

*Alveolar Structure  
for the technological  
prototype of ECAL*

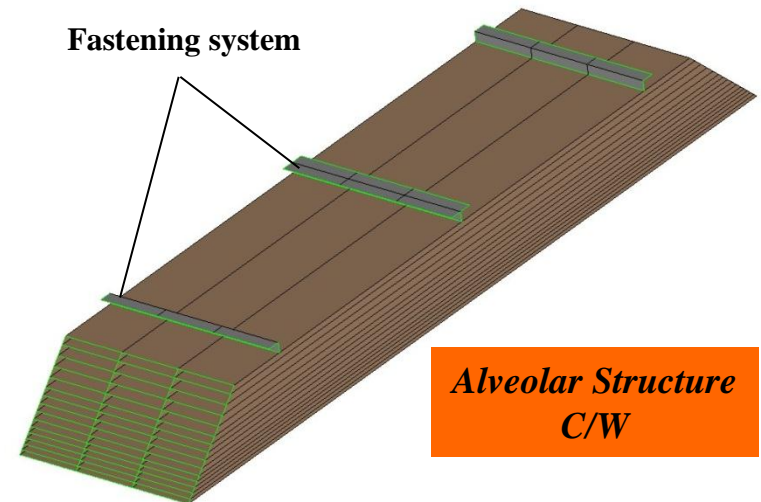
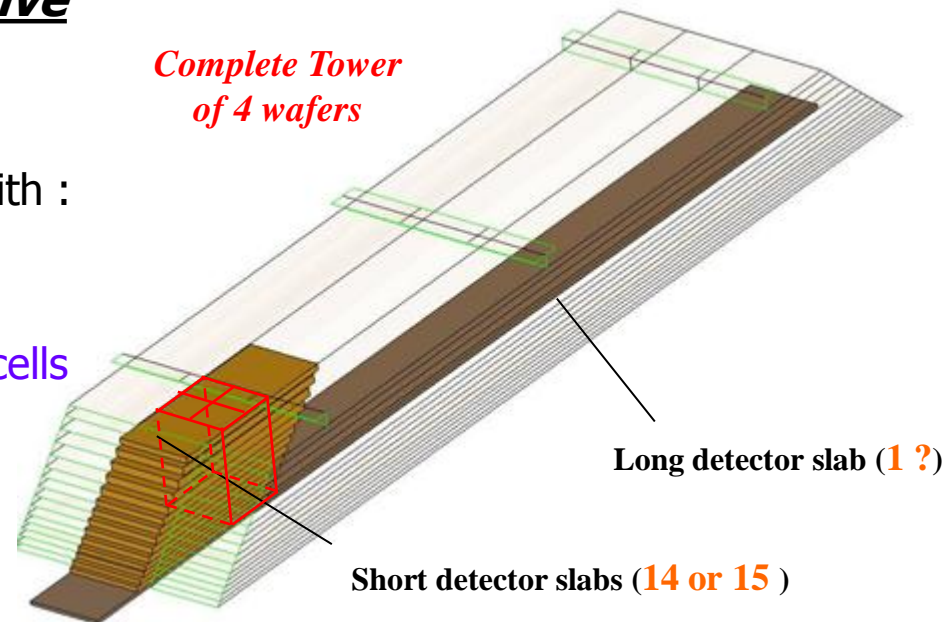
**CALICE collaboration meeting @**



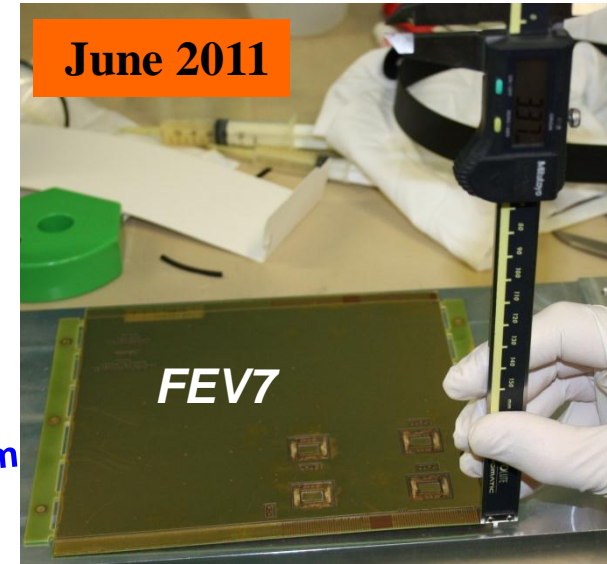
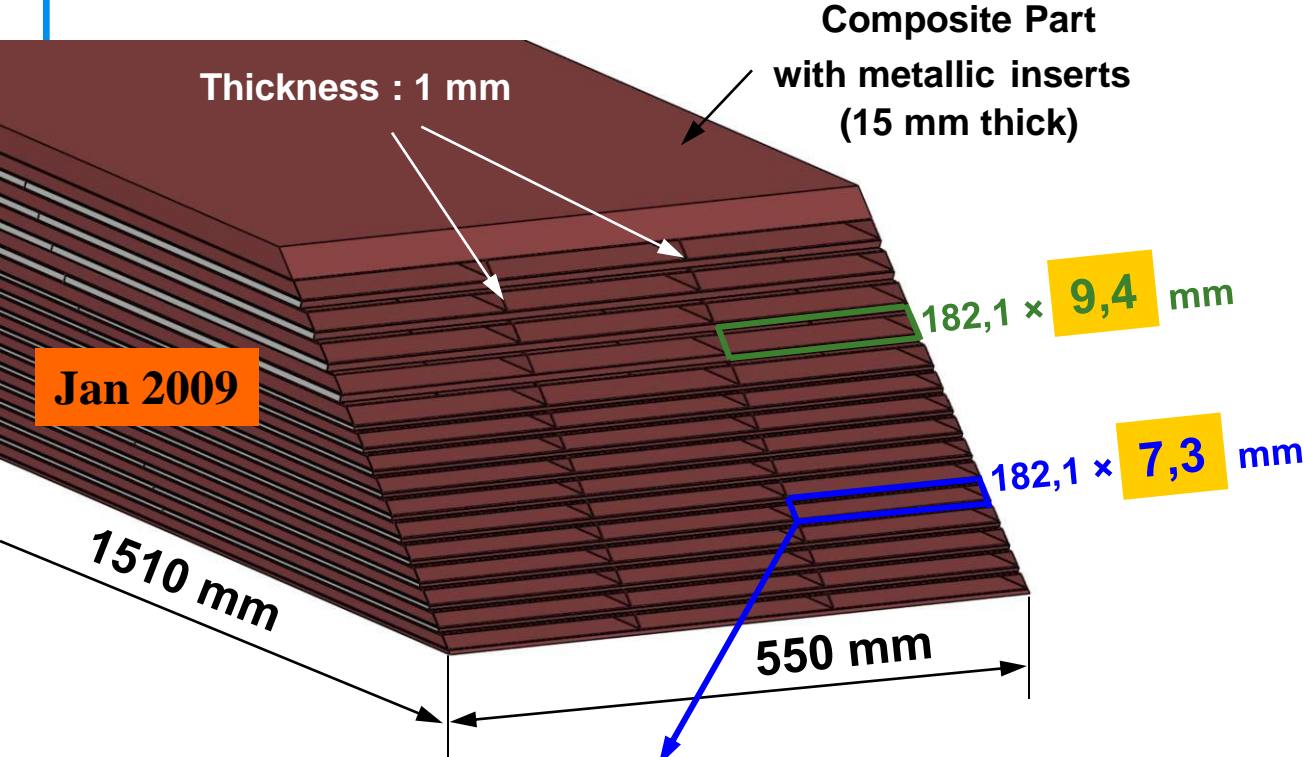
# Technological prototype

## Concept : to be the most representative of the final detector module of ECAL

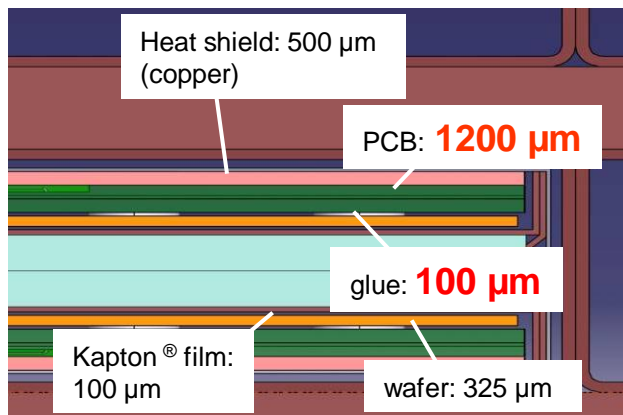
- An alveolar composite/tungsten structure with :
  - same **W sampling** :  
20×2.1 mm and 9×4.2 mm thick
  - 3 columns of cells to have **representative cells** in the middle of the structure (with thin composite sheets )  
width : 182 mm
  - Identical global dimensions (1.5m long) and **shape** (trapezoidal)
  - **fastening system** ECAL/HCAL (include in the design of composite structure)
  
- 15 Detector slabs with **FE chips integrated**
  - **1 long** and **complete** slab ? (L=1.3m)
  - **14 or 15 short** slabs to obtain a complete **tower** of detection (typ. L=40 cm)
  - design of **compact outlet** (cooling system)



# Current Design



Flatness problem with standard process :  
*Flatness ~ 3,4 mm*

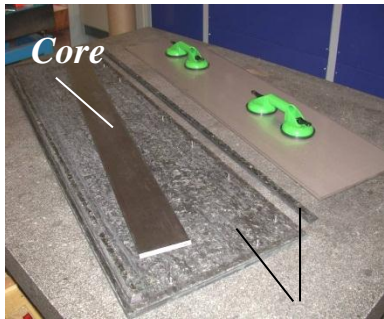


- ⇒ Gaps (slab integration) : 500  $\mu\text{m}$
- ⇒ Heat shield : 500  $\mu\text{m}$
- ⇒ PCB : 1200  $\mu\text{m}$  ? (flatness problems)
- ⇒ Thickness of glue : 100  $\mu\text{m}$  ? (gluing problems @ LPNHE)
- ⇒ Thickness of wafer : 325  $\mu\text{m}$
- ⇒ Kapton® film HV : 100  $\mu\text{m}$
- ⇒ Thickness of W : 2100/4200  $\mu\text{m}$  ( $\pm 80 \mu\text{m}$ )

# First test : the demonstrator

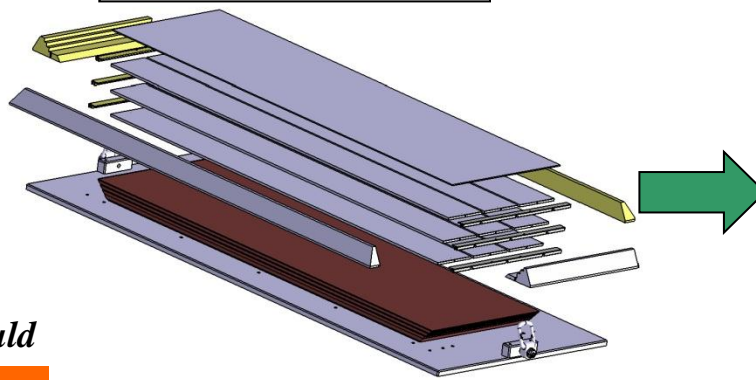
- A **real first test** of assembling : 2 layers of W + 3 layers of alveoli
- Dimensions based on **physic prototype** (cells width : 124 mm)
- Used for **thermal studies** and analysis : first cooling system design (LPSC)
- First test of long **slab integration**, gluing, interconnection (LAL,...)

*1st alveolar layer mould*



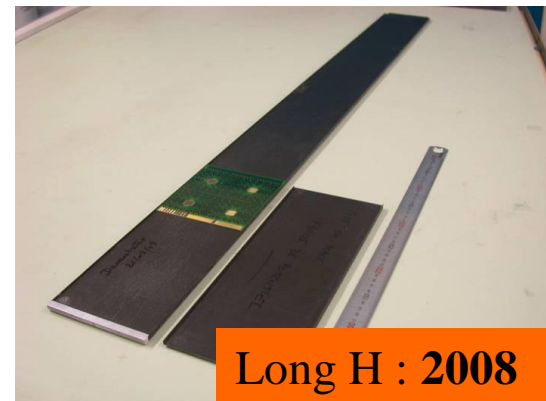
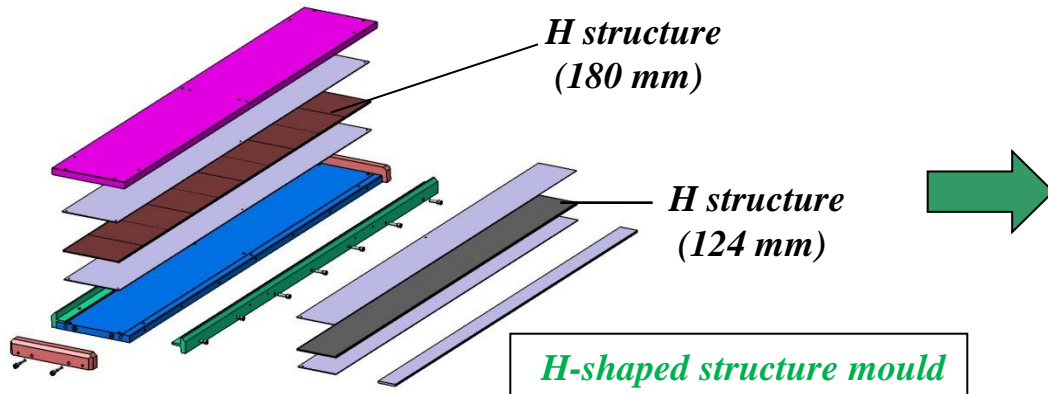
*Hextool mould*

*1st assembly mould*



**Structure : 2009**

**Design & moulds : 2008**

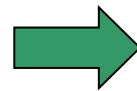
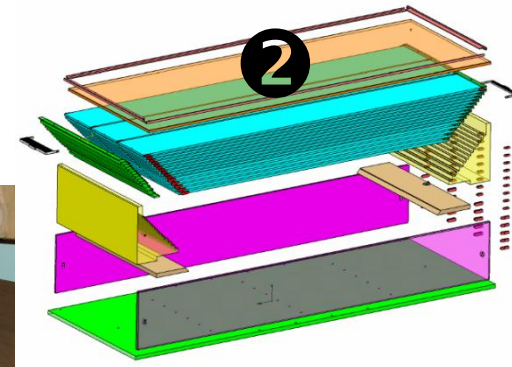
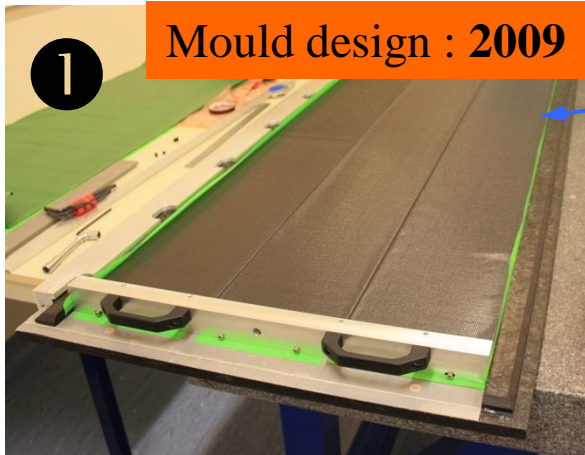
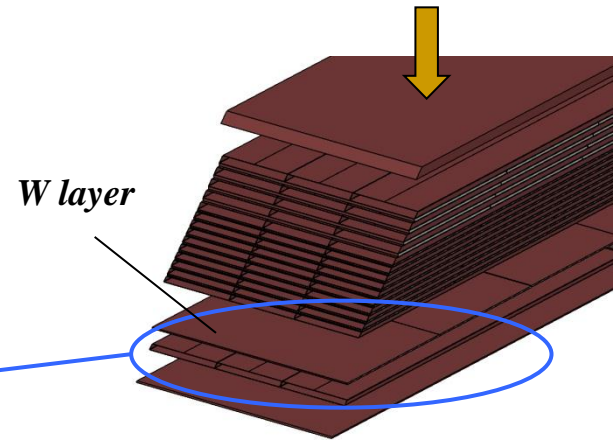


**Long H : 2008**

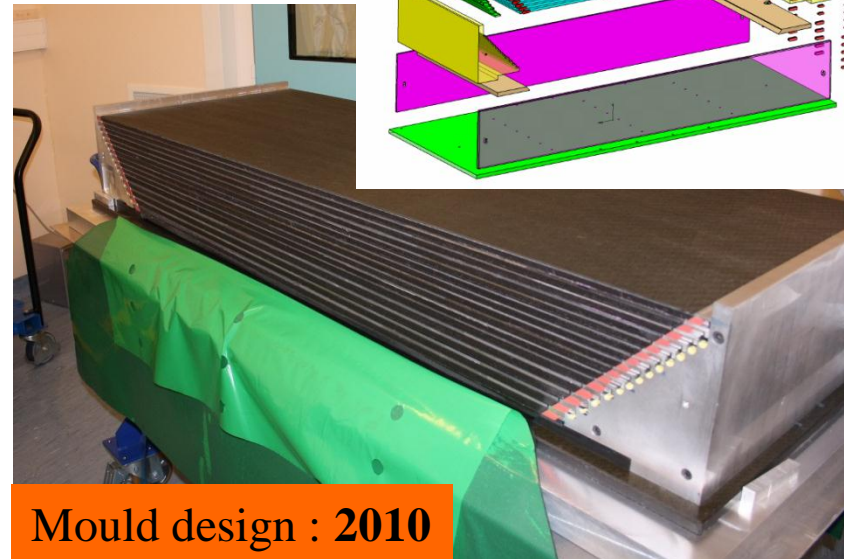
# Alveolar structure - concept

## Assembled structure process in 2 steps :

Each alveolar layer are done **independently** using an « alveolar layer » mould (❶), cut to the right length (with 45°) and **assembled** alternatively with W plates in a second curing step using an assembly mould (❷)



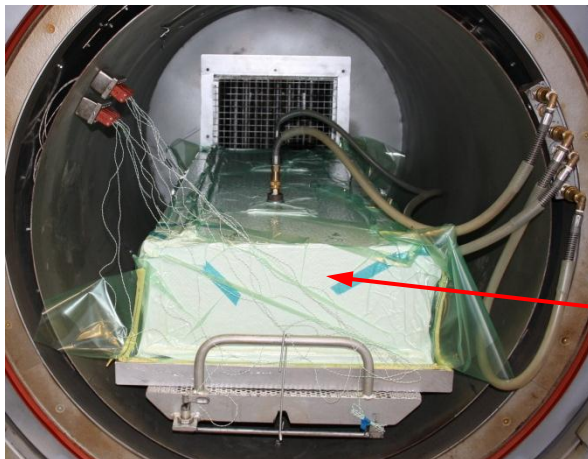
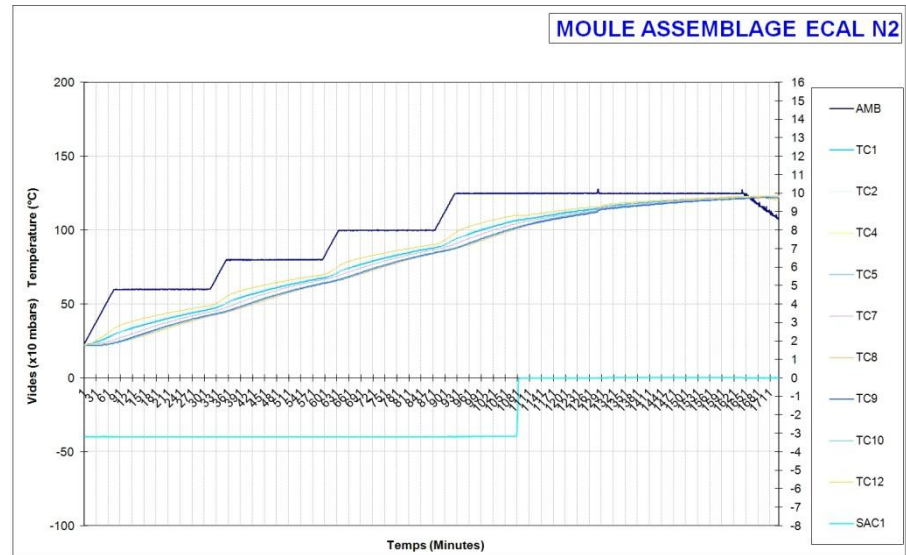
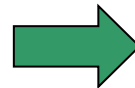
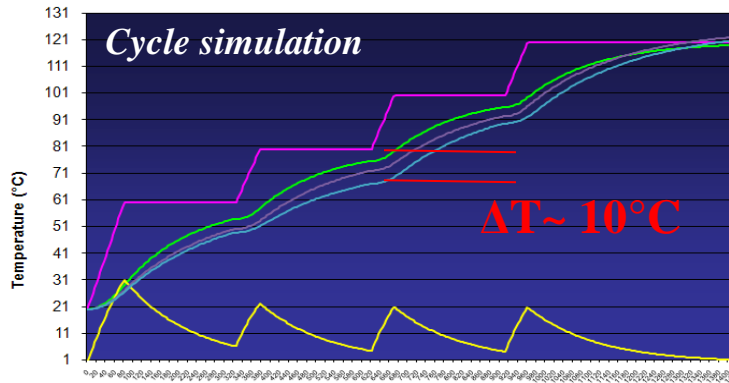
(x15)



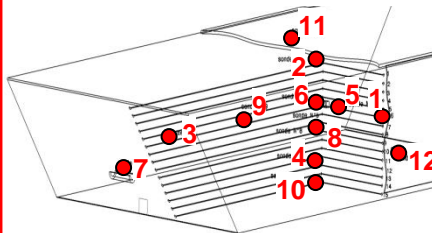
# Alveolar structure - Curing cycle definition

## Optimisation of the polymerisation cycle:

- Try to **reduce** the impact of **thermal inertia** on the mould ( $\sim 1,5$  t)
- **limit** the temperature gradient between external and internal temperature ( $\sim 10$  °C) to define all levels of the cycle
- **Experimental tests** to valid the good curing cycle (all materials have been included)



## *Exp. Tests (12 sensors)*



**Definition : 2011**  
(Cycle  $\sim 30$  h)

# Alveolar structure - construction

## Main steps of the construction (3 days):

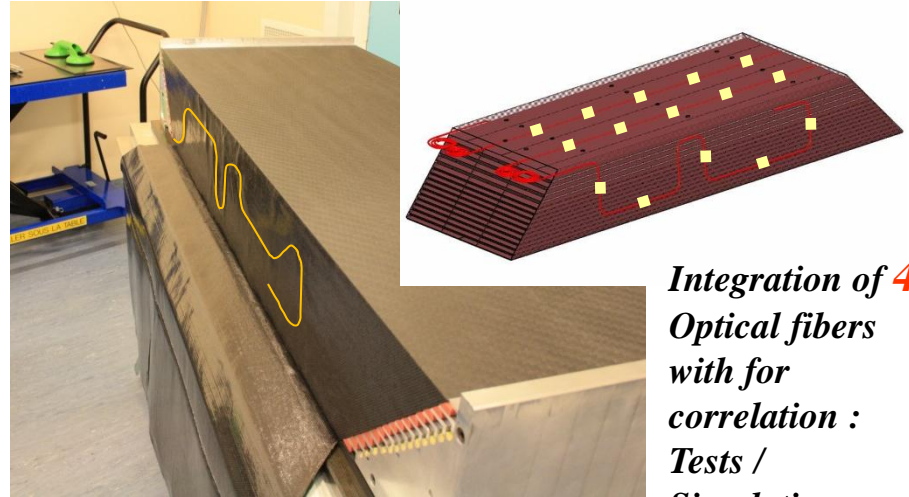
1- Start of the assembling (ticker composite plate)



2- All layers (composite/W/glue) mounted

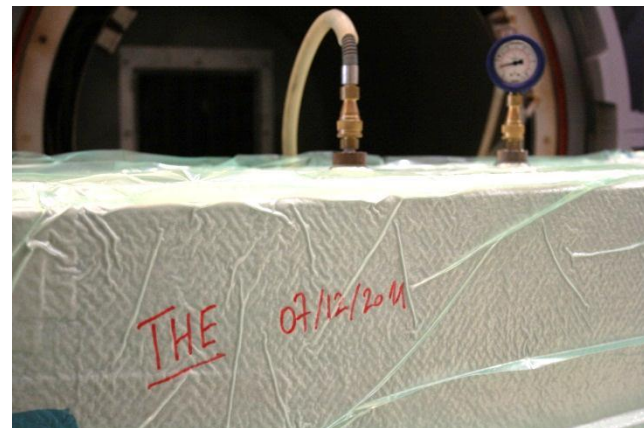


3- optical fiber insertion (5 BG / fiber)



Integration of 4  
Optical fibers  
with for  
correlation :  
Tests /  
Simulations

4- ready for 4,5 bars @ 125°C !!!



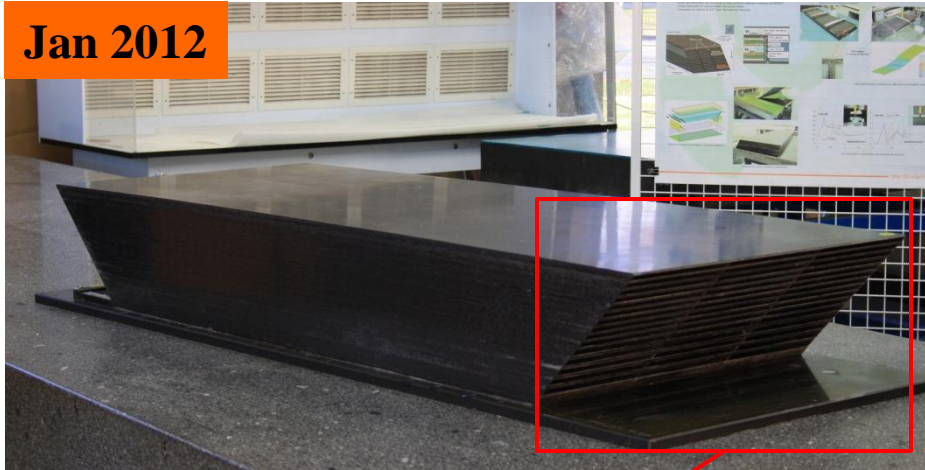
« THE » structure : Dec 2011

# Alveolar structure

## Final demouling and dimensional inspection :

Using a 3D measuring arm machine (FARO) from IAS

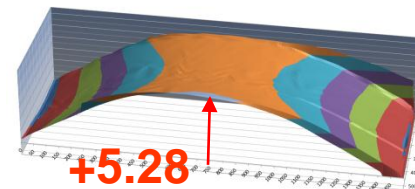
Jan 2012



- 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 !!!**



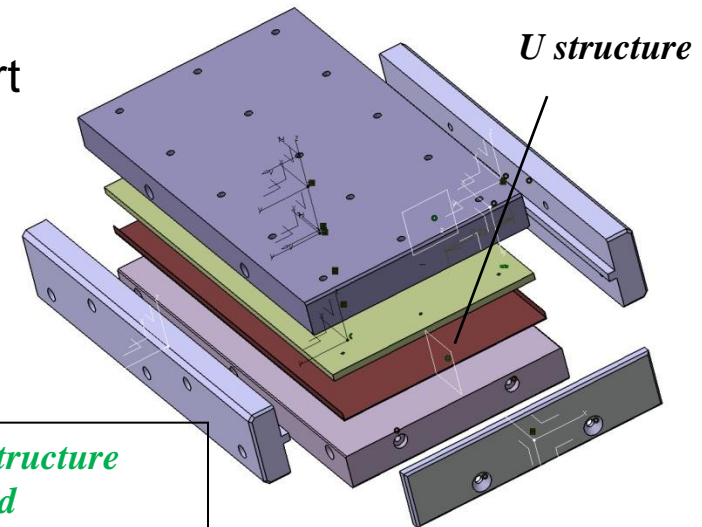
Top surface is bended  
(Need to be studied)

*Expected (structure dim.) vs Measured*



# Conclusion

- **5 years** of studies and R&D have been necessary to obtain with success this structure  
(design with **mechanical simulations**, definition of all **steps of the fabrication** with demonstrator, study for **BG integration** for future correlations, **optimization** of the polymerization for heavy structure of ~700 Kg...)
- **Now available** for testbeams
- Really **representative** and **transposable** to a final module for ILC (ready for a Module 0 ?)
- Next step : Design and production of the support structure of the slab  
(H and U) according to the different solutions :
  - 1- ECAL Si/W “**base-line**” : **H-Shaped structure**
  - 2- ECAL Si/W “**conservative design**” &  
ECAL Scint/W : **U-Shaped structure (same !)**



U-shaped structure  
mould