FRONTIER IR SINGLE-RANGE SYSTEMS

User's Guide

PerkinElmer®

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Introduction

About This Manual

This manual contains the following sections:

- Introduction
- Warnings and Safety Information
- An Overview of the Frontier IR Single-Range Spectrometers
- Unpacking and Installation
- Using the Spectrometer with Spectrum
- Routine Maintenance
- Advanced Maintenance
- Appendices.

For further information on collecting, viewing and processing spectra using Spectrum software, refer to the help file that you can access from the Help menu, or by clicking **Help** on a dialog.

NOTE: This manual shows details for using your instrument with the Spectrum software package (version 10 or later). If you have Spectrum ES or AssureID software, please refer to the Administrator's Guide for your software which can be found on the *IR & Raman Manuals CD* (L1050002), or refer to the on-screen Help.

Conventions Used in this Manual

Normal text is used to provide information and instructions.

Bold text refers to text that is displayed on the screen.

UPPERCASE text, for example ENTER or ALT, refers to keys on the PC keyboard. '+' is used to show that you have to press two keys at the same time, for example, ALT+F.

All eight digit numbers are PerkinElmer part numbers unless stated otherwise.

The term 'instrument' refers to the mid- or near-infrared Frontier IR spectrometers, and any sampling accessory fitted.

Notes, Cautions and Warnings

Three terms, in the following standard formats, are also used to highlight special circumstances and warnings.

NOTE: A note indicates additional, significant information that is provided with some procedures.

*We use the term WARNING to inform you about situations that could result in **personal injury** to yourself or other persons. Details about these circumstances are in a box like this one.*

D

Warning (Warnung)

*Bedeutet, daß es bei Nichtbeachten der genannten Anweisung zu einer **Verletzung** des Benutzers kommen kann.*

DK

Warning (Advarsel)

*Betyder, at brugeren kan blive **kvæstet,** hvis anvisningen ikke overholdes.*

E

Warning (Peligro)

*Utilizamos el término **WARNING** (PELIGRO) para informarle sobre situaciones que pueden provocar **daños personales** a usted o a otras personas. En los recuadros como éste se proporciona información sobre este tipo de circunstancias.*

F

Warning (Danger)

*Nous utilisons la formule **WARNING** (DANGER) pour avertir des situations pouvant occasionner des **dommages corporels** à l'utilisateur ou à d'autres personnes. Les détails sur ces circonstances sont données dans un encadré semblable à celui-ci.*

I

Warning (Pericolo)

*Con il termine **WARNING** (PERICOLO) vengono segnalate situazioni che potrebbero provocare **incidenti alle persone.** Troverete informazioni su tali circostanze in un riquadro come questo.*

NL

Warning (Waarschuwing)

*Betekent dat, wanneer de genoemde aanwijzing niet in acht wordt genomen, dit kan leiden tot **verwondingen** van de gebruiker.*

P

Warning (Aviso)

*Significa que a não observância da instrução referida poderá causar um **ferimento** ao usuário.*

CN

Warning (警告)

我们使用“警告”这一术语来通知您有关可能会对您自己或他人造成人身伤害的情况。
有关这些情况的详细信息可在此类方框中找到。

JP

Warning (警告)

使用者及びその他周辺に危害が及ぶ恐れがある場合は、
この様なボックスの中に注意事項が表示されています。

CAUTION

*We use the term CAUTION to inform you about situations that could result in **serious damage to the instrument** or other equipment. Details about these circumstances are in a box like this one.*

D

Caution (Achtung)
*Bedeutet, daß die genannte Anleitung genau befolgt werden muß, um einen **Geräteschaden** zu vermeiden.*

DK

Caution (Bemærk)
*Dette betyder, at den nævnte vejledning skal overholdes nøje for at undgå en **beskadigelse af apparatet**.*

E

Caution (Advertencia)
*Utilizamos el término **CAUTION** (ADVERTENCIA) para advertir sobre situaciones que pueden provocar **averías graves en este equipo** o en otros. En recuadros éste se proporciona información sobre este tipo de circunstancias.*

F

Caution (Attention)
*Nous utilisons le terme **CAUTION** (ATTENTION) pour signaler les situations susceptibles de provoquer de **graves détériorations de l'instrument** ou d'autre matériel. Les détails sur ces circonstances figurent dans un encadré semblable à celui-ci.*

I

Caution (Attenzione)
*Con il termine **CAUTION** (ATTENZIONE) vengono segnalate situazioni che potrebbero arrecare **gravi danni allo strumento** o ad altra apparecchiatura. Troverete informazioni su tali circostanze in un riquadro come questo.*

NL

Caution (Opgelet)
*Betekent dat de genoemde handleiding nauwkeurig moet worden opgevolgd, om **beschadiging van het instrument** te voorkomen.*

P

Caution (Atenção)
*Significa que a instrução referida tem de ser respeitada para evitar a **danificação do aparelho**.*

CN

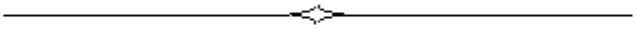
Caution (小心)

我们使用“小心”这一术语来通知您有关可能会对
***本仪器或其它设备造成严重损害**的情况。*
有关这些情况的详细信息可在此类方框中找到。

JP

Caution (注意)

分光器や他の機材等に深刻なダメージを与える恐れがある場合は、
この様なボックスの中に表示しています。



Warnings and Safety Information

Safety Summary

The Frontier IR spectrometers have been designed to comply with a wide variety of international standards governing the safety of laboratory equipment. In routine use, the instruments pose virtually no risk to you. If you take some simple, common-sense precautions, you can make sure that you maintain the continued safe operation of your instrument:

DO make sure that the instrument is properly connected to the electrical supply; in particular make sure that the ground (earth) is securely connected.

DO disconnect the electrical power cable before opening the main cover of the instrument.

DO keep the instrument dry. Avoid spilling liquid into the instrument. Clean all external spills immediately. If anything that is spilled enters the main body of the instrument, switch off the power and contact a PerkinElmer Service Engineer.

DO NOT stare into the internal laser beam under the instrument cover. The instrument contains a low power, visible (red) laser; momentary exposure to the beam is not dangerous, but deliberate, direct viewing of the beam along its axis could damage your eye.

DO NOT use a flammable gas to purge the instrument. The instrument contains a hot source, and a fire or explosion will result. Only use clean, dry, oil-free nitrogen or air to purge the instrument.

DO read the more detailed information on warnings and safety in the following pages to ensure the safe operation of the instrument.

General Safety

The Frontier IR spectrometers have been designed and tested in accordance with PerkinElmer specifications and in accordance with the safety requirements of the International Electrotechnical Commission (IEC). The instruments conform to IEC publication 61010-1 ("Safety requirements for electrical equipment for measurement, control, and laboratory use") as it applies to IEC Class 1 (earthed) appliances and therefore meets the requirements of EC low voltage directive 2006/95/EC.

If the instrument is used in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired. Only use the instrument indoors and under the following conditions:

Temperature	15 °C to 35 °C
Relative Humidity	80% maximum (non-condensing)

If possible, avoid any adjustment, maintenance and repair of the opened, operating instrument. If any adjustment, maintenance and repair of the opened, operating instrument is necessary, this must only be done by a skilled person who is aware of the hazard involved.

Whenever it is likely that the instrument is unsafe, make it inoperative. The instrument may be unsafe if it:

- Shows visible damage
- Fails to perform the intended measurement
- Has been subjected to prolonged storage in unfavorable conditions
- Has been subjected to severe transport stresses.

WARNING

If the equipment is used in a manner not specified herein the protection provided by the equipment may be impaired.

The instrument has been designed to be safe under the following environmental conditions:

- Indoor use
- Altitude up to 2000 m (above mean sea level)
- Ambient temperatures of 5 °C to 40 °C
- A maximum ambient relative humidity of 80% for temperatures up to 31 °C, decreasing linearly to 50% relative humidity at 40 °C
- Mains supply fluctuations not exceeding ±10% of the nominal voltage.

Location and Ventilation

WARNING

Make sure that the switch at the electrical supply inlet on the rear of the instrument is not obstructed.

To allow for adequate cooling

Do not site the instrument near to room heating equipment, for example, central heating radiators.

During operation, there should be a minimum gap of:

- 15 cm (6 inches) between any surface and the cooling louvers at the rear of the instrument.
- 7 cm (3 inches) between the instrument and adjacent equipment.
- 45 cm (18 inches) between any surface and the top surface of the closed sample area lid (to allow for the lid to be opened fully).

To allow any nitrogen used to disperse

WARNING

Do not site the instrument in a poorly ventilated area if nitrogen will be used as a purge gas, or if liquid nitrogen will be used to cool a detector.

Oxygen depletion in an enclosed space does not trigger a gasping reflex, and errors of judgment, confusion, or unconsciousness can occur in seconds and without warning.

The spectrometer includes a coupling that enables the instrument body, and another coupling that enables the sample compartment, to be purged using clean, dry, oil-free air or nitrogen. The recommended flow rate to each connector is 10 l/min, and both the instrument and the sample compartment vent to their surroundings.

If the instrument is fitted with an MCT detector, this is cooled using liquid nitrogen. A risk assessment should include personal protection protocols, and proper actions in the event of accidental spillage. 1 l (2 US pints) of liquid nitrogen evolves to 700 l (approximately 25 cubic feet) of nitrogen gas, and the cold vapor can pool at floor level.

Use of flammable solvents and samples

WARNING

The instrument contains a hot source and contact with flammable vapors may cause an explosion. When working with flammable solvents or samples, particularly during unattended operation with flow-cells, it is recommended that the instrument optics area should be continuously purged with dry air or nitrogen to maintain a positive pressure and prevent flammable vapor from entering the instrument.

WARNING

If flammable solvents or samples are spilled on the instrument and there is any possibility that they have entered the interior (by coming into contact with cover gaskets, for example) then the instrument must be switched off immediately and disconnected from the power supply. The optics area should then be thoroughly purged with dry air or nitrogen, or the main cover should be opened to thoroughly ventilate the optics area before proceeding.

WARNING

Flammable solvents or samples should not be stored on or near the instrument. Handling of such materials during preparation should be performed in a safe area away from the instrument such as a fume cabinet.

WARNING

Do not use a flammable gas to purge the Frontier IR instruments. Use only clean, dry, oil-free nitrogen or air.

Electrical Safety

- Connect the instrument to a power supply line that includes a switch or other means of disconnection from the electricity supply.
- Only plug the instrument into an electricity-supply socket that is provided with a protective earth connection.
- When fuses need replacing, use only those with the required current rating and of the specified type. Do not use makeshift fuses and do not short-circuit fuse holders.
- When the instrument is connected to its electricity supply, terminals may be live and the removal of covers other than those which can be removed by hand is likely to expose live parts.
- Capacitors inside the instrument may still be charged even if the instrument has been disconnected from all voltage sources.
- The instrument must be disconnected from all voltage sources before it is opened for any adjustment, replacement, maintenance or repair.

WARNING

Any interruption of the protective earth conductor inside or outside the instrument or disconnection of the protective earth terminal can make the instrument dangerous.

The instrument has an IEC Insulation Class I rating for external circuits – only connect other equipment that meets the requirements of IEC 61010-1, IEC 60950 or equivalent standards.

Laser Safety Regulations

The Frontier IR spectrometers are Class 1 laser products as defined by IEC 60825-1. The optical module contains a Class 2 Helium Neon (HeNe) laser, which emits visible, continuous wave radiation at a wavelength of 633 nm and has a maximum output power of 1 mW. Some diffuse HeNe laser radiation, within Class 1 limits, emerges from:

- The window in the left hand side of the sample compartment when an internal beam path is selected.
- An external beam port when the beam port cover is removed, no accessory is fitted at the port, and the beam path to the port is selected.

WARNING

Do not stare into any laser beam. Staring into a laser beam (intrabeam viewing) can cause permanent damage to your eyes.

The laser is automatically shut down when the main cover of the instrument is raised.

WARNING

Do not attempt to override or modify the interlock system.

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

The instrument complies with the following laser safety regulations:

1. 21 CFR Part 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No.50 dated 24 June 2007. Administered by the Center for Devices and Radiological Health, U.S. Department of Health and Human Services.
2. European Standard EN 60825-1:2007 – "Safety of laser products – Part 1: Equipment classification and requirements".

Radiation Hazards and their Classification

Laser radiation

Indirect observation of the laser beam radiation in the optical path is not hazardous. Directly viewing the laser beam along its axis (allowing the laser beam radiation to pass into the eye) can be hazardous, depending upon the power of the beam, the length of time that the eye is exposed to the beam and the optical efficiency of the exposed eye. Direct viewing of a laser beam along its axis is termed *intrabeam* viewing.

Protection of the eye during accidental, momentary intrabeam viewing of a Class 2 laser beam is normally given by the eye's aversion response, including the blink reflex, which limits exposure of the eye to less than 0.25 seconds.

Class 1 levels of laser radiation are not considered to be hazardous.

Radiation emitted by the Frontier FT-NIR

The Frontier IR FT-NIR quartz halogen bulb, which produces the near infra-red beam, emits ultraviolet, visible and infrared radiation. The majority of this radiation is in the infrared region. Do not stare into the beam produced by this bulb.

Measurements of the infrared radiation emitted from the sample area show that exposure limits recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) and International Commission on Non-Ionizing Radiation Protection (ICNIRP) will not be exceeded during normal operation.

Labels

When this label is attached to an instrument it means 'Caution, risk of danger'. Refer to the manual to find out the nature of the potential hazard and any actions that have to be taken.

The product identification label is on the front of the instrument. Other labels are fixed to the Frontier IR spectrometers in the locations shown in Figure 1 and Figure 2:

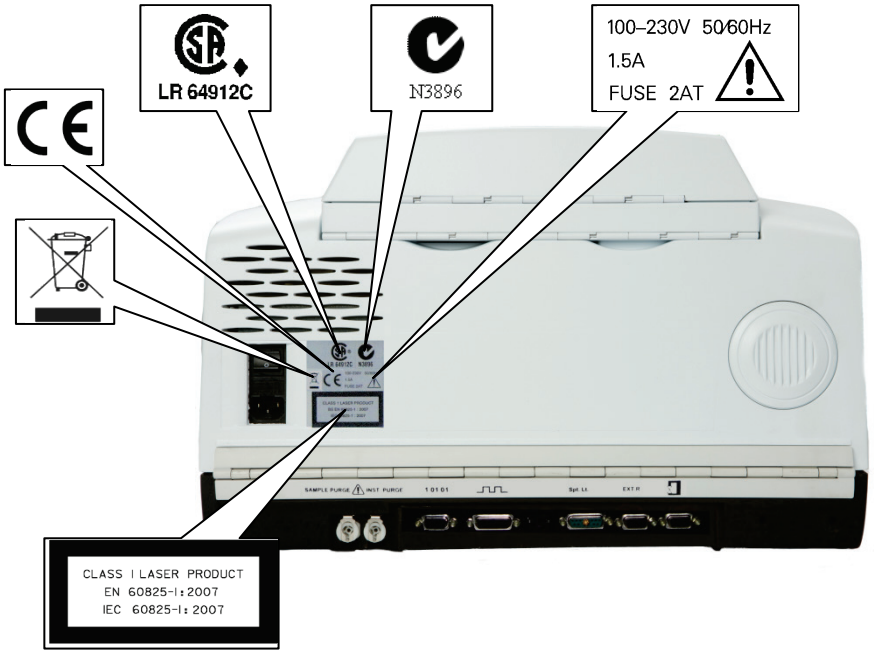
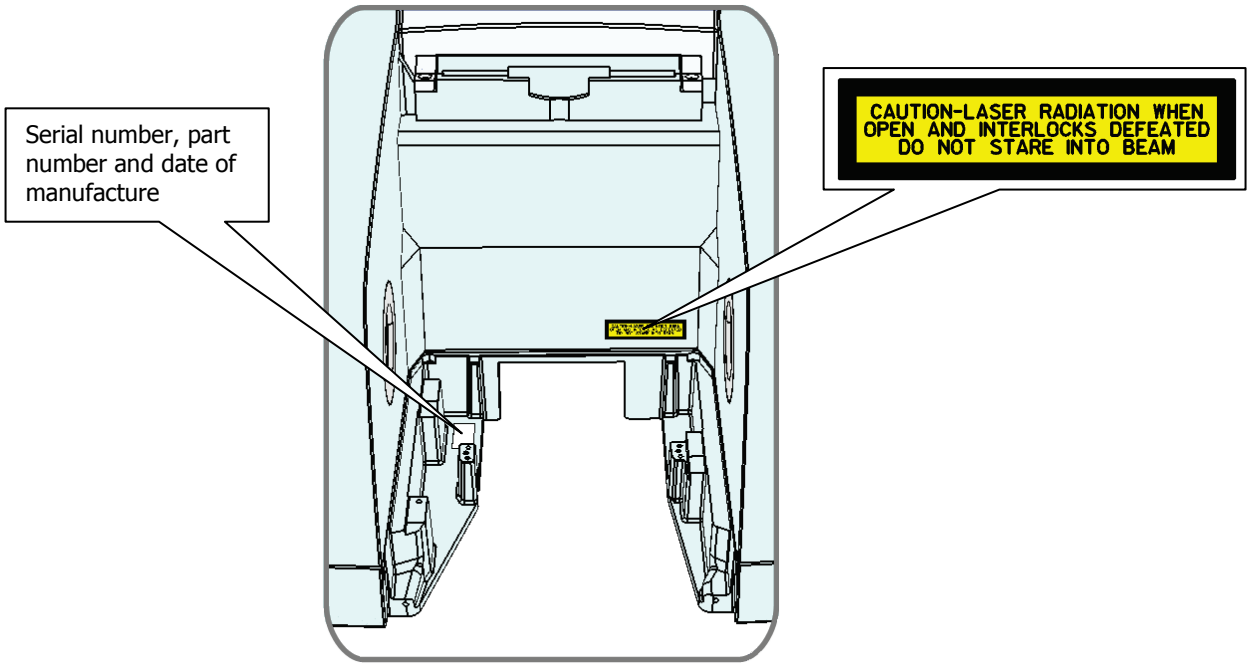


Figure 1 Labels (rear of instrument)

NOTE: The label with a crossed-out wheeled bin symbol and a rectangular bar indicates that the product is covered by the Waste Electrical and Electronic Equipment (WEEE) Directive. *Refer to Appendix 5: WEEE Instructions for PerkinElmer Products* on page 96.



NOTE: There is a second copy of the CAUTION label inside the sample compartment cover.

Figure 2 Labels (sample compartment)

Warning Signs on the Instrument

Caution, hot surface.

Caution, risk of electric shock.

Caution, laser radiation hazard.

Caution, risk of danger.

Refer to accompanying documents in all cases where this symbol is used to find out the nature of the potential hazard and any actions which have to be taken.

EMC Compliance

European EC Directive

The Frontier IR spectrometers have been designed and tested to meet the requirements of the EC Directive 2004/108/EC.

FCC rules and regulations

These products are classified as digital devices used exclusively as industrial, commercial, or medical test equipment. They are exempt from the technical standards specified in Part 15 of the FCC Rules and Regulations, based on Section 15.103(c).

An Overview of the Frontier IR Single-Range Spectrometers

A Guided Tour of the Frontier IR Single-Range Spectrometers

PerkinElmer Frontier IR single-range spectrometers are bench-top FT-IR instruments.

Figure 3 Frontier IR Systems spectrometer

- Frontier FT-IR spectrometers:
  - The optical system enables you to collect data over a total range of 8300 to 350 cm^{-1} with a best resolution of 0.4 cm^{-1}.
  - A $LiTaO_3$ MIR detector.
  - Optional gold optics.
  - Optional MCT detector.
- Frontier Performance Pack Systems FT-IR spectrometers:
  - The optical system enables you to collect data over a total range of 8300 to 350 cm^{-1} with a best resolution of 0.4 cm^{-1}.
  - A DTGS (deuterated triglycine sulfate) MIR detector as standard for enhanced signal-to-noise.
  - Optional gold optics.
  - Optional MCT detector.
- Frontier Extended Range Performance Pack FT-IR spectrometers:
  - The optical system with CsI beamsplitter enables you to collect data over a total range of 7800 to 225 cm^{-1} with a best resolution of 0.4 cm^{-1}.
  - A DTGS (deuterated triglycine sulfate) MIR detector as standard.
  - Optional gold optics.
  - Optional MCT detector.
- Frontier FT-NIR spectrometers:
  - The optical system enables you to collect data over a total range of 14700 to 2000 cm^{-1} with a best resolution of 0.5 cm^{-1}.
  - An NIR DTGS (deuterated triglycine sulfate) detector.
  - Gold optics as standard.

The instrument can operate in ratio, single-beam, or interferogram mode.

The instrument is connected to a PC, either point-to-point or over a network. The Spectrum software package supplied enables you to control the instrument and to manipulate the spectra that you collect.

Optical system

The optical system is under the main cover of the system. Usually the main cover of the instrument is closed, but to perform most maintenance tasks the cover has to be open. When you do this, a safety interlock automatically switches off the power. Nevertheless, the instrument should be disconnected from the mains before opening the main cover for maintenance.

Consistent, reliable performance is achieved by having few moving or adjustable parts, and by extensive insulation of the optical system from the effects of humidity and vibration.

Stability of the optical system

The entire optical system is purged and sealed at the factory. A supply of desiccant placed within the system removes any water vapor and carbon dioxide that may enter. A desiccant indicator is fitted in the top cover, which warns you when the desiccant needs changing (an internal humidity sensor is available as an option).

In Frontier FT-IR spectrometers, KBr or CsI windows separate the sample compartment from the purged optical system. For Frontier FT-NIR spectrometers, these windows are CaF_2.

NOTE: Before you select the MCT detector (optional) in Spectrum software, fit one of the attenuators supplied (Attenuator Set – L1160560) to the window to the right of the sample compartment to prevent the detector from overloading. See *Installing/ Replacing Windows* on page 78 for more information.

You can purge the sample compartment with clean, dry, oil-free air or nitrogen. Either one removes water vapor; however, nitrogen is preferable because it also removes atmospheric carbon dioxide.

WARNING

Do not use a flammable gas to purge Frontier IR Systems. The instruments contain a hot source, and a fire or explosion will result. Only use clean, dry, oil-free nitrogen or air to purge the instrument.

The optics are kinematically mounted to ensure accurate positioning and to make them rugged. The interferometer is enclosed and mounted on anti-vibration mounts to guard against air and bench borne disruptions. The interferometer uses very low-friction point bearings and a frictionless electromagnetic drive to ensure long life.

Top panel controls

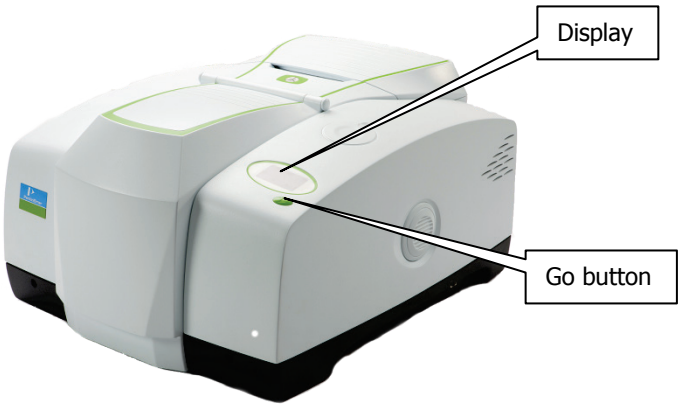


Figure 4 Top panel controls

The display on the front right of the top of your instrument has two purposes:

- To display messages generated by the instrument's firmware, such as those that monitor initialization and diagnostics when the instrument is switched on.
- To display prompts and other messages generated by Spectrum software.

The instrument's Go button is used in concert with the displayed prompts and other messages generated by Spectrum software. It allows you to Start and Halt data collection while you are away from your computer.

The sample compartment

The instrument has a large purgeable sample compartment (Figure 5) located at the front of the instrument.

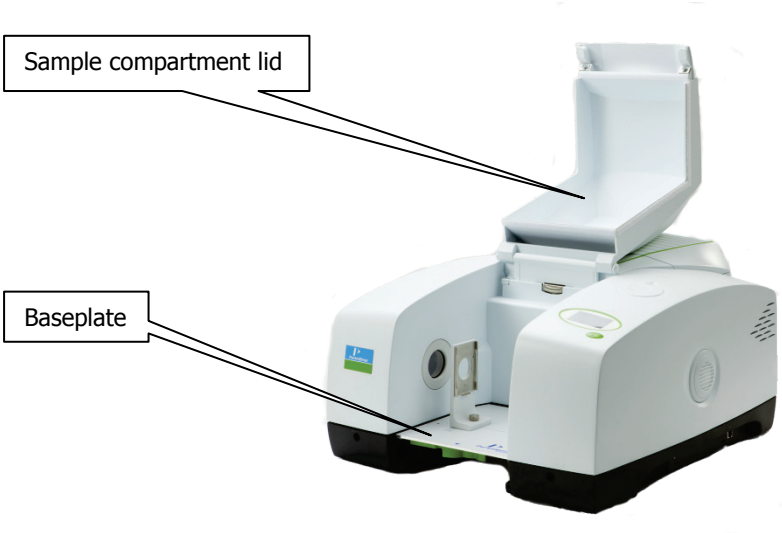


Figure 5 Sample compartment

CAUTION	*Frontier IR spectrometers are fitted with sample compartment windows that are composed of KBr or CsI that, although coated, can be damaged by high levels of humidity.* *If you spill a liquid in the sample compartment, wipe it up quickly. When working with water-based samples open to the air, either purge the sample compartment or leave the cover open.*

CAUTION	*For the Frontier FT-IR, a relative humidity higher than 80% (or 45% if your instrument is fitted with CsI optics) can damage the windows of the sample compartment. If you expect the humidity to exceed 80% (or 45% if your instrument is fitted with CsI optics), continually purge or desiccate the sample compartment.* *Frontier FT-NIR spectrometers are fitted with sample compartment windows that are composed of CaF_2, which is relatively resistant to humidity.*

Open the sample compartment by lifting the cover using the recess at the front.

The infrared beam enters the sample compartment through an aperture on the left. After passing through the sample, it enters the detector area through an aperture on the right side of the sample compartment.

Standard accessories are mounted on a baseplate. The standard baseplate has a sample holder located by a knurled screw.

Internal accessories

A wide range of optional MIR or NIR accessories, such as the Universal ATR accessory, fit in the sample compartment (Figure 6).

Figure 6 Frontier IR with Universal ATR accessory

It is easy to remove an internal accessory and to replace it with another. See *Appendix 1: Changing the Sampling Accessory* on page 90.

The instrument identifies the type of accessory fitted using a coded connector on its baseplate that plugs into a socket on the rear wall of the sample compartment.

External accessories

The external beam port on the right side of the instrument is used, for example, with the optional External Near Infra-Red Accessory (External NIRA). Spectrum software enables you to switch the instrument between this external accessory and another accessory fitted in the sample compartment.

Figure 7 Frontier IR with External NIRA accessory

NOTE: To use your instrument with an external accessory, you require the optional External Beam Pack. If you did not purchase the External Beam Pack with your spectrometer, it is available as a field-fitted upgrade (L1280248).

For information about removing or refitting an external accessory, refer to its User's Guide, which is distributed on the *IR & Raman Manuals CD* (L1050002) as a .pdf file.

CAUTION	*Do not attempt to remove the external accessory bracket mounted within the handhold on the right of the instrument or to transfer the bracket to another spectrometer.* *The external accessory bracket is fitted by a PerkinElmer Service Engineer, along with any other internal components that may be required.*

CAUTION	*Do not attempt to lift the instrument, or to move it to another location, when an external accessory is attached.* *The optical alignment of the accessory may be disturbed.*

For information about moving the instrument, see *Moving the Spectrometer* on page 54.

Imaging systems

The external port on the left side of the instrument is used with the Spotlight Imaging Systems and Multiscope Imaging Systems (Figure 8).

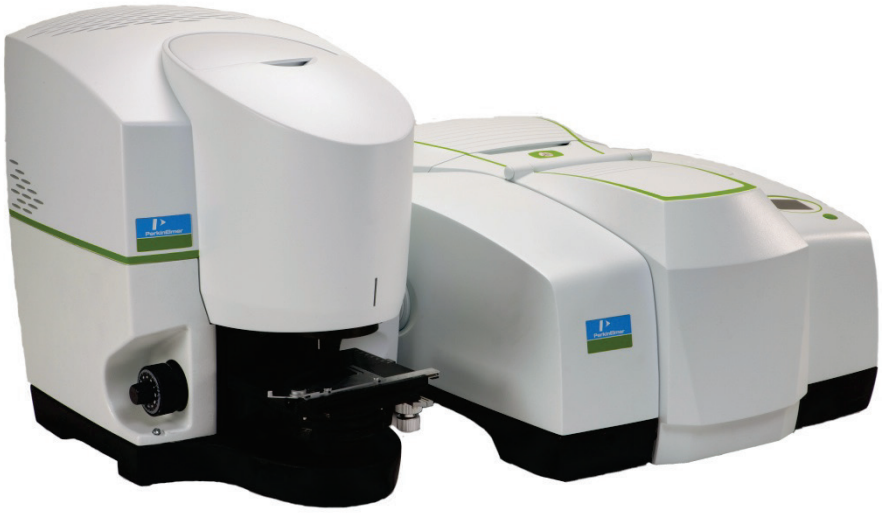


Figure 8 Spotlight 150: Microscope and Frontier FT-IR spectrometer

NOTE: To use your instrument with a microscope, you require the optional External Beam Pack. If you did not purchase the External Beam Pack with your spectrometer, it is available as a field-fitted upgrade (L1280248).

Storage compartment

You can store your polystyrene reference film, sample slides and other small accessories in the storage compartment on the top of the spectrometer (Figure 9).

Figure 9 Storage compartment on top of the spectrometer

Power switch and communication ports

The power switch, AC power cable connector, and communications ports are on the rear of the instrument. The power switch is marked **I/O** (on/off).

NOTE: It can take the instrument about two hours to equilibrate when switched on after being switched off overnight. To save time, we suggest that you leave the instrument switched on at all times.

Accessories

A wide range of optional accessories, such as the Universal ATR accessory (UATR), fits in the sample compartment. In addition, a number of external accessories are available, including the External NIRA. An external accessory can be fitted in conjunction with another internal accessory.

Table 1 Sampling accessories for the Frontier IR instruments

Accessory	MIR	NIR
Sample Shuttle	Yes	Yes
Horizontal ATR	Yes	n/a
Universal ATR	Yes	n/a
Diffuse Reflectance	Yes	n/a
NIRA	n/a	Yes
External NIRA	n/a	Yes
NIR Fiber Optic Probe	n/a	Yes
NIR Tablet Autosampler*	n/a	Yes
Liquid Sipper*	Yes	Yes
TL 8000 EGA System (TG-IR)	Yes	Yes
General Purpose Optical Bench (GPOB) with External MCT Detector**	Yes	Yes
General Purpose Optical Bench (GPOB) and External $LiTaO_3$ Detector**	Yes	Yes

*The Liquid Sipper and NIR Tablet Autosampler accessories are supported by AssureID software and Spectrum software version 6.x. They are not supported in Spectrum software version 10.0 or later.
** For more details of the GPOB options, contact your PerkinElmer Sales Representative.

Further information about the use of these accessories can be found on the *IR & Raman Manuals CD* (L1050002).

Frontier IR Systems Upgrades

The Frontier IR systems as designed to be flexible, upgradable instruments, including the ability to upgrade from a single-range to a dual-range instrument. The upgrades available for Frontier IR Single-Range Systems are listed in Table 2.

Table 2 Frontier IR Single-Range Systems Upgrades

Part Number	Description
L1280247	Performance Pack Upgrade – DTGS detector upgrade
L1280248	External Pack Beam Upgrade – Microscope, GPOB, NIRA and external beam input port ready The kit contains KBr windows, but other windows are available. Ask your PerkinElmer Customer Service Representative for details
L1280258	Single-Range FT-IR to Dual-Range FT-IR/FT-NIR upgrade
L1280259	Single-Range FT-NIR to Dual-Range FT-IR/FT-NIR upgrade
L1280260	Single-Range FT-IR to Dual-Range FT-IR/FT-FIR upgrade
L1280249	Narrow band 1 mm MCT FT-IR Second Detector (adds an MCT detector in the second detector position) FT-IR instruments only
L1280250	Medium band 1 mm MCT FT-IR Second Detector (adds an MCT detector in the second detector position) FT-IR instruments only
L1280251	Wide band 1 mm MCT FT-IR Second Detector (adds an MCT detector in the second detector position) FT-IR instruments only
L1250477	ZnSe Window Upgrade Kt (optional ZnSe window for Single-Range FT-IR instruments)
L1200391	Electronic Humidity Sensor

Unpacking and Installation

Requirements

NOTE: Read the warnings and safety information at the start of this manual before you install the instrument. They contain important information.

Electrical requirements

The Frontier IR instruments can operate on electricity supplies of 50 or 60 Hz and in the 100 V to 230 V range without any adjustment.

The nominal power consumption of the instrument is 120 VA.

The line supply must be within 10% of the nominal voltage.

If possible, do not connect the instrument to circuits that have heavy duty equipment connected, such as large motors.

If possible, do not use photocopiers, discharge lamps, radio transmitters, and other equipment with large or frequent transient loads on the same supply circuit.

The primary fuse (2 AT, 250 V) is in the drawer on the rear of the instrument next to the mains inlet: the spare fuse is in the same drawer. The primary fuse is connected in the live line.

Environment

To obtain the best performance from your instrument:

- Place the instrument in an environment that is relatively dust-free.
- Make sure that the bench top is free from vibration or mechanical shocks.
- Do not place the instrument or the PC near to room-heating equipment, such as central-heating radiators.
- Do not position the instrument in direct sunlight, as this may cause overheating.
- Leave at least 15 cm (6 inches) from any surface and the cooling louvers at the rear of the instrument.
- Leave at least 7 cm (3 inches) from any vertical obstacle to the sides of the instrument, to permit an adequate flow of cooling air.
- Make sure that there are no overhanging shelves, and no water pipes or faucets that could leak onto the instrument.
- The area near the PC must be free of strong magnetic fields, direct sunlight, and heating or cooling units or ducts.

The instrument has been designed for indoor use and operates correctly under the following conditions:

Ambient temperature	15 °C to 35 °C
Ambient relative humidity	80% maximum (non-condensing)

Unpacking the Spectrometer


WARNING

The spectrometer is a heavy precision instrument, so two people are required for safe handling.

The instrument weighs approximately 34 kg unpacked (40 kg packed) and has a lifting recess on either side. Consult the local codes of practice issued by safety advisors before attempting to lift it.

Take care not to injure yourself or others, or to drop the instrument.

CAUTION

Take great care when installing your Frontier IR spectrometer, and follow the procedures described in this manual. If you require assistance, contact your local PerkinElmer Service Engineer.

Opening the shipping container

Your spectrometer is packed inside the box in a silver bag that protects it from condensation.

1. First remove the software box, leads, and so on from the box, and check that all the following parts are present:

Part Number	Description	MIR	NIR
L1202057	Polystyrene Calibration Film	1	–
L1180479	NIR Performance Validation Kit	–	1
04974265	Quick Release Purge Coupling	2	2
L1200466	Ethernet Crossover Cable	1	1
04790839	2 A, 250 V Time Lag Fuse	2	2
09923433	8.0 mm Hexagonal Wrench	1	1
L1050002	IR & Raman Manuals CD	1	1
L1250230	Spectrum Configuration Disk	1	1
LX108873 OR LX108875	Spectrum Standard Software Kit OR Spectrum ES Software Kit	1	1
L1240055	Cuvette Holder Assembly	–	1
L1240056	Cell Holder Assembly & Disposable Cells (5)	–	1

If any items are missing or damaged, contact your local PerkinElmer office.

2. Carefully remove the instrument from the shipping container, but not from the bag in which it was shipped.

CAUTION	*The spectrometer must be allowed to reach the temperature of its surroundings before it is removed from the bag. This means leaving it overnight if it has been moved from a cold area, and at least 4 hours after removal from the shipping container.*

3. When the spectrometer has been allowed to warm to the temperature of its surroundings, remove it from the bag and place it on the bench where it is to be used. Ensure that you can reach the rear of the spectrometer to connect the cables.

NOTE: Any accessories will be shipped in separate boxes.

The Desiccant Indicator

The optical system of the spectrometer is purged at the factory. This protects the beamsplitter and the sample compartment windows from being damaged by humidity. Replaceable packs of desiccant keep the optics dry and free of CO_2.

The top panel of the instrument includes a desiccant indicator, whose sectors change sequentially from blue to pink as the desiccant packs are exhausted (Figure 10). Change the desiccant in the instrument when the sector marked 10 becomes pink, but while the sectors marked 15 and 20 are still blue.

Refer to *The Desiccant Indicator in Detail* on page 56 for more information about the appropriate action to take if the sectors marked 15 and 20 are pink.

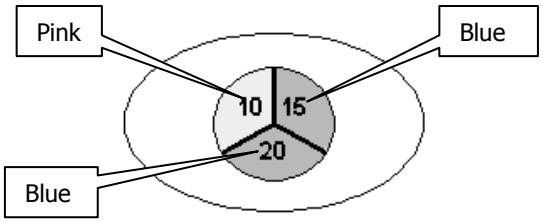


Figure 10 The desiccant indicator

CAUTION	*If all three sectors of the desiccant indicator are pink, then you **must** change the desiccant.* *The instrument optics may be fogged. Do not switch the instrument either ON or OFF until all sectors are blue.*

Connecting up the Spectrometer

Connecting to the PC

NOTE: To control your instrument from a PC, use the crossover cable supplied.
To control your instrument over your network, use a standard Ethernet cable (not supplied).

1. Plug one end of the cable into the connector port on the right-hand side of the instrument (Figure 11).

Figure 11 PC connection port

2. Plug the other end of the cable into the network connection on your PC (if you are using the crossover cable) or network hub (if you are using a standard Ethernet cable).

Connector details

Description	Connector Type	Voltage	Maximum Current
10/100 Base-T Ethernet connector. This is the standard interface between the PC and the instrument, or between a Local Area Network (LAN) and the instrument. If connecting directly from the PC to the instrument use the Category 5 UTP Cross-Over cable supplied. If you are connecting to your network, use a standard Ethernet cable. DO NOT USE THE CROSS-OVER CABLE TO CONNECT TO YOUR NETWORK.	Ethernet	<5 V	<100 mA

Other connectors

The communication ports for peripheral devices are shown in Figure 12.

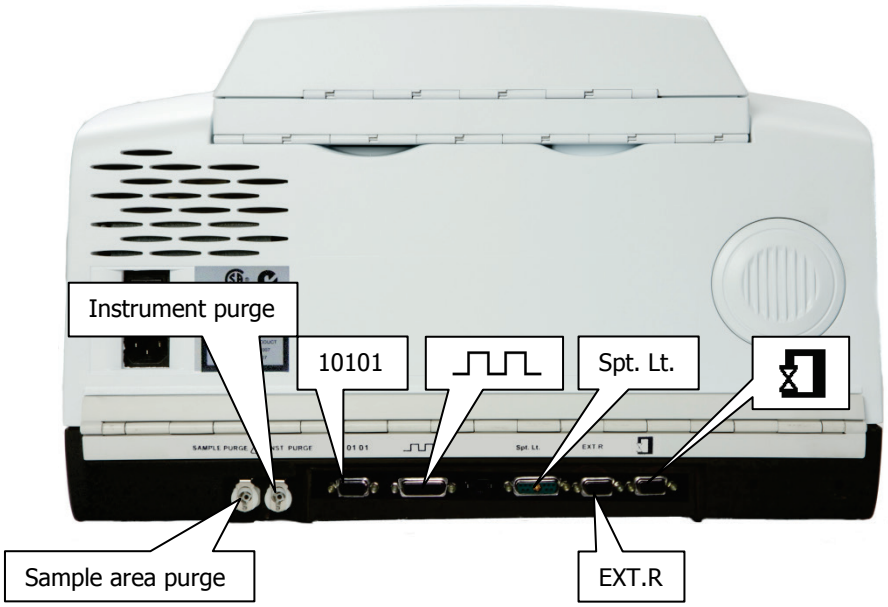


Figure 12 Communication ports

Icons that identify the function of each of the communications ports are printed on the hinge molding directly above the port.

Connector details

Icon	Description	Connector Type	Voltages	Maximum Currents
10101	Serial port. Connects a PC to the instrument using an RS232 interface cable. This connector is only used for service diagnostics.	9-way D-type	+12 V	<100 mA
			−12 V	<100 mA
⎍⎍⎍	General Purpose Optical Bench (GPOB). Allows synchronization between the instrument and an external accessory.	26-way high density D-type	+5 V	<50 mA
Spt.Lt	Spotlight. Used to connect the instrument to a Spotlight Imaging System.	11-way mixed D-type	+5 V	<100 mA
			±12 V	50 mA

Icon	Description	Connector Type	Voltages	Maximum Currents
EXT.R	Right external detector module. Connects to an external detector module. Usually the detector is located in an accessory placed on the right of the instrument.	15 way high density D-type	+12 V	0.65 A
			−12 V	0.65 A
			+5 V	4 A
	Microscope external detector module. Connects to a PerkinElmer infrared microscope, placed on the left of the instrument.	15 way high density D-type	+12 V	0.65 A
			−12 V	0.65 A
			+5 V	4 A

CAUTION *Do not attempt to connect a monitor to either the EXT.R port or the  MICROSCOPE port or you will cause serious damage to the instrument when it is switched on.*

Connecting the spectrometer to the electrical supply

The power cable for the electrical supply plugs into the rear of the instrument. It has a molded socket at one end. If it is necessary to fit a plug on the power cable, use the wire color code below:

Plug Pin	Wire Color (100–120 V)	Wire Color (220–240 V)
Ground (Earth)	Green or Green/Yellow	Green/Yellow
Live	Black	Brown
Neutral	White	Blue

WARNING *To ensure safe and satisfactory operation of the instrument, it is essential that the green or green/yellow ground (earth) wire of the power cord is connected to a ground that complies with the regulations of the local electricity supply authority (or equivalent body); ground circuit continuity is essential for safe operation of the equipment.*

Frontier IR instruments can operate on electricity supplies of 50 Hz or 60 Hz and in the 100 V to 230 V range without any adjustment.

1. Fit the molded socket of the power cable into the electrical supply inlet (Figure 13) of the instrument.

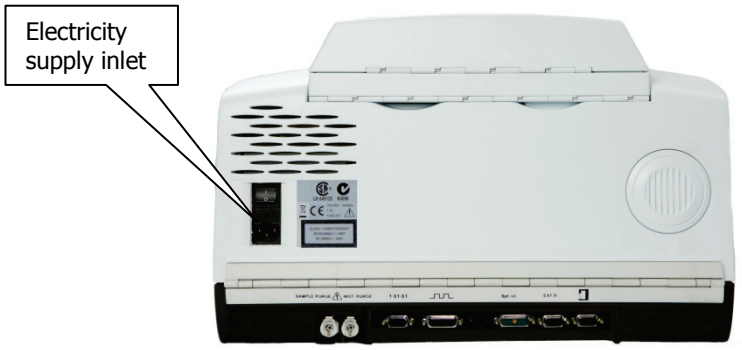


Figure 13 Electrical supply inlet

2. Switch on the power at the supply.
3. Switch on the instrument at the switch above the supply inlet.
   I is on and **O** is off.

After a short diagnostic check, which takes about 2 minutes and is described in *Appendix 2: Instrument Self-Checks* on page 90, your instrument will be ready to communicate with the PC.

Installing the Instrument in the Software

Before you can use the instrument it must be set up in the software.

Installing the software

NOTE: If you are supplying your own computer, make sure that it meets the minimum requirements for hardware and software set out in the "PC Requirements" section of the *Administrator's Guide* for your software, which can be found on the *IR & Raman Manuals CD* (part number L1050002) supplied with your instrument.

- To install Spectrum software, insert the supplied DVD and follow the instructions on the screen. Details of the installation program are given in the *Administrator's Guide*.

The Instrument Install Wizard

After installing your software you will need to install your instrument.

- If you have Spectrum software or Spectrum ES software, select **Add Instrument** from the **Administration** group on the Setup menu.

  The Instrument Install Wizard starts.

  OR

  If you have AssureID software, select **Configure Instruments** from the **Configure Instruments and Accessories** group on the Tools menu.

  The Instrument Install Wizard starts.

Details of the Instrument Install Wizard can be found in the *Administrator's Guide* for your software, which can be found on the *IR & Raman Manuals CD* (part number L1050002) supplied with your instrument.

Using the Spectrometer with Spectrum

Basics of Software Control

Starting Spectrum software

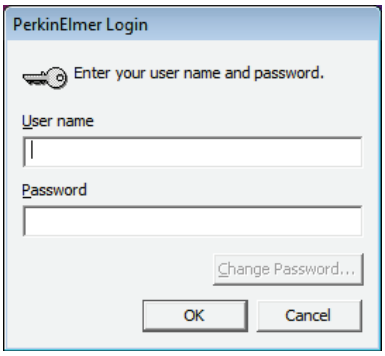
1. Switch on the power to the instrument using the switch on the rear of the instrument.
   The instrument will initialize, which will take approximately 2 minutes.

NOTE: It can take the instrument about two hours to equilibrate when switched on after being switched off overnight. To save time, we suggest that you leave the instrument switched on at all times.

2. From the Start menu select **Programs**; the **PerkinElmer Applications** group; the **Spectrum** sub-group and then the **Spectrum** application.

   OR

   Double-click the shortcut icon on the desktop.
   The Spectrum start-up splash-screen is displayed, followed by a dialog that may require your login details:



3. If required, enter your **User name** and **Password**, and then click **OK**.
   If you already have an instrument set up in Spectrum or AssureID software for this user on this PC, the Instrument Connection dialog may be displayed, unless Auto Connect is set up for the instrument. If Auto Connect is enabled Spectrum will automatically connect to the instrument.

4. Select the **Instrument** you want to use.

   OR

   If you want to work with data that has been collected previously, without connecting to an instrument, select **work offline**.

NOTE: Working offline can free a networked instrument for use by another user.

   Spectrum starts.

Scanning samples

When you connect to your spectrometer the instrument settings will default to appropriate values for your instrument type and accessory.

The configurable Scan toolbars at the top of the workspace include the tools you need to collect a sample spectrum (Figure 14).

Figure 14 Frontier IR Single-Range systems default scan toolbars

By default, the Measurement bar includes **Scan**, **Halt**, **Background** and **Monitor** buttons. You can also select **Scanalyze** and then choose one of the scan and then process options **Scan and Compare**, **Scan and Search** or **Scan and Quant**. All these commands can be selected from the Measurement menu.

NOTE: The Scan toolbars are not displayed if you have chosen to work offline.

To scan a sample:

1. Check and set the instrument parameters.

   Here you set the **Start** and **End** points of the scan range (by default in wavenumbers, but the abscissa units can also be set to nanometers or microns on the Setup Instrument Basic tab) and the **Accumulations** required, either as a number of scans, or as a length of time. You can enter a unique **Sample ID** and **Description** for the sample. You can also set the **Resolution** (in cm^{-1}). This will set the **J-Stop** size (in mm) to the default for that resolution, which you can then edit.

   By default, sensible values for the scan and instrument parameters are entered in the Instrument Settings toolbar. The values applied depend on your instrument and accessory. To amend any value, select the parameter and then enter your new value, or select a value from the drop-down list.

2. If a background scan is required, the **Scan** button includes a small background flag. Clear the instrument beam path, or insert a suitable background material, and then click  to collect a background spectrum.

   The background spectrum is displayed briefly, and then the Viewing Area is prepared for data collection from your sample.

   We recommended that you run a background scan before every sample.

NOTE: If you wish to run a background scan with a filter in place, you must set the **Scan Type** to **Background** on the Setup Instrument Basic tab, rather than using the toolbar button. See the Spectrum on-screen Help for more information.

3. Place your sample in the instrument or accessory and then click  to begin scanning your sample.

   By default, during scanning the sample data is displayed on the Live tab in the Viewing Area.

   The completed spectrum is displayed on the Graph tab, and added to the current Samples View in the Data Explorer.

4. If, for any reason, you want to stop scanning your sample, click  .

You can use the Sample Shuttle Accessory (L1200302) to set up an interleaved cycle scan so that you do not have to open the sample compartment between the background and sample scans. This helps to reduce changes in the concentration of carbon dioxide and water vapor in the sample compartment. Set the **Scan Type** to **Interleaved** on the Setup Instrument Basic tab. See the Spectrum on-screen Help for more information.

Working with the instrument display and Go button

The display on the top of your instrument is used to display prompts and other messages generated by Spectrum software.

Simply follow the prompts in the instrument display and use the Go button located on the instrument to complete a series of sample scans.

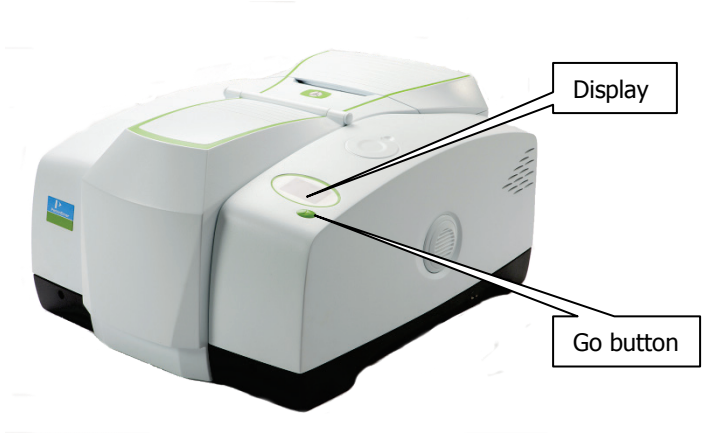


Figure 15 Top panel controls

Changing the beam path

Hover over the icons on the Setup Instrument BeamPath tab to identify elements in the instrument beam path. As you click on each item, the appropriate row in the Settings Table is highlighted.

The accessory fitted in the sample compartment is identified by a graphic element in the beam path schematic. If an external accessory is fitted at the beam port on the right of the instrument, or a Spotlight Imaging System is fitted, the Setup Instrument BeamPath tab includes additional elements that enable you to redirect the beam path to the accessory you want to use.

In Figure 16 the beam path is directed to the standard sample slide. In this example, the additional interface elements for the Spotlight microscope are also shown.

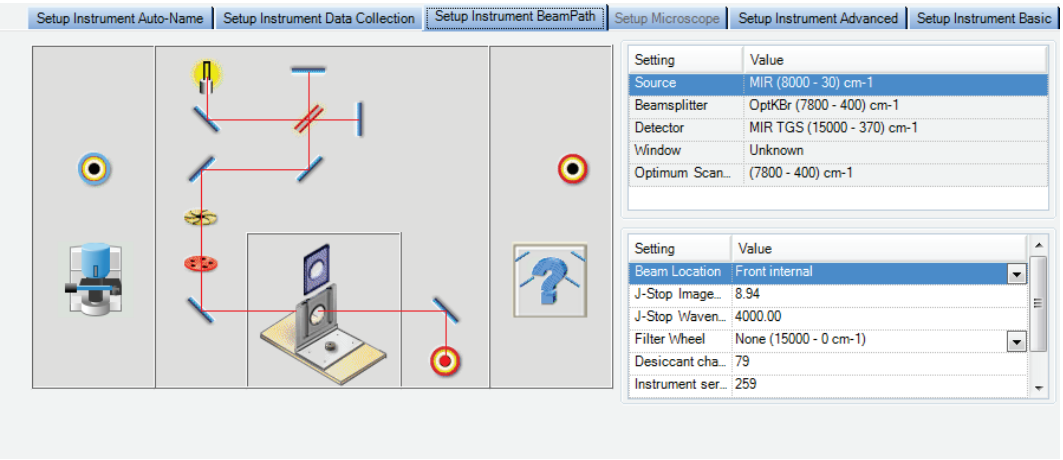


Figure 16 Setup Instrument BeamPath tab with the beam path directed to the Slide Holder

- To direct the beam to the Spotlight microscope, select **Left external** from the **Beam Location** drop-down list.

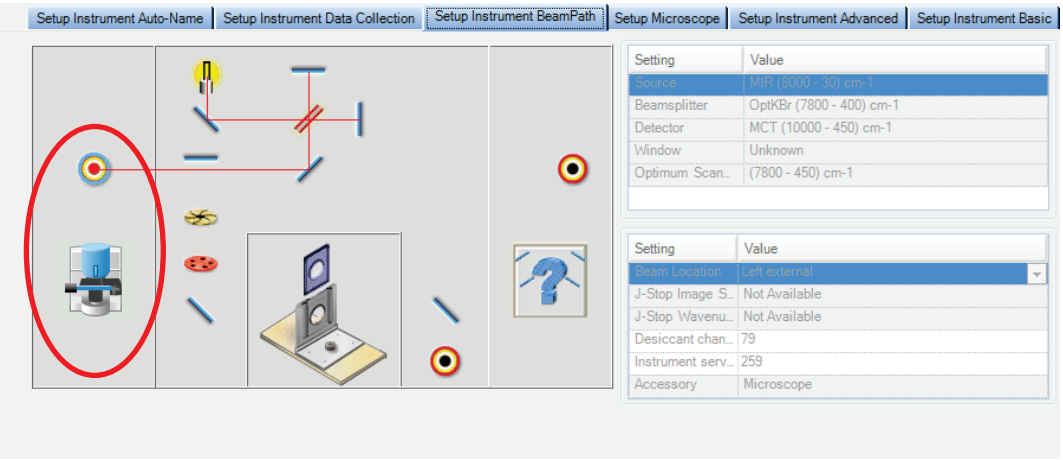


Figure 17 Setup Instrument BeamPath tab with the beam path directed to the Microscope (circled)

Using the Spectrum on-screen Help system

Use the Spectrum Help system to find further information about using Spectrum software to control, set up and adjust your instrument.

To open the Help file, select **Contents** from the **Help** menu. This menu also includes links to on-screen tutorials (**Tutorials**), and information about the software (**About**).

Atmospheric (CO_2/H_2O) Suppression

Atmospheric suppression can be selected in the Setup Instrument Advanced tab (Figure 18).

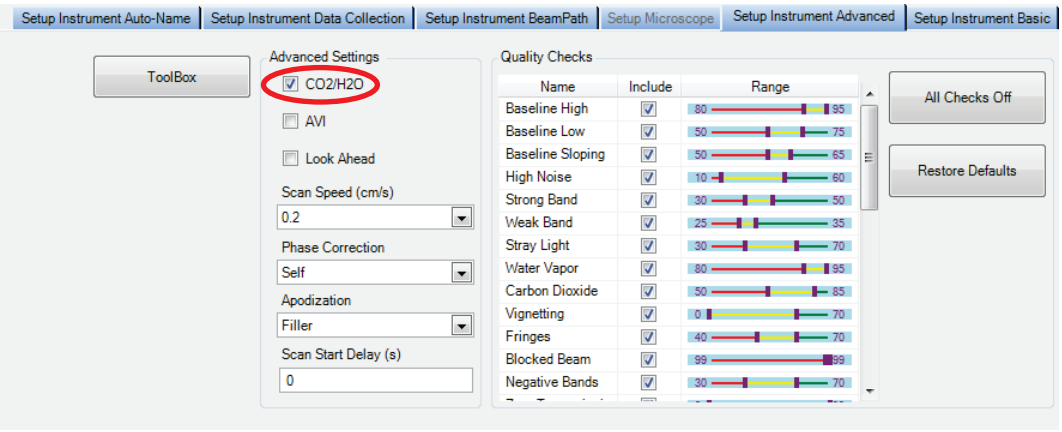


Figure 18 Setup Instrument Advanced tab in Spectrum

What is atmospheric suppression?

This is an atmospheric correction routine. This routine is more powerful than simple subtraction, overcoming the following issues:

- Non-linearity due to resolution
- The measured spectrum is temperature dependent
- Lineshape and calibration are affected by J-stop and sample or accessory.

What does atmospheric suppression do?

When **CO2/H2O** is switched on, the software uses a single reference spectrum derived from high resolution data and our understanding of the instrument to model the lineshape, then finds the current real instrument parameters by least squares fitting to the measured spectrum.

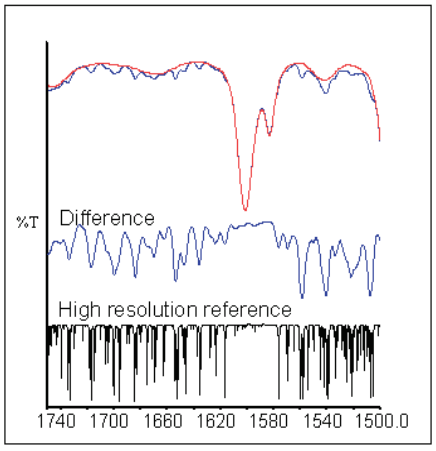


Figure 19 Correction of an MIR spectrum at 4 cm^{-1} resolution

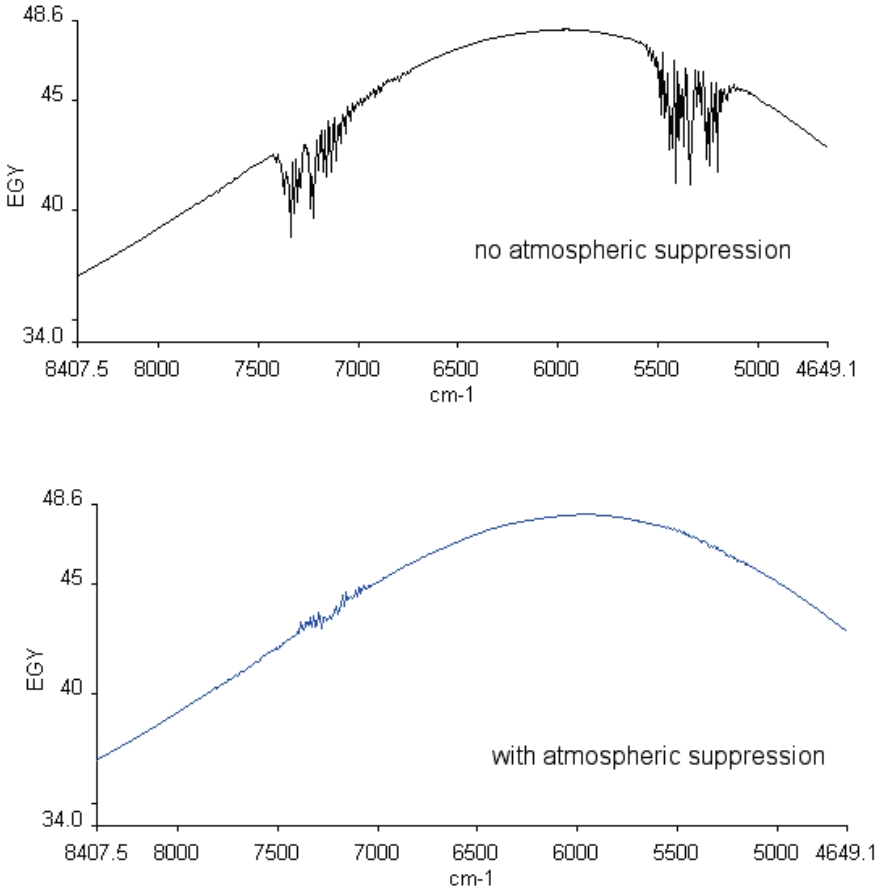


Figure 20 Atmospheric suppression

AVI Correction

AVI correction can be selected in the Setup Instrument Advanced tab in Spectrum (Figure 18).

AVI correction can only be performed if an AVI Calibration has been set up for the current configuration and resolution. Select **AVI** from the **Adjustments Toolbox**, available from the Setup Instrument Advanced Tab. Follow the instructions on-screen. For further information, refer to the Spectrum on-screen Help file.

NOTE: AVI correction uses a methane gas cell installed in the filter wheel.

What is AVI correction?

The objectives of Absolute Virtual Instrument (AVI) correction are:

- Consistent performance over time and between instruments
- Traceability for all measurements.

Although FT-IR spectrometers use a reference laser, the wavenumber calibration and lineshape are affected by differences in beam divergence and uniformity. This is true for all FT-IR spectrometers. Differences can occur between instruments, when using different sampling accessories and when components are changed. AVI allows calibration and lineshape to be maintained.

The Absolute Virtual Instrument is an instrument with theoretical performance, such that the result of measuring a known sample on such an instrument can be predicted. So, if we measure with a real instrument and calculate the software transform to match the theoretical result, we can apply this transform to future measurements.

The Absolute Virtual Instrument is defined by wavenumber calibration, instrument lineshape and ordinate accuracy.

What does AVI correction do?

When **AVI** is switched on, the software measures the current instrument profile relative to an absolute standard (the methane cell) and an ideal lineshape function, and applies a correction (Figure 21). If you have an automated, internal filter wheel, this can provide correction for any sampling configuration.

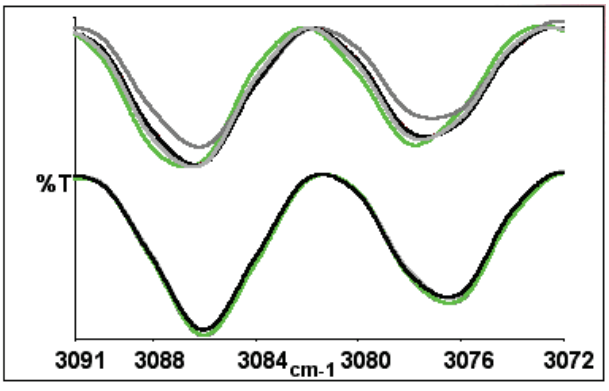


Figure 21 Spectra of methane at 4 cm^{-1} resolution as measured (top) and with AVI (bottom)

Look Ahead

Look Ahead can be selected in the Setup Instrument Advanced tab (Figure 18).

What is Look Ahead?

Look Ahead is a novel system where the spectrometer scans continuously and uses the properties of the measured spectrum to identify changes corresponding to sample removal, sample insertion, or sample change, automatically.

This information is used to identify the scans that are being collected, and to accumulate sample scans. This can decrease the overall scanning time required for those samples that require scan accumulation.

What does Look Ahead do?

If **Look Ahead** has been enabled, the spectrometer scans continuously. When you request a sample scan, the scan collected is compared to the scans that have already been collected. If identical scans are found, the number of scans requested is decreased by the number of scans found, so decreasing the overall scanning time.

Quality Checks

Quality Checks can be selected in the Setup Instrument Advanced tab (Figure 18).

What are Quality Checks?

Quality checking is a tool for less experienced IR users that identifies possible problems in the spectrum being collected and suggests ways of improving the measurement.

What do Quality Checks do?

Simply select the **Quality Checks** that you want to perform from the list in the Setup Instrument Advanced tab and, if required, adjust the threshold range using the slider bars. To display more information about an individual test, double-click on its name in the list.

When you collect your spectrum, the selected tests are performed as the data is collected and a signal light (green , amber , or red) indicates the result.

The results from the Quality Checks imply:

Okay ( ) – the quality of the spectra is satisfactory.

Caution ( ) – the software has identified a problem that you may want to investigate in order to improve the quality of the spectra you are collecting.

Warning ( ) – the software has identified a serious problem that you should attempt to cure before collecting further spectra.

Routine Maintenance

Cleaning the Spectrometer

Clean the outside of the instrument using a damp cloth. If necessary, a mild detergent may be used. Before you clean the entire instrument, always perform a patch test on an inconspicuous area.

Avoid spilling liquid into the instrument. Clean all external spills immediately. If anything that is spilled enters the main body of the spectrometer, switch off the power and contact a PerkinElmer Service Engineer.

CAUTION	*Do not touch or attempt to clean any optical surface in the instrument, because this will impair its performance and may easily damage the component.*

Cleaning the display

Clean grease and dirt off the display using a soft damp cloth and a mild detergent.

Moving the Spectrometer

WARNING

The spectrometer is a heavy precision instrument, so two people are required for safe handling.

Consult the local codes of practice issued by safety advisors before attempting to lift it.

Take care not to injure yourself or others, or to drop the spectrometer.

WARNING

Before moving the spectrometer, switch off the power supply, wait 60 seconds, and disconnect the power cable.

The spectrometer can be lifted using the shaped handholds on its sides, as shown in Figure 22. Two people are needed to lift it because its basic weight is approximately 34 kg.

Figure 22 Lifting a Frontier IR spectrometer

Condensation

Be aware that condensation caused by moving your spectrometer from a cooler environment to a warmer one can damage the windows of the sample compartment. To prevent this damage from occurring:

- Make sure that the windows are protected by placing fresh bags of desiccant in the sample compartment.
- Leave the spectrometer to reach the temperature of the surroundings before removing the desiccant.

The Desiccant Indicator in Detail

The optical system of the spectrometer is purged at the factory. This protects the KBr (or CaF_2) beamsplitters, sample compartment windows, or external port windows from being damaged by humidity. Replaceable packs of desiccant maintain the purge.

The top panel of the instrument includes a desiccant indicator (Figure 23), whose sectors change sequentially from blue to pink as the desiccant becomes exhausted. Change the desiccant packs in the instrument when the sector marked 10 becomes pink, but while the sectors marked 15 and 20 are still blue. These numbers correspond to the approximate % Relative Humidity in the instrument.

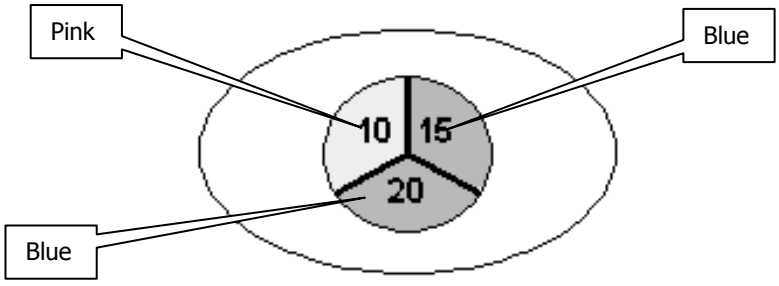


Figure 23 The desiccant indicator: when desiccant packs should be changed

CAUTION	*If all three sectors of the desiccant indicator are pink, then you **must** change the desiccant.* *The instrument optics may be fogged. Do not switch the instrument either ON or OFF until all sectors are blue.*

Sector	Action Required
All sectors blue	None. The humidity levels in the instrument are below approximately 10% Relative Humidity.
Sector 10 pink	Desiccant change is recommended. If the instrument has been switched OFF for an extended period, do not switch ON until you have changed the desiccant and all sectors are blue.
Sector 10 & 15 pink	Replace desiccant the immediately to avoid instrument damage. Do not switch the instrument ON or OFF until you have changed the desiccant and all sectors are blue.

Changing the Desiccant

CAUTION	*Expect to change the desiccant in the spectrometer every six months. Old, used desiccant releases moisture.* *In regions experiencing high humidity levels we recommend that you change the desiccant more often.*

The desiccant change interval is set in the **Desiccant change due in (days)** option on the Setup Instrument BeamPath tab in Spectrum software (Figure 24).

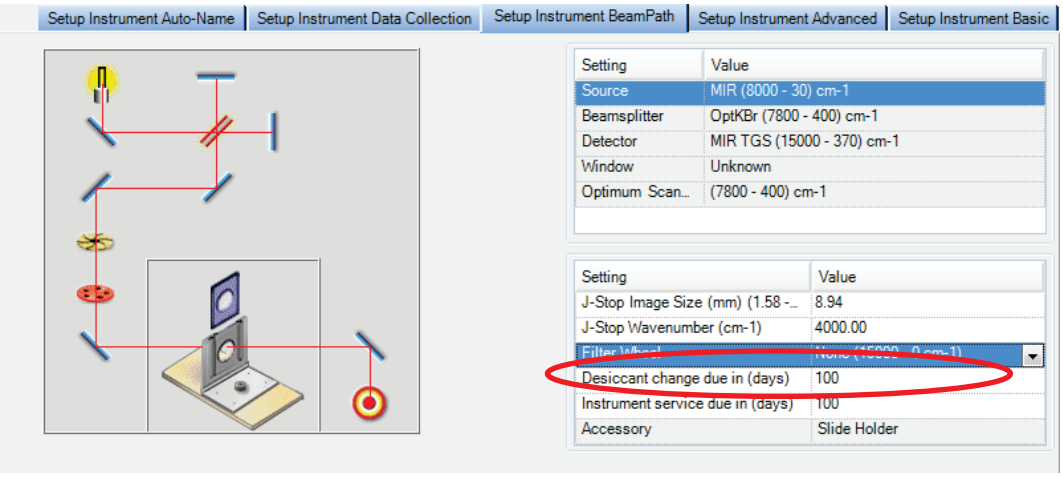


Figure 24 Setup Instrument BeamPath tab in Spectrum

If an instrument desiccant change is overdue, a warning will be displayed in the Status Bar and in the Setup Instrument BeamPath table.

The warning is displayed until you tell the software that the desiccant has been changed. To reset the desiccant change interval, select the current value, click **Changed** to clear any warning messages, and then enter the number of days before the next desiccant change is due.

Renewing the instrument desiccant

CAUTION	*Old, used desiccant releases moisture and can cause catastrophic failure of KBr optics.* *Do not use damaged packs of desiccant. Make sure that the packs you use have not been left in contact with the air.*

You can purchase disposable desiccant kits from PerkinElmer (part number N0171159). A kit contains two packs of desiccant, and three kits are required.

1. Inspect the humidity indicator card in the plastic bags in which the spare desiccant packs are packed. If the card indicates humidity in the bag, discard the desiccant pack.

2. Remove the sample area cover, if fitted, by opening the cover, pressing the clip and pulling the cover vertically to remove (Figure 25).

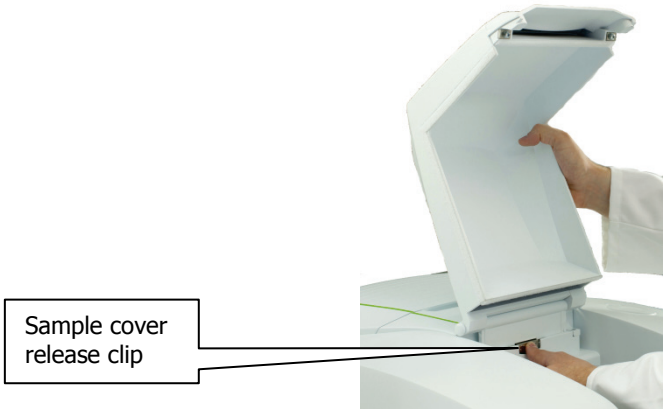


Figure 25 Removing the sample compartment cover

3. Undo the two captive screws securing the desiccant cover (Figure 26).

Figure 26 Captive screws securing the desiccant cover

4. Open the cover and remove all the exhausted desiccant packs (Figure 27), noting how they are installed.

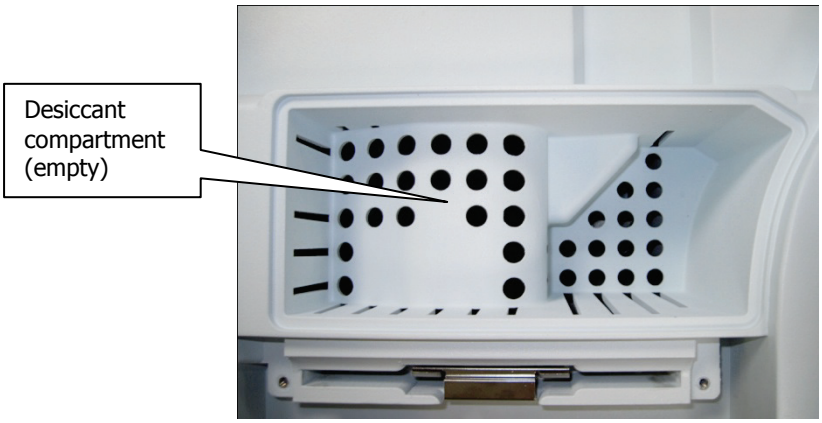


Figure 27 Desiccant removed

5. Place the first three packs of desiccant upright in the recess on the right of the desiccant holder then, one at a time, lay the three remaining packs flat in the upper part of the holder (Figure 28).

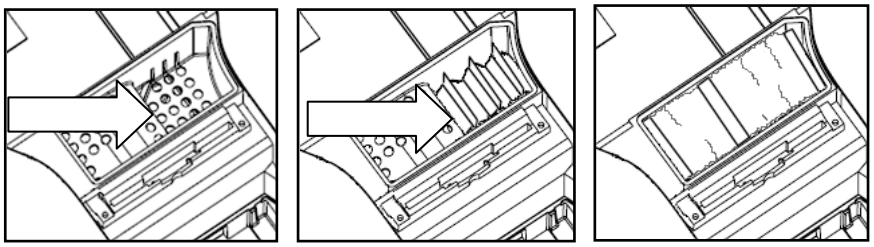


Figure 28 Stowing the desiccant packs

Ensure that when the packs have been installed they do not rise above the level of the black rubber purge seal.

6. Close the cover and tighten the screws.

7. Refit the sample area cover.

Installing rechargeable desiccant in the instrument

There is also a rechargeable desiccant kit available (part number L1250311).

To install rechargeable desiccant packs follow the *Renewing the instrument desiccant* procedure starting on page 58.

The instrument requires two rechargeable desiccant packs; the packs are sized to fit into the left (70 mm × 78 mm × 33 mm) or right (102 mm × 78 mm × 84 mm) of the desiccant container.

The standard kit contains two pairs of rechargeable desiccant packs. This is so you can immediately replace the desiccant in the instrument with re-activated packs.

The desiccant packs can be re-activated by baking them in an oven at 250 °C for approximately 8 hours. They should be cooled in a dry atmosphere. For optimum results, re-activate the packs immediately before re-use.

Purging the Spectrometer

Under most circumstances, you do not need to purge the optical system. However, after performing any maintenance tasks that involved opening the main cover, you may purge the optical system to remove water vapor and CO_2 that entered while the system was open.

Purge the sample compartment if you need to make sure that no residual water vapor or CO_2 peaks are visible in the spectrum.

There are two separate sets of connectors for purge gas lines, one for the sample compartment and one for the optical system. You can purge with either dry air or nitrogen. Both remove water vapor; however, nitrogen is preferable because it also removes atmospheric carbon dioxide.

A typical cylinder of dry nitrogen (or dry air) stores 6.26 m^3 at 1.4 × 104 kPa (220 ft^3 at 2200 lbf/in^2). Make sure that the gas is free of oil, water, or dirt particles larger than 25 μm (0.001 inch).

WARNING

Do not site the instrument in a poorly ventilated area if nitrogen will be used as a purge gas.

Oxygen depletion in an enclosed space does not trigger a gasping reflex, and errors of judgment, confusion, or unconsciousness can occur in seconds and without warning.

WARNING

Do not use a flammable gas to purge the instrument. The spectrometer contains a hot source, and a fire or explosion will result. Only use clean, dry, oil-free nitrogen or air to purge the instrument.

WARNING

Never connect the purge tubing directly to a gas cylinder or other high pressure supply; always use a pressure regulator and set the pressure to a maximum of 1 lbf/in^2 (6.9 kPa) before you start the flow.

A length of clear plastic tubing (4 mm internal diameter) will be required to transfer the gas from the gas bottle to the instrument purge connectors.

1. The tubing is connected to the instrument by a universal pipe fitting which is secured to the tubing with a nut. Two sets of fittings are supplied with the instrument. Assemble the fittings to the tubing as illustrated in Figure 29.

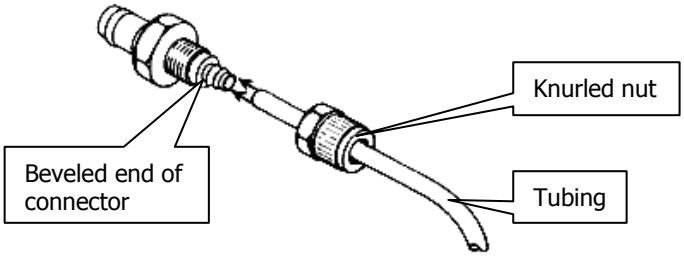


Figure 29 Purge fittings

2. Tighten the nut, ensuring it is not over tightened.

3. Push the connector on the end of the tubing into the purge connector of the compartment to be purged (Figure 30).

   If the connector will not push in, press the clip at the bottom of the port and try again.

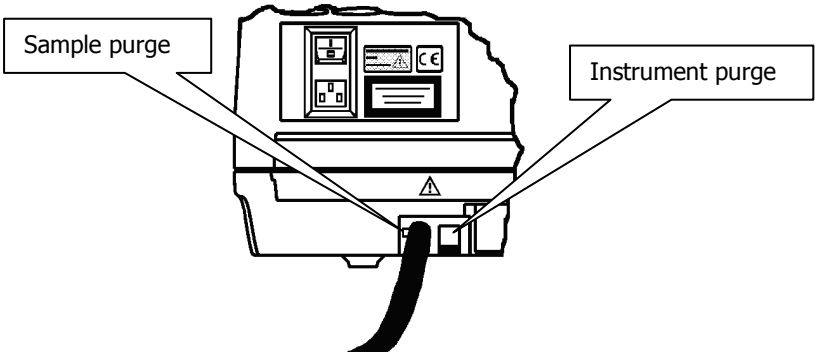


Figure 30 Connector fitted to purge port

4. Connect the free end of the tubing to the gas regulator.

NOTE: Ensure the regulator is set to a pressure not greater than 6.9 kPa (1 lbf/in^2).

5. Open the gas flow valve on the regulator until a flow rate of 28 l/minute (1 ft^3/minute) is achieved.

   The instrument compartment is purged in 10 minutes. The sample compartment is purged in 2 minutes.

6. Once purging is complete turn off the gas supply.

7. Disconnect the fitting from the instrument by pushing the clip located at the bottom of the purging port (Figure 31).

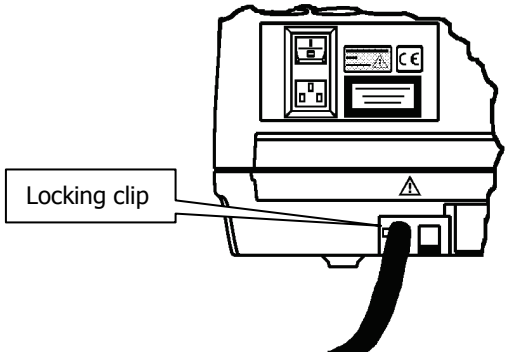


Figure 31 Disconnect the locking clip

Changing the External Fuse

Very occasionally, a fuse may fail with age and will need to be changed.

NOTE: If fuses fail repeatedly, there is an electrical fault: disconnect the power supply and contact your PerkinElmer Service Engineer.

There is one spare fuse in the fuse drawer. If you need more, order 2A, 250V Time Lag fuses (part number 04970839) from PerkinElmer. You must only replace the fuse with one of this type and rating. Do not use makeshift fuses and do not short-circuit fuse holders.

WARNING

Before you begin this procedure, switch off the power to the spectrometer, wait for 60 seconds, and disconnect the power cable.

This will protect you from electrical shock.

The external fuse drawer is located at the rear of the instrument between the power switch and the power socket (Figure 32).

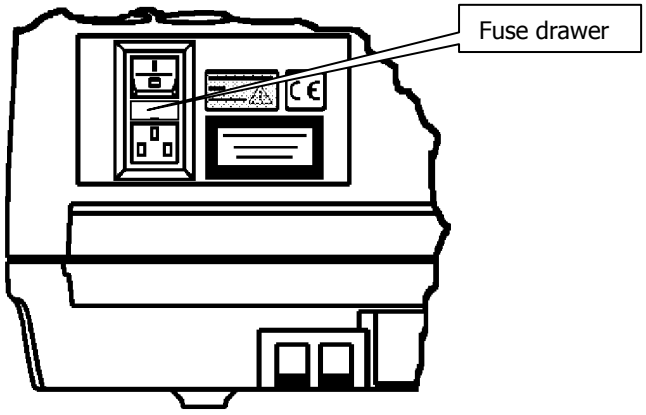


Figure 32 Fuse drawer closed

1. Lever out the fuse drawer so that it swings down over the power socket.
   The fuse is in the right hand slot.
2. Remove the old fuse and discard it.
3. Fit the new fuse into the slot (Figure 33).

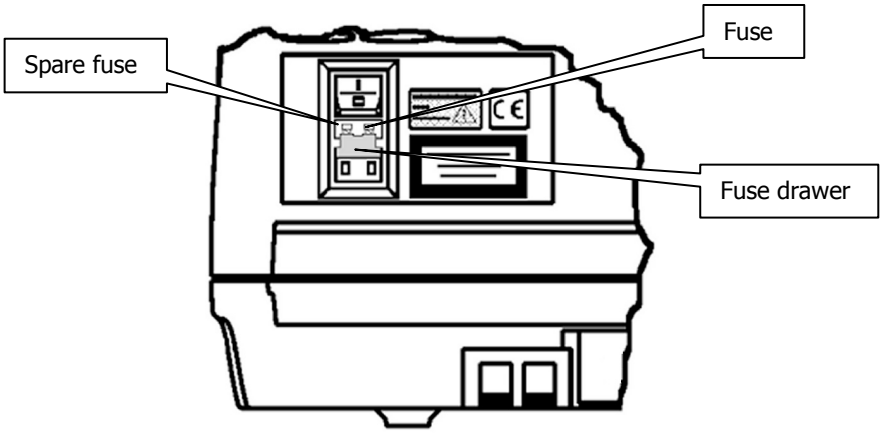


Figure 33 Fuse fitted; drawer open

4. Close the drawer.
   The new fuse is now installed.
5. Reconnect the power cable and switch on the instrument.

Cooling the MCT Detector (If Fitted)

Optionally, the Frontier FT-IR may be fitted with an MCT (mercury cadmium telluride) detector. When it is fitted in the instrument it must be cooled to 77 K before you collect spectra. The detector is mounted in a dewar that can be filled with liquid nitrogen. The detector is not enabled until it has been sufficiently cooled.

WARNING

Do not site the instrument in a poorly ventilated area if liquid nitrogen will be used to cool a detector.

Oxygen depletion in an enclosed space does not trigger a gasping reflex, and errors of judgment, confusion, or unconsciousness can occur in seconds and without warning.

WARNING

The extremely low temperature of liquid nitrogen can burn skin and eyes. Avoid exposure by wearing protective gloves and safety goggles whenever you work with it.

WARNING

As liquid nitrogen cools the detector it evaporates so rapidly that the resulting pressures can send a funnel or detector cap suddenly and forcefully shooting upward from the top of the dewar.

WARNING

Be sure to wait the specified time when filling the funnel and before replacing the plug. This enables the bubbling nitrogen to settle down and the pressure to dissipate. In addition to wearing safety goggles at all times, stand back from the instrument after each time you fill the funnel.

1. Remove the MCT coolant cover (Figure 34).

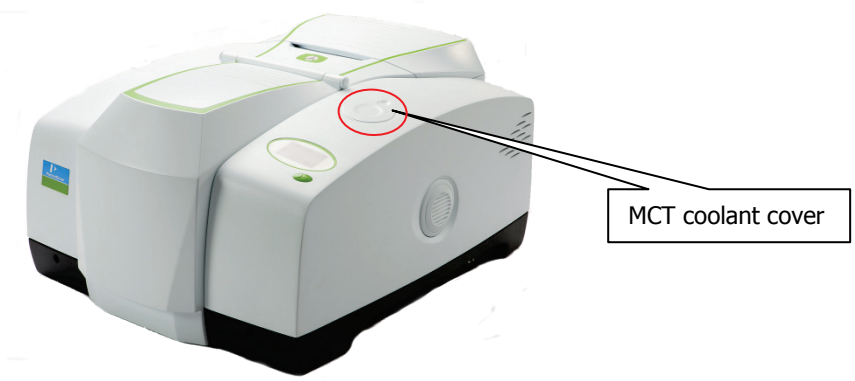


Figure 34 Location of MCT coolant cover

2. Remove the plug from the dewar.

3. Ensure that the funnel guide, which helps prevent overspill entering the instrument body rather than the dewar, is in place.

4. Make sure the supplied plastic funnel is dry.

CAUTION	*Stand where you can see the inside of the funnel as you pour the nitrogen in. Pour slowly, so that neither the funnel nor the dewar overflows. Take care not to overfill the funnel and splash liquid nitrogen onto the instrument covers.*

5. Insert the plastic funnel into the funnel guide and slowly fill the detector dewar with liquid nitrogen.

NOTE: Make sure that the detector dewar is filled to the top with liquid nitrogen before selecting the detector. Prevent radiation from reaching the detector by obstructing the beam path in the sample area during filling.

6. Stand back and wait two minutes.

   This nitrogen also vaporizes as the dewar continues to cool. The two-minute wait allows the bubbling to settle down and the pressure of the vaporizing nitrogen to dissipate.

7. Continue to pour liquid nitrogen into the funnel, adding a little more each time the funnel empties.

   The funnel takes longer to empty as the dewar fills. This happens after two or three more funnels of liquid nitrogen. Because the dewar has now cooled, the liquid nitrogen does not vaporize, but instead fills the dewar.

8. Remove the funnel and wait two minutes.

   The liquid nitrogen settles down and bubbling slows.

9. When the nitrogen stops bubbling, refit the plug.

   When the detector dewar has been filled, it will remain at its operating temperature for approximately eight hours.

NOTE: Cooled detector dewars require pumping down after approximately 12 months operation. When the boil-off rate of liquid nitrogen becomes excessive (that is, the liquid nitrogen level is low after 3–4 hours of operation), consult your PerkinElmer Service Engineer.

Advanced Maintenance

Opening the Main Cover

To perform most maintenance tasks, you have to open the main cover of the spectrometer.

NOTE: If you have any samples or reference materials in the storage compartment, you are advised to remove these before opening the main cover.

WARNING

Switch off the mains power supply to the spectrometer, wait 60 seconds and disconnect the power cable before you open the cover of the spectrometer. This makes sure that you are safe from electrical shock and laser radiation.

CAUTION

Do not open the main cover if the humidity is:

>80% relative humidity for an instrument fitted with KBr optics.
>45% relative humidity for an instrument fitted with CsI optics.

The humidity sensitive optics will be damaged if subjected to a relative humidity in excess of the specified levels.

The main cover is hinged at the back of the instrument and opens from the front. Figure 35 identifies the locking bolts, which are on the front of the instrument.

Figure 35 Main cover locking bolts

1. Switch off the power supply to the spectrometer.
2. Wait for 60 seconds.
3. Disconnect the power cable.
4. Remove the sample compartment cover, if fitted; open the cover, press on the cover retaining clip and then pull the cover vertically to remove it (Figure 36).

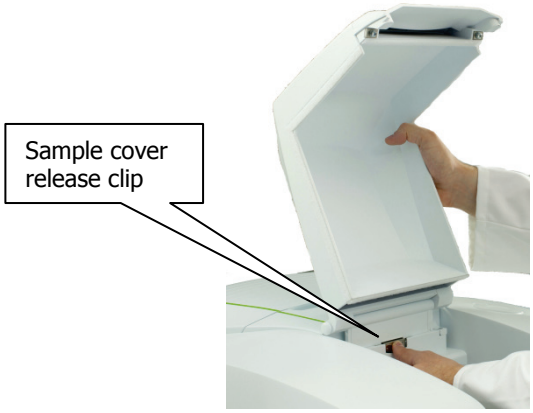


Figure 36 Removing the sample compartment cover

5. Remove the fitted sampling accessory, by pulling the release handle towards you and sliding the accessory towards you (Figure 37).

Figure 37 Removing the sampling accessory

6. Undo the two locking bolts on the front of the instrument using the hexagonal wrench supplied; insert the wrench, so that the free end is pointing horizontally away from the instrument and then rotate the wrench 180° in the direction indicated by the arrows in Figure 38.

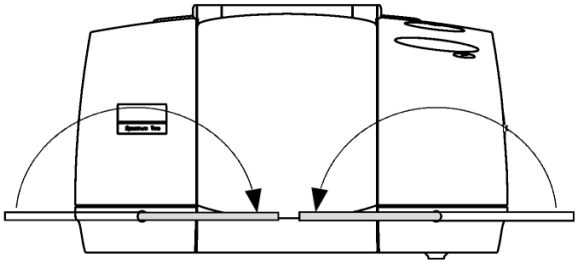


Figure 38 Undoing the locking bolts

7. Lift the main cover from the front.

8. Ensure the cover is fully open and retained by the stay.

9. Perform the necessary maintenance inside the instrument.

   Figure 39 illustrates the primary component parts of a Frontier IR Single-Range spectrometer.

NOTE: The exact configuration will depend on your instrument type. For example, if you have the External Beam Pack installed the laser power supply will be in a different position, and the mirrors for changing the beam direction will be installed (Figure 40).

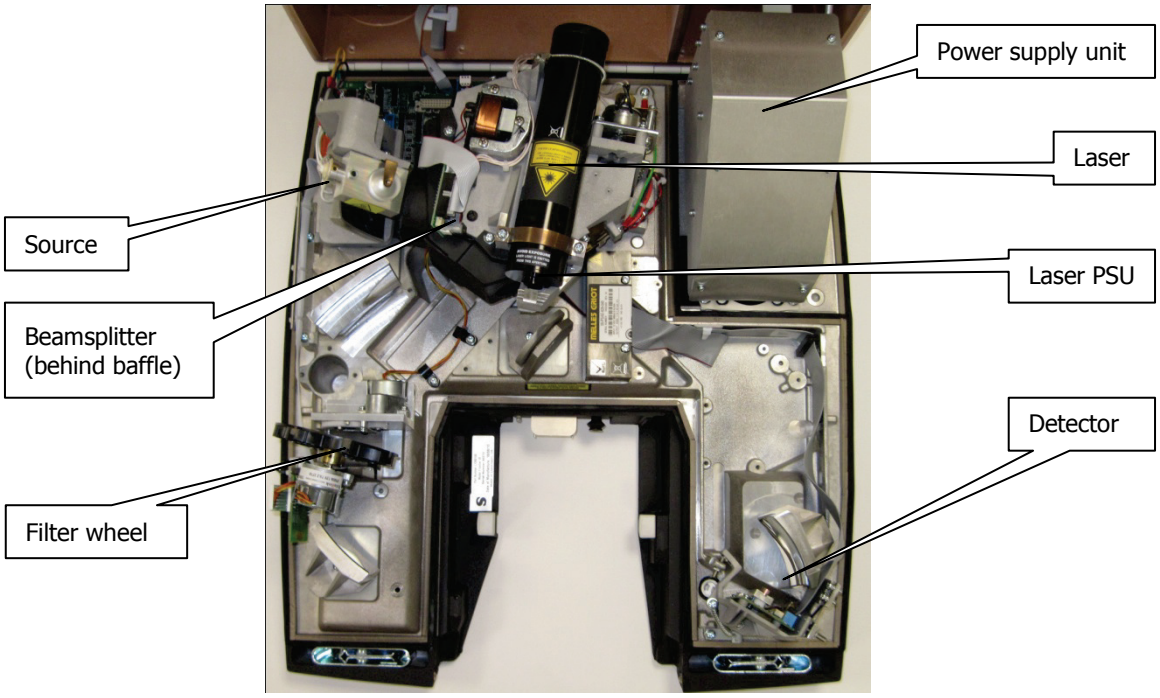


Figure 39 Frontier IR Single-Range spectrometer component parts

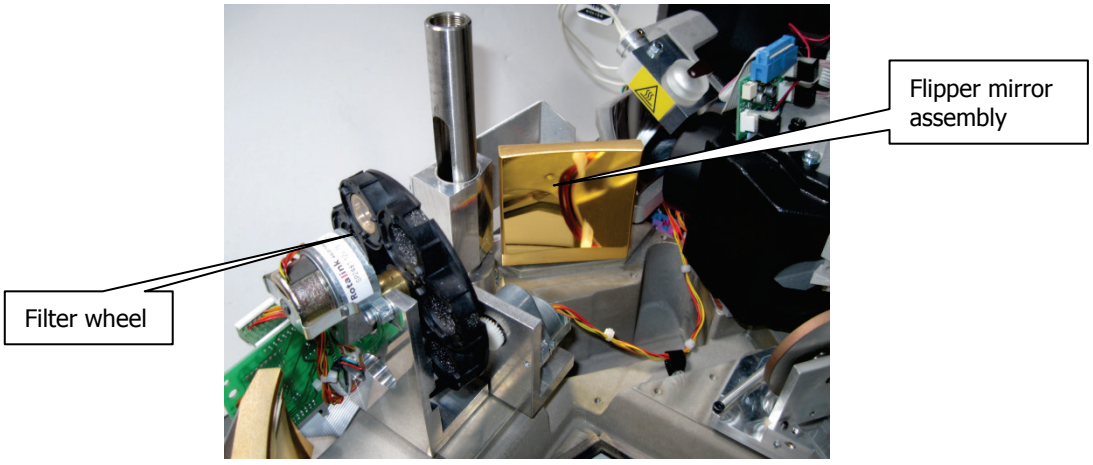


Figure 40 Flipper mirror included with the External Beam Pack option

10. Close the cover.
11. Lock the two locking bolts by inserting the wrench into each bolt in turn and rotating it opposite to the direction indicated by the arrows in Figure 38.
12. If required, reinstall the sampling accessory by sliding it on the ledge and pushing it into the sample compartment until it engages with the connector.
13. If required, refit the sample cover by inserting the hinge into the grooves and pushing the cover downwards until the clip engages.

14. Reconnect the power cable and switch the power back on.
15. If required change the desiccant (see page 56), and/or purge the instrument (see page 60).

    If the cover is left open for more than 1 hour, the desiccant should be replaced.

Replacing the Source

WARNING

Switch off the mains power supply to the spectrometer, wait 60 seconds and disconnect the power cable before you open the cover of the spectrometer. This makes sure that you are safe from electrical shock and laser radiation.

WARNING

Due to its high operating temperature allow sufficient time for the source to cool before attempting to remove it.

1. Open the main cover of the instrument as detailed on page 70 and identify the source (Figure 41).

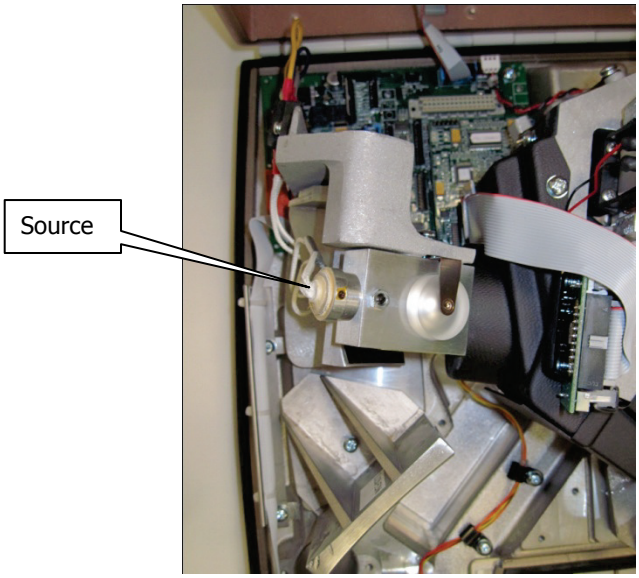


Figure 41 Source location

Caution, hot surface.

The source housing and source itself will be hot if recently switched on. Allow to cool before performing the following procedure.

CAUTION

The source element is brittle and can be broken if not handled properly. Be careful when removing and installing the source.

Do not touch the glass bulb as this will degrade the performance of the bulb and shorten its life.

2. Slacken the two terminal screws (Figure 42) securing the wires leading to the source. Disconnect the wires from the connectors.

   For the Frontier FT-IR spectrometer, the connecting wires for the MIR source are white. For the Frontier FT-NIR spectrometer, the connecting wires for the NIR source are red.

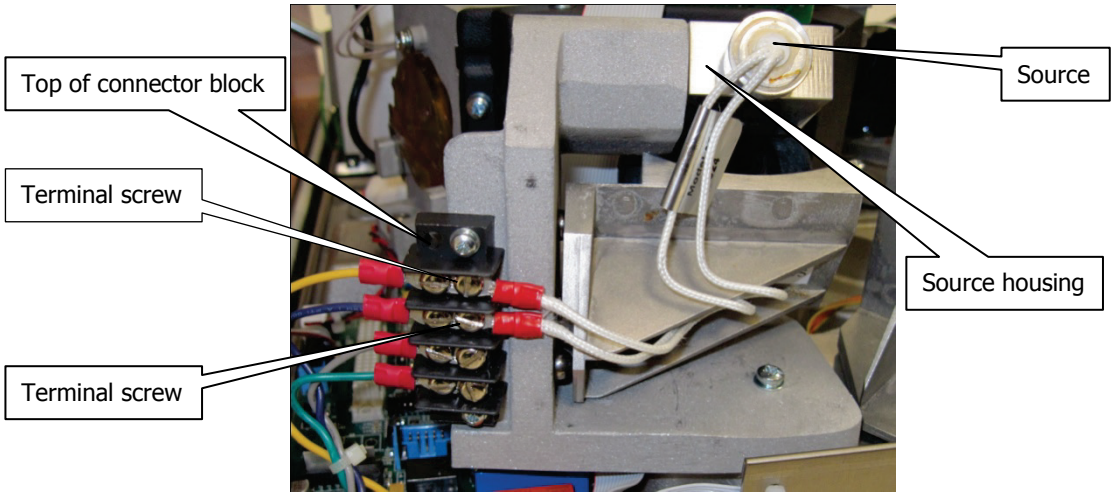


Figure 42 Terminal screws (MIR source shown)

3. By grasping the round metal source body, NOT the wires, remove the source from its housing by pulling, noting its installed position.
4. Install the new source in its housing, by pushing in until it clicks into place.
5. Reconnect the two wires to the terminals and secure by tightening the two terminal screws.
6. Close and secure the main cover.

   Refer to page 72, steps 10 to 15.

Allow the source temperature to stabilize for approximately 2 hours before using the instrument.

Replacing the Beamsplitter

WARNING

Switch off the mains power supply to the spectrometer, wait 60 seconds, and disconnect the power cable before you open the cover of the spectrometer. This makes sure that you are safe from electrical shock and laser radiation.

1. Open the main cover of the instrument, as detailed on page 70 and identify the Beamsplitter, which is behind the laser baffle (Figure 43).

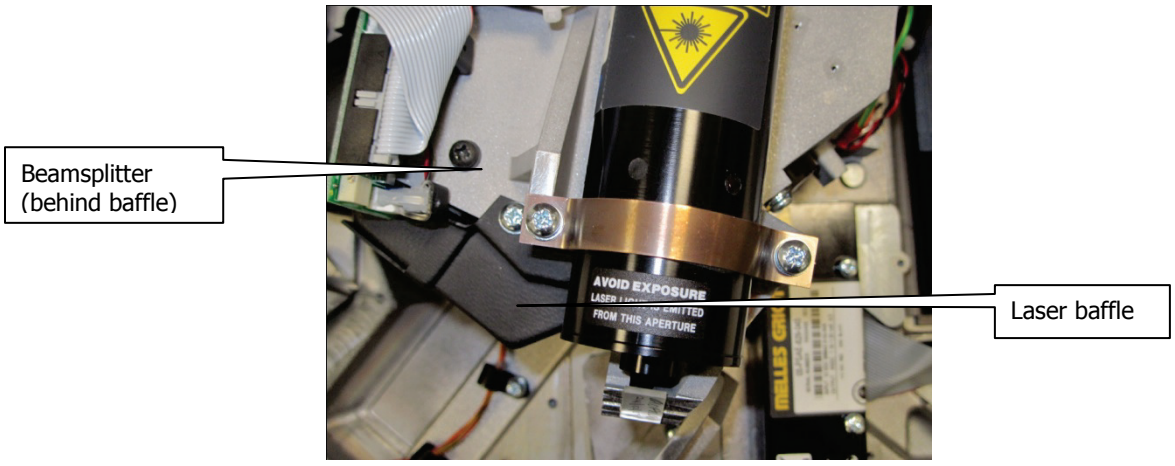


Figure 43 Beamsplitter location

2. Unscrew the laser baffle retaining screws and remove the laser baffle (Figure 44).

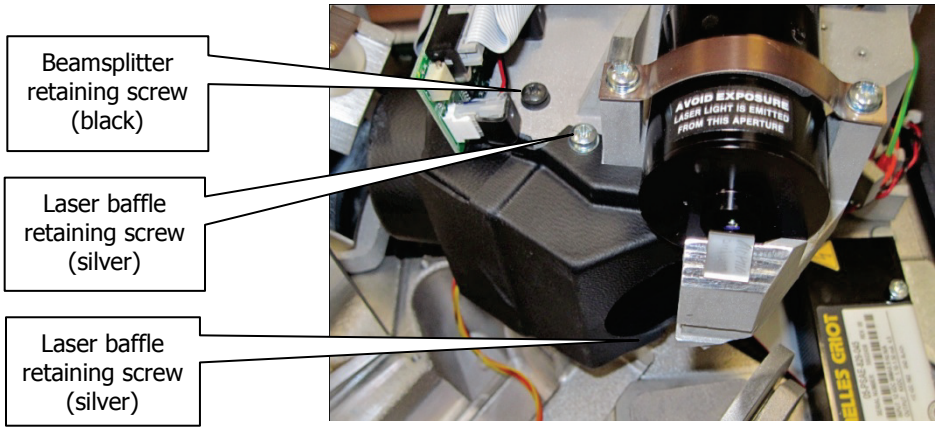


Figure 44 Laser baffle

3. Remove the beamsplitter retaining screw.
4. Noting its installed position, pull out the beamsplitter.
5. Install the new beamsplitter and secure with the retaining screw.

6. Refit the laser baffle and secure with retaining screws.
7. Close and secure the main cover.
   Refer to page 72, steps 10 to 15.

Installing/Replacing Windows

The following procedure describes how to install a window in one of the external beam ports. The details apply equally to windows in the sample compartment.

WARNING

Switch off the mains power supply to the spectrometer, wait 60 seconds, and disconnect the power cable before you open the cover of the spectrometer. This makes sure that you are safe from electrical shock and laser radiation.

1. Open the main cover of the instrument, as detailed on page 70.
   - Using the hexagonal wrench supplied with the new window kit, slacken and remove the screws and washers securing the beam port cover or current window to the main cover.

     Remove the screws carefully, and ensure that the washers do not fall into the instrument.
   - Remove the beam port cover or current window and seal. Retain for further use.

CAUTION

Be careful not to get moisture on the optical surface of the window. Do not touch or breathe on the optical surface of the window.

2. Ensure the seal is fitted to the window and is correctly seated (Figure 45).

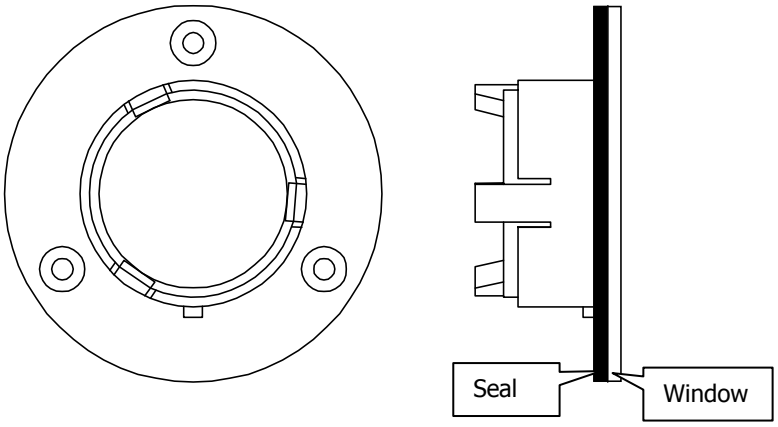


Figure 45 Seal fitted to window

3. Fit the window to the main cover from the outside in.

   Ensure the seal is fully seated and the key on the window lines up with the notch in the main cover (Figure 46).

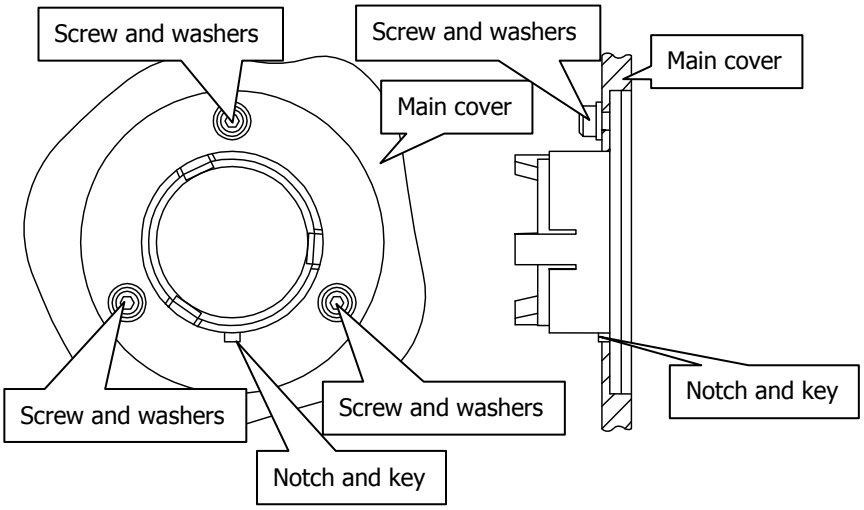


Figure 46 Window installed in main cover

4. Secure the window to the main cover by fitting the screws and washers and tightening the screws using the hexagonal wrench (Figure 46).

5. Close and secure the main cover.

   Refer to page 72, Steps 10 to 15.

If you have an MCT detector fitted, you will be supplied with an Attenuator kit (L1160560) containing 1%T, 4%T, 6%T, 14%T and 32%T attenuators. The attenuators attach to the window magnetically. You will require the ferritic window surround (part number C1201453) to attach the attenuators to the new windows.

Before selecting the MCT detector in Spectrum software, fit one of the attenuators supplied to the window to the right of the sample compartment to prevent the detector from overloading. If you have an open beam, we recommend a 14%T attenuator.

Installing Filters in the Filter Wheel

The following procedure describes how to install a filter in the filter wheel. The same procedure should be followed when replacing a filter or the methane cell.

The filter wheel assembly is removed from its mounting and placed on the standard sample slide baseplate. It therefore may be necessary to remove the sample slide.


WARNING

Switch off the mains power supply to the spectrometer, wait 60 seconds, and disconnect the power cable before you open the cover of the spectrometer. This makes sure that you are safe from electrical shock and laser radiation.

1. Set the **Filter Wheel** to Position 1 on the Setup Instrument BeamPath tab in Spectrum software.
   Position 1 will be labeled as **None 15000 – 0 cm^{-1}** and be the first option in the drop-down list.

2. Open the main cover of the instrument as detailed on page 70 and identify the filter wheel (Figure 47).

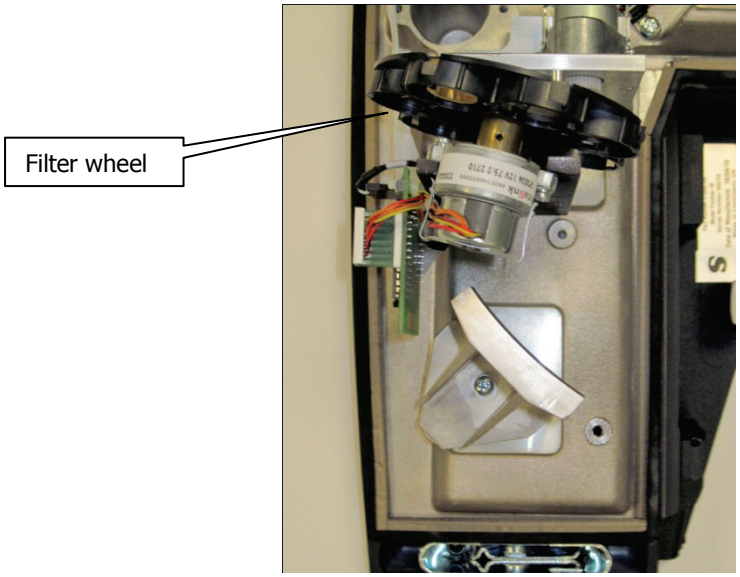


Figure 47 Filter wheel location

3. Install the standard sample holder baseplate, but remove the sample holder itself by unscrewing the knurled screw.

Figure 48 Knurled screw

4. To remove the filter wheel, loosen the set screw that secures it to its shaft using a 1.5 mm Allen key, and then gently ease the filter wheel off the shaft, rotating the filter wheel as required to clear the filter wheel from the other instrument components.

   Take care not to remove the spacer ring from the spindle, as this may be lost.

NOTE: If the set screw is not accessible, you may not have moved the filter wheel to Position 1 as described in Step 1.

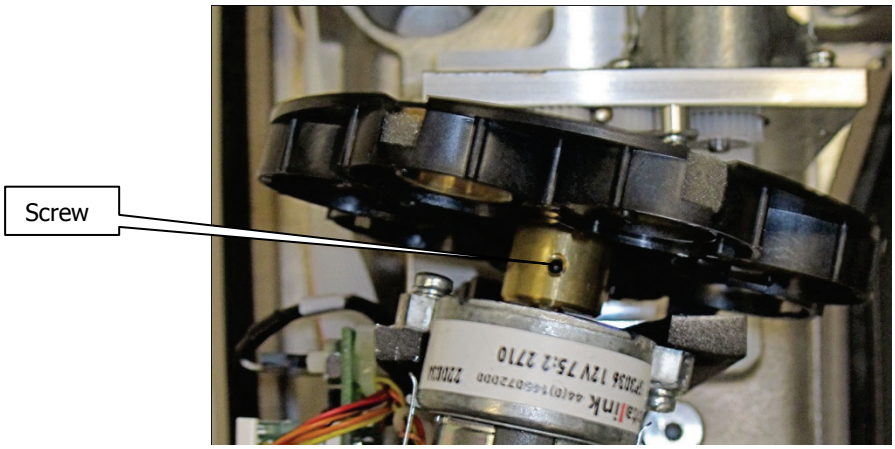


Figure 49 Filter wheel securing screw

CAUTION

Avoid touching the filters.

Some of the filters are quite difficult to see.

5. Place the assembly face down on the sample holder baseplate.

6. Working clockwise around the filter wheel, identify the next available filter position.

   The positions already filled in the filter wheel will depend on your instrument type (Figure 50).

   A Frontier FT-IR will have a polystyrene filter in Position 2 and a Frontier FT-NIR will have a polystyrene filter in Position 6. A Frontier FT-NIR will have a NG11 Schott glass sample in Position 3. The methane cell for AVI will be in Position 4.

   Position 5 and Position 7 are always available for your custom filters.

NOTE: Do not change the positions of the standard filters, or place a filter in Position 1.

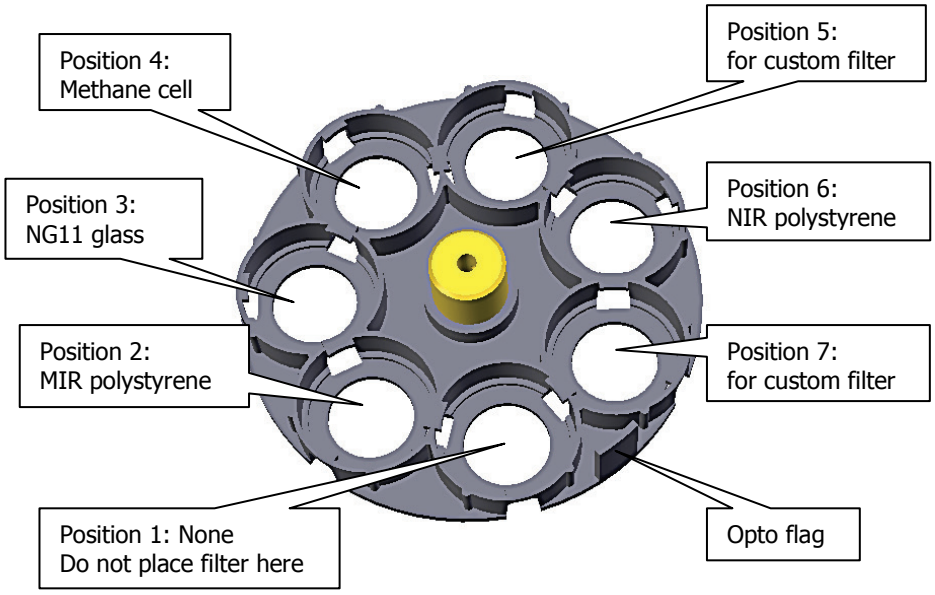


Figure 50 Filter wheel positions

7. Release the filter holder by turning it about 30 degrees counter-clockwise, and then remove the filter holder and foam spacer.

8. Place the filter in the hole, place the foam spacer on top of it, and then fit the filter holder.

   Figure 51 illustrates the assembly sequence.

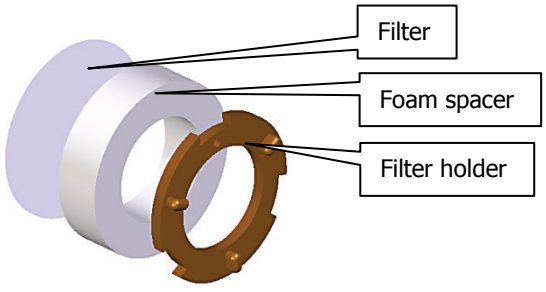


Figure 51 Filter, foam spacer and filter holder

9. Align the notches of the holder with the indents in the filter wheel. You must twist the holder clockwise to lock it to the filter wheel.

   When fitted correctly, the small hole in the filter holder is close to the outer edge of the filter wheel.

10. Refit the filter wheel to its spindle and secure it with the set screw.

CAUTION	*Make sure that you tighten the set screw onto the flat of the shaft.* *If the set screw is tightened onto a round portion of the shaft the filter wheel may loosen.*

11. Refit the sample holder onto the baseplate with the knurled screw.

12. Close and secure the main cover.

    Refer to page 72, steps 10 to 15.

13. Select the filter you would like to use in the beam path from the **Filter Wheel** drop-down list on the Setup Instrument BeamPath tab in Spectrum Software.

NOTE: If you wish to run a background scan with a filter in place, you must set the **Scan Type** to **Background** on the Setup Instrument Basic tab, rather than using the **Background** toolbar button  . See the Spectrum on-screen Help for more information.

Replacing the Laser and Power Supply

WARNING

Switch off the main power supply to the spectrometer, wait 60 seconds and disconnect the power cable before you open the cover of the spectrometer. This makes sure that you are safe from electrical shock and laser radiation.

WARNING

Do not attempt to separate the Laser from the power supply. The Laser retains an electrical charge even when the main power is switched off.

1. Open the main cover of the instrument as detailed on page 70 and identify the laser and laser power supply (Figure 52).

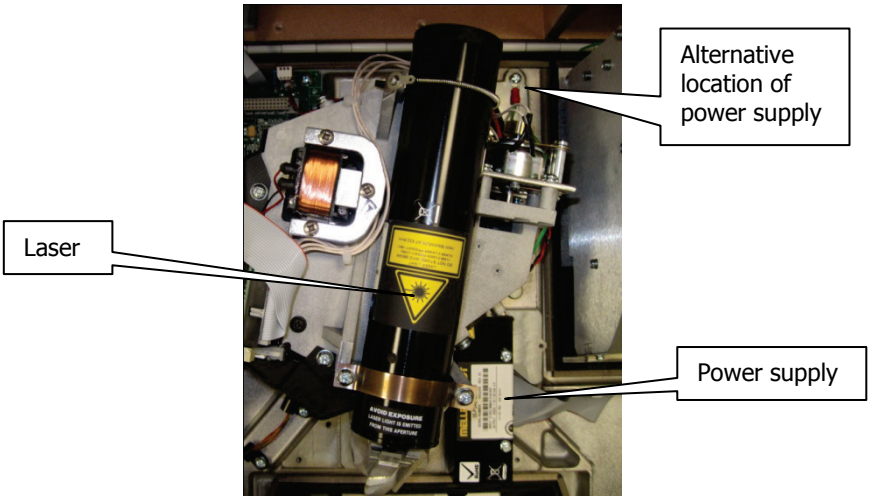


Figure 52 Laser and power supply

NOTE: If you have the External Beam Pack installed the laser power supply is in a different position (Figure 52). Follow the procedure in *Replacing the laser and power supply (External Beam Pack option fitted)* on page 86.

2. Slacken the two screws securing the laser power supply.
3. Disconnect the thin black and red cables from the board connector which is located under the rear of the laser assembly (Figure 53).

WARNING

Be careful, the nearby source housing may be hot.

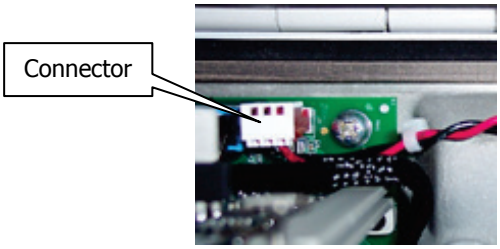


Figure 53 Laser board connector

4. Unhook the spring and remove the two screws on the retaining bracket, as shown in Figure 54.

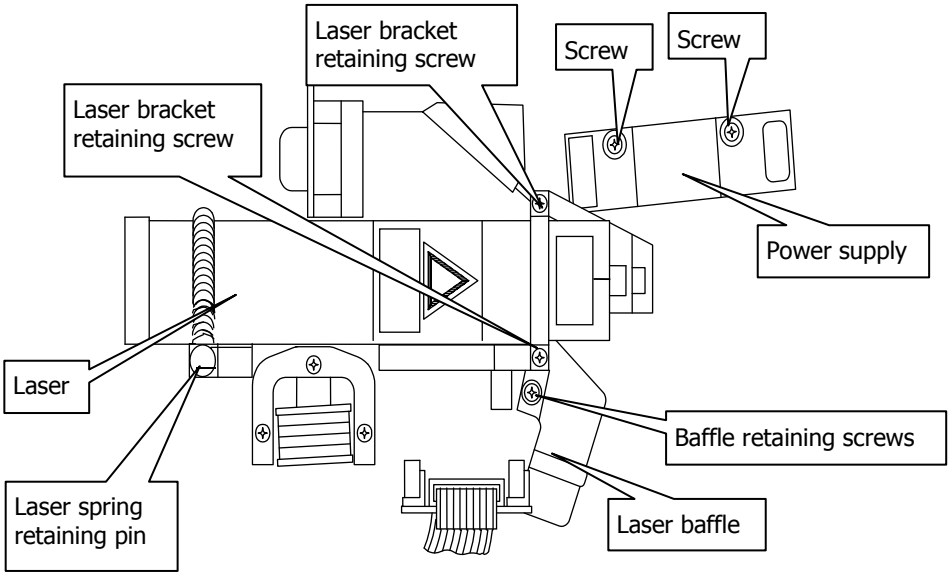


Figure 54 Laser and power supply installation

5. Remove the laser and power supply; noting the way the cabling is routed.
6. Install the new laser and power supply.
7. Ensure the laser is pushed fully home to the stop at the front of the housing.
   The laser must be installed so that the yellow laser warning label is facing directly upwards.
8. Refit the laser retaining bracket and secure with the two securing screws.
9. Secure the spring on the retaining pin.
10. Reconnect the PSU Laser cable to the board connector.
11. Secure the laser power supply with the two securing screws.
    Make sure that the laser cabling is secured so that it does not get trapped in the cover.
12. Close and secure the main cover.
    Refer to page 72, steps 10 to 15.

Replacing the laser and power supply (External Beam Pack option fitted)

1. Open the main cover of the instrument as detailed on page 70 and identify the laser and laser power supply (Figure 52).

2. Snip, and remove, the cable tie surrounding the power supply, noting how it secures the laser cables (Figure 55).

   The laser power supply fixings are accessible from the left of the instrument.

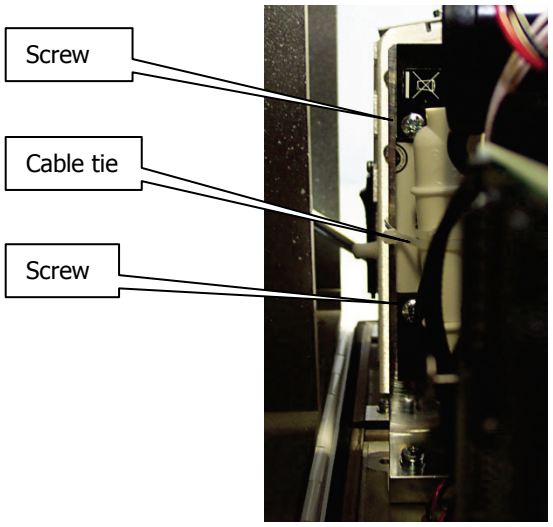


Figure 55 Laser power supply fixings (from left of instrument)

3. Slacken the two screws securing the laser power supply.

4. Unscrew and remove the cable clip that secures the thin black and red PSU laser cable at the rear of the instrument, underneath the laser assembly (Figure 56).

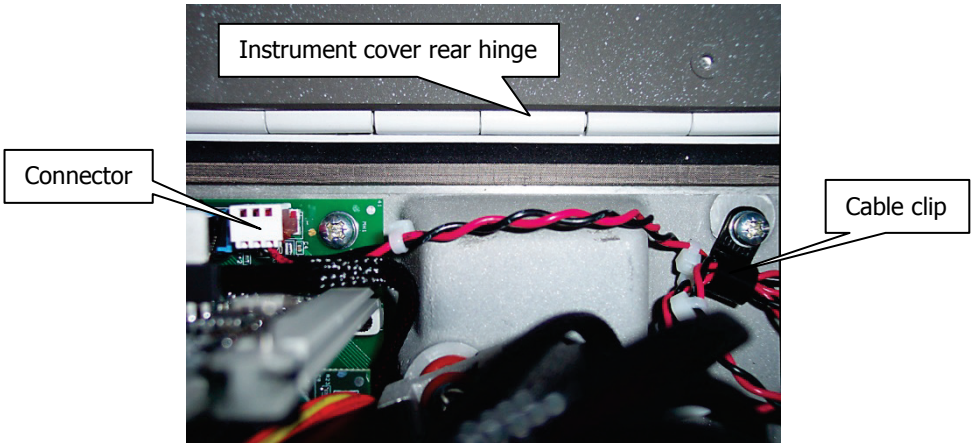


Figure 56 Laser board connector and cable clip (from top of instrument)

5. Disconnect the black and red PSU laser cable from the board.

WARNING

Be careful, the nearby source housing may be hot.

6. Unhook the spring at the rear of the laser, and remove the two screws on the retaining bracket at the front of the laser (Figure 57).

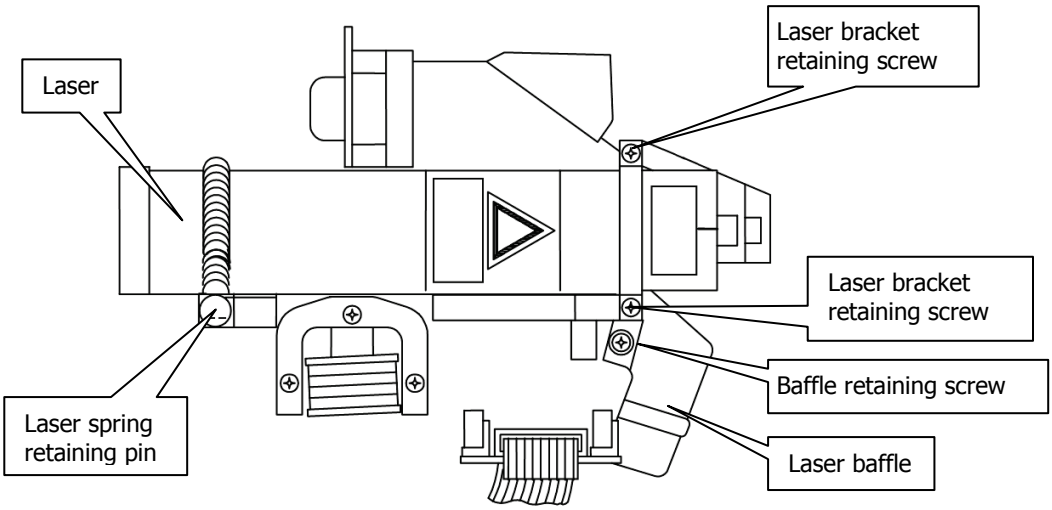


Figure 57 Laser and power supply installation

7. Remove the laser and power supply; noting the way the cabling is routed.
8. Install the new laser and power supply.
   Ensure the laser is pushed fully home to the end stop at the front of the housing.
   The laser must be installed so that the yellow laser warning label is facing directly upwards.
9. Refit the laser retaining bracket and secure with the two securing screws.
10. Secure the spring on the retaining pin.
11. Reconnect the PSU laser cable to the board connector.
12. Secure the laser power supply with the two securing screws (Figure 55).
13. Refit the cable clip (Figure 56), so that it does not get trapped in the cover.
14. Secure the laser cabling to the laser power supply with a new cable tie.
15. Close and secure the main cover.
    Refer to page 72, steps 10 to 15.

Appendices

Appendix 1: Changing the Sampling Accessory

1. Remove the sample area cover if fitted by opening the cover, pressing the clip and pulling the cover vertically to remove (Figure 58).

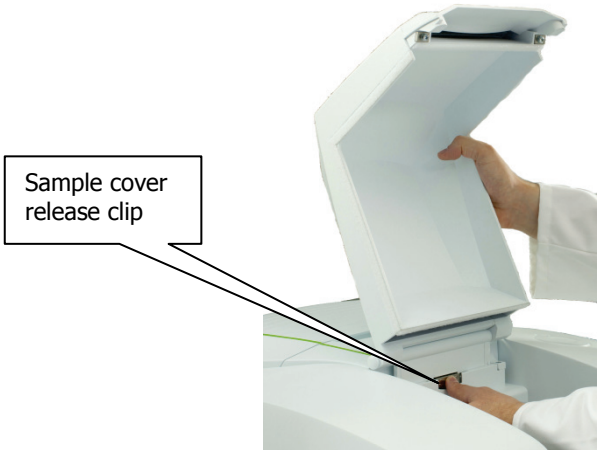


Figure 58 Removing the sample area cover

2. Remove the current sampling accessory by pulling the release handle (under the baseplate of the accessory) towards you and then sliding the accessory towards you (Figure 59).

Figure 59 Removing a sampling accessory

3. Install the new accessory (Figure 60) by sliding it onto the ledge and pushing it into the sample compartment until it engages with the connector.

Figure 60 Installing a sampling accessory

Spectrum automatically recognizes which accessory is installed, and displays the accessory information on the Setup Instrument tabs.

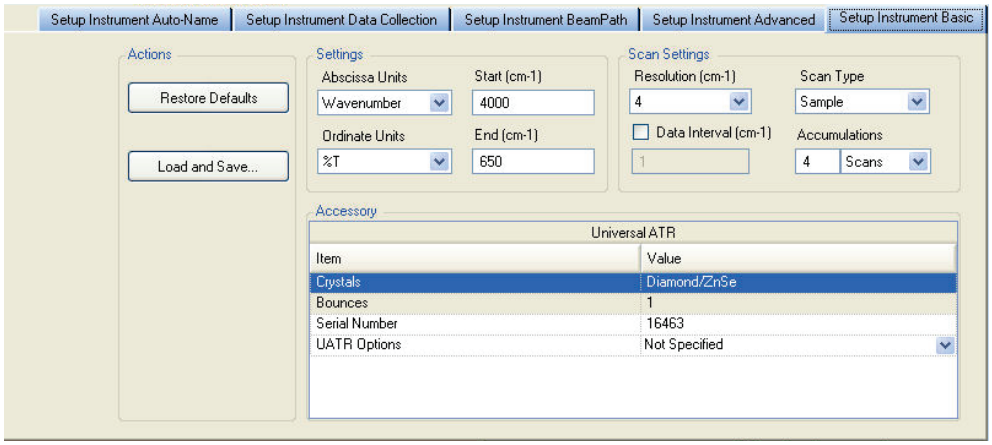


Figure 61 Setup Instrument Basic tab

Appendix 2: Instrument Self-Checks

NOTE: It can take the instrument up to 2 hours to equilibrate when switched on after being switched off overnight. To save time, we suggest that you leave the instrument switched on at all times.

- When you switch on the instrument, the instrument display provides this sequence of messages:

  >Initializing
  Initializing
  Checking Program Integrity
  Checking Instrument Configuration
  Checking Source
  Checking Laser
  Checking Scan
  Checking Calibration
  Initialization Complete.

- When initialization is complete the last message fades, leaving the instrument identity message:

  PerkinElmer Frontier FT-IR

  When connected to a PC, the instrument display adds *Ready*.

- When collecting data, the instrument display provides prompts generated by the PerkinElmer application software.

Initialization errors

If your instrument generates one of the following error messages, switch off the instrument, then switch the instrument on again.

Consult your PerkinElmer service representative if the problem persists.

Error message	**Action**
Program Integrity Failed	The instrument's firmware may be corrupt, so must be reinstalled.
Instrument Configuration Failed	Suggests that one or more internal device is failing. If the problem persists, note any associated error messages and consult your PerkinElmer service representative.
Scan Failed	If the problem persists, note any associated error messages and consult your PerkinElmer service representative.
Laser Failed Replace Laser	Refer to *Replacing the Laser and Power Supply* on page 84.
Source Failed Replace Source	Refer to *Replacing* on page 74.
Calibration Failed	Too little energy may be reaching the detector. Make sure the sample compartment is clear.

Appendix 3: Instrument Performance Validation Kits

The Frontier FT-NIR is supplied with the NIR Performance Validation Kit (L1250405), which contains a polystyrene reference sample.

For the Frontier FT-IR, the MIR Performance Validation Kit (L1250404) is available. This kit contains a polystyrene reference sample and an NG11 Schott Glass reference sample.

Macros are supplied with Spectrum software (version 10 or later) that can be used with the Performance Validation kits to produce a report certifying your instrument.

Appendix 4: Decontamination and Cleaning

Before using any cleaning or decontamination methods except those specified by PerkinElmer, users should check with PerkinElmer that the proposed method will not damage the equipment.

Decontamination

Customers wishing to return instrumentation and/or associated materials to PerkinElmer for repair, maintenance, warranty or trade-in purposes are advised that all returned goods must be certified as clean and free from contamination.

The customer's responsible body is required to follow the "Equipment Decontamination Procedure" and complete the "Certificate of Decontamination". These documents are available on the PerkinElmer public website:

http://las.perkinelmer.com/OneSource/decontamination.htm

Alternatively, if you do not have access to the internet contact Customer Care:

Customer Care USA:	1-800-762-4000	(inside the USA)
(8:30 a.m. – 7 p.m. EST)	(+1) 203-925-4602	(outside the USA)
Customer Care Canada:	800-561-4646	
Customer Care EU:	0800 40 858	(Brussels)
	0800 90 66 42	(Monza)

If you are located outside of these regions, please call your local PerkinElmer sales office for more information.

Cleaning the instrument

Exterior surfaces may be cleaned with a soft cloth, dampened with a mild detergent and water solution. Do **not** use abrasive cleaners or solvents.

Appendix 5: WEEE Instructions for PerkinElmer Products


or


A label with a crossed-out wheeled bin symbol and a rectangular bar indicates that the product is covered by the Waste Electrical and Electronic Equipment (WEEE) Directive and is not to be disposed of as unsorted municipal waste. Any products marked with this symbol must be collected separately, and in accordance with the regulatory guidelines in your area.

The objectives of this program are to preserve, protect and improve the quality of the environment, protect human health, and utilize natural resources prudently and rationally. Specific treatment of WEEE is indispensable in order to avoid the dispersion of pollutants into the recycled material or waste stream. Such treatment is the most effective means of protecting the customer's environment.

The requirements for waste collection, reuse, recycling, and recovery programs are set by the regulatory authority at your location. Contact your local responsible person (such as your laboratory manager) or authorized representative for information regarding applicable disposal regulations.

See the PerkinElmer web address below for information specific to PerkinElmer products, and contact details for the Customer care department in your region.

http://las.perkinelmer.com/OneSource/Environmental-directives.htm

Products from other manufacturers may also form a part of your PerkinElmer system. These other manufacturers are directly responsible for the collection and processing of their own waste products under the terms of the WEEE Directive. Please contact these manufacturers directly before discarding any of their products.

Consult the PerkinElmer web site (above) for manufacturer's names and web addresses.

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