

Status Report for the \bar{P} ANDA Cluster-Jet Target

\bar{P} ANDA Collaboration Meeting 21/3
Target Session
Sophia Vestrick

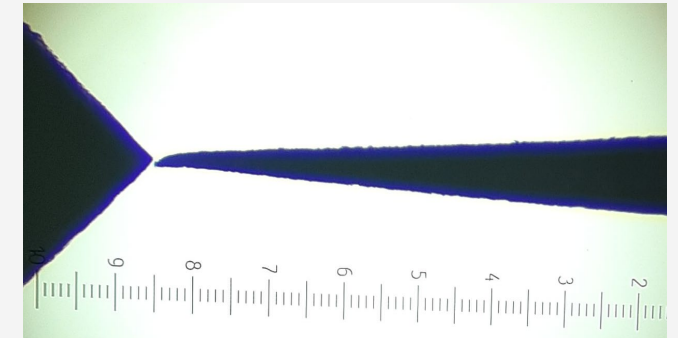
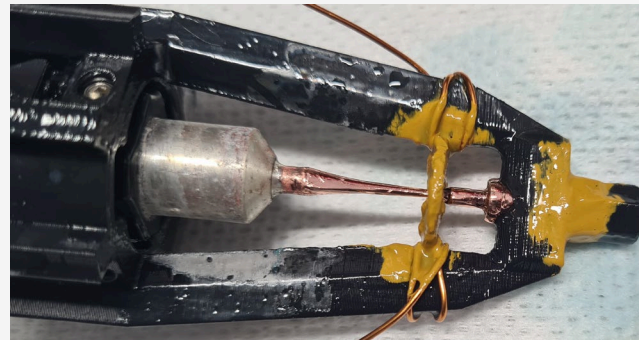
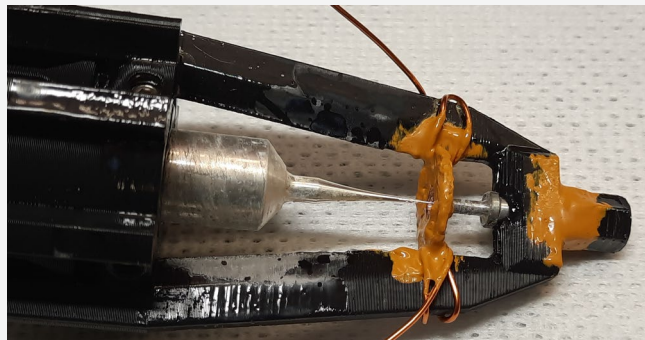


Current measurements and developments

- Copper nozzle production
- Shadowgraphy measurements of clusters
- Clustering of heavy gases
- $\overline{\text{P}}$ ANDA cryopump prototyping
- Modified $\overline{\text{P}}$ ANDA beam dump setup

Copper nozzle production

- Counterpart of the nozzle is galvanized in a copper bath with a 3D-printed support structure (black) for excellent alignment
- Due to optimizations the galvanization process takes only one week
- Some additional work afterwards necessary for the final geometry

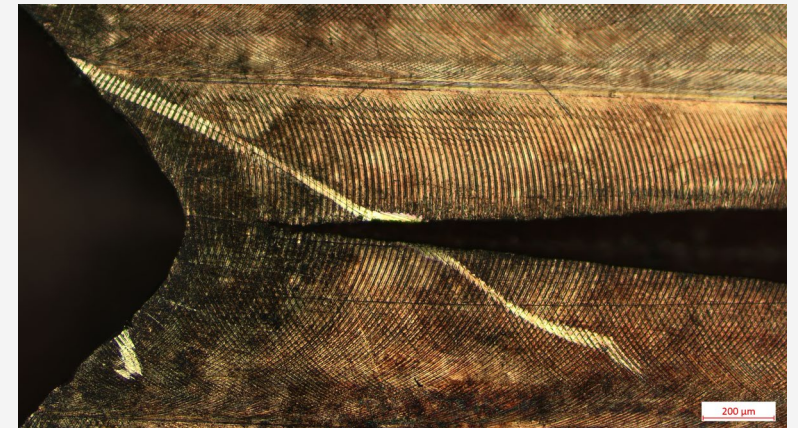
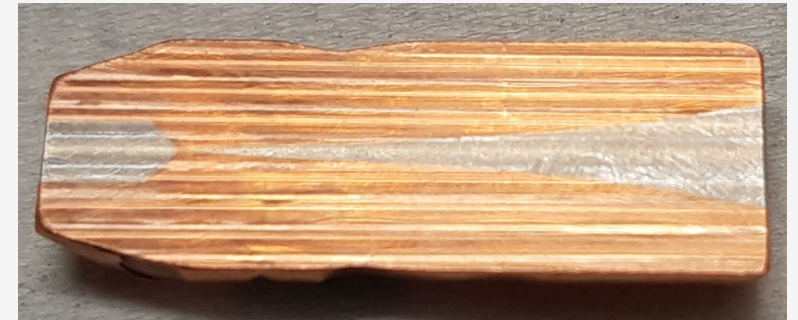


1 small scale division = 12.5 μm



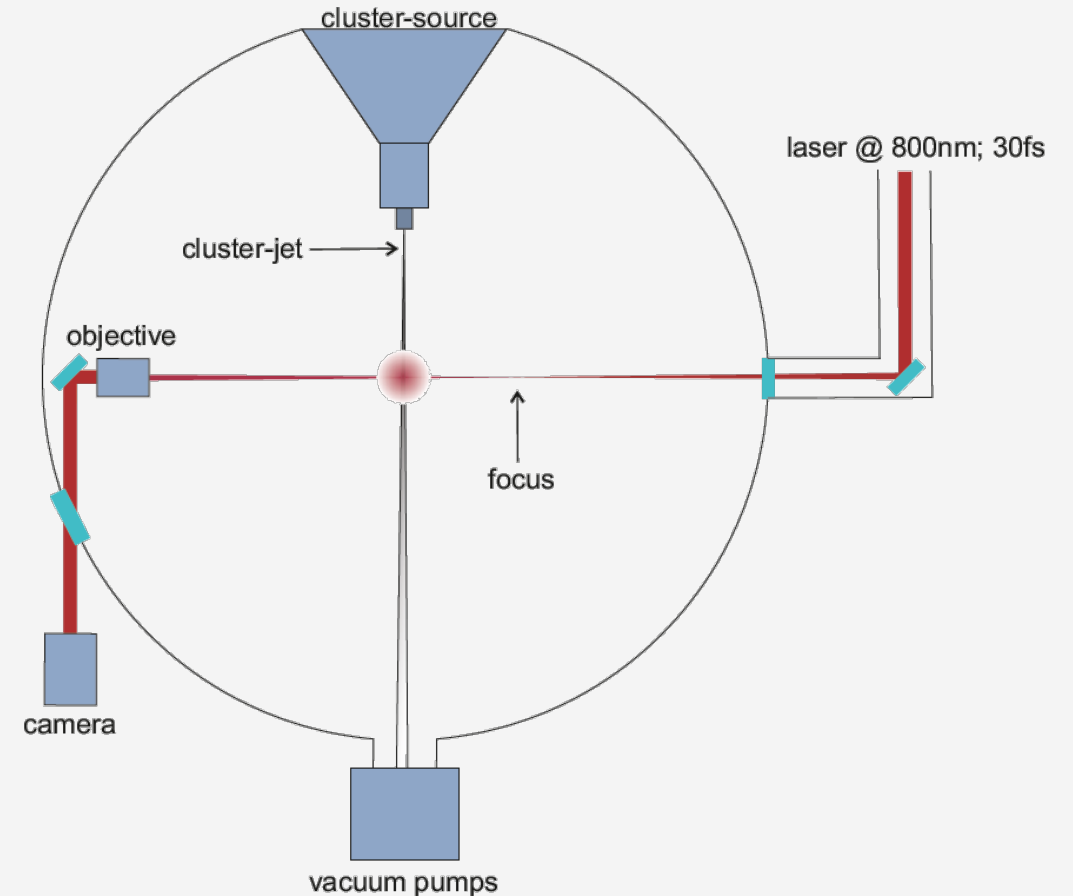
Copper nozzle production

- Cross-section of workpiece is examined to confirm success:
 - Distance between inlet and outlet $< 300\mu\text{m}$
 - Micro-drilling is a possibility to establish the connection
- New nozzle is in fabrication and will be tested in near future



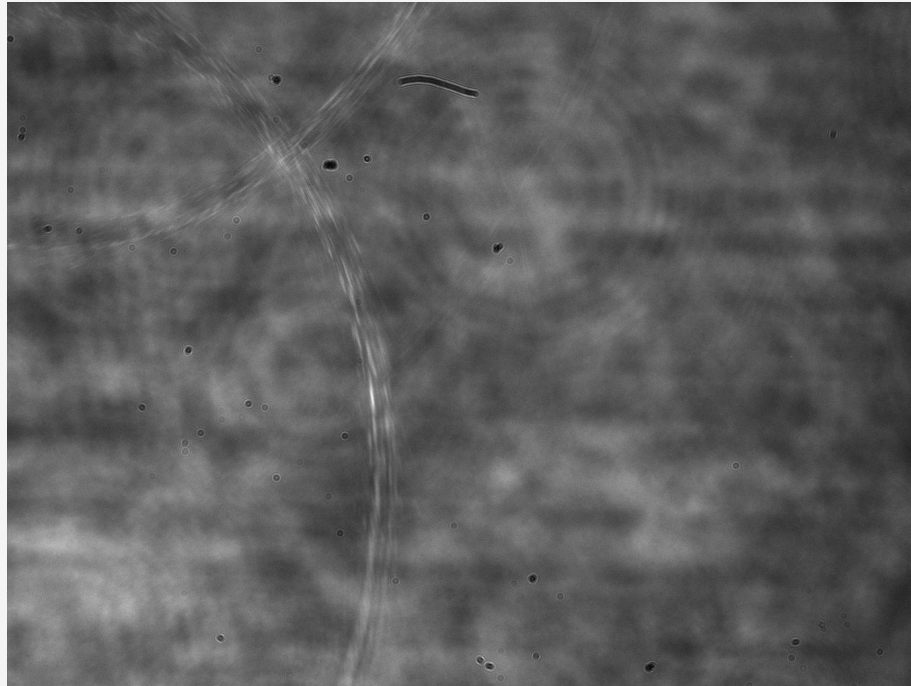
Shadowgraphy measurements

- Method to determine cluster-size distribution
- In cooperation with Düsseldorf University
- Ultra-short pulse laser (~ 30 fs) used as background illumination of cluster-jet
 - Clusters practically do not move within exposure time (~ 1 ps)

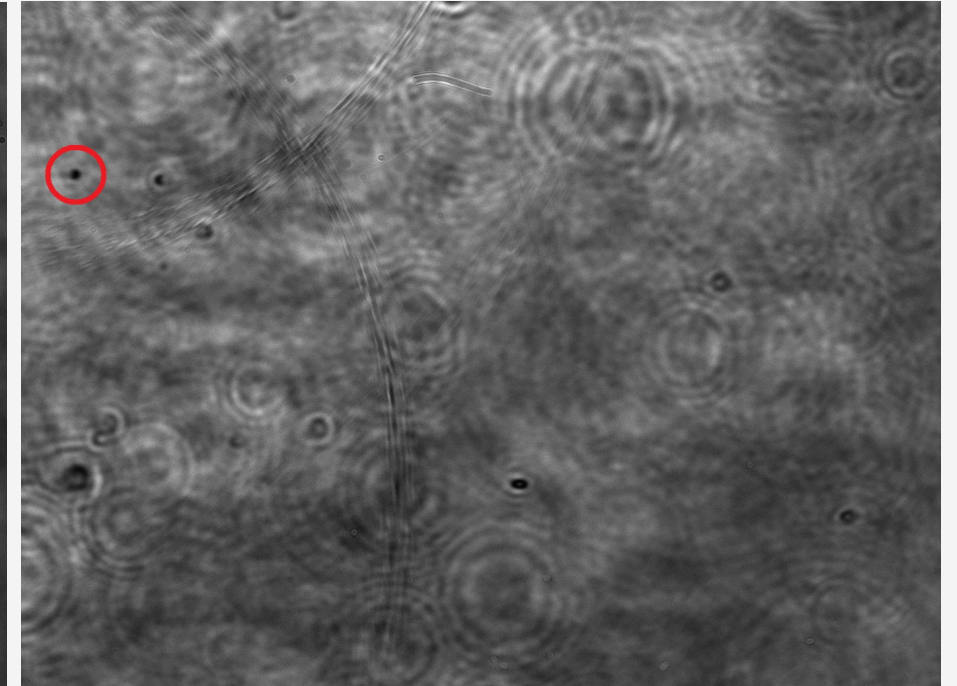


Shadowgraphy measurements

- Several sources for background
- Background subtraction
- Clusters are visible as dark spots (“shadows”)



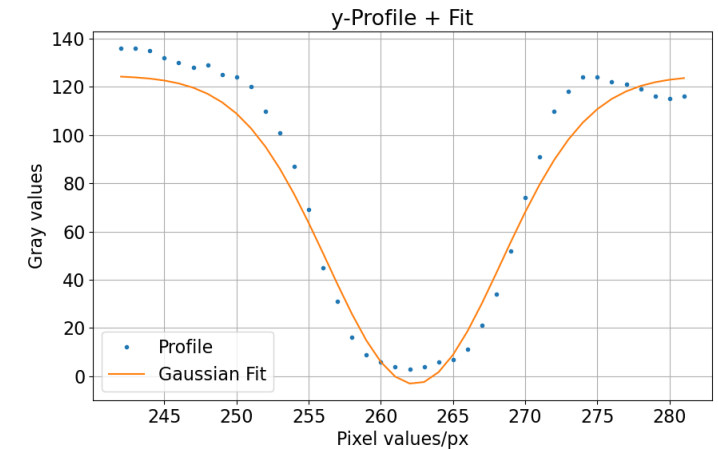
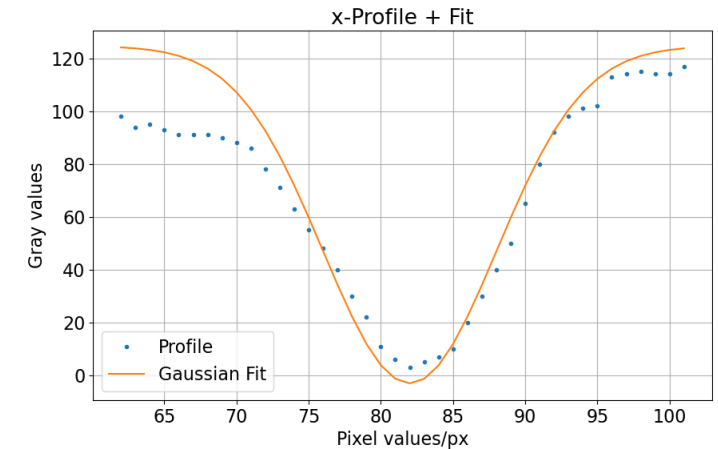
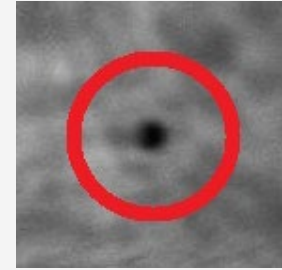
Background



Data

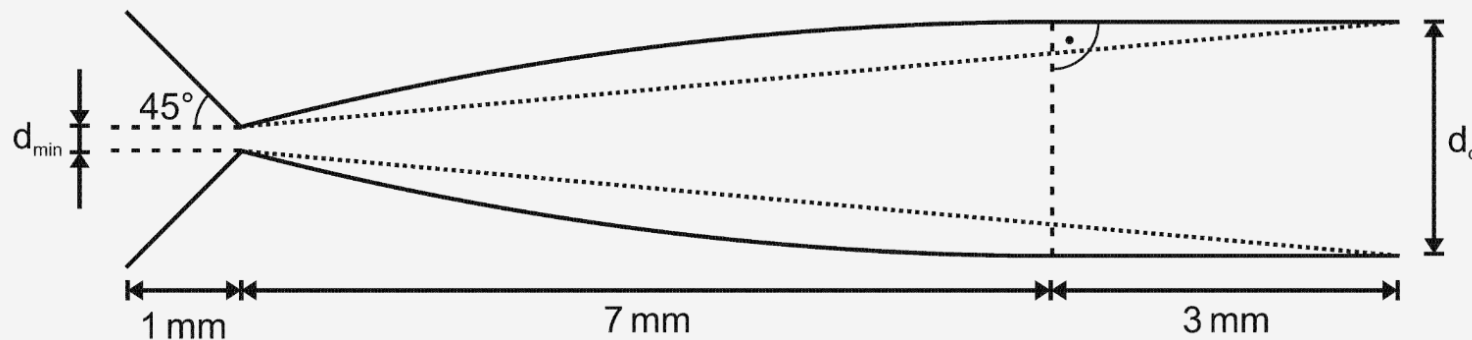
Shadowgraphy measurements

- Cluster production is statistical → analysis of several thousands of pictures
- Each cluster is found with particle detection (ImageJ) and fitted with a 2D-gaussian (python, here: $\sigma = 6.02$ px)
- Calibration of images by reference object ($80\text{ }\mu\text{m} \triangleq 159\text{ px}$)
- Preliminary result: many large clusters with diameters ranging from $2\text{ }\mu\text{m}$ up to $10\text{ }\mu\text{m}$ (here: $5.81\text{ }\mu\text{m}$)
- Note: not sensitive for small clusters due to camera resolution



Clustering of heavier gases

- Cluster production is also possible with other gases
- Challenges:
 - Temperature range (~ 100 K for Ar or N₂) not ideal for cold head, but feasible
 - Smaller flow through nozzle \rightarrow different geometry needed (larger inner diameter, i.e. 80-120 μm)



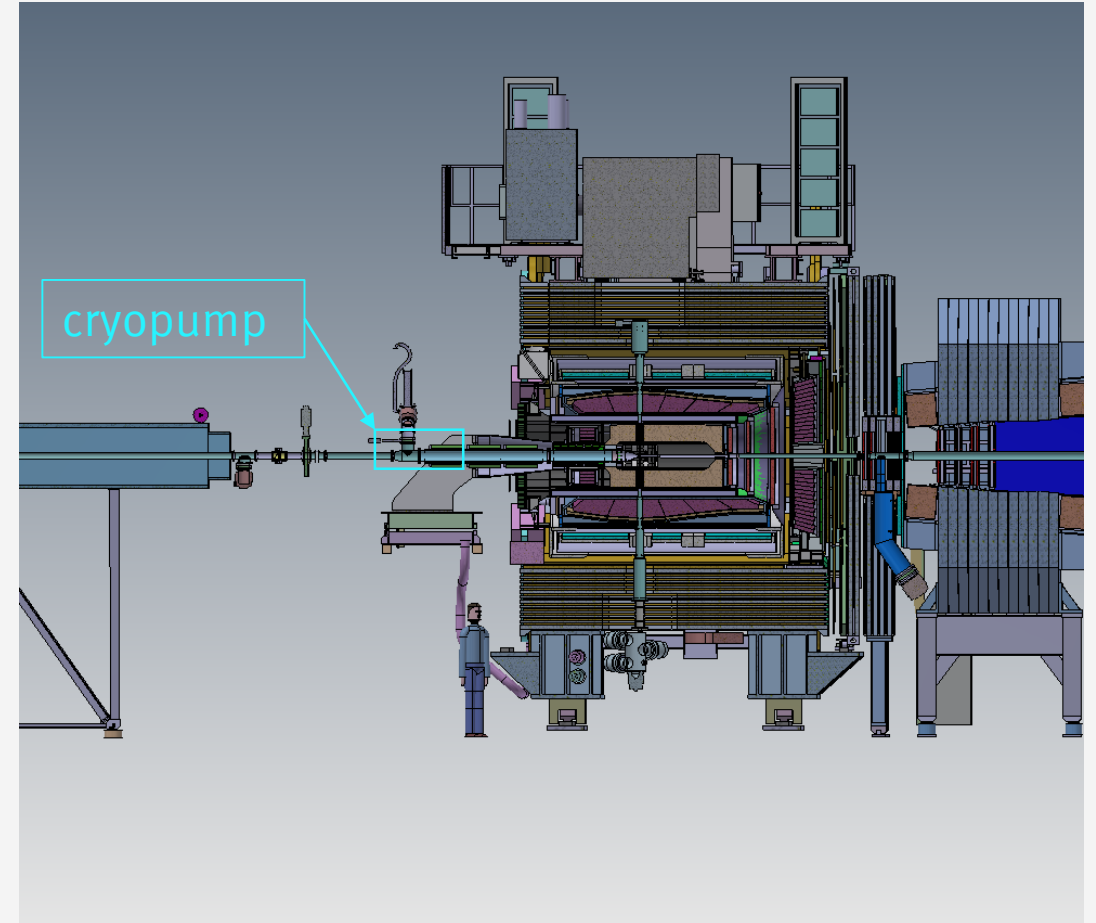
Clustering of heavier gases (here: argon)

- First test started in cooperation with the MAGIX collaboration at MAMI with Münster jet-target for MAGIX (120 μm nozzle)
 - Liquid argon in front of nozzle (~ 5 bar, ~ 100 K)
 - Nearly no jet divergence visible
 - Here: interaction directly behind the nozzle, no skimmer or collimator used
- Operation of a cluster-jet target with some heavier gases (i.e. N_2 , Ar) is possible
- More investigations needed (stability, long distance, ...)



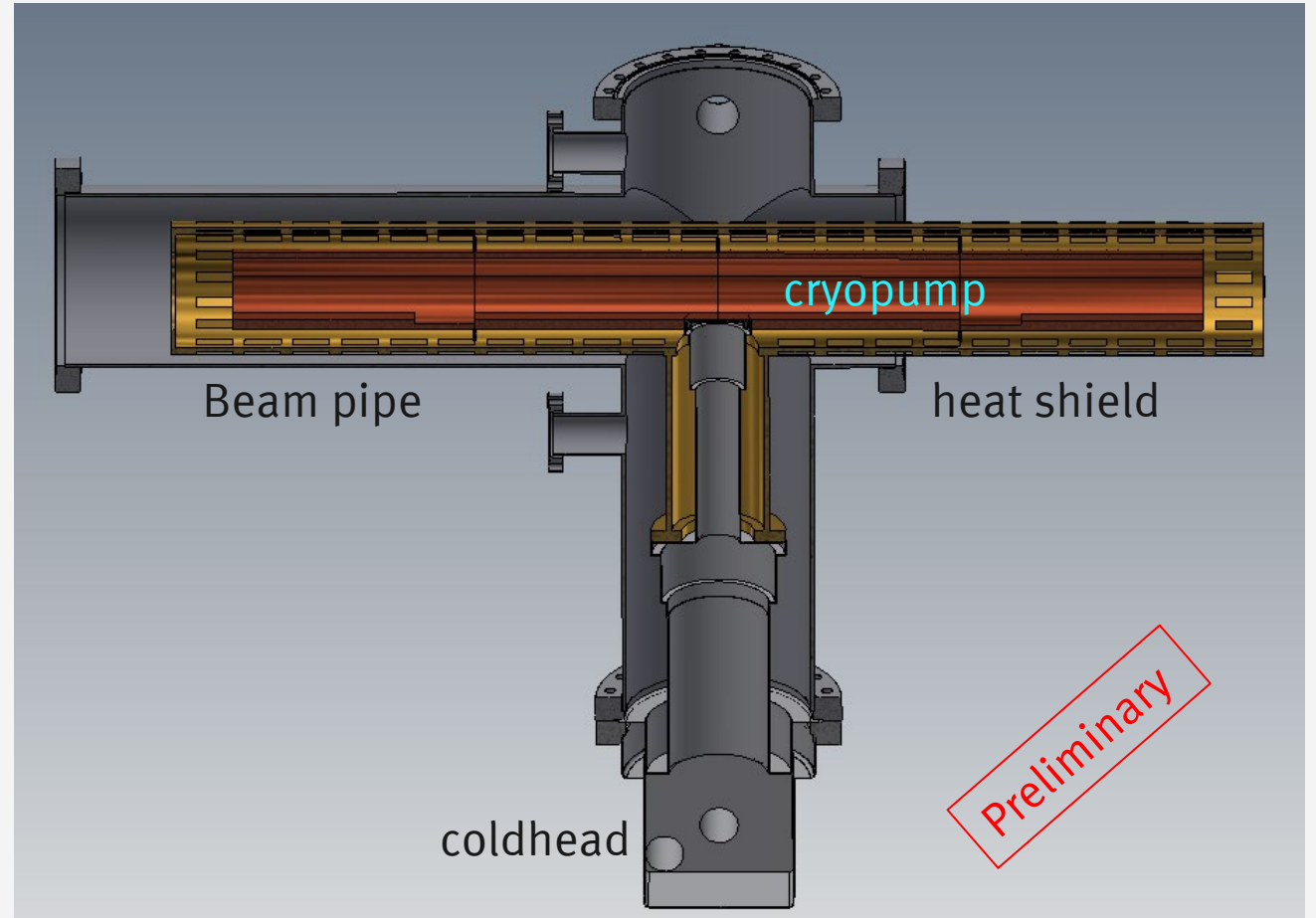
PANDA cryopump

- Efforts are ongoing to design a cryopump for PANDA
- Vacuum simulations show a decrease of $\sim 30\%$ in rest gas thickness
- Pumping speed is in the range of 100.000 l/s and regeneration interval is 2 months



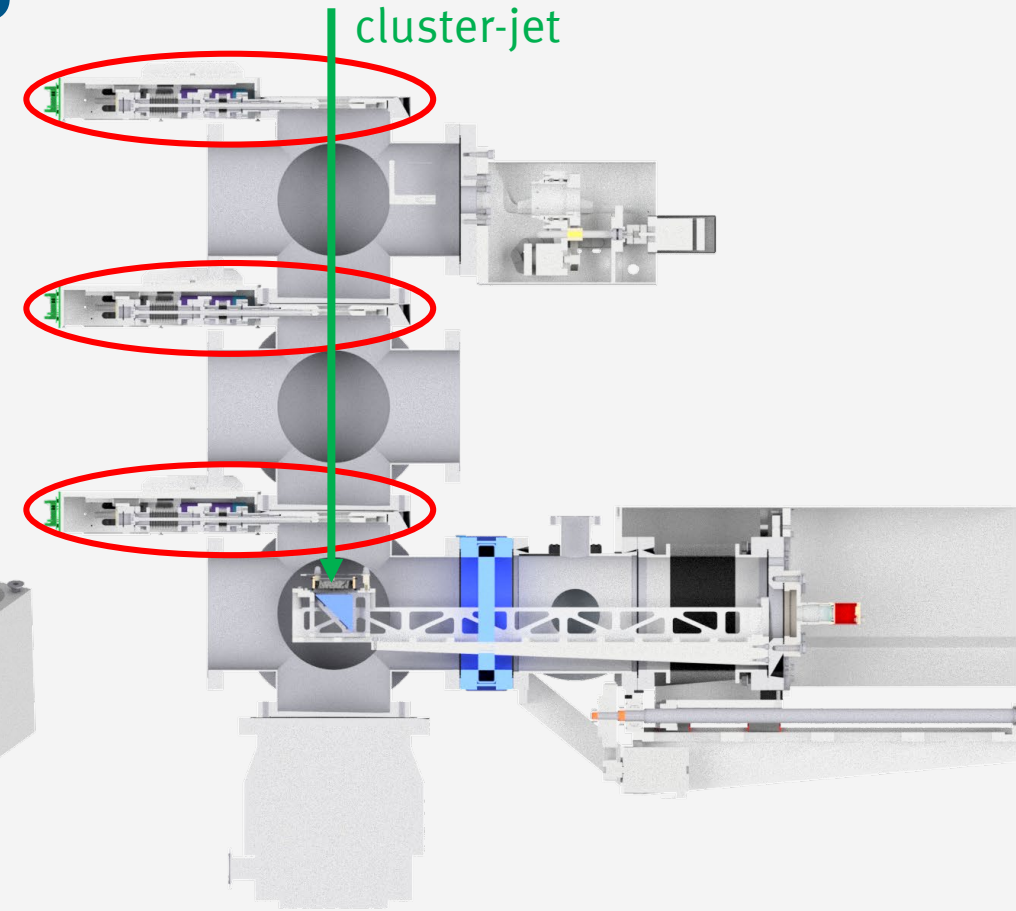
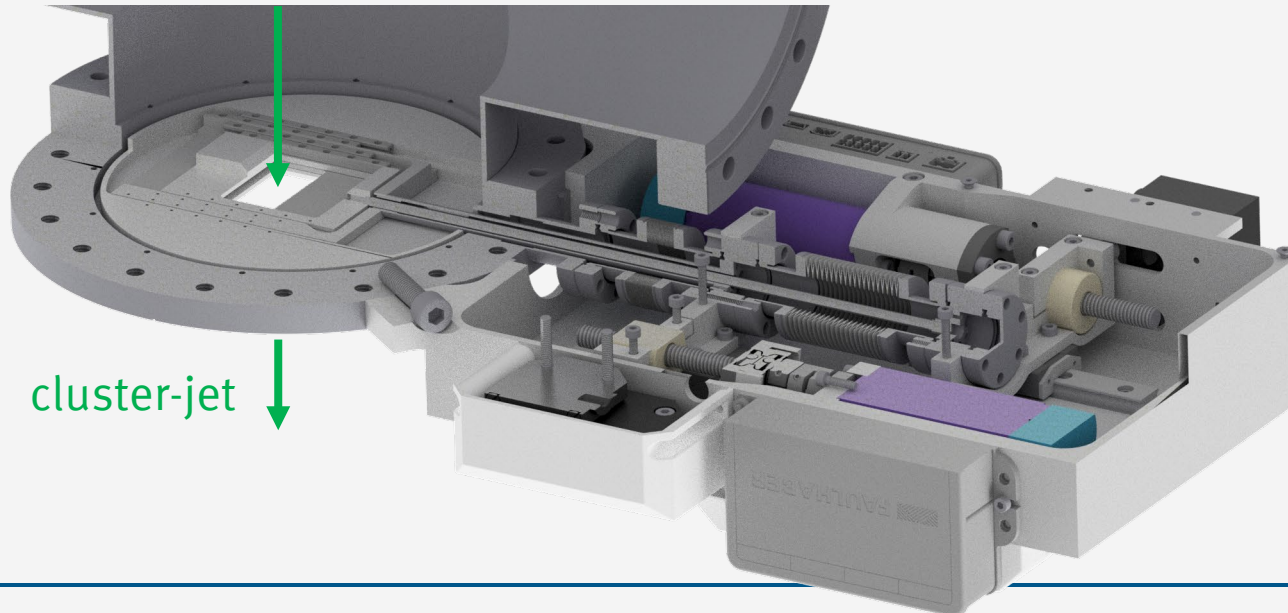
Cryopump prototyping

- prototype cryopump and beam pipe section (partly) housing the cryopump are currently being designed
- The prototype will be used to determine the accuracy of the simulations
 - eventual design optimizations can be included into the final design



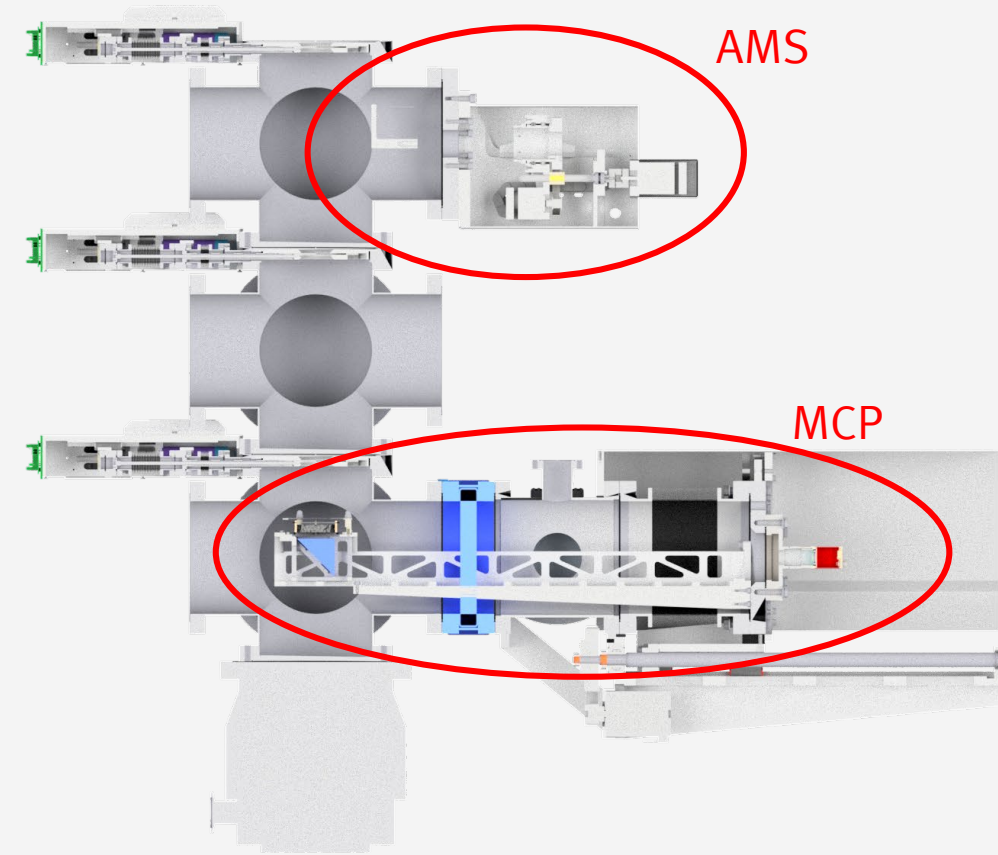
Design of a modified target beam dump

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



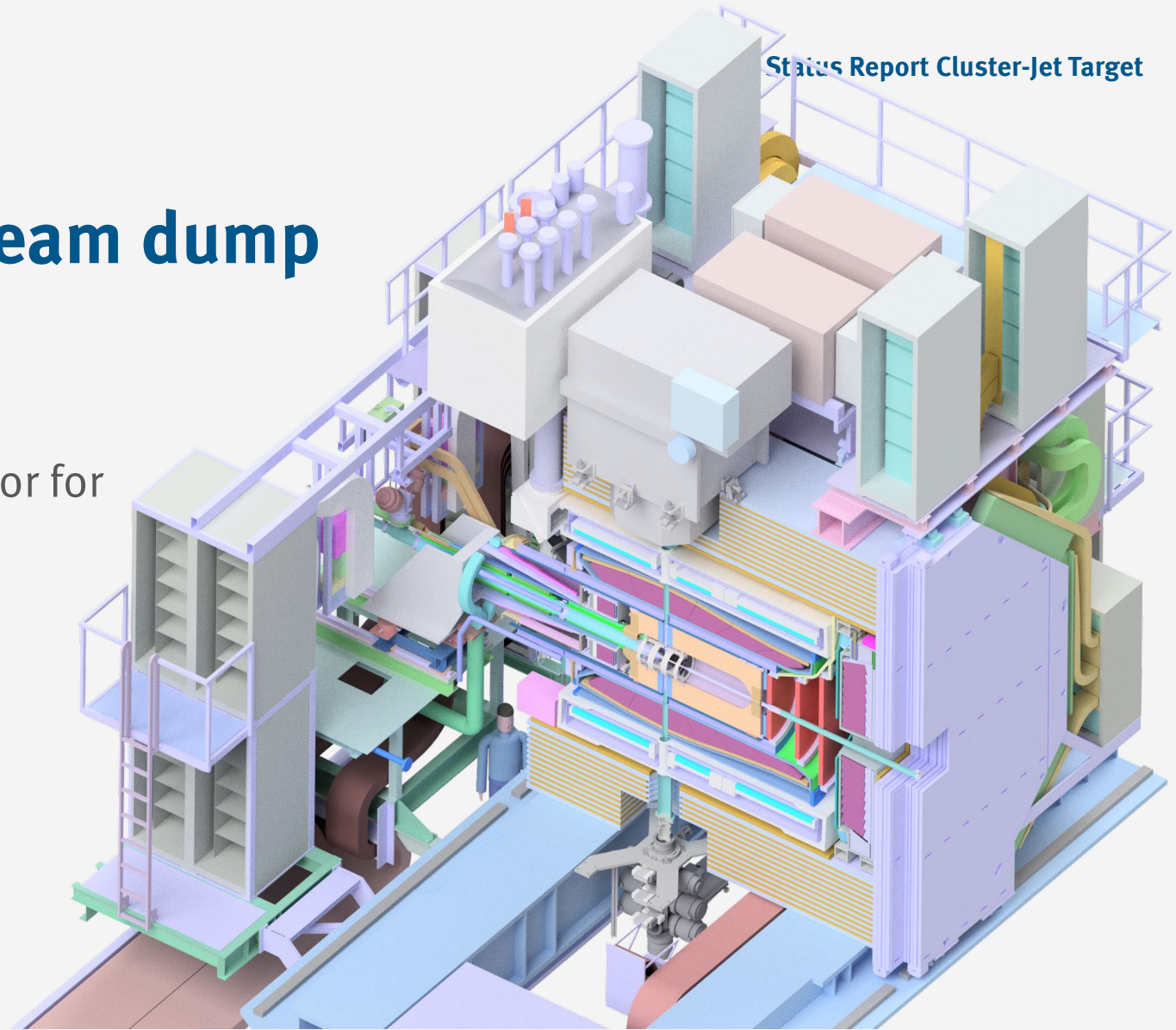
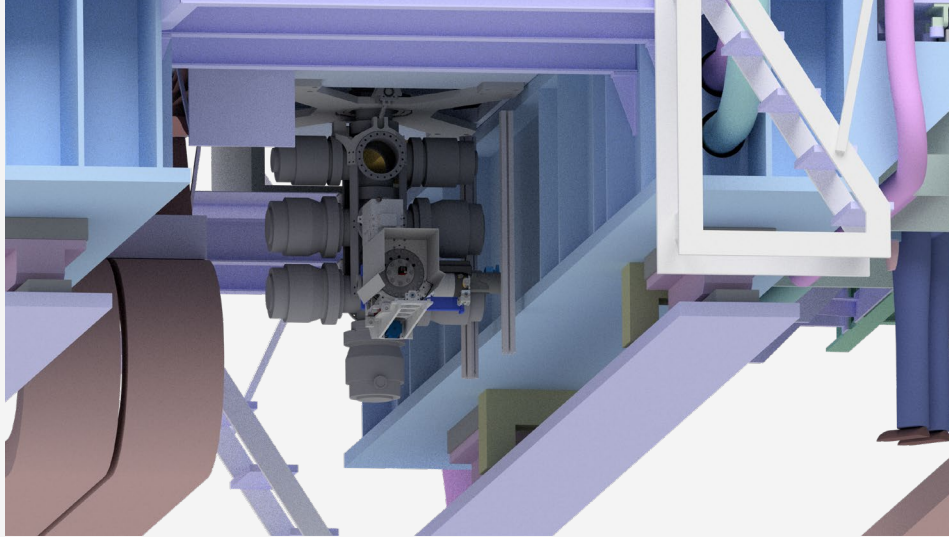
Design of a modified target beam dump

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



Design of a modified target beam dump

- New design fits into PANDA model
- Space reserved for pellet tracking chamber (or for an additional pumping stage)



Summary / Outlook

- Nozzle production is ongoing
- Shadowgraphy measurements are currently analysed
- Target with argon is in operation at MAMI
- Prototype cryopump will be tested soon
- Modified beam dump is in preparation
- Preparation of beam time at COSY within the first half of 2022
- “The Residual Gas Contribution of Clusters and Droplets in Vacuum” → Benjamin Hetz