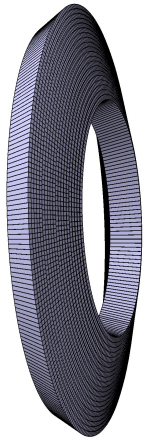
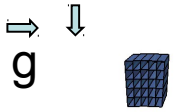
FEM MODULE LYSO

This is the static linear analysis of SuperB forward calorimeter module. The Modulus have a geometry distribution over four rings 360° total angle, each ring has variable number of modulus. In this analysis the module is simulated in three critical position 0°, -+90°, and 180°.





0° position

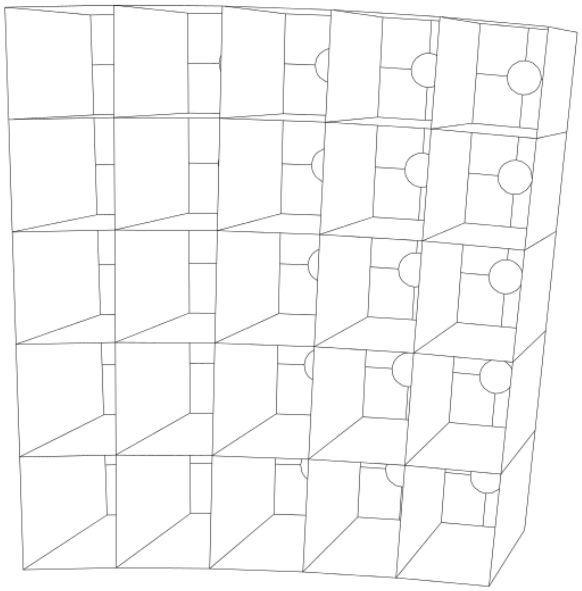
-90° position

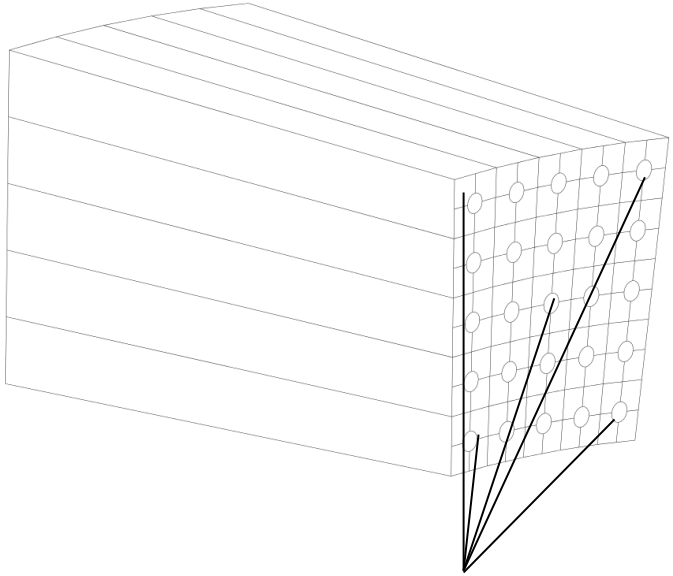
90° position

180° position

Geometry

Module based on M.L. design has 25 box cells whose sides are thin walls built in composite material and the bottom plate (front fwd) is CFRP with a central hole. Five of these holes are used to fixing the module on the forward mechanical base structure

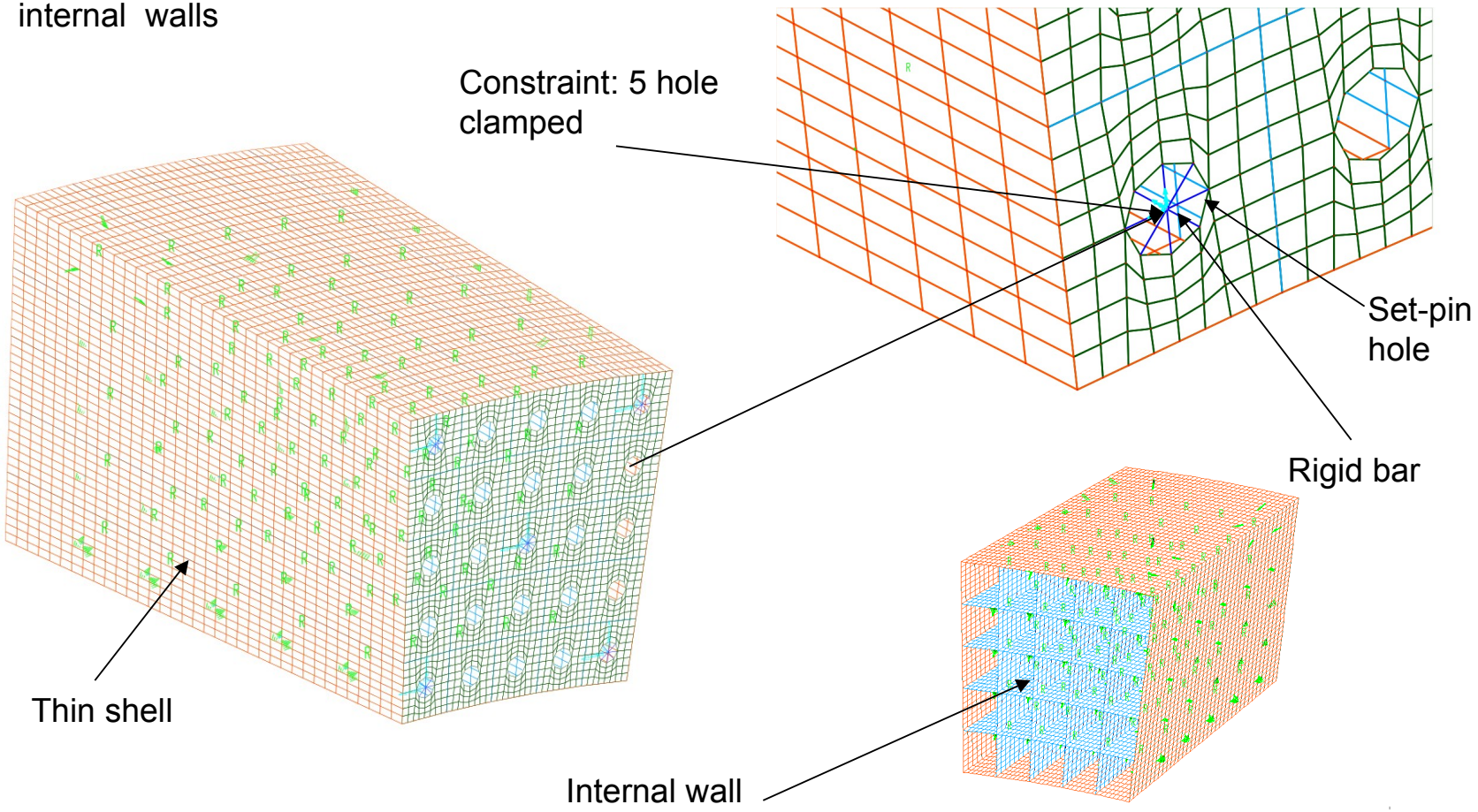




Set-pins holes

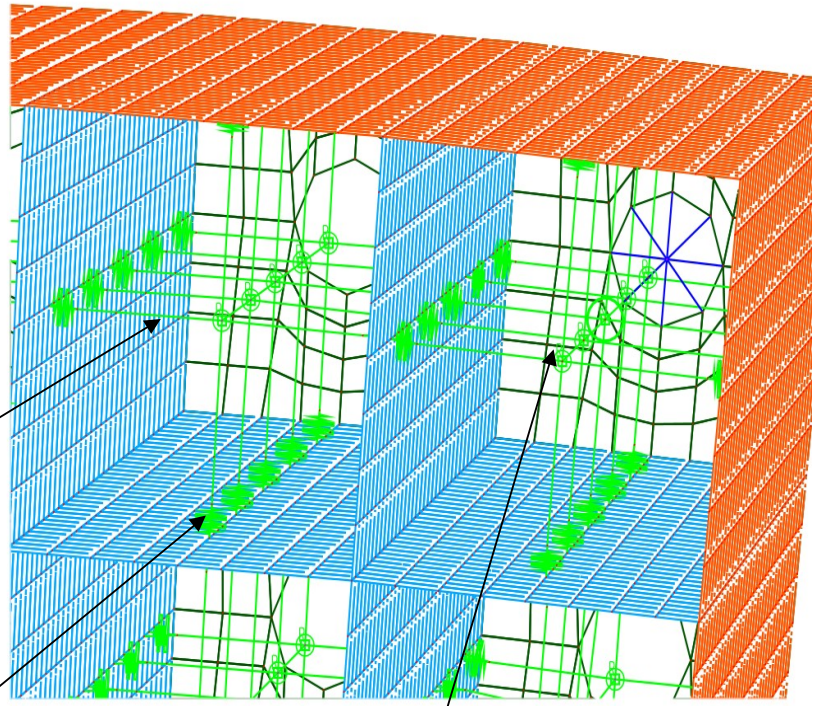
Boundary condiction / mesh

Thin shell elements on external and internal walls



Load Distribution

The load is the weigth of crystals (total weigth per module 25 Kg) and each one has mass of about 1 Kg. For this purpose to simulate it a "rigid bar" with 5 nodes was used along the centre alveolar cell, and a “lumped mass” 1/5 of crystal weight is positioned in each of this nodes. This nodes are then connected with some nodes near alveolar walls with rigid bar and from these latter connected to the alveolar walls nodes with "gap and spring" elements



Materials

The material used for the fem analysis are laminae of 0.1mm thick. For external wall the orientation is one 0° and the other one at 90°, the total ply thickness is 0.2mm, while internal walls have a double adjacent walls of 2 cells and ply thickness is 0.4mm. For the bottom plate was used Aluminium of 6mm equivalent to CFRP material

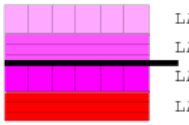
CF lamina and Al property

Property	Unit	MTM49-3	Al
0° Tensile Strength	GPa	155	
In-Plane Shear Modulus	GPa	3.1	
Yung modulus	GPa		73

Thickness	Angle	Ply	Material
0.0001	+90	2	LAMINA_1
0.0001	+0	1	LAMINA_1

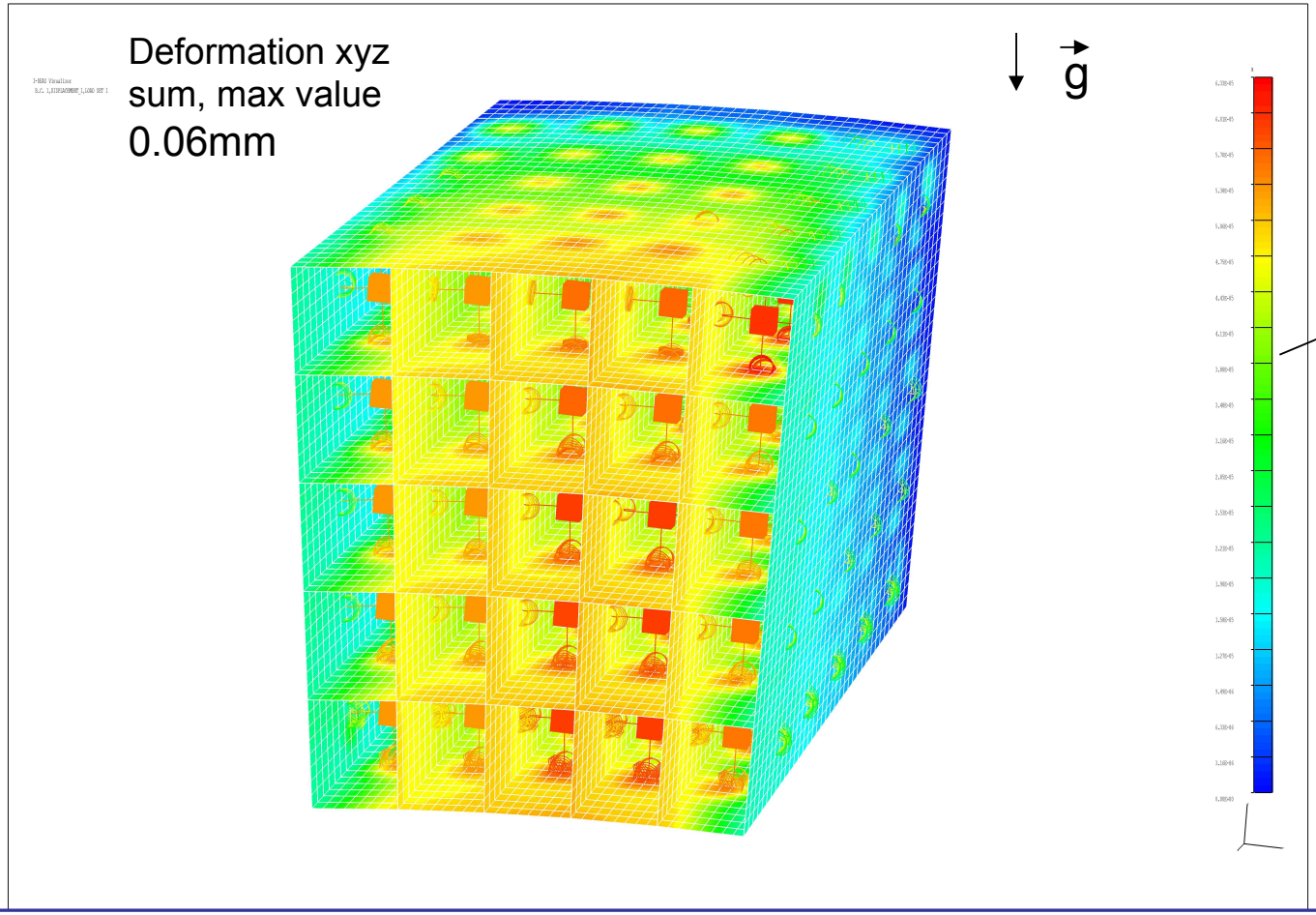
Number of plies: 2
Total thickness: 0.0002 m

Thickness	Angle	Ply	Material
0.0001	+90	4	LAMINA_1
0.0001	+0	3	LAMINA_1
0.0001	+90	2	LAMINA_1
0.0001	+0	1	LAMINA_1

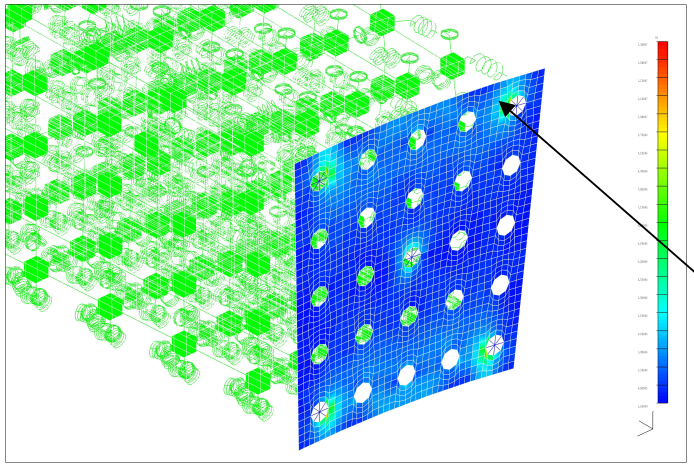


Number of plies: 4
Total thickness: 0.0004 m

Case 0° position

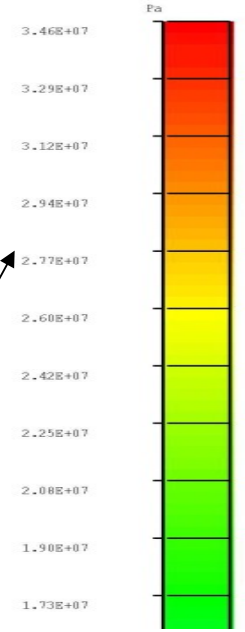


Case 0° position

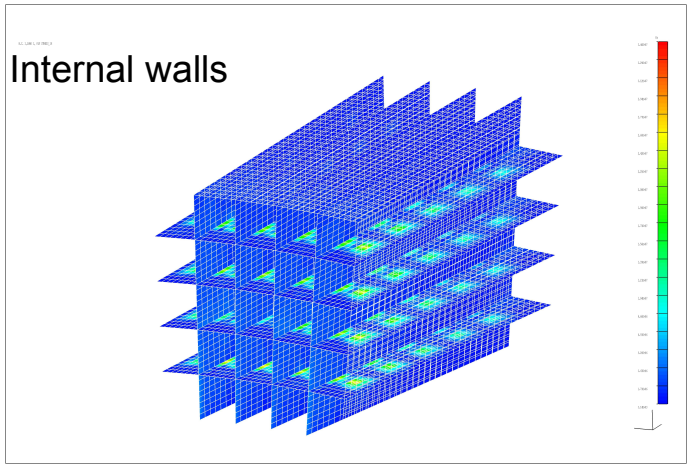


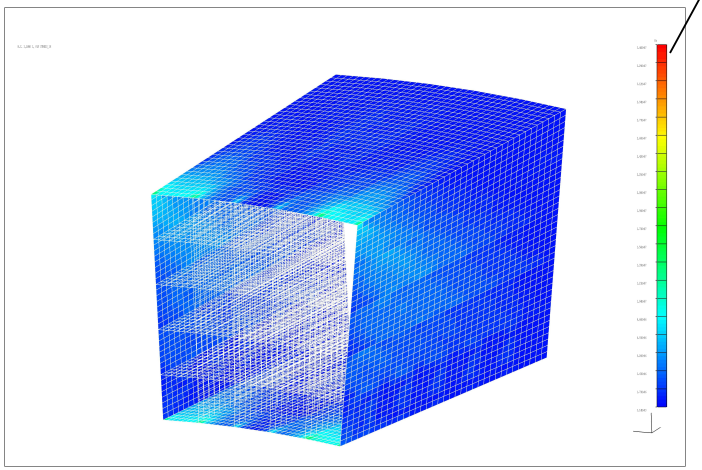
The maximum value of ply stress is as shown 35 MPa on layer 2

Front plate: an isotropic Aluminium of 6mm equivalente to CFRP was used max Von Mises stress value is 13 MPa



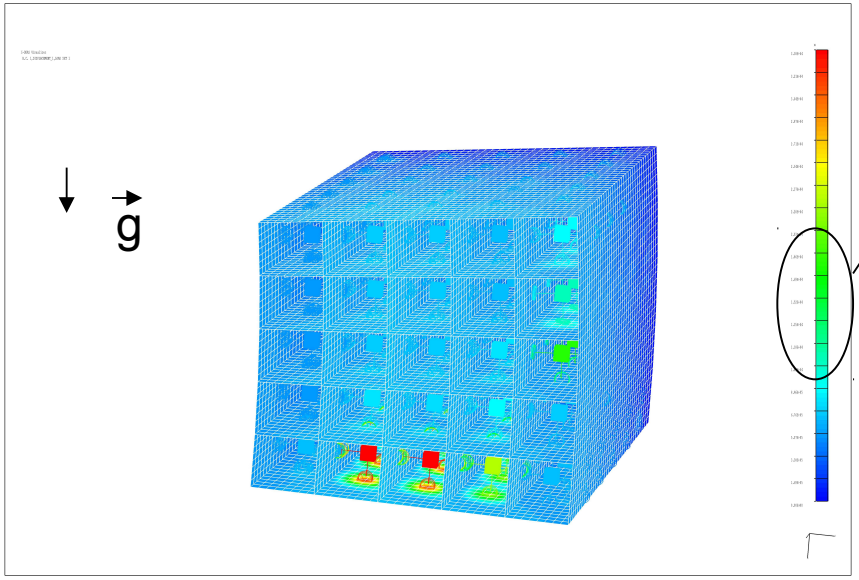
Internal walls

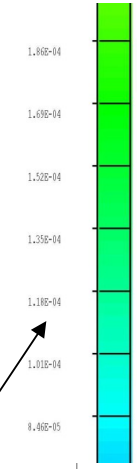




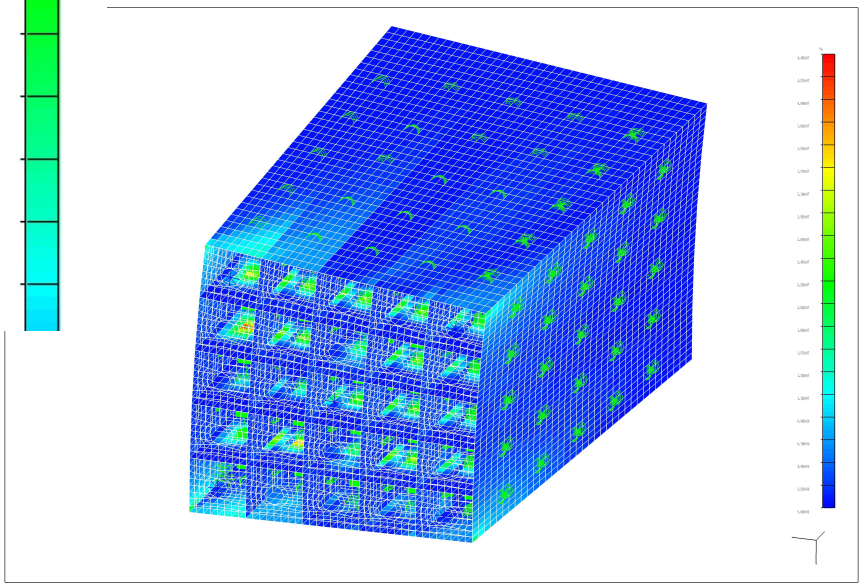
Case 90° position

The value of deformation is about 0.1mm not taking into account the local effects due to the spring element connected to the wall





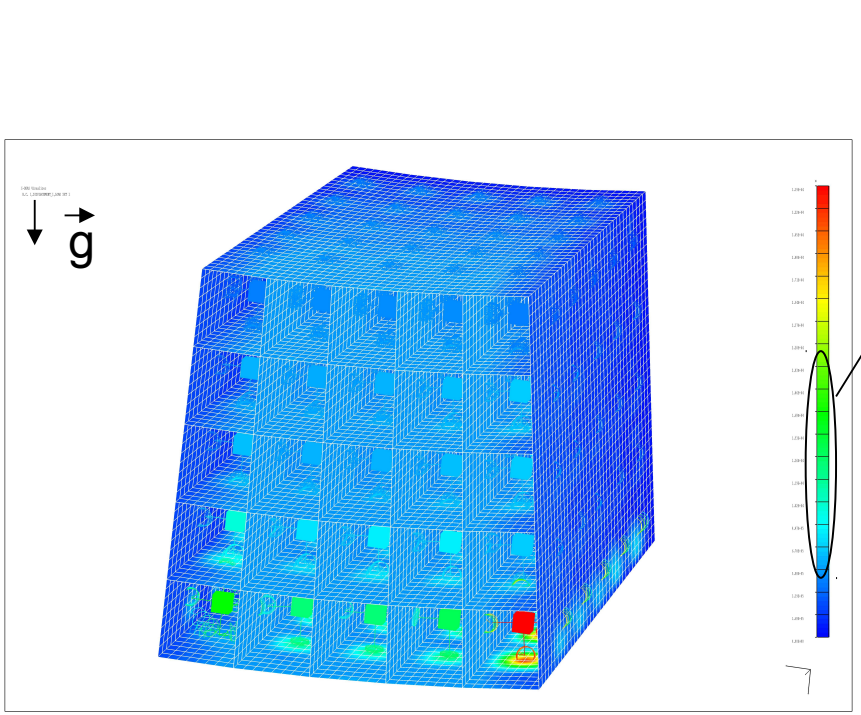
Max ply stress is 10 MPa

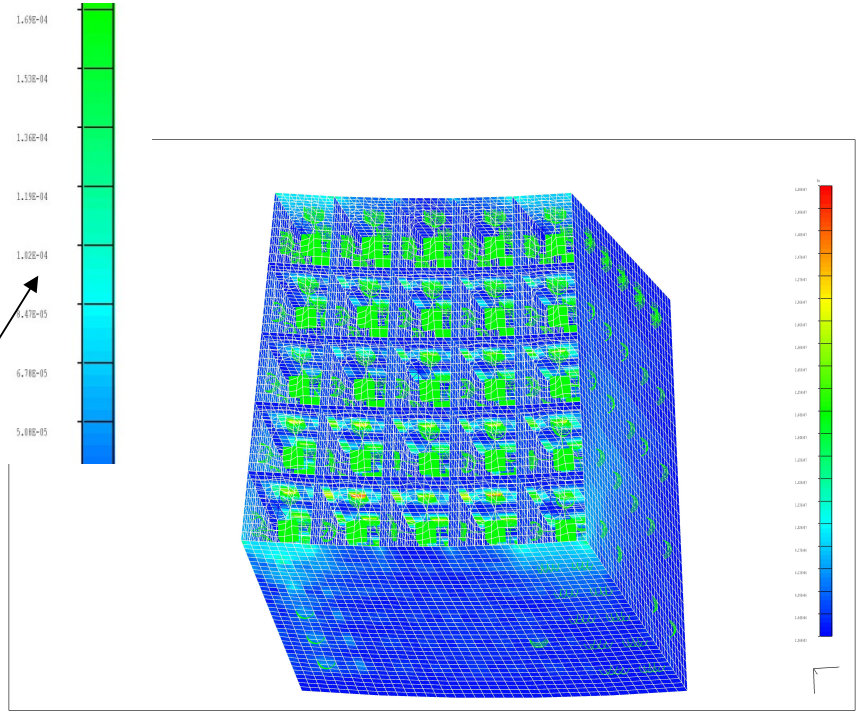


Case 180° position

In the case 180° position the maximum displacement value is about 0.1mm.
The maximum stress on the front plate is near the setpins hole where the module is constrained the value is 13 MPa

Max Ply stress value is about 30 MPa





Results

Position	*Displacement (mm)*
Case 0°	0.06
Case 90°	0.1
Case 180°	0.1

Case 0°	Ply stress (MPa)	Index Failure
xx	35	1/48
yy	2.6	1/10
xy	1.4	1/16

Case 90°	Ply stress (MPa)	Index Failure
xx	5	1/342
yy	10	½,6
xy	1.7	1/13

Case 180°	Ply stress (MPa)	Index Failure
xx	30	1/57
yy	7	1/4
xy	1.5	1/15

In this fea analysis the theoretical model seems works well and the failure index is < 1

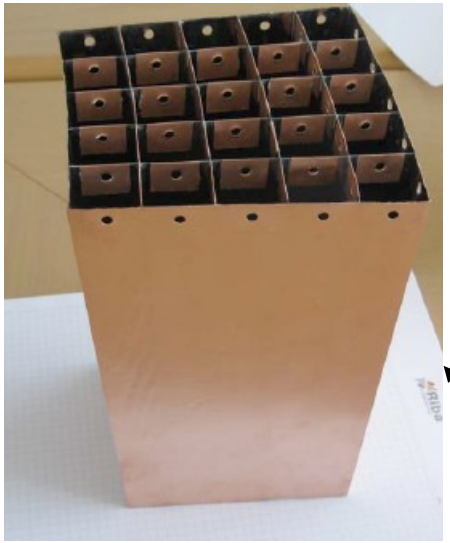
Index failure = $\frac{\sigma_1}{X_{T/c}}$, $\frac{\sigma_2}{Y_{T/c}}$, $\frac{\tau_{1,2}}{S}$

CF lamina material property:

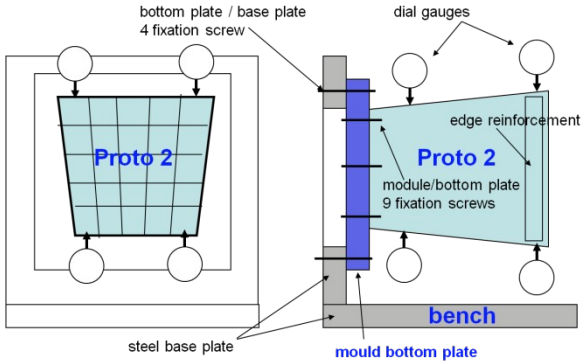
Allowable stress in tension X-direction	1.7e+03 (MPa)
Allowable stress in tension Y-direction	2.6e+01 (MPa)
Allowable in-plane shear stress XY	2.3e+01 (MPa)

Conclusion

The FEA model and results need to be validate with PROTO 2 test



Proto 2



alveolar module test setup