The Monitor Systems of the Cluster-Jet Target

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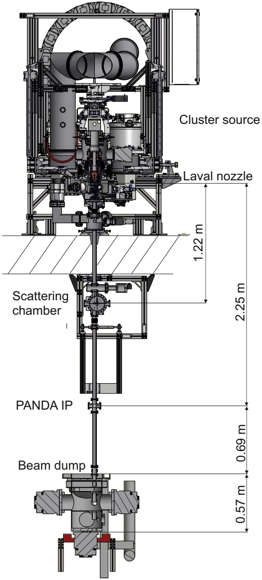
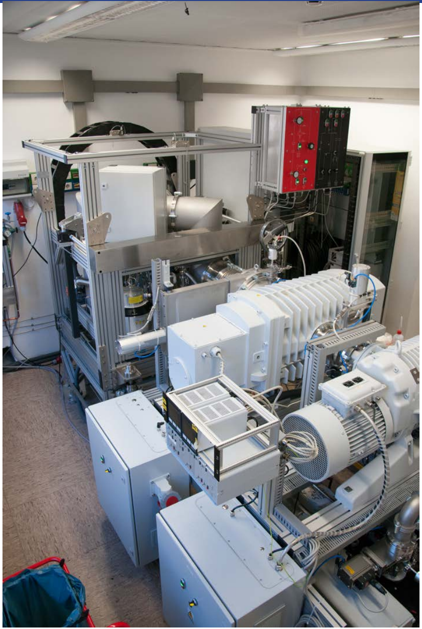
Münster Setup of the Cluster Target

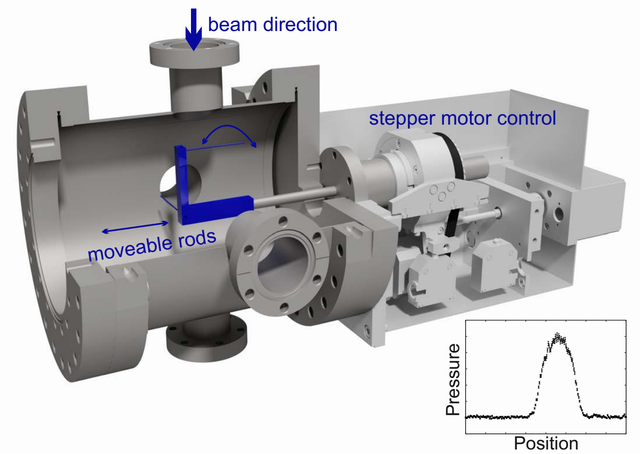




Monitoring system in scattering chamber

Scanning rod system

- Set successfully into operation
- Determination of cluster beam properties easily possible
- Highest pressure increase corresponds to cluster beam thickness



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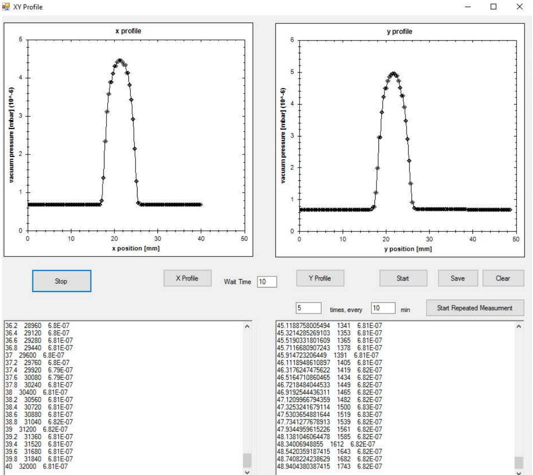

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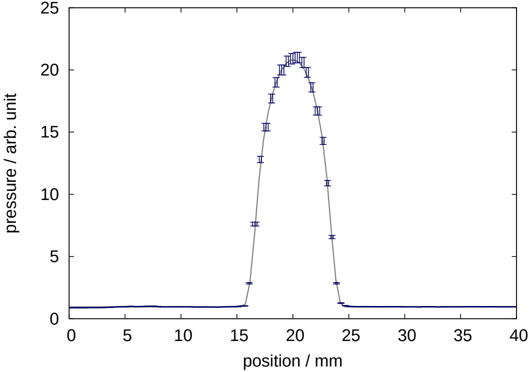


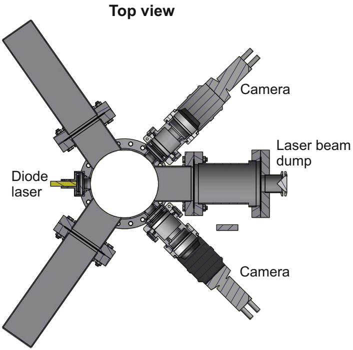
- 17 bar, 35 K
- Thickness: $\rho_T = (5.85 \pm 0.36) \times 10^{13}\ \frac{\text{atoms}}{\text{cm}^2}$ (no adjustments!!)
- Radius: $r = 3.64$ mm
  $\Rightarrow$ calculated value
  $r = 3.57$ mm

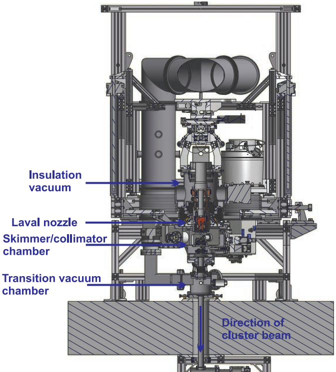
Optical Monitoring System

⇒Transition vacuum chamber

- Installation of an optical monitoring system consisting of diode laser and two CCD cameras

  Software and installation realized by Bachelor student M. Seifert
- Possibility to monitor cluster beam without influence of the cluster beam itself in a distance of 35 cm from nozzle
- Intensity of image corresponds directly to thickness



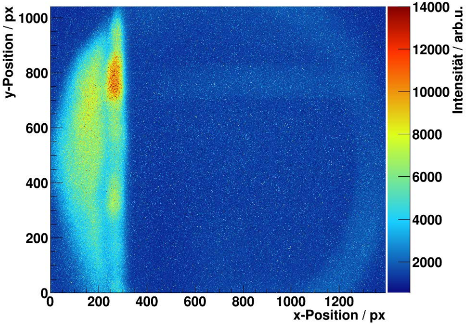


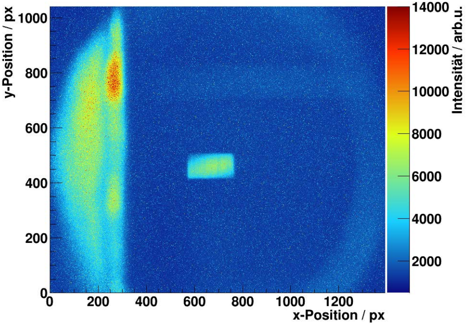
Optical Monitoring System

Measurement procedure

- Record two pictures (beam off, beam on)
- Make projections
- Projection in y direction corresponds to cluster beam thickness
- Fit the projection
- Calibration with system of scattering chamber

beam direction: ⟵





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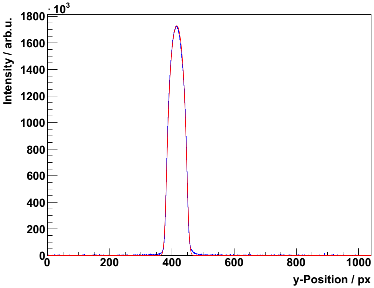


$$f_{erf}(y) = I_0 \cdot f_e(y - y_0) + I_U$$

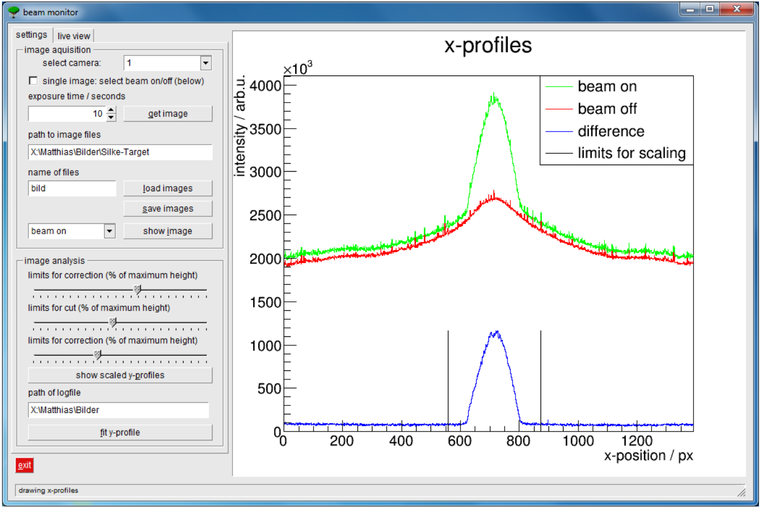
with

$$f_e(y) = \int_{-\infty}^{\infty} dx \int_{y-\frac{d}{2}}^{y+\frac{d}{2}} dy \frac{1}{2}\left(1 - \mathrm{erf}\left(\frac{r-R}{s}\right)\right)$$

- I_0: maximum intensity
- I_U: background intensity
- R: radius
- s: smearing parameter

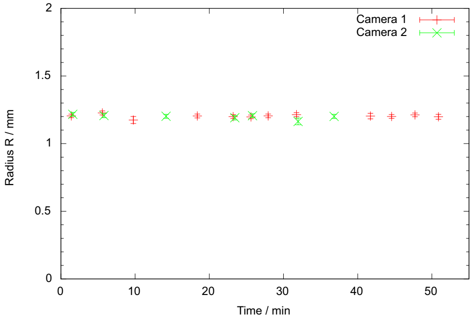
Optical Monitoring System

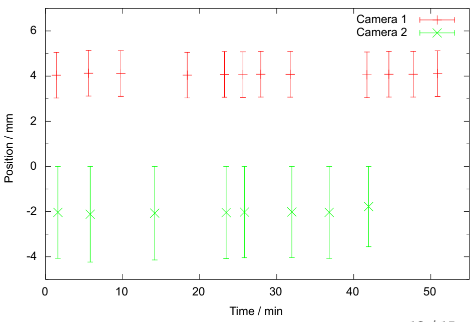
Graphical User Interface



- All data is logged $\Rightarrow$ can be provided for whole experiment

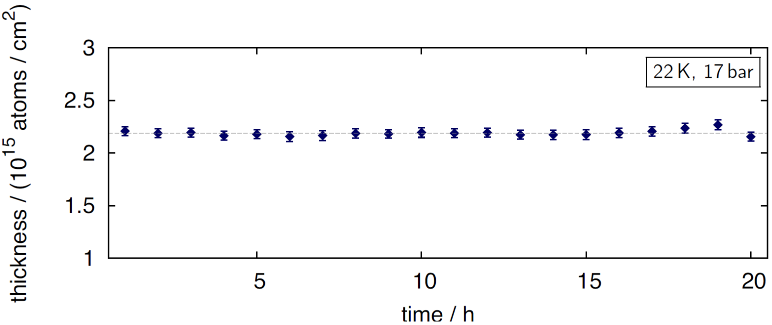
- Measurement series at 17 bar & 35 K
- Radius constant over time & corresponds to calculated value of $\approx 1,2\,\mathrm{mm}$
- Position constant over time
- Further adjustments necessary $\rightarrow$ beam not in the center of TVC





Beam stability

Prototype



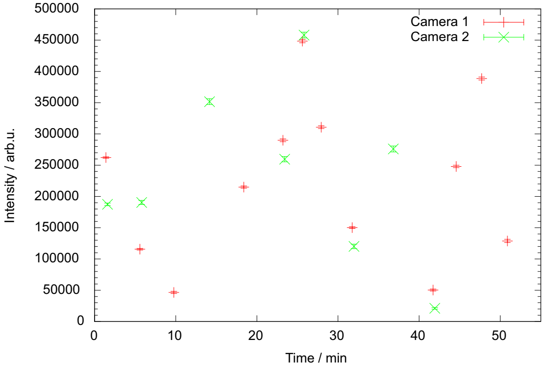
E. Köhler, PhD Thesis, WWU Münster 2015

- Same nozzle like in the final target
- Beam is stable over hours and days

Beam stability

Optical Monitoring system – final Target

- Measurement series at 17 bar & 35 K
- Beam stability and thickness can be monitored easily



- Cluster target newly set into operation

⇒ Intensity of the cluster beam not constant!

Cluster Beams
Instabilities

- Cluster beam is not stable at liquid stagnation conditions
- Gas flow decreases with time $\rightarrow$ nozzle freezing?
- Example: $10\,\mathrm{bar}$ & $24\,\mathrm{K}$
- Visible with camera system of skimmer chamber
  (Pictures recorded every $5\,\mathrm{s}$)

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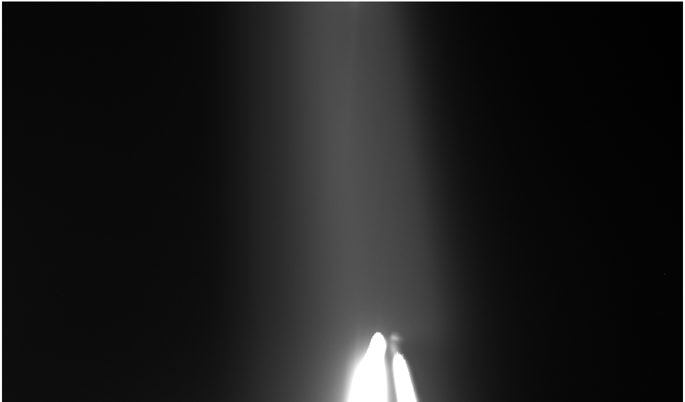

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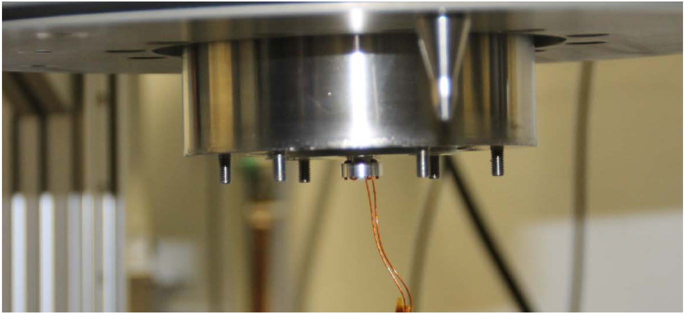
Cluster Beams
Instabilities

- Assumption: hydrogen freezes in outlet zone of nozzle

$\rightarrow$ Reduced gas flow

$\rightarrow$ Moving of core beam

- Possible solution: partial heating of nozzle outlet



- Nozzle heater: several wire loops in a aluminum holder

Next steps

- Tests with nozzle heater
- Improvement of the beam stability
- Adjustments of skimmer, collimator and spherical joint to achieve highest thicknesses
- Determination of vacuum conditions (IP, beam dump...)
- ...