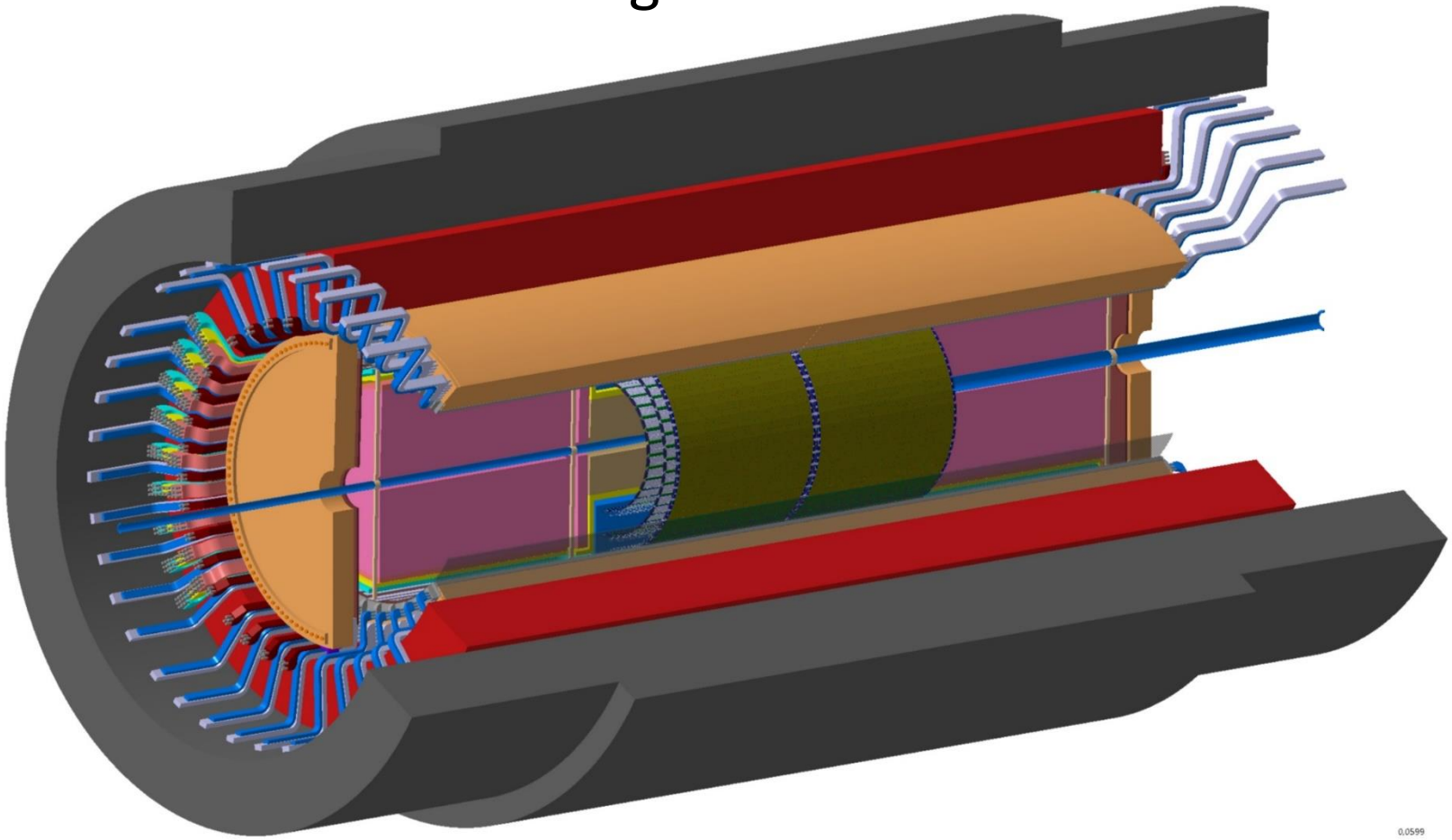
ALICE3 – Outer tracker status in Heidelberg

Update on mechanical design

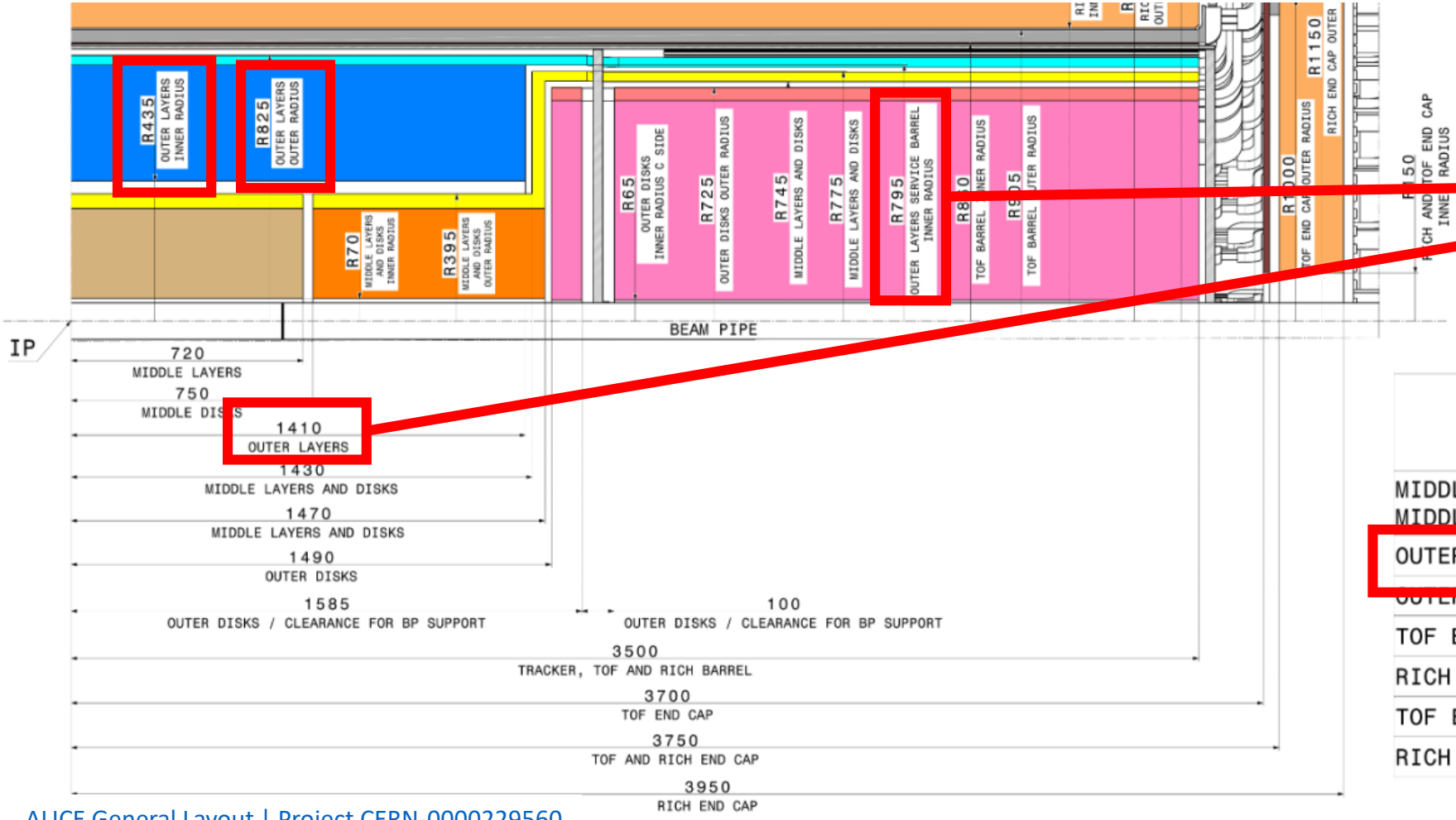


Bernd Windelband – Uni Heidelberg
Stefan Dittrich – Uni Frankfurt

1. OT barrel, layout and design status
2. Stave design and carbon spaceframe prototype
3. Summary, next steps

Layout and design of the OT Barrel – Geometrical constraints

Interface Control Drawing and Detector Volume



Detector Volume (half Barrel)	
Length	1410 mm
Inner Radius	435 mm
Outer Radius	825 mm
Service inner radius	795 mm
Service outer radius	825 mm

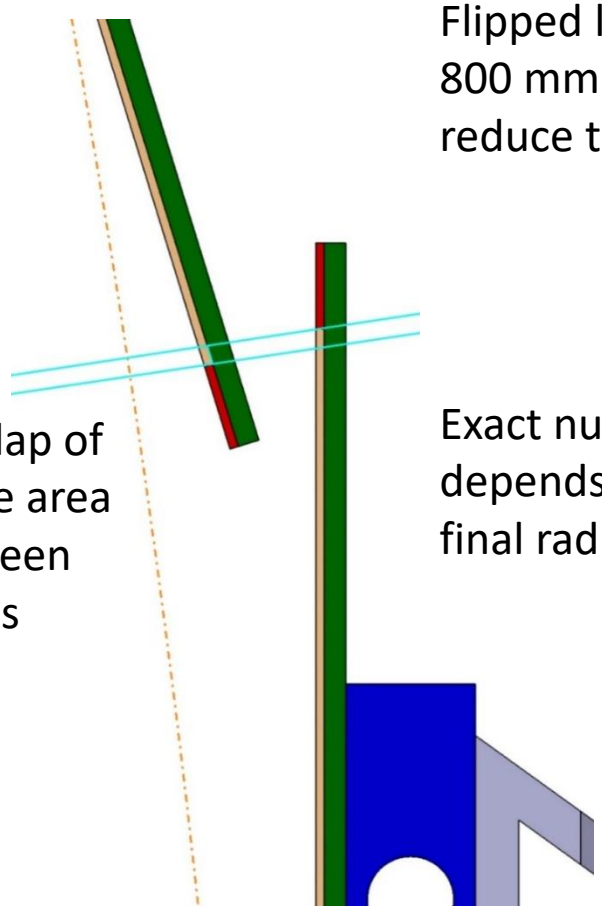
	(mm2)
MIDDLE LAYERS AND MIDDLE DISKS	58000
OUTER LAYERS	101000
TOF BARREL	66000
RICH BARREL	200000
TOF END CAP	60000
RICH END CAP	74000

[ALICE General Layout | Project CERN-0000229560]

CERNBOX

https://cernbox.cern.ch/s/kJ8ZyxV9KH63Kj7

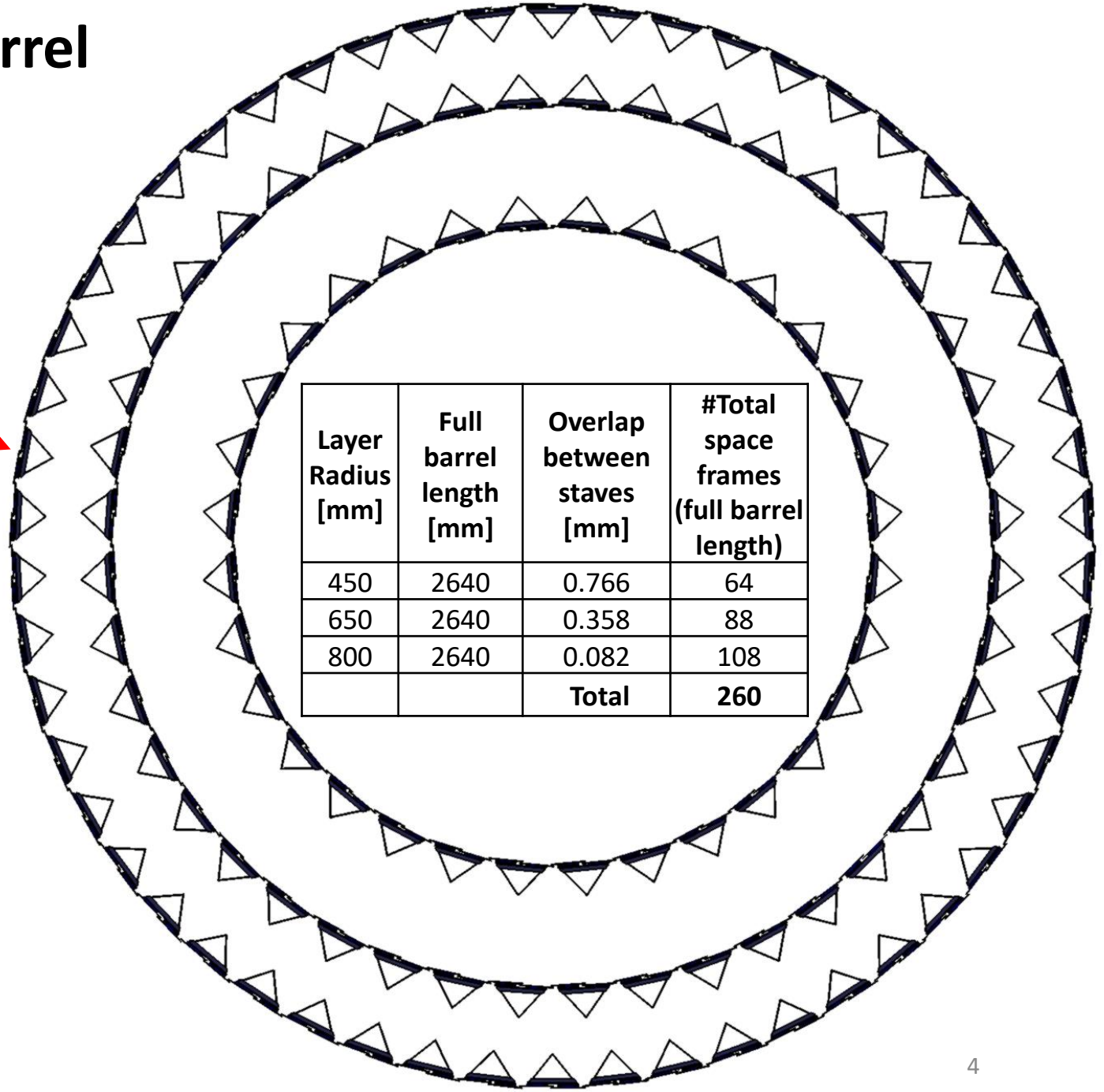
Layout and design of the OT Barrel



Overlap of active area between staves

Flipped layer 10 at 800 mm to reduce the outer radius

Exact numbers of staves depends on overlap and final radius

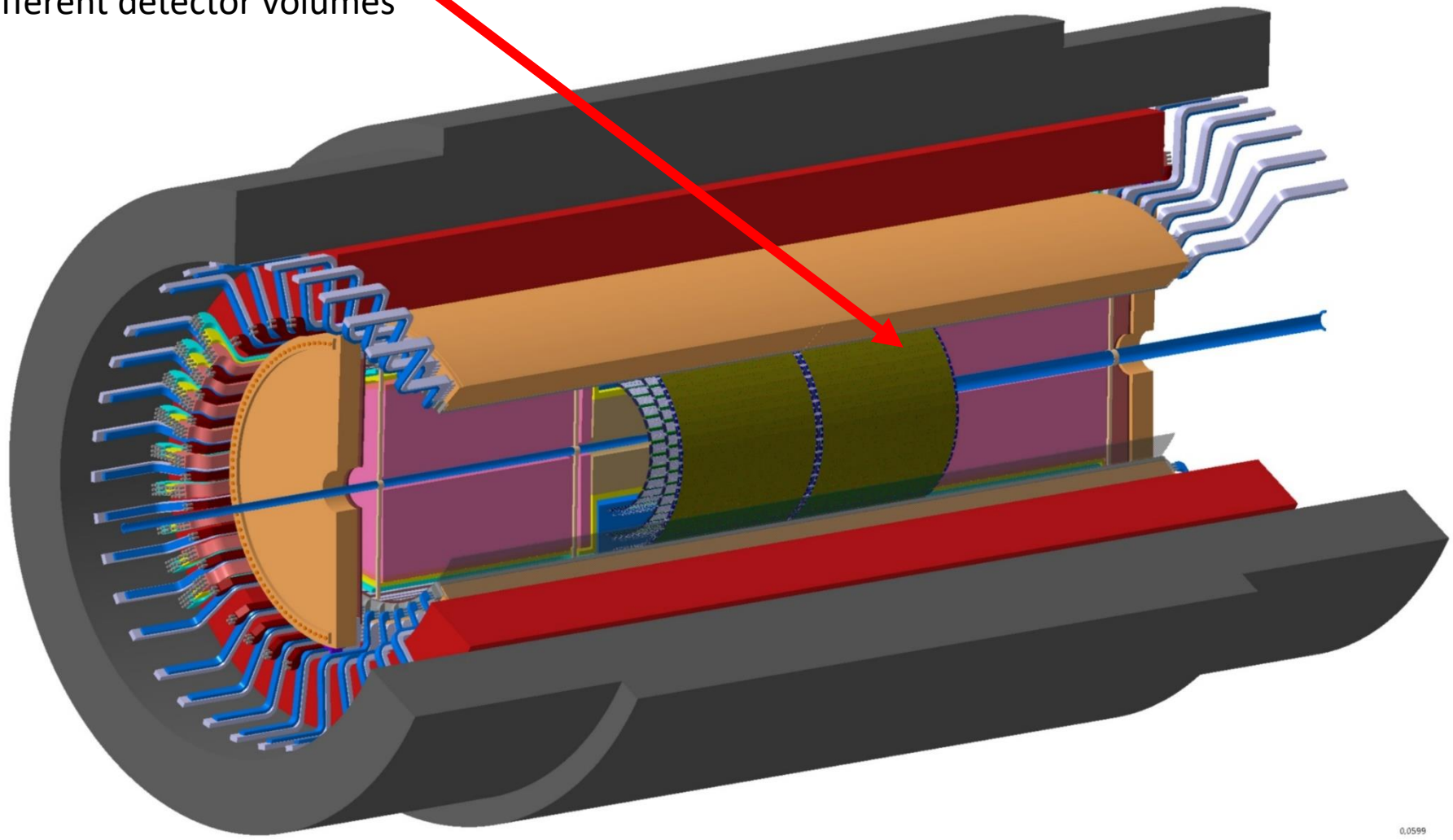


Layer Radius [mm]	Full barrel length [mm]	Overlap between staves [mm]	#Total space frames (full barrel length)
450	2640	0.766	64
650	2640	0.358	88
800	2640	0.082	108
		Total	**260**

Layout and design of the OT Barrel – Geometrical constraints

Interface Control Drawing and Detector Volume

Current CAD design implemented to check dimensions and compatibility with the different detector volumes



Layout and design of the OT Barrel – Half barrel

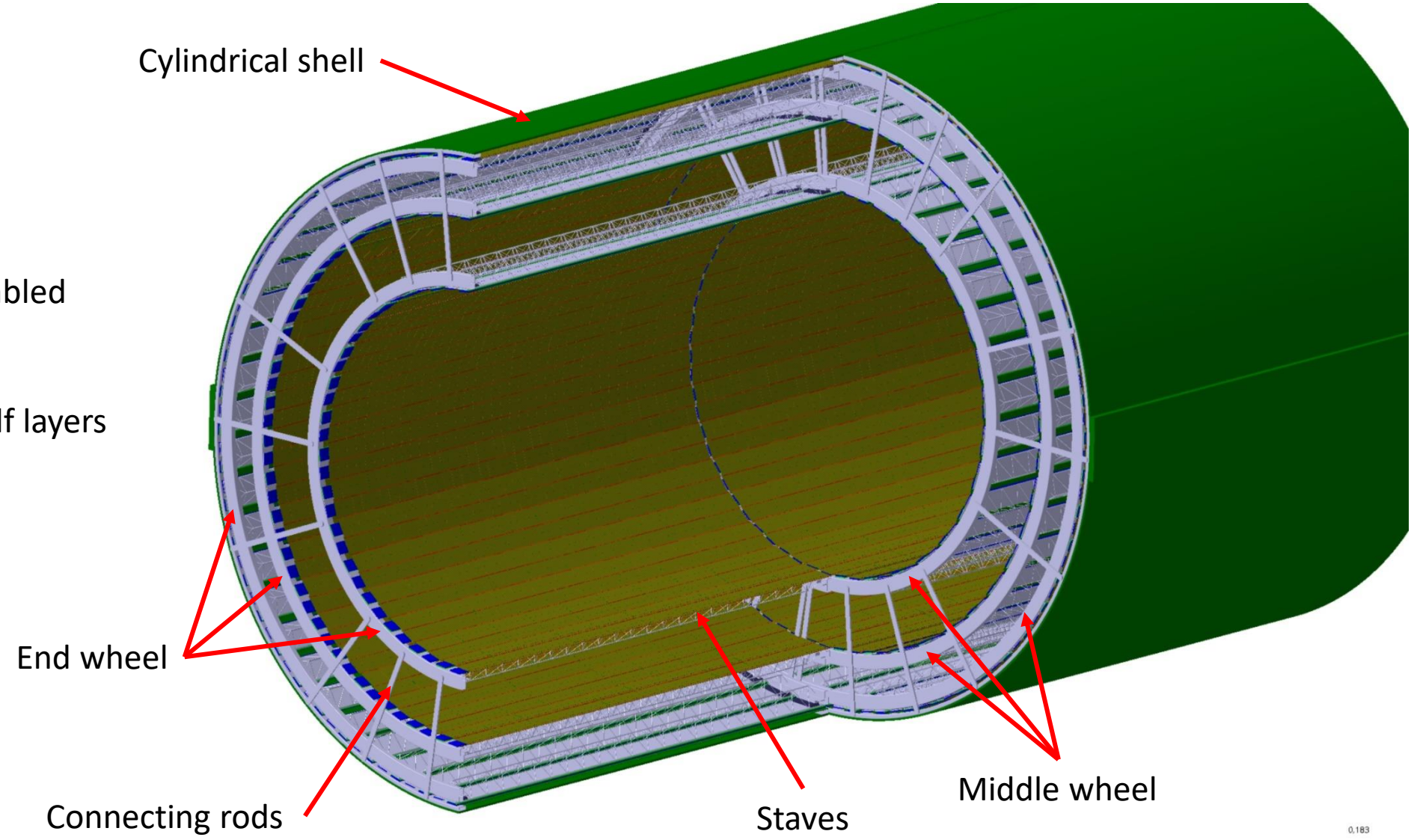
First rough 3D model to show the modularity

Idea:

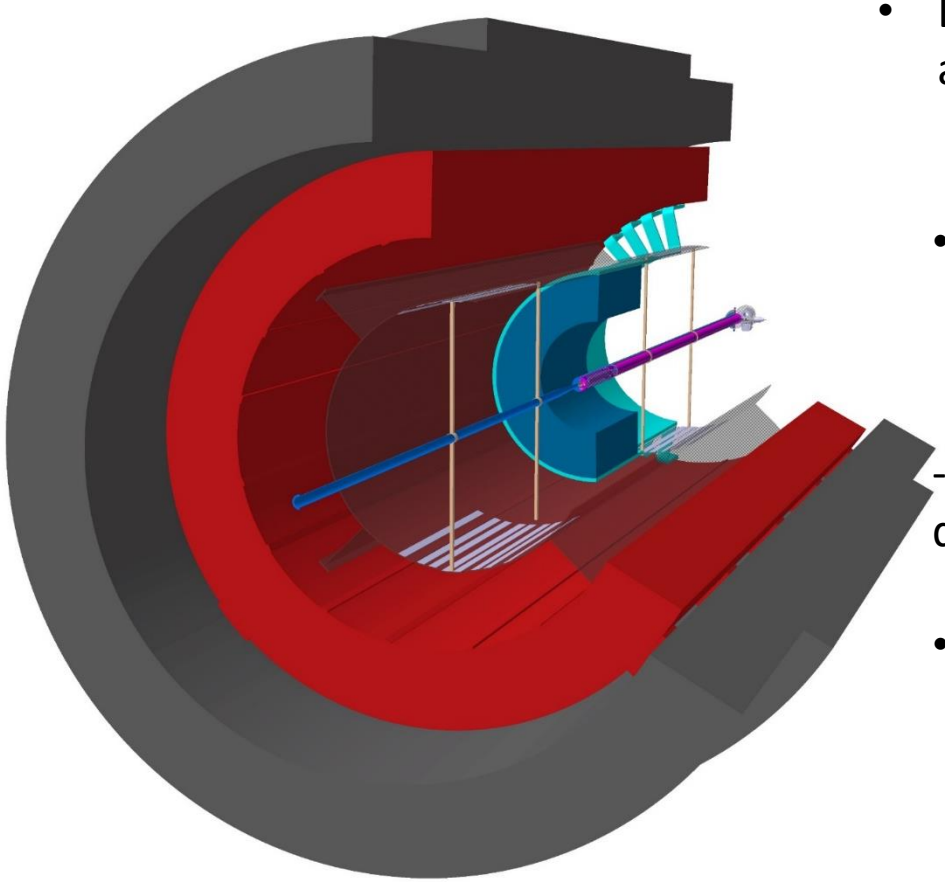
Each half layer can be assembled independently.

1 half barrel consists of 3 half layers connected by rods.

Cylindrical shell connects end and middle wheel.



Layout and design of the OT Barrel – 3D Model



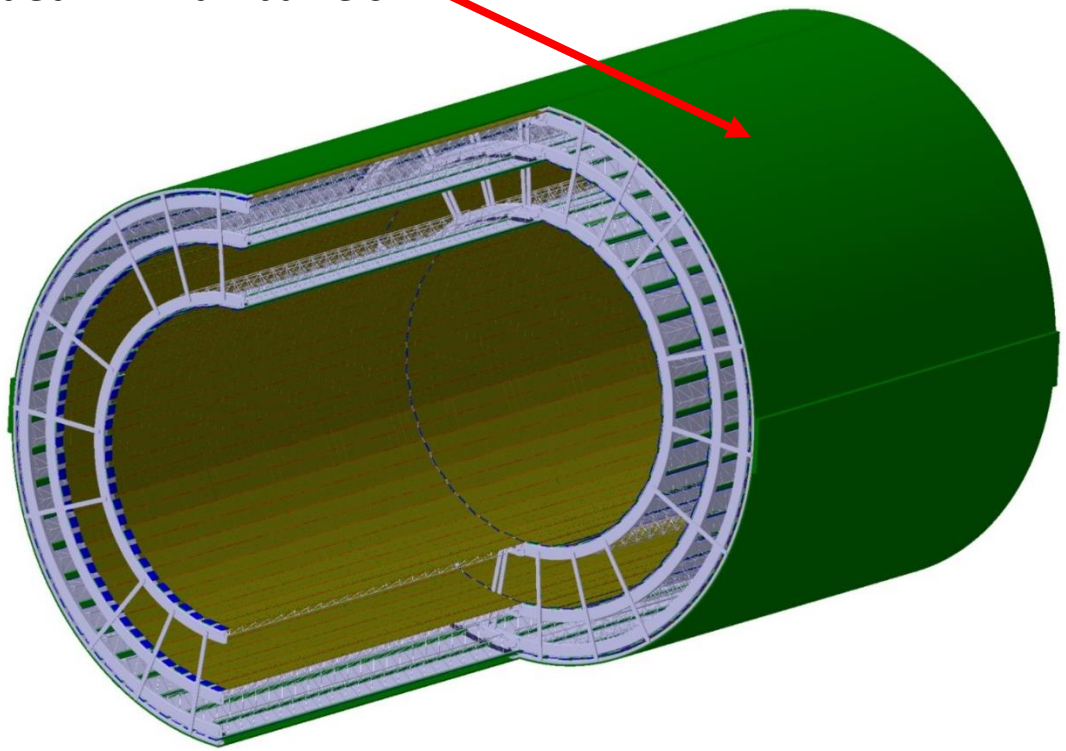
Design Requirement:

- Beam pipe supports require a separation of the OT barrel along the vertical axis for insertion/extraction the detector
  -> OT is subdivided in 4 half barrels

- More detailed designs of the end and middle wheels

-> learn from existing designs

- effort to minimize gap between the barrels

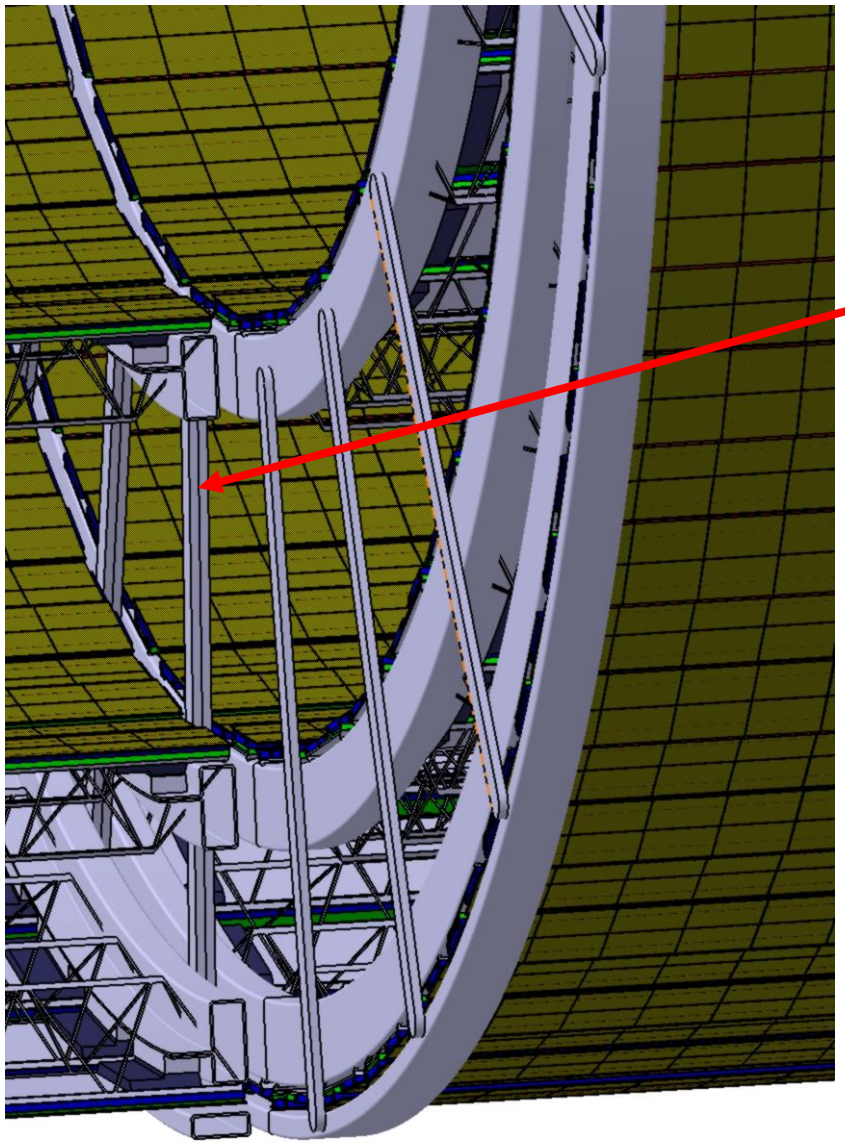


ALICE3 Interface Control Drawing and Detector Volumes

Current 3D model (Heidelberg and Frankfurt)

Layout and design of the OT Barrel – 3D Model

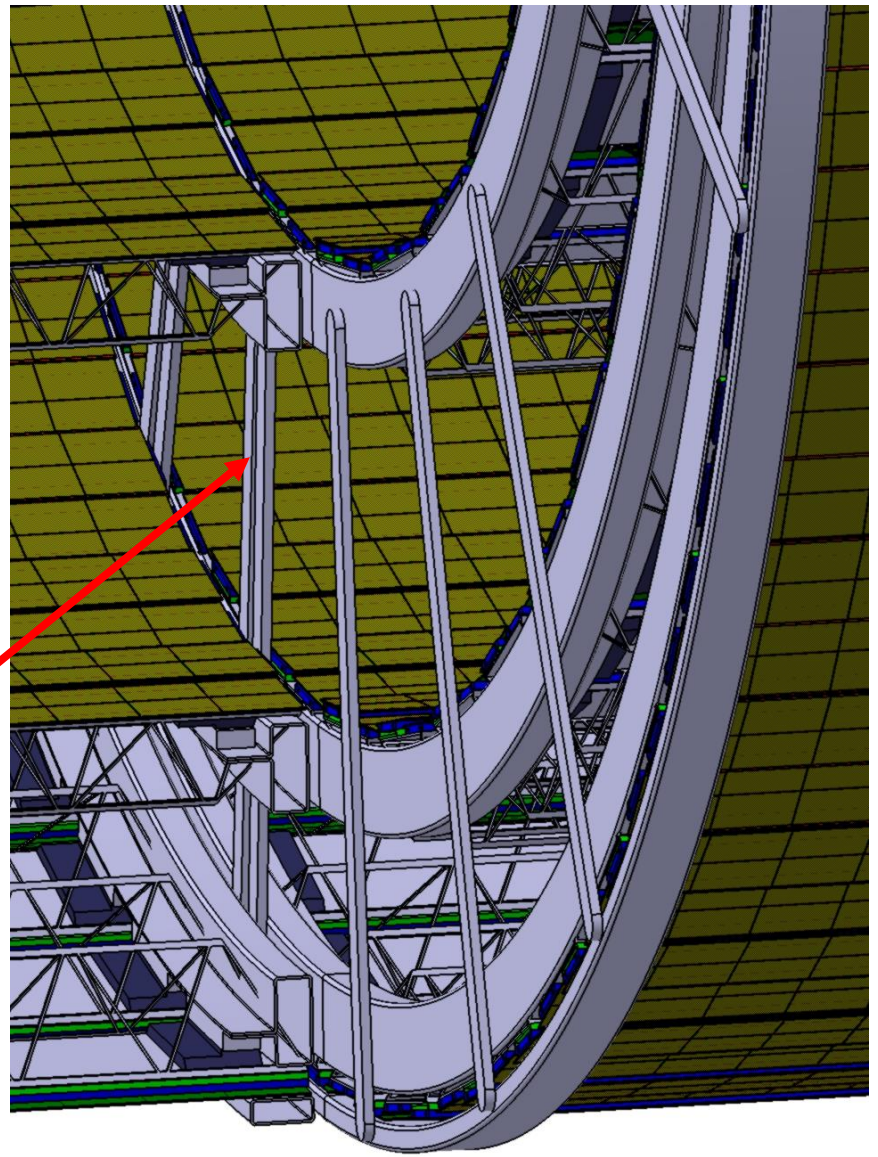
Gap between the Barrels



First Design:
Connecting rods of the middle weels at the same (azimuthal) position
-> Gap = 2 x Thickness of connecting rod

New design approach:
Displacement of face to face wheels in azimuthal direction
-> Gap = Thickness of connecting rod

Thickness of connecting rods?
-> Depends on Material and the requirements (e.g. stability, material budget)
-> currently 4mm + Clearance
-> can still be optimized



Layout and design of the OT Barrel

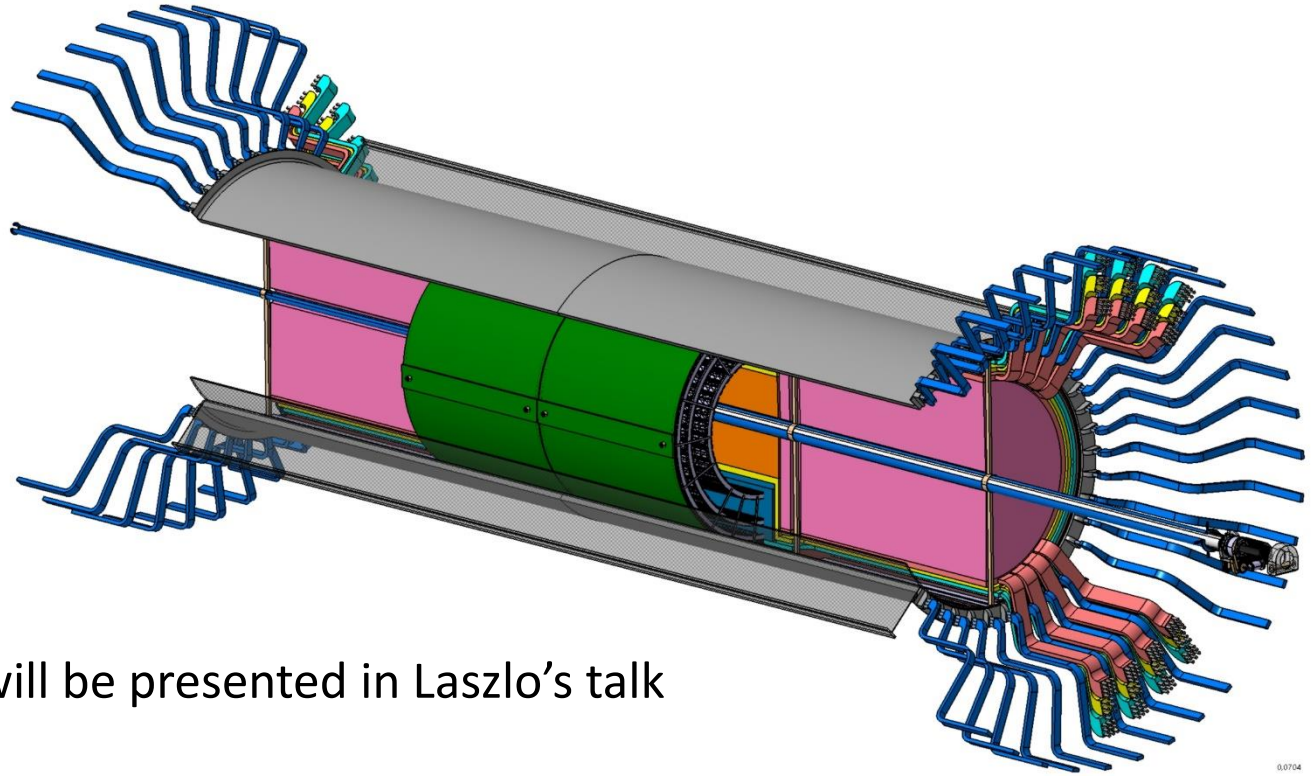
Further work packages and open questions

Interface to cage?

Mechanical interface for the
middle wheels in the cage?

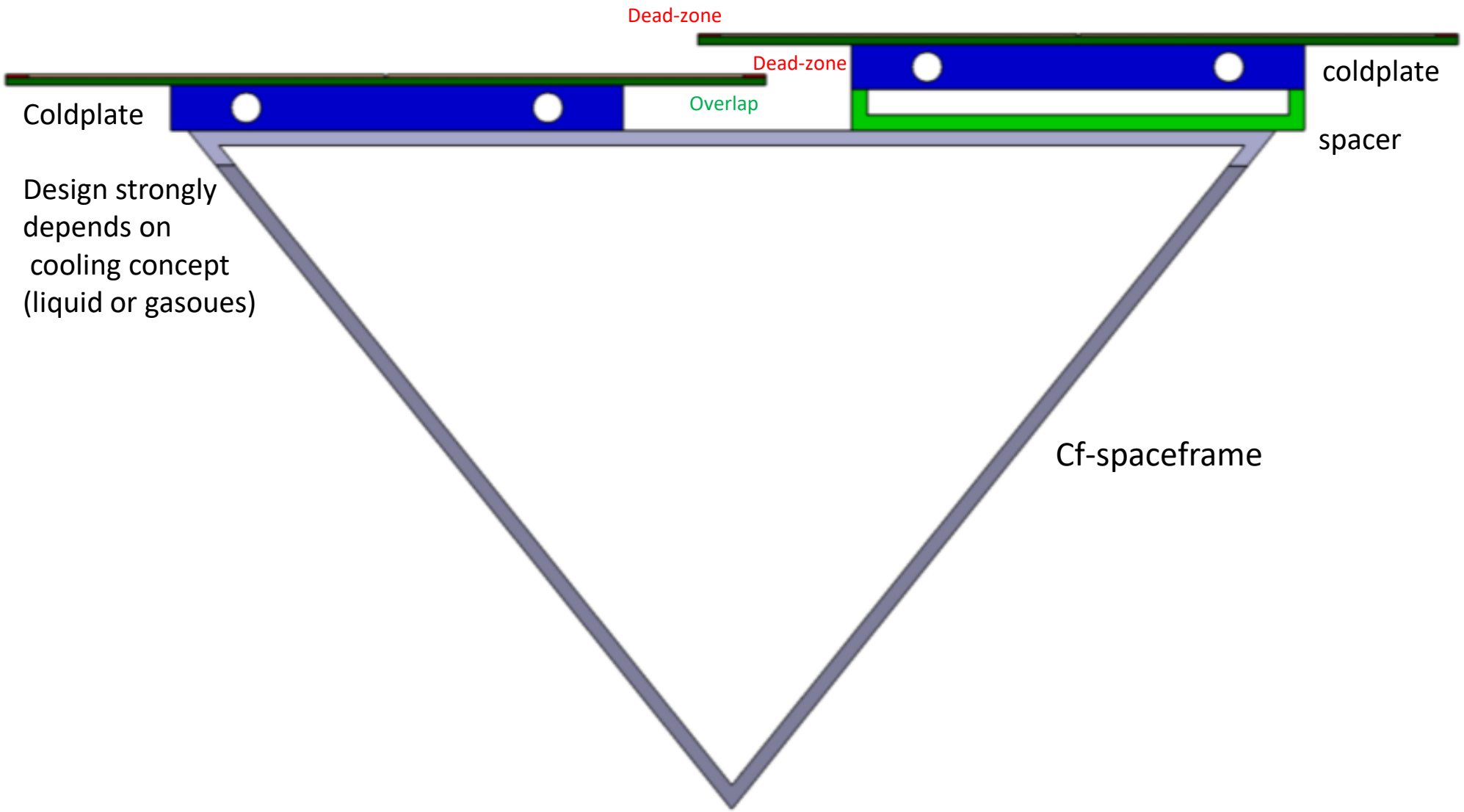
Interface to other detectors

Integration of cooling system?
-> Details and progress on the cooling system will be presented in Laszlo's talk



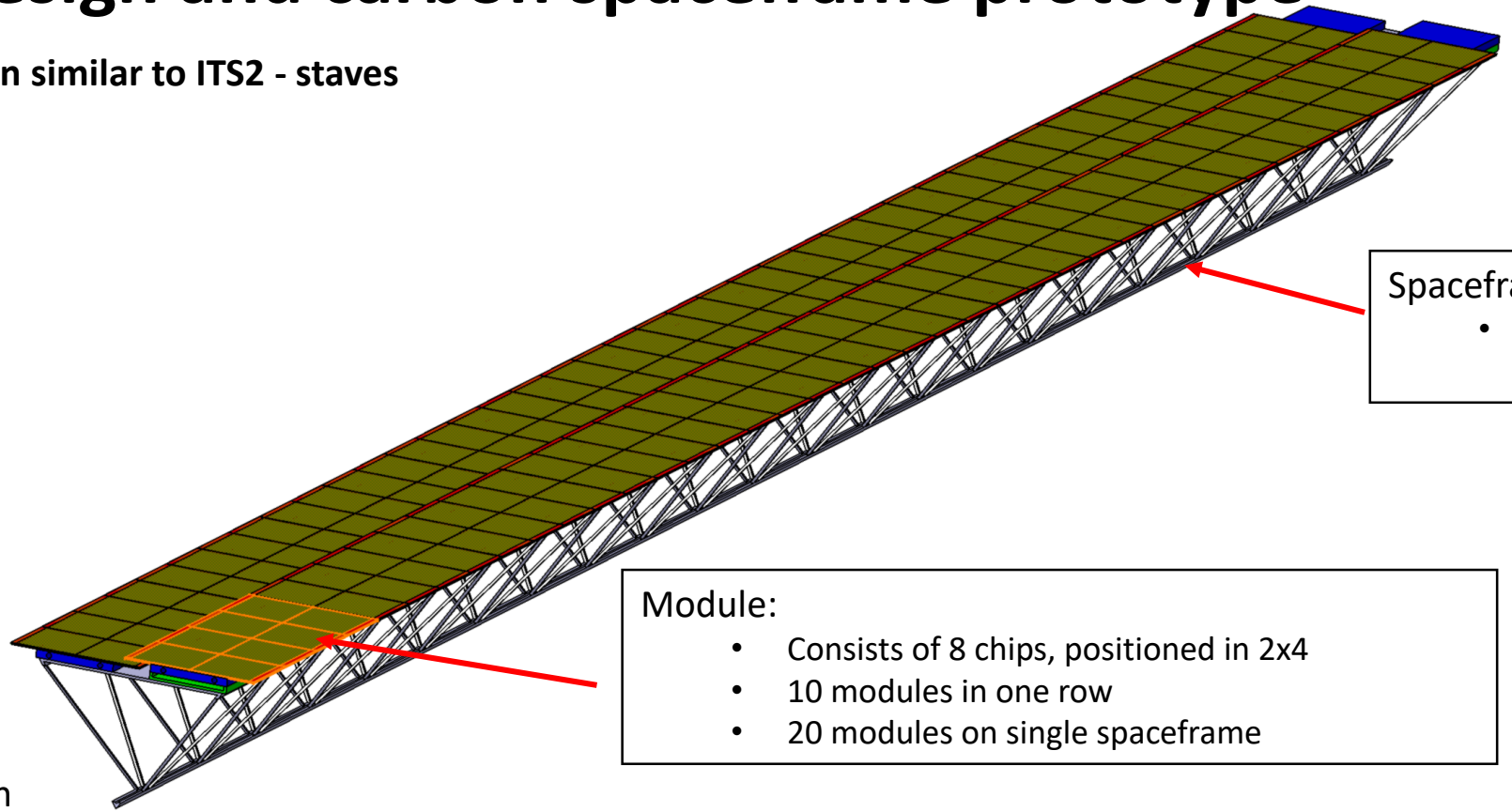
Still many "construction sites"

Stave design and carbon spaceframe prototype



Stave design and carbon spaceframe prototype

Principal design similar to ITS2 - staves



Spaceframe
- CF structure, geometry similar to ITS2

Module:
- Consists of 8 chips, positioned in 2x4
- 10 modules in one row
- 20 modules on single spaceframe

Final design depends on cooling concept

Cooling options will be discussed in a following talk (Laszlo Varga)

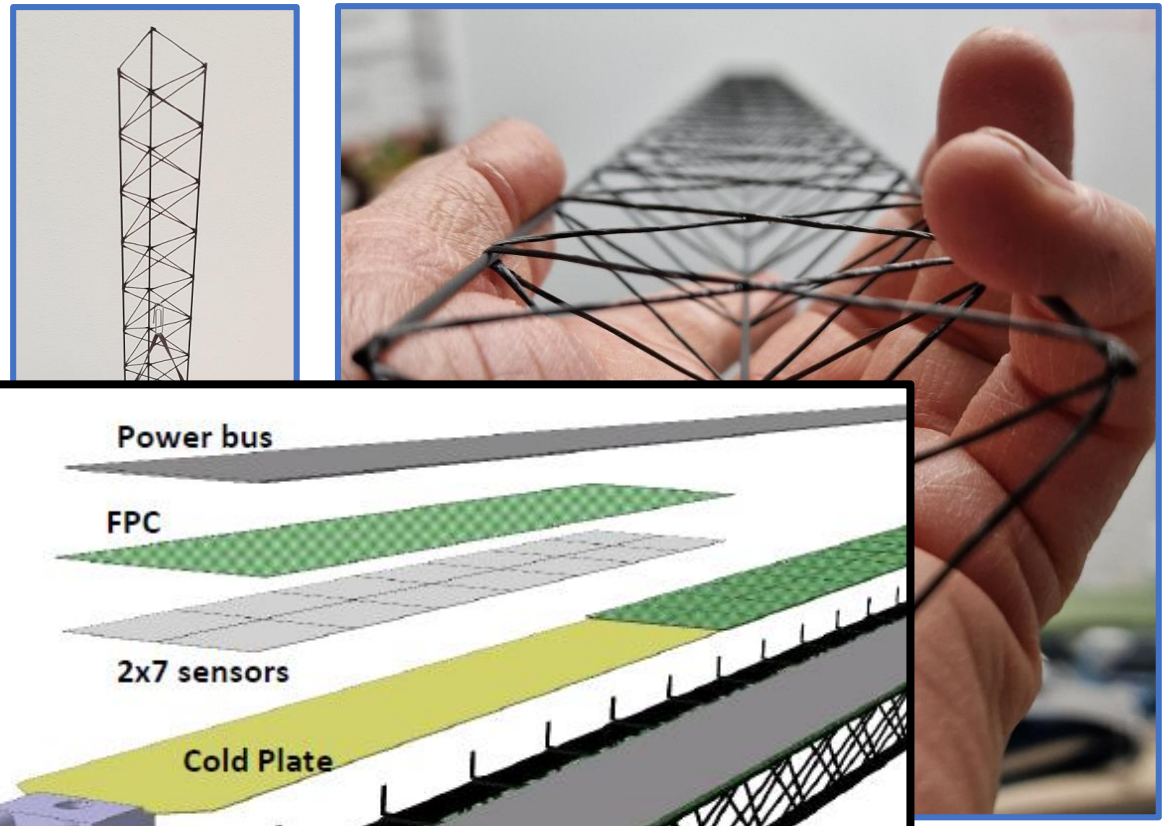
Cooling could be integrated in the spaceframe design

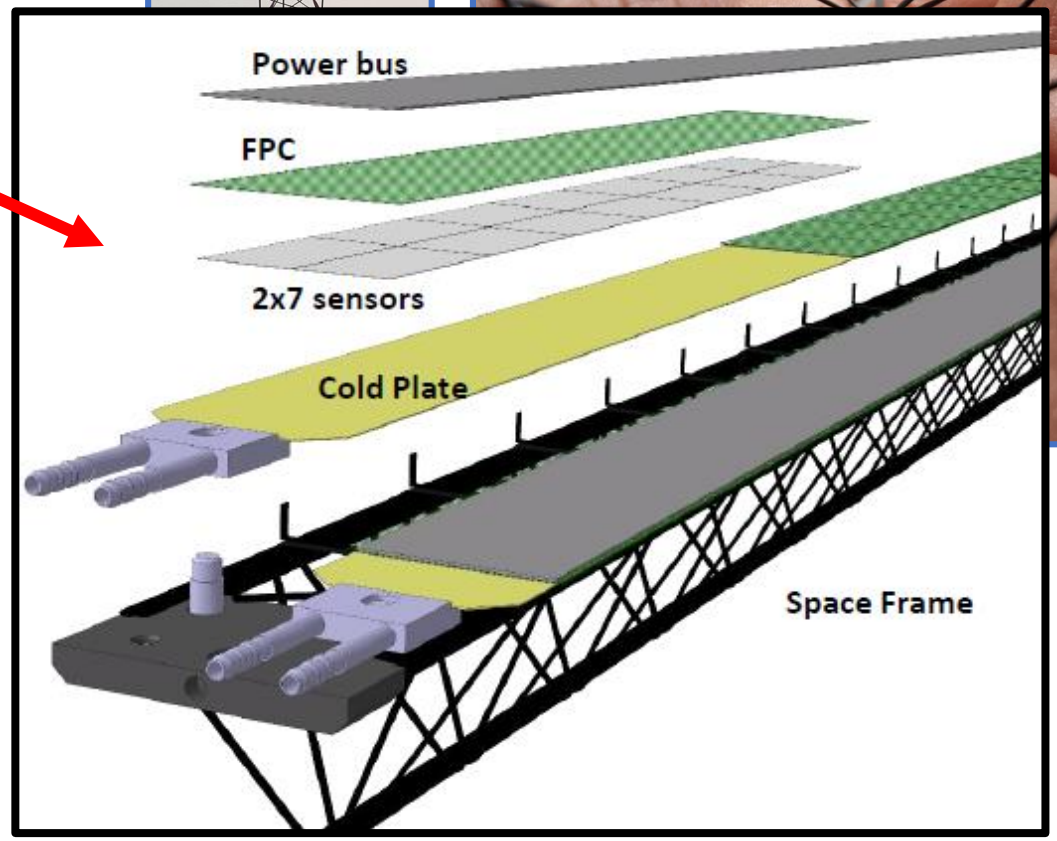
Stave design and carbon spaceframe prototype

First spaceframe prototype

Next design step:

- Fixation of the sensor and cooling on the frame
  - Close to ITS2 design?
  - Other design approach in preparation
    -> modular design
    -> alternative way of spaceframe production
  - for more detailed design work further input on module structure first needed (see Laszlo's talk)





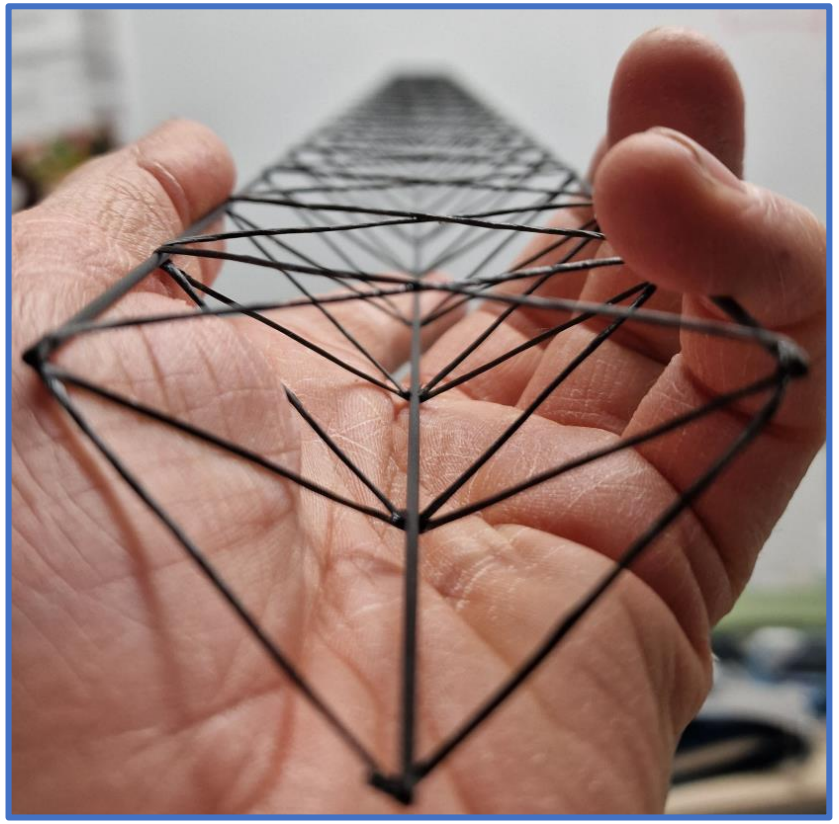
Stave design and carbon spaceframe prototype

First spaceframe prototype

Alternative industrialized manufacturing process discussed with ICM-Composites – **woven carbon filament** around 3 carbon tubes as shown in the pictures below (other geometries possible).

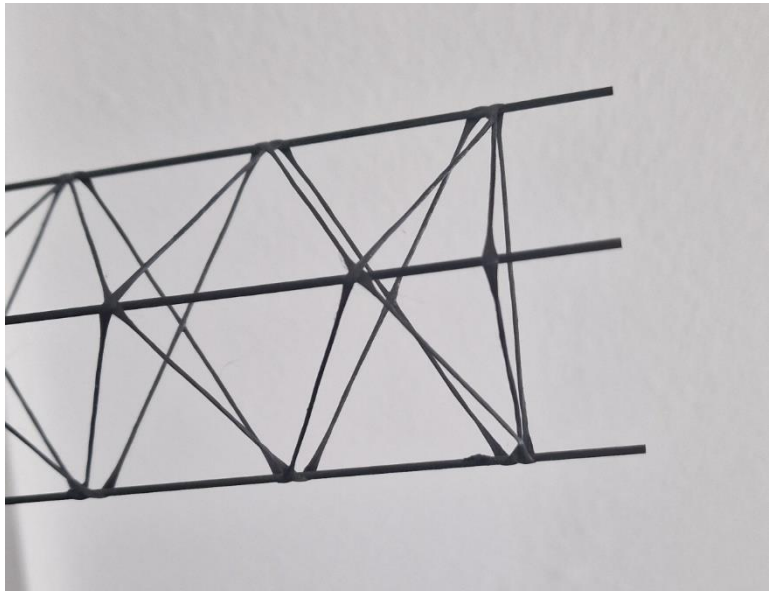
Discussions with ICM
https://icm-composites.de/

- Existing process of woven fibers can be adapted to the ALICE3 OTR dimensions.
- ICM offered to produce a first carbon spaceframe prototype similar to the existing design of the FAIR CBM STS detector project.
- Adaption of existing tooling to ALICE3 OTR dimensions necessary. Easily possible with existing design. Need to extend the winding core to the length required for OTR stave.
- The fabrication process is assumed to be much faster than assembling and gluing the frame out of individual parts.



Stave design and carbon spaceframe prototype

First spaceframe prototype



Offer from ICM
https://icm-composites.de/

- Production of 5 carbon spaceframes with the existing tooling slightly modified (dimensions are almost the same)

  Costs for 5 samples: 3.800 €

- adaption of the existing tooling to the required length of 1285mm

  Costs: 800€

- Order was placed mid of July

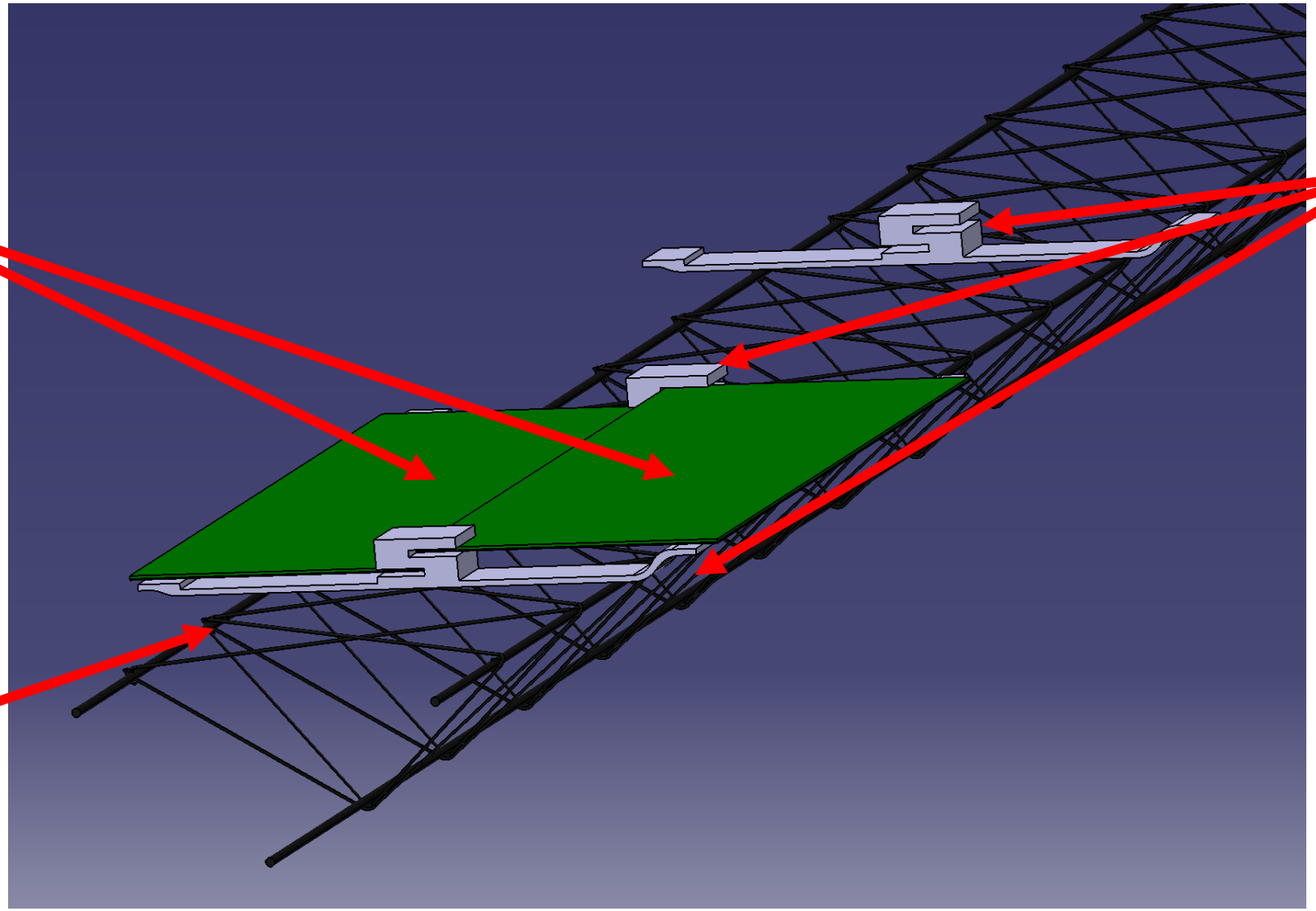
  awaiting prototypes 2nd half of October

  Some delays due to workshop issues 😔

➢ **Meeting with ICM and TUM colleagues on October 17.**

Stave design and carbon spaceframe prototype

Present idea of module fixation on spaceframe



Modules

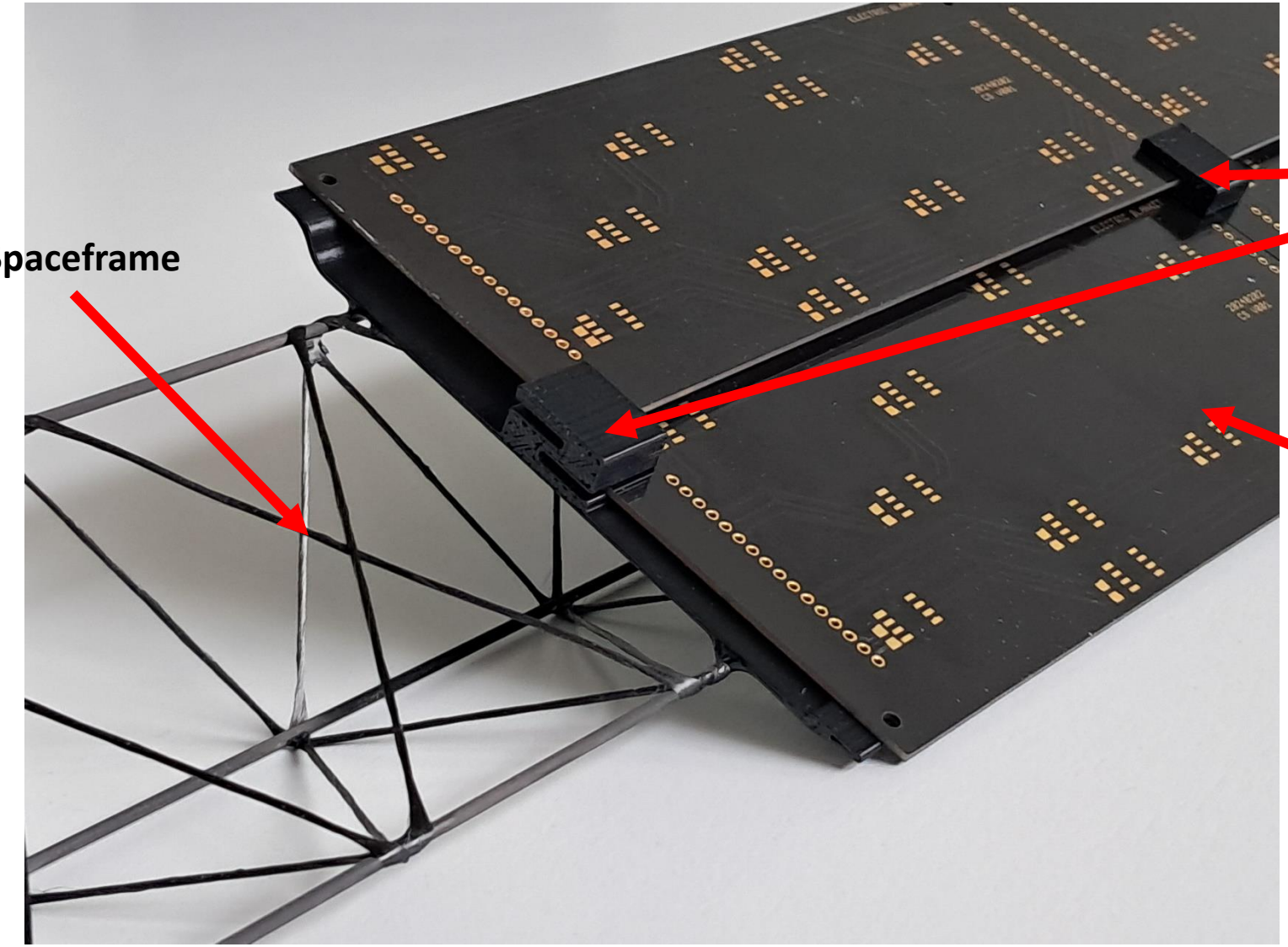
Support brackets

being glued onto the spaceframe

Spaceframe

Stave design and carbon spaceframe prototype

Present idea of module fixation on spaceframe



Spaceframe

support brackets

Brackets being glued on to the spaceframe

Dummy modules for cooling tests (TUM)

Summary

- Schematic 3D model containing the layers and half barrels exists
  - Design will be adapted based on further developments of OTR and surrounding detectors
  - More detailed solutions (e.g. fixation of the staves, connection of the layers an barrels) will be developed
  - First carbon spaceframe prototypes based on CBM STS design expected soon from ICM
  - Mechanical studies und further cooling tests with ICM protos

Next steps

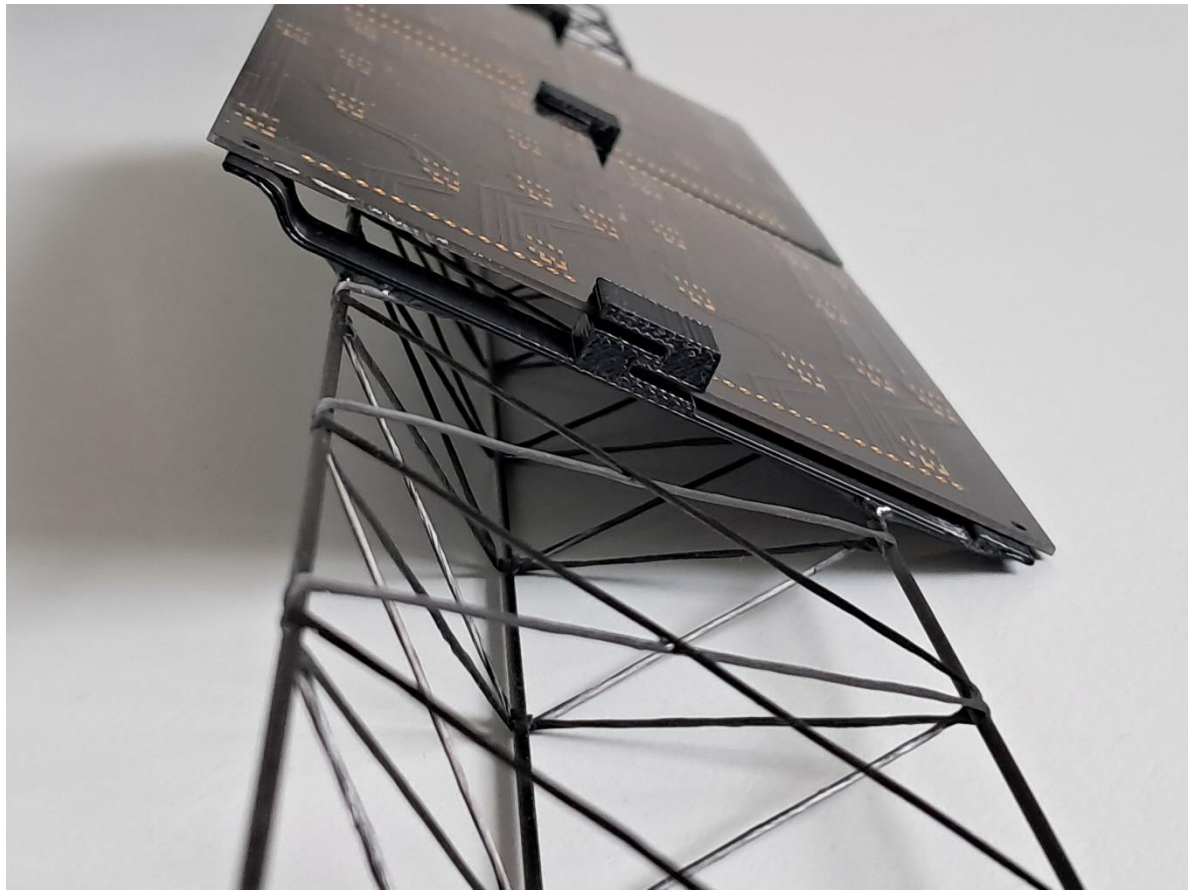
- Continue design fixation of the sensor modules based on cooling/sensor input
- Implement cooling system into spaceframe
- Development of more detailed design of the detector barrel mechanics

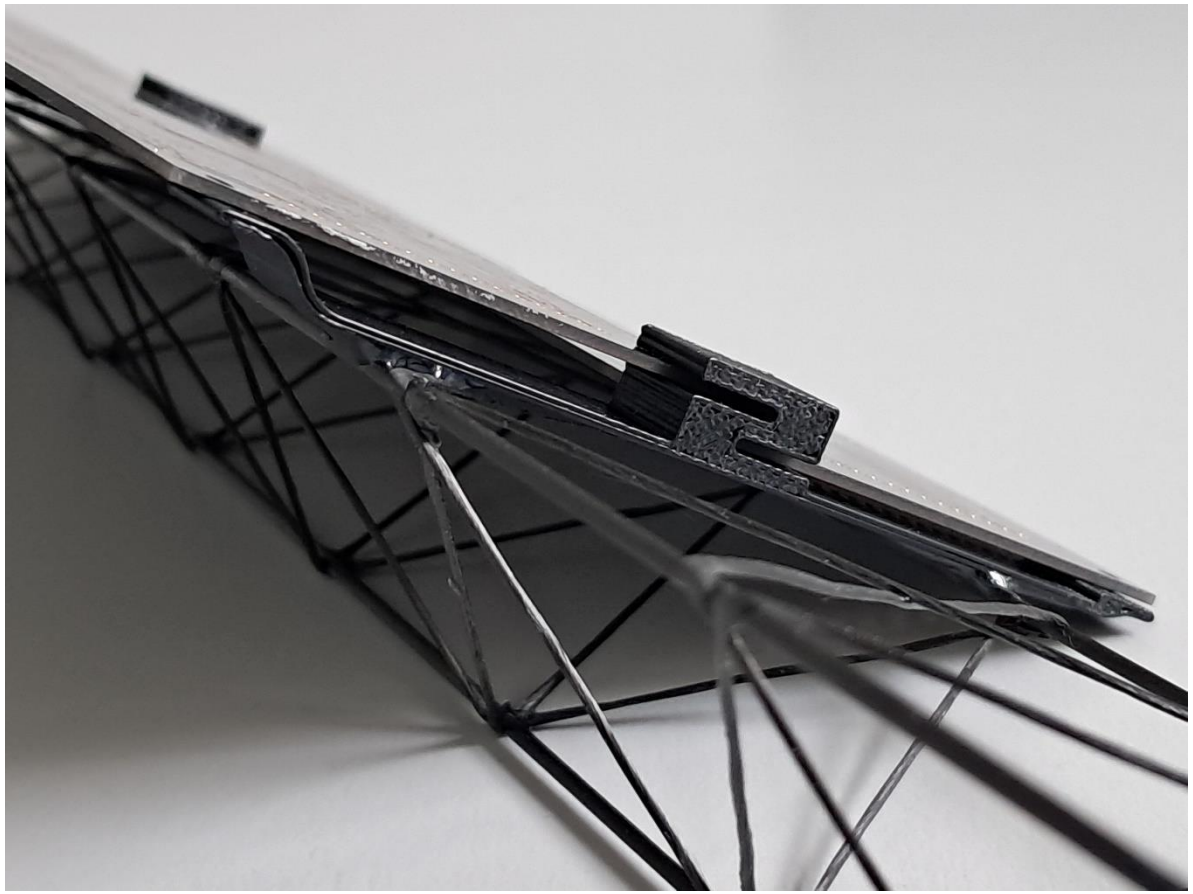
Merçi beaucoup ☺

Backup

Backup slides

Backup slides





Design options for the mechanical support structure

Existing designs and solutions from ITS2 are prefered and should be implemented, if compatible to the ALICE3 requirements

Main components:
- Stave
- Half Layers
- Half Barrels
- Cylindrical Shell
- Service Barrels

Difference to ITS:
- Barrel is divided into two parts in beam direction
  -> additional middle wheels
- Vertical beam pipe support