SiW ECAL

Mechanics/cooling

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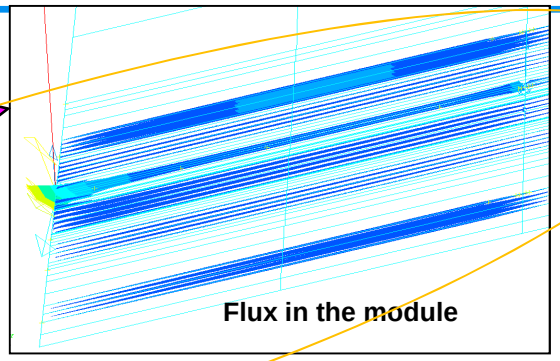
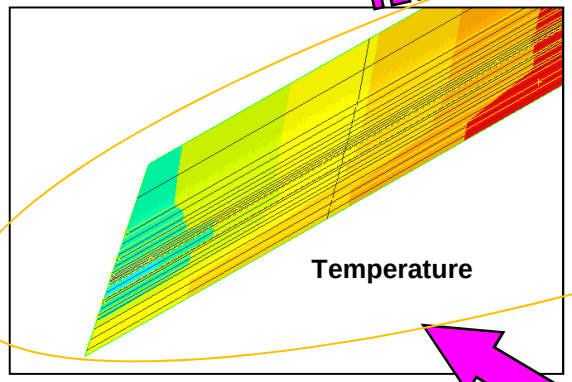
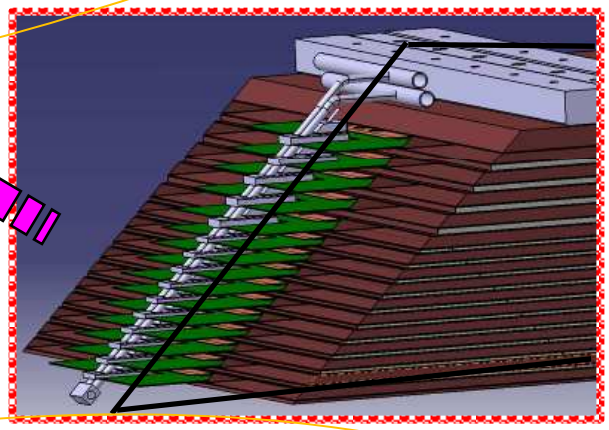
Work performed in cooling during 2011 and before

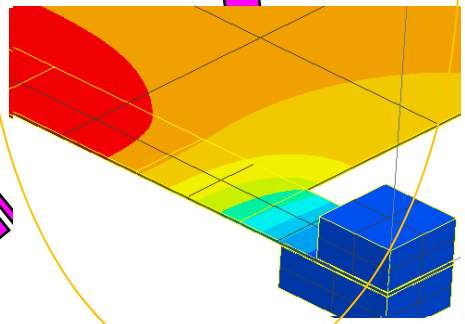


2 : Connection module / cooling

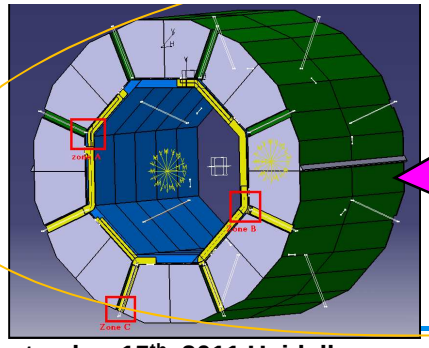


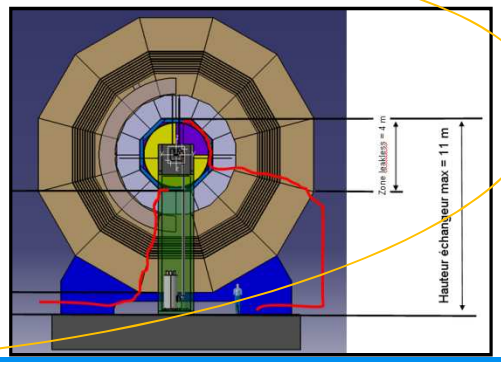


1 : Thermal transfert inside the module



Cooling distribution (see integration talk tomorrow)



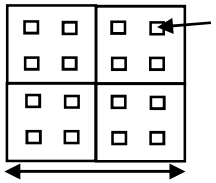


3 : Cooling global / Pipe integration

Thermal flux inside modules

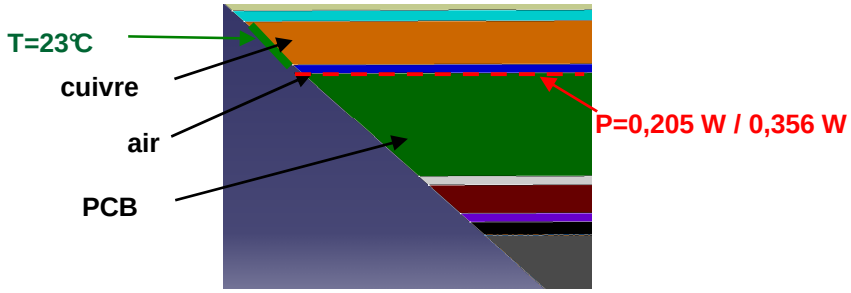
Inlet

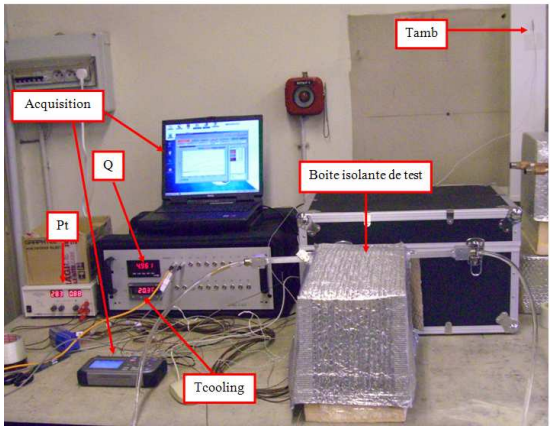
Power on PCB = 0,205 W / 0,356 W

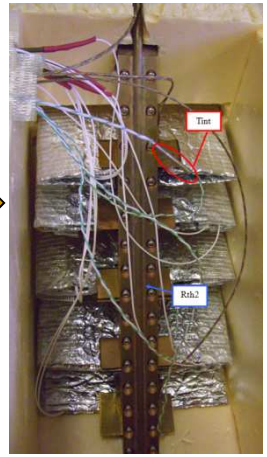


Barrel : (1,6.10-3*16)/180*1445=0,205 W
EndCap : (1,6.10-3*16)/180*2500=0,356W

Boundary condition T = 23 ℃ beginning of the coppe r plate
Air between copper plate and pcb is in the model







Results

Barrel : (1.5m)

ΔT = 2,2℃

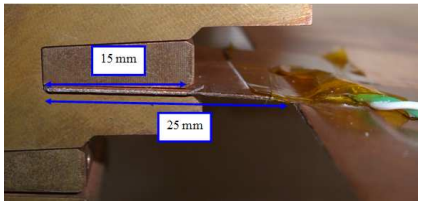
End Cap : (2.5m)

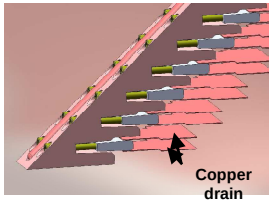
ΔT = 6℃

Conclusion

Low T°gradient -> cooling system suitable
Cooling front –end (front of slab sufficient)

Confirmation: **25 mm** free opening in DIF for extraction of cooling system





Copper plate / heat exchanger link

Cooling: leak less system

Ongoing :

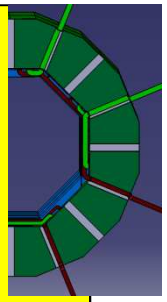
- A space test with a drop of 14 meters is available at LPSC.

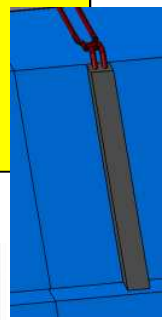
- Work on real scale leak less loop including different module altitude / electronic / sensors

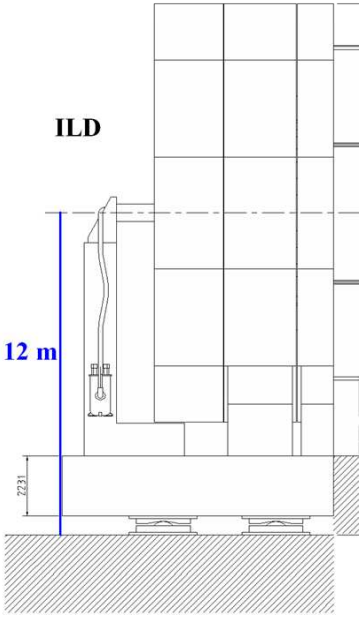
- Main components of the leak less station are ordered

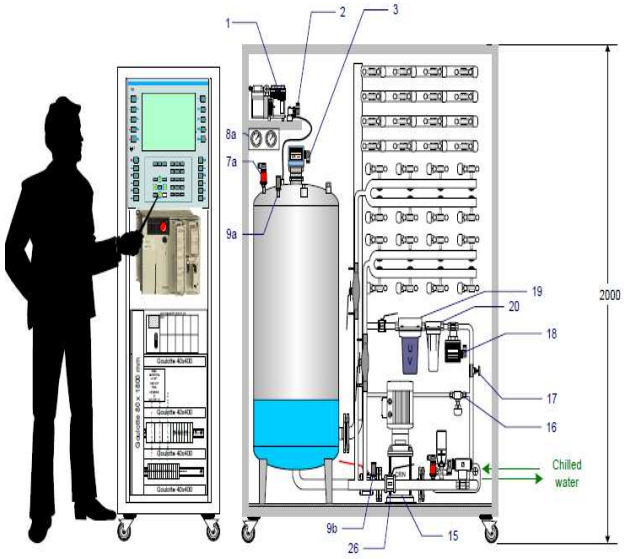
- Three lines will be conducted: height mini, medium and maximum

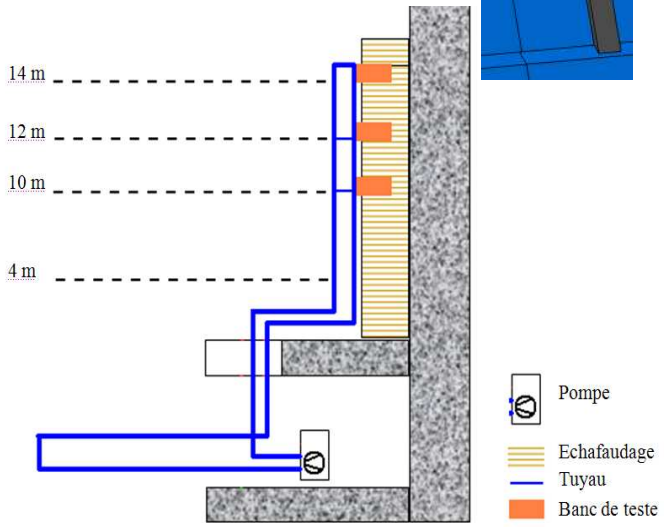
- Work on reliable connection between the cooling system and the water heat exchanger



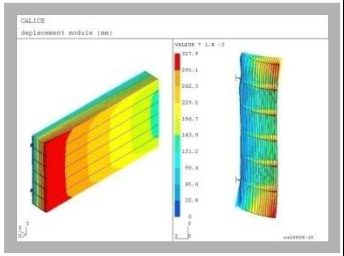
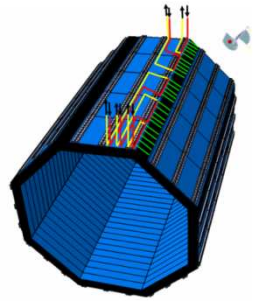
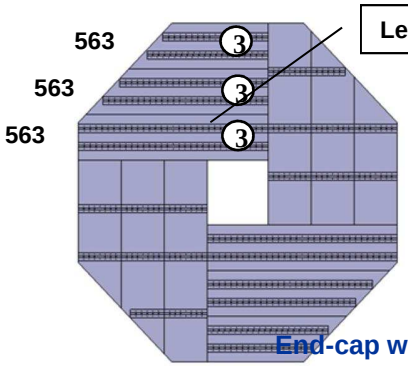
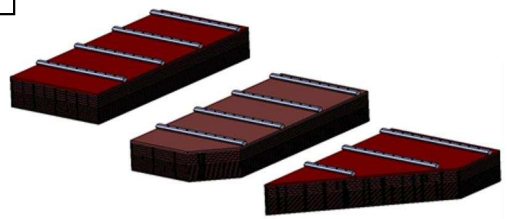
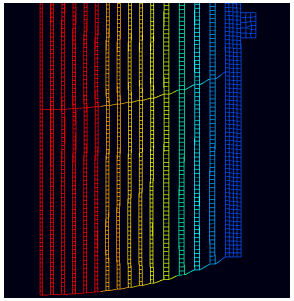
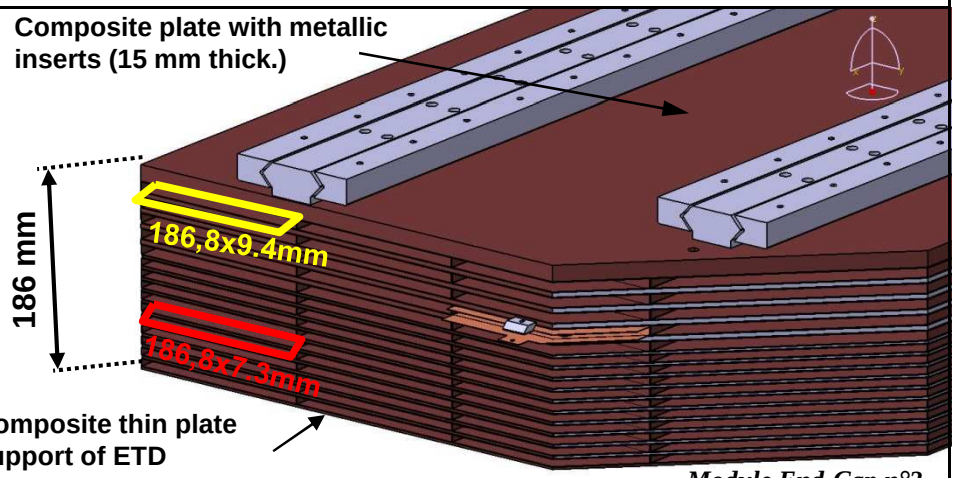




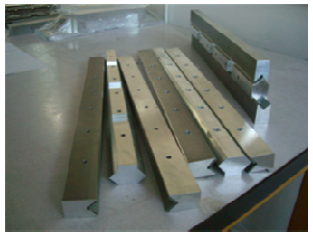
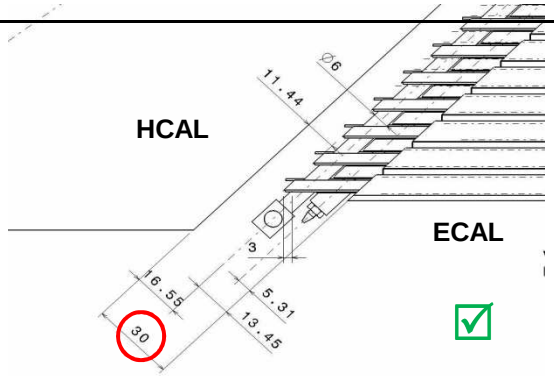
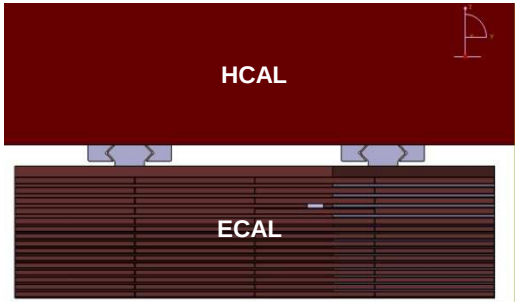
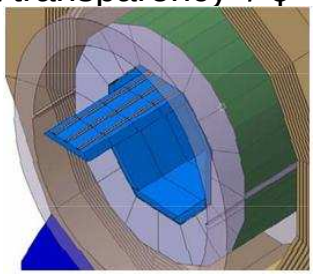
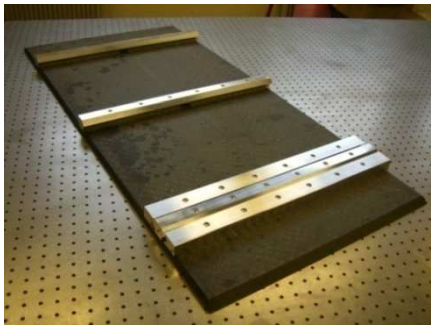
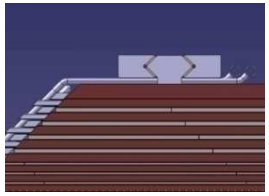
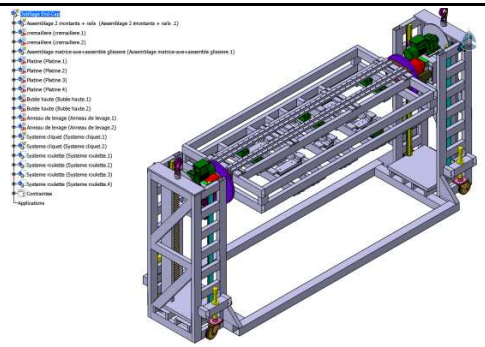
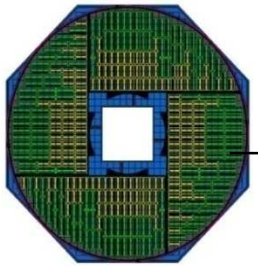
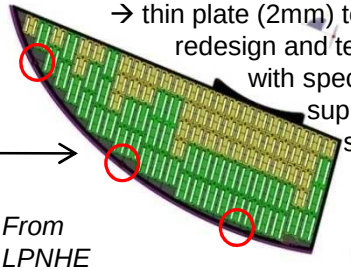




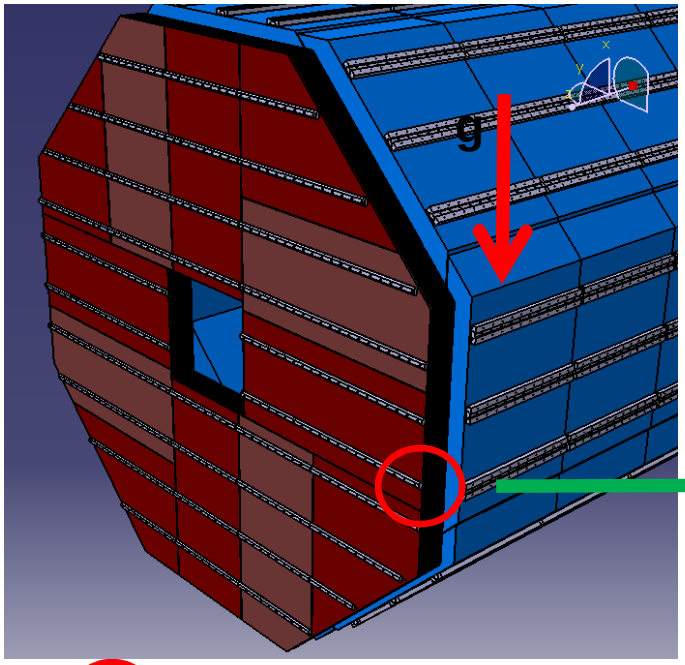
Structure of End-Caps

	Barrel: 40 modules	End-Caps: 4 x 3 modules each
Modular structure (2 orientations)  *Module End-Cap n°1*	 R_{barrel}=2028	  End-cap weight : ~ 17 T
Alveolar structure ***Configuration 90°*** **FEA / deformations** 	Alveolar W-Carbon HR structure with: - Fastening system •Rails •Thick plate/ inserts (HCAL side) •Thin plate / inserts ? (ETD side) - Cooling system - Depending on the design: •From 3 to 5 columns of15 alveoli - Geometry: •Bevel impacting electronics •Free ways for services ≠ / design	**Composite plate with metallic inserts (15 mm thick.)**  **Composite thin plate support of ETD** *Module End-Cap n°2*
Advantages	-- Construction process of sets ~ 540 cells similar to barrel BUT with long length - No crack / physics	
Drawbacks	-- Several variations of carbon parts (thick plates with orientation of inserts), mandatory ! -- Fastening system to be reinforced (modules behaviour) -- Alveoli width different / barrel → different slabs (wafers / DIF…) - Construction of alveoli up to 2.5 m (to be validated) & Cooling along 2,5m slab (*back end T° of slabs)*	

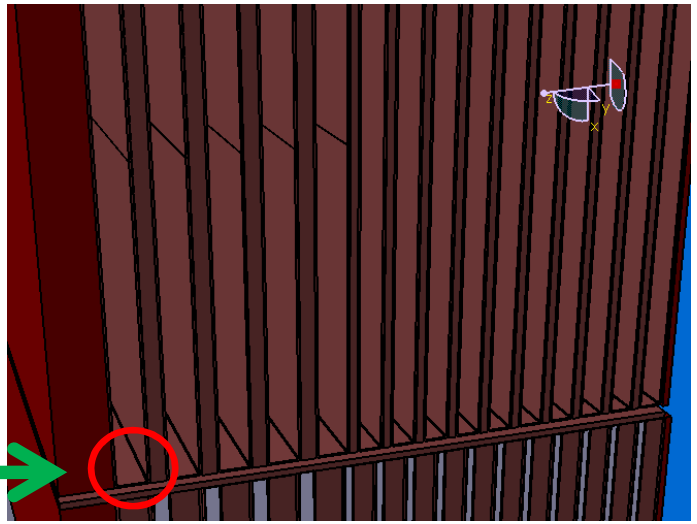
INTEGRATION of End-Cap

Space available	Barrel: 3 cm ☑	End-Cap: 1,5 cm ☒ Insufficient / fixing of cooling
Free space 	 ☑	 15 mm ☒
Rigidity of the supporting structure & transparency / φ 	 Carbone HR plate 15 mm thick, with metallic inserts *Design to be continued: validation of "double rows" rails*	   or system rails (structural composite)
Conception of specific handling tools		**ETD Support**  *From LPNHE*  Fastening locations / ECAL → thin plate (2mm) to redesign and test with special supporting systems

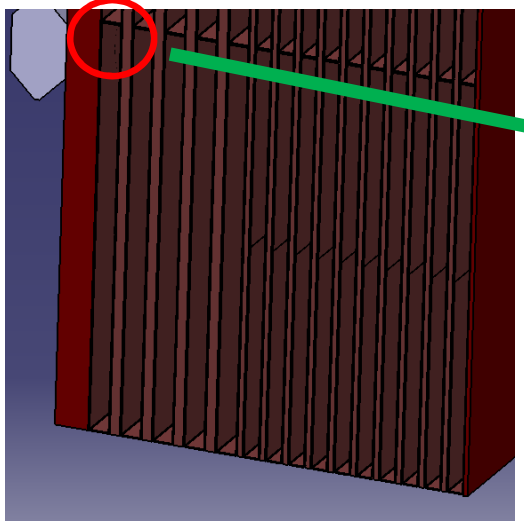
End Cap : global simulation



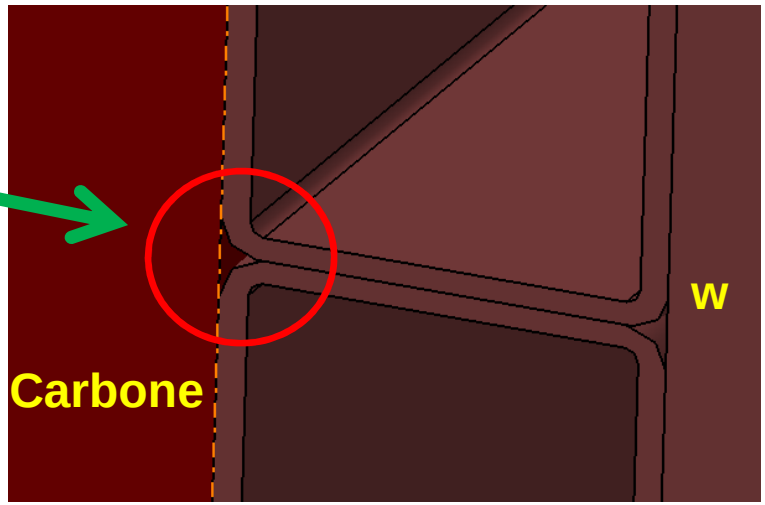
Clamp



Bending on lateral pannel

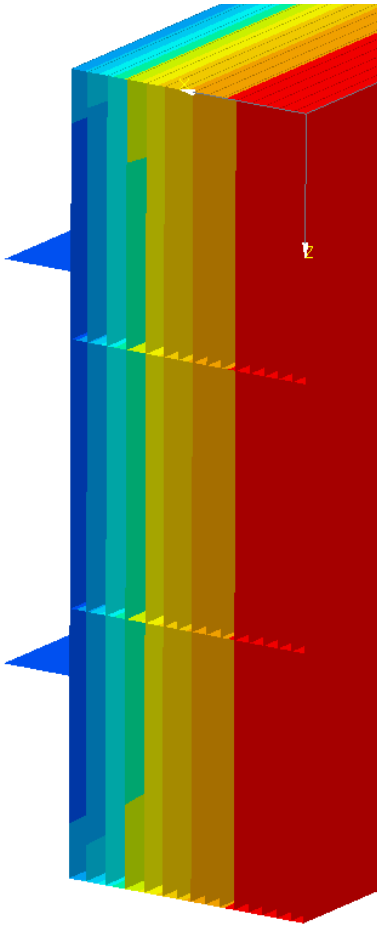


Detail



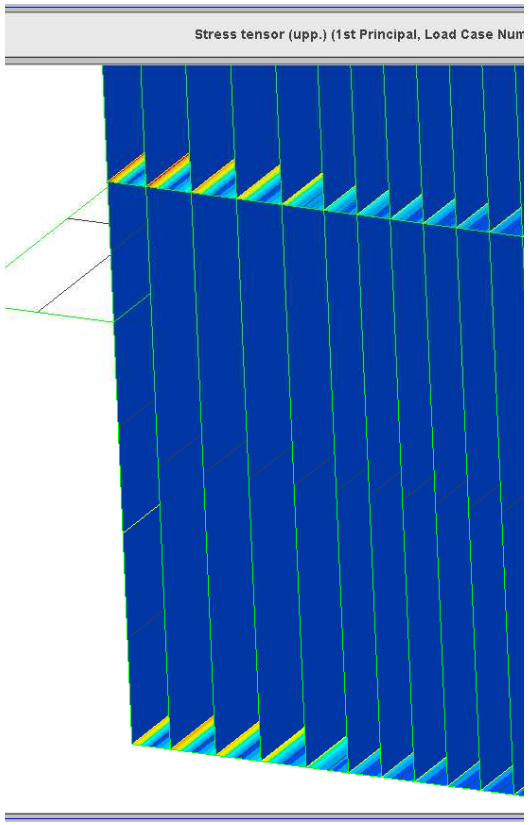
End Cap : global simulation

Displacement



Vertical displacement 1 mm

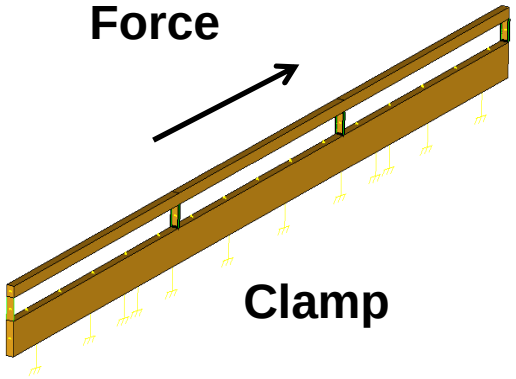
Stress

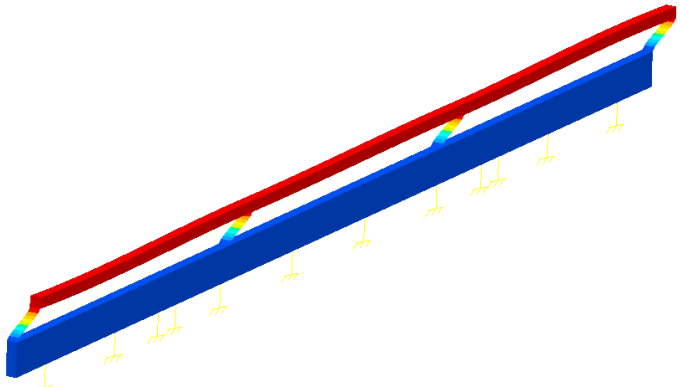


First principal stress: 106 MPa

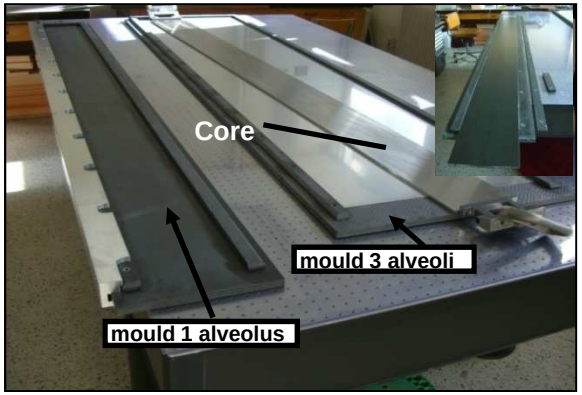
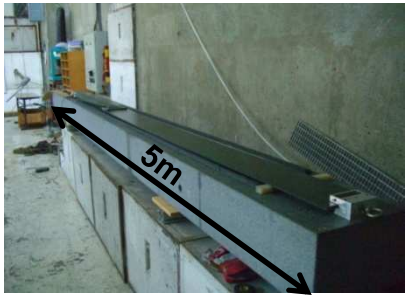
- Alveoli : 4 x 0.25 mm
- Max admissible stress 13 MPa (LLR traction test) => 106 MPa in simulation => PROBLEM

=> We plan real scale tests on representative structure





Structure of End-Caps : tests

	Moulding	Finished part
Alveoli moulding 2,5 m • **Cell thickness: 6.5 mm** • **Wall: 0.5 mm** • **Length : 2.492 m**		***First test negative: friction core/ carbon plies*** ***Alveolus 2,50m: extraction of core >> 6000 N !***  **Adaptation of extraction clamp**  **Extraction of alveolus**
Machining or moulding of rails	 **Mould HP (80T) for heating press, for Carbone HR male rails**	  **Footprints in the rails 25 mm wide minimum, to enable the cooling system and cables to pass trough (1 per column)**
Comments Next : 2011 and beyond	***Specific heavy tools:*** • ***Handling cores & moulds (cumbersome)*** • ***Moulds*** ***Conception to be continued:*** • ***Specifications of assembly mould M2*** • ***Realization: mould HP for external thin rails*** • ***Modification of mould HP rail male: larger*** • ***Mechanical simulations / design End-Cap***	***Tests to be continued:*** • ***Extraction of core after moulding: on aluminium core*** • ***Validation of a 2,5 m layer*** •***Thinner Carbon plate (13mm) with inserts modified*** • ***bending on lateral pannel*** •***Characterization, tests & optimization: elements & composite rails (bending on lateral pannel)*** •***Alternative for external composite walls of modules: filament winding***