

FAIMS

Operator's Manual

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June 2007

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EMC Directive 89/336/EEC, 92/31/EEC, 93/68/EEC

EMC compliance has been evaluated by TUV Rheinland of North America, Inc.

| | | | |
|--------------|--------------|--|--------------|
| EN 61326-1 | (1997) | EN 61000-4-6 | (1996, 2001) |
| EN 55011 | (1998) | EN 61000-4-11 | (1994, 2001) |
| EN 61326 | (1998) | EN 61000-3-2 | (1995) |
| EN 61000-4-2 | (1998) | EN 61000-3-3 | (1995) |
| EN 61000-4-3 | (2002) | CFR 47 - Part 15 - Subpart B: 2005 - Class A | |
| EN 61000-4-4 | (1995, 2001) | CFR 47 - Part 18: 2005 | |
| EN 61000-4-5 | (1995, 2001) | | |

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Preface

About This Manual

This manual describes the information required to use the Thermo Scientific high-Field Asymmetric waveform Ion Mobility Spectrometry (FAIMS) system on TSQ Quantum series and LTQ series mass spectrometers. This guide also describes maintenance and troubleshooting information.

This manual assumes that the FAIMS system has been installed by Thermo Fisher Scientific's authorized representative and is ready for use. Information in this manual about setting up the FAIMS system on your instrument is provided only in the event you must remove or reassemble parts.

Related Documentation

In addition to this Operator's Manual, Thermo Fisher Scientific provides the following documents for the TSQ Quantum series and LTQ series mass spectrometers:

- Preinstallation Requirements Guide
- Getting Connected
- Getting Started
- Hardware Manual

Safety and Special Notices

Make sure you follow the precautionary statements presented in this guide. The safety and other special notices appear in boxes.

Safety and special notices include the following:



CAUTION Highlights hazards to humans, property, or the environment. Each CAUTION notice is accompanied by an appropriate CAUTION symbol.

IMPORTANT Highlights information necessary to prevent damage to software, loss of data, or invalid test results; or may contain information that is critical for optimal performance of the system.

Note Highlights information of general interest.

Tip Helpful information that can make a task easier.

Hazard Symbols

Hazard symbols identify important information to protect the user from personal injury and to prevent damage to the FAIMS system. Failure to comply with these precautions violates the safety standards of the design and intended use of the equipment.

The following symbols are used on the FAIMS system and in this documentation to indicate safety cautions that indicate risks for people. Disregard for these cautions may cause personal harm.



Indicates the presence or use of compressed gas.



Indicates danger from high voltages.



Indicates potential harm due to hot surfaces.



Indicates danger from toxic substances.



Indicates danger from corrosive substances.



Indicates danger from flammable substances.



Indicates the presence of alternating current (AC) power.



Indicates the system protective earth location.



Indicates a general caution for additional care to be taken.

General Safety and Instrument Considerations




Observe the following:



CAUTION When working with the FAIMS system, always follow these general safety and instrument considerations, as well as others described throughout this manual. Disregard for these cautions may cause harm to the user or the FAIMS system.

- The FAIMS system (referring to both its waveform generator and temperature control modules) must be connected to the mass spectrometer for normal operation. Do not operate the temperature control module without connecting it to the mass spectrometer or the waveform generator.
- Do not attempt to open the waveform generator or the temperature control module. All servicing must be performed by a Thermo Fisher Scientific authorized representative.
- The FAIMS waveform generator applies high voltages. Power down the FAIMS system before performing any procedures that cause exposure to these voltages.
- Use the FAIMS system and mass spectrometer only in the manner specified by Thermo Fisher Scientific Corporation. Any other use may impair the protection provided by the equipment.
- During operation, components of the mass spectrometer and the FAIMS system may become very hot. Ensure that components are cool before attempting to handle them.
- Observe good laboratory practices when working with chemicals (for example, when cleaning the FAIMS electrodes). Use a fume hood and wear appropriate personal protective equipment.
- To prevent overheating of the FAIMS system, do not block its top ventilation holes.
- Inspect all components and connections on a regular basis to ensure they remain in proper working condition.
- Replace the AC fuse only with the appropriate fuse, as described in “[Replacing AC Fuses](#)” on [page 101](#).

The following symbols are used on the FAIMS system to indicate whether power is being supplied to the FAIMS waveform generator or temperature control modules:

-  Indicates the position of the power switch to apply power to the FAIMS waveform generator and temperature control modules.
-  Indicates the position of the power switch when power is not being applied to the FAIMS waveform generator or temperature control modules.
-  Identifies the location of the fuse. The fuse value appears beside this symbol.

Environmental Considerations

The following table describes the environmental considerations for the FAIMS system. Unless specified otherwise, values apply to both the waveform generator and the temperature control module.

| Requirement | Description |
|---|---|
| Input voltage range | 120 to 240 V at 50 to 60 Hz AC |
| Maximum current (waveform generator) | <ul style="list-style-type: none">• 2.5 A at 120 VAC• 1.3 A at 240 VAC |
| Maximum current (temperature control module) | <ul style="list-style-type: none">• 5 A at 120 VAC• 2.5 A at 240 VAC |
| Installation environment | Installation category II, Pollution degree 2 |
| Operating temperature | 15° C to 30° C |
| Operating humidity | 5% to 95% RH non-condensing |
| Operating altitude | 0 to 2000 meters above sea level |
| Storage temperature | -40 °C to 70 °C |
| Storage humidity | 5% to 95% RH non-condensing |
| Input air pressure (temperature control module) | Minimum: 40 psi Maximum: 60 psi |

Performance Considerations

When working with the FAIMS system, the following can affect FAIMS system performance:

- When handling stainless steel components such as the FAIMS electrodes, ensure that the surfaces are not scratched.
- The high voltage lead includes a wire of a fixed length and rings at either end of the lead that can easily be damaged if not handled properly. Damage to the high voltage lead caused by stretching or bending the lead is not covered by warranty.

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Fax: 1-561-688-8736
E-mail: TechSupport.C+MS@thermofisher.com
Knowledge base: <http://www.thermokb.com>

Find software updates and utilities to download at <http://mssupport.thermo.com>.

Contact Customer Service

For ordering information in the U.S. and Canada:

Phone: 1-800-532-4752
Fax: 1-561-688-8731
Web site: www.thermo.com/finnigan

Changes to the Manual and Online Help

To suggest changes to this guide or to the Help, use one of the following:

- Fill out a reader survey online at www.thermo.com/lcms-techpubs.
- Send an e-mail message to the Technical Publications Editor at techpubs.finnigan-lcms@thermofisher.com.

FAIMS Overview

This chapter provides an overview of the high-Field Asymmetric waveform Ion Mobility Spectrometry (FAIMS) system. This chapter also describes the components of the FAIMS system and the general system operation. The FAIMS system with the TSQ Quantum Ultra and LTQ XL are shown below.



Figure 1. FAIMS system and TSQ Quantum Ultra



Figure 2. FAIMS system and LTQ XL

FAIMS Operation

FAIMS adds another dimension of selectivity to LC/MS/MS experiments, providing the additional selectivity that is often required in challenging LC/MS/MS assays.

Using FAIMS, only selected ions pass from the ion source to the mass spectrometer. The result is increased selectivity, improved detection limits, and increased throughput.

Selection of Ions

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

At low field strengths, the ion mobility is independent of the applied electric field. However, at 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.

In the FAIMS system, alternating high and low electric fields are applied to a set of concentric cylindrical electrodes. Alternating electric fields are supplied via a waveform generator that produces an asymmetric waveform. This asymmetric waveform applies a high electric field, called the dispersion voltage (DV), between the electrodes for a short period of time and then applies a lower electric field for a longer time.

When the FAIMS electrodes are installed on the mass spectrometer, desolvated ions are introduced into the annular region between the two cylindrical electrodes and are carried toward 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 mobility of the ion during the application of the DV is different than during the low voltage portion of the waveform, ions begin to drift towards one of the two electrodes. This is illustrated in Figure 3. If an ion reaches an electrode surface, it is discharged and neutralized.

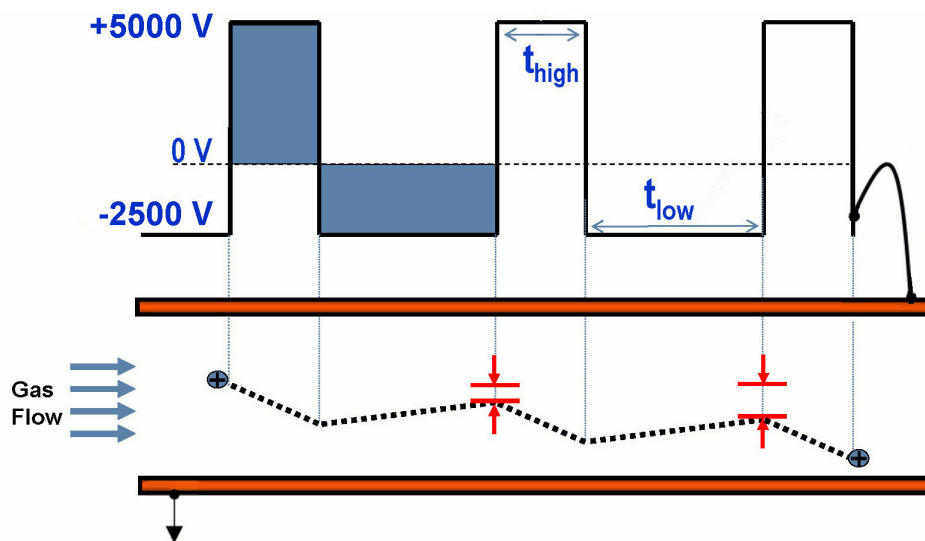


Figure 3. Illustration of the FAIMS effect (parallel plate example), showing ion drift

To prevent an ion from being discharged, a small dc potential, called the compensation voltage (CV), is applied to the inner electrode. The CV compensates for the drift that an ion experiences as the result of the application of the asymmetric waveform. This is illustrated in Figure 4.

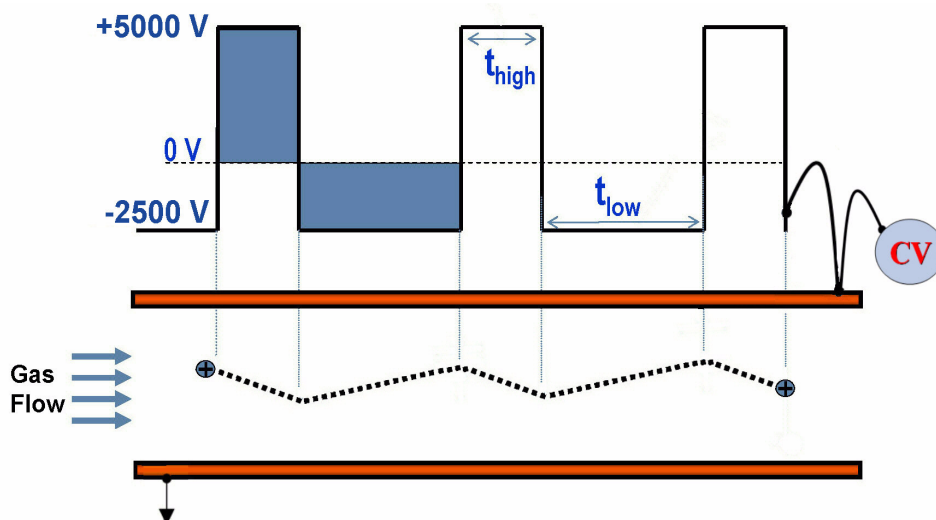


Figure 4. Illustration of the FAIMS effect (parallel plate example), with compensation voltage (CV), showing ion transmission

The CV needed 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 5 shows plots of the ion signal intensity versus CV for a drug and its metabolite. The drug can be selected because the metabolite does not contribute signal at the monitored CV of the drug.

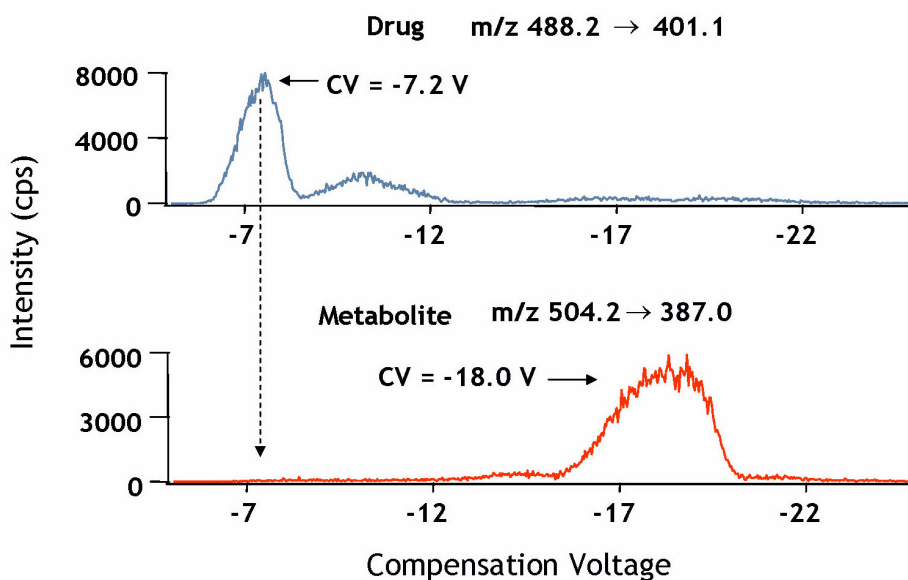


Figure 5. FAIMS-MS/MS selection of drug and metabolite

Summary of FAIMS Parameters

The settable parameters for FAIMS are:

- Dispersion voltage (DV)
- Compensation voltage (CV)
- Electrode temperatures
- Carrier gas composition
- Carrier gas flow rate

Dispersion Voltage

The dispersion voltage (DV) is the peak potential of the asymmetric waveform. As the DV increases, the CV tends to increase as does the ion intensity. The DV is most often set to its maximum value of ± 5000 V. The polarity is set to negative for positive ions and positive for negative ions.

Compensation Voltage

The 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, as was shown in [Figure 5](#).

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 need to be temperature controlled, otherwise the CV changes during system equilibration. The inner and outer electrode temperatures are adjusted independently. They are controlled by air flowing past the electrodes. Differences between the temperatures of the inner and outer electrodes can be used to enhance selectivity. Standard temperature settings are 70 °C for the inner electrode and 90 °C for the outer electrode.

[Figure 6](#) shows how the CV peak width changes for minoxidil as the temperature difference between the inner and outer electrodes increases.

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

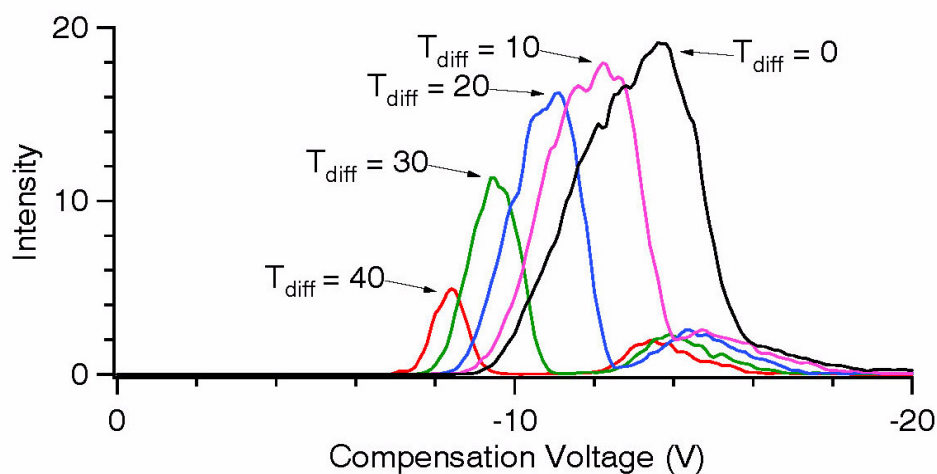


Figure 6. Effect of the temperature difference of the electrodes on the intensity and compensation voltage for minoxidil, with the outer electrode temperature higher than the inner electrode temperature

Carrier Gas Composition

The carrier gas transports ions through the electrode assembly. The interaction of the carrier gas with the ion affects selectivity and sensitivity. See [Figure 7](#). For most analyses, a carrier gas composition of 50:50 N₂:He is optimal.

Note For the analysis of some environmental and low molecular weight compounds, using 100% nitrogen and a positive DV for positive ions or a negative DV for negative ions may result in improved sensitivity.

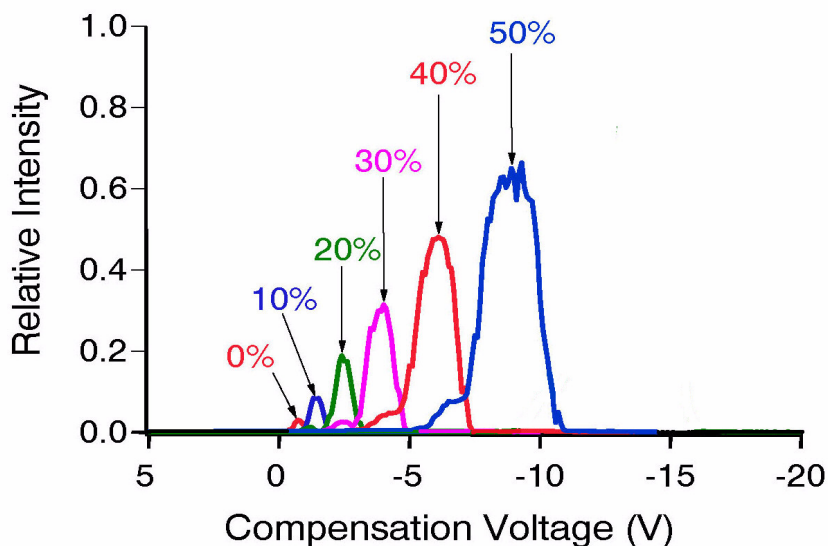


Figure 7. Effect of %He on the intensity and resolution for atrazine

Carrier Gas Flow Rate

The optimal carrier gas flow rate is between 2.5 and 4 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 may be made:

- There are several peaks in the CV spectrum for a particular m/z value. These may 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 will be different than for desolvated ions.

A carrier gas flow rate set too high may cause turbulence in front of the entrance plate. The ion intensities will decrease from the optimal value, but the CV of transmission will remain unchanged.

The effect of the carrier gas flow rate on the intensity and CV is illustrated in [Figure 8](#). A good starting point is a combined flow rate of 3.5 L/min of He + N₂.

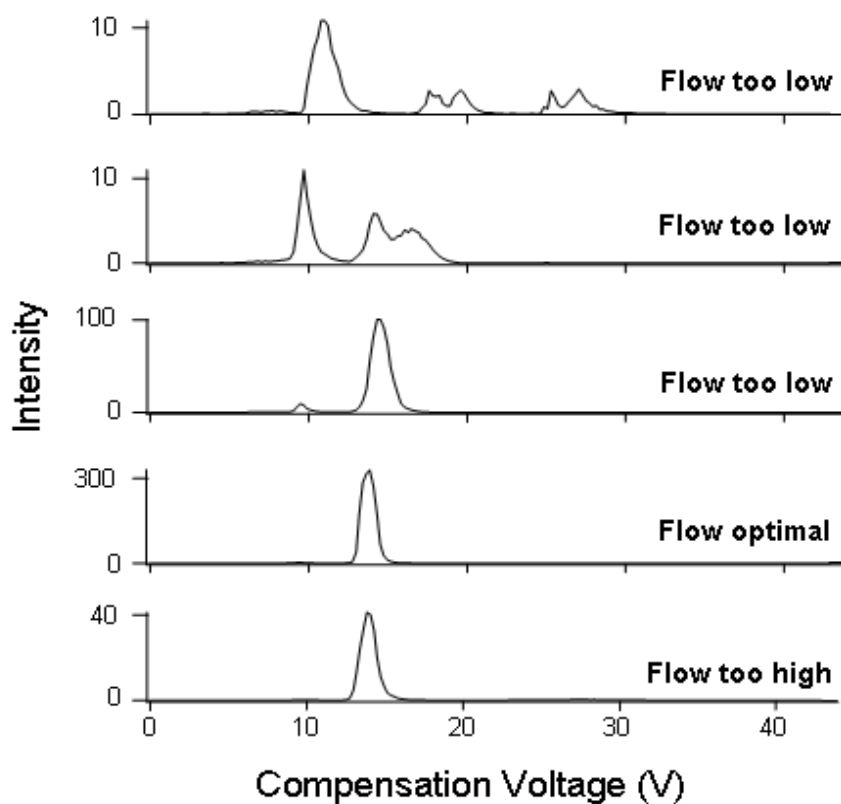


Figure 8. Effect of carrier gas flow rate on the intensity and compensation voltage for terephthalic acid

Components of the FAIMS System

The major components of the FAIMS system include:

- [FAIMS Waveform Generator](#)
- [FAIMS Temperature Control Module](#)
- [FAIMS High Voltage Lead](#)
- [FAIMS Interface Assembly](#)
- [FAIMS Electrode Assembly](#)

FAIMS Waveform Generator

Figure 9 shows the front of the FAIMS waveform generator.

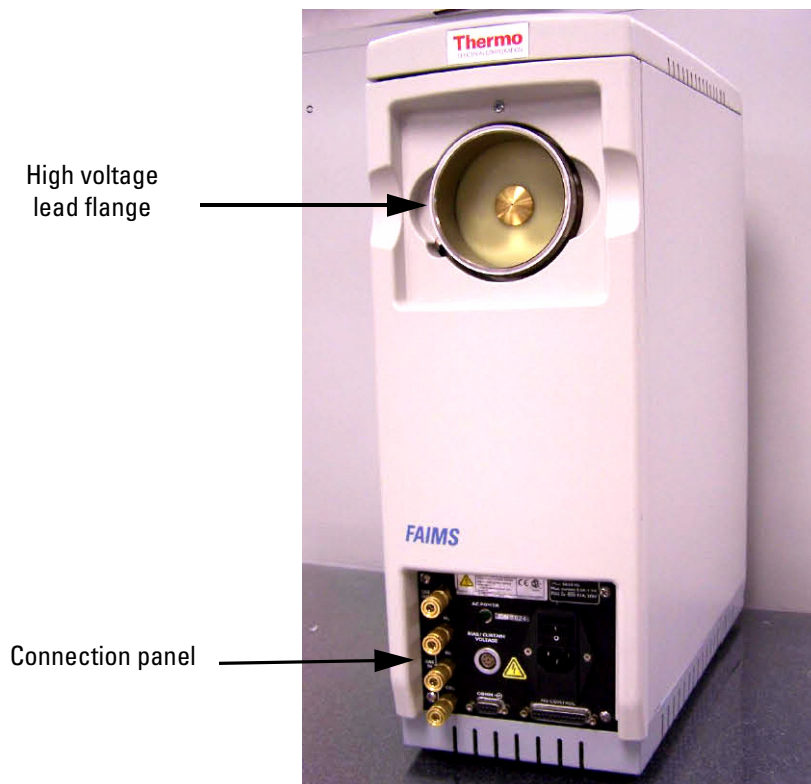


Figure 9. FAIMS waveform generator (front)

The FAIMS waveform generator includes:

- Function generator that produces the asymmetric waveform and dc voltages required to operate the FAIMS
- Gas flow system
- Connection panel for the power supplies required to operate the electrodes and other types of interfaces
- High-voltage lead flange for connecting the high voltage lead
- Safety interlocks

The gasses, power, and communications inputs and outputs of the waveform generator are shown in Figure 10.

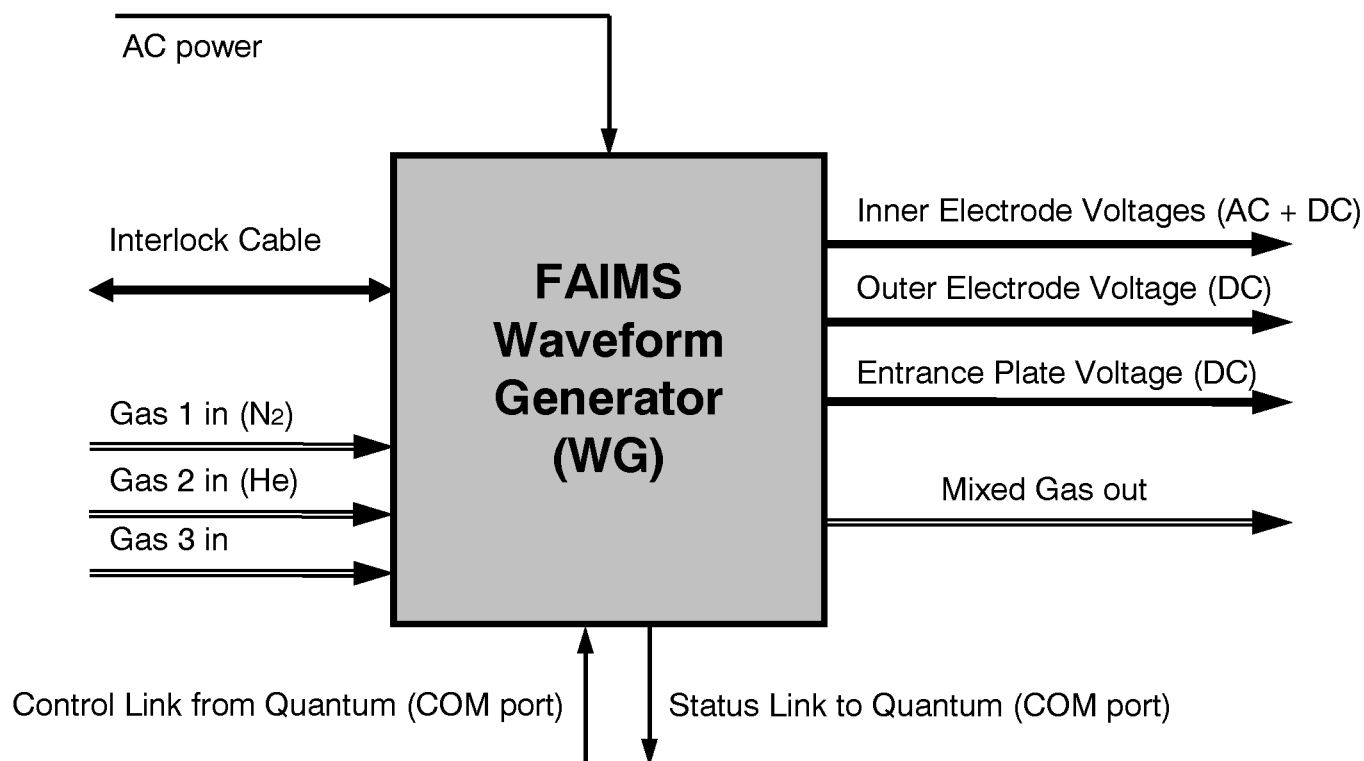


Figure 10. Gases, voltages, and communication of the waveform generator

Function Generator

The function generator performs the following operations:

- Produces the asymmetric waveform supplied to the electrodes. The asymmetric waveform provides a maximum dispersion voltage (DV) of ± 5000 V and operates at a frequency of 750 kHz.
- Produces the outer bias and compensation voltages that are applied to the FAIMS electrodes.

Gas Flow System

The FAIMS electrodes require a supply of clean, dry carrier gas. The carrier gas assists in desolvation and transport of ions through the electrodes. The standard mixture is 50:50 He:N₂.

During FAIMS operation, gases from external sources are provided to the gas flow system located in the waveform generator. Each gas passes through its own purification cartridge. The gas purification cartridges, located in the rear compartment of the waveform generator,

can last several months depending on the purity of gases and the frequency of use. For information about replacement cartridges, see “Replacing Gas Purification Cartridges” on page 100.

After leaving the gas purification cartridge, each gas enters a mass flow controller, calibrated specifically for that gas. The gasses are mixed in a tee union and the gas is then delivered to the region of the FAIMS electrodes located between the entrance plate and the outer electrode.

The gas is delivered using Teflon[®] tubing to the region of the FAIMS electrodes located between the entrance plate and the outer electrode.



CAUTION A continuous gas flow through the electrodes is essential for optimal performance of the FAIMS interface. Never use the ion source without a gas flow.

Connection Panel

The connection panel provides access to the electronics, communications, and gases. This panel is located at the front of the waveform generator, as Figure 11 shows.

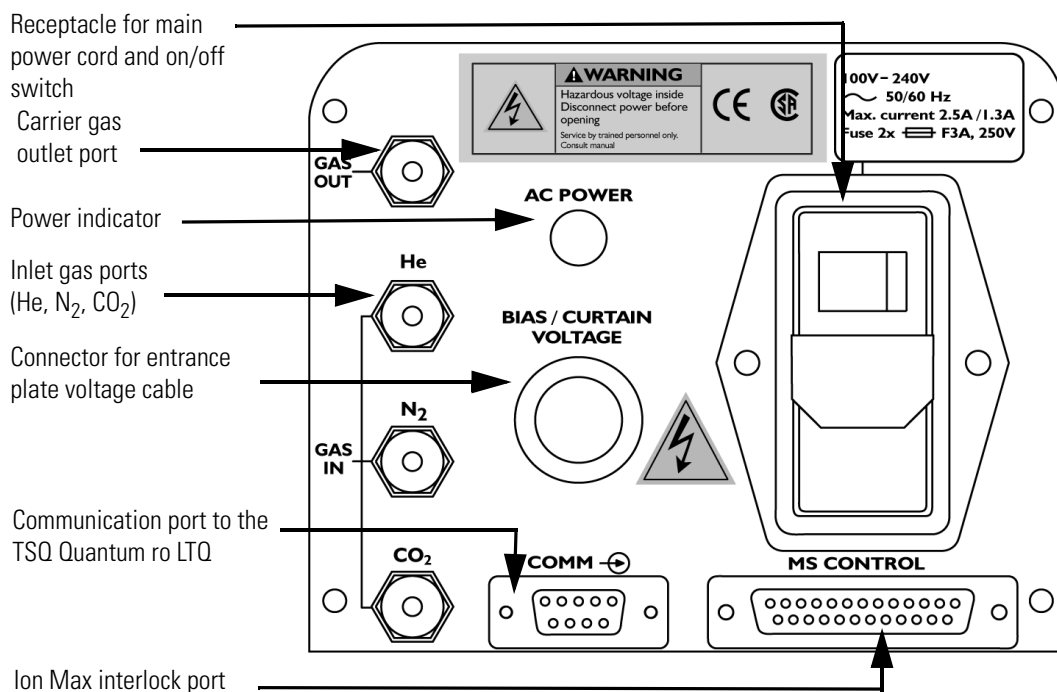


Figure 11. Connection panel on the FAIMS waveform generator

High Voltage Lead Flange

The high voltage lead flange allows quick connection of the high voltage lead to the waveform generator. This flange also makes up part of the FAIMS safety interlock system. A brass contact located in the middle of the flange transfers the specialized waveform from the waveform generator to the high voltage lead. For high-voltage to be applied to the contact, the high-voltage lead must be in place and connected to the FAIMS interface assembly.

FAIMS Temperature Control Module

The temperature control module monitors and controls the temperature of the FAIMS electrodes. See [Figure 12](#).



Figure 12. FAIMS temperature control module.

The temperature control module does the following:

- Monitors the temperatures of the inner and outer heaters in the heater assembly
- Supplies a readback to the software from thermocouple measurements taken in the exhaust lines
- Adjusts the output of the heaters to ensure that the desired temperature is maintained within ± 1 °C

Connections for the external gas supply, electrodes, and communications are available from the connection panel, located at the rear of the temperature control module. The gas and control inputs and outputs of the temperature control module are shown in [Figure 13](#).

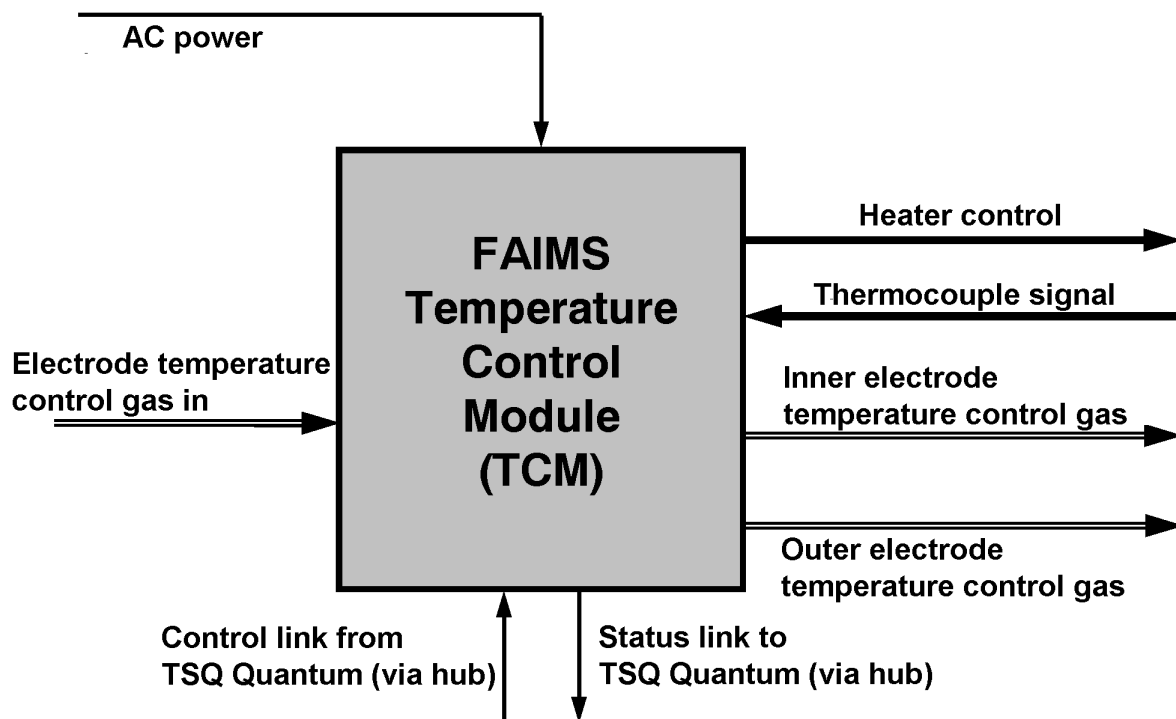


Figure 13. Gas and control inputs and outputs of the temperature control module

FAIMS High Voltage Lead

The high-voltage lead is a stainless steel tube through which the wire carrying the asymmetric waveform and the inner bias voltage is passed, as [Figure 14](#) shows. The high-voltage lead connects to the high-voltage flange on the waveform generator and to the high-voltage lead adapter on the interface assembly. The lead is slightly flexible for easier installation.

The high-voltage lead is part of the FAIMS interface safety interlock system. If the high-voltage lead is not connected to both the high voltage lead flange on the waveform generator and the high-voltage lead adapter on the interface assembly, voltages are not be supplied.

During installation of the FAIMS interface, the authorized Thermo Fisher Scientific representative adjusts the high voltage lead to fit the mass spectrometer. Changes, such as bending or stretching this lead after initial installation may affect the unit's performance. Damages due to these types of changes made without the assistance of an authorized representative are not covered by warranty.

1 FAIMS Overview

Components of the FAIMS System



Figure 14. FAIMS high voltage lead (TSQ Quantum)

FAIMS Interface Assembly

The FAIMS interface assembly adapts the mass spectrometer's ion source so that it can accommodate the FAIMS electrodes. Through the interface assembly, voltages, carrier gas, and heated air are applied to the electrodes. All interlock conditions must be satisfied before the FAIMS interface becomes operational.

The [Figure 15](#) shows the interface assembly, including the electrodes.

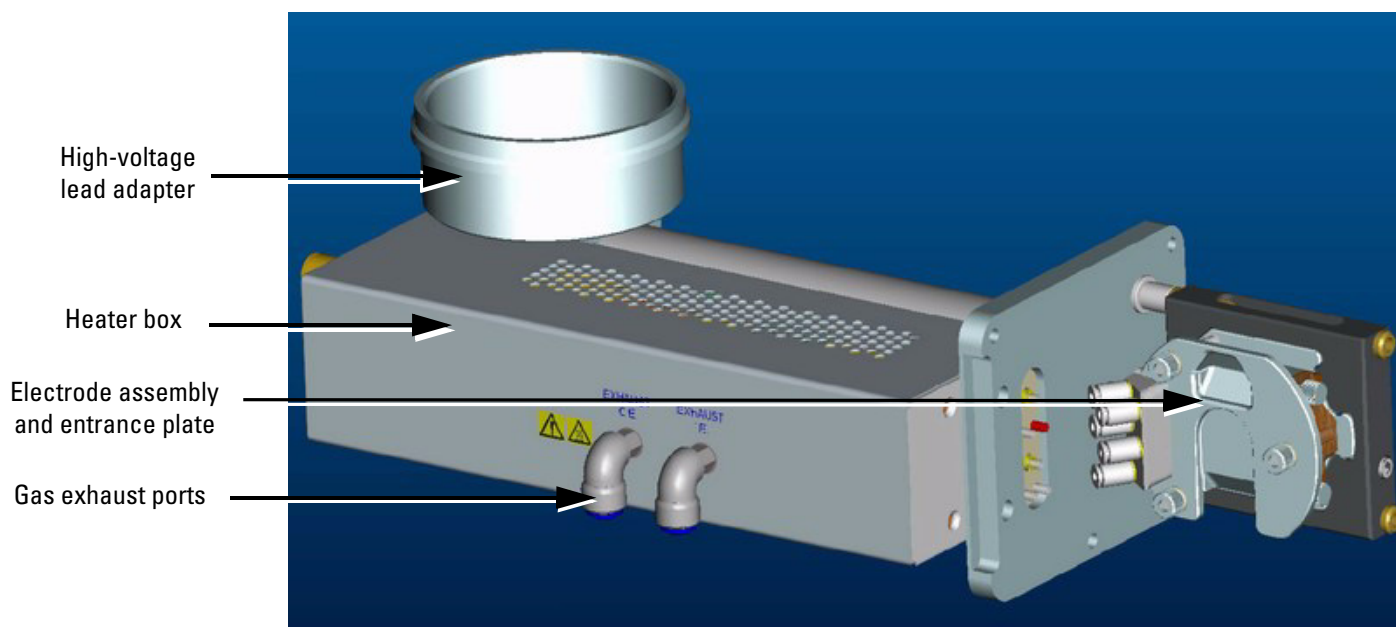


Figure 15. FAIMS interface assembly and electrodes

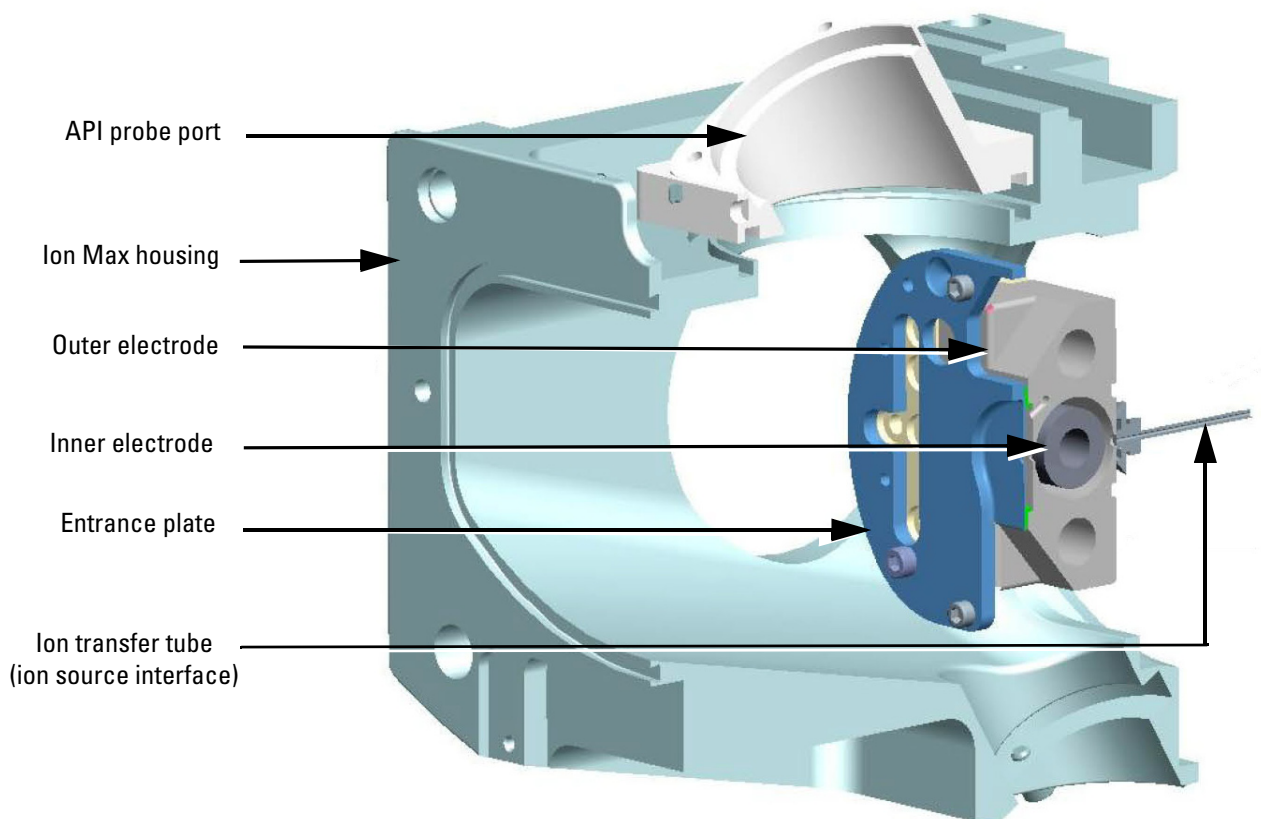


Figure 16. FAIMS components inside the Ion Max source housing

FAIMS Electrode Assembly

The electrodes are central to the FAIMS system. Positioned between the ion source and the mass spectrometer's ion transfer tube, the electrodes selectively transmit subsets of ions to the mass spectrometer. There is a 2.5 mm separation between the inner and outer electrodes. The inner and outer electrodes are secured between two endcaps, as [Figure 17](#) shows.

Carrier gas and the electrode heating gasses enter the electrode assembly through ports in the left endcap. Also, the outer electrode bias voltage and the entrance plate voltage are supplied via the left endcap. The FAIMS interface supplies the dispersion and compensation voltages to the inner electrode by a push pin contact.

The carrier gas exits the outer electrode and gets redirected by the entrance plate (not shown) to the ion entrance. At the ion entrance, the carrier gas enters the electrode assembly and transports the ions through the electrode assembly.

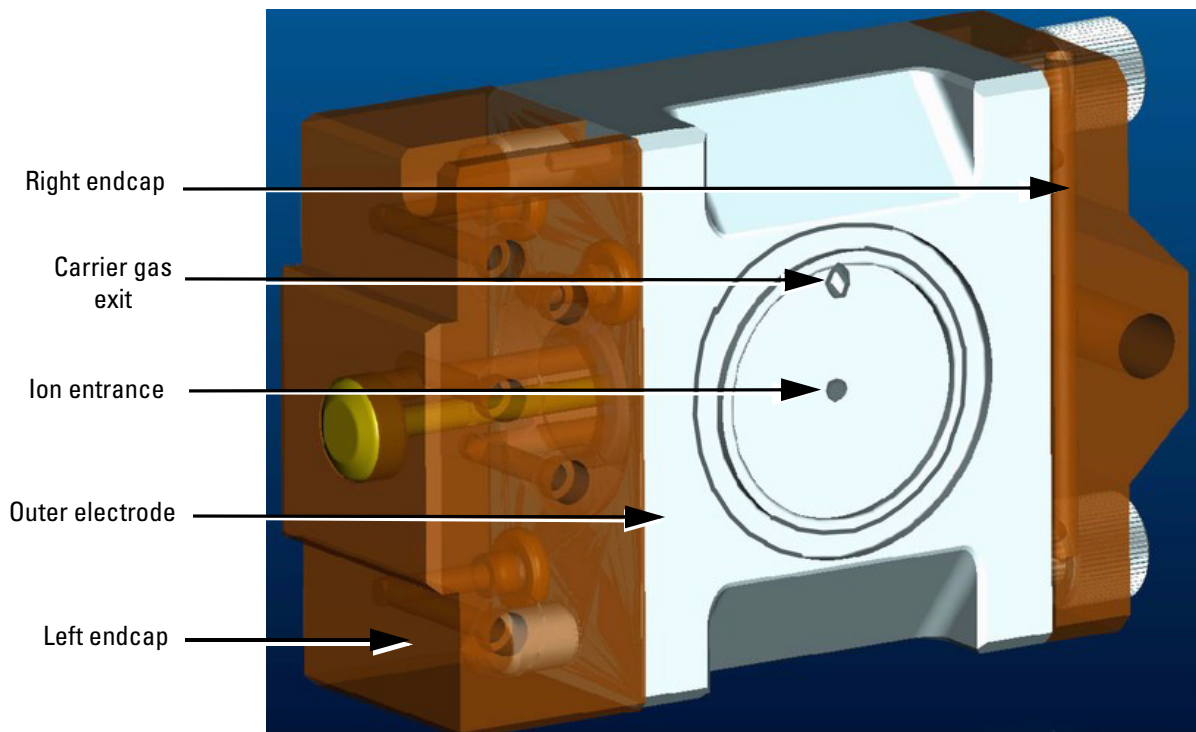


Figure 17. FAIMS electrode assembly (front)

Safety Interlocks

In addition to the standard TSQ Quantum and LTQ safety interlocks, the following conditions must be satisfied before the FAIMS system applies voltage to the electrodes:

- H-ESI or APCI probe must be installed
- High-voltage lead must be connected
- Bias voltage cable must be connected
- Communication between the waveform generator and the TSQ Quantum or LTQ must be functional



CAUTION Safety interlocks protect you. Do not tamper with these interlocks.

Xcalibur displays a popup error message and places the system in standby if one or more of the above conditions is not met. In addition, Xcalibur displays a popup error message and places the system in standby if a thermal fault occurs or if the maximum allowable number of discharge events is reached.

FAIMS Control Software: TSQ Quantum Series

During an experiment, Xcalibur's FAIMS control software manages the voltages, gas composition, gas flow rate, and temperature settings used for FAIMS separations. These parameters can be constant for the duration of an experiment or they may be changed at predefined intervals over the course of the experiment.

Note When the TSQ Quantum is turned on, Quantum firmware will check for FAIMS attachment by sending commands to the FAIMS waveform generator. If the Quantum receives valid responses to these commands, the firmware will assume that FAIMS is currently attached to the mass spectrometer. When you open the Quantum Tune or Instrument Setup, Xcalibur enables you to create instrument methods or tune methods specific to FAIMS.

This chapter provides an overview of the FAIMS control software in the following sections:

- [FAIMS Settings](#)
- [Saving the Settings in a Tune File](#)
- [Copying the Optimized CVs to Instrument Setup and LCQuan](#)
- [Putting the FAIMS System in Standby](#)

For a tutorial on performing a FAIMS analysis using a polytyrosine calibration solution, see [“Getting Started Using FAIMS on TSQ Quantum Series Mass Spectrometers”](#) on page 31.

FAIMS Settings

The following FAIMS parameters can be controlled by Xcalibur:

- Compensation voltage
- Outer bias voltage
- Dispersion voltage
- Gas composition and flow rate
- Electrode temperatures

There are two places where you can set FAIMS parameters:

- FAIMS Control view
- Tune Table view

FAIMS Control View

❖ To set FAIMS parameters by using the FAIMS Control view

1. Choose **Start > Programs > Xcalibur > Quantum Tune** to open the Quantum Tune window.
2. Click the FAIMS button on the toolbar to display the FAIMS Control view. See [Figure 18](#).
3. Enter the values of the FAIMS settings in the appropriate boxes and click **Apply**. (You can also use the up and down arrows to change the settings.) Begin with the standard operating values listed in [Table 1](#) or [Table 2](#).
4. 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 (V) and Stop (V) boxes and click Start. To find the optimum CV value, select **Optimization** first.



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. Thus, the FAIMS Control view enables a fine CV optimization if the peak's resolution is sharp and you want to find the most optimum CV.

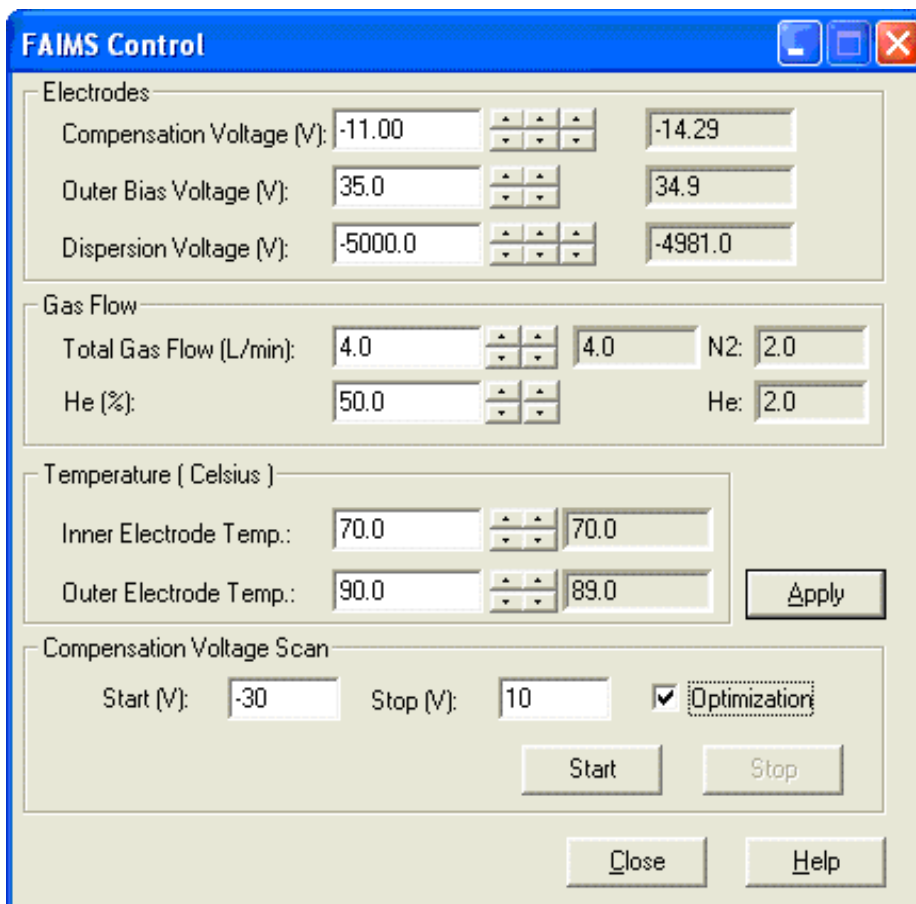


Figure 18. FAIMS Control view

Table 1. Standard operating values for positive ions

| FAIMS Parameter | Value |
|-----------------------------|---|
| Compensation voltage | Scan -30 to +10 V |
| Outer bias voltage | Same as the heated capillary |
| Dispersion voltage | -5000 V |
| Gas percentage | 50% He |
| Gas flow | 3.5 L/min |
| Inner electrode temperature | 70 °C |
| Outer electrode temperature | 90 °C |
| API probe position | Probe depth: C Micrometer: 1 Lateral position: center |

Table 2. Standard operating values for negative ions

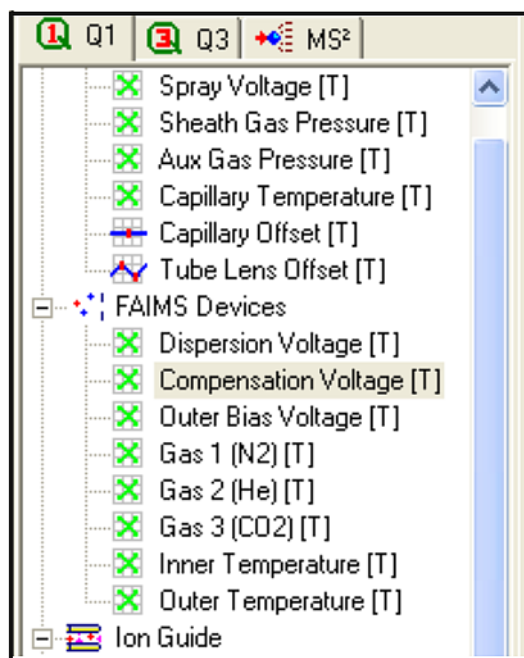
| FAIMS Parameter | Value |
|-----------------------------|---|
| Compensation voltage | Scan -10 to +30 V |
| Outer bias voltage | Same as the heated capillary |
| Dispersion voltage | +5000 V |
| Gas percentage | 50% He |
| Gas flow | 3.5 L/min |
| Inner electrode temperature | 70 °C |
| Outer electrode temperature | 90 °C |
| API probe position | Probe depth: C Micrometer: 1 Lateral position: center |

Tune Table View

You can also set FAIMS parameters individually in the Tune Table view.

❖ To set FAIMS parameters using the Tune Table View

1. Click on the Full Instrument Control button on the toolbar in Quantum Tune to open the Device view, as [Figure 19](#) shows.

**Figure 19.** Device view showing the FAIMS devices

2. Click on a FAIMS parameter listed under FAIMS Devices to display the Tune Table for that parameter, as Figure 20 shows.

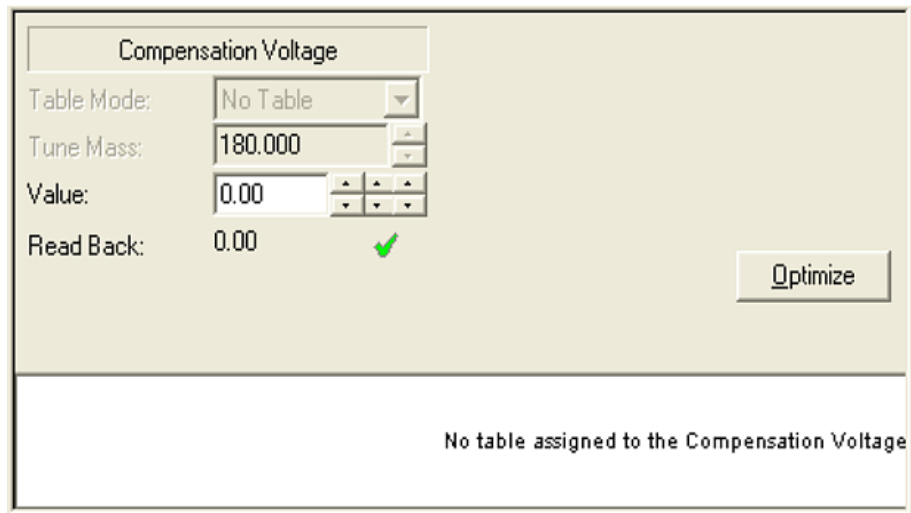


Figure 20. Tune table for the compensation voltage

Note If you optimize the CV from the Tune Table view, the optimization procedure ramps the CV for each ion from +10 to -30 V (-10 to +30 V for negative ions) in increments of 0.3 V.

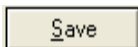
You can automatically optimize only the compensation voltage and the outer bias voltage.

Saving the Settings in a Tune File

In Instrument Setup, the acquisition time is divided into segments. Each segment can use a different tune method with different mass spectrometer and FAIMS settings. Tune methods are saved in tune files with extension .TSQTune.

To save the mass spectrometer and FAIMS settings in a tune file

1. Choose **File > Save Tune As** to open the Save As dialog box.
2. Browse to the destination folder of the tune file.
3. Enter a name for the new tune file and click **Save** to save the settings in the tune file.



Copying the Optimized CVs to Instrument Setup and LCQuan

You can export the selected ion monitoring (SIM) or selected reaction monitoring (SRM) settings, including the optimized CVs, to Instrument Setup and LCQuan. These settings can then be saved in an Instrument Method or an LCQuan Method.

❖ To copy the optimized CVs to Instrument Setup or LCQuan



1. In Quantum Tune, click the **Define Scan** button on the Control / Scan Mode toolbar to display the Define Scan view.
2. Right-click anywhere in the Define Scan view and select **Copy Scan Event** from the menu that appears.
3. Click on the TSQ Quantum icon in Instrument Setup to display the MS Detector page, or choose **Start > Programs > Xcalibur > LCQuan** to display the Scan Editor page of LCQuan.
4. Select a scan event on the Scan Event bar.

Note You can change CVs between scan events, but not the other FAIMS settings.

5. Right-click anywhere and select **Paste Scan Event** from the menu that appears. Xcalibur pastes the SIM or SRM masses, tube lens voltages, and CVs from Quantum Tune into the SIM or SRM table, as [Figure 21](#) shows.

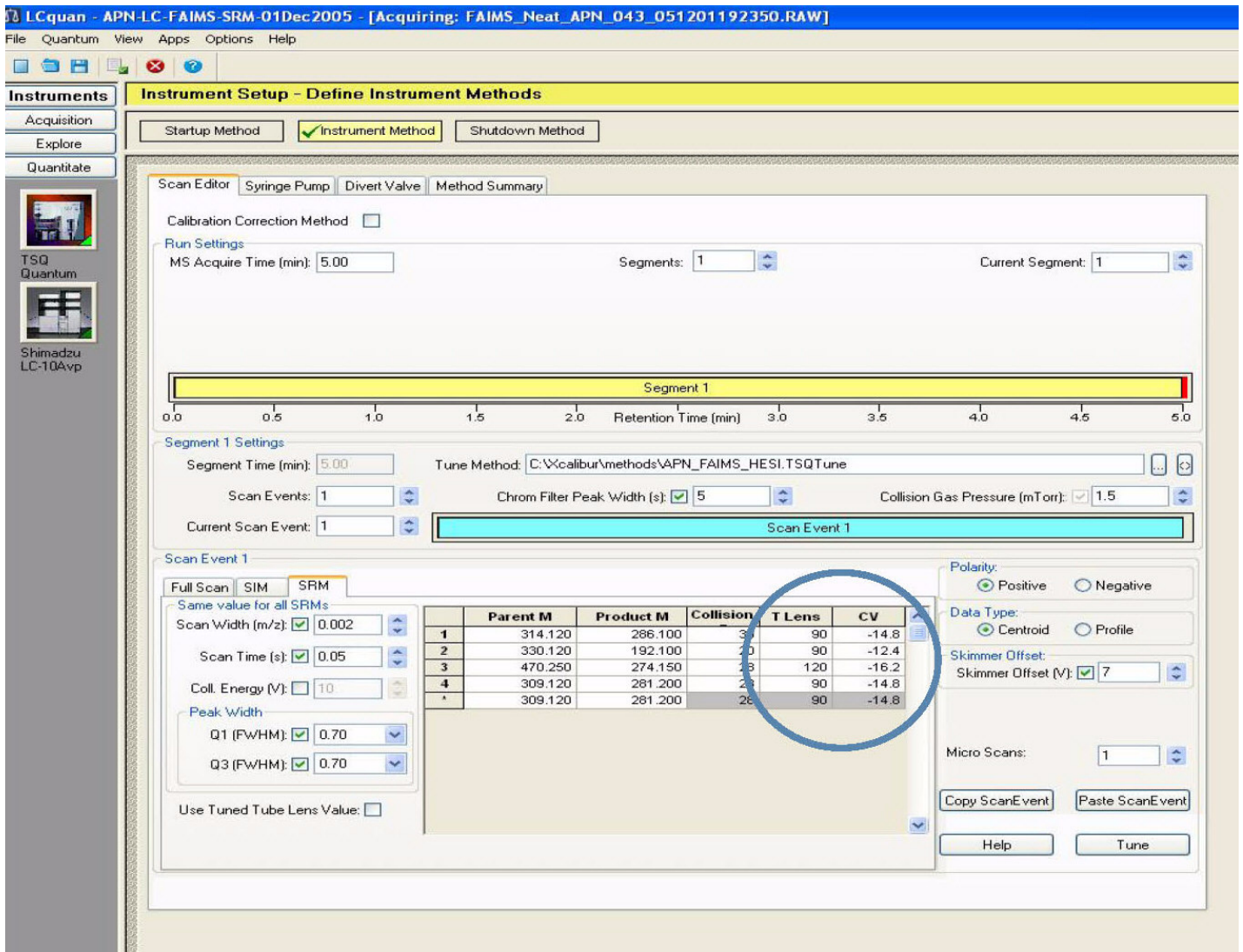


Figure 21. LCquan, showing the imported CVs

Putting the FAIMS System in Standby

When FAIMS is not being used, put it in standby rather than powering it down. When FAIMS is put in standby:

- All voltages are turned off. Voltages are reinstated to their pre-standby values when FAIMS is put back into operation.

Note Voltages can also be turned off by manually setting them to “0”. Standby is a faster way to do this and provides the benefit of quickly reinstating the voltage values.

- N₂ gas flow to the electrodes continues at a flow rate of 1.5 L/min, which keeps the electrodes clean.



❖ To put the FAIMS in standby

In Quantum Tune, click the **On** button.



❖ To resume operation

In Quantum Tune, click the **Standby** button.

All user-definable settings in the control software are enabled.

Although all voltages are turned off when FAIMS is put on standby or powered down, standby is the preferred option.

N₂ gas flow to the electrodes continues in standby. Because powering down the FAIMS stops the gas flow, the electrodes may require cleaning before the system is used again. For this reason, powering down the FAIMS is recommended only under one or both of these circumstances:

- The electrodes are being removed for cleaning.
- The system will not be used for an extended period of time.

FAIMS Control Software: LTQ Series

During an experiment, Xcalibur's FAIMS control software manages the voltages, gas composition, gas flow rate, and temperature settings used for FAIMS separations. These parameters can be constant for the duration of an experiment or they may be changed at predefined intervals over the course of the experiment.

This chapter provides an overview of the FAIMS control software in the following sections:

- [Configuring FAIMS](#)
- [Setting FAIMS Parameters](#)
- [Optimizing the Compensation Voltage](#)
- [Saving the Settings in a Tune File](#)
- [Putting the FAIMS System in Standby](#)

For a tutorial on performing a FAIMS analysis using the LTQ's tuning and calibration solution, see "[Getting Started Using FAIMS on LTQ Series MS Detectors](#)" on [page 49](#).

Configuring FAIMS

You use Xcalibur Instrument Configuration to specify that a FAIMS system is installed on your LTQ series MS detector.

❖ To configure the FAIMS system

Choose **Start > All Programs > Xcalibur > Instrument Configuration** to open Xcalibur Instrument Configuration.



Configure

1. Click on the **LTQ** icon in the Configured Devices window.
2. Click **Configure** to display the LTQ Configuration dialog box.
3. Select **FAIMS** to display the FAIMS page.

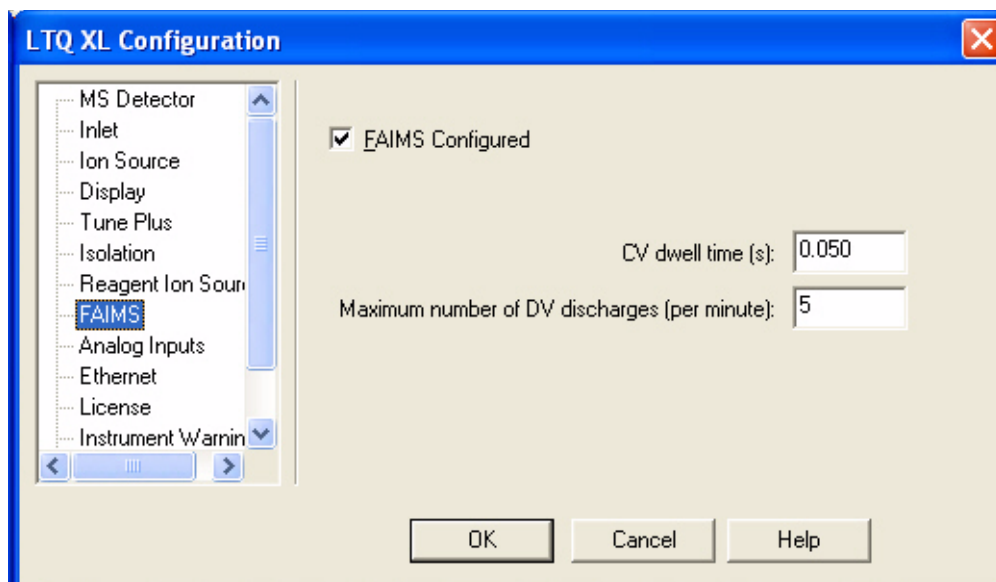
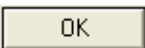


Figure 22. Instrument Configuration - FAIMS page

4. Select **FAIMS Configured**.



CAUTION Do not change the CV dwell time or maximum number of DV discharges unless you are instructed to by Thermo Fisher Scientific Technical Support or Field Service.



5. Click **OK** and restart the PC to apply the configuration settings.

Setting FAIMS Parameters

You can set the following FAIMS parameters from Xcalibur:

- Compensation voltage
- Outer bias voltage
- Dispersion voltage
- Gas composition and flow rate
- Electrode temperatures

You set FAIMS parameters in the FAIMS Control dialog box.

❖ To set FAIMS parameters

1. Choose **Start > All Programs > Xcalibur > LTQ Tune** to open the Tune Plus window.



- Click the **FAIMS Control** button on the toolbar (or choose **Setup > FAIMS Control**) to display the FAIMS Control dialog box.

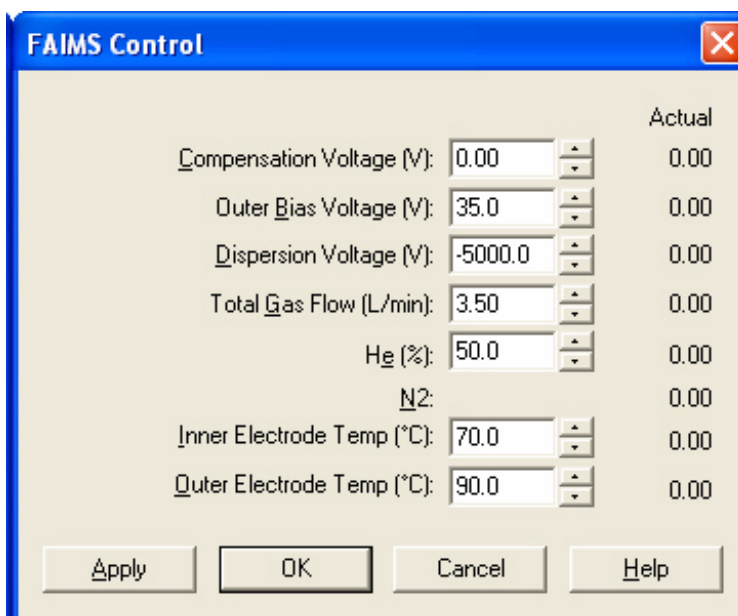
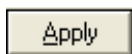


Figure 23. FAIMS Control dialog box



Enter the values of the FAIMS settings in the appropriate boxes and click **Apply**. Begin with the standard operating values listed in [Table 3](#) or [Table 4](#).

Table 3. Standard operating values for positive ions

| Scan Parameter | Value |
|-----------------------------|---|
| FAIMS Parameter | Value |
| Compensation voltage | Scan -30 to +10 V |
| Outer bias voltage | Same as the heated capillary |
| Dispersion voltage | -5000 V |
| Gas percentage | 50% He |
| Gas flow | 3.5 L/min |
| Inner electrode temperature | 70 °C |
| Outer electrode temperature | 90 °C |
| API probe position | Probe depth: C Micrometer: 1 Lateral position: center |

Table 4. Standard operating values for negative ions

| Scan Parameter | Value |
|-----------------------------|---|
| FAIMS Parameter | Value |
| Compensation voltage | Scan -10 to +30 V |
| Outer bias voltage | Same as the heated capillary |
| Dispersion voltage | +5000 V |
| Gas percentage | 50% He |
| Gas flow | 3.5 L/min |
| Inner electrode temperature | 70 °C |
| Outer electrode temperature | 90 °C |
| API probe position | Probe depth: C Micrometer: 1 Lateral position: center |

Optimizing the Compensation Voltage

You optimize the compensation voltage (CV) by performing a CV scan. Refer to “[Running CV Scans](#)” on [page 53](#) for an example of running CV scans using the LTQ tuning and calibration solution.

❖ To optimize the compensation voltage

1. Choose **Start > All Programs > Xcalibur > LTQ Tune** to open the Tune Plus window.
2. Click on the **Tune** button (or choose **Control > Tune**) and then the **FAIMS** tab to display the FAIMS page.



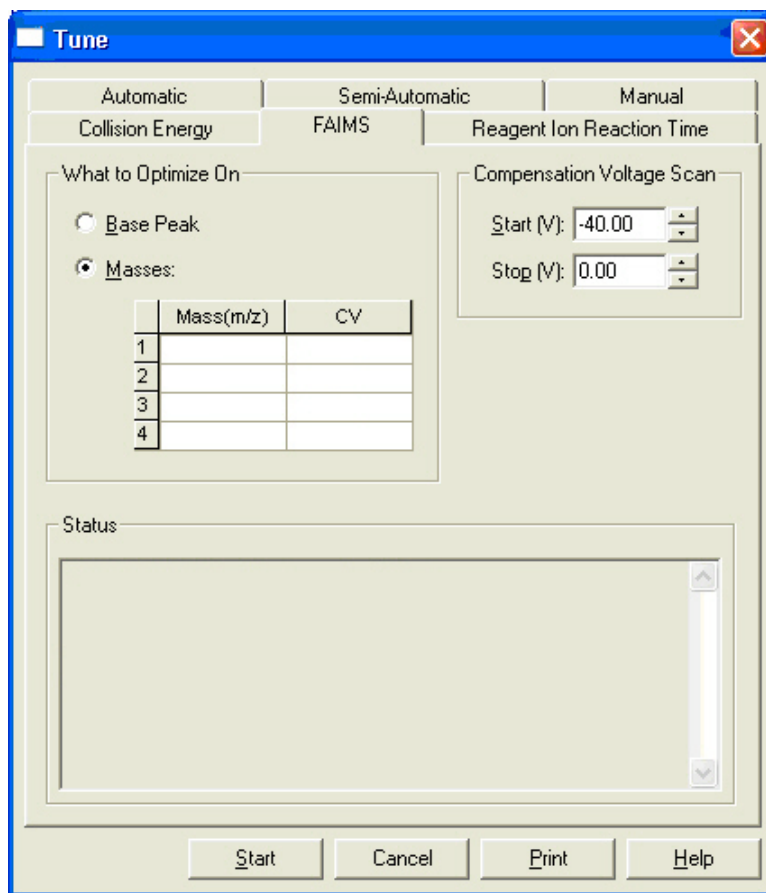


Figure 24. FAIMS page of the Tune dialog box

3. Select **Base Peak** or **Masses** to specify optimizing the CV for the base peak or up to four selected masses.
4. If you selected **Masses**, enter up to four masses in the mass table.
5. Specify the starting and ending voltages for the CV scan.
 - For positive ions, scan from -50 to +10 V.
 - For negative ions, scan from -10 to 50 V.

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. Thus, the FAIMS page enables a fine CV optimization if the peak's resolution is sharp and you want to find the most optimum CV.



6. Click the **Display Graph** button on the Tune Plus toolbar to display the CV plot.
7. Click **Start** to begin the CV scans.

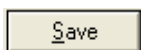
LTQ plots the ion intensities versus CV for the base peak or the masses you specified. LTQ enters the optimum CV for each mass in the CV column of the FAIMS page.

Saving the Settings in a Tune File

In Instrument Method, the acquisition time is divided into segments. Each segment can use a different tune method with different MS detector and FAIMS settings. Tune methods are saved in tune files with extension .LTQTune.

To save the MS detector and FAIMS settings in a tune file

1. Choose **File > Save As** to open the Save As dialog box.
2. Browse to the destination folder of the tune file.
3. Enter a name for the new tune file and click **Save** to save the settings in the tune file.



Putting the FAIMS System in Standby

When FAIMS is not being used, put it in standby rather than powering it down. When FAIMS is put in standby:

- All voltages are turned off. Voltages are reinstated to their pre-standby values when FAIMS is put back into operation.
- N₂ gas flow to the electrodes continues at a flow rate of 1.5 L/min, which keeps the electrodes clean.

❖ To put the FAIMS in standby

In Tune Plus, click the **On** button.



❖ To resume operation

In Tune Plus, click the **Standby** button.



All user-definable settings in the control software are enabled.

Although all voltages are turned off when FAIMS is put in standby or powered down, standby is the preferred option.

N₂ gas flow to the electrodes continues in standby. The N₂ gas flow cools the electrodes and keeps them clean. Because powering down the FAIMS stops the gas flow, the electrodes may require cleaning before the system is used again. For this reason, powering down the FAIMS is recommended only under one or both of these circumstances:

- The electrodes are being removed for cleaning.
- The system will not be used for an extended period of time.

Getting Started Using FAIMS on TSQ Quantum Series Mass Spectrometers

This chapter describes a procedure for running a FAIMS experiment on a TSQ Quantum series mass spectrometer. The procedure uses a polytyrosine – 1, 3, 6 tuning and calibration solution, but you can use your own analyte.

Note Before using the FAIMS system, your mass spectrometer needs to be properly tuned and calibrated, without the FAIMS interface, in the H-ESI/MS mode. Refer to *TSQ Quantum Getting Started*.

❖ To perform the FAIMS experiment

1. Set up the syringe pump to infuse sample.
2. Set up the mass spectrometer and FAIMS system.
3. Infuse a low concentration tuning and calibration solution containing polytyrosine – 1, 3, 6 directly into the H-ESI source by using the syringe pump.
4. Run CV scans.
5. Test the efficiency and stability of the spray of the polytyrosine solution into the mass spectrometer.
6. Test selectivity.
7. Further optimize the FAIMS parameters.
8. Save the settings in a Tune file.
9. Copy the optimized CVs to Instrument Setup or LCquan.

Setting Up the Syringe Pump to Infuse Sample

Use a syringe pump as the sample introduction device. The syringe pump enables you to infuse the polytyrosine tuning and calibration solution directly into the H-ESI source for extended periods.

4 Getting Started Using FAIMS on TSQ Quantum Series Mass Spectrometers

Setting Up the Syringe Pump to Infuse Sample

The syringe and the syringe pump are located on the front panel of your TSQ Quantum mass spectrometer. The plumbing connections for H-ESI/MS sample introduction from the syringe pump are shown in [Figure 25](#) and [Figure 26](#).

❖ To set up the syringe pump for infusion

1. Place the mass spectrometer and FAIMS system in standby.
 - a. Choose **Start > Programs > Xcalibur > Quantum Tune** to open the Quantum Tune window.
 - b. From the Quantum Tune window, choose **Control > Standby** (or click the **On/Standby** button).
2. Connect a 4 cm (1.5 in.) segment of Teflon® tube with a fingertight fitting and a ferrule to an LC union.

The LC union has coned-bottom, 10-32 receiving ports. [Figure 25](#) shows the suggested fittings for connecting the syringe to the LC union.

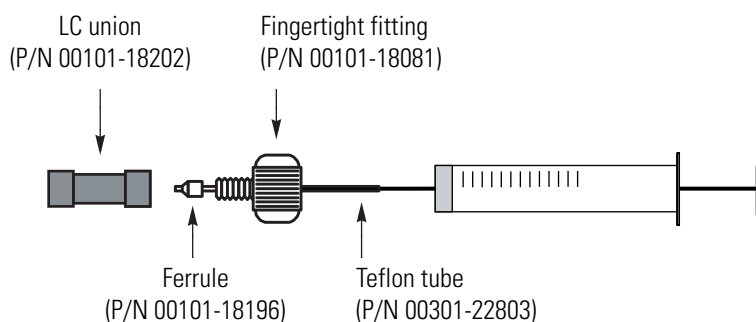


Figure 25. Plumbing connections for the syringe.

Note To minimize the possibility of cross-contamination, use a different syringe and a different sample transfer line for your tuning and calibration solution than you do for your samples and compound optimization solution.

3. Load a clean syringe with the polytyrosine – 1, 3, 6 tuning and calibration solution. (Refer to “Appendix A: Solution Formulations” of *TSQ Quantum Getting Started* for the procedure for preparing the tuning and calibration solution.)
4. Insert the syringe needle into the segment of Teflon tube.
5. Place the syringe into the syringe holder of the syringe pump.
6. While squeezing the blue release button on the syringe pump handle, push the handle forward until it just contacts the syringe plunger.

7. Using fingertight fittings and ferrules, connect an infusion line of PEEK tubing (0.005-in. ID × 1/16-in OD) between the LC union and the grounding union that is held by the grounding union holder on the H-ESI probe.

Figure 26 shows the suggested fittings and ferrules for connecting the LC union to the grounding union. Both the LC union and the grounding union have 10-32, coned-bottom receiving ports.

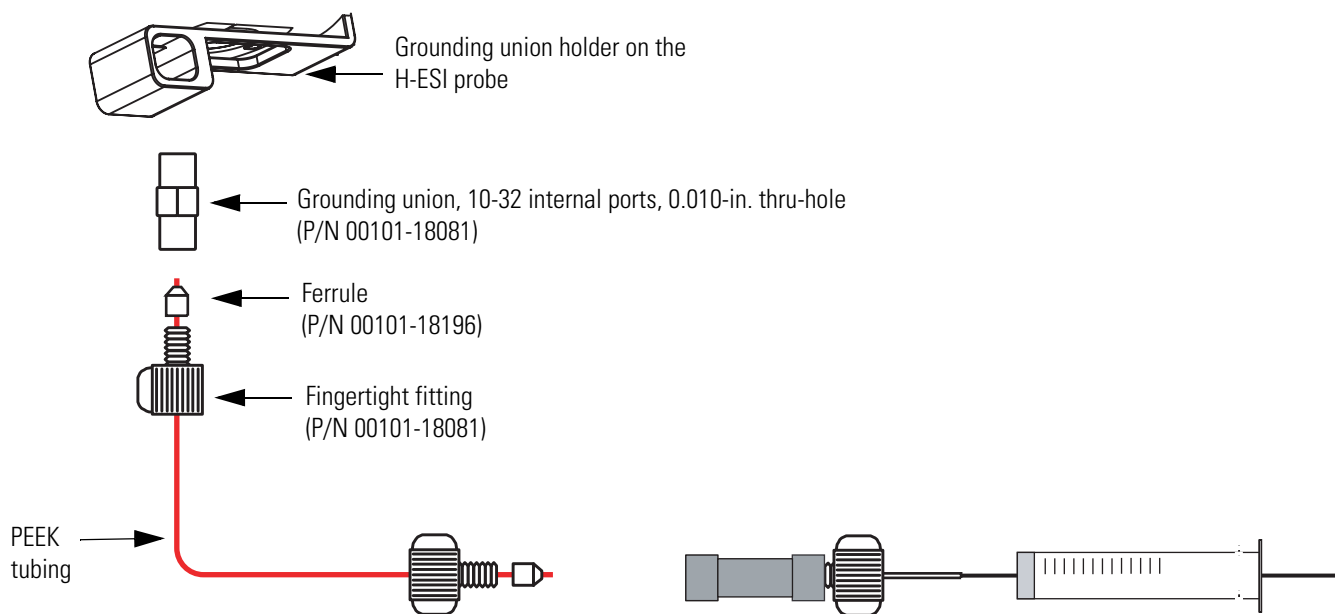


Figure 26. Plumbing connections for the infusion line between the LC union and the grounding union

Setting Up the Mass Spectrometer and FAIMS System

❖ To set up the mass spectrometer and FAIMS system for the FAIMS/polytyrosine experiment

1. Position the H-ESI probe as follows:
 - Lateral position: center
 - Front to back position: micrometer 1.5 back
 - Probe depth: B
2. Choose **Start > Programs > Xcalibur > Quantum Tune** to open the Quantum Tune window.



3. Click on the **On/Standby** button on the toolbar to turn on the mass spectrometer. (The three different states of the On/Standby button are shown at the left.)

4 Getting Started Using FAIMS on TSQ Quantum Series Mass Spectrometers

Setting Up the Mass Spectrometer and FAIMS System



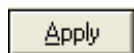
4. Ensure that the mass spectrometer is in the positive ion polarity mode. You can determine the ion polarity mode of the mass spectrometer by observing the state of the Polarity button (as shown at the left).

5. Click the **FAIMS** button on the toolbar to display the FAIMS Control view.

6. In the FAIMS Control view, input the FAIMS settings that are listed in [Table 5](#).

Table 5. FAIMS settings for polytyrosine - 1,3,6

| FAIMS Parameter | Value |
|----------------------------------|-------|
| Outer bias voltage (V) | 35 |
| Dispersion voltage (V) | -5000 |
| Total gas flow (L/min) | 4 |
| % He | 50 |
| Inner electrode temperature (°C) | 70 |
| Outer electrode temperature (°C) | 90 |



7. Click **Apply** to apply the FAIMS settings.

8. Observe the readbacks in FAIMS Control view. Verify that the readbacks match the setpoints.

9. Click on the **Define Scan** button on the toolbar to display the Define Scan view.

10. Click on **SIM** and **Q1MS**.

11. In the Define Scan view, input the instrument settings that are listed in [Table 6](#).

Table 6. Instrument settings for polytyrosine

| Parameter | Value |
|----------------------------|-------|
| Scan width (m/z) | 10 |
| Scan time (sec.) | 0.2 |
| Q1 peak width (m/z) | 0.7 |
| Aux valve flow (units) | 5 |
| Capillary temperature (°C) | 270 |
| Capillary offset (V) | 35 |

12. Clear () the Use Tube Lens Value option.

13. In the SIMS table, input the SIMS settings that are listed in [Table 7](#).



Table 7. SIMS settings for polytyrosine

| Mass (m/z) | Tube Lens (V) | CV (V) |
|------------|---------------|--------|
| 182.0 | 50 | -10 |
| 508.0 | 75 | -10 |
| 997.0 | 125 | -10 |



14. Click **Apply** to apply the settings.
15. Click the **Full Instrument Control** button to display the Device view and Tune Table view, as [Figure 27](#) shows.
16. Click each H-ESI parameter in the Device view to display that parameter's setting in the Tune Table view.

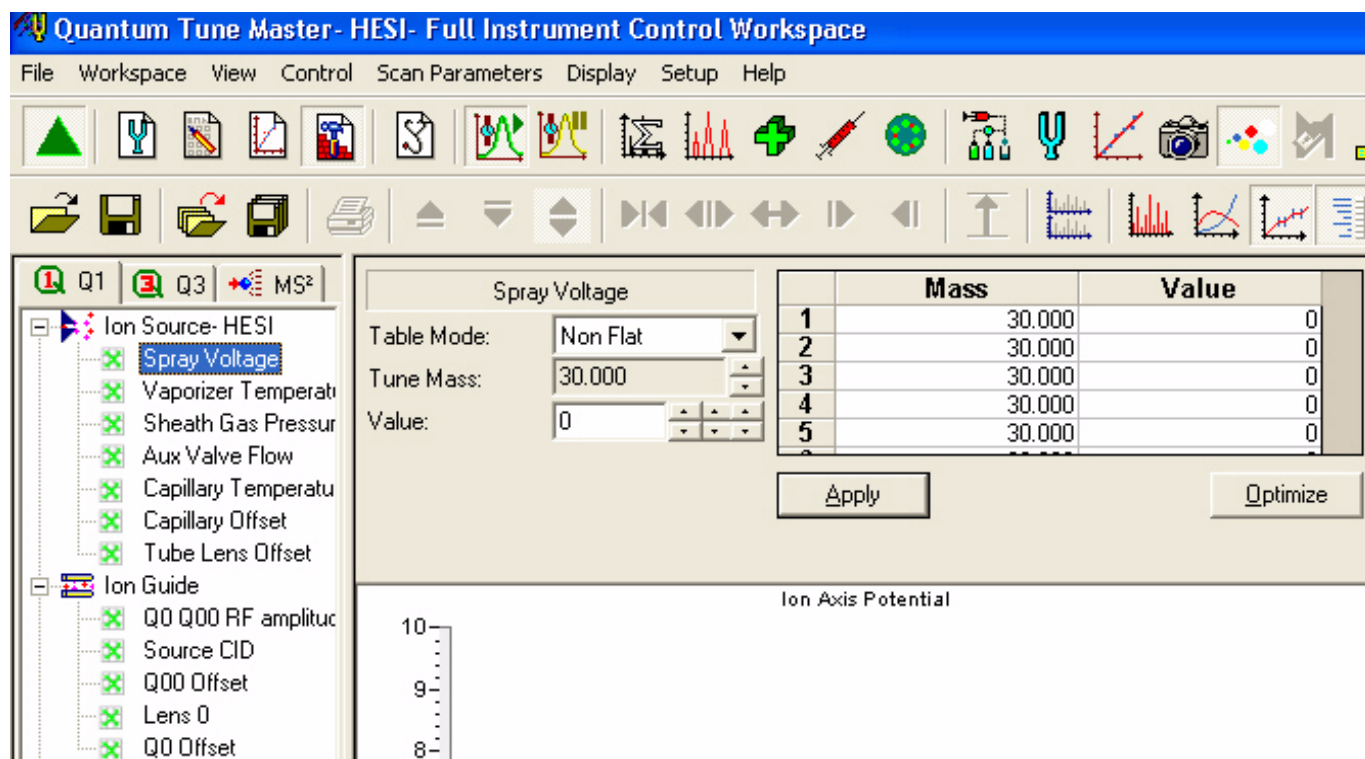


Figure 27. Spray voltage selected in the Device view and displayed in the Tune Table view

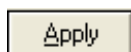
4 Getting Started Using FAIMS on TSQ Quantum Series Mass Spectrometers

Configuring the Syringe Pump and Infusing the Polytyrosine

17. In the Tune Table view, set each H-ESI parameter to the value that is listed in [Table 8](#).

Table 8. H-ESI parameters for polytyrosine

| H-ESI Parameter | Value |
|----------------------------|-------|
| Spray voltage (V) | 4000 |
| Vaporizer temperature (°C) | 30 |
| Sheath gas pressure (psi) | 5 |
| Aux valve flow (units) | 5 |
| Capillary temperature (°C) | 270 |
| Capillary offset (V) | 35 |



18. Click **Apply** to apply the settings.
19. Click **Ion Source H-ESI** in the device view to display the readbacks for the H-ESI parameters. Verify that the readbacks match the setpoints.

Configuring the Syringe Pump and Infusing the Polytyrosine

❖ To configure the syringe pump and infuse the polytyrosine – 1, 3, 6 tuning and calibration solution

1. Choose **Setup > Syringe Pump & Sample Loop** to display the Syringe Pump and Sample Loop view in the top right corner of the workspace, as [Figure 28](#) shows.

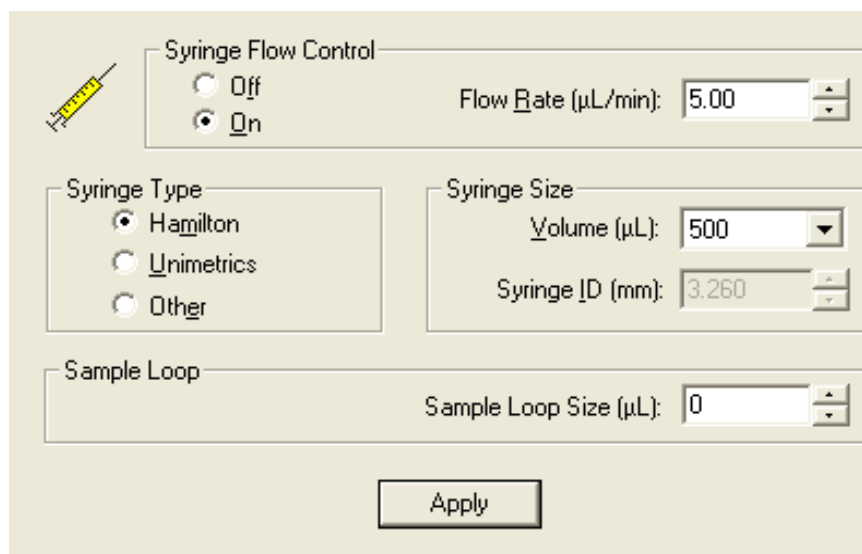


Figure 28. Syringe Pump and Sample Loop view

2. In the Syringe Flow Control box, select **On** to activate the Flow Rate spin box.

3. Enter 5.00 in the Flow Rate spin box to set a flow rate of 5.00 $\mu\text{L}/\text{min}$. (The flow rate can be adjusted within the range of 1.00 to 15.00 $\mu\text{L}/\text{min}$ to achieve the best ion beam intensity and stability.)
4. In the Syringe Type box, specify the **syringe type**.
5. In the Syringe Size box, specify the **syringe size**.
6. Click **Apply** to apply these settings and to start the syringe pump. The polytyrosine – 1, 3, 6 tuning and calibration solution should now flow into the ion source.



Running CV Scans

❖ To run a CV scan for each SIM ion



1. Click the **Full Instrument Control** button on the toolbar in Quantum Tune to display the Device view.

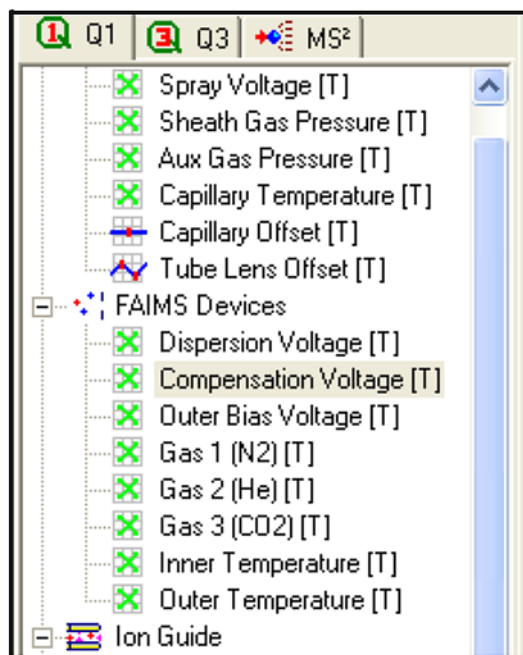


Figure 29. Device view showing the FAIMS devices

2. Click **Compensation Voltage** to display the Tune view for the compensation voltage, as [Figure 30](#) shows.

4 Getting Started Using FAIMS on TSQ Quantum Series Mass Spectrometers

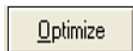
Running CV Scans

| Compensation Voltage | |
|----------------------|----------|
| Table Mode: | No Table |
| Tune Mass: | 180.000 |
| Value: | 0.00 |
| Read Back: | 0.00 ✓ |

Optimize

No table assigned to the Compensation Voltage

Figure 30. Tune view for the compensation voltage



3. Click **Optimize** to begin the optimization of the CVs. The optimization procedure ramps the CV for each SIM ion from -30 to +10 V (-10 to +30 V for negative ions).

The ion intensity versus CV plots are shown in [Figure 31](#).

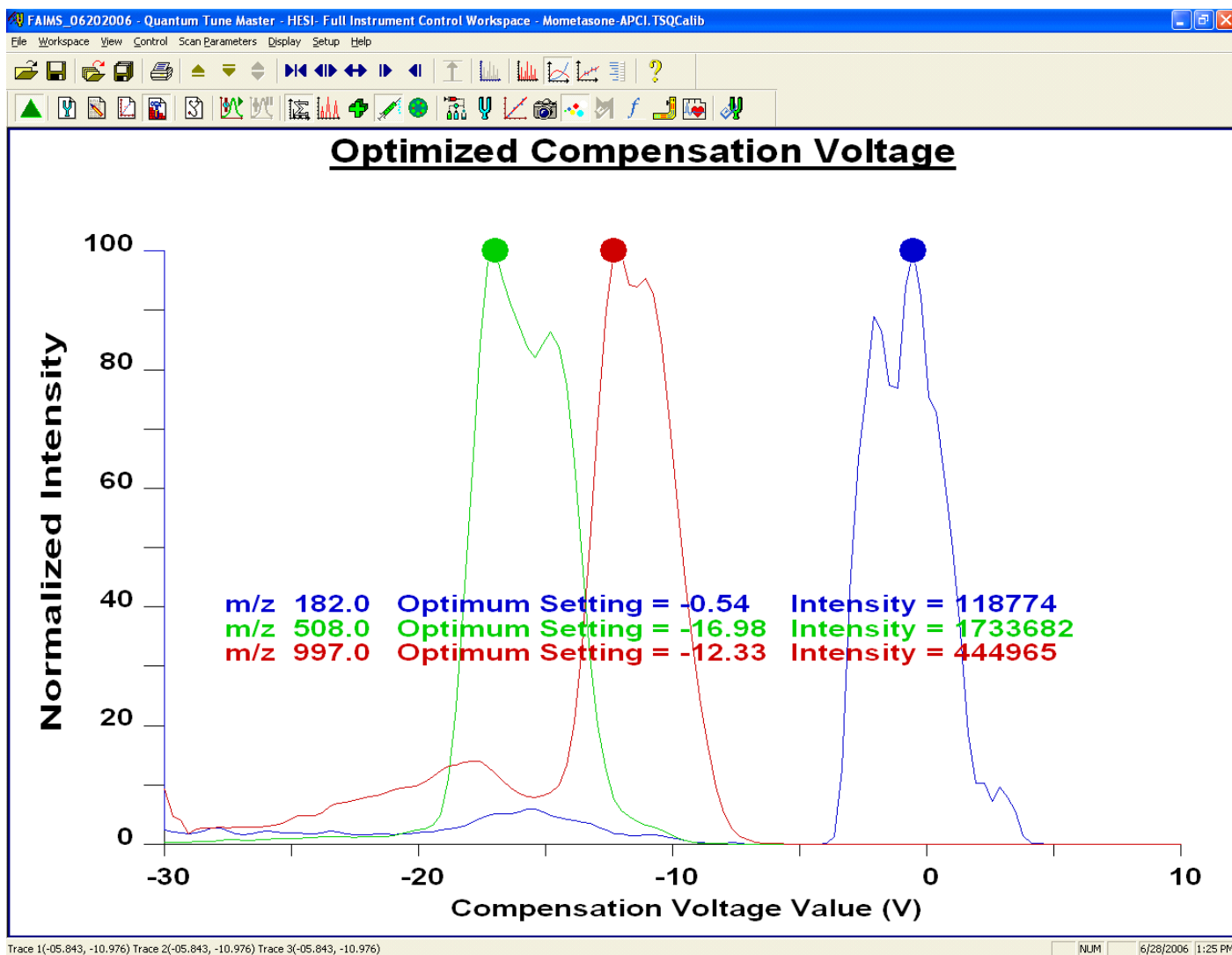


Figure 31. Optimization CV scans of polytyrosine - 1, 3, 6

Verifying a Stable Ion Beam

If your initial ion signal was weak or unstable, you need to establish a stable ion beam and optimize the CV again. The intensity and stability of the ion beam largely depends on the performance of the ion source. You can adjust the ion source settings to optimize the ion beam intensity and stability.

❖ To observe the intensity and stability of the ion beam

1. Set the FAIMS parameters corresponding to polytyrosine - 3 (m/z 508).
 - a. Click the FAIMS button on the toolbar to display the FAIMS Control view.
 - b. In the FAIMS Control view, input the FAIMS settings that are listed in [Table 9](#).

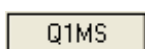
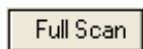


4 Getting Started Using FAIMS on TSQ Quantum Series Mass Spectrometers

Verifying a Stable Ion Beam

Table 9. FAIMS settings for polytyrosine - 3

| FAIMS Parameter | Value |
|----------------------------------|--------|
| Compensation voltage (V) | -16.98 |
| Outer bias voltage (V) | 35 |
| Dispersion voltage (V) | -5000 |
| Total gas flow (L/min) | 4 |
| % He | 50 |
| Inner electrode temperature (°C) | 70 |
| Outer electrode temperature (°C) | 90 |



- c. Click **Apply** to apply the FAIMS settings.
2. Set the scan parameters.
 - a. On the toolbar, click on the **Instrument Method Development Workspace** button. The Instrument Method Development workspace appears.
 - b. Click on **Full Scan** and **Q1MS** to display the Full Scan parameters and to select the Q1MS scan mode.
 - c. In the Scan Range box, select Entry Mode: **Center Mass** to display the Center Mass and Scan Width spin boxes.
 - d. In the Center Mass box, enter **508.2** to set the center of the scan range to m/z 508.2.
 - e. In the Scan Width box, enter **10.000** to set the scan width to m/z 10.000.
 - f. In the Scan Time spin box, enter **0.20** to set the scan time to 0.20 s.
 - g. Confirm that the Source CID, Data Processing, and Q2 CID Gas check boxes are not selected to ensure that these options are off.
 - h. Click on **Apply** to apply these scan parameters.

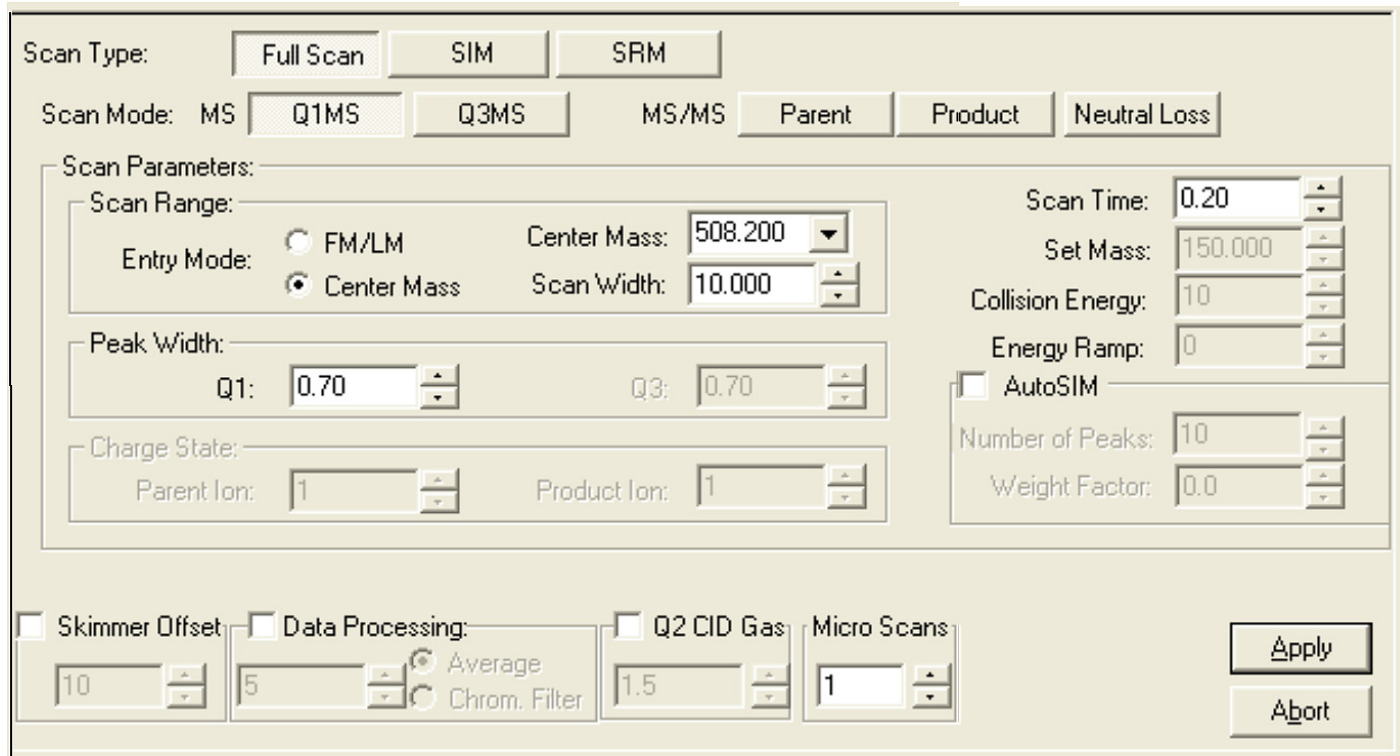
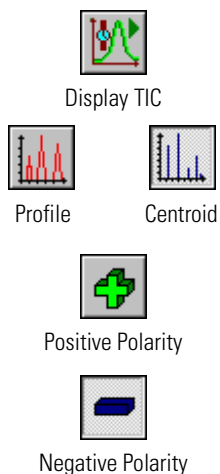


Figure 32. Define Scan view, showing typical settings for establishing a stable ion current



3. On the toolbar, click the **Display TIC** button to begin an ion current trace in the Graph view in the bottom right corner of the workspace.
4. Ensure that the **Profile/Centroid** button is in the profile state to display profile type data. If the button is in the centroid state (as shown at the left), click it to toggle the data type to profile.
5. Ensure that the mass spectrometer is in the **positive ion polarity** mode. You can determine this by observing the state of the Polarity button (as shown at the left).

4 Getting Started Using FAIMS on TSQ Quantum Series Mass Spectrometers

Verifying a Stable Ion Beam

6. Determine if you have a stable ion beam.

- In the Spectrum view in the bottom left corner of the workspace, observe the mass spectrum. You should see signal at the polytyrosine – 3 mass.
- Click anywhere in the Spectrum view to enable the Display buttons on the File / Display toolbar.
- Click on the **Creep** toolbar button to invoke the creep Y-axis normalization mode. This enables you to observe changes in the intensities of the ions. The profile mass spectrum at m/z 508 is shown in Figure 33.

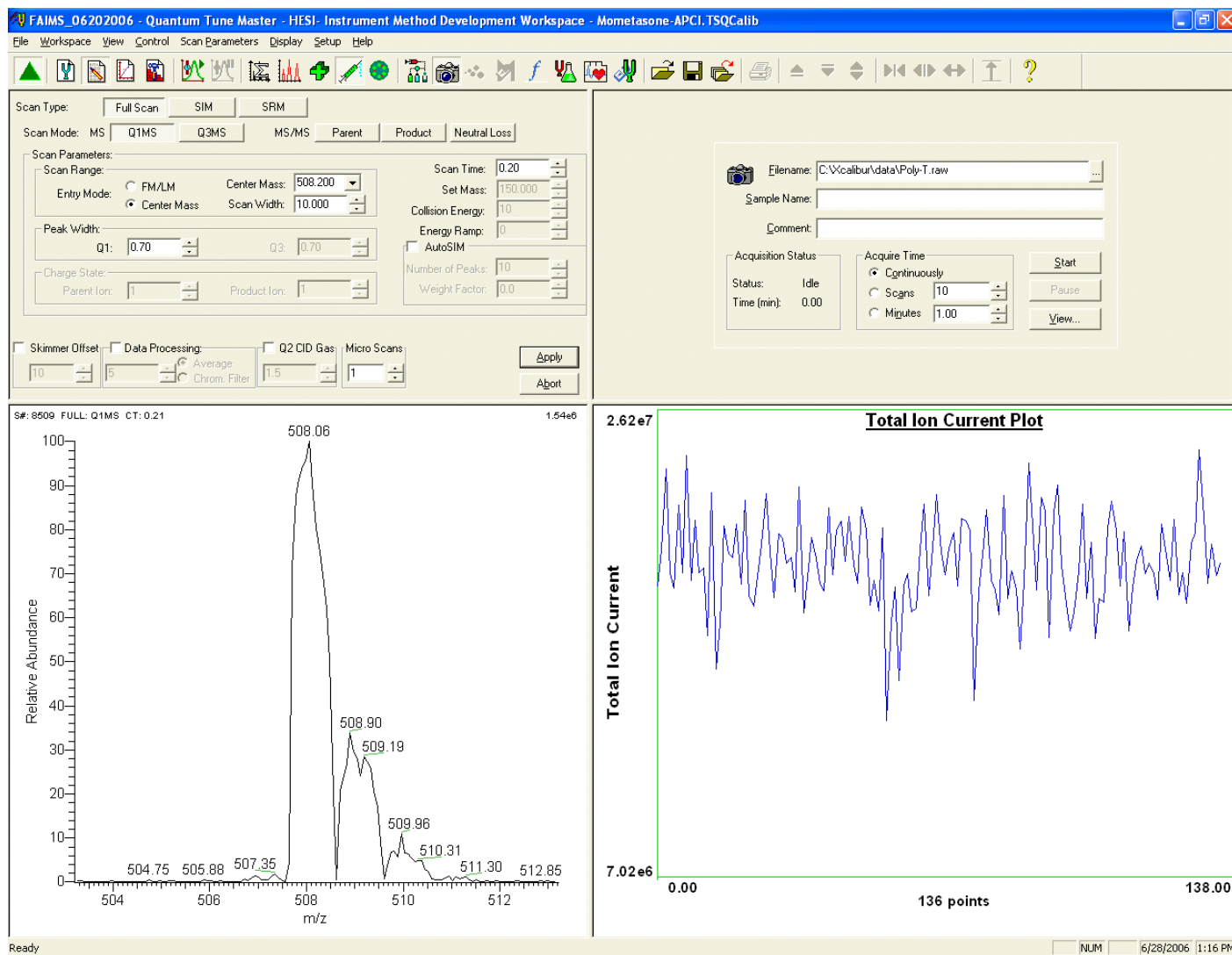


Figure 33. Instrument Method Development workspace, showing stable ion beam

Note Adjust the sheath gas pressure to establish a stable ion beam. Too low a sheath gas pressure can cause a loss of signal stability, whereas too high a pressure can cause a loss of peak intensity.

7. Observe the signal of the polytyrosine – 3 ion.
 - If the tops of the peaks are steady, you have a stable ion beam and you do not need to adjust the H-ESI source settings. The peak height should not vary by more than about 30% from scan to scan.
 - If the top of the peak is unsteady, you need adjust the H-ESI source settings. Start by adjusting the pressure of the sheath gas.

Note The TIC can be observed in the Graph view in the bottom right corner of the workspace. Large fluctuations in the TIC may indicate an unstable ion beam.

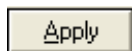
8. If you changed the ion source settings to obtain a stable beam, repeat the CV scan as described in “Running CV Scans” on page 37.

Testing the FAIMS Selectivity

Use the CV scans in [Figure 31](#) on [page 39](#) to develop a strategy for FAIMS selectivity. Ideally you want to choose a CV at which the intensity of the ion of interest is high and the intensities of the unwanted ions are low.

❖ To test the FAIMS selectivity

1. Set the scan parameters.
 - a. On the toolbar, click the **Instrument Method Development Workspace** button. The Instrument Method Development workspace appears.
 - b. Click **Full Scan** and **Q1MS** to display the Full Scan parameters and to select the Q1MS scan mode.
 - c. Set the scan parameters as shown in [Figure 34](#).
 - d. Click on **Apply** to apply these scan parameters.



4 Getting Started Using FAIMS on TSQ Quantum Series Mass Spectrometers

Testing the FAIMS Selectivity

Scan Type:

Scan Mode:

Scan Parameters:

Scan Range: First Mass: 150.000 Last Mass: 1010.000

Entry Mode: FM/LM Center Mass

Peak Width: Q1: 0.70 Q3: 0.70

Charge State: Parent Ion: 1 Product Ion: 1

Scan Time: 0.48

Set Mass: 150.000

Collision Energy: 10

Energy Ramp: 0

AutoSIM

Number of Peaks: 10

Weight Factor: 0.0

Skimmer Offset: 10

Data Processing: Average Chrom. Filter

Q2 CID Gas: 1.5

Micro Scans: 1

Figure 34. Define Scan view, showing settings for a full scan mass spectrum of polytyrosine - 1, 3, 6



Profile



Centroid

2. Ensure that the **Profile/Centroid** button is in the centroid state to display centroid type data. If the button is in the profile state (as shown at the left), click it to toggle the data type to centroid.



3. Set the CV to select the polytyrosine - 3 ion.

- Click on the FAIMS button on the toolbar to display the FAIMS Control view.
- Enter -16.98 in the Compensation Voltage box and click **Apply**. [Figure 35](#) shows the mass spectrum with FAIMS selection of the polytyrosine - 3 ion.

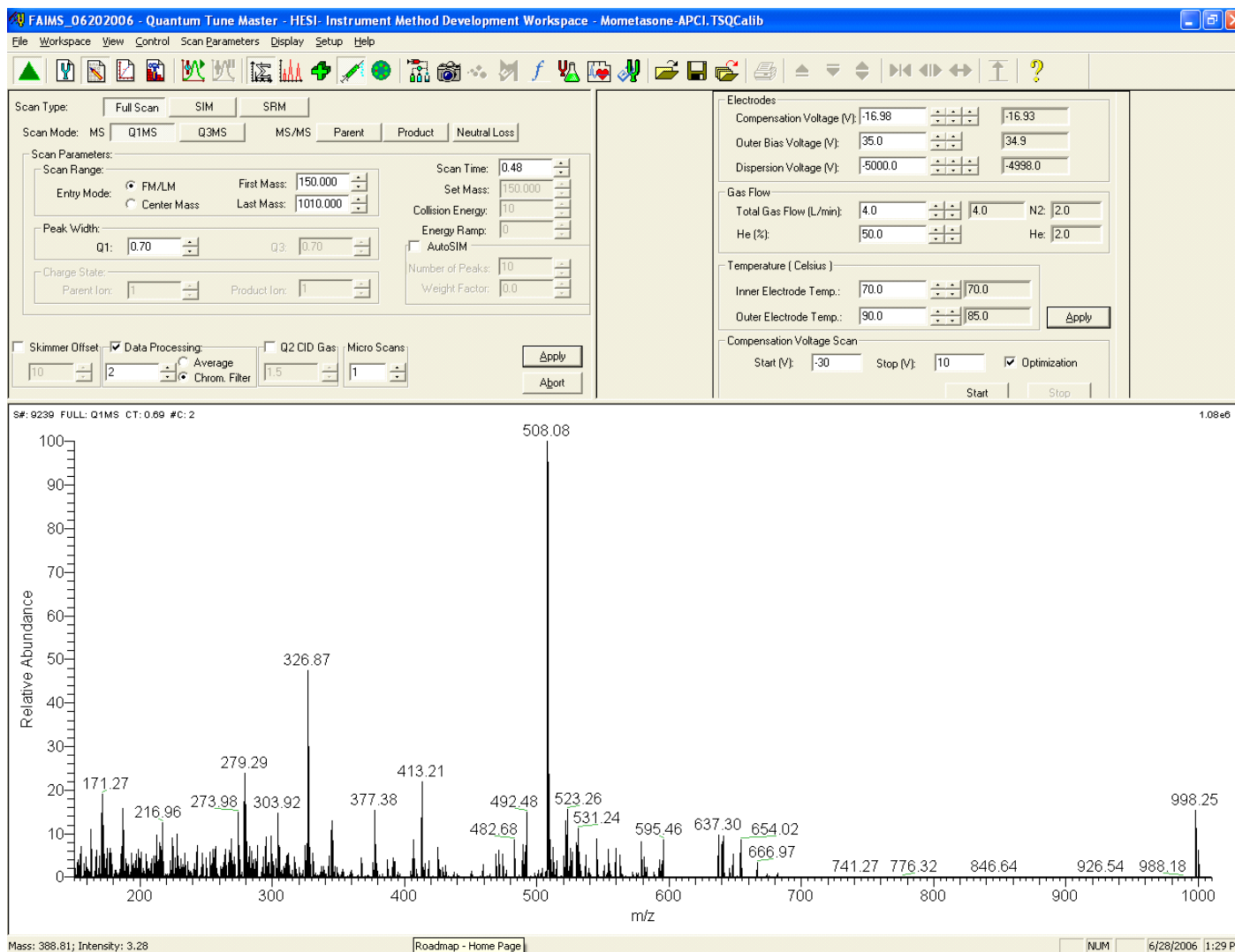
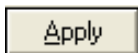


Figure 35. Mass spectrum with FAIMS selection of polytyrosine - 3



4. Enter **-0.60** in the Compensation Voltage box and click **Apply** to select the polytyrosine - 1 ion. Figure 36 shows the mass spectrum with FAIMS selection of the polytyrosine - 1 ion.

4 Getting Started Using FAIMS on TSQ Quantum Series Mass Spectrometers

Further Optimization of FAIMS Parameters for Selectivity

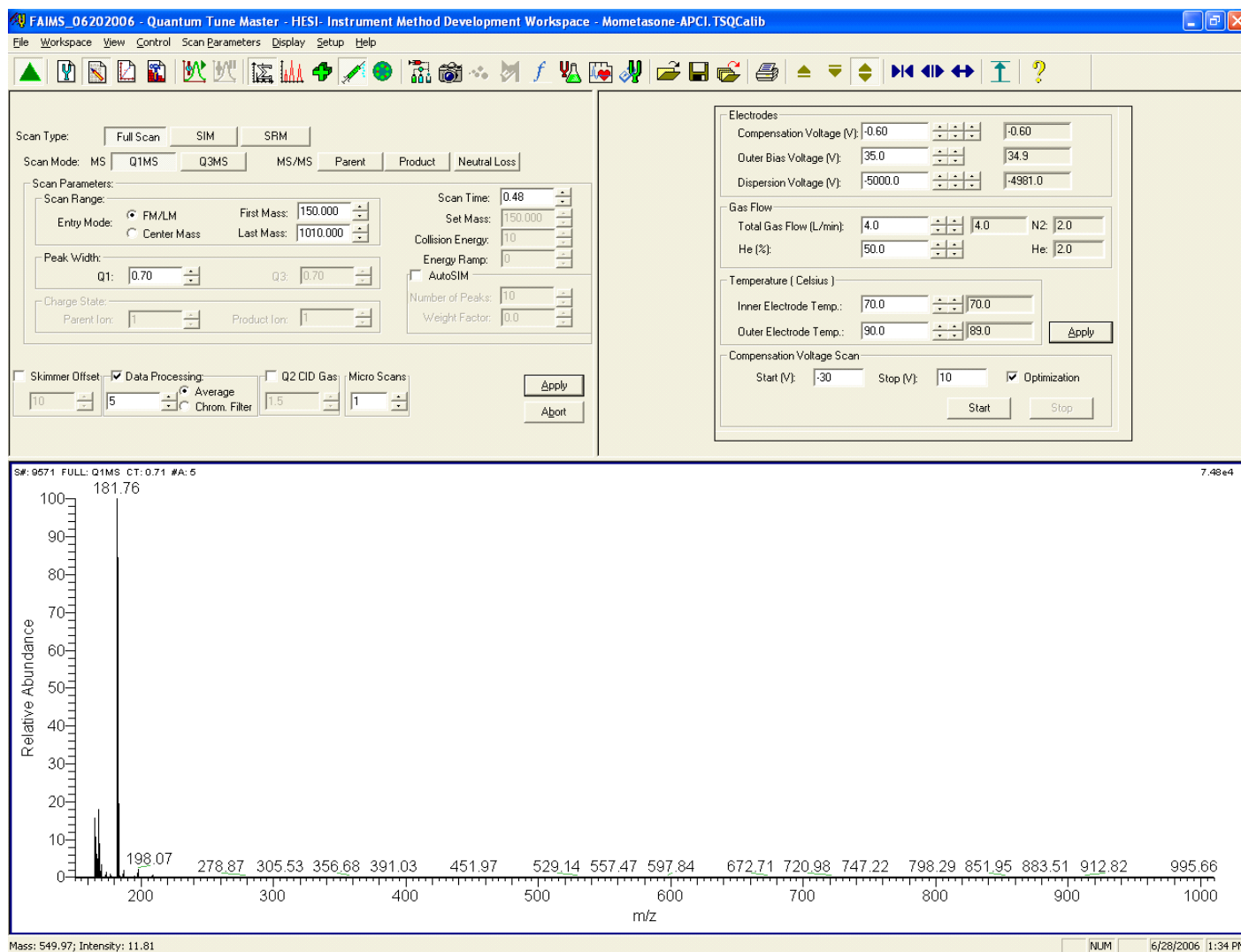


Figure 36. Mass spectrum with FAIMS selection of polytyrosine - 1

The selection of polytyrosine - 1 is superior to that of polytyrosine - 3 because its CV spectrum does not overlap those of polytyrosine - 3 or 6 at -0.60 V.

Further Optimization of FAIMS Parameters for Selectivity

To optimize the FAIMS settings other than the CV, see [Chapter 6, “Advanced Optimization of FAIMS Settings.”](#) on page 65.

Saving the Settings in a Tune File

An acquisition is divided into time segments. Each segment can use a different tune method with different mass spectrometer and FAIMS settings. Tune methods are saved in tune files with extension .TSQTune.

To save the mass spectrometer and FAIMS settings in a tune file, see “[Saving the Settings in a Tune File](#)” on [page 21](#).

Copying the Optimized CVs to Instrument Setup or LCquan

You can export the SIM or SRM settings, including the optimized CVs, to Instrument Setup or LCquan. These settings can then be saved in an instrument method or LCquan method.

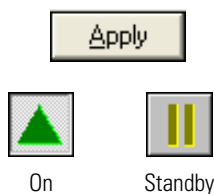
To copy the optimized CVs to Instrument Setup or LCquan, see “[Copying the Optimized CVs to Instrument Setup and LCquan](#)” on [page 22](#).

Flushing the System

This topic describes how to clean your mass spectrometer after performing this polytyrosine example. It is recommended that you clean the mass spectrometer before acquiring data on your analyte of interest.

❖ To clean the mass spectrometer

1. Turn Off the flow of liquid from the syringe pump.
 - a. Choose **Setup > Syringe Pump & Sample Loop** to display the Syringe Pump and Sample Loop view in the top right corner of the workspace. See [Figure 28](#) on [page 36](#).
 - b. In the Syringe Flow Control group box, select **Off** and then click **Apply** to stop the syringe pump.
2. Click the **On/Standby** button on the toolbar to place the mass spectrometer in standby.
3. Remove the syringe from the syringe pump holder.
 - a. Lift the handle off the syringe while depressing the black release button on the syringe pump handle.
 - b. Remove the syringe.
 - c. Remove the tip of the syringe needle from the end of the Teflon tube on the syringe adapter assembly.
4. Clean the syringe thoroughly with a solution of 50:50 methanol – water.



4 Getting Started Using FAIMS on TSQ Quantum Series Mass Spectrometers

Flushing the System

5. Flush the sample transfer line, sample tube, and H-ESI probe.
 - a. Fill the cleaned syringe with a solution of 50:50 methanol–water (or with another appropriate solvent).
 - b. While holding the plunger of the syringe in place, carefully insert the needle of the syringe into the end of the Teflon tube on the syringe adapter.
 - c. Flush the sample transfer line, sample tube, and H-ESI probe with the solution by slowly depressing the syringe plunger. Visually check that the solution is exiting the tip of the H-ESI probe on the inside of the probe assembly.
 - d. Remove the needle of the syringe from the syringe adapter.

Getting Started Using FAIMS on LTQ Series MS Detectors

This chapter describes a procedure for running a FAIMS experiment on an LTQ series MS detector. The procedure uses the LTQ's caffeine, MRFA, and Ultramark 1621 tuning and calibration solution, but you can use your own analyte.

Note Before using the FAIMS system, your MS detector needs to be properly tuned and calibrated, without the FAIMS interface, in the H-ESI/MS mode. Refer to *LTQ Getting Started*.

❖ To perform the FAIMS experiment

1. Set up the syringe pump to infuse the tuning and calibration solution containing caffeine, MRFA, and Ultramark 1621 directly into the H-ESI source by syringe pump infusion.
2. Set up the MS detector.
3. Configure the syringe pump and start infusion.
4. Run CV scans.
5. Verify that there is a stable ion beam.
6. Test selectivity.
7. Save the settings in a Tune file.
8. Flush the sample line, sample tube, and H-ESI probe.

Setting Up the Syringe Pump

The syringe pump allows you to infuse a sample solution for extended periods of time. You use the syringe pump to introduce tuning and calibration solution into the H-ESI source.

Note To minimize the possibility of cross-contamination, use a different syringe and length of PEEK tubing for the tuning and calibration solution than you would for your sample solution.

❖ To set up the syringe pump for infusion

1. Fill a clean syringe with the caffeine, MRFA, and Ultramark 1621 tuning and calibration solution. For instructions on preparing the tuning and calibration solution, refer to the *Getting Started* manual.
2. Connect a 4 cm (1.5 in.) segment of Teflon® tube with a fingertight fitting and a ferrule to an LC union.

The LC union has coned-bottom, 10-32 receiving ports. [Figure 37](#) shows the suggested fittings for connecting the syringe to the LC union.

3. Insert the syringe needle into the segment of Teflon tube.

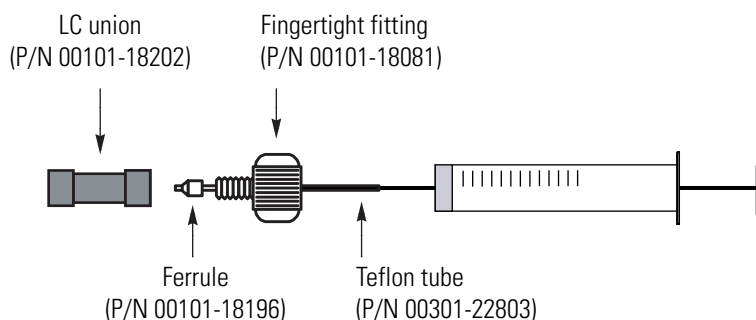


Figure 37. Plumbing connections for the syringe.

4. Place the syringe into the syringe holder of the syringe pump.
5. While squeezing the release button on the syringe pump handle, push the handle forward until it just contacts the syringe plunger.
6. Using fingertight fittings and ferrules, connect an infusion line of PEEK tubing (0.005-in. ID × 1/16-in OD) between the LC union and the grounding union on the H-ESI probe.

[Figure 38](#) shows the suggested fittings and ferrules for connecting the LC union to the grounding union. Both the LC union and the grounding union have 10-32, coned-bottom receiving ports.

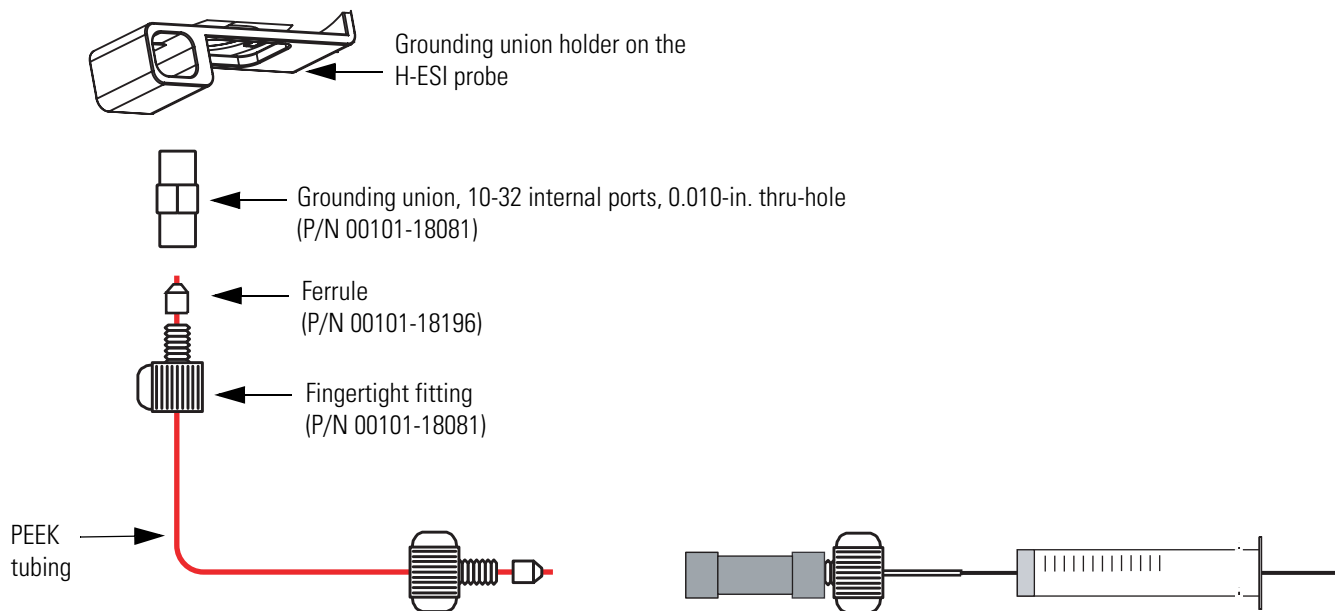


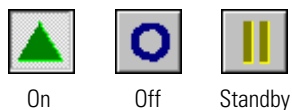
Figure 38. Plumbing connections for the infusion line between the LC union and the grounding union

Setting Up the MS Detector

❖ To set up the LTQ series MS detector for the FAIMS experiment

1. Position the H-ESI probe as follows:

- Lateral position: center
- Front to back position: micrometer 1.5 back
- Probe depth: B



On Off Standby



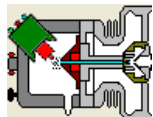
Positive Negative

2. Click on the **On/Standby** button on the toolbar to turn on the mass spectrometer. (The three different states of the On/Standby button are shown at the left.)

3. Ensure that the LTQ is in the positive ion polarity mode. You can determine the ion polarity mode of the LTQ by observing the state of the Polarity button (as shown at the left).

4. Set the H-ESI source parameters.

- a. Click the **H-ESI** icon on the toolbar (or choose **Setup > Heated ESI Source**) to display the Heated ESI Source dialog box.
- b. In the Heated ESI Source dialog box, input the H-ESI settings that are listed in [Table 10](#).



5 Getting Started Using FAIMS on LTQ Series MS Detectors

Setting Up the MS Detector

Table 10. H-ESI settings for the LTQ tuning and calibration solution experiment

| H-ESI Parameter | Value |
|----------------------------|-------|
| Heater temperature (°C) | 20 |
| Sheath gas flow rate | 12 |
| Aux gas flow rate | 5 |
| Sweep gas flow rate | 0 |
| Spray voltage (kV) | 5.5 |
| Capillary temperature (°C) | 270 |
| Capillary voltage (V) | 25 |
| Tube lens voltage (V) | 100 |



- c. Click **Apply** to apply the H-ESI settings.
- d. Observe the readbacks in Heated ESI Source dialog box. Verify that the readbacks match the setpoints.

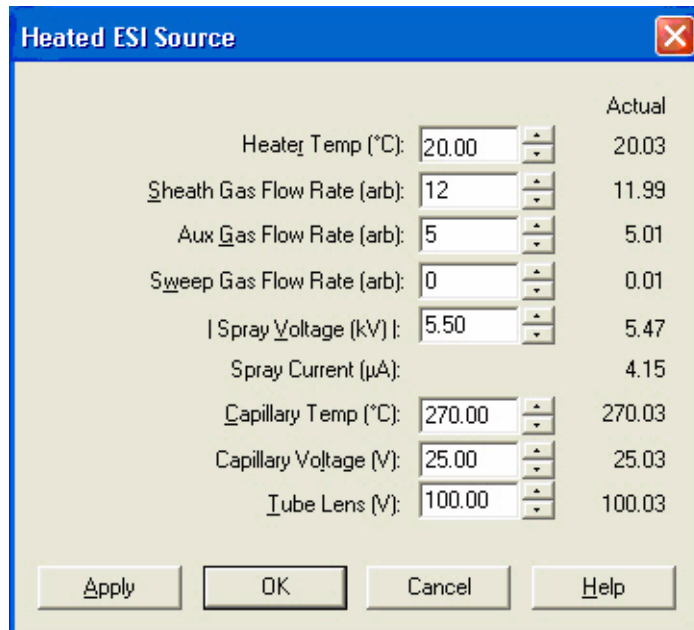


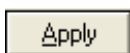
Figure 39. H-ESI source setpoints and readbacks

5. Set the scan parameters.
 - a. Click the **Define Scan** button to display the Define Scan dialog box.
 - b. In the Define Scan dialog box, input the scan settings that are listed in following table.



Table 11. Scan settings

| Scan Parameter | Value |
|-----------------------------|--------|
| Mass range | Normal |
| Scan rate | Normal |
| Scan type | Full |
| Microscans | 1 |
| Maximum injection time (ms) | 10 |
| Source fragmentation | Off |
| First mass (m/z) | 150 |
| Last mass (m/z) | 2000 |



- c. Click **Apply** to apply the scan settings.

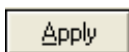
Configuring the Syringe Pump and Infusing the Calibration Solution

You use the Syringe Pump dialog box to configure and start the syringe pump.

❖ To configure and start the syringe pump



1. Click on the **syringe pump** icon on the toolbar (or choose **Setup > Syringe Pump**) to display the Syringe Pump dialog box.
2. In the Syringe Flow Control box, select **On**.
3. Enter **3.00** in the Flow Rate box to set a flow rate of 3.00 $\mu\text{L}/\text{min}$. (The flow rate can be adjusted to achieve the best ion beam intensity and stability.)
4. In the Syringe Type box, select the **syringe type**.
5. In the volume box, select the **syringe volume**.
6. Click **Apply** to apply these settings and to start the syringe pump. The tuning and calibration solution should now flow into the ion source.



Running CV Scans

You determine the optimum compensation voltage for an ion by performing a CV scan.

❖ To perform CV scans for caffeine, MRFA, and Ultramark (m/z 1522) ions

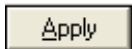


1. Click the **FAIMS Control** icon on the toolbar (or choose **Setup > FAIMS Control**) to display the FAIMS Control dialog box.

- In the FAIMS Control dialog box, input the following FAIMS settings.

Table 12. FAIMS settings for the LTQ tuning and calibration solution

| FAIMS Parameter | Value |
|----------------------------------|---------------------------------------|
| Compensation voltage (V) | -24 |
| Outer bias voltage (V) | same as capillary voltage (here 25 V) |
| Dispersion voltage (V) | -5000 |
| Total gas flow (L/min) | 3.75 |
| % He | 50 |
| Inner electrode temperature (°C) | 70 |
| Outer electrode temperature (°C) | 90 |



- Click **Apply** to apply the FAIMS settings.
- Observe the readbacks in FAIMS Control view. Verify that the readbacks match the setpoints.

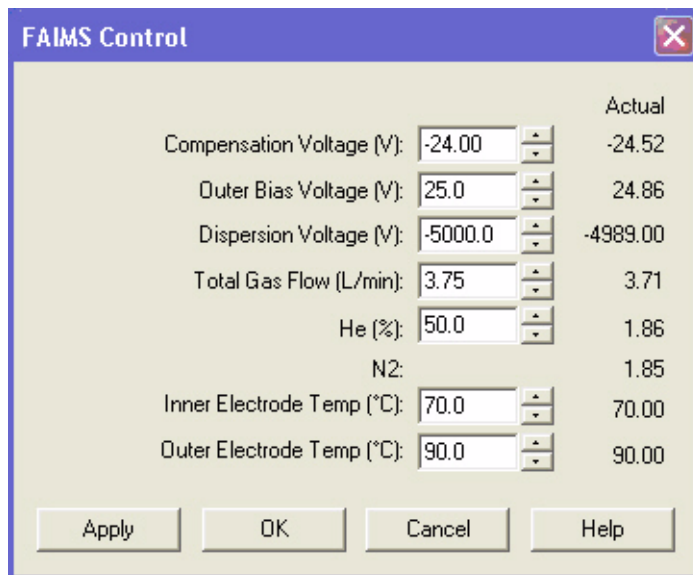


Figure 40. FAIMS setpoints and readbacks



- Click on the **Tune** button and then the **FAIMS** tab to display the FAIMS page of the Tune dialog box.
- In the FAIMS page, input the following FAIMS settings.

Table 13. FAIMS tune settings for the LTQ tuning and calibration solution

| FAIMS Parameter | Value |
|---------------------|--------|
| What to Optimize On | Masses |
| Mass 1 | 195 |
| Mass 2 | 524 |
| Mass 3 | 1522 |
| Start (V) | -40 |
| Stop (V) | 0 |

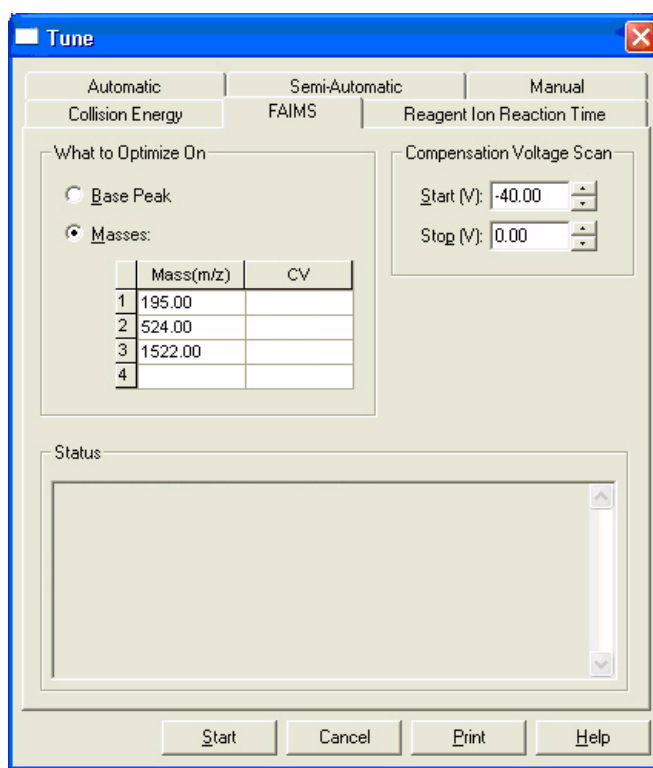
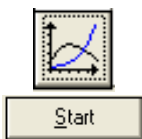


Figure 41. FAIMS page of the Tune dialog box, before the CV scans



7. Click the **Display Graph** button in the Tune Plus toolbar to display the graph window.
8. Click **Start** to begin the CV scans.

The optimization procedure ramps the CV for each ion from -40 to 0 V. Tune Plus plots the intensity versus CV for each ion and determines the optimum CV. Tune Plus lists the optimum CVs in the CV column of the FAIMS page.

5 Getting Started Using FAIMS on LTQ Series MS Detectors

Running CV Scans

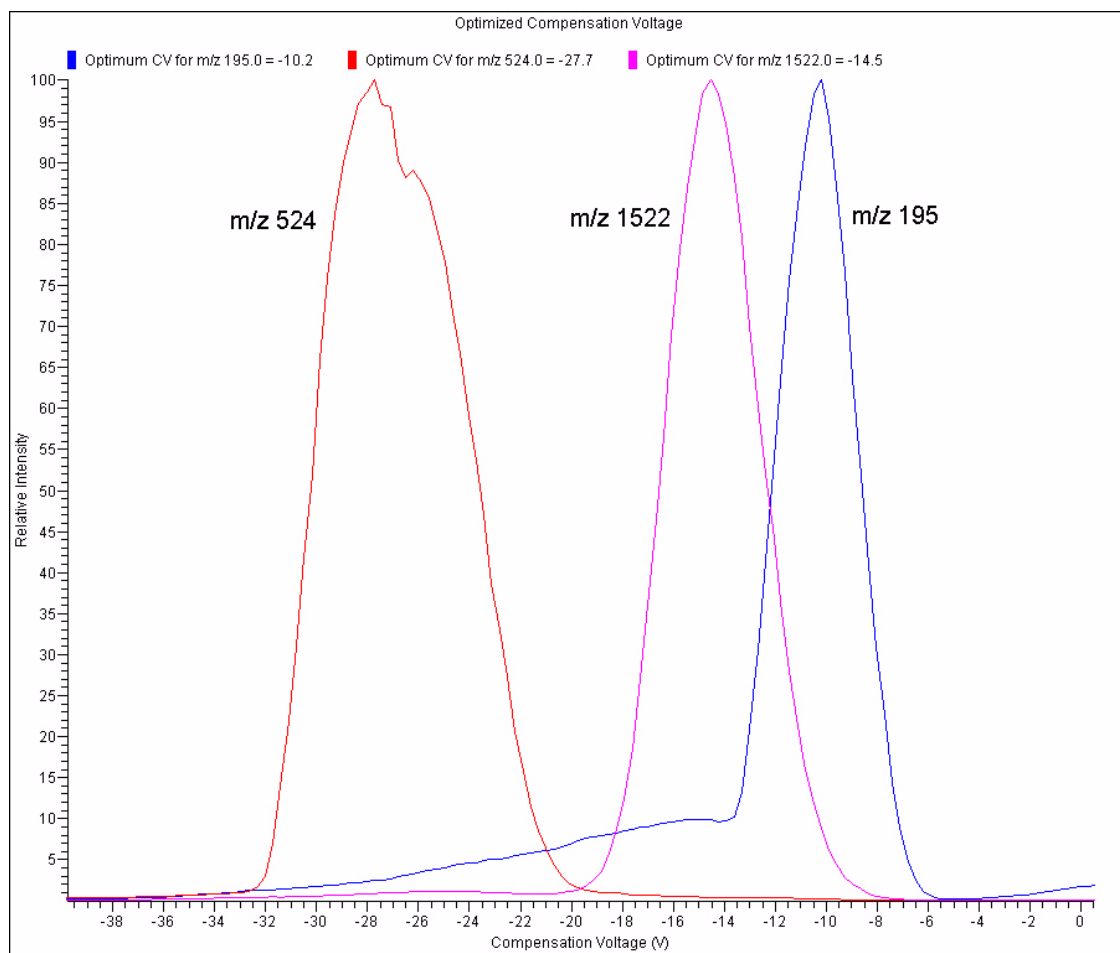


Figure 42. CV scans for caffeine, MRFA, and Ultramark (m/z 1522 ion)

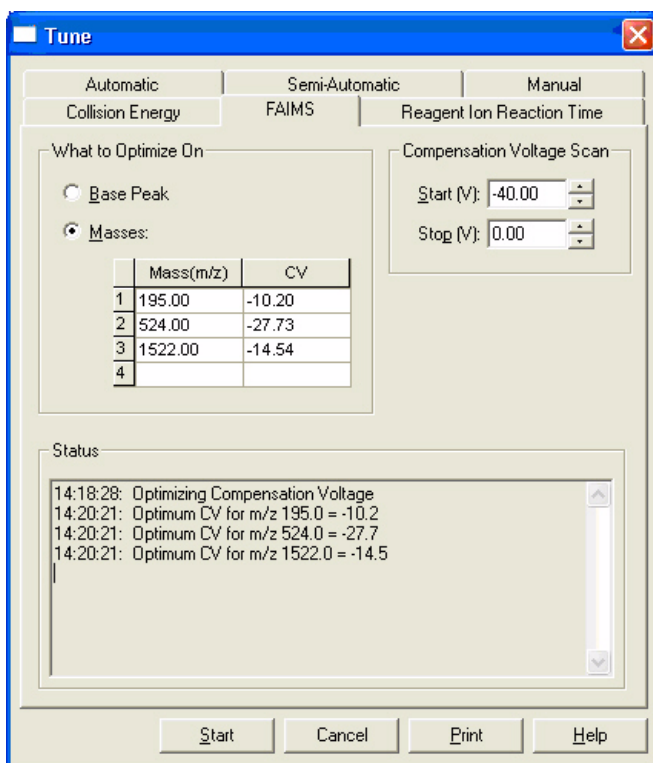


Figure 43. FAIMS page of the Tune dialog box, showing the optimum CVs

Verifying a Stable Ion Beam

If your initial ion signal was weak or unstable, you need to establish a stable ion beam and optimize the CVs again. The intensity and stability of the ion beam largely depends on the performance of the ion source. You can adjust the ion source settings to optimize the ion beam intensity and stability.

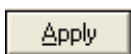
❖ To check the stability of the ion beam

1. Set the scan parameters.
 - a. Click the **Define Scan** button to display the Define Scan dialog box.
 - b. In the Define Scan dialog box, input the scan settings for m/z 195 that are listed in the following table.



Table 14. Scan settings for observing the caffeine ion signal

| Scan Parameter | Value |
|-----------------------------|--------------|
| Mass range | Normal |
| Scan rate | Normal |
| Scan type | SIM |
| Microscans | 1 |
| Maximum injection time (ms) | 50 |
| Source fragmentation | Off |
| FAIMS CV (V) | -10.2 |
| Input | Center/Width |
| Mass 1 (m/z) | 195 |
| Width 1 (m/z) | 10 |



c. Click the **Apply** to apply the settings.

2. On the toolbar, click the **Display Spectrum View** button.

The Spectrum view appears.

3. On the toolbar, click the **Profile/Centroid** button to display the peaks as

profile  .

4. Observe the peak as calibration solution infuses. Consider the following questions about the ion current signal:

- Is the signal present?
- Is the signal stable, varying by less than about 15% from scan to scan?

If you answered “yes” to the questions in [step 4](#), then your MS detector is operating properly.

If you answered “no” to either of these questions, try the following troubleshooting measures:

- Ensure that the fused-silica sample tube does not extend beyond the tip of the ESI needle. For instructions on inserting the fused-silica sample tube, refer to the *Ion Max and Ion Max-S API Source Hardware Manual*.
- Ensure that the entrance to the ion transfer capillary is open and clean.
- Ensure that the solution entering the probe is free of air bubbles and that the tubing and connectors are free of leaks.

- Ensure that the flow rate of the sheath gas is set to a minimum value of 8 units.

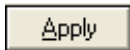
If you modify the H-ESI source parameters, rerun the CV scans as described in “Running CV Scans” on page 53.

Testing the FAIMS Selectivity

Use the CV scans in Figure 42 on page 56 to develop a strategy for FAIMS selectivity. Ideally you want to choose a CV at which the intensity of the ion of interest is high and the intensities of the unwanted ions are low. In this example we use the CVs listed in Figure 43.

❖ To test the FAIMS selectivity

1. Set the scan parameters.
 - a. Click the **Define Scan** button to display the Define Scan dialog box.
 - b. In the Define Scan dialog box, input the scan settings that are listed in Table 11 on page 53.
2. Select the caffeine ion (m/z 195).
 - a. Enter -10.2 in the FAIMS: CV box.
 - b. Click **Apply** to apply the FAIMS settings.



5 Getting Started Using FAIMS on LTQ Series MS Detectors

Testing the FAIMS Selectivity

#48746 IT: 10.000 ST: 0.19 uS: 1 CS: 255 AMW: 0.00 NL: 1.56E5
F: ITMS + c HESI cv=-10.20 Full ms [150.00-2000.00]

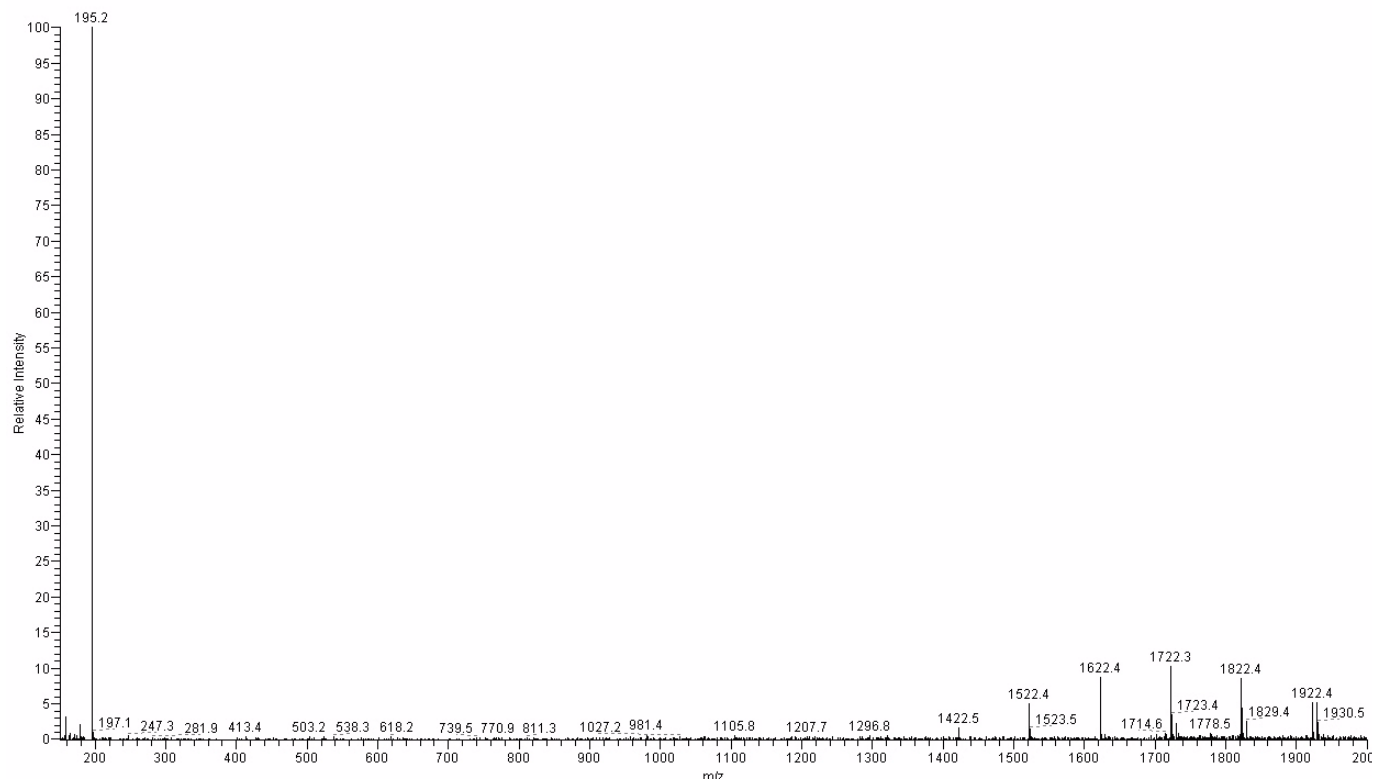


Figure 44. Mass spectrum with FAIMS selection, showing the selected caffeine ion at m/z 195.

3. Select the MRFA ion (m/z 524).
 - a. Enter -27.73 in the FAIMS: CV box.
 - b. Click **Apply** to apply the FAIMS settings.



#49702 IT: 5.842 ST: 0.55 uS: 3 CS: 255 AMV: 0.00 NL: 3.05E5
F: ITMS + c HESI cv=-27.70 Full ms [150.00-2000.00]

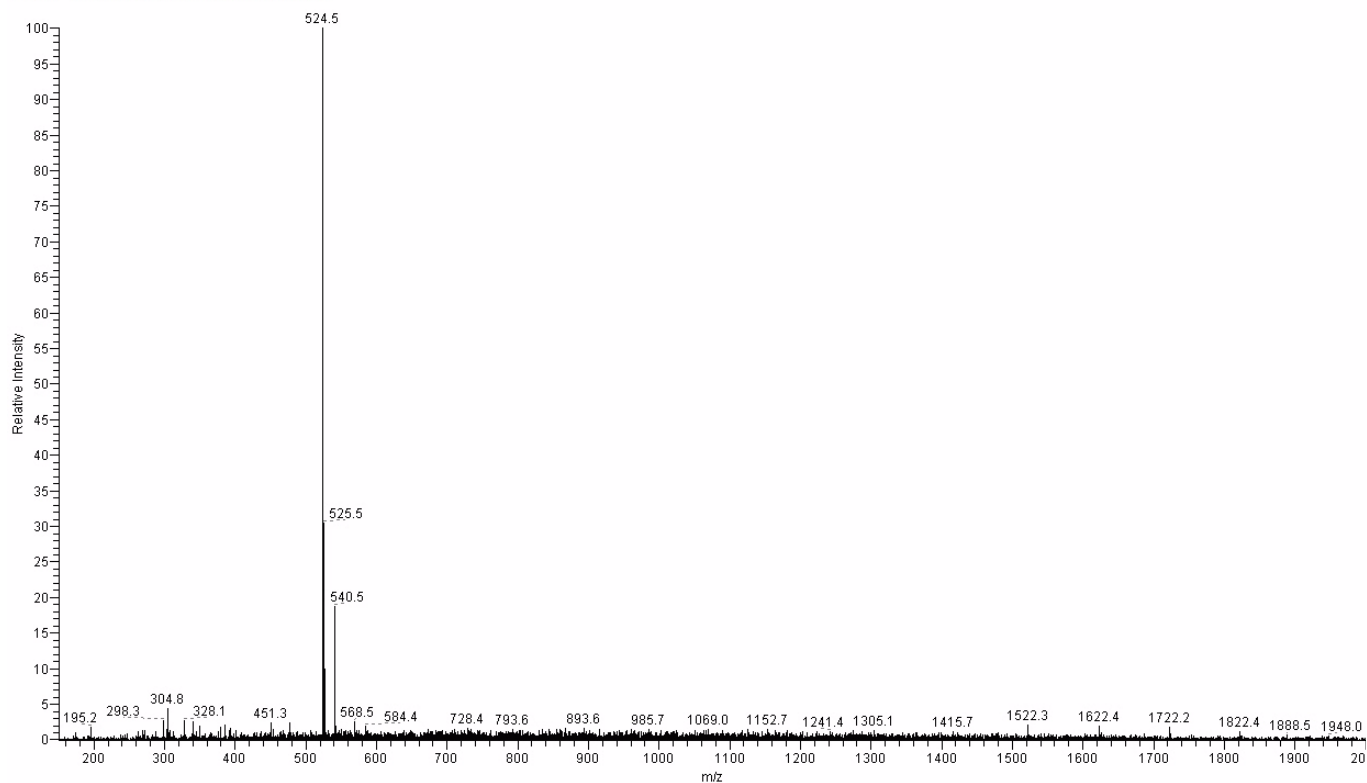
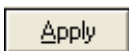


Figure 45. Mass spectrum with FAIMS selection, showing the selected MRFA ion at m/z 524.

4. Select the Ultramark ion (m/z 1522).
 - a. Enter -14.54 in the FAIMS: CV box.
 - b. Click **Apply** to apply the FAIMS settings.



5 Getting Started Using FAIMS on LTQ Series MS Detectors

Further Optimization of FAIMS Parameters for Selectivity

#49852 IT: 7.369 ST: 0.55 uS: 3 CS: 255 AMW: 0.00 NL: 3.29E5
F: ITMS + c HESI cv=-14.50 Full ms [150.00-2000.00]

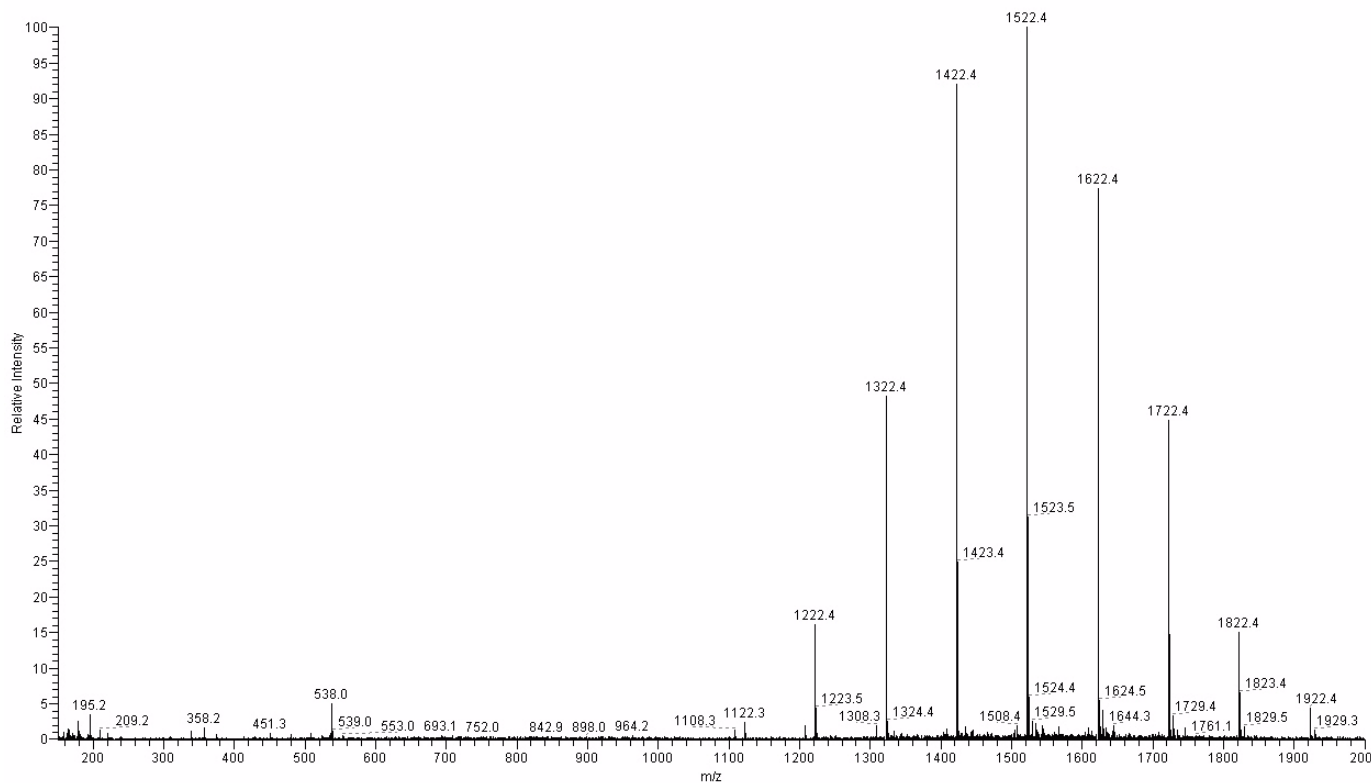


Figure 46. Mass spectrum with FAIMS selection, showing the selected Ultramark ions.

Note The Ultramark ions are chemically similar, so they have similar optimum CVs.

Further Optimization of FAIMS Parameters for Selectivity

To further optimize the FAIMS settings for selectivity, change the settings in [Table 12](#) according to the suggestions in Chapter 5. Rerun the CV scans as described in “[Running CV Scans](#)” on [page 53](#). Observe the mass spectra with the newly optimized CVs.

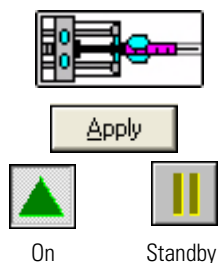
Saving the Settings in a Tune File

The acquisition time is divided into segments. Each segment can use a different Tune Method with different mass spectrometer and FAIMS settings. Tune Methods are saved in Tune files with extension .LTQTune.

To save the mass spectrometer and FAIMS settings in a Tune file, see “[Saving the Settings in a Tune File](#)” on [page 30](#).

Flushing the Sample Transfer Line, Sample Tube, and H-ESI Probe

❖ To flush the sample transfer line, sample tube, and H-ESI probe



1. Turn off the flow of liquid from the syringe pump.
 - a. Click on the **syringe pump** icon on the toolbar (or choose **Setup > Syringe Pump**) to display the Syringe Pump dialog box.
 - b. Select **Off** and then click **Apply** to stop the syringe pump.
2. Click the **On/Standby** button on the toolbar to place the LTQ in standby.
3. Fill a clean syringe with a solution 5% formic acid in water or an appropriate solvent.

The solvent you use to flush the sample transfer line, sample tube, and H-ESI probe assembly depends on the sample matrix. For example, if you are using a buffered solution of a high concentration, an acidic solution is appropriate.
4. While holding the plunger of the syringe in place, carefully insert the needle of the syringe into the free end of the Teflon tube.
5. Slowly depress the syringe plunger to flow the solution through the sample transfer line, sample tube, and H-ESI probe.
6. Remove the needle of the syringe from the Teflon tube.
7. Repeat [step 3](#) through [step 6](#) with a solution of 50:50 methanol / water.
8. Repeat [step 3](#) through [step 6](#) with acetone.

Advanced Optimization of FAIMS Settings

Standard operating parameters for FAIMS are provided in [Table 15](#). When standard operating parameters do not provide the necessary selectivity, first follow the flowchart in [Appendix A, “FAIMS Optimization Flowchart.”](#)

Table 15. Standard FAIMS operating parameters

| FAIMS Parameter | Positive Ions | Negative Ions | Allowed Range |
|-----------------------------|------------------------------|------------------------------|---|
| Compensation voltage (CV) | ramp -30 to +10 V | ramp -10 to +30 V | -200 to +200 V |
| Dispersion voltage (DV) | -5000 V | +5000 V | -5000 to -2000 V, 0 V, +2000 to +5000 V |
| Outer bias voltage | set same as capillary offset | set same as capillary offset | -200 to +200 V |
| Inner electrode temperature | 70 °C | 70 °C | 30 to 120 °C |
| Outer electrode temperature | 90 °C | 90 °C | 30 to 120 °C |
| %He | 50% He | 50% He | 0 to 50% He |
| Carrier gas flow | 3.5 L/min | 3.5 L/min | 0 to 5 L/min per gas |

This chapter describes advanced optimization of FAIMS parameters for higher selectivity and sensitivity.

Optimizing the selectivity

In addition to the CV, the following FAIMS parameters can also be optimized:

- Dispersion voltage
- Gas composition
- Inner and outer electrode temperatures
- Outer bias voltage

Optimization of these parameters will change the CV values needed to transmit specific analytes. Therefore, when optimizing these parameters, use CV ramps to examine the effect of various values on the transmission of the analyte through the FAIMS electrodes.

To minimize solution switchover time when using single-analyte reference solutions, perform several steps with one reference solution before switching to another reference solution.

When decreasing the helium content of the carrier gas or the electrode temperatures, ramp the CV over a wider range, for example from +10 to -40 V (-10 to +40 for negative ions).

Thermo Fisher Scientific recommends that you follow these procedures in the order described.

❖ To vary dispersion voltage to optimize selectivity

1. Collect a CV ramp at -5000 V (positive ions) or +5000 V (negative ions).
2. Examine the CV traces.
3. Decrease the DV by 500 V (magnitude) and ramp the CV.
4. Examine the CV traces.
5. Repeat step 3.

❖ To vary gas composition to optimize selectivity

1. Set the DV to the optimal value determined in the previous procedure or set the DV to ± 5000 V if the optimal value is unknown.
2. Decrease helium to 25% and ramp the CV.
3. Examine the CV traces and do one of the following:
 - If selectivity has noticeably improved, investigate the effect of increasing and decreasing the DV.
 - If selectivity did not noticeably improve, decrease helium to 0%, increase DV to ± 5000 , and ramp the CV. Examine the CV traces.

❖ To vary the electrode temperatures to optimize selectivity when there is partial separation between the CV peaks for the analytes

1. Set the DV and gas composition to the optimal values determined in the previous procedures.
2. From an initial temperature of 90 °C on the outer electrode and 70 °C on the inner electrode, decrease the temperature on the inner electrode in 10 °C increments. Ramp the CV and examine selectivity and signal intensity.

Note For a temperature of 90 °C on the outer electrode, the inner electrode is limited to a low temperature of approximately 45 °C.

3. If the signal intensity increases, the temperature values may be too high for the analyte. In this case, proceed to the next procedure for analytes with little or no CV peak separation.

Note Generally, intensity decreases as the difference in temperature between electrodes becomes larger, if the inner electrode temperature is lower than the outer electrode temperature. Intensity tends to increase as the difference in temperature between the electrodes becomes larger, if the inner electrode temperature is higher than the outer electrode temperature.

- ❖ **To vary the electrode temperatures to optimize selectivity when there is little or no separation between the CV peaks for the analytes**
 1. Decrease the outer electrode temperature to 70 °C and the inner electrode temperature to 50 °C.
 2. Repeat the procedures for varying the DV and gas composition to optimize selectivity, as necessary.
 3. If more selectivity is required, decrease the outer electrode temperature to 50 °C and the inner electrode temperature to 40 °C. Repeat the procedures for varying the DV and gas composition to optimize selectivity, if necessary.
- ❖ **To vary outer bias voltage to optimize selectivity**
 1. Using the optimal conditions determined for the dispersion voltage, gas composition, and temperature, set the outer bias voltage to 5, 20, and 35 V (-5, -20, and -35 V for negative ions) and ramp the CV at each voltage.
 2. Examine the traces to determine if selectivity is sufficient. Some signal intensity may be lost in the optimization of the outer bias voltage.

Optimizing the Sensitivity

Optimization of sensitivity, by varying the FAIMS settings, should be secondary to achieving the required selectivity. Try adjusting the H-ESI or APCI probe settings and position to optimize sensitivity.

Getting Connected

The initial installation of the FAIMS system is performed by a Thermo Fisher Scientific Field Service Engineer. If the FAIMS interface must be removed and then re-installed on the mass spectrometer at a later time, this chapter describes how to connect cables and gas lines to the FAIMS system and between modules of the FAIMS system.

Figure 47 shows a block diagram of the communication connections of the TSQ Quantum or LTQ, FAIMS temperature control module (TCM), and FAIMS waveform generator (WG). The TSQ Quantum or LTQ communicate with the FAIMS waveform generator via an RS 232 connection. The TSQ Quantum or LTQ communicate with the FAIMS temperature control module through the Ethernet hub via an Ethernet connection.

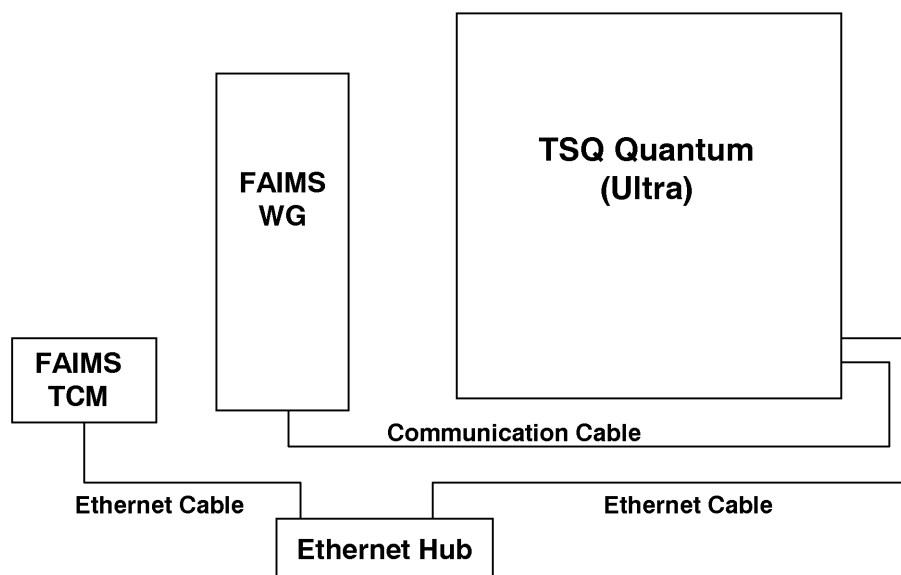


Figure 47. Waveform generator (WG), temperature control module (TCM), and TSQ Quantum or LTQ communication

Figure 48 shows a block diagram of the gasses, power, and communication inputs and outputs of the waveform generator.

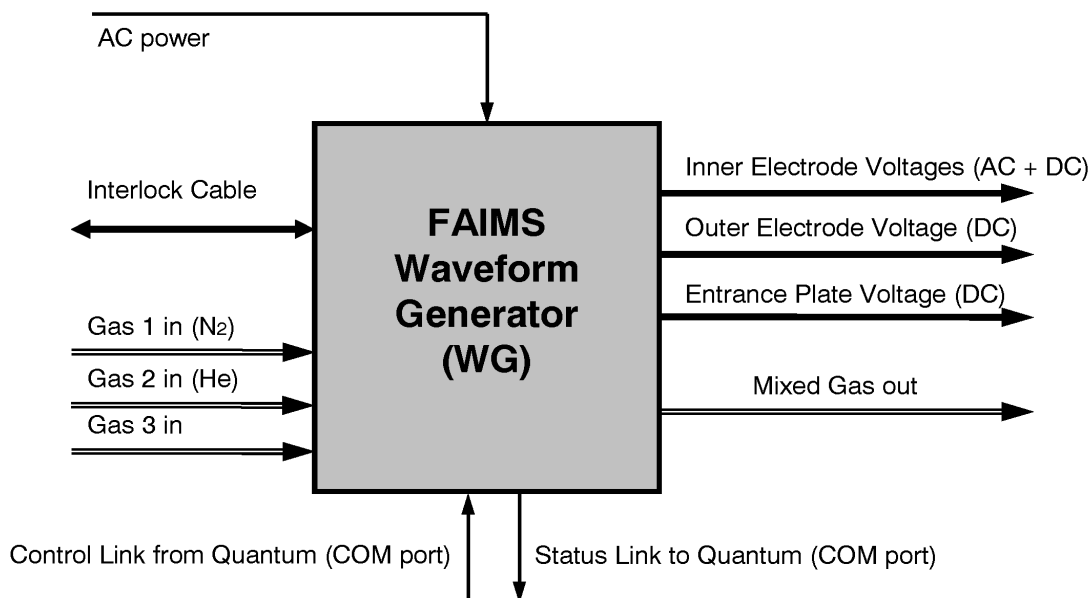


Figure 48. Block diagram showing the gasses, power, and communication inputs and outputs of the waveform generator

Figure 49 shows a block diagram of the gasses, power, and communication inputs and outputs of the temperature control module.

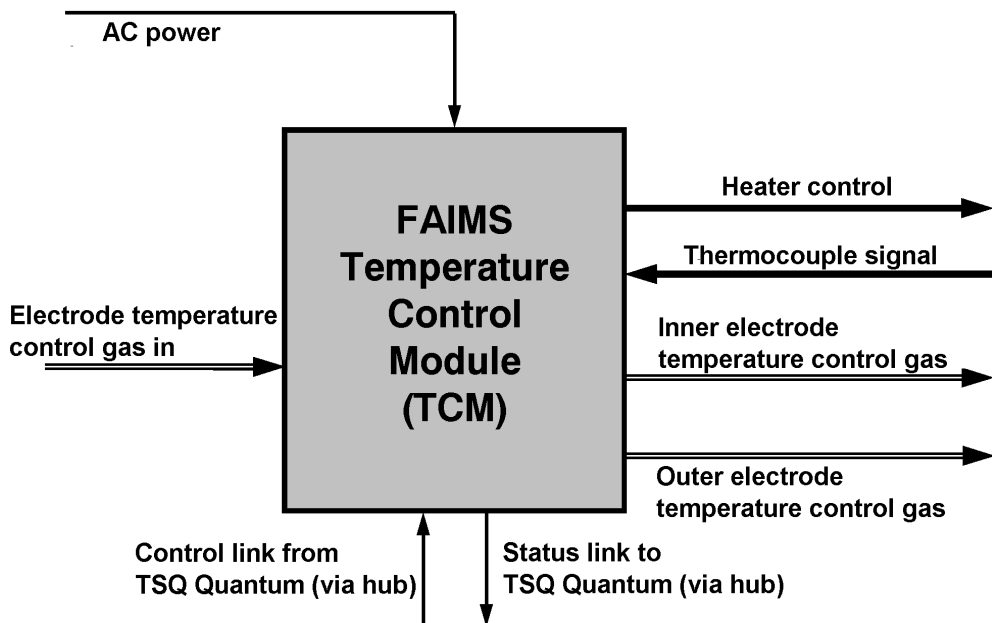


Figure 49. Gases, voltages, and communication of the temperature control module (TCM)

Figure 50 shows the power panel of the TSQ Quantum, and Figure 51 shows the power panel of the LTQ.

Carrier gasses are supplied to the FAIMS system through three quick-disconnect fittings on the connection panel of the waveform generator. These inlet gas ports are labeled He, N₂, and CO₂. Figure 52 shows the connection panel of the FAIMS waveform generator.

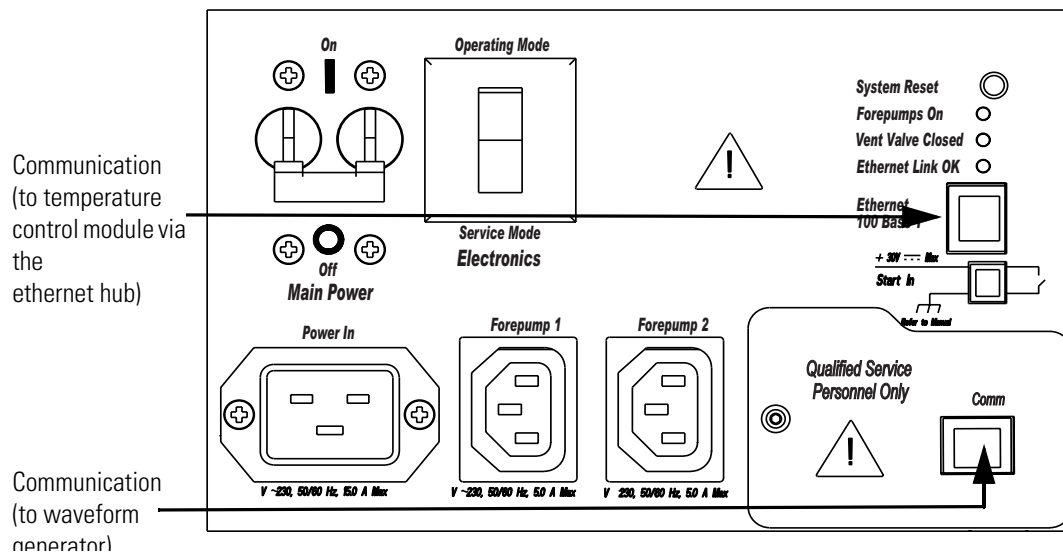


Figure 50. Power panel of the TSQ Quantum

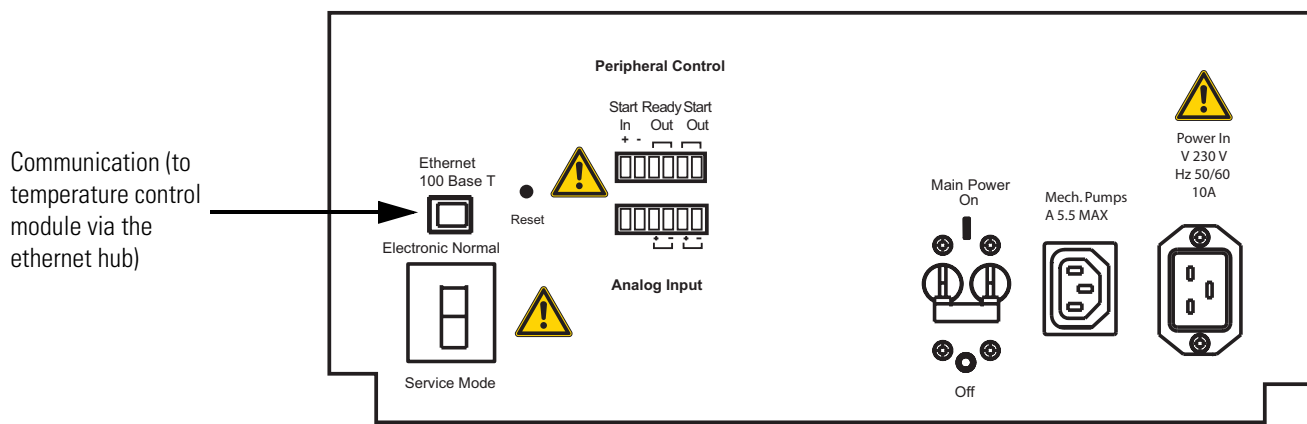


Figure 51. Power panel of the LTQ

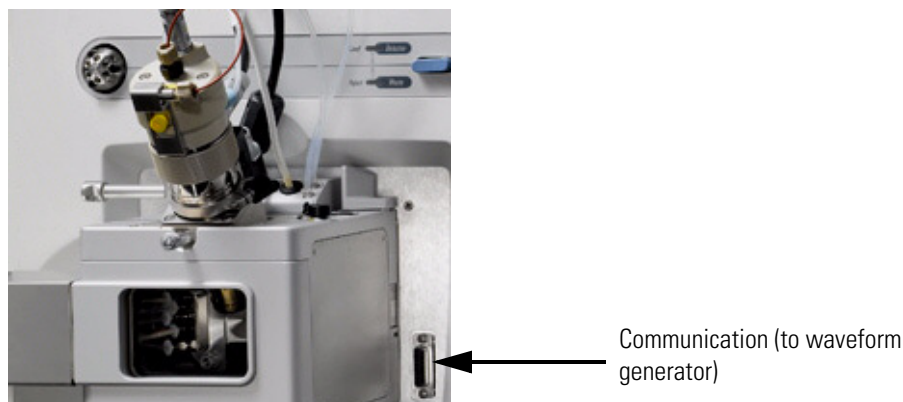


Figure 52. 15-pin connector on LTO

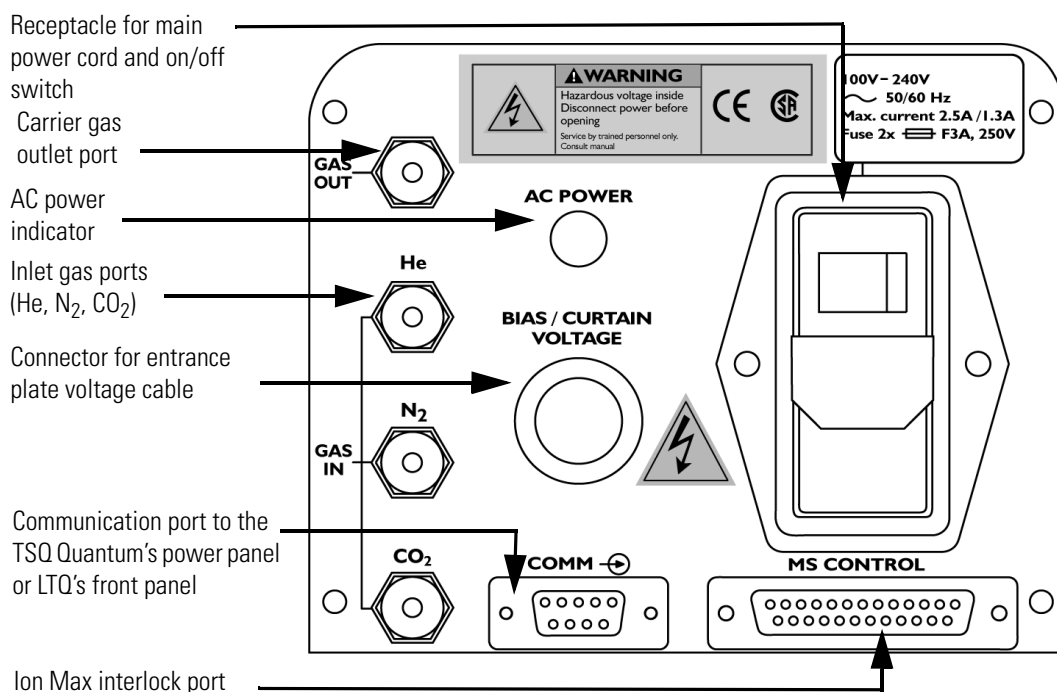


Figure 53. Connection panel on the FAIMS waveform generator

The procedures to connect the gas sources to the waveform generator depend on the laboratory environment. A Thermo Fisher Scientific Field Service engineer will help to connect the gas sources during the initial installation.

Note For the gas cartridges to be sealed from the environment when these gas lines are removed, the quick disconnect functionality must be used. Removing the lines using the Swagelock nut causes the gas cartridges to be left open to absorb water from the air.

❖ **To connect the gas line to the temperature control module**

1. Attach a length of ¼ in. gas line tubing to the compressed gas line.
2. Insert the other end of the gas line tubing into the quick disconnect fitting on the IN port on the temperature control module.

Figure 53 shows the connection panel of the FAIMS temperature control module.

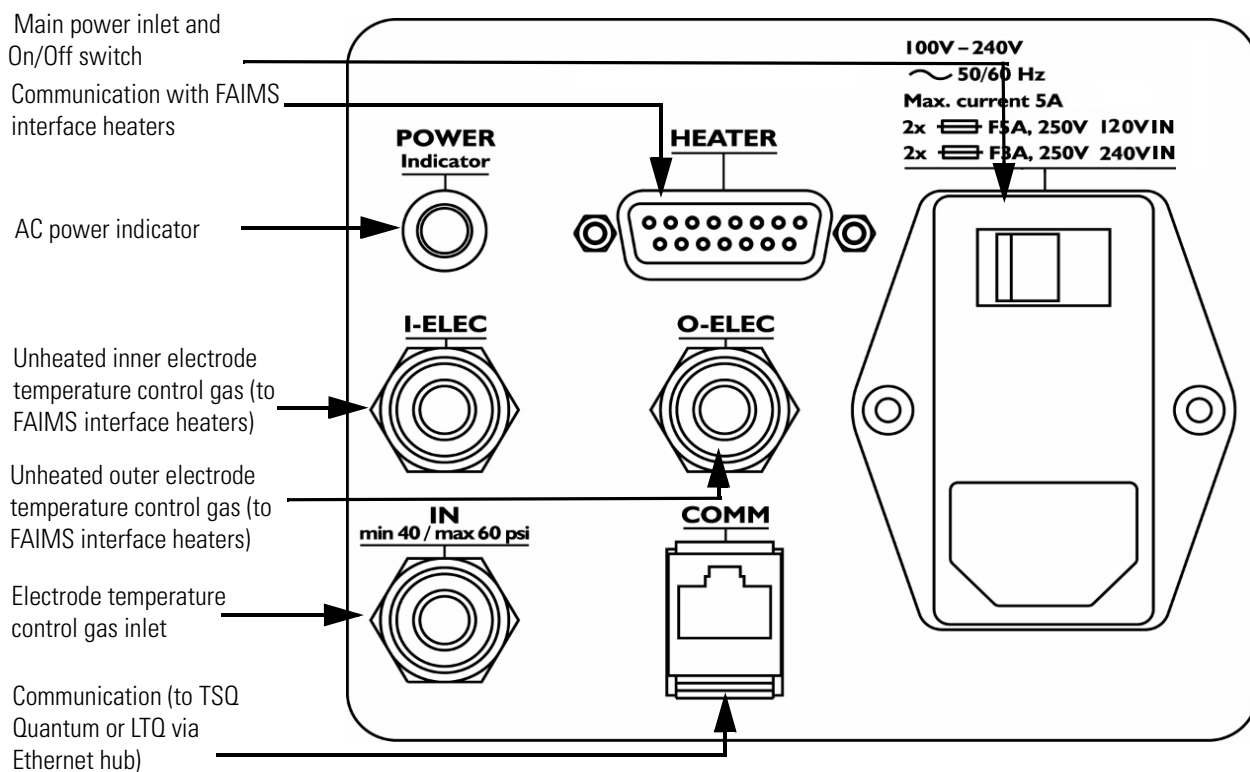


Figure 53. Connection panel on the temperature control module

Figure 54 shows the connection panel on the heater box of the FAIMS interface.

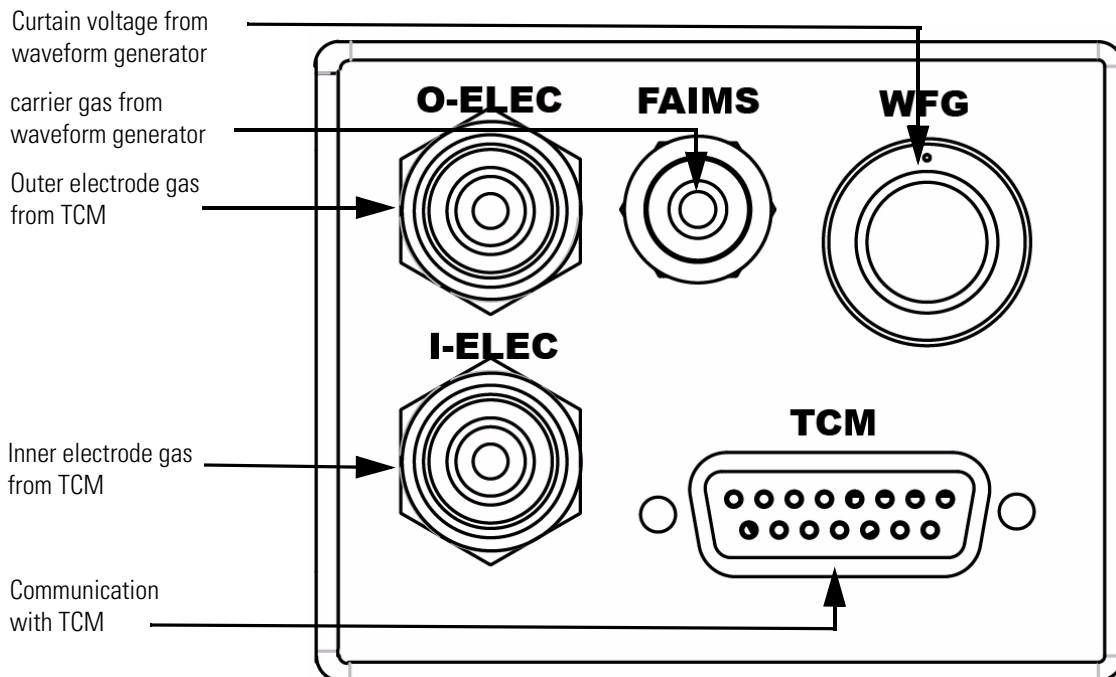


Figure 54. Connection panel on the FAIMS interface heater box

❖ **To connect the gas lines to the temperature control module and FAIMS interface heater box panel**

1. Attach a length of $\frac{1}{4}$ in. gas line tubing to the compressed gas line.
2. Insert the other end of the gas line tubing into the quick disconnect fitting on the IN port on the temperature control module, as [Figure 53](#) shows.
3. Using $\frac{1}{4}$ in. OD tubing, connect the O-ELEC ports on the temperature control module and FAIMS interface heater box, as [Figure 54](#) shows.
4. Using $\frac{1}{4}$ in. OD tubing, connect the I-ELEC ports on the temperature control module and the FAIMS interface heater box.

❖ **To make the electrical connections**

1. Connect one end of the Fischer cable to the BIAS/CURTAIN VOLTAGE connector on the connection panel of the FAIMS waveform generator ([Figure 52](#)) and the other end to the WFG connector on the FAIMS interface heater box, as [Figure 54](#) shows.
2. Connect the heater cable between the HEATER connector on the temperature control module, as [Figure 53](#) shows, and the TCM connector on the FAIMS interface heater box, as [Figure 54](#) shows.
3. Connect the interlock cable between the MS CONTROL connector on the waveform generator, as [Figure 52](#) shows, and the connector on the Ion Max housing.

Table 16 lists FAIMS cables and Table 17 lists carrier gas lines.

Table 16. FAIMS cables list

| From | Label | To | Label |
|-------------------|-----------------------------|----------------------------|------------|
| Quantum or LTQ | Ethernet 100 Base T | Ethernet hub | |
| Ethernet hub | | TCM | COMM |
| Quantum | Comm | WG | COMM |
| LTQ | (15-pin connector on front) | WG | COMM |
| Ion Max interlock | | WG | MS CONTROL |
| WG | BIAS/CURTAIN VOLTAGE | FAIMS interface heater box | WFG |
| TCM | HEATER | FAIMS interface heater box | TCM |

Table 17. gas lines list

| From | Label | To | Label |
|--|---------|----------------------------|----------------|
| Electrode temperature control gas source | | TCM | IN |
| N ₂ source | | WG | N ₂ |
| He source | | WG | He |
| WG | GAS OUT | FAIMS interface heater box | FAIMS |
| TCM | I-ELEC | FAIMS interface heater box | I-ELEC |
| TCM | O-ELEC | FAIMS interface heater box | O-ELEC |

Maintenance

This chapter provides information about how to maintain the FAIMS system and contains the following:

- Safety cautions when performing any maintenance procedures and performance considerations
- Procedure for cleaning the FAIMS electrodes, including the equipment required and the frequency of cleaning
- Procedure for inspecting and replacing the O-rings in the electrode assembly
- Procedure for replacing the gas purification cartridges
- Procedure for replacing the AC fuses

Safety, Instrument, and Performance Considerations



CAUTION Do not attempt to open the waveform generator or the temperature control module. All servicing of the waveform generator or the temperature control module must be performed by a Thermo Fisher Scientific Field Service Engineer.



CAUTION When working with the FAIMS interface, **always** follow the general safety and instrument considerations described in “[General Safety and Instrument Considerations](#)” on [page v](#), as well as others described throughout this manual. **Disregard for these cautions may cause harm to you or the FAIMS interface.**



CAUTION The FAIMS interface applies high voltages and failing to power down the FAIMS interface before performing certain procedures will expose the user to these voltages.

When working with the FAIMS interface, be aware of the performance considerations, as described in “[General Safety and Instrument Considerations](#)” on [page v](#).

Cleaning the FAIMS Electrodes

The FAIMS electrode set is made of stainless steel. The electrodes are cleaned before installation on the mass spectrometer to remove any water or contaminants deposited on their surfaces during shipping and storage.

After initial installation, the frequency of cleaning depends on the cleanliness of samples being analyzed, continuity of gas flow through the electrodes, condition of the gas purification cartridges, and the occurrence of discharge events within the electrodes. When a decline in performance of the electrodes cannot be attributed to another cause, the electrodes should be cleaned.

Cleaning the electrodes requires approximately one hour.

Cleaning Equipment

Cleaning the FAIMS electrodes requires the following equipment:

- An ultrasonic bath
- An oven that can be set to a minimum of 105 °C for drying the stainless steel electrodes after cleaning
- An ovenproof glass dish large enough to hold the electrodes while in the oven

Cleaning Procedures

Because the electrodes have already been installed, they must first be removed from the FAIMS interface and disassembled. Once the electrodes have been cleaned, they can be reassembled and reinstalled.

Cleaning the FAIMS electrodes involves the following tasks, which must be performed in the order listed:

1. Stop the LC flow and place the TSQ Quantum Ultra in Standby.
2. Turn off the waveform generator by using its power switch.
3. Disconnect the LC line from the H-ESI or APCI probe.
4. Remove the FAIMS interface and the Ion Max housing.
5. Remove the FAIMS interface from the Ion Max housing.
6. Remove the electrode assembly from the FAIMS interface.
7. Disassemble the electrodes.

8. Clean the electrodes in an ultrasonic bath and dry them in an oven.

Note When handling the cleaned electrodes, wear powder-free gloves to avoid contaminating the cleaned electrodes.

9. Inspect the O-rings.

10. Clean the entrance plate.

11. Reassemble the electrode assembly.

12. Reinstall the electrode assembly on the FAIMS interface.

13. Reinstall the FAIMS interface on the Ion Max housing.

14. Reinstall the Ion Max housing on the mass spectrometer.

15. Connect the LC line to the H-ESI or APCI probe.

16. Turn on FAIMS system power.

17. Place the system in the On condition.

Placing the System in Standby Condition

❖ To place the TSQ Quantum Ultra system in the standby condition

1. Wait until data acquisition, if any, is complete.
2. Turn off the flow of liquid from the LC (or other sample introduction device) to the API source.
3. From the Quantum Tune window, choose **Control > Standby** (or click the **On/Standby** button) to put the mass spectrometer and FAIMS system in Standby.

Note When you choose Control > Standby from Quantum Tune, all voltages to the FAIMS system are turned off, and N₂ at 1.5 L/min is supplied to the electrodes to keep them clean.

Typically, placing the system in standby is preferred to turning it off. Turning off the FAIMS system, by using the power switches on the waveform generator and temperature control model, is recommended only if:

- You are removing the electrodes for cleaning.
- The FAIMS system will not be used for an extended period of time. In this case, remove and clean the electrodes before they are used again.

4. Leave the mass spectrometer power on.
5. Leave the LC power on.
6. Leave the autosampler power on.
7. Leave the data system power on.

Turning off Power to the waveform generator

Turning off the waveform generator stops gas flows and ensures that voltages to the FAIMS interface and electrodes are off.

❖ To turn off power to the waveform generator

Place the power switch on the waveform generator (see [Figure 52](#) on [page 72](#)) in the Off (O) position.

Disconnecting the LC line From the H-ESI or APCI Probe

❖ To disconnect the LC line from the H-ESI or APCI probe

Disconnect the LC line from the grounding union (H-ESI) or probe inlet (APCI) by turning the fitting counterclockwise until you can pull the fitting and LC line free from the grounding union or probe inlet.

Removing the FAIMS Interface Assembly and the Ion Max Source Housing

It is best to remove the FAIMS interface and Ion Max housing as a unit.



CAUTION Before removing the FAIMS interface and Ion Max source from the mass spectrometer, ensure that the waveform generator is turned off.

❖ To remove the FAIMS interface assembly and Ion Max source housing



CAUTION Allow the Ion Max source housing to cool before you remove it.

1. Disconnect the gas lines and cables at the heater box connection pane, as [Figure 55](#) shows.

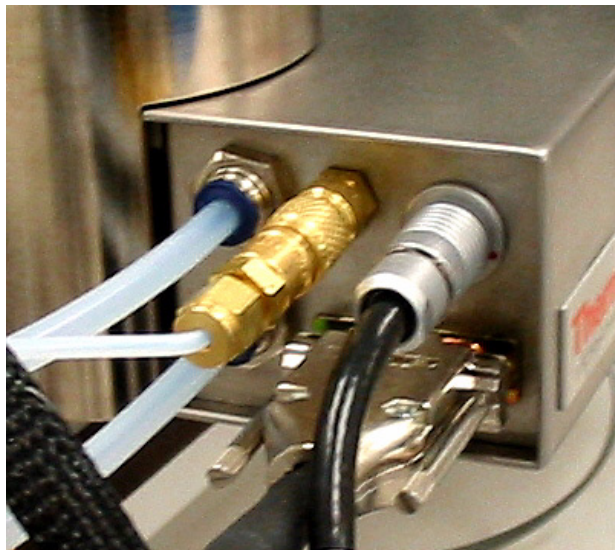


Figure 55. Gas lines and cable connections to the heater box connection panel

2. Unclip and disconnect the high-voltage lead from the high-voltage adapter on the interface assembly, as [Figure 56](#) shows.
3. Disconnect the exhaust tube from the heater box, as [Figure 56](#) shows.
4. Disconnect the interlock cable from the Ion Max source.

8 Maintenance

Cleaning the FAIMS Electrodes

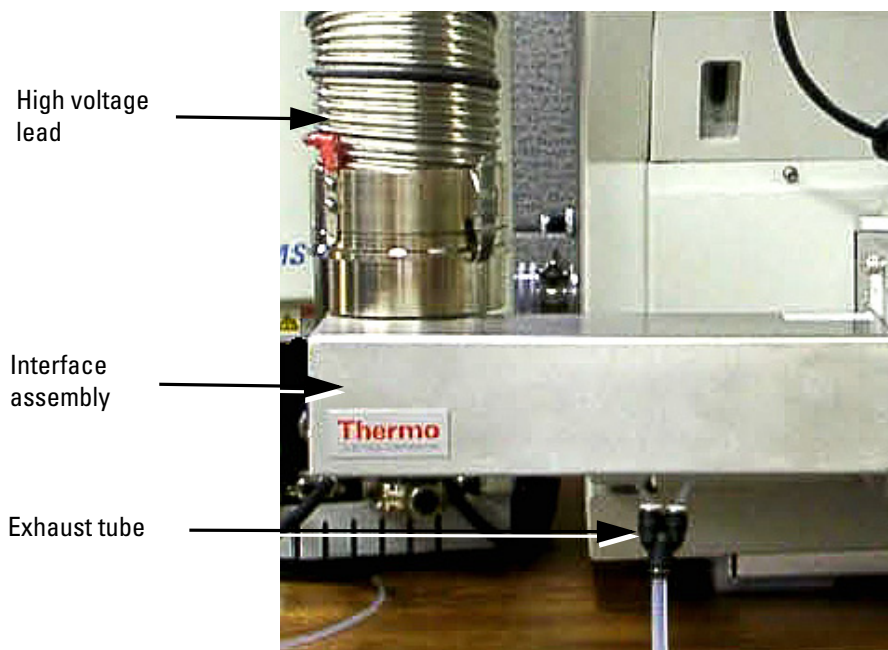


Figure 56. FAIMS interface, showing the high voltage lead and exhaust tube

5. Remove the Ion Max housing and FAIMS interface as follows:
 - a. Remove the drain tube from the Ion Max housing drain.
 - b. Rotate the two ion source housing locking levers 90 degrees to release the ion source housing from the ion source mount assembly, as Figure 57 shows.
 - c. Remove the ion source housing by pulling it straight off of the ion source mount assembly. Place the housing with the right side down, as Figure 58 shows.

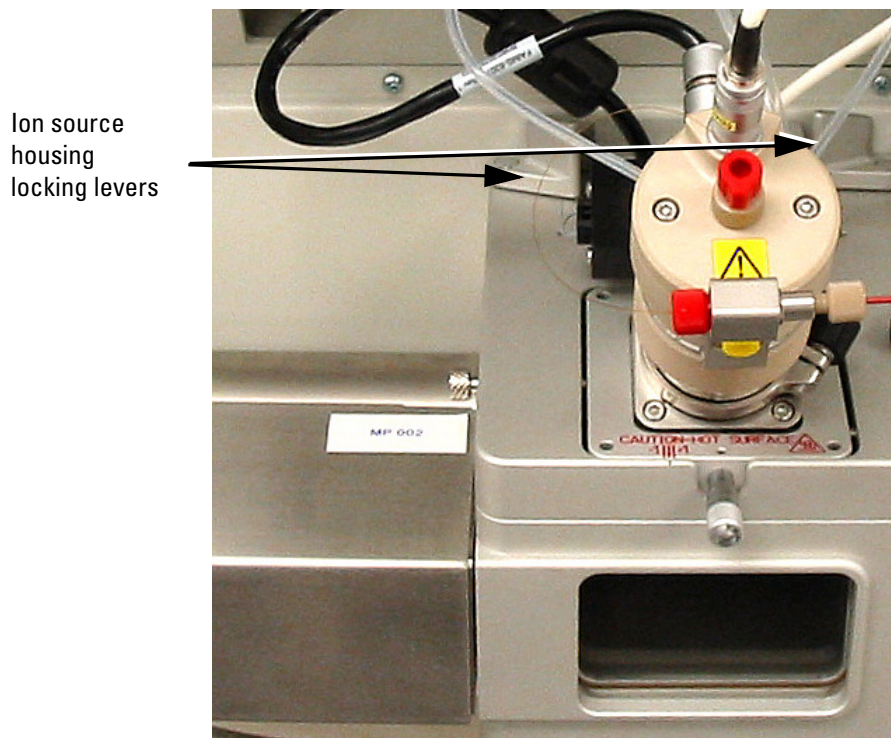


Figure 57. Ion Max housing, showing the locking levers



Figure 58. FAIMS interface and Ion Max source housing removed from the mass spectrometer

Removing the FAIMS Interface Assembly from the Ion Max Source Housing

❖ **To remove the FAIMS interface assembly**



CAUTION Allow the FAIMS electrodes and Ion Max housing to cool before you remove the FAIMS interface from the Ion Max housing.

1. With a 5/32 in. ball driver, loosen and remove the three screws that secure the FAIMS interface assembly to the Ion Max housing, as [Figure 59](#) shows.
2. Carefully remove the FAIMS interface from the Ion Max housing and set it down with its entrance plate up, as [Figure 60](#) shows.

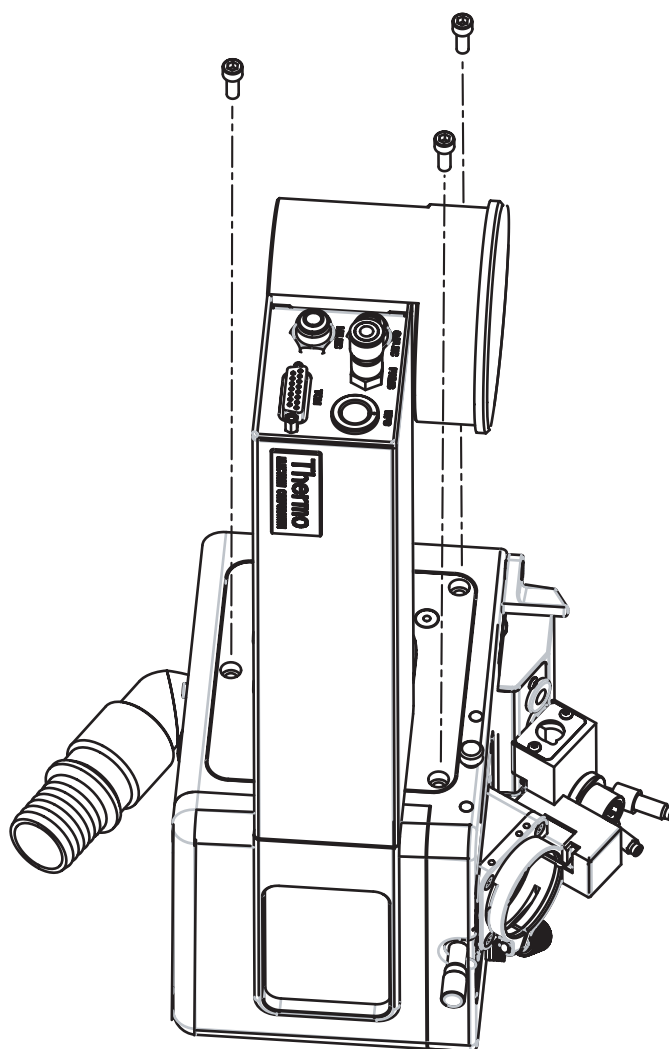


Figure 59. FAIMS interface and Ion Max housing, showing the three screws that secure them together

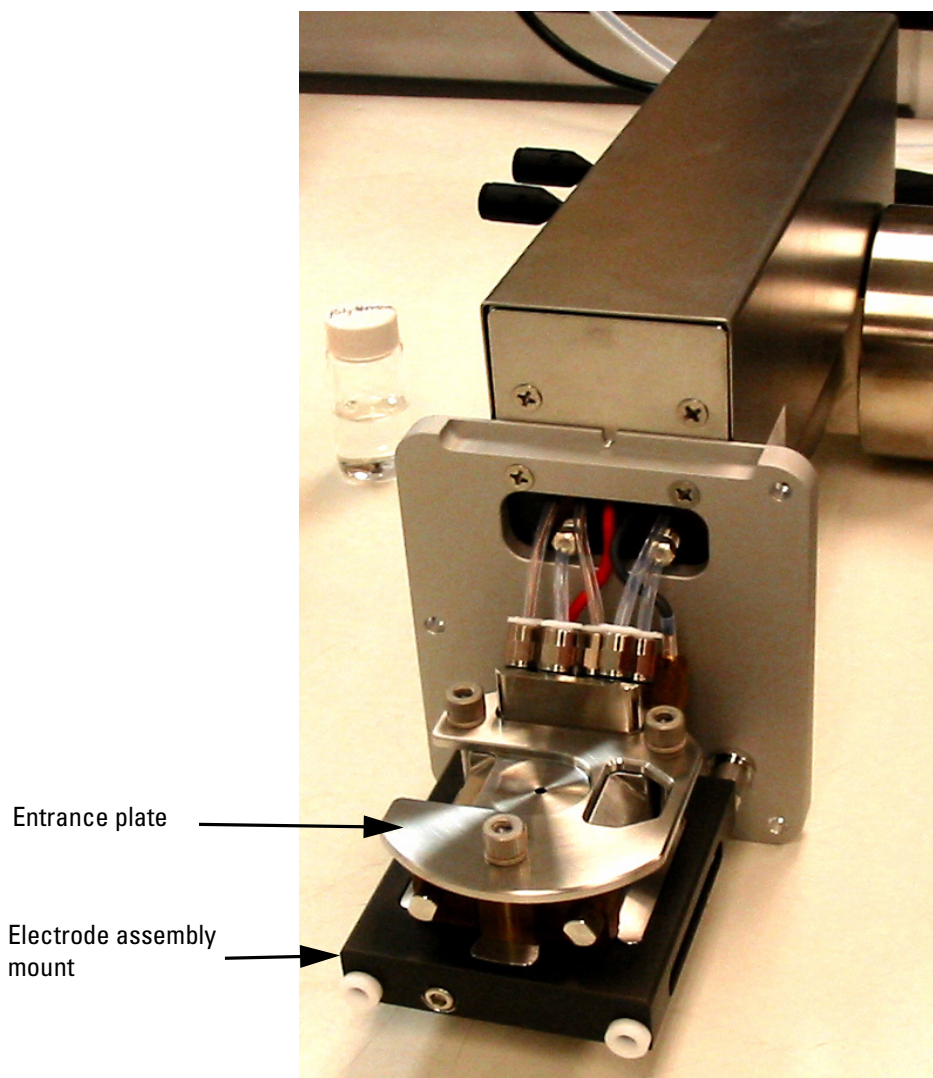


Figure 60. FAIMS interface removed from the Ion Max source housing, with the entrance plate up
An exploded diagram of the electrode end of the FAIMS interface is shown in [Figure 61](#).

8 Maintenance

Cleaning the FAIMS Electrodes

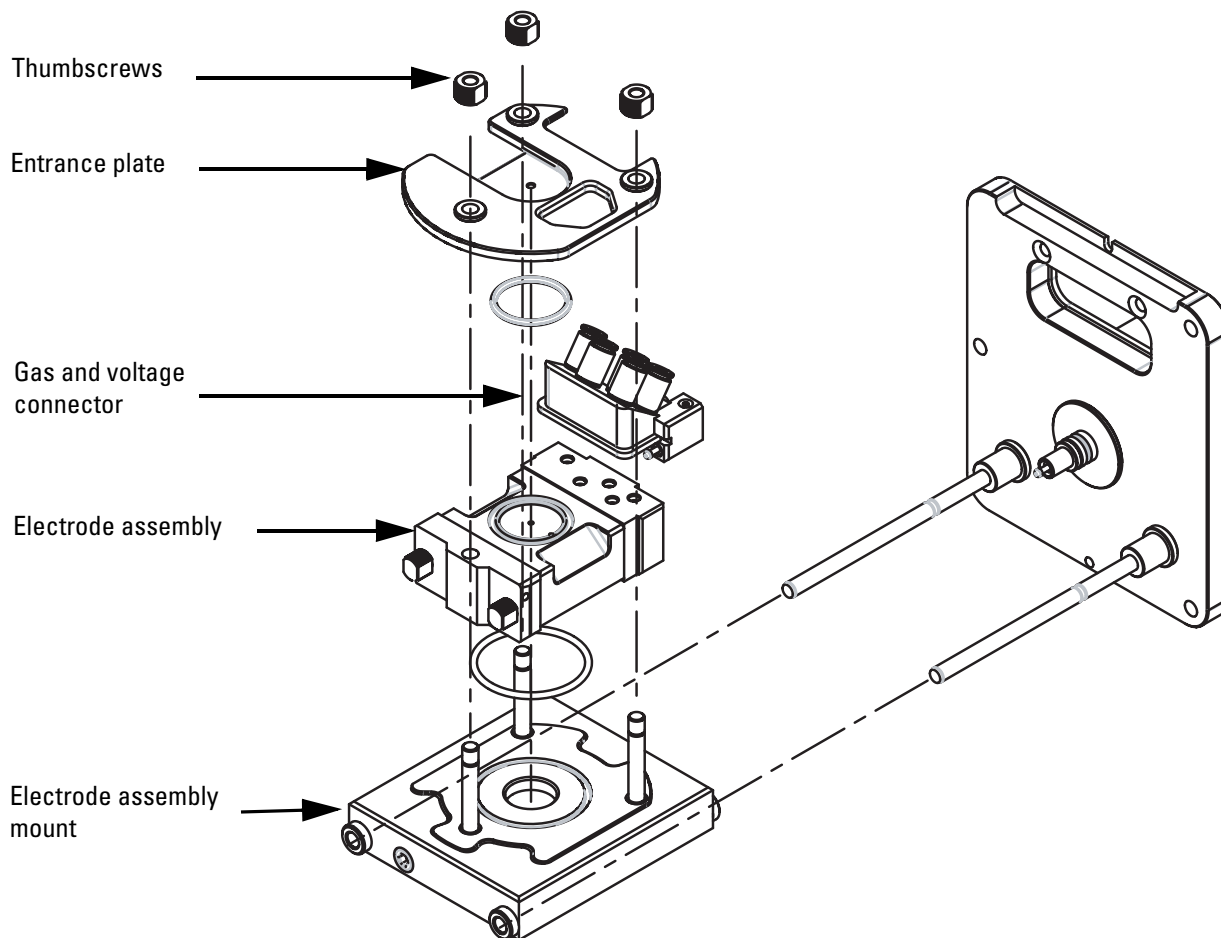


Figure 61. Exploded view of the electrode end of the FAIMS interface

Removing the FAIMS Electrode Assembly from the FAIMS Interface

❖ To remove the FAIMS electrode assembly

1. Remove the entrance plate.
 - a. Loosen and remove the three thumbscrews that secure the entrance plate to the electrode assembly mount, as [Figure 61](#) shows.
 - b. Lift the entrance plate off the electrode assembly and place it on a clean surface.
2. Carefully disconnect the gas and voltage connector from the electrode assembly, as [Figure 62](#) shows.

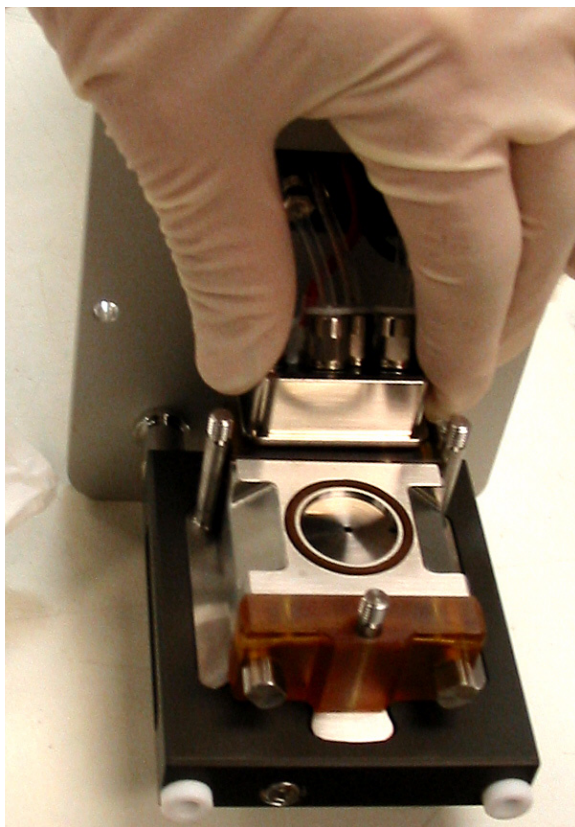


Figure 62. Disconnecting the gas and voltage connector from the electrode assembly

3. Remove the electrode assembly and mount by pulling them off the two posts, as [Figure 63](#) shows.

8 Maintenance

Cleaning the FAIMS Electrodes

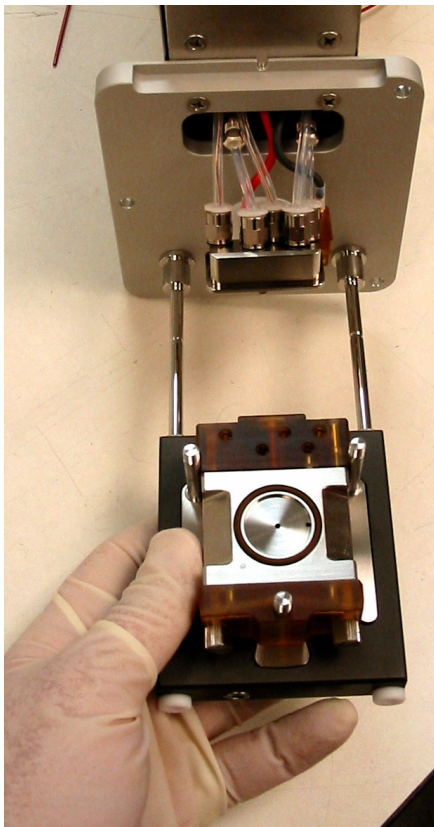


Figure 63. Removing the electrode assembly and mount

4. Pull the electrode assembly off the mount, as [Figure 64](#) shows.

Tip It may be difficult to remove the electrode assembly if it is hot. Allow it to cool.
If necessary, use methanol as a lubricant.

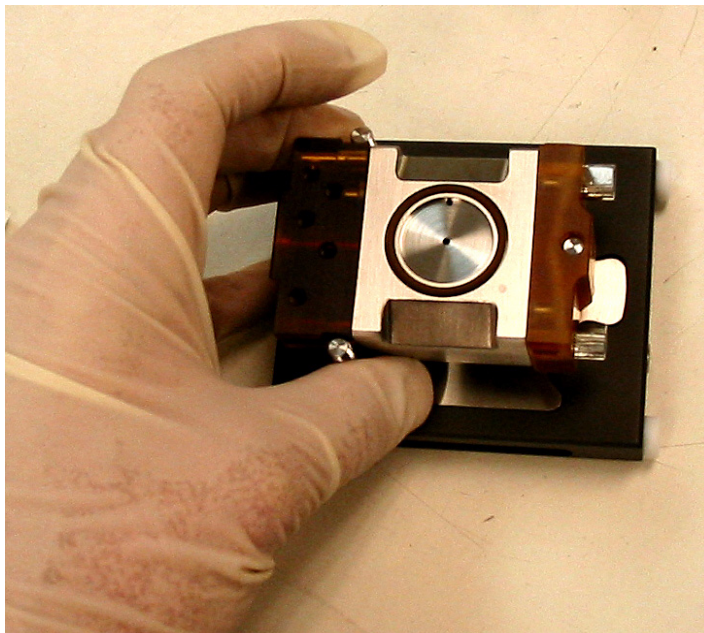


Figure 64. Removing the electrode assembly from its mount

Disassembling the FAIMS Electrode Assembly

[Figure 65](#) shows the location of the electrode assembly parts.

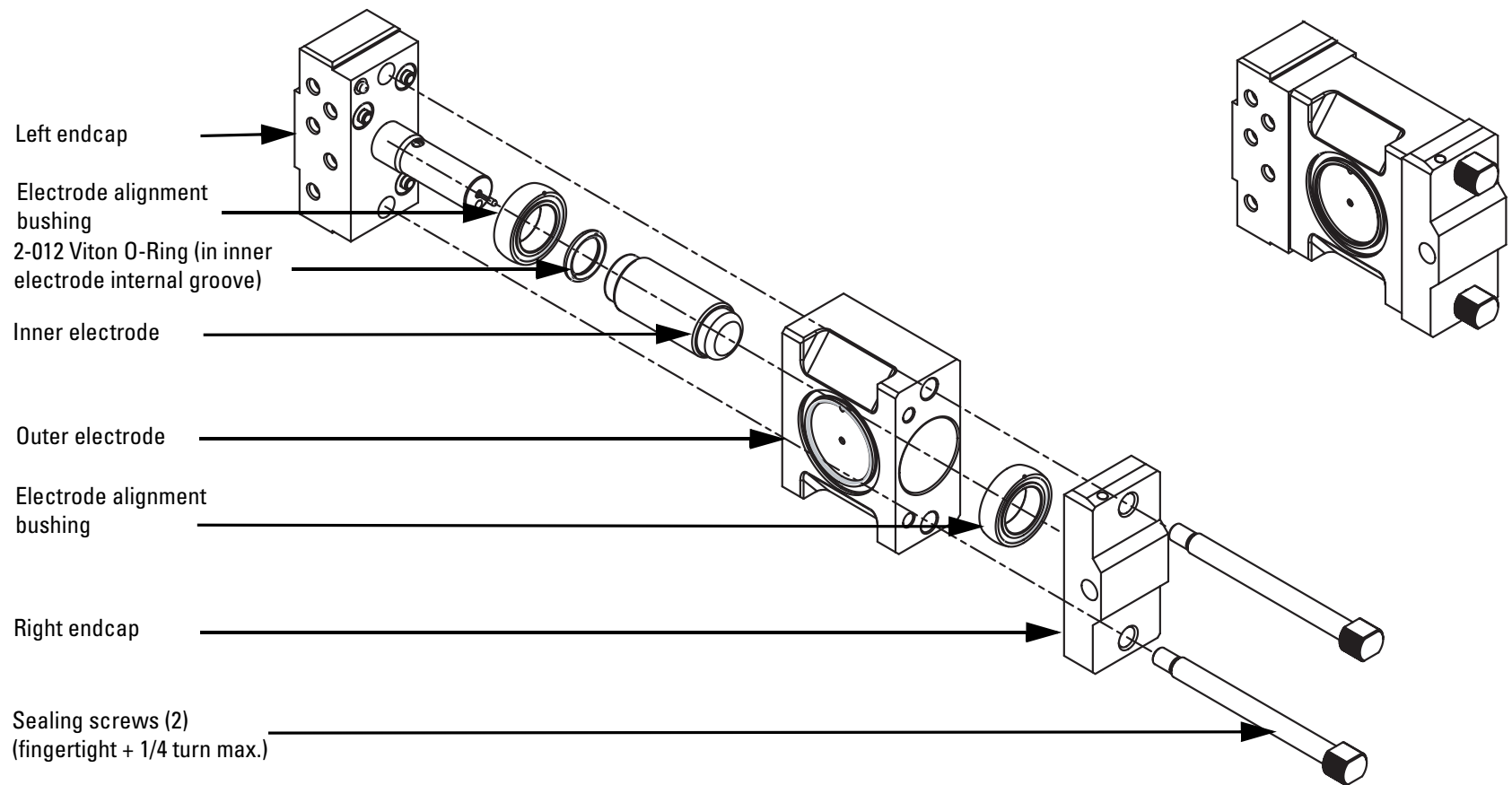


Figure 65. FAIMS electrode assembly, exploded and assembled views

❖ **To disassemble the FAIMS electrode assembly**

1. Use a 1/4 in. wrench to loosen the two sealing screws.
2. Remove the right endcap and sealing screws. See [Figure 66](#).

Tip After you loosen the two sealing screws, a good way to separate the endcaps from the electrodes is to press the sealing screw heads down on the table while holding the outer electrode.

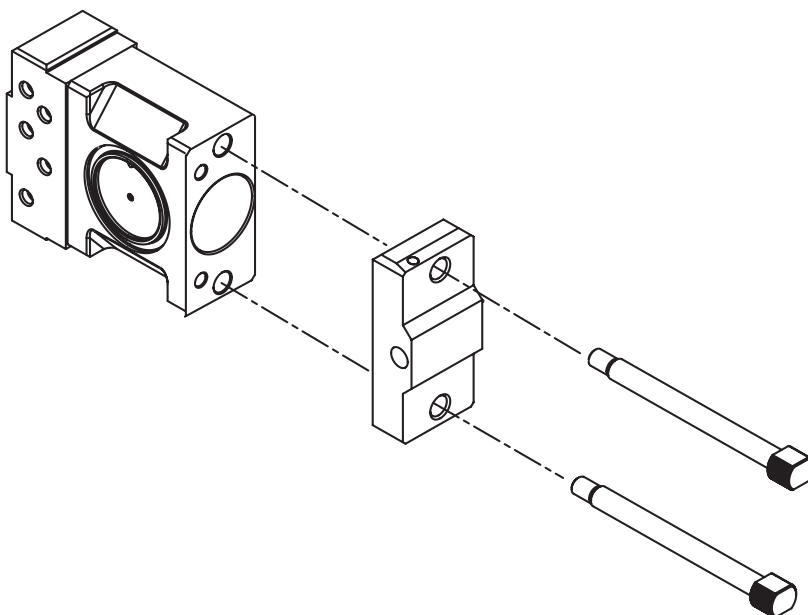


Figure 66. Removing the right endcap and sealing screws

3. Remove the outer electrode from the inner electrode and left endcap. See [Figure 67](#).

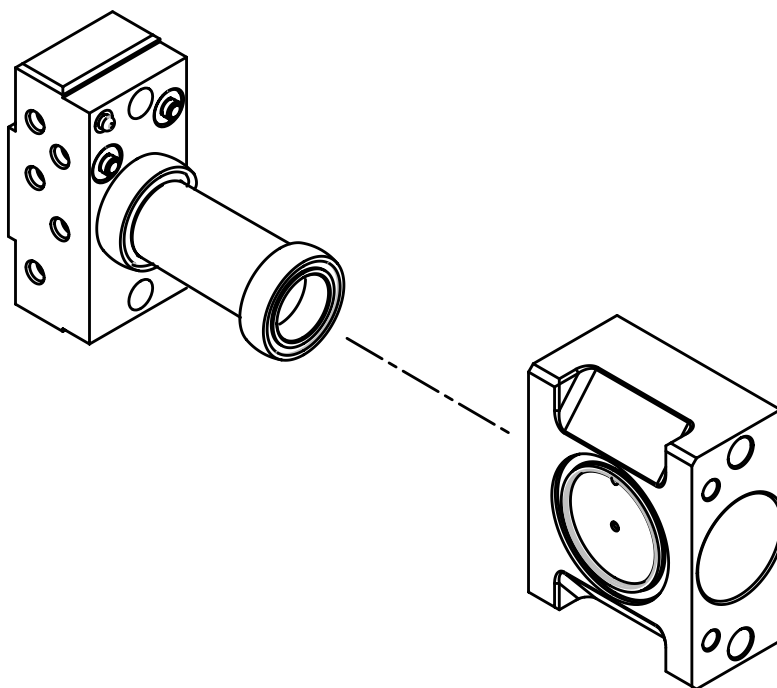


Figure 67. Inner electrode mounted on the left endcap, and the outer electrode

4. Remove the inner electrode from the left endcap, as [Figure 68](#) shows.

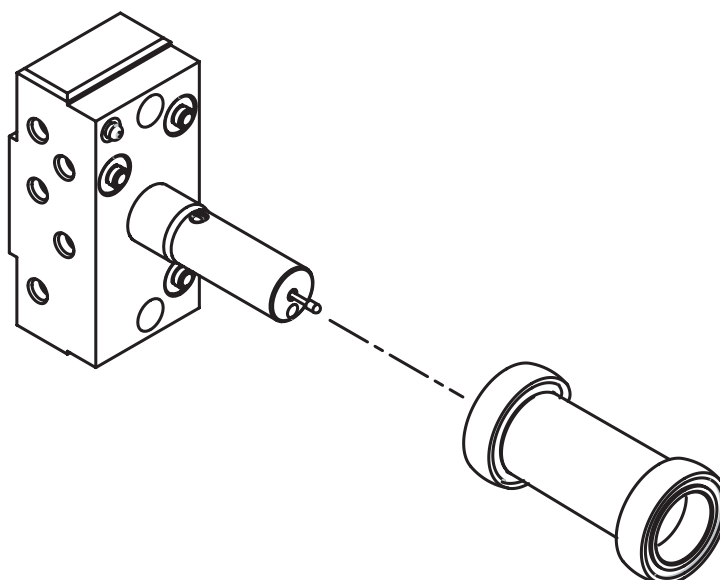


Figure 68. Left endcap and inner electrode

5. Remove the alignment bushings from the inner electrode. See [Figure 69](#).

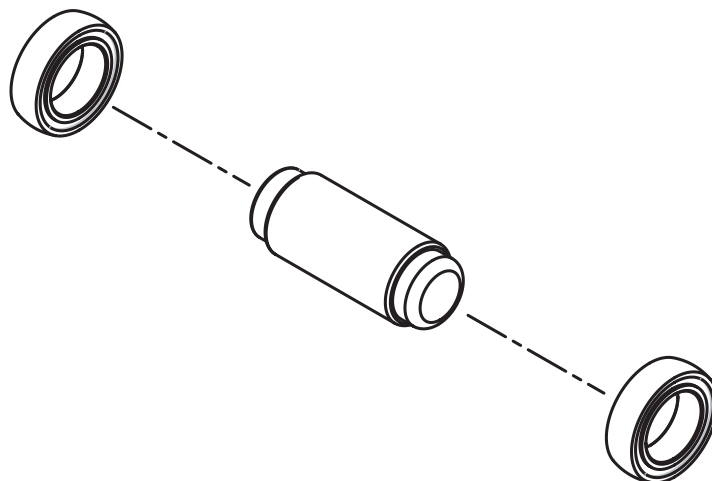


Figure 69. Inner electrode and alignment bushings

Cleaning and Drying the FAIMS Electrodes



CAUTION Observe good laboratory practices when working with the chemicals used for cleaning. Use a fume hood and wear appropriate personal protective equipment.

❖ To clean the FAIMS electrodes

1. Place the stainless steel inner and outer electrodes in a solution containing 48:48:4 methanol / distilled water / formic acid and place in an ultrasonic bath for approximately 15 min.
2. Carefully remove the electrodes from the cleaning solution.
3. Rinse all surfaces of the electrodes well with distilled water, then methanol, and then isopropyl alcohol (IPA).
4. Place the electrodes in an ovenproof glass dish and then put the dish in an oven to dry the electrodes. The oven temperature should be at least 105 °C. Dry the electrodes for approximately 20 min.



CAUTION Electrodes being removed from the oven are hot. Insulated gloves should be worn.

5. When dry, remove the dish containing the electrodes from the oven and allow the electrodes to cool to room temperature.

Inspecting the O-rings

The FAIMS electrode assembly includes three O-rings. One O-ring resides inside the inner electrode, as [Figure 70](#) shows. This O-ring forms a seal with the left endcap.

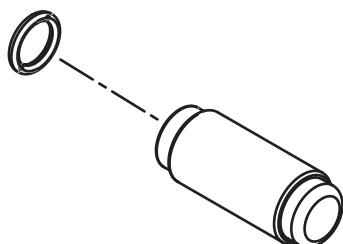


Figure 70. Inner electrode and O-ring (O-ring resides in a groove inside the electrode)

Note The O-ring inside of the inner electrode is difficult to reinstall. Thermo Fisher Scientific recommends that you inspect it visually, but do not remove it unless you think it is damaged. Bad sensitivity due to the bleeding of compressed air inside the FAIMS cell may indicate a damaged O-ring.

Tip You can use a needle to remove and install the O-ring.

A second O-ring is seated in the outer electrode, and forms a seal between the outer electrode and the entrance plate, as [Figure 71](#) shows.

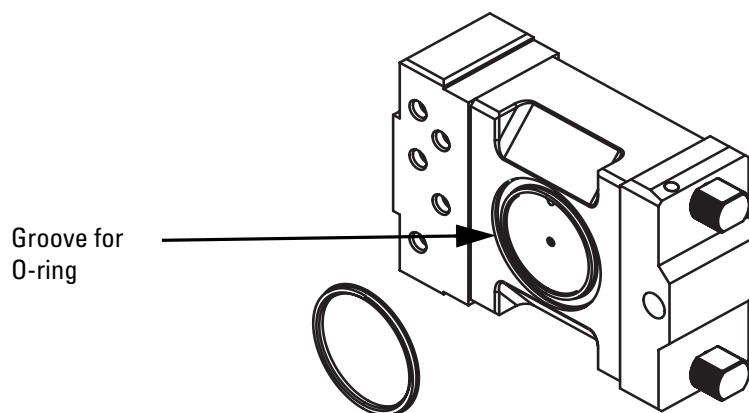


Figure 71. Outer electrode and O-ring

A third O-ring is seated in the electrode assembly mount, and forms a seal between the electrode assembly and the electrode assembly mount, as [Figure 72](#) shows.

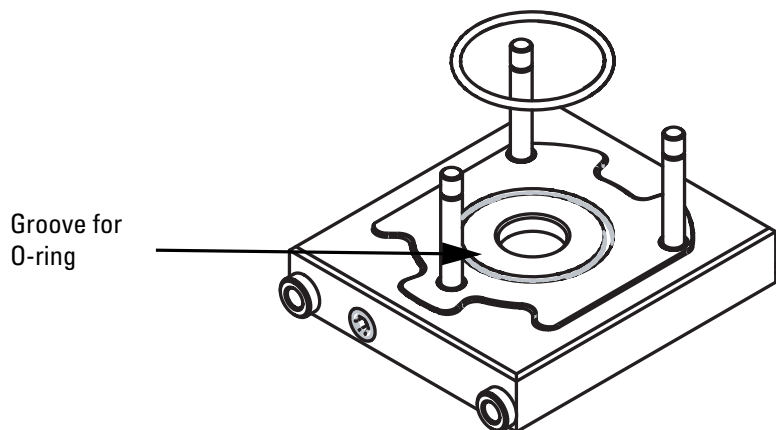


Figure 72. Electrode assembly mount and O-ring

Inspect the O-rings for damage and replace them if they are damaged.

Cleaning the Entrance Plate

❖ To clean the entrance plate

1. With a lint-free swab, scrub the entrance plate with a solution of detergent and water.
2. Rinse the entrance plate with tap water to remove the detergent.
3. Rinse the entrance plate with distilled water.
4. Place the entrance plate in a tall beaker and immerse it completely in HPLC-grade methanol. Move the entrance plate up and down in the methanol for 15 s.
5. Remove the entrance plate from the methanol bath, and then rinse it thoroughly with fresh methanol.
6. Dry the entrance plate with a rapid stream of nitrogen gas.

Reassembling the FAIMS Electrode Assembly

❖ To reassemble the electrode assembly

Figure 65 on page 90 shows the locations of the components of the electrode assembly.

Note Wear clean, powder free gloves when handling the clean electrodes.

1. Reinstall the alignment bushings on the inner electrode, as Figure 69 on page 93 shows.
2. Reinstall the inner electrode on the left endcap, as Figure 68 on page 92 shows.
3. Reinstall the outer electrode by inserting the inner electrode and alignment bushings into the outer electrode, as Figure 67 on page 92 shows.

4. Reinstall the right endcap and sealing screws, as [Figure 66](#) on [page 91](#) shows.
5. Tighten the two sealing screws until finger tight, and then use a 1/4 in. wrench to tighten the sealing screws by a maximum of 1/4 turn.

Reassembling the FAIMS Interface

❖ To reassemble the FAIMS interface

[Figure 61](#) on [page 86](#) shows the locations of the FAIMS interface components.

1. Seat the electrode assembly on its mount, as [Figure 64](#) on [page 89](#) shows. Orient the electrode assembly such that the ion entrance in the outer electrode is up, and the left endcap (with the gas ports) is on the same side as the two holes in the side of the mount.
2. Reinstall the electrode assembly mount on the two posts, as [Figure 63](#) on [page 88](#) shows.
3. Carefully seat the gas and voltage connector onto the left endcap. Make sure that it is completely seated, as [Figure 62](#) on [page 87](#) shows.
4. Reinstall the entrance plate onto the electrode assembly and secure it with the three thumbscrews, as [Figure 61](#) on [page 86](#) shows.

Reinstalling the FAIMS Interface on the Ion Max Housing

❖ To reinstall the FAIMS interface on the Ion Max housing

1. Orient the Ion Max housing such that the right side is down and the FAIMS entrance is up.
2. Carefully insert the FAIMS interface into the Ion Max housing such that the entrance plate is facing the Ion Max window, as [Figure 58](#) on [page 83](#) shows.
3. Insert the three screws that secure the FAIMS interface assembly to the Ion Max housing and tighten with a 5/32 in. ball driver, as [Figure 59](#) on [page 84](#) shows.

Installing the Ion Sweep Cone

Sweep gas must be used during FAIMS operation. The ion sweep cone must be installed to use sweep gas.

If the ion sweep cone is already installed, go to [Reinstalling the Ion Max Source Housing Onto the Mass Spectrometer](#).

❖ To install the ion sweep cone

1. Align the gas inlet on the ion sweep cone with the sweep gas supply port on the ion source mount. Firmly press the ion sweep cone into ion source moun, as [Figure 73](#) and [Figure 74](#) show.

2. Reinstall the Ion Max source housing on the mass spectrometer as described in [“Reinstalling the Ion Max Source Housing Onto the Mass Spectrometer”](#) on page 98.

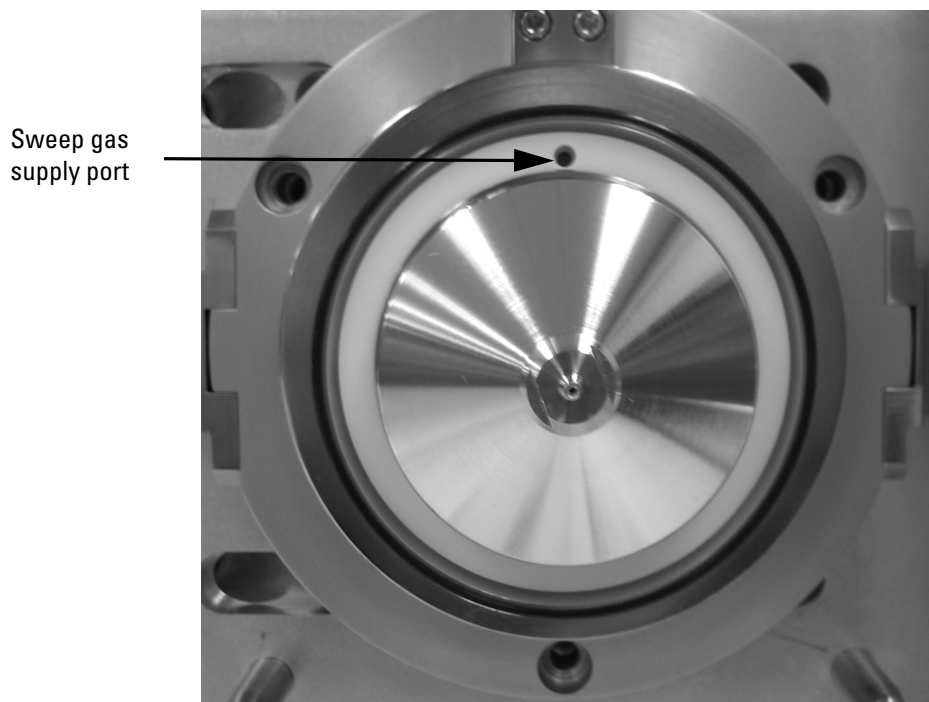


Figure 73. Ion source interface, showing the sweep gas supply port in the API cone seal

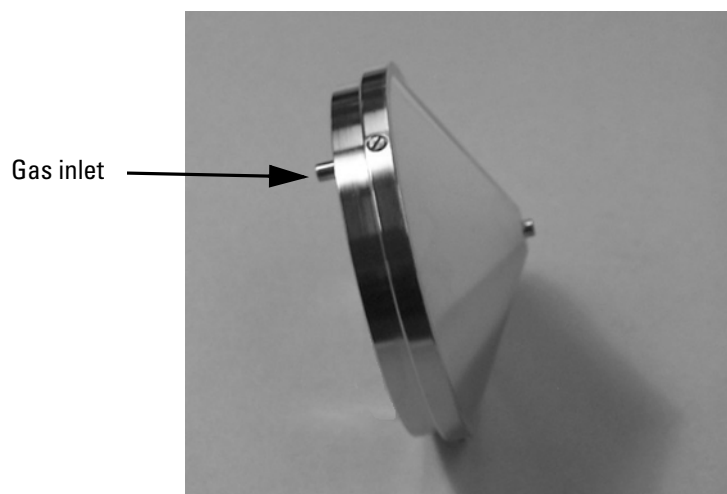


Figure 74. Ion sweep cone, showing the gas inlet

Reinstalling the Ion Max Source Housing Onto the Mass Spectrometer

❖ To reinstall the Ion Max ion source housing

1. Carefully align the two guide pin holes on the rear of the ion source housing with the ion source housing guide pins on the mass spectrometer, and carefully press the ion source housing onto the ion source mount, as [Figure 57](#) on [page 83](#) and [Figure 75](#) show.

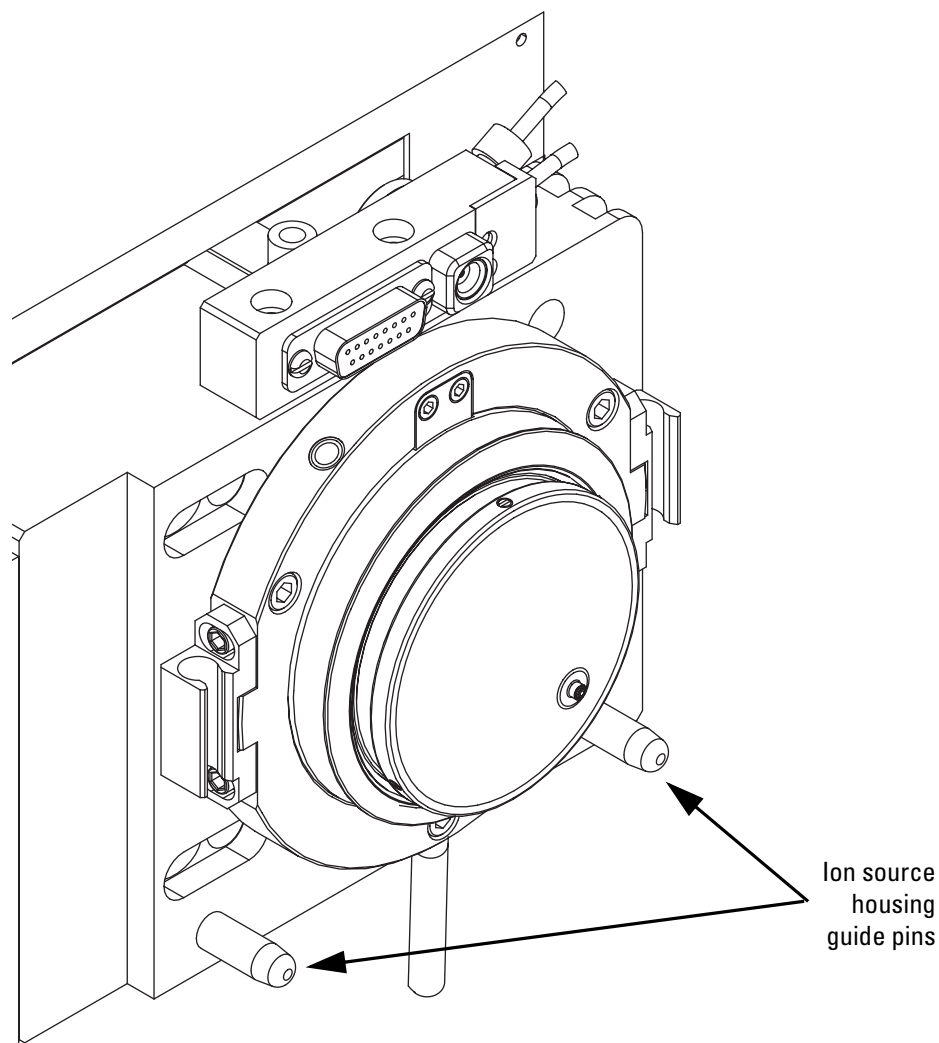


Figure 75. Ion source mount showing ion source housing guide pins

2. Rotate the Ion Max housing locking levers 90 degrees to lock the ion source housing onto the ion source mount assembly.
3. Reinstall the Ion Max drain tube.
 - a. Connect the Tygon[®] tubing to the ion source housing drain fitting.
 - b. Attach the free end of the hose to a dedicated drain system. Ideally, the drain system should be vented to a fume exhaust system.

4. Connect the exhaust tube to the heater box, as [Figure 56](#) on [page 82](#) shows.
5. Connect the interlock cable to the Ion Max source.

Note Voltages will not be applied to the FAIMS electrodes if the interlock cable is not properly installed. A popup message in Xcalibur appears to inform you of an interlock fault.

6. Connect the high voltage lead to the adapter on the FAIMS interface. Secure it with the two clips.
7. Connect the gas lines and cables to the heater box connection panel, as [Figure 76](#) and [Figure 55](#) on [page 81](#) show.

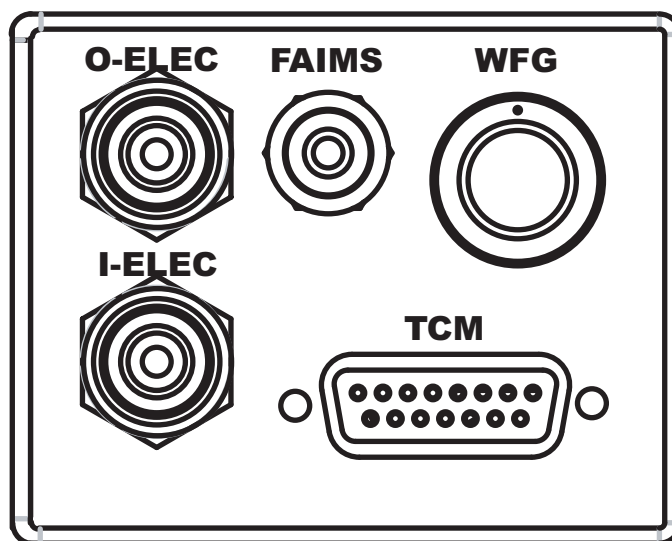


Figure 76. Heater box connection panel

Reconnecting the LC Line to the H-ESI or APCI Probe

- ❖ **To connect the LC line from the H-ESI or APCI probe**

Insert the LC line, fitting, and ferrule into the grounding union (H-ESI) or probe inlet (APCI). Turn the fitting clockwise to secure the LC line.

Turning On Power to the FAIMS System

- ❖ **To turn on power to the FAIMS system**

Place the power switch on the waveform generator in the On (I) position.

Placing the System in On Condition

❖ To place the mass spectrometer and FAIMS system in the On condition

From the Quantum Tune window or LTQ Tune Plus window, choose **Control > On** (or click on the On/Standby button) to turn on the mass spectrometer and FAIMS system.

When you place the system in the On condition, all user-defined settings of the FAIMS system are activated.

Replacing Gas Purification Cartridges

The carrier gas purification cartridges are located in the back of the waveform generator, as [Figure 77](#) shows. Gas purification cartridges can last several months when high purity gas is used. Replace the gas purification cartridges when a change is noted in the compensation voltage at which an ion is transmitted through the FAIMS interface under known conditions (such as known DV, carrier gas flow rate, and gas composition).

New purification cartridges or repacking material can be purchased from Chromatographic Specialties (#C36120), VWR International (#80083-116), or Agilent (#HMT200-2).

❖ To replace a gas purification cartridge

1. Close the valve controlling the flow of gas into the FAIMS waveform generator.
2. Loosen the 1/8 in. Swagelock nuts connecting the gas lines to the purification cartridge. When the lines are disconnected, remove the purification cartridge from the waveform generator.
3. Attach the gas lines to the replacement cartridge and clip it in place within the waveform generator.
4. Reopen the valve controlling the gas flow into the FAIMS waveform generator.



Figure 77. Gas purification cartridges

Replacing AC Fuses

AC fuses may need to be replaced. For example, if the FAIMS system will not power up, check whether the fuse is blown.

Replace AC fuses only with the part described in the following table:

Table 18. Waveform generator and temperature control module fuses

| FAIMS unit | 120 V | 240V |
|----------------------------|--------------|-------------|
| Waveform generator | F3A | F3A |
| Temperature control module | F5A | F5A |

Figure 78 shows a representation of a fuse compartment and identifies the location of the replaceable fuse:

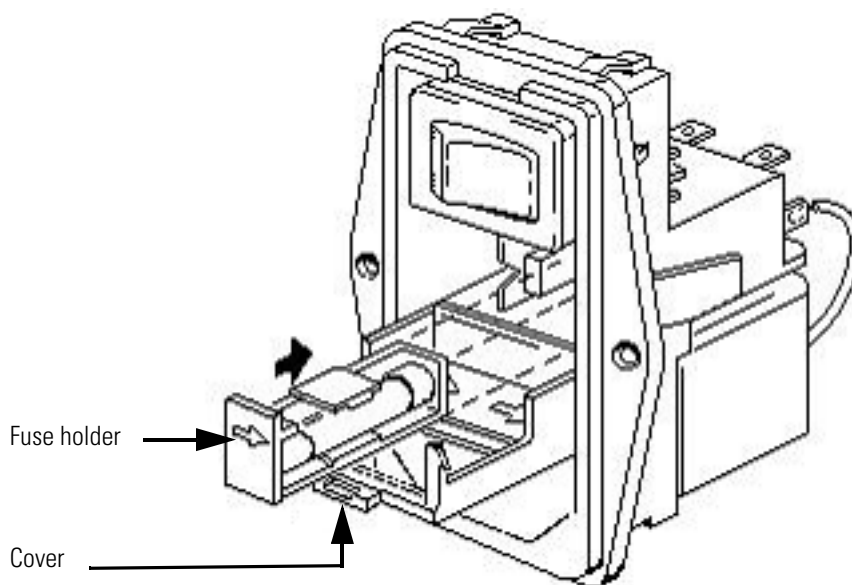


Figure 78. Fuse compartment.

❖ **To replace the fuse**

1. Place the power switch in the Off (O) position and disconnect the power cord.
2. With the cover hinges forward and down, open the cover using a screwdriver with a small blade or a similar tool.
3. Apply slight pressure to pull the fuse holder forward.
4. Replace the fuse and slide the fuse holder back into its compartment.
5. Close the cover.
6. Reconnect the power cord and place the power switch in the On (I) position.

Troubleshooting

This chapter helps you resolve issues that might occur while using the FAIMS interface. [Table 19](#) describes possible causes for each issue that may occur, along with suggested solutions or explanations.



CAUTION When working with the FAIMS interface, **always** follow the general safety and instrument considerations described in “[General Safety and Instrument Considerations](#)” on [page v](#), as well as others described throughout this manual. **Disregard for these cautions may cause harm to the user or the FAIMS interface.**



CAUTION The FAIMS interface applies high voltages and failing to power down the FAIMS interface before performing certain procedures exposes you to these voltages.

Table 19. Troubleshooting problems and solutions

| Problem | Solution |
|--|--|
| FAIMS will not power up | |
| Power supply not working properly | If the green indicator light on connection panel is off, check the following: Power source connection. If the power cable is disconnected, reconnect it and verify that the connection is secure. AC inlet fuse. If the fuse is blown, replace it. Spare fuses are provided in the Spares kit. Both neutral and live wires have a fuse. See “ Replacing AC Fuses ” on page 101 . |
| A Communication Problem has Occurred | |
| The FAIMS is not powered up. | Power up the waveform generator and verify that the green status light on the connection panel is on. |
| The IP address of the TSQ Quantum or LTO was changed. | The IP address of the FAIMS system must be set to the TSQ Quantum’s or LTO’s IP address +1. |
| Communications cable not connected or wrong cable is used. | Ensure connection and cable are correct. Cable connections are one-to-one and pin-for-pin between connectors. The instrument functions as Data Terminal Equipment (DTE). No “null modem” is required. |
| Gas Actual Values are Unexpectedly Zero | |
| Gas sources are not connected. | Connect the gas sources. |
| Gas lines are not connected properly. | Verify that the gas lines are secured properly between controllers, filters and bulk unions. |

| Problem | Solution |
|---|--|
| MFC cable is not connected properly. | Ensure the cable is connected properly. |
| A mass flow controller is not working. | Replace the mass flow controller. |
| He or N ₂ tank is empty | Replace He or N ₂ tank. |
| Dispersion Voltage Readback is Unexpectedly Near Zero | |
| Power is not being supplied to the FAIMS waveform generator. | Check that the green light on the waveform generator is on. |
| Interlocks on the high voltage lead are not activated. | Check that the high voltage lead is properly installed. |
| Ion source interlocks are not activated. | Check that the FAIMS interface and mass spectrometer's ion source are properly installed. |
| No dispersion voltage specified. | Specify a value for the Dispersion Voltage parameter in the FAIMS control software. |
| A discharge in the FAIMS electrodes caused the electronics to shut down. | Check for error messages indicating shutdown due to discharge. |
| DV Does Not Reach Set Value | |
| Capacitance of system has changed. | Check that the configuration of the high voltage lead has not been altered. Check all connections to the FAIMS interface assembly. |
| Mass Spectrometer's Ion Source Does Not Turn On | |
| FAIMS interface or API probe is not installed such that the interlocks are activated. | Check the installation of the FAIMS interface and API probe. |
| No Ion Signal at All | |
| Power is not being supplied to the FAIMS waveform generator. | Check that the green light on waveform generator is on. |
| No communication between the software host computer and the FAIMS waveform generator. | Check the serial connection between FAIMS waveform generator and the host computer. |
| Electrical connections not connected. | Check that the outer bias and high voltage connectors are attached. |
| Interlocks are not activated. | Check that the interlocks on the high voltage lead and ion source are activated. |
| No gas being introduced into the FAIMS electrodes. | Check that the gas lines are installed and a gas supply is available. Check that Gas Flow parameters are specified in the FAIMS control software. |
| Improper voltages specified. | Compare values to the Standard conditions found in Appendix A. |
| Ion source not working. | Check the ion source. |
| No sample flow to source. | Check the sample flow. |
| No Signal for Ion of Interest | |
| Compensation voltage is incorrect. | Ramp the compensation voltage over a range of +10 to -40 for positive ions, or =10 to +40 for negative ions while monitoring for the m/z of interest to determine the conditions under which the ion is transmitted. |
| Dispersion voltage is incorrect. | Check the value of the Dispersion Voltage parameter in the FAIMS control software. |

| Problem | Solution |
|---|--|
| Carrier gas composition is incorrect. | Check the Gas Flow parameters in the FAIMS control software to verify the carrier gas composition. |
| Carrier gas flow rate is too low. | Increase the Total Gas parameter FAIMS control software. |
| Concentration too low. | Increase the concentration of the analyte and check for a signal. |
| Solution not being delivered to the ion source. | Check the delivery lines and connections for leaks. |
| FAIMS electrodes are dirty. | Remove, disassemble, clean, reassemble, and reinstall the electrodes. See the topic "Cleaning the FAIMS Electrodes" on page 78. |
| Gas purification cartridge is wet. | Replace the gas purification cartridge. See the topic "Replacing Gas Purification Cartridges" on page 100. |
| Decreased Ion Intensities | |
| Dispersion voltage is incorrect. | Check the value of the Dispersion Voltage parameter in the FAIMS control software. |
| Compensation voltage is incorrect. | Ramp the compensation voltage while monitoring for the m/z of interest to determine the conditions under which the ion is transmitted. |
| Carrier gas flow rate is too high or too low. | Check the Gas Flow parameters in the FAIMS control software to verify the carrier gas composition. Re-optimize, if necessary. |
| Different mass spectrometer conditions used. | Check tune/state file and instrument pressures. |
| Entrance plate is dirty. | Clean the entrance plate. |
| FAIMS electrodes are dirty. | Remove, disassemble, clean, reassemble, and reinstall the electrodes. |
| Gas purification cartridge is wet. | Replace the gas purification cartridge. |
| Mass spectrometer interface is dirty. | Clean the mass spectrometer interface as described in the documentation provided with the mass spectrometer. |
| Position of ion source has changed. | Re-optimize ion source position relative to the FAIMS electrodes. |
| Compensation Voltage Shifted from Previously Observed Values | |
| Different dispersion voltage. | Check the value of the Dispersion Voltage parameter in the FAIMS control software. |
| Carrier gas composition is different. | Check the Gas Flow parameters in the FAIMS control software to verify the gas mixture. |
| Temperatures of the heaters are different. | Check the temperature settings of the electrode heaters and allow equilibrium to be reached. |
| Carrier gas flow rate is different. | Check the Total Gas parameter in the FAIMS control software to verify the carrier gas flow rate. |
| Solution flow rate is different and desolvation effects are being observed. | Increase the carrier gas flow rate. |
| FAIMS electrodes have become contaminated by a droplet from the ion source. | Remove, disassemble, clean, reassemble, and reinstall the FAIMS electrodes. |
| Gas purification cartridges are wet. | Replace the gas purification cartridges. |
| Gas purification cartridges were wet, but have been recently replaced. | Previous data was collected under non-ideal conditions. |

| Problem | Solution |
|---|--|
| Compensation Voltage Shifts with Gas Flow Rate | |
| Poor desolvation. | If the FAIMS electrodes have been recently cleaned, check for gas leaks after re-assembly. Increase the gas flow rate until the ion is transmitted at a constant compensation voltage value. |
| Gas mixture is changing. | Check the readbacks (which are displayed in the Actual Value box associated with each parameter) in the FAIMS control software to verify that the carrier gas composition isn't changing. |
| More than One Peak for Ion m/z | |
| Peaks are from different ions. | Confirm ion identities using the mass spectrometer. |
| Multimeric species are present. | Lower the ion concentration. |
| Adduct species are present. | Collect the mass spectrum under gentle conditions and look for adduct species. Increasing the carrier gas flow rate may reduce the presence of adduct species. |
| Poor desolvation. | Increase the carrier gas flow rate. |
| Ion can assume more than one conformation. | The FAIMS is resolving ions of different conformations. This behavior might be observed with proteins, peptides, and in some cases, small molecules. |
| Change in Peak Shape | |
| FAIMS electrodes have been reassembled improperly. | Check the assembly of the electrodes. |
| Misalignment of FAIMS electrodes on mass spectrometer. | Check that the entrance plate has not been overtightened. |
| Incorrect carrier gas flow rate. | Reoptimize the carrier gas flow rate. |
| Gas purification cartridges are wet. | Replace the gas purification cartridges. If the change in peak shape occurred after replacing the gas purification cartridges, previous cartridges might have been wet. |
| High Variability in Signal | |
| API probe position of the ion source is too close to the inlet of the FAIMS electrodes. | Re-optimize the API probe position. |
| FAIMS temperatures are too high. | Reduce the temperatures of the inner and outer heaters by 10 °C and collect a CV ramp. |
| Ion source is not operating properly. | Check that a steady ion beam is being provided. |
| Carrier gas flow rate too high/too low. | Optimize the carrier gas flow rate. |
| Gas purification cartridges are wet. | Replace the gas purification cartridges. |
| Change in Peak Resolution | |
| Gas flow rate or composition has changed. | Check the Gas Flow parameters in the FAIMS control software to verify the gas flow rate and composition. |
| Different dispersion voltage. | Check the value of the Dispersion Voltage parameter in the FAIMS control software. |
| FAIMS electrodes are dirty. | Remove, disassemble, clean, reassemble, and reinstall the electrodes. |
| Increased Background | |
| Different sample matrix. | "Dirty" samples may have higher background than "clean" samples. |

| Problem | Solution |
|--|--|
| Dispersion voltage, compensation voltage, or outer bias voltage changed. | Check the value of the appropriate parameter in the FAIMS control software. |
| FAIMS electrodes need cleaning. | Remove, disassemble, clean, reassemble, and reinstall the FAIMS electrodes. |
| Gas purification cartridges are wet. | Replace the gas purification cartridges. |
| Mass spectrometer conditions changed. | Check the mass spectrometer voltages. |
| Ion source not working properly. | Check that the ion source is working properly. |
| Mass spectrometer interface is dirty. | Remove the FAIMS electrodes from the mass spectrometer and check whether background is higher than normal when the electrodes are not installed. |
| Optimal Gas Flow Rate Changed | |
| Gas leaks in system. | Check that all gas lines are properly installed. Check that the FAIMS electrodes are assembled properly. |
| Solution flow rate has been increased or decreased. | Desolvation gas requirements change if flow rate is increased or decreased significantly. |
| Frequent Discharge within the FAIMS Electrodes | |
| Too much helium at the DV and temperature settings being used. | Reoptimize conditions (DV, temperature and gas composition). |
| Adduct Species Have Suddenly Appeared | |
| Poor desolvation of ions. | Increase the carrier gas flow rate. |
| FAIMS electrodes are dirty. | Remove, disassemble, clean, reassemble, and reinstall the electrodes. |
| Running solution or electrode cleaning solution is contaminated. | Check if adducts exist after solutions are changed. |
| Gas lines contaminated. | Bypass gas lines embedded within the FAIMS waveform generator by using new gas lines. Check if adducts still appear. |

Site Preparation and System Specifications

This chapter describes the necessary preparations for the installation of the FAIMS system. These preparations must be completed before Thermo Fisher Scientific Corporation's authorized service personnel arrive at your site.

This chapter discusses the following:

- [Installation Guidelines](#)
- [Dimensions and Weight](#)
- [Configuration](#)
- [Environment](#)
- [Electrical](#)
- [Gases and Regulators](#)
- [Data System Computer](#)
- [Installation Equipment and Reagents](#)
- [Installation Checklist](#)

Installation Guidelines

The FAIMS system must be installed by a Thermo Fisher Scientific Corporation's authorized representative. The service representative will then ensure that the instrument is operating properly.

The person from your organization who will be responsible for the system should be available during installation to verify the acceptance of the instrument and to receive operation training.

Dimensions and Weight

The FAIMS system includes a waveform generator and a temperature control module. The dimensions of the waveform generator are:

- Width: 25 cm (10 in.)
- Depth: 38 cm (15 in.)
- Height: 52 cm (20.5 in.)

The dimensions of the temperature control module are:

- Width: 25 cm (10 in.)
- Depth: 38 cm (15 in.)
- Height: 15 cm (6 in.)

The waveform generator and temperature control modules have a combined mass of approximately 20 kg (45 lb.).

Configuration

The waveform generator must be located next to the TSQ Quantum or LTQ on its left, as Figure 79 shows.



Figure 79. FAIMS waveform generator, FAIMS interface, and TSQ Quantum

The temperature control module can be placed anywhere as long as the cable and gas lines can reach the connection panel on the FAIMS interface heater box. Possible locations of the temperature control module are:

- Next to the waveform generator
- On top of the TSQ Quantum or LTQ



CAUTION Ensure that there is room to access the power switches for the waveform generator and the temperature control module. The AC power switch of both module must remain easily accessible. Do not position the modules or other equipment in a way that hinders access to these switches.

Environment

Locate the FAIMS system in an area that it is kept free from excessive dust.

Operation

Ambient temperature: 15 °C to 30 °C
Humidity: 5% to 95% relative humidity, non-condensing
Altitude: 0 to 2000 meters

Storage

Ambient temperature: -40 °C to 70 °C
Humidity: 5% to 95% relative humidity, non-condensing

Radio Emissions

Do not place the FAIMS system within an RF field of greater than 5 V/m.

Magnetic Fields

Locate the FAIMS system away from strong magnetic fields.

Electrical

Outlets must be available within reach of the FAIMS system AC power cord. The outlets must meet the appropriate electrical specifications for your region:

- North America: Single phase 115 VAC, 60 Hz, 2.5 A
- Europe: Single phase 230 VAC 50 Hz, 1.3 A

Gases and Regulators

Gases need to be supplied to the FAIMS system for two separate purposes:

- To desolvate and deliver ions through the electrodes and into the mass spectrometer (the carrier gas)
- To actively control the electrode temperatures

For the carrier gas, nitrogen and industrial grade helium gases must be available for installation. Two-stage regulators should be used (delivering gas at a pressure of 40 to 80 p.s.i.) and a connection to a 1/8 in. gas line leading to the FAIMS waveform generator must be made.

Prior to introduction of the carrier gas to the electrodes, gases are purified using gas purification cartridges. These cartridges are provided with the system. Typical total gas flow is 2.5 to 4 L/min.

For actively controlling the temperatures of the FAIMS electrodes, compressed air must be used. When FAIMS is operating, the total gas flow through the electrodes is approximately 3 cubic feet/min (85 L/min). This gas does not come into contact with the solvents from the ionization source of the mass spectrometer and is typically merged with the exhaust stream of the TSQ Quantum or LTQ. This gas needs to be delivered at a pressure between 40 and 60 psi with a connection to a 1/4 in. gas line leading to the temperature control module.

To test that the gas supply for temperature control can deliver the necessary flow rate, attach a 30 cm length of 1/4 in. tubing to the gas outlet near the regulator. With the line fully opened, ensure a pressure of 40 psi can be achieved.

Note All other sinks to the gas supply should be on to represent a normal gas use condition.

For the compressed gas used for controlling the temperatures of the electrodes, Thermo Fisher Scientific strongly recommends that a desiccant air dryer be used to remove some of the moisture, oil, and dirt that might be present.

Data System Computer

The Xcalibur FAIMS system control software allows you to control the voltages and the composition and flow rate of the carrier gas, as well as the temperature of the heating gases that are applied to the FAIMS electrodes.

The Xcalibur FAIMS system control software communicates with the FAIMS waveform generator by using a serial connection between the TSQ Quantum or LTQ and the FAIMS waveform generator.

The control software also communicates with the FAIMS temperature control module via a dedicated Ethernet port. If an Ethernet port is unavailable, a dedicated USB port can also be used.

The minimum computer requirements are:

- Microsoft® Windows® 2000 or Microsoft Windows XP
- 1 GHz processor
- 512 MB memory
- Dedicated serial port (RS232)
- Dedicated Ethernet 10baseT, 100baseT, or USB 2.0 port
- 10 MB free hard drive space
- CD-ROM drive

Installation Equipment and Reagents

During installation, the service representative cleans the FAIMS electrodes. Cleaning the FAIMS electrodes requires the following:

- Ultrasonic bath
- Solution of 4% formic acid in 1:1 methanol:water
- Oven that can be set to a minimum of 105 °C for drying the stainless steel electrodes after cleaning
- Glass dish large enough to hold the electrodes while in the oven

The following reagents must be available for installation:

- HPLC-grade water or water purified by reverse osmosis
- Formic acid
- Methanol
- Isopropanol



CAUTION Observe good laboratory practices when you work with chemicals (for example, when making solutions). Use a fume hood and wear appropriate personal protective equipment.

Installation Checklist

Part 1: Site Requirements

Table 20. Site requirements check list

| Requirement | Satisfied? |
|--|--|
| Space (page 111) <ul style="list-style-type: none"> Adequate space on the left of the mass spectrometer for the FAIMS waveform generator Adequate space on top of the mass spectrometer or next to the waveform generator for the FAIMS temperature control module | <input type="checkbox"/> <input type="checkbox"/> |
| Environment (page 111) <ul style="list-style-type: none"> Meets requirements for temperature Meets requirements for humidity Meets requirements for radio emissions Meets requirements for magnetic fields | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> |
| Electrical (page 112) <ul style="list-style-type: none"> Outlets meet the electrical specifications Outlets are available within 10 ft. of the location of the FAIMS system | <input type="checkbox"/> <input type="checkbox"/> |
| Gases and Regulators (page 112) <ul style="list-style-type: none"> Helium and industrial grade Nitrogen with two-stage regulators (40-80 psi). Compressed air supply can achieve a pressure of 40 psi when a 30 cm length of 1/4 in. tubing is attached to the regulator. | <input type="checkbox"/> <input type="checkbox"/> |
| Computer (page 113) <ul style="list-style-type: none"> Meets requirements for the FAIMS system control software Dedicated Ethernet port or USB port Dedicated serial port | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> |
| Maintenance Equipment (page 114) <ul style="list-style-type: none"> Ultrasonic bath Oven (can operate at 105°C) | <input type="checkbox"/> <input type="checkbox"/> |
| Reagents (page 114) <ul style="list-style-type: none"> Formic acid Ammonium acetate Methanol and isopropanol Reagent grade water or water purified by reverse osmosis | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> |

Table 20. Site requirements check list

| Requirement | Satisfied? |
|--|--|
| Solvent Delivery System <ul style="list-style-type: none"> • Syringe pump • HPLC pump • Autosampler or injection valve | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> |

Indicate if any preinstallation actions are required:

Part 2: Availability of Personnel

The individual responsible for the daily operation of the FAIMS system in your lab is:

Will this person will be present for the installation of the FAIMS system and for training in its operation?

Yes No

The percentage of time that this person will be available during this time is:

Arrangements for the installation of the FAIMS system at your site should be made with:

who can be contacted at:

E-mail:

Phone: _____

Cell Phone: _____

Lab Address: _____

FAIMS Optimization Flowchart

The flowchart shown below provides primary and secondary procedures for setting the FAIMS parameters for positively and negatively charged ions. For positively charged ions, the two procedures are referred to as mode P1 and mode P2. For negatively charged ions, the two procedures are referred to as mode N1 and mode N2. [Table 21](#) lists FAIMS parameters for these modes.

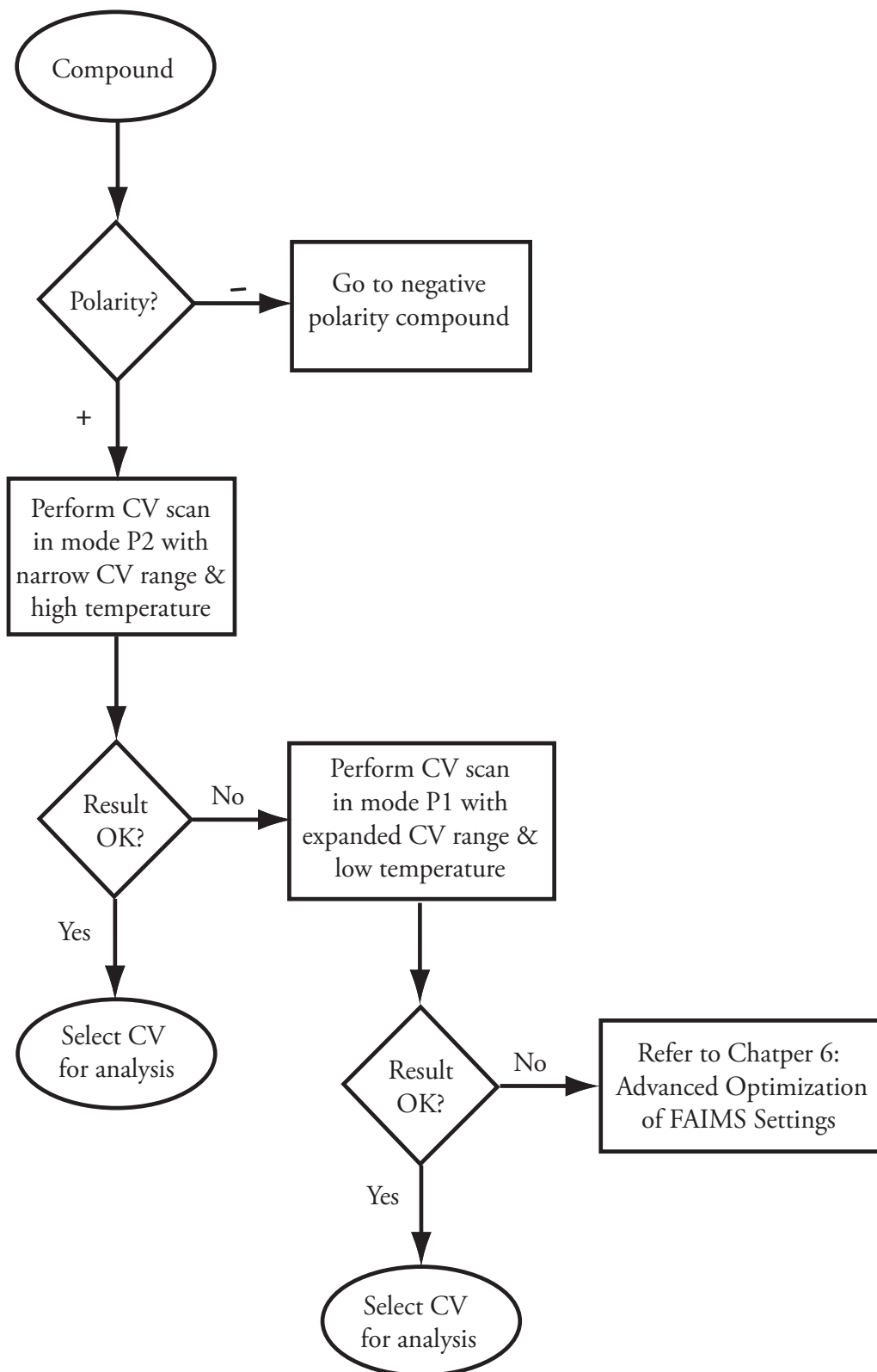


Figure 80. Flowchart for determining FAIMS parameters for positively charged ions

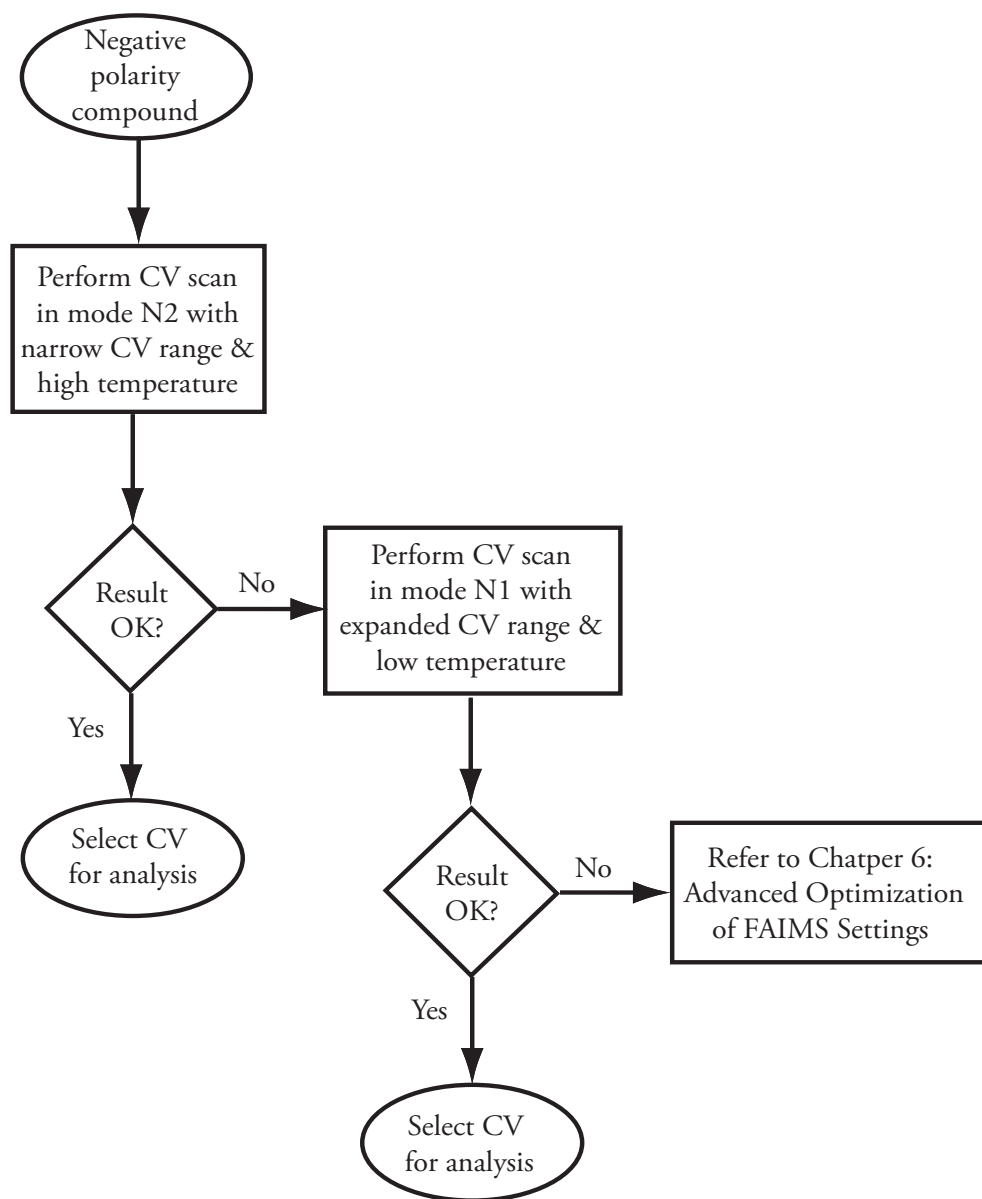


Figure 81. Flowchart for determining FAIMS parameters for negatively charged ions

Table 21. Settings for the FAIMS flowchart

| Starting Parameter | Mode P2 | Mode P1 | Mode N2 | Mode N1 |
|---------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Polarity | Positive ion | Positive ion | Negative ion | Negative ion |
| Dispersion voltage | -5000 V | +5000 V | +5000 V | -5000 V |
| Carrier gas composition | 50% He | 0% He | 50% He | 0% He (|
| Gas flow rate | 3.5 L/min | 3.5 L/min | 3.5 L/min | 3.5 L/min |
| Outer bias voltage | Same as capillary offset | Same as capillary offset | Same as capillary offset | Same as capillary offset |
| Narrow CV scan range | -30 to 10 V | -30 to 10 V | -10 to 30 V | -10 to 30 V |
| Expanded CV scan range | -50 to 10 V | -50 to 10 V | -10 to 50 V | -10 to 50 V |
| High temperature | Inner=70 °C, Outer=90 °C | Inner=70 °C, Outer=90 °C | Inner=70 °C, Outer=90 °C | Inner=70 °C, Outer=90 °C |
| Low temperature | Inner=50 °C, Outer=70 °C | Inner=50 °C, Outer=70 °C | Inner=50 °C, Outer=70 °C | Inner=50 °C, Outer=70 °C |

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