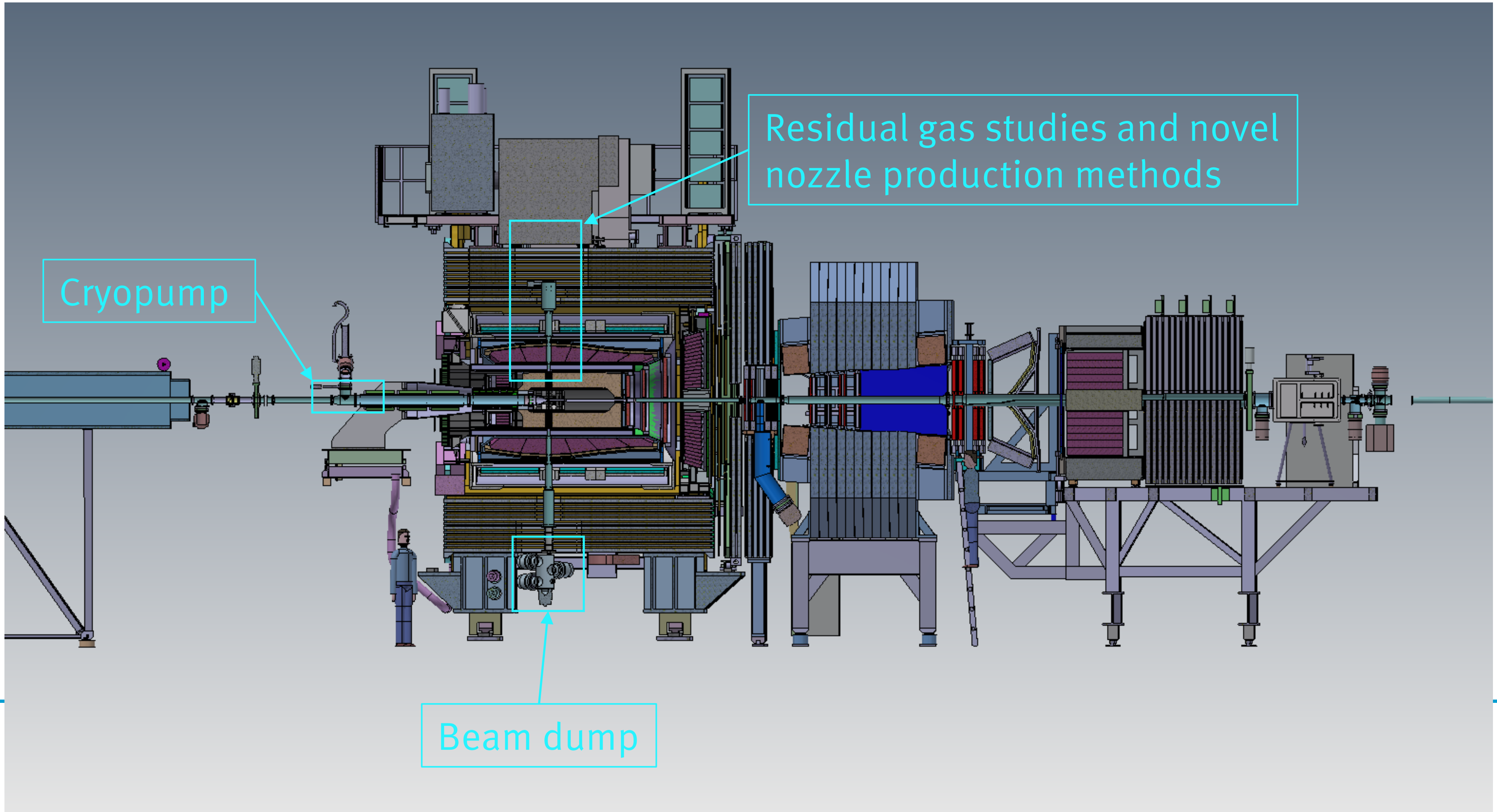
WWU MÜNSTER

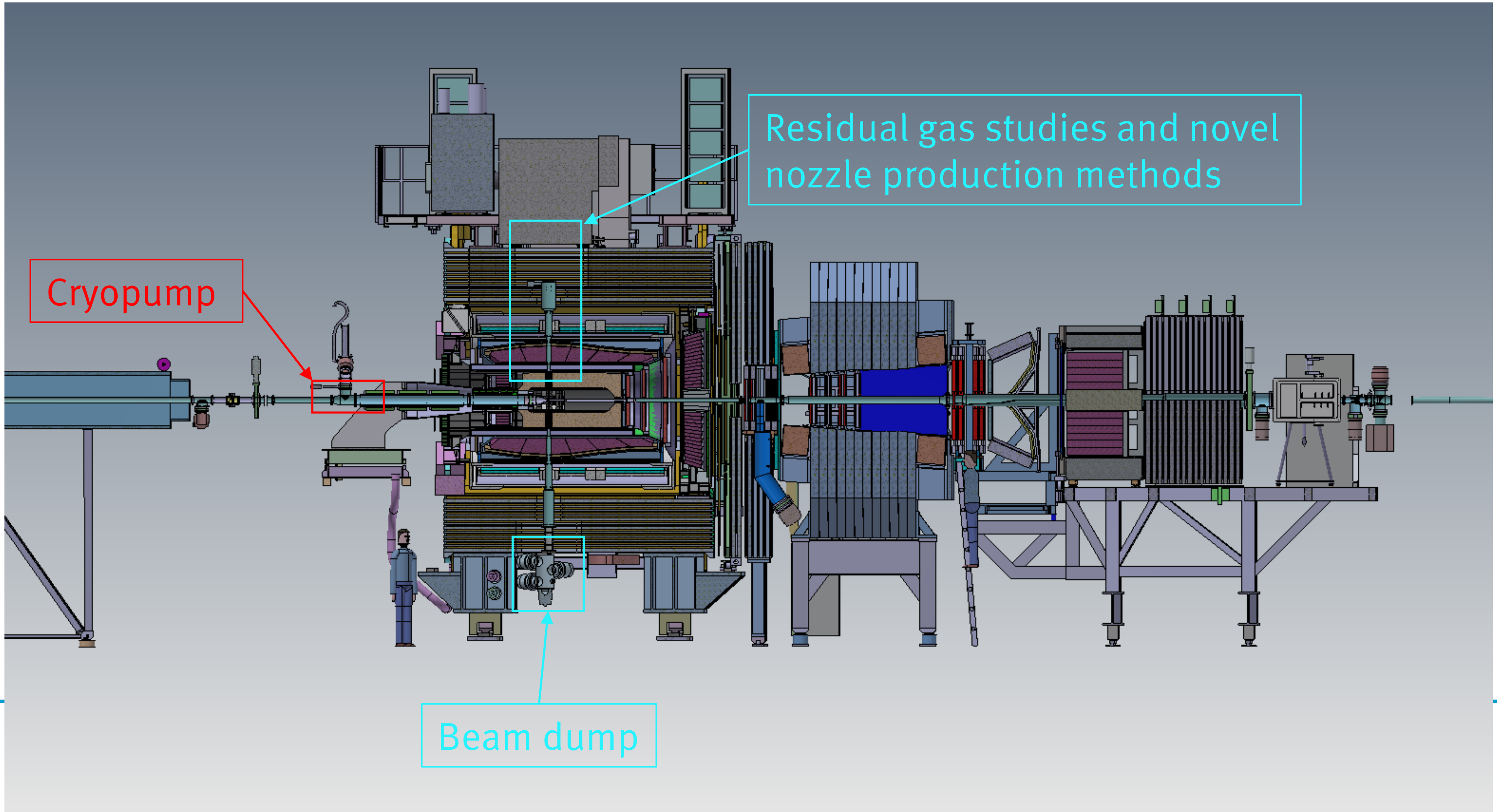
PANDA Cluster Target activities in Münster

Christian Mannweiler
Institut für Kernphysik
10.03.21

The PANDA Cluster Target activities in Münster:



The PANDA Cluster Target activities in Münster: The cryopump

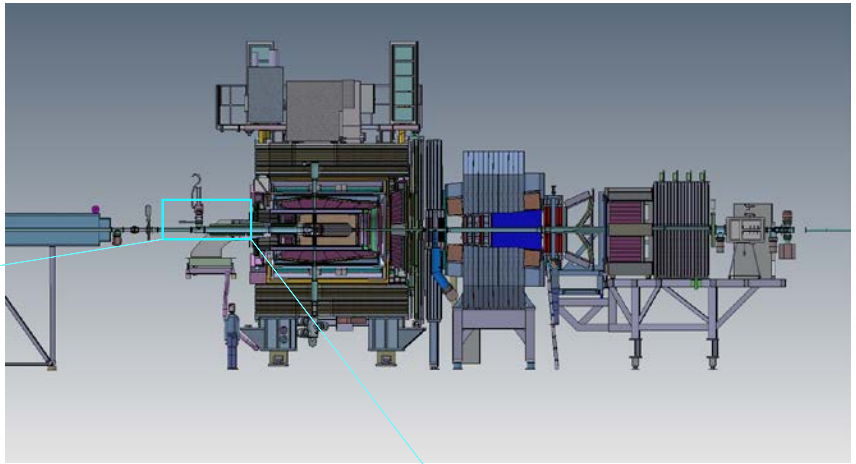


Cryopump activities:

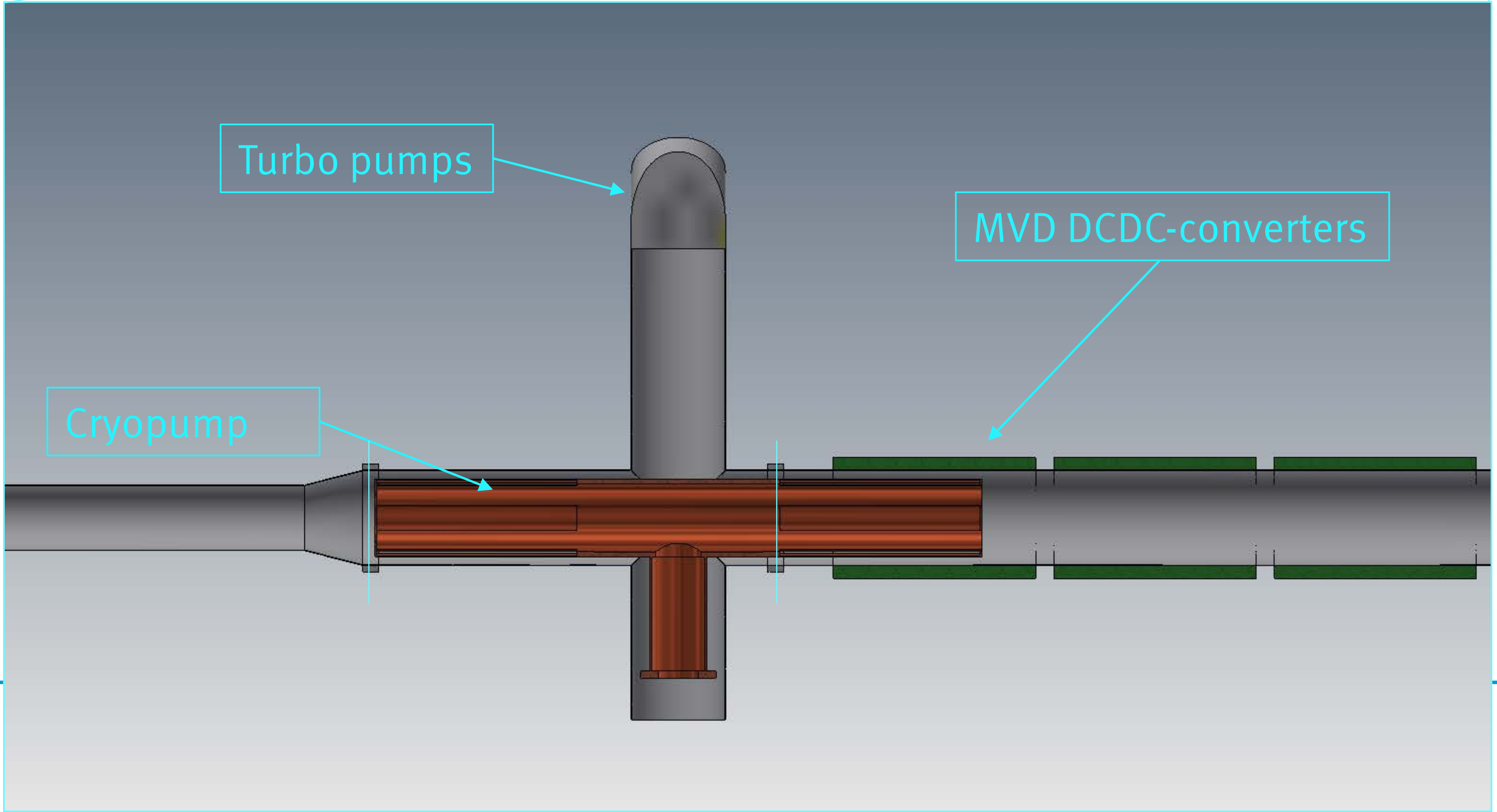
- Modifying the PANDA beam pipe to accommodate the cryopump
- Further investigations concerning the regeneration interval of the cryopump
- Investigations on the feasibility of solutions to minimise impedance issues
- Simulation of a cryopump with glue and activated charcoal

Shown work performed by Christian Mannweiler and Jeremy Runge

Shown work performed by Christian Mannweiler and Jeremy Runge

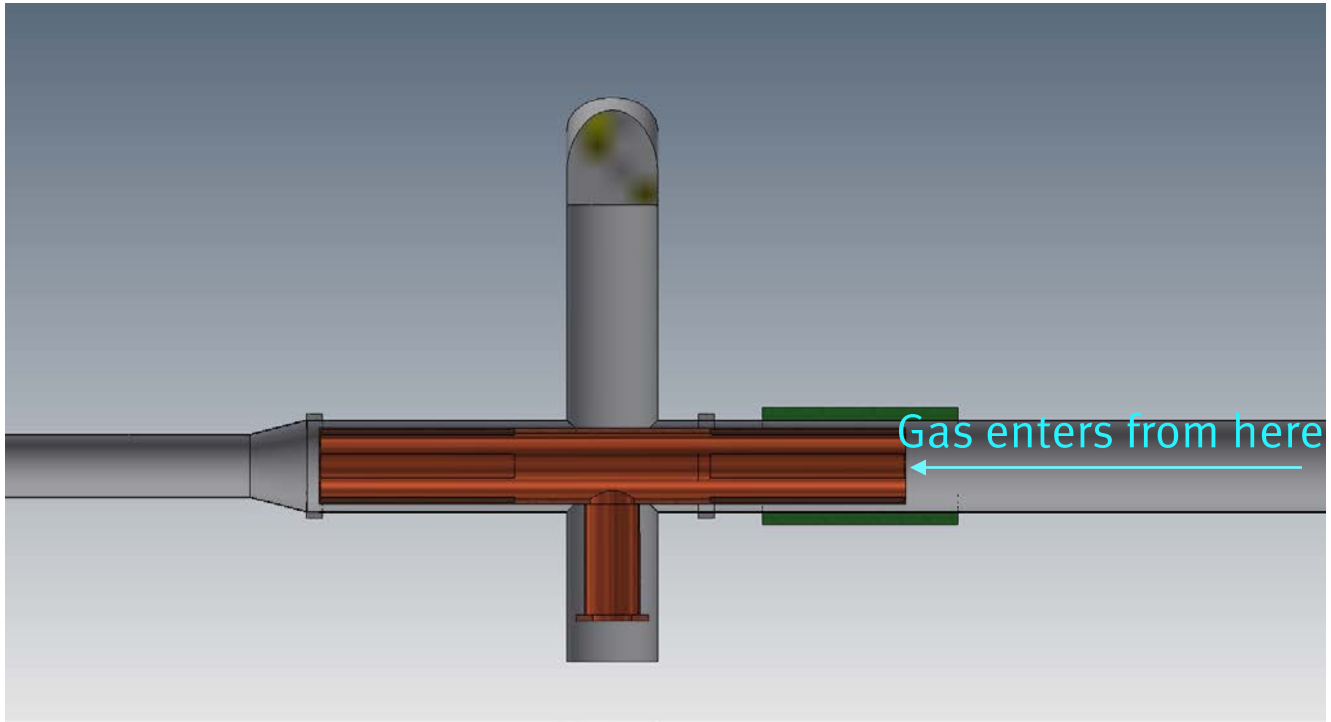


Positioning of the cryopump:

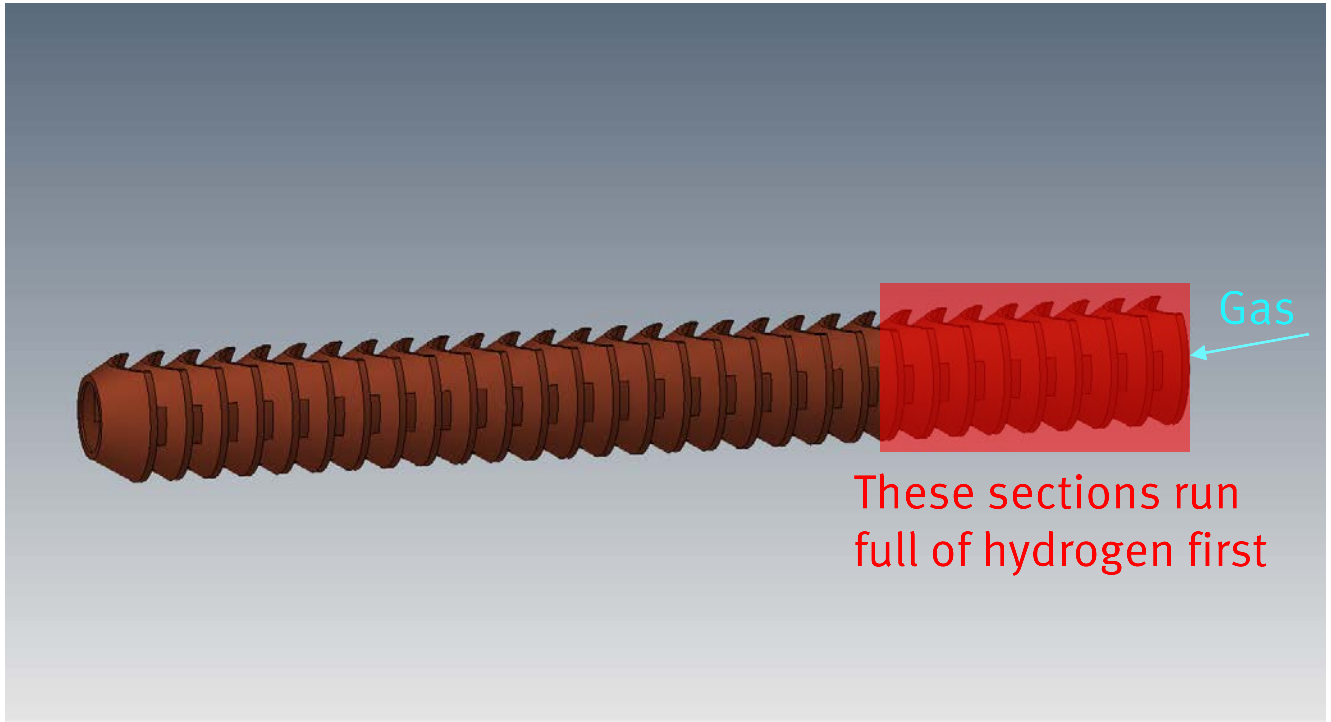


Preliminary design of the relevant beam pipe section

Uneven distribution of hydrogen gas needs to be considered:



Uneven distribution of hydrogen gas needs to be considered:

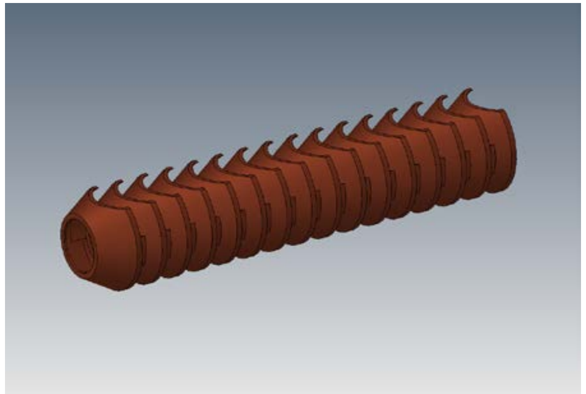


Vacuum situation after a month

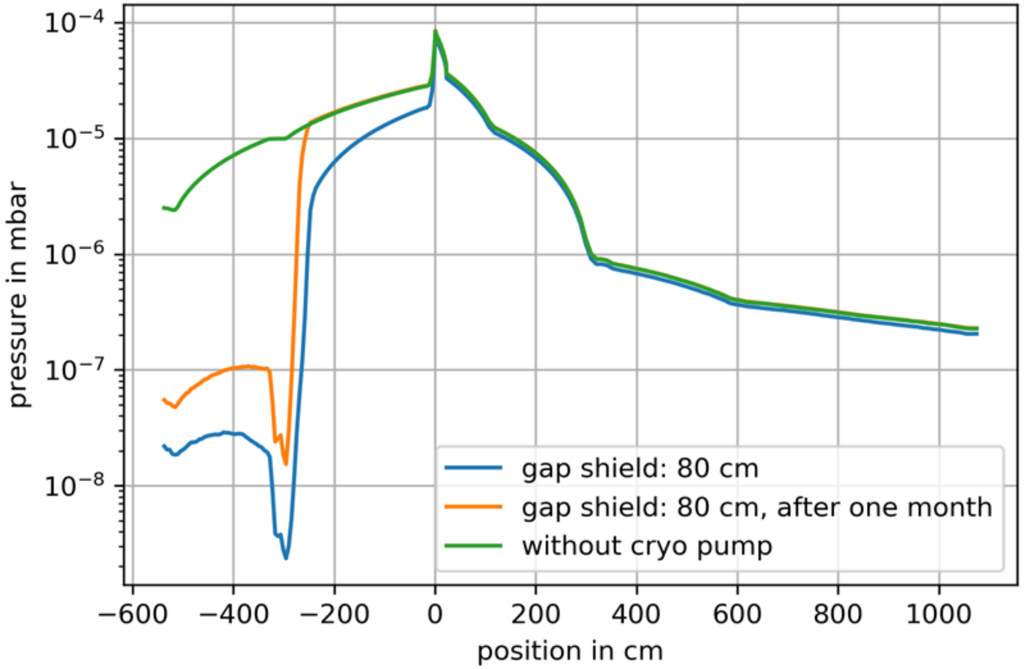
- We perform Monte Carlo simulations for the adsorption of hydrogen on our cryopump

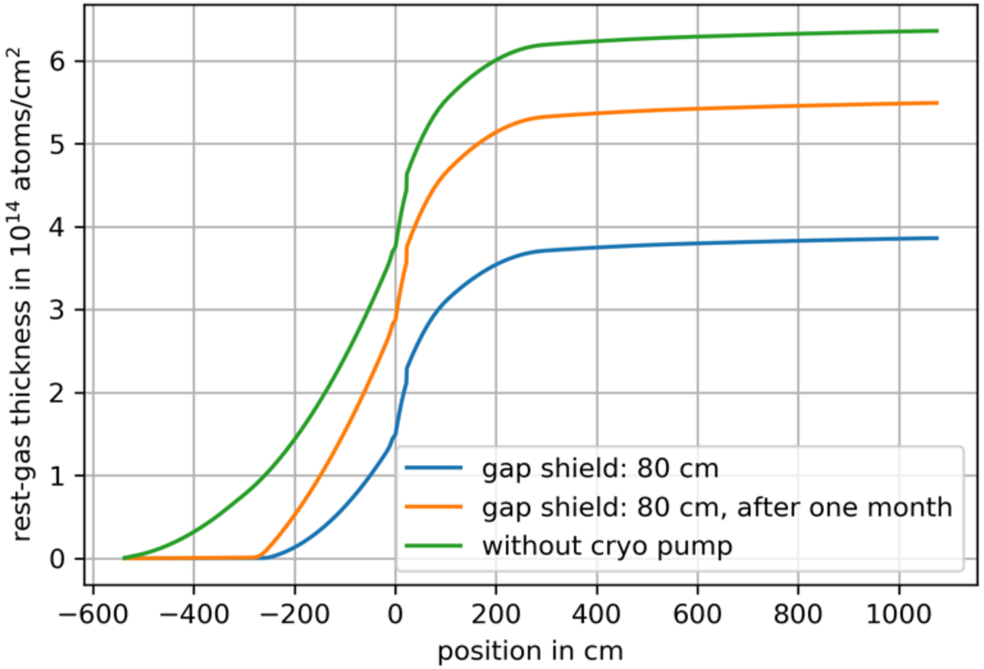
- In this case we analyse the following situation:
  - Gasflow at the interaction point is assumed to be 0.01mbar*l/s
  - Gas enters the cryopump from downstream
  - The cryopump has been in use for a month
  - Baffles which have been filled to capacity possess no pumping speed at all anymore

aperture geometry



Vacuum situation after a month

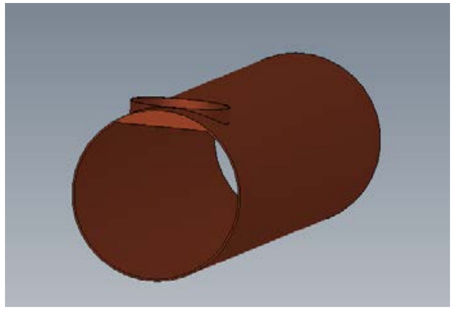




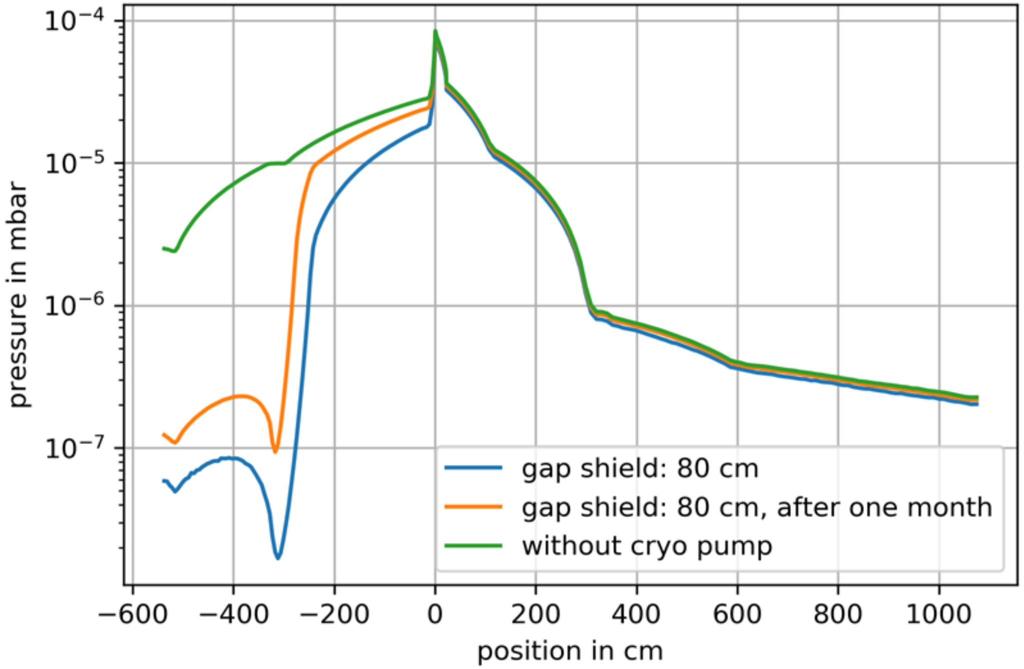
Shown work performed by Christian Mannweiler and Jeremy Runge

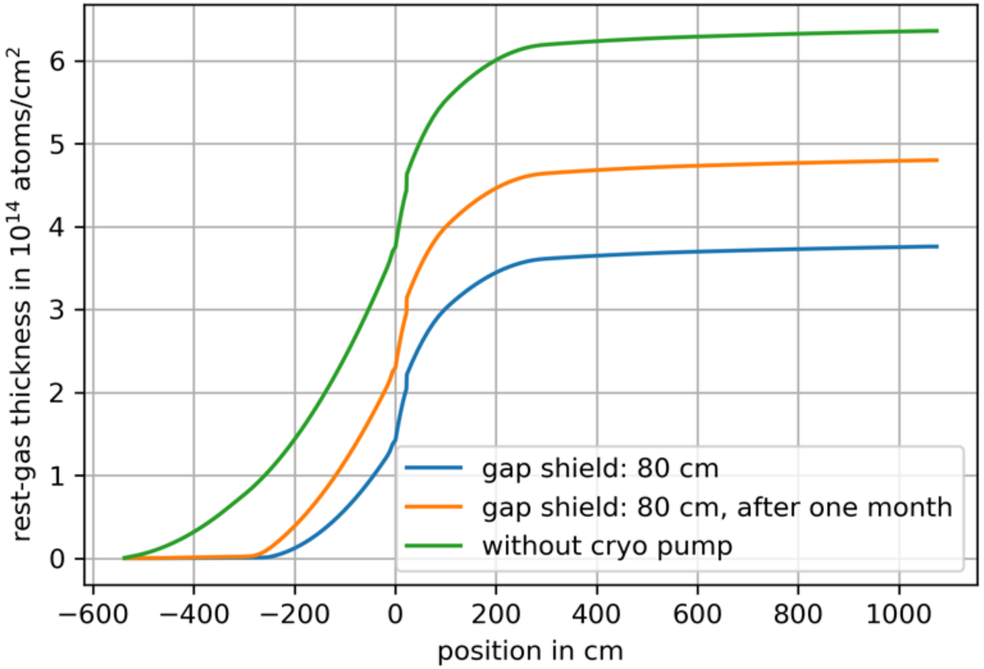
WWU MÜNSTER

tube geometry



Vacuum situation after a month

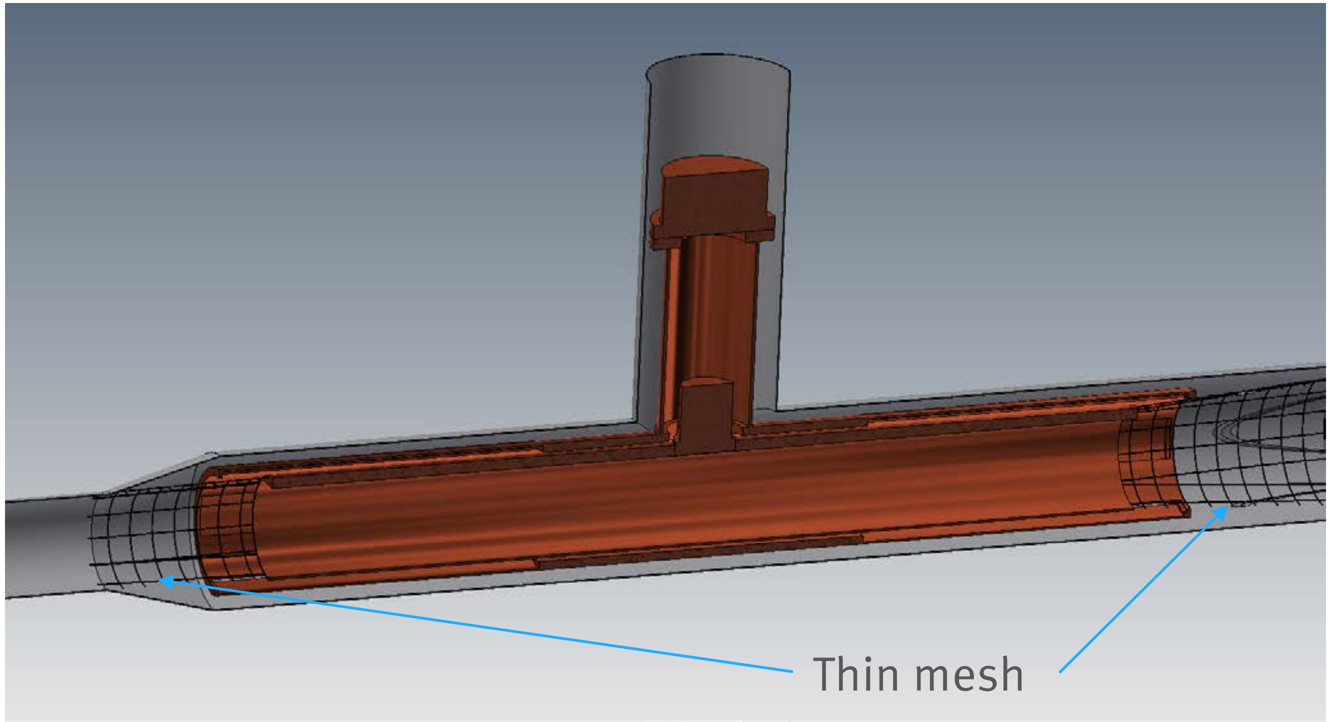




Conclusion: Cryopump geometry also needs to take regeneration intervals into account

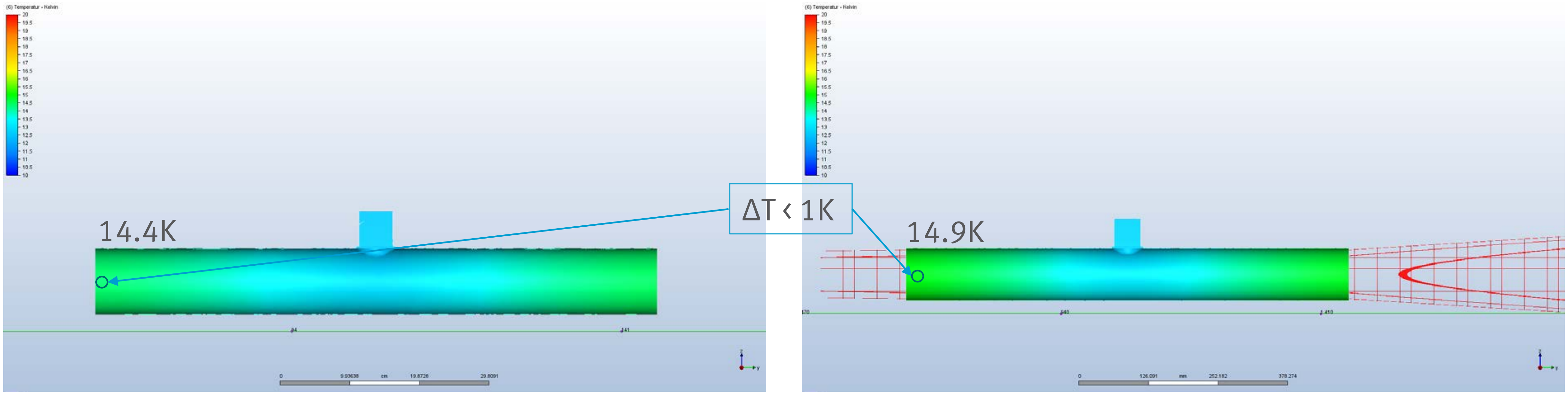
Shown work performed by Christian Mannweiler and Jeremy Runge

Minimising the influence of the cryopump on the accelerator beam



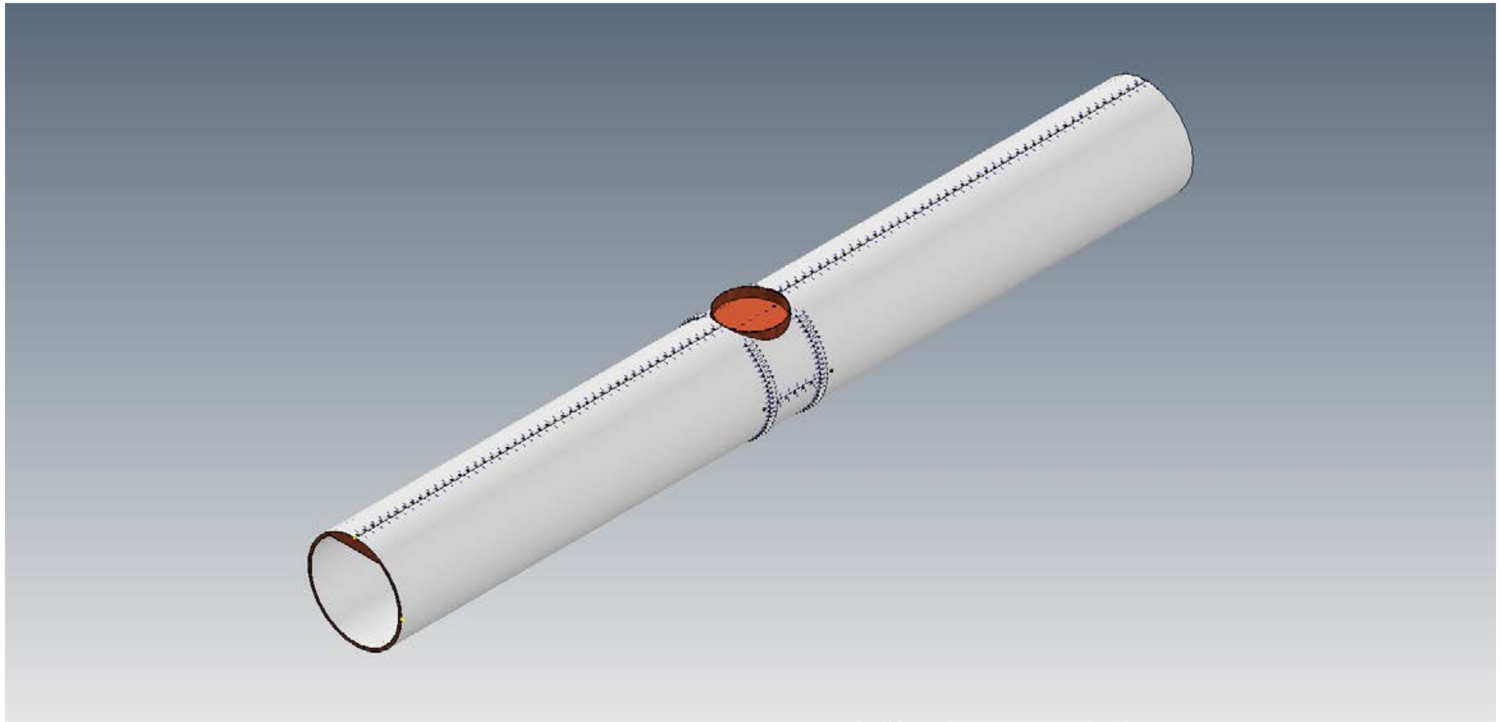
Shown work performed by Christian Mannweiler and Jeremy Runge

Minimising the influence of the cryopump on the accelerator beam



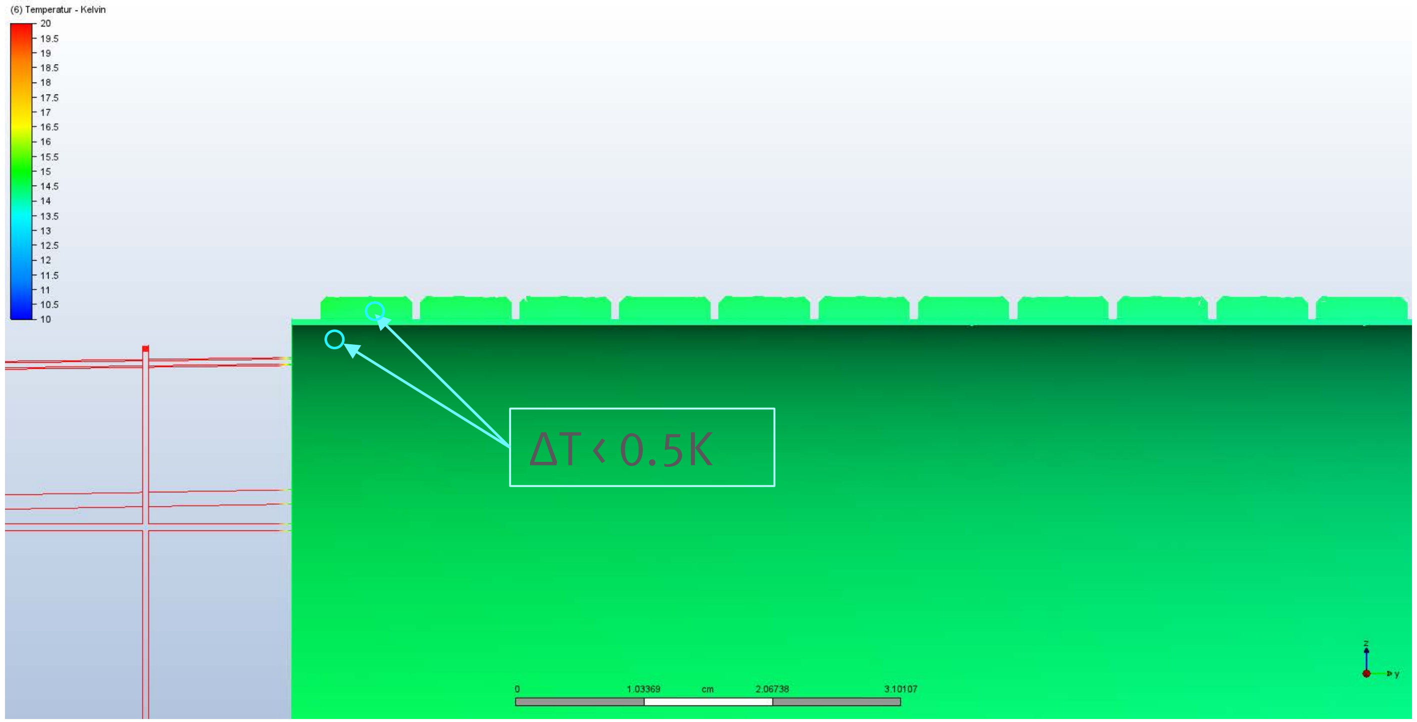
Conclusion: installation of a mesh has minimal influence on cryopump performance

Simulation of a cryopump with glue and activated charcoal



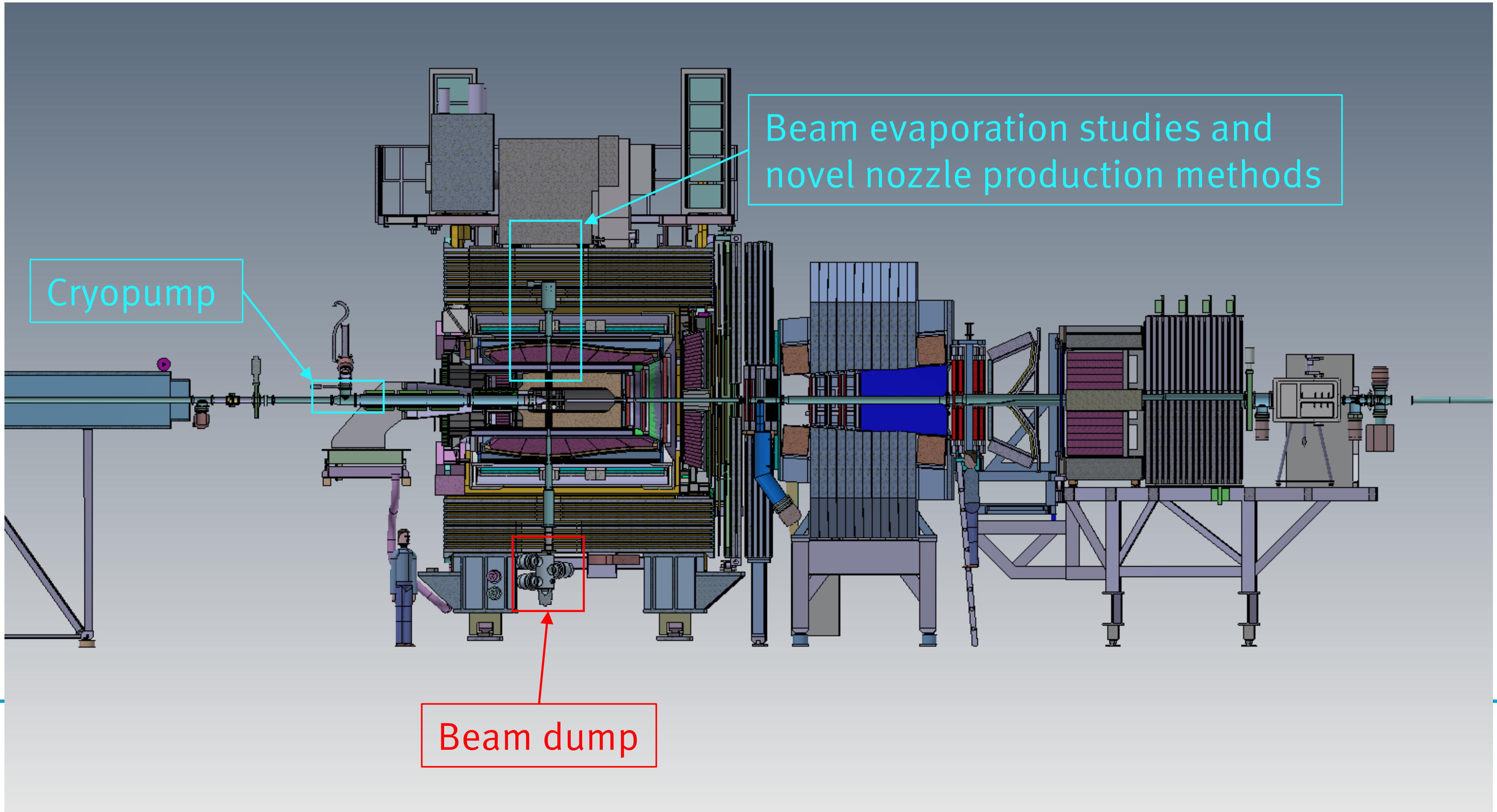
Shown work performed by Christian Mannweiler and Jeremy Runge

Simulation of a cryopump with glue and activated charcoal



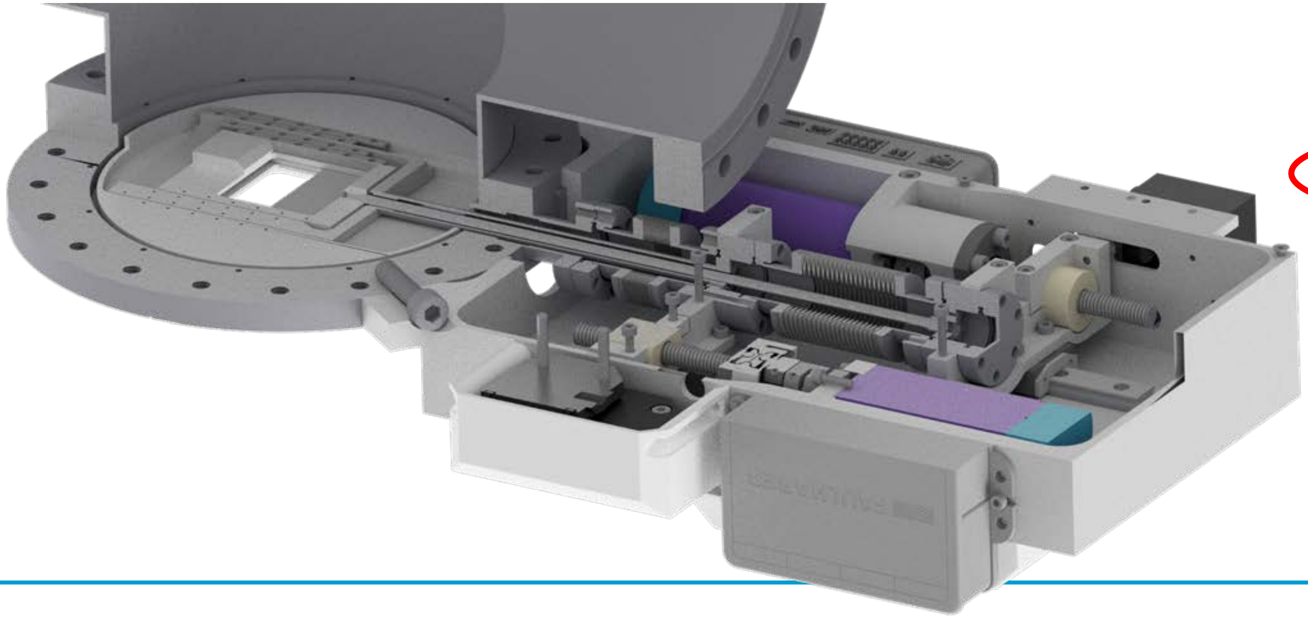
Conclusion: activated charcoal achieves practically identical temperatures as the copper

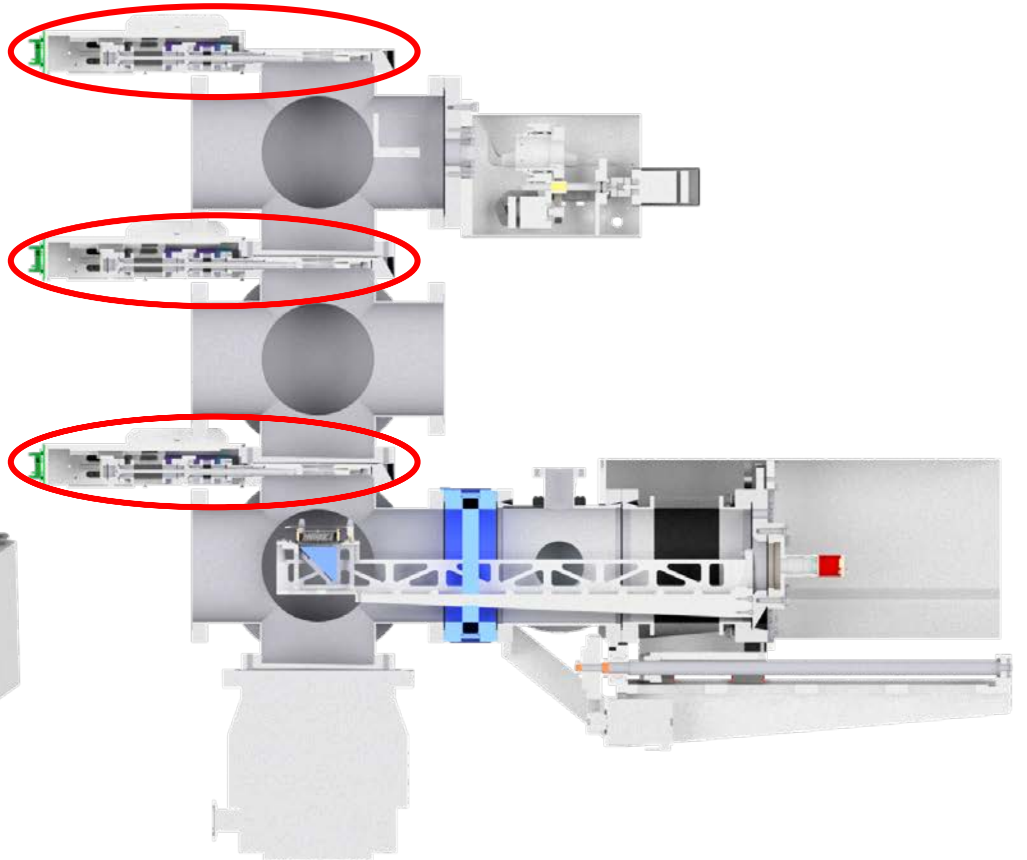
The PANDA activities in Münster: The Beam dump



Design of a modified target beam dump

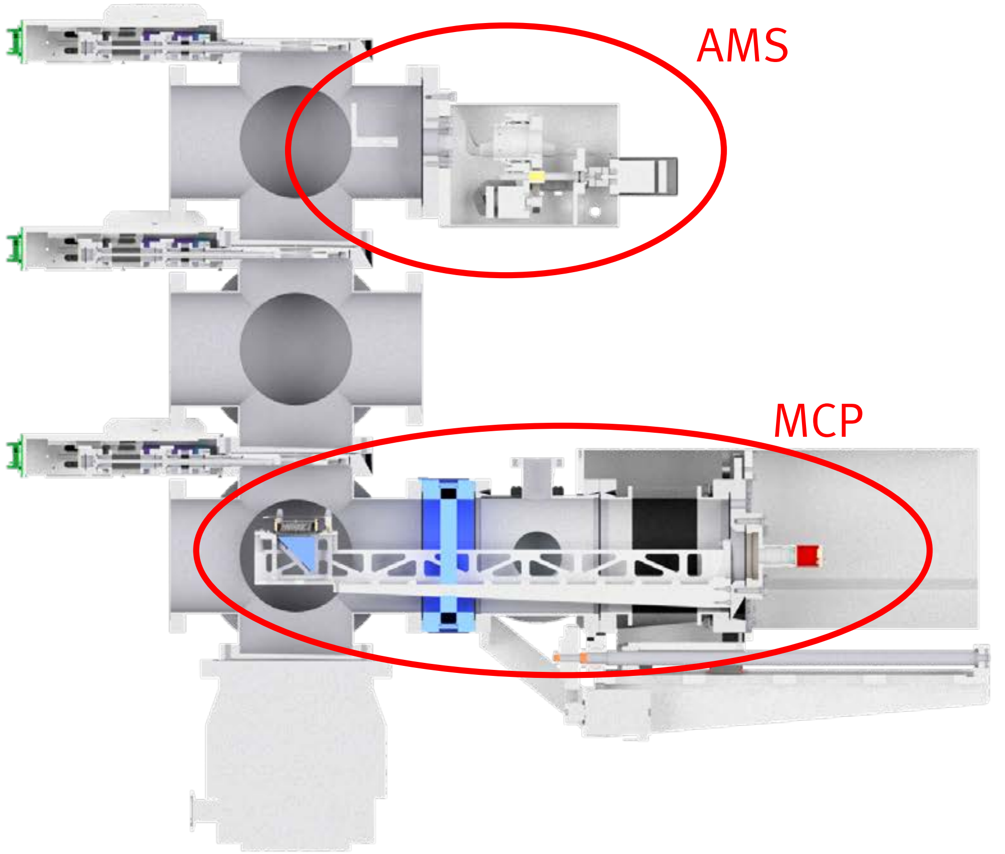
- Similar to current design (3 stages, 7 pumps)
- 3 orifices with variable size





Design of a modified target beam dump

- Similar to current design (3 stages, 7 pumps)
- Orifices with variable size
- Can be equipped with several monitor systems
  - Absolute thickness monitor system (AMS)
  - Electron gun + movable MCP system for 2D beam visualisation and cluster velocity measurement



Shown work performed by Philipp Brand and Niklas Humberg. Beam dump designed by Daniel Bonaventura

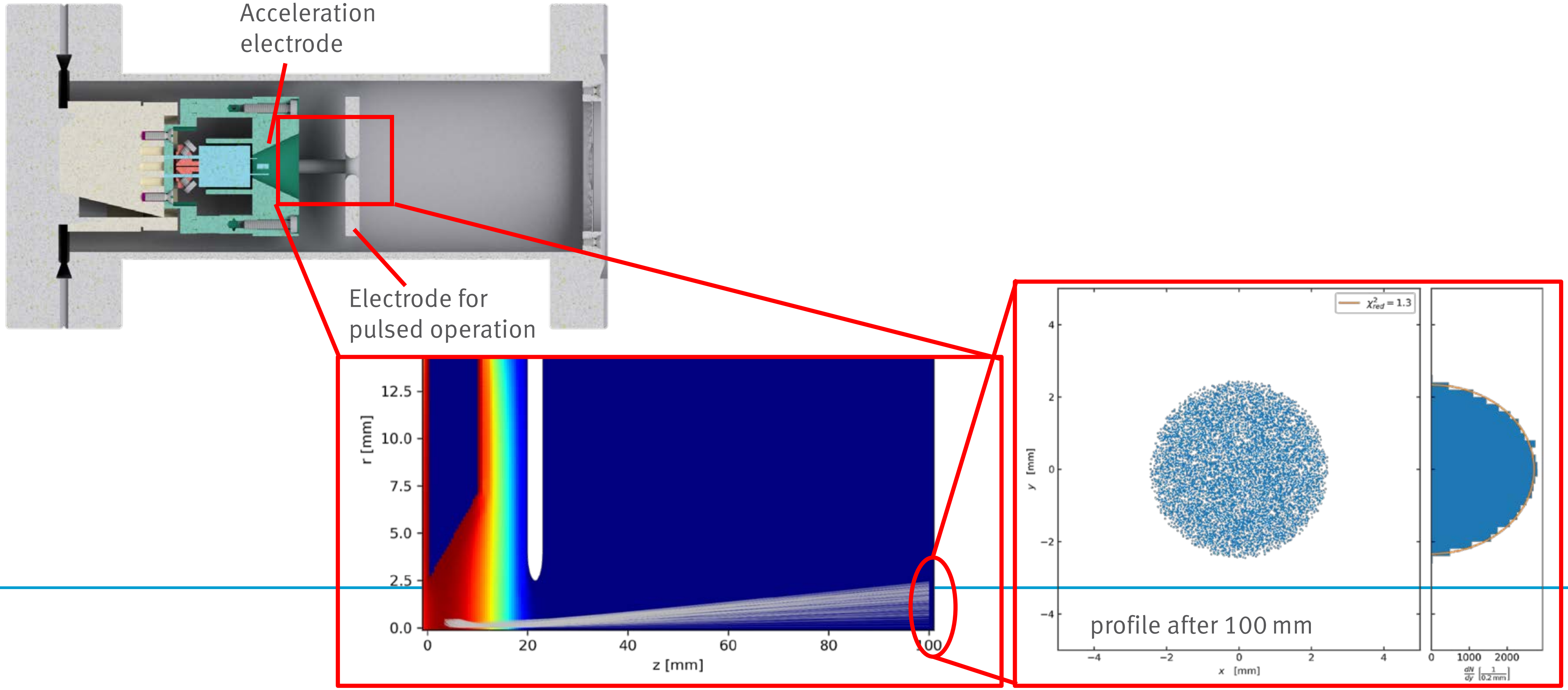
Studies on a new electron gun design

- For MCP visualisation the cluster beam needs to be ionised by
  - Accelerator beam → vertex zone visualisation
  - Electron gun → cluster beam visualisation and velocity measurement
- Pulsed operation for ToF/velocity
- Design studies with simulations

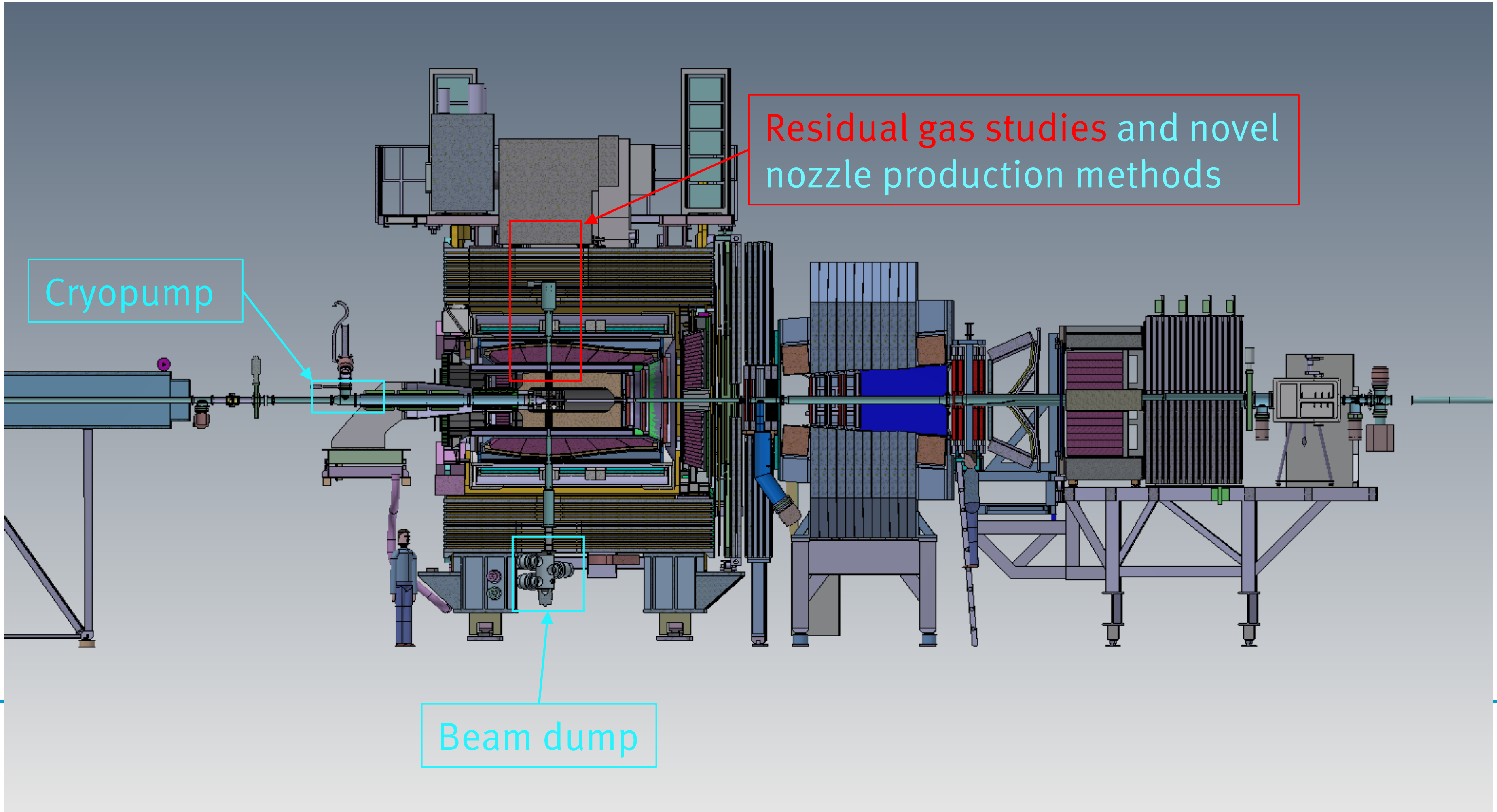
Shown work performed by Philipp Brand and Niklas Humberg

Shown work performed by Philipp Brand and Niklas Humberg

Studies on a new electron gun design



The PANDA Cluster Target activities in Münster: Beam evaporation studies



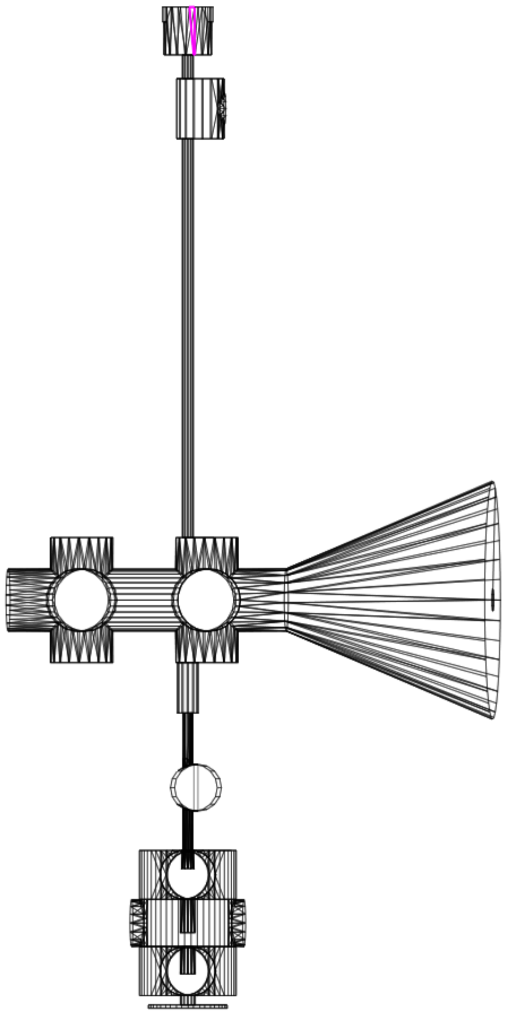
Residual gas studies

- Backflow from dump/source not the only cause for residual gas!
  - Proven by direct flow measurements at WWU and COSY and backed up by vacuum simulations
  - Evaporation of cluster by ion beam interaction negligible (measured at COSY)

- Other possible residual gas source?
  - Evaporation of cluster/pellet material while traversing the vacuum system

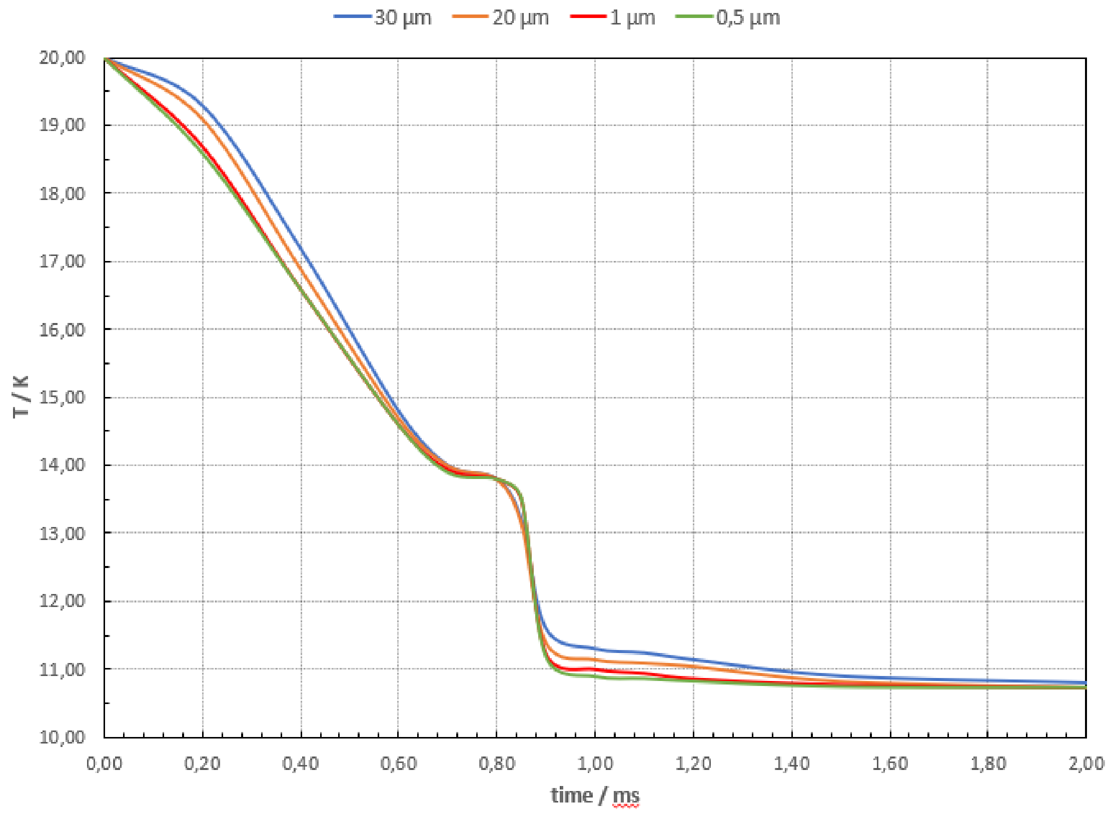
Indicators for Cluster evaporation

- Other possible residual gas source?
  - Evaporation of cluster/pellet material while traversing the vacuum system
  - Vacuum studies using a simple evaporation model describe the measured vacuum conditions at COSY quite well



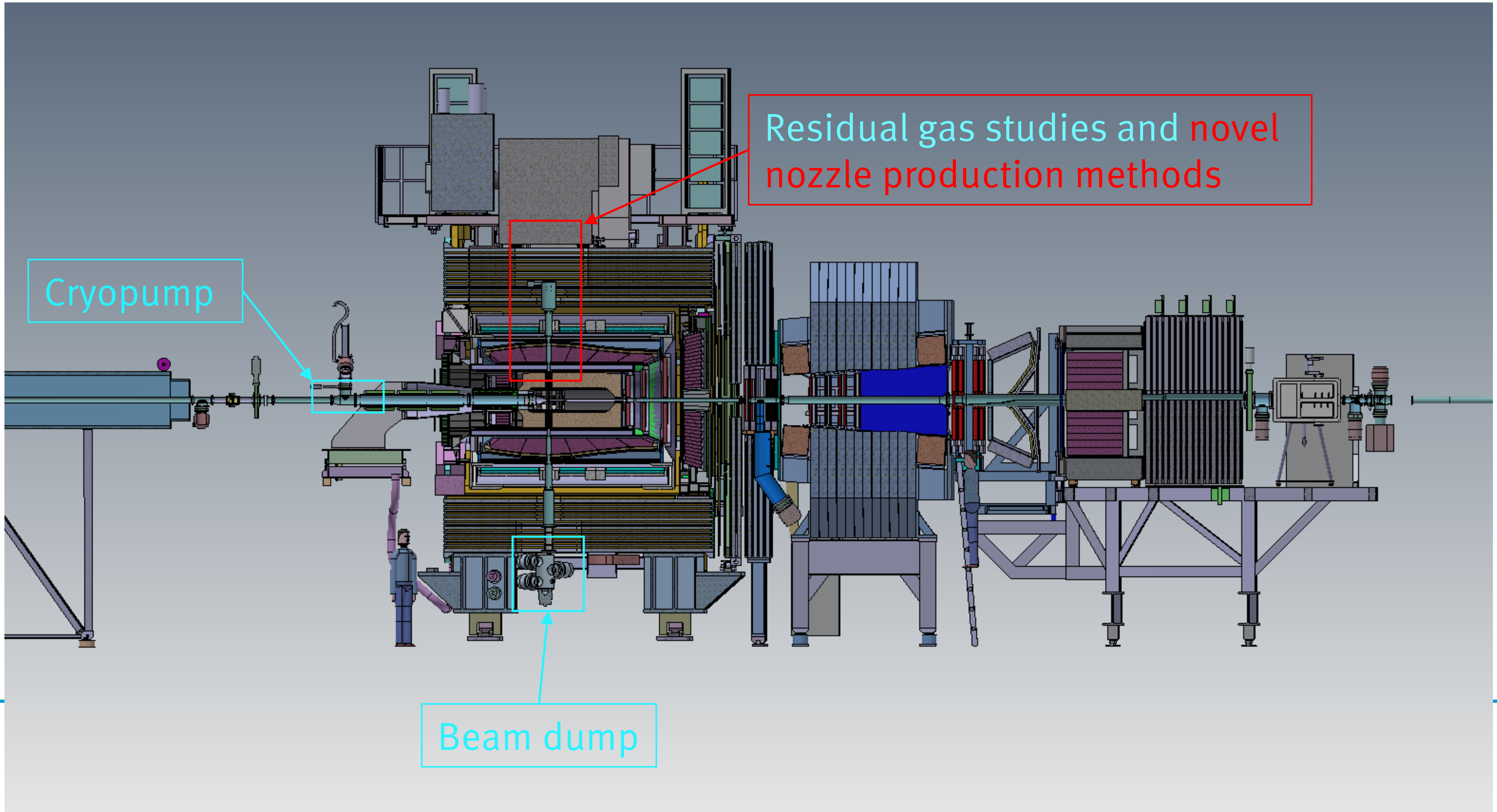
Simulation of evaporating droplets

- Calculations on the evaporation of single H_2 droplets is being performed
- This evaporation introduces gas continuously along the jet pipe
- Already, the calculated evaporation rates are in the same order of magnitude as the measurements at COSY
- Understanding the causes for the residual gas opens up new avenues to combat the issue.



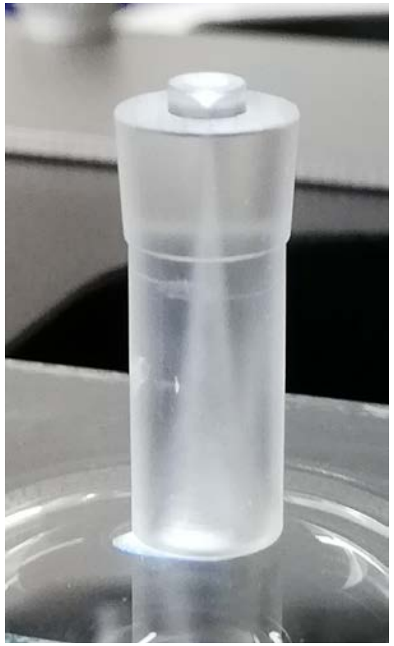
Shown work performed by Benjamin Hetz

The PANDA Cluster Target activities in Münster: Novel nozzle production methods



Glass Nozzle with full length

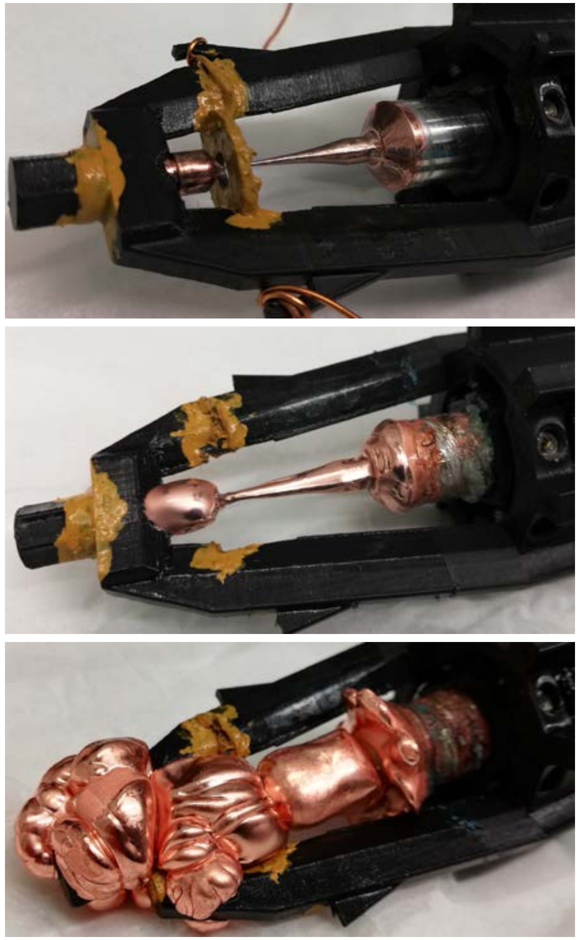
- Reminder: we are testing glass nozzles produced by external partner LightFab according to our CAD drawings
- Glass nozzles with a total length of 10 mm produce a cluster beam with usual beam properties in the gaseous and supercritical regime
- Fabrication process was adapted, leading to the possibility of glass nozzles with a total length of 18 mm (shown on the right hand-side)
- First measurements are ongoing

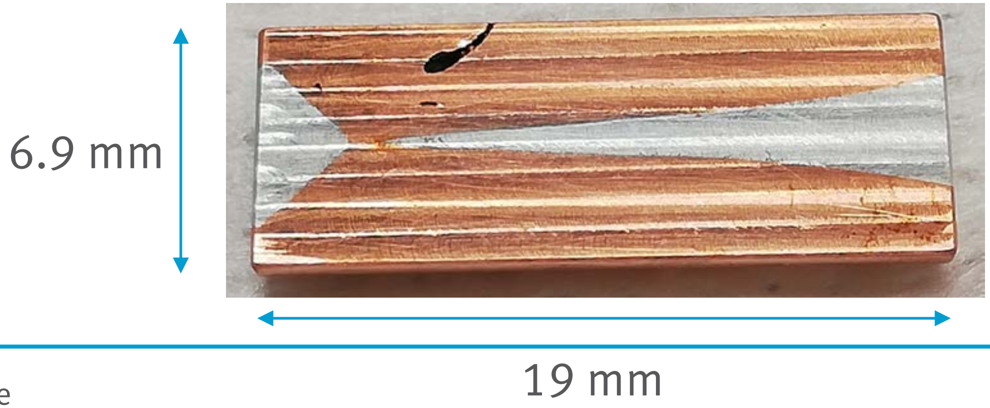


Shown work performed by Sophia Vestrick and Michael Weide

Galvanising Copper Nozzles

- Established nozzle production technique, but still challenging, very sensitive to small deviations, and time consuming ($\approx$ 3 weeks per nozzle)
- Counterpart of the nozzle is galvanized in a copper bath with a newly developed, 3D-printed support structure (black)
- In order to determine the success of the galvanization process, the cross-section is examined

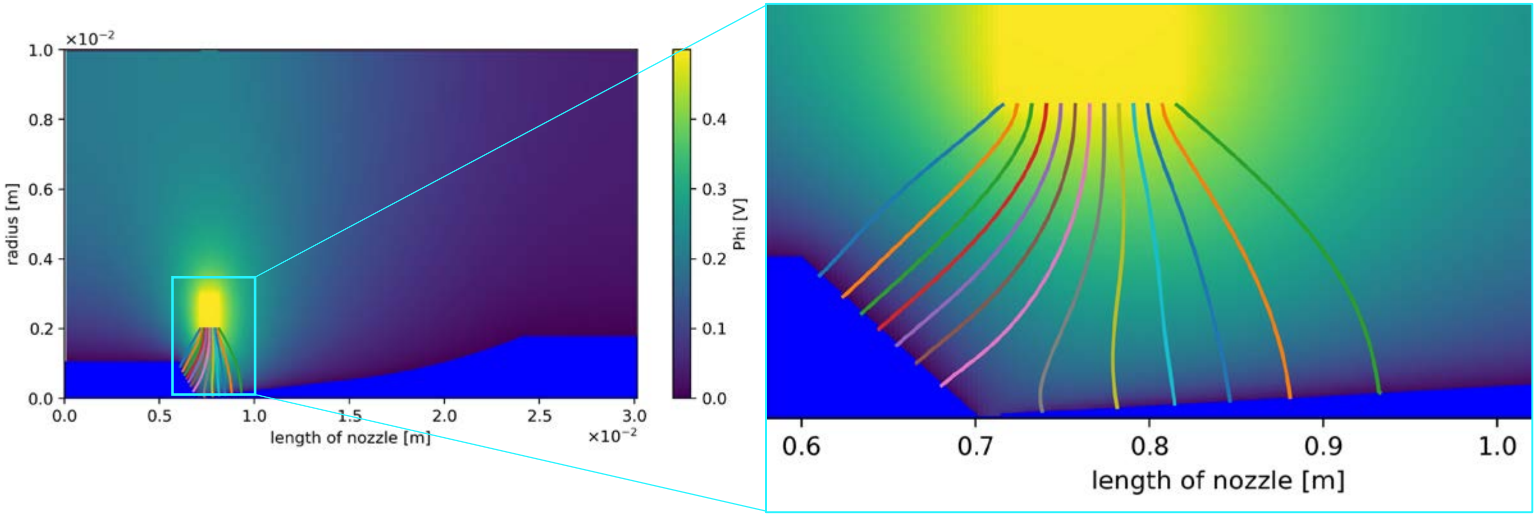


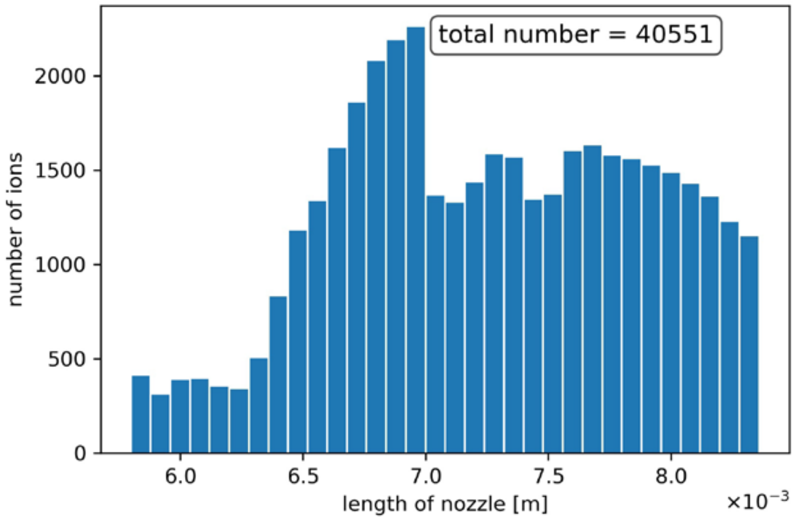


Shown work performed by Sophia Vestrick and Michael Weide

Galvanising Copper Nozzles

- Galvanization process can be optimised by adding another anode
  - Simulations ongoing





Shown work performed by Sophia Vestrick and Michael Weide

Summary

- PANDA related work is progressing on several fronts
  - Design work on the Cryopump is steadily advancing
  - An updated beam dump is being designed and its diagnostic systems are being developed
  - Evaporation studies which will help understand and mitigate the rest gas density issue are ongoing
  - Novel nozzle production methods are being researched

WWU
MÜNSTER

Thank you for your attention!
Are there any questions?