PhysLAB

VSM Service Manual: Evacuating and Recharging the System

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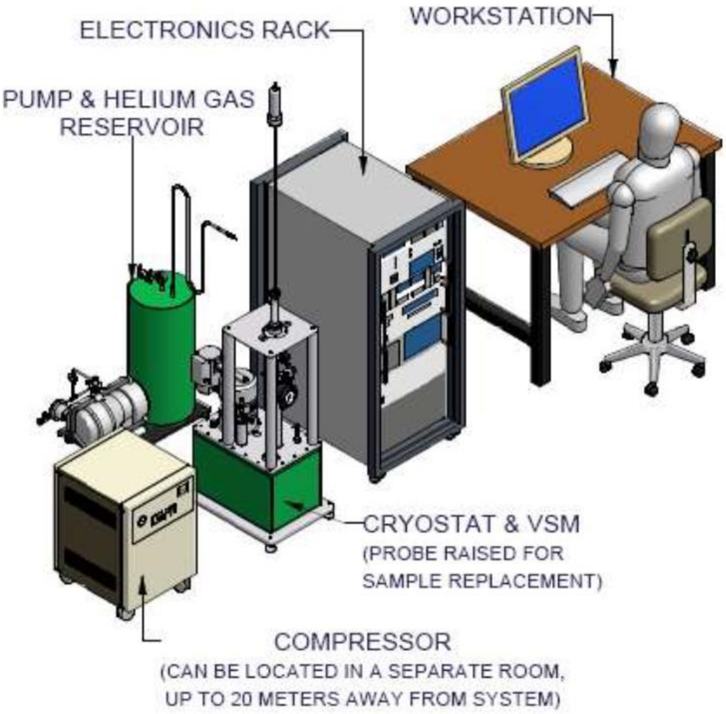

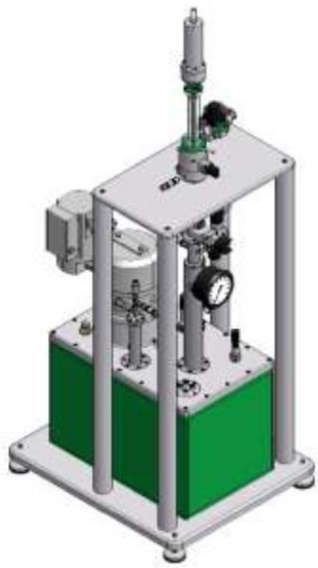

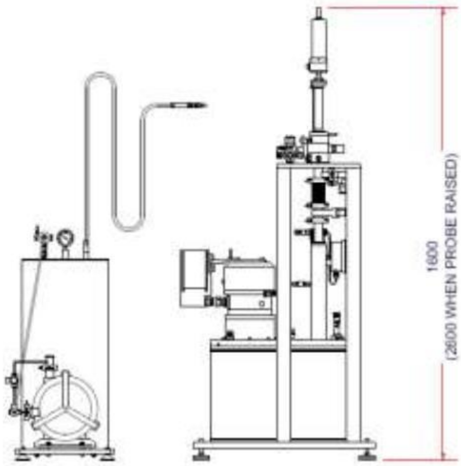

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Evacuating and Recharging the System

Different types of the problem may arise during the use of the VTI. Common problems are

- The VTI may not reach base temperature.
- The flow rate may not respond to the needle valve and/ or be limited.
- The flow rate may decrease at high temperatures or collapse completely at low temperatures.

If VTI is contaminated and is either partially or fully blocked then it is required to evacuate the VTI and hoses and recharge the dump. This process is best done when the Measurement System is at room temperature, but can be done while the system is above 77K. **If a sample is loaded it should be removed.**

The first step is to warm up the system as described below.

Switching off the system

There are a few steps that must be taken to ensure that the system can be safely restored to room temperature.

- Ensure that the magnet is at zero current.
- Open the VTI needle valve and switch off the oil-free pump by pressing the red STOP button as in figure 1. Leave the V11 & V12 opened. It will let the helium expand back into the DUMP through the self-sealer at the inlet.
- Switch off cryocooler compressor by turning the position to 0 from Drive as in figure 2.
- Wait 10 minutes then w\switch off the chiller.

The system will begin to warm up immediately. It is recommended that the system be left to warm to room temperature naturally for **36 – 48 hours**. The warm up can be monitored in the same ways as the cooldown. The system can be cooled down again without waiting for the system to return to room temperature.

Figure 1. Oil free pump

Figure 2. Cryocooler Compressor

Precautions

- Do not disconnect the hose, from the helium dump to the helium inlet at VTI circuit, unless the system is at room temperature or the helium has been pumped out from the VTI circuit.
- Never disconnect the compressor hoses unless the system is at room temperature.
- Do not be tempted to allow air into the vacuum space in order to warm the cryostat more rapidly. If done carelessly it can cause serious damage.

Pumping out the vacuum chamber of Cryostat

At room temperature, the materials used in the construction of the cryostat desorb gases ("outgas"). This does not indicate a leak but does mean that you should pump out the vacuum chamber each time the system has been warmed to room temperature. Connect the vacuum pumping port Number 8 in figure 3 to Turbo Molecular Pump capable of a pumping speed of 50l/sec and base pressure below 10-5 mbar. Leave the system for overnight.

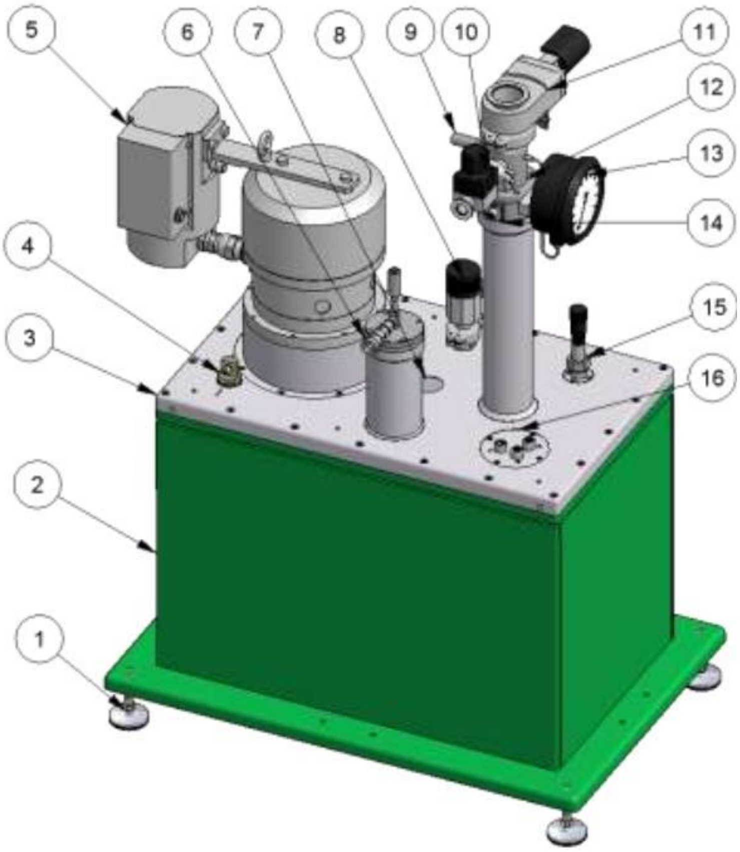

Figure 3.The Cryostat a vacuum insulated Chamber

Operational Steps

- Close the cryostat pump out valve at port number 8 in figure 3.
- Switch ON the rotary pump by turning the knob at the position of RP from PT 50 for 15 minutes or until the pressure reaches less than 10^{-2} mbar as in figure 4.

Figure 4. Rotary and Turbomolecular Pump (TMP) PT 50.

- Open the cryostat pump out valve at port number 8 in figure 3.

- When the pressure is maintained at 10^{-2} mbar, switch ON the turbo molecular pump (TMP) by turning the knob at the position of TMP from PT 50. The pressure should reach less than 10^{-6} mbar. Keep it ON until the evacuation and recharging is completed.
- When the evacuation is completed, close the cryostat pump out valve from port number 8 in figure 3 and turn Turn OFF TMP.
- After 20 minutes, Turn OFF RP from PT 50.

Evacuating the VTI Circuit

- Switch off the oil free and the rotary pump from the “valve control VI”.
- Close the valves V11, V12 & V13.
- Disconnect the helium inlet hose and protect it with a cover as in figure 5. To disconnect, pull back the outer sleeve whilst withdrawing the stem.

Figure 5. Protecting helium inlet hose with cover

- Fully open the needle valve.
- Disconnect the Airlock vacuum hose from its usual position located at the back of the gate valve.
- Attach the adapter to this hose as shown in figure 6.

Figure 6. The adapter to be attached the hose.

- Connect the adapter connected hose to the helium inlet port (position a in figure 7. Now the rotary pump from valve block within electronic rack is connected to the helium inlet port.

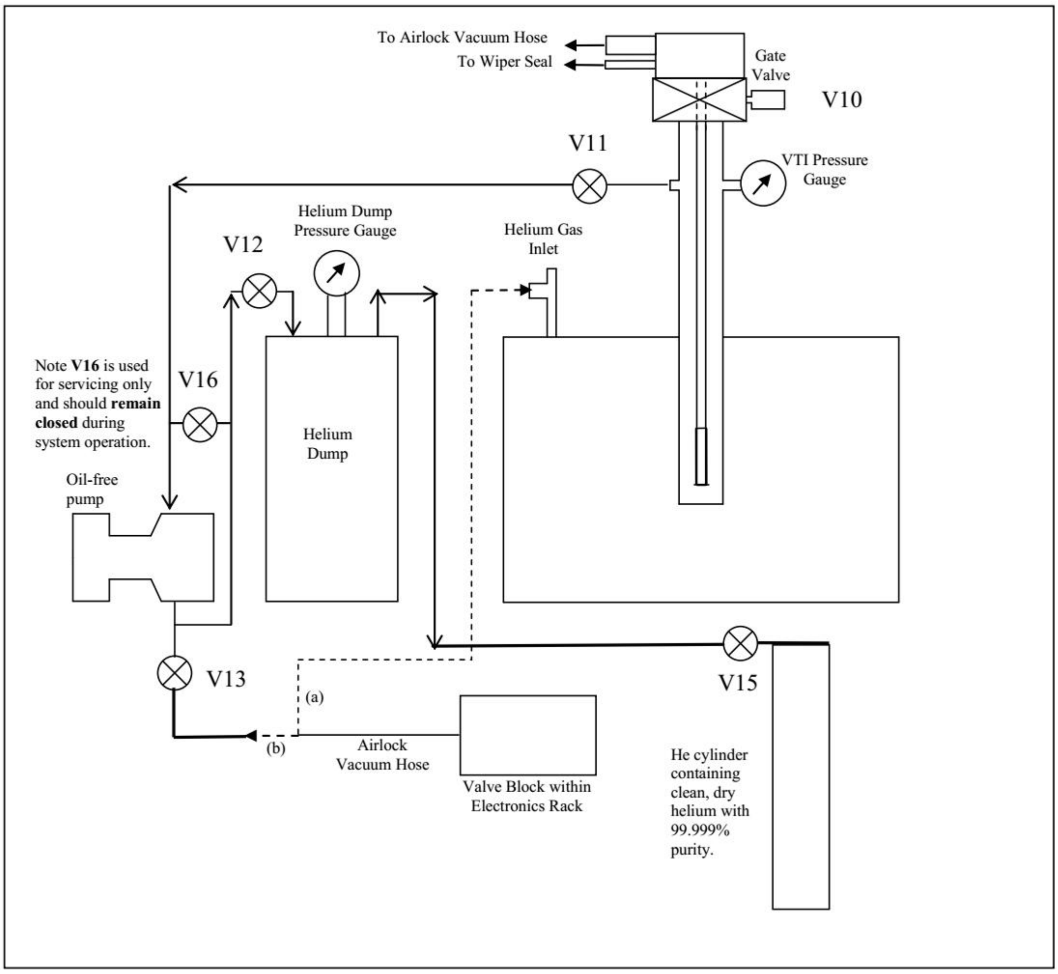

Figure 7. Block diagram for evacuation and recharging.

- Start the rotary pump and open airlock from the "valve control VI" as shown in figure 8. Evacuation starts from helium inlet port of VTI Circuit.

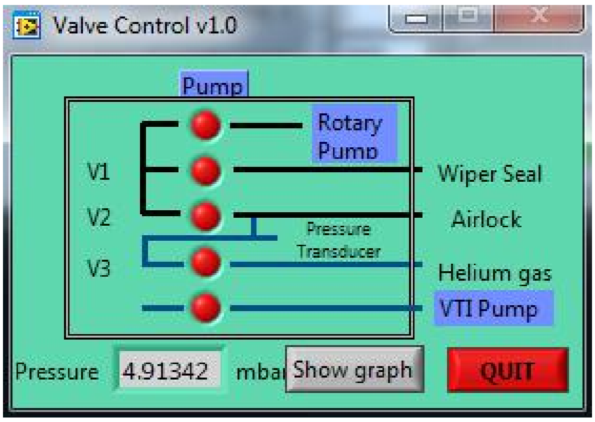

Figure 8. Valve control VI.

- Open V13, turn on the 'Oil-free pump' manually from a switch located on its body by pressing green button as shown in figure 1, and then open V11. Evacuation starts from the top of VTI circuit through V11 by the scroll pump. At the start the VTI gauge will be above 50 but after few minutes it should move towards 0 mbar.

- Leave both the rotary and oil-free pumps running for at least 6 hours (6 h recommended but should be more than 12 hours). This will ensure that the contamination is removed from the **VTI pipework and charcoal**.

Evacuating and Recharging DUMP

1. Close V11 and switch off both pumps and turn off air lock.
2. Disconnect the Airlock vacuum hose from the Helium inlet port. Remove its red adapter as shown in figure 6 and connect it at it usual location at the back of the gate valve.
3. Close the cryostat pump out valve, port number 8 in figure 3.
4. Disconnect the vacuum hose from this cryostat pump out port number 8 and connect it to the port behind V13 (position b in the block diagram of figure 7).
5. Keep the oil free pump switched off and rotate the knob to the RP position to start the rotary pump from the Turbo Molecular Pump PT 50 as shown in figure 4. **Don't rotate the knob to the TMP position at this stage.**
6. Open V13, it allows the pump PT 50 to be used for evacuating the DUMP.
7. Open V12 and observe the helium dump pressure gauge. It should begin to decrease in pressure. Evacuation will take about 30 minutes.
8. When the dump has been fully evacuated and its gauge shows a reading of -1.0 bar, then close V12.
9. Disconnect the helium hose from the helium port in the valve block of the instruments rack.
10. Attach an adapter to this helium hose coming from the helium cylinder as in figure 9. Connect this Helium hose to the DUMP. Keep V15 closed.

Figure 9. Parts to connect the adapter

11. Gradually adjust the helium cylinder regulator to a pressure above 1.25 Atmosphere.
12. Flush the helium dump with helium gas by opening V15 and allowing the helium dump pressure gauge to rise to at least -0.5 bar then close V15.
13. Fully evacuate the helium dump again by following steps from 5 to 8.
14. Finally close V12, open V15 and fill the dump to operating pressure, typically +0.25 bar. Close V15 when helium DUMP reaches the pressure +0.25 bar.
15. Disconnect the helium inlet hose of the DUMP from the helium cylinder. Remove its protective cover.
16. Close V13 and switch off the rotary pump from the turbo molecular pump.
17. The helium gas bottle can now be reconnected to the helium port in the valve block of the instruments rack. Now the system can be started as usual.

Starting the system

Before the system is cooled down a few checks need to be done as described in chapter 6 on page 57 of the mini crygen-free user manual. However, VTI check is explained here.

VTI checks

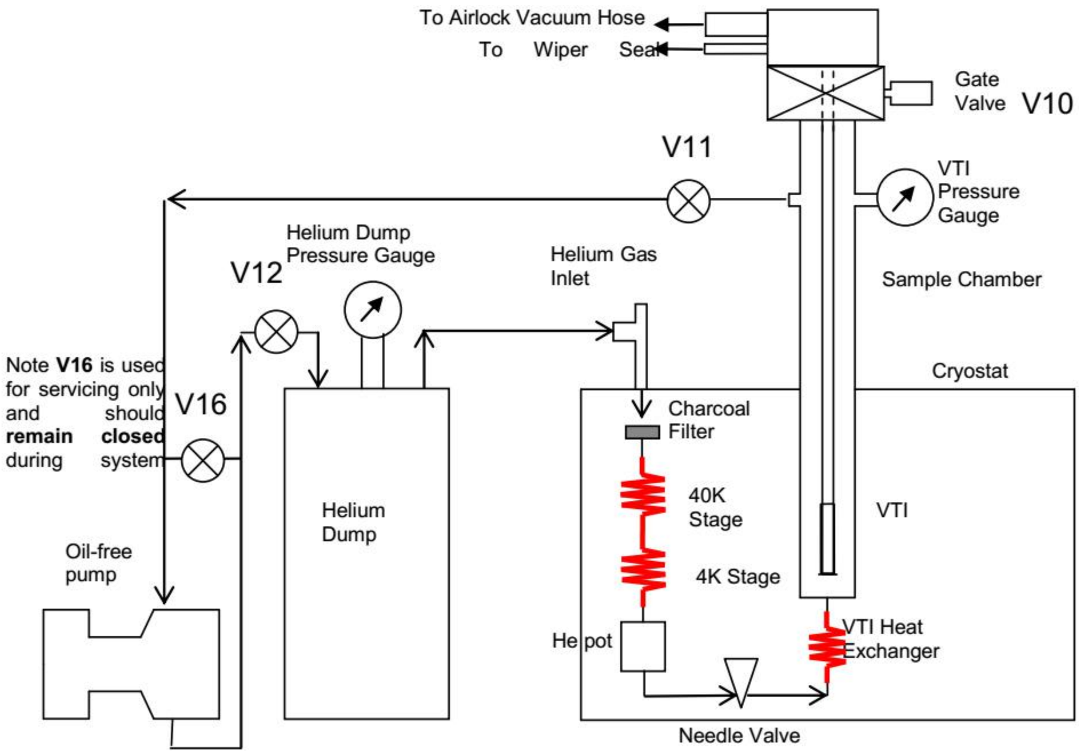

Figure 10. Schematic diagram of the VTI cooling circuit.

- Check that the set-up matches the arrangement depicted in Figure 10.
- Check that the helium dump is properly connected to the cryostat using the small diameter reinforced stainless steel hose. The helium inlet uses a self-sealing connector, **to connect**, push the stem into the helium gas inlet until it clicks. **To disconnect**, pull back the outer sleeve whilst withdrawing the stem.
- Check that the by-pass (valve 16) on the oil-free pump (identified in the figure 10) is closed.
- Switch on the oil-free pump and check that it is possible to control the pressure (on the VTI pressure gauge) using the needle valve. With the needle valve fully open it should be possible to achieve a pressure in excess of 30 mbar while the gas is circulating. This test checks that
  the flow impedance is correct and there are no obstructions in the circuit.
- Leave the needle valve open, switch off the pump and close V11. This ensures that the helium from the external gas reservoir condenses in the helium pot during cooldown and that the helium only circulates in the one direction.
- Check that the external helium gas reservoir (”dump”) is charged to the correct pressure, approximately 1.25 bar absolute (0.25 bar on the gauge) with clean dry helium gas (99.99% purity recommended). The pressure gauge on the helium reservoir reads the pressure relative
  to atmospheric pressure rather than absolute pressure relative to vacuum. Hence, atmospheric pressure is 0 bar and vacuum is -1 bar.

Compressor and Coldhead

Never disconnect the compressor hoses unless the system is at room temperature. Check that the helium gas pressure in the Cryo-cooler compressor is at 1.7 Mpa (figure 11).

Figure 11. helium gas pressure in the Cryo-cooler compressor gauge.

Starting the Cooldown

The software provides a convenient way to log the temperature of various parts of the system during the cool down process, confirming normal operation. There are two ways of recording the cooldown, the background temperature logger or to run a sequence. After these checks have been made and any problems identified and corrected the system may be started. To do so:

- Ensure that V11 at the top of the VTI (and V12 was previously closed) are closed.
- Leave the needle valve fully opened.
- Ensure that the scroll pump is off.
- Ensure that chillar is started and adequate cooling water is being supplied to the compressor.
- After 20 minutes switch on the compressor. Temperature reading should show less than 15C^{o}.
- Indications of normal cooldown are as follows:
  - The cryocooler will make a "chirping" sound.
  - Temperatures within the system fall steadily. To view a plot of the temperatures click on the View data option in the main menu (see section 6.4.6). You will be supplied with a typical cooldown plot for reference.

As the second stage reaches 4K, the gas pressure in the helium dump will fall towards its base value (about 0.2bar) as the helium condenses in the helium pot.

Once the system is cold

Once the system has reached operating temperature as shown in Table below then the VTI circulation may be started. The helium pot will be the last part of the system to reach operating temperature. As the pot reaches 4.2K the helium will condense and form liquid, as this happens the pressure in the helium reservoir will drop during normal use the pressure in the reservoir will vary according to the VTI temperature as explained in 4.4.2 on page 19.

To start the VTI circulation:

- Make sure that valves 11 and 12 at the exhaust of the VTI and the top of the helium reservoir are open. If valve 12 is left closed when starting the pump, the pump will be damaged by the high pressure at the exhaust of the pump.
- Ensure the bypass valve 16 is closed.
- Switch on the oil free scroll pump.
- Use the needle valve to set an appropriate flow rate, typically about 8-15 mbar.
    - If the helium flow rate is too low you will not reach the base temperature of the VTI.
    - If the flow rate is too high the cryo-cooler 2nd stage, magnet and helium pot temperatures will rise. This limits the maximum ramp rate of the magnet and result in unstable performance of the VTI.

Once the flow is established and stable the system can start to be used. There is no need to wait for the VTI to reach base temperature.

Table. Typical temperature locations

Location	Typical Temperature	Measured by	Type
Cryo-cooler 1st stage	45-50 K	Temperature Monitor channel 1	CCS
Cryo-cooler 2nd stage	3.0-4.5 K	Temperature Monitor channel 2	CCS
Magnet winding	3.0-4.5 K	Temperature Monitor channel 3	CCS
Persistent mode switch	3.0-15 K	Temperature Monitor channel 4	CCS
Helium pot	3.0-4.2 K	Temperature Monitor channel 5	CCS
Cryo-pump	3.0-4.5K (0.2 Ω)	Temperature Monitor channel 7	PT100
Charcoal filter	50-90 K	Temperature Monitor channel 8	CCS
VTI Heat exchanger	1.6-325 K	Temperature controller channel A	Cernox
Sample	1.6-325 K	Temperature controller channel B	Cernox

1 atm = 760 torr = 1.01325 bar = 101325 pascal = 14.695 pound-force per square inch