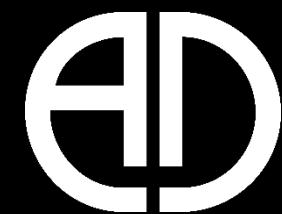


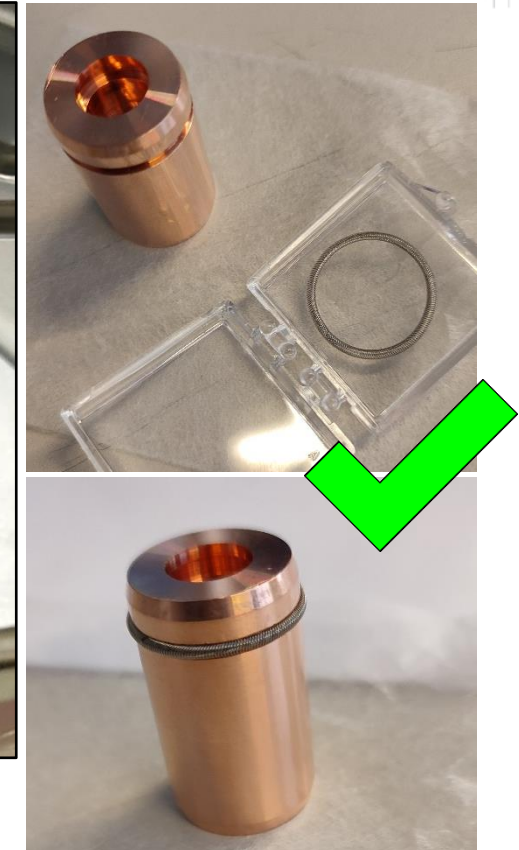
# Positrons for anti- hydrogen



# Positron source



- Old  $^{22}\text{Na}$  source activity at 5.5 mCi (<200 MBq)
- New source has arrived at CERN: wrong holder
- **Ongoing:** Sending back to Africa, wait for exchange with the correct holder (produced by ourselves and some special pieces from Rod Greaves, many thanks!)
- CERN RP/Shipping have a difficult time with bureaucracy, import requests ... it is getting solved, but very slowly
- Estimated arrival: **summer**



# Main positron HW issues 2023



# Maintenance during the YETS 23/24



MaintenanceToDo - Projects an X +

https://aegisgateway.cern.ch:8443/elog/MaintenanceToDo/53

Meistbesucht AEGIS overview AEGIS DAQ control Mail - Benjamin Rienna... AEGIS RunLog EDH - Home (Benjami... Captor Google Ü

Aegis | RunLog | HbarLog | Detectors | RunList | MaintenanceToDo

AEGIS Maintenance To-Do List

Message ID: 53 Entry time: Tue Feb 22 14:25:33 2022

Author:	Benji
Subject:	Projects and maintenance
Status:	To Do
Hardware:	Positrons

**High priority**

**I) Migrate the old AEGIS-POS into AEGIS-POS7**  
>> ACCESS PCI-DA 12-16 driver <https://acesio.com/drivers-downloads/>

**II) Maintenance of the ACC and TRAP cryopump -> Send to Trillium!**  
>> UPDATE 01/04/2023: The TRAP pump started to hammer and run irregularly, so I replaced it with the **refurbished** one.  
>> 01.12.2023: I heard bad noise from the TRAP cryo pump and switched it off. Opening it revealed we were coming close to a major m  
We started to make a mechanical fix of the problem (the displacer is held by a steel rod in a cylindrical pipe) and bak  
>> 05.12.2023: We baked the displacer at 80degC for 2 days, let it cool down and installed it back in the cleaned cryostat. We then pu

**III) Replace broken Trap ion gauge with a full range cold cathode (large pressure spikes common).**  
>> Gosia ordered a MPT 200 from Pfeiffer. In the positron cupboard in the CR

**IV) Replace the two USB-RS Boxes with one 8-Channel Moxa that works and reconnect the RGM**  
>> Exchange done! Contin. rack is already working again. The RGM communication is half-way working.  
>> The MOXA box has different RS485 2W pinout than the old NI box - needs new adapter cables  
>> 05.12.2023: New cables made, installed and tested: Now everything that worked before works again.

**V) Repair the bad GV communication. Might be related to the USB-RS boxes.**  
>> 05.12.2023: The new MOXA box did solve the issue for the nitrogen and the Neon feed and bypass lines.  
Not for CO2, though, where still one button toggles both valves at once. Needs more attention.

**VI) Repair/Exchange the Trap Pfeiffer HiCube membrane pump.**  
>> HiCube of Trap exchanged with the spare one - it works nicely. I do not see a port for the remote control though. Needs looking-into

**VII) Mass flow controller issue**  
>> Check if old ones still work. If yes, reinstall and send Seba back his three. Otherwise, buy three new ones.  
>> Seba might have money to buy one as of 20.01.2024

**VIII) Install and test new positron source**  
>> 18.10.2023 New 50 mCi source has arrived at CERN  
>> 07.11.2023 Meeting with RP about the installation at AEGIS. We need at least two volunteers to extract and insert the old and new s  
>> Impact for extraction: <https://impact.cern.ch/impact/secure/?place=editActivity:220248>  
>> 01.12.2023: RP finds per visual inspection that the holder is wrong on the right capsule. Also, iThemba has not provided the tungster  
Law demands to send the source back for this steps ... Theo suggested to ask a Swiss institute to do the installation

**IX) Look into the Trap magnet repair/replacement**  
>> Wrote an email to Technicoil, got response, they are certain they can repair at their facility. They generate a quotation for repair and  
>> They also suggest to buy a new one, for 17,000 Dollar. Additionally, they wish to know how to get more jobs from CERN.

**X) Install the new PbWO4 detector in the BB**  
>> We have all the components in the positron cupboard in the CR

**XI) Make and test a new converter target procedure, which does the final activation in situ the chamber at air**  
>> Either it is O2 or H2O doing the polution. We can test this in the BB, by keeping the target 1,2,3,4 weeks in air and see the performai

## High priority

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>> 05.12.2023: We baked the displacer at 80degC for 2 days, let it cool down and installed it back in the cleaned cryostat. We then purged everything wit  
>> 20.12.2023: The pump performs well, but the sound has not much improved ... hmm I think we should hurry with the maintenance from Trillium

### III) Replace broken Trap ion gauge with a full range cold cathode (large pressure spikes common).

>> Gosia ordered a MPT 200 Pirani+CC from Pfeiffer. In the positron cupboard in the CR  
>> 20.12.2023: I installed the gauge, by that breaking the vacuum of the Trap. Closing and pumpdown immediately after started.  
It should be noted that the CC has a collar made from a permanent magnet around the entrance, about 15cm away from the beam tube;  
I measured the residual magnetic field near the beam tube, it was negligibly small. However, near the potted trap housing there were some

### IV) Replace the two USB-RS Boxes with one 8-Channel Moxa that works and reconnect the RGM

>> Exchange done! Contin. rack is already working again. The RGM communication is half-way working.  
>> The MOXA box has different RS485 2W pinout than the old NI box - needs new adapter cables  
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### V) Repair the bad GV communication. Might be related to the USB-RS boxes.

>> 05.12.2023: The new MOXA box did solve the issue for the nitrogen and the Neon feed and bypass lines.  
Not for CO2, though, where still one button toggles both valves at once. Needs more attention.  
>> 20.12.2023: I also noticed that the GV between the Acc chamber and the Acc cryo pump currently cannot be closed. Electro valve issue?  
>> 20.04.2024: Did not find a reason for the last communication issues, but in general it is running again good enough.

### VI) Repair/Exchange the Trap Pfeiffer HiCube membrane pump.

>> HiCube of Trap exchanged with the spare one - it works nicely. I do not see a port for the remote control though.  
>> The old one maybe can be cleaned and fixed on site ...

### VII) Mass flow controller issue

>> Check if old ones still work. If yes, reinstall and send Seba back his three. Otherwise, buy three new ones.  
>> Seba might have money to buy one as of 20.01.2024  
>> 17.12.2023: Checked the old ones, re-confirmed that I cannot communicate with any of the devices, and the SF6 one even is completely dead.  
I removed Sebas MKS mass flow controller, has he needs it in Trento in Jan/Feb; I will order three new ones.  
>> 25.04.2024: 2/3 new ones from HORIBA have arrived and work well!

### VIII) Install and test new positron source

>> 18.10.2023 New 50 mCi source has arrived at CERN  
>> 07.11.2023 Meeting with RP about the installation at AEGIS. We need at least two volunteers to extract and insert the old and new source, respectively.  
>> Impact for extraction: <https://impact.cern.ch/impact/secure/?place=editActivity:220248>  
>> 01.12.2023: RP finds per visual inspection that the holder is wrong on the right capsule. Also, iThemba has not provided the tungsten cask.  
Law demands to send the source back for this steps ... Theo suggested to ask a Swiss institute to do the installation with our odl holder.  
>> 20.12.2023: Contacted PSI, Head of HotLab Marco Streit thinks it can be done, but not before end of January 2024.  
>> 27.04.2024: Import request solved, but shipping bureaucracy still is ongoing from the side of CERN RP/Shipping

### IX) Look into the Trap magnet repair/replacement

>> Wrote an email to Technicoil, got response, they are certain they can repair at their facility. They generate a quotation for repair and replacement  
>> They also suggest to buy a new one, for 17,000 Dollar. Additionally, they wish to know how to get more jobs from CERN.  
>> 02.05.2024: I have not seen any problems in trapping or usability without the first trim coil. I'd say we are good for now and can close this topic.

### X) New BB equipment

>> 2in PbWO4+PMT in new detector cup  
>> New laser mirror assembly  
>> Design and install new cryostat for cool experiments

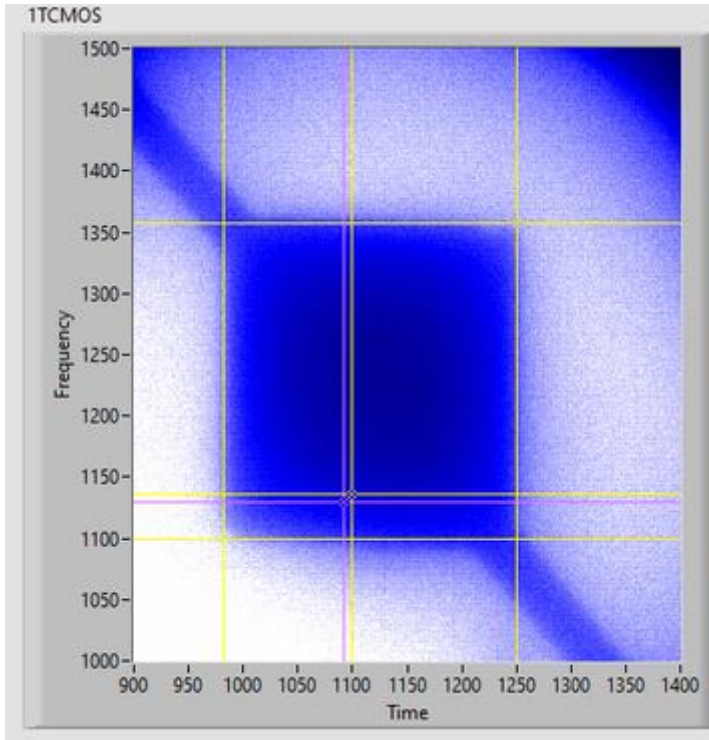
### XI) Make and test a new converter target procedure, which does the final activation in situ the chamber at air

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# Positrons in 1T

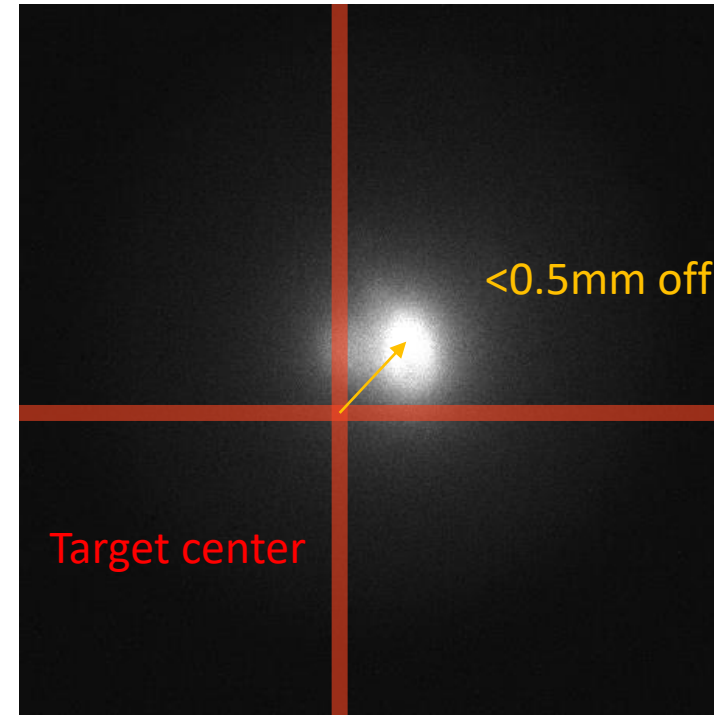


Electron image 2024

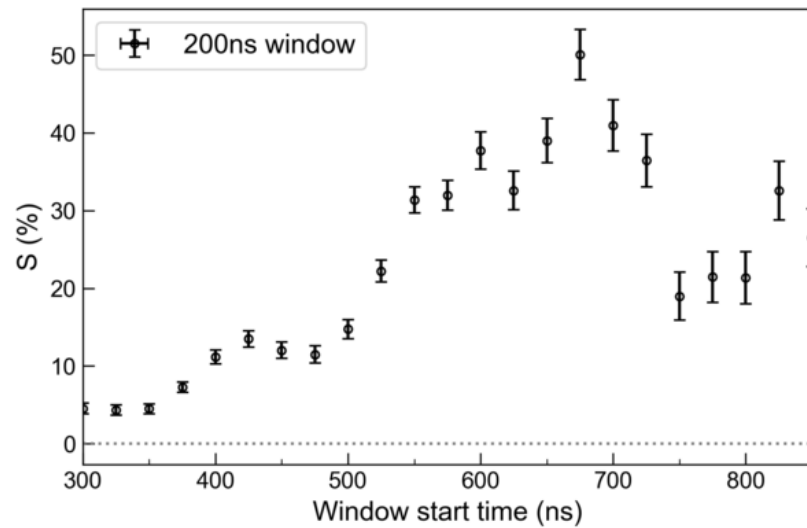
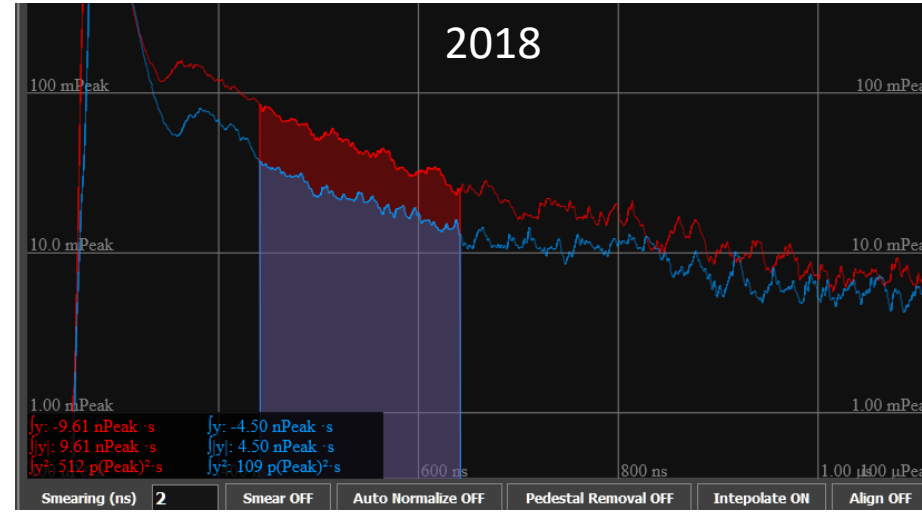
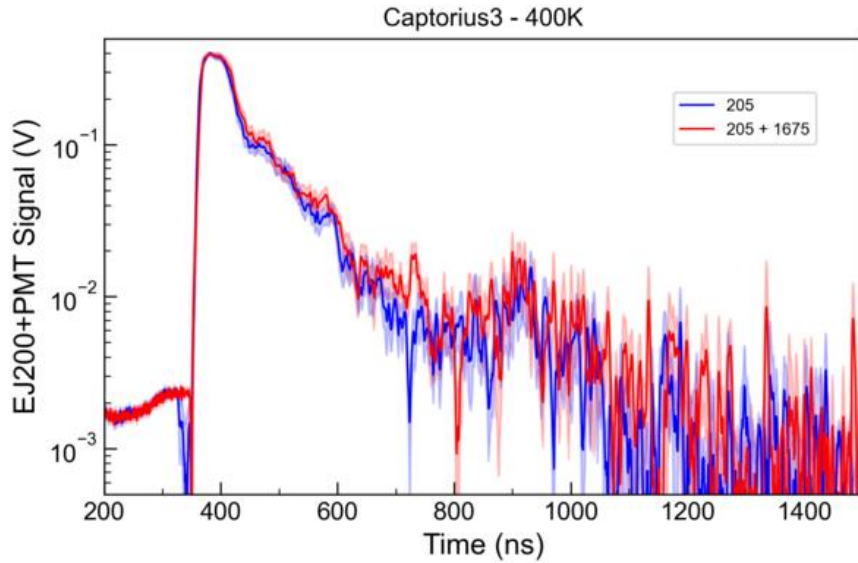


Target center May:  
**(1117, 1229)**

Last steering of 2023 still valid



# Ps in 1T



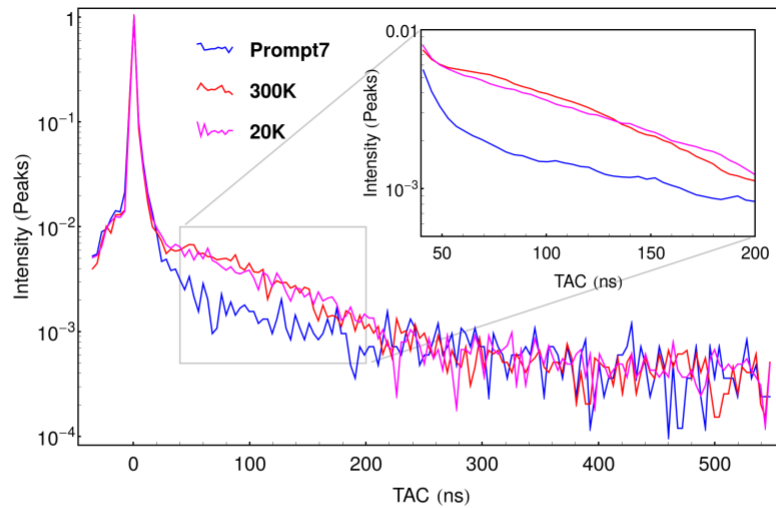
BG integral: 4.50 (2018) vs 3.9 (2024)

Signal integral: 9.78 (2018) vs 4.9 (2024)

Delta integral: 5.28 vs. 1.0

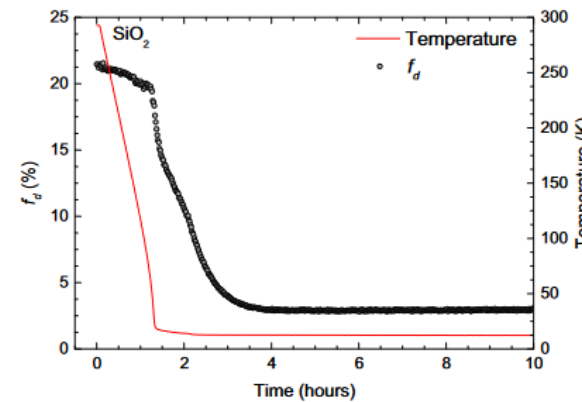
- Gain of PMT20? Splitter? ---  $4.5/3.9 = 1.154$
- Normalized Deltas ---  $4.6$  vs  $1.0$
- Source activity 2018/2024:  $5/1$
- NoP:  $2018/2024 = 750/1000 = 0.75$
- What to expect?  $4.6/5/0.75 = 1.2 \iff 1$

PhD thesis F. Guatieri



**Figure 2.9:** 7 keV ToF prompt spectrum measured on a silicon chip (blue) superimposed to the **300K** (red) and **20K** (magenta) spectra. In the inset the same spectra are presented averaged over a moving window of width 64 ns.

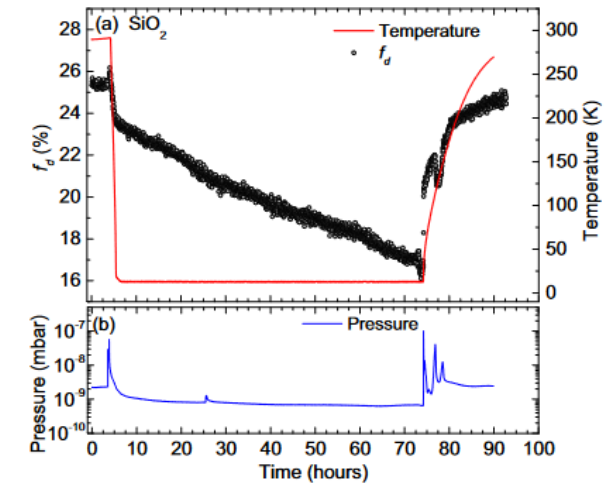
POSITRONIUM PRODUCTION IN CRYOGENIC ENVIRONMENTS



**FIG. 4.** Delayed fraction  $f_d$  from cooled mesoporous  $\text{SiO}_2$  measured in the high-pressure ( $5 \times 10^{-6}$  mBar) chamber. The delayed fraction error bars ( $\pm 0.1\%$ ) are not shown.

expected to work with similar efficiency at any temperature. In mesoporous materials, as well as metal oxide powders,

PHYSICAL REVIEW B 93, 125305 (2016)



**FIG. 5.** (a) Delayed fraction  $f_d$  from cooled  $\text{SiO}_2$  measured in the low-pressure ( $10^{-9}$  mBar) chamber. (b) Pressure in the target chamber associated with the cooling and heating cycle of (a).

## Enhancement of Ps-Ps interaction in nanoporous materials:

- Spin exchange during collision and becoming short-lived 2x p-Ps:  $\tau=125\text{ps}$
- Spin exchange during collision and becoming  $m=0$  state 2x o-Ps:  $\tau=142\text{ns}$   
+ strong magnetic field (1.5T): magnetic quenching of  $m=0$  states:  $\tau=125\text{ps}$
- Formation of  $\text{Ps}_2$ :  $\tau=0.25\text{ns}$

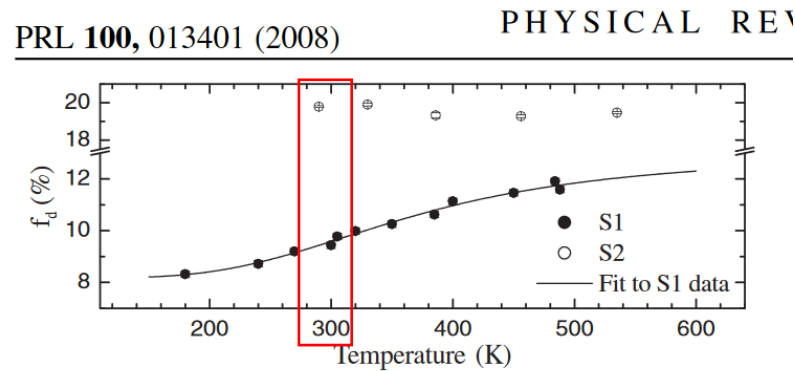


FIG. 2.  $f_d$  as a function of temperature for S1 (filled circles) and S2 (open circles) taken at the low beam density. The S2 data were taken using a reduced magnetic field of 0.15 T to minimize the effect of radiation damage, which leads to an increase in  $f_d$ . A fit was made to the S1 data using the procedure described in the text.

- S1 (at **1.5 T**): chaotic nanopores  
S2 (**0.15 T**): structured channels
- Thermal Ps desorption = increase with higher temperature
- Our target (**1.0T**):  
Si(111), highly porous, SEM: chaotic