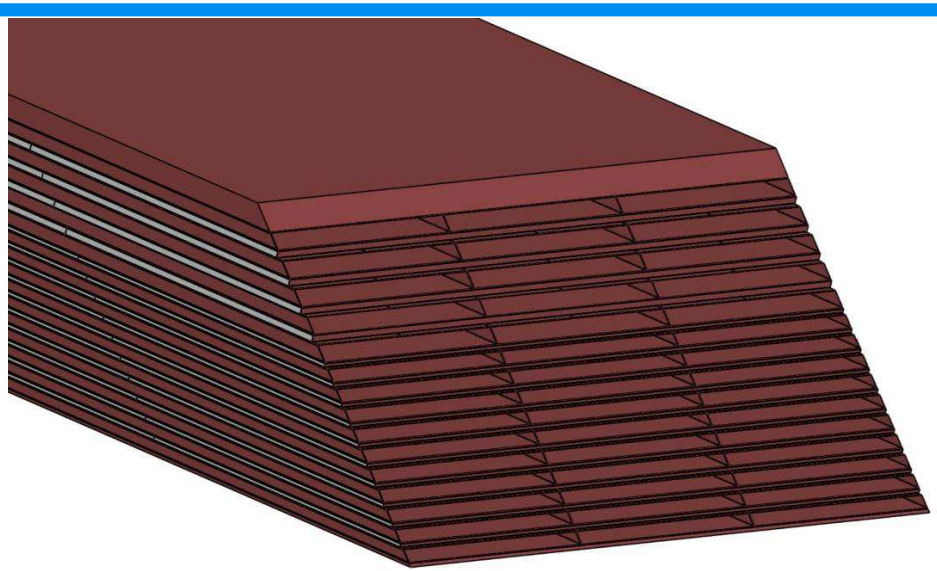
ECAL
Composite structure



CALICE Collaboration Meeting @ HEIDELBERG / September 16th, 2011

State of ECAL composite structure.

1 ECAL Mould

2 Thermal studies

3 Mechanical studies

4 Conclusion

5 Schedule

ECAL module – parts of Mould

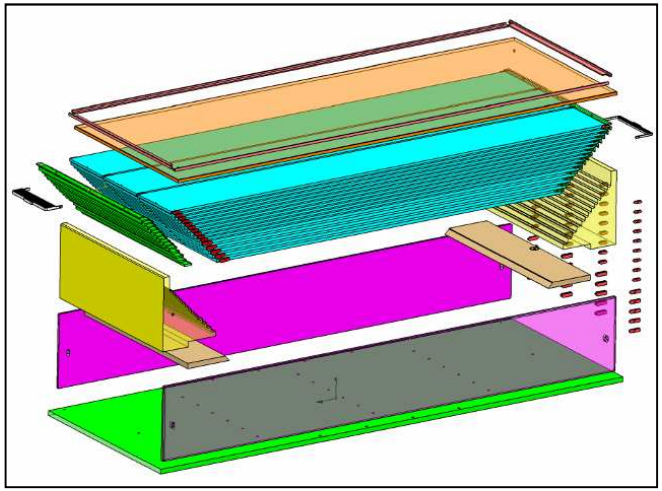
⇨ ECAL structure : ***Nov 2011***

⇨ **The goal:**

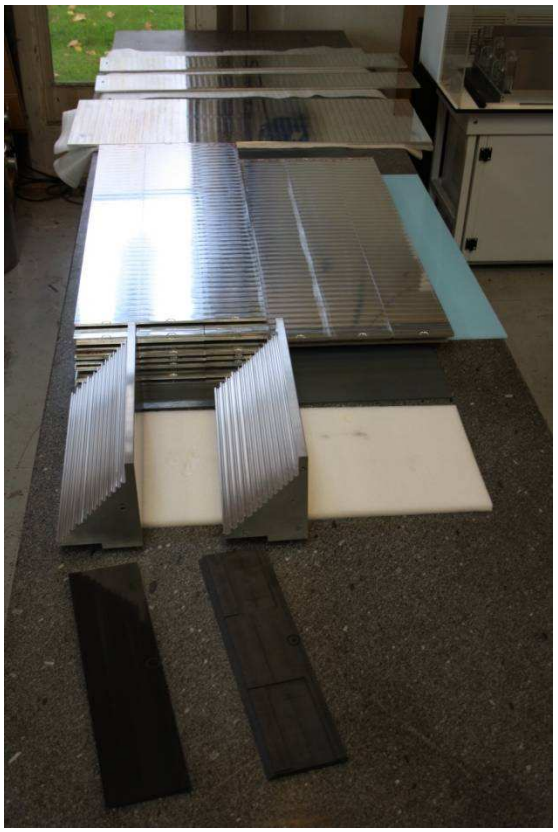
Design a mould for the reassembly of 15 alveolar carbon layers and 15 layers of tungsten to purpose:

- ***Paste all the layers together.***
- ***Ensuring the integrity of the 45 cells after cooking.***
- ***Ensuring the positioning all layers of carbon and tungsten.***

Today, all parts of the mould are finished and operational



All the 15 structures are been moulded
The production of one layer with
the FBG is now finish.



All the parts of the mould
Have been received and were checked

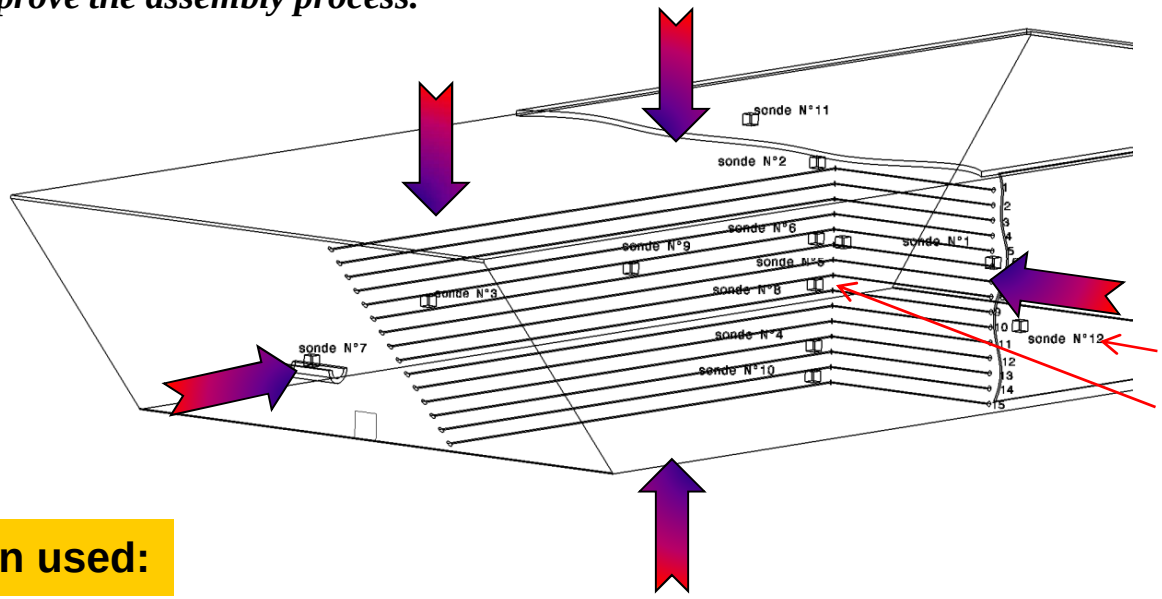
ECAL module – Thermal studies

⇨ The goal:

1 - Create a heating cycle adapted to the structure to avoid a bad polymerization

2 - Understanding the propagation of heat from the outside to the inside of the module and the structure of C and W

3 - Test and improve the assembly process.



⇨ The mean used:

To measure the heat flux in 3D we placed 12 temperatures sensors in three directions and the data were recorded in the autoclave.

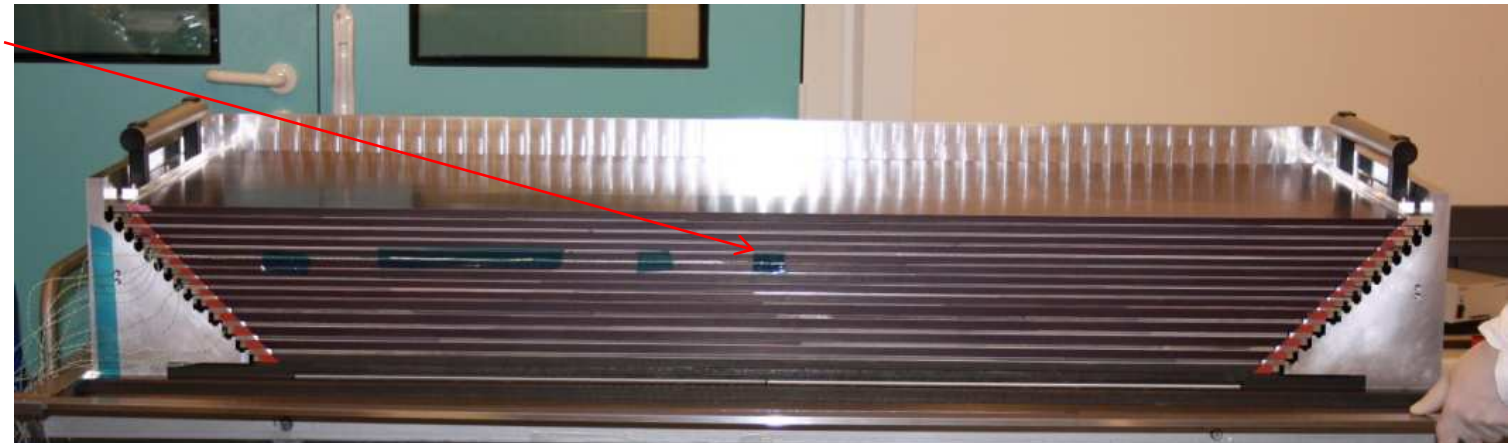
12 Temperature Sensors

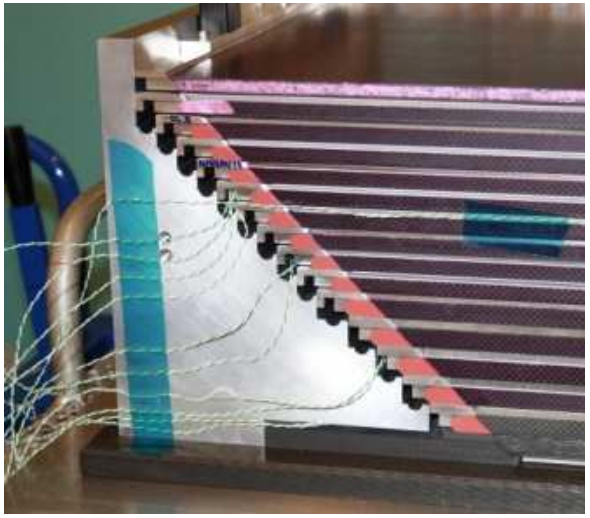
Thermal Flow

ECAL module – Thermal studies

⇨ **what we have already done :** End of assembly ***Feb 2011***

Temperature Sensors N°12





The temperature sensor wires are maintained on the staircase

We have assembled all the parts of the mould and the parts of the ECAL module in a clean room and tested the assembly process.

All temperature sensors were glued into each respective layer and out of the staircase structure as shown in left photo.

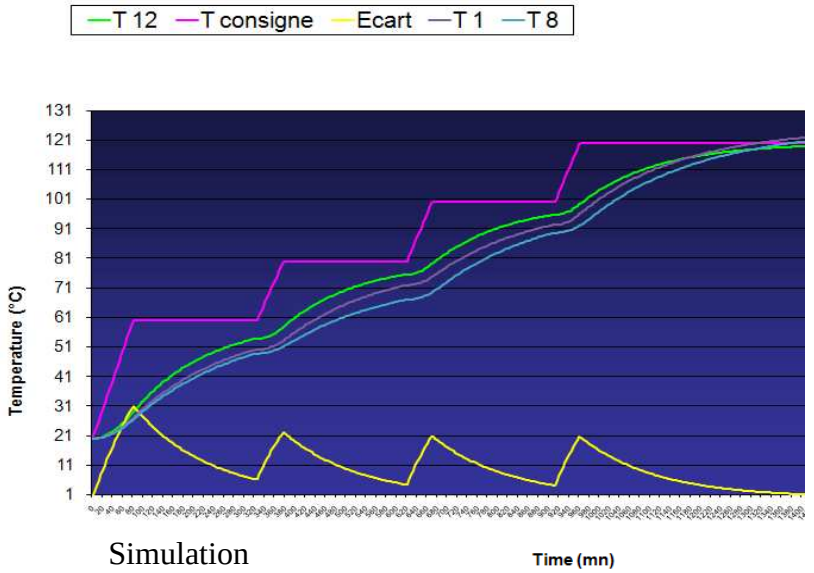
After a first test, we determined the time constant of our assembly and we have done simulations to optimize the final cycle of heating. (see to next slide)

With these data we made a heating cycle which guarantees a temperature difference between the center (sensor No. 8) and outside (sensor No. 12) about 10 degrees.

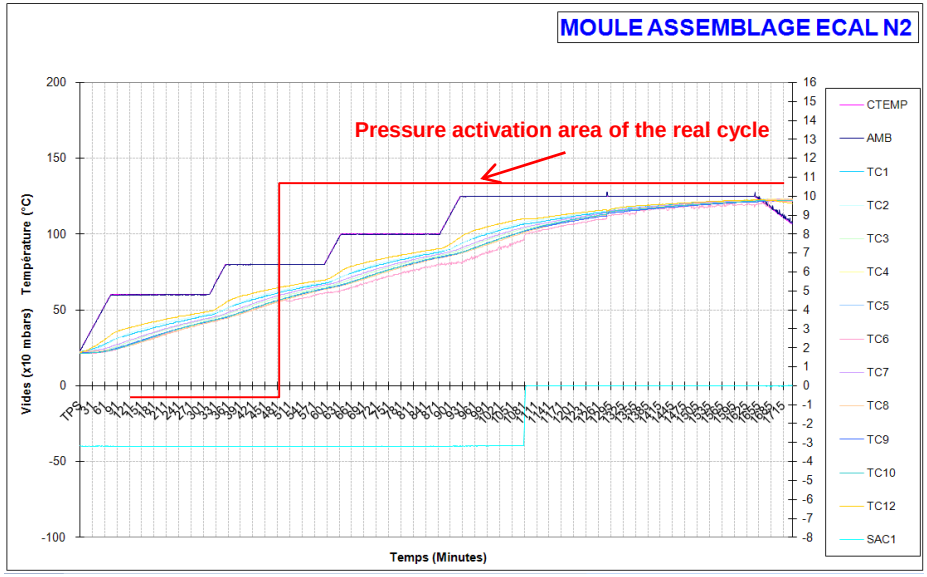
ECAL module – Thermal studies

⇨ **what we have already done : *March 2011***

Insertion of mould inside the oven



Simulation



Second Test in oven

⇨ Conclusion :

- ***Total duration of the cycle will be 38 hours.***
- ***The pressure cycle should begin 8 hours after the start of heating cycle.***
- ***We will let the structure cool down in the oven off.***

ECAL module – Mechanical Studies

⇨ **what we have already done (ECAL module): *April 2011***

⇨ **The goal:**

1 – Determine the maximum allowable stress in the alveolar wall in a case of loading at 0 °
2 – Improve the simulation about the global mechanical behaviour

The simulations showed that stress concentrations are in the walls.
That is why we need to know as precisely as possible the stress in these areas.

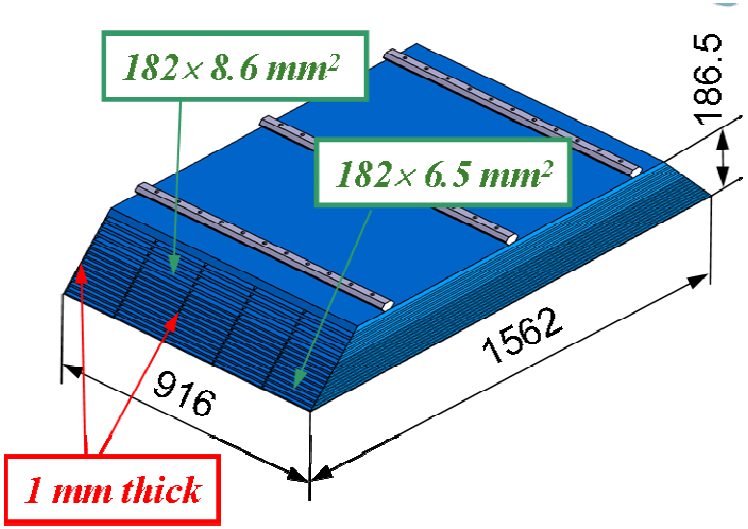


Fig.1a – ECAL Module

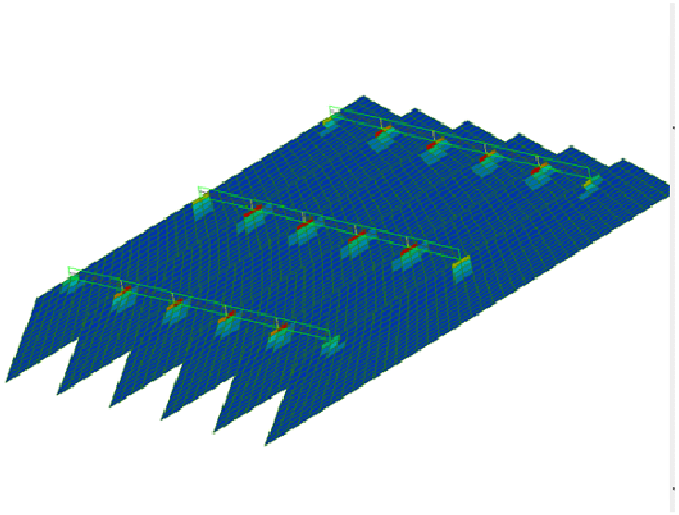
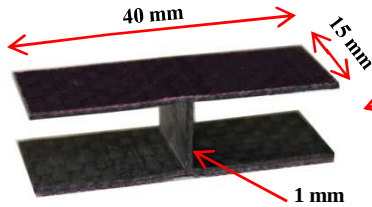


Fig.1b – Location of maximum stress under its own weight (TSAI-HILL)

ECAL module – Mechanical Studies

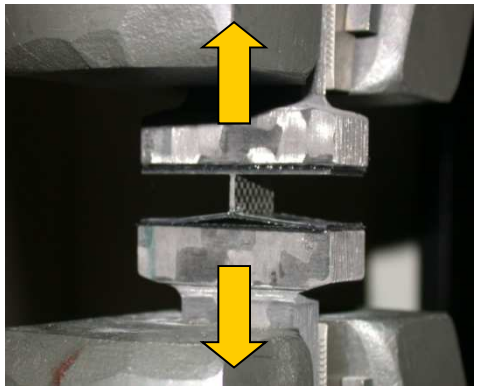
⇨ The mean used:

- *we made carbon supports to paste above the samples.*
- *In the first test we used only the structure bonded to the substrate.*
- *In the second test, we used the layers who to be used in the ECAL module (a layer of tungsten, a layer of prepreg 3K, a layer of STRUCTIL glue and the I structure)*

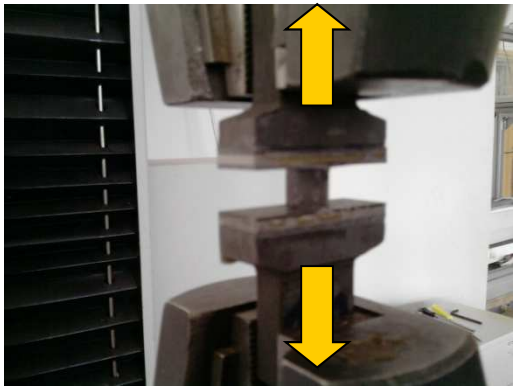


I sample structure

first case

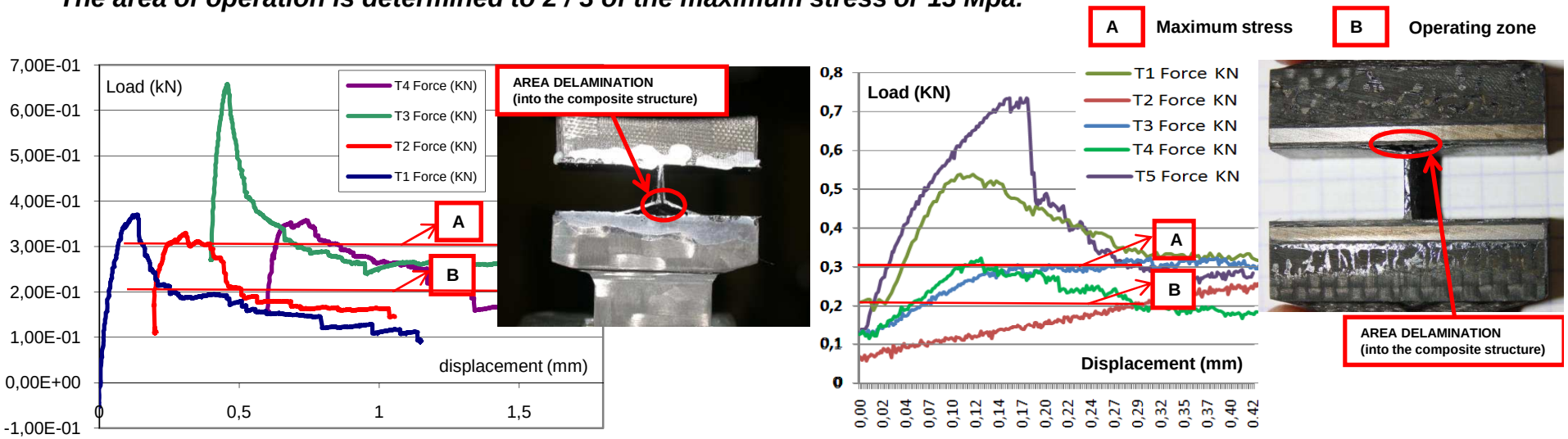


second test



ECAL module – Mechanical Studies

The area under stress is 15mm2.
The majority of the sample is broken around or above 0.3 KN or 20Mpa, that why we determined this value as maximum stress.
The area of operation is determined to 2 / 3 of the maximum stress or 13 Mpa.



⇨ Conclusion : ***On going (first results)***

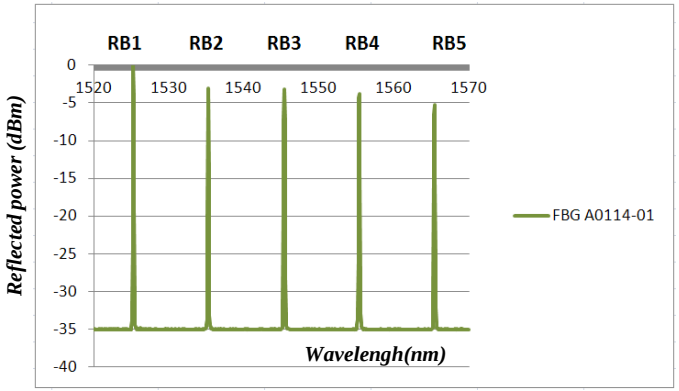
- ***We plan more sample to increase measurement accuracy***
- ***The fracture zone is located in the structure and not in the glue.***
- ***At the present time, the maxi stress value admissible into the structure seems to be around 13 Mpa***

ECAL module – Mechanical Studies

⇨ **what we have already done: *July 2011***

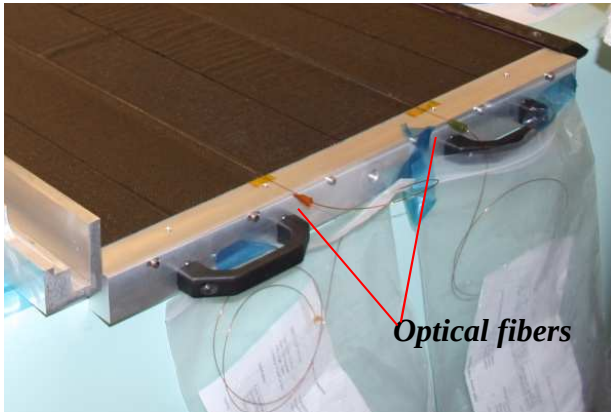
⇨ **The goal:** ***3 – Study the deformation inside the structure.***

1



Control the response of each Bragg Grating measured by Armando Laudati, CNR-IMCB –ITALY, before insertion

2

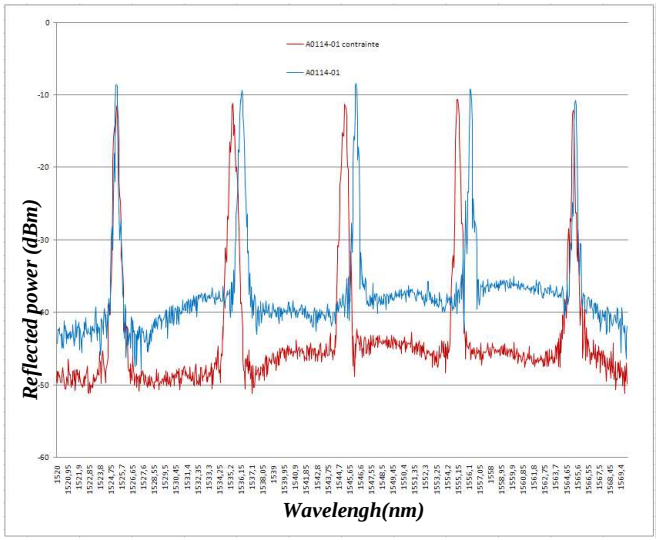


Integration of Optical fibers between two layers of carbon (ECAL)

3

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

4



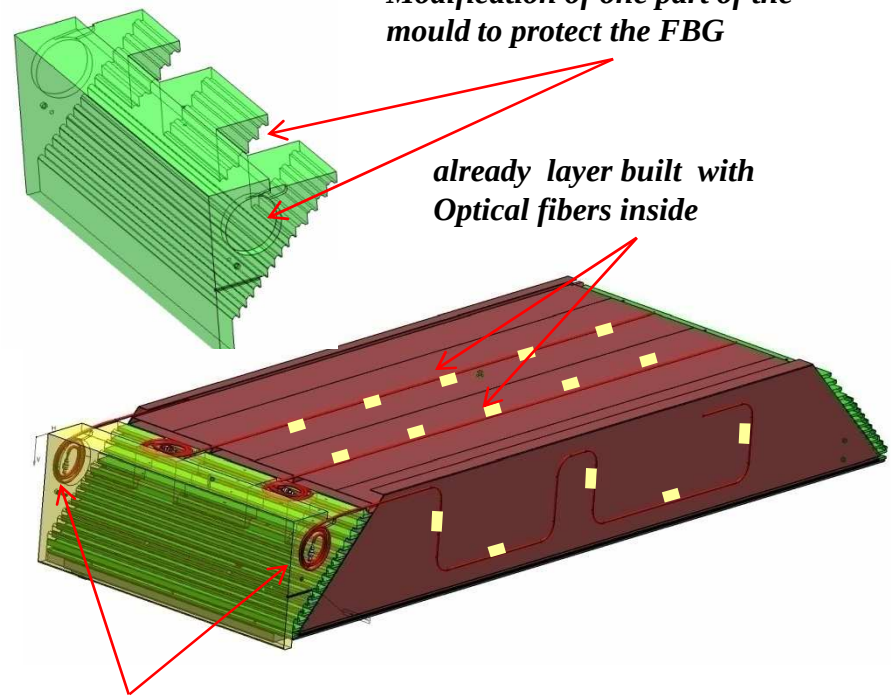
response of 10 Bragg Grating after insertion. Red = constrained Blue=free

ECAL module – Mechanical Studies

⇨ what we have already done : *JUN 2011*

To study the stresses in the structure in the area of delamination, the insertion of fiber in this area will allow us to measure accurately the real constraint in this area.

To achieve this schema, we must ensure the integrity of the fibers in the mold assembly, which is why we decided to protect the fibers in the staircase as shown in the right drawing.



Integration of 2 new optical fiber on the sides of the ECAL module during the assembly operation.

⇨ Conclusion :

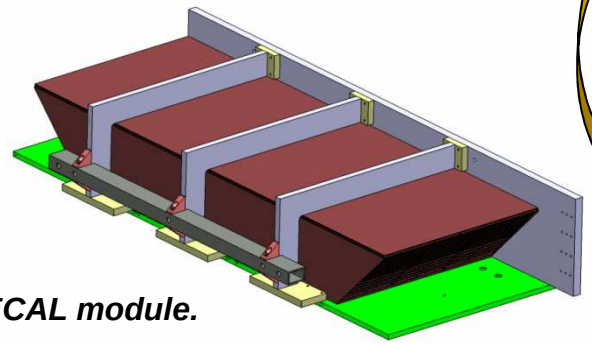
- ***The modification of the staircase are finished in July***
- ***We are sure that all FBG are in good working condition, inside the layer***
- ***We prepared a 3-point bending test with the layer and the FBG***

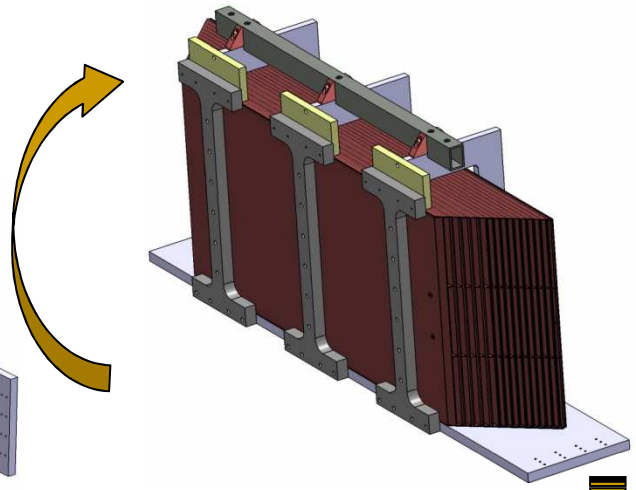
ECAL module – Mechanical Studies

⇨ **what remains to be done:** Realization transport system ***Octo 2011***

⇨ **The goal:**

1 – Guarantee the structure against to mechanical stress .
2 – Provide transportation for test beam

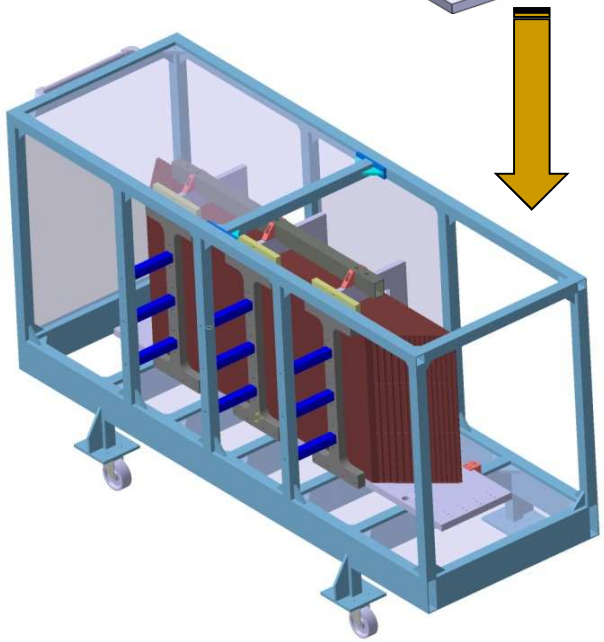




We study a system for transporting the ECAL module.

This system provides the structure against mechanical stress during all displacement.

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



⇨ Conclusion :

- ***The*** **manufacture of mechanical parts began in September**
- **All parts should be completed in October.**

The schedule: conclusion

- ECAL module :
  - ***Today, all parts of the mould are finished and operational***
  - ***All parameters of the heating cycle are know***
  - ***We plan more samples to increase the stress measurement accuracy inside the structure***
  - ***We are building the system for, transporting the ECAL module and a mechanical support to prepared a FBG 3-point bending test***
  - ***All FBG in the structure are operational !***
  - ***We are ready to assemble the ECAL module after 3-Point bending test***

The schedule:

- ECAL module :
  - Build ***3***-point bending test with FBG — **Oct** **2011**
  - ECAL module construction — **Nov** **2011**
  - System for transporting the ECAL module — **Nov** **2011**