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Orbitrap Exploris GC and Orbitrap Exploris GC 240 Mass Spectrometers

Operating Manual

1R120631-0002 Revision A March 2021

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Orbitrap Exploris GC and Orbitrap Exploris GC 240 Mass Spectrometers

Operating Manual

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Legal Notices

Original Operating Instructions

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General Lab Equipment, Not for Clinical, Patient or Diagnostic Use.

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Technical Data for Orbitrap Exploris GC and Orbitrap Exploris GC 240 Systems

This table summarizes technical data of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 systems. See the respective chapters of the manual for details and additional instrument properties.

Technical Data for Orbitrap Exploris GC and Orbitrap Exploris GC 240 Systems (Sheet 1 of 2)

Parameter	Specification		Value
Instrument Properties			
Mass spectrometer	Depth × width × height		1063 × 534 × 703 mm
	Weight		120 kg
Foreline pump	Length × width × height		460 × 200 × 250 mm
	Weight		24 kg
Complete system (incl. data system)	Noise emission		Below 70 dB(A)
	Heat generation		3440 W
Power Requirements			
Mass spectrometer	Input	Nominal voltage	208–240 Vac, 50/60 Hz, 10 A_{MAX}
		Power	apparent power: 800 VA; effective power: 750 W
		Fuse[a]	10 A
	Output	4×	208–240 Vac, 50/60 Hz, 3 A total
	Protection type		IP 20
TRACE 1310 GC	Input	Nominal voltage	230 Vac ± 10%, 50/60 Hz, 10 A_{MAX}
		Power	2000 VA
		Fuse[a]	16 A
Foreline pump	Input (110 V)	Nominal voltage	110 Vac, 50 Hz, 6.8 A_{MAX}; 115–120 Vac, 60 Hz, 6.9 A_{MAX}
		Power	450 W
	Input (220 V)	Nominal voltage	220–240 Vac, 50 Hz, 3.4 A_{MAX}; 230–240 Vac, 60 Hz, 3.4 A_{MAX}
		Power	550 W
Data system	Input	Nominal voltage	115–240 Vac, 50/60 Hz
		Fuse[a]	15/16 A
Gas Requirements			

Technical Data for Orbitrap Exploris GC and Orbitrap Exploris GC 240 Systems (Sheet 2 of 2)

Parameter	Specification	Value
HCD gas (mandatory)	Type	Nitrogen
	Purity	99.999% or better (ultra high purity)
	Supply rate	max. 30 mL/min split between HCD and forevacuum in On or Standby. No gas flow in Off state.
	Pressure	0.6 ± 0.05 MPa (87 ± 7 psi)
Vent gas (mandatory)	Type	Nitrogen
	Purity	99% or better
	Supply rate	175–300 mL/min (during venting); No gas flow when instrument is powered on.
	Pressure	0.6 ± 0.05 MPa (87 ± 7 psi)
Carrier Gas (mandatory)	Type	Helium[b]
	Purity	99.999% Ultra-high purity
	Supply rate	50 mL/min
	Pressure	0.4–0.7 MPa (58–102 psi)
CI Gas[c]	Type	Methane[d]
	Purity	99.995% High purity
	Supply rate	1–3 mL/min
	Pressure	0.035–0.24 MPa (5–35 psi)
Operating Environment		
	Laboratory temperature	18–27 °C
	Max. temperature fluctuation	0.5 °C/10 min
	Humidity	20–80%, non-condensing and non-corrosive atmosphere
	Pollution degree	2 (normally non-conducting)
	Max. altitude	3000 m above sea level
Pump exhaust requirements	Inrush flow rate	4.5 m^3/h maximum
	Continuous flow rate	40 mL/min

[a] Dedicated wall outlet

[b] Hydrogen carrier gas is not supported on the system.

[c] Required for installation of systems with chemical ionization and for negative ion calibrations.

[d] While other CI gases can be used with the Orbitrap Exploris GC, only methane is required for CI installation.

1

Using this Manual

Welcome to the Thermo Scientific™ Orbitrap Exploris GC and Orbitrap Exploris GC 240™ system! Orbitrap Exploris GC and Orbitrap Exploris GC 240 systems are members of the Thermo Scientific family of mass spectrometer (MS) detectors that are powered by Orbitrap™ technology.

Contents

- About this Manual on page 1-1
- Typographical Conventions on page 1-2
- Reference Documentation on page 1-4
- Contacting Us on page 1-5

About this Manual

This *Orbitrap Exploris GC and Orbitrap Exploris GC 240 Operating Manual* contains precautionary statements that can prevent personal injury, instrument damage, and loss of data if properly followed. It also describes the modes of operation and principle hardware components of your Orbitrap Exploris GC and Orbitrap Exploris GC 240 instrument. In addition, this manual provides step-by-step instructions for cleaning and maintaining your instrument.

Designed, manufactured and tested in ISO9001 certified facilities, this instrument has been shipped to you from our manufacturing facility in a safe condition. This instrument must be used as described in this manual. Any use of this instrument in a manner other than described here may result in instrument damage and/or operator injury.

Typographical Conventions

This section describes typographical conventions that have been established for Thermo Fisher Scientific manuals.

Signal Words

Make sure that you follow the precautionary statements presented in this manual. The special notices appear different from the main flow of text:

NOTICE Points out possible material damage and other important information in connection with the instrument.

Tip Highlights helpful information that can make a task easier.

Viewpoint Orientation

The expressions *left* and *right* used in this manual always refer to the viewpoint of a person that is facing the front side of the instrument.

Data Input

Throughout this manual, the following conventions indicate data input and output with the computer:

- Messages displayed on the screen are represented by capitalizing the initial letter of each word and by italicizing each word.
- Input that you enter by keyboard is identified by quotation marks: single quotes for single characters, double quotes for strings.
- For brevity, expressions such as "choose **File > Directories**" are used rather than "pull down the File menu and choose Directories."
- Any command enclosed in angle brackets < > represents a single keystroke. For example, "press **<F1>**" means press the key labeled *F1*.
- Any command that requires pressing two or more keys simultaneously is shown with a plus sign connecting the keys. For example, "press **<Shift>** + **<F1>**" means press and hold the <Shift> key and then press the <F1> key.
- Any button that you click on the screen is represented in bold face letters. For example, "click **Close**."

Topic Headings

The following headings are used to show the organization of topics in a chapter:

Chapter Name

Second Level Topics

Third Level Topics

Fourth Level Topics

Reference Documentation

This *Orbitrap Exploris GC and Orbitrap Exploris GC 240 Operating Manual* represents the Original Operating Instructions. In addition to this manual, Thermo Fisher Scientific provides other documents for the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer that are not part of the Original Operating Instructions. Reference documentation for the Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS includes the following:

- *Orbitrap Exploris GC and Orbitrap Exploris GC 240 Pre-Installation Requirements Guide*

  This manual contains information on the necessary environmental conditions in the intended location for the instrument.

- *Orbitrap Exploris GC Help*

  This Help describes the features of the instrument software.

- *Orbitrap Exploris GC and Orbitrap Exploris GC 240 QuickStart Guide*

  This manual gives an introduction on setting up and using the instrument.

You can access PDF files of the documents listed above and of this manual from the data system computer. The software also provides Help.

❖ **To view product manuals**

From the Microsoft™ Windows™ taskbar, choose **Start > All Programs > Thermo Instruments > model x.x**, and then open the applicable PDF file.

A printed version of this *Orbitrap Exploris GC and Orbitrap Exploris GC 240 Operating Manual* is shipped with the instrument.

Refer also to the user documentation that is provided by the manufacturers of third-party components:

- Forepump
- Turbomolecular pump
- Data system computer and monitor
- Safety data sheets

Contacting Us

There are several ways to contact Thermo Fisher Scientific. You can use your smartphone to scan a QR Code, which opens your email application or browser.

Contact	Link / Remarks	QR Code
Brochures and Ordering Information	www.thermofisher.com/orbitrap	
Service Contact	www.unitylabservices.com	
Technical Documentation SharePoint	❖ **To get user manuals for your product** 1. With the serial number (S/N) of your instrument, request access on our customer SharePoint as a customer at www.thermoscientific.com/Technicaldocumentation 2. For the first login, you have to create an account. Follow the instructions given on screen. Accept the invitation within six days and log in with your created Microsoft™ password. 3. Download current revisions of user manuals and other customer-oriented documents for your product. Translations into other languages may be available there as well.	
Customer Feedback	❖ **To suggest changes to this manual** You are encouraged to report errors or omissions in the text or index. Send an email message to the Technical Editor at techpubs-austin@thermofisher.com.	

Scope of Delivery

This chapter lists the components that are shipped with your Orbitrap Exploris GC and Orbitrap Exploris GC 240 GC/MS system.

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 standard system has the following components:

- Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer
- TRACE 1310 GC
- Autosampler
- Data system computer with monitor
- Forepump
- Drip pan for forepump
- Installation Kit including
  - Equipment for connecting the above components (hoses, cables)
  - Computer equipment
  - Tools for installation and maintenance
  - Spare parts
- Printed manuals
  - *Orbitrap Exploris GC and Orbitrap Exploris GC 240 Operating Manual*

  In addition to this printed manual, other documents for the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer are available as PDF files on the data system computer. See “Reference Documentation” on page 1-4 for a list.

3

Functional Description

This chapter provides an overview of the functional elements of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer.

Contents

- General Description on page 3-2
- Instrument Front Side on page 3-5
- Left Instrument Side on page 3-7
- Right Instrument Side on page 3-9
- Ion Optics on page 3-14
- Curved Linear Trap on page 3-18
- Orbitrap Analyzer on page 3-20
- HCD Cell on page 3-23
- Vacuum System on page 3-23
- Electronic Assemblies on page 3-26
- Cooling Fans on page 3-26

General Description

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer is a stand-alone Orbitrap™ instrument with an electronic ionization (EI) source or chemical ionization (CI) source for gas chromatography (GC) mass spectrometry (MS) high-throughput applications. The instrument is designed to be placed on a bench in the laboratory. This chapter describes the principal components of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 system and their respective functions.

Layout of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 Mass Spectrometer

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer consists of six main components. They are described in the topics that follow:

- Ion source that is removable under vacuum
- Ion transfer optics, including injection flatapole and bent flatapole
- Quadrupole mass filter for precursor ion selection
- Intermediate storage device (C-Trap) for short pulse injection
- Collision cell for performing HCD (Higher Energy Collisional Dissociation) experiments
- Orbitrap analyzer for Fourier transform mass analysis

For a schematic view of the instrument layout, see Figure 3-11 on page 3-16. Figure 3-1 shows a front view of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS.

Figure 3-1. Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS front view

Operating Modes of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS

Samples can be introduced into the TRACE 1310 GC manually or by using an autosampler. See the GC and autosampler user manuals for instructions on injecting samples.

The injection flatapole and bent flatapole transmit ions from the source to the quadrupole.

The quadrupole rod assembly operates as an ion transmission device with the possibility to filter the transmitted ions according to their mass-to-charge ratios. By applying RF voltages and DC voltages to the rods, the filter characteristic is configured. See "Quadrupole Mass Filter" on page 3-17 for details.

The ions are transferred into the C-Trap through multiple stages of differential pumping. See "Ion Optics" on page 3-14 for details. In the C-Trap, the ions are accumulated and their energy is dampened with a trapping gas (nitrogen). The ions are then injected through three further stages of differential pumping by a lens system (Z-lens) into the Orbitrap analyzer where mass spectra are acquired by image current detection. The vacuum inside the Orbitrap analyzer is maintained below 1E-9 mbar. See "Orbitrap Analyzer" on page 3-20 for details.

In MS/MS modes, ions are passed through the C-Trap into the HCD cell. The HCD cell adds a Higher Energy Collision Induced Dissociation capability to the instrument. In combination with the quadrupole mass filter, this allows MS/MS experiments or all-ion fragmentation (AIF) in case of a broad range of selected mass-to-charge ratios. After the ions have been fragmented in the HCD cell, the HCD cell voltages are ramped up and the ions are transferred back into the C-Trap from where they are injected into the Orbitrap analyzer for detection. See page 3-23 for a description of the HCD cell.

Performance Specifications

Table 3-1. Performance specifications of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS

Mass Range for Full Scans	*m/z* 30–3000 Scan range: last mass ≤ 15× first mass.
Precursor Ion Selection	
30 < *m/z* ≤ 400	Any isolation widths between *m/z* 0.4 and full scan
400 < *m/z* ≤ 700	Any isolation widths between *m/z* 0.7 and full scan
700 < *m/z* ≤ 1000	Any isolation widths between *m/z* 1.0 and full scan
1000 < *m/z* ≤ 1500	Any isolation widths between *m/z* 1.5 and full scan
1500 < *m/z* ≤ 2000	Any isolation widths between *m/z* 2.0 and full scan
2000 < *m/z* ≤ 2500	Any isolation widths between *m/z* 3.0 and full scan
2500 < *m/z* ≤ 3000	No precursor ion selection.
Mass Resolution	7500 at *m/z* 200 at a scan rate of 40 Hz 15000 at *m/z* 200 at a scan rate of 22 Hz 30000 at *m/z* 200 at a scan rate of 12 Hz 60000 at *m/z* 200 at a scan rate of 7 Hz 120000 at *m/z* 200 at a scan rate of 3 Hz 240000 at *m/z* 200 at a scan rate of 1.5 Hz
Mass Accuracy	<3 ppm with external calibration (under defined conditions) <1 ppm using internal standard, lock masses (under defined conditions)
Polarity Switching	One full cycle in < 1 sec (one full scan positive mode and one full scan negative mode at resolution setting of 60000)
Dynamic Range	>5000 within a single scan

Instrument Front Side

System status control LEDs and vacuum probe interlock are on the front side of the instrument.

System Status LEDs

The system status LEDs at the front side (See Figure 3-2.) indicate main functions of the system. Table 3-2 explains the function of the LEDs.

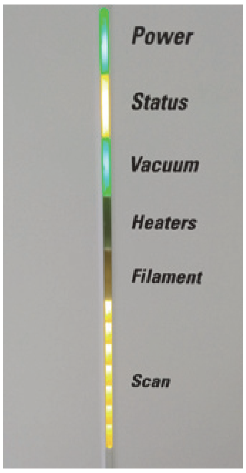


Figure 3-2. System status LEDs

Table 3-2. System status LEDs of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer

LED	Status	Information
Power	Green	Instrument is receiving power. (The electronics service switch is in the Operating Mode position.)
	Off	Instrument is not receiving power or the instrument control board is resetting.
Status	Green	Instrument is in operating mode. No errors or warnings.
	White flashing	A procedure is running.
	Yellow	Warnings are present.
	Yellow flashing	Serious warnings are present. Check instrument messages.
	Off	The instrument is off or the electronics service switch is in the Service Mode position.
Vacuum	Green	Vacuum is working correctly. No errors or warnings.
	Yellow	Instrument is pumping down, baking out, or UHV is unknown.
	Yellow flashing	Instrument is pumping down.
	Red flashing	Vacuum error.
	Off	Vacuum status is unknown

Table 3-2. System status LEDs of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer, continued

LED	Status	Information
Heaters	Green	Ion source heaters ± 4 °C of set values.
	Yellow flashing	Ion source is not at set temperature.
	Off	Ion source heaters off.
Filament	Green	Filament on and ready.
	Yellow	Filament on and not ready.
	Red	Selected filament is blown.
	Off	Filament off.
Scan	Blue animation[a]	Instrument is scanning.
	Purple animation[a]	Instrument is scanning in HCD mode.
	Yellow, Green, and White	Same as Status mode.
	Off	Instrument is in off mode. (If powered and not in Service Mode.)

[a] The animation changes with the actual scan rate.

Tip The system status LEDs give a quick overview of the general system status. They do not have any function for the safety status of the instrument. It is not sufficient that the Power LED is off because it might be defective. Before you perform any maintenance on the instrument, make sure that the main power circuit breaker switch (labeled Main Power) is in the Off (O) position and that the power cords of the *mass spectrometer and the forepump* are disconnected.

Left Instrument Side

The forepump connection and gas inlets are on the left side of the instrument.

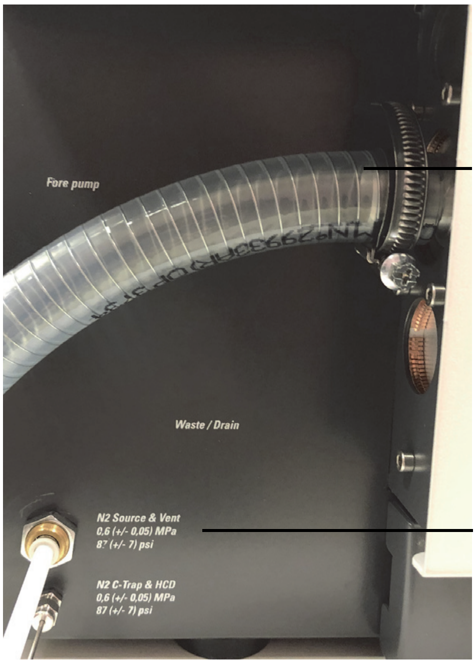


Figure 3-3. Connections at the left instrument side

Forepump connection Ports

Connect the forepump to the large vacuum connection at the left side of the instrument. One section of 19 mm (¾ in.) ID reinforced PVC tubing is shipped with the instrument. For detailed information about the vacuum system, see page 3-23.

Gas Inlets

Two gas inlet ports are at the bottom of the left side of the instrument. The port for vent gas (top) has a press-in fitting for a 6 mm hose. The port for C-Trap gas & HCD cell gas (bottom) has a Swagelok™-type fitting for 1/16 in. tubing. See "Gas Supply" on page 5-16 for instructions for connecting the nitrogen supply of the laboratory to the instrument.

Tip Do not connect gases other than nitrogen to the left side of Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer! This might affect instrument performance. The maximum pressure for the gas inlet is 0.65 MPa (94 psi).

Use high-purity (HP, 99%) nitrogen for venting the vacuum manifold. The HP nitrogen is also used to vent the vacuum manifold with the vent valve if the system is shut down. The collision gas (trapping gas) of the

C-Trap and the collision gas for the HCD cell require ultra-high purity (UHP, 99.999%) nitrogen. The necessary gas pressure is 0.6 ± 0.05 MPa (87 ± 7 psi).

Gas Distribution

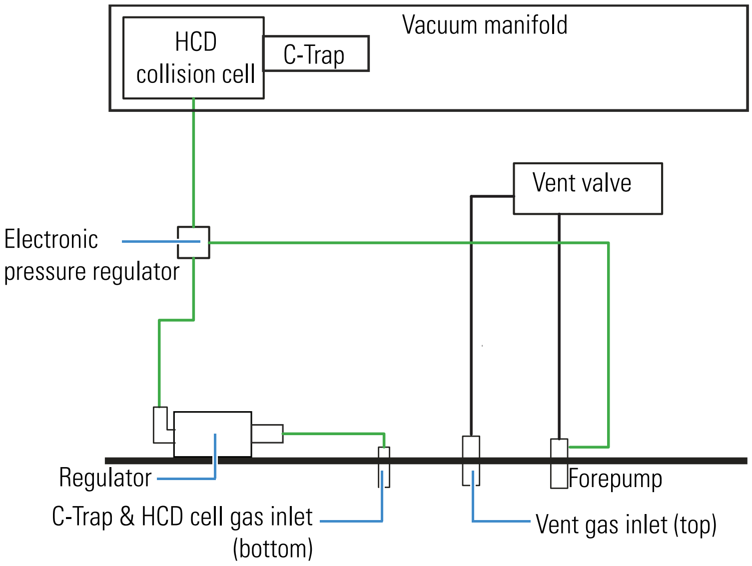


Figure 3-4. Schematic of the internal gas supplies

The gas flow from the top gas port is directed through a Teflon™ hose to the vent valve (See page 3-25 for further information.). When the instrument switches the vent valve, the nitrogen is led through stainless steel tubing to the forepump The nitrogen gas flow ensures a clean and controlled venting of the instrument.

The gas flow from the bottom gas port is directed through 1/16 in. tubing to a pressure regulator, which keeps the gas pressure to C-Trap and HCD cell constant. An electronic pressure regulator sets the nitrogen pressure according to the operating mode of the instrument and the chosen user setting. From the electronic regulator, a small part of the gas is led as collision gas to the HCD cell next to the C-Trap. The nitrogen gas that leaks from the HCD cell is used for ion trapping and cooling in the C-Trap.

Right Instrument Side

Figure 3-5 shows the right side of the instrument. Visible are the control panel, power column, ventilation slots, and the accessories cabinet.

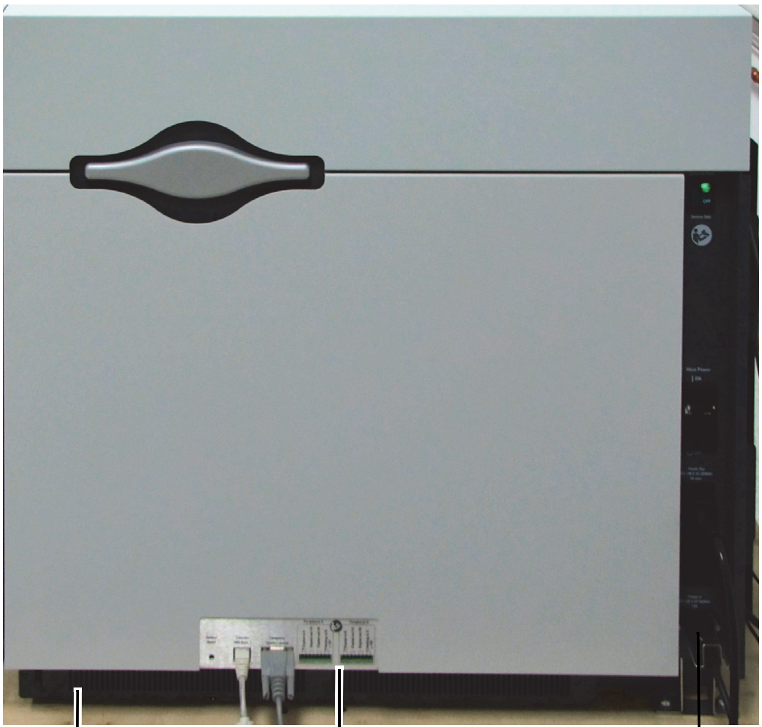


Figure 3-5. Right side of instrument (partial view)

Control Panel

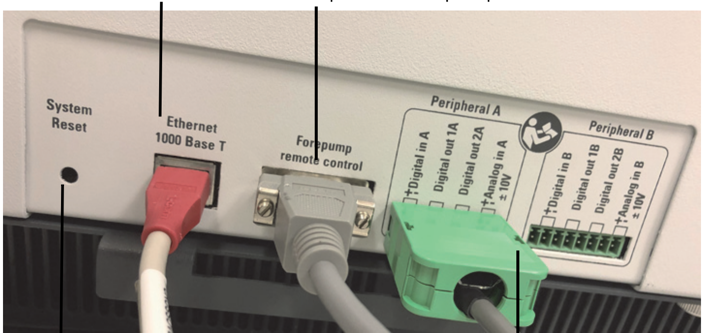


Figure 3-6. Control panel

The *reset button* is located on the control panel. When you press the reset button, the instrument software is reloaded from the data system.

See "Resetting the System" on page 6-12 for information on resetting the mass spectrometer.

Tip Use the reset button only if the instrument does not respond to the control program on the data system computer or if you must restart the instrument without turning off the electronics service switch.

Use the Ethernet port to connect the mass spectrometer to the data system computer.

Use the D-sub port to connect the remote control cable that is used for switching the forepump with a contact closure (relay output) signal. See "Turbomolecular Pump" on page 3-25.

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS have two identical connectors (Peripheral A, Peripheral B) to communicate with peripherals by digital and analog signals. The GC start cable must be plugged into Peripheral A.

Table 3-3. Peripheral control connectors

Port	Description
±Digital in	+ (positive, pin 1) and – (negative, pin 2) Based on the configuration, the mass spectrometer starts the data acquisition when it receives a digital contact closure signal from an external device.
Digital out 1 Digital out 2 (interchangeable)	The mass spectrometer transmits the ready status through contact closure to an external receiving device.
	The mass spectrometer transmits a programmable contact closure output signal to the inputs of an external receiving device.
Analog In ±10 V	+ (positive, pin 7) and – (negative, pin 8) The mass spectrometer can record an analog signal between –10 V and +10 V from an external device with the mass spectrometer data.

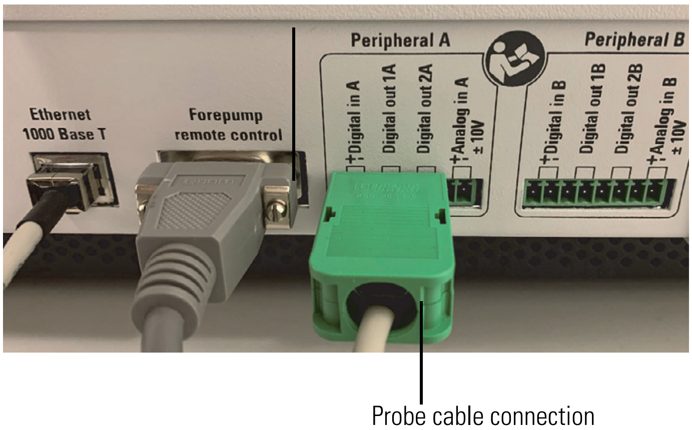


Figure 3-7. Probe cable connection

If you are using a Direct Probe to introduce samples rather than a GC, connect the probe start cable to the Peripheral A connection, ensuring that the leftmost pin on the probe connector is inserted in the leftmost connection on the Peripheral A panel (±Digital in A) as shown in Figure 3-7.

In **Instrument Configuration**, change the **Contact Closure** of the MS to Low-to-High Edge before using a direct probe. Refer to the instrument Help for this and other information about setting up the communication with external devices.

The contact closure signals are transmitted through a trigger cable that connects the respective port to the external device. Suitable plug connectors for the peripheral control connection are provided with the Installation Kit. See “User I/O Connections” on page 5-23 for specifications of the peripheral control input connection ports.

Power Column

The power column at the far right side of the instrument provides switches and connections that concern power supply for the instrument and peripherals. See Figure 3-8.

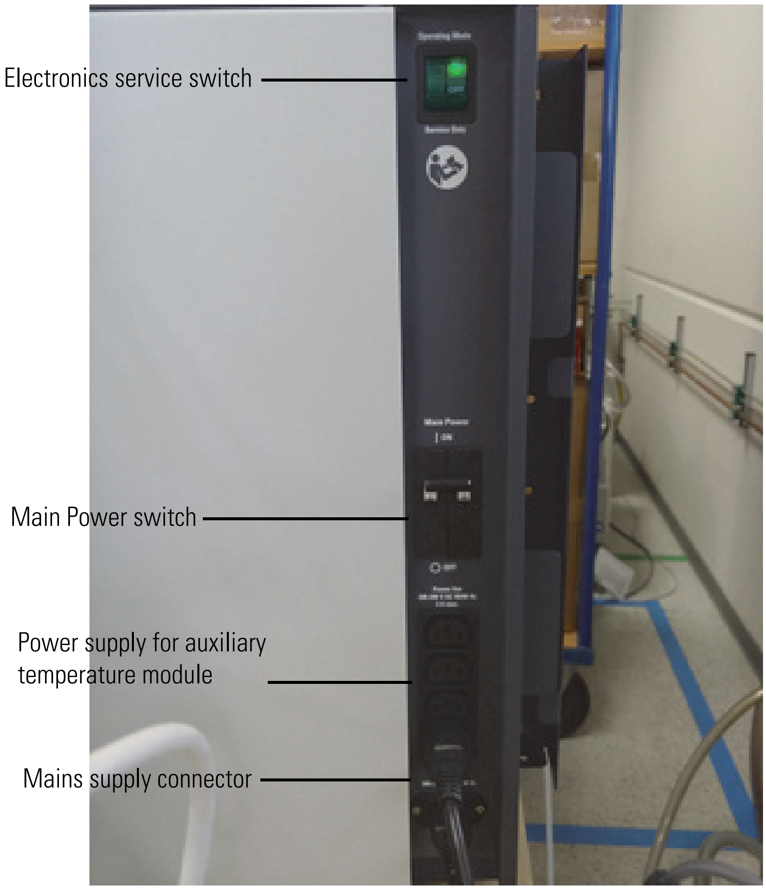


Figure 3-8. Power column

The *electronics service switch* is located at the top position of the power column. In the Service Only position, the switch removes power to all components of the mass spectrometer except the vacuum system. In the Operating Mode position, power is supplied to all components of the mass spectrometer.

The *main power circuit breaker switch* (labeled Main Power) is located in the middle of the power column. In the OFF (O) position, the circuit breaker removes all power to the mass spectrometer, including the turbomolecular pump. It switches off the forepump by the remote control cable.In the ON (|) position, power is supplied to the mass spectrometer. In the standard operational mode, the circuit breaker is kept in the ON (|) position.

Tip Power is to remain on. The mass spectrometer should remain on and pumping continuously for optimum performance.

Both switches contain circuit breakers that protect the electrical wiring of the instrument from an overloaded (overcurrent) condition when it is exposed to more electrical current than it is designed to handle. In case of a thermal overload they interrupt the power supply to the instrument. After cooling down (and removal of the overload), the circuit breakers close and both switches can be used again. If you cannot reset the instrument to the operating mode despite repeated tries, the circuit breaker inside the switch is blown. In this case, call a Thermo Fisher Scientific field service engineer to replace it.

The only device expected to be connected to the strip of four power outlets below the main power circuit breaker is the Aux temperature module of the GC. This will cause the transferline heater to be switched off if the MS is powdered off. The auxiliary temperature control module is rated for 355 VA, so the sum of current needed for any additional devices plugged into the outlets must not exceed 1.4 A. These outlets are rated at 208–240 V AC, 50/60 Hz, 3 A total maximum. They are controlled by the main power circuit breaker switch and not by the electronics service switch.

Use separate wall outlets to supply electrical power for the forepump, the data system, and the devices of the GC/MS system such as autosamplers if applicable.

The power connector for the mains supply is located below the four power outlets. The Orbitrap Exploris GC and Orbitrap Exploris GC 240 instrument is designed to operate at a nominal voltage of 208–240 V AC, 50/60 Hz. See "Power Supply" on page 5-14 for details.

Ion Optics

The ion optics focus the ions that are produced in the ion source and transmit them to the C-Trap. Figure 3-11 shows the schematic view of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS.

Source Ion Optics

There are three types of ion sources available for the Orbitrap Exploris GC mass spectrometers: an electron ionization (EI) source, a chemical ionization (CI) source that enables that enables positive ion chemical ionization (PCI) and negative ion chemical ionization (NCI), and a combination EI/PCI/NCI source. Ion sources include an ion volume, repeller, source lenses, an RF lens, and dual filaments and are programmable from 50 °C to 350 °C. Figure 3-9 provides images of the three available ion volumes.

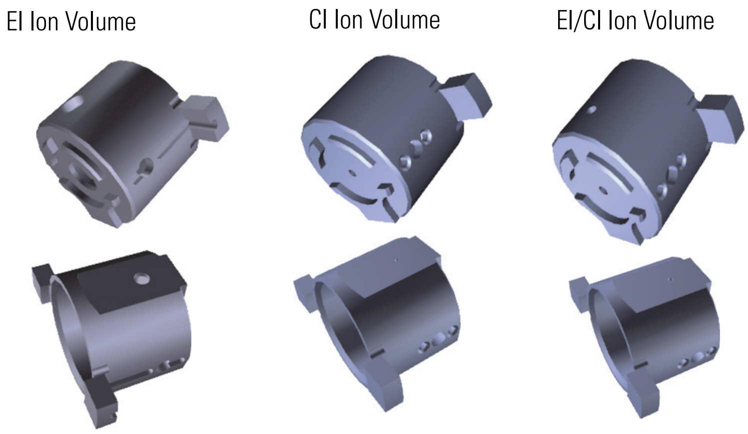


Figure 3-9. Available Ion Sources

The ion source parts are contained in an ion source cartridge. See Figure 3-10.

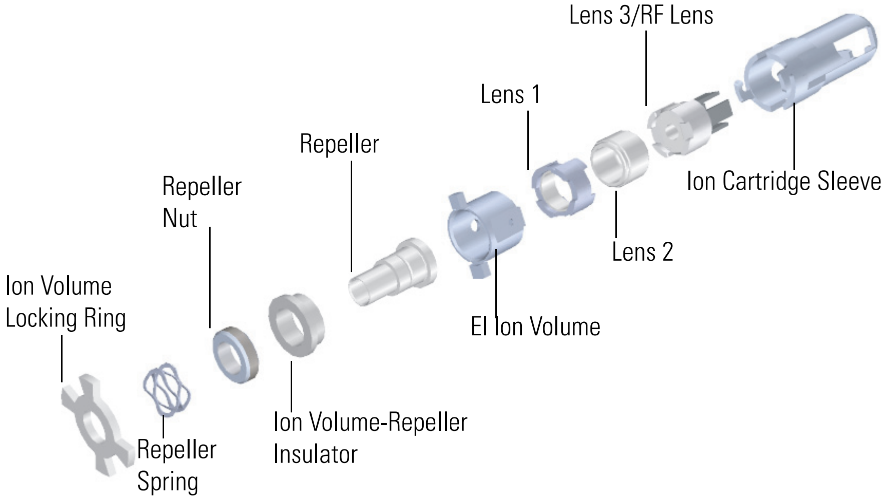
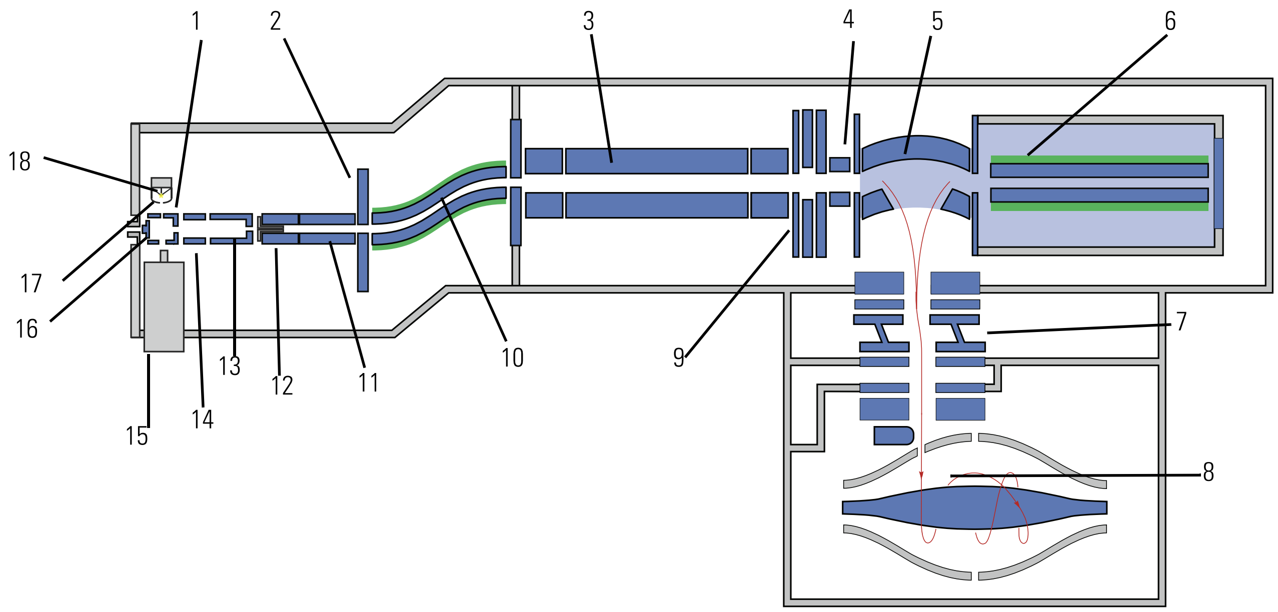


Figure 3-10. Components of the Orbitrap Exploris GC Ion Source

The ion source cartridge is removable while the mass spectrometer is under vacuum. For removal and cleaning instructions see "EI/CI Source Maintenance" on page 8-15.



Labeled Components: 1=Ion Volume; 2=Inter Flatapole Lens; 3=Quadrupole; 4=Transfer Multipole; 5=C-Trap; 6=HCD Collision Cell; 7=Z-lens; 8=Orbitrap Mass Analyzer; 9=Independent Charge Detector; 10=IBent Flatapole; 11=Injection Flatapole; 12=Lens3/RF Lens; 13=Lens 2; 14=Lens 1; 15=Transfer Line; 16=Repeller; 17=Electron Lens; 18=Dual Filament

Figure 3-11. Schematic of the Orbitrap Exploris GC MS

Analyzer Ion Optics

The *bent flatapole* always acts as an ion transmission device. It guides the ions through an arc from the injection filter to the quadrupole. Because of the bent shape of the flatapole, the neutral particles cannot follow the bent path of the flatapole.

An RF voltage with a common mode DC offset enables an efficient ion transport and the separation from neutrals. An additional axial DC gradient is applied to the bent flatapole to accommodate a fast ion transport.

The quadrupole is described in the next topic.

The *independent charge detector (ICD)* is positioned between quadrupole and the C-Trap. It is used to increase the fidelity of the Automatic Gain Control (AGC) in certain operation modes and is not commonly used in GC models. The assembly includes a split lens, which is used to start and stop the injection of ions into the C-Trap. A precise determination of the ion beam intensity and a fast switching of the ion beam are used for the Automatic Gain Control (AGC) of the Orbitrap mass analyzer. The assembly also includes a short transport RF multipole, which is the interface between the ICD and the C-Trap.

Quadrupole Mass Filter

The Orbitrap Exploris GC MS uses advanced quadrupole technology (AQT). It comprises a hyperbolic segmented *quadrupole*, for higher transmission efficiency and optimized transmission window shape. Ceramic spacers act as electrical insulators between adjacent rods.

In a quadrupole rod assembly, rods opposite each other in the array are connected electrically. Thus, the four rods can be considered as two pairs of two rods each. RF voltages and DC voltages are applied to the rods and these voltages are adjusted for each scan. Voltages of the same amplitude and sign are applied to the rods of each pair. However, the voltages applied to the different rod pairs are equal in amplitude but opposite in sign. See Figure 3-12.

The RF voltage applied to the quadrupole rods is of constant frequency of approximately 860 kHz and varies from 0 to 6000 V peak-to-peak amplitude. The DC voltage varies from 0 to ±500 V.

In Figure 3-13, the solid line represents the combined RF voltage and DC voltage applied to one rod pair, and the dashed line represents the combined RF voltage and DC voltage applied to the other rod pair. The RF-to-DC-voltage ratios and their values determine the range of mass-to-charge ratios to be transmitted through the quadrupole mass filter.

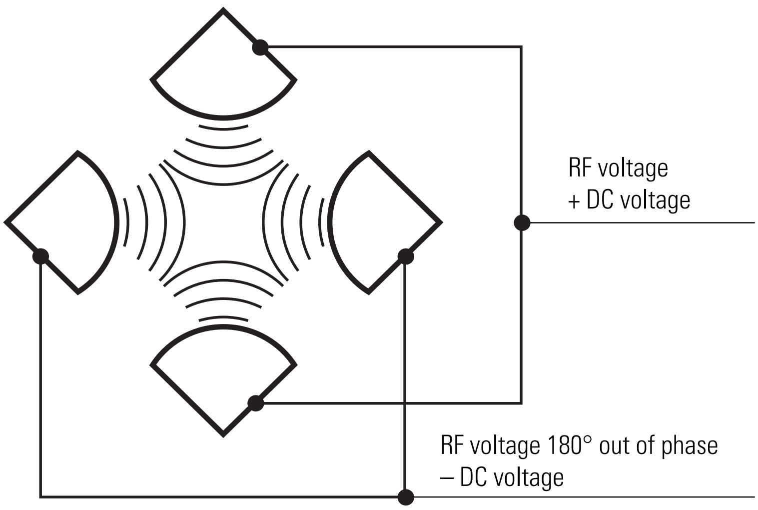


Figure 3-12. Polarity of the RF voltages and DC voltages applied to the rods of the quadrupole mass filter

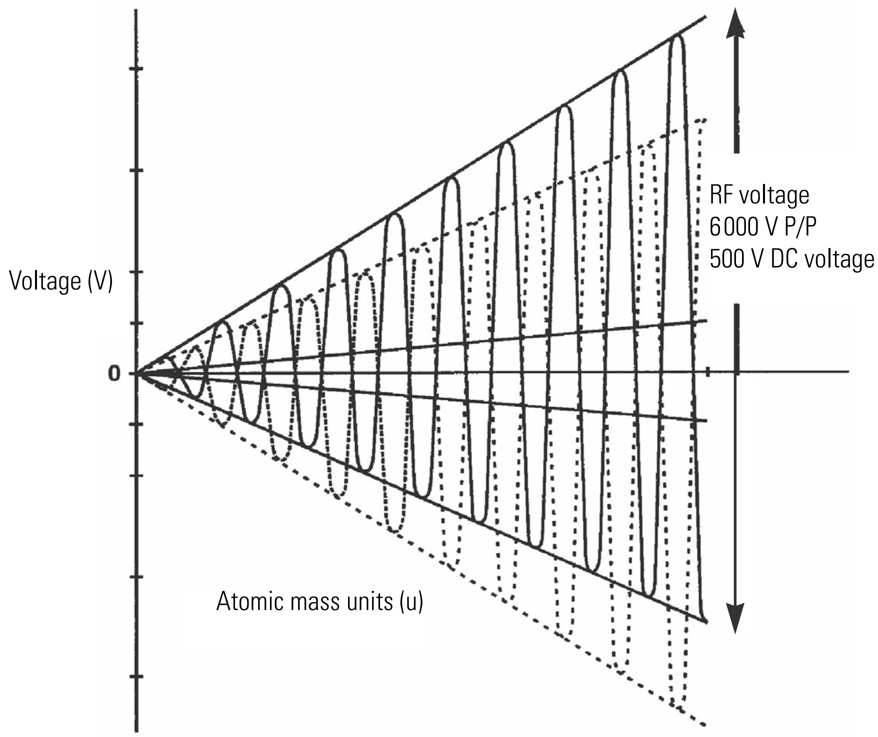


Figure 3-13. Magnitude of the RF voltages and DC voltages applied between the rods of the quadrupole mass filter

In the mass spectrometer, the rods of the quadrupole are supplied with a variable ratio of RF voltage and DC voltage (Figure 3-13). For each injection, controlled by the split lens, the quad RF amplitude and DC voltage are set to fixed values. Under these conditions, only ions of a certain range of *m/z* ratios are maintained within bounded oscillations as their velocity carries them through the mass filter. At the same time, all other ions undergo unbounded oscillations. These ions strike one of the rod surfaces, become neutralized, and are pumped away, or they are ejected from the rod assembly.

The quadrupole offset voltage is a DC potential applied to the quadrupole rods in addition to the filtering DC voltage. The offset voltage applied to the two rod pairs of the assembly is equal in amplitude and equal in sign. The quadrupole offset voltage accelerates or decelerates ions and, therefore, sets the translational kinetic energy of the ions as they enter the quadrupole rod assembly.

The quadrupole can be cleaned by the user, see “Maintenance of the Ion Optics” on page 8-47.

Curved Linear Trap

On their way from the ion source to the Orbitrap analyzer, ions move through the gas-free RF transfer multipole into the gas-filled curved linear trap (C-Trap). See Figure 3-11 on page 3-16. Ions that enter the

C-Trap lose their kinetic energy in collisions with nitrogen trapping gas and get collected near the middle part of the C-Trap. The nitrogen collision gas (trapping gas) is used for dissipating the kinetic energy of injected ions and for cooling them down to the axis of the C-Trap.

Voltages on the end apertures of the C-Trap (entrance and exit apertures) are elevated to provide a potential well along its axis. These voltages may be later ramped up to squeeze ions into a shorter thread along this axis.

Orbitrap Analyzer

The heart of the Orbitrap™ analyzer is an axially-symmetrical mass analyzer. It consists of a spindle-shape central electrode surrounded by a pair of bell-shaped outer electrodes. See Figure 3-14. The Orbitrap analyzer employs electric fields to capture and confine ions.

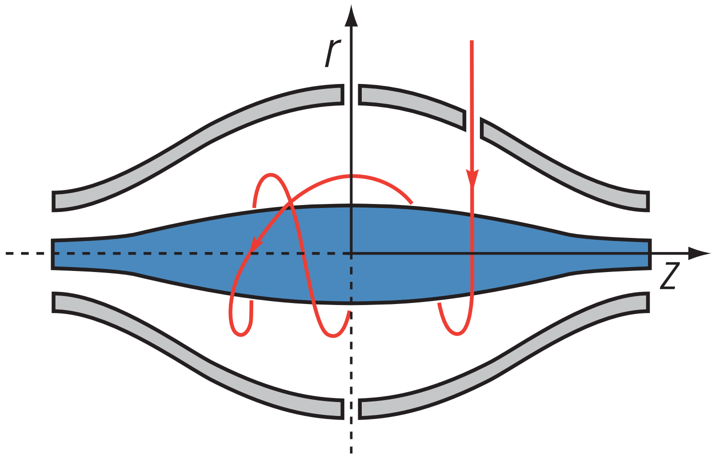


Figure 3-14. Schematic of Orbitrap cell and example of stable ion trajectory

Extraction of Ion Packets

For ion extraction, the RF voltage on the rods of the C-Trap is ramped off and extracting voltage pulses are applied to the electrodes, pushing ions orthogonally to the curved axis through a slot in the inner electrode. Because of the initial curvature of the C-Trap and the subsequent lenses, the ion beam converges on the entrance into the Orbitrap analyzer. The lenses that follow the C-Trap (Z-lens) also act as differential pumping slots and cause spatial focusing of the ion beam into the entrance of the Orbitrap analyzer. Ions are electrostatically deflected away from the gas jet, thereby eliminating gas carryover into the Orbitrap analyzer.

Owing to the fast pulsing of ions from the C-Trap, ions of each mass-to-charge ratio arrive at the entrance of the Orbitrap analyzer as short packets that are only a few millimeters long. For each mass-to-charge population, this corresponds to a spread of flight times of only a few hundred nanoseconds for mass-to-charge ratios of a few hundred Daltons per charge. Such durations are considerably shorter than a half-period of axial ion oscillation in the C-Trap. When ions are injected into the Orbitrap analyzer at a position offset from its equator (See Figure 3-15.), these packets start coherent axial oscillations without the need for any additional excitation cycle.

The evolution of an ion packet during an increase of the electric field is shown schematically in Figure 3-15. When the injected ions approach the opposite electrode for the first time, the increased electric field (owing to the change of the voltage on the central electrode) contracts the radius of the ion cloud by a few percent. The applied voltages are adjusted to prevent collision of the ions with the electrode. A further increase of the field continues to squeeze the trajectory closer to the axis, meanwhile allowing for newly arriving ions (normally, with higher *m/z*) to enter the C-Trap as well. After ions of all *m/z* have entered the Orbitrap analyzer and moved far enough from the outer electrodes, the voltage on the central electrode is kept constant and image current detection takes place.

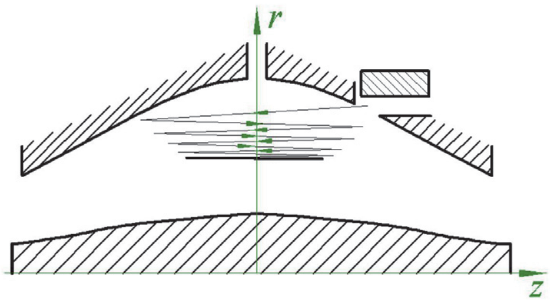


Figure 3-15. Principle of electrodynamic squeezing of ions in the Orbitrap analyzer as the field strength is increased

Measuring Principle

In the mass analyzer shown in Figure 3-14 on page 3-20, stable ion trajectories combine rotation around an axial central electrode with harmonic oscillations along it. The frequency *w* of these harmonic oscillations along the z-axis depends only on the ion's mass-to-charge ratio *m/z* and the instrumental constant *k*:

$$\omega = \sqrt{\frac{z}{m} \times k}$$

Two split halves of the outer electrode of the Orbitrap analyzer detect the image current produced by the oscillating ions. By Fast Fourier Transformation (FFT) of the amplified image current, the instrument obtains the frequencies of these axial oscillations and therefore the mass-to-charge ratios of the ions.

Ion Detection

During ion detection, the central electrode and the additional electrode, which deflects ions during injection and compensates electric field imperfections during the measurement (See Figure 3-15 on page 3-21.), are maintained at very stable voltages so that no mass drift can take place. The outer electrode is split in half at *z*=0, allowing the ion image current in the axial direction to be collected. The image current on each half of the outer electrode is differentially amplified and then undergoes analog-to-digital conversion before processing by the fast Fourier transform algorithm.

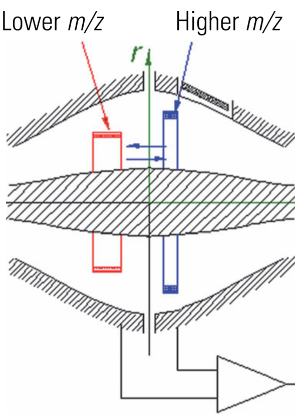


Figure 3-16. Approximate shape of ion packets of different *m/z* after stabilization of voltages

As mentioned above, stable ion trajectories in the Orbitrap analyzer combine axial oscillations along the z-axis with rotation around the central electrode and vibrations in the radial direction. (See Figure 3-14 on page 3-20.) For any given *m/z*, only the frequency of axial oscillations is completely independent of initial ion parameters, whereas rotational and radial frequencies exhibit strong dependence on initial radius and energy. Therefore, ions of the same mass-to-charge ratio continue to oscillate along *z* together, remaining in-phase for many thousands of oscillations.

In contrast to the axial oscillations, the frequencies of radial and rotational motion will vary for ions with slightly different initial parameters. This means that in the radial direction, ions dephase orders of magnitude faster than in the axial direction, and the process occurs in a period of only 50–100 oscillations. After this, the ion packet of a given *m/z* assumes the shape of a thin ring, with ions uniformly distributed along its circumference. See Figure 3-16. Because of this angular and radial smearing, radial and rotational frequencies cannot appear in the measured spectrum. Meanwhile, axial oscillations will persist, with axial thickness of the ion ring remaining small compared with the axial amplitude. Moving from one half outer electrode to the other, this ring will induce opposite currents on these halves, thus creating a signal to be detected by differential amplification.

HCD Cell

The HCD cell consists of a straight multipole mounted inside an enclosed assembly, which is connected in direct line-of-sight to the C-Trap. It is supplied with a collision gas to supply increased gas pressure inside the multipole. The C-Trap is directly attached to the HCD cell, so part of the collision gas flows into the C-Trap to serve as trapping gas. See "Gas Distribution" on page 3-8 for details.

For HCD (Higher Energy Collisional Dissociation), ions are passed through the C-Trap into the HCD cell. The offset between the C-Trap and HCD is used to accelerate the precursor ions into the gas-filled cell. A potential gradient is applied to the HCD cell to provide fast extraction of ions, such that it returns ions at a reliable rate.

The spectra of fragments generated in the HCD cell and detected in the Orbitrap analyzer are comparable to the typical fragmentation patterns obtained on triple-quadrupole instruments.

Vacuum System

The vacuum manifold encloses the ion source interface, the ion guides, the C-Trap, and the Orbitrap analyzer. The vacuum manifold consists of thick-walled aluminum chambers with machined flanges on the front, the sides, and the bottom, and various electrical feedthroughs and gas inlets. The vacuum manifold is divided into multiple chambers. A multi-stage turbomolecular pump (TMP) applies a vacuum of increasing quality along the other vacuum chambers, with the final region being evacuated by the UHV stage of the TMP. Figure 3-17 shows a schematic overview of the vacuum system, Table 3-4 shows the vacuum regions of the mass spectrometer.

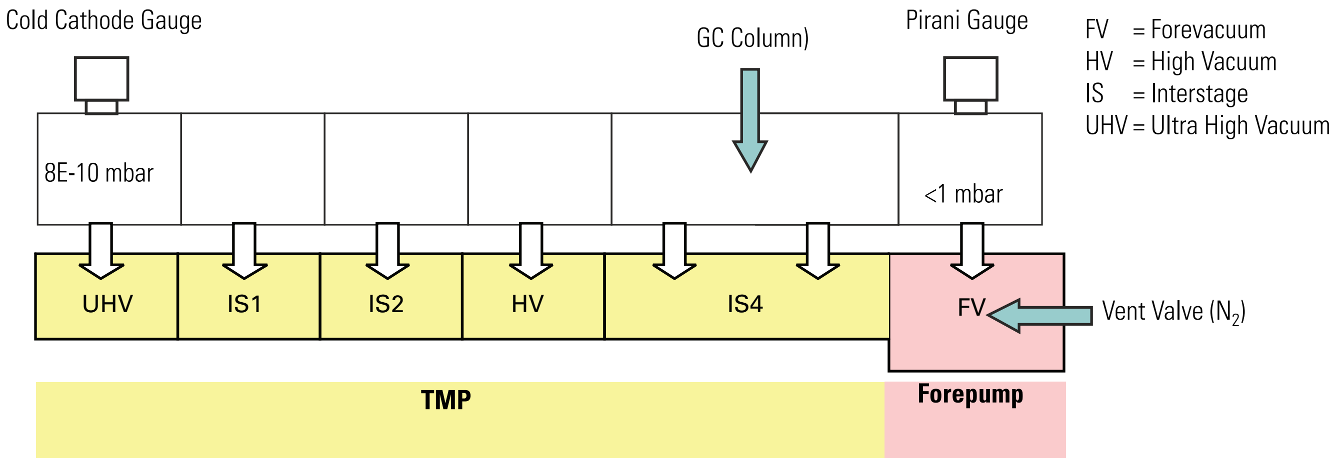


Figure 3-17. Schematic of vacuum system in Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS

Table 3-4. Vacuum regions overview

Region in instrument	Vacuum [mbar]	Gauge type	applied by
Ion source housing	3E-5		TMP IS4
Injection filter			
Bent flatapole			
Quadrupole	~4E-05		TMP HV
Z-lens			TMP IS2
Region between Z-lens and Orbitrap analyzer			TMP IS1
Orbitrap analyzer	< 8E-10	Cold cathode	TMP UHV
HCD collision cell	1.1E-2	Pirani	

Three vacuum gauges monitor the vacuum:

- The forepump region is monitored by an Active Pirani gauge that is connected to the forevacuum line.
- The vacuum in the HCD collision cell is monitored by an Active Pirani gauge.
- The vacuum in the Orbitrap analyzer chamber is monitored by a Compact Cold Gauge. This gauge is directly mounted to the turbomolecular pump.

Forepump

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS is shipped with a forepump that provides the low vacuum for the mass spectrometer. The forepump is controlled by the MS vacuum control board and an external relay with a by +24 V DC (480 W) signal originating from the D-sub port on the control panel at the right side of the MS.

The forepump is switched on and off with the relay by a cord that is plugged into the D-sub port on the control panel at the right side of the MS. The power supply cord of the forepump is plugged into the relay output which obtains the main power for the forepump from a separate wall outlet at the relay input. The +24 V DC signal to power the forepump is turned off by the main power circuit breaker switch, but not by the electronics service switch. The forepump is air cooled by a fan mounted in the pump, which should remain unobstructed. The pump is placed on a drip pan under the workbench supporting the MS.

Tip The forepump automatically shuts off when the communication with the mass spectrometer via the pump controller cable is disconnected or the mass spectrometer is powered off at the circuit breaker.

The forepump supply voltage may be configured based upon the local outlet voltage supplied to the forepump through the relay. See page 5-11 for detailed information about connecting the forepump to the MS and the laboratory infrastructure. For a detailed description of the forepump and for instructions on user maintenance, refer to the handbooks of the manufacturer. See also "Maintenance of the Forepump" on page 8-10.

Turbomolecular Pump

A multi-stage turbomolecular pump (TMP) provides the high vacuum for the mass spectrometer. The air cooled TMP mounts onto the bottom of the vacuum manifold. A pump controller supplies power to the TMP and controls it. The controller sends status information of the TMP (such as temperature or rotational speed) to the MS and the data system. The main power circuit breaker switch turns off the TMP. The electronics service switch has no effect on the pumps.

For a detailed description of the TMP and for instructions on user maintenance, refer to the handbook for the pump. See also "Maintenance of the Turbomolecular Pump" on page 8-11.

Vent Valve

The vent valve is a solenoid-operated valve that allows the vacuum manifold to be vented. The vent valve is closed when the solenoid is energized.

The vacuum manifold is vented when external power is removed from the instrument. (Power is removed from the instrument by a power failure or by placing the main power circuit breaker in the Off (O) position.) After the external power is removed, power is provided to the vent valve until the rotational speed of the TMP is reduced sufficiently to allow controlled venting of the instrument. If external power is not restored to the instrument in this time, power to the vent valve solenoid is shut off. When power to the vent valve solenoid is shut off, the vent valve opens and the manifold is vented with nitrogen. See Figure 3-17 on page 3-23. The vent valve closes after power is restored to the instrument.

System Bakeout

After the system has been open to the atmosphere (for example, during maintenance work or a power outage), the vacuum deteriorates due to contaminations of the inner parts of the vacuum system caused by moisture. These contaminations must be removed by heating the vacuum system: a system bakeout. See "Baking Out the System" on page 8-11 for instructions on performing a system bakeout.

Several heating elements inside the vacuum chamber provide the high temperatures that are necessary to perform a system bakeout.

Electronic Assemblies

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer is controlled by a PC running the Xcalibur™ software suite. The software controls all aspects of the instrument. The main software elements are the control of ion detection and the control of the Orbitrap analyzer.

The electronic assemblies that control the operation of the mass spectrometer are distributed among various printed circuit boards (PCBs) and other modules, in the embedded computer, and on or around the vacuum manifold of the mass spectrometer. You cannot service the electronic assemblies.

Tip If you need assistance, contact your local Thermo Fisher Scientific field service engineer. Before you call a service engineer, try to find the defect by means of errors indicated in the Tune software. A precise description of the defect will ease the repair and reduce the costs.

Cooling Fans

Several fans, including those in the power supply subassemblies, provide internal cooling for the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer. Cooling air enters through the three main air intake fans on three sides of the MS. Exhaust air exits the instrument from ventilation slots at the rear side and the top side.

The only user-serviceable part are the air filters in front of the air intake fans. For the recommended maintenance schedule, see "Maintenance of the Fan Filters" on page 8-13.

In addition to the fans described in this topic, various printed circuit boards are equipped with individual fans.

4

Safety

This chapter contains information that is important for your own safety or the safety of others, and that prevents damage to the instrument, Read this chapter carefully before you install or operate the instrument and its accessories, or come into contact with it.

Contents

- Safety Symbols and Signal Words in this Manual on page 4-2
- Safety Symbols on the Instrument on page 4-3
- Intended Use on page 4-5
- Electric Safety Precautions on page 4-8
- In Case of Emergency on page 4-9
- Residual Hazards on page 4-11

Safety Symbols and Signal Words in this Manual

Notices concerning the safety of the personnel operating the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer appear different from the main flow of text:

⚠ Always be aware of what to do with, and the effect of, safety information.

CAUTION Points out a hazardous situation that can lead to minor or medium injury if it is not avoided.

WARNING Points out a hazardous situation that can lead to severe injury or death if it is not avoided.

DANGER Points out a hazardous situation that will lead to severe injury or death if it is not avoided.

Observing this Manual

Keep this manual always near the instrument to have it available for quick reference.

⚠ Be sure to read and comply with all precautions described in this manual.

System configurations and specifications in this manual supersede all previous information received by the purchaser.

Safety Symbols on the Instrument

Table 4-1 lists all safety labels on the instrument and their respective positions. See the indicated safety notices to prevent harm to the operator and to protect the instrument against damage. If present, read and follow the instructions on the labels.

Table 4-1. Safety labels on the instrument

Label	Label description	Label position
	This label is attached to the transfer line that connects the MS to the GC. The first symbol indicates the presence of a hot surface. The second symbol indicates that the MS should not be lifted by the transfer line. See "Installing the Column" on page 6-14 for details.	
		Labels of this type are attached to several places on the instrument that are designed for user interaction. They remind you to read the manual before you operate the instrument.
		This label is attached to several places on the instrument that may be accessed by users. It indicates that only personnel that have received a special training may service the instrument. User maintenance is restricted to operations that are described in this manual.
		This label is attached to several places on the instrument that may be accessed by users. It indicates that hazardous electric voltage is used in the instrument that can cause serious injury or even death. To make sure that the instrument is free from all electric current, always disconnect the power cord of the instrument before you remove the covers.
		This label is attached to the rear side of the instrument. It indicates that, because of its weight, handling the instrument alone might cause muscle strain and back injury. See "Moving the Instrument" on page 5-5 for instructions.

Table 4-1. Safety labels on the instrument, continued

Label	Label description	Label position
		This label is attached to the lid of the quadrupole chamber. It indicates that a crushing hazard is present when the lid is not in its resting position. Keep your hands clear when the lid is open. See "Maintenance of the Ion Optics" on page 8-47 for instructions.

Rating Plate

To identify the instrument correctly when you contact Thermo Fisher Scientific, always have the information from the rating plate available. The rating plate is attached below the power column at the right side of the instrument. See Figure 4-1. It contains the serial number, which is important in any type of communication with Thermo Fisher Scientific.

Figure 4-1. Rating plate

Intended Use

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer is a stand-alone Orbitrap™ instrument used for gas chromatography (GC) mass spectrometry (MS) high-throughput applications.

Observe the following usage guidelines when you operate the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer:

- The instrument is designed to be placed on a bench in the laboratory. It is not designed for use outdoors.
- The instrument is designed to be used exclusively with ion sources and probes that are approved by Thermo Fisher Scientific.
- The instrument is designed for laboratory research use only. It is not designed for use in diagnostic or medical therapeutic procedures.

If the mass spectrometer is used in a manner that is not specified by Thermo Fisher Scientific, the protection that is provided by the instrument could be impaired. Thermo Fisher Scientific assumes no responsibility and will not be liable for instrument damage and/or operator injury that might result from using the instrument with other ion sources and probes.

Notice on the Susceptibility to Electromagnetic Transmissions

The instrument is designed to operate in a controlled electromagnetic environment. Do not use radio frequency transmitters, such as mobile phones, in close proximity to the instrument.

Qualification of the Personnel

⚠ Personnel that install or operate the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer must have the following qualifications:

- Electrical Connections
  The electrical installation must be made by qualified and skilled personnel (electrician) according to the appropriate regulations (for example, cable cross-sections, fuses, grounding connection). Refer to the *Orbitrap Exploris GC and Orbitrap Exploris GC 240 Pre-Installation Requirements Guide* for the specifications.

- Installation
  Only employees of Thermo Fisher Scientific or personnel who act on behalf of Thermo Fisher Scientific are allowed to install the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer.

- General Operation
  The Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer is designed to be operated by qualified laboratory personnel. Before they start, all users must be instructed about the hazards that are presented by the instrument and by the used chemicals. The users must be advised to read the relevant Material Safety Data Sheets (MSDSs).

- Decommissioning
  Only employees of Thermo Fisher Scientific or personnel who act on behalf of Thermo Fisher Scientific are allowed to decommission the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer. For information about decommissioning third-party components (for example, the forepump), refer to the manuals that came with these components.

Permitted Materials

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer is designed to be operated with these materials:

- Nitrogen gas: Used for the C-Trap trapping gas, and the HCD collision gas

- Forepump oil: Used for the cooling, the lubrication, and the sealing of the forepump

NOTICE Use only the forepump oil that is indicated on the name plate and pump. If other oils are used, the manufacturers reject all responsibility should any trouble occur.

- Calibration compounds, samples

  Polar or less polar chemical compounds—soluble in water or appropriate organic solvent. Compounds can have different molecular sizes. Compounds derive from environmental specimens of different origins. The origin can be from living or non-living matter. Examples are sugars (carbohydrates) from plant material, proteins or peptides from animal or human cell lines, synthetic polymers deriving from an organic synthesis. Small molecules can derive from a honey sample when screening for or quantifying pesticides or from an organic synthesis.

- Solvents, additives

  Typically, mixtures of organic solvents are applied. Organic solvents can be isooctane, hexane, or acetone.

- Optional chemical ionization reagent gases including: methane, isobutane, and ammonia.

Electric Safety Precautions

⚠ **WARNING**

High Voltage. High voltages (up to 4 kV) that can cause an electric shock are used in the instrument. Observe these safety precautions when you operate or do maintenance on the instrument:

- The instrument is properly grounded in accordance with regulations when it is shipped. You do not need to make any changes to the electrical connections or to the instrument's chassis to ensure safe operation.
- There are no customer serviceable parts inside. Do not remove any housing or protective cover except it is permitted elsewhere in this manual. When you leave the system, make sure that all protective covers and doors are properly connected and closed, and that heated areas are separated and marked to protect unqualified personnel.
- Do not turn on the instrument if you suspect that it has incurred any kind of electrical damage. Instead, disconnect the power cords of the mass spectrometer and the forepump and contact a Thermo Fisher Scientific field service engineer for a product evaluation. Do not try to use the instrument until it has been evaluated. Electrical damage might have occurred if the system shows visible signs of damage, or has been transported under severe stress.
- Do not place any objects on top of the instrument—especially not containers with liquids—unless it is requested by the user documentation. Leaking liquids might get into contact with electronic components and cause a short circuit.

In Case of Emergency

WARNING

Electric Current. Electric shock hazard. Do not use the electronics service switch to shut down the instrument. See Figure 4-2. The electric components of the vacuum system will still be connected to the electric power supply and the pumps will remain running. Placing the main power circuit breaker switch on the power column in the Off (O) position may not be sufficient for safe work on the instrument.

❖ **To shut down the system in case of emergency**

1. Disconnect the power cord of the mass spectrometer to ensure that the instrument is free from all electric current. All power to the MS, including the pump, is shut off. Also, all power to any devices that are supplied with power by the MS (for example, switching valves and forepump) is shut off.

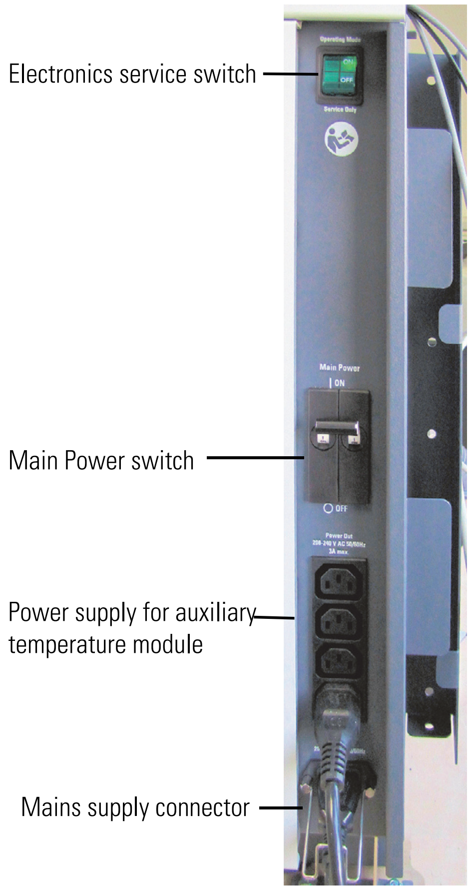


Figure 4-2. Power column

2. The forepump is only switched off with the relay control cable. To disconnect the forepump from its electric power supply, unplug the power cord.

Tip The pump automatically shuts down when the communication with the mass spectrometer stops.

3. Turn off the computer with its On/Off switch.

Residual Hazards

Users of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer must pay attention to the following residual hazards.

⚠ WARNING

Suffocation Hazard. A significant amount of the nitrogen that is introduced into the vent gas port can potentially escape into the laboratory atmosphere. Accumulation of nitrogen gas could displace sufficient oxygen to suffocate personnel in the laboratory. Make sure that the laboratory is well ventilated. Always operate the forepump so that an exhaust line is connected. Local regulations may make a risk assessment for the workplace necessary.

⚠ WARNING

Electromagnetic Radiation. Parts of the forepump emit electromagnetic radiation. This radiation can interfere with the operation of cardiac pacemakers and implanted heart defibrillators, possibly causing death or serious injury. If you wear these devices, keep at least 30 cm away from the forepump.

⚠ CAUTION

Hazardous Chemicals. Samples, solvents, and detergents might contain toxic, carcinogenic, mutagenic, or corrosive/irritant chemicals. Avoid exposure to potentially harmful materials. Always wear protective clothing, gloves, and safety glasses when you handle solvents or samples. Also contain waste streams and use proper ventilation. Refer to your supplier's Material Safety Data Sheet (MSDS) for proper handling of a particular compound.

⚠ CAUTION

Hot Parts. The forepump in function is hot and some surfaces could reach a temperature higher than 80 °C (176 °F). Touching parts of the forepump might cause burns. Switch off the pump and let it cool down before any intervention. If you must work on a pump that is “still warm from operation,” then always wear heat protective gloves.

⚠ CAUTION

Hot Parts. Touching hot parts of the ion source interface might cause severe burns. During operation of the mass spectrometer, the ExtractaBrite removable ion source might reach temperatures of up to 350 °C, while the GC column transfer line might reach temperatures of up to 400 °C. To let the ion source interface cool down, set the ion source and transfer line temperatures to 25 °C. Wait until the ion source has cooled down to room temperature (for approximately 60 minutes) before you begin working on it. Do not leave the instrument unattended when the covers and front door are removed, exposing the hot source parts. Hot ion source parts might ignite combustible material. Keep combustible materials away from the ion source mount.

NOTICE To ensure safety and proper cooling, always operate the MS with its covers in place. This is also necessary to comply with product safety and electromagnetic interference regulations.

Personal Protective Equipment

Appropriate safety clothing must be worn at all times while you operate the instrument, particularly when you handle hazardous material.

This manual can only give general suggestions for personal protective equipment (PPE), which protects the wearer from hazardous substances. Refer to the Material Safety Data Sheets (MSDSs) of the chemicals handled in your laboratory for advice on specific hazards or additional equipment.

Eye Protection

The type of eye protection required depends on the hazard. For most situations, safety glasses with side shields are adequate. Where there is a risk of splashing chemicals, goggles are necessary. Always wear eye protection when changing compresses gas supplies and making changes to gas connections.

Protective Clothing

When the possibility of chemical contamination exists, protective clothing that resists physical and chemical hazards should be worn over street clothes. Lab coats are appropriate for minor chemical splashes and solids contamination, while plastic or rubber aprons are best for protection from corrosive or irritating liquids.

Gloves

For handling clean parts, chemical compounds, and organic solvents, Thermo Fisher Scientific recommends white nitrile clean room gloves from Fisher Scientific or Unity Lab Services.

For handling hot objects, gloves made of heat-resistant materials (for example, leather) should be available.

Installation

This chapter describes the conditions for an operating environment that will ensure continued high performance of your Orbitrap Exploris GC and Orbitrap Exploris GC 240 system.

To be sure that your laboratory is ready for the installation of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 system, you have to meet all requirements that are specified in the *Orbitrap Exploris GC and Orbitrap Exploris GC 240 Pre-Installation Requirements Guide*. This guide also provides comprehensive information to assist in planning and preparing your lab site.

Contents

- Placing the Instrument on page 5-2
- Laboratory Conditions on page 5-14
- Setting Up Instrument Hardware and Adjusting System Parameters on page 5-22

Placing the Instrument

This section provides information that helps you position the instrument in the laboratory.

Instrument Dimensions

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 systems (including the TRACE 1310 GC) have these dimensions: *height* 703 mm (28 in.), *width* 954 mm (38 in.), *depth* 1036 mm (41 in.). There must also be 105 mm (4 in.) between the system and the wall. Figure 5-1 shows a schematic view of the instrument with important instrument dimensions.

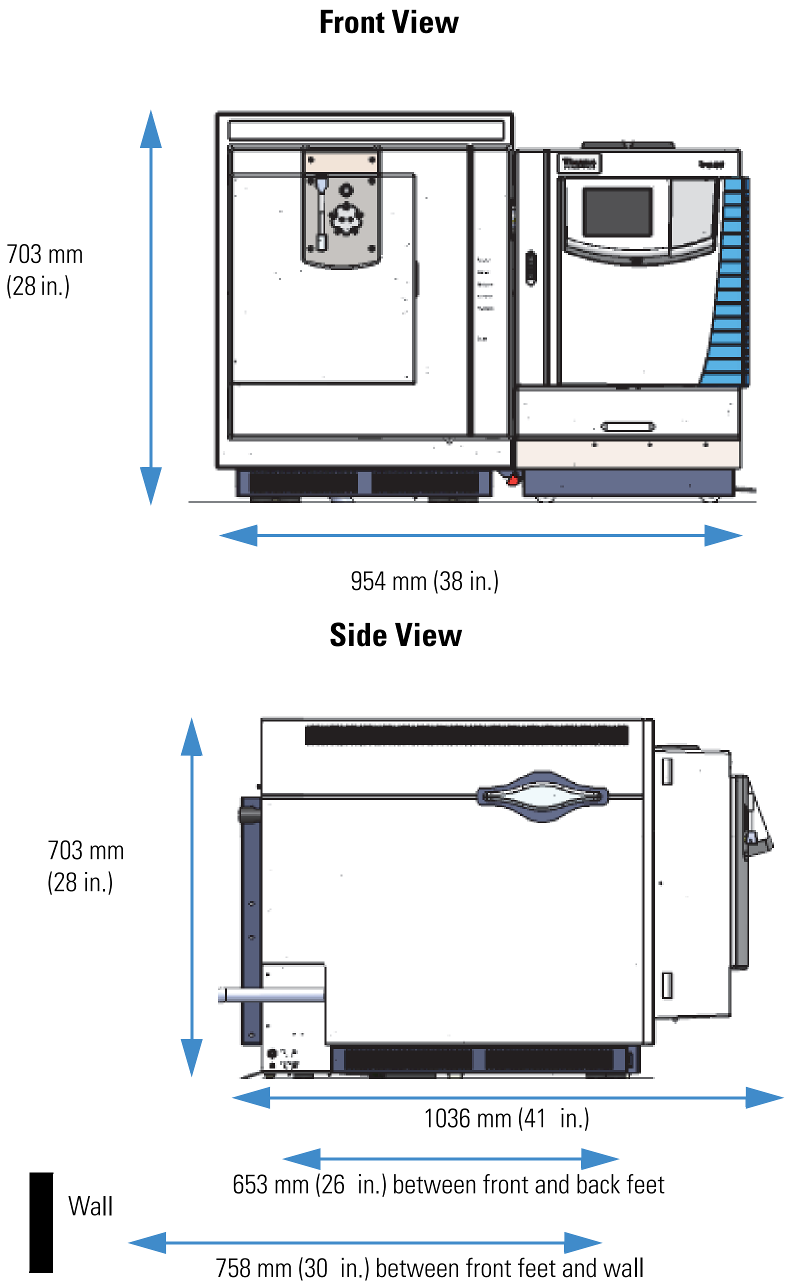


Figure 5-1. Dimensions of Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS

Workbench for Instrument

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS is designed to be placed on top of a workbench with its rear panel facing a wall. To set up a typical GC/MS system, Thermo Fisher Scientific recommends that you have a minimum of two workbenches. Table 5-1 lists the recommended minimum surface dimensions for each workbench.

Table 5-1. Minimum workbench surface dimensions (length × width × depth)

Equipment	Surface
Data system	120 × 100 cm (47¼ × 39 3/8 × 24 in.)
GC/MS system	150 × 100 cm (59 1/16 × 39 3/8 × 30 in.)

The workbench for the GC/MS system must be capable of supporting the weight of the mass spectrometer (about 120 kg) plus the weight of any option (gas chromatograph, autosampler) and stand in a secure and level position.

The workbench depth (front to back) for the GC/MS system must be at least 30 in. (762 mm). Leave at least 4 in. (105 mm) between the back of the system and the wall. If a 750 mm bench is used, it must not be placed against a wall or there will not be enough clearance for the system.

⚠ Only workbenches with at least four legs provide sufficient stability for the mass spectrometer. The workbench top must be dry and clean (free of grease). Thermo Fisher Scientific recommends that you use a workbench with a skidproof top.

Follow these clearance guidelines for the workbenches:

- Place the data system workbench and the GC/MS workbench adjacent to each other to prevent strain on the interconnecting Ethernet communications cables.
- Make sure that you have the following minimum clearances:
  - 900 mm (35½ in.) between the top of the system and any shelves above it.
  - 105 mm (4 in.) between the back of the MS and the wall.
  - 400 mm (16 in.) between the left side and the right side of the system and any other components

NOTICE See the documentation for your autosampler for its minimum clearances.

Spacers at the rear side of the instrument provide sufficient space for airflow.

⚠ To allow shutting off the mass spectrometer in an emergency, free access to the wall power cord must be possible at any time.

NOTICE Do not block the ventilation slots of the mass spectrometer. Items might fall behind the instrument, inhibit airflow, and cause the system to overheat.

Moving the Instrument

⚠ Before you move the instrument from one place to another, all participating personnel must carefully read and follow the instructions given in this manual.

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 instrument has eight recessed grips at its underside—two at the front side and three at each the left side and the right side. The grips become accessible after the filter brackets are removed. For shipment, the instrument is fixed with two brackets on a pallet. See Figure 5-2.

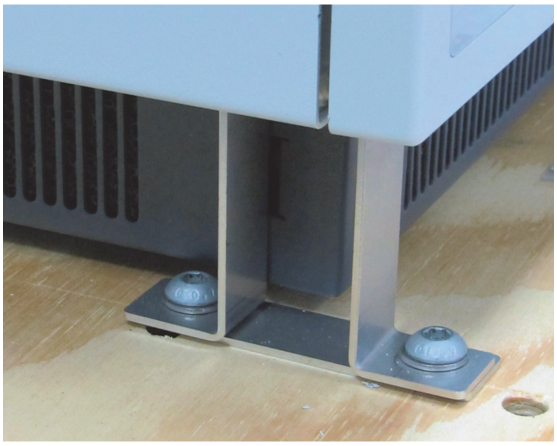


Figure 5-2. Bracket, fixed on the transport pallet

⚠ CAUTION **Heavy Load.** Because of its weight of about 120 kg, handling the instrument alone might cause muscle strain and back injury. To lift and move the instrument, at least *four persons* are necessary to keep the individual load below acceptable limits (maximum 40 kg for men or 15 kg for women for a duration of 5 seconds). The carriers must be trained in how to carry loads properly (for example, by rising from the knees with a straight back). Thermo Fisher Scientific recommends that you use a pallet jack to lift the mass spectrometer to the height of the workbench.

⚠ CAUTION **Heavy Objects.** The mass spectrometer and the forepump might move uncontrollably and cause injuries. Wear steel-reinforced safety shoes and gloves during installation or maintenance.

Considerable space for maneuvering must be available for the four persons that carry the instrument. Therefore, Thermo Fisher Scientific recommends that you use a pallet jack when you move the instrument into another room.

The instructions that follow assume that the instrument has been moved to the installation site with a pallet jack and the top cover of the transport crate has been removed.

❖ **To move the instrument onto the workbench**

1. Gather four persons and appoint one person that takes command and gives instructions to the remaining people.
2. Lift the instrument to the height of the working bench with the pallet jack.
3. Remove the two brackets that attach the instrument to the transport pallet. See Figure 5-2.
4. Remove the front filters.
5. Remove the filter brackets on the sides of the instrument. The lifting handles on the MS come into view.

Figure 5-3. Revealing the lifting handles

6. The instrument may have a bracket with two thumbscrews on the right side. Undo the two thumbscrews to remove the bracket to access the right front lifting handle.
7. On command, all four carriers lift off the instrument simultaneously—to prevent them from experiencing an uneven load distribution. Place the MS onto the bench.
8. Only two persons are necessary for moving the MS into its final position on a bench. The rear row of the support points below the instrument consists of synthetic material that has a low frictional resistance and should easily slide above the surface of your workbench. The front row of the support points below the instrument consists of synthetic material that has a high frictional resistance and should keep the MS safely in position.

Placing the GC

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS are shipped with a TRACE 1310 GC. The GC weighs 35 kg (77 lbs), so two people should lift the instrument onto the workbench. It is shipped in a separate box from the MS and is not strapped to a pallet.

❖ **To move the GC onto the workbench**

1. Gather two people and appoint one person to take command and give instructions to the remaining person.
2. Lift the GC out of the box to the height of the working bench.
3. Place the GC to the right of the MS on the riser with the drawer. The drawer must remain closed until the GC and MS are connected. See Figure 5-1 for correct orientation.
4. Remove the lower panel on the bottom right side of the GC. See Figure 5-4.

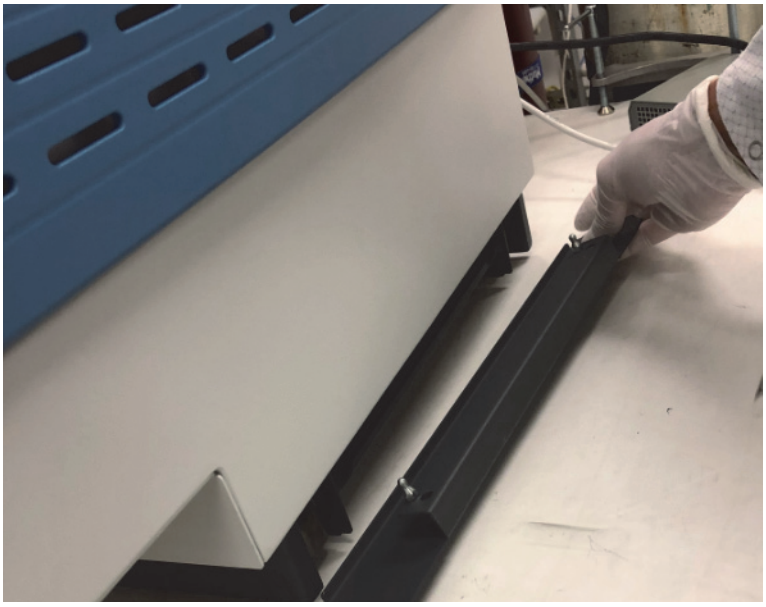


Figure 5-4. Removing the GC panel

5. Lift up on the center brake to take off the GC brakes. See Figure 5-5.

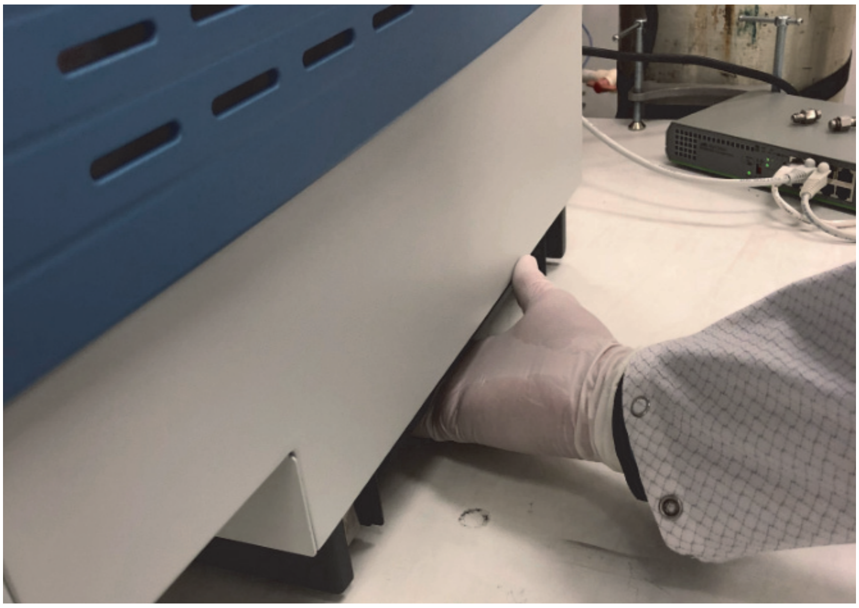


Figure 5-5. Taking off the GC brakes

6. To attach the GC to the MS, line up the brackets between the two instruments and move them together. Use caution to avoid damaging the MS transfer line. The hole in the GC oven wall must be carefully aligned with the MS transfer line as the GC is rolled on its riser toward the MS.

7. Insert the alignment pin to secure the brackets. See Figure 5-6.

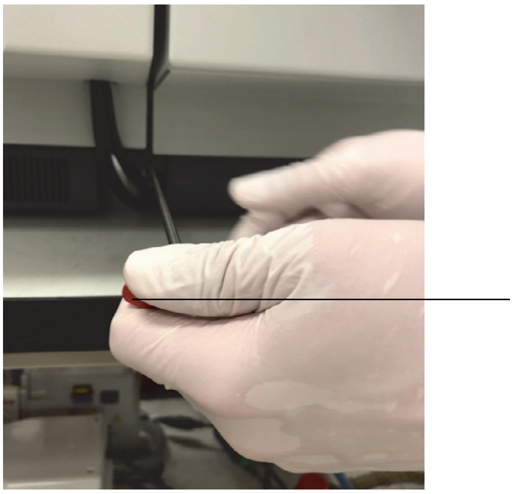


Figure 5-6. Securing the GC to the MS with the Alignment Pin

8. If needed, level the GC riser by adjusting the four alignment pins on each corner of the riser base. See Figure 5-7.

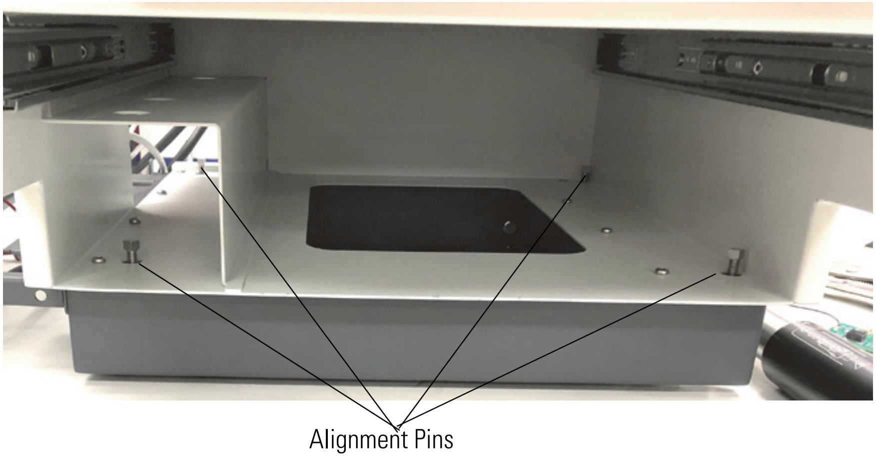


Figure 5-7. Leveling the GC with the alignment pins

9. Slide the drawer into the GC riser on the tracks carefully. See Figure 5-8.

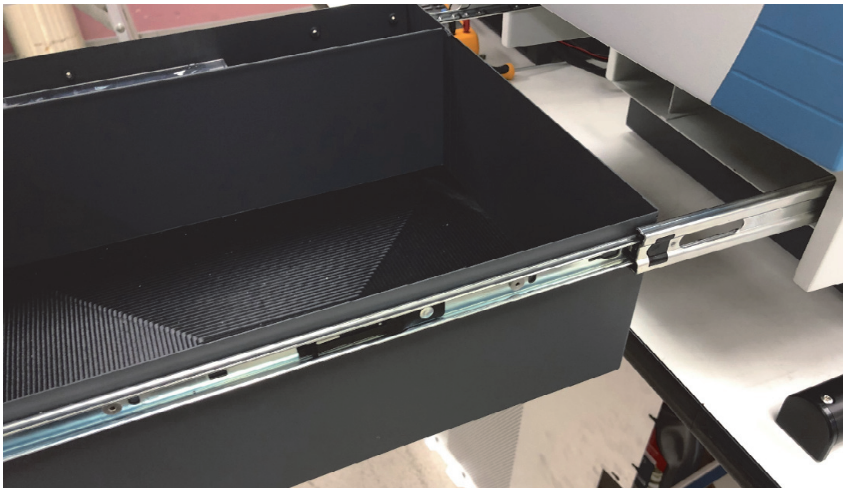


Figure 5-8. Sliding the drawer into the GC riser

⚠CAUTION Do not store more than 4 kg of items in the GC riser drawer to prevent the GC from tipping forward when the drawer is open.

10. Insert the GC start cable in the Peripheral A slot on the Control panel on the left side of the MS. See Figure 5-9

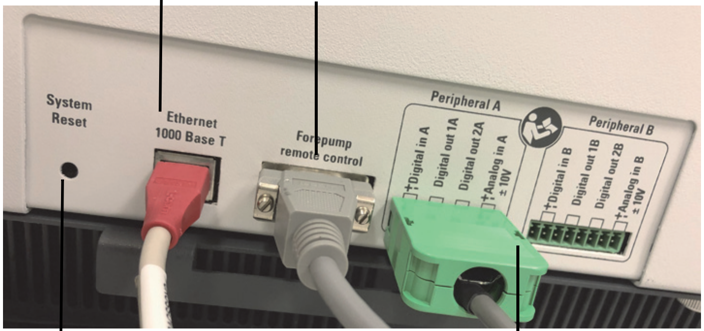


Figure 5-9. Control panel

11. Secure the transfer line cables to the clip under the back bracket of the GC. See Figure 5-10.

Figure 5-10. Clip location on back GC bracket

12. Attach the other cables correctly to the back of the GC. See Figure 5-11.

Figure 5-11. GC cables

NOTICE See the *TRACE 1300 and TRACE 1310 GC Hardware Manual* for additional connection information.

Placing the Forepump

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS are shipped with a forepump.

Place the pump on a drip pan. Install the forepump on the floor below the workbench, immediately behind the MS. Before you place the pump, Thermo Fisher Scientific strongly recommends that you consider the information contained in "Vibration" on page 5-21.

⚠CAUTION **Heavy Object.** Because of its weight of about 24 kg, the forepump might move uncontrollably and cause injuries. Wear steel-reinforced safety shoes when you move the pump during the installation.

Connecting the Forepump

The vacuum hose of the forepump has an inner diameter of 19 mm (¾ in.). Connect the vacuum hose of the forepump to the vacuum port at the left side of the MS. See Figure 5-12.

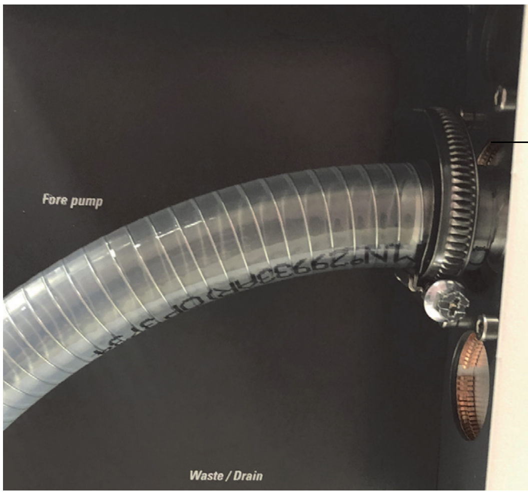


Figure 5-12. Vacuum port of Orbitrap Exploris GC MS

Connect the exhaust hose of the pumps to the exhaust system of the laboratory.

NOTICE

Check the line voltage supplying power to the forepump and confirm it matches the voltage displayed on the pump. See Figure 5-13. If the voltages do not match, do not continue installation of the forepump. Consult the manufacturer's documentation to configure the forepump for the correct supply voltage or install a power conditioning device to supply the correct rated voltage to the forepump.

Figure 5-13. Confirming the Pump Voltage

Attach the forepump power cord to the pump relay. Attach the green cable on the pump relay to the side of the MS. Connect the switch cord of the pump to the D-sub port on the control panel at the right side of the MS. See Figure 5-14.

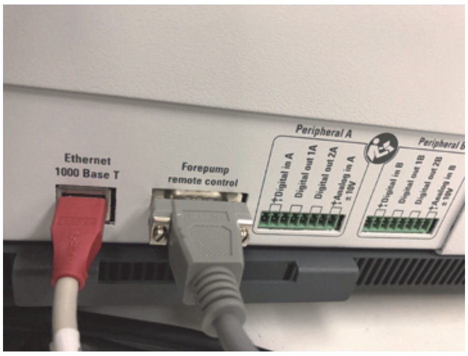


Figure 5-14. Power connection for forepump on Orbitrap Exploris GC MS

Connect the power supply cords of the pump relay to a wall outlet or power source that meets the pump voltage requirements on the label on the pump. Note that power supplies that are not within 10% of the pump labeled voltage may damage the pump. See page 5-14 for specifications of the power supply.

Laboratory Conditions

This section gives an overview of important requirements for the laboratory where the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer is placed. For details, refer to the *Orbitrap Exploris GC and Orbitrap Exploris GC 240 Pre-Installation Requirements Guide*.

Power Supply

An Orbitrap Exploris GC and Orbitrap Exploris GC 240 GC/MS system has the basic power requirements as shown in Table 5-2.

Table 5-2. Power Requirements

Mass Spectrometer	
Nominal voltage	208–240 Vac, 50/60 Hz, single phase
Power	apparent power: 800 VA; effective power: 750 W
Fuse[a]	10 A (tripping characteristic C)
TRACE 1300/1310 GC	
Nominal voltage	230 Vac ±10%, 50/60 Hz, 10 AMAX
Power	2000 VA
Fuse[a]	16 A
The GC cannot be reconfigured in the field.	
Foreline Pump	
Nominal voltage (230 V systems)	220-240 Vac, 50 Hz 3.4 A / 230-240 Vac, 60 Hz 3.4 AMAX
Power	550 W
Nominal voltage (120 V systems)	110 Vac, 50 Hz 6.8 A/115-120 Vac, 60 Hz 6.9 AMAX
Power	450 W
Fuse[a]	16 A (115 V) / 6 A (230 V), slow
Data System (Computer and Monitor) and GC	
Nominal voltage	100–240 Vac, 50–60 Hz, 5 AMAX
Fuse[a]	15/16 A

[a] dedicated wall outlet

Thermo Fisher Scientific provides power cords for the gas chromatograph, mass spectrometer, forepump, data system, and monitor. They are approximately 2.5 m (8 ft) long. One power cord fits into a standard IEC 60320 C19 socket on the GC. The other cords fit into standard IEC 60320 C13 sockets on the mass spectrometer and the other system components.

NOTICE

Inadequately rated power cords might cause damage to the instrument. Do not replace the power cords that are shipped with the instrument by other cords.

The power column at the far right side of the instrument provides power connections for the mains supply, and the auxiliary temperature module. See Figure 5-15.[1]

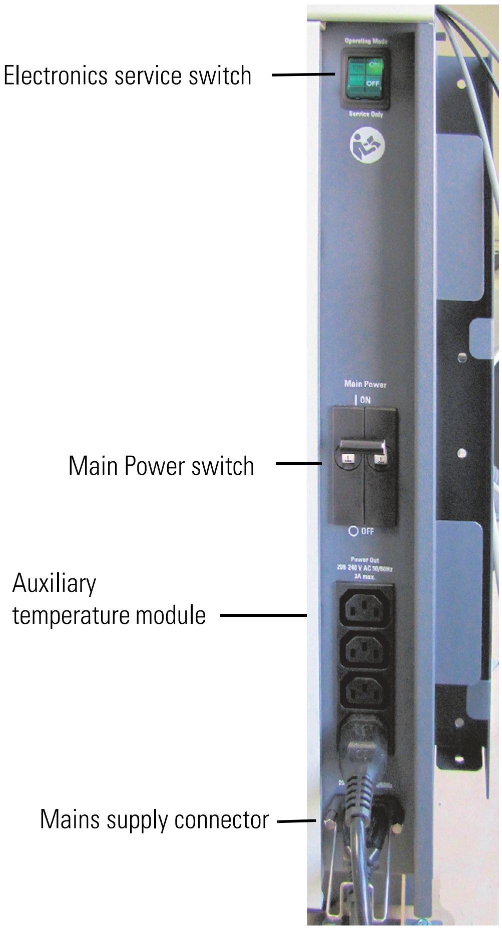


Figure 5-15. Power column

Notice for Customers in North America Systems that are installed in areas with 208 V power experience voltage sags during high use periods that might place the line voltage below the operating parameters described in this section.

WARNING

Electric Current. Electric shock hazard. Incorrect usage of these ports might endanger personnel. Read and understand this manual to prevent harm to the operator and to protect equipment against damage. To make sure that the instrument is free from all electric current, always disconnect the power cords of the *mass spectrometer and the forepump* before you try any type of maintenance.

[1] Four outlets for secondary consumers are available on the MS. The total maximum current of the secondary consumers must not exceed 3 A.

Gas Supply

Orbitrap Exploris GC and Orbitrap Exploris GC 240 instruments require nitrogen gas for the C-Trap bath gas and HCD collision gas. The gas consumption strongly depends on the type of analysis the instrument is used for. It is essential that the gas be delivered with the necessary pressure and purity. See Table 5-3.

The gas inlet ports are at the left side of the instrument. See Figure 5-16. The port for the vent gas (top) has a press-in fitting for a 6 mm hose. The port for C-Trap gas & HCD cell gas (bottom) has a Swagelok™-type fitting for 1/16 in. tubing.

Figure 5-16. Gas connections at the left instrument side

NOTICE

Do not connect other gases than nitrogen to the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer! This might affect instrument performance. The maximum pressure for the gas inlet is 0.65 MPa (94 psi).

The fragment ions that are generated in the HCD cell are generally quite reactive. High purity nitrogen contains notably more water and oxygen than ultra-high purity nitrogen, which gives rise to gas-phase adducts and related products. These species would deteriorate the MS/MS spectral assignments. For the HCD cell, ultra-high purity (UHP, 99.999%) nitrogen is therefore mandatory.

Table 5-3. Nitrogen supply requirements

Gas type	Pressure	Purity	Tubing OD	Maximum Flow	Consumption
C-trap and HCD gas	0.6 ± 0.05 MPa	99.999%[a]	1/16 in.	0.04 L/min	~50 L/day

[a] mandatory

NOTICE

The instrument can operate reliably only when the pressure of the source gas stays within the required limits. If your laboratory gas supply provides nitrogen also for other consumers, then you must install a pre-regulator in the gas line that leads to the source gas port of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS.

You can supply the nitrogen for your instrument from one source (single supply) or two sources (dual supply). See Table 5-4 for an overview. Figure 5-16 shows an instrument that is completely supplied with UHP nitrogen (single supply). Make sure that the maximum flow rate of the nitrogen source of your choice matches the requirements of your applications. Also consider the information about nitrogen gas consumption in “Checking the Nitrogen Supply” on page 6-3.

Table 5-4. Gas supply properties for single supply and dual supply

Supply Type	Nitrogen Purity		Nitrogen Source (Examples)
Single Supply	>99.999% purity (<0.001% oxygen content)		LN2 evaporator, cylinder bundle, PSA nitrogen generator
Dual Supply	C-trap and HCD gas:	>99.999% purity (5.0)	LN2 evaporator, cylinder bundle, PSA nitrogen generator
	Vent gas:	Required: >99% (<5% oxygen content)	Membrane nitrogen generator
		Recommended: >99% (<0.5% oxygen content)	LN2 evaporator, cylinder bundle, PSA nitrogen generator

❖ **To connect a single nitrogen source to the mass spectrometer**

1. Connect an appropriate length of Teflon™ hose to the UHP nitrogen source in the laboratory. The Installation Kit contains hoses for the HCD and vent gas lines. The connection for the Teflon hose to the nitrogen gas supply is not provided in the kit. You have to supply this part.

2. Insert the opposite end of the Teflon hose into the press-in fittings that are attached to the gas ports at the left side of the instrument. See Figure 5-16. To connect the hose, align the Teflon hose with the opening in the fitting and firmly push the hose into the fitting until the hose is secure.

3. Attach a brass Tee to the nitrogen tank to split the nitrogen flow to the vent and the HCD ports. The vent gas then goes through an in-line toggle and then goes to the vent.

    a. Connect the 6 mm hose that comes from the *high-purity nitrogen* source to the *top nitrogen inlet* of the instrument.

b. Connect the 1/16 in. tubing that comes from the *ultra-high purity nitrogen* source to the *bottom nitrogen inlet* of the instrument.

❖ **To connect two nitrogen sources to the mass spectrometer**

1. Connect the 6 mm hose that comes from the *high-purity nitrogen* source to the *top nitrogen inlet* of the instrument.
2. Connect the 1/16 in. tubing that comes from the *ultra-high purity nitrogen* source to the *bottom nitrogen inlet* of the instrument.

Connecting the Orbitrap Exploris GC and Orbitrap Exploris GC 240 CI Gas Supply

If you are using chemical ionization on the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer, follow the steps below to connect the CI gas supply to the mass spectrometer.

1. If connecting a flammable gas (such as methane) to the CI gas supply, power off the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer and the TRACE 1310 GC. See "Shutting Down the System" on page 6-7 for instructions to shut down the mass spectrometer. Refer to the TRACE 1310 user documentation for instructions to shut down the GC.
2. Open the front door. The CI gas ports are on the lower right side.
3. Attach the CI reagent gas to either port A or port B. If connecting to port B, use the small wrench (P/N 1R176360-0208) provided with your system.

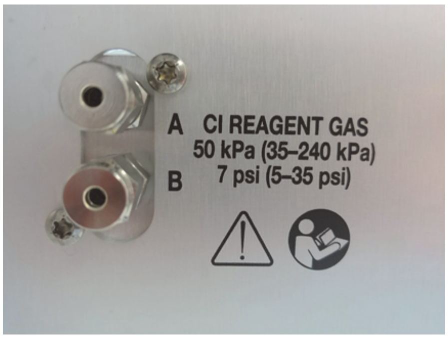


Figure 5-17. Connecting the CI gas supply

CAUTION

Hazardous Chemicals. Some CI gases, such as ammonia, are toxic. Make sure that supply tubing and fittings are rated for the gas being plumbed. Make sure these gases are properly exhausted and all gas fittings on the system are leak-free. Check for leaks by pressurizing the gas lines, shutting off the gas supply, and ensuring that the pressure does not drop. If you have an electronic leak detector available, use it to detect leaks as well. Consult your local Environmental and Safety Regulations for information about how to properly exhaust fumes from your laboratory. Use stainless steel tubing, which is not supplied with the system, for corrosive gases.

NOTICE

If no CI gas is selected, the instrument control software chooses the first port starting with port A that is configured for the gas requested in the method. If both ports are configured for and connected to the same gas type, port B can only be used in a method acquisition if it set on in the Tune application before starting an acquisition.

NOTICE

The instrument can operate reliably only when the pressure of the source gas stays within the required limits. If your laboratory gas supply provides nitrogen also for other consumers, then you must install a pre-regulator in the gas line that leads to the source gas port of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS.

WARNING

Fire Hazard. Some CI gases, such as methane and isobutane, are flammable. Make sure these gases are properly exhausted and all gas fittings on the system are leak-free. Check for leaks by pressurizing the gas lines, shutting off the gas supply, and ensuring that the pressure does not drop. If you have an electronic leak detector available, use it to detect leaks as well. Gases flowing into the ion source exit the system our the forepump exhaust. Consult your local Environmental and Safety Regulations for information about how to properly exhaust fumes from your laboratory.

Laboratory Temperature

The mass spectrometer is designed to operate at a laboratory room temperature between 18 and 27 °C (64 and 81 °F).

NOTICE

Do not put the mass spectrometer under an air duct, near windows, or near heating and cooling sources. Temperature fluctuations of 0.5 °C or more over a 10-minute period can affect instrument performance.

If the temperature in the laboratory has changed by more than 2 °C since the last mass calibration, Thermo Fisher Scientific strongly recommends that you refresh the mass calibration.

Humidity

The relative humidity of the operating environment must be between 20 and 80%, with no condensation. Thermo Fisher Scientific recommends that your laboratory be equipped with a temperature/humidity monitor. This makes sure that the laboratory is always within the specifications for temperature and humidity.

NOTICE

Operating the mass spectrometer at very low humidity might cause the accumulation and discharge of static electricity, which can shorten the life of electronic components. Operating the mass spectrometer at high humidity might cause condensation, oxidation, and short circuits, and will also block the filters on the cooling fans.

A significant change of the humidity in the laboratory can affect the mass accuracy. If the humidity in the laboratory has changed significantly since the last mass calibration, Thermo Fisher Scientific recommends that you refresh the mass calibration.

Ventilation and Fume Exhaust

Consider the following safety guidelines for ventilation and exhaust.

⚠ WARNING

Suffocation Hazard. Accumulation of nitrogen gas could displace sufficient oxygen to suffocate personnel in the laboratory. Ensure that the laboratory is well ventilated. Local regulations may require a risk assessment for the workplace.

⚠ WARNING

Hazardous Chemicals. The effluent of the forepump might contain noxious chemicals. The forepump eventually exhausts much of what is introduced into the mass spectrometer, including the small amount of oil vapor that mechanical pumps can emit. The connection of the forepump to an adequate exhaust system is mandatory!

WARNING

Hazardous Chemicals. Samples and solvents might contain toxic, carcinogenic, mutagenic, or corrosive/irritant chemicals. Avoid exposure to potentially harmful materials. Always wear protective clothing, gloves, and safety glasses when you handle solvents or samples. Also contain waste streams and use proper ventilation. Refer to your supplier's Material Safety Data Sheet (MSDS) for proper handling of a particular compound.

Tip Organic compounds that are present in laboratory air can contaminate the GC/MS system. They may be the source of background signals in the mass spectrum. Take precautions to keep the laboratory air clean. Prevent airborne contaminants from entering the solvents.

Vibration

Floors must be free of vibration caused, for example, by equipment in adjoining locations.

NOTICE

Because of the natural vibration of a forepump during operation, it must not have any mechanical contact to the mass spectrometer with the exception of the vacuum hose. Otherwise, the vibration might affect instrument performance. Therefore, install the pump on the floor below the mass spectrometer and not near the system on the workbench.

Airborne Noise Emission

The A-weighted emission sound pressure level created by the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer at work stations does not exceed 70 dB(A).

Setting Up Instrument Hardware and Adjusting System Parameters

⚠ Only employees of Thermo Fisher Scientific or personnel who act on behalf of Thermo Fisher Scientific are allowed to install the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer.

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer and other devices shipped with it are installed by a Thermo Fisher Scientific field service engineer. During the installation, the service engineer will demonstrate the basics of equipment operation and routine maintenance.

For detailed information about changing the instrument parameters and developing experiments for the instrument, refer to the *Orbitrap Exploris GC Software Manual* or the Tune Help.

User I/O Connections

This section describes the specifications for the identical control connections for two peripherals. Peripheral A is always used for the GC start cable. Location and function of the peripheral control connections are described in “Control Panel” on page 3-9.

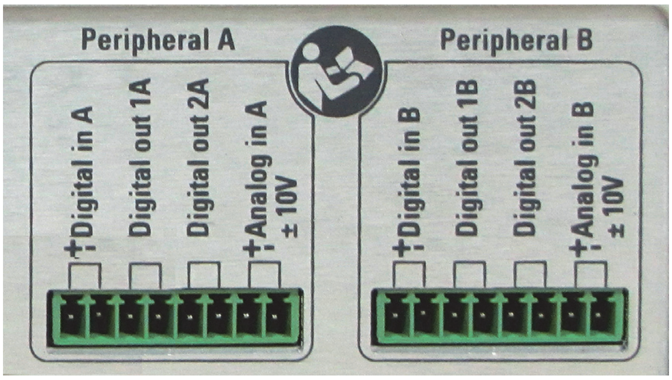


Figure 5-18. Peripheral control connectors

Output Specifications

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer outputs correspond to the status functions listed below. The outputs are potential-free relay contacts, which are closed when the status indicated by the name is true.

These interchangeable outputs are available:

- Digital Out 1 (Pins 3 and 4)
- Digital Out 2 (Pins 5 and 6)

Figure 5-19 shows the circuit diagram and Table 5-5 lists the specifications of the peripheral control output.

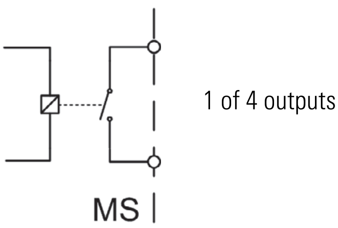


Figure 5-19. Output equivalent schematic

Table 5-5. Output circuit specifications

Contact closed	R_{on} < 1 W
Contact open	R_{off} > 1 GW (typically)
Current	I_{max} = 0.6 A

Table 5-5. Output circuit specifications

Voltage	V_{max} = 60 V
Power	P_{max} = 720 mW

Input Specifications

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer provides a digital input and an analog input to connect external devices.

The *Digital In* input (Pins 1 and 2) is an input with internal pull-up resistor for connecting external relays contacts or open collector transistors. Start is triggered with the falling edge of input voltage. Figure 5-20 shows the circuit diagram and Table 5-6 lists the specifications of the peripheral control output.

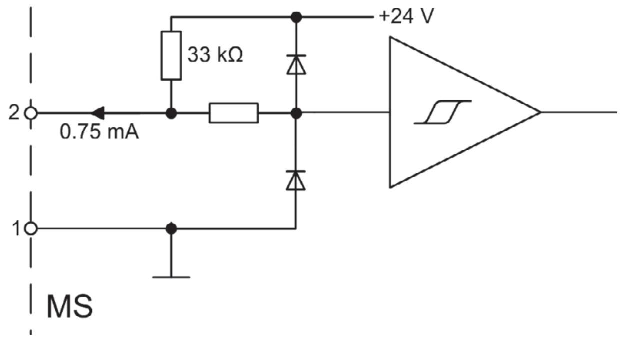


Figure 5-20. Digital In input equivalent schematic

Table 5-6. Digital In input circuit specifications

Low level input voltage	U_{in} < 0.8 V @ 0.75 mA
High level input voltage	U_{in} > 2.0 V

The *Analog In* input (Pins 7 and 8) is a differential input without isolation for connecting external analog voltages. Figure 5-21 shows the circuit diagram and Table 5-7 lists the specifications of the peripheral control output.

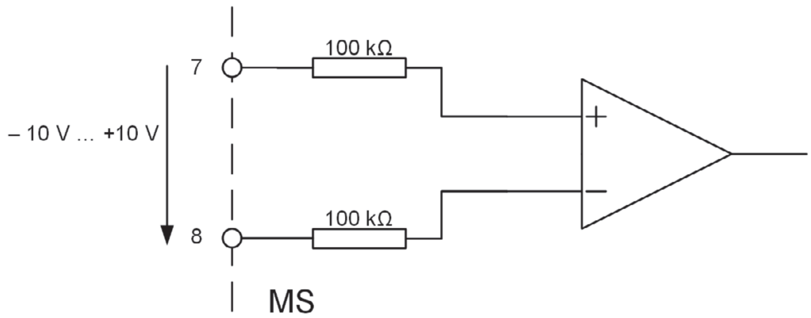


Figure 5-21. Analog input equivalent schematic

Table 5-7. Analog input circuit specifications

Input Voltage	U_{in}	–10 V … +10 V
Input Resistance	R_{in}	>200 kW (differential)
Input Resistance	R_{in}	>100 kW (ground)

Troubleshooting Instrument Connection

There must not be other devices or a local area network with the same subnet connected to the same instrument PC. The MS must not share a network connection with a local area network on the PC. The MS must not share a network connection with other devices on the same subnet. For this reason, each instrument ships with three network connections - one for the local area network, one for the MS, and one for the GC and autosampler (shared).

Communication between the MS and the instrument control PC can be broken if another device is on the same subnet or the subnet masks cause the devices to overlap.

The MS network card will have an IP address that starts with 172.16.#.# and subnet mask 255.255.0.0

Other devices such as the GC and auto ampler must not have IP addresses that begin with 172.16.0.# and subnet mask of 255.255.255.0.

6

Operation

This chapter describes the checks and procedures of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 system that you should perform to ensure proper operation.

Contents

- Safety Guidelines for Operation on page 6-2
- Before Operating the Mass Spectrometer on page 6-3
- Setting the System in Standby Condition on page 6-6
- Shutting Down the System on page 6-7
- Starting Up the System after a Shutdown on page 6-9
- Resetting the System on page 6-12
- Installing the Column on page 6-14

Safety Guidelines for Operation

When you operate the Orbitrap Exploris GC and Orbitrap Exploris GC 240 system, pay attention to the following general safety guidelines.

WARNING

Hazardous Chemicals. The forepump eventually exhausts much of what is introduced into the mass spectrometer, including the small amount of oil vapor that mechanical pumps can emit. The effluent of the forepump might contain noxious chemicals. The connection to an adequate exhaust system is mandatory!

WARNING

Hazardous Chemicals. The source exhaust might contain noxious material. It will contain traces of the samples and solvents that you are introducing into the source. Potential health hazards of these compounds include chemical toxicity of solvents, samples, and buffers, as well as biohazards of biological samples. To prevent contamination of the laboratory, always operate the instrument with the drain tubing connected to a waste container that is connected to a dedicated fume exhaust system.

CAUTION

Risk of Eye Injury. The thin, sharp, flexible capillaries are difficult to see against the light. There is a risk of being stabbed or cut when you do work with the capillaries. Wear safety glasses to prevent eye injuries!

NOTICE

To ensure safety and proper cooling, always operate the MS with its covers in place. This is also necessary to comply with product safety and electromagnetic interference regulations.

Before Operating the Mass Spectrometer

Every day before you start analyses, make sure that the instrument is ready for operation with these procedures:

- Checking the Forepump
- Checking the Nitrogen Supply
- Checking the System Vacuum Levels
- Checking the Disk Space on the Data System
- Checking the Mass Accuracy of the Instrument
- Checking the CI Reagent Gas

Tip Accurate results can be obtained only if the system is properly calibrated.

Checking the Forepump

❖ **To check the forepump before use**

Make sure that these conditions are met:

- The forepump is filled with oil.
- The forepump is connected to the power supply.
- The relay control cable is connected to both the MS and the forepump.
- The gas ballast is shut.

Checking the Nitrogen Supply

Check the nitrogen supply on the regulator of the nitrogen gas tank. Make sure that you have sufficient gas for your analysis. Based on 24 hour per day operation, typical nitrogen consumption is 50 L (1.8 ft^3) per day. If necessary, replace the tank. Verify that the pressure of nitrogen reaching the mass spectrometer is at 0.6 ± 0.005 MPa (87 ± 7 psi). If necessary, adjust the pressure with the tank pressure regulator.

Checking the System Vacuum Levels

For proper performance, the Orbitrap Exploris GC and Orbitrap Exploris GC 240 system must operate at the acceptable vacuum levels. Operating the system at poor vacuum levels can cause reduced sensitivity and tuning problems. Check your system for air leaks and check the system vacuum levels before you start the first acquisition.

❖ To check the vacuum pressures

Make sure that the Vacuum LED at the front of the mass spectrometer is green, which indicates that the pressure gauges are within their threshold values. In the Tune window, a green square () indicates that the readback value is good. If the LED is not green, you might have an air leak. See “Vacuum Leak” on page 7-5 for instructions.

Checking the Disk Space on the Data System

Periodically verify that your hard disk drive has enough free space for data acquisition. The amount of available disk space is shown in the Disk Space dialog box.

❖ To determine the amount of available disk space

1. From the Home Page window (which is available by choosing **Start** > **Programs** > **Thermo Xcalibur** > **Xcalibur**), choose **Actions** > **Check Disk Space** to open the Disk Space dialog box. The Disk Space dialog box lists the following:

   - Current drive and directory (for example, C:\Xcalibur\system\programs)
   - Number of Mb that are available (free) on the current drive
   - Percentage of the current drive that is available
   - Total capacity of the current drive

2. To select another disk drive so that you can determine its disk space, click **Directory**.

3. When you have completed this procedure, choose **OK** to close the dialog box.

If necessary, you can free space on the hard disk by deleting obsolete files and by moving files from the hard disk drive to a backup medium. First, copy files to the backup medium. After you have copied the files, you can delete them from the hard disk.

Checking the Mass Accuracy of the Instrument

Thermo Fisher Scientific recommends that you check the mass accuracy before you start to use the instrument. If the instrument indicates that the calibration parameters are not optimal, Thermo Fisher Scientific recommends that you calibrate the mass spectrometer.

NOTICE The instrument must have stable vacuum and temperature and have been in standby or on mode for more than 15 minutes before calibrating.

Tip *Calibration parameters* are instrument parameters that affect the mass accuracy and resolution. They are independent of the sample.

Checking the CI Reagent Gas

If performing chemical ionization, make sure the gas supply is on and the regulator displays adequate pressure.

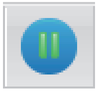
Setting the System in Standby Condition

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 system should not be shut down completely if you are not going to use it for a short period of time, such as overnight or over the weekend. In that case, you can keep the system in Standby condition.

Thermo Fisher Scientific recommends that you keep the mass spectrometer in Standby overnight to provide the best mass accuracy next day.

❖ **To place the Orbitrap Exploris GC and Orbitrap Exploris GC 240 system in the Standby condition**

1. Wait until data acquisition, if any, is complete.



2. In the Tune window, click the **On/Standby** button to put the instrument in Standby condition. The Scanning LED on the front panel of the mass spectrometer turns yellow when the system is in Standby condition.
3. Keep the GC power On.
4. Keep the autosampler power On.
5. Keep the data system power On.
6. Keep the Orbitrap Exploris GC and Orbitrap Exploris GC 240 main power circuit breaker switch in the On position.

Shutting Down the System

The Orbitrap Exploris GC and Orbitrap Exploris GC 240 system must not be shut down completely if you are not going to use it for a short period of time, such as overnight or over a weekend. See "Setting the System in Standby Condition" on page 6-6. This section describes how to shut down the system for a maintenance or service procedure.

NOTICE

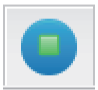
Power is removed abruptly when you place the main power circuit breaker switch (see Figure 3-6 on page 3-9) in the Off (O) position. Although no component in the system is harmed, this is not the recommended shutdown procedure to follow.

❖ **To shut down the Orbitrap Exploris GC and Orbitrap Exploris GC 240 system**

1. Wait until data acquisition, if any, is complete.

2. Turn off the GC (or other sample introduction device).

   For instructions on how to operate the GC from the touch screen, refer to the manual that came with the GC.



3. In the Tune window, click the **On/Standby** button to put the instrument in Off condition. All high voltages are shut off.

4. Put the main power circuit breaker switch of the mass spectrometer in the Off position.

⚠ WARNING

High Voltage. Hazardous electric voltage that can cause an electric shock is used in the instrument. To make sure that the instrument is free from all electric current, always disconnect the power cords of the *mass spectrometer and the forepump* before you try any type of maintenance.

⚠ CAUTION

Hot Parts. During operation of the mass spectrometer, the ion transfer line can reach temperatures up to 400 °C. This might cause severe burns upon touching or ignite combustible material. The external surface of transfer line can become hot enough to cause skin burns.

Do not touch the transfer line when the mass spectrometer is in operation. Let the transfer line and ion source cool down as described in this manual before you remove the ion source through the VPI or change the GC column.

If you plan to do routine maintenance or preventive system maintenance on the mass spectrometer only, you do not need to switch off the GC, autosampler, or the data system. In this case, the shutdown procedure is completed. However, if you do not plan to operate the system for an extended period of time, you might want to switch off the GC, the autosampler, and the data system.

NOTICE Dust can be sucked in through the VPI. To reduce this risk to a minimum, keep the VPI knob installed on the mass spectrometer also during off times and standby times.

Tip An instrument that is shut down consumes more nitrogen than in normal operation because the vent valve is connected to the nitrogen supply of the laboratory. Keeping on the nitrogen flow prevents humidity from contaminating the vacuum system of the mass spectrometer. You may however switch off the nitrogen if your supply is limited.

Starting Up the System after a Shutdown

To start up the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer after it has been shut down (and vented), you must do the following:

1. Start up the instrument
2. Set up conditions for operation

❖ **To start up the Orbitrap Exploris GC and Orbitrap Exploris GC 240 system**

1. Make sure that the main power circuit breaker switch of the MS is in the Off (O) position.
2. Make sure that the power cords of all components of the GC/MS system are plugged into the wall outlets.
3. Make sure all vacuum interfaces such as the GC interface and the VPI are sealed.
4. Switch on the data system and the monitor as described in the manuals that came with them. Wait until the operating system of the computer is completely loaded.
5. Open the Tune application by choosing **Start > All Apps > Thermo Instruments > model x.x > model Tune**.

   Tip The data system must be running before you start up the instrument. The instrument will not operate until software is received from the data system.

6. Turn on the nitrogen flow at the tank, if it is off.
7. Place the main power circuit breaker switch of the MS in the On (|) position. When you place the main power circuit breaker switch in the On (|) position, the forepump and the turbomolecular pump are started.

   When the vacuum system is switched on, the following occurs:

   a. After the main switch is switched On, the pumps of the mass spectrometer are run up. The Pirani gauge (see "Vacuum System" on page 3-23) monitors the pressure at the forepump. In a short time, a significant pressure decrease must be observed. The quality of the vacuum can be estimated by means of the rotation speed of the TMP (for example, 80% after 15 minutes).

      Check glass cover if system shuts off during startup, as it may have broken its seal when the system was last vented.

If the working pressure is not reached after a preset time, the complete system is switched off.

b. The Cold Cathode Gauge is switched on only after the TMP has exceeded 90% of its maximum rotation speed for five minutes. It is then used to monitor the vacuum in the Orbitrap analyzer.

c. The system will turn off the UHV gauge shortly after initial pump down to save lifetime of the gauge. The system will then start and automatic bakeout following any full vent cycle. This will keep the instrument inaccessible for 10 hours of baking and 3 hours of cooling. The UHV gauge turns back on after system bakeout is complete.

d. The Status LED on the system panel turns green when all the following conditions are met:

- In the Tune software, all LEDs are green.
- Analyzer temperature is below 45 °C.
- The TMP frequency has exceeded 90% of its maximum rotation speed.

e. When the vacuum measured by the Cold Cathode Gauge is better than 1E-8 mbar, the power supplies of the high voltage electronics are switched on.

8. If you have a GC or autosampler, start it as is described in the manual that came with the GC or autosampler. If you do not have either, set up your mass spectrometer for operation as described below.

NOTICE

Always set the GC to use vacuum compensation for setting carrier gas flow when connected to the MS detector. This may not be the default setting for a new GC.

❖ **To set up your Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer for operation**

1. Operation of the system with excessive air and water in the vacuum manifold can cause reduced sensitivity and tuning problems. Before you start data acquisition with your Orbitrap Exploris GC and Orbitrap Exploris GC 240 system, you must wait for the system to automatically bake out for at least ten hours plus a cooling period of three hours. See “Baking Out the System” on page 8-11.

2. After you have performed a system bakeout, make sure in the Tune software that the UHV pressure is ≤1E-8 mtorr. Also make sure that the FV pressure is < 1 mbar. Compare the values of the other parameters in the instrument status window with values that you recorded previously.

3. Make sure that the gas pressure is within the operational limits:

   Nitrogen: 0.6 ± 0.05 MPa (87 ± 7 psi)

4. See also “Before Operating the Mass Spectrometer” on page 6-3 for additional information.

Checks for an Instrument that was vented

Before you can use the instrument again, you have to perform a system calibration check. The check includes these items:

- Leak check
- EI/CI source tune
- Mass accuracy test
- System calibration checks.

Refer to the instrument Help for instructions.

Resetting the System

If communication between the mass spectrometer and data system computer is lost, then it may be necessary to reset the system with the reset button of the mass spectrometer.

❖ **To reset the system**

1. Make sure that the mass spectrometer and the data system computer are both powered on and that the mass spectrometer is in Standby condition. See page 6-6 for instructions about placing the instrument in Standby condition.

2. To reset the mass spectrometer, unlock the GC riser on the right side, carefully slide the GC away from the MS, and the press the black reset button on the control panel. See Figure 6-1 on page 6-12.

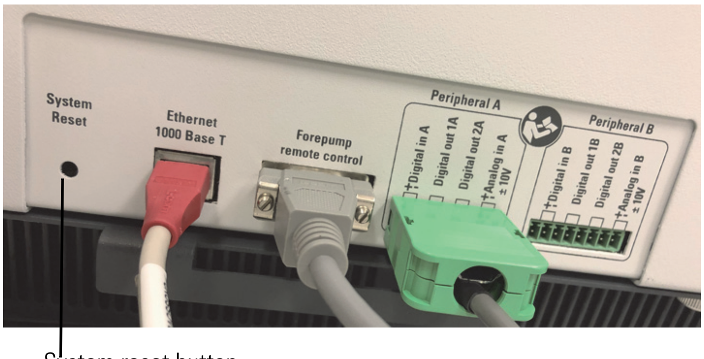


Figure 6-1. System reset button on control panel

Make sure that the Status LED is off before you release the reset button. When you press the reset button, the following occurs:

a. An interruption of the embedded computer causes the CPU to reboot. All LEDs on the front panel are off except the Power LED.

b. After several seconds, the Status LED turns yellow to indicate that the data system and the instrument are starting to establish a communication link.

c. After several more seconds, the Status LED turns green to indicate that the data system and the instrument have established a communication link. Software for the operation of the instrument is then transferred from the data system to the instrument.

After three minutes, the software transfer is complete. The System LED is either green to indicate that the instrument is functional and the high voltages are on, or yellow to indicate that the instrument is functional and it is in Standby condition.

Tip If resetting the system does not resolve the failure:

1. Put the electronics switch into the Service Mode position.
2. Wait for about ten seconds.
3. Put the electronics service switch back into the Operating Mode position.

Installing the Column

Check the column for leaks, condition the column, and perform a column evaluation if needed before inserting it into the MS transfer line.

NOTICE Never install a column into the ion source that has not been conditioned. The column should be conditioned with vacuum compensation set off and the column flow exiting outside the MS. Conditioning a column into the ion source will contaminate ion optics and require cleaning the MS.

❖ To check the column for leaks

1. On the TRACE 1310, select the Leak Check icon in the Maintenance menu. Otherwise, perform the leak check through the Chromatography Data System. Refer to the *TRACE 1300 and TRACE 1310 Series GC User Guide* for instructions.

2. Start the leak check:

   The split and purge valves of the selected channel are automatically closed, and the channel is pressurized with carrier gas to the leak check set point.

   The system monitors the pressure for one minute. If the pressure does not drop more than the maximum allowed sensitivity value, then the leak check will pass. If the leak check does not pass, use the leak detector to find and fix any leaks.

NOTICE Leaks can be caused by not tightening the fitting on the column flowmeter connector. Check the fitting before looking for the leak elsewhere.

NOTICE **INSTRUMENT DAMAGE:** Do not allow the column flowmeter connector to exceed 80 °C (176 °F). Otherwise, it will melt and damage the instrument.

3. Repeat the leak check until no leaks are indicated.

4. Calibrate the carrier gas flow (column evaluation):

a. Carefully push the capillary column end into the flowmeter section of the column flowmeter connector.

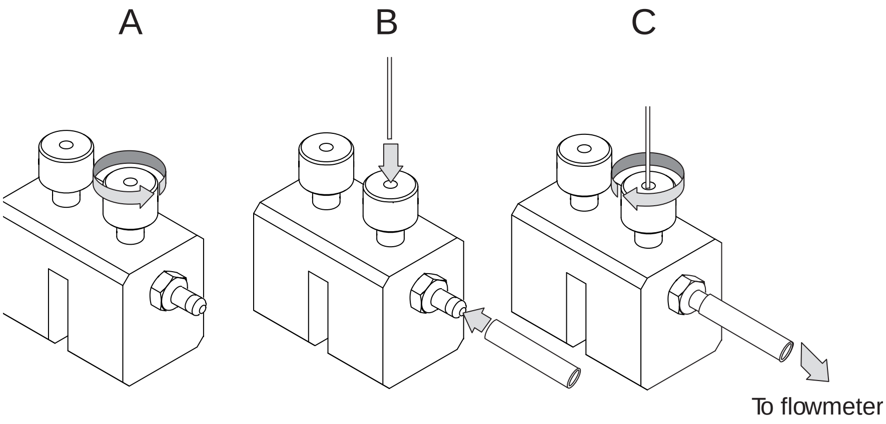


Figure 6-2. Connecting the Column to the Flowmeter

b. Connect the flowmeter to the dedicated fitting on the column flowmeter connector.

c. If you have a TRACE 1310, select the Back or Front Column icon in the Configuration menu. Otherwise, perform the column evaluation through the Chromatography Data System. See the TRACE 1300 and TRACE 1310 User Guide for instructions.

d. Select Column and input the column's physical characteristics.

e. If a pre-/post column is present, set the length and nominal internal diameter of the pre-/post column in the same valid ranges for the column. The following two lines are added to the menu.

NOTICE For the most reproducible results, you should conduct a more detailed column evaluation. However, the following steps, while recommended, are not required.

f. Start the column evaluation. According to the physical characteristics of the column, the system calculates and displays the relevant column K-factor. At the end of the routine, a message will indicate that the evaluation was successful.

g. Expect a K-factor of approximately 0.7–0.9 for a 15 m, 0.25 mm i.d. column (1.3–2.0 for a 30 m, 0.25 mm i.d. column). If the column does not report a K-factor within this range or within 0.1 units of the previous stored value, check for a leak or broken column using the leak detector. The K-factor is a measured resistance for the column. A K-factor that is too low may indicate a leak in the system, while a K-factor that is too high may indicate a blockage.

Fix any issues found and rerun column evaluation until an appropriate K-factor is achieved.

5. Disconnect the column flowmeter.

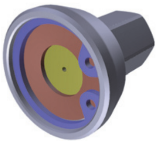
6. Disconnect the column from the column flowmeter connector.

7. Remove the clear plastic component, including its fittings, from the oven and set them aside.

Nut and Ferrule Combinations

The two transfer-line nut and ferrule combinations available for the Orbitrap Exploris GC and Orbitrap Exploris GC 240 systems are shown in Table 6-1. You must use one or the other combination.

Table 6-1. Nut and Ferrule Combinations

Combination	Nut	Ferrule	Maximum Continuous Operating Temperature	Notes
Combination 1	Standard Nickel-plated Brass Nut: P/N 290BT240 	15% Graphic/85% Vespel™ Ferrule (10/pkg): P/N 29033496 	260 °C	Can be used at a continuous operating temperature up to 280 °C with a shortened lifetime.
Combination 2	Adjustable Nut: P/N 1R120434-0010 	SCP-5000 Vespel Ferrule (5/pkg): P/N 290VT221 	320 °C	This can exceed the continuous operating temperature of some columns or their polyimide coating. Confirm column limits and trim away any column that has already been exposed to continuous high temperature when making a new seal.

❖ **To install the column in the Orbitrap Exploris GC and Orbitrap Exploris GC 240 system**

1. In Tune, place the instrument in the **Standby** state.

2. Cool the oven, transfer line and source:

   a. On the GC, set the Oven to **Off**.

   b. On the GC, in the Auxiliary Temperature Control, set Transfer Line 1 and Transfer Line 2 to **Off**.

   c. In Tune Instrument Control – EI/CI source, set the ion source temp to 175 °C (to avoid excessive oxidation of source parts or contamination from the source plug).

3. Using the source removal tool and vacuum interlock, remove the ion source. (See “EI/CI Source Maintenance” on page 8-15 for correct use of the vacuum interlock and source insertion/removal tool.)

4. Place the ion source cartridge on the source holder and set aside.

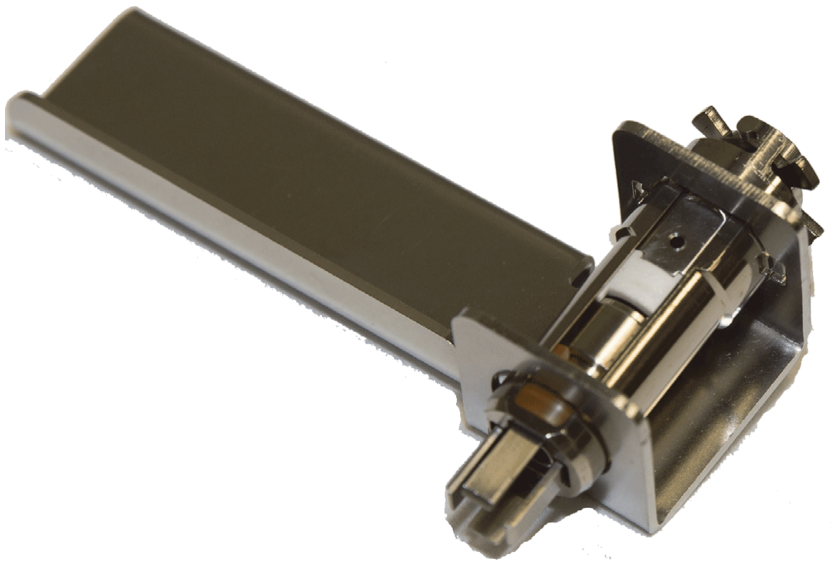


Figure 6-3. Storing the Ion Source Cartridge in the Source Holder

5. Place the source plug in the source plug holder.

Figure 6-4. Attaching the Source Plug to the Source Plug Holder

6. Attach the source exchange tool to the source plug in the source plug holder.

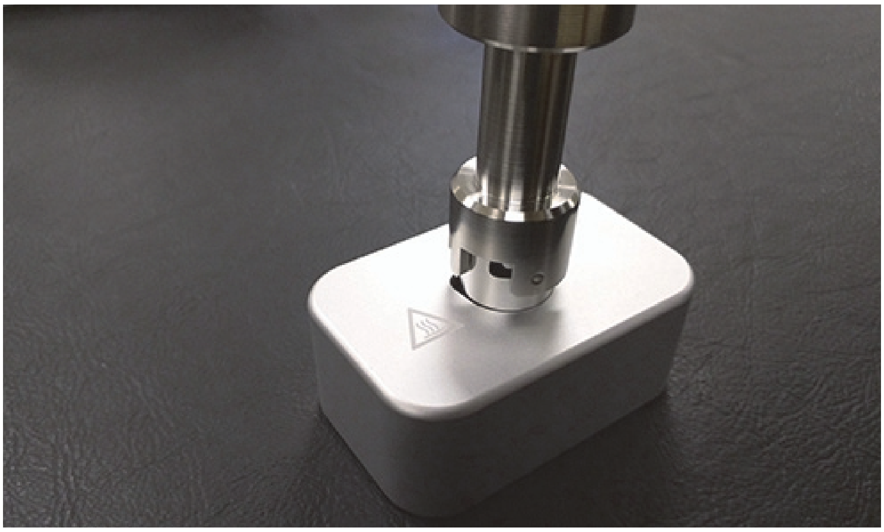


Figure 6-5. Attaching the Source Plug to the Source Exchange Tool

7. Twist the plug until it aligns securely in the grooves in the source exchange tool and remove the plug from the holder.

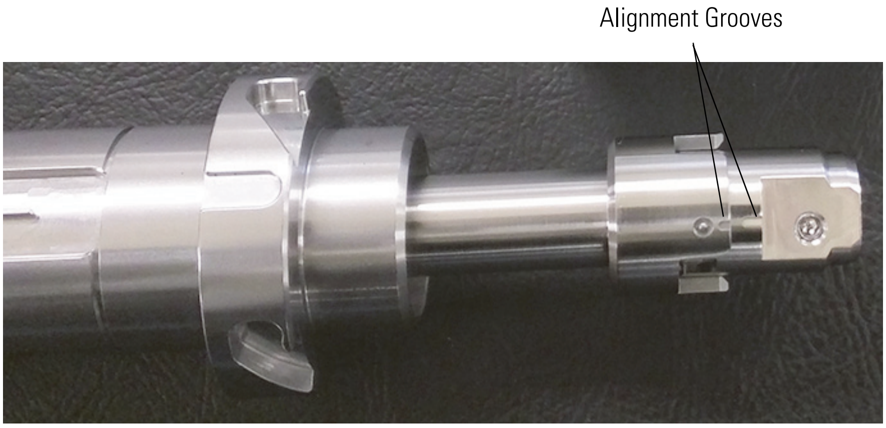


Figure 6-6. Attaching the Source Plug to the Source Exchange Tool

NOTICE Use compressed air to blow all the dust off the source plug before inserting it into the mass spectrometer.

8. Once the ion source temperature has dropped below 200 °C, insert the barrel end of the source exchange tool into the vacuum interlock and twist it clockwise to lock it into position. Be sure the black handle remains fully extended and locked.

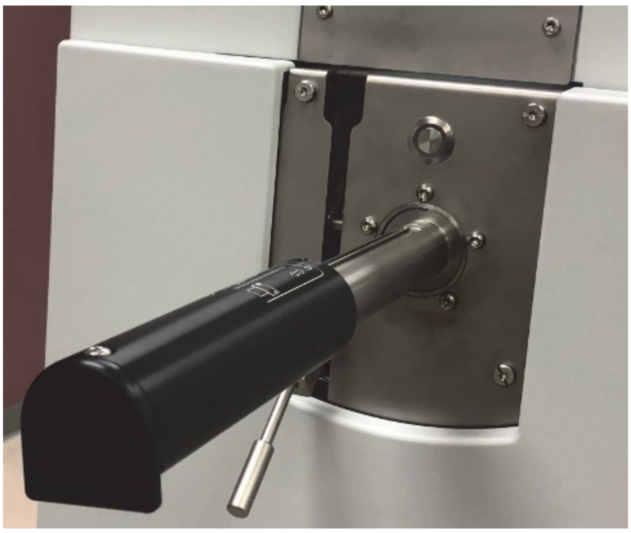


Figure 6-7. Inserting the Source Plug into the Vacuum Interlock

9. Evacuate the VPI.

   a. Confirm that the source removal tool is properly engaged in the VPI.

   b. Press the blue Evacuate button on the front of the instrument.

c. The Evacuate button lights will begin to flash amber and then green once the forevauum is okay and ten seconds have elapsed. The button should continue to flash for approximately 30 seconds total. See Figure 6-8 for VPI LED status indicators.

d. If the pressure has returned to an acceptable value after the 30-second wait, button lights will change to constant green indicating the vacuum inlet is ready to open. At that point, the air has been evacuated from the instrument and it is safe to open the vacuum interlock valve.

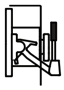
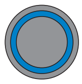
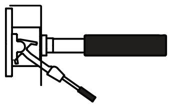
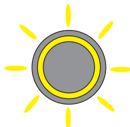
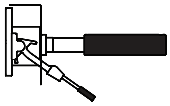
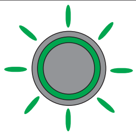
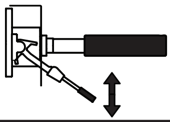
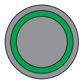
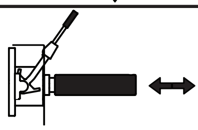
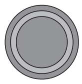
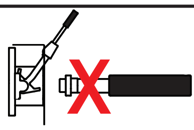
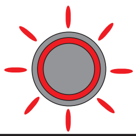
VPI Position	LED	Status
		Standby
		Evacuating
		Evacuating with Vacuum Okay
		Ready to Open
		Open
		Vacuum Fault

Figure 6-8. VPI LED Status Indicators

10. Pull the vacuum interlock handle up when the button lights are a solid green.

11. Twist the handle of the tool slightly to the left until it is feels like it is lodged into the left-most track.

12. Push the handle toward the instrument until the end of the handle aligns with the engraved line at the end of the barrel. When you reach this line, the tool is all the way in and the source plug is securely placed in the instrument.

NOTICE The source plug should remain attached to the source exchange tool. Do not rotate the source exchange tool handle to attempt to disengage the source plug.

13. Wait for oven and transfer line temperatures to drop below 50 °C to avoid burns before proceeding to touch the column and nut.

14. Remove the current column and nut if present.

NOTICE Monitor the foreline pressure when removing the column and nut to confirm that the source plug is properly sealing the transfer line. If the pressure exceeds 3 mbar, the leak is excessive, and the source plug should be reseated while the column nut is in place or inspected for damage. If the turbomolecular pump is forced off by the vacuum protection and the pump speed drops below 80% speed, cycling power will not restart the turbomolecular pump. The pump speed must further drop below 25% before cycling the power to reset the pump and allow it to spin up to 100%. Be careful not to have the circuit breaker off for more than 5 seconds or there is a risk that the system will vent and must be pumped down overnight.

15. Unwind an appropriate column length to insert into the transfer line along the front of the instrument.

16. Wipe approximately 300 mm (12 in.) of the column with a tissue soaked in methanol.

17. Choose an appropriate ferrule for the outer diameter of your column.

18. Wipe the column again with a tissue soaked in methanol.

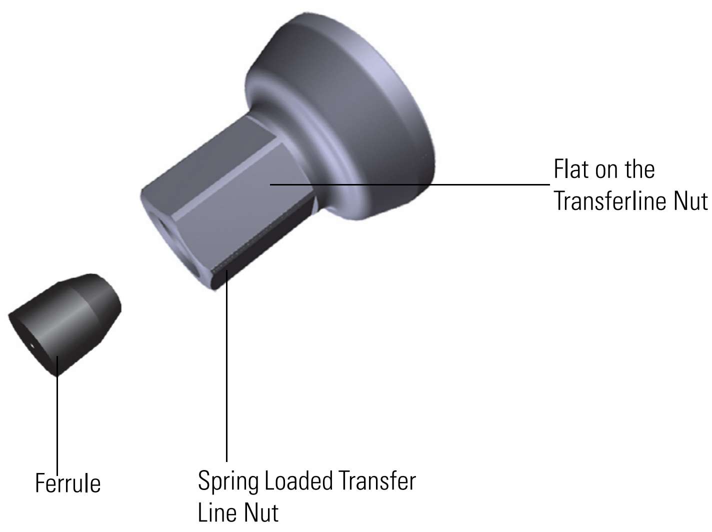


Figure 6-9. Transfer line nut and ferrule orientation

19. Insert the new column through the MS transfer line.

20. Carefully extend the column out the front to allow application of the nut and ferrule.

21. Insert the column through the nut and ferrule (flat side of the nut faces the MS).

22. Use a scoring wafer to score and then remove the last 10 mm of column to provide a clean, well-cut end.

23. Wipe the column with an alcohol soaked-wipe after inserting through the ferrule.

24. Carefully push the column back into the GC transfer line while keeping the nut and ferrule on the column.

25. Insert the column into the MS transfer line and tighten the nut until the column just resists sliding through the ferrule.

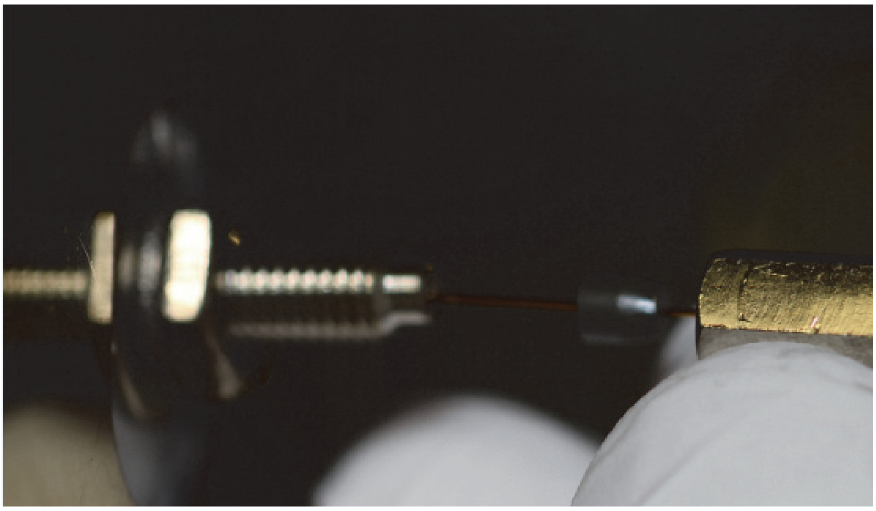


Figure 6-10. Inserting the New Column through the MS Transfer Line

26. Loosen the nut ¼ turn and gently push the column into the MS transfer line until it just touches the source plug.

27. Pull the column ½ to 1 mm away from the source plug and tighten the nut ½ turn..

NOTICE To avoid forcing the column into the source plug when tightening the nut, the column can be pulled back approximately 1 mm before tightening the nut. Remove the source plug with the insertion/removal tool.

28. Ensure the column and nut are correctly installed in the MS transfer line.

29. Pull the handle away from the instrument until the source plug has been removed from the source block and is enclosed within the tool.

30. Lower the handle to close the vacuum interlock.

NOTICE Ensure that the tool is not protruding into the ball valve. If the ball valve is closed with the tool extended, then the tool and/or ball valve can become damaged.

31. Remove the source exchange tool.

32. Allow the source plug to cool.

33. Carefully remove the source plug from the insertion/removal tool using the source plug holder.

Tip To avoid collecting dust on the source plug, store it in a closed container when not in use.

34. Using the source holder, place the ion source on the insertion/removal tool and install the ion source using the vacuum interlock.

35. In Tune **Instrument Control > EI/CI Source**, set the:

    a. MS transfer line temp to the method temperature.

    b. Ion source temp to the method temperature.

36. In Tune, place the instrument in the On state.

37. Leak check at the nut with tetrafluoroethane spray and tighten with a 1/4” wrench as needed. Perform leak checking by scanning in full scan and looking for $+CF_3$ (68.99466) and $+CH_2CF_3$ (83.01031) peaks while spraying potential leak spots with tetrafluoroethane (dusting spray or refrigerant R-134A).)

38. If vacuum compensation was set to **Off** for any reason (such as conditioning a new column), set vacuum compensation to **On**.

NOTICE Please do not reuse no-hole ferrules to plug the transfer line when conditioning new columns. Reuse of ferrules causes the ferrule material to extrude into the transfer line, blocking access to install new columns. If the transfer line becomes blocked, remove the transfer line and use the transfer line cleaning tool (PN 1R120630-9903)to remove the debris by pushing the wire through the transferline through the bore of the transferline from the ion source end towards the GC end. Please contact Service for assistance.

39. On the GC, set the Oven to **On**.

40. On the GC, in the Auxiliary Temperature Control, set Transfer Line 1 and Transfer Line 2 to **On**.

41. Reinsert the ion source to assure good electrical contacts using the insertion/removal tool and vacuum interlock once all temperatures have stabilized for 30 minutes and the source has thermally expanded.

42. Replace the vacuum interlock knob and evacuate the inlet valve chamber to remove the remaining air between the ball valve and interlock plug.

43. Confirm there are no leaks before beginning any tuning or analyses.

7

Troubleshooting

This chapter provides information about identifying and solving common problems with Orbitrap Exploris GC mass spectrometers.

Contents

- Safety Guidelines for Troubleshooting on page 7-2
- Fault Table on page 7-3
- Main Power Failure on page 7-4
- Vacuum Leak on page 7-5
- Failure of UHV Chamber Heating Control on page 7-7
- Turbomolecular Pump is not Running on page 7-7
- Failure of Source Heaters / Transfer Line Heaters on page 7-8

Safety Guidelines for Troubleshooting

When you troubleshoot the Orbitrap Exploris GC and Orbitrap Exploris GC 240 systems, pay attention to these general safety guidelines.

WARNING

High Voltage. High voltages that can create an electric shock are used in the instrument. Do not remove protective covers from PCBs. Opening the instrument housing is only allowed for maintenance purposes by Thermo Fisher Scientific personnel. To make sure that the instrument is free from all electric current, always disconnect the power cords of the *mass spectrometer and the forepumps* before you try any type of maintenance.

CAUTION

Hot Parts. Touching hot parts of the ion source interface might cause severe burns. During operation of the mass spectrometer, the ExtractaBrite removable ion source might reach temperatures of up to 350 °C, while the GC column transfer line might reach temperatures of up to 400 °C. To let the ion source interface cool down, set the ion source and transfer line temperatures to 25 °C. Wait until the ion source has cooled down to room temperature (for approximately 60 minutes) before you begin working on it. Do not leave the instrument unattended when the covers and front door are removed, exposing the hot source parts. Hot ion source parts might ignite combustible material. Keep combustible materials away from the ion source mount.

CAUTION

Hot Parts. A forepump in function is hot and some surfaces could reach a temperature higher than 80 °C (176 °F). Touching parts of the forepump might cause burns. Switch off the pump and let it cool down before any intervention. If you must work on a pump that is “still warm from operation,” then always wear heat protective gloves.

Service by the customer must be performed by trained qualified personnel only and is restricted to servicing mechanical parts. Service on electronic parts must be performed by Thermo Fisher Scientific field service engineers only.

Do not try to repair or replace any component of the system that is not described in this manual without the assistance of your Thermo Fisher Scientific field service engineer.

Fault Table

If malfunctions on the mass spectrometer occur, you will find possible causes and instructions for repair in Table 7-1.

Table 7-1. Troubleshooting

Problem	Possible Causes	Remedy/Information
Tune software shows bad vacuum	System was vented because of a mains failure	page 7-4
	Vacuum leak	page 7-5
Temperature of UHV chamber is higher than expected	UHV chamber heating control has failed	page 7-7
Turbomolecular pump is not running	TMP is switched off because of overheating. TMP is switched off because forepump has switched off or because of forevacuum leak or forevacuum failure.	page 7-7

Main Power Failure

A main power failure has the same consequence as switching off with the main power circuit breaker switch. If the power is available again, the system starts up automatically: the pumps are switched on and the vacuum is created. If the system has been vented during the mains failure, the system will automatically start to bake out if vacuum is adequate. See "Baking Out the System" on page 8-11.

If the log file of the data system shows a reboot of the system and the pressure reading in the Tune software shows a bad vacuum, this indicates that the system was vented. In case of frequent but short power failures, Thermo Fisher Scientific recommends that you install an uninterruptible power supply (UPS). If main power failures occur frequently while the system is not attended (for example, in the night), Thermo Fisher Scientific recommends that you install a power fail detector.

Vacuum Leak

For proper performance, the Orbitrap Exploris GC system must operate at acceptable vacuum levels. You can check the current pressure values in the Tune software window.

❖ **To check the vacuum levels**

1. Make sure that the Vacuum LED on the front of the mass spectrometer is green, which indicates that the pressure gauges are within their threshold values. In the Tune window, a green square ( ) indicates that the readback value is good.

2. Compare the current values of the pressures in the vacuum manifold with the values listed in Table 7-2. If the current values are higher than normal, there might be an air leak.

Table 7-2. Typical pressure readings

Gauge type	Name in Tune software	Typical values
Pirani	Forevacuum	about <1 mbar, depends on helium gas flow through GC column
Cold cathode	Ultra High Vacuum	< 8E-10 mbar

3. If the pressure in the Ultra High Vacuum region is high (above 1E-9 mbar), the instrument must be baked out for about 10 hours or more. See "Baking Out the System" on page 8-11 for instructions on performing a system bakeout.

If the pressure remains high, the system might have an air leak. See below for instructions.

❖ **To check the system for major air leaks**

Listen for a rush of air or a hissing sound inside the mass spectrometer.

Possible causes of a major leak might be a loose or disconnected fitting, an improperly positioned O-ring, or an open valve. If you suspect an air leak in the forevacuum region, check the vacuum tube for holes. Also check the clamp that fixes the vacuum tube to the forevacuum port of the mass spectrometer. See Figure 3-8 on page 3-12. It might be loose because the forepump was shifted or the vacuum tube is twisted.

❖ **To fix an air leak**

1. Shut down the system. See page 6-7.

2. Make a visual inspection of the vacuum system and vacuum lines for leaks.

3. Check each fitting and flange on the system for tightness, and tighten the fittings or flanges that are loose.

   Do not tighten fittings indiscriminately. Pay particular attention to fittings that have been changed recently or to fittings that have been subjected to heating and cooling.

4. Make sure that the O-rings and the cover plates of the vacuum manifold are properly positioned.

If you cannot find the location of the leak or fix the leak yourself, contact your Thermo Fisher Scientific field service engineer.

Failure of UHV Chamber Heating Control

During general operation of the mass spectrometer, the temperature of the UHV chamber is not regulated. Only during a system bakeout, electric power is supplied to the heating elements of the UHV chamber. Thus, failure of the heating control does not lead to a dangerous overheating of the mass spectrometer.

If the mass spectrometer does not operate as expected, use the Tune software for error diagnosis.

In case of a failure of the UHV chamber heating control, shut down the mass spectrometer as described on page 6-7. To prevent permanent damage to components of the Orbitrap Exploris GC mass spectrometer, Thermo Fisher Scientific recommends that you call a Thermo Fisher Scientific field service engineer.

Turbomolecular Pump is not Running

A turbomolecular pump may be switched off because of one of the following reasons:

- Turbomolecular pump is blocked
- Failure of fans in turbomolecular pump
- Failure of forevacuum

Each of the above reasons might lead to an overheating of the pump. When overheated, a turbomolecular pump switches off automatically to prevent its destruction. This overheating protection prevents the outbreak of a fire and minimizes the risk of destructing the pump.

Confirm the GC column is intact and that the interface to the MS is not leaking.

If the mass spectrometer does not operate as expected, use the Tune software for error diagnosis.

In case of an overheated turbomolecular pump, shut down the mass spectrometer as described on page 6-7. To prevent permanent damage to components of the mass spectrometer, Thermo Fisher Scientific recommends that you call a Thermo Fisher Scientific field service engineer.

The turbomolecular pump may also shut off if power to the forepump is lost. Verify there is an appropriate amount of oil present in the forepump. Also verify all electrical connections are present on the forepump and relay. See “Connecting the Forepump” on page 5-12.

Failure of Source Heaters / Transfer Line Heaters

A failure of the source heater control or transfer line heater control might lead to an overheating of ion source parts. Non-metallic parts of the ion source (insulators, for example) are made of non-flammable materials, thus preventing any ignition.

If the mass spectrometer does not operate as expected, use the Tune software for error diagnosis.

A contrast between the temperatures displayed in the Tune software and the observed temperature of hardware components indicates a failure of the heater control.

In case of a failure of the source heater control or transfer line heater control, shut down the mass spectrometer as described on page 6-7. To prevent permanent damage to components of the mass spectrometer, Thermo Fisher Scientific recommends that you call a Thermo Fisher Scientific field service engineer.

Maintenance

This chapter describes routine maintenance procedures that must be performed to ensure optimum performance of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer.

Contents

- Safety Guidelines for Maintenance on page 8-2
- Guidelines for Maintenance on page 8-3
- Inspection- and Servicing Plan on page 8-4
- Tools and Supplies on page 8-8
- Maintaining the Vacuum System on page 8-10
- Maintenance of the Fan Filters on page 8-13
- EI/CI Source Maintenance on page 8-15
- Maintenance of the Ion Optics on page 8-47
- Consumables on page 8-59
- Thermo Fisher Scientific Service on page 8-60

Safety Guidelines for Maintenance

When you do maintenance on the Orbitrap Exploris GC and Orbitrap Exploris GC 240 system, pay attention to these general safety guidelines:

⚠ WARNING

High Voltage. High voltages that can cause an electric shock are used in the instrument. Do not remove protective covers from PCBs. Opening the instrument housing is only allowed for maintenance purposes by Thermo Fisher Scientific personnel. To make sure that the instrument is free from all electric current, always disconnect the power cords of the *mass spectrometer and the forepump* before you try any type of maintenance.

⚠ CAUTION

Hazardous Chemicals. Samples, solvents, and detergents might contain toxic, carcinogenic, mutagenic, or corrosive/irritant chemicals. Avoid exposure to potentially harmful materials. Always wear protective clothing, gloves, and safety glasses when you handle solvents or samples. Also contain waste streams and use proper ventilation. Refer to your supplier's Material Safety Data Sheet (MSDS) for proper handling of a particular compound.

⚠ CAUTION

Risk of Eye Injury. The thin, sharp, flexible capillaries are difficult to see against the light. There is a risk of being stabbed or cut when you do work with the capillaries. Wear safety glasses to prevent eye injuries!

⚠

It is the user's responsibility to maintain the system properly by performing the system maintenance procedures on a regular basis.

Service by the customer must be performed by trained qualified personnel only and is restricted to servicing mechanical parts. Service on electronic parts must be performed by Thermo Fisher Scientific field service engineers only.

Do not try to repair or replace any component of the system that is not described in this manual without the assistance of your Thermo Fisher Scientific field service engineer.Thermo Fisher Scientific assumes no responsibility and will not be liable for instrument damage and/or operator injury that might result from any servicing other than that contained in this manual or related manuals.

Guidelines for Maintenance

Preventive maintenance must start with installation, and must continue during the warranty period to maintain the warranty. Thermo Fisher Scientific offers maintenance and service contracts. Contact your local Thermo Fisher Scientific representative for more information. Routine and infrequent maintenance procedures are listed in Table 8-1.

Accurate results can be obtained only if the system is in good condition and properly calibrated.

❖ **To prepare the work area**

Do the following:

- Make sure that the surrounding area is neat and clean.
- Prepare a clean work surface by covering the area with lint-free paper or a large sheet of clean aluminum foil.
- Have nearby the necessary tools, supplies, and replacement parts (when applicable).

For optimal results, follow these guidelines when you perform the procedures in this chapter:

- Always wear a new pair of lint- and powder-free gloves when handling internal components. Do not reuse gloves after you remove them because the surface contaminants on them recontaminate clean parts. See "Personal Protective Equipment" on page 4-12 for a specification for the gloves.
- Always place the components on a clean, lint-free work surface.
- Dirty tools can contaminate your system. Keep the tools clean and use them exclusively for maintenance and service work at the mass spectrometer.
- Do not insert a test probe (for example, an oscilloscope probe) into the sockets of female cable connectors on PCBs.
- Do not overtighten a screw or use excessive force.

NOTICE Make sure that you do not introduce any scratches or surface abrasions while you handle the internal components. Even small scratches can affect performance if they are close to the ion transmission path. Do not use tools, such as metal pliers, that might scratch these components.

Inspection- and Servicing Plan

Routine and infrequent maintenance procedures to be performed by the user are listed in Table 8-1. For a list of maintenance procedures that must be performed by Thermo Fisher Scientific personnel, see page 8-60.

Table 8-1. User maintenance procedures

MS Component	Procedure	Frequency	Procedure Location
Instrument	System bakeout	After the system was vented (even partially by a short power outage).	page 8-11
	Check warning labels on instrument	Annually	page 8-6
	Leak check gas lines	Annually	page 8-6
	Check condition of tubings and hoses	Annually	page 8-7
Cooling fans	Check fan filters	Every four weeks.	page 8-13
	Clean fan filters	If necessary.	
Ion optics	Clean quadrupole	Check bi-weekly. Clean if quadrupole performance evaluation indicates contamination.	page 8-47
	Clean bent flatapole	When you clean the quadrupole.	page 8-53
	Tip If you believe that it is necessary to clean components of the ion optics that are not listed in this table, you should contact your Thermo Fisher Scientific service representative.		
Ion source	Clean ion source cartridge	As needed.	page 8-15
Filament	Replace filament	As needed.	
Forepump	Purge (decontaminate) oil	Monthly[a]	See manufacturer's documentation
	Check oil level	Daily	page 8-10, see also manufacturer's documentation
	Check oil condition	Depends on process.	
	Add oil	If oil level is below minimum.	
	Check filer insert of external oil mist filter	Daily	
	Check gas ballast valve	Monthly	
	Change oil	Every 3000 h of operation.	
	Replace exhaust filter	If oil mist appears at exhaust or annually.	
	Check anti-suckback valve	Annually	
	Clean fan cover	Annually	

[a] Depends on the types and amounts of samples and solvents that are introduced into the instrument. For low flow applications, purging the forepump is rarely necessary.

Cleaning the Surface of the Instrument

Clean the outside of the instrument with a dry cloth. To remove stains or fingerprints on the surface of the instrument (panels, for example), slightly dampen the cloth (preferably made of microfiber) with distilled water.

NOTICE Prevent any liquids from entering the inside of the instrument. Leaking liquids might get into contact with electronic components and cause a short circuit.

Checking the Warning Labels

Safety warnings on the mass spectrometer and other devices of the GC/MS system must always be complete, clearly visible and legible.

In addition to the safety instructions that can be found throughout this manual, various warning labels on the instrument inform the user about possible hazards (for example, caused by hot surfaces or high voltage). See "Safety Symbols on the Instrument" on page 4-3 for an overview. To protect all personnel coming near the instrument, annually make sure that all warning labels on the instrument are still present. Also check the warning labels on the forepump and other devices of the GC/MS system.

Leak-Checking the Gas Lines

Regularly leak check each gas line from the gas supply in the laboratory to the instrument. The instrument must be powered on, but in the **System Off** mode for the test. The main power closes the vent valve and the system off mode closes the HCD and C-Trap gas valve.

❖ **To perform a leak check for a gas line**

1. After you have closed all valves in the instrument, monitor the manometer of the gas regulator for some minutes.

2. If the pressure falls significantly (for example, the nitrogen pressure falls by more than 10 psi / 690 mbar in two minutes), then you should search for leaks in the gas line.

3. Search for leaks in the gas line, for example, by using a conventional thermal conductivity-based leak detector, such as is widely used to check leaks in gas chromatography equipment.

NOTICE These leak detectors will not detect nitrogen levels. ▲

NOTICE When the Orbitrap Exploris GC and Orbitrap Exploris GC 240 system is in the **On** or **Standby** state, nitrogen is consumed at approximately 30 mL/min. The system should be placed in the **Off** state for pressure checks.

4. If you detect a leak (which is usually at a connection), then verify the tightness of the connection. In case of doubt, replace it.

5. When you cannot find a leak in the gas line, Thermo Fisher Scientific recommends that you call a Thermo Fisher Scientific field service engineer to check for gas leaks in the instrument.

Checking the Condition of Tubings and Hoses

Regularly inspect all tubings and hoses that are connected to the mass spectrometer for damage.

❖ **To check the condition of tubings and hoses**

1. Make sure that the gas lines are securely connected, free from kinks, and not trapped.

2. Visually inspect all tubing for leaks or signs of deterioration.

If you detect a leak or other damage to any tubing or hose, then you must replace it.

Tools and Supplies

Very few tools are necessary to perform routine maintenance for the Orbitrap Exploris GC and Orbitrap Exploris GC 240 MS. You can remove and disassemble many of the components by hand. Table 8-2 lists the necessary chemicals, tools, and equipment for maintaining the instrument.

⚠ **Avoid exposure to potentially harmful materials.** By law, producers and suppliers of chemical compounds must provide their customers with the most current health and safety information in the form of Material Safety Data Sheets (MSDSs) or Safety Data Sheet (SDS). The MSDSs and SDSs must be freely available to lab personnel to examine at any time. These data sheets describe the chemicals and summarize information on the hazard and toxicity of specific chemical compounds. They also provide information on the proper handling of compounds, first aid for accidental exposure, and procedures to remedy spills or leaks.

Read the MSDS or SDS for each chemical you use. Store and handle all chemicals in accordance with standard safety procedures. Always wear protective gloves and safety glasses when you use solvents or corrosives. Also, contain waste streams, use proper ventilation, and dispose of all laboratory reagents according to the directions in the MSDS or SDS.

Table 8-2. Chemicals, tools, and equipment

Description
Chemicals
Organic solvent: xOH (for example, methanol, ethanol, or isopropanol), UHPLC/MS-grade
Water, UHPLC/MS-grade
Detergent (for example, Liquinox™)
Nitrogen gas, clean and dry
Performance Maintenance Starter Kit (sold separately)
Tools
Source removal tool
T10 and T20 Torx screwdrivers
3 and 4 mm Allen wrenches
Performance Maintenance Starter Kit (sold separately)
(Optional) Toothbrush, soft (or similar tool)
(Optional) Tweezers, plastic (or similar tool)

Table 8-2. Chemicals, tools, and equipment, continued

Description
Equipment
Beaker or graduated cylinder (for use with methanol)
Magnifying device
Sonicator
Gloves, lint-free and powder-free
Chamois-tipped swabs
Cotton swabs with long wood handle, sterile, lint-free
Fisherbrand™ standard foam swab, polypropylene handle
Industrial tissues, lint-free
Nylon/polypropylene wipes
Saturated lint-free wipes, 70:30 isopropanol:water
Polishing paste (for example, 1 µm grain size diamond paste)
MICRO-MESH (for example, 6000 and 12000 grit)

Maintaining the Vacuum System

This section describes user maintenance procedures for the vacuum pumps and the vacuum manifold of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer.

This section only outlines the user maintenance procedures for the forepump and the turbomolecular pump (TMP) of the mass spectrometer. The manuals of the pump manufacturers give detailed advice regarding safety, operation, maintenance, and installation. Note the warnings and precautions contained in these manuals!

Maintenance of the Forepump

For the forepump, several maintenance procedures must be performed by the user. See Table 8-1 on page 8-4. To simplify the maintenance work, the pump manufacturer recommends that you combine several jobs. For maintenance instructions, refer to the manual that came with the forepump.

⚠ **CAUTION**

Hot Parts. The forepump in function is hot and some surfaces could reach a temperature higher than 80 °C (176 °F). Touching parts of the forepump might cause burns. Switch off the pump and let it cool down before any intervention. If you must work on a pump that is "still warm from operation," then always wear heat protective gloves. Take note of the warning labels on the pump.

⚠ **CAUTION**

Hot Liquid. Touching hot forepump oil might cause burns. Always wear protective gloves and protective goggles when you handle the forepump oil.

⚠ **CAUTION**

Hazardous Chemicals. The forepump oil might cause skin or eye irritation and it might contain toxic, carcinogenic, mutagenic, or corrosive/irritant chemicals. Avoid exposure to potentially harmful materials. Always wear protective clothing, gloves, and safety glasses when you handle the forepump oil.

⚠ When you dispose used oil, observe the relevant environmental regulations! For instructions about proper handling, refer to the Material Safety Data Sheet (MSDS) for the forepump oil.

Forepump oil and exhaust filters are available from Thermo Fisher Scientific. If you wish to order other spare parts, contact the pump manufacturer.

NOTICE

To prevent an unwanted operation of the forepump, connect the MS and the forepump to the power supply in the correct sequence:

- When you deinstall or service a system, first disconnect the power supply cords, then disconnect the cord between the instrument and the forepump.

Maintenance of the Turbomolecular Pump

To do maintenance for the TMP, it is necessary to remove the instrument housing and to partially disassemble the instrument. Therefore, a Thermo Fisher Scientific field service engineer must be called if TMP maintenance is necessary. See also page 8-60.

The pump manufacturer recommends that you change the operating fluid reservoir every four years at the latest. Depending on the operating conditions, changing in two-year intervals might be necessary. Changing of the TMP bearing is recommended every four years, at least.

Baking Out the System

The system bakeout of the mass spectrometer removes unwanted gases or molecules (collected or remaining) from the high-vacuum region of the instrument. Ions can collide with those gases or molecules resulting in lower overall sensitivity. Therefore, Thermo Fisher Scientific recommends that you bake out the instrument if the ultra high vacuum increases noticeably following maintenance or during routine operation.

Bakeout is mandatory after the system has been vented for maintenance or service work in the analyzer region. You should bake out an instrument that has been vented for at least ten hours before you can start using it again.

If the system has been vented during a power failure, then it is necessary to bake out the system to attain the operating vacuum. See "Starting Up the System after a Shutdown" on page 6-9.

Tip Before you start the bakeout, make sure that the pumps are up and running at their operating speed. If you have just switched on the mass spectrometer, this will take about ten minutes.

❖ **To perform a system bakeout**

1. Click the **Diagnostics** icon ( ), and then choose **System > Bake Vacuum Chamber**.

2. Click **Start**.

3. In the Tune window, do the following:

a. Open the Status pane, click the downward arrow, and then choose **By Function**.

b. Double-click **Vacuum System**, and then verify that the UHV Pressure readback value is below the operating threshold limit.

NOTICE The bakeout procedure turns the UHV gauge off and on during the procedure to preserve the gauge lifetime.

Table 8-3. Threshold limits for the vacuum pressure gauge

Forepump pressure:	< 5 mbar
UHV pressure:	5×10^{-8} Torr

In the Tune window, normal readback measurements show a green square (■).

⚠ CAUTION **Hot Parts.** If you abort a system bakeout, parts of the instrument can be hot. Touching hot parts of the instrument immediately after a bakeout might cause burns. Let the instrument cool for at least three hours before you start to operate it again.

Maintenance of the Fan Filters

Each of the ventilation slots at the left side and the right side of the mass spectrometer is equipped with a fan filter. See Figure 8-1.

Figure 8-1. Fan filter

NOTICE

Do not block the ventilation slots of the mass spectrometer. Items might fall behind the instrument, inhibit airflow, and cause the system to overheat.

Checking the Fan Filters

Check the fan filters every four weeks and clean them if they are dirty. Replacements for the fan filters are available from Thermo Fisher Scientific, see Chapter 9, "Replaceable Parts."

❖ **To check the fan filters**

1. Each fan filter bracket is plugged into the instrument frame. Pull the fan filter assemblies away from the frame to remove them. See Figure 8-1 and Figure 8-2.

Figure 8-2. Removing a fan filter bracket

2. Remove each fan filter from the base of the mass spectrometer and pull it out of its bracket. See Figure 8-2.

   If the fan filters are covered with dust, continue with step 3. If the fan filters are clean, proceed to step 6.

3. Wash the fan filters in a solution of soap and water.

4. Rinse the fan filters with tap water.

5. Squeeze the water from the fan filters and let them air dry.

6. Reinstall the fan filters in the fan filter brackets.

7. Reinstall the filter brackets

EI/CI Source Maintenance

Removing the Ion Source Cartridge from the Orbitrap Exploris GC and Orbitrap Exploris GC 240 System

1. Twist (counter-clockwise) off the round vacuum interlock knob located on the interior front panel and set it aside. There is a vacuum feedthrough with a ball valve that allows access to the ion source without venting the instrument

NOTICE To prevent leaks through the vacuum interlock, the vacuum interlock knob must be attached to the instrument, except when you are removing or inserting the ion source cartridge. After you reattach the knob, press the **Evacuate** button to remove any air inside the vacuum interlock. ▲

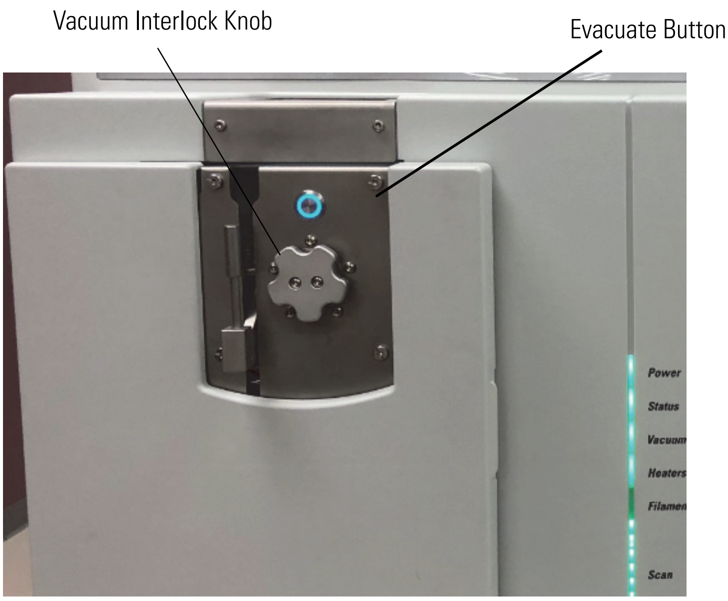


Figure 8-3. Locating the Vacuum Interlock Knob and Evacuate Button

2. Get the source exchange tool that shipped with your instrument. It is used to remove and insert the ion source cartridge through the vacuum interlock. The tool has a large black handle on one end and a stainless steel barrel at the other. On the black handle is a diagram describing how to insert and remove the ion source cartridge from the instrument using the tool. The stainless steel barrel is cut with a track and the black handle moves up and over the track, depending on whether you are removing or installing an ion source cartridge.

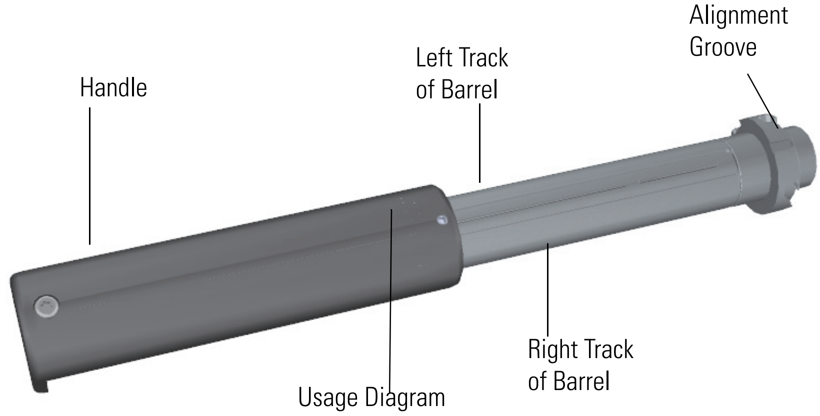


Figure 8-4. Locating the Vacuum Interlock Knob and Evacuate Button

3. Grasp the handle of the source exchange tool in one hand and use your other hand to pull the metal barrel out and away from the handle so that tool is fully extended.

4. Attach the source exchange tool to the front of the instrument.

   a. With your hand around the stainless steel barrel, twist the tool until the alignment groove at the end of the barrel aligns with the left screw around the slot vacated by the vacuum interlock knob.

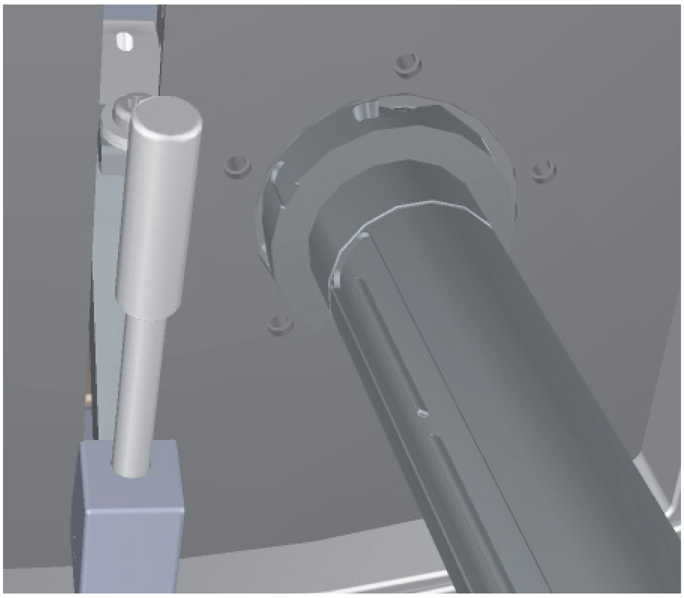


Figure 8-5. Inserting the Ion Volume Tool

b. Twist and push the stainless steel barrel to the right until it clicks into place under the screw at the top of the slot.

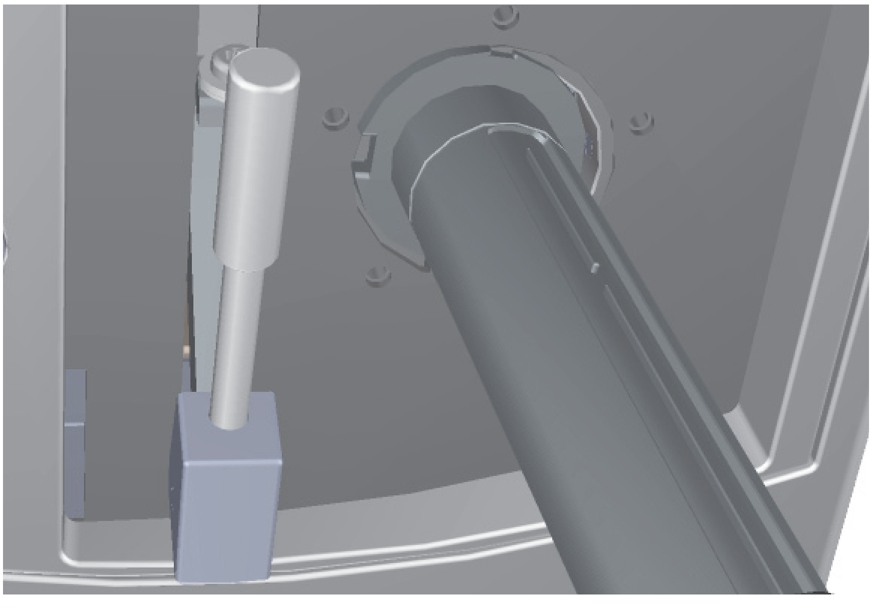


Figure 8-6. Twisting the Tool into Place

5. Evacuate the vacuum probe interlock (VPI).

   a. Confirm that the source removal tool is properly engaged in the VPI.

   b. Press the blue **Evacuate** button on the front of the instrument.

   c. The **Evacuate** light flashes amber and then green as the inlet evacuates and should continue to flash green for approximately 20 seconds.

   d. If the pressure has returned to an acceptable value after the 20-30 second wait, the evacuate light will turn solid green. At that point, the air has been evacuated from the ball valve and it is safe to open the vacuum interlock valve.

NOTICE If the evacuate light flashes for only a short time or changes to red then returns to a solid light without turning solid green, there is a leak in the VPI seal. The source removal tool connection should be checked or field service contacted.

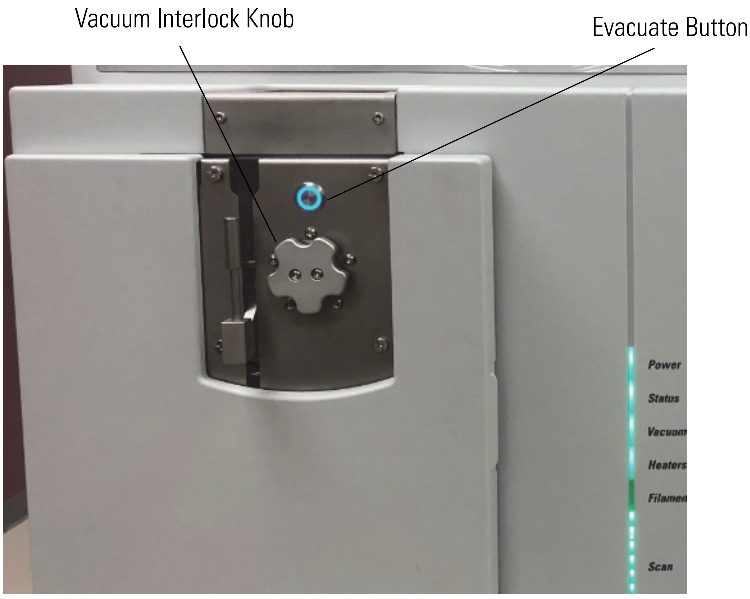


Figure 8-7. Evacuating the System

6. Twist, then loosen the top part of the vacuum interlock handle to allow the entire handle to swing up and down. This handle controls the interior ball valve, which seals the vacuum chamber.

7. Swing the handle down and then twist the top of it in the opposite direction to lock it into place.

NOTICE

Be sure the source exchange tool handle is locked securely by fully rotating the handle to the right before proceeding to the next step (opening the interior ball valve). The locking function is designed to prevent the source exchange tool from being sucked into the manifold when the ball valve is opened.

8. Lift the handle up to open the interior ball valve.

NOTICE

If more than 60 seconds have passed since the **Evacuate** indicator light has turned solid green, it will turn off. You should press the **Evacuate** button and wait until it is solid green again before opening the valve. Do not open the valve if the **Evacuate** light is not solid green. This may indicate a leak in the valve region. When a leak is detected during the evacuate sequence, the red evacuate LED will flash on and off.

9. Slowly push the ion cartridge tool into the instrument. Because you are removing the ion volume in this step, you will go down the right side of the metal track on the barrel.

NOTICE

INSTRUMENT DAMAGE: Make sure the vacuum interlock handle is all the way up. Otherwise if you insert the tool with the handle down, you can damage the instrument.

Figure 8-8. Pushing the Tool into the Instrument

10. Once the tool is all the way in (when the groove at the end of the barrel is covered by the black handle) twist the handle to the left to

engage the ion source cartridge and move it onto the end of the barrel. You are essentially disconnecting the ion source cartridge from the ion source block and moving it onto the tool.

11. Pull the tool toward you and down the left side of the metal track on the barrel. As you keep pulling it toward you, more and more of the barrel will be exposed. You may encounter resistance while removing the source. To release the source from the spring contacts make small repeated rotations (vibrations) of the handle to the left and right quickly. See Figure 8-9.

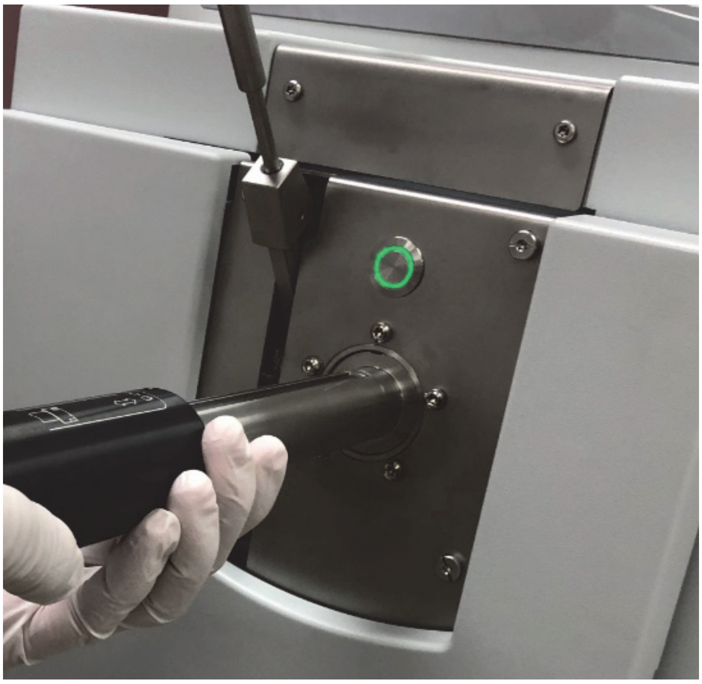


Figure 8-9. Pulling the Tool Down the Left Track

12. Once you reach the end of the track (when the back line at the end of the barrel is uncovered by the black handle), twist the handle to the left to lock it into place. See Figure 8-10.

Figure 8-10. Locking the Tool in Place. Note: Tool is Rotated Left.

13. Pull the vacuum interlock handle down to close the interior ball valve. See Figure 8-11.

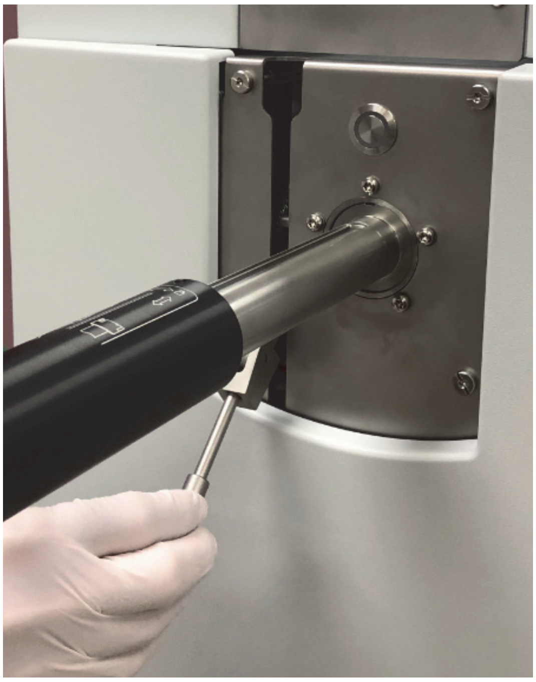


Figure 8-11. Pulling Down the Vacuum Interlock Handle

14. Twist the end of the vacuum interlock handle and flip the swing handle up so that it rests next to the vacuum interlock knob location. Then twist the end again to hold it in place.

15. Replace the plug in the VPI to prevent accidental venting and excessive leaks.

NOTICE

INSTRUMENT DAMAGE: Do not move the main interlock handle when you move the swing handle to the up position or you will open the interior ball valve, which might cause you to lose vacuum and possibly damage the instrument.

16. Remove the tool from the instrument. See Figure 8-12.

Figure 8-12. Removing the Tool from the Instrument

17. Let the ion source cartridge cool.

⚠CAUTION

HOT SURFACE Touching hot parts of the ion source interface might cause severe burns. During operation of the mass spectrometer, the ion source can reach temperatures up to 350 °C. Wait until the ion source has cooled down to room temperature before you begin working on it.

18. Hold the handle of the source exchange tool with one hand and use the other hand to pull the barrel toward you and into the handle.

Figure 8-13. Exposing the Ion Source Cartridge

19. Invert the source exchange tool so that the barrel is pointed toward the floor.

20. Slide the source holder, which is in the MS toolkit, onto the end of the ion source cartridge. The opening of the source holder is designed to accommodate the handles of the ion volume.

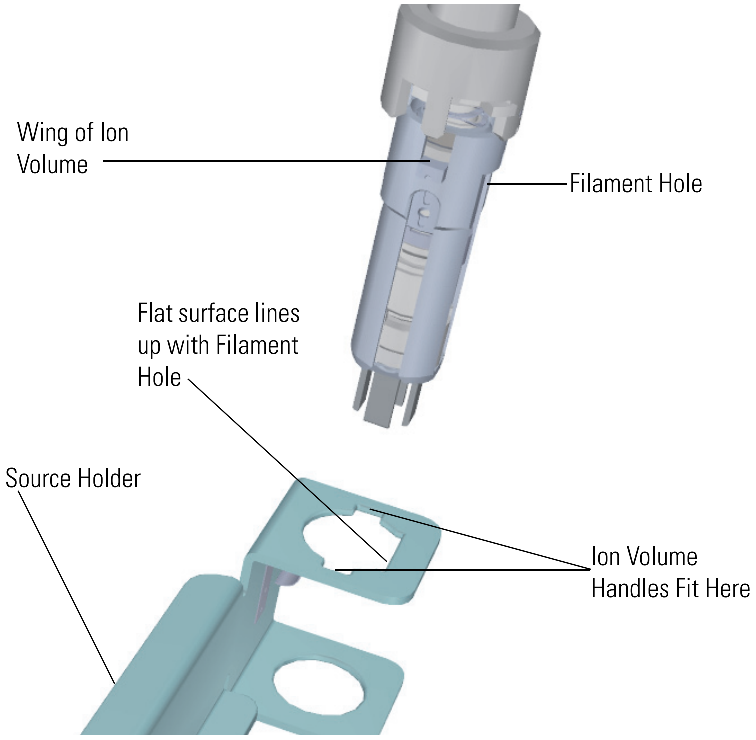


Figure 8-14. Attaching the Source Holder

21. Twist the holder to disengage the ion source cartridge from the tool.

NOTICE

The repeller locking nut is now loose on the repeller spring. Be careful not to tip the source or the components will fall out.

22. Set the ion source cartridge and holder on a clean surface

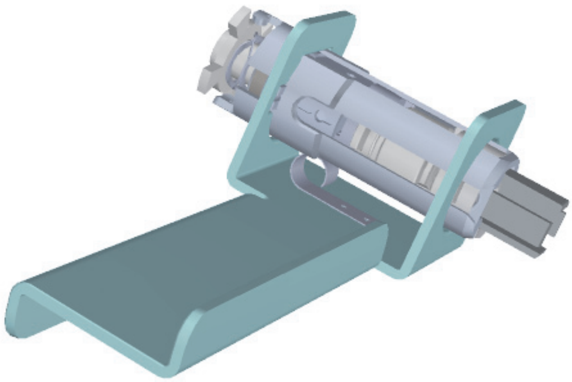


Figure 8-15. Removing the Ion Source Cartridge

⚠CAUTION

HOT SURFACE The ion source parts might be hot, so use caution when handling.

23. Let the ion source cartridge cool down before removing it from the source holder.

24. Disassemble the ion source cartridge by removing the locking ring first, then the repeller spring, then the nut, insulator, and repeller (which comes out in one piece), ion volume, lens 1, lens 2, and lens 3/RF lens.

NOTICE

IMPORTANT Many nitrile and latex gloves not certified for clean room use contain silicone mold releasing agents that will contaminate the instrument. For this reason, clean room gloves are strongly recommended when handling the ion source cartridge. We recommend Cardinal Health CP100 Nitrile Cleanroom Gloves.

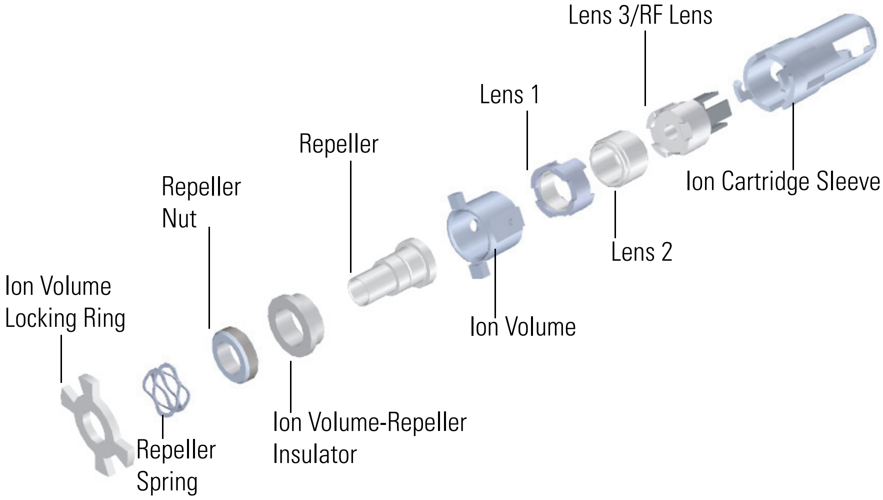


Figure 8-16. Components of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 Ion Source

25. Set the components on a clean work surface.

26. Replace the ion source cartridge or any individual component.

Reassembling the Ion Source Cartridge

❖ **To reassemble the ion source cartridge.**

1. Place the ion volume-repeller insulator on the repeller and hold it in place with the repeller nut. Set it aside for now.

2. Insert the ion cartridge sleeve into the source holder.

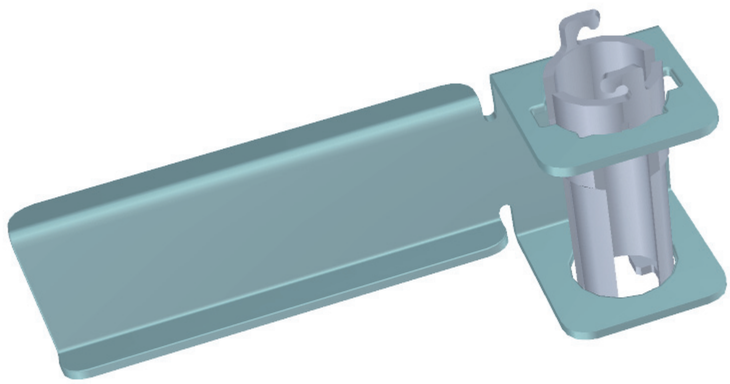


Figure 8-17. Inserting the Sleeve into the Source Holder

3. Align the long tooth of lens 3/RF lens with the notch on the bottom of the sleeve and drop the lens into the sleeve.

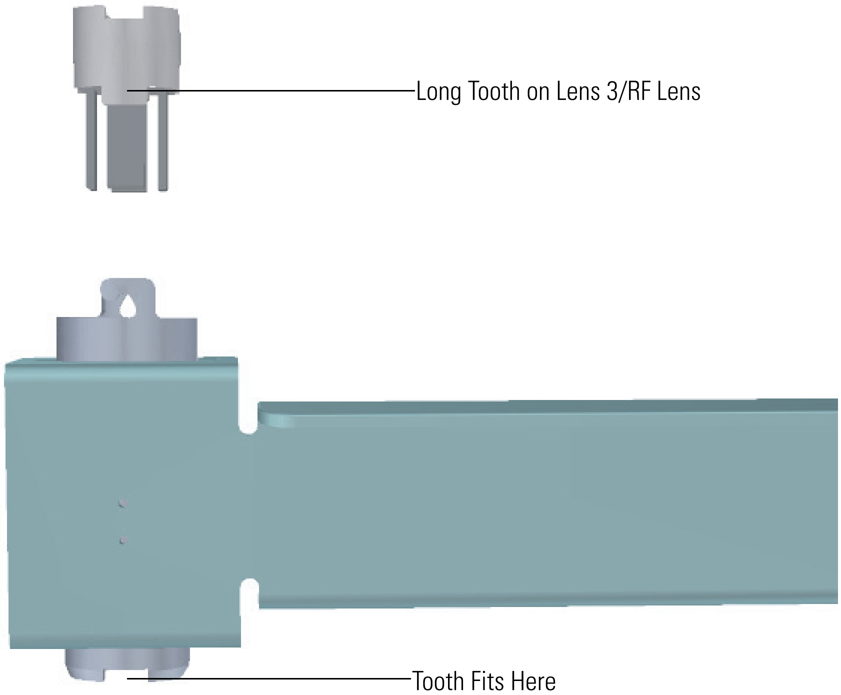


Figure 8-18. Inserting Lens 3/RF Lens into the Source Sleeve

4. Place lens 2 on top of lens 3/RF lens with the small hole facing down. It should fit snugly and sit evenly on top of lens 3/RF lens.

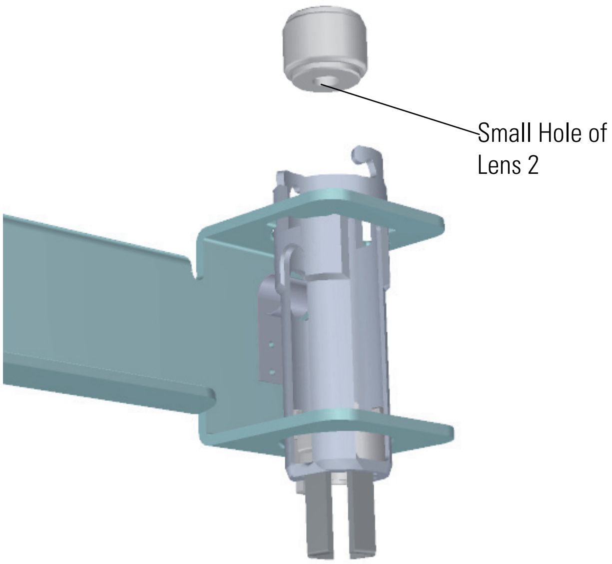


Figure 8-19. Inserting Lens 2 into the Source Sleeve

5. With the longer teeth of lens 1 facing down toward lens 2, align the larger metal section of lens 1 with the sleeve window and let it fall into place.

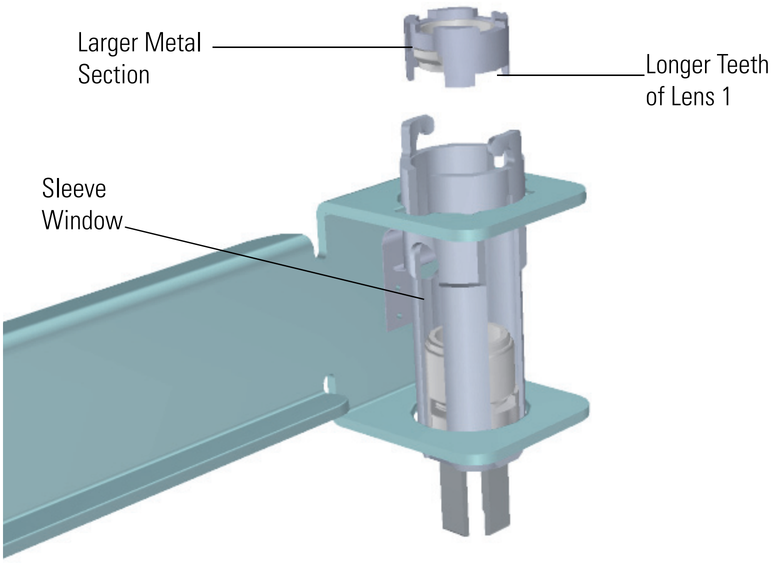


Figure 8-20. Inserting Lens 1into the Source Sleeve

6. Insert the ion volume with the handles fitting into the notches of the sleeve. Make sure the ion volume is firmly seated into the gap on lens 1. You may need to rotate lens 1 slightly to make the ion volume fit correctly.

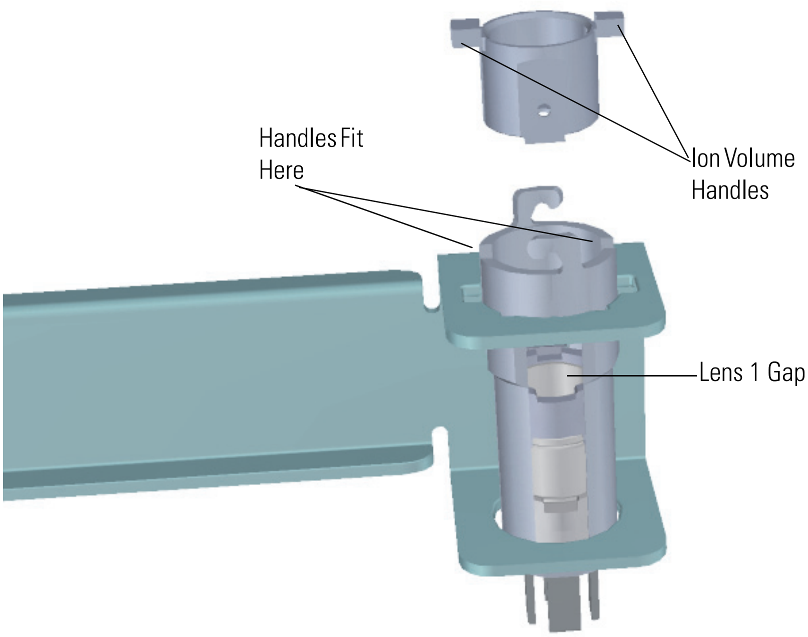


Figure 8-21. Inserting the Ion Volume into the Source Sleeve

NOTICE The ion volume handles are different sizes and will only fit into the sleeve one way.

7. Insert the ion volume repeller insulator onto the repeller.
8. Tighten the repeller nut.
9. Insert the large flat end of the repeller so that it rests on top of the ion volume.

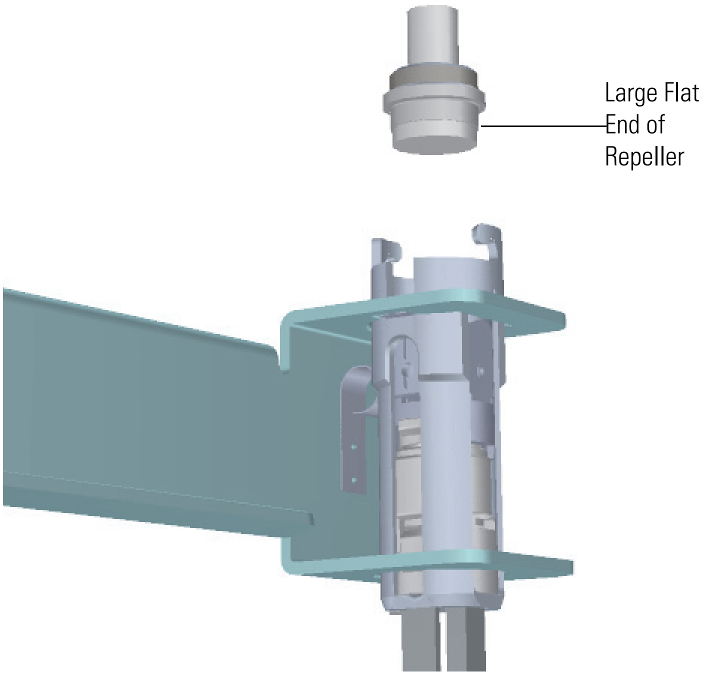


Figure 8-22. Inserting the Repeller

10. Slide the repeller spring onto the repeller.

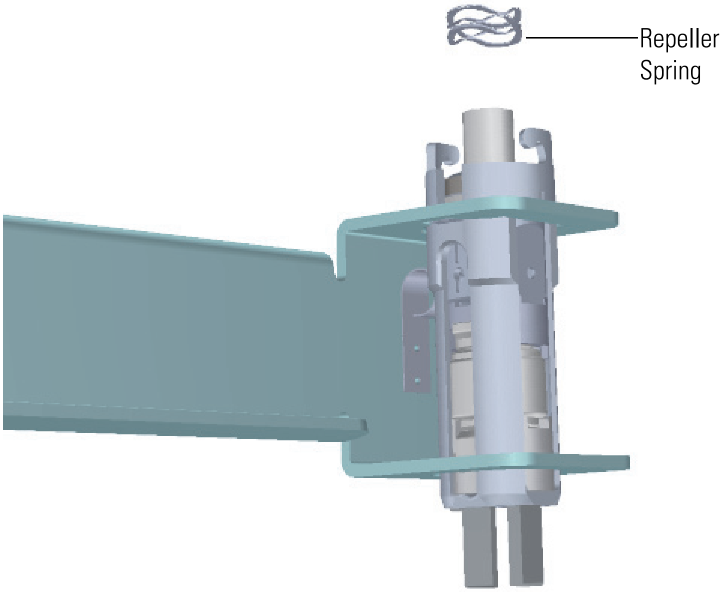


Figure 8-23. Inserting the Repeller Spring into the Sleeve

NOTICE

With repeated use, the repeller spring may become compressed. It must apply enough force on the repeller to keep the source in good electrical contact with the ion source contacts. It can be stretched to rejuvenate the force, but if it is damaged, it must be replaced.

11. Place the locking ring on top of the repeller spring so that the repeller protrudes through the center hole on the locking ring. The hooks on the sleeve fit between the larger gaps on the locking ring.

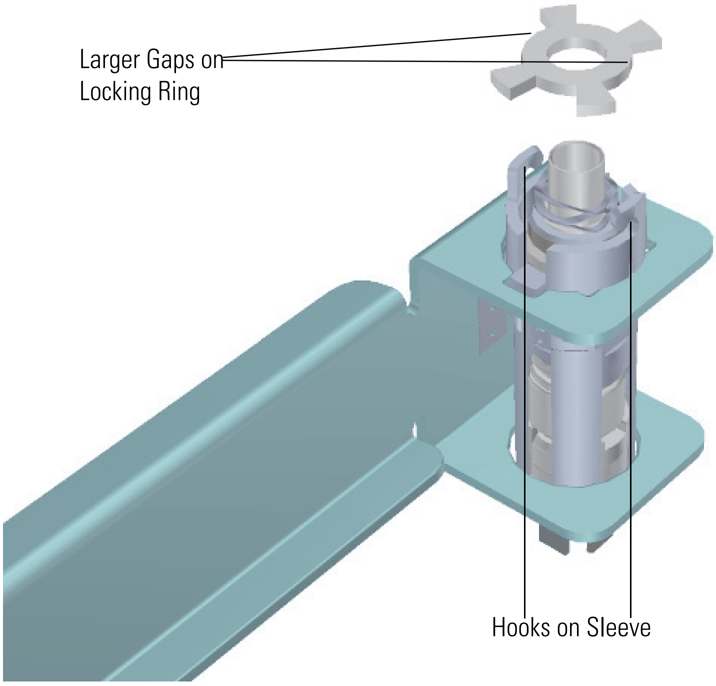


Figure 8-24. Inserting the Locking Ring into the Sleeve

NOTICE Do not twist and lock the locking ring on the sleeve at this time.

Reinserting the Ion Source Cartridge

NOTICE When inserting a cold ion source cartridge such as after cleaning or when switching between EI and CI modes, the ion source and lens stack will expand as the source cartridge heats, often pushing the ion volume and lenses away from the rear of the instrument where they are firmly held by the RF Lens spring contacts. To avoid intermittent electrical contacts to the lenses, you should insert the ion source cartridge, wait 30 minutes for it to get to temperature, then remove and reinsert it.

❖ **To reinsert the ion source cartridge**

1. Hold the source holder and ion source cartridge in one hand and use the other hand to hold the ion cartridge tool so that the barrel is facing toward the floor. The diagram on the tool should be facing you.

NOTICE If you try to attach the ion source cartridge to the tool by inverting it, the components will likely fall, so make sure you are working over a table. Otherwise, you may have to stop and clean the components again.

2. Look for a small vertical 3 mm line engraved on the end of the barrel. This line always up with the picture on the handle. There is a similar engraved line on the sleeve of the ion source cartridge. This line matches up with the filament and should always face to the top of the MS when inserting the ion source to align the filament with the ion volume.

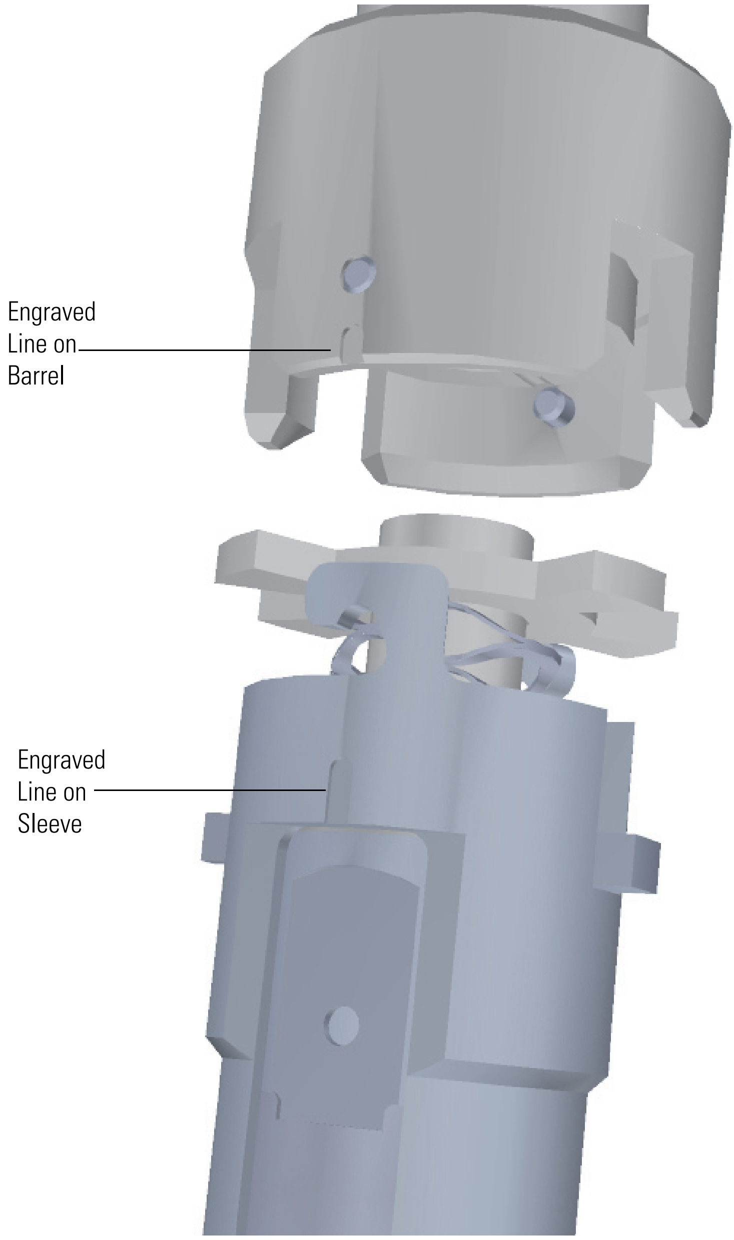


Figure 8-25. Aligning the Tool with the Ion Source Cartridge

3. Position the engraved line on the tool with the open end of the hook on the sleeve. There is a pin the source exchange tool that will latch under the hook.

4. Push the ion source cartridge up into the barrel of the tool and twist it until the engraved lines are aligned. The ion source cartridge should easily slide into place with very little force.

NOTICE

INSTRUMENT DAMAGE If you push the ion source cartridge into the barrel and it will not slide easily into position, make sure the components are assembled correctly and have not slid out of place inside the sleeve. Using too much force when inserting the ion source cartridge into the barrel can cause damage.

NOTICE

The ion volume and lenses have keying features to assure the lens spring contacts will align with the metal parts of the lenses.

5. Gently pull the source holder away from the ion source cartridge.

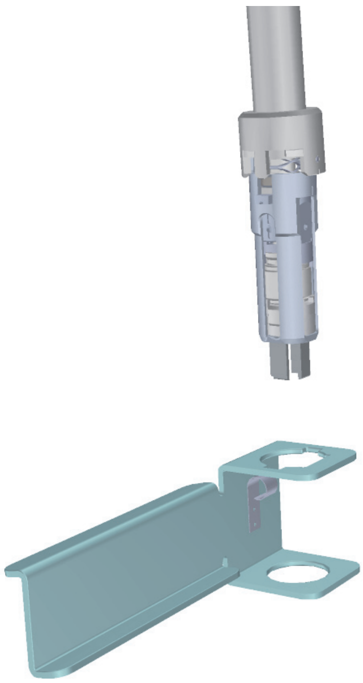


Figure 8-26. Removing the Source Holder

NOTICE

When the source exchange tool is inverted, the source should stay attached. If this does not happen, the source will not insert correctly into the instrument.

6. Turn the source exchange tool around so that the ion source cartridge is furthest away from you.
7. Firmly grasp the black handle of the ion cartridge tool in one hand and use your other hand to pull the metal barrel out and away from the handle so that tool is fully extended.The ion source cartridge is now hidden inside the barrel.
8. When the barrel can go no further, twist the handle to the left to lock it into position.

9. Insert the barrel end of the ion cartridge tool into the vacuum interlock and twist it to the right to lock it into position. Be sure the black handle remains in the locked position.

Figure 8-27. Evacuating the Instrument

10. Evacuate the VPI.

    a. Confirm that the source removal tool is properly engaged in the VPI.

    b. Press the blue **Evacuate** button on the front of the instrument.

    c. The Evacuate light will begin to flash amber then green as the inlet evacuates, and should continue to flash green for approximately 20 seconds.

    d. If the pressure has returned to an acceptable value after the 20-30 second wait, the evacuate light will turn solid green. At that point, the air has been evacuated from the instrument and it is safe to open the vacuum interlock valve.

11. Pull the vacuum interlock handle up when the **Evacuate** light is a solid blue.

12. Twist the handle of the tool slightly to the left until it is feels like it is lodged into the left-most track.

NOTICE Make sure you take the correct track on the tool or the ion volume will disassemble inside the instrument. If that happens, the tool will get stuck and you will have to shut down, vent the instrument, and manually remove the source cartridge.

Figure 8-28. Pushing the Tool into the Instrument

13. Push the handle toward the instrument until the end of the handle aligns with the engraved line at the end of the barrel. When you reach this line, the tool is all the way in and the ion source cartridge has been placed back onto the ion source block. You may notice

slight resistance when the handle is approximately 2 cm from the engraved line. This is normal. Do not force the cartridge into the instrument. To release the source from the spring contacts make small repeated rotations of the handle to the left and right quickly. Gently apply pressure to the back of the handle.

NOTICE Do not push down on the handle of the source exchange tool while inserting the ion source cartridge. This could result in opening an air leak that may cause your instrument to shut itself down to protect the vacuum pumps.

NOTICE **INSTRUMENT DAMAGE** Make sure the vacuum interlock handle is all the way up. Otherwise if you insert the tool with the handle down, you can damage the instrument.

14. Twist the handle of the source exchange tool to the right and pull it back toward you and down the right side of the barrel's metal track until the line at the end of the track appears. See Figure 8-29.

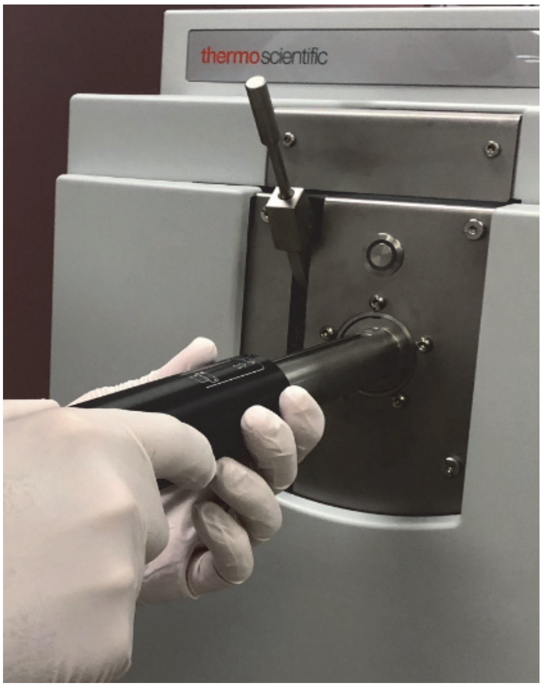


Figure 8-29. Pulling the Tool Down the Right Track

15. Pull the vacuum interlock handle down to close the interior ball valve. See Figure 8-30.

Figure 8-30. Pulling Down the Vacuum Interlock Handle

16. Twist the end of the vacuum interlock handle and flip the swing handle up so that it rests next to the vacuum interlock knob location. Then twist the end again to hold it in place.

NOTICE

INSTRUMENT DAMAGE Do not move the main interlock handle when you move the swing handle to the up position or you will open the interior ball valve, which might cause you to lose vacuum and possibly damage the instrument.

17. Remove the tool from the instrument.
18. Reattach the vacuum interlock knob and press the Evacuate button again to pump out the volume between the knob and the inlet valve.

NOTICE

Tip To prevent leaks in the vacuum interlock, we recommend that you leave the vacuum interlock knob attached to the instrument, except when you are removing or inserting the ion source cartridge. After you reattach the knob, press the **Evacuate** button will also eliminate any air inside the vacuum interlock.

19. For optimal performance, wait at least 30 minutes for the ion source to heat up to the same temperature as the inside of the instrument. Otherwise, the masses or intensities may drift during operation.

Cleaning the Orbitrap Exploris GC and Orbitrap Exploris GC 240 Ion Source Cartridge and Durable Components

NOTICE

IMPORTANT If there is any doubt about a compatibility of decontamination of cleaning agents with parts of the equipment or material contained in it, the responsible party must contact Thermo Fisher Scientific product support personnel.

You can ONLY clean the following durable source components inside the ion source vacuum manifold:

- Repeller
- Ion volume
- Lens 1
- Lens 2
- Lens 3/RF lens
- Ion cartridge sleeve

NOTICE

It is not necessary to use abrasive to remove brown oxidation from the ion cartridge sleeve as oxidation actually helps prevent the sleeve from getting stuck in the ion source block.

- Heat shield for the source interface board
- Screws

NOTICE

You only need to clean the repeller, ion volume and all the lenses most frequently. Cleaning the other components are not part of the expected maintenance.

To clean durable components of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 instrument, you will need the following cleaning supplies:

- Acetone, reagent grade (or other suitable polar solvent)
- Aluminum oxide abrasive powder, number 600
- Applicators, cotton-tipped
- Beaker
- Deionized water
- Detergent (Alconox, Micro, or equivalent)
- Dremel rotary tool or equivalent (recommended)
- Forceps
- Gas, clean and dry (Nitrogen, Helium or equivalent)
- Gloves, clean, lint- and powder-free, latex or nitrile
- Glycerol, reagent grade
- Toothbrush
- Cotton swab with wood handle
- Razor blade
- Ultrasonic cleaner

⚠ CAUTION

MATERIAL AND EYE HAZARD Wear impermeable laboratory gloves and eye protection when cleaning components.

❖ **To clean the durable components:**

1. Remove contaminants from all the components you are cleaning.
   a. Use a slurry of #600 aluminum oxide in glycerol on a cotton-tipped applicator to clean each component. Contamination can be indicated by a dark or discolored area, but it is often invisible. The heaviest contamination is usually found around the apertures, such as the electron entrance hole of the ion volume.

NOTICE Clean only the metal pieces of the repeller, lens 1 and lens 3/RF lens with aluminum oxide.

   b. Clean each component thoroughly, even if no contamination is visible. To clean components faster, use a Dremel™ tool and polishing swab at its lowest speed.

⚠WARNING **ELECTRIC CURRENT** Electric shock hazard. Exposing the Dremel tool to standing water may cause an electrical shock.

⚠WARNING **FIRE HAZARD** Using the Dremel tool near flammable vapors may cause a fire.

   c. Clean the crevices of a component using a non-metal tool. It is very important to make sure you remove all of the debris or discoloration found in small edges of each component, in particular the ion volume. Otherwise, the debris or discoloration might affect the quality of your data.
   d. If you are cleaning the CI ion volume, use a razor blade to sharpen the wooden end of a wooden cotton swab to a 45° angle.

e. Twist the sharpened end of the swab into the electron entrance hole on the CI ion volume to clean out debris. You may need to use several swabs before the electron entrance hole is clear of debris.

Figure 8-31. Cleaning the CI Ion Volume

NOTICE

Tip Clean the CI ion volume under a microscope to verify that you removed all debris.

f. If you notice any deep scratches on the components, you may need to replace the component. Scratches can affect the performance of your instrument.

2. Rinse the components with clean tap water. Use a toothbrush under a stream of water to remove the aluminum oxide slurry. Do not let the slurry dry on the components because it is difficult to remove. If the components still look dirty, repeat step 1.

3. Sonicate the components in warm detergent.

   a. Use forceps to place the components in a beaker of warm detergent.

   b. Place the beaker and its contents in an ultrasonic bath for five minutes.

   c. Rinse the components with tap water to remove the detergent.

4. Sonicate the components in deionized water.

   a. Use forceps to place the components in a beaker of deionized water.

   b. Place the beaker and its contents in an ultrasonic bath for five minutes. If water is cloudy after sonicating, replace the water with fresh water, and put the beaker and contents in a ultrasonic bath again for five minutes. Repeat until the water is clear.

5. Use forceps to immediately transfer the components to a clean beaker of acetone.

6. Sonicate the components in acetone.

WARNING **FIRE HAZARD** Acetone is flammable and volatile, so make sure the ultrasonic bath is properly ventilated to prevent the buildup of vapors.

   a. Place the beaker and its contents in an ultrasonic bath for one minute.

   b. Use forceps to transfer the components to a beaker of fresh acetone.

   c. Place the beaker and its contents in an ultrasonic bath for one minute.

7. Wearing gloves, blow clean, dry gas on the components to remove the acetone.

Acetone should not be allowed to dry on the part. It will leave a residue that may affect instrument performance.

Refilling the Calibrant Reservoir of the Orbitrap Exploris GC and Orbitrap Exploris GC 240 Mass Spectrometer

The calibrant reservoir should be refilled yearly or as needed.

❖ **To refill the calibrant reservoir**

1. Open the front door of the mass spectrometer.

2. The calibration reservoir is located under the manifold. Twist the calibrant reservoir cover counter-clockwise and remove it from the calibration gas controller.

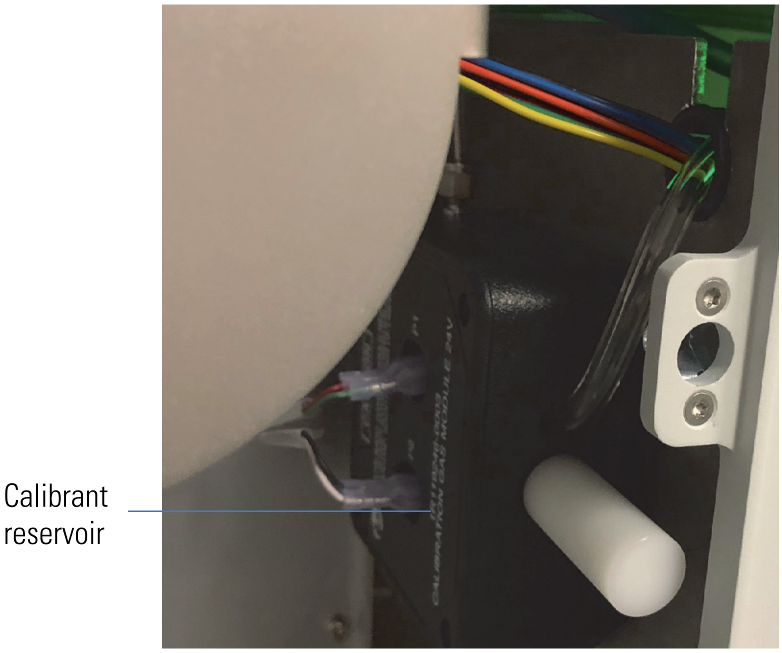


Figure 8-32. Locating the Calibrant Reservoir

3. Fill a syringe with 200 µL of the FC 43 calibration compound, which contains perfluorotributylamine (PFTBA) (P/N 50010-30059), and inject it slowly into the calibrant reservoir.

Figure 8-33. Locating the Calibrant Reservoir

4. If you see liquid pooled on top of the white frit, remove the excess liquid according to local environmental regulations.

NOTICE

INSTRUMENT DAMAGE Adding more than 300 µL of calibration compound can damage the calibration gas controller. Be sure liquid does not get into the controller when you reattach the reservoir.

5. Reattach the cover to the calibration gas controller.

6. Close the front door of the instrument.

Replacing a Dual Filament in the Orbitrap Exploris GC and Orbitrap Exploris GC 240 Mass Spectrometer

The number of ions produced in the ion source is proportional to the filament emission current. If the measured emission current is substantially less than the set emission current value, or if the measured emission current is decreasing, you may need to replace the dual filament because it has failed or is failing. Also, if one of the filaments has burned out, it may be time to replace it.

You can increase the life of your dual filament by:

- Setting the solvent delay so that the analyzer will not turn on while the solvent peak is eluting.

- Performing regular ion source leak checks and avoid running the filament when an oxygen leak is detected
- Not overriding the solvent delay at the beginning of a run.
- Selecting a lower emission current.

Click the Instrument Control button in the Xcalibur Status panel to switch between filaments A and B.

❖ **To replace a dual filament**

1. Shut down the Orbitrap Exploris GC and Orbitrap Exploris GC 240 system by following the steps in "Shutting Down the System" on page 6-7.
2. Open the front door of the mass spectrometer
3. Use a T20 Torxhead screwdriver to loosen the four captured screws around the manifold door. See Figure 8-34

Figure 8-34. Loosening the Manifold Screws

4. Pull the manifold door out to open. Once the screws have been removed from the manifold, swing the manifold door open.

NOTICE

INSTRUMENT DAMAGE: Many nitrile and latex gloves not certified for clean room use contain silicone mold releasing agents that will contaminate the instrument. For this reason, clean room gloves are strongly recommended when touching components inside the vacuum manifold. We recommend Cardinal Health CP100 Nitrile Cleanroom Gloves.

5. Use a clean set of tweezers to pull the filament clip away from the source block. See Figure 8-35.

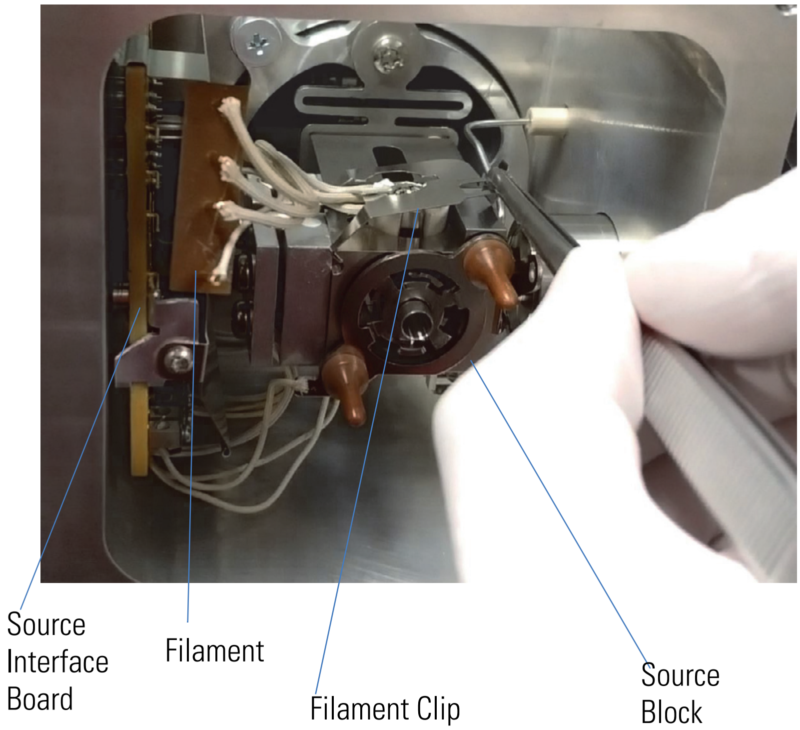


Figure 8-35. Loosening the Filament Clip from the Source Block

6. Rotate the clip away from the filament.

7. Disconnect the filament board and wires from the source interface board.

8. Remove the filament.

9. Insert the replacement filament into its slot, rotate the spring into position, and snap the filament back in place onto the source block.

10. Bend the filament wires so they do not touch any metal component. You may want the old filament as a model.

11. Attach the connector of the replacement filament to the source interface board.

12. Swing the manifold door so that it is parallel to the opening. Guide the screws into place.

NOTICE

The manifold door will not swing closed. There will be a 1 cm gap. You must push the door to close it completely. Do not apply excess force to the thumbscrews or components may be damaged. ▲.

NOTICE Once the manifold door is closed, ensure the filament wires do not contact the metal surface of the door or magnet yoke.

13. Use a T20 Torxhead screwdriver to replace the four screws around the manifold door. Do not overtighten the screws, and stop tightening when the front door metal touches the manifold metal.

14. Close the front door of the Orbitrap Exploris GC and Orbitrap Exploris GC 240.

15. Start up the instrument by following the steps in "Starting Up the System after a Shutdown" on page 6-9.

Maintenance of the Ion Optics

⚠CAUTION Keep your hands clear when the lid is open. Do not place hands or fingers where they could be pinched when moving the lid.

NOTICE The interior of the quadrupole chamber must stay free of any contamination. Make sure that the chamber is only open when you do work on the components inside.

Dirty tools can contaminate your system. Keep the tools clean and use them exclusively for the maintenance of the ion optics. Store the disassembled parts on a clean, lint-free surface (for example, lint-free tissue paper). When you do work within the system, you should wear clean, powder-free and lint-free gloves. See page 4-12 for a recommendation for the gloves.

Contact your Thermo Fisher Scientific service representative if you believe that it is necessary to clean components of the ion optics that are not described in this manual.

Cleaning the Quadrupole

❖ **To remove the quadrupole**

1. Shut down and vent the system:
   a. Wait until data acquisition, if any, is complete.
   b. In the Tune window, click the **System Off** button to put the instrument in Off condition. All high voltages are shut off, as are the sheath and auxiliary gas.
   c. Put the main power circuit breaker switch of the mass spectrometer in the Off position. The instrument is shut down and vented.
2. After five minutes, disconnect the power cords of the mass spectrometer and the forepump from the wall outlets. This prevents the system from being switched on in the open state.
3. Wait for 15 minutes to make sure that the instrument is completely vented.
4. Remove the alignment pin that connects the GC brackets to the MS bracket. See Figure 8-36.
5. Free several coils of column inside the GC oven to allow the GC to be pulled away from the MS without breaking the column.

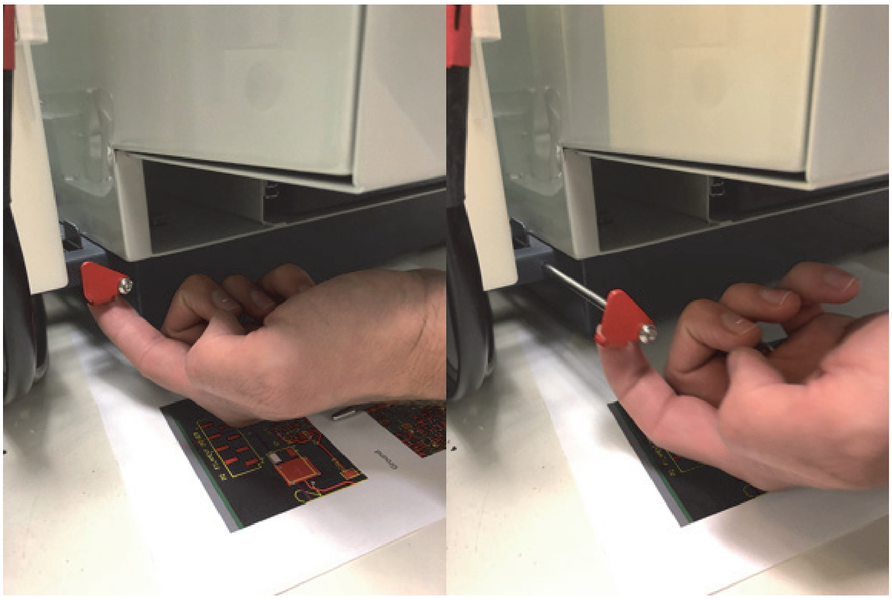


Figure 8-36. Removing the alignment pin

6. Remove the lower panel on the bottom right side of the GC. See Figure 8-37.

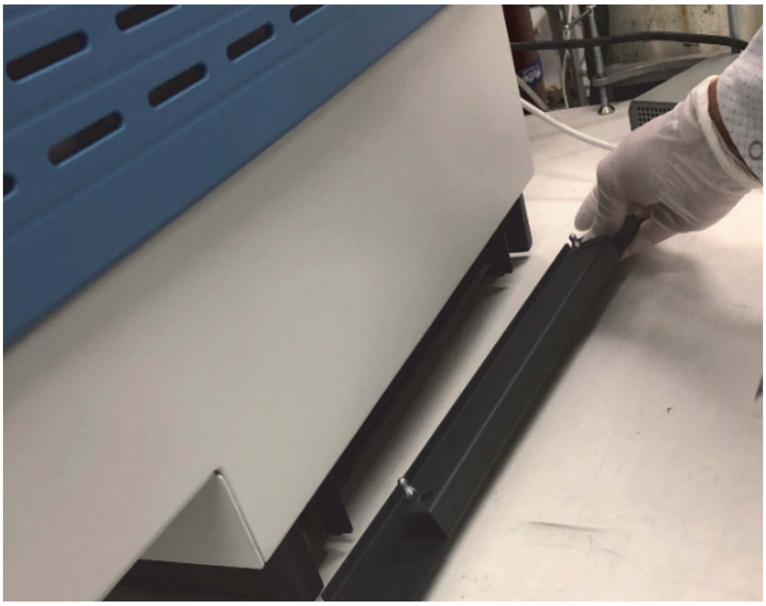


Figure 8-37. Removing the GC panel

7. Lift up on the center brake to take off the GC brakes. Move the GC to the right away from the MS. See Figure 8-38.

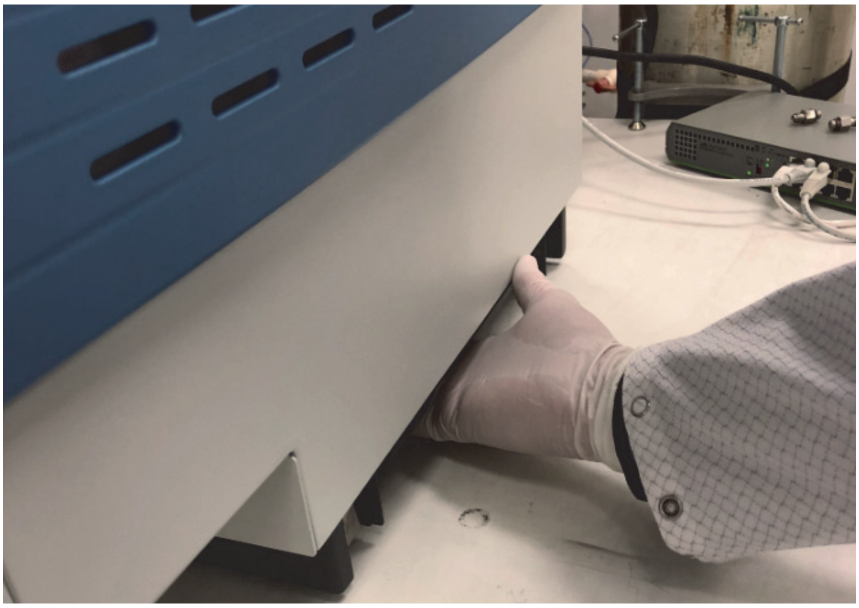


Figure 8-38. Moving the GC away

8. Prepare a clean surface on the bench or ideally in a fume hood, for example by placing some clean aluminum foil on the bench.

9. Loosen the five 3 mm hex screws in the accessories cabinet that connect the top cover to the instrument frame. See red circles in Figure 8-39.

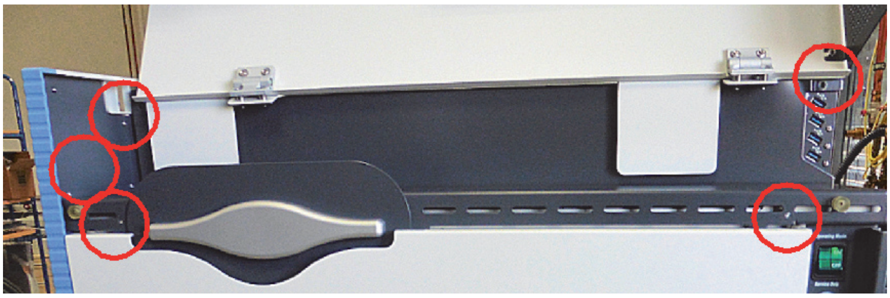


Figure 8-39. Top cover screws

10. Grab the front of the top cover of the instrument with both hands and push it a small distance toward the rear side of the instrument. Then grab the Orbitrap-shaped handles of the cover with both hands and lift it off. Store the cover in a safe place.

Figure 8-40. Removing the top cover

11. The hinged lid of the quadrupole chamber is visible. Grab the handle rail on the right side of the lid and pull it upwards. The quadrupole chamber opens. Open the lid all the way (>90°) until it rests on the hinges.

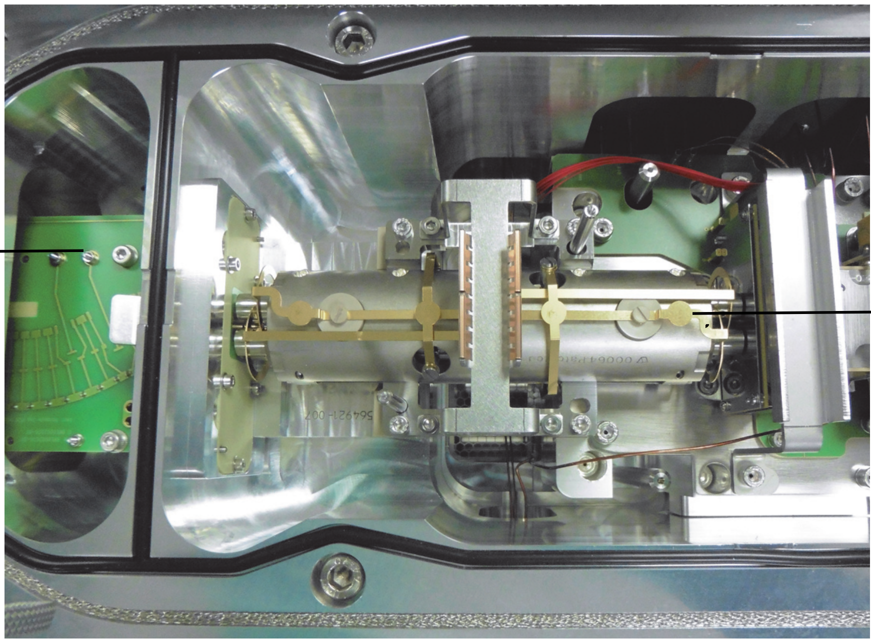


Figure 8-41. Inside of quadrupole chamber (customer accessible parts)

12. Put on a new pair of lint- and powder-free gloves.

NOTICE The interior of the quadrupole chamber must stay free of any contamination. Make sure that the chamber is open only when you do work on the components inside. When you lean over the quadrupole chamber, make sure that no particles or fibers from your clothing fall into it. We recommend that you wear the bouffant cap that is shipped with the performance maintenance starter kit.

13. Loosen the four 3 mm hex screws in the corners of the quadrupole holder. See red circles and arrows in Figure 8-42. Put them on a clean, lint-free surface.

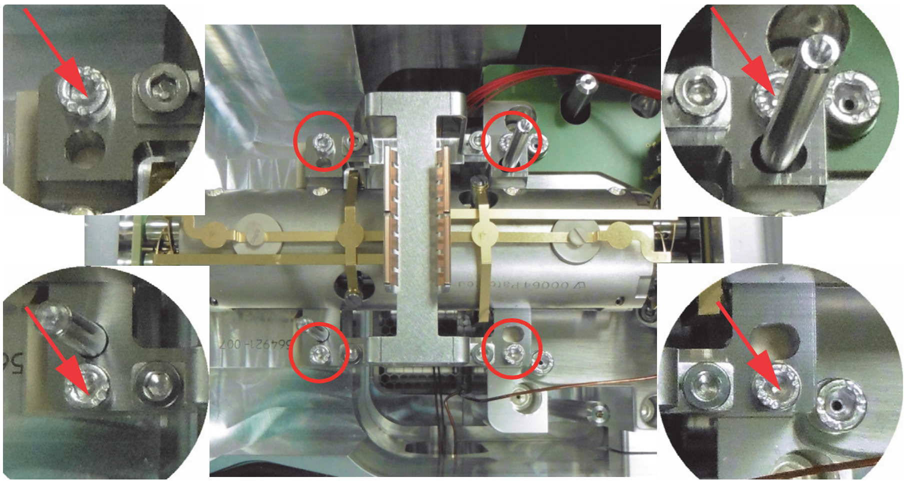
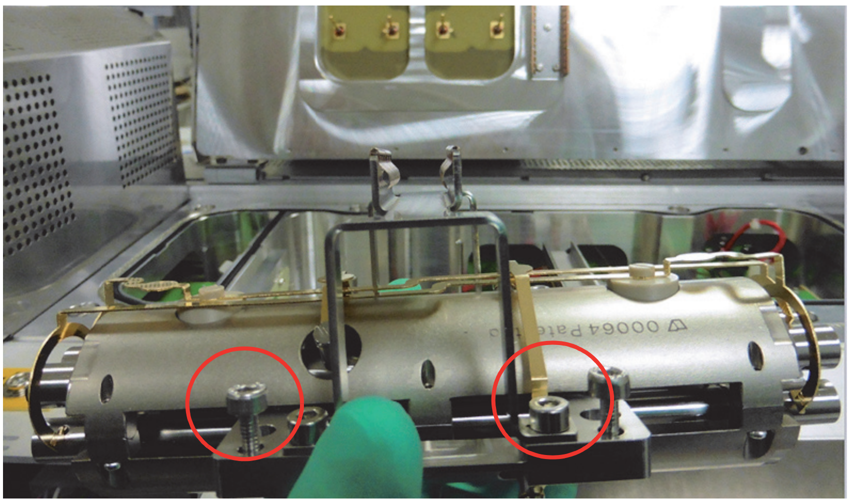


Figure 8-42. Quadrupole screws

14. The screws should be moving freely by a few millimeters, but remain in the holder. See Figure v. (The other four hex screws hold the EMC bracket on the quadrupole holder.)



❖ **Quadrupole screws**

15. Grab the quadrupole with both hands and lift the quadrupole straight up. If it does not move freely, make sure that none of the screws is still catching on the threads below.

NOTICE Do not to bump the ends of the quadrupole on any adjacent parts.

16. Put the quadrupole gently into the holder that comes with the performance maintenance starter kit.

Cleaning the Bent Flatapole

Clean the bent flatapole when you clean the quadrupole. You can remove the bent flatapole after you have removed the quadrupole.

❖ **To remove the bent flatapole**

1. Remove the quadrupole as described on page 8-47.

2. Loosen the two 4 mm hex screws that attach the metal retainer to the side wall of the analyzer chamber. The screws remain in the analyzer chamber.

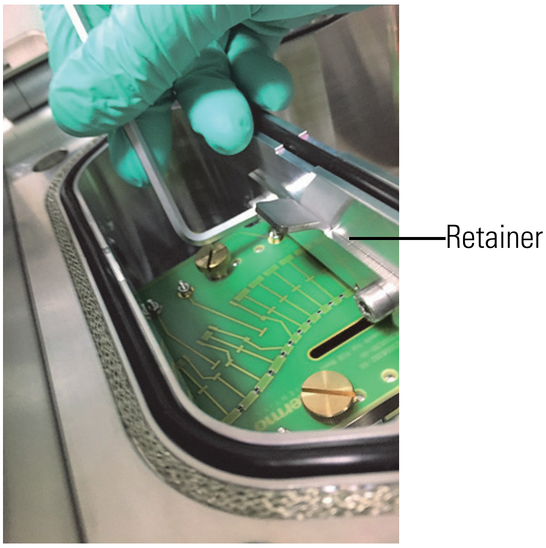


Figure 8-43. Loosening the screws of the bent flatapole

3. Remove the retainer and put it on a clean, lint-free surface.

4. Slide the complete assembly straight toward the C-trap until the metal holder of the exit lens has cleared the separation.

5. Lift up the assembly until the bent flatapole is clear of the analyzer chamber. Put it on a clean, lint-free surface.

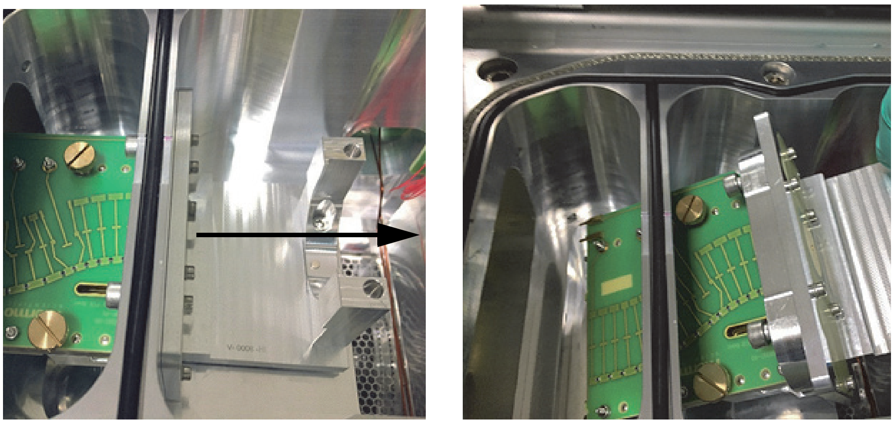


Figure 8-44. Sliding out the bent flatapole

6. Close the lid of the quadrupole chamber to prevent contamination of the chamber.

❖ To remove the bent flatapole exit lens

1. Grab the two latches at the other side of the assembly with your fingers. Pull them out slightly and turn them in opposite directions to release the metal lens and the insulator behind it. Be careful with the little holder pins below the latches.

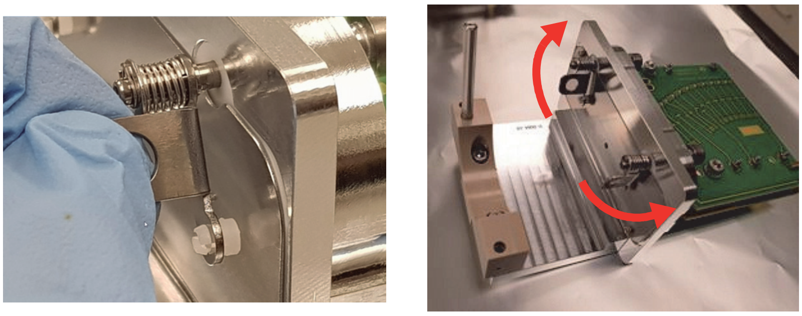


Figure 8-45. Releasing the bent flatapole exit lens

2. Grab the exit lens and pull it away from the holder. Do not to cause damage to the two metal cylinders (neutral collectors) that are attached to the other side of the lens. See Figure 8-46. Put the lens on a clean, lint-free surface.The white insulator rings will stay in place.

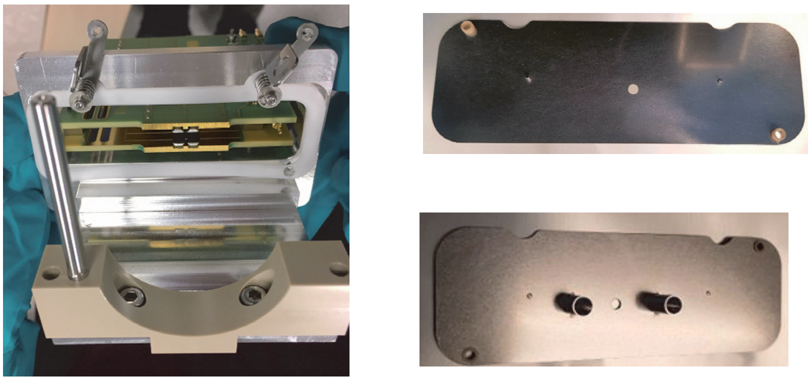


Figure 8-46. Bent flatapole exit lens

❖ To clean the quadrupole

1. Prepare the cleaning tool with isopropanol and water.

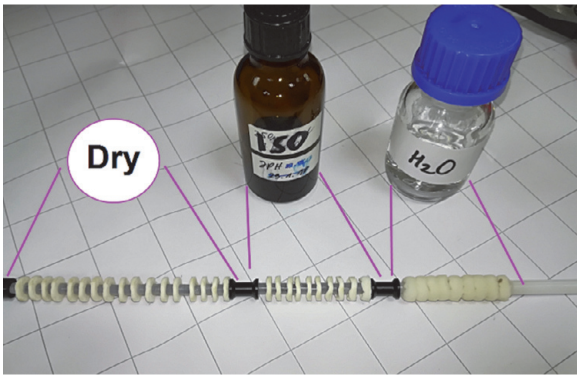


Figure 8-47. Preparing the cleaning tool

1. Mount the quadrupole in the supplied holder. The orientation is given by the blocked hole, which will not allow it to go onto the alignment bolts.
2. Make sure that you have sufficient space on the bench to pull the quad cleaning tool all the way through the quadrupole.
3. Assemble the quadrupole cleaning tool by attaching the cleaning tool to the handle.

4. Place the quadrupole cleaning tool into the holder recess.

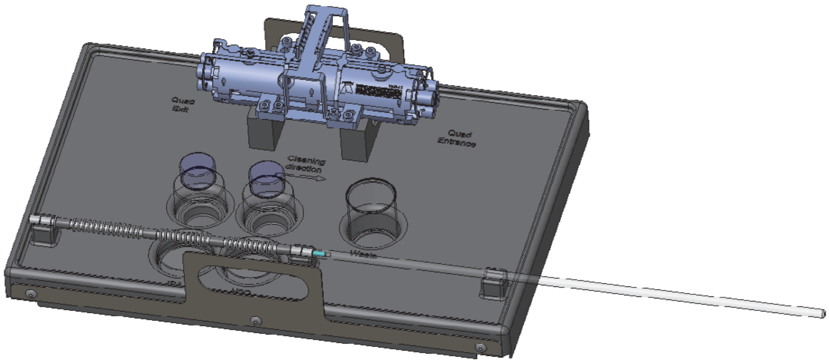


Figure 8-48. Quadrupole mounted on holder

5. Fill one drip bottle with isopropanol and the other with water. Put labels on the bottles.
6. Prepare the quadrupole cleaning tool with isopropanol and water. See Figure 8-49.
   a. Wet the first section (left) of the cleaning tool with water. Use only a few drops of water. Otherwise, the water will be pressed out of the tool and possibly drip into the quadrupole.
   b. Wet the second section (center) of the cleaning tool with isopropanol.

   Do not wet the third section (right) because this section is used for drying the quadrupole.

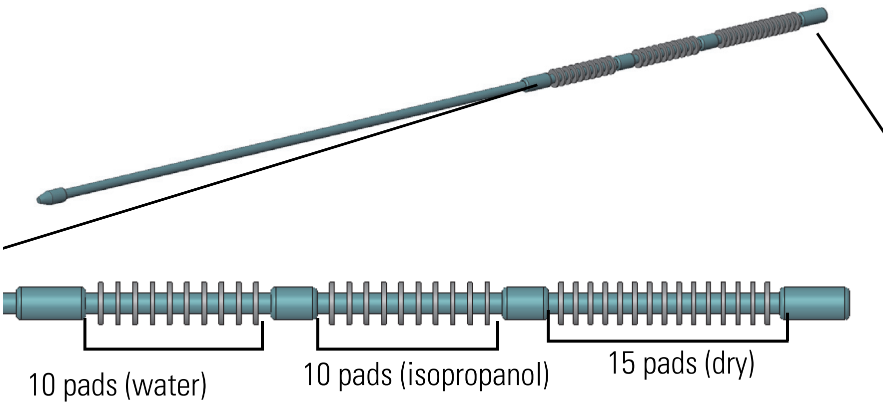


Figure 8-49. Preparing the cleaning tool

7. Insert the handle of the cleaning tool carefully into the exit side of the quadrupole until it emerges on the entrance side.

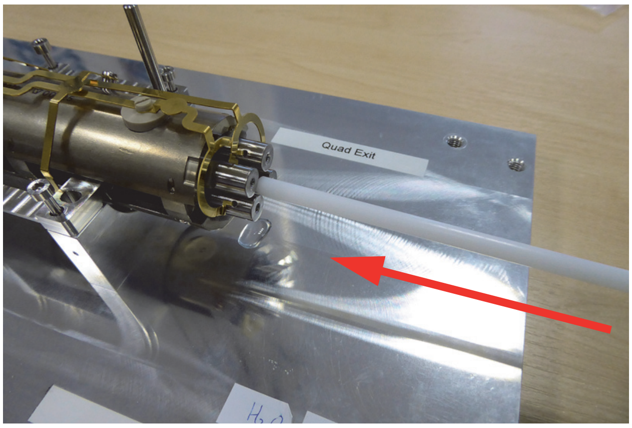


Figure 8-50. Inserting the cleaning tool

8. Grip the handle and pull the tool through completely.

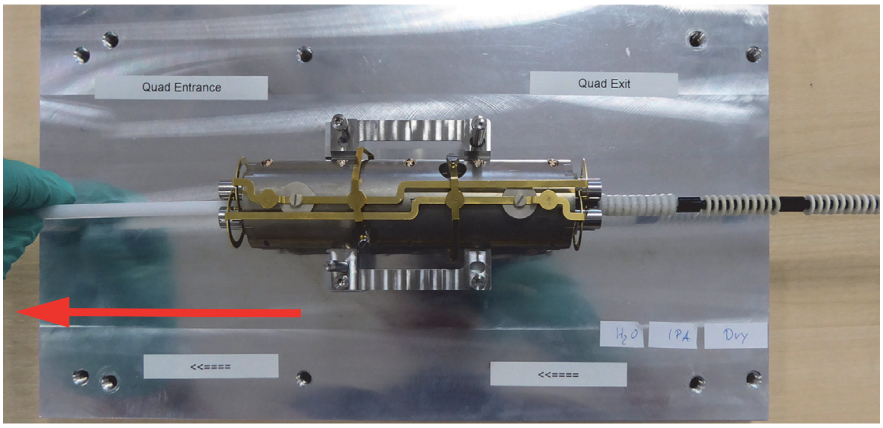


Figure 8-51. Cleaning the quadrupole

9. Repeat steps shown in Figure 8-50 and Figure 8-51 four times.

10. Dry the quadrupole with a strong stream of oil-free nitrogen gas to make sure that the solvent evaporates completely.

11. With a magnifying device, inspect the quadrupole for any lint, particulates, and sample buildup or coatings. Use plastic tweezers or a similar tool to remove lint or particulates or purge again with nitrogen.

❖ To clean the bent flatapole

Purge the component from any particles with a strong stream of oil-free nitrogen gas.

❖ To clean the bent flatapole exit lens

1. Clean the inside of the orifice with a conical swab that is soaked with a 50:50 isopropanol:water solution.

2. Clean the neutral spot with a lint-free wipe that is soaked in a 50:50 isopropanol:water solution. The spot is on the right side of one of the metal cylinders.
3. Clean the lens orifice from both sides with a lint-free wipe that is soaked in a 50:50 isopropanol:water solution.
4. Clean the lens orifice from both sides with a lint-free wipe that is soaked in 100% isopropanol.

5. Dry the component with a strong stream of oil-free nitrogen gas to make sure that the solvent evaporates completely.

Reverse the steps described in the disassembly section. Ideally, purge each ion optic with nitrogen once more before you reinstall it.

❖ To install the bent flatapole

1. If it is closed, pull up the lid of the quadrupole chamber.
2. Put on a new pair of lint- and powder-free gloves.
3. Attach the flatapole exit lens to the bent flatapole holder and turn the two latches towards each other.
4. Insert the bent flatapole back into the chamber to the left side of the quadrupole.

5. Attach the retainer with the two 4 mm hex screws.

❖ To install the quadrupole

1. Place the quadrupole straight down onto the holders.

NOTICE Do not to bump the ends of the quadrupole on any adjacent parts.

2. Make sure that the quadrupole seating is correct. Check the copper clips for a proper seating to make sure that they will not fall into the chamber.

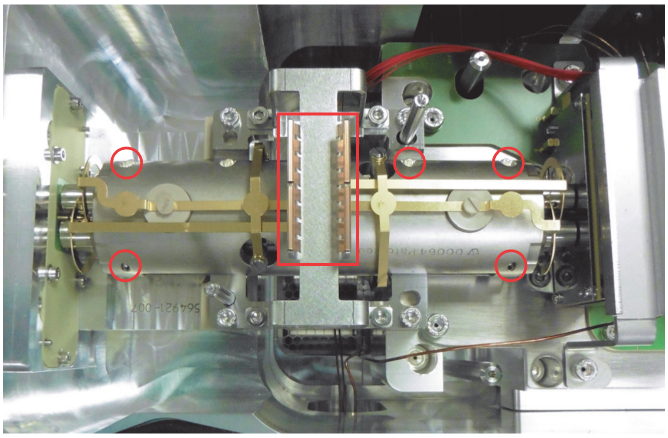


Figure 8-52. Checking the quadrupole seating

3. Tighten the four 3 mm hex screws.

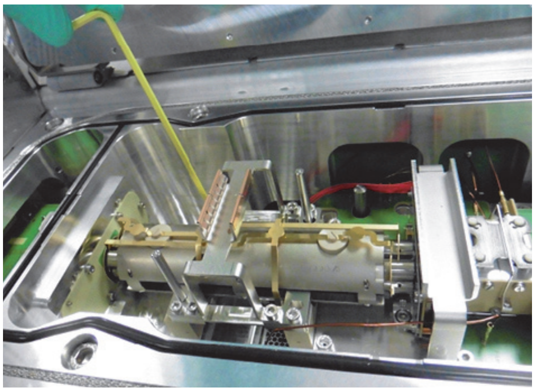


Figure 8-53. Reinstalling the quadrupole

4. Close the analyzer chamber.
   a. Make sure that there are no particles on the black sealing of the chamber lid. If necessary, remove them.
   b. Use the handle to close the chamber lid.

Occasionally the weight of the lid will not provide an immediate seal. Therefore, leave the top cover off for this stage.

❖ To restart the instrument

1. Connect the power cords of the mass spectrometer and the forepump to the power outlets.
2. Put the main power circuit breaker switch of the mass spectrometer in the On position.
3. Listen for any excessive hissing noise or pump noise that comes from the analyzer chamber. It should become quiet after a few seconds. If it does not, push gently on each corner of the analyzer lid.

NOTICE Check the source manifold glass cover. It might need to be pressed down in place.

4. Now reinstall the top cover. Insert the two guides at the back of the cover first, and then lower it down. It can be easier to do this with two persons.
5. When the top cover rests on the instrument frame, pull it toward the front side of the instrument into the correct position.
6. Tighten the five 3 mm hex screws that attach the top cover to the instrument frame. See Figure 8-39 on page 8-49.
7. Roll the GC back in place.

After the turbomolecular pump has completely spun up, the instrument should automatically start a bakeout procedure. If the bakeout has not started after 15 minutes, trigger it manually from the diagnostics section in the Tune software.

Consumables

For information on consumables such as fittings, nitrogen gas, or cleaning agents, refer to the *Orbitrap Exploris GC Pre-Installation and Orbitrap Exploris GC 240 Requirements Guide,* chapter *Consumables*.

The forepump oil is used for the cooling, the lubrication, and the sealing of the forepump. See "Maintenance of the Forepump" on page 8-10 for information about forepump oil disposal. Also refer to the Material Safety Data Sheet (MSDS) for the forepump oil.

Thermo Fisher Scientific Service

This section contains information concerning maintenance work that must be performed by Thermo Fisher Scientific personnel.

⚠ CAUTION

Hazardous Chemicals. Hazardous material might contaminate certain parts of your system during analysis. To protect our employees, we ask you to adhere to special precautions when you return parts to the factory for exchange or repair.

If hazardous materials have contaminated instrument parts, Thermo Fisher Scientific can only accept these parts for repair if they have been properly decontaminated.

Materials that due to their structure and the applied concentration might be toxic or which are reported in publications to be toxic are regarded as hazardous. Materials that will generate synergetic hazardous effects in combination with other materials present are also considered hazardous.

Parts contaminated by radioisotopes must not be returned to Thermo Fisher Scientific—neither under warranty nor within the exchange part program. If you are unsure whether parts of the system are possibly contaminated by hazardous material, make sure that the Thermo Fisher Scientific field service engineer is informed before the engineer starts to do work on the system.

Returning Parts

To protect our employees, we ask you for some special precautions when returning parts to the factory for exchange or repair.

Your signature on the Health and Safety Form confirms that the returned parts have been decontaminated and that they are free of hazardous materials. This form is available on page 10-3. Instead of copying or printing this page, request a copy from the Thermo Fisher Scientific field service engineer.

Services to be Performed by Thermo Fisher Scientific Service Only

Table 8-4 lists services that must be performed by a Thermo Fisher Scientific field service engineer only. Depending on the actual workload of your Orbitrap Exploris GC and Orbitrap Exploris GC 240 mass spectrometer, you might increase the maintenance frequency.

Table 8-4. Thermo Fisher Scientific service procedures

MS Component	Procedure	Frequency
TMP	Change operating fluid reservoir	Every four years
	Change TMP bearing	Every four years

Replaceable Parts

This chapter contains part numbers for replaceable and consumable parts for the mass spectrometer, data system, and kits. To ensure proper results in servicing the Orbitrap Exploris GC or Orbitrap Exploris GC 240 system, order only the parts listed or their equivalent.

For information on how to order parts, see "Contacting Us" on page 1-5.

Instrument Parts

GC Start Cable. 1R119378-0120
Ethernet Cable, 2 ft.. . . . . .1R76322-0602
Glass Cover, Source 1R120705-0148
Transfer Line to Source Locking Clip (3/pk) 1R120630-6207
Ferrule, Reducing 1/8 in. to 1/16 in. .1R76458-0009
Reducing Union, 1/4 in. to 1/8 in.. . . . . .1R76256-1014
Vacuum Hose. 1R76505-0750
Dual Filament 1R120404-1940
Filament Clip 1R120630-1555
Aluminum Oxide. 1R32000-60340
Performance Maintenance Starter Kit. BRE0021873
EI Ion Source Cartridge (Low Activity), includes below: . 1R120404-4100
- Ion Cartridge Sleeve. 1R120404-1105
- EI Ion Volume (Low Activity) 1R120404-4111
- Ion Volume-Repeller Insulator. .1R120404-1114
- Repeller (Low Activity) 1R120404-1161
- Ion Volume Locking Ring 1R120404-1118
- Repeller Spring (pkg of 5) 1R76485-1000K
- Repeller Nut 1R120404-1120
- Lens 3/RF Lens 1R120574-0103
- Lens 1 . . . . .1R120574-0139
- Lens 2 . . . . .1R120404-1140

CI Reagent Gas Flow Module 1R123331-0092
CI Ion Volume 1R120404-4112
CI Ion Source Cartridge Assembly .1R120404-4500
EI/CI Ion Volume 1R120404-4113
Spring Contact Assembly 1R120404-1750
Bushing in the Source Exchange Tool. 1R120406-2203
Seal in the Source Exchange Tool 1R120406-2204
Clip in the Source Exchange Tool. 1R76483-2102
Source Exchange Tool. 1R120406-2000
VPI Toolkit, which includes*: 1R120467-0003
- Source Holder 1R120471-0001
- Source Removal Tool (Small) 1R120406-2250

Source Plug 1R120589-2000
Source Plug Holder 1R120589-1050
CI Ion Volume 1R120404-4112
EI/CI Ion Volume 1R120404-4113
T10 Torxhead Key 1R3812-5T10
T20 Torxhead Key 1R3812-5T20
T30 Torxhead Key 1R3812-5T30
Forceps, 8 in. 1R76360-0008
Wrench, Open-Ended, 1/4-in., 5/16-in. 1R76360-0109
Wrench, Open-Ended, 3/8 in., 7/16-in. 1R76360-0108
Wrench, Open-Ended, 1/2-in., 9/16-in. 1R76360-0110
Wrench, Open-Ended, 1/2 in., 7/16-in. 1R76360-0111
Wrench for CI Connection 1R76360-0208

*The VPI tool kit also includes the Source Exchange Tool (P/N 1R120406-2000)

Probe Kit 1R120705-0036

Legal Documents

Contents

- FCC Compliance Statement on page 10-2
- WEEE Compliance on page 10-3
- Declaration of Conformity on page 10-5

FCC Compliance Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of the equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the receiver into an outlet on a circuit different from that to which the equipment is connected.
- Consult the dealer or an experienced radio/TV technician for help.

WEEE Compliance

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2012/19/EU. It is marked with the following symbol:

Thermo Fisher Scientific is registered with B2B Compliance (B2Bcompliance.org.uk) in the UK and with the European Recycling Platform (ERP-recycling.org) in all other countries of the European Union and in Norway.

If this product is located in Europe and you want to participate in the Thermo Fisher Scientific Business-to-Business (B2B) Recycling Program, send an email request to weee.recycle@thermofisher.com with the following information:

- WEEE product class
- Name of the manufacturer or distributor (where you purchased the product)
- Number of product pieces, and the estimated total weight and volume
- Pick-up address and contact person (include contact information)
- Appropriate pick-up time
- Declaration of decontamination, stating that all hazardous fluids or material have been removed from the product

⚠ This recycling program is not for biological hazard products or for products that have been medically contaminated. You must treat these types of products as biohazard waste and dispose of them in accordance with your local regulations.

RoHS

For information about the Restriction on Hazardous Substances (RoHS) Directive for the European Union, search for RoHS on the Thermo Fisher Scientific European language websites.

Declaration of Conformity

Thermo Fisher SCIENTIFIC

Declaration of Conformity

Manufacturer's Name:	Thermo Fisher Scientific
Manufacturer's Address:	Hanna-Kunath-Strasse 11 28199 Bremen Germany
Model Name:	**Orbitrap Exploris GC Series Mass Spectrometer**
Date:	February 2021

EMC	Safety
EN 613261:2013	IEC 61010-1:2012/R:2018-11
EN 61326-2-6:2006	CAN/CSA-C22.2 No. 61010-1:2012/A1:2018-11
FCC Part 15 Subpart B	

I, the undersigned, hereby declare that the equipment listed conforms to the l requirements of the above standards by Design as required by the European Union Low Voltage Directive (2014/35/EU) and the Restriction of Hazardous Substances Directive (2015/863/EU).

Director, Applied Research	Brody Guckenberger	
Title	*Name*	*Signature*

UK Declaration of Conformity

Manufacturer's Name:	Thermo Fisher Scientific
Manufacturer's Address:	Hanna-Kunath-Strasse 11 28199 Bremen Germany
Model Name:	**Orbitrap Exploris GC Series Mass Spectrometer**
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BS EN 613261:2013	BS EN 61010-1:2012/R:2018-11
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Director, Applied Research	Brody Guckenberger	
Title	*Name*	*Signature*

Health and Safety Form

4. Description of process substances and/or compounds

Which substances have been in contact with the material or instrumentation? (trade name and/or chemical term of service fluids and substances; properties of substances or compounds according to the Material Safety Data Sheet; e.g. toxic, flammable, corrosive, radioactive)

	Part Number	Trade Name	Chemical / Substance Name / Properties
a)			
b)			
c)			
d)			
e)			
f)			

5. Legally binding declaration

Has the material/instrument undergone a decontamination process? ☐ Yes → go to section 6 ☐ No

Is the material/instrument safe to handle for Thermo Fisher Scientific and third-party personnel? ☐ Yes ☐ No

Components, materials and/or instruments that have been contaminated to a harmful level by whatever substances and/or compounds as stated in sections 3. and 4. above will not be accepted without written evidence of proper decontamination.
I hereby declare that the instrument has undergone successfully all required decontamination procedures and is safe to handle for Thermo Fisher Scientific and/or third-party service personnel or suppliers such as Pfeiffer Vacuum, Leybold Vacuum, Edwards Vacuum products, or others.
I confirm that all information, which is supplied on this form, is accurate, complete and sufficient to judge any contamination level. I acknowledge and agree that I will be liable for any personal injury or any other damage, which might result from a false, inaccurate or incomplete statement and that I will indemnify and defend Thermo Fisher Scientific and/or any other concerned third party for and against any liabilities, claims, losses, and/or damages of all kinds arising out of and/or caused by such false, inaccurate or incomplete statements.
Thermo Fisher Scientific reserves the right not to process refunds or returns where the declared or observed use or previous contamination of the product/material has by Thermo Fisher Scientific judgement impacted its integrity.

6. Detailed description of the decontamination process used

Part Number	Serial Number	Describe the decontamination process

Return Number	Name of authorized person (block letters)	Date	Signature	Company stamp

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