MAINTENANCE TRACKING TOOL

Pre-Maintenance

Usage/Calendar based maintenance (UBM/CBM) NOTE! Refer to the PETtrace Service Manual - Maintenance (direction 2169049-100) for detailed instructions, apply LOTO and use PPE.	
System ID:	NE209962
Maintenance performed in accordance with instructions as outlined in the PETtrace Service Manual - Maintenance (direction 2169049-100) (signature (typed and signed)):	

Location	Action	Labor time (min.)	Sign.	For only optional operations note down if the operation is performed or not
Vacuum	**NOTE! Hydrogen gas flow should be on as for normal production.** • Read and record the vacuum pressure • Perform a BEV leak check : open the BEV for 2 minutes and close it. After 10 minutes open again the BEV,the vacuum value must not reach the value of 1.0*E-5	50		

Vacuum pressure readout — **Gas flow(sccm):** 4.0

Gauge number	Pressure (x10-) without gas	Pressure (x10-) with gas
A1 (4 on TCS 1001):	3,60E-03	3,50E-02
A2 (13 on TCS 1001):	UR	UR
B1 (14 on TCS 1001):	5,30E-08	1,20E-05

TPG parameters

	Low limit (x10-)	High limit (x10-)
A1:	1,00E-01	7,00E-02
A2:	1,80E-05	7,00E-01
B1:	2,00E-01	3,00E-05

• Press OFF on the VCU, followed by VENT, read and record the current VENT time

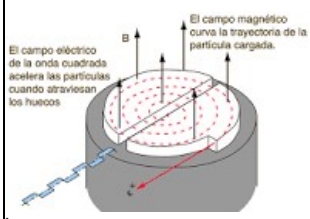
Vacuum VENT time

System software

Subsytem	Version
Master:	3,6
ACS:	4.3.2
Service System:	3.6.0
Manager:	TSA
Informix (only applicable to SUN-Master Station):	NA

VENT time:	2022-11-06 16:13

Comments:	comments
	Photo name:



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Vacuum

Test of vacuum tightness on PSS

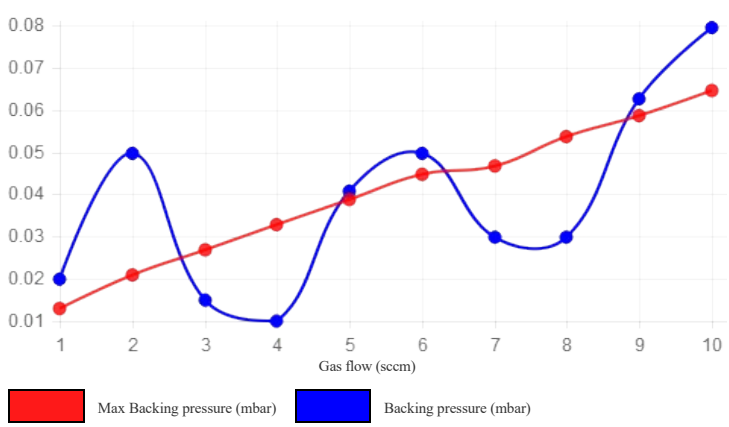
Plot vacuum pressure as function of gas flow from 1sccm to 10 sccm.
Vacuum pressure vs gas pressure should be a linear relationship.

Gas flow setting: 5,0 +/- 1 sccm

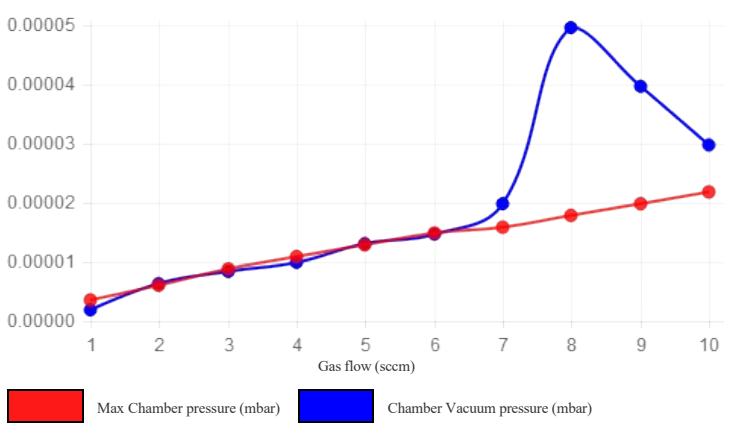
Gas flow	Chamber vacuum pressure (mbar)	Backing pressure	Max Chamber pressure (mbar)	Max Backing pressure (mbar)
1	1.9E-6	0.02	3,60E-06	1,30E-02
2	6.4E-6	0.05	6,10E-06	2,10E-02
3	8.45E-6	0.015	8,90E-06	2,70E-02
4	1.0E-5	0.01	1,10E-05	3,30E-02
5	1.32E-5	0.041	1,30E-05	3,90E-02
6	1.48E-5	0.05	1,50E-05	4,50E-02
7	2.0E-5	0.03	1,60E-05	4,70E-02
8	5.0E-5	0.03	1,80E-05	5,40E-02
9	4.0E-5	0.063	2,00E-05	5,90E-02
10	3.0E-5	0.08	2,20E-05	6,50E-02

OK value Too low value

Backing Pressure



Chamber Pressure

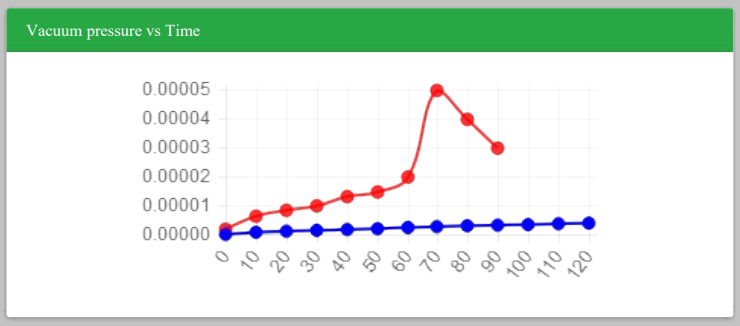


Pass critera: Linear relationship between vacuum pressure and gas flow. (Blue line should be below red line)

Vacuum leak test performed on PSS
With the vacuum system operating in pump mode with all BEV closed and without gas flow.

Set Vacuum system on VCU to Standby and observe the leak rate into the cavity (using pressure as proxy)

Time from Set Standby (sec)	Vacuum pressure (mbar)	Max leak rate
0	3.0E-8	1,80E-07
10	1.9E-7	1,00E-06
20	3.4E-7	1,50E-06
30	5.0E-7	1,90E-06
40	6.5E-7	2,30E-06
50	9.2E-7	2,70E-06
60	1.0E-6	3,00E-06
70	1.2E-6	3,30E-06
80	1.3E-6	3,60E-06
90	1.4E-6	3,90E-06
100	1.5E-6	4,20E-06
110	1.6E-6	4,60E-06
120	1.7E-6	4,90E-06



Pass critera: Time to reach 1.0E-5 mbar > 10 s (Blue line should be below red line)

Vacuum	• Switch on the water cooling to the diffusion pump • Press STANDBY on the VCU, record time
	Standby time **Actual standby start time:** 10:27
	• Verify that the green DP-lamp on the VCU lights up within 30min, re-adjust DP temp-switch as required
	DP-lamp activation time **DP -lamp activated in (min):** 0 **Max 30min**
	• Press PUMP on the VCU and note the following values:
	Pumping down **Time before HVV opening** 11 **10-15 min** **Actual time for HVV opening:** 0 **<30s** **Actual time to reach 1.0*E-5** 0
	• After reaching the vacuum value of 1.0*E-5 open the IS gas flow at 10sccm for 15 minutes

Vacuum	**WARNING! Diffusion pump may be very warm, verify that at least 2hrs has passed since pump shutdown.** **WARNING! Rotary and/or diffusion pump oil may be radioactive, verify activity level by performing an activity survey!** **NOTE! Verify that all cables are free from interference with the diffusion pump, interference may cause cable melting and/or electrical shortcut** • Verify the oil level and the color of the rotary pump oil, re-fill or change as required, record re-filled or changed volume
	Rotary pump oil level **Date of the last replacement of oil:** 2022-11-07 **Volume filled/changed (ml):** 0
	Maintenance of the diffusion pump: to be performed every 5 years **Last maintenance of the diffusion pump**
	Ventilate the diffusion pump by removing Pirani 1 **NOTE! Verify that the water cooling is shut off before disconnection of the diffusion pump** • Remove the diffusion pump and drain the oil **NOTE! Measure the lenght of the Jet assy before it is disassembled. The lenght is critical to pump performance.** • Disassemble and clean the diffusion pump • Replace the heater • Reassemble, reinstall and fill the diffusion pump with new oil
	Diffusion pump oil replacement **Volume filled/changed (ml):** 0
	• Verify the condition of the rotary pump oil mist filter, clean, inspect or replace as required • Verify the condition of the rotary pump oil mist filter O-ring, clean, inspect for damage and/or deformation, replace as required • Verify the functionality of the pirani gauges and the penning gauge, clean, inspect or replace as required

Comments:	
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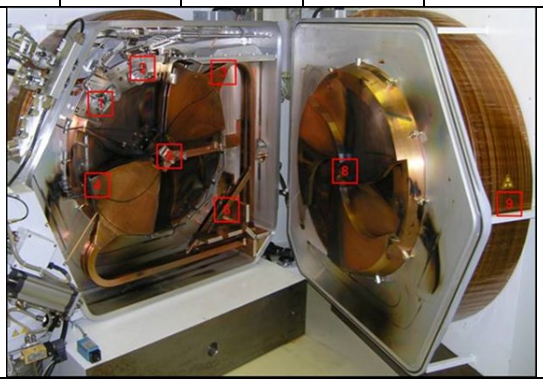
MAINTENANCE TRACKING TOOL

Chamber

Survey	Date: 2022-11-06					Time: 16:25				
EOB	Date: 2022-11-06		Time: 16:25			H:		Time after EOB in hour :		
Survey point	1	2	3	4	5	6	7	8	9	10
Probe dose rate (mSv/h)	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0



Targets

• Disconnect all targets from the service PC

• Switch off the manual water valves to the targets on the water manifold (the large wall mounted water manifold)

NOTE! 18F2 Deuteron target system requires NEON gas flushing before opening of connections.

NOTE! 18F2 Proton target system requires ARGON gas flushing X 3 before opening of connections.

NOTE! Do not disconnect the C11CH4 target, any atmosphere entering this target may ruin the target.

• Physically disconnect all targets from the cyclotron and transport them to safe/shielded location

• Verify condition and functionallity of the beam exit valves (BEV), repair or replace as required

BEV & Compressed air Tubing: annual replacement for BEV/ 3 years replacement for air tubing

Target position	**T1**	**T2**	**T3**	**T4**	**T5**
Date of the last BEV replacement:	APR2019	NA	NA	APR2019	NA
Action Performed (Y/N)	N	N	NA	N	NA
Date of the last compressed air tubing replacement	APR2019	NA	NA	APR2019	NA
Action Performed (Y/N)	NA	NA	NA	N	NA

Cyclotron

WARNING! Pinch hazard.

• Check the screws between yoke actuator and cyclotrons chassis: remove them, inspect for damage and if damaged replace them, otherwise put them back.

• Remove the magnet door bolt, inspect for damage. If damaged repair or replace, otherwise regrease to make it prepared for installation.

• Verify the magnet door functionality, the play between the yoke and the magnet, re-adjust as required, record play

Yoke to magnet play

Recorded play (mm):	5	**Limit 2-10mm**

RF flaps

• Verify flap and flap drive function, calibrate, repair and/or replace as required, read and record the current

Flap motor current

	Flap 1	**Flap 2**
Recorded current (mA):	82	117

• Verify the flap to DEE play, readjust as required, read and record

Flap to DEE play

Flap number	**0% (4mm +0,5/-0)**	**50% (>4 - <2mm)**	**100% (>26mm)**	**Working Position**
1:	4.34	11.72	34.52	NA
2:	4.84	11.82	31	NA

Central region

• Verify the DEE tip condition, replace if worn and/or damaged

NOTE! This action is only to be executed if the Ion-Source requires maintenance and/or replacement.

NOTE! Ion-Source maintenance may require paper burn to verify beam position in target.

• Read and record ion source adjustment, replace the anode assembly (ion source 'block' with anode/s and cathodes), re-read and record the adjustment

Ion source adjustment (with dummy anode)

Location	Recorded distance (mm) After	Typically (mm)
A:	0.45	0,9-1,2
B:	0.75	0,3-0,5
C:	0.4	0,4-0,6
D:	0.75	1,1-1,3

• Verify flip-in probe condition, position, insulation and functionality, reposition and/or replace as required, read and record

Flip-in probe insulator surface reading		
Recorded reading (kΩ):	29.5	Typically 29,4kΩ

• Read and record DEE settings, adjust as required (refer to original factory settings, if adjusted re-read and record

DEE settings

Measurement point	Height (mm)	Thickness (mm)	Theoretical midplane from pole (mm)	Actual midplane from pole (mm)	Variance (max 0,5mm)
Dee1 tip top (A):	46.20	33.20	30	29.6	0.4
Dee1 upper corner (B):	74.10	33.10	58	57.55	0.45
Dee1 lower corner (C):	47.10	33.50	30	30.35	-0.35
Dee1 tip lower (D):	46.40	33	30	29.7	0.3
Dee2 lower tip (E):	74.30	33.40	58	57.6	0.4
Dee2 lower corner (F):	47.10	33.80	30	30.2	-0.2
Dee2 upper corner (G):	74.90	33.20	58	58.3	-0.3
Dee2 upper tip (H):	75.00	33.50	58	58.25	-0.25
Stem 1 (I)	100.50	NA			
Stem 1 connecting block (J)	102.00	NA			
Stem 2 (K)	101.00	NA			
Stem 2 connecting block (L)	102.00	NA			

NOTE! Do not touch or clean the DEE pick ups.

• Verify thightness of the DEE and the stem screws, re-tighten if required

Extraction

• Verify foil condition, in case of >3 broken foils; replace the carousel and transport the replaced unit to a safe/shielded location for decay

• Verify functionality and status of the limit switches, repair and/or replace as required

• Verify capton cable condition, repair and/or replace as required

• Verify carousel turn mechanism functionality, repair and/or replace as required

• Verify that the carousel insulation, repair and/or replace as required, read and record resistance

Carousel insulation (ground resistance)		
Recorded resistance extraction 1 (carousel to carrier) (kΩ):	29.4	Typically 29.4kΩ
Recorded resistance extraction 2 (carousel to carrier) (kΩ):	29.45	Typically 29.4kΩ
Recorded resistance extraction 1 (cable to carrier) (kΩ):	0	>500kΩ
Recorded resistance extraction 2 (cable to carrier) (kΩ):	0	>500kΩ

• Verify extraction drive mechanism functionality, the balance functionality, repair and/or replace as required, calibrate, read and record the motor current

Extraction and balance motor current		
Maximum recorded current extraction 1 (mA):	142	Limit 50-200 mA
Maximum recorded current extraction 2 (mA):	101	Limit 50-200 mA
Maximum recorded current balance (mA):	120	Limit 100-300mA

Collimators

• Verify collimator condition, openings, re-adjust, repair and/or replace as required, read and record insulation

Collimator readings

Collimator position	Insulation (recorded ground resistance) (typically 29,4kΩ)	Horizontal opening (mm)	Vertical opening (mm)
1 (lower)	29.46	1	10
1/2	29.48	0	0
2/3	0	0	0
3/4	29.46	0	0
4/5	0	0	0
5/6	0	0	0
6 (upper)	0	0	0

• Verify target clamps insulation, repair and/or replace as required, read and record insulation

Target clamps insulation (ground resistance)	
Target clamp position	Recorded resistance (typically 20,4kΩ)
T1	0
T2	0
T3	0
T4	0
T5	0
T6	0

Tank

• Verify that no parts are; burned, covered by aluminum oxide (sputtered), foreign material and/or other contamination, replace parts as required and document by photo

	• Verify that no damage, contamination and/or deformation are present on the vacuum tank o-ring, replace as required, otherwise clean and regrease • Verify that the finger contacts are properly secured in place and that no damage and/or deformation are present, reinstall and/or replace as required • Verify that the silicon baffles are properly fitted and tightly secured at their locations and that no damage are present, tighten and/or replace as required • Verify that the the screen plate and the screws for the covers at the top right inside of the tank are securely attached and that no damages are present, if required tighten and/or replace
Water cooling	• Switch on the secondary water cooling (Swedewater), let it run for at least 10 minutes, verify normal operation' • Verify that no leaks are present on the water manifold (target panel), the magnet connections, the RF system, the ion-source system, the PSMC, repair and/or replace as required • Verify the condition of the water cooling lines for the targets, if hard or brittle, replace as required • Turn off the main water cooling pump on the secondary water cooling system (Swedewater) (optional: perform only in case of cooling problems) • Inspect and replace filter Z2 at the Swedewater (optional: perform only in case of cooling problems) • Inspect and clean filter Z1 and Z3 at the Swedewater (optional: perform only in case of cooling problems) • Verify water conductivity and flow at the Swedewater, if conductivity error has occurred/occurrs during production, replace the ion exchanger resin (normally once a year) • Off mode: Verify water level and pressure at the Swedewater, re-fill and/or adjust as required, read and record

Secondary water cooling system (Swedewater) system off data		
Water volume filled (ml):		**If fill is not required, mark N/R**
Static pressure compressed air (kPa):	0	**Limit 40-200 kPa**

• On mode: Verify water cooling system readings, adjust as required, read and record

Secondary water cooling system (Swedewater), system on data	
Expansion vessel BP1 (bar):	
Main pump pressure BP2 (bar):	
Vacuum cooling pump BP3 (bar) (if present):	
System temperature BT1 (degree C):	
Temperature alarm (degree C):	
Cooling water out temperature BT2 (degree C):	
Cooling water in temperature BT3 (degree C):	
Deonizer flow BF10 (liter/min):	
Conductivity BQ1 (µS cm-1):	

Targets	• Replace LTF peek (Optional operation) • Verify the condition of the water cooling tubes, if hard or brittle, replace as required
Annual maintenance: Check of the PDU terminal screws	For the PDU, yearly check to be done: • If Vacuum still OFF, stop the swedewater pump and then turn off the power of the PDU • Put the gloves and helmet for electrical interventions • Check and if needed tigthen the terminal screws inside the PDU
End of inside-bunker operations	• Install the paper burn target • Verify the sealing of the target gasket • Close the bunker before restart the vacuum

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MAINTENANCE TRACKING TOOL

Beam

Beam	• Perform a paper burn test in DB for both targets

• Dismount the paper burn targets and put the standard targets in place

• Check the He flow inside flowmeters fot both target in SB and DB and close the bunker

• At the Service System: Connect targets and verify target vacuum tightness, repair and/or replace as required
• At the Service System: Select FILL TARGET (for F18 target select: O16 water) and verify the fill volume verify that the target pressure increases in accordance with the specification for the specific target type, adjust, repair and/or replace as required
• Verify that the vault door are closed
• Connect the Service System to the ACU and power up the Service System, set the master to local and log in to the Service System
NOTE! Only Service System: BEAM CONTROL and TARGET pages are to be utilized.
• Start the water cooling, verify vacuum system status at the VCU, set magnet to on and set configuration value
• Set RF to STANDBY, select target and set the extraction foil to the selected target position, park the other extraction foil
• Set the flip-in probe to: IN, select H- particle, set RF to NORMAL
• Verify Ion-source gas, turn on the Ion-source and set to 50mA, verify current on the flip-in probe and set flip in probe to OUT
NOTE! Maximum collimator and tuning (extraction foil current) current is 10µA.
• Read and record the target, the foil, the collimator current, adjust the extraction foil until equal collimator current is achieved
• Adjust the magnet current, the RF DEE voltage, the RF delta DEE voltage, the extraction foil current and the gas flow to achieve optimal beam

Beam performance	
Beam performance	**H-**
Magnet current (A):	430
DEE voltage :	34
Delta Dee Voltage	1
Ion source current (mA):	98
Ion source voltage (kV):	1012
Gas flow (sccm):	4
Flip-in probe current (IFLIP (µA)):	
Target 1 position/type:	
Target 2 position/type:	98,3
Foil 1 current	98,3
Foil 2 current	31,6
Collimator lower 1 current	1,6
Target 1 current	12,79%
Collimator upper 1 current	16,99%
Collimator lower 2 current	
Target 2 current	
Collimator upper 2 current	
Target 1 beam width (Col lower+Col upper / Itarget in%)	
Target 2 beam width (Col lower+Col upper / Itarget in%)	
Extraction foil current (IEXT (µA)):	
Transmission Target 1 = ITAR/Ifoil	
Transmission Target 2 = ITAR/Ifoil	
Acceleration Efficiency = Ifoil/Iprobe (H > 60%)	
ISEFFICIENCY=IFLIP/IARC (H- >0.20, D- >0.10) (µA/mA):	
Water cooling system (Swedewater), with beam-on	
Expansion vessel BP1 (bar):	
Main pump pressure BP2 (bar):	
Vacuum cooling pump BP3 (bar):	
System temperature BT1 (degree C):	
Cooling water out temperature BT2 (degree C):	
Cooling water in temperature BT3 (degree C):	
Deonizer flow BF10 (liter/min):	
Conductivity BQ1 (µS cm-1):	
Water cooling system (Swedewater), with beam-on	
External temperature	
	Valve position
Cyclotron in standby condition	
After 1 hour of irradiation	
After 2 hour of irradiation	

Comments:	
PHOTO:	**Photo name:**