Westfälische
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Technical design of the cluster-target-source for the MAGIX-experiment

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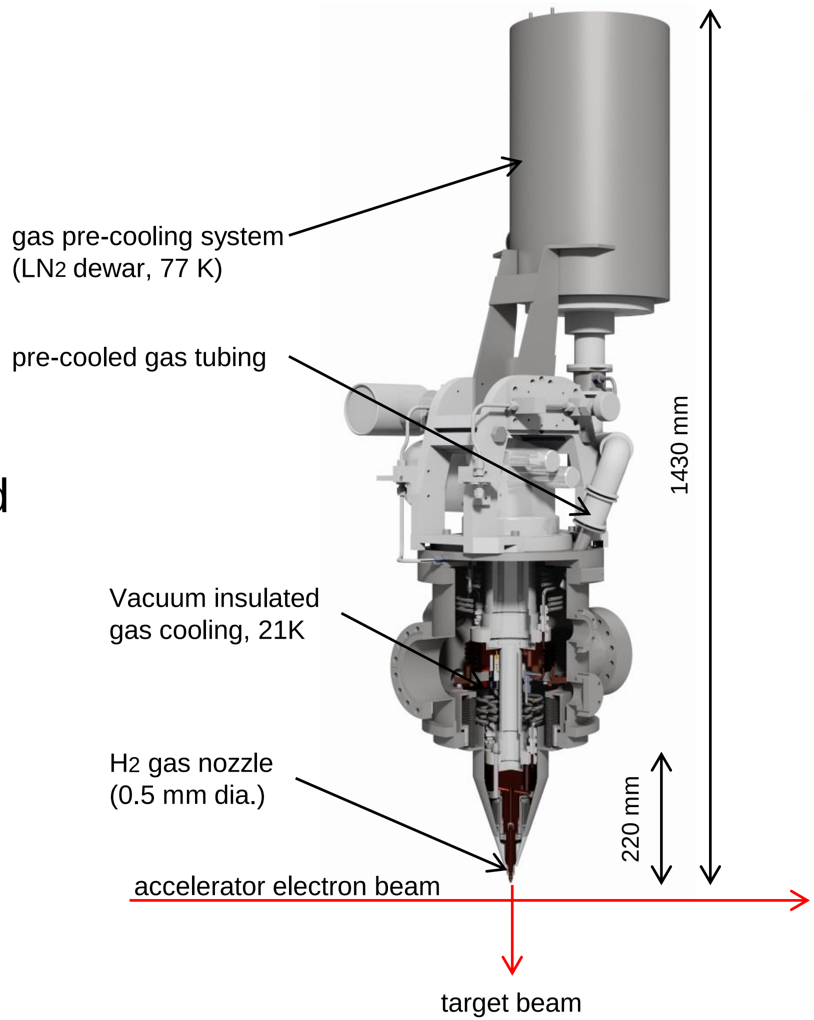
- Production of individually formed copper-nozzles

Target overview

Target boundary conditions:

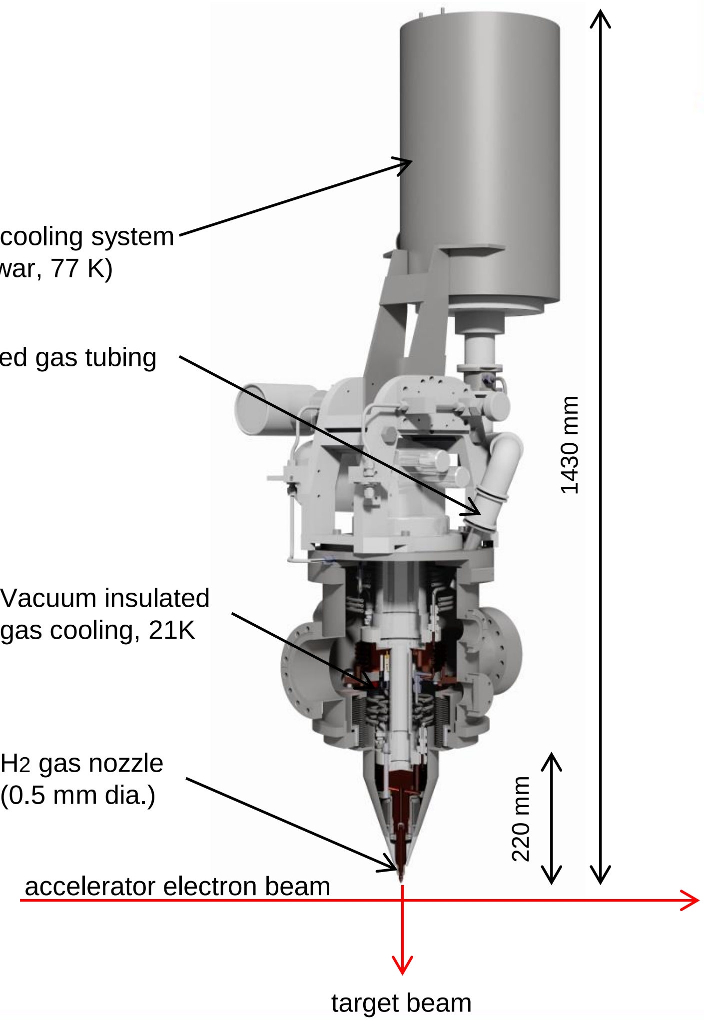
- highly intense H_2 target beam needed (in the order of 10^{19} atoms/cm²)
- interaction point close to the target`s nozzle
- high detector acceptance around nozzle area



Target overview

Target requirements:

- H_2 beam at 40 K and 40 l/min to reach required thickness
- Insulation vacuum for gas cooling system
- interaction with electron beam close to the nozzle
- Insulation vacuum chamber with thin conical tip (20°) at nozzle feedthrough for maximum detector acceptance

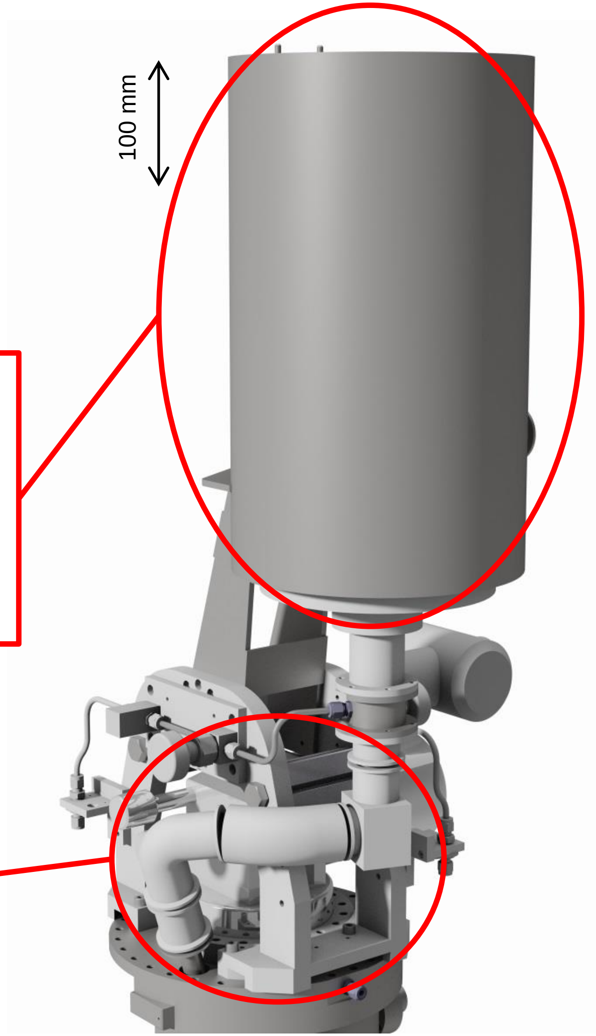


Design of the gas cooling system → LN_2 pre-cooling

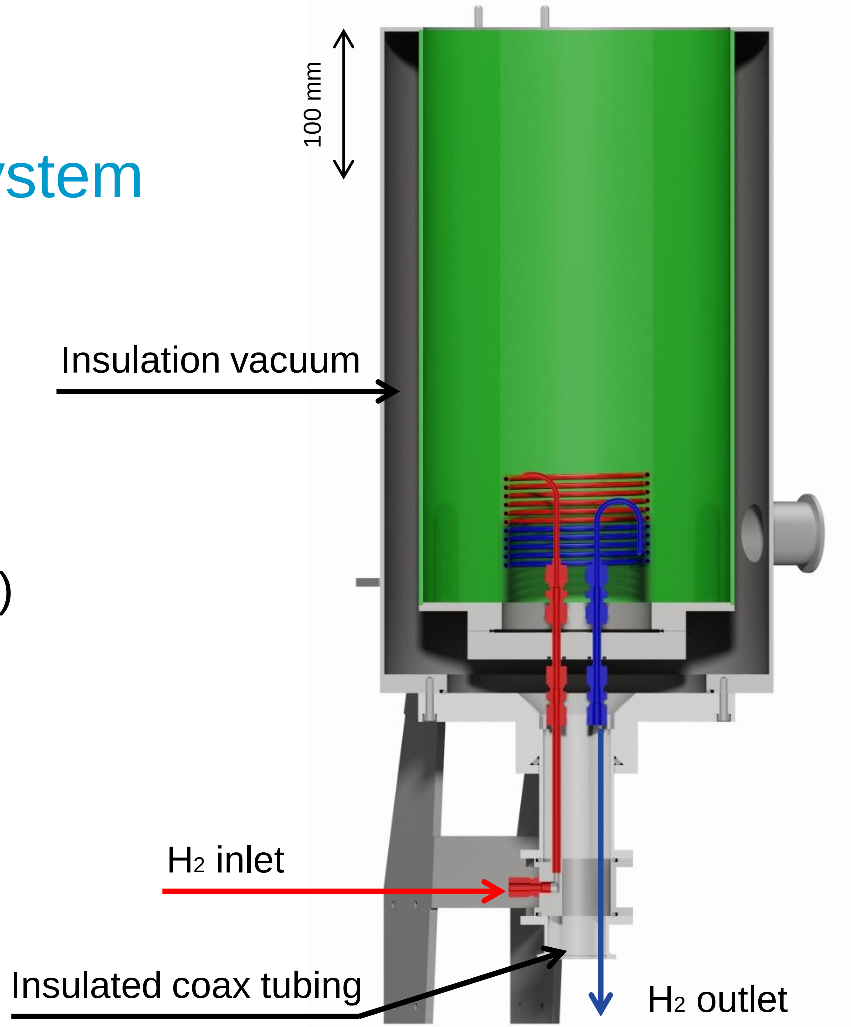
LN_2 storage dewar

- 14 l filling volume (10 l usable)
- LN_2 consumption app. 10 l/h

Insulated H_2-piping with vacuum feedthrough



Design of the gas cooling system → LN_2 pre-cooling



Green: LN_2 volume

Red: H_2 inlet (room temperature, 40 l/min)

Blue: H_2 outlet (77 K)

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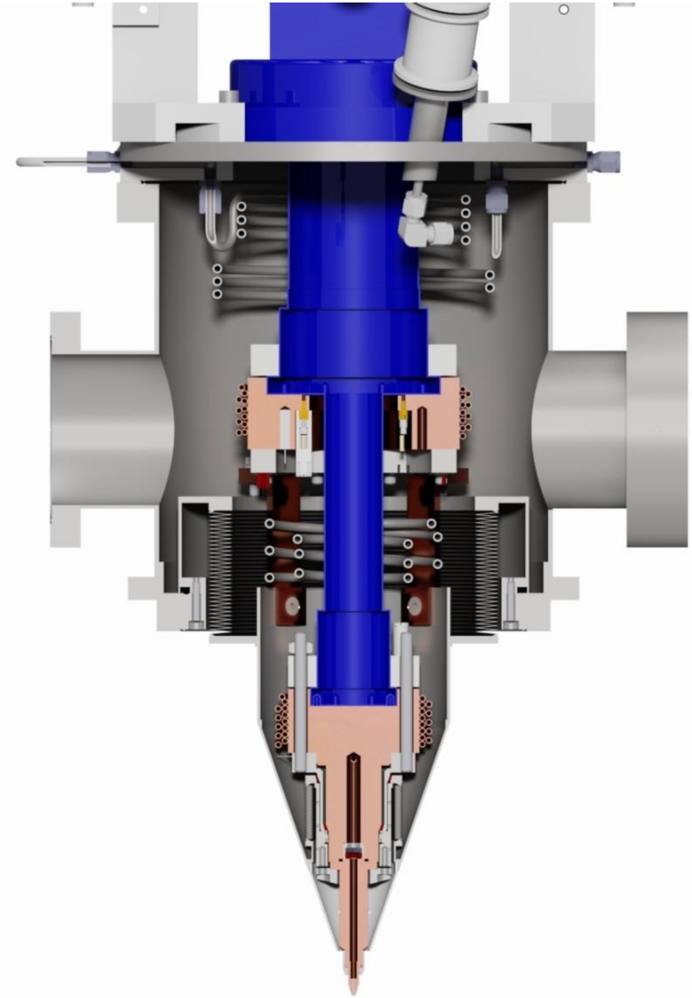
Design of the gas cooling system → two stage cold head cooling

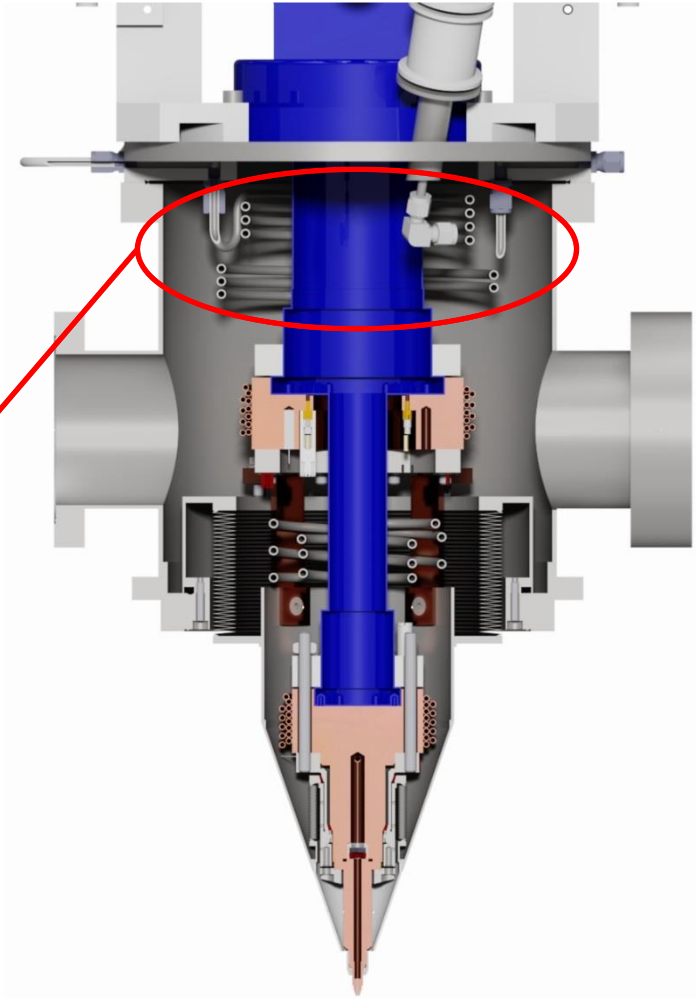


- Two stage Leybold coolpower 10MD (coloured in blue)
- Motor driven cold head
- Gas inlet temperature 77 K, 40 l/min
- Outlet temperature 1st stage app. 38 K
- Outlet temperature 2nd stage app. 21 K

Design of the gas cooling system
→ two stage cold head cooling

6 mm stainless steel tubing

- Vacuum insulated feedthrough
- H_2 gas transfer pipes
- Several windings for temperature decoupling of 1st cooling stage



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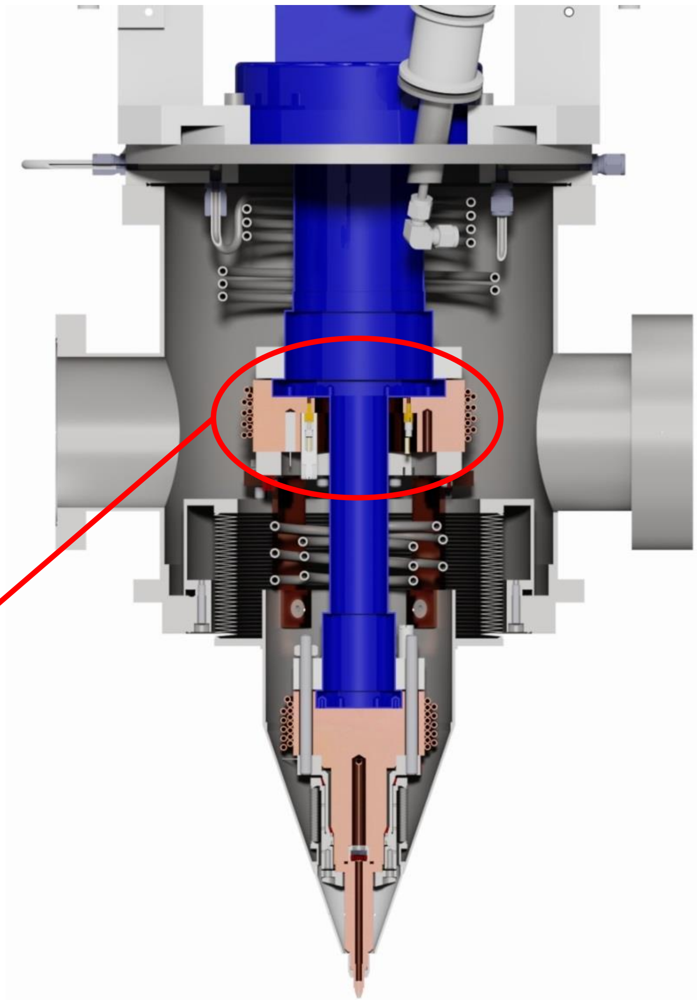
Design of the gas cooling system → two stage cold head cooling



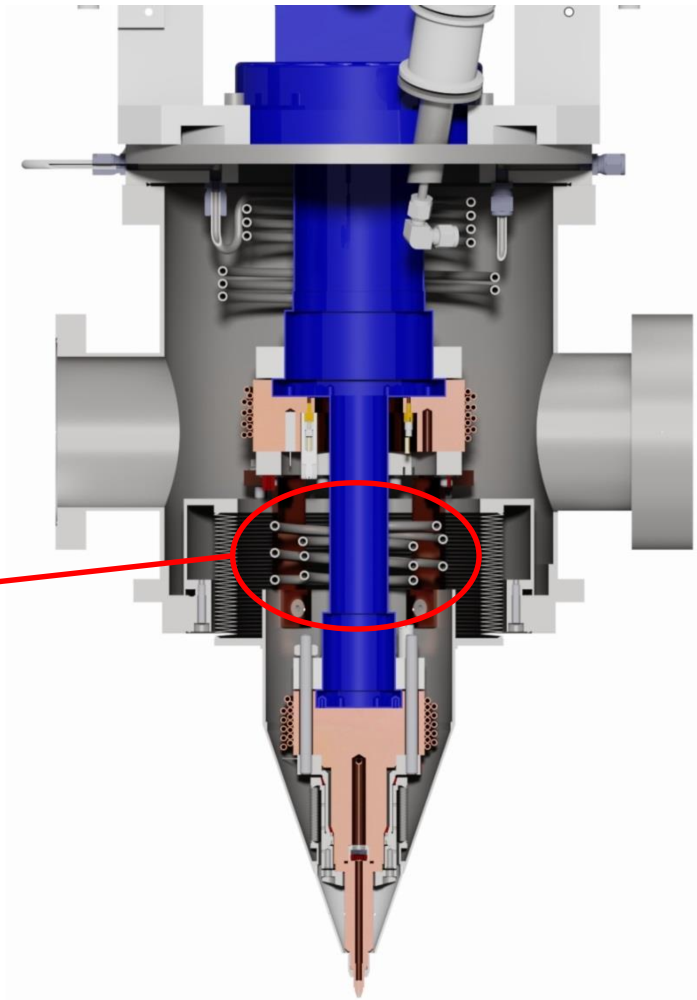
1st cooling stage (warm stage)

- Copper cooling block including soldered gas pipes for optimum heat exchange
- 2x 100 W heating power
- 2x silicon temperature diode
- Controlled by Lakeshore Mod. 336

Design of the gas cooling system → two stage cold head cooling

6 mm stainless steel tubing

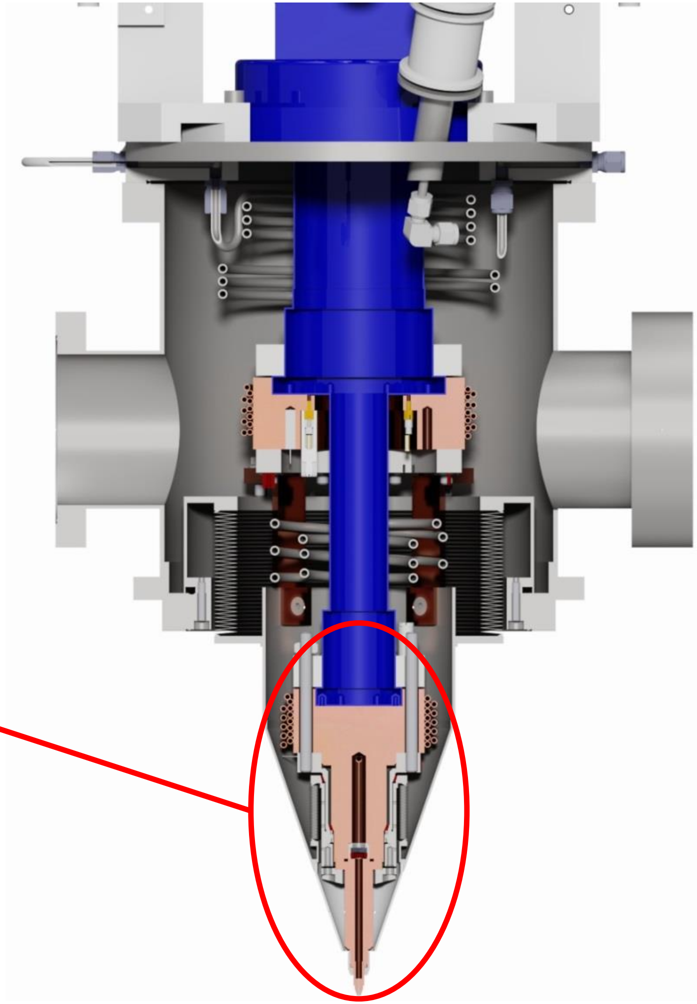
- H_2 gas transfer pipes
- Several windings for temperature decoupling 1st cooling stage from 2nd cooling stage



Design of the gas cooling system → two stage cold head cooling

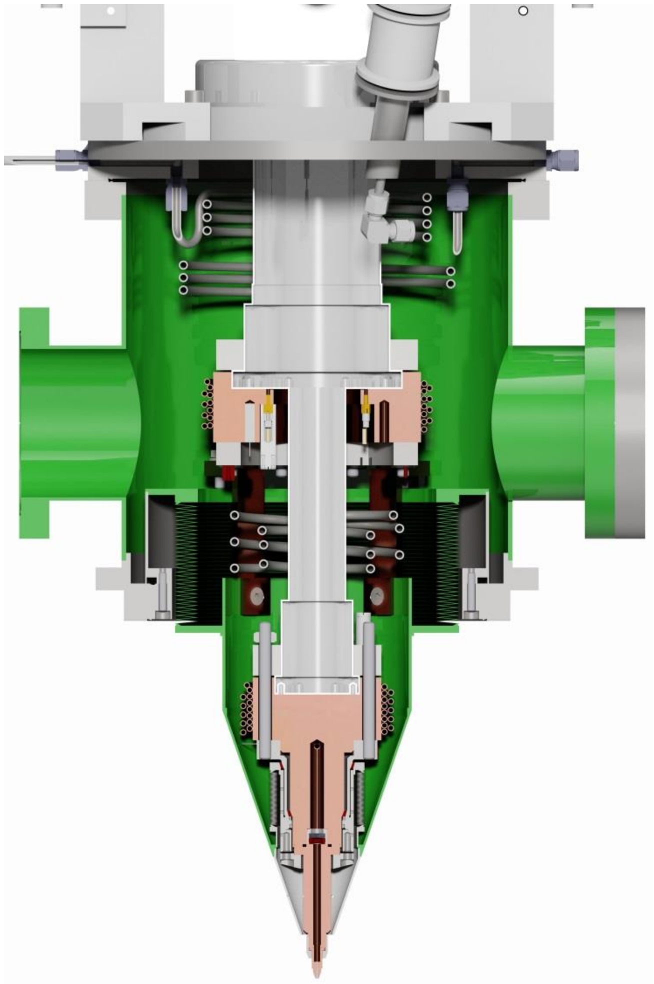
2nd cooling stage (cold stage)

- Copper cooling block including soldered gas pipes for optimum heat exchange
- 2x 50 W heating power
- 2x silicon temperature diode
- Controlled by Lakeshore Mod. 336



Insulation vacuum and sealing

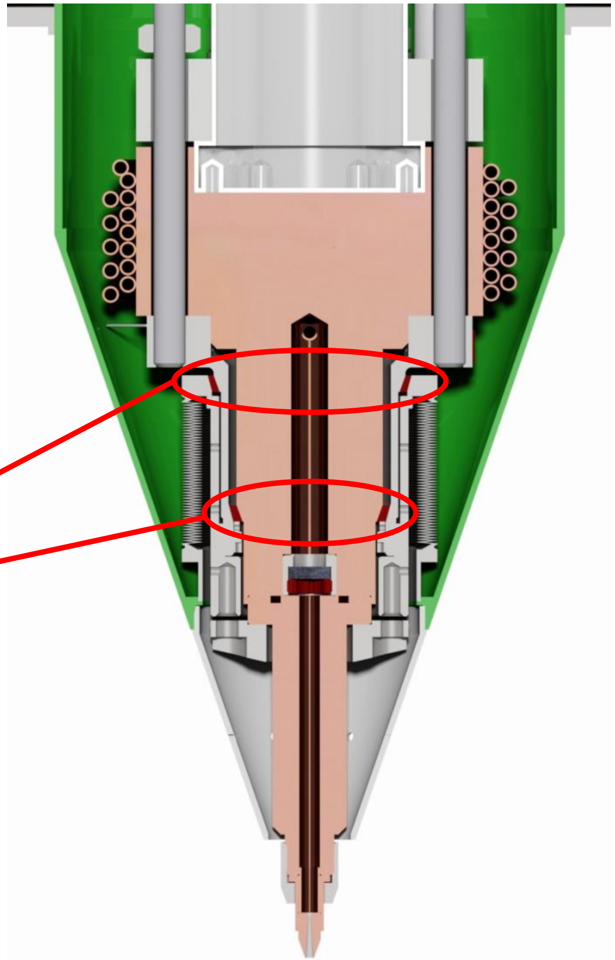
- Chamber made from stainless steel
- Conflat flanges for all vacuum connections
- Swagelok tube fittings for gas tubing
- DN 100CF for turbo pump
- Vacuum monitoring by Leybold ITR-200



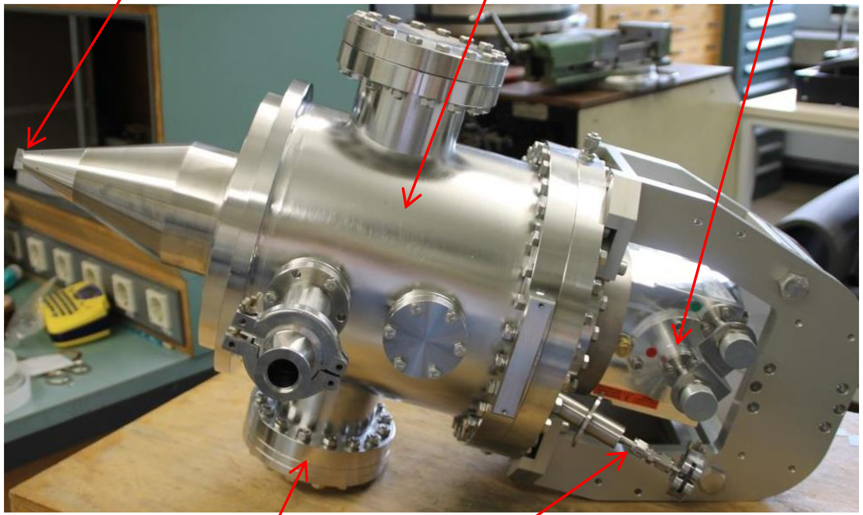
Insulation vacuum and sealing

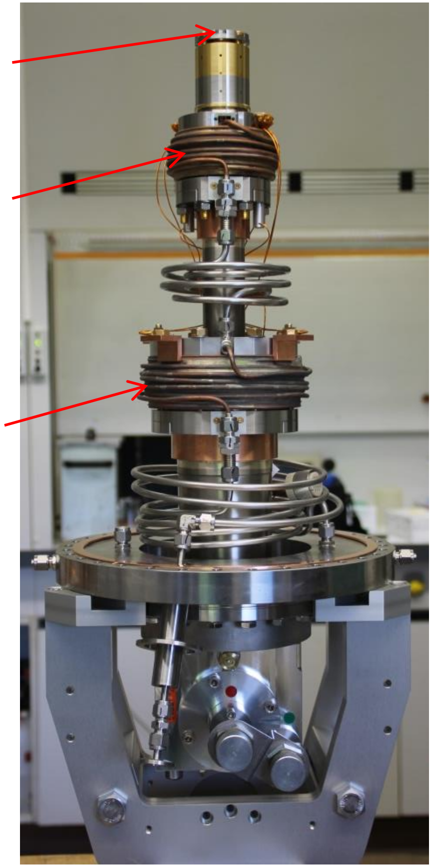
Special formed polyimid sealing for nozzle feedthrough

- High radiation resistance
- Good sealing performance at minimum temperatures (max. 10^{-5} mbar in IVC)
- Reusable sealing

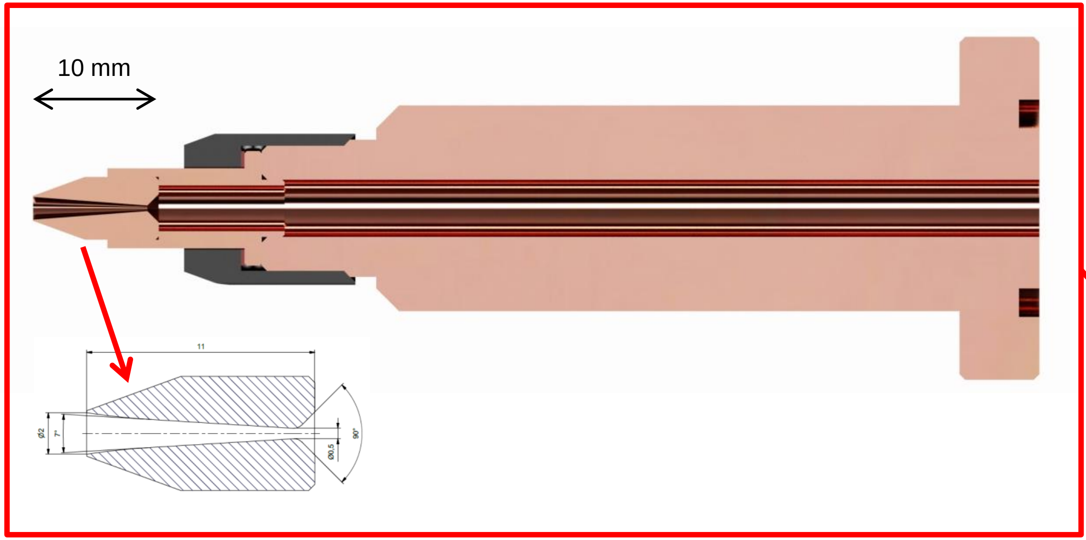


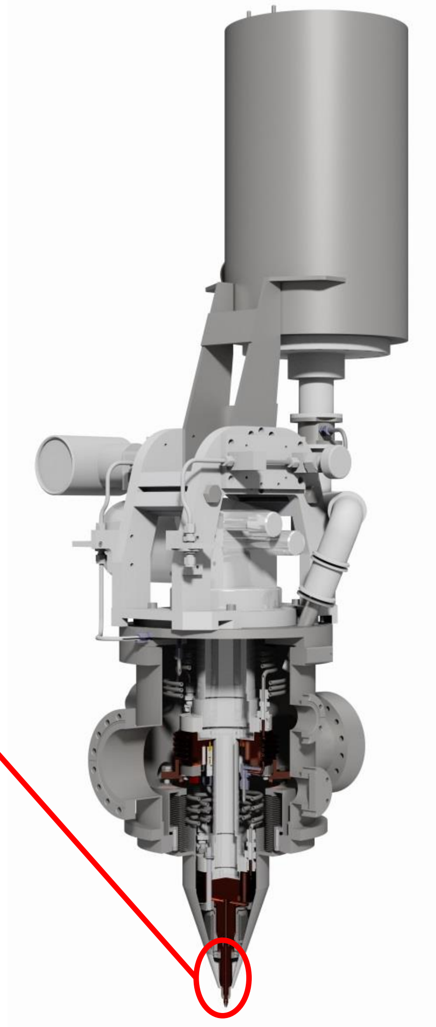
Target assembly in Münster





Nozzle assembly and sealing

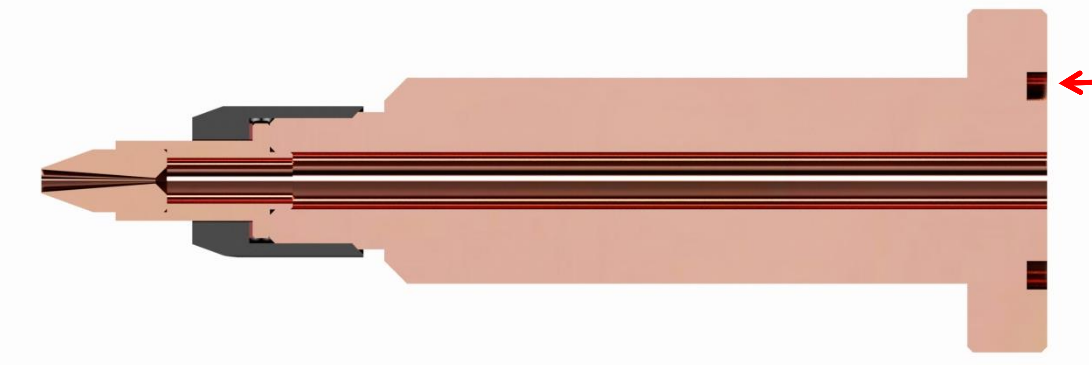


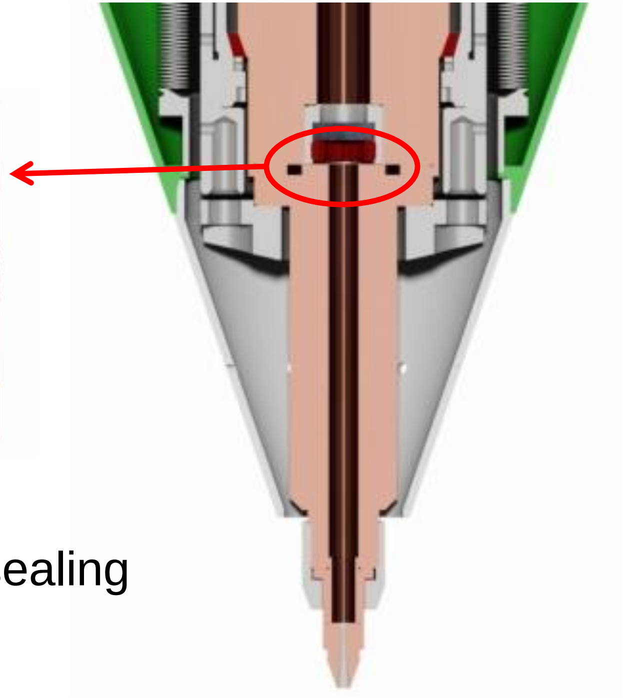


Nozzle mount assembled with nozzle extention

- Nozzle mount sealing: Indium

Nozzle assembly and sealing

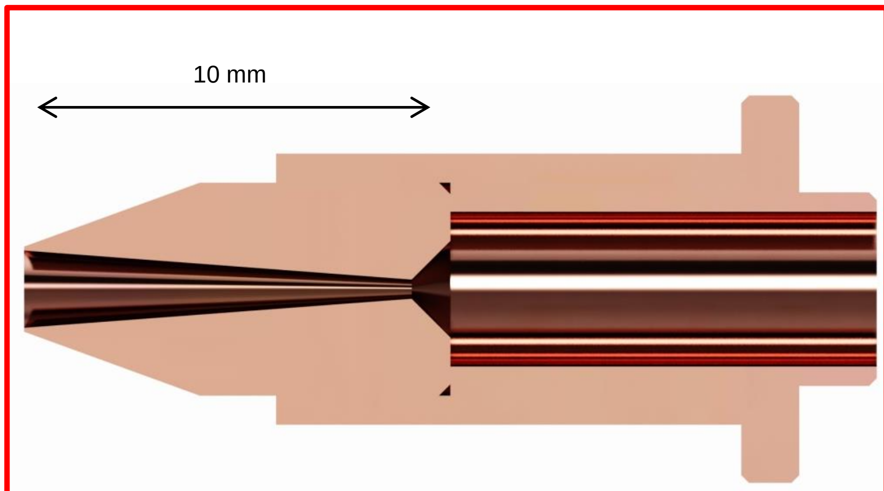


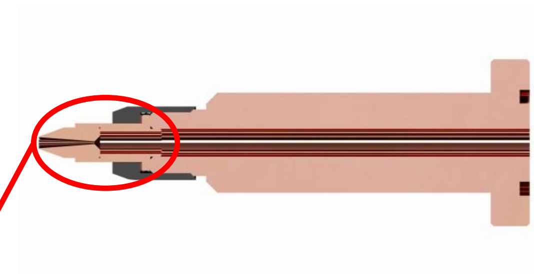


Nozzle mount assembled with nozzle extention

- Nozzle extention sealing: special Polyimid-sealing
- Reusable
- Leak tight at 20 K

Nozzle assembly and sealing

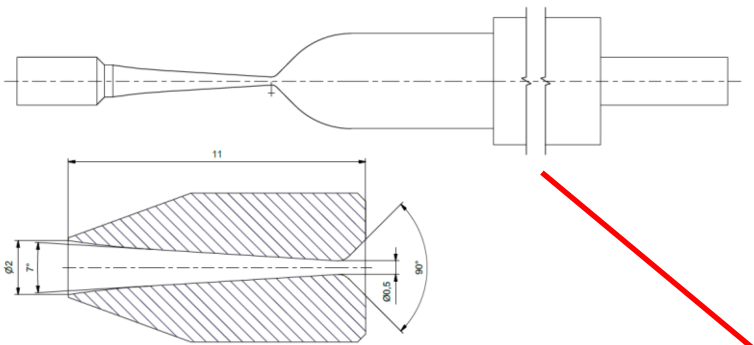




Nozzle mount with individually formed nozzle

- Nozzle and mount welded

Production of individually formed cu-nozzles



CAD-drawings of nozzle geometry

- 45° inlet cone
- 0.5 mm diameter at narrowest point
- 7° outlet cone
- 2 mm outlet diameter

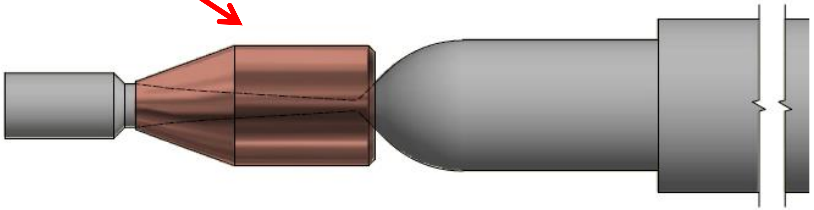
Nozzle negative

- Turned from Aluminium

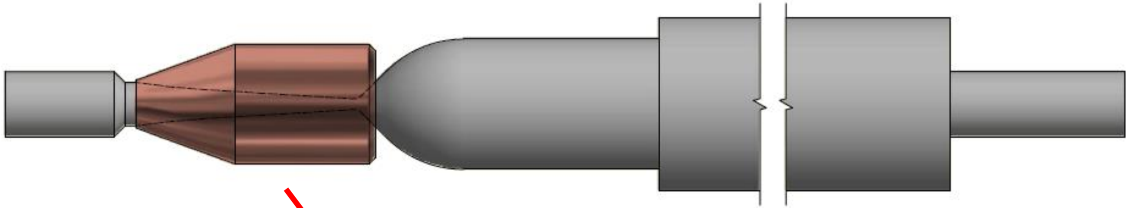
Production of individually formed cu-nozzles

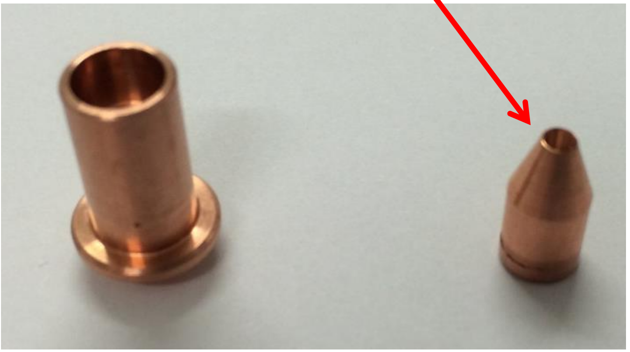
Electroformed copper positive

- Formed in copper sulfate
- Processing time 5 days
- Outer geometry turned
- Nozzle extracted mechanically



Production of individually formed cu-nozzles





Turned nozzle mount
merged with formed nozzle

Conclusion

- New Target source set up with LN_2 pre-cooling and additional two stage cold head cooling
- Target operation started for initial tests (vacuum, cooling, sealing)
- Minimum H2 temperatures of e.g.< 40 K at maximum flow rates of 40 l/min
- Using newly developed copper nozzles with individual geometries

Outlook

- Further development of copper nozzles
- Developement of nozzles with different shapes (slit nozzles)