Team 11: Pressure Sensor for an MLI Blanket

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Specifications

Table 1: Specifications

Specification	Value
Measuring Range	1e^{-3} torr to 1e^{-5} torr
Operating Temperature Range	300K to 77K
Installation Orientation	Completely immersed in vacuum
Internal Volume	108 in.^{3}
Materials Exposed to Vacuum	Tungsten rods, Fused quartz, Wooden support, Wiring, Neodymium magnets, Magnet housing
Length	3.5 in.
Height	5 in.
Width	3.5 in.

Equipment Needed

For the cold cathode sensor to be properly examined, a variety of critical equipment had to be gathered. Ideally, the system should be able to input an instantaneous voltage of approximately 2000 V through the anode rod. Once performed, ionization of the particles within constraint multilayer space occurs. The cathode rod would collect the ionized current. send it to the multigauge, and then sends it to the voltmeter. Finally, the GBIB attached to the voltmeter would convert it from an analog to a digital signal, where it transfers into the LabView Program on a computer. Through LabView, the current reading gets read through and converted into a pressure reading.

The device providing 2000 V is the 953 multi-gauge box sent by the team's NASA sponsors. The following figure displays the utilized power source.

Figure 1: 953 Multi-Gauge Box

Connected to the multi-gauge are two anode and cathode tungsten rods. Respectively, a voltage and current wire are attached to the two rods. These wires feed through the female end of the ampherol connector, providing a properly sealed connection with the outside of the testing chamber. This assembly is shown below.

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Figure 2: Tungsten Rod with Wire Configuration

The custom 8 pin ampherol connection will only utilize 4 of the pins. 2 were established as the current and voltage connection while the other 2 were purposed as their grounds. This was performed to prevent potential shortages that could occur. This connection was welded to a KF flange that's welded to the testing chamber's top flange. The pin configuration is better represented with the image below.

Figure 3: Ampherol Connector Welded to KF Flange

A female ampherol connector is attachable to the male connector above. This female connection consists of the same pair of voltage and current wires that will connect to the back of the multigauge box. It consists of an ion current port and a high voltage port.

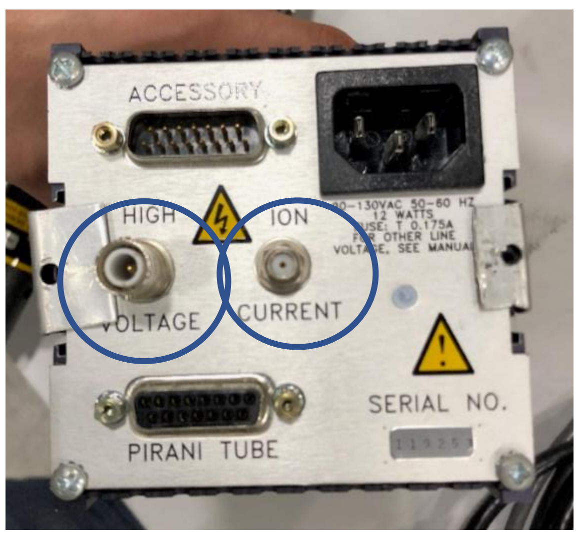

Figure 4: Rear End of 953 Multi-Gauge Box

The metallic shielding around the plastic housing act as the voltage ground. The accessory port above will utilize 2 of the 16 present pins. Pins 7 and 16 act as the voltage + and voltage – respectively.

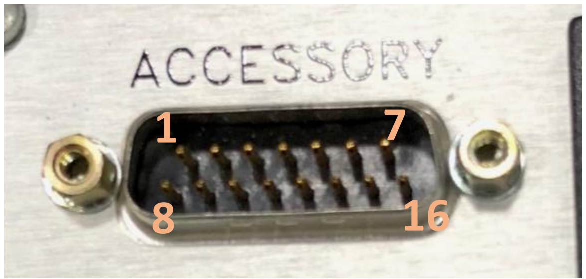

Figure 5: Accessory Pin Code

A female VGA connector with two soldered wires at the 7 and 16 pin connections will connect to the corresponding positive and negative voltage ports on the voltmeter. The following connections are shown below on the voltmeter.

Figure 6: Front of the Voltmeter

After properly configuring the expected voltage range on this device, a LabView GBIB is attached to its rear.

Figure 7: Back of the Voltmeter GBIB Connection

The GBIB will then attach to the computer's USB port. A function LabView program was then developed to collect the voltage input based on the established sampling frequency. The shielding on the rear voltage and current port helps decreased the frequency noise, allowing for more consistent readings.

To reliably vacuum the testing dewar, a vacuum and diffuser pump was provided. It has the capability of reliably measuring to 10^{-6} torrs and recording the decreasing pressure reading.

Figure 7: Vacuum/Diffuser Pump System with Gauge Controller

While the pressure reading from the diffuser pump is recording, a proportional relationship between this gauge and the voltage reading from the prototype sensor could be established.

Equipment Set Up & Operation

To set up the pressure run, the voltage and current wires must be connected to the tungsten rods. Usually, metallic clamps to each post would suffice in terms of a voltage connection. However, since this is examined within a cryostat, a screwed connection is the most ideal for sturdiness. Two neodymium magnets will then be positioned outside the tungsten rods as close as possible to induce a stronger magnetic field. This magnetic field promotes ionization when voltage is running through the system. The magnets and rods are constrained by utilizing the quartz glass as the gauge's base. Quartz also acts as a material with higher dielectric strength, increasing the chances of an electric arc forming between the system's posts. Sturdily position this sensor inside the testing dewar and seal the system's top flange. The following image illustrates each significant component that must be connected before its official operation.

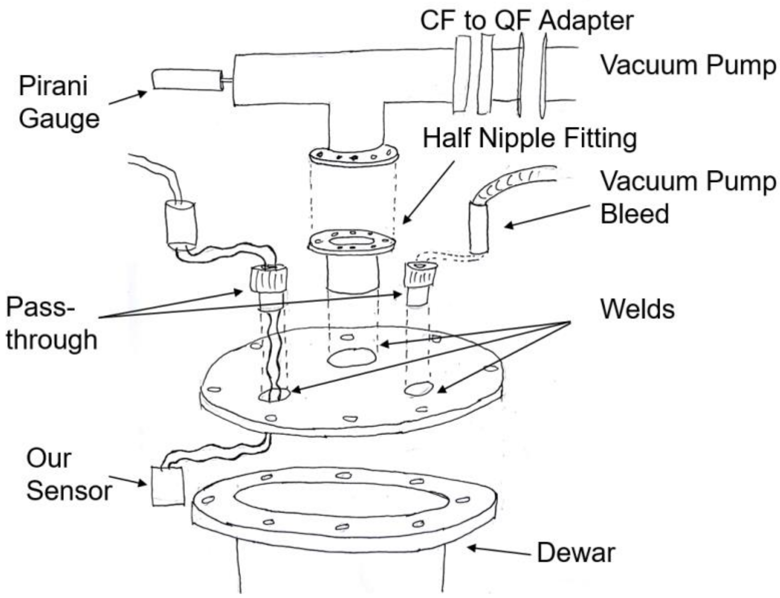

Figure 8: Diagram of Testing Dewar System

After tightening the system's ampherol connections, turn on the voltmeter and ensure that it has minute fluctuations.

Once these early procedures are performed, start the vacuum pump. Afterwards, begin running the LabView program to record the decreasing pressure.

How to Use (Experimental CCG)

The cold cathode gauge (CCG) is controlled and supplied voltage by the cold cathode gauge meter (953-gauge controller). Once the vacuum chamber is sealed with the gauge inside it, the CCG meter will be the only way to control the gauge. The vacuum should then be turned on, allowing the pressure within the chamber to fall. The pressure measurements can be found using the reference gauge on the vacuum pump itself. Additionally, a Pirani gauge will be used as a reference gauge from ambient pressure to a pressure of $1e^{-3}$ torr. The test gauge will be turned on by the CCG meter once the pressure is at $1e^{-3}$ torr. The test gauge assembly can be found in the figure below.

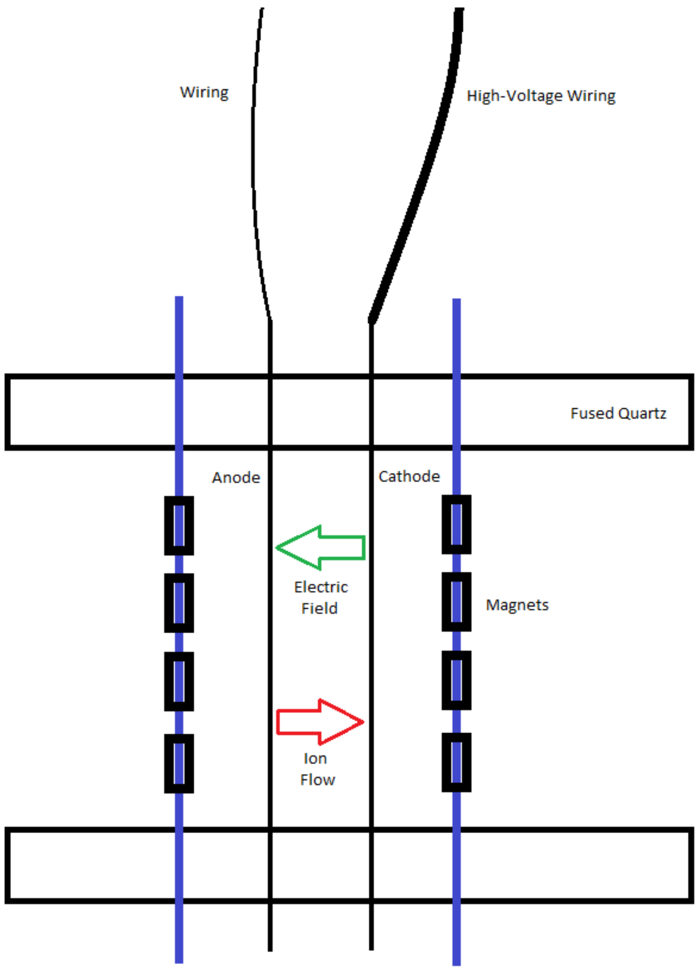

Figure X: Test Cold Cathode Gauge Diagram

Once the CCG meter is switched on, an instantaneous 2,000 volts of electricity will be applied to the cathode. The voltage difference produced will arc across to the anode as the fused quartz prevent any short circuiting. The arc will then be maintained by a much lower voltage and the ionization will begin. Remember that the test gauge is only supposed to operate in a pressure below $1e^{-3}$ torr, so the tungsten will not be damaged. If used above that pressure, the current collected will be too significant to track change and the tungsten rods will corrode. The magnets will help keep the arc stable between the two terminals. The ions will collect and draw more current from the cathode. This current will then be measures and sent to the voltmeter, simultaneously, by the CCG meter. From the voltmeter, the data will be converted into a digital set of data. Then the digital data can be collected on a data acquisition device to be recorded and manipulated later.

The test gauge will take measurement from $1e^{-3}$ torr to $1e^{-5}$ torr as the pump continues to pump down the chamber. Once the chamber passes the high vacuum pressure limit of the gauge, the gauge can be turned off because the data collection is finished. Then the vacuum bleed-off valve can be slowly opened allowing ambient pressure to slowly creep back into the chamber. Once ambient pressure is restored to the chamber the experiment is over and the gauge can be put away.

How to clean up

The tungsten rods can become dirty after multiple uses as debris will build up as the anode and cathode ionize and neutralize molecules. As this happens there are two specific ways to clean the tungsten rods either use ultrasonic cleaning or scrub with mild abrasives.

Ultrasonic

- For ultrasonic cleaning refer to the cleaner manual. Use high quality tungsten capable detergents.

Abrasives

- Apply mild abrasive to fine cloth
- Scrub areas desired to be cleaned
- Rinse with alcohol after

In addition to the gauge itself, the vacuum chamber will need a bit of maintenance. The seal between the top plate and the Dewar is achieved by a single O-ring. The slit on top of the Dewar needs to be cleaned so that there are no particles in the groove. This will ensure that the vacuum chamber is able to be pumped down to the high vacuum pressures that the experiment requires.

How to Store

Tips to store the sensor include:

- If sensor and equipment are not in use keep in a space that will not put that at risk of being deformed or crushed
- Keep in a temperate environment with normal humidity to avoid any type of corrosion
- Avoid keeping sensor in a place in which it can be dropped / damaged

Part list

The part list below lists all the individual components needed to run the experiment with the cold cathode gauge. The purpose of each sub-assembly is defined above in the "Equipment Needed" section of the manual. The gauge itself is made up of two tungsten rods that act as the two terminals. One terminal is the cathode, which will be supplied a voltage that will arc to the other rod which will act as the anode. The rods will have magnets on either side to produce a magnetic field. Fused quartz plates have holes drilled through them to allow them to hold the two rods and magnet supports in place. Then a wooden support is added to support the quartz. A high-voltage wire will be connected to the cathode to supply an initial 2,000 volts, which will then ramp down after the arc is initiated between the two terminals.

Table 2: Parts List

Cold Cathode Gauge				
Part Name	**Part Description**	**Quantity**	**Sub-Assembly**	**Acquisition Source**
Tungsten Rod		2	Cold Cathode Gauge	Purchased
Fused Quartz		2	Cold Cathode Gauge	Purchased
High Voltage Wiring	Capable of 2,000 volt load	7 ft.	Cold Cathode Gauge	NHMFL
Wiring		7 ft.	Cold Cathode Gauge	NHMFL
Magnet	N52 Neodymium Magnet	8	Cold Cathode Gauge	Purchased
Wood	Support for Quartz/Gauge	12 in. X 2 in. X 4 in.	Cold Cathode Gauge	NHMFL
Magnet Support	PVC tubing	1 ft.	Cold Cathode Gauge	Purchased

Supporting Hardware				
Part Name	**Part Description**	**Quantity**	**Sub-Assembly**	**Acquisition Source**
Dewar		1	Vacuum Chamber	MS&T at NHMFL
T-Bar Fitting		1	Vacuum Chamber	NASA
Copper Gaskets		4	Vacuum Chamber	MS&T at NHMFL
CF to KF Adapter		1	Vacuum Chamber	Purchased
Top Plate		1	Vacuum Chamber	Purchased
Top Plate to CF Adapter		1	Vacuum Chamber	Purchased
Ultra Torr Pass-through		1	Vacuum Chamber	Purchased
10-Pin Pass-through		1	Vacuum Chamber	Built
Vacuum Pump		1	Vacuum Pump	MS&T at NHMFL
Pirani Gauge		1	Reference Gauge	NASA
Cold Cathode Gauge Meter		1	Cold Cathode Gauge Meter	NASA
Voltmeter		1	Voltmeter	NHMFL