

/CEH

PS/LI/Note 86-10

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**THE OXYGEN PREINJECTOR
OPERATION**

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THE SOURCE

Startup of Oxygen source from cold

Source interlock indications are at the top of rack OP05 as are the controls for the various Faraday cups (FCx). FC2 is the RF-PROBE and FC-HF the BEAM STOP in J. Robert's Linac 1 interlock chain. However, before attempting to start the source, first verify the state of the racks and the vacuum system. If all seems normal, proceed.

- 1) Open the 2 demineralised water supply valves at the side of the source. The return valves are normally open.
- 2) In the triangle, start the Haezemeyer power supplies with the switch Alim/Telecom set to Alim; ON auxiliaries, RESET alarms, ON power. If the main circuit breaker falls, reset it and try again. Switch back to Telecom. Raise the current from OP05 to around 1000A until the lamp 'MAGNETFELD' becomes green on the u-Gen interlocks.
- 3) At the 10GHz generator switch on the filament after resetting the WATER alarm. Verify after 5 minutes that filament has stayed on and reset any remaining alarms (u-Gen). Wait about 20 minutes for interlock relay to clear (LED 'Pret' on).
- 4) Switch on the focusing solenoids SOL12 and SOL22 and bending BHZ12 power supplies after clearing any alarms locally. Verify references and acquisitions of the currents (BHZ12 66A) either locally or at the console.
- 5) Idem for the 3 DC quads and the three pulsed quads on the balcony.
- 6) Switch on necessary scopes and 300V bias (OP0 4+5).
- 7) Put RFQ (and OXYBUNCHER) 200MHz on to warm up (DRFQ0 6).
- 8) Open the valve on the Helium bottle (grey). After verifying that the vacuum relay IKW010 is on, switch on the Helium valve RVG040 (OP05) and set the helipot to 400. Interlock u-Gen 'QUELLEN' should become green.
- 9) Switch on 'KUEHLUNG HEXAPOLE' (OP05). Verify that its lamp on the u-Gen chain becomes green and that the orange lamp at the bottom of the plug-in becomes orange.
- 10) Open the valve on the Oxygen bottle (blue), then open the hand valve on the source 2.5 turns.
- 11) Switch on the Extraction power supply to 15KV for D6+ (OP05). Do not confuse the ON/OFF with the Local/Remote switch (metal lever switch).
- 12) With the 10GHz output potentiometer at zero (OP05) and the LED 'PRET' green, switch on the HT (see point 3 above). Wait about 15 seconds until the HT meter on the generator rises to about the top of the scale and then increase the generator power output to about 500W. The HT can only be switched on if the output potentiometer is at ZERO. If this is not the case the LED flashes. This procedure also applies if the HT trips for any reason.
- 13) Increase the two source solenoids to their nominal values. A signal of about 4mA should be present on FC1.
- 14) Open Valves 22 on LEBT and RFQ vacuum controls in OP03 if they are not already open (page 5). The Faraday cups protect the valves and can not be removed if the valves are closed.

- 15) Switch on steering power supplies (OPD 4).
- 16) Remove FC1 and observe signal on FC2 (ATTENTION FC2 IS THE SO CALLED RF PROBE AND SHOULD ONLY BE REMOVED WHEN THE LINAC1 INTERLOCK CHAIN IS COMPLETE). The Red button puts the cup in, the Green out. LEDs show the status of the cup. Stabilise the signal by varying the two solenoid currents. However, they should not be too different from the reference values. Aim for a signal of about 5-6 cm on 100mV/cm. The quantity of Helium also influences the stability, so play with all three quantities but do not depart too far from the reference values. After some time the amplitude on FC2 should increase (Warm-up effects). Keep the source stability under control with the solenoids and Helium flow. You should aim eventually for about 5-6cm an 200mV/cm with a u-wave power of about 700W and helium around 360. Trim the source as needed. Also verify the current in BHZ12 by sweeping the extraction voltage around 15KV, the signal on FC2 should be a maximum at 15KV. Adjust BHZ12 if needed.
- 17) Switch the rest of the RF on (ORFQD 6) and tune the RFQ as needed (OPD 4). Cooling the RFQ seems to upset the tuning so the RFQ is not normally cooled. The RFQ is on the Linac cooling system if cooling is needed. During the first day of operation verify the tuning of the RFQ regularly.
- 18) Before removing the beam-stop verify that the current falling on it (scope OPD4) corresponds to at least 3 divisions on 50mV/cm. (75uA)
- 19) Switch on beam chopper at +/- 700v (platform)
- 20) Open sector valve DIO.VVS30 (LR102) and verify the operation of the ion pumps (DIO.VPI-101, OIC.VPI-101) on the Bunchers (LR101). Verify that BHZ15 is OFF and OIP.VVS20 is closed.

Reference values can be found in the source log book. NB Too much 10GHz RF power can make the source very unstable. Apply power with care and check the source regularly for stability of the beam on FC2. Initial source adjustments are easier if the chopper is off. A poor source adjustment could perforate the vacuum envelope.

Total switch off

- 1) 10GHz power to zero, HT off, filament off.
- 2) Helium valve RVG040 off, Oxygen hand valve closed, Bottles closed.
- 3) Solenoids to zero. However, it may be easier to switch on the supplies with some loading (200A say). Then Off, but the auxiliaries can stay on.
- 4) Power supplies and scopes off.
- 5) Hexapole Kuhlung off.
- 6) Close Valves #22. (procedure page 5)
- 7) Close inlet valves for demineralised water.
- 8) Close DIO.VVS30 in LR102.

Warm Standby

- 1) Close the valves #22 in the LEBT and RFQ (procedure page 5). The Faraday cups will enter automatically.
- 2) Close the sector valve OIO.VVS30 (LR102).
- 3) Put beam stop O.STP10 in.
- 4) Reduce the RF and modulator levels of Tanks 2 & 3.
- 5) Reduce the 10GHz power level to about 50% noting the helipot value for future reference.
- 6) Verify that the Tank 1 formation program is running.

Warm startup

- 1) Open valves #22 in the LEBT and RFQ (rack OP03). The procedure is given on page 5.
- 2) Increase the 10GHz RF power to its nominal value if it was reduced at standby time. (rack OP05)
- 3) Verify the presence of beam on FC1 (rack OP05) and then remove the probe.
- 4) Verify the presence of beam on FC2 (rack OP05) but do not remove this probe yet. (SONDE RF in the interlock chain)
- 5) Open sector valve OIO.VVS30 (rack LR102).
- 6) Verify ALL RF levels, (is the Tank 1 formation program running?), and the helipot LEVEL MODULATORS Tanks 2 & 3.
- 7) Verify that the two LINACs are pulsing in parallel (rack LCR14, NIM20, station 1 -->!!LINAC2).
- 8) Verify the radiation security interlock chain. (Zone inspection?)
- 9) Remove the RF probe FC2 and verify the presence of beam on the beam stop (FC-HF) (rack OP05).
- 10) Open the beam stop O.STP10 (rack LCR10) and verify the beam on the SEMGRIDS.
- 11) If the beam has no users, put the RF probe FC2 in as any alarm on the radiation interlock chain will cut the RF of Tank 1.

VACUUM SYSTEM

Operation of Valves 22 (Balzers microprocessor controls)

- 1) Press RECALL
- 2) Press 'Soft Key' "CHANGE"
- 3) Reply to "New Menu" '06' to open or '07' to close.
- 4) Press ENTER.
- 5) Press RECALL twice to return to pressure reading.
[A reply of '79' at step 3 puts you in control. Enter the element number to access that element and reply to the prompts]

Regeneration of RFQ Cryopumps (or restart when needed)

If pumps start to show heavy condensation or frost on their outsides, it is time to regenerate them.

- 1) Goto Menu 79, element 10, close valves 10.
- 2) If possible leave valve 22 open to pump RFQ via the LEPT.
- 3) Element 5, stop cryopumps. Leave the pumps to warm up overnight if possible. Otherwise purge with DRY nitrogen. During warm up condensation on the pump bodies is normal.
- 4) Next morning, via Menu 79, start roughing pump element 1. Its circuit breaker will have to be closed. Verify that the vent valve on the roughing line is closed and that the pressure on the locally mounted gauge falls.
- 5) Fill the trap with liquid nitrogen (LN₂).
- 6) Open the two small hand valves at the cryopump heads and maintain an adequate liquid nitrogen level in the trap.
- 7) When the pressure on the local Pirani is below 10E-1torr restart the cryopumps (element 5) verifying that the pumps work (sight glass) and that the breaker has not tripped (on wall behind GSI racks).
- 8) After about 30 minutes close the hand valves but always maintain an adequate LN₂ level in the trap.
- 9) When the pump head temperature is in the blue range (better still below 20K) and the pressure in the RFQ is low enough (better than 10E-3) open valves 10.
- 10) The RFQ pressure should fall quite rapidly to the range 10E-6.
- 11) Stop roughing pump (element 1), vent the line and close the vent valve. This pump normally stays off so open its circuit breaker (near bottom of the rack).
- 12) Return the controller to pressure indication by the double RECALL procedure.

If it is necessary to pump down the RFQ as well proceed as follows.

- 1) If it is not already in service, start up roughing pump 1 as outlined above up to the end of step 5.
- 2) Open hand operated roughing valve and pump RFQ to as low a pressure as possible whilst maintaining an adequate LN₂ level in the trap.
- 3) Close the roughing valve and the proceed from step 9 above.

Clean up of gas lines

If after a prolonged stop the pressure gauges on the gas bottles are indicating a negative pressure, the gas lines should be cleaned.

- 1) Repressurise the lines and then release the pressure by opening them for a very short period.
- 2) Helium line:- open the Helium valve (OPD 5) with the bottle closed and wait until the bottle gauge shows -1 with the valve voltage showing maximum. Switch off valve before repressurising line.
- 3) Oxygen line:-
 - a) Via Menu 79 close valve 10 on ECR Source 1st Stage.
 - b) Lift lever of small manual valve on stainless steel line going to fore pump. A temporary alarm on gauge 4 is normal.
 - c) Wait until bottle gauge shows -1 before closing hand valve
 - d) Repressurise line.

Reprogramming the Balzers TCS 1000 controllers

There are a number of ways of reprogramming the TCS 1000 controllers, but in an emergency the following procedure is probably the best. In theory, during this reprogramming procedure the controlled system should retain its previous status until START is initiated. However, it is probably better to put the system to safety by closing sector valves using menu 79 (the manual control menu). If the RFQ is being treated, leave valve 22 open to allow pumping by the LEBT.

- 1) Choose menu 73.
- 2) Reply to MANUAL AUTO REMOTE ETC [MARE] with soft key ETC.
- 3) Reply to next menu ERASE.
- 4) Reply YES to ERASE ALL, all LEDS on the synoptic will go out.
- 5) MARE now reappears, reply STORE.
- 6) Reprogramme each element of the system according to the programming sheets. At the end of each step the corresponding LED on the synoptic should light up with the current status of that element.
- 7) Quit the programming mode with the key STOP instead of entering an element number.
- 8) You will be returned to the MARE prompt, reply AUTO.
- 9) Reply with the next batch of programming information to the questions displayed.
- 10) The final prompt will be START VENT CHANGE press START.
- 11) If all has gone well, the system should reset itself to its new environment after about 30 seconds. (NB. valves may close etc.)

Programming data

For each subsystem the replies to give for each element are given below after the element number. Enter the element number before programming the element.

ECR Source 1st stage

#1 IN-AD= E(nter).
#4 PLUG= 1; LL= 1.0E-1; UL= 2.5E-1.
#5 TURBO ; 80% IN-AD= 1, CH= 2; K2 IN-AD= 1, CH= 1;
ST.BY OUT-AD= 1, CH= 8.
#8 PLUG= 3; LL= 1.0E-1; UL= 2.5E-1.
#10 OP.IN-AD= 1, CH=3; CL.IN-AD= 1, CH= 4;
OUT-AD= 1, CH= 1; OUT-AD= E.
#20 IN-AD= 1, CH= 5; OUT-AD= 1, CH= 7.

Turbo stby MANUAL
Valve 10 AUTO
Roughing via 10 NO
Time 1 00:10:00
Time 2 00:00:30
Time 3 00:00:10
Time 4 00:30:00
Time 5 02:00:00
Start-Stop Remote IN-AD= E.

ECR Source 2nd stage

#1 IN-AD= E(nter).
#4 PLUG= 1; LL= 6.0E-2; UL= 2.0E-1.
#5 TURBO ; 80% IN-AD= 1, CH= 2; K2 IN-AD= 1, CH= 1;
ST.BY OUT-AD= 1, CH= 8.
#10 OP.IN-AD= 1, CH= 3; CL.IN-AD= 1, CH=4;
OUT-AD= 1, CH= 1; OUT-AD= E.
#20 IN-AD= 1, CH= 5; OUT-AD= 1, CH= 7.

Turbo stby MANUAL
Valve 10 AUTO
Roughing via 10 NO
Time 1 00:10:00
Time 2 00:00:30
Time 3 00:00:10
Time 4 00:30:00
Time 5 02:00:00
Start-Stop Remote IN-AD= E.

EXTRACTION LEFT

#1 IN-AD= E(nter).
#4 PLUG= 1; LL= 2.0E-2; UL= 1.0E-1.
#5 TURBO ; 80% IN-AD= 1, CH= 2; K2 IN-AD= 1, CH= 1;
ST.BY OUT-AD= 1, CH= 8.
#10 OP.IN-AD= 1, CH= 3; CL.IN-AD= 1, CH= 4;
OUT-AD= 1, CH= 1; OUT-AD= E.
#20 IN-AD= 1, CH= 5; OUT-AD= 1, CH= 7.

Turbo stby MANUAL
Valve 10 AUTO
Roughing via 10 NO
Time 1 00:10:00
Time 2 00:00:30
Time 3 00:00:10
Time 4 00:30:00
Time 5 02:00:00
Start-Stop Remote IN-AD= E.

EXTRACTION RIGHT

#1 IN-AD= E(nter).
#4 PLUG= 2; LL= 1.0E-2; UL= 1.0E-1.
#5 TURBO ; 80% IN-AD= 1, CH= 2; K2 IN-AD= 1, CH= 1;
ST.BY OUT-AD= 1, CH= 8.
#10 OP.IN-AD= 1, CH= 3; CL.IN-AD= 1, CH= 4;
OUT-AD= 1, CH= 1; OUT-AD= E.
#13 PLUG= 1; LL= 5.0E-3; UL= 1.0E-2.
#14 PENNING; CARD= 1; RELAY CONTACT OUT-AD= 1, CH= 3;
LL= 5.0E-5; UL= 2.0E-4.
#20 IN-AD= 1, CH= 7; OUT-AD= 1, CH= 7.

Turbo stby MANUAL
Valve 10 AUTO
Roughing via 10 YES
Time 1 00:10:00
Time 2 00:00:30
Time 3 00:00:10
Time 4 00:30:00
Time 5 02:00:00
Start-Stop Remote IN-AD= E.

LEBT

#1 IN-AD= E(nter).
#5 TURBO ; 80% IN-AD= 1, CH= 2; K2 IN-AD= 1, CH= 1;
ST.BY OUT-AD= 1, CH= 8.
#13 PLUG= 1; LL= 5.0E-3; UL= 1.0E-2.
#14 PENNING; CARD= 1; RELAY CONTACT OUT-AD= 1, CH= 2;
LL= 9.0E-6; UL= 2.0E-5.
#20 IN-AD= 1, CH= 3; OUT-AD= 1, CH= 7.
#22 OP.IN-AD= 1, CH= 4; CL.IN-AD= 1, CH=5;
FREIGABE IN-AD= 1, CH= 6; OUT-AD= 1, CH=1.

Turbo stby MANUAL
Roughing via 10 YES
Time 1 00:10:00
Time 2 00:00:30
Time 4 00:30:00
Time 5 02:00:00
Start-Stop Remote IN-AD= E.

RFQ CRYOPUMPS

#1 IN-AD= E(nter).
#5 TURBO ; 80% IN-AD= E.; K2 IN-AD= E.;
ST.BY OUT-AD= 1, CH= 8.
#10 OP.IN-AD= 1, CH= 6; CL.IN-AD= 1, CH= 7;
OUT-AD= 1, CH= 3; OUT-AD= E.
#13 PLUG= 2; LL= 1.0E-2; UL= 1.0E-1.
#14 PENNING; CARD= 1; RELAY CONTACT OUT-AD= 1, CH= 7;
LL= 9.0E-6; UL= 2.0E-5.
#22 OP.IN-AD= 1, CH= 3; CL.IN-AD= 1, CH=4;
FREIGABE IN-AD= 1, CH= 5; OUT-AD= 1, CH=5.

Turbo stby MANUAL
Valve 10 AUTO
Roughing via 10 NO
Time 1 01:30:00
Time 2 01:00:00
Time 3 00:00:10
Time 4 00:30:00
Time 5 02:00:00
Start-Stop Remote IN-AD= E.