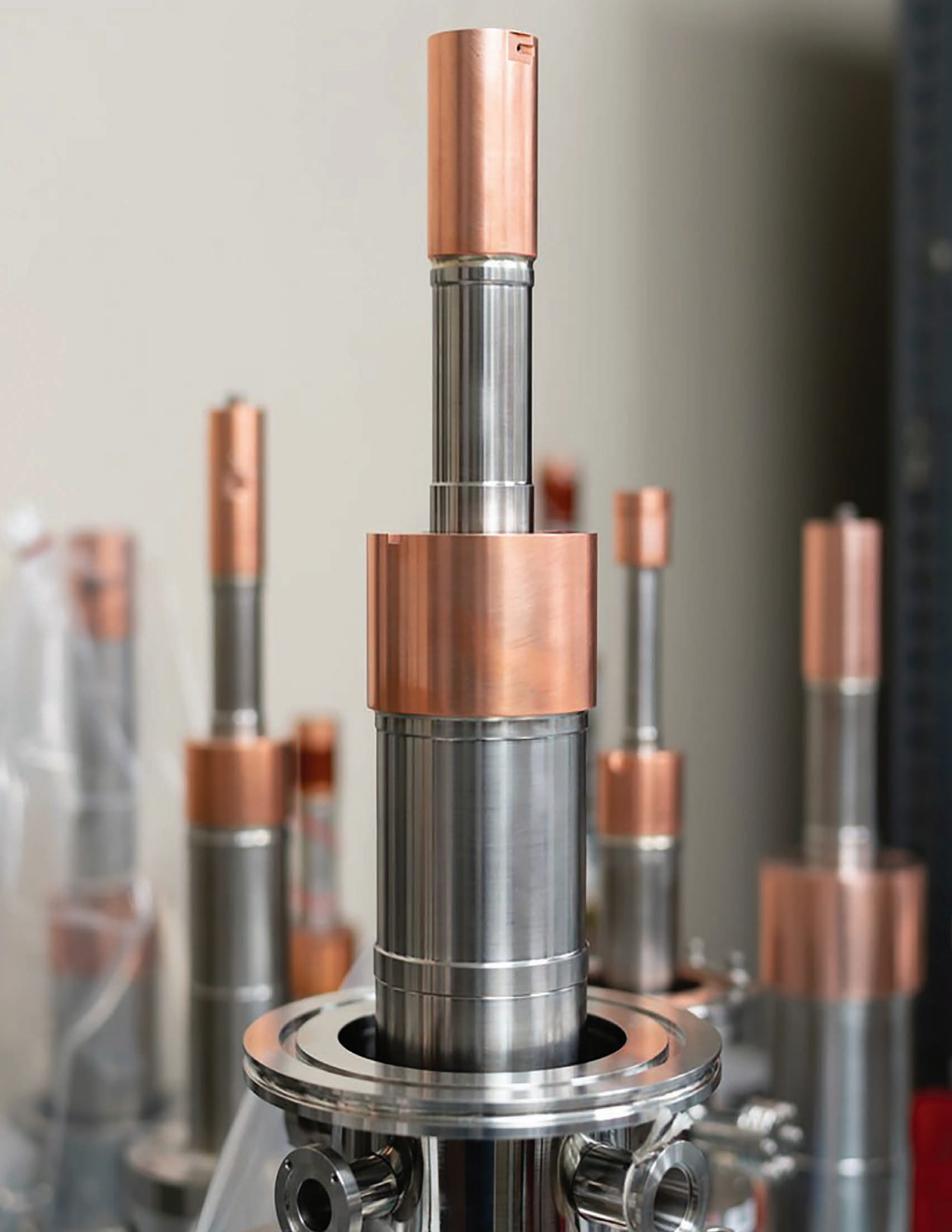
# Laboratory Cryogenics

## By Advanced Research Systems



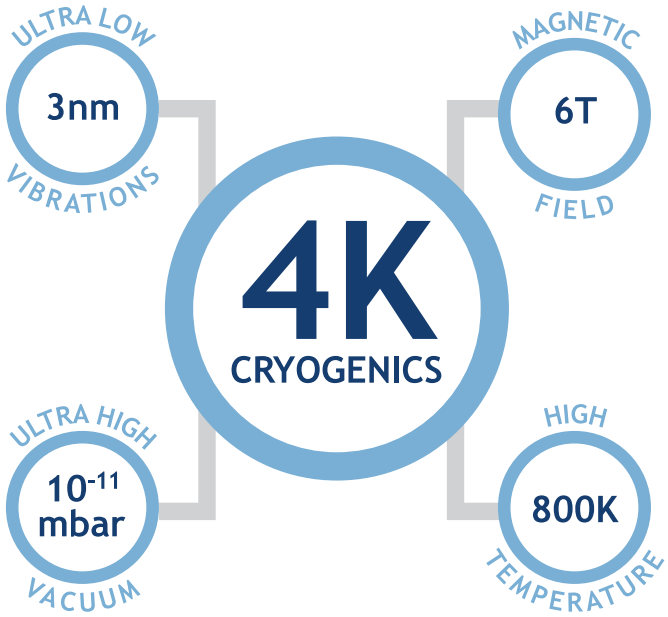
# Who We Are

Since 1986, **Advanced Research Systems, Inc.** has been dedicated to providing cryogenic solutions to the ever-changing world of scientific research. We have designed and built hundreds of unique cryostats for thousands of scientific and industrial applications **from 1.5 Kelvin to over 800 Kelvin.**

Advanced Research Systems is dedicated to serving the research community by providing **high quality, reliable, and cutting-edge cryogenic systems.** Our focus on elite customer service and relentless product development continues to allow scientists worldwide to achieve their research goals.

# Our Technologies

The **ARS Solvay** closed-cycle cryocooler and **ARS Helitran®** liquid flow cryocooler form the foundations of our product lines. Upon these technologies, we offer a wide range of cryogenic instruments, from our standard closed-cycle cryostats and flow cryostats to our Nanoscience systems and cryogenic probe stations; each optimized for use in ultra-high vacuum environments to strong magnetic fields.



# Solvay Cryocoolers

## 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

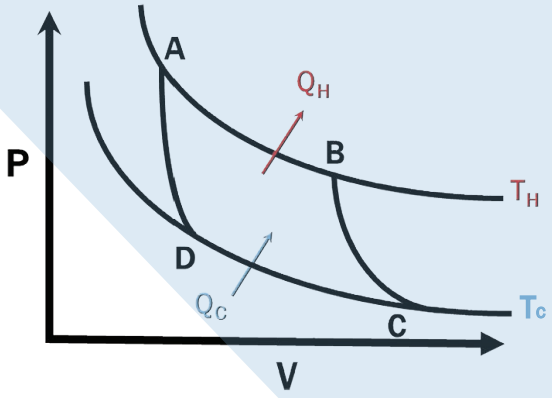
☑ Operation in any orientation

☑ Simple maintenance between long intervals

## A Closed Cycle Without Compromise

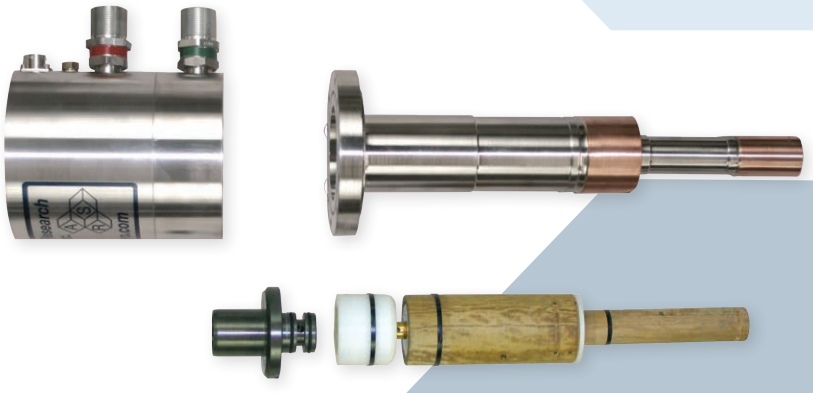
The Solvay cycle is a pneumatically-driven Gifford-McMahon refrigeration cycle. Rather than using a mechanical linkage like traditional GM cryocoolers, the displacer is cycled using the internal pressure differential of the helium refrigerant itself. This results in vastly fewer internal moving parts (just three). Refer to the P-V Diagram for refrigeration principle:

A-D: Helium expansion cooling
D-C: Displacer Retracts; helium cools regenerator material
C-B: High pressure helium enters
B-A: Displacer Extends; regenerator pre-cools helium gas




## 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.



Solvay cryocoolers contain only three moving parts: the motor, the valve disk, and the displacer, making them extremely serviceable and highly reliable.

## Model 210

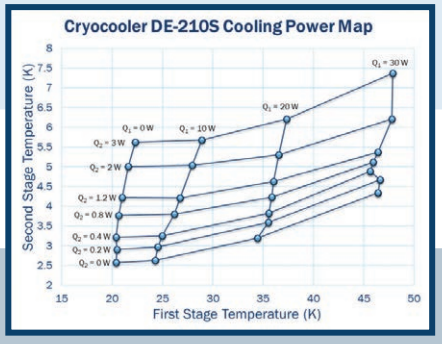
For the most demanding cooling applications

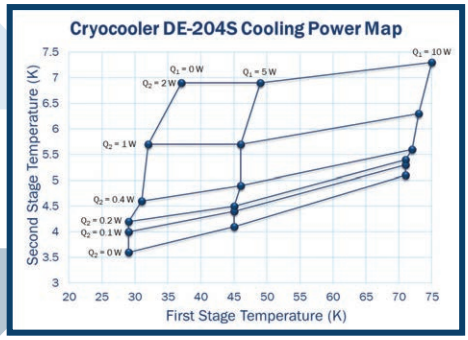

## Model 204

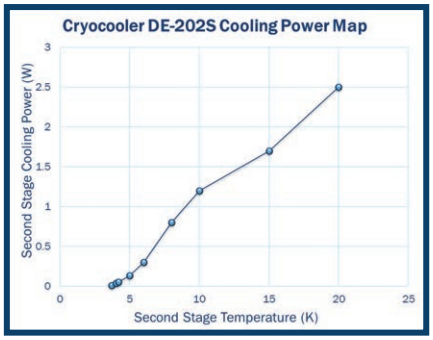
Best price to performance workhorse


## Model 202

Smallest, lightest, and lowest vibration




| | 210 Series | | 204 Series | | | 202 Series | | |
|---|---|---|---|---|---|---|---|---|
| **Model** | DE-210S | DE-210A | DE-204S | DE-204P | DE-204A | DE-202S | DE-202P | DE-202A |
| **Base Temp.** | 3 K | 9 K | 4 K | 5.5 K | 9 K | 4.5 K | 5.5 K | 9 K |
| **Cooling Power** | 1.1 W at 4.2 K | 4 W at 10K | 0.2 W at 4.2 K | 3 W at 10 K | 2 W at 10 K | 0.1 W at 4.5 K | 1 W at 10 K | 0.5 W at 10 K |
| **Cool Down Time** | 60 min | 70 min | 90 min | 80 min | 60 min | 90 min | 90 min | 70 min |

# Cryostat Systems

## A Complete Cryostat

Beyond the cryocooler, our cryostats feature an insulating vacuum enclosure with feed-throughs and a precooled thermal radiation shield for intercepting blackbody radiation.


## Temperature Control

To precisely hold a temperature of interest, heat is inputted to the cold tip to modulate from under 3 Kelvin to as high as 800 Kelvin with stability within ± 0.1 K.



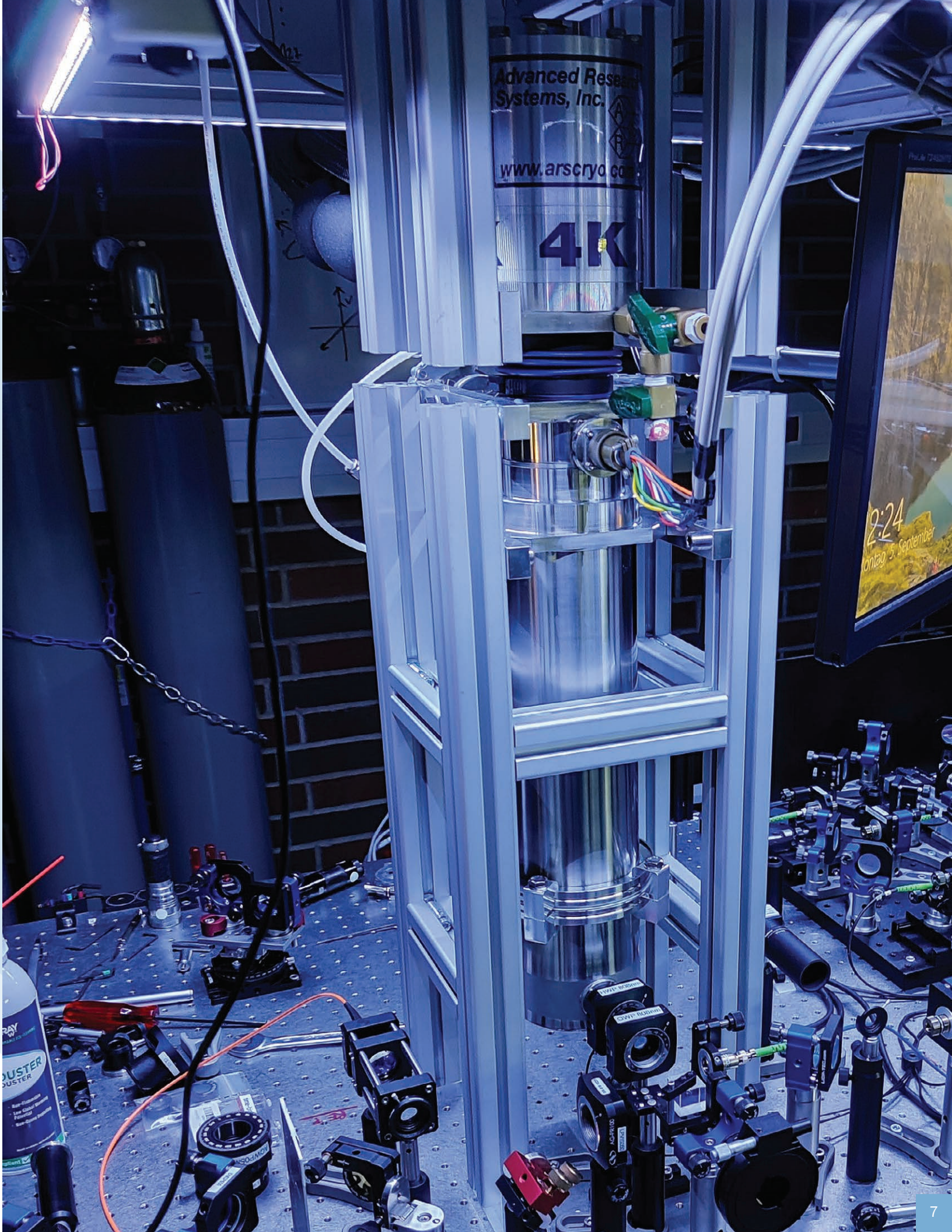

## Helium Compressor

Powering the Solvay 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.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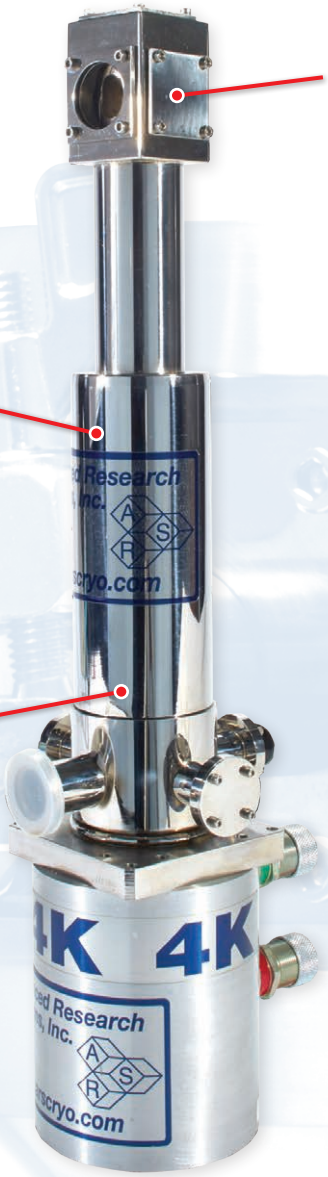
Montag 3. September

# Solvay Cryostats

## X-1 Series Spectroscopy

Our most versatile benchtop cryostat featuring up to five perpendicular windows, the X-1 series is commonly used for optical spectroscopy including Raman, Photoluminescence, FTIR and more.




### Compact Optical Block

At just 56mm wide the compact optical block will fit comfortably into the sample compartment of many spectrometers.

Despite their small size, the windows are still interchangeable with O-ring seals.

### Stainless Steel Construction

The stainless steel construction of the vacuum space results in better vacuum levels with lower background water vapor pressure.

### Double O-Ring Seal

The vacuum shroud seals over double O-Rings, allowing easy removal and rotation of the optical block under vacuum.

| Model | Base Temperature | Cooling Power | Sample Space | Window Ports | Window Clear View | f/# |
|---|---|---|---|---|---|---|
| DMX-1 | 4.5 K \| 5.5 K \| 9 K | 0.1 W at 4.5 K | Ø36 x 30 mm | 5 | Ø32 mm | f/0.8 |
| FMX-1 | 4 K \| 5.5 K \| 9 K | 0.2 W at 4.2 K | Ø42 x 32 mm | 5 | Ø32 mm | f/1.0 |
| GMX-1 | 3 K \| 9 K | 1.1 W at 4.2 K | Ø79 x 49 mm | 4 | Ø32 mm | f/1.6 |

# X-3 Series Transport

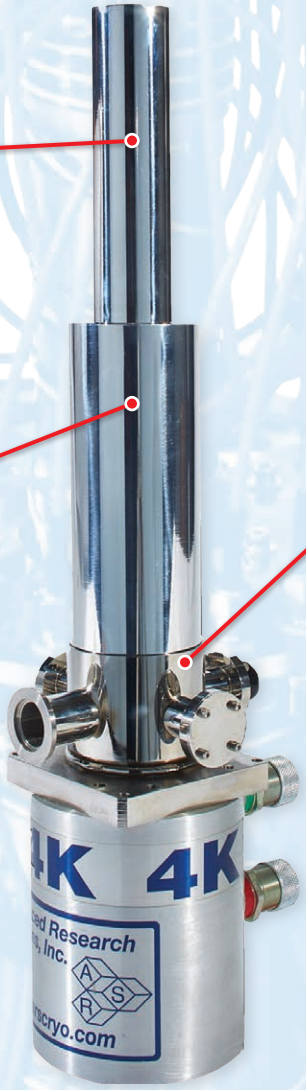
When optical access is not required, the X-3 series are fully enclosed to limit parasitic heat loads. Frequent applications include Hall Effect, Superconductivity, Transport, and Resistivity measurements.

## Ultra Narrow Gap

Customizable to as low as Ø19mm, the vacuum chamber can fit into narrow electromagnet pole spacings for high magnetic fields.

## Non-Ferromagnetic

The vacuum shroud is available in non-magnetic Aluminum, and radiation shield made of either aluminum or nickel-free gold-plated OFHC copper.




## Expansive Feedthroughs

Measure electrical properties with a wide range of wires and cables for DC or high frequency RF signals.

| Model | Base Temperature | Cooling Power | Sample Space | Outer Diameter |
|---|---|---|---|---|
| DMX-3 | 4.5 K \| 5.5 K \| 9 K | 0.1 W at 4.5 K | Ø48 x 84 mm | Ø70 mm |
| DMX-3-1 (Narrow) | 4.5 K \| 5.5 K \| 9 K | 0.1 W at 4.5 K | Ø36 x 39 mm | Ø45 mm |
| FMX-3 | 4 K \| 5.5 K \| 9 K | 0.2 W at 4.2 K | Ø79 x 49 mm | Ø83 mm |
| FMX-3-1 (Narrow) | 4 K \| 5.5 K \| 9 K | 0.2 W at 4.2 K | Ø41 x 45 mm | Ø51 mm |
| GMX-3 | 3 K \| 9 K | 1.1 W at 4.2 K | Ø137 x 205 mm | Ø151 mm |

# Solvay Cryostats

## X-12 Series Magneto-Optics

For magneto-optical measurements, our narrow-gap cryostats combine optical access with a sample chamber suitably sized for placement between electromagnet poles.

### Magneto-Optical Block

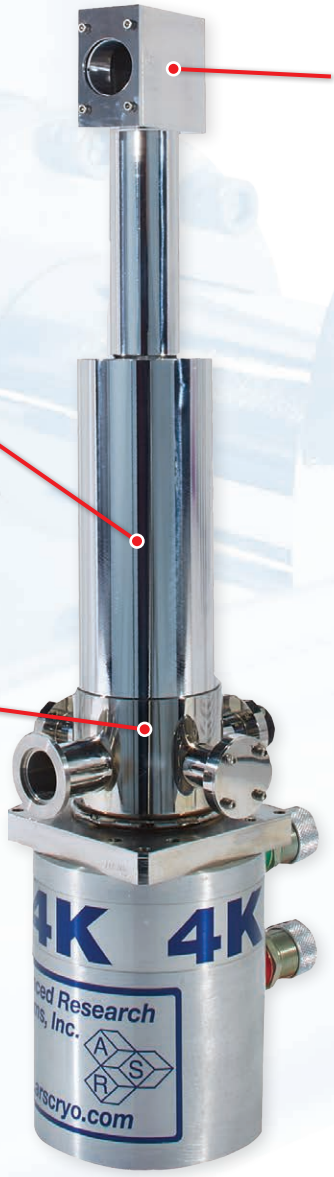
The sample space fits in magnet gaps as low as 35mm, with dual windows for optical access.

### Non-Ferromagnetic

The vacuum shroud is available in non-magnetic Aluminum, and radiation shield made of either aluminum or nickel-free gold-plated OFHC copper.

### Sample Rotation

The cryocooler is easily rotatable by hand, allowing rotation with respect to the optical block.




| Model | Base Temperature | Cooling Power | Sample Space | Outer Width | Window Clear View |
|---|---|---|---|---|---|
| DMX-12 | 4.5 K \| 5.5 K \| 9 K | 0.1 W at 4.5 K | Ø28 x 30 mm | Ø41 mm | Ø25 mm |
| DMX-12B | 4.5 K \| 5.5 K \| 9 K | 0.1 W at 4.5 K | Ø27 x 30 mm | Ø35 mm | Ø25 mm |
| FMX-12 | 4 K \| 5.5 K \| 9 K | 0.2 W at 4.2 K | Ø36 x 36 mm | Ø50 mm | Ø25 mm |

# B Series Ultra High Vacuum

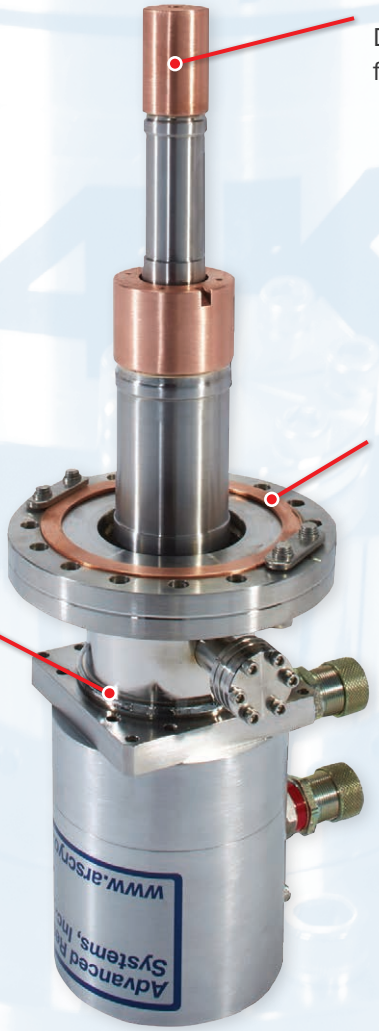
From surface science studies to space simulation, our cryostats uniquely feature a fully-welded flange for a True-UHV rating (10 $^{-11}$ mbar). Translators, rotators, custom thermal shields, and extensions can be pre-installed by ARS.

## Customizable Interface

Designed by cryogenics experts, the cold tip is fully customizable and extendable.

## True UHV ($10^{-11}$ mbar)

Unlike conventional cryostats which use O-rings, the Conflat flange is welded directly to the cryocooler with full stainless-steel construction, for a truly achievable $10^{-11}$ mbar vacuum level.



## Any Vacuum Flange

Choose between Conflat, ISO-F, ISO-K, ISO-KF, or even custom vacuum flanges.

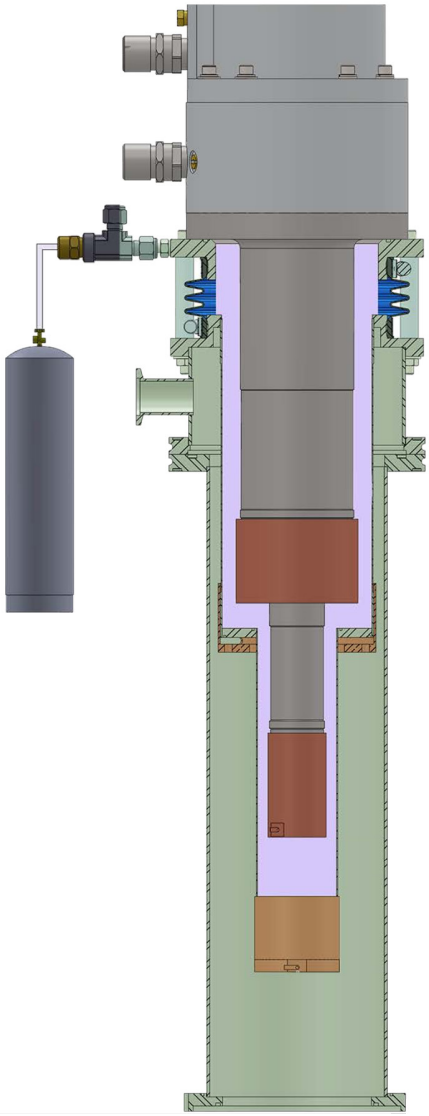
| Model | Base Temperature | Cooling Power | Flange Size | Length from Flange |
|---|---|---|---|---|
| DE-202B | 4.5 K \| 5.5 K \| 9 K | 0.1 W at 4.5 K | DN63 or larger | 216 mm |
| DE-204B | 4 K \| 5.5 K \| 9 K | 0.2 W at 4.2 K | DN63 or larger | 238 mm |
| DE-210B | 3 K \| 9 K | 1.1 W at 4.2 K | DN100 or larger | 335 mm |

# Nanoscience Systems

## Stability at the Nanometer Scale

Modern nanoscience applications are increasingly demanding of sample stability at low temperature.

To meet this need, ARS has continued to develop vibration reduction technologies.



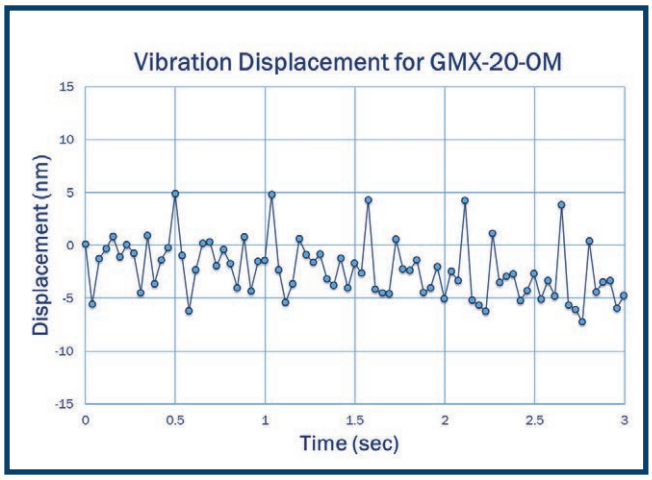
## Helium Exchange Decoupling

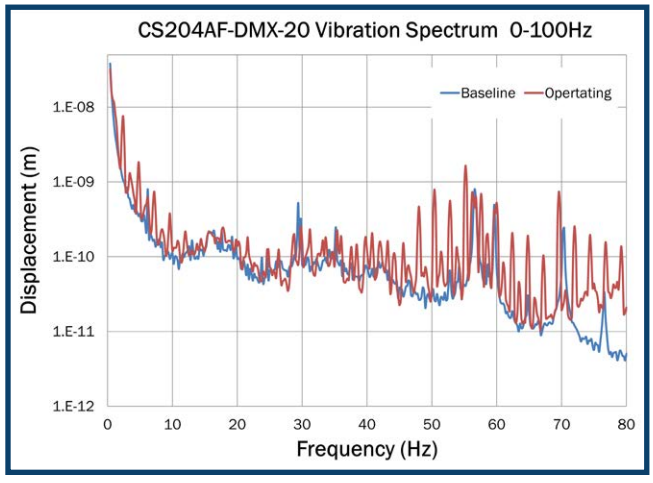
As the largest contributor of vibrations, the cryocooler is physically decoupled from the sample space, convectively cooling it via a highly-efficient heat exchanger. This method results in the following benefits:

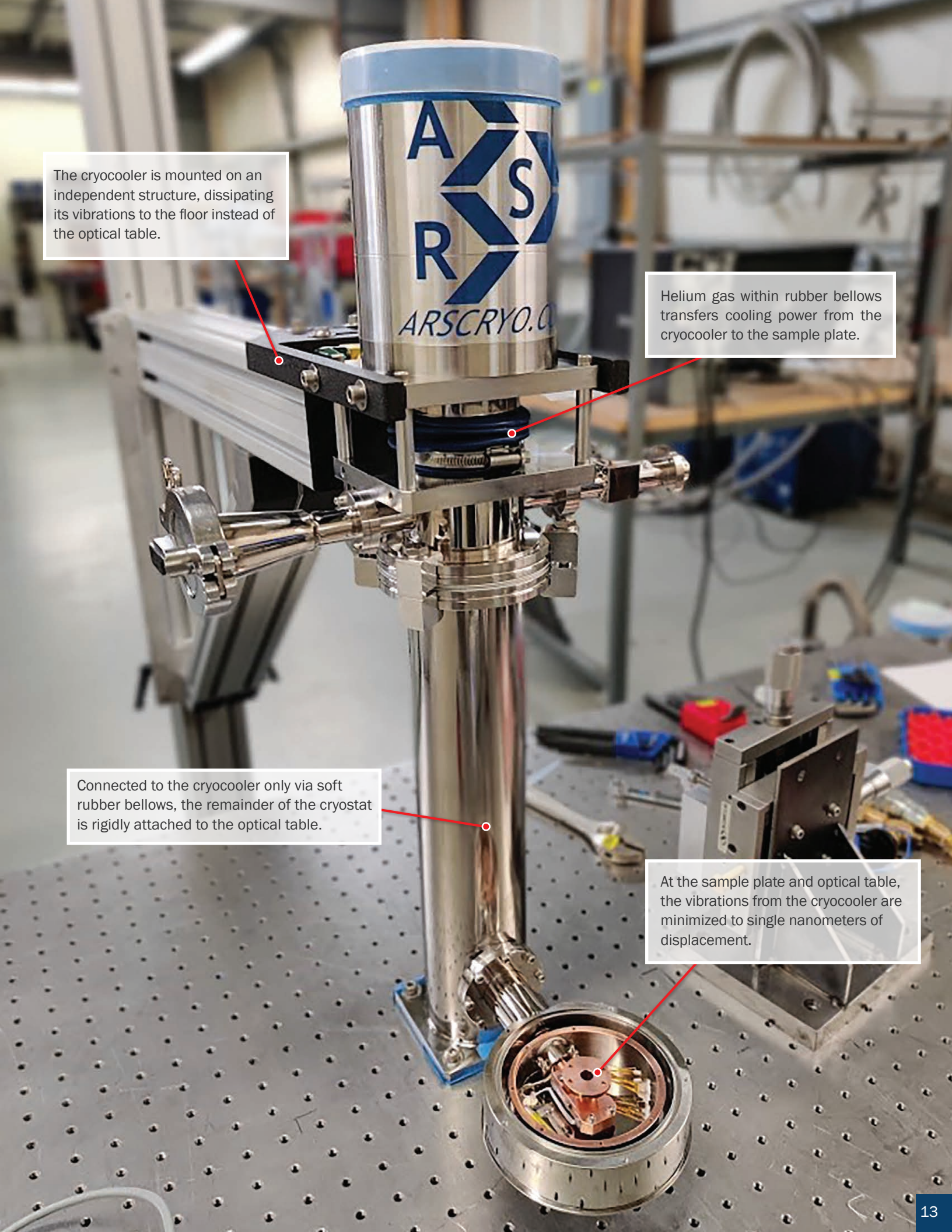
- ☑ Nanometer scale vibrations at the sample mount
- ☑ Cryocooler vibrations directed away from the experiment entirely
- ☑ No need for expensive and scarce liquid helium

## Field-Proven Results

Over decades, hundreds of researchers have designed their experiments around ARS nanoscience systems, ranging from Scanning Probe microscopy techniques to ion traps. In real-world conditions, scientists have reported sample vibrations **as low as 3 nanometers.**




The cryocooler is mounted on an independent structure, dissipating its vibrations to the floor instead of the optical table.
Helium gas within rubber bellows transfers cooling power from the cryocooler to the sample plate.
Connected to the cryocooler only via soft rubber bellows, the remainder of the cryostat is rigidly attached to the optical table.
At the sample plate and optical table, the vibrations from the cryocooler are minimized to single nanometers of displacement.

# Nanoscience Cryostats

## X-20-OM Series Microscopy

The X-20-OM series cryostat combines our ultra-low vibration interface with a sample chamber designed for high powered microscopes in either reflection or transmission modes.

### Rotatable Chamber

The chamber is simply rotated by 45° increments to accommodate both vertical and horizontal optical setups.

### Ultra Low Working Distance

A continuously-adjustable holder allows the sample to be brought as close as 1.5mm to the cryostat exterior, enabling the use of high-powered optics.

### Thin Extension

Like our LT3-OM cryostat, the sample chamber is narrow enough to fit under the objective in most microscopes.


| Model | Base Temperature | Sample Space | Sample Vibration | Working Distance | Window |
|---|---|---|---|---|---|
| DMX-20-OM | 8 K \| 9.5 K \| 13 K | Ø19 x 7 mm | 3-5 nm | 1.5 mm | 1 or 2; Ø23 mm |
| GMX-20-OM | 4 K \| 10 K | Ø19 x 7 mm | 5-10 nm | 1.5 mm | 1 or 2; Ø23 mm |

# µDrift Series Quantum Optics

Designed for ultimate sample stability and optical access, the µDrift sports cutting edge drift cancellation technology in a modular and spacious sample chamber.


## Vast Sample Space

A 100mm-diameter breadboard 4K sample plate sits within a highly modular 50mm tall chamber, allowing vast space for sample holders, nanopositioners, in-vacuum objectives, and other customizations.

## Ultra Low Drift

Our latest drift-compensating technology minimizes sample motion to the nanometer scale for ultra stable long-term measurements.

## Customizable Ports

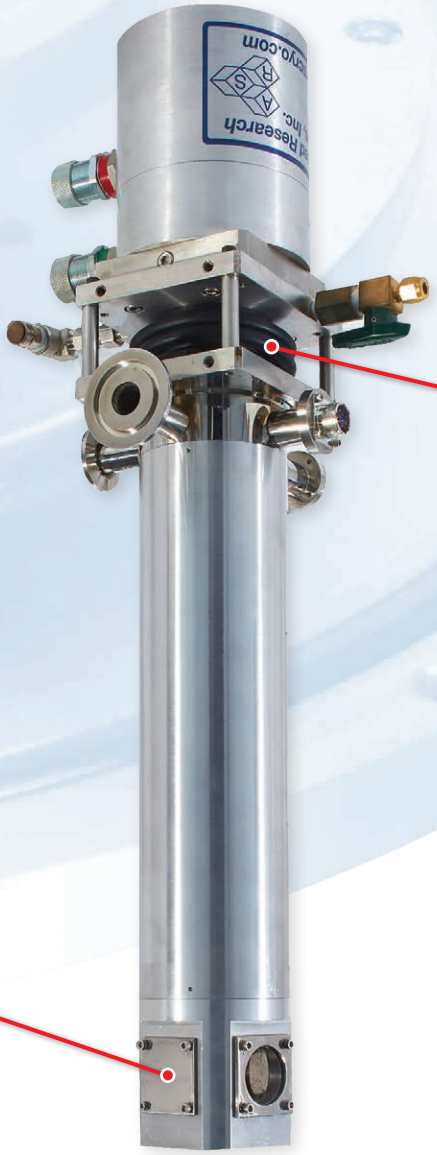
Four bulkheads provide great possibilities for DC wires, low noise/ high frequency cables, optical fibers, gas capillaries, and other feedthroughs.

| Model | Base Temperature | Sample Vibration | Sample Drift | Windows |
|---|---|---|---|---|
| DMX-20-µDrift | 8 K \| 9.5 K \| 13 K | 3-5 nm | <1 µm per 24 hours | 5; Ø38 mm |
| GMX-20-µDrift | 4 K \| 10.5 K | 5-10 nm | <1 µm per 24 hours | 5; Ø38 mm |

# Nanoscience Cryostats

## X-20 Series Spectroscopy

Harnessing helium-exchange gas antivibration technology, our X-20 series combines strong cooling power with industry leading vibration performance, often used for microPL and microRaman.



### Helium Exchange Gas

Like all our Nanoscience cryostats, the X-20 decouples vibrations using a highly efficient helium exchange gas decoupling system.

### Modular Optical Block

Exchange the standard optical block for ultra-narrow magneto-optic variants, or those fitted with nanopositioners for precise sample motion.

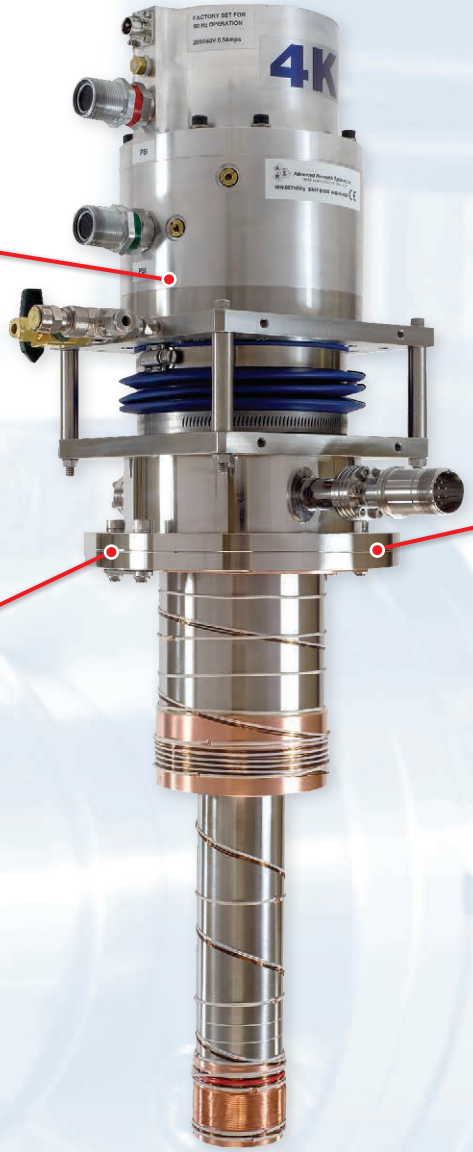
| Model | Base Temperature | Cooling Power | Sample Space | Sample Vibration | Windows |
|---|---|---|---|---|---|
| DMX-20 | 6 K \| 7 K \| 11 K | 0.1 W at 6.2 K | Ø47 x 39 mm | 3-5 nm | Four; Ø32 mm |
| GMX-20 | 4 K \| 10 K | 1.0 W at 4.2 K | Ø61 x 39 mm | 5-10 nm | Four; Ø32 mm |

# X-20B Series Ultra-High Vacuum

The X-20B Series brings high cooling power to the UHV chamber, delivering strong cooling power and minimal vibrations to critical applications including SPM techniques and Cold Ion Traps.

## Bake-Out Ready

Since the cryocooler is decoupled from the cryostat body, it is removable within minutes to allow a 200 °C bakeout.




## True UHV ($10^{-11}$ mbar)

Unlike conventional cryostats which use O-rings, the Conflat flange is welded directly to the cryocooler with full stainless-steel construction, for a truly achievable $10^{-11}$ mbar vacuum level.

## Any Vacuum Flange

Choose between Conflat, ISO-F, ISO-K, ISOKF, or even custom vacuum flanges.

| Model | Base Temperature | Cooling Power | Min. Flange Size | Sample Vibration |
|---|---|---|---|---|
| DMX-20B | 6 K \| 7.5 K \| 11 K | 0.1 W at 6.2 K | DN100 | 3-5 nm |
| GMX-20B | 4 K \| 10 K | 1.0 W at 4.2 K | DN160 | 5-10 nm |

# Helitran® Cryostats

## Meeting the Challenge of Helium Scarcity

Helium is a nonrenewable resource, drawing ever nearer to permanent depletion. At ARS, we recognize this fact and have refined our liquid helium cryostats to efficiently extract the maximum possible cooling power from every drop of LHe. To minimize helium consumption, our Helitran® systems are equipped with:

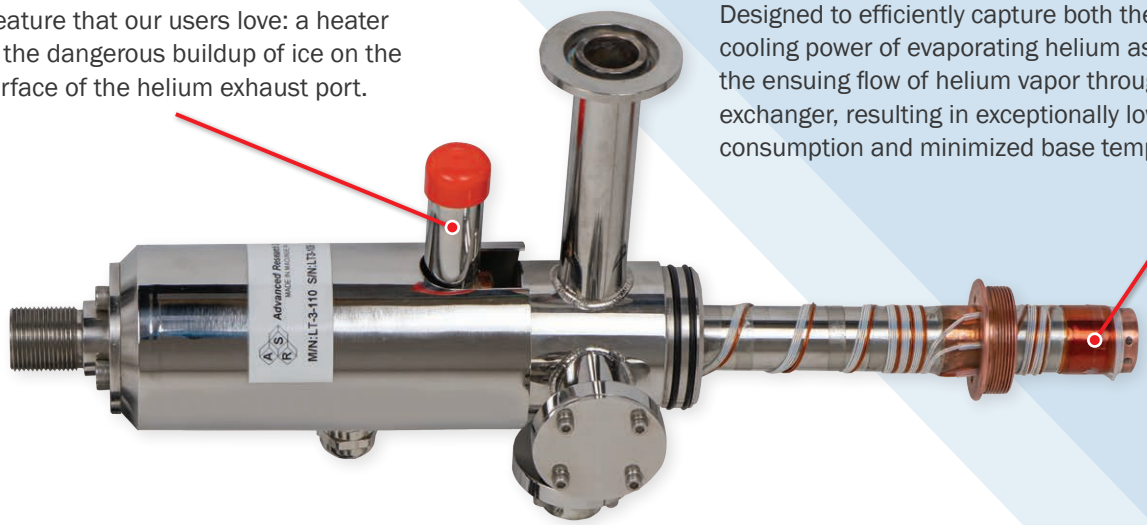
- The **Matrix® Heat Exchanger**, designed to extract as much enthalpy as possible from the liquid helium flow.
- Our high performance **Coaxial Flow Transfer Line**, which recycles the exhaust helium for improved product flow insulation.
- An **Impedance Valve** at the transfer line's outlet, granting extremely fine flow control and enabling sub-4.2K Joule-Thompson cooling.

## Exhaust Port Heater

A simple feature that our users love: a heater to prevent the dangerous buildup of ice on the outside surface of the helium exhaust port.

## Matrix® Heat Exchanger

Designed to efficiently capture both the cooling power of evaporating helium as well as the ensuing flow of helium vapor through the exchanger, resulting in exceptionally low helium consumption and minimized base temperature.



## Coaxial Flow Transfer Line

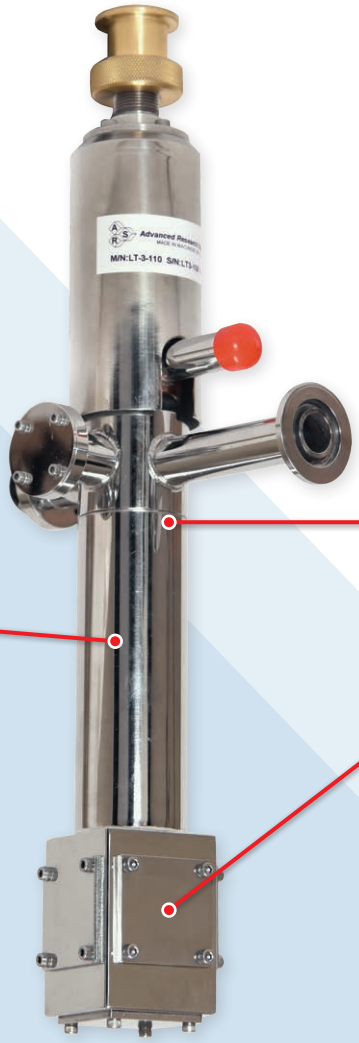
Uses the cryostat's helium exhaust to pre-cool the incoming liquid helium flow, further reducing helium consumption and eliminating vibrations from mixed-phase product flow.

## Impedance Valve

The impedance valve transforms the matrix heat exchanger into a Joule-Thompson expansion chamber. Partially closing the impedance valve and pumping on the exhaust port creates a pocket of low pressure for the liquid helium to expand into cooling to temperatures as low as 1.7K.

# X-1 Series Spectroscopy

Our most versatile benchtop cryostat featuring up to five perpendicular windows, the X-1 series is commonly used for optical spectroscopy including Raman, Photoluminescence, FTIR and more.



## Double O-Ring Seal

The double O-ring seal allow for the sample to be rotated about the cryocooler axis while the system is cold and under vacuum.

## Stainless Steel Construction

The stainless steel construction of the vacuum space results in better vacuum levels with lower background water vapor pressure.

## Compact Optical Block

At just 56mm wide the compact optical block will fit comfortably into the sample compartment of many spectrometers.

Despite their small size, the windows are still interchangeable with O-ring seals.

| Model | Base Temperature | Sample Space | Window Ports | Window Clear View | f/# |
|---|---|---|---|---|---|
| LT3-WMX-1 | 1.7 K—4.2 K with LHe<br>77 K with $LN_2$ | Ø36 x 39 mm | 5 | Ø32 mm | f/0.8 |
| LT4-DMX-1 | 4.2 K with LHe<br>77 K with $LN_2$ | Ø36 x 39 mm | 4 | Ø32 mm | f/1.0 |

# Helitran® Cryostats

## -B Series Ultra-High Vacuum

Prized for extremely sensitive applications from STM to Beamline Science, our LT-3B Helitran cryostat brings highly efficient LHe cooling into any UHV chamber.

### Bakeable to 200 °C

The entire cryostat is made of high temperature resistance materials, permitting bakeout up to 200 °C.

### Customizable Length

The cold finger length can be extended to lengths over 3 feet [1 meter] without sacrificing low temperature performance.

### True UHV ($10^{-11}$ torr)

Unlike conventional cryostats which use O-rings, the Conflat flange is welded directly to the cryocooler with full stainless-steel construction, for a truly achievable $10^{-11}$ mbar vacuum level.

| Model | Base Temperature | Flange Size | Length from Flange |
|---|---|---|---|
| LT-3B | 1.7 K—4.2 K with LHe<br>77 K with $LN_2$ | DN40 or larger | 115 mm or longer |
| LT-4B | 4.2 K with LHe<br>77 K with $LN_2$ | DN40 or larger | 115 mm or longer |

# OM Series Microscopy

Specifically designed for Microscopy the LT3-OM offers a low vibration, low drift sample cooling platform with a compact size that allows it to fit with most microscopy setups. This system works well for MicroRaman, MicroPL Quantum Dots, and many other applications.

## Low Profile Optical Block

At just 38mm thick, the microscopy extension will fit under the objective in most microscopes.

## Low Drift Design

The sample stage is supported by radial pins, decoupling the sample from the cold finger and thereby minimizing temperature-dependent drift.

## Continuously Adjustable

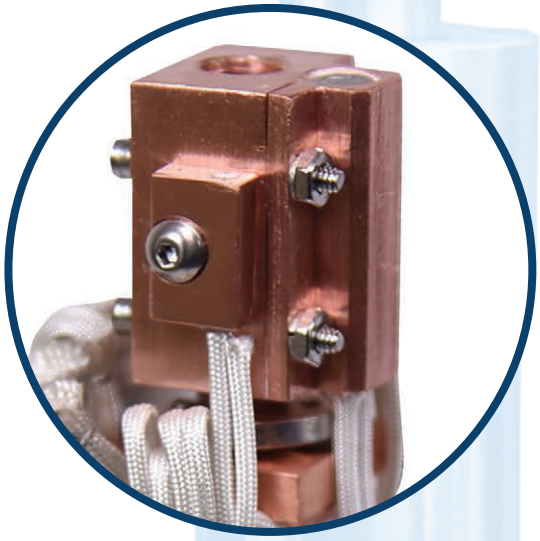
The sample stage is continuously adjustable allowing for sample thickness from 0 - 4.5 mm.

| | Base Temperature | Sample Space | Drift | Sample Vibration | Window Clear View | Working Distance |
|---|---|---|---|---|---|---|
| LT3-OM | 1.7 K—4.2 K with LHe<br>77 K with $LN_2$ | Ø19 x 4.5 mm | ~100 nm | 5-10 nm | 23 mm | 0.5 - 4.5 mm |

# Options & Accessories

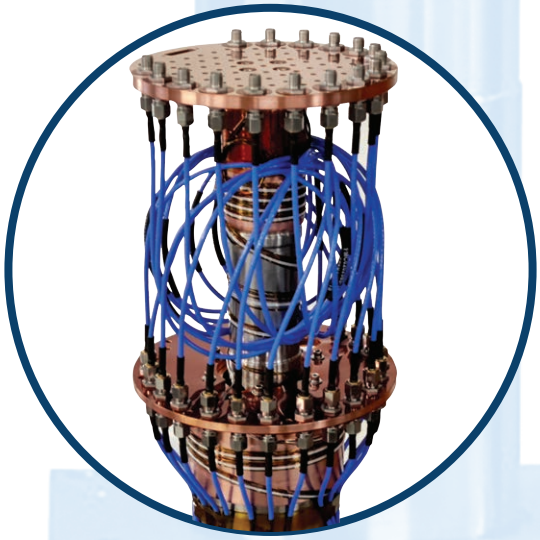
## High Temperature Interfaces

With an additional accessory and upgraded thermometry, our cryostats can be configured for rapid operation up to 450K or 800K while still maintaining a sub-4K base temperature.



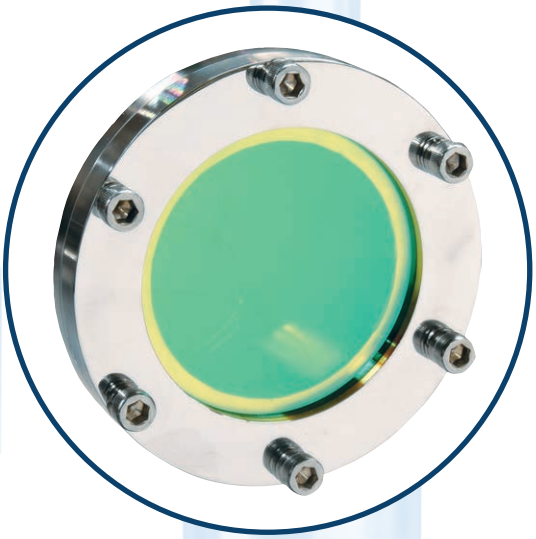
## Sample Wiring

Signal and measurement wires can be expertly pre-installed and thermalized in our cryostats, with options for DC and high frequency cabling or fiber optics.



## Sample Holders

Browse our standard lineup of diverse sample holders, or design a custom one for your experiment with one of our experienced cryogenics applications specialists.



## Optical Windows

Our optical cryostats can be outfitted with all readily available window types and can be optimized for high NA, ultra low working distance, or low path-length optical arrangements.


## Air Cooling Modules

Prefer to air-cool the helium compressor? Add a CoolPac recirculation unit to dissipate the compressor's waste heat without the need for a laboratory water loop.

## Cryostat Supports

Standard fixtures are available to mount the cryostat vertically or horizontally from the floor or table.

# Making Every Application Cold.

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