



# Status of pellet tracking in Uppsala

The pellet tracking system for PANDA is based on line-scan CCD cameras and diode lasers configured in several measurement positions.

It is designed to provide\*:

- **individual pellet positions ( $\sigma \approx 0.1$  mm)** at a hadronic event
- **useful information for  $\approx 90$  % of the hadronic events**

\*) see the PhD thesis of Andrzej Pysznik:

*Development and Applications of Tracking of Pellet Streams* (January 2015)

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

**The tracking system can also be used as a monitoring system** together with any target generator, but only with pellet target

**in “Pellet TRacking mode” operation it can provide useful tracking info.**

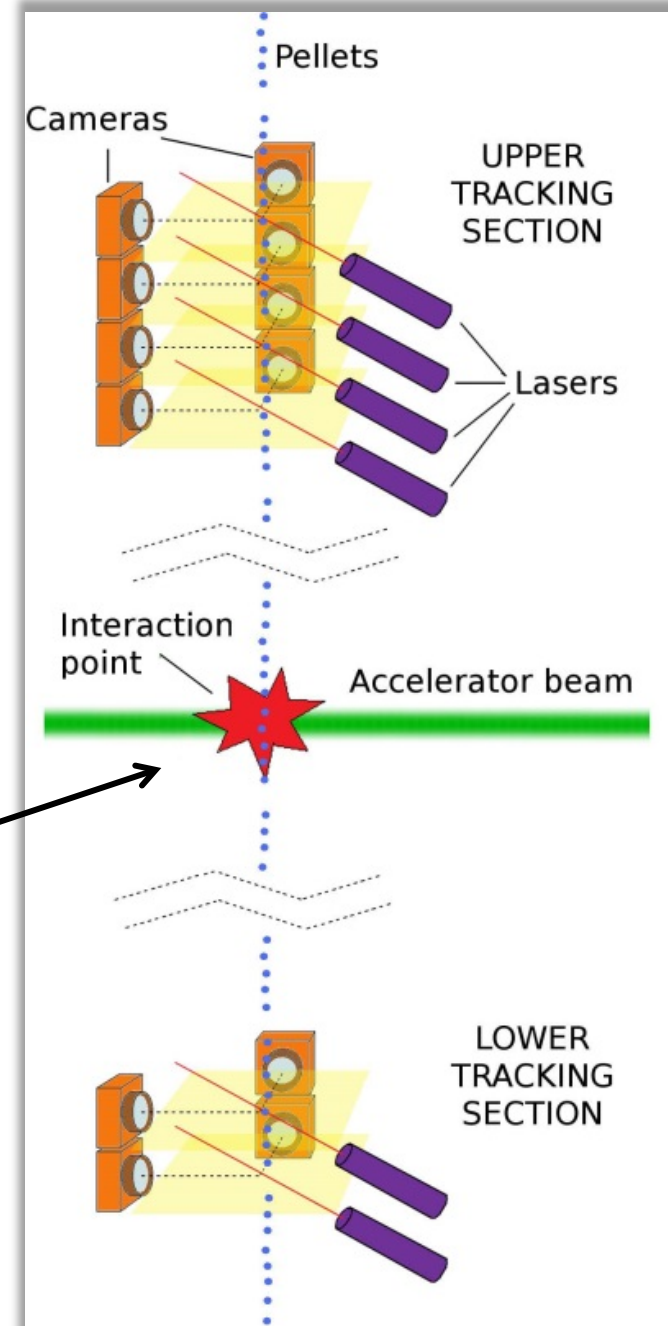
For pellet “Pellet High Luminosity mode” and for Cluster-Jet, it mainly could provide stream (jet) position, shape and time structure info.



# Tracking Pellets

- **Laser beams with a horizontal beam line profile of 3 mm width and 50  $\mu\text{m}$  height.**
- **Line-Scan CCD cameras taking one line of 512 pixels, size 35x35  $\mu\text{m}^2$ , at 100 kHz frequency.**
- **The camera line of sight and the beam line profile of the laser must coincide within 10  $\mu\text{m}$ .**
- **A pellet measurement accuracy of 20  $\mu\text{m}$ .**

**Position of a pellet in the interaction region can be reconstructed with a precision of 0.1 mm**





# The tracking sections consist of measurement levels.

**Equipment and procedures have been developed\* so that the complete measurement level system can be (fine) tuned offline and then be securely installed at the tracking section of the target pipe.**

**It then maintains its performance during the experimental conditions without need for further manipulation (continuous easy access).**

**A prototype measurement level Detection Module (DM) was tested successfully at UPTS under real conditions with pellets in August 2016.**

**\*) see the Master thesis of Jenny Regina:**

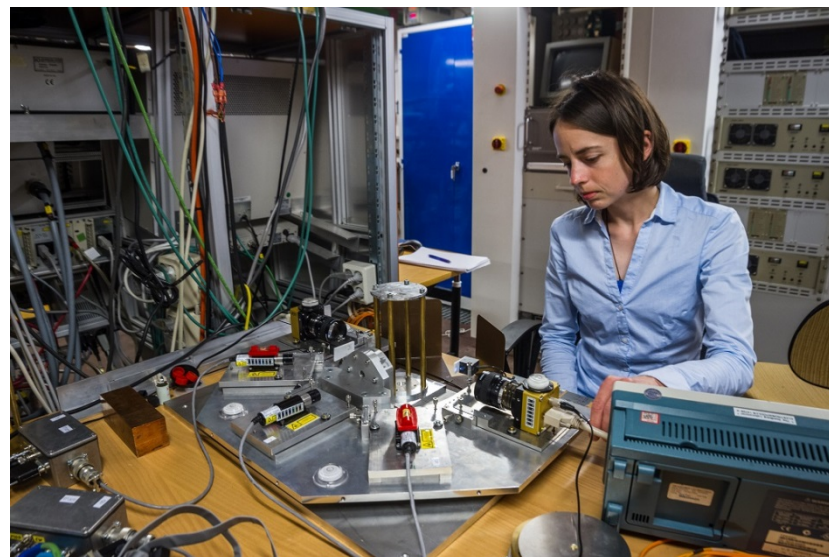
*A measurement level module for a pellet tracking system* (February 2017)



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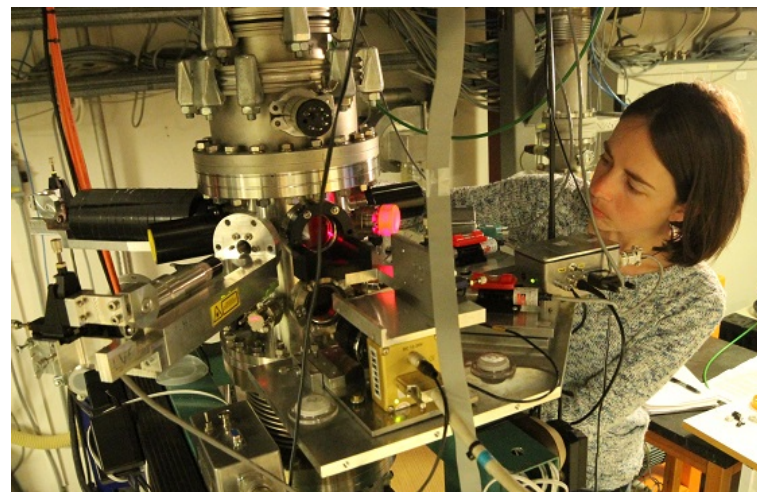
**Testing and tuning of the  
detection module prototype  
in the table top setup.**

**Internal alignment of cameras  
and lasers is done by using  
fishing lines as targets.**



**Installation of the detection  
module at the old PTR chamber.**

**Fixation by 4 screws onto a sight  
glass flange.**



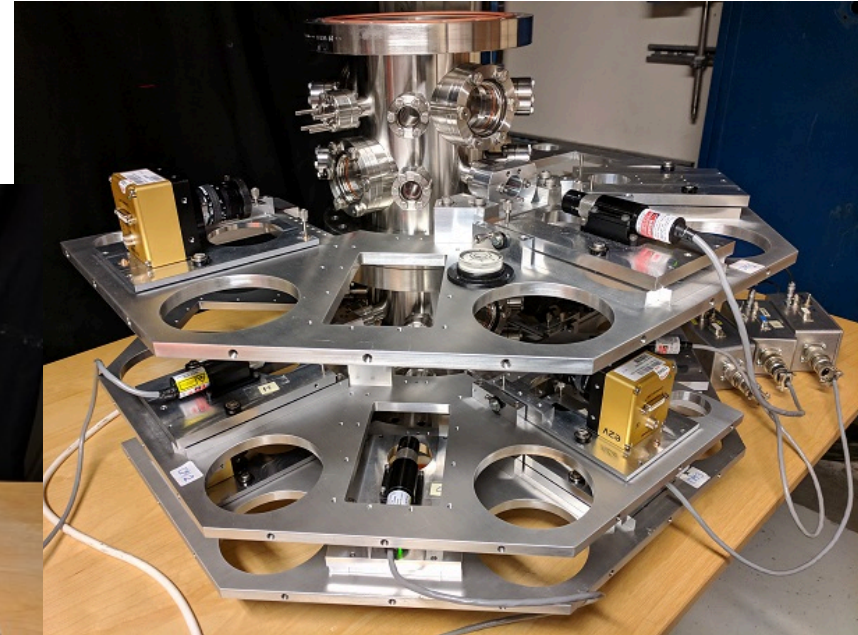
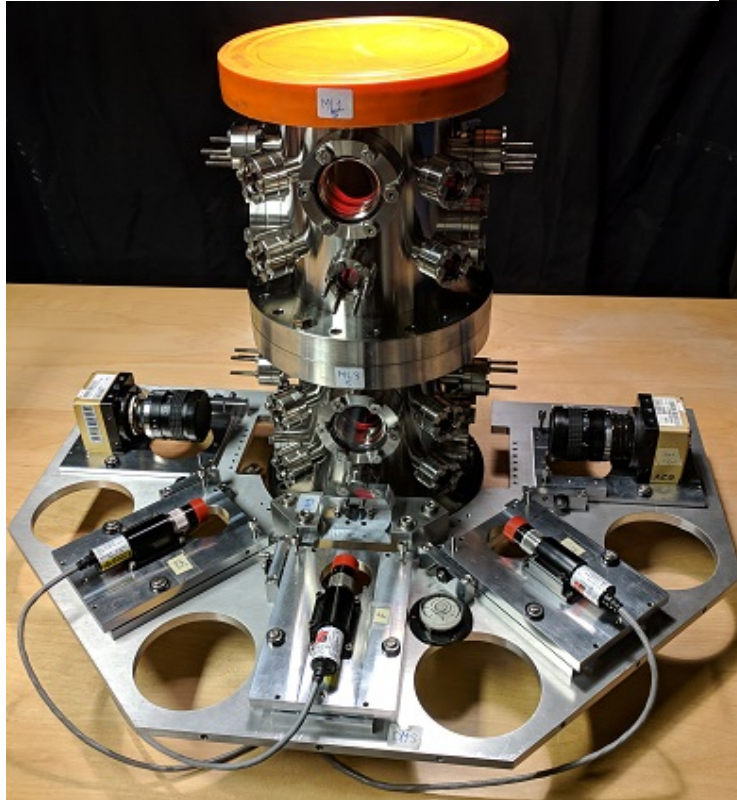
PTR measurement  
module tests  
at UPTS  
Summer Autumn 2016





## The tracking sections consist of measurement levels.

The upper tracking section chamber can house four measurement levels.



Three DM plates mounted on the tracking section chamber.

A new DM plate fully equipped with three STR-lasers and two LS-cameras.



## Connections between the Pellet tracking system and other systems (sub-projects):

System	Item	Status (August 2017)
Cluster-Jet generator	Pumps and valves in upper yoke-pit. Space for 4-layer PTR section and possibility for pumping below a second skimmer.	Not clear if PTR (pellet target) requests are met. They should be considered in the final design.
Vacuum	Piping & pumping at upper yoke-pit.	Not clear.
Vacuum, Physics, Accelerator	Vacuum at IP region. Need for more pumps at target dump.	Reduces pressure at least with 50% (Report by J.Löfgren, Apr 14)
Target dump, Vacuum	Pumps and piping in lower yoke-pit. Space for 3-layer PTR section. Access.	No draft design available?
Accelerator	Beam size vertically $\approx 5$ mm for PTR mode.	Not clear. (Simple?)
Pellet target generator	PTR mode operation ( $\Phi_{\text{stream}} \approx 3$ mm, $\Phi_{\text{pellet}} \approx 25$ $\mu\text{m}$ , $v \approx 70$ m/s, $f \approx 15$ k/s, ...)	Parameters well known. (Std pellet target operation so far).
Pellet target	Valves, pumps, skimmers, access space etc. just below the target generator.	No draft design available yet (?). Approximate space requirement for the PTR section itself is well known.
Control, monitoring	Eventual usage of PTR info	Not started.
Physics analysis	Merging of PTR data and hadronic event data	Not started. (Example from WASA-at-COSY exists (A.Pyszniak PhD thesis)).



### Project planning and status (May 2019)

**Ongoing:** Multi-camera r/o, control, monitoring and analysis developments.

A “generator” tracking chamber that can house four measurement levels has been prepared and is being prepared for test measurements with DMs.

**Time line:** Tests of a measurement level module (DM) prototype with pellets were done 2016.

Tuning of the “generator” tracking section starts in autumn 2019 ...

Design of the “dump” tracking section is pending. It depends on funding and on the work on mechanical design of the target dump area.

To be able to prepare the complete system with two tracking sections, additional funding is needed. Then it may take only a few years if some of our expert personnel (and infrastructure) is still available.

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

**Funding:** Consumables and running: Almost zero ...

**HPH2020 funding granted, may be available in 2020 ... (?)**

**Equipment:** Zero. **Application to CTS for 2020 was submitted.**