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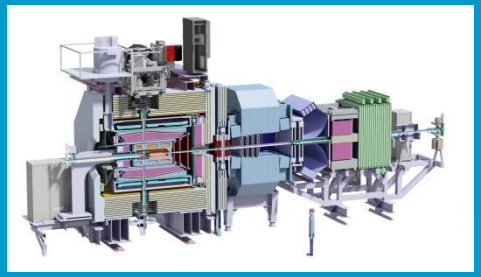

Status Report: Targets for PANDA

PANDA LV. Collaboration Meeting
Vienna, Nov. 30th – Dec. 4th, 2015

wissen.leben
WWU Münster

Alfons Khoukaz

Institut für Kernphysik

Contents

- Status of the Cluster Jet Target

  A. Khoukaz, WWU Münster

- Status of the Pellet Target

  A. Gerasimov, ITEP Moscow

- Status of the Pellet Tracking System

  H. Calén, Uppsala University

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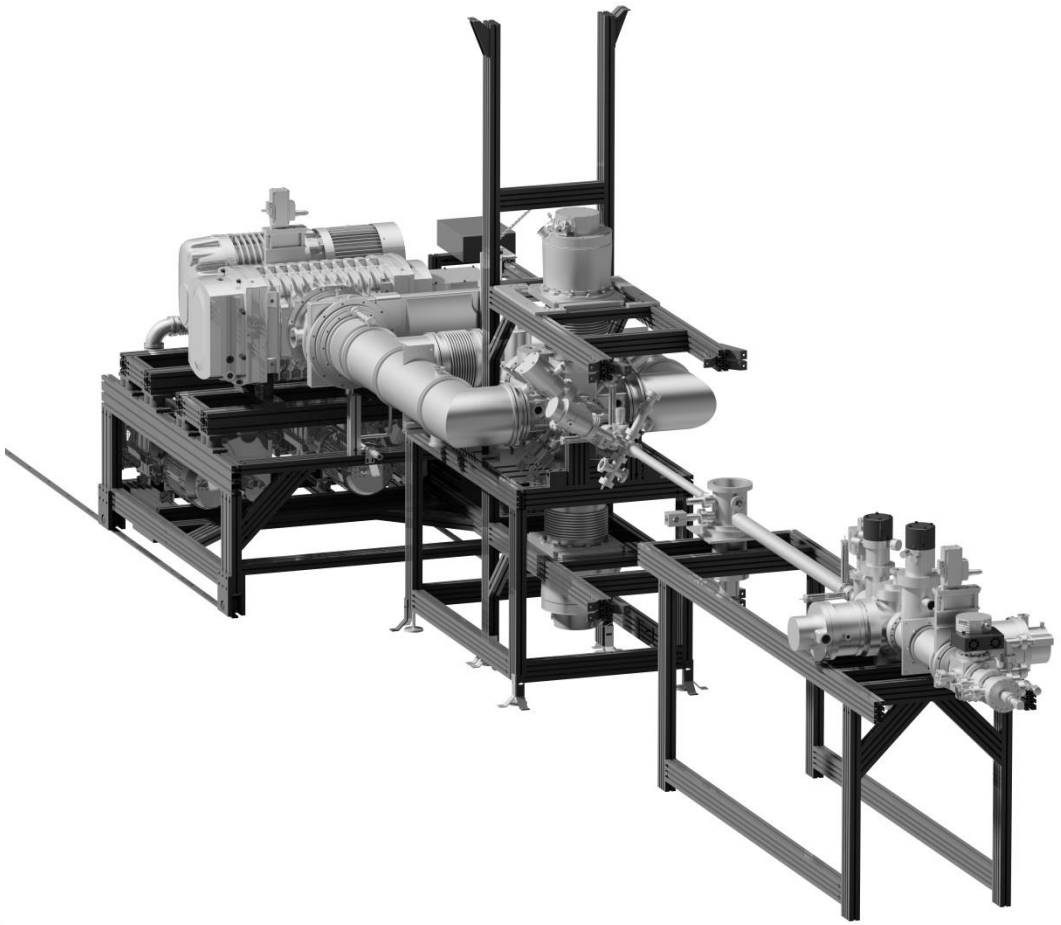
Status of the Cluster Jet Target

(A. Khoukaz, WWU Münster)

Prototype Target in PANDA Geometry

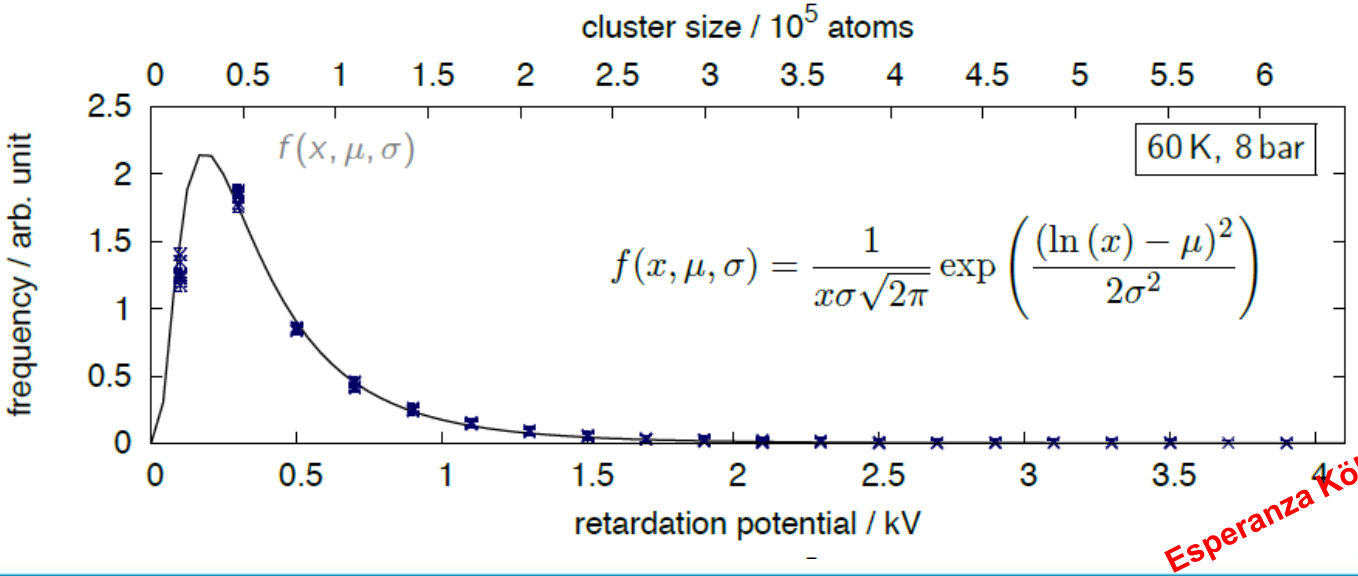
- Stable operation of the PANDA prototype target since years
- Routinely achieved thickness at (PANDA) interaction point:

$\rho_{H2} = 2 \times 10^{15}$ atoms/cm^2



Recent Results on Cluster Beams

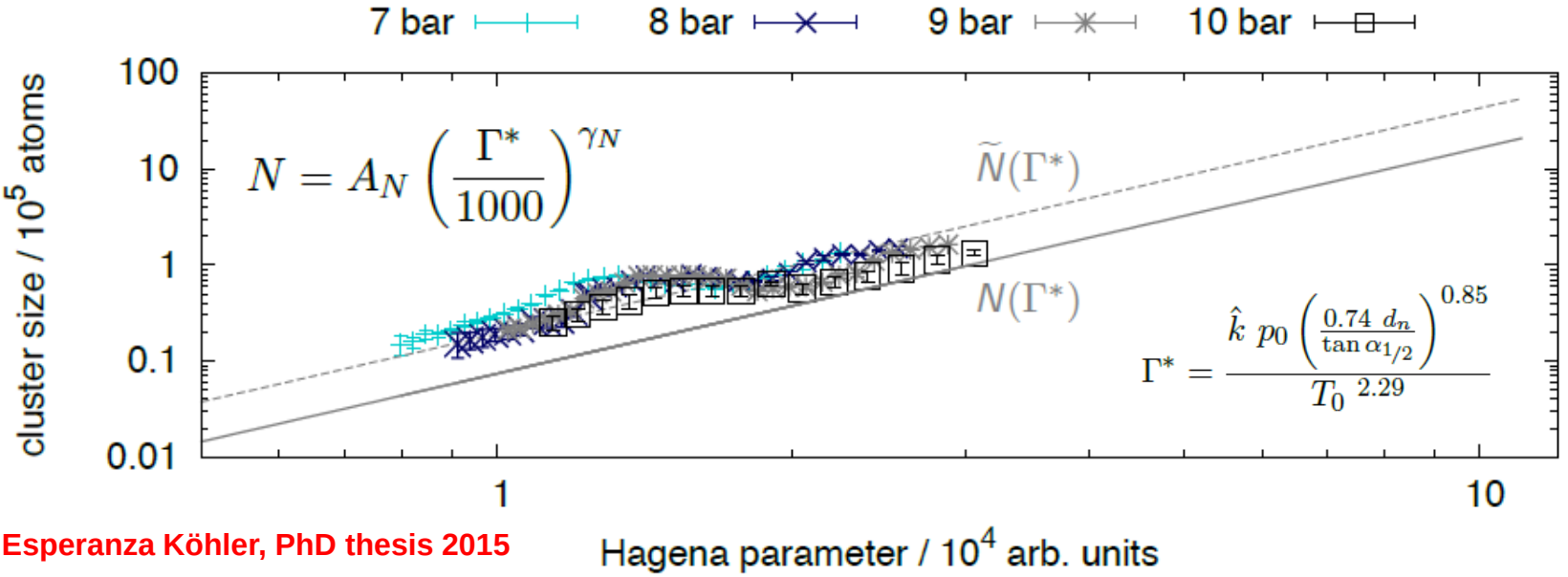
- Studies on cluster mass distributions (here: hydrogen in gaseous phase before entering the nozzle)
- Cluster beam mass distribution can be described well by log-normal distribution



Esperanza Köhler, PhD thesis 2015

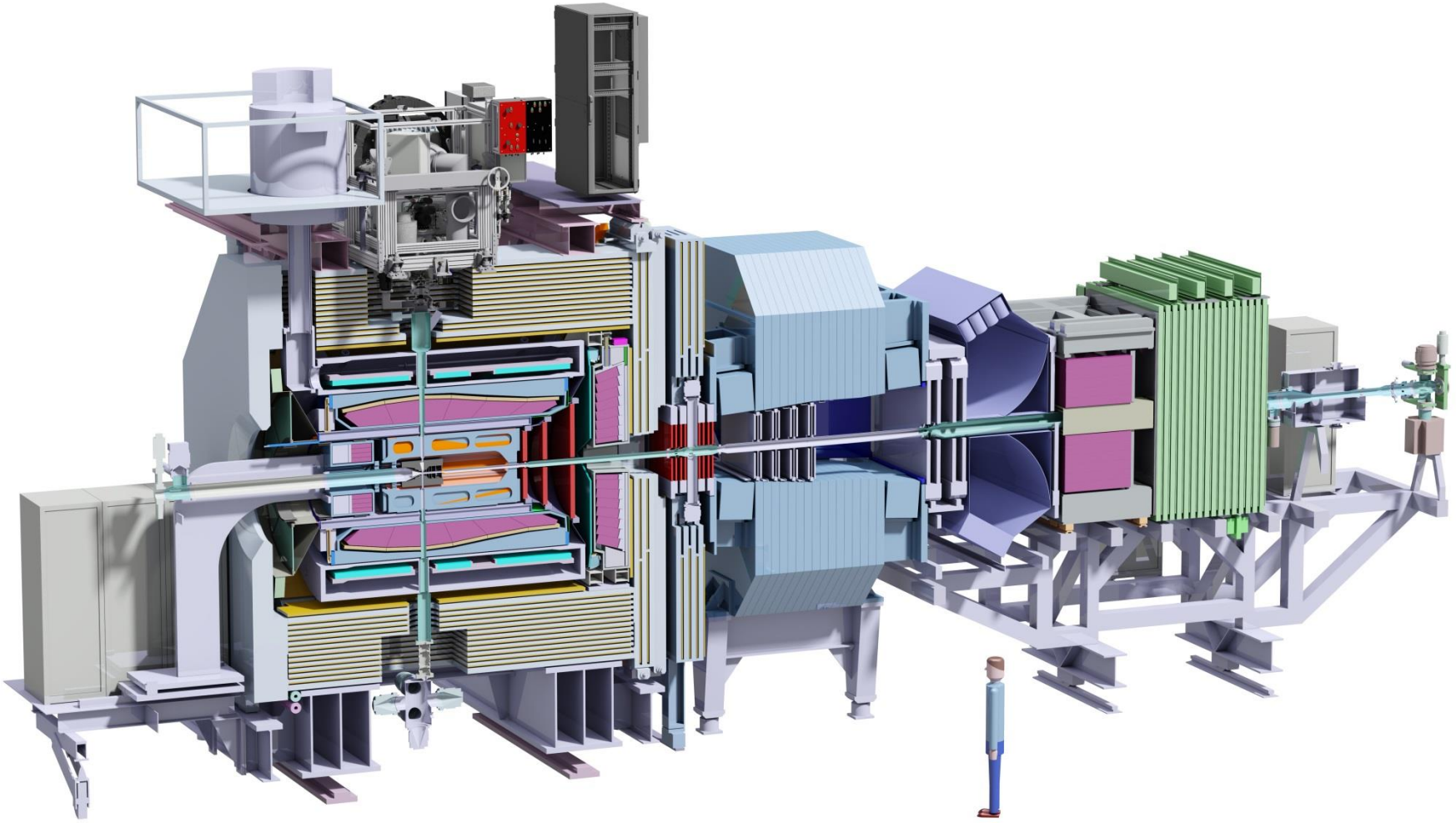
Recent Results on Cluster Beams

- Cluster masses as function of stagnation conditions (p_0, T_0) and nozzle diameter (d_n) can be described well by Hagena law: Important for PANDA (event rate, DAQ, dead time, ...)

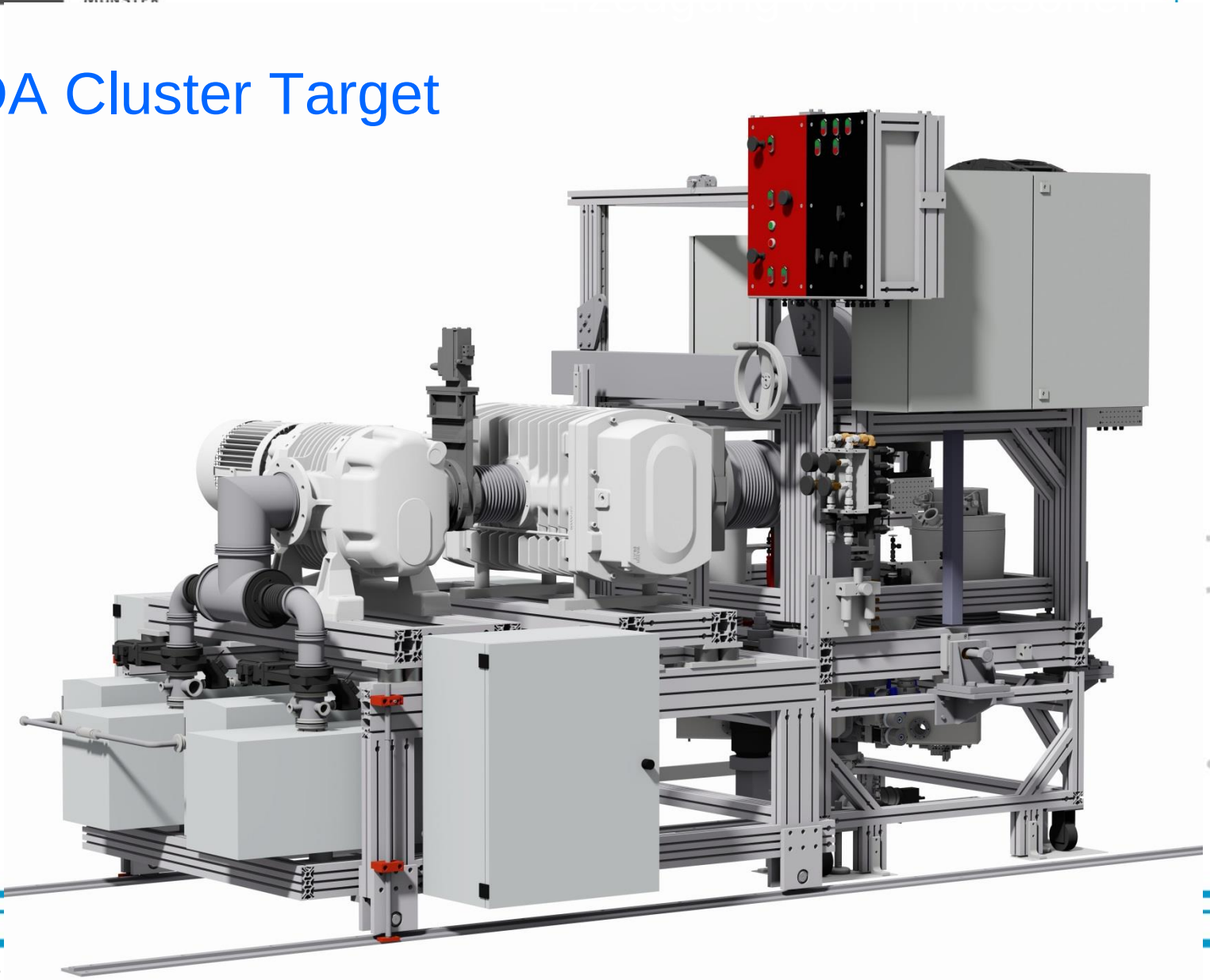


Esperanza Köhler, PhD thesis 2015

Planned PANDA Setup with Cluster Target



PANDA Cluster Target



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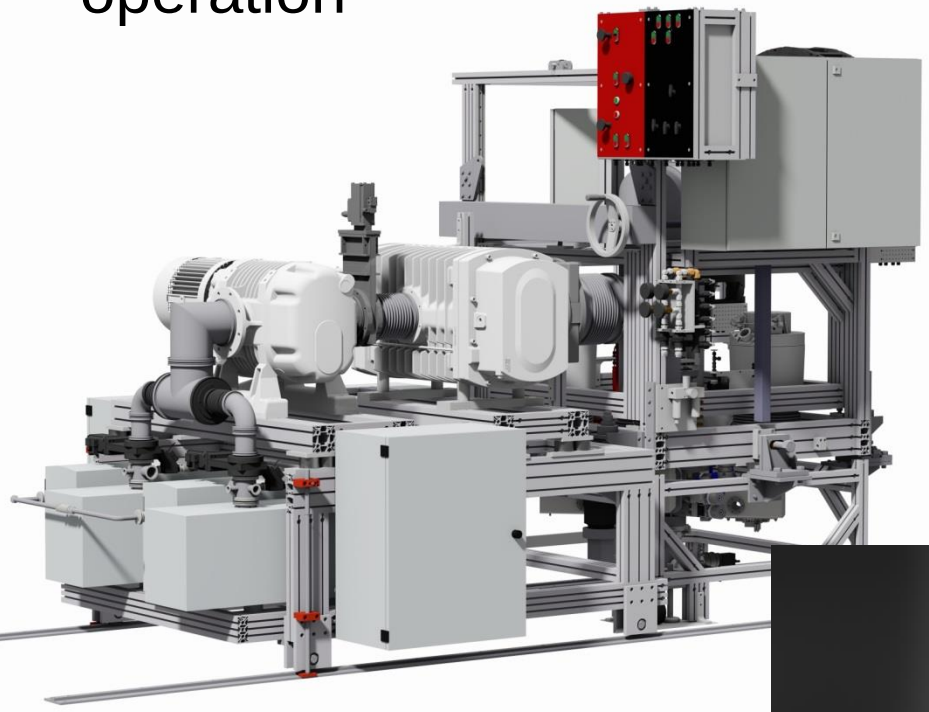
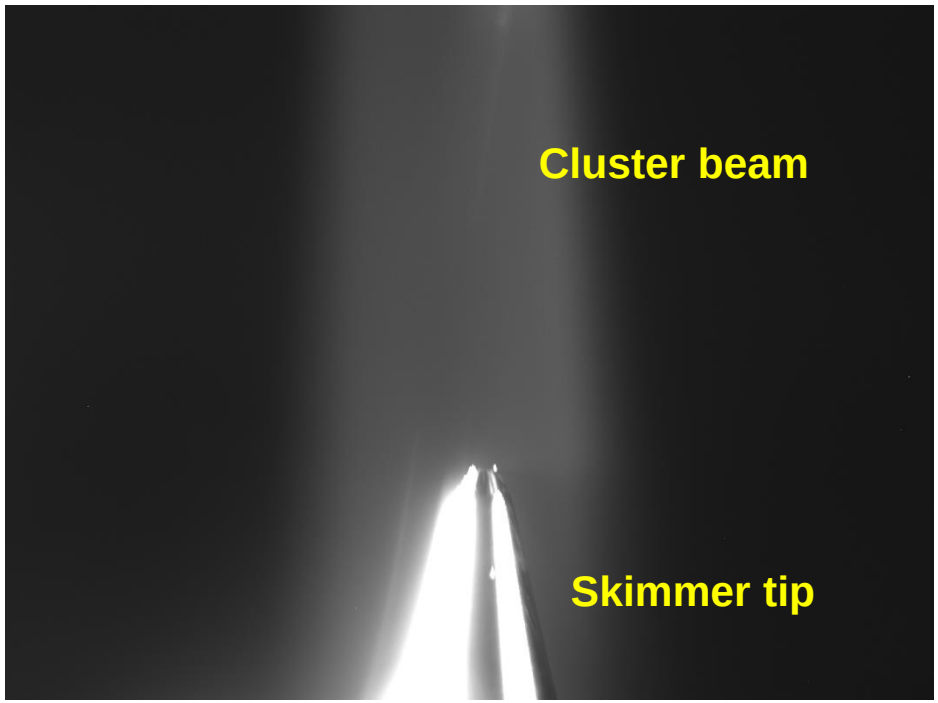
PANDA Cluster Target

PANDA cluster target + pumping system now fully in operation

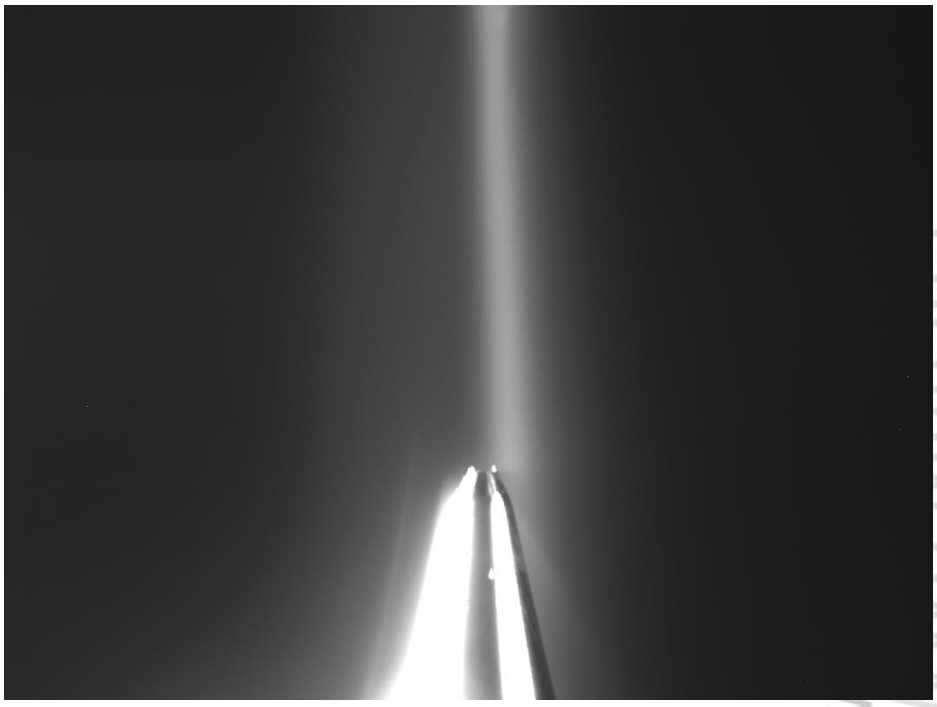


First Cluster Beams (03.12.2015!)

T = 22 K, p = 16 bar



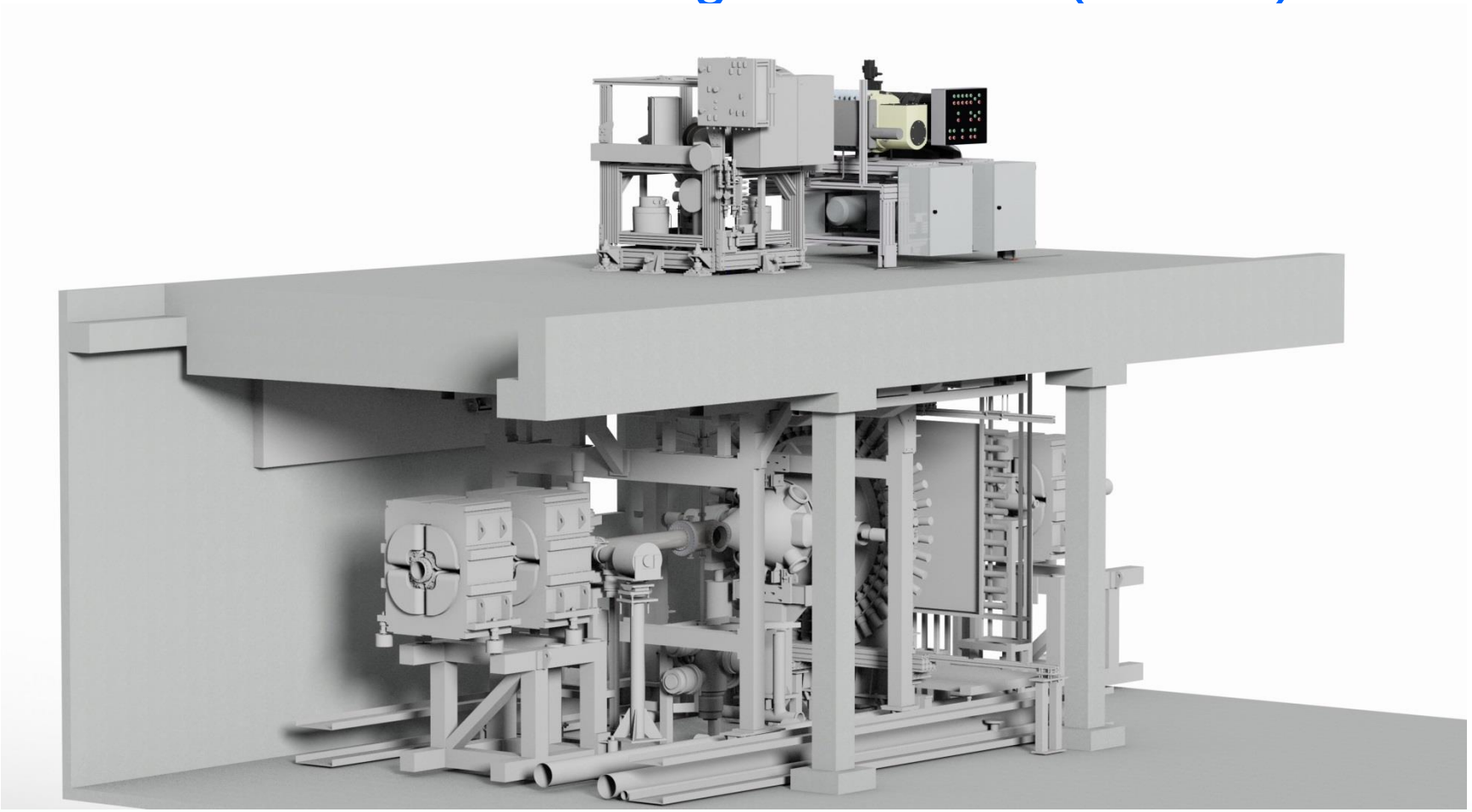
T = 22 K, p = 17 bar



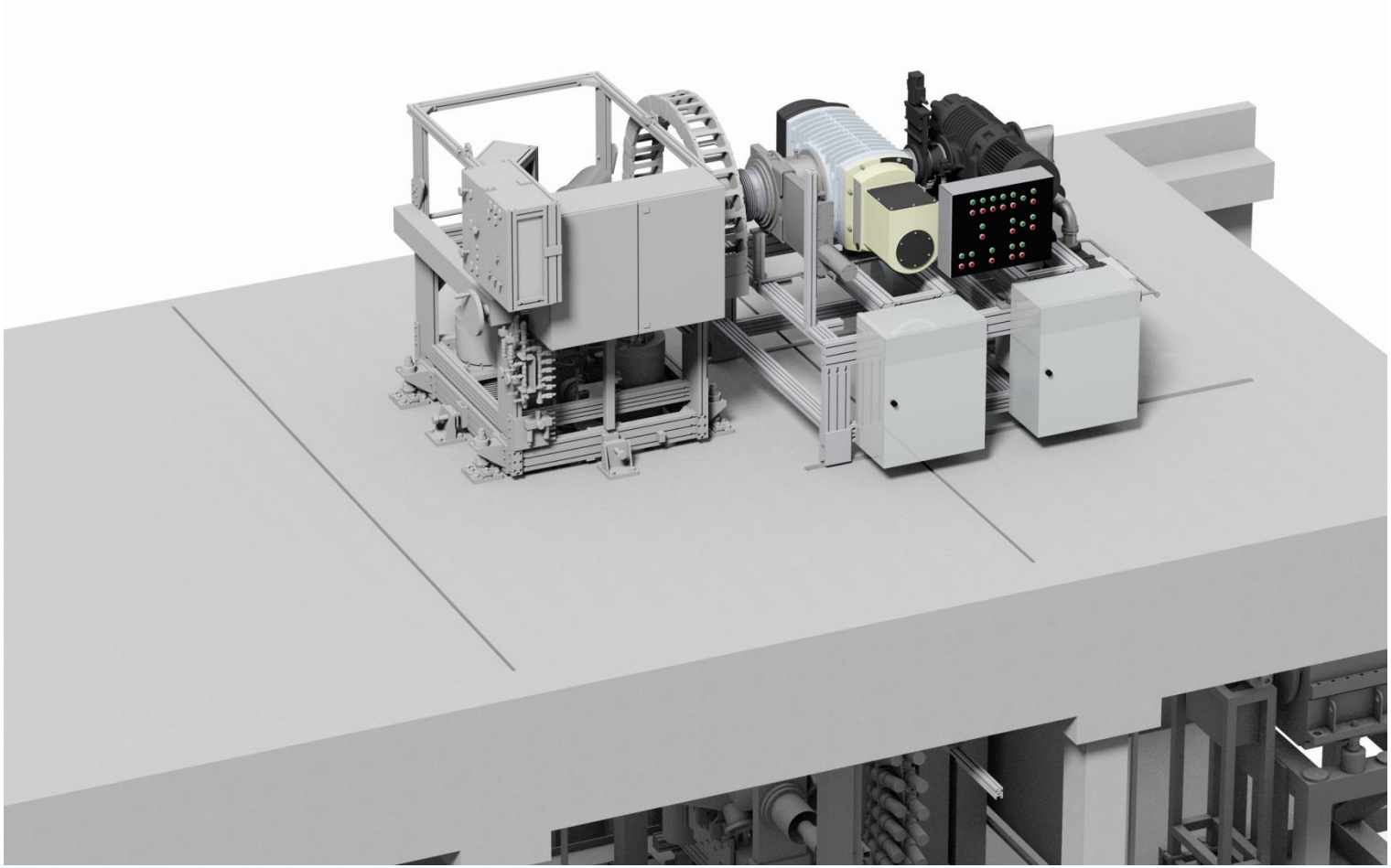
Next Steps

- Systematic tests and optimization studies at Münster
  - Highest target thicknesses
  - Long term measurements
- Transport of the Genua beam dump from GSI to Münster
  - Full operation of the target
  - Vacuum situation at the scattering chamber (see: scrutiny report)
- Studies on cluster size distribution at high thicknesses
- Installation at COSY/Jülich
  - Realistic vacuum tests (see: scrutiny report)
  - Beam-target interaction studies
  - Time structure in DAQ, physical background, beam cooling, …

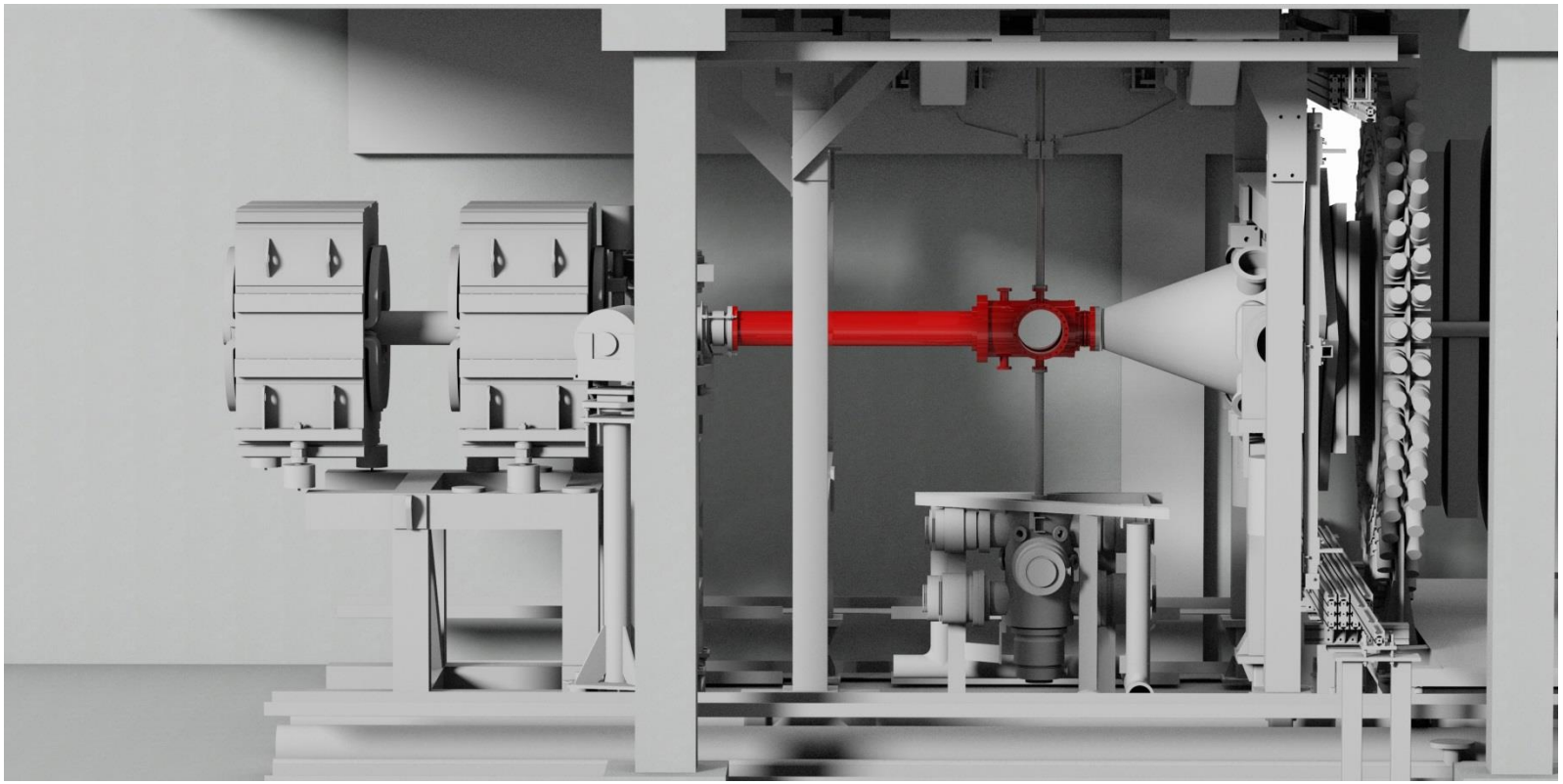
PANDA Cluster-Jet Target at COSY (WASA)



PANDA Cluster-Jet Target at COSY (WASA)



Modification of Beam Pipe and Scattering Chamber



Next Steps

- Production of cluster from heavier gases
- Development of diagnostic tools for target thickness and luminosity check (see: scrutiny report)
- Measurement of cluster mass distribution for lowest nozzle temperatures, i.e. highest target thicknesses

Status of Subsystems

- Cluster beam source + beam dump
  - Basic version ready for first test operation
  - Adaption of the beam dump vacuum system required
  - Open funding decision from German BMBF introduces delays:
    - Cluster scanner and luminosity monitor system for the beam dump missing (R&D and construction time!)
    - Adaption of the beam dump open
    - Several electronic control units for the pumping systems missing
    - Nozzle production line stopped
- Slow control system
  - Construction/programming work will be started as soon as FAIR money will be available (Warsaw/Poland)

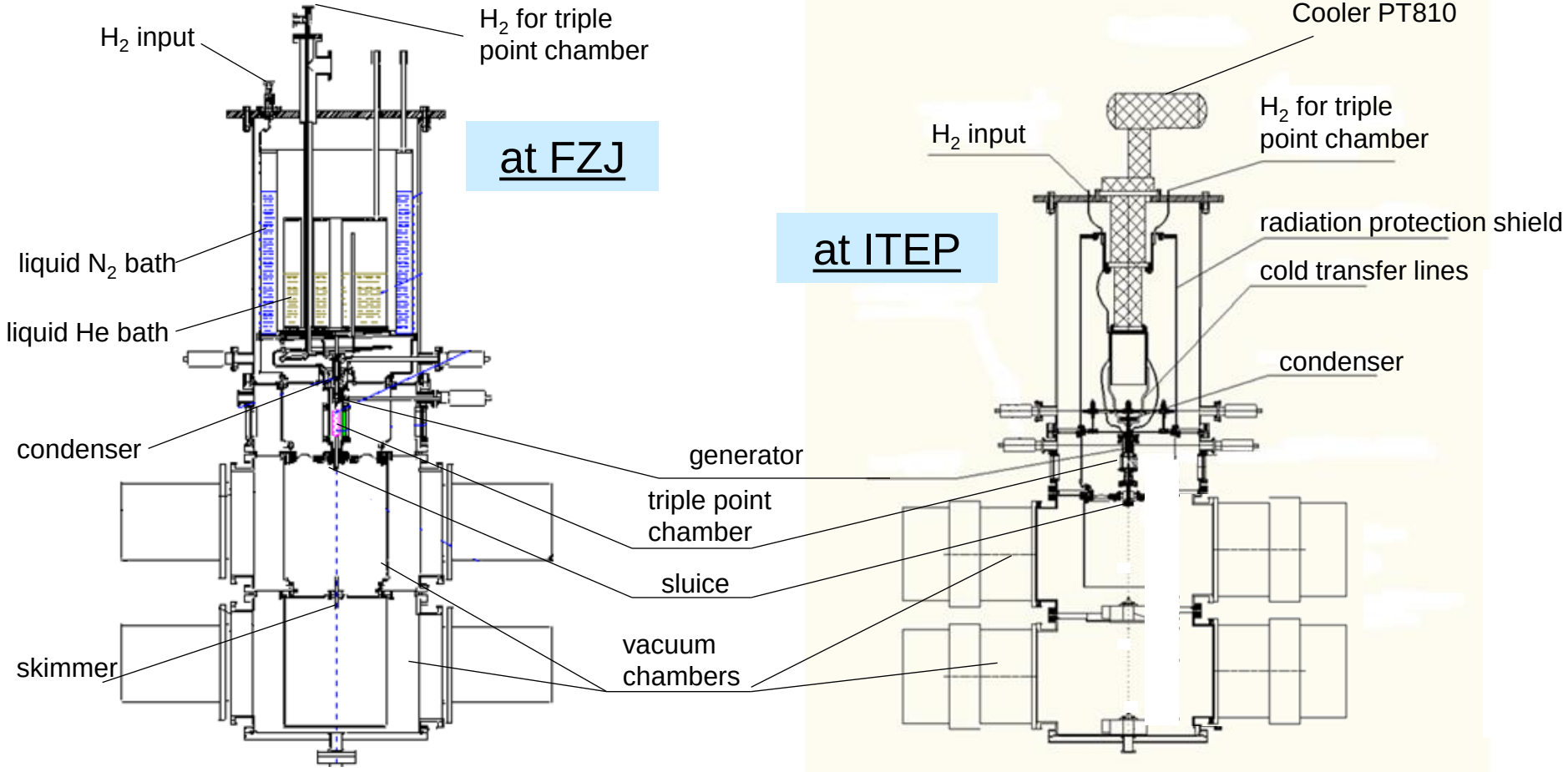
Status of Subsystems

- Gas purification and supply system
  - Construction work will be started as soon as Austrian BMWFW funding will be granted
- Target integration in PANDA well under control

Status of the Pellet Target

(A. Gerasimov, ITEP Moscow)

First and Second Pellet Target Prototype

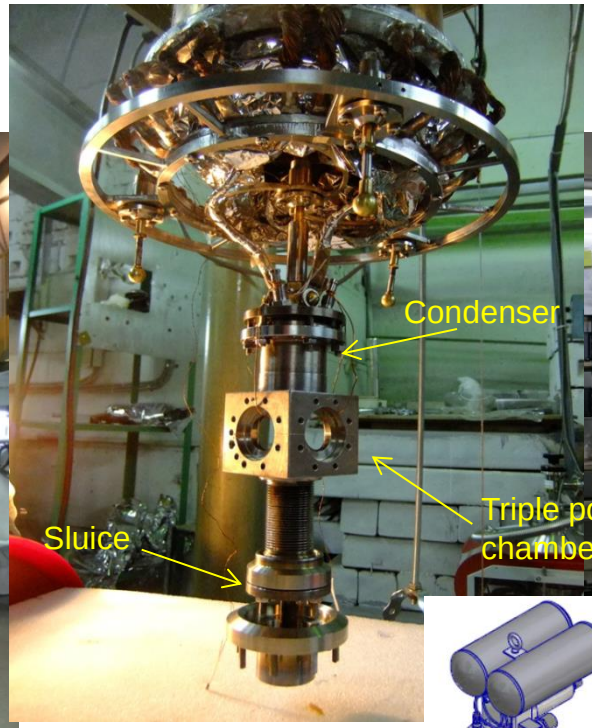


Status: disassembled, will be transported to ITEP

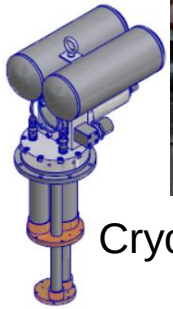
Status: active tests at ITEP

Second Pellet Target Prototype at ITEP

Test hall



Target cryostat

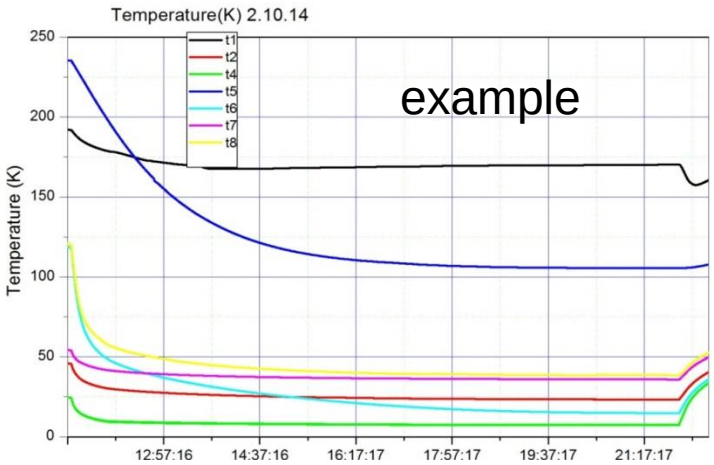


Cryocooler PT810

Advantages of cryocooler compared to LHE:
a) easier maintenance and operation
b) reduction of the operating costs (no liquid N_2 and He).

Status of the 2nd Pellet Target Prototype at ITEP

Active low temperature tests



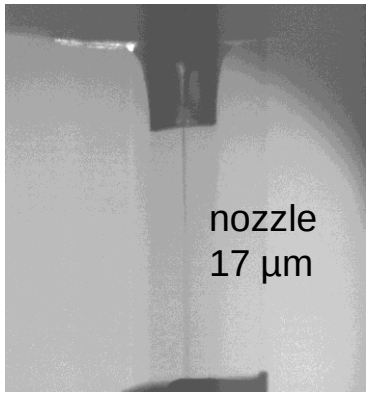
Achieved:

- ✓ Necessary temperature in condenser
- ✓ Liquid jets from hydrogen
- ✓ Remote control system

Going on:

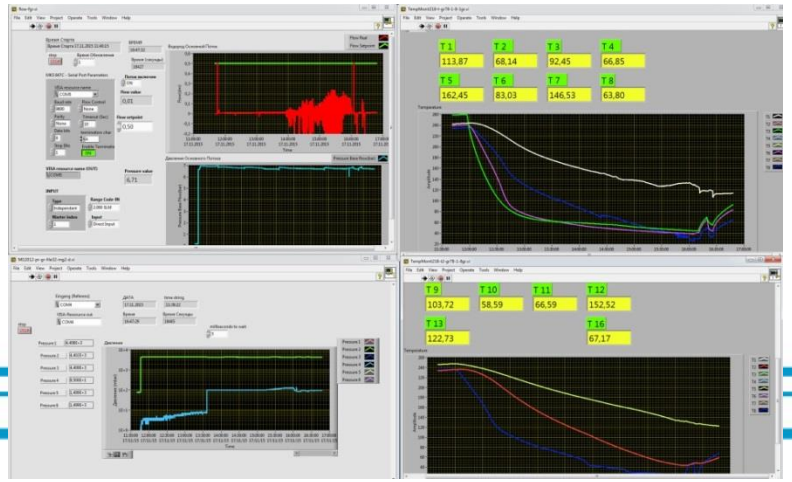
- ➢ Optimization of parameters
- ➢ Upgrade of diagnostics
- ➢ Improvement of details

Hydrogen jets in the triple point chamber



(see: scrutiny report)

Remote control system and data collection



Status of the Pellet Target

- Funding
  - Support from ITEP: staff, equipment, designers and workshop
  - Application for Horizon2020 grant
- Personnel
  - 12 permanent staff in the pellet target group
  - Invited designers and workshop
  - Invited 3 people for diagnostics

Status of the Pellet Target

- Time schedule
  - 2016 – 2017 R&D development of the target and preparation of TDR
  - 2017 (spring) submission of TDR
  - 2017 approval of TDR (see: scrutiny report)
  - 2018-2019 manufacture of the pellet target, assembling and tests in ITEP
  - 2020-2021 transfer to and assembling at GSI

Status of the Pellet Tracking System

(H. Calén, Uppsala University)

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Status of pellet tracking activities

Pellet tracking system for PANDA is designed to provide:

- pellet positions ($\sigma \approx 0.1$ mm accuracy) at a hadronic event

- useful information for ≈ 90 % of the hadronic events

Design studies are described in the **PhD** thesis of **Andrzej Pyszniak**:

Development and Applications of Tracking of Pellet Streams

(January 2015) *(see e.g. New_PANDA_Website Documents)*

The tracking system is separated (geometrically, mechanically, electronically etc.) from target generator and target dump.

In principle it can be used together with any target generator, but only

in "Pellet TRacking mode" operation it provides useful tracking info.

For pellet "Pellet High Luminosity mode" and for Cluster-Jet, it mainly could provide only stream (jet) position and time structure info.

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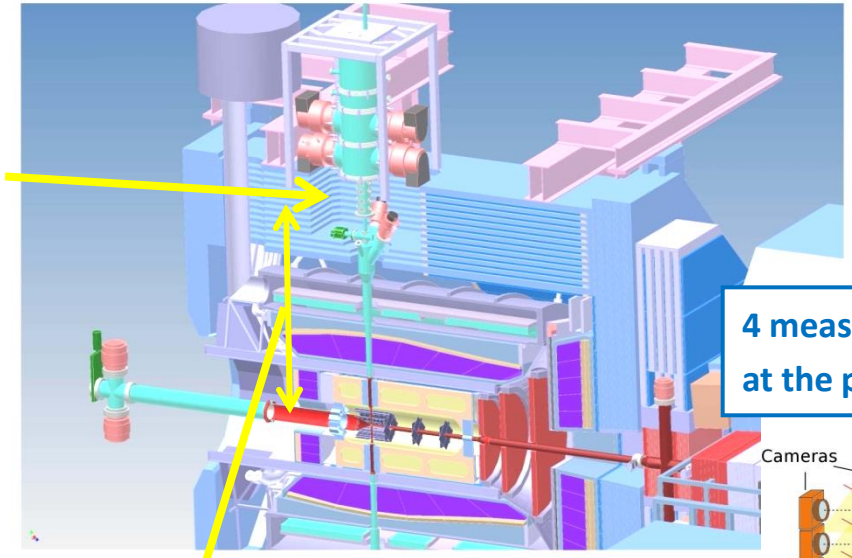
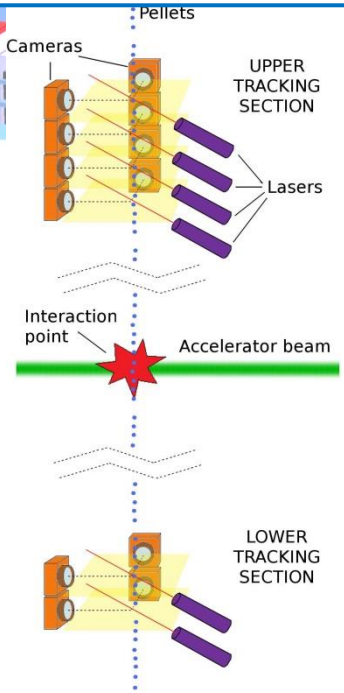
Tracking system design

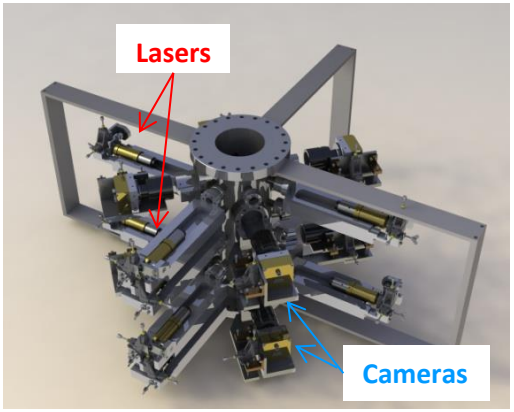
Two 40 cm long sections of the target pipe, one at the generator and one at the dump are reserved for tracking equipment.



PTR section – Int. region ≈ 2 meters

4 measurement levels at the pellet generator





Tracking section (TDR 2012).
Design idea with 4 measurement levels, each with 2 lasers and 2 LS-cameras. Level spacing: 60 mm

Design 2014.
The selected configuration has 4 + 3 measurement levels, each with 2 lasers and 2 cameras.

3 measurement levels at the pellet dump

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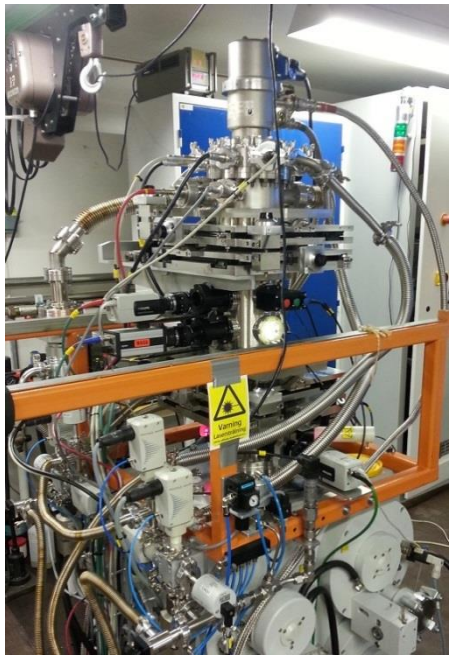
UPTS pellet generator



UPTS provides a pellet stream according to PANDA tracking mode operation requirements.

(Φ_{stream} ≈ 3 mm, Φ_{pellet} ≈ 25 μm, v ≈ 70 m/s, f ≈ 15 k/s, ...)

A PTR pellet stream with high availability and reliability is necessary for the continued preparation of the pellet tracking system ... but

... operation at TSL from 2016 is very uncertain ....

The UPTS generator, together with the WASA generator framework and dump, might become a suitable standalone target (test) setup .....

The WASA pellet generator in its support framework was removed from the WASA-at-COSY setup October 2015.

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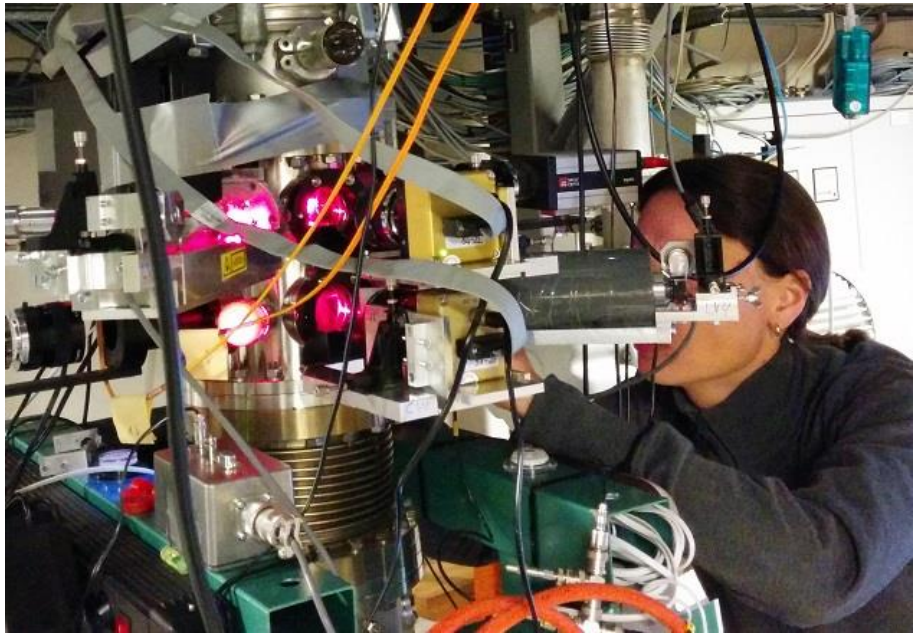
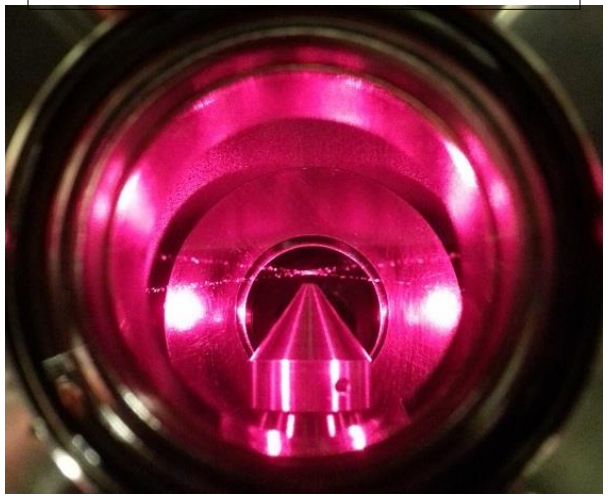
UPTS in operation. Visual inspection of pellets and pellet stream in the tracking development chamber (≈2 m below the pellet generator). (CM in June 2015).



Pellet stream (and bouncing pellets) seen in the laser beams above skimmer.



Pellet stream (Φ ≈ 2.5mm) in the tracking chamber

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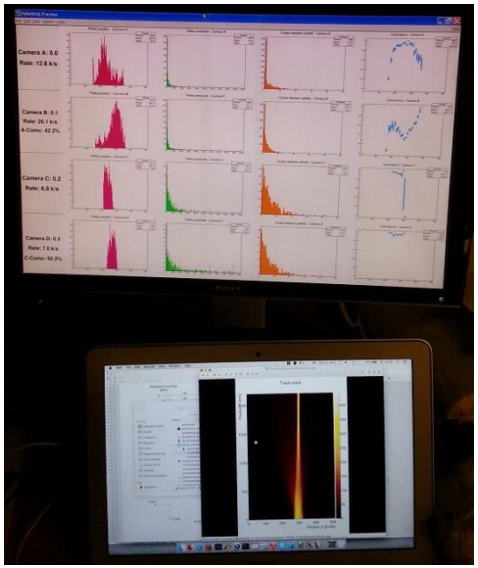
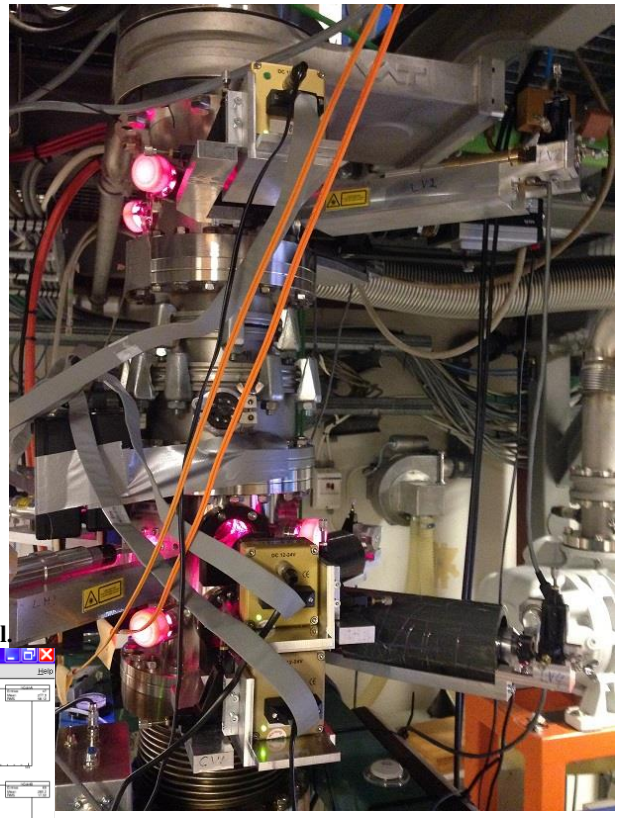
UPTS pellet tracking development setup. Multi-camera readout prototype system

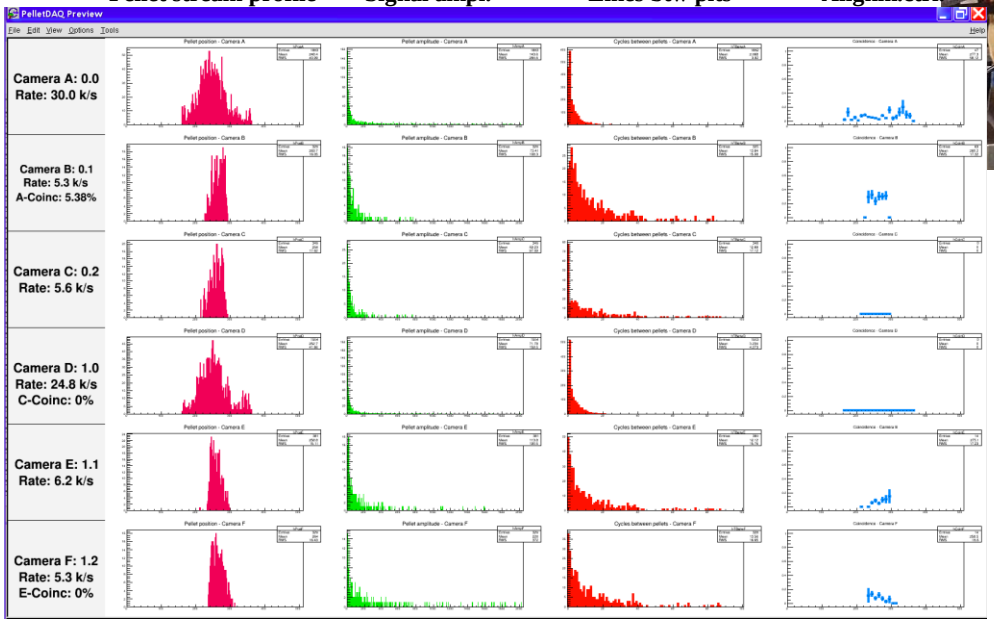


Information from the individual cameras.

Reconstructed pellet tracks.



Pellet stream profile | Signal ampl. | Lines btw plts | Alignm.ctrl.



First tests with six synchronized cameras at UPTS in a pellet run with the prototype CamControl readout (June 2015).

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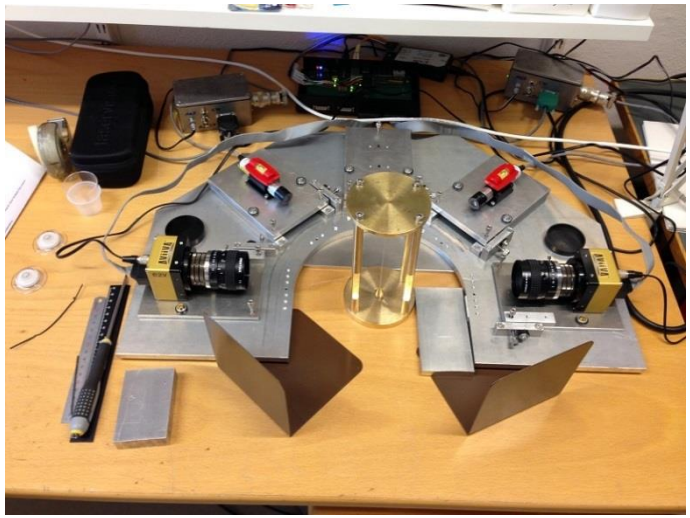
Prototype of integrated PTR measurement level module

Difficult to obtain the necessary alignment accuracy (< 0.01 mm) with independent camera and laser adjustment at the measurement positions (below).

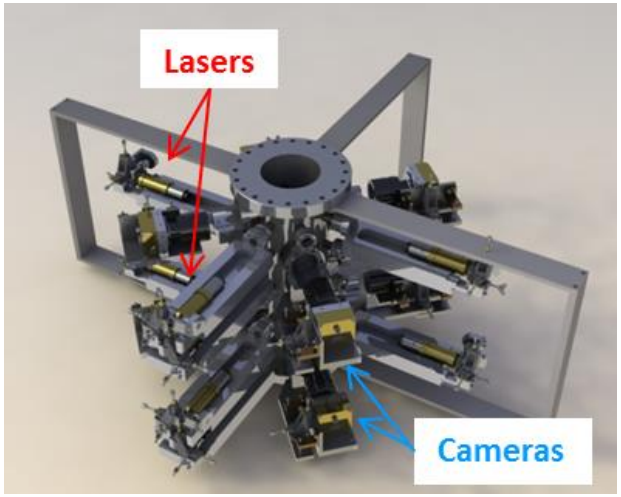
Instead an integrated measurement level module that can be aligned externally and then be installed at the tracking section is being prepared (right).

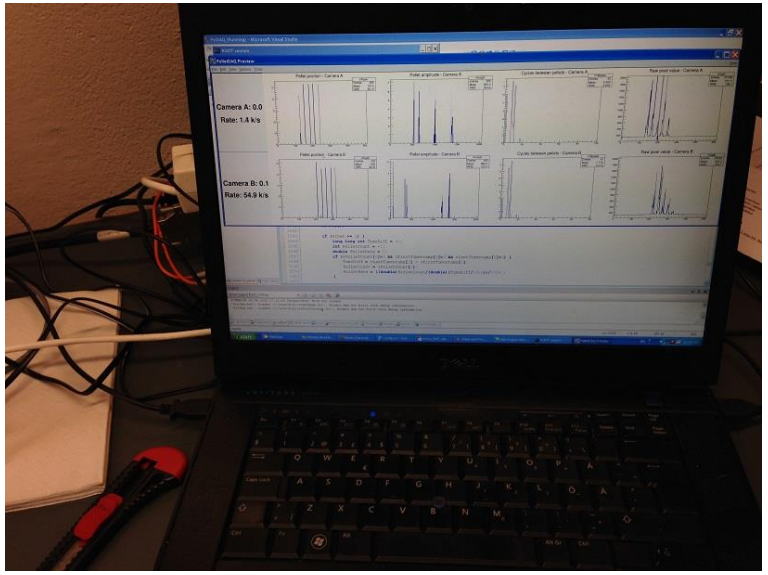
Tests of first version were done in June 2015.



Integrated measurement level with 2 lasers and 2 LS-cameras being aligned in a desktop setup using 5 fishing lines.

TDR 2012: Tracking section with lasers and LS-cameras mounted in independent holders.





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Project planning and status (November 2015)

Ongoing: Multi-camera r/o and control being tested.
Measurement level module prototype being tested.

Time line: Need for new funding to start the preparation of the main part of the equipment. Then it may take 1-2 years if our expert personnel is available.
Present funding (CTS see below) makes possible only the preparation of one (out of seven) detection module during 2015-16 ….

Risks: Evaluation done (Autumn 2013 (TDR), Feb 2015 (SG)).

Funding: Running: SRC application 2015-18 rejected Nov2014. No new try !
HPH2020 application rejected …. New try in 2016?

Equipment: KAW application was (strongly) rejected Oct13.
CTS appl. (30k€) approved Nov 2014 !

SG comment: "*Funding remains an open problem*"

The pellet tracking project is not in the PANDA cost book and it is not a Swedish FAIR in-kind contribution. It can therefore not get part of the dedicated SRC support for PANDA. We see no possibility for substantial financing at present.

UPPSALA "team" (Autumn 2015): Hans Calén, Kjell Fransson (5%), Pawel Marciniewski (5%)


Thank you very much....

Expected Target Parameters at PANDA

	Cluster Target	Pellet Target	
		PTR mode (tracking)	PHL mode (high luminosity)
Effective target thickness	> 2×10^{15} at./cm^2	≤ 2×10^{15} at./cm^2	≥ 4×10^{15} at./cm^2
Cluster/Pellet size	nm - µm	Ø ≥ 20 µm	Ø ≤ 15 µm
Cluster/Pellet frequency	Continuous beam	≈ 15 k plt/s	≥ 150 k plt/s
Target stream diameter	4 mm x 12 mm	Ø ≈ 3 mm	Ø ≤ 3 mm
Average dist.between cluster/pellets	≤ 10 µm	≥ 4 mm	<< 4 mm
$\overline{p}$ beam size	Ø ≤ 1 mm	$Ø_{vertical}$ ≥ 3.5 mm	$Ø_{vertical}$ ≤ 3.5 mm
Average no. of cluster/pellets in $\overline{p}$ beam	≥ 10^7	≈ 1	≈ 10

Scrutiny Report: Cluster Target

…Possible problems with beam-induced background are not yet solved. Experiments to eliminate the rest gas uncertainties are postponed into 2016. A remaining risk is the mechanical connection to the target pipe of the interaction region above and below the IP and the achievable vacuum at the IP with the very limited pumping in that region.

Task of HESR group

An interesting development still going on is the cluster-jet diagnostics on top, measuring the density profile (Rayleigh scattering of light) and in the dump, visualizing the pbar overlap region. These techniques might allow an independent determination of the luminosity with a precision comparable to that of the luminosity monitor

The funding of the cluster-jet target is secured.

Summary:

The cluster-jet target will be available for tests at COSY already in 2017. During this running period, the issue of the background gas load should be addressed. Its readiness for PANDA at the HESR in 2018 is well under control. Hydrogen and heavier atom clusters can be provided reaching a luminosity of $L=10^{31}s^{-1}cm^{-2}$ with the intensity-reduced start-up version of pbar production.

Scrutiny Report: Pellet Target

…The (…) 'second target prototype' (…) has been built at Moscow and can replace the previous bath-type reservoir for continuous running without refilling helium/nitrogen cryostats. It is unclear whether droplets could be produced by now in the triple-point chamber with the new set-up or if progress now depends on the delivery of the Jülich equipment.

… Demonstrations of the pellet flow into vacuum with different pellet sizes could be achieved in Jülich. However the pellet distributions at the IP as well as longer running periods (hours) are not shown yet.

…The promised TDR for 2015 is very unlikely to be provided this year. The collaboration with the pellet-tracking group from Uppsala is not visible.

Summary:

To our strong regret a running version as required by PANDA was never achieved. Now, solely in hands of the ITEP group with more steady work on the project in Moscow, progress may be expected very soon. The financing will be secured provided the TDR is written and approved by FAIR.

Scrutiny Report: Pellet Tracking System

The Uppsala group has shown the concept of pellet tracking to work… With altogether 6 tracking planes, the efficiency (…) is estimated to be around 90% for sufficiently large pellets and rates around 10^4/s. This socalled tracking mode would allow determining the position of the pellet at the IP with 0.1 mm precision. Tracking for the high luminosity is not possible yet.

…The experimental technique and the tracking algorithm have been developed… The build-up of the full tracking system could occur in time provided sufficient funding becomes available. The request for funding encompasses costs of upgrading the UPTS and continuing access to it. In fact further readiness of a separate pellet source in Uppsala is mandatory. Towards this goal the return of the WASA-pellet apparatus to Uppsala will be beneficial.

Summary:

The tracking of pellets with size larger than 20 micron and rates around 10 kHz has been demonstrated. Based on an excepted TDR, a small group at Uppsala continues the developments for PANDA. Funding remains an open problem.