



Optical Flow Cryostat - Helitran®

The LT3-WMX-1SS offers a wide range of flexibility at a reasonable cost. This high performance systems offers an all stainless steel constructed vacuum shroud along with a welded stainless steel instrumentation skirt. This system is capable of achieving vacuum levels of 10^{-7} Torr with an appropriate vacuum system. The nickel plated copper radiation shield provides low emissivity which is ideal for low temperature experiments.

Applications

- Optical– UV, Vis, IR
- Raman
- FTIR
- Photoluminescence
- Deep Level Transient Spectroscopy (DLTS)
- Electro and Magneto Optical
- Hall Measurements
- Diamond Anvil Cell
- Electrical and Magnetic Susceptibility
- Matrix Isolation
- Mossbauer

Features

- Welded Stainless Steel Construction
- Large Clear View Optical Windows (1.25 in)
- Large Sample Viewing Angle for Optical Collection (F/0.8)
- Matrix Heat Exchange
- Coaxial Shield Flow Transfer Line
- 4K Liquid Helium Operation (1.7K with Pumping)/ 77K with LN2
- 0.7 LL/hr Liquid Helium Consumption at 4.2K
- Precision Flow Control
- Fully Customizable

Typical Configuration

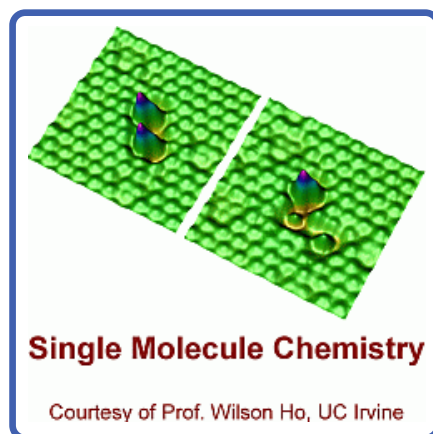
- Cold head (LT3-WMX-1)
- Coaxial Shield Flow Transfer Line
- Stainless steel instrumentation skirt
- Dewar Adapter
- Flow Meter Panel for Helium Flow Control and Optimization
- Welded stainless steel vacuum shroud for optical and electrical experiments (WMX-1SS)
- Nickel Plated OFHC Copper Radiation Shield
- Instrumentation for temperature measurement and control:
 - 10 pin UHV feed through
 - 36 ohm thermofoil heater (wire wrapped)
 - Silicon diode sensor curve matched to (± 0.5 K) for control
 - Calibrated silicon diode sensor (± 12 mk) with 4 in. free length for accurate sample measurement.
- Wiring for electrical experiments:
 - 10 pin hermetic feed through
 - 4 copper wires
- Sample holder for optical and electrical experiments
- Temperature Controller

Options and Upgrades

- High Flow Transfer Line
- High Temperature Interface (450K and 800K)
- Custom temperature sensor configuration (please contact our sales staff)
- Custom wiring configurations (please contact our sales staff)



The above picture shows LT3B Helitran® with a radiation shield.



Single Molecule Chemistry

Courtesy of Prof. Wilson Ho, UC Irvine



Optical Flow Cryostat - Helitran[®]

Cooling Technology-

| | |
|----------------------|-----------------------------|
| LT4 | Open Cycle Cryocooler |
| Refrigeration Type | Liquid Helium/Nitrogen Flow |
| Liquid Cryogen Usage | Helium, Nitrogen Compatible |

Temperature*-

| | |
|---|---------------------------------|
| LT4 | <4.2K—350K |
| With 800K Interface | (Base Temp + 2K) - 700K |
| With 450K Interface | Base Temp - 450K |
| Stability | <2mK (with properly tuned flow) |
| *Based on bare cold head with a closed radiation shield, and no additional sources of experimental or parasitic heat load | |

Sample Space -

| | |
|--------------------------|--|
| Diameter | 36 mm (1.43 in.) |
| Height | 39 mm (1.53 in.) |
| Sample Holder Attachment | 1/4 - 28 screw |
| Sample Holder | www.arscopy.com/Products/SampleHolders.html |

Optical Access-

| | |
|-----------------|--|
| Window Ports | 5 - 90° Apart |
| Diameter | 41 mm (1.63 in) |
| Clear View | 32 mm (1.25 in) |
| #/F | 1 |
| Window Material | www.arscopy.com/Products/WindowMaterials.html |

Temperature Instrumentation and Control - (Standard) -

| | |
|-------------------------------|--|
| Heater | 36 ohm Thermfoil Heater anchored to the coldtip |
| Control Sensor | Curve Matched Silicon Diode installed on the coldtip |
| Sample Sensor | Calibrated Silicon Diode with free length wires |
| Contact ARS for other options | |

Instrumentation Access-

| | |
|------------------------|---------------------------------|
| Instrumentation Skirt | Welded, Stainless Steel |
| Pump out Port | 1 - NW 25 |
| Instrumentation Ports | 2 |
| Instrumentation Wiring | Contact sales staff for options |

Vacuum Shroud -

| | |
|----------|-------------------------------------|
| Material | Welded Stainless Steel |
| Length | 338 mm (13.3 in) |
| Diameter | 79 mm (3.12 in) at the sample space |
| Width | 56 mm (2.21 in) at the sample space |

Radiation Shield -

| | |
|----------------|------------------------------------|
| Material | OFHC Copper, Nickel Plated |
| Attachment | Threaded |
| Optical Access | 0, 2, 4, or 5 (customer specified) |

Cryostat Footprint -

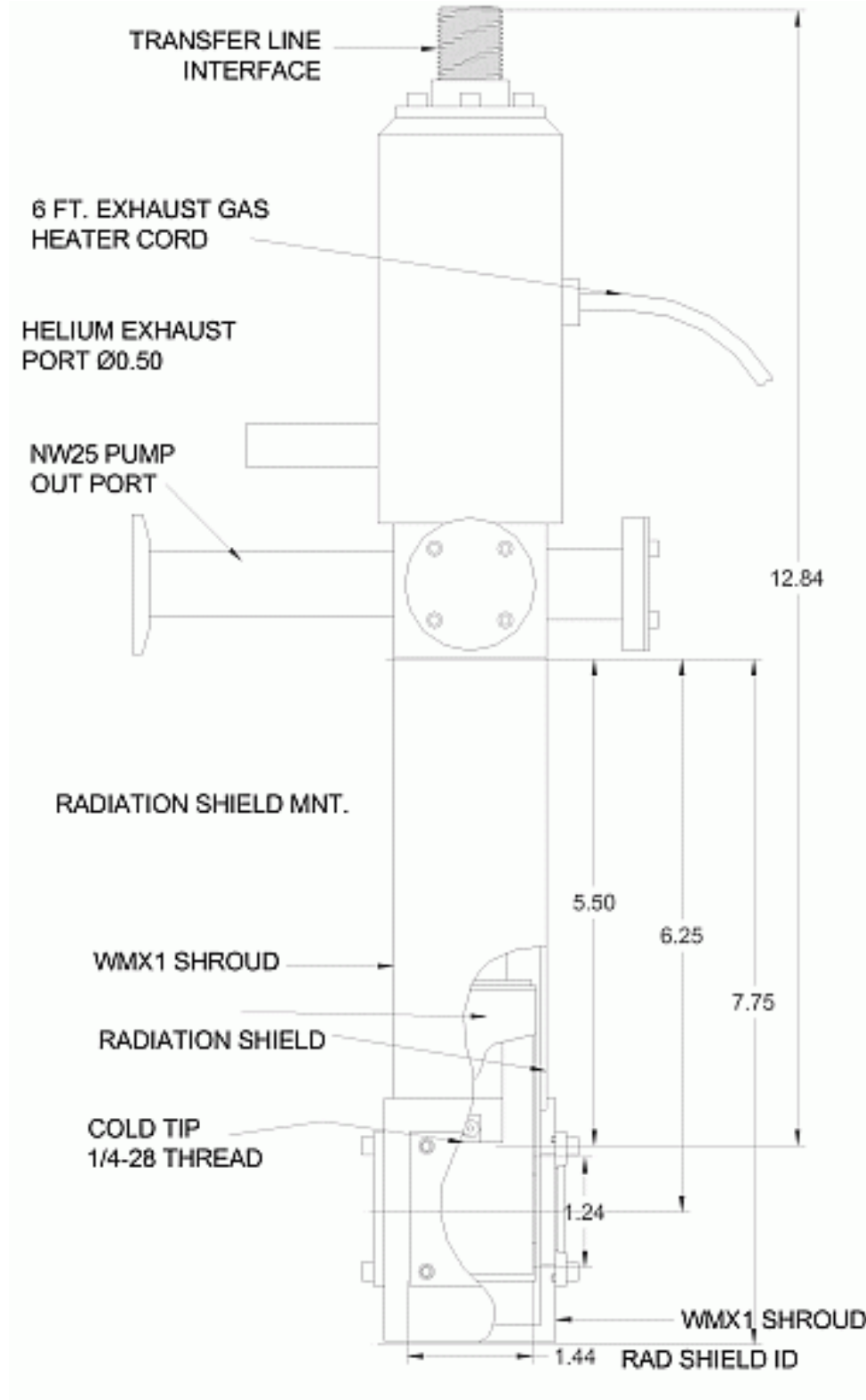
| | |
|----------------|----------------|
| Overall Length | 383 mm (15 in) |
|----------------|----------------|

| Cryostat Model | LT3 | | |
|---|--|------------------|-----------------|
| | Liquid Helium | | Liquid Nitrogen |
| Cryogen | | | |
| Base Temperature | 4.2K | <2K with Pumping | 77K |
| Nominal Helium Consumption at 4.2K | 0.7 LL/hr | - | |
| Cooling Capacity | 0.7 LL/hr | 2 LL/hr | |
| | 4.2K | 0.5W | 1.5W |
| | 20K | 3.0W | 8.0W |
| | 50K | 7W | 20W |
| Maximum Temperature | 450K with cold gas through transfer line | | |
| Cooldown Time | 20 min | | |
| Weight | 0.9 kg (2 lbs) | | |



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LT3-WMX-1SS Outline Drawing





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Advanced Features of LT3B Helitran[®]

The Helitran[®] has been designed for high performance with advanced features not normally found in traditional open cycle cryostats. A detailed description of the **Matrix Heat Exchanger**, the **Adjustable Impedance Valve** and the **Coaxial Transfer Line** is presented in this paper

Helium Consumption:

Conventional Helium Flow Cryostats do not incorporate extended surface Heat Exchangers (at the sample mount) for cost reasons. The liquid helium is contained in a reservoir similar to a copper cup over the sample mount. As the helium boils and evaporates only the latent heat of vaporization is used to cool the sample mount, there is no provision to capture the enthalpy of the gas as it escapes from the cryostat at 4.2K regardless of the sample temperature. The cooling power of the gas is wasted. Enthalpy of Helium gas from 4.2 to 300K is substantial at 1542 Joules/gm.

The Helitran[®] incorporates an extended surface tip heat exchanger (**Matrix Heat Exchanger**) which provides efficient heat transfer between the helium and the sample mount. The Liquid helium flows through this heat exchanger and as the latent heat of vaporization cools the sample mount, the liquid evaporates, the gas continues to flow through the exchanger providing additional cooling (capturing the enthalpy of the gas) to the sample mount. If the flow is optimized the helium gas will exit the Matrix Heat Exchanger at a temperature equal to the sample temperature.

Helium usage is dramatically reduced as reported by J. B. Jacobs in Advances in Cryogenic Engineering, Volume 8, 1963, Page 529 as follows:

Amount of Cryogenic fluid required to cool metals (Liters/Kg.) to 4.2K.

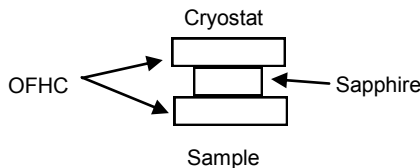
| Cryogen | ⁴ He | ⁴ He |
|---|------------------------------|-----------------------|
| Initial Temperature of 1 Kg of Copper. | 300K | 77K |
| Final Temperature of 1 Kg of Copper, | 4.2K | 4.2K |
| Using the latent heat of vaporization only. (Inefficient Heat Transfer) | 31.1 Liters of Helium | 2.16 Liters of Helium |
| Using the Enthalpy of Gas. (Efficient Heat Transfer) | 0.79 Liters of Helium | 0.15 Liters of Helium |

From this it is clear that for any sample size the consumption of He during initial cooldown is 40 times higher without an extended surface cryostat tip heat exchanger from 300K (room temperature) to 4.2K and 14 times higher when cooling from 77K to 4.2K.

Temperature Range:

Sub 4.2K Operation: The temperature of helium drops to 1.8K when the pressure is reduced across an **Adjustable Impedance Valve**. Pumping on a reservoir, as in a traditional system is not practical as all the helium will evaporate rather quickly. In the Helitran[®] the suction is applied against the Impedance Valve by attaching a vacuum pump, this reduces the pressure of the helium as it flows through the Matrix Heat Exchanger, The matrix heat exchanger and the conductively coupled sample mount are cooled to below 1.8K.

800K Operation: The high temperature can be achieved by incorporating a thermal switch, composed of a sapphire and OFHC copper arrangement as shown below. The unique property of sapphire is utilized, where its thermal conductivity is equal to that of copper from 4-300K but it becomes a thermal insulator above 300K. The high cooling power of the Matrix Heat exchanger protects the cryostat.



Temperature Stability:

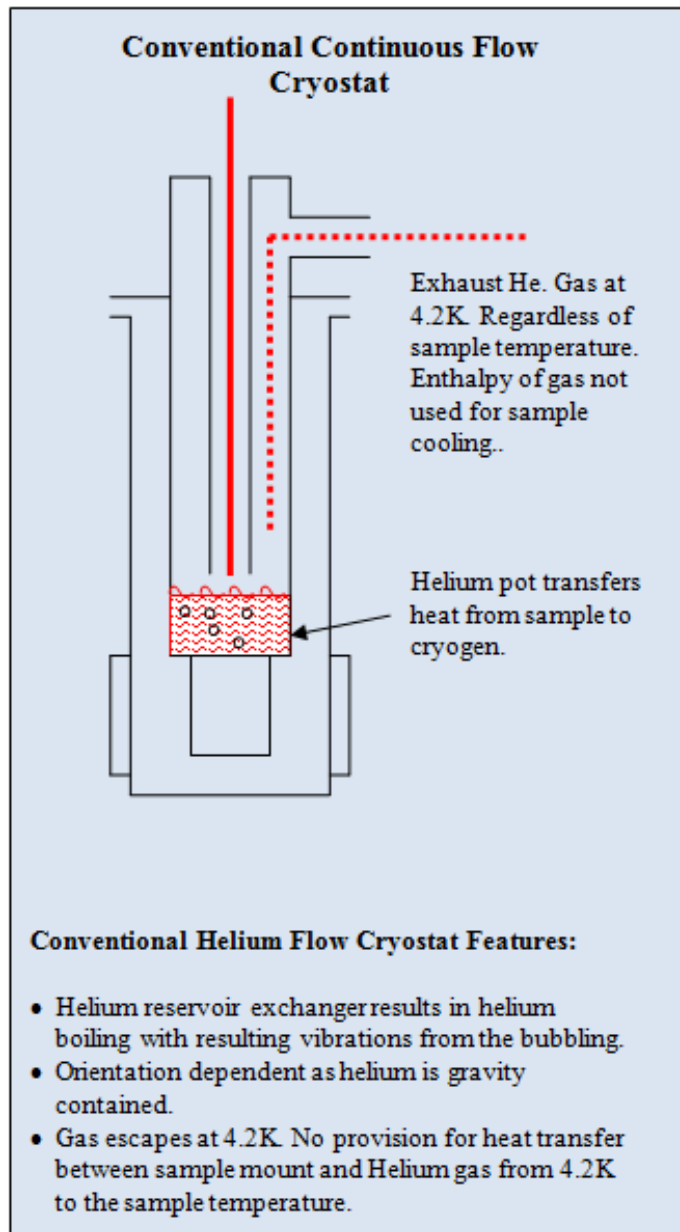
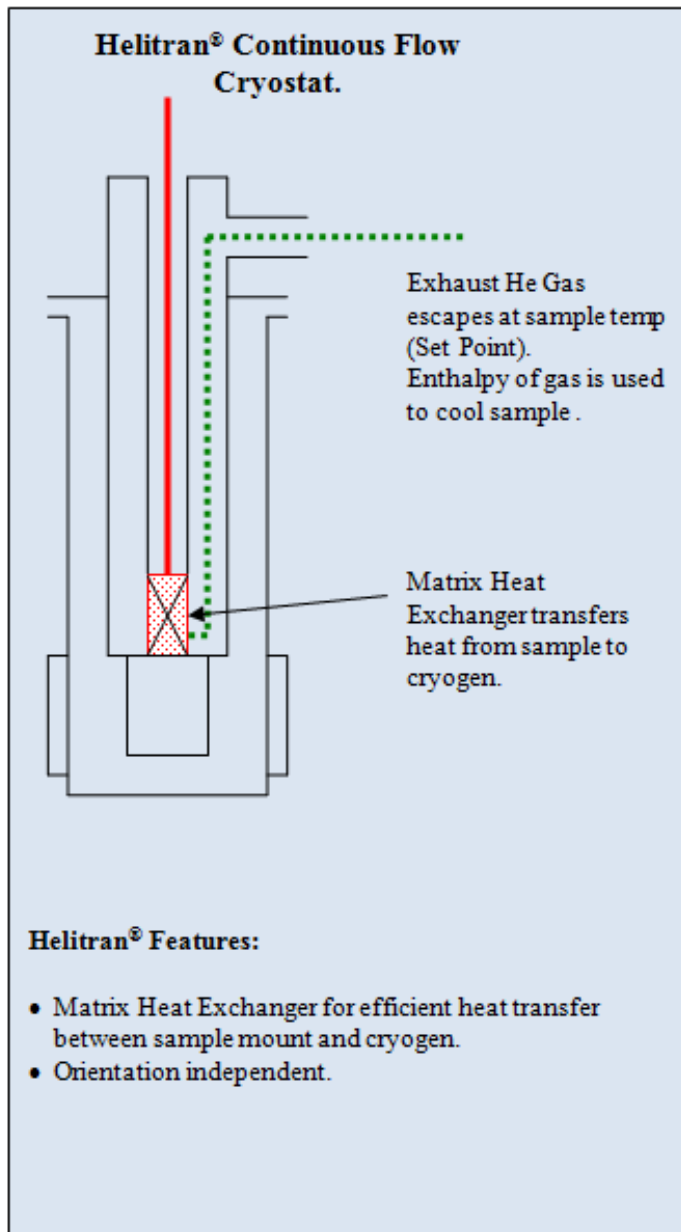
Conventional helium flow cryostats utilize a capillary tube in a vacuum jacket with superinsulation to reduce the radiant heat load. However as the helium absorbs radiant heat the liquid is vaporized and forms bubbles of gas which have a larger volume than the liquid thus forming a temporary block to the flow of the liquid called "vapor binding". At the delivery end of the transfer line this results in the liquid/gas mixture being delivered in spurts with accompanying pressure and temperature cycling.

The coaxial flow transfer line incorporates a shield flow (See figure) surrounding the tip flow for the entire length of the transfer line. The entrance to the coaxial shield flow tube is provided with a nozzle which results in a pressure and corresponding temperature drop in the shield flow which subcools the tip flow in the center tube. This subcooling prevents boiling and gas bubble formation in the helium, even at very low flow rates. The Helium is delivered at the sample end with the desired temperature stability and low vibrations.



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Cryostat Design Features





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Helium Flow Transfer Line Features

