thermo scientific

FAIMS Pro System

User Guide

High-Field Asymmetric Waveform Ion Mobility Spectrometry System

98100-97000 Revision A • January 2019

DOCUMENTATION SURVEY

ThermoFisher SCIENTIFIC

Release history: Rev A, January 2019

Software version: (Thermo) Foundation 3.1 SP5 and later, Xcalibur 4.2 and later, Tune 3.1 and later

For Research Use Only. Not for use in diagnostic procedures.

thermoscientific

Regulatory Compliance

Thermo Fisher Scientific performs complete testing and evaluation of its products to ensure full compliance with applicable North American and European regulations. Your system meets the applicable requirements in the electromagnetic compatibility (EMC) and product safety standards described in this section.

Unauthorized changes that you make to your system will void regulatory compliance and may defeat the built-in protections for your instrument. Some examples of unauthorized changes include using replacement parts or adding components, options, or peripherals that Thermo Fisher Scientific has not qualified and authorized. Unauthorized changes can also result in bodily injury and/or damage to your system and laboratory.

Ensure continued compliance with regulatory standards:

- Follow all installation instructions provided in the documentation that comes with your system.
- Order replacement parts (as specified in the instrument manual) and additional components, options, and peripherals directly from Thermo Fisher Scientific or an authorized representative.

Low Voltage Directive 2014/35/EU

This device complies with Low Voltage Directive 2014/35/EU and the safety standards EN 61010-1:2010, UL 61010–1:2012, CAN/CSA 22.2 61010-1-12; EN 61010-2-010:2014, UL 61010-010:2015, CAN/CSA 22.2 61010-2-010:2015.

EMC Directive 2014/30/EU

This device was tested by TÜV Rheinland of North America and complies with the following EMC standards:

47 CFR 15, Subpart B, Class A: 2015	EN 55011:2009 + A1	EN 61000-4-4: 2012
CISPR11: 2009 + A1	IEC/EN 61326-1: 2013	EN 61000-4-5: 2014
ICES-003 Issue 6: 2016	IEC 61000-3-2: 2014	EN 61000-4-6: 2014
AS/NZS CISPR22: 2009	IEC/EN 61000-3-3: 2013	IEC/EN 61000-4-11: 2004 / ISH1:2010
AS/NZS CISPR32: 2015	IEC/EN 61000-4-2	
VCCI CISPR 32: 2015	IEC 61000-4-3: 2006 + A2	

FCC Compliance Statement

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS: (1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRED OPERATION.

thermoscientific

CAUTION Read and understand the various precautionary notes, signs, and symbols contained inside this manual pertaining to the safe use and operation of this product before using the device.

Notice on Lifting and Handling of Thermo Scientific Instruments

For your safety, and in compliance with international regulations, the physical handling of this Thermo Fisher Scientific instrument ***requires a team effort*** to lift and/or move the instrument. This instrument is too heavy and/or bulky for one person alone to handle safely.

Notice on the Proper Use of Thermo Scientific Instruments

In compliance with international regulations: This instrument must be used in the manner specified by Thermo Fisher Scientific to ensure protections provided by the instrument are not impaired. Deviations from specified instructions on the proper use of the instrument include changes to the system and part replacement. Accordingly, order replacement parts from Thermo Fisher Scientific or one of its authorized representatives.

thermo scientific

WEEE Directive

2012/19/EU

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

For additional information about the Restriction on Hazardous Substances (RoHS) Directive for the European Union, search for RoHS on the Thermo Fisher Scientific European language websites.

IMPORTANT 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.

Contents

Figures

Preface

The *FAIMS Pro System User Guide* contains the installation instructions, descriptions of the primary components, and maintenance procedures for the Thermo Scientific™ FAIMS Pro™ system, which is a high-field asymmetric waveform ion mobility spectrometry (FAIMS) system. To ensure a compatible setup, see Compatible Mass Spectrometers and API Sources.

Also, because this guide uses drawings of various connections and component parts to help illustrate procedures, be sure to start from 1, no matter where it appears.

Contents

Accessing Documentation

The FAIMS Pro system includes complete documentation.

For mass spectrometer (MS) requirements, refer to the release notes on the software DVD.

Viewing the Product Manuals

The Thermo Fisher Scientific™ service engineer installs the instrument control applications and the instrument manuals on the data system computer.

❖ **To view the product manuals**

From the Microsoft™ Windows™ taskbar, choose **Start > All Apps** (Windows 10) or **All Programs** (Windows 7) **> Thermo Instruments >** ***model x.x***, and then open the applicable PDF file.

Accessing the Help Menu Options

Follow this procedure to view the Help systems for the instrument-control applications.

❖ **To view the Help**

Do the following as applicable:

- Thermo Tune instrument-control application: Click the **Options** icon,  , and choose **Tune Help**.
- Thermo Xcalibur™ Method Editor application: Choose an option from the **Help** menu (or press the F1 key).

Viewing Online User Documentation

Visit the Thermo Fisher Scientific website for product manuals and more.

❖ **To view user documentation from the Thermo Fisher Scientific website**

1. Go to thermofisher.com.
2. Point to **Services & Support,** and click **Manuals** on the left.
3. In the Refine Your Search box, search by the product name.
4. From the results list, click the title to open the document in your web browser, save it, or print it.

   To return to the document list, click the browser **Back** button.

Providing Documentation Feedback

❖ **To suggest changes to the documentation or to the Help**

Complete a brief survey about this document by clicking the button below. Thank you in advance for your help.

Compatible Mass Spectrometers and API Sources

Use the FAIMS Pro system with the appropriate Thermo Scientific MS and ion source for nanoelectrospray (commonly referred to as nanoES or nanospray™) analysis. Table 1 lists several compatible MSs. For information about your specific system, refer to the product manuals.

CAUTION If you connect the FAIMS Pro system to another type of MS, you might impair the safety protection provided by the equipment.

Table 1. Compatible Thermo Scientific ion sources and mass spectrometers

Ion source models	Mass spectrometer models
• EASY-Spray NG™	• Orbitrap™ Tribrid™ Series[a]
• Nanospray Flex NG™	• TSQ™ Series II

[a] In 2019, the name “Orbitrap Fusion™ Series” changed to “Orbitrap Tribrid Series.”

Special Notices, Symbols, and Cautions

Make sure you understand the special notices, symbols, and caution labels in this guide. Most of the special notices and cautions appear in boxes; those pertaining to safety also have corresponding symbols. Some symbols are also marked on the instrument itself and can appear in color or in black and white. For complete definitions, see Table 2.

Table 2. Notices, symbols, labels, and their meanings (Sheet 1 of 2)

Notice, symbol, or label	Meaning
IMPORTANT	Highlights information necessary to prevent damage to software, loss of data, or invalid test results; or might contain information that is critical for optimal performance of the product.
Note	Highlights information of general interest.
Tip	Highlights helpful information that can make a task easier.
	**Caution:** Read the cautionary information associated with this task.
	**Chemical hazard:** Observe safe laboratory practices and procedures when handling chemicals. Only work with volatile chemicals under a fume or exhaust hood. Wear gloves and other protective equipment, as appropriate, when handling toxic, carcinogenic, mutagenic, corrosive, or irritant chemicals. Use approved containers and proper procedures to dispose of waste oil and when handling wetted parts of the instrument.
	**Hot surface:** Allow any heated components to cool before touching them.
	**Risk of electric shock:** This instrument uses voltages that can cause electric shock and personal injury. Before servicing the instrument, shut it down and disconnect it from line power. While operating the instrument, keep covers on.
	**Risk of eye injury:** Eye injury can occur from splattered chemicals, airborne particles, or sharp objects. Wear safety glasses when handling chemicals or servicing the instrument.

Table 2. Notices, symbols, labels, and their meanings (Sheet 2 of 2)

Notice, symbol, or label	Meaning
	**Sharp object:** Avoid handling the tip of the syringe needle.
	**Trip obstacle:** Be aware of cords, hoses, or other objects located on the floor.

Safety Precautions

Read and understand the following cautions that are specific to the shutdown of the MS system or to the removal of parts for cleaning.

CAUTION If you must turn off the MS in an emergency, turn off the main power switch located on the right-side power panel. This switch turns off all power to the MS, including the forepump, without harming components within the system. However, do not use this method as part of the standard shutdown procedure. Instead, see Shutting Down the LC/MS/FAIMS Pro System. To turn off the LC, autosampler, and data system computer in an emergency, use their respective on/off switch or button.

CAUTION To avoid an electrical shock, be sure to follow the instructions in Shutting Down the LC/MS/FAIMS Pro System.

CAUTION Do not turn the MS on if you suspect that it has incurred any kind of electrical damage. Instead, disconnect the power cord and contact Thermo Fisher Scientific technical support for a product evaluation. Do not attempt to use the MS 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.)

CAUTION The FAIMS Pro system must connect to a certified Thermo Scientific MS, which supplies high voltage capable of delivering a maximum of 8 kV and 100 µA. If you connect the FAIMS Pro system to another type of MS, you might impair the protection provided by the equipment.

CAUTION Do not place any objects (for example, containers with liquids) on top of the MS, unless instructed to in the documentation. Leaking liquids might contact the electronic components and cause an electrical short circuit.

CAUTION Do not perform any servicing other than that contained in this manual. To avoid personal injury or damage to the FAIMS Pro system, do not perform any servicing other than that contained in this manual or related manuals unless you are qualified to do so.

CAUTION Do not disconnect the power cords at the MS or MCB while the other ends are still plugged into the electrical outlet.

Risk of electric shock: The FAIMS Pro system must be properly earthed through a supply outlet that has an earthing connection. If you are not sure, check with a qualified electrician.

CAUTION Allow heated components to cool to room temperature (approximately 20 minutes) before servicing them.

Contacting Us

Contact	Email	Telephone	QR Code[a]
U.S. Technical Support	us.techsupport.analyze@thermofisher.com	(U.S.) 1 (800) 532-4752	
U.S. Customer Service and Sales	us.customer-support.analyze@thermofisher.com	(U.S.) 1 (800) 532-4752	
Global Support	❖ **To find global contact information or customize your request** 1. Go to thermofisher.com. 2. Click **Contact Us**, select the country, and then select the type of support you need. 3. At the prompt, type the product name. 4. Use the phone number or complete the online form. ❖ **To find product support, knowledge bases, and resources** Go to thermofisher.com/us/en/home/technical-resources. ❖ **To find product information** Go to thermofisher.com/us/en/home/brands/thermo-scientific.		

Note To provide feedback for this document, go to surveymonkey.com/s/PQM6P62 or send an email message to Technical Publications (techpubs-lcms@thermofisher.com).

[a] You can use your smartphone to scan a QR Code, which opens your email application or browser.

1

FAIMS Theory

Contents

What is FAIMS Technology

FAIMS is an acronym for high-**F**ield **A**symmetric waveform **I**on **M**obility **S**pectrometry, a technology used in conjunction with Thermo Fisher Scientific mass spectrometers and provides additional selectivity that is often required in challenging LC/MS/MS experiments. FAIMS is an ion separation technique based on differences in an ion's mobility at low and high electric fields between two electrodes. This technique lets selected ions pass from the ion source to the mass spectrometer for improved selectivity (signal-to-noise ratio), improved detection limits, and increased throughput.

FAIMS Value Points

The following are improved features provided using FAIMS with MS.

- Improve signal-to-noise ratio by limiting chemical noise/interferences from entering the MS
- Improve signal-to-noise ratio by transmitting more homogeneous population of ions to the MS
- Improve Limits of Detection (LOD) and Limits of Quantitation (LOQ)
- Increase throughput by shortening/eliminating chromatography
- Improve data quality for peptide ID
- Separate exact mass isomers (lipids, phosphopeptides)

Supported FAIMS Platforms

The following Thermo Fisher Scientific MS series are supported for FAIMS.

- TSQ Quantiva™
- TSQ Endura™
- TSQ Altis™
- TSQ Quantis™
- Tribrid Oribitrap Fusion™
- Tribrid Orbitrap Lumos™ Fusion™

The following Thermo Fisher Scientific ion sources are supported for FAIMS.

- NanoSpray Flex™ Series
- Easy-Spray™ Series

Figure 1 shows the FAIMS Pro assembly, and Figure 2 shows a FAIMS Pro system attached to an Oribtap Lumos.

Figure 1. FAIMS Assembly

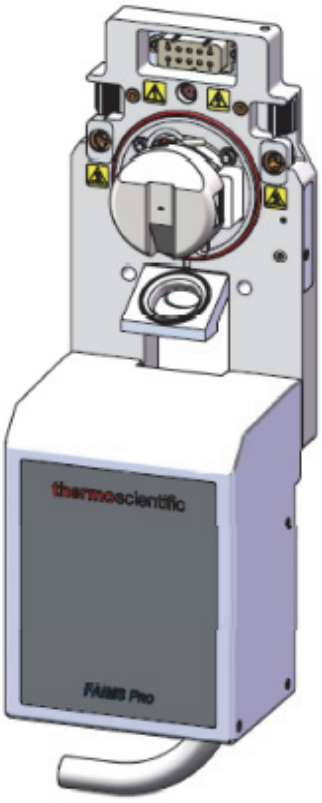


Figure 2. FAIMS Pro and Obritrap Lumos

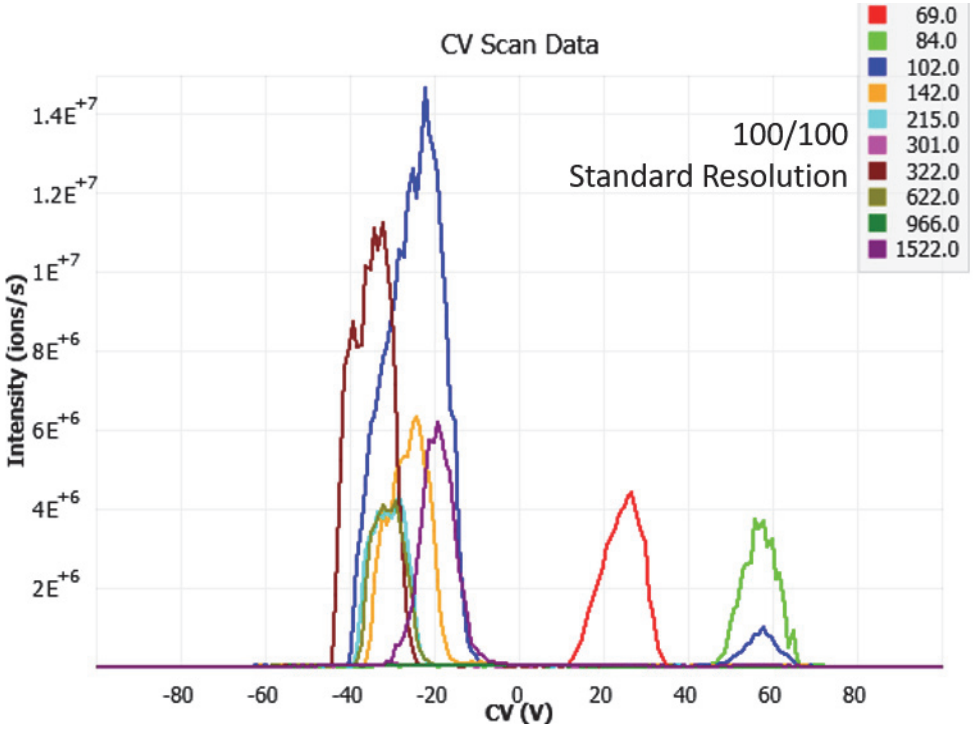
Standard-Resolution and High-Resolution Modes

The inner and outer electrode temperature has a significant role in determining FAIMS field strength. Both cylindrical electrodes can be independently temperature controlled to change the magnitude of the FAIMS field (E) in a gas of density (N) between the electrodes. The user has three types of resolution modes - Standard Resolution, High Resolution, and a User-Defined mode of temperature differential. The Standard Resolution mode offers improved sensitivity, the High Resolution mode offers improved resolution without changing DV or hardware, and the User-Defined mode has user-defined temperatures. The electrode temperature affects separation and transmission.

Standard Resolution Mode

In Standard Resolution mode (Figure 3), the temperature is set at inner electrode (100 °C) and outer electrode (100 °C). The separation of ions results in sensitivity improvement in wider CV peaks and larger relative peak intensity.

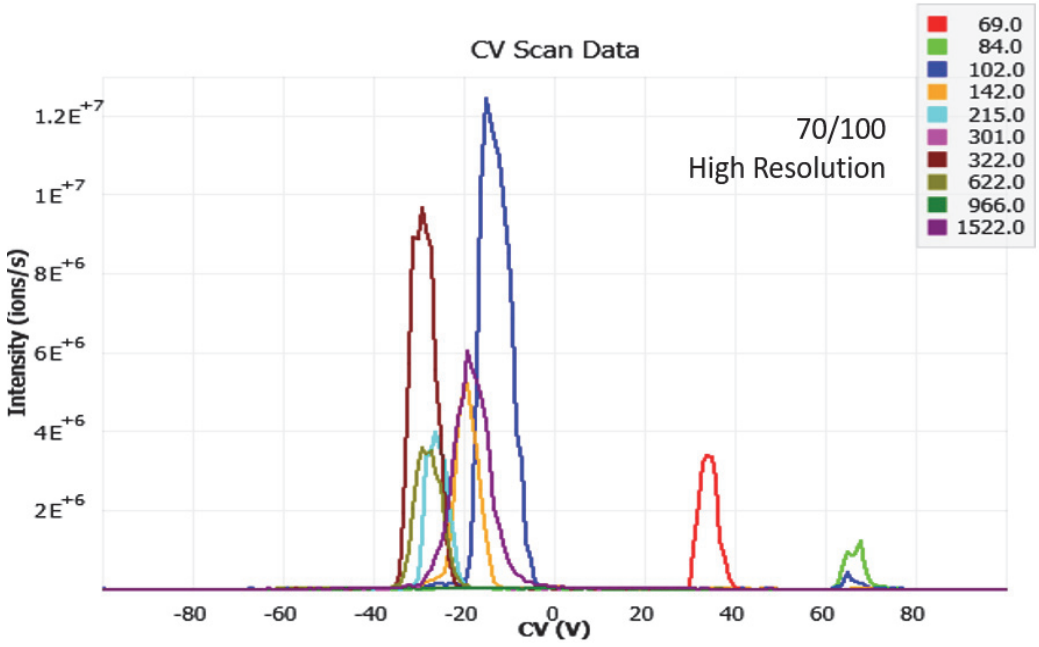
Figure 3. Standard Resolution Mode Example



High Resolution Mode

In High Resolution Mode (Figure 4), the temperature is set at inner electrode (70 °C) and outer electrode (100 °C). The separation of ions in this mode results in improved resolution with narrower CV peaks and lower relative peak intensity.

Figure 4. High Resolution Mode Example



Additional Available Modes

- Off: Voltages off (transmission of all ions through the device)
- User Defined: Electrode temperature can be defined by the user

2

FAIMS Operation

Contents

Selection of Ions

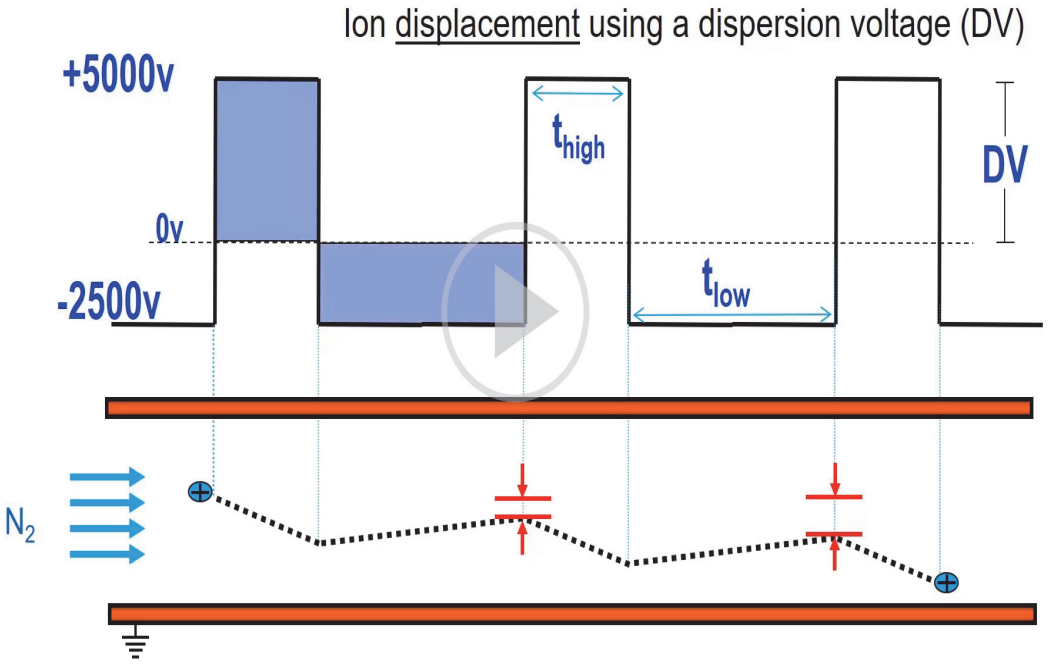
The FAIMS system continuously selects and focuses ions at atmospheric pressure by using changes that occur in ion behavior when exposed to high electric fields.

At low field strengths, an ion's mobility is independent of the applied electric field. However, in high electric fields (for example, greater than 2.5 KV/cm) the mobility of an ion changes with electric field strength. These compound-dependent changes in the mobility of an ion at high field relative to low field provide ion selectivity within the FAIMS interface.

The FAIMS system applies alternating high and low electric fields to the electrode set. Alternating electric fields are supplied through a waveform generator that produces an asymmetric waveform. This asymmetric waveform applies a high electric field between the electrodes for a short period of time and, then applies a lower electric field for a longer time. The amplitude of the waveform is called the dispersion voltage or DV.

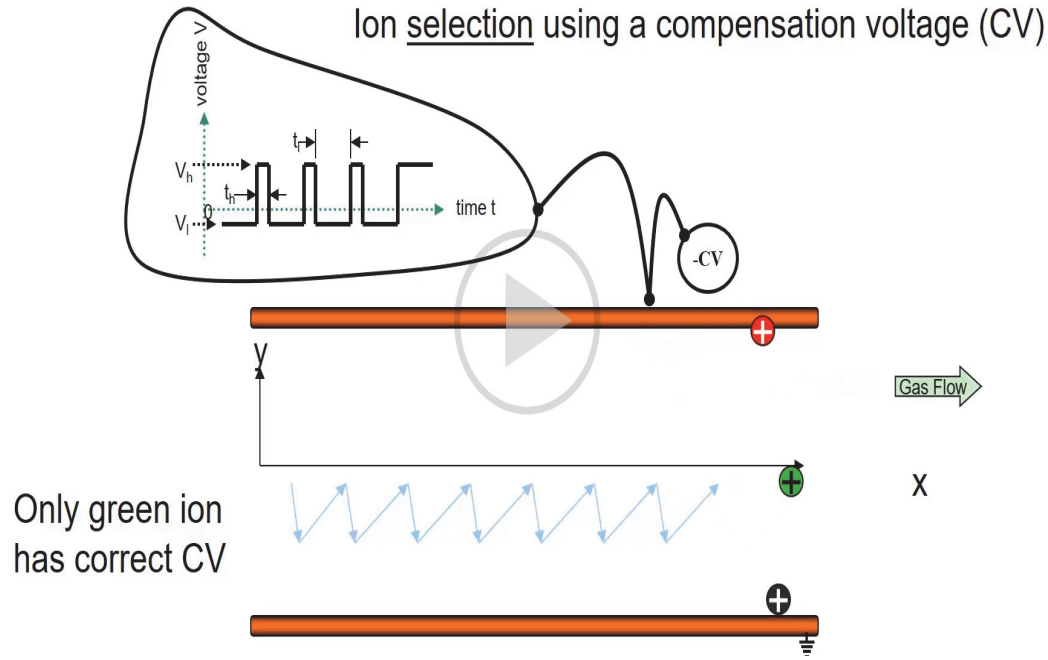
The FAIMS system introduces desolvated ions into the mass spectrometer by a flow of gas, called the carrier gas. The ions move radially between the electrodes as the result of the applied asymmetric waveform. Because the ion mobility during the application of the DV is different from the ion mobility during the low-voltage portion of the waveform, ions begin to drift toward one of the two electrodes. As shown in Figure 5, if an ion reaches an electrode surface, it is discharged and neutralized.

Figure 5. Animation: FAIMS effect showing ion drift (parallel plate example)



To prevent an ion from being discharged, the FAIMS system applies a small DC potential, called the compensation voltage (CV), to the inner electrode (Figure 6). The CV compensates for the ion drift that is the result of the applied asymmetric waveform.

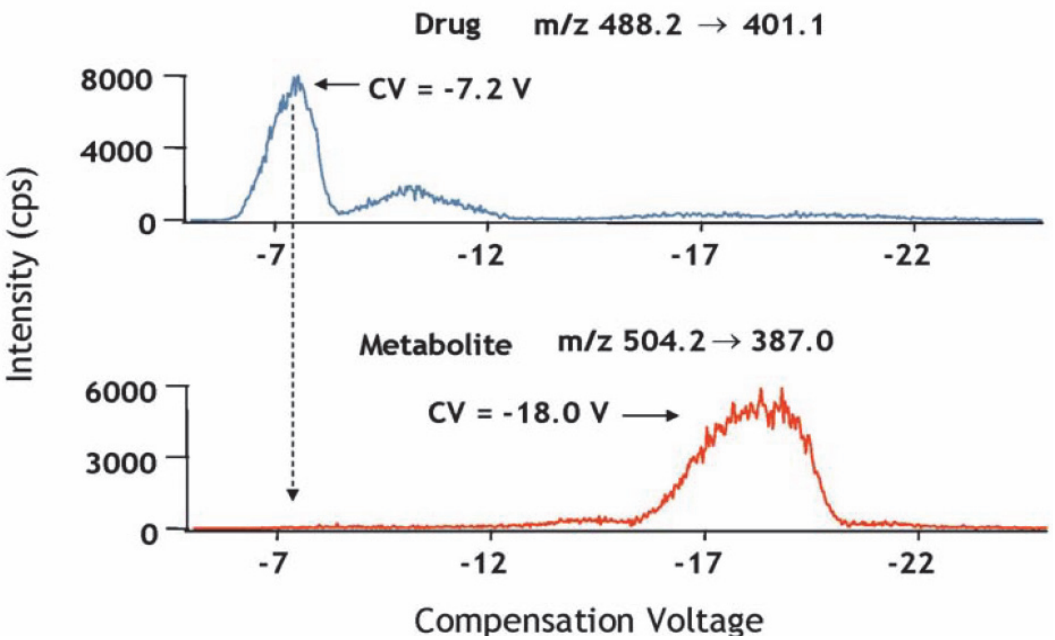
Figure 6. Animation: FAIMS effect with CV showing ion transmission (parallel plate example)



The CV required to compensate for drift is ion dependent. Therefore, the CV is a selection parameter for transmitting a subset of ions to the mass spectrometer.

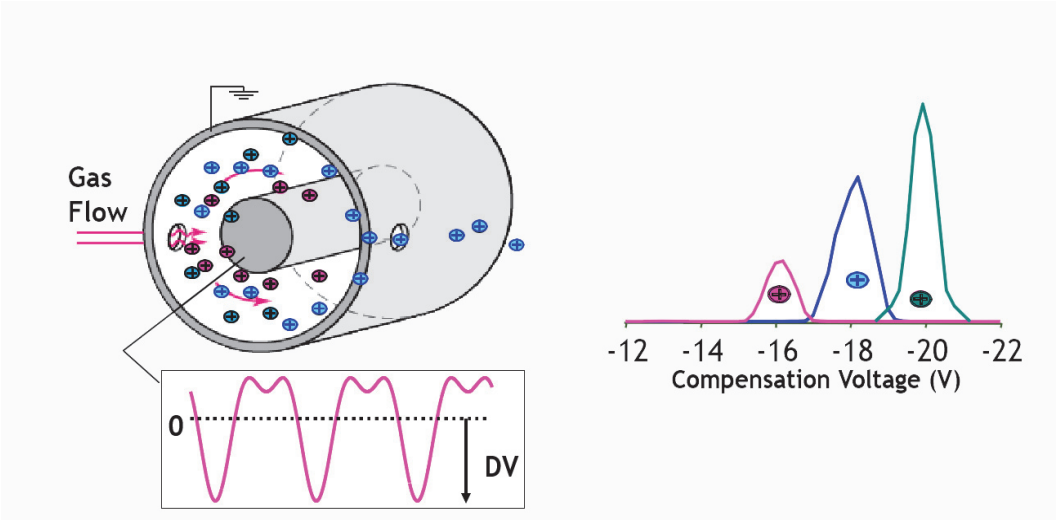
Figure 7 shows the ion signal intensity versus the CV for a drug and its metabolite. The drug and metabolite can be separated because the metabolite does not contribute any signal at the drug's monitored CV.

Figure 7. FAIMS-MS/MS selection of drug and metabolite



The summation of DV and CV electric fields separates the ions for the mass spectrometer. Figure 8 describes the combined effect with the resulting ion separation and focus of the blue ions within the region of cylindrical electrodes.

Figure 8. Gas flow with ions in the cylindrical electrodes



FAIMS Pro Instrument-Control Parameters

During an experiment, the Xcalibur data system manages the voltages, gas flow rate, and temperature settings in effect for FAIMS separations. These parameters can be constant for the duration of an experiment, or you can change these at predefined intervals over the coarse of the experiment.

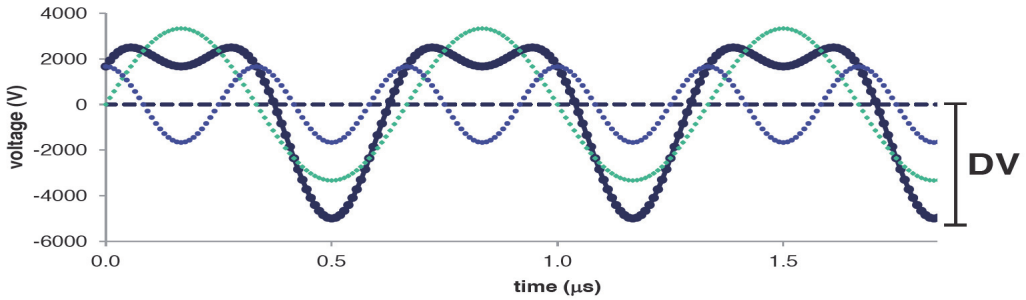
Note When you turn on the MS, the firmware checks for the FAIMS Pro attachment by sending commands to the FAIMS waveform generator. If the instrument receives valid responses to these commands, the firmware assumes that FAIMS is currently attached to the mass spectrometer. When attached, the FAIMS parameters appears in the Tune application and Method Editor in the Instrument Setup application of the data system Xcalibur.

Dispersion Voltage

DV is the peak potential of the asymmetric waveform. As the DV increases, the CV tends to increases as does the ion intensity. The DV is automatically set to its maximum value of –5000 for positive ions and +5000V for negative ions. For FAIMS, the DV is predefined and not user-defined.

An example ideal FAIMS waveform is shown in Figure 9 (dark blue). It was produced by summing two sine waves, one with an high field amplitude (HF) of 1.67KV at 3 MHz (blue) and the other ninety degrees out of phase with an low field amplitude (LF) of 3.33KV at 1.5 MHz (green). The resulting waveform is asymmetric (2.5KV to –5.0KV). The DV is the amplitude of the high field component of the waveform (–5.0KV).

Figure 9. Example ideal FAIMS waveform



Compensation Voltage

CV is the DC potential offset that is applied to the inner electrode to transmit selected subsets of ions through the electrodes. The CV is typically negative for positive ions and positive for negative ions. The CV is tuned for a specific ion.

Electrode Temperatures

Temperature can affect ion selection by changing the gas density within the electrodes. Temperature control enables stable conditions to be reached quickly and maintained indefinitely. The electrodes must be temperature controlled, otherwise the CV changes during system equilibration. The inner and outer electrode temperatures are adjusted independently. They are controlled by nitrogen flowing past the electrodes. The temperature differential between the inner and outer electrodes is used to enhance selectivity. Standard default temperature settings are 100 °C for the inner electrode and 100 °C for the outer electrode.

Note If the inner electrode temperature is lower than the outer electrode temperature, then intensity decreases as the difference in temperature between electrodes increases. If the inner electrode temperature is higher than the outer electrode temperature, then intensity tends to increase as the difference in temperature between the electrodes increase.

Carrier Gas Flow Rate

The carrier gas flow rate is determined by the mass spectrometer type and is automatically set. To add more gas, you can adjust the FAIMS User Gas setting in Tune. This adds a user-defining flow rate of nitrogen to the carrier gas flow rate. The optimal carrier gas flow rate is between 0 and 5 L/min. If the carrier gas flow rate is set too low, the arriving ions are not well desolvated. In such cases, one of several observations might be made:

- There are several peaks in the CV spectrum for a particular *m/z* value. These might arise from variously solvated species.
- The transmission CV differs from a previously observed value for a particular ion.
- The ion signal intensity is lower.

- The CV required for the transmission of solvated species is different 0for desolvated ions.

A carrier gas flow rate that is set too high can cause turbulence in front of the entrance plate. When this occurs, the ion intensities decrease from the optimal value, but the CV of transmission remains unchanged.

Readback Measurements

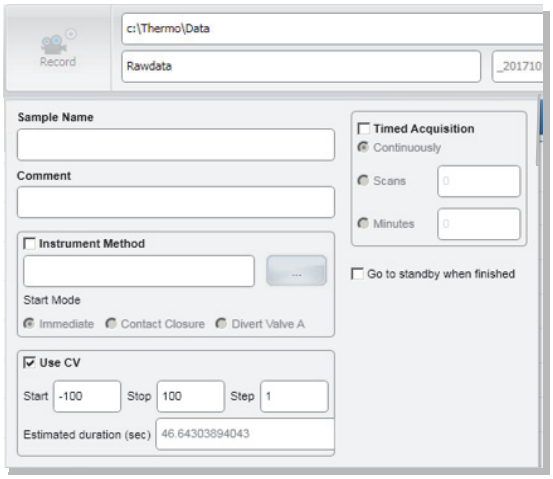
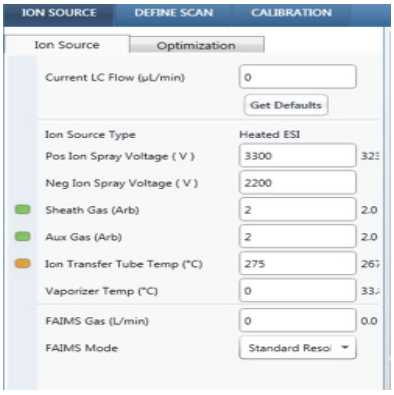
The readback measurements for the FAIMS parameters are on the Tune status panel and in the raw data file. The following parameters are available to the user:

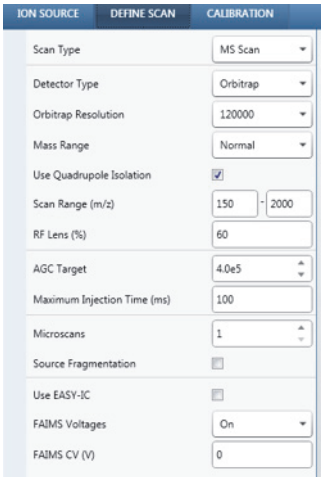
- CV value
- DV value
- Entrance Plate voltage
- FAIMS Gas flow
- Cooling gas flow
- Inner electrode temperature
- Outer electrode temperature by heater 1 and heater 2

Configuring the System Parameters

The Tune application controls the FAIMS Pro System parameters and displays the status.

Table 3. Tune FAIMS parameters

Parameter	Description
Data Acquisition Settings pane	
Enable FAIMS CV Scan	(NSI mode with the optional FAIMS Pro™ system) Indicates the use and configuration of the FAIMS compensation voltage (CV) scan tool. The Start and Stop values define the FAIMS CV range. The Step value defines the step size in volts within the range. The Estimated Duration read-only value counts down the estimated completion time (in seconds) for the CV scan. Range (start/stop): –300 to 300; default: –100 to 100 Range (step): 0.1–2; default: 1
Ion Source page	

Parameter	Description
FAIMS Gas (L/min)	The flow rate for the FAIMS nitrogen gas. Range: 0–5; default: 0
FAIMS Mode	The temperatures for the FAIMS electrodes are as follows: • Standard Resolution: Provides the best transmission mode by setting the inner and outer electrodes to 100 °C. • High Resolution: Provides twice the resolution of the standard resolution mode by setting the inner electrode to 70 °C and the outer electrode to 100 °C. • User Defined: Displays the fields to enter the electrode temperatures. **Note** The electrode temperatures affect ion separation. Although ion transmission might be lower in FAIMS high resolution mode, the peaks are narrower due to the electrodes' temperature differential.
FAIMS Inner Electrode Temp (°C)	(User Defined mode) The maximum temperature for the inner electrode in the FAIMS Pro system. Range: 70–100; default: 100
FAIMS Outer Electrode Temp (°C)	(User Defined mode) The maximum temperature for the outer electrode in the FAIMS Pro system. Range: 70–100; default: 100
Define Scan pane	
FAIMS Voltages	Turns on or off the FAIMS compensation voltage and dispersion voltage (DV). Default: Off
FAIMS CV (V)	The FAIMS compensation voltage allows a subset of ions to pass through the FAIMS electrodes. Range: –300 to 300; default: 0

Calibration Solutions and Procedures

You must complete the calibration for the MS without the FAIMS attached and with the calibration solutions in Consumable Parts. For procedures to calibrate the MS, refer to the *TSQ Series Hardware Manual* or *Obritrap Tribrid Series Hardware Manual*.

FAIMS Component On/Off Status Under Varying Power Conditions

Table 4 summarizes the on/off status of the FAIMS system components, voltages, and API gas flows. For information about the MS components, refer to the appropriate instrument manual.

Table 4. On/off status of FAIMS system components, voltages, and API gas flows

FAIMS system components	FAIMS system MCB power switch, Off (0) position	MS standby mode 	MS off mode 	MS electronics service switch, Service Mode position	Power switch, Off (0) position
Compensation voltage, electrodes	Off	Off	Off	Off	Off
Dispersion voltage, electrodes					
High-voltage, MCB			On	On	On
Cooling gas, MCB		On	Off	Off	Off
FAIMS gas, MCB					
Temperatures, electrodes					
Cooling fan, RF transformer box			On	On	On
Power supply, MCB					

Functional Description

Contents

Main Controller Box

The main controller box (MCB) provides power and control signals to the RF Transformer Box. The MCB interfaces with the MS for analysis of the ion stream and provides readback measurements to the MS. Figure 10 shows the LEDs on the front of the MCB, and Table 5 describes their function.

Figure 10. LEDs on the MCB front

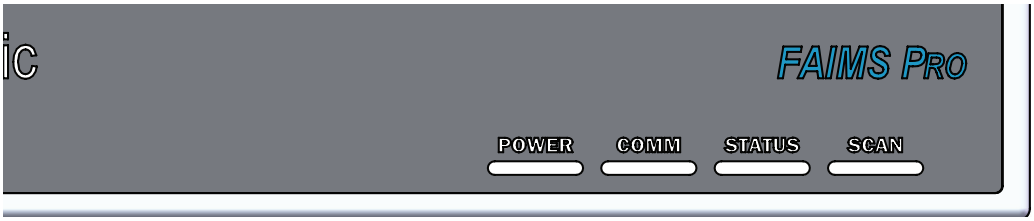


Table 5. LED indicator descriptions

LED indicator	Active LED description
Power	Power from the power supply is on.
Comm	Communication is in progress with the MS through the Instrument Manager.

Table 5. LED indicator descriptions

LED indicator	Active LED description
Status	Status is Ready with no errors from the FAIMS.
Scan	Dispersion Voltage is on. • Left LED: Low Field is on • Right LED: High Field is on • Center LED: Both High Field and Low Field are on

Figure 11 shows the interconnect on the rear of the main controller box, and Table 6 describes their function.

Figure 11. Interconnect on the MCB rear

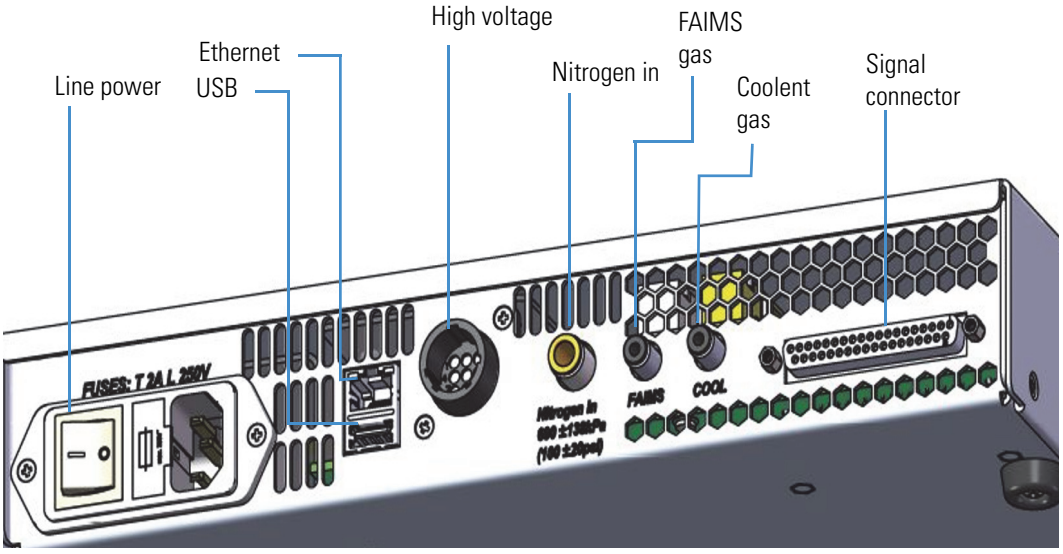


Table 6. Interconnect description

Connection	Direction	Description
Line Power	In	Line power 100 - 240VAC.
Ethernet	In/Out	Connection to PC.
USB	In/Out	Reserved for future use.
High Voltage	Out	High Voltage for the FAIM.
Nitrogen In	In	Nitrogen source for carrier and cooling gas.
FAIMS	Out	Carrier gas for the FAIMS.

Table 6. Interconnect description

Connection	Direction	Description
COOL	Out	Cooling gas for the FAIMS.
Signal Connector	In/Out	37-pin D connector for controlling the FAIMS and for readbacks.

Note For information about the MCB fuse, see Chapter 10, "Specifications."

Note The MCB's USB port is reserved for future use.

Housing Adapter and RF Transformer Box

The housing adapter provides the following features.

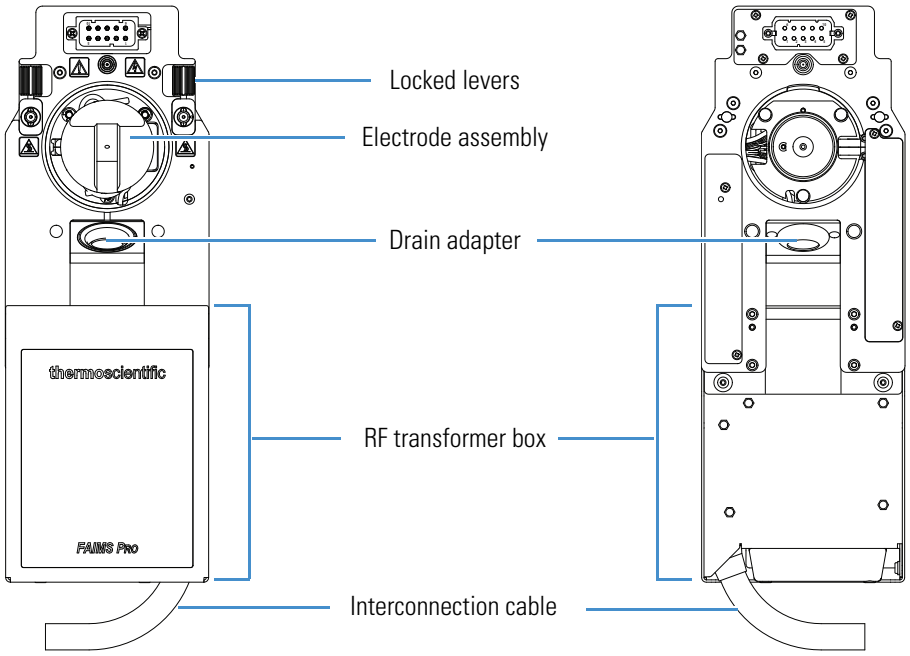
- Spacing for the ion path through the electrode assembly
- A mount to the MS
- A mount for the electrode assembly
- A mount for the Ion Source
- Creates a cable and gas feed through from the RF transformer box

The RF transformer box has the following features.

- Provides RF sample feedback from the FAIMS housing adapter /electrodes to the MCB
- Delivers high voltage DC for the electrodes
- Creates the FAIMS waveform for CV and DV

Figure 12 shows the front and back of the housing adapter and RF transformer box. (See Connecting the Nitrogen Gas and Electrical Cables to the MCB for the cable connectors.)

Figure 12. Adapter housing and RF transformer box (front and back with partial cable)



Electrode Assembly

The electrode assembly provides the following features.

- A mount for the electrode set
- Fits onto the adapter Housing
- Contains the outer electrode (DC voltages) and inner electrode (RF, heating)
- Provides cooling and analytical gas paths
- Provides gas seal

Figure 13, Figure 14, and Figure 15 show the front and rear views of the electrode assembly that mounts onto the housing adapter.

Figure 13. Electrode assembly with unlocked levers (front and right side)

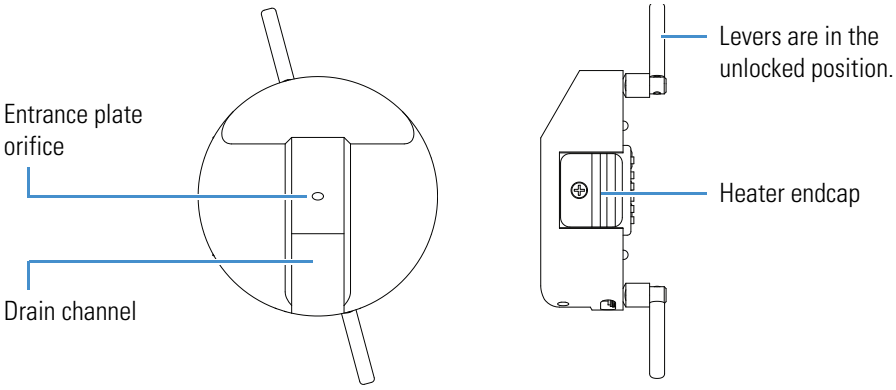


Figure 14. Entrance plate with and without the electrode assembly (back)

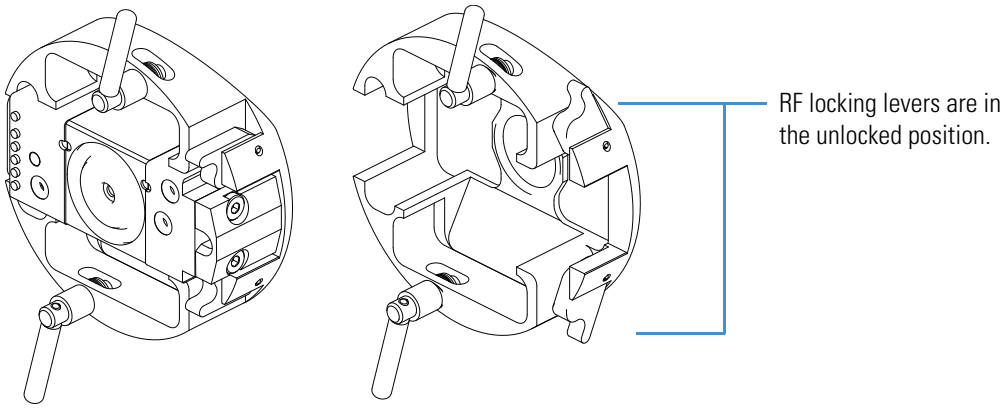
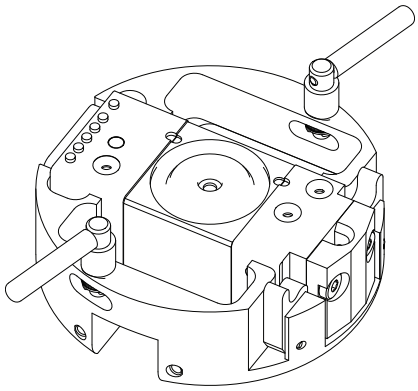


Figure 15. Electrode assembly with unlocked levers (back and bottom)



Electrode Set

The electrode set provides the following functions.

- Provides a heater for the electrode (heater endcap)

- Provides a mount for the outer and inner electrodes (RF and heater endcaps)
- Provides high voltage path to the electrodes (RF endcap)
- Provides gas seals (O-rings)
- Provides electrical insulation of electrodes (bushings)

Figure 16, Figure 17, and Figure 18 show the components of the electrode set that mounts onto the electrode assembly.

Figure 16. Electrode set removed from the entrance plate

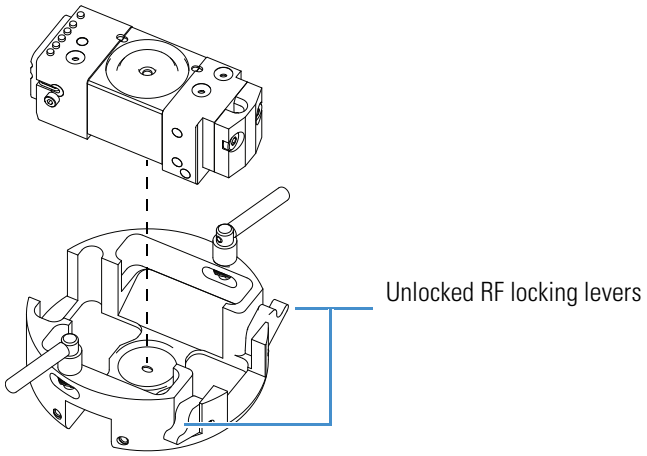


Figure 17. Partial exploded view of the electrode set

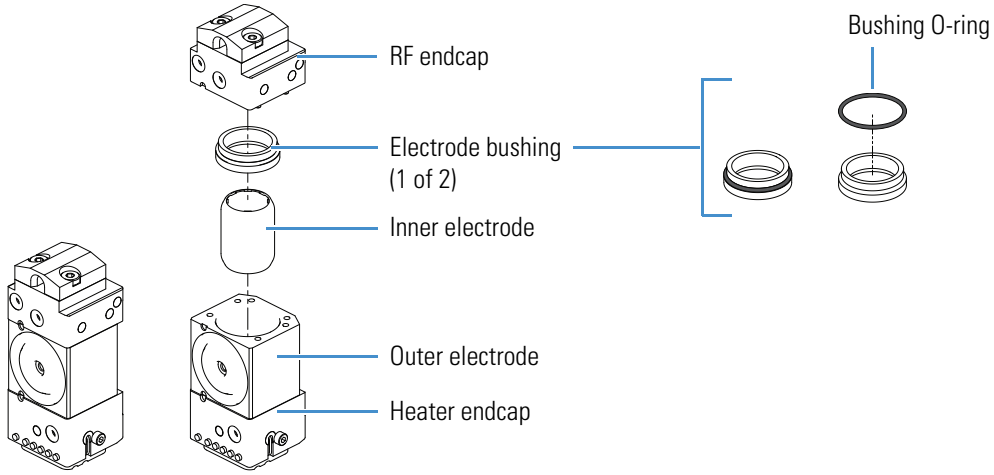
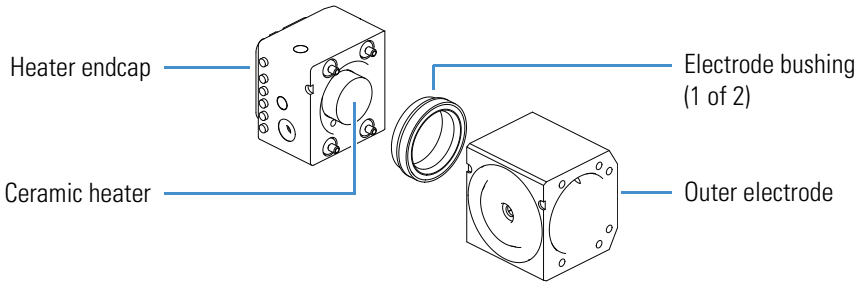


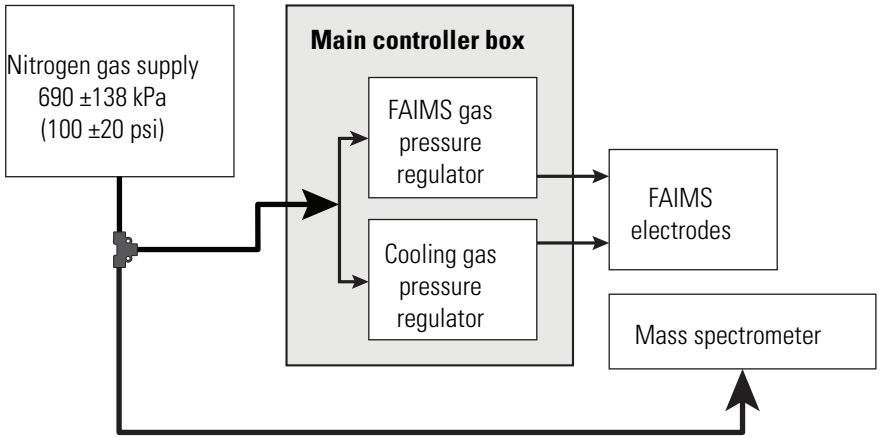
Figure 18. Heater endcap with heater, bushing assembly, and outer electrode



Gas Delivery to the FAIMS Electrodes

Figure 19 shows the delivery path for the nitrogen gas to the FAIMS electrodes and the MS.

Figure 19. Schematic of the gas delivery to the FAIMS system and MS



Installing the FAIMS Pro System

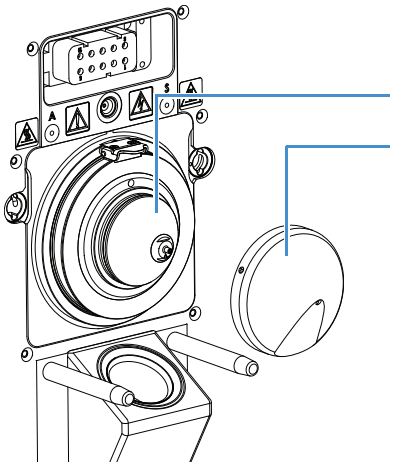
Contents

Removing the MS Ion Sweep Cone

CAUTION Hot surface. The external surface of the spray insert, API source housing, MS Ion sweep cone, and entry to the ion transfer tube can be hot enough to burn your skin. Allow the parts to cool to room temperature (approximately 20 minutes) before you touch them.

Before you install the FAIMS system, remove the MS ion sweep cone.

❖ To remove the MS ion sweep cone



MS spray cone

Let the MS ion sweep cone cool to room temperature, then remove it by grasping its outer ridges to pull it off.

Note If you cannot remove by hand, use a small slotted screwdriver to loosen the screws on the ion sweep cone. The spray cone is directly behind the ion sweep cone.

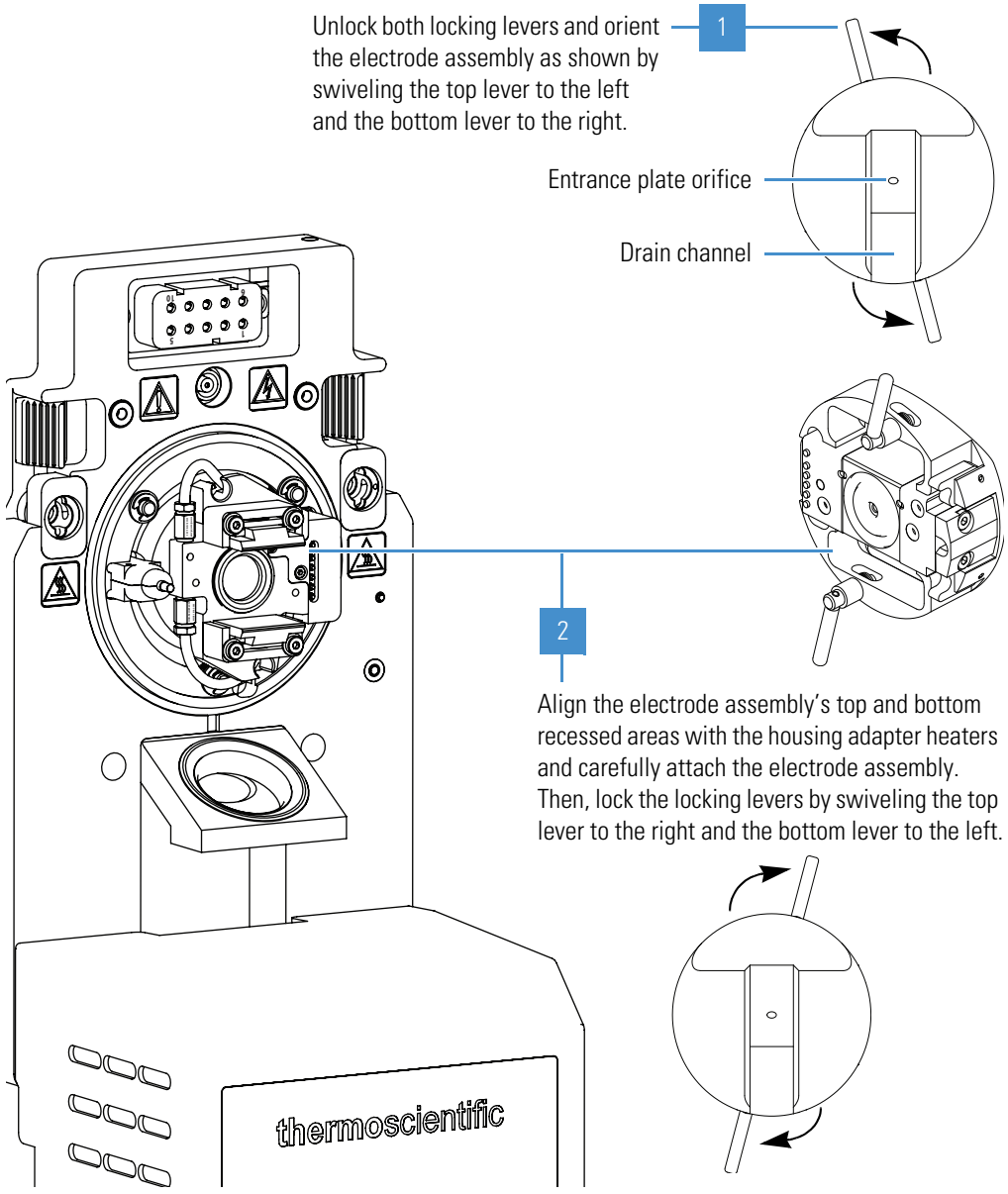
Related Topics

- Installing the FAIMS Pro System
- Installing the EASY-Spray NG Ion Source on the FAIMS Pro System
- Installing the Nanospray Flex NG Ion Source on the FAIMS Pro System

Installing the Electrode Assembly to the Housing Adapter

The electrode assembly orientation is such that waste flows into the ion source drain.

❖ **To install the electrode assembly onto the housing adapter**



Related Topics

- Removing the Electrode Assembly from the Housing Adapter

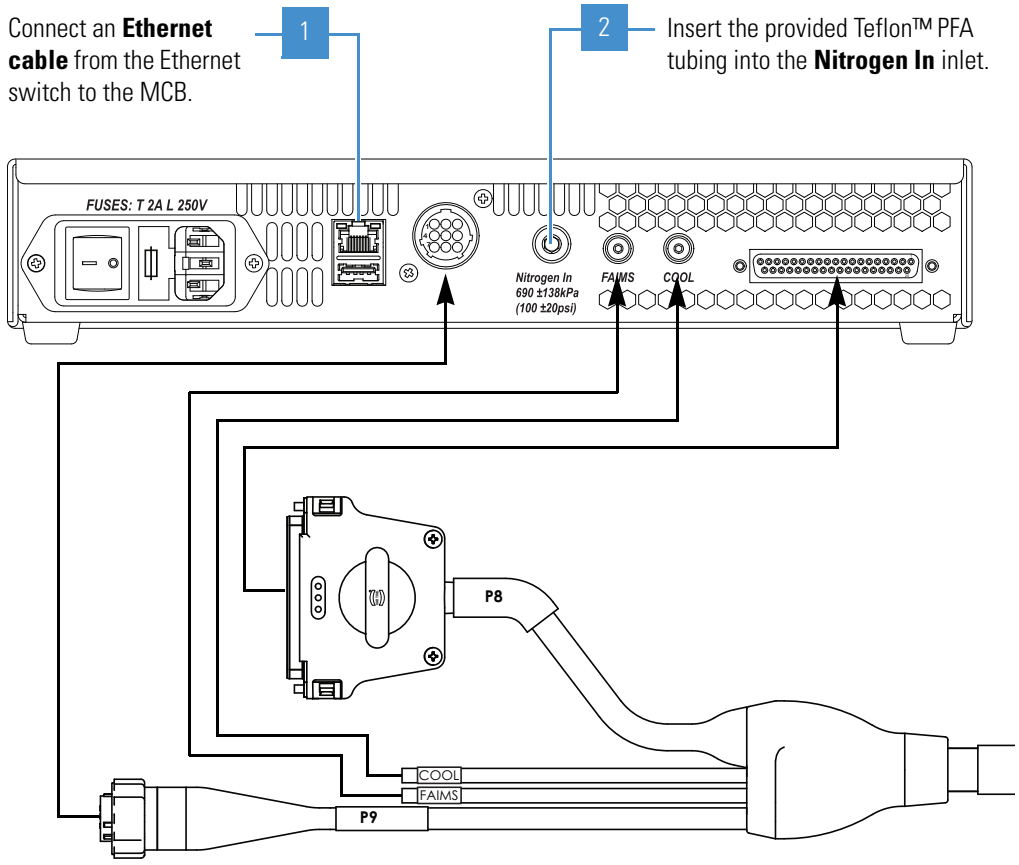
Connecting the Nitrogen Gas and Electrical Cables to the MCB

You can connect the high-purity nitrogen gas supply directly to the MCB or use the provided union Tee to share the MS nitrogen gas supply.

Tip For troubleshooting purposes, you might want to record each of the devices and their corresponding ports on the Ethernet switch.

CAUTION After completing these connections, route the power cord so that it is not a trip hazard.

❖ To connect the gas supply and electrical cables



3 Insert the FAIMS and cooling tubings into the appropriate gas inlets.

4 Connect the circular, high-voltage connector and serial connector.

5 Connect both ends of the power cord—do not turn on the MCB power switch.

Installing the FAIMS Pro System

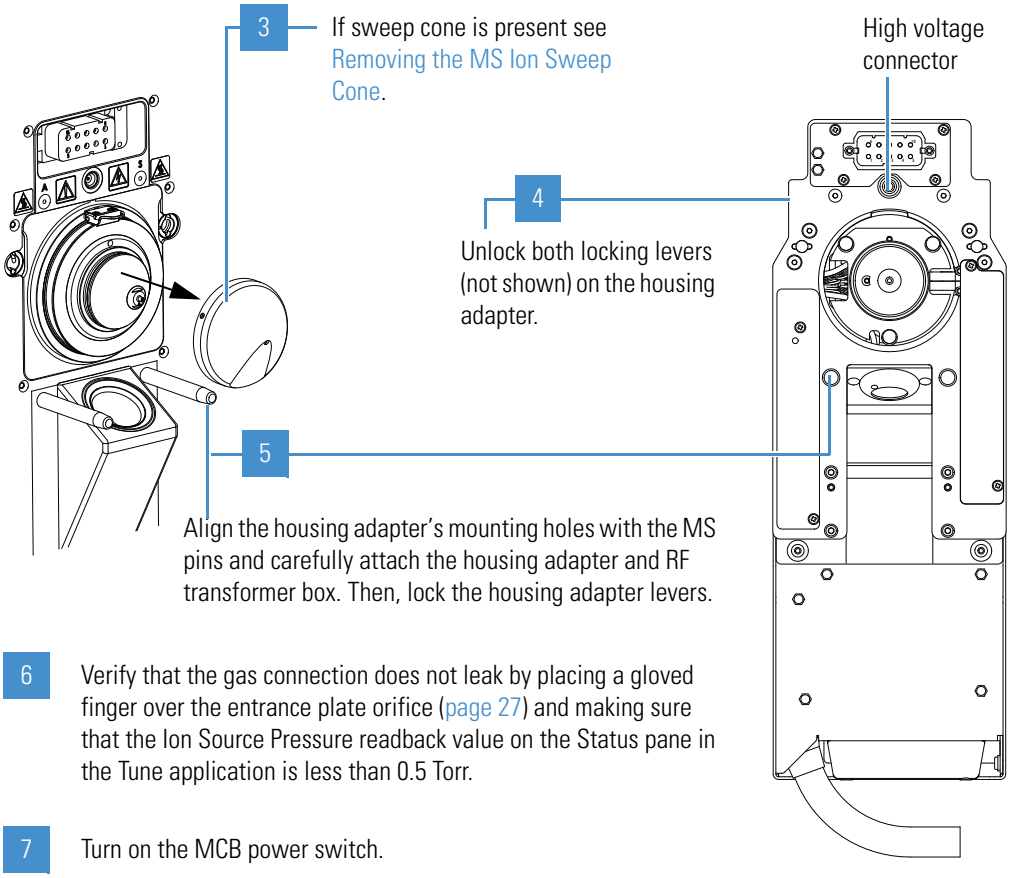
After each installation of the FAIMS system, ensure that the gas connection does not leak, as noted in this procedure.

CAUTION Hot Surface. The external surface of the spray insert, API source housing, and entry to the ion transfer tube can be hot enough to burn your skin. Allow the parts to cool to room temperature (approximately 20 minutes) before servicing them.

CAUTION To avoid contaminating the ion transfer tube, do not touch its exposed entrance.

❖ To install the FAIMS system onto the MS

1. If you previously installed the MS syringe pump and modular valve assembly, remove it without disconnecting the cables.
2. Place the MCB on the upper-left corner of the MS, and then place the optional syringe pump and modular valve assembly on top of the MCB.



6. Verify that the gas connection does not leak by placing a gloved finger over the entrance plate orifice (page 27) and making sure that the Ion Source Pressure readback value on the Status pane in the Tune application is less than 0.5 Torr.
7. Turn on the MCB power switch.

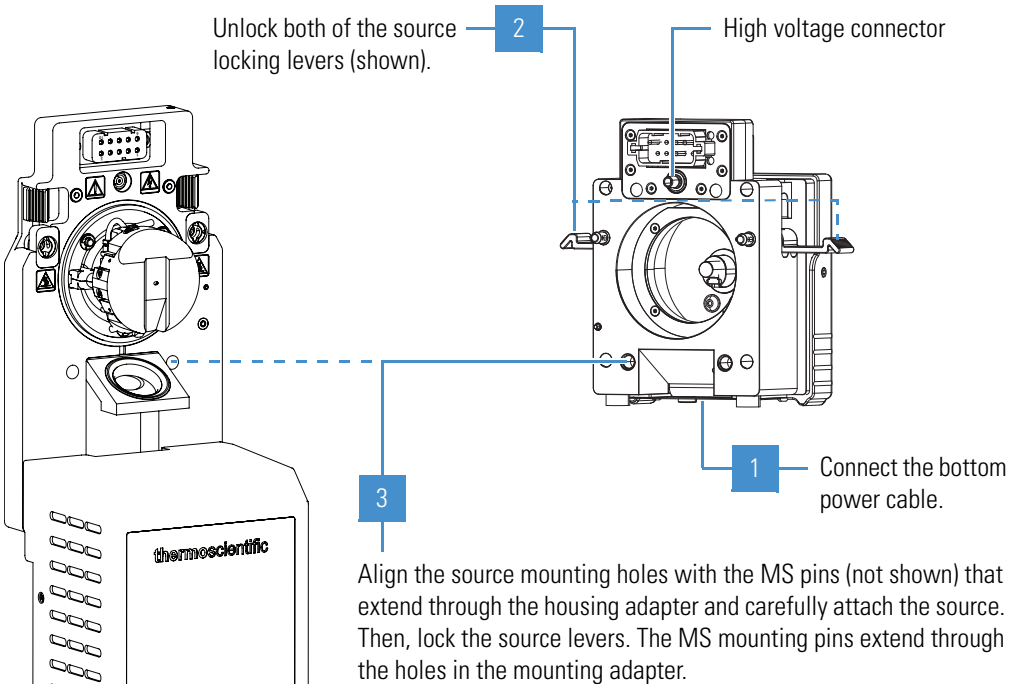
Related Topics

- Installing the Electrode Assembly to the Housing Adapter
- Connecting the Nitrogen Gas and Electrical Cables to the MCB
- Fixing a Gas Leak Between the MS and the Electrodes

Installing the EASY-Spray NG Ion Source on the FAIMS Pro System

Follow this procedure to install the EASY-Spray NG ion source onto the FAIMS system.

❖ **To install the EASY-Spray NG source onto the FAIMS system**



Related Topics

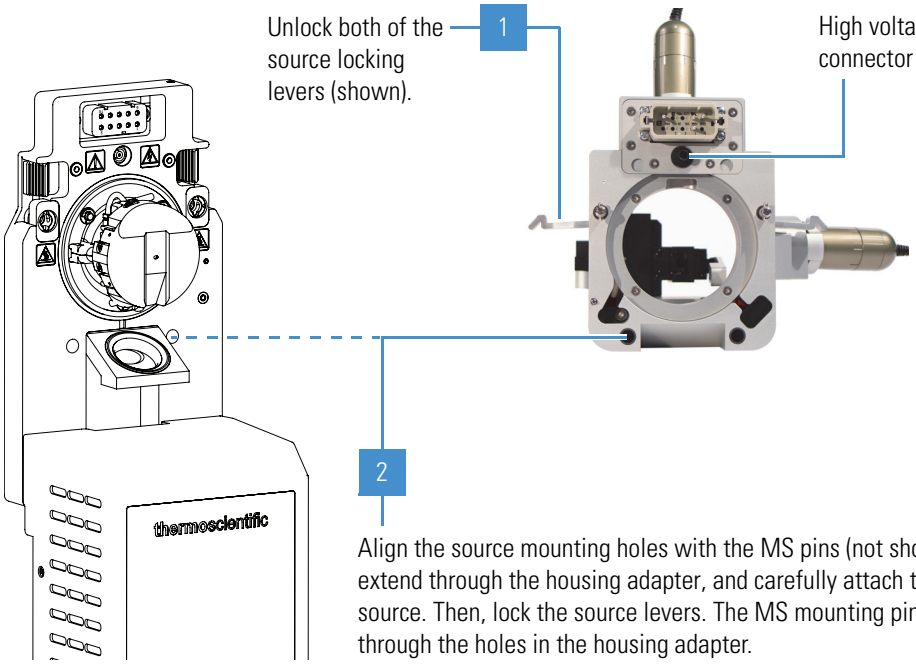
- For additional information, refer to the *EASY-Spray Series Ion Source User Guide*.

Installing the Nanospray Flex NG Ion Source on the FAIMS Pro System

Follow this procedure to install the Nanospray Flex NG ion source onto the FAIMS system.

Note If the optional nitrogen gas connection under the Nanospray Flex NG source is in use, purchase and install an elbow adapter for the 1/8 in. OD tubing to allow for the reduced clearance space.

❖ **To install the Nanospray Flex NG source on the FAIMS system**



Align the source mounting holes with the MS pins (not shown) that extend through the housing adapter, and carefully attach the source. Then, lock the source levers. The MS mounting pins extend through the holes in the housing adapter.

Related Topics

- For additional information, refer to the *Nanospray Flex Series Ion Source User Guide*.

5

Generating a FAIMS Diagnostics Report

Contents

Running the FAIMS User Diagnostics

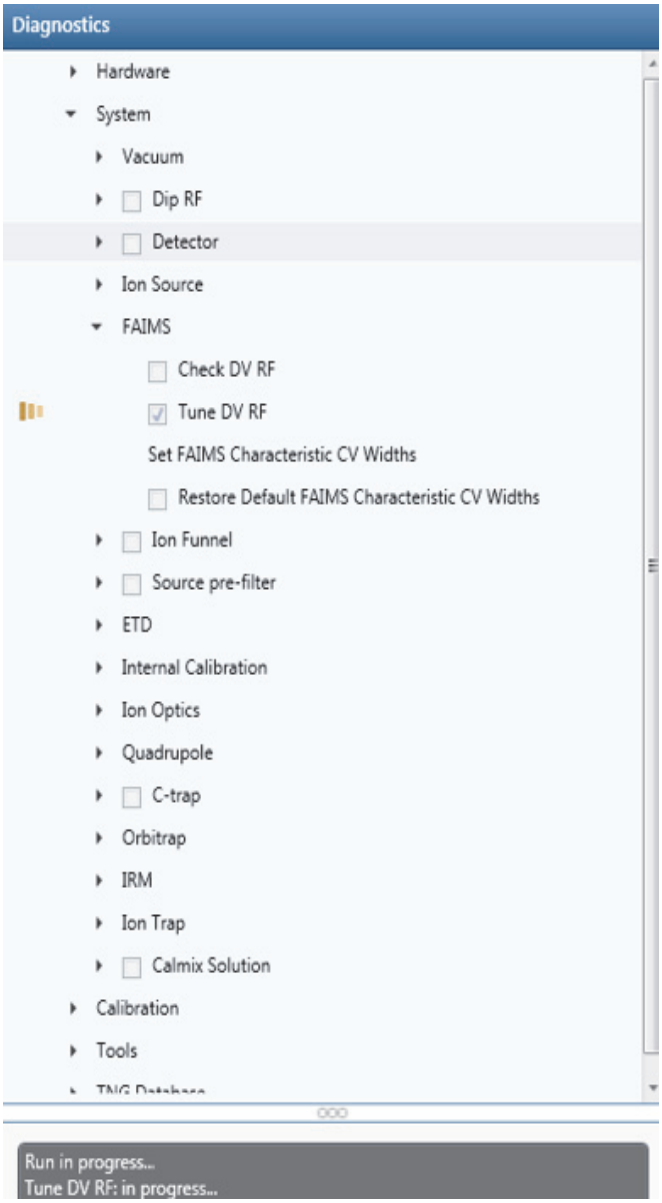
The Tune diagnostics options appear only when FAIMS Pro is attached to the MS. The Tune DV RF and Check DV RF are available to the user. The Tune DV RF automatically sets (within specification) the high electric field (HF) and low electric field (LF) that create the DV waveform applied to the electrodes. The DV asymmetric waveform is the sum of two sine waves with voltage amplitudes for HF and LF. Check DV RF verifies that a tuned DV waveform delivers specified output power at specified voltages. The example below, describes the procedures for a user diagnostics on a Tribrid Tune DV.

❖ **Running the FAIMS user diagnostic - Tune DV RF option**

1. In the Diagnostics pane, select the **Tune DV RF** check box.

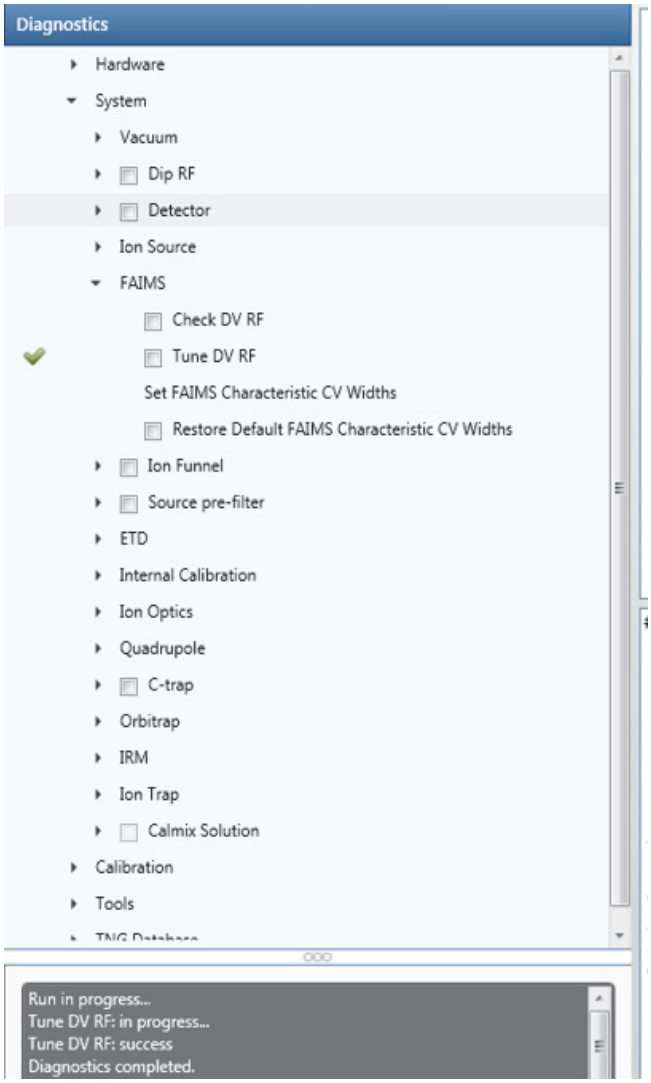
   A yellow progress symbol to the left that check box appears. The status panel at the bottom of the Diagnostics pane indicates “Run in progress.”

Figure 20. FAIMS Diagnostics pane - Tune DV RF in progress



When the Tune DV RF run is completed, a green check appears next to the Tune DV RF check box. The status panel at the bottom of the Diagnostics pane indicates “Diagnostics completed.”

Figure 21. FAIMS Diagnostics pane - Tune DV RF complete

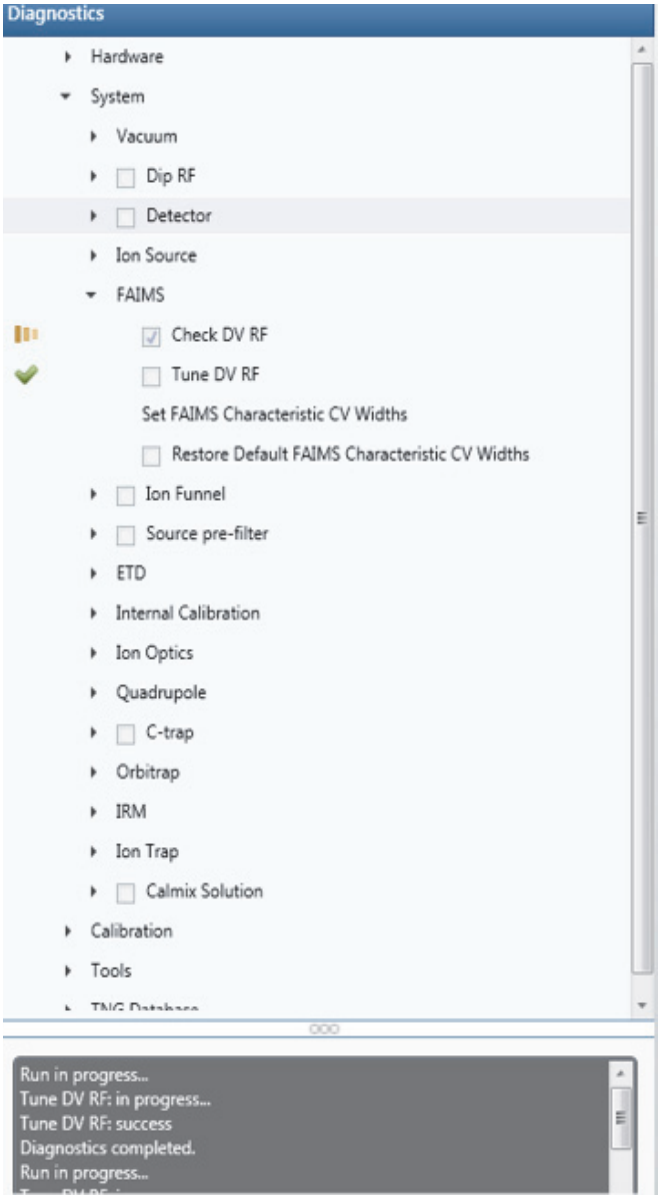


❖ Running the FAIMS user diagnostic - Check DV RF option

1. In the Diagnostics pane, select the **Check DV RF** check box.

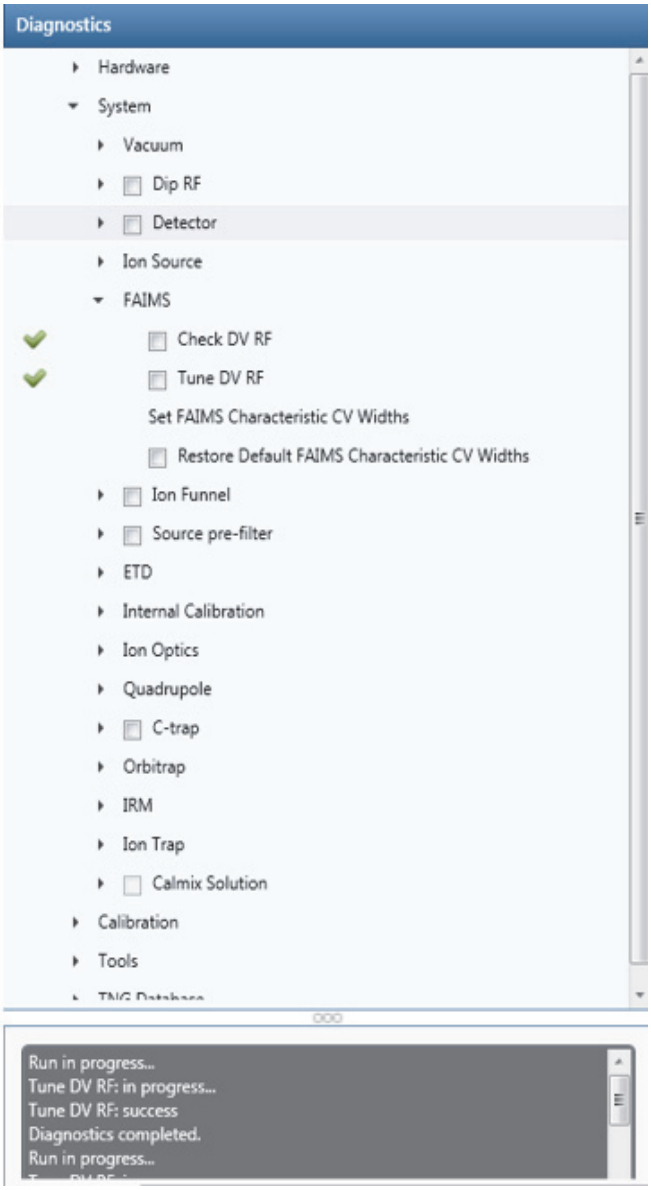
   A yellow progress symbol to the left of the check box appears. The status panel at the bottom of the Diagnostics pane will indicates “Run in progress.”

Figure 22. FAIMS Diagnostics pane - Check DV RF in progress



When the Check DV run is completed, a green check appears next to the Check DV RF check box. The status panel at the bottom of the Diagnostics pane indicates “Diagnostics completed.”

Figure 23. FAIMS Diagnostics pane - Check DV RF completed



Diagnostics Results of the Tune DV RF Process

The Diagnostics report pane displays a success or failed result after the Tune DV RF run completes. You do not have to set any values. The Tune DV RF runs the following steps:

- High field RF coarse tuning (scan RF frequency, low power)
- High field RF fine tuning (middle power)
- Low field RF coarse tuning (scan variable capacitance position, low power)
- Low field RF fine tuning (middle power)

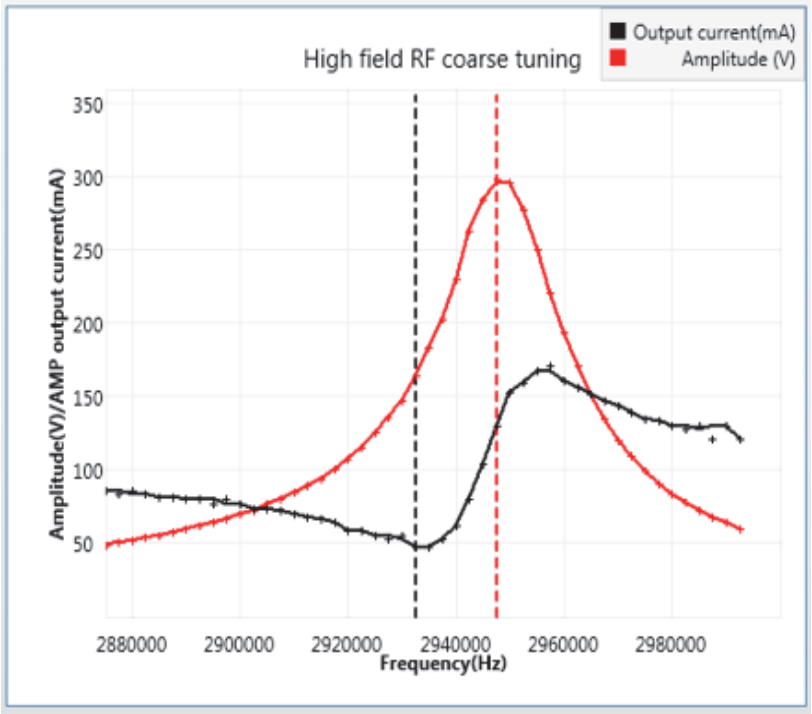
- Wait DV modulation DC to settle (full power, 5KV)
- High/Low field modulation DAC adjust

❖ High field RF coarse tuning

The High field RF coarse tuning step locates the two boundary frequencies that contains the resonance frequency for the DV. The resonance frequency has minimum drive current, maximum output voltage, and minimum power for the amplifier (AMP) that generates the RF waveform for the DV.

1. Scans the preset range from 2.875 MHz to 3.075MHz to find the minimum drive current and corresponding frequency.
2. Scans the preset range from 2.875 MHz to 3.075MHz to find the maximum output voltage and corresponding frequency.
3. If either step 1 or step 2 are not completed, then the tuning failed.
4. If step 1 and step 2 are both completed, then the tuning passed. The Tune DV RF run proceeds to the High Field fine RF tuning step.
5. The application marks the two frequency values and amplitude values for steps 1 and steps 2 with a black and red dashed line.

Figure 24. High field RF coarse tuning

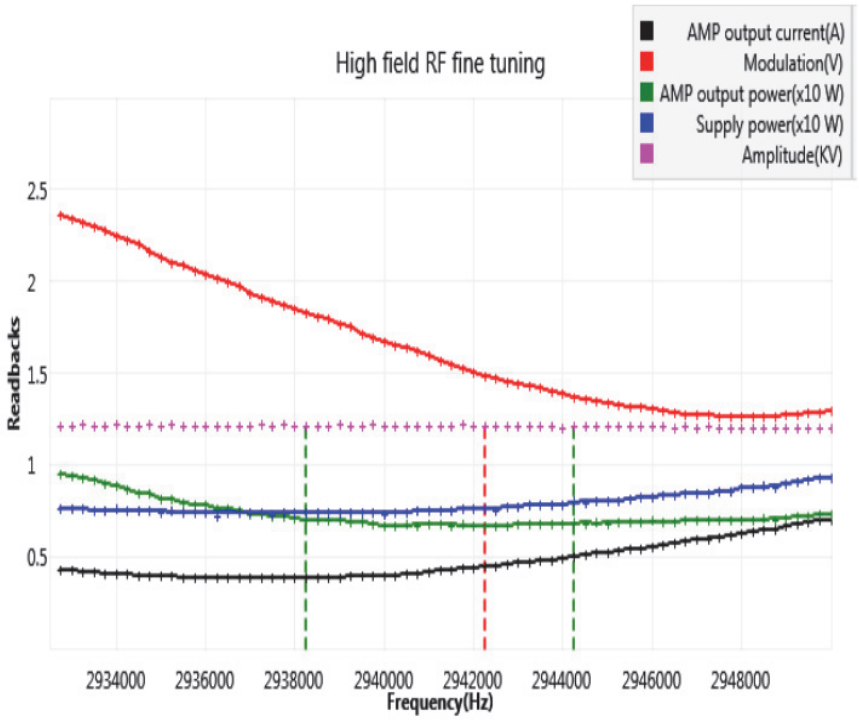


❖ High field RF fine tuning

The High field RF fine tuning step locates the resonance frequency. The resonance frequency has the minimum drive current, maximum output voltage, and minimum power for the amplifier (AMP) that generates the RF waveform for the DV.

1. Scans the frequency range derived from High field RF coarse tuning step to find the resonance frequency that has the lowest output power. The two frequencies will be marked by a dashed green line.
2. If a minimum amplifier power (AMP) cannot be located within this range or if the amplitude cannot reach 1.2 KV, then tuning failed.
3. If a minimum amplifier power (AMP) can be located within this range or if the amplitude can reach 1.2 KV, then tuning passed. The application marks the resonance frequency by a dashed red line.

Figure 25. High field RF fine tuning

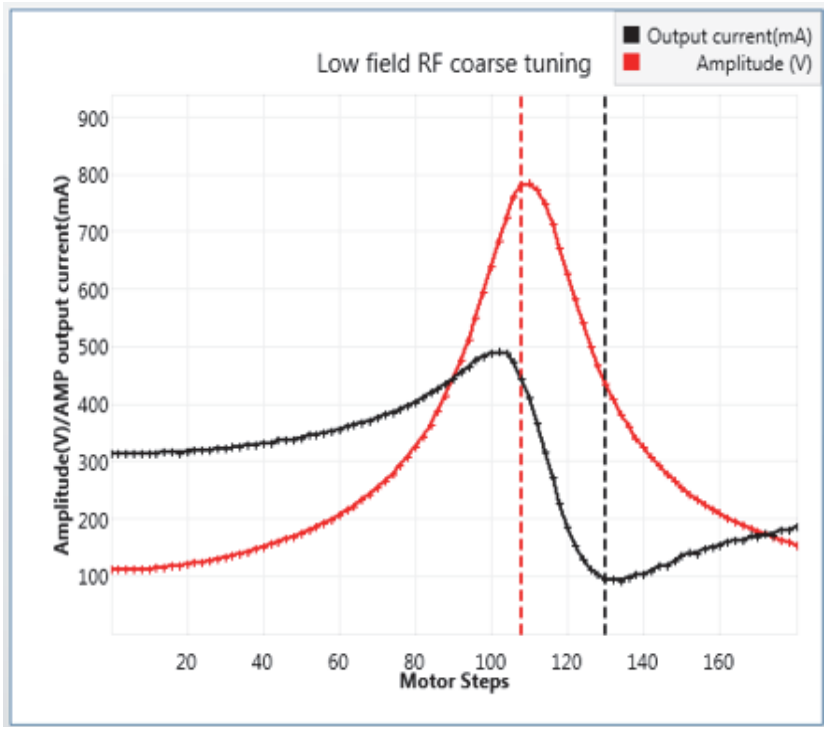


❖ Low field RF coarse tuning

The Low field RF coarse tuning step locates the two motor steps that contain the resonance point for the DV. A motor step is a fixed position of value for a variable capacitor that controls the frequency of operation. A variable capacitance motor controls the capacitance value in locating the resonance frequency. The resonance point has minimum drive current, maximum output voltage, and minimum power for the amplifier (AMP) that generates the RF waveform for DV.

1. Scans the variable capacitance motor from position 0 to 200 to find the minimum drive current and corresponding motor step.
2. Scans the variable capacitance motor from position 0 to 200 to find the maximum output voltage and corresponding motor step.
3. If either step 1 or step 2 are not completed, then the tuning failed.
4. If step 1 and step 2 are both completed, then the tuning passed. The Tune DV process proceeds to the Low Field fine RF tuning step.
5. The application marks the two motor step values and amplitude values for steps 1 and steps 2 with a black and red dashed line.

Figure 26. Low field RF coarse tuning

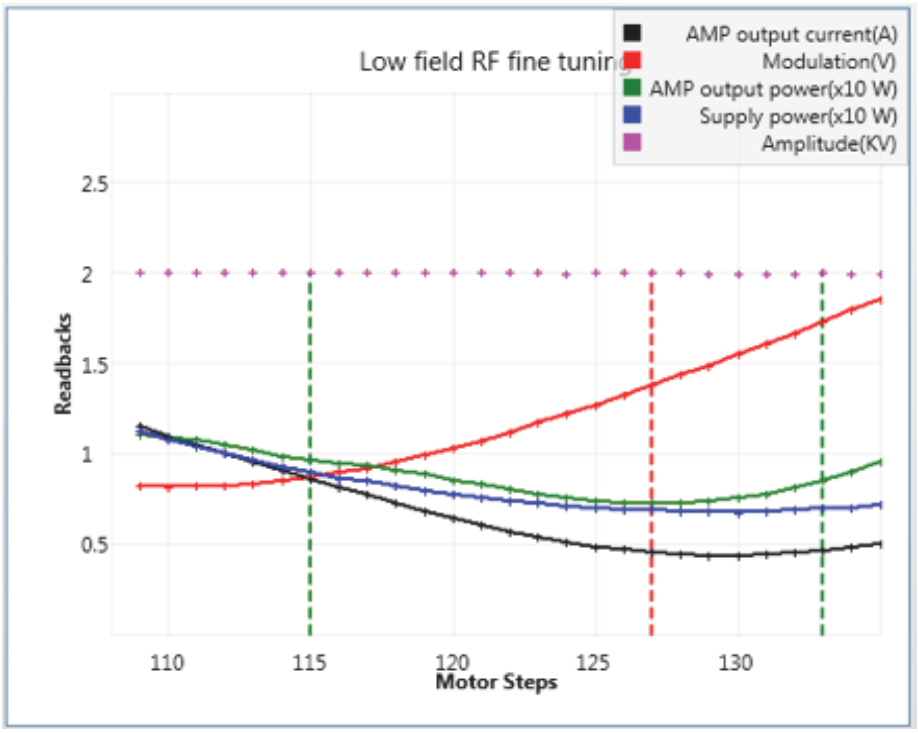


❖ Low field Fine RF tuning

The Low field RF fine tuning step locates the motor step that has the resonance point. The resonance point has a minimum drive current, maximum output voltage, and minimum power for the amplifier (AMP) that generates the RF waveform for DV.

1. Scans the motor steps range derived from the Low field RF coarse tuning step to find the resonance frequency that has the lowest output power. The application marks two frequencies by dashed green lines.
2. If a minimum amplifier power (AMP) cannot be located within this range or if the amplitude cannot reach 2 KV, then tuning failed.
3. If a minimum amplifier power (AMP) can be located within this range or if the amplitude can reach 2 KV, then tuning passed. The application marks the resonance frequency by a dashed red line.

Figure 27. Low field RF fine tuning

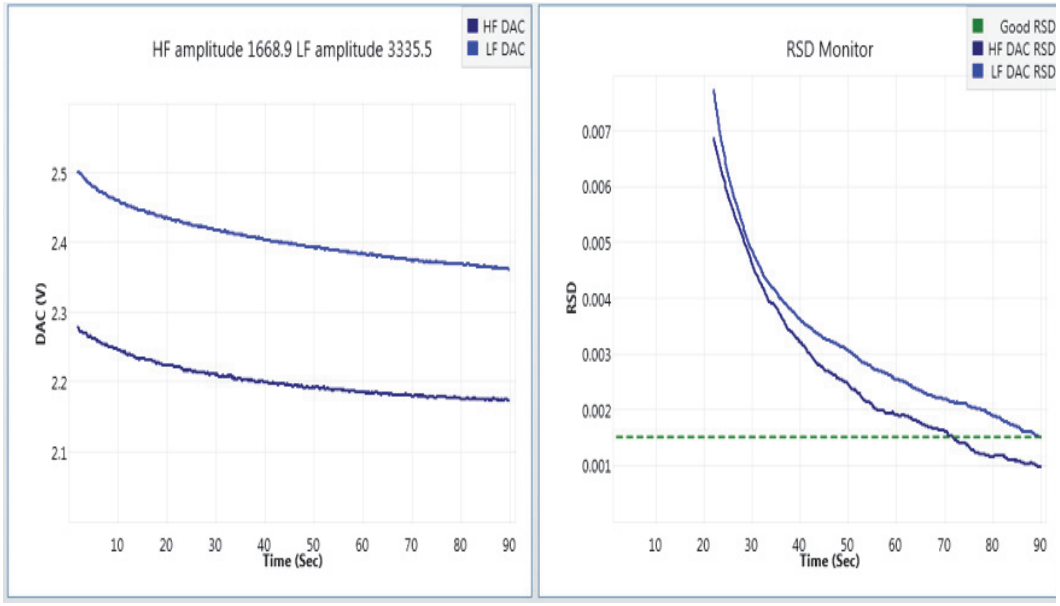


❖ **Wait DV modulation DC to settle (Full power, 5KV)**

An HF DAC and LF DAC (Digital to Analog Converter) generate the two waveforms that sum to create the DV waveform before the amplifier (AMP). Because RF heating changes the system resonance, both DACs must be tuned after the system settles in time at the tuned resonance frequency. The RSD (Relative Standard Deviation) Monitor shows the quality of both DAC amplitudes.

1. Sets the DV AMP voltage to full power at 5 KV (HF 1.66 and LF 3.33 KV)
2. Waits 95 secs to settle.
3. The tuning fails if either the HF DAC RSD or th LF DAC RSD are above the dashed green line, which represents the Good RSD.
4. The tuning passes if either the HF DAC RSD or the LF DAC RSD are at or below the dashed green line, which represents the Good RSD.

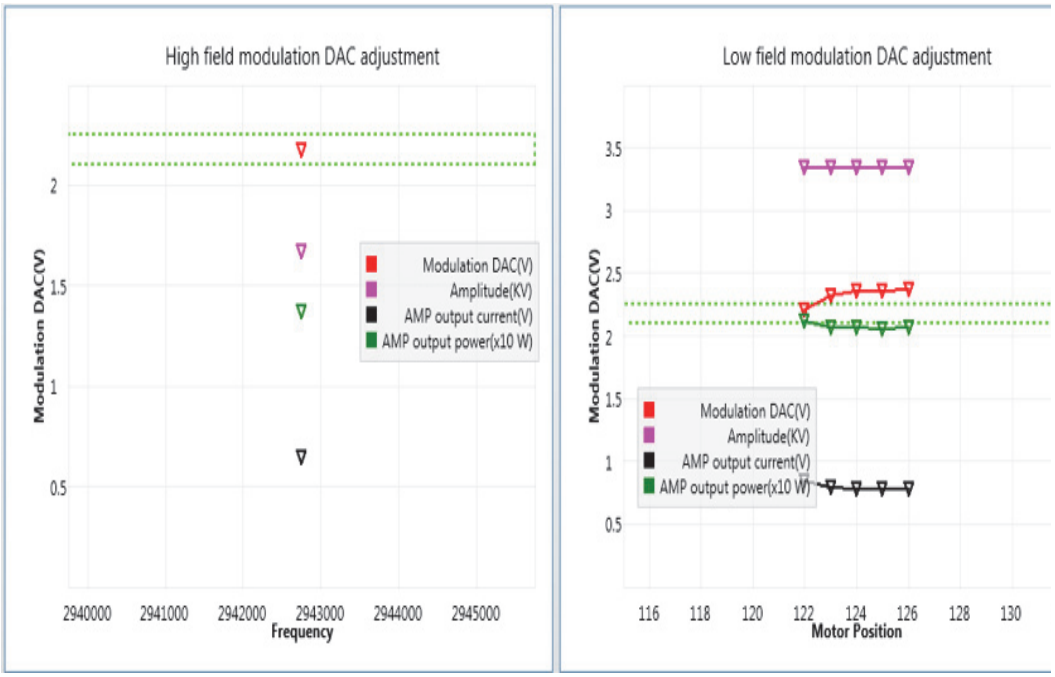
Figure 28. Wait DV modulation DC to settle



❖ **HF and LF modulation DAC adjust**

The frequency (HF) and motor position (LF) are adjusted to move the modulation control DAC to the specified range defined by the dashed green lines. After this step is completed, the DV is tuned.

Figure 29. HF & LF modulation DAC adjust



Diagnostics Results of Check DV RF

The diagnostics report pane displays a success or failed result after the Check DV RF procedure completes. You do not have to set any values. The following steps are preset and executed in sequence when a Check DV RF run is in progress. The Check DV RF procedure executes the following steps:

- A DV RF ramp check if DV amplitude can reach a list of different set points
- A fine head room check to verify that, at full power, the RF modulation DAC is in the specified range

Note The FAIMS Pro system continuously executes a Check DV RF verification for any ion source changes that you make. A change in ion source results in a change to the output power, resonance frequency, and the motor step of DV due to the different source housing electrical impedances between ion sources. The Tune software will request that you perform a Tune DV RF procedure.

❖ DV RF ramp check

The DV amplitude (black line) of HF and LF are checked to reach a preset voltage. If the DV RF reaches the set points amplitudes HF (5KV, 1.66KV) and LF (5KV, 3.33KV) on the display, then the Check DV RF procedure passes. If the set amplitude points are not reached, then the Check DV RF fails and FAIMS requires a DV Tune RF procedure.

Figure 30. DV RF ramp check HF amplitude

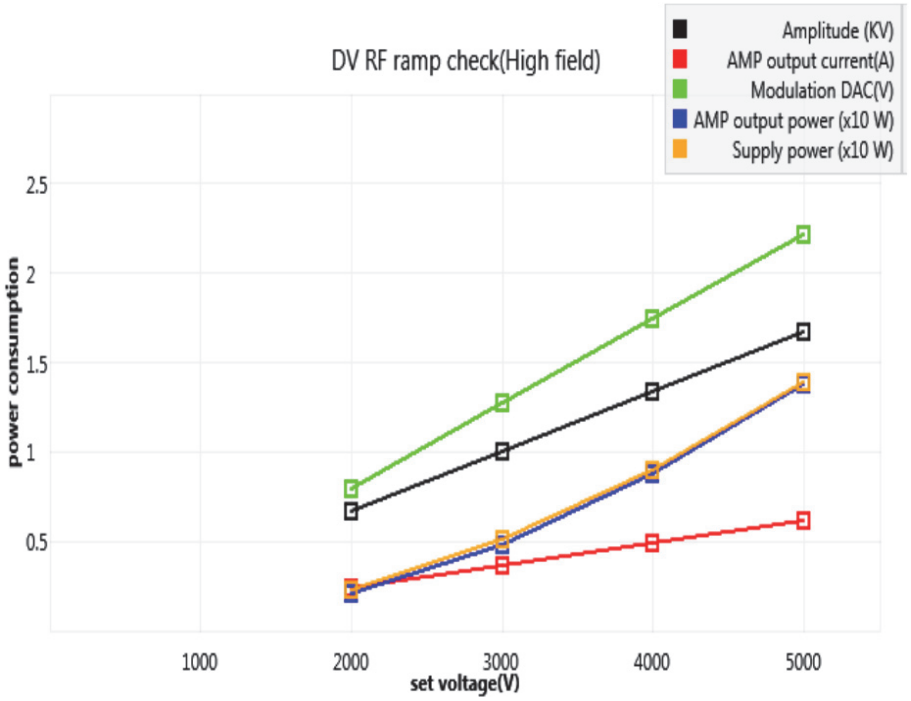
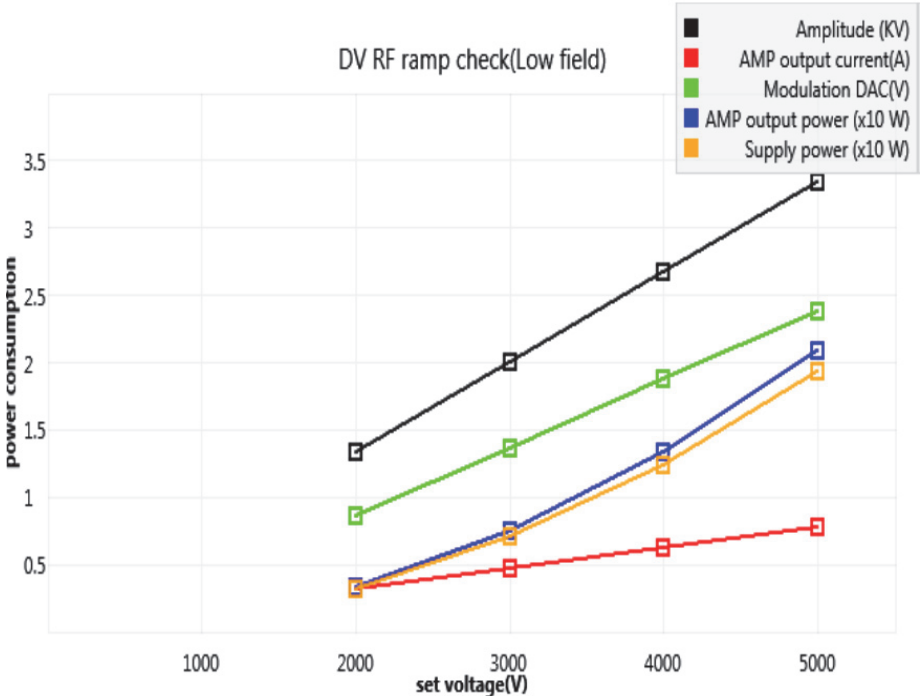


Figure 31. DV ramp check of LF Amplitude

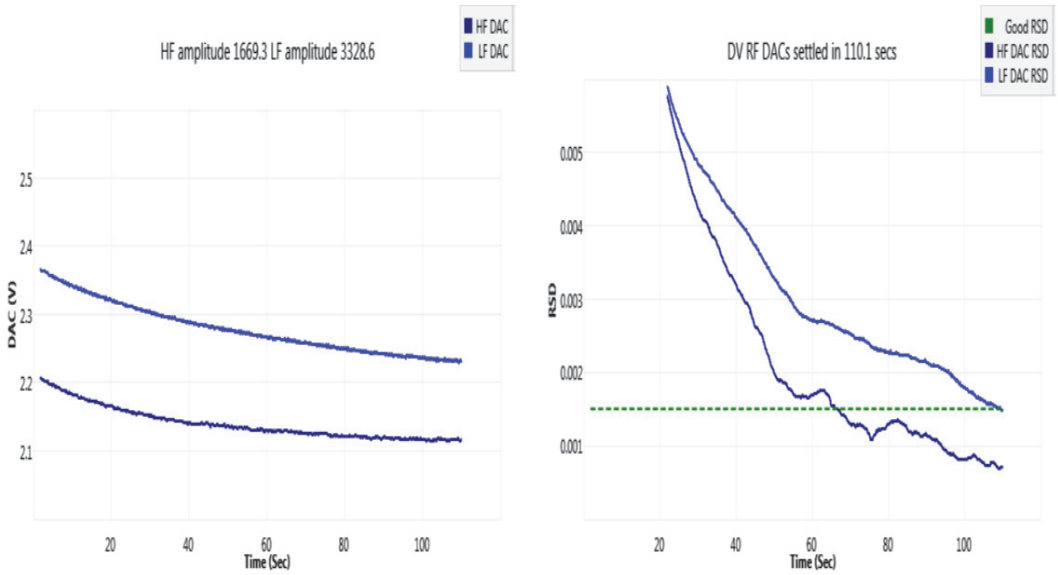


❖ **Wait DV modulation DC to settle (Full power, 5KV)**

A HF and LF DAC (Digital to Analog Converter) generates the two waveforms that sum to create the DV waveform before the amplifier (AMP). Because RF heating changes the system resonance, both DACs must be tuned after the system settles in time at the tuned resonance frequency. The RSD (Relative Standard Deviation) Monitor shows the quality of the both DAC amplitudes.

1. Sets DV AMP voltage to full power at 5 KV (HF 1.66 and LF 3.33 KV)
2. Waits 95 secs to settle for HF DAC RSD and LF DAC RSD are at or below the dashed green line which is the Good RSD.
3. The Check DV RF procedure fails if the output power is 15% higher than the optimal output power recorded by the DV Tune RF procedure.

Figure 32. Wait DV modulation DC to settle



Example Diagnostics Report

This application generates a PDF report from the execution of the Tune DV RF and the Check DV RF runs. The report provides the locations and widths, reports pass or fail, and includes any incidental comments needed to interpret the result. The application determines a pass or fail result by comparison with stored targets.

Figure 33. Check DV RF Diagnostic Report

Diagnostic Report

Thermo SCIENTIFIC

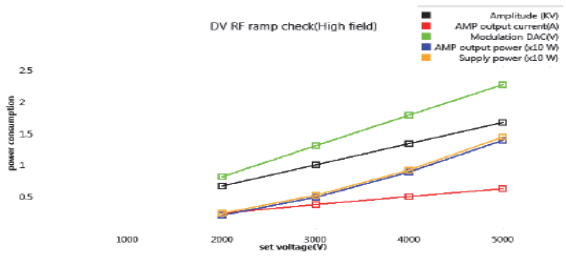
Date & Time	Thursday, July 19, 2018 4:46 PM
Instrument Model	Orbitrap Fusion Lumos
Instrument Serial	FSN20410
Software Version	3.1.2412.14

Name	Result	Value	Minimum	Maximum	Comment
Check DV RF	Passed	-	-	-	-

Check DV RF:

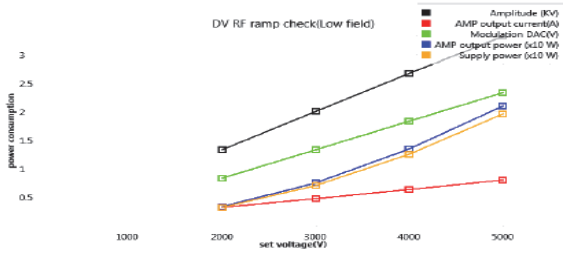
Name	Result	Value	Minimum	Maximum	Comment
Check FAIMS DV RF	Passed	-	-	-	

DV RF amplitude ramp check



DV RF ramp check(High field)

Set voltage	amplitude	modulation	output I	output pwr	supply pwr
666.7	667.5	0.806	0.238	2.090	2.328
1000.0	999.9	1.296	0.367	4.866	5.204
1333.3	1334.0	1.784	0.495	8.790	9.186
1666.7	1667.6	2.265	0.626	13.900	14.353

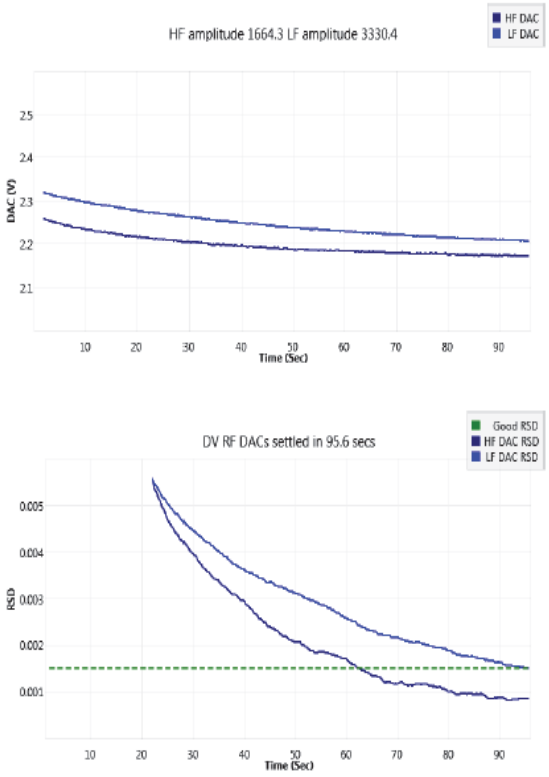


DV RF ramp check(Low field)

Set voltage	amplitude	modulation	output I	output pwr	supply pwr
1333.3	1334.0	0.826	0.316	3.318	3.154
2000.0	2000.3	1.330	0.475	7.486	7.079
2666.7	2668.3	1.831	0.636	13.384	12.535
3333.3	3330.9	2.326	0.798	20.957	19.548

Figure 33. Check DV RF Diagnostic Report

DV RF modulation DAC head room check



High field DAC regulated at 2.17 V

High field Output power is 13.71 W

Low field DAC regulated at 2.21 V

Low field Output power is 21.09 W

Figure 34. Tune DV RF Diagnostic Report

Diagnostic Report

Thermo SCIENTIFIC

Date & Time Thursday, July 19, 2018 4:40 PM
Instrument Model Orbitrap Fusion Lumos
Instrument Serial FSN20410
Software Version 3.1.2412.14

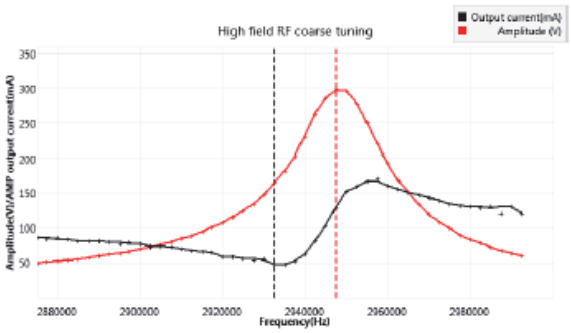
Name	Result	Value	Minimum	Maximum	Comment
Tune DV RF	Passed	-	-	-	-

Tune DV RF:

Name	Result	Value	Minimum	Maximum	Comment
Tune FAIMS DV RF	Passed	-	-	-	

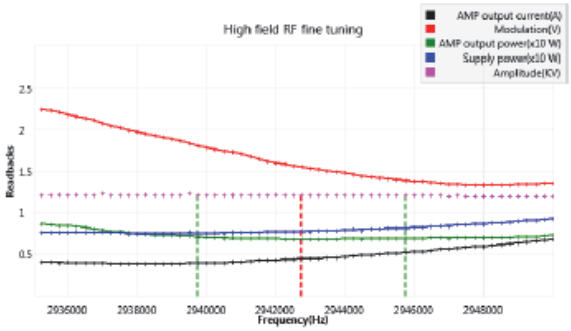
Min output current 47.53 at frequency 2932500.0

Max amplitude 296.15 at frequency 2947500.0



High field fine RF tuning

Min output power 6.73 at frequency 2942750.0



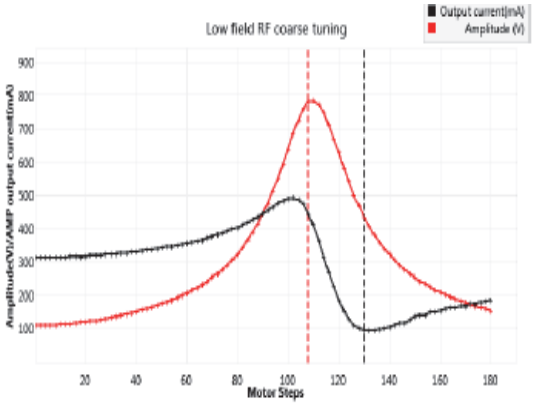
High field RF dipping is done! Set RF frequency to 2942750.0

Low field coarse RF tuning

Min output current 92.65 at step 130.0

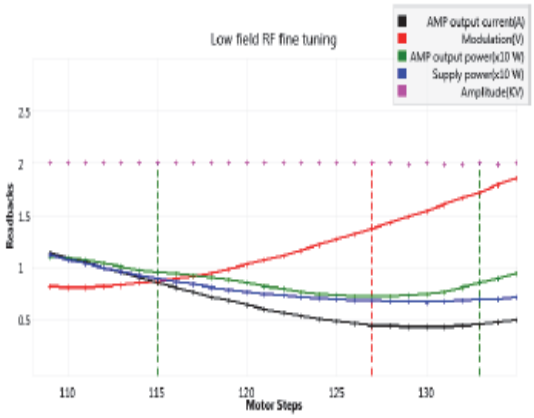
Max amplitude 780.87 at step 108.0

Figure 34. Tune DV RF Diagnostic Report



field fine RF tuning

Min output power 7.26 at step 127.0



Low field RF dipping is done! Set motor position to 126.0

t DV modulation DAC to settle...

Figure 34. Tune DV RF Diagnostic Report

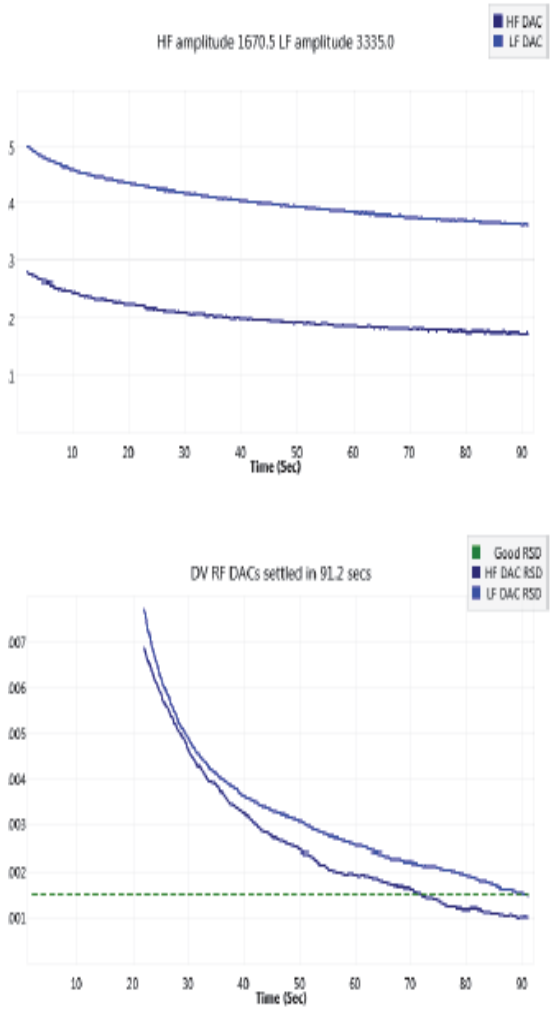


Figure 34. Tune DV RF Diagnostic Report

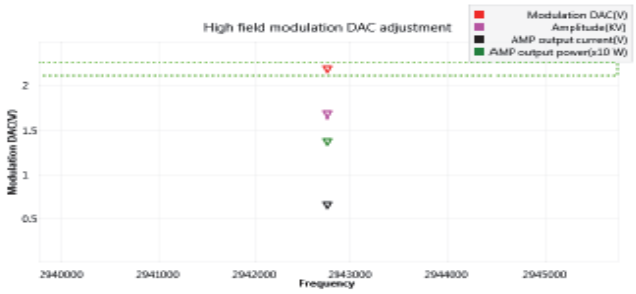
```
Adjust DV modulation DAC for head room
    High field DAC regulated at 2.17 V

    High field Output power is 13.66 W

    Calibrated value: 2942750.0 saved

    MaxDAC value: 2.5 saved

    Minimal power: 13.66 (W) saved
```



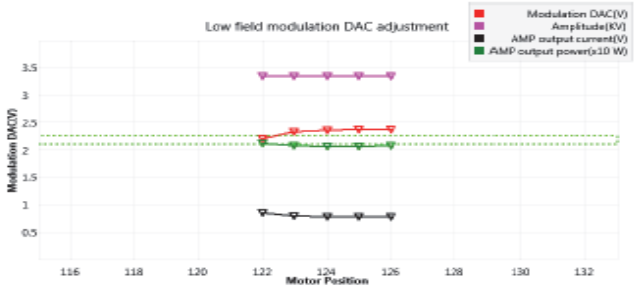

```
Low field DAC regulated at 2.20 V

Low field Output power is 21.15 W

Calibrated value: 122.0 saved

MaxDAC value: 2.5 saved

Minimal power: 21.15 (W) saved
```



6

Identifying Optimal CV Values

Contents

Configuring the CV Scan Tool

❖ **To set the FAIMS parameters**

1. (Windows 7) From the taskbar, choose **Start > All Programs > Thermo Instruments > *model x.x,*** and then m the Microsoft Windows open the Tune window.

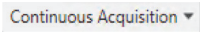
   (Windows 10) From the Windows taskbar, choose **Start > All Apps > Thermo Instruments > *model x.x,*** and then open the Tune window.

   For information about the buttons and icons in the Tune application and what they control, refer to the *Tune Help*.

2. Click the Ion Source page to display the FAIMS gas and FAIMS mode parameters.
3. Type the values of the gas flow rate in the box and choose a resolution mode in the drop down list.

   A User Defined mode selection displays both electrode temperature boxes for entry.

4. Click the Define Scan page to display the **FAIMS Voltages** drop down and **FAIMS CV (V)** box.
5. Choose **On** for **FAIMS Voltages** and type the value for **CV (V)** voltage.
6. Click **Continuous Acquisition** on the Data Acquisition pane to display the Use CV check box and CV voltage parameters.

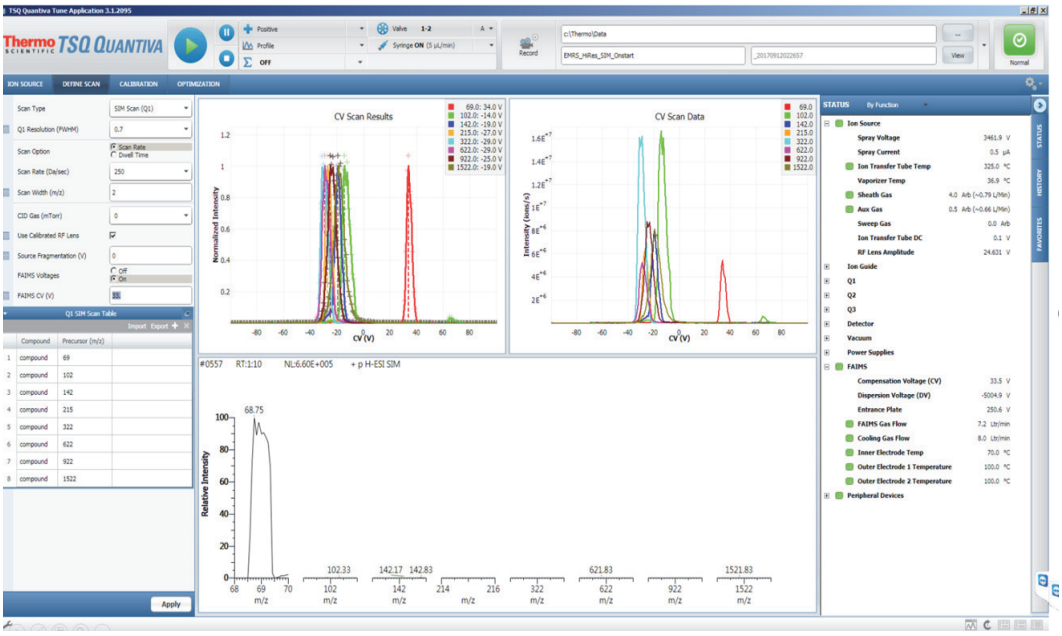
   

7. Enter the values of the CV **Start**, **Stop**, and **Step** settings in the appropriate boxes.

8. Obtain a CV spectrum (that is, ion intensity versus CV) by performing a CV ramp. To perform a CV ramp, type the starting and ending CV voltages in the **Start** and **Stop** boxes and click **Record**.

> **Note** If the range between the start and stop values is 10 V or less. Xcalibur uses a CV increment of 0.1 V instead of 0.3 V. Therefore, the FAIMS enables a fine CV optimization if the peak's resolution is sharp and you want to find the most optimum CV.

Figure 35. Results of FAIMS CV Scan in Tune



Defining the Scan Parameters

There are two different procedures to define scan parameters for the process of optimizing CV.

❖ Off-Line CV optimization

1. Infuse a sample into the MS with the FAIMS Pro System.
2. Set Full scan or SIM scan (recommended).
3. Ramp the CV over a range of volts while the MS is scanning in the Tune Window, using the CV Scan tool in the Data Acquisition Settings pane.
4. Record the file and the CV resulting in the maximum signal (SIM scan only) that is reported.

5. Open the Xcalibur raw data file in FreeStyle (v1.3 and later) to plot intensity vs CV, and the spectrum at each CV. Use the CV Plot view to determine the optimum compensation voltages for your LC/MS/FAIMS experiments.

Related Topics

For more information on FreeStyle, refer to the *FreeStyle Users Guide* - FAIMS Working with CV Plots and for FAIMS Data.

❖ On-Line CV Optimization

1. Infuse a sample using an LC-MS/MS method with FAIMS.
2. Apply a single FAIMS CV throughout the run.
3. Repeat the process by injecting the sample multiple times, each time using a different FAIMS CV throughout the entire run.

The DDA-type data can be processed to show the CVs resulting in the most identifications (Proteome Discoverer 2.2 or later) or analyte intensities (extracted in FreeStyle 1.3 or later).

Saving the Optimal CV Values

The acquisition time is divided into segments. Each segment can use a different Tune setting with different mass spectrometer and FAIMS settings. You can rename and save the change record to the Favorites pane for future use in the Tune application or the Method Editor.

❖ Saving the FAIMS parameters settings

1. In the Tune window, modify the parameters in the Ion Source or Define Scan pane.
2. Click **Apply** or **Export**.
3. Click the **Favorites** tab to display the Favorites pane.
4. Click **Save Current State**, and then type a unique name in the box.
5. Click **Save Current State** again to save the state.

❖ Loading the FAIMS parameters settings

Under User Settings, right-click the state name, and then choose one of the following:

- **Load** to only display the key parameters in the applicable parameter boxes.
- **Apply** to submit the key parameters to the MS.

  You can click Apply without first loading the parameters.

7

Conducting an Example FAIMS Experiment

Contents

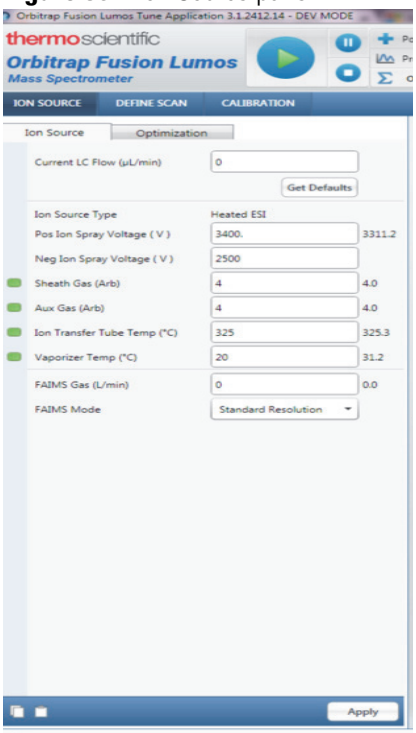
Using Tune to Acquire Sample Data

To manually acquire sample data, use the Tune application. Before acquiring sample data with FAIMS Pro, prepare the MS system by connecting a sample flow to the source and calibrate the MS as described in the MS hardware manuals - *TSQ Altis and TSQ Quantis Hardware Manual* and *Orbitrap Hybrid Hardware Manual*.

Here is an example acquisition on a Fusion Lumos MS.

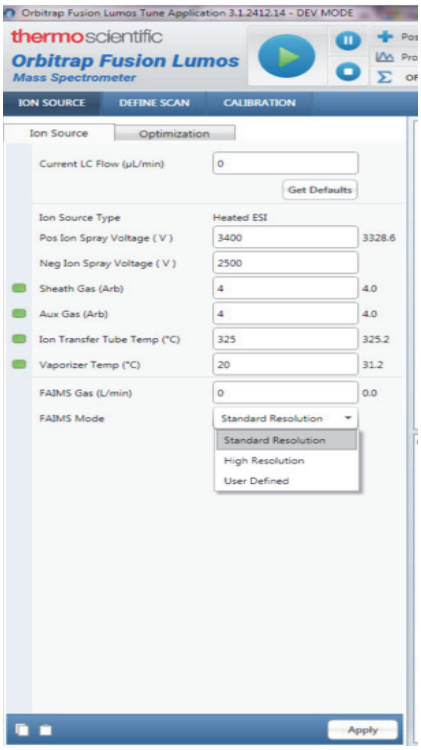
1. Calibrate FAIMS by running and completing **Tune DV RF** and **Check DV RF**.
2. Enter the ion source values in the Ion Source pane, and then click **Apply**

Figure 36. Ion Source pane



3. Choose **Standard Resolution** for **FAIMS Mode** in Ion Source pane, then click **Apply.**

Figure 37. Select FAIMS mode

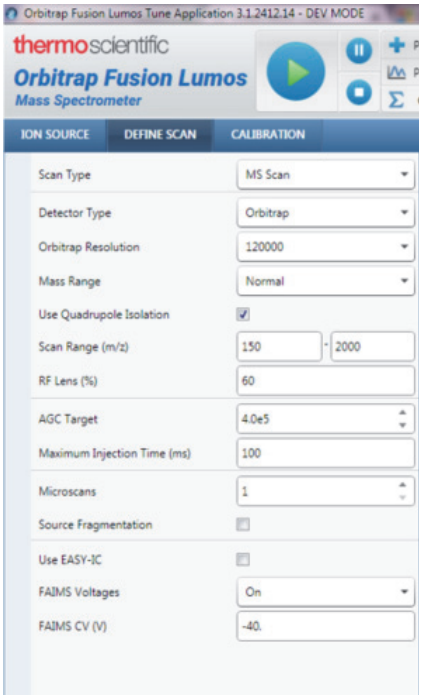


4. Choose your **Scan Type** from the dropdown list in the Define Scan pane.

Figure 38. Setup Scan Type

5. Set **FAIMS Voltages** to On and enter your **FAIMS CV (V)** value.
6. Click **Apply**

Figure 39. Activate FAIMS



7. Click the **Continuous Acquisition** button and choose **FAIMS CV Scan.**

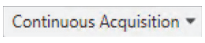
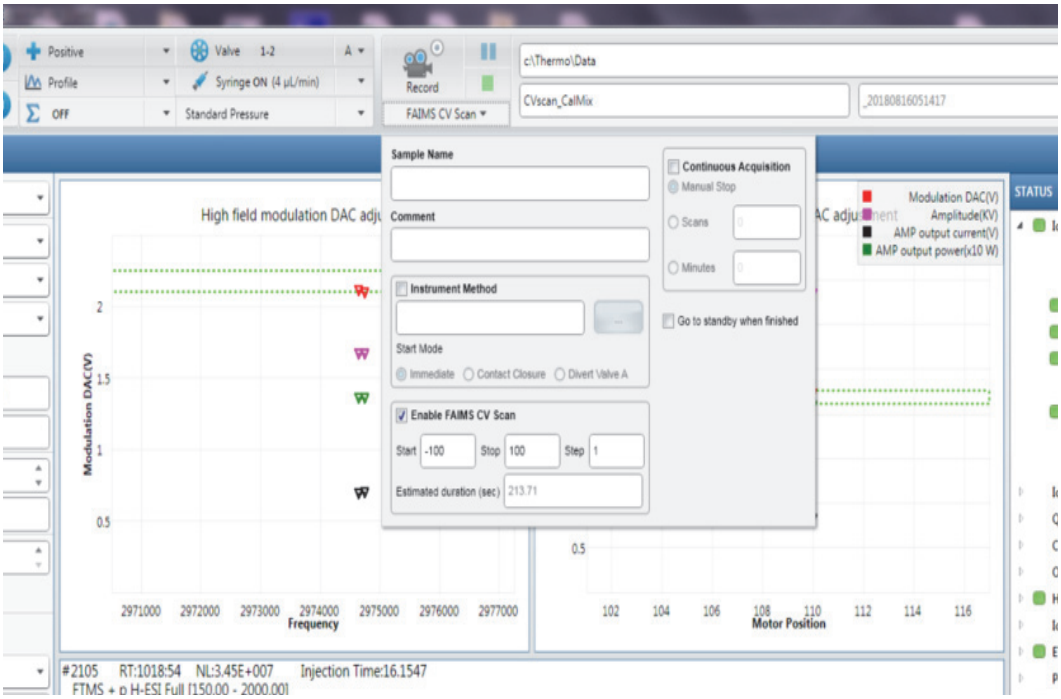
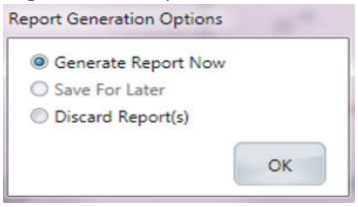


Figure 40. Setup CV Scan Steps



8. Select the **Enable FAIMS CV Scan.**
9. Select **Generate Report Now** in the Report Generation Options dialog box and click **OK.**

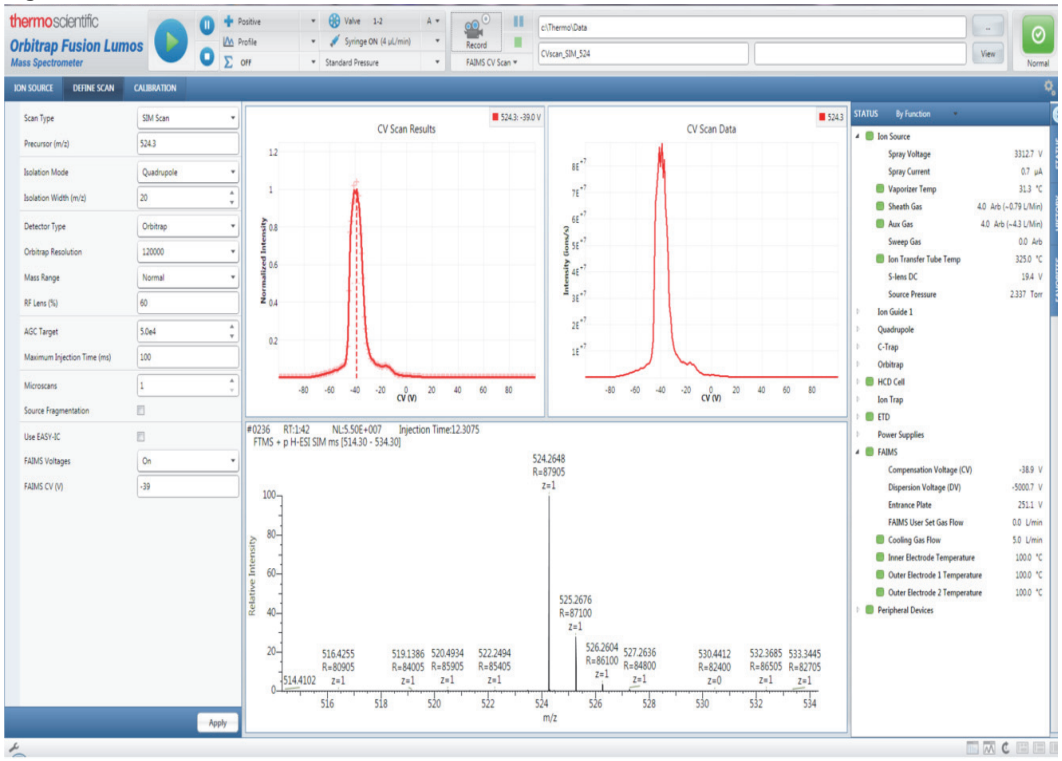
Figure 41. Report Generation



10. Click the **Record** button.

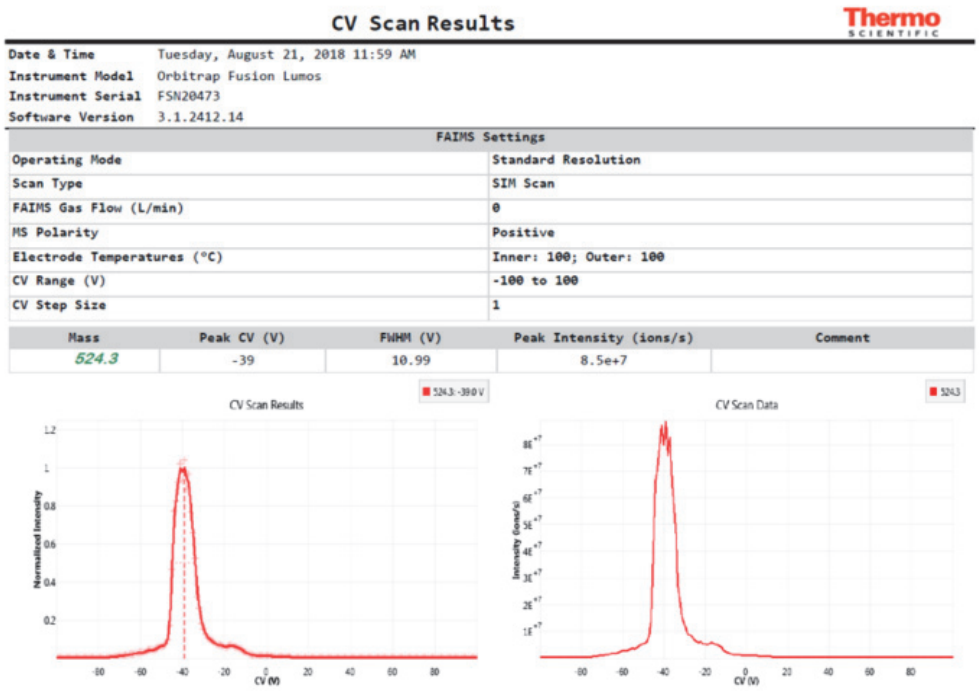
The following display appears after recording:

Figure 42. CV Scan Results



The corresponding CV Scan results will be stored in the PDF from Report Generation.

Figure 43. CV Scan Results Report



CV Scan Results

Thermo SCIENTIFIC

Date & Time	Tuesday, August 21, 2018 11:59 AM
Instrument Model	Orbitrap Fusion Lumos
Instrument Serial	FSN20473
Software Version	3.1.2412.14

FAIMS Settings	
Operating Mode	Standard Resolution
Scan Type	SIM Scan
FAIMS Gas Flow (L/min)	0
MS Polarity	Positive
Electrode Temperatures (°C)	Inner: 100; Outer: 100
CV Range (V)	-100 to 100
CV Step Size	1

Mass	Peak CV (V)	FWHM (V)	Peak Intensity (ions/s)	Comment
524.3	-39	10.99	8.5e+7	

Using Method Editor Templates to Acquire Sample Data

The Method Editor in the Xcalibur Instrument Setup window contains several FAIMS method templates that serve as starting points for DDA peptide ID, TMT, and label-free quantitation workflows. The results are suitable results for bottom-up proteomics applications without optimization. Methods greater than 90 minutes might benefit from 2-3 CV scans in the experiments used throughout the entire run. Methods greater than 2 hours can benefit from 3-4 CV scans in the experiments used throughout the entire run. Optimization and data evaluation include ensuring that an appropriate number of points are detected across the MS1 chromatographic peak at each CV scan (≥8) and adjusting the MS cycle time based on chromatographic peak width. You can change the CVs selected in the method templates, but the original CVs represent the best starting point for tryptic peptides. The CV range for tryptic peptides is -30 to -120 V. For intact protein analyses, the CVs are not well predicted, and some optimization might be required for best performance. The CV range for intact proteins is -70 to +60 V.

From the Xcalibur Instrument Setup window, you can use the Method Editor to create aninstrument method for your experiment:

1. Open the system template designed for the experiment type that you want to perform.
2. Enter the parameters specific to the experiment.

3. Save the entries as part of an Xcalibur instrument method (.meth file name extension).

Using FreeStyle to View Previously Acquired Sample Data

To post-process a previously acquired sample data from an Xcalibur raw data file, use the FreeStyle application. The FreeStyle application can visualize and qualitatively analyze mass spectrometry data.

❖ To select the traces for display in the CV Plot view

1. Open an Xcalibur raw data file with data acquired from a mass spectrometer with the FAIMS interface.
2. In the Chromatogram Ranges view, set up the traces of interest.
3. In the Workspace Options toolbar, click **CV Plot**.

   The CV Traces dialog box opens.
4. Select the check boxes for the traces of interest.
5. Click **OK.**

Use the CV Plot view to determine the optimum compensation voltages for your LC/MS/FAIMS experiments.

Related Topics

For more information on FreeStyle, refer to the *FreeStyle Users Guide* - FAIMS Working with CV Plots and for FAIMS Data.

Maintaining the FAIMS Pro System

Contents

For a list of replaceable parts, see Chapter 9, "Replaceable Parts."

CAUTION Before performing maintenance tasks, either shut down the MS or place it in standby mode as specified in the applicable procedure.

CAUTION **Hot Surface.** The external surface of the spray insert, API source housing, and entry to the ion transfer tube can be hot enough to burn your skin. Allow the parts to cool to room temperature (approximately 20 minutes) before servicing them.

Maintenance Schedule

Table 7 lists the maintenance procedures and their recommended frequency.

Table 7. FAIMS system maintenance procedures and frequency

Component	Procedure	Recommended frequency	Reference
Inlet components	Flush (clean) the path from the sample transfer line to the source.	Daily	page 69
Housing adapter	Clean the inner and outer electrodes.	As needed	page 74
	Clean the drain adapter.	As needed	page 75
	Clean the entrance plate.	As needed	page 73
	Replace the entrance plate O-ring.	As needed	page 77
Main control box	Replace one or both fuses.	As needed	page 78
RF transformer box	Clean the air filter.	Every 4 months	page 75

Guidelines

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

- Always wear a new pair of lint- and powder-free gloves when handling internal components. Never reuse gloves after you remove them because the surface contaminants on them recontaminate clean parts.
- Always place the components on a clean, lint-free work surface.
- Have nearby the necessary tools, supplies, and replacement parts (when applicable).
- Never overtighten a screw or use excessive force.
- Proceed methodically.

IMPORTANT Make sure that you do not introduce any scratches or surface abrasions while handling the entrance plate and electrodes. Even small scratches can affect performance if they are close to the ion transmission path. Avoid using tools, such as metal pliers, that might scratch these components.

Tools and Supplies

The FAIMS system requires very few tools to perform routine maintenance procedures. You can remove and disassemble many of the components manually. Table 8 lists the necessary chemicals, tools, and equipment for maintaining the system.

CAUTION To prevent corrosion, do not use nitric acid to clean metal parts.

CAUTION Avoid exposure to potentially harmful materials.

By law, producers and suppliers of chemical compounds are required to provide their customers with the most current health and safety information in the form of Material Safety Data Sheets (MSDS) or Safety Data Sheet (SDS). The MSDS and SDS 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. Chemicals, tools, and equipment (Sheet 1 of 2)

Description	Part number
Chemicals	
Detergent (for example, Liquinox™)	(Liquinox) Fisher Scientific: • 50-821-299 (1 quart) • 50-821-298 (1 gallon)
Methanol, UHPLC/MS-grade	Fisher Scientific A458-1
Nitrogen gas, clean and dry	–
Water, UHPLC/MS-grade	Fisher Scientific W8-1
Tools	
Screwdriver, Phillips	–

Table 8. Chemicals, tools, and equipment (Sheet 2 of 2)

Description	Part number
Equipment	
Gloves, lint-free and powder-free	Fisher Scientific 19-120-2947[a] Unity Lab Services: • 23827-0008 (medium size) • 23827-0009 (large size)
Industrial tissues, lint-free	–
Magnification device	–

[a] Multiple sizes are available.

Shutting Down the LC/MS/FAIMS Pro System

Shut down the LC/MS/FAIMS system when you are not using it for an extended period of time or when you must shut it down for maintenance or service.

❖ To shut down the MS/FAIMS system

1. If your system includes an LC pump, turn off the liquid flow to the source.
2. In the Tune window, place the MS in Standby mode,  .
3. Place the MS electronics service switch in the Service Mode (down) position.

   This turns off the front LEDs and the power to the non-vacuum system electronics.
4. Turn off the MS Main Power switch and the MCB power switch.
5. Unplug the MS and MCB power cords from the electrical outlets.

CAUTION Do not disconnect the power cords at the MS or MCB while the other ends are still plugged into the electrical outlets.

6. (Optional) Turn off the LC instruments, gas supply at its tank, and data system computer.

Note For routine or preventive system maintenance, you do not need to turn off the LC instruments, gas supply, and data system. In this case, the shutdown procedure is complete.

To restart the LC/MS system refer to “Starting the System after a Complete Shutdown” in the instrument manual, and then turn on the MCB power switch to restart the FAIMS system.

Flushing the Inlet Components

Leaving the FAIMS system attached to the MS, flush the syringe and the inlet components at the end of each work day (or more often if you suspect contamination). You can also use an LC pump to flush a 50:50 methanol/water solution through the inlet components to the ion source at a flow rate of 200–400 µL/min for approximately 15 minutes.

CAUTION When the MS ion transfer tube is installed, do not flush the MS with cleaning solution, which flushes the residue into it.

❖ To flush the inlet components

1. Turn off the liquid flow from the syringe pump.
2. Place the MS in Standby mode,  .
3. Remove the syringe from the syringe pump, and then carefully remove the syringe needle from the Teflon™ tube on the syringe adapter assembly.
4. Rinse the syringe with a solution of 50:50 methanol/water.
5. Flush the sample transfer line, sample tube, and spray insert as follows:
   a. Load the clean syringe with a solution of 0.1% formic acid in 50:50 methanol/water (or another appropriate solvent).
   b. Carefully reinsert the syringe needle into the Teflon tube on the syringe adapter assembly.
   c. Slowly depress the syringe plunger to flush the solution through the sample transfer line, sample tube, and spray insert.
   d. Remove the syringe needle from the syringe adapter assembly.

Removing Components

See these topics:

- Removing the Ion Source from the FAIMS Pro System
- Removing the Electrode Assembly from the Housing Adapter
- Removing the Electrode Set from the Entrance Plate
- Removing the FAIMS Pro System from the MS

Removing the Ion Source from the FAIMS Pro System

Although the MS automatically goes into standby mode when you remove the ion source, it is a good habit to manually place the MS into standby mode.

CAUTION Hot surface. The external surface of the spray insert, API source housing, MS Ion sweep cone, and entry to the ion transfer tube can be hot enough to burn your skin. Allow the parts to cool to room temperature (approximately 20 minutes) before you touch them.

❖ To remove the ion source from the FAIMS Pro System

1. Turn off the LC liquid flow to the source, and disconnect the LC plumbing.
2. Place the MS in Standby mode,  .
3. For additional instructions, refer to the ion source manual.

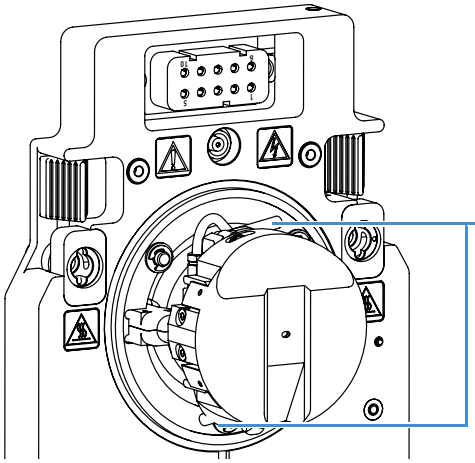
Related Topics

- Installing the EASY-Spray NG Ion Source on the FAIMS Pro System
- Installing the Nanospray Flex NG Ion Source on the FAIMS Pro System

Removing the Electrode Assembly from the Housing Adapter

No tools are needed to remove or install the electrode assembly.

❖ To remove the electrode assembly from the housing adapter



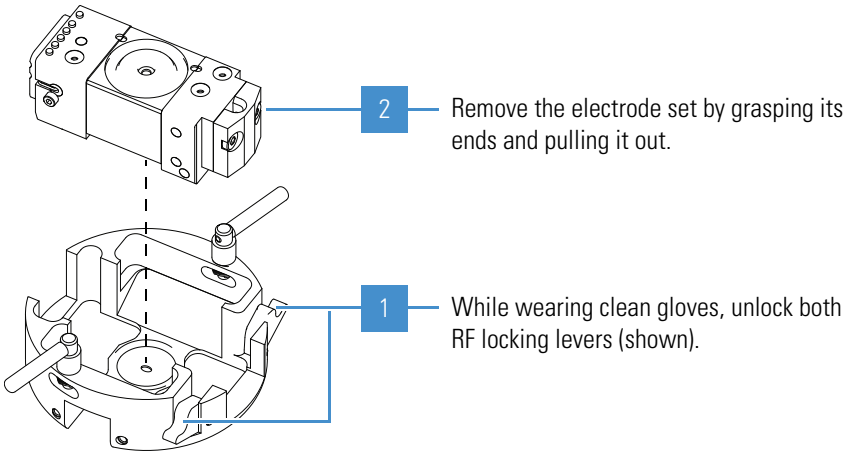
Related Topics

- Cleaning the Entrance Plate
- Installing the Electrode Assembly to the Housing Adapter

Removing the Electrode Set from the Entrance Plate

No tools are needed to remove or install the electrode set from the entrance plate.

❖ **To remove the electrode set from the entrance plate**



Related Topics

- Removing the Electrode Assembly from the Housing Adapter
- Cleaning the Electrodes

Removing the FAIMS Pro System from the MS

For optimal performance of non-FAIMS experiments, remove the FAIMS system. You can optionally disconnect the MCB connections and leave that box on top of the MS. You do not need tools to remove or install the FAIMS system.

Tip If you are removing the housing adapter and RF transformer box for a short period of time, place the assembly on top of the MS and place a clean tissue over the electrode assembly.

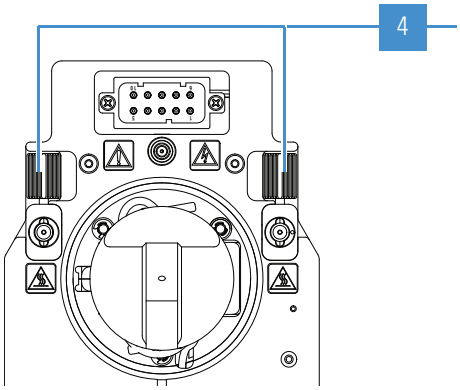
❖ To remove the FAIMS system from the MS

1. After the system cools to room temperature (approximately 20 minutes), follow the procedure in Removing the Ion Source from the FAIMS Pro System.

   Note You cannot unlock and remove the FAIMS system while the source is still attached.

2. If you are removing the FAIMS system, remove the syringe pump and modular valve assembly from the top of the MS.

3. Turn off the MCB power switch, and then disconnect its power cord from the electrical outlet. If you are removing the FAIMS system, disconnect all MCB connections.



4. Unlock the housing adapter's locking levers (not shown), grasp behind the RF transformer box and pull off the housing adapter and RF transformer box.

   IMPORTANT Do not pull on or hold the system by its cable.

Cleaning Components

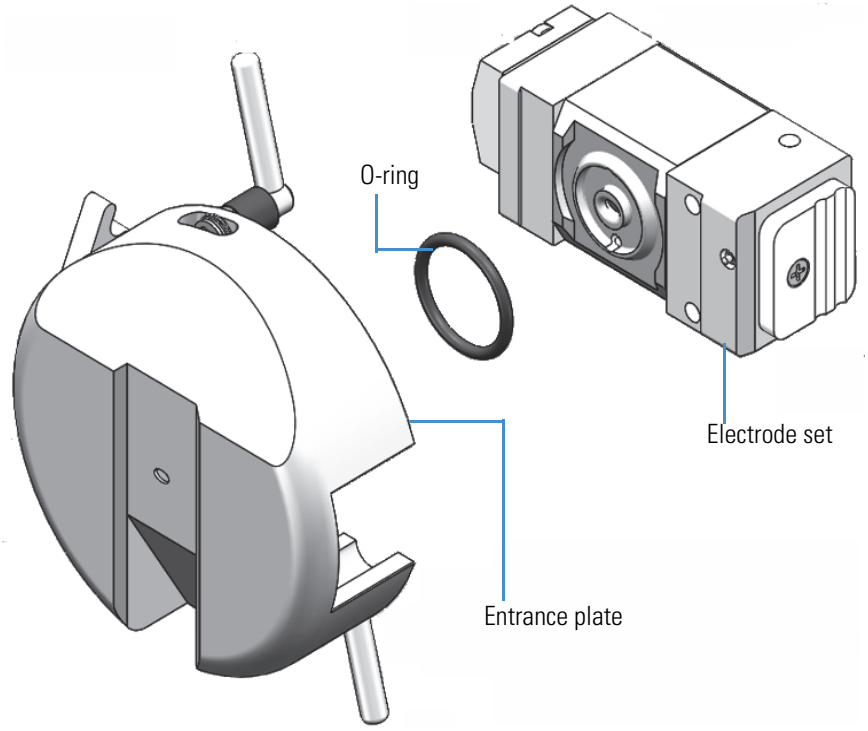
See these topics:

- Cleaning the Entrance Plate
- Cleaning the Electrodes
- Cleaning the RF Transformer Box's Air Filter
- Cleaning the Housing Adapter's Drain Adapter

Cleaning the Entrance Plate

Note Remove the electrode set and O-ring before cleaning the entrance plate.

Figure 44. Entrance plate

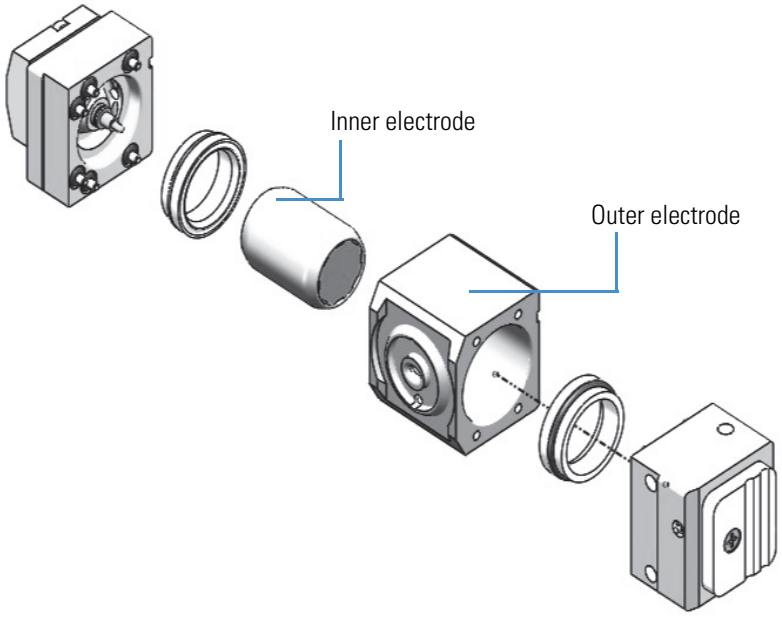


❖ **To clean the entrance plate**

1. Use a soft toothbrush to clean the entrance plate with a 1% solution of Liquinox in water.
2. Clean both the entrance and exit sides of the entrance plate.
3. Use a cotton swab to clean inside the entrance plate orifice.
4. Thoroughly rinse the entrance plate with water.
5. Rinse the entrance plate with methanol.
6. Blow the entrance plate with a stream of nitrogen gas until it is dry.

Cleaning the Electrodes

Figure 45. Separate the inner electrode and the outer electrode from electrode set assembly



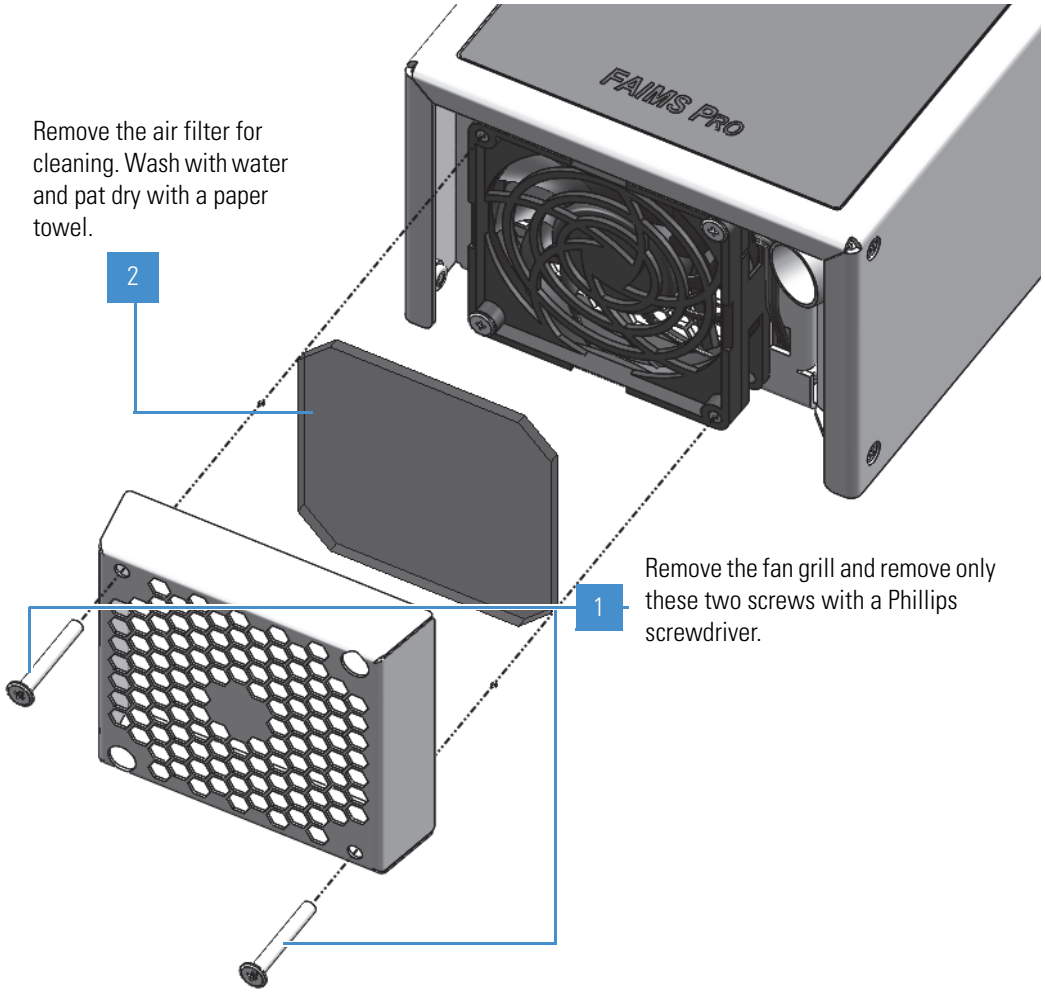
CAUTION Do not use Micro-Mesh (TM) products or any abrasive substance that could damage the electrodes metal surface.

❖ To Clean the inner and the outer electrodes

1. Separate the inner electrode and the outer electrode from the electrode set.
2. Sonicate the inner electrode and the outer electrode in a 1% solution of Liquinox in water.
3. Thoroughly rinse the inner electrode and the outer electrode with water.
4. Rinse the inner electrode and the outer electrode with methanol.
5. Blow the inner electrode and the outer electrode with a stream of nitrogen gas until they are dry.

Cleaning the RF Transformer Box's Air Filter

Figure 46. Air filter on the bottom of the RF transformer box

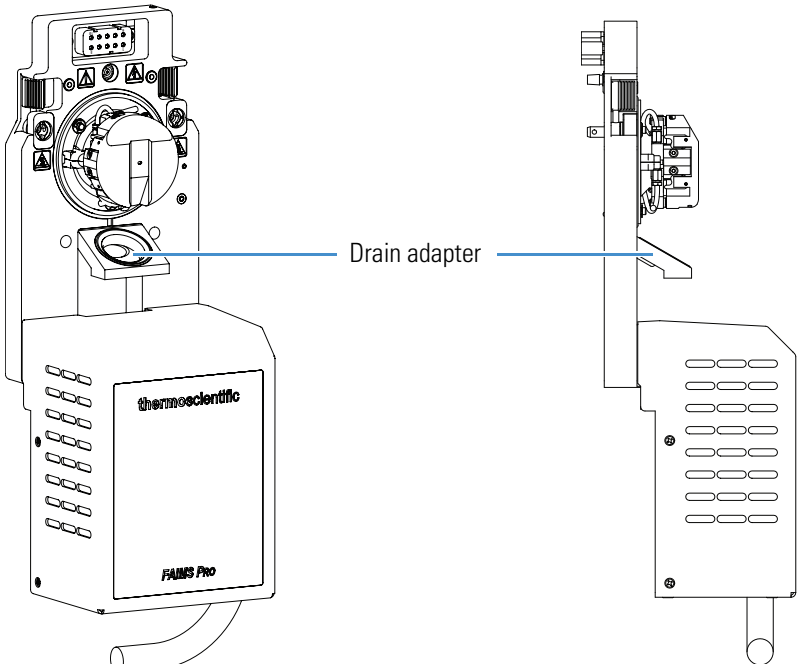


Cleaning the Housing Adapter's Drain Adapter

Cleaning is needed if there is a high background.

IMPORTANT Clean the drain adapter after the housing adapter is removed from the MS.

Figure 47. Drain adapter on the housing adapter



❖ To clean the drain adapter

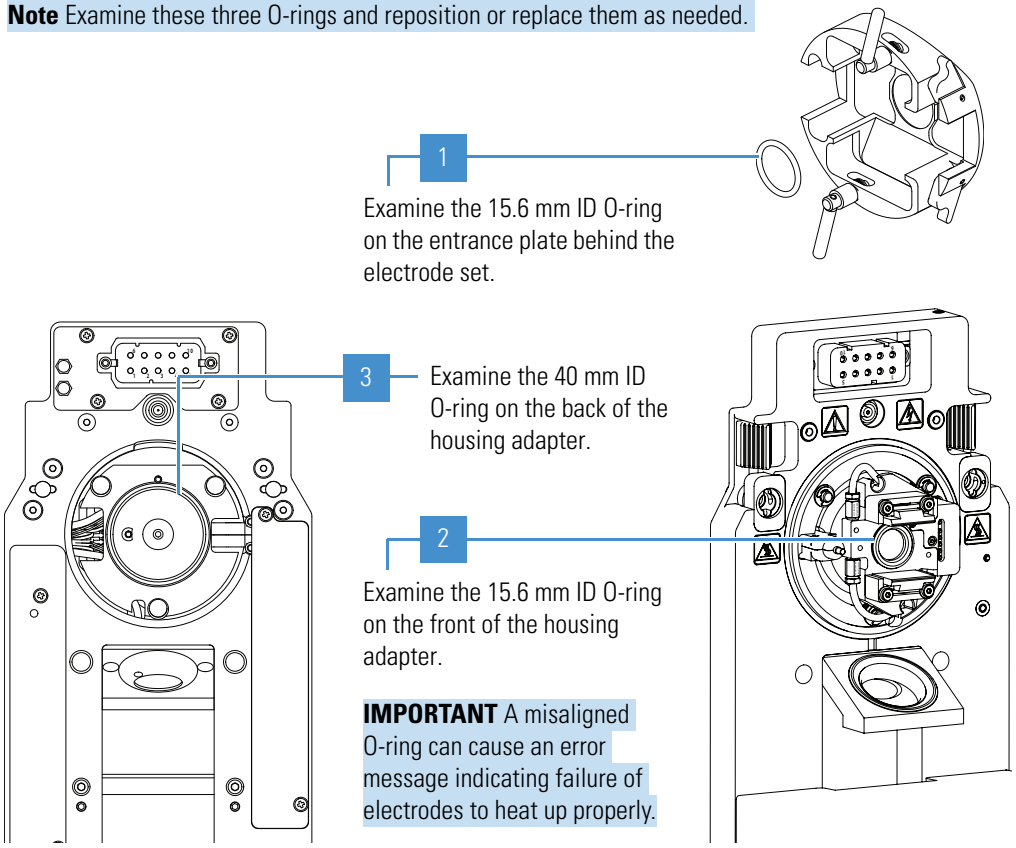
1. Use a soft toothbrush to clean the drain with a 1% solution of Liquinox in water.
2. Thoroughly rinse the drain with water.
3. Rinse the drain with methanol.
4. Blow the drain with a stream of nitrogen gas until it is dry.

Fixing a Gas Leak Between the MS and the Electrodes

If you observe a gas leak after installing the FAIMS system, reposition or replace the three captive O-rings as shown in this procedure.

❖ **To reposition or replace the FAIMS system O-rings**

Note Examine these three O-rings and reposition or replace them as needed.



IMPORTANT A misaligned O-ring can cause an error message indicating failure of electrodes to heat up properly.

Related Topics

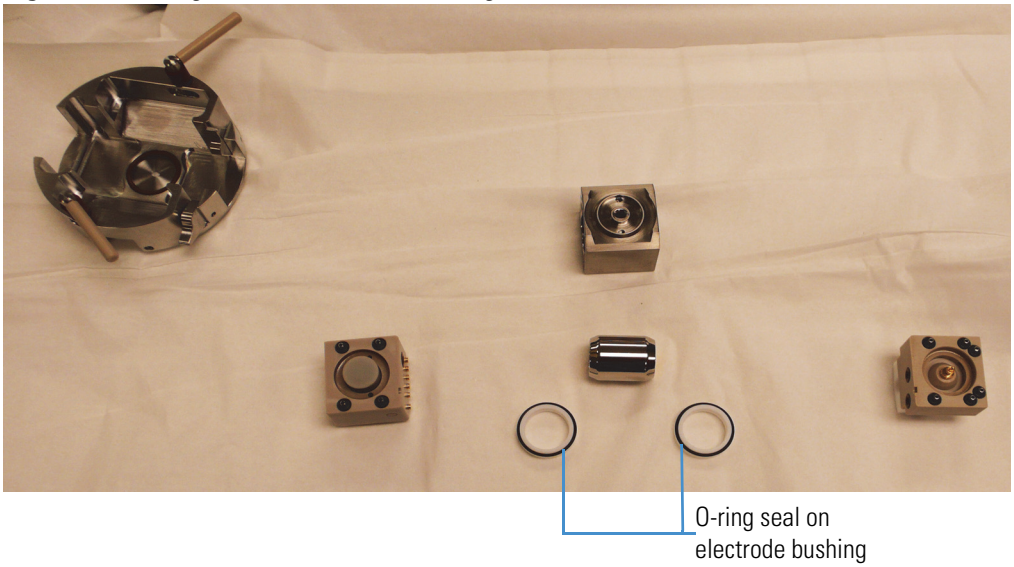
- Installing the FAIMS Pro System
- Removing the Ion Source from the FAIMS Pro System
- Removing the Electrode Assembly from the Housing Adapter
- Removing the Electrode Set from the Entrance Plate
- Removing the FAIMS Pro System from the MS
- Chapter 9, “Replaceable Parts.”

Reassemble Components

❖ **To reassemble the electrode set and entrance plate**

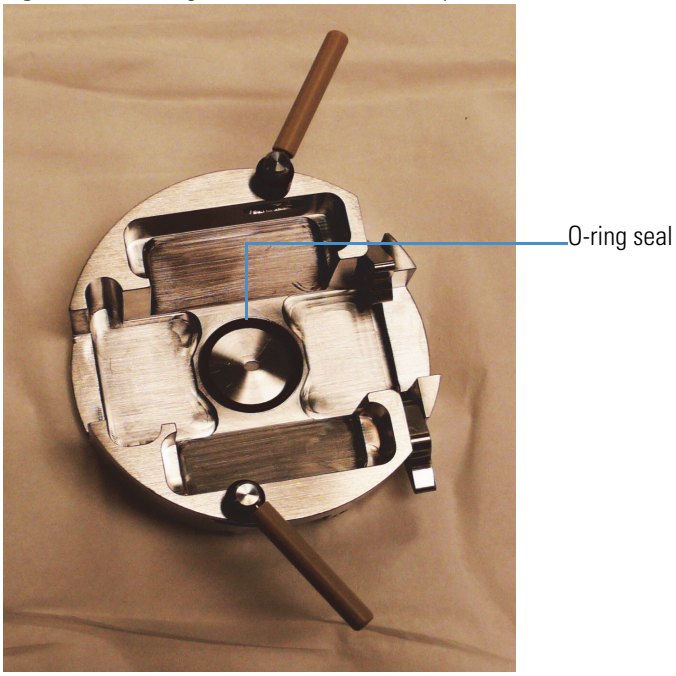
1. Place the two smaller O-rings onto the two electrode bushings.

Figure 48. O-ring seals for electrode bushing



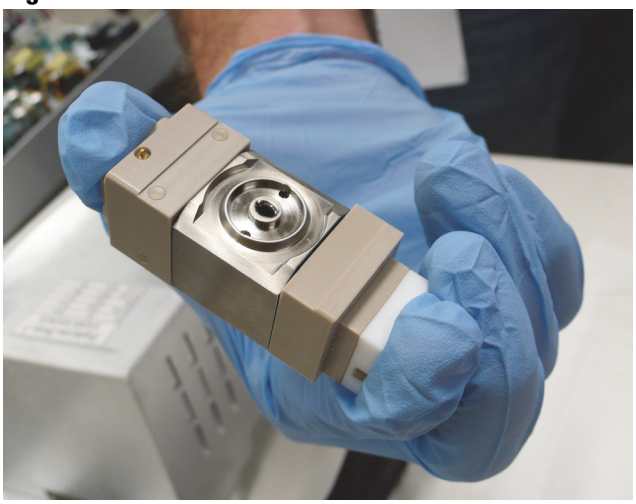
2. Place the one larger O-ring into the correct position one the back side of the entrance plate.

Figure 49. O-ring seals for the entrance plate



3. Reassemble the electrode set and hold the electrode set with thumb and forefinger.

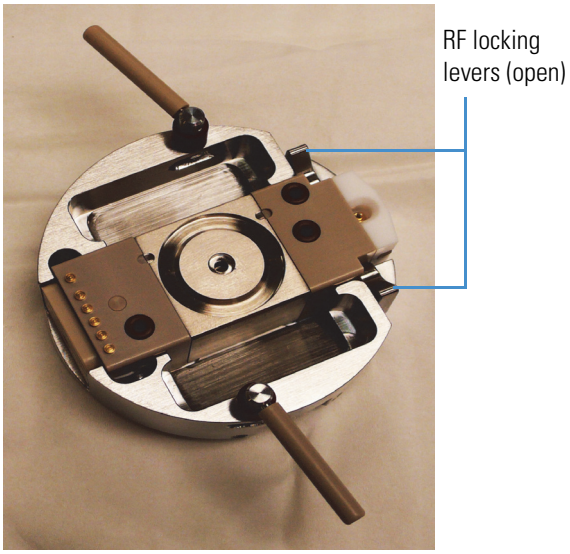
Figure 50. Assembled electrode set



4. Place the assembled electrode set into the entrance plate above the larger O-ring.

   The electrode set is self aligning and will fit in only one correct position within the entrance plate.

Figure 51. Electrode set inserted into entrance plate



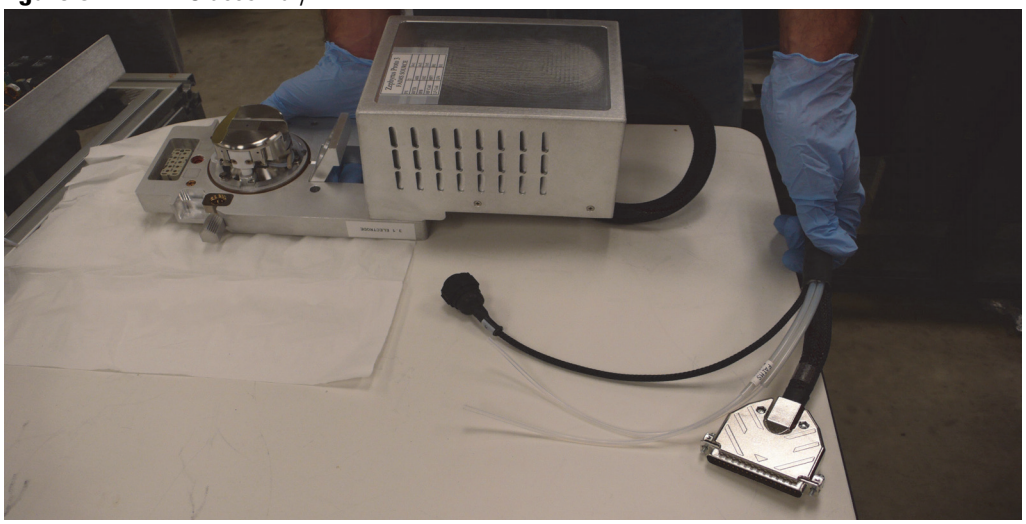
5. Close the two RF locking levers on the entrance plate.

❖ To connect the electrode assembly to the housing adapter to form the FAIMS assembly

1. Place the housing adapter on a clean lint-free surface.
2. Attach the assembled electrode assembly onto the housing adapter to form the FAIMS assembly.

3. Close the locking levers on the electrode assembly to attach to the housing adapter.

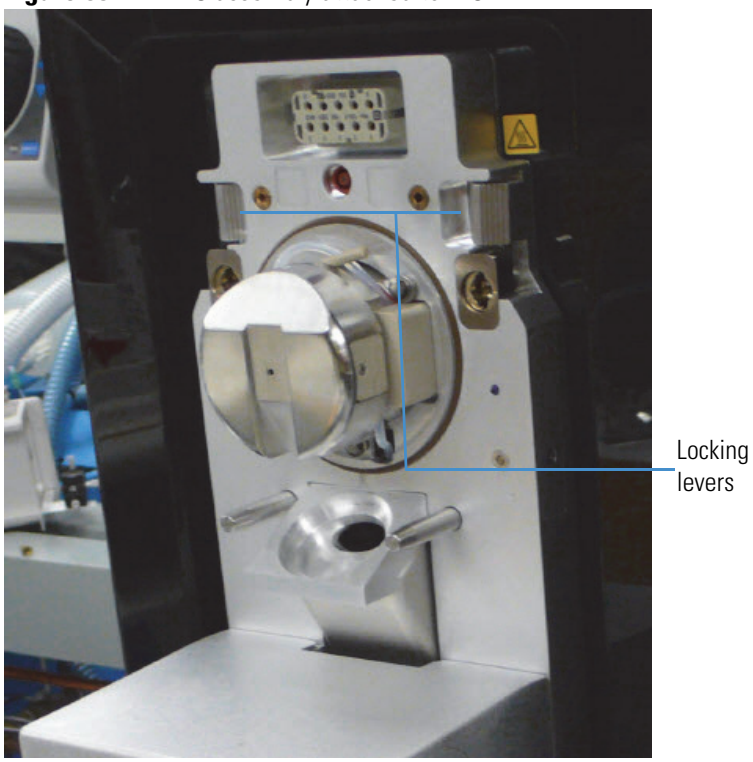
Figure 52. FAIMS assembly



❖ To attach the FAIMS assembly to the MS

1. Turn off the MCB.
2. Set the MS electronics service switch to service mode position.
3. Place the FAIMS assembly on the MS.
4. Close the locking levers around the FAIMS assembly to attach to the MS.
5. Connect the Signal Connector cable, FAIMS gas tubing, Coolent gas tubing, and High-Voltage cable from the FAIMS Assembly to the MCB.

Figure 53. FAIMS assembly attached to MS



Replaceable Parts

Contents

Note The FAIMS Pro system ships with an installation kit and a power cord. Use the provided part numbers when ordering replacement parts.

Additional Parts

Fuse, miniature cartridge, 5 × 20 mm, time-lag, low-breaking capacity, 2 A 250 V (for the MCB AC inlet) 00006-09105

O-ring, Viton 884, 1-5/8 in. ID, 1/16 in. wide (back of the housing adapter) 00107-01-00019

Consumable Parts

Calibration solutions

Pierce™ FlexMix™ solution A39239

Pierce triple quadrupole extended-mass range solution (EMRS) 88340

Power Cord

Country or territory[a]	Receptacle type	Plug type	Plug rating	Cord length
North America (P/N 6003-0160)	C13	NEMA 5-15, nonpolarized	125 Vac, 10 A	2.3 m (7.5 ft)
International[b] (various part numbers)	C13	Various	250 Vac, 10 A	2.5 m (8.2 ft)

[a] Part number is provided for Thermo Fisher Scientific field service use only.

[b] "International" designation is for countries or territories that do not use the North American plug configuration.

Specifications

Table 9 lists the specifications for the FAIMS Pro system.

Table 9. FAIMS Pro system specifications (Sheet 1 of 2)

Parameter	Specification
Dimensions (*w* × *l* × *d*)	
Housing adapter and RF transformer box	14 × 39.6 × 14.8 cm (5.5 × 15.6 × 5.8 in.)
Main controller box (MCB)	31.9 × 6.1 × 48 cm (12.6 × 2.4 × 18.9 in.)
Weight	
Housing adapter, RF transformer box, cable assembly, and electrode assembly	3.5 kg (7.7 lb)
Main control box (MCB)	2.7 kg (6 lb)
Electrical requirements	
Input rating	100–240 Vac, 50/60 Hz, 2.2 A
Input fuse (MCB AC inlet filter/fuse holder)	Miniature cartridge, 5 × 20 mm, 250 Vac, 2 A, time-lag, low-breaking capacity
Transient overvoltages	Category II
Electrical outlet (wall receptacle)	• North America and other countries with the same configuration: NEMA 5-15 (250 Vac, 5 A) • Other locations outside North America: various plug types (250 Vac, minimum 5 A)
Power cord	See Power Cord for lengths and plug types.

Table 9. FAIMS Pro system specifications (Sheet 2 of 2)

Parameter	Specification
Environmental requirements	
Relative humidity	40–80%, noncondensing
Temperature	• Operating range: 15–27 °C (59–81 °F) • Optimum operating range: 18–21 °C (64–70 °F) • Ambient temperature fluctuations: Less than 1 °C or 2 °F over a one-hour period
Heat output (power)	180 VA (614 BTU/h)
Gas supply requirements	
Nitrogen	• High-purity (99.5%) • 690 ±138 kPa (100 ±20 psi) • Cooling Gas: 5- 20 L/min • FAIMS Carrier Gas: 1.5 - 7.2 L/min • User Gas: 0 - 2 L/min • Tubing, Teflon™ PFA, 1/4 in. (6.35 mm) OD, 0.062 in. (1.57 mm) thick, 4.6 m (15 ft) long (gas supply tank)
Gas consumption flow rate (Software set to 2 L/min.)	(NSI mode) 6.5–18.2 L/min (0.229–0.501 ft^3/min)

Table 10 list the Nitrogen Gas Requirements per ion source for the FAIMS Pro system.

Table 10. FAIMS Nitrogen Requirements - Ion Source Mode

		FAIMS Carrier Gas (L/min)				
		1.5	5.6	7.2	1.5	5.6
Ion Source Mode	Cooling Gas (L/min)	Quantis (L/min)	Altis (L/min)	Quantiva (L/min)	Fusion (L/min)	Lumos (L/min)
NSI	5	6.5	10.6	12.2	6.5	10.6
ESI	13	14.5	18.6	20.2	14.5	18.6

Note An optional user gas adds an additional **0-2 L/min** to the selected value in the table.

Index

R

S

T

V

W