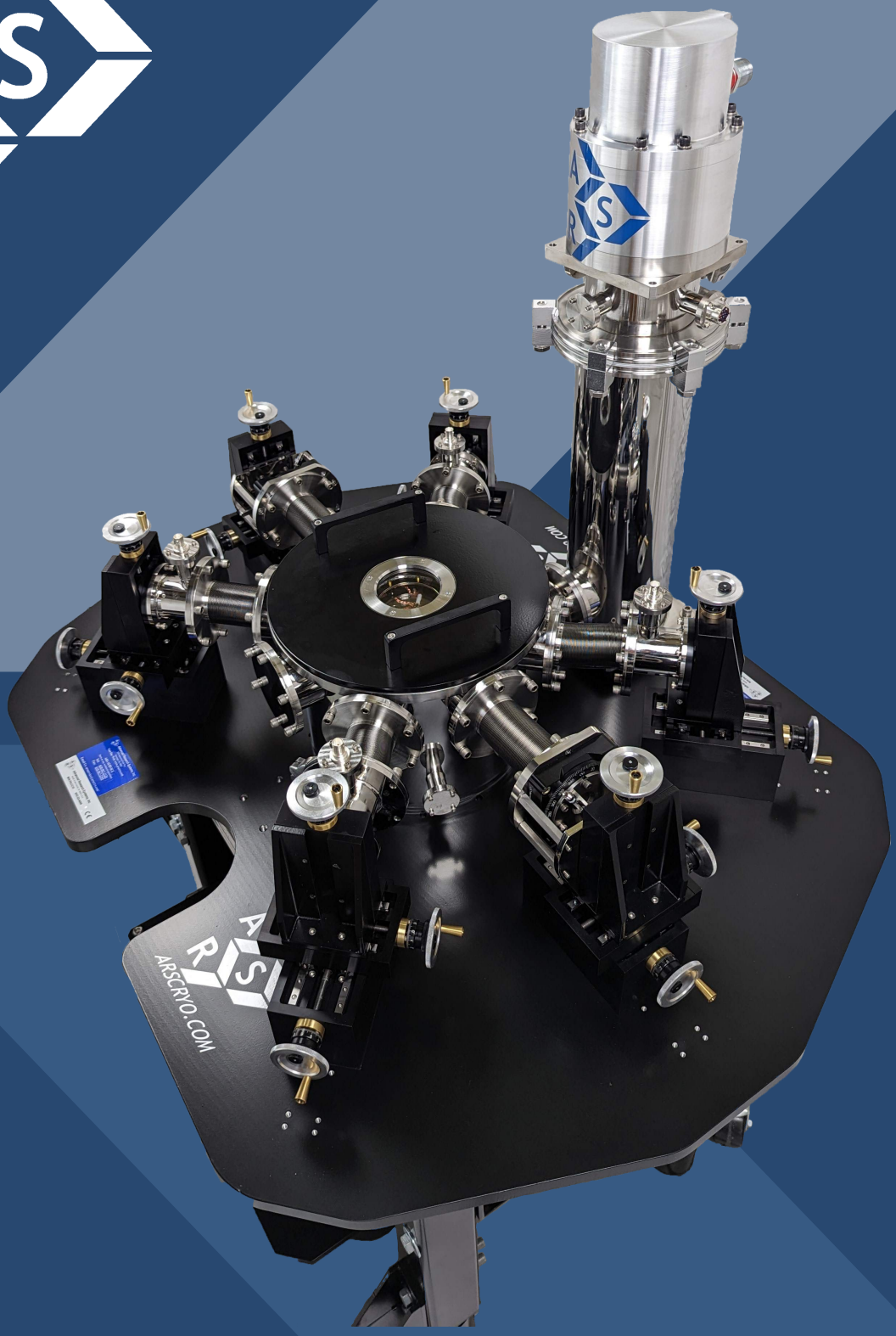


Cryogenic Probe Stations

By Advanced Research Systems

Cryogenic Probe Station Guide

Advanced Research Systems is proud to manufacture cryogenic probe stations that satisfy the latest sample environment needs of scientists worldwide. Our probe stations allow electrical probing using DC and RF probes that are moveable while the sample is under vacuum and at cryogenic temperatures.

Learn.

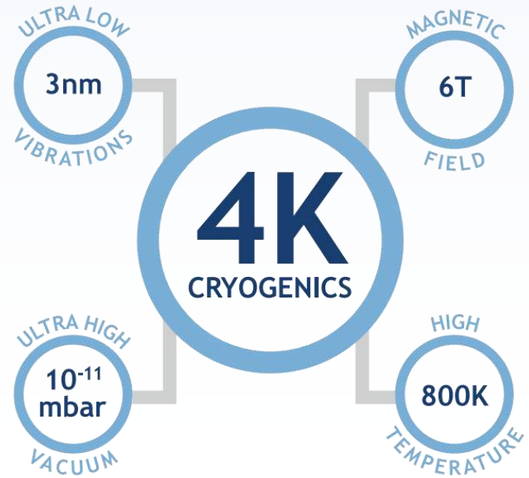
Cryogenic probe stations are complex laboratory instruments. Become familiarized with the major subsystems and components common to all cryogenic probers.

Explore.

Investigate our main platforms and select a base system to meet your core experimental needs.

Configure.

Outfit your probe station with the desired probes, upgrades, customizations, and accessories to build the ultimate prober.



Probe Station Anatomy

Cryogenic probe stations come in many shapes and sizes but all have the same key features. From this basic platform, each system is tailored to suit the needs of the researcher. ARS strives for the best balance between performance and modularity, allowing our customers to not just fulfil their experimental needs today, but to also have a roadmap for future research.

Cryocooler

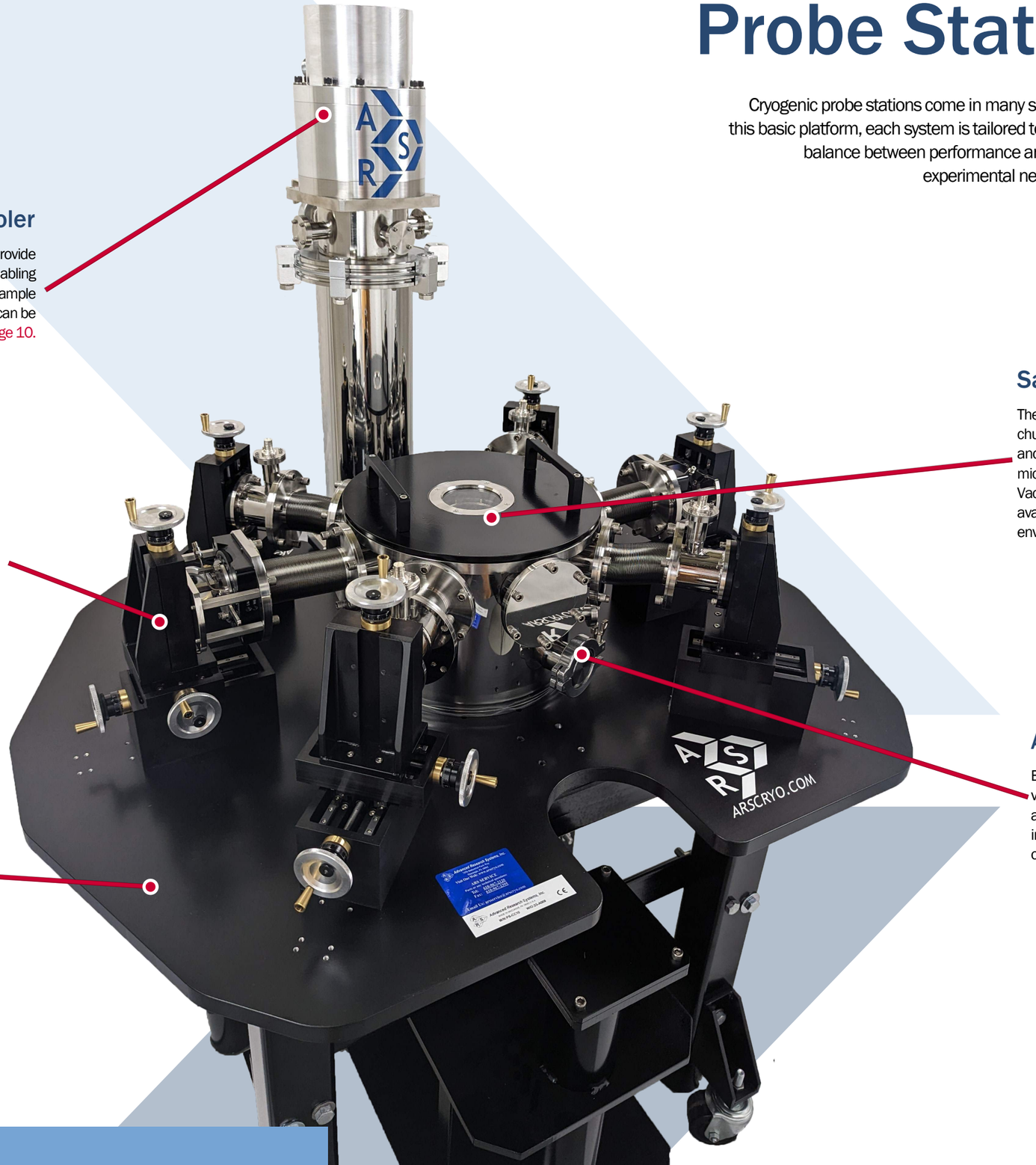
The ARS manufactured Solvay cryocoolers provide high cooling power with low vibrations, enabling temperatures as low as 3.5 Kelvin on the sample plate. More information about our cryocoolers can be found on page 10.

Probe Arms

Individually configurable and modular probe arms on ARS cryogenic probe stations can explore a wide variety of measurements and phenomena. More information about our probe arms can be found on page 6.

Table

The probe station may be equipped with a free-standing table featuring a full vibration dampening system, or may be built on a table-top for convenient installation on a benchtop or optical table.



Sample Environment

The main vacuum chamber houses the sample chuck, radiation shield, and probe arms. Samples and probe tips can be viewed with a provided microscope through the quartz viewport. Both High Vacuum and Ultra High Vacuum chambers are available. More information on our sample environment can be found on page 8.

Accessories

Below the probe arms, a series of access ports are built for vacuum pumping, temperature instrumentation feedthroughs, and accessories like sample bias connections, additional instrumentation, gas injection ports and more. More information on our probe station accessories can be found on pages 20-23.

Probe Arms

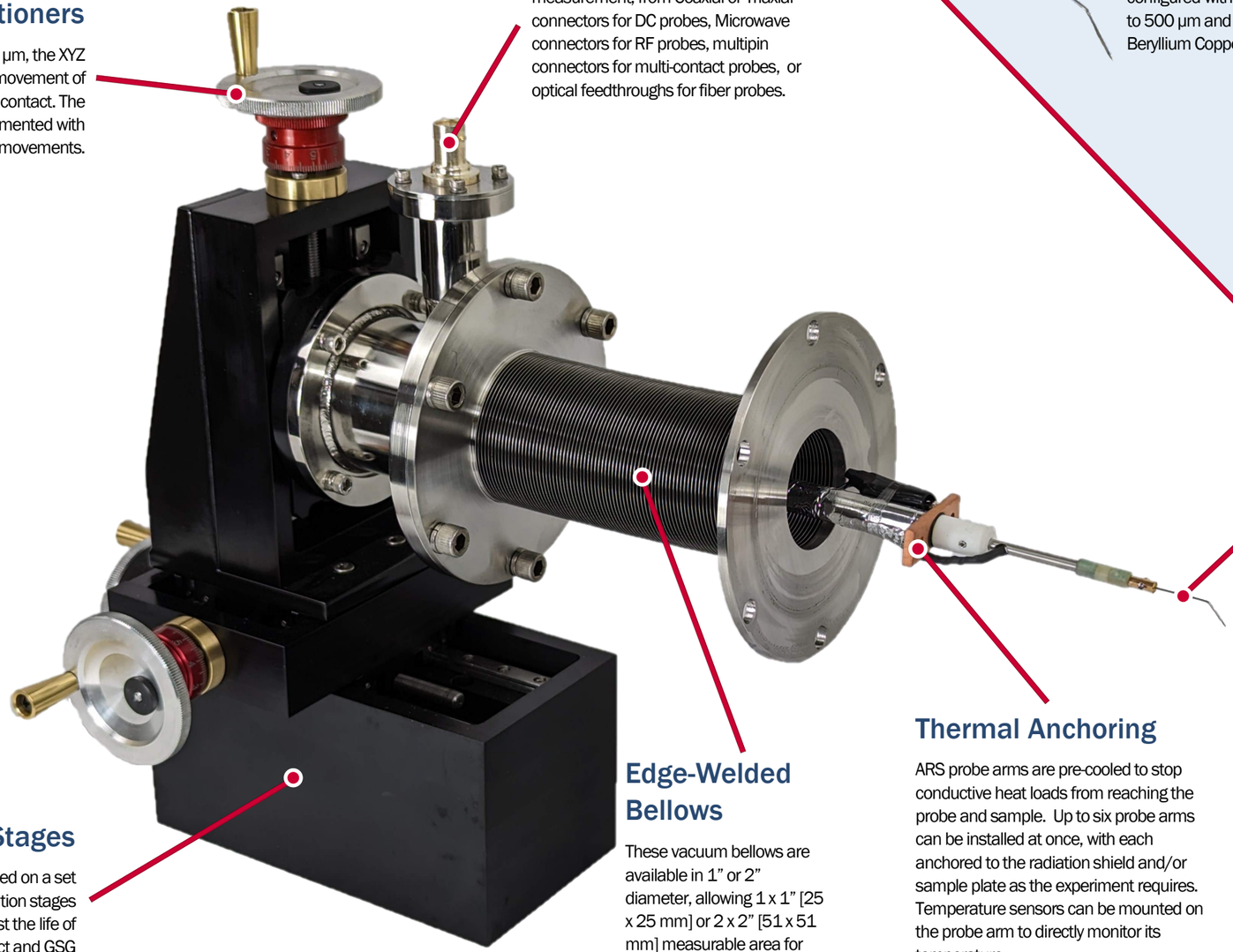
Each probe station can have multiple different probe arms increasing measurement versatility,. The construction of each arm is modular allowing for future upgrades and performance optimizations.

XYZ Micropositioners

Sensitive to within 5 µm, the XYZ micrometers allow precise movement of the probes for repeatable contact. The hand wheels may be augmented with motors for automated movements.

Feedthrough

Probes are pre-wired to vacuum feedthroughs applicable for the measurement, from Coaxial or Triaxial connectors for DC probes, Microwave connectors for RF probes, multipin connectors for multi-contact probes, or optical feedthroughs for fiber probes.



Translation Stages

The probe arm assembly is mounted on a set of ARS designed precision translation stages with hardened bearings built to last the life of the probe station. Multi-contact and GSG probe arms also feature angular adjustment to ensure equal contact for the numerous tips.

Edge-Welded Bellows

These vacuum bellows are available in 1” or 2” diameter, allowing 1 x 1” [25 x 25 mm] or 2 x 2” [51 x 51 mm] measurable area for probing.

Thermal Anchoring

ARS probe arms are pre-cooled to stop conductive heat loads from reaching the probe and sample. Up to six probe arms can be installed at once, with each anchored to the radiation shield and/or sample plate as the experiment requires. Temperature sensors can be mounted on the probe arm to directly monitor its temperature.

Probe Tips and Holders

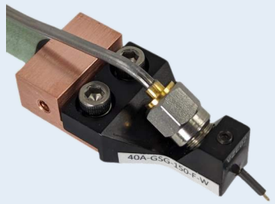
From DC to Microwave, one tip or many, even fiber optics, ARS has it covered.

DC Probes

For general purpose DC-100 MHz probing, single tip DC probes can be configured with tip radii from 0.5 µm to 500 µm and in either Tungsten or Beryllium Copper.

Fiber Optic Probes

Customizable single-mode or multi-mode optical fibers can be outfitted into our probe arms, allowing optical access or excitation of samples.

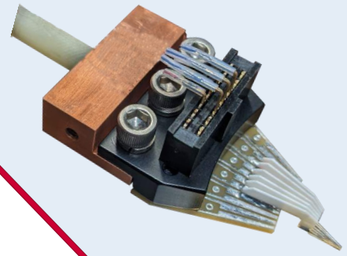


Microwave Probes

High frequency probing (40 GHz, 50 GHz, or 67 GHz) is done with RF probes configured in GSG, GSSG, or GSGSG footprints.

Multi-Contact Probes

For probing consistent pad layouts, wedge probes can feature up to 14 probe tips at customizable spacings.



Sample Environment

Protected from atmosphere and heat by vacuum chamber and radiation shield, the sample sits in the center of the measurement space. The large work area makes it easy to adjust the space to suit the needs of the experiment.

Sensors and heaters control the sample temperatures to as low as 3.5K and as high as 800K while probes move from sample to sample for measurements.

Our Ultra High Vacuum chamber configuration offers vacuum levels below 10^{-11} torr, while other configurations feature gas injection or deposition.

Sample Chuck

Available in 2.25” and 4.25” diameters, the sample chuck is conductively cooled by the cryocooler, reaching temperatures as low as 3.5K and as high as 800K. The sample plate may also be electrically isolated and biasable with coaxial or triaxial shielding.

Vacuum Chamber

In order to reach cryogenic temperatures a high vacuum environment is required. The vacuum chambers are made from high quality welded stainless steel or hard coated precision machined aluminum and provide a large clean work space for sample manipulation.

Radiation Shield

The radiation shield is responsible for intercepting blackbody radiation from the environment.

Probe Arm & Probe

The probe is manipulated across a 1x1” or 2x2” square in the center of the sample chuck.

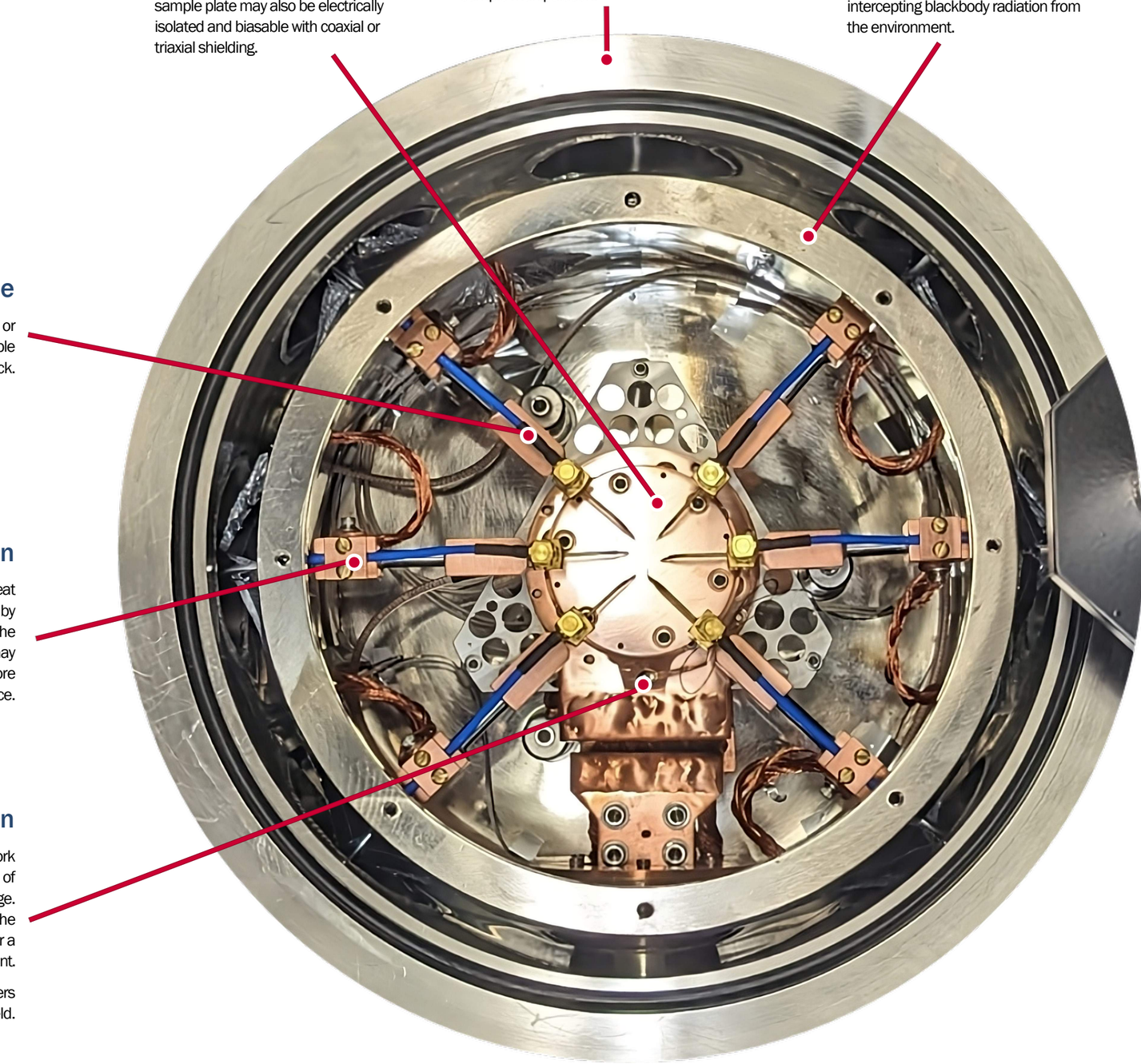
Probe Arm Thermalization

The probe arm is thermalized in two stages. Heat conducted from the environment is first intercepted by copper braids that connect the probe arm to the radiation shield. A second copper braid may thermalize the probe tip to the sample plate for a more isothermal probing experience.

Temperature Instrumentation

A silicon diode temperature sensor and a heater work in tandem to provide precise temperature control of the sample chuck across the full temperature range. An additional temperature sensor is available to the user for placement on or nearby the sample for a direct calibrated measurement.

For rapid warmup, another sensor and set of heaters are included on the radiation shield.



Cryocooling

ARS cryogenic probe stations are powered by closed cycle pneumatic Gifford McMahon (Solvay) cryocoolers. Depending on the desired temperature range and anticipated experimental heat load, the probe station can be outfitted with either our Model 210 or Model 204 cryocooler.

The Solvay Advantage

Our Closed-Cycle Cryocoolers operate using the reliable yet powerful Solvay cycle that endlessly recirculates Helium gas, offering unique characteristics:

- ☑ Fast, quiet cooldown to base temperatures below 3 Kelvin
- ☑ Inherently low vibrations at the sample
- ☑ Operation in any orientation
- ☑ Simple maintenance between long intervals

Ease of Service

Maintenance requirements are few and far between. Our users report tens of thousands of operating hours before needing service, which can be done easily in the field due to such simple design.

Helium Compressor

Powering the GM refrigeration cycle, the helium compressor sends high pressure Helium gas for expansion in the cryocooler. ARS manufactures quiet and compact water-cooled units with optional air-cooling modules.

SuperFlex® Helium Hoses

Braided stainless steel hoses transfer Helium in a closed cycle from the compressor to the cryocooler, available in 10 ft. [3 m] lengths and longer.

Model 210

For the most demanding cooling applications, reaching < 2.7K on the cold finger and allowing < 4K on the sample chuck.

Model 204

Best price to performance workhorse, reaching < 5.5K on the cryocooler tip, and 10K on the sample plate.

Model	DE-210S	DE-204P
Base Temp.	3 K	5.5 K
Cooling Power	1.1 W at 4.2 K	3 W at 10 K
Cooldown Time	60 min	80 min

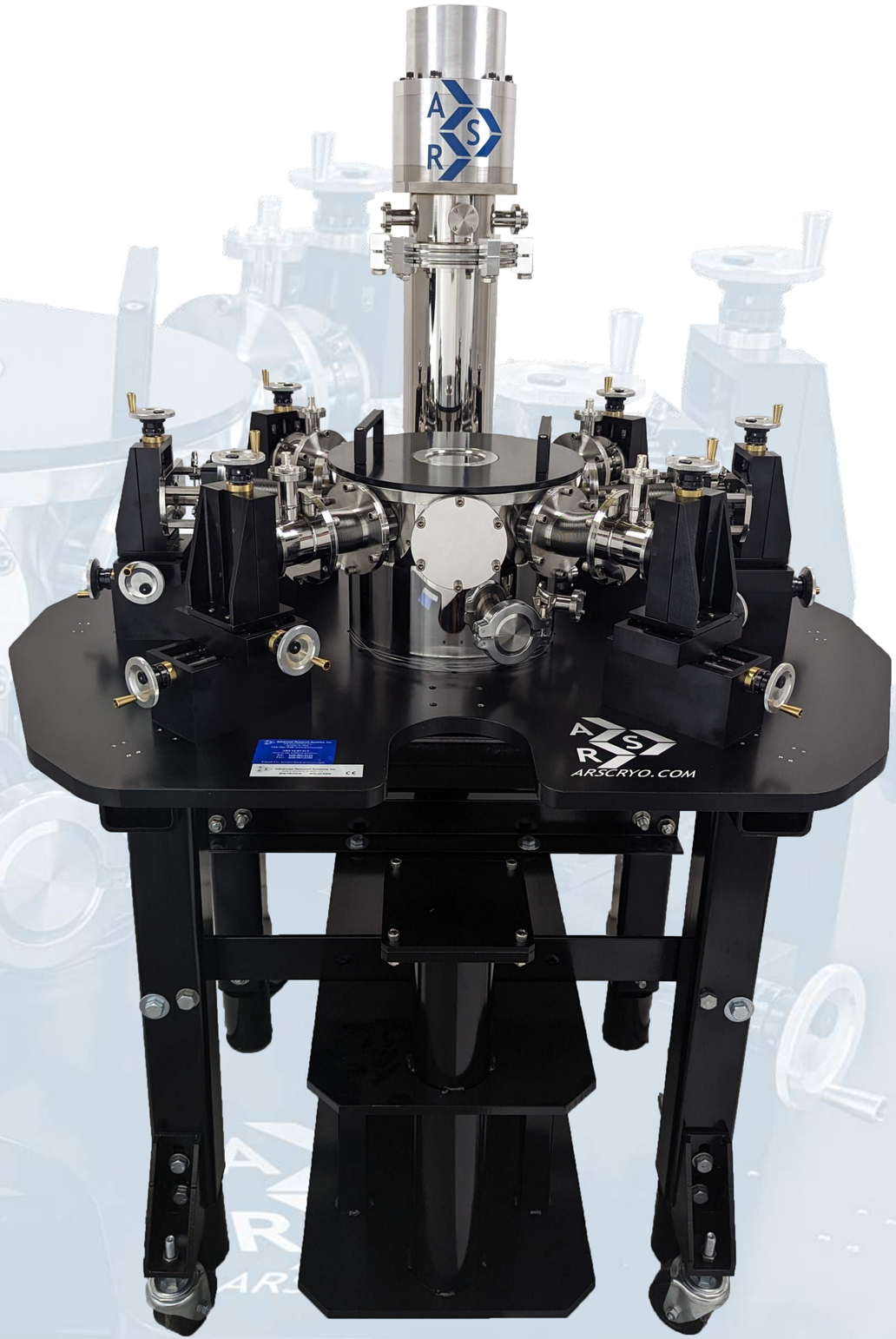
Closed Cycle Cryogenic Probe Station (PS-CC)

The ARS manufactured PS-CC Closed Cycle Cryogenic Probe Station provides a high vacuum cryogenic environment for probing samples from sub 4K to as high as 800K. This model is compatible with a wide array of modular accessories and customizations.

- ☑ **Downward Cold Tip Advantage**. Closed-cycle cryocoolers operate with maximum cooling with their cooling stages oriented downwards towards the floor. The PS-CC10 model uniquely achieves **base temperatures in the 3.5 - 4K range** by taking advantage of this behavior, since the cryocooler is mounted on tip-downwards and enters the chamber with a horizontal cold finger.
- ☑ **Advanced Probe Thermalization**. Probes are pre-cooled over multiple stages to reduce heat from the environment from reaching the surface of the sample. Sample chuck temperatures below 4.5K have been reached with four single-tip DC probes in contact.

Key Specifications

Model	PS-CC10	PS-CC4
Base Temperature	4 K	11 K
Cooling Technology	1.1W @ 4.2K Closed Cycle Solvay Cryocooler (Model DE-210S) (Cold Tip Down)	3W @ 10K Closed Cycle Solvay Cryocooler (Model DE-204P) (Cold Tip Up)
Cooldown Time	150 mins to 10 K 210 mins to 5K	120 mins to 20K 180 mins to 10K
Maximum Temperature	400 K | 500 K | 800 K	400 K | 500 K | 800 K
Probe Arm Ports	6	8
Sample Chuck Size	2.25” | Customizable	2.25” | Customizable
Vibration	<1.2 µm	<1 µm
Mounting Style	Free-standing Table	Free-standing Table



Nanoscience Probe Station (PS-NANO)

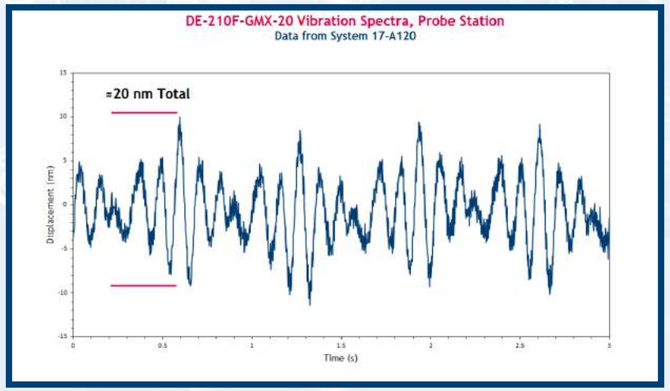
The ARS Closed Cycle Nanoscience Probe Station model PS-NANO is designed for the ultimate in flexibility for non-destructive device testing. This system enhanced with a GMX-20 Ultra Low Vibration exchange gas interface provides optimal vibration isolation of the sample and probes.

As the largest contributor of vibrations, the cryocooler is physically decoupled from the sample space, convectively cooling it via a highly-efficient heat exchanger. This method results in the following benefits:

- ☑ Nanometer scale vibrations at the sample mount
- ☑ Cryocooler vibrations directed away from the experiment entirely

Key Specifications

Model	PS-NANO
Base Temperature	7 K
Cooling Technology	Closed Cycle Solvay Cryocooler Helium Exchange Gas Ultra Low Vibration Interface
Vibration	10 - 20 nm
Cooldown Time	210 mins to 10 K 320 mins to 7 K
Maximum Temperature	400 K | 500 K | 800 K
Probe Arm Ports	6
Sample Chuck Size	2.25” | Customizable
Mounting Style	Tabletop (optical table ready)



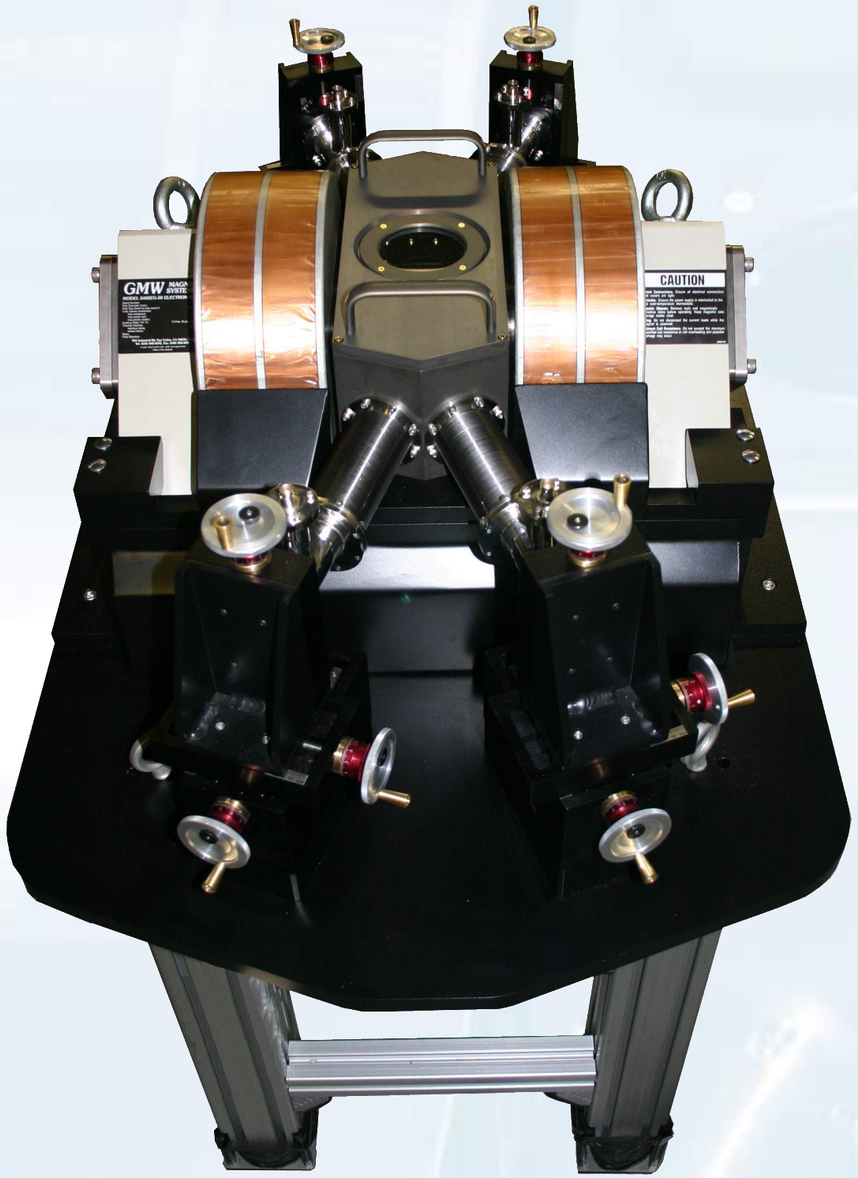
Superconducting Magnet Probe Station (PS-SCM)

The ARS Closed Cycle Superconducting Magnet probe station model PS-CC-SCM is designed to provide ultimate flexibility for non-destructive device testing. This system is enhanced with a 6T Vertical superconducting Magnetic Field and is ideal for the study of magneto-optical and magneto-electrical properties in variety of experiments, including quantum dots, spintronic devices and nanoscale electronics.

- ☑ **Dual Cryocooler Advantage.** This Probe station is equipped with dual DE 210 Cryocoolers; one dedicated to cooling the superconducting magnet and the other for cooling the sample stage. This grants large cooling power to the system.
- ☑ **Temperature Independence.** Since the sample plate and superconducting magnet have independent cooling systems, the temperature of the sample plate can be varied while keeping the magnet at its lowest temperature. This allows the sample plate to reach temperatures even above room temperature with the magnet operating at maximum field.

Key Specifications

Model	PS-SCM
Base Temperature	5 K
Cooling Technology	Two 1.1W @ 4.2K Closed Cycle Solvay Cryocoolers (one for the magnet one for the sample)
Magnetic Field	6T Vertical Field (Nominal) 3 - 4T at the sample plate
Vibration	<1.2 µm
Cooldown Time	210 mins to 10K 320 mins to 7K
Maximum Temperature	400 K | 500 K
Probe Arm Ports	6
Sample Chuck Size	2.25”
Mounting Style	Free-standing Table



Electromagnet Cryogenic Probe Station (PS-CC-EM)

The ARS manufactured Electromagnet Cryogenic Probe Station model PS-CC-EM is designed for the ultimate in flexibility for non-destructive device testing. This closed cycle Probe Station with built in electromagnet provides a horizontal magnetic field of 0.6 T or 1 T on the sample plate.

- ☑ **Bipolar Power Supply.** The bipolar power supply allows reversal of the magnetic field.
- ☑ **Hall Sensor and Gaussmeter.** The magnetic field can be measured in-situ with an available instrumentation package.

Key Specifications

Model	PS-EM
Base Temperature	11 K
Cooling Technology	3W @ 10K Closed Cycle Solvay Cryocooler (Model DE-204P) (cold tip up)
Magnetic Field	0.6T | 1.0T Horizontal Field
Vibration	<1 µm
Cooldown Time	120 mins to 20K 180 mins to 10K
Maximum Temperature	400 K | 500 K
Probe Arm Ports	4
Sample Chuck Size	1”
Mounting Style	Free-standing Table

Upgrades & Customizations

ARS Cryogenic Probe Stations are built with modularity, customizability, and upgradeability in their core.

A

UHV & Load Lock

Featuring a fully-welded stainless steel design with Conflat flanges, our probe stations can be upgraded for deep UHV environments to accommodate air-sensitive sample. Also available are load locks, sample transfer suitcases, and cryogenic sample receivers

B

Custom Probes

Our general purpose DC, GSG, and Fiber Optic probes suit the needs of most users, but some applications require specific probing solutions. Multicontact wedge probes can be built with any custom number DC and RF needles at varying pitches. Probe arms can feature interchangeable designs to allow flexibility in the laboratory.

C

In-Vacuum Objectives

Popular on our Nanoscience Probe Station, objective lenses can be mounted inside the vacuum chamber to allow the ultimate low working distance optics. Nanopositioners are essential for optical alignment under an in-vacuum lens.

D

Coaxial/Triaxial Shielding & Sample Bias

The sample plate can be configured as grounded, or with Coaxial or Triaxial shielding using interlayered sapphire plates. Shielded sample plates are also biasable with a dedicated feedthrough.

E

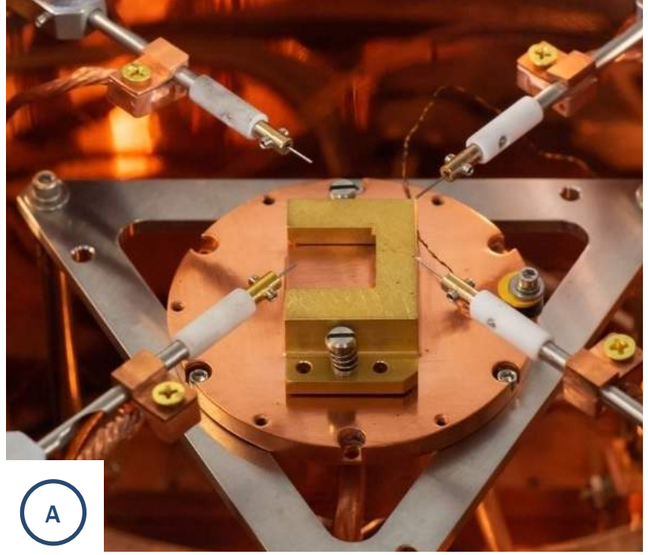
Custom Sample Holders

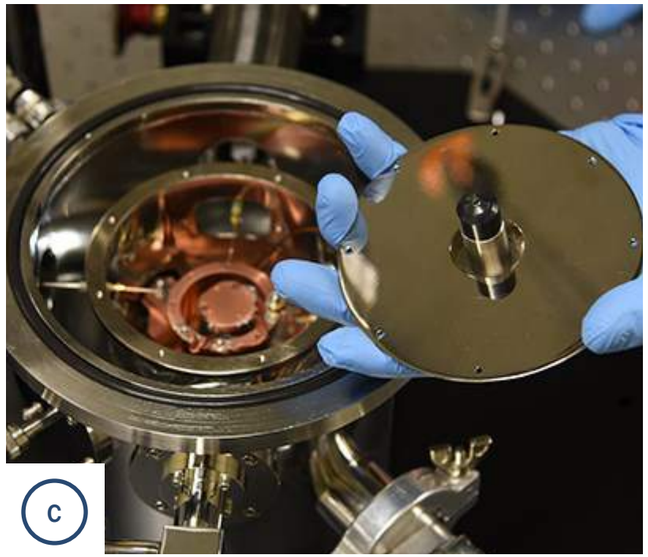
A flat 2.25” sample plate comes standard on our probe stations, but this can be easily customized. For example, the sample chuck can be enlarged to accommodate 3” or 4” wafers, Custom DIP or LCC sample holders can be modularly attached to the sample plate for packaged samples.

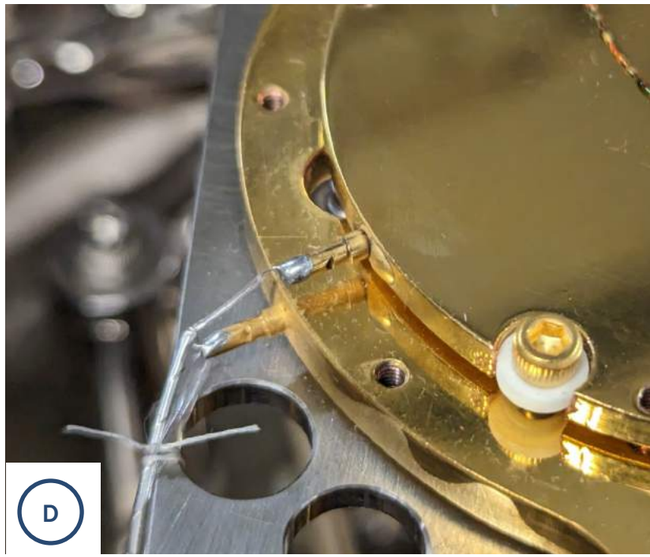
F

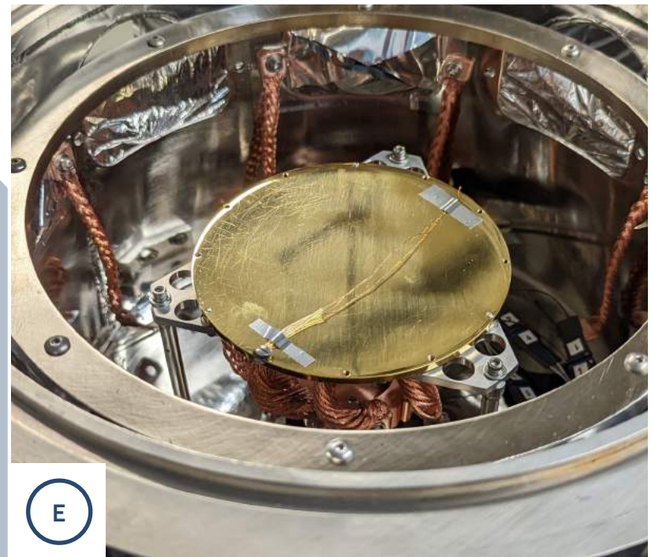
Custom Windows

Our probe stations are equipped with a High Purity Quartz outer window and a Sapphire cold window by default, but these windows can be easily customized to be different sizes and materials with AR coatings, or built as re-entrant windows for low working distance.









Accessories

G

Microscope

A microscope kit is bundled with the probe station to see the micron-sized probe tips and land them on the sample. Select between our popular 7:1 zoom package or upgrade to our 12.5:1 zoom ratio kit. The microscope kit includes the lenses, camera, fiber optic light source, XYZ manipulator and mounting stand.

H

Vacuum Pump

A vacuum of 10^{-4} torr or better is required for thermal insulation of the cryogenic surfaces. We can bundle a rotary pump or turbopump with the probe station for user convenience, or the user may choose to use their own vacuum pump.

I

Gaussmeter

For our Superconducting Magnet and Electromagnet probe stations, a cryogenic Hall sensor and Gaussmeter can be added for measuring the in-situ magnetic field.

J

Feedthroughs

All probe station vacuum chambers are equipped with at least one spare accessory port onto which accessory feedthroughs can be installed. Common feedthroughs include multipin feedthroughs, extra BNC or SMA connections, and gas injection ports.

K

Nanopositioners

Although the probes themselves are moveable, some applications require translation and rotation of the sample plate while the sample is at low temperature. ARS can outfit the probe station with a set of piezoelectric nanopositioners to allow millimeter-range motion in XYZ, and ±180° of rotation of the plate. This option is popular on our Nanoscience Probe Station (PS-NANO) for optical alignment and scanning.

L

High Temperature Interface

Most of our probe station systems are upgradeable to reach sample plate temperatures as high as 800K using our proprietary heating system.

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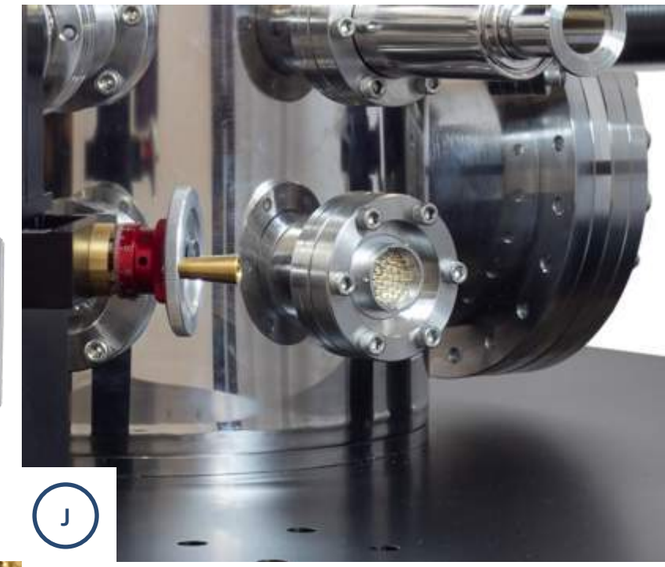

J

K

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Making every application cold.

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