Development of High Density Cluster-Jet-Targets for Storage Ring Experiments

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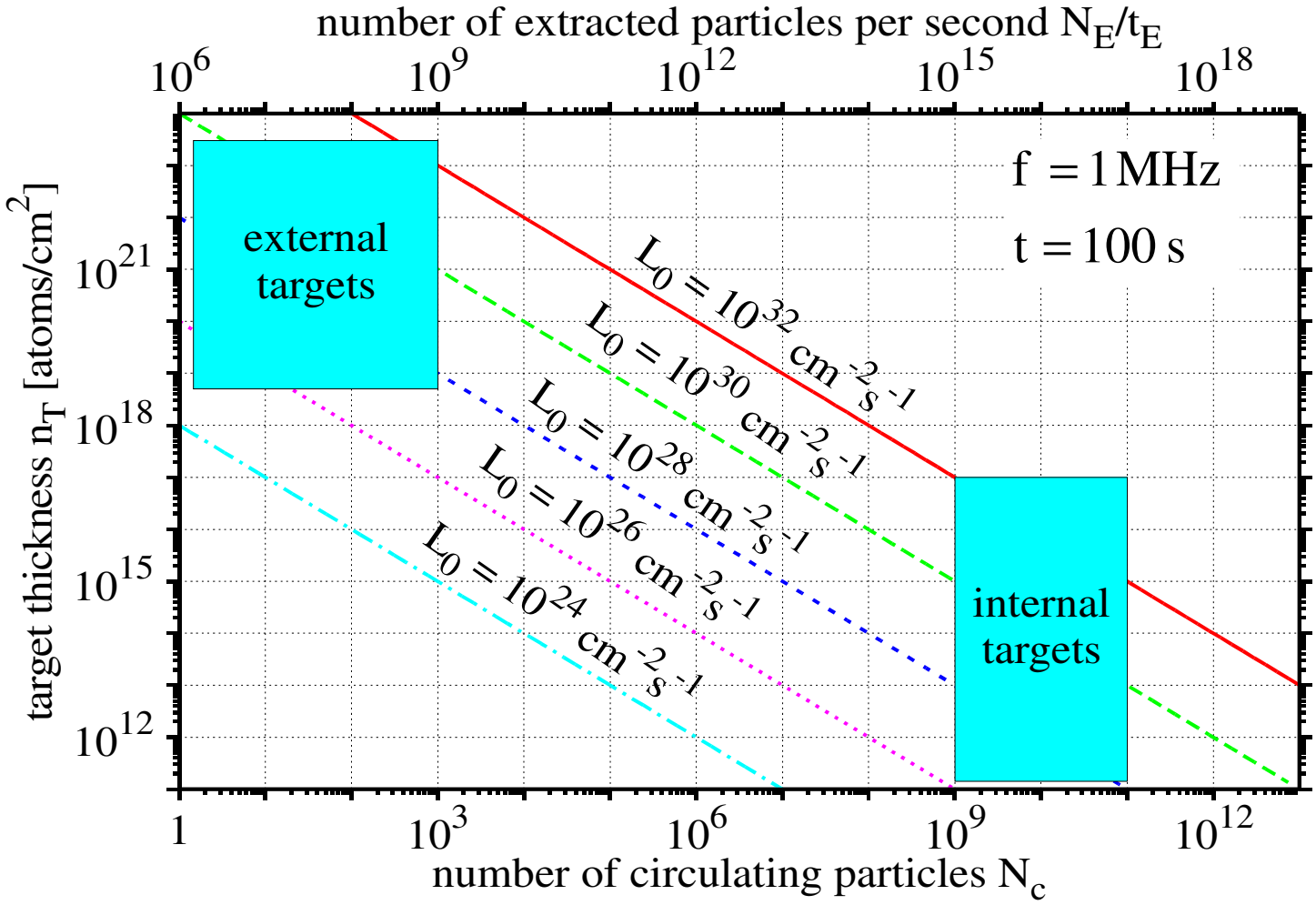
Peak luminosity of internal and external targets



$\Rightarrow$ lower target thickness = less background

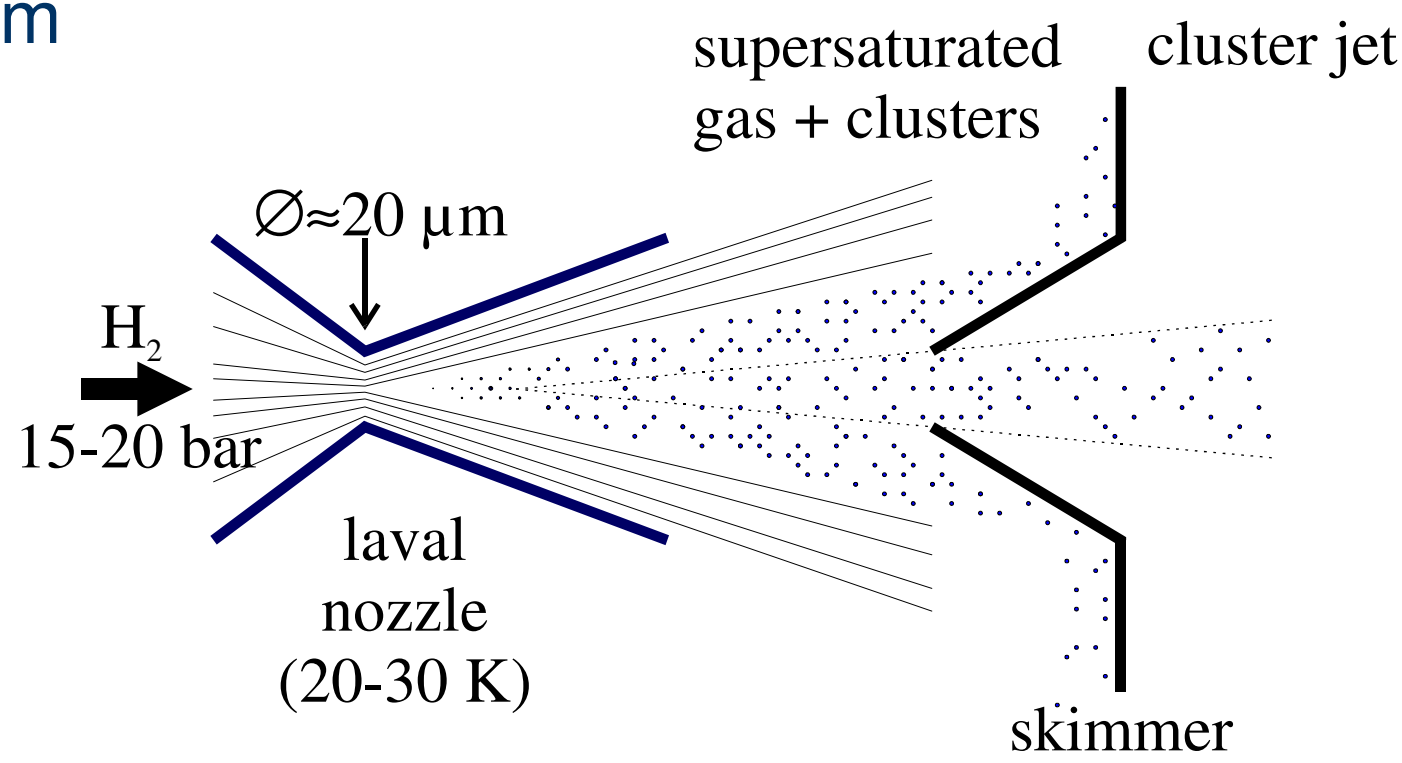
+ better momentum resolution

Requirements for internal targets

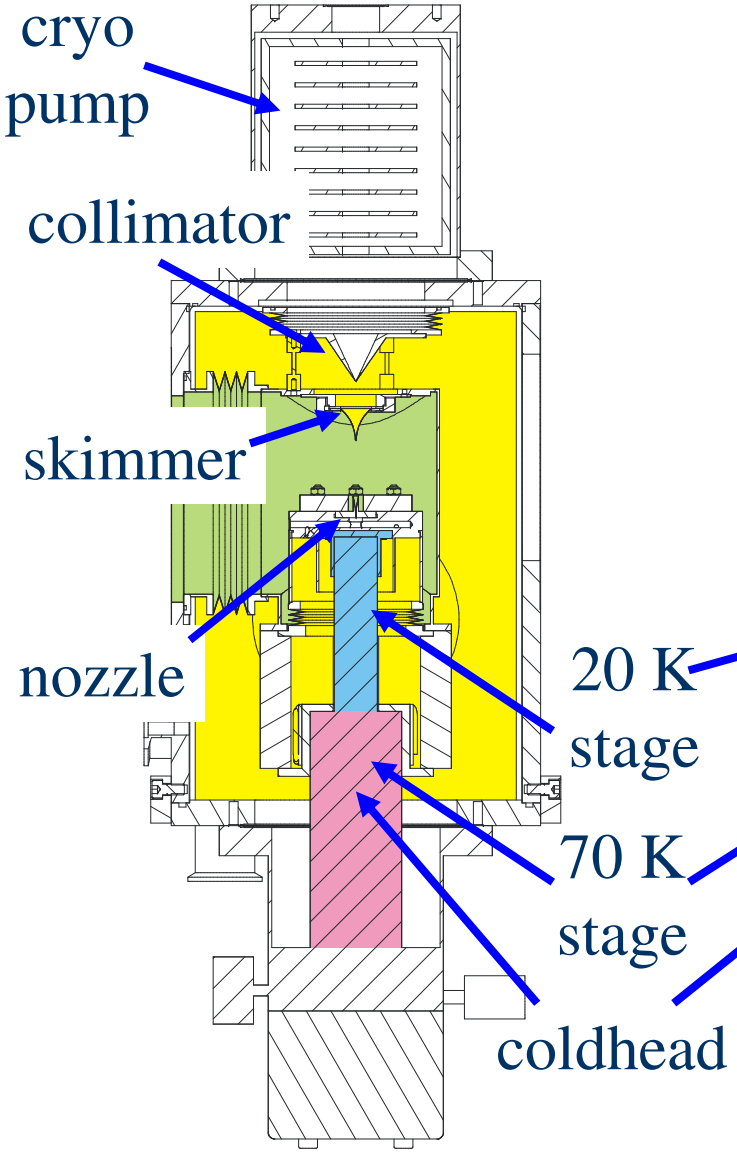
- target thickness should be
  - constant in time
  - stable (constant) spatial distribution
  - adjustable over several orders of magnitude
- high purity of target material (especially no windows)
- low influence on vacuum conditions in the accelerator
- target size and shape customisable
- possibility to switch the target on/off at any time

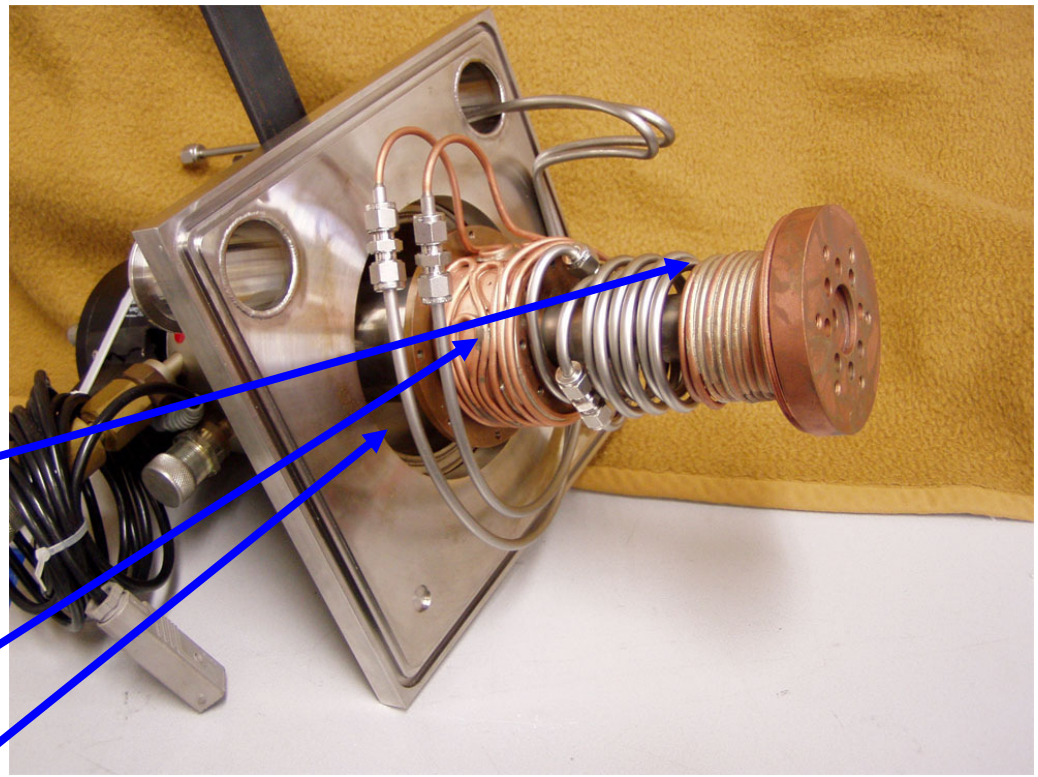
Cluster Jet Targets

- principle of operation:
  purified H_2 or D_2 gas at high pressure and low temperature passes a very thin laval nozzle
  $\Rightarrow$ formation of a cluster-jet surrounded by a gas beam



The Münster cluster-jet source





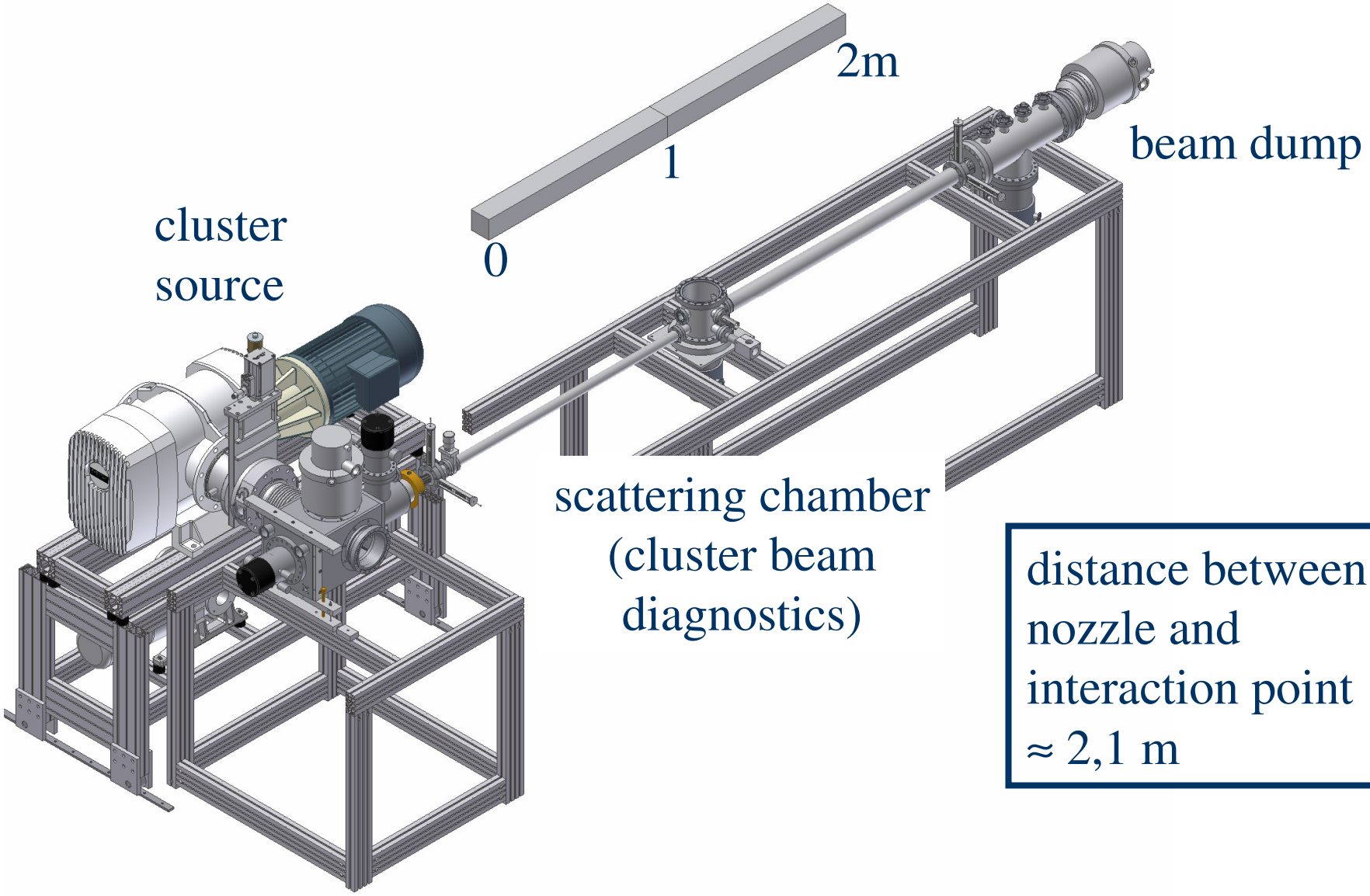
Performance of established Hydrogen Cluster Jet Targets

	CELSIUS	E835 Fermilab	ANKE COSY11
Nozzle diameter	100 µm	37 µm	11-16 µm
Gas temperature	20 – 32 K	20 – 32 K	22 – 35K
Gas pressure	1,4 bar	< 10 bar	14 – 20 bar
distance from nozzle	0,32 m	0,26 m	0,65 m
Target thickness	$1{,}3\times10^{14}$ cm^{-2}	3×10^{14} cm^{-2}	$\geq10^{14}$ cm^{-2}

Next generation experiments in hadron physics will have a **distance d** of **2 m** between nozzle and interaction point

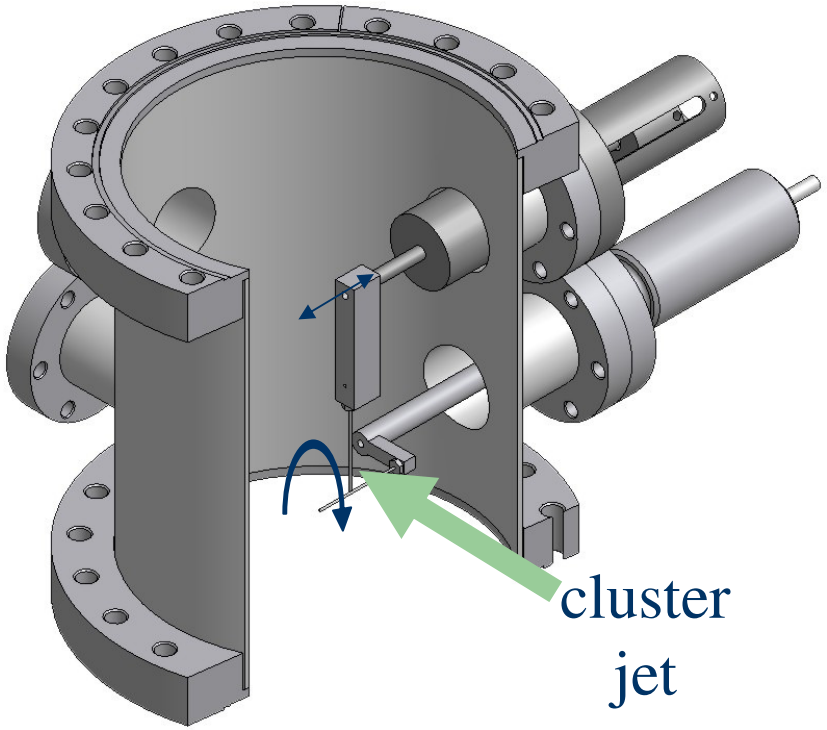
$n_T \propto d^{-2} \Rightarrow$ **target thickness** must be improved by 1-2 orders of magnitude

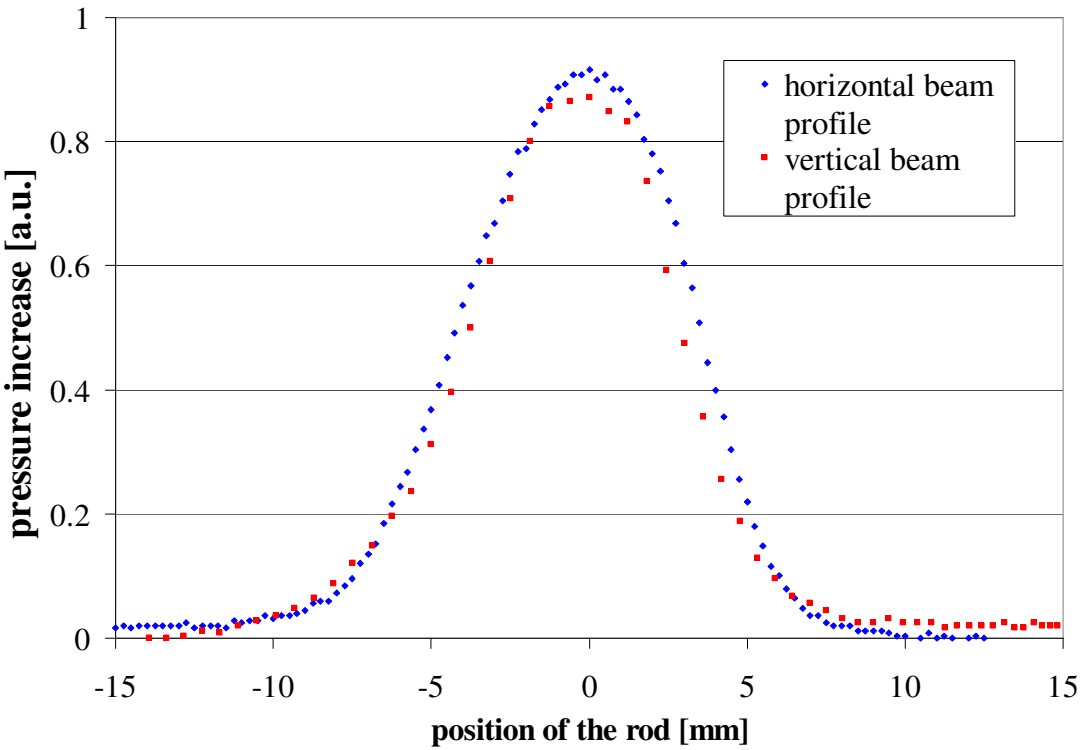
The cluster target setup in Münster



distance between nozzle and interaction point ≈ 2,1 m

Measurement of the target thickness





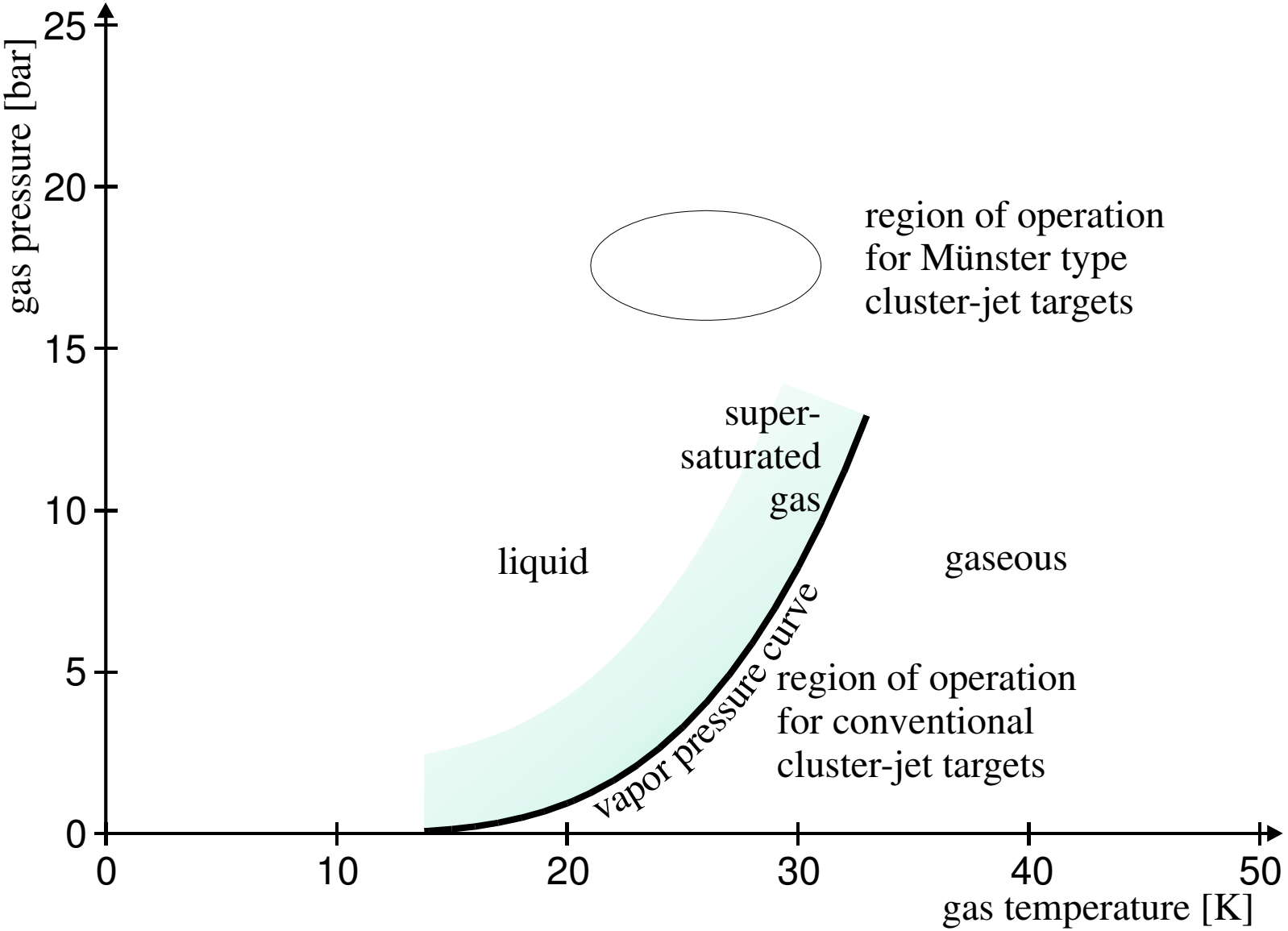
$$n_T = \frac{\Phi_{jet}}{A \cdot v_{jet}}$$

Φ_{jet} = cluster jet flow (atoms/s)

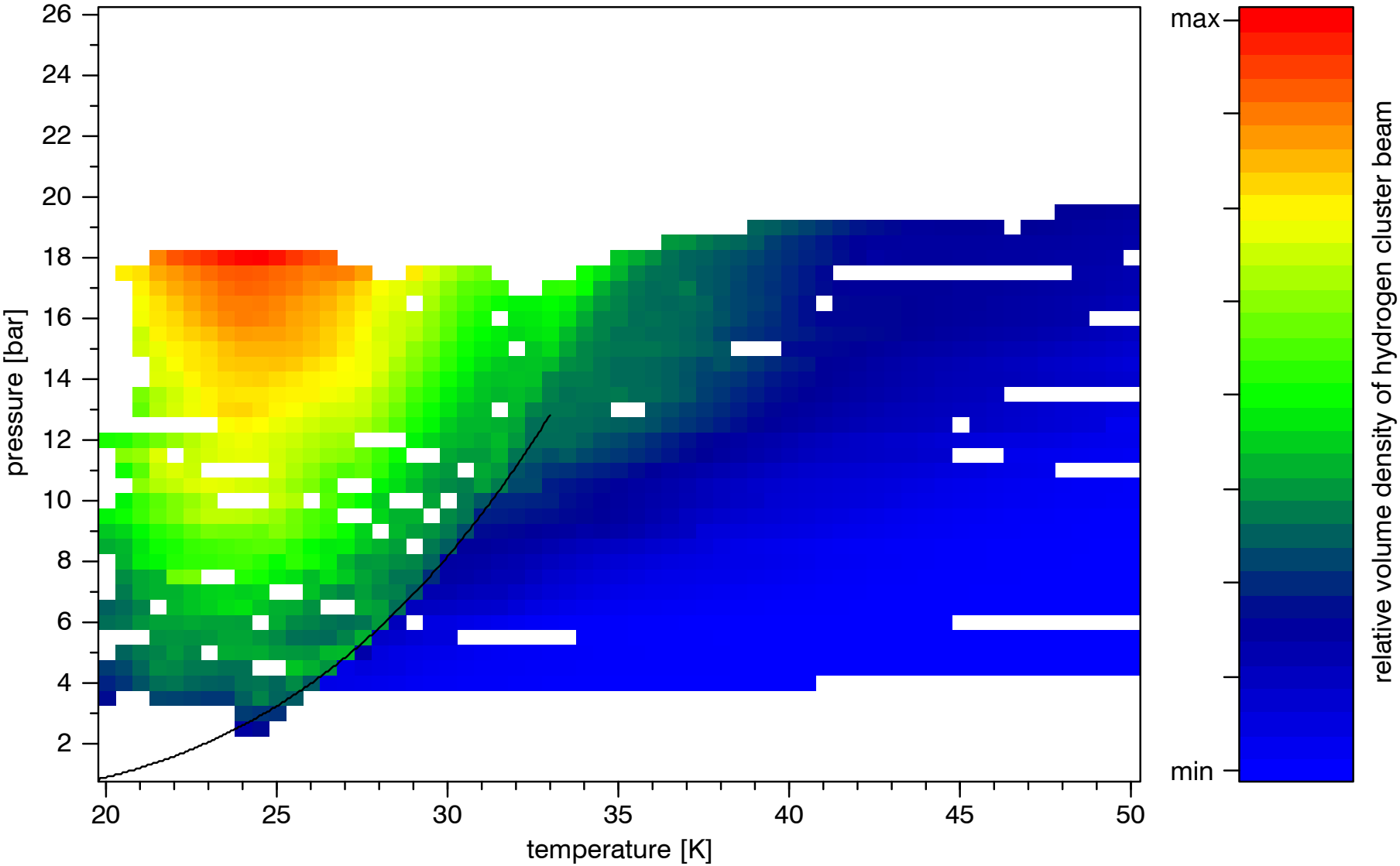
A = cluster jet cross section

v_{jet} = cluster jet velocity $\propto \sqrt{T}$

Mapping of the target thickness

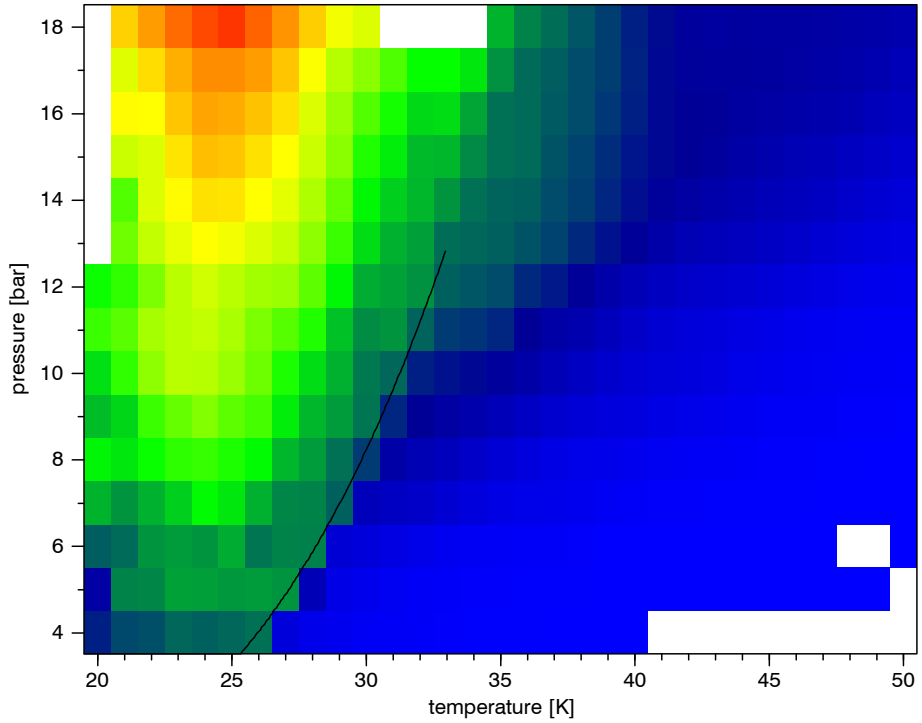


Density map of the cluster jet target in Münster

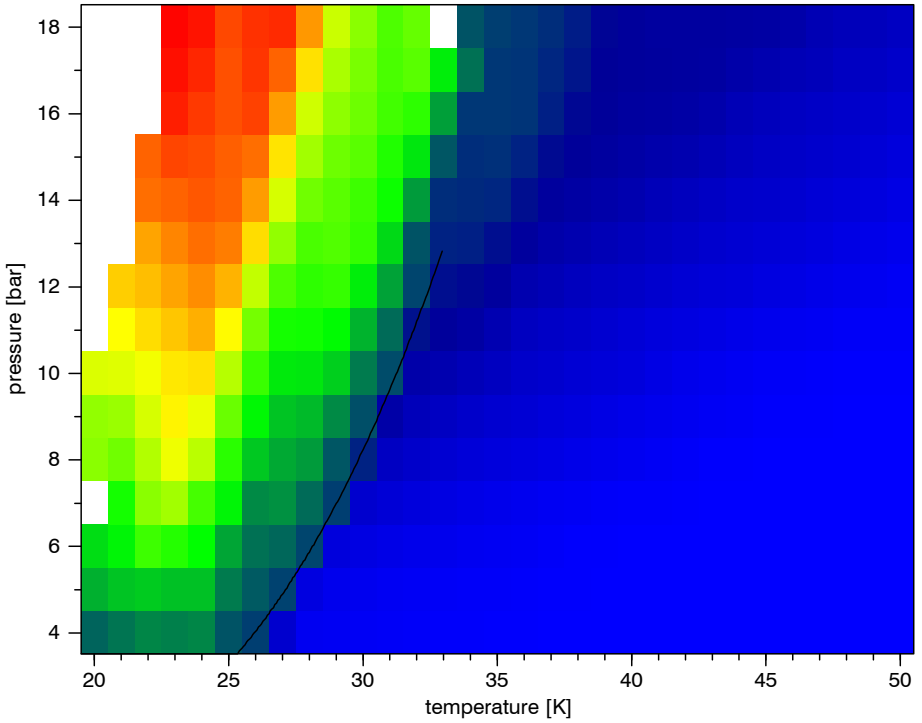


Influence of the vacuum pressure in the nozzle chamber on the target density

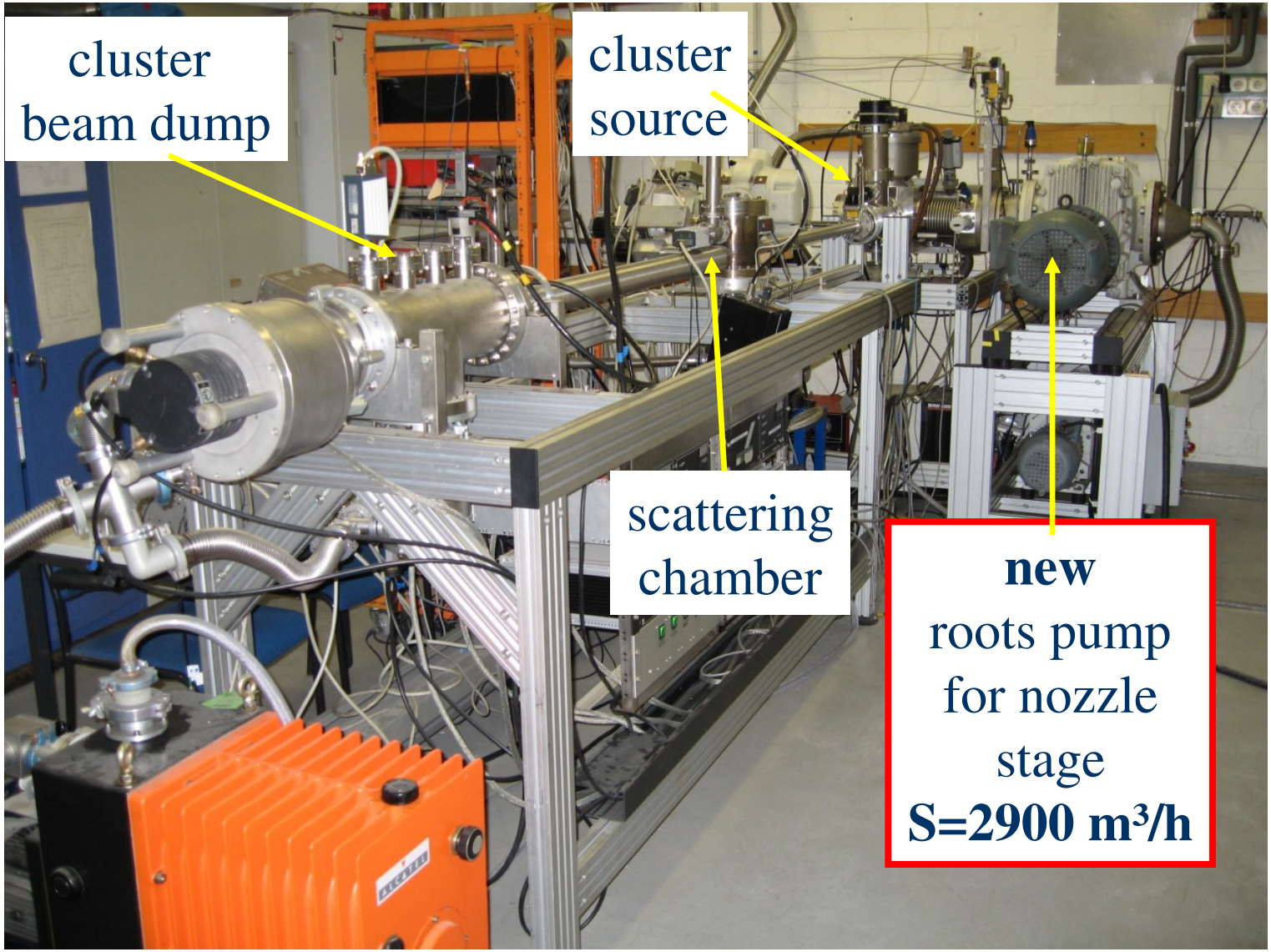
Volume density
with **low** pumping speed
in the nozzle stage



Volume density
with **high** pumping speed
in the nozzle stage



The Münster Cluster-Jet Target 2006



Achievements

	CELSIUS	E835 Fermilab	ANKE COSY11	**Münster**
Nozzle diameter	100 µm	37 µm	11-16 µm	**16-28 µm**
Gas temperature	20 – 32 K	20 – 32 K	22 – 35K	**20 – 35K**
Gas pressure	1,4 bar	< 10 bar	14 – 20 bar	**> 18 bar**
distance from nozzle	0,32 m	0,26 m	0,65 m	**2,1 m !!!**
Target thickness	$1{,}3\times10^{14}$ cm^{-2}	3×10^{14} cm^{-2}	$>>10^{14}$ cm^{-2}	**2×10^{14} cm^{-2}**

First direct observation of a hydrogen cluster jet