

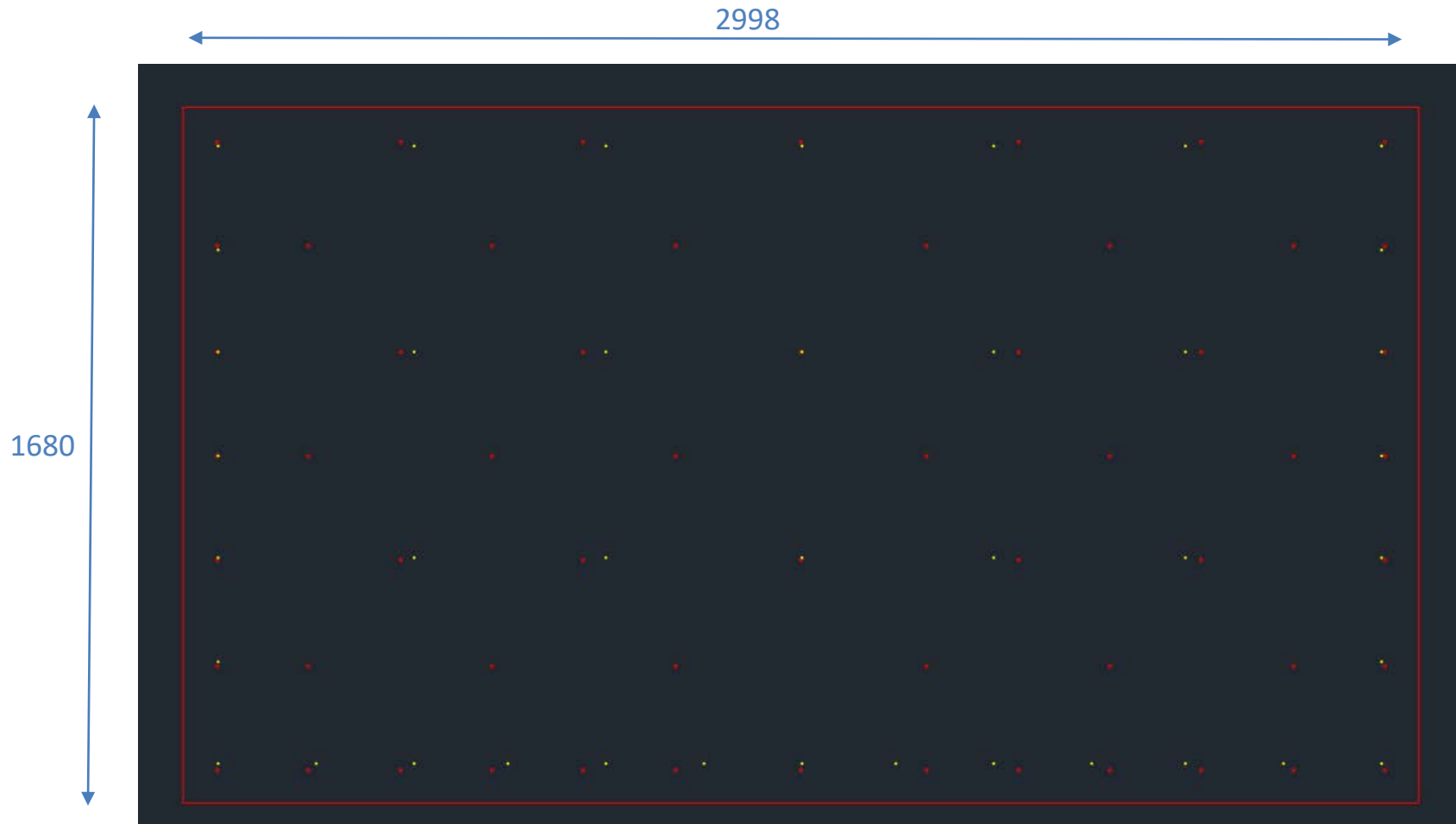
# Anodes simulations

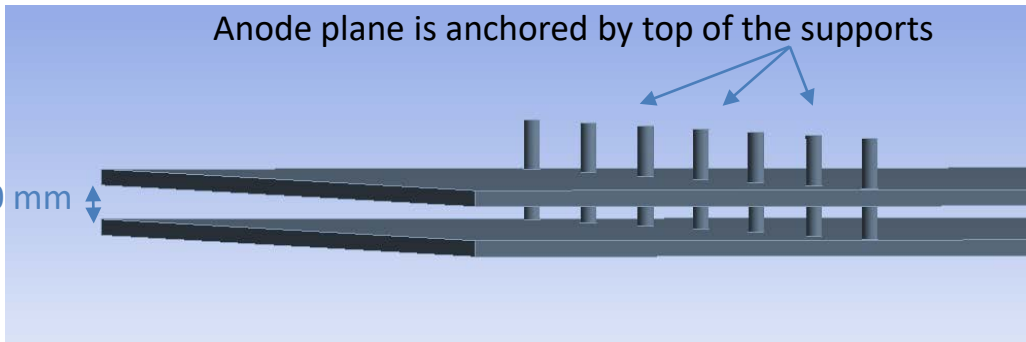
- *DUNE Vertical Drift* -

Two anode supports configs proposed by Bo : <https://edms.cern.ch/document/2479999/1>

Config 1 : 58 supporting points

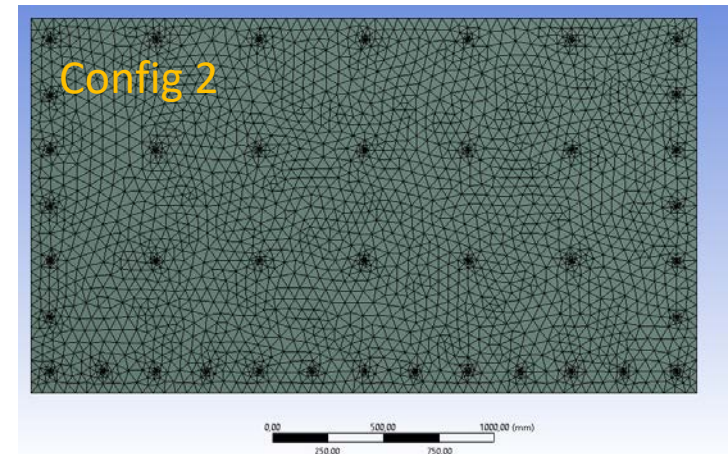
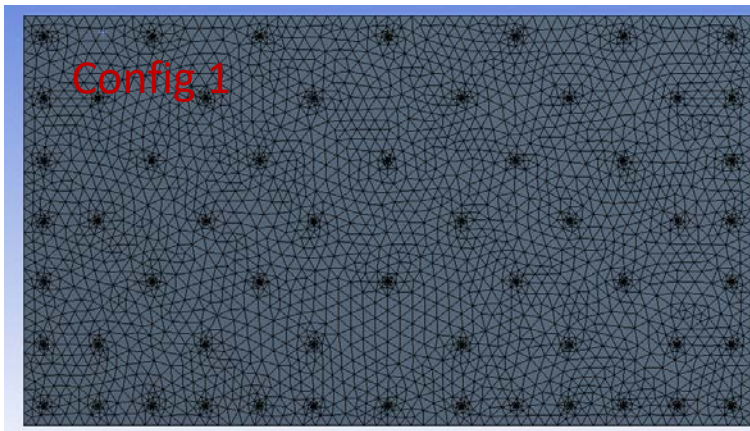
Config 2 : 40 supporting points (slightly asymmetric / Off-centered)



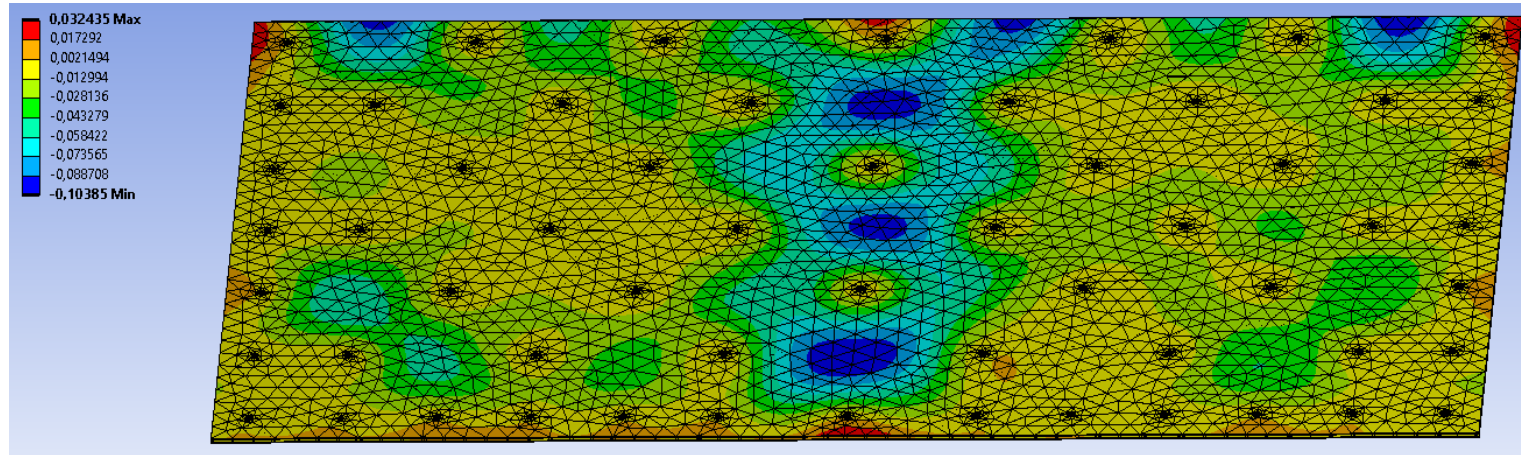


The only load is the gravity (in the air)

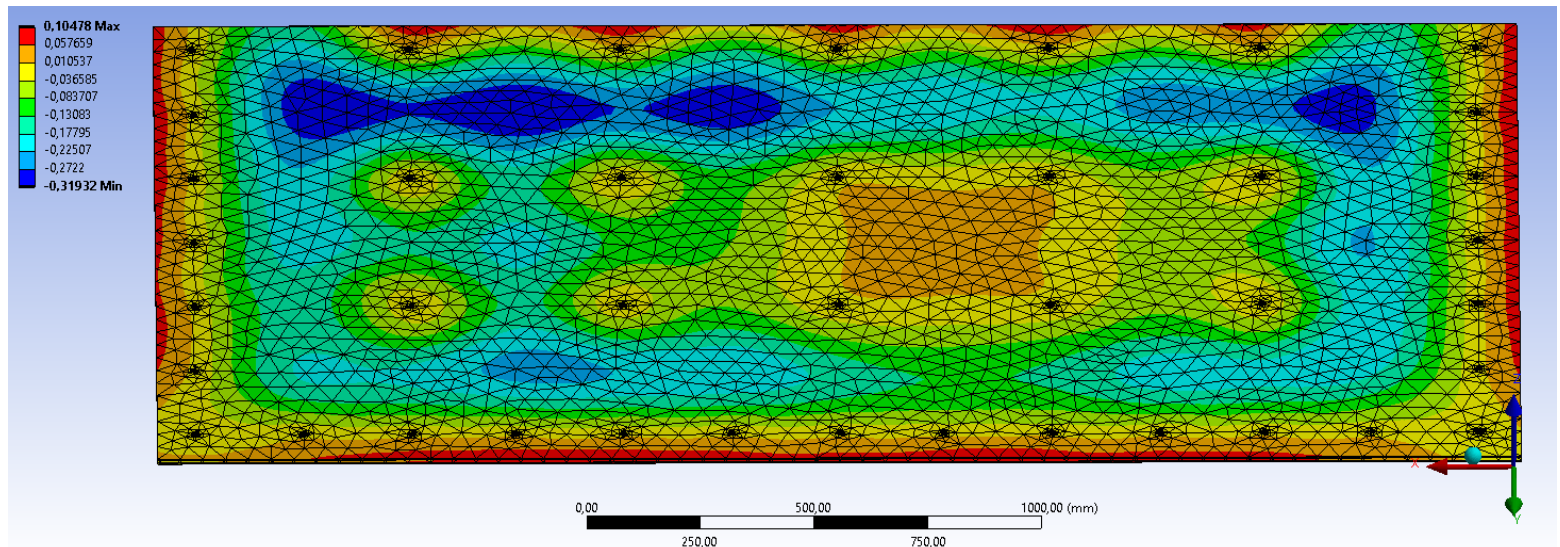
Deformations in liquid should be smaller



## Config 1

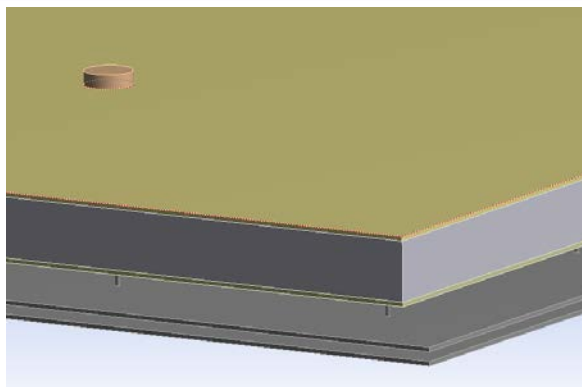
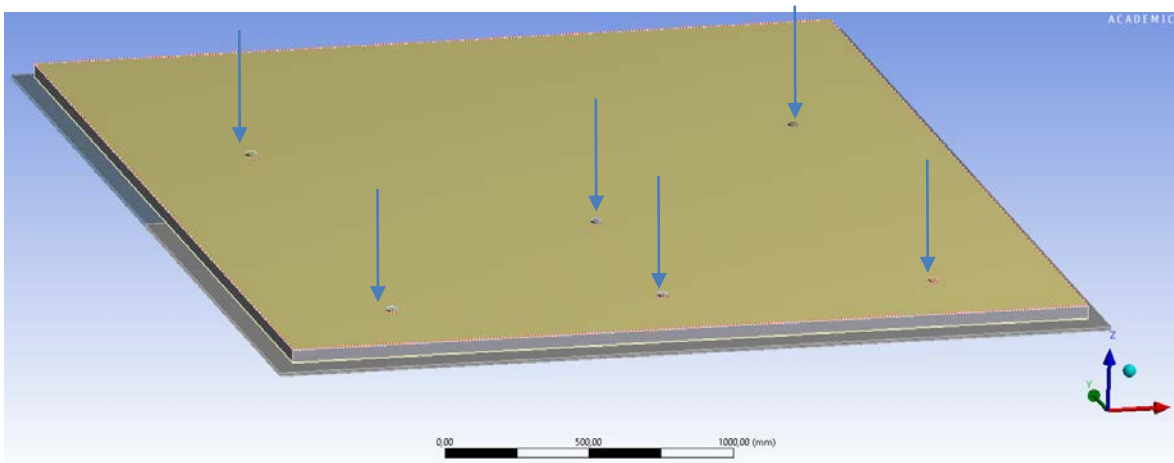
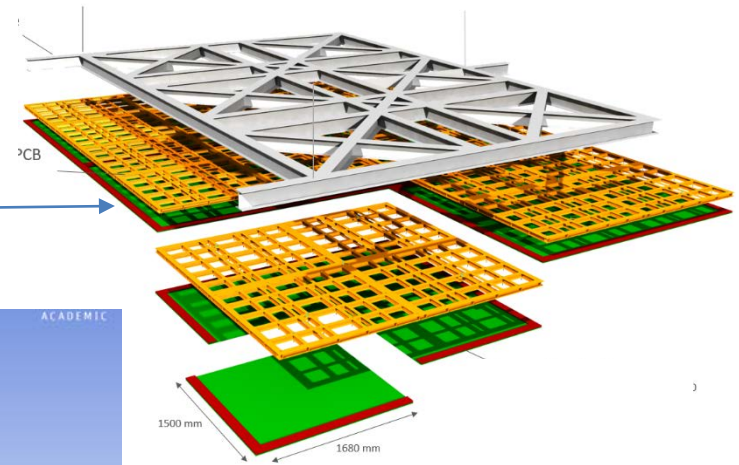


## Config 2



Composite support frame is anchored by six points, under gravity only

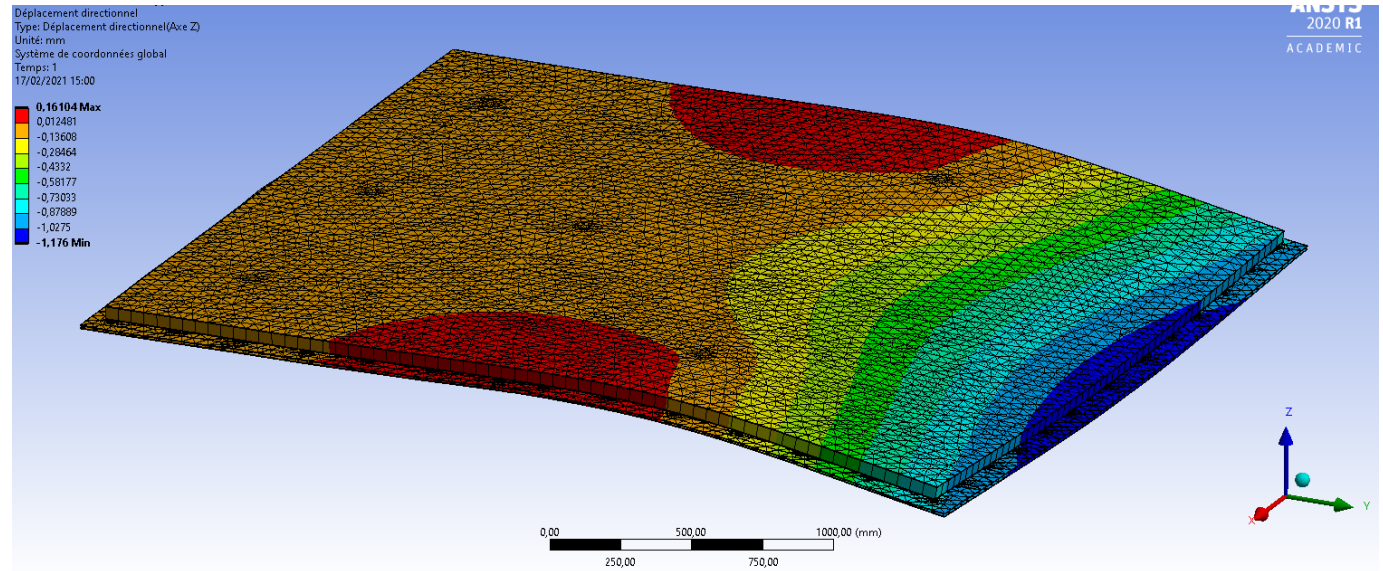
Corresponding to the config of a plane in the center of the Super-Structure



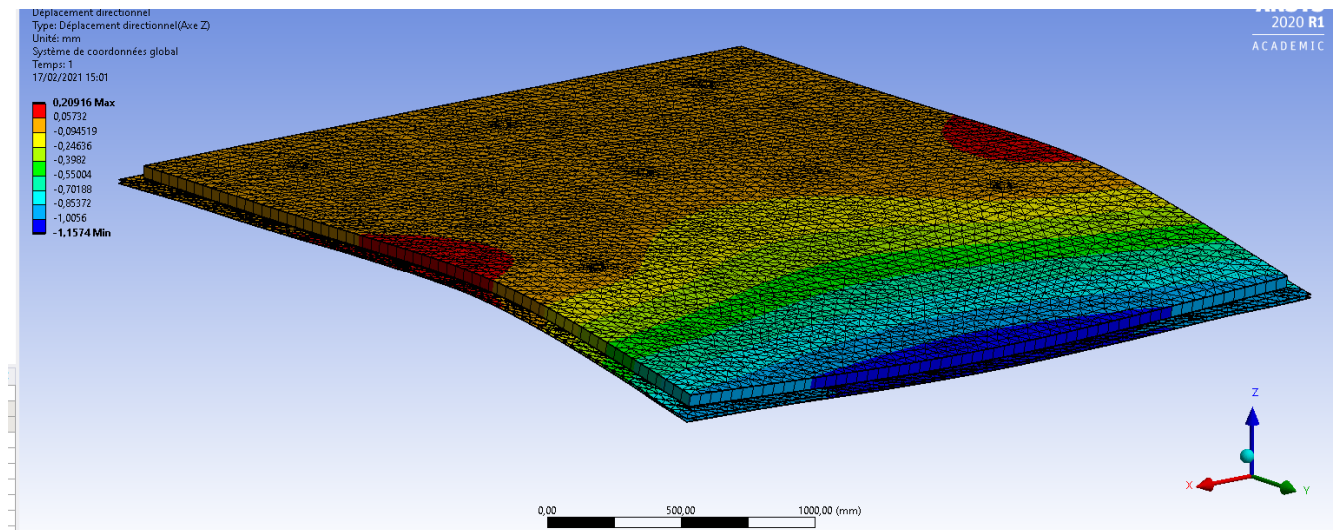
← Aluminium / G10 honeycomb panel (equivalent material)

← Anodes (equivalent material)

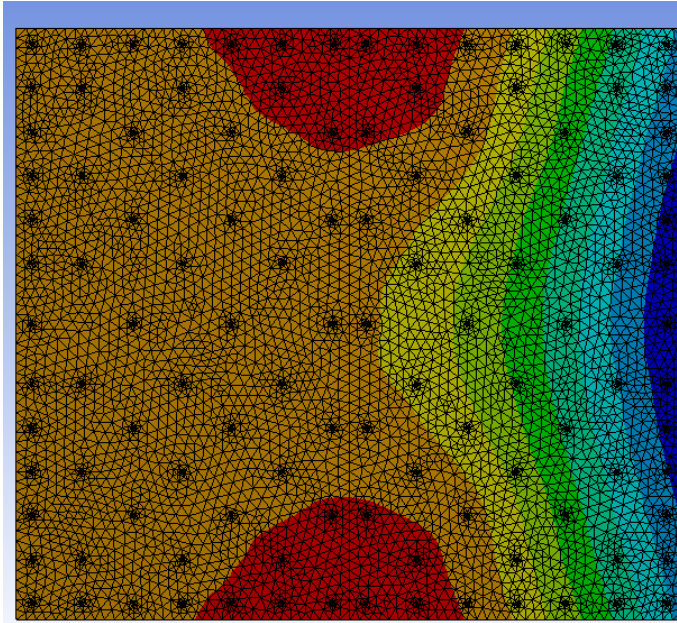
## Config 1



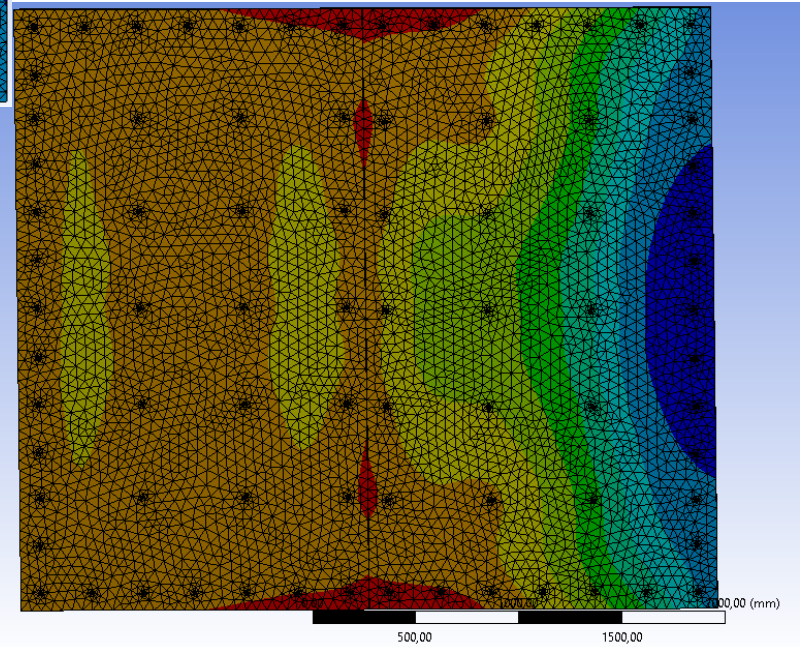
## Config 2



Config 1  
Less than 1,4mm

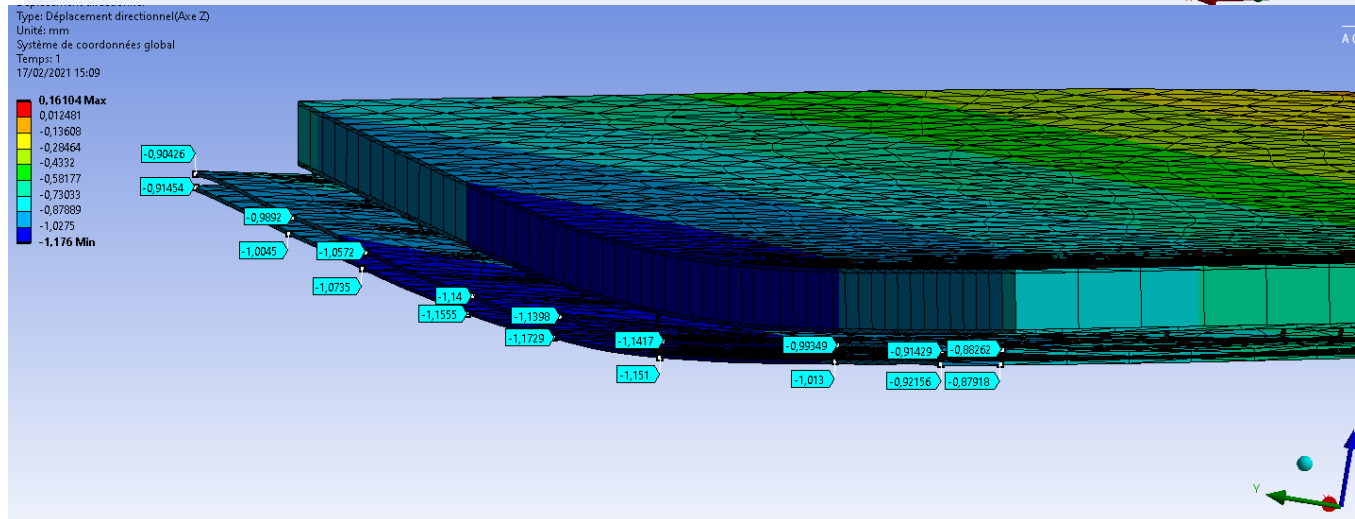
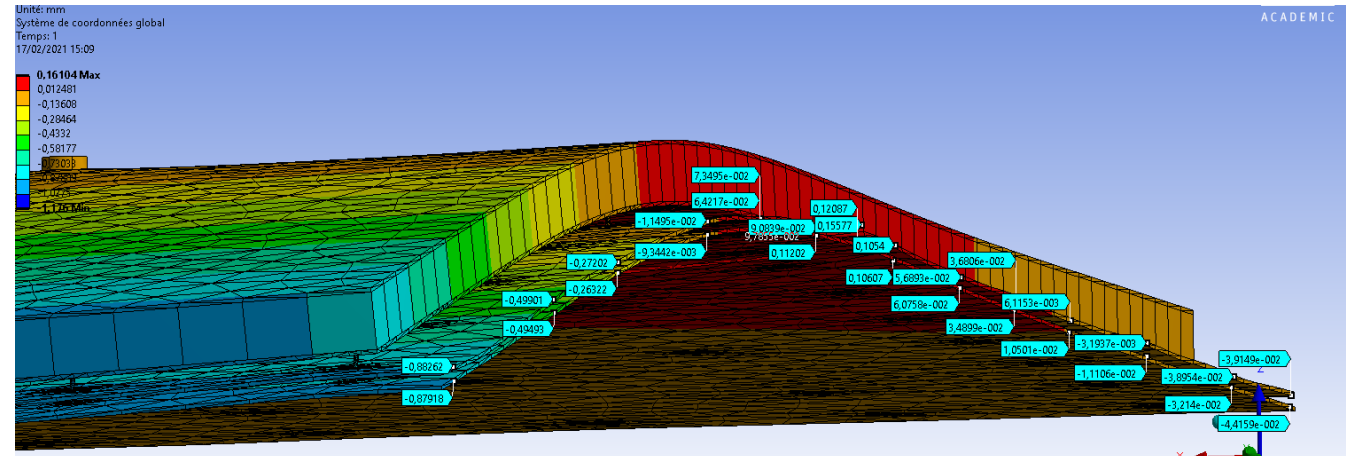


Config 2 : less than 1,4 mm



Relative deformations between anodes planes are around 10 – 30  $\mu\text{m}$

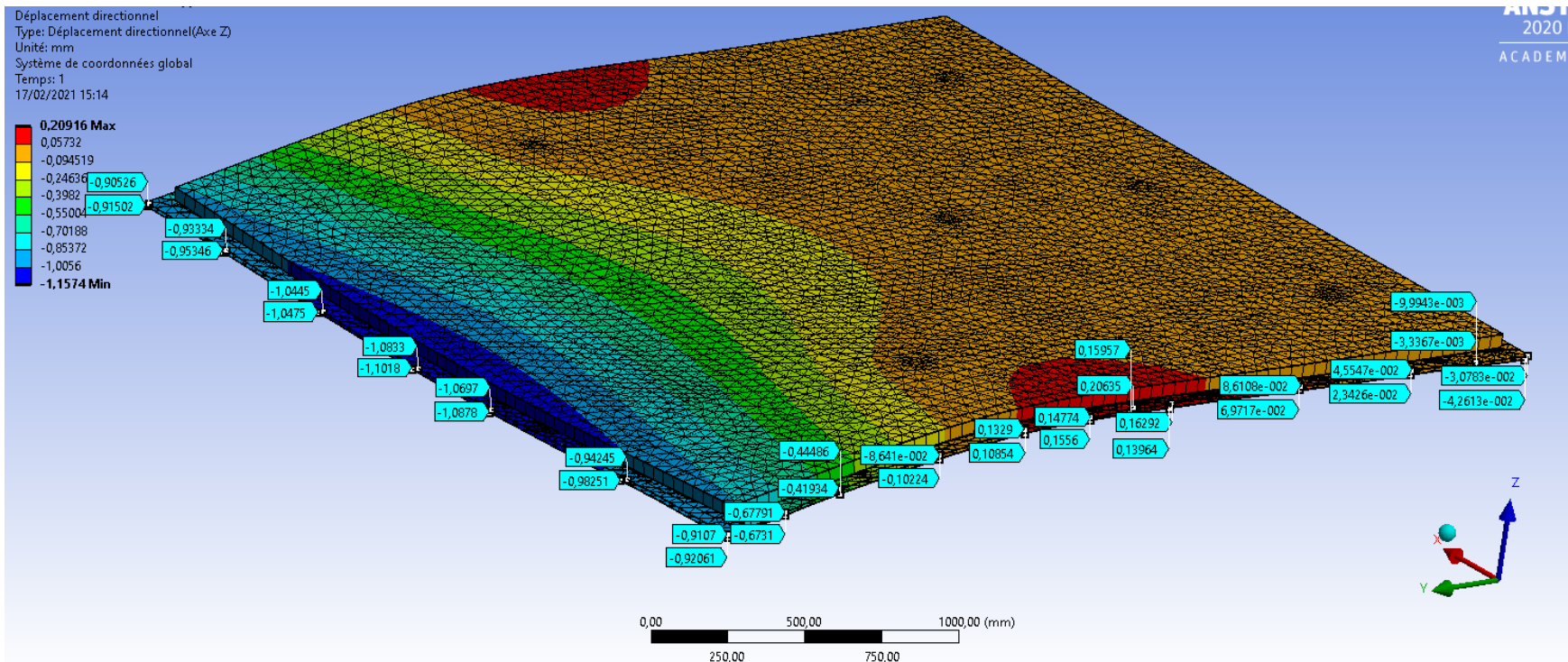
Config 1





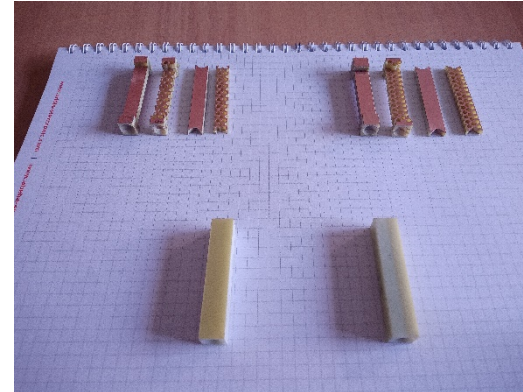
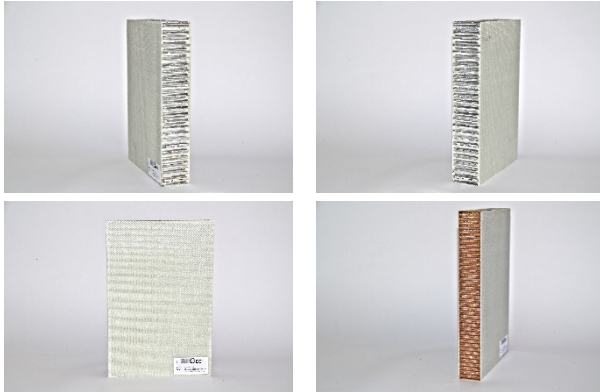
Relative deformations between anodes planes are around 10 – 30  $\mu\text{m}$

## Config 2



- Deformation results are similar for both support configurations
- Intrinsic Anodes deformation are small ( $\sim 0,1 - 0,4$  mm) compared to global CRP deformations ( $\sim 1,4$ mm)
- Relative deformation between anodes planes are small ( $\sim 10$  to  $30$   $\mu\text{m}$ ) and should have limited impact on pin connections

- Thermal load has to be added to the model (including tests results from Cryolab)
  - Tests on honeycomb panels and anode material will start this week



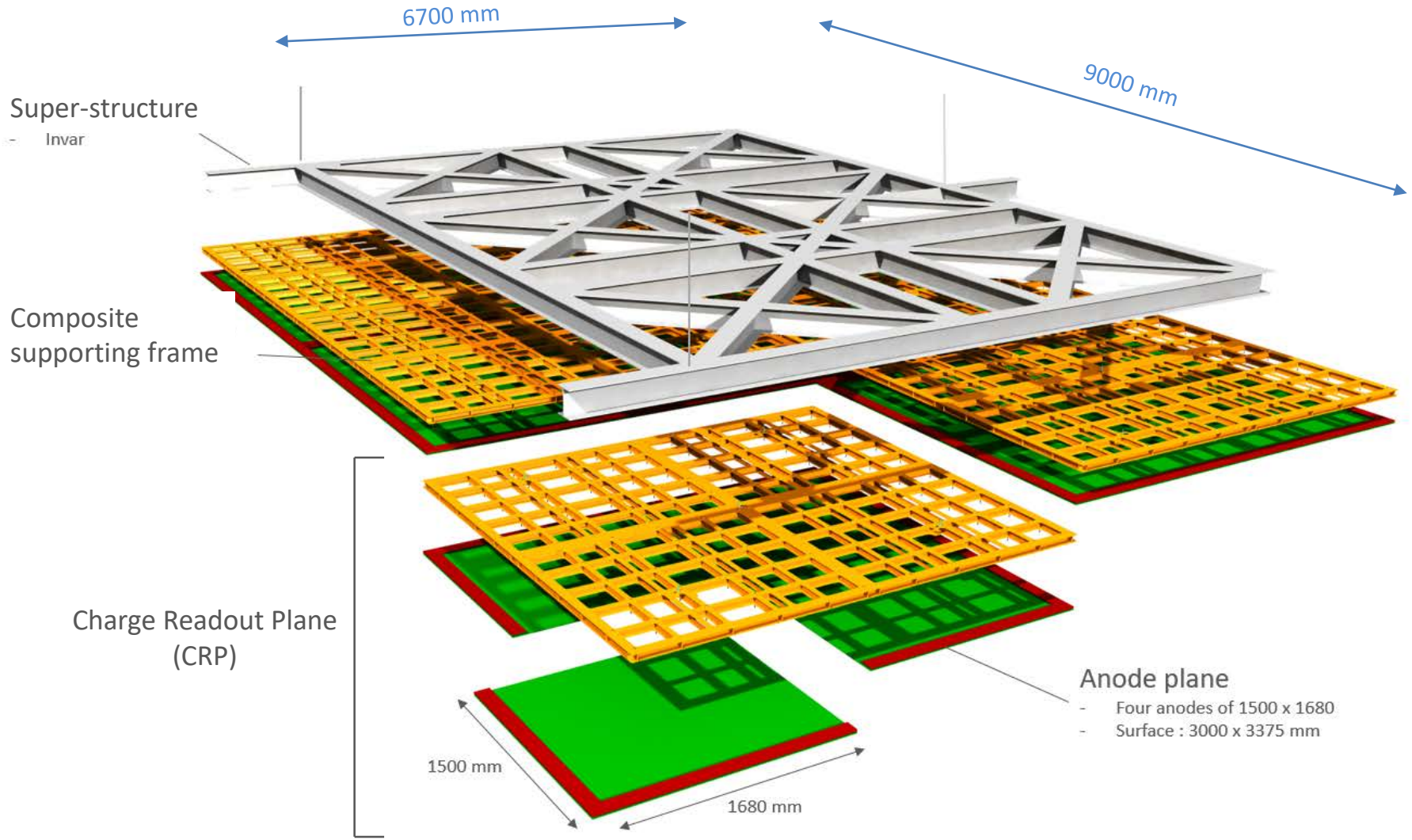
- Adapter boards and additional masses have to be included
- Global model of CRP with Super-Structure will be implemented including those models
- PEEK solutions for supporting screws are under investigation
  - Considering cryogenic conditions
  - When CRP has to be tilted or transported vertically

Resin Screw (PEEK/Hex S)



NBK  
PEEK is a  
chemical a  
and conce  
temperatu

# Backup



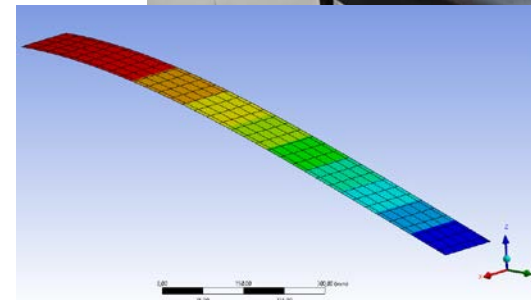
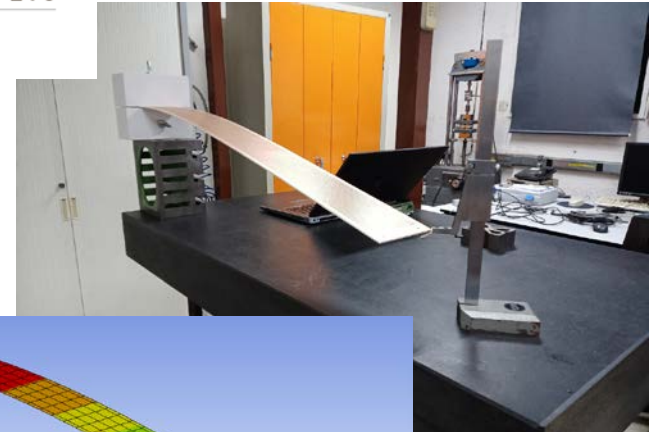
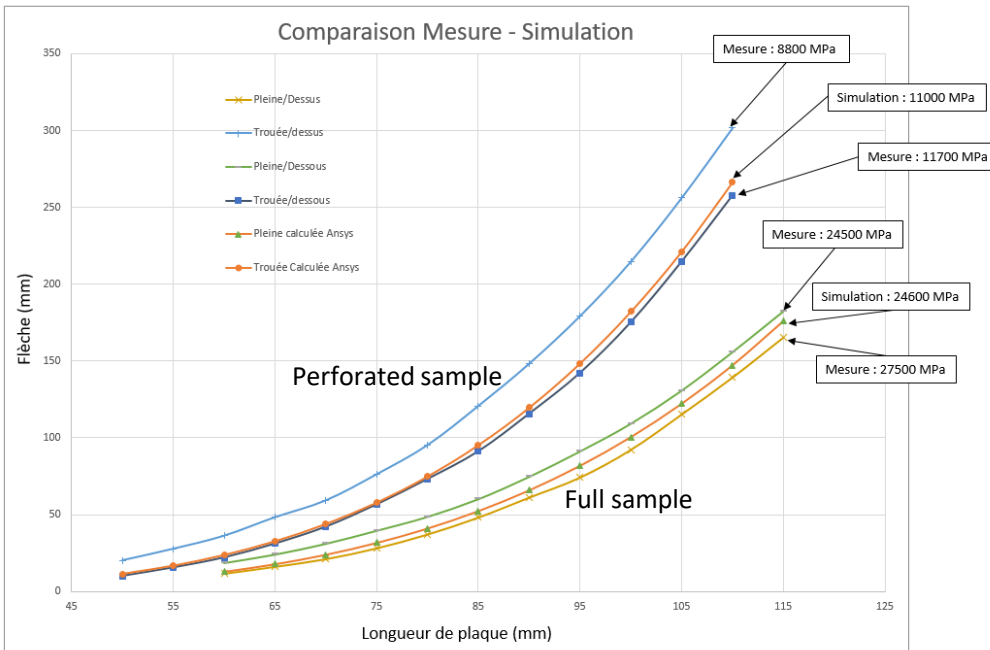
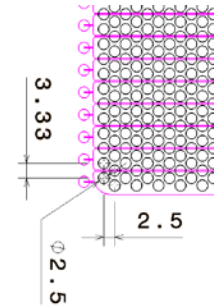
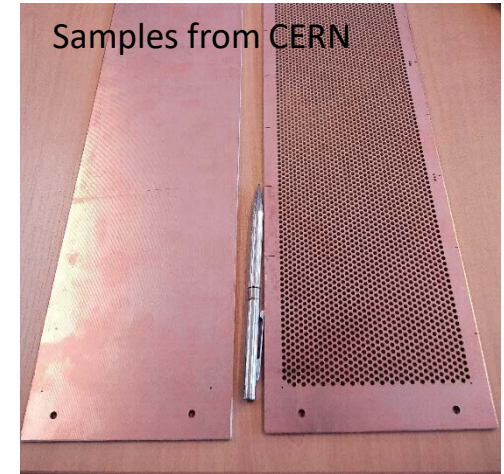
Full and drilled PCB : copper plated glass fiber - 3,2mm/2x35µm

Length variation / Deflection measurement

From measurements : Reference equivalent Young modulus for simulations :

**Full Plate : 24600 MPa** (24500-27500 MPa)

**Drilled Plate : 10000 MPa** (8800-11700 MPa)



Density Measurement / Calculation includes :  
 mass and external dimensions measurements  
 copper plating mass/thickness

Reference equivalent density for simulations:

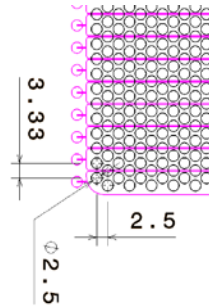
**Full Plate : 1845,5 kg/m<sup>3</sup>**

**Drilled Plate : 804 kg/m<sup>3</sup>**

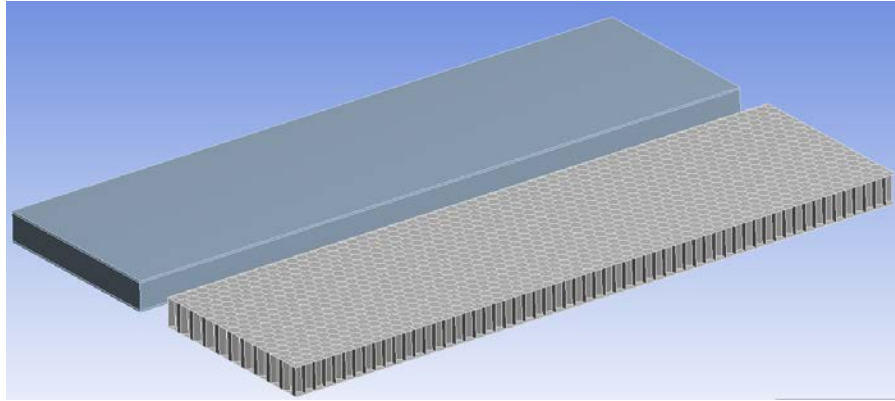
For information :

1 layer of 1,5 x 1,68m drilled/plated PCB : 6,5 kg

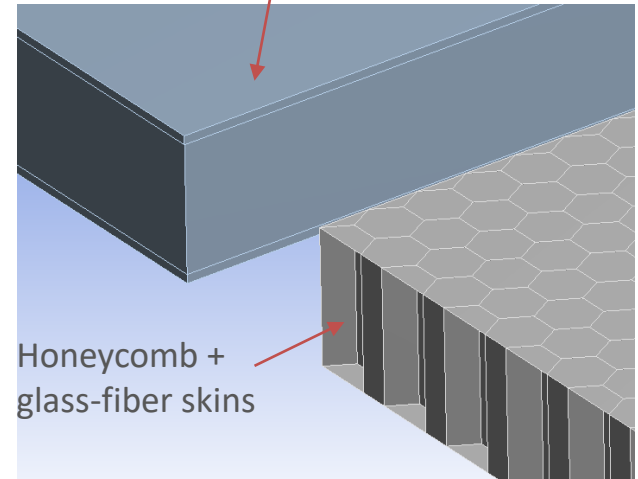
2 layers of 3 x 3,4m drilled/plated PCB : 52 kg



Masse mesurée de la plaque pleine	1,019 kg
Masse volumique PCB plein (calculée)	1688 kg/m <sup>3</sup>
Masse volumique Cuivre	8900 kg/m <sup>3</sup>
Longueur	1450 mm
Largeur	119 mm
Epaisseur PCB	3,13 mm
Longueur partie trouée	1400 mm
Largeur partie trouée	98 mm
Epaisseur de cuivre	0,035 mm
Diamètre des trous	2,5 mm
Espacement en largeur	5,00 mm
Espacement en longueur	1,666665 mm
Volume PCB d'une plaque pleine	0,000540082 m <sup>3</sup>
Masse PCB d'une plaque pleine	0,91 kg
Volume cuivre d'une plaque pleine	1,20785E-05 m <sup>3</sup>
Masse cuivre d'une plaque pleine	0,11 kg
Masse totale d'une plaque pleine	1,0190 kg
<b>Densité corrigée d'une plaque pleine plaquée cuivre</b>	<b>1845,479571 kg/m<sup>3</sup></b>
Nombre de trous dans la partie trouée	15624 trous
Volume de trous PCB	0,000240053 m <sup>3</sup>
Masse de trous PCB	0,41 kg
Volume de trous Cuivre	0,00000536859
Masse de trous Cuivre	0,0478 kg
Masse calculée de la plaque trouée échantillon	0,566 kg
Masse mesurée plaque trouée	0,574 kg
Ecart masse	-0,01 kg
Ecart pourcentage	-1,40 %
Nombre de trous dans la partie trouée	19836,02 trous
Volume de trous PCB	0,00 m <sup>3</sup>
Masse de trous PCB	0,51 kg
Volume de trous Cuivre	0,00
Masse de trous Cuivre	0,0607 kg
Masse calculée d'une plaque taille échantillon, trouée intégralement :	0,4440 kg
<b>Densité corrigée d'une plaque trouée plaquée cuivre</b>	<b>804 kg/m<sup>3</sup></b>
Masse d'une anode de 1,5*1,68 (une seule épaisseur trouée)	6,48 kg
Masse du plan d'anode de 3*3,4 trois vues (deux épaisseurs trouées)	51,87 kg



Equivalent material for simulation  
+ glass-fiber skins



Deflection comparison under standard load, to validate model

