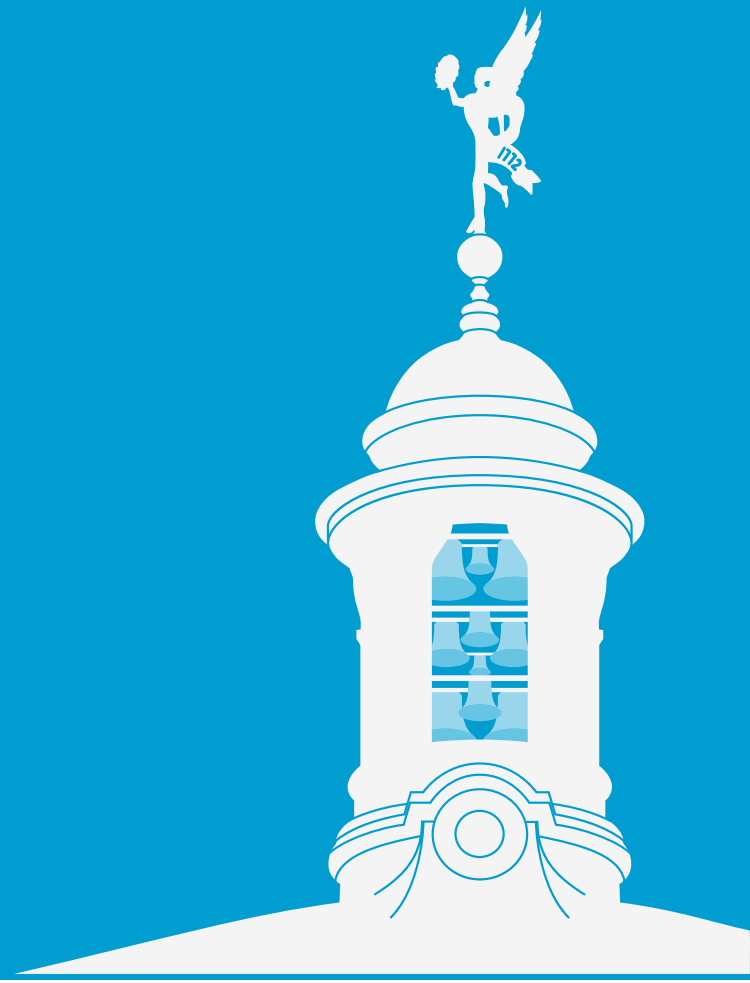
WWU
MÜNSTER

A cryopump for PANDA

Christian Mannweiler
Institut für Kernphysik
WWU

24.6.2020



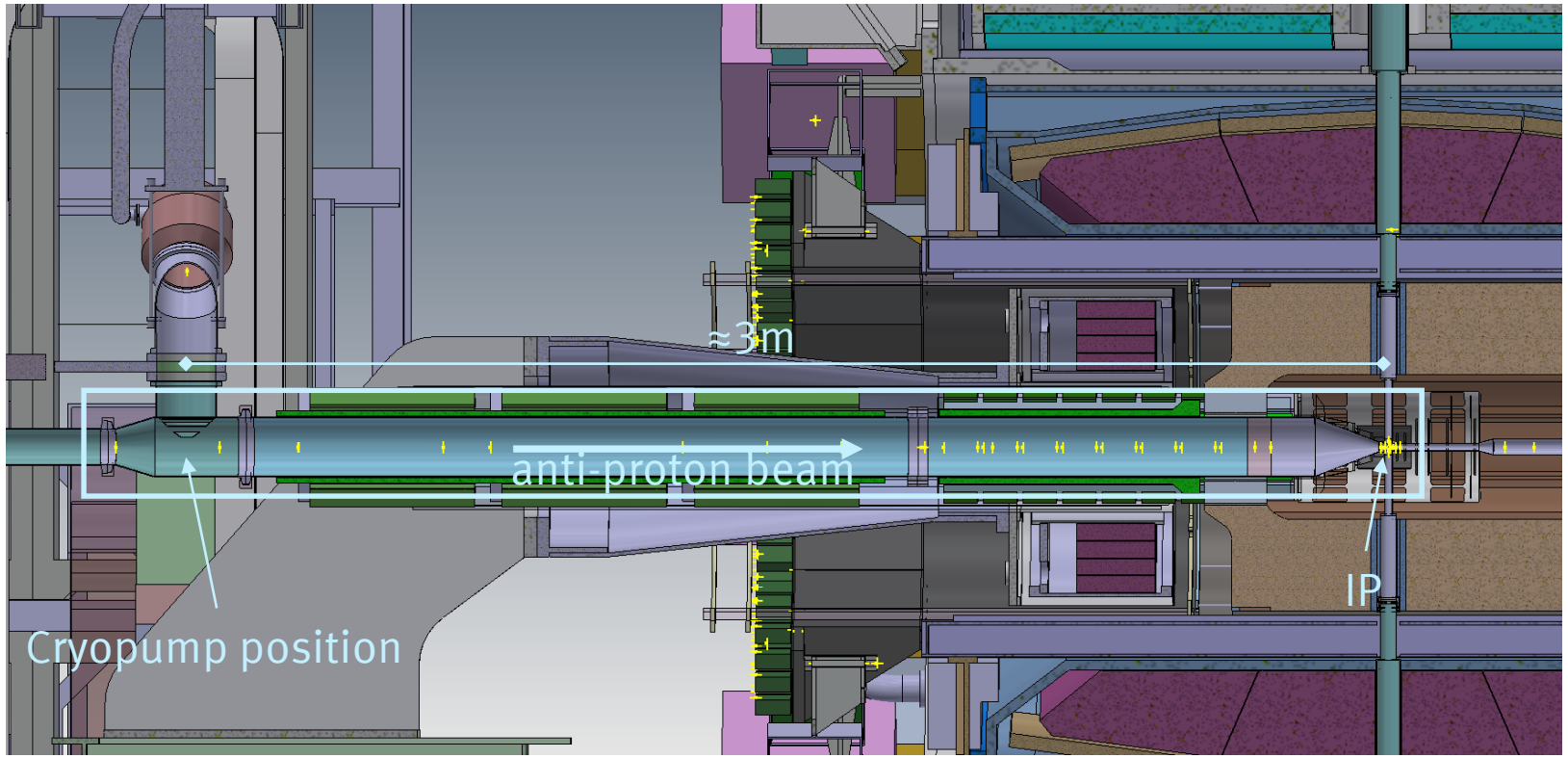
Motivation

- Expected residual gas density in PANDA poses a challenge on multiple fronts
  - **For example: for the luminosity detector, beam lifetime, vertex point reconstruction**

➢ Multipronged approach:

- **Optimisation of IP (D. Klostermann)**
- **Cooling of target beam pipe (D. Klostermann)**
- **Cryopump for (anti-)proton beam line**

Position of the cryopump



Cooling hardware and analysis software

- Coldhead: Leybold Coolpower 10 MD
  - **≈ 30K at warm stage**
  - **≈ 10K at cold stage**

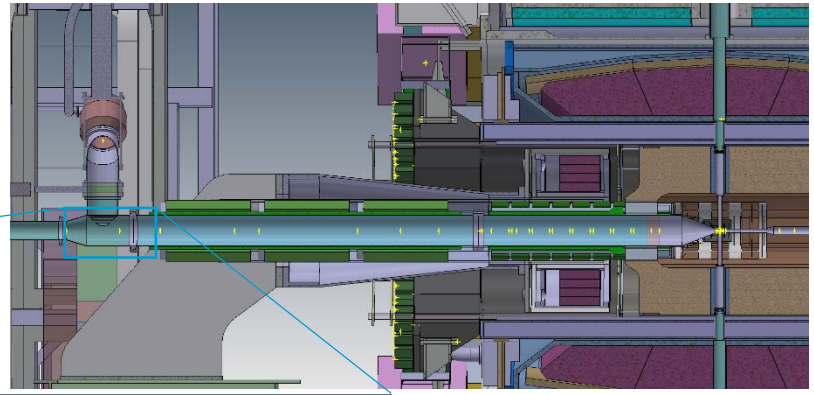
- Temperature simulations performed with Autodesk CFD 2019

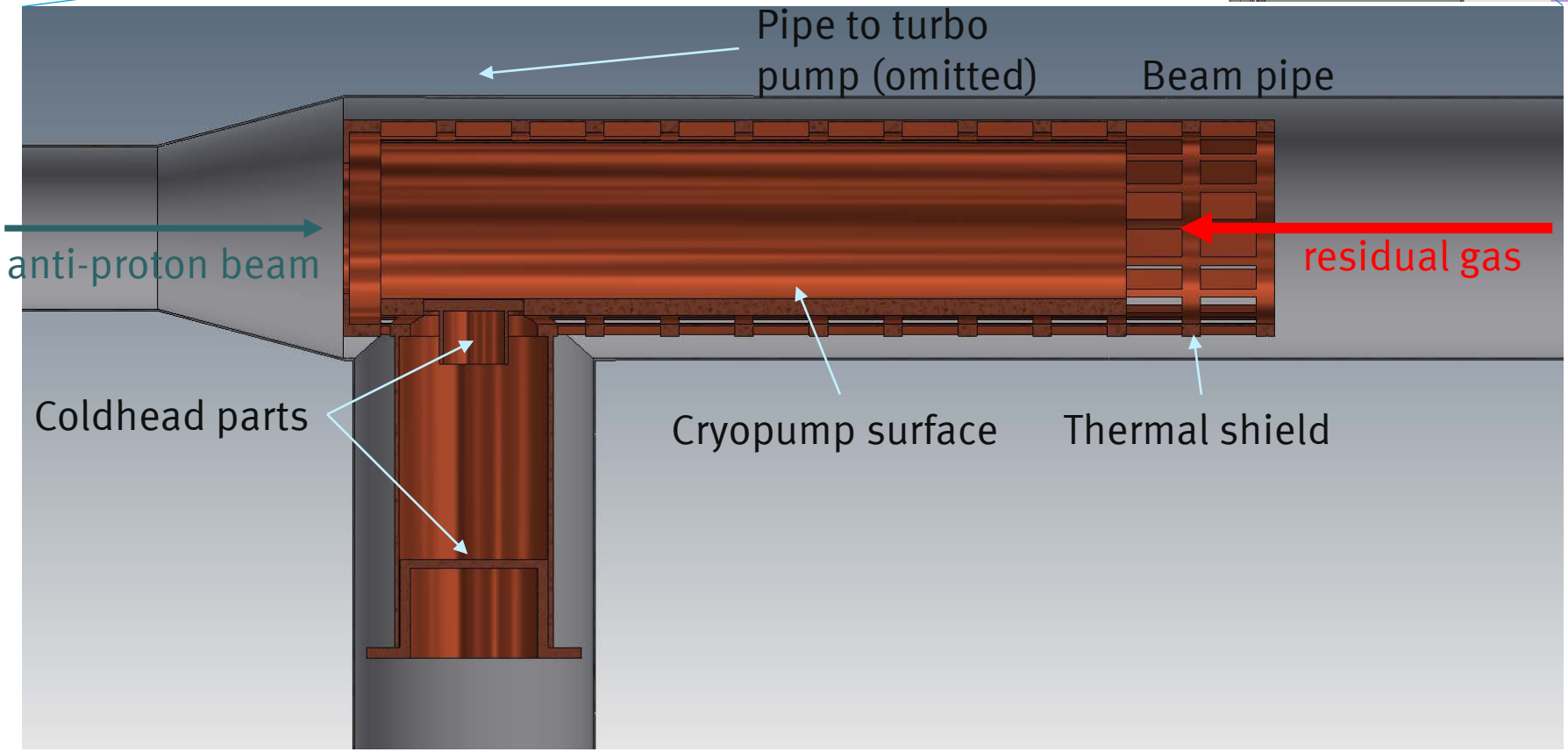
- Vacuum simulations performed with Molflow+

[1]

[1] https://www.leyboldproducts.de/media/image/1e/fe/33/PC_842010_3_600x600@2x.jpg

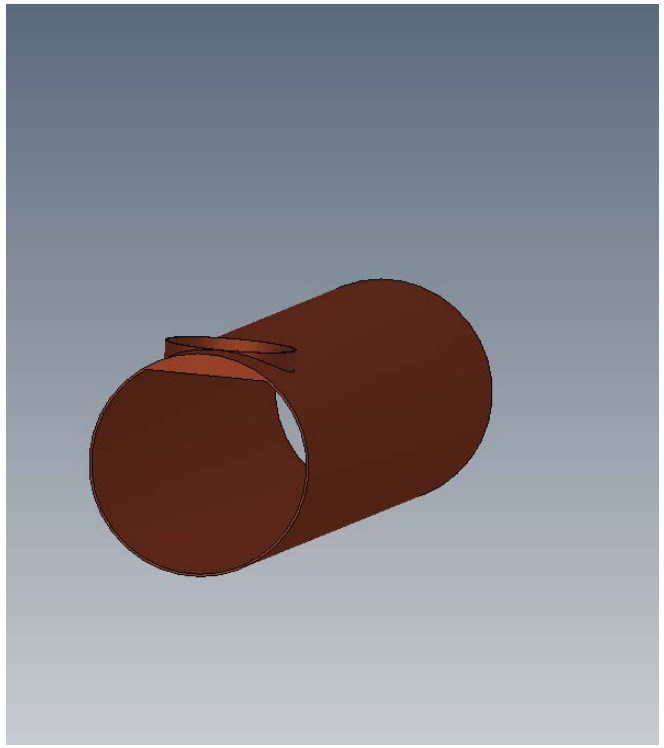
Example of an inserted cryopump



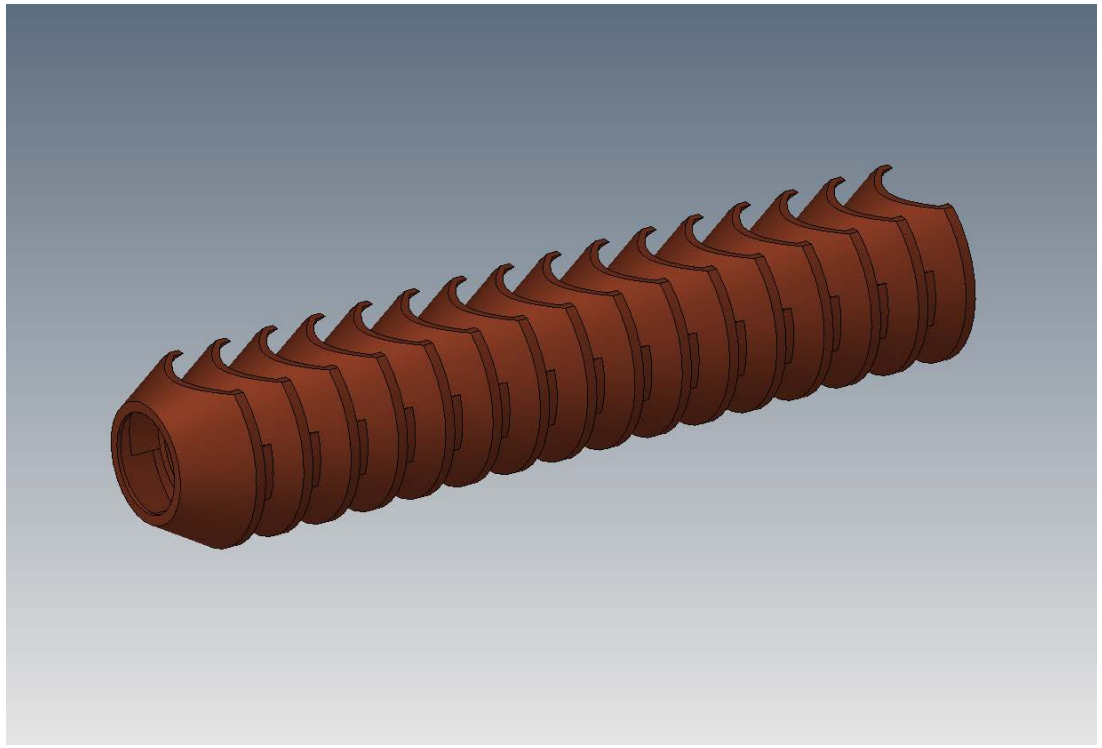


Different cryopump geometries

tube cryopump

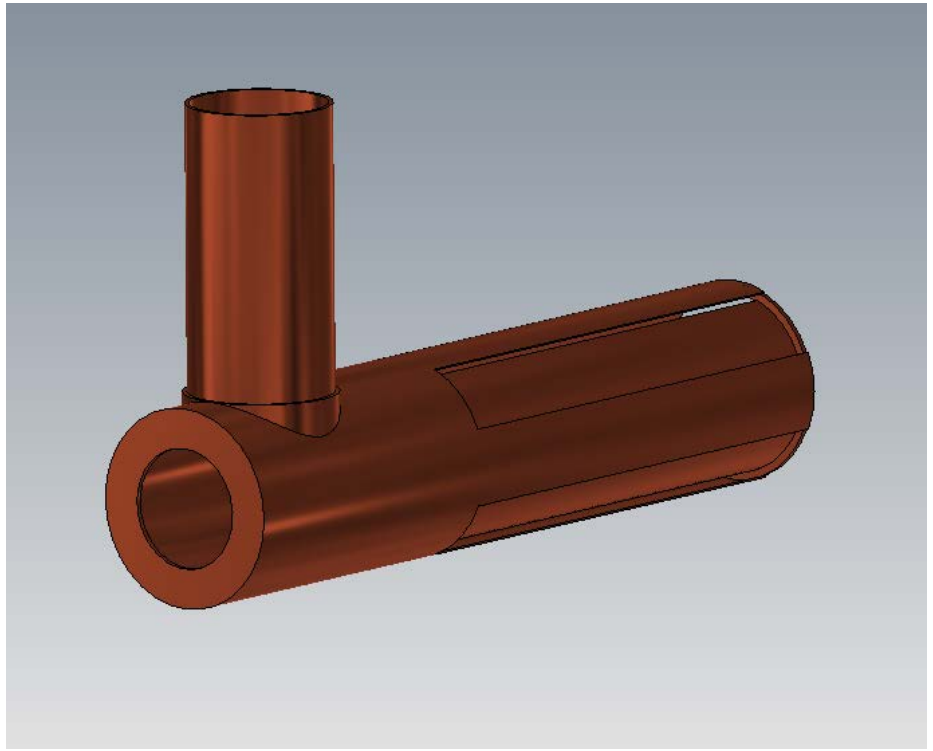


aperture cryopump

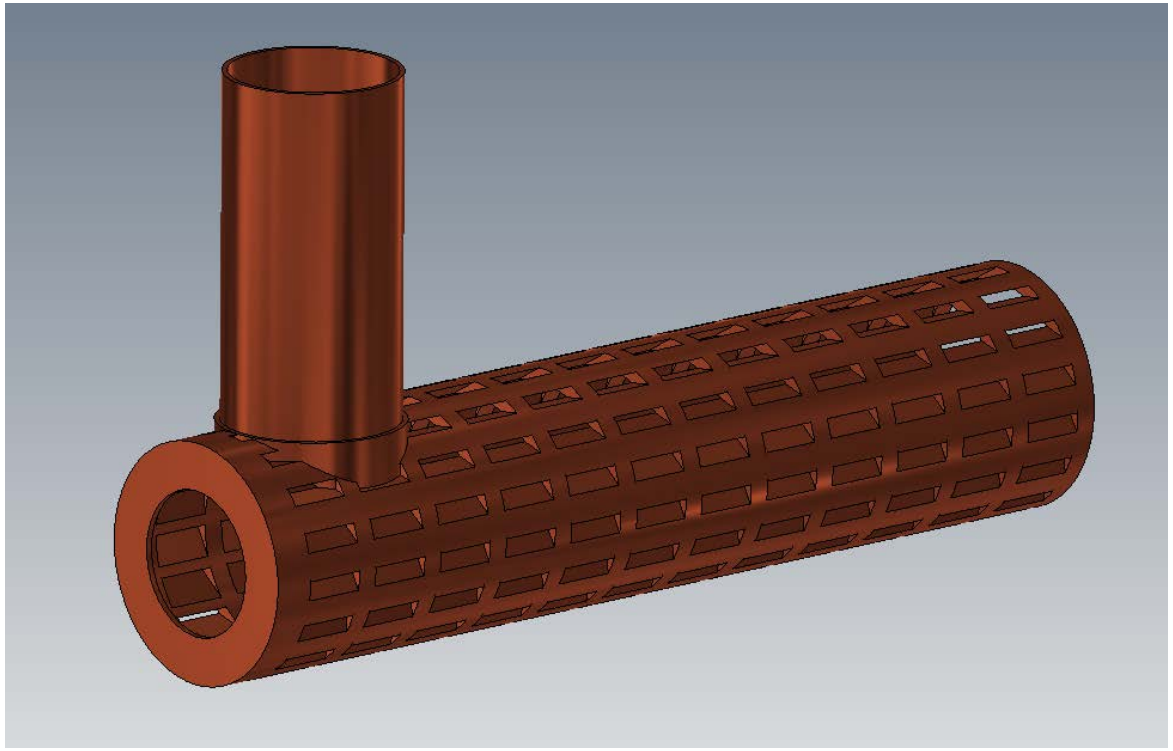


Different thermal shield geometries

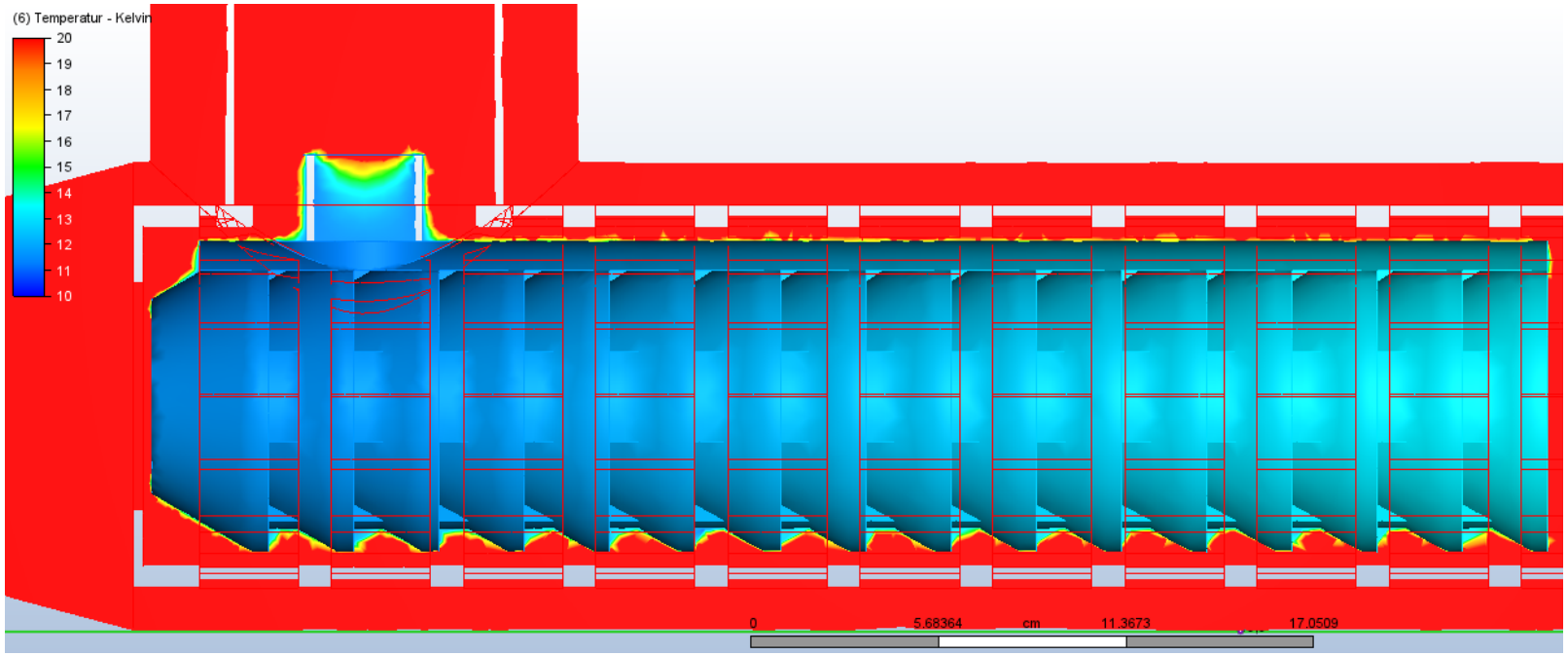
Gap shield



Hole shield



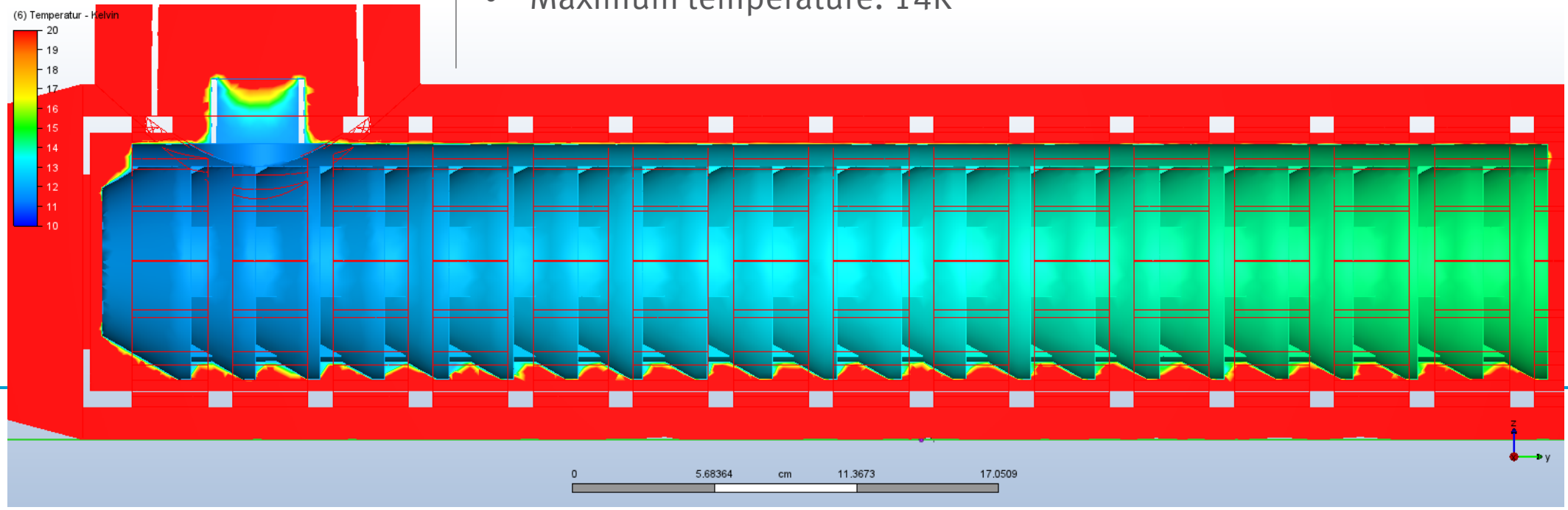
Aperture cryopump with a hole shield



- Length: ≈ 40 cm
- Pumping surface: 3527 cm^2
- Regeneration interval: ≈ 2.4 months
- Minimal temperature: 11K
- Maximum temperature: 13K

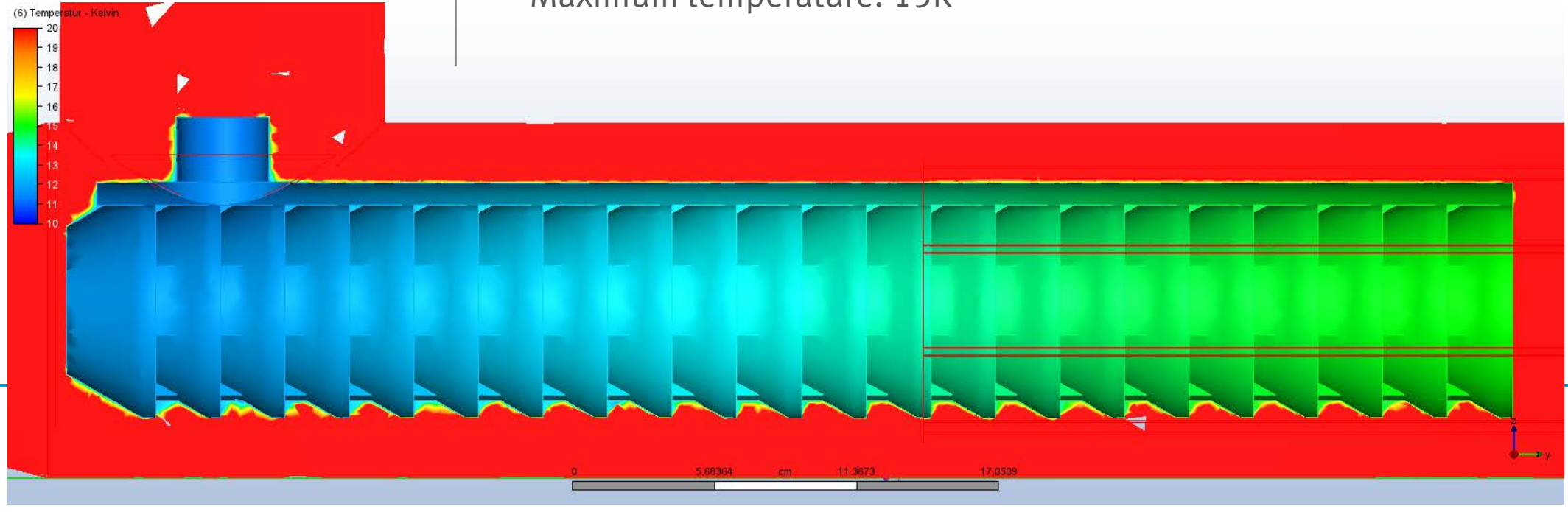
Aperture cryopump with a hole shield

- Length: ≈ 60 cm
- Pumping surface: 4863 cm^2
- Regeneration interval: ≈ 3.3 months
- Minimal temperature: 11K
- Maximum temperature: 14K

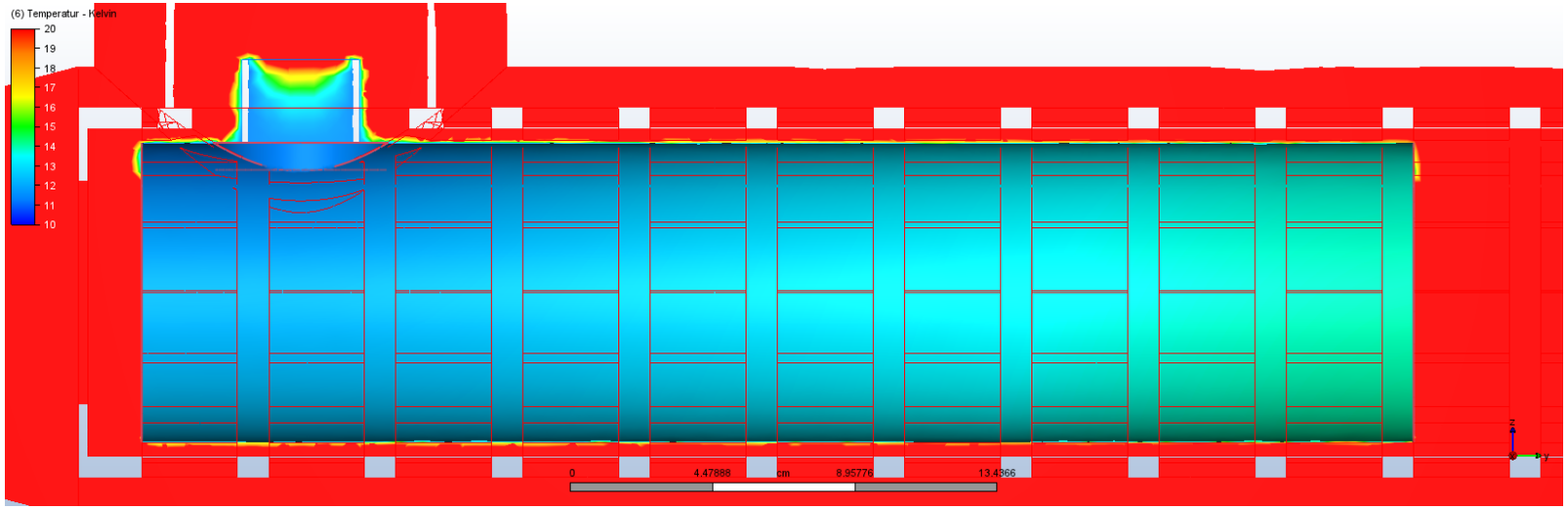


Aperture cryopump with a gap shield

- Length: ≈ 60 cm
- Pumping surface: 4863 cm^2
- Regeneration interval: ≈ 3.3 months
- Minimal temperature: 12K
- Maximum temperature: 15K



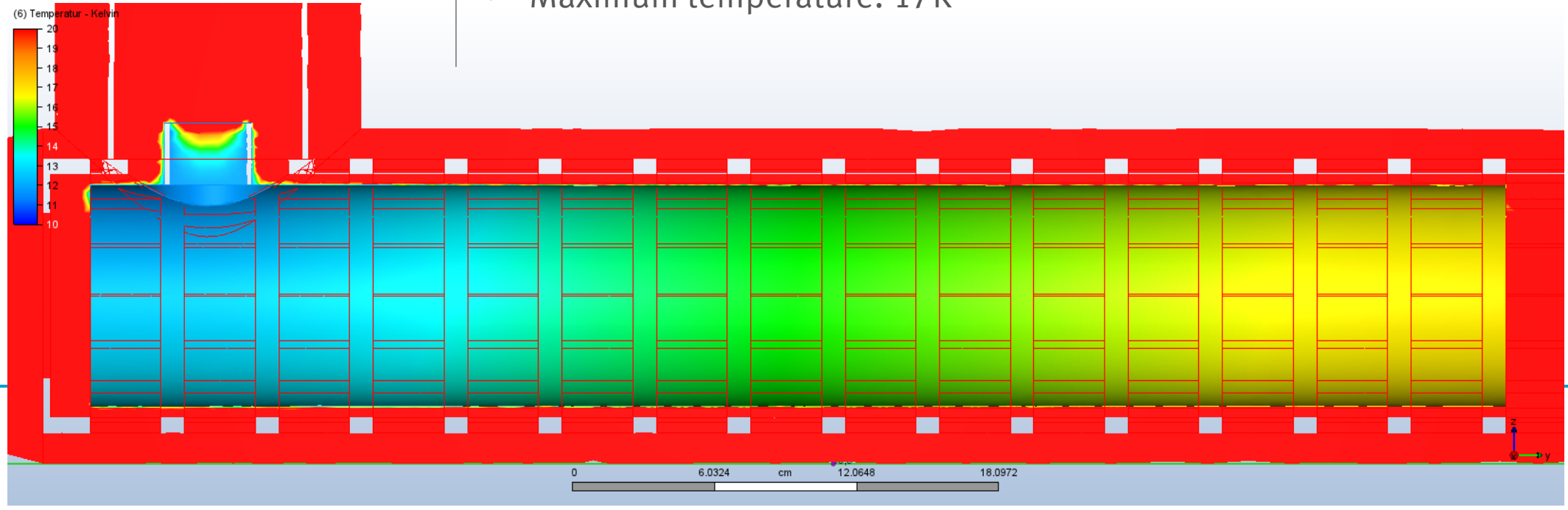
Tube cryopump with a hole shield



- Length: ≈ 40 cm
- Pumping surface: 2332 cm^2
- Regeneration interval: ≈ 1.6 months
- Minimal temperature: 11K
- Maximum temperature: 14K

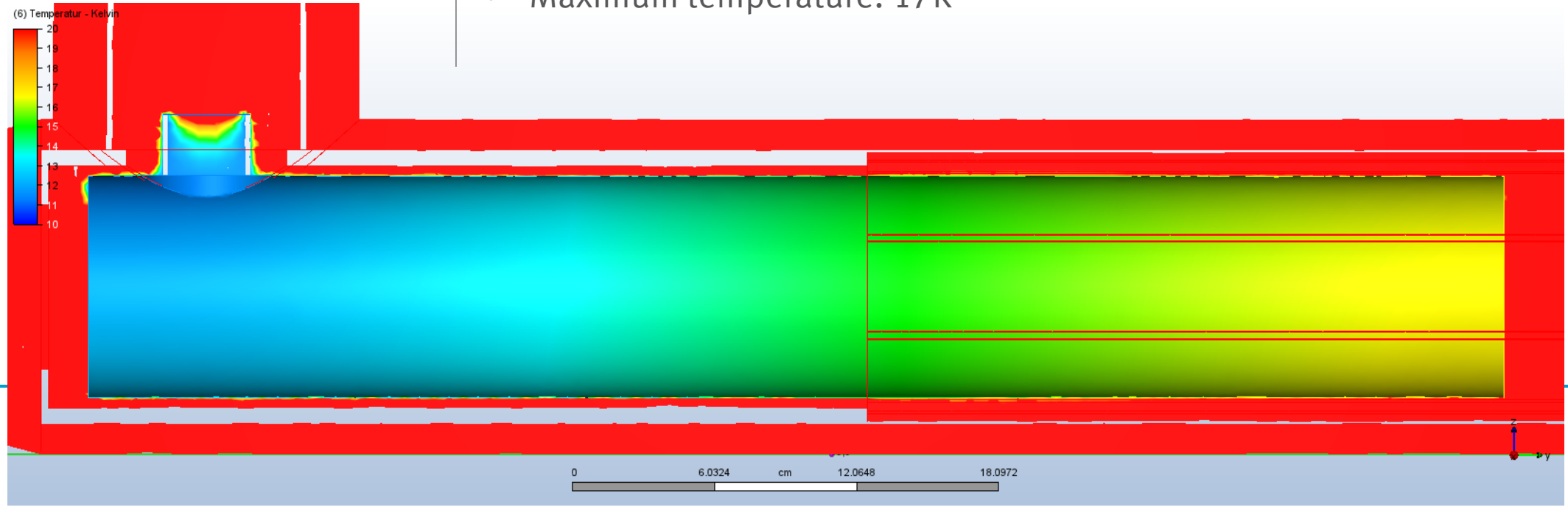
Tube cryopump with a hole shield

- Length: ≈ 60 cm
- Pumping surface: 3491 cm^2
- Regeneration interval: ≈ 2.4 months
- Minimal temperature: 12K
- Maximum temperature: 17K



Tube cryopump with a gap shield

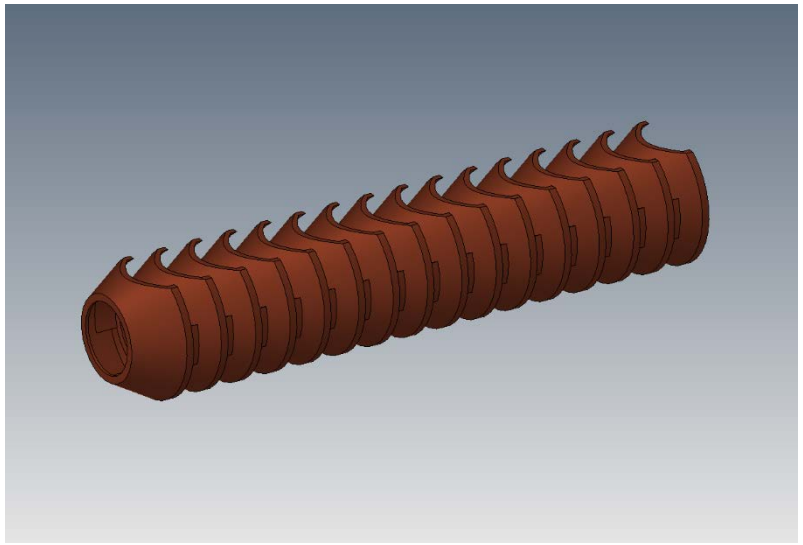
- Length: ≈ 60 cm
- Pumping surface: 3491 cm^2
- Regeneration interval: ≈ 2.4 months
- Minimal temperature: 12K
- Maximum temperature: 17K



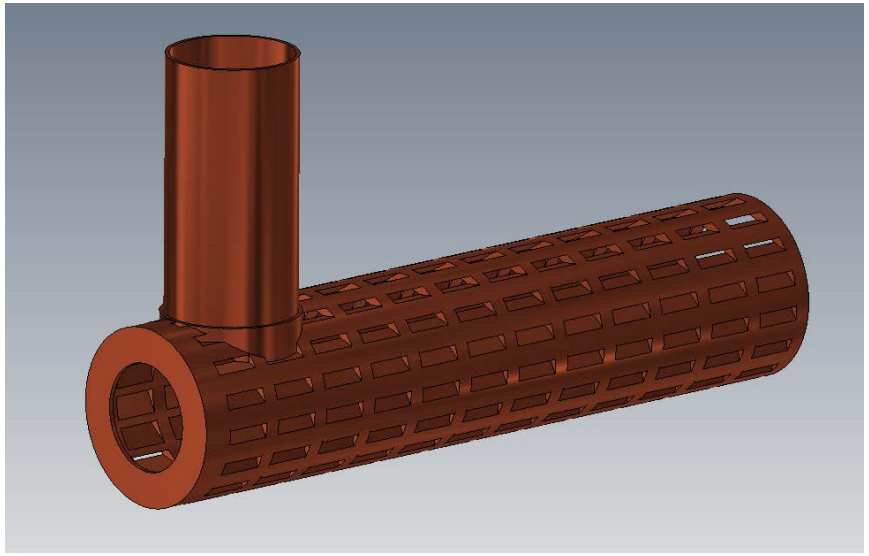
Conclusion

- Optimal combination concerning regeneration interval and temperature:

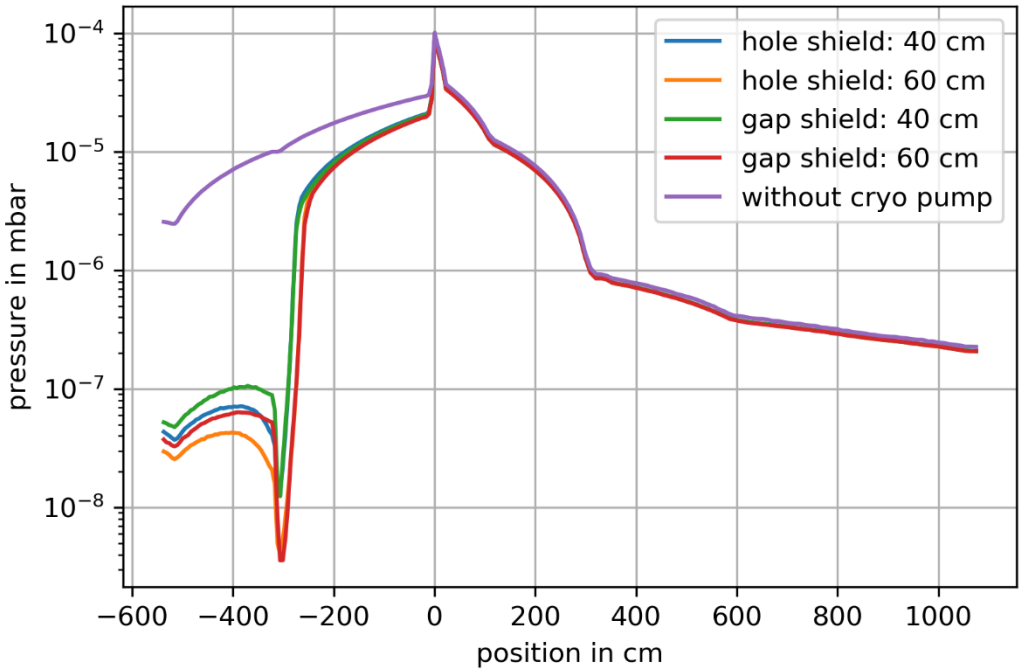
aperture cryopump

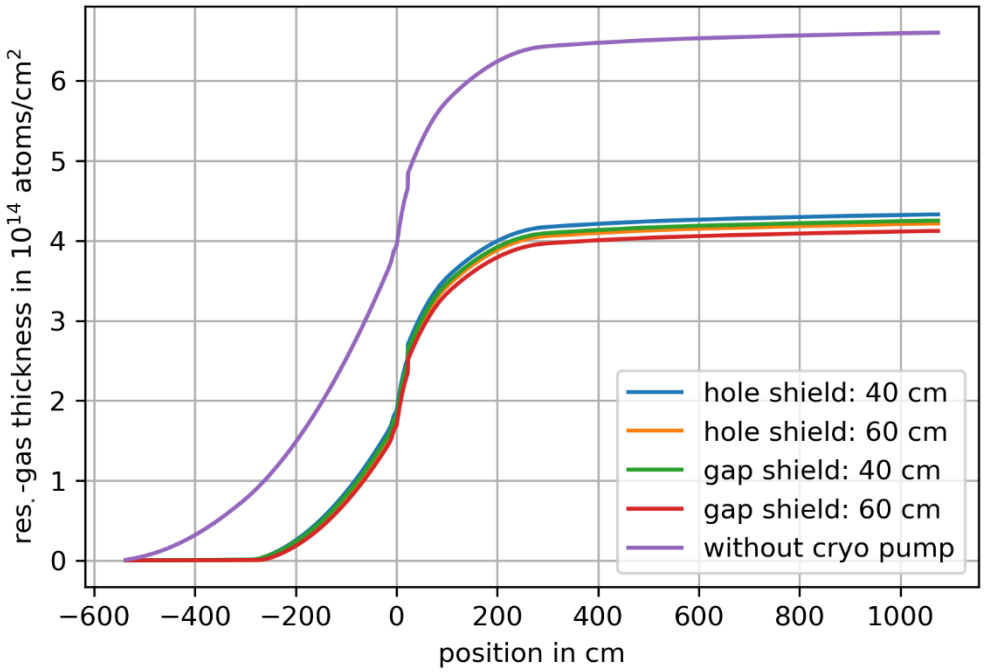


hole shield



Comparison of vacuum results for aperture geometry





Summary and outlook

- Minimal temperatures are achieved by the aperture geometry in conjunction with a hole shield
- Residual gas density is improved by over 30%, with only a weak dependency on the exact geometry of the cryopump
- Regeneration intervals are only rough estimates. The exact adsorption capacity of the activated carbon needs to be determined
- Based on these results, a prototype cryopump will be constructed

WWU
MÜNSTER

Thank you for your attention!
Are there any questions?