SOP : attoDRY 1000 System

Figure 1: attoDRY 1000 Cryostat

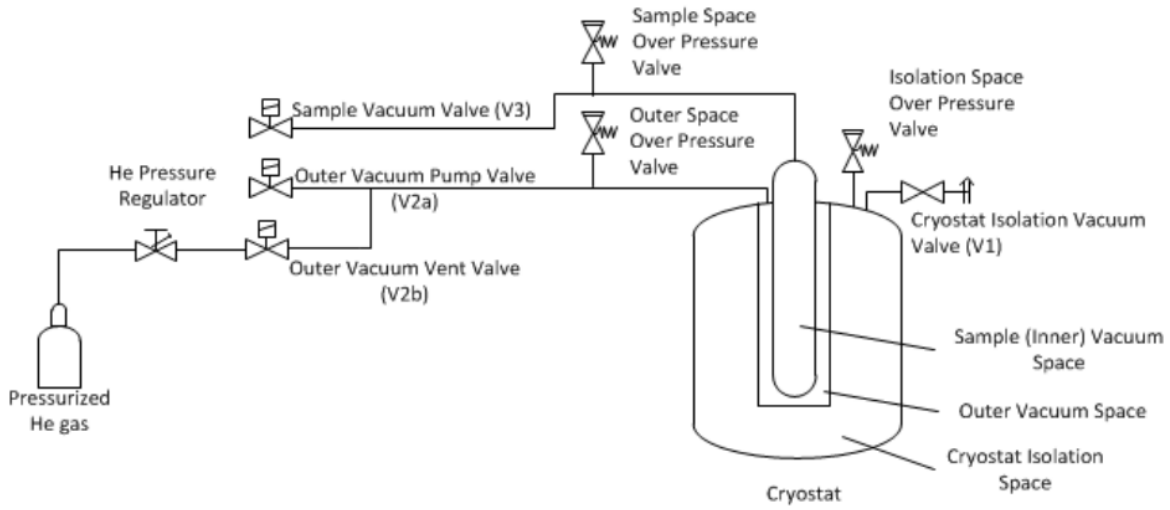

Figure 2: Gas Handling system for attoDRY 1000

Procedure to follow to restart the system when system is at room temperature

1. **Turbo Motor Suction Pipe Evacuation and Helium-Air Flush**
   a. Create a vacuum in the `suction pipe` of the `Turbo motor`.
   b. Flush the remaining air out by flowing `Helium` gas into the suction pipe.
2. **Inner Vacuum Chamber (IVC) Evacuation and Helium Flow**
   a. Create a vacuum in the IVC.
   b. Flow Helium gas into the IVC.
3. **Inner Vacuum Chamber IVC Insertion into Outer Vacuum Chamber (OVC)**
4. **Outer Vacuum Chamber (OVC) Evacuation and Helium flow**
   a. Evacuate the OVC to create a vacuum.
   b. Flow Helium gas into the OVC.
5. **Cryostat Isolation Chamber (Magnet Space) Evacuation**
6. **Switch ON the Chiller and Compressor**
   a. The compressor initiates the cooling process.

1 Procedure for removing the sample (inner) vacuum space [IVC] from Outer Vacuum Chamber [OVC]

Tools required

O ring should be used as support to placed sample stick situated inside the cylindrical tube on the stand.

WEAR HANDGLOVES AND HEADCAP BEFORE PERFORMING FOLLOWING PROCEDURE.

Following procedure should be followed when sample temperature is 4K.

1. Open the respective knob of the cylinder. Then open the line where you want to flow the **Helium** gas.

Figure 3: Helium cylinder

2. Open the Helium exchange gas knob so that **He** gas will flow into the outer vacuum chamber. There will be *whistle* from overpressure valve when **He** gas pressure exceeds 1 bar.

3. As soon as we start flowing the **He** gas into outer vacuum chamber, we need to remove 3 *screws* with spanner. Do not placed this screws near the opening of the chamber, so that it will not fall inside the chamber.

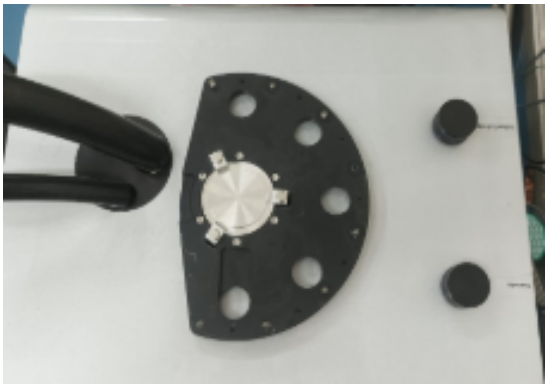

Figure 4: Remove these 3 screws

Note

When we start flowing the **He** gas into the system; untill we placed `dancing cap` on it's position, we should follow all steps little bit fast. So that we will not waste so much of the **He** gas. Also make sure that big O-ring at it's position below the dancing cap.

Why we flow *He* gas inside the chamber?

If we do not flow **He** gas inside the `outer vacuum chamber` with minimum of **1 bar** pressure then air will go inside the chamber when we load or unload the `Sample (Inner) Vacuum Space`. Then there will be *condensation* inside the `outer vacuum chamber`. So to avoid the condensation, we flow the **He** gas inside the `outer vacuum chamber` continuously till we are not closing the `outer vacuum chamber` with dancing cap OR untill OVERPRESSURE VALVE whistle.
He gas act as medium to dissipate heat from `inner (vacuum) sample space chamber` to outer environment through the `Outer Vacuum Chamber`.

4. After removing the screws, remove `sample (inner) vacuum space` very carefully and slowly and placed it on the stand.
   Hold `sample (inner) vacuum space` at the top and in vertical position only. It is very cold at bottom. If we touched it then there is possibility of getting ice burn. Wait till `sample (inner) vacuum space` come to the room temperature then proceed for the next step.

Figure 5: `sample (Inner) vacuum sapce` just after removing from the `Outer Vacuum Chamber`

5. As soon as we removed `sample (inner) vacuum space`, checked whether the bigger O-ring in its position at the opening of the `Outer Vacuum Chamber` then only placed the `dancing cap` on `Outer Vacuum Chamber` and tightened the same 3 screws that we removed initially.
   (Need 2 people for this process. Some **Helium** gas will leak out of the chamber while placing this `dancing cap`. Do not worry about it. It's normal. Try to minimize this **Helium** gas wastage.)

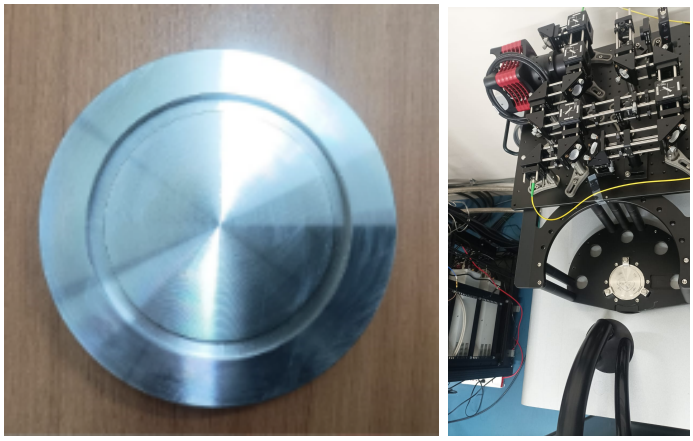

Figure 6: (left) Dancing cap + (right) Dancing cap after placement in it's position after removing `Inner (vacuum) sample sapce`

6. Sample temperature (**A**) will show **OVER** if we disconnect the corresponding cable (No.4) attached to `cylindrical sample stick`.

7. After `sample space cylinder` reaches room temperature, remove the `lock`. Then slowly and carefully remove the `Sample stick` from the `Inner (vacuum) sample sapce` (cylinder) and keep it on the stand. Carefully check the **O-ring** between `Inner (Vacuum) Sample Space` cylinder and Sample stick in it's position for support of the **sample stick**.

Figure 7: (left) Remove this lock; (middle) Lock; (right) Sample stick

8. Now stick the `sample` onto the PCB with special glue for low temperature then mount the PCB on piezo stage.

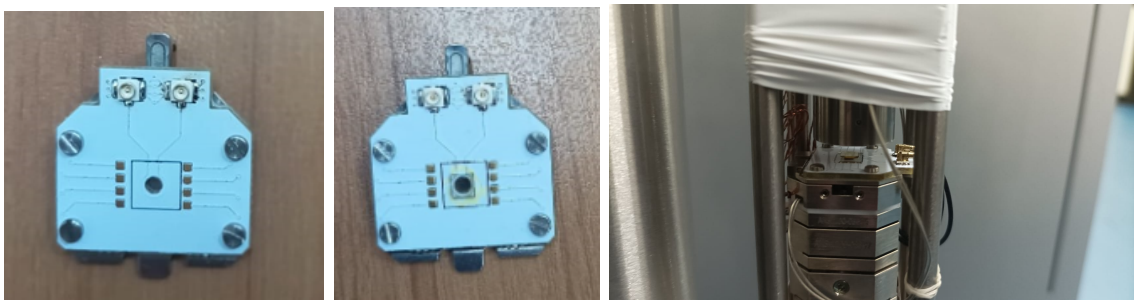

Figure 8: (left) PCB without sample; *(middle)* PCB with sample; *(right) PCB mounted on piezo stage*

9. Now put `Sample stick` inside the `sample (inner) vacuum space` (cylinder).

Note

Check and note down the following parameters after mounting the sample on the PCB and before inserting the sample stick into `Sample (Inner) Vacuum Space [IVC]`

1. Make the the Microwave antenna connection with the PCB where sample is mounted.
2. Make sure that wires in the sample stick are not entangled and piezo position is at the center.
3. Distance between *objective* and *sample* (mounted on PCB) should be **0.65 mm** which is `working distance` of the objective.
4. Initially adjust it **manually** when `Inner (vacuum) sample sapce` at room temperature by taking *objective* near to the sample on PCB then adjust X, Y, Z position with `AMC300 motion controller`.
5. Note down the *position parameters* for all 3 axes (Axis 1, Axis 2, Axis 3) shown on `AMC 300 Motion Controller` for further use. This will help for alignment at low temperature.

2 Procedure for evacuating and flowing Helium into `Sample (Inner) Vacuum Space [IVC]`

VERY CRITICAL PROCEDURE
FOLLOW THE SEQUENCE OF THE PROCEDURE.

There is some air inside the **Helium** gas pipe when we exposed **Helium** gas line with atmosphere. This contaminated **Helium** need to first flush out into atmosphere. For that purpose, we first create vacuum in the `Suction pipe` then flow **Helium** into `Suction pipe` then close the **Helium** supply by closing the `Needle valve`.

For creating vacuum in the `Suction pipe`:

1. Make sure that **Helium** gas line is attached to `Turbo pump` and `Suction pipe` is attached with `Inner (vacuum) sample space`.

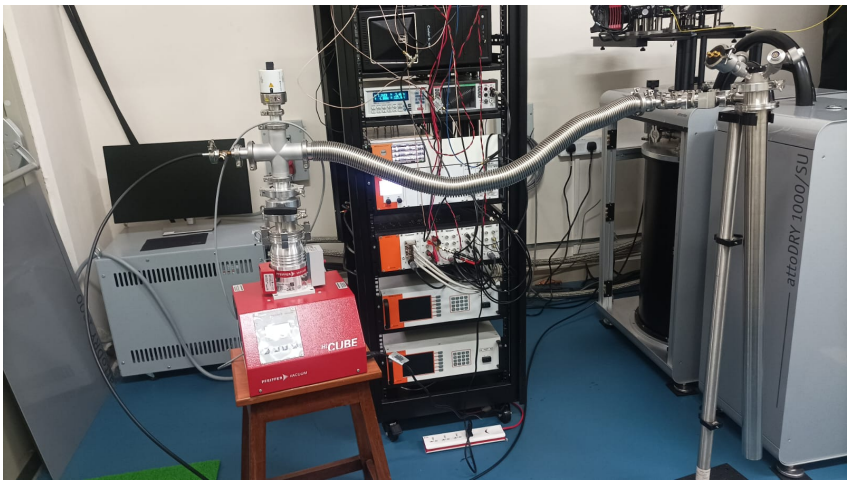

Figure 9: **Helium** gas line attached to Turbo pump and Suction pipe is attached with `Inner (vacuum) sample space`

2. Closed the `Manual valve` on the `Inner (vacuum) sample space`. `Needle valve` should be closed.

3. Open the `Gating valve`.

4. Turn ON the `Turbo pump`.
   Now wait till it's speed reaches to 1500 RPM. Then it will take some time for creating the vacuum. When pressure will reach to 10^{-4} to 10^{-5} **hPa** then close the `Gating valve`.

5. Then flow **Helium** gas into the `Suction pipe` by opening `Needle valve`. Then close the `Needle valve` after filling the **Helium** in the `Suction pipe`.

6. Then we will open the `Manual valve` on the `Inner (vacuum) sample space` so that there will be (Air + Helium gas) in the (`Inner (vacuum) sample space + Suction pipe`) region.

7. Now open the `Gating valve`.
   Make sure Turbo spins at 0 RPM before opening the `Gating valve`.

For creating vacuum in the `Inner (vacuum) sample space + Suction pipe` region :

8. Now open the `Manual valve` on the `Inner (vacuum) sample space` so that there will be (Air + Helium gas) in the (`Inner (vacuum) sample space + Suction pipe`) region.

9. Make sure Turbo spins at 0 RPM before opening the `Gating valve`.
   Now open the `Gating valve`.

10. Start the `Turbo motor`. We will wait till pressure of this region to reach upto 10^{-4} to 10^{-5} **hPa**.

11. When pressure reaches at 10^{-4} to 10^{-5} **hPa** then close the `Gating valve` and turn off the `Turbo motor` only.

12. Now we will open the `Needle valve` and fill (`Inner (vacuum) sample space + Suction pipe`) region with **Helium** gas.

    When Overpressure valve on the `Inner (vacuum) sample space` whistle i.e. exhaust the **Helium** gas that means pressure inside the `Inner (vacuum) sample space` exceeds **1 bar**.

13. Then immediately close the `Manual valve` on `Inner (vacuum) sample space` so we will cutoff the **Helium** flow to the `Inner (vacuum) sample space`.

14. After that close the `Needle valve`. Close the **Helium** gas cylinder with respective knobs.

15. Now we have filled the `Inner (vacuum) sample space` with **Helium** gas. So detach the `Suction pipe` from the `Inner (vacuum) sample space`.
    Make sure that both `Turbo pump` and `Roughing pump` are off.

Now we are ready to insert `Inner (vacuum) sample space` with inside the `Outer Vacuum Chamber`.

Note

Check the **O-ring** while flowing **Helium** gas everytime whether there is **He** gas leaking or not. If gas is leaking then change the **O-ring** at the place where gas is leaking.

3 Procedure for inserting Sample (Inner) Vacuum Space [IVC] inside the Outer Vacuum Chamber [OVC]

1. Before inserting the Sample (inner) vacuum space into the Outer vacuum chamber, flow the **Helium** gas into the Outer vacuum chamber continuously by opening **He** GAS EXCHANGE valve then remove the Dancing cap by loosening the 3 *screws*. *(Use spanner No.*13).

2. After that, check whether big O-ring is in it's position on top of the Outer vacuum chamber opening and immediately insert the Sample (inner) vacuum space into the Outer vacuum chamber very carefully. Then closed 3 screws very tightly. (This process should be done little bit fast and efficient way.)

3. Now make connections for wire no.1 and 4 at Inner (vacuum) sample space head.

4. Wait till *sample temperature* reach at **4K**.

4 Procedure for 4K sample space temperature

1. Before turning on the Chiller, make sure that Condenser is cleaned and check the water level of the Chiller.
Water level meter is at backside of the Chiller. It should be half or more than half filled. Chiller need RO water. Available at CEN.

2. Now, turn on the **Chiller**. Wait till chiller temperature reaches to **15°C** temperature.

3. Now turn on the **compressor**. (Follow the instructions shown on display of the compressor for turning it on.)

4. Wait overnight till temperature of the sample (inner) vacuum sapce will reached to **4K**.

Note

(a) Monitor the chiller and compressor for some time, few hours. If everything is fine then it will work normally. Otherwise, compressor will shut down automatically.

(b) If everything works well then check the temperture. It will slowly go down to **4K**. (It will take overnight/ 18-20 hours)

(c) If there is problem in chiller then it will display RED light and show some error message. When this will happened then immediately contact lab members and KS.

5 Procedure for evacuation of the Outer Vacuum Chamber [OVC]:

1. Connect the Suction pipe of the Turbo pump to Outer vacuum chamber pump valve.
2. Open the **Evacuate valve** (black colour) completely.
3. Open the Gating valve.
4. Turn ON Turbo motor.
5. When pressure of the (Suction pipe + Outer Vacuum Chamber) reached 10^{-4} to 10^{-5} **hPa** then close the Gating valve.
6. Turn OFF the Turbo motor.
7. Now open the Needle valve to flow the **Helium** gas into the (Suction pipe + Outer Vacuum chamber). When OVERPRESSURE VALVE whistle then immediately close the Evacuate valve.
8. Then cutoff the **Helium** gas supply. Closed the Needle valve and respective valves of the cylinder system.
9. Remove the Suction pipe of the Turbo pump from the Outer vacuum chamber pump valve.

This process needs to be followed only when we want to evacuate and cool the system from the room temperature.

6 Procedure for Evacuation of `Cryostat Isolation space (Magnet space)` and Cooling the system

1. Connect the `Suction pipe` of the `Turbo pump` to the `Isolation chamber` near the `Manual valve`.

Figure 10: Suction pipe attached to Isolation chamber valve

2. Open the `Gating valve`.
3. Switch ON the `Turbo motor`.
4. When pressure in the `Suction pipe` reaches between 10^{-4} to 10^{-5} **hPa** then slowly **open** the `Manual valve` little bit while checking the pressure which will drop (10^{-5} to 10^{-2} hPa range). Open `Manual valve` completely and slowly.

Note

(a) If `Manual valve` is not opened slowly, then the immediate change in pressure when it is exposed to the `Cryostat Isolation chamber` may damage the `Turbo pump` OR Turbo pump might be not run with full RPM.

(b) If there is any problem, then `Turbo pump` will turn OFF automatically. (`Roughin motor` will run continuously.)

(c) `Cryostat Isolation chamber` should always be in vacuum and it should **not** be filled with **Helium**.

5. Now monitor pressure for 30 to 50 minutes. Pressure will gradually start dropping. Also RPM of the Turbo motor may vary from 1300 RPM to 1500 RPM. It will take around 18 to 20 hours to create the vacuum in the `Cryostat Isolation chamber`.

6. When pressure in `Cryostat Isolation space (Magnet space)` reached 10^{-5} **hPa** then Turn ON the `Chiller`.

7. When Chiller temperature stabilized around **15**°C then switch ON the `Compressor`.

8. When `Base temperature` of the system reaches the atleast **70K** then we can follow the next steps. (We can do following steps even at **4K** `Base temperature`.)

   I. Close the `Manual valve`.
   II. Close the `Gating valve`. (Pressure will show some changes.)
   III. Turn OFF the `Turbo motor`.

This procedure need to be followed even when Base temperature exceeds 70K.

Turbo pump

Turbo has 2 motors/pump **:** `Turbo pump` and `Roughin pump`.

Program no. 23 : ON/OFF Turbo motor
Press the middle 2 buttons simultaneously. Then it will show `ON` on the screen. Again press these 2 buttons simultaneously so turbo motor will be in `ON` state. Then press the rightmost button so `Turbo motor` will be `ON` after few seconds.

Program no. 340 : It will shows us Pressure. (It should be around 10^{-5} to 10^{-6} **hPa**.)

Pressure will be shown in hPa (Hecto Pascal)
1 hPa = 1 mbar

Program no. 309 : Motor rotations will be shown in **Hz**. (Maximum 1500 Hz)
1 Hz = 1 RPM

`Gating valve` should be in **open** position while evacuating the `Suction pipe` or `IVC` or `OVC` or `Cryostat Isolation chamber`.

`Gating valve` should be in **closed** position while flowing **Helium** gas into the `Suction pipe` or `IVC` or `OVC`.

Turning ON Turbo motor:
Go to `program no.23` and press middle 2 buttons simultaneously. Then it will show `ON` on the screen. Again press these 2 buttons simultaneously so `Turbo motor` will be in `ON` state. Then press the rightmost button so `Turbo motor` will be ON after few seconds.

Turning OFF motor:
After turning OFF the `Turbo motor` wait till it's rotation goes to 0 Hz. Then only turn OFF the `roughin motor` by pressing rightmost button.

Figure 11: attoDRY 1000 Cryostat (QCL)