UHV Cryostat - Low Power ULV

The **CS202*F-DMX-20B** opens up a wide range of possibilities never before possible with a closed cycle cryocooler. The ARS manufactured DMX-20B interface, like our “B” series cold heads is a True UHV System (10^{-11} Torr) where all of the rubber o-ring seals have been replaced with welded joings and metal seals. A CF flange is The DE202*F-DMX-20B uses a Helium Exchange Gas to decouple the sample from the cold tip of the DE202 Cryocooler. This prevents almost all vibration from being transmitted to the sample. Sample vibration levels of 3-5nm have been demonstrated by users. Due to the exchange gas being less conductive, the base temperature will increase by 1-2K and the cooling capacity is roughly cut in half at varying temperatures.

Applications

- Low Vibration UHV applications
- Microscopy Applications
- Surface Science
- Nanomaterials

Features

- **Ultra Low Vibrations (3-5 nm)**
- True UHV (10^{-11} Torr)
- Bakeable to 200C with cold head removed
- Open Sample Space
- Cold Tip Down Orientation
- Fully customizable

Typical Configuration

- Cold head (DE-202AF)
- Compressor (ARS-4HW)
- 2 Helium Hoses
- 6” Rotatable CF flange
- Nickel Plated OFHC copper radiation shield terminating 0.125” short of the cold tip
- 2 High purity quartz windows
- Instrumentation for temperature measurement and control:
  - 10 pin hermetic feed through
  - 50 ohm thermofoil heater
  - Silicon diode sensor curve matched to (±0.5K) 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

- 4.5” CF flange available but uses non standard ID and may not fit existing chambers
- 8” CF flange avilable
- 4K Coldhead (0.2W @ 4.2K) CS204SF-DMX-20B **(DE-202S not recommended)**
- 5.5K Coldhead (3W @ 10K) CS204PF-DMX=20B **(DE-202P not receommened)**
- 450K High Temperature Interface
  (Not required with the DMX-20 interface, but the 450K interface is helpful for high temperature performance)
- 800K High Temperature Interface
- Turbo upgrade for faster cooldown times
- Custom temperature sensor configuration (please contact our sales staff
- Custom wiring configurations (please contact our sales staff)
- Sample holder upgrades (custom sample holders available)

The above picture shows a cryocooler with a vacuum shroud, radiation shield, and sample holder installed.

The above picture shows the compressor for the system. What is not shown is a required vacuum pump, Helium Hoses (included with system), temperature controller and Helium Gas bottle with regulator for the exchange gas.

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Cooling Technology-

DE-204	Closed Cycle Cryocooler
Refrigeration Type	Pneumatically Driven GM Cycle
Liquid Cryogen Usage	None, Cryogen Free

Temperature*- DMX-20 adds 1-2K to base temperature

DE-204AF	< 10K - 350K
DE-202PF	Not Recommended
DE-202SF	Not Recommended
With 800K Interface	(Base Temp + 2K) - 700K
With 450K Interface	(Base Temp + 2K) - 450K
Stability	0.1K
*Based on bare cold head with a closed radiation shield, and no additional sources of experimental or parasitic heat load	

Sample Space -

Diameter	Large Open Radiation Shield
Height	Large Open Radiation Shield
Sample Holder Attachment	1/4 - 28 screw
Sample Holder	www.arscryo.com/Products/SampleHolders.html

Chamber Interface -

Flanges	CF, ISO
Size	4.5”, 6”, 8” 10” (4.5” CF flange non standard may not fit all chambers)

Temperature Instrumentation and Control - (Standard) -

Heater	50 ohm Thermofoil 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	0
Instrumentation Ports	2
Instrumentation Wiring	Contact sales staff for options

Radiation Shield -

Material	Nickel Plated OFHC Copper
Attachment	Threaded
Optical Access	Open End Radiation Shield terminateds 0.125” short of cold tip (customer specified)

Cryostat Footprint -

Overall Length	590 mm (23.24 in) 295 mm (11.63 in) standard flange to tip length
Motor Housing Diameter	114 mm (4.5 in)
Rotational Clearance	200 mm (8 in) with “G” Configuration

Cryocooler Model		**DE-202AF**		**DE-202A(T)F**		**DE-202PF**		**DE-202SF**	
	Frequency	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz
Base Temperature		<9K	<9K	<9K	<9K	<5.5K	<5.5K	<4.2K	<4.2K
Cooling Capacity	4.2K	-	-	-	-	-	-	0.1W	0.08W
	10K	0.5W	0.4W	0.7W	0.56W	1W	0.8W	1.2W	1W
	20K	2.5W	2W	3.7W	3W	3.5W	2.8W	4W	3.2W
	77K	4W	3.2W	6W	4.8W	3.5W	2.8W	4W	3.2W
Radiation Shield Cooling Capacity		10W	8W	15W	12W	10W	8W	10W	8W
Cooldown Time	20K	50 min	60 min	35 min	42 min	60 min	72 min	60 min	72 min
	Base Temperature	70 min	84 min	50 min	60 min	90 min	108 min	90 min	108 min
Compressor Model		ARS-2HW		ARS-2HW		ARS-2HW		ARS-4HW	
Typical Maintenance Cycle		12,000 hours		8,000 hours		12,000 hours		12,000 hours	

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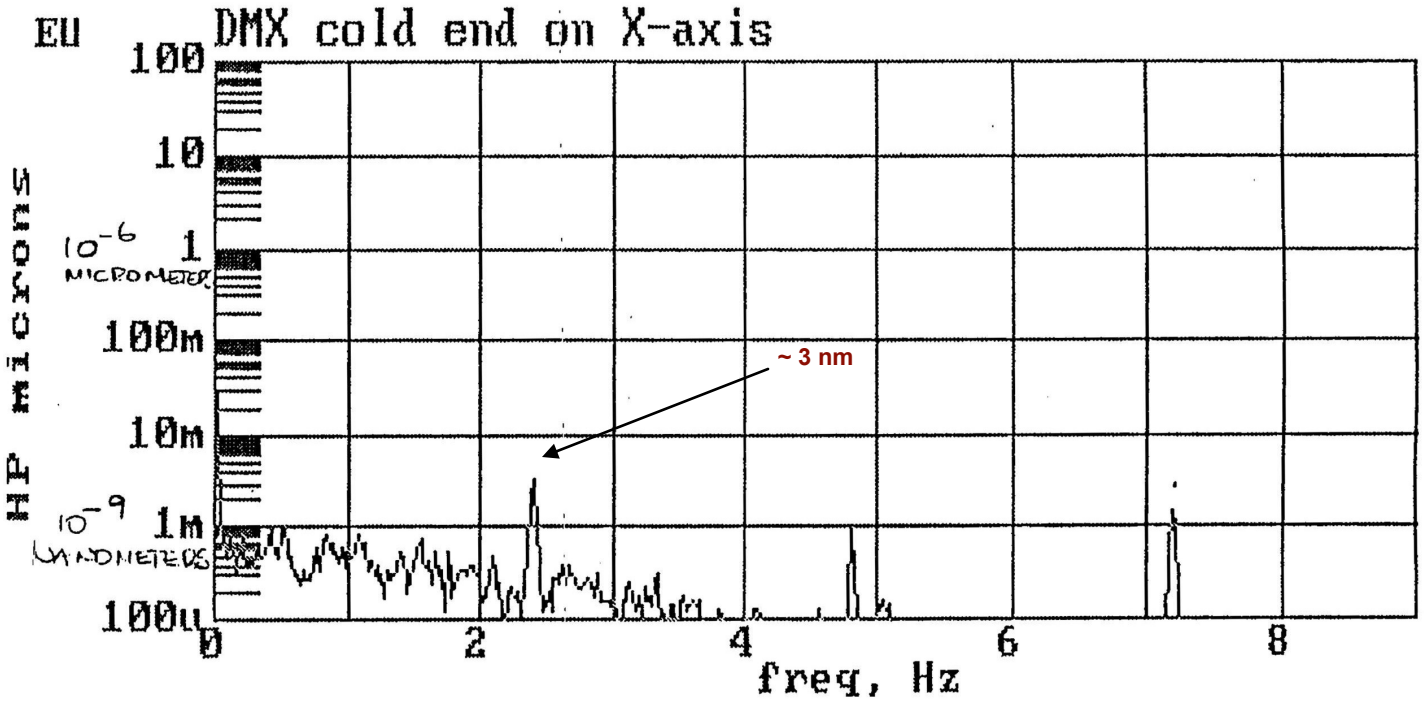
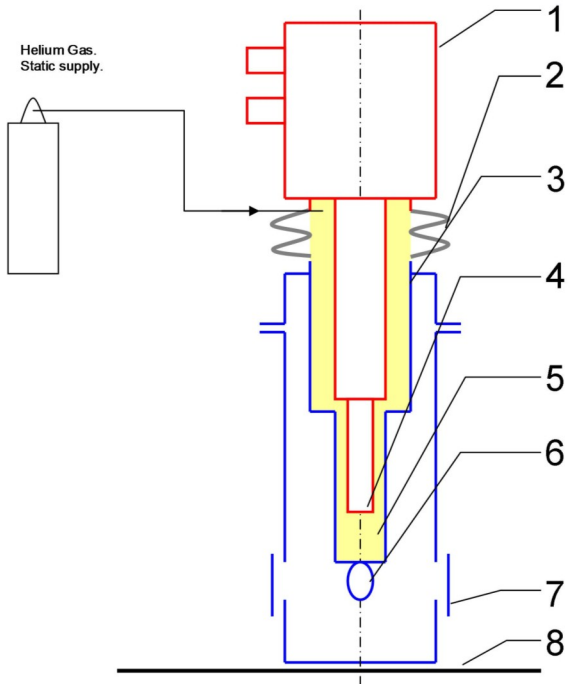
DE202*F-DMX-20 Vibration Spectra



Understanding the DMX-20 Interface

The **X-20** Interface uses a Helium Exchange Gas to decouple the sample space from the cold tip of the cryocooler. This prevents almost all vibration from being transferred to the sample space. Scientists have demonstrated vibration levels as low as 3-5 nm with the **DE202*F-DMX-20** (as shown above)

1. The Cryocooler is supported from a Floor Stand
2. The soft rubber bellows minimize vibrations transmitted to the sample while keeping in the Helium Exchange Gas
3. The X-20 interface has no contact with the cryocooler except through the rubber bellows.
4. The cold tip has 10-30 micron vibrations (depending on CCR model) but no direct contact with the sample space.
5. Convective pockets of Helium Exchange Gas cools the sample space.
6. The sample is only in contact with the X-20 Interface
7. Windows for Optical Experiments
8. The X-20 Interface is mounted directly on a (user provided) Vibration Isolation Table.



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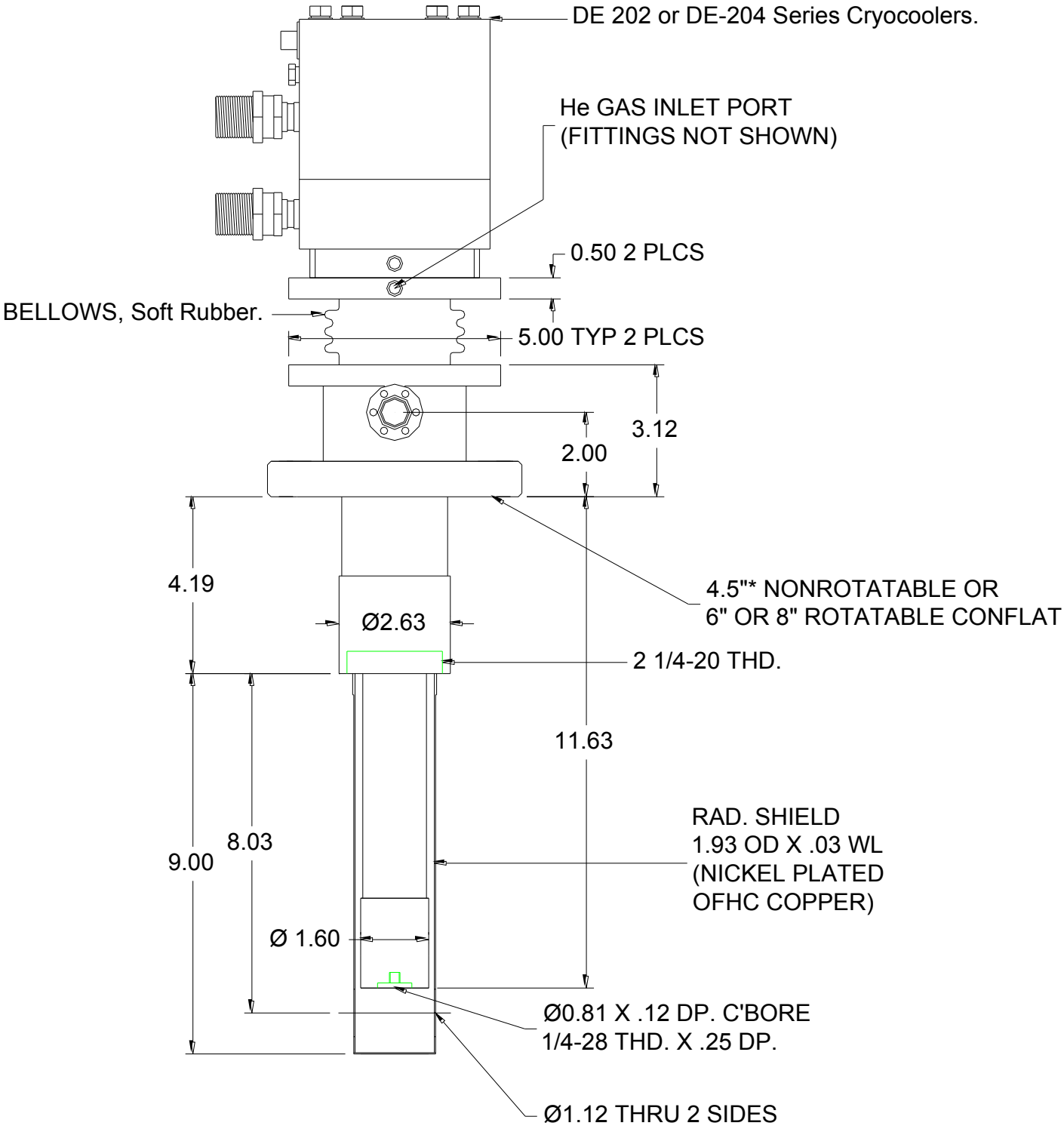
DE202*F-DMX-20B Outline Drawing



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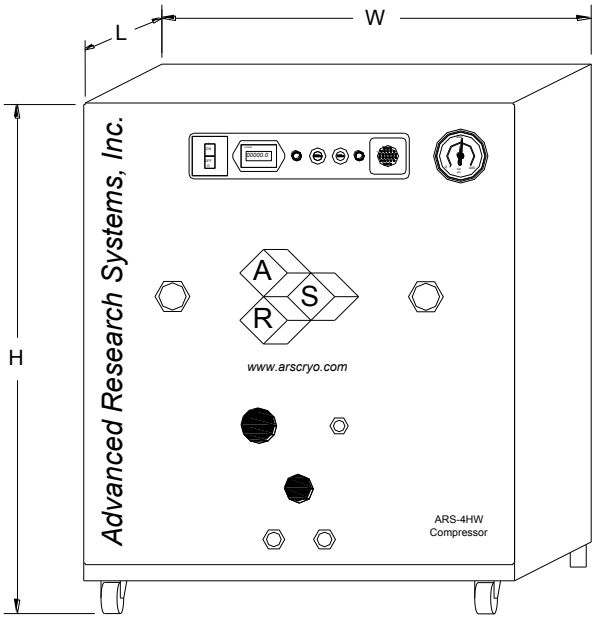
Direct Mounting

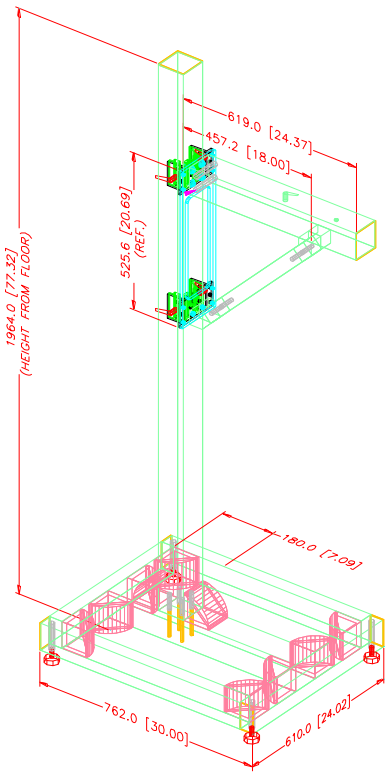
The DMX-20 can be direct mounted on the Cryocooler. The vibrations at the sample will go up to 140 nm. It can be useful if the sample has to be translated in XYZ.

ARS-4HW Compressor



Compressor Model		ARS-4HW	
	Frequency	60 Hz	50 Hz
Standard Voltage	Min	208 V	190 V
	Max	230 V	210 V
Transformer Options	10%		220 V, 230 V
	15%		240 V
Power Usage	Single Phase	3.6 kW	3.0 kW
Refrigerant Gas		99.999% Helium Gas, Pre-Charged	
Noise Level		60 dBA	
Ambient Temperature			
Cooling Water	Consumption	2.3 L / min (0.6 Gal. / min)	
	Temperature	10 - 35 C (50—95 F)	
	Connection	3/8 in. Swagelok Fitting	
Dimensions:	L	483 mm (19 in)	
	W	434 mm (17.1 in)	
	H	516 mm (20.3 in)	
Weight		72 kg (160 lbs)	
Typical Maintenance Cycle		12,000 hours	
Water Recirculation Option		CoolPac Compatible	

Floor Stand



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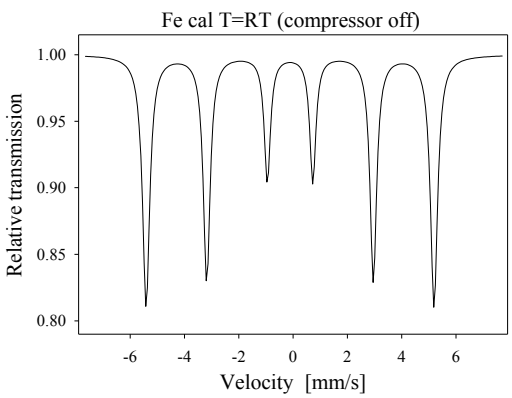
Mossbauer Spectra with DMX-20

Cryocooler Off



Calculated parameters:

WID=0.269 mm/s
W13=1.17

W23=1.08

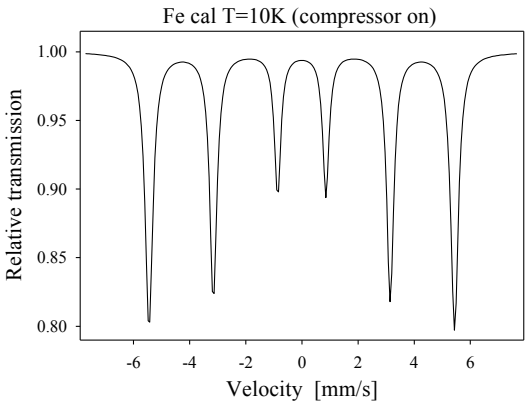
ISO=0.000 mm/s

BHF=32.94T

Calibration spectrum:

Measurement with metallic iron foil (thickness 25 mm)

Cryocooler On



Calculated parameters:

WID=0.270 mm/s
W13=1.21

W23=1.11

ISO=+0.115 mm/s

BHF=33.81T

Calibration spectrum:

Measurement with metallic iron foil (thickness 25 mm)

When the system is properly mounted to the wall and the table and properly adjusted then the effect of vibrations induced by the working compressor is very small (almost negligible).

The broadening (rather no broadening!) is fully reproducible and is well below 2%. Such broadening has practically no effect and in almost all cases can be ignored. However, compare the lin ewidths calculated in the same way!

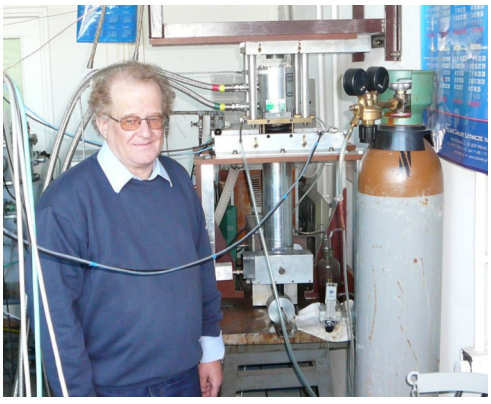
The Displex system is virtually vibration free!

Prof. Dr. habil. Michal Kopcewicz

Institute of Electronic Materials Technology

WARSAW, Poland

Mossbauer Cryostat, DMX-20



Prof. Dr. habil. Michal Kopcewicz

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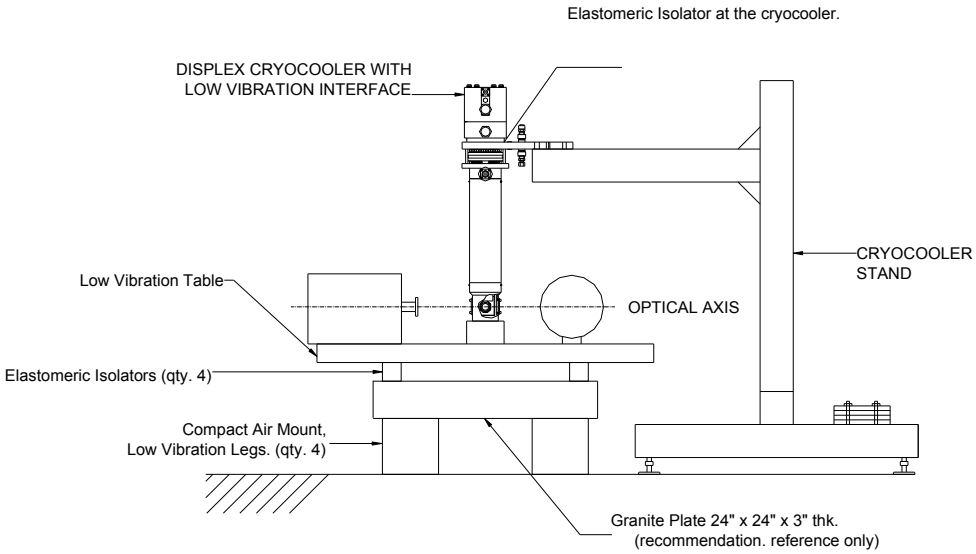
Possible Mossbauer Configuration



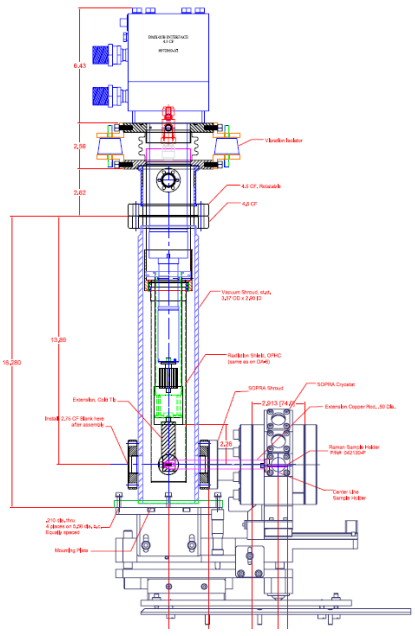
For maximum isolation proper mounting of the system is important. ARS offers a special ULV stand to isolate the ultra low vibration cryostat from the vibrating components of the cooler and the floor vibrations.

The cryocooler stand can be adjusted for the proper height, this holds the cooler.

The cryostat is mounted on the low vibration table. which consists of a high mass granite block (User supplied), resting on 4 air legs (optional ARS offering). Additional elastomeric isolators additional filter the unwanted frequencies from the floor to the cryostat.

System can be tested by shutting off the cryocooler only and watching the vibration effect on the experiment.

Ellipsometry



Low Vibration system for SOPRA Ellipsometer

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SEM Setup

The picture shows the Displex and its interface. All items showing stainless steel in the photo are modifications to our JSM-5910 SEM. Please also note the published papers on my website, which demonstrate CL results that were acquired with this cooling system.

The sample temperature, is between 40 K and 50 K.

Courtesy; Prof. Dan Rich, Ben Gurion University, Beer Sheva, Israel.

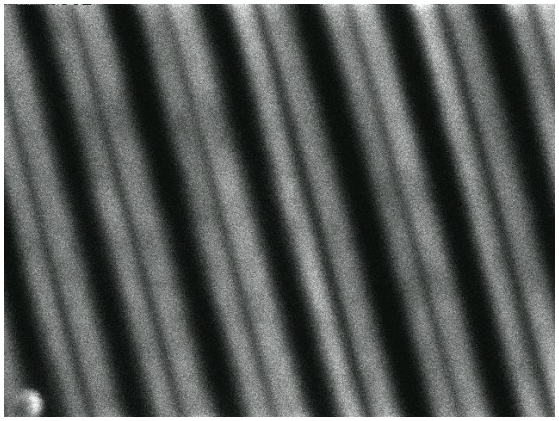
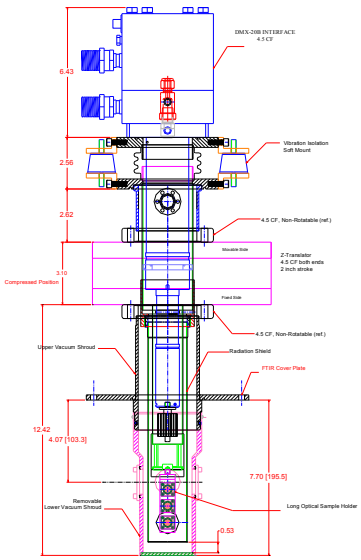


Image of a InGaN/GaN quantum well grown on a patterned GaN substrate. The patterning consists of stripes with a periodicity of 10 microns.

Monochromatic CL image (Mag. 2000) taken with a 390 nm detection wavelength.

The degradation of image quality from room temperature and 50K suggests that the vibration is less than 10nm.

FTIR Setup



Low Vibration system for FTIR spectrometer. Sample holder with 3 samples can be translated in Z direction.

Low Vibration system for BOMEM, DA8 FTIR spectrometer.

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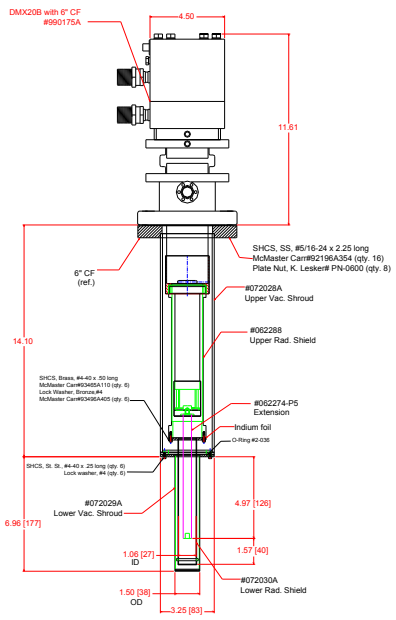
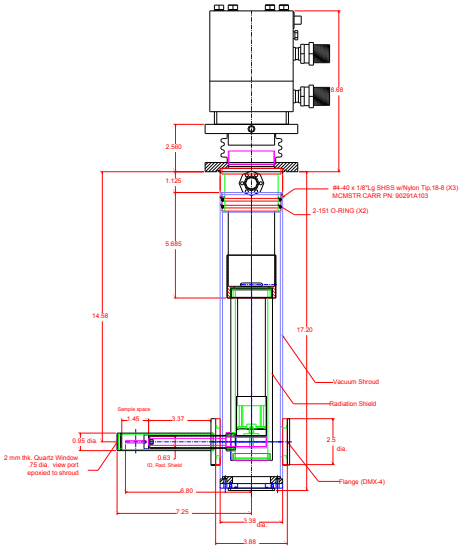
Magneto Electrical Experiments



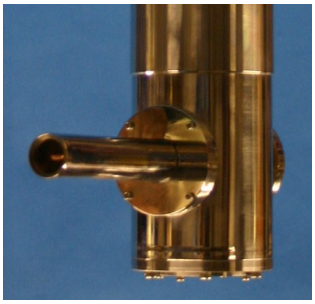
The vacuum shroud becomes narrow to permit sample insertion into a small magnet pole space.

The vacuum shroud becomes narrow to permit sample insertion into a small magnet pole space.

Magneto Optical Experiments (MOKE)



Low Vibration Side looking window can be placed in a MOKE, (Magneto Optical Kerr Effect). Sample can be located in any plane. The pole spacing can be as low as 1 inch.



Small diameter vacuum housing can be inserted into a narrow gap (high field). The optical window allows collection of light from the sample. The window can be very close to the sample for short focal length objective.