Status of pellet tracking activities

UPPSALA UNIVERSITET

Pellet tracking system for PANDA is designed to provide:

- pellet positions (σ ≈ 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

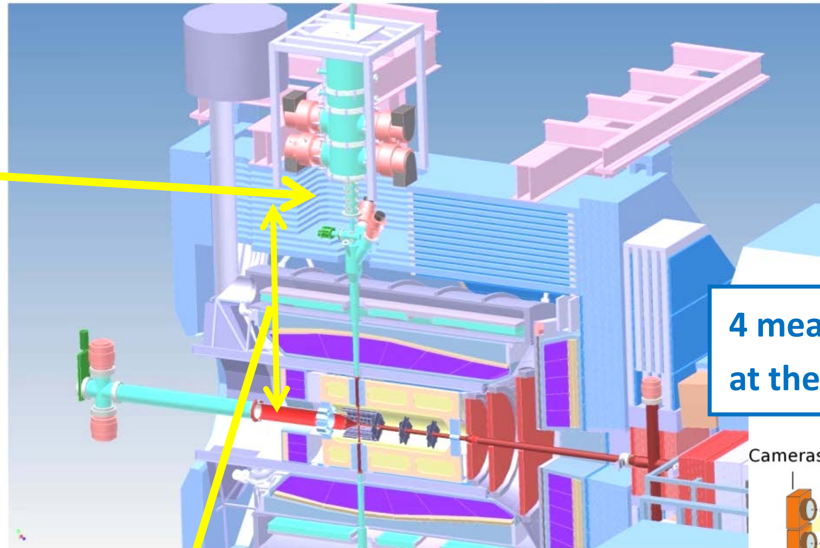
in "Pellet TRacking mode" operation it provides useful tracking info.

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

UPPSALA UNIVERSITET

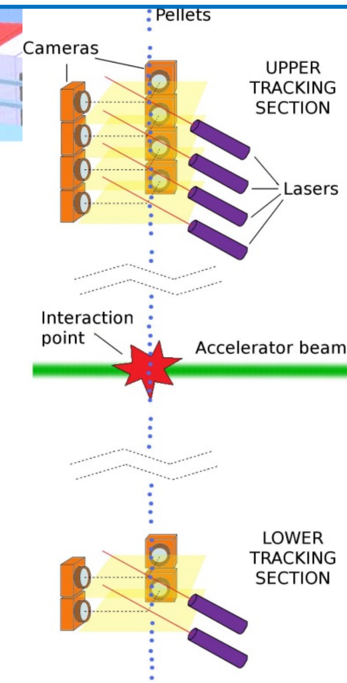
Tracking system design

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

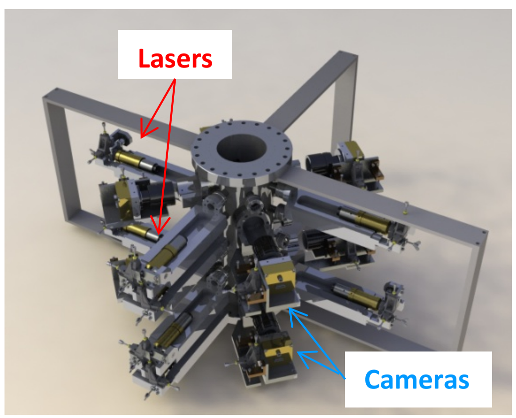


PTR section – Int. region ≈ 2 meters

4 measurement levels at the pellet generator



3 measurement levels at the pellet dump



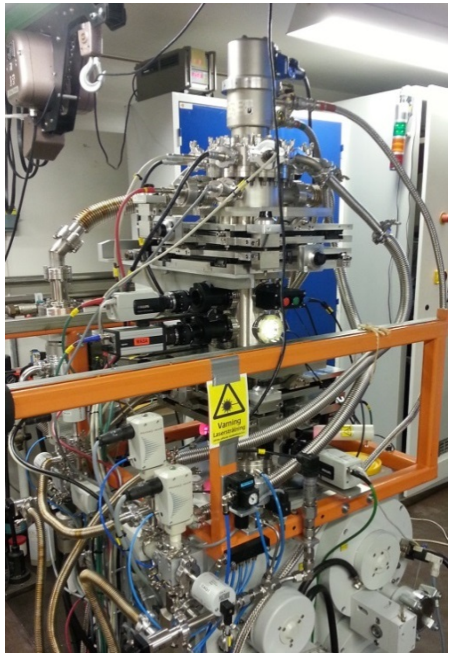
Tracking section (TDR 2012).
Design idea with 4 measurement levels, each with 2 lasers and 2 LS-cameras.
Level spacing: 60 mm

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

PTR status
Panda CM Vienna
November 2015
Hans Calén

UPPSALA UNIVERSITET

UPTS pellet generator



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

($\Phi_{stream} \approx 3$ mm, $\Phi_{pellet} \approx 25$ 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

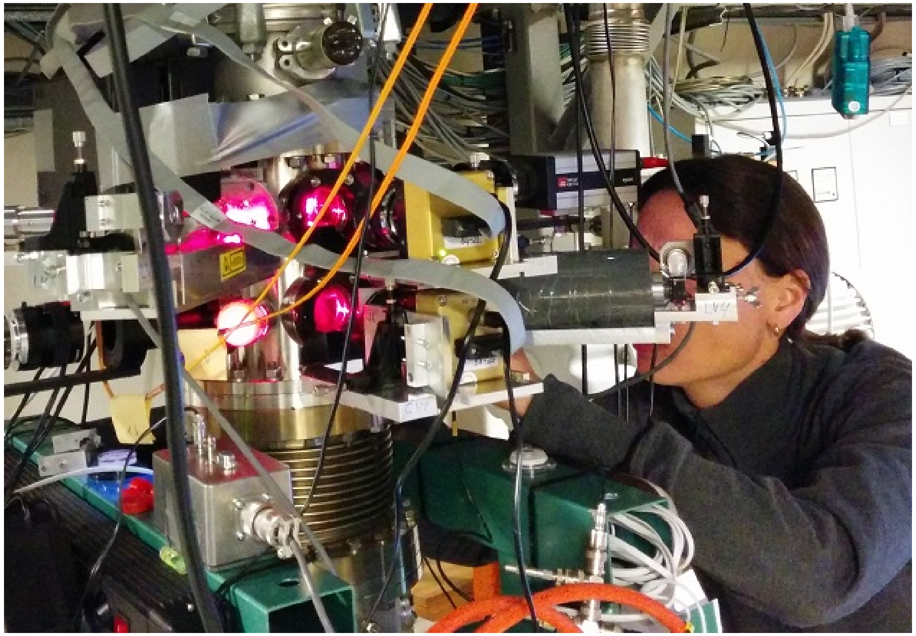
... operation at TSL from 2016 is very uncertain ....

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

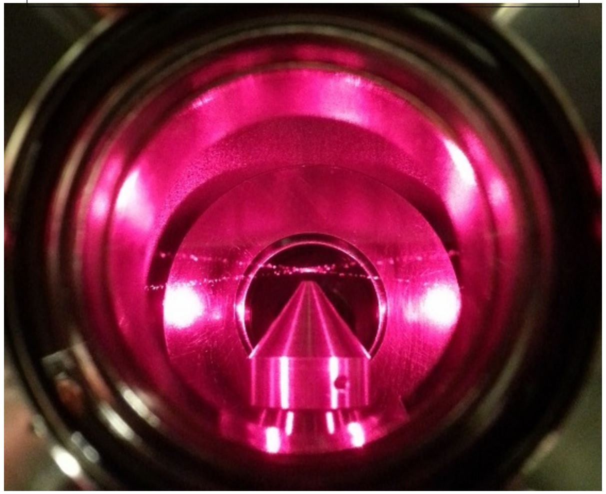
The WASA pellet generator in its support framework was removed from the WASA-at-COSY setup October 2015.

UPPSALA UNIVERSITET

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).



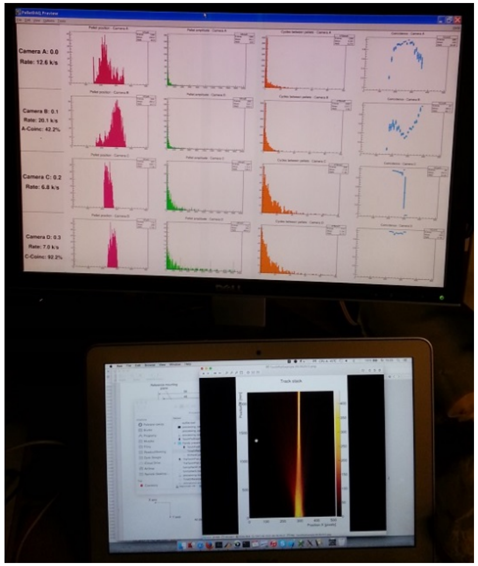
Pellet stream (and bouncing pellets) seen in the laser beams above skimmer.



Pellet stream ($\Phi \approx 2.5$mm) in the tracking chamber

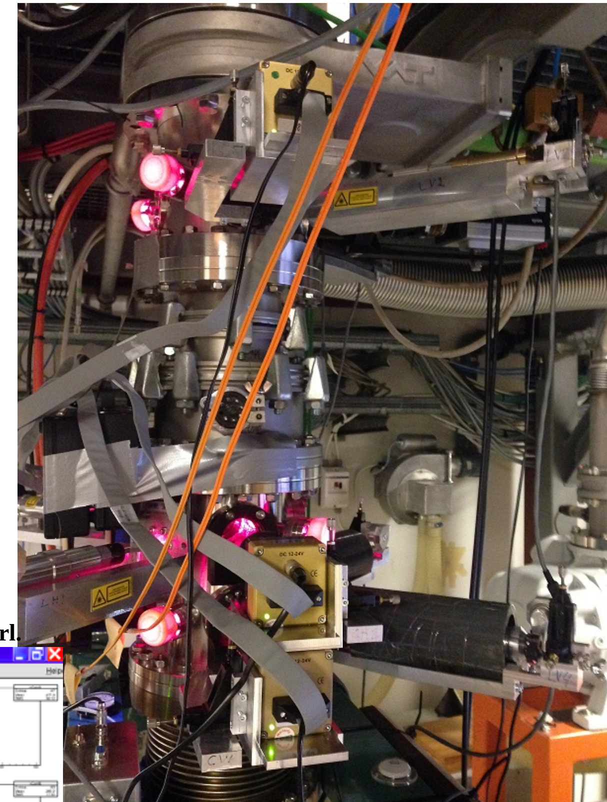
UPPSALA
UNIVERSITET

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

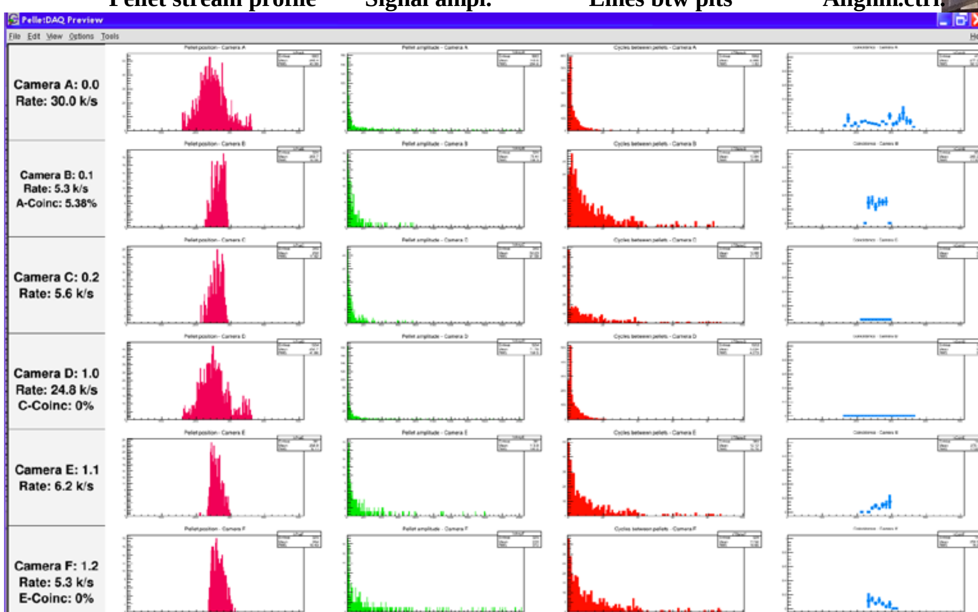


Information from the individual cameras.

Reconstructed pellet tracks.



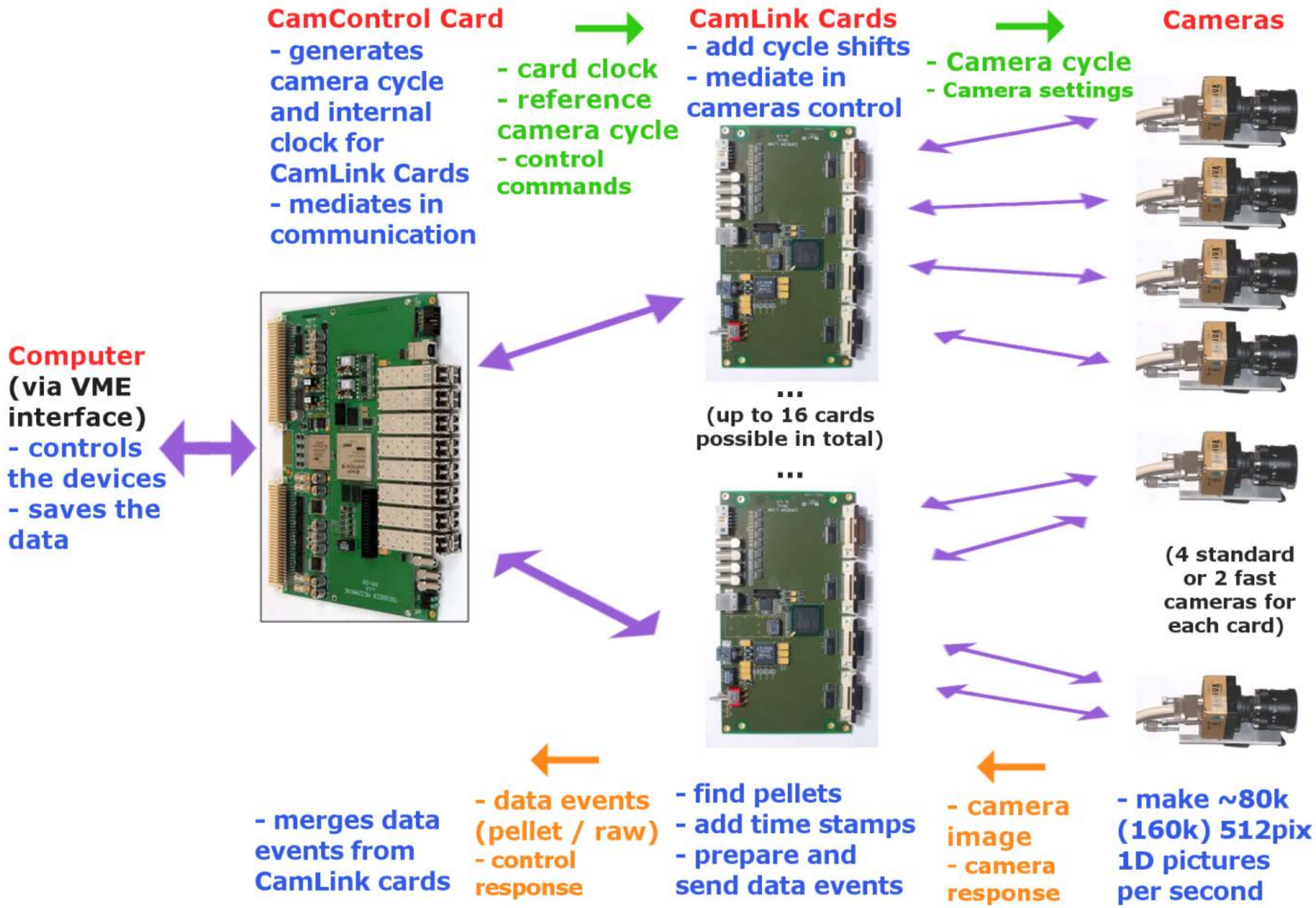
Pellet stream profile **Signal ampl.** **Lines btw plts** **Alignm.ctrl.**



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

Multi camera readout development

From project description by Andrzej Pyszniak (June 2015)



Remaining work

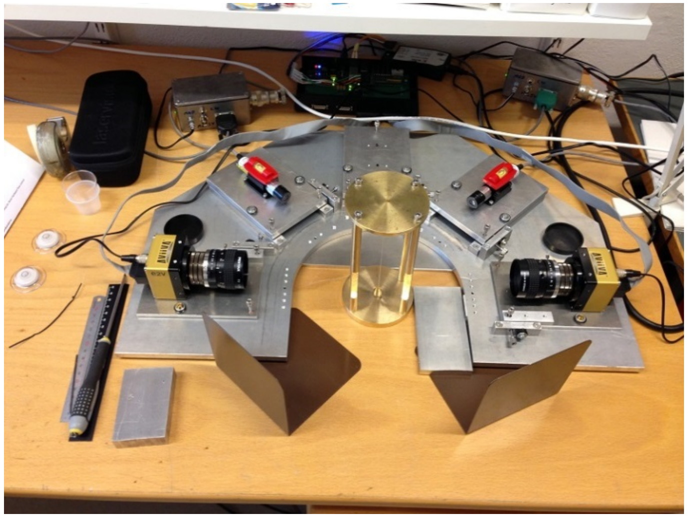
- **Continue synchronization of cards and cameras ..... in pellet runs.**
- **Implementation in the PTR data handling and analysis software.**
- **Extensive complete tests with different multi-camera setups ...**

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).

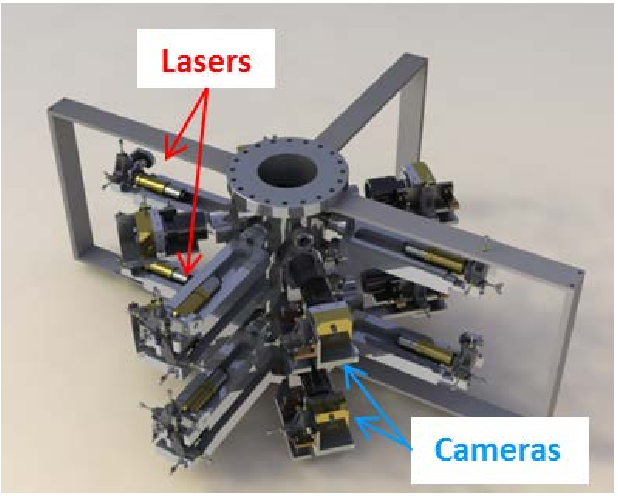
Instead an integrated measurement level module that can be aligned externally and then be installed at the tracking section is being prepared (right).

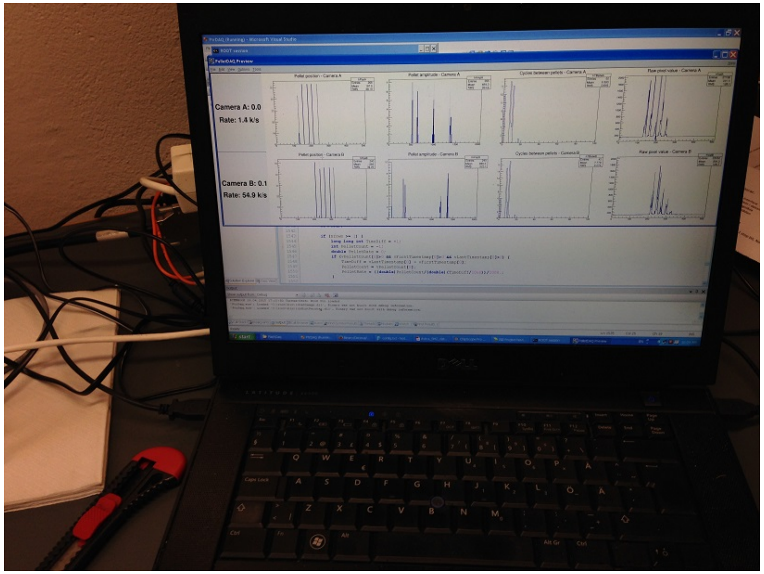
Tests of first version were done in June 2015.



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.





UPPSALA UNIVERSITET

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

System	Item	Status
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 and 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 2014)
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 ≈ 5 mm for PTR mode.	Not clear. (Simple?)
Pellet target generator	PTR mode operation (Φ_{stream} ≈ 3 mm, Φ_{pellet} ≈ 25 μm, v ≈ 70 m/s, f ≈ 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 (AP PhD thesis)).

UPPSALA UNIVERSITET

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

System	Item	Status
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 and 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 2014)
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 ≈ 5 mm for PTR mode.	Not clear. (Simple?)
Pellet target generator	PTR mode operation ($\Phi_{stream} \approx 3$ mm, $\Phi_{pellet} \approx 25$ µm, v ≈ 70 m/s, f ≈ 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 (AP PhD thesis)).

Fitting of the PTR system in the recesses in the iron yoke.

UPPSALA UNIVERSITET

General comment:

The space needed for the actual PTR equipment is given in the TDR, i.e. for each section 0.4 meter height and 0.5 meter radially. This equipment fits in both the upper (1x1.2 m^2) and lower (1x1 m^2) rectangular shaped "pits". The PTR section will extend to ≈100mm inside the yoke surface. (Then the pellet generator section can be placed at 2.2 m distance from the accelerator beam (≈ 0.85 m more distant than at WASA)).
In addition, space for installation, adjustment and access for fine-tuning/service during operation is required.

Some comments and conclusions from the model study (February 2013).

Pumps in the pit.

In the upper pit, bent pump pipes with angle valves (VAT S57 DN100) can be put in 2 quadrants. The space for each pump can then be 200 x 200 x h300 mm^3 (in quadrant corners). A 250-300 l/s turbo would fit geometrically in this space. The pumps can be removed when not needed. The flanges are at 250 mm above the pit floor and centered at 200 / 240 mm distance from the pit walls. The flange on the main valve (VAT S10 DN160) is at height 200 mm.

Installation of PTR section.

Mechanics for cameras and lasers should be attached and aligned before installation in the pit. The PTR section should then be attached to the target pipe. The access to the flange above the main valve (VAT S10 DN160) might be too difficult. If so the space can be increased by extending the PTR section a few cm.

Access to PTR components during pellet operation.

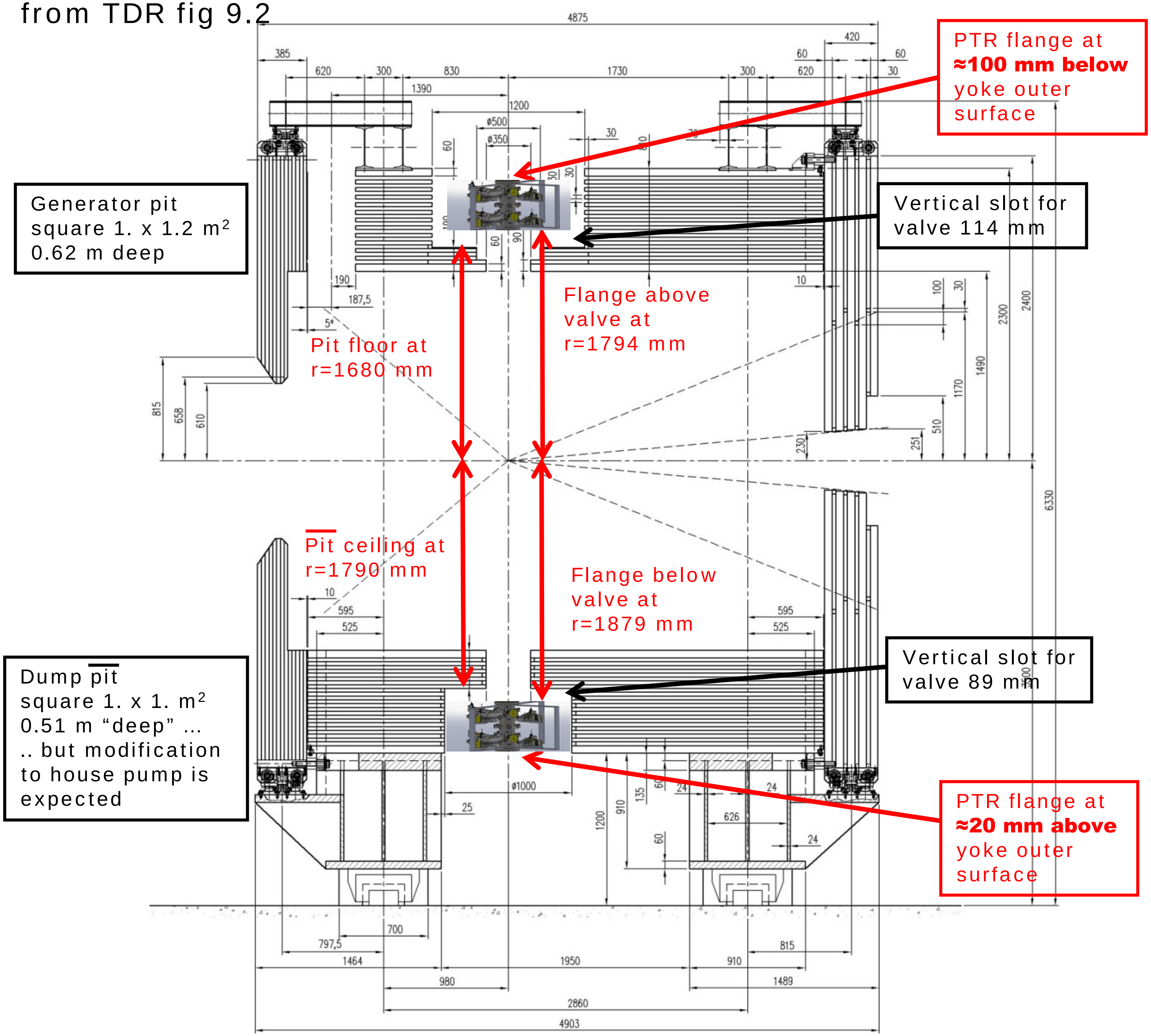
Fine-adjustment of cameras and lasers must be done with pellet beam. Then human access to the equipment is needed when the pellet generator and dump are in place (also for possibility to replace malfunctioning cams, lasers, LEDs …).
This mainly concerns the design and configuration of equipment placed just outside the pits.

Camera electronics.

Might be disturbed by pumps and magnetic field. The closest distances of camera to yoke iron and of camera to pump are 200-250mm …. Cameras need air cooling (small fans may do the job) …. .

UPPSALA UNIVERSITET

Drawing (H. Orth May 2, 2012). Positions for target pipe valve flanges from TDR fig 9.2



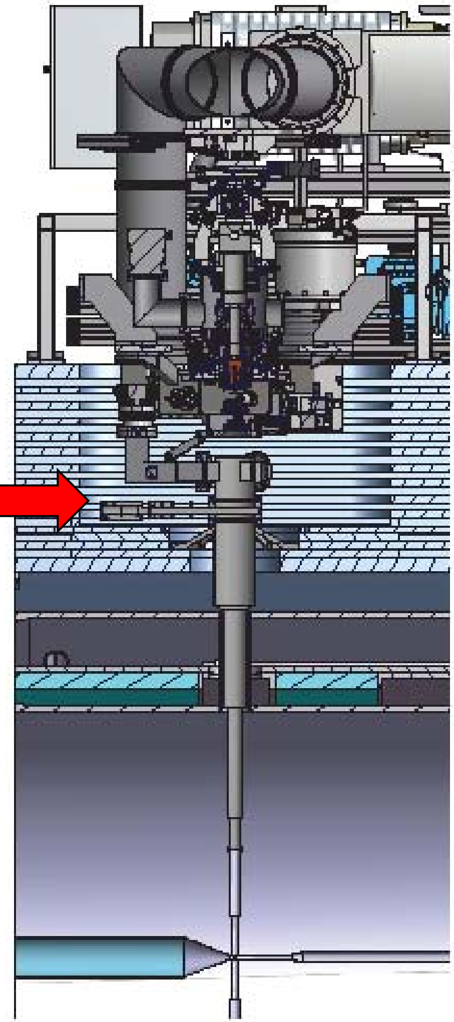
PTR status
Panda CM Vienna
November 2015
Hans Calén

UPPSALA UNIVERSITET

Space available for piping and “extra” pumps in the upper recess in the iron yoke.

4

Pump chamber for the cluster source



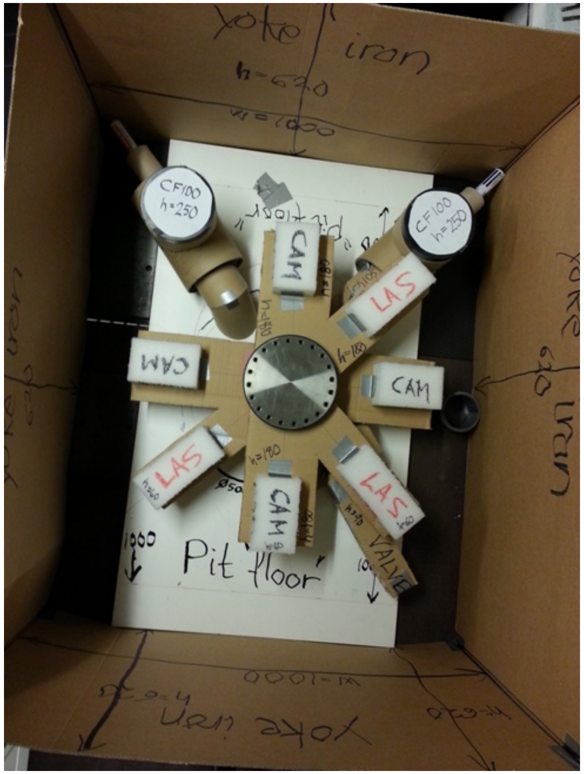
Sketch from Alexander Täschner’s presentation at CM in Paris 2012-09-10

Place for 100mm pipes and angle valves in two corners?
(Need h ≈ 250 mm at a few positions.)
These pipes would be blinded during cluster source operation.

PTR status
Panda CM Vienna
November 2015
Hans Calén

UPPSALA UNIVERSITET

Photos of PTR yoke-pit model. 20130227



Angle valve
(VAT S57)

The photos show top views (from “upstream”) of the paper model of the upper yoke pit (l =1200, w=1000, h=620 mm). Only the two lowest PTR detection levels (out of four) are included. Foam plastic blocks illustrate the sizes of cams and lasers. The full height of a detection level is ≈ 60mm. The shaft of the main valve (VAT S10 DN160) is seen down to the right. In the upper corners of the photos, angle valves (VAT S57 DN100) are seen. The flange is at position 200mm and 240mm from the walls and 250mm above the floor.

UPPSALA UNIVERSITET

Space available in the lower recess in the iron yoke.

The PTR measurement level configuration for the lower section at the dump is not decided yet. The lower yoke pit will be slightly smaller (l =1000, w=1000, h=510 mm) than the upper one.

An arrangement of piping for "extra" pumps as the one shown below might be used.

The photo shows a side view (from "downstream") of the paper model of the upper yoke pit (l =1200, w=1000, h=620 mm).
Pipes and "CF90" flanges for pumps (in two alternative configurations) with the heights of the flanges above the floor are indicated.

UPPSALA UNIVERSITET

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

System	Item	Status
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 and 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 2014)
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 ≈ 5 mm for PTR mode.	Not clear. (Simple?)
Pellet target generator	PTR mode operation ($\Phi_{stream} \approx 3$ mm, $\Phi_{pellet} \approx 25$ µm, v ≈ 70 m/s, f ≈ 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 (AP PhD thesis)).

UPPSALA UNIVERSITET

Summary of comparison between target related background conditions at WASA and at ANKE.

		WASA pellet	ANKE cluster-jet
	Target beam size	Φ = 3.8 mm	Φ = 10 mm
	Target thickness	2 - 6 · 10^{15} at./cm² (H_2,D_2)	0.3 · 10^{15} at./cm² (H_2)
	Pressure in scatt.-chamber	≈ 10^{-6} mbar (modelled)	≈ 10^{-6} mbar (guess)
1	Background level expected from vacuum situation	≈ 0.01 % (H_2)	≈ 0.05 %
2	Background level from event reconstruction	≈ 0.2 % (eg pp@0.5 GeV)	≈ 1 %
	Results from COSY beam energy loss measurements:	May 2014, pd @1GeV	2004, pp @2.65 GeV (published 2008)
	Target thickness	58.0·10^{14} at./cm²	2.60·10^{14} at./cm²
	Thickness no target	0.12·10^{14} at./cm²	0.14·10^{14} at./cm²
3	Thickness rest gas ...expected background level	< "no target" value < 0.004%	0.07·10^{14} at./cm² 0.02 %

There are certainly differences between the pellet and the cluster-jet target situation .... but nothing very dramatic (or unexpected*) was found in this study.
All 3 methods, give physics background levels that are ≈ 5 times higher for Anke CJT than for Wasa PT.

*) e.g. from experience at CELSIUS

UPPSALA UNIVERSITET

Some features of the background condition measurements at WASA and at ANKE.

Target condition studies at COSY

	WASA pellet	ANKE cluster-jet
Geometry at interaction region Pumping of interaction region	Narrow cross. Accelerator pipe Φ=60 (Pellet pipe Φ=5). Upstr and downstr ≈ 1 m	Big box lwh=900x700x200 (Cluster pipe Φ=38). Direct (?) on the box
Vacuum measurements	in pellet pipe up/down and acc.beam pipe (scattering chamber) ≈ 1 m from IP	upstream of the scattering chamber
Background measurement i.e. event detection ..... and reconstruction	External detection of photons and protons. Complete eta/pi0 production events	Internal detection of single protons/deutrons. Single tracks
COSY beam energy loss measurement	Worked (despite small space in scatt.chamber)	Worked well

The three type of measurements should be done at the same time or under same conditions. This was unfortunately not the case for the presented studies.

The measurement of background event level is higher than what is expected from both vacuum and acc.beam energy loss measurements. It must be understood why ....

UPPSALA UNIVERSITET

Comments on expected background conditions at PANDA from the measurements at COSY.

Target condition studies at COSY

	Pellet (PTR mode)	Cluster-jet
Basic parameters: Target beam size Target thickness	Φ = 4 mm 2 · 10^{15} at./cm^2 (H_2)	Φ = 4-15 mm (oval) 1 · 10^{15} at./cm^2 (H_2)
Background expected at PANDA from just scaling up WASA / ANKE values due to 10x worse vacuum.	Bg event level 2% in vertex-z distr. <10% of target thickn. due to rest-gas	Bg event level 10% in vertex-z distr. ≈25% of target thickn. due to rest-gas
Expectations from differences of PANDA with respect to WASA and ANKE		
Narrow cross. Accelerator and target pipe Φ=20.	Target pipe wider than at WASA (Φ=5). Good (?).	Target pipe tighter than at ANKE (Φ=38). Bad (?).
Better skimming of the target beam at the generator.	Better catching of skimmed-off pellets and a second skimmer at the PTR section. Good !	A narrow oval skimmer should reduce the gas load with 65% compared to a std round one. Good !
Better target dump.	Better pumping and maybe improved dump design (needs testing). Good !	Yes ? (Lack of knowledge about ANKE dump)

Fig. 9.2 from Targets TDR (february 2012)

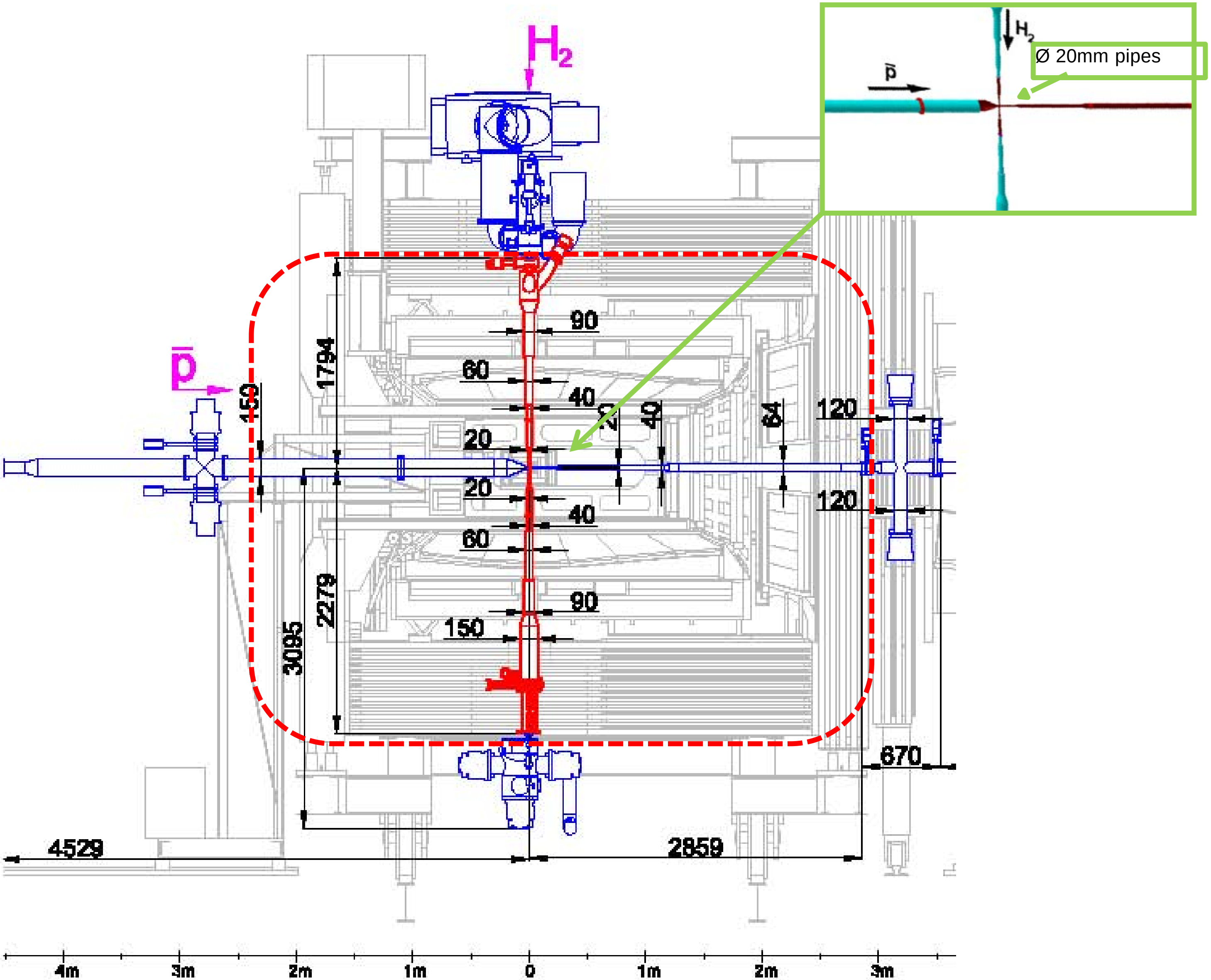


Figure 9.2: Cross section of the Target Spectrometer with detector components in light gray. The target and dump lines are marked in red. The antiproton beam line, as well as the cluster-jet target and the target beam dump, is marked in blue. The dimensions are given in mm. The diameters refer to inner diameters of the tubes.

UPPSALA UNIVERSITET

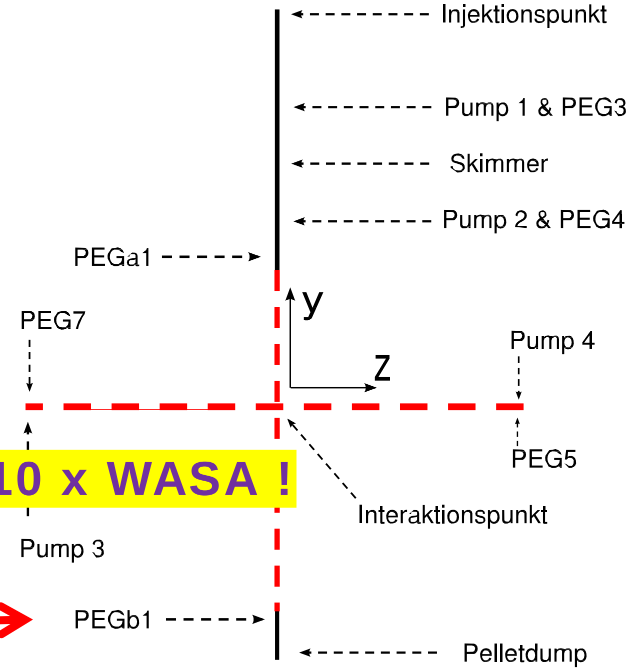
PTR status
Panda CM Vienna
November 2015
Hans Calén

Calculated pressures with pellet target at PANDA

WaC pump configuration
and nominal capacity

Measurem. point.	*Plts ON P [mbar]*	*Plts OFF P [mbar]*
PEG3	120×10^{-6}	130×10^{-6}
PEG4	9.2×10^{-6}	7.3×10^{-6}
PEGa1	9×10^{-6}	7.1×10^{-6}
PEG5	0.048×10^{-6}	0.005×10^{-6}
PEGb1	120×10^{-6}	1.5×10^{-6}
PEG7	1.8×10^{-6}	0.09×10^{-6}
Int.pt.	14×10^{-6}	0.66×10^{-6}

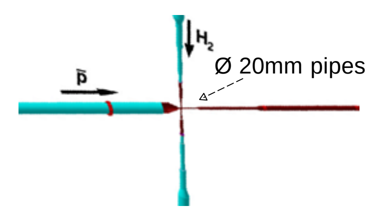
≈10 x WASA !



WaC pump configuration with
EXTRA 500 l/s pump at PEGb1

Measurem. point.	*Plts ON* P_{extra}/P	*Plts OFF* P_{extra}/P
PEG3	1.0	1.0
PEG4	1.0	1.0
PEGa1	0.88	1.0
PEG5	0.45	0.94
PEGb1	0.04	0.24
PEG7	0.42	0.89
Int.pt.	0.43	0.88

The red cross
= PANDA piping
(The rest are WASA components)



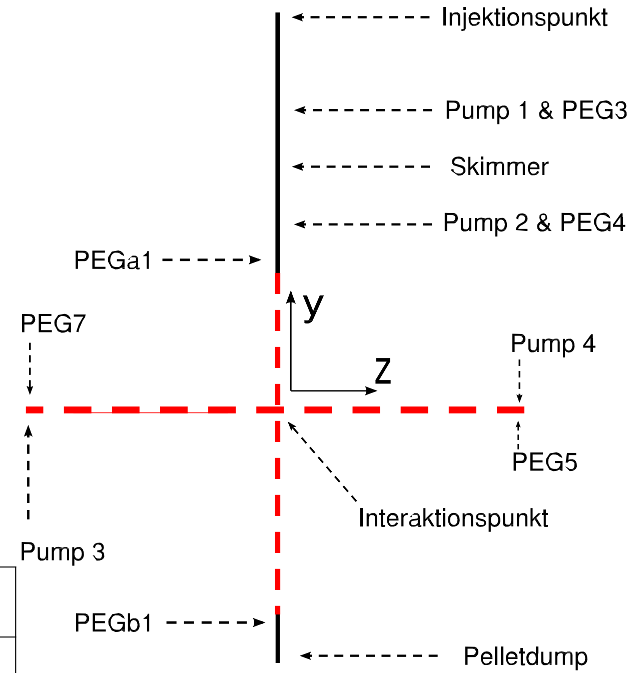
Calculated pressures for pellet target at PANDA

PANDA Pellet vacuum

UPPSALA UNIVERSITET

PANDA pump configuration

Pumps	*TDR (AG)*	*Wasa (JL)*
Generator	2x360 l/s	4000 l/s
Dump	-	1000 l/s
Upstream	2x1000 l/s	1500 l/s
Downstream	2x700 l/s	3000 l/s



Pellets ON

Pressure (mbar)	TDR (AG)	Wasa (JL)
Generator	20.e-6	9.e-6
Dump	200.e-6	120.e-6
Int.point	40.e-6	14.e-6
Upstream	2.e-6	1.8e-6
Downstream	4.e-6	0.05e-6

The red cross
= PANDA piping
(The rest are WASA components)

Pellets OFF

Int.point	2.e-7	7.e-7
Upstream	0.1 e-7	1.e-7
Downstream	1.e-7	0.05e-7

UPPSALA UNIVERSITET

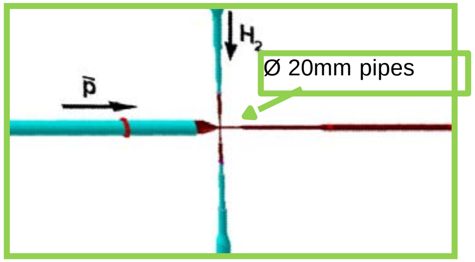
Pumping capacity cases. (The TDR case is given for reference only).

Pumps	*TDR*	*LOW*	*NOMinal*	*EXTRA*
Generator	720 l/s	2650 l/s	4000 l/s	
Dump	-	1000 l/s	1000 l/s	NOM+500 l/s
Upstream	**2000 l/s**	**1000 l/s**	**1500 l/s**	
Downstream	**1400 l/s**	**500 l/s**	**3000 l/s**	

Vacuum pressures for different cases compared to the case with nominal (WaC) pumping capacity.

Cases	*Upstr*	*IP*	*Downstr*
NOMinal pumping WaC	**1.8e-6**	**14.e-6**	**0.05e-6**
EXTRA 500 l/s pump at dump	**42%**	**43%**	**45%**
LOWer pumping capacity	**150%**	**112%**	**640%**
Narrow forw pipe L=23->77 cm	**102%**	**106%**	**50%**

- It seems difficult to influence the pressure at the IP dramatically with the present pump configuration.
- The vacuum upstream and downstream is just proportional to the pumping capacity there.
- The upstream pressure is higher since there the gas is pumped away.



- **Good pumping in the target pipe is most important.**

PTR status
Panda CM Vienna
November 2015
Hans Calén

UPPSALA UNIVERSITET

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

System	Item	Status
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 and 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 2014)
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 ≈ 5 mm for PTR mode.	Not clear. (Simple?)
Pellet target generator	**PTR mode operation ($\Phi_{stream} \approx 3$ mm, $\Phi_{pellet} \approx 25$ µm, v ≈ 70 m/s, f ≈ 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 (AP PhD thesis)).

Pellet target modes of operation

PELLET TRACKING (PTR) MODE:
-Useful tracking information available for most interaction events

PELLET HIGH LUMINOSITY (PHL) MODE:
- High and even target thickness for highest luminosity

UPTS conditions

	PTR	PHL
• **Pellet diameter**	≥ 20 μm	≤ 15 μm
• **Pellet frequency**	≈ 15k plt/s	≥ 150k plt/s
Average pellet velocity	≈ 60 m/s	≈ 60 m/s
• **Total spread in pellet relative velocity**	σ ≤ 2 %	as small as possible
• **Average distance between pellets**	≥ 4 mm	<< 4 mm
• **Effective target thickness (10^{15} at./cm^2)**	≤ 1.5	≥ 4
Pellet stream diameter	≈ 3 mm	≤ 3 mm
• **Accelerator beam vertical diameter**	≥ 3.5 mm	≤ 3.5 mm
• **Average no. of pellets in acc. beam**	≈ 1	≈ 10

UPPSALA UNIVERSITET

UPPSALA UNIVERSITET

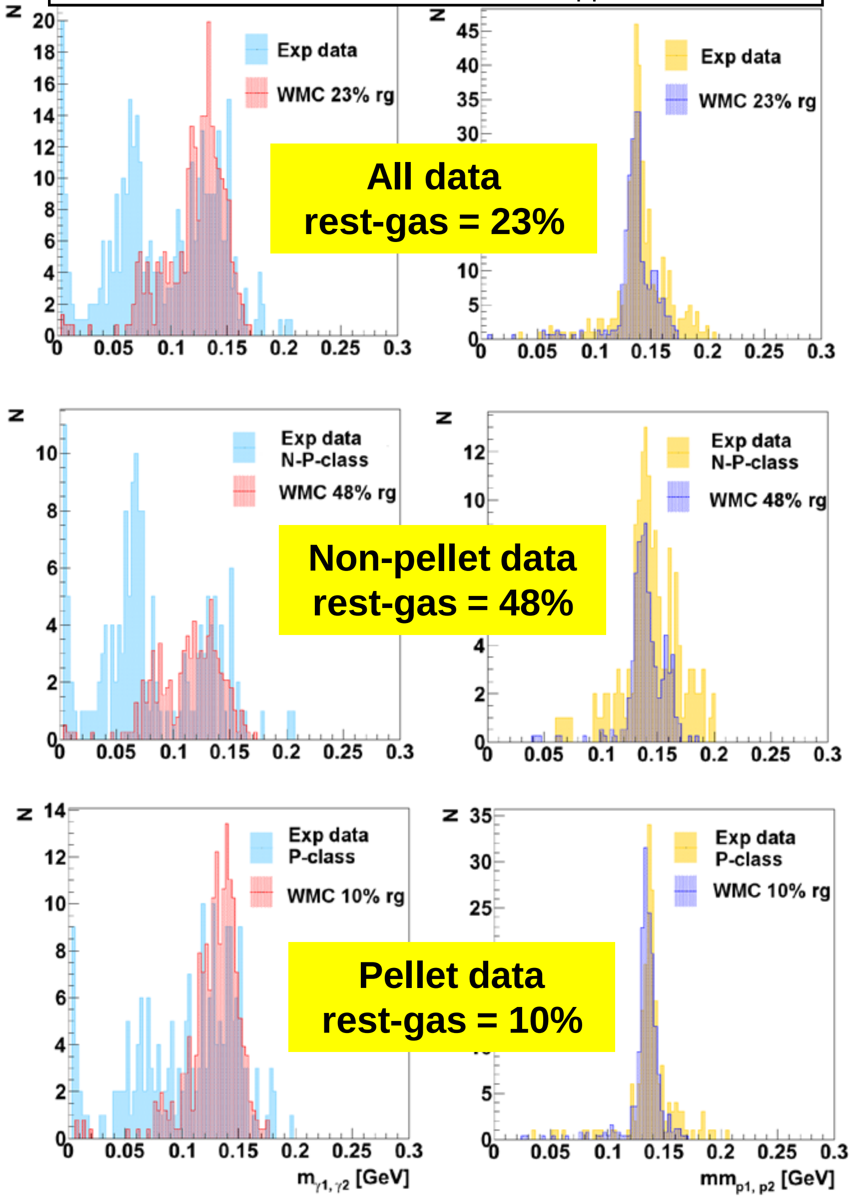
Connections between the Pellet tracking system and other systems (sub-projects):

System	Item	Status
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 and 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 2014)
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 ≈ 5 mm for PTR mode.	Not clear. (Simple?)
Pellet target generator	PTR mode operation ($\Phi_{stream} \approx 3$ mm, $\Phi_{pellet} \approx 25$ µm, v ≈ 70 m/s, f ≈ 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 (AP PhD thesis)).**

Background study at WASA pp-> pp π^0 run (π^0-> $\gamma\gamma$)

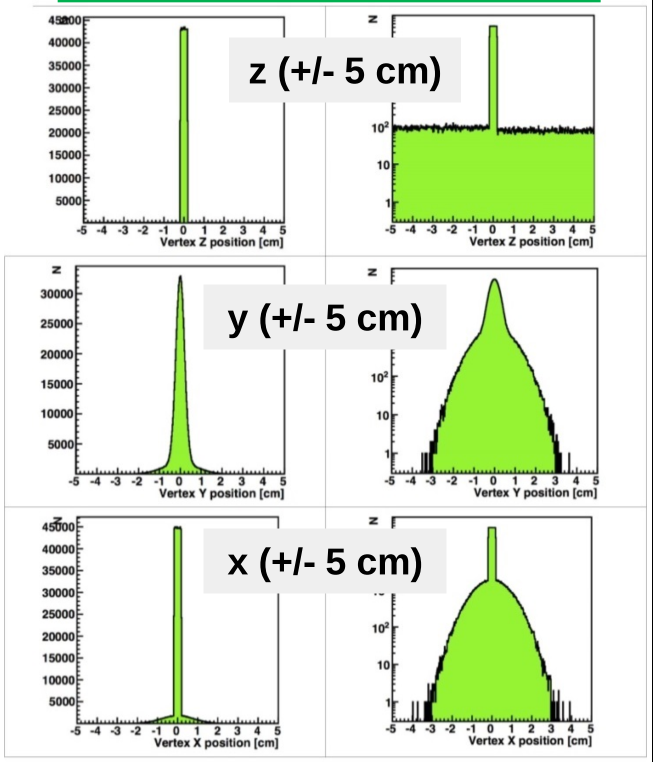
WaC Pellet vacuum

IM$\gamma\gamma$ (GeV/c^2)	MM$_{pp}$ (GeV/c^2)



Interaction-point distribution at WASA (25% occur in rest-gas)

Lin scale Log scale



UPPSALA UNIVERSITET

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*”

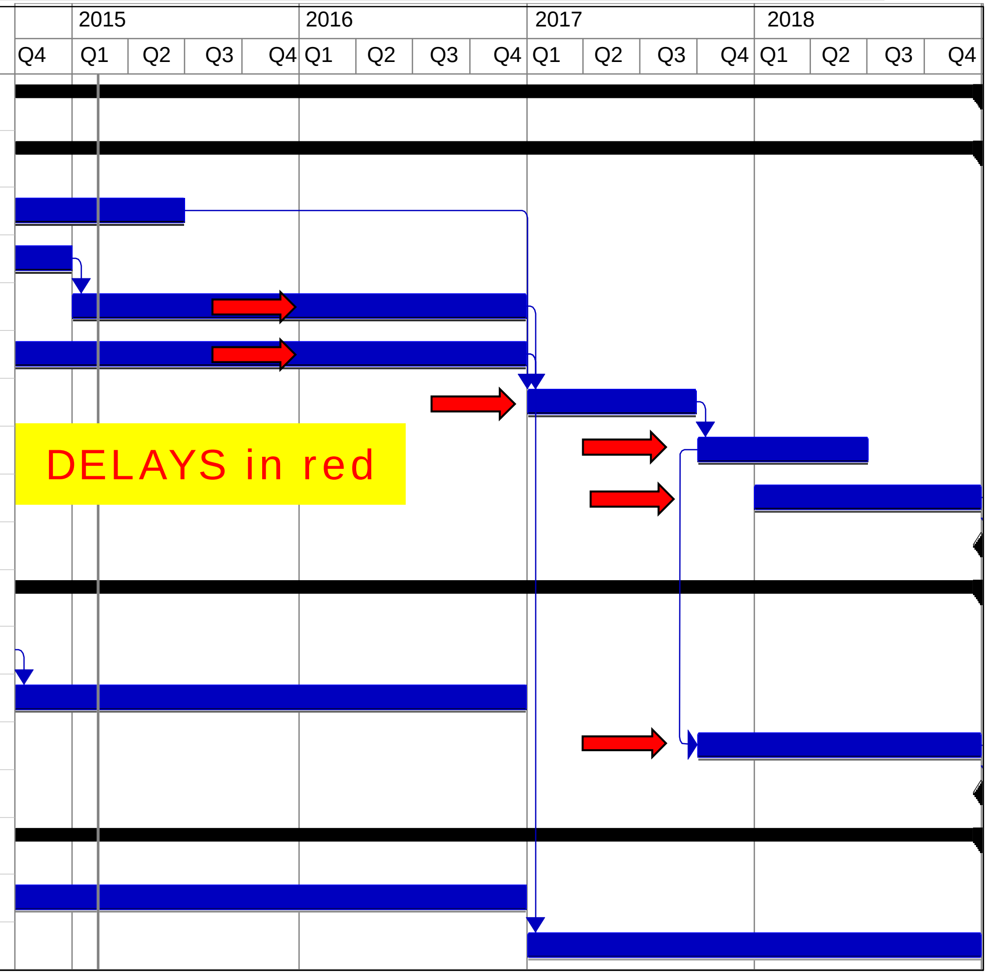
The pellet tracking project is not in the PANDA cost book and it is not a Swedish FAIR in-kind contribution. It can therefore not get part of the dedicated SRC support for PANDA. We see no possibility for substantial financing at present.

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

Project plan for the pellet tracking system developments 2015-2018

Jan 2015

ID	Task Name
1	**Pellet tracking system**
2	**Measurement configuration**
3	**Prestudies with UPTS PTR prototype 2-level setup**
4	**Design an operation scheme for (2) cams at a meas. level**
5	**Design a meas. level with mechanics for cams and lasers**
6	**Design the (2) multi-level measurement sections**
7	**Prepare a PANDA prototype (upper) section**
8	**Test the prototype section**
9	**Prepare and test both sections**
10	**Ready to install mechanics in PANDA**
11	**Readout system**
12	**Design multi-camera readout electronics**
13	**Test readout system with 2-4 cameras at UPTS**
14	**Test a complete system at the PANDA prototype section**
15	**Ready to install readout system (and cameras) at PANDA**
16	**Procedures and software**
17	**Design track processing and interfacing with event info**
18	**Design alignm procedures for all the parts of the system**



UPTS at TSL ?????

Need for new funding (pers+eqpt)

EC HP3: 30% eng (+cons)

SRC: 20% eng (+cons+eqpt)

PhD student: (JU/UU) ID=3,13,17

CTS: 13% eng (+30k€ eqpt) ID=5

UU pers (55% res, 10% eng (ID=12,13) **)**

(pers=personnel, eqpt=equipment, cons=consumables, eng=engineer, res=researcher, UPTS=Uppsala Pellet Test Station, TSL=The Svedberg Laboratory, UU=Uppsala Univ., JU=Jagiellonian Univ., EC=European Commission, HP3=Hadron Physics 3, SRC=Swedish Research Council, CTS=Carl Tryggers Foundation)