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# QUICK REFERENCES

## GPS – $\pi$ M3 AREA

### QUANTUM CRYO – 9506

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$\mu$ SR FACILITY 2011

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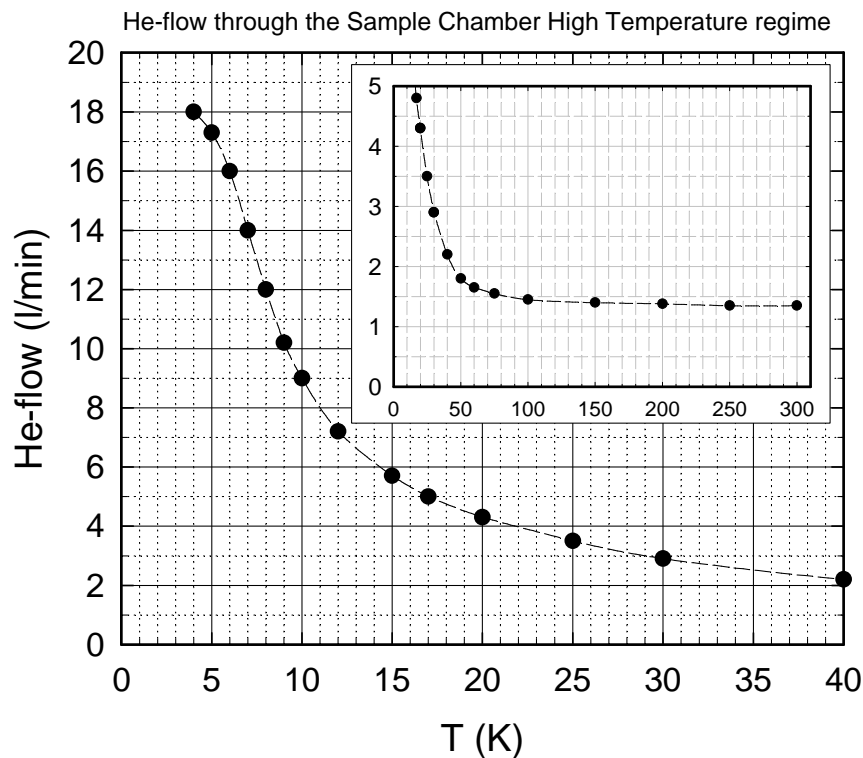
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# 1 QUANTUM CRYOSTAT – QUICK REFERENCE

High temperature regime (5 K → 300 K):

1. Flow F1 (Transfer Line) at about 11-12 l/min to keep the Phase Separator temperature at about 4.3 K (if necessary adjust yellow valve V1).  
Note: this temperature can be slightly higher when  $T_{diffuser}$  is near room temperature.
2. Manual valve V2 closed.
3. PUMP2\_B switched OFF.
4. He-flow controlled by the electromagnetic valve V3b Controller and instruction in Counting Room.
5. Needle valve V4: 0.5 mm open (50 units)
6. 230 mA in Tube Heater.
7. The desired temperature is obtained by choosing the He-flow F2 according to the Figure and by sending the required setpoints to the temperature controller.

*Note that if the needle valve V4 is not enough open, the necessary flow to reach 5 K cannot be reached → open slightly more the needle valve V4*  
*On the other hand if the needle valve V4 is too much open, temperature oscillations may occur around 15-20 K → close slightly the needle valve V4*



Low temperature regime ( $\sim 2.3 \text{ K} \rightarrow 10 \text{ K}$ ):

1. Flow F1 (Transfer Line) at about 11-12 l/min to keep the Phase Separator temperature at about 4.3 K (if necessary adjust yellow valve V1).
2. Manual valve V2 fully open.
3. PUMP2\_B switched OFF.
4. No current in Tube Heater.
5. The lowest stable temperature is obtained by gradually closing the needle valve V4. As the valve is closed the pressure P2 will gradually decrease and the sample temperature will decrease correspondingly.
6. Higher temperatures (up to 10 K) are achieved by keeping the He-flow constant and solely changing the setpoints of the temperature controller.  
*Note that a temperature scan is only possible once the pressure and flow conditions necessary to reach the lowest temperature are obtained (i.e.  $F2 \simeq 5 \text{ l/min}$  and  $P2 \simeq 30 \text{ mbar}$ )*

Low temperature regime ( $\sim 1.8 \text{ K} \rightarrow 10 \text{ K}$ ):

1. Flow F1 (Transfer Line) at about 11-12 l/min to keep the Phase Separator temperature at about 4.3 K (if necessary adjust yellow valve V1).
2. Manual valve V2 fully open.
3. PUMP2\_B switched ON.
4. No current in Tube Heater.
5. The lowest stable temperature is obtained by gradually closing the needle valve V4. As the valve is closed the pressure P2 will gradually decrease and the sample temperature will decrease correspondingly.
6. Higher temperatures (up to 10 K) are achieved by keeping the He-flow constant and solely changing the setpoints of the temperature controller.  
*Note that a temperature scan is only possible once the pressure and flow conditions necessary to reach the lowest temperature are obtained (i.e.  $F2 \simeq 5 \text{ l/min}$  and  $P2 \simeq 5 \text{ mbar}$ )*

## 2 CONDUCTUS TEMPERATURE CONTROLLER

The *Conductus* temperature controller connected to the *Quantum* cryostat is usually utilized in a REMOTE-mode and can be directly controlled from `deltat`.

The following steps describe how to configure and use the *Conductus* temperature controller from `deltat`.

- **Configuration:**

Each time that you change the configuration of the cryostat (new sample stick), you have to configure the driver controlling the temperature controller.

In the tab `Modify Devices` choose the temperature controller entry and hit the buttons `Modify` and, on the pop-up window, `Modify Setup`.

Choose the corresponding sample stick from the drop-down list.

Hit the `Next` button and choose the corresponding `Entry` for your setup

*Remember that the QUANTUM is usually controlled by the Conductus in a two-loop mode*

Hit the `Apply & Exit` button and at this point the software should automatically detect the PID tables needed and load them into the *Conductus* temperature controller.

Remember to put the controller in the `CONTROL` mode.

- **Setting a temperature:**

In the tab `Modify Devices` choose the temperature controller entry and hit the buttons `Modify` and, on the pop-up window, `Modify Temperature`.

On the pop-up window, change for both loops the setpoints and hit the button `Apply Changes`.

- **Autorun sequences:**

Before writing an autorun sequence, be sure that the *Conductus* is in the desired mode (one or two-loop mode).

*In the autorun file, do not forget to give all (6) the arguments in the two-loop mode.*

To change the temperature, you will need an entry like:

```
SET Temperature 100.0 1.0 30 100.0 1.5 30
WAIT Temperature INRANGE
```

In this example the setpoints are 100.0 K for both loops, the tolerances 1.0 K for the first loop and 1.5 K for the second loop and the waiting times are 30 seconds

### 3 He-FLOW CONTROL

The He-flow through the “Sample Space” can only be controlled when solely the Electromagnetic Valve V3b (PFEIFFER EVR116) is used, the big bypass valve V2 is shut and the PUMP2\_B is switched OFF.

The control is performed by the Valve Controller PFEIFFER RVC300. The actual He-flow is measured by a flowmeter (HASTINGS HS-50KS) and is also indicated on the center display located at the top of the rack.

- *Setting a flow from **deltat**:*

In the tab **Modify Devices** choose the flow controller entry and hit the **Modify** button. Enter the new flow value in the pop-up window and close it.

- *Setting a flow in an autorun sequence:*

A He-flow setpoint can also be included in a auto-run sequence by using the command **SET Flow FLOW XXX** command.

*Example:*                    **SET Flow FLOW 4.3**

With this example, an He-flow setpoint has been set to 4.3 liter-gas/minute.

- *Manual setpoint (only in case of emergency):*

Locate the RVC300 device in the area rack.

Press the button locate below **PARAM**.

Press the **edit** button to edit the **SOLL** value. Change it with arrow buttons (note that 100 mV correspond to 1 l/min).

Press the button locate below **SAVE**

The time needed for the actual He-flow to reach the setpoint value will depend on the PID parameters of the RVC300 controller.

When increasing the temperature, the He-flow should be changed first, if necessary. The temperature controller setpoint, should be changed in a second step. The opposite should be done when decreasing the temperature. If a large change of flow is required, big temperature overshoots can be observed. To minimize the overshoots, the He-flow setpoint should be changed in different steps prior to change the temperature controller setpoint.

Depending on the setting of the needle valve V4 between the “Phase Separator” and the “Sample Space”, it is possible that a desired He-flow cannot be reached eventhough the RVC300 controller will fully open the Electromagnetic Valve V3b. To fix this problem, one should more open the needle valve.

## 4 SAMPLE CHANGE

The following points describe the process of changing a sample in the “Quantum Cooler” cryostat.

- **For safety reasons, a sample change should only be performed in the “High Temperature regime” with a sample temperature  $T > 30$  K.**
- Switch OFF the heaters by setting the Conductus (or Neocera) temperature controller in the *Monitor* Mode [by pressing the *Local* button (if necessary) and pressing the *Monitor* button].
- Switch OFF the Tube Heater.
- Disconnect the electrical plug from the sample holder.
- Dismount the rotation motor.
- Stop the He-flow through the pumps PUMP1 and PUMP2\_A by closing:
  - the two valves V2 and V3a on the pumping line of the Sample Chamber (do not disconnect the electrical plug of the electrovalve V3b).
  - the yellow valve V1 on the transfer-line pump (use the closing-ring without changing the actual setting of the valve).
- Pressurize slightly the “Sample Chamber” with He-gas by opening the valve V6 until you reach a pressure P2 slightly above 1000 mbar (check that the He-gas cylinder is open).
- **Check carefully and frequently** the pressures P1 and P2 in the “Phase Separator” and in the “Sample Chamber”. (An overpressure in the sample chamber could damage the titanium windows).
- Remove the clamp of the sample holder.
- Remove the sample holder from the cryostat.
- **Immediately** mount a blind-flange on the cryostat opening.
- Stop blowing He-gas by closing the valve V6.
- Restart the He-flow through the He-pumps by opening the valves V1, V3a.

When you are ready to insert the sample holder with the new sample, you should follow an analog procedure as above. Namely:

- Stop the He-flow through the pumps by closing:

- the two valves V2 and V3a on the pumping line of the Sample Chamber (do not disconnect the electrical plug of the electrovalve V3b).
  - the yellow valve V1 on the transfer-line pump (use the closing-ring without changing the actual setting of the valve).
- Pressurize slightly the “Sample Chamber” with He-gas by opening the valve V6 until you reach a pressure P2 slightly above 1000 mbar (check that the He-gas cylinder is open).
  - **Check carefully and frequently** the pressures P1 and P2 in the “Phase Separator” and in the “Sample Chamber”.
  - Dismount the blind-flange very shortly before inserting the sample holder.
  - Insert the sample holder **carefully** (to insert a *warm* sample holder requires more force than to remove a *cold* holder).
  - Replace the clamp.
  - **Immediately** stop blowing He-gas by closing the valve V6.
  - Restart the He-flow through the He-pumps by opening the valves V1, V3a (and V2 if the low temperature regime is needed).
  - Readjust the He-flows.
  - Reconnect the electrical plug to the sample stick
  - When a sufficient He-flow is detectable in the Sample Chamber, set the temperature controller in the *Control* Mode.  
This is done either:
    - If you are sure that you are using the same sample holder as previously, you can locally press the *Local* button (if necessary) and press the *Control* button.
    - If you have changed sample holder you will have to configure the temperature controller through the `deltat` programme
  - If you want to operate in the High Temperature regime, do not forget to switch ON the Tube Heater.

## 5 CHECK-LIST WHEN CHANGING THE SAMPLE

The following points should be checked when changing a sample.

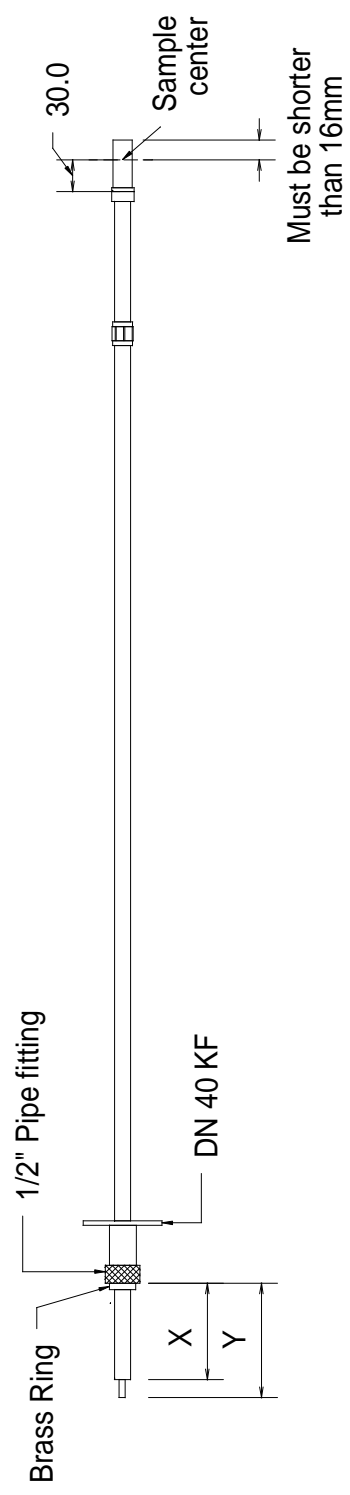
- **Using the standard sample holder, the stick can be inserted only 1.5 mm more than its nominal value.**
- Check that flat brass part located on the external part of the stick corresponds to the sample holder orientation.
- Check that you have exactly **one** O-ring before introducing the target stick into the cryostat.
- The positioning of the sample can also be done by checking the external dimensions of the stick (see drawing).
- Check (if needed) that the sample holder is perpendicular to the beam (use the flat brass part located on the external part of the stick).
- The cryostat should be at the nominal X-position 11.2
- Be sure that your temperature controller is correctly configured (through the programme `deltat`) and that it is on the *Control* Mode.



## 6 He-DEWAR CHANGE

Should the He-Dewar levelmeter read below  $\sim 15\%$  (in the case of a 100-liters dewar) or below 100 mm (in the case of a 250-liters dewar), the He-Dewar needs to be changed.

- **For safety reasons, a He-dewar change should only be performed in the “High Temperature regime” with a sample temperature  $T > 30$  K.**
- Stop the He-flow through the pumps PUMP1 and PUMP2\_A by closing:
  - the two valves V2 and V3a on the pumping line of the “Sample Chamber” (do not disconnect the electrical plug of the electrovalve V3b).
  - the yellow valve V1 on the transfer-line pump (use the closing-ring).
- Switch OFF the heaters by setting the Conductus (or Neocera) temperature controller in the *Monitor* Mode [by pressing the *Local* button (if necessary) and pressing the *Monitor* button].
- Switch OFF the Tube Heater.
- Lift up slightly ( $\sim 50$  cm) the transfer line on the He-dewar side (the bottom part of the transfer line in the He-dewar should now be above the liquid-He level).
- Pressurize slightly the “Phase separator” with He-gas by opening the valve V5 until you reach a pressure P1 of about 1000 mbar (check that the He-gas cylinder is open).
- **Check carefully and frequently** the pressures P1 and P2 in the “Phase Separator” and in the “Sample Chamber”. (An overpressure in the “Sample Chamber” could damage the titanium windows).
- Disengage the adaptor of the transfer line from the top of the dewar by releasing the O-rings.
- Slide the adaptor upward along the transfer line.
- Remove completely the transfer line on the He-dewar side.  
Replace the plug of the He-dewar to prevent freezing of the He-dewar.
- **Carefully** warm up the transfer line using the available heat-gun.
- Be sure that the sintered end-part is free of any ice.
- Change the He-dewar.



Holder	X (mm)	Y (mm)
8	60.6	77.8
9	61.2	78.4
10	60.6	77.7
11	60.7	77.7

- **Check that the He-recovery line is connected to the dewar and that the corresponding valves are open. Be sure that the recovery line is not bent and that the He-gas can flow freely.**
- Insert slowly the transfer line in the new He-dewar.
- As soon as the sintered part is enough inserted in the dewar, lower the adaptor and connect it to the dewar.  
**Make sure that the adaptor of the transfer line is well inserted in the dewar, and that all O-rings are tightened.**  
Leave the transfer line above the liquid-He level.
- Stop blowing He-gas by closing the valve V5.
- Open the valves on both He-pumps (do not forget, if necessary, to reconnect the electrical plug of the electromagnetic valve V3b).  
Open the valve V1 completely.
- Wait 30 seconds.
- Pull down slowly the transfer line in the He-dewar.  
**Check carefully and frequently that the transfer line is well aligned with the dewar and that it does not bent; if necessary move slowly and carefully the He-dewar to align it with the transfer-line.**  
Be also sure that the transfer line does not touch the bottom of the He-dewar (leave it few centimeters above the bottom).
- The He-flow in the transfer line will first show a rapid increase, due to the sudden overpressure in the He-dewar, which will be followed by a decrease. After 1-2 minutes, the He-flow through the transfer line will again increase to its maximum value.
- After a few minutes, the temperature of the “Phase Separator” should drop to the nominal value.
- Readjust the He-flows.  
(For this last point, experience shows that the “Transfer Line” flow F2 should be maintained for few minutes to a high value and gradually decreased)
- When a sufficient He-flow is detectable in the Sample Chamber, set the temperature controller in the *Control* Mode [by pressing the *Local* button (if necessary) and pressing the *Control* button].
- If you want to operate in the High Temperature regime, do not forget to switch ON the Tube Heater.
- Do not forget to tightly close the empty He-dewar and to connect it to the He-recovery line

## 7 SAMPLE ROTATION

The motor control unit *EL734* switches automatically to local mode as soon as a local operation is performed.

To rotate manually the sample:

- Be sure that the “+” and “-” buttons are lit (otherwise wait few seconds). Press the green round button corresponding to the motor # 1  
The green LED of the button should now be ON
- Press and hold the “+” (or “-”) yellow button to rotate the sample in one or the other direction
- If during this operation, the green square button suddenly lit, it means that the computer has taken the control of the device. In this case, wait few seconds and restart the procedure. The computer connects to the device every 30 seconds..., so be quick...)

To rotate the sample remotely:

- In *deltat*, the tab **Modify Devices** contains the device **Position**. Choose this device and hit the **Modify** button. Enter the new position value in the pop-up window and close it.
- A rotation of the sample can also be included in a auto-run sequence by using the command

```
SET Position ANGLE 100.0
```

With this example, an angle of 100 is requested.

## 8 EPICS-CONTROLLED POWER SUPPLIES

Since 2011, all the power supplies for the beam magnets are now controlled by the system EPICS (Experimental Physics and Industrial Control System). In addition, almost all the power supplies have been replaced and few more will be replaced during the next shutdown.

All power supplies can be controlled via the Beamline PC (PC8290). The “Experiment Magnets” can be controlled through the `deltat` application running on the console (PC6012). Both computers run EPICS clients applications. The heart of the EPICS control for the  $\pi$ M3 beamline is a VME crate located on the platform above the GPS cabin, in the first left-hand side row of power supplies.

The beamline PC uses the “SetPoint” application which can be started either:

- with the icon “SetPoint” on the Desktop or
- with the command-line:  
`/afs/psi/intranet/HIPA/Secondary/bin/setpoint_new.tcl`

From this application one can set the magnets, switch them ON/OFF, open/close the beam-blockers and also control the Spin-Rotator high-voltages.

## 9 BEAM-LINE SETTINGS

*Which settings ?*

Some standard settings are normally provided (transverse or longitudinal mode; shared or not shared, MEG or not MEG...). The names are normally self-explanatory.

*How to set the beam-line ?*

- Start the SetPoint application on the PC8290 (see above).
- When loading a new setpoint-file (.sp files) the values are read and displayed in the column “File value”.
- In order to set the power supplies, one should select them (via the button “Select All” for example) and press the button “Set File value (→)”. At this point the power supplies should ramp-up to the desired values.
- For the high-voltage power supplies block, the setting is not automatic and one should additionally press the drop-down list on the right-hand side and choose the option “HVSET”. Note that the setting of the high-voltage power-supplies can take several seconds.
- When saving the current setting, the value in the column “Set value” will be written in the file and the column “File value” will be updated accordingly.

Due to hysteresis effects, cycle the steering magnets SSK31, SSK32 and SSK33: set their minimum values (either -10 or -15 Amps); wait few seconds and put back the proper initial values of the file.

By going from transverse to longitudinal mode, it is sometimes necessary to retune the spin rotator value. Note that this retune could be necessary over a long time scale (hours...).

If better settings are found, it is strongly requested to save them (with the standard notation and by doing a proper entry in the logbook) to the benefit of the following users.

**NEVER OVERWRITE EXISTING SETTINGS !!**

## 10 SETTING THE EXPERIMENT MAGNETS

The magnets WED, WEDL and WEP are normally set via the `deltat` application (giving a set value in Gauss).

With the `deltat` application, the action of setting the power supplies WED or WEDL automatically switches the current cables to the appropriate power supply, switches it ON and switches OFF the unused power supply.

In addition, by setting WEP, WEDL or WED to zero the corresponding power supply will be switched OFF.

Examples:

- To switch the main coils between WED and WEDL: just set for the appropriate power supply the desired value with the `deltat` application. This is done in the tab `Exp. Magnets`.
- To switch between the main coils and the small transversal coils (WEP): set the last used power supply to zero; set the WEP power supply to the desired value.
- To switch between the small transversal coils (WEP) and the main coils: set WEP to zero; set the WED (or WEDL) power supply to the desired value.

## 11 TRUE ZERO-FIELD MEASUREMENTS

Extensive tests have shown that a weak remanent field is present at the sample region after that the main field (WED) has been set to high values.

This field has a value of few hundreds of milliGauss and is directed approximately along the beam direction (angle of about 20 degrees).

High statistic runs have demonstrated that this field can be **completely** suppressed by applying, for a very short time, a small field of 100 Gauss with the auxilliary coils (WEP).

After such a WEP cycling, zero field is dynamically performed (compensation better than 30 mG) by a newly installed automatic compensation device. Such compensation relies on a continuous field measurement realized slightly off-center. The correction due to the off-center position is taken into account and regularly performed by the Instrument Scientist.

When performing measurements in applied (such as Knight-shift measurements), any stray fields created by the major magnets located in (or near) the experimental hall are tabulated and automatically compensated by the automatic compensation device.

## 12 SWITCHING ON THE “FORWARD” VETO

In the normal mode, solely the “active collimator” (Backward veto) is utilized as a veto for the muons and positrons.

If measurements on small samples (and holders) are mandatory, the center part of the Forward detector can be used as an additional veto (Forward veto).

To switch on the Forward veto:

Starting from 2010, solely the CAEN TDC DAQ electronics is used on the instrument GPS. With this electronics, the switching between different logics is performed by software by changing the TDC settings. Such TDC settings can be modified/seen/saved by selecting on the `deltat` GUI the tab **TDC Settings** to be active.

By pressing the button **Modify Settings**, you have the possibility to modify the set-up of the TDC used for the experiment (and saved in the ODB – online database). Each setup configuration is saved on a so-called setup file located on the back-end computer. These setup files are maintained by the Instrument Scientist. A setup file contains all the necessary logic as well as the histogram grouping and information on the `t_0` and First Good Bins.

A Wizard-Tab will lead the user through the setup configuration. On the first wizard-tab, a drop-down menu will present the available setup files for the instrument. Hopefully the names should be self-explanatory.

A complete description of the `deltat` GUI interface is given in the following document:

<http://lmu.web.psi.ch/facilities/software/deltat/deltat.pdf> A complete description of how to setup the TDC electronics is given in the following document:

<http://lmu.web.psi.ch/facilities/electronics/TDC/TDC.pdf>