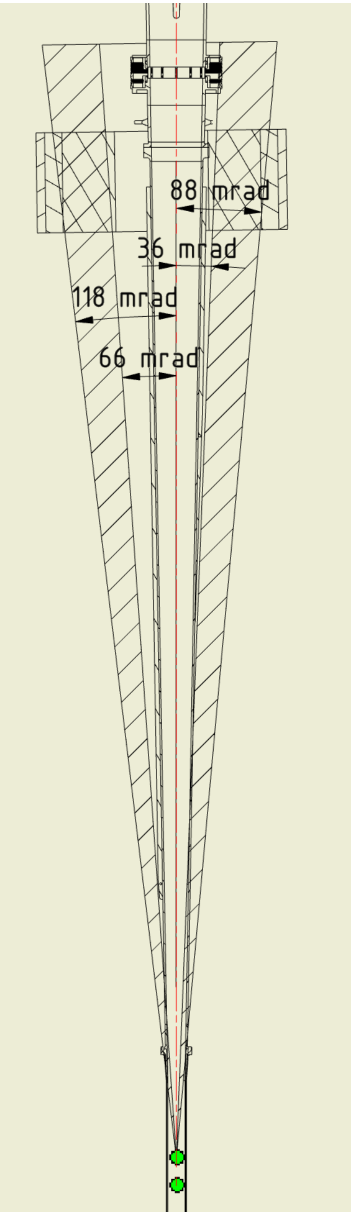
UPDATE ON MECHANICAL IR DESIGN

Speaker: Francesco Fransesini

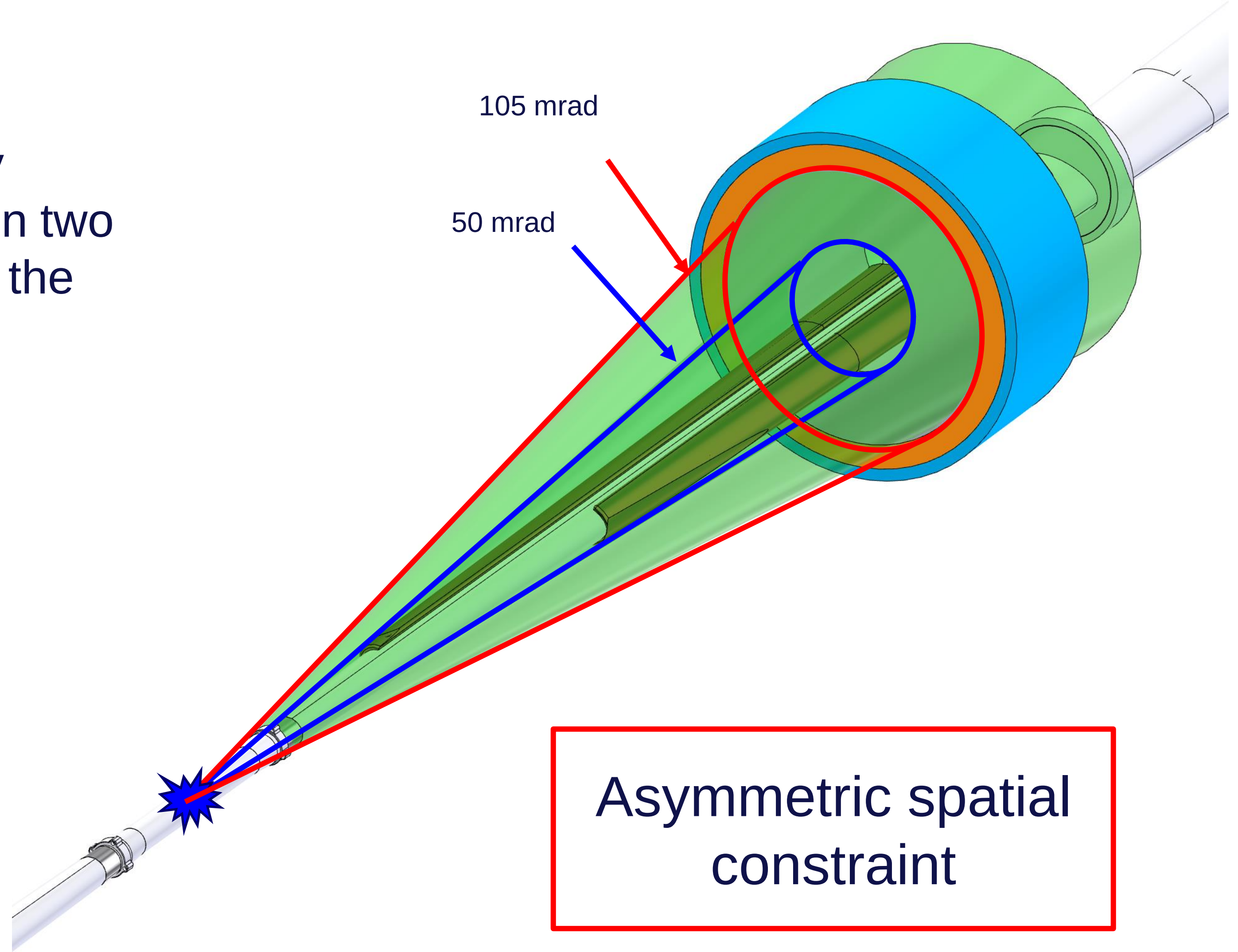
On behalf of the FCC e^+e^- MDI INFN-LNF working group

Spatial constraints - LumiCal Cones



The Lumical is centred on the outgoing beam pipe.
The device to perform properly needs an empty space between two cones, the 50 mrad cones and the 105 mrad cone.

The components integration and each component (i.e. the conical chamber) have been designed to keep everything out of this range, or the thickness has been optimized to achieve the maximum transparency possible.



Asymmetric spatial constraint

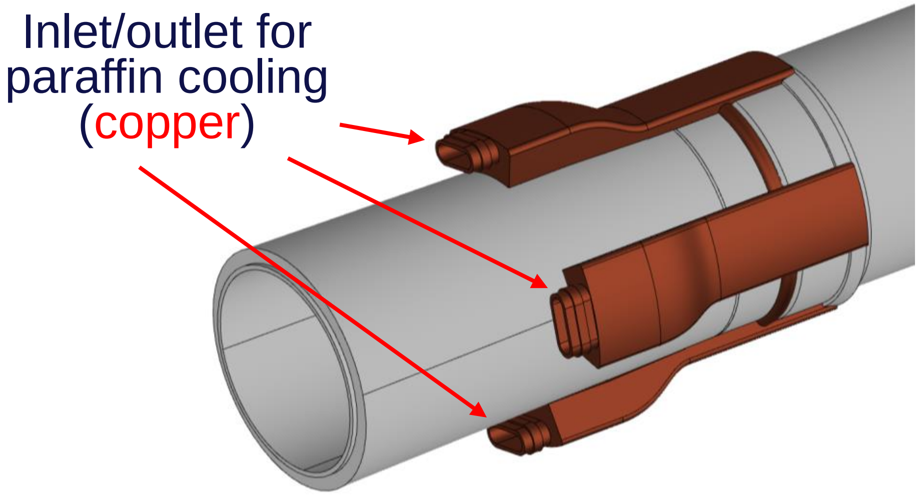
Central chamber – change of the design

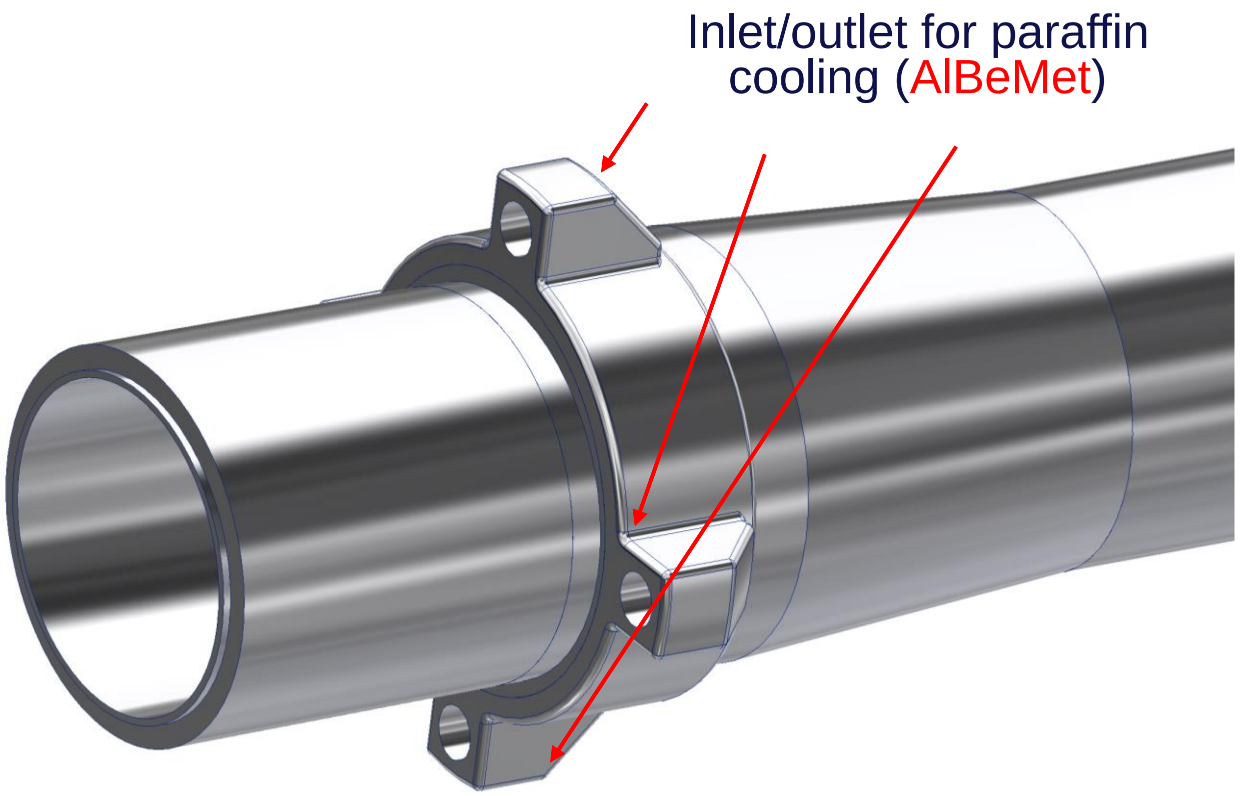
The main characteristics are maintained:

- AlBeMet 162 as main material
- Three layers from 0-90 mm from IP
  - 0.35 mm of AlBeMet162 (62% Be, 38% Al)
  - 1 mm gap for Paraffin
  - 0.35 mm of AlBeMet162
- Paraffin as coolant
- Geometry studied to integrate the central chamber with the vertex detector

Change of the inlet and outlet material

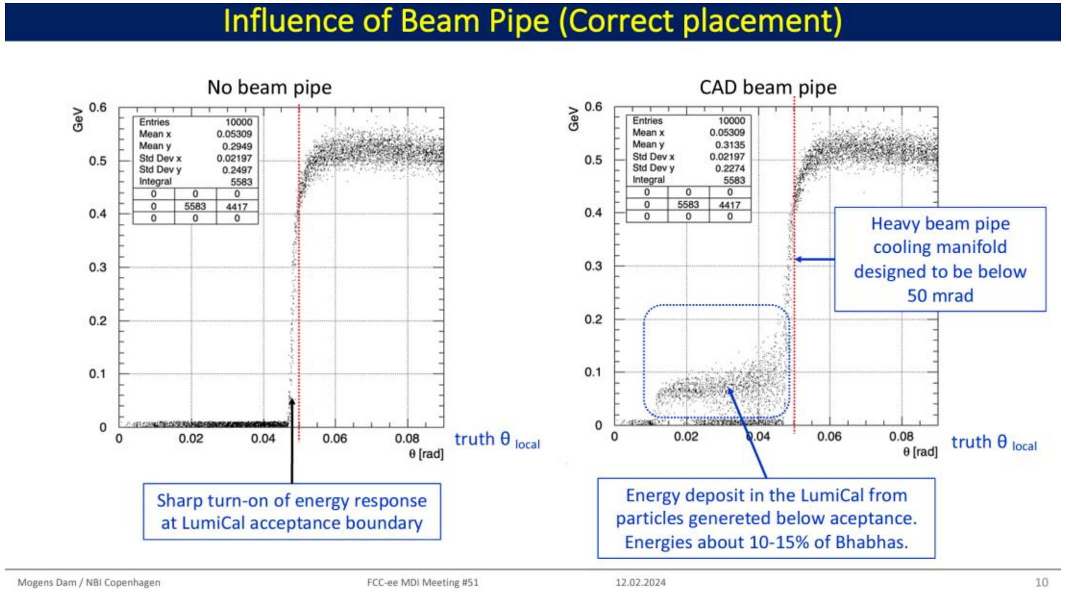
- Reduction of the material budget, avoiding any manifold in copper

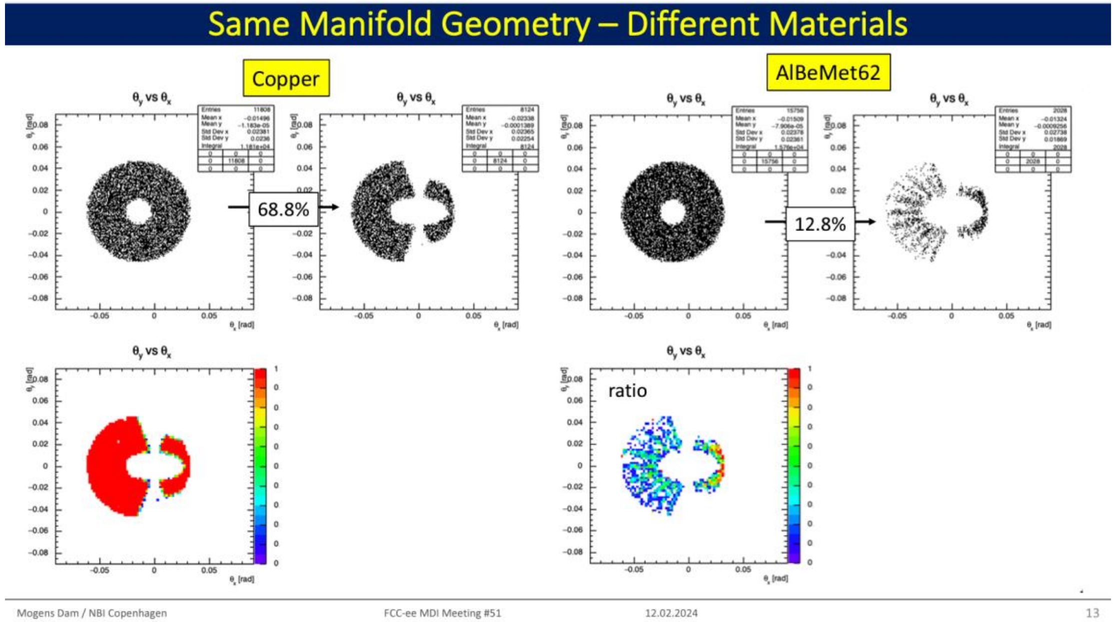




Lesson learnt from Mogens talk in Annecy

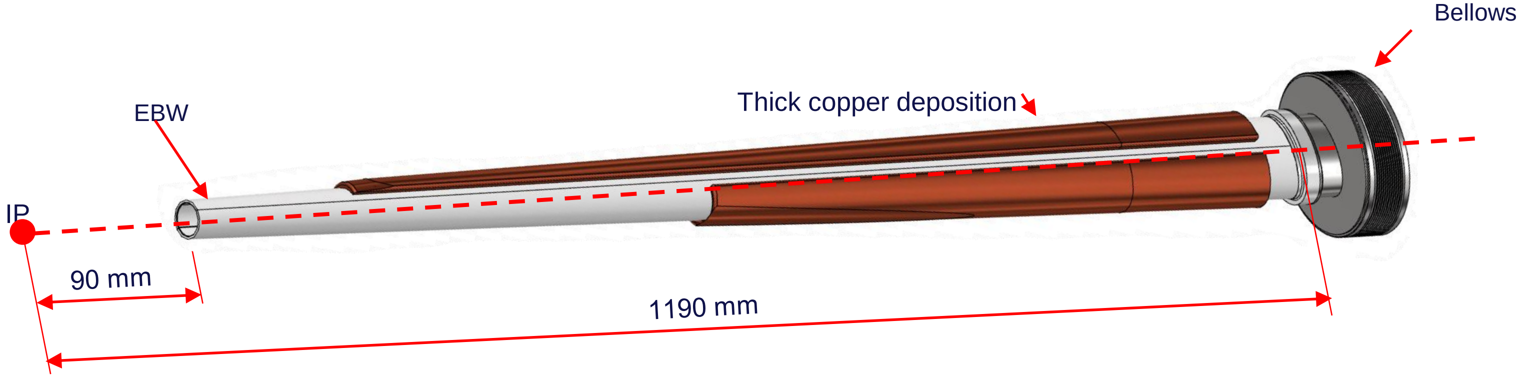
7th FCC Physics Workshop
29 January 2024 to 2 February 2024
Laboratoire d'Annecy de physique des particules





During the workshop in Annecy Mogens Dam highlights the weakness of the ellipto-conical chamber design with the copper cooling

Change of the material from copper to AlBeMet 162



Considerations

- The thick copper deposition is not possible with the AlBeMet162 → The cooling channels will be machined directly on the chamber
- The manifold for the inlet and outlet can't be made in copper due to the material modification → We have to create a standard connection, no 3d printed as before
- The LumiCal spatial constraint must be guaranteed

Conical chamber

Ellipto-Conical chamber

Common main characteristics:

- **AlBeMet162** is the main material.
- The chamber consists of two halves, machined considering the internal shape of the chamber, and assembled using EBW (Electron Beam Welding).
- The cooling is based on an **asymmetric solution**, using the **50 mrad Lumical acceptance** cone as the cutting profile.

- The cooling system is created using **copper manifolds** deposited over the chamber using the "**Thick copper deposition**" technique.
- **five channels** for each side

- Machined cooling system over

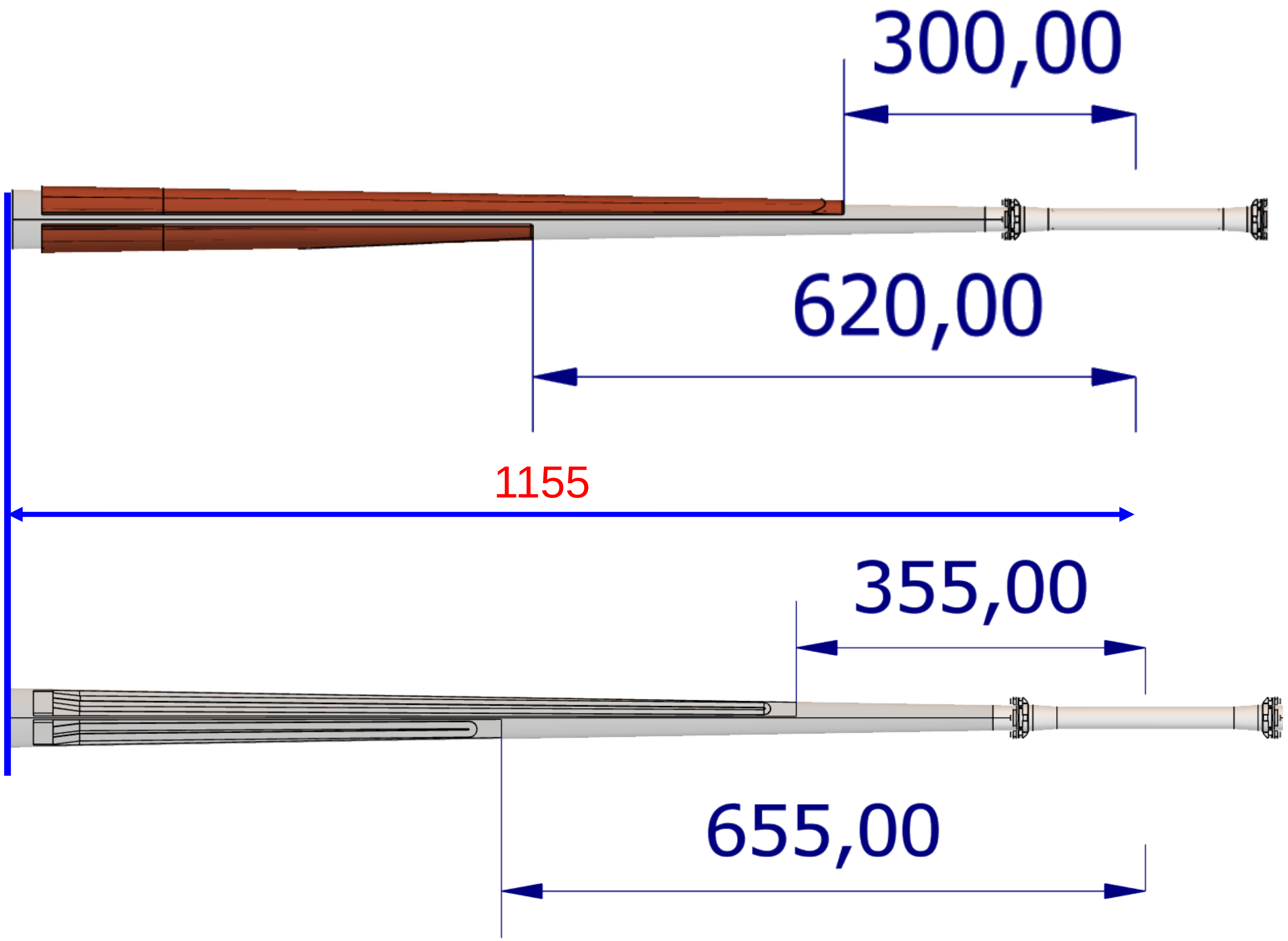
Comparison with the previous design

Similarities:

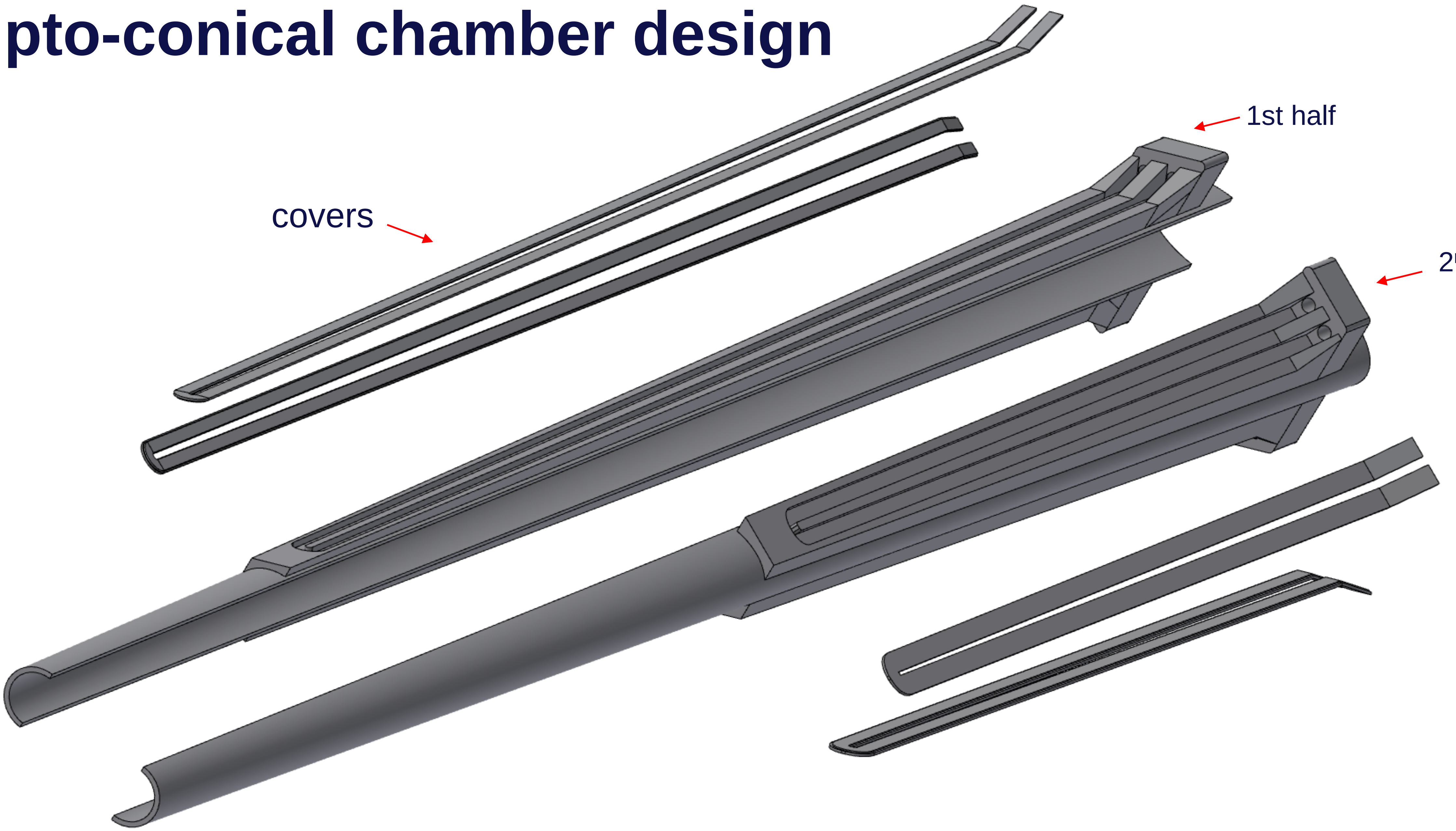
- same total length
- same internal shape
- Same unformal thickness → 2 mm

Differences:

- Shorter ingoing cooling channels
- Shorter outgoing cooling channels



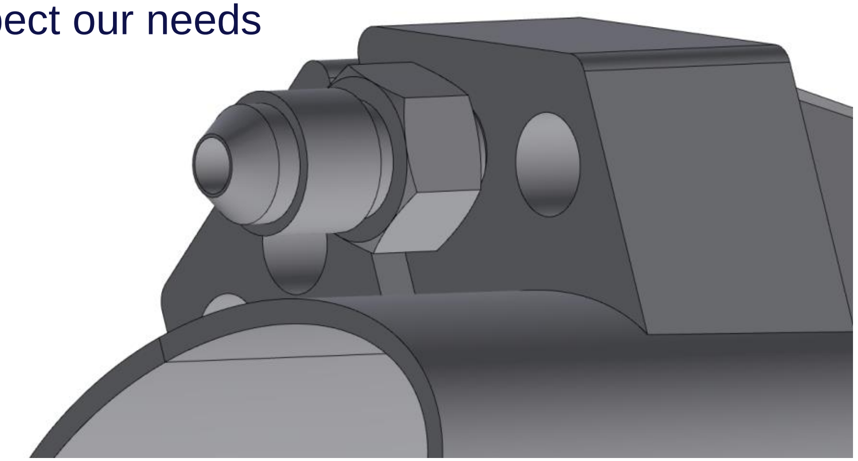
Ellipto-conical chamber design



The design is still preliminary, we are working on the following topics:

- Weight optimization
- Study of the feasibility in terms of machining
- Study of the hydraulic connections

We are developing a homemade connector that respect our needs



The covers are welded over the machined cooling channel, in order to create the hydraulic tightness

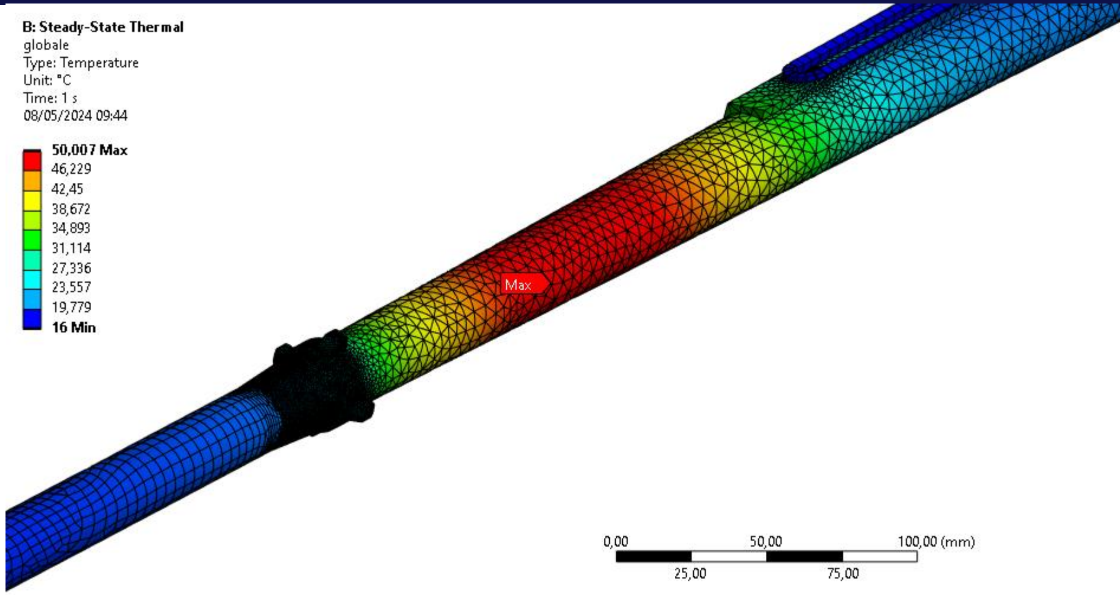
The design is still asymmetric

See Andrea’s talk for the material budget evaluation

Thermal analysis

From CST calculations (**Alexander Novokhatski (SLAC)**)

- **Heat load**
- 54 W central
- 130 W AlBeMet162 for each part



- **Paraffin flow (central chamber)**
  - Flow rate: 0,015 kg/s
  - Section:68,17 mm^2
  - Velocity: 0,3 m/s
  - Inlet temperature: 18°C
  - Convective coefficient: 900 W/m^2K

- **Water flow (Ellipto-Conical chamber)**
  - Flow rate: 0,01 kg/s (4 channels per side)
  - Total flow rate per side: 0,04 kg/s
  - Section: 12,25 mm^2
  - Velocity: 1 m/s
  - Inlet temperature: 16°C
  - Convective coefficient: 1200 W/m^2K

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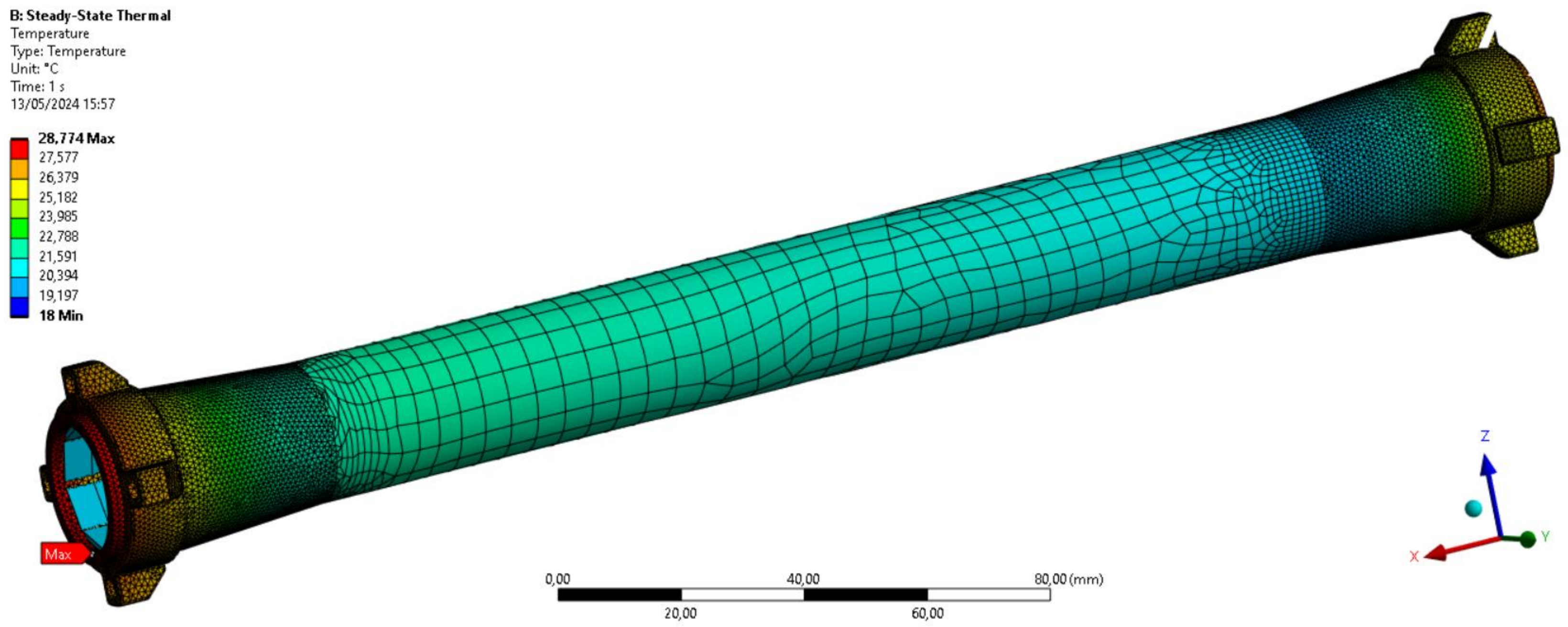
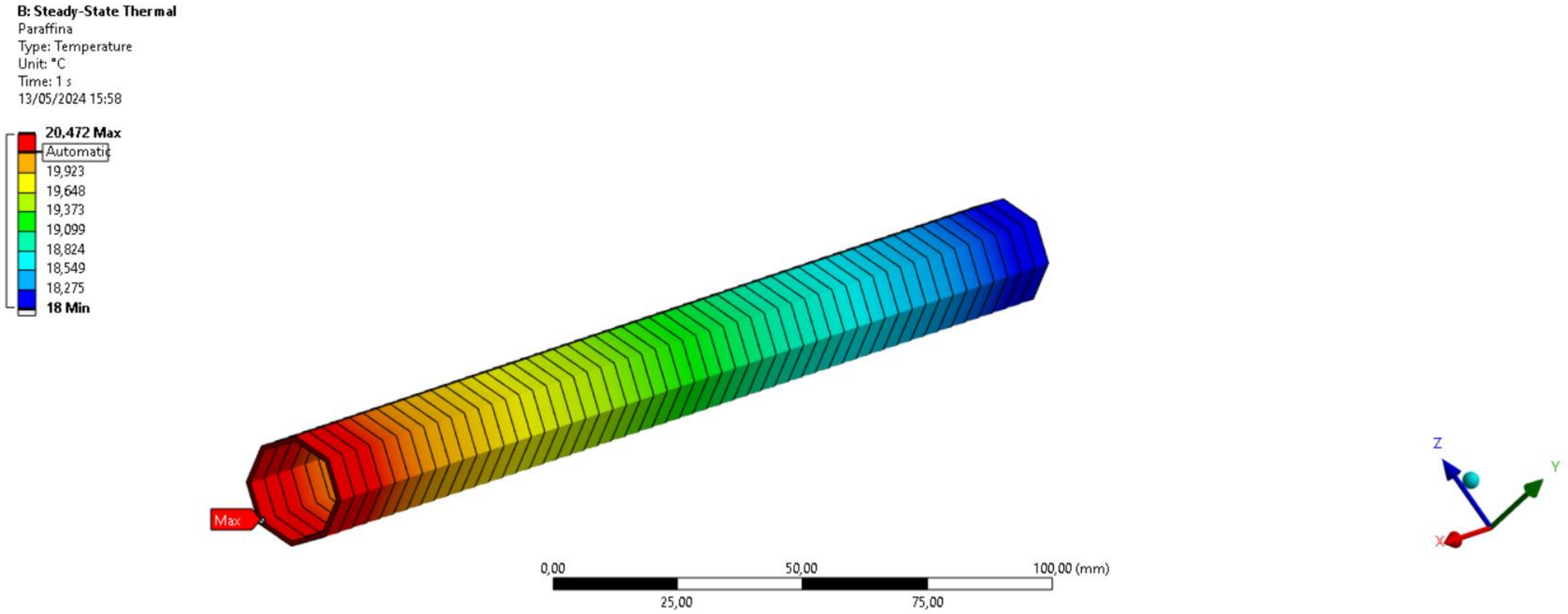
Chamber design (until the bellows)

	Conical chamber	**Central chamber**
Coolant	Water	Paraffin
Maximum chamber temperature [°C]	50	29
T_out coolant [°C]	18	20,5

Central chamber



Paraffin



Progress on the mock-up activities

- We are ordering the central chamber realization
- We are studying an optimized solution for the Support tube in close contact with companies
- We are developed a prototype for hydraulic connection. The connection is airtight, and in the next weeks we will create the real hydraulic connector, using the needed dimensions.

At the moment we realized a prototype only of the hydraulic fittings and tested it under pressure using air. In the following test we will use water and then paraffin.

Thanks to Frascati group: Ugo Rotundo, Sergio Cantarella, Gianluca Luminati, Marta Cianfrini and Andrea Iungo for the help

THANK YOU FOR YOUR ATTENTION

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