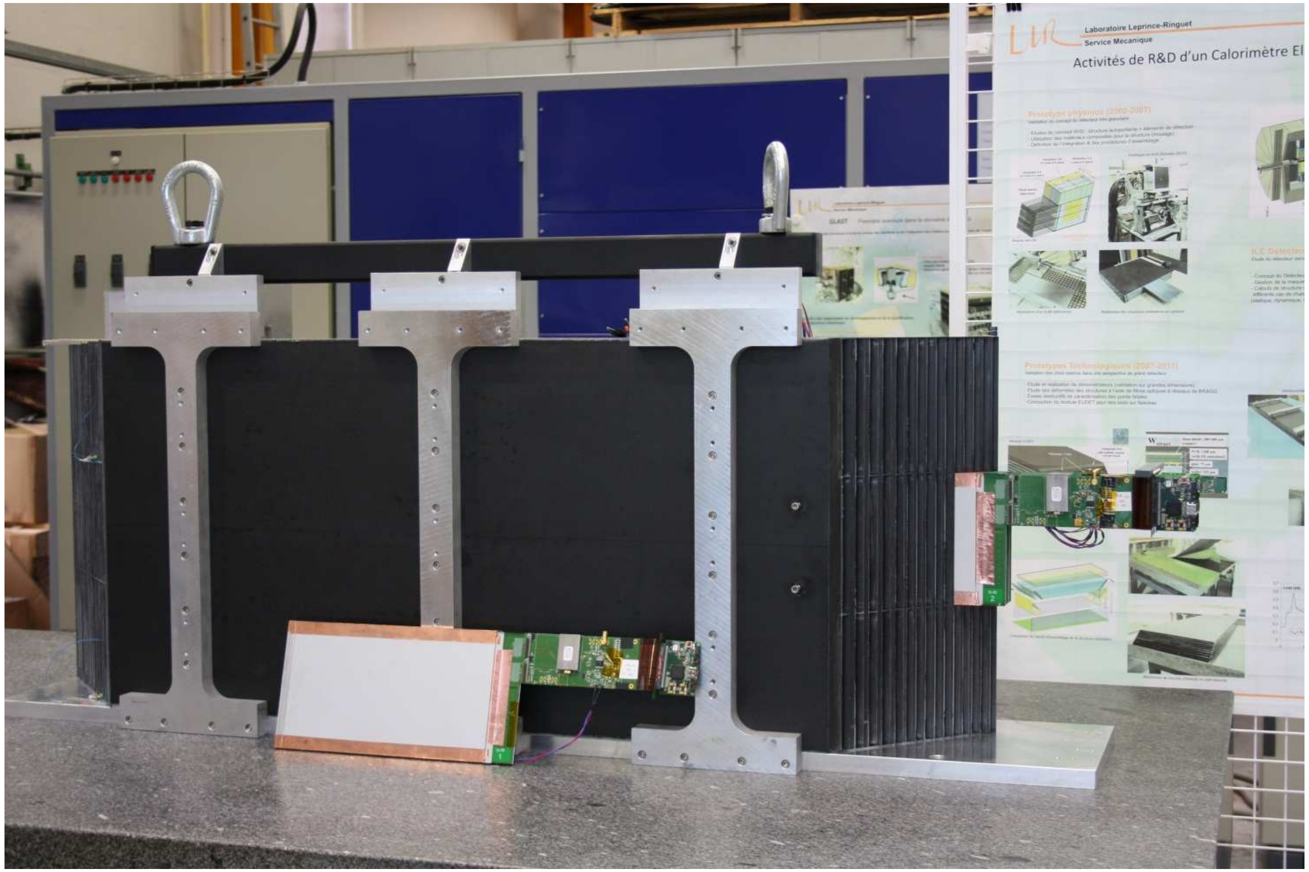
ECAL Technological prototype for test beam



CALICE Collaboration Meeting @ Cambridge / September 17th-19th, 2012
ANR-2010-BLANC-0429-01

ECAL Technological prototype for test beam

1 ECAL Si/W “conservative design”

2 ECAL Si/W “test beam”

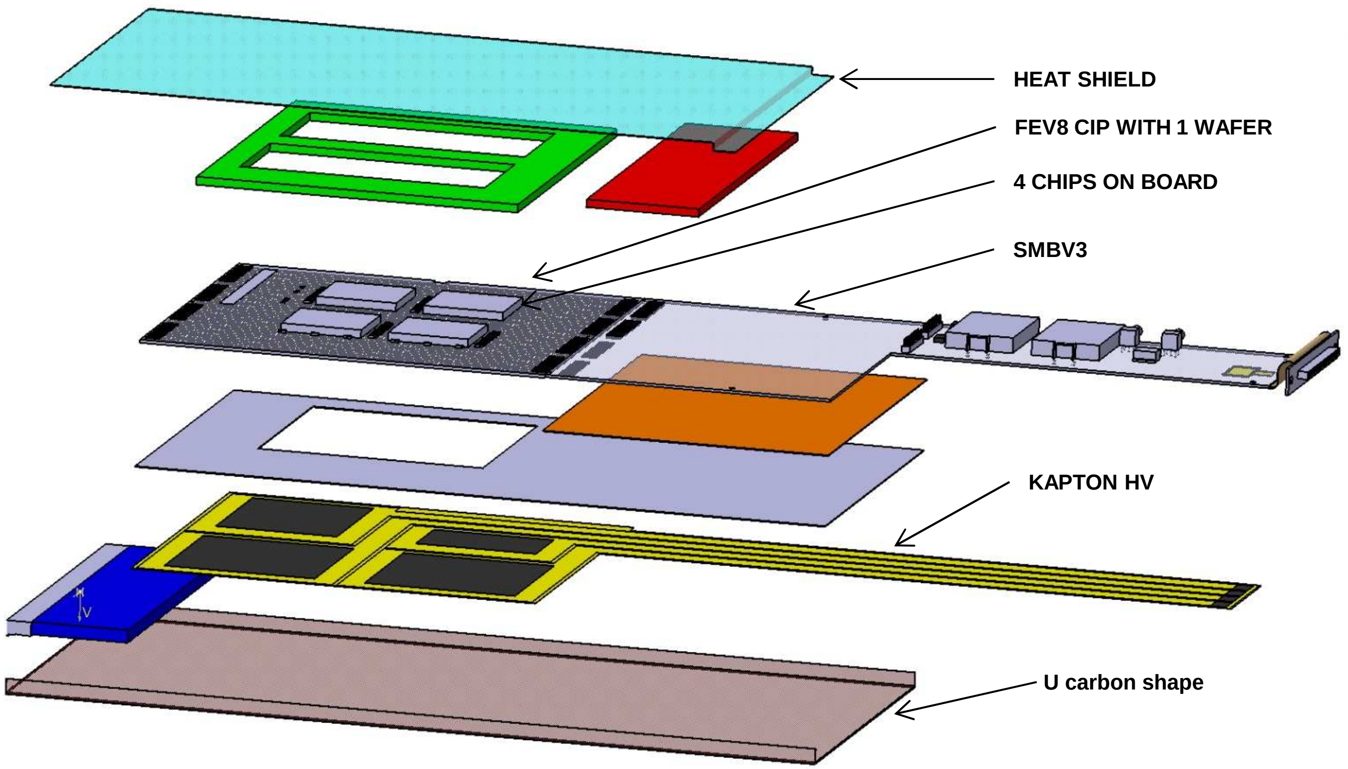
3 ECAL Si/W “BGA design””

4 ECAL design

ECAL Si/W "conservative design"

⇨ The goal:

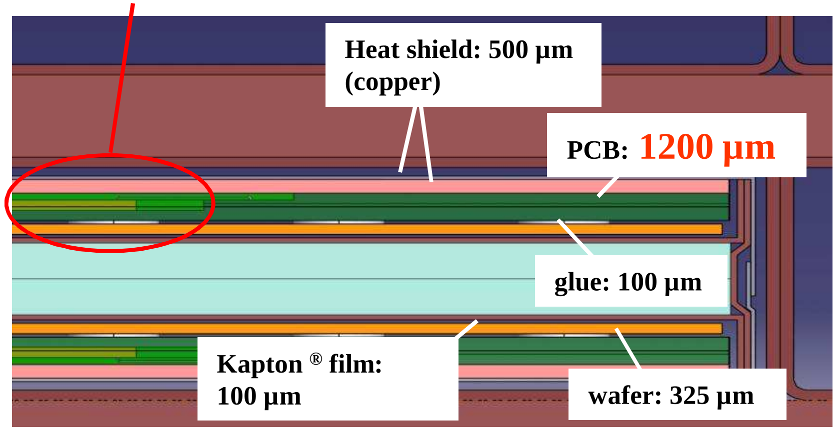
1 – Build an operational SLAB for alveolar structure of 7.3 mm thick and 180 mm wide



ECAL Si/W "conservative design"

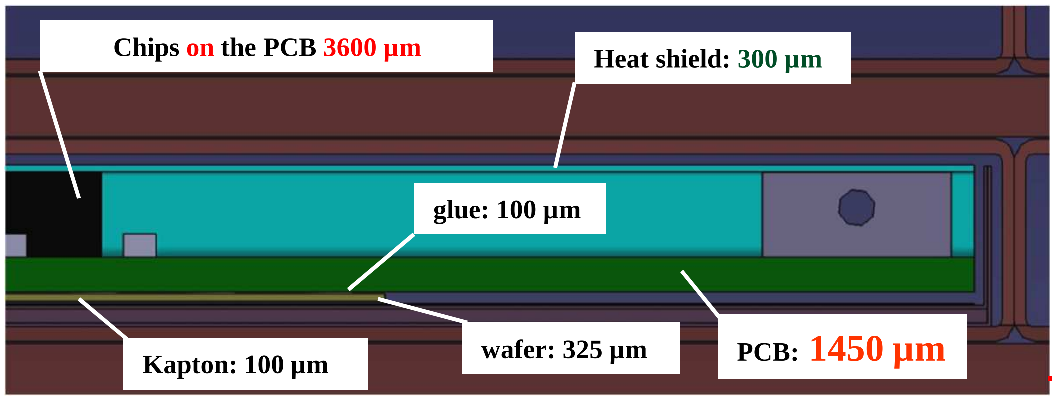
➩ Current design: 2 SI detection layer per Slab

Chips and bonded wires inside the PCB



- ➩ *Gaps (slab integration) : 500 µm*
- ➩ *Heat shield : 500 µm*
- ➩ *PCB : 1200 µm ? (flatness problems)*
- ➩ *Thickness of glue : 100 µm (gluing by LPNHE)*
- ➩ *Thickness of wafer : 325 µm*
- ➩ *Kapton® film HV : 100 µm*
- ➩ *Thickness of W : 2100/4200 µm (± 80 µm)*

➩ Conservative design: Short U Slab CIP, 1 SI detection layer per Slab

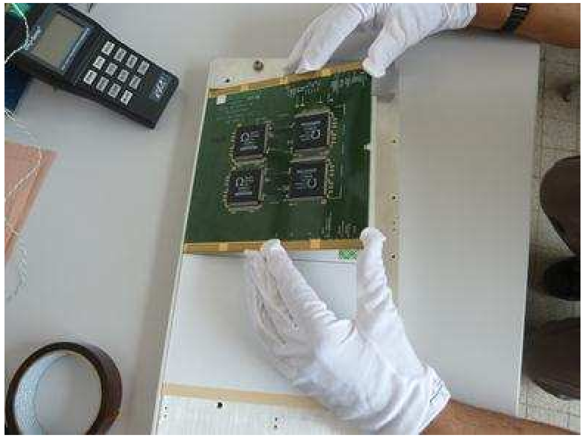


- ➩ *Gaps (slab integration) : 400 µm*
- ➩ *Heat shield : 300 µm*
- ➩ *PCB : 1450 µm (flatness ok)*
- ➩ *Chips : 3600 µm*
- ➩ *Thickness of glue : 100 µm (LPNHE)*
- ➩ *Thickness of wafer : 325 µm*
- ➩ *Kapton® film HV : 100 µm*
- ➩ ~~*Thickness of W : 2100/4200 µm*~~

ECAL Si/W "conservative design"

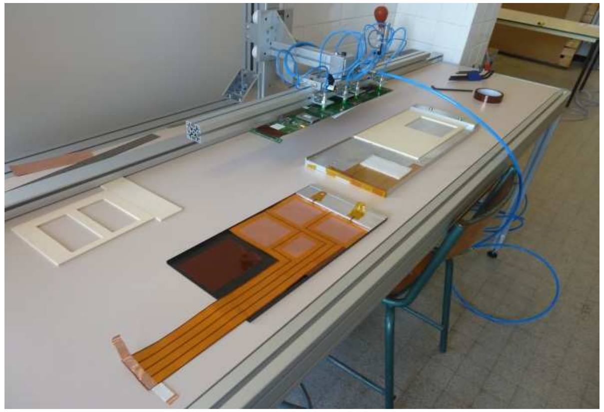
Assembling process at LAL

1 ASU/adapt mounting station

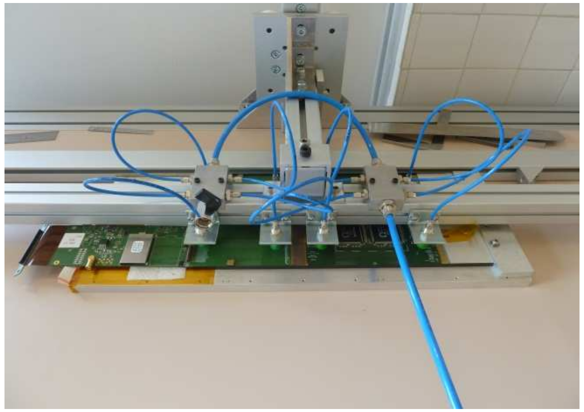


2 Interconnection ASU/Adapt

3 Slab part Assembling



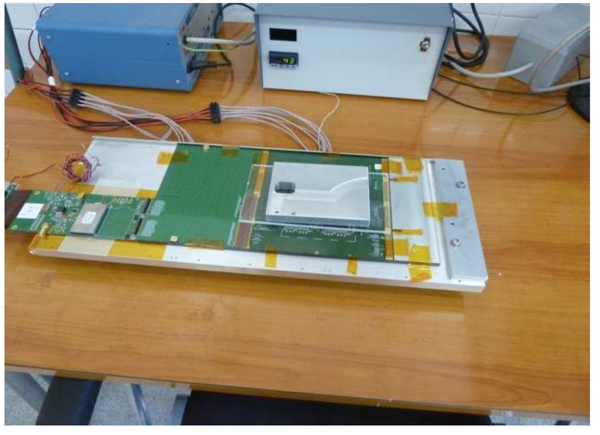
4 ASU/Adapt Assembling in U Slab



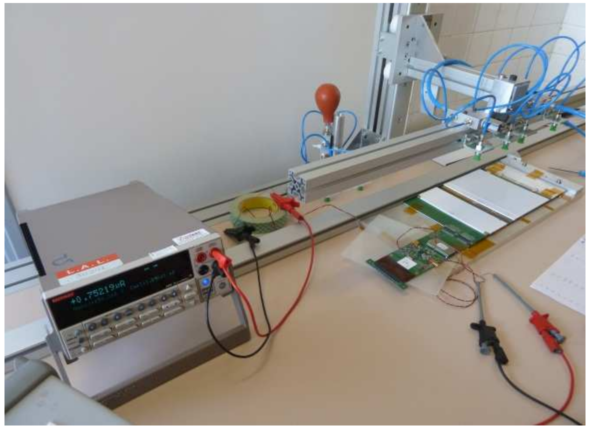
ECAL Si/W "conservative design"

Assembling process at LAL

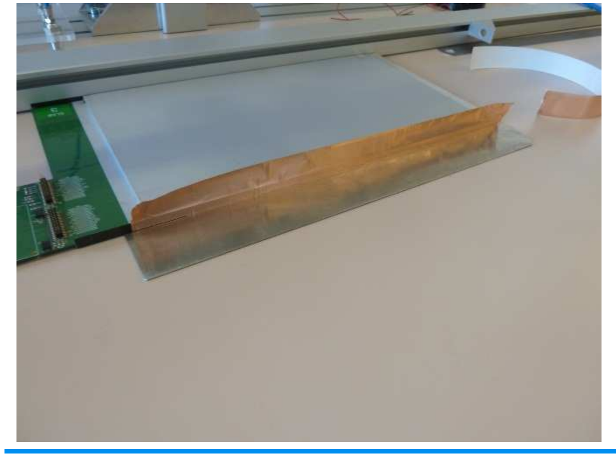
5 Heating glue station



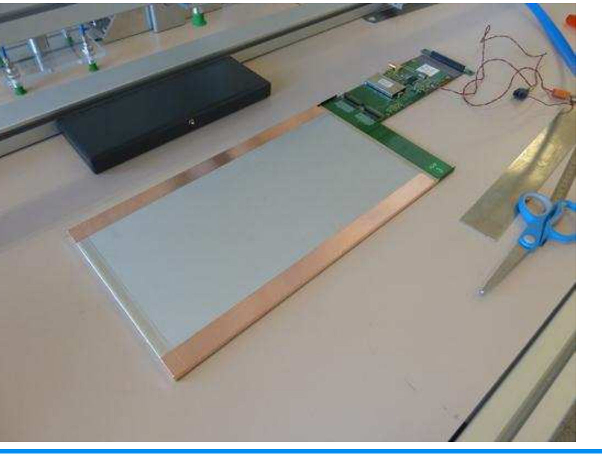
6 Wafer leakage current test



7 Slab closing



8 Finished slab



ECAL Si/W "conservative design"

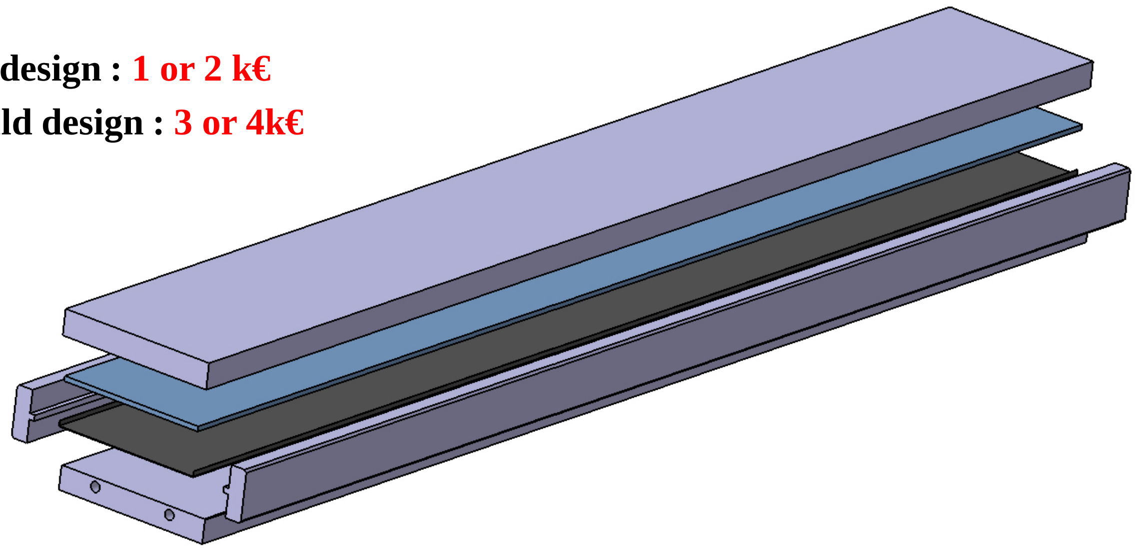
⇨ Conservative design: **Long U Slab CIP**

Next step : Design and production of the support structure of the slab and the mould of the long slab

U shape according to the different solutions :
ECAL Si/W "conservative design" & ECAL Scint/W : U-Shaped structure (same !)
Do we need this long U slab?

If yes…We need

- ⇨ **Long Slab support design : 1 or 2 k€**
- ⇨ **New long Slab mould design : 3 or 4k€**
- ⇨ **Term: 2 months**



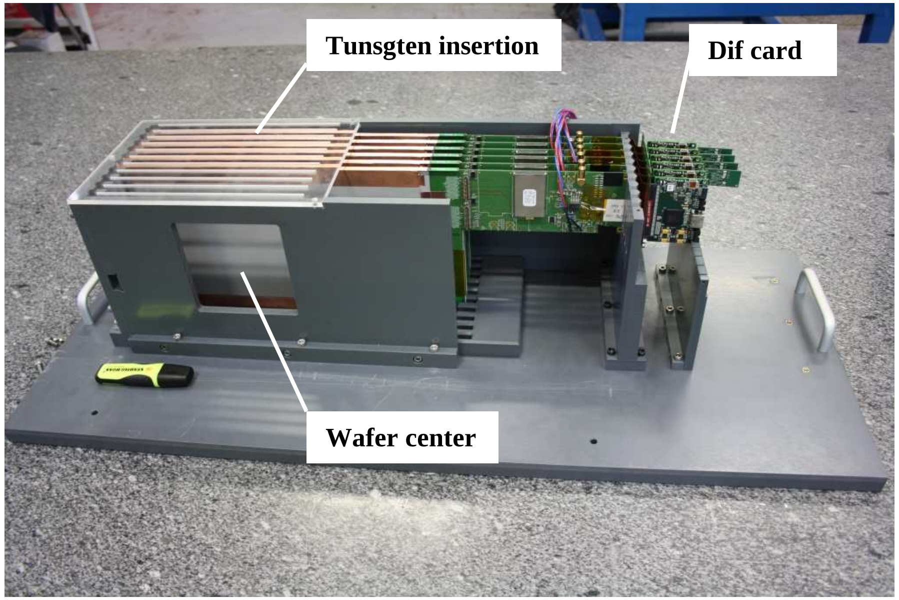
ECAL Si/W "test beam"

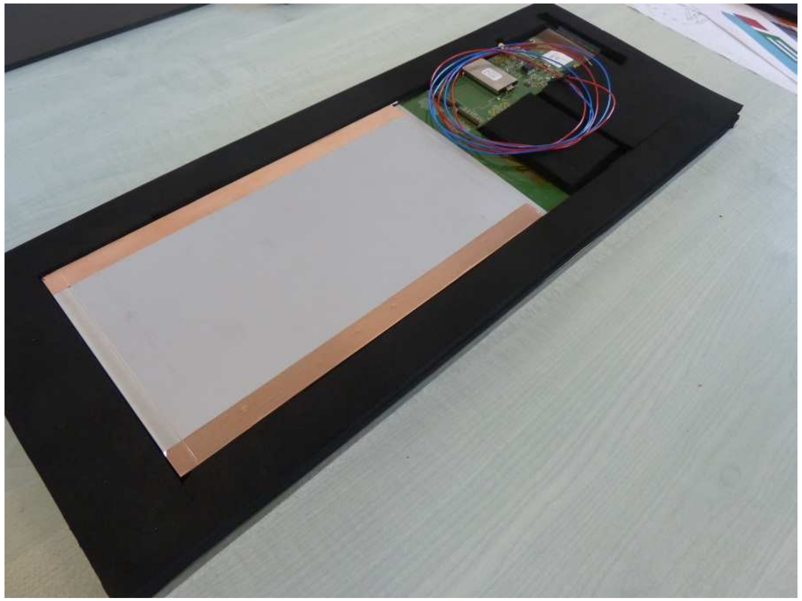
⇨ The goal:

1 – Realize a mechanical system to secure the Slab in position :

- 10 Short U SLAB CIP (conservative design)

- 10 W plates of 2,1mm thickness

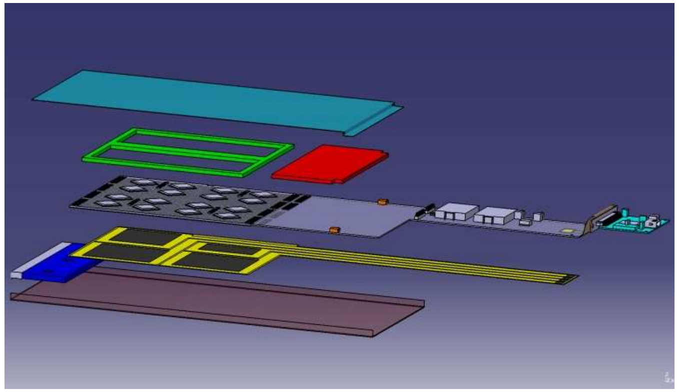


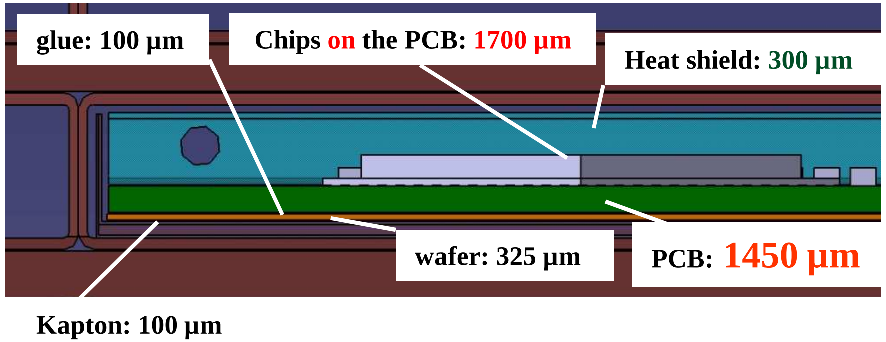


ECAL Si/W "BGA design"

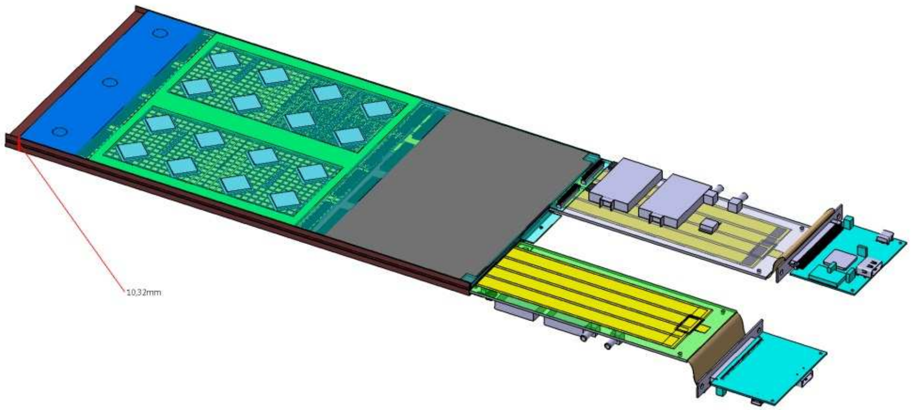
➩ The goal: *Build a slab with chip CIP as thin as possible and already tested*

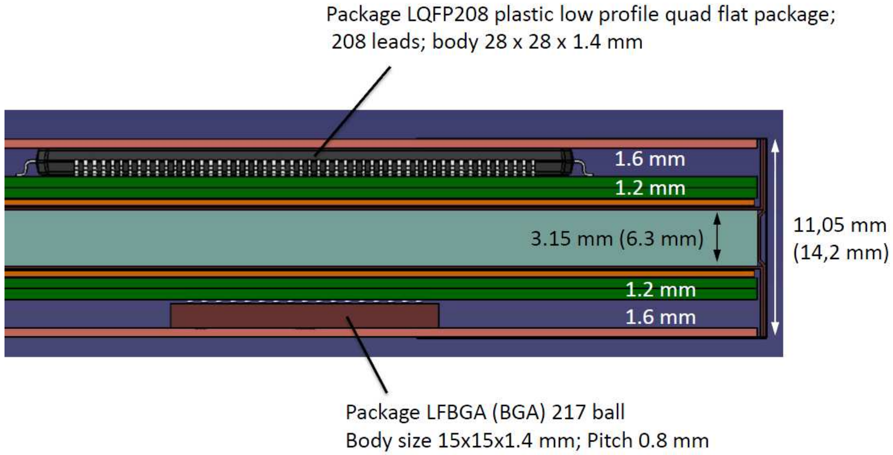
1 – Study a short U Slab with 16 chips CIP BGA for read 4 wafers (1 layer)





2 – Study a short H Slab with 32 chips CIP BGA for read 8 wafers (2 layers)





ECAL design

⇨ Beam structure:

This Beam structure is necessary to rotate the ECAL structure and protect it during the manipulation operations

1 – Scew the Beam structure on the mould plate

2 – Turn the Ecal structure module with the beam structure

3 – Unscrew the mould plate

4 – And screw the <u>false rails</u> on the Ecal

ECAL design

⇨ Safety structure:

1 – This system can be completely removed for beams tests and simulates a space of 30mm between the ECAL and another detector.

2– This system can be used for test-beam combined

- Global length:
1491 mm vs 1491.15 mm +/- 0.15

- Global width:
552.3 mm vs 552.65 mm +/- 0.05

- Global tickness:
205.3 mm vs 205 mm 0/+5.28 !!!

Expected (structure dim.) vs Measured

ECAL design

⇨ Transport carriage:

This carriage is necessary for protect the ECAL against mechanical stress during all transport

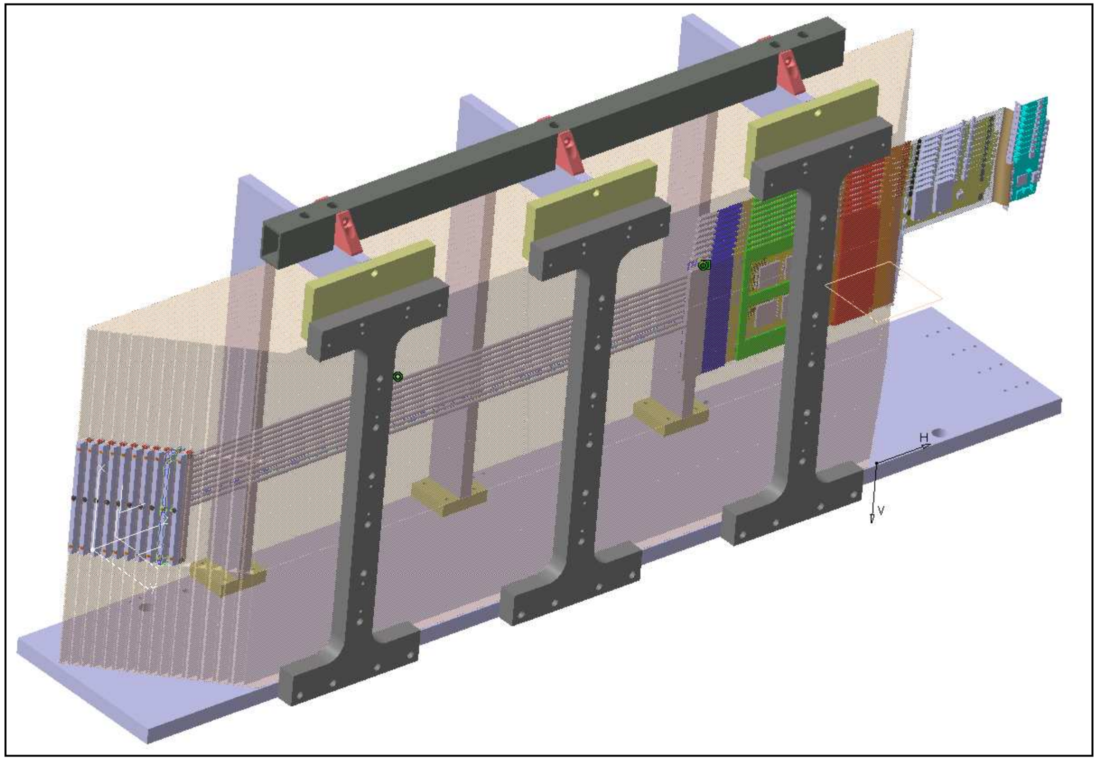
1 – This transport carriage is provided with a shock absorber in case of too severe transport conditions

2– All the windows can be closed by a plate 3 mm aluminum thick.

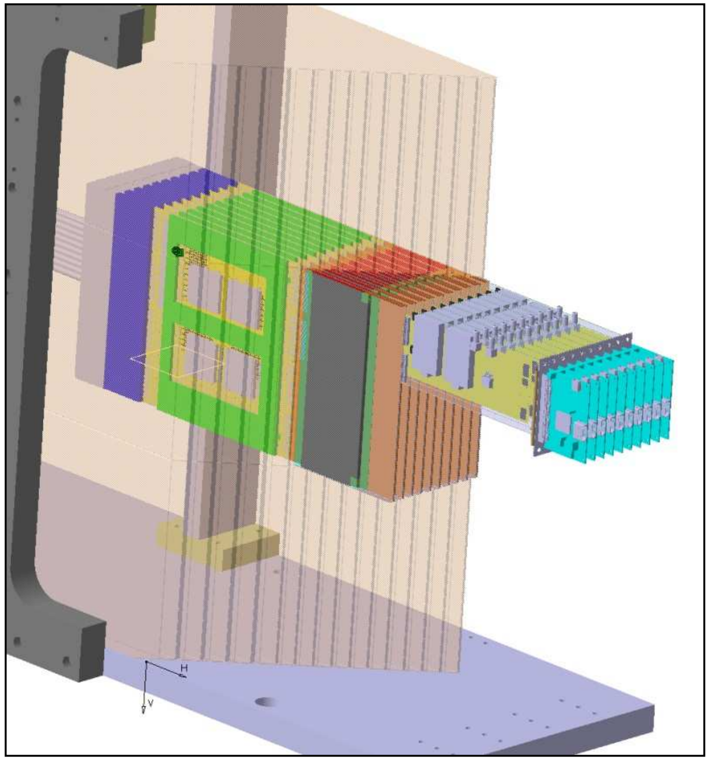
ECAL design

⇨ Clamping Slab: *The clamping system is used to lock all the short Slab inside the alveolar structure during the test beam.*

1 – This system allows to lock the slabs at 45 ° or 90 ° in the ECAL structure



10 slabs at 45 ° inside the ECAL structure



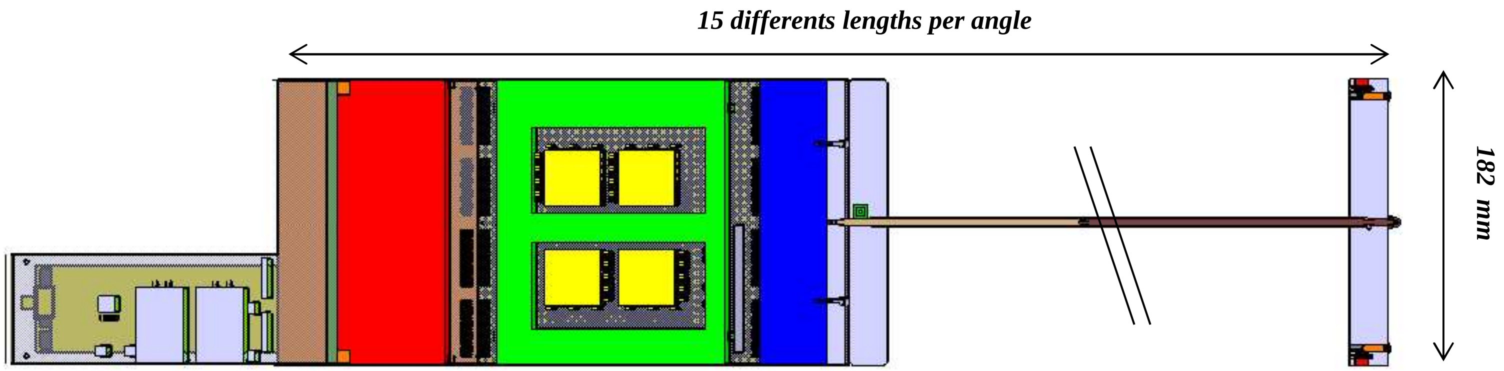
10 slabs at 90 ° inside the ECAL structure

ECAL design

⇨ Clamping Slab: ***The clamping system is used to lock all the short Slab inside the alveolar structure during the test beam.***

1 – If the modification of the angle is necessary…

it would be better to choose the beam angle before the tests because the slab displacement will take several hours (disassembly of cables, supports ……)



ECAL design

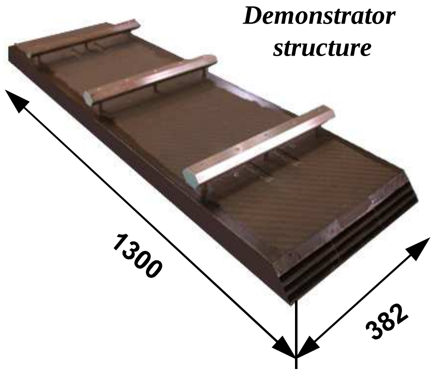
⇨ Preparation of mechanical test:

1 – Determine the maximum allowable stress in the alveolar wall in a case of loading at 0 °, 45°,90°

2 – Find a subcontractor to constrain our demonstrator while recording measurements of fiber Bragg Grating molded into it (like the schema 2 and 3)

3 –Improve the simulation about the global mechanical behavior

1

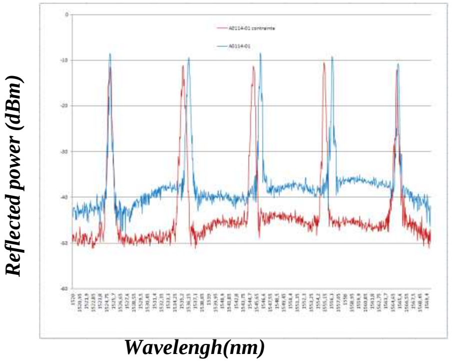


- It's consisted of
    - 3 alveolar layers + 2 Tungsten layers
    - 3 columns of cells : representative cells in the middle of the structure
- Width of cells : 126 mm
- Identical global length : 1.3m and shape (trapezoidal)
- Fastening system ECAL/HCAL
- weight : ~ 60 Kg

2

Set up to Check the response of Bragg Grating after insertion . These measurements were conducted by Institut d'Optique Graduate School at Palaiseau, France. (1 layer)

3



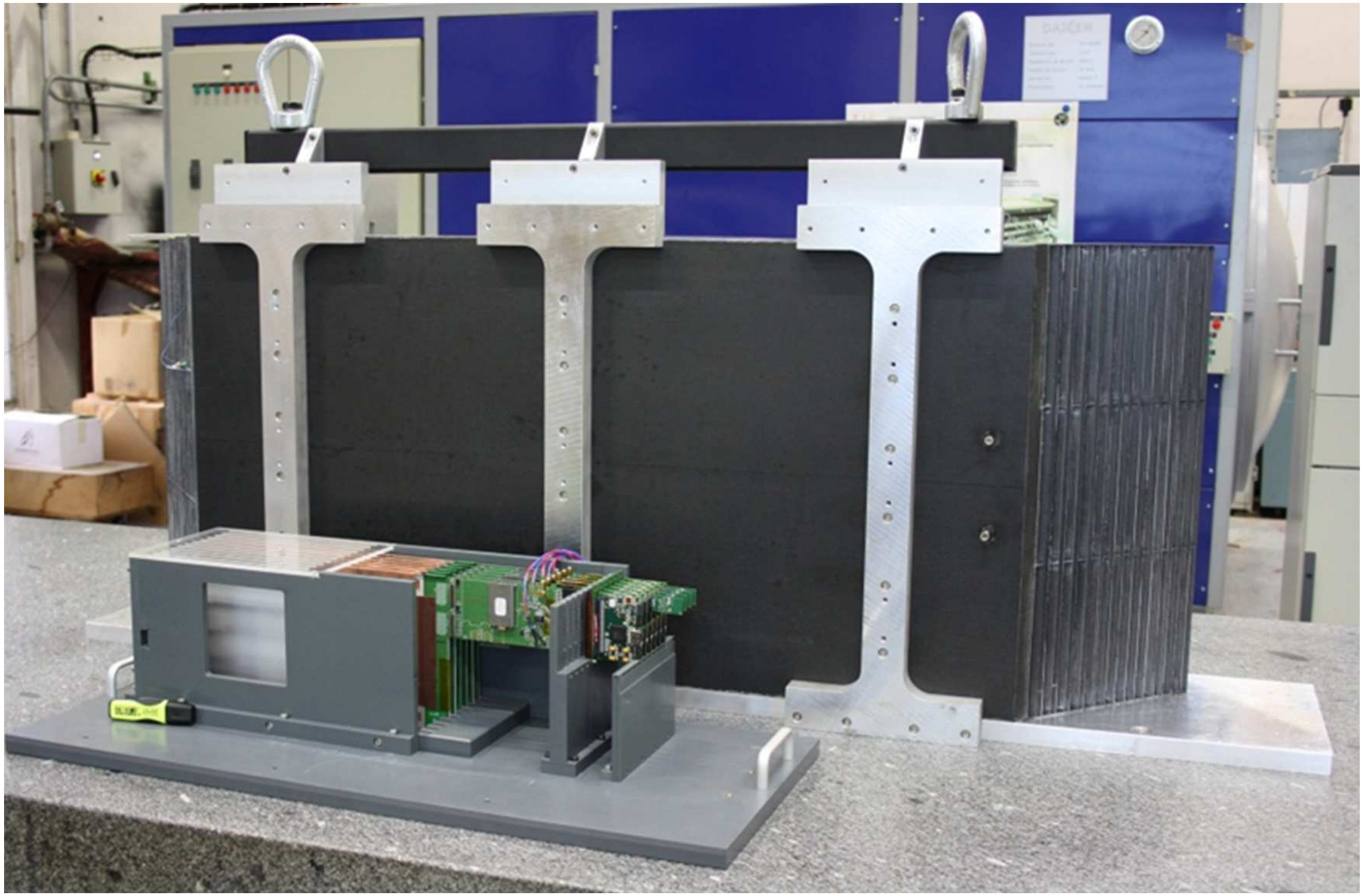
response of 10 Bragg Grating after insertion.
Red = constrained
Blue=free

Conclusion

- ***Today, 6 short Slab U are operational***
- ***We plan to study more molds and parts for Slabs development short U/H and long U/H***
- **We prepare our demonstrator for destructive test**
- **We prepare some tools to integrate the Slabs and ECAL structure for next test beam .**

The conclusion

Thank you for your attention



ECAL Endcap

structure and cooling studies

18.09.2012

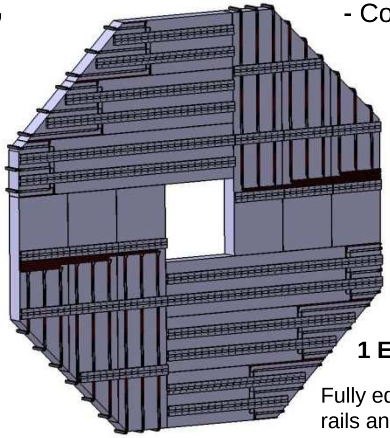
Denis Grondin, Julien Giraud, Johann Menu, Guilhem Frèche

CALICE Collaboration Meeting @ Cambridge / September 17th-19th, 2012

Current structure of End-Caps

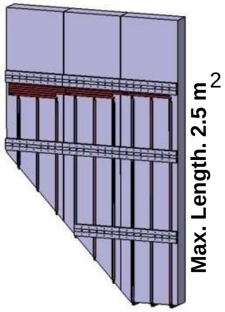
Modular structure	2 End-Caps Total of 2x12 modules = 2 x [4 quarters each]

- Construction process of sets ~ 540 cells similar to barrel BUT with different length (up to 2,50m)

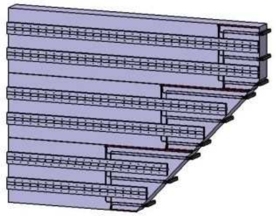


1 EC ~25,5 T

Fully equipped with slabs, rails and pipes

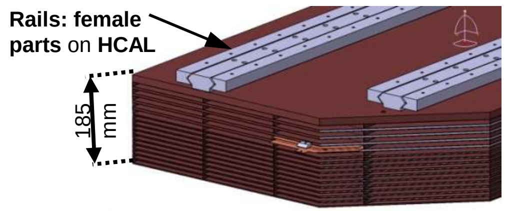


2 quarters ~6,5 T each



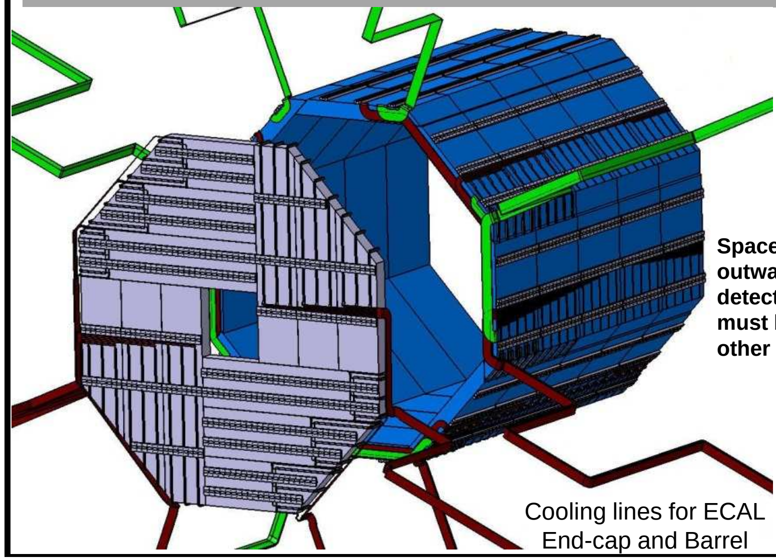
Alveolar W-Carbon HR structure with Fastening (rails) **and Cooling system**

3 modules in each quarter



1 of the 3 « standard » modules of each quarter

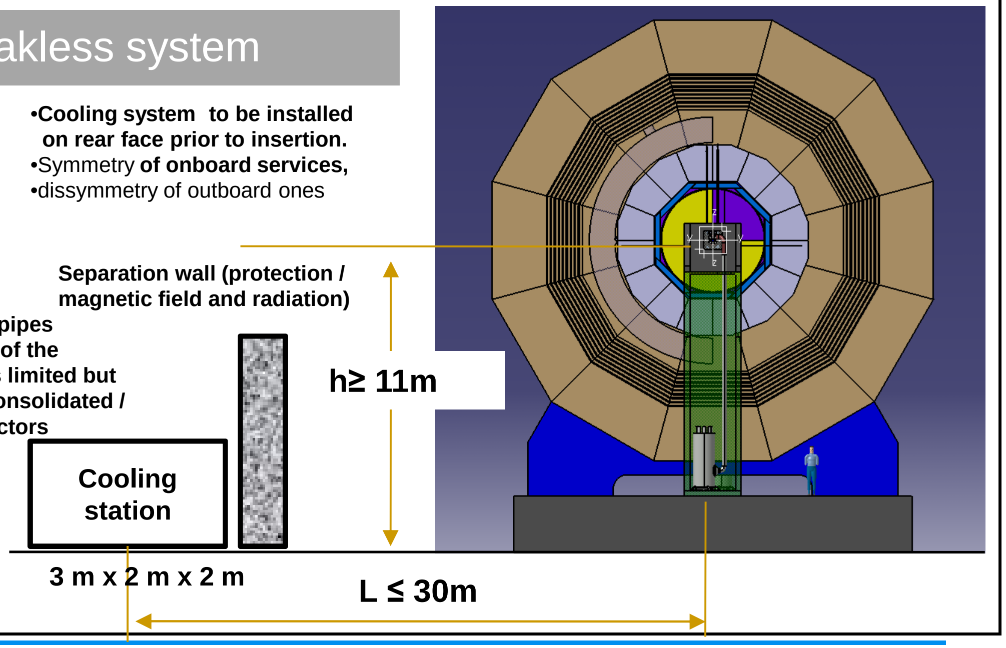
ECAL General Cooling Integration - Leakless system



Cooling lines for ECAL End-cap and Barrel

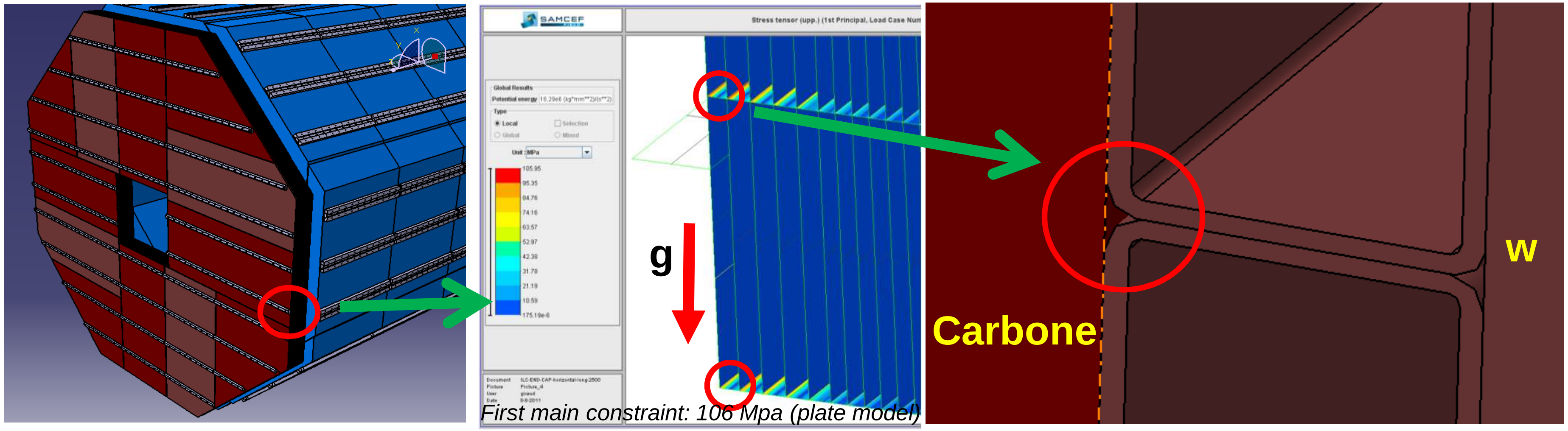
- **Cooling system to be installed on rear face prior to insertion.**
- Symmetry **of onboard services,**
- dissymmetry of outboard ones

Space for pipes outwardly of the detector is limited but must be consolidated / other detectors

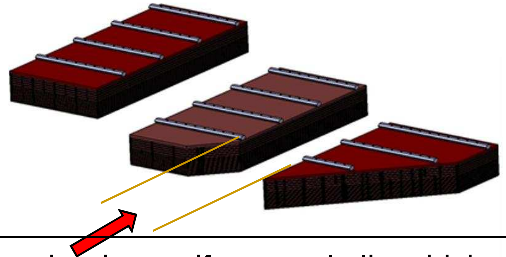


End Cap : evolution of skin thickness

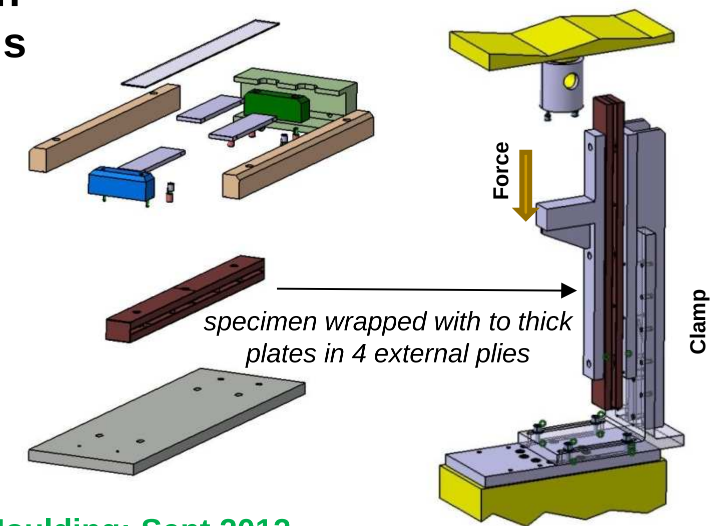
Problem of bending stress of alveoli skins



Influence of modification of external ply thickness on the first main constraint of external and internal walls



Impact on dead zone if external plies thickness increases (up to 5 mm in order to have a 10 MPa constraint)



Moulding: Sept.2012

Shearing tests: Oct.2012

Optimization of deflection values

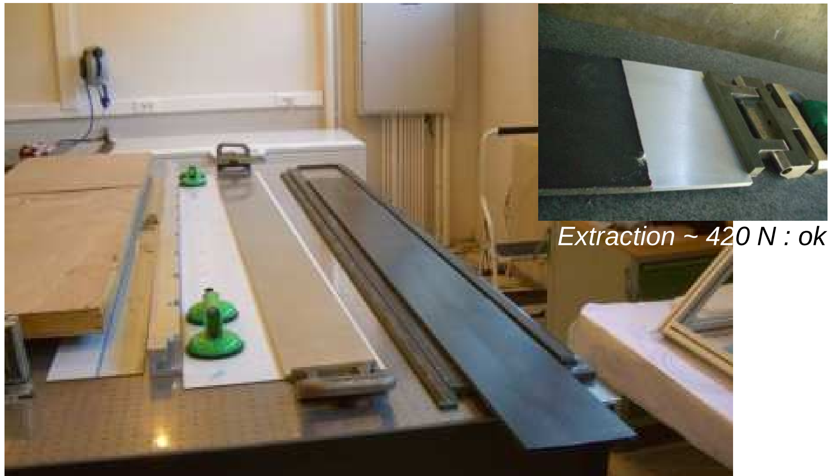
With a magnitude of maximal deflection of 1 mm, the maximal stress has a value greater than 13 Mpa (eligible tensile criteria)

Next step: acceptable maximal stress (+safety factor) → destructive tests

Long alveoli moulding & fastening

2.5 m alveoli molding

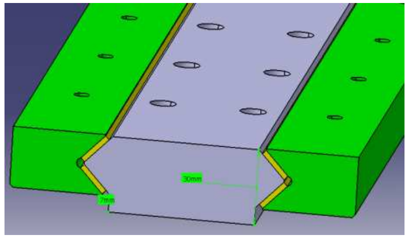
- **The end-cap layer test consisted of**
- **3 long alveoli** (representative of end-cap module longest layers)
- **Width of cell : 182,3 mm** like barrel's one (for electronic uniformity) ➡ Design don't fit LOI parameters (R~2062 / 2090 of LOI)
- **Thickness of cells : 7.3 mm - wall: 0.5 mm**
- **Length : 2.490 m**

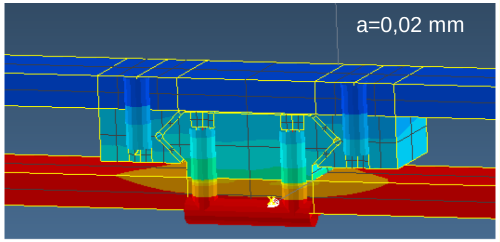


After first test negative with stainless steel core, the 1st long alveolus (186,8 x 6,5 mm) molded with aluminium core fit LOI Parameters, but ≠ from barrel alveoli

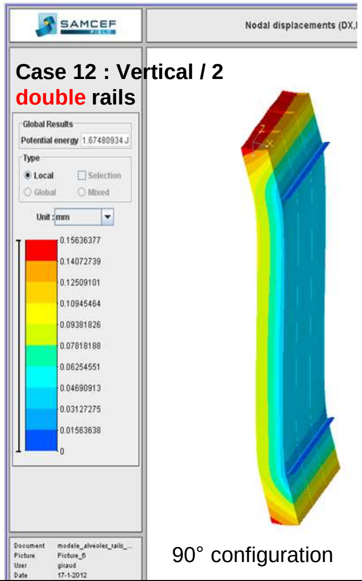
➢ **Next test: Long End-Cap alveolar layer (September 2012)**

3D design of different fastening system
⇒ Thickness 30 mm & double row sized



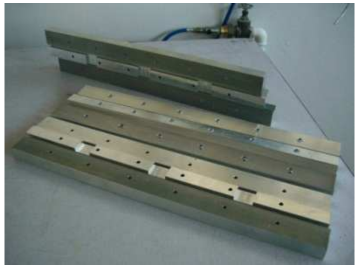


Finite element calculation to determine the stiffness of the rails



90° configuration

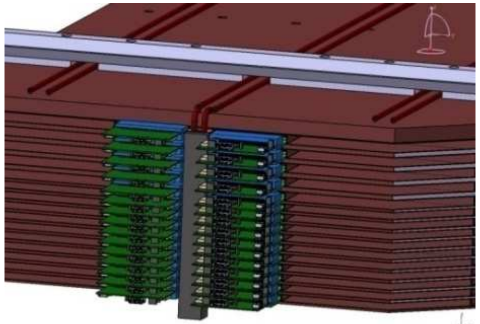
Type d'accrochage (vertical, horizontal)	Vertical
Nombre de rails	2
Type de rail (simple, bouble)	Double
Première contrainte principale (11411) (MPa)	8
Critères de TSAI Hill Version 1 (7621)	9.90E-03
Déplacement (mm)	0.16



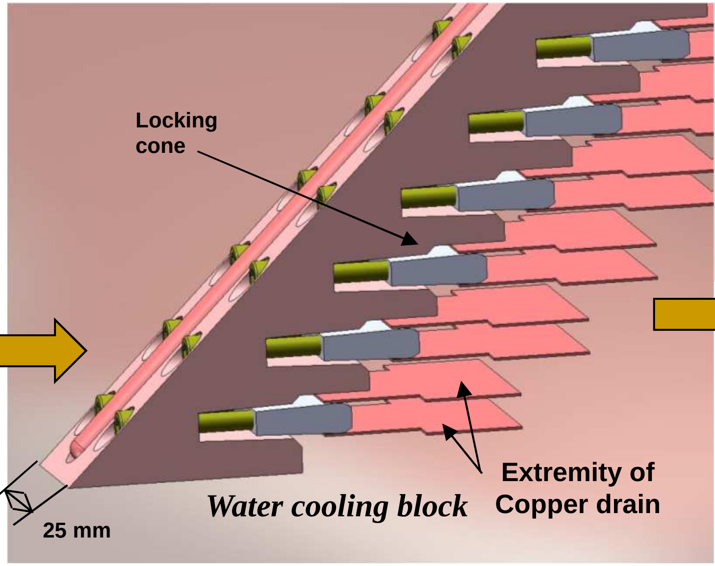
Opening in rails for cooling and services on each column (EUDET)

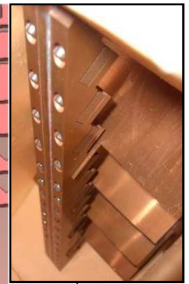
Finite element End Cap simulation : MODULE N°1
2.5 m long / 3 columns / position 0° and 90° / M = 2550 Kg
⇒ Goal of simulations: Influence of position / nbr of fastening systems on the mechanical behaviour (displacement / stress) …
⇒ Even if module is fastened with 2 double rails instead of 3 simple rails, deflections are less important.

Cooling/ heat exchanger link

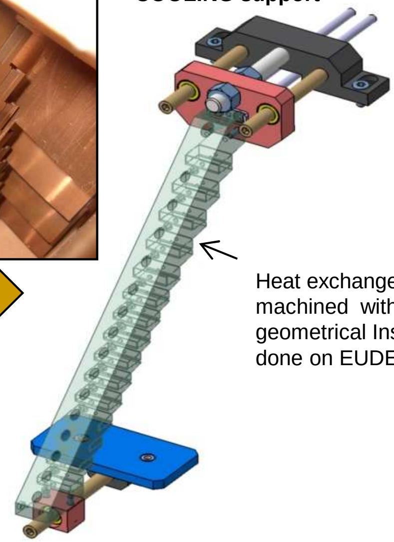


Heat exchanger on central column

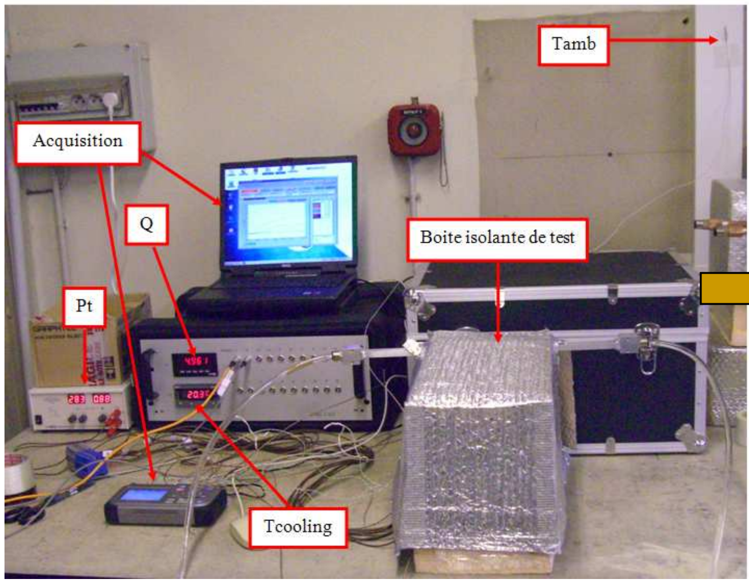


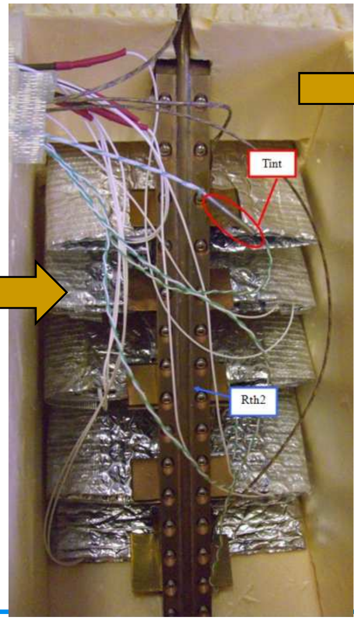


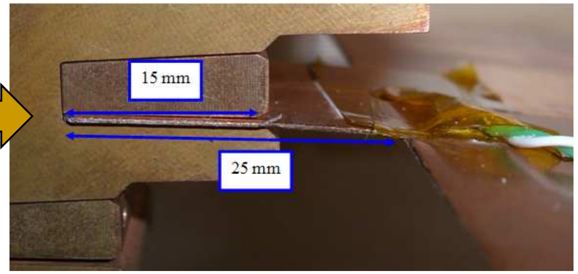
COOLING support

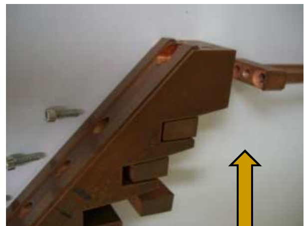


Heat exchanger machined with geometrical Inspection done on EUDET







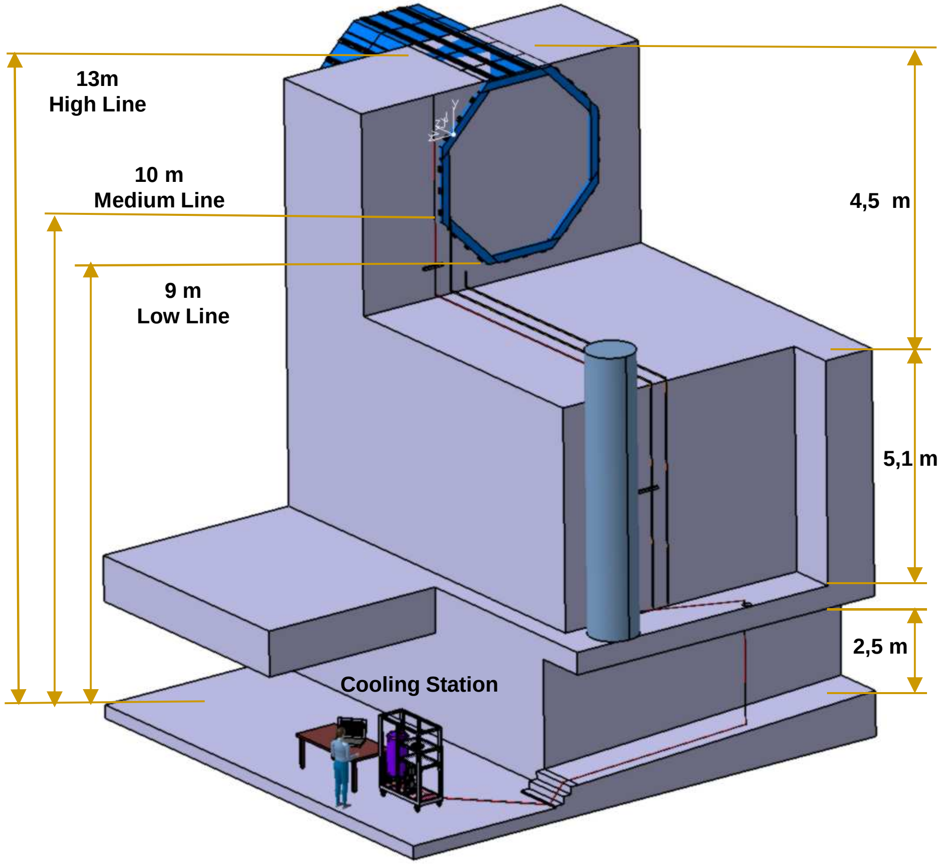


Next step: Heat exchanger of EUDET
Test of the full heating column (15 layers)
Delivery: **October 2012**

Cooling/ true scale leakless loop

LPSC cooling test area and cooling station

Fall 2012 : design of cooling station : tank, pipes, wiring
Spring 2013 : cooling station assembly, leak less tests (<1atm)



LPSC cooling test area **with a drop of 13 m**

ECAL End-Cap intrados
with cooling lines

Work on real scale leak less loop including real module altitude / electronic / sensors

- **Three lines will be conducted: height mini, medium and maximum**
- **Work on reliable connection between the cooling system and the water heat exchanger**
- **First Design: hydraulic safety, hardened components, cooling supervision…**
- **Global cooling / Pipe integration**