Integral variable temperature insert and helium reservoir cryostat, with interchangeable tails and inserts

The Variox provides a controlled low temperature sample environment, in which the sample is cooled through a static exchange gas. This system offers extremely good temperature control and fast cool down times. Its base temperature (1.6 K) and automated features make the Variox ideal for many applications.

Components

The basic structure of a Variox cryostat is:

- VTI: Variable temperature insert
- OVC: Outer vacuum container. This is the main body of the cryostat
- IVC: Inner vacuum container which provides an inner thermal barrier for the VTI
- Tail: bottom assembly of the cryostat, which can be configured to fit the experimental interface

To run a Variox cryostat, the following items are required:

- Cryogen transfer tube
- ITC temperature controller
- High vacuum pumping system
- Gas flow pump

Optional:

- Nitrogen and helium level meter
- Gas flow controller
- Wiring and electrical connections to the sample
- Ultra low temperature inserts

Features and benefits:

- 1.6 to 300 K temperature range (using a 40 m^3/hr gas flow pump)
- No helium refill required over a 3 day period with VTI running at base temperature
- Extremely low helium consumption (0.15 L/hr), optimised by using an automated needle valve
- Large sample space (50 mm diameter as standard and larger diameters available on request)
- Compatible with the HelioxVT (^{3}He system) and KelvinoxVT (Dilution Refrigerator) inserts giving access to milliKelvin temperatures
- Wide range of demountable tails to suit various applications
- The exchange gas sample environment ensures rapid sample change and fast cool down time
- User friendly: Hands-off operation using the auto needle valve to regulate the helium flow
- Convenient control of the sample space exchange gas pressure by using a 3-way valve
- Optimised thermal design provides excellent control and stability of the sample temperature (0.1 K)
- A heater, fitted at the bottom of the needle valve, prevents blockages

Applications:

- Neutron and muon scattering experiments
- X-ray scattering and absorption measurements
- Mössbauer spectroscopy
- Optical spectroscopy
- Magneto-optical spectroscopy, when used in conjunction with an electromagnet
- General physical properties measurements, eg: electrical, magnetic, heat capacity

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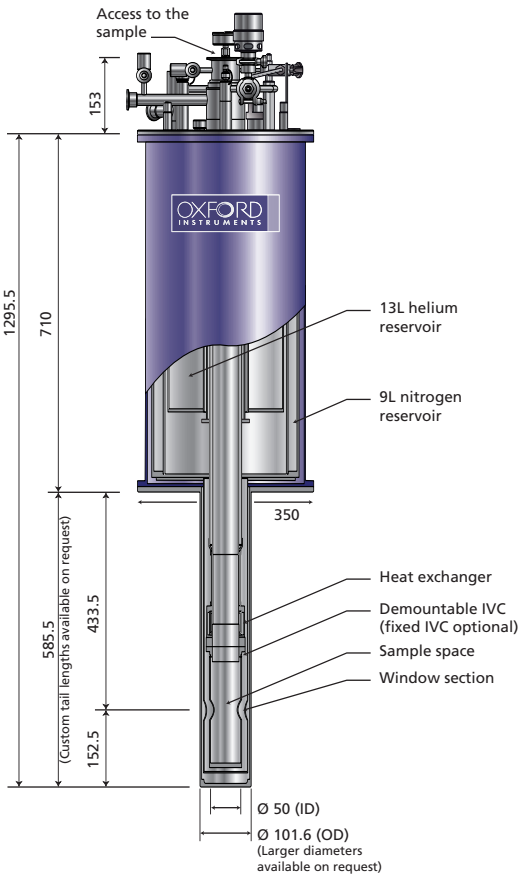
Mode of operation

The Variox has a 13-litre helium reservoir shielded by a 9-litre nitrogen reservoir. An integrated variable temperature insert extends into the lower section (tail) of the cryostat, configured to provide the appropriate experimental interface. Liquid helium from the main reservoir passes through a needle valve and via a capillary tube to a heat exchanger surrounding the central sample tube. The heat exchanger is fitted with a heater and a Cernox temperature sensor. The temperature of the heat exchanger is controlled by the dual action of regulating the helium flow and the electrical power in a resistive heater in contact with the heat exchanger. The temperature-controlled liquid/gas then flows up an annular channel surrounding the central sample tube, which contains low-pressure helium exchange gas to cool the sample. The coolant exits at the top of the cryostat and passes to a gas flow pump and controller combination.



Variox

The cryostat is fitted with a 3-way valve, enabling the control of the exchange gas pressure in the sample space, by allowing helium gas to be tapped off from the main bath to fill the sample space.

The sample is mounted on a sample rod and inserted into the helium exchange gas down the central variable temperature insert. For experiments requiring high accuracy temperature monitoring at the sample position, an extra temperature sensor can be fitted to the sample holder.

Interchangeable inserts

Rotation and height adjustment

To optimise the sample position and orientation, a sample rod can be provided with height adjustment (+/- 15mm, standard) and 360° rotation (optional).

Access to mK temperatures:

The Variox cryostat can also be fitted with a ^{3}He insert (HelioxVT-300 mK base temperature) or a dilution refrigerator (KelvinoxVT-30 mK base temperature). Note: this requires 1.6 K operation in the variable temperature insert.

All inserts are interchangeable providing experiment flexibility and a completely integrated solution.

Height adjustment sample rod Rotational stage available on request)

HelioxVT insert

KelvinoxVT insert

Choice of tails

The Variox tail can be supplied in different configurations depending on the application:

Neutron scattering: VarioxNS

Neutrons interact with the nuclei of the material being studied and are then scattered at angles, which are a function of the atomic structure within the material.

The favoured tail material for neutron experiments is aluminium because it is a weak neutron scatterer and virtually transparent to the neutron beam.

The VarioxNS tail is supplied with 0.5 mm thinned Aluminium (360° access) in the beamline region.

Muon scattering: VarioxMS

In muon scattering, muons are being implanted into a material then decay into positrons whose direction of emission is dependent on the local magnetic field of the host material. Muons are often a probe of the magnetic properties of the sample so no magnetic material should be present in the vicinity of the beamline. Generally muons have little penetrating power so cryostat windows need to be very thin.

For the VarioxMS, the tail is fitted with:

- Two 40 mm dia. Kapton inner windows, located at 180° to each other.
- Two 50 mm dia. aluminised Mylar radiation shield windows, located at 180° to each other.
- Two 50mm dia. aluminised Mylar outer vacuum chamber windows, located at 180° to each other.

The aluminised Mylar and Kapton windows are 127 µm thick.

X-ray scattering: VarioxXS

Generally X-Rays do not penetrate very much below the surface of the material being studied.

The favoured material for the cryostat tail, in this case, is Beryllium or Kapton film.

Mössbauer spectroscopy: VarioxMOS

The Variox is a low vibration cryostat so is convenient for Mössbauer applications. The VarioxMOS is fitted with Mylar windows.

Optical spectroscopy: VarioxOS

For optical spectroscopy applications requiring long hold time, high temperature stability and/or milliKelvin temperatures, an optical tail can be provided. Up to five sets of windows can be provided (four radial and one axial). All windows are demountable and may be exchanged at a later date for measurements over different regions of the optical spectrum. Oxford Instruments offers an extensive range of window materials permitting spectroscopic measurements from ultraviolet to extreme infrared (including THz applications).

Physical properties measurements:

For these measurements, the cryostat can be provided with a plain tail.

Removable OVC tail

The OVC tail section can be removed to integrate the cryostat within a beamline vacuum.

Custom tails

The dimensions for the standard tail are indicated on the drawing on the opposite page. However we can also supply custom tails to fit your experimental requirements.

High temperature option

A 400 K temperature option is available on request.

The MuSR spectrometer at ISIS (pulsed neutron & muon source situated at the UK Rutherford Appleton Laboratory near Oxford) regularly uses a Variox cryostat. The main advantage for the ISIS team is the fast cool down time and automatic needle valve (it can be used above 5 K). The cryostat is used to investigate novel materials using muon spin relaxation and rotation. Materials such as high temperature superconductors, frustrated magnetic systems and organic conductors are under investigation. The Variox cryostat is compatible with their Kelvinox dilution refrigerator insert, which broadens the temperature range from 35 mK to 300 K. Since experiments at ultra low temperatures are performed within the same cryostat, the background remains constant over the full temperature range.

Automated operation

Automated operation of the Variox is possible with the automated needle valve supplied as standard. A heater is fitted at the bottom of the needle valve body to avoid blockages. This, coupled with the advanced features of the ITC temperature controller, allows fully automated control across the entire temperature range (1.6-300 K).

Electrical access

For electrical measurements, wires may be terminated at pins above the sample holder and/or on wired coax connectors. This provides maximum flexibility for different experimental configurations. Contact your local sales representative for special requirements.

System components

VARIOXNS	Variox cryostat for Neutron scattering
VARIOXMS	Variox cryostat for muon scattering
VARIOXXR	Variox cryostat for X-ray scattering
VARIOXMOS	Variox cryostat for Mössbauer spectroscopy
VARIOXOS	Variox cryostat for Optical spectroscopy

Optional items:

VSR	Height adjustment sample rod
ITC503	Temperature controller
CC1	3m Cryostat cable
TTN2F	Flexible liquid helium transfer tube
GF4	Gas flow pump (for 3 K base temperature)
EPS40	40m³/hr helium pumping system (for 1.6 K base temperature)
VC41	Gas flow controller with helium and nitrogen flowmeter
ILM211	Nitrogen and helium double level meter and probes
TSR	Calibrated Rhodium Iron sensor wired to the sample rod (for 400 K temperature option)
LX10	Wired 10 pin seal
CX1	Wired miniature coax connector
HVP	Turbo vacuum pumping station

Insert options:

SRHG	Sample holder height adjust and goniometer
HELIOXVT	Heliox insert
KELVINOXVT	Kelvinox insert

Standard Specifications

Temperature range	1.6-300 K (using EPS40 pump) 3-300 K (using GF4 pump)
Liquid helium volume	Nominally 13 L
Liquid helium consumption at 4.2 K	Nominally 150 cc/hr (with sample rod and insert at base temperature)
Liquid helium hold time	More than 72 hours
Liquid nitrogen volume	Nominally 9 L
Liquid nitrogen consumption	Nominally 300 cc/hr
Liquid nitrogen hold time	30 hours
Sample space	50 mm in diameter
Temperature stability	+/- 0.1 K using Oxford Instruments ITC controller (measured over 20 min period)
Cooldown time to base temperature	Less than 60 minutes (Note 1)

Notes: **1.** Starting conditions: Helium bath at 4.2 K and variable temperature insert at 300 K.
2. These specifications are based on VarioxMS tail configuration.

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