



Magneto-optical superconducting magnet systems

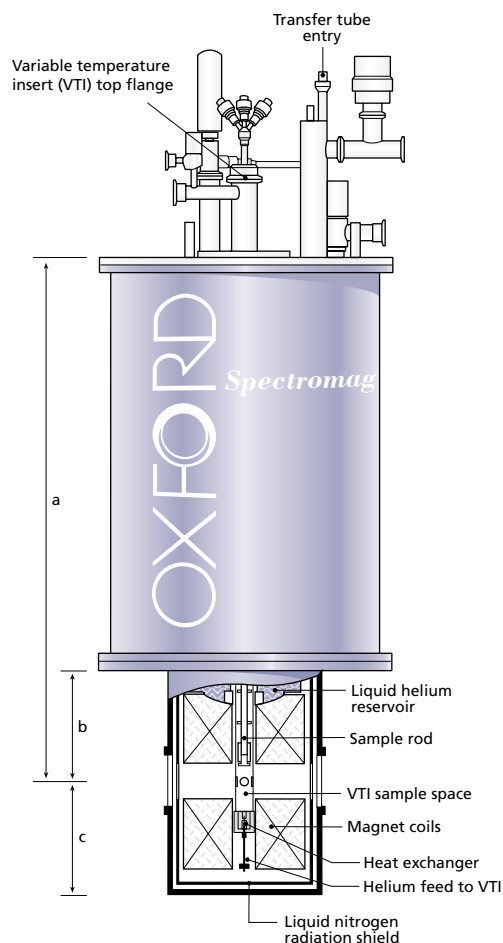
The Spectromag SM4000 superconducting split pair, horizontal field magnet system, provides optical access to a sample in a variable magnetic field / low temperature environment.

System features include:

- Magnetic fields up to 11 tesla in a compact geometry
- Inserts to provide sample temperatures from 0.45 to 300 K
- Rectangular tails cryostat providing excellent optical access to the sample
- Wide range of windows for measurements from the near ultra-violet to the far infra-red
- Option for fully automatic control

The Spectromag may be used for a wide range of applications, including:

- Magneto circular dichroism
- Mössbauer spectroscopy
- Raman spectroscopy
- Photoluminescence
- Faraday effect measurements



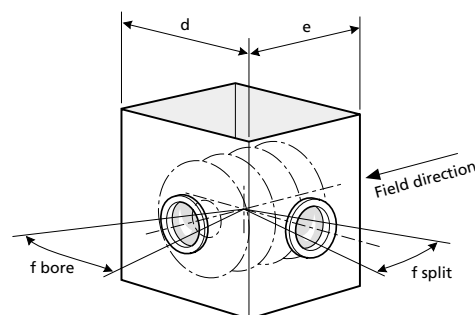
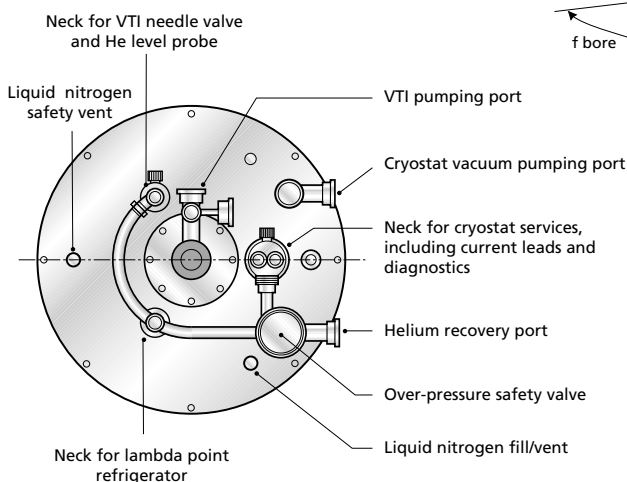
Basic spectromag SM4000 system configuration

System profile

The Spectromag SM4000 system comprises:

- Horizontal field split pair superconducting magnet
- Ultra-low boil-off helium cryostat with fixed low loss current leads for safe and efficient operation
- Cryostat tails with a rectangular cross section to:
 - maximise the optical access to the sample
 - reduce the dead volume of liquid helium surrounding the magnet
 - increase the efficiency of the lambda point refrigerator used to provide enhanced fields at 2.2 K
- 1.5 to 300 K variable temperature insert:
 - top loading to allow samples to be changed while the system is cold and the magnet is at field
 - dynamic type where helium passes through a heat exchanger at the base of the sample tube before flowing directly over the sample
 - automatic stepper motor controlled needle valve (control via ITC503 temperature controller)
 - needle valve fitted with a heater to allow blockages to be cleared without the need to warm up the entire system.
 - heat exchanger fitted with heater and calibrated Cernox sensor to allow temperature measurement and control

- Sample tube clear inner diameter of 25 mm permits full rotation of the sample, for measurements both parallel and perpendicular to the field
- Sample rod with manual ± 15 mm axial adjustment and 360° rotation about a vertical axis
- Optical access in the horizontal plane both parallel and perpendicular to the field
 - tails and insert fitted with 4 radial sets of Spectrosil B quartz windows in strain free mounts
 - no liquid helium in the optical paths (other than in the sample space at temperatures below 4.2 K)
 - other window materials are available to suit particular experimental requirements.
- Electronics cabinet including
 - magnet power supply
 - temperature controller
 - cryogen level meters and probes
 - interconnecting cables



Spectromag SM4000
cryostat tail unit
configuration

Spectromag top plate services

Low temperature option

- 0.45 to 80 K HelioxTL ³He insert
 - changing the inserts is an easy operation, requiring the replacement of only one indium seal, and the operation takes a few hours with the cryostat warm
 - integral sorption pump
 - 4 radial Spectrosil B quartz windows in strain-free mounts
- Top loading probe with a wired 24-way connector.

Sample holders

The Spectromag system is supplied with a sample rod with three 10-pin Fischer connectors, one wired and two unwired. The sample rod, which is provided with an axial adjust

mechanism, also allows the sample to be rotated about a vertical axis and can be fitted with a range of standard sample holders.

Special sample rods are available to provide precision movement of the sample about vertical and horizontal axes. In most cases automatic control using a stepper motor drive is also possible.

Control system

All standard electronic items are provided with LabVIEW[®] drivers to allow control through the Oxford Instruments LabView System Control Software. The software allows LabView users to control the sample temperature and magnetic field. In

addition it is possible to integrate with other virtual instruments to provide full experimental control.

The Lambda Point Controller (LPC) complements the LabView System Control Software to provide computer control of the cryogenic environment for the magnet. In particular it carries out control and monitoring functions associated with cooling the magnet below 4.2 K for operation at higher field. The LPC is able to monitor and control the operation of the lambda point refrigerator. It controls a stepper motor driving the refrigerator's needle valve, senses the pumping pressure and monitors the temperature sensors on the coils of the lambda point refrigerator.

System configurations

Model	SM4000-8	SM4000-9	SM4000-10	SM4000-11
System height (m)	1.28	1.32	1.32	1.32
Ceiling height (to remove unjointed sample rod) (m)	2.3	2.3	2.3	2.3
Weight (approx.) (kg)	135	140	145	145
Dimension a (mm)	823	823	823	823
Dimension b (mm)	172	172	172	172
Dimension c (mm)	141	181	181	181
Dimension d (mm) perpendicular to field*	245	316	316	316
Dimension e (mm) parallel to field*	248	241	241	241

* The window mounts protrude from the surface of the cryostat tail unit by 5 mm

Specifications

Part number	SM4000-8	SM4000-9	SM4000-10	SM4000-11
Magnet				
Field at 4.2 K	7 tesla	8 tesla	10 tesla	10 tesla
Field at 2.2 K	8 tesla	9 tesla	N/A	11 tesla
Homogeneity (over a 10 mm diameter sphere)	0.6 %	0.6 %	0.6 %	0.6 %
Current at 4.2 K	<100 A	<100 A	<100 A	<100 A
Current at 2.2 K	<120 A	<120 A	N/A	<120 A
Stability in persistent mode	<0.01 %/hr	<0.01 %/hr	<0.01 %/hr	<0.01 %/hr
Sweep rate at 4.2 K (with IPS120-10)	1 tesla/min	1 tesla/min	1 tesla/min	1 tesla/min
Cryostat				
Helium volume	20 l			
Helium consumption	0.18 l/hr (zero helium flow through insert and zero current in magnet leads)			
Helium hold time	>100 hr			
Nitrogen volume	24 l			
Nitrogen consumption	0.5 l/hr			
Nitrogen hold time	>40 hr			

Variable temperature insert	
Temperature range	1.5 to 300 K
Temperature stability	
below 4.2 K	±0.05 K
above 4.2 K	±0.1 K
Sample space diameter*	25 mm

* Optional 30 mm sample space diameter is available with restricted temperature range

HelioxTL ³He insert

Temperature range	<0.45 to 1.5 K (windows open)
Temperature stability	
below 1.2 K	≤ ±3 mK
above 1.2 K	±0.1 K
Hold time at base temperature	>10 hours (windows open)
Sample space diameter	25 mm
Ceiling height required	3.3 m (nominal)



Typical custom built sample holders

Alternative window materials

Material	Inner window	Outer window
Spectrosil B quartz	✓	✓
Spectrosil WF quartz	✓	✓
Crystalline Quartz	✓	✓
Zinc Selenide	✓	✓
Zinc Sulphide	✓	✓
KRS 5	✗	✓
Polypropylene	✓	✓
Mylar	✓	✓
Aluminised Mylar	✓	✓

Key: ✓ – Window available ✗ – Window material not suitable

Please note: radiation shield fitted with re-entrant tube as standard, i.e no windows fitted.

The following table shows the window diameters for the Spectromag system.

Note that the clear access to the sample space is determined by the inner window clear access which is 10 mm (diameter) in all cases.

Access	Through the split	Along the bore
Inner window	10 mm diameter	10 mm diameter
Re-entrant tube	14 mm diameter	14 mm diameter
Outer window	60 mm diameter	80 mm diameter
Reduced outer window*	40 mm diameter	40 mm diameter

* An optional 40 mm diameter window is available for Zinc Selenide, Zinc Sulphide and KRS5. This does increase the f-number (see below).

The f-number of the system depends on the combination of windows and re-entrant tubes. The different options are summarised below. Note that if any combination of standard windows, re-entrant tubes and 40 mm outer windows is used in the same set then the f-number for the set is the largest f-number.

Model	SM4000-8	SM4000-8	SM4000-9 SM4000-10 SM4000-11	SM4000-9 SM4000-10 SM4000-11
	Bore	Split	Bore	Split
Standard windows (with re-entrant tubes)	f/2.4	f/4.2	f/2.4	f/5.9
With 40 mm outer windows	f/4.1	f/4.2	f/4.0	f/5.9

Window thicknesses

Material	Inner window	Outer window along the bore	Outer window through the split
Spectrosil B quartz	2 mm	3 mm	2 mm
Spectrosil WF quartz	2 mm	3 mm	2 mm
Crystalline Quartz	2 mm	2 mm	2 mm
Zinc Selenide	2 mm	3 mm	2 mm
Zinc Sulphide	2 mm	3 mm	2 mm
KRS 5	N/A	2 mm*	2 mm*
Polypropylene	75 µm	2 mm*	2 mm*
Mylar	127 µm	127 µm	127 µm
Aluminised Mylar	127 µm	127 µm	127 µm

* 40 mm diameter window



IPS120-10 Magnet Power Supply



ITC500 Series Temperature
Controllers



ILM200 Series Cryogenic Level
Meters

Special systems

Special versions of Spectromag are available and include:

■ Vertical field split pair magnets

These systems provide optical access and variable temperature inserts as per the standard Spectromag. Special systems are available for Mössbauer spectroscopy experiments with a vertical cooled source/absorber configuration.

■ Horizontal field solenoids with room temperature bores

These systems are particularly suited to beamline experiments and fields up to 11 tesla are available with a room temperature bore of 50 mm, using the standard Spectromag cryostat. Special systems with higher fields and bores are available by quotation. The use of a separate continuous flow cryostat provides for sample temperatures down to <4 K.

■ Vertical field solenoids with variable temperature insert and axial optical axis

Fields up to 18 tesla are available using the standard Spectromag cryostat. The variable temperature inserts are provided with Spectrosil B quartz windows in the base. Special systems are available for Mössbauer spectroscopy experiments with a vertical cooled source/absorber configuration.

■ Higher homogeneity magnets

Experiments such as ODMR (optically detected magnetic resonance) and EPR (electron paramagnetic resonance) require magnetic fields with uniformities of up to 10 ppm. Special versions of the Spectromag have been produced for these applications and are available by quotation.



Horizontal bore solenoid configuration



Vertical bore solenoid configuration

System Components

SM4000	<ul style="list-style-type: none"> ■ Cryostat with horizontal field split pair magnet ■ Lambda point refrigerator for 2.2 K operation of magnets ■ Variable temperature insert ■ Sample rod with three 10-pin Fischer connectors, one wired down to sample position. ■ 4 radial sets of Spectrosil B quartz windows ■ Accessories and spares kit
ECSM	<ul style="list-style-type: none"> ■ Electronics cabinet including ■ IPS120-10 magnet power supply ■ ILM211 helium-nitrogen level meter and probes ■ ITC503 temperature controller ■ CC4 cryostat cable
TTN2F	Flexible helium transfer tube
GF4/VC31	Gas flow pump/controller for 3.8 to 300 K operation of insert
EPS40	Pumping system for 1.5 to 300 K operation of insert, including 40 m ³ /hr pump, valve and line

Options

SMSH1	Plain flat sample holder
SMSH2	Sample holder with 12.7 mm diameter aperture and clamp
SMSH3	Sample holder with 15 mm diameter aperture and clamp
SMSR1	Sample rod with 1 wired 10 pin Fischer connectors
SMSR2	Sample rod with 2 wired 10 pin Fischer connectors
SMSR3	Sample rod with 3 wired 10 pin Fischer connectors
SMSR4	Sample rod with 1 wired 10 pin Fischer connectors and wired Cernox and heater
SMSR5	Sample rod with 2 wired 10 pin Fischer connectors and wired Cernox and heater
SCI	Extra sensor channel interface for ITC503 temperature controller
CC4	Cryostat cable for SCI
HCB	Heater control board for ITC503 temperature controller
CX1	Miniature BNC connector wired down to sample holder position
LPC	Automatic lambda point refrigerator controller including stepper motor, pressure transducer, 65 m ³ /hr pump, valve and line
EPSLPF	Pumping system for lambda point refrigerator consisting of 65 m ³ /hr pump, valve and line
OXCONT	Control package with PC, LabVIEW [®] software and virtual instrument drivers
SMHE3INS1	Heliox TL ³ He insert system interchangeable with 1.5 K insert
SMHE3INS2	Heliox TL ³ He insert system supplied instead of 1.5 K insert
HESG15	³ He gas for Heliox TL

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