The Miniball Vacuum System

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Contents

1 Overview

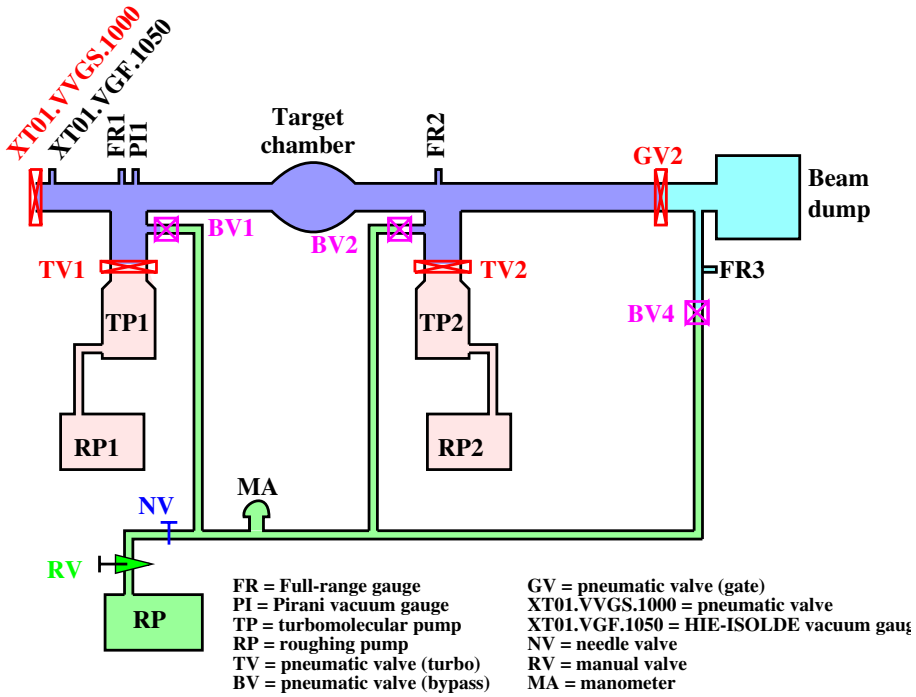

Figure 1: The schematics of the Miniball vacuum system. Note that the PPAC ionisation chamber and Bragg chamber have their own vacuum and gas systems, which are not shown here. The colours indicate the different sections. This version is the 2015 setup without the PPAC.

The original vacuum system had seven main parts separated by gate valves:

- The HIE-ISOLDE vacuum system up to valve XT01.VVGS1000.
- The beamline, including the target chamber, but not the PPAC actuator and beam dump.
- The PPAC actuator, separated from the beamline by valve GV1 (not present in 2015).
- The beam dump, separated from the beamline by valve GV2. The pressure in the beam dump must never exceed that in the Bragg chamber.
- The upstream turbo pump TP1. This should always be at high vacuum.
- The downstream turbo pump TP2. This should also always be at high vacuum.
- The bypass line, which should never have high vacuum and is used for pumping down and venting. It is separated from the beamline by valves

BV1, BV2 and BV4, and may be opened to the air via a needle valve, which is used for venting.

The valve XT01.VVGS1000 which separates Miniball from HIE-ISOLDE should be closed for all manipulations of the vacuum system. A mistake with XT01.VVGS1000 open could result in the EBIS being vented! The control for XT01.VVGS1000 is in pictogram program for the REX vacuum system (in the control room).

The two turbo pumps (TP1 and TP2) and their roughing pumps (RP1 and RP2) are normally kept running at all times, with the corresponding sections of the vacuum system under high vacuum. When we don't want high vacuum in the main beam line, we close the valves TV1 and TV2, which separate them from the beamline. There is a single pair of open/close buttons on the control box to open or close TV1 and TV2 simultaneously. As we require differential pumping of the target chamber, we do not want one open and the other closed, so this state cannot normally be achieved.

In 2015, we decided not to mount the PPAC, as it hadn't been used in the previous campaigns. Consequently, the gate valve GV1 is also missing, as is the pump RPA and the gauge PI4.

Note that sometimes we used a Bragg chamber at the end of the beam line, but usually it was the ionisation chamber. From the point of view of the beam-line vacuum, they are rather similar.

In 2022, the beamline turbos were replaced after one was stolen, but this doesn't change anything in this documentation.

2 Venting

2.1 Venting the beamline

First of all, we don't want voltages on the detectors within the beam line (CD, T-REX, SPEDE, PPAC etc.) when venting, so:

- Make sure CD high voltage is off (in the electronics rack 1).
- Make sure CD PAD high voltage is off (in the electronics rack 1).
- Make sure SPEDE high voltage is off.

We need to make sure the bypass line is isolated from the beamline:

- Check that valves BV1, BV2 and BV4 are closed (this should already be the case).

In this procedure, we will pump down the bypass to roughing vacuum, then stop pumping on the main beamline with the turbo pumps and then connect the two:

- Make sure the roughing pump is connected to the bypass line.

- Make sure the needle valve at the roughing pump is closed.
- Make sure the roughing pump is switched on.
- Open the hand valve between the roughing pump and the bypass line.
- Check that the manometer pressure goes down to zero. If it wasn't already pumped down. Wait a couple of minutes.

Next we want to separate the beamline from everything else:

- Close valve XT01.VVGS1000, which is the last valve between REX and Miniball. It is controlled with a pictogram program for the REX vacuum system.
- Close valve GV2, which separates the beam dump from the beamline. **WARNING: do not allow the pressure in the beamline to rise above that in the Bragg chamber. In other words, if the Bragg chamber is pumped down, and you vent the main beamline, you need to start pumping on the beam dump as soon as possible. However, as this is done using the same roughing pump as that for the main beamline, you can only do this after you have completed the venting procedure.**
- Close valves TV1 and TV2, which separate the turbo pumps from the beamline. Make sure you hear both of them click shut. One is a bit faster than the other, so you should here both clicks.

Now we have the beamline, which was under high vacuum, disconnected from its pumps and the bypass pumped down, so we can open up between the two:

- Open valves BV1 and BV2.

Now the whole beamline is connected to the roughing pump via the bypass line. So we can stop pumping and start venting:

- Close the hand valve between the roughing pump and the bypass. Now, nothing is pumping the bypass and beamline.
- **VERY slowly**, open the needle valve at the roughing pump. This gradually lets air into the beamline. How slowly you have to go depends on the targets in the target chamber. Note, however, that even the bonding wires of the CD can have problems if you go too fast. About 1 mbar/s is an upper limit on the venting rate.
- Once the beam line is up to air (the target chamber lid should be loose), close the needle valve.
- Close valves BV1 and BV2.
- You can turn off the roughing pump, if the Bragg chamber is vented.

If the Bragg chamber is pumped down there is a danger that the vacuum in the beam dump (which isn't being pumped on at all at this stage) will get slowly worse, until the pressure there exceeds that in the Bragg chamber and destroys the windows of the Bragg chamber. If you are going to open the beamline for any period of time, it is, therefore, a good idea, to start pumping on the beam dump.

- Make sure the roughing pump is running.
- Make sure the needle valve is closed.
- Make sure valves BV1, BV2 and BV4 are closed.
- Open the valve between the roughing pump and the bypass line.
- Once there is rough vacuum in the bypass line, you can open BV4. Now the roughing pump is pumping on the beam dump and it is safe.

2.2 Venting the beam dump

First isolate the beam dump from the rest of the beamline:

- Close valve GV2 between the beam dump and the beam line.
- Make sure the valve BV4 between the beam dump and the bypass line is closed (this should already be the case).

We need to vent the Bragg chamber before venting the beam dump, so:

- Turn the high voltage of the Bragg detector off.
- Set the upper switch of the control unit to "IST".
- Turn off the gas supply, either by setting the lower switch on the control unit to "ZU" or by closing the gas bottle's valve.
- Turn off the roughing pump for the Bragg chamber.
- Keeping the needle valve for the Bragg chamber closed, disconnect it from the roughing pump. This breaks the vacuum on the outside of the needle valve, but as the valve is closed, it doesn't break the vacuum in the Bragg chamber.
- VERY slowly, open the needle valve to let air into the Bragg chamber.

Next we need to make sure the bypass line is pumped down to roughing vacuum.

- Make sure the roughing pump is connected to the bypass line.
- Make sure the needle valve at the roughing pump is closed.
- Make sure the roughing pump is switched on.
- Open the hand valve between the roughing pump and the bypass line.
- Check that the manometer pressure goes down to zero. If it wasn't already pumped down. Wait a couple of minutes.

Now with the Bragg chamber at atmospheric pressure and the bypass line at roughing vacuum, we can open up between the beam dump and the bypass line:

- Open valve BV4 so we connect the beam dump to the bypass.

Now the beam dump is connected to the roughing pump via the bypass line. So we can stop pumping and start venting:

- Close the hand valve between the roughing pump and the bypass and turn off the roughing pump. Now, nothing is pumping the bypass and beamline.
- VERY slowly, open the needle valve at the roughing pump. This gradually lets air into the beamline. How slowly you have to go depends on the targets in the target chamber.
- Once the beam dump is up to air, close the needle valve.

3 Pumping down

3.1 Pumping down the beamline

First make sure various valves are closed (this should already be the case):

- The valve XT01.VVGS1000 between REX and Miniball should be closed.
- The two valves TV1 and TV2 to the turbo pumps should be closed.
- The valve GV2 separating the beam dump from the main beam line should be closed.
- The bypass valves BV1, BV2 and BV4 should be closed.
- Make sure the bypass line is up to air. If it is not, make sure the valve to the roughing pump is closed and open the needle valve until the bypass is vented.
- Make sure the valve to the roughing pump is closed.

Now we can start pumping down:

- Close the needle valve.
- Start the roughing pump.
- Open the bypass valves BV1 and BV2 (there is a single button to open both together).
- Slowly open the valve between the roughing pump and the bypass line. Since the bypass valves are open, this opens up from the pump right to the target chamber. How fast you can go depends on the targets you have installed, but note even the bonding wires on the CD can have problems if you pump too fast.
- Pump down to about 5×10^{-2} mbar or better.
- Close BV1 and BV2 (there is a single button to close both together) and open the valves to the turbo pumps TV1 and TV2 (again there is a single button to open both valves together.

The beamline should now pump down into the 10^{-5} mbar range.

3.2 Pumping down the beam dump

Note that the beam dump **must** be pumped down before the Bragg chamber as we may never have a higher pressure in the Bragg chamber than in the beam dump.
First of all we shoudl make sure that various valves are closed, though normally they will be closed already:

- Check that the valve GV2 between the beam dump and the beamline is closed.
- Check that the bypass valve BV4 between the beam dump and the bypass line is closed.
- Check that the bypass valves BV1 and BV2 between the beamline and the bypass line are closed.
- Make sure the bypass line is vented. If it is not, close the valve between the roughing pump and the bypass line and open the needle valve to vent the bypass line (as long as BV1,2 and 4 are closed, there is nothing connected to this line, so it can be opened quickly).

Now we can start pumping down:

- Close the needle valve.
- Start the roughing pump.
- Open the bypass valve BV4.
- Slowly open the valve between the roughing pump and the bypass line. Since BV4 is open, we are now open all the way into the beam dump. So don't pump too fast, or you will damage the Bragg chamber!
- Pump down to about 5×10^{-2} mbar or better.

If the main beam line is at a similar pressure or less (e.g. high vacuum), you can open up between the beam dump and the main beamline:

- Close the bypass valve BV4.
- Open the gate valve GV2.

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Do not open GV2 with BV4 open and the main beamline up to high vacuum, because this will suck the oil from the roughing pump.

4 Leak checking the beamline

Before doing any work on the beamline, **always** turn off the high voltages of any devices in the beam line (e.g. CD detector, T-REX, SPEDE, PPAC, multi channel plates, start/stop detectors etc.) Currently we are only running with the CD installed, but other detectors have been used in the past.

Also before doing anything on the beamline, always close the gate valve between the Miniball and the bending magnet. This valve is called XT01.VVGS1000[1] and the control via a pictogram program for the REX vacuum system.

First of all, we want to check the leak checker **before connecting it to the beamline** to make sure it is working and in the right mode. We do not want the leak checker to vent when "cycle" is pressed twice, so we have to select the mode where it doesn't do this. So before we connect the leak checker to the beam line, we check it in standalone mode with a blank end. Pump it down and check with helium. The leak checker should be set to "Inlet vent off" mode. If it is not, this can be changed with "F3".

In order to leak check the beamline, we want to replace the roughing pump for the downstream turbomolecular pump with the helium leak checker. There is a valve between the roughing pump and the turbo at this end but the turbo at the upstream end of Miniball doesn't have such a valve.

Since we want to stop a turbo pump, we need to close the valves between both turbo pumps and the beamline. Then we stop the turbo at the downstream end, close the valve between the turbo and its roughing pump, disconnect the roughing pump, put the leak checker in its place and pump down. Then we can open the valve to the turbo pump and restart the turbo pump and wait for it to get up to speed.

Then, as long as the vacuum in the beamline hasn't deteriorated too much, we can reopen the valves to the turbo pumps. If the vacuum has got too bad, we have to pump it down with the roughing pump, as if we were pumping down after venting the beamline, before we open up.

Then we can check for leaks. After we have finished, we simply reverse the process. In the past we got down to 2.5 x 10^{-8} mbar l/s.

To summarize:

- HV for all systems inside the beam line must be off (CD, PAD, SPEDE, T-REX, PPAC etc.)
- Gate valve XT01.VVGS1000 must be closed.
- Check the leak checker before connecting to beamline.
- Make sure leak checker is set to "Inlet vent off".
- Close valves to turbo pumps.
- Press "STOP" on control of downstream turbo pump.
- Close valve between this turbo and its roughing pump.
- Turn off that roughing pump and disconnect it.
- Put the leak checker in its place and pump down.
- Open valve between leak checker and the turbo pump.
- Press "START" on turbo and wait to reach full speed.

[1] This was V5A until the beginning of 2007, but the valves were renumbered, then it was V7A, and in 2011 it became L6510.VVGS1. With HIE-ISOLDE it is XT01.VVGS1000 since 2015.

- Check that vacuum in beam line is good enough to open valve to turbo. If not, pump down via the bypass line as you would if you were pumping down after opening the target chamber.
- Open valves to turbo pumps.
- Check for leaks.
- Close valves to turbo pumps.
- Stop downstream turbo pump.
- Close valve between turbo pump and leak checker.
- Stop and vent leak checker.
- Put the roughing pump in the place of the leak checker.
- Start roughing pump.
- Open valve to turbo.
- Start turbo.
- Check that vacuum in beam line is good enough to open valve to turbo. If not, pump down via the bypass line as you would if you were pumping down after opening the target chamber.
- Open valves to turbo pumps.

5 Bypassing the automatic control of GV2

Sometimes we wish to open GV2 when both sides are at atmospheric pressure. For example, in order to align, we vent the beam line and the beam dump and remove the ionisation chamber and look through to the target position with the telescope with the lid of the target chamber removed to let light in. In the past we have removed the whole GV2 gate valve in order to do this, which is rather cumbersome. There is, however, another way.

The logic for GV2 is simple. There are two Pfeiffer TPG 262 dual gauges involved (FR2 and FR3). The former measures the beam line and the latter the beam dump. Each is connected to the inerlock. Note that for FR2, the interlock is connected twice, once for the interlock of TV1/2 and once for the interlock of GV2. Both connections are assigned to the same physical gauge, but have different set points. If the vacuum is better than the set point, the Pfeiffer module closes a relay, which the interlock detects. If, and only if, both the beam line and the beam dump have vacuums below the set points, then the GV2 may be opened. Otherwise it is interlocked and the manual "Open" button does nothing.

In principle, you can increase the set point all the way up to 1000 mbar, so if you do that for both, it should stay open for atmospheric pressure. The trouble is that the gauges often go over range and display "or". When this happens, the set point condition is no longer fulfulled and the valve is closed automatically.

To override this, you can do the following.

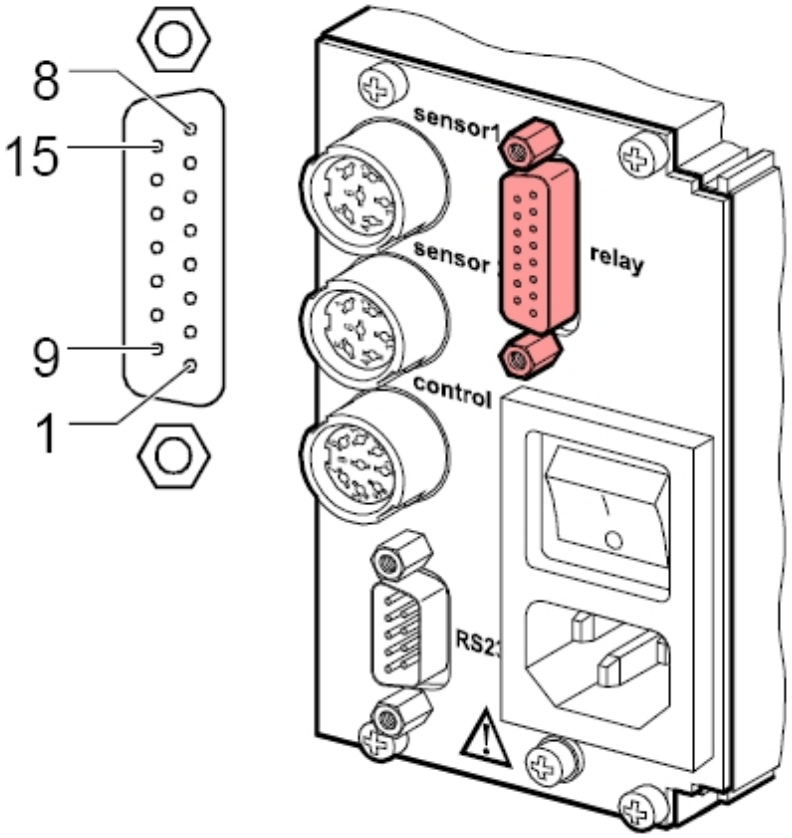

Figure 2: Pin assignment of the female 15-pole D-Sub appliance connector (taken from page 22 of the Pfeiffer TPG 262 dual gauge manual)

- Unplug the D-sub cable going into the back of the Pfeiffer TPG 262 dual gauge for the beam dump. It is normally connected to the "relay" output. The connector has only two pins, which correspond to pins 3 and 4. From the manual of the TPG 262 (page 22), the TPG 262 connects these pins together if set point 1 is fulfilled. So just put a jumper on them (e.g. the one from the packet of DGF jumpers). This fakes the set point condition being satisfied. Note the jumper should be on the connector attached to the cable going to the control unit, not the Pfeiffer module!
- It is similar for the second Pfeiffer TPG 262 dual gauge, except this time there are four pins: pins 3 and 4 for set point 1 and pins 7 and 8 for set point 2. In this case, we want 3 and 4 (i.e. the same pins as on the other connector). The other pins are for the interlock on TV1/2. Again, just put a jumper on pins 3 and 4.

After doing this, both set points are faked, so you can open and close GV2 using the buttons on the control box. Remember to reverse this procedure

before pumping down! You should **only** use this override when both sides of the valve are at atmospheric pressure. Do not pump with this override in use.

This is also documented in the electronic logbook (entry 12230), but be warned, that at that time pins 7 and 8 were assigned to the PPAC actuator.