



# Closed Cycle Nanoscience Probe Station

The ARS Closed Cycle Nanoscience Probe Station model PS-CC-NS is designed for the ultimate in flexibility for non-destructive device testing. This system enhanced with a **GMX-20 Ultra Low Vibration** exchange gas interface, optimal vibration isolation of the sample and probes.

This system is ideal for the study of electro-optical properties in variety of experiments, including quantum dots, spintronic devices, and nanoscale electronics. The probe configuration and system design can be customized to suit your specific experimental requirements, including RF Probes for high frequency response and low drift supports for long-term viewing of the sample.

This model of Probe Station utilizes the **DE-210 Series** of cryocoolers. These cryocoolers allow for sample stage **Temperatures of 7K**. All of the ARS Closed Cycle Cryocoolers are designed with high first stage cooling capacity which allows for fast cool downs and dissipation of high radiative heat loads.

The system comes with a polished stainless steel Vacuum Chamber and an Au/Ni plated OFHC Radiation Shield. The high quality materials allow for high vacuum levels and ultimately cleaner sample environments.

ARS' integrated approach of manufacturing for both the cryocooler and the probe station ensures consistent performance, and also facilitates diagnostics and service of the integrated system.

## Applications

- Magnetic Properties
- Microwave Properties
- DC, RF S-Parameter Measurements
- MEMS/NEMS
- Nanoscale Electronics
- Superconductivity
- Electro-Optical Properties of Nano-devices
- Quantum Dots and Nanowires
- Single Electron and Low Current Physics
- Non Destructive Device Testing

## Features

- Cryogen-free operation
- Ultra Low Vibration Interface featuring +/- 10nm displacement and low accelerations into the supporting table
- Ease to operation, with exceptional probe manipulator build quality
- Allows unsupervised cooldown
- High Vacuum, with  $10^{-10}$  UHV Also Available

## Typical Configuration

- Two-stage closed cycle refrigerator with 1.1W cooling power at 4.2K
- Cryogen-Free Ultra Low Vibration Interface and Floor Stand
- 4 DC probe arms
- 7:1 zoom microscope with <3 micron resolution and coaxial or ring light
- Precision instrumentation and heaters mated to 4 Channel Controller for easy control and warm up

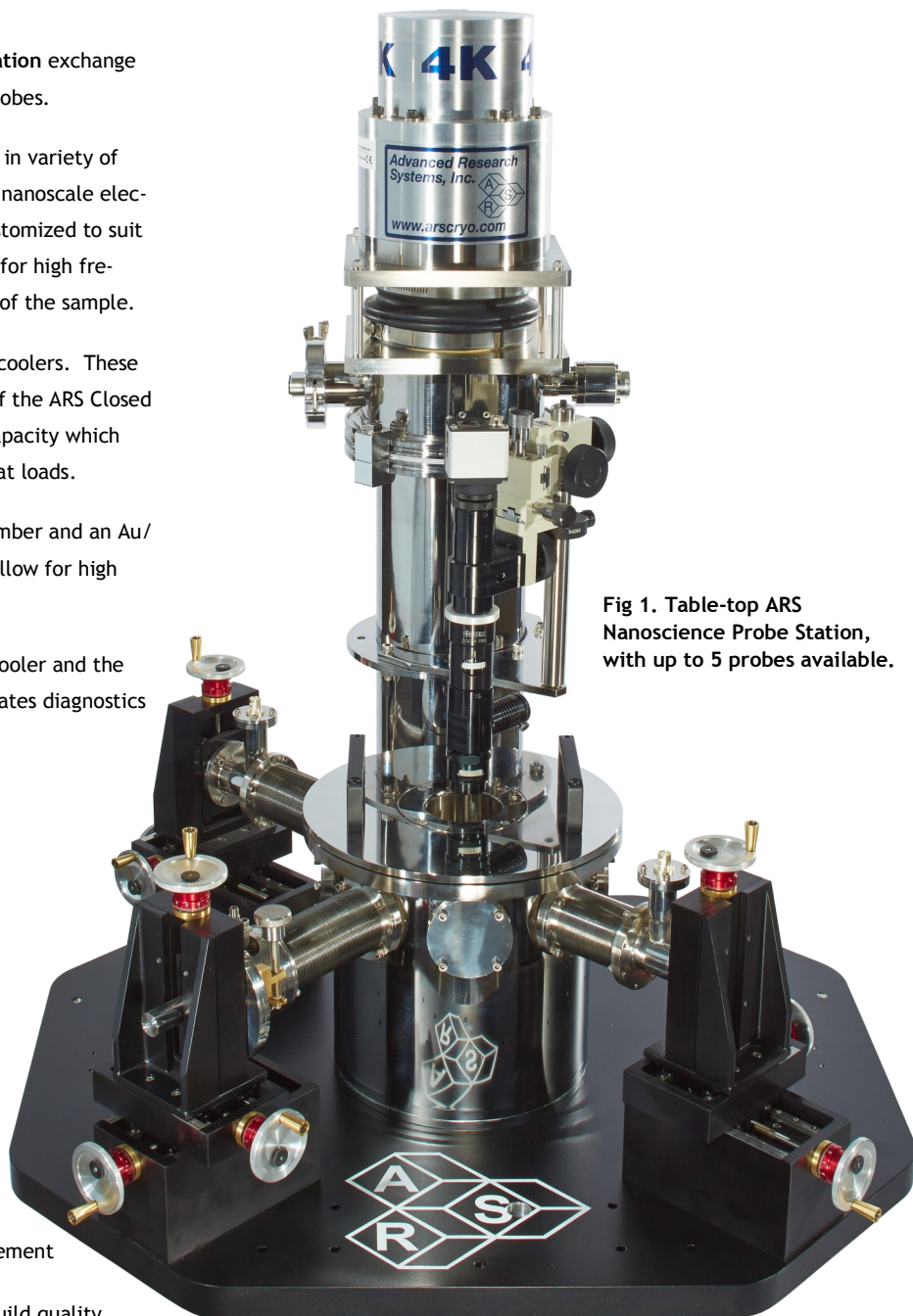


Fig 1. Table-top ARS Nanoscience Probe Station, with up to 5 probes available.



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## Sample Temperature

Temperature Range	7K Temperature-300K, DE-210SFg GMX-20 Interface
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## Cool Down and Pump Down Time

Pump Down Time	2hr (90 min to reach $<1 \times 10^{-3}$ torr)
Room Temperature	$10^{-4}$ Torr
Base Temperature	7 Kelvin, $10^{-6}$ Torr
Cool down time	3hr

\*The pump down time listed are approximate timelines using an ARS supplied vacuum pumping system. Actual vacuum levels of the system will be dependent of the vacuum pump itself and options. Outgassing of certain options can effect vacuum level

\*\*The cool down time to Base Temperature is listed for the DE210S cryocooler under typical conditions without sample mounted. Customizations can effect heat load, cooldown time and minimum temperature.

## Vibration Levels

Sample Stage Vibrations	$< \pm 10$ Nanometers
Vibration Dampening	3 Stages
Stage 1 (Low Frequency)	User supplied, floating optical table
Stage 2 (All Frequencies)	GMX-20 Ultra Low Vibration Interface with Floor Stand
Stage 3 (Sample Stage)	Supersoft Copper Braids to transmit maximum cooling power and minimal vibrations from the cold tip to the sample stage

## Cooling Technology

DE-210S	Closed Cycle Cryocooler
Refrigeration Type	Pneumatically Driven GM Cycle
Liquid Cryogen Usage	None, Cryogen Free

## Vacuum Chamber

Material	Eletroless polished stainless steel 304
Diameter	11" (280mm)
Tall	11.75" (294 mm)
Probe Ports	Up to 6
Lid	Removable Lid with Quartz Window.
Chamber access	9" (229mm) diameter open
Optical Access	
Window Material	High purity Quartz
Window Diameter	3" (76 mm)
Window Clear View	2.75" (67 mm)

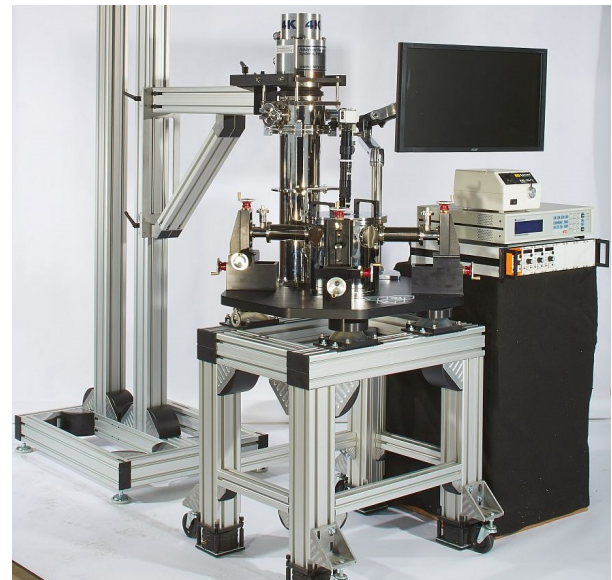
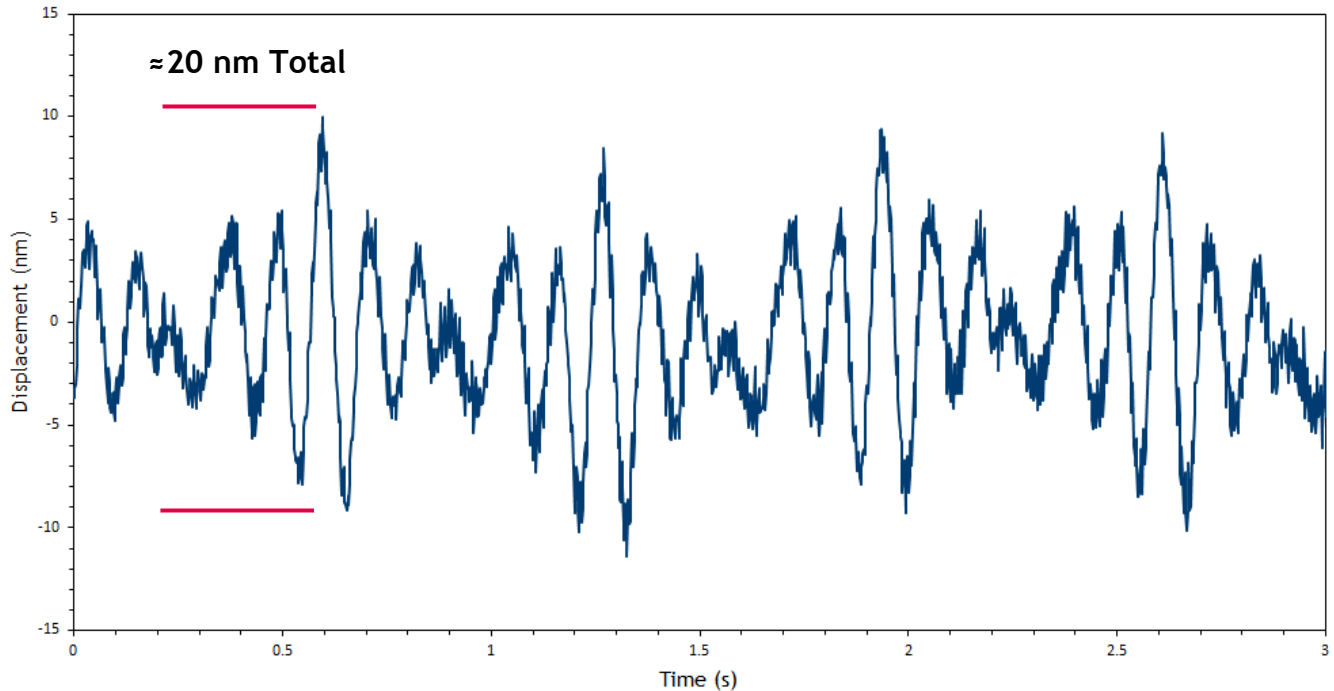


Fig 2. The above picture shows the probe station with optional floor table, piezo controller, as well as standard temperature controllers, monitor, cryocooler stand, and light source. Ideal configuration should employ pneumatic optical table for best vibrations.

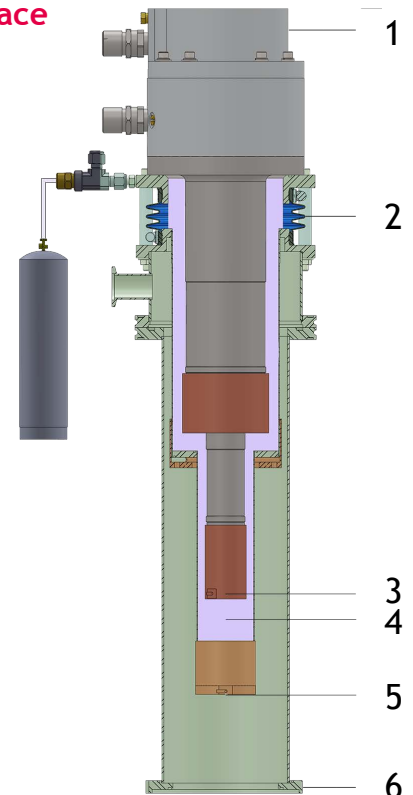
## DE-210F-GMX-20 Vibration Spectra, Probe Station Data from System 17-A120



### Understanding the GMX-20-OM Interface

The X-20-OM 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  $\pm 10$  nm with the DE210F-GMX-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 cold tip has 10-30 micron vibrations (depending on CCR model) but no direct contact with the sample space.
4. Convective pockets of Helium Exchange Gas cools the sample space.
5. The sample is only in contact with the X-20 Interface
6. The X-20 Interface is mounted directly on a (user provided) Vibration Isolation Table.





# Closed Cycle Nanoscience Probe Station

## Translation Stages

Drive	Direct Drive
Bellows	Stainless Steel, Edge Welded
Motion	
X-Motion (Axial)	2" (50 mm) Standard
Y-Motion (Lateral)	1" (25 mm) Standard
Z-Motion (Vertical)	0.5" (12.5 mm) Standard
Graduations	10 micron
Sensitivity	5 micron

## Radiation Shield

Material	Nickel plated OFHC
Sample Access	9" (229mm) diameter lid
Lid	Removable Lid with Sapphire Cold window
Mounted On	1st stage of Cryocooler
Optical Access	
Window Material	Sapphire
Window Diameter	3" (76 mm)
Window Clear View	2.7" diameter (69 mm)

## Sample Holders

2.25 inch electrical floating sample holder, bias-able sample plates also available

1 inch measureable area

2 inch (51mm) diameter recommended maximum sample size

\*Custom sample holders, and low working distances also available

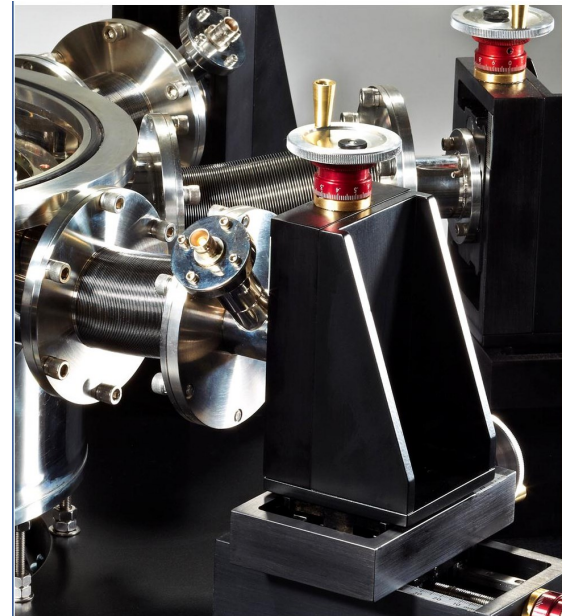
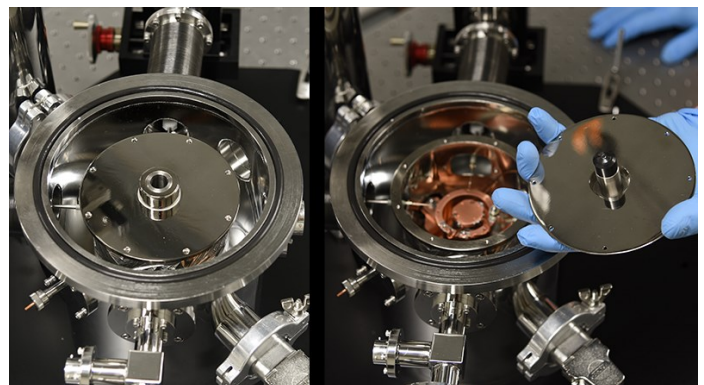


Fig 4. XYZ translation stages have hardened steel ball bearing for smooth and precise motion control, theta rotation for planarization

## Control Stability

Sample Stage Temperature	Stability
Base Temperature (no heat control)	Not specified
<7K	+/-50mK
10K to 200K	+/-10mK
201K to 300K	+/-10mK

Fig 5. In-Vacuum Objectives for Ultra-Low Working Distance Observation





# Closed Cycle Nanoscience Probe Station

## Instrumentation for Temperature Control\*

Temperature Sensors	Silicon Diode, with optional Calibration
Installed on the radiation shield	High accuracy +/-0.25K from 2-100K
Calibrated Silicon Diode Sensor Installed on the top of the sample stage for accurate sample temperature	
Installed on the cryocooler cold tip for diagnostics	Accuracy +/-0.5K from 2-100K
Installed on the 1st stage of cryostat	High accuracy +/-0.25K from 2-100K
Heaters	Cartridge Heaters (50 Watt) For fast warm up and temperature ramping
Temperature Controller	4 Channel Temperature Controller with 150W heater power.

\*Interconnecting cables from the probe station to the temperature controller are supplied.

## Cryocooler Compressor

Compressor Model		ARS-10HW	
Frequency		60 Hz	50 Hz
Standard Voltage	Min	208 V	190 V
	Max	230 V	210 V
High Voltage	Min	440 V	380 V
	Max	480 V	415 V
Power Usage	Phase	(3 Ph) 7.7 kW	
Refrigerant Gas		99.999% Helium Gas, Pre-Charged	
Noise Level		60 dBA	
Ambient Temperature		5 - 40 C (40 - 104 F)	
Cooling Water	Consumption	5.7 L / min (1.5 Gal. / min)	
	Temperature	< 20C (68F)	
Dimensions:	Connection	1/2 in. Swagelok Fitting	
	L	483 mm (19 in)	
	W	533 mm (21 in)	
	H	617 mm (24.3 in)	
Weight		105 kg (230 lbs)	
Typical Maintenance Cycle		12,000 hours	

\* Air Cooled Compressor Options Available



# Closed Cycle Nanoscience Probe Station

## Probe Arm and Microscope Options

### GSG Microwave Frequency Probe Arms

\*All GSG Microwave Frequency Probe Arms include the Translation Stages. Probe arms are thermally anchored to the sample chuck and include +/- 5° Theta Planarization

<b>40 GHz</b>	<b>Optional</b>
Connector	K
Cable	Semirigid Coaxial
Frequency	0 to 40 GHz
Tip Material	Tungsten
Pitch	50 - 2450 micron (100 or 150 micron Typical)
<b>50 GHz</b>	<b>Optional</b>
Connector	2.4
Cable	Semirigid Coaxial
Frequency	0 to 50 GHz
Tip Material	Tungsten
Pitch	50 - 1250 micron (100 or 150 micron typical)
<b>67 GHz</b>	<b>Optional</b>
Connector	1.85
Cable	Semirigid Coaxial
Frequency	0 to 67 GHz
Tip Material	Tungsten
Pitch	50 - 1250 micron (100 or 150 micron typical)

### Fiber Optic Probe Arms

Range	UV/VIS or VIS/IR
Connector	Male SMA 905
Sample Termination	Bare Polished
Size (Typical)	100 micron - 400 micron
Mode	Single Mode or Multi Mode
Cable Material	Polyimide, Fused Silica

\*All Fiber Probe Arms include the Translation Stages. This does not include a light source or detector.

### DC/Low Frequency Probe Arms

\*All DC/Low Frequency Probe Arms include the Translation Stages. Probe arms are thermally anchored to the sample chuck.

<b>Microminiature Coax Cable</b>	<b>Standard</b>
Connector	SMA or BNC
Frequency	0 to 100 MHz
Impedance	50 Ohm
Includes Outer Ground Shield with Clip Connector	
<b>Triaxial Cable</b>	<b>Optional</b>
Connector	Triaxial - 3 Lug
Frequency	0 to 100 MHz
Impedance	50 Ohm
<b>Kelvin Probes**</b>	<b>Optional</b>
Cable	Coaxial or Triaxial
Connector	SMA, BNC, or Triaxial
Frequency	0 to 100 MHz
<b>Probe Tips:</b>	
Material	Tungsten (Standard) Gold Plated Tungsten (Optional) Beryllium Copper (Optional)
Tip Radius	0.5 micron (standard) Other radius' also available

\*\*Kelvin Probes use 2 cables and 2 connectors, but converge down to a single tip.

### GigE Microscope with Zoom Lens

Zoom	7:1 (Standard)	16:1 (Optional)
Sensor	1/2" CMOS	1/2" CMOS
Field of View	4.2 mm - 0.61 mm	12.8 mm - 0.8 mm
Working Distance	89 mm	89 mm
N.A.:	0.024 - 0.08	0.0090 - 0.15
Light (Includes Light Source)	Ring or Coaxial	Ring of Coaxial
Resolution	3 microns	2 microns
Stand	Boom Stand with XYZ manipulation	Boom Stand with XYZ manipulation
Computer Interface	Ethernet Cable	Ethernet Cable
High Resolution Monitor	24"	24"



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