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

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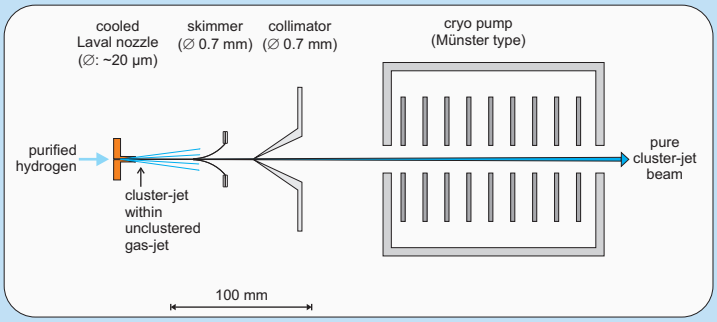
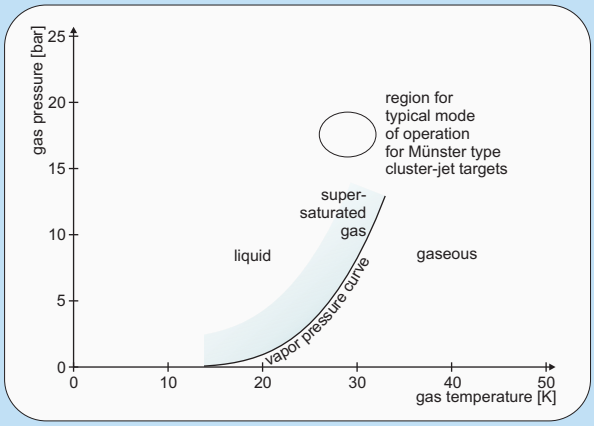
What ... ?

Cluster-Jet-Targets of Münster Type:
- internal proton or deuteron target (heavier gases also possible)
- production of cluster-jet beams:
  - using a very thin Laval nozzle (~ 20 µm diameter)
  - very pure (99.9999999 %) hydrogen gas at high pressure (15-20 bar) and low temperature (20-30 K) passes the nozzle
    ⇒ formation of a cluster-jet beam surrounded by a gas beam
  - separation of gas from the cluster-jet by collimators

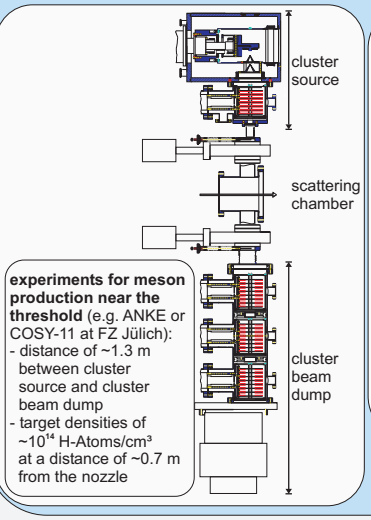
- advantages:
  - target density adjustable over several magnitudes
  - long term stability of the target density (spatial distribution and absolute values)
  - density of the target has no time structure
  - windowless target
  - no radiation damage of the target (continous gas flow)
  - negligible number of secondary reactions in the target
  - low influence on vacuum conditions in the accelerator
  - target beam can be switched on/off within seconds
  - volume density constant over beam profile



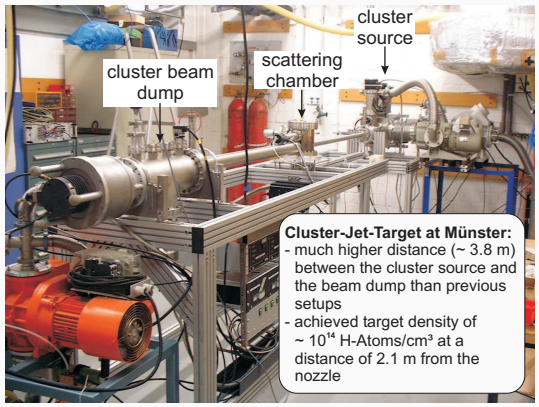


Why ... ?

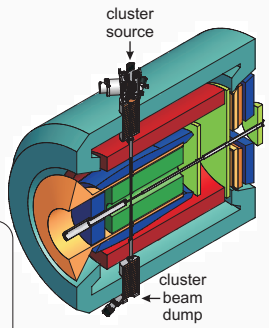
1999 — 2005 — 2012



experiments for meson production near the threshold (e.g. ANKE or COSY-11 at FZ Jülich):
- distance of ~1.3 m between cluster source and cluster beam dump
- target densities of ~10^{14} H-Atoms/cm³ at a distance of ~0.7 m from the nozzle



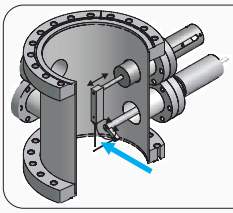
Cluster-Jet-Target at Münster:
- much higher distance (~ 3.8 m) between the cluster source and the beam dump than previous setups
- achieved target density of ~ 10^{14} H-Atoms/cm³ at a distance of 2.1 m from the nozzle



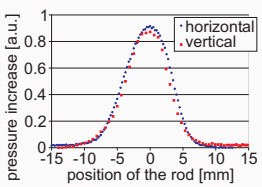
next generation experiments in hadron physics:
- distance of ~4 m between cluster source and cluster beam dump
- required target densities of ~ 10^{15} H-Atoms/cm³ at a distance of ~2 m from the nozzle

How ... ?

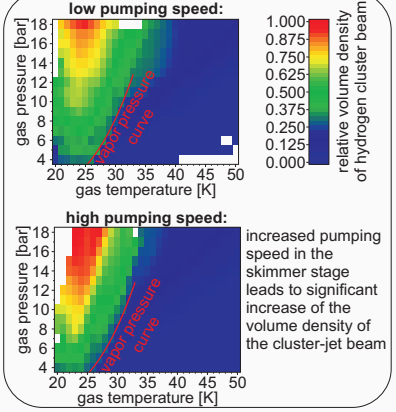
measurement of the target density distribution



detection of the areal density of the cluster-jet beam: measurement of the pressure increase caused by insertion of a rod in the cluster-jet beam

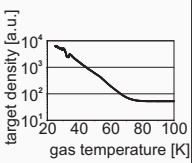


study of the influence of the vacuum in the skimmer stage on the target density



usage of Molecular Beam Skimmers to minimize skimmer interference with the cluster-jet beam

target density adjustable over several magnitudes



future plans:
- increase of the pumping speed in the skimmer and the collimator stage
- further reduction of heat losses by modifications of the vacuum system in order to achieve lower gas temperatures
- improvements of the cluster beam dump in order to minimize the backflow of gas to the scattering chamber
- new types of nozzles?
- design and test of new cryopumps