Laboratoire d'Annecy de Physique des Particules

ProtoDUNE CRP status

09/07/2020

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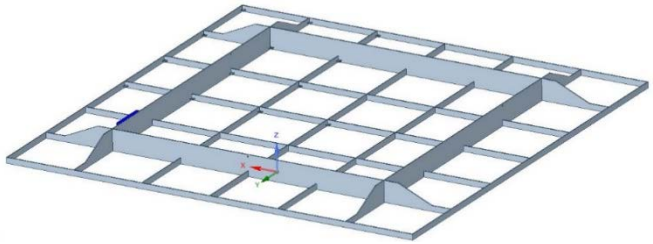
cnrs

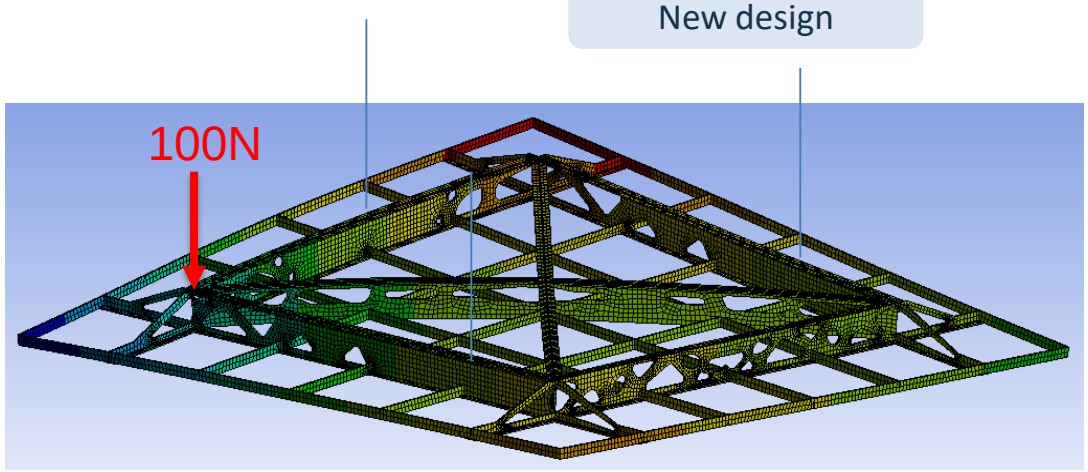
UNIVERSITÉ SAVOIE MONT BLANC

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

Previous design



New design

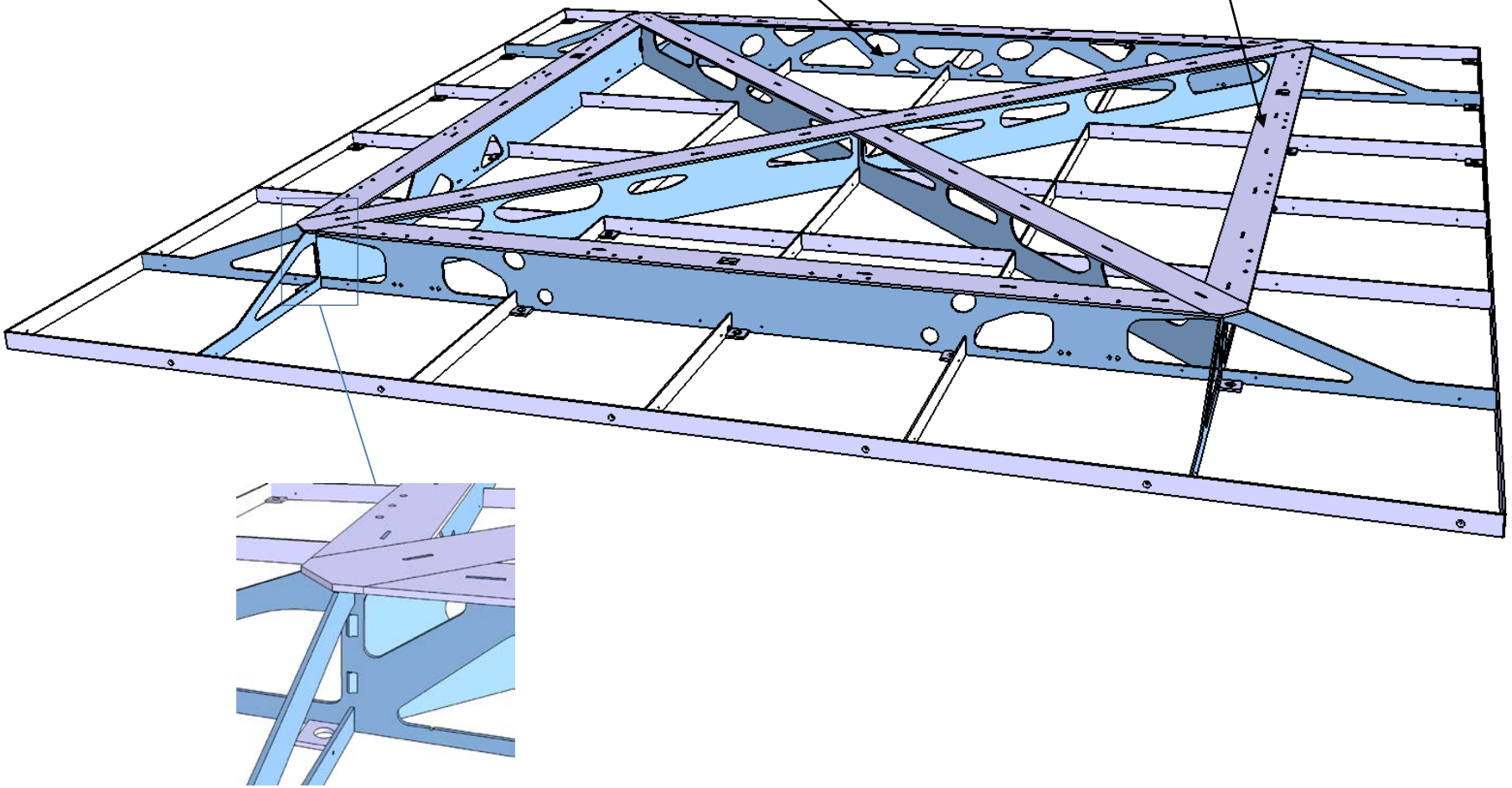


	Initial	Optimised
Static / 100N : max displacement	27mm	**0,1 mm**
First eigenfrequency	2 Hz	**15,6 Hz**
Invar mass	140 kg	**160 kg**

Invar frame improvements

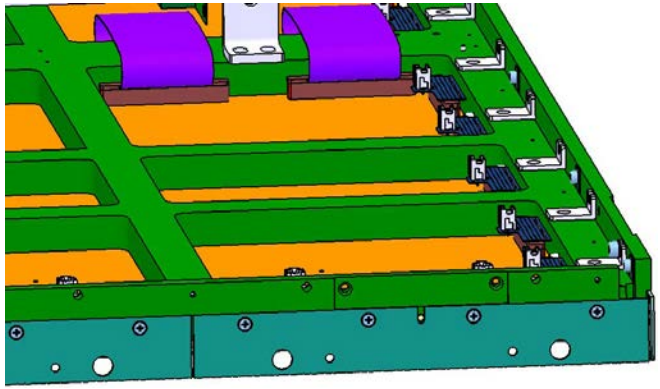
Main beams
Reduced thickness : 6mm --> 4mm
Ansys mass/stiffness optimization - Lazer cut openings

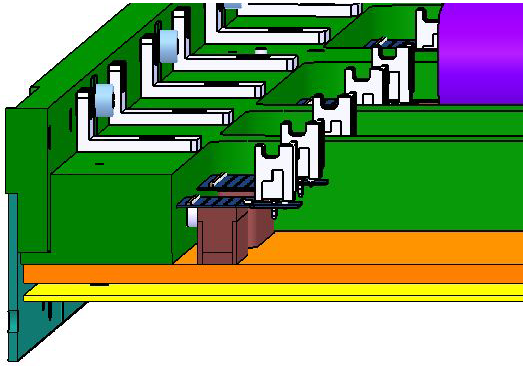
Soles stiffeners
Th.=6mm



G10 frame upgrades

Previous design :

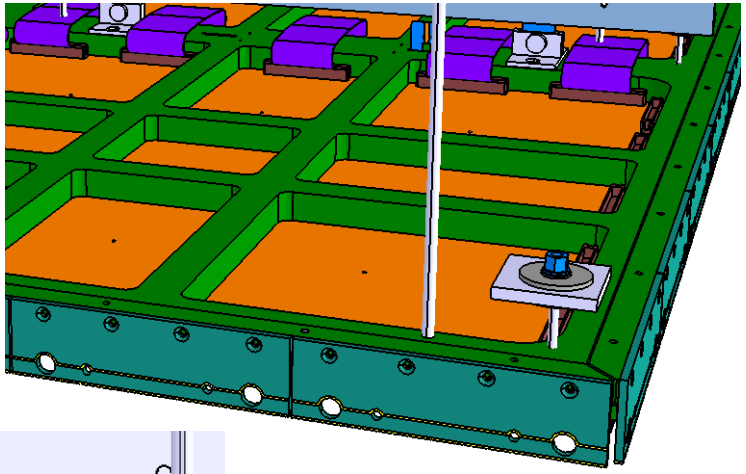


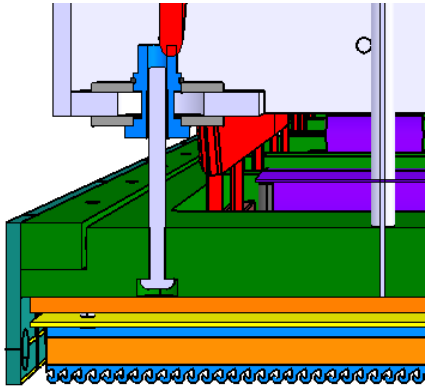


Upgraded design :

- Suppression of numerous parts
- No machining on the edges
- Globaly simplified machining
- Strengthening of weak parts

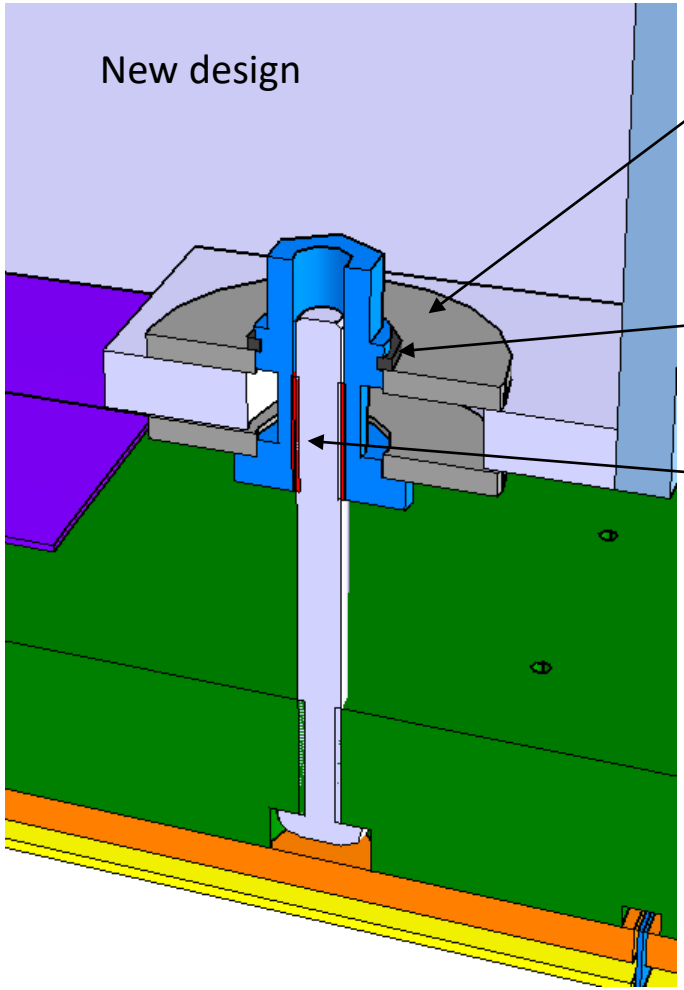
➢ Prod. open to new manufacturers





Suspension / Decoupling systems

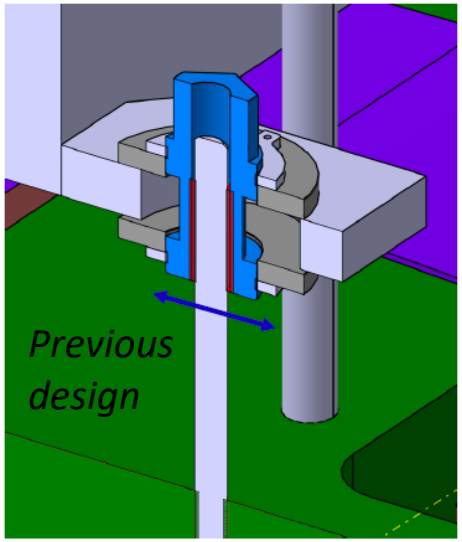
50 suspensions points between invar and G10



Widened and machined washers for better hole covering
--> easier planarity adjustment procedure
--> improved planarity of CRP under thermal contraction

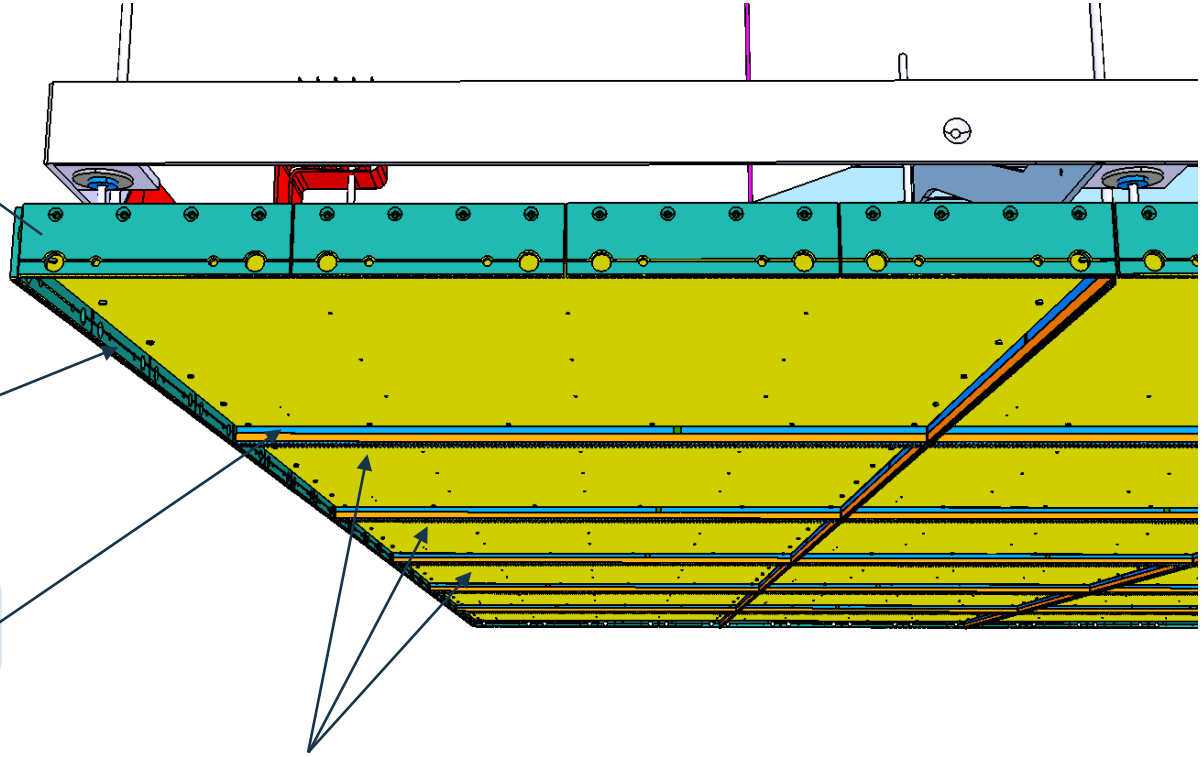
Only one circlips
--> simplified solution for production and assembly

Self-locking thread inserts
-> brass to avoid stainless steel seizure



Extraction grid : General layout

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



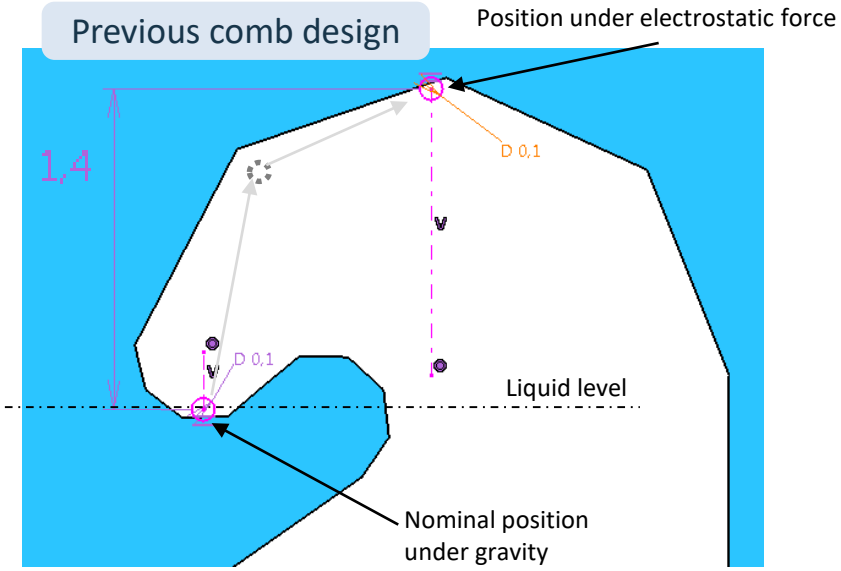
Electrical protection : **Spark guides**

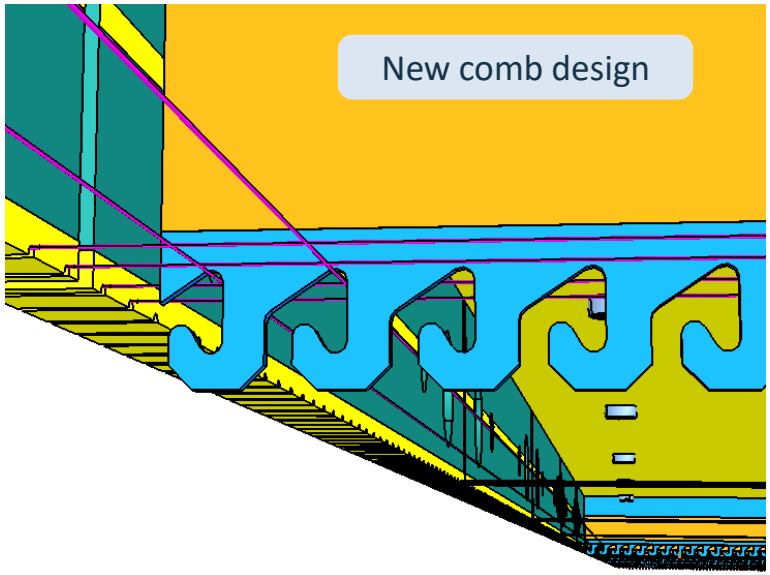
Excedent charge collection :
Resistive combs

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

Combs mechanical improvements

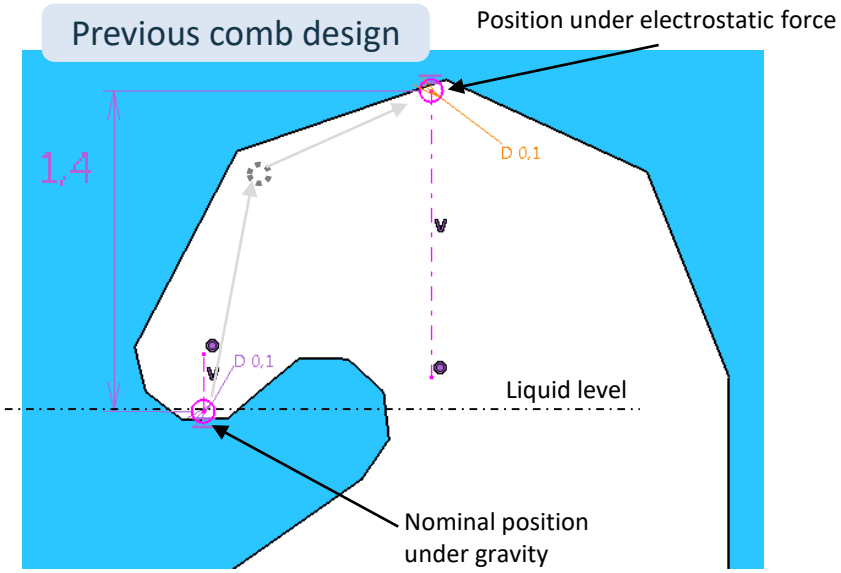
Previous comb design

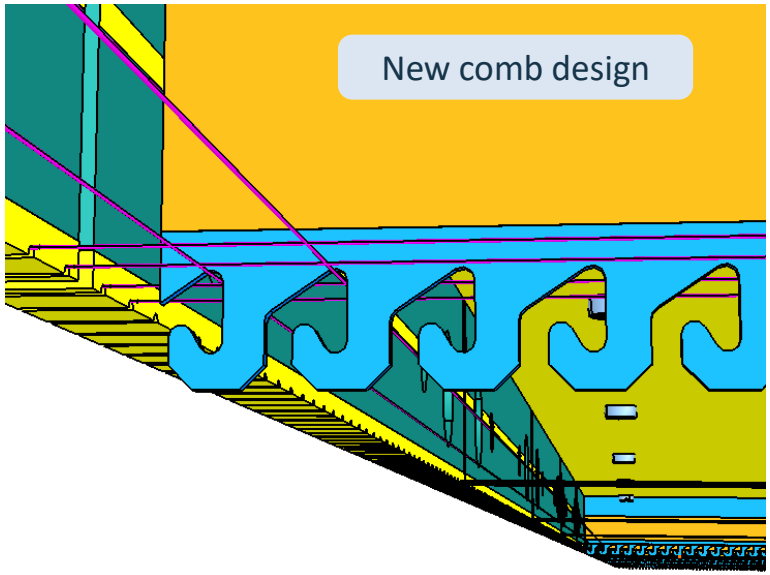




- Electrostatic force is higher than gravity during operation

Combs mechanical improvements

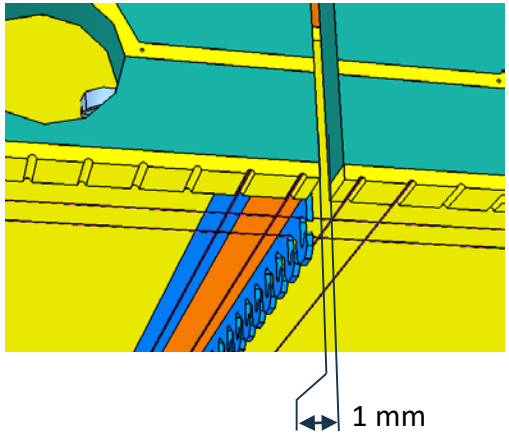




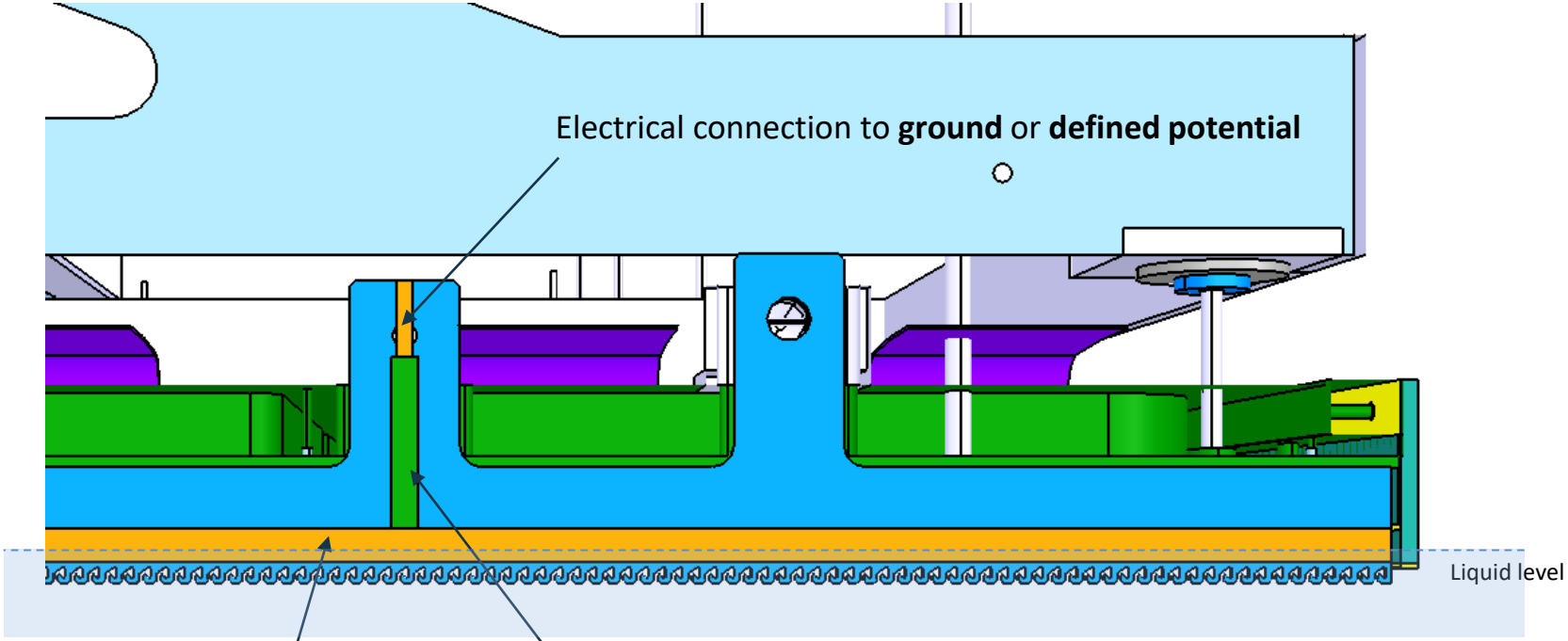
- Electrostatic force is higher than gravity during operation

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

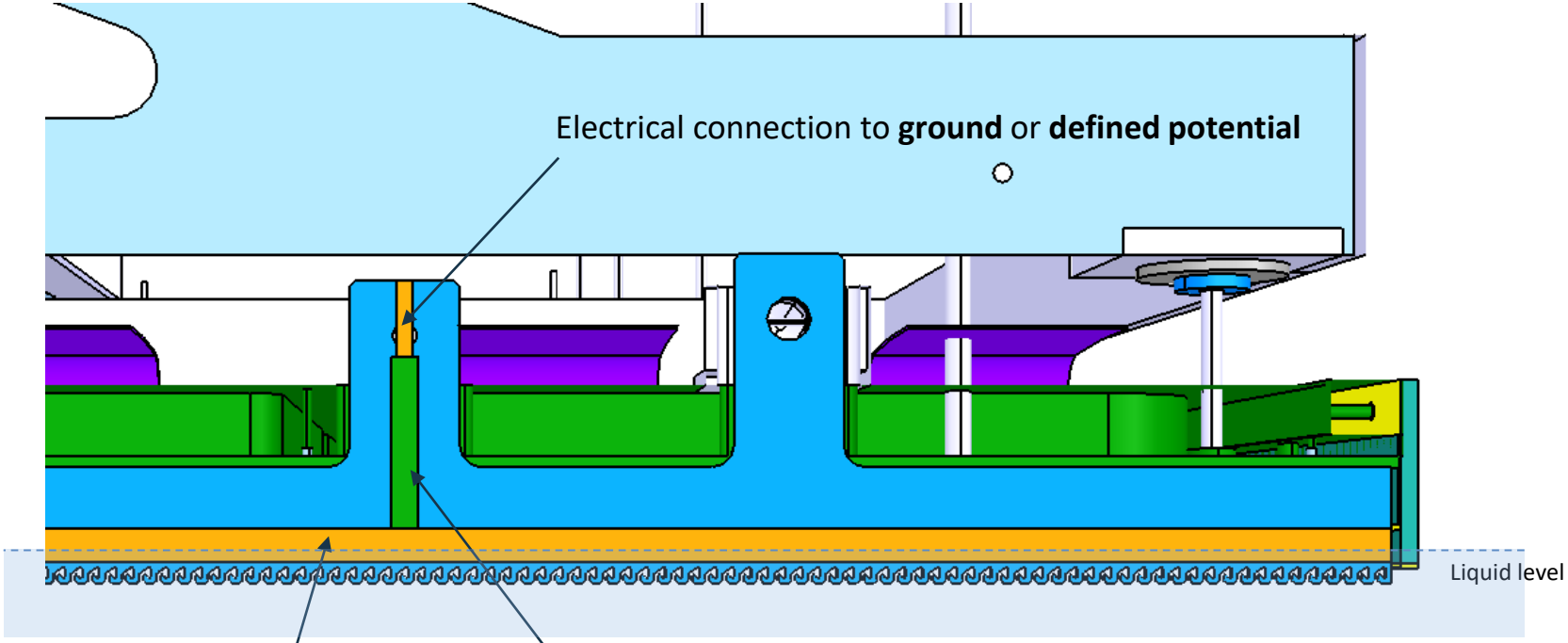
- Better wire support
- Gap between LEMs is wider : 1 mm (prev. 0,5-0,8)
  - CRP dimension maintained, LEMs/Anodes dimensions are reduced

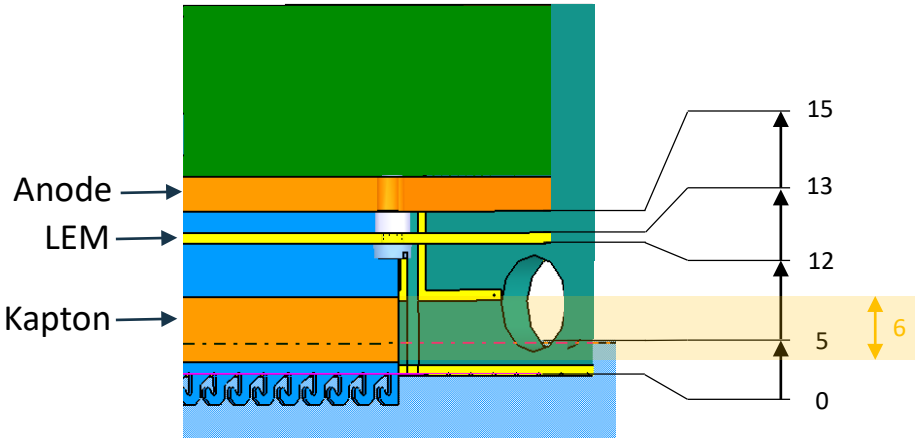


Excedent charge collection

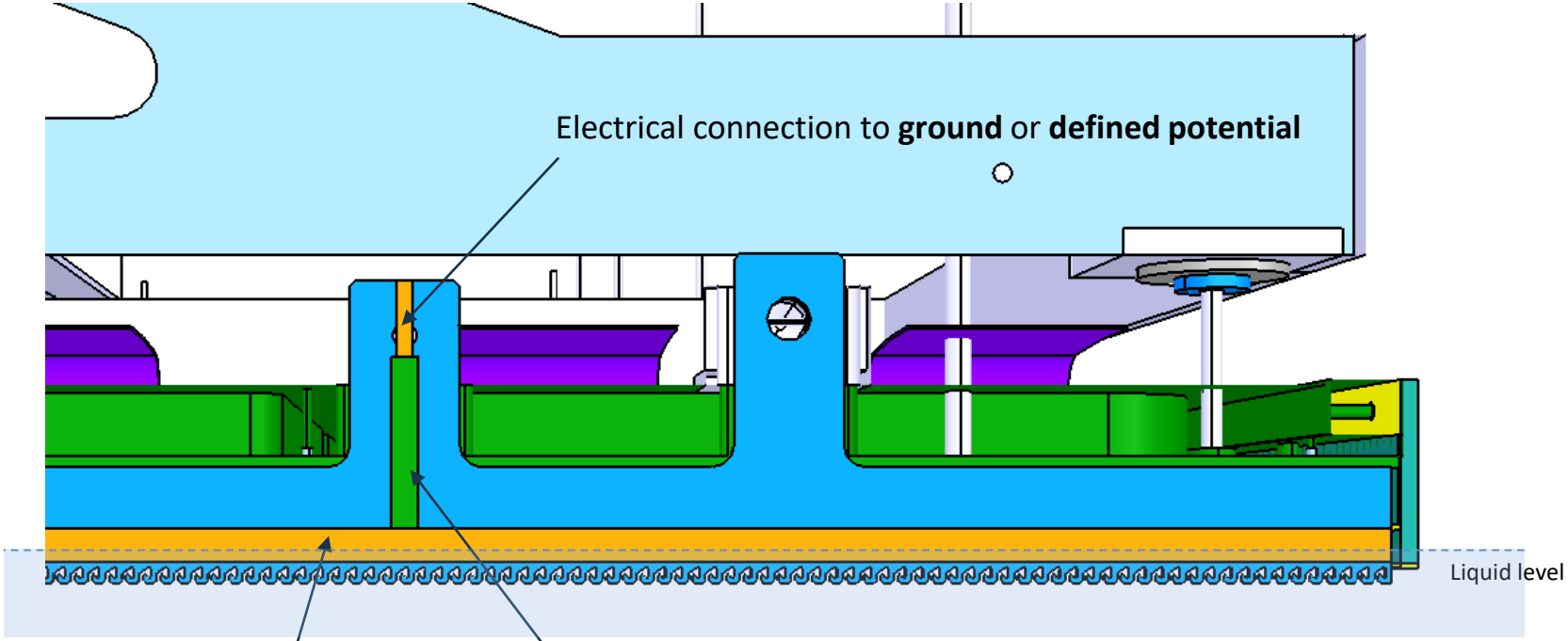


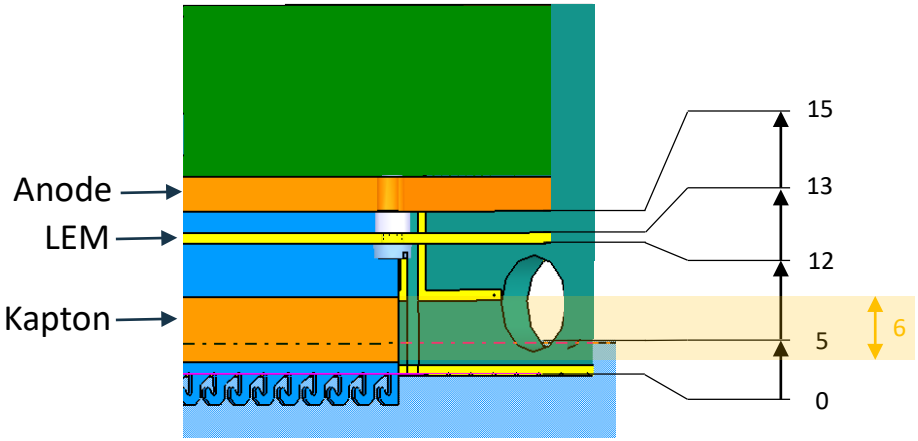
Excedent charge collection





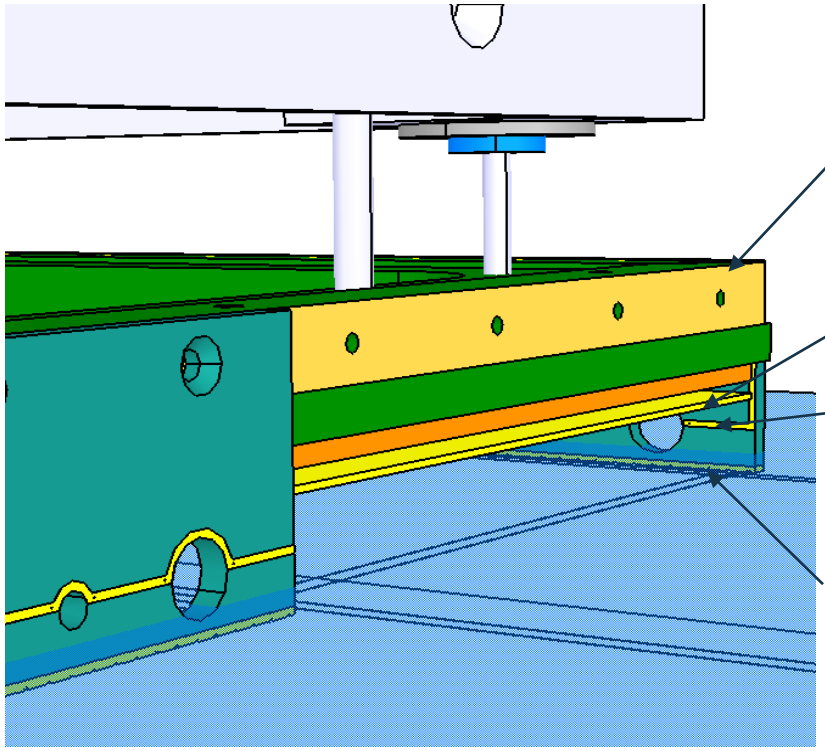
Excedent charge collection





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

Spark guides - Electrical protection

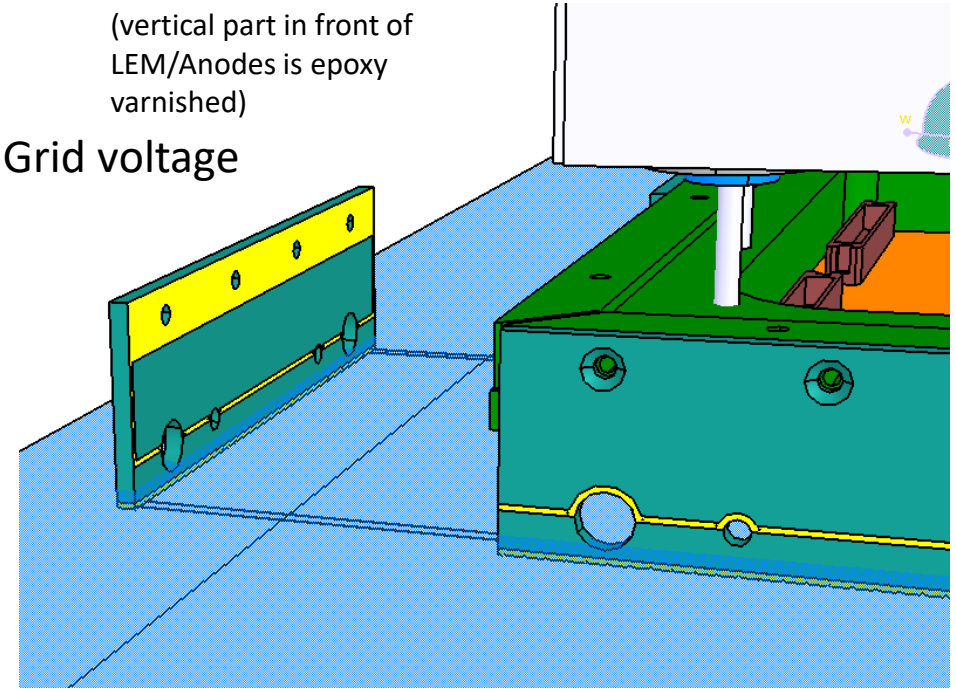


Conductive plate for ground chaining

LEM down voltage

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

Grid voltage

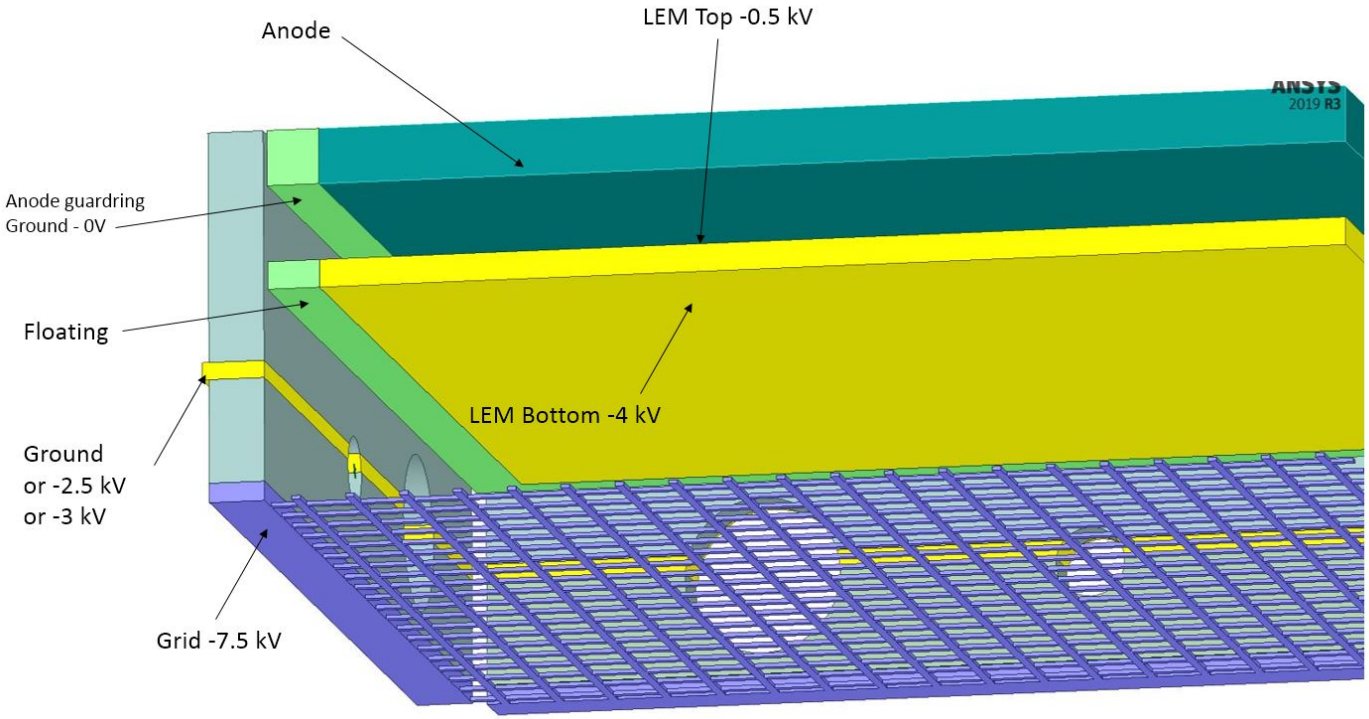


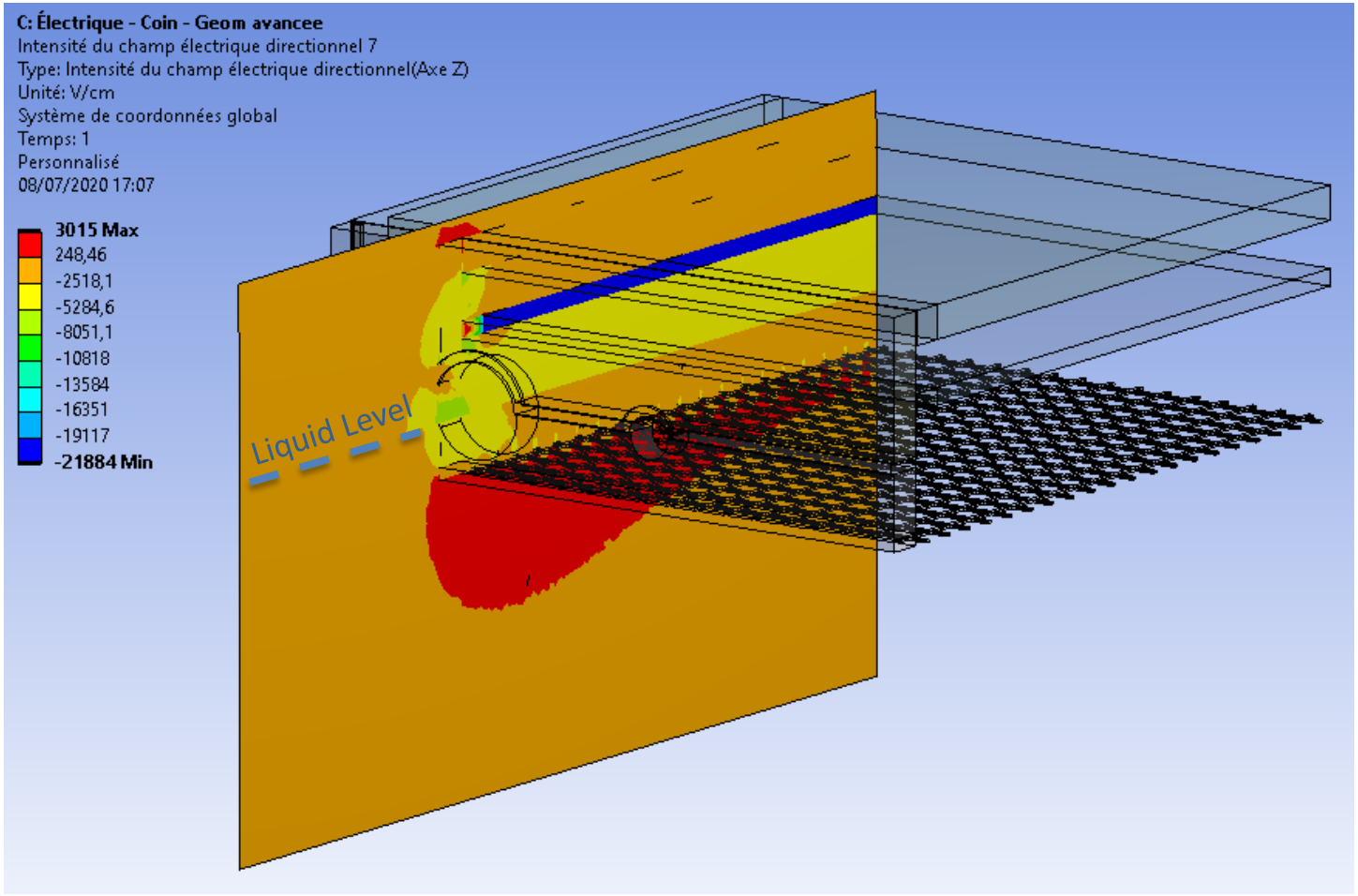
- To be validated by electrostatic simulations

SparkGuide : Evaluation of the field perturbation

- Vertical direction
- Corner of the CRP
- Nominal fields :
  - Gas : 3300 V/cm
  - Liquid : 2260 V/cm

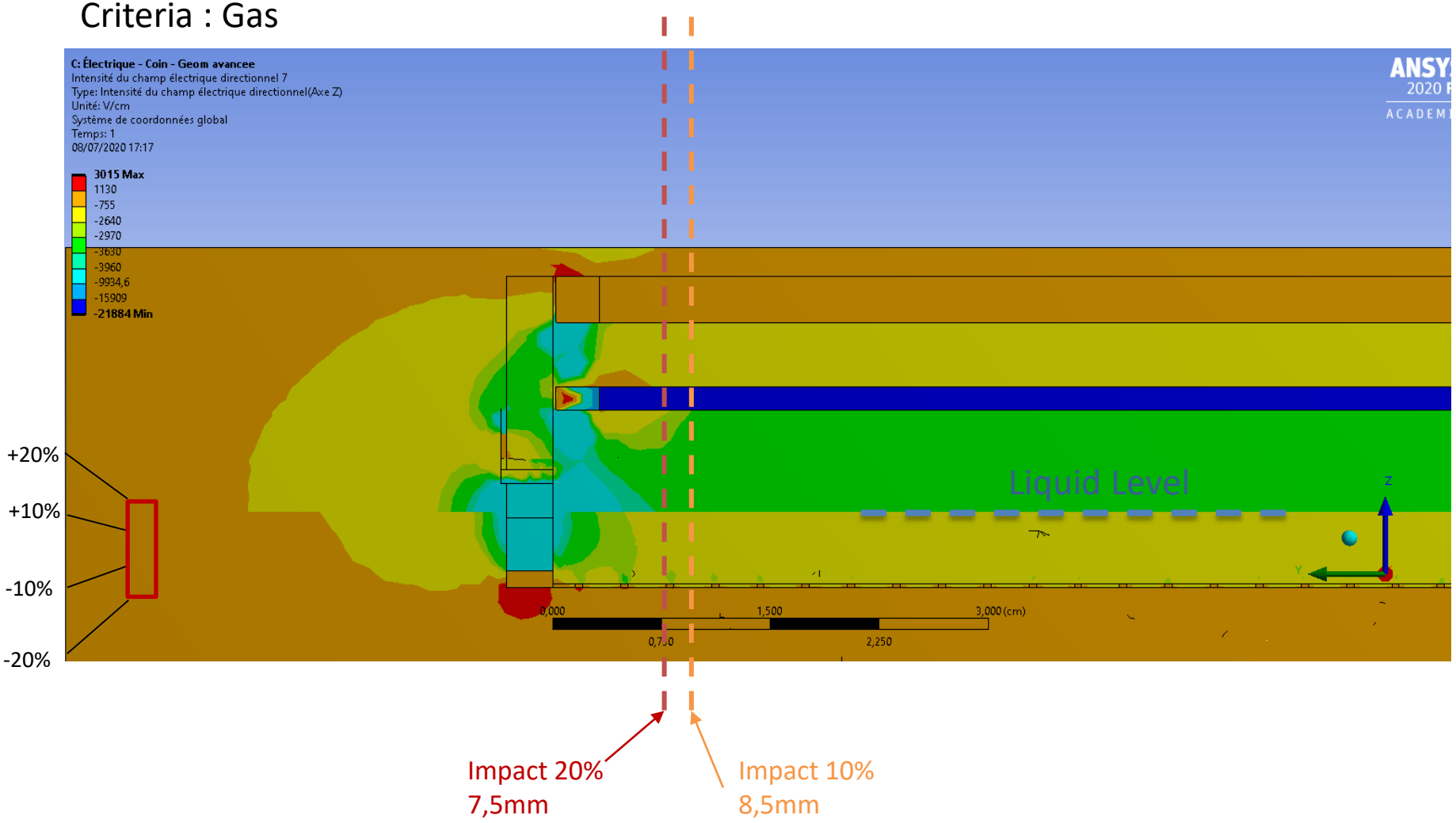
Material	Permittivity	Source
GAr	1.000513	From 3x1x1
LAr	1.505	MicroBoone
Copper	1000	High Value
Stainless Steel	1000	High Value
FR-4	3,5	Common value




C: Électrique - Coin - Geom avancee
Intensité du champ électrique directionnel 7
Type: Intensité du champ électrique directionnel(Axe Z)
Unité: V/cm
Système de coordonnées global
Temps: 1
Personnalisé
08/07/2020 17:07
3015 Max
248,46
-2518,1
-5284,6
-8051,1
-10818
-13584
-16351
-19117
-21884 Min
Liquid Level

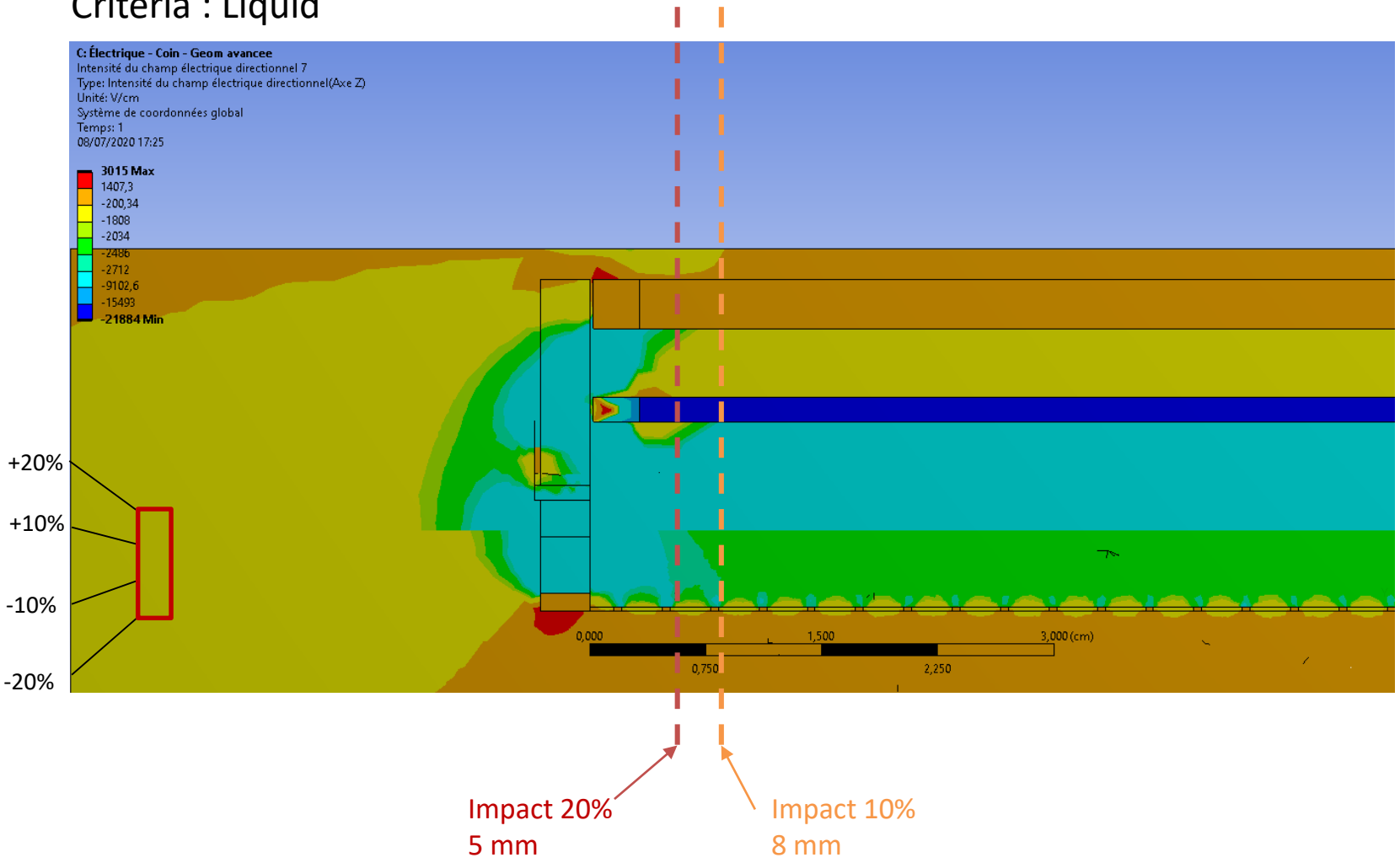
Spark guide : Floating (similar to the existing CRP)

Criteria : Gas



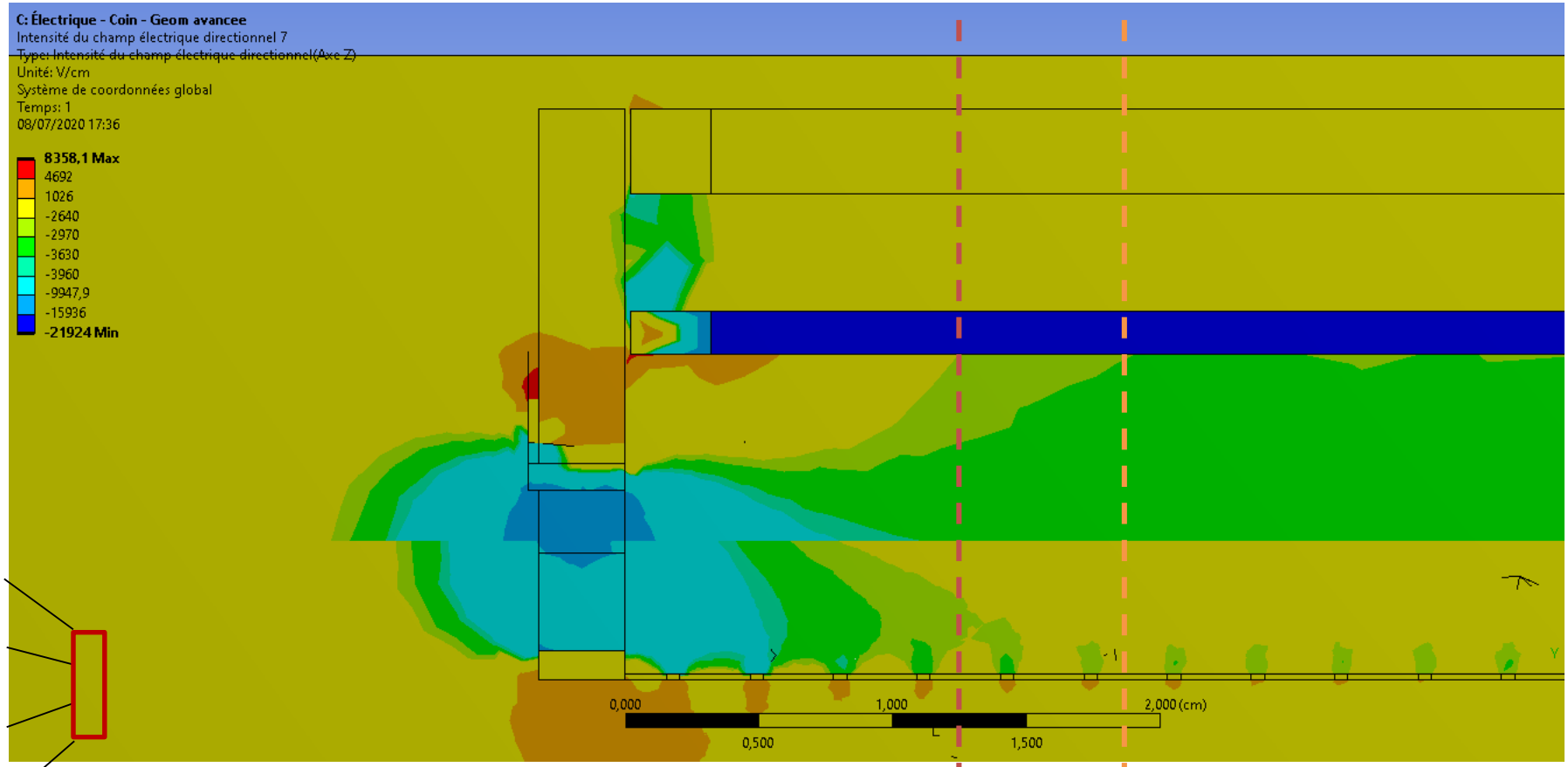
Spark guide : Floating (similar to the existing CRP)

Criteria : Liquid



Spark guide : Ground

Criteria : Gas



+20%

+10%

-10%

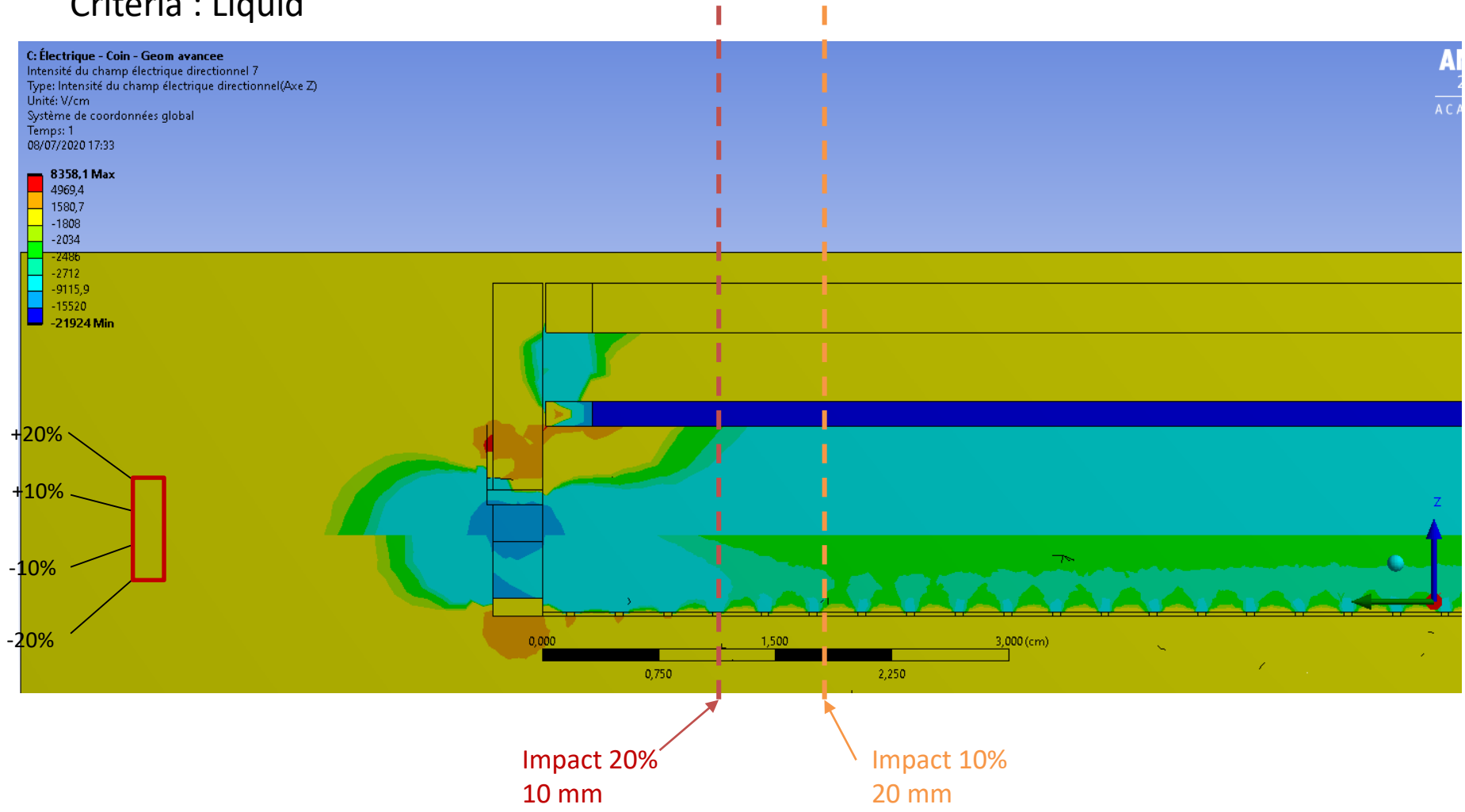
-20%

Impact 20%
12,5 mm

Impact 10%
18 mm

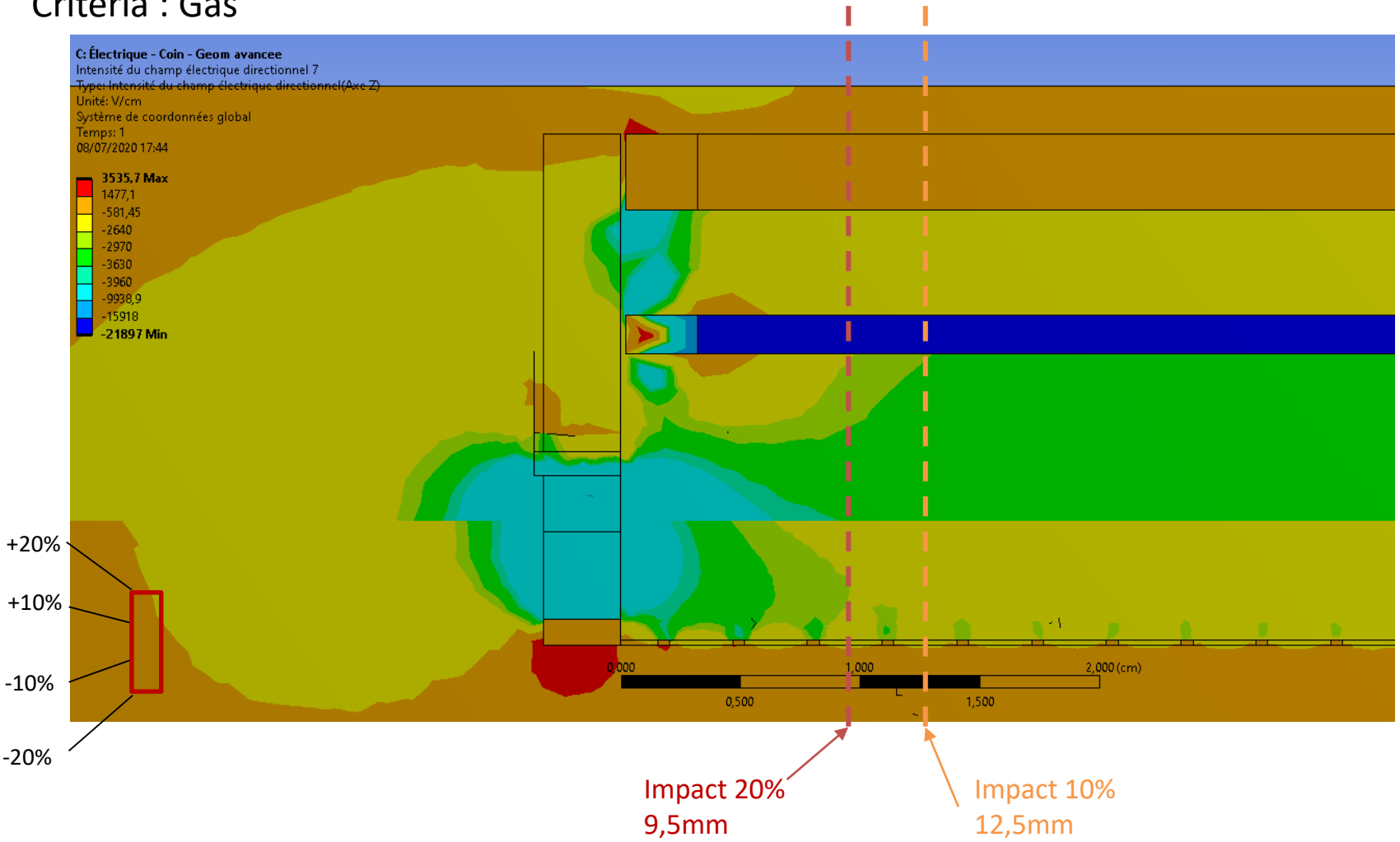
Spark guide : Ground

Criteria : Liquid



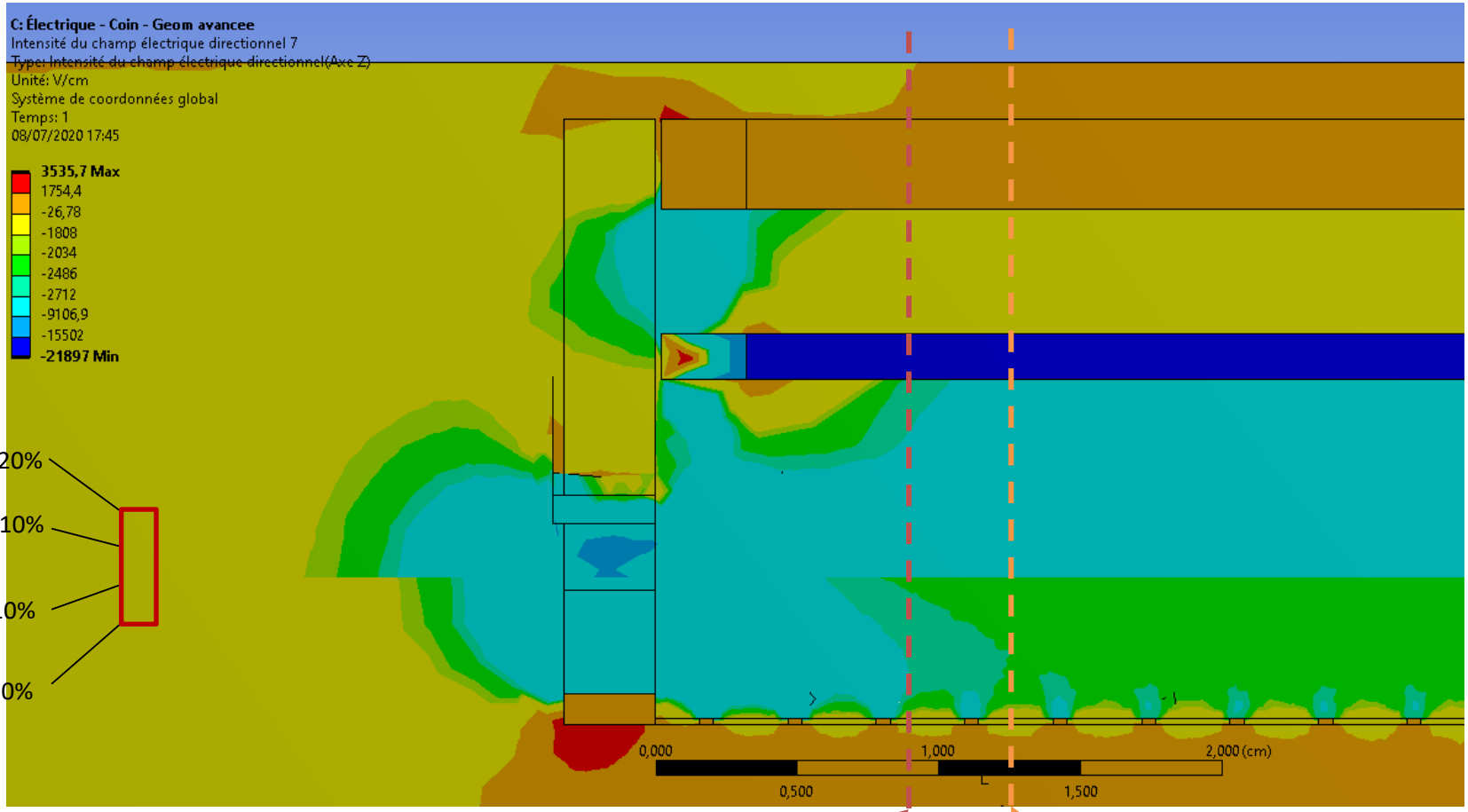
Spark guide : -2,5kV

Criteria : Gas



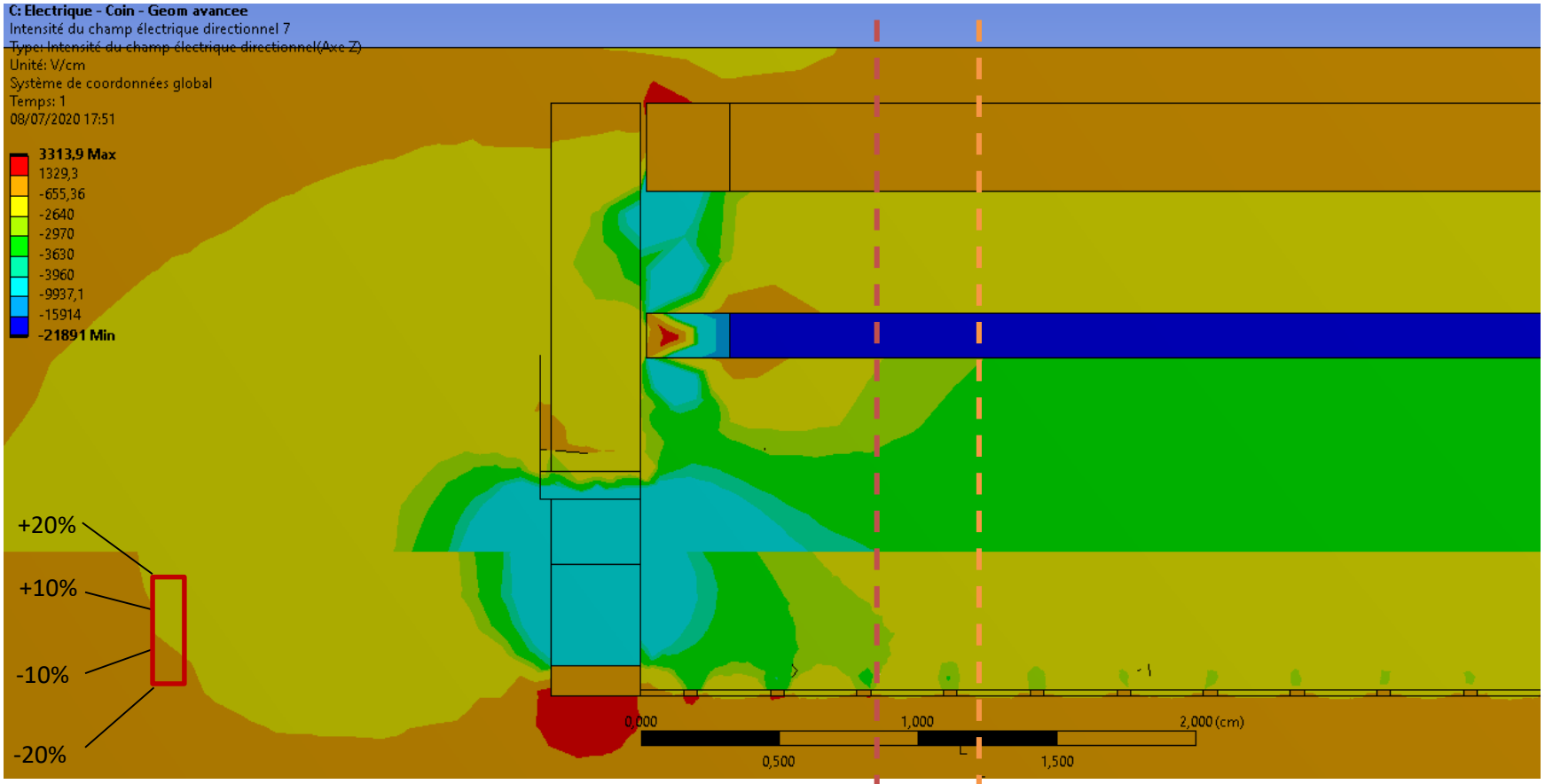
Spark guide : -2,5kV

Criteria : Liquid



Spark guide : -3kV

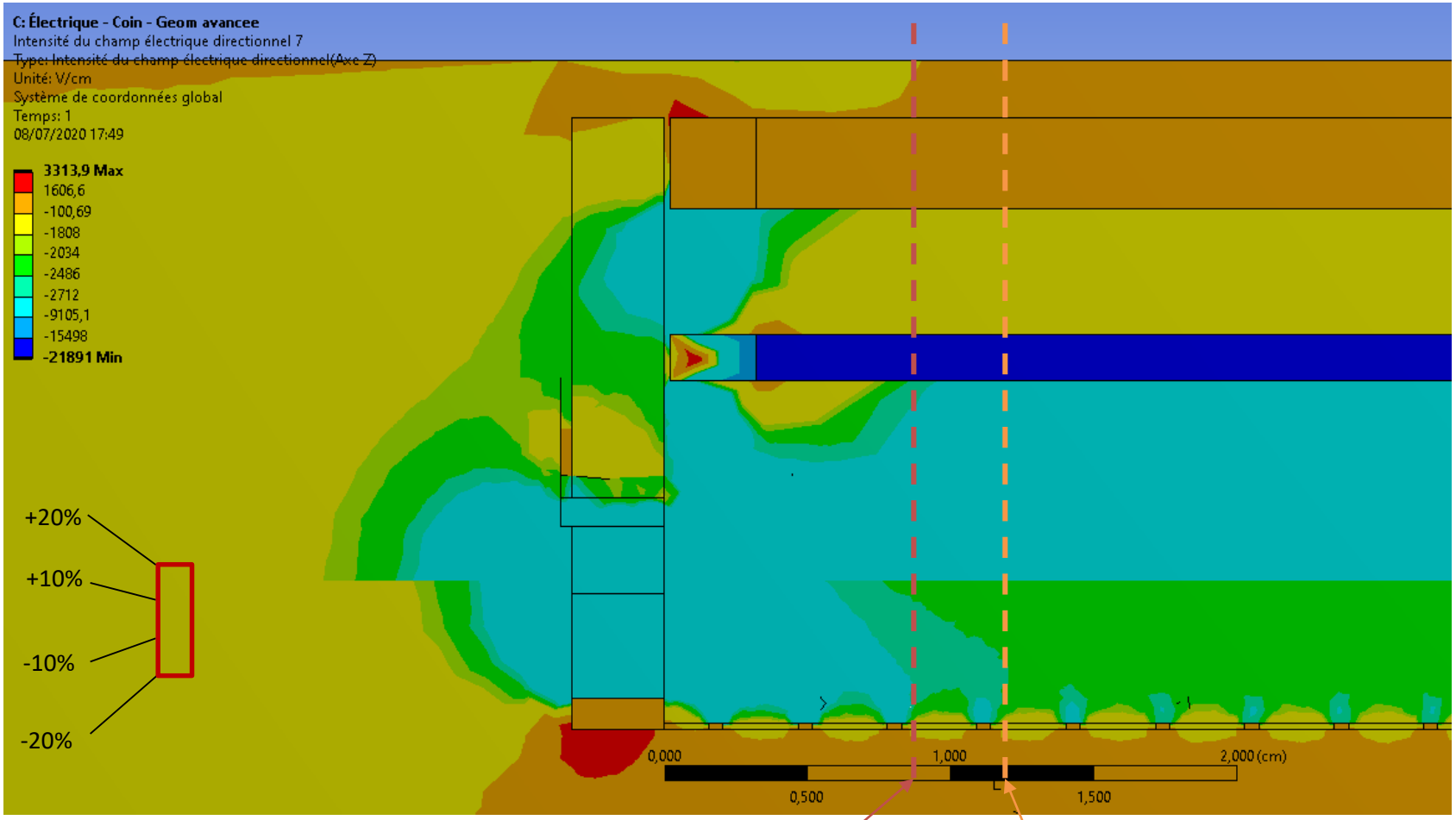
Criteria : Gas



Impact 20%
8 mm

Impact 10%
12,5 mm

Spark guide : -3kV
Criteria : Liquid



Distance from PCB in mm for vertical electrical field variation of >10% or >20%

Spark guide voltage

Impact Gas	10%	20%
Floating	8,5	7,5
Ground	18	12,5
-2,5kV	12,5	9,5
-3kV	12,5	8

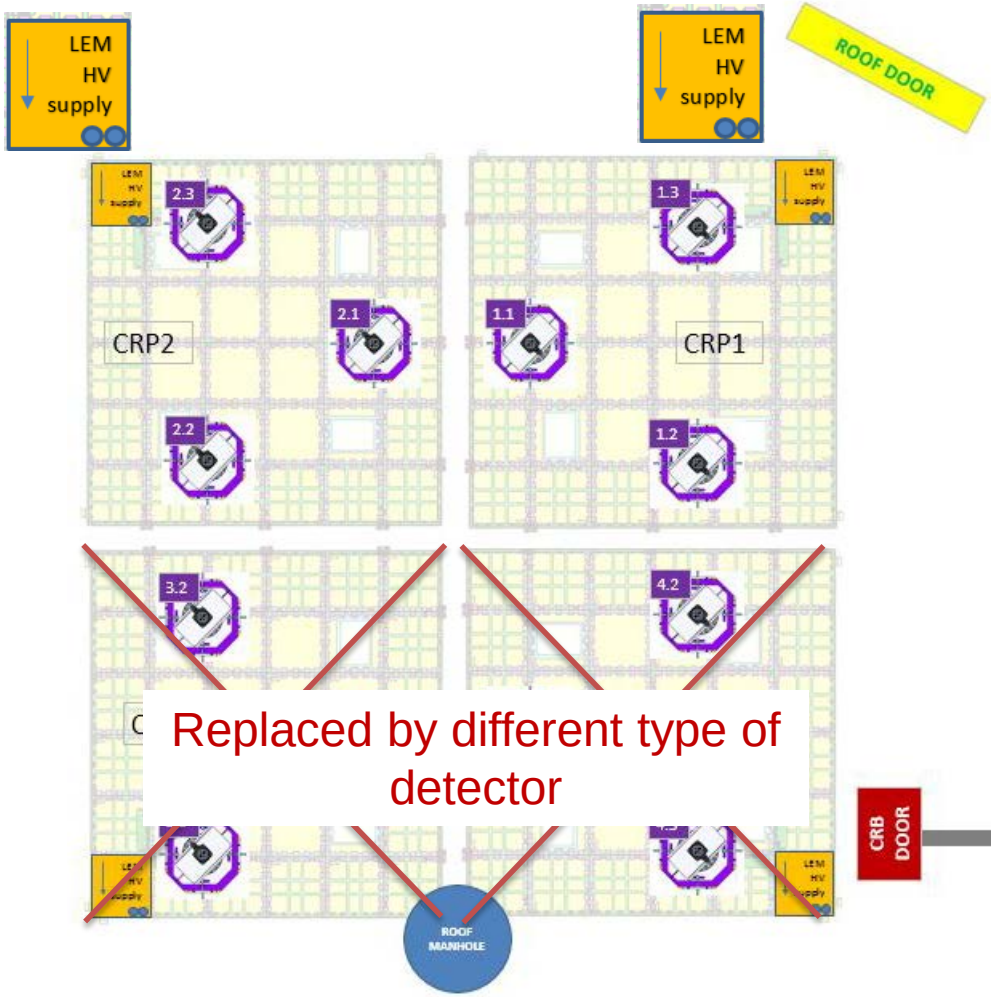
Impact Liquid	10%	20%
Floating	8	5
Ground	20	10
-2,5kV	12,5	9
-3kV	12	8

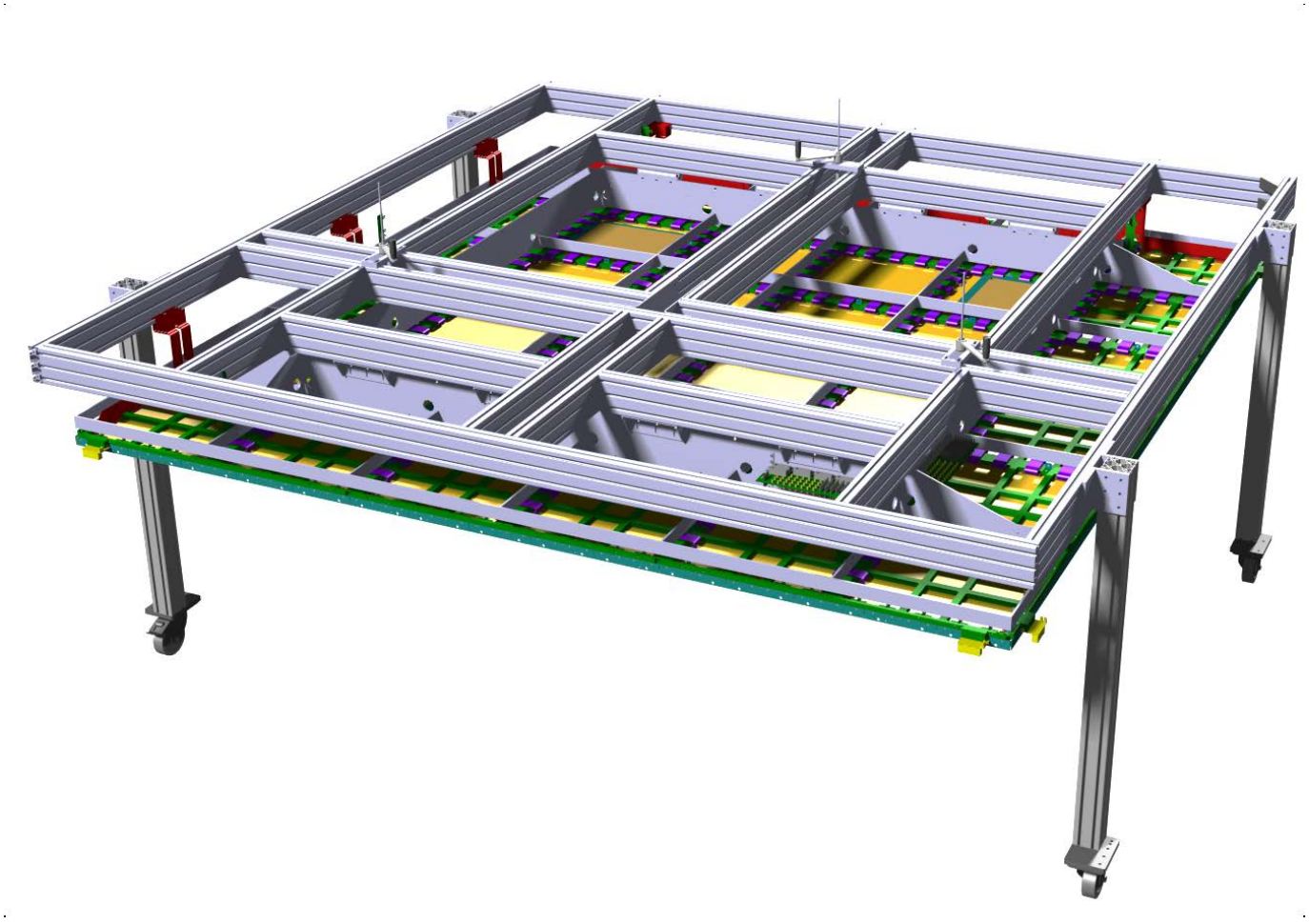
Parameters and conditions to apply for optimisation have to be agreed

ProtoDUNE phase 1 - transition

- Hypothesis: All CRPs will be dismanteled on place and evacuated without transport box
- 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

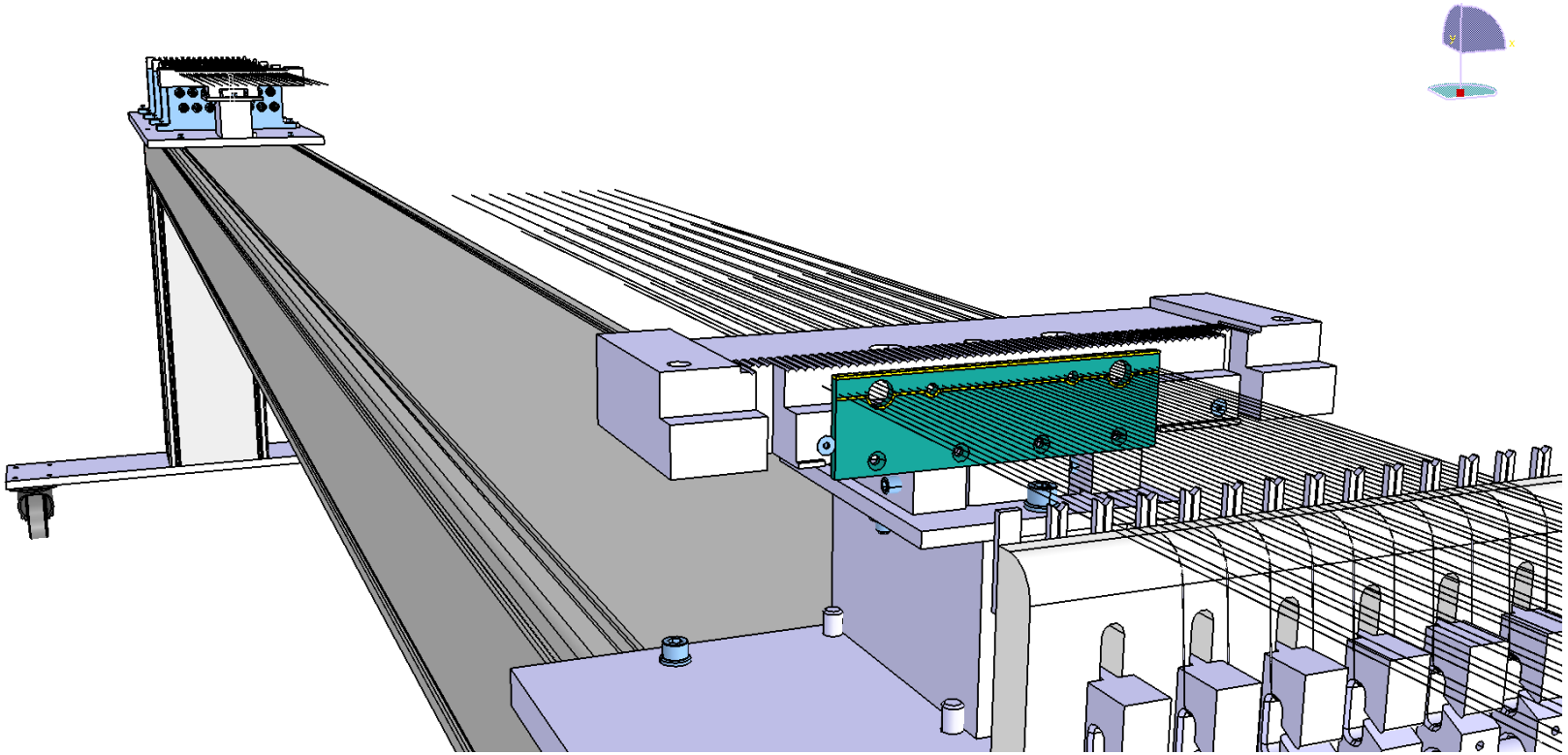
--> updated "Cabling layout" file available, to be finalized with cable lengths :





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

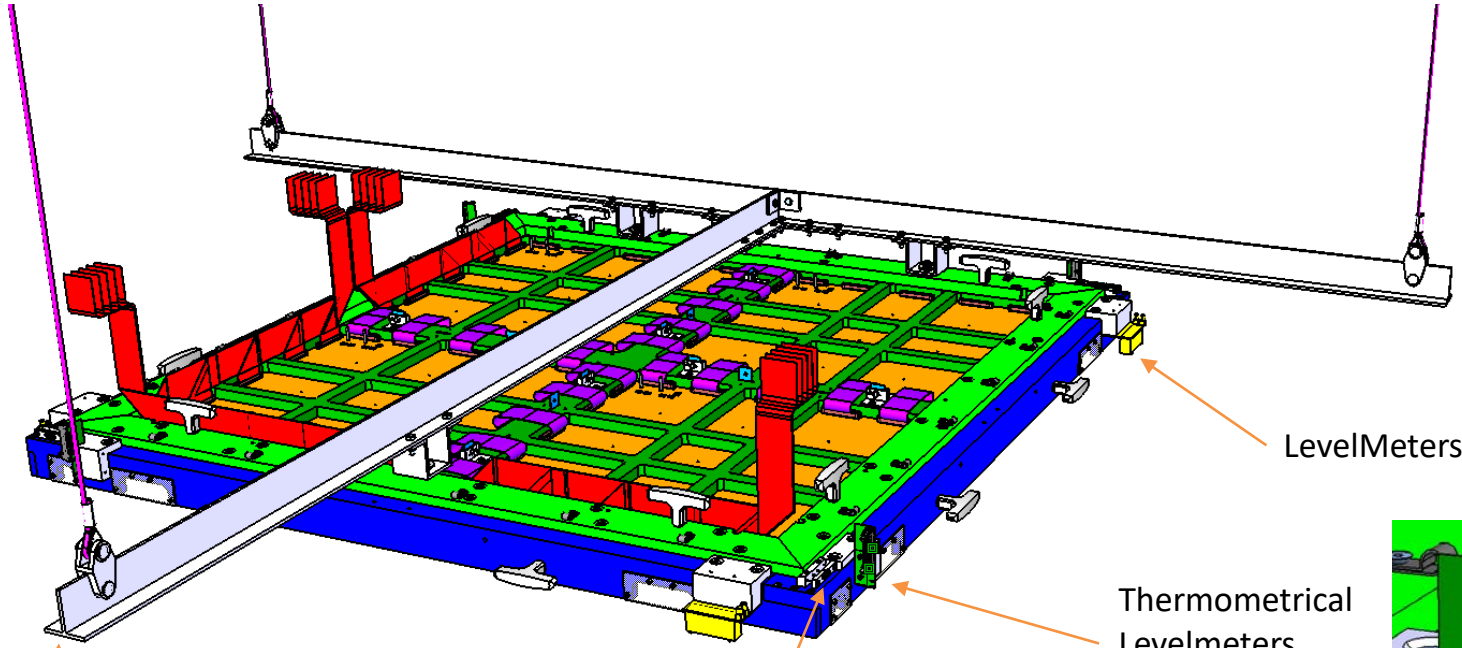
Grid production tool

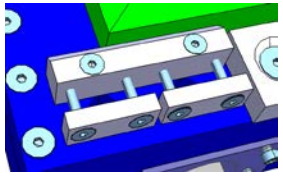


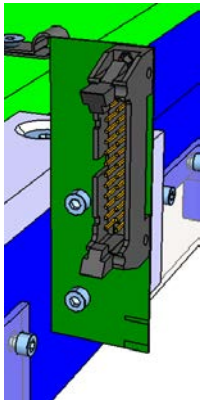
- Minor changes in grid production tooling are necessary (support blocs machining)
- Storage system for grid subsets have to be designed for 2 - 3 full CRPs.

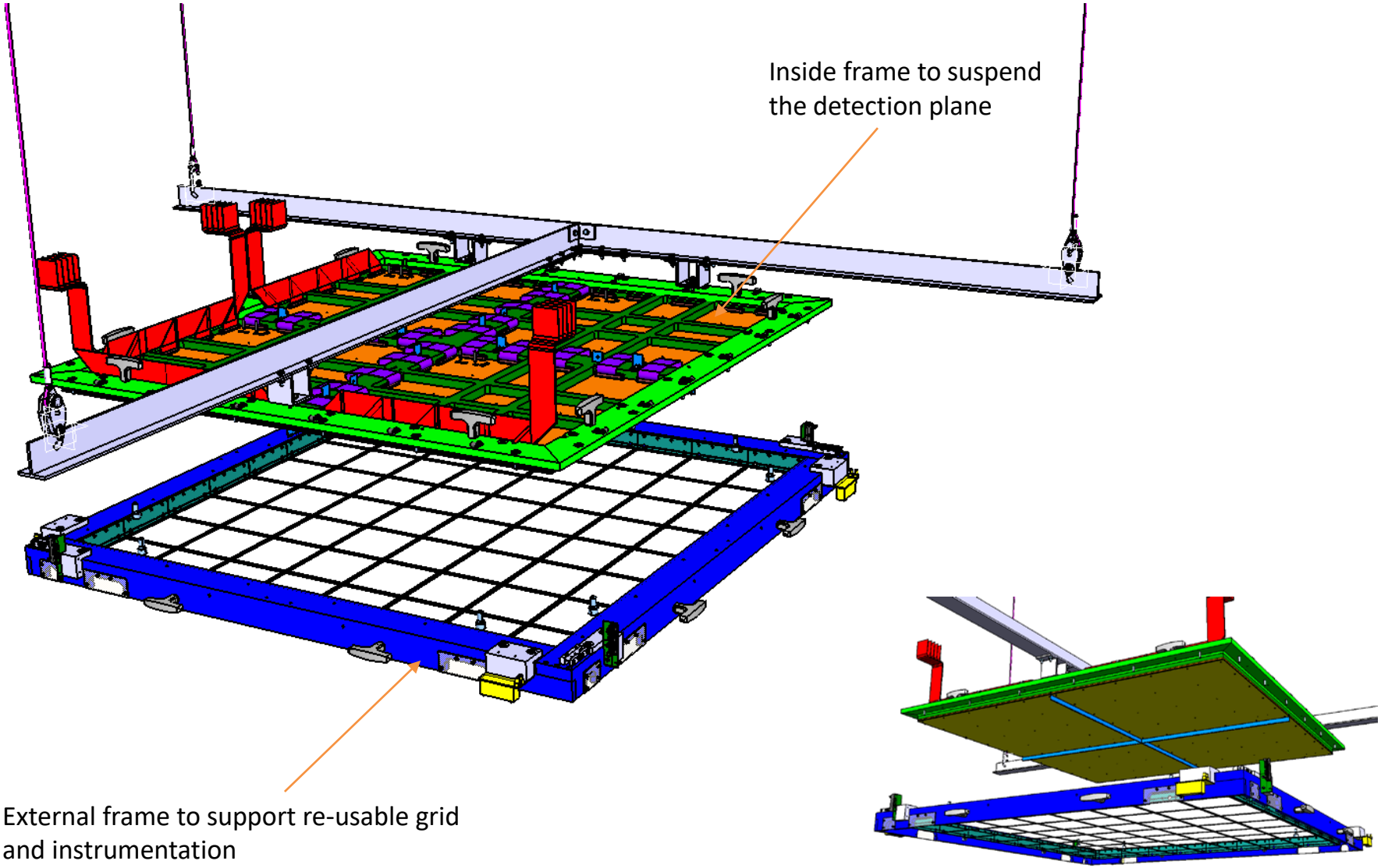
Mini-CRP : 1x1 meter facility to be used in ColdBox to validate :

- New LEM / Anodes design
- Instrumentation
- SparkGuides / Charge collection combs

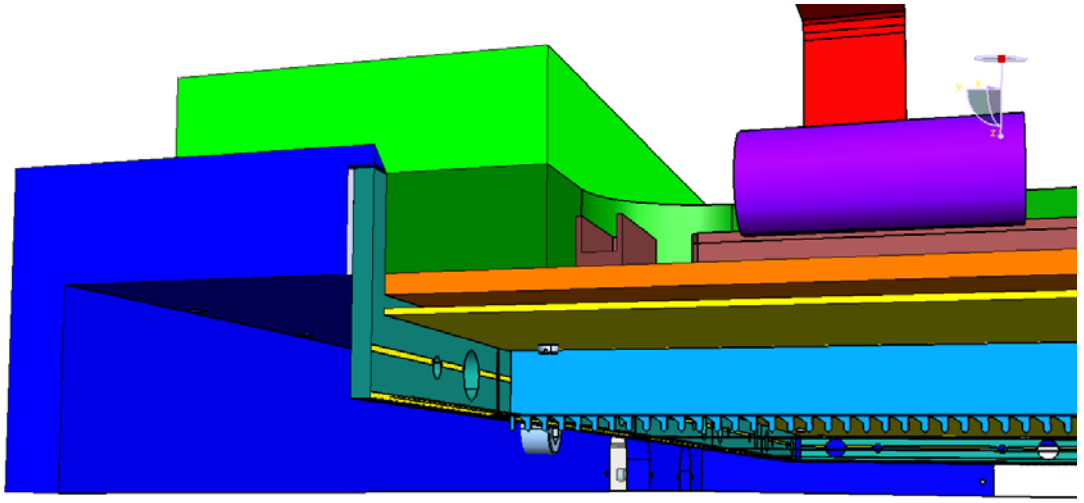


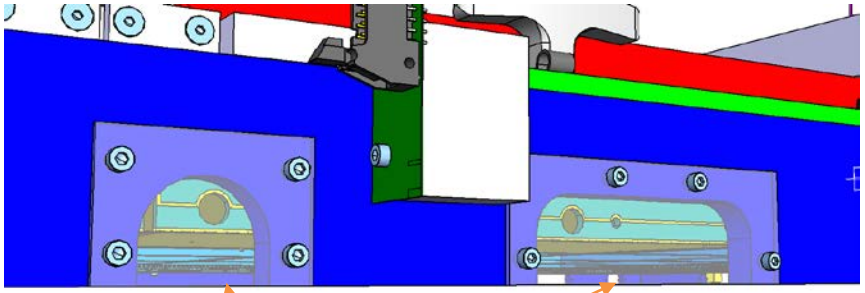





Inside frame to suspend
the detection plane
External frame to support re-usable grid
and instrumentation

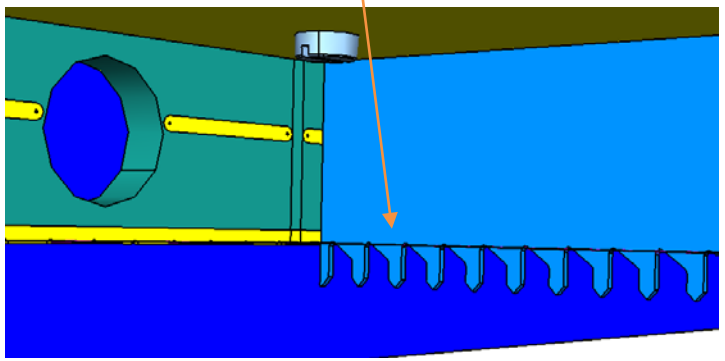
G10 Support, Mini CRP
can be placed on a table





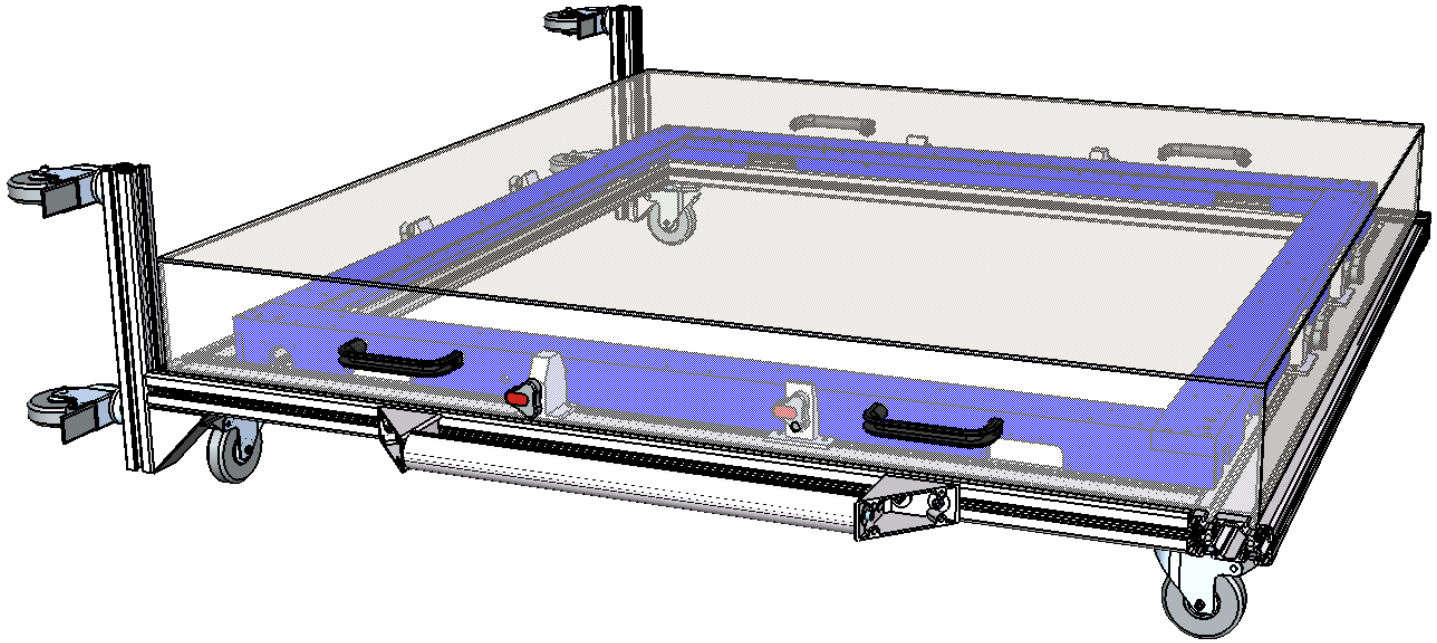
Windows
for camera

Removable combs



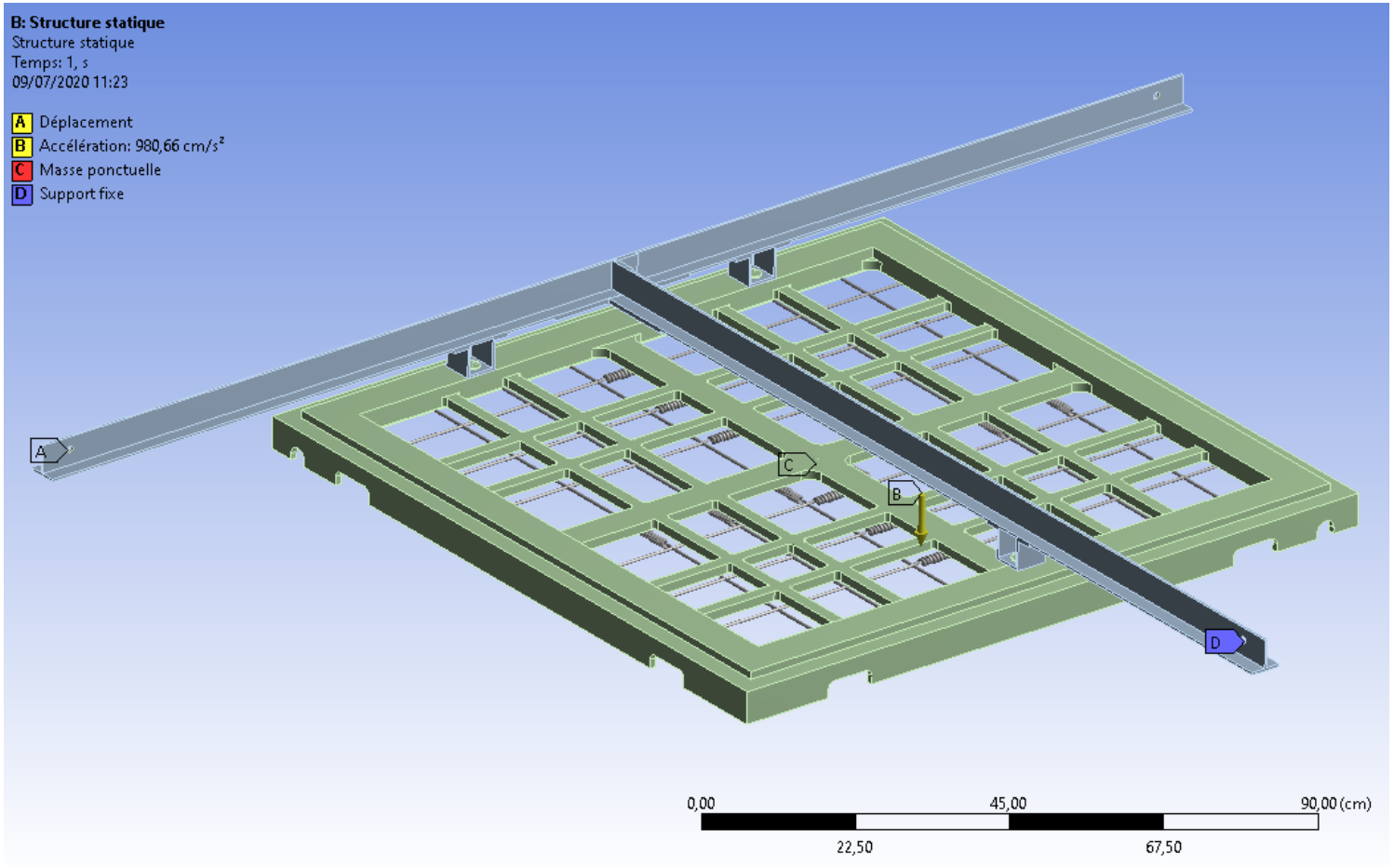
Transport box, to avoid dirts and damages

- External dimensions : 1438x1425x372 mm (to verify if compatible with B.182 elevator)
- Total weight with Mini-CRP : ~ 80 kg



Model is including :

- LEM/Anodes mass
- Gravity
- Cable suspensions
- Extraction grid mechanical tension (based on actual tension)
- Liquid temperature
- Thermal gradient in the gas (2°/cm)

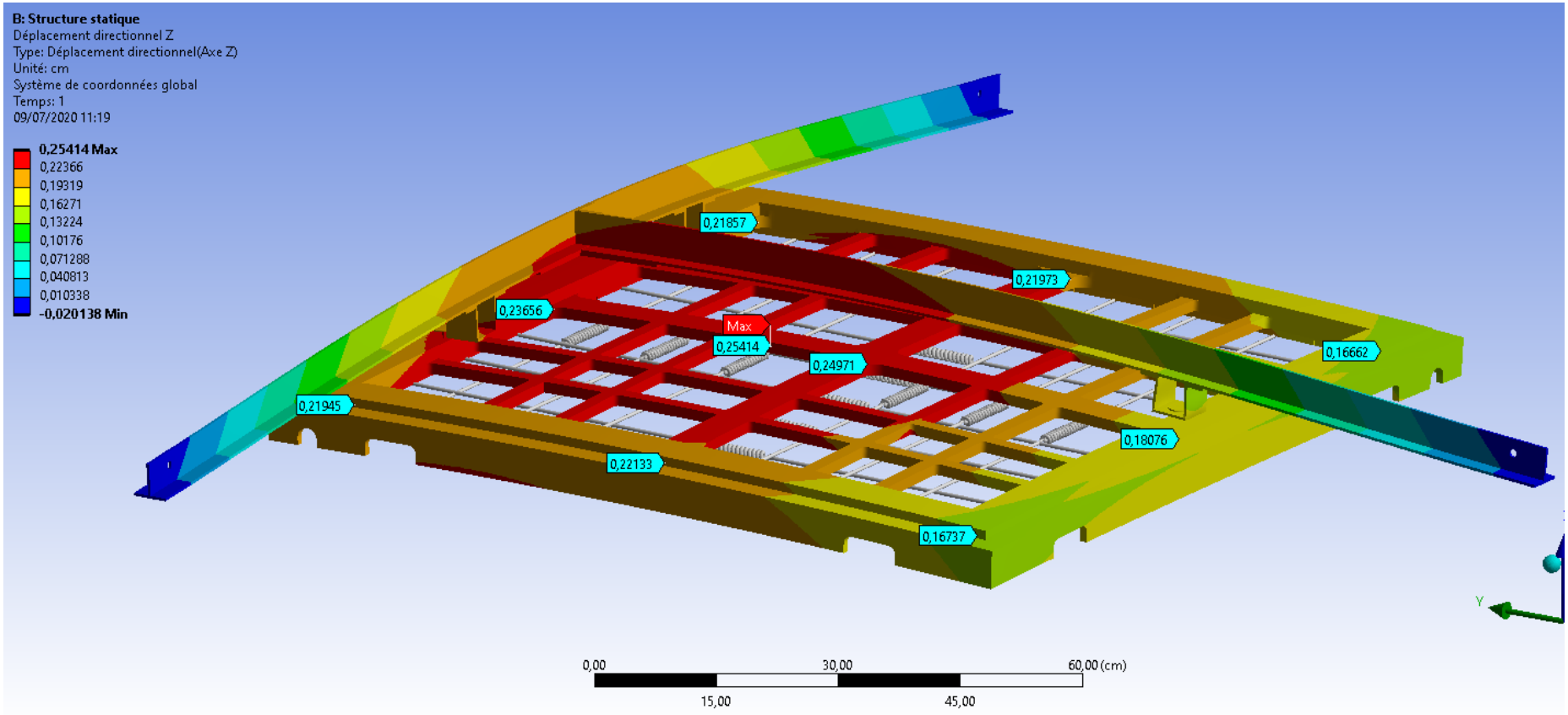


Displacement results : 0,1mm

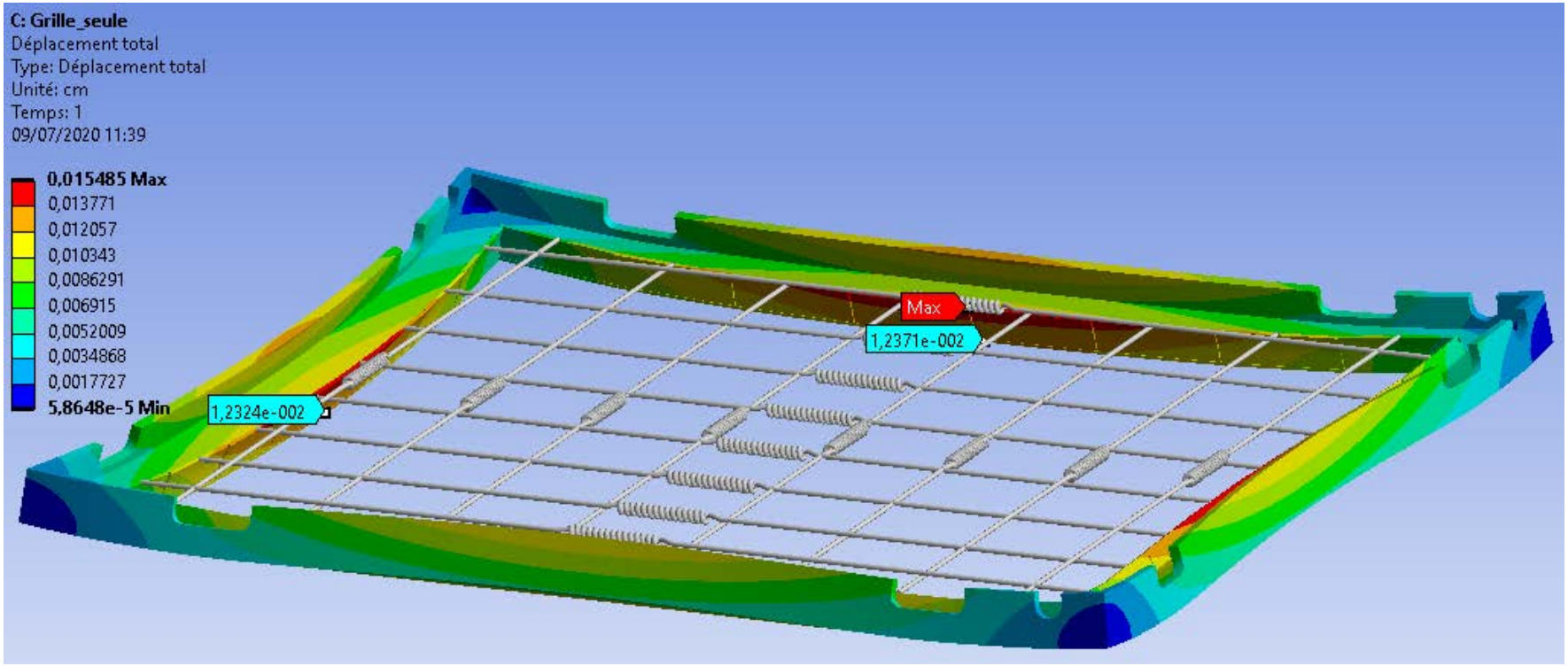
Vertical direction, max planarity defect

Average stress in the structure : 20-60MPa

- Mostly caused by beams thermal deformation
- Initial planarity defect may be corrected by local wedging or weighting



Deformation due to grid tension is insignificant



Construction - installation planning