

Option User Manual

Cryo-Optic® Module

CryoAdvance® 50 | CryoAdvance® 100 |
Cryostation® s200 | Cryostation® 200 PT

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Specifications and product information listed in this document are accurate to the time of publishing for a standard system. Options, custom designs, and/or other modifications may cause slight differences. Future design changes to the system, including software updates, may change information.

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Section 1 - Preface

 **WARNING**

Read all instructions before using this product

All users must read and understand this manual and all other safety instructions before using the equipment. Retain these instructions for future reference.

This manual is intended for users of the Montana Instruments products and systems described herein. Users include anyone who may physically interact with the system or peripheral equipment, including installing, setting up, or configuring the system or anyone who may operate system components via operating panels, the supplied user interface, or remote interfaces.

This manual may be used by facilities personnel to determine infrastructure requirements in the room or building where the equipment will be installed.

This manual should be referenced by authorized service personnel for important safety and hazard information and other product restrictions.

1.1 Conventions Used in this Manual

The following style conventions are used in this document:

- Vertical bar (|)
 - Indicates alternative selections. The bar may be used in place of “and” or “or”.
- Alphanumeric List (1., 2., 3...| a., b., c...)
 - Indicates instructions or actions which should be completed in a specific ordered sequence.
- Bulleted List (• | ◦ | -)
 - Indicates instructions, commands, or additional information about an action.
 - May alternatively be used for unordered lists of materials or additional reference notes.
- Courier Font
 - Indicates a label or indicator on a physical product or part.
 - Indicates a system output, such as a display reading.
 - May also be used for URLs, file paths, file names, scripting language, prompts, or syntax.

1.2 Abbreviations

The following abbreviations may be used:

- ACM: Ancillary Control Module
- CAN: Controller Area Network
- DMM: Digital Multimeter
- HDMI: High-Definition Multimedia Interface
- MI: Montana Instruments
- PCB: Printed Circuit Board
- TCM: Temperature Control Module
- UI: User Interface
- UPS: Uninterruptible Power Supply
- USB: Universal Serial Bus
- VNC: Virtual Network Computing
- International System of Units (SI) symbols
- System of Imperial Units symbols
- Element, molecule, and compound abbreviations

1.3 Explanation of Safety Warnings

Safety and hazard information includes terms, symbols, warnings, and instructions used in this manual or on the equipment to alert users to precautions in the care, use, and handling of the system. The following hazard levels and information are considered:

 **DANGER**

Serious personal injury

Imminent hazards which, if not avoided, will result in serious injury or death.

 **WARNING**

Serious personal injury

Potential hazards which, if not avoided, could result in serious injury or death.

 **CAUTION**

Possible personal injury

Potential hazards which, if not avoided, could result in minor or moderate injury.

NOTICE

Command or Product Safety Notice







Potential hazards which, if not avoided, could result in product damage.

» NOTE

Points of particular interest for more efficient or convenient equipment operation; additional information or explanation.

1.4 Graphical Symbols

The following symbols may be used in diagrams, supporting text, and on physical parts:

	Hazard Alert: General Warning		Hazard Alert: High Voltage
	Hazard Alert: Laser Radiation		HDMI port
	CAN bus module		USB port

1.5 General Hazard Information

The following descriptions are of general hazards and unsafe practices that may result in product damage, severe injury, or death.

- The products, parts, and components in this manual are to be serviced by authorized Montana Instruments service representatives only. Failure to do so will void the warranty and may damage the product and/or create a safety hazard.
- Only use all components provided for the intended purpose described herein.
- If the equipment or any component is used or modified in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

The following hazards may be typical for this product:

WARNING

Risk of injury when lifting or moving system components

System components, including standalone equipment and installed assemblies, may be heavy.

- Use caution when lifting or moving equipment or assemblies. Ensure proper lifting principles are used to avoid injury.
- Equipment or assemblies >20 kg should always be lifted by two or more people or with a suitable lifting device.

WARNING

High voltage: danger of electric shock

Electric shocks and burns from capacitor discharge or power circuits could lead to serious injury or death.

- Before turning on any power supply, the ground prong of the power cord plug must be properly connected to the ground connector of the wall outlet. The wall outlet must have a third prong or must be properly connected to an adapter that complies with these safety requirements.
- Only use replacement power cords or power plugs with the same polarity and power rating as that of the original ones. Do NOT use inadequately rated cables.

If the equipment or the wall outlet is damaged, the protective grounding could be disconnected.

- Do NOT use damaged equipment until its safety has been verified by authorized personnel.
- Do NOT disconnect or tamper with the operation of the protective earth terminal inside or outside the apparatus.

NOTICE

Only clean exterior surfaces with acceptable fluids

- Only use deionized water, glass cleaner, or isopropyl alcohol to clean the exterior surfaces of any enclosure. Do NOT use any volatile chemicals other than isopropyl alcohol.
- Apply fluid to a clean, lint-free cloth and wipe surface with cloth. Do NOT apply fluid directly to any surfaces or enclosures.

1.6 Technical Support Information

Any technical questions or issues with the system that cannot be resolved with the information in this manual should be referred to as an authorized Montana Instruments service representative.

1.6.1 Warranty & Repairs

If the system or parts need to be returned to the Montana Instruments factory or an authorized service center for repair or service, contact an authorized service representative for a return merchandise authorization (RMA) number and instructions on returning the unit.

For a copy of the Limited Warranty Agreement, visit: www.montanainstruments.com/About/Warranty

1.6.2 Accessories & Replacement Parts

Only use cables, hoses, accessories, and parts provided or approved by the manufacturer. Follow all instructions for proper installation or replacement.

- To order spare or replacement parts, please contact your local service representative.
- To order new accessories or options, or for more information on other Montana Instruments products and technologies, please contact your local sales representative.

1.6.3 Contact Details

For a complete list of sales and service centers visit: www.montanainstruments.com/Contact

North American Authorized Service

- M-F 8:30am-5pm MST | Call: +1.406.551.2796
- Email: support@montanainstruments.com

North American Sales

- M-F 8:30am-5pm MST | Call: +1.406.551.2796
- Email: sales@montanainstruments.com

International Sales & Authorized Service

- Visit www.montanainstruments.com/Contact/Sales-Offices for contact information for your local representative.

Section 2 - Option Overview

2.1 Cryo-Optic

Models
CryoAdvance® 50 - CO
CryoAdvance® 100 - CO
Cryostation® s200 – CO
Cryostation® 200 PT – CO

2.1.1 Intended Use

The Cryo-Optic module is an add-on option for the Cryostation that integrates a high NA objective into the sample space. The assembly allows the user to place the sample and objective in very close proximity.

2.1.2 Components

The Cryo-Optic module consists of a vacuum-compatible, high NA objective mounted inside an objective holder assembly. The assembly includes an aperture lid, alignment system, and thread adapter.

The objective is held between 250 K – 310 K under vacuum. A PID controlled heater ring receives feedback from a Cernox® thermometer on the objective mount to automatically maintain the objective temperature.

Nanopositioners

An XYZ nanopositioner stack provides three-axis range of sample motion while the sample chamber is cold or under vacuum. The positioners are required for focusing with respect to the fixed objective. The user-specified sample mount is attached to the top of the nanopositioner stack.

2.1.3 Models

Vertical Cryo-Optic (CryoAdvance® 50-CO)

The CryoAdvance® 50 Cryo-Optic assembly consists of a vacuum-compatible, high NA objective vertically mounted above the sample platform with overhead optical access.

Horizontal Cryo-Optic (CryoAdvance® 100-CO, Cryostation® s200-CO, and Cryostation® 200 PT – CO)

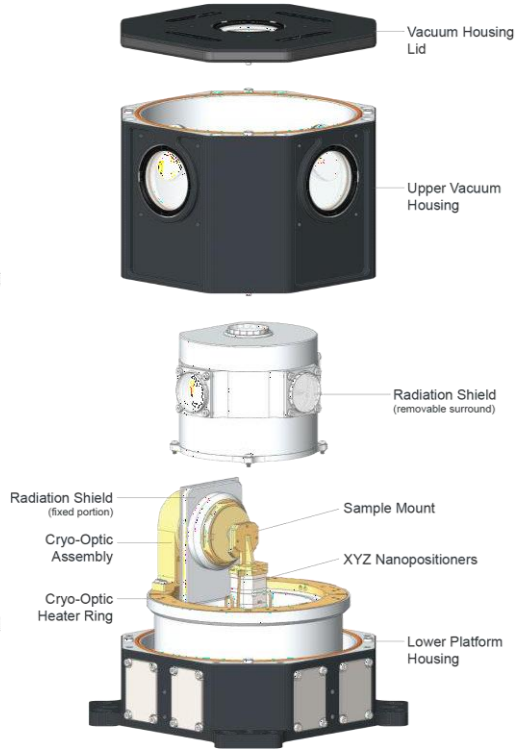
The CryoAdvance® 100 and Cryostation® s200 Cryo-Optic assemblies consist of a vacuum-compatible, high NA objective mounted horizontally with the sample mount platform for side optical access.

The CA100 has a two-piece radiation shield consisting of a fixed portion around the Cryo-Optic and a removable surround with three radial optical ports and one overhead optical port.

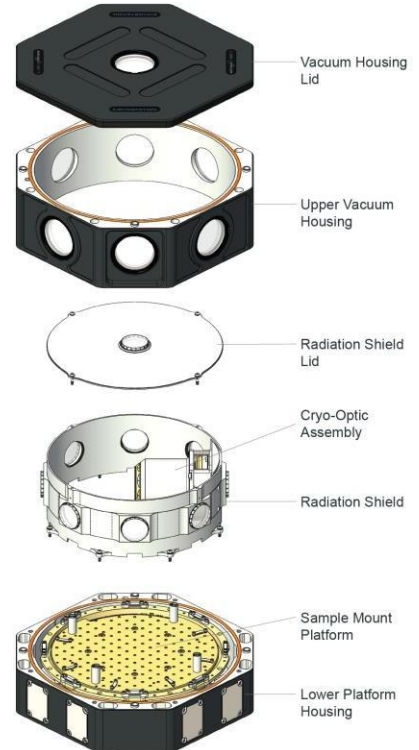
In the s200, the objective assembly is affixed to the inside of one of the side optical ports in the radiation shield. There are seven additional radial optical ports on this shield and a removable top lid with one overhead optical port.



Vertical Cryo-Optic (CA50 – CO)



Horizontal Cryo-Optic (CA100 – CO)



Horizontal Cryo-Optic (s200 – CO)

Section 3 - Option Configuration

Refer to the System User Manual for instructions on unpacking, mounting, and installing the cryostat. Complete these steps before configuring the Cryo-Optic.

NOTICE

Keep sample chamber and surfaces clean

- Always wear sterile gloves when working in the sample chamber to avoid getting oils on the surfaces.
- Be sure to keep the O-ring seals clean and free from debris. Do NOT set the housing down on an O-ring seal unless there are protruding bosses to keep it from touching the surface.
- Before replacing vacuum housings and lids, carefully check O-rings for loose fibers or debris. If necessary, clean with a dry lens tissue and re-grease with a thin layer of L-grease.

Before connecting or disconnecting wiring inside the system, ensure the power to the system control unit is off.

- Tap (press and release) the power button on the front of the system control unit, then turn off power to the unit completely by toggling the power switch on the back of the unit OFF (o).

3.1 Configuring the Vertical Cryo-Optic (CryoAdvance® 50 – CO)

3.1.1 Installing the Vertical Cryo-Optic

The vertical Cryo-Optic module ships disassembled in a protective hard case. The nanopositioners and sample mount typically ship pre-installed in the sample chamber. The components include:

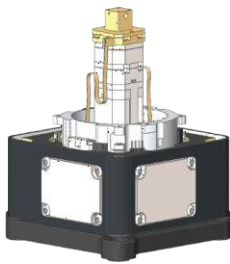
- Objective holder assembly with pre-aligned objective and aperture installed
- Wiring harness interconnect cable
- Radiation shield
- Vacuum housing and vacuum housing lid

To assemble the sample chamber with a vertical Cryo-Optic:

1. Configure the sample chamber options, sample wiring, and sample mount.
 - a. Refer to the Manual Addendum for any specific instructions regarding the sample mount configuration. Ensure all wiring runs under the sample platform radiation ring thermal clamps.
2. Place the lower radiation shield around the sample mount assembly onto the sample platform radiation ring. Secure into place with four M3 socket head screws.
 - a. Check to ensure there are no wires or components touching the inside of the radiation shield. Adjust if necessary.
3. Install the Cryo-Optic objective assembly:
 - a. Add a thin layer of N-grease (just enough so the surface is shiny) to the top surface of

the lower radiation shield.

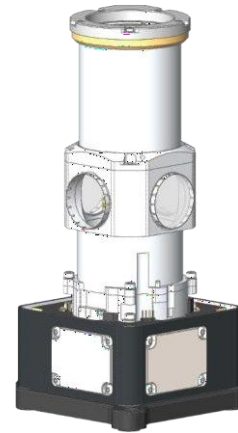
- b. With the system control unit off, connect the wiring harness to the heater ring on the objective assembly. The wiring harness can only be connected in one orientation. Ensure the other end of the wiring harness is connected to the proper connectors (as labeled) on the sample platform circuit board.
- c. Place the Cryo-Optic assembly on the lower radiation shield. There are pins to ensure proper alignment of the two components.
- d. Secure in place with four M3x8 cap head screws.



Step 1



Step 2



Step 3

After the objective assembly has been properly attached and aligned, the vacuum housing can be installed:

4. Locate the intermediate vacuum housing with windows. Align and place over the objective and radiation shield assembly onto the lower platform housing.
5. Locate the upper vacuum housing without windows. Align and place over the objective assembly onto the intermediate housing.
6. Locate the vacuum housing lid. Align and place on top of the intermediate vacuum housing.



Step 4



Step 5



Step 6

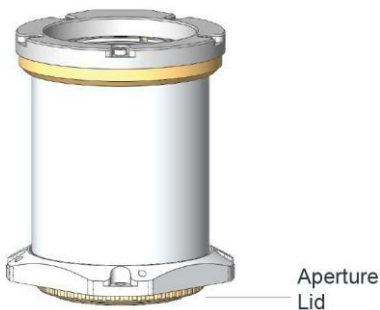
3.1.2 Accessing the Sample Chamber

To access the sample or sample mount assembly, reverse the steps in the previous section. Users may be able to leave the lower radiation shield in place (step #2) when exchanging samples.

3.1.3 Replacing the Aperture

To replace the aperture:

1. Unscrew the original aperture lid (gold ring) from the objective housing assembly.
2. Screw on the new aperture lid until hand tight. There should be no gap between the gold ring and objective housing assembly.



NOTICE

Check nanopositioner vertical position before cooling down

- Ensure the Z-stage of the nanopositioners is all the way down prior to cooling down. Contraction of components during cooldown could cause a collision between the sample mount and aperture.

3.2 Configuring the Horizontal Cryo-Optic (CryoAdvance® 100 - CO)

The Cryo-Optic objective assembly attaches to a heater ring around the sample chamber for horizontal optical access through one of the side optical ports on the sample chamber. The initial configuration will ship with the objective assembly pre-installed in the geometry determined during the system design. The nanopositioners and sample mount are typically also pre-installed in the sample chamber.

3.2.1 Accessing the Sample Chamber

To access the sample chamber:

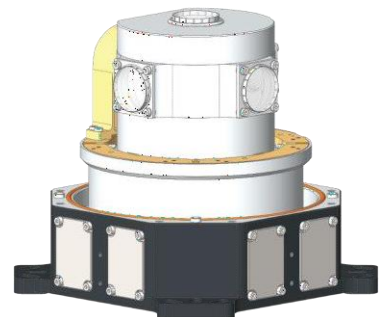
1. Carefully lift the top lid from the sample chamber and place it on the table with the protruding bosses down. The lid may sit on the bosses without compromising the clean surface inside the lid.
2. Using two hands, carefully lift the window assembly from the sample chamber. Place the window assembly on the table with the protruding bosses down so it is not resting on an O-ring or window.
3. Unfasten the four M3 socket head screws on each side of the radiation shield (red circles).
 - a. Lift the window portion of the shield back and up to remove.
 - b. The fixed portion around the gold objective assembly should remain in place (blue arrow).
4. Configure the sample chamber options, sample wiring, and sample mount.
 - a. Refer to the Manual Addendum for any specific instructions regarding the sample space configuration.
5. Reverse steps 1-4 above to reinstall the radiation shield and vacuum housing.
 - a. Adjust any wiring or internal components to ensure nothing is contacting the inside of the radiation shield.



Fully assembled chamber

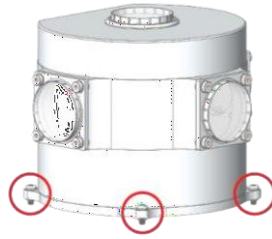


Lid removed

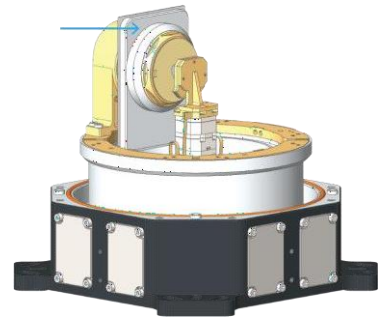


Housing removed

Step 3:
remove screws around radiation shield
(3/4 shown circled red)



Step 3b:
fixed side of radiation shield stays in place (indicated with blue arrow)



3.2.2 Moving the Cryo-Optic Assembly

If the objective assembly ever needs to be removed or moved to a different location around the sample chamber, contact an authorized service representative for detailed instructions.

3.3 Configuring the Horizontal Cryo-Optic (s200 - CO, 200 PT - CO)

The Cryo-Optic objective assembly attaches to the inside of the radiation shield for horizontal optical access through one of the side optical ports on the sample chamber. The initial configuration will typically ship with the objective assembly pre-installed in the geometry determined during the system design.

3.3.1 Accessing the Sample Chamber

To access the sample chamber:

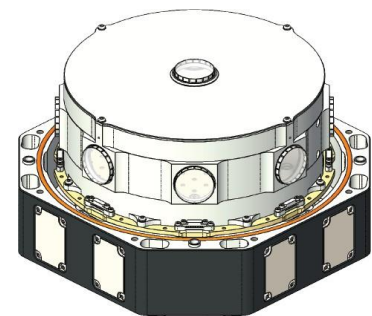
1. Carefully lift the top lid from the sample chamber and place it on the table with the protruding bosses down. The lid may sit on the bosses without compromising the clean surface inside the lid.
2. Using two hands, carefully lift the window assembly from the sample chamber. Place the window assembly on the table with the protruding bosses down so it is not resting on an O-ring or window.



Fully assembled chamber

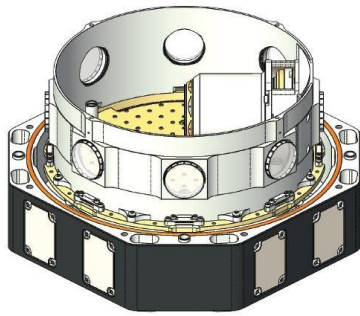


Step 1: Lid removed

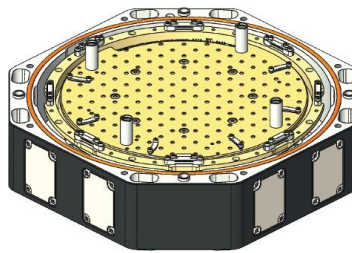


Step 2: Housing removed

3. Unfasten the four M3 button head screws on the lid of the radiation shield to remove it.
4. With the system control unit off, disconnect the wiring harness connected to the back of the objective assembly. This harness is routed from a side panel, through the gap between the lower vacuum housing and radiation shield and connects to the objective assembly through a cutout in the radiation shield directly below the optical port.
5. Unfasten the eight M3 button head screws on each side of the radiation shield. Lift up to remove, taking care not to contact any sample mounts or other internal components on the platform.
6. On the open platform, configure the sample chamber options, sample wiring, and sample mount.
 - a. Refer to the Manual Addendum for any specific instructions regarding the sample space configuration.



Radiation lid removed



Everything removed, open platform

3.3.2 Installing the Cryo-Optic Assembly

If the objective assembly is not already installed or needs to be re-installed:



1. With the radiation shield removed from the sample chamber platform, locate the objective assembly. Add a thin layer of N-grease (just enough so the surface is shiny) to the flat back plate of the assembly (the surface opposite the aperture).
2. Place the back plate of the assembly against the flat edge inside the radiation shield such that the objective aligns with the radiation optical port. There are two pins to ensure proper alignment.
3. While holding the assembly in place, attach it to the radiation shield with four M3 socket head screws and Belleville spring washers. These are secured through the outside of the radiation shield (red circles).
4. Place the radiation shield back on the sample platform such that the Cryo-Optic aligns with the intended optical path.
 - a. Adjust any wiring or internal components to ensure nothing is contacting the inside of the radiation shield.
 - b. Fasten the eight M3 button head screws on each side of the radiation shield.
5. Connect the Cryo-Optic wiring harness (located between the lower vacuum housing and radiation shield) into the back of the objective assembly via the cutout just below the optical port.
6. Replace the radiation shield lid (and screws), outer vacuum housing, and vacuum housing lid.

3.4 Hardware Torque Specifications

All hardware in a Montana Instruments cryostat is torqued to specifications that ensure optimal and safe system operation. Over time, however, hardware can become loose, so it may be necessary for users to tighten hardware themselves. The following tables show the torque specifications for screws used in the cryostat system, with values in in*lbs and N*m. The torque specifications are based on the material of the screw, the size of the screw and the temperature environment the screw is present in. By following the instructions below, users can ensure their cryostats continue to operate at peak performance. For further questions or help, please contact our Customer Service team.

Application	Screw Material	Torque (in*lbs) ¹							
		M1.6	M2	M3	M4	M5	M6	M7	M8
Room Temp	Brass	0.5	1.1	3.9	9.0	18.1	30.8	51.6	74.8
	Stainless Steel	0.7	1.5	5.4	12.6	25.5	43.4	72.6	105.2
Cold, clamping aluminum	Brass	0.6	1.3	4.7	10.9	21.9	37.3	62.5	90.6
	Stainless Steel ^{2,3}	1.0	2.1	7.5	17.5	35.2	60.0	100.4	145.6
Cold, clamping copper	Brass	0.3	0.7	2.5	5.8	11.7	20.0	33.4	48.5
	Stainless Steel ²	1.0	1.9	7.1	16.4	33.2	56.4	94.4	136.9

Notes:
1. Based on target of 70% of fastener yield stress (when cold) unless noted
2. Belleville washer recommended
3. Based on target of 20% of fastener yield stress

Application	Screw Material	Torque (N*m) ¹							
		M1.6	M2	M3	M4	M5	M6	M7	M8
Room Temp	Brass	0.06	0.1	0.4	1.0	2.0	3.5	5.8	8.4
	Stainless Steel	0.08	0.2	0.6	1.4	2.9	4.9	8.2	11.9
Cold, clamping aluminum	Brass	0.07	0.1	0.5	1.2	2.5	4.2	7.1	10.2
	Stainless Steel ^{2,3}	0.11	0.2	0.8	2.0	4.0	6.8	11.3	16.4
Cold, clamping copper	Brass	0.04	0.1	0.3	0.7	1.3	2.3	3.8	5.5
	Stainless Steel ²	0.11	0.2	0.8	1.9	3.7	6.4	10.7	15.5

Notes:
1. Based on target of 70% of fastener yield stress (when cold) unless noted
2. Belleville washer recommended
3. Based on target of 20% of fastener yield stress

How to Torque Screws to Specification

1. Identify screw material, screw size, and temperature environment the screw is in.
2. Obtain a torque screwdriver of appropriate size for the screw. Units in either in*lbs or N*m
3. Set torque screwdriver value to the correct specification from the chart. NOTE: Ensure units match between chart and screwdriver to avoid damage to screws or screws being too loose.
4. Tighten screw (clockwise) using torque screwdriver. The screwdriver will click once the set torque value is achieved.

Section 4 - Option Usage & Operation

Refer to the System User Manual for detailed user interface control functions.

4.1 Primary Operations

NOTICE

Check Cryo-Optic connections

- Prior to enabling the Cryo-Optic, ensure the Cryo-Optic heater and thermometer wiring is connected.

4.1.1 Enabling the Cryo-Optic



Before cooling down the system, the Cryo-Optic temperature channel must be enabled.

1. In the UI for the CRYOSTATION instrument, navigate to the SAMPLE CHAMBER display screen and select the CRYO-OPTIC temperature channel to bring up its operation controls.
2. Toggle the Cryo-Optic Control switch to ENABLED. When enabled, the temperature and heater values will display live readings.
3. (Optional) Set the objective temperature in the CRYO-OPTIC TARGET input box. The default setting is 295 K. Minimum temperature setpoint is 250K.

The Cryo-Optic objective temperature will now be actively maintained using a PID control loop of the heater ring and objective mount thermometer. The temperature of the platform and sample are controlled independently from the objective.

NOTICE

Ensure Cryo-Optic is enabled before every cooldown!

- Before every cooldown, check the UI to verify the Cryo-Optic is enabled and actively reading the objective temperature. Operating the cryostat with the Cryo-Optic disabled may damage the objective.

Check nanopositioner position before cooling down

- For the vertical Cryo-Optic configuration, ensure the Z-stage of the nanopositioners is all the way down prior to cooling down. Contraction of components during cooldown could cause a collision between the sample mount and aperture.

4.2 Diagnostics & Troubleshooting

If there are any issues with the option, please contact an authorized service representative.

4.2.1 Alignment Troubleshooting

The objective ships pre-installed in the objective holder assembly and typically does not require further alignment. If the objective becomes mis-aligned or needs to be removed or replaced, contact an authorized service representative for detailed alignment instructions.

There are specialized alignment tools and components provided in the accessory kit.

Section 5 - Appendices

5.1 Related Documentation

For a copy of associated documentation, see below:

Document Number	Document Title	Location
4100-DOC001	System User Manual: Cryostation s-series	https://www.montanainstruments.com/support/product-documentation
DOC102	General Terms and Conditions of Sale	www.montanainstruments.com/About/Terms
DOC103	Limited Warranty Agreement	www.montanainstruments.com/About/Warranty
DOC104	End User License Agreement	http://www.montanainstruments.com/about/EULA
N/A	Patent Information	https://www.montanainstruments.com/patents

