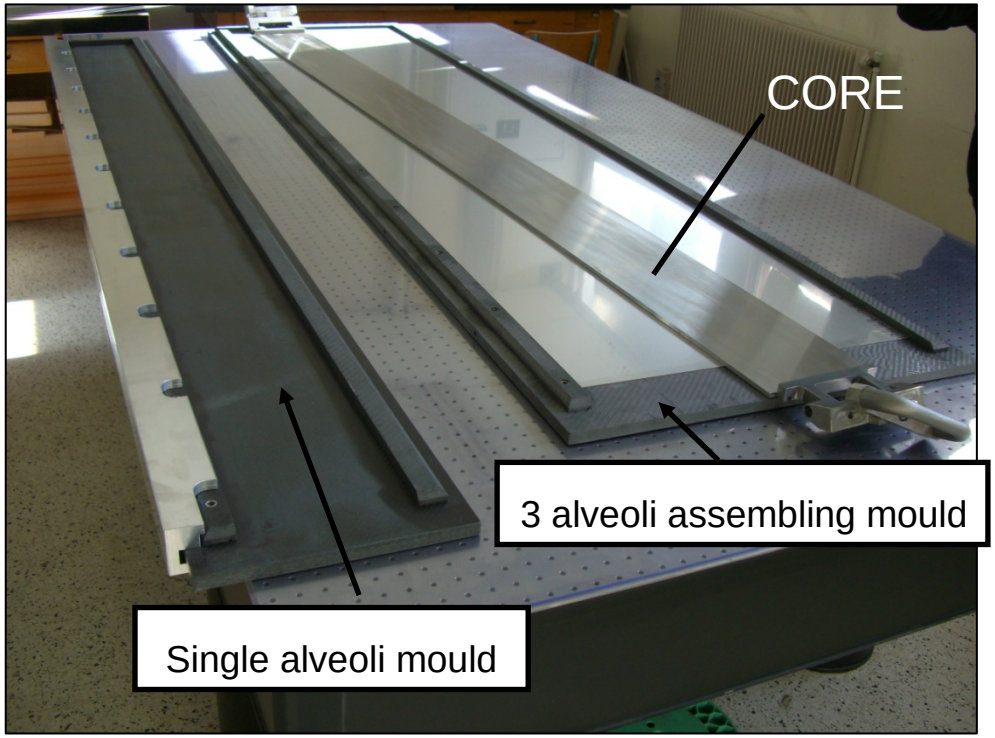
(ok / cracks- but technology…)

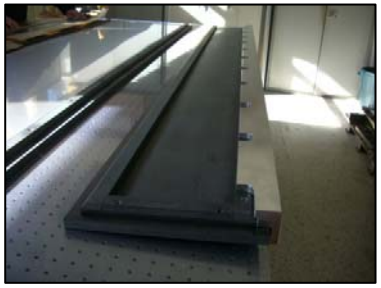


For End-caps *(design 2)* the goal is now to build 2,50 m long alveoli, and to demonstrate whether or not the main process steps (similar to barrel ones) can be adapted.

End-cap structure : study and validation of most of technological solutions which could be used for the final detector (moulding process, cooling system, sizes of structures,…) taking into account industrialization aspect of process

End-Caps : long alveoli molding test



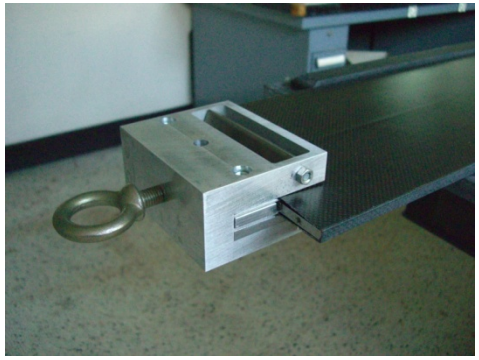


2.5 m alveoli molding

- **The end-cap layer test consisted of**
- **1 long alveolar layer of 3 cells**
  (representative of the end-cap module longest layers)
- **Width of cells : 186.8 mm**
  (Design2 - to fit LOI parameters (R~2090))
- **Thickness of cells : 6.5 mm - wall: 0.5 mm**
- **Length : 2.492 m**

Alveoli 2,50m: extraction of core

Pliers for extraction with good adhesion on carbon plies



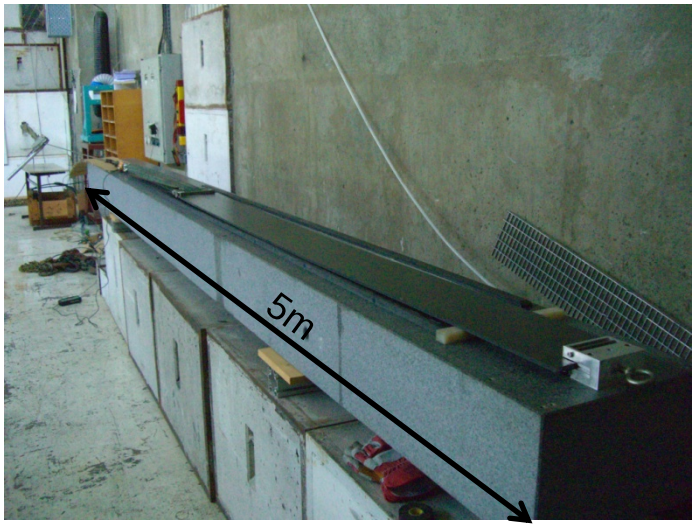
Adaptation on alveoli

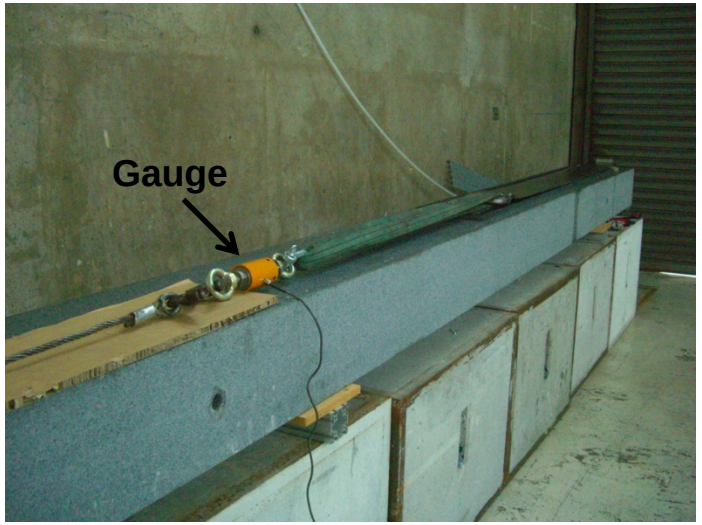
Friction core/ carbon plies

First test: negative

Extraction : >> 6000 N !

⇒To risky



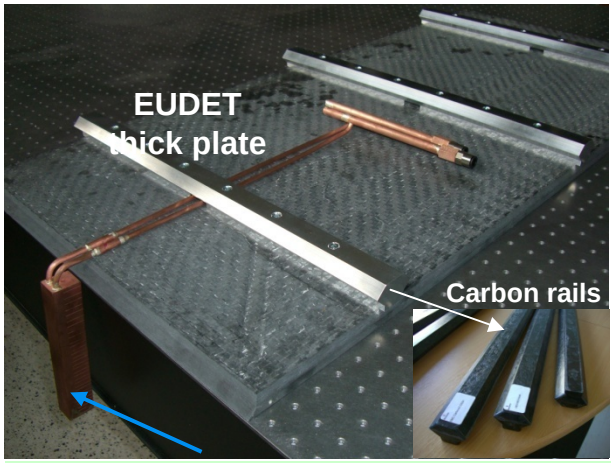


New alveoli to mould with aluminium core: *Fall 10*

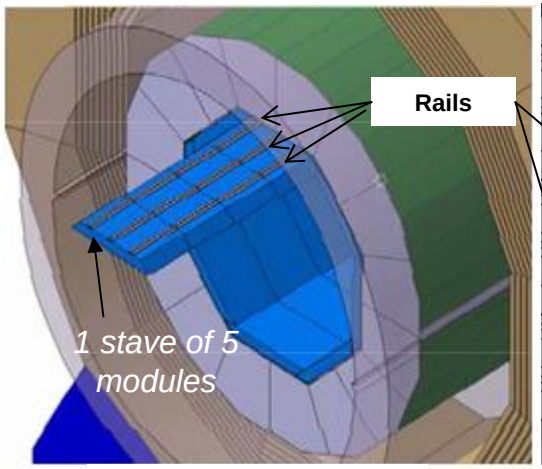
Fastening ECAL/HCAL

Constraints

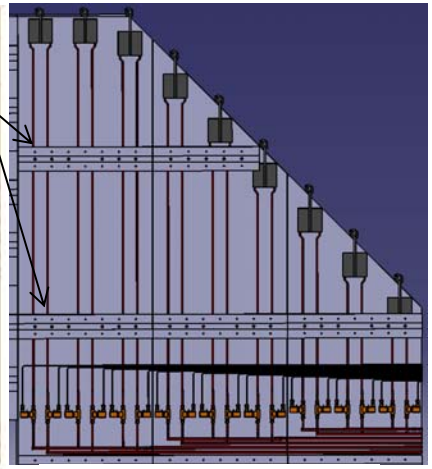
- Fastening in a structure “wheel”: bending constraints
- Carbon structure (thick plates and support…)
- Cooling pipes & cables (DAQ + HV + GND) integration



A column (cooling pipe), (25 mm wide minimum) to ensure quick thermal system’s connection



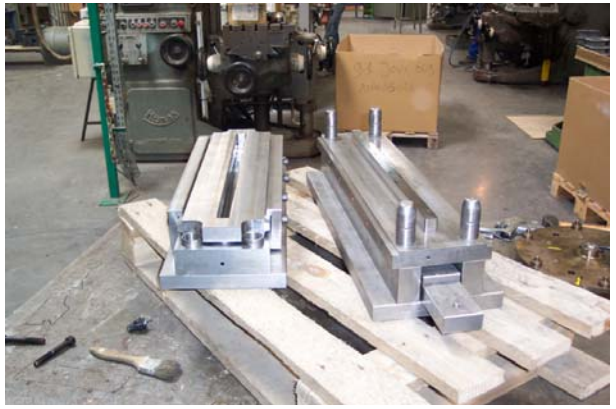
Barrel fastening



End-cap fastening

From metallic rails… to… composite structural system
•validation of technological solution
•industrialization aspect of process

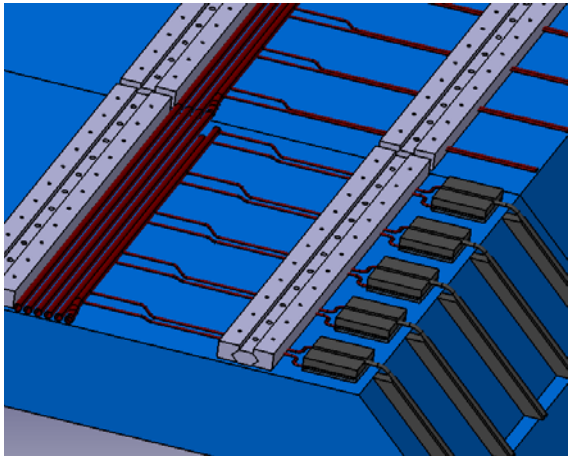
Solutions to investigate :
- Alternative for fastening and positioning system: isostatic system
- Coupling of modules.
- Handling and positioning tools for modules



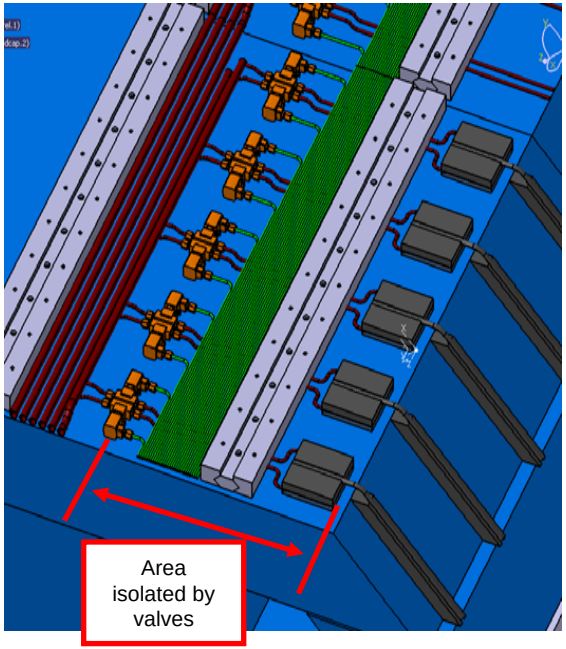
Mould delivered, ready to mould HexMC & SMC Carbon rails on a 80T heating press

INTEGRATION COOLING ECAL

See next talk from LPSC « ILD studies: cooling & cables » about tests & integration



Barrel: several solutions



Characteristic :

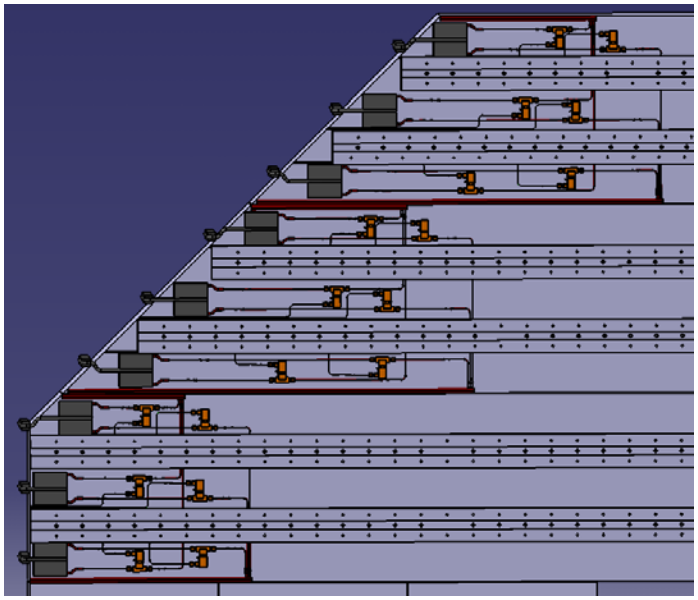
- Control by module
- Pipes Ø: 15mm

Advantage / disadvantage :

+ Less connexion to install

+ High power range :15/150W

+ Compact (80 lines for barrel)



End cap: Control by column

Characteristic :

- Control by column (end of the circuit only)
- Pipes Ø :15mm (water), 4mm (air)

Advantage / disadvantage :

+ Control by column (end of the circuit only)

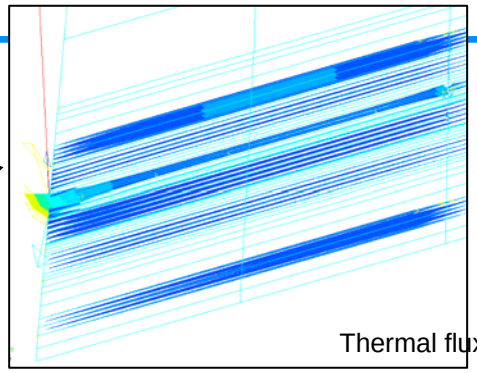
+ High power range :15/150W

– Largest dimensions (pipes+ valves)

– Adding connections to valves

–Management of valves (distributor, command)

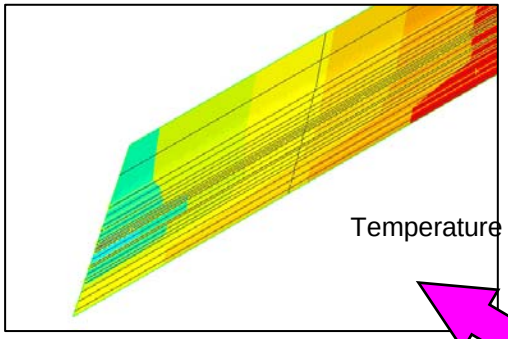
Cooling



Thermal flux / layer

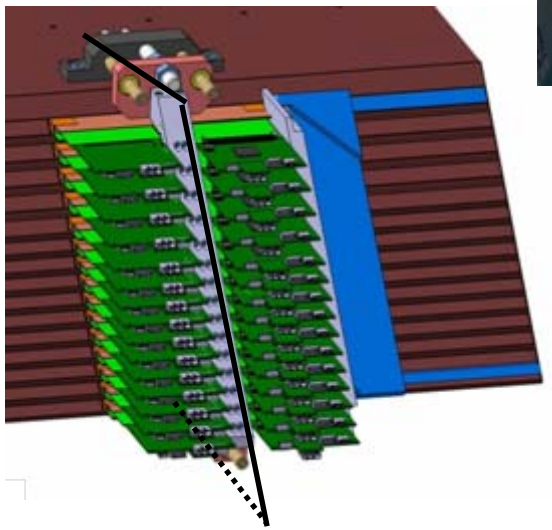
SLAB / Cooling connection

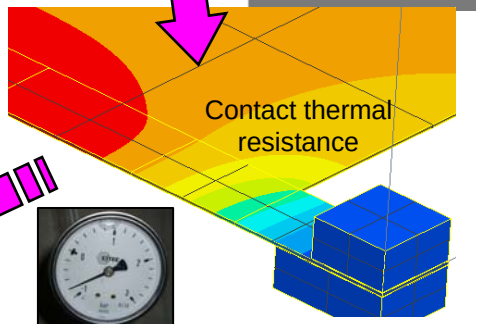
Test on demonstrator



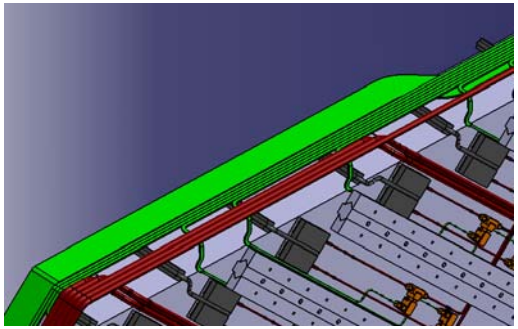
Temperature

Module section thermal simulation

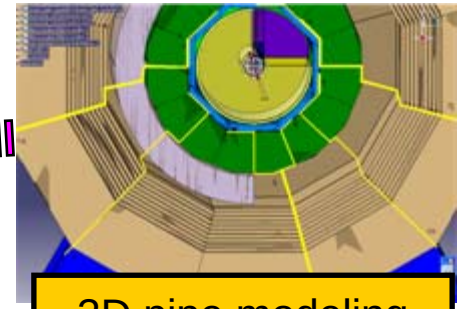




Contact thermal resistance



Water circulation on module



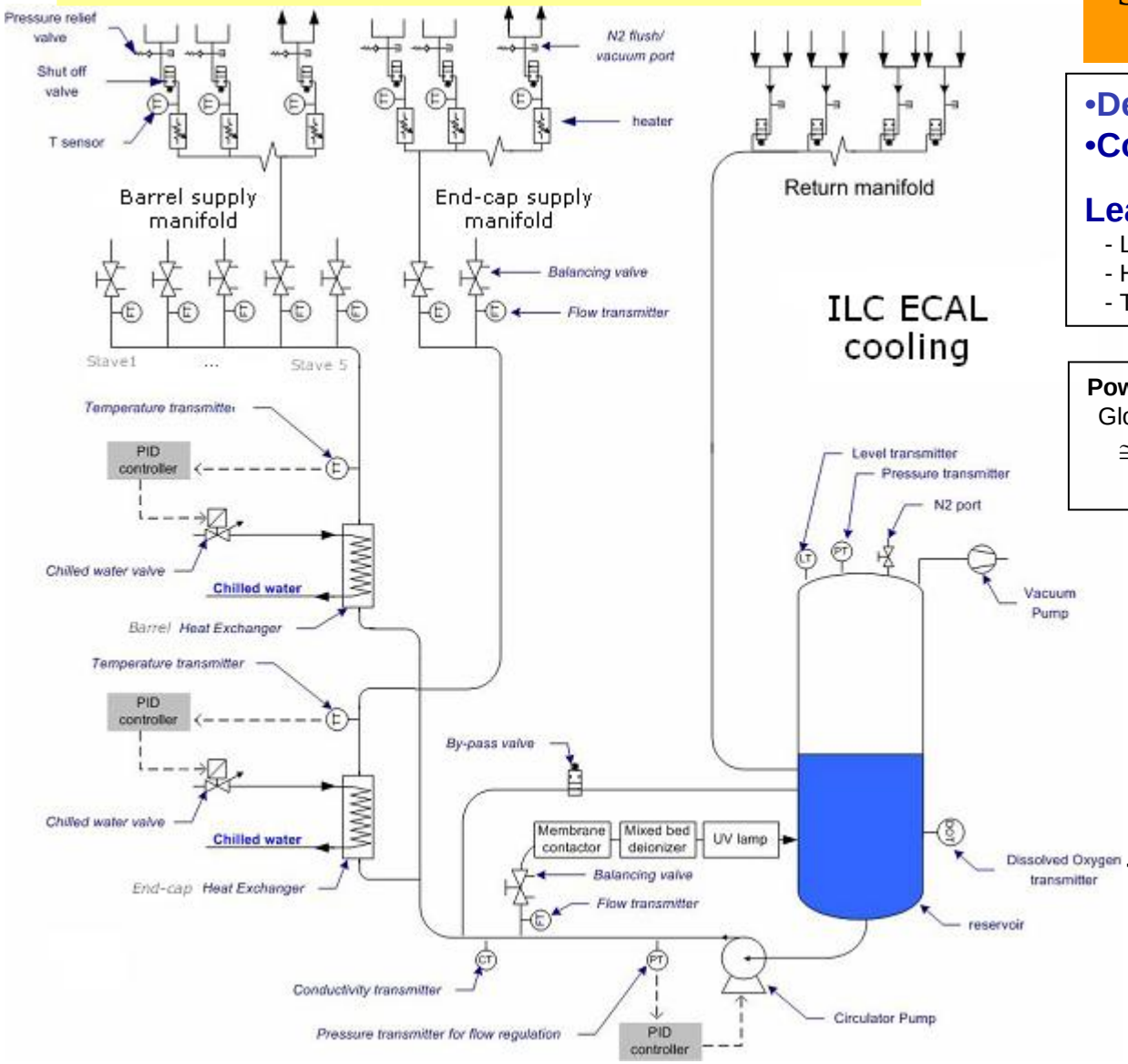
3D pipe modeling

Global cooling Leakless mode restriction

(leakless zone is at the top of the loop)

ECAL: Global COOLING

Simplified P&I diagram of cooling plant extrapolated from a CERN's Detector.



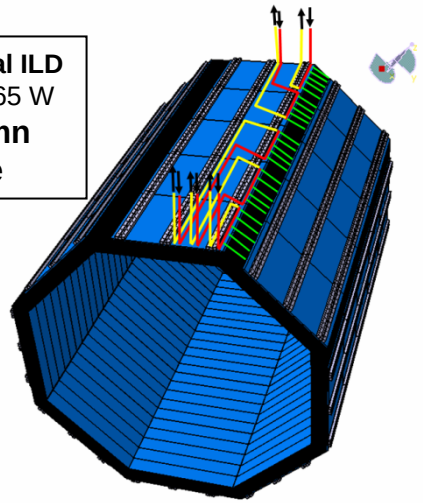
Study of the global cooling system for ECAL to continue:

- **Design including safety systems**
- **Cost estimation (several solutions)**

Leakless system :

- Low water speed
- Heat pipe termination
- Temperature and power range adapted

Power results / goal ILD
Global Power : 4565 W
≅15 W / column to dissipate



Leakless cooling system mock-up: **2010**

True scale leakless cooling system test
Base line : leakless system with representative systems to control

- the right components, sensors…
- process, regulation
- Interface and control

Conclusion :

Cooling

Barrel / End cap global section simulation	June 2010
Slab / cooling system connection thermal test (transfer coeff., contacts...)	Sum 2010
Specific cooling system for EUDET (portable)	Nov 2010
First Design: hydraulic safety, hardened components, cooling supervision...	Fall 2010
Design & build a “true scale test loop” : cooling system « Leakless » (<1atm)	Fall 2010
Alternative cooling studies: µ-circulation fluid, carbon pipes; MCP...	2010...

Fabrication – Long alveoli molding tests - characterization

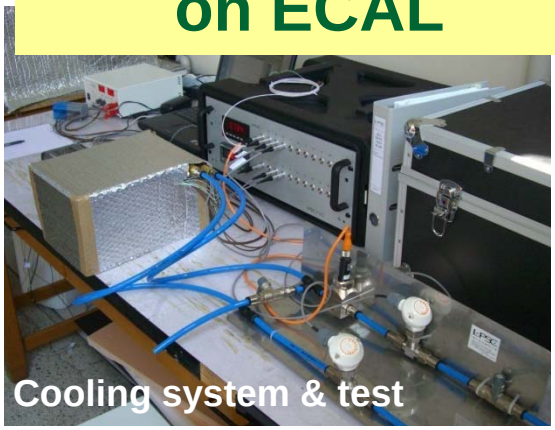
“Alveolar cell & layer” **moulds** reception	march 2010
End-cap: 2.5 m **alveoli** molding test	march 2010
End-cap: 2.5 m **layer** molding test	Sum 2010
Characterisation, tests & optimisation: composite elements and rails	Fall 2010

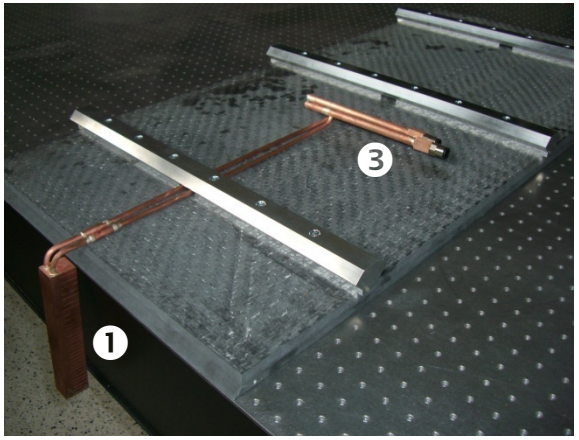
Conception - Simulation

End-cap **design** & mechanical simulations	Fall 2010
Fastening system ECAL/HCAL: alternatives; modules’ coupling.	Sum 2010
Handling and positioning tools for modules	Fall 2010

Thank you for your attention

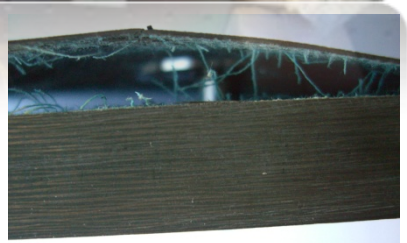
Mechanical R&D on ECAL



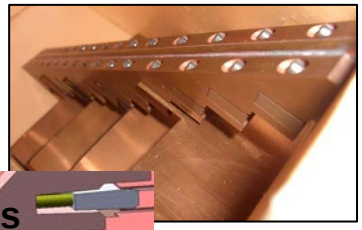


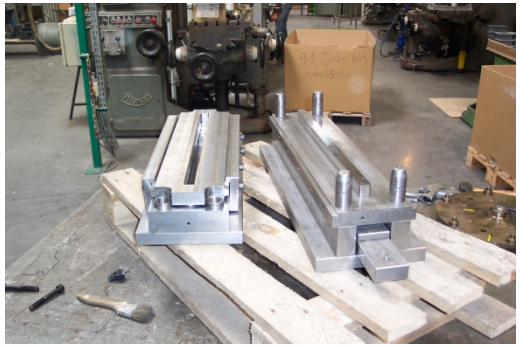
15mm thick plate with it's rails; ready to be assembled with EUDET's layers

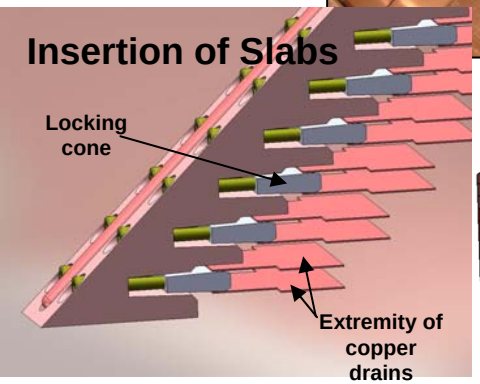
THERMAL tests



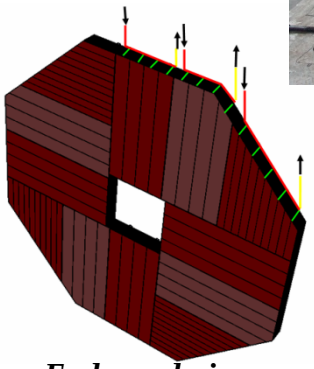
Destructive tests



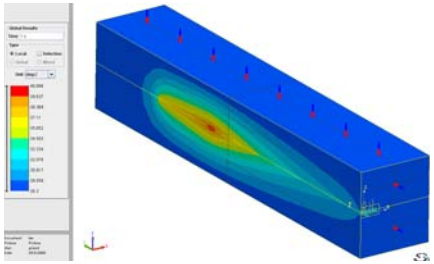




Water cooling block



End-cap design



Fastening system