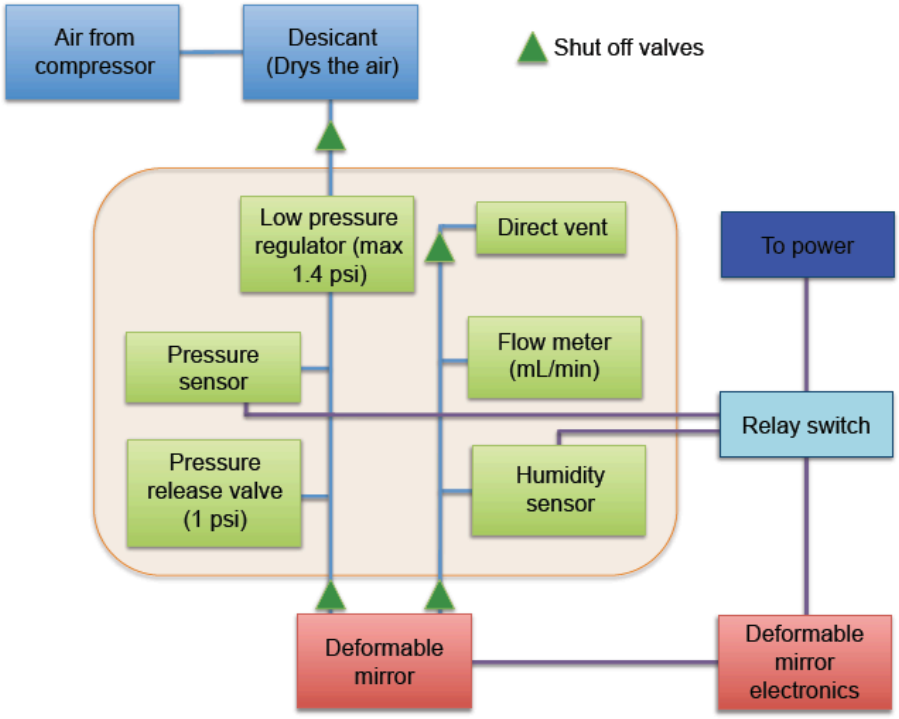
Instructions for gas supply system for the deformable mirror

by Nemanja Jovanovic on the 7/12/2013

!!!!Before operating the deformable mirror you must read this document!!!!!!

The deformable mirror (DM) should not be operated above 15% relative humidity as an advanced corroding process takes place, which can degrade the DM irreparably in only a few hours. For this reason the DM is enclosed in a small chamber that has fittings for gas to be driven through in order to dry out the air. In addition to dryness the pressure in the DM chamber should not exceed 2 psi. In fact it should be as low as possible. The aim is to have dry air flowing through chamber but not enough to bludge the chamber or window which will induce more wavefront aberrations. The following document describes the components of the gas supply and monitoring system.

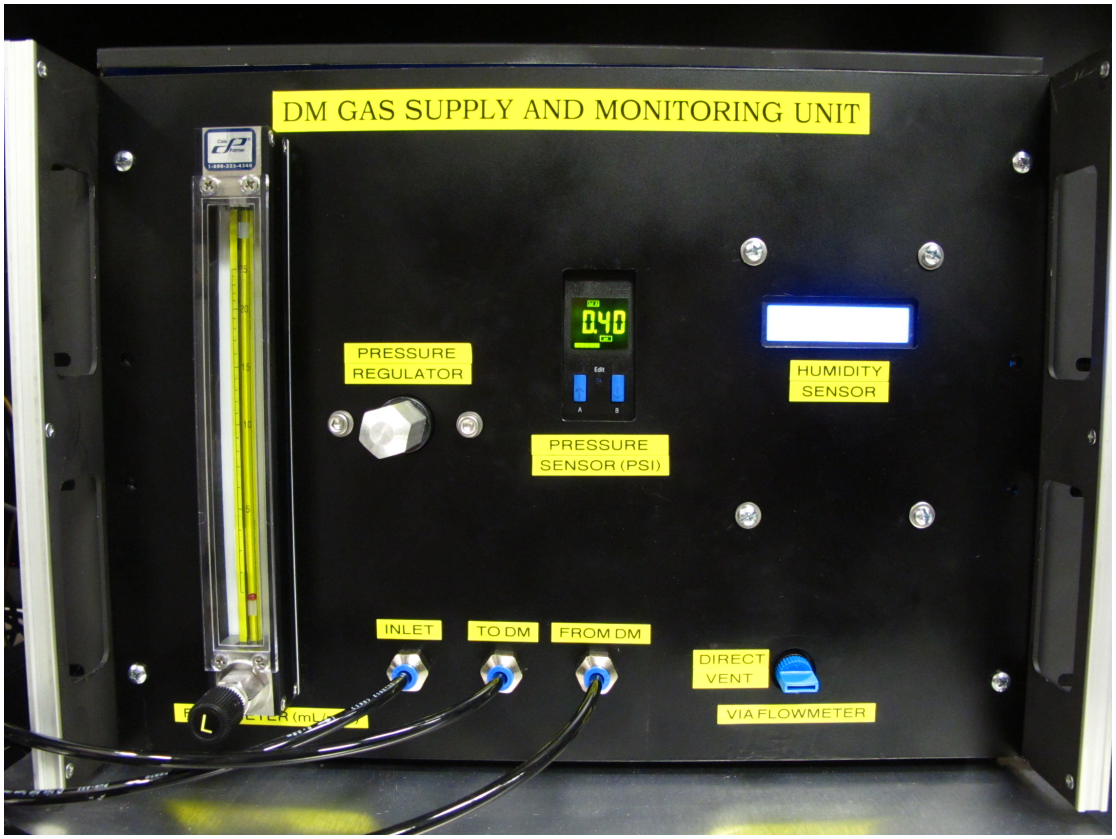
The following is a flow diagram of the how the gas supply and monitoring system is designed to operate:



- The air is supplied by an oil free compressor. It runs at over 100 psi.
- The air is then dried with a desicant. This is the large blue box with hose fittings in the simlab, in the detector lab or at the summit. This dries the air to a dew point (DP) of -30°C (3% Relative Humidity (RH)) if the compressor is not running well or down to -50°C DP (<1% RH) if it is.
- The standard hose fittings are then adapted to the 6 mm push on tuning (FESTO).
- A shut of valve is used to control the inlet port to the gas supply and monitoring unit.
- The gas enters the unit via the inlet port. The front panel of the unit is shown below.
- The inlet port is connected to a low-pressure regulator. This can induce a maximum line pressure of 1.4 psi. However, as we are trying to minimize the pressure in the chamber to avoid deformation we have set it at 0.4 psi. The

pressure regulator can be set by removing the screw on cover, releasing the nut and then adjusting the screw with a flat head screw driver. Dont forget to lock it.

- The low pressure air is routed to the 'to DM' port on the front panel via two T-pieces which are connected to a pressure sensor and a pressure relief valve. The pressure sensor is used to monitor the pressure and indeed to set the pressure regulator. It has a range from -15 to +15 psi. There is an alarm set on the pressure sensor so that when the pressure drops below 0.2 psi an output will switch which is used to trigger the relay switch which will cut the power to the electronics for the DM. This is preventative, it basically turns the DM off in case the gas supply unexpectedly stops. The pressure relief valve is a simple membrane based device which opens to vent gas if the pressure is greater than 1 psi above ambient. This is a hard over-pressure limit which helps avoid the pressure in the line building up unexpectedly. This is a redundancy as the pressure regulator should stop this as well.
- The hose from the 'to DM' port of the front panel is connected to one of the shut-off valves permanently attached to the DM. The hose from the other shut-off valve goes to the 'from DM' port on the front panel. The shut off-valves are used to stop the air circulating in the DM chamber, which may be useful for observations or even transport.
- The 'from DM' port is directly connected to the humidity sensor. This is so that the moisture leaving the DM chamber can be sensed as close to the chamber as possible. The humidity sensor can measure down to -60° DP (<1% RH). In addition an alarm has been set on the sensor so that if the RH rises above 15% and output will switch which will drive a relay switch that will turn off the electronics to the DM.
- After the humidity sensor the gas is split with a T-piece and one arm goes to a shut-off valve while the other is connected to the flow meter. The flow meter allows for a maximum flow rate of 25 mL/min, which is extremely low and very hard to sense. By closing the shut-off valve (i.e. setting it to the 'Via flowmeter' position), the air will be directed via the flowmeter. By leaving it open (or in the 'Direct vent' position), the air will simply vent and avoid the flow meter. The flow meter is used to reduce the flow rate to avoid the DM getting damaged as it's a thin and fragile membrane. However, the resistance of the compression fittings attached to the DM chamber due to their small inner diameters are a very effective flow controller already and the post DM flow rate is sufficiently low. Hence the flow meter really only needs to be used when a) one is trying to do precise measurements or observations as this will minimize turbulence in the chamber or b) if you are not using air but high purity nitrogen which is expensive and needs to be conserved.



This circuit architecture is designed so that a positive pressure is always maintained signifying that the dry air is being pumped in and the RH and flow rate are low.

Tips and other useful information:

- When the system has been disconnected or transported wet air will inevitably get in the lines. This needs to be dried out before the system can be used. It is quicker to dry the pipes out with a higher flow rate so don't shut the final valve but leave it in the 'Direct vent' position.
- The alarm on the pressure sensor can be set by using the A and B buttons on the front panel. Please refer to the users manual which is in a box in the simlab. In essence, the signal output is currently set to have an open loop if the pressure is between 0.2 and 0.8 psi. However, if the pressure goes outside this range the signal port will close the circuit and there will be 24 V across these two wires. We have connected them to a potential divider which reduces this to 12 V. This 12 V signal is connected to the 'Remote port' on the Furman relay switch via an orange black wire pair. If 12V is present it will turn off the relay and power will be cut to the DM electronics. Once the pressure is within range again it will turn back on. This is not ideal as it would be better for it to stay off until cleared by a team member.
- The alarm for the humidity sensor can be set by connecting to the RS232 cable inside the box to a laptop. If operating a windows laptop you can use the hyperterminal, which is in the accessories in XP and can be downloaded for 7 or newer. In Mac or linux you need to use the terminal. Start the hyperterminal and set the baud rate to 19200 kbits/s and change the last option to none and click apply. You should now see information from the front panel of the sensor streaming on the screen. By clicking the escape button you can open a menu to review the settings of the sensor. At this point it is easiest to refer to the

instruction manual, which is also in the box in the simlab. This will help you change the front display or set the alarms as required. The sensor is currently set so that if the RH<15% the signal port is open loop and if the humidity rises above 15% the signal ports become a closed loop. This cable is connected to the 'Force off' on the relay switch. When the circuit goes closed loop 12V generated within the relay switch are used to turn the relay off. If the switch is turned off by this sensor it will not turn itself back on if the RH drops. Instead, the RH must drop below 15% and once it does a person must toggle the bypass button on the side of the box twice to restore power to the electronics.

- Plug all pipes when you are disconnecting them to minimize moist air getting back into the circuit. Also shut off all valves.
- Don't exchange pipes too often, as each pipe needs time to be dried out. The initial drying process can take several days.
- To check if air is flowing you can plug and unplug the end of a pipe with your thumb. However, in some instances the flow is so low you wont feel it, in this case hold the pipe to your ear and you should hear it or feel it.
- If using nitrogen there is a 2-stage regulator already purchased which is suitable for high purity nitrogen. It should be in the simlab somewhere. Standard grade nitrogen should be suitable for use in the system. The only requirement is dryness.