User Manual - Original Instructions

# OptistatDryBLV

# OptistatDry BLV Manual

Oxford Instruments Nanoscience

Sep 2017

# Contents

# 1

# OptistatDryBLV - Principles of Operation

A dry, compact cryostat providing optical access to a temperature-controlled sample in vacuum.

## 1.1 Revision history

Always use the latest issue of the manual. Check for updates online at https://support.myoxinst.com.

## 1.2 Contents



## 1.3 Copyright




- **Next** - Introduction

# 2

# Introduction

This manual contains user and technical information for the OptistatDry BLV system.

## 2.1 Documents supplied with the system

The following documents are supplied as electronic or paper copies:

- Operator's manual (this document)
- Factory test results
- Thermometer calibration data
- OptistatDry BLV Safety Sheet
- Unpacking Sheet
- Quick start operation sheet
- Cryocooler manual (air- or water-cooled option)
- Compressor technical manual (air- or water-cooled option)
- Cold head technical instruction (air- or water-cooled option)
- MercuryiTC manual
- Pumping Kit Manual (if a vacuum pump is ordered)
- Practical Cryogenics
- Safety Matters

This manual contains important information for the safe operation of your system. We recommend that you read this manual carefully before operating the system for the first time.

Please keep all the manuals supplied with your system and make sure that you check for updated information and incorporate any amendments. If you sell or give away the product to someone else, please give them the manuals too.

If you have bought a complete system from Oxford Instruments, separate manuals will have been supplied describing the other components. Please ensure you have reviewed the information supplied in all of the manuals before you attempt to operate your system.

## 2.2 Statement of intended use

The equipment has been designed to operate within the process parameter limits that are outlined in the user manual. The equipment is intended to be installed, used and operated only for the purpose for which the equipment was designed, and only in accordance with the instructions given in the manual and other accompanying documents. Nothing stated in the manual reduces the responsibility 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 equipment 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, as well as incorrect use or operation of the equipment, may relieve Oxford Instruments or its agent of the responsibility for any resultant non-compliance damage or injury. The system must only be used with all external covers fitted.

## 2.3 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 contact.

## 2.4 Maintenance and adjustment

Only qualified and authorised persons should service or repair this equipment. Under no circumstances should the user attempt to repair this equipment while the electrical power supply is connected.

## 2.5 Support

If you have any questions, please contact us with the following details :

- **System type** :
- **Serial number** : the Sales Order (SO) number and/or other identifiers of your system.
- **Installation/Shipment Address** :
- **Contact information** : how we can contact you. email/telephone.
- **Details of your query** : The nature of your problem, part numbers of spares required, etc.

Please contact Oxford Instruments first before attempting to service, repair or return components.

## 2.6 Contact information

**Europe, Middle East, Africa and India (EMEAI)** OINS, Tubney Woods, Abingdon, Oxon, OX13 5QX, UK Tel: +44(0)1865 393200 (sales) Tel: +44(0)1865 393311 (support) Fax: +44(0)1865 393333 (sales and support) Email: nanoscience@oxinst.com (sales) Email: ServiceNSUK@oxinst.com (service and support) Web: www.oxford-instruments.com

**Americas** OINS, 300 Baker Avenue, Suite 150, Concord, MA 01742, USA Tel: +1 800 447 4717 (sales) Tel: +1 800 447 4717 (support) Fax: +1 978 369 8287 (sales and support) Email: nanoscience@oxinst.com (sales) Email: ServiceNSAmericas@oxinst.com (service and support) Web: www.oxford-instruments.com

**Asia** OINS, Floor 1, Building 60, No.461, Hongcao Road, Shanghai, 200233, China Tel: +86 (0) 400 678 0609 (sales, service and support) Email: nanoscience@oxinst.com (sales) Email: ServiceNSAsia@oxinst.com (service and support) Web: www.oxford-instruments.cn

**Japan** OINS, IS Building, 3-32-42, Higashi-Shinagawa, Shinagawa-ku, Tokyo, 140-0002, Japan Tel: +81 3 6732 8966 (sales) Tel: +81 3 6732 8966 (support) Fax: +81 3 6732 8939 (sales and support) Email: nanoscience.jp@oxinst.com (sales, service and support) Web: www.oxford-instruments.jp

## 2.7 Acronyms

A number of acronyms may be used throughout this document. Please refer to the document Practical Cryogenics for a glossary of terms.

---

- **Next** - Safety Information

# 3

# Safety Information

Before you attempt to install or operate your system, please make sure that you are aware of all safety precautions listed in this manual together with the warnings and cautions set out in other documents supplied with the system.

All cryogenic systems are potentially hazardous and you must take precautions to ensure your own safety.

The general safety precautions required when working with cryogenic systems are given in the OINS' document Safety Matters. We recommend that all users should read this document, become thoroughly familiar with the safety information provided and be aware of the potential hazards.

It is the responsibility of customers to ensure that the system is installed and operated in a safe manner. It is the responsibility of customers to conduct suitable risk assessments to determine the nature and magnitude of hazards.

## 3.1 Disclaimer

Oxford Instruments assumes no liability for use of any document supplied with the system if any unauthorised changes to the content or format have been made.

Oxford Instruments policy is one of continued improvement. The Company reserves the right to alter without notice the specification, design or conditions of supply of any of its products or services. Although every effort has been made to ensure that the information in this document and all accompanying documents is accurate and up to date, errors may occur. Oxford Instruments shall have no liability arising from the use of or reliance by any party on the contents of this these documents (including this document) and, to the fullest extent permitted by law, excludes all liability for loss or damages howsoever caused.

Oxford Instruments cannot accept responsibility for damage to the system caused by failure to observe the correct procedures laid down 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.

## 3.2 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 (giving full product details) before any disposal begins.

## 3.3 General hazards

The following general hazards must be considered when planning the site for installation and operating the equipment. Please take notice of the following relevant warnings.

### 3.3.1 Warning notices

Warning notices draw attention to hazards to health. Failures to obey a warning notice may result in exposure to the hazard and may cause serious injury or death. A typical warning notice is shown below:


Warning: The warning triangle highlights dangers which may cause injury or, in extreme circumstances, death.

### 3.3.2 Caution notices

Caution notices draw attention to events or procedures that could cause damage to the equipment. Failure to obey a caution notice may result in damage to the equipment. A typical caution notice is shown below:


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

## 3.4 Specific hazards

Your system manual will indicate which of the following specific hazards relate to your system. Refer to Safety Matters for more information in each case.

## 3.5 Electrical hazards


Contact with hazardous voltage can cause death, severe injury or burns. Ensure that a local electrical earth (ground) connection is available at the installation site.

Parts of the system carry high voltages that can cause death or serious injury. Ensure that a local electrical earth (ground) connection is available.

The electrical supply to the system must include an isolation box to ensure that mains electrical power to the system can be isolated. The isolation box must allow the supply to be locked OFF, but must NOT allow the supply to be locked ON.

## 3.6 Protective earth


The cryostat, electronics, pumps, and any other parts of the system fitted with earthing points must be connected to protective earth at all times when the system is in operation.

## 3.7 Low temperature


Contact with cold objects and cryogens can cause serious injury to the skin. Skin may adhere to cold objects. Ensure that any cryogenic or coolant delivery systems are designed to prevent contact with the cold components.

Consider the hazards of low temperatures when planning the installation of the system. Proper safety equipment must be made available to all personnel expected to handle cryogenic liquids, including hand and eye protection.

## 3.8 Pressure relief


Closed vessels in the system are protected by pressure relief valves that exhaust directly to atmosphere unless otherwise stated.

Do not tamper with any of the pressure relief devices fitted to the system or attempt to modify or remove them. Also ensure that the outlets of the relief devices are not obstructed. The correct operation of these relief valves is critical to the safety of the system.

## 3.9 Weight and lifting


Incorrectly lifting heavy objects can cause severe injury. Use the appropriate lifting equipment, operated by fully

trained personnel, when handling heavy system components.

Appropriate lifting equipment and personal protective equipment (PPE) must be provided at the installation site for the duration of the system installation.

## 3.10 Magnetic fields


Powerful magnetic fields can interfere with the operation of cardiac pacemakers. Do not approach the equipment if you wear a cardiac pacemaker.

Systems with the magnet option contain powerful electromagnets. These electromagnets can produce a powerful magnetic field, which can interfere with the operation of cardiac pacemakers in the vicinity of the system, causing death or serious injury.

Risk to personnel with cardiac pacemakers.

Where necessary, the appropriate warning signs should be in place around the installation site. Personnel who have a cardiac pacemaker must not approach the system at any time, even when it is powered off. The magnet can exert a force on nearby ferromagnetic objects, which presents a hazard to personnel if these objects are free to move.

## 3.11 Asphyxiation


Helium and nitrogen can displace the oxygen from air and cause death by asphyxiation. Ensure that adequate ventilation is provided.

Areas where these chemicals are stored or used must be well ventilated to avoid the danger of suffocation. Oxygen level detection equipment should be installed in suitable locations to warn personnel if the oxygen concentration falls below a threshold value. Take precautions to prevent spillage of liquid cryogens.

## 3.12 Fire


Atmospheric oxygen can condense on cryogenicaly-cooled objects. Oxygen can cause flammable substances to ignite in the presence of heat or arcing, risking severe injury.

Rooms where cryogenic liquids are being handled must be designated as no smoking areas. While liquid helium and nitrogen do not support combustion, their low temperature can cause oxygen from the air to condense on surfaces and may increase the oxygen concentration in these areas.

## 3.13 Safety equipment

The following items are recommended for safe operation of any system:

- Personal protective equipment, including thermally insulated gloves, face protection and protective footwear.
- Hazard warning signs, barriers or controlled entry systems to ensure that personnel approaching the system are aware of the potential hazards. This precaution is especially important if you system includes a superconducting magnet.

## 3.14 Maintenance


Observe the necessary maintenance schedule for the system. Consult Oxford Instruments if you are unsure about the required procedures.

## 3.15 Pressure relief valves

There is an over-pressure relief plate on the front of the cryostat, shown below. It prevents the internal pressure in the cryostat outer vacuum chamber from rising significantly above atmospheric pressure by lifting to allow gas to vent. Four restoring springs provide the force required to re-seal the relief plate automatically when the pressure drops. Note that the relief plate will not lift during normal operation of the system.

Figure 3.1: pressure-relief

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

## 3.16 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.

## 3.17 Mercury iTC temperature controller

OptistatDry systems will normally be supplied with a MercuryiTC. Safety features for this temperature controller are described in the corresponding manual, as supplied with the system. You should ensure that you understand and comply with all safety warnings and cautions.

---

- **Next** - System Description

# 4

# System Description

The OptistatDry 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 OptistatDry range is designed to be versatile, upgradeable, simple to use, and to provide optical excellence.

## 4.1 The cryostat

The OptistatDry BLV (Bottom Loading in Vacuum) system provides a temperature controlled sample-in-vacuum measurement environment within a cryofree cryostat. The system enables optical and electrical measurements to be carried out on the user's sample.

[OptistatDry BLV][img-optistatdry-blv]

The cooling source for the cryostat is a two-stage Gifford McMahon (GM) refrigerator supplied by Sumitomo Heavy Industries (SHI). 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 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 and the vacuum space 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.

Labelled diagrams of the cryostat (front and rear view) are shown below.

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

The above diagrams are consistently labelled such that *right* and *left* sides are denoted as viewed from the *front*. Note that the *front*-facing edges of the side panels are slightly wider than those at the *rear*.

## 4.2 The system

The main components of the system, as shown in the scheamatic above, are:

1) The cryostat, consisting of:

- The heat exchanger, fitted with a temperature sensor and heater wired to the 15-way micro-D connector on the OVC. The sample mounting platform can be removed from the heat exchanger when you need to change samples.
- The cold head, to which the heat exchanger is thermally linked. The 1$^{st}$ and 2$^{nd}$ stages of the cold head are fitted with temperature sensors, wired to the 15-way micro-D connector on the OVC.
- The outer vacuum chamber (OVC) and radiation shields, isolating 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 OVC must be pumped to a high vacuum using an external pumping system before the cryostat is cooled down.

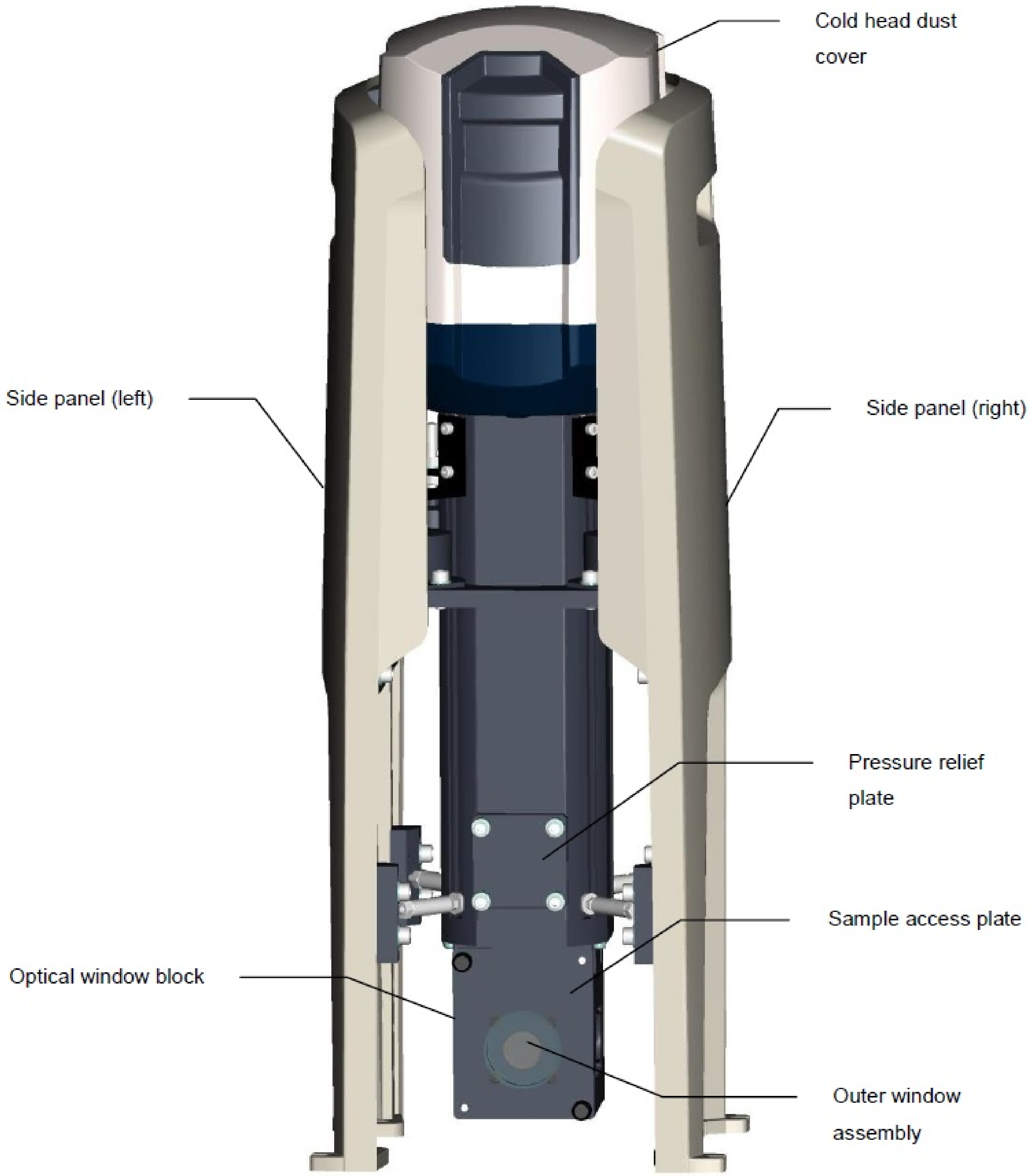


Figure 4.1: Cryostat front view

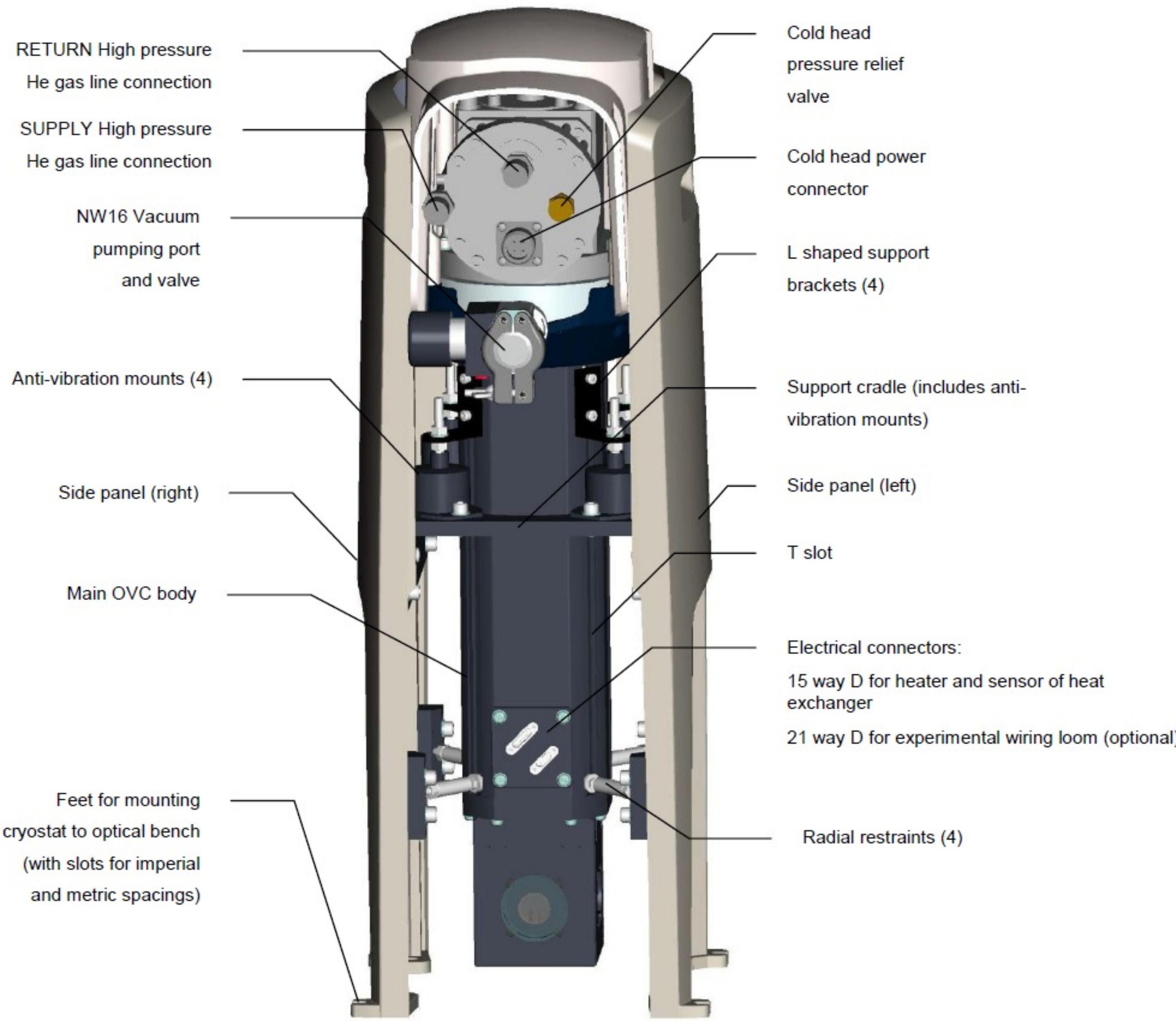


Figure 4.2: Cryostat rear view

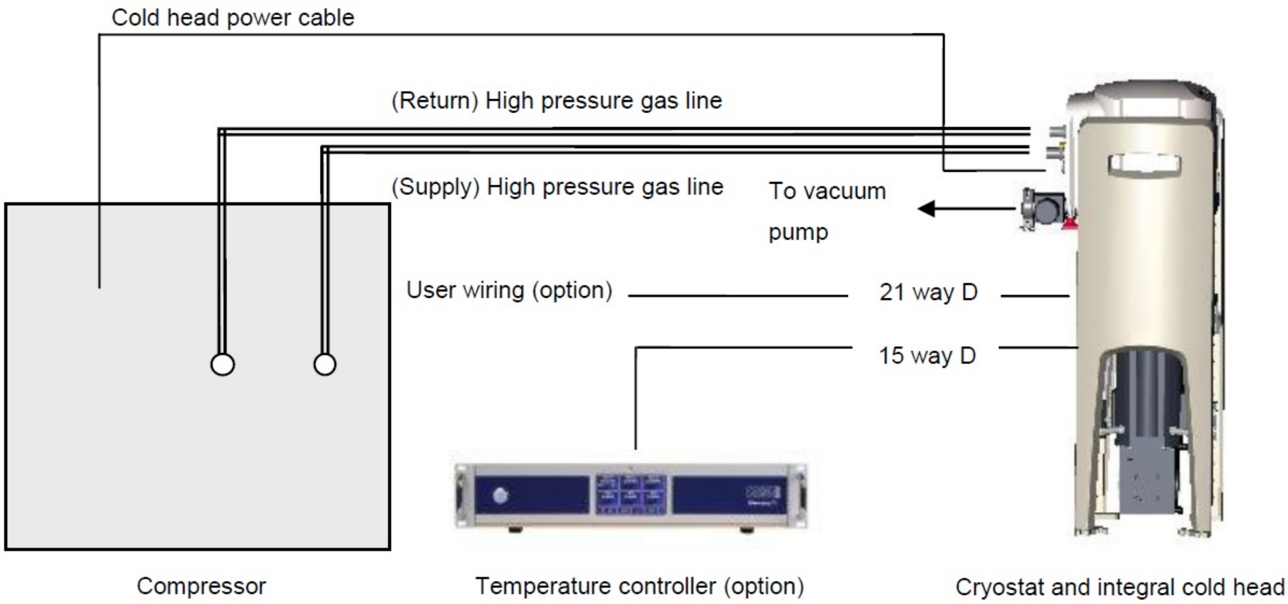


Figure 4.3: System configuration (schematic)

- The optical window block, allowing optical and physical access to the sample mounting region.

2) The cryostat stand, for supporting the cryostat and enabling it to be mounted securely to an optical table, 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 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, which:

- Controls and monitors the heating and thermometry for the VTI heat exchanger.
- Controls and monitors the heating and thermometry for the sample probe.
- Monitors the thermometry for the $1^{st}$ and $2^{nd}$ stages of the GM cooler.

---

- **Next** - Installation

# 5

# Installation

Assembly of the OptistatDry system is a straightforward procedure requiring no specialist training. This chapter describes how to prepare the installation site, unpack and assemble the system, and prepare the system for operation.

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

## 5.1 Site preparation

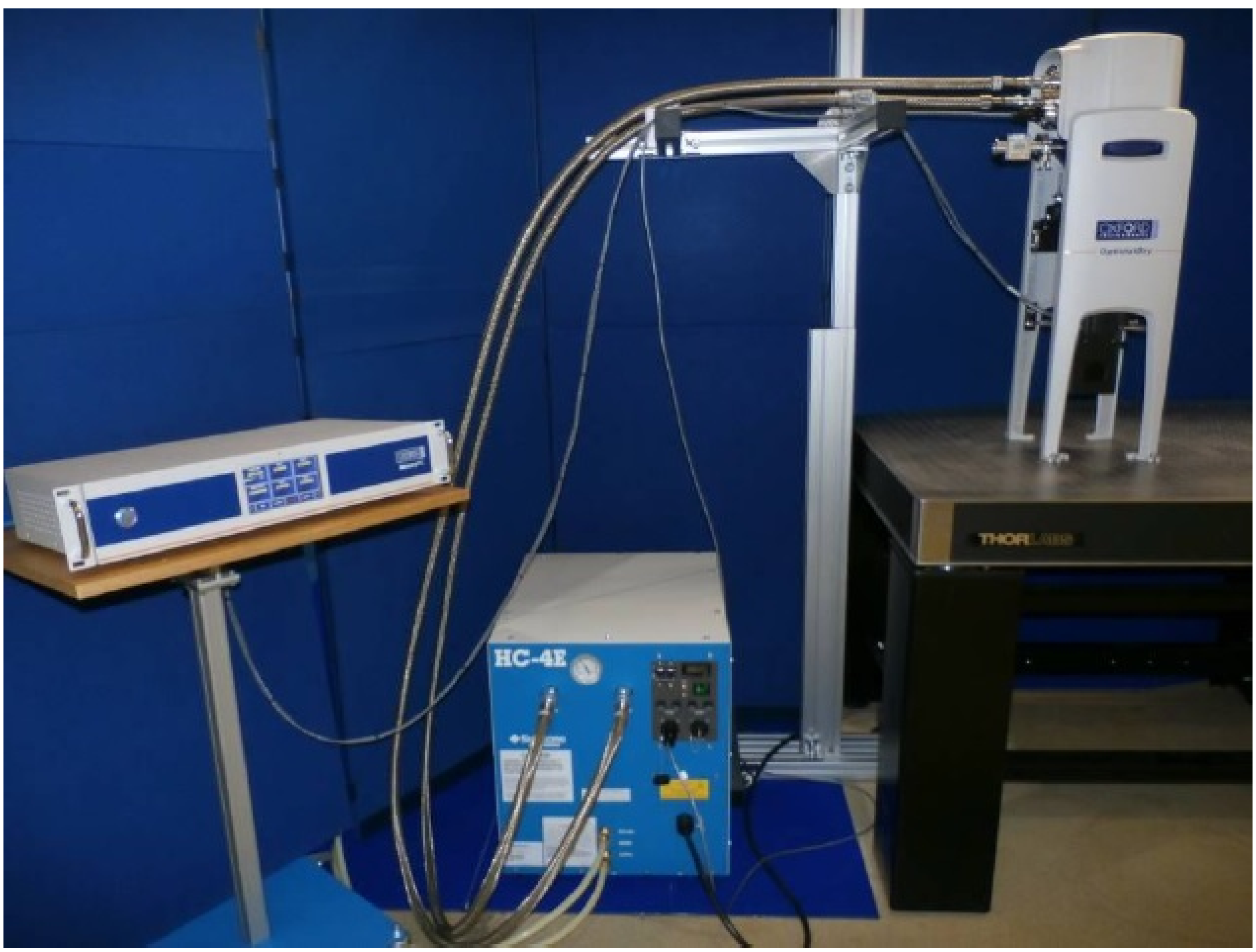


Figure 5.1: System configuration (photograph)

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 compressor technical manual.

- Standard high pressure Helium gas lines are 3m long. Longer lines (up to 20m) are available, but may affect the cryogenic performance of the system.
- Allow enough space so that the Helium lines from the compressor can be supported horizontally where they attach to the cold head.
- The gas lines should remain flexible, not taut.
- Bending arcs for the gas lines should have large radii. The minimum bend radius is 180mm.
- Allow at least 600mm on all sides of the compressor for maintenance.
- Ensure that the compressor is level (within 5° of horizontal).
- Prepare all tooling required for assembly in advance. Refer to the tables below for a comprehensive tooling list.

## 5.2 Toolkit lists

The following is a list of tools required for installing the system. These are included in the spares kit.

| Tool | Function |
|---|---|
| 5mm ball end hex-key | Cryostat height adjustments |
| Radial restraint adjustments | |
| 2.5mm ball-end hex-key | Radial restraint adjustments |
| 10mm open-ended spanner x2 | Cryostat height adjustments |
| Radial restraint adjustments | |
| 7mm ring spanner | Adjustment of locator studs |
| Small flat blade screwdriver (0.5 x 3mm typ.) | Installation of cryostat cable |
| Medium flat blade screwdriver (0.8 x 5mm typ.) | Removal/fitting of optical windows |

The following tools are provided with the compressor package

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

## 5.3 Unpacking the system

The OptistatDryBLV system is supplied as 2 main packages, each on wooden pallets. Please retain all packing materials, should you need to transport or store the system in the future.

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.

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 *installation* section. 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 covered later.

The second package consists of the cryostat, windows, sample holder(s) and any additional items ordered, e.g. MercuryiTC, cables and spares kit. Open this box by turning the two black plastic closure fittings and lifting back the lid. These fittings may be quite stiff - you can use pliers to turn them. Remove the internal packing foam layers and take out all the system components components, except for the cryostat itself. Leave this in place until it is required.

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

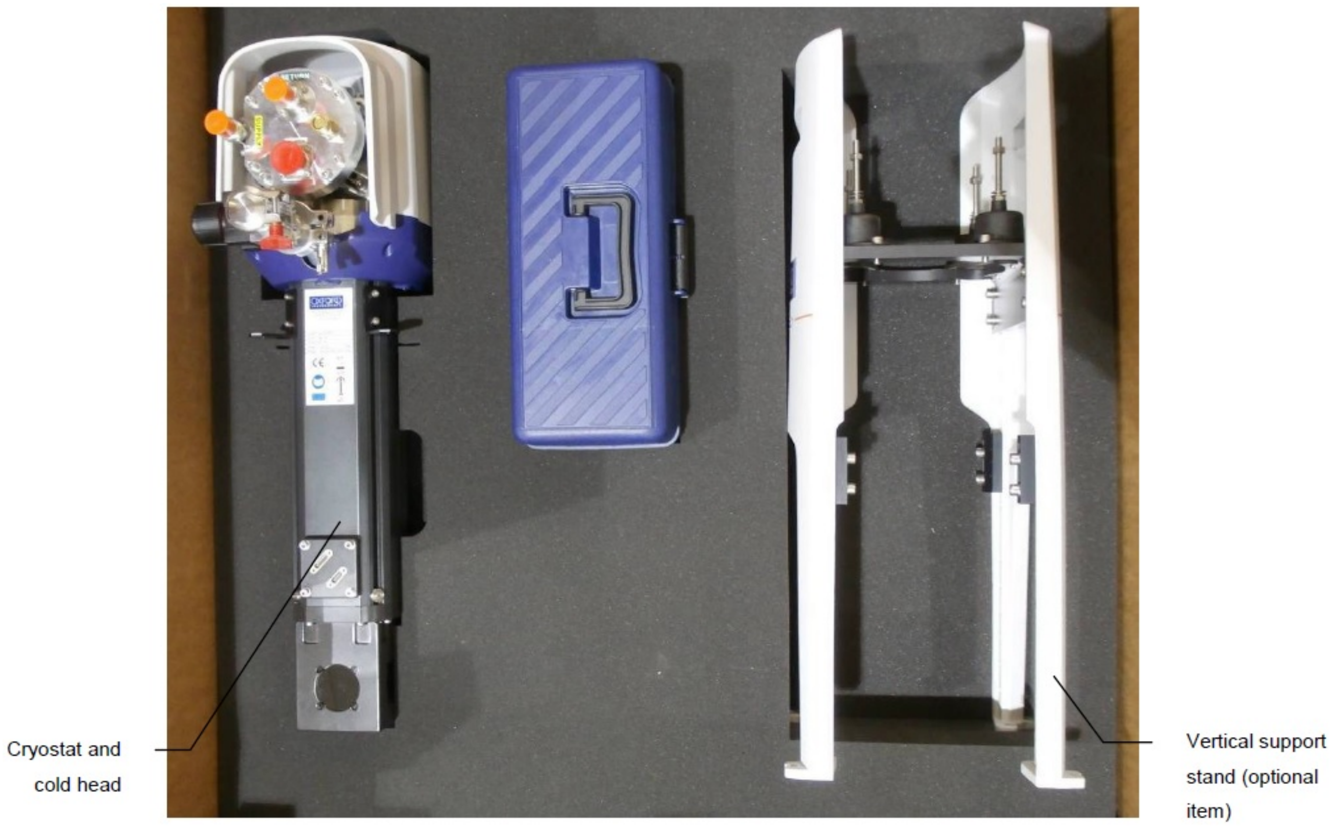


Figure 5.2: The cryostat, packaged as delivered

When unpacking the system, cheak each item against the packing list to make sure that all the components are present. Examine the system to make sure that it has not been damaged since it left the factory. If you find any missing items or any signs of damage, please contact Oxford Instruments immediately.

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 and to change samples (both described later).

The system is shipped with the blanking windows fitted (black, opaque). It is a good idea to keep these in position whilst the system is installed. These can be removed and swapped for the system windows after the system has been cooled for the first time to check its performance.

The OptistatDry BLV system is fitted with transit fixtures that must not be removed until the cryostat is as close as practical to its final operating position.

The cryostat and frame should be placed upright on a firm flat surface. Note that the weight of the cryostat and frame assembly is 23kg, therefore two people are required to lift and move the assembly safely.

## 5.4 Mounting the cryostat

### 5.4.1 The vertical support stand

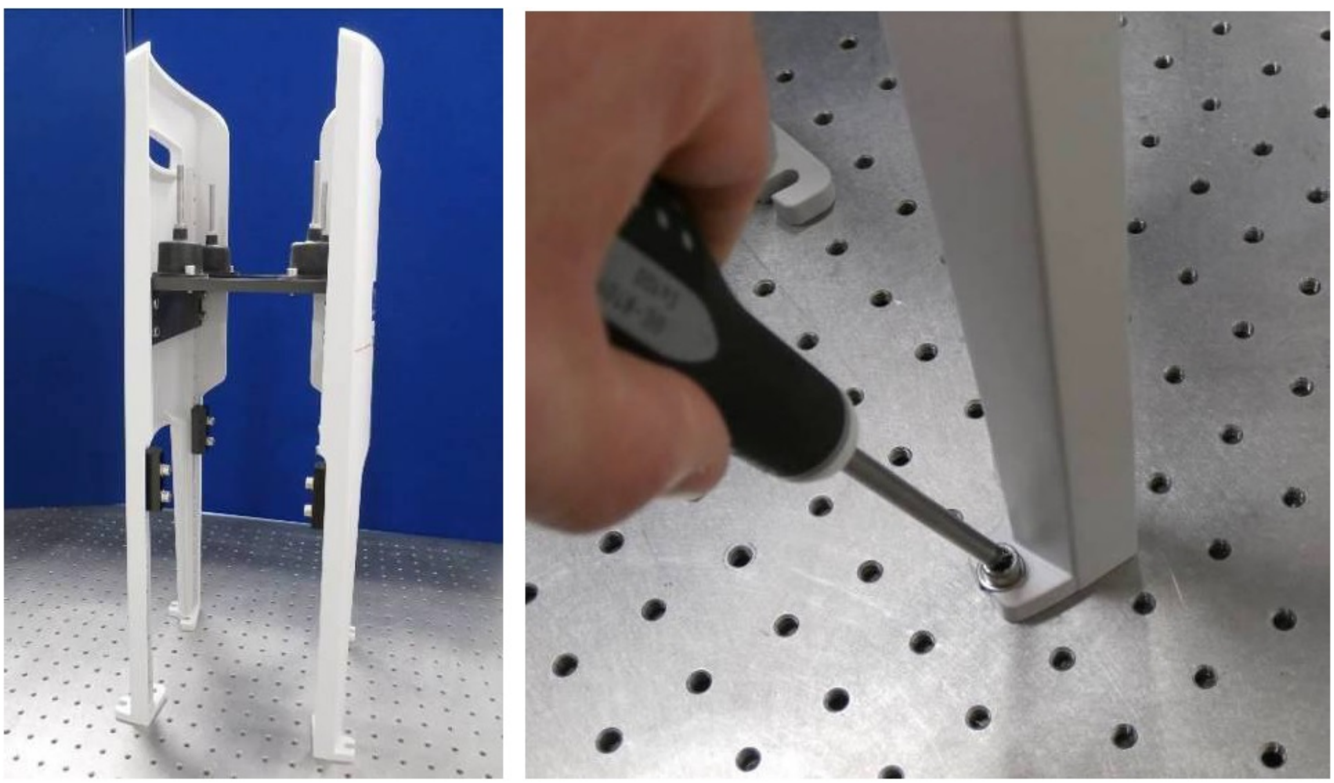

Figure 5.3: Securing the support stand

The cryostat vertical support stand, shown above, consists of two side panels and a support cradle. It may be used to support the cryostat securely above a standard optical table. The support stand has four legs, with slotted feet for compatibility with both imperial (1") and metric (25mm) optical tables.

The support cradle can be moved up or down with respect to the side panels by unscrewing the fixing as shown above. This allows the height of the cryostat windows above the optical table to be varied in order to suit the experimental set-up.

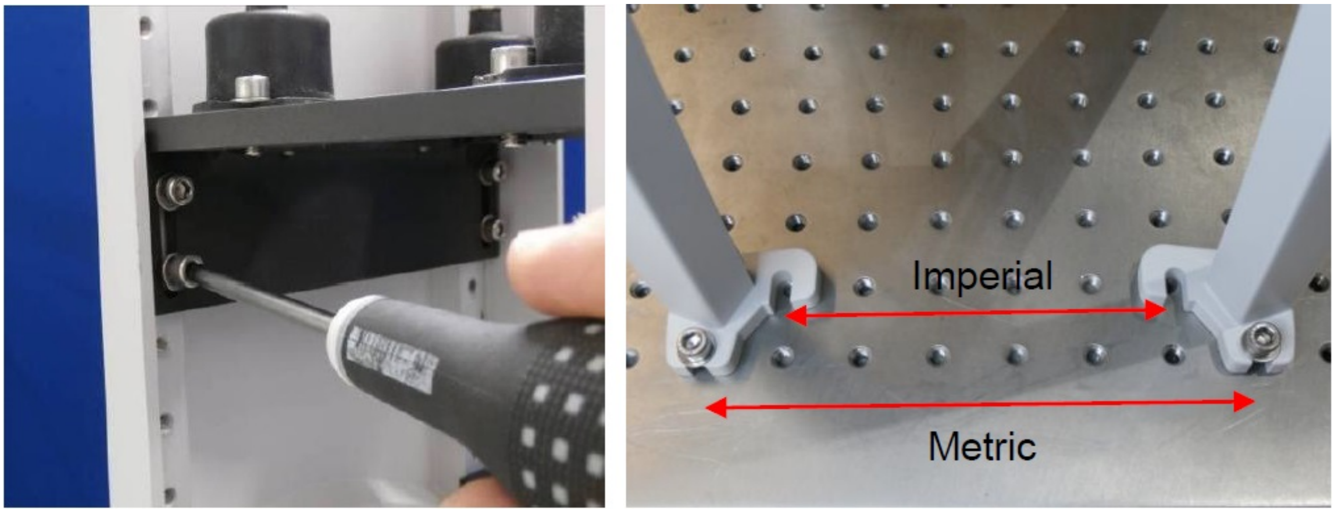


Figure 5.4: Adjusting the cradle

The default position of the support cradle (as shipped) within the stand is the lowest setting that permits the 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, the sample may be accessed through the sample access plate.

### 5.4.2 Setting or adjusting the height

In the default cradle position, the optical centreline can be adjusted within the approximate range of 155mm to 180mm from the surface of the table, as detailed in the *Minor adjustments” section below.

If the experimental setup requires a window height outside of this range, instead follow the instructions in the section *Defining the window height / moving the support*. This should be done before fixing the cryostat into the support stand.

### 5.4.3 Defining 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 below.

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 the table and diagram below to determine the best position for your support cradle with respect to the side panels. If there are two options for your required value of A, choose the lower position for the cradle.

| Required 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 | |

| Required A / mm | Use side panel holes | Note |
|---|---|---|
| 180 - 205 | 5 and 6 | |
| 155 - 180 | 6 and 7 | Defaut settings - 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 optical table. |

The tapped holes in the side panels are numbered starting from the top.

Minor adjustments, within the ranges given, can be made as described later. Major adjustments can also be made without the need for complete disassembly.

### 5.4.4 Setting the height of the support cradle

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.

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

When the support cradle has been moved to the correct height, the support stand should be placed on the floor prior to inserting the cryostat.

### 5.4.5 Fitting the cryostat to the 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.

Remove and retain the top M6 nut and washer from each of the four anti-vibration (AV) mounts on the support cradle. If the cryostat is wrapped in plastic sheet, remove the sheet carefully before lifting the cryostat (with integral cold head) out of packing box.


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

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.

Identify the front and rear of the side panels. 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 responsible for lifting and fitting the cryostat into the frame and the other responsible for guiding the installation.

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

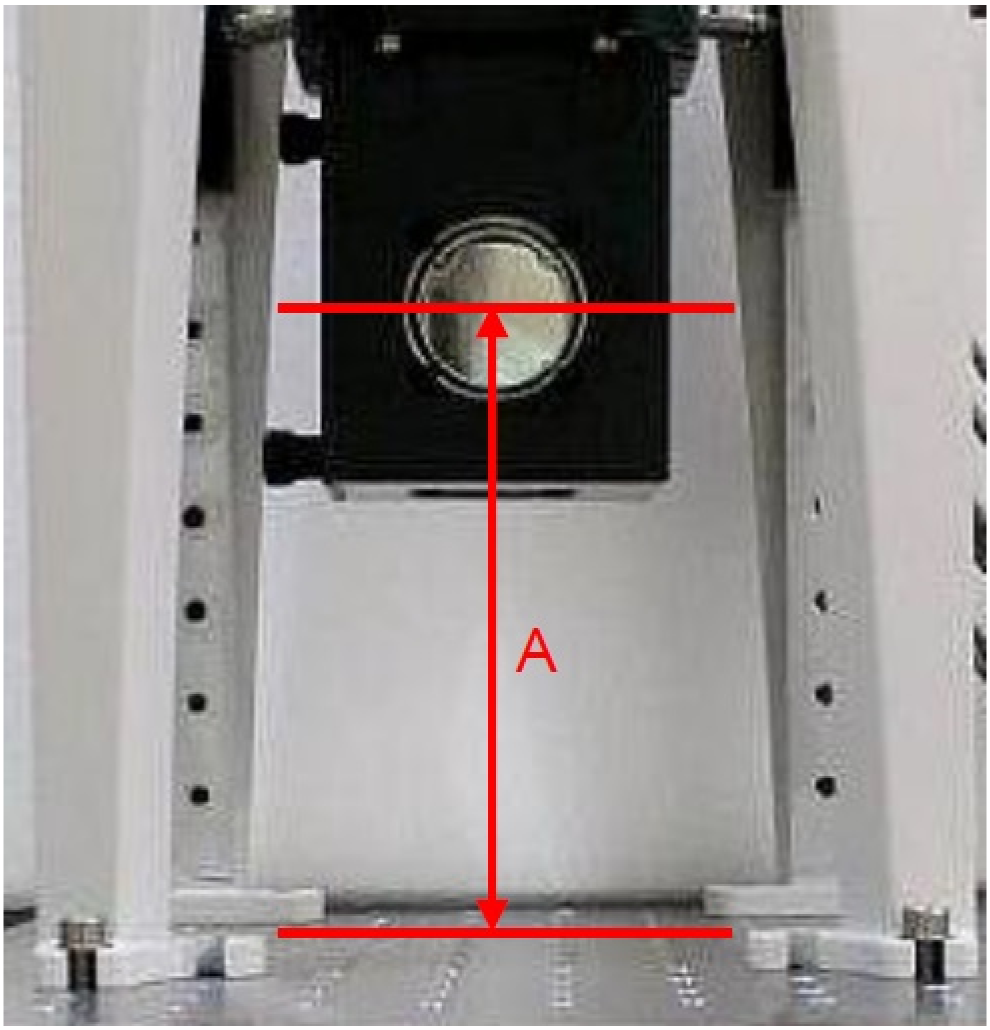


Figure 5.5: Defining the window height, A

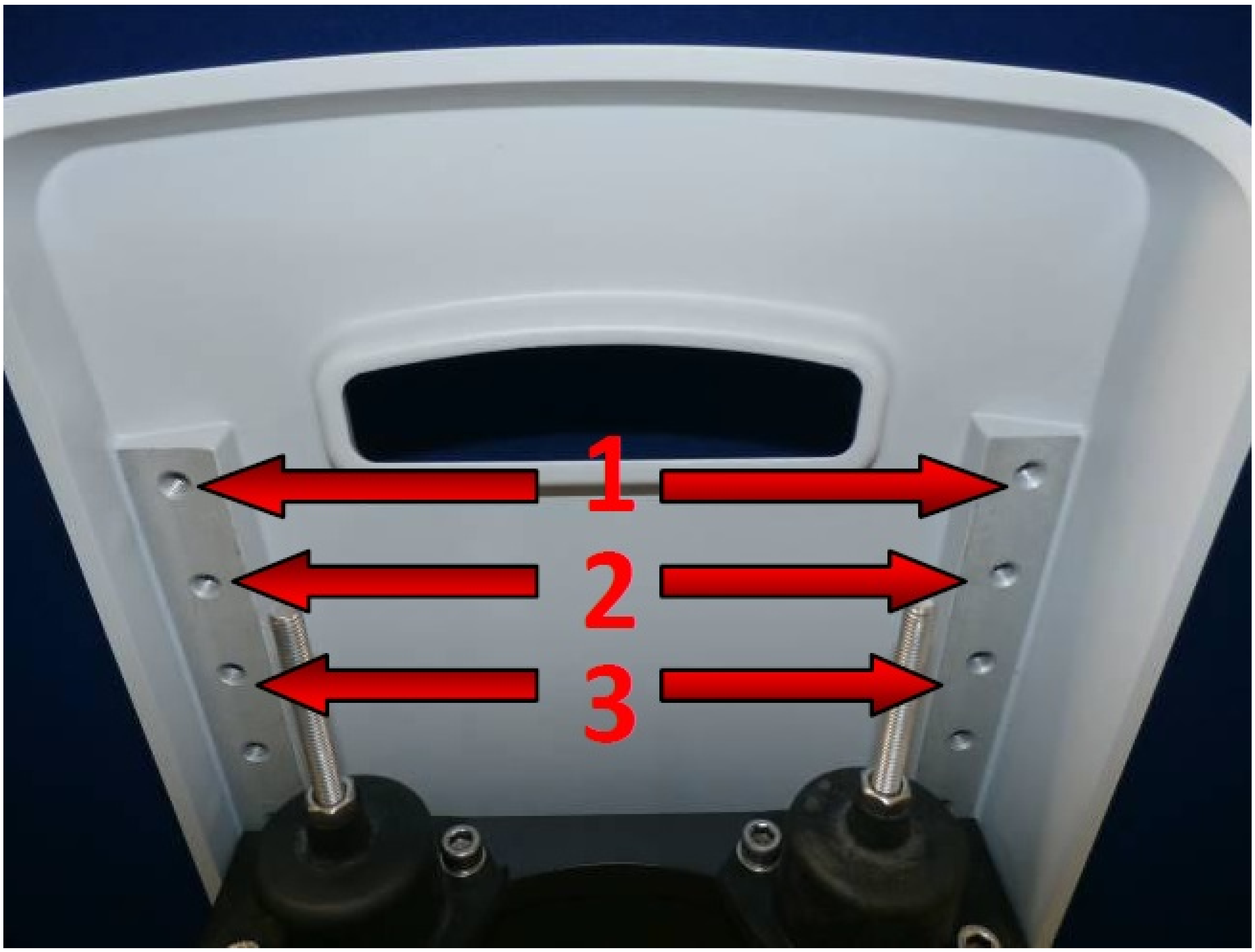


Figure 5.6: Side panel hole numbering

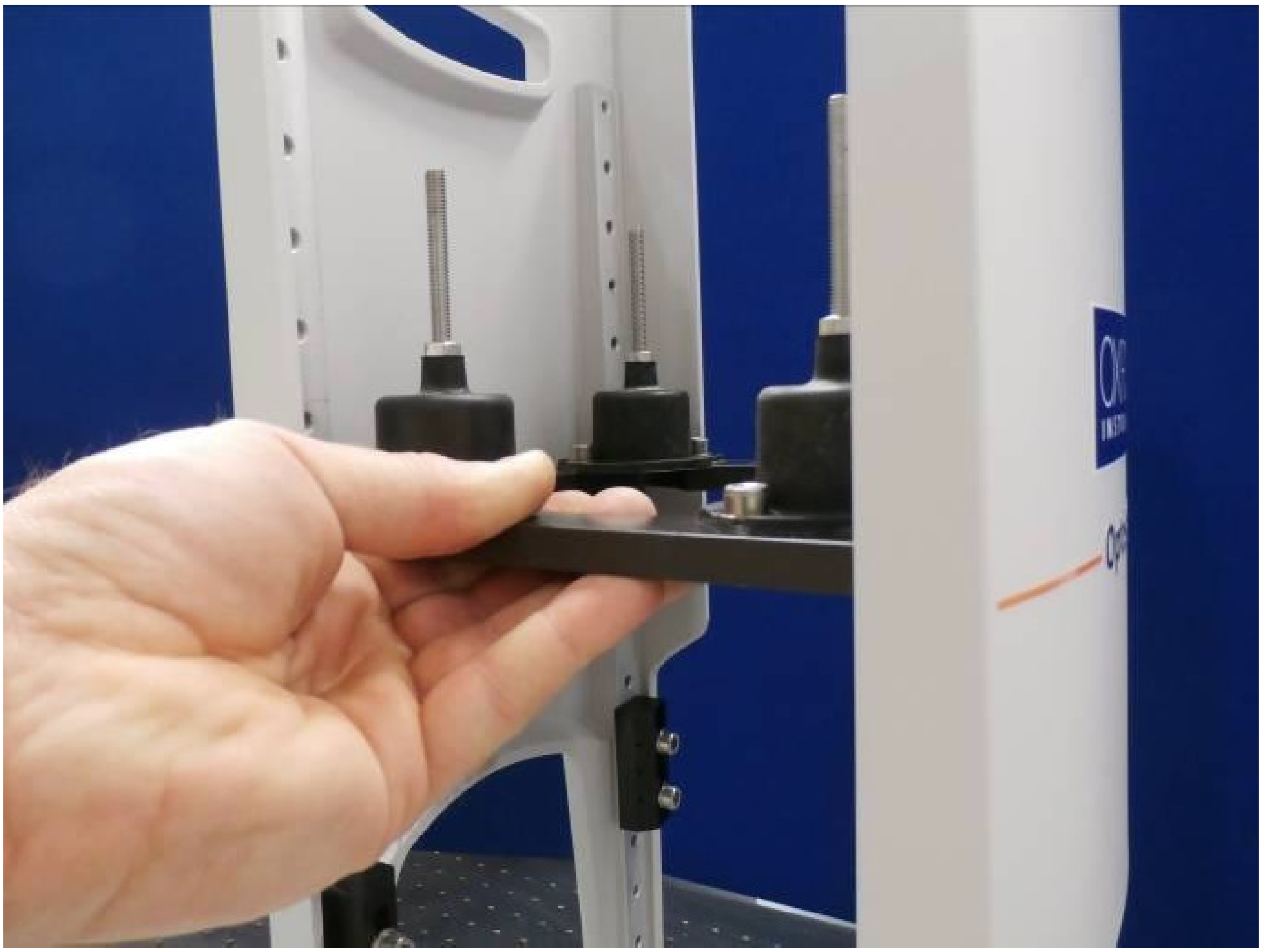

Figure 5.7: Cradle height adjustment

Figure 5.8: Removing the upper nuts from the anti-vibration (AV) mounts

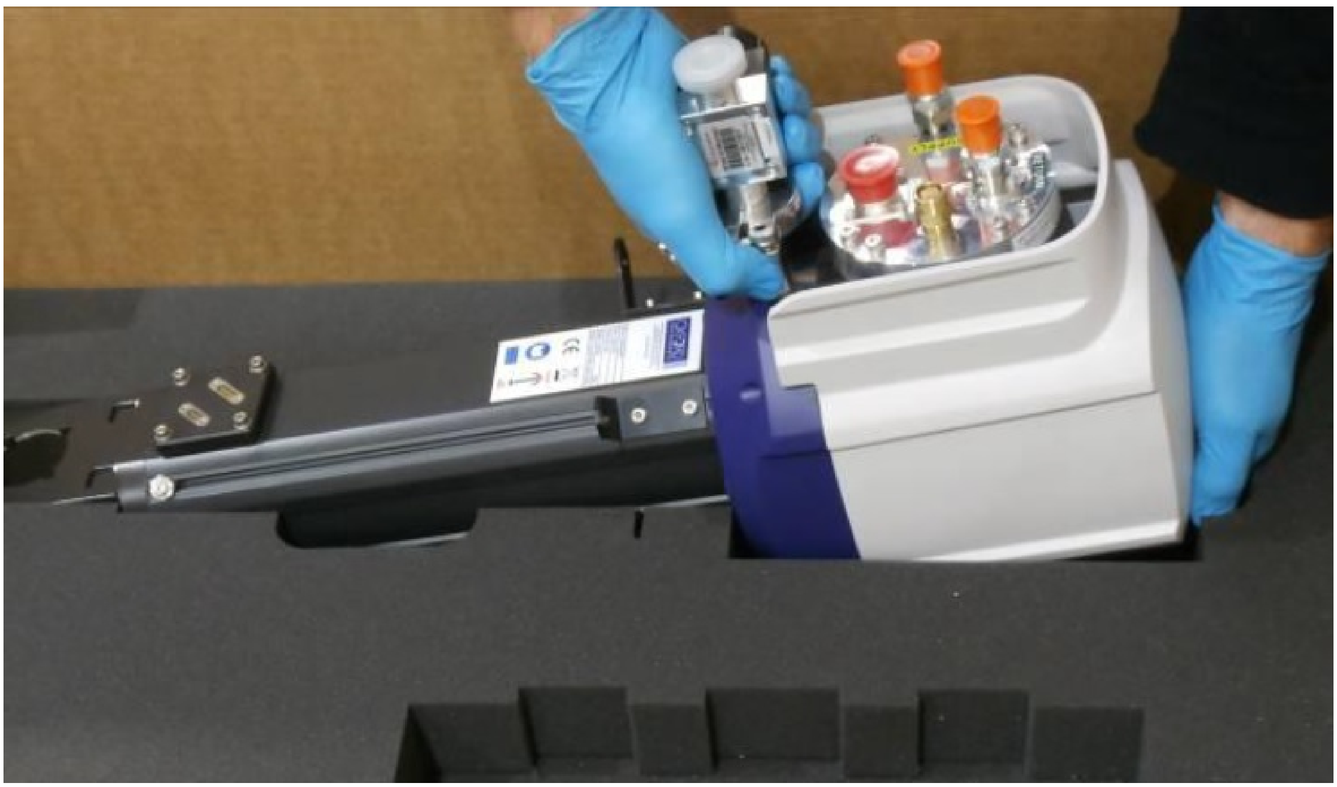

Figure 5.9: Removing the OptistatDry from its packaging

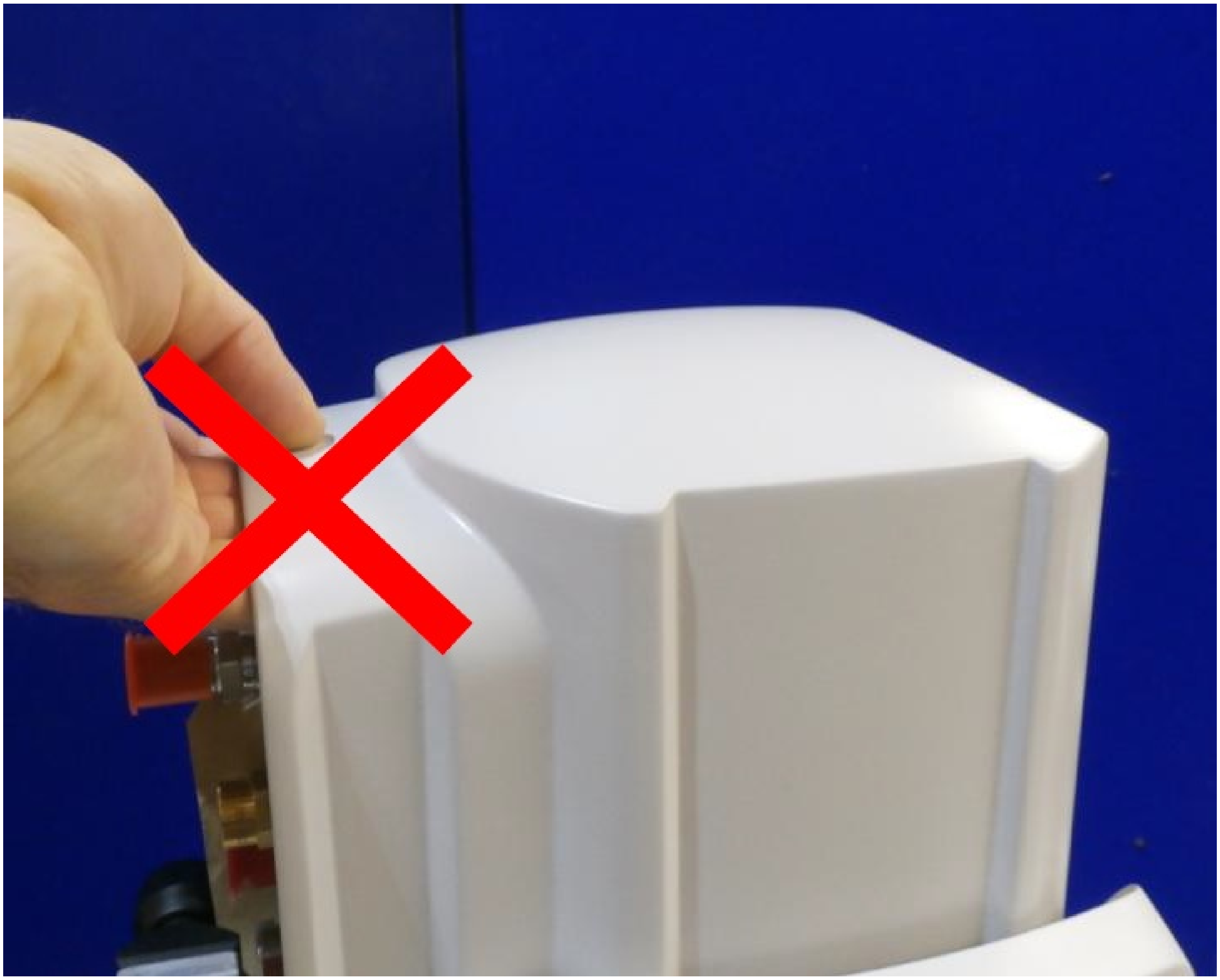

Figure 5.10: Do not lift by the cover


Figure 5.11: Inserting the cryostat

Figure 5.12: Mounting the cryostat


Figure 5.13: The AV mounts and L-brackets

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.

### 5.4.6 Setting the vertical alignment

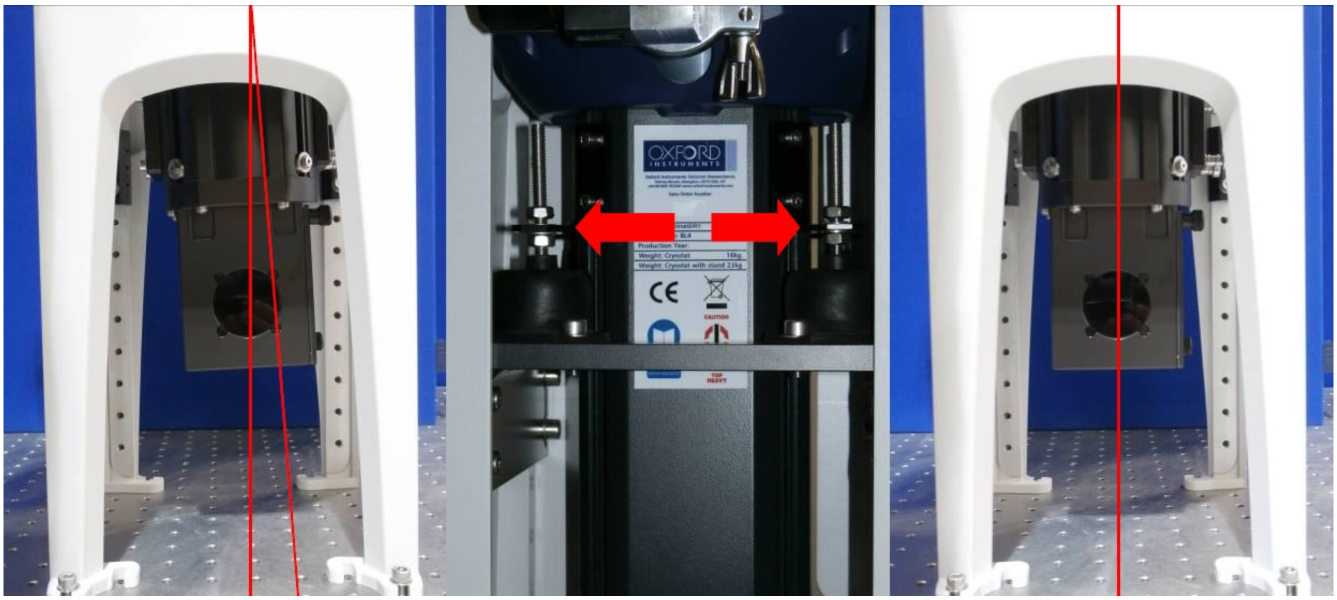

Figure 5.14: The system should sit vertically within the support stand

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. 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 (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.

## 5.5 Cryostat height adjustments

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

## 5.6 Coarse height adjustments

The height of the cryostat is coarsely adjustable in 25mm stages using the bolt-hole pairs (1-11) on each side panel. To do this, the clearance between the base of the window block and the optical table must be sufficient to slide a laboratory jack between the two.

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

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

- If the cryostat is to be raised, remove the four lower bolts holding the cradle to the side panels. Loosen, but do not remove, the four upper bolts.

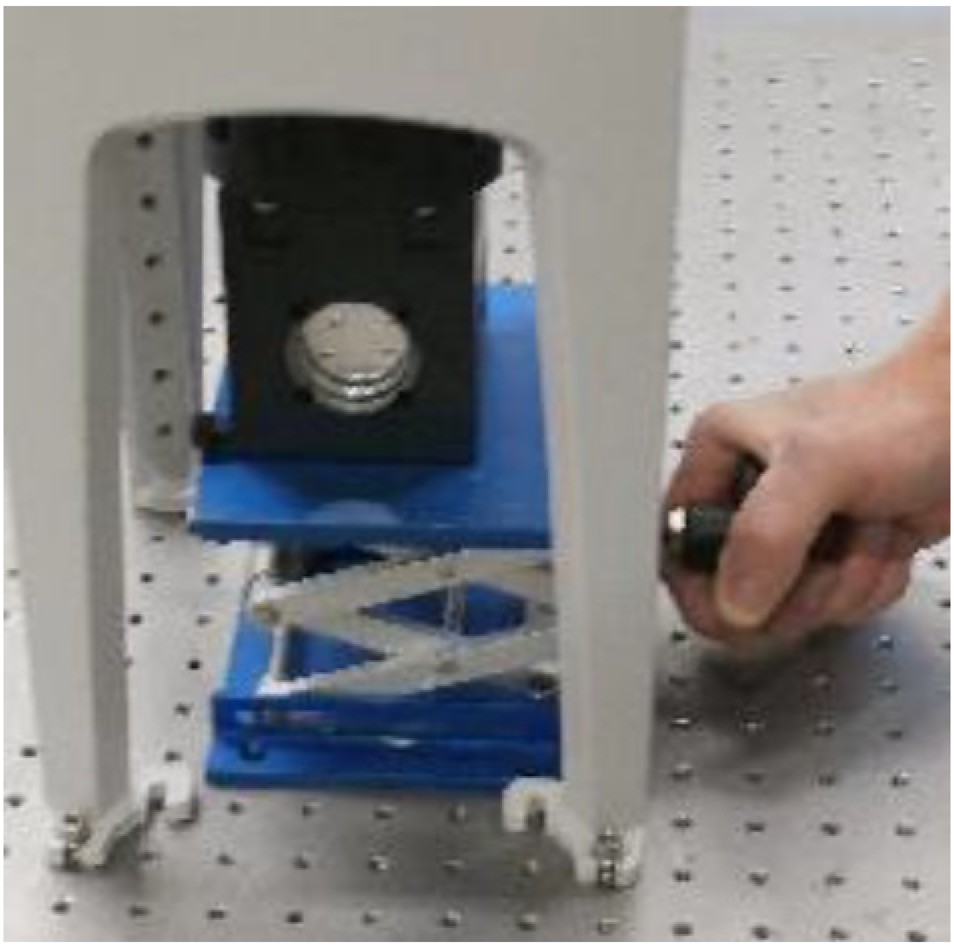

Figure 5.15: Support the cryostat weight with a lab jack

- If the cryostat is to be lowered, remove the four upper bolts holding the cradle to the side panels. Loosen, but do not remove, the four lower bolts.

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

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

If necessary, carry out any fine height adjustments as described below.

### 5.6.1 Fine height adjustment

Fine adjustments, of up to 25mm, are possible at the cradle anti-vibration mounts using the M6 nuts to adjust the height of the cryostat. Use a 10mm open-ended spanner to adjust the nuts.

Move the upper nut clear of the bracket 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 height, A, is set correct. Finally, for each mount, hold the lower nut stationary with an open-ended spanner and turn the upper nut with a second 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.

## 5.7 Fitting the radial restraints

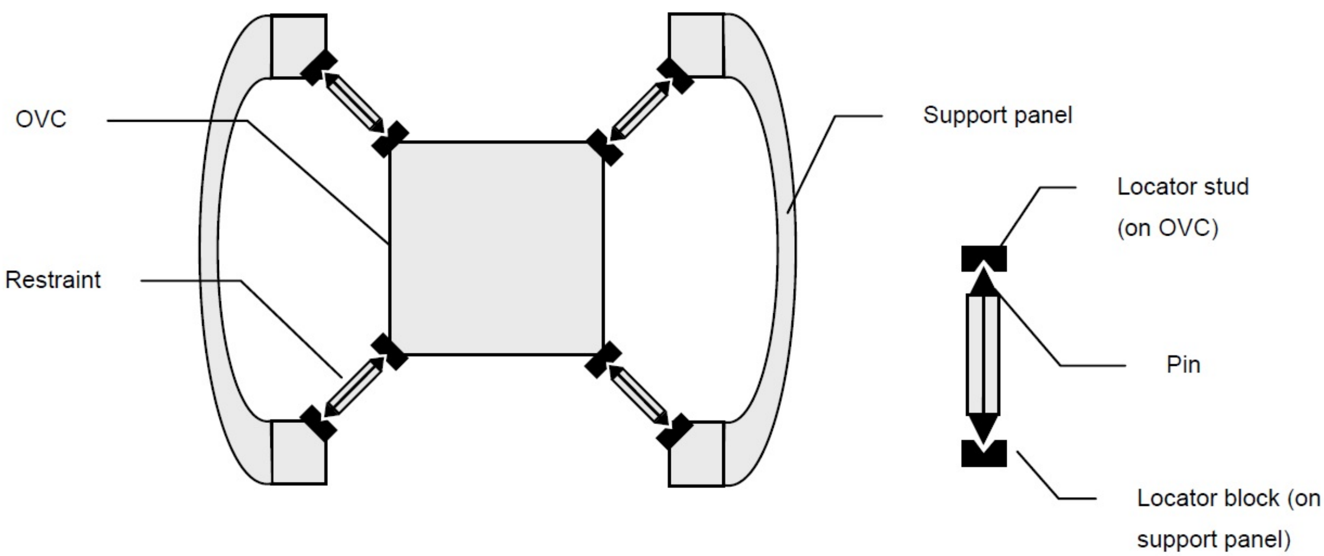


Figure 5.16: Schematic of the radial restraints in position

It is important that the cryostat sits centrally to the support stand. The radial restraints provide lateral support and help attenuate cryostat vibration relative to the optical table. 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 above. 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 cryostat and support frame are securely bolted to the laboratory table, and that the cryostat has been adjusted for vertical alignment within the frame.

Loosen the 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 5.17: Position the locator studs

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.

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

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

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.

Repeat for the opposite radial restraint, then for the remaining two radial restraints.

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.

Do not try to over-extend the restraints. It is enough that the elastomer inside each restraint is slightly compressed. Hold the barrel to stop it rotating and gently tighten the hexagonal nut on each restraint support, using a 10mm open-ended spanner, to fix the overall length.

## 5.8 Setting up the compressor

You must read and follow the following procedures described in the SHI compressor technical manual *installation* section:

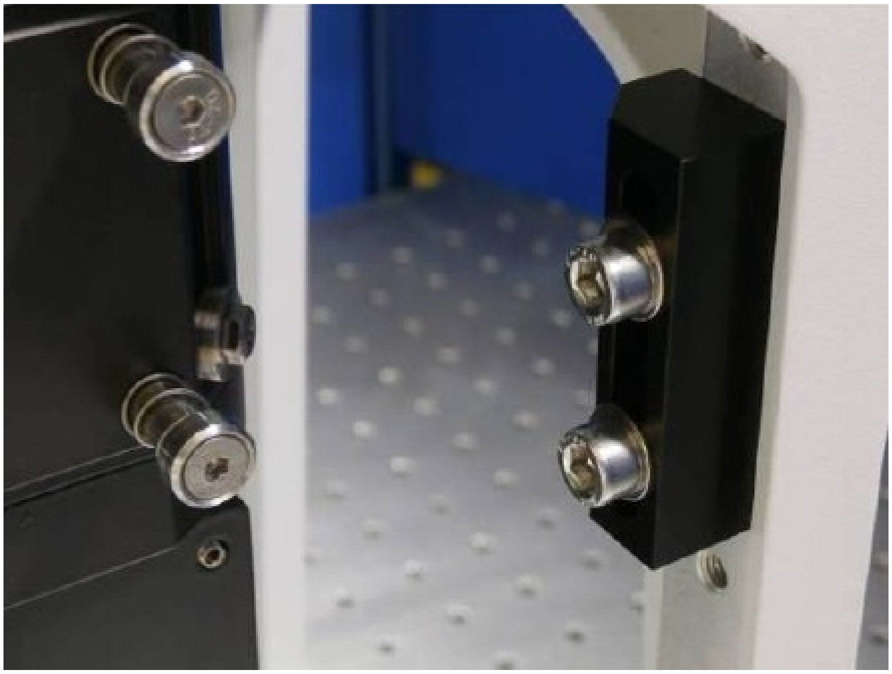

Figure 5.18: Mount the locator blocks

Figure 5.19: Adjust the positon of the blocks

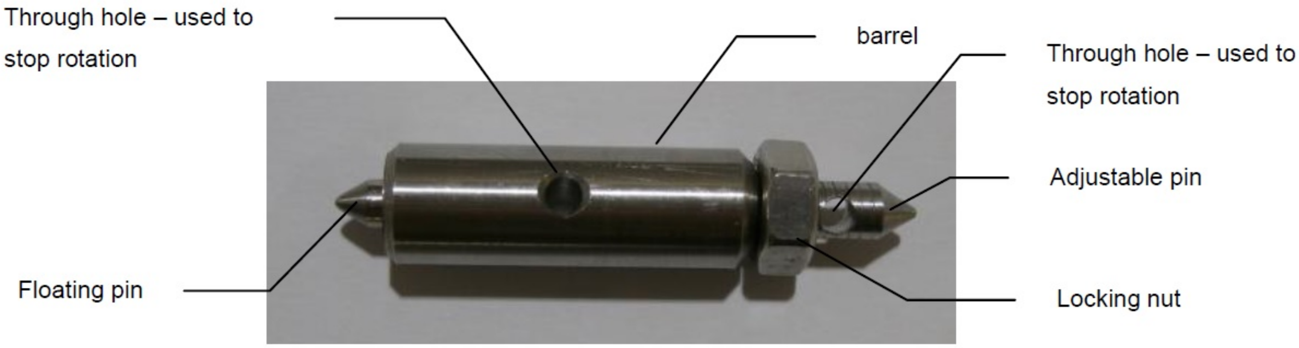


Figure 5.20: Diagram of a radial restraint

Figure 5.21: Adjusting the restraints

Figure 5.22: Fixing the restraint length

- Remove the shipping bolt.
- Mains Power Supply Connection.
- Field Wire the Compressor. 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.


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


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

## 5.9 Setting up the compressor lines

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 lines are otherwise identical.

*xx*

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 so that they exert no force on the cryostat.
- The cryostat 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.
- 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*.
- 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.

Make the connections to the compressor first, following the guidance notes in the SHI Helium compressor technical manual. Connect the cold head motor power cable to the correct receptacle on the compressor front panel. Support the other ends of the lines as described previously before making the 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, gas line length and compressor. The nominal charge is 16.6bar / 240psi

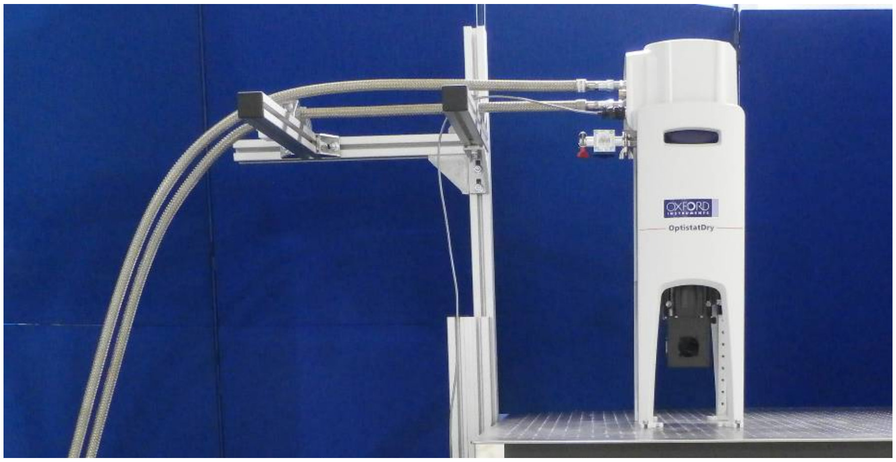


Figure 5.23: Support the lines horizontally

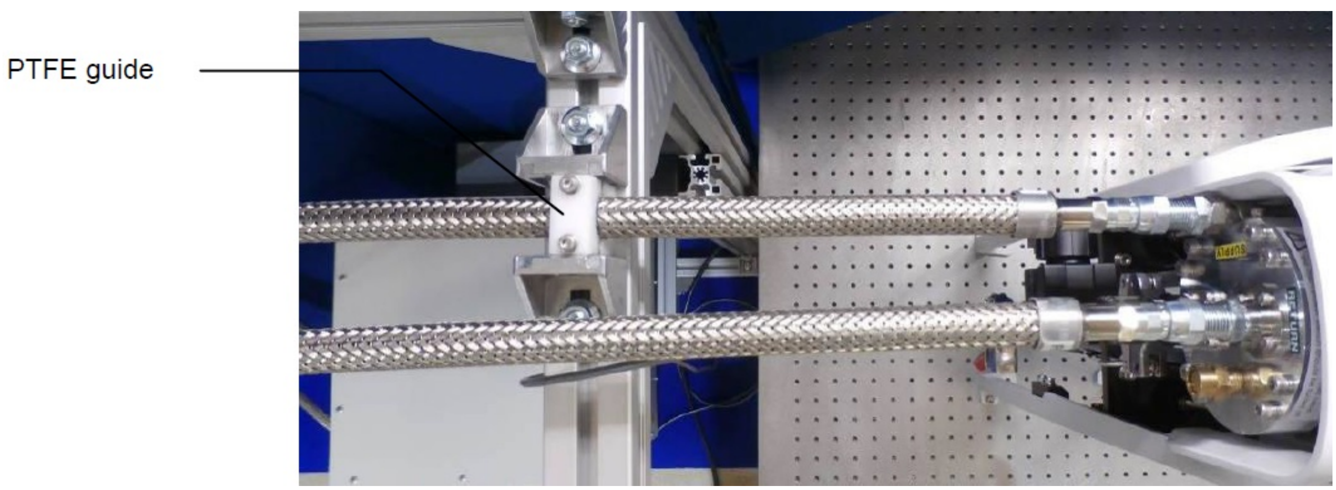


Figure 5.24: Restrain the supply line without damaging it

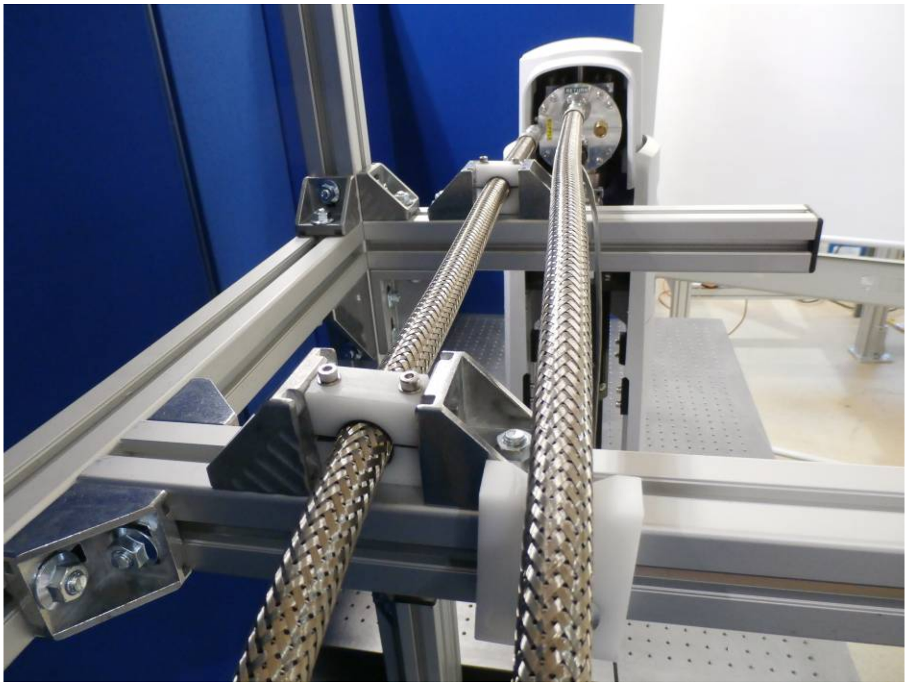

Figure 5.25: Support, but do not restrain, the return line


Figure 5.26: Connections to the compressor

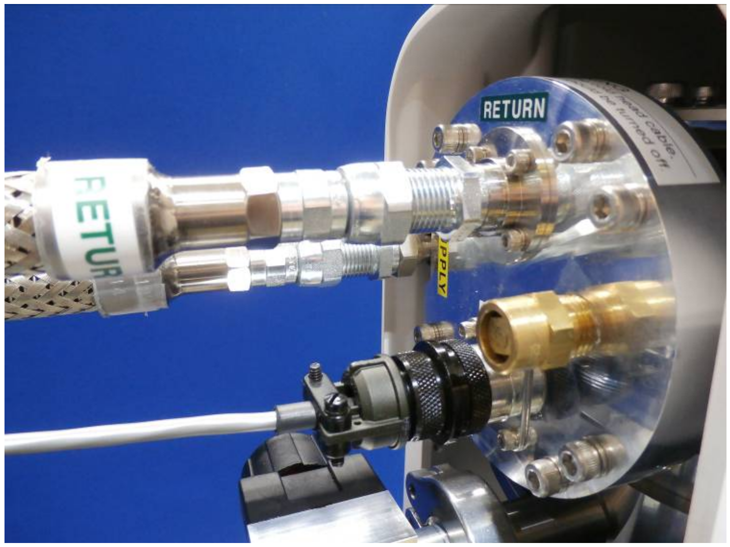


Figure 5.27: Connections to the cold head

## 5.10 Electrical connections to the temperature controller

The Mercury iTC has been configured by Oxford Instruments to suit the system ordered. When you first switch on the Mercury iTC you will see the instrument home screen, similar to that shown below:

The Mercury iTC temperature controller should be connected to the cryostat as follows:

- The cable supplied should be connected between the 15-way D-socket on the rear of the cryostat OVC body and the main sensor/heater connection (9-way D-connector) on the rear of the MercuryiTC.

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.

### 5.10.1 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:

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

If you are planning to use an existing temperature controller, or a power supply or 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 with the test results for the cryostat.

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


Figure 5.28: Mercury home screen


Figure 5.29: Electrical connections to the Mercury iTC

---

- **Next** - System Operation

# 6

# System Operation

This section describes how to cool the OptistatDry BLV to base temperature for the first time with blanking pieces fitted to the radiation shield openings and the OVC window mounts. The 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 ordered, they can be fitted to the system and the appropriate radiation shield openings uncovered.

The steps are summarised below:

- Vent the OVC and remove the sorption pump
- Condition the sorption pump and close up system
- Connect vacuum pump and pump down the cryostat
- Start up the compressor and cool the cryostat
- Monitor cryostat temperature and confirm that it reaches base temperature.)
- Control the sample region temperature at 300K
- Switch off compressor and allow cryostat to warm up.
- Fit the optical windows, if applicable

## 6.1 Venting the cryostat to remove the sorption pump

Carefully open the OVC vacuum valve 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.

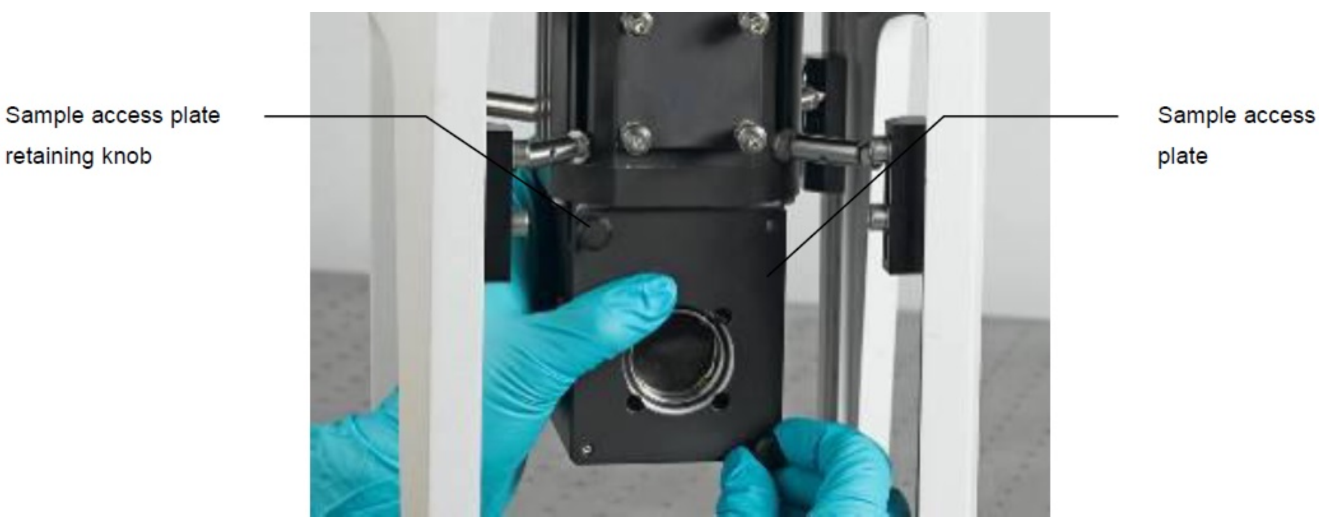


Figure 6.1: Remove the sample access plate

 

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.

Figure 6.2: Remove the radiation shield plate

## 6.2 Conditioning the sorption pump

During use, the cryostat vacuum is maintained using an internal sorption pump (with activated charcoal as the adsorption material). 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.

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

In order to regenerate the sorb, it should be heated to around 100°C, either with a heat gun, fan heater or on a hot plate. Where possible, the sorb should be warmed whilst in a vacuum chamber, which will assist in the removal of contaminants. Hold the sorb at this temperature for at least 10 minutes, whilst pumping to a pressure of 0.1mbar or lower if possible.

Set the sample mounting platform to temperature control at 300K (FIXME see section below…).

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

As soon as the radiation shield plate is cool enough to handle safely, re-fit the plate and securely bolt it into place - the bolts should be tightened to a torque ~1.0Nm.

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

Replace the sample access plate (making sure that the O-ring is clean) on to the window block and secure into place using the retaining knobs. Immediately proceed to pump out the OVC.

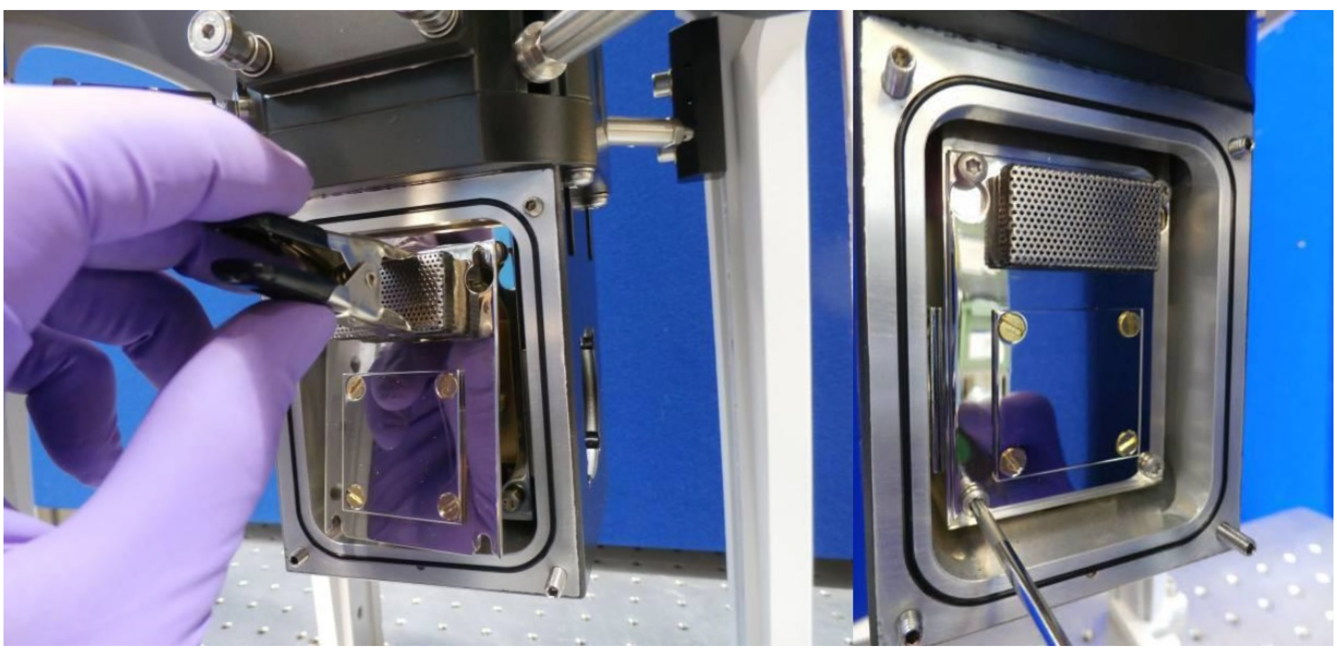

Figure 6.3: Replacing the sample access plate

Always try to minimize the time the OVC and sorption pump are left exposed to atmosphere. It is advisable to refit the radiation plate (with sorption pump) and pump out the cryostat OVC as soon as possible, even if you are not intending to cool the system immediately.

During operation, the refrigerator maintains the sorption pump temperature below 60K 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 once the system is cold.

## 6.3 Evacuate the cryostat

Refer to the manual supplied with the pump for details of how to operate your pump. Optional turbo pumps supplied by Oxford Instruments (H4-600 or H4-601) have their own manuals. If using another pump, the pump should be oil-free and capable of achieving a base pressure of $<1\times10^{-6}$mbar.

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 pump to the cryostat.

Pump out the cryostat to $<1\times10^{-4}$mbar, as indicated by the pressure gauge connected directly to the cryostat pumping port. 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 (when using an OI supplied pump).

## 6.4 Checking the Mercury iTC

Confirm that the correct cables are connected between the Mercury iTC and the cryostat and probe.

Operate the switch on the rear panel of the Mercury iTC so that the "1" is depressed, then press the Power button on the left of the front panel, which will illuminate blue.

The Mercury iTC initialises and the Home page appears on the touch screen. Check that the indicated temperatures, shown in Figure 4□5, are all consistent with your laboratory environmental temperature.

Ensure that the temperature controller is in manual mode and that no heat is being applied to the VTI heat exchanger or sample probe, then close the OVC pumping port valve and disconnect the pumping system. Immediately proceed to start cooling the system by starting the compressor as described below.

## 6.5 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 OVC valve is closed when the compressor is running.

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

Start up the compressor as instructed in the SHI manual, by first closing the compressor circuit breaker and then pressing the power switch. The indicator in the switch will light and the compressor will start.

## 6.6 Running 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.

## 6.7 Temperature control with the Mercury iTC

You can control the temperature of the system either using the heater and sensor on the VTI heat exchanger, or the heater and sensor on the sample probe. The control temperature for the VTI or probe should be a value between base temperature and 300K.

caution Do not set a control temperature higher than 300K.

The MercuryiTC can control the heater power automatically, adjusting the applied power to maintain the set temperature. The Mercury iTC is a three-term controller - the temperature control is optimised by setting the best values for:

- Proportional band (P)
- Integral action time (I)
- Derivative action time (D)

On the Mercury iTC home screen (see above), tap **Control** to give the following screen:


Figure 6.4: mercury-control

Select the *Sensor* that you want to use for control (either VTI or Probe), set the desired control temperature in the *Set Point* box and then switch the heater control from *Manual* to *Auto*.

The PID values given in the test results for the system are suitable to give good stability. If you wish to improve the stability further you may be able to do this by adjusting the three terms slightly. In *Manual* mode, individual PID values can be changed during operation. Control theory and the procedure for optimising the PID values are described in the mercury iTC manual.

## 6.8 Control the sample region at 300K

Set the sample mounting platform to control at 300K; warming to this temperature should take approximately 30 minutes. When the set temperature is reached, leave the system controlling at this temperature for approximately one hour.

## 6.9 Warming the system to room temperature

Switch off the compressor, then use the MercuryiTC to control the VTI heat exchanger at 300K.

When the system temperature is above 100K, as measured by the temperature sensors on the GM cold head stages (GM1 and GM2), it is possible to accelerate the warm up process by introducing a few mbar of **dry** Nitrogen gas into the cryostat via the OVC pump-out port. **Do not use air**. When all the system temperature sensors read above 285K you should stop the VTI heat exchanger temperature control and ensure that the heater output is zero.

## 6.10 Fitting the optical windows

The OptistatDry BLV is supplied with plastic blanks fitted on all window mounts. Windows are supplied separately in protective packaging.

This section describes how to remove blanks and fit or change windows. It is only necessary to change the windows on each axis requiring optical access. Before proceeding, ensure that the system is fully warm by checking that all temperature sensors read above 285K. Windows/blanks can be removed and replaced while the cryostat is mounted on the optical table, as long as there is adequate access.

Should any of the windows require cleaning, wear protective latex gloves. Remove dust or fibres using dry compressed air from an aerosol can. Use lint-free tissue with a suitable solvent (e.g isopropanol) to remove grease or moisture.

- Use dry Nitrogen gas to vent the system via the OVC vacuum valve.
- Each window on the OVC tail is held in place by one O-ring and 4xM3 nylon screws. Remove the nylon screws holding the window in place.
- Next, remove the window or blank. A vacuum tool (such as the Oxford Instruments *DRYLOAD*) or plastic tweezers can be helpful.
- Remove the radiation shield window/blank by removing the spring clip. Fit the new window as required, or leave the mounting point on the radiation shield open.
- Carefully remove the OVC window O-ring. Never use sharp tools when handling O-rings. Clean the O-ring by wiping with lint-free tissue, examining for any damage (cuts, abrasions). If any signs of wear are found, the O-ring must be replaced. Coat the O-ring surface with a thin layer of Silicone vacuum grease, giving a shiny appearance, then carefully place the O-ring back in the groove.
- Remove the OVC window from its protective packaging. Clean if necessary. Hold the window by its edges and place directly on the O-ring.
- Finally, replace the four nylon screws. Tighten the screws uniformly until the heads just make contact with the window surface. 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 nylon 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.

## 6.11 Sample holders

The sample mounting platform has two main variants.

- **Standard sample holder :** A nickel-plated copper blade platform suited to optical experiments with no or limited electrical measurement requirements.
- **Puck sample holder :** A circuit board style platform (puck) suited to combined optical/electrical transport experiments.

Figure 6.5: The standard sample holder

### 6.11.1 Standard sample holder - fitting and removing

To perform a sample change, it is assumed that the system is at room temperature, with the OVC vented with dry Nitrogen gas.

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

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.

Lift up the plate and remove it, storing carefully.

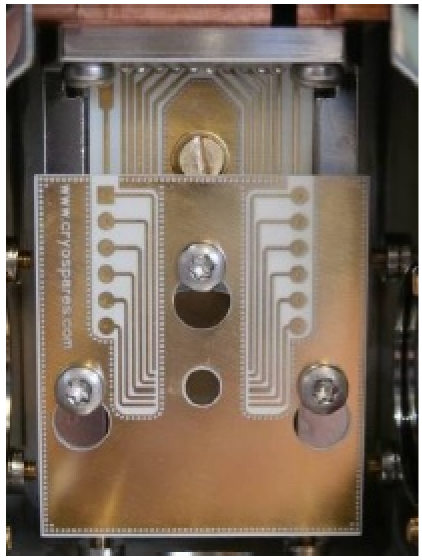


Figure 6.6: The puck sample holder

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.

Whilst the sample is being prepared, it is recommeded that you should re-attach the radiation shield and sample aceess plate and pump out the cryostat, in order to help maintain the condition of the sorbtion pump.

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.

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.

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

### 6.11.2 Removing the optical tail for greater access

This procedure may be helpful if you have the DRYLX20 option 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 above prcedure.

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 window height (A) is greater than 155mm.

Unscrew completely the two knobs holding the sample access plate. Remove the plate and store it carefully. Also remove and store the radiation shield plate as described above.

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.

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

Figure 6.7: Removing the standard sample holder

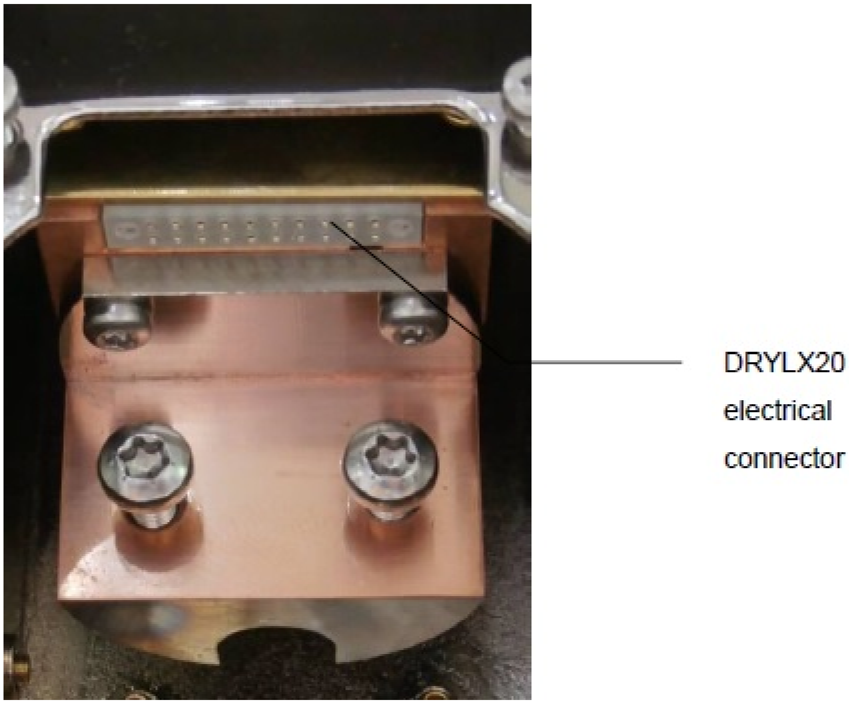


Figure 6.8: DRYLX20 connector near the sample positon

Figure 6.9: Remove the bolts in the OVC

Figure 6.10: Remove the window block

Loosen the four T20 Torx bolts in the radiation shield 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.

Remove the radiation shield tail and store carefully in a clean, dry,sealed bag.

There is now easy access to the sample region and 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 B.

To re-assemble the optical tail, simply follow the reverse of the above procedure.

## 6.12 Puck sample holder - fitting and removing

Remove the sample access plate and the radiation shield plate as described previously.

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.

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.

Before mounting the puck, make sure that the three screws on the sample holder are loosened (by 2-3 turns). 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.

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

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,

Figure 6.11: Remove the bolts in the radiation shield

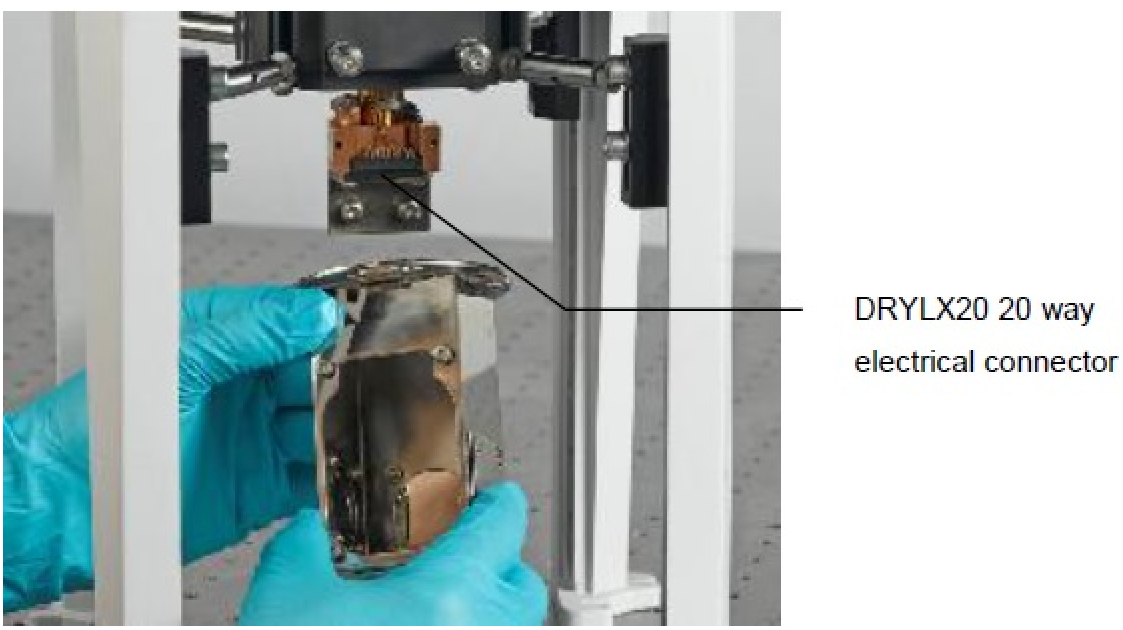


Figure 6.12: Remove the radiation shield tail

 

Figure 6.13: Using the *DRYLOAD* tool

applicable to soldering and aluminium wire bonding, and provides good thermal contact.

Fit the puck, reversing the procedure described above. The sample puck bolts should be tightened to a torque of approximately 1.0Nm.

## 6.13 Conditioning the sorption pump

If the OVC has been vented or if you are experiencing problems with the OVC vacuum whilst the system is running (e.g. unable to cool system to base temperature), follow the steps detailed at the beginning of this chapter. Note that the system must be fully warmed to room temperature before removing the OVC sealing plate.

## 6.14 Cooling and warming the system

Follow the steps outlines above to cool the system for operation, or to warm for sample exchange.

## 6.15 Temperature control

Set the system to control at the desired temperature between base and 300K. Note that you are able to control the temperature of either the VTI heat exchanger or the sample probe. For most experiments it is recommended that you control using the probe heater and sensor as this will give the best sample position temperature control.

caution Do not set a control temperature in excess of 300K.

When the set temperature is reached, the system will control at the set temperature until the control temperature is changed.

---

- **Next** - Service and Maintenance

# 7

# Service and Maintenance

The OptistatDryBLV will deliver repeatable and reliable performance if maintained appropriately during its usage. This section contains basic, essential maintenance information.

## 7.1 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 OINS customer support |
| Compressor adsorber | 30,000 hours | Order: C10-034 |

## 7.2 Rubber O-rings

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

Whenever you remove part of the cryostat, or should you suspect that there is a leak on the system, check the O-rings on the sample space and OVC. Ensure that the O-ring is clean, undamaged and lightly greased. Replace any damaged O-rings.

## 7.3 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 system into its stand on a two year cycle.

## 7.4 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.

## 7.5 Troubleshooting

Should you encounter a problem with your system, it is first important to establish the source. This could be:

- The cold head and compressor
- The MercuryiTC
- Within the OptistatDryBLV cryostat itself.

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.

Diagnosis of MercuryiTC temperature controller faults should be made using the MercuryiTC manual *Troubleshooting* chapter.

Refer to the following table for problems arising from the OptistatDry BLV cryostat or a combination of the above.

| Problem | Possible cause | Recommended action |
|---|---|---|
| Poor temperature control | Incorrect temperature controller PID settings | Refer to the system's test results and the MercuryiTC manual |
| | Heater or sensor wiring fault | Check wiring resistances and compare with values in the appendix |
| High base temperature | Poor cryostat vacuum | See actions below |
| | Thermometer fault | Check sensor resistance at base temperature and compare with the supplied sensor calibration data (remember to account for the resistance of the system wires if not making 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<br>Check the cryocooler compressor's run-time counter and compare with recommended SHI service intervals |
| | Temperature controller fault | Refer to MercuryiTC manual |
| Condensation on OVC body | Poor cryostat vacuum | See actions below |
| Condensation on OVC windows | Air humidity | Use a dry nitrogen source to shield the windows |
| 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<br>Check windows are correctly sealed and undamaged<br>Check electrical connector is undamaged<br>Check over pressure relief valve is correctly sealing<br>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 unable to resolve the problem, please direct allqueries through your nearest support facility.

---

- **Next** - Appendices

# 8

# OptistatDry BLV Specifications

## 8.1 Performance

- Temperature range: ~6.5 to 300 K
  - May be extended down to < 3 K (see notes)
- Temperature stability: ± 0.1 K

## 8.2 Vibration

- Typical RMS displacement of 10 microns at the sample position

## 8.3 Operating Cycle

| **System Cooldown** | Specification |
|---|---|
| Room temperature to base (LX20) | approx. 2.5 hours |
| Room temperature to base (DC12) | approx. 3.0 hours |

## 8.4 Physical

| Parameter | Specification |
|---|---|
| Dimensions (HxWxD) | 635-900 (adjustable) x 240 x 290 mm |
| Cryostat+Stand Weight | 23 kg |
| Compressor Weight | **Standard A** 111 kg or **Option W** 82 kg |

## 8.5 Gifford-McMahon Refrigerator

The refrigerator is a Sumitomo SHI 101D cold head with **Standard A** SHI HC4A2 air-cooled or **Option W** SHI HC4E2 water-cooled compressor.

- Service intervals
  - Displacer replacement: 10,000 hrs
  - Compressor absorber: 30,000 hrs

## 8.6 Electrical Power

**Single Phase**

The maximum power consumption of each unit in this application is:

| Component | Power Consumption | Voltage | Frequency |
|---|---|---|---|
| MercuryiTC controller | 450 W | 100 - 240 V | 50 / 60 Hz |
| Compressor **Standard A** | 3.0 kW | 200V, 220V, 230/240 V | 50 Hz |
| Compressor **Standard A** | 3.4 kW | 220 V | 60 Hz |
| Compressor **Option W** | 2.6 kW | 200V, 230/240 V | 50 Hz |
| Compressor **Option W** | 3.0 kW | 208 - 230 V | 60 Hz |

- The GM compressor power comsumption figures are for steady-state useage. Start-up power requirements may exceed this, typically by 10%.
- The GM compressor requires a single phase mains supply. A standard wall supply may not meet the power requirements.

**Three Phase**

- None

## 8.7 Environment

| Parameter | Nominal Value |
|---|---|
| Compressor ambient temperature range | 7°C to 38°C (45°F to 100°F) |

## 8.8 Notes

- The standard cryostat is fitted with 4 optical radial windows and 1 blank axial window.
- Base temperature may be reduced by fitting blanks to each of the windows. Radial window blanks are supplied as spares with the system.
- The maximum operating temperature will be set accordingly in the Mercury iTC supplied with the system.

## 8.9 Further Information

- Test Specifications
- OptistatDry Index

# 9

# Appendices

## 9.1 Appendix A - System weights and dimensions

| Component | Dimensions D x W x H / mm | Weight / kg |
|---|---|---|
| OptistatDry BLV cryostat | 290 x 170 x 635 | 16 |
| Cryostat with support stand | 290 x 240 x 900 (max) | 23 |
| Mercury iTC | 310 x | tbd |
| Sumitomo compressor | 485 x xxx x xxx | tbd |

The dimension across the BLV tail is 80mm.

## 9.2 Appendix B - System wiring configuration

### 9.2.1 15-way micro-D connector to sample sensor and heater

| Hermetic micro-D connector pin | Wire type | Sensor / Heater | Typical resistance at 300K |
|---|---|---|---|
| 1 | Constantan 42SWG | Cernox sensor (V-) | From pin 1 to: |
| 9 | Constantan 42SWG | Cernox sensor (V+) | 200 - 300 Ω |
| 2 | Constantan 42SWG | Cernox sensor (I+) | 200 - 300 Ω |
| 10 | Constantan 42SWG | Cernox sensor (I-) | 150 - 200 Ω |
| 3 | Copper 36SWG | Firerod heater (I+) | from pin 3 to: |
| 11 | Copper 36SWG | Firerod heater (I+) | 40 Ω |
| other | | not used | |

### 9.2.2 21-way micro D connector to DRYLX20

| Hermetic micro-D connector pin | Wire type | Solder pin number |
|---|---|---|
| 1 | Constantan 42SWG | 1 |
| 12 | | 12 |
| 2 | Constantan 42SWG | 2 |
| 13 | | 13 |
| 3 | Constantan 42SWG | 3 |
| 14 | | 14 |

| Hermetic micro-D connector pin | Wire type | Solder pin number |
|---|---|---|
| 4 | Constantan 42SWG | 4 |
| 15 | | 15 |
| 5 | Constantan 42SWG | 5 |
| 16 | | 16 |
| 6 | Constantan 42SWG | 6 |
| 17 | | 17 |
| 7 | Constantan 42SWG | 7 |
| 18 | | 18 |
| 8 | Constantan 42SWG | 8 |
| 19 | | 19 |
| 9 | Constantan 42SWG | 9 |
| 20 | | 20 |
| 10 | Copper 36SWG | 10 |
| 21 | | 21 |
| 11 | not used | |

DRYLX20 mating connector board

The DRYLX20 option comes with a mating connector board, as 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 the table above). 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.

## 9.3 Appendix C - Sample puck options

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.

| Hermetic micro-D connector pin | Wire type | Track number DRYPUCK12R / 12T |
|---|---|---|
| 1 | Constantan 42SWG | 1 |
| 12 | | 2 |
| 2 | Constantan 42SWG | 3 |
| 13 | | 4 |
| 3 | Constantan 42SWG | 5 |
| 14 | | 6 |
| 4 | Constantan 42SWG | 7 |
| 15 | | 8 |
| 5 | Constantan 42SWG | 9 |
| 16 | | 10 |
| 10 | Copper 36SWG | 11 |
| 21 | | 12 |
| 6, 7, 8, 9 | not used | |
| 17, 18, 19, 20 | not used | |

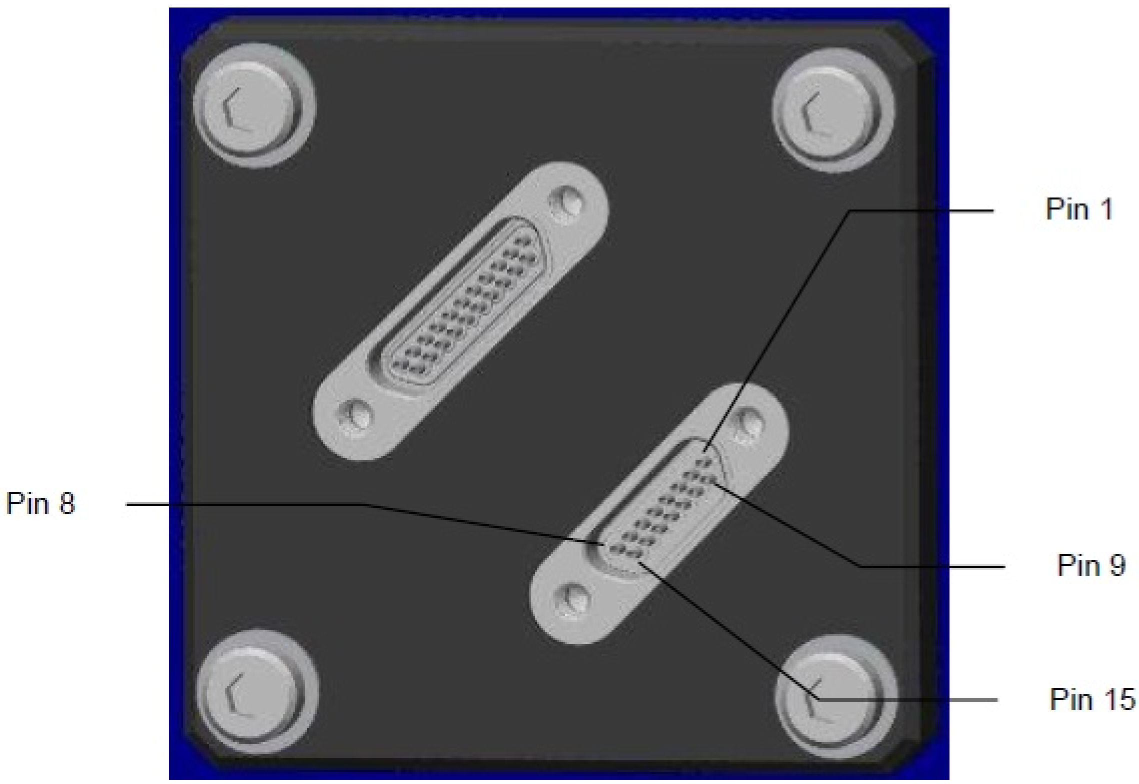


Figure 9.1: 15-way pin numbering

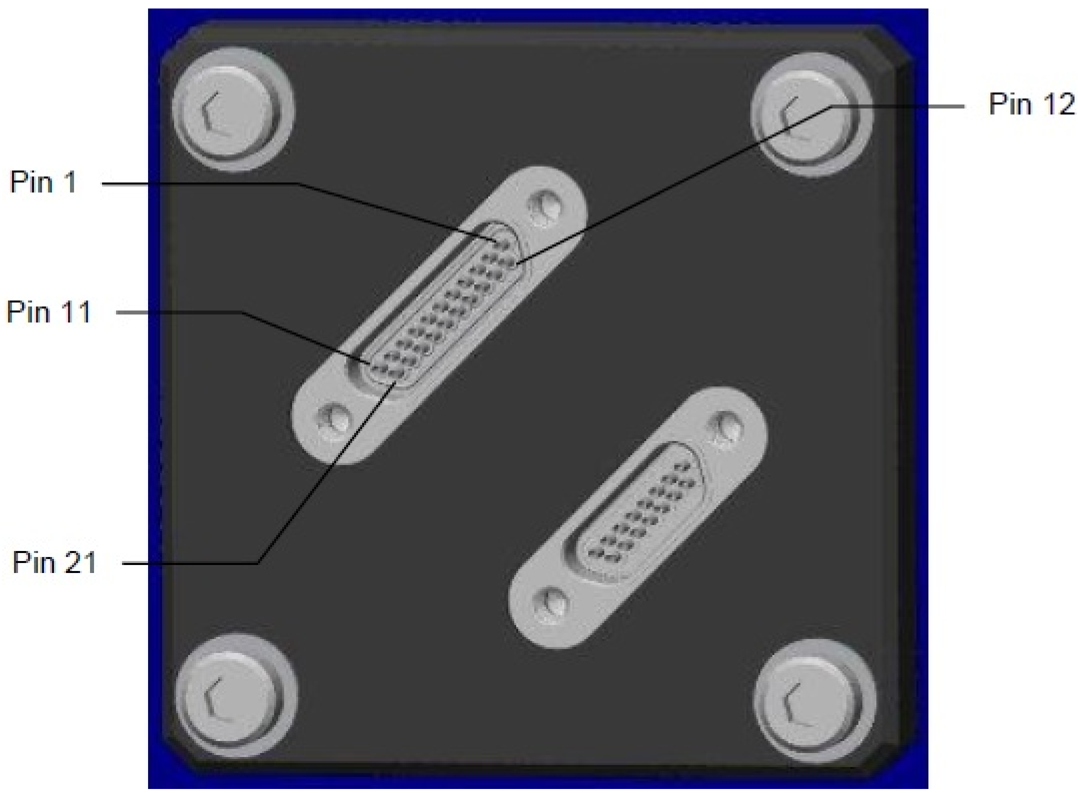


Figure 9.2: 21-way pin numbering

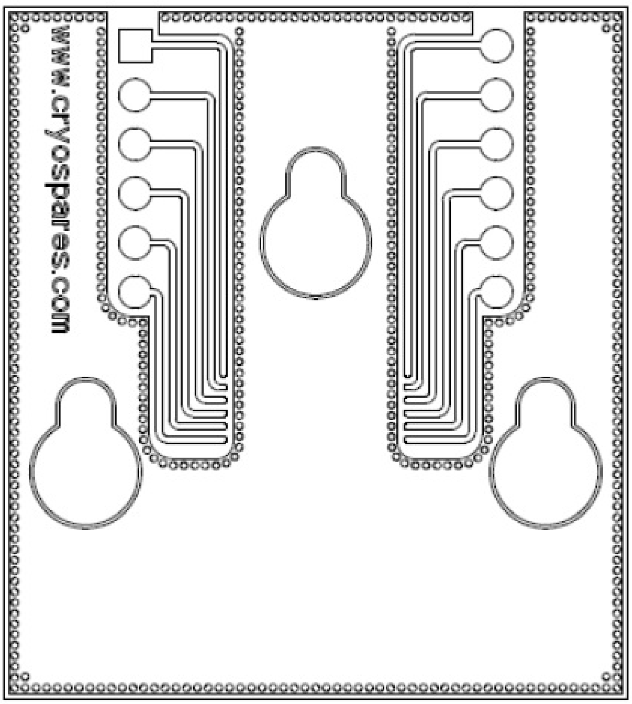


Figure 55 DRYPUCK12R sample puck for reflection measurements with 12 DC connections for customer use.

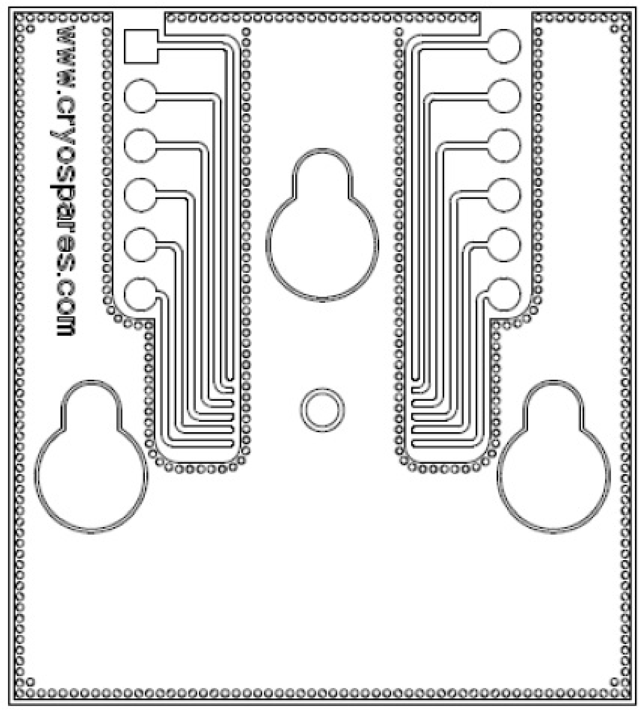


Figure 56 DRYPUCK12T sample puck for transmission measurements (a 4mm diameter opening) with 12 DC connections for customer use.

Figure 9.3: DRYPUCK12R and 12T puck schematics

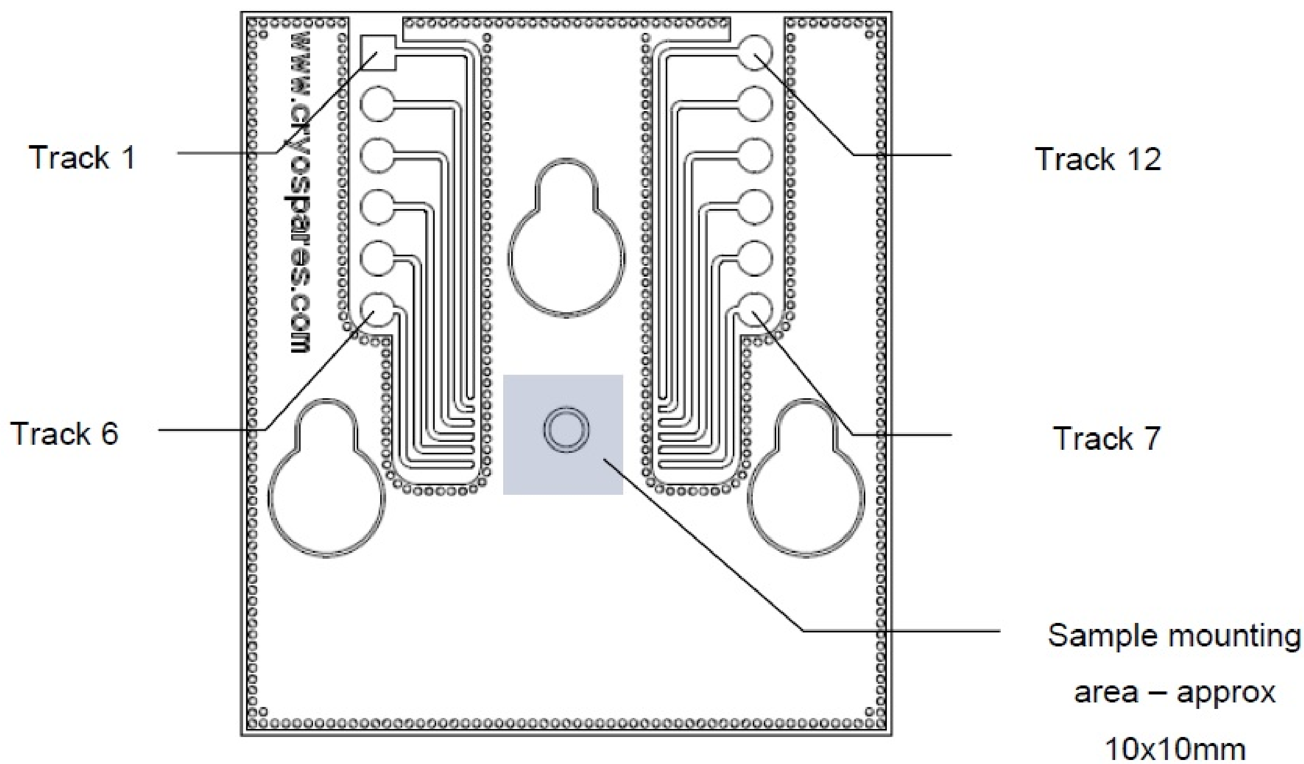


Figure 9.4: Puck track numbers and sample position

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.

---

- **Back to** - OptistatDry BLV front page