System Manual

Oxford Instruments

OptistatDry BL4

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Contents

PREFACE

Welcome to the System Manual for the **Optistat**Dry BL4 cryogenic system.

Copyright

Use of this manual

This System Manual and accompanying documents supplied with the system provide all the information necessary for the safe and proper installation, operation and servicing of the **Optistat**Dry BL4.

Chapters 1 to 5 of this manual provide essential information that must be read and understood before operating the **Optistat**DRY BL4 for the first time.

Other documents supplied with the system

The following documents are supplied (hard copy and/or CD) with the **Optistat**Dry BL4 system depending on options ordered:

- Safety Matters
- Practical Cryogenics
- **Optistat**Dry BL4 Safety Sheet
- Unpacking Sheet
- Operation Quick Start sheet
- SHI SRDK-101D-HC4A2 Cryocooler Operation Manual (CD32ZZ-421A) - for **Optistat**Dry BL4A air cooled option

- SHI SRDK-101D-HC4E2 Cryocooler Operation Manual (CD32ZZ-422A) - for **Optistat**Dry BL4W water cooled option
- SHI HC-4A and HC-4A2 Zephyr Air-Cooled Helium Compressors Technical Manual (267825A) - for **Optistat**Dry BL4A air cooled option
- SHI HC-4E1 and HC-4E2 Helium Compressors Technical Manual (267318A) - for **Optistat**Dry BL4W water cooled option
- SHI RDK-101D 4K Cold Head Technical Instruction (CD32ZZ-108)
- **Mercury**iTC Temperature Controller Manual UMC0071 (if temperature controller option ordered)
- H4-600 or H4-601 Pumping Kit Manual (if vacuum pump option ordered)
- Thermometer calibration data
- System Test Data Sheet

Intended users

Users of this product must have received adequate training on its safe and effective use before attempting to work with the equipment. Please contact Oxford Instruments Omicron NanoScience for information on training requirements and training courses that are available.

Training requirements vary from country to country. Users must ensure that training is given in accordance with all applicable local laws and regulations.

If any user of the equipment has not been directly trained by Oxford Instruments Omicron NanoScience, ensure that they understand the safety issues associated with the equipment, and that they consult relevant personnel for guidance when operating the equipment.

Statement of intended use of the OptistatDry BL4

The **Optistat**Dry BL4 has been designed for use in a laboratory environment. The equipment has been designed to operate within the process parameter limits that are outlined in this manual.

The **Optistat**Dry BL4 is intended to be installed, used and operated only for the purpose for which it was designed, and only in accordance with the instructions given in this manual and other accompanying documents. Nothing stated in this manual reduces the responsibilities of users to exercise sound judgement and best practice.

It is the user's responsibility to ensure the system is operated in a safe manner. Consideration must be made for all aspects of the system's life-cycle including, handling, installation, normal operation, maintenance, dismantling, decontamination and disposal. It is the user's responsibility to complete suitable risk assessments, to determine the magnitude of hazards.

The installation, use and operation of the **Optistat**Dry BL4 are subject to laws in the jurisdictions in which the equipment is installed and in use. Users must install, use and operate the equipment only in such ways that do not conflict with said applicable laws and regulations.

If the equipment is not installed, used, maintained, refurbished, modified and upgraded as specified by the manufacturer, then the protection it provides could be impaired. Any resultant non-compliance, damage, or personal injury would be the fault of the owner or user.

Use of the equipment for purposes other than those intended and expressly stated by Oxford Instruments Omicron NanoScience, as well as incorrect use or operation of the equipment, may relieve Oxford Instruments Omicron NanoScience or its agent of the responsibility for any resultant non-compliance, damage or injury.

Revision history

This is issue 01 of the **Optistat**Dry BL4 System Manual, as shown in the header at the top of each page.

The changes made to this document and a summary of previous issues are listed in the table below. Always use the latest issue of the manual.

Revision	Affected page(s)	Summary of changes
01	All pages	First edition of the **Optistat**Dry BL4 System Manual

Disclaimers

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All documents (including this manual) are provided without warranty of any kind, either implied or expressed, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.

Customer support

Oxford Instruments Omicron NanoScience has global customer support facilities that provide a coordinated response to customer's queries. All queries are recorded on our support database and are dealt with as quickly as possible. If we are not able to answer the query immediately, we will contact you promptly.

Before contacting a customer support facility, please ensure that you have followed the guidance given in section 7 of this manual.

If you are still unable to resolve the problem, please direct all queries through your nearest support facility (see last page of this manual).

Health and safety information

There are potential hazards associated with the use of the **Optistat**Dry BL4. Before working with the product, all personnel must read and become thoroughly familiar with the information given in section 1. In particular, users must read, understand and strictly observe all:

- Warning notices
- Caution notices
- Safety labels and markings on the equipment

For ease of reference and rapid response in an emergency, the system is supplied with a document titled "**Optistat**Dry BL4 Safety Sheet" which summarizes the hazards mentioned in this manual. This Safety Sheet must be kept close to the equipment.

In addition, you should always provide access to the System Manual close to where the system is used.

Warranty

The Oxford Instruments customer support warranty provides repair to faults that are a result of manufacturing defects at Oxford Instruments Omicron NanoScience.

Modifications to the **Optistat**Dry BL4 made without the consent of Oxford Instruments Omicron NanoScience will void the warranty.

Acknowledgements

All trade names and trademarks that appear in this manual are hereby acknowledged.

Acronyms

The following is a list of acronyms used in this manual.

GM	Gifford-McMahon (refrigerator)
OVC	Outer Vacuum Chamber – the insulating vacuum space around the sample space and the refrigerator
PID	Proportional, Integral and Derivative – temperature control algorithm terms
RT	Room Temperature
SHI	Sumitomo Heavy Industries

Certification compliance statements

We, Oxford Instruments Nanotechnology Tools Ltd (trading as Oxford Instruments NanoScience), do hereby declare under our sole responsibility that the product(s) listed below are in conformity with the following Directives and Standards:

EU Directives covered by this Declaration
New Machinery Directive: 2006/42/EC

Product covered by this Declaration
OptistatDRY BL4 Cryogenic System

Relevant Standards applied

EN61010-2010 Safety requirements for electrical equipment for measurement, control and laboratory use

Approved

Signature: Date: 10th Dec 2014

Name Dr Steve Chappell

Position Technical Director
Oxford Instruments NanoScience

1 HEALTH AND SAFETY

This chapter describes all health and safety considerations relating to the Oxford Instruments Omicron NanoScience **Optistat**Dry BL4. Before you attempt to install or operate this equipment for the first time, please make sure that you are aware of the precautions that you must take to ensure your own safety.

The following safety precautions must be observed during the operation, service and repair of this instrument.

Safety procedures are vital to prevent

- Serious injury or death
- Serious damage to the equipment.

All staff, including cleaning and maintenance staff, who work in the laboratory must read the Oxford Instruments booklet Safety Matters which accompanies this manual.

1.1 Safety symbols used in this manual

Symbols are used in this manual to draw your attention to safety procedures that you must follow to protect yourself or the equipment.

There are two levels of hazard.

A **warning** indicates a risk to people.

The yellow warning triangle highlights dangers which may cause injury or, in extreme circumstances, death. The text explains the hazard and the correct procedure. The warning triangle may be followed by specific symbols and instructions.

A **caution** indicates a risk to equipment.

The general caution symbol highlights actions that you must take to prevent damage to the equipment. The action is explained in the text.

1.2 Safety requirements

It is your responsibility to ensure your own safety, and the safety of the people working around you.

Before you attempt to install or operate this system, please make sure that you are aware of all safety precaution listed in this document (the System Manual) together with the warnings and cautions listed and the operating procedures set out in the other manuals supplied with the system (e.g. SHI helium compressor technical manual and ***Mercury****iTC manual).*

Warnings and cautions must be followed to ensure your own safety.

The helium compressor, flexible lines and cold head are supplied already pressurised with pure helium gas at pressures greater than 15 bar (200 psig). Do not attempt to modify couplings unless you understand the procedures for doing this safely. Refer to the SHI helium compressor technical manual.

1.3 Warnings

Before you attempt to install or operate this equipment for the first time, please make sure that you are aware of the precautions that you must take to ensure your own safety.

Before you operate this equipment, you must make sure that you are aware of the precautions necessary to ensure your own safety. We supply a separate booklet called Safety Matters with the system. Please read it carefully so that you fully understand the hazards you may encounter when using cryogenic equipment.

Oxford Instruments Omicron NanoScience cannot accept responsibility for damage to the system caused by failure to observe the correct procedures described in this manual and the other manuals supplied with the system. The warranty may be affected if the system is misused, or the recommendations in the manuals are not followed.

The cryostat (including the two side panels and support cradle – see Figure 3) weighs approximately 23Kg). Two people are required to lift and move it safely. See section 3.3 of this manual.

1.4 Temperature and voltage limits

If you have bought a cryostat and temperature controller together from Oxford Instruments the temperature controller will have been set up in the factory in order to

- prevent you from accidentally exceeding the maximum safe operating temperature of the cryostat
- limit the maximum heater voltage to a safe level.

If you are planning to use an existing temperature controller, or a controller made by another manufacturer, you should take the same precautions. The recommended values for the heater voltage limit and the temperature limit are given in the System Test Data Sheet.

If you do not safeguard the system, it is possible to cause serious damage.

1.5 Service and repair

Only qualified and authorised persons must service or repair this equipment.

1.6 Restrictions on use

The equipment is not suitable for use in explosive, flammable or hazardous environments.

The equipment does not provide protection against the ingress of water. The equipment must be positioned so that it will not be exposed to water ingress.

1.7 Safety features

1.7.1 Compressor and cold head

The compressor is manufactured by Sumitomo (SHI) Cryogenics of America, Inc. and the cold head is manufactured by Sumitomo Heavy Industries, Ltd.

Safety features for the cold head and compressor are described in the SHI documentation supplied with this system. You should ensure that you understand and comply with all SHI safety warnings and cautions.

1.7.2 MercuryiTC temperature controller

OptistatDry BL4 systems will normally be supplied with a **Mercury**iTC temperature controller.

*Safety features for the **Mercury**iTC temperature controller are described in the manual supplied with this system. You should ensure that you understand and comply with all safety warnings and cautions.*

1.7.3 Cryostat

There is a single over-pressure relief plate on the front of the cryostat (see Figure 1 and Figure 3). It prevents the internal pressure in the cryostat from rising significantly above atmospheric pressure by lifting to allow gas to vent. Note that the relief plate will not lift during normal operation of the system. Four restoring springs provide the force required to re-seal the relief plate automatically when the pressure drops.

Figure 1 Optistat Dry **BL4 pressure relief plate**

Do not modify or tamper with this safety feature in any way. Ensure that nothing can restrict the movement of the plate.

1.8 Disposal and recycling instructions

Before disposing of this equipment, it is important to check with the appropriate local organisations to obtain advice on local rules and regulations about disposal and recycling.

You **must** contact Oxford Instruments Omicron NanoScience Customer Support (giving full product details) before any disposal begins.

2 INTRODUCTION

The **Optistat**Dry systems comprise a range of compact cryostats with optical access cooled by a closed cycle refrigerator. These systems are capable of cooling samples to helium temperatures without the need for liquid cryogens. This provides significant benefits in terms of ease of use and running costs. Cooling of samples becomes a very straightforward, reliable process that requires no cryogenic infrastructure. The **Optistat**Dry is designed to be

- Versatile
- Upgradeable
- Simple to use.

and to provide

- Optical excellence.

The **Optistat**Dry BL4 (bottom loading) system provides a temperature controlled sample-in-vacuum measurement environment within a cryofree cryostat (i.e. a cryostat that is cooled by a mechanical refrigerator as opposed to liquid cryogens). The system enables optical and electrical measurements to be carried out on the user's sample.

The cooling source for the cryostat is a two-stage Gifford McMahon (GM) refrigerator supplied by Sumitomo Heavy Industries (the RDK-101D cold head and HC-4 compressor). The sample cools through a direct conductive thermal path to the second stage of the refrigerator. The first stage of the refrigerator is used to cool a radiation shield which acts to minimise the radiative heat load to the second stage of the refrigerator and to the sample region.

The lower tail section of the cryostat (the window block) has been designed so that it is easy to remove and replace the sample mounting platform once the cryostat has been warmed to room temperature (cooler switched off) and the cryostat vacuum let up to atmospheric pressure. The sample mounting platform has two main variants. The first is a nickel plated copper blade platform suited to optical experiments with no or limited electrical measurement requirements. The second is a circuit board style platform (puck) suited to combined optical/electrical transport experiments.

2.1 Description of the OptistatDry BL4 system

Figure 2 shows a schematic diagram of the complete **Optistat**Dry BL4 system. Note that some components are optional and may not be supplied with your system. The main components are:

1 The cryostat, consisting of

- the heat exchanger, which is fitted with a temperature sensor and heater – internal wiring from hermetic 15 way micro D connector on the OVC. The sample mounting platform (copper blade or puck) can be removed from the heat exchanger when you need to change samples.
- the cold head (to which the heat exchanger is thermally attached)
- the outer vacuum chamber (OVC) and radiation shields that isolate the sample from the room temperature surroundings. The radiation shield is fitted with an activated charcoal sorption pump which helps maintain the cryostat vacuum when the system is in operation
- the optical window block which allows optical and physical access to the sample mounting region
- experimental wiring loom (optional extra) – internal wiring from hermetic 21 way micro D connector on the OVC to the sample mounting region connector.
- external cable for the experimental wiring loom (optional extra) – plugs into the hermetic 21 way micro D connector on the OVC and terminates with free ending wires so that the cable can be easily adapted to suit your experimental requirements.

2 The optional cryostat stand (used to support the cryostat and enable it to be mounted securely to an optical bench), consisting of

- a pair of side panels
- a support cradle with anti-vibration mounts
- four radial restraints

3 The cryocooler, consisting of

- the compressor (which supplies the compressed He gas to the cold head)
- the cold head

- the return and supply high pressure gas lines (between the cold head and compressor).
- the power cable between the cold head and the compressor

4 The temperature controller (optional extra), which monitors and controls the heating and thermometry for the heat exchanger.

5 The temperature control cable (optional extra), which links the temperature controller to the temperature sensor and heater at the heat exchanger via the hermetic 15 way micro D connector on the OVC.

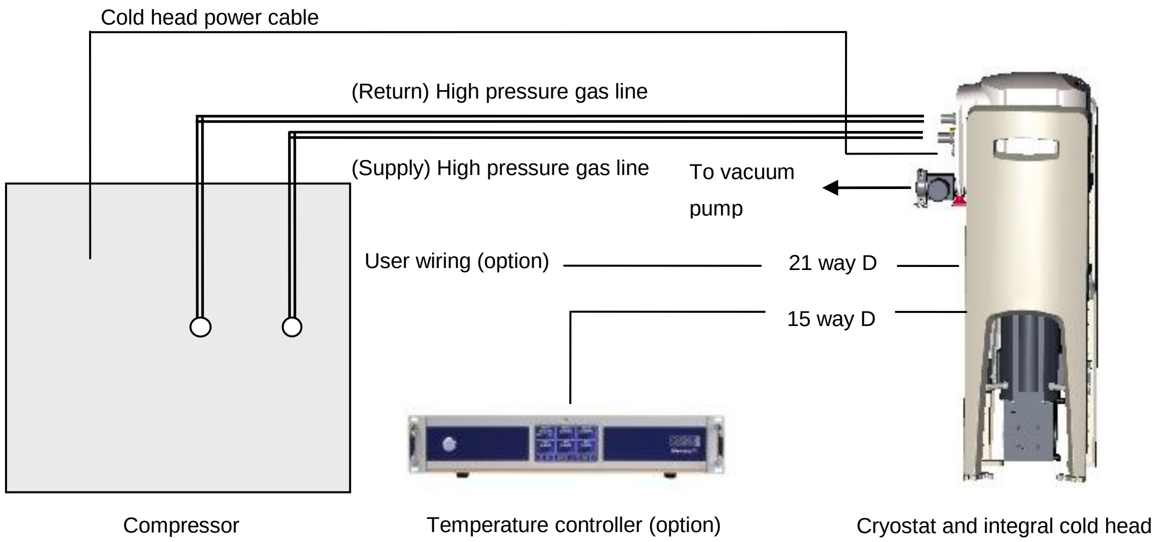


Figure 2 Schematic diagram of OptistatDry BL4 system

The sample space and radiation shields are thermally isolated from the room temperature surroundings by the OVC. The OVC must be pumped to a high vacuum using an external pumping system before the cryostat is cooled down.

During use, the cryostat vacuum is maintained using an internal sorption pump (with activated charcoal as the adsorption material). The sorption pump is an integral part of the removable radiation shield inside the window block. The refrigerator maintains the sorption pump temperature at about 40K (or colder) even when the sample region is controlled at 300K. Consequently, the pumping efficiency is maintained at all times and there is no need to have the OVC continuously connected to an external pumping system.

2.2 OptistatDry BL4 cryostat components

Figure 3 (front view) and Figure 4 (rear view) identify the main components of the **Optistat**Dry BL4 cryostat assembly. The **front/rear** convention is defined as follows:

- The **front** of the cryostat provides access for sample changing.
- The compressed gas lines are attached to the cold head at the **rear**.

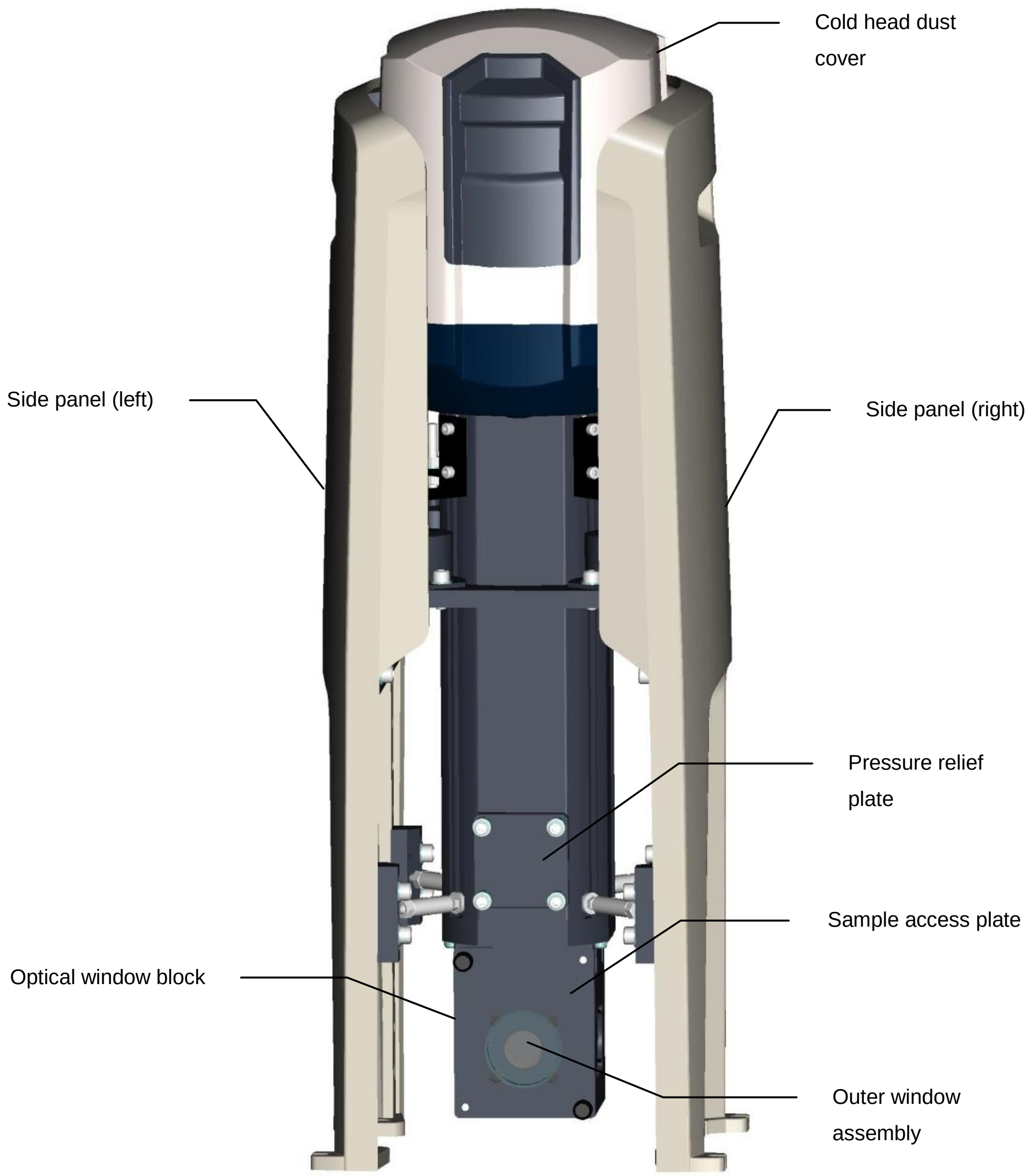


Figure 3 Optistat Dry BL4 **front view**

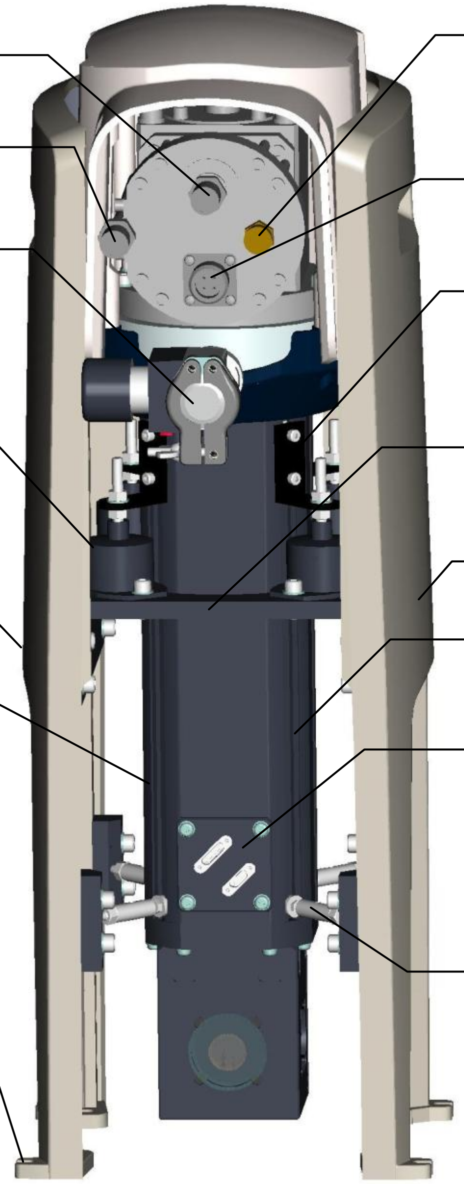


Figure 4 Optistat Dry BL4 **rear view**

Note that the **front**-facing edges of the side panels are wider than those at the **rear**. Figure 3 and Figure 4 are consistently labelled to show that the **right** (or left) side panel is on the **right** (or left) as viewed from the **front**.

3 UNPACKING AND ASSEMBLY

Assembly of the **Optistat**Dry BL4 is a straightforward procedure requiring no specialist training. This chapter describes how to:

- Decide the best position for your **Optistat**Dry BL4.
- Unpack and check the **Optistat**Dry BL4 components.
- Attach the cryostat to the vertical support frame (side panels and support cradle, if applicable).
- Adjust the height of the cryostat in the support frame so that the cryostat windows are the correct height above your optical table (if applicable).
- Fit cryostat restraints (if applicable).
- Prepare the compressor for operation.
- Connect He compressed gas lines to the cold head.
- Connect the **Mercury**iTC temperature controller (if applicable).

An optional spares kit is available with all the tools required for assembly.

3.1 Siting considerations

When choosing a site for the compressor and cryostat, the following points should be taken into account. Please also follow the advice given in the SHI Helium Compressor Technical Manual.

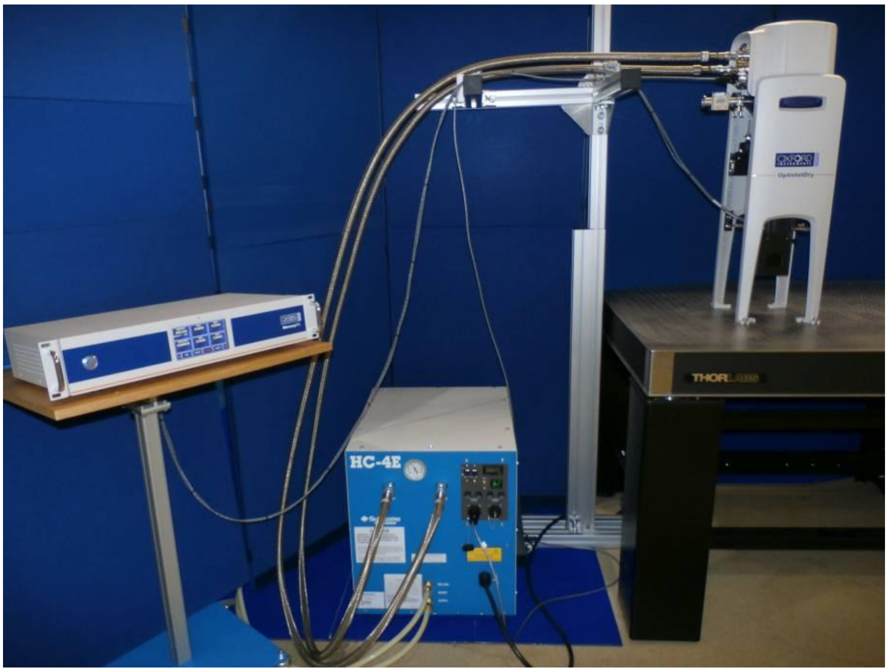


Figure 5 Typical Optistat Dry **BL4 system set-up**

- Allow enough space so that the helium lines from the compressor can be supported horizontally where they attach to the cold head.
- Standard high pressure helium gas lines are 3m long. Longer lines (up to 20m) are available but these may affect the cryogenic performance of the system.
- The gas lines should remain flexible, not taut
- Bending arcs for the gas lines should have large radius. The minimum bend radius is 180mm.
- The gas lines must exit the cold head horizontally (see section 3.7).
- Allow at least 600mm on all sides of the compressor for maintenance
- Ensure that the compressor is level (within 5° of horizontal).

It is suggested that all tools required for assembly be prepared in advance (Tables 1 and 2).

Tool	Where used	Recommended torque
5mm ball end hex-key (5mm ball driver preferable)	Cryostat height adjustments Radial restraint adjustments	n/a
2.5 mm hex-key also known as an Allen key	Radial restraint adjustments	n/a
10 mm open-ended spanner (two required)	Cryostat height adjustments Radial restraint adjustments	n/a
7mm ring spanner	Adjustment of locator studs	n/a
Small flat blade screwdriver (0.5mm x 3mm typical)	Installation of cryostat cable Removal/fitting of sample clamp on DRYTSH sample holder	n/a
Medium flat blade screwdriver (0.8 mm x 5mm typical)	Removal/fitting of radiation shield tail blanks Removal/fitting of optical windows	n/a
T-10 Torx screwdriver	Removal/fitting of radiation shield plate	1.2 Nm
	Removal/fitting of DRYPUCK12 sample holder	1.0 Nm
T-20 Torx screwdriver	Removal/fitting of window block	1.8 Nm
	Removal/fitting of radiation shield tail	2.5 Nm
	Removal/fitting of DRYTSH and DRYRSH sample holders	2.5 Nm

Table 1 Tools required for the OptistatDry BL4 assembly and fitting of parts

Tool	Where used
17 mm Spanner or socket + ratchet	Removal of shipping bolt underneath compressor package
5/16 inch Open ended spanner (water cooled only)	Compressor bulkhead water fitting jam-nut
7/8 inch Open ended spanner (water cooled only)	Compression nut on water fitting

Table 2 Additional tools required for compressor installation

3.2 Unpacking

The **Optistat**Dry BL4 system is supplied as 2 main packages, each on wooden pallets.

The first package includes the SHI compressor, gas lines and assembly tools. Remove external plastic wrapping and proceed as described in the SHI Compressor Technical Manual section describing Installation. At this stage, the main tasks are siting of the compressor and the removal of the shipping bolt beneath the compressor. Electrical connections, water connections (if applicable) and compressor testing are summarised in section 3.6

The second package consists of the cryostat, windows, sample holder(s) and any optional items ordered (e.g. **Mercury**iTC temperature controller and cable, vertical support stand, spares kit). Open this box by turning the two black plastic closure fittings and lifting back the lid. These fitting can be quite stiff and it may be necessary to use pliers to turn them. Remove the internal packing foam layers one by one and take out all the **Optistat**Dry BL4 components except for the cryostat with integral cold head. Leave this in place until required in section 3.3.3.

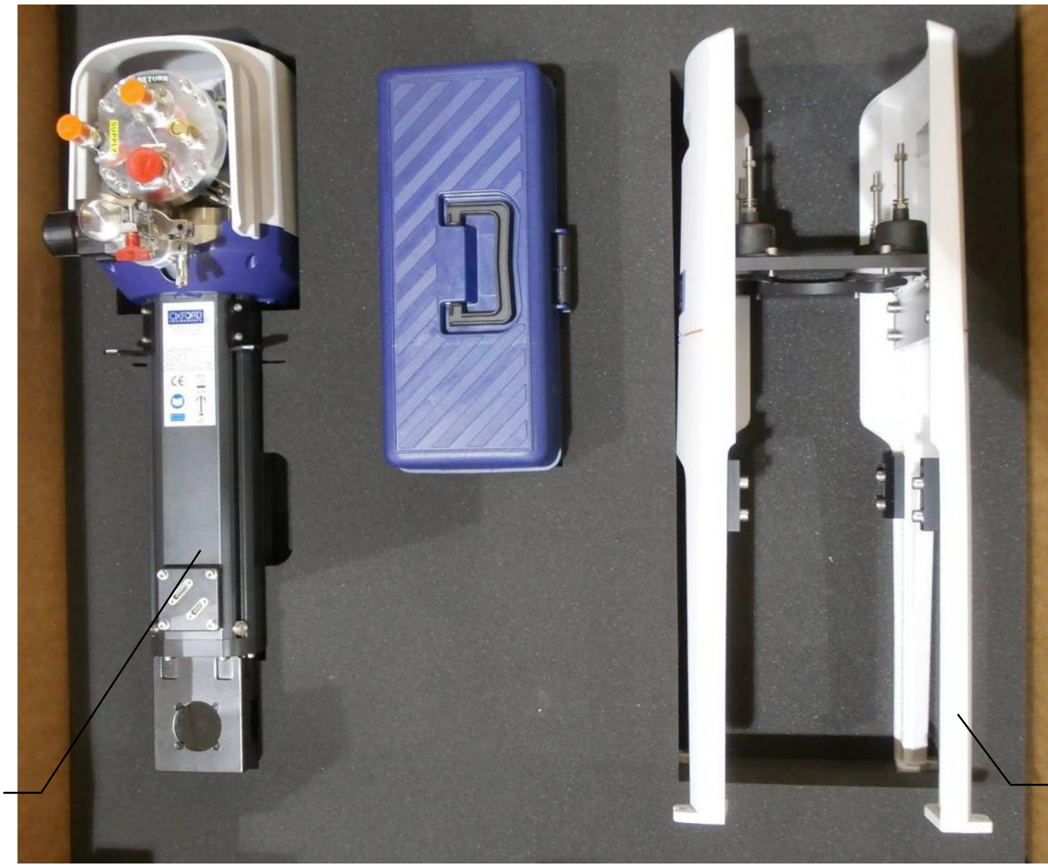


Figure 6 View of main items in packing crate

Check all items against the packing list(s) supplied. If any discrepancies are found, please contact your nearest customer support facility (see last page of this manual).

Note that the cryostat is shipped under vacuum in order to keep the charcoal sorption pump as clean and dry as possible. The OVC will have to be let up to atmospheric pressure to fit or replace the optical windows (section 4.9) and to change samples (section 5.2).

If an optional turbo pump is supplied, this will be an additional package

Users should keep all packing materials, either to re-ship items or to store them safely.

3.3 Fitting the cryostat to the vertical support stand

The cryostat vertical support stand is an optional item. It consists of the two side panels and support cradle, as shown in Figure 3 and Figure 4. It is used to support the cryostat securely above a standard optical table. Note that the feet of the support stand have two sets of slots – one is suitable for optical tables with standard metric hole spacing and the other for optical tables with standard imperial hole spacing.

As the support cradle can be moved up or down with respect to the side panels, the height of the cryostat windows above the optical table can be varied to suit the experimental set-up.

The default position of the support cradle (as shipped) within the stand is the lowest that will permit complete removal of the optical window block. If the cradle is re-positioned at a lower setting within the stand, it will not be possible to completely remove the window block from the cryostat once it has been assembled into the support stand. In this case, access to the sample can be made through the sample access plate.

In the default cradle position the optical centreline can be adjusted within the range of approximately 155mm to 180mm from the surface of the table (as explained in section 3.4.1 Minor adjustments). If this is outside the range required by your experimental set-up, follow the instructions in section 3.3.1 “Define the window height” and section 3.3.2 “Move the support cradle to the correct height” in order to change the optical centreline adjustment range. This should be done before fitting the cryostat to the support stand.

The total weight of the cryostat and the vertical support stand is approximately 23kg. This is too heavy for one person to manage safely. All processes that require lifting or moving the partly or fully assembled system require two people.

3.3.1 Define the window height

There will normally be an optimum distance between the centre of the transverse windows and the top surface of the optical table, as required by the experimental set-up. This defines the height A, as shown in Figure 7.

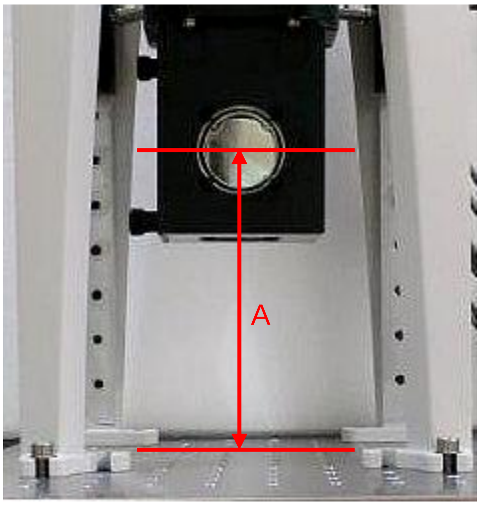


Figure 7 Height setting

The minimum value of A is determined by the physical dimensions of the optical window block and the requirement that the bottom window mount should not come into direct contact with the optical bench. A nominal 5mm clearance is recommended.

The maximum value of A is defined by the height of the side panels.

The overall range for A is approximately 55 – 310mm.Use Figure 8 and Table 3 to determine the best position for the support cradle with respect to the side panels. Minor adjustments, within the ranges given, can be made as described later (section 3.4.1). Major adjustments can also be made without the need for complete disassembly (section 3.4.2).

The tapped holes in the side panels are numbered starting from the top; see Figure 8.

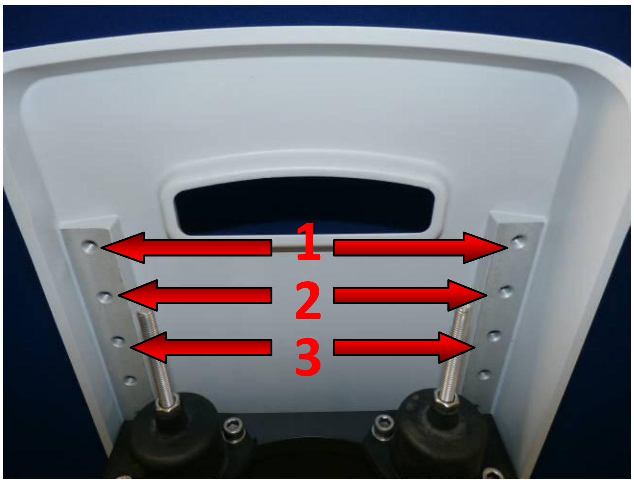


Figure 8 Side panel tapped hole pairs numbering convention

Required value of A (mm)	Use side panel holes……	Note
280 - 310	1 and 2	
255 - 280	2 and 3	
230 - 255	3 and 4	
205 - 230	4 and 5	
180 - 205	5 and 6	
155-180	6 and 7	Default setting – allows for removal of window block
130 - 155	7 and 8	
105 - 130	8 and 9	
80 - 105	9 and 10	
55 - 80	10 and 11	Window block just clear of optical table.

Table 3 Selection table for side panel holes

If there are two options for your required value of A, choose the lower position for the cradle.

3.3.2 Move the support cradle to the correct height

The vertical support stand consists of the two side panels, with the support cradle bolted between them, holding them together. In order to move the cradle up or down, it must be unbolted from the side panels. It is therefore essential to fix the feet of the side panels to an optical bench (or similar) before any height adjustments are made. When the support cradle has been moved to the correct height, the support stand should be placed on the floor prior to commencing section 3.3.3.

1 Securely fix the feet of the vertical support stand to an optical bench using four suitable bolts.

The side panel feet are compatible with optical benches having tapped holes separated by either imperial (1 inch) or metric (25mm) spacings.

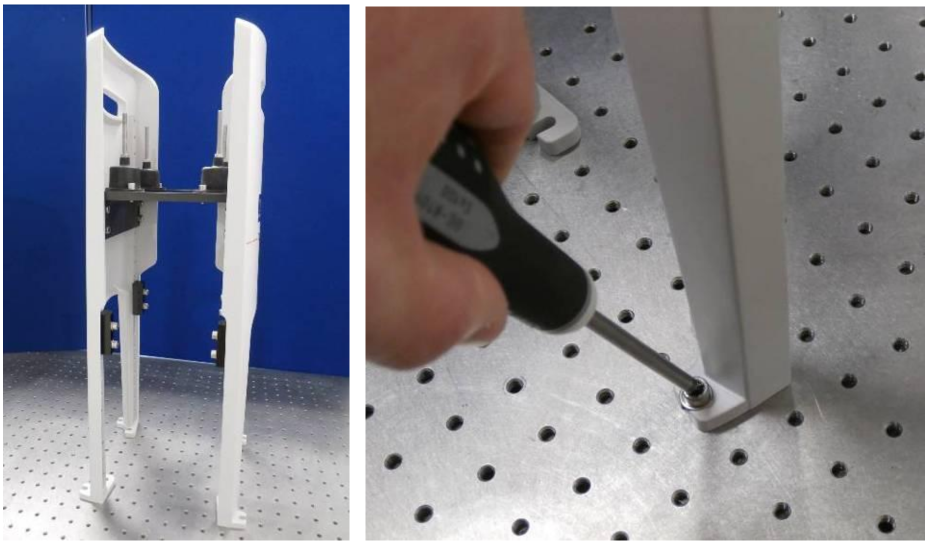


Figure 9 Optistat Dry **BL4 DRYSTDV support stand**

2 Remove the four pairs of M6 bolts that fix the support cradle to the side panels. Ensure that you hold the cradle before removing the last M6 bolt.

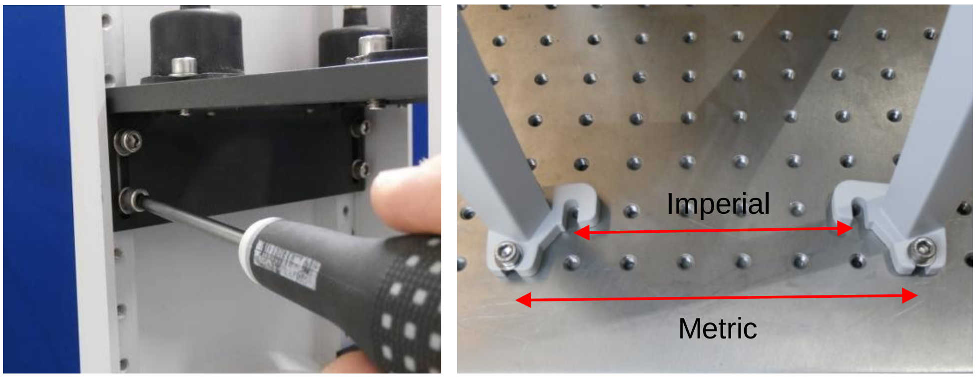


Figure 10 Optistat Dry **BL4 DRYSTDV support stand cradle and feet**

3 Raise or lower the support cradle and re-bolt it to the side panels at the required height.

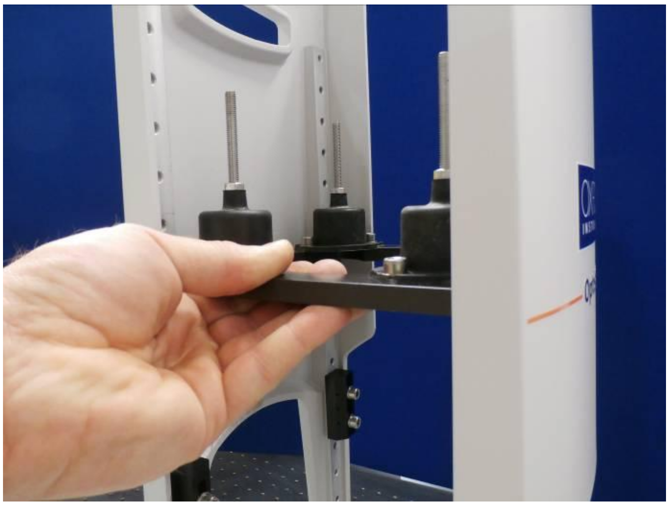


Figure 11 Optistat Dry **BL4 DRYSTDV support stand cradle adjustment**

3.3.3 Fit the cryostat to the vertical support stand

In all cases, for safety and handling reasons, the support stand must be placed on a level floor with unrestricted access all around before the cryostat can be loaded into it. Do not attempt to fit the cryostat with the frame mounted on the optical table.

1 Remove the top M6 nut and washer from each of the four anti-vibration mounts on the support cradle and retain.

Figure 12 Optistat Dry **BL4 DRYSTDV support stand anti-vibration mounts**

2 Lift out the cryostat with integral cold head from the packing box.

Take care. The cryostat with its integral cold head weighs approximately 16 kg.

Do not attempt to lift the cryostat while it is wrapped in plastic sheet. If the cryostat is wrapped in plastic sheet, remove the sheet carefully before lifting. Start removing the sheet from the top of the cold head.

Figure 13 Optistat Dry **BL4 cryostat removal from packaging**

3 Place one hand under the lower cold head cover to facilitate a stable vertical lift.

Do not attempt to lift the cryostat vertically using any part of the white cold-head cover.

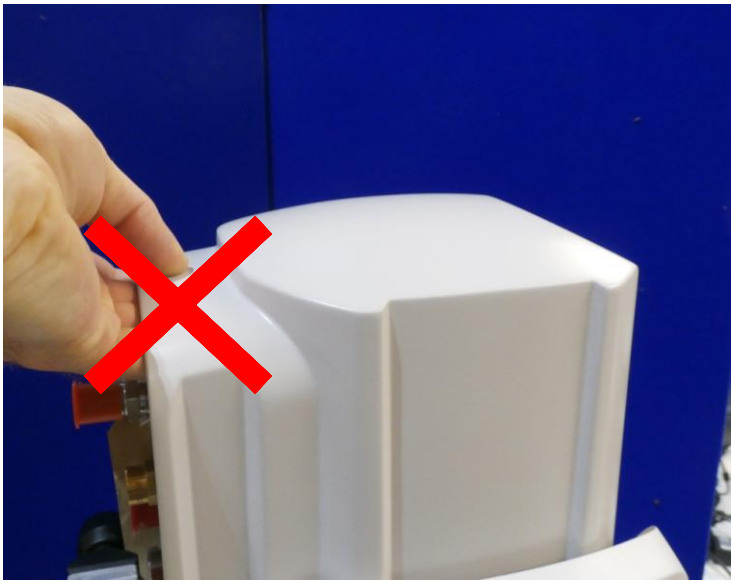


Figure 14 Optistat Dry **BL4 DRY- do NOT lift from the cover**

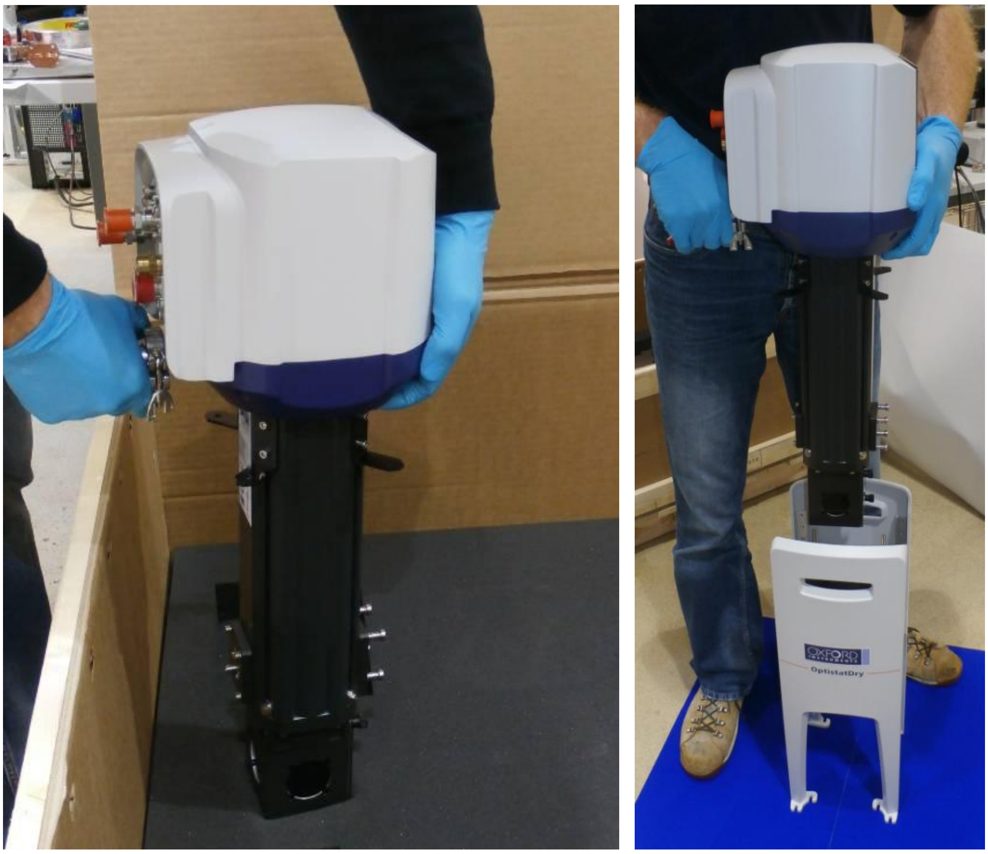


Figure 15 Lower the cryostat into the side panel assembly

4 Identify the front and rear of the side panels (see section 2.2 for guidance). The cold head services must face the rear. Carefully lower the cryostat, in the correct orientation, so that the L brackets fit over the anti-vibration mounts. Note that some manipulation of the cryostat (slight tilting and rotating) will be required to get the OVC pressure relief plate retaining screws past the support cradle as it is lowered into the stand. Take care not to damage the relief plate components. This operation requires two persons. One person should be responsible for lifting and fitting the cryostat to the frame and the other person responsible for guiding the installation.

Figure 16 Rear view

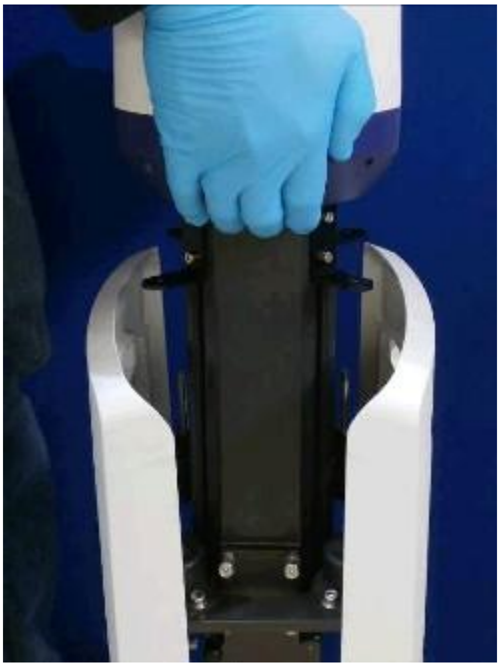


Figure 17 Front view

5 Replace the four M6 washers and nuts. Turn the nuts until they just make contact with the L brackets; there is no need to fully tighten them at this stage.

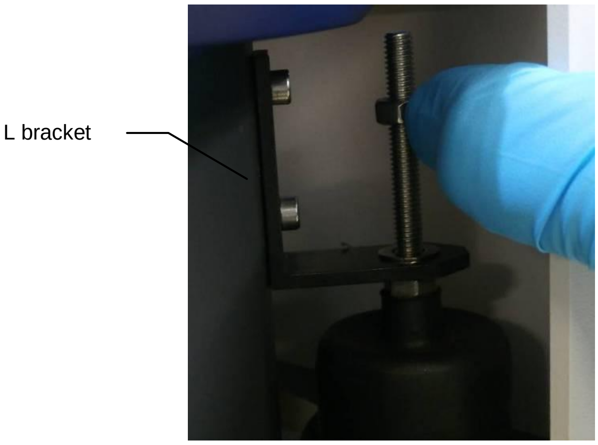


Figure 18 L bracket on anti-vibration mount

6 With the cryostat fitted into the support stand, the entire assembly should be carefully lifted on to the optical table by two persons and secured in the desired position. The next step is to adjust the vertical alignment of the cryostat within the frame. This should be done as part of any minor height adjustment (see section 3.4.1). Perform this adjustment before the helium lines are fitted to the cold head and before the radial restraints are fitted. The lower fine adjustment nuts at the rear of the cryostat should be wound approximately 3mm

higher than those at the front (note that 3mm is equivalent to three full turns of the M6 nut). This compensates for the extra compression of the rear pair of anti-vibration mounts caused by the offset mass of the cold head motor.

Figure 19 Adjust the vertical alignment of the cryostat

3.4 Cryostat height adjustments

This section describes how to adjust the height of the cryostat in the vertical support stand in order to set precisely the distance between the centre of the transverse windows and the top face of the optical bench (dimension A in Figure 7).

3.4.1 Minor adjustments

Fine adjustments, of up to approximately 25mm, are possible at the cradle anti-vibration mounts using the M6 nuts to adjust the height of the cryostat. Use 10mm A/F open-ended spanners to adjust the nuts. Move the upper nut clear of the bracket (as shown in the photograph below) and use the lower nut to adjust the offset between the bracket and the cradle. Each turn of the M6 nut changes the cryostat height by 1mm.

Repeat, in stages, for each anti-vibration mount until the window position (dimension A) is correct. Finally, for each mount, hold the lower nut stationary with an open-ended spanner and turn the upper nut with another open-ended spanner until it is tight against the bracket.

Take care that the cryostat does not tip from vertical during this procedure. The cold head makes the cryostat top heavy.

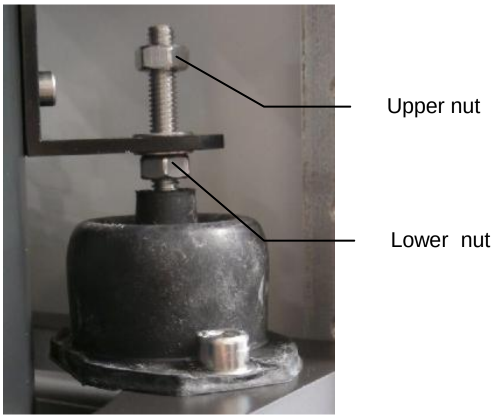


Figure 20 Anti-vibration mount

3.4.2 Major adjustments

The cryostat can also be moved in 25mm steps by altering the cradle height after assembly of the cryostat into the stand. However, the clearance between the base of the window block and the optical table must be sufficient to slide a laboratory jack between the two.

Note that the stand must be securely bolted to the optical table before attempting this procedure.

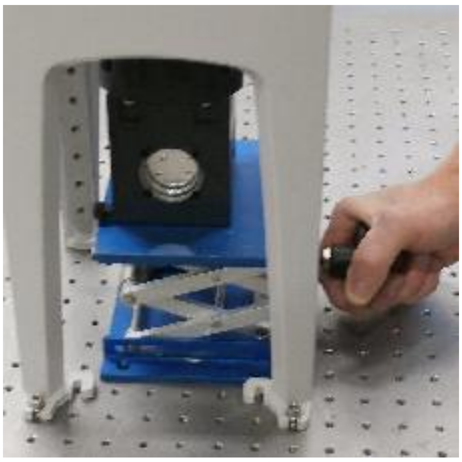


Figure 21 Support the weight with a laboratory jack

1 Support the weight of the cryostat using a laboratory jack, as shown.

Ensure that the jack does not come into direct contact with the optical window (or blank) on the base of the window block.

2 If the cryostat is to be raised, remove the four lower bolts holding the cradle to the side panels and loosen, **but do not remove**, the four upper bolts. If the cryostat is to be lowered, remove the four upper bolts holding the cradle to the side panels and loosen**, but do not remove,** the four lower bolts.

3 Raise or lower the cryostat by 25mm using the laboratory jack. The fitted bolts slide along the cut-outs in the support cradle.

4 Replace the four bolts in the new set of tapped holes that are exposed through the slots in the cradle.

If you need to adjust the cradle height by another 25mm (or multiples of 25mm), simply repeat the previous steps, as required.

5 Tighten all eight M6 bolts, which secure the cradle to the side panels, before removing the laboratory jack.

6 Carry out any minor adjustments, if necessary, as described in 3.4.1

3.5 Fitting cryostat radial restraints

These provide lateral support and help attenuate cryostat vibration relative to the optical table. They are fully demountable. They are fitted (under slight compression) between the T-slots on the exterior of the main OVC body and the four side panel legs, as shown schematically inFigure 22. Pins at the ends of each restraint match recesses in a locator block on each side panel leg and a similar recess on the corners of the cryostat.

Before fitting the radial restraints, ensure that the following conditions have been met.

- The cryostat and support frame are securely bolted to the laboratory table.
- The cryostat has been adjusted for vertical alignment within the frame.

Fit cryostat supports only when the side panels are securely bolted to the optical bench and all eight cradle fixing bolts are tightened.

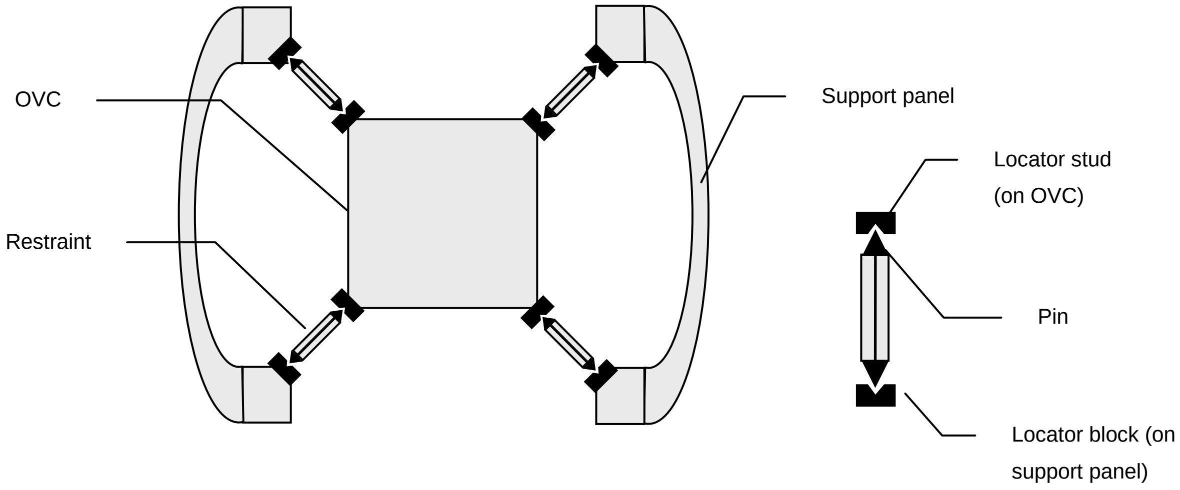


Figure 22 Cross section of cryostat showing location of restraints

1 Loosen the four locator studs in the T-slots using a 7mm ring spanner, slide them down and position them near the bottom of the main OVC body. Re-tighten the studs.

Figure 23 Loosen the locator studs

2 Position the four locator blocks on the side panel legs (using two M6 x 25mm bolts per block) so than one of the three location holes is approximately opposite the locator studs.

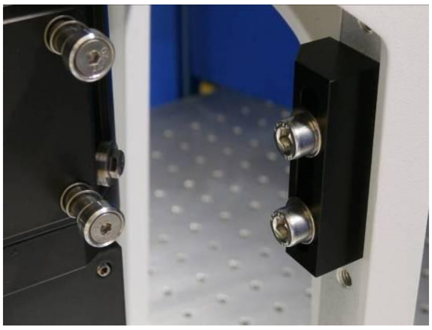


Figure 24 Locator blocks

3 Adjust the exact position of the locator blocks so that the radial restraints can be fitted horizontally.

Figure 25 Adjust the position of the locator blocks

Do not fit or adjust the restraints unless the cryostat stand is securely bolted to the optical bench.

4 Loosen the hexagonal locking nut on each restraint by one to two turns using a 10mm open-ended spanner.

Figure 26 Radial restraint details

5 Increase or reduce the overall length of the restraint by screwing the adjustable pin in or out by hand, so that the restraint fits loosely between the main OVC body and side panel pin locator block.

6 Repeat for the opposite radial restraint.

7 Repeat for the remaining two radial restraints.

8 Using a small Allen key (or similar tool) to prevent the adjustable pins from rotating, increase the length of each radial restraint by turning the barrels using your fingers until all the radial restraints fit securely.

Figure 27 Increase the length of the radial constraints using your fingers

Do not try to over-extend the restraints. It is enough that the elastomer inside each restraint is slightly compressed.

9 Hold the barrel to stop it rotating and gently tighten the hexagonal nut on each restraint support, using a 10mm A/F open ended spanner, to fix the overall length.

Figure 28 Fix the final length of the radial constraints

Do not try to over-extend the restraints. It is enough that the elastomer inside each restraint is slightly compressed.

3.6 Making the compressor ready

You must read and follow the following procedures described in the SHI Compressor Technical Manual (Installation section):

- Remove the shipping bolt
- Mains Power Supply Connection
- Field Wire the Compressor. This describes how to hard wire the compressor to your power supply.
- Compressor Checkout. The compressor should be operated before being connected to the other system components. This section also describes connection to the coolant supply, for water-cooled compressors.

PREVENT EQUIPMENT DAMAGE. If the compressor boost transformer tap settings do not match the mains supply voltage it can result in damage to the compressor

AVOID ELECTRIC SHOCK. Permit only qualified electrical technicians to open electrical enclosures, to perform electrical checks or to perform tests with the power supply connected and wiring exposed. Failure to observe this warning can result in serious injury or death.

3.7 Connect helium gas lines to cold head

You must read and follow the procedure described in the SHI compressor Technical Manual:

The compressor and cold head ports are labelled SUPPLY or RETURN. You must connect correctly, SUPPLY to SUPPLY and RETURN to RETURN. The two helium gas lines are identical.

For optimum vibration performance, the following guidelines should be followed when routing the helium gas lines from the compressor to the cold head. The images depict a typical support and restraint setup.

- The lines must be supported horizontally where they attach to the cold head. They should also be in-line with the cryostat.

The cold head must be supported evenly on all four anti-vibration mounts so that the cryostat body is vertical. Check that the clearance between the cold head cover and side panels is the same on both sides to confirm that this is the case.

Figure 29 Support the lines horizontally

- The supply line should be restrained as close as is practically possible to the cold head. Ideally, the restraint should take the form of a rubber lined clamp that conforms to the profile of the line **without crushing or damaging it**.

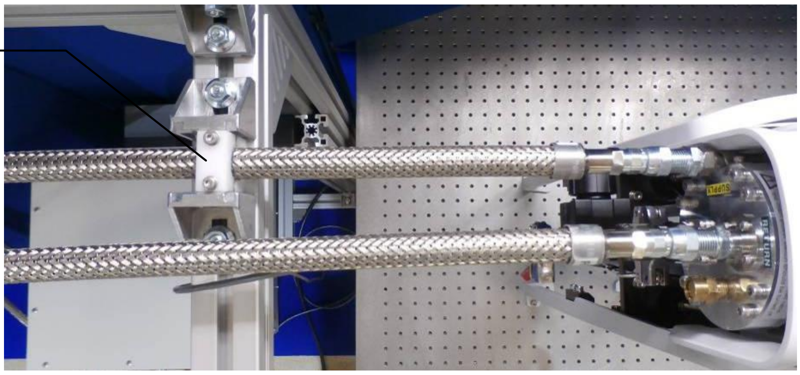


Figure 30 Restrain the supply line without damaging it

- The return line should be supported but not restrained. The return line is subject to slight movements caused by gas pressure pulses and hence should be provided with a guide manufactured from PTFE or similar that will allow it to move without causing wear to the protective outer braid.

Figure 31 Support the return line

Firstly, unpack the helium lines and affix the appropriate SUPPLY or RETURN labels to each one. The lines are identical as supplied so it does not matter which one is chosen to be the supply or return line. However, it is important to ensure that the lines are correctly labelled at each end to avoid incorrect connection between the compressor and the cold head.

Figure 32 Fit the labels to the lines

Make the helium line connections to the compressor first, following the guidance notes in the installation section of the SHI Helium Compressor Technical Manual. Then connect the cold head motor power cable to the correct receptacle on the compressor front panel.

Figure 33 Make the helium line connections to the compressor

Then support the other end of lines as described previously before making the connections to the cold head.

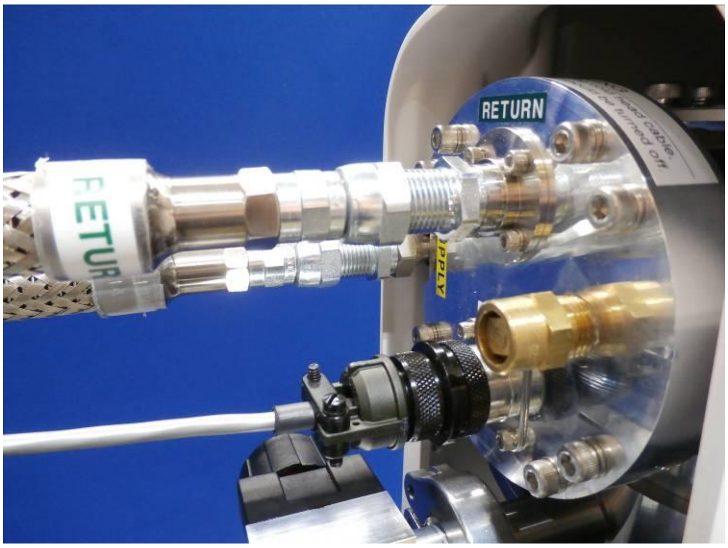


Figure 34 Make the helium line connections to the cold head

With all the helium gas line connections made, check that the static pressure indicated on the gauge of the compressor is within the range specified for your combination of cold head (model RDK-101D), gas line length and compressor.

3.8 Temperature monitoring and control system

3.8.1 Set up the temperature controller

If you have bought a cryostat and temperature controller together from Oxford Instruments the temperature controller will have been set up in the factory in order to

- prevent you from accidentally exceeding the maximum safe operating temperature of the cryostat
- limit the maximum heater voltage to a safe level.

If you are planning to use an existing temperature controller, or a controller made by another manufacturer, you should take the same precautions. The recommended values for the heater voltage limit and the temperature limit are given in the System Test Data Sheet.

If you do not set up the temperature controller correctly, it is possible to cause serious damage to the cryostat.

3.8.2 Connect the temperature controller

If you have purchased a **Mercury**iTC temperature controller and temperature control cable, the cable should be connected between the 15 way D socket on the rear of the cryostat OVC body (see Figure 4) and the main sensor/heater connection (9 way D connector) on the rear of the **Mercury**iTC (see Figure 35).

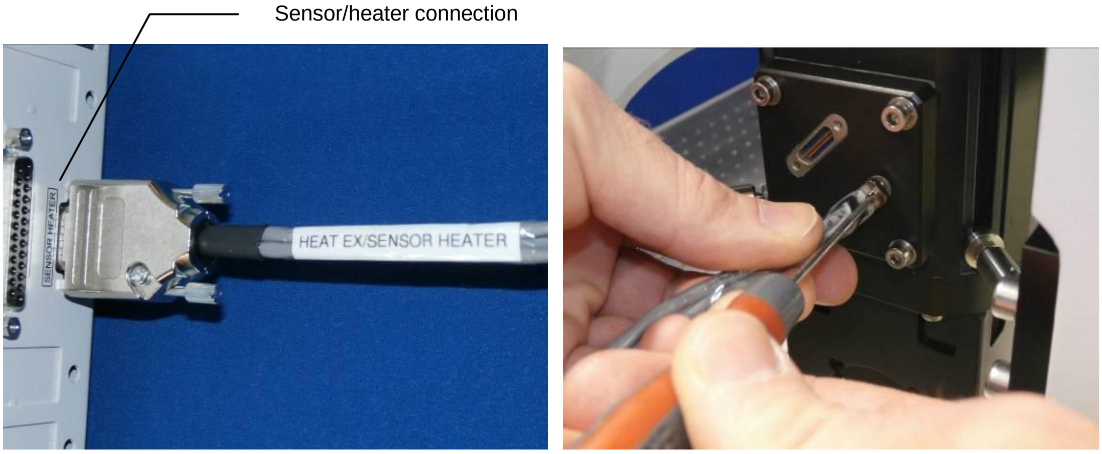


Figure 35 Connections between MercuryiTC **rear panel and cryostat**

If you are using another temperature controller, you will need to construct a suitable cable using the wiring information for the 15 way micro D connector given in Appendix A.

4 FIRST TEST

4.1 Introduction

This section describes how to cool the **Optistat**Dry BL4 to base temperature for the first time with blanking pieces fitted to the radiation shield openings and the OVC window mounts. The first test sequence includes running the system to base temperature, controlling the sample position at 300K and then warming the entire system to room temperature. Following successful completion of this first test, if optional optical windows have been order, they can be fitted to the system and the appropriate radiation shield openings uncovered. The steps are summarised in the following flow chart.

START

Vent the OVC and remove the sorption pump (section 4.2)

Condition the sorption pump and close up system (section 4.3)

Connect vacuum pump and pump down the cryostat (section 4.4)

Start up the compressor and cool the cryostat (section 4.5).

Monitor cryostat temperature and confirm that it reaches base temperature (see System Test Data Sheet) (section 4.5.1)

Control the sample region temperature at 300K (section 4.6).

Switch off compressor and allow cryostat to warm up. Set T=300K on temperature controller (sections 4.7 and 4.8)

Fit the optical windows, if applicable (section 4.9)

END

4.2 Vent the cryostat and remove the sorption pump

Carefully open the OVC vacuum valve (see Figure 4) to release the vacuum inside the cryostat. Unscrew completely the two knobs holding the sample access plate. Remove the plate and store carefully, for example in a clean, dry, sealed bag.

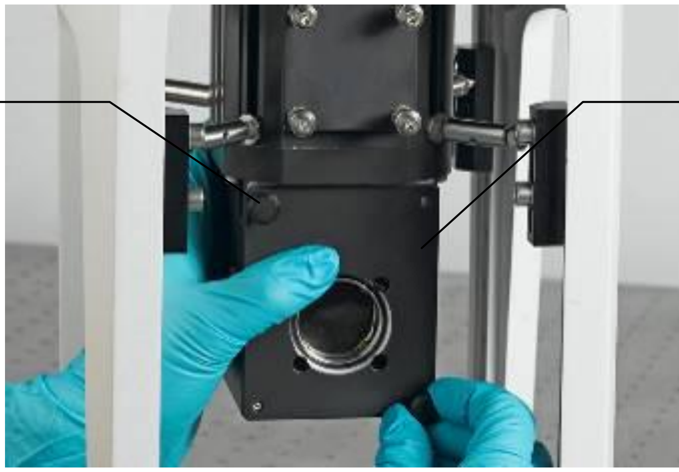


Figure 36 Remove sample access plate

Using a T10 Torx screwdriver, unscrew by two or three turns each of the four bolts holding the removable radiation shield plate (with integral sorption pump). There is no need to remove the bolts completely. Lift up the radiation shield plate and remove it so that the sorption pump can be conditioned, as described in section 4.3 below.

Figure 37 Remove radiation shield plate

4.3 Condition the sorption pump and close up system

The high adsorption activity of the charcoal sorption pump means that, even at room temperature, it readily attracts water vapour when exposed to the atmosphere. The sorption pump also adsorbs water vapour that outgases from the internal surfaces of the cryostat. Adsorption of water vapour by the sorption pump can prevent it working correctly. Hence, just before cooling the system the sorption pump must be conditioned by heating and pumping the removable radiation shield plate, as described below.

1 [Ideal method] Place the radiation shield plate with its integral sorption pump in a vacuum chamber and heat to 100°C for a period of at least ten minutes while pumping to a pressure of 0.1 mbar or lower.

  [Alternative method] Use a temperature controlled hot air gun or laboratory hot plate to heat the sorption pump to 100°C for a period of at least ten minutes.

The temperature of the shield plate and integral sorption pump should not be allowed to exceed 110°C.

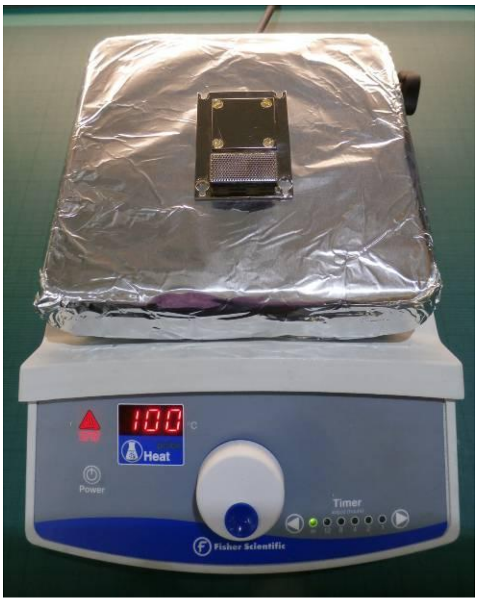


Figure 38 Radiation shield plate with integral sorption pump on laboratory hot plate

2 Set the sample mounting platform to temperature control at 300K (see section 4.8 for details).

3 With the radiation shield plate still hot, replace the radiation shield plate and bolt into place securely.

The radiation shield plate should be hot when it is bolted into place. Take suitable precautions to ensure safe handling.

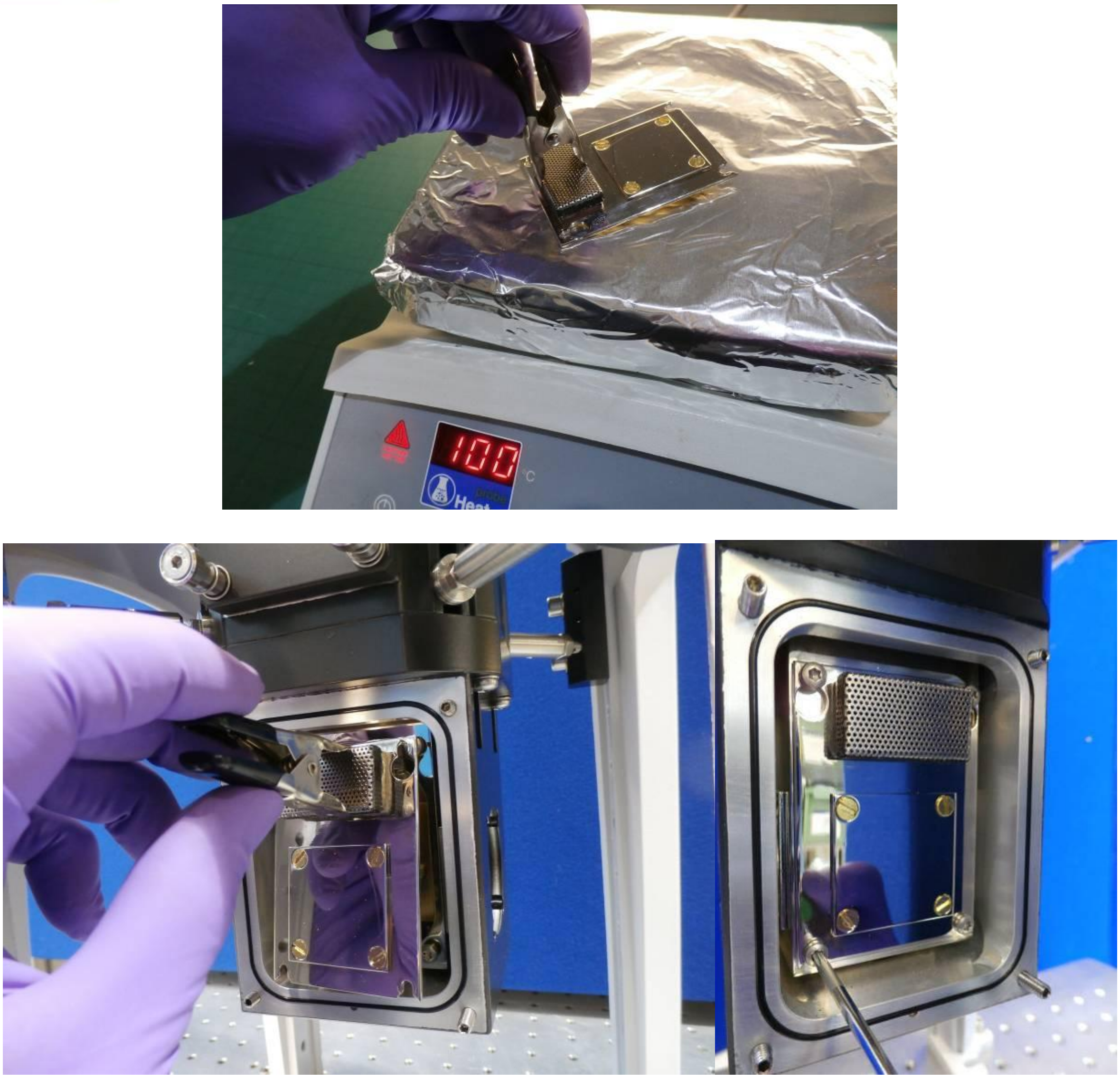


Figure 39 Replace radiation shield plate

The bolts should be tightened to a torque ~1.0Nm.

Install the sample access plate on to the window block and secure into place using the retaining knobs. Immediately proceed to pump out the cryostat as described below.

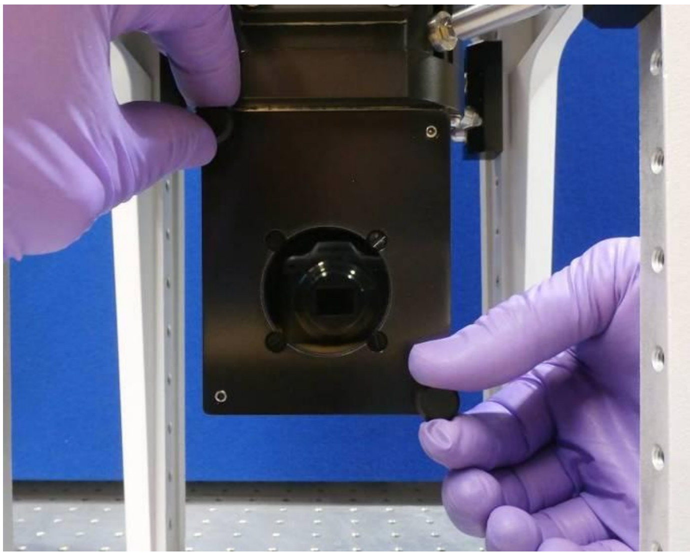


Figure 40 Install the sample access plate

> A single hair or speck of dirt across an O-ring can lead to poor vacuum. Please examine the O-ring carefully before final assembly.

4.4 Pump out the cryostat

Refer to the operating instructions supplied with the pump for details of how to operate. Optional turbo pumps supplied by Oxford Instruments (H4-600 or H4-601) have their own manuals.

1 Connect a suitable pumping system to the cryostat pumping port using a suitable length of 25mm diameter flexible stainless steel pumping line. Avoid straining the cradle anti-vibration mounts and cryostat restraints when connecting the external pump to the cryostat.

> A pumping system supplied by the user should be oil-free and capable of a base pressure of less than 1×10^{-6} mbar.

2 Pump out the cryostat to a pressure below 1×10^{-4} mbar.

This is the pressure indicated on a gauge connected directly to the cryostat pumping port (see Figure 4). The H4-601 optional turbo pump from Oxford Instruments has its own gauge. The cryostat should be pumped for a minimum of 2 hours using any of the optional turbo pumps supplied by Oxford Instruments.

3 Stop the 300K temperature control of the sample mounting platform (either change the set temperature to 0K or put the heater control into Manual mode and set the heater output to zero).

4 Close the pumping port valve and disconnect the pumping system. Immediately proceed to start cooling the system by starting the compressor as described below.

4.5 Start up the compressor

Do not operate the compressor while pumping out the cryostat. If you do, there is a risk of contaminating the cryostat vacuum space. In normal use, the cryostat vacuum valve is closed when the compressor is running.

1 Examine the static (equilibrium) gas pressure reading on the compressor and compare this with the data in the SHI Compressor Technical Manual. If any correction is needed, proceed as described in the SHI manual.

2 Confirm that the 50/60 Hz toggle switch on the compressor front panel is set correctly.

3 Start up the compressor as instructed in the SHI compressor technical manual under Operation.

(a) Close the compressor circuit breaker by pushing up the handle.

(b) Press the power switch. The indicator in the switch will light and the compressor will start.

4.5.1 Run the system to base temperature

Monitor the sample position temperature sensor and confirm that it reaches base temperature as stated in the System Test Data Sheet. This should take less than 3 hours from when the compressor is switched on. Leave the system running at base temperature for approximately one hour.

4.6 Control the sample region at 300K

Set the sample mounting platform to control at 300K (see section 4.6 for details). The sample region should take approximately 30 minutes to warm to 300K. When the set temperature is reached, leave the system controlling at this temperature for approximately one hour.

4.7 Warm the cryostat to room temperature

1 Switch off the compressor.

2 Ensure that the sample position is warmed to 300K using the **Mercury**iTC temperature controller.

The cryostat will take approximately 4 hours to warm up fully. When the sample position temperature is over 100K, it is possible to accelerate the warm up process by introducing a few mbar of DRY nitrogen gas into the cryostat via the pump out port. DO NOT USE AIR. **Do not vent the cryostat to atmosphere as soon as the sample position reaches 300K as other internal parts will still be cold**. Always try to minimize the time the OVC and sorption pump are left exposed to atmosphere i.e. always refit the removable radiation plate (with integral sorption pump) and pump out the cryostat OVC as soon as possible with an external pump (even if you are not intending to cool the system immediately).

4.8 Using the MercuryiTC temperature controller

4.8.1 Powering up the MercuryiTC

1 Confirm that the correct cable is connected between the **Mercury**iTC and the 15 way D socket on the cryostat, as shown in Figure 2.

2 Operate the switch on the rear panel of the **Mercury**  so that the **1** is depressed.

3 Press the **Power** button on the left of the front panel. The button illuminates blue.

4 The **Mercury**iTC initialises, then the **Home** page appears on the touch screen. The top left widget correctly indicates room temperature with the heater off (0%).

The indicated temperature in the top left widget will respond as the cryostat cools down.

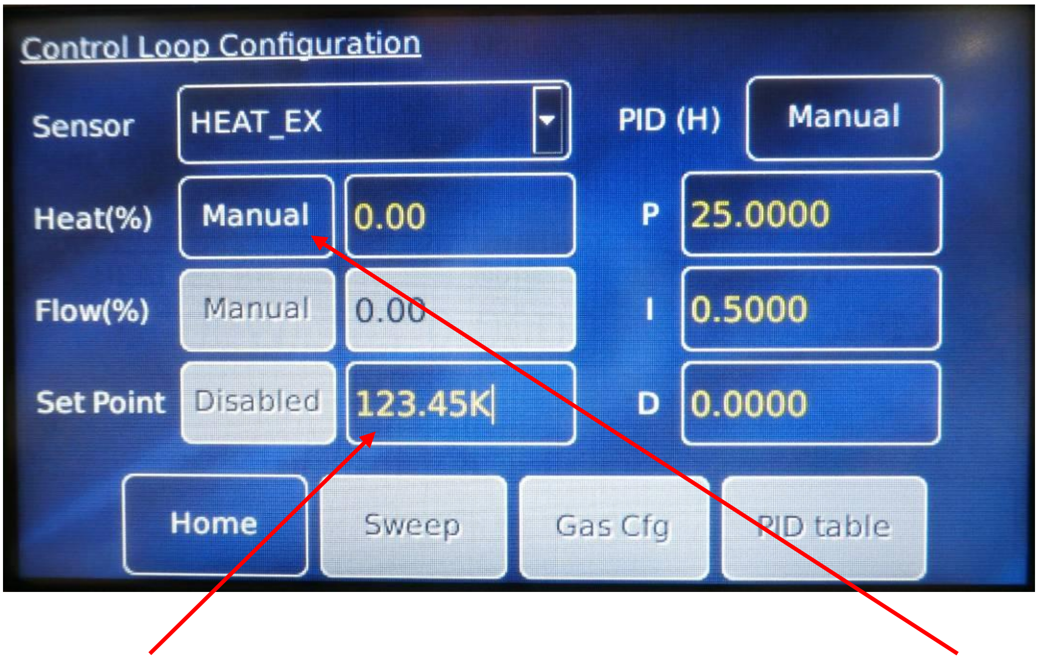
4.8.2 Temperature control above base temperature

You can control the temperature of the sample between base temperature and 300 K. The **Mercury**iTC temperature controller is used to control the heater power automatically, and adjusts the power to maintain the set temperature. These temperature controllers are three term controllers. The temperature control is optimised by setting the best values for:

- Proportional band (P). Note that **Mercury**iTC uses units of K (i.e. proportional band and not a gain value)
- Integral action time (I). Note that **Mercury**iTC uses units of minutes.
- Derivative action time (D). Note that **Mercury**iTC uses units of minutes.

For more information on PIDs and temperature control please refer to the **Mercury**iTC temperature controller manual section 14.

Tap **Control** on the home screen to give the following screen.



Select the desired temperature on the **Mercury**iTC and switch the **Mercury**iTC heater control from Manual to Auto.

This shows control using P=25, I=0.5, D=0. The values given in the System Test Data Sheet for the system may differ but are suitable to give good stability across the operational temperature range. In Manual mode, individual PID values can be changed during operation. Control theory and a procedure for optimising the PID values are given in the **Mercury**iTC manual.

4.9 Fit optical windows

The **Optistat**Dry BL4 is supplied with plastic blanks fitted on all window mounts. Windows are supplied separately in protective packaging.

A wide range of window materials is available for the **Optistat**Dry BL4. This section describes how to remove blanks and fit or change windows.

- Each window on the OVC tail is held in place by one O-ring and 4 screws.
- Windows/blanks can be removed and replaced while the cryostat is mounted on the optical bench, as long as there is adequate access.

5 Carefully open the OVC vacuum valve to release the vacuum inside the cryostat. If possible use low pressure dry nitrogen gas to vent the OVC.

6 Remove the four M3 nylon screws that hold the window/blank in place.

7 Remove the window/blank. A vacuum tool (such as the Oxford Instruments DRYLOAD) or plastic tweezers can be helpful.

8 Remove the O-ring.

Never use sharp tools when handling O-rings.

9 Clean the O-ring by wiping with lint-free tissue and examine for cuts and abrasions. If any are found, the O-ring must be replaced.

10 Apply just enough Silicone vacuum grease to coat the O-ring surface with a thin layer of grease, giving a shiny appearance.

11 Carefully place the O-ring in the groove, ensuring that it does not become twisted. If this is done correctly there will be no tendency for the O-ring to pop out of the groove.

12 Remove the new window from its protective packaging.

13 If the window needs cleaning, use lint-free tissue and a suitable solvent (typically, isopropanol).

14 Hold the window by its edges and place directly on the O-ring.

15 If necessary, remove dust or fibres from the window using dry compressed air from an aerosol can. Do not use a laboratory compressed air supply.

16 Replace the four M3 screws. Tighten the screws uniformly until the heads **just** make contact with the window surface (thick windows, including blanks). For 2mm thick windows the screws will stop on the shoulder of the screw hole before making contact with the window.

DO NOT over-tighten the screws. They are only required to stop the window falling out of the mounting hole. The vacuum force exerted in operation will seal the window uniformly. Over-tightening one or more of the screws could lead to window fracture or poor vacuum sealing.

5 NORMAL OPERATION

This chapter describes normal operation of the **Optistat**Dry BL4, including sample changing.

5.1 Introduction to normal operation

- If you have DRYRSH or DRYTSH (standard) sample holders, read sections 5.2 and 5.5.
- If you have DRYPUCK12R or DRYPUCK12T sample holders, read sections 5.4 and 5.5.

Figure 41 DRYTSH standard sample holder

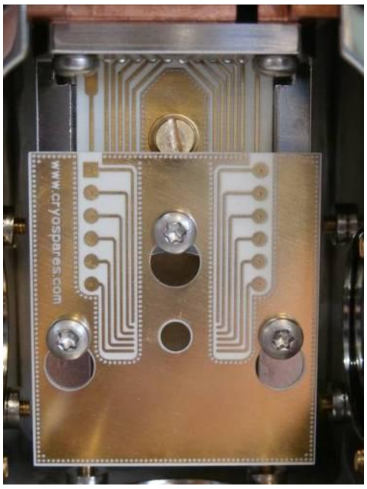


Figure 42 DRYPUCK12T puck sample holder

- If you wish to remove the optical tail for greater access to the sample region, you should also read section 5.3.

The steps are summarised in the following flow chart. This chart assumes

- The cryostat is under vacuum but the pump is disconnected
- All internal parts of the cryostat are at room temperature (i.e. the cryostat has been warmed to room temperature as described in section 4.7)

START

Carefully open the cryostat vacuum valve to release the vacuum. If possible use dry nitrogen gas to vent the OVC.

Remove DRYRSH or DRYTSH sample holder (section 5.2) or

Remove entire optical tail for greater access (section 5.3) or

Remove DRYPUCK12R or DRYPUCK12T (section 5.4)

Replace the radiation shield and sample access plates (section 4.2) – it is not necessary to condition the sorption pump as part of this step. Pump down cryostat. (section 4.4). This will help keep the sorption pump and cryostat clean and dry.

Prepare sample on sample holder or puck.

Carefully open the cryostat vacuum valve to release the vacuum

Remove sample access plate (section 5.2).

Fit sample holder or puck (section 5.2 or 5.4). Make electrical connections to sample if using DRYLX20 option (section 5.2.1).

Condition sorption pump and close up the cryostat (section 4.3).

Connect vacuum pump and pump down the cryostat (section 4.4). Close valve, switch off and disconnect pump.

Start up the compressor and cool the cryostat (section 4.5).

Control temperature (section 4.8.2) and collect data.

Switch off compressor, set the sample temperature to control at 300K and allow cryostat to warm up for sample change (section 4.7).

END

5.2 Fitting and removing the standard sample holder

1 Unscrew completely the two knobs holding the sample access plate. Remove the plate and store carefully, for example in a clean, dry, sealed bag.

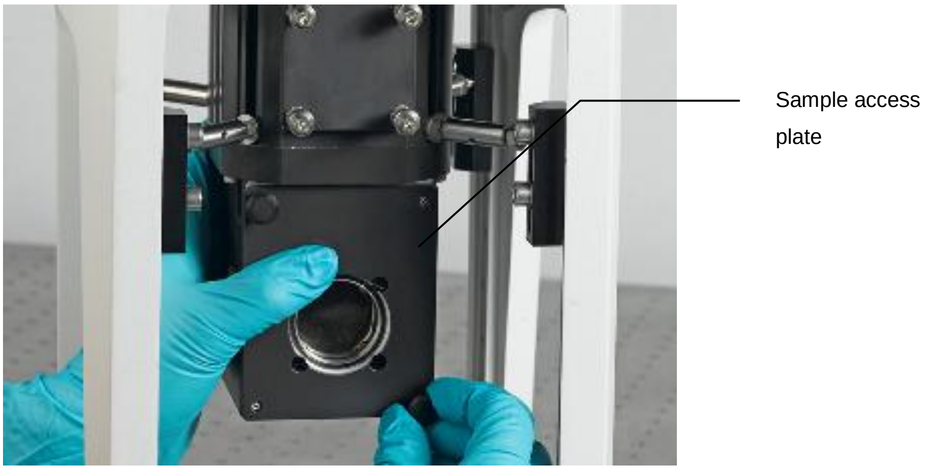


Figure 43 Remove sample access plate

2 Using a T10 Torx screwdriver, unscrew by two or three turns each of the four bolts holding the removable radiation shield plate. There is no need to remove the bolts completely. When the radiation shield plate is refitted the bolts should be tightened to a torque ~1.0Nm.

3 Lift up the plate and remove it, storing carefully.

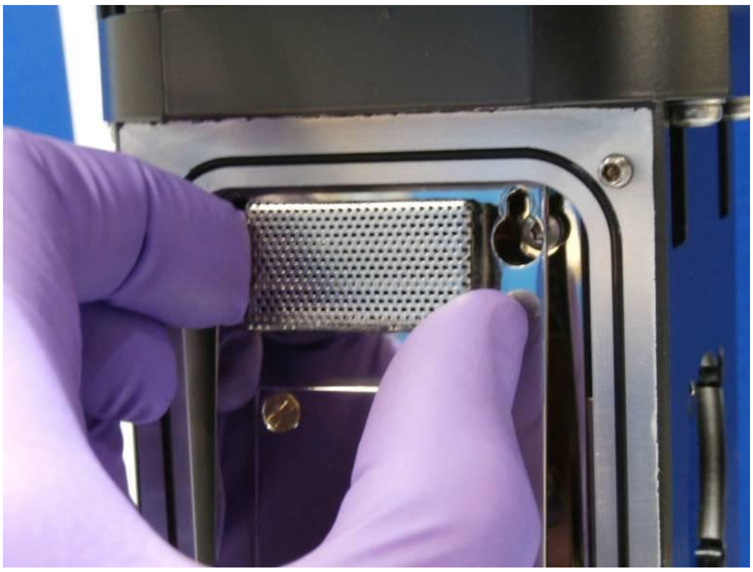


Figure 44 Remove radiation shield plate

4 Using a T20 Torx screwdriver, loosen the two bolts holding the sample holder by about two turns. There is no need to remove the bolts completely. Lift up slightly and remove it.

Figure 45 Remove sample holder

5 Prepare your sample and attach it to the sample holder.

The sample is mainly cooled by conduction to the copper sample holder. It is therefore important that the sample is in good thermal contact with the holder.

6 Fit the sample holder, reversing the procedure described above.

The sample plate bolts should be tightened to a torque ~2.5Nm to provide good thermal contact.

5.2.1 Electrical connection via the DRYLX20 connector

The optional DRYLX20 connector can be found at the top of the sample space as shown below.

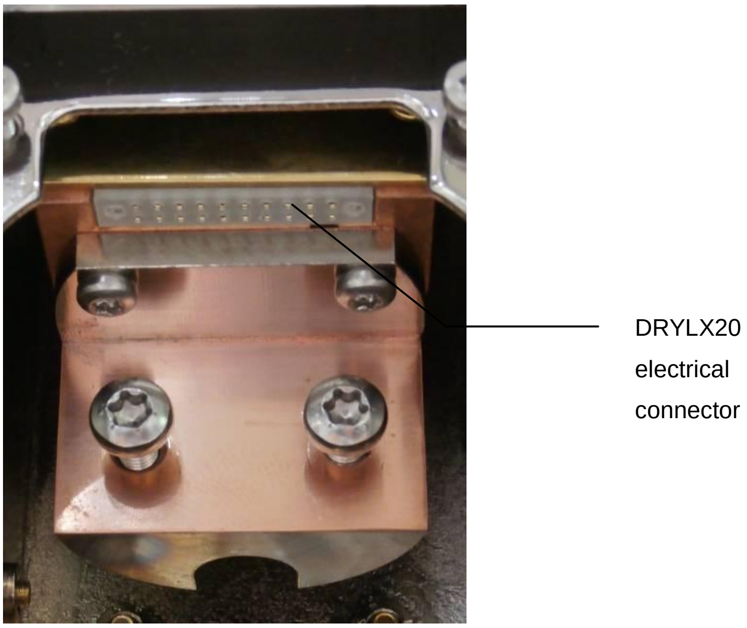


Figure 46 DRYLX20 connector near sample position

The mating connector, which can be used to make electrical connection to your sample, is a push fit into this connector. Please take care when making and breaking this connection so as not to bend the pins on the mating connector. More details can be found in Appendix A4.

5.3 Fitting and removing the optical tail for greater access

This procedure may be helpful if you have the DRYLX20 option (section 5.2.1) and need to make electrical connections to a sample on a plain or optical sample holder or simply require greater access than is provided by the procedure in section 5.2.

The OVC window block assembly and lower section of the radiation shield can be unbolted from the main cryostat for greater access to the sample mounting region. If the cryostat is fitted to the vertical support stand, this is only possible if the dimension A (see section 3.3.1 and Figure 7) is more than 155mm.

1 Unscrew completely the two knobs holding the sample access plate as shown in section 5.2 step 1. Remove the plate and store carefully, for example in a clean, dry, sealed bag.

2 Using a T10 Torx screwdriver, unscrew by two or three turns each of the four bolts holding the removable radiation shield plate. There is no need to remove the bolts completely. When the radiation shield plate is refitted the bolts should be tightened to a torque ~1.0Nm.

3 Remove the six T20 Torx bolts holding the window block to the main OVC body. Hold the block in position as the last bolt is removed. When the window block is refitted the bolts should be tightened to a torque ~1.8Nm.

Figure 47 Remove Torx bolts in OVC body

4 Lower the optical window block, remove it and store in a clean, dry, sealed bag.

Figure 48 Remove optical window block

5 Loosen the four T20 Torx bolts by two turns while holding the radiation shield tail. Rotate the radiation shield tail slightly to the left and the bolt cut-outs will allow the tail to be lowered. When the radiation shield tail is refitted the bolts should be tightened to a torque ~2.5Nm.

Figure 49 Remove Torx bolts in radiation shield tail

6 Remove the radiation shield tail and store carefully in a clean, dry, sealed bag. There is now access to the sample region.

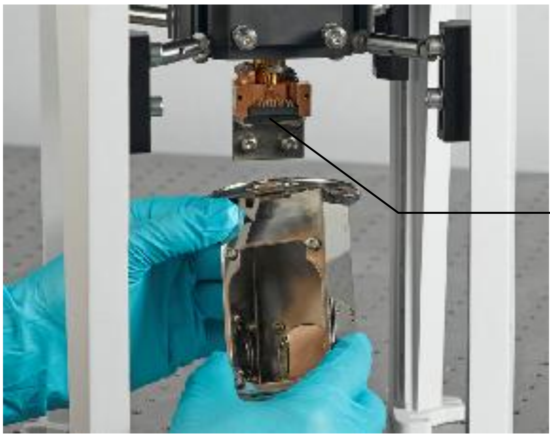


Figure 50 Remove radiation shield tail

There is now easy access to the 20 way electrical connector. This can be used to provide electrical access to samples mounted on the sample holder. Connector wiring details are given in Appendix A4.

7 Assembly is simply the reverse of the above procedure.

5.4 Fitting the puck sample holder

1 Remove the sample access plate and the radiation shield plate as shown in section 5.2.

2 To load the puck, the optional DRYLOAD tool should be used. When picking up a puck, aim the suction cup of the DRYLOAD tool at an area on the puck with a smooth surface (not across any tracks). Press the button on the DRYLOAD tool to apply vacuum to the suction cup. Make sure that the three screws on the sample holder are loose (approximately 2-3 turns) before mounting the puck. The puck will drop into its position on the sample holder. Release the vacuum by pressing the button on the DRYLOAD tool. Using a T10 Torx screwdriver tighten all three screws with a torque driver set at 1.0Nm.

3 To remove the puck, first loosen the three screws supporting the puck using a T10 Torx screwdriver. The screws have to be slackened off so that the puck is clear of the spring loaded pins of the cold head before attempting to unload. There is no need to remove the screws completely; two or three turns is usually sufficient. Use the DRYLOAD tool as described above.

4 Grasp the puck using a vacuum tool, as shown below. Lift it slightly and remove the puck.

Figure 51 DRYLOAD tool

5 Prepare your sample and thermally attach it to the puck. Make electrical connections, if applicable.

The surface of the puck has an 'ENIG' surface finish. ENIG is an electroless nickel layer capped with a thin layer of immersion gold. It is a multifunctional surface finish, applicable to soldering, aluminium wire bonding and as a surface for good thermal contact.

6 Fit the puck, reversing the procedure described above.

The sample puck bolts should be tightened to a torque of approximately1.0Nm.

5.5 Condition the sorption pump and close up system

Follow the steps detailed in section 4.3.

5.6 Pump out the cryostat

Follow the steps detailed in section 4.4.

5.7 Start up the compressor

Follow the steps detailed in section 4.5.

5.8 Control sample temperature

Follow the steps detailed in section 4.8.

5.9 Warm up for sample change

Follow the steps detailed in section 4.7 in order to warm the cryostat ready for sample change.

6 MAINTENANCE AND SERVICING

6.1 Introduction

The **Optistat**Dry BL4 will deliver repeatable and reliable performance if maintained appropriately during its usage. This section contains basic, essential maintenance information. For more detailed information, consult Oxford Instruments.

6.2 Maintenance Schedule

Maintenance	Frequency	Comments
Cryostat O-rings	2 years	Order:A4-861
Anti-vibration mounts	2 years	Order: A4-862
Radial restraints	2 years	Order: A4-863
GM cold head	10,000 hours	Service exchange units available: contact Customer Support (pg.70)
Compressor adsorber	30,000 hours	Order: C10-034

Oxford Instruments offer service contracts for maintaining the **Optistat**Dry BL4 and would be happy to discuss requirements with you. Please consult us for more information.

6.3 Cryostat O-rings

We recommend replacing the cryostat O-rings on a two year cycle, with the sample loading door O-ring being replaced on an ad-hoc basis.

6.4 Anti-vibration mounts and radial restraints

In order to achieve repeatable and reliable sample position stability performance, we recommend replacing the anti-vibration mounts and radial restraints used to secure the **Optistat**Dry BL4 into its stand on a two year cycle.

6.5 GM cold head and compressor maintenance

During normal operation the GM cold head's internal components will wear through friction and the oil mist adsorber will become saturated.

Maintenance on the GM cold head is recommended at 10,000 run hours for optimum performance.

Adsorber replacement must occur every 30,000 hours, as it is critical in ensuring the helium gas circuit remains contaminant free. The adsorber replacement and helium gas charging procedures are described in the SHI Helium Compressor Technical Manual.

Oxford Instruments offers on-site installation of service exchange cold heads and compressor adsorbers. Please consult us for service contract details and more information.

7 TROUBLESHOOTING

It is important to establish if the source of the problem is a fault in the cold head and compressor, or the **Mercury**iTC temperature controller or within the **Optistat**Dry BL4 cryostat itself.

1 Diagnosis of cold head and compressor faults should be made using the Troubleshooting section of the SHI SRDK-101D-HC4A2 (or HC4E2) Cryocooler Operation Manual.

2 Diagnosis of **Mercury**iTC temperature controller faults should be made using the **Mercury**iTC manual Troubleshooting chapter.

3 Use the following table to examine problems that can arise from the **Optistat**Dry BL4 cryostat or a combination of the above.

Problem	Possible cause	Action
Poor temperature control	Incorrect temperature controller PIDs	Refer to test results and **Mercury**iTC manual
	Heater or sensor wiring fault	Check wiring resistances and compare with Appendix A3
High base temperature	Poor cryostat vacuum	Check poor cryostat vacuum action points
	Thermometer fault	Check sensor resistance at base temperature with a suitable digital voltmeter and compare with the supplied sensor calibration data. Remember that you will have to take into account the resistance of the connecting wires (including those inside the cryostat) if you do not make a 4-wire measurement.
	Cryocooler performance	Warm up and compare the static room temperature helium pressure readings on the cryocooler compressor with data in the SHI manual
		Check the cryocooler compressor's run-time counter and compare with recommended SHI service intervals
	Temperature controller fault	Refer to **Mercury**iTC manual
Condensation on OVC body	Poor cryostat vacuum	Check poor cryostat vacuum action points
Condensation on OVC windows	Air humidity	Use a dry nitrogen source to shield the windows

Problem	Possible cause	Action
Poor cryostat vacuum	Water contamination	Warm up thoroughly to ensure all internal surfaces are free of condensed water and regenerate the OVC sorption pump
	Vacuum leak	Examine all O-rings for damage or contamination
		Check windows are correctly sealed and undamaged
		Check electrical connector is undamaged
		Check over pressure relief valve is correctly sealing
		Use a leak detector to check windows and vacuum chamber seals to identify the leak
Compressor will not start	Electrical supply	Refer to SHI manual and check fuses
Compressor stops unexpectedly	High helium discharge temperature inside the cryocooler compressor	Refer to SHI manual

If you are still unable to resolve the problem, please direct all queries through your nearest support facility (see last page of this manual).

If you have to return any components (or the complete system) for service or repair, it is essential that the item is shipped together with a signed declaration that the product has not been exposed to any hazardous contamination or that the appropriate decontamination procedures have been carried out so that the product is safe to handle.

APPENDIX A TECHNICAL DATA

A1 Physical specifications of cryostat

Item	Specification
Width	170 mm
Depth (excluding gas lines to cold head)	290 mm
Height	635 mm
Dimension across optical tail	80 mm
Weight without vertical support stand	16 kg

A2 Physical specifications of cryostat fitted to optional vertical support stand

Item	Specification
Width	240 mm
Depth (excluding gas lines to cold head)	290 mm
Height	635 - 900mm (adjustable)
Weight with vertical support stand	23 kg

A3 Wiring of 15 way micro D connector to sample heater and thermometer

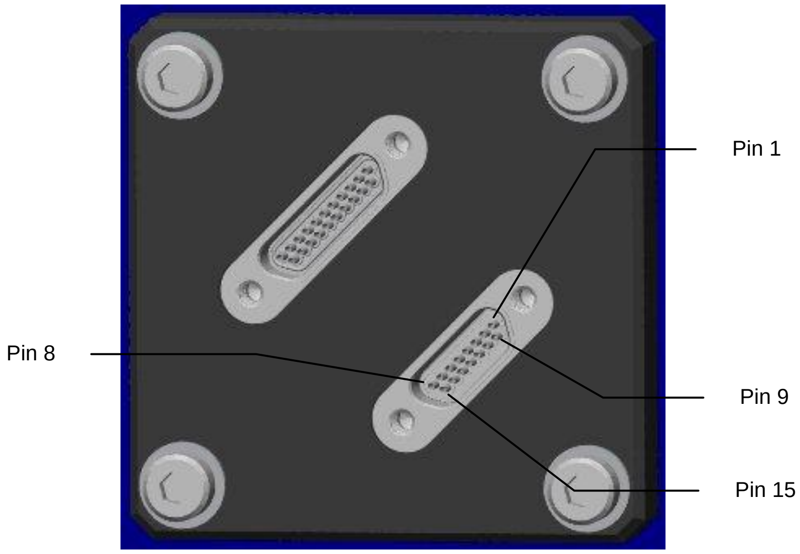


Figure 9 Flange with electrical feedthroughs

Pin numbering for hermetic 15 way micro D connector

Hermetic micro-D connector flange	Wire type	Sensor / Heater	Function	Typical room temperature resistance
1	Constantan 42 SWG twisted pair	Cernox sensor	Sensor V-	From pin 1 to:
9			Sensor V+	Pin 9 - 200Ω to 300Ω
2	Constantan 42 SWG twisted pair		Sensor I+	Pin 2 - 200Ω to 300Ω
10			Sensor I-	Pin 10 - 150Ω to 200Ω
3	Copper 36 SWG twisted pair	40W / 40V Firerod heater	Heater I+	From pin 3 to:
11			Heater I-	Pin 11 - 40Ω
4	Not used			
12	Not used			
5	Not used			
13	Not used			
6	Not used			
14	Not used			
7	Not used			
15	Not used			
8	Not used			

A4 Wiring of optional 21 way micro D connector to DRYLX20

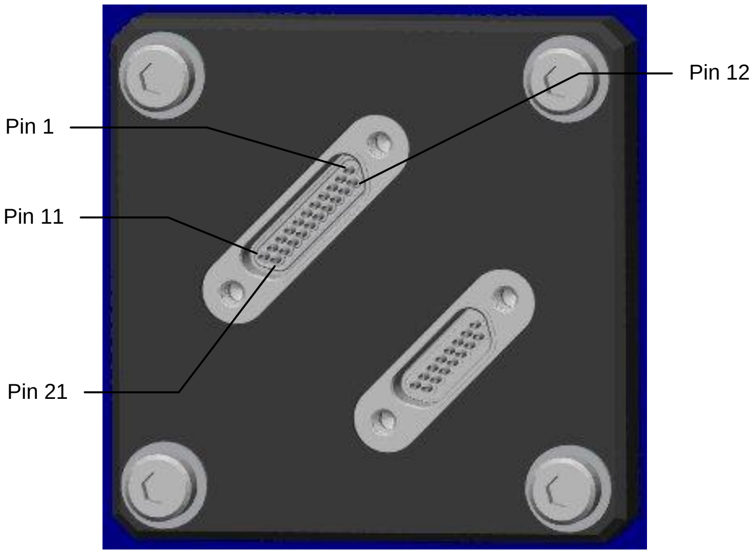


Figure 53 Flange with electrical feedthroughs. Pin numbering for hermetic 21 way micro D connector

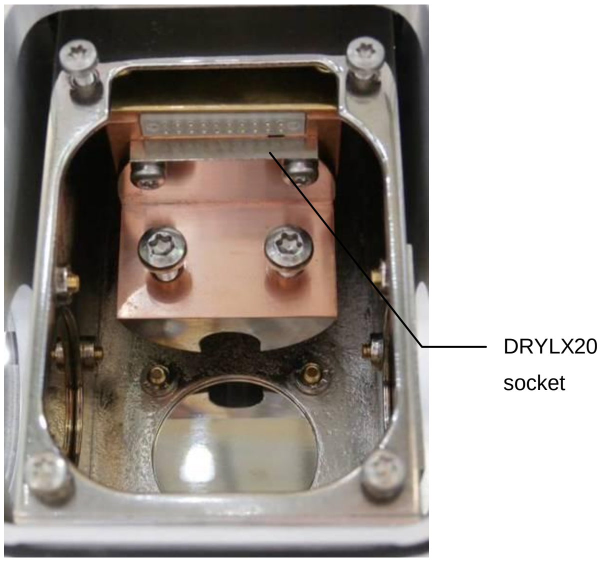
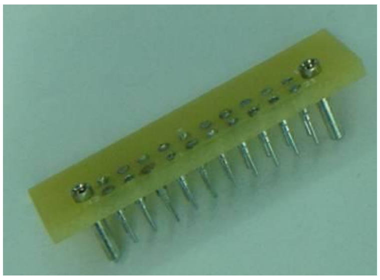


Figure 54 Location of DRYLX20 socket on the cold head (adjacent to sample mounting platform)



The DRYLX20 option comes with a mating connector board (shown above). This board has guide pins to facilitate alignment with the DRYLX20 socket on the cold head. The solder cups on this connector are numbered to help identification.

The pin number allocations for the micro-D connector at the flange and on the DRYLX20 mating connector are identical (see table on the right). The internal wiring between these terminations consist of nine twisted pairs of constantan 42 SWG wiring and one twisted pair of copper 36 SWG wires.

Hermetic micro-D connector flange	Wire type	Solder Pin No.
1	Constantan 42 SWG twisted pair	1
12		12
2	Constantan 42 SWG twisted pair	2
13		13
3	Constantan 42 SWG twisted pair	3
14		14
4	Constantan 42 SWG twisted pair	4
15		15
5	Constantan 42 SWG twisted pair	5
16		16
6	Constantan 42 SWG twisted pair	6
17		17
7	Constantan 42 SWG twisted pair	7
18		18
8	Constantan 42 SWG twisted pair	8
19		19
9	Constantan 42 SWG twisted pair	9
20		20
10	Copper 36 SWG	10
21	twisted pair	21
11	Not used	

APPENDIX B SAMPLE PUCK OPTIONS

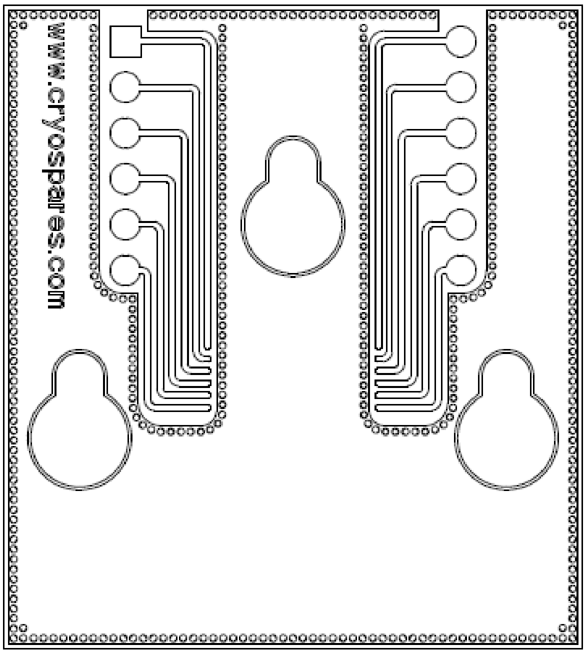


Figure 55 DRYPUCK12R sample puck for reflection measurements with 12 DC connections for customer use.

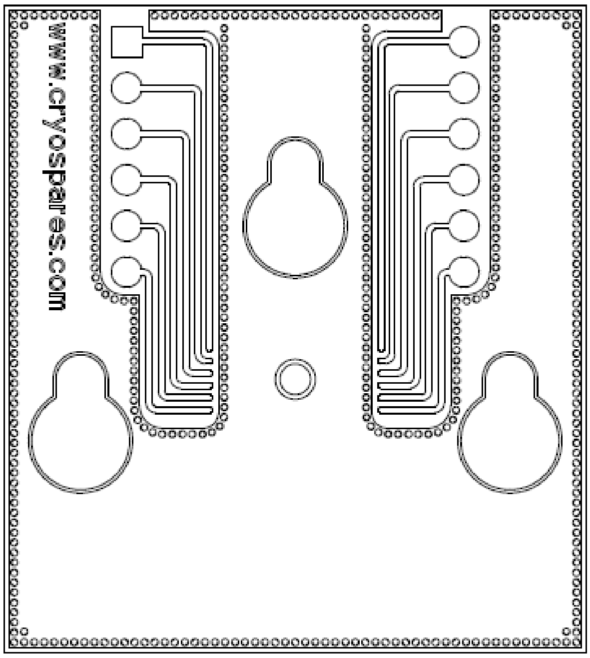


Figure 56 DRYPUCK12T sample puck for transmission measurements (a 4mm diameter opening) with 12 DC connections for customer use.

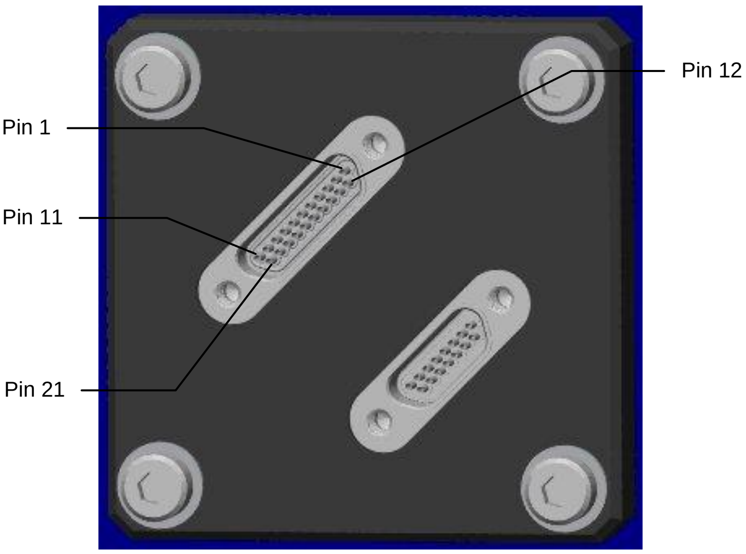


Figure 57 Pin numbering on the hermetic 21 way micro D connector flange

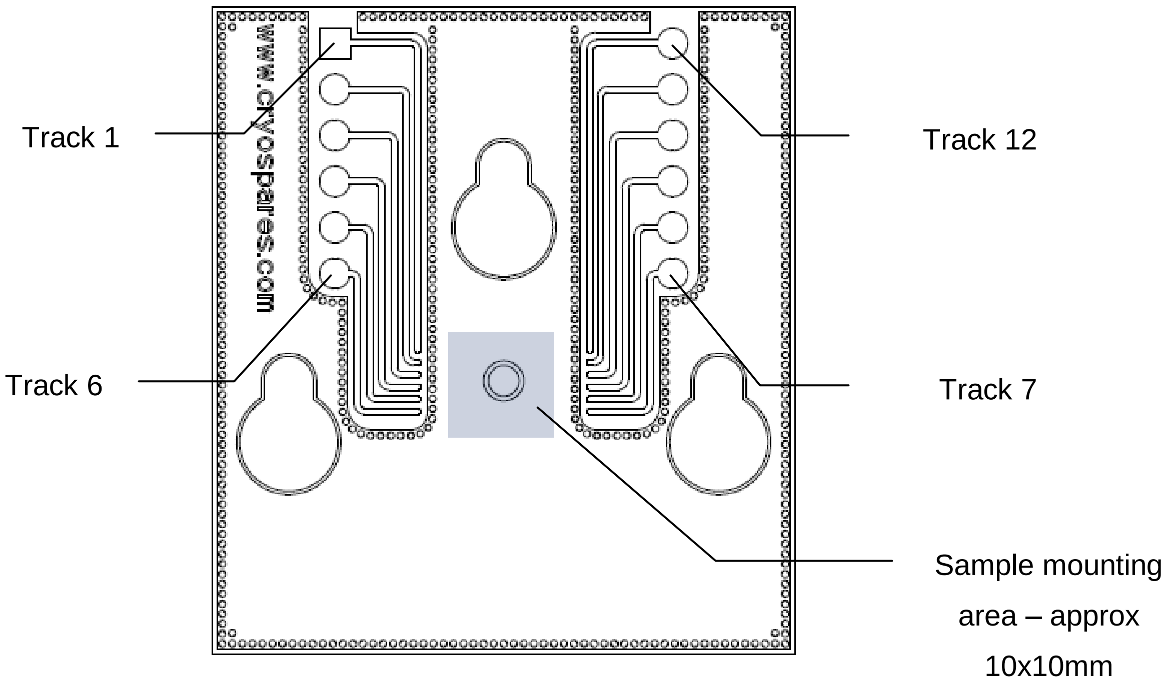


Figure 58 Sample puck showing track numbers and sample mounting position.

Hermetic micro-D connector flange	Wire type	Track no. DRYPUCK12R	Track no. DRYPUCK12T
1	Constantan 42 SWG twisted pair	1	1
12		2	2
2	Constantan 42 SWG twisted pair	3	3
13		4	4
3	Constantan 42 SWG twisted pair	5	5
14		6	6
4	Constantan 42 SWG twisted pair	7	7
15		8	8
5	Constantan 42 SWG twisted pair	9	9
16		10	10
10	Copper 36 SWG twisted pair	11	11
21		12	12
6, 7, 8, 9	Not used		
17, 18, 19, 20	not used		

The pin number allocations on the micro-D connector at the flange and the track numbers on DRYPUCK12R and DRYPUCK12T are shown in the table above.

The internal wiring between these terminations consist of five twisted pairs of constantan 42 SWG wires and one twisted pair of copper 36 SWG wires.

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