The Design and Performance of the Münster Gas-Jet Target for MAGIX at MESA

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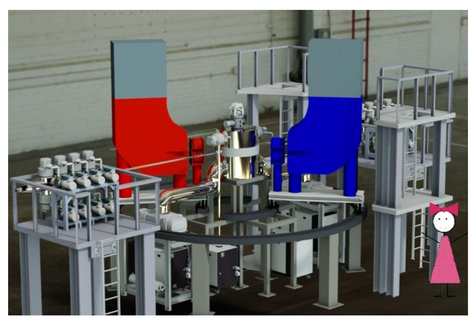
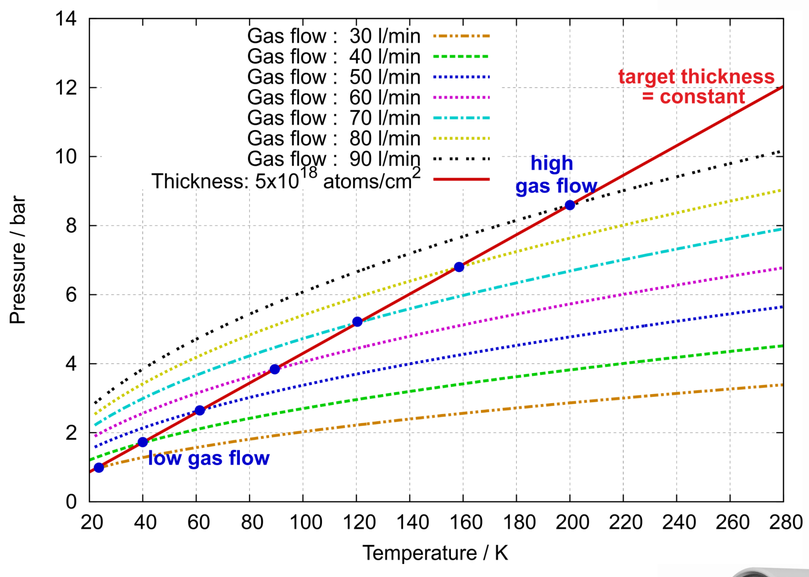
Motivation

The experiments at the future electron accelerator MESA (Mainz Energy-recovering Superconducting Accelerator) at the University of Mainz focus on tests of the validity of the Standard Model of particle physics. Thereby, the main interest is the search for dark photons as candidates for dark matter, and precision measurements of fundamental constants, such as the proton radius or the electroweak mixing angle. The MAGIX experiment (MESA Gas Internal target eXperiment) will be located in the energy-recovering sector of this future electron accelerator with energies up to 105 MeV, a beam current of 1 mA, and a high luminosity of 10^{35} 1/cm²s . MAGIX will consist of a multi-purpose spectrometer and a gas-jet target which was designed, built up, and set into operation at the University of Münster.



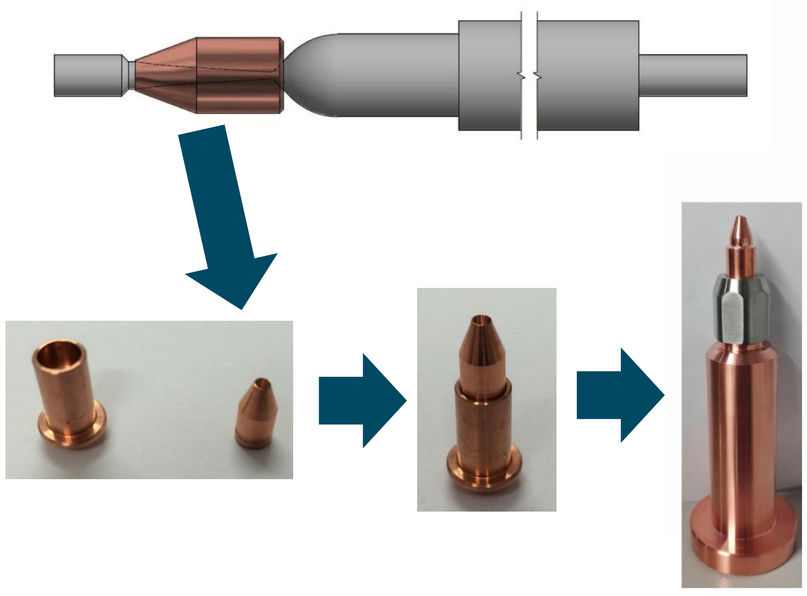
Target Thickness

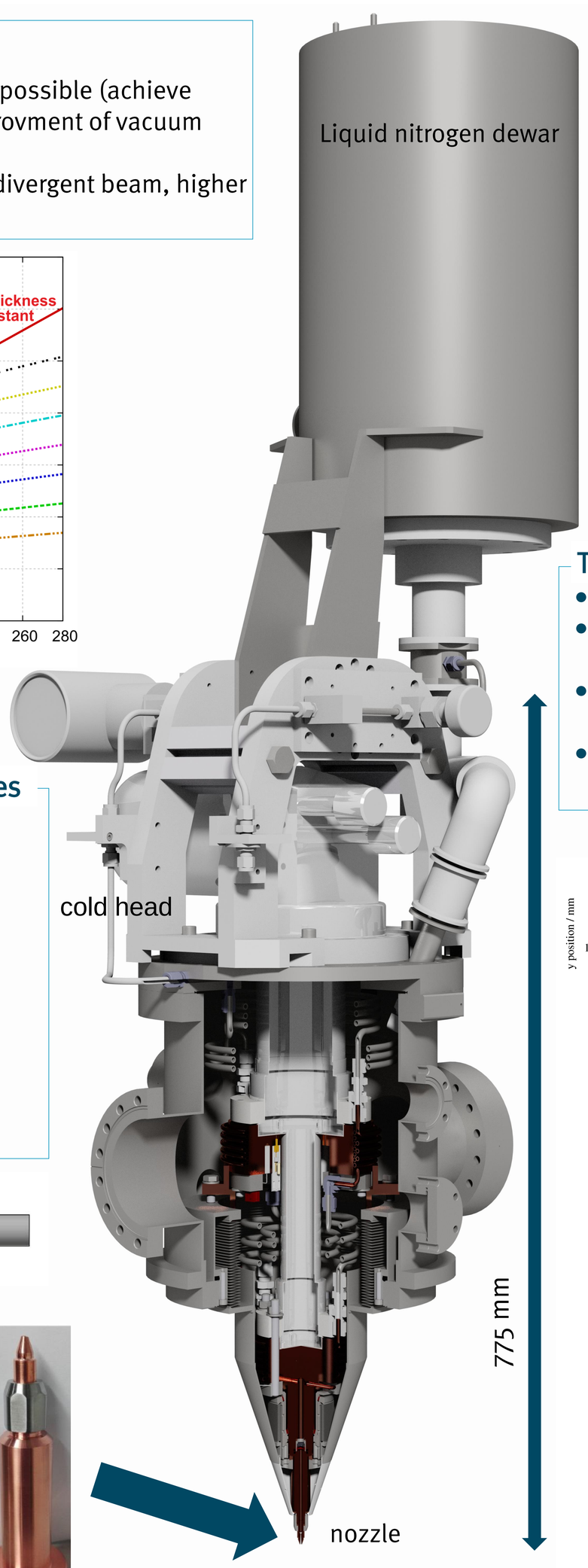
- Target thickness of 10^{19} atoms/cm²
- Gas temperature and volume flow as low as possible (achieve same thickness, minimize background, improvment of vacuum conditions)
- Additional cluster formation (directed, less divergent beam, higher range in vacuum)



Production of individually formed Nozzles

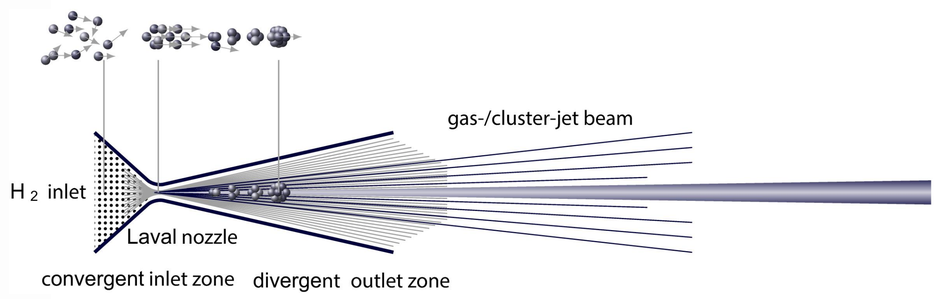
- Production of the counterpart model of the long outlet zone turned out from aluminum
- Diameter of 0.5 mm at the tip (narrowest point) and a 2 mm outlet diameter
- Electroformed copper positive forms nozzle body (processing time 5 days)
- Final shape of the nozzle is turned out
- Nozzle extracted meachanically
- Outer geometry is turned
- Turned nozzle mount merged with formed nozzle





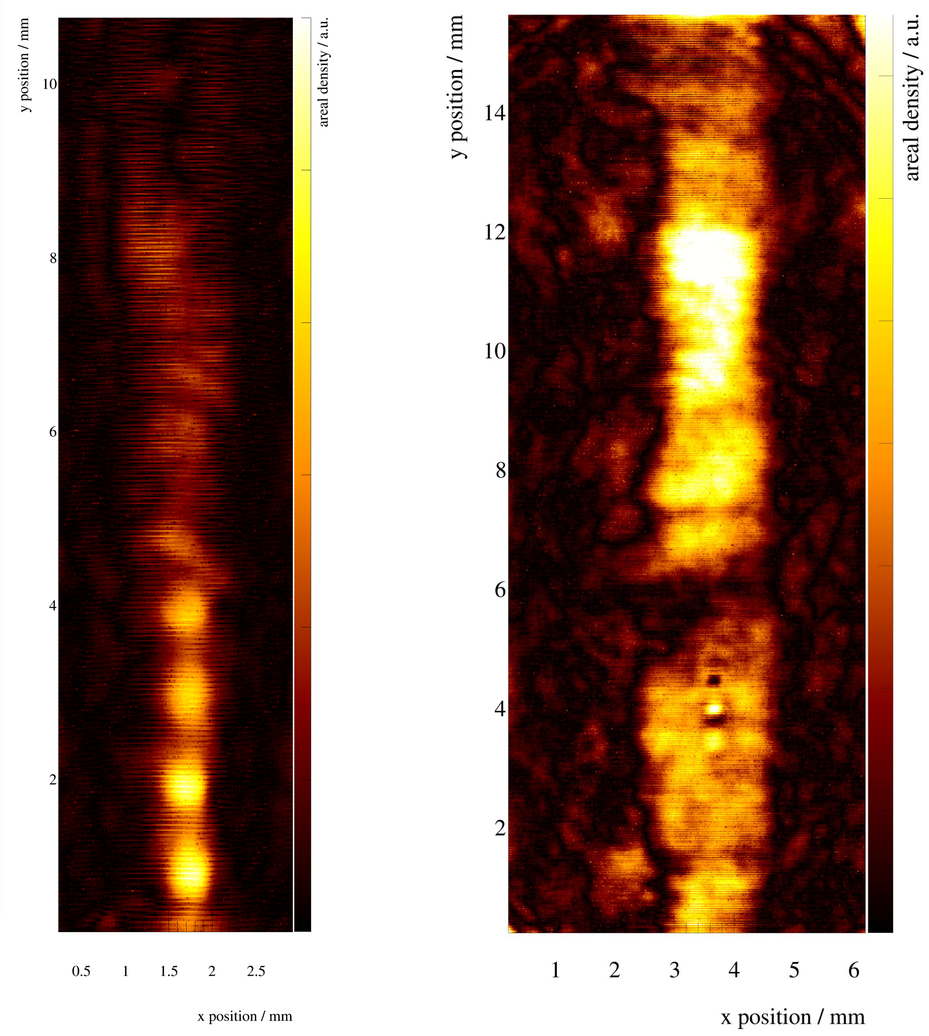
Cluster Production Process

- Laval nozzle is the heart of a gas-/cluster source
- Temperature range: 25K – 300 K
- Pressure range: 2 bar – 20 bar



Target Thickness Monitoring

- Beam investigations with a Mach-Zehnder Interferometer
- Analysis program works with the proportionality among target thickness and phase shift of the interference fringes
- Left: Nitrogen gas-jet, produced at a gas pressure of 20 bar and a temperature of 288 K, expanding into atmosphere
- Right: Hydrogen cluster-jet, produced with a gas flow of 40 l/min and a temperature of 40 K, expanding into vacuum



Summary & Outlook

- Jet-Target for MAGIX fulfills all the requirements
- Target is ready for operation
- First succesfully produced nozzles and beam studies
- Production and investigations of different nozzle designs
- Studies with different vacuum and stagnation conditions
- First beam time at MAMI this year (proton radius puzzle)

Cluster of Excellence PRISMA Precision Physics, Fundamental Interactions and Structure of Matter

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Questions?
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