ND280 meeting – CERN – 2018/07/25

TPC composite material Field Cage status report

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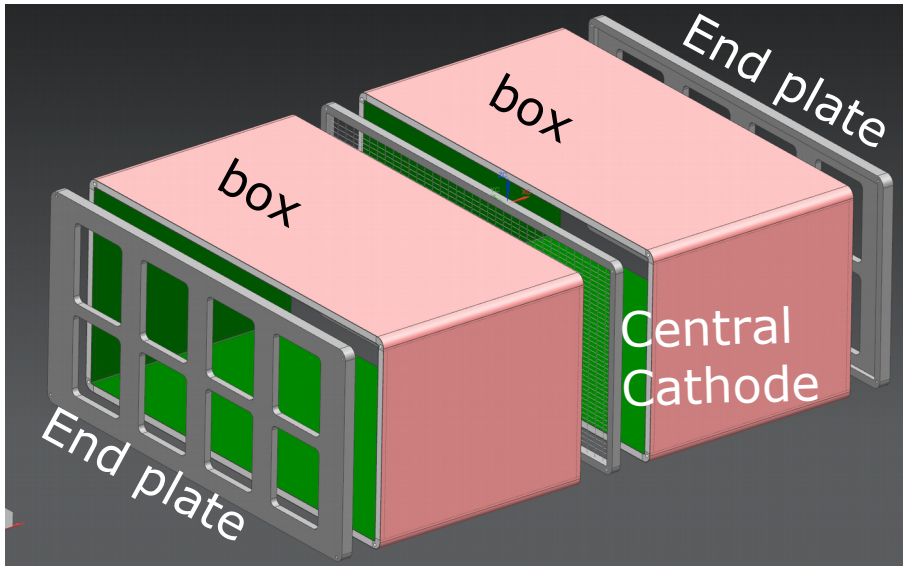
Overview

- introduction
- about the prototype FC
- a proposal for the HA TPC FC+cathode design

New TPC design – Concept and Specs

Thin walls TPCs obtained by joining **TWO boxes** made of **composite material**



Walls composite structure to define active gas volume and to provide mechanical support to electrodes. Main specs:

→ gas tightness → O_2 level below O(1ppm)

→ electric insulation against breakdown with cathode V max of O(30kV)

→ internal surfaces (E field shaping strips) flatness better than O(100μm) considering O(5mbar) overpressure (and gravity)

→ alignment of strips plane (x-y) || end-plates || cathode better than O(100μm) → relative to drift distance at level O(10^{-4})

TPC design concepts – Box wall structure

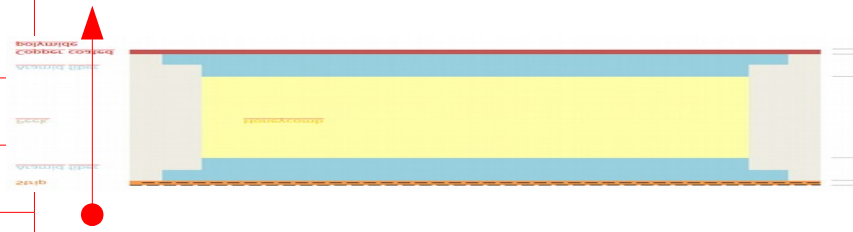
- Rectangular TPC of 200 (B field / drift dir.) x 180 (beam dir.) x 85 (height) cm^3
- Aiming at thin wall (~3cm) made of low Z composite material (few % X_0)

Aramide Fiber fabric based layer stack

outer layer

inner layer

	Material	Thickss (mm)
	Copper coated polymide film	*~ 0.15*
	Aramid Fiber Fabric (Kevlar)	*2.00*
	Aramide HoneyComb panel	*30.00*
	Aramid Fiber Fabric (Kevlar)	*2.00*
	Polymide film (insulation)	*~ 0.10*
	Strips (double later) on Kapton foil	*~ 0.15*
	TOTAL RADIATION LENGHT **~ 2%** X_0	*~34.40*

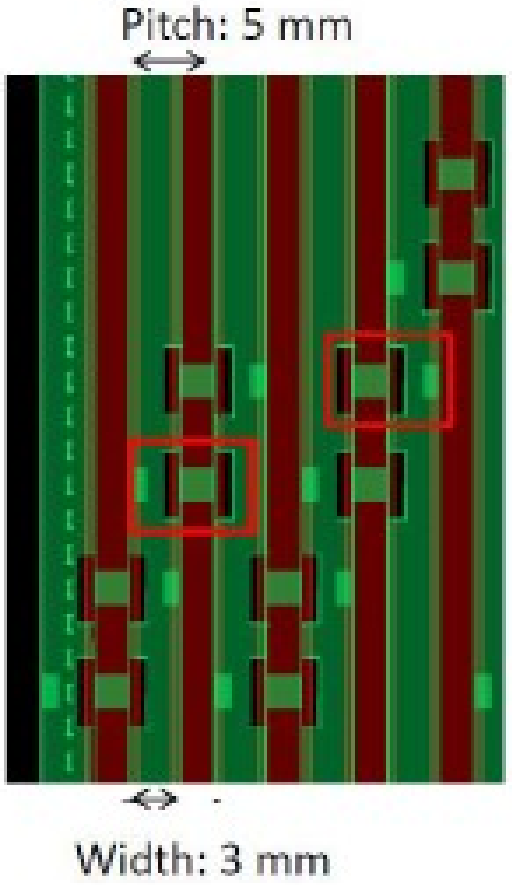


Box wall structure fixed → to be tested on the TPC prototype

Note: aiming at a thin and low Z composite wall:
- peels symmetry about honeycomb (HC) core to minimize deformations (overpressure 5mbar)

- Aramid Fiber (Kevlar) allows very simple stack:
  - electical insulation
  - mechanical stability: from simulation get deformation well below O(150μm)
  - acceptable relative rad. length (2%)

TPC design concepts – Strip design



- double sided
- mirror strips
- all resistors on inner side
- cut marks all 5 cm on inner side
- cross marks for alignment on mirror strip
- foil dimensions currently: ~55x220 cm

ILC TPC Design

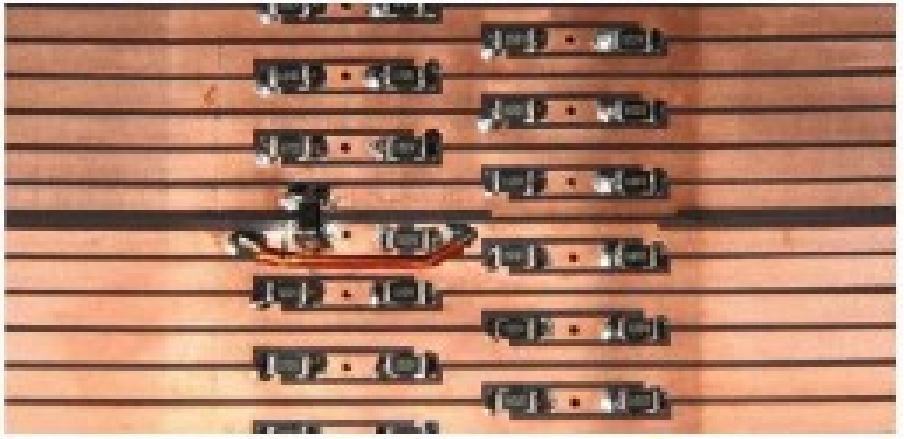
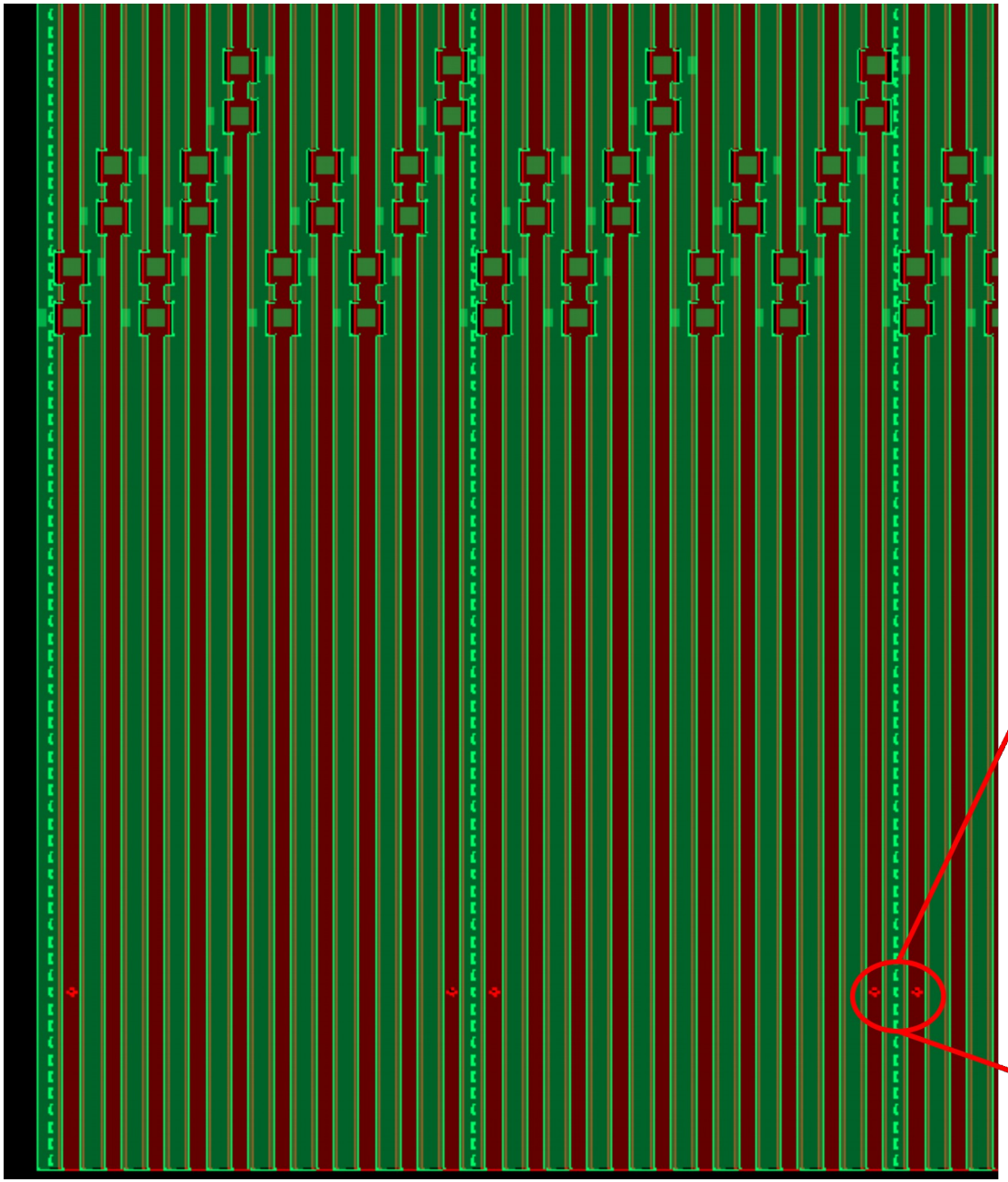


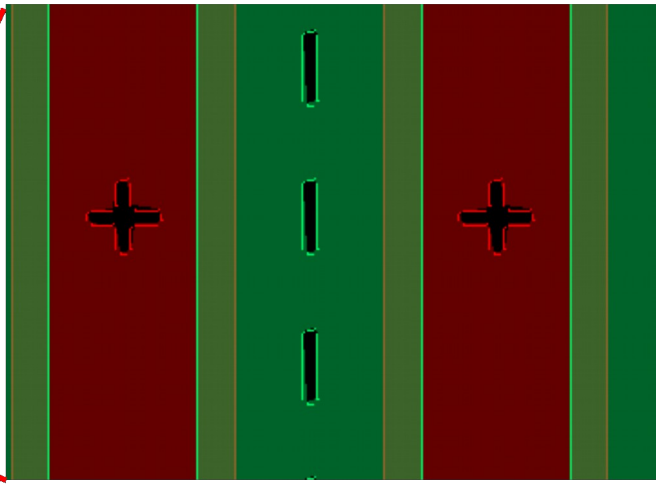
Figure 5.13: *Resistor chain on the field cage at the central connection between the half boards*

TPC design concepts – Strip design



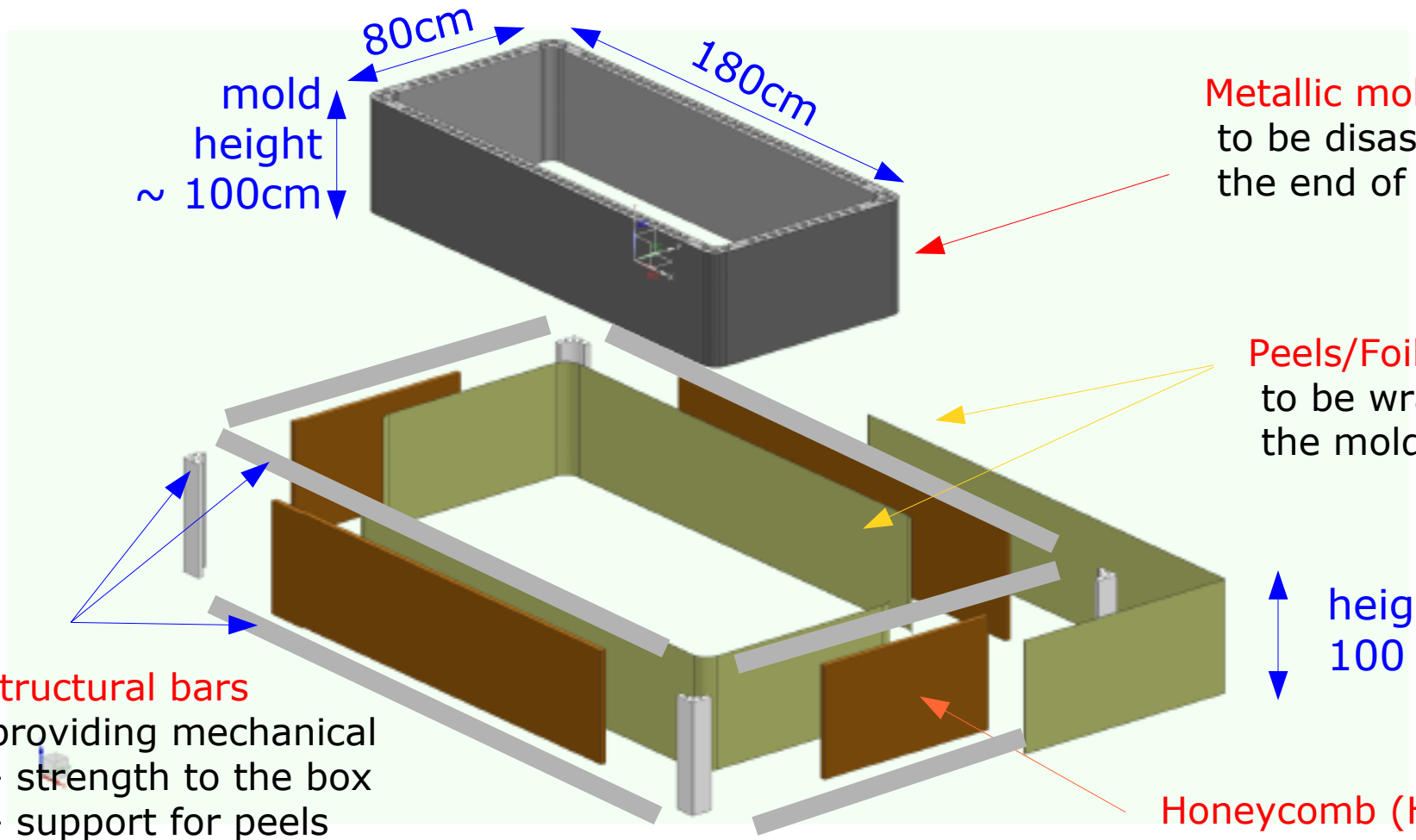
- designed at IFAE

- 4 foils ordered at CERN
  for tests on prototype
  (delivery date → early June)



Prototype TPC FC in composite material

- mold design
- detailed procedure definition



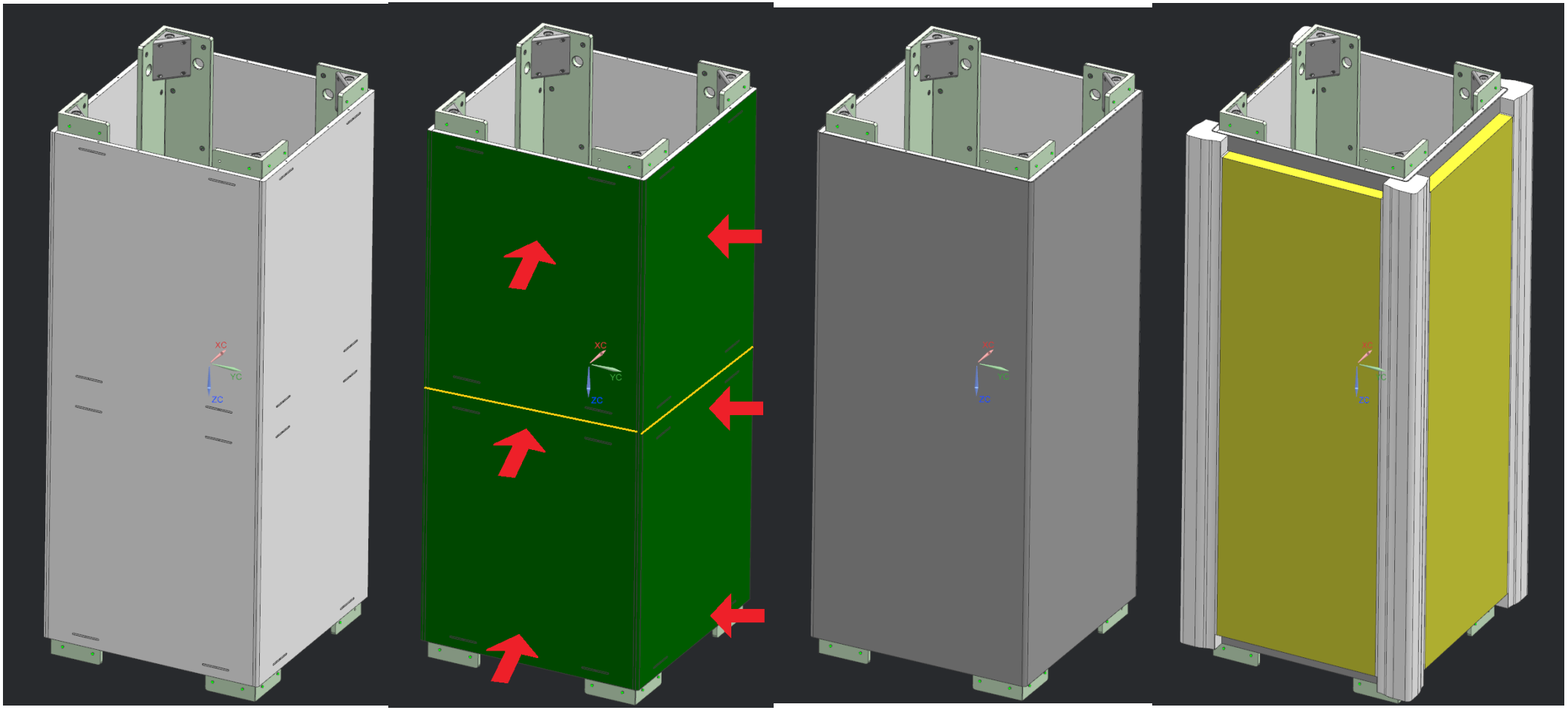
Procedure for the composite prototype FC

bare mold

1st layer (most internal)
→ 2 strip folis 50cm
(height) x 200cm (length)

2nd layer (outward)
→ single kevlar foil
100cm (height)
x 200cm (length)

3rd layer (outward)
→ Honecomb panels x4
+ Angular bars (x4)

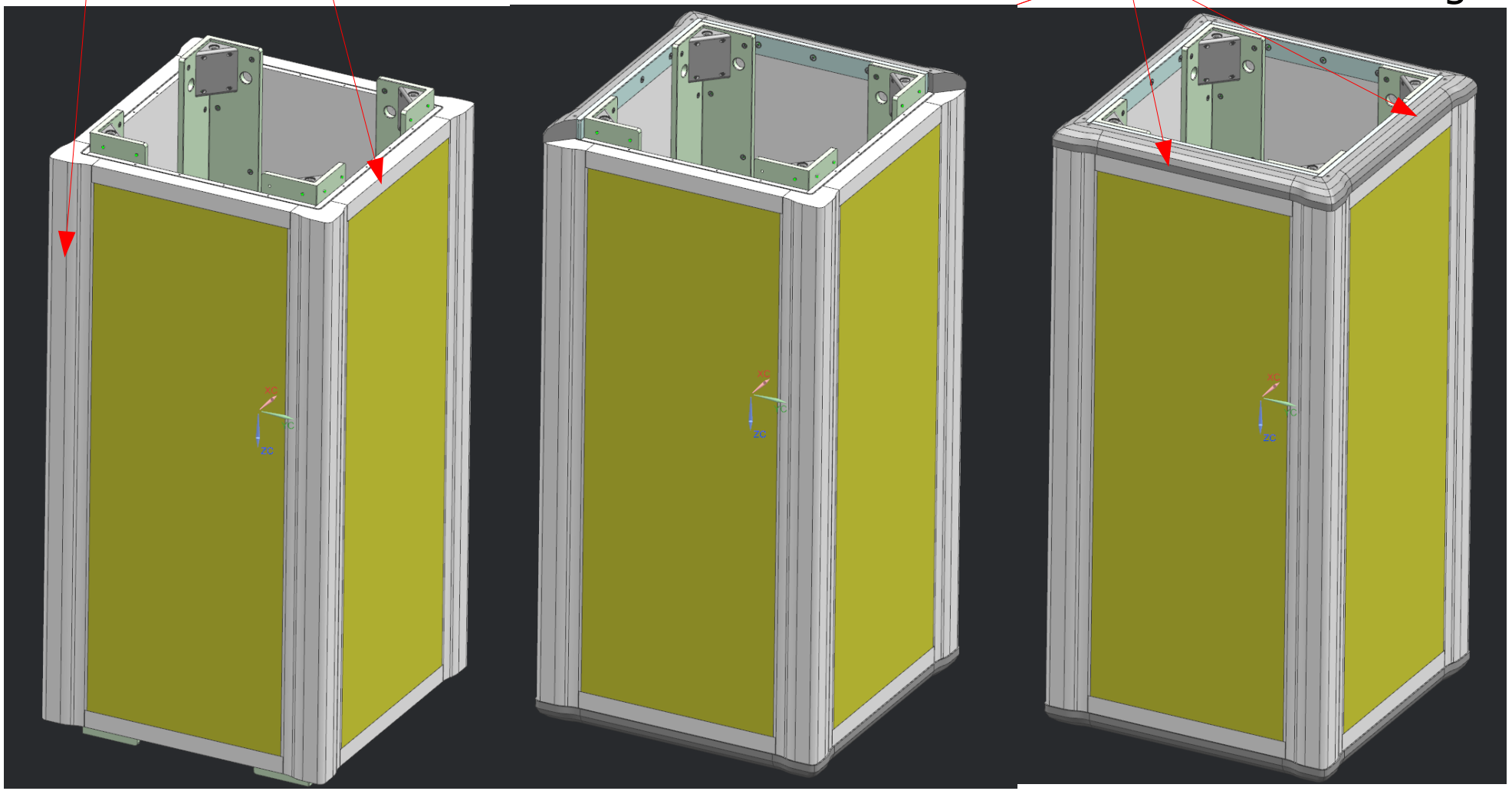


Procedure for the composite prototype FC

Corner bars

+ Edge bars

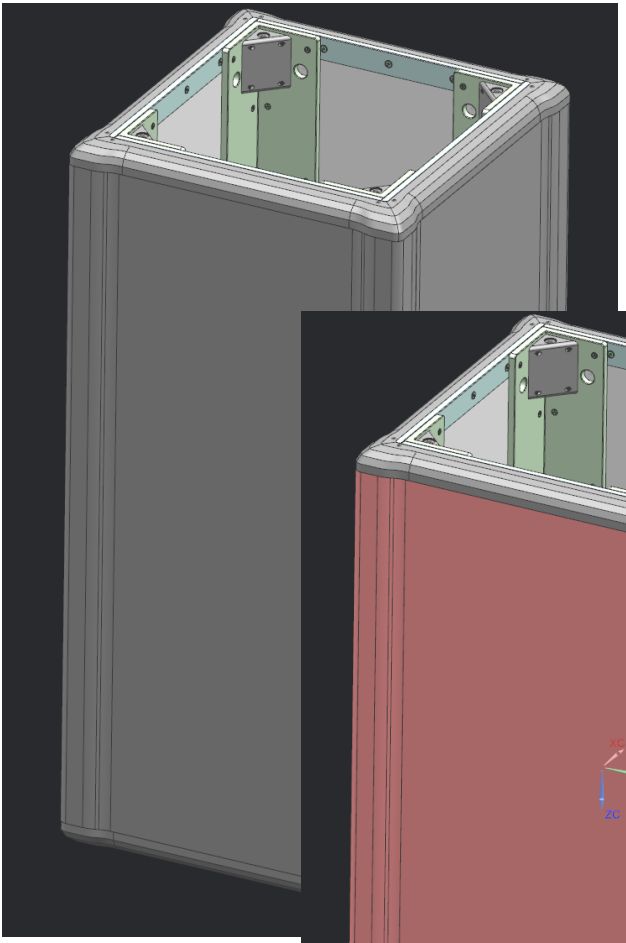
Brakets → for keeping egde bars in position & protecting vaccum bag



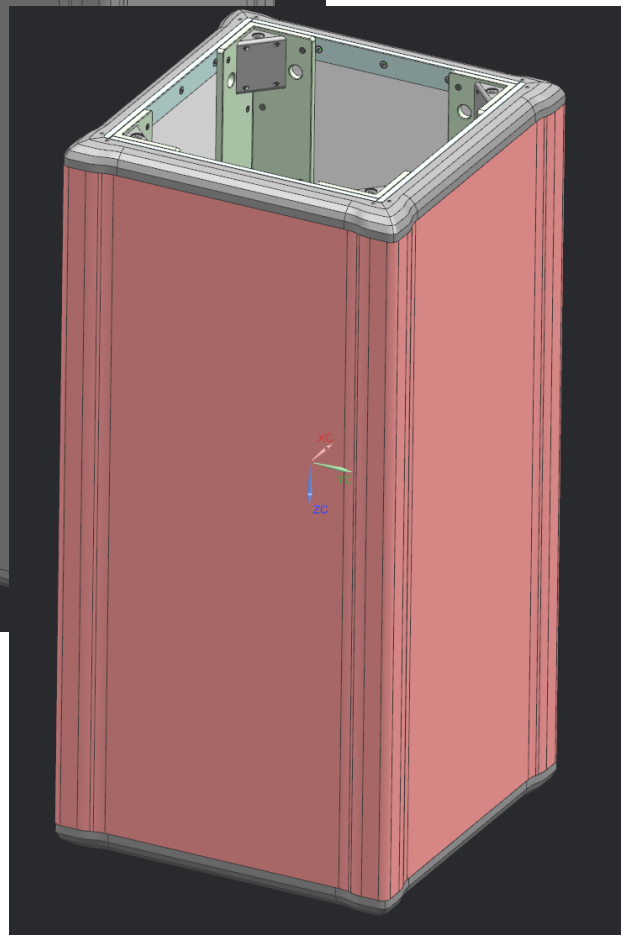
Note: bars in peek or Aluminum

Procedure for the composite prototype FC

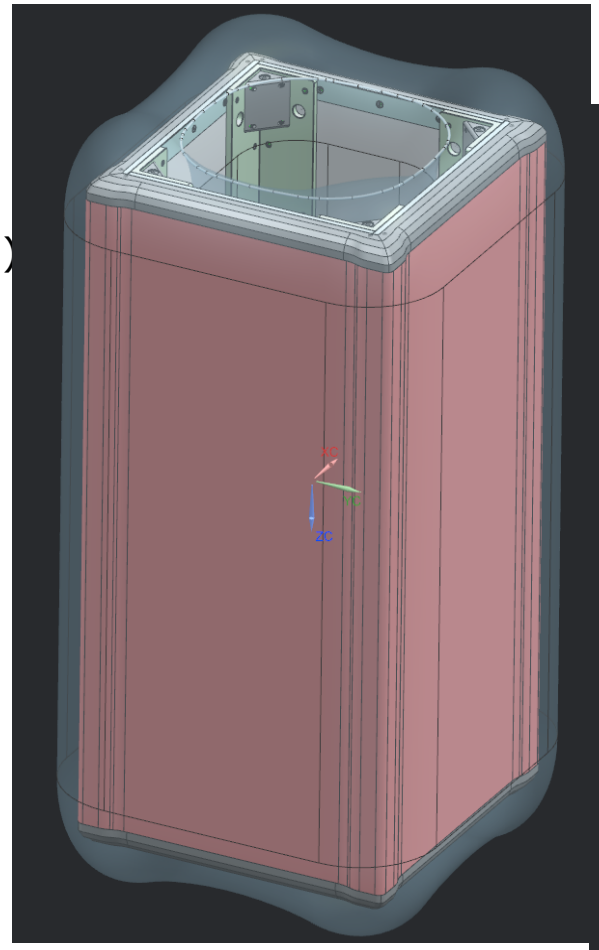
4th layer (outward)
→ single Kevlar layer



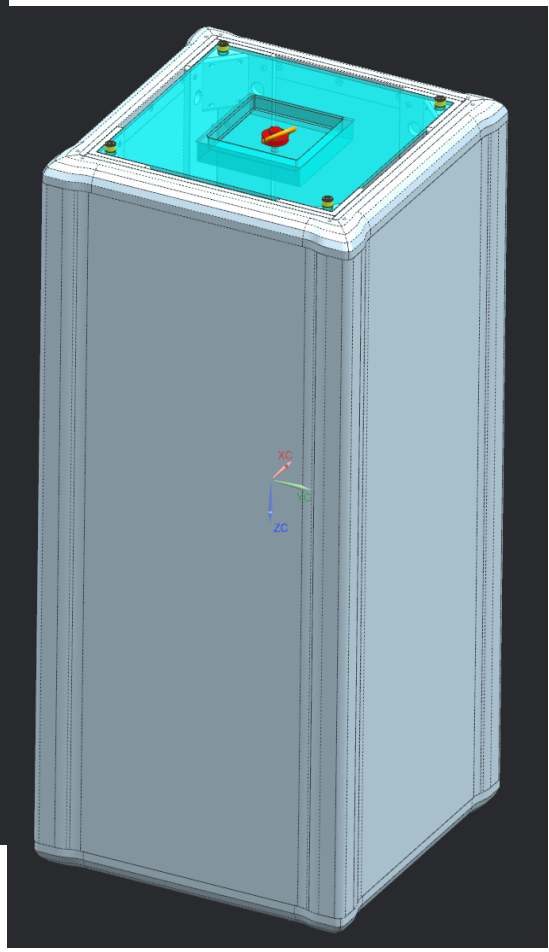
5th layer (outward)
→ kapton/copper layer



+ toroidal vacuum bag



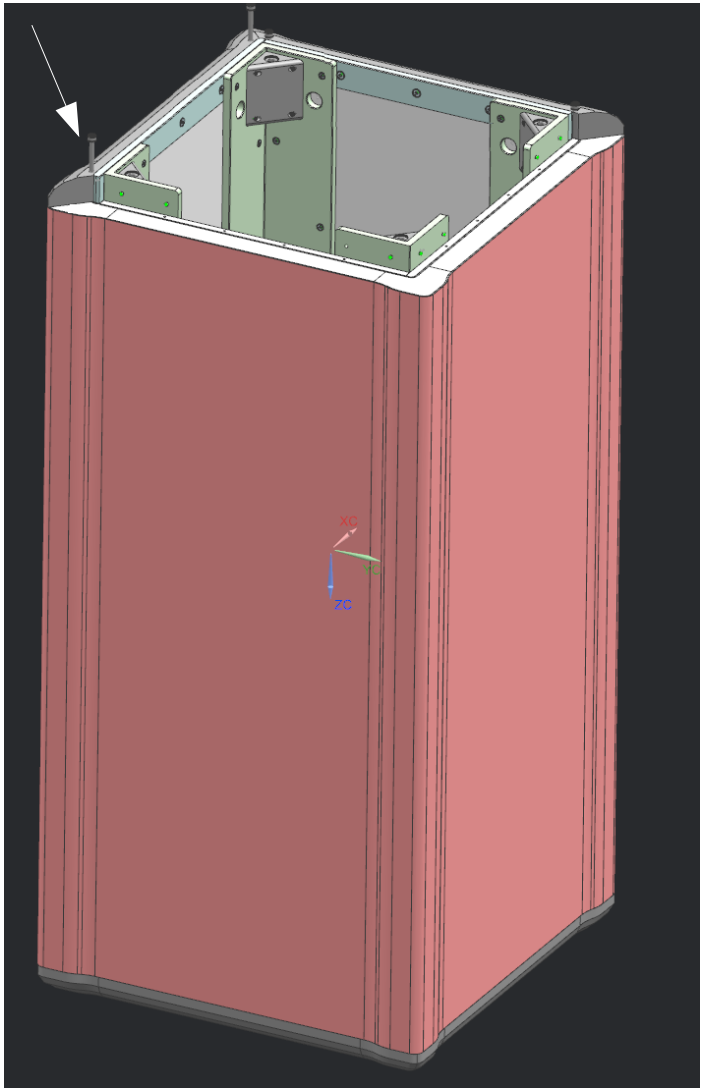
+ plate for handling the assembly (with bag in vacuum)



→ then: curing phase in autoclave (high T or cold)

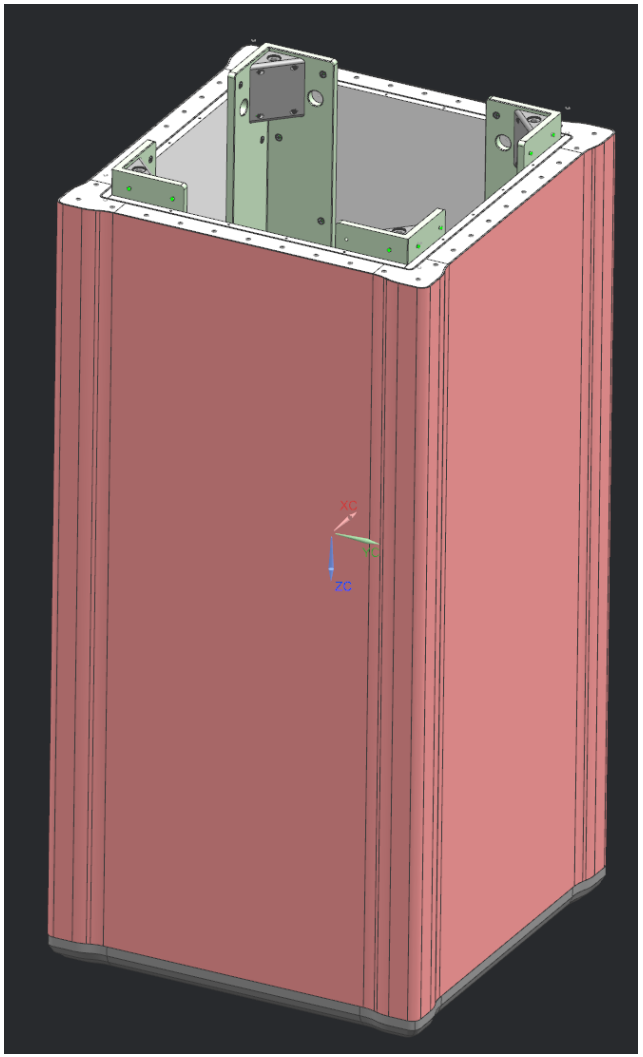
Procedure for the composite prototype FC

Dismounting brackets and part of the mold

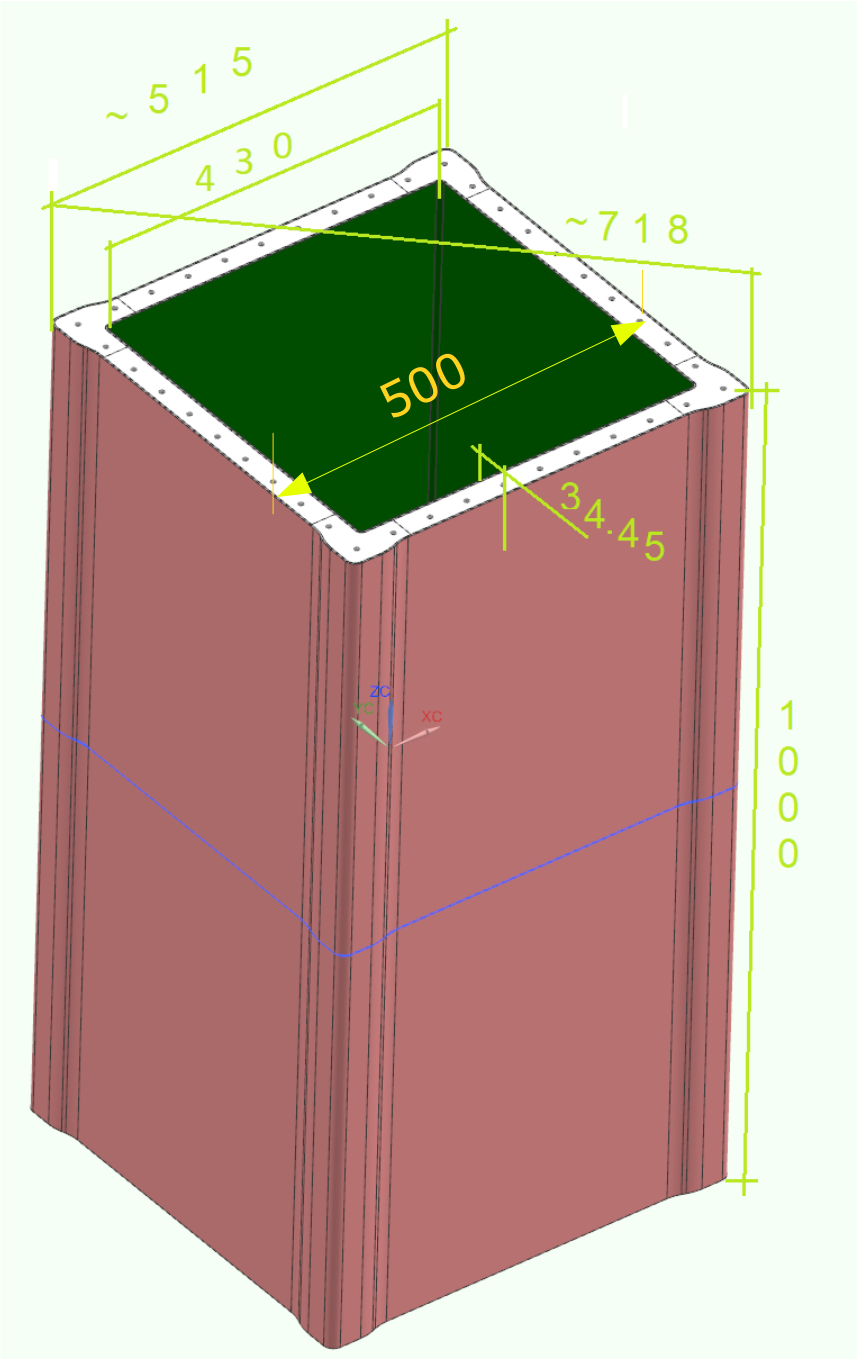


Post-processing: (still with part of the mold on)

- precision machining of edges
- holes for screws
- …

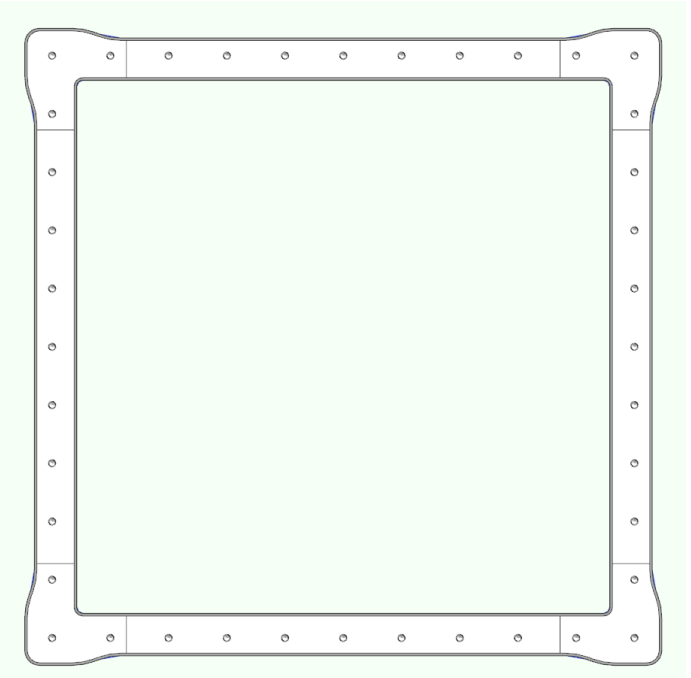


Procedure for the composite prototype FC



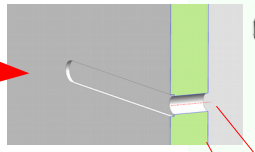
Finally the box...

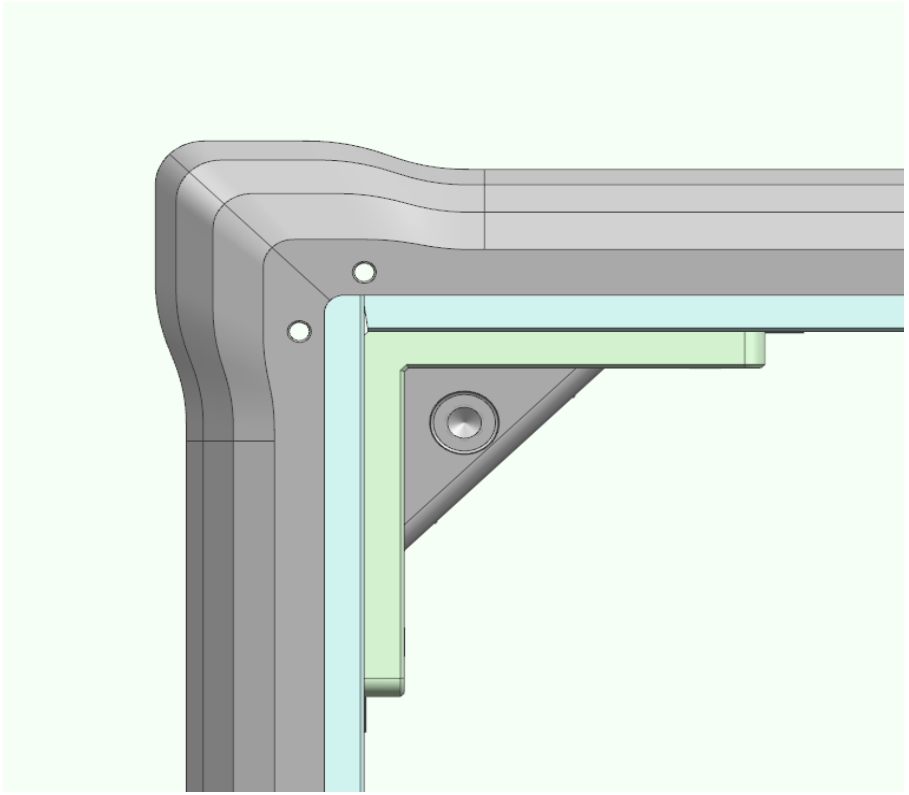
Note: extended corners for enhanced stiffness

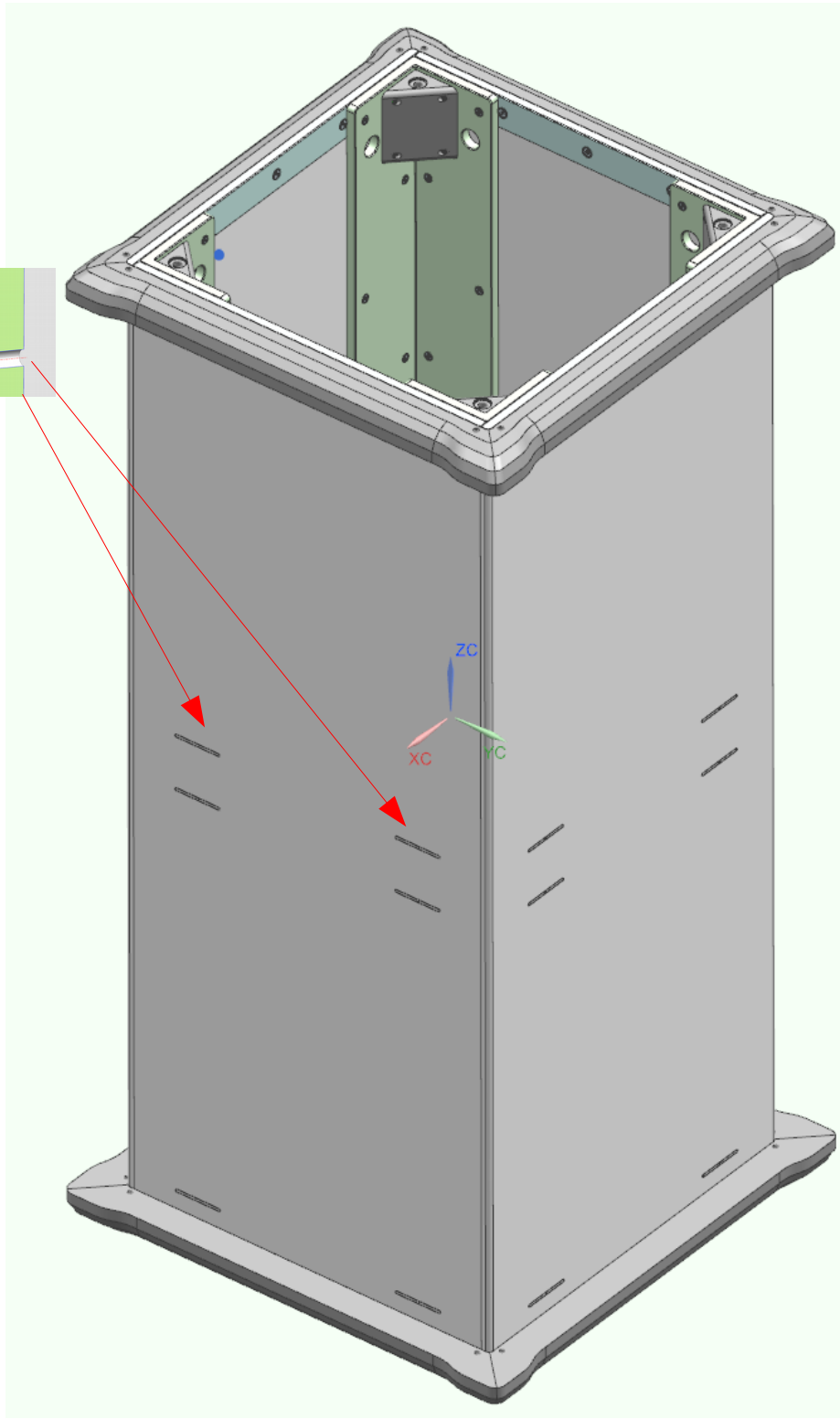


Mold Design

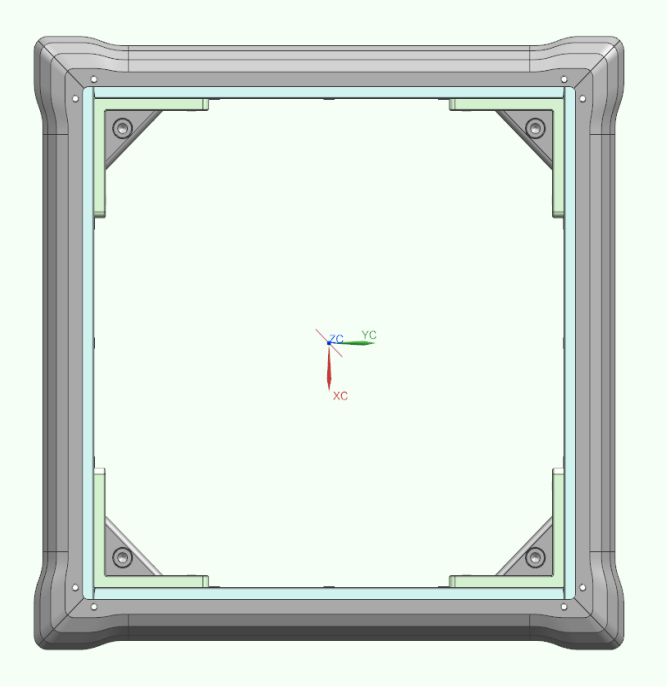
- AlCoA stabilized & rectified planes:
high precision planarity and thickness
pre-milled sheets (12mm thick)
- air flow: grooves and holes (M4)
- angular L structures: keeping □ shape
- brackets: for protecting vacuum bag
and for keeping peek/Alu bars in position

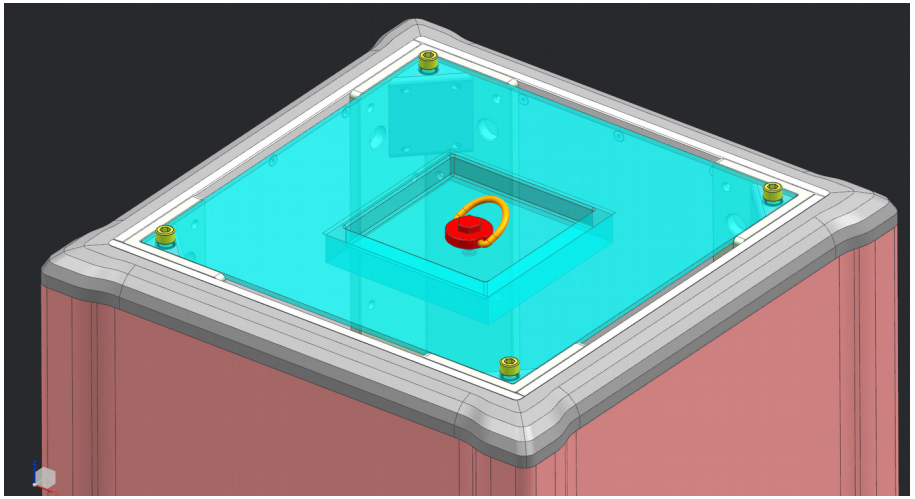


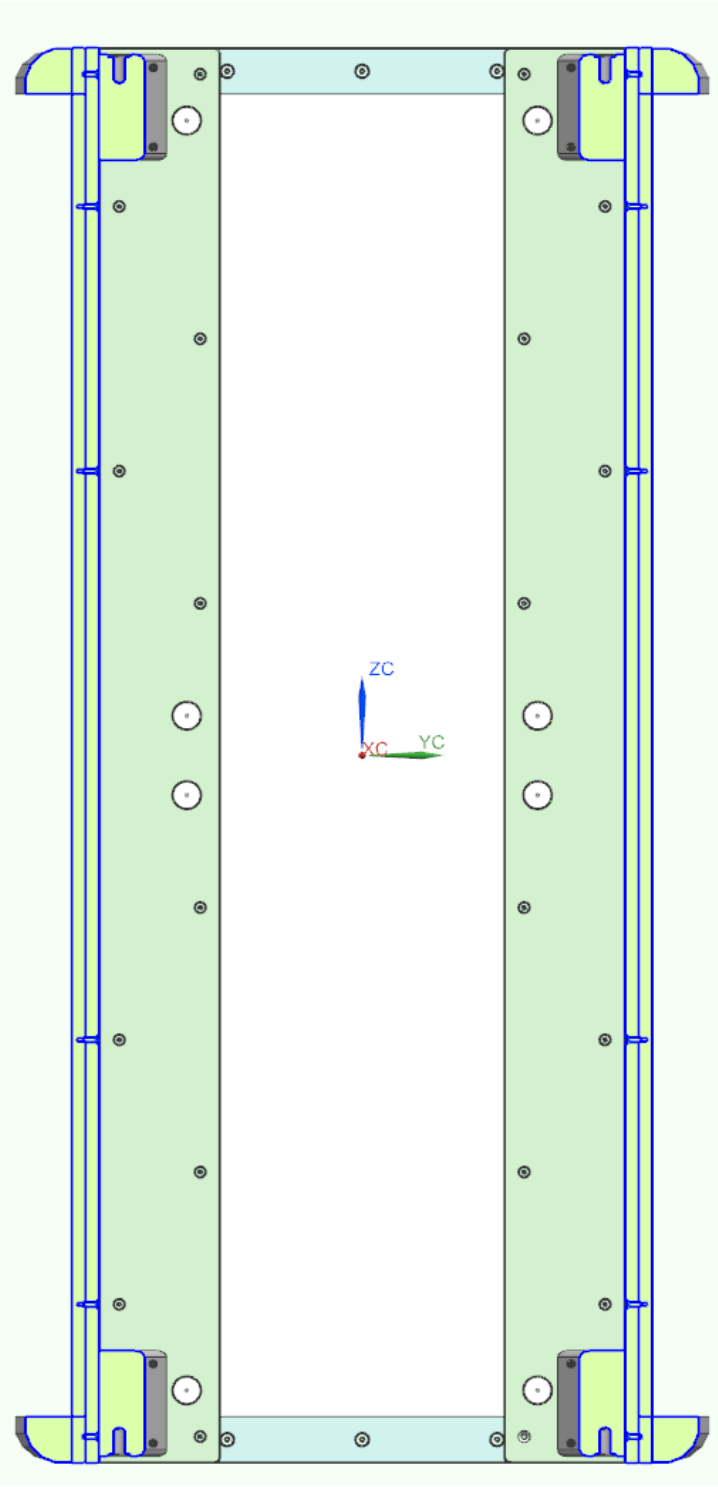




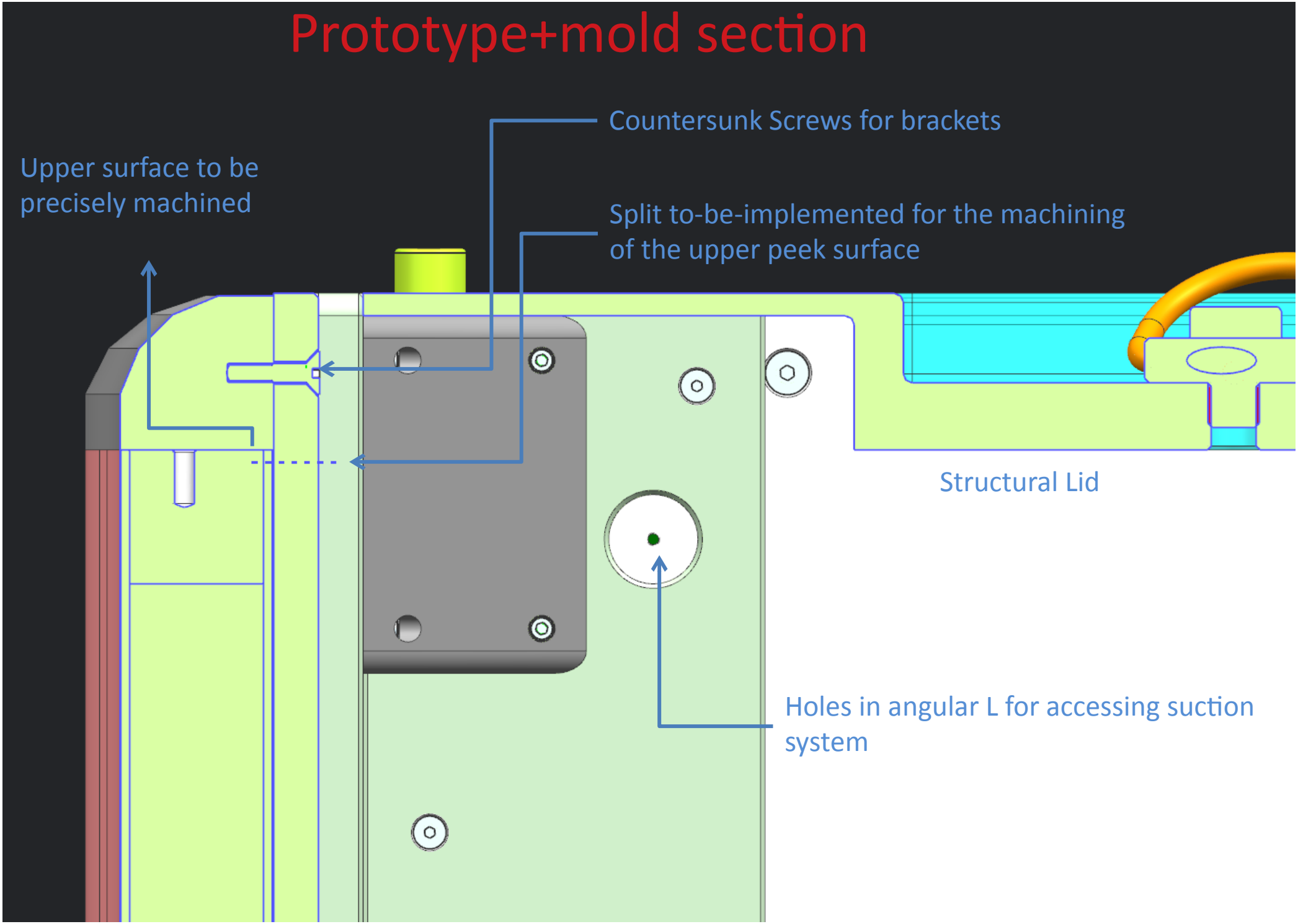
Mold Design



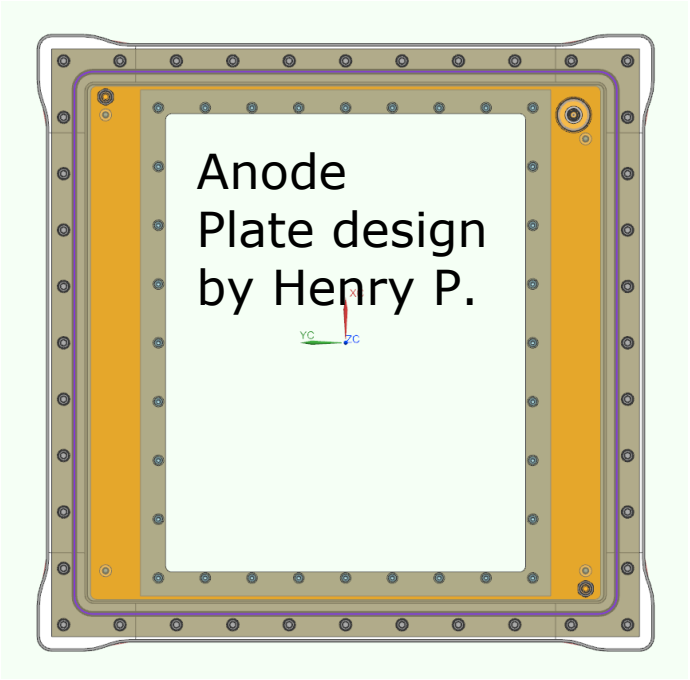


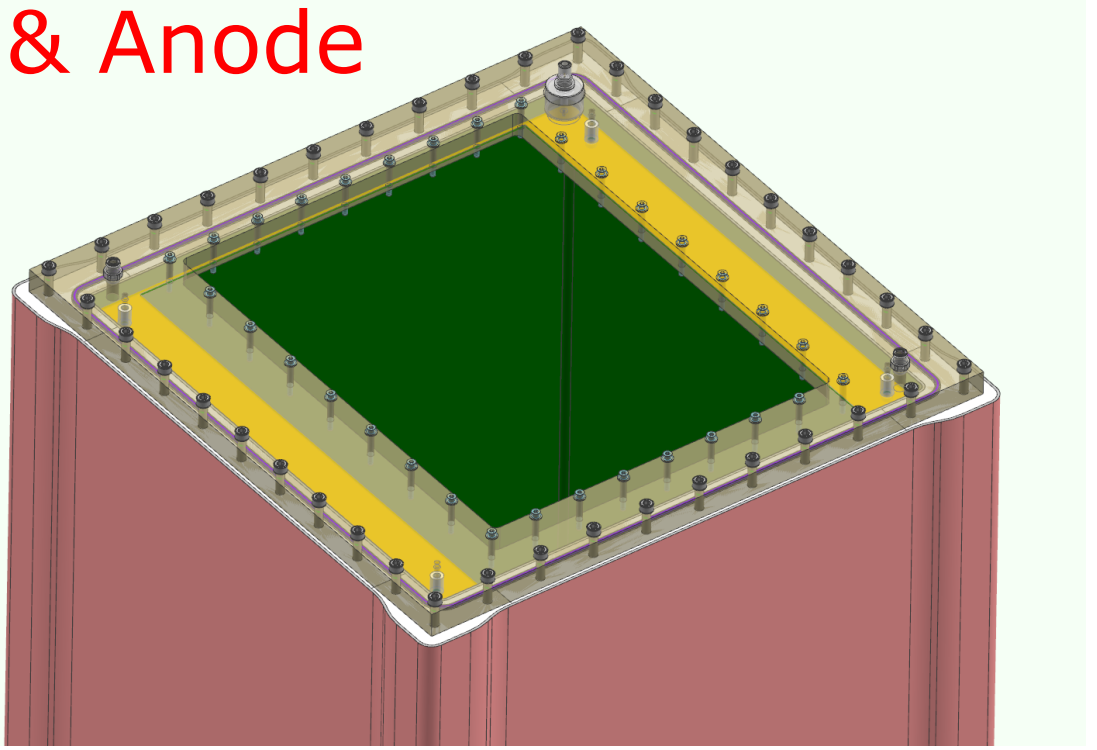


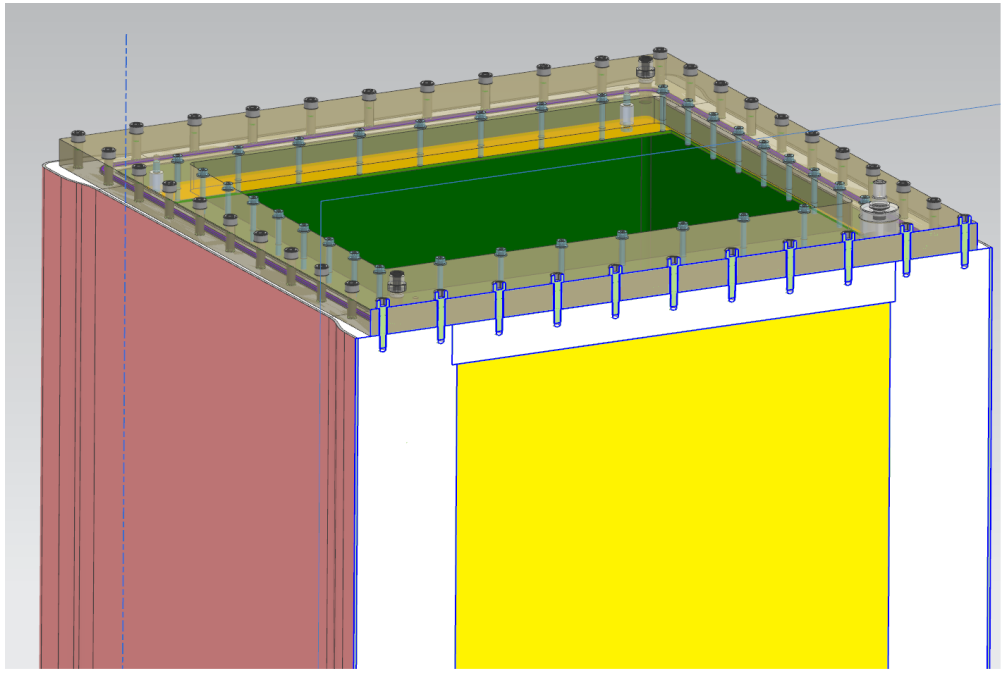
Prototype+mold section

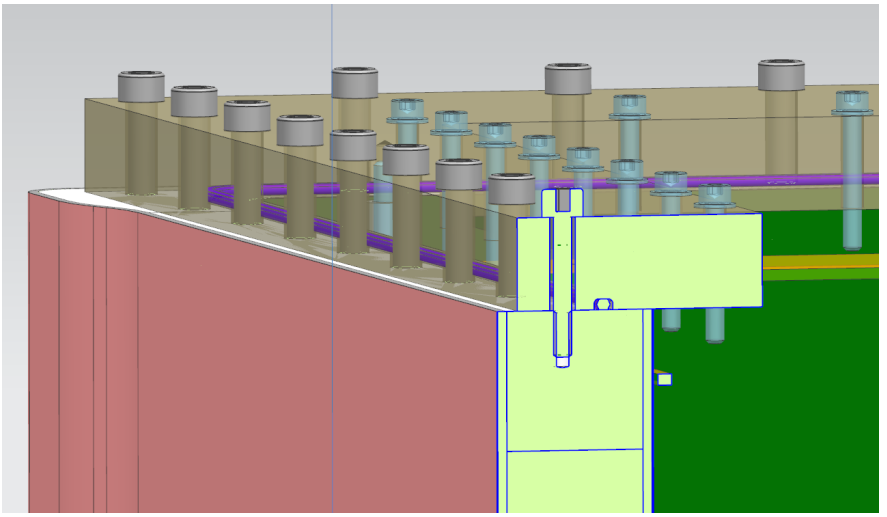


Prototype Field Cage & Anode



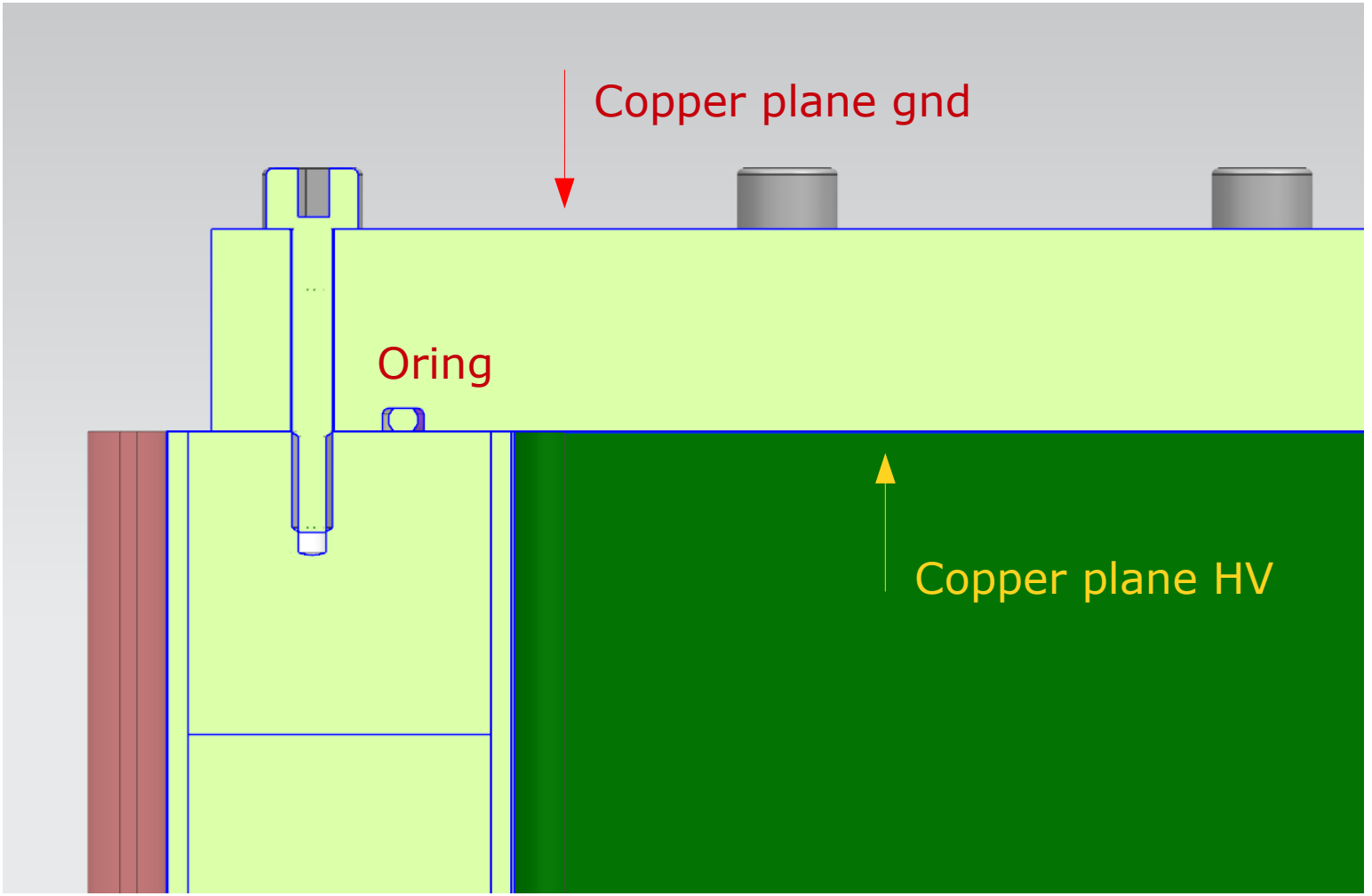






Prototype Field Cage & Cathode

Planar Cathode (single face)
→ same screw scheme as for Anode



What do we learn from the prototype FC ?

1. about building a 1m long box
- validating the composite building process
- cold or/and high T curing process (thermal stability)

2. “tolerance chains” (tolerace propagation)
- planarity of internal wall plane
- bubbles affecting internal wall side planarity
- tolerances of box edges including precision machining (Anode/Cathode alignment)

2. mechanical properties of walls
- deformation
- screw holding effectiveness

3. electrical insulation & breakdown
- @ box edges

4. gas related
- tightness (O_2 / H_2O)
- rate and composition of degassing material

Timeline for the Prototype FC production

Prototype

✓ mold design INFN-Padova completed
(after various iterations, including discussions with NEXUS

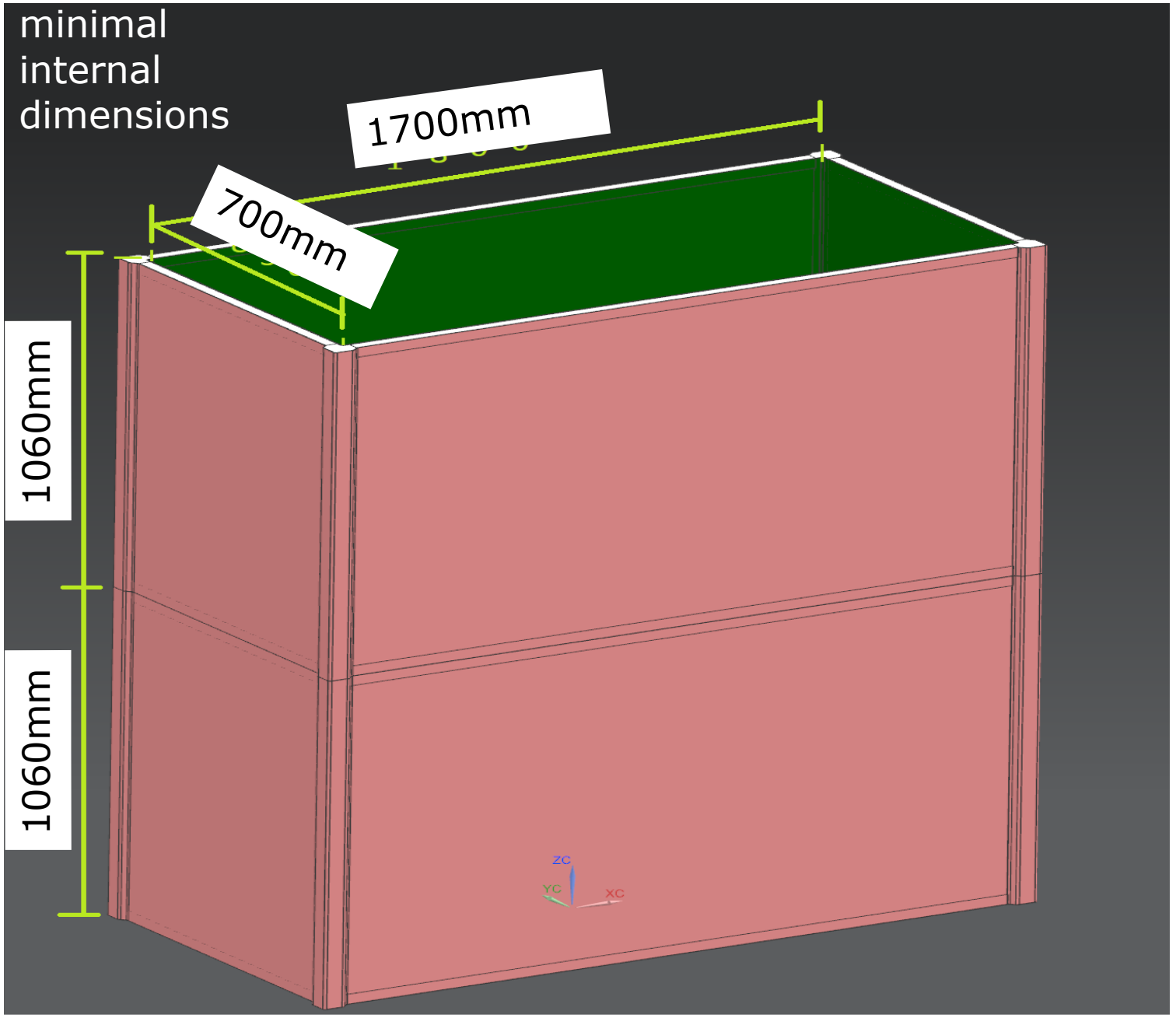
→ in EDMS https://edms.cern.ch/ui/#!master/navigator/project?P:100090603:100175780:subDocs

✓ meeting INFN-Bari/Padova (2018/7/12) for details about mold production
- mold material procurement → INFN Bari by early September
- new meeting INFN Pd+Ba with NEXUS to fix procedure: by early September
- mold production / assemby measurement (INFN Bari): by end of September
- mold at NEXUS (Barcelona): early october
- building of the prototype boxes: @ NEXUS by the end of 2018 (preliminary estimate by NEXUS)

Test structures

- test structures already produced by NEXUS: to be tested
  → tolerances (INFN Padova)
  → HV/breakdown tests (INFN Legnaro)
  → mechanical properties (TBD)

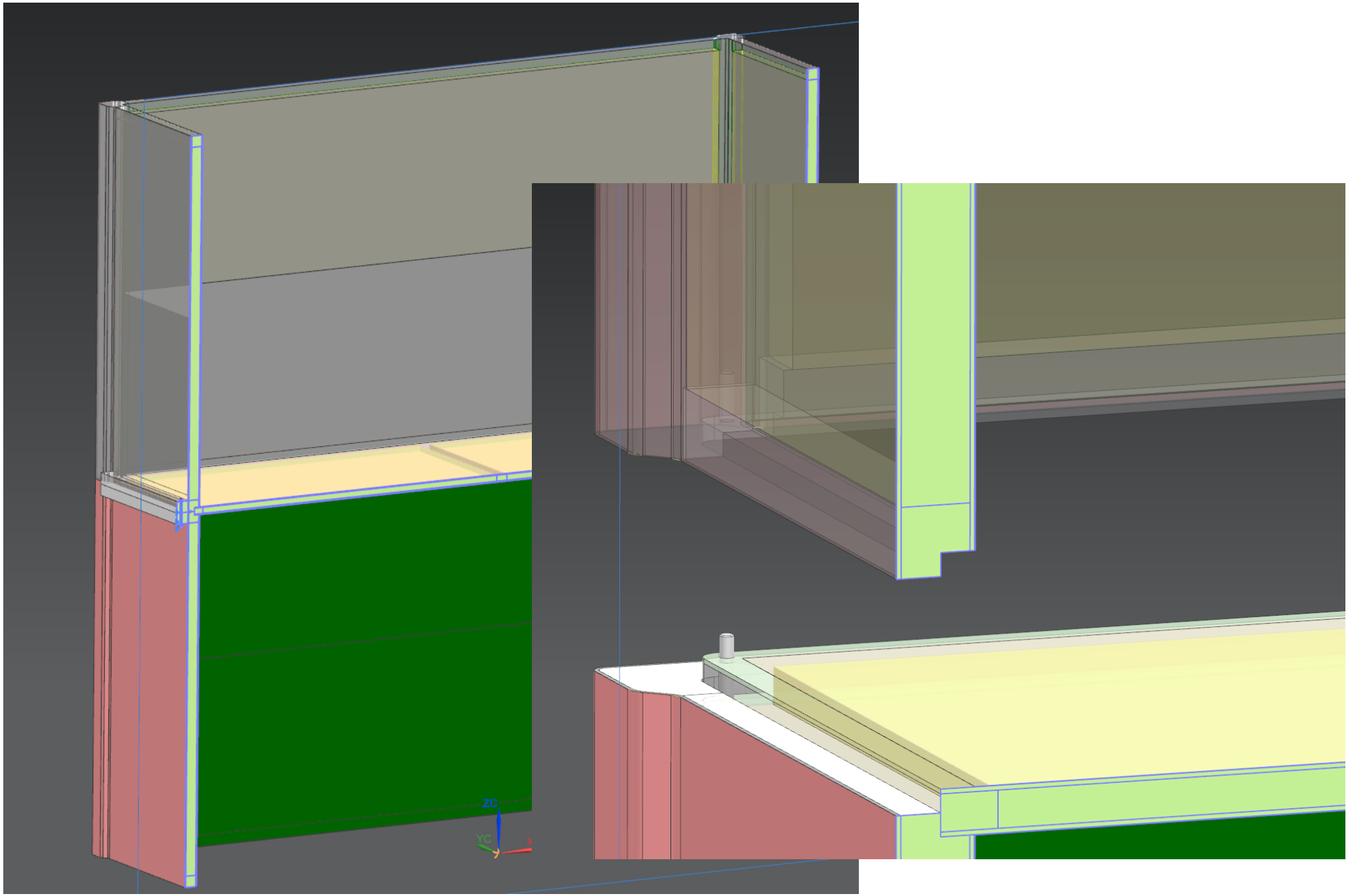
Model of the TPC FC = 2 Boxes + Cathode (internal panel)



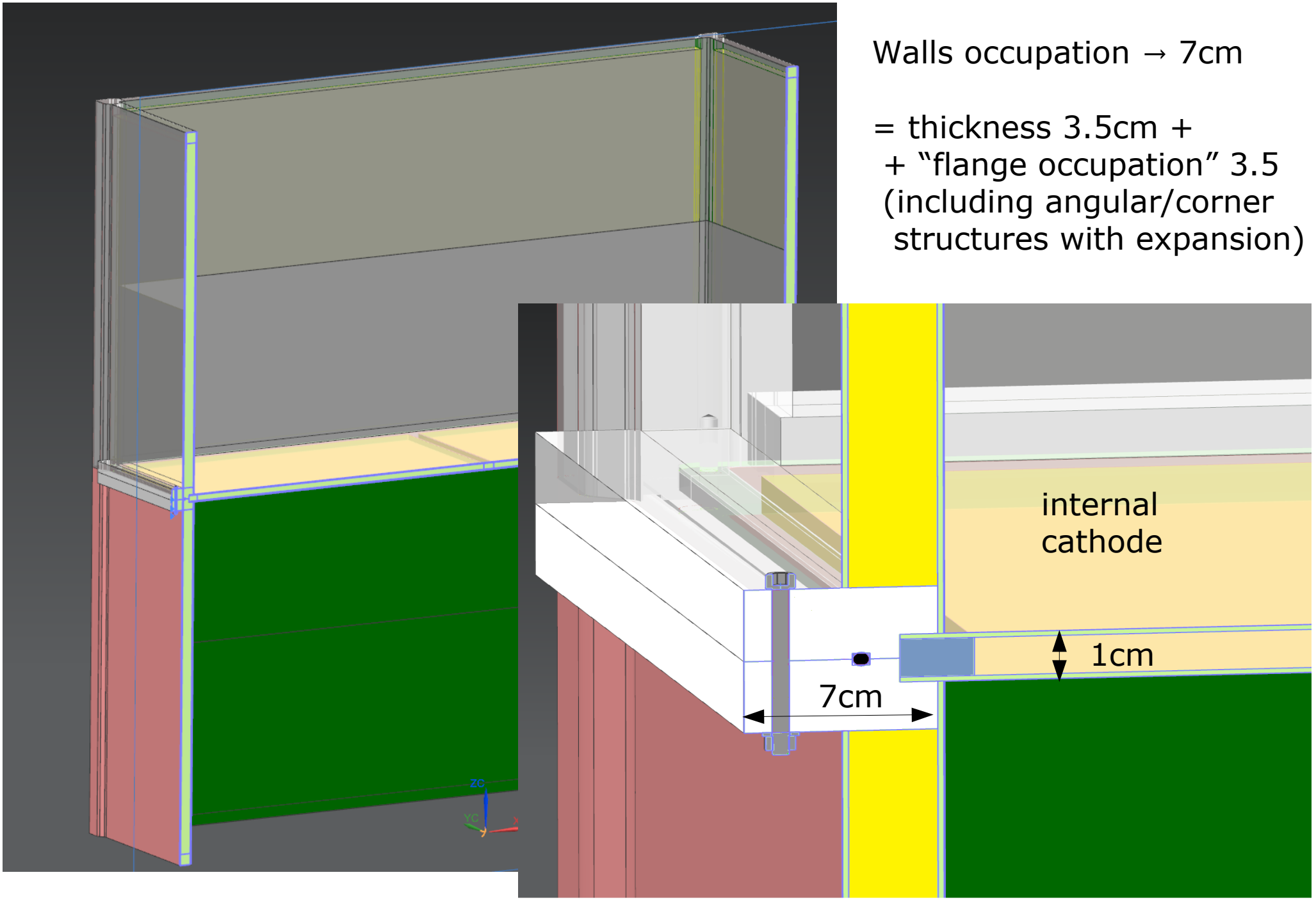
Anode plane dimensions considering 8 MM
4 (horiz) x 2 (vert)

MicroMegas dimensions =
x 420 mm (horiz)
x 340 mm (vert)

TPC Cathode proposal



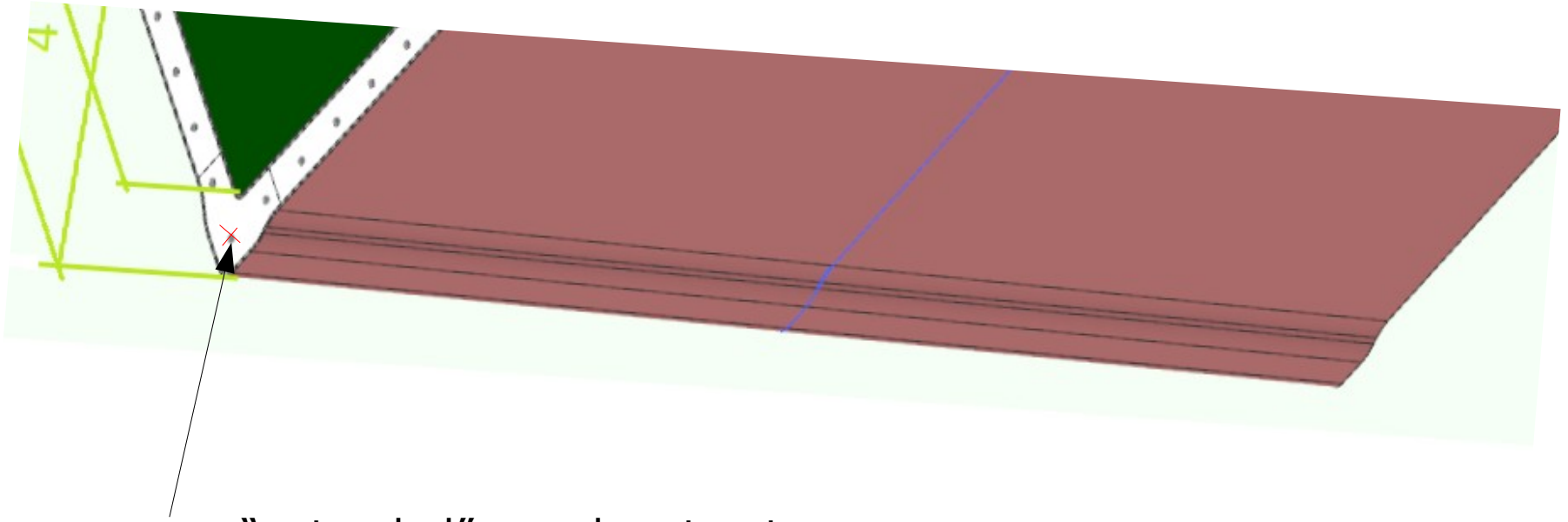
TPC Cathode proposal



Walls occupation → 7cm

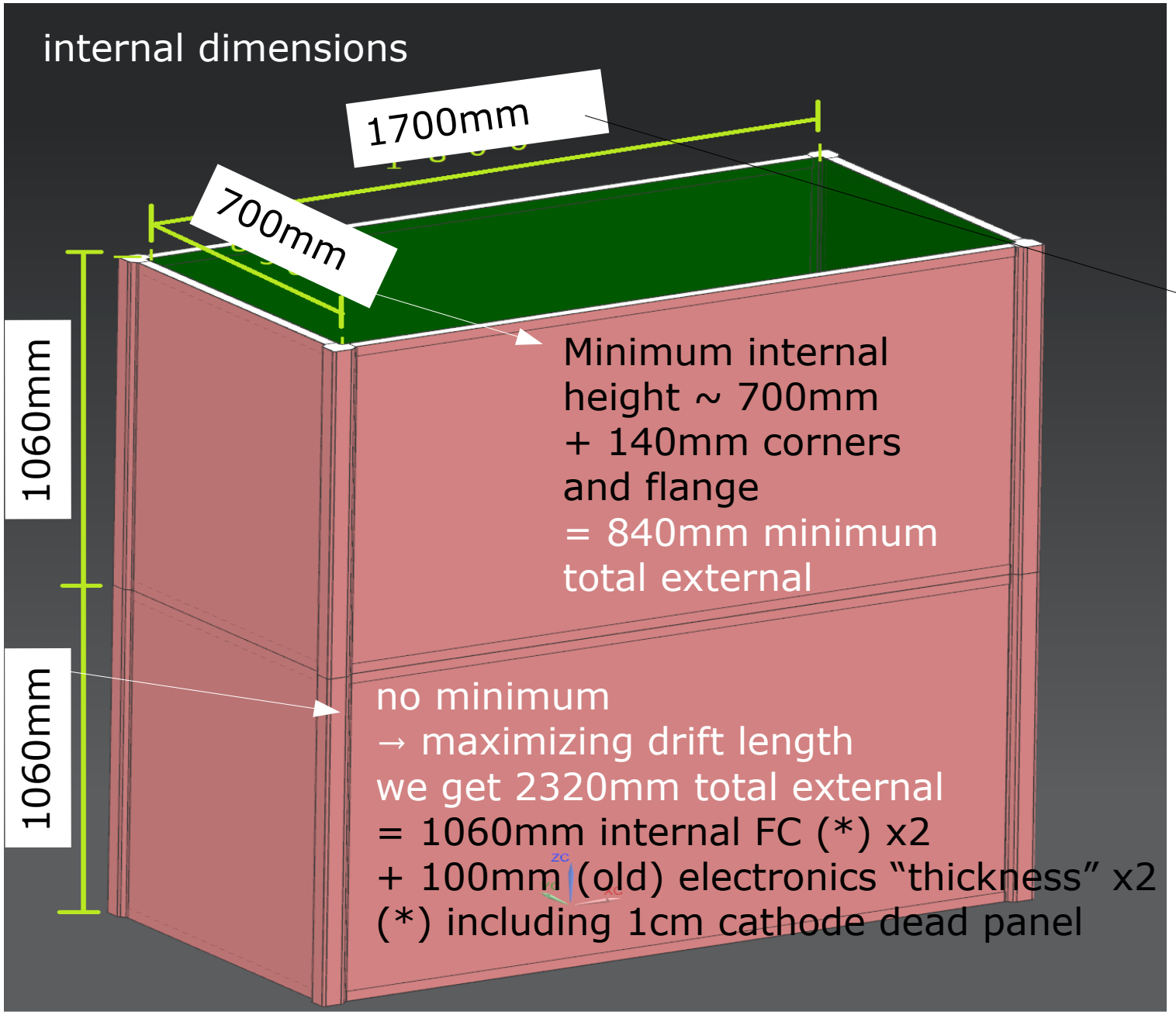
= thickness 3.5cm +
+ "flange occupation" 3.5
(including angular/corner
structures with expansion)

TPC field cage corners



"extended" angular structures
→ good for holding the TPC's (on 4 points)

Model of the TPC FC = 2 Boxes + Cathode (internal panel)

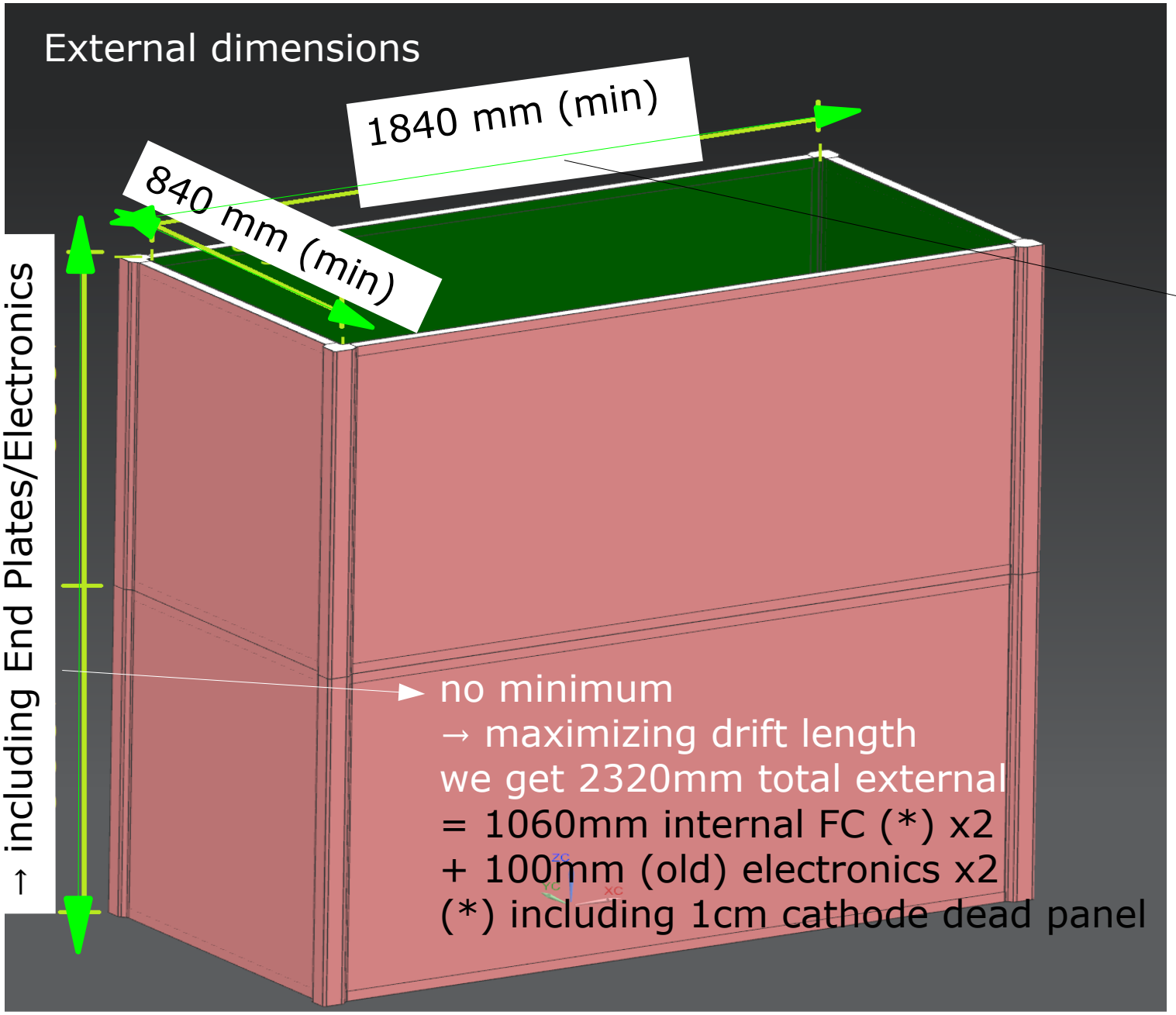


Minimum internal height ~ 1700mm

+ 140mm corners and flange

= 1840 mm minimum total external

TPC external overall dimensions



Minimum internal height ~ 1700mm

+ 140mm corners and flange

= 1840 mm minimum total external

Conclusions

Prototype

Field Cage

- Aiming at validating procedure and mold design
- Mold design ready → production by end 2018/9 – by INFN
- Field Cage to be produced at NEXUS by end of 2018

Cathode

- simplest planar design proposed → production by INFN
  (unless other Institution willing to do)

Final TPC

- proposed draft design for Field Cage & Cathode

Additional material