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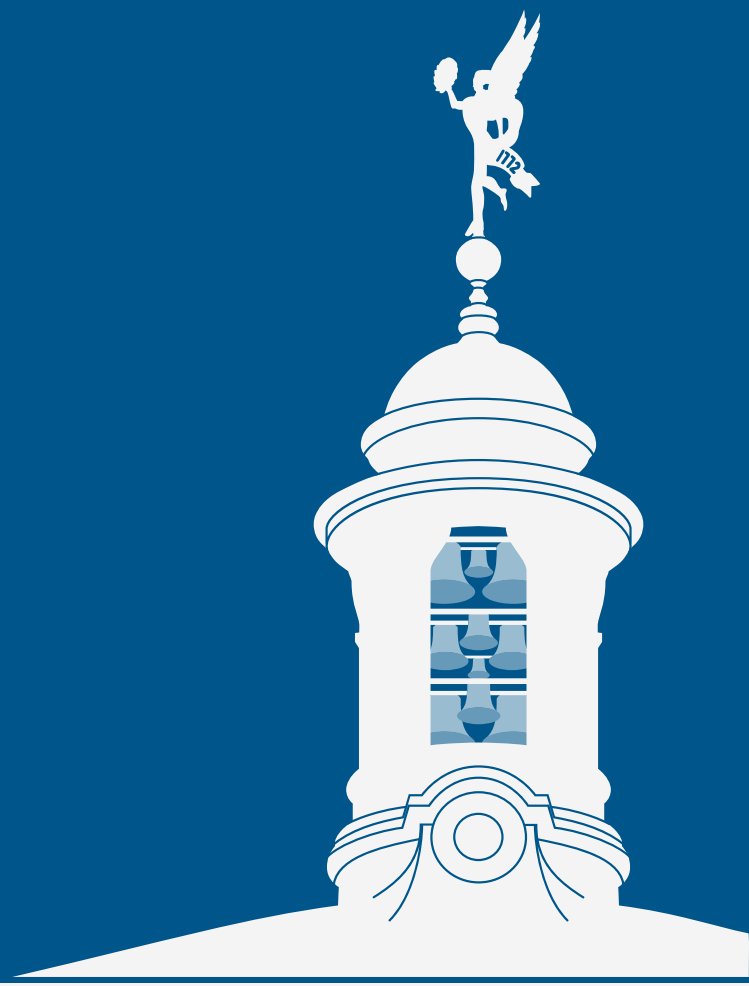
Status of the Determination and Analysis of the Cluster Size Distribution



Hanna Eick, Philipp Brand, Christian Mannweiler, Sophia Vestrick,
and Alfons Khoukaz

Institute for nuclear physics, WWU Münster, May 31, 2022

PANDA Meeting
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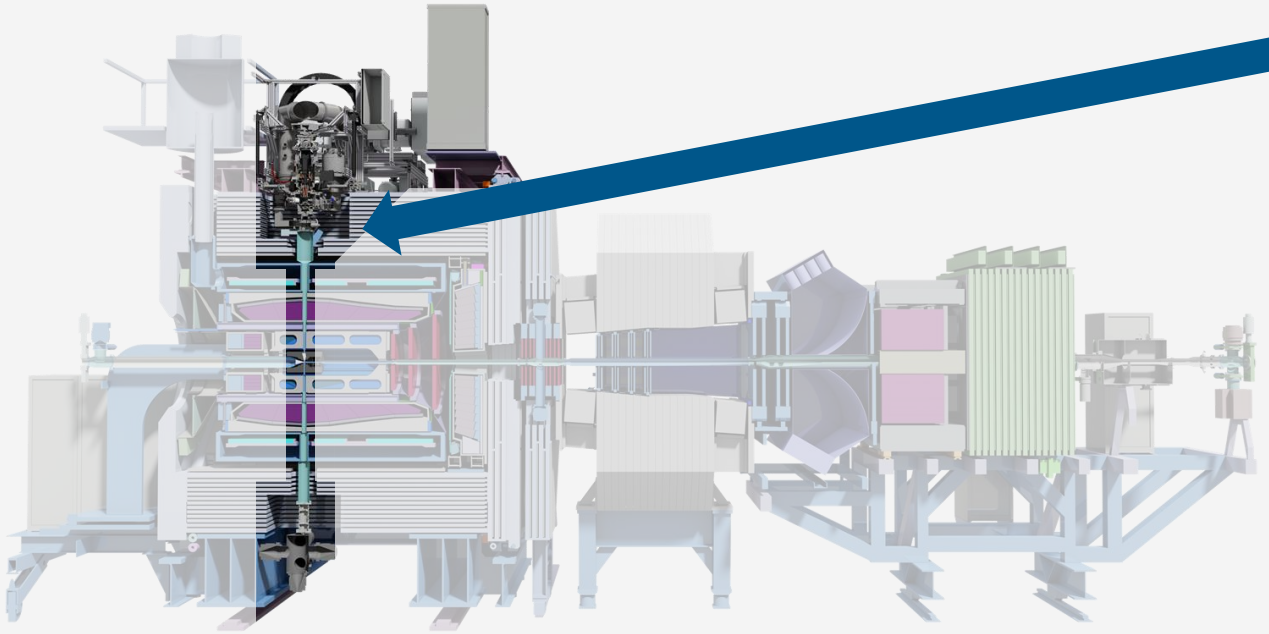
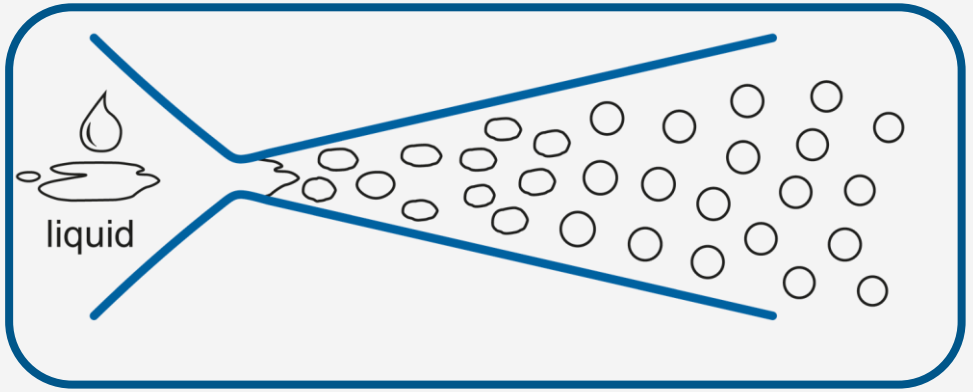
Motivation of Shadowgraphy Measurements

- It is necessary to understand the target with its properties and the cluster generation in the best possible way in order to prepare it optimally for later experiments
- Important properties of the target are the sizes of clusters and the size distribution
- Investigation of time structure of the cluster beam possible
- Important measurement to understand the residual gas at the interaction point

Cluster-Jet Target and Cluster Production



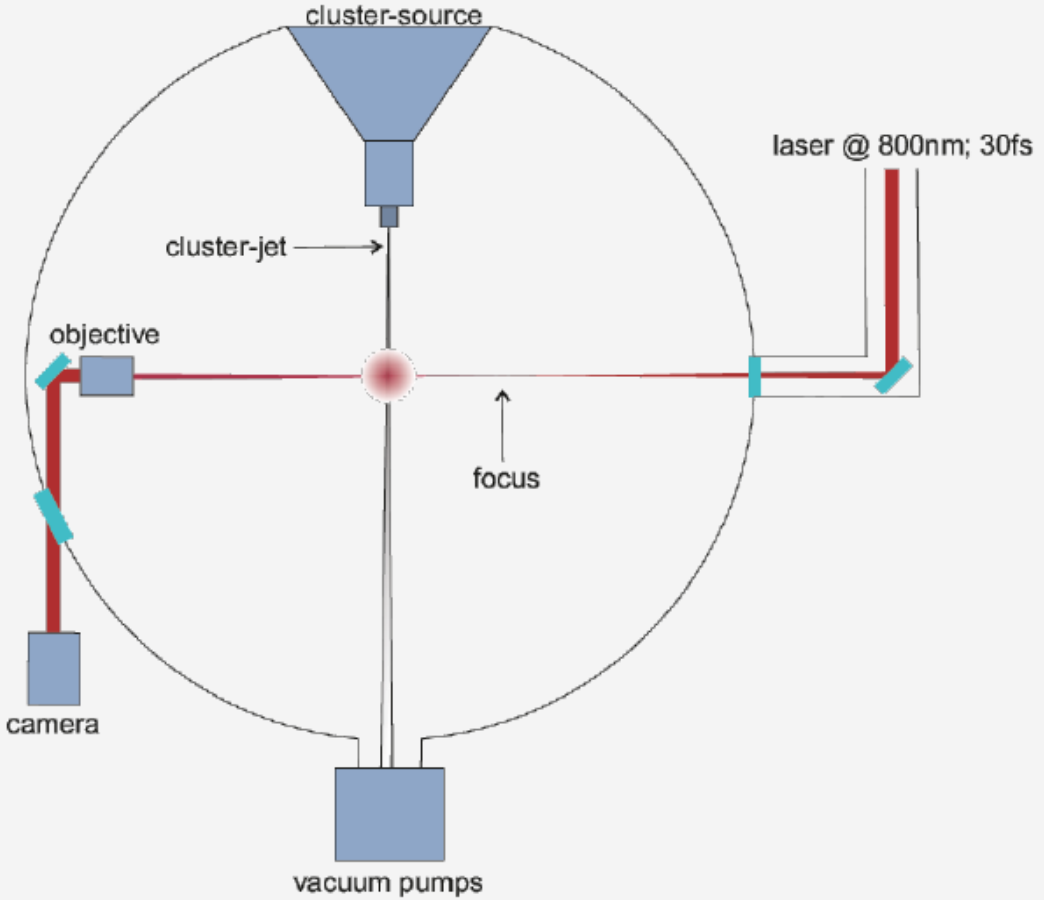
CAD drawing of the PANDA experiment at HESR



Liquid hydrogen in front of nozzle leads to cluster formation and high densities at interaction point.

Set-up for Shadowgraphy Measurements

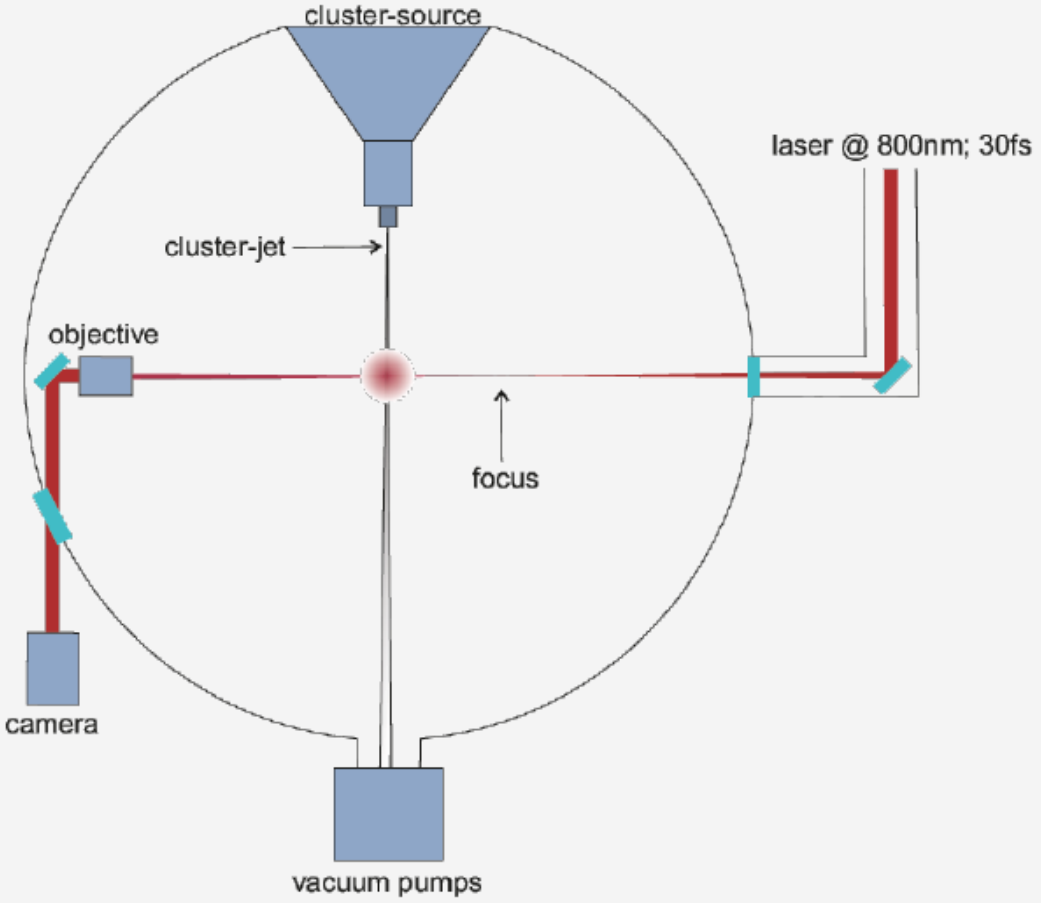
- Top view of experimental set-up
- Cluster-Jet Target, developed and built up in Münster (simplified version of the PANDA target)
- Can be operated at different settings → different densities/cluster sizes



Created by Christian Mannweiler

Set-up for Shadowgraphy Measurements

- ARCTURUS laser system of HHU Düsseldorf
- Ultrashort-pulse laser (30 fs) is used as background lightening
- Pictures of clusters are taken with camera in combination with microscope objective
- With longer exposure time clusters at about (200 - 1000) m/s would no longer be recognizable as dots



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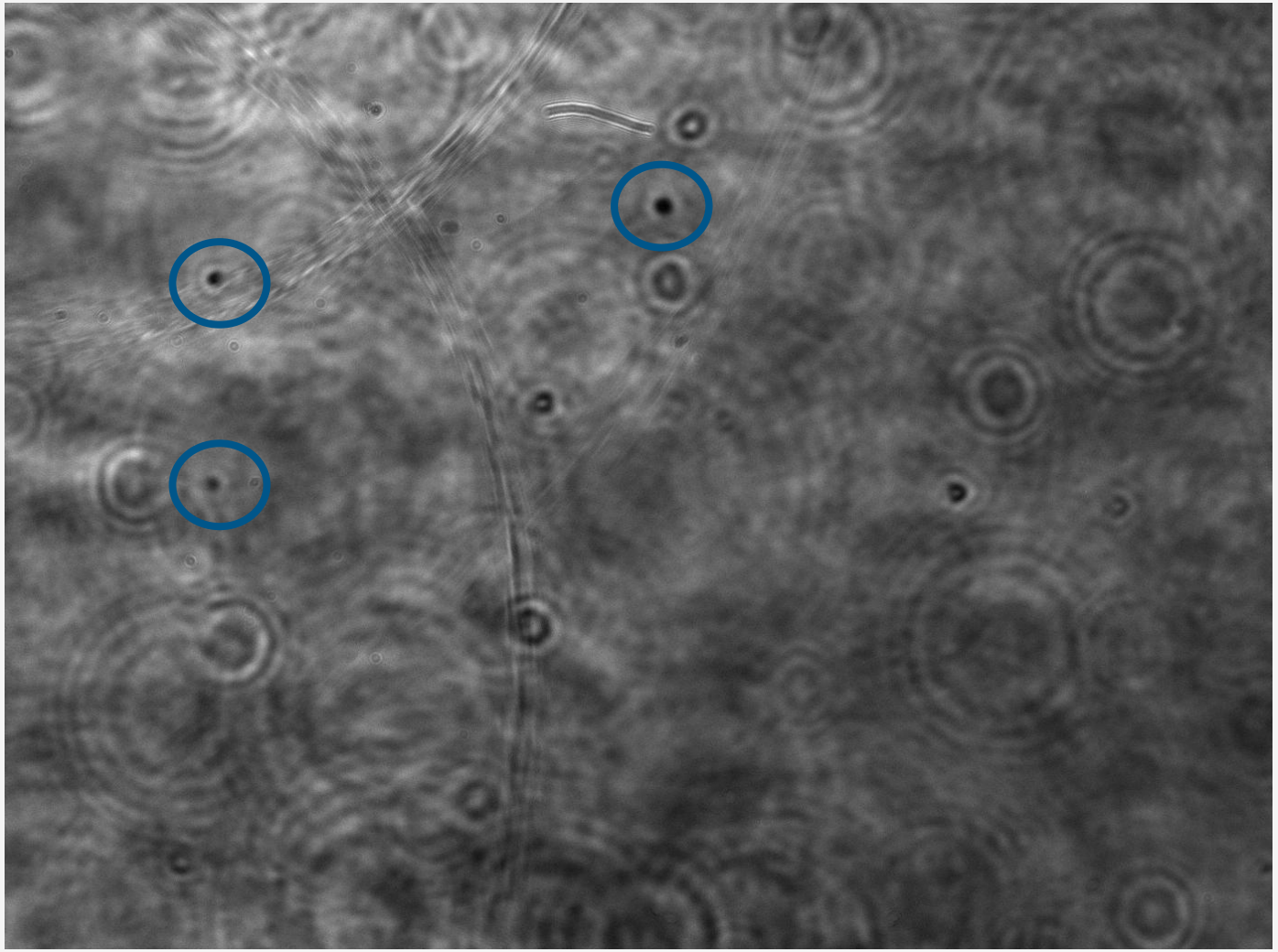
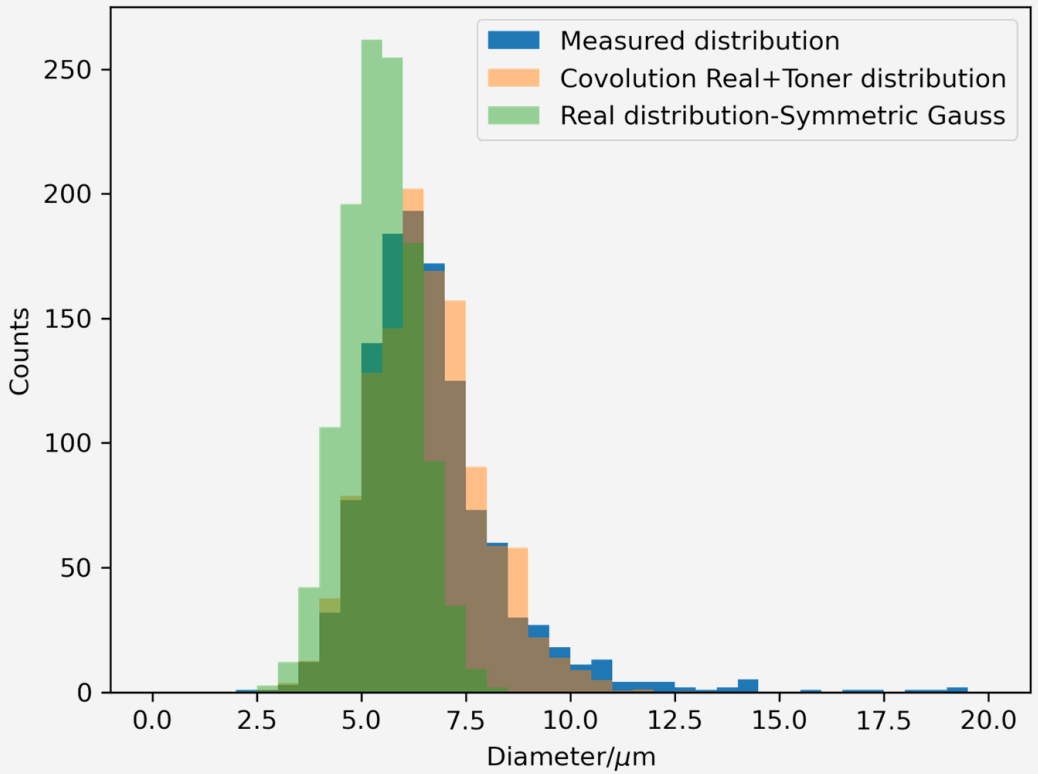
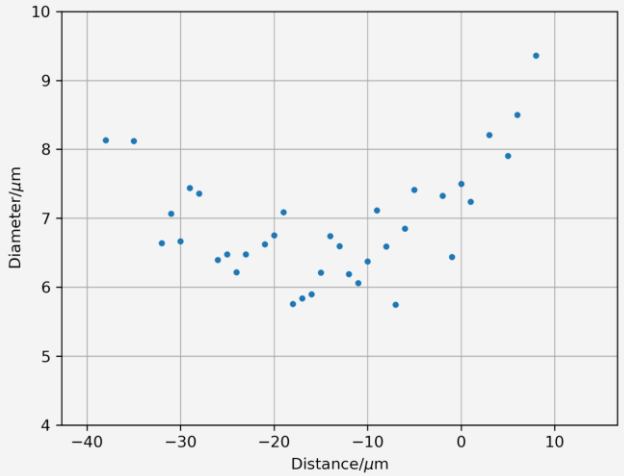
Shadowgraphy Image (background subtracted) with some sharp clusters

Clusters are found, selected and fitted with a two-dimensional function that includes the diameter.



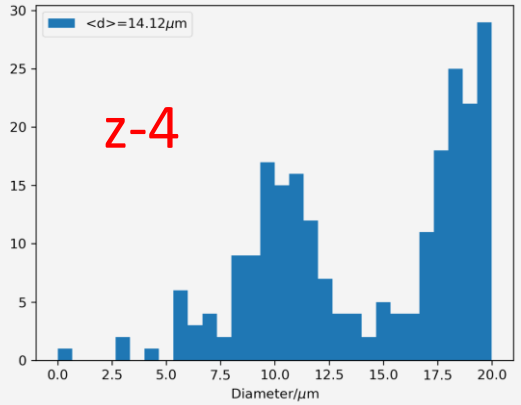
Cluster Size Distribution for 28K, 16bar

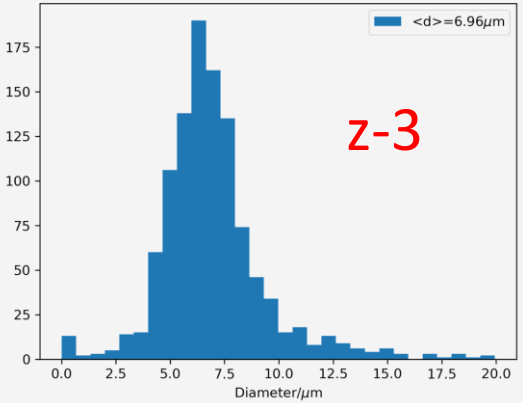


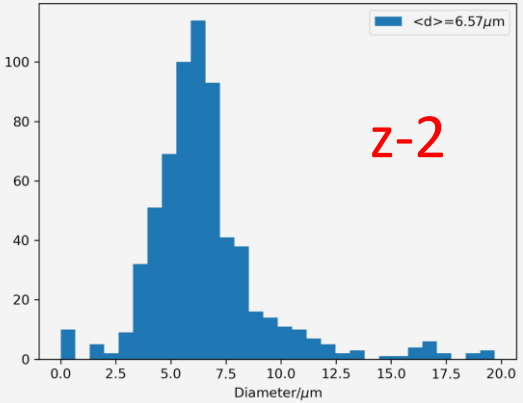


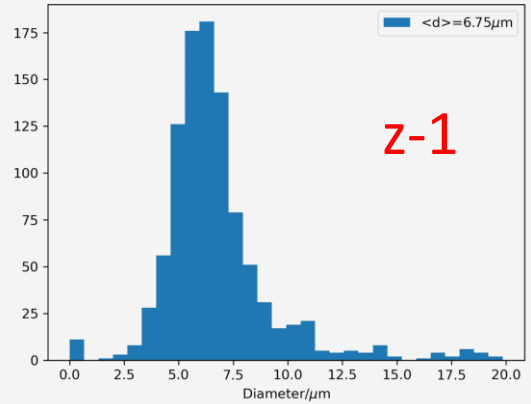
- Blue distribution: Measured and calculated cluster sizes
- But not all the cluster, that are analyzed, are exactly in focal plane → Look larger than they really are
- Deconvolution (assumption of gaussian function) shown in green

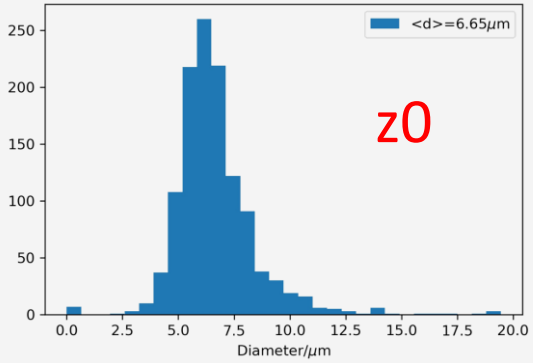
Z-scan through cluster beam

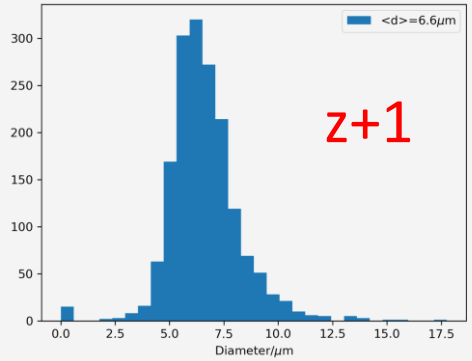


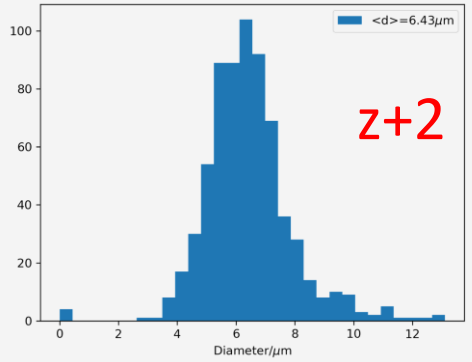


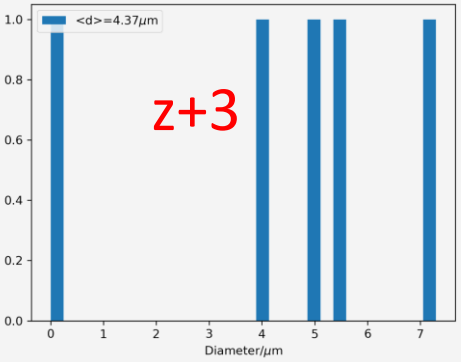






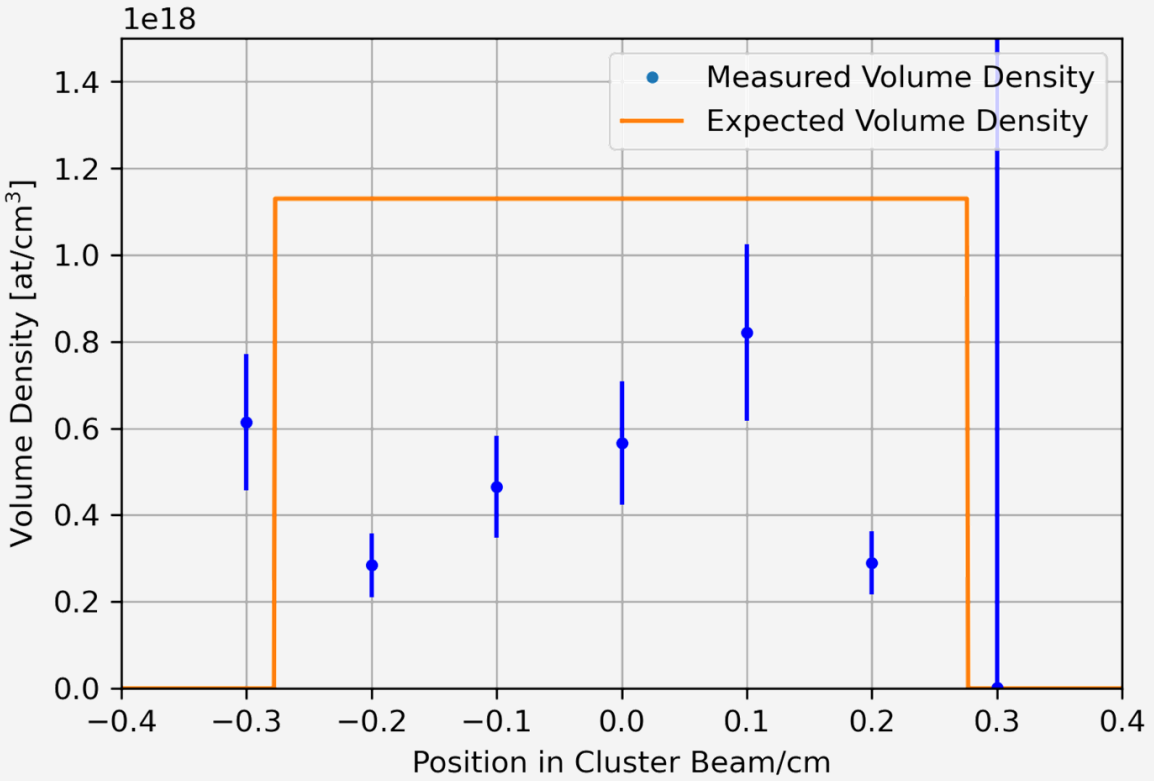






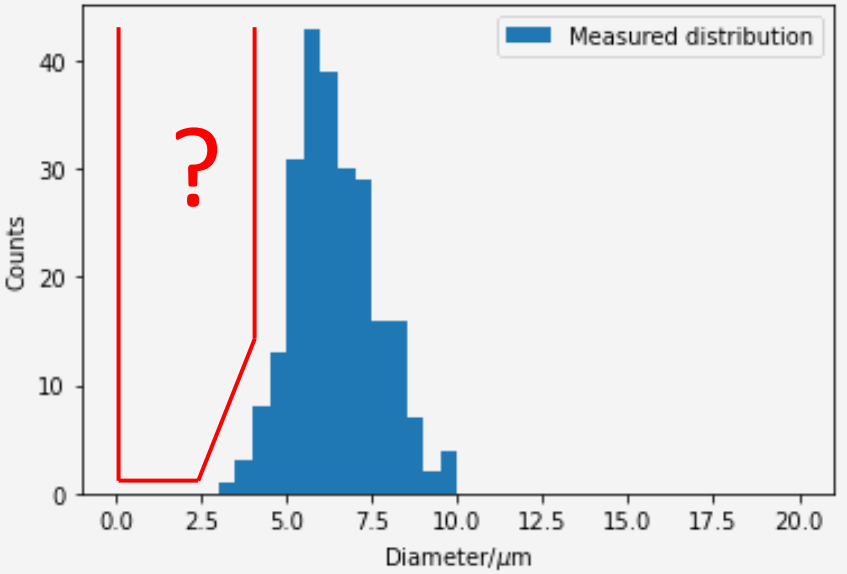
Volume Density Distribution

- Calculated volume density for every position in the cluster beam (blue)
- Not all the density comes from the big clusters → also smaller clusters have impact
- Structure can be seen in profile of cluster beam (→ core beams)



Outlook

- It is very likely that there are also smaller clusters, but they cannot be found with shadowgraphy method (at the mentioned conditions)
- Methods to find the distribution of smaller clusters will be tested in the future (3-WEM measurements)



Summary

- Shadowgraphy measurements were performed at the ARCTURUS laser system in Düsseldorf (similar conditions as later in PANDA experiment) to estimate the cluster size distribution of a Münster Cluster-Jet Target
- A routine was developed to find, select and analyze the clusters, which can be seen as dark spots on the shadowgraphy images
- Preliminary cluster size distribution was calculated and the information of the Toner measurements is used to find out the ‘real‘ distribution with a maximum of approximatly 10 µm