

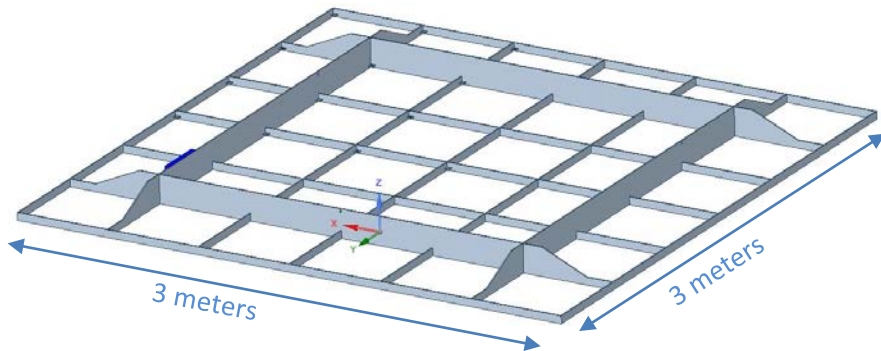
# ProtoDUNE CRP Upgrade

07/04/2020

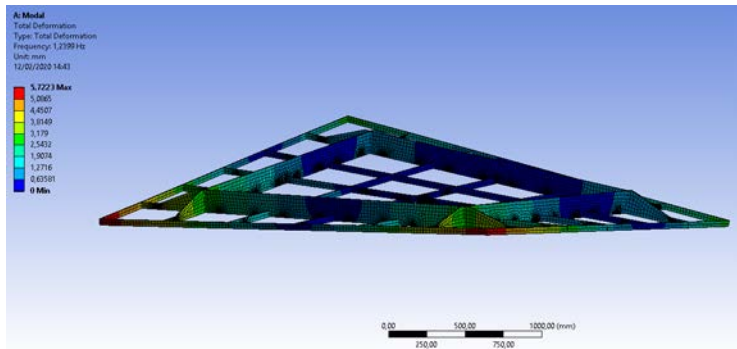
*B.Aimard, G.Deleglise, D.Duchesneau,  
N.Geffroy, J-M.Nappa, F.Peltier, S.Vilalte*

Modal study to evaluate CRP stiffness based on first deformation mode (saddle shape)

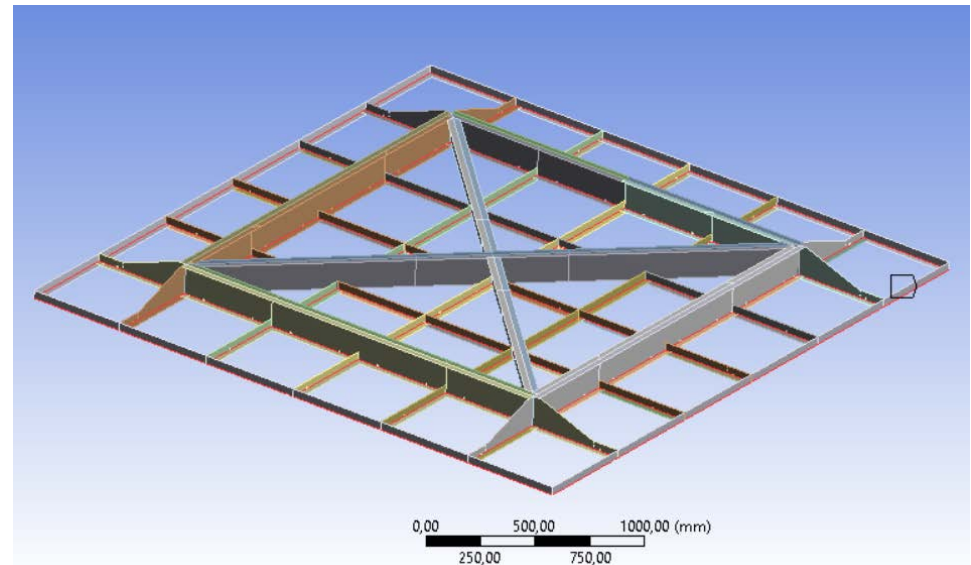
Actual CRPs  
Invar mass : 140kg  
**F1 ~ 2 Hz**



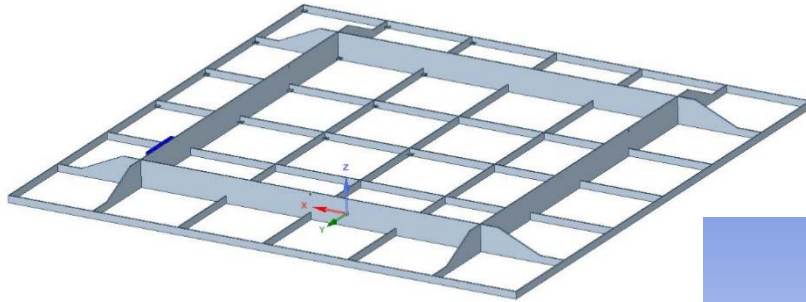
Shape of the first deformation mode :



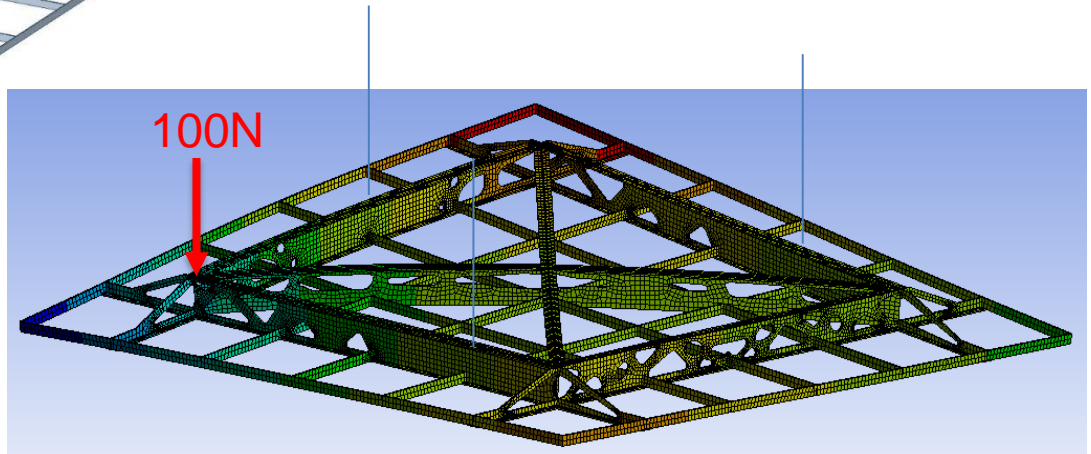
1st optimization :  
Invar mass 330 kg  
**F1 ~ 15 Hz**



Previous design



New design



	Initial	Optimised
Static / 100N : max displacement	27mm	<b>0,1 mm</b>
First eigenfrequency	2 Hz	<b>15,6 Hz</b>
Invar mass	140 kg	<b>160 kg</b>

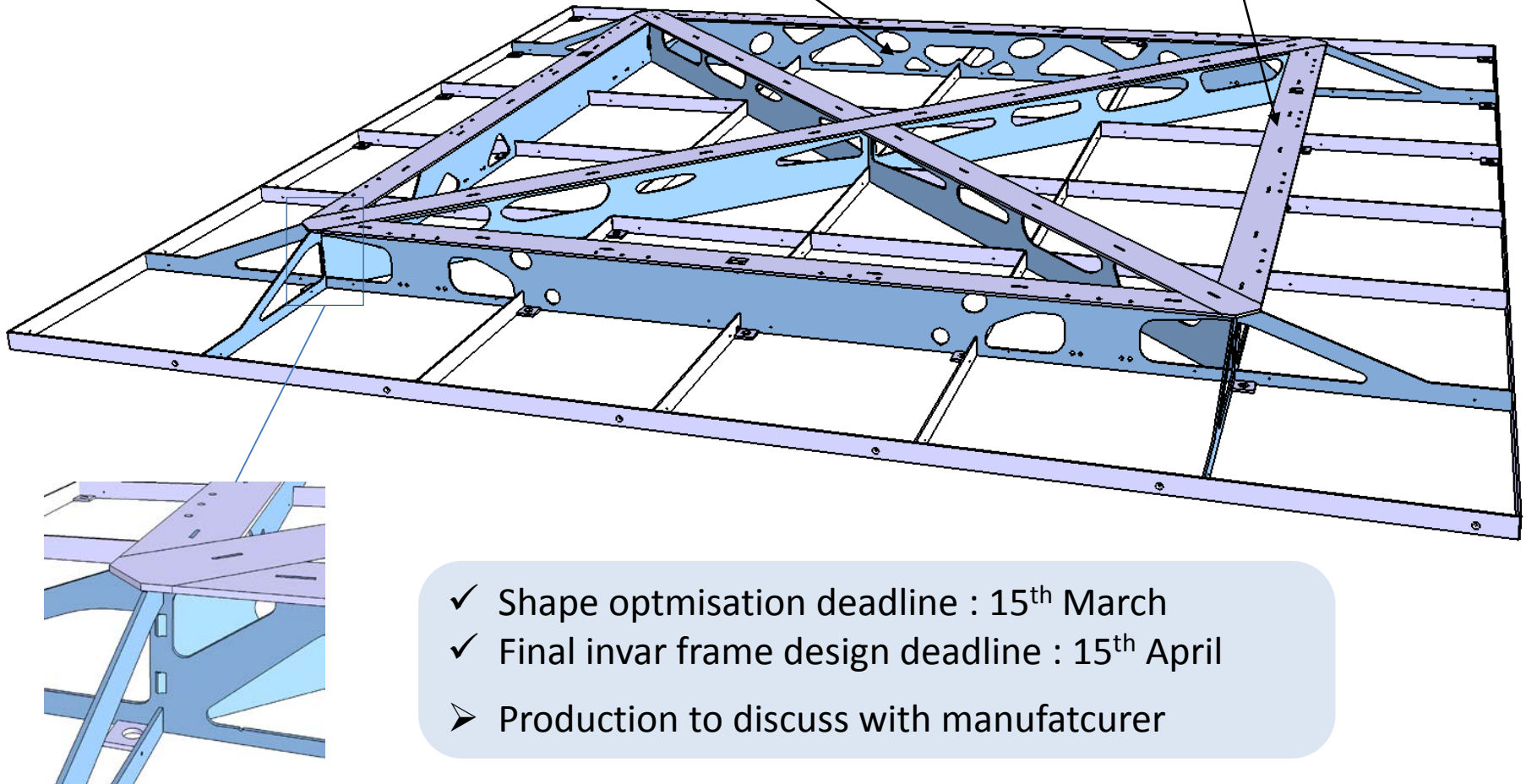
## Main beams

Reduced thickness : 6mm --> 4mm

Ansys mass/stiffness optimization - Lazer cut openings

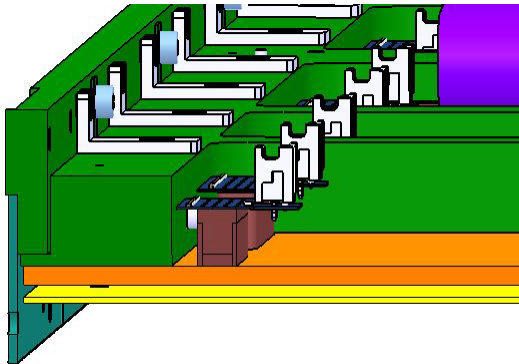
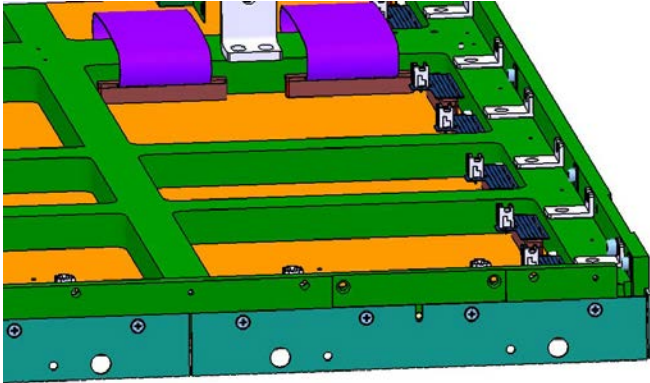
## Soles stiffeners

Th.=6mm



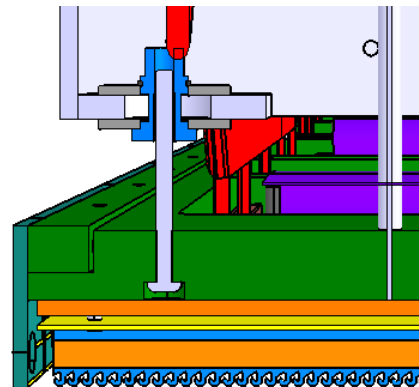
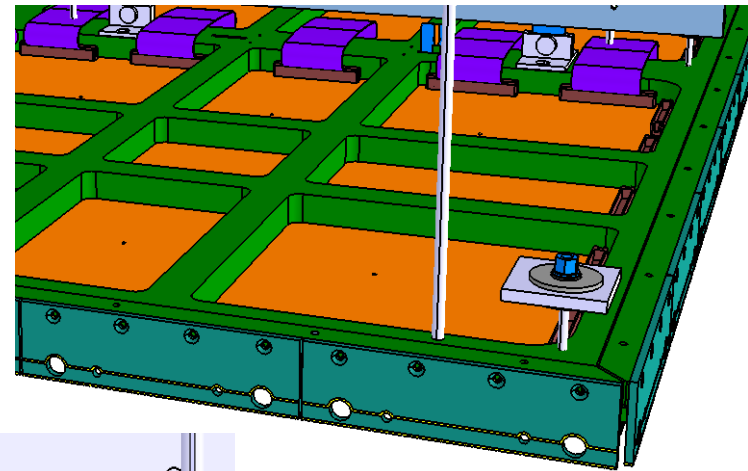
- ✓ Shape optimisation deadline : 15<sup>th</sup> March
- ✓ Final invar frame design deadline : 15<sup>th</sup> April
- Production to discuss with manufatcurer

## Previous design :



## Upgraded design :

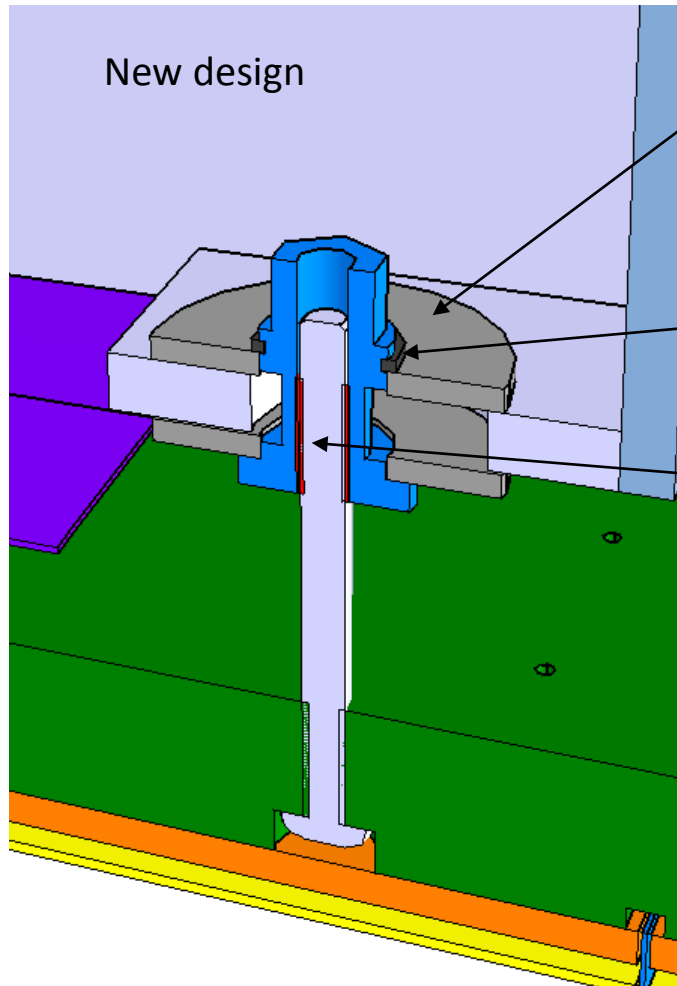
- Suppression of numerous parts
- No machining on the edges
- Globally simplified machining
- Strengthening of weak parts
- Prod. open to new manufacturers



Final design deadline :

✓ 15<sup>th</sup> June--> Production

*50 suspensions points between invar and G10*



**Widened and machined washers for better hole covering**

--> easier planarity adjustment procedure

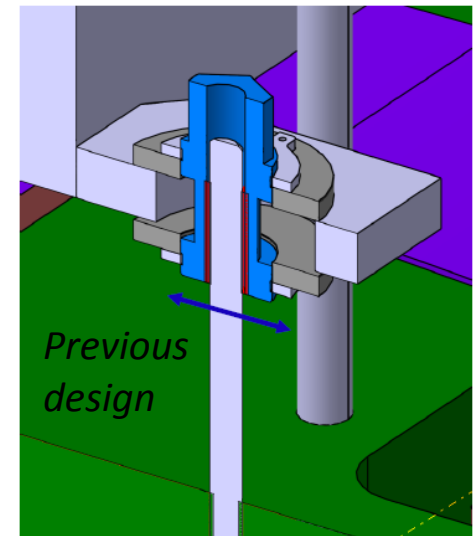
--> improved planarity of CRP under thermal contraction

**Only one circlips**

--> simplified solution for production and assembly

**Self-locking thread inserts**

-> brass to avoid stainless steel seizure

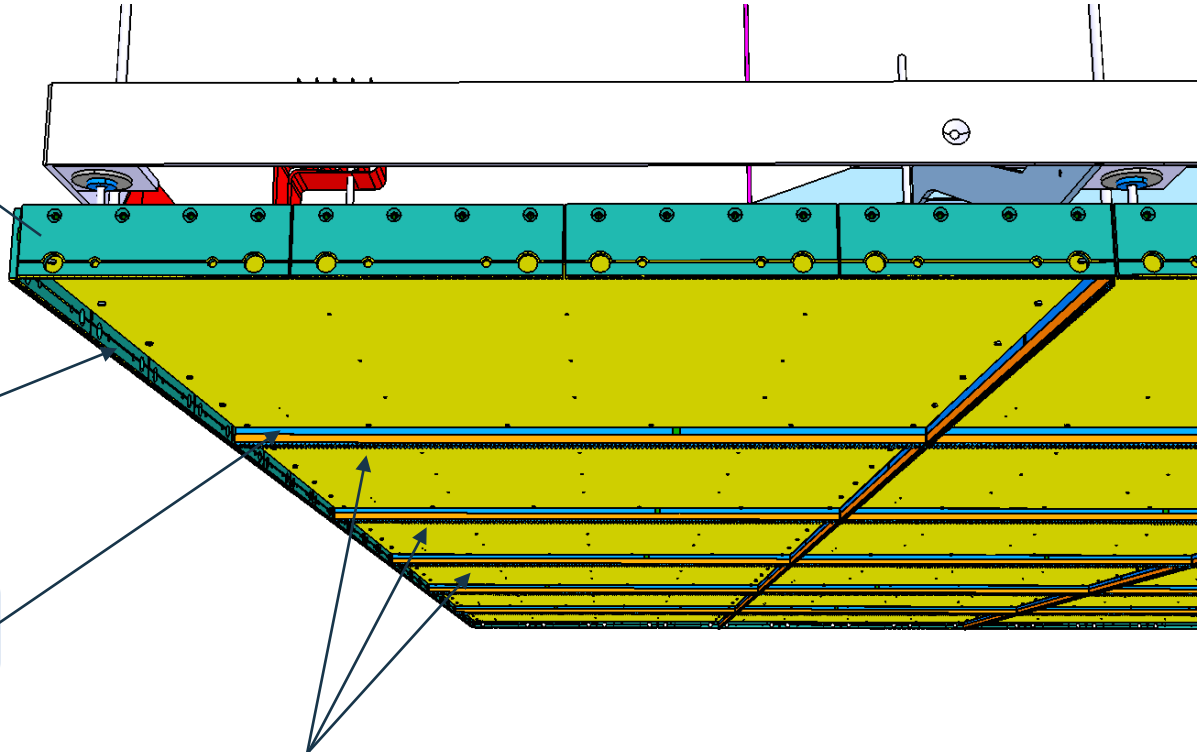


Narrower PCBs : **40 wires** (prev. 64)  
*3,125mm step is preserved*

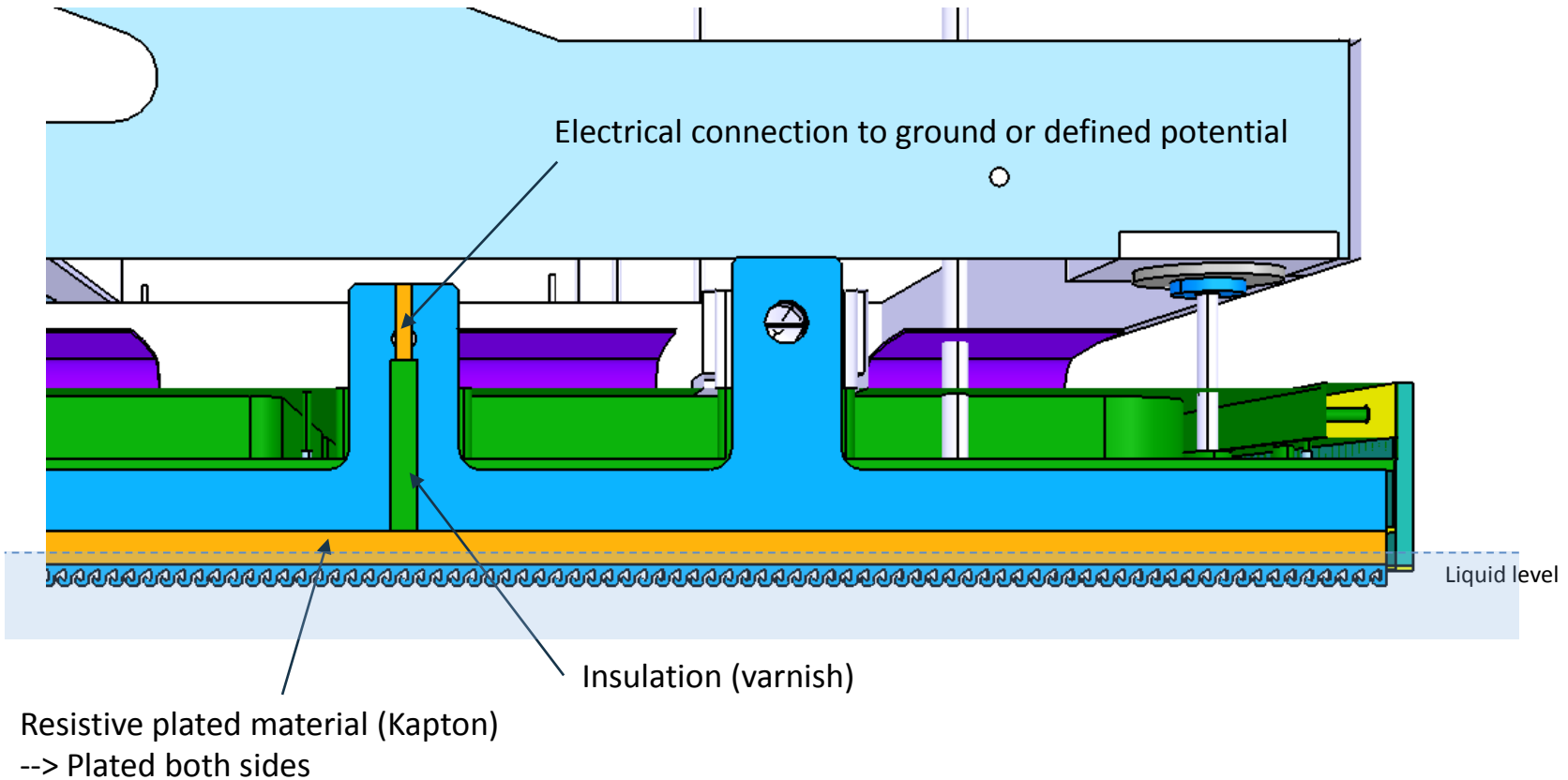
Electrical protection : **Spark guides**

Excedent charge collection :  
**Resistive combs**

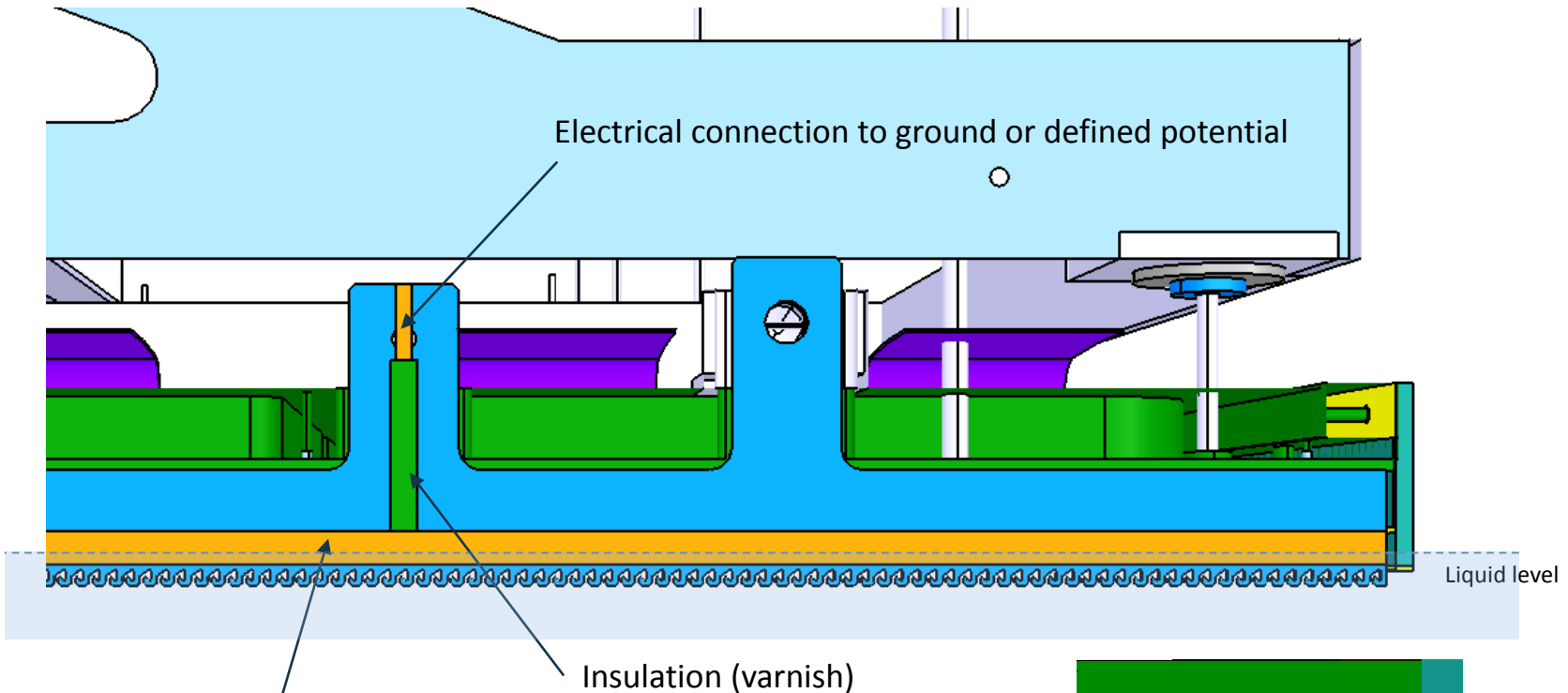
Comb **each 50cm** (prev. each meter)



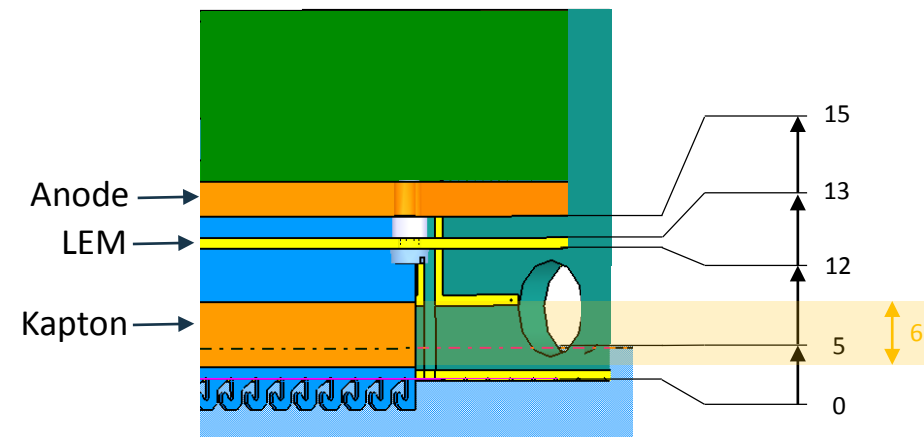


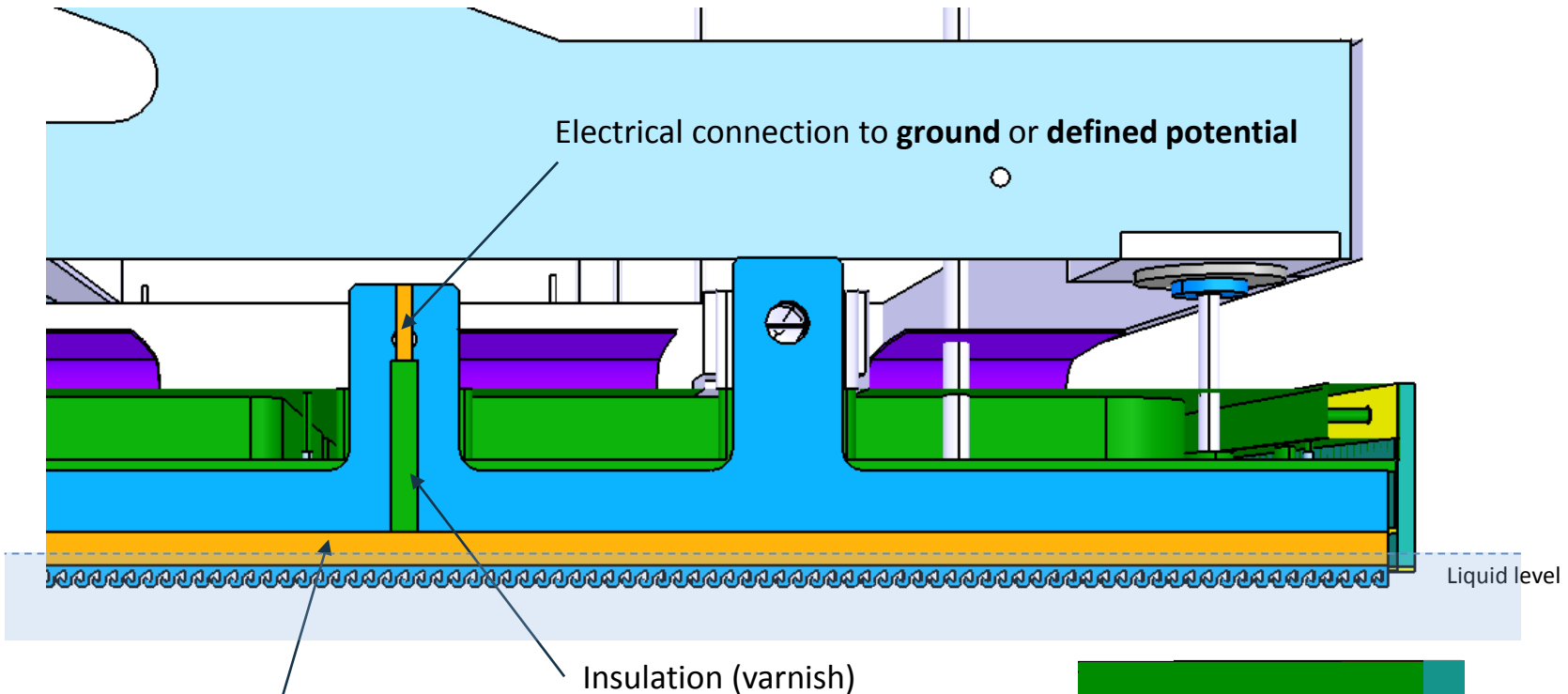






Resistive plated material (Kapton)  
--> Plated both sides

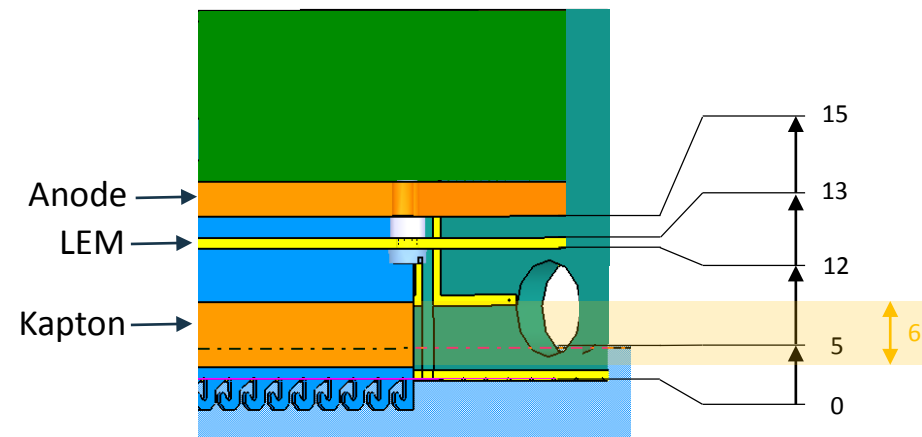


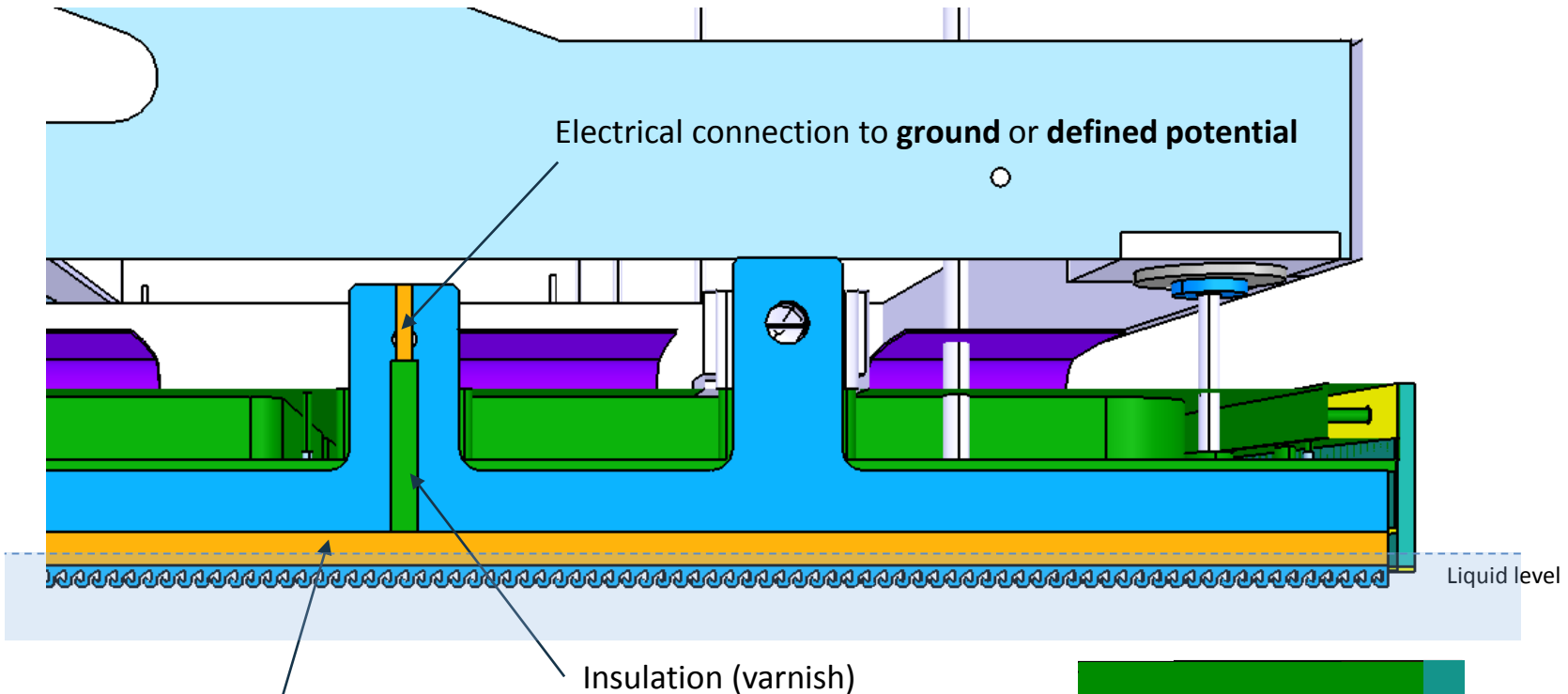


Resistive plated material (Kapton)

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- Plating test to be done soon at CERN
- To be sized and validated by electrostatic simulations



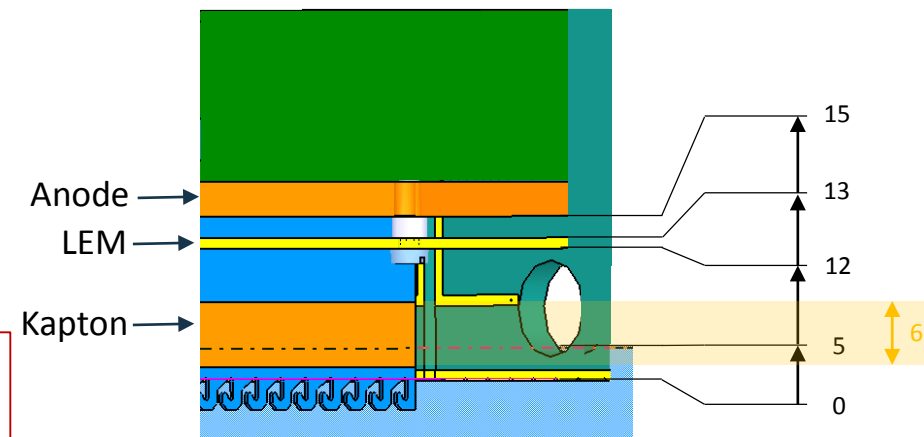


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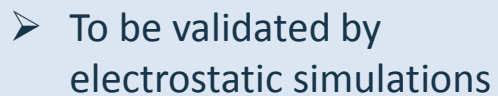
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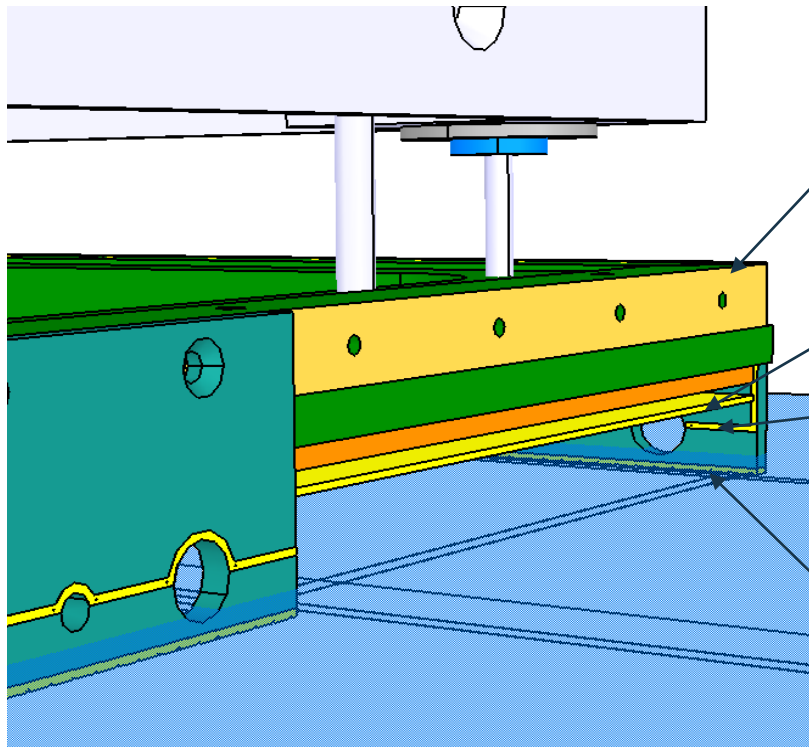
**Contribution  
welcome**





- Grid voltage





Conductive plate for  
ground chaining

LEM down voltage

Ground  
(vertical part in front of  
LEM/Anodes is epoxy  
varnished)

Grid voltage

➤ To be validated by  
electrostatic simulations

Contribution  
welcome

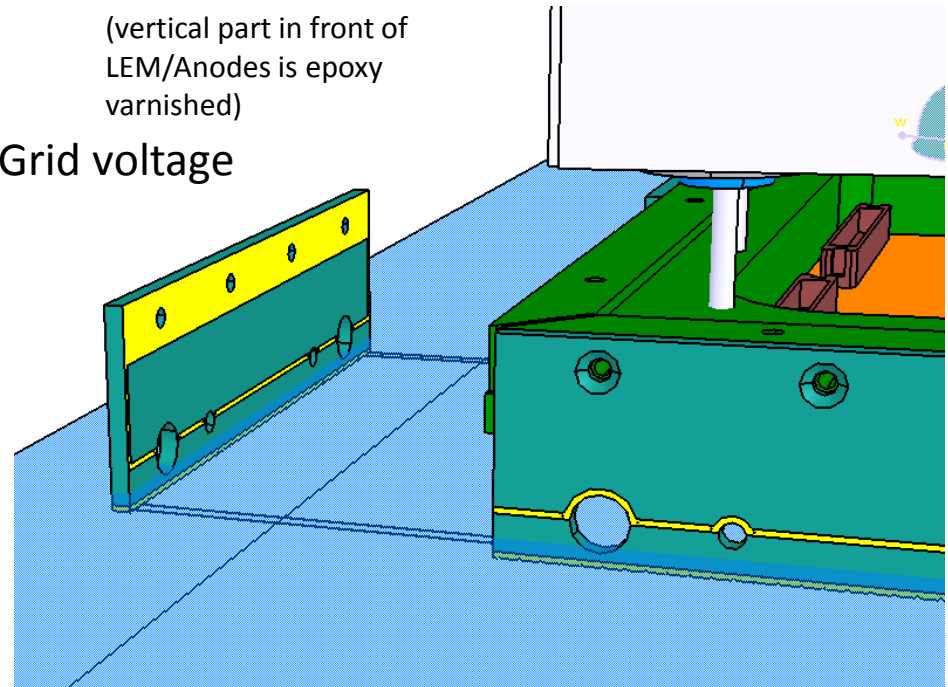
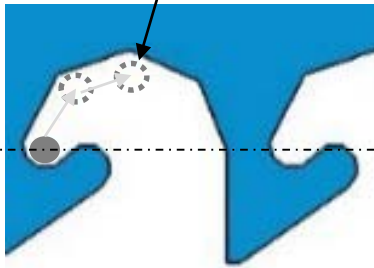


Photo of

Previous comb design

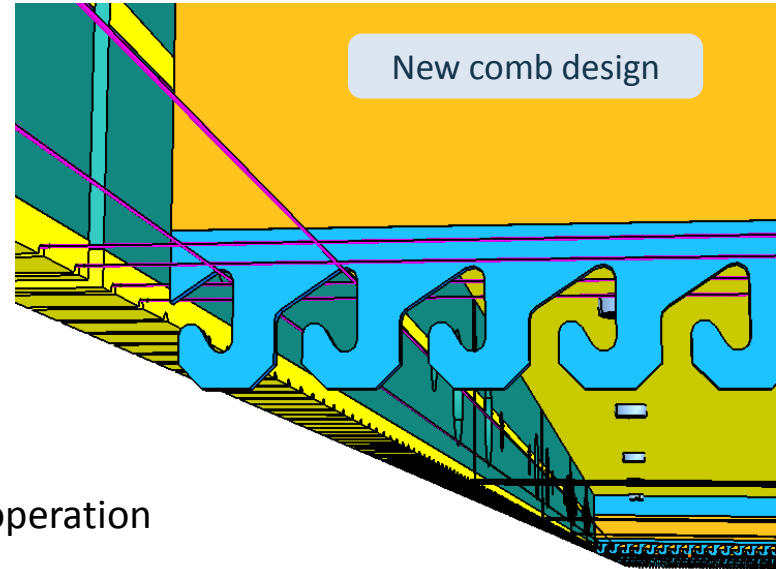
Position under electrostatic force

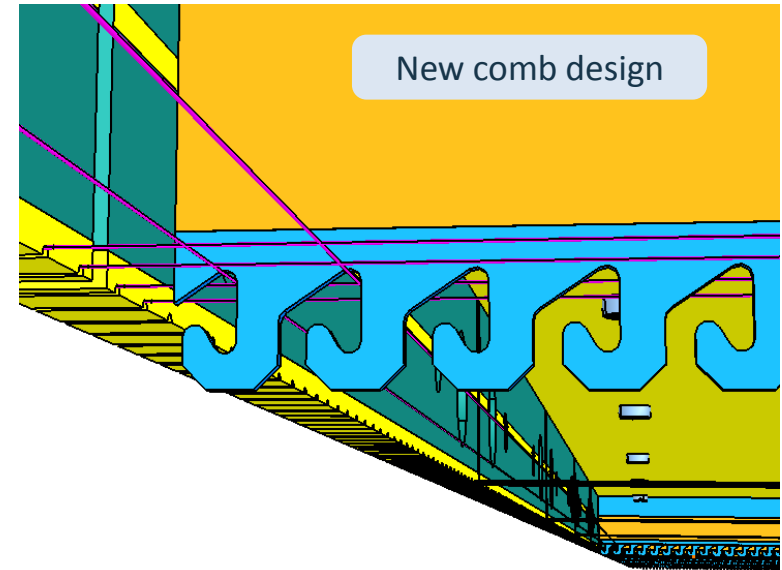
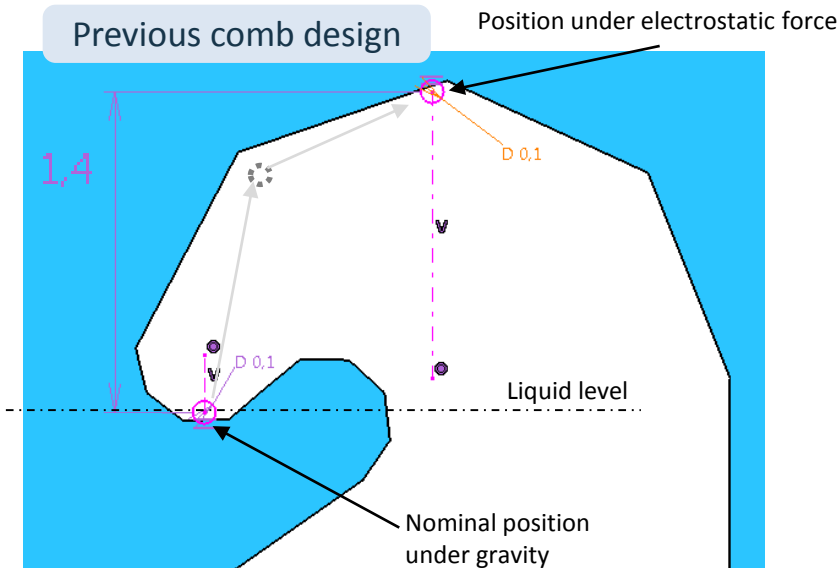
Nominal position  
under gravity



- Electrostatic force is higher than gravity during operation

New comb design

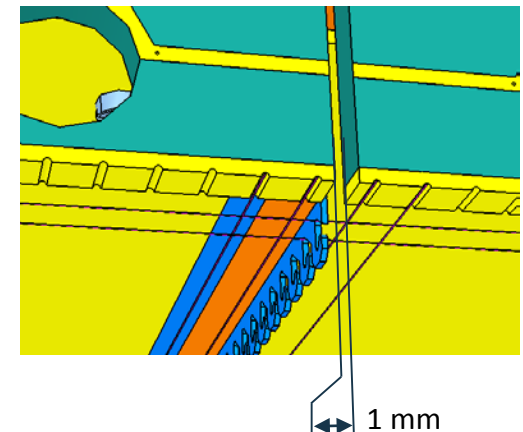




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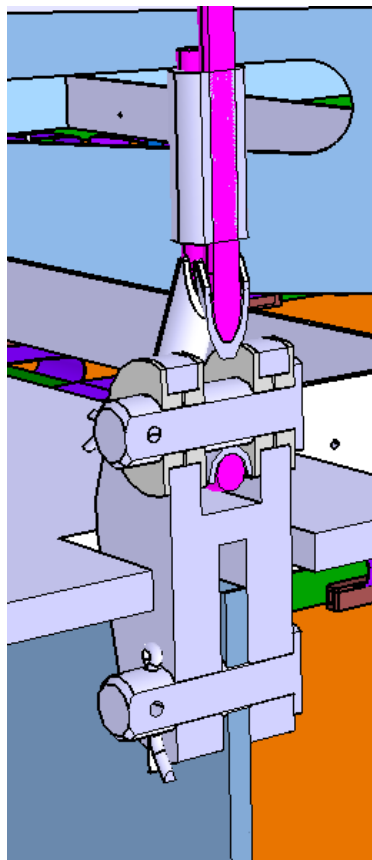
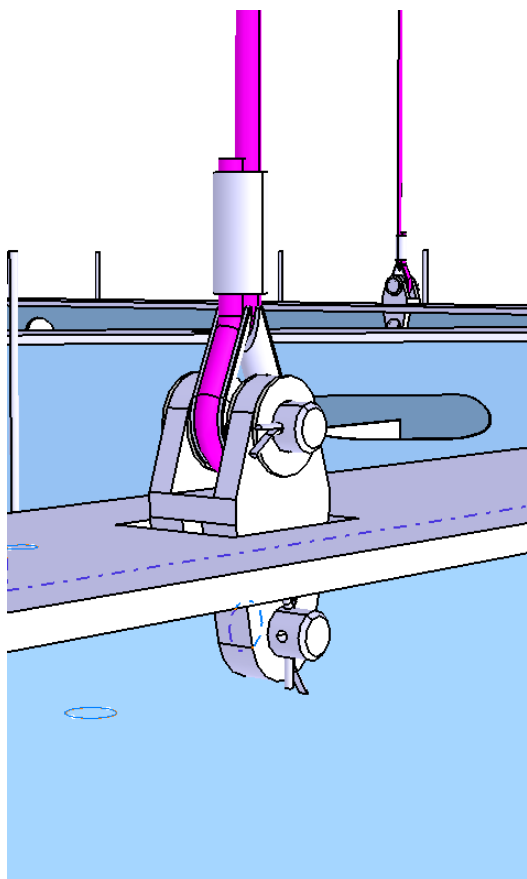
Combs **thickening to 0,5mm** (prev. 0,2mm)

- Better wire support
- Gap between LEMs is wider : 1 mm (prev. 0,5-0,8)
  - CRP dimension maintained, LEMs/Anodes dimensions are reduced

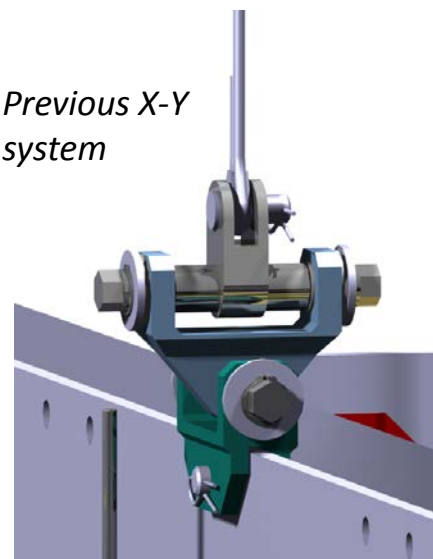




Previous unused X-Y system is replaced by a simpler one :

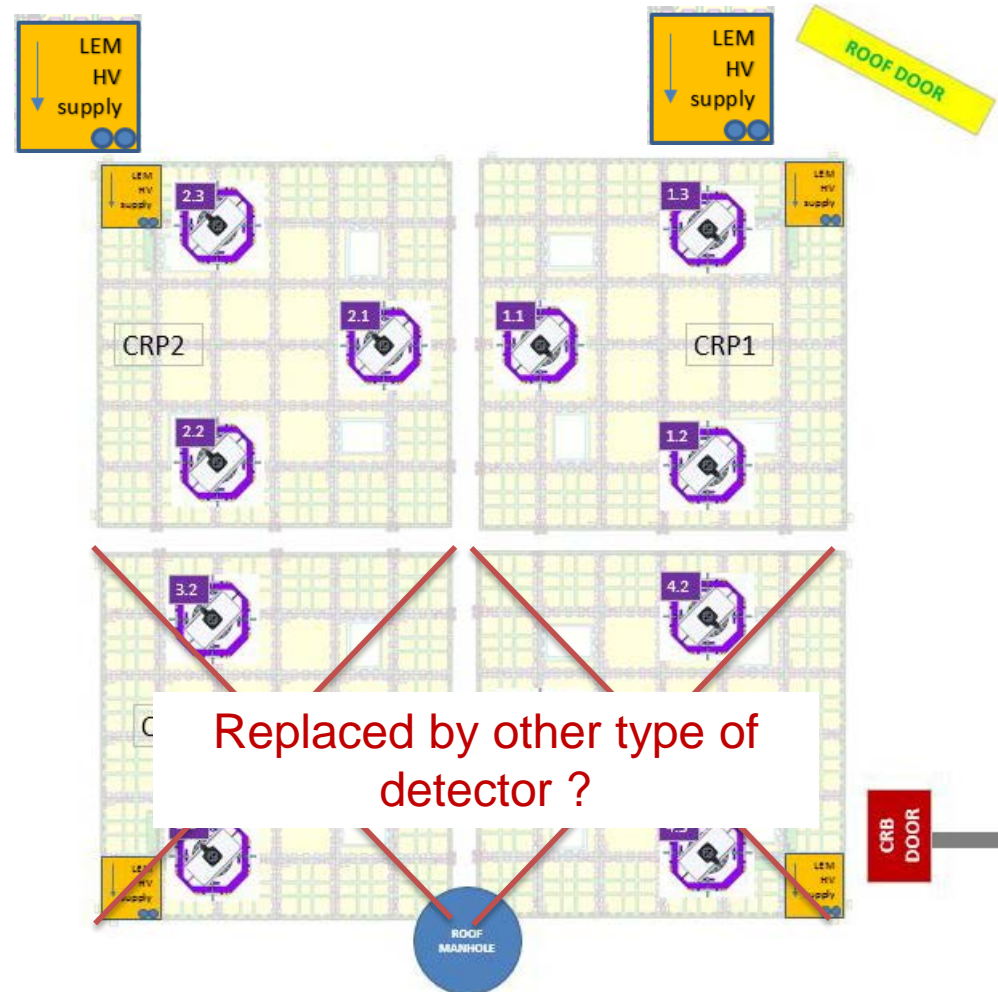


*Previous X-Y system*



- All CRPs will be dismantled on place and evacuated without transport box
  - Then trashed or recycled
- CRP 1 & 2 replaced by 1bis and 2bis
- CRP 3 & 4 replaced by other type of detector
  - Study of technology compatibility and common run aspects

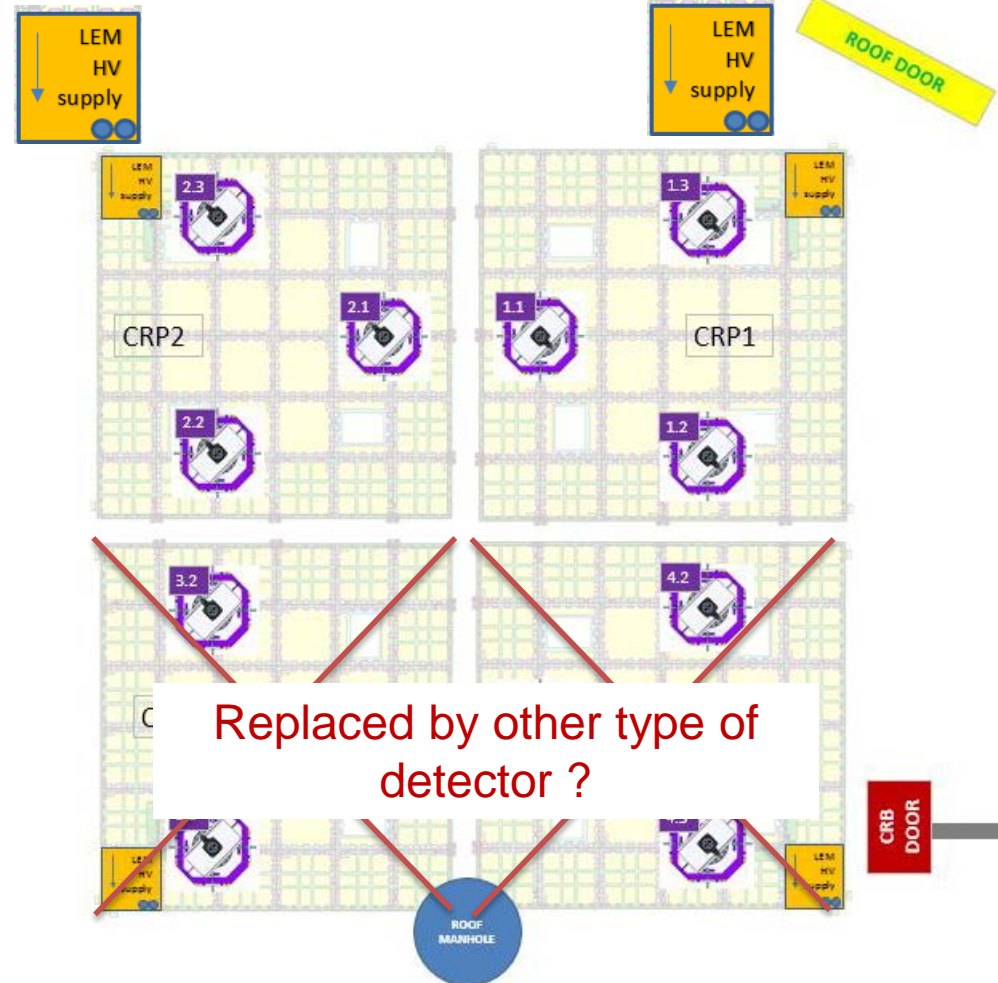
--> updated "Cabling layout" file available, to be finalized with cable lengths :



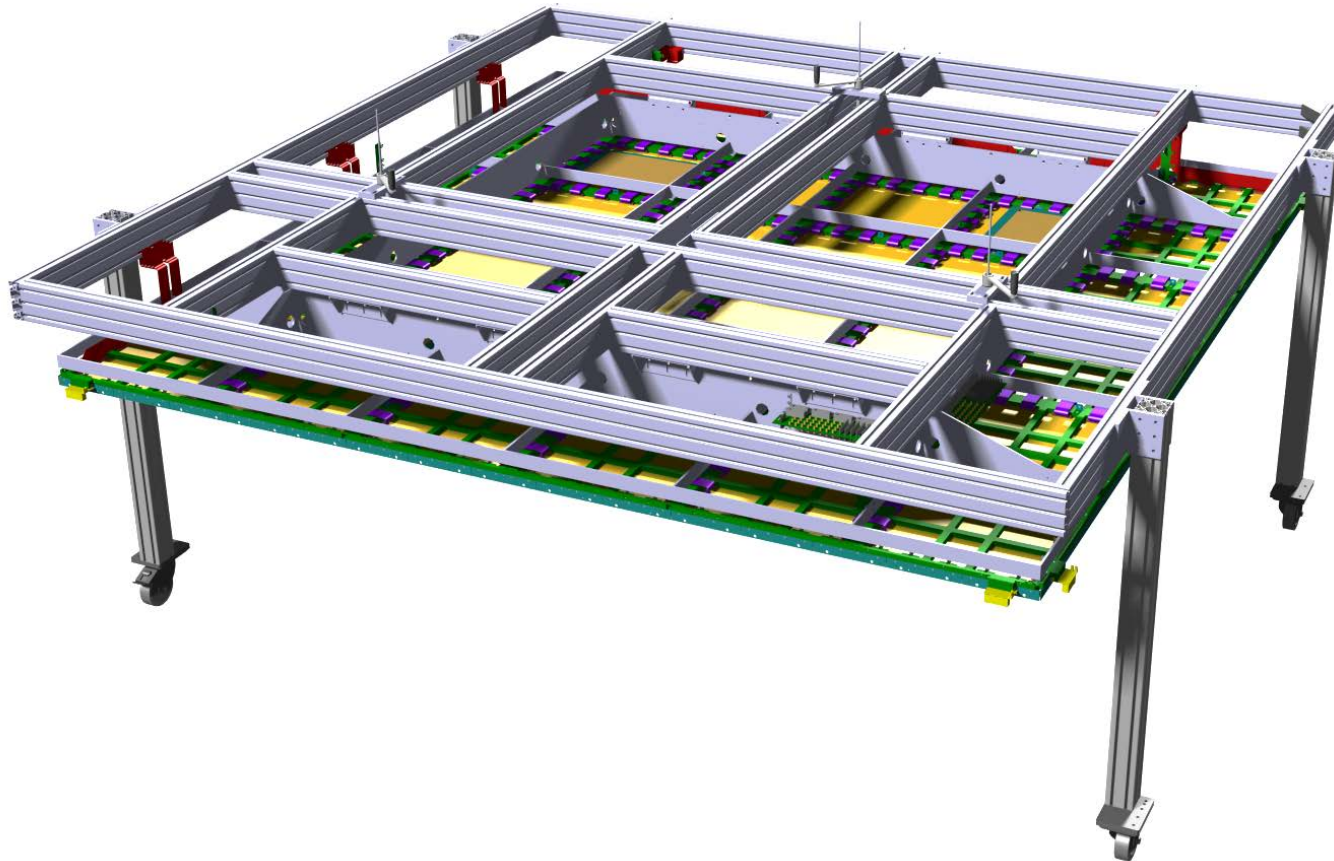
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Contribution  
welcome

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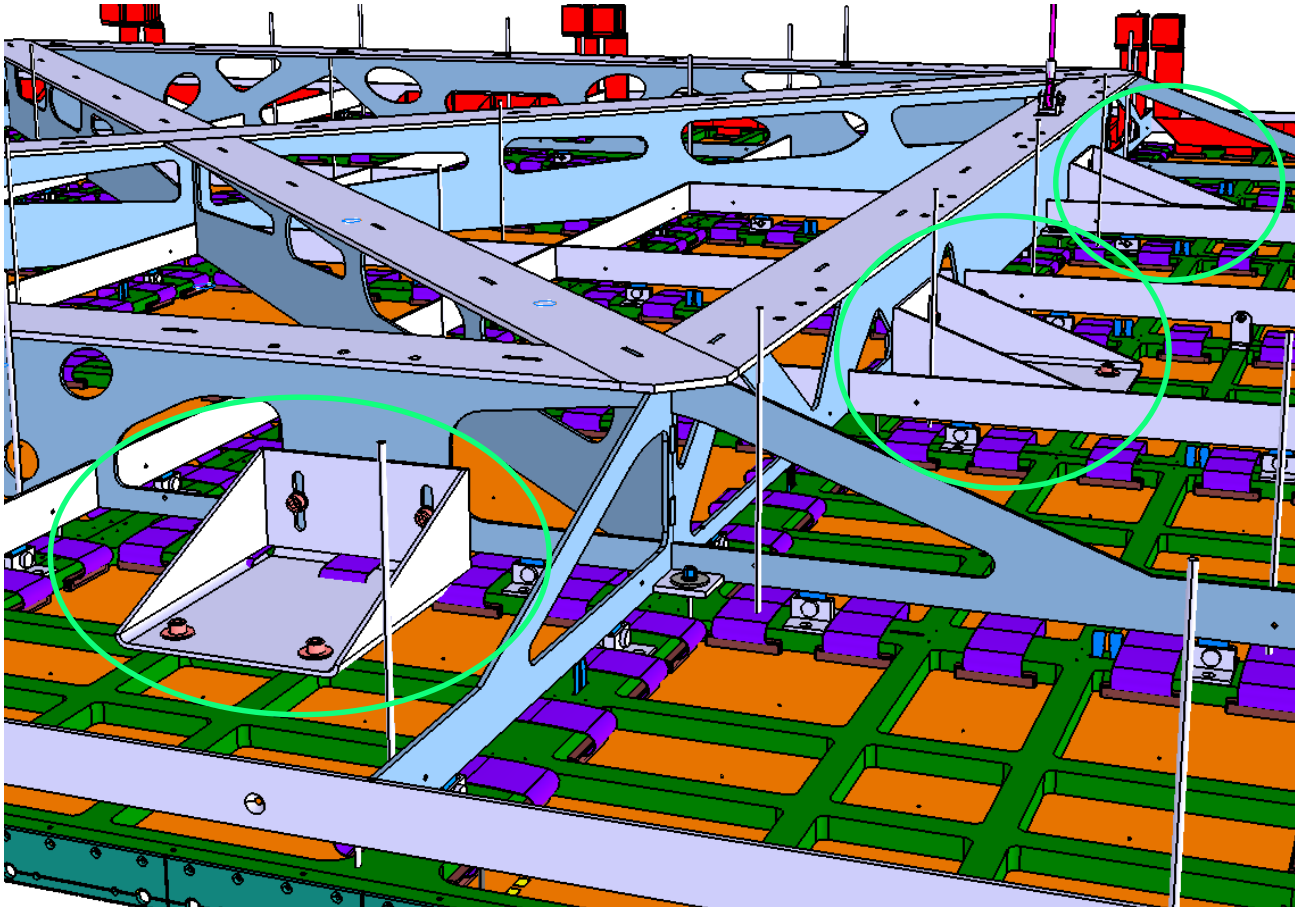


Replaced by other type of  
detector ?



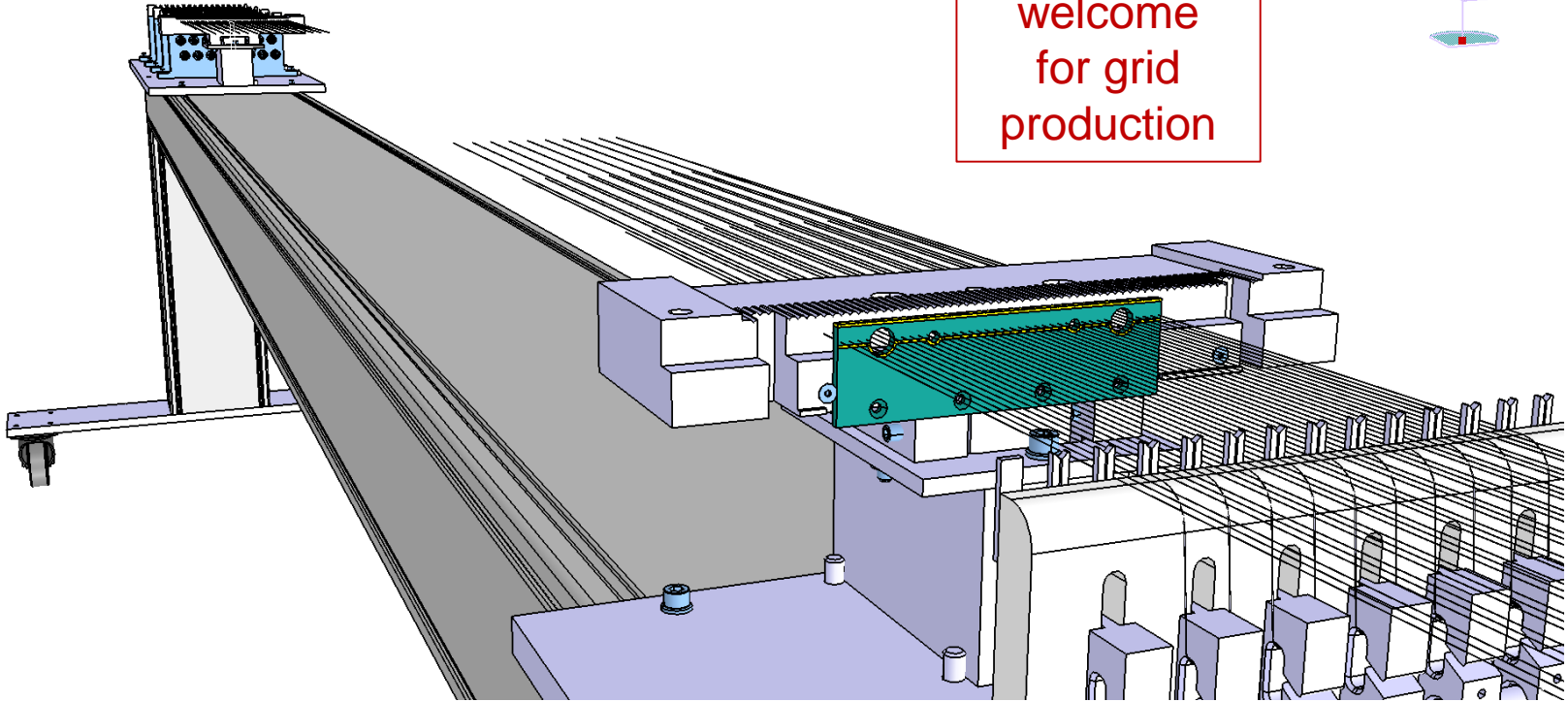
- Transport boxes from phase 1 will be reused, with minor modifications





- Some systems, like G10/Invar transporting squares, are optimised to spare time in transport

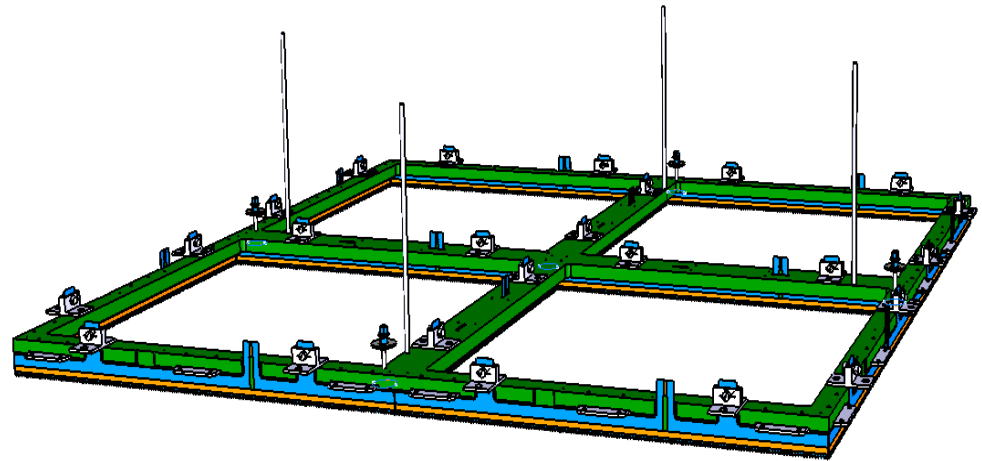
Contribution  
welcome  
for grid  
production



- Minor changes in grid production tooling are necessary (support blocs machining)
- Storage system for grid subsets have to be designed for 2 - 3 full CRPs.

Creation of a 1x1m mini CRP, for validation of :

- **New LEM / Anode design (CEA)**
- Charge collection (resistive combs)
- Spark guides
- Instrumentation
  - Thermal LevelMeters
  - Deformation probes
  - ...



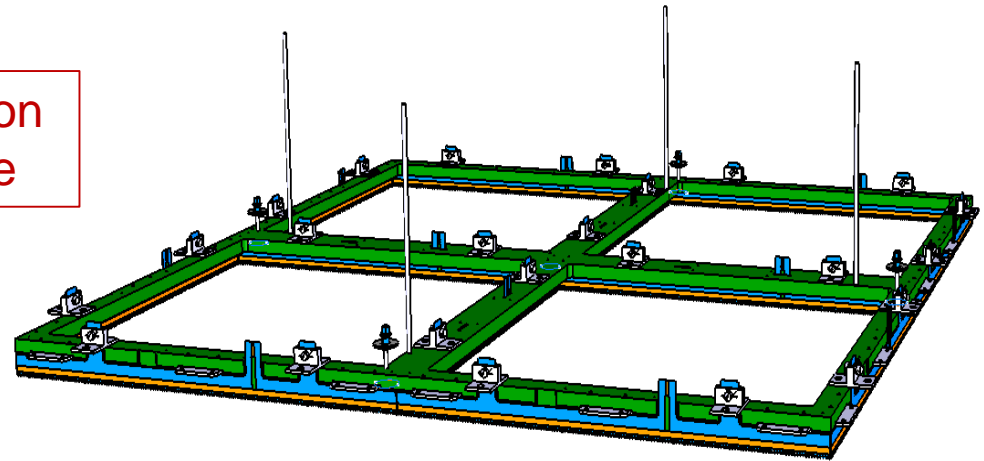
- Used in the coldBox test facility at CERN
- Design at LAPP : 04/2020 --> 06/2020 then production
- Available by 10/2020



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Contribution  
welcome

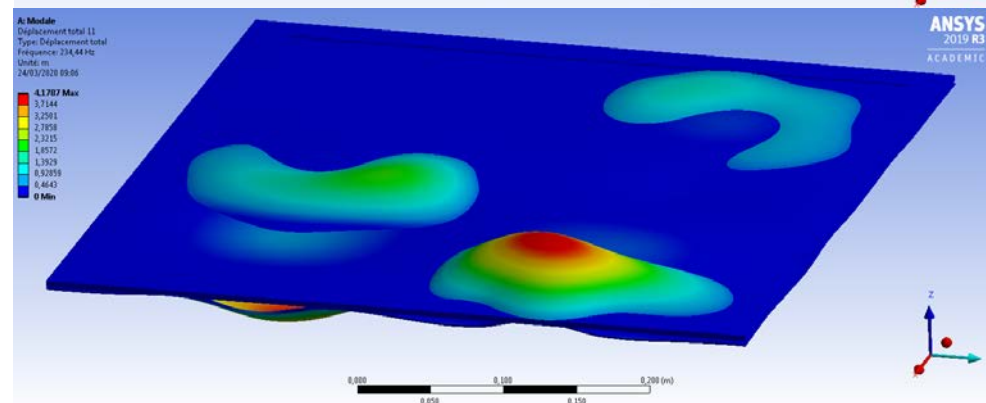
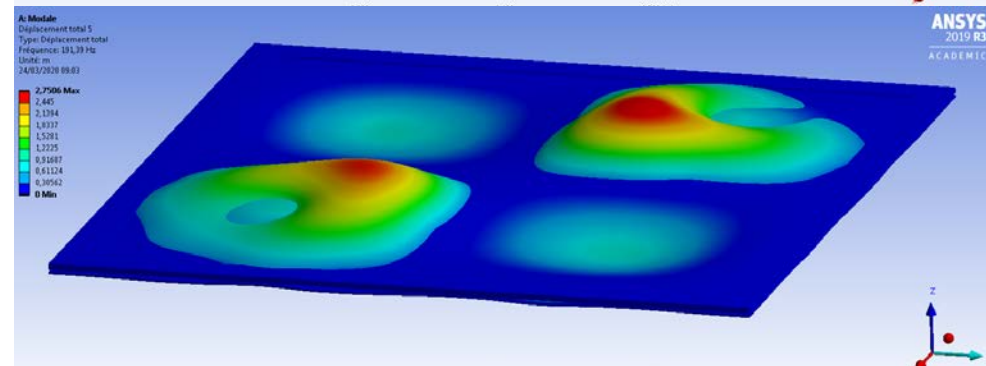
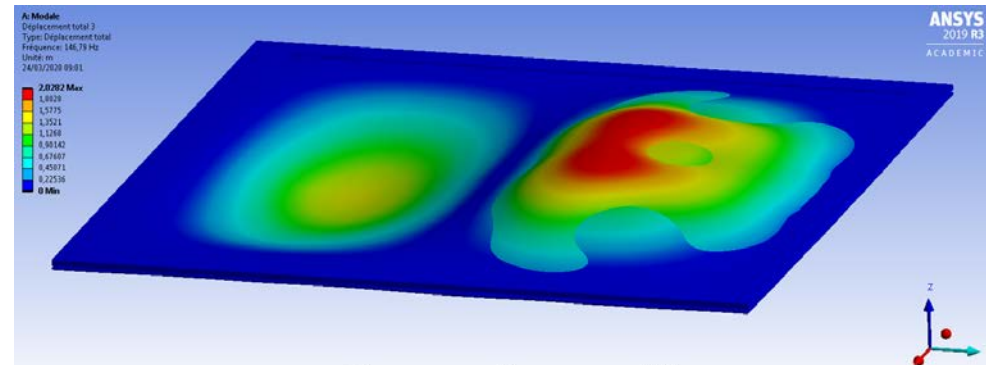
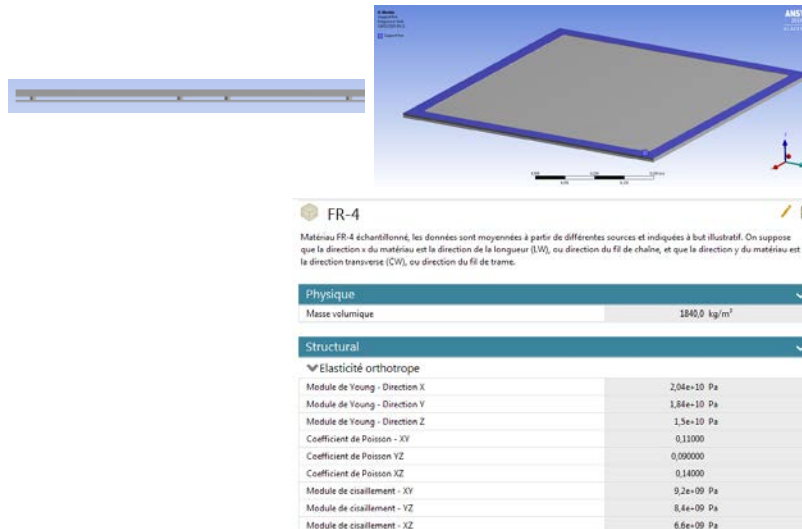


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LEMs/Anodes modal simulations to explain microphony phenomena

Further investigation have to be performed

- Sandwich structure optimization
- Tests with real structures

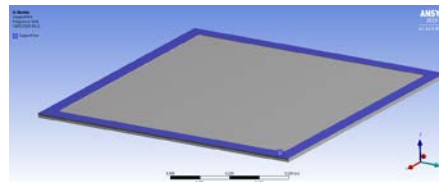
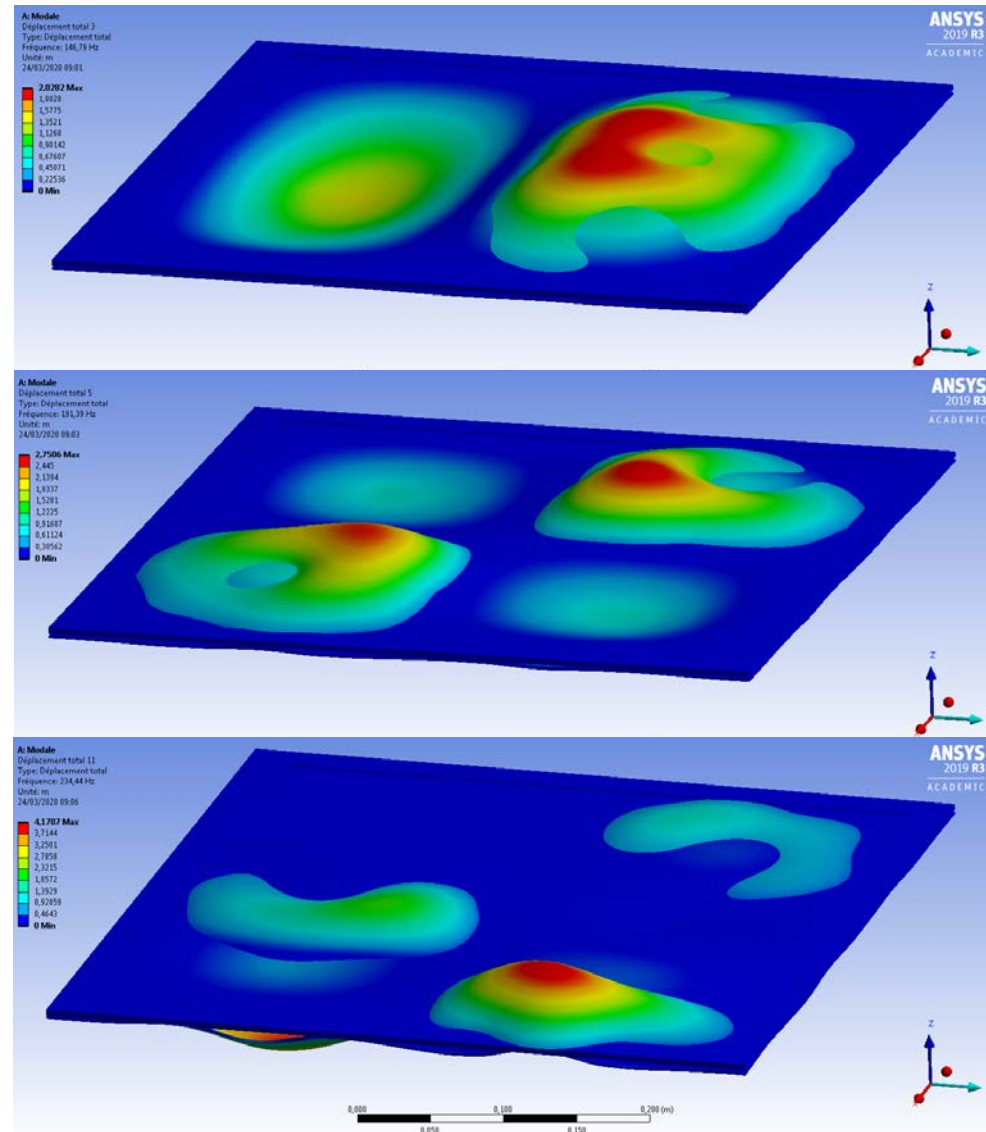


LEMs/Anodes modal simulations to explain microphony phenomena

Further investigation have to be performed

- Sandwich structure optimization
- Tests with real structures

Contribution welcome



**FR-4**

Matériau FR-4 échantillonné, les données sont moyennées à partir de différentes sources et indiquées à titre illustratif. On suppose que la direction x du matériau est la direction de la longueur (LW), ou direction du fil de chaîne, et que la direction y du matériau est la direction transverse (CW), ou direction du fil de trame.

Physique	
Mass volumique	1840.0 kg/m <sup>3</sup>
Structural	
Elasticité orthotrope	
Module de Young - Direction X	2,04e+10 Pa
Module de Young - Direction Y	1,84e+10 Pa
Module de Young - Direction Z	1,5e+10 Pa
Coefficient de Poisson - XY	0,11000
Coefficient de Poisson - YZ	0,090000
Coefficient de Poisson - XZ	0,14000
Module de cisaillement - XY	9,2e+09 Pa
Module de cisaillement - YZ	8,4e+09 Pa
Module de cisaillement - XZ	6,6e+09 Pa

- Electrostatic simulations and concepts validations
  - Resistive combs
  - Spark guide
- Instrumentation developpement and reliability improvements
  - Thermal LevelMeters
  - Deformation probes
- Manual operations during production/installation
  - Extraction grid production
  - CRPs disassembly in NP02 detector

