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READ THIS FIRST

Welcome to the Finnigan LCQ™ LC/MS^n System!

This **LCQ MS Detector Hardware Manual** contains a description of the modes of operation and principal hardware components of your LCQ system. In addition, this manual provides step-by-step instructions for cleaning and maintaining your LCQ MS detector. The following chapters are included in this manual:

Chapter 1: Introduction discusses the ion polarity modes, ionization modes, and scan modes of your LCQ system.

Chapter 2: Functional Description describes the principal components of your LCQ system and their respective functions.

Chapter 3: Preparing for Daily Operation describes the checks of the LCQ system that you should perform every day before you begin your first analysis.

Chapter 4: Changing API Probe Assemblies contains procedures for switching ESI and APCI probes.

Chapter 5: MS Detector Maintenance outlines the maintenance procedures that you should perform on a regular basis to maintain optimum MS detector performance.

Chapter 6: System Shutdown, Startup, and Reset provides procedures for shutting down and starting up the LCQ system.

Chapter 7: Diagnostics and PCB and Assembly Replacement discusses procedures for testing the major electronic circuits within the instrument and for replacing failed PCBs and assemblies.

Chapter 8: Replaceable Parts lists the replaceable parts for the MS detector and data system.

Appendix A: Control of External Devices describes how to connect to and control external devices from the LCQ.

Changes to the Manual and Online Help

To suggest changes to this manual or the online Help, please send your comments to:

Editor, Technical Publications
Finnigan Corporation
355 River Oaks Parkway
San Jose, CA 95134-1991

You are encouraged to report errors or omissions in the text and index. Thank you.

Abbreviations

The following abbreviations are used in this and other LCQ manuals and in the online Help.

A	ampere
ac	alternating current
ADC	analog-to-digital converter
AP	acquisition processor
APCI	atmospheric pressure chemical ionization
API	atmospheric pressure ionization
b	bit
B	byte (8 b)
°C	degrees Celsius
cfm	cubic feet per minute
CI	chemical ionization
CIP	Carriage and Insurance Paid To
cm	centimeter
cm^3	cubic centimeter
CPU	central processing unit (of a computer)
CRM	consecutive reaction monitoring
<Ctrl>	control key on the terminal keyboard
d	depth
DAC	digital-to-analog converter
dc	direct current
DDS	direct digital synthesizer
DS	data system
DSP	digital signal processor
ESD	electrostatic discharge
ESI	electrospray ionization
eV	electron volt
f	femto (10^{-15})
°F	degrees Fahrenheit
ft	foot
g	gram
G	giga (10^9)
GND	electrical ground
GPIB	general-purpose interface bus

h	height
h	hour
HPLC	high performance liquid chromatograph
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
in.	inch
I/O	input/output
k	kilo (10^3, 1000)
K	kilo (2^{10}, 1024)
kg	kilogram
l	length
L	liter
LAN	local area network
lb	pound
LC	liquid chromatograph
LC/MS	liquid chromatograph / mass spectrometer
LED	light-emitting diode
m	meter
m	milli (10^{-3})
M	mega (10^6)
M^+	molecular ion
µ	micro (10^{-6})
min	minute
mL	milliliter
mm	millimeter
MS	scan power: MS^1
MS/MS	scan power: MS^2
MS^n	scan power: MS^n, n = 1 through 10
m/z	mass-to-charge ratio
n	nano (10^{-9})
OD	outside diameter
Ω	ohm
p	pico (10^{-12})
Pa	pascal
PCB	printed circuit board

PID	proportional / integral / differential
P/N	part number
P/P	peak-to-peak voltage
ppm	parts per million
psig	pounds per square inch, gauge
RAM	random access memory
<Return>	Return or Enter key on the terminal keyboard
RF	radio frequency
RMS	root mean square
ROM	read-only memory
RS232	industry standard for serial communications
s	second
SIM	selected ion monitoring
solids probe	direct insertion probe
SRM	selected reaction monitoring
TIC	total ion current
Torr	torr
u	atomic mass unit
V	volt
V ac	volts alternating current
V dc	volts direct current
VGA	Video Graphics Array
w	width

Note. The symbol for a compound unit that is a quotient (e.g., degrees Celsius per minute or grams per liter) is written with a negative exponent to indicate the denominator. In the online Help, these symbols are written with a slash (/) because of design constraints in the online Help. For example:

°C min^{-1} (in this manual) °C/min (in the online Help)
g L^{-1} (in this manual) g/L (in the online Help)

Exponents are written as superscripts. In the online Help, exponents are written with a caret (^) or with *e* notation, again, because of design constraints in the online Help. For example:

MS^n (in this manual) MS^n (in the online Help)
10^5 (in this manual) 10e5 (in the online Help)

Typographical Conventions

Typographical conventions have been established for Finnigan manuals for the following:

- Data input
- Notes, Cautions, and WARNINGS
- Topic headings

Data Input

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

- Prompts and messages displayed on the screen are represented in this manual by capitalizing the initial letter of each word and italicizing each word.
- Input that is to be entered by keyboard or buttons that are to be clicked on by the mouse is represented in **bold face letters**. (Titles of topics, chapters, and manuals also appear in bold face letters.)
- For brevity, expressions such as “choose **File | Directories**” are used rather than “pull down the File menu and choose Directories.”
- Any command enclosed in angle brackets < > represents a single keystroke. For example, press **<F1>** means press the key labelled F1.
- Any command that requires pressing two or more keys simultaneously is shown with a hyphen connecting the keys. For example, press **<Shift>-<F1>** means depress and hold the <Shift> key and press the <F1> key.

Notes, Cautions, and Warnings

Notes, cautions, and WARNINGS are dispayed in boxes such as the one below.

> **Note.** Boxes such as this are used to display notes, cautions, and WARNINGS.

A ***note*** contains information that can affect the quality of your data. In addition, notes often contain information that you may need if you are having trouble.

A ***caution*** contains information necessary to protect your instrument from damage.

A ***WARNING*** describes hazards to human beings. If you could get hurt, a WARNING is posted to indicate the danger. Hazard warnings are categorized in this manual as follows:

- Electric shock
- Chemical
- Heat
- Fire
- Eye hazard
- General hazard

Each type of hazard has a hazard symbol associated with it. In this manual, the hazard symbol is placed next to the WARNING box to call your attention to the hazard.

Topic Headings

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

CHAPTER NAME

1.1 First Level Topics

1.1.1 Second Level Topics

1.1.1.1 Third Level Topics

Fourth Level Topics

Fifth Level Topics

Safety Precautions

Observe the following safety precautions when you operate or perform service on the MS detector.

Do Not Perform Any Servicing Other Than That Contained in the LCQ MS Detector Hardware Manual.

To avoid personal injury or damage to the instrument, do not perform any servicing other than that contained in the **LCQ MS Detector Hardware Manual** or related manuals unless you are qualified to do so.

Shut Down the MS Detector and Disconnect It From Line Power Before You Service It.

High voltages capable of causing personal injury are used in the instrument. Some maintenance procedures require that the MS detector be shut down and disconnected from line power before service is performed. Do not operate the MS detector with the top or side covers off. Do not remove protective covers from PCBs.

Respect Heated Zones.

Treat heated zones with respect. The heated capillary and the APCI vaporizer may be very hot and may cause severe burns if they are touched. Allow heated components to cool before you service them.

Place the MS Detector in Standby (or Off) Before You Open the Atmospheric Pressure Ionization (API) Source.

The presence of atmospheric oxygen in the API source when the MS detector is On could be unsafe. (LCQ automatically turns the MS detector Off when you open the API source, however, it is best to take this added precaution.)

Make Sure You Have Sufficient Nitrogen For Your API Source

Before you begin normal operation each day, make sure that you have sufficient nitrogen for your API source. The presence of atmospheric oxygen in the API source when the MS detector is On could be unsafe. (LCQ automatically turns the MS detector Off when you run out of nitrogen, however, it is best to take this added precaution.)

Provide an Adequate Fume Exhaust System and Contain Waste Streams.

It is your responsibility to provide an adequate fume exhaust system. Samples and solvents that are introduced into the LCQ will eventually be exhausted from the rotary-vane pump. Therefore, the rotary-vane pump should be connected to a fume exhaust system. Consult local regulations for the proper method of exhausting the fumes from your system.

The API source can accommodate high flow rates. Therefore, provisions must be made to collect the waste solvent. The API source is fitted with a 6 mm (0.25 in.) ID connector for solvent drainage. A 6 mm (0.25 in.) PVC drain tube, which is provided with the system, should be connected between the API source and an appropriate collection container. (The waste container can be something as simple as an old solvent bottle with a modified cap.)

Use Care When Changing Vacuum Pump Oil.

Treat drained vacuum pump oil and pump oil reservoirs with care. Hazardous compounds introduced into the system might have become dissolved in the pump oil. Always use approved containers and procedures for disposing of waste oil. Whenever a pump that has been operating on a system used for the analysis of toxic, carcinogenic, mutagenic, or corrosive/irritant chemicals, the pump must be decontaminated by the user and certified to be free of contamination before repairs or adjustments are made by a Finnigan Customer Support Engineer or before it is sent back to the factory for service.

Solvent and Gas Purity Requirements

Use the highest purity solvents available. The LCQ MS detector is extremely sensitive to solvent impurities. Some solvent impurities are transparent to UV/Visible detectors, but are easily detected by the LCQ MS detector. Liquid chromatography grade is the minimum acceptable purity. Higher grade solvents are preferred. Distilled water is recommended. Deionized water contains impurities and is not recommended.

The following is a list of international sources that can supply high quality solvents:

Solvent Source	Telephone Number
Mallinckrodt/Baker, Inc.	Tel: (800) 582-2537 Fax: (908) 859-9318
Burdick & Jackson, Inc.	Tel1: (800) 368-0050 Tel2: (616) 726-3171 Fax: (616) 728-8226
E. M. Science, Inc.	Tel1: (800) 222-0342 Tel2: (609) 423-6300 Fax1: (800) 336-4422 Fax2: (609) 423-4389

The LCQ MS detector uses helium as a damping gas. The helium should be ultra-high purity (99.999%) with less than 1.0 ppm each of water, oxygen, and total hydrocarbons. The required gas pressure is 40 ±10% psi (36 to 44 psi). Finnigan Corporation has found that particulate filters are often contaminated and are therefore not recommended.

The LCQ MS detector uses nitrogen as a sheath gas and auxiliary gas. The nitrogen should be high purity (99%). The required gas pressure is 100 psi ± 20% (80 to 120 psi).

Service Philosophy

Servicing the LCQ system consists of performing procedures required to maintain system performance standards, to prevent system failure, and/or to restore the system to an operating condition. Routine and preventive maintenance procedures are documented in this manual.

Routine and preventive maintenance are the responsibility of the user during and after the warranty period. Regular maintenance will increase the life of the system, maximize the up-time of your system, and allow you to achieve optimum system performance.

Service not described in this manual should be performed only by a Finnigan Customer Support Engineer or similarly trained and qualified technical personnel.

Level of Repair

Finnigan's service philosophy for the LCQ system calls for troubleshooting to the lowest part, assembly, PCB, or module listed in the **Replaceable Parts** chapter of this manual.

For mechanical failures: A mechanical assembly typically is to be repaired to the level of the smallest item listed in the **Replaceable Parts** chapter of this manual.

For electronic failures: PCBs are not repaired to the component level except in certain cases of fuses, relays, etc. When these exceptions occur, the components can be found in the **Replaceable Parts** chapter.

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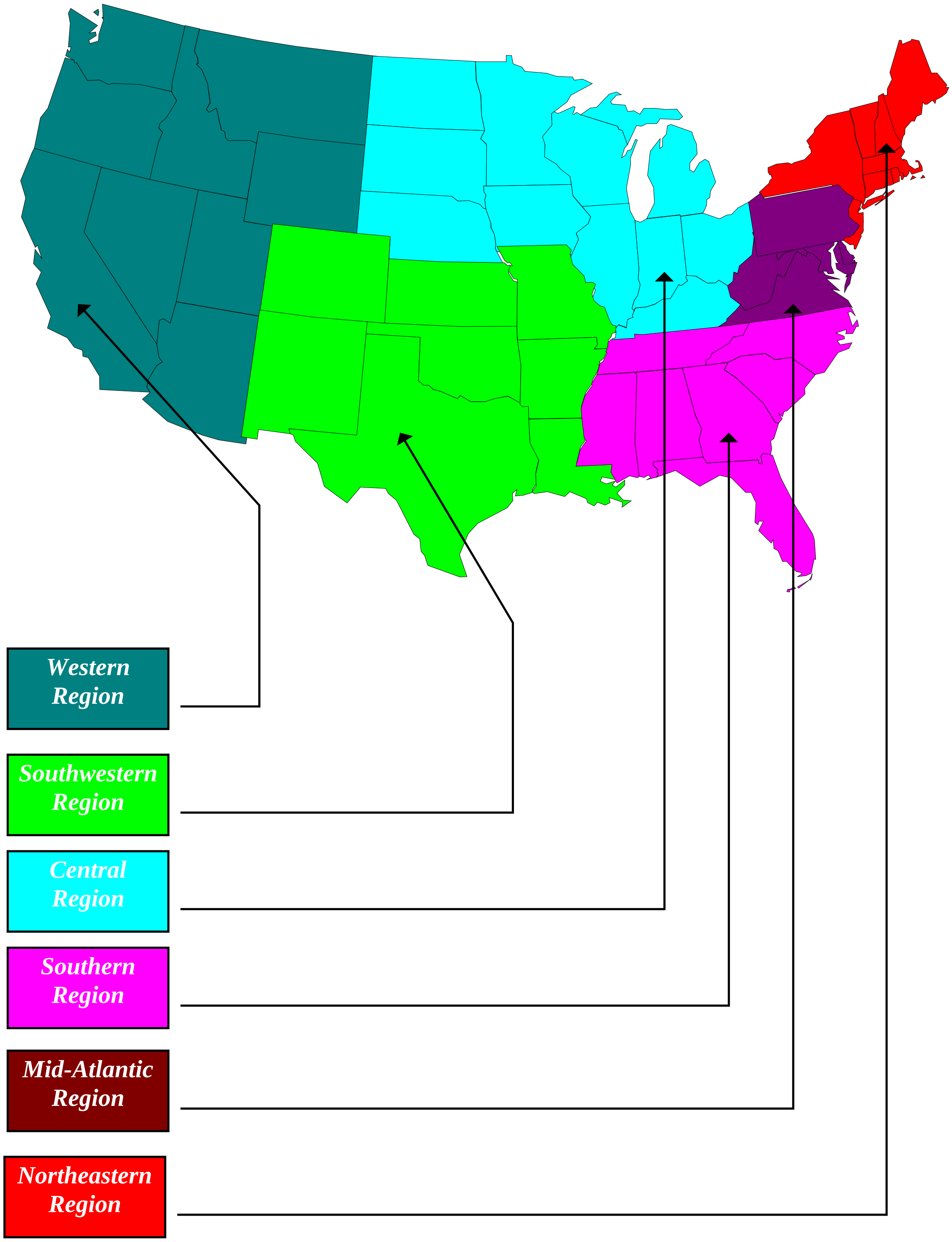

Ordering Replaceable Parts

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Experience has shown that maximum value can be derived from a scientific instrument if there is one person, the key operator, who has a major responsibility for the instrument. It is recommended that you designate a key operator to manage the operation and maintenance of your Finnigan instrument in your laboratory. It is also recommended that about one month after your instrument has been installed the key operator receive training for the operation and maintenance of the system at the ThermoQuest Institute, at your site, or at one of the local ThermoQuest offices.

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INTRODUCTION

The LCQ is an advanced analytical instrument that includes a mass spectrometer (MS) detector, a syringe pump, and a data system. See Figure 1-1. In a typical LC/MS analysis, a sample is introduced into a liquid chromatograph (LC) either manually or by an autosampler. After the sample has entered the LC, the sample separates into its chemical components as it moves through the LC column. The separated chemical components pass through a transfer line and then enter the LCQ MS detector to be analyzed one at a time. You can also introduce a sample directly into the MS detector with the syringe pump.

Figure 1-1. Finnigan LCQ system

The LCQ MS detector consists of an atmospheric pressure ionization (API) source, ion optics, mass analyzer, and ion detection system. The ion optics, mass analyzer, ion detection system, and part of the API source are enclosed in a vacuum manifold. Ionization of the sample takes place in the API source. The specific process used to ionize the sample is referred to as the ***ionization mode***. The ions produced in the API source are transmitted by the ion optics into the mass analyzer, where they are trapped in stable orbits by a time-varying electric field. The polarity of the potentials applied to the lenses in the API source and ion optics determines whether positively charged ions or negatively charged ions are transmitted to the mass analyzer. You can configure the LCQ to analyze positively or negatively charged ions (called the positive or negative ***ion polarity mode***). The lenses in the API source and ion optics act as a gate to start and stop the transmission of ions from the API source to the mass analyzer. The gate is set to transmit the optimum number of ions to the mass analyzer.

The mass-to-charge ratios of the ions produced in the API source are measured by the mass analyzer. Selected ions are ejected from the mass analyzer and reach the ion detection system, where they produce a signal. The ion detection system signal is then amplified by the system electronics.

The ion detection system signal is analyzed by the LCQ data system. The data system also serves as the user interface to the MS detector, autosampler, LC, and syringe pump. Refer to the online Help or the **LCQ Software Manual** for more information on the LCQ data processing and instrument control software.

Each sequence of loading the mass analyzer with ions followed by mass analysis of the ions is called a ***scan***. The LCQ uses several different *scan modes* of different *scan powers* to load, fragment, and eject ions from the mass analyzer. The ability to vary the scan modes and scan power, as well as the ionization and ion polarity modes, affords the user great flexibility in the instrumentation for solving complex analytical problems.

This chapter describes the following topics:

- Ion polarity modes
- Ionization modes
- Scan power
- Scan modes
- Scan data types

1.1 Ion Polarity Modes

You can operate the LCQ in either of two ***ion polarity modes***: positive or negative. Both positively charged and negatively charged ions are formed in the API source of the MS detector. The LCQ can control whether positive ions or negative ions are transmitted to the mass analyzer for mass analysis by changing the polarity of the potentials applied to the API source and ion optics. The ion optics are located between the API source and the mass analyzer.

The information obtained from a positive-ion mass spectrum is different from and complementary to that obtained from a negative-ion spectrum. Thus, the ability to obtain both positive-ion and negative-ion mass spectra aids you in the qualitative analysis of your sample. You can choose the ion polarity mode and ionization mode to obtain maximum sensitivity for the particular analysis of interest.

1.2 Ionization Modes

You can operate the LCQ in either of two ionization modes, as follows:

- Electrospray ionization (ESI)
- Atmospheric pressure chemical ionization (APCI)

1.2.1 Electrospray Ionization

The electrospray ionization (ESI) mode transforms ions in solution into ions in the gas phase[1]. Many samples that previously were not suitable for mass analysis (for example, heat-labile compounds or high molecular weight compounds) can be analyzed by the use of ESI. ESI can be used to analyze any polar compound that makes a preformed ion in solution. The term *preformed ion* can include adduct ions. For example, polyethylene glycols can be analyzed from a solution containing ammonium acetate, because of adduct formation between the NH_4^+ ions in the solution and oxygen atoms in the polymer. With ESI, the range of molecular weights that can be analyzed by the LCQ is greater than 100,000 u, due to multiple charging. ESI is especially useful for the mass analysis of polar compounds, which include: biological polymers (for example, proteins, peptides, glycoproteins, and nucleotides); pharmaceuticals and their metabolites; and industrial polymers (for example, polyethylene glycols).

In ESI, ions are produced and analyzed as follows:

1. The sample solution enters the ESI needle, to which a high voltage is applied.
2. The ESI needle sprays the sample solution into a fine mist of droplets that are electrically charged at their surface.
3. The electrical charge density at the surface of the droplets increases as solvent evaporates from the droplets.

---

[1] Refer to the following papers for more information on the electrospray ionization process: Fenn, J. B.; Mann, M.; Meng, C. K.; Wong, S. F.; Whitehouse, C. M. *Mass Spectrom. Reviews* **1990**, *9*, 37; Smith, R. D.; Loo, J. A.; Edmonds, C. G.; Barinaga, C. J.; Udseth, H. R. *Anal. Chem.* **1990**, *62*, 882; Ikonomou, M. G.; Blades, A. T.; Kebarle, P. *Anal. Chem.* **1991**, *63*, 1989.

4. The electrical charge density at the surface of the droplets increases to a critical point, known as the Rayleigh stability limit. At this critical point, the droplets divide into smaller droplets because the electrostatic repulsion is greater than the surface tension. The process is repeated many times to form very small droplets.
5. From the very small, highly charged droplets, sample ions are ejected into the gas phase by electrostatic repulsion.
6. The sample ions enter the MS detector and are analyzed.

Figure 1-2 shows the steps in the formation of ions from highly charged droplets.

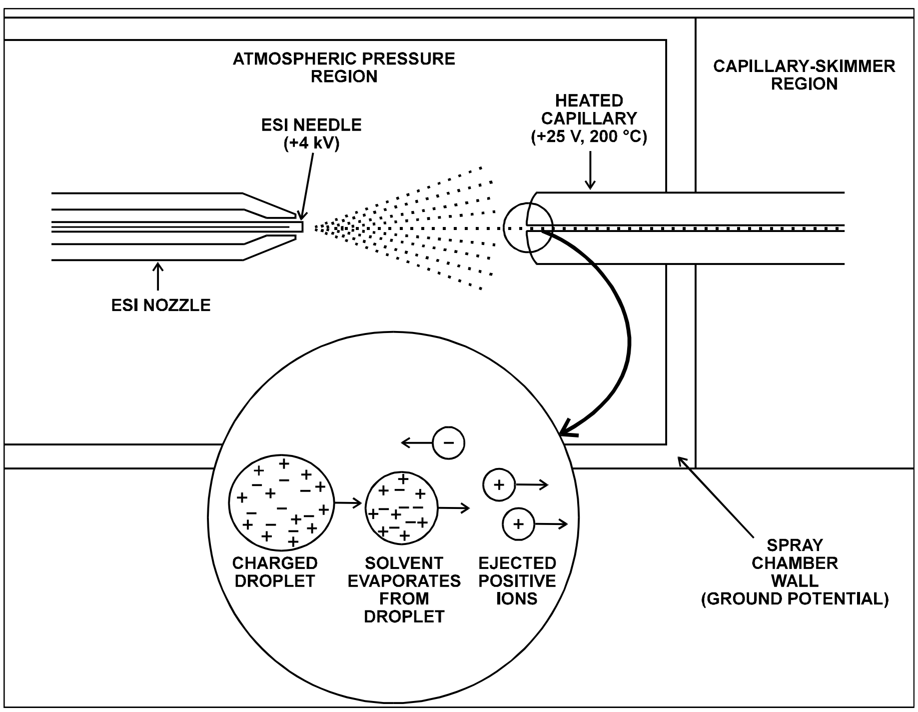

Figure 1-2. ESI process in the positive ion polarity mode

You can use the ESI mode in either positive or negative ion polarity mode. The ion polarity mode of choice is determined by the polarity of the preformed ions in solution: Acidic molecules form negative ions in solution, and basic molecules form positive ions. The ejection of sample ions from droplets is facilitated if the ionic charge and surface charge of the droplet are of the same polarity. Thus, a positively charged needle is used to analyze positive ions and a negatively charged needle is used to analyze negative ions.

Sample ions can carry a single charge or multiple charges. The number of charges carried by the sample ions depends on the structure of the analyte of interest and the carrier solvent. (In ESI, the buffer and the buffer strength both have a noticeable effect on sensitivity. Therefore, it is important to choose these variables correctly.) In the case of higher molecular weight proteins or peptides, the resulting mass spectrum consists typically of a series of peaks corresponding to a distribution of multiply charged analyte ions.

The ESI process is effected by droplet size, surface charge, liquid surface tension, solvent volatility, and ion solvation strength. Large droplets with high surface tension, low volatility, strong ion solvation, low surface charge, and high conductivity prevent good electrospray.

Organic solvents such as methanol, acetonitrile, and isopropyl alcohol are superior to water for ESI. Volatile acids and bases are good, but salts above 10 mM and strong acids and bases are extremely detrimental.

The rules for a good electrospray are:

- Keep salts out of the solvent system
- Use organic/aqueous solvent systems and volatile acids and bases
- Optimize the pH of the solvent system.

1.2.2 Atmospheric Pressure Chemical Ionization

Atmospheric pressure chemical ionization (APCI) is a soft ionization technique, but not as soft as ESI. APCI is used to analyze compounds of medium polarity that have some volatility.

In APCI, ions are produced and analyzed as follows:

1. The APCI nozzle sprays the sample solution into a fine mist of droplets.
2. The droplets are vaporized in a high temperature tube (the vaporizer).
3. A high voltage is applied to a needle located near the exit end of the tube. The high voltage creates a corona discharge that forms reagent ions through a series of chemical reactions with solvent molecules and nitrogen sheath gas.
4. The reagent ions react with sample molecules to form sample ions.
5. The sample ions enter the MS detector and are analyzed.

Figure 1-3 shows the APCI process for a positive adduct ion formation.

APCI is a gas phase ionization technique. Therefore, the gas phase acidities and basicities of the analyte and solvent vapor play an important role in the APCI process.

In the positive-ion mode, sample ionization occurs in a series of reactions that start with the electron-initiated cation formation. Typical examples of primary, secondary, and adduct ion formation are shown below:

Primary ion formation

$$e^- + N_2 \rightarrow N_2^{+\cdot} + 2e^-$$

Secondary ion formation

$$N_2^{+\cdot} + H_2O \rightarrow N_2 + H_2O^{+\cdot}$$

$$H_2O^{+\cdot} + H_2O \rightarrow H_3O^+ + HO^\cdot$$

Proton transfer

$$H_3O^+ + M \rightarrow (M{+}H)^+ + H_2O$$

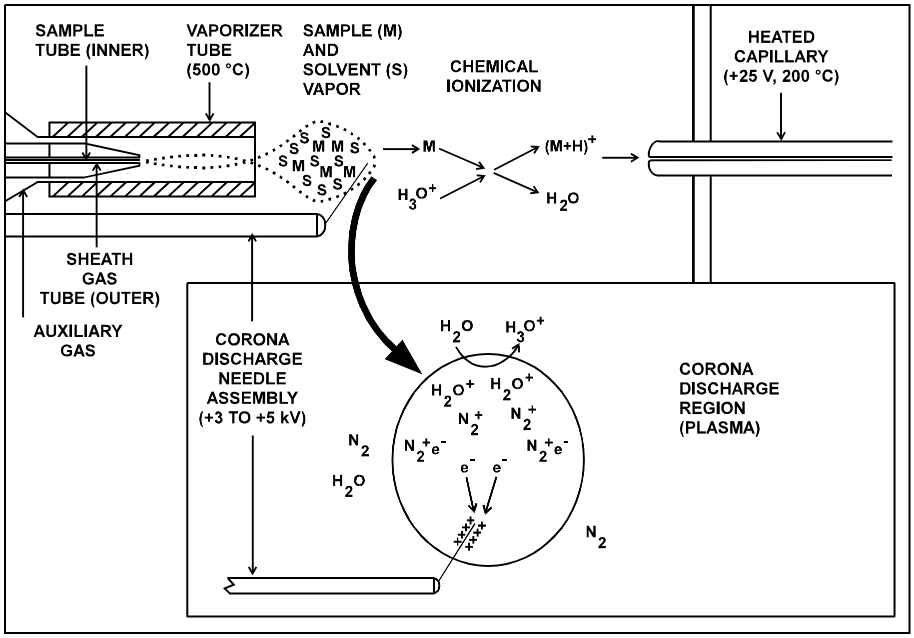

Figure 1-3. APCI process in the positive ion polarity mode

In negative-ion mode, $(M\text{-}H)^-$ is typically formed by the abstraction of a proton by OH^-.

APCI is typically used to analyze small molecules with molecular weights up to about 2000 u. APCI is a very robust ionization technique. It is not affected by minor changes in most variables such as changes in buffer or buffer strength.

You can use APCI in positive or negative ion polarity mode. For most molecules, the positive-ion mode produces a stronger ion current. This is especially true for molecules with one or more basic nitrogen (or other basic) atoms. An exception to the general rule are molecules with acidic sites such as carboxylic acids and acid alcohols, which produce more negative ions than positive ions.

Although, in general, fewer negative ions are produced than positive ions, negative ion polarity is sometimes the mode of choice. This is because the negative ion polarity mode sometimes generates less chemical noise than does the positive mode. Thus, selectivity might be better in the negative ion mode than in the positive ion mode.

Note. Because APCI and ESI use the same API stack (that is, the portion of the API source that is under vacuum), you can switch between these two ionization techniques in just a few minutes. Switching ionization modes merely involves switching the probes and does not break vacuum.

1.3 Scan Power

Ions that are produced in the ion source are often referred to as ***parent ions***. These parent ions can be mass analyzed to produce a mass spectrum. Alternatively, by varying the RF voltages of the mass analyzer, LCQ can first eject all ions except for several selected parent ions and then collide these ions with background gas that is present in the mass analyzer. The collisions of the selected parent ions with the background gas may cause them to fragment into ***product ions***. The product ions can be mass analyzed or fragmented further.

The number of stages of mass analysis is often represented as MS^n where n is the ***scan power***. (Each stage of mass analysis includes an ion storage step.) LCQ supports scan powers from $n = 1$ to $n = 10$. The higher the scan power, the more structural information is obtained about the analyte.

The ten scan powers supported by LCQ can be grouped as follows:

- MS scan ($n = 1$)
- MS/MS scan ($n = 2$)
- MS^n scan ($n = 3$ to $n = 10$)

1.3.1 MS Scan

An ***MS*** or ***mass spectrometry scan*** corresponds to a single stage of mass analysis (that is, a scan power of $n = 1$). An MS scan involves only parent ions, and no fragmentation of the parent ions takes place. An MS scan can be a full scan experiment or a selected ion monitoring (SIM) experiment (see below).

1.3.2 MS/MS Scan

An ***MS/MS scan*** corresponds to two stages of mass analysis ($n = 2$ scan power). In an MS/MS scan, parent ions are fragmented into product ions. An MS/MS scan can be a full scan experiment or a selected reaction monitoring (SRM) experiment (see below).

1.3.3 MS^n Scan

An ***MS^n scan*** involves three to ten stages of mass analysis ($n = 3$ to $n = 10$ scan power). [However, the term can also be applied to one stage of mass analysis (with $n = 1$) or to two stages of mass analysis (with $n = 2$).] An MS^n scan can be either a full scan experiment or a consecutive reaction monitoring (CRM) experiment (see below).

1.4 Scan Modes

You can operate the LCQ in the following scan modes:

- Full scan
- Selected ion monitoring (SIM)
- Selected reaction monitoring (SRM)
- Consecutive reaction monitoring (CRM)
- ZoomScan™

1.4.1 Full Scan

The ***full scan*** scan mode provides a full mass spectrum of each analyte or parent ion. With full scan, in the last step of mass analysis (the ion scan-out step) the mass analyzer is scanned from the first mass to the last mass without interruption.

Full scan scan mode provides more information about an analyte than does selected ion monitoring (SIM), selected reaction monitoring (SRM), or consecutive reaction monitoring (CRM), but full scan does not provide the sensitivity that can be achieved by the other scan modes.

The full scan scan mode includes the following:

- Single-stage full scan
- Two-stage full scan
- Multi-stage full scan

1.4.1.1 Single-Stage Full Scan

The single-stage full scan mode has one stage of mass analysis (n = 1 scan power). With single-stage full scan mode, the ions formed in the ion source are stored in the mass analyzer. Then, these ions are sequentially scanned out of the mass analyzer to produce a full mass spectrum.

Single-stage full scan experiments can be used to determine the molecular weight of unknown compounds or the molecular weight of each component in a mixture of unknown compounds. For example, you need a full scan to determine the molecular weight of each component of a mixture of unknown compounds, because you do not know what masses to expect from the mixture.

To use the SIM, SRM, or CRM scan mode, you need to know what ions you are looking for before you can perform an experiment. Thus, for SIM, SRM, or CRM you can use a full scan to determine the identity of an analyte and obtain its mass spectrum. Then, you might use SIM, SRM, or CRM to do routine quantitative analysis of the compound.

1.4.1.2 Two-Stage Full Scan

The two-stage full scan mode has two stages of mass analysis ($n = 2$ scan power). In the first stage of mass analysis, the ions formed in the ion source are stored in the mass analyzer. Then, ions of one mass-to-charge ratio (the parent ions) are selected and all other ions are ejected from the mass analyzer. The parent ions are excited so that they collide with background gas that is present in the mass analyzer. The collisions of the parent ions cause them to fragment to produce one or more product ions.

In the second stage of mass analysis, the product ions are stored in the mass analyzer. Then, they are sequentially scanned out of the mass analyzer to produce a full product ion mass spectrum.

The two-stage full scan mode gives you more information about a sample than does SRM, but two-stage full scan mode does not yield the speed that can be achieved by SRM. With two-stage full scan, you spend more time monitoring the product ions than you do in SRM. Thus, two-stage full scan provides greater information, but lower speed than SRM does.

To use the SRM scan mode, you need to know what reaction you are looking for before you can perform an experiment. Thus, for SRM you might use one-stage full scan mode to determine the parent mass spectrum and two-stage full scan mode to determine the product mass spectra for parent ions of interest. Then, you might use SRM to do routine quantitative analysis of the compound.

1.4.1.3 Multi-Stage Full Scan

The multi-stage full scan mode is a full scan mode with three to ten stages of mass analysis (n = 3 to n = 10 scan power). In the first stage of mass analysis, the ions formed in the ion source are stored in the mass analyzer. Then, ions of one mass-to-charge ratio (the parent ions) are selected and all other ions are ejected from the mass analyzer. The parent ions are excited so that they collide with background gas that is present in the mass analyzer. The collisions of the parent ions cause them to fragment to produce one or more product ions.

In the second stage of mass analysis, the product ions are stored in the mass analyzer. Then, product ions of one mass-to-charge ratio are selected and all other ions are ejected from the mass analyzer. The selected product ions now become the new parent ions for the next stage of mass analysis. The new parent ions are excited so that they collide with background gas. The collisions of the new parent ions cause them to fragment to produce one or more new product ions.

In the third stage of mass analysis, the new product ions are stored in the mass analyzer. The process described in the previous paragraph is repeated up to seven more times until the final product ions of interest are produced.

In the nth stage of mass analysis, the final product ions are stored in the mass analyzer. Then, they are sequentially scanned out of the mass analyzer to produce a full final product ion mass spectrum.

1.4.2 Selected Ion Monitoring

Selected ion monitoring (SIM) is a single-stage (n = 1 scan power) technique in which a particular ion or set of ions is monitored. In the SIM scan mode, the ions formed in the ion source are stored in the mass analyzer. Ions of one or more mass-to-charge ratios are selected and all other ions are ejected from the mass analyzer. Then, the selected ions are sequentially scanned out of the mass analyzer to produce a SIM mass spectrum.

SIM experiments are useful in detecting small quantities of a target compound in a complex mixture when the mass spectrum of the target compound is known. Thus, SIM is useful in trace analysis and in the rapid screening of a large number of samples for a target compound.

Because only a few ions are monitored, SIM can provide lower detection limits and greater speed than a single-stage full scan analysis can provide. SIM achieves lower detection limits because more time is spent monitoring significant ions that are known to occur in the mass spectrum of the target sample. SIM achieves greater speed because only a few ions of interest are monitored; regions of the spectrum that are empty or have no ions of interest are not monitored.

SIM can improve the detection limit and decrease analysis time, but it can also reduce specificity. In SIM, only specific ions are monitored. Therefore, any compound that produces those ions appears to be the target compound. Thus, a false positive result can be obtained.

1.4.3 Selected Reaction Monitoring

Selected reaction monitoring (SRM) is a two-stage (n = 2 scan power) technique in which parent ion and product ion *pairs* are monitored.

In the first stage of mass analysis, the ions formed in the ion source are stored in the mass analyzer. Ions of one mass-to-charge ratio (the parent ions) are selected and all other ions are ejected from the mass analyzer. Then, the parent ions are excited so that they collide with background gas that is present in the mass analyzer. The collisions of the parent ions cause them to fragment to produce one or more product ions.

In the second stage of mass analysis, the product ions are stored in the mass analyzer. Ions of one or more mass-to-charge ratios are selected and all other ions are ejected from the mass analyzer. Then, the selected ions are sequentially scanned out of the mass analyzer to produce an SRM product ion mass spectrum.

Like SIM, SRM allows for the very rapid analysis of trace components in complex mixtures. However, because you are monitoring pairs of ions (one product ion for each parent ion), the specificity obtained in SRM can be much greater than that obtained in SIM. Thus, you are very unlikely to get a false positive result with SRM. To get a false positive result, the interfering compound must do the following: First, it must form a parent ion of the same mass-to-charge ratio as the selected parent ion from the target compound. Second, it must also fragment to form a product ion of the same mass-to-charge ratio as the selected product ion from the target compound.

1.4.4 Consecutive Reaction Monitoring

Consecutive reaction monitoring (CRM) is the multi-stage (n = 3 to n = 10 scan power) analog of SIM (n = 1) and SRM (n = 2), in which a multi-step reaction path is monitored. In the first stage of mass analysis, the ions formed in the ion source are stored in the mass analyzer. Ions of one mass-to-charge ratio (the parent ions) are selected and all other ions are ejected from the mass analyzer. The parent ions are excited so that they collide with background gas that is present in the mass analyzer. The collisions of the parent ions cause them to fragment to produce one or more product ions.

In the second stage of mass analysis, the product ions are stored in the mass analyzer. Product ions of one mass-to-charge ratio are then selected and all other ions are ejected from the mass analyzer. The selected product ions now become the new parent ions for the next stage of mass analysis. The new parent ions are excited so that they collide with background gas. The collisions of the new parent ions cause them to fragment to produce one or more new product ions.

In the third stage of mass analysis, the new product ions are stored in the mass analyzer. The process described in the previous paragraph is repeated up to seven more times until the final product ions of interest are produced.

In the nth stage of mass analysis, the final product ions are stored in the mass analyzer. Ions of one or more mass-to-charge ratios are selected and all other ions are ejected from the mass analyzer. Then, the selected ions are sequentially scanned out of the mass analyzer to produce a CRM final product ion mass spectrum.

In CRM, the specificity increases as the number of consecutive reactions that you monitor increases. However, the sensitivity decreases as the number of consecutive reactions that you monitor increases—especially if there are many fragmentation pathways available to the ion.

1.4.5 ZoomScan

The determination of the mass of an ion from its mass-to-charge ratio may be complicated by the fact that the charge state of the ion may be unknown. ***ZoomScan*** is a high resolution MS scan mode in which LCQ performs a high resolution scan that allows you to determine the charge state and molecular weight of an ion. LCQ conducts a high resolution scan of 10 u width and evaluates the ^{12}C /^{13}C isotopic separation of a specified ion or ions. If the isotopic peaks are 1 u apart, the ion has a charge state of ±1. If the isotopic peaks are 0.5 u apart, the ion has a charge state of ±2. If the isotopic peaks are 0.33 u apart, the ion has a charge state of ±3, etc. You can then determine the molecular weight of the ion from a knowledge of the charge state and mass-to-charge ratio of the ion. You may conduct a ZoomScan analysis of up to ten ions by specifying the mass-to-charge ratios of the ions.

1.5 Scan Data Types

You can acquire and display mass spectral data (intensity versus mass-to-charge ratio) with the LCQ in one of two scan data types:

- Profile scan
- Centroid scan

1.5.1 Profile Scan

In the ***profile scan data type***, you can see the shape of the peaks in the mass spectrum. Each atomic mass unit is divided into approximately 15 sampling intervals. The intensity of the ion current is determined at each of the sampling intervals. The intensity at each sampling interval is displayed with the intensities connected by a continuous line. In general, the profile scan data type is used when you tune and calibrate the MS detector so that you can easily see and measure mass resolution.

1.5.2 Centroid Scan

In the ***centroid scan data type***, the mass spectrum is displayed as a bar graph. In this scan data type, the intensities of each set of 15 sampling intervals are summed. This sum is displayed versus the integral center of mass of the 15 sampling intervals. In general, the centroid scan data type is used for data acquisition because the scan speed is faster. Data processing is also much faster for centroid data.

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FUNCTIONAL DESCRIPTION

This chapter describes the principal components of the LCQ system and their respective functions. The principal components of the LCQ system are as follows:

- Autosampler (optional)
- Liquid chromatograph (optional)
- Syringe pump
- Divert/inject valve
- MS detector
- Data system

A functional block diagram of the LCQ system is shown in Figure 2-1. A sample transfer line connects the LC to the MS detector. The autosampler and LC are usually installed on the left of the MS detector. The syringe pump and divert/inject valve are integrated into the MS detector cabinet.

Samples are injected (either manually or by an autosampler) into the LC inlet. The LC then separates the sample molecules by liquid chromatography. The separated constituents from the LC flow through the transfer line and are introduced into the atmospheric pressure ionization (API) source. You can also inject (infuse) samples into the API source with the syringe pump or the divert/inject valve.

Upon entering the API source, sample molecules are ionized by electrospray ionization (ESI) or atmospheric pressure chemical ionization (APCI). The ion optics focus and accelerate the resulting sample ions into the mass analyzer, where they are analyzed according to their mass-to-charge ratios. The sample ions are then detected by an ion detection system that produces a signal proportional to the number of ions detected. The ion current signal from the ion detection system is received and amplified by the system electronics and is then passed on to the data system for further processing, storage, and display. The data system provides the primary LCQ user interface.

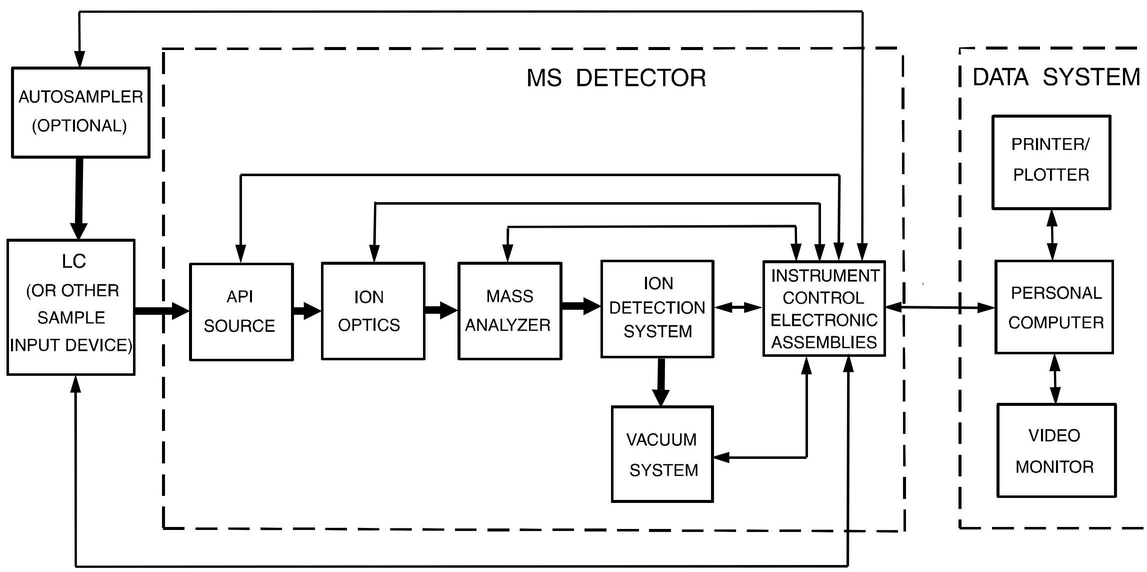

Figure 2-1. Functional block diagram of the LCQ system. The broad, single-headed arrows represent the flow of sample molecules through the instrument. The narrow, double-headed arrows represent electrical connections.

2.1 Autosampler

The ***autosampler*** is used to inject samples automatically into the LC inlet. Thermo Separation Products AS3000, Waters Alliance 2690, and Hewlett-Packard 1050, 1090, and 1100 autosamplers can be controlled directly from the LCQ. With an autosampler, you can automate your LC/MS analyses.

Autosampler communication with the LCQ is provided by a serial I/O line, by an optional IEEE 488 (GPIB) line (Hewlett-Packard autosamplers only), or by contact closure. Refer to **Appendix A: Control of External Devices** for information on connecting autosamplers to the LCQ. You can set up, monitor, and control the autosampler from the data system. You specify the model name, model number, and serial number, and choose either the direct control option or contact closure option (for autosamplers other than the TSP AS3000, Waters Alliance 2690, and HP 1050, 1090, and 1100), at the Autosampler tab in the Instrument Configuration dialog box, which is available from the Options menu in the Navigator window. You set the injection volume in the Autosampler dialog box , which is obtained from the Experiment Method window. Refer to the online Help for the Experiment Method window or to the **Experiment Method** chapter of the **LCQ Software Manual** for instructions on configuring and operating the autosampler from the data system.

Front-panel (keypad) operation of the autosampler and maintenance procedures for the autosampler are described in the documentation provided with the autosampler.

2.2 Liquid Chromatograph

The high performance ***liquid chromatograph*** (LC) separates a sample mixture into its chemical components by liquid chromatography. In liquid chromatography, the sample mixture partitions between a solid stationary phase of large surface area and a liquid mobile phase that percolates over the stationary phase. The molecular structure of each component of the mixture determines when each component elutes from the LC and enters the MS detector.

Thermo Separation Products P4000, Waters Alliance 2690, and Hewlett-Packard 1050, 1090, and 1100 LCs can be controlled directly from the LCQ. You can connect the LC to the MS detector by a serial I/O line or by an optional IEEE 488 (GPIB) line (Hewlett-Packard LCs only). Alternatively, you can connect other LCs to the MS detector by a contact closure interface. Refer to **Appendix A: Control of External Devices** for information on connecting LCs to the LCQ.

You can configure the LC from the data system. You specify the model name, model number, and serial number, and choose either the direct control option or contact closure option, in the Configuration dialog box available from the Options menu in the Navigator window. Refer to the online Help and the **LCQ Software Manual** for instructions on configuring the LC from the data system.

You can also set up, monitor, and control the TSP P4000, Waters Alliance 2690, and HP 1050, 1090, and 1100 LCs from the LCQ data system. You can specify the pump and UV detector settings in the Liquid Chromatograph dialog box available from the Setup menu of the Experiment Method window. (The pump settings are the time, flow rate, percentages of solvents, events, and channels. UV detector settings are the time and initial wavelength for each UV channel used.) Refer to the online Help for the Experiment Method window and the **Experiment Method** chapter of the **LCQ Software Manual** for instructions on setting up and operating the LC from the data system.

Front-panel (keypad) operation of the LC and maintenance procedures for the LC are described in the documentation provided with the LC.

2.3 Syringe Pump

The LCQ includes an electronically-controlled, integrated, dual syringe pump. The ***syringe pump*** delivers sample solution and/or sheath liquid from the syringes into the API source. See Figure 2-2. When the syringe pump is operating, a motor drives a ***pusher block*** that depresses the plunger of the syringe at a controlled rate. Liquid flows out of the syringe needle and into the sample transfer line or sheath liquid line as the plunger is depressed. The syringe is held in place by a ***syringe holder***. Refer to the topic **Setting Up the Inlet: Syringe Pump** in the **LCQ Operator's Manual** for instructions on setting up the syringe pump.

You can control the syringe pump from the LCQ data system. You specify the syringe type (manufacturer), syringe volume, syringe ID, and flow rate in the Syringe Pump dialog box, which can be reached from either the Tune Plus window or the Experiment Method window. Refer to the online Help and the **Tune Plus** and **Experiment Method** chapters of the **LCQ Software Manual** for instructions on operating the syringe pump from the data system.

You can start and stop the syringe pump from the data system or by pressing the ***start/stop button***. The ***syringe pump LED*** is illuminated whenever the syringe pump is pumping.

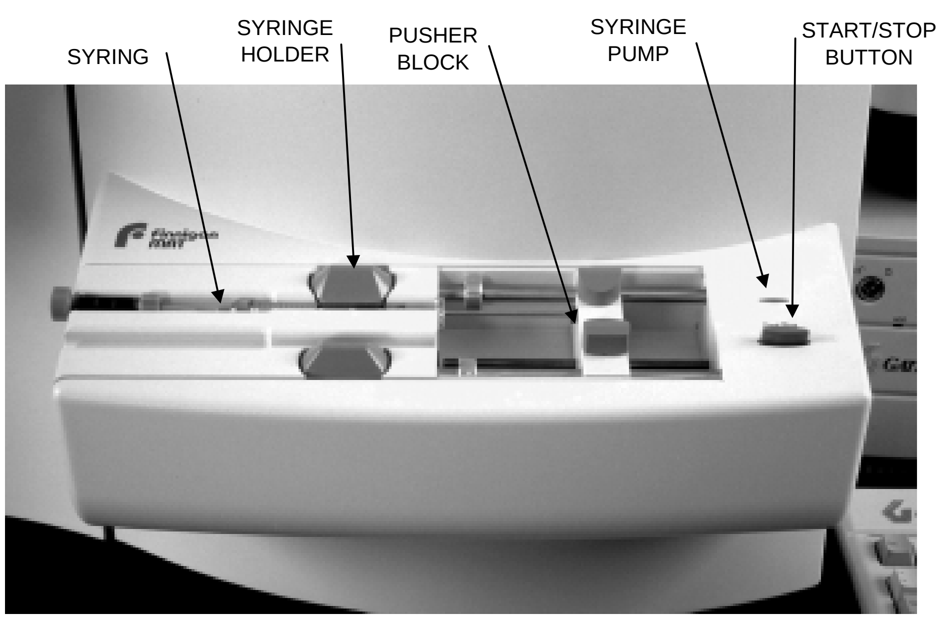

Figure 2-2. Syringe pump

2.4 Divert/Inject Valve

The divert/inject valve is located on the front of the LCQ to the left of the API source. See Figure 2-3. You can configure (plumb) the divert/inject valve as a loop injector (for flow injection analysis) or as a divert valve. Procedures for plumbing the valve in the loop injector or divert valve configuration are given in the topic **Connecting LC Plumbing to the LCQ** in **Appendix A: Connecting External Devices**.

You can control the divert/inject valve from the data system. You specify the parameters of the divert/inject valve in the Divert/Inject Valve dialog box, which can be reached from the Tune Plus window or the Experiment Method window. Refer to the online Help and the **Tune Plus** and **Experiment Method** chapters of the **LCQ Software Manual** for instructions on operating the divert/inject valve from the data system.

You can also use the divert/inject valve button to divert the LC flow between the MS detector and waste when the valve is in the divert valve configuration, or switch between load and inject modes when the valve is in the loop injector configuration.

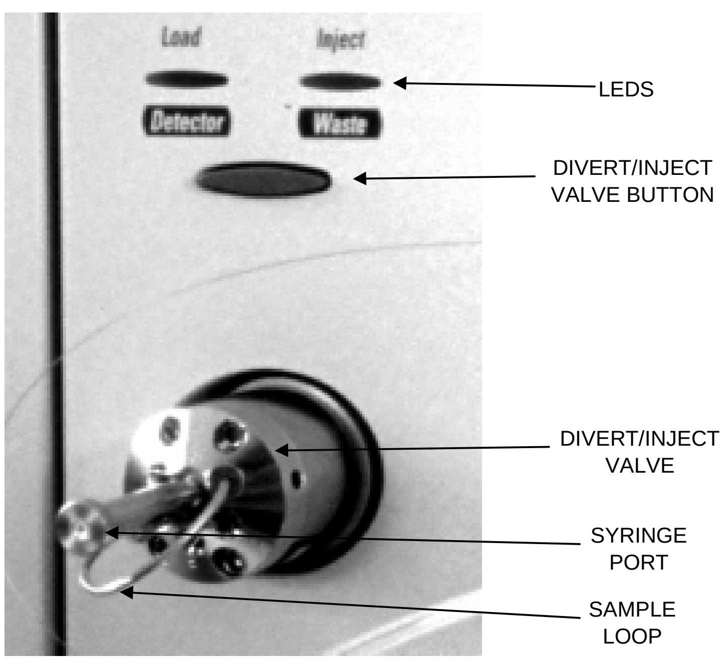

Figure 2-3. Divert/inject valve

2.5 MS Detector

The ***MS detector*** provides sample ionization and mass analysis of injected samples or samples eluted from a liquid chromatograph. The LCQ MS detector uses a quadrupole ion trap mass analyzer with an ion source external to the mass analyzer. Several important features of the LCQ MS detector are as follows:

- Universal, selective, and specific detector
- High sensitivity
- m/z 50 to 2000 mass range
- ESI and APCI ionization modes
- Positive and negative ion polarity modes
- MS^n with scan powers of n = 1 to 10
- Full scan, SIM, SRM, CRM, and ZoomScan scan modes

The MS detector includes the following components:

- Controls and indicators
- API source
- Ion optics
- Mass analyzer
- Ion detection system
- Vacuum system and inlet gasses hardware
- Cooling fans
- Electronic assemblies

2.5.1 Controls and Indicators

Five light-emitting diodes (LEDs) are located at the upper right corner of the front panel of the MS detector. See Figure 2-4.

The LED labeled *Power* is illuminated green whenever power is supplied to the vacuum system and electronic assemblies of the MS detector.

The LED labeled *Vacuum* is illuminated green whenever the vacuum protection circuitry indicates that the vacuum is OK and the safety-interlock switch on the API source is depressed (that is, the API flange is secured to the spray shield).

The LED labeled *Communication* is illuminated yellow when the MS detector and the data system are trying to establish a communication link. The Communication LED is illuminated green when the communication link between the MS detector and the data system has been made.

The LED labeled *System* is illuminated yellow whenever the MS detector is in Standby (that is, high voltage is not supplied to the API source, mass analyzer, and ion detection system, but the MS detector power is on). The System LED is illuminated green whenever the MS detector is On (that is, high voltage is supplied to the API source, mass analyzer, and ion detection system).

The LED labeled *Scan* flashes blue whenever the MS detector is On and scanning ions.

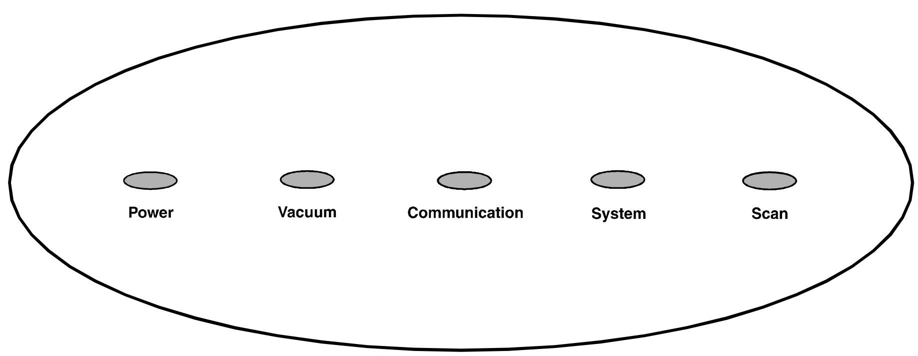

Figure 2-4. Front panel LEDs of the MS detector

Two additional LEDs and a push-button switch are located on the front panel above the divert/inject valve. See Figure 2-5. When the divert/inject valve is set up for loop injections, the divert/inject valve button toggles the valve between load and inject modes and the labels *Load* and *Inject* apply. When the divert/inject valve is set up for divert valve operation, the divert/inject valve button toggles the LC flow between the MS detector and the waste container and the labels *Detector* and *Waste* apply.

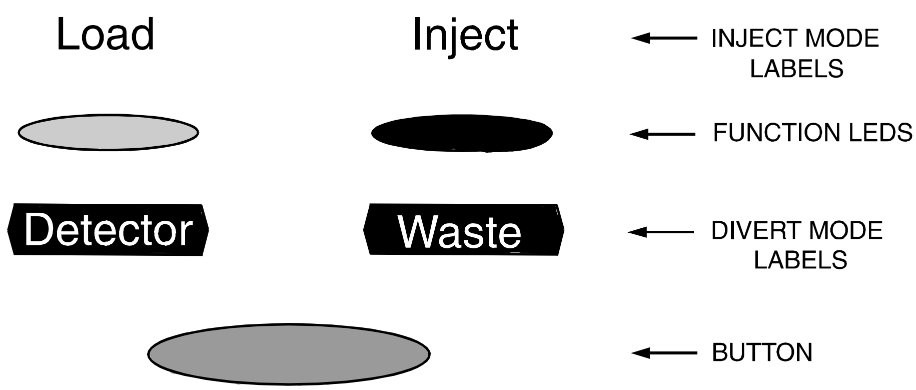

Figure 2-5. Divert/inject valve button and LEDs

The ***main power circuit breaker switch*** (labeled *Main Power*) is located on the power panel at the lower right corner of the right side panel of the MS detector. See Figure 2-6. In the Off (O) position, the circuit breaker removes all power to the MS detector, including the vacuum pumps. In the On (|) position, power is supplied to the MS detector. In the standard operational mode, the circuit breaker is kept in the On (|) position.

The ***electronics service switch*** (labeled *Electronics*) is located on the power panel (Figure 2-6). In the Service (OFF, O) position the switch removes power to all components of the MS detector other than the vacuum system. In the Normal (ON, |) position power is supplied to all components of the MS detector.

Note. To shut off all power to the MS detector in an emergency, place the main power circuit breaker switch (labeled *Main Power*) in the Off (O) position. Do not use the electronics service switch (labeled *Electronics*).

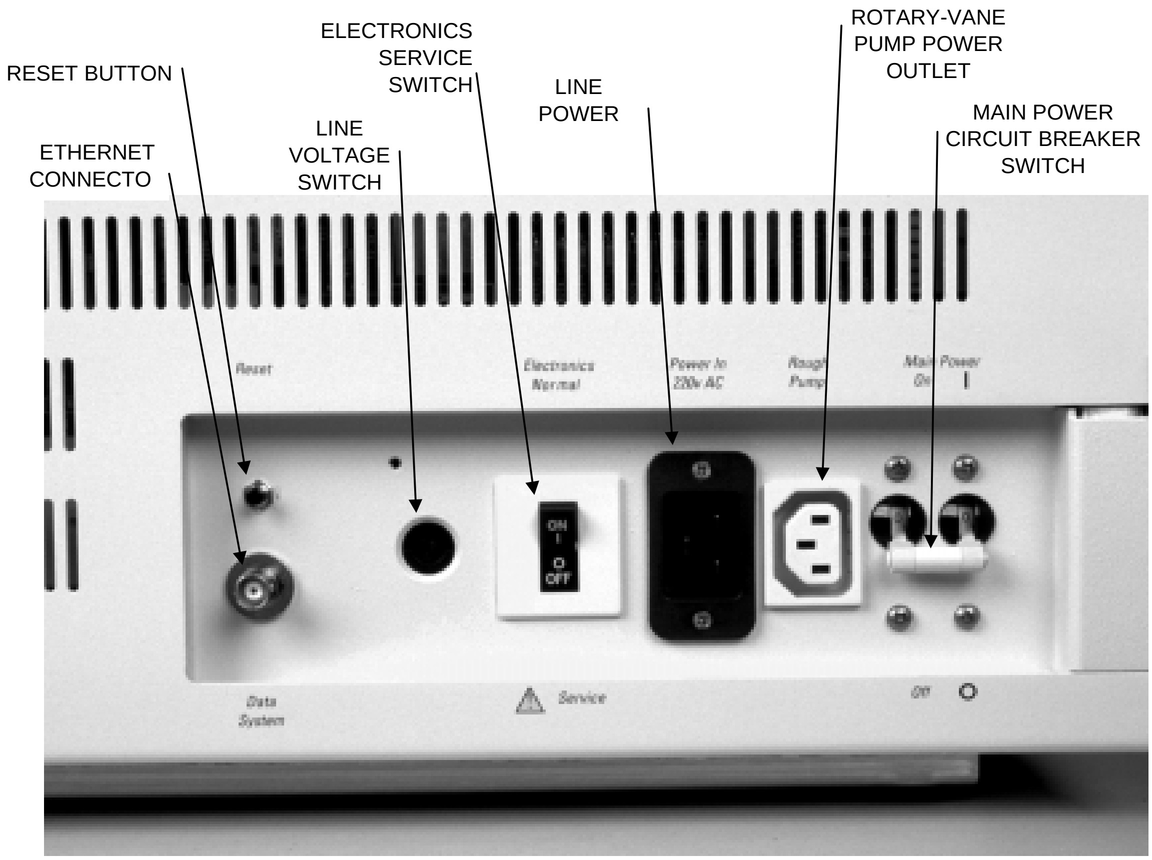

Figure 2-6. Power panel

The ***reset button*** (labeled *Reset*) is also located on the power panel. When you press the reset button, LCQ software is reloaded from the data system. Refer to the topic **Resetting the MS Detector** in the **System Shutdown, Startup, and Reset** chapter for information on resetting the MS detector.

2.5.2 API Source

The ***atmospheric pressure ionization (API) source*** forms gas phase sample ions from sample molecules that are contained in solution. The API source also serves as the sample interface between the LC and the MS detector. You can operate the API source in either the electrospray ionization (ESI) or atmospheric pressure chemical ionization (APCI) mode.

The API source consists of two assemblies:

- API probe assembly (ESI or APCI)
- API stack

2.5.2.1 API Probe Assembly

The ***API probe assembly*** is the portion of the API source that is external to the vacuum manifold. You need to switch probe assemblies when you change ionization modes. Two API probe assemblies are available with the LCQ:

- ESI probe assembly
- APCI probe assembly

2.5.2.1.1 ESI Probe Assembly

The ***ESI probe assembly*** consists of the ESI flange and the ESI probe. See Figure 2-7 and Figure 2-8. The ***ESI flange*** holds the ESI probe in position next to the entrance of the heated capillary, which is part of the API stack (see below). The ESI flange also seals the atmospheric pressure region of the API source; and, when it is in the operating position against the spray shield, compresses the high-voltage safety-interlock switch. The ESI flange mounts on rails that allow movement of the flange toward and away from the vacuum manifold for easy servicing. Two ***flange retainer bolts*** hold the flange in place against the spray shield of the API stack. A ***grounded fitting holder*** secures a fitting that connects the sample transfer line to the ESI sample tube. A ***probe retainer bolt*** secures the ESI probe to the ESI flange.

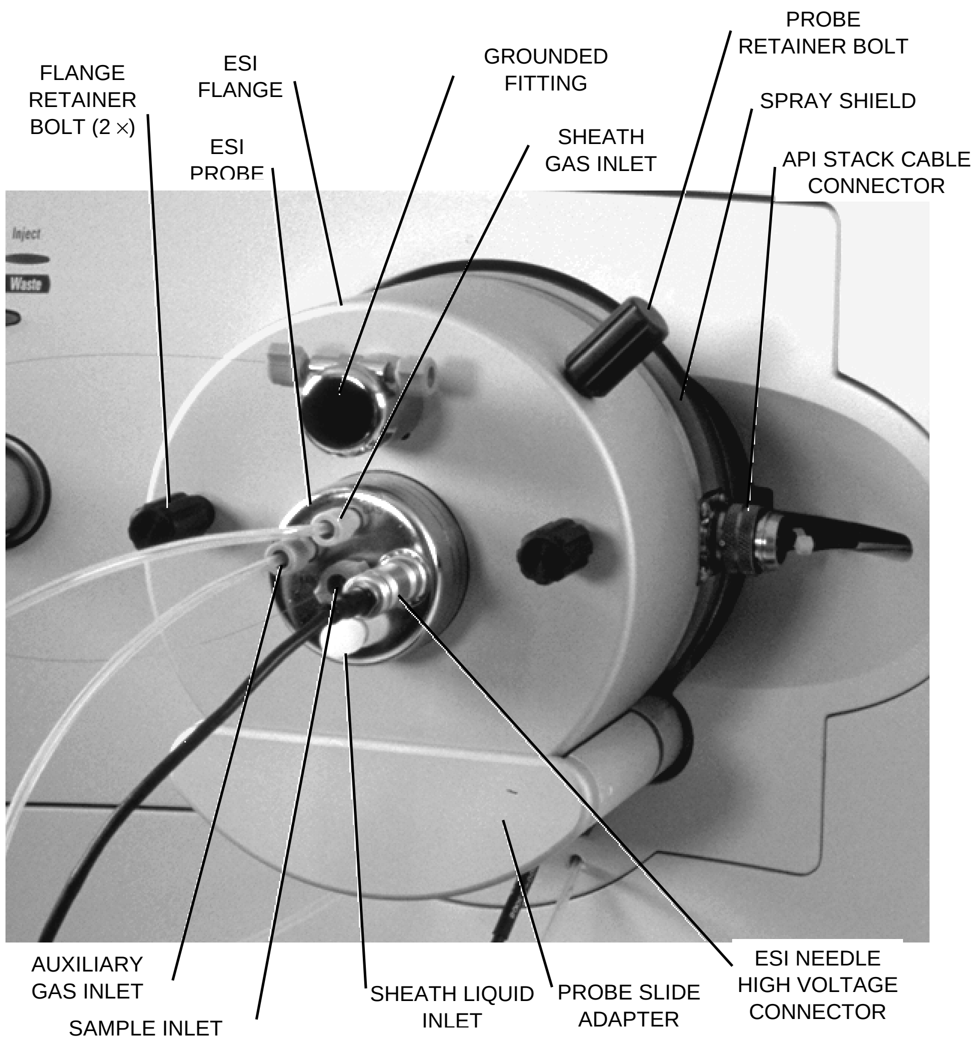

Figure 2-7. ESI probe assembly

The ***ESI probe*** produces charged aerosol droplets that contain sample ions. The ESI probe accommodates liquid flows of 1 μL min^{-1} to 1 mL min^{-1} without splitting.

The ESI probe includes the ESI sample tube, needle, nozzle, and manifold. Sample and solvent enter the ESI probe through the sample tube. The ***sample tube*** is a short section of 0.1 mm ID fused-silica tubing that extends from a fitting secured to the grounded fitting holder, through the sample inlet and into the ESI needle, to within 1 mm from the end of the ESI needle. The ESI ***needle***, to which a large negative or positive voltage is applied (typically ±4.5 to ±5 kV), sprays the sample solution into a fine mist of charged droplets. The ESI ***nozzle*** directs the flow of sheath gas and auxiliary gas at the droplets. The ESI ***manifold*** houses the ESI nozzle and needle and includes the sheath gas, auxiliary gas, and sheath liquid plumbing. The ***sheath gas plumbing*** and ***auxiliary gas plumbing*** deliver dry nitrogen gas to the nozzle. The ***sheath liquid plumbing*** delivers sheath liquid to the nozzle.

The ESI probe has inlets for the introduction of sample solution, sheath gas, auxiliary gas, and sheath liquid into the API source. The ***sheath gas*** is the inner coaxial nitrogen gas that sprays (nebulizes) the sample solution into a fine mist as it exits the sample tube. Typical sheath gas flow rates for ESI are 60 units for sample flow rates of 3 μL min^{-1} and 80 units for sample flow rates of 1 mL min^{-1}. (Typical sheath gas flow rates for APCI are 60 units for sample flow rates of 100 μL min^{-1}, 80 units for sample flow rates of 1 mL min^{-1}, and 85 units for sample flow rates of 2 mL min^{-1}.) When you tune the LCQ, you should adjust the sheath gas flow rate until the ion signal is stable.

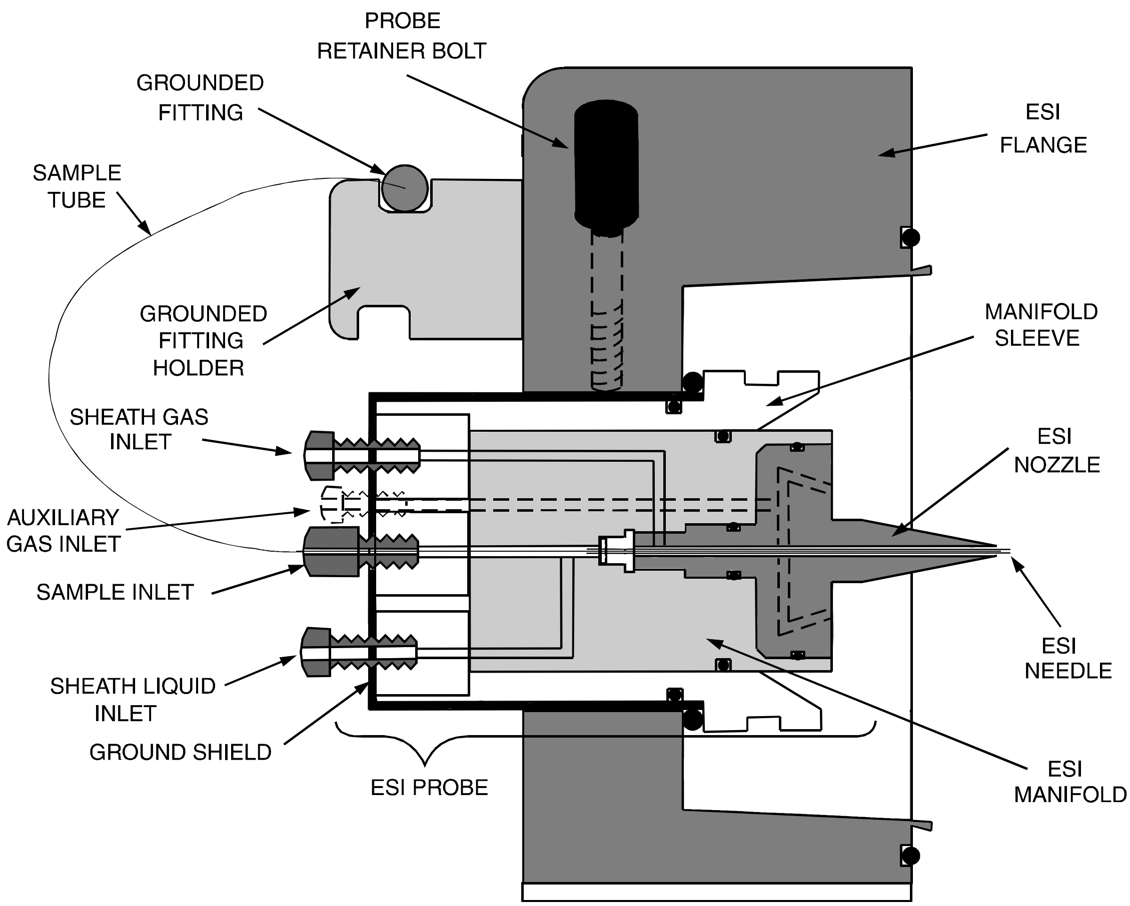

Figure 2-8. Cross sectional view of the ESI probe assembly

The ***auxiliary gas*** is the outer coaxial nitrogen gas that assists the sheath gas in the nebulization and evaporation of sample solutions. The auxiliary gas also helps lower the humidity in the ion source. Typical auxiliary gas flow rates for ESI and APCI are 10 to 20 units. Auxiliary gas is usually not needed for sample flow rates below 100 μL min^{-1}.

The ***sheath liquid*** is a solvent used to stabilize and enhance the ESI process for some solution chemistries (for example, high aqueous content) that do not readily form an electrospray. Sheath liquid is injected by the syringe pump and exits the nozzle coaxially to the sample tube.

2.5.2.1.2 APCI Probe Assembly

The ***APCI probe assembly*** includes the APCI flange, the APCI probe, and the corona discharge needle assembly. See

Figure 2-9 and Figure 2-10. The ***APCI flange*** holds the APCI probe and the corona discharge needle assembly in position next to the entrance of the heated capillary (see below). As with the ESI flange, the APCI flange seals the atmospheric pressure region (also called the spray chamber) of the API source. The APCI flange mounts on rails that allow movement of the flange toward and away from the vacuum manifold for easy servicing. Two ***flange retainer bolts*** hold the flange in place against the spray shield of the API stack. When the APCI flange is in the operating position against the spray shield, it compresses the high-voltage safety-interlock switch. A ***probe retainer bolt*** secures the APCI probe to the APCI flange.

The ***APCI probe*** ionizes the sample by atmospheric pressure chemical ionization. The APCI probe accommodates liquid flows of 100 μL min^{-1} to 2 mL min^{-1} without splitting. The APCI probe includes the APCI sample tube, nozzle, sheath gas and auxiliary gas plumbing, and vaporizer. Sample and solvent enter the APCI nozzle through the ***sample tube***. The sample tube is a short section of 0.15 mm ID fused silica tubing that extends from the sample inlet to 1 mm past the end of the nozzle. The ***manifold*** houses the APCI nozzle and includes the sheath gas and auxiliary gas plumbing. The ***APCI nozzle*** sprays the sample solution into a fine mist. The ***sheath gas and auxiliary gas plumbing*** deliver dry nitrogen gas to the nozzle. The droplets in the mist then enter the vaporizer. The ***vaporizer*** flash vaporizes the droplets at temperatures up to 800 °C.

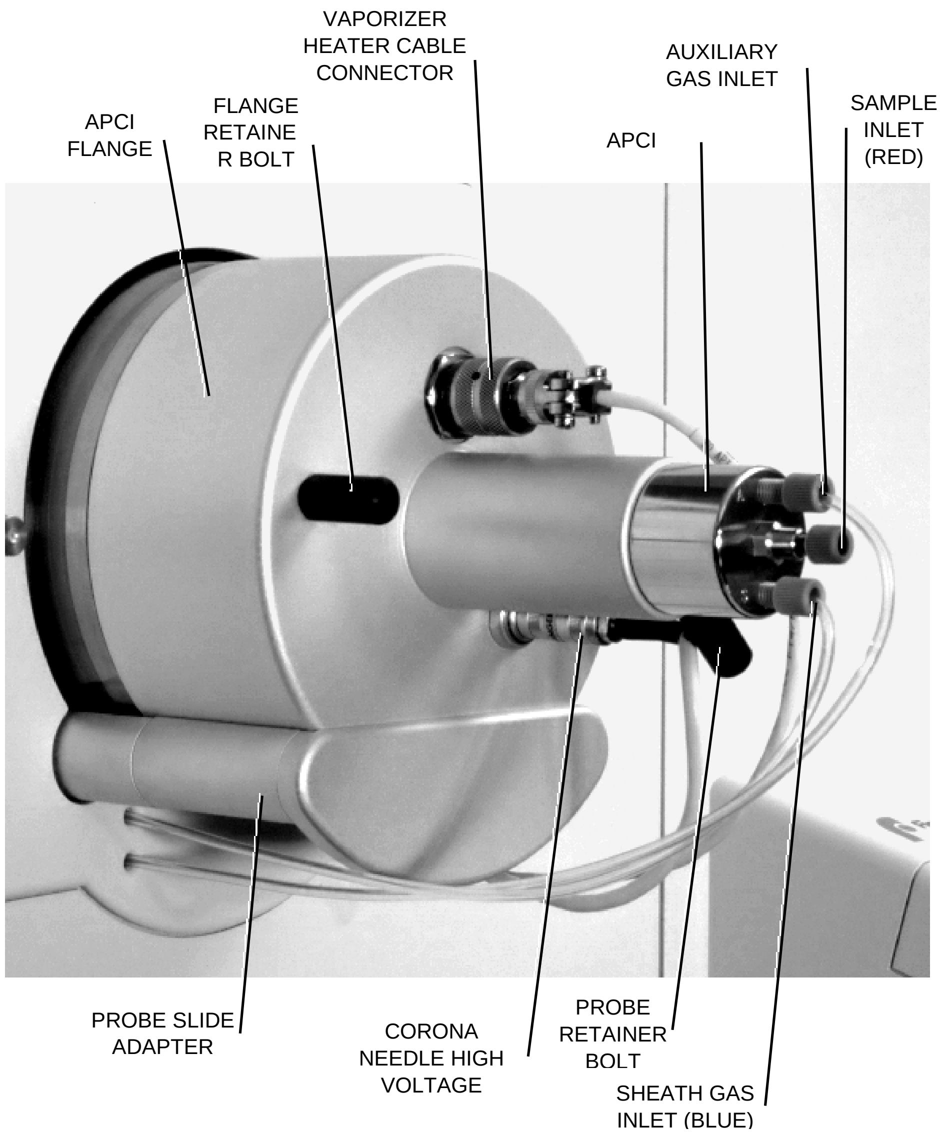

Figure 2-9. APCI probe assembly

Typical vaporizer temperatures are 350 to 400 °C for flow rates of 100 µL min^{-1}, 450 to 500 °C for 1 mL min^{-1} (normal APCI flow rate), and 550 to 600 °C for 2 mL min^{-1}. The sample vapor is swept toward the corona discharge needle by the flow of the sheath and auxiliary gasses.

The ***corona discharge needle assembly*** is mounted on the APCI flange. The assembly positions the tip of the corona discharge needle near the vaporizer. A high potential (typically ±3 to ±5 kV) is applied to the ***corona discharge needle*** to produce a ***corona discharge current*** of up to 10 µA. (A typical value of the corona discharge current is 5 µA.) The corona discharge from the needle produces a reagent ion plasma primarily from the solvent vapor.

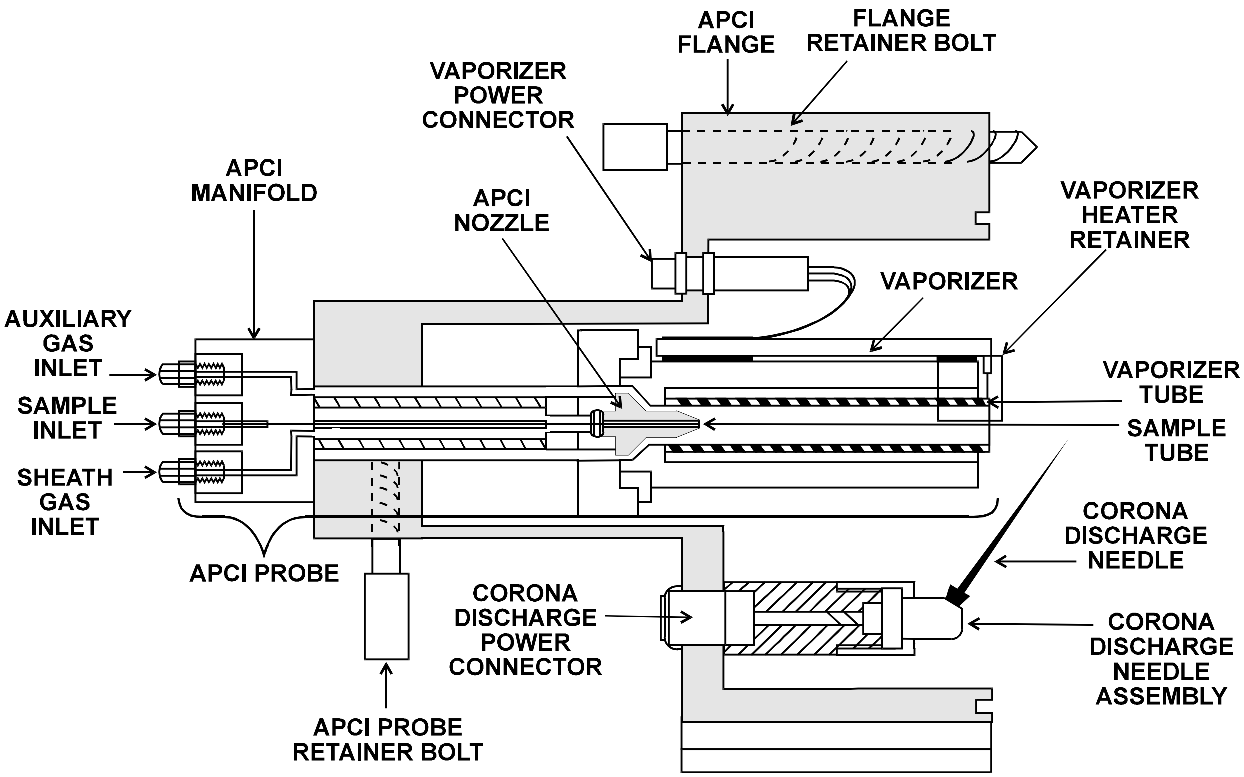

Figure 2-10. Cross sectional view of the APCI probe assembly

The sample vapor is ionized by ion-molecule reactions with the reagent ions in the plasma.

APCI requires a constant source of electrons for the ionization process. Thus, the corona discharge current is set and regulated. The potential applied to the corona discharge needle varies, as needed, to provide the required current.

2.5.2.2 API Stack

The ***API stack*** consists of the components of the API source that are held under vacuum (except for the atmospheric pressure side of the spray shield). The API stack includes the spray shield, heated capillary, tube lens, skimmer, heated capillary mount, and tube lens and skimmer mount. See Figure 2-11. The same API stack is used for both ESI and APCI ionization modes.

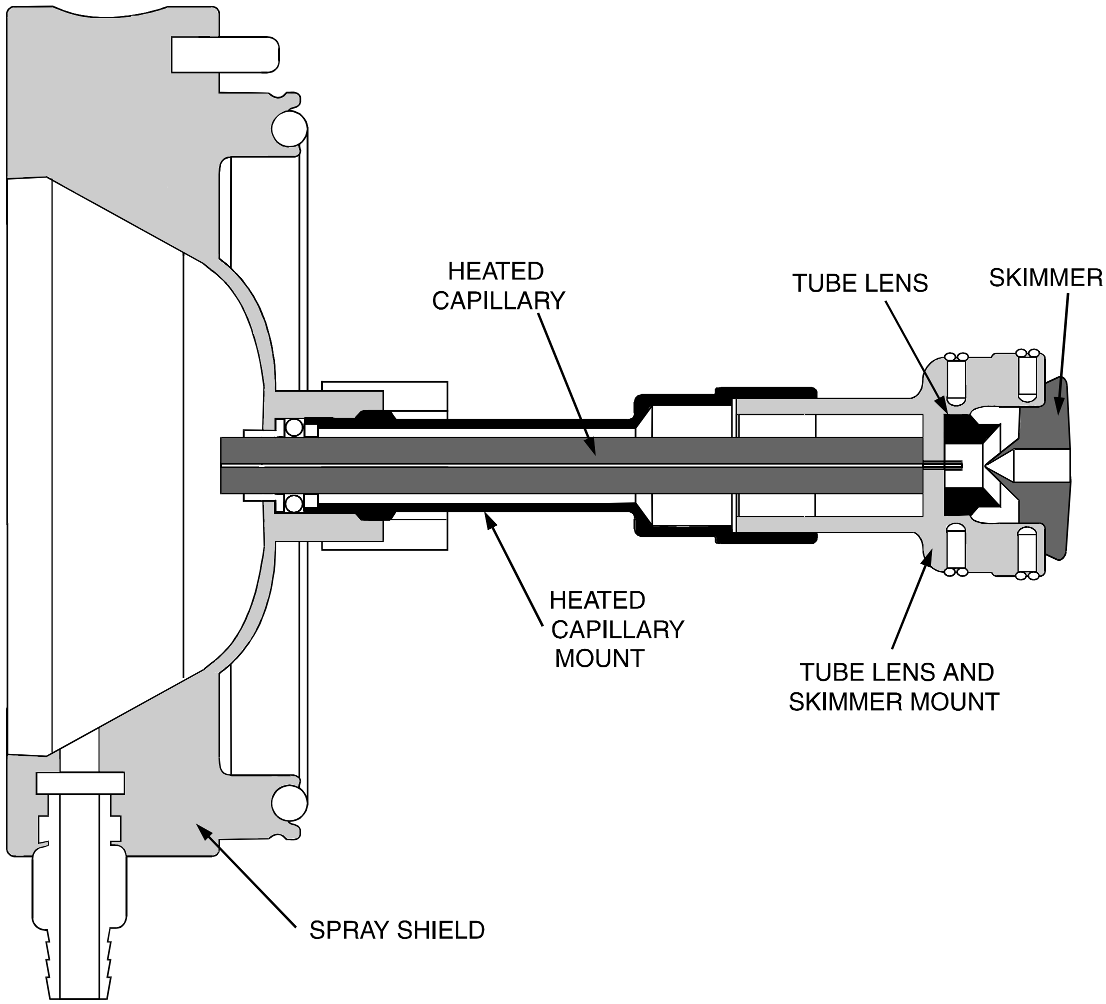

Figure 2-11. Cross sectional view of the API stack

The ***spray shield*** is a stainless steel, cylindrical vessel that, in combination with the ESI or APCI flange, forms the atmospheric pressure region of the API source (also called the spray chamber). The spray shield inserts into an opening in the vacuum manifold and serves as a base for the API stack. An opening in the bottom of the spray shield serves as a drain for waste liquid. Two flange retainer bolts on the ESI or APCI flange secure the flange to the atmospheric pressure side of the spray shield.

The ***heated capillary*** assists in desolvating ions that are produced by the ESI or APCI probe. The heated capillary is an elongated, cylindrical tube made of metal that has a hole bored through the center of its long axis. A heater embedded in the capillary surrounds the hole and heats the capillary to temperatures up to 300 °C. Typical temperatures of the heated capillary are 200 °C for ESI and 150 °C for APCI. The heated capillary passes through a hole in the center of the spray shield. Ions are drawn into the heated capillary in the atmospheric pressure region and transported to the capillary-skimmer region of the vacuum manifold by a decreasing pressure gradient. A potential of typically 0 to ±10 V (positive for positive ions and negative for negative ions) assists in repelling ions from the heated capillary to the skimmer.

Ions from the heated capillary enter the ***tube lens***. The tube lens (also called the tube gate) has a mass dependent potential applied to it to focus the ions towards the opening of the skimmer. An additional potential of between 0 and ±40 V (positive for positive ions and negative for negative ions), called the ***tube lens offset voltage***, can be applied to the tube lens to accelerate the ions into background gas that is present in the capillary-skimmer region. Collisions with the background gas aid in the desolvation of the ions and increases sensitivity. If the tube lens offset voltage is too high, however, collisions with the background gas can be energetic enough to cause the ions to fragment. This fragmentation, called ***ion source collision induced dissociation*** (CID), decreases sensitivity. When you tune the LCQ, you adjust the tube lens offset voltage to maximize sensitivity by balancing desolvation with fragmentation.

The tube lens also serves as a gate to stop the injection of ions into the mass analyzer. A potential of -200 V is used to deflect positive ions away from the opening in the skimmer, and a potential of +200 V is used to deflect negative ions away from the opening in the skimmer.

Ions from the tube lens pass through the skimmer and move toward the first octapole. The ***skimmer*** acts as a vacuum baffle between the higher pressure capillary-skimmer region (at 1 Torr) and the lower pressure first octapole region (at 10^{-3} Torr) of the vacuum manifold. The skimmer is at ground potential. The bore of the heated capillary is offset with respect to the opening in the skimmer to reduce the number of neutral molecules and large charged particles that pass through the skimmer and create detector noise.

The ***heated capillary mount*** screws into the spray shield on the capillary-skimmer region side. The ***tube lens and skimmer mount*** attaches to the heated capillary mount. The tube lens and skimmer mount contains spring-loaded machine screws that hold the tube lens and skimmer in place. The heated capillary abuts with the tube lens and skimmer mount, thus ensuring that the exit end of the heated capillary is at the proper distance from the opening in the skimmer.

2.5.3 Ion Optics

Ions enter the ion optics after passing through the skimmer. The ***ion optics*** transmit ions from the API source to the mass analyzer. The ion optics consist of two octapoles and an interoctapole lens. See Figure 2-12 and Figure 2-17. Each ***octapole*** is an octagonal array of cylindrical rods that acts as an ion transmission device. An RF voltage (2.45 MHz, 400 V peak to peak) and dc offset voltage (typically -10 to +10 V) that are applied to the rods give rise to an electric field that guides the ions along the axis of the octapole. During ion transmission, the offset voltage is negative for positive ions and positive for negative ions. The octapole RF voltage is turned off during mass analysis.

The two octapoles are separated by the interoctapole lens. The ***interoctapole lens*** assists in the focusing and gating of ions. The interoctapole lens also serves as a baffle between the first octapole region and the analyzer region of the vacuum manifold. The LCQ tune procedure optimizes the potentials that are applied to the octapoles and interoctapole lens to maximize the ion current to the mass analyzer. During ion transmission, a potential of typically between -10 and +10 V is applied to the interoctapole lens. The potential is negative for positive ions and positive for negative ions. During gating, the potential is +300 V for positive ions and -300 V for negative ions.

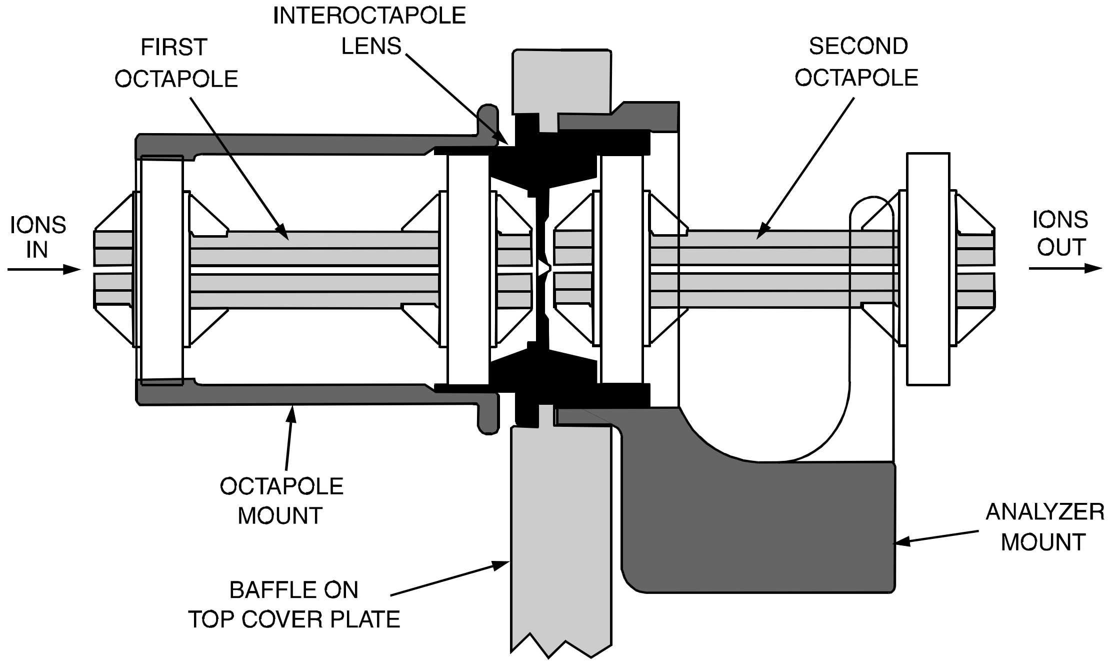

Figure 2-12. Cross sectional view of the ion optics

2.5.4 Mass Analyzer

The quadrupole ion trap ***mass analyzer*** is the site of mass analysis (that is, ion storage, ion isolation, collision induced dissociation, and ion scan out). This section describes the components of the mass analyzer, the voltages applied to the mass analyzer electrodes, the presence of helium damping gas in the mass analyzer cavity, and the operation of the mass analyzer during mass analysis.

2.5.4.1 Components of the Mass Analyzer

The mass analyzer is mounted on the analyzer mount opposite the second octapole. The mass analyzer is shown in cross section in Figure 2-13 and in a photograph in Figure 2-17.

The mass analyzer includes three stainless steel electrodes: the entrance endcap electrode; the exit endcap electrode; and the ring electrode. The inner surfaces of electrodes are hyperbolic. Together, they form a cavity in which mass analysis occurs.

The ***entrance endcap electrode*** is the electrode that is closest to the ion optics, and the ***exit endcap electrode*** is the electrode that is closest to the ion detection system. Both endcap electrodes have a small hole in their centers to permit the passage of ions into and out of the mass analyzer cavity. The ***ring electrode*** is located between the endcap electrodes. Ions produced in the API source enter the mass analyzer cavity through the entrance endcap electrode. Ions can be ejected through either endcap electrode during mass analysis. Ions that are ejected through the exit endcap electrode are focused by the conversion dynode accelerating potential through the ***exit lens*** (at ground potential) towards the ion detection system. Helium damping gas enters the mass analyzer cavity through a nipple on the exit endcap electrode.

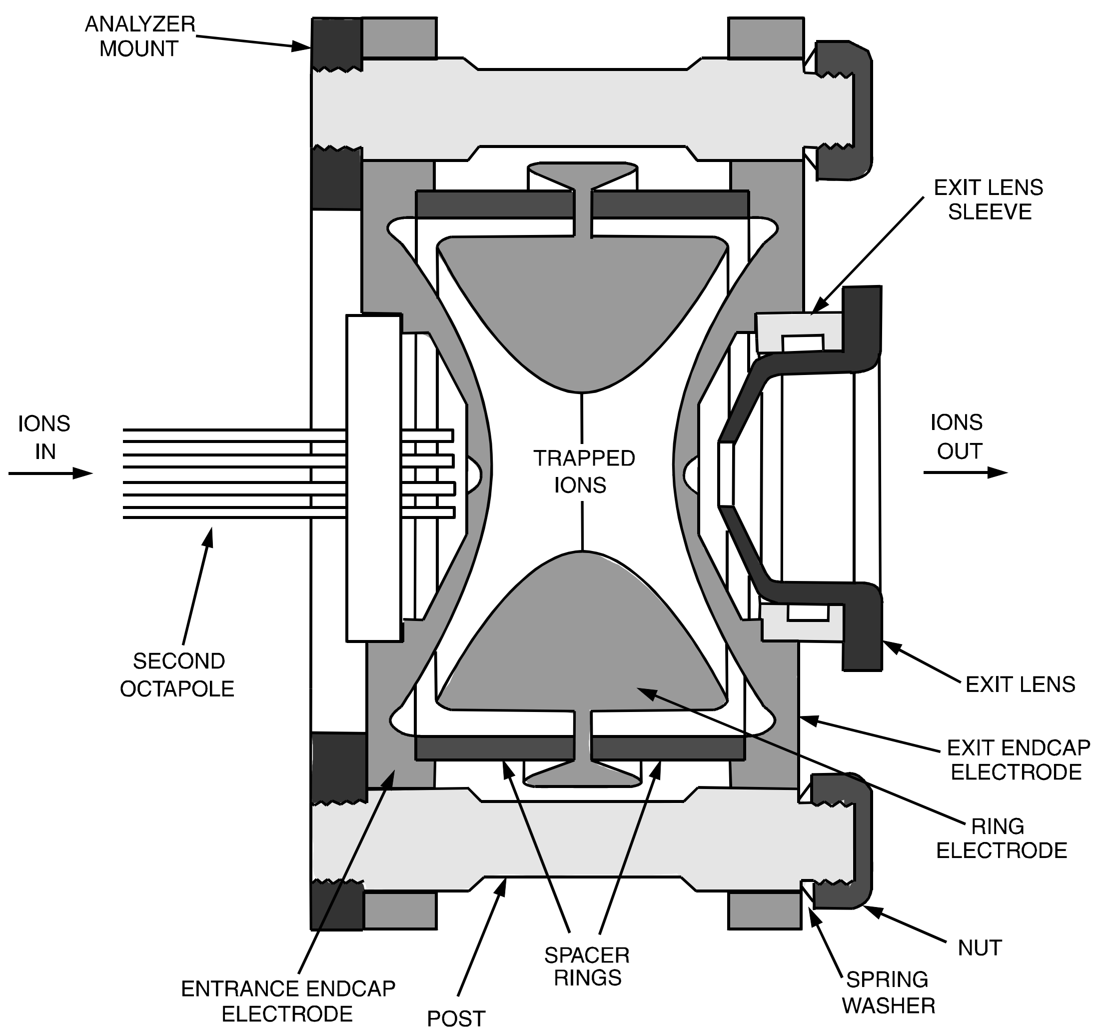

Figure 2-13. Cross sectional view of the mass analyzer

The entrance endcap electrode, exit endcap electrode, and ring electrode are separated by two quartz spacer rings. The ***spacer rings*** position the electrodes at the proper distance apart and also serve as electrical insulators. Two nonconducting ***posts*** pass through both endcap electrodes and screw into the analyzer mount (also nonconducting). A ***spring washer*** and ***nut*** on the end of each post apply a force to the exit endcap electrode that holds the electrodes and spacers in place.

A dc offset voltage, called the ***mass analyzer dc offset voltage***, is applied to the mass analyzer electrodes to draw in ions from the ion optics. The magnitude of the mass analyzer dc offset voltage is -10 V for positive ion polarity mode and +10 V for negative ion polarity mode.

Various ac voltages are applied to the ring and endcap electrodes to trap, fragment, and eject ions according to their mass-to-charge ratios. These ac voltages, referred to as the ring electrode RF voltage, waveform voltage, resonance excitation RF voltage, and resonance ejection RF voltage, are discussed below.

2.5.4.2 Ring Electrode RF Voltage

An ac voltage of constant frequency (0.76 MHz) and variable amplitude (0 to 8500 V zero-to-peak) is applied to the ring electrode by a spring-loaded pin that contacts the ring electrode when the mass analyzer is in place. The frequency of the ac voltage is in the radio-frequency (RF) range, and this voltage is referred to as the ***ring electrode RF voltage***.

The application of an RF voltage to the ring electrode produces a three-dimensional quadrupole field within the mass analyzer cavity. This time-varying field drives ionic motion in both the axial (toward the endcaps) and radial (from the ring electrode toward the center) directions. Ionic motion must be stable in both the axial and radial directions for an ion to remain trapped. (A stable trajectory is an oscillatory trajectory that is confined within the mass analyzer.) During ion scan out, the system produces a mass-dependent instability to eject ions from the mass analyzer in the axial direction.

When the amplitude of the ring electrode RF voltage is low, all ions above a minimum mass-to-charge ratio are trapped. This RF voltage is referred to as the ***storage voltage***, and the minimum mass-to-charge ratio is usually chosen to be greater than the mass-to-charge ratios associated with air, water, and solvent ions. During ion scan out, the ring electrode RF voltage is ramped at a constant rate corresponding to approximately 5,500 u s^{-1}. As the ring electrode RF voltage increases, ions of increasing mass-to-charge ratio become successively unstable in the axial direction and are ejected from the mass analyzer. The voltage at which an ion is ejected from the mass analyzer is defined as its ***resonance voltage***. The ejection of ions of each mass-to-charge ratio occurs over a very short time. Many of these ions are detected by the ion detection system.

2.5.4.3 Ion Injection Waveform Voltage, Ion Isolation Waveform Voltage, Resonance Excitation RF Voltage, and Resonance Ejection RF Voltage Applied to the Endcap Electrodes

The ion injection waveform voltage, ion isolation waveform voltage, resonance excitation RF voltage, and resonance ejection RF voltage are ac voltages that are applied to the endcap electrodes to stimulate motion of the ions in the axial direction. The voltages applied to the endcap electrodes are equal in amplitude but are 180° out of phase to one another. When the RF frequency applied to the endcaps equals the resonance frequency of a trapped ion, which depends on its mass, the ion gains kinetic energy. If the magnitude of the applied voltage is large enough, the ion is ejected from the mass analyzer in the axial direction.

The ***waveform voltages*** consist of a distribution of frequencies between 10 and 380 kHz containing all resonance frequencies except for those corresponding to the ions to be trapped. There are two types of waveform voltages: the ion injection waveform voltage and the ion isolation waveform voltage.

The ***ion injection waveform voltage*** acts during the ion injection step to eject unwanted ions from the mass analyzer and allow the concentration of target ions. The ion injection waveform voltage is used for the detection of small target analyte mass peaks that otherwise would be obscured by an intense mass peak from another component. The ion injection waveform voltage can be used for all scan modes. By default, the ion injection waveform voltage is turned off. You can turn on the ion injection waveform voltage in the Injection Control dialog box in Tune Plus.

The ***ion isolation waveform voltage*** acts during the ion isolation step of SIM, SRM, CRM, and MS^n full scan (with $n > 1$) applications. The ion isolation waveform voltage, in combination with the ring electrode RF voltage, ejects all ions except those of a selected mass-to-charge ratio or narrow ranges of mass-to-charge ratios. The ion isolation waveform voltage is calculated by the LCQ and automatically applied at the correct time.

During the collision induced dissociation step of SRM, CRM, and MS^n full scan (with $n > 1$) applications, the ***resonance excitation RF voltage*** is applied to the endcap electrodes to fragment parent ions into product ions. The resonance excitation RF voltage is not strong enough to eject an ion from the mass analyzer. However, ion motion in the axial direction is enhanced and the ion gains kinetic energy. After many collisions with the helium damping gas, which is present in the mass analyzer, the ion gains enough internal energy to cause it to dissociate into product ions. The product ions are then mass analyzed.

During ion scan out, the ***resonance ejection RF voltage*** facilitates the ejection of ions from the mass analyzer and thus improves mass resolution. The resonance ejection RF voltage is applied at fixed frequency and increasing amplitude during the ramp of the ring electrode RF voltage. Only when an ion is about to be ejected from the mass analyzer cavity by the ring electrode RF voltage is it in resonance with the resonance ejection RF voltage. When an ion comes into resonance, it moves farther away from the center of the mass analyzer, where the field generated by the ring electrode RF voltage is zero (and space-charge effects are strong), into a region where the field produced by the ring electrode RF voltage is strong (and space-charge effects are small). As a result, the ejection of the ion is facilitated, and mass resolution is significantly improved.

2.5.4.4 Helium Damping Gas in the Mass Analyzer Cavity

The mass analyzer cavity contains helium that is used as a damping gas and a collision activation partner. The helium damping gas enters the mass analyzer cavity through a nipple on the exit endcap electrode. The flow of gas (1 mL min^{-1}) into the mass analyzer cavity is regulated by a pressure regulator and a capillary restrictor. The flow of gas out of the mass analyzer cavity (and into the turbomolecular pump) is restricted by the holes in the endcap electrodes. The flows into and out of the cavity are matched so that the partial pressure of helium in the mass analyzer cavity is maintained at approximately 0.1 Pa (10^{-3} Torr).

The collisions of the ions entering the mass analyzer with the helium slow the ions so that they can be trapped by the RF field in the mass analyzer.

The presence of helium in the mass analyzer cavity significantly enhances sensitivity and mass spectral resolution. Before their ejection from the mass analyzer cavity, sample ions collide with helium atoms. These collisions reduce the kinetic energy of the ions, thereby damping the amplitude of their oscillations. As a result, the ions are focused into the center of the cavity rather than being allowed to spread throughout the cavity.

Helium in the mass analyzer cavity also serves as a collision activation partner. During the collision induced dissociation step of an SRM, CRM, or MS^n full scan (with $n > 1$) analysis, the resonance excitation RF voltage applied to the endcap electrodes drives parent ions into the helium atoms. After gaining sufficient internal energy from the resulting collisions, the parent ion dissociates into one or more product ions.

2.5.4.5 Summary of Mass Analyzer Operation

The processes that occur in the mass analyzer can be broken down into four steps:

- Ion storage
- Ion isolation [SIM, SRM, CRM, and MS^n full scan (with $n > 1$) only]
- Collision induced dissociation [SRM, CRM, and MS^n full scan (with $n > 1$) only]
- Ion scan out (the ion detection step)

For SRM, CRM, and MS^n full scan (with $n > 1$) applications the ion isolation and collision induced dissociation steps are performed *n*-1 times, where *n* is the scan power.

Before ion storage, the following conditions are established:

- Helium is present in the mass analyzer cavity at a partial pressure of about 0.1 Pa (10^{-3} Torr).
- Ring electrode RF voltage is set to the storage voltage.
- Ion injection waveform voltage on the endcap electrodes is on, if you have selected it.
- Ion isolation waveform voltage, resonance excitation RF voltage, and resonance ejection RF voltage on the endcap electrodes are off.

With these conditions achieved, sample ions formed in the API source are trapped in the mass analyzer if the following conditions are met:

- The ions have mass-to-charge ratios greater than the minimum storage mass-to-charge ratio.
- The ions are not ejected by the ion injection waveform voltage.

After an optimum number of ions have been trapped, the ion injection waveform voltage is turned off. The ring electrode RF storage voltage remains on.

Next, for SIM, SRM, CRM, and MS^n full scan (with $n > 1$) analyses, the ion isolation waveform voltage is applied to the endcap electrodes, in combination with a ramp of the ring electrode RF voltage to a new storage voltage, to eject all ions except those of the selected mass-to-charge ratio.

Then, for SRM, CRM, and MS^n full scan (with $n > 1$) analyses, the resonance excitation RF voltage is applied to the endcap electrodes to cause collision induced dissociation. Product ions with mass-to-charge ratio greater than the minimum storage mass-to-charge ratio are stored. (The minimum storage mass during collision induced dissociation is typically set to one quarter of the parent ion mass-to-charge ratio.)

For SRM, CRM, and MS^n full scan (with $n > 1$) applications the ion isolation and collision induced dissociation steps are performed *n*-1 times, where *n* is the scan power.

Finally, the sample ions or product ions are scanned out: The ring electrode RF voltage is ramped from low voltage to high voltage, and simultaneously the resonance ejection RF voltage is applied to the endcap electrodes to facilitate ejection. As the ring electrode RF voltage is increased, ions of greater and greater mass-to-charge ratios become unstable and are ejected from the mass analyzer. Many of these ions are focused toward the ion detection system where they are detected.

2.5.5 Ion Detection System

The LCQ is equipped with a high sensitivity, off-axis ***ion detection system*** that produces a high signal-to-noise ratio and allows for voltage polarity switching between positive ion and negative ion modes of operation. The ion detection system includes a 15-kV conversion dynode and a channel electron multiplier. The ion detection system is located at the rear of the vacuum manifold behind the mass analyzer. See Figure 2-14 (cross sectional view), Figure 2-16 (conversion dynode), and Figure 2-17 (electron multiplier).

The ***conversion dynode*** is a concave metal surface that is located at a right angle to the ion beam. A potential of +15 kV for negative ion detection or -15 kV for positive ion detection is applied to the conversion dynode. When an ion strikes the surface of the conversion dynode, one or more secondary particles are produced. These secondary particles can include positive ions, negative ions, electrons, and neutrals. When positive ions strike a negatively charged conversion dynode, the secondary particles of interest are negative ions and electrons. When negative ions strike a positively charged conversion dynode, the secondary particles of interest are positive ions. These secondary particles are focused by the curved surface of the conversion dynode and are accelerated by a voltage gradient into the electron multiplier. The ***conversion dynode shield***, ***tube***, and ***disk*** shield the vacuum manifold from the electric field produced by the conversion dynode.

The electron multiplier is mounted on the top cover plate of the vacuum manifold next to the mass analyzer. See Figure 2-14 and Figure 2-17. The ***electron multiplier*** includes a cathode and an anode. The ***cathode*** of the electron multiplier is a lead-oxide, funnel-like resistor. A potential of up to -2.5 kV is applied to the cathode by the ***high voltage ring***. The exit end of the cathode (at the anode) is near ground potential. The cathode is held in place by the high voltage ring, two ***support plates***, the ***electron multiplier support***, and the ***electron multiplier shield***. A spring washer applies a force to the cathode to hold it in contact with the electron multiplier shield. The electron multiplier support is attached to the top cover plate of the vacuum manifold by two screws.

The ***anode*** of the electron multiplier is a small cup located at the exit end of the cathode. The anode collects the electrons produced by the cathode. The anode screws into the anode feedthrough in the top cover plate.

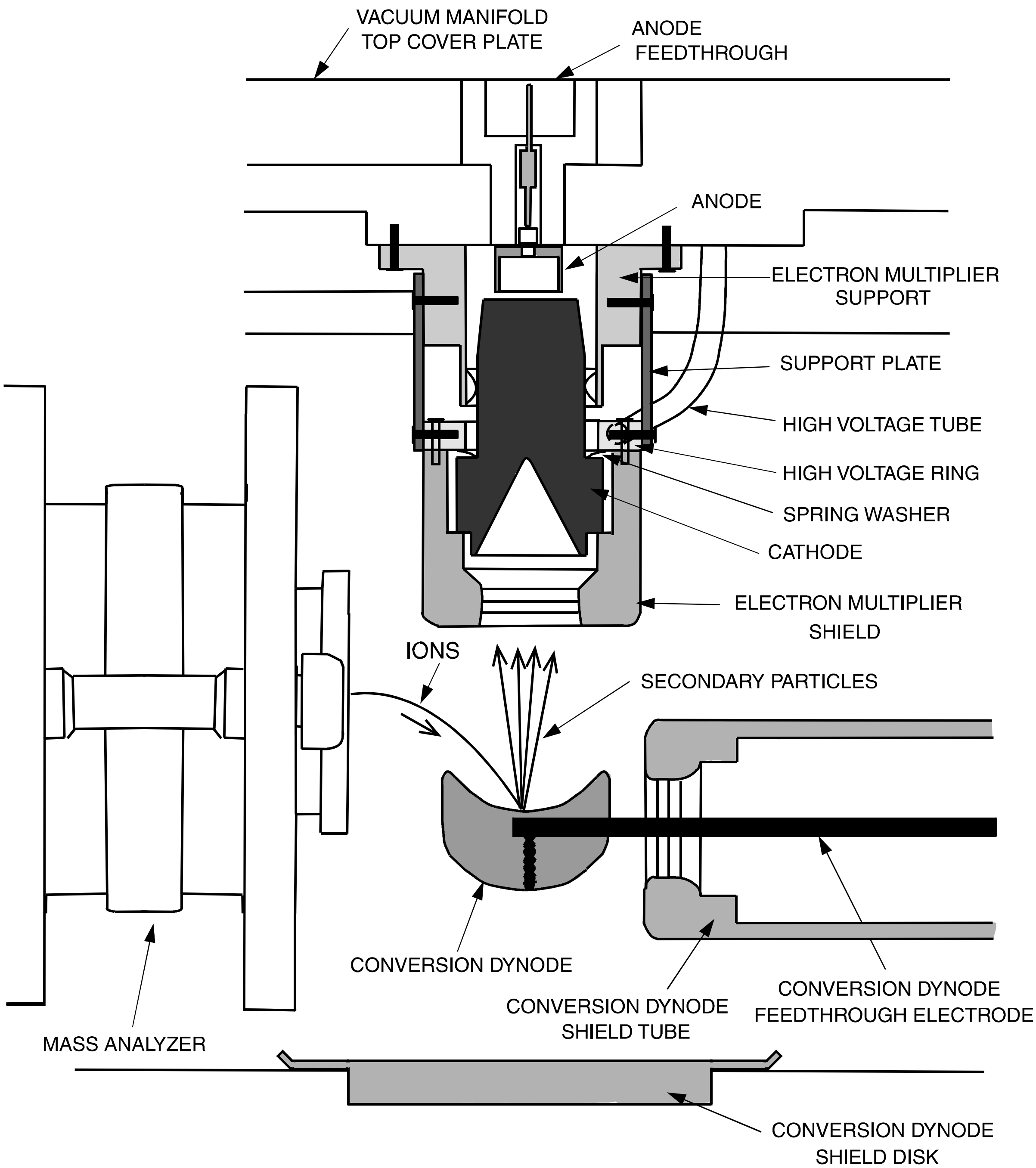

Figure 2-14. Cross sectional view of the ion detection system, showing the electron multiplier and the conversion dynode

Secondary particles from the conversion dynode strike the inner walls of the electron multiplier cathode with sufficient energy to eject electrons. The ejected electrons are accelerated farther into the cathode, drawn by the increasingly positive potential gradient. Due to the funnel shape of the cathode, the ejected electrons do not travel far before they again strike the inner surface of the cathode, thereby causing the emission of more electrons. Thus, a cascade of electrons is created that finally results in a measurable current at the end of the cathode where the electrons are collected by the anode. The current collected by the anode is proportional to the number of secondary particles striking the cathode. Typically, the electron multiplier is set to a gain of about 3×10^5 (i.e., for each ion or electron that enters, 3×10^5 electrons exit). The current that leaves the electron multiplier via the anode is converted to a voltage by the electrometer circuit and recorded by the data system. Refer to the topic **Ion Detection System Electronic Assemblies** on page 2-53.

The ion detection system of the LCQ increases signal and decreases noise. The high voltage applied to the conversion dynode results in a high conversion efficiency and increased signal. That is, for each ion striking the conversion dynode, many secondary particles are produced. The increase in conversion efficiency is more pronounced for more massive ions than for less massive ions.

Because of the off-axis orientation of the ion detection system relative to the mass analyzer, neutral molecules from the mass analyzer tend not to strike the conversion dynode or electron multiplier. As a result, the noise from neutral molecules is reduced.

2.5.6 Vacuum System and Inlet Gasses Hardware

The ***vacuum system*** evacuates the region around the API stack, ion optics, mass analyzer, and ion detection system. The principal components of the vacuum system include the following:

- Vacuum manifold
- Turbomolecular pump
- Rotary-vane pump
- Convectron™ gauge
- Ion gauge

The ***inlet gasses hardware*** controls the flow of damping gas, sheath gas, auxiliary gas, and air (during venting) into the MS detector. The inlet gasses hardware includes the following components:

- Vent gas valve
- Damping gas inlet assembly
- Sheath gas valve
- Auxiliary gas valve

A functional block diagram of the vacuum system and inlet gasses hardware is shown in Figure 2-15.

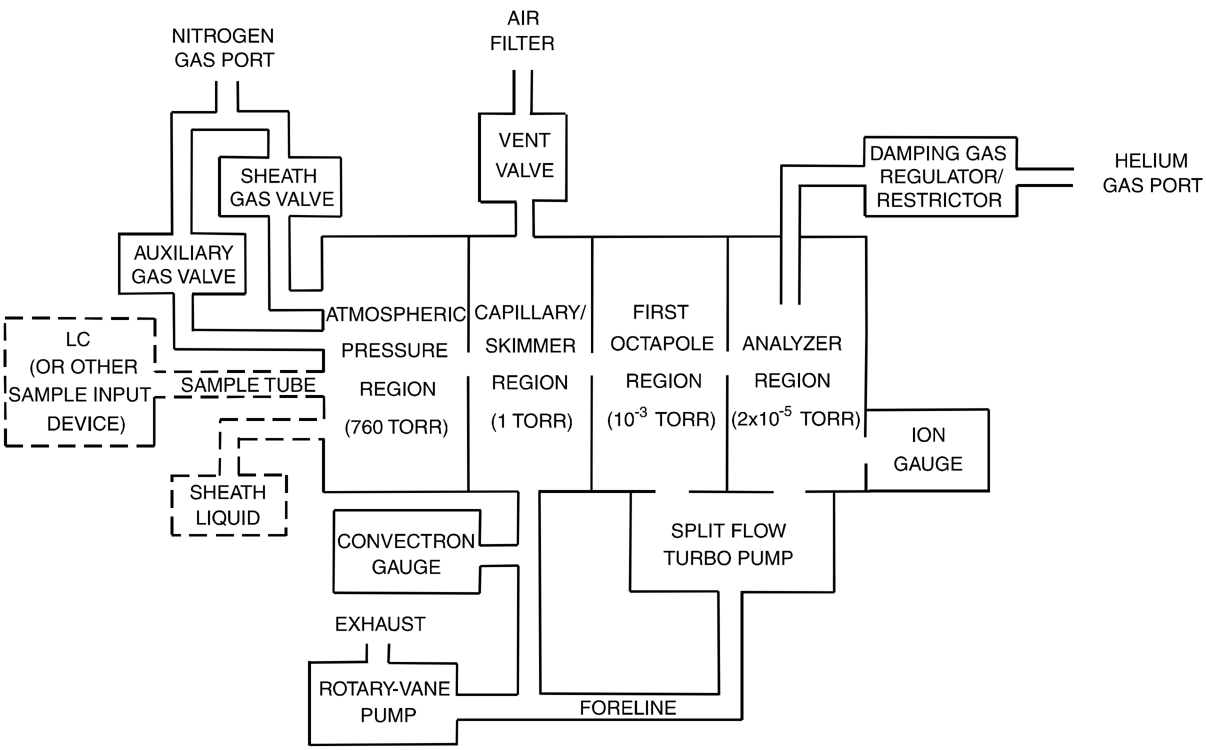

Figure 2-15. Functional block diagram of the vacuum system and inlet gasses hardware

2.5.6.1 Vacuum Manifold

The ***vacuum manifold*** encloses the API stack, ion optics, mass analyzer, and ion detection system assemblies. The vacuum manifold is a thick-walled, aluminum chamber with a removable top cover plate, machined flanges on the front, sides, and bottom, and various electrical feedthroughs and gas inlets.

The vacuum manifold is divided into three chambers by two baffles. See Figure 2-16. The region inside the first chamber, called the ***capillary-skimmer region***, is evacuated to 1 Torr by the rotary-vane pump. The region inside the second chamber, called the ***first octapole region***, is evacuated to 10^{-3} Torr by the interstage port of the split-flow turbomolecular vacuum pump. The region inside the third chamber, called the ***analyzer region***, is evacuated to 2×10^{-5} Torr by the high vacuum port of the split-flow turbomolecular pump. The turbomolecular pump in turn discharges into the rotary-vane pump through the foreline.

Two high-voltage electrical feedthroughs pass through the vacuum manifold:

- A feedthrough for the high voltage for the conversion dynode passes through the rear wall
- A feedthrough for the ring electrode RF voltage of the mass analyzer passes through the bottom

An inlet for the introduction of air into the vacuum manifold (for venting the manifold) passes through the front wall of the vacuum manifold. The vacuum manifold also has an opening for the ion gauge.

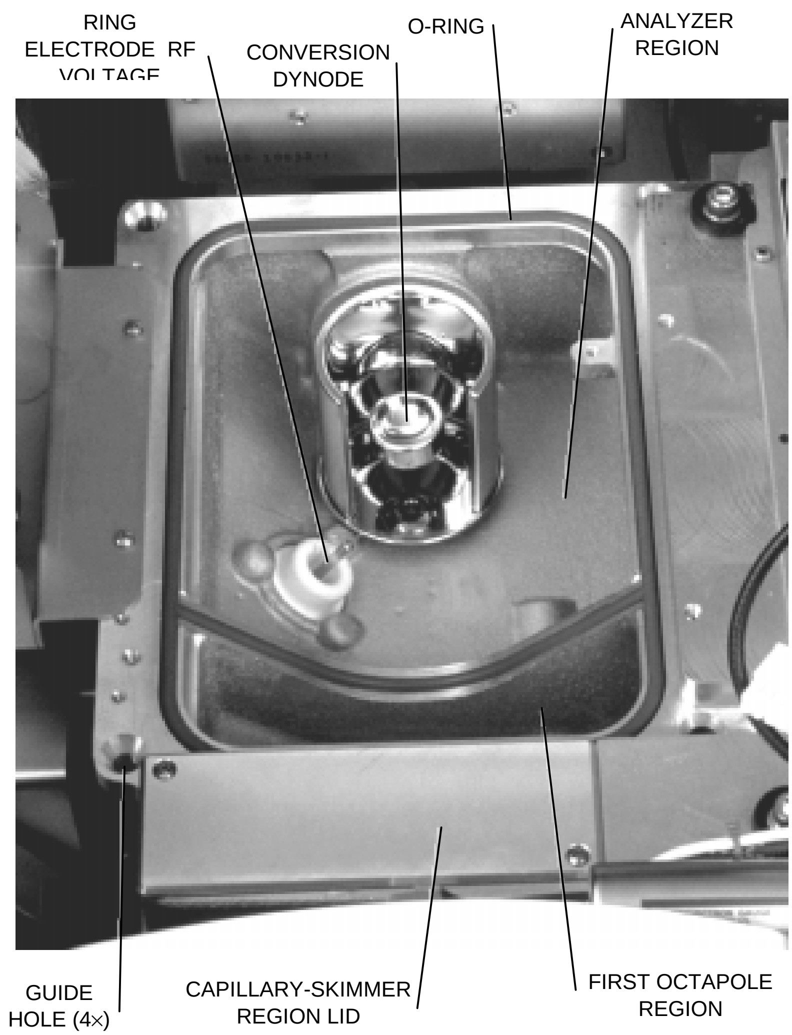

Figure 2-16. Vacuum manifold (interior)

The removable ***top cover plate*** of the vacuum manifold holds the ion optics, mass analyzer, and electron multiplier (one part of the ion detection system). Thus, removal of the top cover plate allows easy access to these assemblies. Two handles on the top and four guide posts on the underside of the top cover plate facilitate its removal and installation. An electrically conductive O-ring provides a vacuum-tight seal between the top cover plate and the vacuum manifold. The top cover plate and its attached assemblies are shown in Figure 2-17.

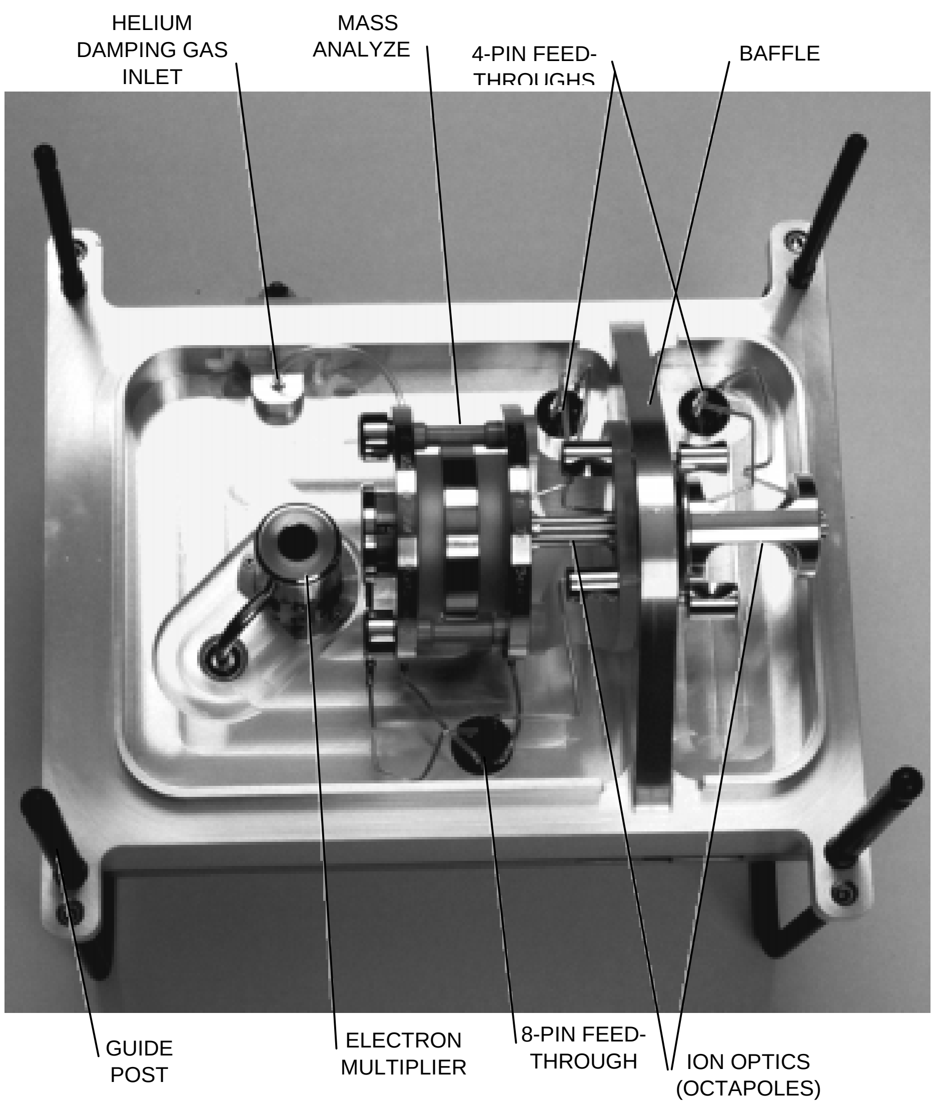

Figure 2-17. Top cover plate of the vacuum manifold (underside) and attached assemblies

Five electrical feedthroughs pass through the top cover plate:

- A 4-pin feedthrough for the first octapole leads
- A 4-pin feedthrough for the second octapole leads
- An 8-pin feedthrough for the leads to the endcap electrodes and exit lens of the mass analyzer, and the interoctapole lens.
- A feedthrough for the high voltage for the cathode of the electron multiplier
- A feedthrough for the ion current signal from the anode of the electron multiplier

An inlet for the introduction of helium damping gas into the mass analyzer passes through the top cover plate.

2.5.6.2 Turbomolecular Pump

A Balzers-Pfeiffer TMH 260-130 split-flow ***turbomolecular pump*** provides the vacuum for the first octapole and analyzer regions of the vacuum manifold. The turbomolecular pump mounts onto the underside of the vacuum manifold with four 5/16-in. socket screws. The interstage port of the turbomolecular pump, which evacuates the first octapole region, is rated at 125 L s^{-1}. The high vacuum port of the turbomolecular pump, which evacuates the analyzer region, is rated at 200 L s^{-1}. Under normal operating conditions the pump provides a vacuum of approximately 0.1 Pa (10^{-3} Torr) in the first octapole region, and 2×10^{-3} Pa (2×10^{-5} Torr) in the analyzer region.

Power to and regulation of the turbomolecular pump is provided by the Turbomolecular Pump Controller. Power for the turbomolecular pump is turned off and on by the main power circuit breaker switch and not by the electronics service switch. The pump is air cooled by a fan that draws air in from the rear of the instrument.

Power to the turbomolecular pump is shut off if the foreline pressure, as measured by the Convectron gauge, is too high, or if the turbomolecular pump overheats. Vacuum protection is discussed further in the topic **Vacuum System Electronic Assemblies** on page 2-47.

2.5.6.3 Rotary-Vane Pump

A Balzers UNO 030B ***rotary-vane pump*** (or roughing pump) establishes the vacuum necessary for the proper operation of the turbomolecular pump. The rotary-vane pump also evacuates the capillary-skimmer region of the vacuum manifold. The pump has a maximum displacement of 30 $m^3 h^{-1}$ and maintains a minimum pressure of approximately 100 Pa (1 Torr).

The rotary-vane pump is connected to the turbomolecular pump by a section of 1-in. ID reinforced PVC tubing. The power cord of the rotary-vane pump is plugged into the outlet labeled *Rough Pump* on the power panel (See Figure 2-6 on page 2-10). This outlet supplies power to the pump and is controlled by the main power circuit breaker switch and not by the electronics service switch.

> **Caution.** Always plug the rotary-vane pump power cord into the outlet labeled *Rough Pump* on the right side of the MS detector. Never plug it into a wall outlet.

2.5.6.4 Convectron Gauge

The ***Convectron gauge*** measures the pressure in the capillary-skimmer region of the vacuum manifold and the foreline, which connects the turbomolecular pump and the rotary-vane pump. The pressure measured by the Convectron gauge is monitored by the System Control PCB. The System Control PCB detects whether the foreline pressure is too high for the proper operation of the turbomolecular pump. Power to the turbomolecular pump is removed if the foreline pressure is too high.

2.5.6.5 Ion Gauge

The pressure in the analyzer region of the vacuum manifold is measured by a Granville-Phillips® 342™ mini ion gauge. The ***ion gauge*** produces energetic electrons that cause the ionization of molecules in the ion gauge. Positive ions formed in the ion gauge are attracted to a collector. The collector current is related to the pressure in the vacuum manifold. The ion gauge is also involved in vacuum protection.

2.5.6.6 Vent Valve

The ***vent valve*** allows the vacuum manifold to be vented to air that has been filtered through a sintered nylon filter. The vent valve is a solenoid-operated valve. The vent valve is controlled by the Vent Delay PCB. The vent valve is closed when the solenoid is energized.

The vacuum manifold is vented when power is removed from the MS detector. (Power is removed from the MS detector by a power failure or by placing the main power circuit breaker in the Off (O) position.) A battery backup on the Vent Delay PCB provides power to the vent valve for 30 s after the power is removed. If external power is not restored to the MS detector in 30 s, a circuit on the Vent Delay PCB times out, and power to the vent valve solenoid is shut off. When power to the vent valve solenoid is shut off, the vent valve opens and the manifold is vented to filtered air. The vent valve closes after power is restored to the MS detector. The battery backup is recharged automatically after power is restored.

2.5.6.7 Damping Gas Inlet Assembly

The ***damping gas inlet assembly*** controls the flow of helium into the mass analyzer cavity. Helium (40 ±10 psig [275 ±70 kPa], 99.999% [ultra-high] purity) enters the MS detector through a 1/8-in. port labeled *Helium In* on the left side of the MS detector. See Figure 2-23 on page 2-57. LCQ regulates the flow of helium by use of a capillary restrictor and a pressure regulator on the helium line. The helium enters the mass analyzer through a nipple on the exit endcap electrode.

Helium in the mass analyzer cavity dampens ionic motion and improves the performance of the MS detector. Refer to the topic **Helium Damping Gas in the Mass Analyzer Cavity** on page 2-24.

Note. Helium damping gas continues to flow to the mass analyzer even after the LCQ is powered off or placed in Standby. To save helium when the LCQ is not operational, turn off the helium flow at the tank.

2.5.6.8 Sheath Gas Valve

The ***sheath gas valve*** controls the flow of sheath gas (nitrogen) into the API source. Dry nitrogen (100 ±20 psig [690 ±140 kPa], 99% purity) enters the MS detector through a 1/4-in. port labeled *Nitrogen In* on the left side of the MS detector. See Figure 2-23 on page 2-57. The sheath gas pressure is regulated by a valve that is controlled by the data system. You can set the sheath gas flow rate (20 to 100 in arbitrary units) in the ESI Source and APCI Source dialog boxes from the Tune Plus window. The sheath gas enters the API source through 1/8-in. ID tubing.

In the event that sheath gas flow is lower than required for operation, LCQ displays a message and changes system status to Standby.

2.5.6.9 Auxiliary Gas Valve

The ***auxiliary gas valve*** controls the flow of auxiliary gas (nitrogen) into the API source. Dry nitrogen (100 ±20 psig [690 ±140 kPa], 99% purity) enters the MS detector through a 1/4-in. port labeled *Nitrogen In* on the left side of the MS detector. The auxiliary gas pressure is regulated by a flow valve that is controlled by the data system. You can set the auxiliary gas flow rate (0 to 60 in arbitrary units) in the ESI Source and APCI Source dialog boxes. The auxiliary gas enters the API source through 1/8-in. ID tubing.

2.5.7 Cooling Fans

Five 100 ft^3 min^{-1} fans provide cooling for the MS detector. One fan cools the RF voltage coil. Two fans cool the electronics in the tower. One fan cools the electronics in the embedded computer. One fan cools the turbomolecular pump. The exhaust air is expelled from the vent slots on the sides of the MS detector.

+24 V dc power to the RF coil fan, the embedded computer fan, and the tower fans is provided by the +5 V, ±15 V, +24 V dc switching power supply. +24 V dc power to the turbomolecular pump fan is provided by the +24 V keep alive power supply in the Power Module.

Caution. To ensure proper cooling, the MS detector must always be operated with its covers in place.

2.5.8 Electronic Assemblies

The electronic assemblies that control the operation of the MS detector are distributed among various printed circuit boards (PCBs) and other modules located in the tower, embedded computer, and on or around the vacuum manifold of the MS detector.

The electronic assemblies of the MS detector include the following:

- Power Module and power distribution assemblies
- System Control PCB
- Vacuum system electronic assemblies
- RF/waveform voltage generation electronic assemblies
- Ion detection system electronic assemblies
- Embedded computer electronic assemblies

Functional block diagrams of the electronic assemblies and their interconnection with the various components of the MS detector are shown in Figure 2-18 through Figure 2-22.

2.5.8.1 Power Module and Power Distribution

The ***Power Module*** provides power to the vacuum system and converts the line power to voltages needed by the MS detector. The Power Module includes the following components:

- Main power circuit breaker
- Line filter
- +24 V keep alive power supply
- Electronics service switch
- Line voltage switch
- Transformer

A functional block diagram of the Power Module and MS detector power distribution is shown in Figure 2-18.

Line power of 230 V ac ± 10%, 16 A, 50/60 Hz, single phase enters the power panel on the right side panel of the MS detector, passes through the main power circuit breaker, and then to a line filter and an outlet for the rotary-vane pump (see Figure 2-6).

The ***main power circuit breaker switch***, located on the right side panel of the MS detector (see Figure 2-6), shuts off all power to the MS detector, including the vacuum system.

The ***line filter*** removes noise from the line power.

After the line filter, power goes in three directions: to the +24 V keep alive power supply; to the Turbomolecular Pump Controller; and to the electronics service switch.

The ***+24 V keep alive power supply*** provides power to the turbomolecular pump fan and the Vent Delay PCB.

The Power Module provides line power for the ***Turbomolecular Pump Controller***, which distributes power to the turbomolecular pump. Refer to the topic **Vacuum System Electronic Assemblies** on page 2-47.

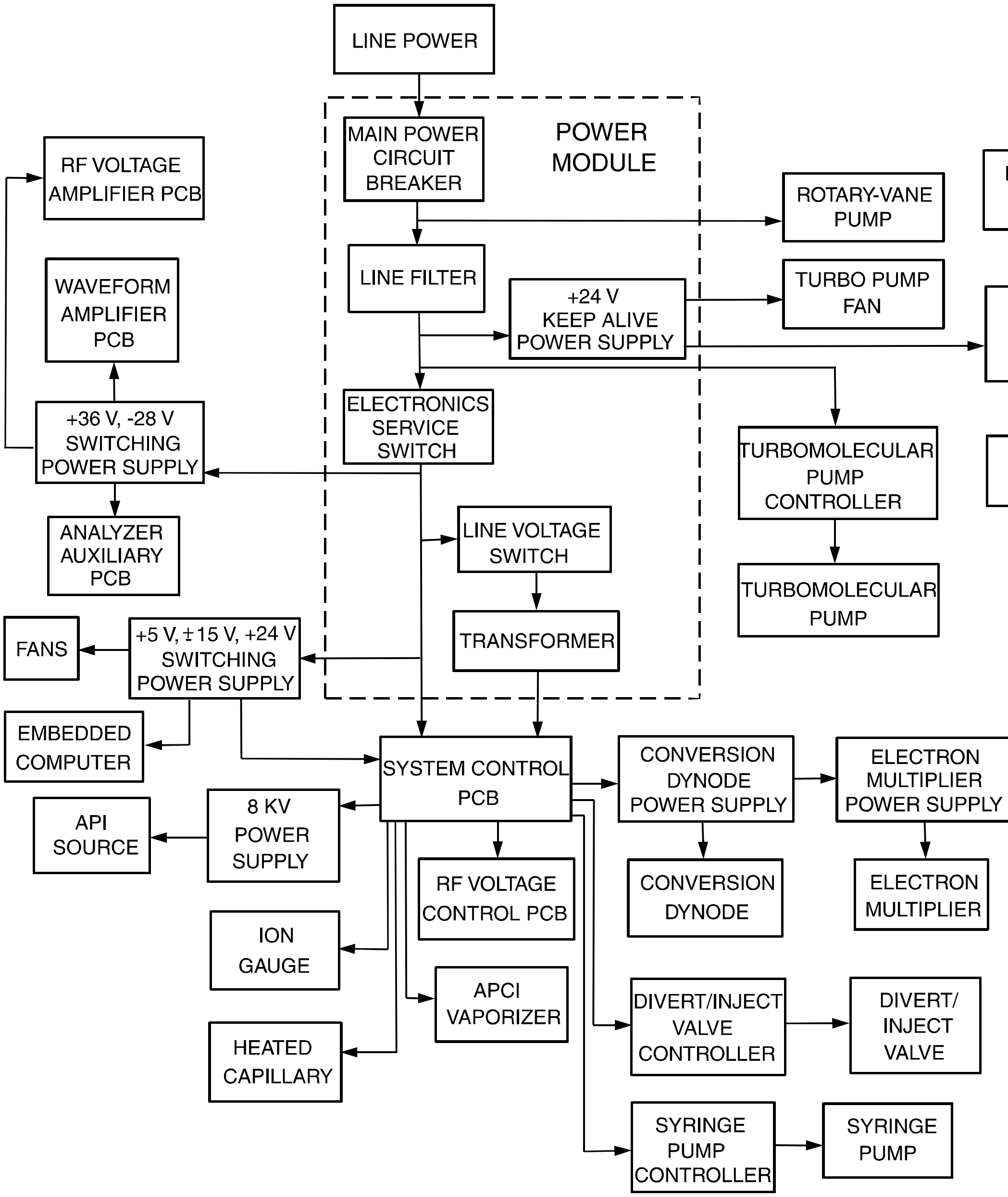

Figure 2-18. Functional block diagram of the Power Module and power distribution of the MS detector

The ***electronics service switch*** is a circuit breaker that allows you to service the non-vacuum system components of the MS detector with the vacuum system still in operation (See Figure 2-6 for the location of the electronics service switch). In the Service (OFF, O) position the switch removes power to all components of the MS detector other than the vacuum system. In the Normal

(ON, |) position power is supplied to all components of the MS detector.

Note. For emergency shutoff of all power to the MS detector, place the main power circuit breaker switch in the Off (O) position. Do not use the electronics service switch to remove power to the system in an emergency.

After the electronics service switch, power goes to the +5 V, ±15 V, +24 V switching power supply, the +36 V, -28 V switching power supply, and the line voltage switch.

The ***+5 V, ±15 V, +24 V dc switching power supply*** provides +5 V dc, ± 15 V dc, and +24 V dc power for analog and digital circuits. It also supplies +24 V dc power to the cooling fans.

The ***+36 V, -28 V dc switching power supply*** provides +36 V dc and -28 V dc power for the RF Voltage Amplifier PCB, the Waveform Amplifier PCB, and the Analyzer Auxiliary PCB.

The ***line voltage switch*** allows for manual adjustment of the main transformer so that it can accept a line voltage lower or higher than 230 V.

Caution. Do not change the setting of the line voltage switch. The proper setting for the switch is determined at the factory. The LCQ system can be damaged if the setting is changed.

After the line voltage switch, power goes to the System Control PCB both directly and through a toroidal transformer. The toroidal ***transformer*** provides 240 V ac, 496 V ac, 248 V ac, 32 V ac, 24 V ac, 25 V ac, and 5 V ac secondary voltages to the power supply circuits on the System Control PCB.

The ***8 kV power supply*** delivers voltage to either the ESI needle in the ESI mode, or the corona discharge needle in the APCI mode. Typical operating voltages range between ±3 to ±6 kV. In the ESI mode, the voltage is regulated, whereas in the APCI mode, the current is regulated.

2.5.8.2 System Control PCB

The ***System Control PCB*** is the principal PCB for controlling and monitoring the operation of the MS detector. The System Control PCB is the large board that is located on the right side of the MS detector. The many interconnections of the System Control PCB with other components of the MS detector can be seen in Figure 2-18 through Figure 2-22.

The System Control PCB contains the following components:

- ±130 V dc, ±330 V dc, ±215 V dc, ±20 V dc, +180 V dc, 24 V ac, +36 V dc, and 4 V ac power supplies
- Dc voltage control circuitry
- Divert/inject valve control circuit
- API source control circuit
- Electron multiplier control circuit
- Conversion dynode control circuit
- Heated capillary heater/sensor control circuit
- APCI vaporizer heater/sensor control circuit
- Ion gauge control circuit
- Convectron gauge control circuit
- Vacuum protection circuitry
- RF voltage control circuitry
- Switching power supply outputs
- Temperature monitoring circuitry
- Diagnostic circuitry
- Interface with the embedded computer

The ***±130 V dc power supply*** provides power for the dc voltages that are applied to the heated capillary, octapoles, and mass analyzer electrodes. The ±130 V dc power supply receives 240 V ac from the toroidal transformer in the Power Module.

The ***±330 V dc power supply*** provides power for the circuitry that provides voltage to the interoctapole lens. The ±330 V dc power supply receives 496 V ac from the toroidal transformer in the Power Module.

The ***±215 V dc power supply*** provides power for the dc voltage that is applied to the tube lens. The ±215 V dc power supply receives 496 V ac from the toroidal transformer in the Power Module.

The ***±20 V dc power supply*** provides power for the RF detector in the RF Voltage Control PCB. The ±20 V dc power supply receives 32 V ac from the toroidal transformer in the Power Module.

The ***+180 V dc power supply*** provides power for the ion gauge grid. The +180 V dc power supply receives 248 V ac from the toroidal transformer in the Power Module.

The ***24 V ac power supply*** provides power for the heater in the heated capillary. The 24 V ac power supply receives 24 V ac from the toroidal transformer in the Power Module.

The ***+36 V dc power supply*** provides power for the conversion dynode and electron multiplier power supplies. The +36 V dc power supply receives 25 V ac from the toroidal transformer in the Power Module.

The ***4 V ac power supply*** provides power for the ion gauge filament. The 4 V ac power supply receives 5 V ac from the toroidal transformer in the Power Module.

The ***dc voltage control circuitry*** controls and monitors the dc voltages that are applied to the heated capillary, tube lens, octapoles, interoctapole lens, and mass analyzer electrodes.

The ***divert/inject valve control circuit*** controls and monitors the divert/inject valve.

The ***API source control circuit*** controls and monitors the high voltage that is applied to the ESI needle and the APCI corona discharge needle.

The ***electron multiplier control circuit*** sends a signal to the electron multiplier power supply that is proportional to the voltage to be applied to the electron multiplier cathode. It also reads back a signal that is proportional to the actual voltage applied to the electron multiplier cathode. The electron multiplier control circuit lowers the electron multiplier voltage when mass analysis is not occurring.

The ***conversion dynode control circuit*** controls and monitors the polarity of the 15 kV potential that is applied to the conversion dynode.

The ***heated capillary heater/sensor control circuit*** monitors the temperature of the heated capillary via a platinum probe temperature sensor. It also provides the voltage needed by the heater in the heated capillary.

The ***APCI vaporizer heater/sensor control circuit*** controls the temperature of the APCI vaporizer via a thermocouple sensor. It also provides 230 V ac line voltage to the heater in the APCI vaporizer.

The ***ion gauge control circuit*** controls the ion gauge and reads back the pressure signal. (The ion gauge measures the pressure in the analyzer region of the vacuum manifold.)

The ***Convectron gauge control circuit*** controls the Convectron gauge and reads back the pressure signal. (The Convectron gauge measures the pressure in the foreline and the capillary-skimmer region of the vacuum manifold.)

The ***vacuum protection circuitry*** monitors the pressure in the foreline (between the turbomolecular pump and the rotary-vane pump), as measured by the Convectron gauge, and in the analyzer region of the vacuum manifold, as measured by the ion gauge. Refer to the topic **Vacuum System Electronic Assemblies** on page 2-47 for more information on vacuum protection.

The ***RF voltage control circuitry*** controls and monitors the RF Voltage Amplifier PCB, Waveform Amplifier PCB, and RF Voltage Control PCB.

The ***switching power supply outputs*** distribute +5 V, ±15 V, and +24 V dc power to various PCBs and modules of the MS detector.

The ***temperature monitoring circuitry*** monitors the temperatures at the RF Voltage Control PCB, Analyzer PCB, RF Voltage Amplifier PCB, and System Control PCB.

The ***diagnostic circuitry*** monitors the outputs of various components and circuits on the LCQ. Information on voltages, currents, temperatures, flow rates, logic, etc. is sent to the data system, where it can be accessed via the Tune Plus Status view and the diagnostics program.

The ***embedded computer interface*** is a high speed serial line that connects the System Control PCB with the Control DSP (digital signal processor) PCB in the embedded computer. The System Control PCB communicates with the data system computer via the embedded computer.

2.5.8.3 Vacuum System Electronic Assemblies

The ***vacuum system electronic assemblies*** control and monitor the vacuum system of the MS detector. The vacuum system electronic assemblies include the following:

- Vacuum protection circuitry
- Turbomolecular Pump Controller
- Vent Delay PCB
- Battery backup

A functional block diagram of the vacuum system electronic assemblies is shown in Figure 2-19.

The ***vacuum protection circuitry*** on the System Control PCB monitors the pressure in the capillary-skimmer region of the vacuum manifold, as measured by the Convectron gauge, and in the analyzer region of the vacuum manifold, as measured by the ion gauge. The vacuum protection circuitry turns off power to the octapole and mass analyzer RF and waveform generation circuitry, 8kV power supply (for the API source), electron multiplier power supply, conversion dynode power supply, APCI vaporizer heater, and dc voltages to the heated capillary, tube lens, octapoles, interoctapole lens, and mass analyzer if one or more of the following conditions arise:

- The pressure in the capillary-skimmer region is above 2 Torr
- The pressure in the analyzer region is above 5×10^{-4} Torr
- The high-voltage safety interlock switch on the API source is open (that is, the API flange is not secured to the spray shield)

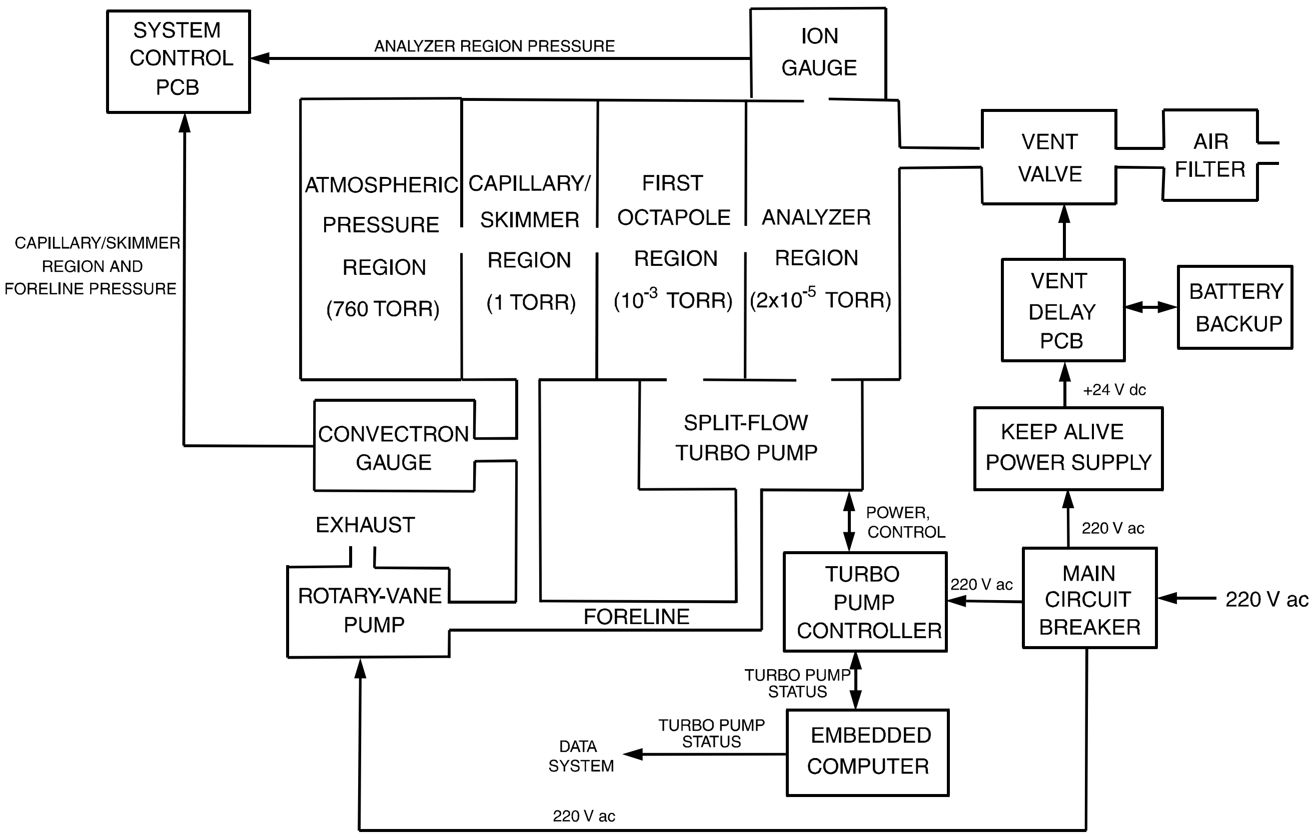

Figure 2-19. Functional block diagram of the vacuum system electronic assemblies

The LED labeled *Vacuum* on the front panel of the LCQ is illuminated green whenever the vacuum protection circuitry indicates that the vacuum is OK (and the safety interlock switch on the API source is closed).

The ***Turbomolecular Pump Controller*** provides power to and control of the turbomolecular pump. The turbomolecular pump status (temperature, rotational speed, etc.) is sent from the Turbomolecular Pump Controller to the embedded computer over a serial line. Power for the Turbomolecular Pump Controller and the turbomolecular pump is turned off and on by the main power circuit breaker and not by the electronics service switch.

The ***Vent Delay PCB*** controls the vent valve. The vent valve is closed when the solenoid is energized. The vacuum manifold is vented to filtered air 30 s after power is removed from the system.

The ***24 V keep alive power supply*** in the Power Module provides power to the Vent Delay PCB and vent valve during normal operating conditions. A ***battery backup*** on the Vent Delay PCB provides power to the Vent Delay PCB and vent valve during a power failure. If external power is not restored to the instrument after 30 s, a circuit on the Vent Delay PCB times out, and power to the vent valve solenoid is shut off. When power to the vent valve solenoid is shut off, the vent valve opens and the manifold is vented to filtered air. The vent valve closes after power is restored to the system. The battery backup is recharged automatically by the system after power is restored.

2.5.8.4 RF/Waveform Voltage Generation Electronic Assemblies

The ***RF/waveform voltage generation electronic assemblies*** produce the ring electrode RF voltage and the octapole RF voltage. They also produce the waveform voltages, resonance excitation RF voltage, and resonance ejection RF voltage that are applied to the endcap electrodes of the mass analyzer. All RF and waveform voltages are controlled by the System Control PCB.

The RF/waveform voltage generation electronic assemblies include the following components. See Figure 2-20.

- Waveform DDS PCB
- Waveform Amplifier PCB
- RF Voltage Amplifier PCB
- Low Pass Filter PCB
- Dc ring filter
- RF voltage coil
- RF Voltage Control PCB
- Analyzer Auxiliary PCB
- Analyzer PCB

The ***Waveform DDS (direct digital synthesizer) PCB***, which is a part of the embedded computer, provides the reference voltages for the resonance excitation RF voltage, resonance ejection RF voltage, ion injection waveform voltage, and ion isolation waveform voltage. These voltages are sent to the Waveform Amplifier PCB in the MS detector. It also provides the reference voltage for the ring electrode RF voltage, which is sent to the RF Voltage Amplifier PCB, and the reference voltage for the octapole RF voltage, which is sent to the Analyzer Auxiliary PCB.

The ***Waveform Amplifier PCB*** receives and amplifies the waveform produced by the Waveform DDS PCB. The Waveform Amplifier PCB also receives a sine wave reference signal from the Waveform DDS PCB that it uses to produce the resonance excitation and resonance ejection RF voltages.

The ***RF Voltage Amplifier PCB*** provides the ring electrode RF primary voltage for the RF voltage coil. The RF Voltage Amplifier PCB receives a sine wave reference signal from the Waveform DDS PCB.

The ***Low Pass Filter PCB*** removes second and third harmonics from the ring electrode RF voltage.

The ***dc ring filter*** filters the dc offset voltage that is applied to the ring electrode.

The ***RF voltage coil*** amplifies the primary voltage from the RF Voltage Amplifier PCB to produce a secondary voltage of 0 to 8500 V ac (peak) that is supplied to the ring electrode of the mass analyzer. Also, the dc offset voltage that is applied to the ring electrode is added to the ring electrode RF voltage at the RF voltage coil.

The ***RF Voltage Control PCB*** detects and controls the amplitude of the RF voltage that is applied to the ring electrode. The RF Voltage Control PCB includes the mass control circuit, and it resides in a thermally stable housing, which helps to prevent mass calibration drift.

The ***Analyzer Auxiliary PCB*** receives the octapole RF sine wave reference signal from the Waveform DDS PCB, and then amplifies and filters it to produce the final RF voltage that is applied to the octapoles (via the Analyzer PCB). The Analyzer Auxiliary PCB also receives the amplified waveform voltages, resonance excitation RF voltage, and resonance ejection RF voltage from the Waveform Amplifier PCB. The Analyzer Auxiliary PCB includes a ***balun*** (balanced to unbalanced) ***transformer*** that splits the waveform voltages, resonance excitation RF voltage, and resonance ejection RF voltage into two RF voltages that are 180° out of phase (one for each of the endcap electrodes of the mass analyzer). The endcap electrode dc offset voltage from the System Control PCB is added to the waveform voltages, resonance excitation RF voltage, and resonance ejection RF voltage at the balun transformer.

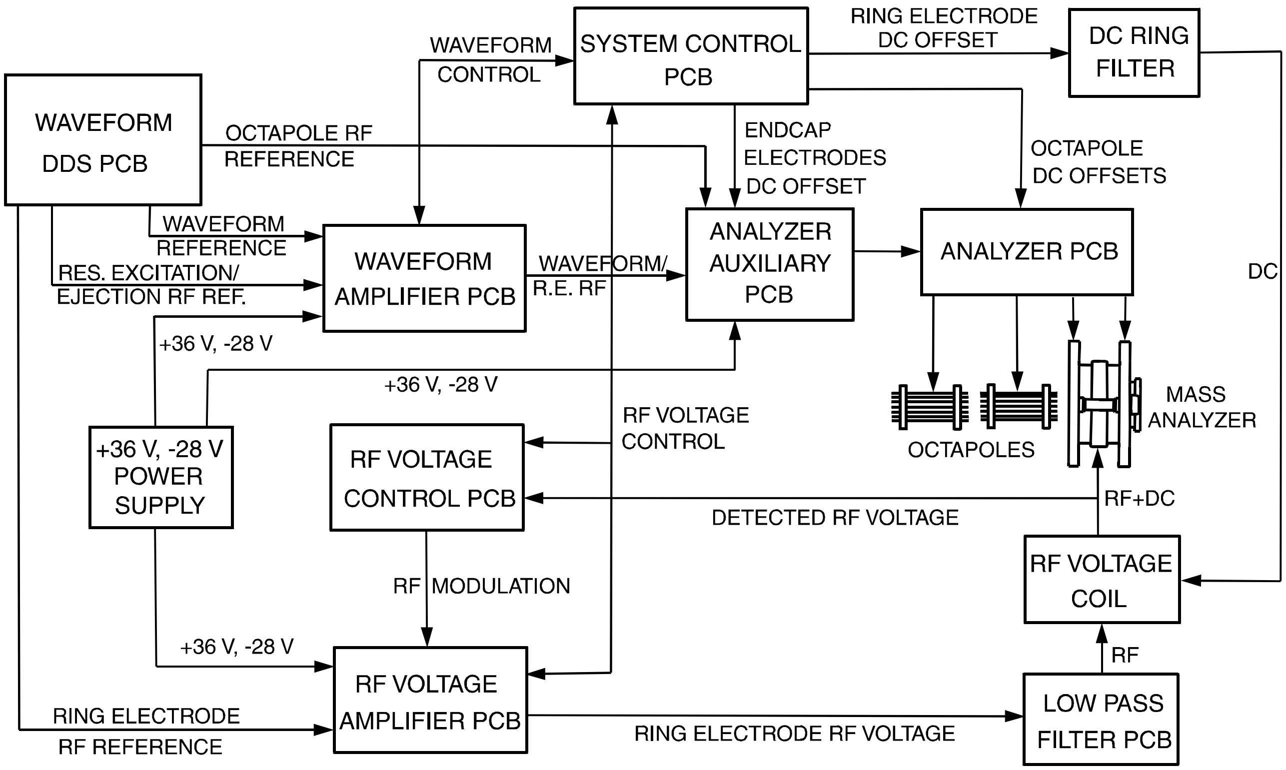

Figure 2-20. RF/waveform voltage generation electronic assemblies

The ***Analyzer PCB*** serves as the interface between the MS detector electronics and the ion optics, mass analyzer, and electron multiplier anode. (It is located on the top of the vacuum manifold top cover plate.) The Analyzer PCB receives the waveform voltage, resonance excitation RF voltage, and resonance ejection RF voltage (plus dc offset voltage) from the Analyzer Auxiliary PCB, and then passes them to the endcap electrodes of the mass analyzer. The Analyzer PCB also receives the octapole RF voltage from the Analyzer Auxiliary PCB. A ***bifilar coil*** on the Analyzer PCB splits the octapole RF voltage into two RF voltages that are 180° out of phase. (The two RF voltages are applied to alternate rods.) Different dc offset voltages for each of the octapoles are added to the RF voltages at the bifilar coil.

2.5.8.5 Ion Detection System Electronic Assemblies

The ***ion detection system electronic assemblies*** provide high voltage to the electron multiplier and conversion dynode of the ion detection system. They also receive the electron multiplier output current signal, convert it to a voltage (by the electrometer circuit), and pass it to the data system. A functional block diagram of the ion detection system electronic assemblies is shown in Figure 2-21.

The ion detection system electronic assemblies include the following:

- Electron multiplier power supply
- Conversion dynode power supply
- Electrometer circuit

The ***electron multiplier power supply*** supplies the -0.8 kV to -2.5 kV dc high voltage to the cathode of the electron multiplier. The high voltage set control signal for the electron multiplier power supply comes from the System Control PCB. This signal controls a feedback control circuit and is proportional to the final high voltage to be applied to the electron multiplier cathode. The electron multiplier voltage is lowered by the System Control PCB during sample ionization to prolong the life of the electron multiplier.

The ***conversion dynode power supply*** supplies +15 kV and -15 kV dc high voltage to the conversion dynode. The polarity of the voltage applied to the conversion dynode is determined by a control signal from the System Control PCB.

The ***electrometer circuit***, located in a shielded enclosure on the Analyzer PCB, receives the amplified ion current from the anode of the electron multiplier, converts the current into a voltage, and then integrates the voltage over time. The integrated voltage is then passed to the Acquisition DSP PCB (in the embedded computer) where it is processed and sent to the data system.

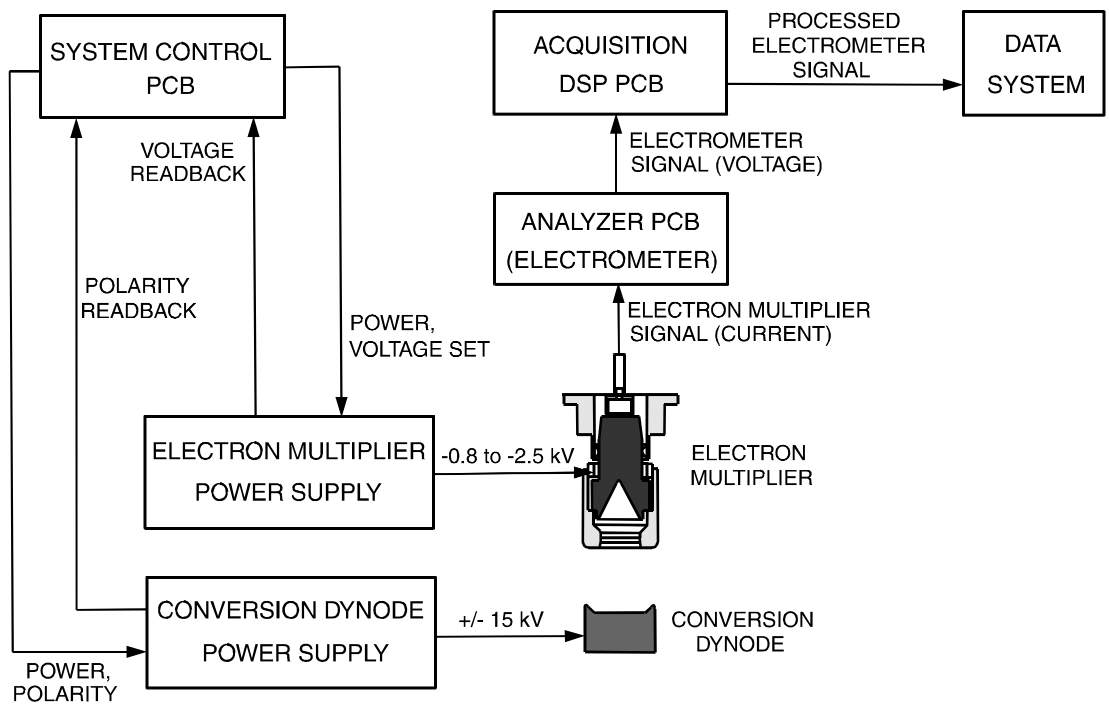

Figure 2-21. Functional block diagram of the ion detection system electronic assemblies

2.5.8.6 Embedded Computer Electronic Assemblies

The ***embedded computer*** is a computer within the MS detector that coordinates instrument control, waveform and RF voltage generation, data acquisition, and communication with the data system and external devices. A functional block diagram of the embedded computer is shown in Figure 2-22. The embedded computer contains the following components:

- ISA bus (AT backplane)
- CPU PCB
- Serial I/O PCB
- Waveform DDS PCB
- Control DSP PCB
- Acquisition DSP PCB
- IEEE 488 I/O PCB (optional)

- Ethernet PCB

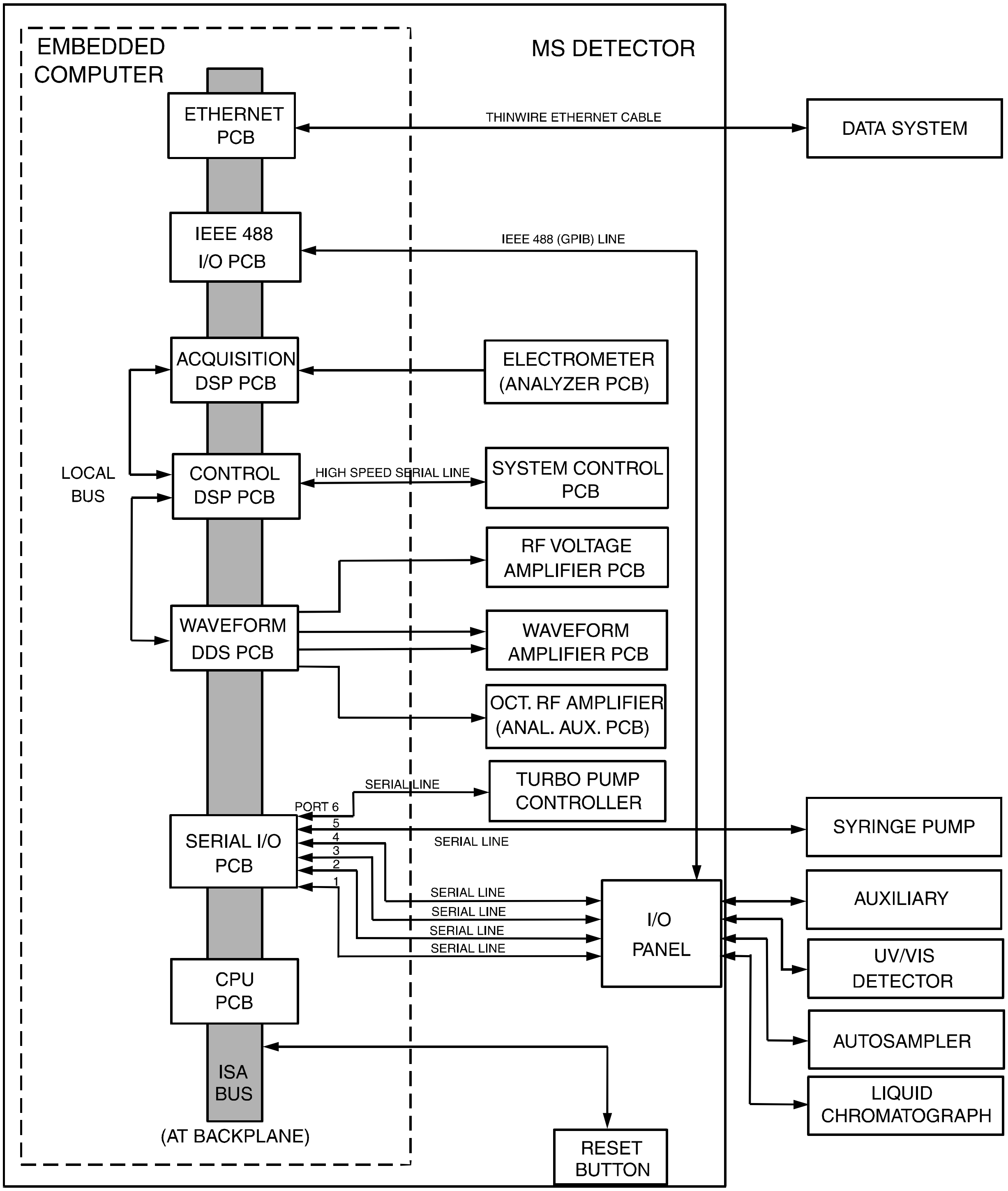

Figure 2-22. Functional block diagram of the embedded computer, showing communication with the MS detector and external devices

The ***ISA (industry standard architecture) bus*** (AT backplane) provides power to and communication between the PCBs in the embedded computer.

The ***CPU PCB*** is the central processing unit for the embedded computer. The CPU PCB contains 16 Mbytes of RAM. Software to run the embedded computer, which is contained in read-only memory on the CPU PCB, is loaded into RAM on bootup. After bootup, software to run the LCQ is transfered from the data system to the embedded computer over an Ethernet. You can reboot the CPU PCB and download the LCQ software from the data system by pressing the reset button on the power panel.

The ***Serial I/O PCB*** provides serial (RS 232) communication with the Turbomolecular Pump Controller (port 6), syringe pump (port 5), auxiliary device (port 4), UV/VIS detector (port 3), autosampler (port 2), and LC (port 1). Serial lines from external devices plug into the serial ports on the I/O panel. See Figure 2-23.

The ***Waveform DDS (direct digital synthesizer) PCB*** provides the reference sine wave or ac voltages for the resonance excitation RF voltage, resonance ejection RF voltage, ion injection waveform voltage, and ion isolation waveform voltage. These voltages are sent to the Waveform Amplifier PCB in the MS detector. It also provides the reference voltage for the ring electrode RF voltage, which is sent to the RF Voltage Amplifier PCB, and the octapole reference voltage, which is sent to the octapole RF amplifier on the Analyzer Auxiliary PCB.

The ***Control DSP (digital signal processor) PCB*** controls the MS detector via the System Control PCB. A ***high speed serial line*** serves as an interface between the Control DSP PCB and the System Control PCB. The Control DSP PCB is where most computations and control functions take place. For example, it determines what waveforms the Waveform DDS PCB produces and when to apply them.

The ***Acquisition DSP PCB*** serves as the digital acquisition link with the electrometer on the Analyzer PCB. It receives data from the electrometer, processes it, and sends it to the data system via the Ethernet local area network connection.

Four coaxial cables transmit the ring electrode RF reference voltage, resonance excitation/ejection RF reference voltage, waveform reference voltage, and octapole RF reference voltage from the Waveform DDS PCB to the RF Voltage Amplifier PCB, Waveform Amplifier PCB, and Analyzer Auxiliary PCB. The

Waveform DDS PCB, Control DSP PCB, and Acquisition DSP PCB communicate with each other over a ***local bus***.

The optional ***IEEE 488 I/O PCB*** provides GPIB communication with Hewlett-Packard devices. The GPIB line from external devices plugs into the IEEE 488 (GPIB) port on the I/O panel. See Figure 2-23.

The ***Ethernet PCB*** provides Ethernet communication between the embedded computer and the data system over a thinwire Ethernet cable.

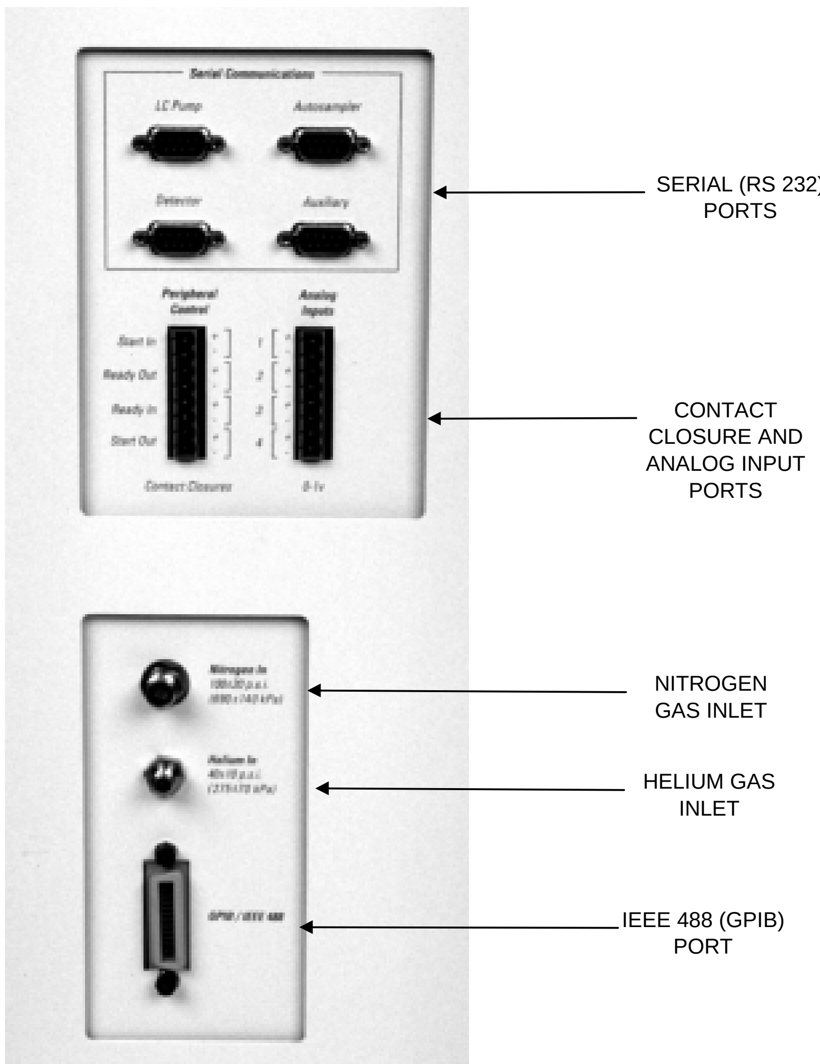

Figure 2-23. I/O panel

2.6 Data System

The ***data system*** controls and monitors the LCQ system. The data system also processes data that is acquired by the LCQ system. The data system is composed of the following:

- Computer hardware
- Computer software
- Data system/MS detector interface
- Data system/local area network interface
- Printer

2.6.1 Computer Hardware

The data system computer is a Gateway 2000® personal computer. Its major features include:

- Intel® Pentium® processor
- 48 MB of random access memory (RAM)
- 32-bit PCI/ISA system architecture
- SCSI hard disk drive
- CD ROM drive
- Primary Ethernet adapter (data system to MS detector)
- Secondary Ethernet adapter (data system to local area network)
- 1.44-MB, 3.5-in. diskette drive
- Video Graphics card with 2 MB RAM
- 17-in., 1024 × 768 resolution, SVGA color monitor
- Keyboard and mouse

For more information about the computer, refer to the manuals that come with the computer.

2.6.2 Computer Software

The software is stored on the hard disk drive and includes the Microsoft® Windows NT™ operating system and the following LCQ software windows:

- You control the LCQ system from the ***Navigator window***. The Navigator window displays sample status, current conditions of the chromatograph run, chromatograph plot, and the mass spectrum of the effluent at any selected time during the chromatograph run.
- The ***Tune Plus window*** allows you to tune and calibrate the MS detector, optimize the tune for your experimental conditions, acquire analytical data one scan at a time, and perform MS detector diagnostics.
- The ***Experiment Method window*** allows you to create an Experiment Method by specifying settings for the LC, autosampler, MS detector, divert/inject valve, and syringe pump.
- The ***Processing Method window*** allows you to create a Processing Method by identifying components and specifying detection and integration criteria.
- The ***Sample List window*** allows you to set up a sample list containing analysis samples, calibration standard samples, quality control samples, and blank samples.
- The ***Processing Queue Manager*** window allows you to control the processing of the LCQ sample queue. You can pause processing, resume processing, purge the queue, remove sample lists from the queue, and obtain details about sample lists.
- The ***Explore window*** allows you to open a raw data file and analyze chromatograms, mass spectra, and maps.
- The ***File Converter window*** allows you to convert files from a specified format to a different format.

In addition, the LCQ data system contains customized tune files for a variety of applications, including ESI high flow, ESI low flow, APCI high flow, and APCI low flow LC/MS experiments. For a complete description of the LCQ software, refer to the **LCQ Software Manual** and the online Help.

2.6.3 Data System / MS Detector Interface

The data system computer contains an Ethernet adapter (called the primary Ethernet adapter) that is dedicated to data system/MS detector communications. The Ethernet adapter on the instrument resides in the embedded computer box. A thinwire Ethernet cable connects the primary Ethernet adapter of the data system with the Ethernet connector on the power panel of the MS detector (see Figure 2-6).

2.6.4 Data System / Local Area Network Interface

The data system computer contains a second Ethernet adapter called the secondary Ethernet adapter. The secondary Ethernet adapter is not involved in data system/MS detector communications. You can use the secondary Ethernet adapter to connect your LCQ PC to a local area network.

2.6.5 Printer

A high resolution laser printer is included with the LCQ. The printer communicates with the PC via a parallel port (LPT1). Refer to the manual supplied by the manufacturer for details about the printer.

You set up the printer from the Print Setup dialog box. To open the Print Setup dialog box, choose **File | Print Setup** in any window.

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PREPARING FOR DAILY OPERATION

This chapter outlines the checks of the LCQ system that should be performed every day before you begin your first analysis. The following checks should be performed every day:

- Check disk space on the data system
- Check helium and nitrogen gas pressures
- Check system vacuum levels
- Print a hard copy of the Tune Plus Status view

Note. You do not need to calibrate or tune the LCQ as part of your daily routine.

Calibration parameters are instrument parameters whose values do not vary with the type of experiment. You need to calibrate the LCQ perhaps once a month, and check the calibration once a week. Refer to the **LCQ Operator's Manual** for a procedure for calibrating the LCQ.

Tune parameters are instrument parameters whose values vary with the type of experiment. You need to tune the LCQ (or change the Tune Method) whenever you change the type of experiment. Refer to the **LCQ Operator's Manual** for procedures for tuning the LCQ in the ESI or APCI mode. (Note that LCQ comes with several standard Tune Methods specific for various experimental conditions, so that tuning is often not required for many types of experiments.)

3.1 Checking the Disk Space

You should verify on a regular basis that your hard disk drive has enough free space for data acquisition. The amount of available disk space is shown in the Check Disk Space dialog box. To determine the amount of available disk space, proceed as follows:

1. From the Navigator window, choose **Samples | Edit Sample List** to open the Sample List window.

2. Choose **Actions | Check Disk Space** (or click on the pie-shaped Check Disk Space button on the toolbar). The Check Disk Space dialog box appears. The Check Disk Space dialog box lists the following:

   - Current drive and directory (for example, C:\LCQ\METHOD)

   - Number of Mbytes that are available (free) on the current drive

   - Percentage of the current drive that is available

   - Total capacity of the current drive

3. To select another disk drive so that you can determine its disk space, click on the Directory button.

4. When you have completed this procedure, click on **OK** to close the dialog box.

If necessary, you can free space on the hard disk by deleting obsolete files and by moving files from the hard disk drive to a backup medium. First, copy files to the backup medium. After you have copied the files, you can delete them from the hard disk. Use the Windows NT Explorer or File Manager copy (or backup) and delete commands to copy (or backup) and delete files. Refer to the Windows NT users manual for information on the Explorer or File Manager.

3.2 Checking the Helium and Nitrogen Supplies

Check the helium supply on the regulator of the gas tank. Make sure that you have sufficient gas for your analysis. If necessary, install a new tank of helium. Verify that the pressure of helium reaching the MS detector is between 200 and 350 kPa (30 to 50 psig). If necessary, adjust the pressure with the tank pressure regulator.

Check the nitrogen supply on the regulator of the nitrogen gas tank or liquid nitrogen boil-off tank. Make sure that you have sufficient gas for your analysis. Typical nitrogen consumption is 100 cubic feet per day (nitrogen on 24 hours per day). If necessary, replace the tank. Verify that the pressure of nitrogen reaching the MS detector is between 550 and 830 kPa (80 to 120 psig). If necessary, adjust the pressure with the tank pressure regulator.

WARNING. Before you begin normal operation each day, ensure that you have sufficient nitrogen for your API source. If you run out of nitrogen, LCQ automatically turns the MS detector Off to prevent the possibility of atmospheric oxygen from entering the ion source. The presence of oxygen in the ion source when the MS detector is On could be unsafe. (In addition, if LCQ turns Off the MS detector during an analytical run, you could lose data.)

WARNUNG. Stellen Sie täglich vor Beginn des normalen Betriebs sicher, daß Sie genügend Stickstoff für Ihre Atmosphärendruck-Ionisationsquelle (API) haben. Wenn der Stickstoff nicht ausreicht, schaltet das LCQ den MS-Detektor automatisch auf AUS, um zu verhindern, daß Luftsauerstoff in die Ionenquelle eindringt. Sauerstoff in der Ionenquelle kann bei eingeschaltetem MS-Detektor eine Gefahr darstellen. (Außerdem können biem Abschalten des MS-Detektors während einer Analyse Daten verloren gehen.)

AVERTISSEMENT. Tous les jours avant d'utiliser l'appareil, vérifiez le niveau d'azote de la source d'ionisation à la pression atmosphérique. En effet, si vous tombez à court d'azote, LCQ désactive automatiquement le détecteur de SM pour empêcher que la source d'ions ne soit contaminée par l'oxygène présent dans l'air. Toute présence d'oxygène dans la source d'ions lorsque le détecteur de SM est activé peut comporter des risques. (En outre, si LCQ désactivait le détecteur de SM pendant une série d'analyses, vous pourriez perdre des données).

3.3 Checking the System Vacuum Levels

For proper performance, your LCQ system must operate at the proper vacuum levels. Operation of the system at vacuum levels that are too high can cause reduced sensitivity, tuning problems, and reduced lifetime of the electron multiplier. You should check your system for air leaks by checking the system vacuum levels before you begin your first acquisition.

> **Caution.** Major air leaks are often identifiable merely by listening for a rush of air or a hissing sound somewhere on the instrument. A major leak might be caused, for example, by an extremely loose or disconnected fitting, by an O-ring that is not properly seated, or by an open valve. **If you hear these sounds, do not turn on the high voltages to the MS detector.**

Air leaks are indicated by the following:

- Vacuum manifold pressure above 5×10^{-4} Torr in the analyzer region (as measured by the ion gauge) or above 2 Torr in the capillary-skimmer region (as measured by the Convectron gauge). If either pressure is too high, the LED labeled *Vacuum* is not illuminated green. [Note that the safety interlock switch on the API source must be depressed (that is, the API flange must be secured to the spray shield) for the Vacuum LED to be illuminated green.]

- Vacuum manifold pressure levels as measured by the Convectron gauge and ion gauge are higher than the levels shown in Table 3-1.

You can check the current values of the pressures in the vacuum manifold, as measured by the Convectron gauge and ion gauge, in the Navigator and Tune Plus windows. In the Navigator window the pressures are listed in the Vacuum group box in the Status view. In the Tune Plus window the pressures are listed in the Vacuum dialog box. To display the Vacuum dialog box, click on the vacuum button or choose **Setup | Vacuum**.

Compare the current values of the pressures in the vacuum manifold with the values listed in Table 3-1 and with values from Status views that you previously printed out. If the current values are higher than normal, you may have an air leak.

Table 3-1. Typical Pressure Readings

Conditions	Convectron gauge reading (foreline, capillary-skimmer region)	Ion gauge reading (analyzer region)
Helium on, heated capillary open (200 °C)	0.9 to 1.1 Torr	2.0×10^{-5} to 2.5×10^{-5} Torr
Helium on, heated capillary open (25 °C)	1.2 Torr (or slightly higher)	2.9×10^{-5} Torr
Helium on, heated capillary closed	2×10^{-3} to 5×10^{-3} Torr	1.8×10^{-5} Torr
Helium off, heated capillary open (200 °C)	0.9 to 1.1 Torr	7×10^{-6} Torr
Helium off, heated capillary open (25 °C)	1.2 Torr (or slightly higher)	9×10^{-6} Torr
Helium off, heated capillary closed	2×10^{-3} to 5×10^{-3} Torr	2.0×10^{-6} Torr

If the pressure is high (above 5×10^{-5} Torr in the analyzer region), and you have restarted the system within the last 30 to 60 minutes, wait an additional 30 minutes and recheck the pressure. If the pressure is decreasing with time, check the pressure periodically until it is low enough for the proper operation of the MS detector.

If the pressure remains high, your system may have an air leak. Check each fitting and flange on the system for tightness, and tighten the fittings or flanges that are loose. Do not tighten fittings indiscriminately. Pay particular attention to fittings that have been changed recently or to fittings that have been subjected to heating and cooling. Make sure that the top cover plate of the vacuum manifold and the spray shield of the API source are properly seated.

3.4 Printing a Hard Copy of the Status View

The Tune Plus Status view lists the current values of the instrument parameters. It is a good idea to print (or save in a file) a hard copy of the status view on a daily basis. This procedure allows you to detect problems by monitoring changes in the instrument parameters.

To print a copy of the Status view, proceed as follows:

1. From the Tune Plus window, choose **Control | On** (or click on the On/Standby button) to turn on voltages to the API source, ion optics, mass analyzer, and ion detection system.

2. Choose **View | Display Status View** (or click on the Display Status View button on the button bar). The Status view appears in the Tune Plus window.

3. Click on the Status view to make it the active window.

4. Print a hard copy of the Status view by choosing **File | Print**.

5. Choose **Control | Standby** to turn off voltages to the API source, ion optics, mass analyzer, and ion detection system.

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CHANGING API PROBE ASSEMBLIES

You need to change the API probe assembly (ESI or APCI) of the API source when you switch between ESI and APCI ionization modes. The ESI probe assembly consists of the ESI flange and probe. The APCI probe assembly consists of the APCI flange, probe, and corona discharge needle assembly. You do not need to shut down or vent the system to change the API probe assembly. The topics in this chapter are as follows:

- Removing the APCI probe assembly
- Installing the ESI probe assembly
- Removing the ESI probe assembly
- Installing the APCI probe assembly

4.1 Removing the APCI Probe Assembly

To remove the APCI probe assembly, proceed as follows. Refer to Figure 4-1 for the location of the components of the APCI probe assembly.

1. Stop the flow of sample solution (from the LC or syringe pump) into the APCI probe.

2. Place the electronics service switch in the Service (OFF, O) position. When you place the electronics service switch in the Service (OFF, O) position, the voltages to the API source (including the APCI probe), ion optics, mass analyzer, and ion detection system are turned off and the flows of sheath gas and auxiliary gas into the APCI probe are stopped.

WARNING. Make sure that the LCQ electronics service switch is in the Service (OFF, O) position before you proceed.

WARNUNG. Kontrollieren Sie, daß der Hauptschalter für LCQ Elektronikteile auf Wartung (Service/OFF/O) geschaltet ist bevor Sie fortfahren.

AVERTISSEMENT. S'assurer que le disjoncteur de branchement LCQ est en position Service (OFF, O) avant de continuer.

3. Loosen the two flange retainer bolts that secure the APCI probe assembly to the API spray shield. See Figure 4-1.

4. Pull back the APCI probe assembly from the spray shield.

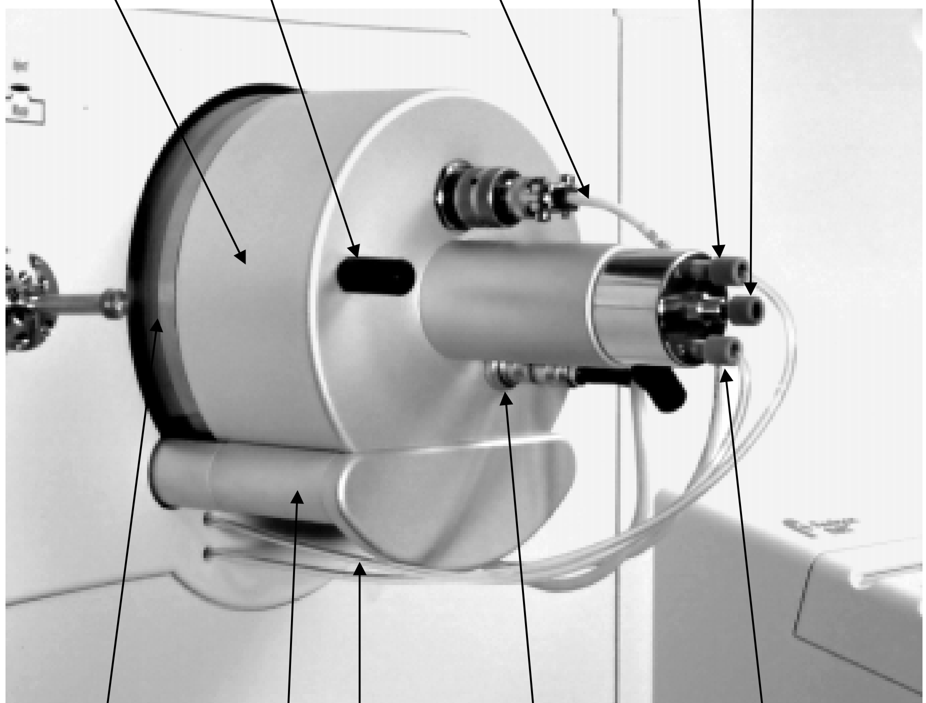

Figure 4-1. APCI probe assembly

5. Disconnect the corona needle high voltage cable from the corona needle high voltage connector. To disconnect the cable, turn the locking ring on the cable counterclockwise until you can pull the cable free.

6. Disconnect the vaporizer heater cable from the connector on the front panel. (Leave the cable connected to the APCI flange.) To disconnect the cable, pull back on the locking ring on the cable.

7. Disconnect the sample transfer line from the APCI probe by turning the sample transfer line fitting counterclockwise until you can pull the transfer line and fitting free from the probe.

8. Disconnect the sheath gas line from the APCI probe by turning the sheath gas line fitting counterclockwise until you can pull the sheath gas line and fitting free from the probe.

9. Disconnect the auxiliary gas line from the APCI probe by turning the auxiliary gas line fitting counterclockwise until you can pull the auxiliary gas line and fitting free from the probe.

WARNING. The APCI vaporizer heater can reach temperatures of 800 °C. Always allow the APCI probe to cool to ambient temperatures before handling or removing the APCI probe from the APCI flange.

WARNUNG. Der APCI-Verdampfer kann Temperaturen bis zu 800 °C erreichen. Lassen Sie die APCI Sonde stets auf Umgebungstemperatur abkühlen, bevor Sie sie berühren oder aus dem APCI-Flansch ausbauen.

AVERTISSEMENT. Le vaporisateur APCI peut atteindre une température de 800 °C. Laisser toujours la sonde APCI refroidir à température ambiante avant de la séparer de la bride APCI.

10. With one hand holding the APCI flange, loosen the knurled fastener that secures the APCI flange to the probe slide adapter.

11. Remove the APCI probe assembly from the probe slide adapter by sliding it off the probe slide adapter. Place the APCI probe assembly on a lint-free tissue and allow it to cool to ambient temperature (approximately 20 min).

12. Remove the corona discharge needle from the APCI probe assembly by pulling it free from the corona discharge needle assembly. Store the corona discharge needle by inserting it into one of the foam walls of the APCI probe assembly storage container.

13. Store the APCI probe assembly in its foam storage container. (Make sure that the APCI probe assembly is at ambient temperature before you place it in its storage container.)

4.2 Installing the ESI Probe Assembly

To install the ESI probe assembly, remove the APCI probe assembly using the procedure described in the previous section; then proceed as follows. Refer to Figure 4-2 for the location of the components of the ESI probe assembly.

1. Place the electronics service switch in the Service (OFF, O) position.

> **WARNING.** Make sure that the LCQ electronics service switch is in the Service (OFF, O) position before you proceed.

> **WARNUNG.** Kontrollieren Sie, daß der Hauptschalter für LCQ Elektronikteile auf Wartung (Service/OFF/O) geschaltet ist bevor Sie fortfahren.

> **AVERTISSEMENT.** S'assurer que le disjoncteur de branchement LCQ est en position Service (OFF, O) avant de continuer.

1. Remove the ESI probe assembly from its storage container.
2. If your ESI probe assembly does not already contain a sample tube (fused-silica capillary), you need to follow the procedure for installing a sample tube that is outlined in the topic **Maintaining the ESI Probe** in the **MS Detector Maintenance** chapter.

> **Note.** Ensure that the probe retainer bolt is tight and the ESI probe is secured to the ESI flange.

FLANGE
RETAINER
BOLT

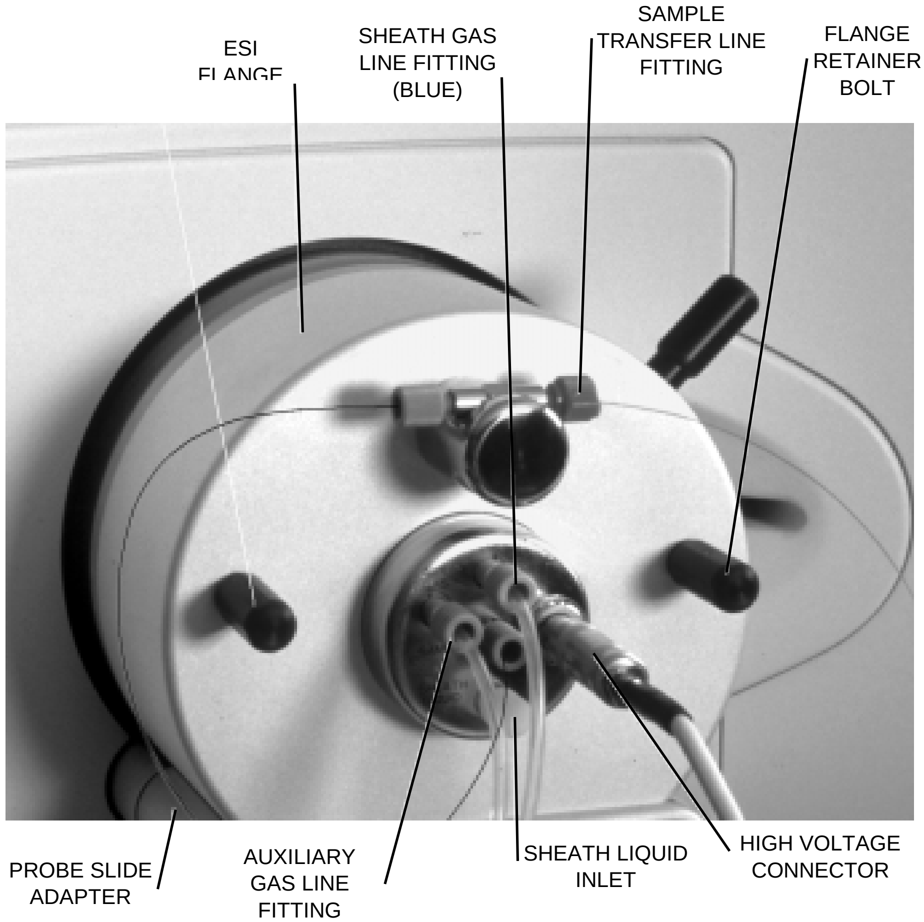

Figure 4-2. ESI probe assembly

4. Slide the ESI probe assembly onto the probe slide adapter. Secure the ESI probe assembly to the probe slide adapter with the knurled fastener that is located on the underside of the probe slide adapter.

5. With one hand, hold the ESI probe on the nozzle side of the probe to keep it from moving in the flange. With the other hand, connect the high voltage power cable to the connector labeled *HV* on the ESI probe. Turn the locking-ring on the cable clockwise to secure the cable.

6. Push the ESI probe assembly against the spray shield.

7. Secure the ESI flange to the spray shield with the two flange retainer bolts.

8. Connect the sheath gas line and (blue) fitting to the inlet labeled *Sheath Gas* on the ESI probe.

9. Connect the auxiliary gas line and (green) fitting to the inlet labeled *Aux Gas* on the ESI probe.

10. Connect the sample transfer line to the grounded fitting.

11. If you are using sheath liquid, connect the sheath liquid line and fitting to the inlet labeled *Sheath Liquid* on the ESI probe. If you are not using sheath liquid, ensure that the 1/4-28 Tefzel® plug fitting (P/N 00101-18075) is inserted in the sheath liquid inlet on the ESI probe.

12. Place the electronics service switch in the Normal (ON, |) position.

13. In the Tune Plus window, choose **Setup | Change to ESI** to configure the LCQ for ESI operation.

> **Note.** The LCQ data system contains customized tune files (in the C:\LCQ\Methods directory) for a variety of applications, including ESI high flow and ESI low flow LC/MS experiments. In the Tune Plus window, choose **File | Open** to display the tune files. Refer to the **LCQ Operator's Manual** for instructions on tuning and operating the LCQ in the ESI mode.

4.3 Removing the ESI Probe Assembly

To remove the ESI probe assembly, proceed as follows. Refer to Figure 4-2 on page 4-6 for the location of the components of the ESI probe assembly.

1. Stop the flow of sample solution (from the LC or syringe pump) into the ESI probe.

2. If necessary, stop the flow of sheath liquid into the ESI source.

1. Place the electronics service switch in the Service (OFF, O) position. When you place the electronics service switch in the Service (OFF, O) position, the voltages to the API source (including the ESI probe), ion optics, mass analyzer, and ion detection system are turned off. The flows of sheath gas and auxiliary gas into the ESI probe are stopped.

WARNING. Make sure that the LCQ electronics service switch is in the Service (OFF, O) position before you proceed.

WARNUNG. Kontrollieren Sie, daß der Hauptschalter für LCQ Elektronikteile auf Wartung (Service/OFF/O) geschaltet ist bevor Sie fortfahren.

AVERTISSEMENT. S'assurer que le disjoncteur de branchement LCQ est en position Service (OFF, O) avant de continuer.

1. Disconnect the high voltage cable from the connector labeled *HV* on the ESI probe. To disconnect the cable, turn the locking ring on the cable counterclockwise until you can pull the cable free.

2. Disconnect the sample transfer line from the grounded transfer line fitting on the ESI flange. See Figure 4-2. (The sample transfer line is the line that comes from the LC, divert/injector valve, or syringe pump. It is not the fused silica capillary that enters the ESI probe.)

3. Disconnect the sheath gas line and fitting from the inlet labeled *Sheath Gas* on the ESI probe by turning the sheath gas line fitting (blue) counterclockwise until you can pull the sheath gas line and fitting free from the probe.

4. Disconnect the auxiliary gas line and fitting from the inlet labeled *Aux Gas* on the ESI probe by turning the auxiliary gas line fitting (green) counterclockwise until you can pull the auxiliary gas line and fitting free from the probe.

5. If the sheath liquid line is attached to the ESI probe, disconnect the sheath liquid line and fitting from the inlet labeled *Sheath Liquid* on the ESI probe by turning the sheath liquid line fitting counterclockwise until you can pull the sheath liquid line and fitting free from the probe.

6. Loosen the two flange retainer bolts that secure the ESI probe assembly to the spray shield.

7. Pull back the ESI probe assembly from the spray shield.

8. With one hand holding the ESI flange, loosen the knurled fastener that secures the ESI flange to the probe slide adapter.

9. Slide the ESI probe assembly off the probe slide adapter. Store the ESI probe assembly in its foam storage container.

4.4 Installing the APCI Probe Assembly

To install the APCI probe assembly, remove the ESI probe assembly using the procedure in the previous section; then proceed as follows. Refer to Figure 4-1 on page 4-3 for the location of the components of the APCI probe assembly.

1. Place the electronics service switch in the Service (OFF, O) position.

> **WARNING.** Make sure that the LCQ electronics service switch is in the Service (OFF, O) position before you proceed.

> **WARNUNG.** Kontrollieren Sie, daß der Hauptschalter für LCQ Elektronikteile auf Wartung (Service/OFF/O) geschaltet ist bevor Sie fortfahren.

> **AVERTISSEMENT.** S'assurer que le disjoncteur de branchement LCQ est en position Service (OFF, O) avant de continuer.

1. Remove the APCI probe assembly and corona discharge needle from the storage container.

2. Insert the corona discharge needle into its socket in the corona discharge needle assembly.

3. If your APCI probe assembly does not already contain a sample tube (fused-silica capillary), you need to follow the procedure for installing a sample tube that is outlined in the topic **Maintaining the APCI Probe** in the **MS Detector Maintenance** chapter. Ensure that the probe retainer bolt is tight and the APCI probe is secured to the APCI flange.

Caution. Inspect the APCI probe. Make sure that the green ground wire is not touching the vaporizer casing. Reposition the ground wire if necessary.

5. Slide the APCI probe assembly onto the probe slide adapter. Secure the APCI probe assembly to the probe slide adapter with the knurled fastener.
6. Connect the sample transfer line and fitting to the inlet labeled *LC* on the APCI probe.
7. Connect the auxiliary gas line and (green) fitting to the inlet labeled *A* on the APCI probe.
8. Connect the sheath gas line and (blue) fitting to the inlet labeled *S* on the APCI probe.
9. Connect the high voltage cable to the connector on the APCI probe assembly. Turn the locking-ring on the cable clockwise to secure the cable.
10. Connect the vaporizer heater cable to the connector on the front panel of the MS detector (beneath the APCI probe assembly). Make sure that the red dot on the cable is aligned with the red mark on the connector.
11. Push the APCI probe assembly against the spray shield.
12. Secure the APCI flange to the spray shield with the two flange retainer bolts.
13. Place the electronics service switch in the Normal (ON, |) position.
14. In the Tune Plus window, choose **Setup | Change to APCI** to configure the LCQ for APCI operation.

Note. The LCQ data system contains customized tune files (in the C:\LCQ\Methods directory) for a variety of applications, including APCI high flow and APCI low flow LC/MS experiments. In the Tune Plus window, choose **File | Open** to display the tune files. Refer to the **LCQ Operator's Manual** for instructions on tuning and operating the LCQ in the APCI mode.

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MS DETECTOR MAINTENANCE

LCQ performance depends on the maintenance of all parts of the instrument. **It is your responsibility to maintain your system properly by performing the system maintenance procedures on a regular basis**.

This chapter describes routine MS detector maintenance procedures that must be performed to ensure optimum performance of the instrument. Most of the procedures involve cleaning. For example, procedures are provided for cleaning the API source, ion optics, mass analyzer, and ion detection system. Procedures are also presented for replacing the API sample tube, heated capillary, and electron multiplier.

Routine and infrequent MS detector maintenance procedures are listed in Table 5-1.

Table 5-1. MS Detector Maintenance Procedures

MS Detector Component	Procedure	Frequency	Procedure Location
API source	Flush (clean) sample transfer line, sample tube, and API probe	Daily	Page 5-8
API source	Flush (clean) heated capillary	Daily (or more often*)	Page 5-10
API source	Flush (clean) spray shield	Daily (or more often*)	Page 5-10
Rotary-vane pump	Purge (decontaminate) oil	Daily	Page 5-74
API source	Clear heated capillary	If heated capillary bore is obstructed	Page 5-13
API source	Replace heated capillary	If heated capillary bore is corroded or if heater fails	Page 5-33

MS Detector Component	**Procedure**	**Frequency**	**Procedure Location**
API source	Clean API stack (spray shield, heated capillary, tube lens, and skimmer)	As needed*	Page 5-33
API source	Replace sample tube	If sample tube is broken or obstructed	Pages 5-16 (APCI) and 5-24 (ESI)
Ion optics	Clean octapoles and interoctapole lens	As needed*	Page 5-44
Mass analyzer	Clean mass analyzer	Yearly (or as needed*)	Page 5-44
Ion detection system	Clean ion detection system (electron multiplier and conversion dynode)	Whenever the top cover plate of the vacuum manifold is removed	Page 5-57
Ion detection system	Replace electron multiplier anode and cathode	If noise in spectrum is excessive or proper electron multiplier gain can not be achieved	Page 5-67.
Turbomolecular pump	Change oil reservoir	At least once a year	Page 5-75.
Turbomolecular pump	Replace turbomolecular pump	If turbomolecular pump fails	Page 5-75.
Cooling fans	Clean fan filter	Every 4 months	Page 5-80
Rotary-vane pump	Add oil	If oil level is low	Manufacturer's documentation
Rotary-vane pump	Change oil	Every 3 months or if oil is cloudy or discolored	Manufacturer's documentation
Fuses	Replace fuse	If fuse has blown	**Diagnostics and PCB and Assembly Replacement** chapter
Electronic modules	Replace electronic module	If electronic module fails	**Diagnostics and PCB and Assembly Replacement** chapter
PCBs	Replace PCB	If PCB fails	**Diagnostics and PCB and Assembly Replacement** chapter
Ion gauge	Replace ion gauge	If ion gauge fails	**Diagnostics and PCB and Assembly Replacement** chapter
* Frequency depends on analytical conditions.			

For instructions on maintaining LCs or autosamplers, refer to the manual that comes with the LC or autosampler.

The topics included in this chapter are as follows:

- Tools and supplies
- Frequency of cleaning
- API source maintenance
- Cleaning the ion optics and mass analyzer
- Replacing the electron multiplier
- Purging the rotary-vane pump oil
- Replacing the turbomolecular pump oil reservoir
- Cleaning the fan filter

Note. The keys to success with the procedures in this chapter are:

- Proceed methodically
- Always wear clean, lint-free gloves when handling the components of the API source, ion optics, mass analyzer, and ion detection system
- Always place the components on a clean, lint-free surface
- Always cover the opening in the top of the vacuum manifold with a large, lint-free tissue whenever you remove the top cover plate of the vacuum manifold
- Never overtighten a screw or use excessive force
- Never insert a test probe (for example, an oscilloscope probe) into the sockets of female cable connectors on PCBs

5.1 Tools and Supplies

The LCQ requires very few tools for you to perform routine maintenance procedures. You can remove and disassemble many of the components by hand. The tools, equipment, and chemicals listed in Table 5-2 are needed for the maintenance of the API source, ion optics, mass analyzer, and ion detection system.

Table 5-2. Tools, Equipment, and Chemicals

Description	Part Number
Wrench, 5/16-in., hex socket (Allen)	
Wrench, 9/16-in., socket	
Wrench, 7/16-in., open end	
Wrench, 9/16-in., open end	
Wrench, 5/16-in., open end	
Wrench, 1/2-in., open end	
Wrench, 3/8-in., open end	
Screwdrivers, set, ball point, Allen (also referred to as ball drivers)	00025-03025
Screwdriver, slot head, large	
Screwdriver, slot head, small	
Screwdriver, Phillips, small	
Fused-silica cutting tool	
Hypodermic tube	00106-20000
Spray bottle	
Beaker, 450 mL	
Gloves, nylon	00301-09700
Kimwipes® or other lint-free industrial tissue	
Applicators (swabs), cotton-tipped	00301-02000
Detergent	
Clean, dry, compressed nitrogen gas	
Distilled water	
Methanol, HPLC grade or better	

WARNING. As with all chemicals, solvents and reagents should be stored and handled according to standard safety procedures and should be disposed of according to local and federal regulations.

WARNUNG. Wie alle Chemikalien sind Lösungsmittel und Reagenzien entsprechend den üblichen Sicherheitsbestimmungen zu lagern und handzuhaben, sowie gemäß lokaler und übergeordneter Bestimmungen zu entsorgen.

AVERTISSEMENT. Ainsi que pour tout produit chimique, les solvants et réactifs doivent être conservés et manipulés en respectant toutes les procédures usuelles de sécurité, et doivent être mis aux déchets conformément aux règlements locaux et nationaux.

5.2 Frequency of Cleaning

The frequency of cleaning the components of the MS detector depends on the types and amounts of samples and solvents that are introduced into the instrument. In general, for a given sample and ionization technique, the closer an MS detector component is to the source of the ions, the more rapidly it becomes dirty.

- The sample tube, API probe, heated capillary bore, and spray shield of the API source should be cleaned at the end of each operating day to remove any residual salts from buffered mobile phases or other contamination that might have accumulated during normal operation. Refer to the topics **Flushing the Sample Transfer Line, Sample Tube, and API Probe** and **Flushing the Spray Shield and Heated Capillary** on pages 5-8 and 5-10.

- The tube lens and skimmer of the API source become dirty at a slower rate than the API probe, spray shield, and heated capillary. Refer to the topic **Maintaining the API Stack** on page 5-33.

- The ion optics and the mass analyzer become dirty at a rate significantly slower than the API source. Refer to the topic **Cleaning the Ion Optics and Mass Analyzer** on page 5-44.

- Clean the electron multiplier and conversion dynode whenever you remove the top cover plate of the vacuum manifold by blowing them with a clean, dry gas. Refer to the topic **Cleaning the Ion Detection System** on page 5-57.

When the performance of your system decreases significantly due to contamination, clean the components of the MS detector in the following order:

- Clean the API probe, spray shield, and heated capillary

- Clean the tube lens and skimmer

- Clean the ion optics and mass analyzer

5.3 API Source Maintenance

The API source requires a minimum of maintenance. Periodically, you need to clean the components of the API source to remove salts or other contaminants. The frequency of cleaning the API source depends on the types and amounts of samples and solvents that are introduced into the system.

Maintenance procedures are provided below to do the following:

- Flush the sample transfer line, sample tube, and API probe
- Flush the spray shield and the bore of the heated capillary
- Clear a blocked heated capillary
- Maintain the APCI probe assembly, including replacing the APCI sample tube
- Maintain the ESI probe assembly, including replacing the ESI sample tube
- Maintain the API stack, including replacing the heated capillary

WARNING. AVOID EXPOSURE TO POTENTIALLY HARMFUL MATERIALS. Always wear protective gloves and safety glasses when you use solvents or corrosives. Also, contain waste streams and use proper ventilation. Refer to your supplier's Material Safety Data Sheets (MSDS) for procedures that describe how to handle a particular solvent.

WARNUNG. KONTAKT MIT POTENTIELL GEFÄHRLICHEN SUBSTANZEN VERMEIDEN! Bei der Verwendung von Lösungs- oder Korrosionsmitteln sind stets Schutzhandschuhe und Schutzbrille zu tragen. Ablußstoffe sind aufzufangen, und gute Belüftung muss vorhanden sein. Nähere Information über den Umgang mit bestimmten Lösungsmitteln können Sie den Sicherheitsdatenblättern vom Lieferanten der jeweiligen Substanz entnehmen.

AVERTISSEMENT. EVITER D'ETRE EXPOSE AUX PRODUITS POTENTIELLEMENT DANGEREUX. Porter toujours des gants de protection et des lunettes de sécurité pour utiliser des solvants ou des matières corrosives. En outre, renfermer les écoulements de déchets et maintenir une ventilation appropriée. Consulter les fiches toxicologiques (MSDS) du fournisseur pour le mode d'emploi d'un solvant particulier.

5.3.1 Flushing the Sample Transfer Line, Sample Tube, and API Probe

You should flush the sample transfer line, sample tube, and API probe at the end of each working day (or more often if you suspect they are contaminated) by flowing a 50:50 methanol:distilled water solution from the LC through the API source.

To flush the sample transfer line, sample tube, and API probe, proceed as follows:

1. Make sure that the API flange is secured to the spray shield by the two flange retainer bolts.

2. From the Tune Plus window, choose **Control | On** (or click on the On/Standby button) to turn on the voltages and gas flows to the API source.

   - If you are operating in APCI mode, go to step 3.
   - If you are operating in ESI mode, go to step 4.

1. Set up the APCI source as follows:

   a. In the Tune Plus window, choose **Setup | APCI Source** (or click on the APCI Source button). The APCI Source dialog box appears.

   b. In the APCI Source dialog box, use the Vaporizer Temp spin box to set the vaporizer temperature to 500 °C.

   c. Use the Sheath Gas Flow Rate spin box to set the sheath gas flow rate to 80.

d. Use the Discharge Current spin box to set the discharge current to 0.

e. Use the Aux Gas Flow Rate spin box to set the auxiliary gas flow rate to 10.

f. Click on **OK** to set the APCI parameters and close the dialog box.

Go to step 5.

2. Set up the ESI source as follows:

   a. In the Tune Plus window, choose **Setup | ESI Source** (or click on the ESI Source button). The ESI Source dialog box appears.

   b. Use the Spray Voltage spin box to set the spray voltage to 0.

   c. Use the Sheath Gas Flow Rate spin box to set the sheath gas flow rate to 80.

   d. Use the Aux Gas Flow Rate spin box to set the auxiliary gas flow rate to 10.

   e. Click on **OK** to set the ESI parameters and close the dialog box.

3. Set up and start a flow of 50:50 methanol:water solution from the LC to the API source, as follows:

   a. In the Tune Plus window, choose **Setup | LC Pump** (or click on the LC Pump button). The LC Pump dialog box appears.

   b. In the LC Pump dialog box, use the Flow Rate spin box to set the flow rate to a value that is typical for your experiments.

   c. Use the Solvent spin boxes to set the flow to 50% methanol and 50% distilled water.

   d. Select the On option button. Then click on **OK** to start the LC pump.

4. Let the solution flow through the sample transfer line, sample tube, and API probe for 15 min. After 15 min, turn off the flow of liquid from the LC to the API source, as follows. Leave the API source (including the APCI vaporizer, sheath gas, and auxiliary gas) on for an additional 5 min.

    a. In the Tune Plus window, choose **Setup | LC Pump** (or click on the LC button). The LC Pump dialog box appears.

    b. Select the Off option button. Then click on **OK** to stop the LC pump.

5. After 5 min, turn off the API source by placing the MS detector in Standby: From the Tune Plus window, choose **Control | Standby** (or click on the On/Standby button) to put the MS detector in Standby.

Go on to the next topic: **Cleaning the Spray Shield and the Heated Capillary**.

5.3.2 Flushing the Spray Shield and Heated Capillary

You need to clean the spray shield and the heated capillary on a regular basis to prevent corrosion and to maintain optimum performance of your API source. A good practice is to flush the spray shield and heated capillary at the end of each operating day after you flush the sample transfer line, sample tube, and API probe with a 50:50 methanol:water solution from the LC. (See the topic **Flushing the Sample Transfer Line, Sample Tube, and API Probe** on page 5-8.) If you are operating the system with nonvolatile buffers in your solvent system or high concentrations of sample, you may need to clean the spray shield and heated capillary more often.

You do not have to vent the system to flush the spray shield and heated capillary. To clean the spray shield and the heated capillary, do the following:

1. Turn off the flow of liquid from the LC (or other sample introduction device) to the API source. To turn off the flow of liquid from the LC to the API source, do the following:

    a. In the Tune Plus window, choose **Setup | LC Pump** (or click on the LC button). The LC Pump dialog box appears.

b. Select the Off option button and then click on **OK** to stop the LC pump.

2. From the Tune Plus window, choose **Control | Standby** (or click on the On/Standby button) to put the MS detector in Standby.

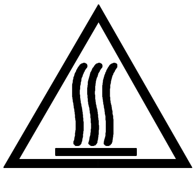
WARNING. Place the MS detector in Standby (or Off) before you open the atmospheric pressure ionization (API) source. The presence of atmospheric oxygen in the API source when the MS detector is On could be unsafe. (LCQ automatically turns the MS detector Off when you open the API source, however, it is best to take this added precaution.)

WARNUNG. Stellen Sie den MS-Detektor auf Bereitschaft (oder AUS), bevor Sie die Atmosphärendruck-Ionisationsquelle (API) öffnen. Luftsauerstoff in der API-Quelle kann bei eingeschaltetem MS-Detektor eine Gefahr darstellen. (Das LCQ schaltet den MS-Detektor automatisch AUS, wenn Sie die API-Quelle öffnen. Es wird jedoch empfohlen, diese zusätzliche Vorsichtsmaßnahme zu ergreifen.)

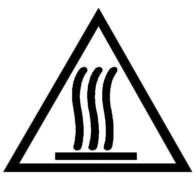
AVERTISSEMENT. Mettez le détecteur de SM en veilleuse (ou hors tension) avant d'ouvrir la source d'ionisation à la pression atmosphérique. Toute présence d'oxygène dans la source d'ionisation lorsque le détecteur de SM est activé peut comporter des risques. (Bien que LCQ désactive automatiquement le détecteur de SM lorsque vous ouvrez la source d'ionisation à la pression atmosphérique, il est préférable de prendre cette précaution supplémentaire).

1. Loosen the two flange retainer bolts that secure the API flange (APCI or ESI flange) to the spray shield.

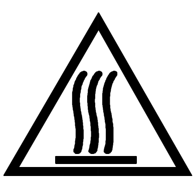
2. Pull back the API flange from the spray shield.



WARNING. AVOID BURNS. At operating temperatures, the APCI vaporizer and heated capillary can severely burn you! The APCI vaporizer typically operates at 400 to 600 °C and the heated capillary typically operates at 100 to 300 °C. Allow the heated vaporizer and heated capillary to cool to room temperature, for approximately 20 min, before you touch or remove either component.



WARNUNG. VERBRENNUNGEN VERMEIDEN! Der APCI-Verdampfer und die beheizten Kapillaren können schwere Verbrennungen verursachen! Die normale Betriebstemperatur des APCI-Verdampfers liegt zwischen 400 und 600°C, die der Kapillaren zwischen 100 und 300°C. Lassen Sie den APCI-Verdampfer und die beheizten Kapillaren 20 Minuten lang auf Umgebungstemperatur abkühlen, bevor Sie eine dieser Komponenten berühren oder entfernen.



AVERTISSEMENT. EVITER LES BRULURES. A température de fonctionnement, le vaporisateur APCI et le capillaire chauffé peuvent infliger des brûlures sévères ! Le vaporisateur APCI fonctionne normalement à des températures de 400 à 600 °C et le capillaire à des températures de 100 à 300 °C. Laisser le vaporisateur APCI et le capillaire chauffé refroidir à température ambiante pendant environ 20 minutes avant d'y toucher ou de tenter de les déplacer.

5. Temporarily place a large Kimwipe (or other lint-free tissue) on the bottom of the spray shield. (The Kimwipe is required to absorb the solution used to flush the heated capillary and spray shield.)

6. Fill a spray bottle with a 50:50 solution of HPLC-grade methanol:distilled water. Spray approximately 5 mL of the solution at the opening of the heated capillary. Do not touch the heated capillary with the tip of the spray bottle.

7. Use the spray bottle filled with the 50:50 solution of HPLC-grade methanol:distilled water to flush contaminants from the interior surface of the spray shield.

8. Remove the Kimwipe you used to absorb the solution. Swab the surface of the spray shield with a dry Kimwipe.

9. Ensure that you have removed any salt or other contaminants that may have been deposited on the spray shield.

10. If you are operating in the ESI mode, wipe off the ESI nozzle with a Kimwipe soaked with the methanol:water solution.

> **Note.** If you are finished operating your LCQ for the day, cap the heated capillary with the septum. Leave the API flange withdrawn from the spray shield. Purge the oil in the rotary-vane pump as described in the topic **Purging the Oil in the Rotary-Vane Pump** on page 5-74.

5.3.3 Clearing the Bore of the Heated Capillary

The bore of the heated capillary can become blocked by buffer salts or high concentrations of sample. A stainless steel hypodermic tube has been included in your accessory kit for clearing a blocked heated capillary.

If the pressure in the capillary-skimmer region (as measured by the Convectron gauge) drops considerably below 1 Torr, you should suspect a blocked heated capillary. (You can check the Convectron gauge pressure in the Vacuum dialog box by choosing **Setup | Vacuum** from the Tune Plus window.)

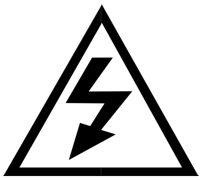
You do not have to vent the system to clear the bore of the heated capillary. To clear the bore of the heated capillary, do the following:

1. Turn off the flow of liquid from the LC (or other sample introduction device) to the API source. To turn off the flow of liquid from the LC to the API source, do the following:

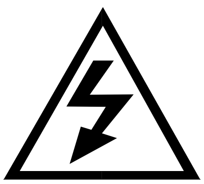
    a. In the Tune Plus window, choose **Setup | LC Pump** (or click on the LC button). The LC Pump dialog box appears.

b. Select the Off option button. Then click on **OK** to stop the LC pump.

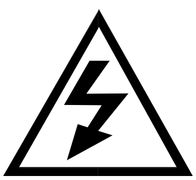
2. Place the electronics service switch (located on the right side of the MS detector) in the Service (OFF, O) position to turn off the non-vacuum system voltages.



WARNING. Make sure that the LCQ electronics service switch is in the Service (OFF, O) position before you proceed.



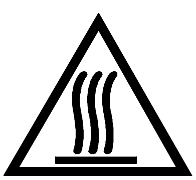
WARNUNG. Kontrollieren Sie, daß der Hauptschalter für LCQ Elektronikteile auf Wartung (Service/OFF/O) geschaltet ist bevor Sie fortfahren.



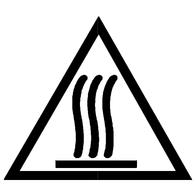
AVERTISSEMENT. S'assurer que le disjoncteur de branchement LCQ est en position Service (OFF, O) avant de continuer.

3. Loosen the two flange retainer bolts that secure the API flange (APCI or ESI) to the spray shield.

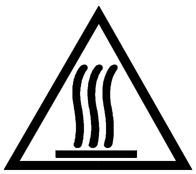
4. Pull back the API flange from the spray shield.



WARNING. The APCI vaporizer typically operates at 400 to 600 °C and the heated capillary typically operates at 100 to 300 °C.



WARNUNG. Die normale Betriebstemperatur des APCI-Verdampfers liegt zwischen 400 und 600 °C, die der Kapillaren zwischen 100 und 300°C.



AVERTISSEMENT. Le vaporisateur APCI fonctionne normalement à des températures de 400 à 600 °C et le capillaire à des températures de 100 à 300 °C.

5. Clear the bore of the heated capillary by inserting and withdrawing the 28 gauge, 10-in hypodermic tube (P/N 00106-20000) included in your accessory kit.

6. Fill a spray bottle with a 50:50 solution of HPLC-grade methanol:distilled water. From a distance of 10 cm from the entrance end of the heated capillary, spray a small amount of the solution down the bore of the heated capillary.

7. Repeat steps 5 and 6 several times.

Note. If you have unblocked the heated capillary, the Convectron gauge pressure should increase to a normal value (approximately 1 Torr). If you can not clear the heated capillary by this method, use the instructions for removing the heated capillary from the spray shield in the topic **Maintaining the API Stack** on page 5-33. Then, try clearing the heated capillary from the exit end by the same method.

8. Push the API flange assembly against the spray shield.

9. Secure the API flange to the spray shield with the two flange retainer bolts.

10. Place the electronics service switch in the Normal (ON, |) position to turn on the non-vacuum system voltages.

5.3.4 Maintaining the APCI Probe

The APCI probe requires a minimum of maintenance. The APCI sample tube (150-µm ID fused-silica tubing) is preloaded at the factory. However, if the sample tube becomes obstructed with salt precipitates or is broken, you need to replace it. Also, you may need to disassemble the APCI probe for cleaning or to replace a part.

Figure 5-1 shows the major components of the APCI probe. You do not need to vent the system to perform maintenance on the APCI probe.

> **Note.** You should flush the APCI probe at the end of each working day by flowing a 50:50 methanol:water solution from the LC through the APCI source. Refer to the topic **Flushing the Sample Transfer Line, Sample Tube, and API Probe** on page 5-8.
>
> **Note.** Wear clean gloves when you handle APCI probe components.

The following procedures are discussed in this section:

- Removing the APCI probe assembly
- Disassembling the APCI probe assembly
- Cleaning the APCI probe components
- Removing the APCI sample tube
- Installing the APCI sample tube
- Reassembling the APCI probe assembly
- Reinstalling the APCI probe assembly

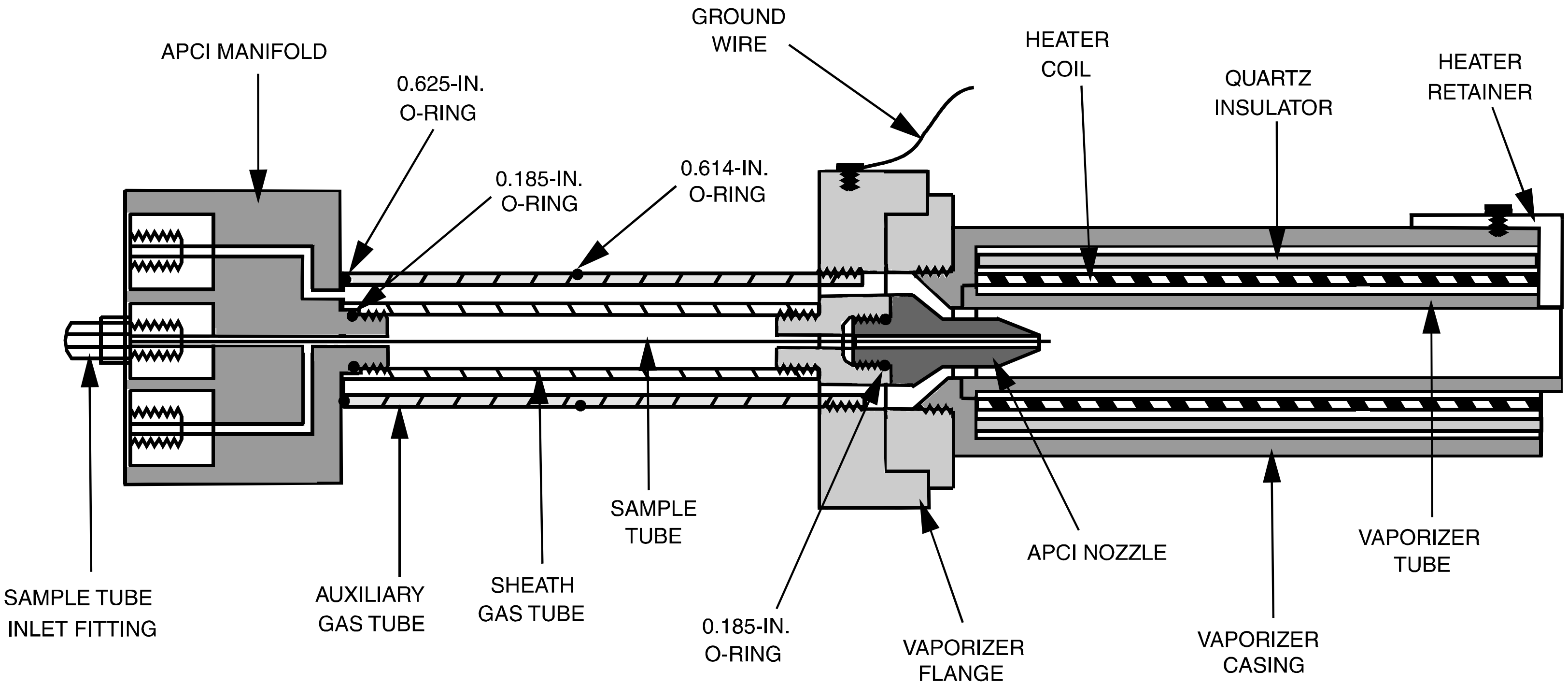
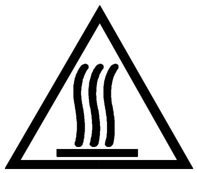


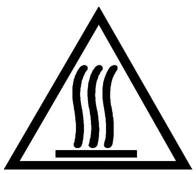
Figure 5-1. Cross sectional view of the APCI probe

5.3.4.1 Removing the APCI Probe Assembly

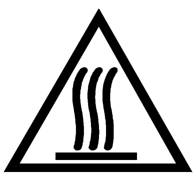
If the APCI probe assembly is installed on the LCQ, first remove the APCI probe assembly as described in the topic **Removing the APCI Probe Assembly** in the **Changing API Probe Assemblies** chapter. Place the APCI probe assembly on a lint-free tissue.



WARNING. AVOID BURNS. The APCI vaporizer heater can reach temperatures of 800 °C. Always allow the APCI probe to cool to ambient temperatures before handling or removing the APCI probe from the APCI flange.



WARNUNG. VERBRENNUNGEN VERMEIDEN! Der APCI-Verdampfer kann Temperaturen bis zu 800 °C erreichen. Lassen Sie die APCI Sonde stets auf Umgebungstemperatur abkühlen, bevor Sie sie berühren oder aus dem APCI-Flansch ausbauen.



AVERTISSEMENT. EVITER LES BRULURES. Le vaporisateur APCI peut atteindre une température de 800 °C. Laisser toujours la sonde APCI refroidir à température ambiante avant de la séparer de la bride APCI.

Caution. Wrench flats on the APCI probe components are provided for your convenience when you dismantle the APCI probe. **NEVER USE THE WRENCH FLATS TO TIGHTEN THE APCI PROBE COMPONENTS.** Only tighten the APCI probe components by hand.

Go on to the next topic: **Disassembling the APCI Probe Assembly**.

5.3.4.2 Disassembling the APCI Probe Assembly

To dissassemble the APCI probe assembly, do the following:

1. Remove the corona discharge needle (P/N 70005-98033) by pulling it free from the corona discharge needle assembly. Store the needle by inserting it into one of the foam walls of the APCI probe assembly storage container.

> **Caution. Do not break the APCI sample tube.** In step 2a, carefully pull the APCI manifold straight back from the APCI probe to prevent the sample tube from touching the sides. If the sample tube hits the sides of the sheath gas tube, it can break.

2. Remove the APCI probe from the APCI flange as follows:

   a. Hold onto the APCI flange with one hand and unscrew and remove the APCI manifold from the APCI probe. The sample tube remains with the APCI manifold.

   b. Loosen the probe retainer bolt that holds the APCI probe in the APCI flange.

   c. Remove the APCI probe from the interior of the APCI flange by gently pushing the probe from the outside of the flange. Do not disconnect the heater wires.

3. Remove the heater coil and quartz insulator as follows:

   a. With an Allen wrench, remove the socket-head screw that secures the heater retainer to the vaporizer casing.

   b. Remove the heater coil and quartz insulator from the vaporizer.

4. With a Phillips screwdriver, disconnect the green electrical ground wire from the vaporizer flange.

If you want to clean the APCI probe components, go on to the next topic: **Cleaning the APCI Probe Components**.

If you want to replace the APCI sample tube only, go to the topic **Removing the APCI Sample Tube** on page 5-21.

5.3.4.3 Cleaning the APCI Probe Components

To clean the APCI probe components, proceed as follows:

1. Complete the disassembly of the APCI probe as follows. See Figure 5-1 on page 5-17 for the location of the components.

   a. Unscrew and remove the vaporizer casing from the vaporizer manifold.

   b. Unscrew and remove the APCI nozzle from the vaporizer manifold.

   c. Unscrew and remove the auxiliary gas tube from the vaporizer manifold.

   d. Unscrew and remove the sheath gas tube from the vaporizer manifold.

2. Remove and check the condition of the 0.185-in. ID O-ring (P/N 00107-02585) on the APCI nozzle and the 0.614-in. ID O-ring (P/N 00107-05700) and 0.625-in. ID O-ring (P/N 00107-09015) on the auxiliary gas tube. Replace the O-rings if necessary.

3. Clean the APCI components with a 50:50 solution of methanol and distilled water and a lint-free swab. Dry the components with nitrogen gas and place them on a lint free tissue.

4. Reinstall the 0.614-in. and 0.625-in. O-rings on the auxiliary gas tube and the 0.185-in. O-ring on the APCI nozzle.

5. Reinstall the sheath gas tube (P/N 70005-20200) by gently screwing it by hand into the vaporizer manifold.

6. Reinstall the auxiliary gas tube (P/N 70005-20199) by gently screwing it by hand into the vaporizer manifold.

7. Reinstall the APCI nozzle (P/N 70005-20196) by gently screwing it by hand into the vaporizer manifold.

8. Reinstall the vaporizer casing (P/N 70005-20217) by gently screwing it by hand into the vaporizer manifold.

If you do not want to replace the APCI sample tube, go to the topic **Reassembling the APCI Probe Assembly** on page 5-22.

If you want to replace the APCI sample tube, go on to the next topic: **Removing the APCI Sample Tube**.

5.3.4.4 Removing the APCI Sample Tube

To remove the APCI sample tube from the APCI manifold, do the following:

1. With a 3/8-in. open-end wrench, remove the sample tube inlet fitting (P/N 70005-20250), 0.239-in. ID O-ring (P/N 00107-04000), and sample tube from the APCI manifold. See Figure 5-2.
2. Remove the exit-end nut (P/N 70005-20220), 0.016-in. ID, PEEK ferrule (P/N 00101-18120), and sample tube from the sample tube inlet fitting.
3. Discard the old sample tube.

Go on to the next topic: **Installing the APCI Sample Tube**.

5.3.4.5 Installing the APCI Sample Tube

To install a new APCI sample tube, proceed as follows:

1. Use a fused-silica cutting tool to cut a piece of 150 µm ID, 390 µm OD fused-silica tubing (P/N 00106-10498) to a length of approximately 15 cm (6 in.). Ensure that you squarely cut the ends of the fused-silica tubing.
2. Slide the exit-end nut (P/N 70005-20220) and ferrule (P/N 00101-18120) onto the length of the fused-silica tubing. See Figure 5-2.
3. Check the condition of the 0.239-in. ID O-ring (P/N 00107-04000) on the sample tube inlet fitting. Replace it if necessary.
4. Insert the fused-silica tubing into the sample tube inlet fitting.
5. Slide the exit-end nut and ferrule down the fused-silica tubing and into the sample tube inlet fitting.
6. Tighten the exit-end nut to secure the new sample tube (fused-silica tubing).

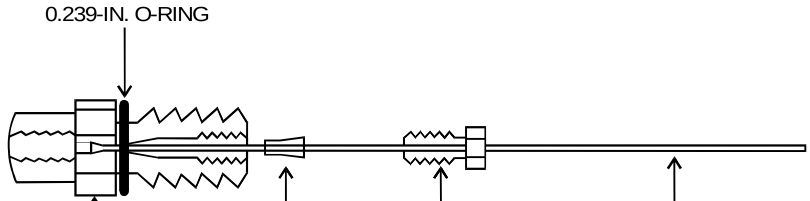


Figure 5-2. APCI sample tube connection

7. Gently slide the sample tube through the sample inlet of the APCI manifold. With a 3/8-in. open-end wrench, tighten down the sample tube inlet fitting to secure the fitting and compress the O-ring.

8. Unscrew and remove the vaporizer casing from the vaporizer flange (to expose the nozzle).

9. Gently slide the sample tube through the sheath gas tube of the APCI probe and out the APCI nozzle. Watch for the sample tube to exit the APCI nozzle. Screw the APCI manifold into the APCI probe (sheath gas tube).

10. Use a fused-silica cutting tool to cut the exit end of the sample tube so that approximately 1 mm protrudes past the tip of the APCI nozzle.

Note. Once the APCI sample tube has been cut to the proper length, you can remove the APCI manifold and accurately measure and record how far the sample tube extends past the end of the APCI manifold. The length should be about 6.5 cm (2.55 in.). In the future, sample tube replacement does not require complete disassembly of the APCI probe; just install the fused silica tubing in the APCI manifold and cut it to the proper length.

Go on to the next topic: **Reassembling the APCI Probe Assembly**.

5.3.4.6 Reassembling the APCI Probe Assembly

To reassemble the APCI probe assembly, proceed as follows:

1. Unscrew and remove the APCI manifold from the APCI probe. Be careful not to damage the sample tube.

2. Gently screw the vaporizer casing back into the vaporizer flange.

3. Reinstall the heater coil and quartz insulator into the vaporizer casing.

4. Use a Phillips screwdriver to reattach the electrical ground wire to the vaporizer flange. Make sure that the flat side of the connector is against the vaporizer flange.

5. Reinstall the heater retainer and secure it with the socket-head screw.

6. Reinstall the APCI probe (minus the APCI manifold) into the APCI flange.

7. Carefully slide the sample tube through the APCI flange, through the sheath gas tube, and out the APCI nozzle.

8. With one hand holding the vaporizer casing to keep the probe from turning, screw the APCI manifold onto the APCI probe.

9. Rotate the APCI probe until the half-moon of the heater retainer is oriented away from the tip of the corona discharge needle (when the corona discharge needle is installed). Tighten the probe retainer bolt to secure the APCI probe to the APCI flange.

10. Move the ground wire away from the vaporizer casing.

11. Reinstall the corona discharge needle by inserting it into the socket in the corona discharge needle assembly.

Go on to the next topic: **Resinstalling the APCI Probe Assembly**.

5.3.4.7 Reinstalling the APCI Probe Assembly

To reinstall the APCI probe assembly onto the LCQ, follow the procedure described in the topic **Installing the APCI Probe Assembly** in the **Changing API Probe Assemblies** chapter, or place the APCI probe assembly in its storage container.

5.3.5 Maintaining the ESI Probe

The ESI probe requires a minimum of maintenance. If the fused-silica sample tube is plugged or broken, you need to replace the sample tube. You can replace the sample tube without disassembling the ESI probe. However, to clean interior surfaces or replace the electrospray needle or needle seal, you need to disassemble the ESI probe.

Note. You should flush the ESI probe at the end of each working day by flowing a 50:50 methanol:water solution from the LC through the ESI probe. Refer to the topic **Flushing the Sample Transfer Line, Sample Tube, and API Probe** on page 5-8.

Note. Wear clean gloves when you handle ESI probe components.

The procedures described in this topic are:

- Removing the ESI probe assembly
- Disassembling the ESI probe assembly
- Removing the ESI nozzle, needle, and needle seal
- Cleaning the ESI manifold sleeve and ground cover
- Cleaning the ESI nozzle
- Reassembling the ESI probe assembly
- Reinstalling the ESI probe assembly

Note. If you only want to replace the ESI sample tube, follow the procedures described in the topics **Removing the ESI Probe Assembly**, **Disassembling the ESI Probe Assembly**, **Reassembling the ESI Probe Assembly**, and **Reinstalling the ESI Probe Assembly**.

5.3.5.1 Removing the ESI Probe Assembly

If the ESI probe assembly is installed on the LCQ, remove the ESI probe assembly as described in the topic **Removing the ESI Probe Assembly** in the **Changing API Probe Assemblies** chapter. Place the ESI probe assembly on a lint-free tissue.

5.3.5.2 Disassembling the ESI Probe Assembly

To disassemble the ESI probe assembly, proceed as follows:

1. Remove the transfer line fitting from the grounded fitting holder on the ESI flange. See Figure 5-3.

2. Remove the sample tube and sample inlet fitting from the ESI probe as follows:

    a. Unscrew the sample inlet fitting.

    b. Remove the sample tube and sample inlet fitting.

3. Loosen the probe retainer bolt that holds the ESI probe in the ESI flange and remove the ESI probe. Pull the ESI probe toward the inside (spray chamber side) of the ESI flange.

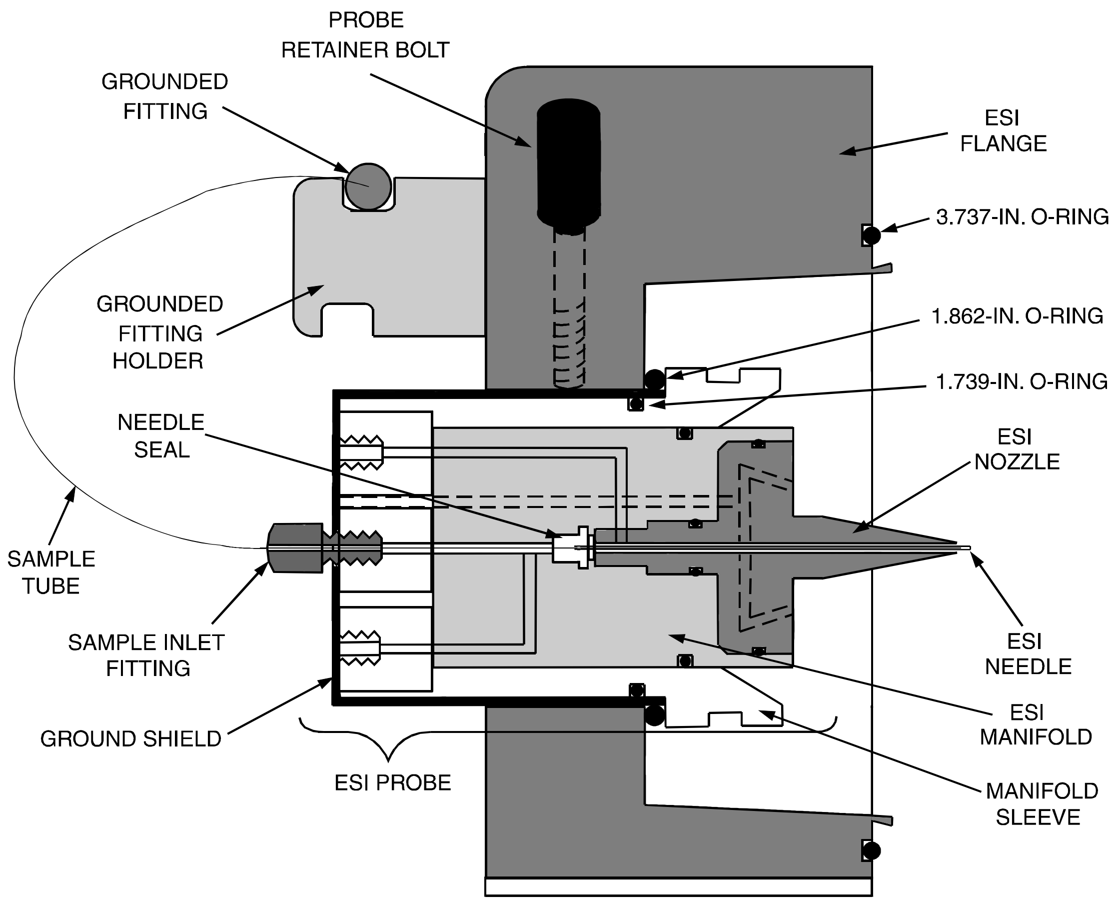


Figure 5-3. Cross sectional view of the ESI probe assembly

5.3.5.3 Removing the ESI Nozzle, Needle, and Needle Seal

You need to replace the ESI needle if it is damaged. You need to replace the needle seal if the sheath liquid is leaking at the needle seal-needle interface. See Figure 5-4.

To remove the ESI nozzle, needle, and needle seal, proceed as follows:

1. Use a 5/16-in. wrench to loosen and remove the ESI nozzle from the ESI manifold.

2. Remove the ESI needle and needle seal from the ESI manifold. (If necessary, after you remove the needle, use the needle to push the needle seal out of the ESI manifold.)

3. If necessary, replace the needle seal (P/N 00950-00952) and/or the ESI needle (P/N 00950-00951).

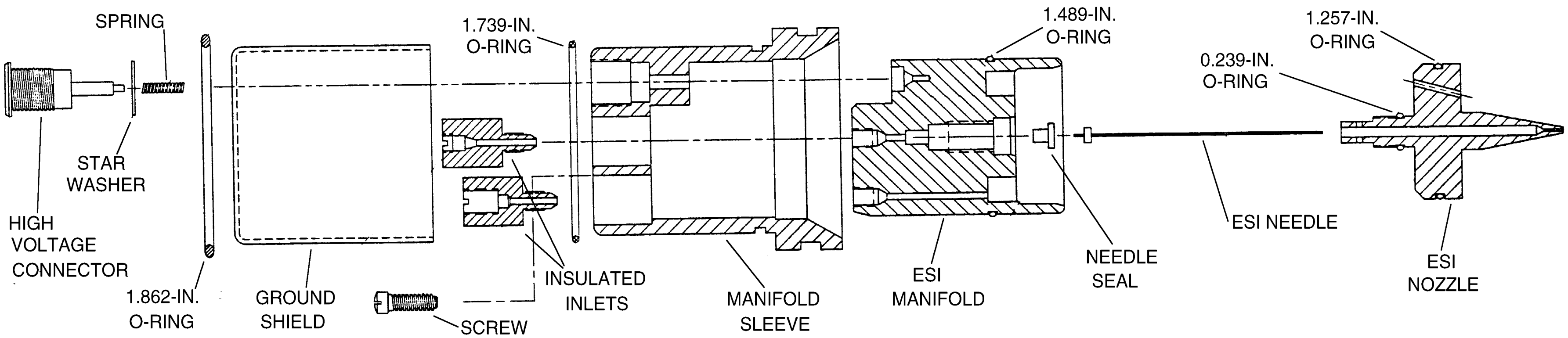


Figure 5-4. Exploded view of the ESI probe

5.3.5.4 Cleaning the Manifold Sleeve and Ground Shield

Liquids can leak between the manifold sleeve and the high voltage ground shield and cause electrical shorting. This leakage usually results from LC flow entering the ESI source without a sheath gas. The LC flow leaks back through the sheath liquid port. If sample liquid has leaked into the manifold sleeve-ground shield interface, you need to remove the ground shield and clean and dry the manifold sleeve and ground shield.

To remove the ground shield and to clean and dry the manifold sleeve and ground shield, proceed as follows (see Figure 5-4):

1. Use a 1/2-in. wrench to remove the high voltage connector, star washer, and spring.

2. Pull the ground shield away from the ESI manifold and manifold sleeve.

3. Rinse the LC leakage away from the manifold sleeve and ground shield with distilled water and then rinse with methanol.

4. Use a Kimwipe to remove the excess methanol from the manifold sleeve and ground shield.

5. Dry the manifold sleeve and ground shield with nitrogen gas.

6. Reinstall the ground shield over the ESI manifold and manifold sleeve. Ensure that the 1.739-in. ID O-ring (P/N 00107-10625) is properly positioned between the manifold sleeve and ground shield.

7. Replace and tighten the high voltage connector (along with the star washer and spring) with a 1/2-in. wrench.

5.3.5.5 Cleaning the ESI Nozzle

If necessary, clean the bore of the ESI nozzle with an appropriate solvent. This will depend on the solubility of the chemical deposits. Then rinse the nozzle with methanol and dry the nozzle with nitrogen gas.

5.3.5.6 Reassembling the ESI Probe

To reassemble the ESI probe (that is, to reinstall the ESI sample tube, nozzle, needle, and needle seal), proceed as follows (see Figure 5-4):

1. Ensure the following:

   a. The 0.239-in. ID O-ring (P/N 00107-04000) and the 1.257-in. ID O-ring (P/N 00107-05915) on the ESI nozzle are in good condition. Replace the O-rings if necessary.

   b. The 0.239-in. ID O-ring is placed past the threads on the ESI nozzle.

   c. The 1.257-in. ID O-ring is properly seated on the ESI nozzle.

   - To reinstall the old sample tube, go to step 4.
   - To install a new sample tube, go to step 2.

2. Reinstall the ESI nozzle, needle, and needle seal as follows:

   a. Insert the entrance end of the ESI needle into the needle seal. See Figure 5-4 for the proper orientation of the needle seal.

   b. Seat the ESI needle and needle seal in the ESI manifold.

   c. Thread the ESI nozzle over the needle and into the ESI manifold.

   d. With a 5/16-in. wrench, gently tighten the ESI nozzle until it is a little more than finger-tight.

3. Install a new sample tube as follows:

   a. Use a fused-silica cutting tool to cut a 25 cm (10-in.) piece of 100 µm ID, 190 µm OD fused-silica tubing (P/N 00106-10499). Ensure that you squarely cut the ends of the fused-silica tubing.

   b. Insert the new sample tube (fused-silica tubing) through the exit end of the ESI needle and into the ESI probe.

   c. Push the sample tube through the ESI probe until it exits the sample inlet.

   d. Slide a 0.008-in. ID Kel-F® ferrule (P/N 00101-18114), narrow end first, onto the sample tube.

   e. Slide the sample inlet fitting (Upchurch 1/16-in. Fingertight fitting; P/N 00101-18195) onto the sample tube and into the sample inlet. Tighten the fitting slightly, but not completely.

   f. Pull the sample tube backwards until it is 1 mm inside the exit end of the ESI needle. See Figure 5-5.

   g. Tighten the sample inlet fitting securely to hold the sample tube in place.

> **Note.** The sample tube may move forward when you tighten the sample inlet fitting. Ensure that the sample tube is retracted into the ESI needle approximately 1 mm. If necessary, loosen the fitting and reposition the sample tube.

   a. Place a 1/16-in. Upchurch Fingertight fitting (P/N 00101-18195) and a 0.008-in. ID, Kel-F ferrule (P/N 00101-18114) on the free end of the sample tube.

   b. Connect the free end of the sample tube to the transfer line fitting.

Go on to the next topic: **Reinstalling the ESI Probe**.

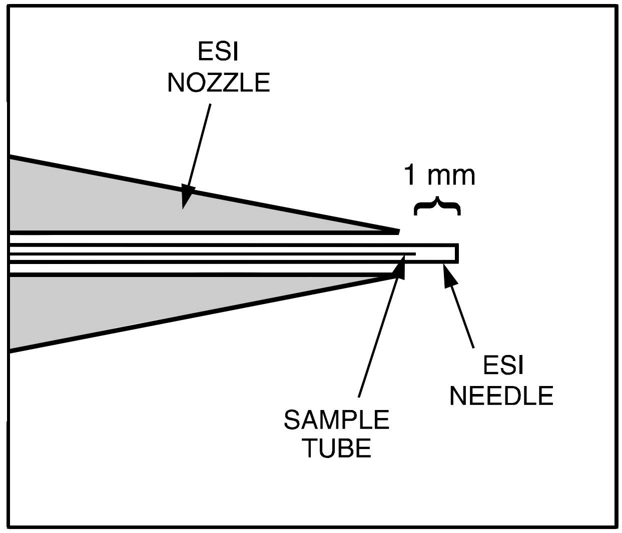


Figure 5-5. ESI nozzle, showing the proper position of the sample tube

4. To install the old sample tube and the ESI nozzle, needle, and needle seal, proceed as follows:

    a. Insert the old sample tube [with a 0.008-in. ID, Kel-F ferrule (P/N 00101-18114) and sample inlet fitting (P/N 00101-18195) on it] through the sample inlet and out the exit end of the ESI probe.

    b. Insert the entrance end of the ESI needle into the needle seal. See Figure 5-4 for the proper orientation of the needle seal.

    c. Insert the ESI needle and needle seal over the sample tube. Seat the ESI needle and needle seal in the ESI manifold.

    d. Ensure that the sample tube protrudes at least 2.5 cm (1 in.) past the end of the needle. Tighten the sample inlet fitting slightly, but not completely.

    e. Thread the ESI nozzle over the sample tube and ESI needle and into the ESI manifold.

    f. With a 5/16-in. wrench, gently tighten the ESI nozzle until it is a little more than finger-tight.

g. Pull the sample tube backwards until it is 1 mm inside the exit end of the ESI needle. See Figure 5-5.

h. Tighten the sample inlet fitting securely to hold the sample tube in place.

> **Note.** The sample tube may move forward when you tighten the sample inlet fitting. Ensure that the sample tube is retracted into the ESI needle approximately 1 mm. If necessary, loosen the fitting and reposition the sample tube.

5.3.5.7 Reinstalling the ESI Probe

To reinstall the ESI probe into the ESI flange, do the following:

1. Ensure that the 1.987-in. ID O-ring (P/N 00107-10650) that seals the ESI probe to the ESI flange is seated properly in the groove in the ESI flange. See Figure 5-3 on page 5-26.

2. Pass the ESI sample tube through the ESI flange and install the ESI probe into the ESI flange.

3. Pull the ESI probe back against the ESI flange. Tighten the probe retainer bolt that holds the ESI probe to the ESI flange.

4. Attach the transfer line fitting to the grounded fitting holder on the ESI flange.

5. Reinstall the ESI probe assembly on the LCQ as described in the topic **Installing the ESI Probe Assembly** in the **Changing API Probe Assemblies** chapter, or place the ESI probe assembly in its storage container.

5.3.6 Maintaining the API Stack

The API stack includes the spray shield, heated capillary, tube lens, and skimmer. The heated capillary has a finite lifetime. You need to replace the heated capillary if the heated capillary bore becomes corroded or if the heater fails. You also need to clean the spray shield, heated capillary, tube lens, skimmer, and other components of the API stack on a periodic basis.

To replace the heated capillary or to clean the spray shield, heated capillary, tube lens, and skimmer, do the following:

- Shut down and vent the system
- Remove the API stack
- Disassemble the API stack
- Clean the API stack components
- Reassemble the API stack
- Reinstall the API stack
- Start up the system

> **Note.** You should flush the spray shield and the bore of the heated capillary at the end of each working day with a 50:50 methanol:water solution. Refer to the topic **Flushing the Spray Shield and Heated Capillary** on page 5-10.

5.3.6.1 Shutting Down the System

Shut down and vent the system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter.

Go on to the next topic: **Removing the API Stack**.

5.3.6.2 Removing the API Stack

To remove the API stack proceed as follows:

WARNING. Make sure that the LCQ power cord is unplugged before you proceed.

WARNUNG. Das LCQ muß vom Netz getrennt werden, bevor irgendwelche Eingriffe vorgenomnen werden.

AVERTISSEMENT. Verifiez que le cordon d'alimentation du LCQ soit débranché de la prise de courant avant de procéder.

1. Loosen the two flange retainer bolts that secure the API flange to the spray shield.

2. Pull back the API probe assembly from the spray shield.

3. Disconnect the waste line from the spray shield.

4. Disconnect the API stack electrical cable from the spray shield by turning the tab on the end of the cable counterclockwise (toward you) and then pulling the cable free. See Figure 2-7.

5. Grasp the spray shield with both hands and carefully pull it and the API stack free from the vacuum manifold. Place the API stack on a clean surface with the spray shield down. Allow the API stack to cool to ambient temperature before you disassemble the API stack.

> **Note.** If you are unable to dislodge the spray shield from the vacuum manifold, reattach the API flange to the spray shield and then pull the flange away from the vacuum manifold.

The API stack is shown in Figure 5-6. Go on to the next topic: **Disassembling the API Stack**.

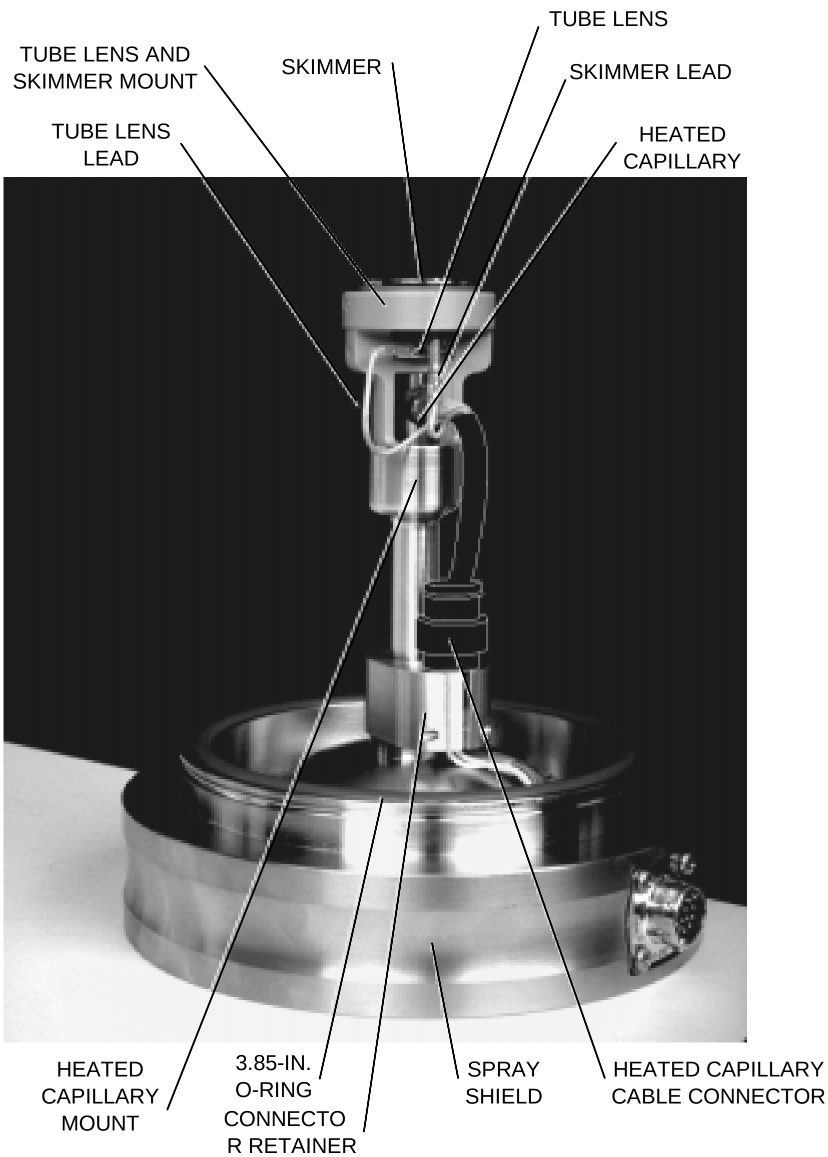


Figure 5-6. API stack

5.3.6.3 Disassembling the API Stack

Wait for the API stack to cool to ambient temperature before you disassemble it. Refer to Figure 5-6 and Figure 5-7 for the location of the various API stack components. To disassemble the API stack proceed as follows.

> **Note.** Wear clean, lint-free, nylon or cotton gloves when you handle the API stack components.

1. Disconnect the skimmer electrical lead from the lead pin on the skimmer.
2. Disconnect the tube lens electrical lead from the lead pin on the tube lens.
3. Pull the tube lens and skimmer mount free from the heated capillary mount.
4. Detach the skimmer from the tube lens and skimmer mount by pushing on its lead pin.
5. Detach the tube lens from the tube lens and skimmer mount by pushing on its guide pin.
6. Unscrew the locking ring on the heated capillary cable. Then, disconnect the heated capillary cable from the connector on the connector retainer.
7. Loosen the screws that hold the connector retainer to the heated capillary mount.
8. Loosen the heated capillary mount from the spray shield by turning it counterclockwise. (Use a wrench if necessary.)
9. Remove the heated capillary, heated capillary sleave, heated capillary mount, 0.299-in. ID O-ring, and bushing by pushing the heated capillary out of the spray shield from the atmospheric pressure side.
10. Pull the heated capillary sleeve and 0.299-in. ID O-ring off the end of the heated capillary.
11. Pull the heated capillary out of the heated capillary mount.

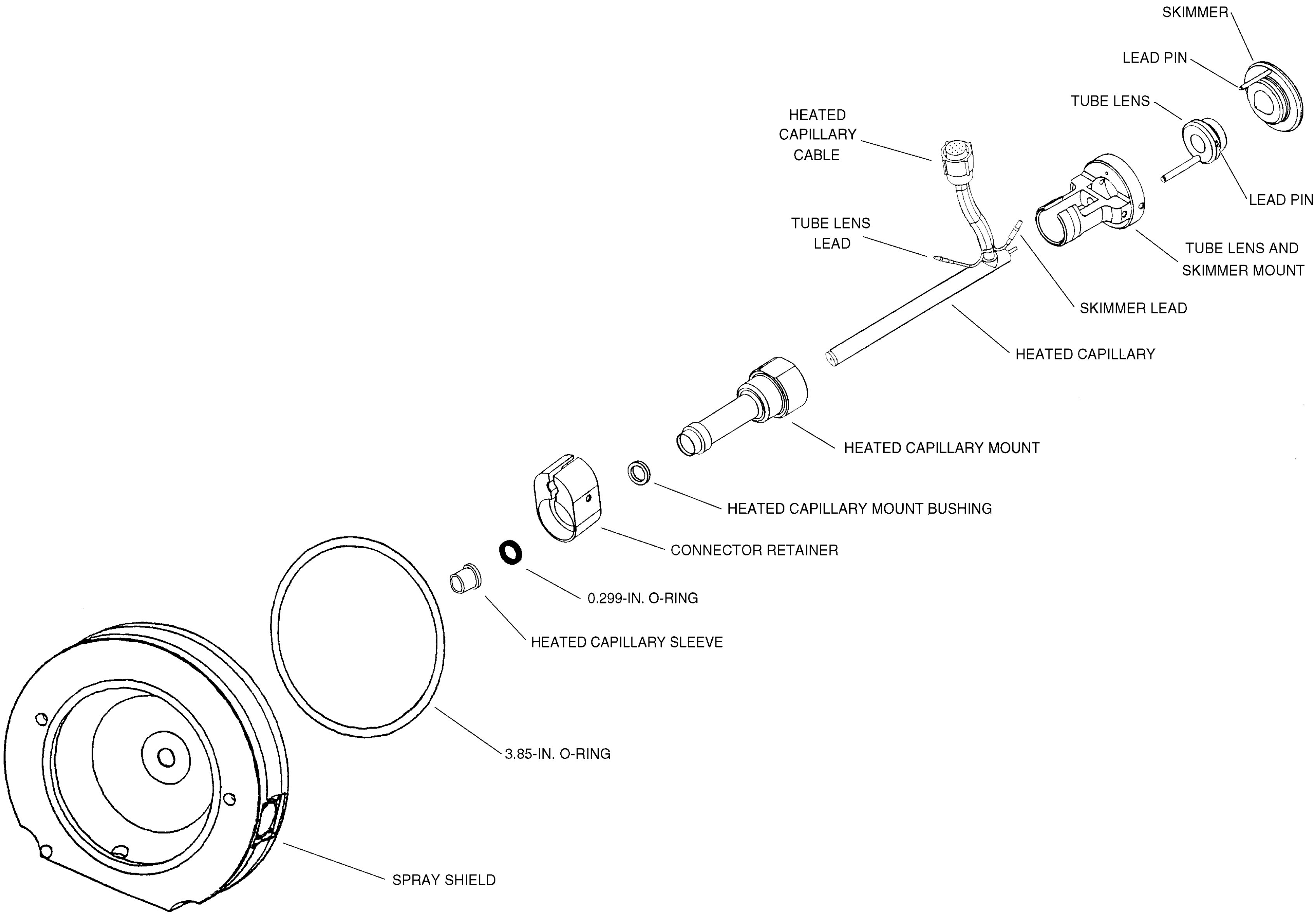


Figure 5-7. Exploded view of the API stack

5.3.6.4 Cleaning the API Stack Components

Inspect the API stack components for contamination that results from routine use. If dirty, clean the API stack components as follows.

> **Note. Solvents required for cleaning the API stack components:** For most cleaning applications, HPLC grade methanol is the solvent of choice. However, use of buffers or salt solutions may require that you use an acidic, aqueous solution. If you need to use a solvent other than methanol, after cleaning the ion source components, flush the component with water and then flush it with methanol as a final wash. In all cases, ensure that all solvent has evaporated from the component(s) before reassembly.

5.3.6.4.1 Cleaning the Tube Lens

Clean the inner bore of the tube lens with HPLC-grade methanol and a cotton-tipped applicator (swab).

5.3.6.4.2 Cleaning the Skimmer

Look at the tip of the cone on the skimmer for a region that shows discoloration due to contamination. (The off-axis pattern that you see is a result of the sample/solvent that exits from the off-axis heated capillary.) Use methanol and a cotton-tipped applicator or Kimwipe to clean the entrance and exit sides of the skimmer.

5.3.6.4.3 Cleaning the Heated Capillary

To clean the heated capillary, do the following:

1. Use methanol and a Kimwipe to clean the entrance end, exit end, and exterior of the heated capillary.
2. Clear the bore of the heated capillary by inserting and withdrawing the 28 gauge, 10-in hypodermic tube (P/N 00106-20000) included in your accessory kit.
3. Flush the bore of the heated capillary with methanol.

4. Dry the bore of the heated capillary with nitrogen gas.

5.3.6.4.4 Cleaning the Spray Shield

To clean the spray shield, wipe the inside and outside of the spray shield with methanol and a Kimwipe.

Go on to the next topic: **Reassembling the API Stack**.

5.3.6.5 Reassembling the API Stack

To reassemble the API stack, proceed as follows. Refer to Figure 5-6 and Figure 5-7 for the location of the API stack components.

1. Wipe the heated capillary sleeve and the 0.299-in. ID O-ring with a lint-free tissue. Ensure that the heated capillary sleeve (P/N 70005-20224) and the 0.299-in. ID O-ring (P/N 00107-10059) are in good condition. Replace them if necessary.

2. Seat the heated capillary mount bushing in the end of the heated capillary mount.

3. Insert the heated capillary (P/N 97000-98002) though the heated capillary mount and heated capillary mount bushing.

4. Place the 0.299-in. ID O-ring and the heated capillary sleeve over the end of the heated capillary so that the heated capillary protrudes by approximately 2.5 cm (1 in.) past the end of the heated capillary sleeve.

5. Insert the heated capillary, heated capillary mount, heated capillary mount bushing, O-ring, and heated capillary sleeve through the connector retainer and into the spray shield until the heated capillary and heated capillary sleeve protrude from the atmospheric pressure side of the spray shield. Make sure that the heated capillary cable is on the same side as the connector on the connector retainer. See Figure 5-6.

6. Screw the heated capillary mount into the spray shield by hand until it is tight. (The heated capillary mount bushing should seat in the end of the heated capillary mount and

apply a force that compresses the 0.299-in. ID O-ring against the heated capillary sleeve. See Figure 5-8.)

7. Tighten the connector retainer screws to secure the connector retainer to the heated capillary mount.

8. Reconnect the heated capillary cable to the connector that is held by the connector retainer. Turn the locking ring on the cable clockwise to lock the cable. See Figure 5-6.

9. Insert the tube lens and skimmer mount over the heated capillary until it seats in the heated capillary mount. The tube lens and skimmer mount should be aligned such that the heated capillary cable comes out of the opening in the side of the tube lens and skimmer mount.

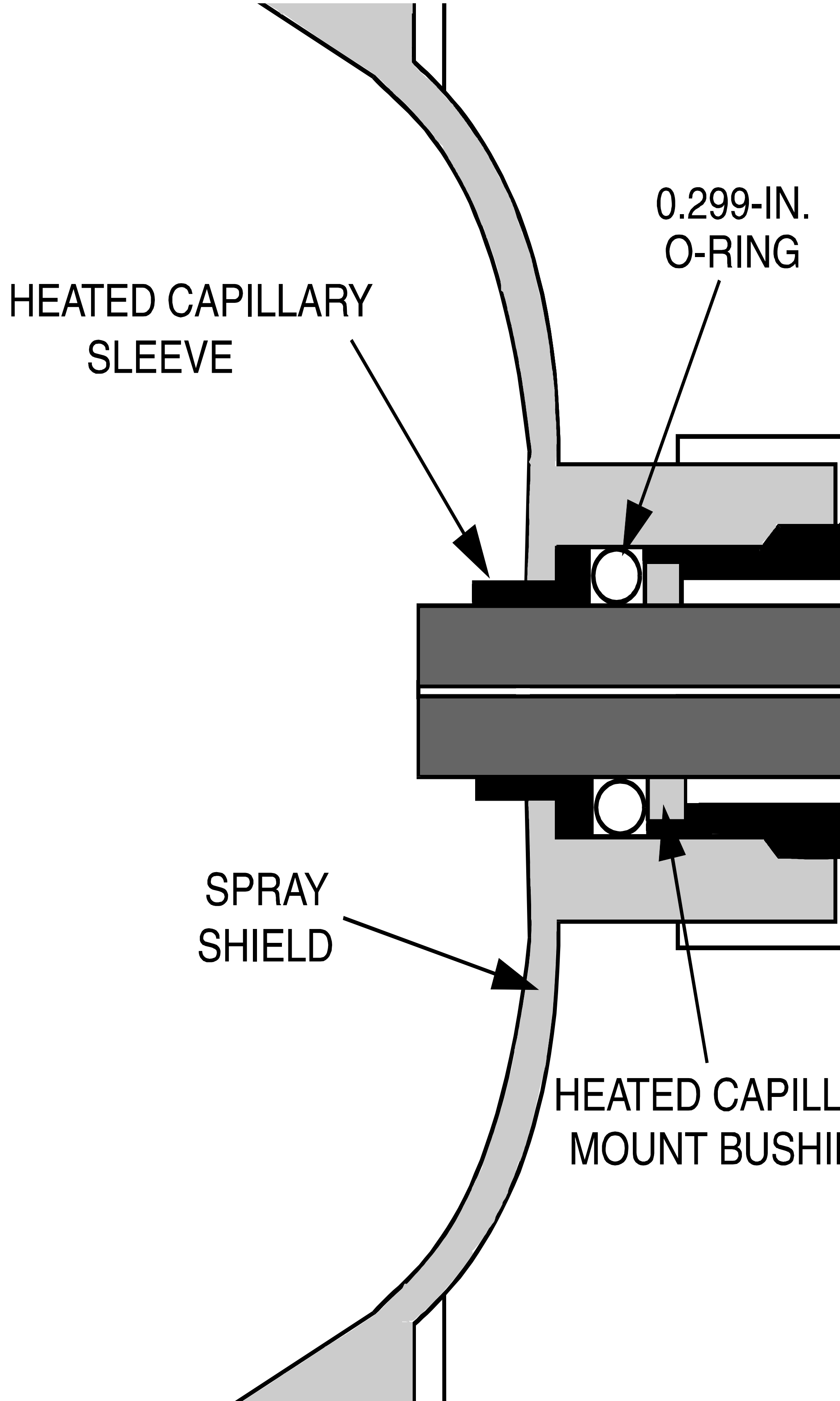

0.299-IN.
O-RING
HEATED CAPILLARY
SLEEVE
SPRAY
SHIELD
HEATED CAPILL
MOUNT BUSHI

Figure 5-8. Cross sectional view of the entrance end of the API stack

10. Align the guide pin on the tube lens with the guide pin hole on the tube lens and skimmer mount. Reinstall the tube lens by inserting it into the tube lens and skimmer mount.
11. Align the lead pin on the skimmer with the lead pin hole on the tube lens and skimmer mount. Reinstall the skimmer by inserting it into the tube lens and skimmer mount.
12. Reconnect the tube lens lead to the lead pin on the tube lens. Use needlenose pliers if necessary.
13. Reconnect the skimmer lead to the lead pin on the skimmer. Use needlenose pliers if necessary.
14. Push the heated capillary from the atmospheric pressure side of the spray shield until the opposite end of the heated capillary abuts with the tube lens and skimmer mount.

> **Note.** Ensure that the heated capillary abuts with the tube lens and skimmer mount. The API source will not operate properly unless the exit end of the heated capillary is at the proper distance from the skimmer.

15. Inspect the API stack. Ensure that the 3.85-in. ID O-ring (P/N 00107-14100) is in good condition and is properly seated on the spray shield. Ensure that all components fit together tightly. See Figure 5-6.

Go on to the next topic: **Reinstalling the API Stack**.

5.3.6.6 Reinstalling the API Stack

To reinstall the API stack, proceed as follows:

1. With a screwdriver, loosen the two screws that secure the lid to the capillary-skimmer region of the vacuum manifold. (See Figure 2-15.) Remove the lid.

2. Align the API stack with the opening in the front of the vacuum manifold. Turn the API stack until the guide pin on the spray shield is aligned with the guide pin hole in the vacuum manifold.

3. Carefully insert the API stack into the opening in the vacuum manifold until it seats in the vacuum manifold. Watch the API stack through the opening in the vacuum manifold. As you insert the API stack, make sure that the tube lens and skimmer mount inserts into the opening to the first octapole region of the vacuum manifold.

4. Reinstall the lid to the capillary-skimmer region of the vacuum manifold. With a screwdriver, tighten the two screws that secure the lid to the vacuum manifold.

5. Reconnect the API stack cable to the connector on the spray shield. Turn the tab on the end of the cable clockwise (away from you) to secure the cable.

6. Reconnect the waste line to the spray shield.

Go on to the next topic: **Starting Up the System**.

5.3.6.7 Starting Up the System

Start up the system as described in the topic **Starting Up the System After a Complete Shutdown** in the **System Shutdown, Startup, and Reset** chapter.

5.4 Cleaning the Ion Optics and Mass Analyzer

An accumulation of chemicals on the surfaces of the ion optics and mass analyzer forms an insulating layer that can modify the electrical fields that control ion transmission and mass analysis. Therefore, clean ion optics and mass analyzer are essential for the proper operation of the instrument. The ion optics and mass analyzer require cleaning less often than the API source. The frequency of cleaning depends on the type and quantity of the compounds that you analyze.

Cleaning the ion optics and mass analyzer involves the following steps:

- Shut down and vent the system
- Remove the top cover of the MS detector
- Remover the top cover plate of the vacuum manifold
- Remove the ion optics and mass analyzer
- Disassemble the ion optics and mass analyzer
- Clean the ion optics and mass analyzer parts
- Reassemble the ion optics and mass analyzer
- Reinstall the ion optics and mass analyzer
- Reinstall the top cover plate of the vacuum manifold
- Reinstall the top cover of the MS detector
- Start up the system
- Tune the ring electrode and octapole RF voltages

5.4.1 Shutting Down the System

Shut down and vent the system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter.

WARNING. Make sure that the LCQ power cord is unplugged before you proceed.

WARNUNG. Das LCQ muß vom Netz getrennt werden, bevor irgendwelche Eingriffe vorgenomnen werden.

AVERTISSEMENT. Verifiez que le cordon d'alimentation du LCQ soit débranché de la prise de courant avant de procéder.

Go on to the next topic: **Removing the Top Cover of the MS Detector**.

5.4.2 Removing the Top Cover of the MS Detector

Remove the top cover of the MS detector as follows:

1. Disconnect any tubing between the syringe pump and the API source.

2. Open the left and right front doors of the MS detector by loosening the 1/4-in. Allen screw on the right front door with an Allen wrench.

3. Loosen the four fasteners that hold the top cover to the MS detector chassis. The fasteners are located in the upper right and left corners of the chassis.

4. Slide the top cover back by about 1.25 cm (0.5 in.).

5. With one hand under the center of the top cover, lift the top cover up and away from the MS detector.

Go on to the next topic: **Removing the Top Cover Plate of the Vacuum Manifold**.

5.4.3 Removing the Top Cover Plate of the Vacuum Manifold

You need to remove the top cover plate of the vacuum manifold to access the ion optics, mass analyzer, and ion detection system. The top cover plate is held in place by gravity and by the air pressure differential between the vacuum manifold and atmospheric pressure. Six cables and one gas line are connected to the top cover plate. See Figure 5-9.

To remove the top cover plate, proceed as follows:

1. Disconnect (at ANAL. AUX 1 IN) the octapoles cable that comes from the Analyzer Auxiliary PCB.

2. Disconnect (at ANALYZER) the lenses cable that comes from the System Control PCB.

3. Disconnect (at ANAL. AUX 2 IN and ANAL. AUX 3 IN) the two endcap electrode cables that come from the Analyzer Auxiliary PCB.

4. Disconnect (at ACQU/DSP) the electrometer cable. (If necessary, use a small screw driver to loosen the screws that secure the cable.)

5. Disconnect (at MULT) the electron multiplier high voltage cable that comes from the electron multiplier power supply.

6. Use a 7/16-in. open-end wrench to disconnect the helium damping gas line from the fitting.

7. Carefully lift the top cover plate straight up by its two handles. Take care not to damage the components on the underside of the cover plate. Place the cover plate upside down (supported on its handles) on a flat surface.

8. Cover the opening in the top of the vacuum manifold with a large, lint-free tissue.

Go on to the next topic: **Removing the Ion Optics and Mass Analyzer**.

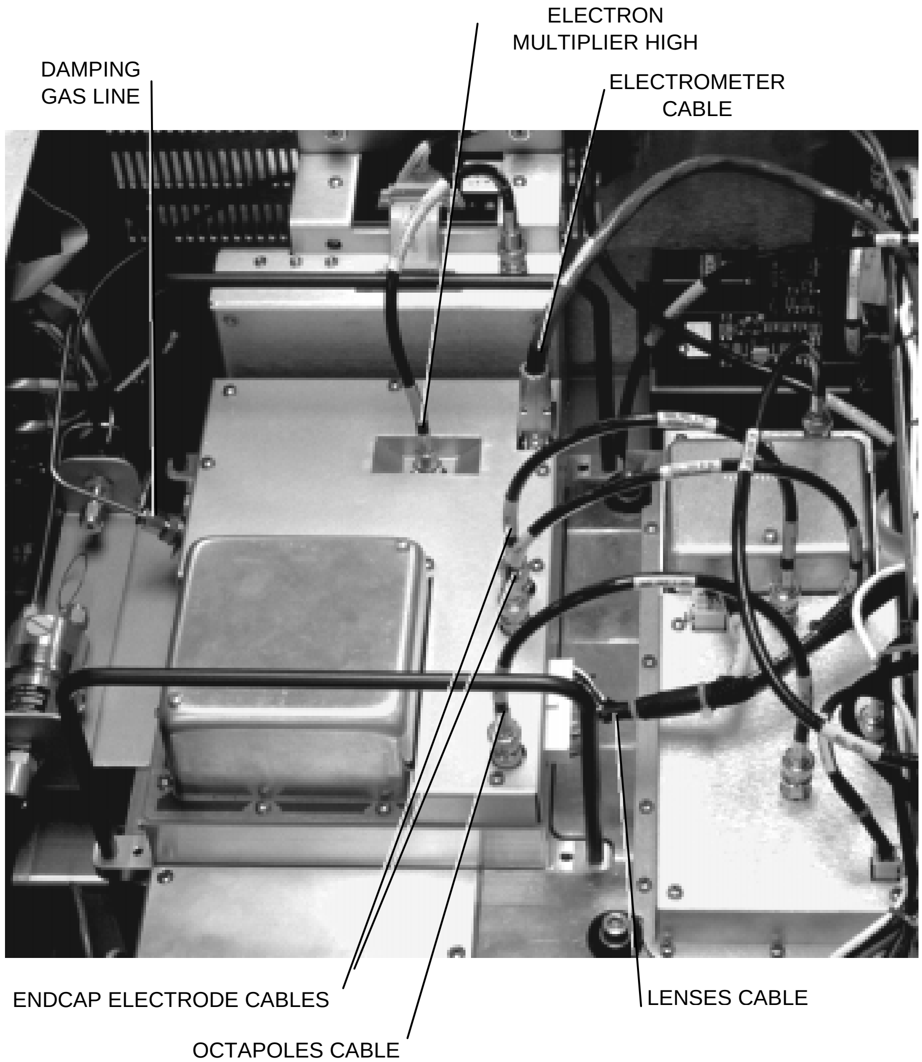


Figure 5-9. Electrical connections and damping gas line connection to the top cover plate of the vacuum manifold

5.4.4 Removing the Ion Optics and Mass Analyzer

The ion optics and mass analyzer are mounted on a baffle on the underside of the top cover plate of the vacuum manifold. See Figure 5-10 and Figure 5-11.

Use the following procedure to remove the ion optics and mass analyzer from the top cover plate. Refer to Figure 5-12 and Figure 5-13 for the location of the ion optics and mass analyzer components.

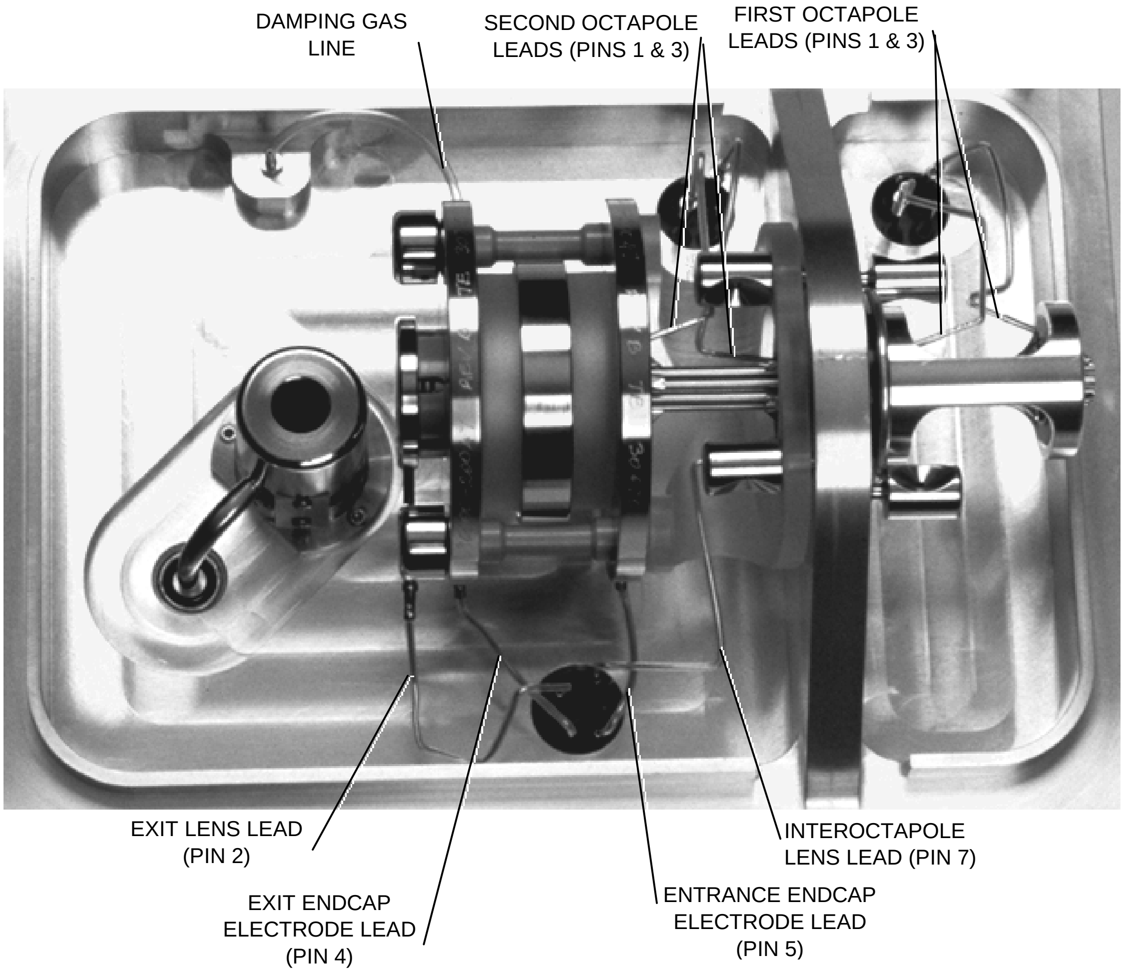


Figure 5-10. Mass analyzer and ion optics, showing electrical and damping gas line connections

> **Note.** Wear clean, lint-free, nylon or cotton gloves when you handle the ion optics and mass analyzer components.

1. Prepare a clean work area by covering the area with lint-free paper. Place each part on the paper as you remove it.

2. Disconnect the two electrical leads to the first octapole. See Figure 5-10.

3. Hold the octapole mount with one hand; loosen and remove the two thumb screws that hold the octapole mount to the baffle on the top cover plate of the vacuum manifold. See Figure 5-11.

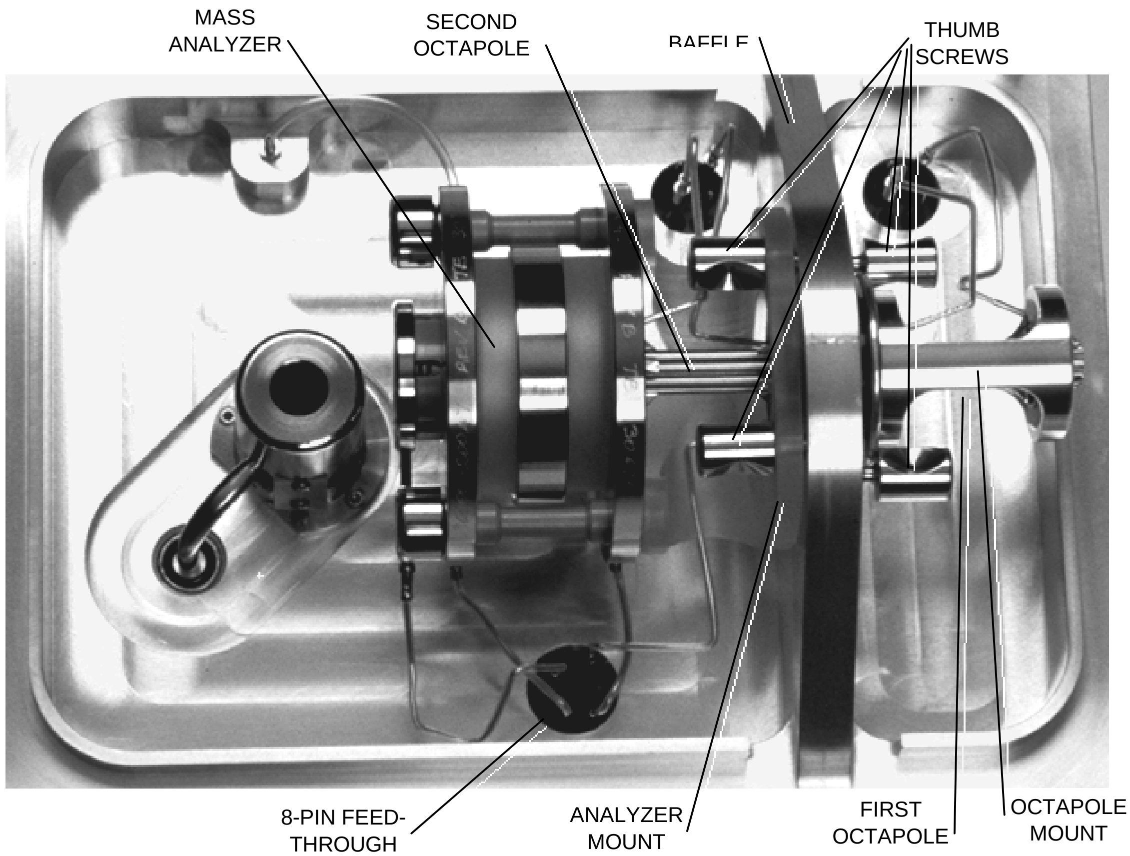


Figure 5-11. Mass analyzer and ion optics, mounted to the baffle on the top cover plate of the vacuum manifold

1. Remove the first octapole and octapole mount.

2. Disconnect the electrical lead to the interoctapole lens. Remove the interoctapole lens (Figure 5-10).

3. Disconnect the electrical leads to the second octapole and to the exit lens, exit endcap electrode, and entrance endcap electrode of the mass analyzer (Figure 5-10).

4. Disconnect the damping gas line from the nipple on the exit endcap electrode by pulling the line free from the nipple (Figure 5-10).

5. Hold the mass analyzer with one hand; loosen the two thumb screws that hold the analyzer mount to the baffle (Figure 5-11).

6. With one hand holding the mass analyzer and the other hand holding the analyzer mount, lift the mass analyzer, second octapole, and analyzer mount out and away from the baffle on the top cover plate. Be careful not to touch the electron multiplier with the mass analyzer. This could damage the electropolished surface.

Go on to the next topic: **Disassembling the Ion Optics and Mass Analyzer**.

5.4.5 Disassembling the Ion Optics and Mass Analyzer

To disassemble the ion optics and mass analyzer, proceed as follows. Refer to Figure 5-12 and Figure 5-13 for the location of the ion optics and mass analyzer components.

1. Remove the first octapole from the octapole mount.

2. Remove the second octapole from the analyzer mount.

3. Disassemble the mass analyzer as follows:

    a. Remove the exit lens by pulling the exit lens out of the exit lens sleeve.

    b. Remove the exit lens sleeve by squeezing the sleeve and pulling it out of the recess in the exit endcap electrode.

    c. Unscrew and remove the two nuts from the posts.

    d. Remove the two spring washers from the posts.

    e. Remove the exit endcap electrode from the posts.

    f. Remove the two spacer rings and the ring electrode.

    g. Remove the entrance endcap electrode from the posts.

    h. Unscrew and remove the two posts from the analyzer mount.

Go on to the next topic: **Cleaning the Ion Optics and Mass Analyzer Parts**.

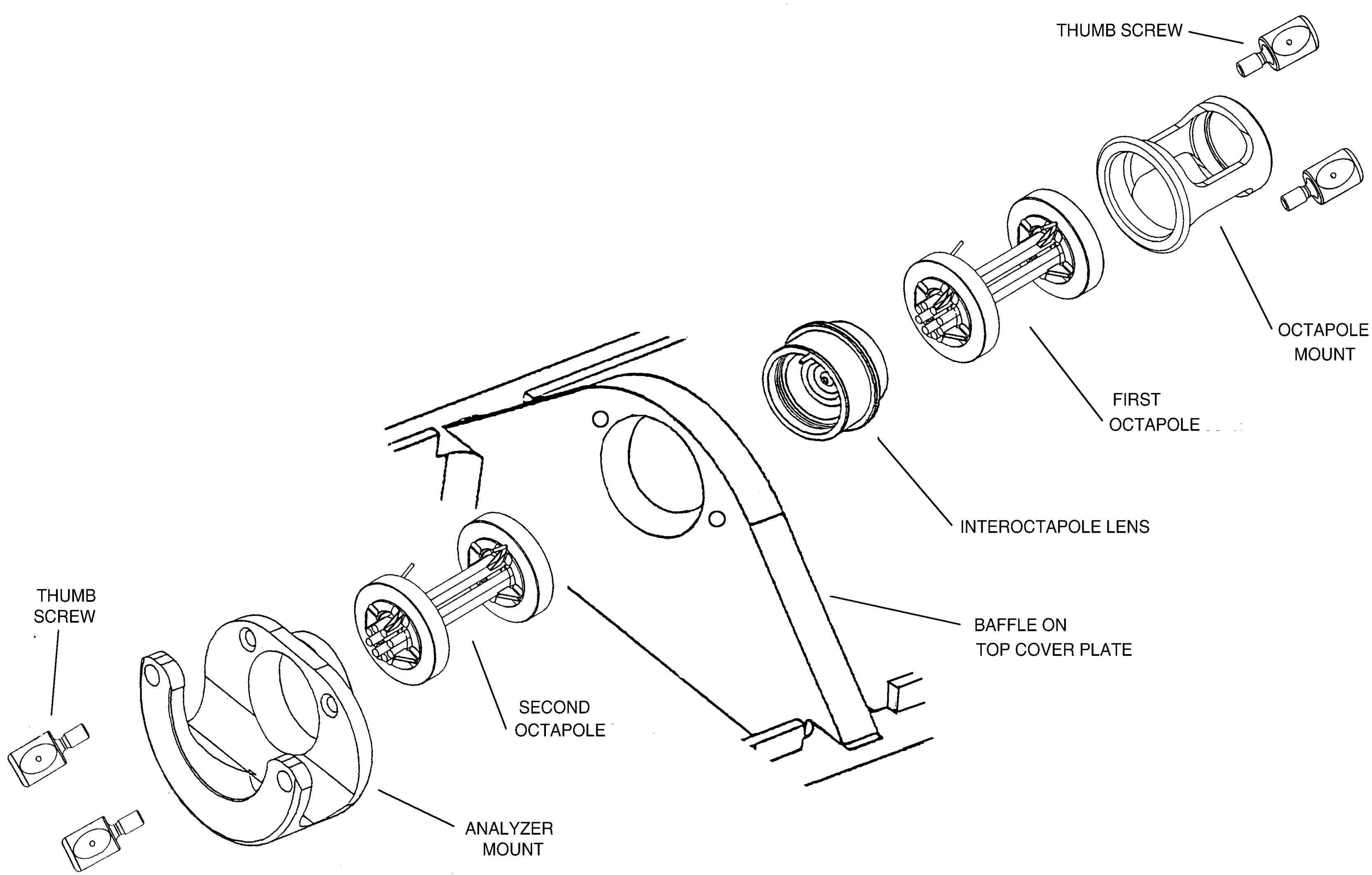


Figure 5-12. Exploded view of the ion optics

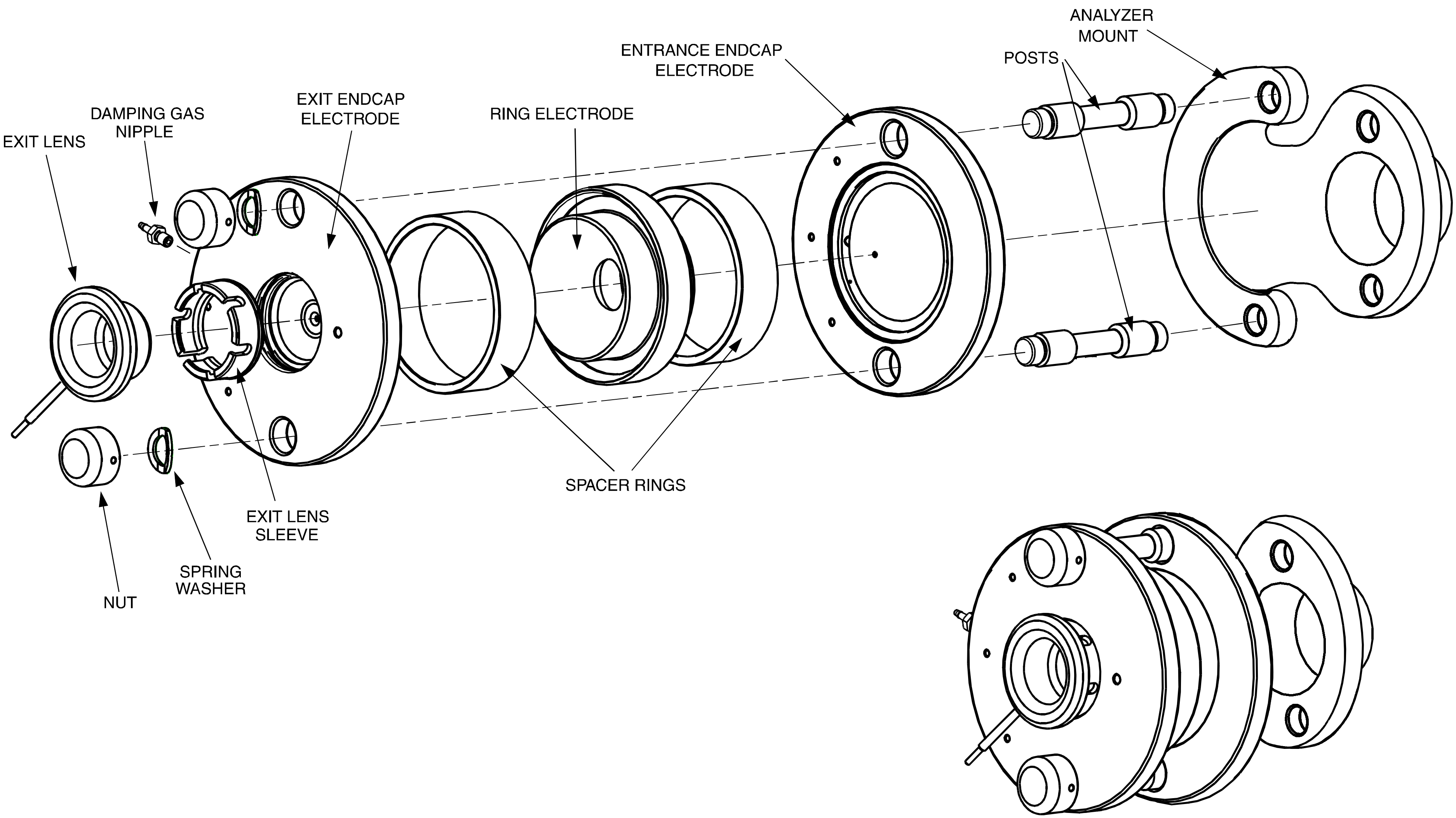


Figure 5-13. Exploded and assembled views of the mass analyzer

5.4.6 Cleaning the Ion Optics and Mass Analyzer Parts

Use the following procedure to remove contamination from the ion optics and mass analyzer parts. Clean each part in turn. After cleaning, place each part on a clean, lint free surface.

> **Caution.** Take care not to chip, scratch, or break the spacer rings of the mass analyzer. Take care not to bump or jar the octapoles. Do not place the octapoles in an ultrasonic cleaner.

> **Note.** When you clean the ion optics and mass analyzer parts, pay particular attention to the inside surfaces.

1. With a soft tooth brush or lint-free swab, scrub the ion optics or mass analyzer part with a solution of detergent and water.
2. Rinse the part with tap water to remove the detergent.
3. Rinse the part with distilled water.
4. Place the part in a tall beaker and immerse it completely in HPLC-grade methanol. Move the part up and down in the methanol for 15 s.

> **Note.** Wear clean, lint-free, nylon or cotton gloves to handle the parts after you clean them in methanol.

1. Remove the part from the methanol bath; then rinse it thoroughly with fresh methanol.
2. Dry the part with a rapid stream of nitrogen gas.
3. Inspect each part for contamination and dust. If necessary, repeat the cleaning procedure.

After all ion optics and mass analyzer parts are clean and dry, go on to the next topic: **Reassembling the Ion Optics and Mass Analyzer**.

5.4.7 Reassembling the Ion Optics and Mass Analyzer

Use the following procedure to reassemble the ion optics and mass analyzer. Refer to Figure 5-12 and Figure 5-13 on pages 5-51 and 5-52.

> **Note.** Wear clean, lint-free, nylon or cotton gloves when you handle components of the mass analyzer.

1. Reassemble the mass analyzer as follows:

   a. Reinstall the two posts by screwing them by hand into the analyzer mount. (Both ends are the same.)

   b. Reinstall the entrance endcap electrode onto the posts. (The entrance endcap electrode is the one **without** the damping gas nipple.) Ensure that the electrode is oriented such that the convex surface faces away from the analyzer mount. Also, the opening in which the pin on the end of the electrical lead inserts should be close to the top cover plate when the analyzer mount is installed on the top cover plate. See Figure 5-10 on page 5-48.

> **Caution.** Handle the spacer rings carefully. Do not scrape the spacer rings against any metal surfaces. Metal deposits on the surfaces of the spacer rings might cause the RF voltage to arc across the spacer rings to the endcaps. Do not overtighten the mass analyzer nuts.

   c. Place a spacer ring into the groove in the entrance endcap electrode.

   d. Reinstall the ring electrode onto the spacer ring so that the spacer ring is held securely between the electrodes. The orientation of the ring electrode is unimportant. (Both sides are the same.)

e. Reinstall the second spacer ring into the groove in the ring electrode.

f. Reinstall the exit endcap electrode (the one with the damping gas nipple) on the posts such that the spacer ring is held in place between the ring electrode and the exit endcap electrode. Make sure that the electrode is oriented such that the convex surface faces the spacer ring. Also, the damping gas nipple should point toward the top cover plate when the analyzer mount is installed on the top cover plate.

g. Inspect the mass analyzer assembly. Ensure that all the parts are aligned properly and that they all fit together snugly.

h. Reinstall the two spring washers on the posts such that the convex side of the washer is toward the exit endcap electrode.

i. Reinstall the two nuts onto the posts and tighten the nuts by hand until they are finger tight. Do not overtighten the nuts.

j. Squeeze the exit lens sleeve and insert it into the recess in the exit endcap electrode. See Figure 5-13 on page 5-52 for the proper orientation of the exit lens sleeve.

k. Insert the exit lens into the exit lens sleeve such that the lead pin on the exit lens points in the same direction as the 8-pin feedthrough when the analyzer mount is installed on the top cover plate. See Figure 5-10 on page 5-48. Make sure that the exit lens lead pin does not contact the nut on the end of the mass analyzer post.

2. Insert one of the octapoles into the octapole mount. (Both octapoles are the same.)

3. Insert the other octapole through the cylindrical end of the analyzer mount until it seats in the entrance endcap electrode of the mass analyzer. Turn the octapole until the lead pins are on the same side as the 4-pin feedthrough (when the analyzer mount is mounted on the top cover plate).

Go on to the next topic: **Reinstalling the Ion Optics and Mass Analyzer**.

5.4.8 Reinstalling the Ion Optics and Mass Analyzer

Use the following procedure to reinstall the ion optics and mass analyzer onto the top cover plate of the vacuum manifold:

> **Note.** Wear clean, lint-free, nylon or cotton gloves when you handle components of the ion optics and mass analyzer.

1. Insert the cylindrical end of the analyzer mount (with the mass analyzer and second octapole attached) into the opening in the baffle on the top cover plate of the vacuum manifold. Ensure that the open side of the analyzer mount is away from the top cover plate. See Figure 5-11.

2. Secure the analyzer mount to the baffle with the two thumb screws.

3. Insert the interoctapole lens, lead pin first, through the opening in the baffle. Turn the interoctapole lens until the lead pin is on the same side as the 8-pin feedthrough. Ensure that the second octapole is held securely between the endcap electrode and the interoctapole lens. Also ensure that the lead pins on the octapole are on the same side as the 4-pin feedthrough.

4. Attach the first octapole and octapole mount to the baffle on the top cover plate with the two thumb screws. Ensure that the interoctapole lens is held securely between the two octapoles. Also ensure that the lead pins on the octapole are on the same side as the 4-pin feedthrough.

5. Inspect the ion optics. Ensure that all the parts are aligned properly and that they all fit together snugly.

6. Reconnect the two electrical leads from pins 1 and 3 of the 4-pin feedthrough (see Figure 5-10 on page 5-48) to the first octapole. (It does not matter which lead is connected to a particular lead pin of the octapole.)

7. Reconnect the electrical lead from pin 7 of the 8-pin feedthrough (Figure 5-10) to the interoctapole lens.

8. Reconnect the two electrical leads from pins 1 and 3 of the 4-pin feedthrough (Figure 5-10) to the second octapole. (It does

not matter which lead is connected to a particular lead pin of the octapole.)

9. Reconnect the electrical lead from pin 5 of the 8-pin feedthrough (Figure 5-10) to the entrance endcap electrode by inserting the pin on the end of the lead into the socket in the electrode.

10. Reconnect the electrical lead from pin 4 of the 8-pin feedthrough (Figure 5-10) to the exit endcap electrode by inserting the pin on the end of the lead into the socket in the electrode.

11. Reconnect the electrical lead from pin 2 of the 8-pin feedthrough (Figure 5-10) to the exit lens. Ensure that the exit lens lead pin does not contact the nut.

12. Reconnect the damping gas line to the nipple on the exit endcap electrode.

Note. Check all leads and ensure that they are secure and that they go to the proper electrodes.

Go on to the next topic: **Cleaning the Ion Detection System**.

5.4.9 Cleaning the Ion Detection System

The conversion dynode and electron multiplier of the ion detection system must be kept dust free. Clean the conversion dynode and electron multiplier whenever you remove the top cover plate of the vacuum manifold. Cleaning the conversion dynode and electron multiplier involves only blowing them with clean, dry gas such as nitrogen. Freon gas is not recommended. **Do not use liquids to clean the ion detection system components.** Always cover the opening in the top of the vacuum manifold with a large, lint-free tissue whenever you remove the top cover plate of the vacuum manifold.

Go on to the next topic: **Reinstalling the Top Cover Plate of the Vacuum Manifold**.

5.4.10 Reinstalling the Top Cover Plate of the Vacuum Manifold

Use the following procedure to reinstall the top cover plate of the vacuum manifold:

1. Remove the tissue from the opening in the top of the vacuum manifold.

2. Check the O-ring that surrounds the opening for signs of wear, and replace it if necessary (P/N 97000-40015). Make sure that the O-ring is seated properly.

> **Note.** Periodically, remove any contamination that might be on the inner walls of the manifold by wiping the inner walls with a lint-free tissue soaked in HPLC-grade methanol. Use a cotton-tipped applicator soaked in methanol to clean around inlets and feedthroughs.

8. Carefully lift the top cover plate up by its two handles and turn it over. Orient the top cover plate such that the electron multiplier is over the conversion dynode. Carefully insert the guide posts on the underside of the top cover plate into the guide holes in the vacuum manifold. Slowly lower the cover plate onto the opening in the vacuum manifold. Take care not to damage the components on the underside of the cover plate. Ensure that the cover plate is seated properly on the vacuum manifold.

9. Use a 7/16-in. open-end wrench to reconnect the helium damping gas line to the fitting. See Figure 5-9 on page 5-47.

10. Reconnect (at ANAL. AUX 1 IN) the octapoles cable that comes from the Analyzer Auxiliary PCB.

11. Reconnect (at ANALYZER) the lenses cable that comes from the System Control PCB.

12. Reconnect (at ANAL. AUX 2 IN and ANAL. AUX 3 IN) the two endcap electrode cables that come from the Analyzer Auxiliary PCB.

13. Reconnect (at ACQU/DSP) the electrometer cable.

14. Reconnect (at MULT) the electron multiplier high voltage cable that comes from the electron multiplier power supply.

Go on to the next topic: **Reinstalling the Top Cover of the MS Detector**.

5.4.11 Reinstalling the Top Cover of the MS Detector

Reinstall the top cover of the MS detector as follows:

1. Open the left and right front doors of the MS detector.
2. With one hand under the center of the top cover, place the top cover over the MS detector such that the front of the cover is about 1.25 cm (0.5 in.) behind the front of the MS detector.
3. Slide the cover forward until it is flush with the front doors (when they are closed).
4. Tighten by hand the four fasteners to secure the top cover to the chassis.
5. Close the left and right front doors of the MS detector.
6. Reconnect any tubing between the syringe pump and the API source to accomodate your instrument configuration.

Go on to the next topic: **Starting Up the System**.

5.4.12 Starting Up the System

Start up the system as described in the topic **Starting Up the System After a Complete Shutdown** in the **System Shutdown, Startup, and Reset** chapter.

Go on to the next topic: **Tuning the Ring Electrode and Octapole RF Voltages**.

5.4.13 Tuning the Ring Electrode and Octapole RF Voltages

You need to tune the ring electrode RF voltage and the octapole RF voltage whenever you service the mass analyzer or ion optics. You also need to tune these voltages if you replace any electronic assembly that is involved in producing the RF voltages. You use the Diagnostics program to tune the ring electrode and octapole RF voltages.

To tune the ring electrode and octapole RF voltages, proceed as follows:

1. Allow the LCQ to pump down for at least 15 min after start up.

2. Open the Tune Plus window.

3. Choose **Control | On** to turn the LCQ On.

4. Open the Diagnostics dialog box and Graph view as follows:

   a. In the Tune Plus window, choose **View | Display Graph View** to open the Graph view.

   b. In the Tune Plus window, choose **Diagnostics | Diagnostics** to open the Diagnostics dialog box.

   c. Select the **Graph** tab.

   d. Reposition the Diagnostics dialog box so that it does not obscure the Graph view. See Figure 5-14.

5. Tune the octapole RF voltage, as follows:

   a. Select **Tune octapole frequency** in the Test Type text box.

   b. Select the **Once** option button in the How many times group box.

   c. Click on the **Start** button to start the octapole RF voltage tune program. A frequency function appears in the Graph view. See Figure 5-15. The minimum of the frequency function should lie between 2400 and 2550 kHz.

d. When the octapole tune program is finished, LCQ displays the message: Do you want to accept the octapole frequency? Click on the **Yes** button.

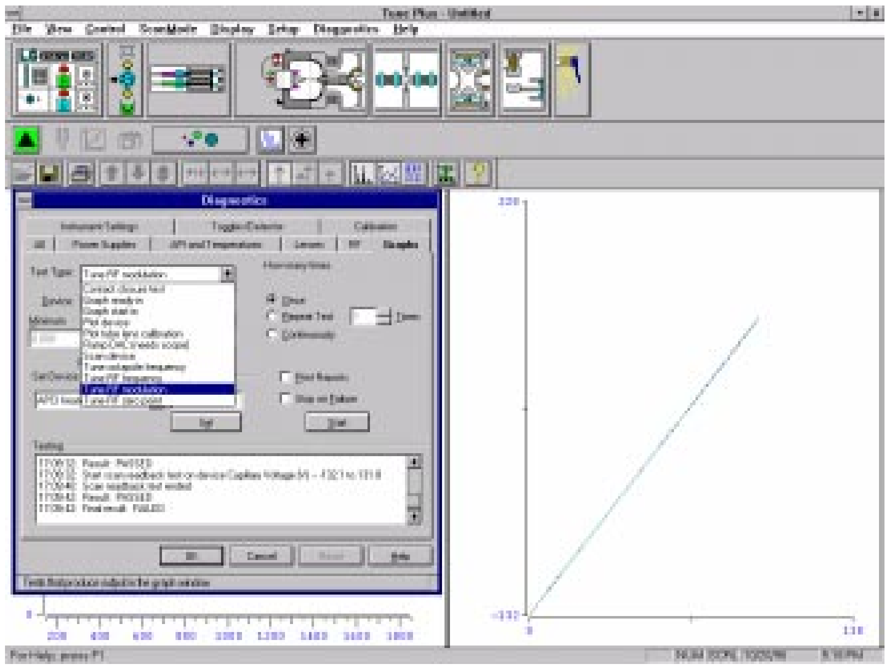


Figure 5-14. Diagnostics dialog box and Graph view

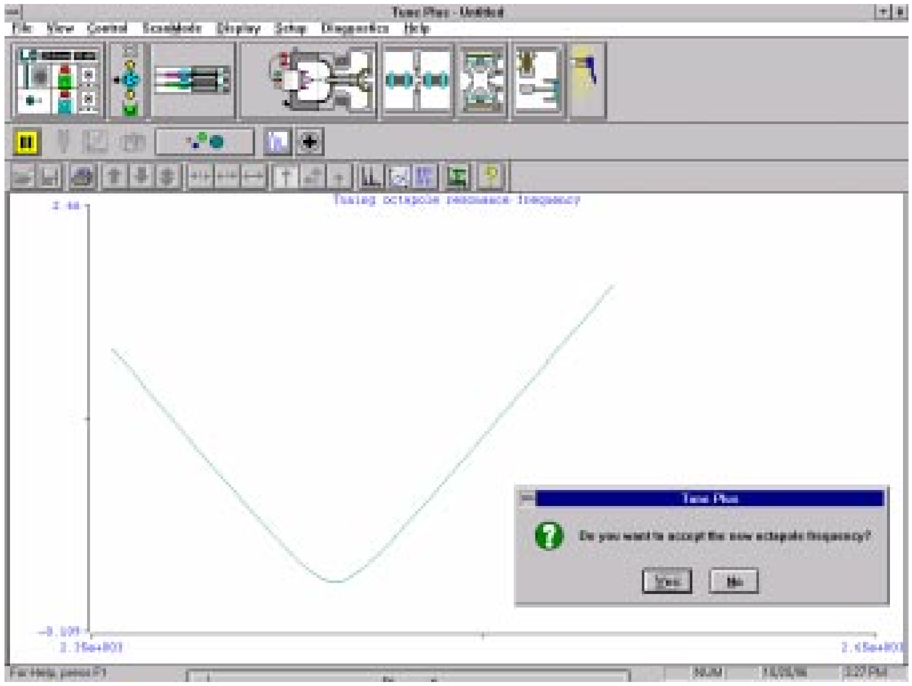


Figure 5-15. Graph view for octapole RF voltage tuning

6. Tune the ring electrode RF voltage modulation, as follows:

   a. Select **Tune RF modulation** in the Test Type text box.

   b. Select the **Once** option button in the How many times group box.

   c. Click on the **Start** button to start the ring electrode RF modulation tune program. The Graph view should look like Figure 5-16:

      - The standing wave ratio switch line should be at 10 V over the entire range.

      - The detected RF voltage should be a straight line that begins at the origin and intersects the standing wave ratio switch line near the highest mass line.

      - The RF voltage modulation should be a curved line that begins at the origin and intersects the highest mass line at a value between 3.5 and 4.5 V.

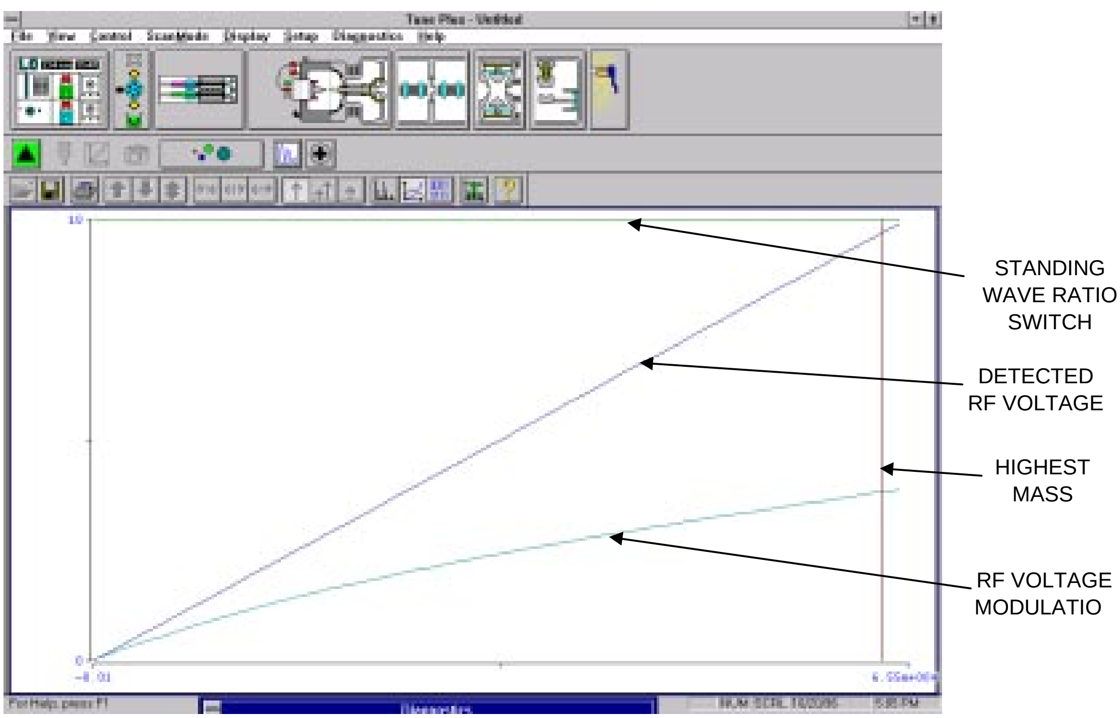


Figure 5-16. Graph view for ring electrode RF voltage modulation tuning

d. Inspect the Graph view:

- If the three above conditions are met, proceed to step 7.

- If the three above conditions are met over part of the range but not all of the range (the curves flatten or change value abruptly), tune the RF voltage frequency as described in step 7. Then, repeat step 6.

- If the standing wave ratio switch, detected RF voltage, and RF voltage modulation lines are all flat, then there might be a loose connection. Make sure that all cables and leads are properly connected and that the spring-loaded pin on the RF voltage feedthrough properly contacts the ring electrode. Repeat step 6.

7. Tune the ring electrode RF voltage frequency, as follows:

   a. Select **Tune RF frequency** in the Test Type text box. The Continuous option button in the How many times group box is automatically selected.

   b. Click on the **Start** button to start the ring electrode RF frequency tune program. The Graph view displays several tune functions, a frequency cursor, and a frequency window. See Figure 5-17.

   c. Allow the program to make at least five passes. Then determine whether the frequency cursor lies within the frequency window:

   - If the frequency cursor lies within the frequency window, then the ring electrode RF voltage frequency is tuned properly. Click on the **Stop** button and exit from the diagnostics program.

   - If the frequency cursor lies outside the frequency window, then you need to manually adjust the ring electrode RF voltage frequency. Leave the Graph view displayed. Go on to the next step.

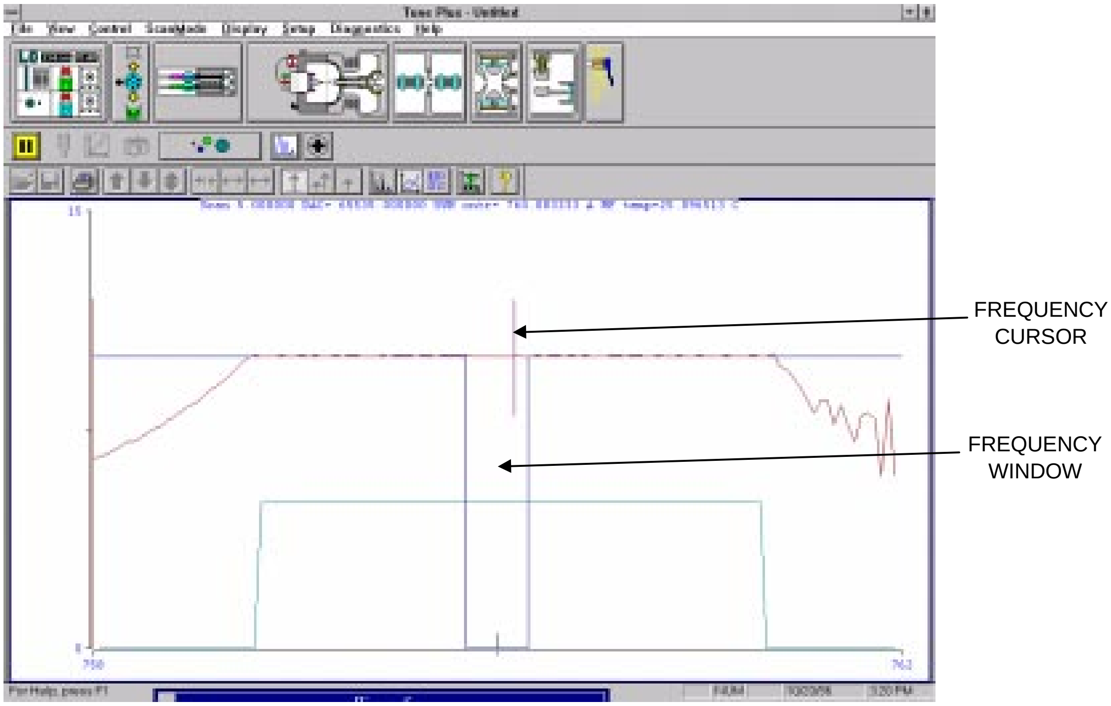


Figure 5-17. Graph view for ring electrode RF voltage tuning

8. Manually adjust the ring electrode RF voltage frequency, as follows:

   a. Open the left front door of the MS detector.

   b. With a Phillips screw driver, remove the air deflector to expose the tuning stud. See Figure 5-18.

   c. With a wrench, loosen the 9/16-in. lock nut that holds the tuning stud in place.

   d. With a screw driver, turn the tuning stud until the frequency cursor lies slightly to the left of the center of the frequency window. (The cursor should shift slightly to the right when the air deflector is reinstalled.)

   e. Tighten the 9/16-in. lock nut.

   f. Reinstall the air deflector and close the left front door of the MS detector. Make sure that the frequency cursor is still within the frequency window. If necessary, repeat the above steps.

g. Click on the **Stop** button to stop the ring electrode RF voltage frequency tune program.

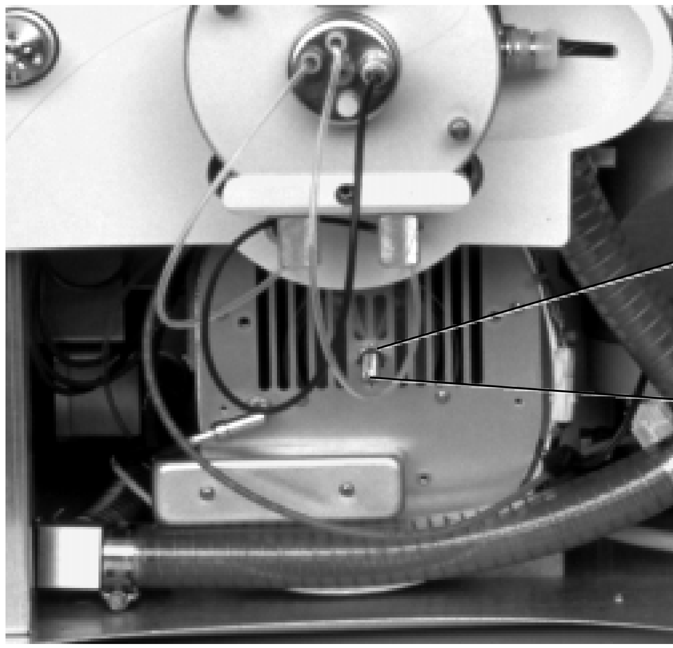


Figure 5-18. Ring electrode RF voltage tuning stud (with air deflector removed)

5.5 Replacing the Electron Multiplier

The electron multiplier of the ion detection system includes an anode and a cathode. The anode and cathode have finite lifetimes. The anode loses sensitivity over time due to contamination of its surface. Things that decrease the lifetime of the cathode are: heat; electron flow (which produces internal heat); air (which causes oxidation and arcing); and water (which causes arcing).

The following symptoms suggest that the electron multiplier may need replacing:

- Excessive noise in the mass spectrum
- Inability of the multiplier gain calibration procedure to achieve a gain of 3×10^5 electrons per ion with an electron multiplier voltage less than or equal to 2.5 kV

You can read the current value of the electron multiplier voltage in the Ion Detection System dialog box, which can be reached from the Tune Plus window by clicking on the ion detection system button.

If you are having problems with the ion detection system, you need to replace the anode and cathode of the electron multiplier. You can replace the cathode separately or as part of the electron multiplier assembly.

To replace the anode and cathode of the electron multiplier, or the entire electron multiplier assembly, proceed as follows:

1. Shut down and vent the system as described in the topic **Shutting the System Down Completely** in the **System Shutdown, Startup, and Reset** chapter.

WARNING. Make sure that the LCQ power cord is unplugged before you proceed.

WARNUNG. Das LCQ muß vom Netz getrennt werden, bevor irgendwelche Eingriffe vorgenomnen werden.

AVERTISSEMENT. Verifiez que le cordon d'alimentation du LCQ soit débranché de la prise de courant avant de procéder.

2. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** on page 5-45.

3. Remove the top cover plate of the vacuum manifold as described in the topic **Removing the Top Cover Plate of the Vacuum Manifold** on page 5-46.

Note. Wear clean, lint-free, nylon or cotton gloves when you handle the electron multiplier components.

4. With an Allen wrench, remove the two socket-head screws that hold the electron multiplier support to the top cover plate of the vacuum manifold. See Figure 5-19.

5. With one hand hold the high voltage tube and with the other hand hold the electron multiplier support. Then, detach the high voltage tube from the high voltage feedthrough in the top cover plate and remove the electron multiplier as a unit. (The anode remains in the anode feedthough in the top cover plate.)

6. Remove the anode from the anode feedthrough by unscrewing it counterclockwise by hand.

7. Install a new anode (P/N 96000-20076) in the anode feedthrough in the top cover plate by screwing it clockwise by hand.

If you want to replace the entire electron multiplier, install a new electron multiplier (P/N 96000-60036) in the next step. If you want to replace only the cathode, install the old electron multiplier in the next step.

> **Caution.** Be careful not to damage the surface of the electron multiplier shield. The electron multiplier shield has been electropolished to prevent field emission.

8. With one hand holding the high voltage tube and the other hand holding the electron multiplier support, install the electron multiplier on the top cover plate. Ensure that the high voltage tube is properly inserted in the high voltage feedthrough and that the screw holes in the electron multiplier support are aligned with the screw holes in the top cover plate.

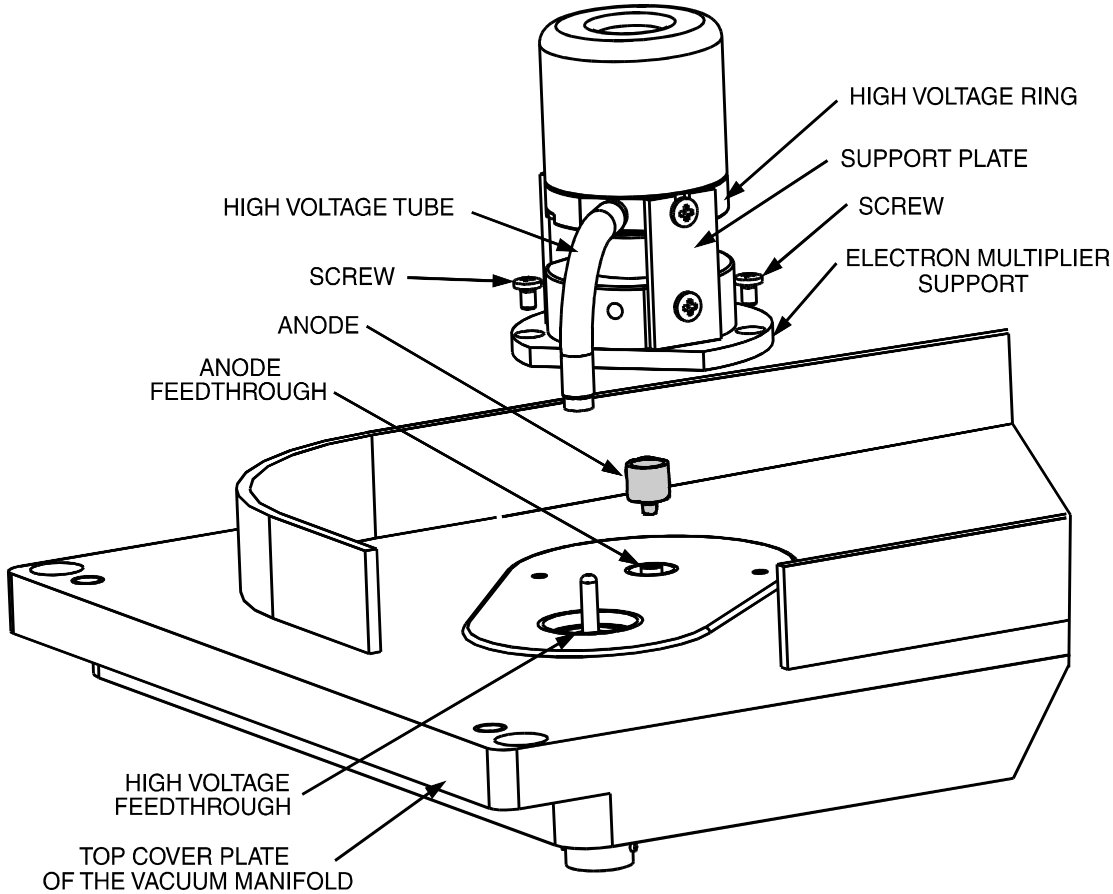


Figure 5-19. Exploded view of the electron multiplier, showing the anode

9. Reinstall the two socket-head screws that secure the electron multiplier support to the top cover plate. Tighten the screws with an Allen wrench.

   - If you installed a new electron multiplier in step 8, go to step 11.

   - If you want to replace the cathode, go on to the next step.

10. To replace the cathode, proceed as follows. See Figure 5-20.

    a. With a Phillips screwdriver, loosen (but do not remove) the two screws that secure the support plates to the high voltage ring.

b. With one hand, hold the high voltage tube. With the other hand, hold the high voltage ring. Then, detach the high voltage tube from the high voltage feedthrough and remove the electron multiplier. Place it on a clean surface. (The electron multiplier support and the support plates should remain attached to the top cover plate.)

c. Turn the assembly over. With a Phillips screwdriver, remove the two screws that secure the electron multiplier shield to the high voltage ring.

d. Remove the electron multiplier shield and cathode from the high voltage ring.

e. Insert the narrow end of a new cathode (P/N 00022-02400) first through the spring washer and then through the high voltage ring.

f. Place the electron multiplier shield over the wide end of the cathode such that the screw holes in the electron multiplier shield are aligned with the screw holes in the high voltage ring.

g. Hold the high voltage ring and electron multiplier shield together to depress the spring washer. Secure the high voltage ring to the electron multiplier shield by using the two Phillips-head screws. (The cathode should be held in place between the high voltage ring and the electron multiplier shield.)

h. Insert the end of the high voltage tube in the electron multiplier feedthrough in the top cover plate. Reattach the high voltage ring to the support plates by inserting the two screws in the sides of the high voltage ring into the notches in the two support plates. Tighten the two Phillips-head screws that secure the high voltage ring to the two support plates.

11. Reinstall the top cover plate of the vacuum manifold over the opening in the vacuum manifold as described in the topic **Reinstalling the Top Cover Plate of the Vacuum Manifold** on page 5-58.

12. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** on page 5-59.

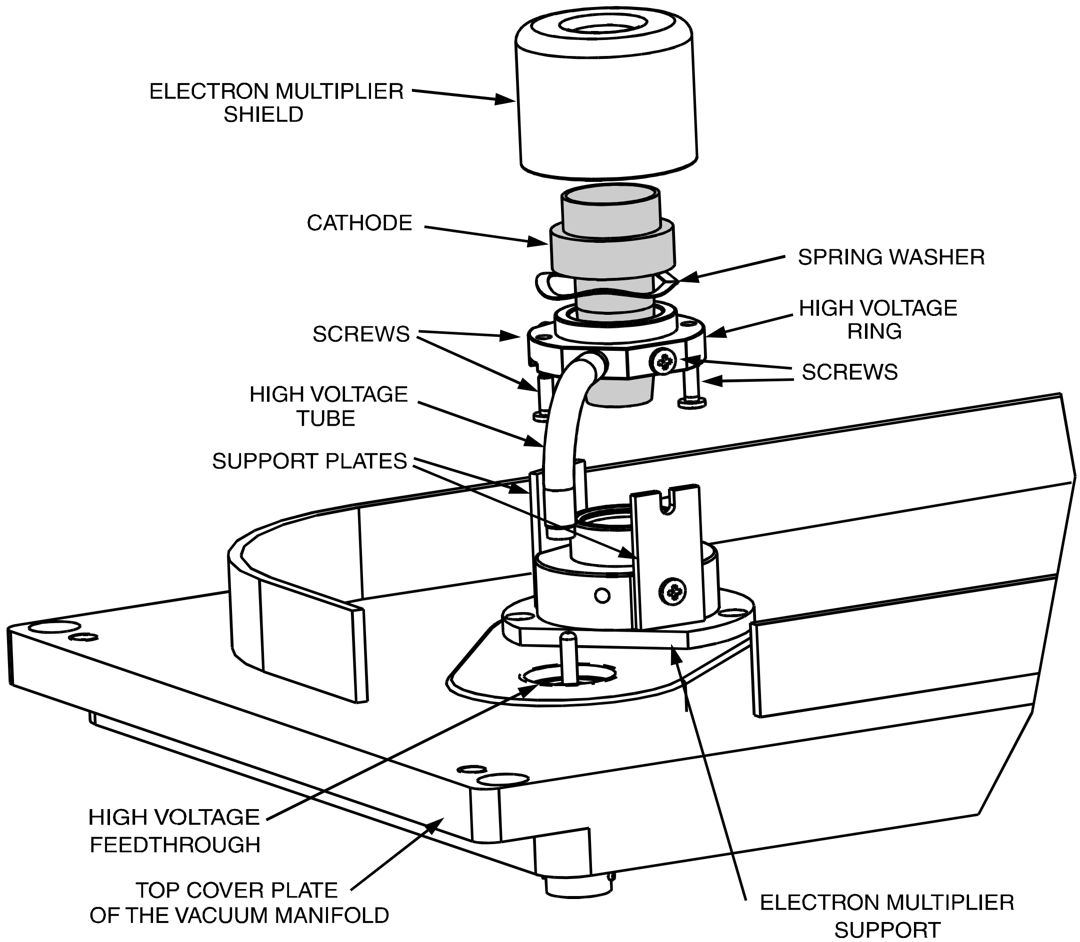


Figure 5-20. Exploded view of the electron multiplier, showing the cathode

13. Start up the LCQ system as described in the topic **Starting Up the System After a Complete Shutdown** in the **System Shutdown, Startup, and Reset** chapter.

14. Set the electron multiplier voltage to -800 V as follows:

    a. From the Tune Plus window, choose **Diagnostics | Diagnostics**.

    b. Select the **Graphs** tab.

    c. In the Set Device Value option box, select **Multiplier (V)**.

d. In the text box to the right of the Set Device Value option box, enter -800.

e. Click on the **Set** button to set the electron multiplier voltage to -800 V.

f. Click on the **OK** button to return to Tune Plus.

15. Calibrate the electron multiplier voltage as follows:

    a. Allow the system to pump down for at least one hour before you turn on the high voltages.

    b. Set up for the infusion of the tuning solution into the MS detector as described in the **LCQ Operator's Manual**.

    c. From the Tune Plus window, choose **Control | Calibrate**. The Calibrate dialog box appears.

    d. Click on the **Semi-Automatic** tab.

    e. Select the Electron Multiplier Gain option. Click on the **Start** button to start the multiplier gain procedure.

16. After the Electron Multiplier Gain program is finished, set up for ESI or APCI operation as described in the **LCQ Operator's Manual**.

5.6 Purging the Oil in the Rotary-Vane Pump

You need to purge (decontaminate) the oil in the rotary-vane pump on a daily basis to remove water and other desolved chemicals from the pump oil. Water and other chemicals in the rotary-vane pump can cause corrosion and decrease the lifetime of the pump. A good time to purge the oil is at the end of the working day after you flush the API probe, spray shield, and heated capillary.

To purge the oil in the rotary-vane pump, proceed as follows:

1. Turn off the flow of sample solution from the LC to the MS detector.

2. From the Tune Plus window, choose **Control | Standby** (or click on the On/Standby button) to put the MS detector in Standby.

3. Withdraw the API flange from the spray shield and place a septum over the entrance to the heated capillary.

4. Open the gas ballast valve on the rotary-vane pump by turning it to position **|**. Refer to the manual that came with the pump for the location of the gas ballast valve.

5. Allow the pump to run for 2 hours with the gas ballast valve open.

6. After 2 hours, close the gas ballast valve by turning it to position O.

5.7 Replacing the Oil Reservoir in the Turbomolecular Pump

You need to replace the oil reservoir in the turbomolecular pump at least once a year. Replacing the oil reservoir in the turbomolecular pump involves the following steps:

- Removing the turbomolecular pump
- Replacing the turbomolecular pump oil reservoir
- Reinstalling the turbomolecular pump

> **Note.** If the turbomolecular pump fails, it must be replaced (P/N 00108-02642). To replace the turbomolecular pump, remove the pump as described in the topic **Removing the Turbomolecular Pump**. Then, install a new pump as described in the topic **Reinstalling the Turbomolecular Pump**.

5.7.1 Removing the Turbomolecular Pump

To remove the turbomolecular pump, proceed as follows:

1. Shut down and vent the system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter.

> **WARNING.** Make sure that the LCQ power cord is unplugged before you proceed.

> **WARNUNG.** Das LCQ muß vom Netz getrennt werden, bevor irgendwelche Eingriffe vorgenomnen werden.

AVERTISSEMENT. Verifiez que le cordon d'alimentation du LCQ soit débranché de la prise de courant avant de procéder.

2. Open the left and right front doors of the MS detector by loosening the 1/4-in. Allen screw on the right front door with an Allen wrench. (Disconnect any sample tubes between the syringe pump and the API source before opening the right front door.)

3. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** on page 5-45.

4. Loosen the red hose clamp (Edwards, KF20) that secures the vacuum hose to the turbomolecular pump. See Figure 5-21. Disconnect the vacuum hose from the turbomolecular pump. Remove the centering ring from the vacuum hose.

5. Disconnect the power cable from the turbomolecular pump.

6. Loosen the four 5/16-in. socket screws that secure the turbomolecular pump to the vacuum manifold. The turbomolecular pump should drop onto the turbomolecular pump rails. If necessary, wiggle the turbomolecular pump to break the seal.

7. Pull the turbomolecular pump out on the rails. If necessary, disconnect one or more of the vacuum hoses at the foreline union by loosening the clamping rings and then pulling the hoses free from the foreline union.

8. Remove the turbomolecular pump.

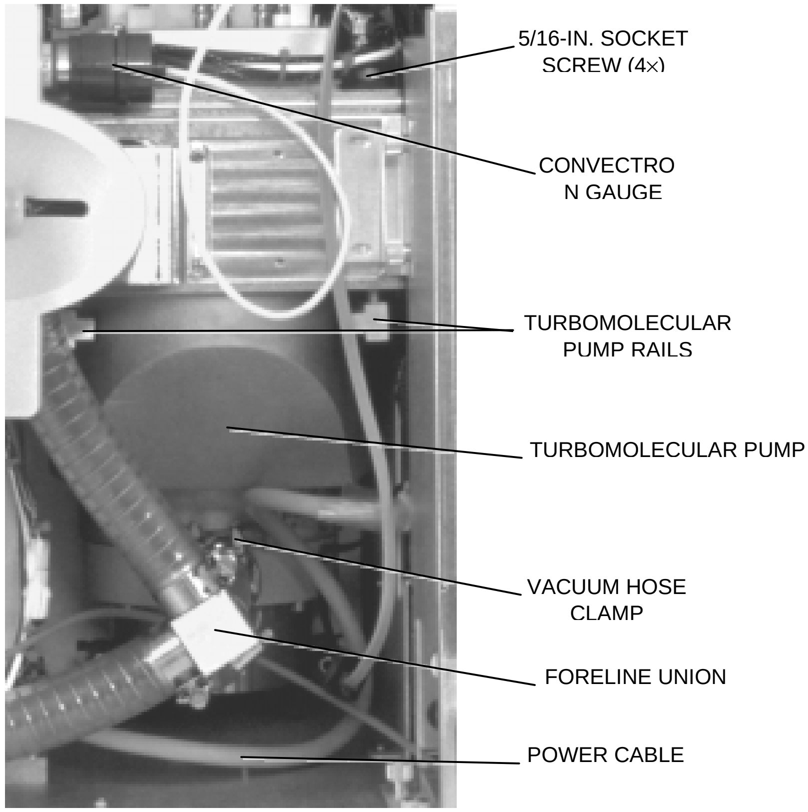


Figure 5-21. Turbomolecular pump

Go on to the next topic: **Changing the Turbomolecular pump Oil Reservoir**.

5.7.2 Changing the Turbomolecular Pump Oil Reservoir

To change the turbomolecular pump oil reservoir, proceed as follows:

WARNING. Toxic residues from samples are likely to be concentrated in the pump oil. Spent pump oil must be disposed of in accordance with local and federal regulations.

WARNUNG. Das Pumpen Öl kann giftige Proben Rückstände enthalten, daher muß benutztes Pumpen Öl entsprechend lokaler oder übergeordneter Bestimmungen entsorgt werden.

AVERTISSEMENT. L'huile de pompe peut retenir des residus vénéneux. On doit donc disposer de l'huile de pompe conformément aux règlements locaux et nationaux.

1. Turn the turbomolecular pump upside down on a work bench.
2. Using a large screwdriver, unscrew the locking cap on the bottom of the turbomolecular pump. Remove the locking cap and O-ring.
3. Using a pair of tweezers, remove the oil reservoir from the pump. Dispose of the oil reservoir properly.
4. Place a new oil reservoir (P/N 00950-01116) in the cavity in the bottom of the pump.
5. Check the condition of the Viton O-ring. If it has any nicks or breaks, replace it with a new one.
6. Reinstall the O-ring and locking cap. Tighten the locking cap securely with a large screwdriver.

Go on to the next topic: **Reinstalling the Turbomolecular Pump**.

5.7.3 Reinstalling the Turbomolecular Pump

To reinstall the turbomolecular pump, proceed as follows (see Figure 5-21):

1. Check the condition of the Viton O-rings around the two openings on the bottom of the vacuum manifold. (Use a small flashlight to illuminate the O-rings.) If they have any nicks or breaks, replace them with new ones (P/N 00107-11100).

2. Place the turbomolecular pump on the turbomolecular pump rails.

3. Slide the turbomolecular pump into position under the openings in the vacuum manifold.

4. With a 5/16-in. ball driver or Allen wrench, carefully tighten the four socket screws that hold the turbomolecular pump to the vacuum manifold. Do not overtighten the screws.

5. Place the centering ring in the end of the vacuum hose. Reconnect the vacuum hose (with the centering ring in place) to the turbomolecular pump. Tighten the red hose clamp (Edwards, KF20) that secures the vacuum hose to the turbomolecular pump.

6. Reconnect the turbomolecular pump power cable.

7. If necessary, reconnect the vacuum hoses to the foreline union. Tighten the clamping rings to secure the vacuum hoses to the foreline union.

8. Reinstall the top cover of the MS detector by following the procedure in the topic **Reinstalling the Top Cover of the MS Detector** on page 5-59.

9. Close the left and right front doors of MS detector.

10. Reconnect any tubing between the syringe pump and the API source that you disconnected earlier.

11. Restart the system as described in the topic **Starting Up the System After a Complete Shutdown** in the **System Shutdown, Startup, and Reset** chapter.

5.8 Cleaning the Fan Filter

You need to clean the fan filter, located on the rear of the MS detector, every four months. To clean the fan filter, proceed as follows:

1. Remove the fan filter by reaching behind the MS detector and pulling the fan filter out to the right.

2. Wash the fan filter in a solution of soap and water.

3. Rinse the fan filter with tap water.

4. Squeeze the water from the fan filter and allow it to air dry.

5. When the fan filter is completely dry, reinstall it on the rear of the MS detector [or replace it with a new one (P/N 97000-20299)].

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SYSTEM SHUTDOWN, STARTUP, AND RESET

Many maintenance procedures for the LCQ system require that the MS detector be shut down completely. In addition, the LCQ can be placed in Standby if the system is not to be used for 12 hours or more.

In this chapter procedures are provided to do the following:

- Shut down the system in an emergency
- Place the system in standby condition
- Shut down the system completely
- Start up the system after a complete shutdown
- Reset the MS detector
- Reset the tune and calibration parameters to their default values
- Reset the data system
- Turn off selected MS detector components

6.1 Shutting Down the System in an Emergency

If you need to turn off the MS detector in an emergency, place the main power circuit breaker switch, located on the power panel on the right side panel of the MS detector (see Figure 6-1), in the Off (O) position. This turns off all power to the MS detector, including the vacuum pumps. Although removing power abruptly will not harm any component within the system, this is not the recommended shutdown procedure to follow. Refer to the **Shutting Down the System Completely** topic, on page 6-5, for the recommended procedure.

To turn off the LC, autosampler, and computer in an emergency, use the on/off switches on the LC, autosampler, and computer.

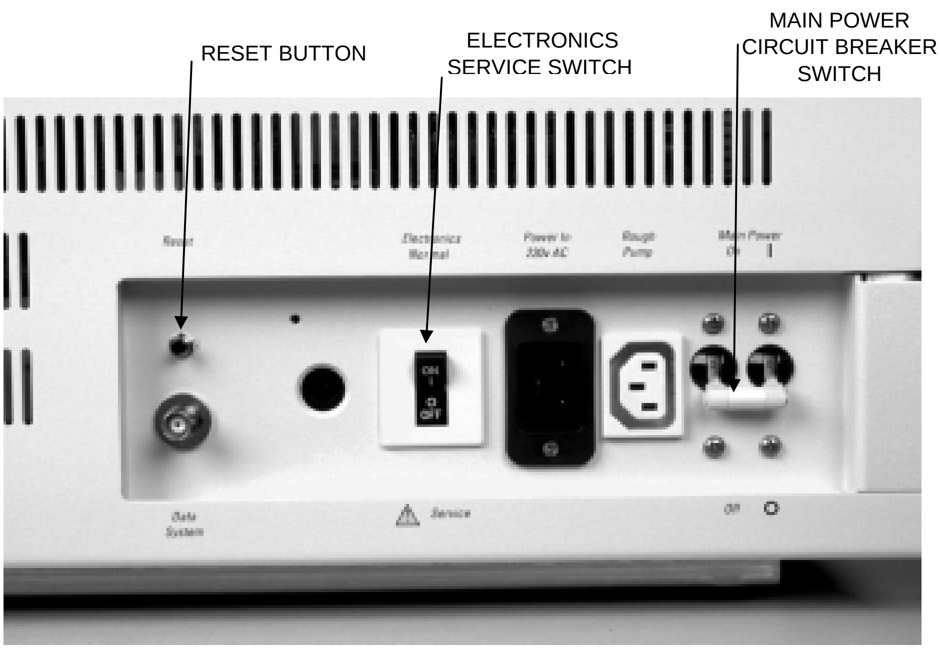


Figure 6-1. Power panel, showing the Reset button, electronics service switch, and the main power circuit breaker switch

6.2 Placing the System in Standby Condition

The LCQ system does not need to be shut down completely if you are not going to use it for a short period of time, such as overnight or over weekends. When you are not going to operate the system for 12 hours or more, you can leave the system in a standby condition.

Use the following procedure to place the LCQ system in the standby condition:

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

2. Turn off the flow of sample solution from the LC to the API source, as follows:

   a. In the Tune Plus window, choose **Setup | LC Pump** (or click on the LC button). The LC Pump dialog box appears.

   b. Select the Off option button. Then click on **OK** to stop the LC pump.

> **Note.** For instructions on how to operate the LC from the front panel, refer to the manual that came with the LC.

8. From the Tune Plus window, choose **Control | Standby** (or click on the On/Standby button) to put the MS detector in Standby. When you choose Control | Standby, the LCQ turns off the electron multiplier, conversion dynode, 8 kV power to the API source, ring electrode RF voltage, and octapole RF voltage. LCQ also turns off the auxiliary gas and sets the sheath gas flow to 20 units. See Table 6-1 on page 6-17 for the On/Off status of MS detector components when the MS detector is in the standby condition. The System LED on the front panel of the MS detector is illuminated yellow when the system is in Standby.

9. Flush the spray shield and the entrance end of the heated capillary of the API source as describe in the topic **Flushing the Spray Shield and Heated Capillary** in the **MS Detector Maintenance** chapter. Cap the heated capillary with the septum. Leave the API flange withdrawn from the spray shield.

10. Purge the rotary-vane pump oil as described in the topic **Purging the Rotary-Vane Pump Oil** in the **MS Detector Maintenance** chapter.
11. Leave the MS detector power on.
12. Leave the LC power on.
13. Leave the autosampler power on.
14. Leave the data system power on.

6.3 Shutting Down the System Completely

The LCQ system does not need to be shut down completely if you are not going to use it for a short period of time, such as overnight or over weekends. (See the topic **Placing the System in Standby Condition**, above.) Shut down the system completely only if it is to be unused for an extended period or if it must be shut down for a maintenance or service procedure.

Use the following procedure to shut down the LCQ system completely:

1. Turn off the flow of sample solution from the LC (or other sample introduction device).

> **Note.** For instructions on how to operate the LC from the front panel, refer to the manual that came with the LC.

8. From the Tune Plus window, choose **Control | Standby** (or click on the On/Standby button) to put the MS detector in Standby. When you choose Control | Standby, the LCQ turns off the electron multiplier, conversion dynode, 8 kV power to the API source, main RF voltage, and octapole RF voltage.

9. Place the electronics service switch, located on the power panel (see Figure 6-1 on page 6-2), in the Service (OFF, O) position. Power to the non-vacuum system electronics is turned off when you place the electronics service switch in the Service (OFF, O) position. The LCQ also turns off the sheath gas and auxiliary gas flows to the API source.

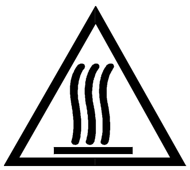
10. Place the main power circuit breaker switch, located on the power panel (Figure 6-1), in the Off (O) position. When you place the main power circuit breaker switch in the Off (O) position, the following occurs:

    - All power to the MS detector, including the turbomolecular pump and rotary vane pump, is turned off. (All LEDs on the front panel of the MS detector are off.)

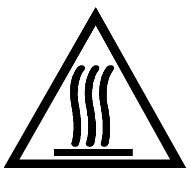
    - The battery backup on the Vent Delay PCB provides power to the vent valve for 30 s. After 30 s, a circuit on the Vent Delay PCB times out, and power to the vent valve solenoid is shut off. When power to the vent valve solenoid is shut off, the vent valve opens and the vacuum manifold is vented to filtered air. You can hear a hissing sound as the air passes through the air filter.

- After about 2 min, the vacuum manifold is at atmospheric pressure.

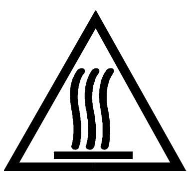
11. Unplug the power cord for the MS detector.



WARNING. Allow heated components to cool before servicing them.



WARNUNG. Warten Sie erhitzte Komponenten erst, nachdem diese sich abgekühlt haben.



AVERTISSEMENT. Permettre aux composants chauffés de refroidir avant d'y effectuer tout service.

Note. If you are planning to perform routine or preventive system maintenance on the MS detector only, you do not need to turn off the LC, data system, and autosampler. In this case, the shutdown procedure is completed. However, if you do not plan to operate your system for an extended period of time, we recommend that you turn off the LC, data system, and autosampler as described in steps 6 through 12 below.

6. Turn off the LC. Follow the procedure described in the manual that came with the LC.

7. Turn off the helium damping gas supply at the tank.

8. Turn off the nitrogen supply at the tank.

- If you have Windows NT 3.5 installed on your data system, go to step 10.

- If you have Windows NT 4.0 installed on your data system, go on to the next step.

9. Turn off the data system with Windows NT 4.0 as follows:

   a. Click on the **Start** button and choose **Shut Down**. The Shut Down Windows dialog box appears.

   b. Select the **Shut down the computer** option button, and then click on **Yes** to start the Windows NT shutdown procedure.

   c. When the Windows NT shutdown procedure tells you that it is safe to turn off the computer, turn off the monitor and computer by using the on/off switches.

   Go to step 11.

10. Turn off the data system with Windows NT 3.5 as follows:

    a. In the Windows NT Program Manager window, choose **File | Shutdown**. The Shutdown Computer dialog box appears.

    b. Select the **Shutdown** option, and then click on **OK** to start the Windows NT shutdown procedure.

    c. When the Windows NT shutdown procedure tells you that it is safe to turn off the computer, turn off the monitor and computer by using the on/off switches.

11. Turn off the printer by using the on/off switch.

12. Turn off the (optional) autosampler by using the main power on/off switch.

6.4 Starting Up the System after a Complete Shutdown

To start up the LCQ system after it has been shut down completely, you need to do the following:

- Start up the LC
- Start up the data system
- Start up the MS detector
- Start up the (optional) autosampler
- Set up conditions for operation

6.4.1 Starting Up the LC

To start up the LC, follow the startup proceedure described in the manual that came with the LC. If necessary, configure the LC as described in **Appendix A: Control of External Devices**. Do not turn on the liquid flow to the MS detector.

6.4.2 Starting Up the Data System

Use the following procedure to start up the data system:

1. Turn on the monitor, computer, and printer.

2. Observe the Windows NT startup procedure on the monitor. When you are prompted to select the operating system to start, use the arrow key to select **Windows NT Workstation**. Then press **<Enter>**.

3. Press **<Ctrl>-<Alt>-<Del>** when you are prompted to do so. Then, click on **OK** or enter your password (if you have one) in the Welcome dialog box (Windows NT 3.5) or Logon Information dialog box (Windows NT 4.0) to complete the start up procedure.

6.4.3 Starting Up the MS Detector

Use the following procedure to start up the MS detector.

> **Note.** The data system must be running before you start up the MS detector. The MS detector will not operate until software is received from the data system.

1. Turn on the flows of helium and nitrogen at the tanks if they are off.

2. Make sure that the main power circuit breaker switch is in the Off (O) position and the electronics service switch is in the Service (OFF, O) position.

3. Plug in the power cord for the MS detector.

4. Place the main power circuit breaker switch in the On (|) position. When you place the main power circuit breaker switch in the On (|) position, the rotary-vane pump and the turbomolecular pump are started. All LEDs on the MS detector front panel are off.

5. Place the electronics service switch in the Normal (ON, |) position. When you place the electronics service switch in the Normal (ON, |) position, the following occurs:

   - The Power LED on the MS detector front panel is illuminated green to indicate that power is provided to the MS detector electronics. (The electron multiplier, conversion dynode, 8 kV power to the API source, main RF voltage, and octapole RF voltage remain off.)

   - The embedded computer reboots. After several seconds the Communication LED on the front panel is illuminated yellow to indicate that the data system and the MS detector have started to establish a communication link.

   - After several more seconds, the Communication LED is illuminated green to indicate that the data system and the MS detector have established a communication link. Software for the operation of the MS detector is then transferred from the data system to the MS detector.

- After 4 or 5 minutes, the System LED is illuminated yellow to indicate that the software transfer from the data system to the MS detector is complete and that the instrument is in Standby.

> **Note.** The Vacuum LED on the front panel of the MS detector is illuminated green only if the pressure in the vacuum manifold is below the maximum allowable pressure (5×10^{-4} Torr in the analyzer region, and 2 Torr in the capillary-skimmer region), and the safety interlock switch on the API source is depressed (that is, the API flange is secured to the spray shield).

If you have an autosampler, go on to the next topic: **Starting Up the Autosampler**. If you do not have an autosampler, go to the topic: **Setting Up Conditions for Operation**.

6.4.4 Starting Up the Autosampler

To start up the autosampler, place the main power switch on the autosampler in the on position. If necessary, configure the autosampler as described in **Appendix A: Control of External Devices**. For procedures for placing sample vials, preparing solvent and waste bottles, installing syringes, etc., refer to the manual that came with the autosampler.

6.4.5 Setting Up Conditions for Operation

You need to do the following to set up your LCQ for operation:

1. Before you begin data acquisition with your LCQ system, you need to allow the system to pump down for at least 1 hour. Operation of the system with excessive air and water in the vacuum manifold can cause reduced sensitivity, tuning problems, and reduced lifetime of the electron multiplier.

2. Ensure that the helium pressure and nitrogen pressure are within the operational limits (helium: 40 ±10 psig [275 ±70 kPa], nitrogen: 100 ±20 psig [690 ±140 kPa]).

3. Look at the status panel in the Tune Plus window. Check to see if the pressure measured by the ion gauge is below about

5×10^{-5} Torr, and the pressure measued by the Convectron gauge is around 1 Torr. Compare the values of the other parameters in the status panel with values that you recorded previously.

4. Set up for ESI or APCI operation as described in the **LCQ Operator's Manual**.

Note. You do not need to calibrate or tune the LCQ each time you restart the LCQ.

Calibration parameters are instrument parameters whose values do not vary with the type of experiment. You need to calibrate the LCQ perhaps once a month, and check the calibration once a week. Refer to the **LCQ Operator's Manual** for a procedure for calibrating the LCQ.

Tune parameters are instrument parameters whose values vary with the type of experiment. You need to tune the LCQ (or change the Tune Method) whenever you change the type of experiment. Refer to the **LCQ Operator's Manual** for procedures for tuning the LCQ in the ESI or APCI mode. (Note that LCQ comes with several standard Tune Methods specific for various experimental conditions, so that tuning is often not required for many types of experiments.)

6.5 Resetting the MS Detector

If communication between the MS detector and data system computer is lost, it may be necessary to reset the MS detector using the Reset button on the power panel. When you press the Reset button, an interupt on the CPU PCB of the embedded computer is created. This causes the embedded computer to restart into a known (default) state.

The procedure given here assumes that the MS detector and data system computer are both powered on and operational. If the MS detector, data system computer, or both are off, refer to the topic **Starting Up the System after a Complete Shutdown** on page 6-8.

To reset the MS detector, press the Reset button located on the power panel. See Figure 6-1 on page 6-2 for the location of the Reset button. When you press the Reset button, the following occurs:

- An interupt on the CPU PCB of the embedded computer causes the embedded computer to reboot. All LEDs on the front panel of the MS detector are off except the Power LED.
- After several seconds, the Communication LED is illuminated yellow to indicate that the data system and the MS detector are starting to establish a communication link.
- After several more seconds, the Communication LED is illuminated green to indicate that the data system and the MS detector have established a communication link. Software for the operation of the MS detector is then transferred from the data system to the MS detector.
- After 4 to 5 min the software transfer is complete. The System LED is illuminated either green to indicate that the instrument is functional and the high voltages are on, or yellow to indicate that the instrument is functional and it is in Standby.

6.6 Resetting the Tune and Calibration Parameters to their Default Values

You can reset the LCQ tune and calibration parameters to their default values at any time. This feature may be useful if you have manually set some parameters that have resulted in less than optimum performance. To reset the LCQ tune and calibration parameters to their default values, proceed as follows:

Note. Make sure that the problems that you are experiencing are not due to improper API source settings (spray voltage, sheath and auxiliary gas flow, heated capillary temperature, etc.) before resetting the system parameters to their default values.

1. In the Tune Plus window, choose **File | Restore Factory Calibration** to restore the default calibration parameters, or choose **File | Restore Factory Tune Method** to restore the default tune parameters.

2. To optimize the LCQ system parameters (that is, to calibrate or tune the system), perform the calibration or tune procedure as described in the **LCQ Operator's Manual**.

6.7 Resetting the Data System

There are two ways to reset the data system:

- By using the Windows NT shutdown and restart procedure
- By pressing the reset button on the personal computer

If possible, use the Windows NT 3.5 or 4.0 shutdown and restart procedure to shut down and restart the data system so that Windows NT can properly close applications and save changes to files.

To reset the data system by using the Windows NT 3.5 shutdown and restart procedure, proceed as follows:

1. In the Windows NT Program Manager window, choose **File | Shutdown**. The Shutdown Computer dialog box appears.
2. Select the Shutdown and Restart option, and then click on **OK** to start the Windows NT shutdown and restart procedure.
3. Observe the Windows NT shutdown and restart procedure on the monitor. When you are prompted to select the operating system to start, use the arrow key to select Windows NT Workstation. Then press **<Enter>**.
4. Press **<Ctrl>-<Alt>-<Del>** when you are prompted to do so. Then, click on **OK** or enter your password (if you have one) in the Welcome dialog box to complete the shutdown and restart procedure.

To reset the data system by using the Windows NT 4.0 shutdown and restart procedure, proceed as follows:

1. Click on the **Start** button and choose **Shut Down**. The Shut Down Windows dialog box appears.
2. Select the **Restart the computer** option button, and then click on **Yes** to start the Windows NT shutdown and restart procedure.
3. Observe the Windows NT shutdown and restart procedure on the monitor. When you are prompted to select the operating system to start, use the arrow key to select Windows NT Workstation. Then press **<Enter>**.

4. Press **<Ctrl>-<Alt>-<Del>** when you are prompted to do so. Then, click on **OK** or enter your password (if you have one) in the Logon Information dialog box to complete the shutdown and restart procedure.

> **Note.** The communications link between the data system and the MS detector should be automatically restablished after you reset the data system. When this occurs the Communication LED on the front panel of the MS detector is illuminated yellow and then green. If the system is unable to restablish the communications link, press the Reset button on the power panel of the MS detector.

If you are unable to reset the data system by using the Windows NT shutdown and restart procedure, proceed as follows:

1. Press the reset button on the personal computer.

2. Observe the Windows NT shutdown and restart procedure on the monitor. When you are prompted to select the operating system to start, use the arrow key to select Windows NT Workstation. Then press **<Enter>**.

3. Press **<Ctrl>-<Alt>-<Del>** when you are prompted to do so. Then, click on **OK** or enter your password (if you have one) in the Welcome dialog box (Windows NT 3.5) or Logon Information dialog box (Windows NT 4.0) to complete the shutdown and restart procedure.

4. When the shutdown and restart procedure has completed, select **Navigator** in the LCQ group to display the Navigator window.

> **Note.** The communications link between the data system and the MS detector should be automatically restablished after you reset the data system. When this occurs the Communication LED on the front panel of the MS detector is illuminated yellow and then green. If the system is unable to restablish the communications link, press the reset button on the power panel of the MS detector.

6.8 Turning Off Selected MS Detector Components

There are five ways that you can turn off some or all of the MS detector components:

- Turn off individual MS detector components from the Tune Plus window. Turning off individual MS detector components may be necessary when troubleshooting or when running certain diagnostic procedures.

- Place the MS detector in Standby. Standby is the normal condition to leave the MS detector in when it is not in use. Choose **Control | Standby** (or toggle the On/Standby button) from the Tune Plus window to place the MS detector in Standby. Alternatively, you can choose **Instrument | System Standby** from the Navigator window.

- Place the MS detector in the Off condition. The Off condition is similar to Standby, except all high voltage components of the MS detector are turned off. Choose **Control | Off** from the Tune Plus window to place the MS detector in the Off condition. Alternatively, you can choose **Instrument | System Off** from the Navigator window.

- Place the electronics service switch in the Service (OFF, O) position. The electronics service switch allows you to perform maintenance procedures involving non-vacuum system components of the MS detector.

- Place the main power circuit breaker switch in the Off (O) position. Placing the main power circuit breaker switch in the Off (O) position removes all power to the MS detector, including the vacuum system.

The on/off status of MS detector components, voltages, and gas flows is summarized in Table 6-1.

Table 6-1. On/Off Status of MS Detector Components, Voltages, and Gas Flows

MS detector component	Standby	Off	Electronics service switch in Service (OFF,O) position	Main power circuit breaker switch in Off (O) position
Electron multiplier	Off	Off	Off	Off
Conversion dynode	Off	Off	Off	Off
Mass analyzer RF/waveform voltages	Off	Off	Off	Off
Mass analyzer dc offset voltage	**On**	Off	Off	Off
Octapole RF voltage	Off	Off	Off	Off
Octapole dc offset voltage	**On**	Off	Off	Off
Interoctapole lens	**On**	Off	Off	Off
Tube lens	**On**	Off	Off	Off
Heated capillary heater	**On**	**On**	Off	Off
Heated capillary dc offset	**On**	Off	Off	Off
Corona discharge needle	Off	Off	Off	Off
APCI vaporizer	Off	Off	Off	Off
ESI needle	Off	Off	Off	Off
Sheath gas	**On** (20 units)	Off	Off	Off
Auxiliary gas	Off	Off	Off	Off
Helium damping gas	**On**	**On**	**On**	**On**
Vent valve	Closed	Closed	Closed	**Open** (after 30 s)
Turbomolecular pump	**On**	**On**	**On**	Off
Rotary-vane pump	**On**	**On**	**On**	Off
Vent Delay PCB	**On**	**On**	**On**	Off (after 30 s)
Embedded computer	**On**	**On**	Off	Off
Turbomolecular Pump Controller	**On**	**On**	**On**	Off
Power supply, electron multiplier	Off	Off	Off	Off
Power supply, conversion dynode	Off	Off	Off	Off

MS detector component	**Standby**	**Off**	**Electronics service switch in Service (OFF,O) position**	**Main power circuit breaker switch in Off (O) position**
Power supply, 8 kV	Off	Off	Off	Off
Power supply, +5, ±15, +24 V dc switching	**On**	**On**	Off	Off
Power supply, +36, -28 V dc switching	**On**	**On**	Off	Off
Power supply, +24 V dc keep alive	**On**	**On**	**On**	Off
Power supply, +180 V dc	**On**	**On**	Off	Off
Power supply, ±130 V dc	**On**	Off	Off	Off
Power supply, +36 V dc	**On**	Off	Off	Off
Power supply, ±20 V dc	**On**	**On**	Off	Off
Power supply, ±215 V dc	**On**	Off	Off	Off
Power supply, 24 V ac	**On**	**On**	Off	Off
Power supply, 4 V ac	**On**	**On**	Off	Off
Power supply, ±330 V dc	**On**	Off	Off	Off
Fan, turbomolecular pump	**On**	**On**	**On**	Off
Fan, RF coil	**On**	**On**	Off	Off
Fans, tower	**On**	**On**	Off	Off
Fan, embedded computer	**On**	**On**	Off	Off
Convectron gauge	**On**	**On**	Off	Off
Ion gauge	**On**	**On**	Off	Off
Syringe pump	Off	Off	Off	Off

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DIAGNOSTICS AND PCB AND ASSEMBLY REPLACEMENT

Many of the MS detector components can be tested by the LCQ diagnostics. Finnigan's service philosophy for the LCQ system calls for troubleshooting to the lowest part, assembly, PCB, or module listed in the **Replaceable Parts** chapter. You should replace LCQ components when indicated by the LCQ diagnostics, by Finnigan Technical Support, or by a Finnigan Customer Support Engineer.

This chapter covers the following topics:

- Running the LCQ diagnostics
- Replacing a fuse in the MS detector
- Replacing a PCB or assembly in the MS detector

7.1 Running the LCQ Diagnostics

The LCQ diagnostics is used to test the major electronic circuits within the instrument and indicate whether the circuits pass or fail the tests. If there is a problem with the instrument electronics, the LCQ diagnostics can often locate the problem. You can then often correct the problem yourself by replacing a faulty PCB or assembly.

The LCQ diagnostics does not diagnose problems that are not electrical in nature. For example, it does not diagnose poor sensitivity due to misaligned or dirty components or to improper tuning. Therefore, it is important to have someone who is familiar with system operation and basic hardware theory run the diagnostics and use it to assist in isolating any problems.

Before running the diagnostics, you should consider the following:

- Did the system fail when you were running samples?
- Did problems occur after you performed maintenance on the instrument, data system, or peripherals?
- Did you change the system's configuration, cables, or peripherals just before the problem occurred?

If the answer is yes to the first item above, there is the possibility of a hardware failure, and running the diagnostics is appropriate.

If the answer is yes to one of the last two items above, the problem is probably mechanical, not electrical. Reverify that alignment, configurations, and cable connections are correct before you run the LCQ diagnostics.

To run the LCQ diagnostics, proceed as follows:

1. Tune the ring electrode and octapole RF voltages as described in the topic **Tuning the Ring Electrode and Octapole RF Voltages** in the **MS Detector Maintenance** chapter.
2. In the Tune Plus window, choose **Diagnostics | Diagnostics**. The Diagnostics dialog box appears. See Figure 7-1.
3. Select one of the following options:
    - To test all of the electronic subsystems (that is, the vacuum system, power supplies, lenses, ion detection system, and

RF voltage electronics), click on the **All** tab and select the **Everything** option.

- To test an individual subsystem, click on the tab corresponding to that subsystem and select the appropriate options.

4. Select how many times you want to run the tests, and whether or not you want to print reports or to stop on a failure.

5. Click on the **Start** button to start the diagnostics.

LCQ starts testing and displays a chronological log of all diagnostic tests in the Testing text box. Once testing for a specific subsystem is completed, LCQ displays either Pass or Fail in the Results group box. If the LCQ diagnostics indicates a problem, perform the maintenance procedure indicated by the LCQ diagnostics, by Finnigan Technical Support, or by a Finnigan Customer Support Engineer. For more information on the LCQ diagnostics, refer to the LCQ online Help.

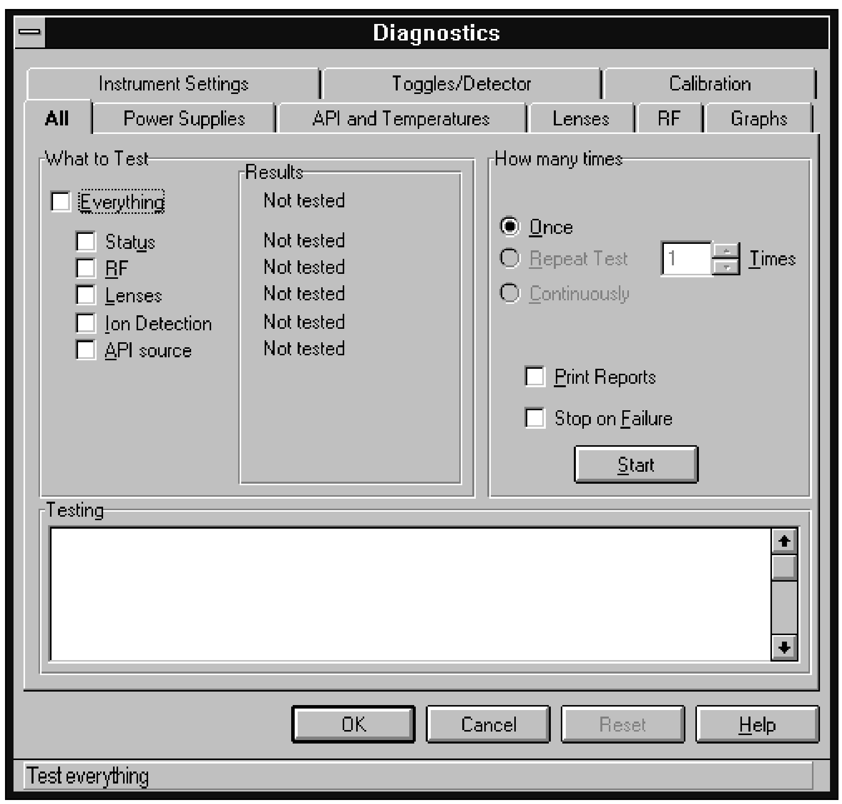

Figure 7-1. Diagnostics dialog box

7.2 Replacing a Fuse

Fuses protect the various circuits by opening the circuits whenever overcurrent occurs. On the MS detector, most of the fuses are located on the System Control PCB. Several fuses, however, are located on the RF Voltage Amplifier PCB, Analyzer Auxiliary PCB, and Power Module. The function and current rating of the various fuses are listed in Table 7-1.

Check fuses when power is lost to a fused subsystem.

WARNING. Always place the electronics service switch in the Service (OFF, O) position (or shut down the system and disconnect the power cord) before you replace fuses on the System Control PCB, RF Voltage Amplifier PCB, or Analyzer Auxiliary PCB.

WARNUNG. Schalten Sie stets den Hauptschalter für Elektronikteile auf Wartung (Service/OFF/O) (oder schalten Sie das System ab, und ziehen Sie den Netzstecker ab) bevor Sie eine Sicherung an der Flachbaugruppe des Systempultes, des RF Verstärkers oder des Hilfsanalysegerätes auswechseln.

AVERTISSEMENT. Placer toujours le disjoncteur de branchement en position Service (OFF, O) (ou mettre le système hors tension et déconnecter le cordon d'alimentation) avant de remplacer un fusible sur le PCB Contrôle de système, PCB Amplificateur RF ou PCB Analyseur auxiliaire.

Table 7-1. MS Detector Fuses

Location	Fuse	Circuit	Description	P/N
System Control PCB	F1	Octapoles and tube lens power supplies, ion gauge grid	0.16 A, time lag, 5 x 20 mm, 250 V	00006-01700
System Control PCB	F2	Octapoles and tube lens power supplies	0.16 A, time lag, 5 x 20 mm, 250 V	00006-01700
System Control PCB	F3	Heated capillary, octapoles, and mass analyzer DC offsets	0.16 A, time lag, 5 x 20 mm, 250 V	00006-01700
System Control PCB	F4	Heated capillary, octapoles, and mass analyzer DC offsets	0.16 A, time lag, 5 x 20 mm, 250 V	00006-01700
System Control PCB	F5	Ion gauge filament	3.15 A, time lag, 5 x 20 mm, 250 V	00006-10510
System Control PCB	F6	Heated capillary heater	2.5 A, Type F, 5 x 20 mm, 250 V	00006-11202
System Control PCB	F7	Conversion dynode power supply	0.25 A, time lag, 5 x 20 mm, 250 V	00006-11204
System Control PCB	F8	RF detector power supply	0.4 A, time lag, 5 x 20 mm, 250 V	00006-05080
System Control PCB	F9	RF detector power supply	0.4 A, time lag, 5 x 20 mm, 250 V	00006-05080
System Control PCB	F10	APCI vaporizer heater	2.5 A, time lag, 5 x 20 mm, 250 V	00006-09510
RF Voltage Amplifier PCB	F1	+36 V	1.0 A, quick act, 5 x 20 mm, 250 V	00006-07610
RF Voltage Amplifier PCB	F2	-28 V	0.5 A, quick act, 5 x 20 mm, 250 V	00006-07608
Analyzer Auxiliary PCB	F1	-28 V	1.6 A, quick act, 5 x 20 mm, 250 V	00006-08610
Analyzer Auxiliary PCB	F2	+36 V	1.6 A, quick act, 5 x 20 mm, 250 V	00006-08610
Power Module	F1	Voltage select switch	3.5 A, time lag, 5 x 20 mm, 250 V	00006-10510

Caution. Use only the fuses specified in Table 7-1. Never replace a fuse with a fuse of a different type, voltage, or current rating.

Note. To replace the fuse in the Power Module you need to remove the tower, System Control PCB, and embedded computer. Do not replace the fuse in the Power Module unless you are qualified to do so.

To replace a fuse on the System Control PCB, RF Voltage Amplifier PCB, or Analyzer Auxiliary PCB, proceed as follows:

1. Place the electronics service switch in the Service (OFF, O) position (or shut down and vent the LCQ system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter).

WARNING. Make sure that the LCQ electronic service switch is in the Service (OFF, O) position (or shut down the system and disconnect the power cord) before you proceed.

WARNUNG. Kontrollieren Sie, daß der Hauptschalter für LCQ Elektronikteile auf Wartung (Service/OFF/O) geschaltet ist (oder schalten Sie das System ab, und ziehen Sie den Netzstecker ab) bevor Sie fortfahren.

AVERTISSEMENT. S'assurer que le disjoncteur de branchement LCQ est en position Service (OFF, O) (ou mettre le système hors tension et déconnecter le cordon d'alimentation) avant de continuer.

1. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

   - To replace a fuse on the System Control PCB, go to step 3.
   - To replace a fuse on the RF Voltage Amplifier PCB, go to step 4.
   - To replace a fuse on the Analyzer Auxiliary PCB, go to step 5.

2. To replace a fuse on the System Control PCB, proceed as follows. See Figure 7-2 for the location of the System Control PCB and its fuses.

   a. Remove the right side cover of the MS detector as follows:

      i. Loosen the fastener that secures the right side cover to the chassis of the MS detector.

      ii. Slide the side cover back about 1.25 cm (0.5 in.), and then lift it out and away from the MS detector.

   b. Remove the protective cover on the System Control PCB as follows:

      i. Insert a finger into the finger hole on the left side of the cover.

      ii. Pull out on the cover to detach the tabs on the cover from the slots in the MS detector chassis.

> **Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

   c. Locate and replace the defective fuse on the System Control PCB with a fuse of the same type, voltage, and current rating. Refer to Table 7-1.

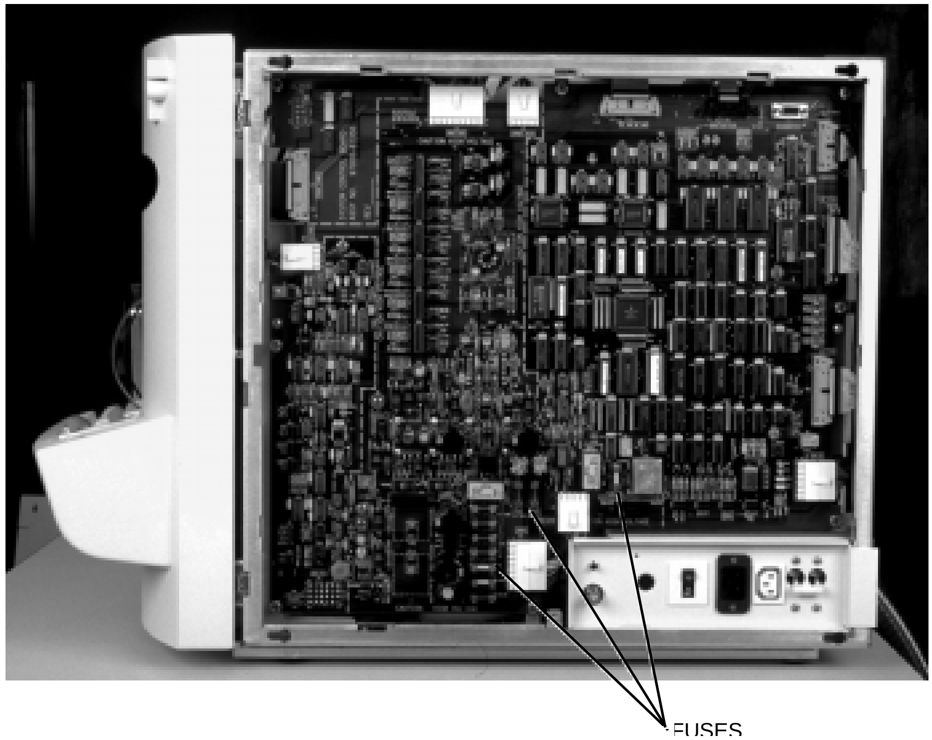

Figure 7-2. System Control PCB, showing the location of the fuses

d. Reinstall the protective cover over the System Control PCB as follows:

   i. Insert the three tabs on the left side of the cover into the corresponding three slots in the MS detector chassis.

   ii. Swing the right side of the cover toward the chassis until the tabs in the cover insert and lock into the slots in the chassis.

e. Reinstall the right side cover of the MS detector as follows:

   i. Place the cover against the right side of the MS detector such that the studs on the cover insert into the guide slots in the MS detector chassis.

   ii. Slide the side cover forward about 1.25 cm (0.5 in.) until the studs on the cover lock in the guide slots.

   iii. Tighten by hand the fastener that secures the side cover to the chassis of the MS detector.

Go to step 6.

4. To replace a fuse on the RF Voltage Amplifier PCB, proceed as follows. See Figure 7-5 on page 7-23 for the location of the RF Voltage Amplifier PCB.

   a. With a Phillips screwdriver, loosen the eight screws that hold the metal cover to the RF Voltage Amplifier PCB. Remove the cover.

   b. Locate and replace the defective fuse on the RF Voltage Amplifier PCB with a fuse of the same type, voltage, and current rating. Refer to Table 7-1.

   c. Place the metal cover over the RF Voltage Amplifier PCB. With a Phillips screwdriver, tighten the eight screws that secure the cover.

   Go to step 6.

5. To replace a fuse on the Analyzer Auxiliary PCB, proceed as follows. See Figure 7-5 on page 7-23 for the location of the Analyzer Auxiliary PCB.

   a. Disconnect the seven cables that connect to the top of the Analyzer Auxiliary PCB. (Three coaxial cables come from the Analyzer PCB, one coaxial cable comes from the Waveform DDS PCB in the embedded computer, one coaxial cable comes from the Waveform Amplifier PCB, one ribbon cable comes from the System Control PCB, and one cable comes from the Dc Ring Filter PCB.)

   b. With a Phillips screwdriver, loosen the six screws that hold the metal cover to the Analyzer Auxiliary PCB. Remove the protective cover to expose the Analyzer Auxiliary PCB.

   c. Locate and replace the defective fuse on the Analyzer Auxiliary PCB with a fuse of the same type, voltage, and current rating. Refer to Table 7-1.

   d. Reinstall the protective cover on the Analyzer Auxiliary PCB. With a Phillips screwdriver, tighten the six screws that hold the metal cover to the Analyzer Auxiliary PCB.

   e. Reconnect the seven cables that connect to the top of the Analyzer Auxiliary PCB. (Three coaxial cables come from the Analyzer PCB, one coaxial cable comes from the

Waveform DDS PCB in the embedded computer, one coaxial cable comes from the Waveform Amplifier PCB, one ribbon cable comes from the System Control PCB, and one cable comes from the Dc Ring Filter PCB.)

6. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

7. Place the electronics service switch in the Normal (ON, |) position.

8. Run the LCQ diagnostics to verify that the system is operational.

7.3 Replacing PCBs and Assemblies in the MS Detector

PCBs and assemblies in the MS detector for which replacement procedures are presented in this chapter can be categorized as follows:

- PCBs and assemblies that are in the tower
- PCBs that are in the embedded computer
- PCBs and assemblies that are accessible from the top of the MS detector
- PCBs and assemblies that are accessible from the right side of the MS detector
- PCBs and assemblies that are accessible from the left side of the MS detector
- PCBs and assemblies that are accessible from the rear of the MS detector

WARNING. With the electronics service switch in the Service (OFF, O) position, power is still supplied to the rotary-vane pump, Turbomolecular Pump Controller, turbomolecular pump, turbomolecular pump fan, +24 V keep alive power supply, vent valve, and Vent Delay PCB. Thus, before these components can be serviced, the main power circuit breaker switch must be placed in the OFF (O) position and the power cord must be unplugged from the power outlet.

WARNUNG. Selbst wenn der Hauptschalter für Elektronikteile auf Wartung (OFF/O) gestellt ist, werden die folgenden Teile noch mit Strom versorgt: Drehschieberpumpe, Turbopumpenregler, Turbopumpe, Turbopumpengebläse, +24 V unterbrechungsfreie Stromversorgung, Wrasenklappe, Flachbaugruppe zur Abzugsverzögerung. Vor Wartungsarbeiten an diesen Komponenten muß daher der Netzschalter auf OFF (O) gestellt *und* der Netzstecker von der Stromversorgung abgezogen werden.

AVERTISSEMENT. Lorsque le disjoncteur de branchement est en position Service (OFF, O), l'alimentation reste présente à la pompe à palettes, au contrôleur de la turbo-pompe, à la turbo-pompe, au ventilateur de la turbo-pompe, au bloc d'entretien d'alimentation +24 V, à la vanne d'évent et au PCB Délai de vanne. Ainsi, avant d'effectuer tout service sur ces composants, le disjoncteur d'alimentation principale doit être mis en position Off (O) et le cordon d'alimentation doit être débranché de la prise de courant.

Caution. Never insert a test probe (for example, an oscilloscope probe) into the sockets of female cable connectors on PCBs. This can damage the sockets.

7.3.1 Replacing PCBs and Assemblies in the Tower

The following PCBs and assemblies are installed in the tower. See Figure 7-3.

- +5 V, ±15 V, +24 V dc and +36 V, -28 V dc switching power supplies
- Turbomolecular Pump Controller
- 8 kV power supply
- Power Module

Note. To service the Power Module you need to remove the tower, System Control PCB, and embedded computer. Do not service the Power Module unless you are qualified to do so.

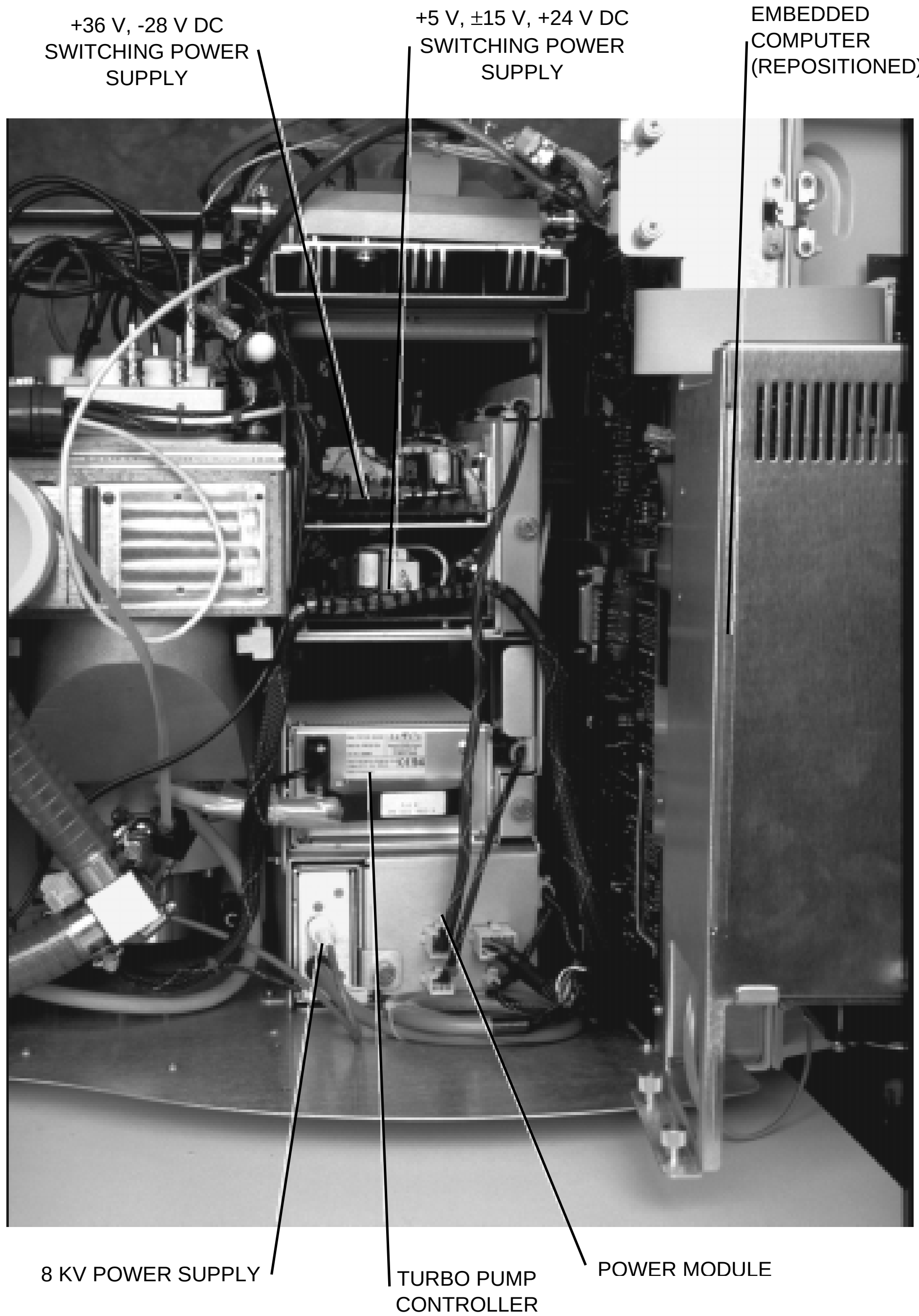

Figure 7-3. Tower (with the embedded computer repositioned)

To replace a component that is in the tower, proceed as follows:

1. Shut down and vent the system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter.

> **WARNING.** Make sure that the LCQ power cord is unplugged before you proceed.

> **WARNUNG.** Das LCQ muß vom Netz getrennt werden, bevor irgendwelche Eingriffe vorgenomnen werden.

> **AVERTISSEMENT.** Verifiez que le cordon d'alimentation du LCQ soit débranché de la prise de courant avant de procéder.

3. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

4. Reposition the embedded computer (to expose the tower) as follows:

    a. Disconnect the cables that connect to the top of the embedded computer.

    b. Loosen the six knurled fasteners that secure the embedded computer to the vacuum manifold, base plate, and chassis.

    c. Lift up the embedded computer a sufficient distance to access the two cables that connect to the bottom of the embedded computer. Disconnect the two cables that connect to the bottom of the embedded computer.

    d. Lift the embedded computer and reposition it such that the two hooks in the back of the embedded computer box insert into the two slots in the MS detector chassis. See Figure 7-4 on page 7-20 for the location of the slots.

- To replace the switching power supply assembly (which includes the +5 V, ±15 V, +24 V dc and +36 V, -28 V dc switching power supplies), go to step 4.
- To replace the Turbomolecular Pump Controller, go to step 5.
- To replace the 8 kV power supply, go to step 6.

5. To replace the switching power supply assembly (which includes the +5 V, ±15 V, +24 V dc and +36 V, -28 V dc switching power supplies), proceed as follows:

   a. Disconnect the cable to the RF Voltage Amplifier PCB from the connector on the RF Voltage Amplifier PCB. (See Figure 7-5 on page 7-23 for the location of the RF Voltage Amplifier PCB, Analyzer Auxiliary PCB, and Waveform Amplifier PCB.)

   b. Disconnect the two cables to the Analyzer Auxiliary PCB from the two connectors on the Analyzer Auxiliary PCB.

   c. Disconnect the cable to the Waveform Amplifier PCB from the connector on the Waveform Amplifier PCB.

   d. Disconnect the cable that is connected to the fan cable.

   e. Disconnect the two cables to the Power Module from the two (upper) connectors on the Power Module.

   f. Disconnect the cable that is connected to the reset button cable.

   g. Loosen by hand (or with a Phillips screwdriver) the fastener that holds the switching power supply assembly to the tower.

   h. Remove the switching power supply assembly from the tower.

   i. Unpack the new switching power supply assembly (P/N 97000-60151). Retain the packing materials so that you can pack and ship the defective switching power supply assembly to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

j. Install the new switching power supply assembly in the space occupied by the old assembly.

k. Tighten by hand the fastener that holds the switching power supply assembly to the tower.

l. Reconnect the cable that is connected to the reset button cable.

m. Reconnect the two cables to the Power Module to the two (upper) connectors on the Power Module.

n. Reconnect the cable that is connected to the fan cable.

o. Reconnect the cable to the Waveform Amplifier PCB to the connector on the Waveform Amplifier PCB.

p. Reconnect the two cables to the Analyzer Auxiliary PCB to the two connectors on the Analyzer Auxiliary PCB.

q. Reconnect the cable to the RF Voltage Amplifier PCB to the connector on the RF Voltage Amplifier PCB.

Go to step 7.

6. To replace the Turbomolecular Pump Controller, proceed as follows:

a. Disconnect from the Turbomolecular Pump Controller the thick cable to the turbomolecular pump.

b. Disconnect from the Turbomolecular Pump Controller the thin cable that comes from the Power Module.

c. Loosen by hand (or with a Phillips screwdriver) the fastener that holds the Turbomolecular Pump Controller to the tower.

d. Remove the Turbomolecular Pump Controller from the tower.

e. Unpack the new Turbomolecular Pump Controller (P/N 97000-60150). Retain the packing materials so that you can pack and ship the defective Turbomolecular Pump Controller to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

f. Install the new Turbomolecular Pump Controller in the space occupied by the old controller.

g. Tighten by hand the fastener that holds the Turbomolecular Pump Controller to the tower.

h. Reconnect to the Turbomolecular Pump Controller the thin cable that comes from the Power Module.

i. Reconnect to the Turbomolecular Pump Controller the thick cable that goes to the turbomolecular pump.

Go to step 7.

7. To replace the 8 kV power supply, proceed as follows:

   a. Disconnect from the 8 kV power supply the cable that comes from the API panel.

   b. Disconnect from the rear of the System Control PCB (at J5), the thick cable that goes to the System Control PCB.

   c. Loosen by hand (or with a Phillips screwdriver) the fastener that holds the 8 kV power supply to the tower.

   d. Remove the 8 kV power supply from the tower.

   e. Unpack the new 8 kV power supply (P/N 97000-60142). Retain the packing materials so that you can pack and ship the defective 8 kV power supply to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

   f. Reinstall the new 8 kV power supply in the space occupied by the old power supply.

   g. Tighten by hand the fastener that holds the 8 kV power supply to the tower.

   h. Reconnect to the rear of the System Control PCB (at J5), the thick cable that comes from the 8 kV power supply.

   i. Reconnect to the 8 kV power supply the thin cable that comes from the API panel.

   Go to step 7.

8. Return the embedded computer to its original position as follows:

a. Lift the embedded computer up and away from the MS detector chassis. Lift up the embedded computer a sufficient distance to access the bottom of the embedded computer.

b. Reconnect to the bottom of the embedded computer the cable that comes from the switching power supplies.

c. Reconnect the fan power cable to the embedded computer fan. Make sure that the plug on the end of the cable contours the fan (that is, the concave side of the plug is against the fan).

d. Reposition the embedded computer in its original position in front of the tower.

e. Tighten the six knurled fasteners that secure the embedded computer to the vacuum manifold, base plate, and chassis.

f. Reconnect the cables that connect to the top of the embedded computer. See Figure 7-4 on page 7-20 and Figure 7-5 on page 7-23.

9. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

10. Close the front doors of the MS detector.

11. Restart the system as described in the topic **Starting Up the System After a Complete Shutdown** in the **System Shutdown, Startup, and Reset** chapter.

12. Run the LCQ diagnostics to verify that the system is operational.

7.3.2 Replacing PCBs in the Embedded Computer

The Ethernet PCB (P/N 97000-60165), IEEE 488 I/O PCB (optional, P/N 00012-27700), Acquisition DSP PCB (P/N 97000-61260), Control DSP PCB (P/N 97000-61270), Waveform DDS PCB (P/N 97000-61280), Serial I/O PCB (P/N 97000-60124), and CPU PCB (P/N 97000-60163) reside in the embedded computer. See Figure 7-4.

To replace a PCB in the embedded computer, proceed as follows:

1. Place the electronics service switch in the Service (OFF, O) position (or shut down and vent the LCQ system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter).

WARNING. Make sure that the LCQ electronic service switch is in the Service (OFF, O) position (or shut down or shut down the system and disconnect the power cord) before you proceed.

WARNUNG. Kontrollieren Sie, daß der Hauptschalter für LCQ Elektronikteile auf Wartung (Service/OFF/O) geschaltet ist (oder schalten Sie das System ab, und ziehen Sie den Netzstecker ab) bevor Sie fortfahren.

AVERTISSEMENT. S'assurer que le disjoncteur de branchement LCQ est en position Service (OFF, O) (ou mettre le système hors tension et déconnecter le cordon d'alimentation) avant de continuer.

1. Open the front doors of the MS detector.

2. Loosen the two knurled fasteners that hold the front cover to the embedded computer. Remove the front cover of the embedded computer.

3. Locate the PCB you want to replace. See Figure 7-4.

4. Disconnect all electrical cables to the PCB that you want to replace.

5. With a Phillips screwdriver, remove the screw that holds the PCB to the card cage.

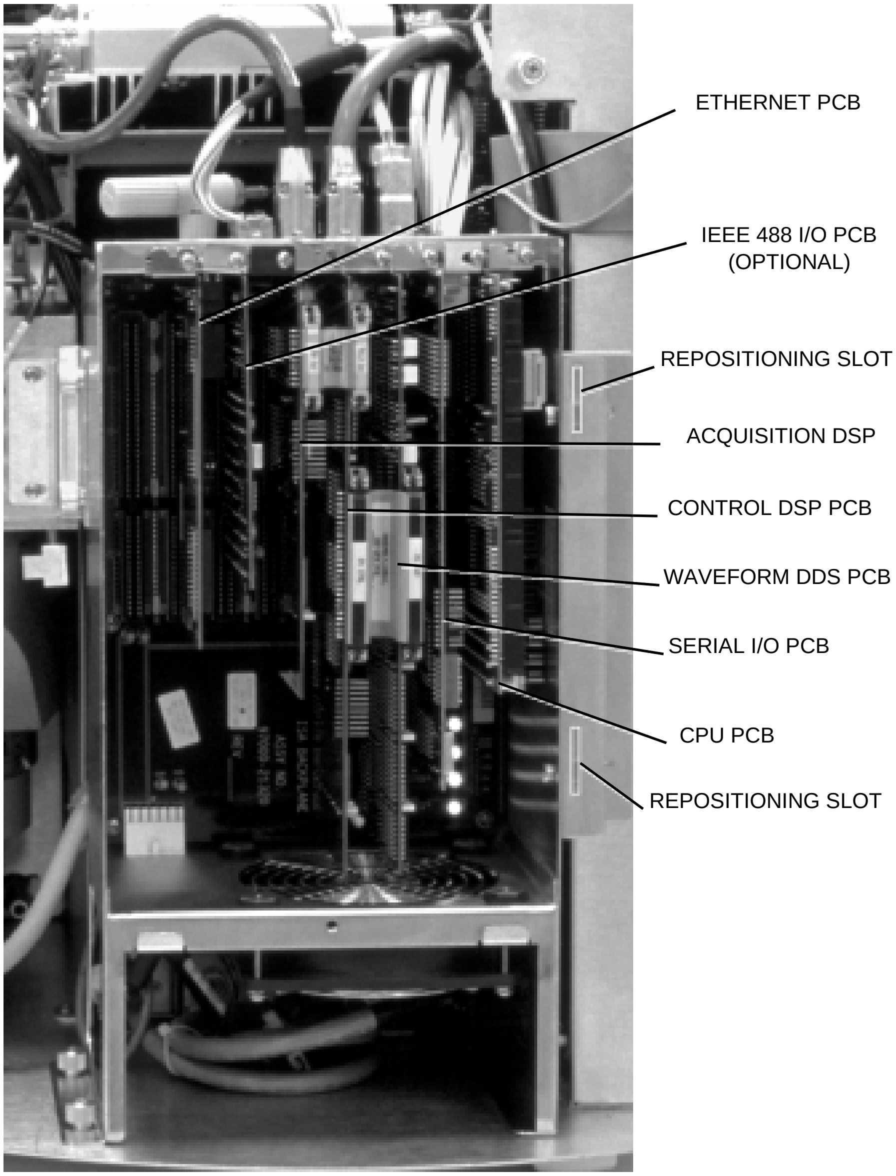

Figure 7-4. Embedded computer (with front cover removed)

> **Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

7. Unseat the PCB from the backplane and pull it out of the embedded computer.

8. Unpack the new PCB. Retain the packing materials so that you can pack and ship the defective PCB to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

9. Seat the new PCB in the backplane.

10. With a Phillips screwdriver, reinstall the screw that holds the PCB to the card cage.

11. Reconnect all electrical cables to the PCB that you replaced.

12. Reinstall the front cover of the embedded computer. Tighten by hand the two knurled fasteners that hold the front cover to the embedded computer.

13. Close the front doors to the MS detector.

14. Place the electronics service switch in the Normal (ON, |) position.

15. Run the LCQ diagnostics to verify that the system is operational.

7.3.3 Replacing the Vent Delay PCB, Ion Gauge, and Vent Valve

The Vent Delay PCB, ion gauge, and vent valve can be accessed from the top of the MS detector. See Figure 7-5.

WARNING. The LCQ system must be shut down and the power cord unplugged before you service the vent valve, Vent Delay PCB, Convectron gauge, or ion gauge.

WARNUNG. Vor der Wartung an den folgenden Komponenten muß das LCQ-System abgestellt und der Netzstecker abgezogen werden: Wrasenklappe, Flachbaugruppe zur Abzugsverzögerung, Convectron oder Eisenmeßgerät.

AVERTISSEMENT. Le système LCQ doit être mis hors tension et le cordon d'alimentation débranché avant d'effectuer tout service sur la vanne d'évent, le PCB Délai de vanne, la jauge Convectron ou la jauge d'ionisation.

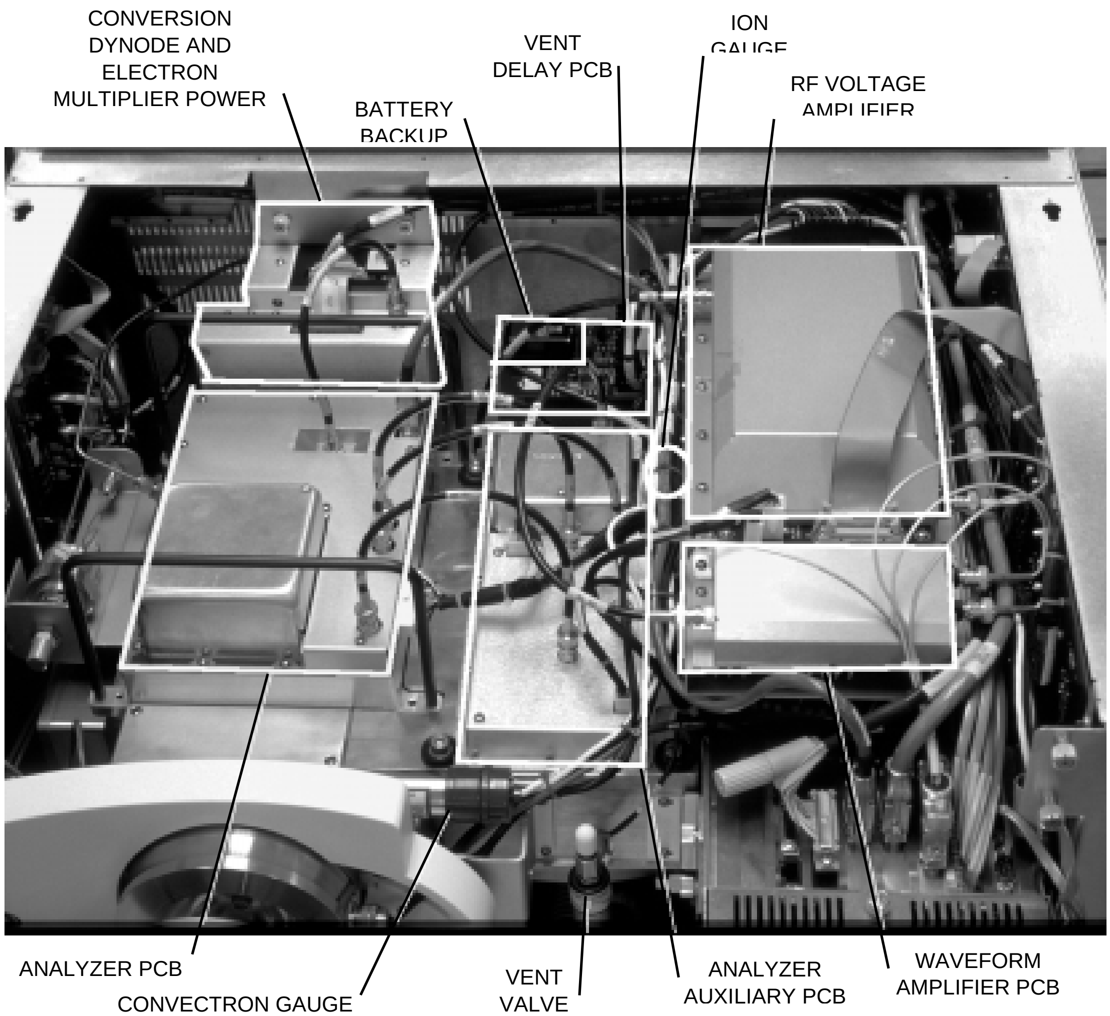

Figure 7-5. PCBs and assemblies that are accessable from the top of the MS detector

To replace the Vent Delay PCB, vent valve, or ion gauge, proceed as follows:

7. Shut down and vent the LCQ system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter.

WARNING. Make sure that the LCQ power cord is unplugged before you proceed.

WARNUNG. Das LCQ muß vom Netz getrennt werden, bevor irgendwelche Eingriffe vorgenomnen werden.

AVERTISSEMENT. Verifiez que le cordon d'alimentation du LCQ soit débranché de la prise de courant avant de procéder.

1. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

    - To replace the Vent Delay PCB, go to step 3.
    - To replace the vent valve, go to step 4.
    - To replace the ion gauge, go to step 5.

2. To replace the Vent Delay PCB, proceed as follows:

    a. Disconnect at J1 the cable to the vent valve.

    b. Disconnect at J2 the cable to the Power Module.

    c. With a Phillips screwdriver, loosen the four screws that secure the Vent Delay PCB to the MS detector chassis. Remove the Vent Delay PCB.

    d. Unpack the new Vent Delay PCB (P/N 97000-61370). Retain the packing materials so that you can pack and ship the defective PCB to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

e. Test the battery. Replace the battery (P/N 00301-05720) if necessary.

f. Position the new Vent Delay PCB in the space that was occupied by the old PCB.

g. With a Phillips screwdriver, tighten the four screws that secure the Vent Delay PCB.

h. Reconnect at J1 the cable that goes to the vent valve.

i. Reconnect at J2 the cable that comes from the Power Module.

Go to step 6.

3. To replace the vent valve, proceed as follows:

a. Disconnect the cable that comes from the Vent Delay PCB.

b. With a 7/16-in. open-end wrench, loosen the fitting to the vent valve solenoid. Remove the vent valve.

c. Replace the old vent valve with a new one (P/N 97000-60128)

d. With a 7/16-in. open-end wrench, tighten the fitting to the vent valve solenoid.

e. Reconnect the cable that comes from the Vent Delay PCB.

Go to step 6.

4. To replace the ion gauge, proceed as follows:

a. Disconnect the cable from the top of the ion gauge by pulling it free from the ion gauge.

b. Unscrew the ion gauge by hand from the vacuum manifold.

c. Replace the old ion gauge with a new one (P/N 00105-01525). Screw it into the vacuum manifold.

d. Reattach the cable to the top of the ion gauge.

Go to step 6

5. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

6. Restart the system as described in the topic **Starting Up the System After a Complete Shutdown** in the **System Shutdown, Startup, and Reset** chapter.

7.3.4 Replacing the Electron Multiplier and Conversion Dynode Power Supplies, Analyzer PCB, Analyzer Auxiliary PCB, Waveform Amplifier PCB, RF Voltage Amplifier PCB, and Battery Backup

The electron multiplier power supply, conversion dynode power supply, Analyzer PCB, Analyzer Auxiliary PCB, Waveform Amplifier PCB, RF Voltage Amplifier PCB, and battery (battery backup) are accessable from the top of the MS detector. See Figure 7-5 on page 7-23.

To replace the electron multiplier power supply, conversion dynode power supply, Analyzer PCB, Analyzer Auxiliary PCB, Waveform Amplifier PCB, RF Voltage Amplifier PCB, or battery (battery backup), proceed as follows:

1. Place the electronics service switch in the Service (OFF, O) position (or shut down and vent the LCQ system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter).

WARNING. Make sure that the LCQ electronic service switch is in the Service (OFF, O) position (or shut down the system and disconnect the power cord) before you proceed.

WARNUNG. Kontrollieren Sie, daß der Hauptschalter für LCQ Elektronikteile auf Wartung (Service/OFF/O) geschaltet ist (oder schalten Sie das System ab, und ziehen Sie den Netzstecker ab) bevor Sie fortfahren.

AVERTISSEMENT. S'assurer que le disjoncteur de branchement LCQ est en position Service (OFF, O) (ou mettre le système hors tension et déconnecter le cordon d'alimentation) avant de continuer.

2. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

   - To replace the electron multiplier power supply and/or the conversion dynode power supply, go to step 3.
   - To replace the Analyzer PCB, go to step 4.
   - To replace the Analyzer Auxiliary PCB, go to step 5.
   - To replace the Waveform Amplifier PCB, go to step 6.
   - To replace the RF Voltage Amplifier PCB, go to step 7.
   - To replace the battery (battery backup) on the Vent Delay PCB, go to step 8.

3. To replace the electron multiplier power supply and/or the conversion dynode power supply, proceed as follows. See Figure 7-5 on page 7-23 for the location of the electron multiplier and conversion dynode power supplies.

   a. Disconnect the conversion dynode high voltage cable at the conversion dynode feedthrough by pulling it free from the feedthrough.

   b. Disconnect the electron multiplier high voltage cable at the electron multiplier power supply.

   c. Disconnect from the top of the electron multiplier and conversion dynode power supplies the electrical cable that comes from the System Control PCB.

   d. Loosen by hand or with a Phillips screwdriver the two knurled fasteners that hold the electron multiplier and conversion dynode power supply module to the MS detector chassis..

e. Carefully lift the electron multiplier and conversion dynode power supply module up and away from the MS detector.

f. You can replace the conversion dynode power supply (P/N 96000-98021) and electron multiplier power supply (P/N 96000-61120) separately, or together as a module (P/N 97000-60170). To replace them separately, you need to disassemble the module with a Phillips screwdriver and replace the individual power supply (PCB). Retain the packing materials so that you can pack and ship the defective power supply module or PCB to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

g. Install the electron multiplier and conversion dynode power supply module in the space occupied by the old power supply module.

h. Tighten with a Phillips screwdriver the two fasteners that hold the electron multiplier and conversion dynode power supply module to the MS detector chassis.

i. Reconnect to the electron multiplier and conversion dynode power supplies the electrical cable that comes from the System Control PCB.

j. Reconnect the electron multiplier high voltage cable to the electron multiplier power supply.

k. Reconnect the conversion dynode high voltage cable to the conversion dynode feedthrough.

Go to step 9.

4. To replace the Analyzer PCB, proceed as follows. See Figure 7-5 on page 7-23 for the location of the Analyzer PCB.

a. Disconnect (at P5) the octapoles cable that comes from the Analyzer Auxiliary PCB. (See Figure 5-9)

b. Disconnect (at P4) the lenses cable that comes from the System Control PCB.

c. Disconnect (at P2 and P3) the two endcap electrode cables that come from the Analyzer Auxiliary PCB.

d. Disconnect (at P1) the electrometer cable. (If necessary, use a small screw driver to loosen the screws that secure the cable.)

e. Disconnect the electron multiplier high voltage cable that comes from the electron multiplier power supply.

f. Use a 7/16-in. open-end wrench to disconnect the helium damping gas line from the fitting.

g. With a Phillips screwdriver, remove the metal cover from the Analyzer PCB.

h. With a Phillips screwdriver, remove the screws that hold the Analyzer PCB to the top cover plate of the vacuum manifold.

Caution. To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

i. Unseat and remove the Analyzer PCB from the top cover plate.

j. Unpack the new Analyzer PCB (P/N 97000-61330). Retain the packing materials so that you can pack and ship the defective PCB to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

k. Carefully align and seat the Analyzer PCB into the 8-pin and 4-pin feedthroughs on the top cover plate.

l. With a Phillips screwdriver, reinstall the screws that hold the Analyzer PCB to the top cover plate.

m. With a Phillips screwdriver, reinstall the metal cover.

n. Use a 7/16-in. open-end wrench to reconnect the helium damping gas line to the fitting.

o. Reconnect (at P5) the octapoles cable that comes from the Analyzer Auxiliary PCB.

p. Reconnect (at P4) the lenses cable that comes from the System Control PCB.

q. Reconnect (at P2 and P3) the two endcap cables that come from the Analyzer Auxiliary PCB.

r. Reconnect (at P1) the electrometer cable.

s. Reconnect the electron multiplier high voltage cable that comes from the electron multiplier power supply.

Go to step 9.

3. To replace the Analyzer Auxiliary PCB, proceed as follows. See Figure 7-5 on page 7-23 for the location of the Analyzer Auxiliary PCB.

   a. Disconnect all cables to the Analyzer Auxiliary PCB.

> **Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

   a. With a Phillips screwdriver, remove the metal cover from the Analyzer Auxiliary PCB.

   b. With a Phillips screwdriver, remove the screws that hold the Analyzer Auxiliary PCB to the top of the vacuum manifold. Remove the Analyzer Auxiliary PCB.

   c. Unpack the new Analyzer Auxiliary PCB (P/N 97000-61340). Retain the packing materials so that you can pack and ship the defective PCB to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

   d. Install the new PCB in the place occupied by the old PCB.

   e. With a Phillips screwdriver, reinstall the screws that secure the Analyzer Auxiliary PCB to the top of the vacuum manifold.

   f. Reinstall the metal cover to the top of the Analyzer Auxiliary PCB.

   g. Reconnect all cables to the Analyzer Auxiliary PCB that you disconnected in step 5a.

   Go to step 9.

6. To replace the Waveform Amplifier PCB, proceed as follows. See Figure 7-5 on page 7-23 for the location of the Waveform Amplifier PCB.

   a. Disconnect all cables to the Waveform Amplifier PCB.

> **Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

   a. With a Phillips screwdriver, remove the metal cover from the Waveform Amplifier PCB.

   b. With a Phillips screwdriver, remove the screws that secure the Waveform Amplifier PCB to the top of the tower. Remove the Waveform Amplifier PCB.

   c. Unpack the new Waveform Amplifier PCB (P/N 96000-61110). Retain the packing materials so that you can pack and ship the defective PCB to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

   d. Install the new PCB in the place occupied by the old PCB.

   e. With a Phillips screwdriver, reinstall the screws that secure the Waveform Amplifier PCB to the top of the tower.

   f. Reinstall the metal cover to the top of the Waveform Amplifier PCB.

   g. Reconnect all cables to the Waveform Amplifier PCB that you disconnected in step 6a.

   Go to step 9.

6. To replace the RF Voltage Amplifier PCB, proceed as follows:

   a. Disconnect all cables to the RF Voltage Amplifier PCB.

> **Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

a. With a Phillips screwdriver, remove the metal cover from the RF Voltage Amplifier PCB.

b. With a Phillips screwdriver, remove the screws that secure the RF Voltage Amplifier PCB to the top of the tower. Remove the RF Voltage Amplifier PCB.

c. Unpack the new RF Voltage Amplifier PCB (P/N 97000-61090). Retain the packing materials so that you can pack and ship the defective PCB to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

d. Install the new PCB in the place occupied by the old PCB.

e. With a Phillips screwdriver, reinstall the screws that secure the RF Voltage Amplifier to the top of the tower.

f. Reinstall the metal cover to the top of the RF Voltage Amplifier PCB.

g. Reconnect all cables to the RF Voltage Amplifier PCB that you disconnected in step 7a.

Go to step 9.

6. To replace the battery on the Vent Delay PCB, proceed as follows. See Figure 7-5 on page 7-23 for the location of the battery.

   a. Remove the battery from the Vent Delay PCB.

   b. Reinstall a new battery (P/N 00301-05720) in the place occupied by the old battery.

   Go to step 9.

7. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

8. Place the electronics service switch in the Normal (ON, |) position.

9. Run the LCQ diagnostics to verify that the system is operational.

10. If you replaced the Analyzer PCB, Analyzer Auxiliary PCB, or RF Voltage Amplifier PCB, tune the ring electrode and

octapole RF voltages as described in the topic **Tuning the Ring Electrode and Octapole RF Voltages** in the **MS Detector Maintenance** chapter.

7.3.5 Replacing the System Control PCB

To replace the System Control PCB, proceed as follows. See Figure 7-2 on page 7-8 for the location of the System Control PCB.

1. Place the electronics service switch in the Service (OFF, O) position (or shut down and vent the LCQ system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter).

WARNING. Make sure that the LCQ electronic service switch is in the Service (OFF, O) position (or shut down or shut down the system and disconnect the power cord) before you proceed.

WARNUNG. Kontrollieren Sie, daß der Hauptschalter für LCQ Elektronikteile auf Wartung (Service/OFF/O) geschaltet ist (oder schalten Sie das System ab, und ziehen Sie den Netzstecker ab) bevor Sie fortfahren.

AVERTISSEMENT. S'assurer que le disjoncteur de branchement LCQ est en position Service (OFF, O) (ou mettre le système hors tension et déconnecter le cordon d'alimentation) avant de continuer.

2. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

3. Remove the right side cover of the MS detector as follows:

a. Loosen the fastener that secures the right side cover to the chassis of the MS detector.

b. Slide the side cover back about 1.25 cm (0.5 in.), and then lift it out and away from the MS detector.

4. Remove the protective cover on the System Control PCB as follows:

   a. Insert a finger into the finger hole on the left side of the cover.

   b. Pull out on the cover to detach the tabs on the cover from the slots in the MS detector chassis. Remove the right side panel of the MS detector.

   c. Remove the plastic cover on the System Control PCB.

5. Disconnect all cables to the System Control PCB. The following cables are connected to the System Control PCB:

   - Front panel (P2)
   - LC I/O (P4)
   - Analyzer Aux. (P5)
   - RF control (P8)
   - RF and waveform amplifiers (P12)
   - Transformer (XMFR) (P1)
   - Spray shield (J6)
   - Analyzer (J3)
   - Ion gauge/ Convectron gauge (P9)
   - Switching power supplies (J2)
   - Electron multiplier/ conversion dynode power supplies (P3)
   - APCI heater (J4)
   - High speed serial (P6)
   - 8 kV power supply (J5).

6. With a Phillips screwdriver, loosen the eight fasteners and three screws that hold the System Control PCB to the MS detector chassis.

> **Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

7. Slide the System Control PCB toward the front of the MS detector by 1.25 cm (0.5 in.) so that it clears the data system cable connector.

8. Carefully lift the System Control PCB out and away from the MS detector.

9. Unpack the new System Control PCB (P/N 97000-61350). Retain the packing materials so that you can pack and ship the defective PCB to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

10. Position the new System Control PCB in the space occupied by the old PCB.

11. With a Phillips screwdriver, tighten the three screws and the eight fasteners that hold the System Control PCB to the MS detector chassis.

12. Reconnect all cables to the System Control PCB. The following cables are connected to the System Control PCB:

    - Front panel (P2)
    - LC I/O (P4)
    - Analyzer Aux. (P5)
    - RF control (P8)
    - RF and waveform amplifiers (P12)
    - Transformer (XMFR) (P1)
    - Spray shield (J6)
    - Analyzer (J3)

- Ion gauge/ Convectron gauge (P9)
- Switching power supplies (J2)
- Electron multiplier/ conversion dynode power supplies (P3)
- APCI heater (J4)
- High speed serial line (P6)
- 8 kV power supply (J5).

13. Reinstall the protective cover over the System Control PCB as follows:

    a. Insert the three tabs on the left side of the cover into the corresponding three slots in the MS detector chassis.

    b. Swing the right side of the cover toward the chassis until the tabs in the cover insert and lock into the slots in the chassis.

14. Reinstall the right side cover of the MS detector as follows:

    a. Place the cover against the right side of the MS detector such that the studs on the cover insert into the guide slots in the MS detector chassis.

    b. Slide the side cover forward about 1.25 cm (0.5 in.) until the studs on the cover lock in the guide slots.

    c. Tighten by hand the fastener that secures the side cover to the chassis of the MS detector.

15. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

16. Place the electronics service switch in the Normal (ON, |) position.

17. Run the LCQ diagnostics to verify that the system is operational.

7.3.6 Replacing the RF Voltage Control PCB

To replace the RF Voltage Control PCB (and its housing), proceed as follows. See Figure 7-6 for the location of the RF Voltage Control PCB.

1. Place the electronics service switch in the Service (OFF, O) position (or shut down and vent the LCQ system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter).

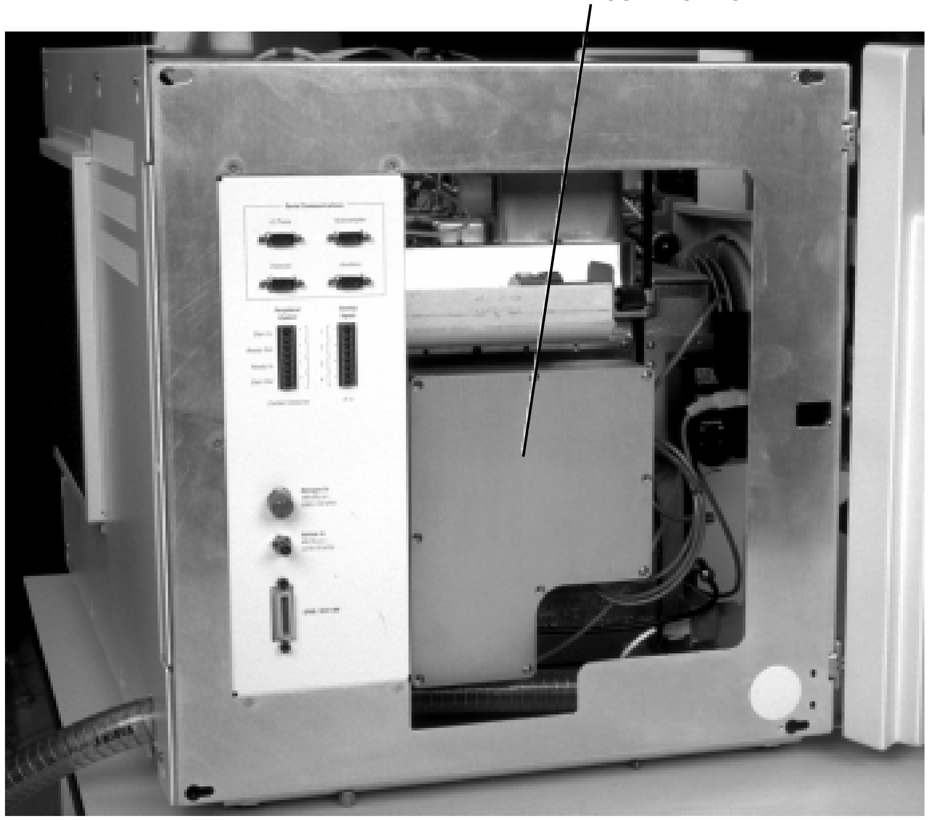

Figure 7-6. Left side of the MS detector, showing the RF Voltage Control PCB

WARNING. Make sure that the LCQ electronic service switch is in the Service (OFF, O) position (or shut down or shut down the system and disconnect the power cord) before you proceed.

WARNUNG. Kontrollieren Sie, daß der Hauptschalter für LCQ Elektronikteile auf Wartung (Service/OFF/O) geschaltet ist (oder schalten Sie das System ab, und ziehen Sie den Netzstecker ab) bevor Sie fortfahren.

AVERTISSEMENT. S'assurer que le disjoncteur de branchement LCQ est en position Service (OFF, O) (ou mettre le système hors tension et déconnecter le cordon d'alimentation) avant de continuer.

2. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

3. Remove the left side cover of the MS detector as follows:

   a. Loosen the fastener that secures the left side cover to the chassis of the MS detector.

   b. Slide the side cover back about 1.25 cm (0.5 in.), and then lift it out and away from the MS detector.

Caution. To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

2. With a Phillips screwdriver, remove the nine screws that secure the front cover of the RF Voltage Control PCB. Remove the front cover to expose the RF Voltage Control PCB.

3. Disconnect the cable that comes from the RF Voltage Amplifier PCB.

4. Disconnect the cable that comes from the System Control PCB.

5. With a Phillips screwdriver, remove the screws that hold the RF Voltage Control PCB housing to the vacuum manifold. Remove the RF Voltage Control PCB and its housing as a unit. Reinstall the cover plate on the housing.

6. Unpack the new RF Voltage Control PCB and housing (P/N 96000-61100). Retain the packing materials so that you can pack and ship the defective PCB and housing to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

7. Position the new RF Voltage Control PCB and its housing against the vacuum manifold where the old assembly was located. With a Phillips screwdriver, reinstall the 21 screws that hold the RF Voltage Control PCB housing to the vacuum manifold.

8. With a Phillips screwdriver, remove the nine screws that hold the front cover of the RF Voltage Control PCB housing to the RF Voltage Control PCB housing. Remove the front cover to expose the RF Voltage Control PCB.

9. Reconnect the cable that comes from the System Control PCB.

10. Reconnect the cable that comes from the RF Voltage Amplifier PCB.

11. Position the front cover over the RF Voltage Control PCB. With a Phillips screwdriver, reinstall the screws that hold the front cover to the RF Voltage Control PCB housing.

12. Reinstall the left side cover of the MS detector as follows:

    a. Place the cover against the left side of the MS detector such that the studs on the cover insert into the guide slots in the MS detector chassis.

    b. Slide the side cover forward about 1.25 cm (0.5 in.) until the studs on the cover lock in the guide slots.

    c. Tighten by hand the fastener that secures the side cover to the chassis of the MS detector.

13. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

14. Place the electronics service switch in the Normal (ON, |) position.

15. Run the LCQ diagnostics to verify that the system is operational.

7.3.7 Replacing the Low Pass Filter PCB

To replace the Low Pass Filter PCB, proceed as follows. See Figure 7-7 for the location of the Low Pass Filter PCB.

1. Place the electronics service switch in the Service (OFF, O) position (or shut down and vent the LCQ system as described in the topic **Shutting Down the System Completely** in the **System Shutdown, Startup, and Reset** chapter).

WARNING. Make sure that the LCQ electronic service switch is in the Service (OFF, O) position (or shut down or shut down the system and disconnect the power cord) before you proceed.

WARNUNG. Kontrollieren Sie, daß der Hauptschalter für LCQ Elektronikteile auf Wartung (Service/OFF/O) geschaltet ist (oder schalten Sie das System ab, und ziehen Sie den Netzstecker ab) bevor Sie fortfahren.

AVERTISSEMENT. S'assurer que le disjoncteur de branchement LCQ est en position Service (OFF, O) (ou mettre le système hors tension et déconnecter le cordon d'alimentation) avant de continuer.

4. Remove the top cover of the MS detector as described in the topic **Removing the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

5. Remove the rear cover of the MS detector as follows:

    a. With a Phillips screwdriver, loosen the 10 screws that secure the rear cover to the chassis of the MS detector.

    b. Slide the rear cover up about 1.25 cm (0.5 in.), and then lift it out and away from the MS detector.

6. Disconnect the two coaxial cables from the BNC connectors that are located on the rear of the Low Pass Filter PCB.

> **Caution.** To prevent damage to the electronics due to electrostatic discharge, attach an electrostatic discharge (ESD) strap to your wrist before continuing.

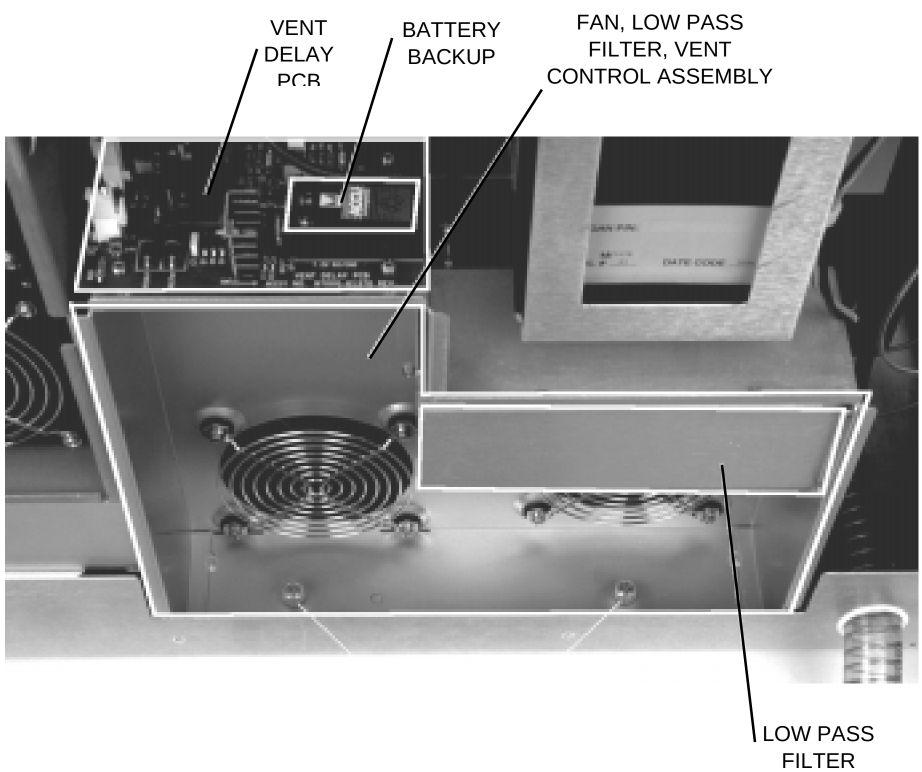

Figure 7-7. Rear view of the MS detector, showing the Vent Delay PCB, battery backup, and Low Pass Filter PCB

9. With a Phillips screwdriver, remove the 8 screws that hold the metal cover of the Low Pass Filter PCB to the fan, low pass filter, vent control assembly. Remove the metal cover.

10. With a Phillips screwdriver, remove the screws that hold the Low Pass Filter PCB to the fan, low pass filter, vent control assembly. Remove the Low Pass Filter PCB.

11. Unpack the new PCB (P/N 97000-61380). Retain the packing materials so that you can pack and ship the defective PCB to the Finnigan Repair Center in San Jose. **Be sure to note the apparent problem or symptoms on the enclosed forms.**

12. Position the new Low Pass Filter PCB in the place that was occupied by the old PCB. With a Phillips screwdriver, reinstall the screws that hold the Low Pass Filter PCB to the fan, low pass filter, vent control assembly.

13. Position the metal cover over the Low Pass Filter PCB. With a Phillips screwdriver, reinstall the 8 screws that hold the metal cover of the Low Pass Filter PCB to the fan, low pass filter, vent control assembly.

14. Reconnect the two coaxial cables to the BNC connectors that are located on the rear of the Low Pass Filter PCB.

15. Reinstall the rear cover of the MS detector as follows:

    a. Place the cover against the rear of the MS detector such that the screws in the MS detector chassis insert into the guide slots on the rear cover.

    b. Slide the rear cover down about 1.25 cm (0.5 in.) until the screws lock in the guide slots on the cover.

    c. With a Phillips screwdriver, tighten the ten screws that secure the rear cover to the chassis of the MS detector.

16. Reinstall the top cover of the MS detector as described in the topic **Reinstalling the Top Cover of the MS Detector** in the **MS Detector Maintenance** chapter.

17. Place the electronics service switch in the Normal (ON, |) position.

18. Run the LCQ diagnostics to verify that the system is operational.

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REPLACEABLE PARTS

This chapter contains part numbers for replaceable and consumable parts for the MS detector, data system, and kits. To ensure proper results in servicing the LCQ system, order only the parts listed or their equivalent.

For information on ordering parts, refer to the topic **Ordering Replaceable Parts** in the **Read This First** chapter of this manual.

8.1 MS Detector

Replaceable parts are available to support the following:

- ESI probe assembly
- APCI probe assembly
- API probe guide
- API stack
- Ion optics
- Mass analyzer
- Ion detection system (electron multiplier/conversion dynode)
- Top cover plate of vacuum manifold
- Divert/inject valve
- Syringe pump
- Turbomolecular pump
- Rotary-vane pump
- Vacuum assemblies
- Mechanical assemblies
- Electrical assemblies
- Printed circuit boards (PCBs)
- RF control/detection assemblies
- Cables
- Covers

8.1.1 ESI Probe Assembly

Assembly, ESI Probe 97000-60135

Connector, receptacle, HV, shielded.. 00004-89626
Container, set, ESI probe 00707-10010
Ferrule, 0.008-in. ID, KEL-F®, HPLC... 00101-18114
Ferrule, 0.016-in. ID, PEEK (polyetheretherketone) HPLC 00101-18120
Fitting, ferrule, 1/8-in., Tefzel® 00101-18199
Fitting, Fingertight 2, Upchurch.. 00101-18195
Fitting, flangeless, stainless steel, 1/8-in., blue, Delrin® 00101-18200
Fitting, flangeless, stainless steel, 1/8-in., green, Delrin 00101-18198
Fitting, transfer line, internal union, 1/16-in., stainless steel 00101-18182
Fitting, plug, 1/4-in. × 28, Tefzel, HPLC.. 00101-18075
Flange, ESI.. 97000-20288
Ground shield, ESI 70005-20170
Manifold, ESI 70005-20166
Manifold inlet, insulated, 1/4-in. × 28 (3 each) 70005-20171
Manifold inlet, insulated, 10-32 70005-20189
Mount, grounded fitting holder 97000-20289
Needle, ESI, D point, 26 gauge, 2-in. long (51 mm)........................... 00950-00951
Nozzle, ESI... 70005-20169
O-ring, 0.145-in. ID, 1/16-in. thick, Viton®.. 00107-02562
O-ring, 0.239-in. ID, 1/16-in. thick, Viton 00107-04000
O-ring, 1.257-in. ID, 0.057-in. thick, Viton 00107-05915
O-ring, 1.489-in. ID, 0.070-in. thick, Viton 00107-10405
O-ring, 1.739-in. ID, 1/16-in. thick, Viton 00107-10625
O-ring, 1.987-in. ID, 0.103-in. thick, Viton 00107-10650
O-ring, 3.737-in. ID, 0.103-in. thick, Viton 00107-10058
Plunger, ball, 1/4-in. × 20, 0.53-in. long, 4 lb-ft 00201-11716
Screw, slot, 6-32 × 5/8-in., nylon 00452-83205
Screw, flat, Phillips, 6-32 × 1-1/8-in., 82 degree, stainless steel 00407-63212
Screw, thumb, ESI probe retainer bolt 97000-20305
Screw, thumb, flange retainer bolt (2 each).. 97000-20268
Seal, standard, needle, 5000 series, Teflon®....................................... 00950-00952
Sleeve, ESI manifold... 70005-20167
Spring, compression, 0.057-in. OD, 0.008-in. thick, stainless steel ... 00201-11613
Tubing, fused silica, 0.1 mm ID × 0.4 mm OD, deactivated (1 m) *l* ... 00106-10504
Tubing, fused silica, 0.1 mm ID × 0.190 mm OD, 6 ft. (1.8 m) *l*......... 00106-10499

8.1.2 APCI Probe Assembly

Assembly, APCI Probe 97000-60134

O-ring, 0.145-in. ID, 1/16-in. thick, Viton 00107-02562
O-ring, 3.737-in. ID, 0.103-in. thick, Viton 00107-10058
O-ring, 0.801-in. ID, 0.070-in. thick, Viton 00107-15300
Plunger, spring, 6-32 × 3/8-in. long 00201-11450

APCI Probe 70005-60075

Ferrule, 0.016-in. ID, PEEK, HPLC 00101-18120
Ferrule, Fingertight 2, Upchurch 00101-18196
Fitting, 10-32, male nut, PEEK 70005-20220
Fitting, APCI flange 70005-20250
Fitting, ferrule, 1/8-in., Tefzel 00101-18199
Fitting, Fingertight 2, Upchurch 00101-18195
Fitting, flangeless, stainless steel, 1/8-in., blue, Delrin 00101-18200
Fitting, flangeless, stainless steel, 1/8-in., green, Delrin 00101-18198
Heater coil, APCI 70005-20216
Insulator, heater, APCI 70005-20195
Manifold, APCI 70005-20201
Nozzle, APCI 70005-20196
O-ring, 0.185-in. ID, 0.056-in. thick, Viton 00107-02585
O-ring, 0.239-in. ID, 1/16-in. thick, Viton 00107-04000
O-ring, 0.614-in. ID, 1/16-in. thick, Viton 00107-05700
O-ring, 0.625-in. ID, 0.029-in. thick, Viton 00107-09015
Retainer, heater, APCI 70005-20222
Screw, pan head, Phillips, 4-40 × 1/8-in., stainless steel 00405-44050
Screw, socket, 4-40 × 3/16-in., stainless steel, silver plated 00419-44005
Tube, auxiliary gas, APCI 70005-20199
Tube, sheath gas, APCI 70005-20200
Tube, vaporizer, APCI 70005-20194
Tubing, fused silica, 0.150 mm ID × 0.363 mm OD, 2 ft. (0.6 m) *l* 00106-10498
Vaporizer casing, APCI 70005-20217
Vaporizer flange, APCI 70005-20239
Washer, flat, #4, 0.312-in. OD × 0.03-in. thick, stainless steel 00470-00410

Vaporizer Kit 97000-62037

Heater coil, APCI 70005-20216
Insulator, heater, APCI 70005-20195
Screw, socket, 4-40 × 3/16-in., stainless steel, silver plated 00419-44005
Tube, vaporizer, APCI 70005-20194
Washer, flat, #4, 0.312-in. OD × 0.03-in. thick, stainless steel 00470-00410

Assembly, Corona Discharge 97000-60161

- Bulkhead nut, corona tube 97000-20310
- Compression nut, corona tube 70005-20226
- Connector, receptacle, HV, shielded 00004-89626
- Contacting, socket, Be-Cu 70001-30016
- Corona tube, APCI 70005-20225
- Needle housing, corona tube 70005-20229
- Needle, corona 70005-98033
- O-ring, 0.176-in. ID, 1/16-in. thick, Viton 00107-02575
- Resistor, fixed, carbon composite, 1/4 W, 22 MΩ, 5% 00015-27820
- Screw-set, socket, 2-56 × 1/16-in., stainless steel 00451-08025
- Spring contacting, corona tube 70005-20228
- Spring, compression, stainless steel 00201-11620

Screw, thumb, APCI probe retainer bolt 97000-20268

Screw, thumb, API flange retainer bolt 97000-20304

8.1.3 API Probe Guide

Kit, Guide, API Probe 97000-62009

- Adapter, slide, API probe 97000-20270
- Guide, API probe flange 97000-20232
- O-ring, 0.237-in. ID, 0.103-in. thick, Viton 00107-12250
- O-ring, 0.296-in. ID, 0.139-in. thick, Viton 00107-04210
- Plate, slide handle 97000-20285
- Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel 00415-63208
- Screw, thumb, 1/2-in. × 20, UNC, API probe 97000-20286
- Shaft, left, API slide 97000-20261

Kit, API, Micro Switch 97000-62017

- Switch, leaf roller, SPDT, 0.5 A 00019-27060

8.1.4 API Stack

Assembly, API Stack 97000-60096

- Bushing, heated capillary mount 97000-20281
- Fitting, 3/8-in. hose, 1 1/2-in. × 13, UNC, male 97000-20269
- Heated capillary 97000-98002
- Mount, heated capillary 97000-20202
- Mount, tube lens and skimmer 97000-20199

O-ring, 0.299-in. ID, 0.103-in. thick, Kalrez® 00107-10059
O-ring, 0.739-in. ID, 0.070-in. thick, Viton 00107-10100
O-ring, 3.850-in. ID, 0.210-in. thick, Viton 00107-14100
Plunger, ball, 6-40, 0.310 long, 1 lb-ft 00201-11719
Retainer, API connector 97000-20280
Screw, pan head, Phillips, 4-40 × 1/4-in., stainless steel 00415-44004
Screw, socket, 6-32 × 3/4-in. long, stainless steel 00419-63212
Skimmer 97000-20201
Sleeve, heated capillary 70005-20224
Spray shield 97000-20197
Tube lens 97000-20200

8.1.5 Ion Optics

Assembly, API octapole insulator 70005-60070

Lens, interoctapole 97000-20165

Mount, analyzer 97000-20179

Mount, octapole 97000-20164

Octapole, 2.0-in. long, welded 97000-60016

Thumb screw, 10-32 97000-20235

Kit, Feedthrough, 4 Pin 97000-62004

Feedthrough, 4 pin, modified 97000-98016
O-ring, 0.737-in. ID, 3/32-in. thick, Viton 00107-10056
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel 00415-63208
Spacer, 4 pin feedthrough 97000-20226

Kit, Feedthrough, 8 Pin 97000-62008

Feedthrough, 8 pin 96000-20115
O-ring, 0.737-in. ID, 3/32-in. thick, Viton 00107-10056
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel 00415-63208
Shield box, PCB 97000-10083
Spacer, 8 pin feedthrough 97000-20225

8.1.6 Mass Analyzer

Electrode, ring 96000-20016

Electrode, endcap, entrance/exit 97000-20327

Exit lens 97000-20205

Mount, analyzer 97000-20179

Nipple, damping gas 96000-20117

Nut... 96000-20022

Post 96000-20083

Sleeve, exit lens.. 97000-20208

Spacer, ring 97000-20302

Spring washer, 0.33-in. ID, 0.49-in. OD, stainless steel......................... 00474-11618

Tubing, Teflon, 14 gauge, 0.016-in. wall thickness................................ 00007-94320

8.1.7 Ion Detection System (Electron Multiplier / Conversion Dynode)

Disk, shield, dynode.. 97000-20263
Shield, dynode 97000-20210

Kit, Conversion Dynode 97000-62085

Feedthrough, dynode 97000-60171
O-ring, 1.37-in. ID, 0.103-in. thick, Viton 00107-10400
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel.................... 00415-63208
Spring, coil, 1.358-in. ID, 0.083-in. height. 00201-11680
Tube, shield, dynode 97000-20275

Kit, Electron Multiplier 96000-62019

Anode, electron multiplier 96000-20076
Feedthrough, HV 96000-20073
Feedthrough, electron multiplier 96000-20072
O-ring, 0.375-in. ID, 0.103-in. thick, Viton 00107-07000
O-ring, 0.688-in. ID, 0.103-in. thick, Viton 00107-09500
Screw, socket, cap, 2-56 × 1/8-in., vented, stainless steel 00452-20000

Assembly, Electron Multiplier 96000-60036

Cathode, electron multiplier.. 00022-02400
Screw, pan head, Phillips, 2-56 × 1/4-in., vented, stainless steel....... 00452-25605
Washer, wave, 0.731-in. OD × 0.588-in. ID....................................... 00471-50080

8.1.8 Top Cover Plate of Vacuum Manifold

Assembly, Top Cover 97000-60051

Connector, Swagelok®, modified 96000-30005

Fitting, Swagelok, ferrule, 1/8-in., tee set 00101-09250
Fitting, Swagelok, nut knurled, 1/8-in., brass 00101-12902
Nipple, damping gas 96000-20117
Pin guide, large top cover 97000-20267
Pin guide, top cover 97000-20222
Pin, PCB, top cover 97000-20223
Plate, top, manifold 97000-20133

Kit, Handle Top Cover, 8-in. 97000-62003

Handle, 8-in., top cover 97000-20220

8.1.9 Divert/Inject Valve

Interconnect Assembly, Divert/Inject Valve 97000-60159

Divert/inject valve, 24 V dc 00110-09998
Screw, flat, Phillips, 8-32 × 3/8-in., zinc 00407-83205
Screw, pan head, Phillips, 6-32 × 3/8-in., stainless steel 00415-63206
Spacer, 0.125-in. long, #6. ID, 1/4-in. OD, stainless steel 00007-68301

8.1.10 Syringe Pump

Interconnect Kit, Syringe Pump 97000-62075

Screw, pan head, Phillips, 6-32 × 3/8-in., stainless steel 00415-63206
Syringe pump 97000-98021

8.1.11 Turbomolecular Pump

Bushing, step, rubber, 0.87-in. OD, 0.31-in. ID. 00201-20050

O-ring, 0.299-in. ID, 3/32-in. thick, Viton 00107-05950

O-ring, 4.100-in. ID, 3/16-in. thick, Viton 00107-11100

Pump oil, turbomolecular, reservoir, felt, TPH 240 00950-01116

Rail, turbomolecular pump, ... 97000-20159

Pump, turbomolecular, TMH 260/130, 200 Ls^{-1} 00108-02642

Screw, socket, 5/16-in. × 18 × 5.0-in. long, stainless steel 00419-63010

Washer, flat, 5/16-in. ID, stainless steel 00471-50010

8.1.12 Rotary-Vane Pump

Interconnect Kit, Rotary-Vane Pump with hardware, 220 V ac 97000-62016

Adapter, hose 25 mm 00108-09005
Clamp, hose, adjustable, 0.81-in. to 1.5-in., stainless steel 00108-09001
Pump oil, vacuum, 1 L 00301-15101
Pump, rotary-vane, 30 m^3 h^{-1}, 220 V ac, 50/60 Hz 00108-02640
Vacuum hardware, clamp, KF20/25 00102-10020

8.1.13 Vacuum System Assemblies

Assembly, Vent Valve 97000-60128

Filter, sintered nylon 00201-06050
Fitting, Swagelok, male adapter, 1/8-in. MPT × 1/4-in. 00101-01740
Fitting, Swagelok, O-seal, 1/4-in. tube, 7/16-in. × 20 00101-13510
O-ring, 0.424-in. ID, 0.103-in. thick, Viton 00107-05550
Ribbon dope, 1/4-in. 00301-16501
Valve, 2 way, solenoid, 6 V dc, 1/32-in., stainless steel, normally open 00110-10708

Assembly, Foreline Interconnect 97000-60127

Clamp, hose, adjustable, 0.81-in. to 1.5-in., stainless steel 00108-09001
Hose, adapter, 25 mm 00108-09005
Hose, PVC, reinforced, 1.0-in. ID, 1.25-in. OD, 1.5 ft. (0.5 m) *l* 00301-24162
Union, duo, forelines, 90 degree 97000-20294
Union, triple, forelines 97000-20283
Vacuum hardware, clamp, KF 20/25, steel 00102-10070

Assembly, Helium, Inlet 97000-60137

Ferrule, 1/8-in. to 0.4 mm, graphite / Vespel 00101-18115
Fitting, Swagelok, bulkhead-union, 1/8-in. × 1/8-in., brass 00101-02101
Fitting, Swagelok, plug, 1/8-in. FPT, brass 00101-02210
Regulator, 0-10 psi, 1/8-in., NPT, stainless steel 00105-03010
Tubing, fused silica, 0.075 mm ID 0.67 ft. (0.2 m) *l* 00106-10520
Tubing, Teflon, 0.125-in. OD, 0.030-in. width, FEP 00101-50000

Kit, Hose Adapter 97000-62005

Adapter, pump manifold, 1.0-in. hose to wall 97000-20215
Convectron™ gauge 00105-00501
O-ring, 0.862-in. ID, 0.103-in. thick, Viton 00107-15350

Ribbon dope, 1/4-in.. 00301-16501
Screw, pan head, Phillips, 6-32 × 1-1/2-in., stainless steel 00425-63224

Kit, Lid Manifold.......... 97000-62006

Manifold lid.......... 97000-20243
O-ring, 3.6-in. ID, 0.21-in. thick, Viton.......... 00107-14050
Screw, pan head, Phillips, 6-32 × 3/8-in., stainless steel 00415-63206

Kit, Ion Gauge 97000-62010

Dynode shield,.......... 97000-20282
Ion gauge, mini, 0.75-in. OD tube 00105-01525
O-ring, 0.737-in. ID, 3/32-in. thick, Viton.......... 00107-10056
Sleeve, 0.75-in. ID, O-ring compression.......... 97000-20211
Sleeve, threaded O-ring seal 97000-20212

8.1.14 Mechanical Assemblies

Cover, top, octapole RF voltage coil.......... 97000-60162

Fan, low pass filter, vent control.......... 97000-60156

Fan, tower 97000-60153

I/O panel, 1-in. 97000-60138

8.1.15 Electrical Assemblies

Assembly, Turbomolecular Pump Controller.......... 97000-60150

Power supply, 8 kV, 100 µA, without bracket (ESI / APCI) 70005-98037

Transformer, 240 VA toroid.......... 97000-98001

Assembly, Power Module 97000-60148

Circuit breaker, 10 A, double-pole, high in-rush 00019-00505
Circuit breaker, 2 pole, 10 A, 230 V ac, rocker 00019-00507
Connector, panel, power inlet, IEC 320/C20.......... 00004-89660
Filter, line, 20 A, screw terminal 00007-18349
Fuse, 3.15 A, 5 × 20 mm, 250 V, time lag 00006-10510
Nut, hex-KEP, 10-32, stainless steel 00461-20320
Screw, flat, Phillips, 4-40 × 3/8-in., stainless steel.......... 00407-44006
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel 00415-63208
Shunt, insulated, mini wrap 00004-89551
Switching power supply, 24 V (1.1 A) 00012-52104

Assembly, Switching Power Supply.. 97000-60151

Power supply, +36 V (11 A), -28 V (4.2 A)... 00012-24223
Power supply, +5 V, ±15 V, +24V, 200 W... 00012-24221

Module, Electron Multiplier / Conversion Dynode
Power Supply 97000-60170

PCB, Electron Multiplier Power Supply 96000-61120
PCB, Conversion Dynode Power Supply (15 kV) 96000-98021

8.1.16 Printed Circuit Boards (PCBs)

PCB, Analyzer 97000-61330

PCB, Analyzer Auxiliary.. 97000-61340

Fuse, 1.60 A, 5 × 20 mm, 250 V, quick acting, (F1 – F2).................... 00006-08610

PCB, Conversion Dynode Power Supply (15 kV) 96000-98021

PCB, Dc Ring Filter 96000-61130

PCB, Divert / Inject Valve... 97000-61390

PCB, Electron Multiplier Power Supply 96000-61120

PCBs, Embedded Computer

PCB, Acquisition DSP... 97000-61260
PCB, Control DSP.. 97000-61270
PCB, CPU.. 97000-60163
PCB, Ethernet, SMC.. 97000-60165
PCB, Serial I/O (RS-232, 8 Port) 97000-60124
PCB, Waveform DDS 97000-61280

PCB, Front Panel 97000-61400

PCB, IEEE 488 I/O, Interface, Ziatech.. 00012-27700

Kit, HPIB Communication HPLC (includes IEEE 488 PCB)............. 97000-62040
Cable tie, 7-in. 00007-90500
Connector, accessory, IEEE-488 screw kit... 00004-89588
Manual, instruction, HP /IP communication kit................................. 97000-97017

PCB, I/O Panel 97000-61420

PCB, Low Pass Filter.. 97000-61380

PCB, RF Voltage Amplifier... 96000-61090

Fuse, 0.50 A, 5 × 20 mm, 250 V, quick acting, (F2) 00006-07608

Fuse, 1.00 A, 5 × 20 mm, 250 V, quick acting, (F1) 00006-07610

PCB, RF Voltage Control 96000-61100

PCB, Syringe Pump 97000-61410

PCB, System Control 97000-61350

Fuse, 0.16 A, 5 × 20 mm, 250 V, time lag (F1 – F4) 00006-01700
Fuse, 0.25 A, 5 × 20 mm, 250 V, time lag (F7).................................... 00006-11204
Fuse, 0.40 A, 5 × 20 mm, 250 V, time lag (F8 – F9) 00006-05080
Fuse, 2.50 A, 5 × 20 mm, 250 V, type F (F6)....................................... 00006-11202
Fuse, 2.50 A, 5 × 20 mm, 250 V, time lag (F10).................................. 00006-09510
Fuse, 3.15 A, 5 × 20 mm, 250 V, time lag (F5).................................... 00006-10510

PCB, Vent Delay 97000-61370

Battery, 7.2 V, nickel / cadium 00301-05720

PCB, Waveform Amplifier 96000-61110

8.1.17 RF Control / Detection Assemblies

Assembly, RF Tuning... 97000-60141

Assembly, RF detector 97000-60078
Assembly, RF plate ceramic 97000-60133
Connector, coax, BNC bulkhead jack, RU-58 00004-33000
RF detector lid housing 97000-20186
RF detector plate insulator 96000-20048
RF detector ring shield 97000-20266
Screw, pan head, Phillips, 6-32 × 3/8-in., stainless steel 00415-63206
Stud, fine tuning 94011-20107
Terminal lug, ring, # 6, solder 00007-41500
Terminal lug, ring, 3/8-in., solder 00007-39500
Tubing, Teflon, 18 gauge, 0.016-in. wall thickness 00007-94330

Kit, RF Feedthrough 96000-62024

O-ring, 1.37-in. ID, 0.103-in. thick, Viton 00107-10400
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel 00415-63208
RF feedthrough 97000-60169

8.1.18 Cables

Cable, electron multiplier power supply – electron multiplier
feedthrough 96000-63008

Cord, power, 230 V ac, 15 A, North America 96000-98035

Cord, power, 230 V ac, 15 A, International... 96000-98036

Cable, System Control PCB – ion gauge – Convectron gauge 97000-63001

Cable, API stack internal – heated capillary, tube lens, skimmer......... 97000-63002

Cable, System Control PCB – spray shield assembly – external interlock.. 97000-63005

Cable, API front panel – APCI heater 97000-63006

Cable, System Control PCB – API front panel – APCI heater 97000-63007

Cable, API front panel – 8 kV API probe connector HV 97000-63008

Cable, 8 kV power supply – API front panel 97000-63009

Cable, Serial I/O (RS-232, 8 Port) PCB – Divert Valve Select PCB (ribbon).. 97000-63011

Cable, I/O Panel PCB – Serial I/O PCB (embedded computer) 97000-63012

Cable, System Control PCB – I/O Panel PCB (ribbon) 97000-63013

Cable, I/O Panel PCB – IEEE 488 I/O PCB (embedded computer), Ziatech (ribbon) 97000-63014

Cable, System Control PCB – RF Voltage Control PCB (ribbon) 97000-63015

Cable, System Control PCB – Conversion Dynode Power Supply PCB (15 kV) – Electron Multiplier Power Supply PCB............................. 97000-63016

Cable, Electron Multiplier Power Supply PCB – electron multiplier HV connector (top cover plate) (coax) 97000-63017

Cable, Analyzer PCB – Acquisition DSP PCB (embedded computer) 97000-63018

Cable, System Control PCB –Analyzer Auxiliary PCB – Dc Ring Filter PCB.. 97000-63021

Cable, Analyzer Auxiliary PCB – Analyzer PCB – RF Voltage Amplifier PCB (4 cables) 97000-63022

Cable, Vent Delay PCB – vent valve 97000-63023

Cable, power supply +36 V (11 A), -28 V (4.2 A) – RF Voltage Amplifier PCB – Waveform Amplifier PCB – Analyzer Auxiliary PCB... 97000-63024

Cable, power supply (+5 V, ±15 V, +24 V, 200 W) – ISA bus (embedded computer motherboard) – System Control PCB – system fans 97000-63025

Cable, Power Module – power supplies (+5, +15, +24, +36) 97000-63026

Cable, Power Module reset button – embedded computer reset connector.. 97000-63027

Cable, interconnect (power module) power supply (+5 V, ±15 V, +24 V, 200 W) – System Control PCB 97000-63028

Cable, 24 V keep-alive power supply (Power Module) – turbomolecular pump fan – Vent Delay PCB 97000-63029

Harness, Power Module 97000-63030

Cable, interconnect (embedded computer), Control DSP PCB – Acquisition DSP PCB (ribbon) 97000-63031

Cable, interconnect (embedded computer), Control DSP PCB – Waveform DDS PCB (ribbon) 97000-63032

Cable, interconnect (embedded computer), ISA bus (embedded computer motherboard) – CPU PCB reset (ribbon) 97000-63033

Cable, RF Voltage Amplifier PCB – Low Pass Filter PCB (coax) 97000-63034

Cable, Low Pass Filter PCB – RF voltage coil connection at front box 97000-63035

Cable, System Control PCB – Front Panel PCB (ribbon) 97000-63036

Cable, Front Panel PCB – Syringe Pump PCB 97000-63037

Cable, Syringe Pump PCB – Serial I/O (RS-232, 8 Port) PCB (embedded computer) 97000-63038

Cable, Power Module – internal Ethernet connector – Ethernet PCB (embedded computer) 97000-63040

Cable, Waveform DDS PCB (embedded computer) – Waveform Amplifier PCB – RF Voltage Amplifier PCB – Analyzer Auxiliary PCB 97000-63041

Cable, System Control PCB – Control DSP PCB (embedded computer) 97000-63042

Cable, Turbomolecular Pump Controller – Serial I/O (RS-232, 8 port) PCB (embedded computer) 97000-63043

Cable, Power Module – Turbomolecular Pump Controller 97000-63045

Cable, switching power supply – embedded computer fan – RF Voltage Control PCB fan – interconnect to tower fans 97000-63046

Cable, RF Voltage Control PCB – RF Voltage Amplifier PCB 97000-63047

Cable, System Control PCB – RF Voltage Amplifier PCB – Waveform DDS PCB (ribbon) 97000-63048

Cable, System Control PCB – Analyzer Auxiliary PCB (ribbon) 97000-63049

Cable, System Control PCB – spray shield – external interconnect 97000-63050

Cable, Sheath / Aux gas valve – I/O Panel PCB 97000-63051

8.1.19 Covers

Cover, Analyzer PCB, small.. 97000-98033
Cover, Analyzer Auxiliary PCB 97000-10088
Cover, balun, shield 96000-98013
Cover, box, balun... 97000-98032
Cover, IEEE port 97000-10089
Cover, manifold front, interconnect... 97000-40003
Cover, RF Voltage Amplifier PCB 97000-10028
Cover, System Control PCB 97000-20301
Cover, Waveform Amplifier PCB.. 97000-10029
Cover, zero box, RF voltage detector 97000-20262

8.2 Data System – Hardware

Kit, Data System, Hardware.. 97000-62038

Cable, thinwire Ethernet.. 00012-50969
Computer system, Gateway, G6, 48 MB RAM, 17-in. monitor 00825-01060
Connector, T-Connector, thinwire Ethernet 00012-50967
PCB, Etherlink 3, PCI Adaptor, Combo... 00825-01002
Terminator, thinwire Ethernet 00950-00918
Toner cartridge, HP LaserJet 5P printer... 00950-20008

8.3 Data System – Software

Kit, Data System, Software.. 97000-62039

LCQ software, revision 1.01 for Windows NT on CD-ROM 97000-64003
Software, Diskkeeper, revision 1.01, service (pack of 2) 00800-00155
LCQ software, revision 1.0.1 for Windows NT on CD-ROM
(Upgrade)... 97000-64003
Software, Windows NT Workstation... 00800-00110

8.4 Chemicals Kit

Kit, Chemicals 97000-62042

Caffeine, 1 mg mL^{-1}, in methanol 00301-12310
Reserpine, 1 gram 00301-12901
Met-Arg-Phe-Ala (MRFA), solids... 00301-07702
Sample, Met-Arg-Phe-Ala (MRFA), solids, 10 mg each...................... 40061-60002

8.5 Accessory Kit

Accessory Kit 97000-62041

Air duct, 1.0-in. ID, flex, blue, 15 ft. (4.5 m) *l* 00301-08301
Cable, shielded, 2-twisted pair, 22 gauge, 24 ft. (7 m) *l* 00302-01800
Chemicals kit 97000-62042
Connector, plug, receptacle, 8 pin, screw (1 each) 00004-02506
Ferrule, HPLC, 1/16-in. stainless steel, Valco (4 each) 00101-18122
Ferrule, Fingertight 2, Upchurch (3 each) 00101-18196
Ferrule, Tefzel, 1/16-in., electrospray (2 each) 00102-10148
Ferrule, 0.008-in. ID, KEL-F, HPLC (4 each) 00101-18114
Ferrule, 0.016-in. ID, PEEK, HPLC (4 each) 00101-18120
Fitting, ferrule, 1/8-in., Tefzel (2 each) 00101-18199
Fitting, ferrule, Swagelok, back, 1/4-in. (2 each) 00101-04000
Fitting, ferrule, Swagelok, front, 1/4-in. (2 each) 00101-10000
Fitting, ferrule, Swagelok, front, 1/8-in. (2 each) 00101-08500
Fitting, ferrule, Swagelok, back, 1/8-in. (2 each) 00101-02500
Fitting, Fingertight 2, Upchurch (2 each) 00101-18195
Fitting, HPLC union, 0.010-in. orifice, PEEK (2 each) 00101-18202
Fitting, HPLC, tee, 0.020-in. orifice, PEEK (1 each) 00101-18204
Fitting, Swagelok, nut, 1/4-in., brass (1 each) 00101-12500
Fitting, Swagelok, nut, 1/8-in., brass (2 each) 00101-15500
Fuse, 0.16 A, 5 × 20 mm, 250 V, time lag (8 each) 00006-01700
Fuse, 0.25 A, 5 × 20 mm, 250 V, time lag (2 each) 00006-11204
Fuse, 0.40 A, 5 × 20 mm, 250 V, time lag (4 each) 00006-05080
Fuse, 0.50 A, 5 × 20 mm, 250 V, quick acting (2 each) 00006-07608
Fuse, 1.00 A, 5 × 20 mm, 250 V, quick acting (2 each) 00006-07610
Fuse, 2.50 A, 5 × 20 mm, 250 V, time lag (2 each) 00006-09510
Fuse, 3.15 A, 5 × 20 mm, 250 V, time lag (4 each) 00006-10510
Hose, PVC, reinforced, 1.0-in. ID, 1.25-in. OD, 1.5 ft.
(0.5 m) *l* 00301-24162
Manual, HPLC troubleshooting (1 each) 00920-05914
Needle, corona discharge 70005-98033
Needle, ESI, D point, 26 gauge, 2-in. long (51 mm) 1 each 00950-00951
Nut, flangeless, 1/16-in., electrospray (1 pack) 00102-10146
Nut, 1/16-in., stainless steel, Valco 00110-16008
O-ring, .299-in. ID × .103-in. thick, Kalrez 00107-10059
Pump oil, rotary-vane vacuum pump, 1 L 00301-15101
Sample loop, 20 µL, stainless steel, Valco 00301-30000
Seal, ESI needle, 5000 series 00950-00952
Sleeve, heated capillary 70005-20224
Syringe, 10 µL, Rheodyne (1 each) 00301-19008
Syringe, 250 µL, Gastight®, removable needle (2 each) 00301-19015
Syringe, 500 µL Gastight, removable needle (1 each) 00301-19016

Tube, copper, 1/8-in. OD × 0.030-in. wall, refrigerant, 16.5 ft. (5 m) *l* 00301-22701
Tube, hypodermic 28 gauge × 10-in.(254 mm) , L304 stainless steel (1 each)........ 00106-20000
Tube, Teflon, 0.030-in. ID × 1/16-in. OD, 1.5 ft. (0.5 m) *l*........ 00301-22915
Tubing, 0.25-in. OD × 0.062-in. wall thickness, PFA, 15 ft. (4.5 m) *l*........ 00101-50100
Tubing, fused silica, 0.150 mm ID × 0.390 mm OD, 2 ft. (0.6 m) *l*........ 00106-10498
Tubing, fused silica, 0.050 mm ID × 0.190 mm OD, 6 ft. (1.8 m) *l*........ 00106-10502
Tubing, fused silica, 0.1 mm ID × 0.4 mm OD, deactivated 3 ft. (1 m)........ 00106-10504
Tubing, fused silica, 0.1 mm ID × 0.190 mm OD, 6 ft. (1.8 m) *l*........ 00106-10499
Tubing, PVC, unreinforced, clear, 3/8-in. ID, 10 ft. (3 m) *l*........ 00301-22895
Tubing, PEEK, red, 0.005-in. ID × 1/16-in. OD, 5 ft. (1.5 m) *l*........ 00301-22912
Wrench, Allen / Hex 1/4-in. ball point........ 00725-00022

8.6 Recommended Spares

Battery, 7.2 V, nickel / cadium........ 00301-05720

Bushing, snap, 1.75-in. diameter, white plastic........ 00201-19081

Dc ring filter box........ 97000-98004

Fan gasket........ 97000-20298

Fan, 100 cfm, 24 V dc........ 00013-00243

Fan, kit........ 97000-62021

Filter, fan........ 97000-20299

Finger guard........ 00007-18600

Fitting, Swagelok, bulkhead-union, 1/8-in. × 1/8-in., stainless steel........ 00101-02102

Foot, bumper........ 00007-18115

Fuse, 0.16 A, 5 × 20 mm, 250 V, time lag........ 00006-01700

Fuse, 0.25 A, 5 × 20 mm, 250 V, time lag........ 00006-11204

Fuse, 0.40 A, 5 × 20 mm, 250 V, time lag........ 00006-05080

Fuse, 0.50 A, 5 × 20 mm, 250 V, quick acting........ 00006-07608

Fuse, 1.00 A, 5 × 20 mm, 250 V, quick acting........ 00006-07610

Fuse, 1.60 A, 5 × 20 mm, 250 V, quick acting........ 00006-08610

Fuse, 2.50 A, 5 × 20 mm, 250 V, Type F 00006-11202
Fuse, 2.50 A, 5 × 20 mm, 250 V, time lag 00006-09510
Fuse, 3.15 A, 5 × 20 mm, 250 V, time lag 00006-10510
Hinge, open 180 degree 00250-08003
Logo, 2 piece molded, right door 97000-40014
Nut, hex-KEP, 6-32, cadmium plated 00460-16321
Nut, hex-KEP, 8-32, stainless steel 00461-28320
Plug, 1.75-in. diameter, white, nylon 00201-20500
Pump oil, turbomolecular, reservoir, felt, TPH 240 00950-01116
Pump oil, rotary-vane vacuum pump, 1 L 00301-15101
Screw, pan head, Phillips, 6-32 × 1 3/4-in., zinc plated 00405-63228
Screw, pan head, Phillips, 6-32 × 1/2-in., stainless steel 00415-63208
Screw, pan head, Phillips, 6-32 × 1/4-in., stainless steel 00415-63204
Screw, pan head, Phillips, 6-32 × 3/8-in., stainless steel 00415-63206
Screw, pan head, slot, 2-56 × 1/4-in., stainless steel 00414-25604
Screw, pan head, slot, 6-32 × 1/4-in., cadmium plated 00404-63204
Stud, ball, 6-32 × 0.375-in. 00201-12110
Switchcap, manifold cover, interconnect 97000-40009
Switchcap, right door, interconnect 97000-40010
Tubing, Teflon, 18 gauge, 0.016-in. wall thickness 00007-94330
Valve assembly, sheath/aux gas, dual manifold 00110-20014
Washer, flat, #6, stainless steel 00472-00600
Washer, interlock, 5/16-in. ID, stainless steel 00479-04400

8.7 Divert / Inject Valve Accessories

Ferrule, HPLC 1/16-in. stainless steel, Valco 00101-18122
Syringe adapter, 1/16-in. fill port liner / ferrule, Valco 00110-16002
Syringe adapter, 1/16-in. fill port, Valco 00110-16000
Valve, replacement nut, 1/16-in. HPLC, stainless steel 00110-16008
Valve, replacement rotor seal, Valco 00110-16006
Valve, replacement stator, Valco 00110-16004

5 µL sample loop, stainless steel, Valco 00110-16010
20 µL sample loop, stainless steel, Valco 00301-30000

8.8 Optional Tools

Hexdriver, 0.28-in. 00025-01810

Hexdriver, 0.35-in. 00025-08041

Tool pin extractor, AMP, large 00725-00013

Tool pin extractor, AMP, small.......... 00725-00020

Wrench, Allen / hex drive, 1/4-in. (with handle) 00725-00015

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APPENDIX A: CONTROL OF EXTERNAL DEVICES

LCQ allows full data system control of the TSP AS3000 autosampler and P4000 LC, HP 1050, 1090, and 1100 autosamplers and LCs, and the Waters Alliance 2690 autosampler and LC. Other external devices, including the Michrom LC, can be controlled via contact closure.

This appendix is organized as follows:

- Full data system control of external devices
- Contact closure control of external devices
- Connecting LC plumbing to the LCQ

A.1 Full Data System Control of External Devices

With full data system control you can configure, monitor, and control external devices from the LCQ data system. You can provide full control of the following devices from the data system:

- TSP P4000 LC and AS3000 autosampler
- HP 1050, 1090, and 1100 LCs and autosamplers
- Waters Alliance 2690 LC and autosampler

You configure external devices for full data system control from the Navigator window by using the following procedure:

1. Turn off all external devices.
2. Complete connections as specified in the topic **Connecting a TSP P4000 LC, AS3000 Autosampler, and UV 2000 Detector**, **Connecting an HP 1050 LC and Autosampler**, **Connecting an HP 1090 LC and Autosampler, Connecting an HP 1100 LC and Autosampler** or **Connecting a Waters Alliance 2690 LC and Autosampler**, below. Do not turn on the external devices.
3. Configure the LCQ as follows:
    a. Make sure that the Tune Plus window is closed.
    b. From the Navigator window, choose **Options | Configure Instrument** to open the Instrument Configuration dialog box.
    c. Select either the HPLC or Autosampler tab. Repeat steps 3d through 3g to configure more than one device.
    d. Select a model name from the Model Name list box. If the model name of your device is not on the list, you need to use contact closure control as described in the topic **Contact Closure Control of External Devices**, below.
    e. Enter the model number in the Model Number text box.
    f. Enter the serial number in the Serial Number text box.
    g. Select the Direct Control option button.

h. If you have a UV/visable detector, select the Analog Inputs tab. Use the In Use check boxes to select the channels that you are using.

i. Choose **OK** to close the dialog box.

4. Turn on and configure the external devices as specified in the topic **Configuring a TSP P4000 LC and AS3000 Autosampler**, **Configuring an HP 1050 LC and Autosampler**, **Configuring an HP 1090 LC and Autosampler, Configuring an HP 1100 LC and Autosampler,** or **Configuring a Waters Alliance 2690 LC and Autosampler**, below.

5. Press the reset button on the LCQ to establish communications between the LCQ and the external devices.

6. Specify LC and autosampler parameters in an Experiment Method by using the Setup menu of the Experiment Method window.

A.1.1 Connecting a TSP P4000 LC Pump, AS3000 Autosampler, and UV2000 Detector

You need a TSP SN4000 controller (P/N A3625-073) to connect the TSP P4000 LC pump and AS3000 autosampler to the LCQ. Your SN4000 was shipped with the cables and adapters listed in Table A-1.

Table A-1. SN4000 Controller Accessory Kit Contents

Description	Function	P/N
Autosampler to LC pump cable/adapter	Connects autosampler Inject Out to LC pump Run Start	A5127-010
RJ11 6-pin, 4-wire cable (2 ft)	Connects autosampler and/or LC pump to SN4000 controller	A3638-010 (5)
RJ45 8-pin, 8-wire cable (25 ft)	Connects SN4000 controller to LCQ	A3598-030
RJ45 to DB9 female adapter	Adapter for A3598-030 cable	A3538-010
RJ45 to DB25 female adapter	Adapter for A3598-030 cable (retain for future use)	A3539-010

To connect the TSP P4000 LC and AS3000 autosampler to the LCQ, proceed as follows:

1. Turn off the P4000 LC, AS3000 autosampler, and SN4000 controller (and disconnect the 12 V dc power supply).

> **Caution.** Before you remove the top cover of the SN4000 controller, turn off the power switch at the rear of the SN4000, and disconnect the 12 V dc power supply.

2. Remove the top cover of the SN4000 controller:

   a. Turn the SN4000 controller upside down to access the four Phillips-head screws that secure the top cover to the case.

   b. Remove the screws and slide the top cover off to expose the PCB and the RJ11 and RJ45 ports.

3. Plug the RJ45 to DB9 adapter into the serial port labeled *LC Pump* on the LCQ

4. Connect the RJ45 8-pin, 8-wire cable from the adapter to the port labeled *Com* inside the SN4000 controller. (Route all cables through the large access hole in the rear panel of the SN4000.)

5. Connect an RJ11 6-pin, 4-wire cable from the port labeled *Pump* inside the SN4000 controller to the port labeled *COMM* on the back of the P4000 LC pump. **Do not turn on the LC pump at this time**.

6. Connect an RJ11 6-pin, 4-wire cable from the port labeled *A/S* inside the SN4000 controller to the port labeled *COMM* on the back of the TSP AS3000 autosampler. **Do not turn on the autosampler at this time**.

7. Reinstall the top cover of the SN4000 controller.

8. Connect the power cable from the 12 V power supply to the port labeled *Power In* on the rear panel of the SN4000

controller. **Do not turn on the SN4000 controller at this time**.

> **Note.** For the hardware configuration of the SN4000 controller to be established correctly, turn on the SN4000 controller only after turning on the LC modules.

9. Connect the autosampler to the LC pump with the adapter and cable provided (P/N A5127-010). This cable synchronizes the pump and autosampler and must be installed for proper operation. The adapter and cable automatically make the hardwire connections listed in Table A-2.

Table A-2. Hardwire TSP AS3000 Autosampler to P4000 LC Pump Connections

Autosampler (pin connection)	LC pump
Ground (1)	Ground (3)
Pump stop output (3)	Pump stop (5)
Pump ready input (5)	Pump ready (1)
Inject hold (7)	Sync (8)
Gradient start (4)	Run grad (7)

10. Connect the TSP UV2000 detector (if you have this module) to the LCQ as follows:

    a. Plug the green, 8-pin connector (P/N 00004-02506) from the LCQ accessory kit into the LCQ analog inputs ports connector.

> **Note.** The LCQ requires a 1 V analog input. Either of the two UV2000 channels can be used. Any of the four LCQ analog inputs can be used. For example, in the next step, channel 1 output of the UV2000 is connected to analog input 1 on the LCQ.

b. Use the analog cable included in your UV2000 accessory kit to connect the ground wire to terminal E and the 1 V full-scale signal wire to terminal F on the back of the UV2000.

c. Connect the other end of the 1 V signal wire to the positive terminal of analog input port 1 on the LCQ.

d. Connect the other end of the ground wire to the negative terminal of analog input port 1 on the LCQ.

A.1.2 Configuring a TSP P4000 LC Pump and AS3000 Autosampler

Turn on and configure the AS3000 autosampler as follows (refer to Table A-3):

1. Turn on the AS3000 autosampler.

2. Set the autosampler communications mode to SpectraNet:

   a. Press the MENU button on the autosampler keypad.

   b. Select OPTIONS by pressing the right arrow button four times to move the cursor to OPTIONS, and then press the ENTER button.

   c. Use the arrow buttons to move the cursor to Configurations and then press the ENTER button.

   d. Use the arrow buttons to move the cursor to the Communications field (the next to the last field). Select SpectraNet communications by pressing the +/- buttons until SprectraNet appears in the Mode field.

3. Set the autosampler input polarity:

   a. Press the MENU button on the keypad.

   b. Select OPTIONS by pressing the right arrow button four times to move the cursor to OPTIONS, and then press the ENTER button.

   c. Use the arrow buttons to move the cursor to Input Polarity and then press the ENTER button.

d. Set Pump Ready Active to Hi and Inj Hold Active to Lo by using the arrow buttons to move the cursor to the appropriate fields and then pressing the +/- buttons to select the appropriate polarities.

4. Set the autosampler output polarity:

   a. Press the MENU button on the keypad.

   b. Select OPTIONS by pressing the right arrow button four times to move the cursor to OPTIONS, and then press the ENTER button.

   c. Use the arrow buttons to move the cursor to Output Polarity and then press the ENTER button.

   d. Set Autosampler Ready to Lo, Inject Out Active to Lo, Grad Start to Lo, and Pump Stop Active to Lo by using the arrow buttons to move the cursor to the appropriate fields and then pressing the +/- buttons to select the appropriate polarities.

5. Set the autosampler gradient delay and cycle times to 0 min in an autosampler method:

   a. Press the MENU button on the keypad.

   b. Select FILES, Edit by pressing the right arrow button to move the cursor to FILES, Edit, and then press the ENTER button. Use the +/- buttons to select File 1.

   c. Press the down arrow button twice and select Cycle Time. Set this value to 0.0 min and then press the ENTER button.

   d. Press the down arrow button until the Injection Menu is displayed.

   e. From the Injection Menu, move the cursor down to the More Menu and press the ENTER button.

   f. Use the arrow buttons to move the cursor to Equilibration Time. Under most circumstances you want to set the Equilibration Time to 0.0 min.

   g. Use the arrow buttons to move the cursor to Gradient Delay. Under most circumstances you want to set the Gradient Delay time to 0.0 min.

Table A-3. TSP AS3000 Autosampler Settings

Section	Item	Setting	Comment
OPTIONS/Configuration	Mode	SpectraNet	
OPTIONS/Input Polarity	Pump Ready Active	Hi	
OPTIONS/Input Polarity	Inj Hold Active	Lo	
OPTIONS/Output Polarity	Autosampler Ready	Lo	Optional but recommended
OPTIONS/Output Polarity	Inject Out	Lo	Optional but recommended
OPTIONS/Output Polarity	Grad Start	Lo	
OPTIONS/Output Polarity	Pump Stop Active	Lo	
FILES/Edit and FILES/Load			
Injection	Cycle Time	0.0	See autosampler manual
More	Gradient Delay	0.0	See autosampler manual
More	Equilibration Time	0.0	See autosampler manual

6. Load the autosampler method you just created:

    a. Press the Menu button.

    b. Select FILES, and Load. Use File 1.

Turn on and configure the P4000 LC as follows (refer to Table A-4):

1. Turn on the P4000 LC.

2. Set the LC Delay Volume to 0.0:

    a. Press the MENU button on the LC keypad.

    b. Select OPTIONS by pressing the right arrow button four times to move the cursor to OPTIONS, and then press the ENTER button.

    c. Use the down arrow button to move the cursor to the More Menu and then press the ENTER button.

d. Move the cursor to Delay Volume and Set the Delay Volume to 0.0. (The autosampler controls the Delay Volume in a SpectraSYSTEM setup.)

3. Set the LC Pressure Units to PSI:

   a. Press the MENU button on the keypad.

   b. Select OPTIONS by pressing the right arrow button four times to move the cursor to OPTIONS, and then press the ENTER button.

   c. Use the down arrow button to move the cursor to the More Menu and then press the ENTER button.

   d. Move the cursor to Pressure Units and use the +/- buttons to set the pressure units to PSI.

4. Set the LC Ready Output Active to Hi:

   a. Press the MENU button on the keypad.

   b. Select OPTIONS by pressing the right arrow button four times to move the cursor to OPTIONS, and then press the ENTER button.

   c. Use the down arrow button to move the cursor to the More Menu and then press the ENTER button.

   d. Move the cursor to Ready Output Active and use the +/- buttons to set it to Hi.

5. Set the LC equilibration time to 0.0 min in an LC method:

   a. Press the MENU button on the keypad.

   b. Select FILES, Edit by pressing the right arrow button to move the cursor to FILES, Edit, and then press the ENTER button. Use the +/- buttons to select File 1.

   c. Move the cursor to the Equilibration Time field. Set this value to 0.0 min.

6. Load the LC method you just created:

   a. Press the MENU button.

   b. Select FILES, and Load. Use File 1.

Table A-4. TSP P4000 LC Settings

Section	Item	Setting
OPTIONS/More	Delay Volume	0.0
OPTIONS/More	Pressure Units	PSI
OPTIONS/More	Ready Output Active	Hi
FILES/Edit/Options	Equilibration Time	0.0

Configure the LCQ as described in step 3 of the topic **Full Data System Control of External Devices**, if you have not already done so.

Turn on the UV2000 and SN4000:

1. Turn on the UV2000 detector if you have this module.
2. Connect the 12 V dc power supply cable to the port labeled Power In on the rear of the SN4000 controller.
3. Turn on the SN4000 controller.

A.1.3 Connecting an HP 1050 LC and Autosampler

You need to have the GPIB communications kit (P/N 97000-62040) installed on your LCQ to connect an HP 1050 LC and autosampler to the LCQ. To connect an HP 1050 LC and autosampler to the LCQ, proceed as follows:

1. Turn off the LC and autosampler.
2. Use a GPIB communication interface cable (P/N 00012-22702) to connect the port labeled *GPIB / IEEE 488* on the LCQ to either the port labeleled *HP-IB* on the back of the HP LC or the port labeleled *HP-IB* on the back of the HP autosampler.
3. If you connected the GPIB cable from the LCQ to the HP 1050 LC, connect (daisy chain) a second GPIB cable from the end of cable that you installed in step 1 (at the HP-IB port on the LC) to the HP-IB port on the autosampler. If you connected the GPIB cable from the LCQ to the HP 1050 autosampler, connect (daisy chain) the second GPIB cable from the end of cable that you installed in step 1 (at the HP-IB port on the autosampler) to the HP-IB port on the LC.

4. Connect an HP intermodule serial cable between the Remote port on the LC and the Remote port on the autosampler.

5. If you have a UV detector, cable the analog out port on the UV detector to the analog inputs port on the LCQ. **Do not** cable the UV detector to the LC or autosampler with a GPIB cable.

A.1.4 Configuring an HP 1050 LC and Autosampler

To configure the HP 1050 autosampler and LC, repeat the following procedure for both the HP autosampler and LC.

1. Turn on the autosampler or LC.

2. Press the CTRL button on the keypad.

3. At the DATE & TIME prompt, press the down arrow (NEXT) button.

4. At the CONFIGURATION prompt, press the ENTER button.

5. At the PARAMETER LOCK OFF prompt, press the down arrow (NEXT) button.

6. At the REMOTE: (Start Request Out) prompt, make sure it is set to HPSystem. If not, press the right arrow button to get into the field. Then press the down arrow (NEXT) button until HPSystem is in the field. Press the left arrow button to get back to the REMOTE field. Then, press the down arrow (NEXT) button.

7. At the COMMUNICATION prompt, press the ENTER button.

8. At the INTER.: (Inst. Control) prompt, make sure it is set to HPIB. If it is not, press the right arrow button to get into the field. Then press the down arrow (NEXT) button until HPIB is in the field. Press the left arrow button to get back into the INTER.: (Inst. Control) field. Press the down arrow (NEXT) button.

9. At the HPIB ADDR.: (Select Address) prompt, make sure it is set to 18 for the autosampler or to 16 for the LC pump. If not, press the right arrow button to get into the field. Then press the down arrow (NEXT) button until the correct number is in the field. Press the left arrow button to get back to the

INTER.: (Inst. Control) field. Press the down arrow (NEXT) button.

10. Press the STATUS button.

A.1.5 Connecting an HP 1090 LC and Autosampler

You need to have the GPIB communications kit (P/N 97000-62040) installed on your LCQ to connect an HP 1090 LC and autosampler to the LCQ. If you do not have a GPIB communications kit, you can connect the HP 1090 to the LCQ by contact closure as described in the topic **Connecting an HP 1090 by Contact Closure**, below.

Use a GPIB communication interface cable (P/N 00012-22702) to connect the port labeled *GPIB / IEEE 488* on the LCQ to the port labeleled *HP-IB* on the back of the HP 1090 LC/autosampler unit.

A.1.6 Configuring an HP 1090 LC and Autosampler

Turn on and configure the HP 1090 for remote operation as follows:

1. Turn on the HP 1090 unit. After the HP 1090 is turned on, it runs various tests and displays various messages.

2. When you are asked to choose remote or local mode, choose remote. If necessary, hold down the escape key to toggle between local and remote modes. (In the remote mode, start and stop are the only operable keys.)

A.1.7 Connecting an HP 1100 LC and Autosampler

You need to have the GPIB communications kit (P/N 97000-62040) installed on your LCQ to connect an HP 1100 LC and autosampler to the LCQ. To connect an HP 1100 LC and autosampler to the LCQ, proceed as follows:

1. Use a GPIB communication interface cable (P/N 00012-22702) to connect the port labeled *GPIB / IEEE 488* on the LCQ to either the port labeleled *HP-IB* on the back of the HP LC or the port labeleled *HP-IB* on the back of the HP autosampler.

2. If you connected the GPIB cable from the LCQ to the HP 1100 LC, connect (daisy chain) a second GPIB cable from the end of cable that you installed in step 1 (at the HP-IB port on the LC) to the HP-IB port on the autosampler. If you connected the GPIB cable from the LCQ to the HP 1100 autosampler, connect (daisy chain) the second GPIB cable from the end of cable that you installed in step 1 (at the HP-IB port on the autosampler) to the HP-IB port on the LC.

3. Connect an HP CAN interface cable between a CAN port on the LC and a CAN port on the autosampler.

4. If you have a UV detector, cable the analog 1 port on the UV detector to the analog inputs port on the LCQ. Connect a CAN interface cable from the CAN port on the UV detector to a CAN port on the LC or autosampler. **Do not** cable the UV detector to the LC or autosampler with a GPIB cable.

Note. At this time, the LCQ only supports direct control of two members of the HP 1100 series: the G1311A quaternary LC pump and the G1313A autosampler. Also, only the 100-vial tray of the HP 1100 autosampler is supported. Vials are numbered 1 to 100. The maximum injection volume is 500 µL. The maximum flow rate for the LC is 10 mL min^{-1}, but a flow rate greater than 5 mL min^{-1} is rejected if the high pressure limit is set to more than 200 bar. Conversely, maximum pressure can be set to 400 bar, but a value greater than 200 is rejected if the LC flow rate is greater than 5 mL min^{-1}.

A.1.8 Configuring an HP 1100 LC and Autosampler

Configure the HP 1100 LC, autosampler, and UV detector as follows:

1. Set the configuration switches on the back of the LC to 00110000.

2. Set the configuration switches on the back of the autosampler to 00110010.

3. Set the configuration switches on the back of the UV detector to 00111000.

4. Turn on the LC, autosampler, and UV detector.

A.1.9 Connecting a Waters Alliance 2690 LC and Autosampler

You need to have the serial control option installed on your Waters Alliance 2690 to connect the Waters Alliance 2690 to the LCQ. To connect to the LCQ, attach a serial (RS 232) cable from the port labeled *LC Pump* on the LCQ to the RS 232 port B on the rear of the LC/autosampler unit.

A.1.10 Configuring a Waters Alliance 2690 LC and Autosampler

The serial port on the Waters Alliance 2690 LC/autosampler unit is autosensing. When you connect the Waters Alliance 2690 to the LCQ by a serial cable, it switches to remote mode. When you disconnect the cable it switches to local mode. No configuring by the user is necessary.

A.2 Contact Closure Control of External Devices

LCQ provides contact closure of external devices that are not currently controlled by the data system. A diagram of external device control signals that are used by the LCQ is shown in Figure A-1. You configure external devices for contact closure from the Navigator window by using the following procedure:

1. From the Navigator window, choose **Options | Configure Instrument** to open the Instrument Configuration dialog box.
2. Select either the HPLC or Autosampler tab.
3. Enter a model name in the Model Name list box.
4. Enter the model number in the Model Number text box.
5. Enter the serial number in the Serial Number text box.
6. Select the Contact Closure option button.
7. Choose **OK** to close the dialog box.
8. Complete connections as specified in the topic **Connecting an HP 1090 by Contact Closure, Connecting a Michrom LC by Contact Closure**, or **Connecting Other Devices**, below.
9. Key in LC and autosampler parameters by using the keypad on the LC and autosampler.

A.2.1 Connecting an HP 1090 by Contact Closure

If you have a GPIB communications kit (P/N 97000-62040) installed on your LCQ, use the procedure described in **Connecting an HP 1090 LC and Autosampler** on page A-13 to connect your HP 1090 to the LCQ.

There are two ways to connect an HP 1090 LC to the LCQ by contact closure. See Table A-2. In option A, pins 3 and 1 of the 9-pin connector labeled Remote on the HP 1090 are connected to the LCQ Start In + and - connectors, respectively. In option B, the top and bottom connectors labeled Contact Closure on the HP 1090 are connected to the LCQ Start In + and - connectors, respectively.

(Ready out from the LCQ is not used.) Refer to the **HP 1090 Installation Guide**.

Table A-5. Contact Closure Connection to an HP 1090 LC

	HP 1090 LC	LCQ
Option A	Remote 9-Pin Connector Pin 3 Pin 1	Start In + -
Option B*	Contact Closure Connector Top Bottom	Start In + -

*A method must be set up on the HP 1090 to produce a contact closure on event trigger 4. Refer to the information on the Ext Cont parameter key in the **Parameter Keys** section of the **Using Your HP 1090** manual.

A.2.2 Connecting a Michrom LC by Contact Closure

Information on connecting a Michrom LC to the LCQ by contact closure is given in Table A-1. For example, Table A-1 shows that the Michrom INJECT OUT top and bottom connectors are connected to the LCQ Start In + and - connectors, respectively.

Table A-6. Contact Closure Connection to a Michrom LC

Michrom LC	LCQ
INJECT OUT Top Bottom	Start In + -
VALVE TO LOAD Top Bottom	Ready Out + -

A.2.3 Connecting Other External Devices

To connect devices other than the Michrom LC and HP 1090 LC to the LCQ by contact closure, refer to Figure A-1 and the documentation that came with the device.

Figure A-1. Diagram of LCQ contact closure control of an external device

A.3 Connecting LC Plumbing to the LCQ

Inside your accessory kit is a 1.5 m length of red PEEK tubing (P/N 00301-22912). You use the PEEK tubing to plumb the LC pump to the divert/inject valve. You also use the PEEK tubing to plumb the divert/inject valve to the transfer line fitting (ESI) or sample inlet fitting (APCI), and the divert/inject valve to the waste container. See Figure A-2 and Figure A-3.

> **Note.** Use a PEEK tubing cutter to cut the red PEEK tubing used to connect the LC to the divert/inject valve and the divert/inject valve to the transfer line fitting (ESI) or sample inlet fitting (APCI). This ensures that the ends of the tubing is cut straight. In addition, make sure that the LC fittings, ferrules, and PEEK tubing are installed properly. By using these precautions void (dead) volumes are prevented. The exclusion of void volumes is critical to microbore LC. Also, void volumes deminish the quality of the ion signal.

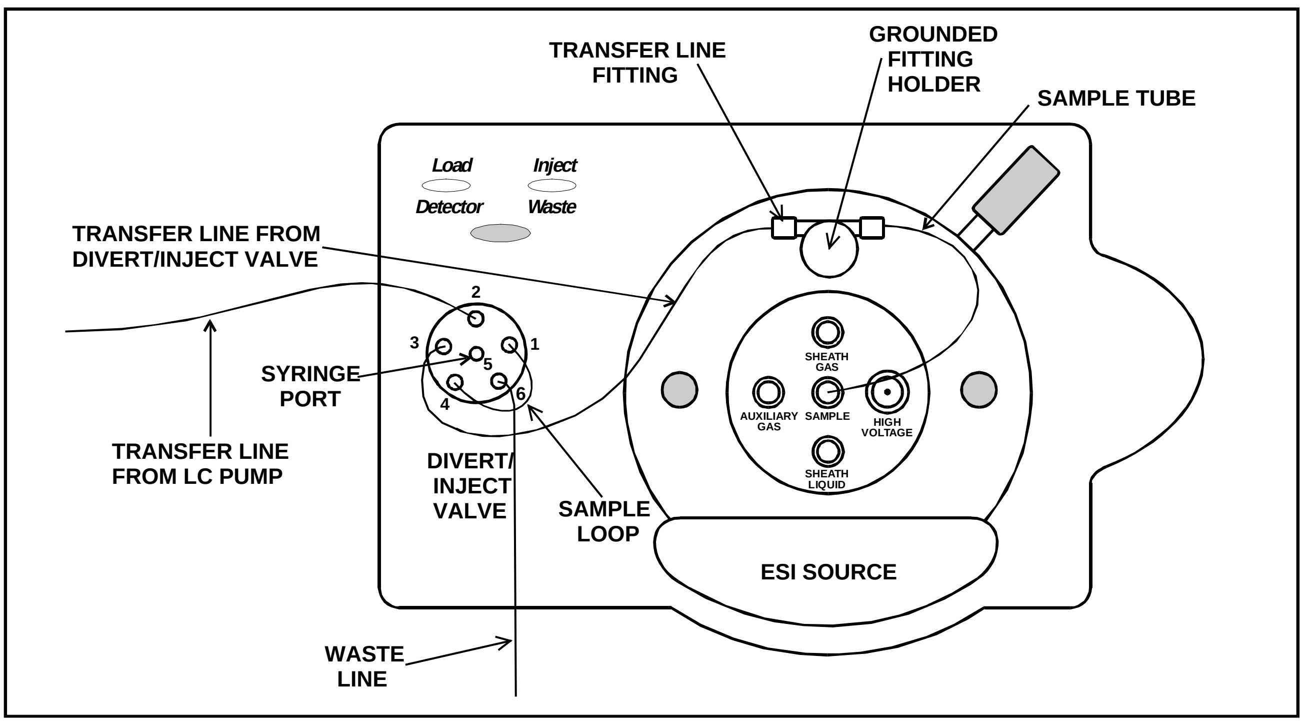

Figure A-2. MS detector console, showing plumbing to the LC, divert/inject valve, and ESI source. The divert/inject valve is configured as a loop injector.

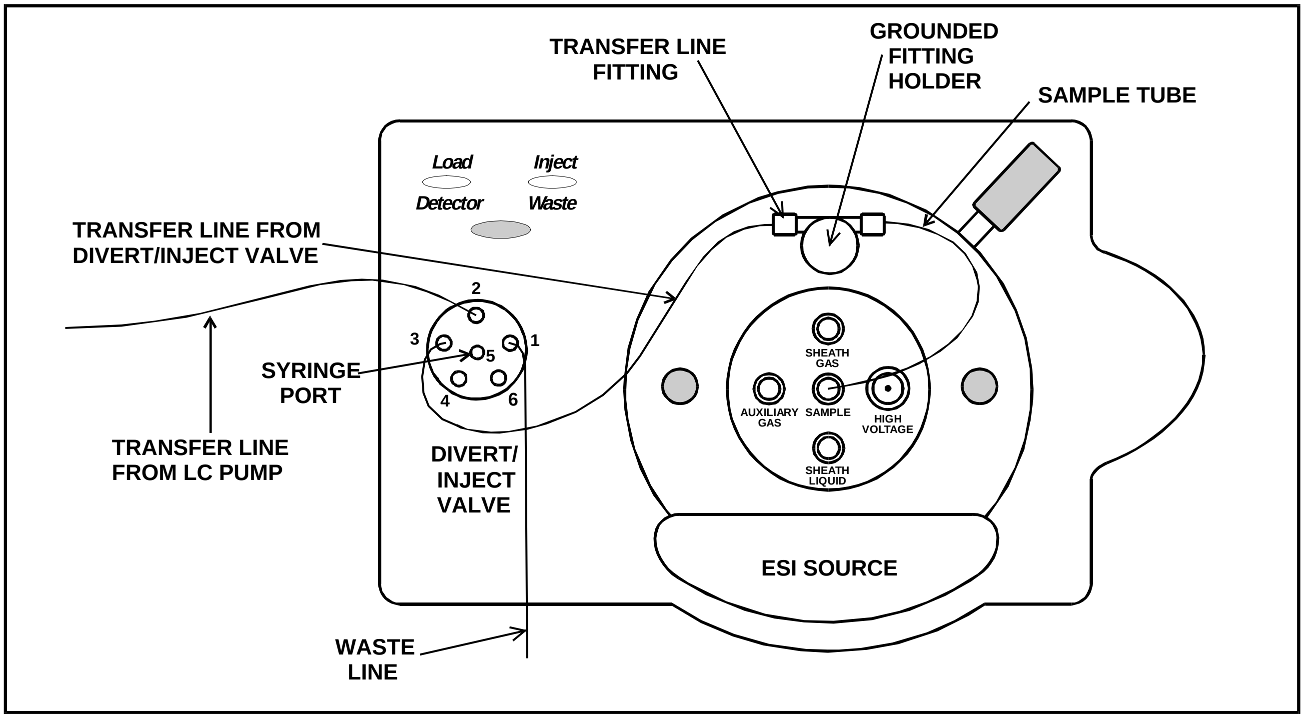

Figure A-3. MS detector console, showing plumbing to the LC, divert/inject valve, and ESI source. The divert/inject valve is configured as a divert valve.

To connect the LC plumbing to the LCQ, proceed as follows:

1. Connect the LC to the divert/inject valve as follows:

   a. Connect one end of a piece of 0.005-in. ID PEEK tubing (the red tubing in your accessory kit) of appropriate length to the outlet of the LC. Use the proper fitting and ferrule for the LC.

   b. Connect the other end of the PEEK tubing to port 2 of the divert/inject valve. Use a Valco nut (P/N 00110-16008) and ferrule (P/N 00101-18122). Both parts are in your accessory kit.

2. Connect the divert/inject valve to the API source as follows:

   a. Connect one end of another piece of PEEK tubing (the sample transfer line) of appropriate length to port 3 of the divert/inject valve. Use a Valco nut (P/N 00110-16008) and ferrule (P/N 00101-18122).

b. Use an Upchurch Fingertight fitting (P/N 00101-18195) and ferrule (P/N 00101-18196) to connect the other end of the PEEK tubing to the sample inlet of the APCI source (if you have an APCI source installed on your LCQ), or to the transfer line fitting of the ESI source (if you have an ESI source installed on your LCQ). Ensure that the transfer line fitting is properly seated in the grounded fitting holder of the ESI source.

- To set up the divert/inject valve as a divert valve, go to step 4.
- To set up the divert/inject valve as a loop injector, go on to the next step.

3. To set up the divert/inject valve as a loop injector, proceed as follows:

    a. Disconnect any tubing, other than the sample loop (if it is installed), from ports 1 and 4 of the divert/inject valve.

    b. Install the 5 µm or 20 µm sample loop between ports 1 and 4 of the divert/inject valve. Use the nuts and ferrules that came with the sample loop.

    c. Connect one end of a piece of PEEK tubing (the waste line) of appropriate length to port 6 of the divert/inject valve. Use a Valco nut (P/N 00110-16008) and ferrule (P/N 00101-18122).

    d. Connect the other end of the waste line to the waste container. The set up is now complete.

4. To set up the divert/inject valve as a divert valve, proceed as follows:

    a. Disconnect any tubing from ports 1 and 4 of the divert/inject valve.

    b. Connect one end of a piece of PEEK tubing (the waste line) of appropriate length to port 1 of the divert/inject valve. Use a Valco nut (P/N 00110-16008) and ferrule (P/N 00101-18122).

    c. Connect the other end of the waste line to the waste container.

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