

# *TRACE DSQ*<sup>TM</sup>

## Hardware Manual

Xcalibur Data System, 1.4

Revision B  
PN 120156-0002



Analyze • Detect • Measure • Control<sup>TM</sup>

## Technical Support

Thermo Electron Corporation offers Technical Support via phone Monday through Friday 9:00 AM to 6:00 PM Eastern US time. Our staff of certified professionals will answer your technical questions regarding all Thermo Electron Corporation product lines. Please contact us by phone/fax or mail at:

Thermo Electron Corporation Technical Support  
1400 Northpoint Parkway, Suite 10  
West Palm Beach, FL 33407

Phone: 800-685-9535  
Fax: 561-688-8736  
e-mail: [techsupport@thermo.com](mailto:techsupport@thermo.com)

Thermo Electron Corporation products are produced under ISO 9001 accredited quality management systems.

## Publication Info

TRACE DSQ Hardware Manual, PN 120156-0002, Revision B. Printed January 2004.

Software: *Xcalibur Data System*  
Technical Content: S. Quarmby, B. Guckenberger  
Technical Publications: T. Sierer  
Technical Illustrations: S. Brinkley, G. Phinney, S. Quarmby

Xcalibur™, TRACE DSQ, and PolarisQ are trademarks and/or product names of Thermo Electron Corporation. Microsoft® is a registered trademark of Microsoft Corporation. Dremel® is a registered trademark of Robert Bosch Tool Corporation.

Technical information contained in this publication is for reference purposes only and is subject to change without notice. Every effort has been made to supply complete and accurate information; however, Thermo Electron assumes no responsibility and will not be liable for any errors, omissions, damage, or loss that might result from any use of this manual or the information contained therein (even if this information is properly followed and problems still arise).

This publication is not part of the Agreement of Sale between Thermo Electron Corporation and the purchaser of a GC/MS or LC/MS system. In the event of any conflict between the provisions of this document and those contained in Thermo Electron Corporation's Terms and Conditions, the provisions of the Terms and Conditions shall govern. System Configurations and Specifications supersede all previous information and are subject to change without notice.

**Information in this book** may refer to the continental USA exclusively. Assurances and specifications might differ in other locations. Specific details are available from the Thermo Electron Corporation **Tech Support** office. However, if you are unsure whom to call, contact the Thermo Electron Corporation **Customer Service** office assigned to your area.

Published by Thermo Electron Corporation Technical Publications, Austin, Texas.  
Copyright© 2004 Thermo Electron Corporation. All rights reserved. Printed in the United States of America.

# Important Information

## Copyright

Under the copyright laws, this publication may not reproduced or transmitted in any form, electronic or mechanical, including photocopying, recording, storing in an information retrieval system, or translating, in whole or in part, without the prior written consent of Thermo Electron.

## FCC Compliance

### *FCC part 15, Class A*

**NOTE:** *TRACE DSO* systems operate reliably under carefully controlled environmental conditions. If you maintain a system outside the specifications listed in this guide, failures of many types may occur. The repair of such failures is specifically excluded from the Standard Warranty and service contract coverage.

---

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy. If it is not installed and used in accordance with the instruction manual, it may cause harmful interference to radio communication. Operation of this equipment in a residential area is likely to cause harmful interference. In this case, users will be required to correct the interference at their own expense.

## EMC Regulatory Compliance

Thermo Electron thoroughly tests and evaluates its products to ensure full regulatory compliance with applicable domestic and international regulations. Your system (instruments and software) is CE compliant and meets Electromagnetic Compatibility (EMC) and safety standards. Standards we use to apply the CE mark on the *TRACE DSO*.

❖ EN61326/1997+A1/1998+A2/2001



To ensure compliance with EMC and safety standards, order replacement parts from only Thermo Electron authorized representatives. If you make any changes to your system, you may void compliance with one or more of these EMC or safety standards, or warranty. Changes to your system include replacing a part.

## Safety Compliance

Low Voltage Directive 73/23/EEC

- ❖ EN61010-1/1993+A1/1992+A2/1995

## Standard Warranty

This standard warranty covers all products manufactured by Thermo Electron hereinafter referred to as the "Seller".

**WARRANTY AND LIMITATIONS.** Seller warrants that the products to be delivered hereunder "products" are free from defects in material and workmanship and meet Seller's field performance specifications as published by the Seller, provided, however, that

1. Seller's liability under this warranty is, at the discretion of the Seller, limited to repairing or replacing or issuing a credit for any product delivered hereunder not conforming to this warranty.
2. The alternative remedies provided for herein are Buyer's sole and exclusive remedies.
3. Except as otherwise provided in this document, Buyer's warranty on all products is limited to a period of ninety (90) days, commencing with the date of acceptance of any such product or one hundred twenty (120) days after shipment, whichever occurs first.
4. Minor deviations from specifications that do not affect performance of the products covered hereby are excluded from this warranty.
5. Warranty on repaired or replaced parts is extended only to the expiration date of an issued standard warranty, and only after receipt of written authorization from Seller.

- 6.** Seller makes no warranty as to expendable items including but not limited to electron multipliers, filaments, O-rings, vacuum gauge tubes, fuses, septa, lamps, sources reaction tubes, and solvents.
- 7.** Moreover, after initial installation, any readjustment, recleaning or recalibration is expressly excluded from this warranty.
- 8.** The warranty will be null and void and Seller will not be liable under this warranty upon the occurrence of the following events unless Seller's prior written consent to the continuation of this warranty is granted:
  - a.** In the event Buyer installs products or physically moves products from their position of installation at time of acceptance by Buyer, or
  - b.** In the event Buyer transfers ownership of products to third parties other than Buyer.
- 9.** Seller will not be liable under this warranty unless:
  - (i) Seller is promptly notified in writing by Buyer upon discovery of the failure of any products to conform to this warranty,
  - (ii) when possible, such, product is returned to Seller with Seller's written approval, transportation charges prepaid by Buyer,
  - (iii) such product is received by Seller not more than ten (10) days after the last day of the applicable warranty period,
  - (iv) Seller's examination of such product shall disclose to Seller's reasonable satisfaction that such defects or failures have not been caused by misuse, neglect, improper installation by Buyer, repair, alteration or accident, including but not limited to failure of electric power, excessive or erratic power, failure of environmental control equipment as defined in Seller's published specifications, failure of Buyer's self-maintenance program, or failure of Buyer to maintain product in accordance with Seller's manual or instructions.
- 10.** All claims under warranty must be made promptly after occurrence of circumstances giving rise thereto and must be received within the applicable warranty period by Seller or its authorized representative.

Such claims should include the product type and serial numbers and a full description of the circumstances giving rise to the claim. At its discretion, Seller may authorize the prepaid return to Seller's plant or designated repair center of products or parts that prove to be defective, or Seller may repair or replace at Buyer's premises. Before any products are returned for repair and / or adjustment, written authorization from Seller for the return and instructions as to how and where the product should be shipped must be obtained.

- 11.** When any product is returned for examination and inspection or for any other reason, Buyer shall be responsible for all damage resulting from improper packing or handling and for loss in transit, notwithstanding any defect or nonconformity in the product.

If it is found that the defective product returned to Seller has been caused by the fault of the Buyer, or has been returned without cause and is still serviceable, Seller shall notify Buyer and shall return such product to Buyer at Buyer's expense; in addition, a charge for testing and examination, may at Seller's discretion, be made on products so returned.

- 12.** Seller will not authorize return or repair or replacement at Buyer's lab of defective products that have been used for the analysis of toxic, carcinogenic, mutagenic or corrosive / irritant chemicals until said products are certified to have been decontaminated by Buyer.

Seller shall not warranty products that have not been decontaminated, and Seller shall have no obligation to repair or replace such products. Any products returned to Seller for examination shall be sent prepaid via the means of transportation indicated as acceptable to Seller.

- 13.** Seller reserves the right to reject any warranty claim not made in accordance with the foregoing procedures or any warranty claim on any item that has been altered or has been shipped by nonacceptable means of transportation.

- 14.** Except as above expressly provided, no warranty is made as to the merchant ability of the goods to be delivered, nor is except as expressly provided above, no warranty is made as to the fitness of such goods for any particular purpose.

- 15.** Statements, expressed or implied, by any person, including employees or authorized representatives of Seller, that are inconsistent or in conflict with this warranty shall not be binding upon Seller unless said statement is in writing and signed by an officer of Seller.

- a.** Liability: In no event shall Seller be liable to buyer or any other party for incidental, consequential, or special damages.
- b.** Damages: Seller's liability (whether by reason of breach of warranty, breach of contract, tort, or otherwise and irrespective of Seller's negligence) for damages shall in no event exceed the payment, if any, received by seller for the unit or product or service furnished or to be furnished, as the case may be, which is the subject of claim or dispute.

August 1998  
This warranty shall be governed by the laws of the State of California  
P / N QSF-PR-0012 Rev A

# Contact Us...

Receive a **FREE** gift, application and technical reports by completing and returning this card by *mail, email* ([techpubsaustin@thermo.com](mailto:techpubsaustin@thermo.com)), or *Fax (512-251-1547)* to Tech Pubs Austin.

## Reader Survey...

TRACE DSQ Hardware Manual, PN 120156-0002, Revision B. Help us improve the quality of our manuals by circling one number for each statement:

	Strongly Agree	Agree	Disagree	Strongly Disagree
The manual is well organized.	1	2	4	5
The manual is clearly written.	1	2	4	5
The manual contains all the information I need.	1	2	4	5
The instructions are easy to follow.	1	2	4	5
The instructions are complete.	1	2	4	5
The technical information is easy to understand.	1	2	4	5
Examples of operation are clear and useful.	1	2	4	5
The figures are helpful.	1	2	4	5
I was able to operate the system using this manual. (If not please comment below.)	1	2	4	5

*Additional Comments.* Attach additional sheets if necessary.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

fold

## Customer Registration...

MY ORGANIZATION IS: (Check only one)	MY PRIMARY APPLICATION IS: (Check only one)
<input type="checkbox"/> Commercial (for profit) lab	<input type="checkbox"/> Analytical
<input type="checkbox"/> Government lab	<input type="checkbox"/> Biomedical
<input type="checkbox"/> Hospital/Clinic	<input type="checkbox"/> Clinical/Toxicology
<input type="checkbox"/> Industrial lab	<input type="checkbox"/> Energy
<input type="checkbox"/> Research institute	<input type="checkbox"/> Environmental
<input type="checkbox"/> University/College	<input type="checkbox"/> Food/Agricultural
<input type="checkbox"/> Veterinary	<input type="checkbox"/> Forensic/Toxicology
<input type="checkbox"/> Other _____	<input type="checkbox"/> Pharmaceutical
	<input type="checkbox"/> Research/Education
	<input type="checkbox"/> Other _____

MY JOB FUNCTION IS: (Check only one)
<input type="checkbox"/> Administration
<input type="checkbox"/> Lab management
<input type="checkbox"/> Operator
<input type="checkbox"/> Other _____

Name \_\_\_\_\_ Title \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

City/State/Postal Code \_\_\_\_\_

Country \_\_\_\_\_

Telephone \_\_\_\_\_ Ext. \_\_\_\_\_

System Type \_\_\_\_\_ Serial Number \_\_\_\_\_ Date purchased \_\_\_\_\_

From \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



PLACE  
STAMP  
HERE

**Editor, Technical Publications**  
THERMO ELECTRON Corporation  
2215 GRAND AVENUE PKWY  
AUSTIN TX 78728-3812  
UNITED STATES OF AMERICA



# *Read Me*

## In This Chapter

Where to Find More Information, pp. x  
Typographical Conventions, pp. xv  
Changes to the Manual, pp. xv



Analyze • Detect • Measure • Control™

This chapter explains how this book is organized and designed, specifications about your system, and where to find more information about your system.

Be sure to tear out the *Contact Us...* card located at the front of this book and return it to us after filling out the *Reader Survey* and the *Customer Registration* forms. The Reader Survey allows you to give us feedback, which helps us to improve the quality of our documentation. The Customer Registration Card allows you to register your product to receive all the privileges associated with being a Thermo Electron Corporation product user. After we receive your *Contact Us...* card, we'll send you a **FREE** Thermo Electron Corporation gift and complimentary application and technical reports.

Before shipping your system, Thermo Electron Corporation installed the *Xcalibur Data System*, Ver. 1.4 on your computer's hard drive.

## Where to Find More Information

Look at your Xcalibur Installation CD for a complete set of hardware and software documentation.

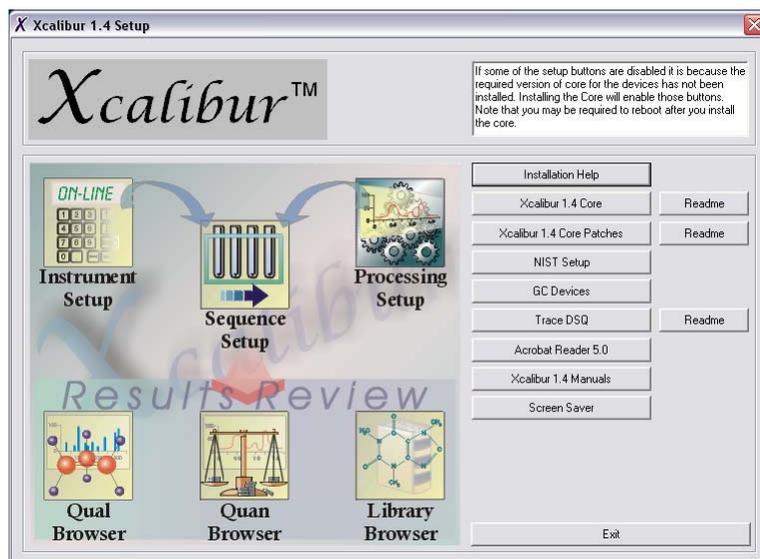


Figure ii-1. Xcalibur 1.4 TRACE DSQ Installation CD Screen

Xcalibur software provides you with the following capabilities:

**Instrument Configuration**—After installation, access to this module is outside the Xcalibur home page and located as a Windows desktop icon. Use this module to configure your instruments for use with Xcalibur.

**Instrument Setup**—Use this module to set up instrument methods and as quick access to the **Tune** program for calibrating your instrument for sensitivity and mass assignments. The remaining Xcalibur modules fulfill your data acquisition and data processing needs.

**Tune** automatically calibrates and tunes the instrument for optimum performance.

**Data Acquisition**—Store mass spectra peaks as they evolve and monitor the total ion chromatogram (TIC) or the intensity of a selected ion.

**Data Processing**—Integrate chromatograms, view mass spectral data, compare spectra to reference libraries, quantify and qualify data, and customize and automate reports.

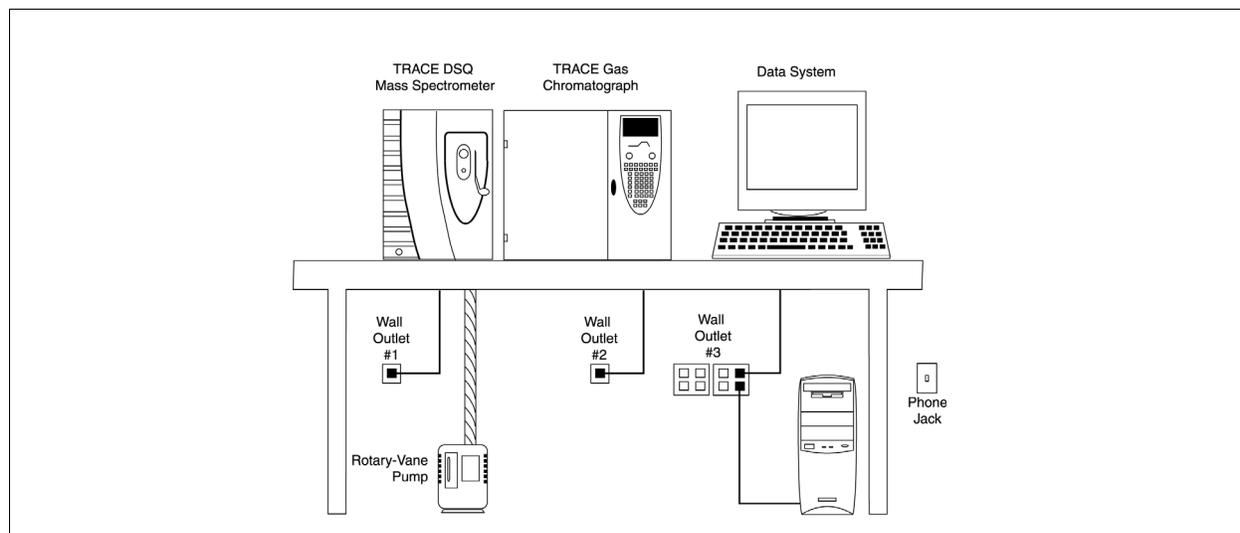
## *About Your TRACE DSQ System*

The *TRACE DSQ* is a powerful quadrupole mass spectrometer (MS Detector), with features benefiting those in the chemical science industry—analysts, technicians, and chemists.

A *TRACE DSQ* System includes the *TRACE DSQ* MS Detector, the TRACE GC, and the Xcalibur software (Ver. 1.4 or higher).

## Features and Specifications

**Table ii.2 TRACE DSQ System Specifications**



Specifications	Features	Options
Certification: Electromagnetic Compatibility (EMC) and FCC Class A	Electron Ionization (EI) with Exchangeable Ion Volumes	Autosamplers: Liquid or Headspace
Dimensions: l 68 cm x w 33 cm x h 44 cm	70 L/s Turbomolecular Pump	Chemical Ionization (CI)
Space Requirements: 2 m (6 ft)	RF-Only Curved Quadrupole Prefilter	Data System Software Options: NIST, Wiley, or Pflieger-Maurer-Weber Library, EnviroLab Forms, ToxLab 2.0
Weight: 45 kg (98 lbs)	Ion Source Temperature up to 300 °C and GC Interface Temperature up to 350 °C	Direct Probes System (DIP or DEP)
Power: 120 V ac or 230 V ac, 50/60 Hz	Mass Range 1 – 1050 u (Unit Mass Resolution)	Inlet valve
Temperature: 15-31 °C (59-88 °F)	Scan Rate up to 10,000 u/s	PPINICI (Pulsed Positive Ion, Negative Ion CI)
Humidity: 40-80%	Full Scan, SIM, and Simultaneous Full Scan/SIM	Programmable Temperature Vaporizer or Cold On-Column Injector
	Post-Acceleration ±10 kV Conversion Dynode	Turbomolecular Pumps: 250 L/s or 200/200 L/s Split-Flow
	Xcalibur Ver. 1.4 Running Under Microsoft® Windows® XP Professional with Office XP	Ion Gauge with internal vacuum protection safety

## Safety Information

- ❖ Read each instruction carefully before using the procedure.
- ❖ Follow all instructions marked on the product and in the manuals.
- ❖ Contact Tech Support to enroll in Instrument Training to prevent accidents and to get maximum use of the instrument.
- ❖ Look for safety alerts (see the following) placed in this manual and on the instrument to protect you from injury and the instrument from damage.

<b>CAUTION</b> Instrument Damage	
	This safety alert contains information to prevent instrument damage or alert against practices that could possibly void the manufacturer's warranty.

<b>CAUTION</b> Personal Injury	
	A <b>CAUTION</b> safety alert indicates a potential hazard exists that <b>MAY</b> result in minor or moderate personal injury. These safety alerts also warn against <b>unsafe</b> practices.

<b>WARNING</b> Personal Injury	
	A <b>WARNING</b> safety alert indicates a potential hazard exists that <b>COULD</b> result in death or serious personal injury.

<b>DANGER</b> Personal Injury	
	A <b>DANGER</b> safety alert indicates a potential hazard exists that <b>WILL</b> result in death or serious personal injury.

<b>Safety Alerts Found on Instruments</b>	
	<b>Read Manual</b> Please <b>READ</b> the manual before using to <i>PREVENT</i> an imminent or potential hazard.
	<b>Personal Injury</b> Indicates imminent or a potential personal injury hazard exists. Please use caution and consult the manual for details.
	<b>Burn Hazard</b> Indicates a hot surface. Make sure the part is room temperature before touching.
	<b>Explosion Hazard</b> Indicates risk of explosion from flammable gas or liquid. Use proper ventilation.
	<b>Shock Hazard</b> Indicates risk of electrical shock. Make sure the instrument is unplugged.
	<b>Material Hazard</b> Wear impermeable laboratory gloves.
	<b>Eye Hazard</b> Wear safety glasses.
	<b>Lifting Hazard</b> Use proper lifting technique.

## Typographical Conventions

Typographical conventions describe how information is presented to our readers.

For example, some text is specially formatted to help you quickly find information contained in the document. For example,

- ❖ **Bold** is used for information required by or for the reader.
- ❖ References are emphasized in *italics*.
- ❖ **Special terms** are emphasized in bold and italic.
- ❖ **Notes** provide important or helpful information about the current topic. In addition, notes can contain troubleshooting information.

**NOTE:** **Notes** are contained in margin boxes like this. They provide important or helpful information about the current topic.

---

## Changes to the Manual

Your comments and suggestions help us to correct errors and improve the documentation. Please send your suggestions and comments to:

**Editor, Technical Publications**  
**Thermo Electron Corporation**  
**2215 Grand Avenue Pkwy**  
**Austin, TX 78728**  
**FAX: (512)-251-1547**  
**email: [techpubsaustin@thermo.com](mailto:techpubsaustin@thermo.com)**

View and Download Manuals: [http://www.tmqaustin.com/fr\\_manuals.htm](http://www.tmqaustin.com/fr_manuals.htm)

**Read Me**

Changes to the Manual \_\_\_\_\_ TRACE DSQ

www.thermo.com

# Contents

<b>Important Information</b>	<b>iii</b>
<b>Contact Us...</b>	<b>vii</b>
<b>Read Me</b>	<b>ix</b>
<b>Contents</b>	<b>xvii</b>
<b>1 Operating Instructions</b>	<b>1</b>
Installing a GC Column	2
Starting Up	10
Shutting Down	12
Removing a GC Column	14
<b>2 Maintenance Instructions</b>	<b>17</b>
Scheduling Maintenance	18
Maintaining System Performance	20
Running Benchmark Tests	20
Removing the Covers	21
Cleaning Stainless Steel Parts	24
Cleaning Non-Stainless Steel or Hybrid Parts	27
Vacuum Manifold Maintenance	30
Ion Source Assembly Maintenance	33
Cleaning the Ion Volume with an Inlet Valve	34
Cleaning the Ion Volume Without an Inlet Valve	44
Cleaning the Ion Source, Lenses, and Prefilter	47
Replacing the Ion Source Filament	55
Quadrupole Assembly Maintenance	59
Ion Detector Assembly Maintenance	60
Cleaning the Anode	60
Replacing the Electron Multiplier	63
Turbomolecular Pump Maintenance	66
Rotary-Vane Pump Maintenance	67
Checking the Oil Level	67

Adding Oil to the Rotary-Vane Pump .....	68
Purging the Rotary-Vane Pump Oil .....	70
Changing the Rotary-Vane Pump Oil .....	72
Replacing Parts .....	75
Quick Overview-Parts Located by Covers .....	76
Replacing the Analog PCB .....	81
Replacing the Analog PCB Fuse .....	83
Refilling the Calibration Gas Flow Module .....	85
Replacing the Calibration Gas Flow Module .....	87
Replacing the CI Reagent Gas Flow Module (Upgrade Option).....	90
Replacing the Conversion Dynode/Electron Multiplier Power Supply .....	93
Replacing the DC Driver Assembly.....	95
Replacing the DC Driver Assembly Fuse .....	97
Replacing the Digital PCB .....	100
Replacing the Electrometer PCB .....	102
Replacing the Forepressure Gauge and Foreline Adapter .....	104
Replacing the Inlet Valve Seal.....	106
Replacing the Ion Gauge (Upgrade Option) .....	109
Replacing the Lens Interface PCB .....	111
Replacing the Low Pass Filter PCB .....	113
Replacing the Power Module .....	118
Replacing the Power Module Fuses.....	120
Replacing the Rear Cooling Fans .....	122
Replacing the RF Detector PCB.....	125
Replacing the RF Generator PCB.....	127
Replacing the RF Generator PCB Fuses .....	129
Replacing the Transfer Line .....	132
Replacing the Turbomolecular Pump Power Supply.....	134
Replacing the Vacuum Control PCB .....	136
Replacing the Vent Valve Solenoid .....	139

### **3 Troubleshooting** **141**

Diagnostics .....	142
To run Xcalibur Diagnostics .....	143
Communication Symptoms .....	144
Contamination Symptoms .....	151
Filament and Lens Control Symptoms .....	154
Heated Zone Symptoms.....	157
High Vacuum Symptoms .....	161
Linearity Symptoms.....	166
Power Supply Symptoms .....	168
RF and DC Control Symptoms.....	172
Sensitivity Symptoms .....	177
Stability Symptoms.....	186
Tuning Symptoms.....	188

<b>4</b>	<b>Vacuum System and Gas Inlets</b>	<b>193</b>
	Vacuum System Components .....	194
	Description.....	195
	Theory of Operations .....	195
	Gas Inlets.....	202
	Description.....	202
	Theory of Operations .....	203
<b>5</b>	<b>Ion Source and Inlet Valve</b>	<b>207</b>
	Ion Source.....	208
	Description.....	209
	Theory of Operations .....	210
	Inlet Valve (Upgrade Option).....	215
	Description.....	215
	Theory of Operations .....	216
<b>6</b>	<b>Prefilter and Quadrupole Assembly</b>	<b>223</b>
	Prefilter and Quadrupole.....	224
	Description.....	225
	Theory of Operations .....	226
<b>7</b>	<b>Ion Detector Assembly</b>	<b>229</b>
	Conversion Dynode .....	231
	Description.....	232
	Theory of Operations .....	233
	Electron Multiplier.....	234
	Description.....	235
	Theory of Operations .....	236
<b>Appendix A</b>	<b>Replaceable Parts</b>	<b>237</b>
	Vacuum Manifold.....	238
	Ion Source Assembly.....	240
	Ion Source Block Assembly .....	242
	Lens Assembly .....	244
	Quadrupole Assembly .....	246
	Gas Inlets and Gauges.....	248
	PCBs and Cables .....	250
	Turbomolecular Pump.....	258
	Split-Flow Turbomolecular Pump (Upgrade Option) .....	260
	Inlet Valve (Upgrade Option).....	262
	Power Module .....	264

Installation Kit ..... 265  
Document Set..... 266  
Miscellaneous Items..... 267

**Appendix B Functional Block Diagrams \_\_\_\_\_ 269**

**Index \_\_\_\_\_ 275**

# 1 *Operating Instructions*

This chapter contains basic operating instructions for using the *TRACE DSQ* Mass Spectrometer Detector. The *TRACE DSQ* uses quadrupole technology to give analysts, technicians, and technical directors a powerful tool for mass spectrometry and complete control when using the *Xcalibur* software.

## In This Chapter

---

- 1.1 *Installing a GC Column, pp. 2*
- 1.2 *Starting Up, pp. 10*
- 1.3 *Shutting Down, pp. 12*
- 1.4 *Removing a GC Column, pp. 14*



Analyze • Detect • Measure • Control™

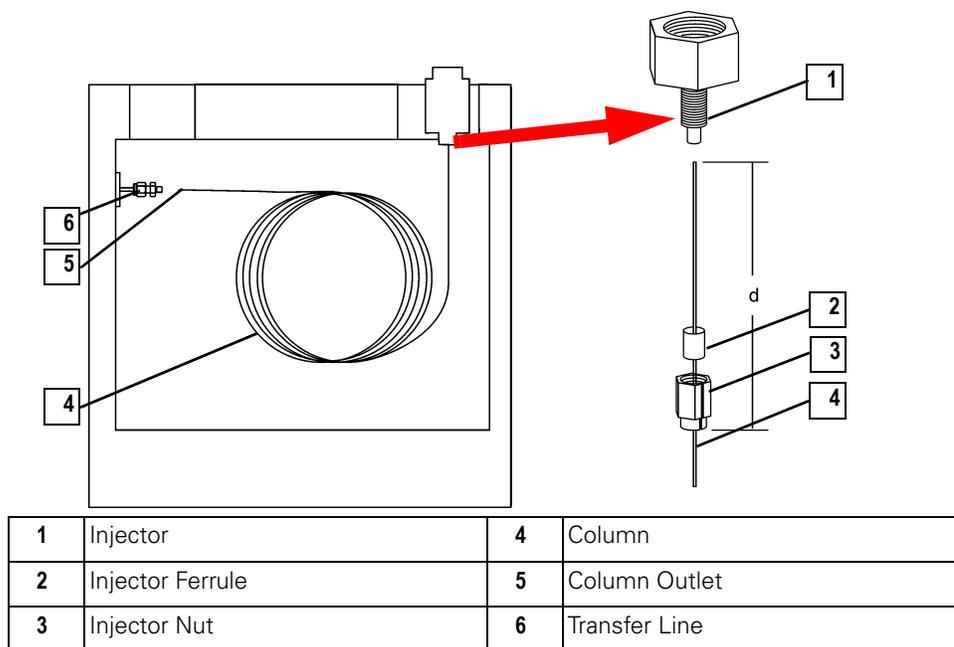
## 1.1 Installing a GC Column

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Capillary column, 5MS, 15 m, 0.25 mm ID, 0.25 <math>\mu</math>m (PN 76317-3015)</li> <li>• Column Measuring Tool (PN 119640-0550), optional</li> <li>• Gloves, clean, lint- and powder-free</li> <li>• Injector ferrule, for 0.25 mm column (PN 290 134 88)</li> <li>• Leak detector, hand-held electronic (GL Sciences, Inc., model LD-228, or equivalent)</li> <li>• Magnifying glass</li> <li>• Methanol or other suitable solvent</li> <li>• Scoring wafer (or sapphire scribe) to cut capillary column</li> <li>• Tissue, lint-free</li> <li>• Transfer line ferrule, 0.4 mm ID (PN A0101-18100)</li> <li>• Wrench, open-ended, 5/16-in.</li> <li>• Wrench, open-ended, 6 mm</li> <li>• Wrench, two, open-ended, 7/16-in.</li> </ul>
	<p><b>Frequency</b> As needed.</p>

For more GC setup information, refer to the documentation supplied with your gas chromatograph.

<p style="text-align: center;"><b>CAUTION</b> <b>Personal Injury</b></p>	
	<p><b>Burn Hazard</b> The injector, oven, and transfer line may be hot. Allow them to cool to room temperature before touching them.</p>

# 1. Connect the **Column (4)** to the **Injector (1)**.



**Figure 1-1. GC Injector (Front)**

**NOTE:** Wear clean, lint- and powder-free gloves when you handle the Column and Injector Ferrule.

- a. Unwind about a half turn of the **Column (4)**.
- b. Wipe about 100 mm (4 in.) of the **Column (4)** with a tissue soaked in methanol.
- c. Insert the **Column (4)** through the **Injector Nut (3)** and ferrule (open end up). Wipe the **Column (4)** again with a tissue soaked in methanol.
- d. Score and then break the **Column (4)** about 2.5 cm (1 in.) from the end with a scoring wafer. With the magnifying glass, check for an even, flat cut. Repeat if necessary.
- e. Insert the **Column (4)** into the Injector so that the end of the **Column (4)** is the proper distance from the back of the **Injector Nut (3)**. Proper distances are as follows: splitless = 64 mm, split = 40 mm, PTV = 30 mm.
- f. Finger-tighten the **Injector Nut (3)** and then give it an additional quarter turn with the wrench.
- g. Score and then break the **Column Outlet (5)** about 2.5 cm (1 in.) from the end with a scoring wafer.
- h. Turn on the GC.

**NOTE:** Sliding a septum on the Column before the Injector Nut will help you measure the proper distance between the Nut and the end of the Column.

2. Set up the GC.
  - a. Set the oven and **Injector (1)** temperatures to 30 °C.
  - b. Set the **Injector (1)** flow to 1.0 mL/min.
  - c. Turn Vacuum Compensation Off (under the Right, or Left Carrier menu).
  - d. Dip the **Column Outlet (5)** in a small vial of methanol. Bubbles indicate there is flow through the **Column (4)**.
  - e. Allow the **Column (4)** to purge for at least 10 minutes.
3. Perform Column Characterization.
  - a. Raise the oven and **Injector (1)** temperatures to 50 °C and allow them to stabilize.
  - b. Run a Column Evaluation by referring to the GC documentation. Run the Column Characterization program. This takes several minutes.
  - c. Expect a K factor of about 0.7 – 0.9 for a 15 m, 0.25 mm ID column (1.3 – 2.0 for a 30 m, 0.25 mm ID column). If the column does not report a K factor within this range or within 0.1 units of the previous stored value, check for a leak or broken column using the leak detector. The K factor is a measured resistance for the **Column (4)**. A K factor that is too low may indicate a leak in the system, while a K factor that is too high may indicate a blockage.
  - d. Raise the oven temperature to 150 °C and allow it to stabilize.
4. Perform a column Leak Check.
  - a. Run an automated Leak Check by referring to the GC documentation.
  - b. If the report indicates a leak, then look for and fix leaks at all the fittings in the GC using the leak detector.
  - c. Repeat Column Eval and Leak Check until no leaks are indicated.

**CAUTION**  
**Instrument Damage**



Do not raise the oven temperature until you are sure the system is leak free. At temperatures above 100 °C, the column will be destroyed if exposed to oxygen.

## 5. Condition the **Column (4)**.

New columns must be conditioned before they are inserted into the *TRACE DSQ*.

CAUTION Instrument Damage	
	The material released from the column (column bleed) during the conditioning will contaminate the ion source if the column is inserted into the transfer line. The ion source must then be cleaned.

- a. Raise the **Injector (1)** temperature to the desired temperature (normally 250 °C).
- b. Run the slow temperature program that is recommended by the manufacturer. For example, hold the **Column (4)** at 40 °C for 15 minutes, then ramp at 10 °C/minute up to 10 °C above the maximum temperature you will operate the **Column (4)** (normally  $300+10$  °C = 310 °C). Hold the **Column (4)** at this temperature for 2 hours.

CAUTION Instrument Damage	
	Never exceed the manufacturer's maximum operating temperature.

## 6. Connect the **Column (4)** to the **Transfer Line (6)**.

- a. Shut down and vent the *TRACE DSQ* (see **Shutting Down** on page 12).
- b. Lower the oven temperature to 30 °C and allow it to cool before continuing.

CAUTION Personal Injury	
	<b>Burn Hazard</b> The oven and Transfer Line may be hot. Allow them to cool to room temperature before touching them. Do not touch the Injector when it is hot.

- c. Unwind about one turn of the **Column (4)** from the **Column Outlet (5)** end.
- d. Wipe about 300 mm (12 in.) of the **Column (4)** with a tissue soaked in methanol.
- e. Insert the **Column (4)** through the **Septum (5)**, Transfer Line Nut, and ferrule. Wipe the **Column (4)** again with a tissue soaked in methanol.
- f. Score and break the end of the **Column (4)** with a scoring wafer. With a magnifying glass, check for an even, flat cut. Repeat if necessary.
- g. Insert the **Column (4)** into the **Transfer Line (6)** using one of the following methods:

**Method One:**

If you have the optional inlet valve, follow these steps:

- i. Remove the *TRACE DSQ* front cover so you can get a better view of the Column.
- ii. Using the I/R tool, remove the Ion Volume, as described in **Cleaning the Ion Volume with an Inlet Valve** on page 34.
- iii. Insert the Column into the transfer line and tighten the **Transfer Line Nut** by hand.
- iv. Push the Column in until you can see it through the Inlet Valve.
- v. Pull the Column back just far enough that you cannot see it.
- vi. Tighten the **Transfer Line Nut** and **Transfer Line Union**.
- vii. Using the I/R tool, replace the Ion Volume, as described in **Cleaning the Ion Volume with an Inlet Valve** on page 34.

**NOTE:** Wear clean, lint- and powder-free gloves when you handle the Column and Transfer Line Ferrule.

---

**NOTE:** Sliding a septum on the Column before the Transfer Line Nut will help you measure the proper distance between the Nut and the end of the Column.

---

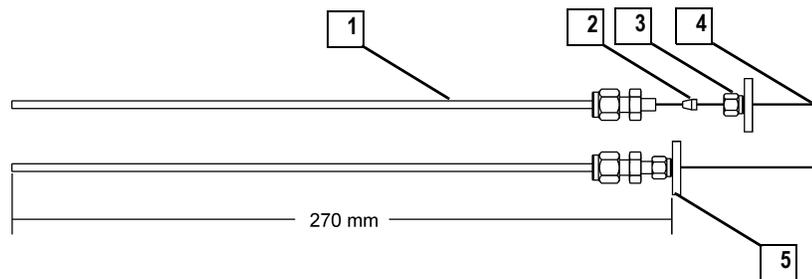
**Method Two:**

- i. Remove the *TRACE DSQ* front and top covers so you can get a better view of the Column.
- ii. Remove the Vacuum Manifold Cover, as described in **Vacuum Manifold Maintenance** on page 30.
- iii. Remove the Ion Source Assembly, as described in **Ion Source Assembly Maintenance** on page 33.
- iv. Adjust the Column so that it extends 1–2 mm past the end of the **Transfer Line**.
- v. Tighten the **Transfer Line Nut** and **Transfer Line Union**.
- vi. Replace the Ion Source Assembly, as described in **Vacuum Manifold Maintenance** on page 30.
- vii. Replace the Vacuum Manifold Cover.
- viii. Replace the *TRACE DSQ* front and top covers.

**Method Three:**

- i. Screw the **Transfer Line Nut (3)** onto the **Column Measuring Tool (1)**.
- ii. Push the Column past the end of the **Column Measuring Tool (1)** and score and break the end of the Column with a scoring wafer. With a magnifying glass, check for an even, flat cut. Repeat if necessary.

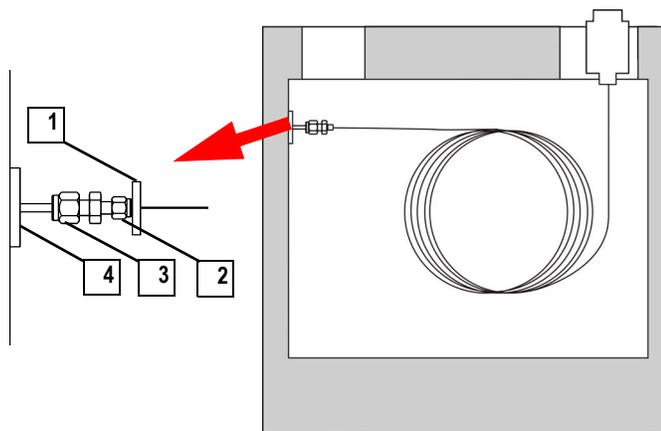
**NOTE:** Sliding a septum on the Column before the Transfer Line Nut will help you measure the proper distance between the Nut and the end of the Column.



1	Column Measuring Tool	4	Column
2	Transfer Line Ferrule	5	Septum
3	Transfer Line Nut		

**Figure 1-2. Column Measuring Tool**

- iii. Pull the Column back so that it is flush with the end of the **Column Measuring Tool (1)**. Tighten the **Transfer Line Nut (2)**.
- iv. Slide the **Septum (1)** up to the back of the **Transfer Line Nut (2)**.
- v. Remove the Column, **Transfer Line Nut (2)** and ferrule from the Column Measuring Tool.



1	Septum	3	Transfer Line Union
2	Transfer Line Nut	4	Transfer Line

**Figure 1-3. Transfer Line (Front)**

- vi. Insert the Column into the **Transfer Line (4)**. Be careful not to move the **Septum (1)**.
- vii. Tighten the **Transfer Line Nut (2)** and the **Transfer Line Union (3)**.

For proper operation, the Column must extend approximately 1 mm past the end of the **Transfer Line (4)**.

7. Condition the **Transfer Line (4)** ferrule. Graphite/Vespel ferrules like the **Transfer Line (4)** ferrule require conditioning to ensure a leak tight seal.

- a. Raise the oven temperature to the maximum temperature you will operate the Column (normally 300 °C).
- b. Wait 10 minutes.

- c. Lower the oven temperature to 30 °C and allow it to cool before continuing.

<b>CAUTION</b> <b>Personal Injury</b>	
	<b>Burn Hazard</b> The oven may be hot. Allow it to cool to room temperature before opening it. The Injector will still be hot so do not touch it.

- d. Re-tighten the **Transfer Line Nut (2)** and the **Transfer Line Union (3)**.

8.

Set up the GC.

- a. Make sure the Column does not have any sharp bends and that it does not touch any metal objects or walls inside the oven.
- b. Raise the oven temperature to the initial temperature you will use (normally 40 °C).
- c. Turn Vacuum Compensation on (under the Right, or Left Carrier menu).

## 1.2 Starting Up

	<p><b>Tools Needed</b> None</p>
	<p><b>Frequency</b> As needed after maintenance.</p>

1. Set up the *TRACE DSQ*.

- a. Install the GC Column (see [Installing a GC Column](#) on page 2).
- b. Be sure the GC is on and there is carrier gas flowing through the Column into the detector.

<b>CAUTION Instrument Damage</b>	
	<p>Damage occurs if you turn on the detector without column flow. This forces air to be drawn through the column, damaging it. This large air leak into the detector will also cause the ion source to require cleaning.</p>

- c. Plug in the power cord for the *TRACE DSQ*.

## 2. Turn on the *TRACE DSO*.

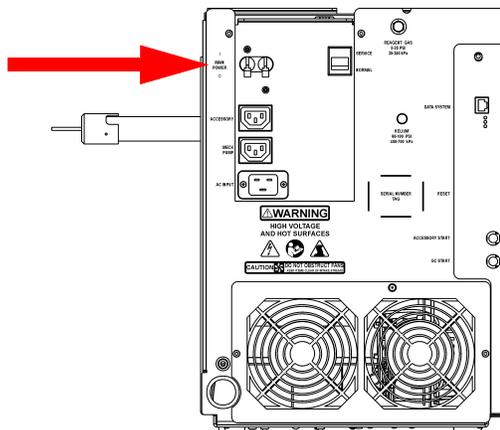


Figure 1-4. Main Circuit Breaker (Rear)

- a. Switch the Main Circuit Breaker to **ON** (I).

When you do, this occurs:

- Rotary-Vane Pump turns on
  - Forepressure reaches the proper operating pressure
  - Turbomolecular Pump turns on
- b. Set the Transfer Line to the desired operating temperature (normally 300 °C). Select **<Aux>**, **<Temp>**, **<Enter>** on the GC and enter the temperature.

## 3. Start *Xcalibur*.

- a. Check the heater status in the Heater tab of the *TRACE DSO* Status display. If the Ion Source is not set to the desired temperature (normally 200 °C), change it in Tune.
- b. Check the vacuum status in the Vacuum tab of the *TRACE DSO* Status display. Within 10 minutes of turning on the detector, Vacuum should read **OK**.

If it does not, see **Chapter 3: Troubleshooting**.

- c. Allow the *TRACE DSO* to stabilize for 30 minutes before running samples.

## 1.3 Shutting Down

	<p><b>Tools Needed</b> None</p>
	<p><b>Frequency</b> To change columns or perform detector maintenance.</p>

### 1. Cool the GC.

If you do not plan to change the column or perform maintenance on the GC, you do not have to lower the Injector temperature. Lower the oven, Injector, and Transfer Line temperatures to 30 °C.

### 2. Shut down the *TRACE DSQ*.

- a. From the Instrument Setup window, click **Tune** to display the Tune window.
- b. Choose **Instrument | Shutdown** to start the automatic shutdown procedure:
  - *Xcalibur* Shut Down screen displays
  - Calibration Gas and CI Reagent Gas are turned off
  - Voltages are turned off to the Ion Source, Quadrupole, and Ion Detector Assembly
  - Ion Source heater turns off
  - Turbomolecular Pump turns off
  - *Xcalibur* counts down ten minutes for the pump to slow down
  - *Xcalibur* waits for the Ion Source to cool to < 175 °C to prevent oxidizing the hot parts when they are exposed to air
- c. Wait for the Transfer Line to cool to < 175 °C.

3. Turn the *TRACE DSQ* off.
  - a. Look for a screen to display that it is okay to turn off the main power to the *TRACE DSQ*.
  - b. Click **OK**.

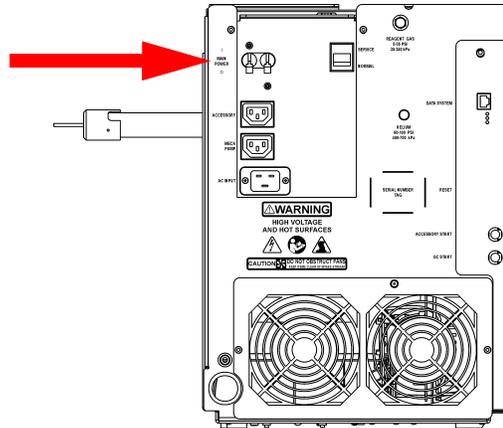


Figure 1-5. Main Circuit Breaker (Rear)

- c. Switch the Main Circuit Breaker to **OFF** (0).

This turns off the Rotary-Vane Pump. Approximately three seconds later, the vent valve opens and the vacuum manifold vents to atmospheric pressure. This takes approximately three to four minutes.

- d. Unplug the *TRACE DSQ* power cord.

STOP HERE if you are planning to perform system maintenance on only the *TRACE DSQ* (for example, to clean the ion source). You don't need to turn off the GC, data system, and autosampler. In this case, the shutdown procedure is complete.

4. Wait for the GC oven, Injector, and Transfer Line to cool to room temperature.

5. Turn off all instruments.

- a. Turn off the GC using the GC main circuit breaker.
  - b. Turn off the GC Helium supply at the tank.
  - c. Turn off the Autosampler (optional) by using the main power on/off switch.

## 1.4 Removing a GC Column

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Gloves, clean, lint- and powder-free</li> <li>• Wrench, open-ended, 5/16-in.</li> <li>• Wrench, open-ended, 7/16-in.</li> <li>• Wrench, open-ended, 6 mm</li> </ul>
	<p><b>Frequency</b> As needed for maintenance or column replacement.</p>

1. Shut down the *TRACE DSQ*.
  - a. Shut down and vent the *TRACE DSQ* (see **Shutting Down** on page 12).
  - b. Lower the oven, Injector, and Transfer Line temperatures to 30 °C and allow them to cool before continuing.

CAUTION Personal Injury	
	<p><b>Burn Hazard</b> The oven, injector, and transfer line are hot. Allow them to cool to room temperature before touching them.</p>

- c. Once cool, turn off the GC.

2. Remove the Column from the **Transfer Line (4)**.

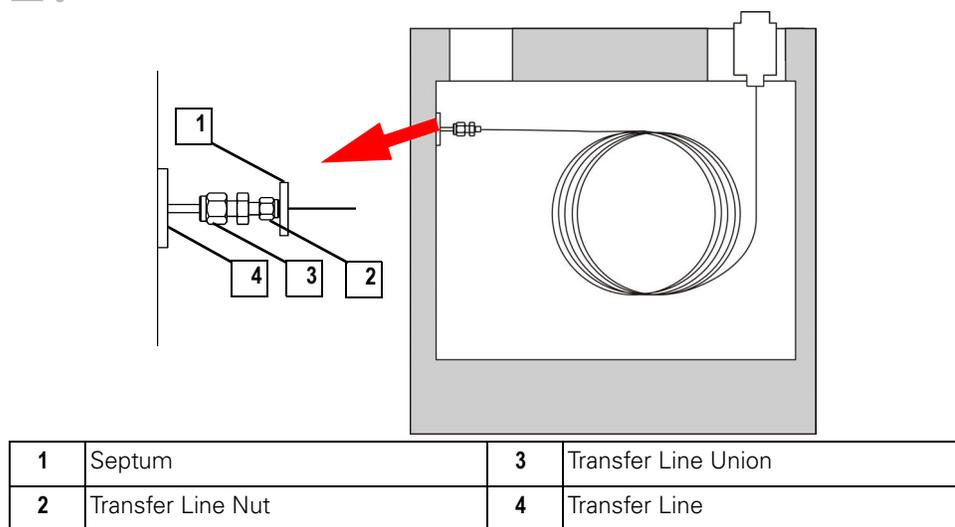


Figure 1-6. Transfer Line (Front)

- a. Unscrew the **Transfer Line Nut (2)**.
- b. Remove the **Column (4)** from the **Transfer Line (4)**.

3. Remove the **Column (4)** from the **Injector (1)**.

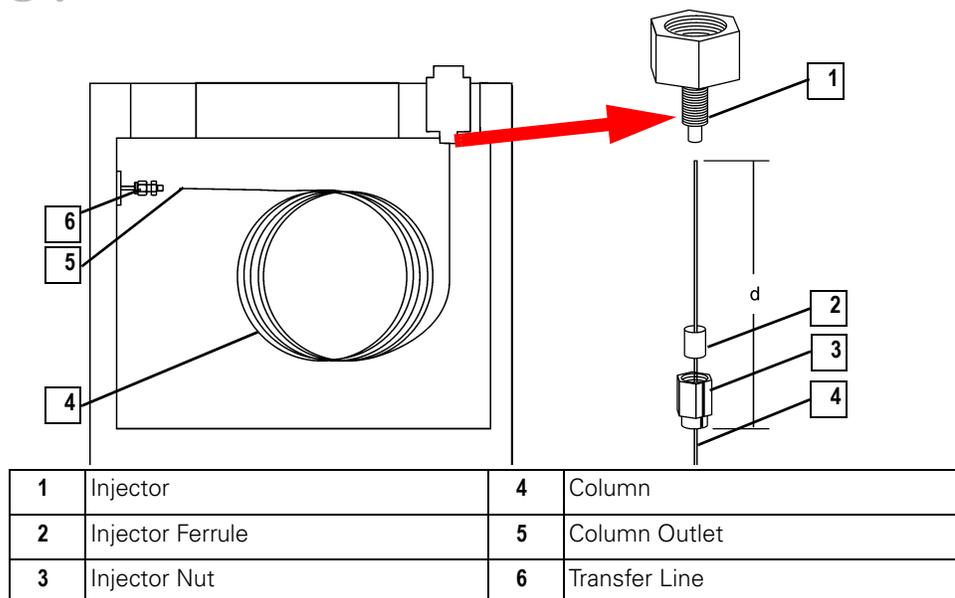


Figure 1-7. GC Injector (Front)

- a. Unscrew the **Injector Nut (3)**.
- b. Remove the **Column (4)** from the **Injector (1)**.



# 2 *Maintenance Instructions*

This chapter contains maintenance instructions for essential detector components. Performing maintenance increases laboratory productivity and helps you get the most out of your instrument.

## In This Chapter

---

- [2.1 Scheduling Maintenance, pp. 18](#)
- [2.2 Maintaining System Performance, pp. 20](#)
- [2.3 Vacuum Manifold Maintenance, pp. 30](#)
- [2.4 Ion Source Assembly Maintenance, pp. 33](#)
- [2.5 Quadrupole Assembly Maintenance, pp. 59](#)
- [2.6 Ion Detector Assembly Maintenance, pp. 60](#)
- [2.7 Turbomolecular Pump Maintenance, pp. 66](#)
- [2.8 Rotary-Vane Pump Maintenance, pp. 67](#)
- [2.9 Replacing Parts, pp. 75](#)



Analyze • Detect • Measure • Control™

## 2.1 Scheduling Maintenance

Performing maintenance requires the detector to be disassembled, cleaned, and sometimes replacing worn parts. Table 2-1 is a factory recommended maintenance schedule, based on running multiple samples in an 8-hour day. Adapt the schedules according to how clean your samples are and how many analyses per day. Also, you might find it helpful to keep a maintenance record to identify variations from normal operation and to take corrective action.

**Table 2-1. Maintenance Schedule (Recommended)**

Procedure	Never/ Replace	1 Month	4 or 6 Months	As Needed*
Maintaining System Performance, as described on <a href="#">page 20</a>				✓
Running Benchmark Tests, as described on <a href="#">page 20</a>				✓
Removing the Covers, as described on <a href="#">page 21</a>				✓
Cleaning Stainless Steel Parts, as described on <a href="#">page 24</a>				✓
Cleaning Non-Stainless Steel or Hybrid Parts, as described on <a href="#">page 27</a>				✓
Vacuum Manifold Maintenance, as described on <a href="#">page 30</a>				✓
Ion Source Assembly Maintenance, as described on <a href="#">page 33</a>				
Cleaning the Ion Volume with an Inlet Valve, as described on <a href="#">page 34</a>				✓
Cleaning the Ion Volume Without an Inlet Valve, as described on <a href="#">page 44</a>				✓
Cleaning the Ion Source, Lenses, and Prefilter, as described on <a href="#">page 47</a>				✓
Replacing the Ion Source Filament, as described on <a href="#">page 55</a>				✓
Quadrupole Assembly Maintenance, as described on <a href="#">page 59</a>	✓			
Ion Detector Assembly Maintenance, as described on <a href="#">page 60</a>				
Cleaning the Anode, as described on <a href="#">page 60</a>				✓
Replacing the Electron Multiplier, as described on <a href="#">page 63</a>				✓
Turbomolecular Pump Maintenance, as described on <a href="#">page 66</a>	✓			
Rotary-Vane Pump Maintenance, as described on <a href="#">page 67</a>				
Adding Oil to the Rotary-Vane Pump, as described on <a href="#">page 68</a>				✓
Purging the Rotary-Vane Pump Oil, as described on <a href="#">page 70</a>		✓		
Changing the Rotary-Vane Pump Oil**, as described on <a href="#">page 72</a>			✓	

\* *As Needed* depends on how close the component is to the sample introduction point. For example, the Ion Volume is closer to the sample introduction point than any other component and requires the most frequent cleaning.

\*\* Perform every month if you use ammonia as a chemical ionization reagent gas.

Figure 2-1 illustrates a sequence of maintenance events to further your understanding of detector disassembly.

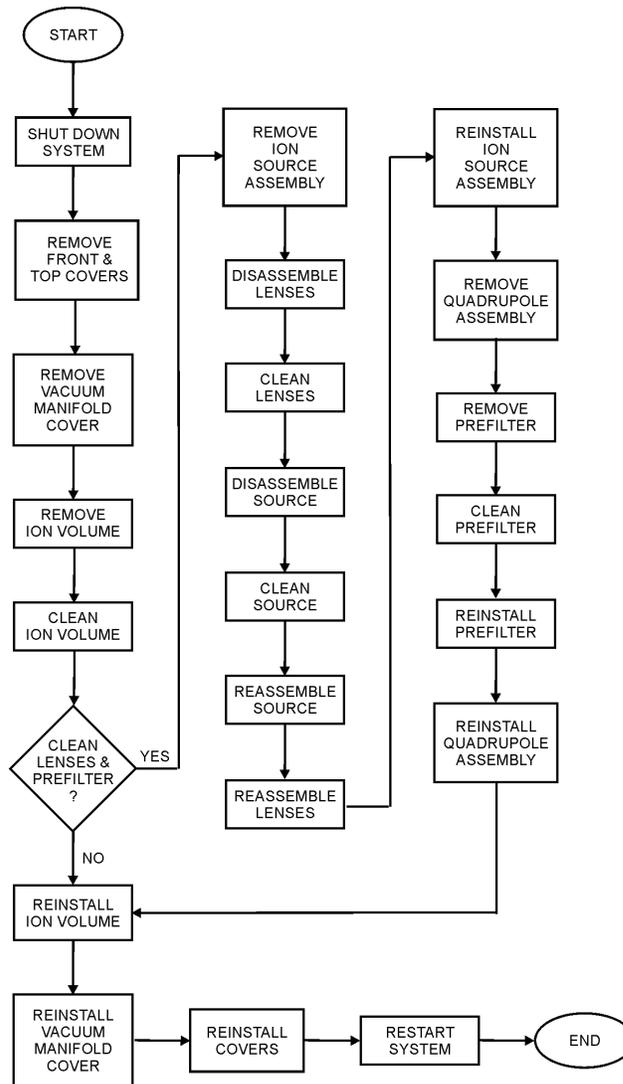
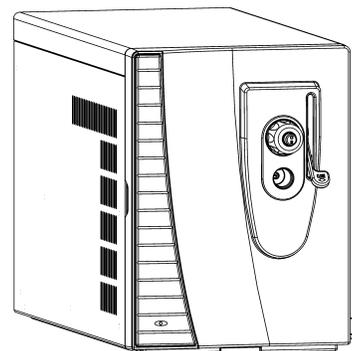


Figure 2-1. Detector Maintenance Schedule Flow Chart

## 2.2 Maintaining System Performance

System performance depends a large part on making sure the *TRACE DSQ* components are clean and operating correctly. Before you begin cleaning, shut down the system, and remove the covers to get access to the assemblies. If your instrument has an inlet valve, you do not need to shut down the instrument to change the ion volume. Also, please use extra caution when using cleaning procedures, as some components can be damaged by exposure to abrasives, solvents, or heat.



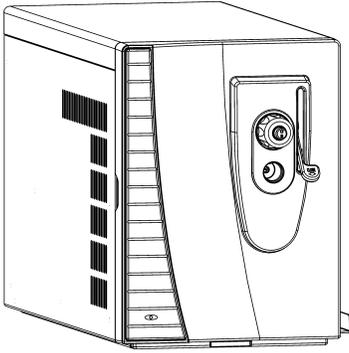
<b>CAUTION</b> Instrument Damage	
	<b>Cleaning Guidelines</b> This section is meant to relate strictly to the parts and components listed in this chapter. Use caution when using these cleaning procedures for other parts. Some components can be damaged by exposure to abrasives, solvents, or heat.

### Running Benchmark Tests

When your instrument is clean and in good working order, perform benchmark tests and record the results. For more information, refer to the *TRACE DSQ or FOCUS DSQ User's Guide*.

1. Run a benchmark QC (quality control) test. A good benchmark test is the mixture of octafluoronaphthalene and benzophenone which is included with the instrument.
2. Compare the results to previous results.
3. Clean the Ion Volume only when the tested performance of your system decreases significantly from your benchmark test results.
4. Run the benchmark test again and compare the results.
5. If performance is not restored, clean the Lenses, Ion Source Assembly, and Prefilter. How often you clean the *TRACE DSQ* depends on the types and amounts of samples and solvents you introduce into the instrument. In general, the closer a component is to the sample introduction point, the more rapidly it becomes dirty. For example, you will clean the ion volume more often than other parts. Many parts can be removed and disassembled by hand. Make sure you have all items listed in *Tools Needed* before using the procedure. You can purchase items without part numbers at the hardware store.

## Removing the Covers



	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Phillips screwdriver, #2</li> <li>• Wrench, Allen, 2.5 mm</li> </ul>
	<p><b>Frequency</b> As needed to get inside the detector.</p>

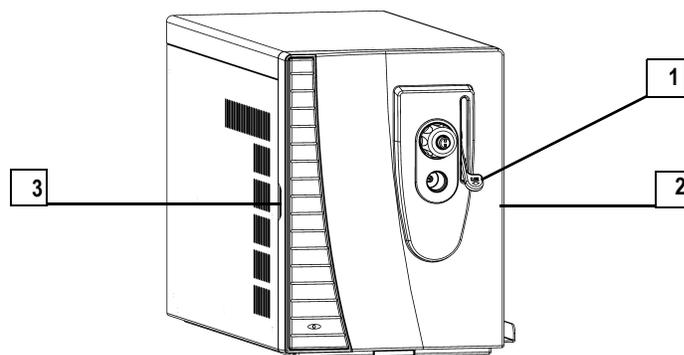
In order to get to the components inside the detector, the covers from the detector have to be removed. Because the covers overlap each other they must be removed in this order: Front, Top, Right, and or Left Cover.

**NOTE:** Covers are specified as right or left as you are looking at the front of the instrument.

1. Prepare the *TRACE DSQ* for maintenance.

<p><b>WARNING</b> Personal Injury</p>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- a. Shut down and vent the system (see [Shutting Down](#) on page 12).



1	Inlet Valve Lever (if equipped)	3	Left Side Handslot
2	Right Side Handslot		

**Figure 2-2. Removing the Front Cover**

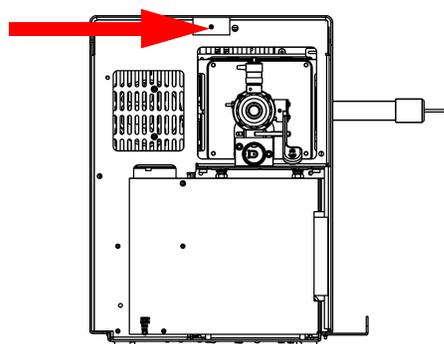
- b. [Upgrade Option] If your system is equipped with an **Inlet Valve**, remove the **Inlet Valve Lever (1)** by pulling it free.

## 2. Remove the **Front Cover**.

- a. Grasp the cover by the **Left** and **Right Hand Slots (2, 3)**.
- b. Pull the cover toward you. It will snap out of the connectors, which are located on the top and bottom of the detector.

Reverse these steps to reinstall the *TRACE DSQ* front cover.

## 3. Remove the **Top Cover**.



**Figure 2-3. Removing the Top Cover**

- a. Loosen the top fastener.
- b. Slide the top cover forward about 2.5 cm (1 in.).
- c. Lift the top cover up and away from the *TRACE DSQ*.

Reverse these steps to reinstall the *TRACE DSQ* top cover.

## 4. Remove the **Right Cover**.

- a. Remove the **Column** (see **Removing a GC Column** on page 14).
- b. Remove the two screws located at the top of the cover.
- c. Slide the cover towards the back of the instrument.
- d. Pull the cover away from the *TRACE DSQ*.

Reverse these steps to reinstall the *TRACE DSQ* right cover. To install the **Column** see **Installing a GC Column** on page 2.

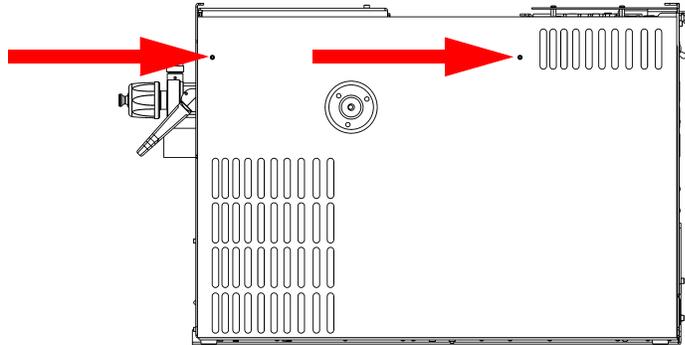


Figure 2-4. Removing the Right Cover

## 5. Remove the **Left Cover**.

CAUTION Instrument Damage	
	<p>Behind the left cover are the Analog PCB and Digital PCB making this cover significantly heavier. Several cables run from the cover to other parts of the instrument. Please do <b>NOT</b> pull the cover too far from the instrument or you will stretch the cables.</p>

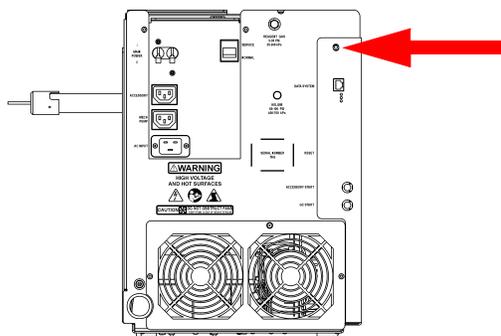


Figure 2-5. Removing the Left Cover

- a. Remove the single screw located at the rear of the instrument.
- b. Slide the cover toward the rear of the instrument until the tabs come to the end of the grooved slots. Pull the cover away from the instrument. Reverse these steps to reinstall the *TRACE DSQ* left cover.

## Cleaning Stainless Steel Parts

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Acetone, reagent grade (or other suitable polar solvent)</li> <li>• Aluminum oxide abrasive, number 600 (PN 32000-60340)</li> <li>• Applicators, cotton-tipped (PN A0301-02000)</li> <li>• Beaker, 450 mL</li> <li>• Clean, dry gas</li> <li>• De-ionized water</li> <li>• Detergent (Alconox, Micro, or equivalent)</li> <li>• Dremel rotary tool or equivalent (recommended)</li> <li>• Foil, aluminum</li> <li>• Forceps</li> <li>• Gloves, latex, impermeable</li> <li>• Gloves, clean, lint- and powder-free</li> <li>• Glycerol, reagent grade</li> <li>• Lint-free cloth</li> <li>• Protective eyewear</li> <li>• Tap water</li> <li>• Toothbrush, soft</li> <li>• Ultrasonic cleaner</li> </ul>
	<p><b>Frequency</b> As needed to clean <i>only</i> stainless steel parts, such as the following:</p> <ul style="list-style-type: none"> <li>• Ion Volume Assembly</li> <li>• Ion Source Block</li> <li>• Lenses</li> </ul>

**CAUTION**  
**Instrument Damage**

	<p>Please do <b>NOT</b> use this procedure to clean ceramic, aluminum, or gold-plated parts. Also, this procedure should not be used on the prefilter, electron multiplier, conversion dynode, quadrupole, or anode feedthrough.</p>
---	--

<b>CAUTION</b> <b>Personal Injury</b>	
	<b>Material and Eye Hazard</b> Please wear impermeable laboratory gloves and eye protection when performing cleaning procedures.

1. Remove contamination from all the surfaces you are cleaning.
  - a. Use a slurry of number 600 aluminum oxide in glycerol and a cleaning brush or cotton-tipped applicator. Contamination appears as dark or discolored areas, but often is not visible. The heaviest contamination is usually found around the apertures - for example, the electron entrance hole on an ion volume.
  - b. Clean each part thoroughly, even if no contamination is visible.
  - c. Use the wooden end of an applicator cut at an angle to clean the inside corners.
  - d. Use a Dremel® tool with the polishing swab at its lowest speed to increase cleaning efficiency, as well as decrease the time required to clean the items. Use care when using the Dremel tool as it is an electrical appliance.
  - e. To prevent personal injury, be sure to keep the tool away from possible hazards such as standing water or flammable solvents.
2. Rinse the parts with clean water.

Use a clean applicator or toothbrush to remove the aluminum oxide slurry. Do not let the slurry dry on the metal; dried aluminum oxide is difficult to remove.
3. Sonicate the parts in a warm detergent solution.
  - a. Using forceps, place the parts in a beaker containing warm detergent solution.
  - b. Place the beaker and contents in an ultrasonic bath for 5 minutes.
  - c. Rinse the parts with tap water to remove the detergent.

4. Sonicate the parts in deionized water.
  - a. Using forceps, place the parts in a beaker containing deionized water.
  - b. Place the beaker and contents in an ultrasonic bath for 5 minutes.
  - c. If the water is cloudy after sonicating, pour off the water, add fresh water, and place the beaker and its contents in a ultrasonic bath again for 5 minutes. Repeat until the water is clear.
5. Sonicate the parts in acetone.
  - a. Using forceps, place the parts in a beaker containing acetone.
  - b. Place the beaker and contents in an ultrasonic bath for 5 minutes.
  - c. Using forceps, transfer the parts to a beaker containing fresh acetone.
  - d. Place the beaker and contents in an ultrasonic bath for 5 minutes.
6. Blow dry the parts immediately.

Blow off the acetone from the parts with a clean, dry gas.
7. Dry the parts in an oven, set at 100 °C, for 30 minutes.

Using forceps, place the parts in an aluminum foil covered beaker in the oven. Allow the parts to cool before putting them back together.

## Cleaning Non-Stainless Steel or Hybrid Parts

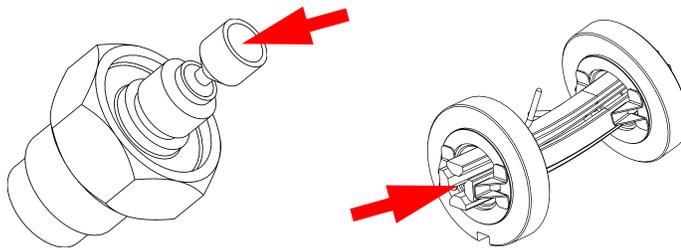
	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Acetone, reagent grade (or other suitable polar solvent)</li> <li>• Aluminum oxide abrasive, number 600 (PN 32000-60340)</li> <li>• Applicators, cotton-tipped (PN A0301-02000)</li> <li>• Beaker, 450 mL</li> <li>• Clean, dry gas</li> <li>• De-ionized water</li> <li>• Detergent (Alconox, Micro, or equivalent)</li> <li>• Dremel rotary tool or equivalent (recommended)</li> <li>• Forceps</li> <li>• Gloves, latex, impermeable</li> <li>• Gloves, clean, lint- and powder-free</li> <li>• Lint-free cloth</li> <li>• Protective eyewear</li> <li>• Tap water</li> <li>• Toothbrush, soft</li> </ul>
	<p><b>Frequency</b></p> <p>As needed to clean non-stainless steel parts (such as aluminum, ceramic, or gold-plated):</p> <ul style="list-style-type: none"> <li>• Lens Holder and Spacers</li> <li>• Filament Spacer</li> <li>• Heater Ring</li> </ul> <p>Or, to clean hybrid parts that are partially made of stainless steel:</p> <ul style="list-style-type: none"> <li>• Prefilter</li> <li>• Anode Feedthrough</li> </ul>

### CAUTION Instrument Damage



Please do **NOT** use this procedure to clean the electron multiplier, conversion dynode, or quadrupole. Also, acetone must **NOT** be used on polycarbonate parts like the RF feedthrough and conversion dynode feedthrough.

CAUTION Personal Injury	
 	<b>Material and Eye Hazard</b> Please wear impermeable laboratory gloves and eye protection when performing cleaning procedures.



**Figure 2-6. Stainless Steel Surfaces to Clean with Aluminum Oxide**

1. Clean inside the cup of the anode feedthrough. On the end of the prefilter closest to the ion source (with the notch), clean the end of the rods and about ½ way down the inside.
2. Remove contamination from stainless steel surfaces (Figure 2-6). It is only necessary to clean surface that come in contact with the ion beam.
  - a. Use a slurry of number 600 aluminum oxide in glycerol and a cleaning brush or cotton-tipped applicator. Contamination appears as dark or discolored areas, but often is not visible.
  - b. Clean each part thoroughly, even if no contamination is visible.
  - c. Use the wooden end of an applicator cut at an angle to clean the inside corners.
  - d. Use a Dremel tool with the polishing swab at its lowest speed to increase cleaning efficiency, as well as decrease the time required to clean the items. Use care when using the Dremel tool as it is an electrical appliance.
  - e. To prevent personal injury, be sure to keep the tool away from possible hazards such as standing water or flammable solvents.

3. Rinse the parts with clean water.  
Use a clean applicator or toothbrush to remove the aluminum oxide slurry. Do not let the slurry dry on the metal; dried aluminum oxide is difficult to remove.
4. Scrub all of the parts with a warm detergent solution.
  - a. Scrub the parts with a toothbrush or clean applicator. Do not soak or sonicate the parts in detergent.
  - b. Using forceps, rinse the parts thoroughly with tap water to remove the detergent.

**CAUTION**  
**Instrument Damage**

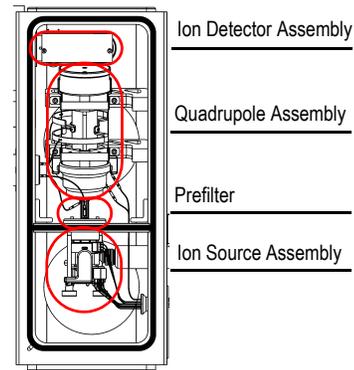


Please do not leave aluminum parts like the heater ring in contact with detergent. Basic solutions such as detergent discolor aluminum.

5. Rinse the parts in deionized water.  
Using forceps, dip the parts in a beaker of deionized water. Change the water if it becomes cloudy. Do not soak or sonicate the parts.
6. Rinse the parts with acetone.  
Using forceps, dip the parts in a beaker of acetone. Change the acetone if it becomes cloudy. Do not soak or sonicate the parts.
7. Blow dry the parts immediately.  
Blow off the acetone from the parts with a clean, dry gas.

## 2.3 Vacuum Manifold Maintenance

After removing the *TRACE DSQ* covers, you must remove the Vacuum Manifold cover to get to the four essential detector assemblies: Ion Source Assembly, Prefilter, Quadrupole Assembly, and the Ion Detector Assembly. We provided operational theory chapters devoted to these assemblies in this manual, to help you better understand how your system operates. Each of these assemblies has specific procedures for cleaning the individual parts.



	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Clean, dry gas</li> <li>• Gloves, clean, lint- and powder-free</li> <li>• Lint-free cloth</li> <li>• Phillips screwdriver, #2</li> <li>• Wrench, Allen, 2.5 mm</li> </ul>
	<p><b>Frequency</b> Better Sample Analysis</p>

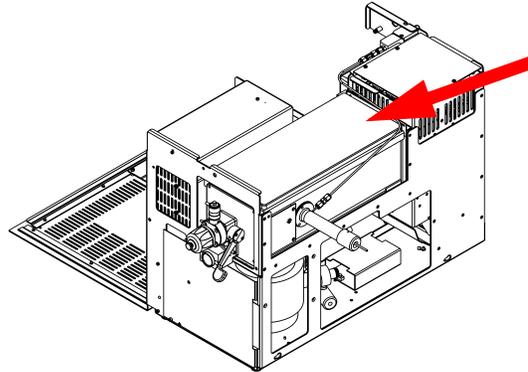
<b>CAUTION</b> Instrument Damage	
	<p><b>Corrupted Data</b> Please replace the Vacuum Manifold cover after maintenance to prevent dust and debris from collecting inside the vacuum manifold. Even small amounts of dust on the electron multiplier, conversion dynode, or quadrupole can cause excessive noise in mass spectra.</p>

1. Prepare the *TRACE DSQ* for maintenance.

<b>WARNING</b> Personal Injury	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- a. Shut down and vent the system (see **Shutting Down** on page 12).
- b. Remove the *TRACE DSQ* front and top covers (see **Removing the Covers** on page 21).

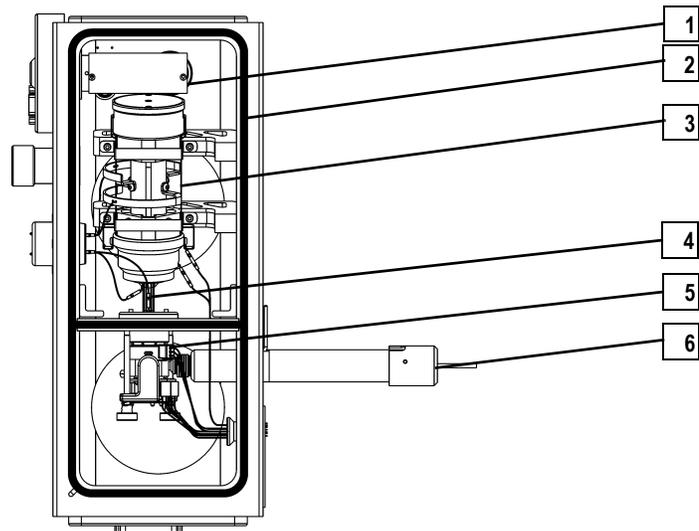
## 2. Lift off **Vacuum Manifold Cover**.



**Figure 2-7. Vacuum Manifold Cover**

The cover is difficult to remove if the vacuum manifold has not been completely vented to atmospheric pressure. The Vacuum Manifold takes approximately four minutes to reach atmospheric pressure. But, when the vacuum manifold is completely vented, the cover is easy to remove.

Figure 2-8 illustrates where the components are located in the vacuum manifold if you are looking from the front of the detector and after the cover is removed.



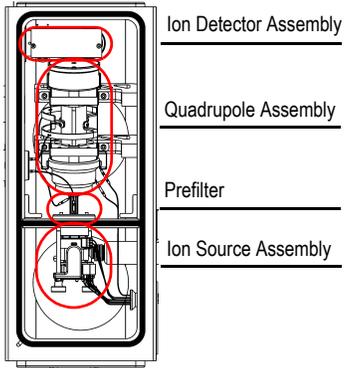
1	Ion Detector Assembly	4	Prefilter
2	O-Ring	5	Ion Source Assembly
3	Quadrupole Assembly	6	Transfer Line

**Figure 2-8. Vacuum Manifold Components**

3. Go to **Ion Source Assembly Maintenance** on page 33 or **Ion Detector Assembly Maintenance** on page 60 for further instructions or continue to the next step.
4. Spray clean essential components.
  - a. Check the **O-Ring (2)** for signs of wear and tear. The **O-Ring** is the thin, black stripping outlining the top of the **Vacuum Manifold**. Replace if necessary.
  - b. Use the clean, dry gas to clean the **O-Ring (2)**, **Ion Detector Assembly (1)**, **Prefilter (4)**, and **Quadrupole Assembly (3)**.
5. Reassemble the *TRACE DSQ*.
  - a. Replace the **Vacuum Manifold Cover**, top and front covers.
  - b. Restart your system.

**NOTE:** Even the smallest amount of dust or lint on the electron multiplier, conversion dynode, prefilter, or quadrupole can cause spectral noise.

---



Ion Detector Assembly

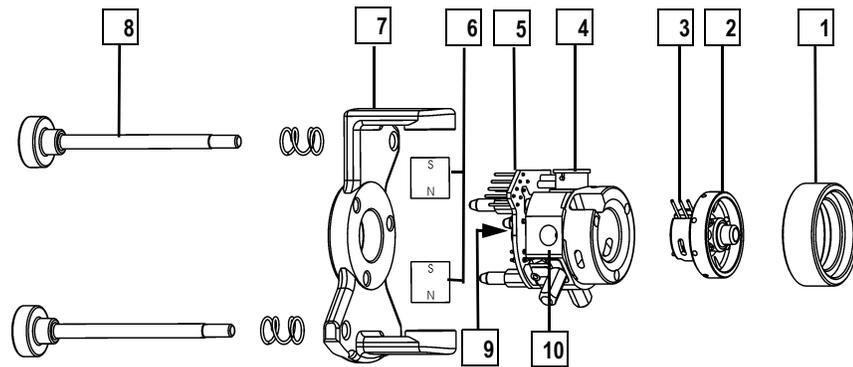
Quadrupole Assembly

Prefilter

Ion Source Assembly

## 2.4 Ion Source Assembly Maintenance

The Ion Source Assembly contains the Ion Volume, Filament Assembly, and Ion Source Lens Assembly. Because the Ion Volume is exposed directly to samples introduced into the detector, it requires the most frequent cleaning to restore the system's performance. You can access the Ion Volume with or without an Inlet Valve.

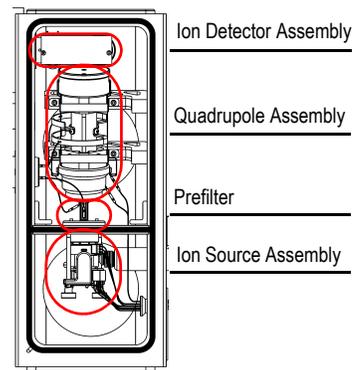


1	Source Spacer	6	Magnets, 2
2	Lens Assembly	7	Magnet Support
3	3-Pin Lens Connection	8	Thumbscrews, 2
4	Filament Assembly	9	Ion Volume (Inside Ion Source Block)
5	8-Pin Connection	10	Ion Source Block

**Figure 2-9. Ion Source Assembly (Right Side)**

## Cleaning the Ion Volume with an Inlet Valve

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Cleaning supplies for stainless steel parts</li> <li>• Gloves, clean, lint- and powder-free</li> <li>• Insertion/Removal Tool (I/R Tool) and Guide Bar</li> <li>• Lint-free cloth</li> </ul>
	<p><b>Frequency</b> To restore system performance</p>



The Ion Volume is where molecules interact with energetic electrons to form ions. Because the Ion Volume is exposed directly to samples introduced into the *TRACE DSQ*, you will clean it more frequently than other parts.

How often you clean the Ion Volume depends on the types and amounts of samples you use. Using an I/R Tool allows you to easily access the Ion Volume by entering the Vacuum Manifold through the Inlet Valve without breaking vacuum, thus saving you from shutting down and disassembling the detector.

1. Open the **Insert/Remove Probe** Screen.
  - a. From the *Xcalibur* Home Page, click on **TRACE DSQ** located in the **Status** tab.
  - b. Click on **Insert/Remove Probe** button located on the **Status** tab to display the **Insert/Remove Probe** screen.

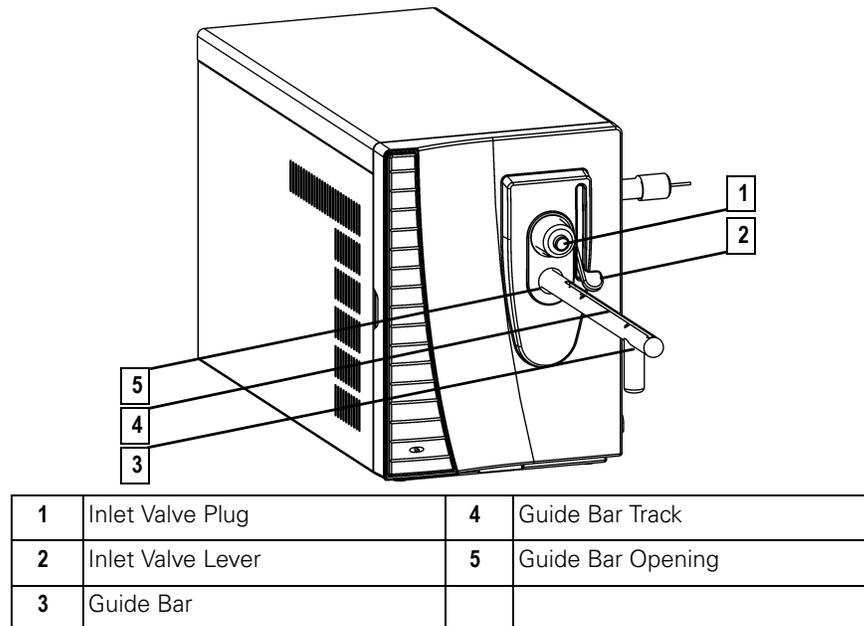
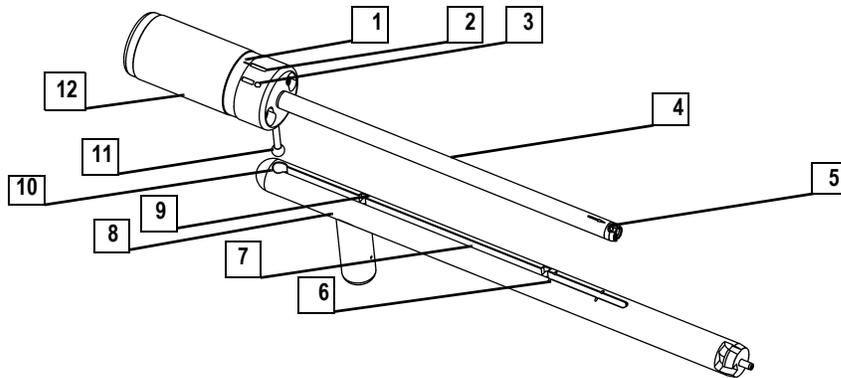


Figure 2-10. Guide Bar (Front)

2. Prepare the **Inlet Valve**.
  - a. With the **Guide Bar Track (4)** facing left, insert the **Guide Bar (3)** into the **Guide Bar Opening (5)**.
  - b. Push the **Guide Bar (3)** in as far as it will go.
  - c. Rotate it 90° clockwise to lock it in the opening.
  - d. Make sure the **Inlet Valve Lever (2)** is closed (lever is down).
  - e. Remove the **Inlet Valve Plug (1)**.

### 3. Insert the **I/R Tool**.



1	Alignment Line	7	Guide Bar Track
2	Hold Position	8	Guide Bar
3	Release Position	9	First Stop
4	I/R Tool	10	Guide Ball Hole
5	Bayonet Lock	11	Guide Ball
6	Second Stop	12	Handle

**Figure 2-11. I/R Tool and Guide Bar Components**

- a. Turn the **I/R Tool (4)** to the **Release Position (3)** . This indicates the I/R Tool is in position to accept the **Ion Volume**.
- b. Insert the **Guide Ball (11)** into the **Guide Ball Hole (10)**.
- c. Slide the **I/R Tool (4)** forward in the **Guide Bar Track (7)** until the **Guide Ball (11)** is at the **First Stop (9)**.
- d. Turn the **I/R Tool (4)** so the **Guide Ball (11)** is in the groove at the **First Stop (9)**. This prevents the probe from being pulled forward when the **Inlet Valve** is evacuated.

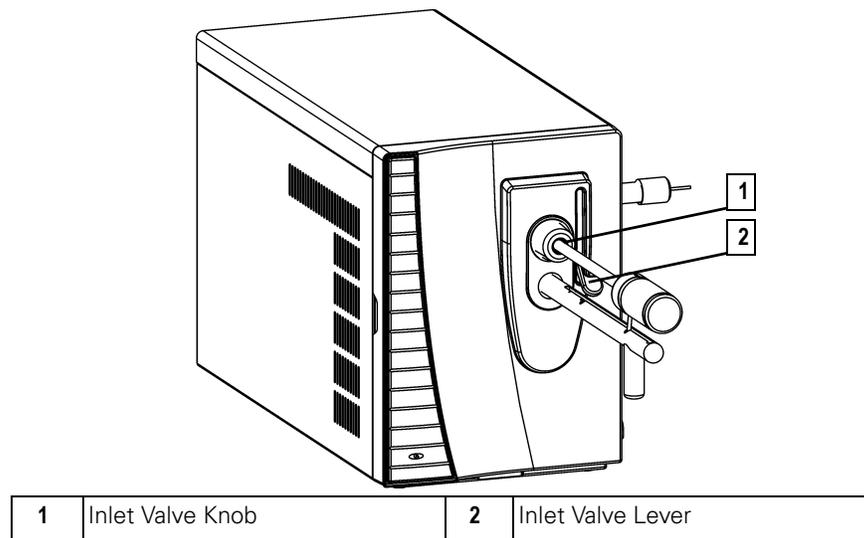


Figure 2-12. I/R Tool Ready to be Inserted

- e. Tighten the **Inlet Valve Knob (1)** to ensure a leak tight seal.

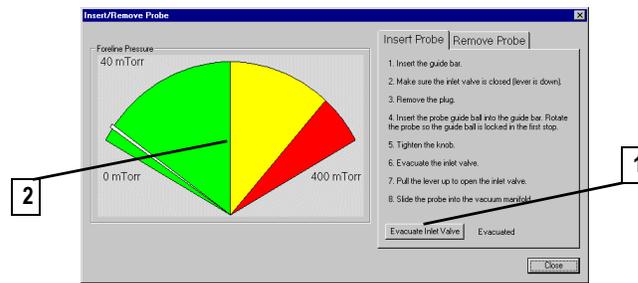


Figure 2-13. Insert Probe Screen

- f. From the **Insert Probe Screen**, select **Evacuate Inlet Valve (1)**.
- g. Monitor the **Forepressure (2)**. The pressure should not remain beyond 350 mTorr. If this occurs, the **Inlet Valve Seal** must be replaced (see [Replacing the Inlet Valve Seal](#) on page 106).
- h. Once evacuation is complete, pull the **Inlet Valve Lever (2)** up to open the **Inlet Valve**.

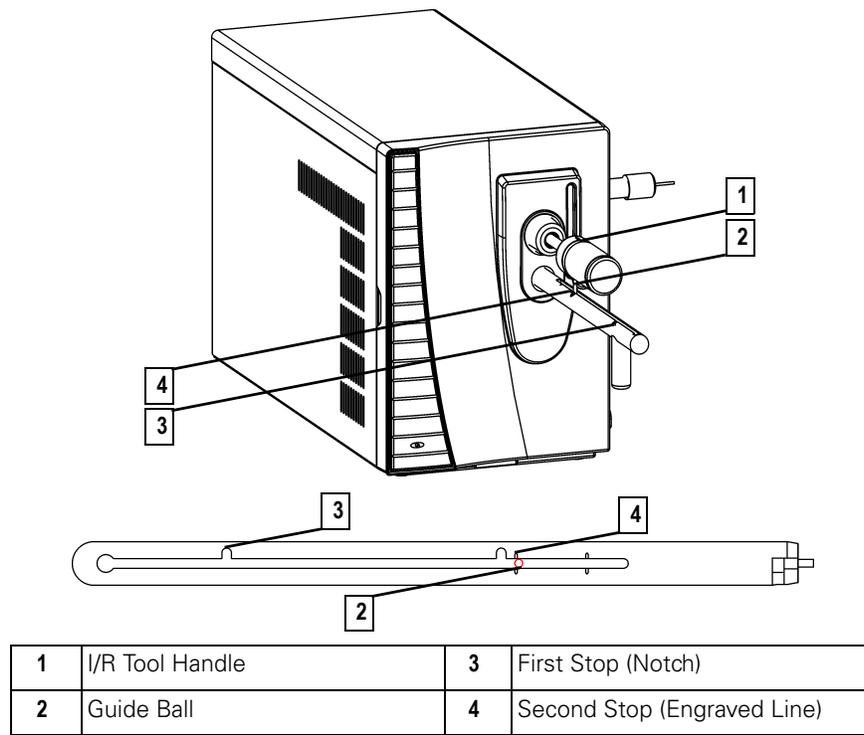


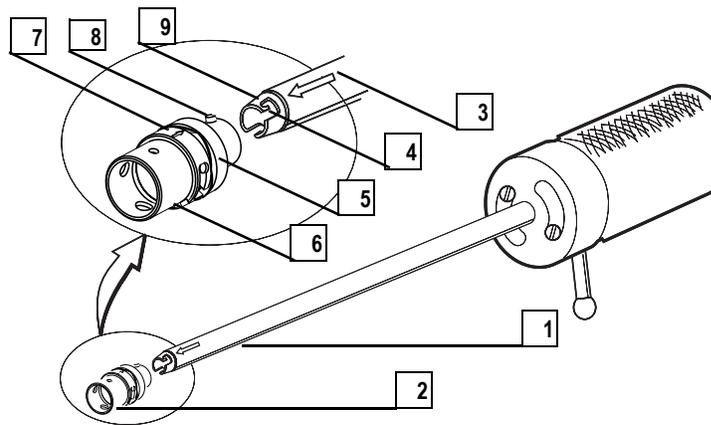
Figure 2-14. I/R Tool Inserted into Detector

4. Remove the **Ion Volume**.
  - a. Slide the **I/R Tool (1)** until the **Guide Ball (2)** is slightly beyond the **Second Stop (4)**.
  - b. Turn the **I/R Tool Handle (1)** counterclockwise to the **Hold Position** . Listen for a “click”.
  - c. Withdraw the **I/R Tool (1)** until the **Guide Ball (2)** reaches the **First Stop (3)**.
  - d. Push the **Inlet Valve Lever** (Figure 2-12) down to close it.
  - e. Loosen the **Inlet Valve Knob** (Figure 2-12).
  - f. Completely remove the **I/R Tool**.

**NOTE:** The Second Stop is the first Engraved Line. The second Engraved Line is for inserting the I/R Tool into a *TRACE DSQ* detector.

5. Clean the **Ion Volume**.

<b>CAUTION</b> Personal Injury	
	<p><b>Burn Hazard</b> The ion volume may be too hot to touch. Let it cool to room temperature before handling it.</p>



1	I/R Tool	6	Spring Washer
2	Ion Volume	7	Ion Volume Alignment Arrow
3	I/R Tool Alignment Arrow	8	Bayonet Pins
4	Pin Guide	9	Bayonet Lock
5	Ion Volume Holder		

Figure 2-15. Ion Volume and I/R Tool

- a. Press the **Ion Volume (2)** forward into the tip of the **I/R Tool (1)** and rotate it to disconnect the **Bayonet Pins (8)** from the **Pin Guides (4)**.
- b. Pull the **Ion Volume (2)** out of the **I/R Tool (1)**.
- c. Clean the **Ion Volume (2)** using the instructions for **Cleaning Stainless Steel Parts** on page 24. If you are cleaning a CI Ion Volume, be sure to clean out the small electron entrance hole. Aluminum oxide can get trapped in this hole, which can adversely affect sensitivity. Use a dental pick or old syringe needle to clean the hole.

- d. Place the **Ion Volume (2)** into the **Bayonet Lock (9)** located on the **I/R Tool (1)**. Make sure the **Alignment Arrows (3)** on the **Ion Volume (7)** and on the **I/R Tool (3)** are facing each other.

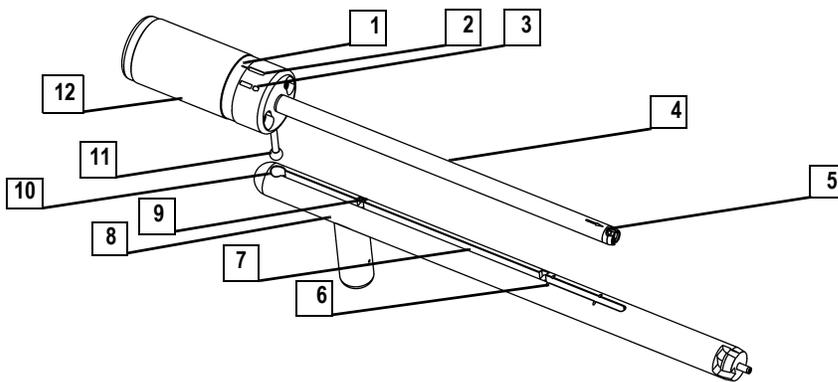
**NOTE:** Wear clean, lint- and powder-free gloves when you handle parts belonging inside the Vacuum Manifold.

**CAUTION**  
Instrument Damage



The arrows on the I/R tool and Ion Volume must be aligned to avoid damage to the source assembly.

## 6. Reinsert the **I/R Tool**.



1	Alignment Line	7	Guide Bar Track
2	Hold Position	8	Guide Bar
3	Release Position	9	First Stop
4	I/R Tool	10	Guide Ball Hole
5	Bayonet Lock	11	Guide Ball
6	Second Stop	12	Handle

**Figure 2-16. I/R Tool and Guide Bar Components**

- a. Turn the **I/R Tool (4)** to the **Hold Position (2)** .
- b. Insert the **Guide Ball (11)** into the **Guide Ball Hole (10)**.
- c. Slide the **I/R Tool (4)** forward in the **Guide Bar Track (7)** until the **Guide Ball (11)** is at the **First Stop (9)**.
- d. Turn the **I/R Tool (4)** so the **Guide Ball (11)** is in the groove at the **First Stop (9)**. This prevents the probe from being pulled forward when the **Inlet Valve** is evacuated.

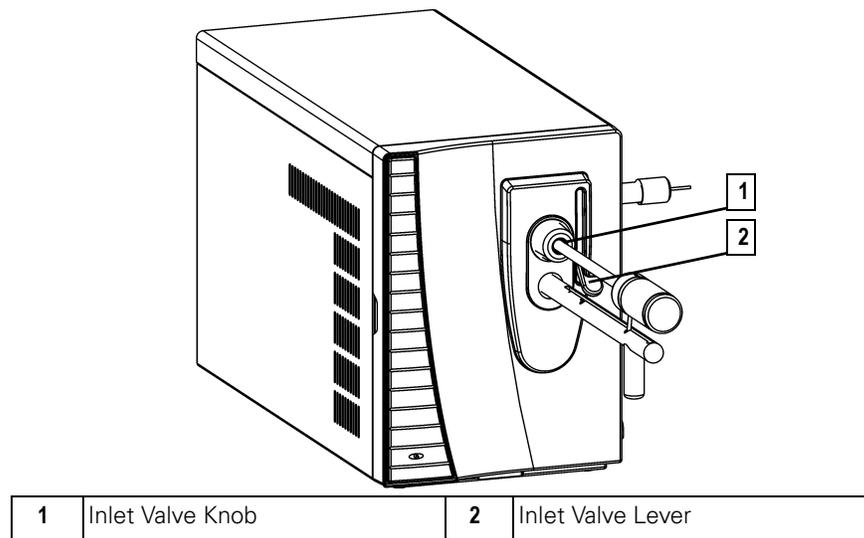


Figure 2-17. I/R Tool Ready to be Inserted

- e. Tighten the **Inlet Valve Knob (1)** to ensure a leak tight seal.

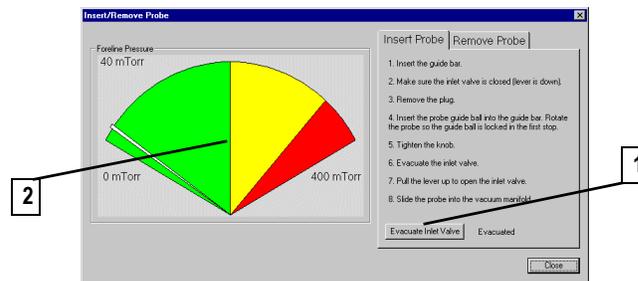


Figure 2-18. Insert Probe Screen

- f. From the **Insert Probe Screen**, select **Evacuate Inlet Valve (1)**.
- g. Monitor the **Forepressure (2)**. The pressure should not remain beyond 350 mTorr. If this occurs, the **Inlet Valve Seal** must be replaced (see [Replacing the Inlet Valve Seal](#) on page 106).
- h. Once evacuation is complete, pull the **Inlet Valve Lever (2)** up to open the **Inlet Valve**.

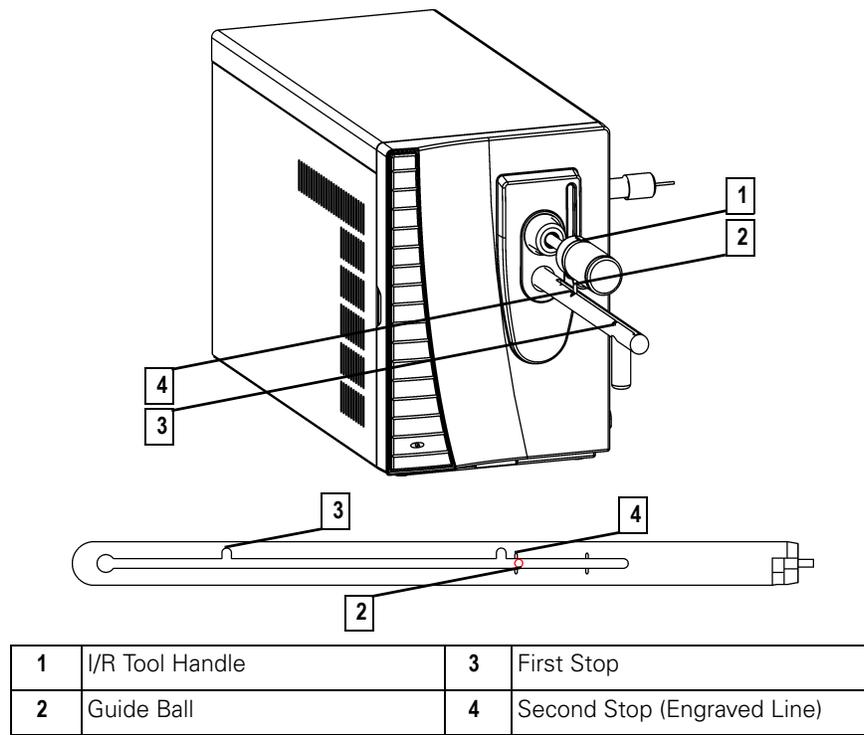
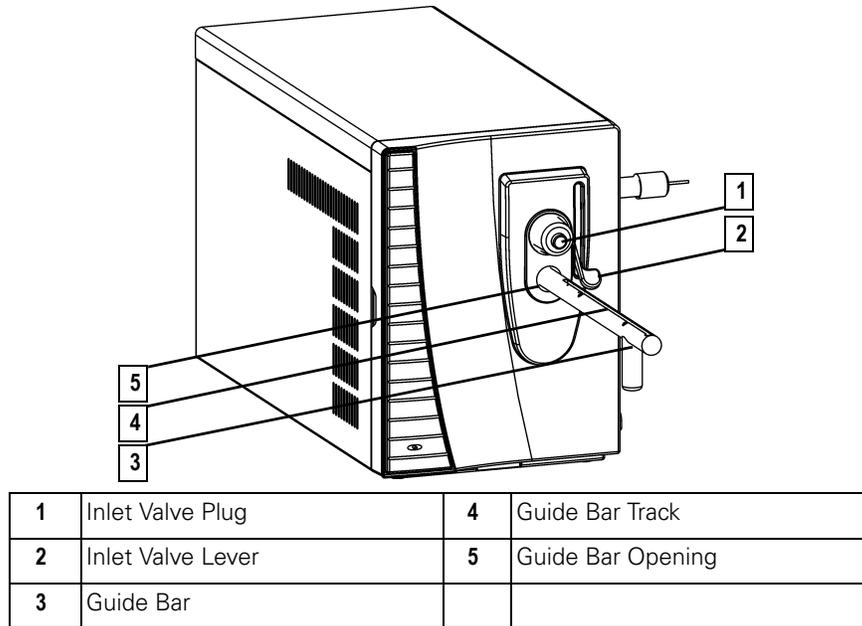


Figure 2-19. I/R Tool Inserted into Detector

7. Reinsert the **Ion Volume**.
  - a. Slide the **I/R Tool (1)** until the **Guide Ball (2)** is slightly beyond the **Second Stop (4)**.
  - b. Turn the **I/R Tool Handle (1)** counterclockwise to the **Release Position** . Listen for a “click”.
  - c. Withdraw the **I/R Tool (1)** away about 2.5 cm (1 in.).
  - d. Turn the **I/R Tool Handle (1)** to the **Hold Position** .
  - e. Slide the **I/R Tool (1)** forward until it touches **Ion Volume**. This ensures that the **Ion Volume** is fully inserted.
  - f. Withdraw the **I/R Tool (1)** until the **Guide Ball (2)** reaches the **First Stop (3)**.
  - g. Push the **Inlet Valve Lever** (Figure 2-17) down to close it.
  - h. Loosen the **Inlet Valve Knob** (Figure 2-17).
  - i. Completely remove the **I/R Tool**.

## 8. Restore the **Inlet Valve**.



**Figure 2-20. Guide Bar (Front)**

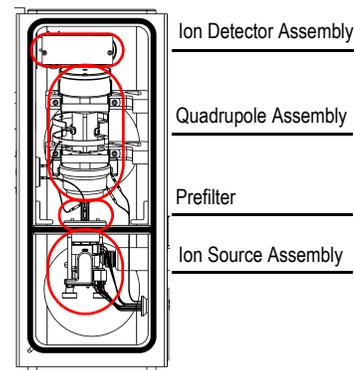
- a. Replace the **Inlet Valve Plug (1)**. Keep **EI** or **CI** label on top to indicate the **Ion Volume** installed. For the **EI/CI Combo Ion Volume**, rotate it in between **EI** and **CI**.
- b. Remove the **Guide Bar (3)** by rotating it 90° counter-clockwise and sliding it out of the **Guide Bar Opening (5)**.

## 9. Close the **Insert/Remove Probe** Screen.

From the **Insert/Remove Probe Screen**, select **Close** to return to the *Xcalibur* Home Page.

## Cleaning the Ion Volume Without an Inlet Valve

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Cleaning supplies for stainless steel parts</li> <li>• Gloves, clean, lint- and powder-free</li> <li>• Ion Volume Tool (PN 119270-0001)</li> <li>• Lint-free cloth</li> </ul>
	<p><b>Frequency</b> To restore system performance</p>

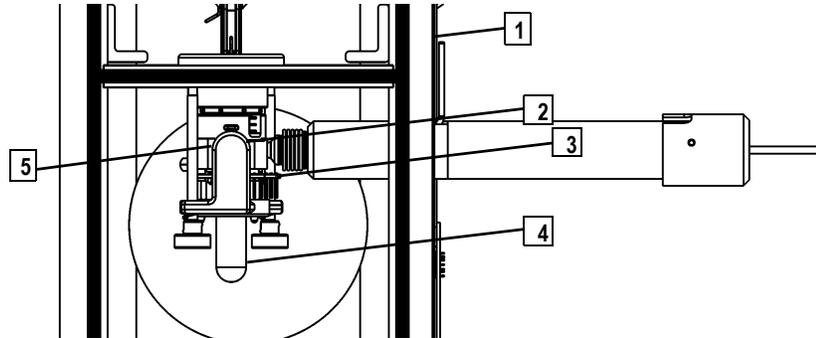


Inside the Ion Volume is where molecules interact with energetic electrons to form ions. Because the Ion Volume is exposed directly to samples introduced into the *TRACE DSQ*, you will clean it more frequently than other parts. How often you clean the Ion Volume assembly will depend on the types and amounts of samples. If you don't have an Inlet Valve you can still access and remove the Ion Volume for cleaning using an Ion Volume Tool.

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down, vent, and remove the Vacuum Manifold Cover (see [Vacuum Manifold Maintenance](#) on page 30).

**NOTE:** Wear clean, lint- and powder-free gloves when you handle parts belonging inside the Vacuum Manifold.

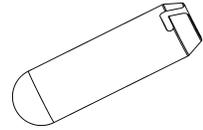
2. Remove the **Ion Volume** from the **Ion Source Assembly**.



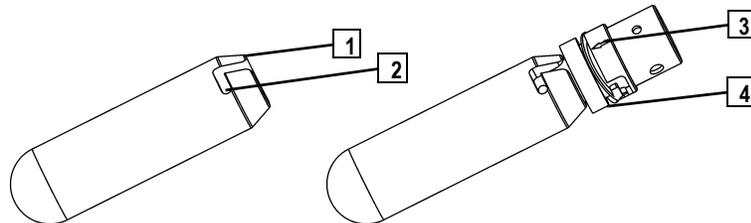
1	Vacuum Manifold	4	Ion Volume Tool
2	Magnet Support	5	Ion Source Block (Ion Volume inside)
3	Ion Source PCB		

**Figure 2-21. Ion Source Assembly with Ion Volume Tool Inserted (Top)**

- a. Hook the **Ion Volume Tool (4)** on the **Ion Volume** through the opening in the **Ion Source PCB (3)**.
- b. Turn the **Ion Volume Tool (4)** counter-clockwise 30° to engage the **Ion Volume**.
- c. Pull the **Ion Volume** straight back and through the opening in the **Ion Source PCB (3)**.



3. Clean the **Ion Volume (4)**, as described in **Cleaning Stainless Steel Parts** on page 24. If you are cleaning a CI Ion Volume, be sure to clean out the small electron entrance hole. Aluminum oxide can get trapped in this hole, which can adversely affect sensitivity. Use a dental pick or old syringe needle to clean the hole.



1	Ion Volume Tool	3	Ion Volume Arrow
2	Bayonet Pin Guide/Lock	4	Ion Volume

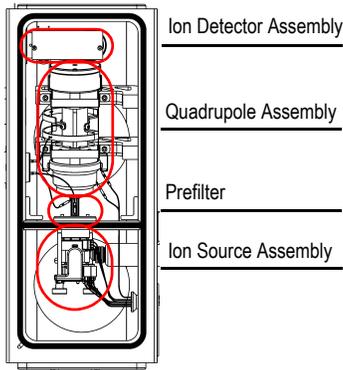
**Figure 2-22. Ion Volume on Ion Volume Tool**

## 4.

- a. Rotate the **Ion Volume (4)** to disconnect it from the **Ion Volume Tool (1)**.
  - b. Clean the **Ion Volume (4)** using the instructions for **Cleaning Stainless Steel Parts** on page 24.
- Replace the **Ion Volume**.
- a. Insert the **Ion Volume (4)** onto the end of the **Ion Volume Tool (1)**.
  - b. Align the **Ion Volume Arrow (3)** so it is facing up.
  - c. Use the **Ion Volume Tool (1)** to push the **Ion Volume (4)** straight through the opening in the **Ion Source PCB** (Figure 2-21).
  - d. Push the **Ion Volume** all the way into the **Ion Source Block** and listen for it to snap into place.
  - e. Turn the **Ion Volume Tool** handle clockwise 30° to disengage the **Ion Volume**.

## 5.

- Reassemble the *TRACE DSQ* for operation.
- a. Replace the **Vacuum Manifold Cover**.
  - b. Replace the *TRACE DSQ* front and top covers.
  - c. Restart the system.



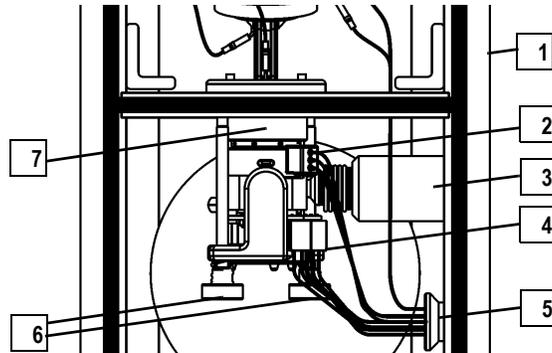
## Cleaning the Ion Source, Lenses, and Prefilter

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Cleaning supplies for non-stainless steel or hybrid parts</li> <li>• Cleaning supplies for stainless steel parts</li> <li>• Forceps</li> <li>• Gloves, clean, lint- and powder-free</li> <li>• Lint-free cloth</li> <li>• Wrench, Allen, 2.5 mm</li> <li>• Wrench, Allen, 3.0 mm</li> </ul>
	<p><b>Frequency</b> To restore system performance</p>

If cleaning the Ion Volume does not restore system performance, try cleaning the **Ion Source** and **Prefilter**. System Performance is determined by your benchmark tests. See **Running Benchmark Tests** on page 20. The Ion Source Lenses (especially **L1**) come in direct contact with samples introduced into the *TRACE DSQ* and need to be cleaned periodically (though not as often as the Ion Volume).

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down, vent, and remove the Vacuum Manifold Cover (see **Vacuum Manifold Maintenance** on page 30).

## 2. Remove the **Ion Source Assembly**.



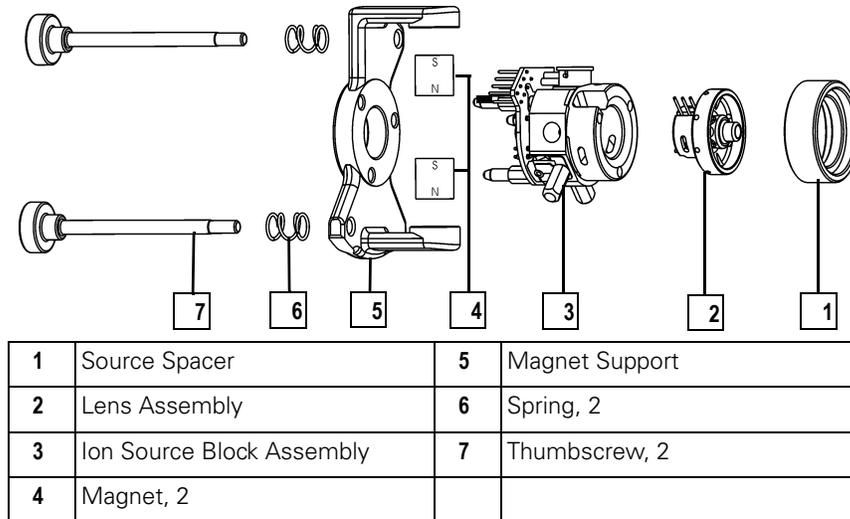
1	Vacuum Manifold	5	12-Pin Connection
2	3-Pin Lens Connection	6	Thumbscrews, 2
3	Transfer Line	7	Source Spacer
4	8-Pin Connection		

**Figure 2-23. Ion Source Assembly (Top)**

- a. Disconnect the **3-pin (2)** and **8-pin Connector (4)** from the **Ion Source Assembly**. Be careful not to pull the connectors by the wires.
- b. Loosen the two **Thumbscrews (6)**.
- c. Slide the **Source Spacer (7)** slightly to the left, while pulling it slightly toward you (away from the **Prefilter**). Once it is free, carefully slide it left to clear the end of the **Transfer Line (3)**. Be careful not to damage the capillary column extending out of the **Transfer Line**.

**NOTE:** Wear clean, lint- and powder-free gloves when you handle parts belonging inside the Vacuum Manifold.

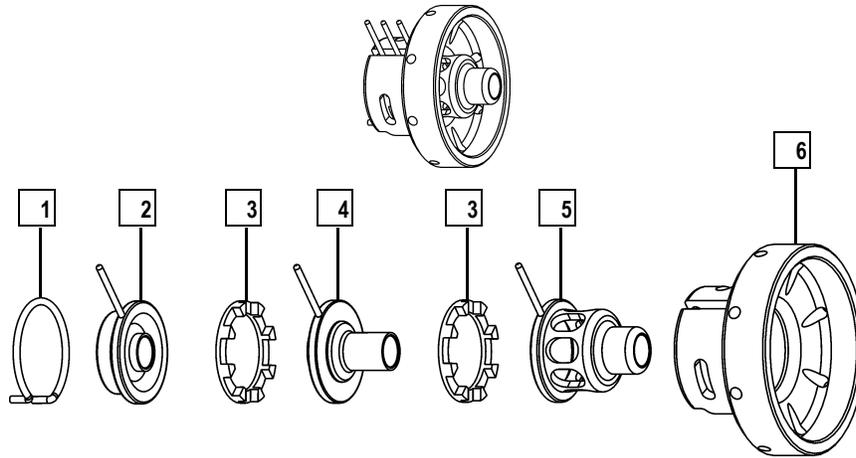
### 3. Disassemble the **Ion Source Assembly**.



**Figure 2-24. Ion Source Assembly (Right Side)**

- a. Remove the **Source Spacer (1)**.
- b. Remove the **Lens Assembly (2)**.
- c. Remove the **Magnet Support (5)**, **Magnets (4)**, and **Thumbscrews (7)**. It is not necessary to disassemble these.

4. Disassemble the **Lens Assembly**.



1	Lens Clip	4	Lens 2
2	Lens 1	5	Lens 3
3	Lens Spacer, 2	6	Lens Holder

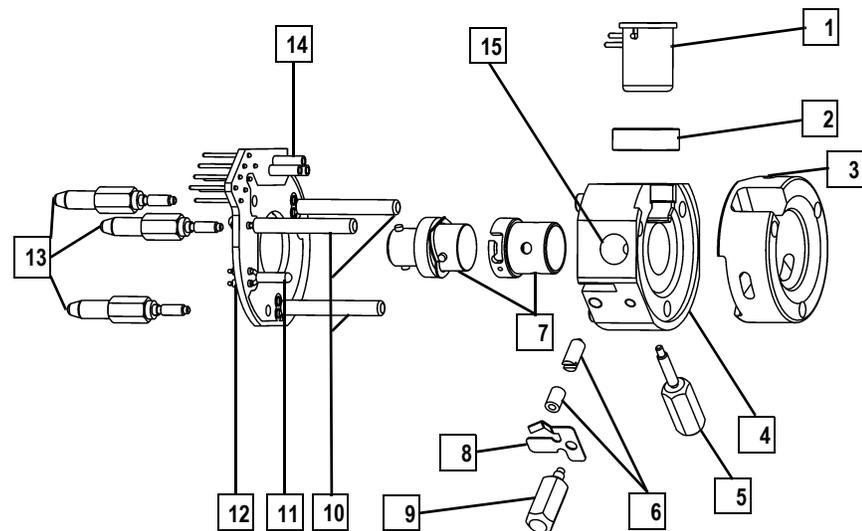
Figure 2-25. Lens Assembly

- a. Remove the **Lens Clip (1)** by pinching the ends with your fingers or forceps.
- b. Remove the **Lenses (2, 4, 5)** and **Lens Spacers (3)** from the ceramic **Lens Holder (6)**.

5. Clean the **Lenses (2, 4, 5)**.

Use the instructions for **Cleaning Stainless Steel Parts** on page 24. Pay particular attention to the areas inside the tube and around the hole in each lens.

6. Disassemble the **Ion Source Block Assembly**.



1	Filament	9	Spring Thumbscrew
2	Filament Spacer	10	Cartridge Heaters, 3
3	Heater Ring	11	Temperature Sensor
4	Ion Source Block	12	Ion Source PCB
5	Alignment Pin/Ion Volume Key Thumbscrew	13	Base-Studs, 3
6	Ion Volume Pin/Set Screw & Ball Plunger	14	3-pin Filament Connector
7	Ion Volume	15	Sample Inlet Aperture
8	Spring		

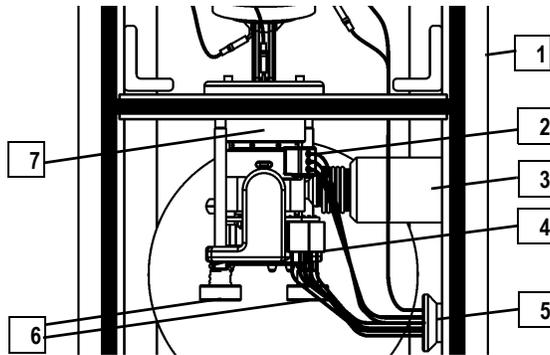
**Figure 2-26. Ion Source Block Assembly**

**NOTE:** Do not bend or twist the Cartridge Heaters or the Temperature Sensor.

- a. Remove the **Base-Studs (13)**. Be careful not to damage the leads on the **Ion Source PCB (12)**.
- b. Gently pull the **Ion Source PCB (12)** from the **Ion Source Block (4)** by sliding the **Cartridge Heaters (10)** and **Temperature Sensor (11)** out of the **Ion Source Block** and pulling the **Filament (1)** straight away from the **3-pin Filament Connector (14)** that is located on the **Ion Source PCB (12)**.
- c. Remove the **Filament (1)** and **Filament Spacer (2)**.
- d. Remove the **Ion Volume Key Thumbscrew (5)**.

- e. Remove the **Spring Thumbscrew (9)** and **Spring (8)**.
7. Clean the **Ion Source Block Assembly**.
- Clean each component by following the instructions for **Cleaning Stainless Steel Parts** on page 24 and **Cleaning Non-Stainless Steel or Hybrid Parts** on page 27. Thoroughly clean the **Ion Source Block** where the **Filament** sits and the well on the opposite side of where the **Ion Volume** sits. It is not necessary to clean the **Magnets, Magnet Support, or Thumbscrews**.
8. Reassemble the **Ion Source Block Assembly**.
  9. Reassemble the **Lens Assembly**.
  10. Reassemble the **Ion Source Assembly**.
  11. Install the **Ion Source Assembly**.

**NOTE:** It is not necessary to remove the Ion Volume Pin. If it is removed, it should be reinserted just far enough so the ball will keep an ion volume from falling out. If the ball extends too far, ion volumes will be difficult to remove.



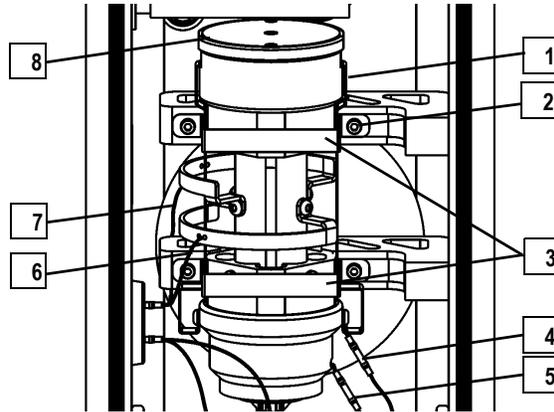
1	Vacuum Manifold	5	12-Pin Connection
2	3-Pin Lens Connection	6	Thumbscrews, 2
3	Transfer Line	7	Source Spacer
4	8-Pin Connection		

Figure 2-27. Ion Source Assembly (Top)

- a. Slip the **Ion Source Assembly** over the end of the **Transfer Line (3)**. Be careful not to damage the capillary column extending out of the **Transfer Line**.
- b. Push the **Source Spacer (7)** to the right until it snaps into place.
- c. Tighten the two **Thumbscrews (6)**.
- d. Connect the **3-pin (2)** and **8-pin Connectors (4)**.

- e. Be sure the **Ion Source Assembly** is still snapped into place by trying to push it left and right. It should not move. If it is not snapped properly into its groove, system performance will degrade and you will not be able to insert and remove ion volumes using the inlet valve.

## 12. Remove the **Quadrupole Assembly**.



1	Quadrupole Assembly	5	Entrance Lens Connection, Short Wire
2	Screw Holding Quadrupole Strap, 4	6	Top RF Feedthrough Connection
3	Quadrupole Strap, 2	7	Bottom RF Feedthrough Connection
4	Exit Lens Connection, Long Wire	8	Exit Lens

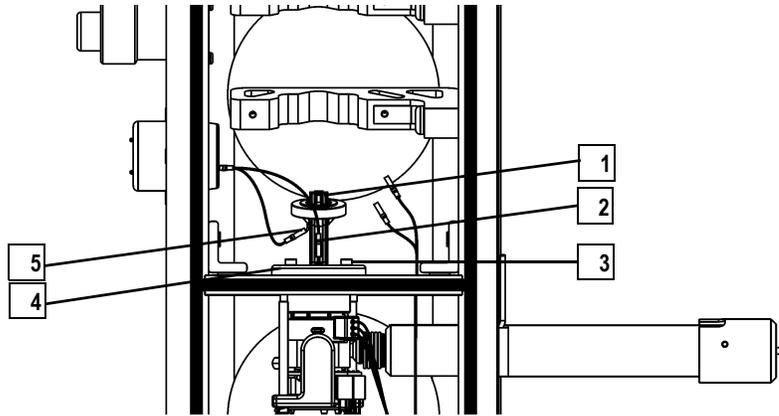
**Figure 2-28. Quadrupole Assembly (Top)**

**NOTE:** Remove the Quadrupole Straps and the Screws together. This makes it easier to remove and reinstall the Screws.

- Unscrew, but do not remove the four **Screws holding the Quadrupole Straps (2)**.
- Remove the two **Quadrupole Straps (3)** and the four **Screws (2)**.
- Disconnect the **Top and Bottom RF Feedthrough Connections (6, 7)** using forceps.
- Slide the **Quadrupole Assembly (1)** slightly back and lift it out. Stand it on its **Exit Lens (8)** somewhere safe. Do not lay it on its side as this can damage the Quadrupole and loosen the **RF Feedthrough Connections (6, 7)**.

# 13.

Remove the **Prefilter**.



1	Prefilter	4	Prefilter Clamp
2	Top Prefilter Connection	5	Bottom Prefilter Connection
3	Screw Holding Prefilter Clamp, 4		

**Figure 2-29. Prefilter (Top)**

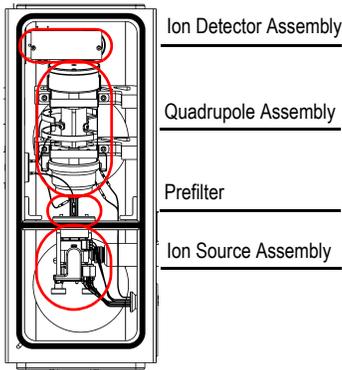
- a. Disconnect the **Top (2)** and **Bottom Prefilter Connections (5)** from the **Prefilter (1)**.
- b. Remove the four **Screws Holding the Prefilter Clamp (3)**.
- c. Remove the **Prefilter (1)**.

**14.** Clean the **Prefilter**. Clean the **Prefilter**, as described in **Cleaning Non-Stainless Steel or Hybrid Parts** on page 27. Note that it is only necessary to clean the rods, especially the front end where most of the ions strike. Also, the **Prefilter** should never be put in an oven.

**15.** Reinstall the **Prefilter**.

**16.** Reinstall the **Quadrupole Assembly**.

**17.** Restore the *TRACE DSQ* for operation.

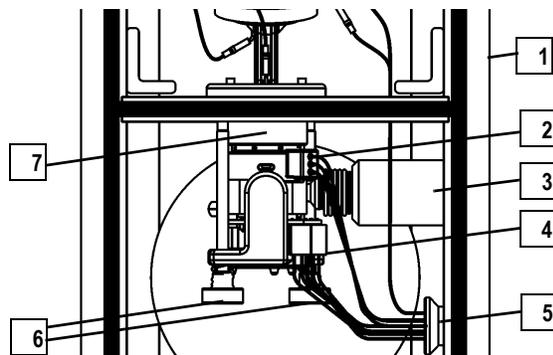


## Replacing the Ion Source Filament

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>Filament (PN 119701-60287)</li> <li>Gloves, clean, lint- and powder-free</li> <li>Lint-free cloth</li> </ul>
	<p><b>Frequency</b></p> <p>When you notice a lack in ion production and the instrument status indicates the filament is open.</p>

The number of ions produced in the Ion Source is approximately proportional to the filament emission current. If you notice a lack in ion production, then this might indicate the filament has failed and needs to be replaced. If the measured emission current is substantially less than the value that the emission current is set to, or if the measured emission current is decreasing over time, then the filament has failed or is failing, and needs to be replaced.

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down, vent, and remove the Vacuum Manifold Cover (see [Vacuum Manifold Maintenance](#) on page 30).
2. Remove the **Ion Source Assembly** from the **Vacuum Manifold**.



1	Vacuum Manifold	5	12-Pin Connection
2	3-Pin Lens Connection	6	Thumbscrews, 2
3	Transfer Line	7	Source Spacer
4	8-Pin Connection		

**Figure 2-30. Ion Source Assembly (Top)**

- a. Disconnect the **3-pin (2)** and **8-pin Connector (4)** from the **Ion Source Assembly**. Be careful not to pull the connectors by the wires.
- b. Loosen the two **Thumbscrews (6)**.
- c. Slide the **Source Spacer (7)** slightly to the left, while pulling it slightly toward you (away from the **Prefilter**). Once it is free, carefully slide it left to clear the end of the **Transfer Line (3)**. Be careful not to damage the capillary column extending out of the **Transfer Line**.

**NOTE:** Wear clean, lint- and powder-free gloves when you handle parts belonging inside the Vacuum Manifold.

### 3. Disassemble the **Ion Source Assembly**.

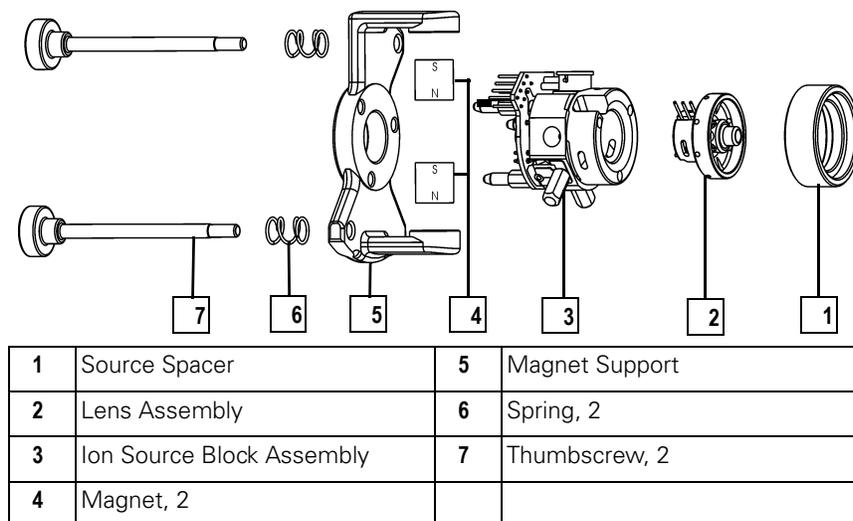
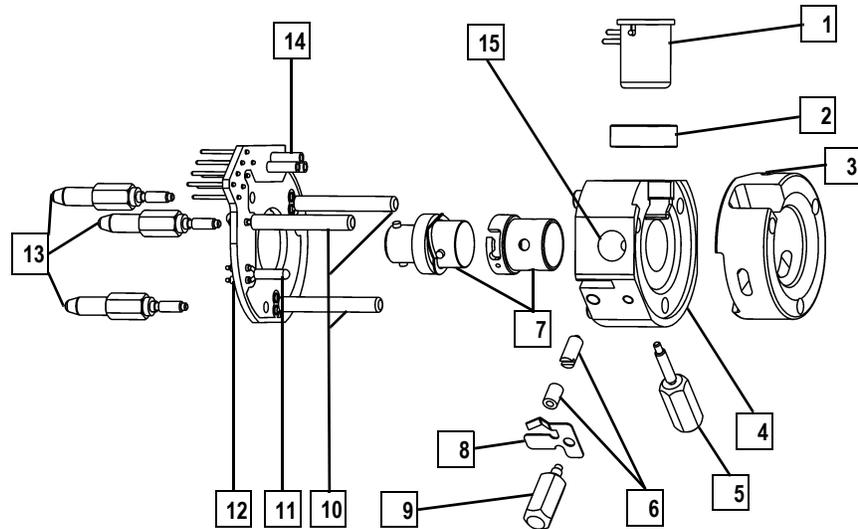


Figure 2-31. Ion Source Assembly

- a. Remove the **Source Spacer (1)**.
- b. Remove the **Lens Assembly (2)**.
- c. Remove the **Magnet Support (5), Magnets (4),** and **Thumbscrews (7)** as an assembly.

#### 4. Disassemble the **Ion Source Block Assembly**.



1	Filament	9	Spring Thumbscrew
2	Filament Spacer	10	Cartridge Heaters, 3
3	Heater Ring	11	Temperature Sensor
4	Ion Source Block	12	Ion Source PCB
5	Alignment Pin/Ion Volume Key Thumbscrew	13	Base-Studs, 3
6	Ion Volume Pin/Set Screw & Ball Plunger	14	3-pin Filament Connector
7	Ion Volume	15	Sample Inlet Aperture
8	Spring		

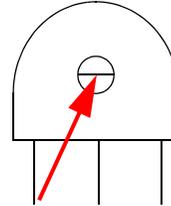
**Figure 2-32. Ion Source Block Assembly**

- a. Remove the **Base-Studs (13)**. Be careful not to damage the leads on the **Ion Source PCB (12)**.
- b. Gently pull the **Ion Source PCB (12)** from the **Ion Source Block (4)** by sliding the **Cartridge Heaters (10)** and **Temperature Sensor (11)** out of the **Ion Source Block** and pulling the **Filament (1)** straight away from the **3-pin Filament Connector (14)** that is located on the **Ion Source PCB (12)**.
- c. Remove the **Filament (1)**.

**NOTE:** Do not bend or twist the Cartridge Heaters or the Temperature Sensor.

5. Inspect the **Filament Wire** on the new **Filament Assembly**.

- a. Verify that the **Filament Wire** is centered in the **Electron Lens Hole**.
- b. If not, carefully use forceps to adjust the **Filament Wire**.



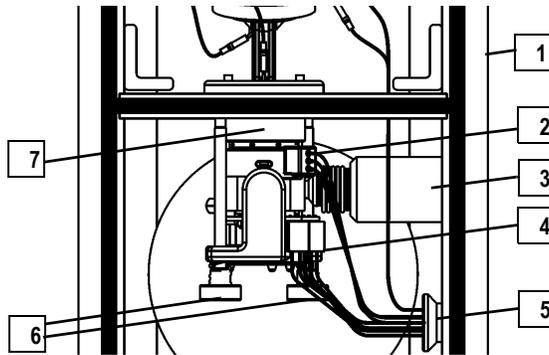
**NOTE:** Now is a good time to clean the Ion Volume, Ion Source, and Lenses.

6. Reassemble the **Ion Source Block Assembly**.

Normally, there is a small gap (about 0.020 in.) between the **Filament** and the connectors. The gap allows the ceramic **Filament Spacer** centering ring to properly position and align the **Electron Lens Hole** with the **Ion Volume**.

7. Reassemble the **Ion Source Assembly**.

8. Install the **Ion Source Assembly**.



1	Vacuum Manifold	5	12-Pin Connection
2	3-Pin Lens Connection	6	Thumbscrews, 2
3	Transfer Line	7	Source Spacer
4	8-Pin Connection		

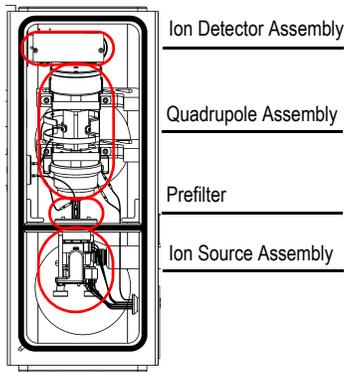
Figure 2-33. Ion Source Assembly (Top)

- a. Slip the **Ion Source Assembly** over the end of the **Transfer Line (3)**. Be careful not to damage the capillary column extending out of the **Transfer Line**.
- b. Push the **Source Spacer (7)** to the right until it snaps into place.
- c. Tighten the two **Thumbscrews (6)**.
- d. Connect the **3-pin (2)** and **8-pin Connectors (4)**.

- e. Be sure the **Ion Source Assembly** is still snapped into place by trying to push it left and right. It should not move. If it is not snapped properly into its groove, system performance will degrade and you will not be able to insert and remove ion volumes using the inlet valve.

9. Restore the *TRACE DSQ* for operation.

- a. Replace the **Vacuum Manifold Cover**.
- b. Replace the *TRACE DSQ* front and top covers.
- c. Restart the system.



Ion Detector Assembly

Quadrupole Assembly

Prefilter

Ion Source Assembly

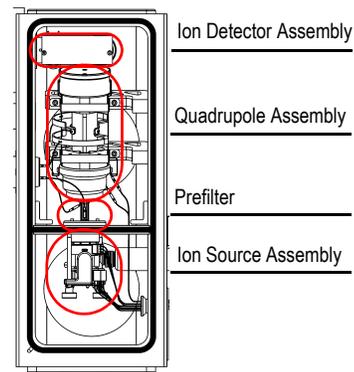
## 2.5 Quadrupole Assembly Maintenance

The Quadrupole rarely needs maintenance other than keeping it dust-free with a clean, dry gas. It must be kept free of dust because even the smallest amount of lint can cause poor sensitivity and peak shape. The Quadrupole Assembly (also known as the Mass Analyzer) is composed of an Entrance Lens, Quadrupole, and Exit Lens. The Quadrupole is a precision device that should never be disassembled. Contact Customer Service for Quadrupole cleaning.

## 2.6 Ion Detector Assembly Maintenance

The Ion Detector Assembly has a **Conversion Dynode** and **Electron Multiplier**. It must be kept clean and free of dust, because even the smallest amount of lint on either the **Electron Multiplier** or the **Conversion Dynode** can cause spectral noise or static discharge, which could lead to power supply failure. Keep these in mind:

- Clean the **Conversion Dynode** and **Electron Multiplier** with clean dry gas, never liquids or abrasives, each time you remove the **Vacuum Manifold Cover**

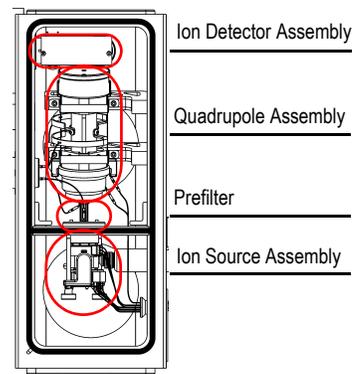


<b>CAUTION</b> Instrument Damage	
	<p>Do not clean the conversion dynode with aluminum oxide. This may damage the surface. An ion burn on the surface of the conversion dynode is normal and will not adversely affect performance.</p>

- Cover the **Vacuum Manifold** with the **Vacuum Manifold Cover**, if you temporarily step away

### Cleaning the Anode

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Gloves, clean, lint- and powder-free</li> <li>• Lint-free cloth</li> <li>• Screwdriver, Phillips #1</li> <li>• Wrench, Allen, 3 mm</li> <li>• Wrench, open-ended, 17 mm</li> <li>• Wrench, open-ended, 9/16-in.</li> </ul>
	<p><b>Frequency</b></p> <p>Still receiving noise, after spray cleaning the Ion Detector Assembly.</p>

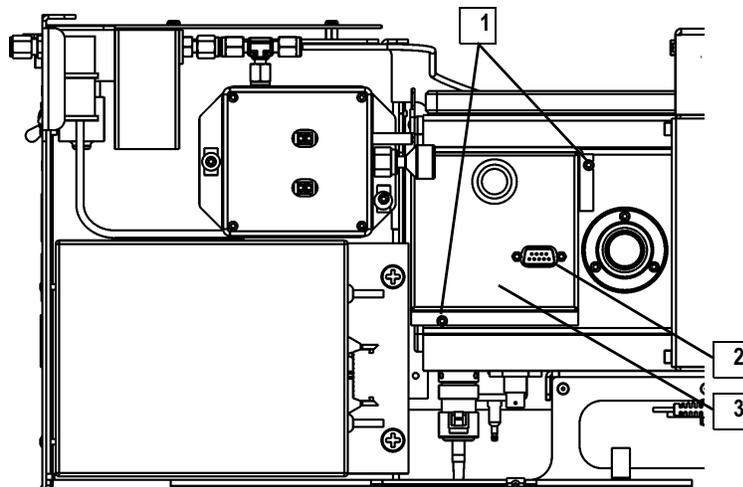


The **Anode** is located on the left side of the **Vacuum Manifold** under the **Electron Multiplier**.

To clean the Anode, follow these steps:

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the *TRACE DSQ* (see **Vacuum Manifold Maintenance** on page 30).
  - b. Remove the front, top, and left side covers (see **Removing the Covers** on page 21).
2. Remove the **Electrometer PCB**.

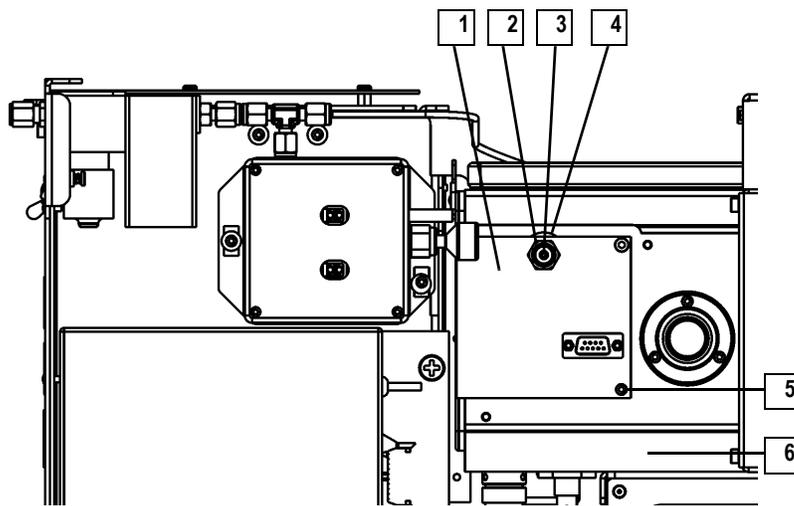
**NOTE:** Wear clean, lint- and powder-free gloves when you handle parts belonging inside the Vacuum Manifold.



1	Screws holding the Electrometer PCB Cover, 2	3	Electrometer PCB Cover
2	Electrometer PCB Cable		

**Figure 2-34. Electrometer PCB (Left Side)**

- a. Disconnect the **Electrometer PCB Cable (2)** at P1.
- b. Remove the two **Screws holding the Electrometer PCB Cover (1)** in place and remove the **Electrometer PCB Cover**.



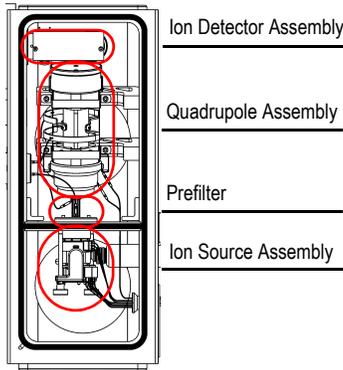
1	Electrometer PCB	4	Anode Feedthrough
2	Nut Holding Electrometer PCB to Anode Feedthrough	5	Screw Holding Electrometer PCB
3	Screw Holding Wire to Anode Feedthrough	6	Vacuum Manifold

**Figure 2-35. Electrometer PCB with Cover Removed (Left Side)**

- c. Remove the **Screw Holding the Wire to the Anode Feedthrough (3)**.
  - d. Remove the **Nut Holding Electrometer PCB to Anode Feedthrough (2)**.
  - e. Remove the **Screw Holding Electrometer PCB (5)** and pull the **Electrometer PCB (1)** free.
3. Remove the **Anode Feedthrough (4)** by unscrewing it from the **Vacuum Manifold**.
  4. Clean the **Anode Feedthrough**.  
Clean the **Anode Feedthrough** as described in **Cleaning Non-Stainless Steel or Hybrid Parts** on page 27. Note that it is only necessary to clean the cup part that extends into the **Vacuum Manifold**. Never put the **Anode Feedthrough** in an oven.

5. Reinstall the **Anode Feedthrough**.
6. Replace the **Electrometer PCB**.
7. Restore the *TRACE DSQ* for operation.

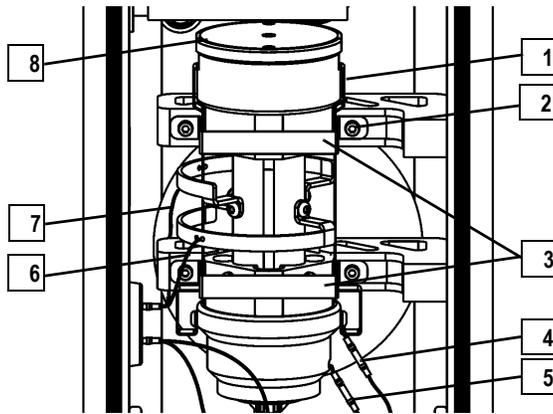
### Replacing the Electron Multiplier



	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Cathode (PN A0022-02401)</li> <li>• Forceps</li> <li>• Gloves, clean, lint- and powder-free</li> <li>• Lint-free cloth</li> <li>• Screwdriver, Flat</li> <li>• Screwdriver, Phillips #1</li> <li>• Wrench, Allen, 2.5 mm</li> <li>• Wrench, Allen, 3 mm</li> </ul>
	<p><b>Frequency</b> Still receiving significant amounts of spectral noise, after cleaning the Anode.</p>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down, vent, and remove the Vacuum Manifold Cover (see **Vacuum Manifold Maintenance** on page 30).
2. Remove the **Quadrupole Assembly**.

**NOTE:** Wear clean, lint- and powder-free gloves when you handle parts belonging inside the Vacuum Manifold.



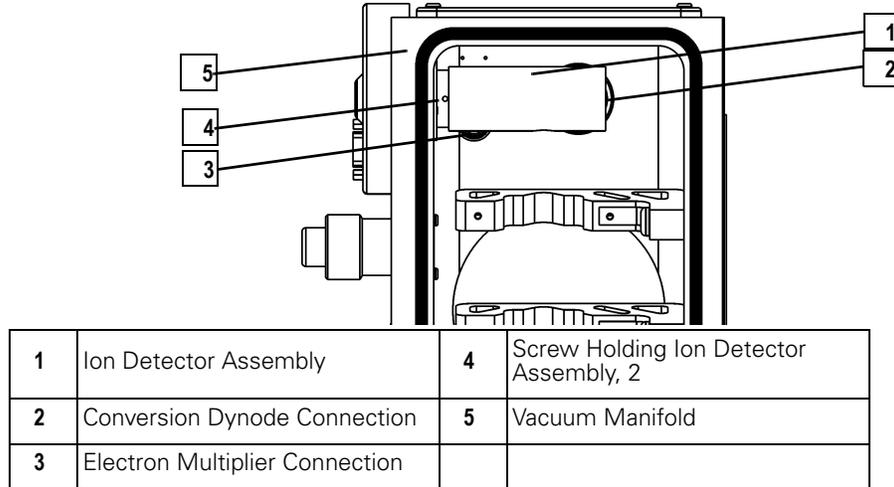
1	Quadrupole Assembly	5	Entrance Lens Connection, Short Wire
2	Screw Holding Quadrupole Strap, 4	6	Top RF Feedthrough Connection
3	Quadrupole Strap, 2	7	Bottom RF Feedthrough Connection
4	Exit Lens Connection, Long Wire	8	Exit Lens

**Figure 2-36. Quadrupole Assembly (Top)**

- a. Unscrew, but do not remove the four **Screws holding the Quadrupole Straps (2)**.
- b. Remove the two **Quadrupole Straps (3)** and the four **Screws (2)**.
- c. Disconnect the **Top and Bottom RF Feedthrough Connections (6, 7)** using forceps.
- d. Slide the **Quadrupole Assembly (1)** slightly back and lift it out. Stand it on its **Exit Lens (8)** somewhere safe. Do not lay it on its side as this can damage the Quadrupole and loosen the **RF Feedthrough Connections (6, 7)**.

**NOTE:** Remove the Quadrupole Straps and the Screws together. This makes it easier to remove and reinstall the Screws.

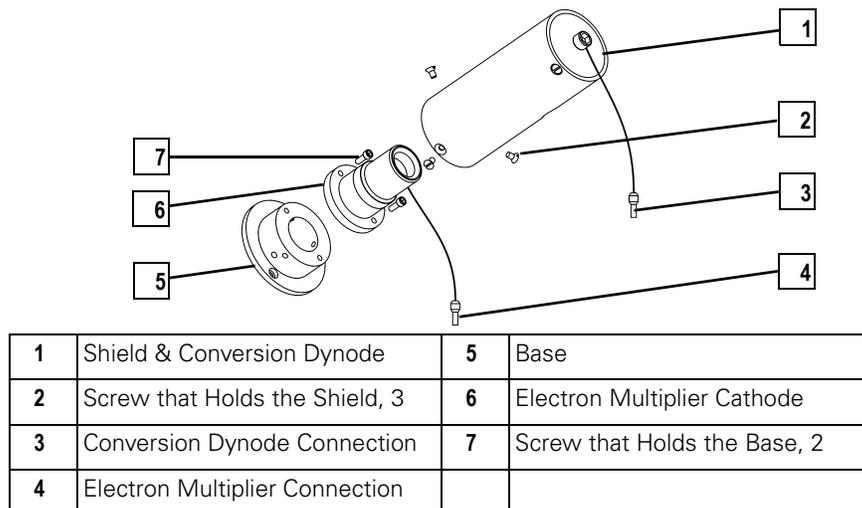
### 3. Remove the **Ion Detector Assembly**.



**Figure 2-37. Ion Detector Assembly (Top)**

- a. Disconnect the **Conversion Dynode Connection (2)** from the connector at the bottom of the **Vacuum Manifold (5)**.
- b. Disconnect the **Electron Multiplier Connection (3)** from the connector at the bottom of the **Vacuum Manifold (5)**.
- c. Remove the two **Screws Holding the Ion Detector Assembly (4)** to the **Vacuum Manifold (5)**.

### 4. Disassemble the **Ion Detector Assembly**.

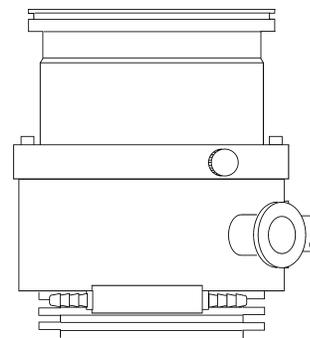


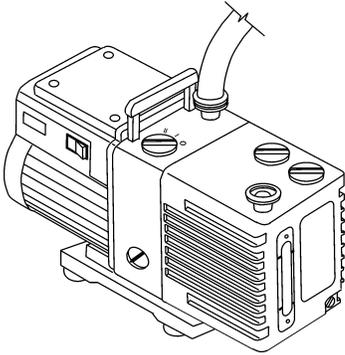
**Figure 2-38. Ion Detector Assembly (Exploded View)**

- a. Remove the three **Screws that Hold the Shield (2)**.
  - b. Remove the two **Screws that Hold the Base (7)**.
  - c. Disconnect the **Electron Multiplier Connection (4)**.
5. Reassemble the **Ion Detector Assembly**.
- a. Attach the new **Electron Multiplier Cathode (6)** with the two **Screws that Hold the Base (7)**. Be sure to orient the **Electron Multiplier Connection (4)** correctly.
  - b. Reconnect the **Electron Multiplier Connection (4)**.
  - c. Attach the **Shield (1)** with the three **Screws that Hold the Shield (2)**.
6. Reinstall the **Ion Detector Assembly**.
7. Reinstall the **Quadrupole Assembly**.
8. Restore the *TRACE DSQ* for operation.

## 2.7 Turbomolecular Pump Maintenance

Your *TRACE DSQ* is equipped with either a 70 L/s Turbomolecular Pump, a 250 L/s Turbomolecular Pump, or a 200/200 L/s split-flow Turbomolecular Pump. No maintenance is required. They contain sufficient lubricant to supply the bearings for life. The **Turbomolecular Pump** is located directly under the **Vacuum Manifold** and provides the high vacuum necessary for ion production.



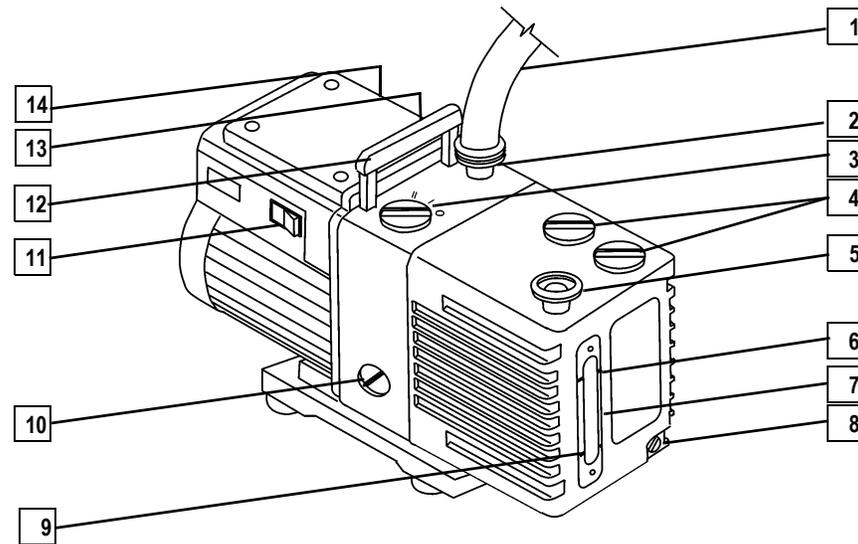


## 2.8 Rotary-Vane Pump Maintenance

The Rotary-Vane Pump is located under the work table where the *TRACE DSQ* is placed. All you have to do to maintain the rotary-vane pump is add, purge, and change the oil.

### Checking the Oil Level

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>Rotary-Vane Pump Oil (PN A0301-15101)</li> </ul>
	<p><b>Frequency</b> Every week</p>



1	Foreline Vacuum Hose	8	Drain Plug
2	Inlet Port	9	MIN (minimum level mark)
3	Gas-Ballast Control	10	Mode Selector
4	Oil Filler Plugs	11	On/Off Switch
5	Outlet Port	12	Handle
6	MAX (maximum level mark)	13	Voltage Indicator
7	Oil-Level Sight-glass	14	Electrical Inlet Connector

**Figure 2-39. Rotary-Vane Pump**

1. Look into the **Oil-Level Sight-Glass (7)** to see if the oil level is between the **MIN (9)** and **MAX (6)** marks.  
If the oil level is below the **MIN (9)** mark, add oil (see **Adding Oil to the Rotary-Vane Pump** on page 68).
2. Look for oil that is both light amber in color and clear.
  - a. If the oil is cloudy or discolored, purge the oil to decontaminate dissolved solvents (see **Purging the Rotary-Vane Pump Oil** on page 70).
  - b. If the pump oil is still discolored, change it (see **Changing the Rotary-Vane Pump Oil** on page 72).

**NOTE:** Set the Mode Selector to High Vacuum mode (turned fully clockwise) and close (position 0) the Gas-Ballast Control for normal operations.

### Adding Oil to the Rotary-Vane Pump

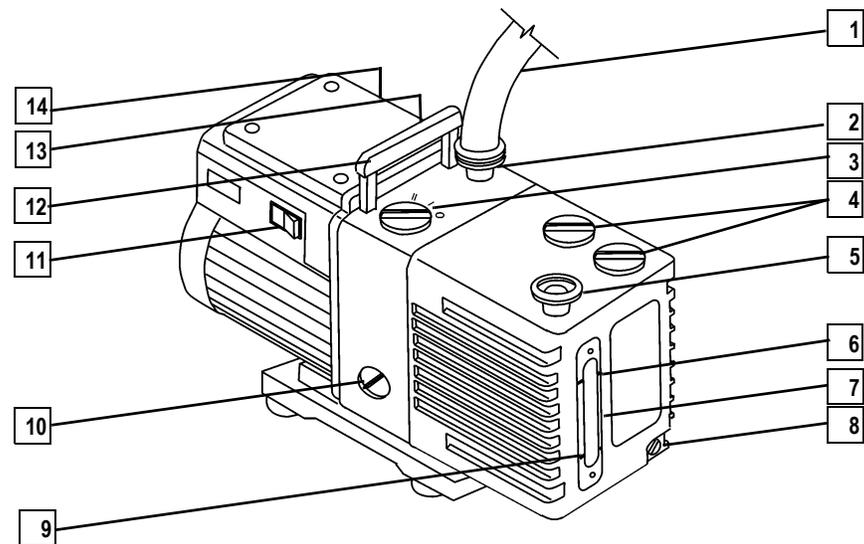
	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>Rotary-vane pump oil (PN A0301-15101)</li> </ul>
	<p><b>Frequency</b></p> <p>As needed (if the oil level is below the MIN mark on the oil level sight glass).</p>

Use this procedure if the oil level is low. You can check the oil level by looking at the Oil Level Sight Glass.

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the *TRACE DSQ* (see **Shutting Down** on page 12).
2. Add Oil.

**NOTE:** The pump oil level must be between the MIN and MAX marks on the oil-level sight-glass for the pump to operate properly.

<b>WARNING</b> <b>Personal Injury</b>	
	<p><b>Electrical Shock Hazard</b></p> <p>Shut down and unplug the detector and Rotary-Vane Pump before adding oil.</p>



1	Foreline Vacuum Hose	8	Drain Plug
2	Inlet Port	9	MIN (minimum level mark)
3	Gas-Ballast Control	10	Mode Selector
4	Oil Filler Plugs	11	On/Off Switch
5	Outlet Port	12	Handle
6	MAX (maximum level mark)	13	Voltage Indicator
7	Oil-Level Sight-glass	14	Electrical Inlet Connector

Figure 2-40. Rotary-Vane Pump

- a. Remove one of the **Oil Filler Plugs (4)** from the **Rotary-Vane Pump**.
- b. Add fresh oil into the reservoir until the oil is half way between the **MIN (9)** and **MAX (6)** Level Marks.

### CAUTION Instrument Damage



Use only factory-approved Rotary-Vane Pump Oil to avoid a decrease in performance and damage to the instrument.

- c. If the oil level goes above the **MAX (6)** Level Mark, remove the **Drain Plug (8)** and drain the excess oil into a suitable container.
- d. Refit the **Oil Filler Plug (4)**.

3. Plug in both the **Rotary-Vane Pump** and the *TRACE DSQ*,
4. Restart the system.

### *Purging the Rotary-Vane Pump Oil*

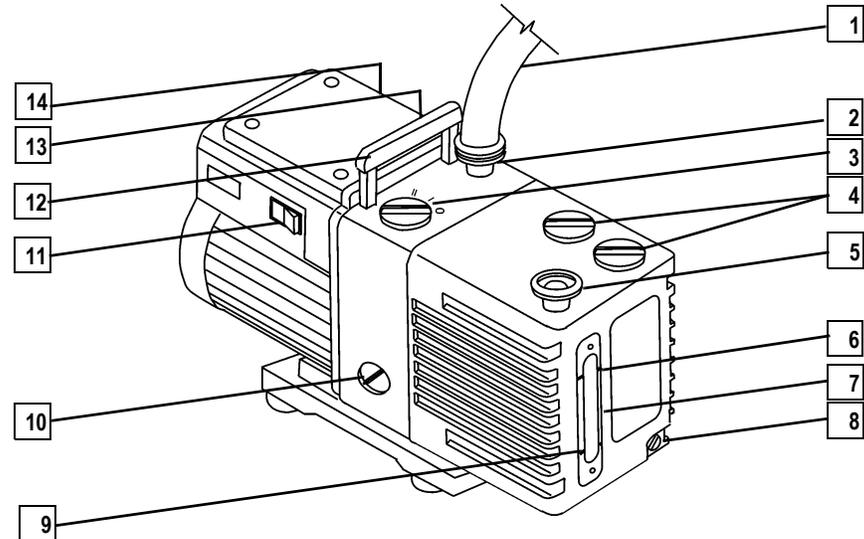
	<p><b>Tools Needed</b> None</p>
	<p><b>Frequency</b> When oil is discolored or cloudy.</p>

Purging (or decontaminating) the oil in the Rotary-Vane Pump removes dissolved gases and low-boiling-point liquids from the pump oil. Purge the pump oil if it is cloudy or discolored. You can purge the pump oil without interrupting system operation. However, do not purge the pump during an **acquisition**, or while the **Electron Multiplier** or **Filament** are on.

1. Make sure you are not in the middle of an **Acquisition** and the **Electron Multiplier** and **Filament** are OFF.

Use the **Xcalibur Tune** window to confirm these items are off.

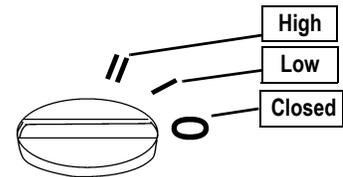
## 2. Prepare the **Rotary-Vane Pump** for purging.



1	Foreline Vacuum Hose	8	Drain Plug
2	Inlet Port	9	MIN (minimum level mark)
3	Gas-Ballast Control	10	Mode Selector
4	Oil Filler Plugs	11	On/Off Switch
5	Outlet Port	12	Handle
6	MAX (maximum level mark)	13	Voltage Indicator
7	Oil-Level Sight-glass	14	Electrical Inlet Connector

**Figure 2-41. Rotary-Vane Pump**

- a. Set the **Gas-Ballast Control (3)** to **Position I, Low Flow**.
- b. Leave it in that position for 10 minutes or until the oil is clear.
- c. If the oil remains cloudy or discolored after 10 minutes, change the oil (see **Changing the Rotary-Vane Pump Oil** on page 72).
- d. Set the **Gas-Ballast Control (3)** to **Position 0, Closed**.



## Changing the Rotary-Vane Pump Oil

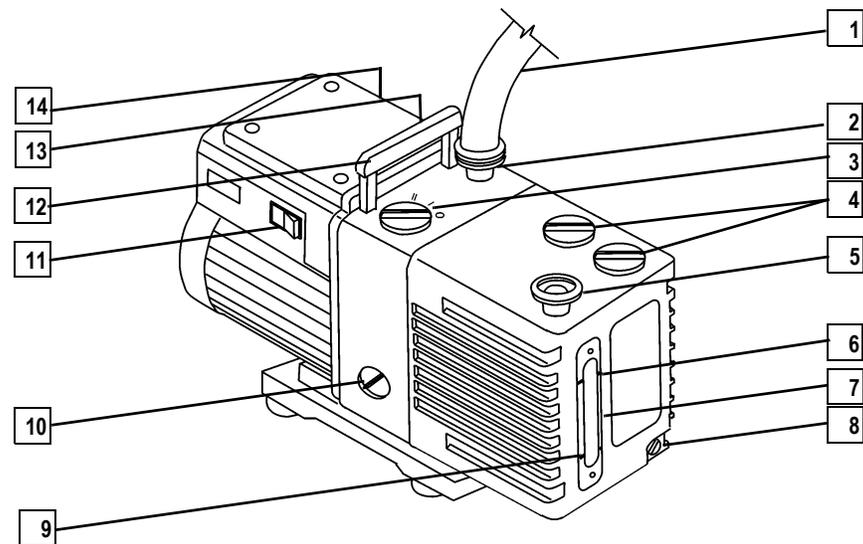
	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Gloves, latex, impermeable</li> <li>• Rotary-vane pump oil (PN A0301-15101)</li> <li>• Suitable container for removing spent oil</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• 4 months (or 3,000 hours)</li> <li>• Monthly, if you use ammonia</li> </ul>

You should change the rotary vane pump oil every four months (about 3,000 hours of operation). If you use ammonia as a chemical ionization reagent gas you should change the oil every month. Ammonia is highly basic and quickly damages seals in the rotary-vane pump. Purging the oil with the **Gas Ballast** also helps remove dissolved ammonia from the oil.

1. Prepare the *TRACE DSQ* for maintenance.  
Shut down and vent the *TRACE DSQ* (see **Shutting Down** on page 12).
2. Unplug the **Rotary-Vane Pump**.

**NOTE:** For best results, change the oil while the rotary-vane pump is still warm from operation. Be careful as the oil can be very hot if the pump was recently operated.

<p style="text-align: center;"><b>WARNING</b> Personal Injury</p>	
	<p><b>Electrical Shock Hazard</b> Shut down and unplug the detector and Rotary-Vane Pump before adding oil.</p>



1	Foreline Vacuum Hose	8	Drain Plug
2	Inlet Port	9	MIN (minimum level mark)
3	Gas-Ballast Control	10	Mode Selector
4	Oil Filler Plugs	11	On/Off Switch
5	Outlet Port	12	Handle
6	MAX (maximum level mark)	13	Voltage Indicator
7	Oil-Level Sight-glass	14	Electrical Inlet Connector

**Figure 2-42. Rotary-Vane Pump**

3. Disconnect the **Foreline Vacuum Hose (1)**.
4. Place the **Rotary-Vane Pump** on a bench.

**WARNING**  
**Personal Injury**



**Lifting Hazard**

Use proper lifting technique with the Rotary-Vane Pump. It weighs approximately 110 kg (50 lbs).

5. Drain the old oil.
- Remove one of the **Oil Filler Plugs (4)**.

CAUTION Personal Injury	
	<b>Material Hazard</b> Please wear impermeable laboratory gloves when changing oil.

- Using gloves, remove the **Drain Plug (8)**, and allow the oil to drain into a suitable container.
- Dispose of the spent oil according to local environmental regulations.
- Replace the **Drain Plug (8)**.

6. Add fresh oil.
- Add oil to the **Oil Filler Plug (4)** opening half way between the **MIN (9)** and **MAX (6)** level marks.
  - If the oil level goes above the **MAX (6)** level mark, remove the **Drain Plug (8)** and drain the excess oil from the pump.

7. Reassemble the **Rotary-Vane Pump**.
- Replace the **Oil Filler Plug (4)**.
  - Return the **Rotary-Vane Pump** to the floor.
  - Reconnect the **Foreline Vacuum Hose (1)**.

8. Plug in both the **Rotary-Vane Pump** and the *TRACE DSQ*.

9. Restart the system.

## 2.9 Replacing Parts

**NOTE:** Keep the packing materials that come with your instrument shipment for returning defective parts.

This section provides instructions for removing and replacing fuses, PCB's, and other assemblies found outside the Vacuum Manifold.

Table 2-1 provides a quick reference to the procedures contained in this section.

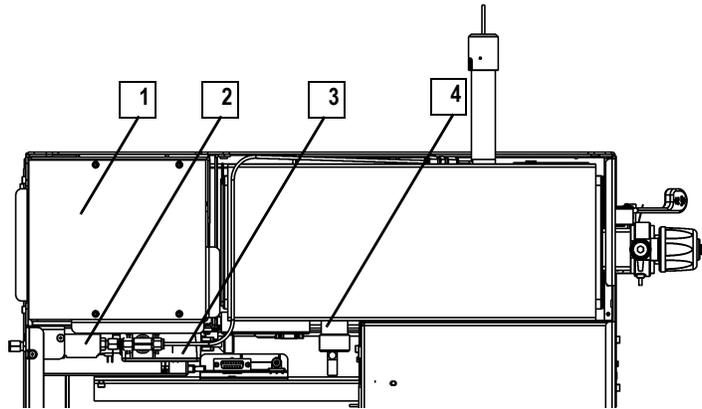
**Table 2-1. Replaceable Parts (Listed Alphabetically)**

Replaceable Parts
<a href="#">Replacing the Analog PCB</a> on page 81
<a href="#">Replacing the Analog PCB Fuse</a> on page 83
<a href="#">Refilling the Calibration Gas Flow Module</a> on page 85
<a href="#">Replacing the Calibration Gas Flow Module</a> on page 87
<a href="#">Replacing the CI Reagent Gas Flow Module (Upgrade Option)</a> on page 90
<a href="#">Replacing the Conversion Dynode/Electron Multiplier Power Supply</a> on page 93
<a href="#">Replacing the DC Driver Assembly</a> on page 95
<a href="#">Replacing the DC Driver Assembly Fuse</a> on page 97
<a href="#">Replacing the Digital PCB</a> on page 100
<a href="#">Replacing the Electrometer PCB</a> on page 102
<a href="#">Replacing the Forepressure Gauge and Foreline Adapter</a> on page 104
<a href="#">Replacing the Inlet Valve Seal</a> on page 106
<a href="#">Replacing the Ion Gauge (Upgrade Option)</a> on page 109
<a href="#">Replacing the Lens Interface PCB</a> on page 111
<a href="#">Replacing the Low Pass Filter PCB</a> on page 113
<a href="#">Replacing the Power Module</a> on page 118
<a href="#">Replacing the Power Module Fuses</a> on page 120
<a href="#">Replacing the Rear Cooling Fans</a> on page 122
<a href="#">Replacing the RF Detector PCB</a> on page 125
<a href="#">Replacing the RF Generator PCB</a> on page 127
<a href="#">Replacing the RF Generator PCB Fuses</a> on page 129
<a href="#">Replacing the Transfer Line</a> on page 132
<a href="#">Replacing the Turbomolecular Pump Power Supply</a> on page 134
<a href="#">Replacing the Vacuum Control PCB</a> on page 136
<a href="#">Replacing the Vent Valve Solenoid</a> on page 139

## Quick Overview-Parts Located by Covers

The following illustrations give you a quick overview to replaceable parts found beneath the covers or the back of the detector.

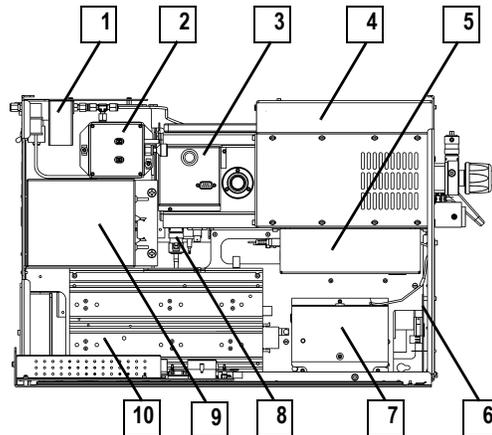
### Under the Top Cover



1	Power Module	3	Calibration Gas Flow Module
2	CI Reagent Gas Flow Module (Upgrade Option)	4	Ion Gauge (Upgrade Option)

**Figure 2-43. Replaceable Parts (Top)**

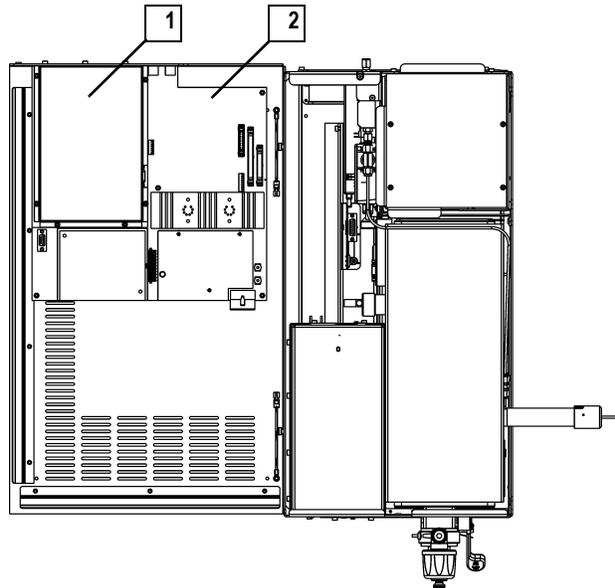
### Behind the Left Cover



1	CI Reagent Gas Flow Module	6	Vacuum Control PCB
2	Calibration Gas Flow Module	7	DC Driver Assembly
3	Electrometer PCB	8	Vent Valve Solenoid
4	RF Detector PCB (Covered)	9	Conversion Dynode/Electron Multiplier Power Supply
5	Low Pass Filter PCB (Covered)	10	RF Generator PCB

**Figure 2-44. Replaceable Parts (Left Side)**

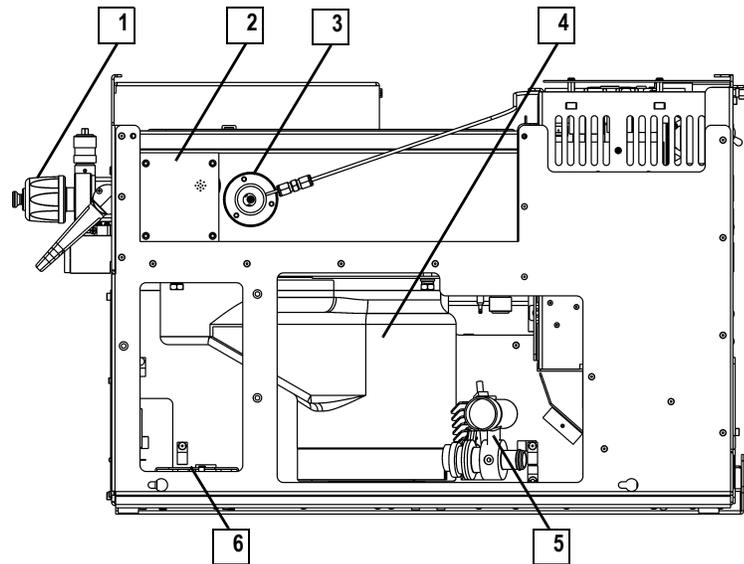
## Under the Left Cover



1	Digital PCB	2	Analog PCB
---	-------------	---	------------

**Figure 2-45. Replaceable Parts (Left Side Panel, Top)**

## Under the Right Cover



1	Inlet Valve	4	High Vacuum Pump
2	Lens Interface PCB	5	Forepressure Gauge and Foreline Adapter
3	Transfer Line	6	Turbomolecular Pump Power Supply

**Figure 2-46. Replaceable Parts (Right Side)**

## Behind the Detector

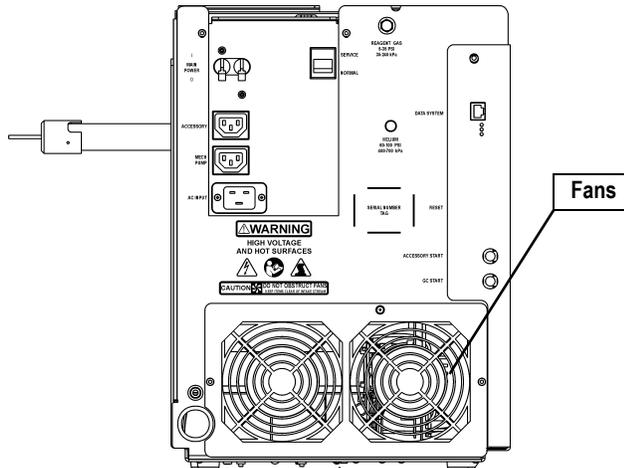
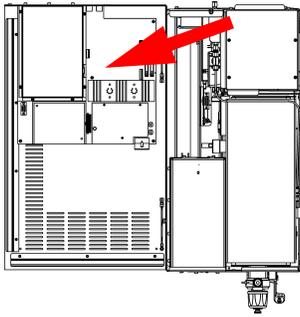


Figure 2-47. Replaceable Parts (Back)



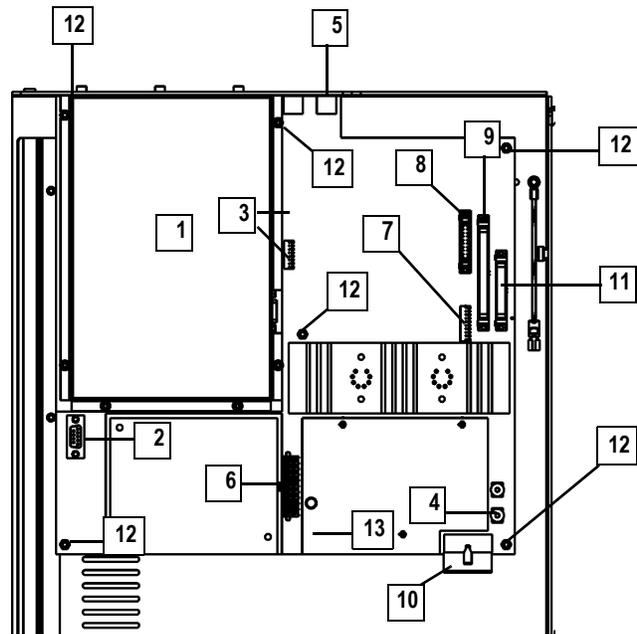
## Replacing the Analog PCB

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Analog PCB (PN 119590-0020)</li> <li>• Nut driver, 5.5 mm</li> <li>• Wrench, Allen, 2.5 mm</li> <li>• Wrench, Allen, 3 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see [Shutting Down](#) on page 12).

<b>WARNING</b> <b>Personal Injury</b>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

2. Remove the **Analog PCB**.
  - b. Remove the *TRACE DSQ* front, top and left side covers (see [Removing the Covers](#) on page 21).

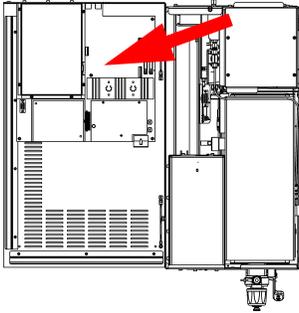


1	Digital PCB	8	Cable P7 (to Electron Multiplier/ Conversion Dynode Power Supply)
2	Cable J1 (to RF Control PCB)	9	Cable P8 (to RF Generator PCB)
3	Cables P4/P5 (to DC Driver Assembly)	10	Cable P9 (to Power Module)
4	Cable J3 (to Low Pass Filter PCB)	11	Cable P10 (to Vacuum Control PCB)
5	Cable J5 (to GC)	12	Nuts Holding the PCB
6	Cable P2 (to Lens Interface PCB)	13	Analog PCB
7	Cable P6 (to CI Reagent Gas Flow Module)		

**Figure 2-48. Analog PCB (Left Side Panel, Top)**

- a. Remove the **Digital PCB (1)** (see [Replacing the Digital PCB](#) on page 100).
- b. Disconnect **Cables (2, 3, 4, 5, 6, 7, 8, 9, 10, 11)**.
- c. Remove the six **Nuts Holding the PCB (12)**.
- d. Remove the **Analog PCB (13)**.

3. Install the new **Analog PCB**.
4. Restore the *TRACE DSQ* for operation.
  - a. Replace the left, top, and front covers of the *TRACE DSQ*.
  - b. Restart the system.



### Replacing the Analog PCB Fuse

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>Analog PCB Fuse F1 (PN 76339-0008; 2 A, very fast microfuse, 125 V)</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>Only when indicated by Xcalibur Diagnostics, or</li> <li>Technical Support, or</li> <li>Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

<b>WARNING</b> <b>Personal Injury</b>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- b. Remove the *TRACE DSQ* front, top and left side covers (see **Removing the Covers** on page 21).

## 2. Replace the **Analog PCB Fuse**.

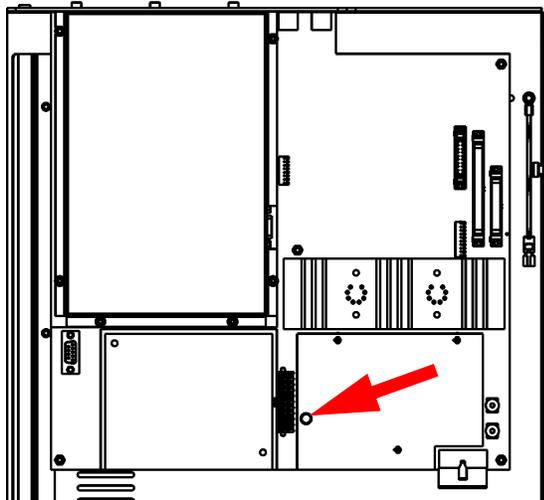


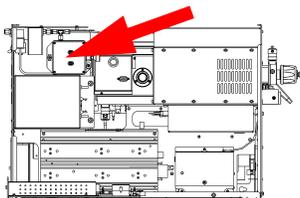
Figure 2-49. Analog PCB Fuse (Left Side Panel, Top)

### CAUTION Instrument Damage



Use only the fuses specified else instrument damage will occur. Never replace a fuse with a fuse of a different type, voltage, or current rating. Also, to prevent damaging the PCBs attach an electrostatic discharge (ESD) strap to your wrist before replacing a fuse.

- a. Unplug the **Analog PCB Fuse (2)**.
  - b. Plug in the new **Analog PCB Fuse (2)**. It does not matter which way it is plugged in.
- ## 3.
- a. Replace the left, top, and front covers of the *TRACE DSQ*.
  - b. Restart the system.



## Refilling the Calibration Gas Flow Module

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• FC-43 calibration compound (PN 50010-30059)</li> <li>• Syringe</li> <li>• Wrench, open-ended, 9/16-in.</li> </ul>
	<p><b>Frequency</b> When Calibration Compound Vial is empty (about once a year).</p>

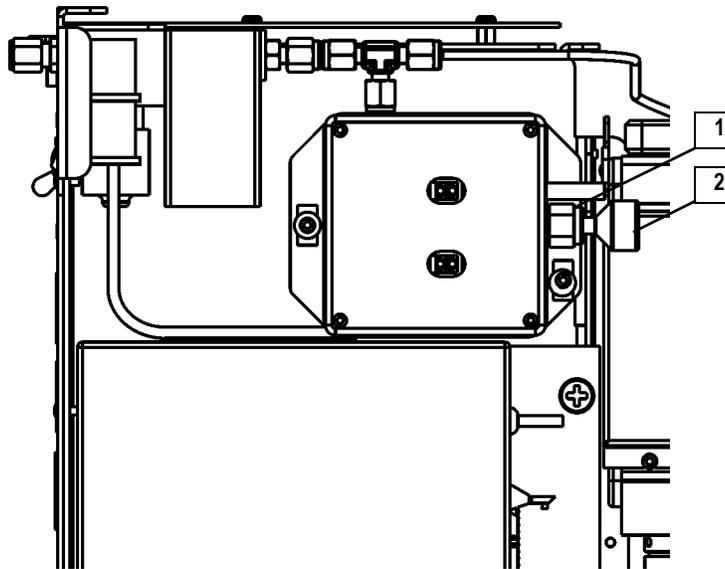
Calibration compound is a liquid whose mass spectrum is used to tune and calibrate the detector. The *TRACE DSQ* uses FC-43 as its calibration compound.

You cannot tell by sight whether calibration compound needs to be added. However, during Xcalibur Automatic Tune an error message displays “the intensity of calibration gas ions is *too low*.” There are many factors that can cause a shortage of calibration gas ions besides a decrease in calibration compound. As a rule, the detector should never require adding calibration compound more than once a year.

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

<b>WARNING</b> <b>Personal Injury</b>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- b. Remove the *TRACE DSQ* front, top, and left side covers (see **Removing the Covers** on page 21).
2. Remove the **Calibration Gas Vial**.



1	Nut and Ferrule	2	Calibration Compound Vial
---	-----------------	---	---------------------------

**Figure 2-50. Calibration Gas Flow Module (Left Side)**

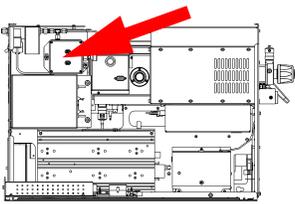
- a. Unscrew the **Nut and Ferrule (1)**.
  - b. Remove the **Calibration Compound Vial (2)**.
3. Fill the **Calibration Compound Vial**.
- a. Fill a syringe with 0.1 mL of **Calibration Compound**.
  - b. Insert the syringe into the **Calibration Compound Vial (2)** until you touch the white frit at the bottom of the vial.
  - c. Inject the **Calibration Compound** into the frit. The frit absorbs the **Calibration Compound**. If you see liquid pooled on top of the frit, pour out the excess liquid according to local environmental regulations.

**CAUTION**  
**Instrument Damage**



Adding more than 0.1 mL of Calibration Compound can result in damage to the Calibration Gas Flow Module. Be sure liquid does not pour into the module when you install the vial.

4. Replace the **Calibration Compound Vial (2)**.  
Be sure not to overtighten the **Nut and Ferrule (1)**.
5. Restore the *TRACE DSQ* for operation.
  - d. Replace the left, top, and front covers of the *TRACE DSQ*.
  - e. Restart the system.



### Replacing the Calibration Gas Flow Module

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Calibration Gas Flow Module (PN 119246-0001)</li> <li>• FC-43 calibration compound (PN 50010-30059)</li> <li>• Syringe</li> <li>• Wrench, Allen, 3 mm</li> <li>• Wrench, open-ended, 7/16-in.</li> <li>• Wrench, open-ended, 9/16-in.</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

<p><b>WARNING</b> <b>Personal Injury</b></p>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- b. Remove the *TRACE DSQ* front, top, left, and right side covers (see **Removing the Covers** on page 21).

- c. Turn off the **CI Reagent Gas Supply** (if present).

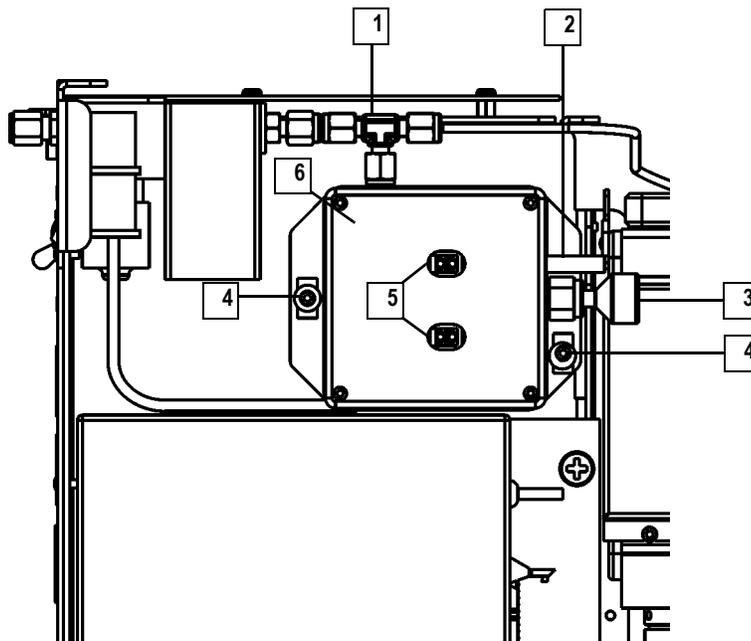
**WARNING**  
Personal Injury



**Explosive or Corrosive Gas Hazard**

CI reagent gases are often flammable or corrosive. You must vent the gas to a fume hood or other suitable exhaust. The CI reagent gas supply line must be leak tight.

- 2. Remove the **Calibration Gas Flow Module**.



1	Gas Fittings	4	Screws, 2
2	Foreline Adapter Tubing	5	Cables, 4
3	Calibration Compound Vial	6	Calibration Gas Flow Module

**Figure 2-51. Calibration Gas Flow Module (Left Side)**

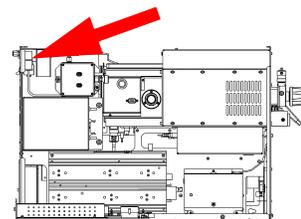
- a. Disconnect the **Gas Fittings (1)**.
- b. Disconnect the **Foreline Adapter Tubing (2)** from the **Foreline Adapter** down by the **High Vacuum Pump**.
- c. Disconnect the four **Cables (5)**.

- d. Remove the two **Screws (4)**.
- e. Remove the **Calibration Gas Flow Module (6)**.
3. Install the new **Calibration Gas Flow Module**.
4. Add **Calibration Compound**.
5. Test the **Gas Fittings (1)** for leaks.
  - a. Turn on the **CI Reagent Gas Supply**.
  - b. Use a leak detector to check each fitting for leaks.

<b>CAUTION</b> Instrument Damage	
	Do not use liquid soap leak detectors (such as Snoop) to check for leaks. Liquid soap leak detectors may contaminate your system.

- c. Correct leaks by tightening or replacing the connections. Continue to check and correct leaks until all connections are leak-free.
6. Restore the *TRACE DSQ* for operation.
  - a. Turn on the **CI Reagent Gas Supply** (if present).
  - b. Replace the right, left, top, and front covers of the *TRACE DSQ*.
  - c. Restart the system.
  - d. Once the detector has pumped down and is operational, check for vacuum leaks using the Automatic Tune.

## Replacing the CI Reagent Gas Flow Module (Upgrade Option)



	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• CI Reagent Gas Flow Module (PN 23331-0091)</li> <li>• Electronic Leak Detector (GL Sciences, Inc., model LD-228, or equivalent)</li> <li>• Screwdriver, Phillips #2</li> <li>• Wrench, open-ended, 7/16-in. (2)</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

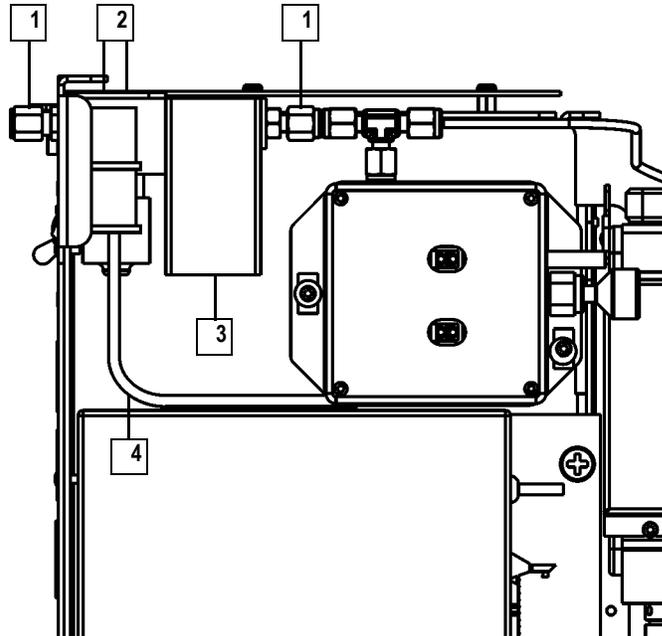
1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

WARNING Personal Injury	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- b. Remove the *TRACE DSQ* front, top, left, and right side covers (see **Removing the Covers** on page 21).
  - c. Turn off the **CI Reagent Gas Supply**.

WARNING Personal Injury	
	<p><b>Explosive or Corrosive Gas Hazard</b> CI reagent gases are often flammable or corrosive. You must vent the gas to a fume hood or other suitable exhaust. The CI reagent gas supply line must be leak tight.</p>

## 2. Remove the **CI Reagent Gas Flow Module**.



1	Gas Fittings, 2	3	Cable (to Analog PCB)
2	Screws Holding the Module, 2	4	Foreline Adapter Tubing

**Figure 2-52. CI Reagent Gas Flow Module (Left Side)**

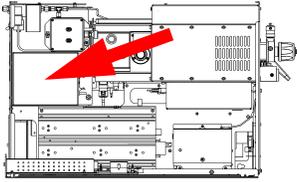
## 3. Install the new **CI Reagent Gas Flow Module**.

- a. Unplug the **Cable (3)**.
- b. Disconnect the two **Gas Fittings (1)**.
- c. Disconnect the **Foreline Adapter Tubing (4)**.
- d. Remove the two **Screws Holding the Module (2)**.

4. Test the **Gas Fittings (1)** for leaks.
  - a. Turn on the **CI Reagent Gas Supply**.
  - b. Use a detector to check each fitting for leaks.

<b>CAUTION</b> Instrument Damage	
	Do not use liquid soap leak detectors (such as Snoop) to check for leaks. Liquid soap leak detectors may contaminate your system.

- c. Correct leaks by tightening or replacing the connections. Continue to check and correct leaks until all connections are leak-free.
5. Restore the *TRACE DSQ* for operation.
  - a. Replace the left, top, and front covers of the *TRACE DSQ*.
  - b. Restart the system.
  - c. Once the detector has pumped down and is operational, check for vacuum leaks using the Automatic Tune.



## Replacing the Conversion Dynode/Electron Multiplier Power Supply

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Conversion Dynode/Electron Multiplier Power Supply (PN 119377-0001 or 119377-0002 with the PPINICI Upgrade Option)</li> <li>• Screwdriver, Phillips #2</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

### WARNING Personal Injury

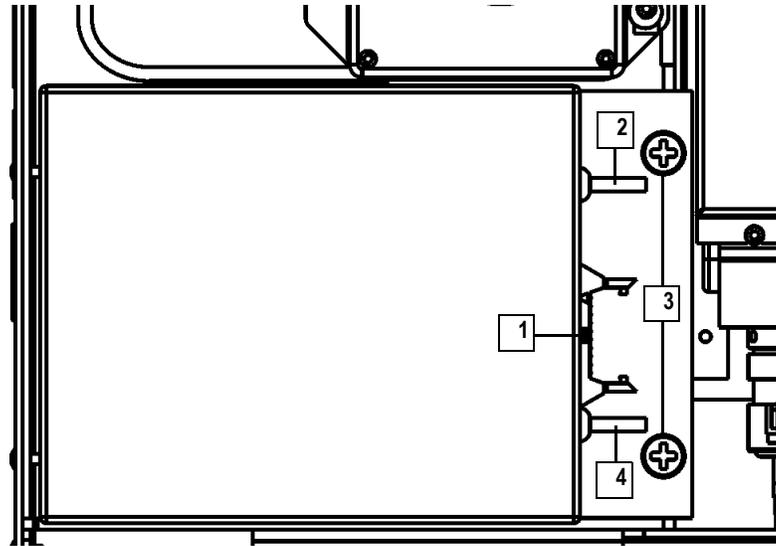


**Electrical Shock Hazard**

Please unplug the detector before proceeding.

- b. Remove the *TRACE DSQ* front, top and left side covers (see **Removing the Covers** on page 21).

2. Remove the **Conversion Dynode/Electron Multiplier Power Supply**.



1	Ribbon Cable	3	Screws Holding the Power Supply
2	Electron Multiplier Cable	4	Conversion Dynode Cable

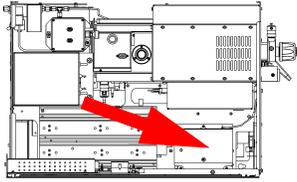
Figure 2-53. Conversion Dynode/Electron Multiplier Power Supply (Left Side)

- a. Disconnect the **Ribbon Cable (1)**.
- b. Disconnect the **Electron Multiplier Cable (2)** from the bottom of the **Vacuum Manifold**.
- c. Disconnect the **Conversion Dynode Cable (4)** from the bottom of the **Vacuum Manifold**.
- d. Remove the two large **Screws Holding the Power Supply (3)**.

3. Install the new **Conversion Dynode/Electron Multiplier Power Supply**.

4. Restore the *TRACE DSQ* for operation.

- a. Replace the left, top, and front covers of the *TRACE DSQ*.
- b. Restart the system.



## Replacing the DC Driver Assembly

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• DC Driver Assembly (PN 120152-1000)</li> <li>• Wrench, Allen, 2.5 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1.

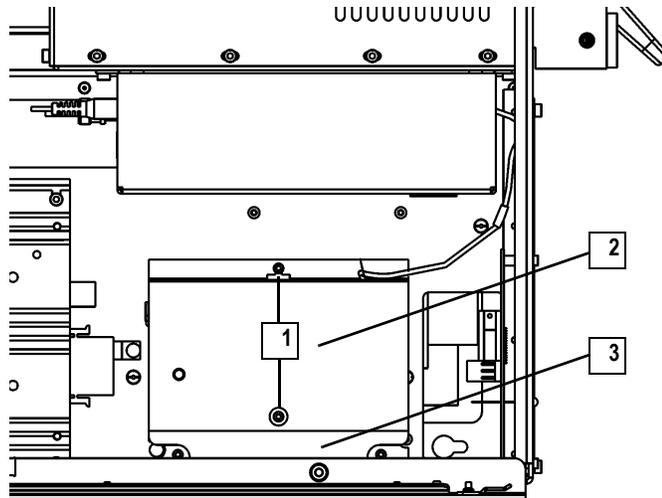
Prepare the *TRACE DSQ* for maintenance.

- a. Shut down and vent the system (see **Shutting Down** on page 12).

<p><b>WARNING</b> Personal Injury</p>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- b. Remove the *TRACE DSQ* front, top and left side covers (see **Removing the Covers** on page 21).

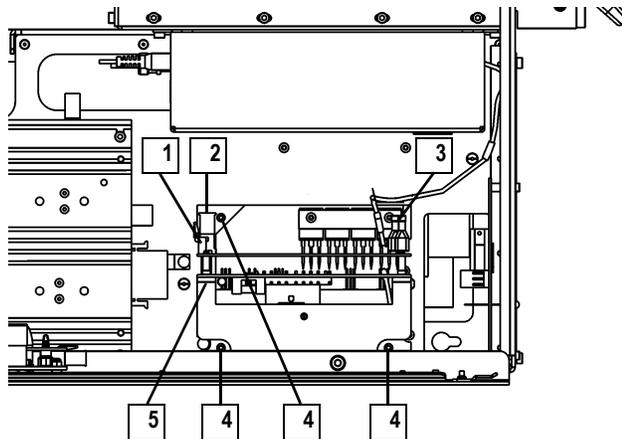
2. Remove the **DC Driver Assembly**.



1	Screws Holding the DC Driver Cover, 2	3	DC Driver Assembly
2	DC Driver Cover		

Figure 2-54. DC Driver Assembly (Left Side)

- a. Remove the two **Screws Holding the DC Driver Cover (1)**.
- b. Remove the **DC Driver Cover (2)**.



1	Cable J8 (to Analog PCB)	4	Screws Holding DC Driver Assembly, 3
2	Cable J2 (to RF Detector PCB)	5	Cable P1 (to Power Module)
3	Cables J3, J4, J7 (to Low Pass Filter PCB)		

Figure 2-55. DC Driver Assembly with Cover Removed (Left Side)

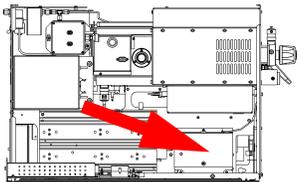
- c. Disconnect **Cables (1, 2, 3, 5)**.
- d. Remove the three **Screws Holding the DC Driver Assembly (4)**.

### 3. Install the new **DC Driver Assembly**.

- a. Reverse Step 2. The green **Cable** to the DC Driver Assembly goes on the left terminal (J7), black **Cable** goes to J4, and red **Cable** goes to J3.

Restore the *TRACE DSQ* for operation.

- a. Replace the left, top, and front covers of the *TRACE DSQ*.
- b. Restart the system.



### Replacing the DC Driver Assembly Fuse

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• DC Driver Assembly Fuse F1 (PN 76703-0125; 1.25 A, SB, 5 x 20 mm, 250 V)</li> <li>• Wrench, Allen, 2.5 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

### 1. Prepare the *TRACE DSQ* for maintenance.

- a. Shut down and vent the system (see **Shutting Down** on page 12).

WARNING Personal Injury	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- b. Remove the *TRACE DSQ* front, top and left side covers (see **Removing the Covers** on page 21).

2. Remove the **DC Driver Assembly Cover**.

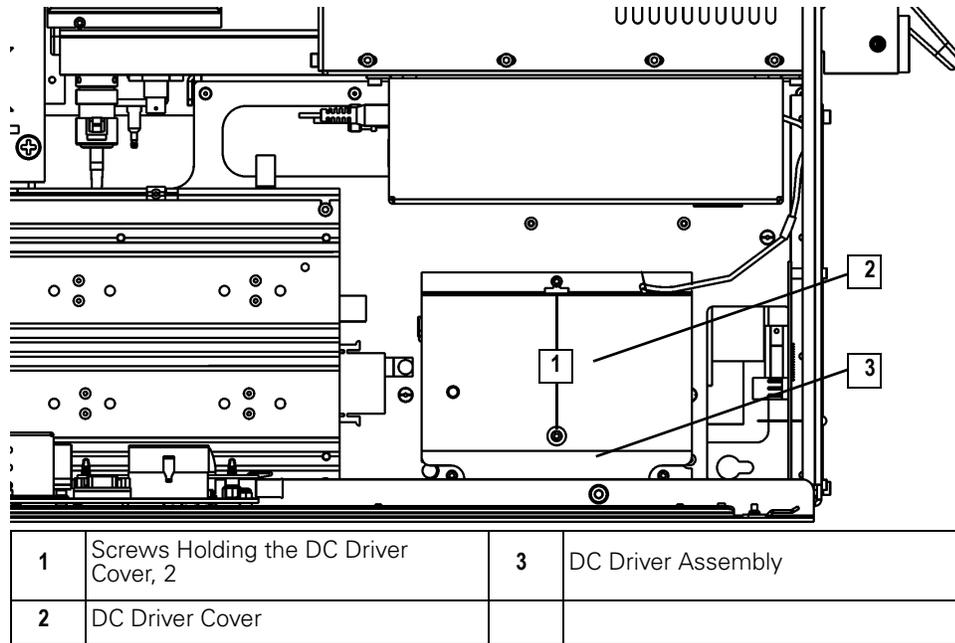


Figure 2-56. DC Driver Assembly (Left Side)

- a. Remove the two **Screws Holding the DC Driver Cover (1)**.
- b. Remove the **DC Driver Cover (2)**.

3. Replace the **DC Driver Assembly Fuse**.

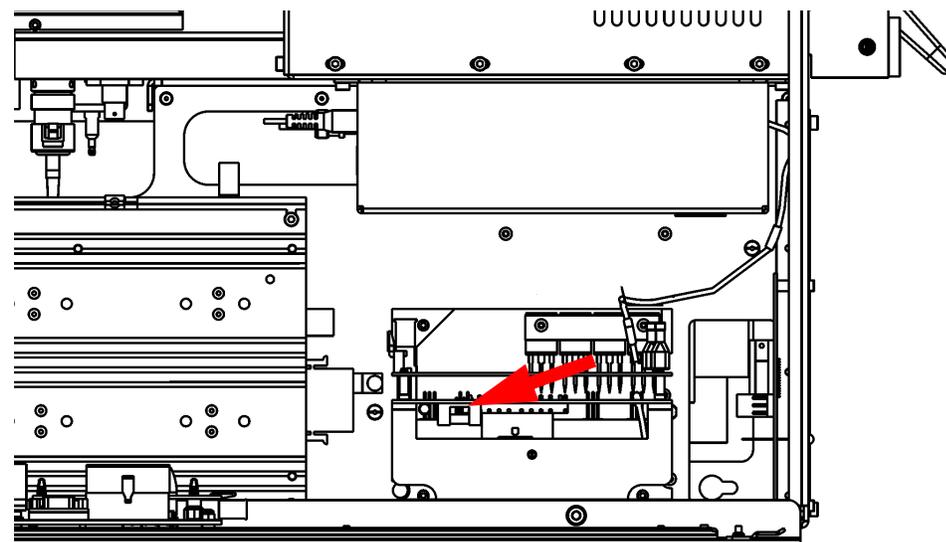


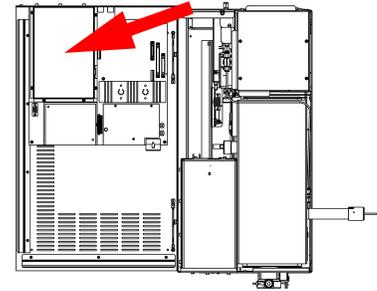
Figure 2-57. DC Driver Assembly Fuse (Left Side)

- a. Unplug the **DC Driver Assembly Fuse**.
- b. Plug in the new **DC Driver Assembly Fuse**. It does not matter how it is plugged in.

<b>CAUTION</b> <b>Instrument Damage</b>	
	Use only the fuses specified else instrument damage will occur. Never replace a fuse with a fuse of a different type, voltage, or current rating. Also, to prevent damaging the PCBs attach an electrostatic discharge (ESD) strap to your wrist before replacing a fuse.

4. Replace the **DC Driver Assembly Cover**.
5. Restore the *TRACE DSO* for operation.
  - a. Replace the left, top, and front covers of the *TRACE DSO*.
  - b. Restart the system.

## Replacing the Digital PCB

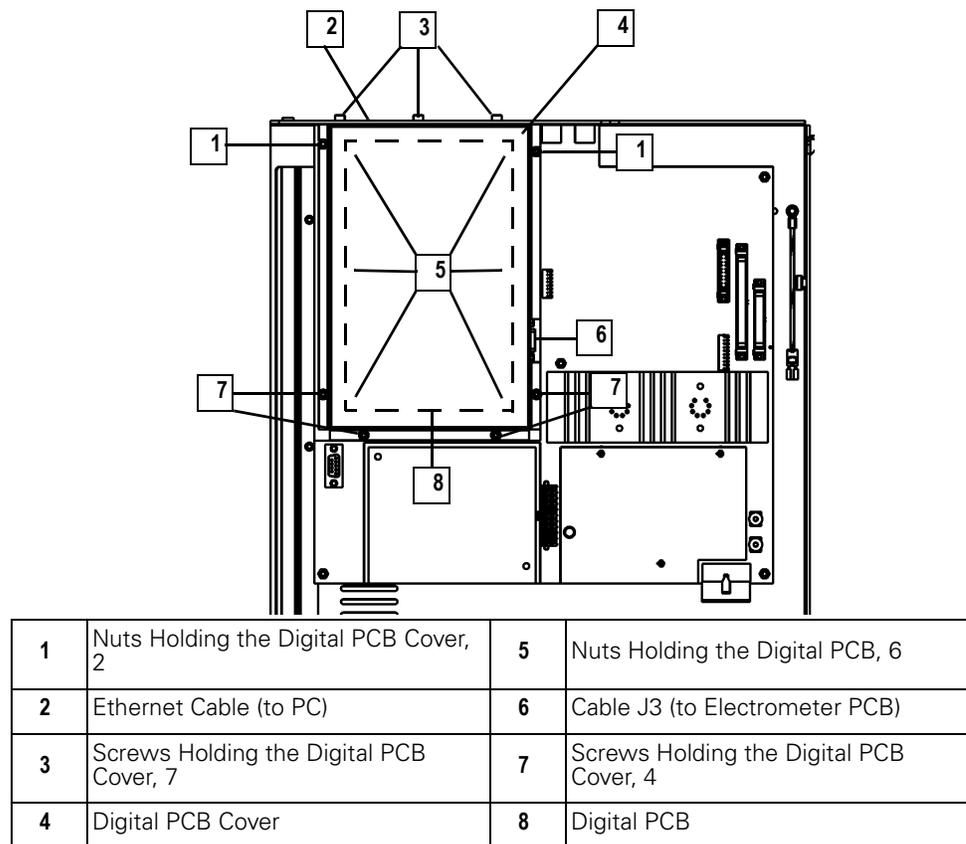


	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Digital PCB (PN 119590-0010)</li> <li>• Nut driver, 5.5 mm</li> <li>• Wrench, Allen, 2.5 mm</li> <li>• Wrench, Allen, 3 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

<b>WARNING</b> <b>Personal Injury</b>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

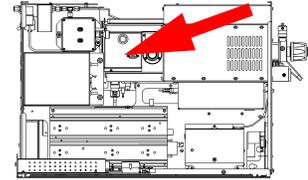
- b. Remove the *TRACE DSQ* front, top and left side covers (see **Removing the Covers** on page 21).
2. Remove the **Digital PCB**.



**Figure 2-58. Digital PCB (Left Side Panel, Top)**

- a. Unplug the **Cables (2, 6)**.
  - b. Remove the seven **Screws Holding the Digital PCB Cover (3)**.
  - c. Remove the two **Nuts Holding the Digital PCB Cover (1)**.
  - d. Remove the **Digital PCB Cover (4)**.
  - e. Remove the six **Nuts Holding the Digital PCB (5)**.
  - f. Carefully remove the **Digital PCB (8)**.
3. Install the new **Digital PCB**.
  4. Restore the *TRACE DSO* for operation.
    - a. Replace the left, top, and front covers of the *TRACE DSO*.
    - b. Restart the system.

## Replacing the Electrometer PCB



	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Electrometer PCB (PN 119590-0101)</li> <li>• Screwdriver, Phillips #1</li> <li>• Wrench, Allen, 3 mm</li> <li>• Wrench, open-ended, 17 mm</li> <li>• Wrench, open-ended, 9/16-in.</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

<p><b>WARNING</b> Personal Injury</p>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- b. Remove the *TRACE DSQ* front, top and left side covers (see **Removing the Covers** on page 21).
2. Remove the **Electrometer PCB**.

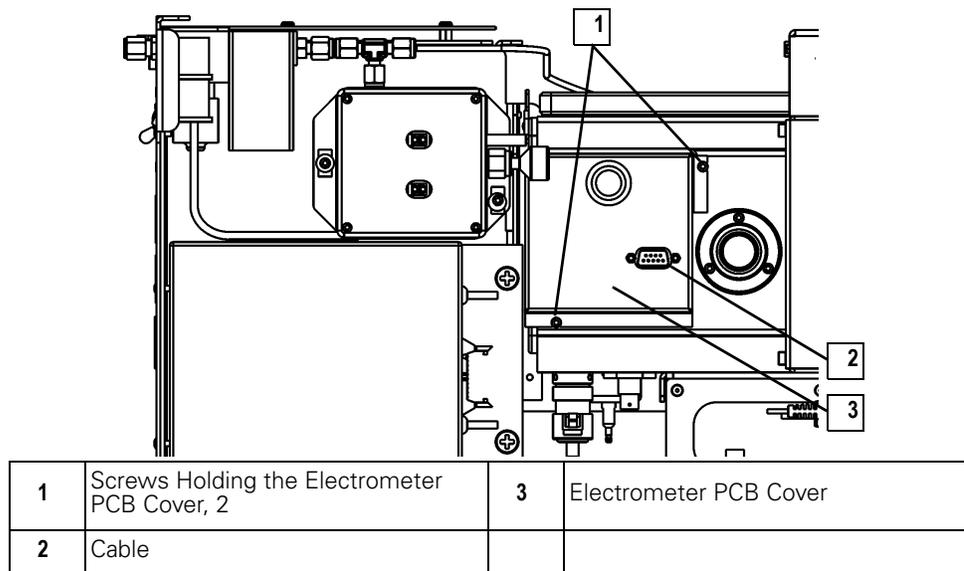


Figure 2-59. Electrometer PCB (Left Side)

- a. Disconnect the **Cable (2)**.
- b. Remove the two **Screws Holding the Electrometer PCB Cover (1)** in place and remove the **Electrometer PCB Cover (3)**.

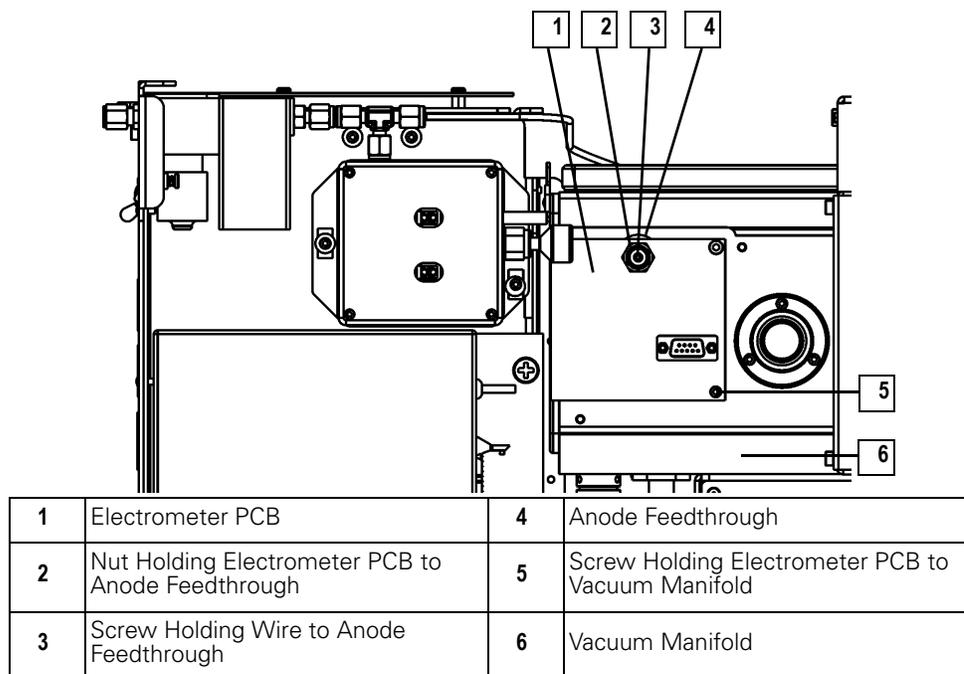
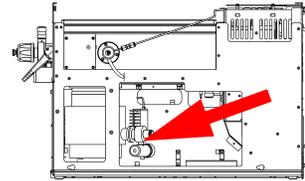


Figure 2-60. Electrometer PCB with Electrometer PCB Cover Removed (Left Side)

3.  
4.

- c. Remove the **Screw Holding the Wire to Anode Feedthrough (3)**.
  - d. Remove the **Nut Holding Electrometer PCB to Anode Feedthrough (2)**.
  - e. Remove the **Screw Holding Electrometer PCB to Vacuum Manifold (5)** and pull out the **Electrometer PCB (1)**.
- Install the new **Electrometer PCB**.
- Restore the *TRACE DSQ* for operation.
- a. Replace the left, top, and front covers of the *TRACE DSQ*.
  - b. Restart the system.

*Replacing the Forepressure Gauge and Foreline Adapter*



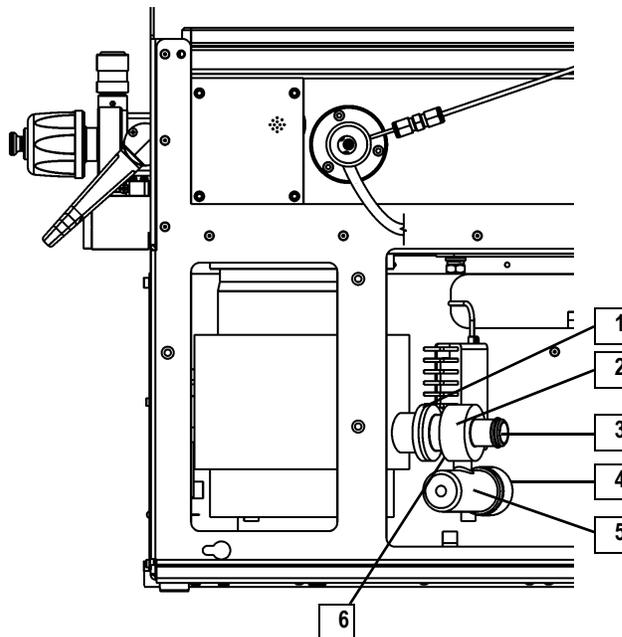
	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Forepressure gauge and foreline adapter - 250 L/s and split-flow turbomolecular pump systems (PN 119259-0002)</li> <li>• Forepressure gauge and foreline adapter - 70 L/s turbomolecular pump system (PN 119259-0003)</li> <li>• lint-free paper</li> <li>• Screwdriver, flat blade</li> <li>• Wrench, adjustable</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSO* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

<b>WARNING</b> <b>Personal Injury</b>	
	<b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.

- b. Remove the *TRACE DSO* front, top and right side covers (see **Removing the Covers** on page 21).

2. Remove the **Forepressure Gauge and Foreline Adapter**.



1	Foreline Adapter Clamp and O-Ring (not shown)	4	Forepressure Gauge Cable (not shown)
2	Foreline Adapter	5	Forepressure Gauge
3	Foreline Hose Clamp (not shown)	6	Foreline Tubing (not shown)

**Figure 2-61. Forepressure Gauge and Foreline Adapter (Right Side)**

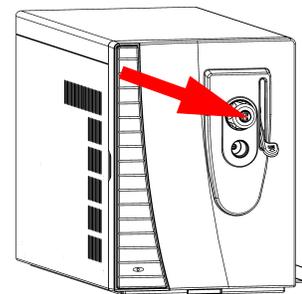
- a. Disconnect the **Forepressure Gauge Cable (4)** from the **Forepressure Gauge (5)**.
- b. Disconnect the **Foreline Tubing (6)** from the Gold Fitting on the **Foreline Adapter (2)**.
- c. Remove the **Foreline Adapter Clamp (1)**.
- d. Remove the **Foreline Hose Clamp (3)**.
- e. Remove the **Forepressure Gauge and Foreline Adapter (2, 5)**.

3. Install the new **Forepressure Gauge and Foreline Adapter**.

4. Restore the *TRACE DSQ* for operation.

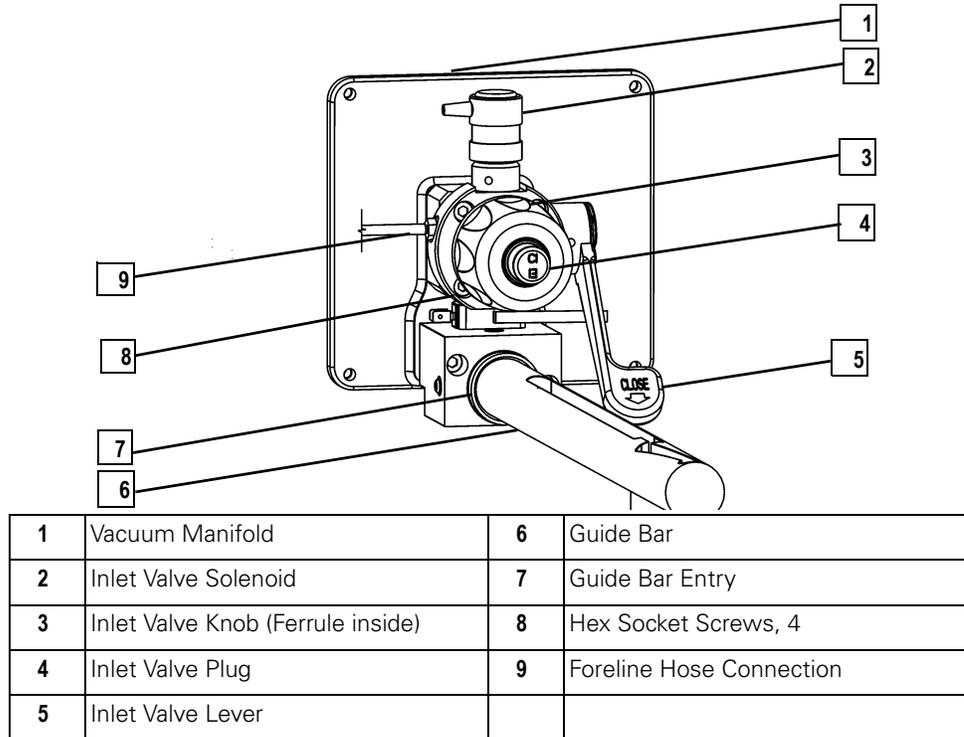
- a. Replace the right, top, and front covers of the *TRACE DSQ*.
- b. Restart the system.

### Replacing the Inlet Valve Seal



	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Inlet Valve Seal Kit, includes: Inlet Valve Seal &amp; Inlet Seal Removal Tool (PN 119265-0003)</li> <li>• Lint-free cloth</li> <li>• Wrench, Allen, 4 mm</li> <li>• Wrench, open-ended, 5/16-in.</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• When the seal is leaking, indicated by the Xcalibur Insert/Probe graph (the line is not in the Green, but positioned in the Red or Yellow)</li> <li>• Tightening the Seal with the Knob doesn't help</li> <li>• Seal is worn, thin, or cracked</li> </ul>

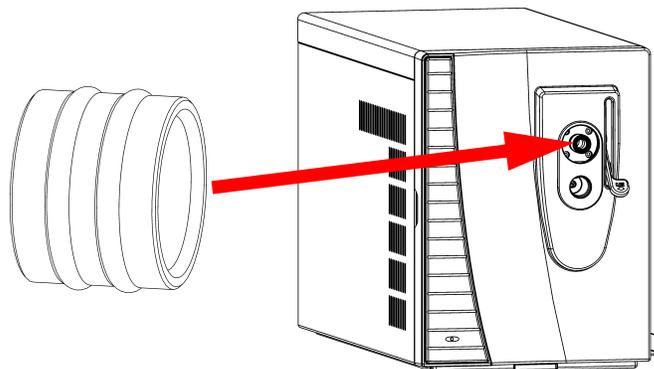
## 1. Disassemble the **Inlet Valve**.



**Figure 2-62. Inlet Valve Components**

- a. Make sure the **Inlet Valve** is closed (pull down the **Inlet Valve Lever (5)**).
- b. Remove the **Inlet Valve Plug (4)**, **Knob (3)**, and **Ferrule (3)**.

## 2. Remove and Replace the **Inlet Valve Seal**.



**Figure 2-63. Inlet Valve Seal**

- a. Insert the **Inlet Seal Removal Tool** into the **Inlet Valve**.



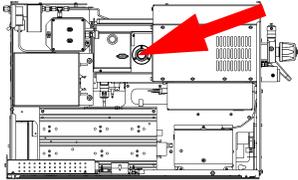
- b. Press the button on the tool to engage the **Inlet Valve Seal**.

<b>CAUTION</b> Instrument Damage	
	Use the supplied Inlet Seal Removal Tool only to keep from scratching the sealing surface.

### 3.

Reassemble the **Inlet Valve**.

- a. Put the **Ferrule, Knob** and **Plug** back into the **Inlet Valve Opening**.
- b. The first time you use the **Inlet Valve**, you will need to tighten the **Inlet Valve Knob** more than usual to prevent it from leaking.



## Replacing the Ion Gauge (Upgrade Option)

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Gloves, clean, lint- and powder-free</li> <li>• Ion gauge (PN A0105-06003)</li> <li>• Wrench, Allen, 3 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSO* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

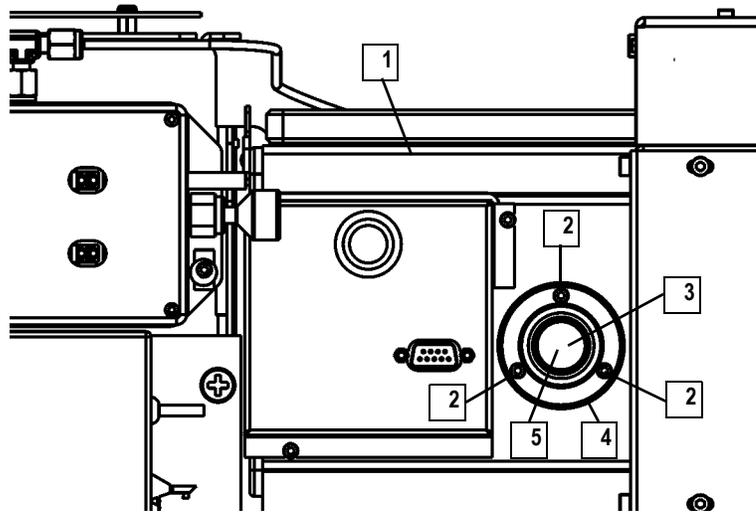
### WARNING Personal Injury



**Electrical Shock Hazard**  
Please unplug the detector before proceeding.

- b. Remove the *TRACE DSO* front, top and left side covers (see **Removing the Covers** on page 21).

2. Remove the **Ion Gauge**.



1	Vacuum Manifold	4	Ion Gauge Collar
2	Screws Holding the Ion Gauge Collar, 3	5	Ion Gauge and O-Ring
3	Cable (to Ion Gauge Control PCB)		

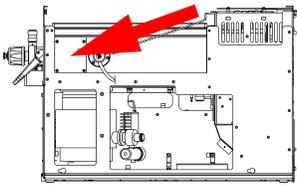
Figure 2-64. Ion Gauge (Left Side)

- a. Disconnect the **Cable (3)**.
- b. Remove the three **Screws Holding the Ion Gauge Collar (2)**.
- c. Remove the **Ion Gauge Collar (4)** and **Ion Gauge (5)** together.
- d. Pull the **Ion Gauge (5)** out of the **Ion Gauge Collar (4)**. Wearing gloves, hold on to the **O-Ring (5)**.

3. Install the new **Ion Gauge**.

- a. Insert the new **Ion Gauge (5)** into the **Ion Gauge Collar (4)**. Slip the **O-Ring (5)** over the end of the **Ion Gauge (5)**.
- b. Push the **Ion Gauge (5)** all the way into the **Vacuum Manifold (1)**. Turn it so the **Cable (3)** will point straight down.
- c. Replace the three **Screws Holding the Ion Gauge Collar (2)**.
- d. Reconnect the **Cable (3)**.

4. Restore the *TRACE DSQ* for operation.
  - a. Replace the left, top, and front covers of the *TRACE DSQ*.
  - b. Restart the system.
  - c. Once the detector has pumped down and is operational, check for vacuum leaks using the Automatic Tune.



### Replacing the Lens Interface PCB

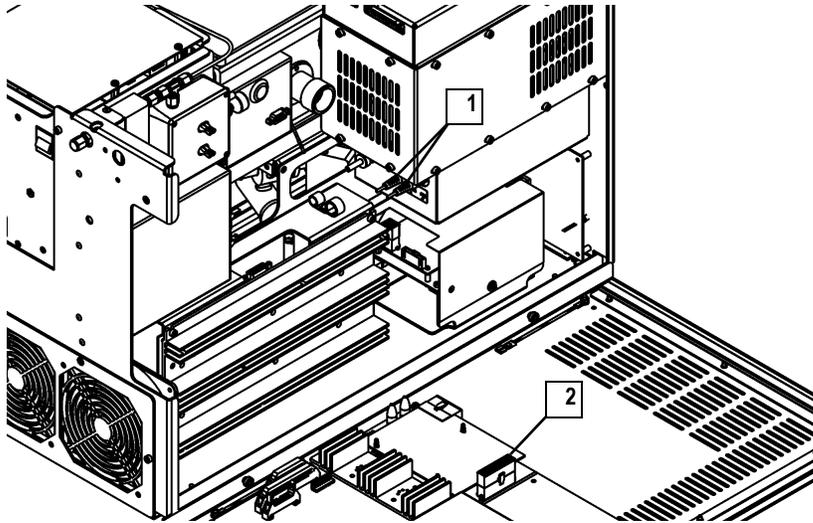
	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Lens Interface PCB (PN 119590-0110)</li> <li>• Wrench, Allen, 3 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

<b>WARNING</b> <b>Personal Injury</b>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- b. Remove the *TRACE DSQ* front, top and left, and right side covers (see **Removing the Covers** on page 21).

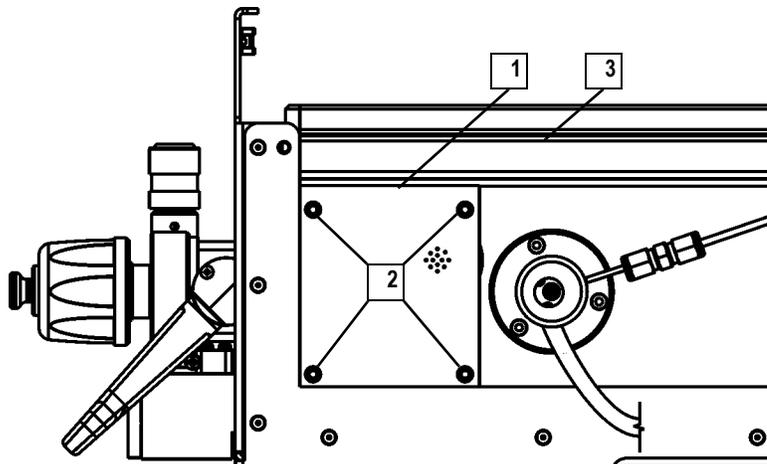
2. Remove the **Lens Interface PCB**.



1	Cables to Low Pass Filter PCB	2	Cable to Analog PCB
---	-------------------------------	---	---------------------

**Figure 2-65. Lens Interface PCB Connections to Analog and Low Pass Filter PCBs (Left Side)**

- a. Disconnect the **Cables to the Low Pass Filter PCB (1)**.
- b. Disconnect the **Cable to the Analog PCB (2)**.



1	Lens Interface PCB	3	Vacuum Manifold
2	Screws Holding the Lens Interface PCB, 4		

**Figure 2-66. Lens Interface PCB (Right Side)**

c. Remove the four **Screws Holding the Lens Interface PCB (2)**.

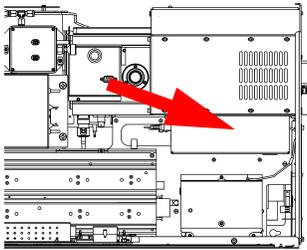
d. Remove the **Lens Interface PCB (1)**.

3. Install the new **Lens Interface PCB**.

4. Restore the *TRACE DSQ* for operation.

a. Replace the right, left, top, and front covers of the *TRACE DSQ*.

b. Restart the system.



### Replacing the Low Pass Filter PCB

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Forceps</li> <li>• Low Pass Filter PCB (PN 119590-0480)</li> <li>• Screwdriver, Phillips #2</li> <li>• Wrench, Allen, 2.5 mm</li> <li>• Wrench, Allen, 3 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

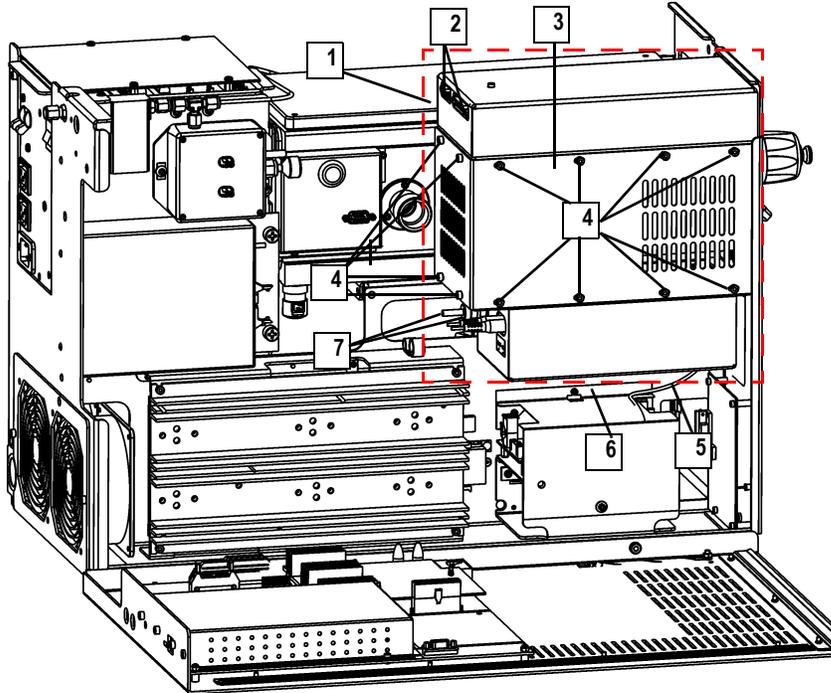
1. Prepare the *TRACE DSQ* for maintenance.

a. Shut down and vent the system (see **Shutting Down** on page 12).

<p><b>WARNING</b> <b>Personal Injury</b></p>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

b. Remove the *TRACE DSQ* front, top and left side covers (see **Removing the Covers** on page 21).

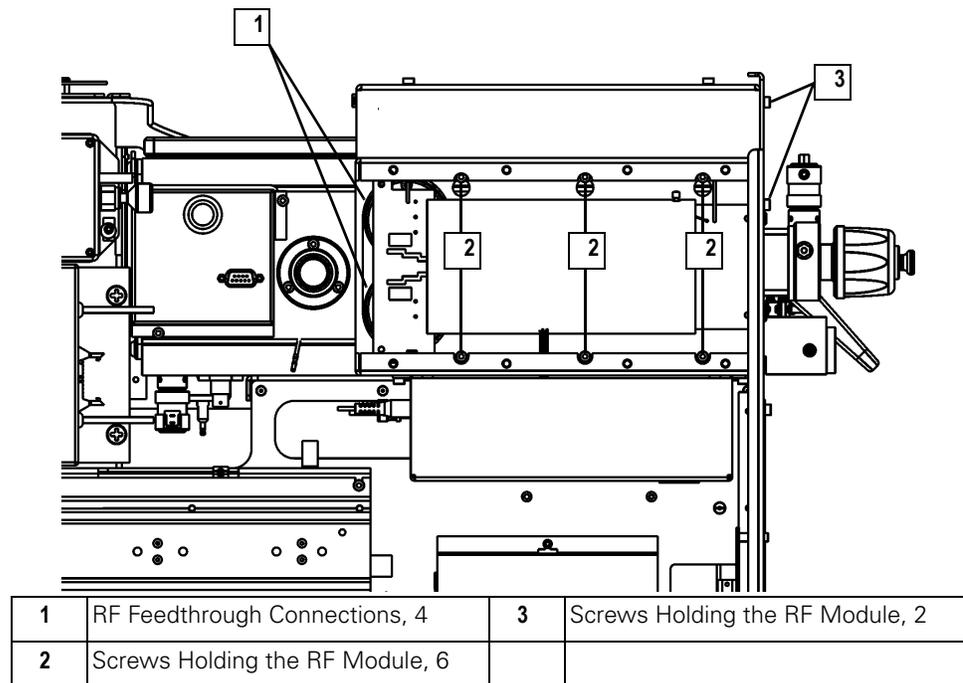
## 2. Disconnect the **RF Module**.



1	RF Module	5	Cables to DC Driver Assembly, 3
2	Cables to RF Detector PCB, 2	6	DC Driver Assembly
3	RF Coil Cover	7	Cables to Lens Interface and RF Generator PCB, 3
4	Screws Holding the RF Coil Cover, 12		

**Figure 2-67. RF Module (Left Side)**

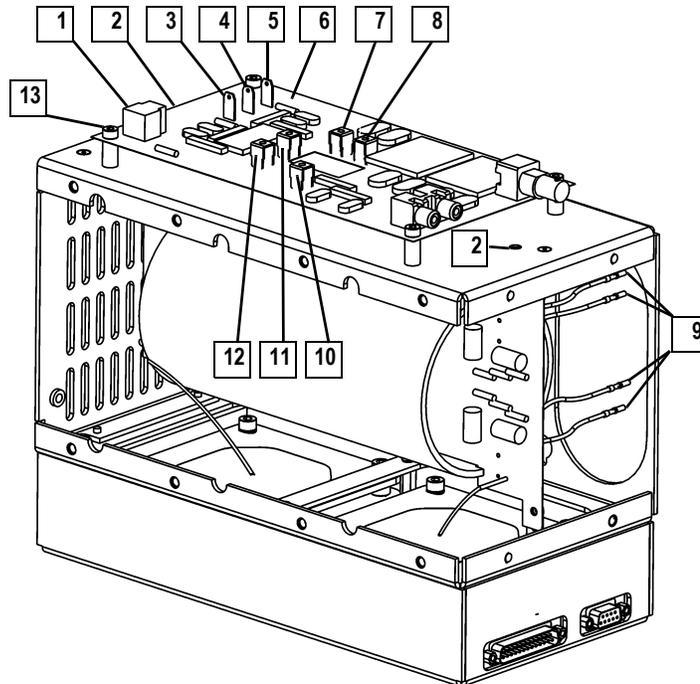
- a. Disconnect the five **Cables (2, 7)** from the **RF Module (1)**.
  - b. Disconnect the three **Cables (5)** from the **DC Driver Assembly (6)**.
- ## 3. Remove the **RF Module**.
- a. Remove the twelve **Screws Holding the RF Coil Cover (4)**.
  - b. Remove the **RF Coil Cover (3)**.



**Figure 2-68. RF Module with RF Coil Cover Removed (Left Side)**

- a. Disconnect the four **RF Feedthrough Connections (1)**. Forceps make it easier to reach the connections.
- b. Remove the bottom three and loosen the top three **Screws Holding the RF Module (2)**.
- c. Remove the two **Screws Holding the RF Module (3)**.
- d. Lift the **RF Module** up and out of its slots.

4. Remove the **Low Pass Filter PCB**.



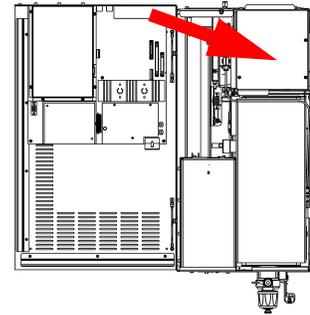
1	Cable J1	8	Wire J6 (gold)
2	Screws Holding the Low Pass Filter Cover	9	RF Feedthrough Connections, 4
3	Cable P1 (green)	10	Wire J2 (white)
4	Cable P2 (black)	11	Wire J5 (red)
5	Cable P4 (red)	12	Wire J4 (green)
6	Low Pass Filter PCB	13	Screws Holding the Low Pass Filter PCB, 4
7	Wire J7 (gold)		

**Figure 2-69. RF Module with Low Pass Filter Uncovered (Upside Down)**

- a. Turn the **RF Module** over (setting it down on its top), and remove the two **Screws Holding the Low Pass Filter Cover (2)**.
- b. Unscrew connectors holding **Wires J2, J4, J5, J6, J7 (10, 12, 11, 8, 7)**.
- c. Disconnect **J1 (1)**.
- d. Disconnect **Cables P1, P2, P4 (3, 4, 5)**.
- e. Remove the four **Screws Holding the Low Pass Filter PCB (13)**.



## Replacing the Power Module



	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• 115 V Power Module (PN 119655-1115) or 230 V Power Module (PN 119655-1230)</li> <li>• Wrench, Allen, 3 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.

a. Shut down and vent the system (see **Shutting Down** on page 12).

<p><b>WARNING</b> Personal Injury</p>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

b. Remove the *TRACE DSQ* front and top covers (see **Removing the Covers** on page 21).

## 2. Remove the **Power Module**.

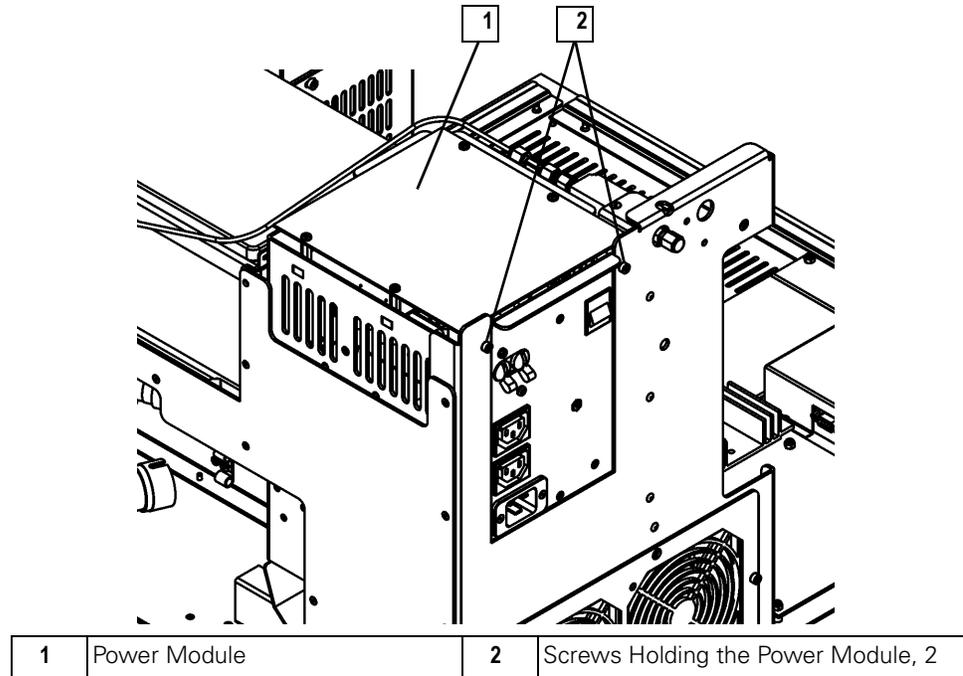


Figure 2-70. Power Module (Back)

- a. Remove the two **Screws Holding the Power Module (2)**.
- b. Lift the **Power Module (1)** straight up.

## 3. Install the new **Power Module**.

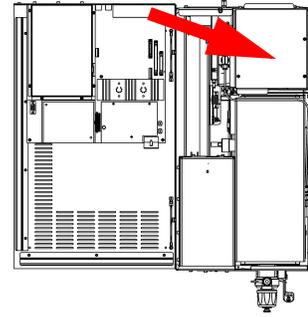
### CAUTION Instrument Damage



The Power Module voltage setting (120 V or 230 V) must match the one that was removed. Otherwise, damage to the instrument and Rotary-Vane Pump will occur. Do not attempt to change the voltage setting of the Power Module. It has been configured at the factory and cannot be changed in the field.

4. Restore the *TRACE DSQ* for operation.
  - a. Replace the top and front covers of the *TRACE DSQ*.
  - b. Restart the system.

### Replacing the Power Module Fuses



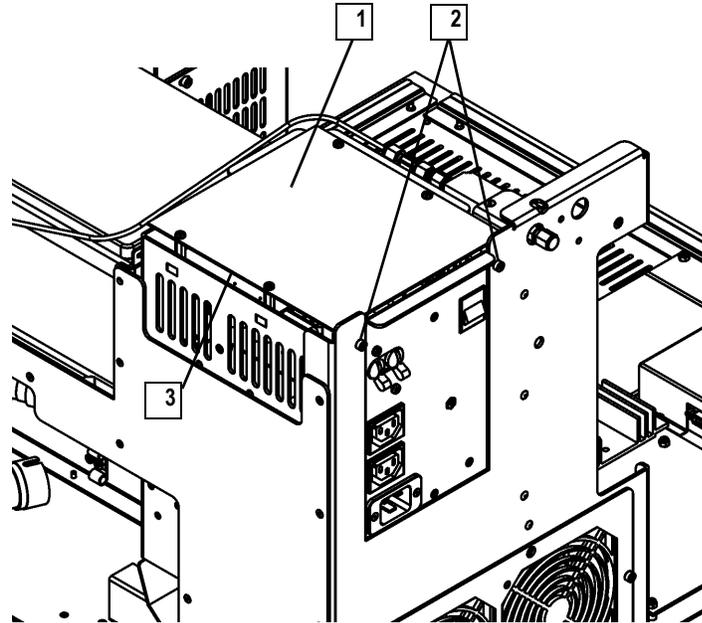
	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Power Module Fuses F1, F2 (PN A0006-04550; 0.315 A, 5 x 20 mm, 250 V)</li> <li>• Power Module Fuse F3 (PN A0006-06075; 800 mA, 5 x 20 mm, 250 V)</li> <li>• Power Module In-line Fuses (PN A0006-10510; 3.15 A, SB, 5 x 20 mm, 250 V)</li> <li>• Screwdriver, Phillips #2</li> <li>• Wrench, Allen, 3 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

<b>WARNING</b>	
<b>Personal Injury</b>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- b. Remove the *TRACE DSQ* front and top covers (see **Removing the Covers** on page 21).

## 2. Remove the **Power Module**.



1	Power Module	3	Power Module Cover
2	Screws Holding the Power Module, 2		

**Figure 2-71. Power Module (Back)**

- a. Remove the two **Screws Holding the Power Module (2)**.
- b. Lift the **Power Module (1)** straight up.

## 3. Replace the **Power Module Fuses**.

CAUTION Instrument Damage	
	<p>Use only the fuses specified else instrument damage will occur. Never replace a fuse with a fuse of a different type, voltage, or current rating. Also, to prevent damaging the PCBs attach an <b>electrostatic discharge (ESD) strap</b> to your wrist before replacing a fuse.</p>

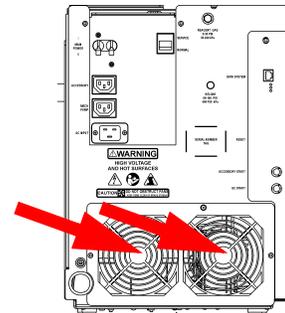
- a. Remove the **Power Module Cover (3)**.
- b. Unplug the **Power Module Fuses**.

4.  
5.

- c. Plug in the new **Power Module Fuses**. It does not matter which way they are plugged in.
  - d. Replace the **Power Module Cover (3)**.
- Reinstall the **Power Module**.
- Restore the *TRACE DSQ* for operation.
- a. Replace the top and front covers of the *TRACE DSQ*.
  - b. Restart the system.

### Replacing the Rear Cooling Fans

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Rear cooling fan (PN 119253-0001)</li> <li>• Wrench, Allen, 3 mm</li> <li>• Wrench, open-ended, 1/4-in.</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

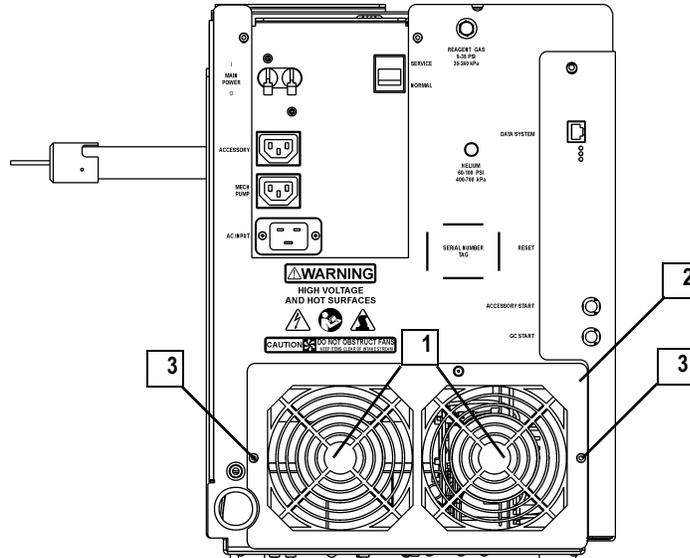


The rear cooling fans provide the necessary airflow to keep the *TRACE DSQ* cool. The fans should be cleaned every 4 months by wiping them with a damp cloth. This helps prevent dust from accumulating inside the instrument.

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

<p><b>WARNING</b> Personal Injury</p>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

## 2. Remove the **Fan Bracket**.

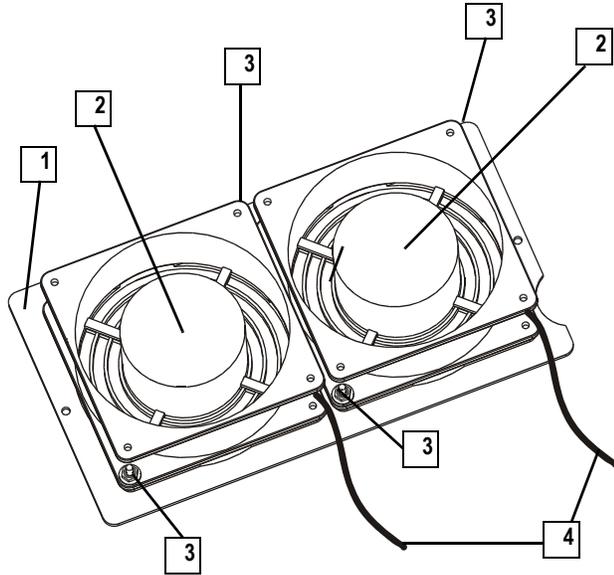


1	Rear Cooling Fans, 2	3	Screws Holding the Fan Bracket, 2
2	Fan Bracket		

**Figure 2-72. Rear Cooling Fans (Back)**

- a. Remove the two **Screws Holding the Fan Bracket (3)**.
- b. Lay the **Fan Bracket (2)** down behind the detector.

3. Remove the **Rear Cooling Fans** from the **Fan Bracket**.



1	Fan Bracket	3	Nuts Holding the Rear Cooling Fans, 4
2	Rear Cooling Fan, 2	4	Fan Cable, 2

Figure 2-73. Fan Bracket (Removed)

- a. Disconnect the two **Fan Cables (4)**.
- b. Remove the four **Nuts Holding the Rear Cooling Fans (3)**.
- c. Remove the **Rear Cooling Fans (2)**.

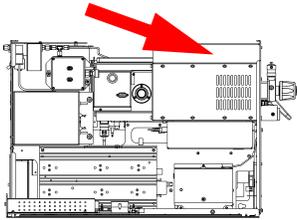
4. Install the new **Rear Cooling Fans** on the **Fan Bracket**.

Make sure the **Airflow Indicator Arrows** on the new **Rear Cooling Fans** point into the *TRACE DSQ* (away from the **Fan Bracket**) and the wires are pointing down.

5. Reinstall the **Fan Bracket**.

Make sure the **Fan Cables** do not get pinched or touch the fan blades.

6. Restart the system.



## Replacing the RF Detector PCB

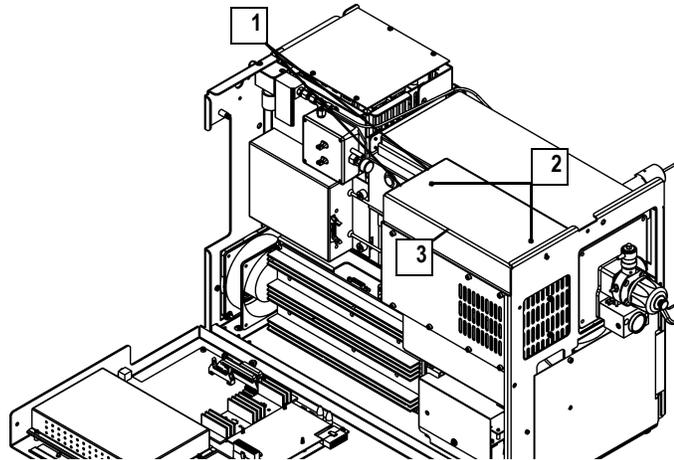
	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• RF Detector PCB (PN 119590-0270)</li> <li>• Wrench, Allen, 2.5 mm</li> <li>• Wrench, Allen, 3 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see [Shutting Down](#) on page 12).

<p><b>WARNING</b> Personal Injury</p>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- b. Remove the *TRACE DSQ* front, top, and left side covers (see [Removing the Covers](#) on page 21).

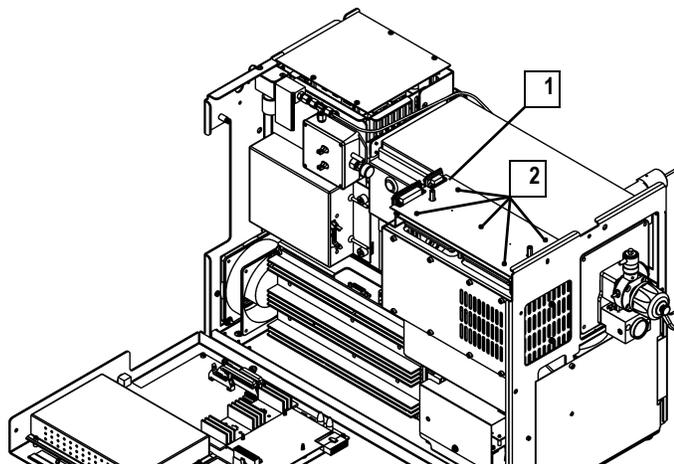
2. Remove the **RF Detector PCB**.



1	Cables, 2	3	RF Detector PCB Cover
2	Screws Holding the RF Detector PCB Cover, 2		

Figure 2-74. RF Detector PCB Cover (Left Side)

- a. Disconnect the two **Cables (1)**.
- b. Remove the two **Screws Holding the RF Detector PCB Cover (2)**.
- c. Remove the **RF Detector PCB Cover (3)**.



1	RF Detector PCB	2	Screws Holding the RF Detector PCB, 5
---	-----------------	---	---------------------------------------

Figure 2-75. RF Detector PCB Uncovered (Left Side)

d. Remove the five **Screws Holding the RF Detector PCB (2)**.

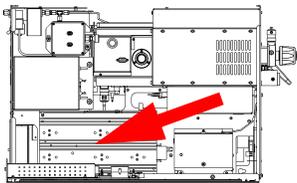
e. Remove the **RF Detector PCB (1)**.

3. Install the new **RF Detector PCB**.

4. Restore the *TRACE DSO* for operation.

a. Replace the left, top, and front covers of the *TRACE DSO*.

b. Restart the system.



### Replacing the RF Generator PCB

	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>RF Generator PCB (PN 119590-0060)</li> <li>Wrench, Allen, 3 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>Only when indicated by Xcalibur Diagnostics, or</li> <li>Technical Support, or</li> <li>Field Service Engineers</li> </ul>

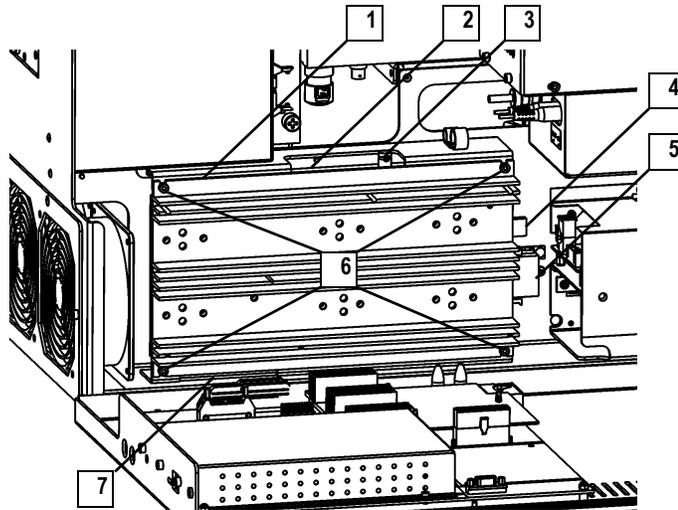
1. Prepare the *TRACE DSO* for maintenance.

a. Shut down and vent the system (see **Shutting Down** on page 12).

<b>WARNING</b> <b>Personal Injury</b>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

b. Remove the *TRACE DSO* front, top, and left side covers (see **Removing the Covers** on page 21).

## 2. Remove the **RF Generator PCB**.



1	RF Generator PCB	5	Cable J3 (to Power Module)
2	Cable P1 (to RF Detector PCB)	6	Screws Holding the RF Generator PCB, 4
3	Cable J1 (to Low Pass Filter PCB)	7	Cable P2 (to Analog PCB)
4	Cable J2 (to Power Module)		

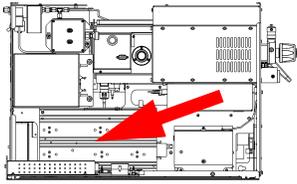
**Figure 2-76. RF Generator PCB (Left Side)**

- a. Disconnect **Cables (2, 3, 4, 5)**.
- b. Remove the top two, and loosen the bottom two, **Screws Holding the RF Generator PCB (6)**.
- c. Lift out the **RF Generator PCB (1)**.
- d. Disconnect **Cable P2 (7)**.

## 3. Install the new **RF Generator PCB**.

## 4. Restore the *TRACE DSQ* for operation.

- a. Replace the left, top, and front covers of the *TRACE DSQ*.
- b. Restart the system.



## Replacing the RF Generator PCB Fuses

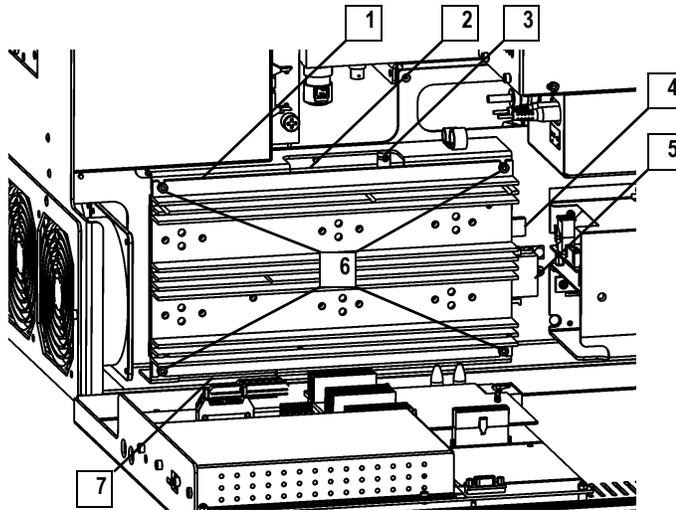
	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>RF Generator PCB Fuse F1 (PN A0006-07608; 0.5 A, Quick Act, 5 x 20 mm, 250 V)</li> <li>RF Generator PCB Fuse F2 (PN A0006-07610; 1.0 A, Quick Act, 5 x 20 mm, 250 V)</li> <li>Wrench, Allen, 3 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>Only when indicated by Xcalibur Diagnostics, or</li> <li>Technical Support, or</li> <li>Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

<b>WARNING</b> <b>Personal Injury</b>	
	<b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.

- b. Remove the *TRACE DSQ* front, top, and left side covers (see **Removing the Covers** on page 21).

## 2. Remove the **RF Generator PCB**.



1	RF Generator PCB	5	Cable J3 (to Power Module)
2	Cable P1 (to RF Detector PCB)	6	Screws Holding the RF Generator PCB, 4
3	Cable J1 (to Low Pass Filter PCB)	7	Cable P2 (to Analog PCB)
4	Cable J2 (to Power Module)		

**Figure 2-77. RF Generator PCB (Left Side)**

- a. Disconnect **Cables (2, 3, 4, 5)**.
- b. Remove the top two and loosen the bottom two **Screws Holding the RF Generator PCB (6)**.
- c. Lift the **RF Generator PCB (1)** out.
- d. Disconnect **Cable P2 (7)**.

3. Replace the **RF Generator PCB Fuses**. Unplug the **RF Generator Fuses**.

<b>CAUTION</b> Instrument Damage	
	Use only the fuses specified else instrument damage will occur. Never replace a fuse with a fuse of a different type, voltage, or current rating. Also, to prevent damaging the PCBs attach an <b>electrostatic discharge (ESD) strap</b> to your wrist before replacing a fuse.

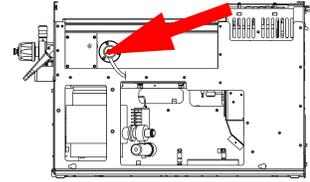
- e. Plug in the new **RF Generator Fuses**. It does not matter which way they are plugged in.

4. Reinstall the **RF Generator PCB**.

5. Restore the *TRACE DSO* for operation.

- a. Replace the left, top, and front covers of the *TRACE DSO*.
  - b. Restart the system.

## Replacing the Transfer Line



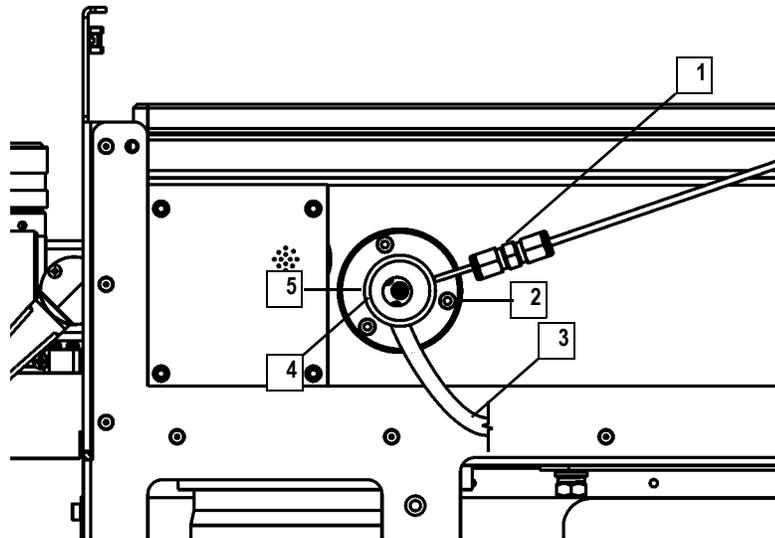
	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Gloves, clean, lint- and powder-free</li> <li>• Transfer line (PN 119640-1050)</li> <li>• Wrench, Allen, 3 mm</li> <li>• Wrench, open-ended, 5/16-in.</li> <li>• Wrench, two, open-ended, 7/16-in.</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).
  - b. Shut down the TRACE GC.

<b>WARNING</b> <b>Personal Injury</b>	
 	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p> <p><b>Burn Hazard</b> The transfer line may be hot. Allow it to cool to room temperature before touching it.</p>

- c. Remove the *TRACE DSQ* front, top, and right side covers (see **Removing the Covers** on page 21).

## 2. Remove the **Transfer Line**.



1	Transfer Line Gas Fitting	4	Transfer Line
2	Screws Holding the Transfer Line, 3	5	O-Ring (not shown)
3	Transfer Line Cable		

**Figure 2-78. Transfer Line (Right Side)**

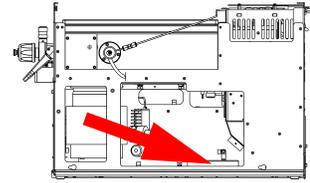
- a. Disconnect the **Transfer Line Cable (3)** from the left side of the GC.
- b. Loosen the **Transfer Line Gas Fitting (1)**.
- c. Remove the three **Screws Holding the Transfer Line (2)**.
- d. Remove **Transfer Line (4)**.

## 3. Install the new **Transfer Line**.

### 4. Restore the *TRACE DSO* for operation.

- a. Replace the right, top, and front covers of the *TRACE DSO*.
- b. Restart the GC.
- c. Restart the system.
- d. Once the detector has pumped down and is operational, check for vacuum leaks using the Automatic Tune.

## Replacing the Turbomolecular Pump Power Supply



	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Screwdriver, Phillips #2</li> <li>• Turbomolecular Pump Power Supply (PN 76330-0100)</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

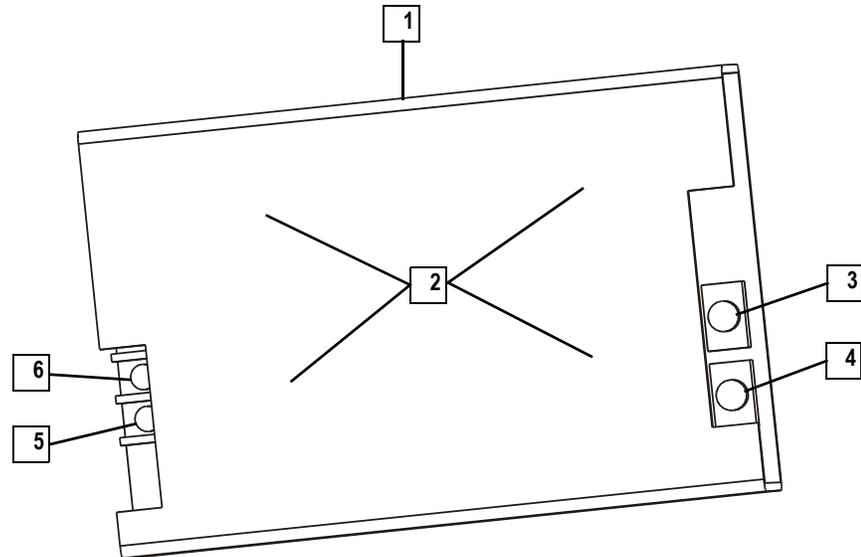
1. Prepare the *TRACE DSQ* for maintenance.

a. Shut down and vent the system (see **Shutting Down** on page 12).

<b>WARNING</b> <b>Personal Injury</b>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

b. Remove the *TRACE DSQ* front, top, and right side covers (see **Removing the Covers** on page 21).

## 2. Remove the **Turbomolecular Pump Power Supply**.



1	Turbomolecular Pump Power Supply	4	Cable P2-2 (+), red wire
2	Screws Holding the Turbomolecular Pump Power Supply, 4	5	Cable P1-2L, brown wire
3	Cable P2-1 (-), black wire	6	Cable P1-2N, blue wire

**Figure 2-79. Turbomolecular Pump Power Supply (Top)**

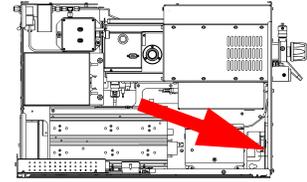
- a. Disconnect the four **Cables (3, 4, 5, 6)**.
- b. From the bottom of the detector, remove the four **Screws Holding the Turbomolecular Power Supply (2)**.
- c. Remove the **Turbomolecular Pump Power Supply (1)**.

## 3. Install the new **Turbomolecular Pump Power Supply**.

## 4. Restore the *TRACE DSO* for operation.

- a. Replace the right, top, and front covers of the *TRACE DSO*.
- b. Restart the system.

## Replacing the Vacuum Control PCB



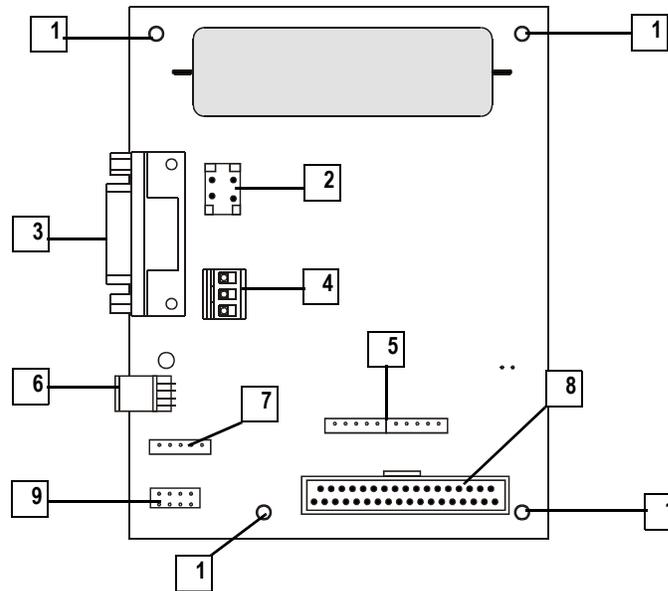
	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Vacuum Control PCB (PN 119590-0030)</li> <li>• Wrench, Allen, 2.5 mm</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

<b>WARNING</b> <b>Personal Injury</b>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- b. Remove the *TRACE DSQ* front, top, and left side covers (see **Removing the Covers** on page 21).

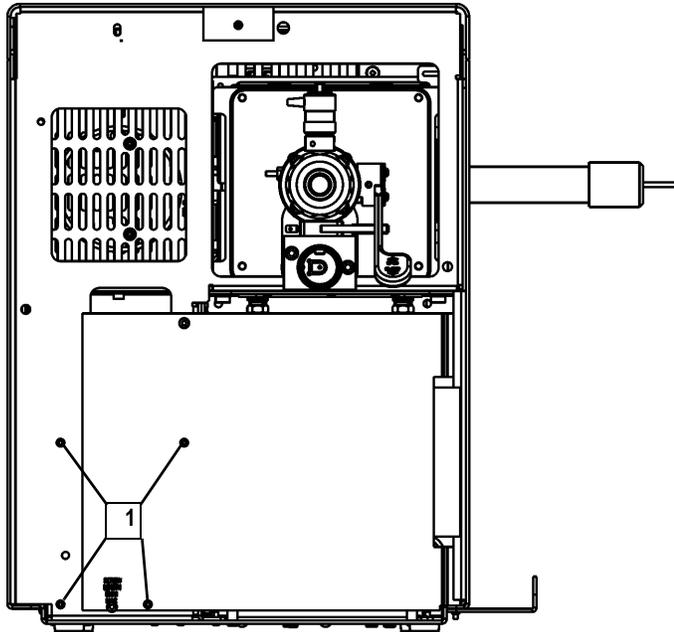
## 2. Remove the **Vacuum Control PCB**.



1	Screws Holding the Vacuum Control PCB, 4	6	Cable J3 (to Turbomolecular Pump Power Supply)
2	Cable J1 (to Forepressure Gauge)	7	Cable P2 (to Inlet Valve Solenoid)
3	Cable J2 (to Turbomolecular Pump Controller)	8	Cable P4 (to Analog PCB)
4	Cable P1 (to Power Module)	9	Cable P5 (to Calibration Gas Flow Module and Vent Valve Solenoid)
5	Cable P3 (to Ion Gauge Control PCB)		

**Figure 2-80. Vacuum Control PCB**

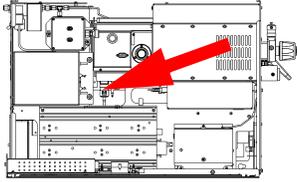
- a. Disconnect all of the **Cables (2, 3, 4, 5, 6, 7, 8, 9)**.



1	Screws Holding the Vacuum Control PCB, 4		
---	--	--	--

**Figure 2-81. Vacuum Control PCB Mounting Screws (Front)**

- b. Remove the four **Screws Holding the Vacuum Control PCB (1)**.
- c. Remove the **Vacuum Control PCB**.
3. Install the new **Vacuum Control PCB**.
4. Restore the *TRACE DSQ* for operation.
- a. Replace the left, top, and front covers of the *TRACE DSQ*.
- b. Restart the system.



## Replacing the Vent Valve Solenoid

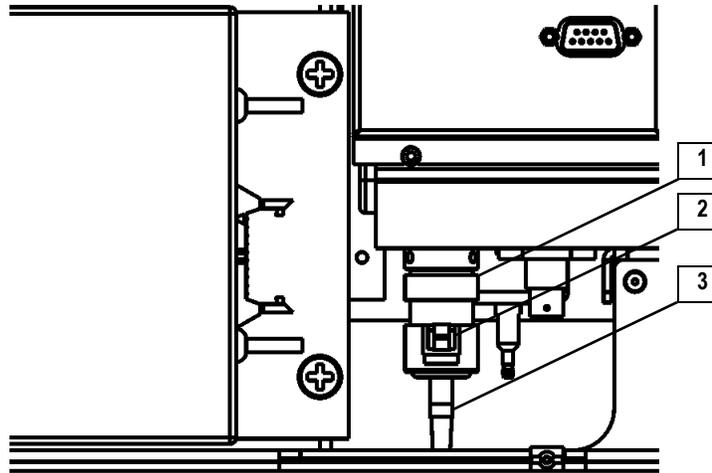
	<p><b>Tools Needed</b></p> <ul style="list-style-type: none"> <li>• Adjustable wrench</li> <li>• Lint-free cloth</li> <li>• Vent valve solenoid (76461-1003)</li> </ul>
	<p><b>Frequency</b></p> <ul style="list-style-type: none"> <li>• Only when indicated by Xcalibur Diagnostics, or</li> <li>• Technical Support, or</li> <li>• Field Service Engineers</li> </ul>

1. Prepare the *TRACE DSQ* for maintenance.
  - a. Shut down and vent the system (see **Shutting Down** on page 12).

<p><b>WARNING</b> Personal Injury</p>	
	<p><b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.</p>

- b. Remove the *TRACE DSQ* front, top, and left side covers (see **Removing the Covers** on page 21).

## 2. Remove the **Vent Valve Solenoid**.



1	Vent Valve Solenoid	3	Vent Valve Filter
2	Cable		

**Figure 2-82. Vent Valve Solenoid (Left Side)**

- a. Disconnect the **Cable (2)**.
  - b. Unscrew the **Vent Valve Solenoid (1)** and remove it.
  - c. Unscrew the **Vent Valve Filter (3)**.
- ## 3.
- Install the new **Vent Valve Solenoid**. On the **Cable (2)**, the orientation of the two plugs does not matter.
- ## 4.
- Restore the *TRACE DSQ* for operation.
- a. Replace the left, top, and front covers of the *TRACE DSQ*.
  - b. Restart the system.
  - c. Once the detector has pumped down and is operational, check for vacuum leaks using the Automatic Tune.

# 3 Troubleshooting

This chapter provides quick reference to identify symptoms, causes, and solutions for poor instrument performance or malfunction.

Typically, *Xcalibur* Diagnostics will display a failure readback on the instrument Status tab, then using this chapter you locate the matching diagnosis and solution. If the material in this chapter is not able to help you troubleshoot the problem, contact Thermo Electron Technical Support.

## In This Chapter

---

- [3.1 Diagnostics, pp. 142](#)
- [3.2 Communication Symptoms, pp. 144](#)
- [3.3 Contamination Symptoms, pp. 151](#)
- [3.4 Filament and Lens Control Symptoms, pp. 154](#)
- [3.5 Heated Zone Symptoms, pp. 157](#)
- [3.6 High Vacuum Symptoms, pp. 161](#)
- [3.7 Linearity Symptoms, pp. 166](#)
- [3.8 Power Supply Symptoms, pp. 168](#)
- [3.9 RF and DC Control Symptoms, pp. 172](#)
- [3.10 Sensitivity Symptoms, pp. 177](#)
- [3.11 Stability Symptoms, pp. 186](#)
- [3.12 Tuning Symptoms, pp. 188](#)



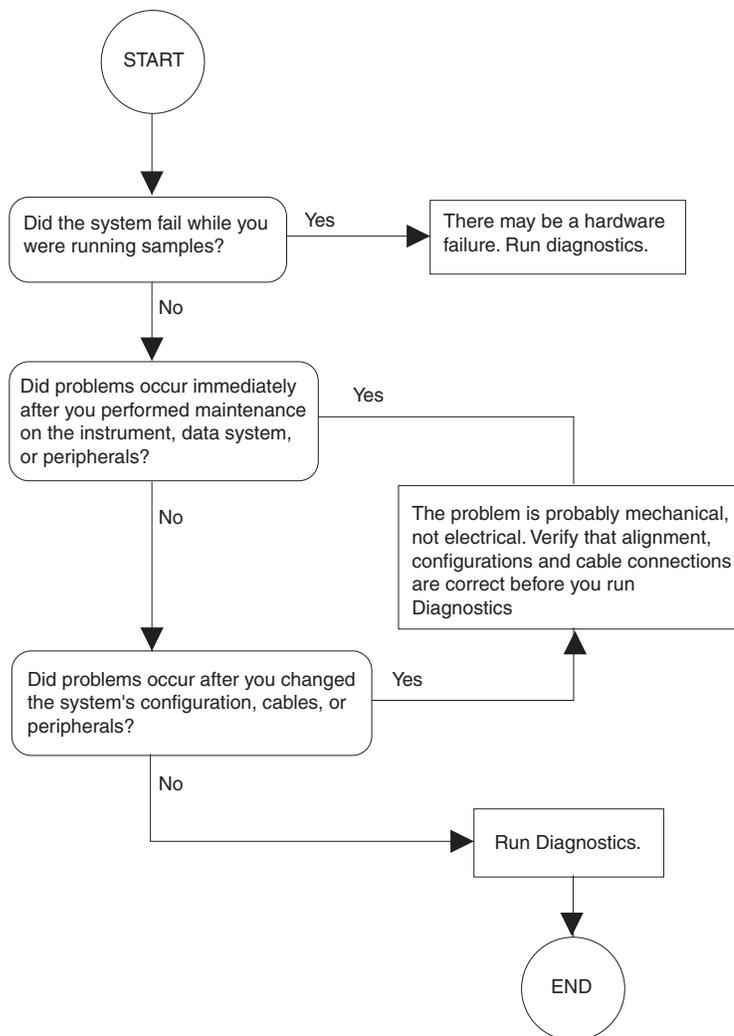
Analyze • Detect • Measure • Control™

## 3.1 Diagnostics

If your instrument is running poorly or suspiciously, *Xcalibur* Diagnostics will most likely detect the problem and recommend a solution. Diagnostics tests electronic circuits and reports whether the circuits pass or fail.

However, problems in sensitivity due to misalignment, dirty components, or improper tuning are not detected by Diagnostics.

Before running the Diagnostics, refer to the flowchart (Figure 3-1) to determine solutions outside of *Xcalibur* Diagnostics.



**Figure 3-1. Diagnostics Flowchart**

## *To run Xcalibur Diagnostics*

1. Navigate to the Diagnostics screen.
  - a. From the *Xcalibur* Home Page select **Instrument Setup**.
  - b. Open the *TRACE DSQ* Method Editor then click the **Tune** button.
  - c. From Tune, select **Diagnostics | Run Tests** to display the Diagnostics screen.
2. Run Diagnostics by clicking on the test you wish to run.

## 3.2 Communication Symptoms

---

Communication symptoms likely involve links between the data system and the mass spectrometer, the gas chromatograph, and the autosampler. This section does not address communication issues with other devices.

Communication symptoms may occur during:

- Data transfer between the mass spectrometer and the data system
- Mass spectrometer, gas chromatograph and autosampler current status readbacks
- Instrument control, method downloading and uploading
- Start, stop, pause and initialize functions
- Error messages

### How does the detector communication work?

The flow of digital information in the *TRACE DSQ* system is bi-directional; the data system downloads analytical methods to the instrument and activates functions to start, stop, shutdown, startup, and initialize. The *TRACE DSQ* reports its readiness state and current tasks, various voltages, heated zones, and pressure readings. It also delivers a steady stream of mass spectral data during acquisition.

### Why does the detector have communication symptoms?

Some communication symptoms are due to mechanical faults—for instance, a cable may be unplugged, or a device may be turned off. In other cases, the instrument method could be incorrect for *TRACE DSQ* operations. Less common communication symptoms are due to defective electronic hardware components.

### How do I detect communication symptoms?

Communication symptoms may be detected from an error message delivered by the data system, or they may be noticed from the failure to perform some expected task.

**Issue:** Data system cannot initialize communication with *TRACE DSQ*.

**Diagnosis/Solution:** The software is not configured correctly.

*Select the **TRACE DSQ** from the Instrument Configuration window.*

**Diagnosis/Solution:** The ethernet cable is unplugged.

*Verify that the ethernet cable is connected to the data system port on the **TRACE DSQ**.*

**Diagnosis/Solution:** The Xcalibur software has locked up.

*Use Task Manager to end HomePage, AcqServer, QuadTune, and QuadInst. Or, reboot the computer.*

**Diagnosis/Solution:** The digital PCB has locked up.

*Press the reset button on the back of the instrument.*

**Diagnosis/Solution:** The communication circuits on the digital PCB are faulty.

*Check connections to digital PCB. Replace if necessary.*

**Diagnosis/Solution:** The ethernet card in the PC is not configured or is faulty.

*Check TCP/IP configuration (compare to the settings shown in the README.DOC file). Replace the card if necessary.*

**Diagnosis/Solution:** The system is in service mode.

*Check if green power LED on front cover is flashing; return service switch to normal position if necessary.*

**Diagnosis/Solution:** The incorrect ethernet cable is used for the detector.

*Use the supplied 10 Base-T Category 5 crossover cable. The length of the ethernet cable may be extended by plugging a standard Category 5 cable in series with the supplied crossover cable.*

**Issue:** Computer loses communication with *TRACE DSQ* intermittently.

**Diagnosis/Solution:** The ethernet cable is loose or damaged.

*Inspect cable and replace if necessary.*

**Diagnosis/Solution:** The communication circuits on the digital PCB are faulty.

*Check connections to Digital PCB. Replace if necessary.*

**Issue:** Cannot download methods to *TRACE DSQ*.

**Diagnosis/Solution:** The software is not properly configured.

*Verify correct settings in Instrument Configuration.*

**Issue:** Unable to start a GC temperature program even though all devices are ready. "NOT RDY - Waiting for Inhibit RDY Signal" displays on the TRACE GC status menu.

**Diagnosis/Solution:** Check the GC and/or autosampler remote start cables for loose or faulty connections.

*GC remote start cable (8-pin) plugs into the GC (**Generic/HS** port) and connects to the *TRACE DSQ* (**GC Start** port). Or,*

*Autosampler remote start cable plugs into GC (**Autosampler** port) and connects to the autosampler controller (**GC** port).*

*More detailed information is listed in the TRACE GC Operating Manual.*

**Diagnosis/Solution:** Configure the Inhibit Ready parameter on the TRACE GC.

*The TRACE GC Handshaking parameter needs to be configured to allow the GC to become ready to run a temperature program. Configure the GC as follows:*

*Press <CONFIG> to display the Configure menu.*

*Press the down arrow key to Handshaking and press <ENTER> to display the Config Handshaking menu.*

*Press the down arrow key to Inhibit ready in and press <ENTER> to display the Inhibit Ready menu.*

*Specify the **Inhibit Ready** parameter. The default setting is **When high**. This allows normal operation of the TRACE DSQ system. If the GC method has not been downloaded from Xcalibur, the GC may not have received a signal from the TRACE DSQ allowing it to become ready. In this case you can either send the GC method from Xcalibur or select **When low** or **Do not inhibit** as the Inhibit Ready parameter.*

**Issue:** Detector acquisition does not start as expected.

**Diagnosis/Solution:** The TRACE DSQ start mode is not properly configured.

*Verify that instrument is configured properly. Refer to Xcalibur online help.*

**Diagnosis/Solution:** The TRACE DSQ Instrument Setup file has incorrect settings.

*Check start time in TRACE DSQ Instrument Setup file.*

**Diagnosis/Solution:** The forepressure is too high due to solvent peak.

*Reduce injection volume or extend filament/multiplier delay time until after solvent peak. See **High Vacuum Symptoms** on page 161.*

**Diagnosis/Solution:** The remote start cable to the GC is disconnected.

*Connect remote start cable.*

**Diagnosis/Solution:** The GC did not start.

*Verify GC methods and configuration. Verify connection between autosampler and GC.*

**Diagnosis/Solution:** The autosampler did not start.

*Verify autosampler methods and configuration. Verify that the sample is present.*

**Diagnosis/Solution:** A heated zone setpoint is not attained.

*Refer to **Heated Zone Symptoms** on page 157.*

**Issue:** Unstable instrument readback.

**Diagnosis/Solution:** There is a faulty cable connection.

*Check connections to the Analog PCB.*

**Diagnosis/Solution:** The Digital PCB is faulty.

*Reseat connector between Analog and Digital PCB; replace if necessary.*

**Diagnosis/Solution:** The Analog PCB is faulty.

*Check connections to the Analog PCB; replace if necessary.*

**Issue:** Acquisition terminates unexpectedly.

**Diagnosis/Solution:** The End Run time in the *TRACE DSQ* Instrument Setup file is incorrect.

*Check the Instrument Setup files for the GC and the MS.*

**Diagnosis/Solution:** The data system is out of disk space.

*Check disk space; back up and remove files.*

**Issue:** Cannot initialize GC.

**Diagnosis/Solution:** The GC is not turned on.

*Turn on the GC.*

**Diagnosis/Solution:** The GC is not configured properly in *Xcalibur* software.

*Check Instrument Configuration.*

**Diagnosis/Solution:** The cable between COM1 and GC is disconnected.

*Verify connection.*

**Diagnosis/Solution:** COM1 is not configured properly.

*Verify COM port configuration.*

**Diagnosis/Solution:** GC communications malfunction.

*Contact Technical Support.*

**Issue:** Cannot download methods to GC.

**Diagnosis/Solution:** There is a discrepancy between method and configuration.

*Verify consistency between method and instrument configuration.*

**Diagnosis/Solution:** COM1 is not configured properly.

*Verify COM port configuration*

**Diagnosis/Solution:** GC communications malfunction.

*Contact Technical Support.*

**Issue:** Cannot initialize Autosampler.

**Diagnosis/Solution:** Autosampler not turned on.

*Turn on Autosampler.*

**Diagnosis/Solution:** Autosampler not configured properly in *Xcalibur* software.

*Check Instrument Configuration*

**Diagnosis/Solution:** Disconnected cable between GC and autosampler.

*Verify connection.*

**Diagnosis/Solution:** Autosampler Instrument Configuration not set for  
"Connected through TRACE"

*Verify configuration.*

**Diagnosis/Solution:** Autosampler communications malfunction.

*Contact Technical Support.*

**Issue:** Cannot download methods to Autosampler.

**Diagnosis/Solution:** Discrepancy between method and configuration.

*Verify consistency between method and instrument configuration.*

**Diagnosis/Solution:** Autosampler communications malfunction.

*Contact Technical Support.*

## 3.3 Contamination Symptoms

Chemical noise is always present in any mass spectrometer. Additionally, the spectra shown in *Xcalibur* Tune and Real-Time Display are auto-normalized, which can make the background appear high when it really is not.

Some chemical noise does present itself, such as septum bleed after a series of injections, vial sample bleed (which occurs if more than one injection is made from a sample vial), and Siloxane peaks that appear in the chromatogram at regular intervals from focusing at the head of the column or in the injector.

Other possible contamination sources include hydrocarbon contamination of the carrier gas, rotary-vane pump, or instrument cleaning solvents.

Always wear clean, lint- and powder-free gloves when handling parts inside the vacuum manifold, and assure that the carrier gas filter, carrier gas lines, and gas regulators are free of contamination and leaks.

**Issue:** There is excessive chemical background due to column bleed ( $m/z$  429, 355, 281).

**Diagnosis/Solution:** Capillary column has not been properly conditioned.

*Condition the capillary column.*

**Diagnosis/Solution:** Capillary column is damaged as a result of exposure to oxygen.

*Find the source of the oxygen in the carrier gas or air leak. Recondition or replace the capillary column.*

**Diagnosis/Solution:** Capillary column is broken off in ion volume.

*Remove broken pieces from ion volume.*

**Issue:** There is excessive injection port septum bleed (Typical  $m/z$  207, 429, 355, 281).

**Diagnosis/Solution:** The septum is worn out or damaged.

*Replace the septum.*

**Diagnosis/Solution:** Small pieces of septum are in the injection port liner.

*Replace the injection port liner, condition the capillary column.*

**Issue:** There is phthalate background manifest in chromatograms ( $m/z$  149, 167, 279).

**Diagnosis/Solution:** Phthalate contamination has occurred due to sample handling or solvent contamination. Phthalates may be observed from packaging materials.

*Isolate source of phthalates such as vial lids or plastic solvent containers and remedy.*

**Issue:** There is excessive hydrocarbon contamination manifest in chromatograms (Typical ions are  $m/z$  43, 57, 71, 85, 99...)

**Diagnosis/Solution:** Carrier gas tubing is contaminated.

*Isolate source of hydrocarbon contamination and remedy.*

*Replace carrier gas tubing. Change carrier gas filters.*

**Issue:** There is chemical background due to rhenium oxide ( $m/z$  185/187, 201/203, 217/219, 233/235, 250/252).

**Diagnosis/Solution:** These series of rhenium oxide ions come from oxidation of the rhenium filament wire due to the introduction of air into the ion source while the filament is on.

*Check for air leaks and remedy. See [High Vacuum Symptoms](#) on page 161.*

**Issue:** Spectra are observed due to solvents:

- Methanol ( $m/z$  31, 32)
- Acetone ( $m/z$  43, 58, 59)
- Methylene chloride ( $m/z$  84/83)
- Hexane ( $m/z$  41, 43, 56, 57, 58, 85, 86)
- Toluene ( $m/z$  91, 92)
- Xylene ( $m/z$  105, 106)
- Trichloroethane ( $m/z$  151, 153)

**Diagnosis/Solution:** There is residual solvent from a cleaning procedure or laboratory background contamination.

*When you finish performing a cleaning procedure, allow cleaned components to dry thoroughly. Warm parts in the GC oven to drive off residual solvent.*

**Diagnosis/Solution:** The observed compounds have been introduced through sample injection. Ultimate source is either a sample solvent or the autosampler rinsing solvent.

*Optimize GC method to separate solvent peak from area of interest in the chromatogram.*

## 3.4 Filament and Lens Control Symptoms

The lifetime of a filament depends on its exposure to oxygen and solvent vapors. The filament assembly protects the filament and increases its lifetime for many months.

*Xcalibur* Diagnostics tests the filament for continuity and current regulation. Testing the filament for continuity before each acquisition ensures that an open filament condition will stop an autosampler sequence and generate an error message.

Diagnostics tests the lenses of the *TRACE DSQ*. A flat line, which represents voltage readback versus the predicted voltage ramp, indicates a lens or other control fault. Contamination causes lens performance to deteriorate over time; the amount of time depends on what type of sample and ionization mode you are using.

**Issue:** Diagnostics indicate filament is open.

**Diagnosis/Solution:** The filament is open.

*Vent the system and remove the filament. Normal resistance is 1.0  $\Omega$ .  
Replace if open.*

**Issue:** Inspection shows filament is good, but diagnostics still indicate filament is open.

**Diagnosis/Solution:** There is a fault in the ion source PCB.

*Replace the ion source PCB.*

**Diagnosis/Solution:** The connection between the analog and lens interface PCB is defective.

*Check the connection.*

**Diagnosis/Solution:** There is a problem with the analog PCB.

*Replace if necessary.*

**Issue:** Emission current is unstable.

**Diagnosis/Solution:** The filament is near the end of its life span.

*Replace the filament.*

**Diagnosis/Solution:** There is a fault in the ion source PCB.

*Replace the ion source PCB.*

**Diagnosis/Solution:** There is a problem with the analog PCB.

*Replace if necessary.*

**Issue:** Short filament lifetime.

**Diagnosis/Solution:** There is an air leak contributing to short filament lifetime.

*Check for leaks; repair if any are found. See [High Vacuum Symptoms](#) on page 161.*

**Diagnosis/Solution:** The filament is on during solvent peak.

*Increase filament/multiplier delay time until solvent peak has passed.*

**Diagnosis/Solution:** High emission current is being used.

*Use lower emission current to extend lifetime.*

**Issue:** Diagnostics indicate flat lens response.

**Diagnosis/Solution:** The power supply to the lens has a fault.

*Check regulator PCB in the power module; replace if necessary.*

**Diagnosis/Solution:** There is a fault with the lens drivers.

*Replace the analog PCB.*

## 3.5 Heated Zone Symptoms

---

The ion source and transfer line are heated zones related to the *TRACE DSQ*. The ion source heater is controlled by the *TRACE DSQ* and the transfer line heater is controlled by the Aux1 heated zone of the TRACE GC.

Often, a heated zone problem is the result of downloading a method to the *TRACE DSQ* that has a different setpoint from the current setting, causing a delay while the heated zone heats or cools.

Component failures are less common, but can occur. These are usually related to open circuits in heater cartridges or faulty temperature sensors.

Heated zones in the gas chromatograph are not discussed in this manual.

**Issue:** Excessive chromatographic peak tailing.

**Diagnosis/Solution:** The ion source and/or transfer line are not hot enough.

*Increase the transfer line temperature. It should be at least as hot as the highest GC oven temperature. Then, try increasing the ion source temperature.*

**Diagnosis/Solution:** Sample analyte is adsorbing in the GC injector.

*Clean and deactivate the injection liner. You can also try liners made of different materials.*

**Diagnosis/Solution:** GC oven is not ramped to high enough temperature.

*Extend upper oven temperature.*

**Diagnosis/Solution:** GC column needs to be replaced or does not have the appropriate stationary phase for your application.

*Change GC column.*

**Diagnosis/Solution:** GC column does not extend 1 mm past the end of the transfer line tip.

*Insert GC column in transfer line so it extends 1 mm past the end of the tip. If the end of the column is inside the tip, an excessive amount of GC effluent will contact the inside wall of the tip.*

**Issue:** Ion source heater will not heat.

**Diagnosis/Solution:** The cartridge heaters are not connected.

*Check connections between the analog and lens interface PCBs and lens interface PCB and ion source PCB.*

**Diagnosis/Solution:** Ion source heater fuse (F1) is blown on the analog PCB.

*Replace the ion source heater fuse on the analog PCB.*

**Diagnosis/Solution:** The 24 V power supply is not operable.

*Replace power module if necessary.*

**Diagnosis/Solution:** One or more heater cartridges on the ion source PCB is defective.

*Vent the system and check that the resistance of the heater circuit  $\approx$  24  $\Omega$ . Replace the ion source PCB if necessary.*

**Diagnosis/Solution:** The ion source temperature sensor (RTD) is defective.

*Vent the system and check the resistance of the RTD (108  $\Omega$  at 20  $^{\circ}$ C, 176  $\Omega$  at 200  $^{\circ}$ C). Replace the ion source PCB if necessary.*

**Diagnosis/Solution:** There is a problem with the analog PCB.

*Contact Technical Support.*

**Issue:** Ion source heater overheats.

**Diagnosis/Solution:** The ion source temperature sensor (RTD) is defective.

*Vent the system and check the resistance of the RTD (108  $\Omega$  at 20  $^{\circ}$ C, 176  $\Omega$  at 200  $^{\circ}$ C). Replace the ion source PCB if necessary.*

**Diagnosis/Solution:** There is a problem with the analog PCB.

*Replace if necessary.*

**Issue:** Transfer line will not heat.

**Diagnosis/Solution:** Aux1 zone of GC is not configured for MS Transfer Line.

*Configure Aux1 zone of GC and set transfer line temperature in GC Method Editor.*

**Diagnosis/Solution:** Transfer line heater elements are defective.

*Turn off the GC. Unplug the transfer line connector. Measure the heater resistance between the following pins:*

*2-3  $\cong$  360  $\Omega$*

*2-4  $\cong$  180  $\Omega$*

*3-4  $\cong$  180  $\Omega$*

*Replace the transfer line if resistance is incorrect.*

**Diagnosis/Solution:** The transfer line temperature sensor (RTD) is defective.

*Measure resistance of RTD across pins 5-6 (108  $\Omega$  at 20  $^{\circ}$ C, 204  $\Omega$  at 275  $^{\circ}$ C). Replace transfer line if necessary.*

**Issue:** Transfer Line overheats.

**Diagnosis/Solution:** The transfer line temperature sensor is defective.

*Turn off the GC. Unplug the transfer line connector. Measure resistance of RTD across pins 5-6 (108  $\Omega$  at 20 °C, 204  $\Omega$  at 275 °C). Replace transfer line if necessary.*

**Diagnosis/Solution:** There is a problem with the Aux1 zone of the GC.

*Contact Technical Support.*

## 3.6 High Vacuum Symptoms

High Vacuum problems can manifest themselves in two ways. First, an intermittent vacuum condition (the vacuum pressure in the vacuum manifold fluxuates intermittently) can cause chromatographic signals to drop out, or, if the pressures exceed the maximum allowed pressures by *Xcalibur*, then the MS can automatically shut down. Second, if the vacuum is consistent enough to where it does not exceed the maximum allowed pressure and avoids the *Xcalibur* automatic shutdown, non-reproducible false chromatographic peaks can be generated in the chromatogram.

Typical forepressure readbacks are 30-40 mTorr (in EI mode), and typical manifold pressure (ion gauge readback) is  $1-5 \times 10^{-5}$  Torr. For CI mode, forepressure is usually 60-90 mTorr, with manifold pressures no greater than  $9 \times 10^{-4}$  Torr.

The leak check in the Automatic Tune is a good way to check for leaks. You can also find vacuum leaks by spraying a gas around the vacuum manifold and looking for the characteristic ions in full-scan EI. Argon produces *m/z* 40. Alternatively, compressed electronic dusting spray containing an HFC can be used. For example, Falcon® Dust-Off® and MicroCare® Micro-Blast™ contain tetrafluoroethane which produce ions at *m/z* 69 and 83.

**Issue:** Automatic Tune reports "Air leak has been detected."

**Diagnosis/Solution:** There may be an air leak.

*Use the procedure described above for finding the leak. The most common leaks are caused by:*

*Loose transfer line nut or union*

*Dust or debris on the top cover o-ring*

*No helium flow from the GC. This causes the detector to suck air through the column.*

**Issue:** Rotary-vane pump will not turn on.

**Diagnosis/Solution:** The rotary-vane pump is off.

*Check the rotary-vane pump switch.*

**Diagnosis/Solution:** The rotary-vane pump power cable from the TRACE DSQ is not connected.

*Connect the power cable.*

**Diagnosis/Solution:** The rotary-vane pump is configured for incorrect line voltage.

*Configure the rotary-vane pump for proper line voltage.*

**Diagnosis/Solution:** The Rotary-Vane Pump is faulty.

*Replace the Rotary-Vane Pump.*

**Issue:** Rotary-vane pump turns on but will not pump down.

**Diagnosis/Solution:** The oil level in the rotary-vane pump is insufficient.

*Check oil level; add if necessary.*

**Diagnosis/Solution:** The foreline is leaking.

*Check the clamps and connectors. Replace the foreline hose if a hole is found.*

**Diagnosis/Solution:** The vacuum manifold top cover is leaking.

*Press down on the top cover to make sure it is seated properly.*

**Diagnosis/Solution:** The rotary-vane pump is faulty.

*Replace the rotary-vane pump.*

**Diagnosis/Solution:** The cable from the fore pressure gauge to the vacuum control PCB is faulty.

*Check the cable.*

**Issue:** Turbomolecular pump will not turn on.

**Diagnosis/Solution:** The fore pressure is not low enough.

*Check the rotary-vane pump and foreline plumbing for leaks and proper operation.*

**Diagnosis/Solution:** Ready is not transmitted by the vacuum control PCB.

*Check cable connections between vacuum control PCB and turbomolecular pump controller; replace if necessary.*

**Diagnosis/Solution:** The laboratory environment is too hot.

*Bring laboratory environment to within TRACE DSQ specifications.*

**Diagnosis/Solution:** Line voltage is out of tolerance.

*Check line voltage; correct as necessary.*

**Issue:** Turbomolecular pump shuts off during operation.

**Diagnosis/Solution:** The fore pressure is too high.

*Check for leaks in the foreline.*

**Diagnosis/Solution:** The cable connection between the turbomolecular pump and vacuum control PCB is faulty.

*Check connections.*

**Diagnosis/Solution:** The turbomolecular pump controller is faulty.

*Replace or repair as necessary.*

**Diagnosis/Solution:** The turbomolecular pump power supply is faulty.

*Replace or repair as necessary.*

**Diagnosis/Solution:** The turbomolecular pump is faulty.

*Replace the turbomolecular pump.*

**Issue:** Unexpected full ventilation occurs.

**Diagnosis/Solution:** A gross leak is present.

*Check for leaks.*

**Diagnosis/Solution:** The system was vented through the inlet valve, there was a GC column break at the transfer line, the foreline was cut.

*Shut off the TRACE DSO main circuit breaker. Allow system to vent and cool to room temperature.*

**Issue:** Vacuum Fault.

**Diagnosis/Solution:** A gross leak is present.

*Check for leaks.*

**Diagnosis/Solution:** The ion gauge must be on (if you have one) and the pressure below  $1 \times 10^{-3}$  Torr.

*Turn on ion gauge from Tune.*

## 3.7 Linearity Symptoms

Linearity symptoms are when a plot of intensity versus concentration of a known compound are not uniform throughout the curve, or vary from their expected peaks. Poor instrument operating conditions can cause linearity problems. Additionally, certain compounds do not give a desired linear response due to chromatographic activity.

A well-maintained instrument will provide good linear response over a wide range of concentration for most compounds. Like any instrument, however, the *TRACE DSQ* has a saturation point.

Perform routine injector and column maintenance to minimize linearity problems. Usually, a hardware fault that affects linearity will show different symptoms than those which might be attributed to linearity.

**Issue:** Calibration plots not sufficiently linear.

**Diagnosis/Solution:** High-end standards are too concentrated.

*Use split injection technique to decrease amount of sample, lower emission current to reduce sensitivity, or lower detector gain.*

**Diagnosis/Solution:** Ion volume, lenses, or prefilter are dirty.

*Clean ion volume, lenses, and prefilter.*

**Diagnosis/Solution:** Detector gain is too high.

*Run Automatic Tune to calibrate detector gain. Select a lower gain setting like  $1 \times 10^5$ .*

**Diagnosis/Solution:** Injection port liner or capillary column is dirty.

*Change the injection port liner and trim the capillary column.*

**Diagnosis/Solution:** Capillary column stationary phase is too thin for high concentration samples.

*Use a higher capacity capillary column with a thicker stationary phase.*

*Use split injection technique.*

**Diagnosis/Solution:** The capillary column is bad.

*Replace capillary column.*

## 3.8 Power Supply Symptoms

*Xcalibur* Diagnostics detects most power supply symptoms. Power supply problems often involve a blown fuse, faulty electronic components, or even something as simple as a disconnected cable. Use extreme care when you replace a fuse or electronic component. Turn the *TRACE DSQ* off and unplug the instrument before removing the covers.

WARNING Personal Injury	
	<b>Electrical Shock Hazard</b> Please unplug the detector before proceeding.

**Issue:** *TRACE DSQ* will not turn on.

**Diagnosis/Solution:** Disconnected power cord.

*Verify that the power cord is plugged in.*

**Diagnosis/Solution:** Voltage not coming from the electrical outlet.

*Verify that the electrical outlet is operational.*

**Diagnosis/Solution:** Improper voltage at the electrical outlet.

*Verify that the outlet is using the correct voltage for your system.*

**Diagnosis/Solution:** Faulty power module.

*Replace power module.*

**Issue:** TRACE DSO turns on, but circuit breaker trips.

**Diagnosis/Solution:** Faulty power module.

*Replace power module.*

**Diagnosis/Solution:** Rotary-vane pump causes circuit breaker to trip.

*Check rotary-vane pump voltage setting; replace if necessary.*

**Issue:** TRACE DSO turns on, but there are no voltages available.

**Diagnosis/Solution:** No +5, +/- 15, +24 V power.

*Check power module. In-line fuse F1 may be blown or power supply 1 may be faulty. Replace if necessary.*

**Diagnosis/Solution:** No +28 V power.

*Check fuse on RF generator PCB; replace if necessary. If fuse blows again after replacement, replace RF generator PCB.*

**Diagnosis/Solution:** No +/- 150 V power

*Check regulator PCB in power module; replace if necessary.*

**Diagnosis/Solution:** No 28 V current.

*Check connections to RF generator PCB, RF control PCB, RF coil, and RF feedthroughs.*

**Diagnosis/Solution:** No +28 V current, -28 V, or +36 V (system is off).

*Turn system on from Tune.*

**Issue:** +28 V current is below acceptable range.

**Diagnosis/Solution:** There is a bad connection in the RF circuit.

*Check connection sequences between RF generator PCB, low pass filter, DC driver, RF coil, RF control PCB, RF feedthroughs, quadrupole, and prefilter.*

**Issue:** +28 V current is higher than acceptable range.

**Diagnosis/Solution:** The RF frequency is not calibrated.

*Calibrate the RF frequency using Automatic Tune.*

**Diagnosis/Solution:** The RF generator PCB overheated.

*Check fans on back of TRACE DSQ; clean or replace as necessary.*

*Verify adequate ventilation around TRACE DSQ.*

*Verify that lab temperature is within operating limits of TRACE DSQ.*

*Verify that the RF frequency is calibrated using Automatic Tune.*

**Diagnosis/Solution:** The RF generator PCB is faulty.

*Replace the RF generator PCB.*

**Diagnosis/Solution:** The RF detector capacitors are faulty.

*Check capacitor plate for high-voltage arcing; replace if necessary.*

**Diagnosis/Solution:** There is a short circuit to ground in an RF feedthrough.

*Replace RF feedthrough.*

**Diagnosis/Solution:** There is a short circuit in the RF coil.

*Replace the RF coil.*

**Issue:**  $\pm 550$  V is outside the acceptable range.

**Diagnosis/Solution:** The DC driver assembly is faulty or the +36 V is missing.

*Make sure the DC driver assembly is plugged in and the +36 V power supply is working correctly.*

## 3.9 RF and DC Control Symptoms

Automatic RF frequency calibration or RF dip and gain problems can be caused by several things. Begin troubleshooting control problems by using *Xcalibur* Diagnostics.

Diagnostics helps you identify whether the fault is due to a power supply problem, a break in the RF signal path, or a faulty component. Figure 3-1 is an excellent resource to begin troubleshooting RF control problems.

If the symptom is observed after performing work on the instrument, it points to mechanical issues; if the symptom arises suddenly during operation of the instrument, it indicates a fault condition.

**Issue:** RF Dip Calibration shows random noise instead of a smooth RF Dip.

**Diagnosis/Solution:** There is a loose cable.

*Check these cables:*

- *Analog to RF Detector PCB (PN 119378-0004)*
- *RF Detector to DC Driver and RF Generator PCB (PN 119378-0038)*
- *Lens Interface to Low Pass Filter PCB*
- *Analog to Low Pass Filter PCB (PN 119378-0039)*
- *RF Generator to Low Pass Filter PCB (PN 119378-0013)*
- *Cables from RF Coil to RF Detector Capacitor or RF feedthroughs*
- *Cables from DC Driver to Low Pass Filter PCB (PN 119378-0036)*
- *Analog to RF Generator PCB (PN 119378-0002)*

**Diagnosis/Solution:** Quadrupole mass filter is not connected to RF feedthroughs.

*Vent the system and check the two connections. The two wires from the quadrupole mass filter should be connected to the top and bottom RF feedthroughs on the rear pins. Or, the connections to the quadrupole mass filter are loose.*

**Diagnosis/Solution:** Prefilter is not connected to RF feedthroughs.

*Vent the system and check the two connections. The two wires from the prefilter should be connected to the top and bottom RF feedthroughs on the front pins.*

**Diagnosis/Solution:** There is high voltage arcing.

*Vent the system and check the quadrupole mass filter and prefilter. Also, check the wires inside the RF coil box. Make sure the four wires going to the RF feedthroughs are far from any surface and especially each other. Check for burn marks or evidence of arcing. Clean components if necessary. Replace the components if problems persist.*

**Issue:** RF Dip Calibration shows random noise instead of a smooth RF Dip.

**Diagnosis/Solution:** There is high voltage arcing.

*Vent the system and check the quadrupole mass filter and prefilter. Also, check the wires inside the RF coil box. Make sure the four wires going to the RF feedthroughs are far from any surface and especially each other. Check for burn marks or evidence of arcing. Clean components if necessary. Replace the components if problems persist.*

**Diagnosis/Solution:** There is a fault with RF Generator PCB power supply (28 V power supply).

*Check the fuse on the RF Generator PCB; replace if necessary.*

**Diagnosis/Solution:** The RF Generator is faulty.

*Replace the RF Generator PCB.*

**Issue:** RF Dip is present, but outside acceptable range.

**Diagnosis/Solution:** There is a fault with the RF coil or the RF detector PCB.

*Contact Technical Support for assistance.*

**Diagnosis/Solution:** There is high voltage arcing.

*Vent the system and check the quadrupole mass filter and prefilter. Also, check the wires inside the RF coil box. Make sure the four wires going to the RF feedthroughs are far from any surface and especially each other. Check for burn marks or evidence of arcing. Clean components if necessary. Replace the components if problems persist.*

**Issue:** The Det RF line (RF Gain Calibration screen) is not a smooth, straight line out to  $m/z$  1050.

**Diagnosis/Solution:** The RF Generator gain is not adjusted.

*Contact Technical Support for assistance.*

**Diagnosis/Solution:** There is high voltage arcing.

*Vent the system and check the quadrupole mass filter and prefilter. Also, check the wires inside the RF coil box. Make sure the four wires going to the RF feedthroughs are far from any surface and especially each other. Check for burn marks or evidence of arcing. Clean components if necessary. Replace the components if problems persist.*

**Issue:** The Det RF and RF Mod lines are erratic.

**Diagnosis/Solution:** There is a loose cable.

*Check these cables:*

- *Analog to RF Detector PCB (PN 119378-0004)*
- *RF Detector to DC Driver and RF Generator PCB (PN 119378-0038)*
- *Lens Interface to Low Pass Filter PCB*
- *Analog to Low Pass Filter PCB (PN 119378-0039)*
- *RF Generator to Low Pass Filter PCB (PN 119378-0013)*
- *Cables from RF Coil to RF Detector Capacitor or RF feedthroughs*
- *Cables from DC Driver to Low Pass Filter PCB (PN 119378-0036)*
- *Analog to RF Generator PCB (PN 119378-0002)*

**Diagnosis/Solution:** There is a problem with the RF control PCB, low pass filter PCB, the RF generator PCB, or the RF coil.

*Contact Technical Support.*

**Diagnosis/Solution:** There is high voltage arcing.

*Vent the system and check the quadrupole mass filter and prefilter. Also, check the wires inside the RF coil box. Make sure the four wires going to the RF feedthroughs are far from any surface and especially each other. Check for burn marks or evidence of arcing. Clean components if necessary. Replace the components if problems persist.*

**Issue:** Rod DC diagnostic fails.

**Diagnosis/Solution:** If all tests fail, the DC driver is unplugged or faulty.

*Check all cables to the DC driver assembly. Replace the assembly if necessary.*

**Diagnosis/Solution:** If A Rod DC and B Rod DC fail but Average DC passes, RF dip, RF gain, or RF null may be adjusted incorrectly.

*Check RF dip and RF gain calibrations. The RF may not be working properly or the DC driver assembly is unplugged or faulty. Check the RF null (see [TRACE DSQ User's Guide](#)).*

## 3.10 Sensitivity Symptoms

If you observe a drop in instrument sensitivity, you should determine if the sensitivity drop was sudden or if it occurred gradually. A sudden loss of sensitivity can be the result of sudden component failure or an unnoticed change in the analytical method. Simple errors such as a plugged autosampler syringe or too low sample level in the sample vial can give the appearance of instrument failure.

Gradual drops in sensitivity are usually the result of ion source, lens, or prefilter contamination, and are easily remedied by cleaning the ion volume, lenses, and prefilter.

The electron multiplier influences sensitivity and has a limited lifetime. Eventually it will need to be replaced.

Improper GC maintenance is another cause of diminished sensitivity. It is important to establish a routine maintenance program for the GC. See your *TRACE GC Maintenance Manual* for more information on establishing a maintenance program.

**Issue:** Poor sensitivity or sudden loss in sensitivity.

**Diagnosis/Solution:** The wrong type of ion volume is installed.

*EI and CI require different ion volumes. They may not be used interchangeably.*

**Diagnosis/Solution:** The ion volume is incorrectly positioned.

*Position the ion volume properly by removing and reinserting it.*

**Diagnosis/Solution:** There is a large air leak.

*Run Leak Check in Automatic Tune or look for m/z 28 as base peak in full scan. See **High Vacuum Symptoms** on page 161.*

**Diagnosis/Solution:** The injector or septum is leaking.

*Replace septum and perform leak check on GC.*

**Diagnosis/Solution:** GC column is not inserted beyond end of transfer line or GC column is broken off in ion source.

*Check column installation.*

**Diagnosis/Solution:** The ion volume, lenses, or prefilter are dirty.

*Clean the ion volume, lenses, and prefilter.*

**Diagnosis/Solution:** Prefilter is misaligned, or broken.

*Check alignment of prefilter.*

**Diagnosis/Solution:** Cables are loose incorrectly installed or missing

*If some ions are present, make sure entrance lens is plugged in and make sure cables for P1 and P2 are plugged in correctly on the Low Pass Filter PCB.*

**Diagnosis/Solution:** The instrument is out of tune, or tune file is incorrect.

*Select correct tune file for the method or run Automatic Tune.*

**Diagnosis/Solution:** The magnets above and below the ion source are installed incorrectly.

*Position both magnets so the south pole is on top. Electrons will not be focused into the ion volume if one magnet is upside down.*

**Diagnosis/Solution:** Emission current is set too low.

*Check the setting listed for the emission current. See Tune | Manual and select the Controls tab.*

**Diagnosis/Solution:** Cable J3 on the analog PCB is plugged into J4.

*Check the cable and correct if necessary.*

**Diagnosis/Solution:** There is a problem with filament or lens control.

See **Filament and Lens Control Symptoms** on page 154.

**Diagnosis/Solution:** The ion source PCB is faulty, allowing emission current to leak to ground.

*Replace the ion source PCB.*

**Diagnosis/Solution:** Reagent gas is leaking into the analyzer, suppressing EI signal.

*Check for presence of Cl reagent ions in spectrum. Replace Cl gas flow module if necessary.*

**Diagnosis/Solution:** Incorrectly matched syringe, injection port liner, and column depth in injector.

*See TRACE GC documentation for correct combination.*

**Diagnosis/Solution:** Insufficient sample delivery due to plugged syringe needle.

*Clean or replace syringe.*

**Diagnosis/Solution:** The injection port liner is contaminated.

*Clean or replace injection port liner.*

**Diagnosis/Solution:** Graphite or septa particles contaminate the injection port.

*Clean the injection port.*

**Diagnosis/Solution:** The capillary column is at the end of its life span.

*Replace capillary column.*

**Diagnosis/Solution:** Dust has collected in the electron multiplier or on the conversion dynode.

*Dust the electron multiplier and conversion dynode with clean, dry gas.*

**Diagnosis/Solution:** Method development problems are present.

*Contact Technical Support.*

**Issue:** Sensitivity is unstable or shows decrease with repeated injections.

**Diagnosis/Solution:** GC temperature ramp does not continue to a high enough temperature to elute high boiling point compounds. Multiple injections cause these compounds to accumulate in column, reducing sensitivity.

*Extend upper temperature or time at upper temperature in GC oven ramp.*

**Diagnosis/Solution:** The ion volume, lenses, or prefilter are dirty.

*Clean the ion volume, lenses, and prefilter.*

**Diagnosis/Solution:** The ion source temperature is too low and cause it to contaminate too quickly.

*Clean the ion volume, lenses, and prefilter and then raise the ion source temperature.*

**Diagnosis/Solution:** There is a problem with the filament emission current control.

See **Filament and Lens Control Symptoms** on page 154.

**Diagnosis/Solution:** The electron multiplier is faulty.

See **Tuning Symptoms** on page 188.

**Diagnosis/Solution:** The injection port liner or capillary column are contaminated.

*Replace the injection port liner and trim the capillary column.*

**Issue:** No ions are visible in Tune after selecting Restore Default Calibration.

**Diagnosis/Solution:** Instrument is not calibrated.

*Run Full Automatic Tune with all calibrations selected.*

**Diagnosis/Solution:** No high  $m/z$  ion intensity because the RF is not tuned correctly.

See **RF and DC Control Symptoms** on page 172.

**Issue:** Poor high mass response.

**Diagnosis/Solution:** No high  $m/z$  ion intensity because the RF is not tuned correctly.

See **RF and DC Control Symptoms** on page 172.

**Diagnosis/Solution:** The ion volume, lenses, or prefilter are dirty.

*Clean the ion volume, lenses, and prefilter.*

**Diagnosis/Solution:** Poor high  $m/z$  ion ratios because the ion source temperature is too high.

*Reduce the ion source temperature to reduce the amount of thermal decomposition and fragmentation of your analyte.*

**Diagnosis/Solution:** The conversion dynode is unplugged or faulty.

*Check the cable or replace the electron multiplier/conversion dynode power supply.*

**Diagnosis/Solution:** Reagent gas is leaking into the analyzer, suppressing EI signal.

*Check for presence of Cl reagent ions in spectrum. Replace Cl reagent gas flow module if necessary.*

**Issue:** Poor low mass sensitivity or  $m/z$  219 is base peak for calibration gas.

**Diagnosis/Solution:** Prefilter offset voltage is too negative.

*Adjust prefilter offset.*

**Diagnosis/Solution:** The ion volume, lenses, or prefilter are dirty.

*Clean the ion volume, lenses, and prefilter.*

**Diagnosis/Solution:** Prefilter is misaligned or broken.

*Check alignment of prefilter.*

**Diagnosis/Solution:** Lens voltages are incorrect.

*Select Restore Default Tune.*

**Issue:** Isotopes are missing or isotope ratios are incorrect.

**Diagnosis/Solution:** Masses are not resolved.

*Adjust Resolution and/or Ion Offset in Tune | Manual Tune View | Resolution Tab.*

**Diagnosis/Solution:** Detector gain is too low.

*Increase detector gain.*

**Issue:** Irregular ion ratios.

**Diagnosis/Solution:** The wrong type of ion volume is installed.

*EI and CI require different ion volumes. They may not be used interchangeably.*

**Diagnosis/Solution:** Lens voltages or prefilter offset voltage are incorrect.

*Select Restore Default Tune.*

**Diagnosis/Solution:** Prefilter is misaligned, or broken.

*Check alignment of prefilter.*

**Diagnosis/Solution:** The ion volume, lenses, or prefilter are dirty.

*Clean the ion volume, lenses, and prefilter.*

**Diagnosis/Solution:** GC column is not inserted beyond end of transfer line or GC column is broken off in ion source.

*Check column installation.*

**Diagnosis/Solution:** There is a large air leak.

*Run Leak Check in Automatic Tune or look for  $m/z$  28 as base peak in full scan. See [High Vacuum Symptoms](#) on page 161.*

**Diagnosis/Solution:** Cables are loose incorrectly installed or missing

*If some ions are present, make sure entrance lens is plugged in and make sure cables for P1 and P2 are plugged in correctly on the Low Pass Filter PCB.*

**Issue:** Weak Signal.

**Diagnosis/Solution:** The ion volume, lenses, or prefilter are dirty.

*Clean the ion volume, lenses, and prefilter.*

**Diagnosis/Solution:** The detector gain is set too low.

*Run Detector Gain Calibration in Automatic Tune. Try a higher gain setting. A multiplier >2-3 years old may be too noisy for the Detector Gain Calibration to accurately set the voltage. The multiplier may need to be replaced.*

**Diagnosis/Solution:** The wrong type of ion volume is installed.

*EI and CI require different ion volumes. They may not be used interchangeably.*

**Diagnosis/Solution:** The ion volume is absent or incorrectly positioned.

*Verify that the ion volume is positioned correctly by removing and reinserting it.*

**Diagnosis/Solution:** There is a filament or lens control problem.

See **Filament and Lens Control Symptoms** on page 154.

**Issue:** Poor sensitivity in CI mode.

**Diagnosis/Solution:**

- An EI Ion Volume is installed. Install a CI Ion Volume.
- The small hole in the CI Ion Volume is plugged. Use a dental pick or old syringe needle to clear it.
- The Filament is not aligned. Remove the Ion Volume and check if the ion burn is centered around the small electron entrance hole. Be sure the Filament is properly inserted into the connector. Carefully bend the Filament wire to better align it with the Ion Volume.
- The Ion Volume is not inserted properly. While running the instrument, you can push on the Ion Volume with the I/R Tool. Be sure to monitor the pressure to ensure that you get a good seal around the I/R Tool. Otherwise, you may damage the Filament. An increase in signal for the calibration gas as you push on the Ion Volume usually indicates that the Filament is not aligned properly.

## 3.11 Stability Symptoms

Stability problem symptoms are concerned with consistent instrument precision and the reproducibility of accurate results. Good operating conditions for the mass spectrometer, gas chromatograph, and autosampler contribute to instrument stability.

Sample preparation, spiking errors, sample injection errors, and lack of routine maintenance on the instruments may cause false stability symptoms.

When hardware faults affect instrument stability, investigate simple solutions first, such as cleaning the ion volume and lenses, or checking for air leaks. Usually, a hardware fault that affects stability will show different symptoms than those which might be attributed to stability.

**Issue:** Mass assignment is unstable.

**Diagnosis/Solution:** The RF and DC have not stabilized.

*Allow the instrument to scan for about 1 min.*

**Diagnosis/Solution:** There is a problem with the RF or DC.

*See [RF and DC Control Symptoms](#) on page 172.*

**Issue:** Signal response is unstable or shows unexpected drop-out.

**Diagnosis/Solution:** Autosampler rinse vials have septum pieces in them, which can clog or change the amount of sample in the syringe. Use aluminum foil instead of septa for the rinse vials. Special Teflon caps are also available for the AI/AS 3000 (PN 31301103).

**Diagnosis/Solution:** There is a problem with filament or lens control.

*See [Filament and Lens Control Symptoms](#) on page 154.*

**Diagnosis/Solution:** There is an air leak.

*Check for leaks. See [High Vacuum Symptoms](#) on page 161.*

**Diagnosis/Solution:** There is a high vacuum problem.

*See [High Vacuum Symptoms](#) on page 161.*

**Diagnosis/Solution:** There is a communication problem.

*See [Communication Symptoms](#) on page 144.*

**Diagnosis/Solution:** Dust has collected in the electron multiplier or on the Conversion Dynode.

*Dust the electron multiplier and conversion dynode with clean, dry gas.*

## 3.12 Tuning Symptoms

Symptoms when tuning may be the result of a misadjusted manual control parameter.

Suspect a tuning problem when *Xcalibur* Autotune fails. Autotune performs several functions, and symptoms or error messages indicate different problems.

A tuning symptom can usually be found in Diagnostics.

**Issue:** Automatic Tune reports "Cannot perform RF frequency calibration".

**Diagnosis/Solution:** There is a problem with the RF control system.

See [RF and DC Control Symptoms](#) on page 172.

**Issue:** Automatic Tune reports "Cannot find calibration gas peaks".

**Diagnosis/Solution:** There is a mechanical problem with the ion source or lenses.

*Verify that an EI ion volume is installed.*

*Verify correct orientation and cleanliness of ion volume.*

*Verify cleanliness and correct operation of lenses.*

**Diagnosis/Solution:** There is a problem with the RF or DC.

See [RF and DC Control Symptoms](#) on page 172.

**Diagnosis/Solution:** The calibration gas vial is empty.

*Add 100  $\mu$ L (max) to calibration gas vial.*

**Issue:** Automatic Tune reports "Mass Calibration or Resolution Calibration should be run"

**Diagnosis/Solution:** Instrument has not been given sufficient time to stabilize.

*Allow instrument to stabilize power supplies while scanning m/z 50 to 650 for 1 minute.*

**Diagnosis/Solution:** Instrument requires calibration.

*Select Mass Calibration or Resolution Calibration in Automatic Tune.*

**Issue:** Automatic Tune reports "Cannot perform detector gain calibration"

**Diagnosis/Solution:** The electron multiplier has not been given sufficient time to outgas since venting.

*Allow more time to pump out.*

**Diagnosis/Solution:** The GC column flow is too high.

*Lower it to 1 mL/min.*

**Diagnosis/Solution:** Dust on conversion dynode or electron multiplier.

*Remove dust with dry gas.*

**Diagnosis/Solution:** The multiplier anode is dirty or leaking.

*Inspect and clean the anode.*

**Diagnosis/Solution:** Mass and resolution are not calibrated.

*Adjust detector gain in Tune to see background ions and run resolution and mass calibrations in Automatic Tune.*

**Diagnosis/Solution:** The calibration gas vial is empty.

*Add 100  $\mu$ L (max) to calibration gas vial.*

**Diagnosis/Solution:** The electron multiplier is near the end of its lifetime.

*Multipliers typically last about 2-3 years before they are too noisy for the gain to be set accurately. Replace the electron multiplier.*

**Diagnosis/Solution:** The electrometer PCB is noisy.

*Replace electrometer PCB.*

**Diagnosis/Solution:** The electron multiplier power supply is faulty.

*Replace electron multiplier power supply.*

**Diagnosis/Solution:** The filament is the source of too much background noise.

See **Filament and Lens Control Symptoms** on page 154.

**Diagnosis/Solution:** Chemical background in the manifold is elevated.

*Remedy leaks or sources of water contamination in carrier gas. See **High Vacuum Symptoms** on page 161.*

**Issue:** Automatic Tune reports "Cannot calibrate resolution."

**Diagnosis/Solution:** Contaminant ions interfere with  $m/z$  100 or  $m/z$  502.

*Allow contaminants to pump away.*

**Diagnosis/Solution:** Calibration gas ions ( $m/z$  69, 131, 264) are present but more than  $\pm 12.5\%$  or  $\pm 20$  u off, whichever is smaller.

*Adjust mass calibration manually by configuring Tune to display Manual Calibration in the Instrument Configuration Service tab. Enter the observed  $m/z$  for calibration gas ions in Manual Calibration and select Mass Calibrate.*

**Diagnosis/Solution:** The calibration gas vial is empty.

*Add 100  $\mu$ L (max) to calibration gas vial.*

**Diagnosis/Solution:** DC/RF gain is set incorrectly.

*Contact Technical Support.*

**Issue:** Automatic Tune reports "Cannot perform mass calibration."

**Diagnosis/Solution:** Resolution is not calibrated.

*Calibrate resolution by running Automatic Tune.*

**Diagnosis/Solution:** Contaminant ions interfere with calibration gas ions.

*Allow contaminants to pump away.*

**Diagnosis/Solution:** Calibration gas ions ( $m/z$  69, 131, 264) are present but more than  $\pm 12.5\%$  or  $\pm 20$  u off, whichever is smaller.

*Adjust mass calibration manually by configuring Tune to display Manual Calibration in the Instrument Configuration Service tab. Enter the observed  $m/z$  for calibration gas ions in Manual Calibration and select Mass Calibrate.*

**Diagnosis/Solution:** The calibration gas vial is empty.

*Add 100  $\mu$ L (max) to calibration gas vial.*

**Issue:** Automatic Tune reports "An air leak has been detected."

**Diagnosis/Solution:** There may be an air leak.

See [High Vacuum Symptoms](#) on page 161.

**Issue:** Tune reports an error while saving a Tune file.

**Diagnosis/Solution:** A file with the same name already exists with read-only attributes.

*Change the existing file's attributes so it can be overwritten.*

# 4 *Vacuum System and Gas Inlets*

This chapter contains theory of operations for the vacuum system and gas inlets.

## In This Chapter

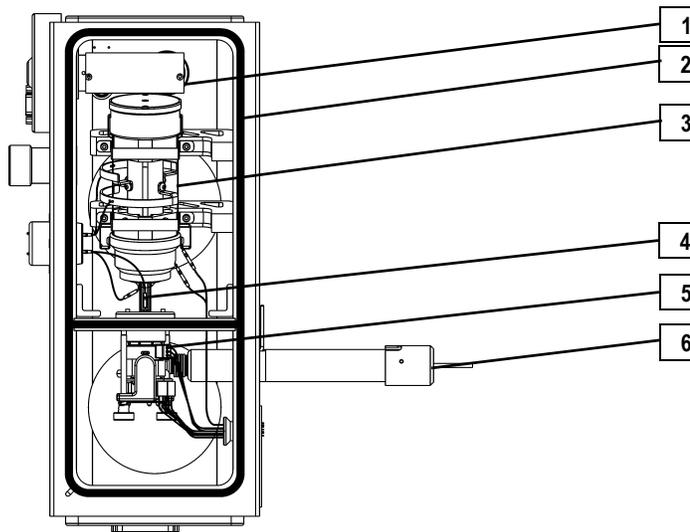
---

[4.1 Vacuum System Components, pp. 194](#)

[4.2 Gas Inlets, pp. 202](#)



Analyze • Detect • Measure • Control™



1	Ion Detector Assembly	4	Prefilter
2	O-Ring	5	Ion Source Assembly
3	Quadrupole Assembly	6	Transfer Line

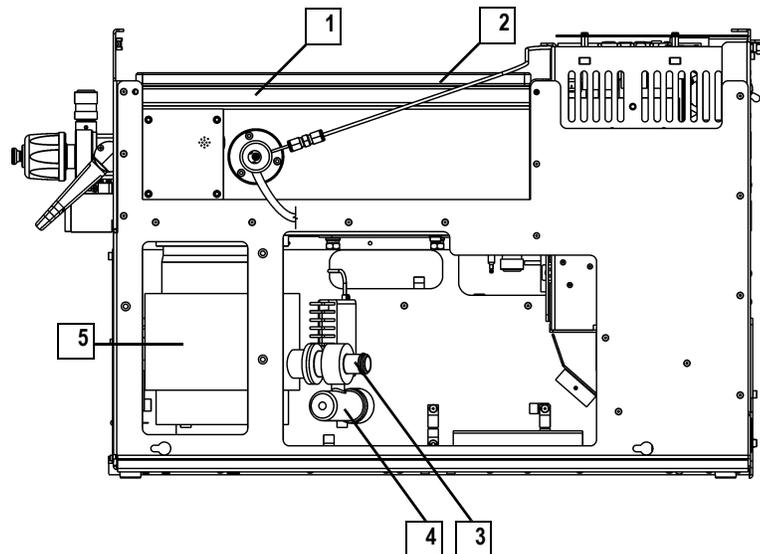
**Figure 4-1. Vacuum Manifold Components**

## 4.1 Vacuum System Components

Vacuum System primary components:

- Forepressure Gauge
- High Vacuum Pump (Turbomolecular)
- Ion Gauge (Upgrade Option)
- Rotary-Vane Pump
- Vacuum Manifold

## Description



1	Vacuum Manifold	4	Forepressure Gauge
2	Ion Gauge (on Left Side of Vacuum Manifold)	5	High Vacuum Pump
3	Foreline Adapter (Connects the Foreline Hose to the Rotary-Vane Pump)		

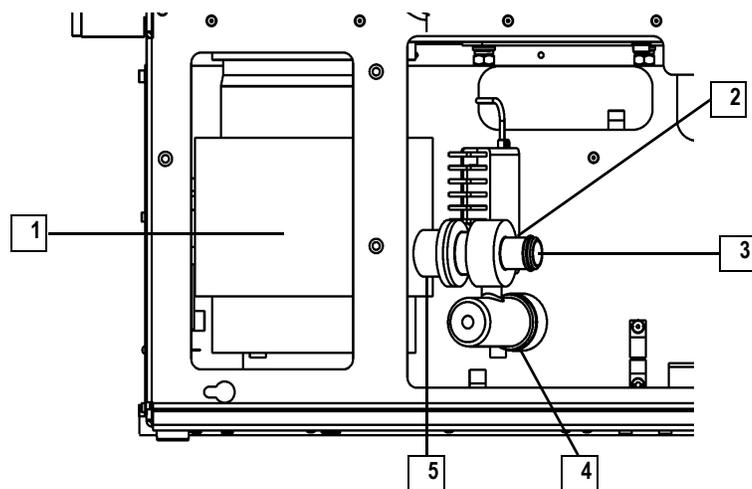
**Figure 4-2. Vacuum System Components (Right Side)**

Vacuum system components lower the pressure within the *TRACE DSQ*. The principal components include: the Forepressure Gauge, High Vacuum Pump, Ion Gauge, Rotary-Vane Pump, and the Vacuum Manifold. This also includes valves, gauges, and associated control devices. All but the Rotary-Vane Pump are located around the vacuum manifold.

## Theory of Operations

These components maintain the low pressure necessary for the Ion Source, Quadrupole, and Ion Detector Assembly to operate properly. The Vacuum Manifold, which houses the Ion Source, Quadrupole, and Ion Detector Assembly, is pumped (or evacuated) by the High Vacuum Pump.

## Forepressure Gauge and Foreline Adapter



1	High Vacuum Pump	4	Forepressure Gauge
2	Foreline Adapter	5	High Vacuum Pump Outlet
3	Foreline Hose Outlet		

**Figure 4-3. Forepressure Gauge and Foreline Adapter (Right Side)**

The Forepressure Gauge and Foreline Adapter are connected to the outlet of the High Vacuum Pump. The Forepressure Gauge measures the pressure in the foreline. If the pressure inside become too high, the Vacuum Control PCB removes power to the High Vacuum Pump to prevent damage.

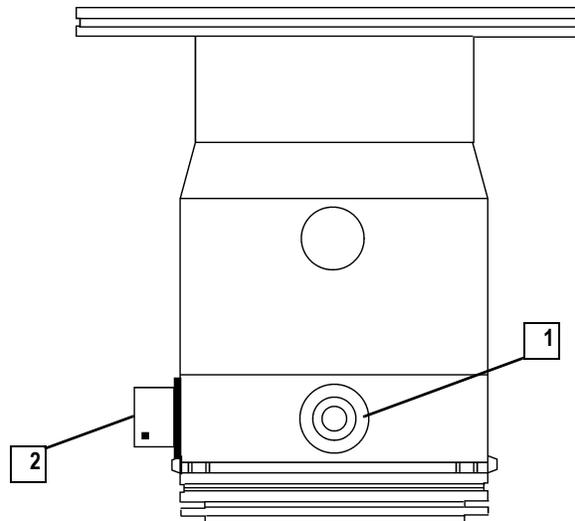
The Foreline Adapter connects the Foreline Hose from the Rotary-Vane Pump inlet to the High Vacuum Pump Outlet.

## High Vacuum Pump (Single Turbomolecular Pump)

The High Vacuum Pump creates the low pressure require by the Ion Source, Quadrupole, and Ion Detector Assembly. The *TRACE DSQ* can be equipped with one of two types of single Turbomolecular Pumps: a 70 L/s or a 250 L/s.

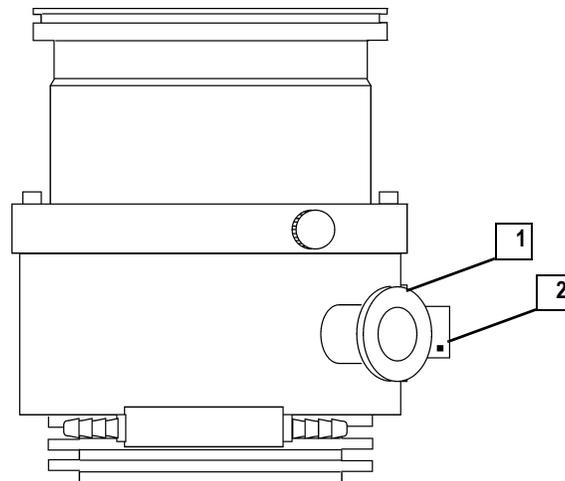
In this configuration, the Ion Source, Quadrupole, and Ion Detector Assembly are pumped by a single pump. The 250 L/s pump is recommended for application that use high gas flows into the Vacuum Manifold such as CI.

Turbomolecular Pump operation is purely mechanical and does not require oil to create a high vacuum. These Turbomolecular Pumps have a multi-stage axial-flow turbine in which high speed rotating blades provide compression by increasing the probability of gas molecules moving in the pumping direction. The Turbomolecular Pump requires the use of a Rotary-Vane Pump to exhaust to atmosphere.



1	Turbomolecular Pump Outlet	2	Electrical Supply Connector
---	----------------------------	---	-----------------------------

**Figure 4-4. 70 L/s Turbomolecular Pump**



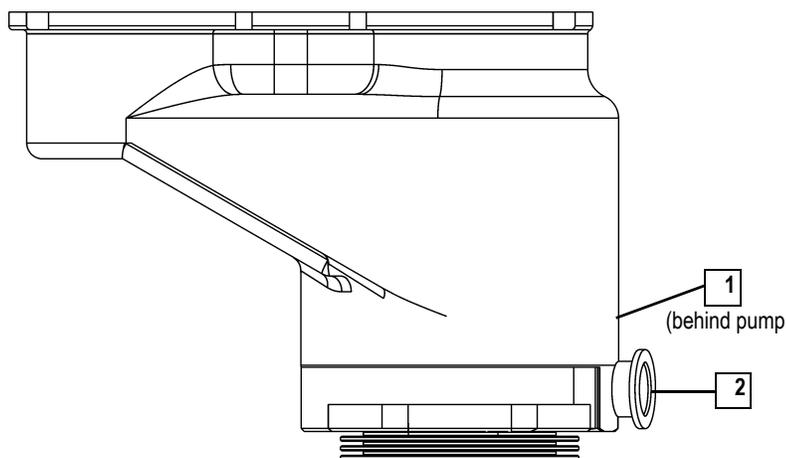
1	Turbomolecular Pump Outlet	2	Electrical Supply Connector
---	----------------------------	---	-----------------------------

**Figure 4-5. 250 L/s Turbomolecular Pump**

## High Vacuum Pump (Split-Flow Turbomolecular Pump)

As an upgrade option, a differentially pumped configuration of *TRACE DSQ* is available. In a differentially pumped instrument, the Ion Source is pumped separately from the Quadrupole and Ion Detector Assembly. Rather than using two individual Turbomolecular Pumps, a split-flow Turbomolecular Pump is used. Such a pump uses less power, is more reliable, and less expensive than two separate pumps.

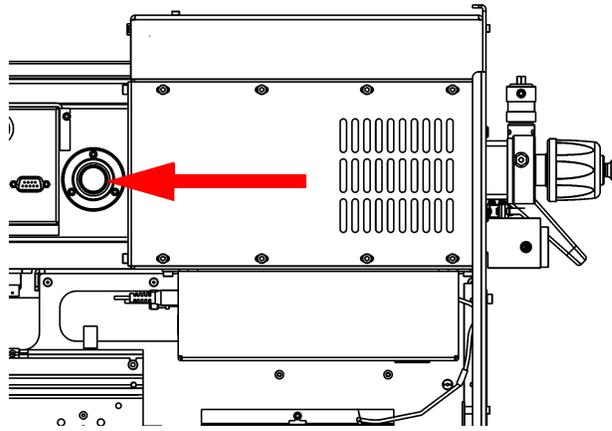
With a differentially pumped system, you can use higher flow rates of gas (helium from the GC and CI reagent gas) into the Ion Source without adversely affecting the performance of the Quadrupole. Sensitivity and resolution are optimum when the pressure in the Quadrupole is low.



1	Electric Supply Connector (Not Shown)	2	Turbomolecular Pump Outlet
---	---------------------------------------	---	----------------------------

**Figure 4-6. Split-flow Turbomolecular Pump**

## Ion Gauge (Upgrade Option)

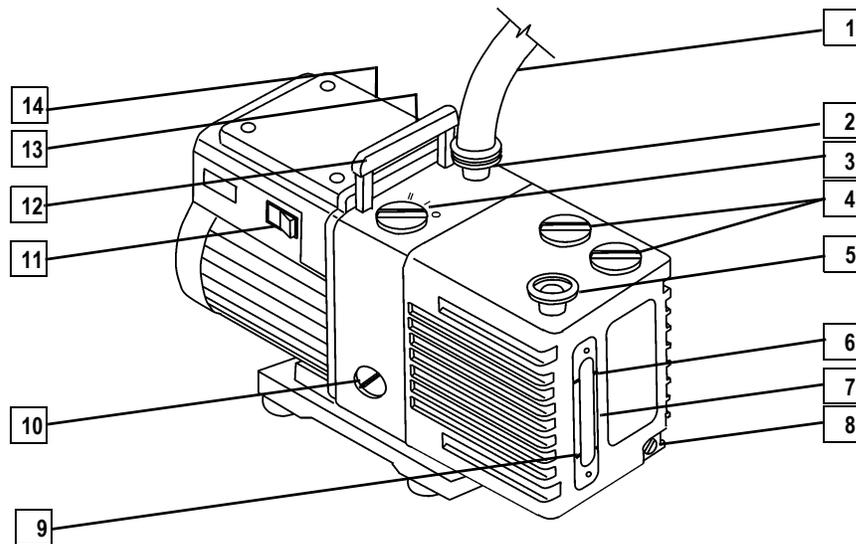


**Figure 4-7. Ion Gauge (Left Side)**

The Ion Gauge mounts on the left side of the Vacuum Manifold. An Ion Gauge measures the pressure inside the Vacuum Manifold, and produces energetic electrons to ionize molecules. Positive ions formed in the Ion Gauge are attracted to a collector. The collector current is related to the pressure in the Vacuum Manifold.

If you have an Ion Gauge, it must be on and the pressure below  $1 \times 10^{-3}$  Torr to turn on the Filament, Electron Multiplier, or Conversion Dynode. This protects these assemblies from damage.

## Rotary-Vane Pump



1	Foreline Vacuum Hose	8	Drain Plug
2	Inlet Port	9	MIN (Minimum Level Mark)
3	Gas-Ballast Control	10	Mode Selector
4	Oil Filler Plugs	11	On/Off Switch
5	Outlet Port	12	Handle
6	MAX (Maximum Level Mark)	13	Voltage Indicator
7	Oil-Level Sight-Glass	14	Electrical Inlet Connector

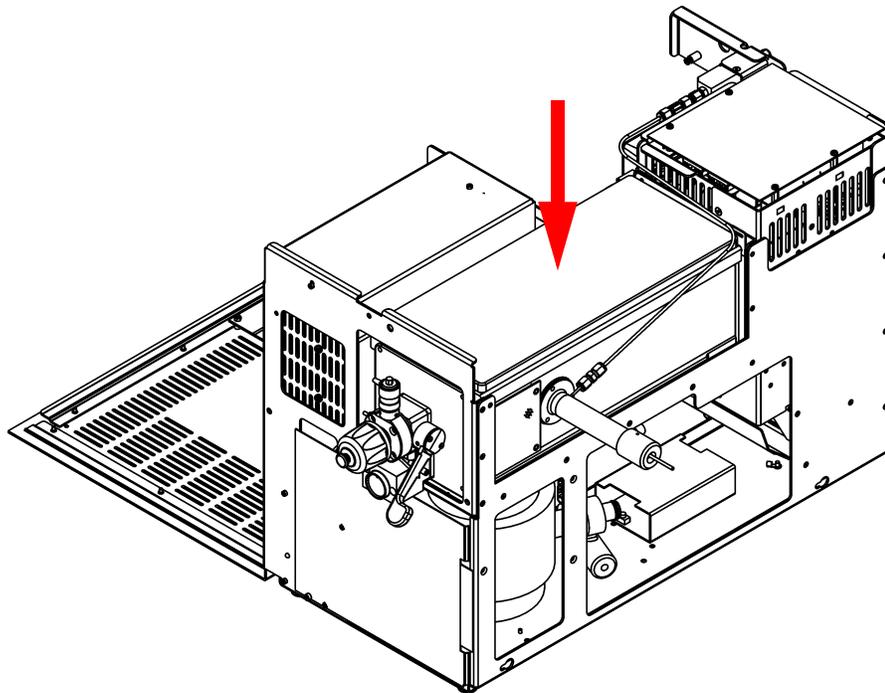
**Figure 4-8. Rotary-Vane Pump**

The Rotary-Vane Pump is typically located on the floor behind the *TRACE DSQ*. It is a two-stage forepump that connects to the outside of the *TRACE DSQ*. It establishes the vacuum necessary for properly operating the High Vacuum Pump.

The Rotary-Vane Pump connects to the High Vacuum Pump by a piece of 0.75 in. ID tubing. The power cord plugs into the rear of the *TRACE DSQ* in the outlet labeled MECH PUMP. This outlet powers the pump and is controlled by the main circuit breaker and not by the service switch.

<b>CAUTION</b> <b>Instrument Damage</b>	
	Always plug the Rotary-Vane Pump power cord into the outlet on the rear of the <i>TRACE DSQ</i> and never into a wall outlet. If the pump is not plugged into the <i>TRACE DSQ</i> rear it will not shut down when the instrument is powered off. As a result, the pump will continue to run and the <i>TRACE DSQ</i> will not be able to vent to atmosphere.

## *Vacuum Manifold*



**Figure 4-9. Vacuum Manifold (Front, Right Side)**

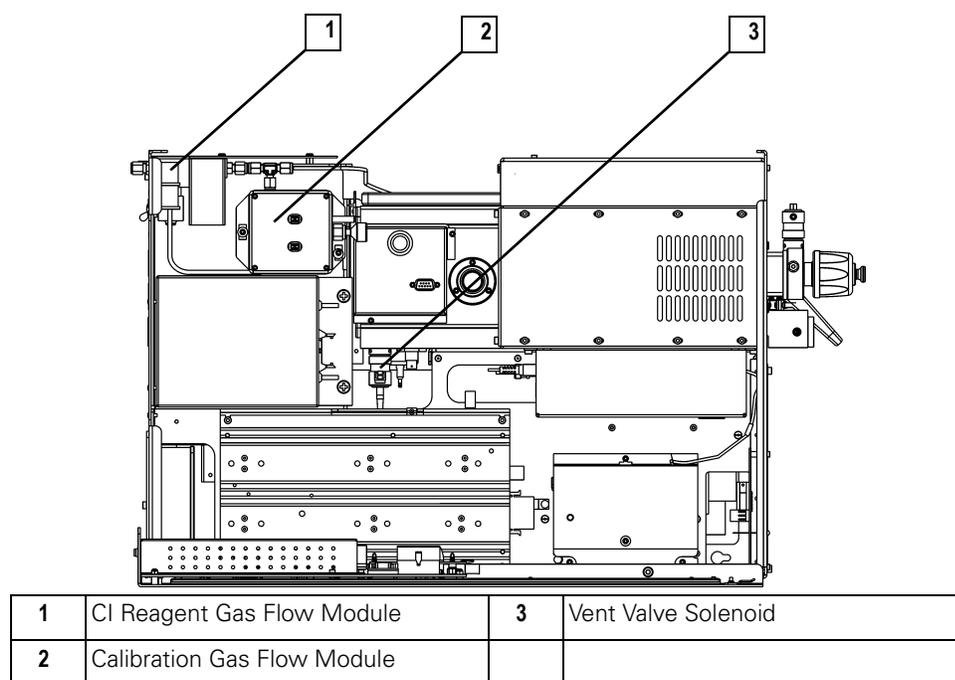
The Vacuum Manifold is located on the top right of the *TRACE DSQ*, directly above the High Vacuum Pump. The Vacuum Manifold is a thick walled, aluminum chamber which encases the heart of the *TRACE DSQ* (the Ion Source, Quadrupole, and Ion Detector Assembly). The Vacuum Manifold has a removable cover, machined flanges on the front and rear, and various electrical feedthroughs and gas inlets.

## 4.2 Gas Inlets

Gas Inlets primary components:

- Calibration Gas Flow Module
- CI Reagent Gas Flow Module (Upgrade Option)
- Vent Valve Solenoid

### Description



**Figure 4-10. Gas Inlets (Left Side)**

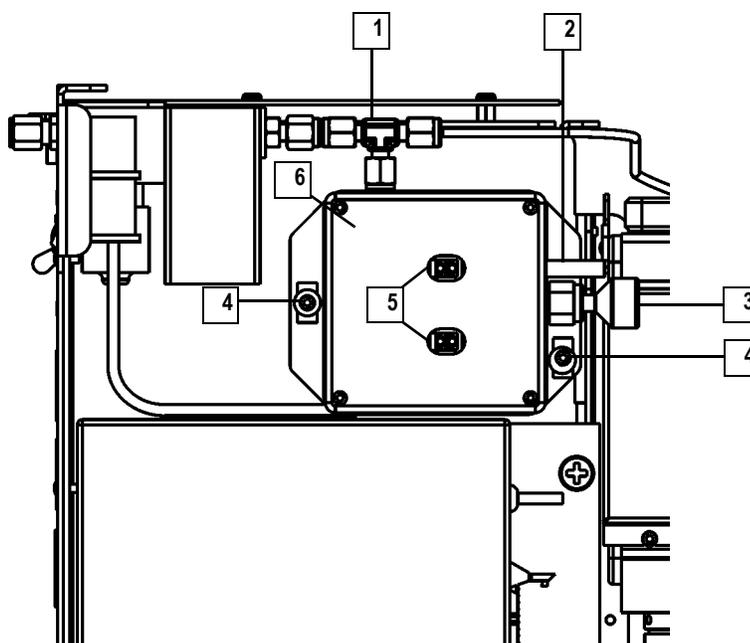
There are three Gas Inlets to the Vacuum Manifold. A Calibration Gas Flow Module for calibration compound control, a CI Reagent Gas Flow Module which regulates the flow of CI reagent gas into the Ion Source, and a Vent Valve Solenoid for venting the Vacuum Manifold to the atmosphere.

## Theory of Operations

Gas Inlets control the input of various gases into the Vacuum Manifold.

### Calibration Gas Flow Module

The Calibration Gas Flow Module controls the flow of calibration compound into the Ion Source and is mounted at the back left of the *TRACE DSQ*. The calibration compound provides reference peaks to tune and calibrate the detector.



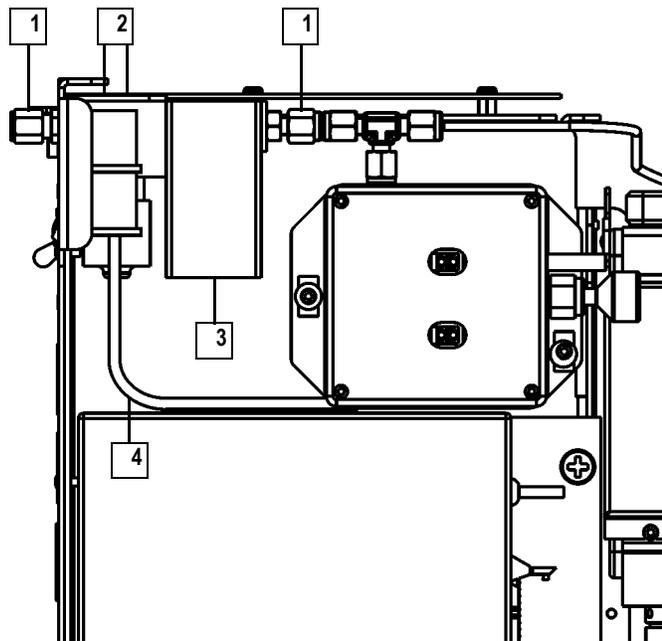
1	Gas Fittings	4	Screws, 2
2	Foreline Adapter Tubing	5	Cables, 4
3	Calibration Compound Vial	6	Calibration Gas Flow Module

**Figure 4-11. Calibration Gas Flow Module (Left Side)**

The module can deliver two different flows of calibration compound. One is a low flow for EI and NICl. The other is a higher flow used for PICl. The module permits calibration compound to enter the Ion Source through 1/8 in. OD tubing.

The module is factory charged with 0.1 mL of perfluorotributylamine, which is adequate for approximately one year of operation.

## CI Reagent Gas Flow Module (Upgrade Option)

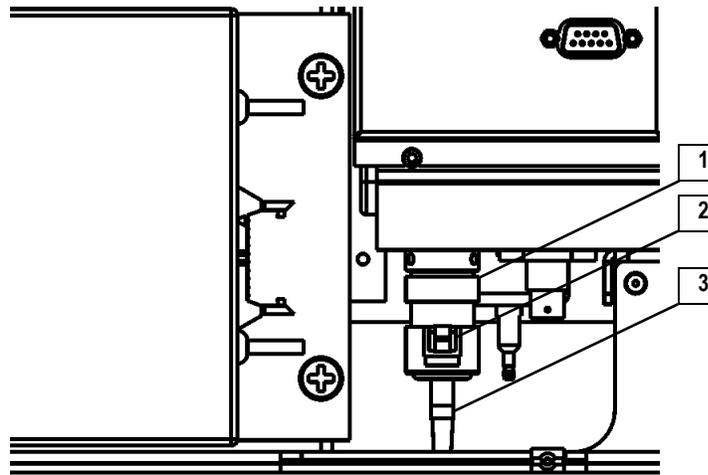


1	Gas Fittings, 2	3	Cable (to Analog PCB)
2	Screws Holding the Module, 2	4	Foreline Adapter Tubing

**Figure 4-12. CI Reagent Gas Flow Module (Left Side)**

The CI Reagent Gas Flow Module controls the flow of CI reagent gas into the Ion Source and is located at the back left of the *TRACE DSQ*. The module uses electronic pressure control to precisely set the flow of reagent gas. The flow is programmed using *Xcalibur*, which allows you to accurately reproduce flows.

## Vent Valve Solenoid



1	Vent Valve Solenoid	3	Vent Valve Filter
2	Cable		

**Figure 4-13. Vent Valve Solenoid (Left Side)**

The Vent Valve Solenoid allows the Vacuum Manifold to vent to atmospheric pressure and is mounted on the bottom of the Vacuum Manifold. It is controlled by the Vacuum Control PCB. The Vent Valve Filter prevents dust and debris from getting in the Vacuum Manifold.

When the main circuit breaker is on, the Vacuum Control PCB supplies power to the Vent Valve Solenoid to keep it closed. Approximately two to three seconds after power is removed from the system, the Vent Valve Solenoid opens and the Vacuum Manifold is vented to atmospheric pressure. This process takes about four minutes.



# 5 *Ion Source and Inlet Valve*

This chapter contains theory of operations for ion source components and the inlet valve.

## In This Chapter

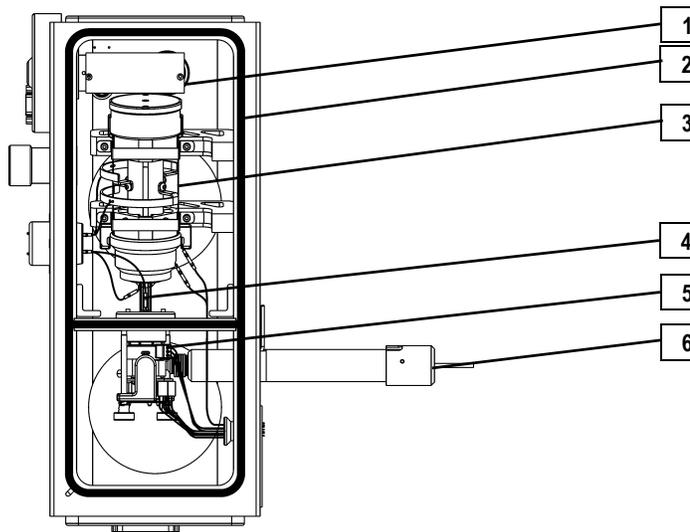
---

[5.1 Ion Source, pp. 208](#)

[5.2 Inlet Valve \(Upgrade Option\), pp. 215](#)



Analyze • Detect • Measure • Control™



1	Ion Detector Assembly	4	Prefilter
2	O-Ring	5	Ion Source Assembly
3	Quadrupole Assembly	6	Transfer Line

**Figure 5-1. Vacuum Manifold Components**

## 5.1 Ion Source

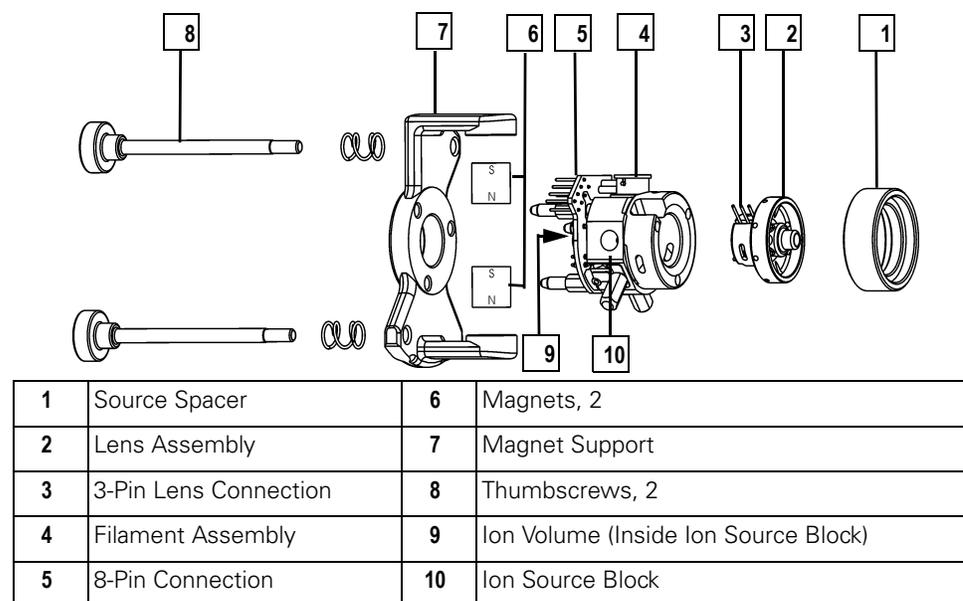
Ion Source (EI or CI) primary components:

- Filament Assembly
- Ion Source Block Assembly
- Ion Volume Assembly
- Lenses
- Magnets and Magnet Support

## Description

The Ion Source is the part of the mass spectrometer where ions are formed. It is located inside and to the front of the Vacuum Manifold.

The Ion Source uses an interchangeable Ion Volume so that two different ionization modes can be used (EI or CI). The Ion Volume sits inside the Ion Source Block, which is heated by three Cartridge Heaters. Three Lenses at the exit of the Ion Volume draw out either positive or negative ions from the Ion Volume and pass them into the Prefilter.



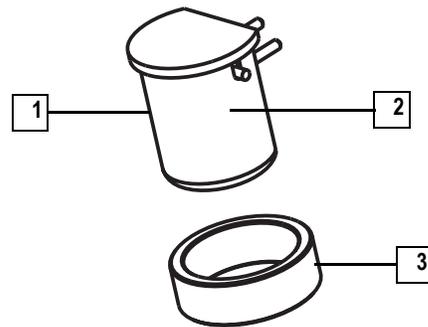
**Figure 5-2. Ion Source Assembly**

## Theory of Operations

An Ion Source has two main functions: to generate a beam of electrons, and to provide a site for these electrons to interact with sample or reagent gas molecules to form ions. Once formed, these ions are then focused by the Lenses into the Prefilter and then the Quadrupole Mass Filter.

### Filament Assembly

A Filament Assembly contains an Electron Lens, Filament, Filament Spacer, and Reflector. It is positioned on top of the Ion Source Block and plugs into the 3-pin Filament Connector on the Ion Source PCB.



1	Electron Lens	3	Filament Spacer
2	Filament and Reflector (inside Electron Lens)		

**Figure 5-3. Filament Assembly**

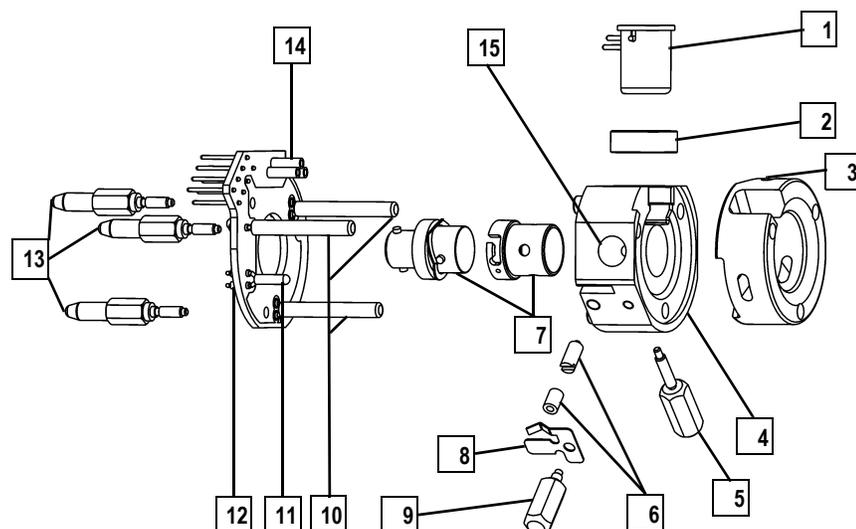
An Electron Lens (the metal cylinder enclosing the Filament and Reflector) prevents positive ions from traveling up the electron beam, extending the life of the Filament. It is located between the Filament and the Ion Volume. The voltage applied to the electron lens affects the flux of electrons that enter the ion volume.

A Filament is a rhenium wire inside the Electron Lens that is electrically heated to produce electrons by thermionic emission.

The Reflector is located inside the Electron Lens, and repels electrons emitted by the Filament toward the Ion Volume. Filaments and reflectors are maintained at negative potential relative to the Ion Volume, usually -70 V. The electrons emitted by the Filament are accelerated into the Ion Volume.

The Filament Spacer is a ceramic ring that aligns the Filament with the electron entrance hole in the Ion Source Block and Ion Volume.

## Ion Source Block Assembly



1	Filament	9	Spring Thumbscrew
2	Filament Spacer	10	Cartridge Heaters, 3
3	Heater Ring	11	Temperature Sensor
4	Ion Source Block	12	Ion Source PCB
5	Alignment Pin/Ion Volume Key Thumbscrew	13	Base-Studs, 3
6	Ion Volume Pin/Set Screw & Ball Plunger	14	3-pin Filament Connector
7	Ion Volume	15	Sample Inlet Aperture
8	Spring		

**Figure 5-4. Ion Source Block Assembly**

During operation, the Ion Source Block holds an Ion Volume in its center. It is aligned by the Ion Volume Key Thumbscrew and secured by the Ball Plunger. Samples are introduced from a GC through the Transfer Line into the sample inlet aperture located on the side of the Ion Source Block. Calibration compound and chemical ionization reagent gas also enter the Ion Volume through the Transfer Line.

The Ion Source PCB supplies voltages to the Filament, Electron Lens, and Cartridge Heaters, as it passes signals from the Temperature Sensor.

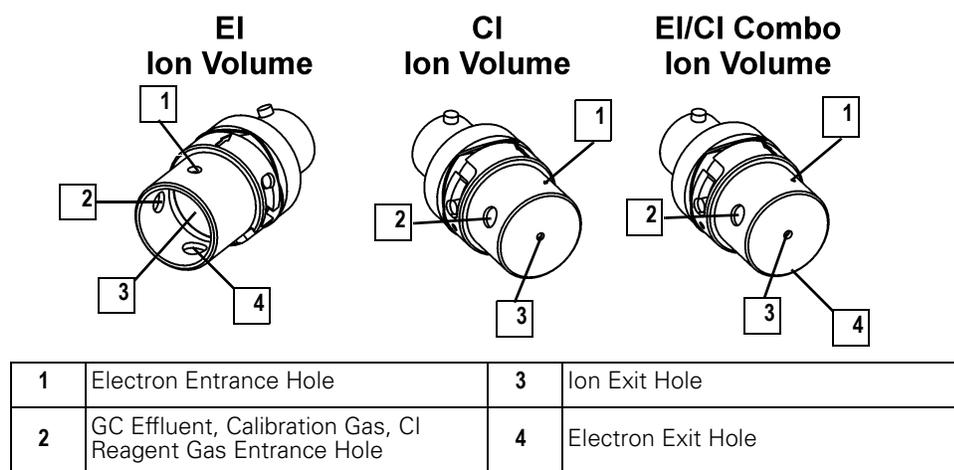
Three Base Studs hold the Ion Source PCB to the Ion Source Block. These studs slip into the Magnet Support and position the Ion Source Block between two permanent Magnets.

Three Cartridge Heaters and a Temperature Sensor are mounted on the Ion Source PCB. Cartridge Heaters pass through and heat the Ion Source Block, as well as heat, align, and support the three ion source Lenses. The Temperature Sensor monitors the temperature of the Ion Source Block.

The Heater Ring slips over the Cartridge Heaters and transfers heat to the Lenses.

## Ion Volume Assembly

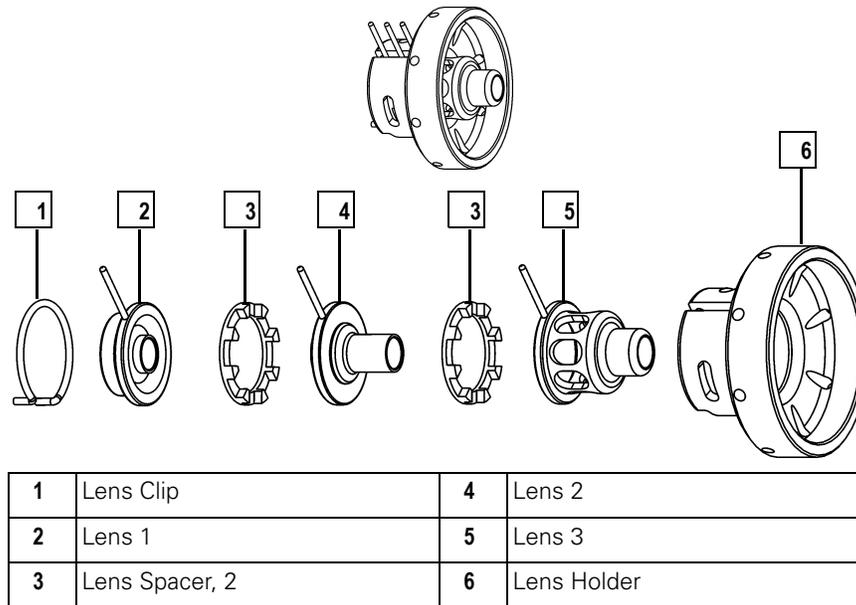
The Ion Volume Assembly consists of the Ion Volume Holder and the Ion Volume. The Ion Volume Assembly is located in the center of the Ion Source.



**Figure 5-5. EI, CI, and EI/CI Combo Ion Volume Assemblies**

The Ion Volume Assembly is the site where the molecules interact with energetic electrons to form ions. Different Ion Volumes are needed for EI and CI operation modes. These optimized geometries maximize sensitivity for each ionization mode. An EI/CI combination Ion Volume is available that offers a compromise in sensitivity for both EI and CI. It allows you to switch ionization modes from one run to the next. This is especially useful for qualitative analysis.

## Lenses

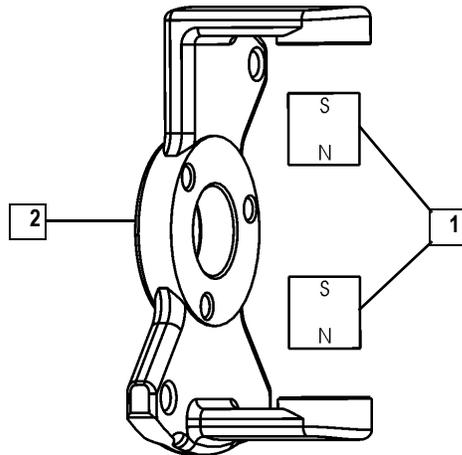


**Figure 5-6. Ion Source Lenses**

Lenses transmit the ions formed in the Ion Volume to the Prefilter. The Lenses are stainless steel plates and tubes to which voltages are applied. The three Lenses are designated L1, L2, and L3, with L1 being nearest to the Ion Volume.

A lens' electrical connection is made through a stainless steel pin protruding from the edge of the lens. A small 3-pin Lens Connector attaches to these pins and carries the voltage from the electrical feedthrough to the Lens.

## Magnets and Magnet Support



1	Magnets	2	Magnet Support
---	---------	---	----------------

**Figure 5-7. Magnets and Magnet Support**

Two Magnets focus emitted electrons into a beam that spirals through the Ion Volume. The spiraling of the beam ensure optimum ionization of the sample. The Magnet Support holds the two Magnets in the proper position above and below the Ion Source Block.

Position both Magnets so the south pole is on top otherwise sensitivity will be poor. Electrons are not focused into the Ion Volume if one Magnet is upside down.

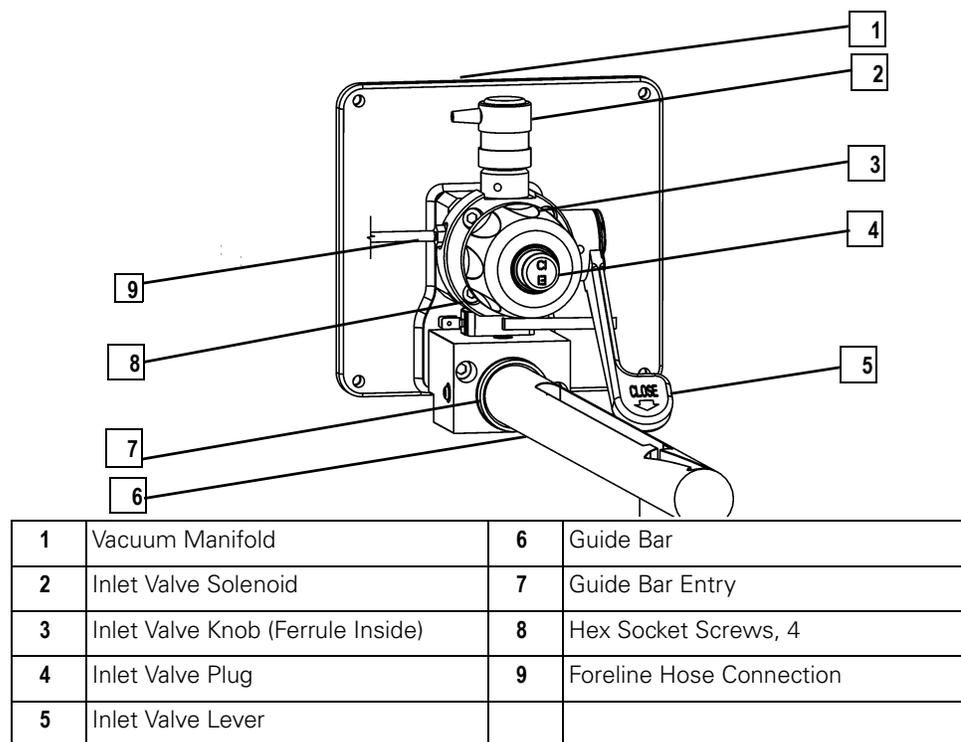
## 5.2 Inlet Valve (Upgrade Option)

Inlet Valve primary components:

- Ball Valve
- Inlet Valve Lever
- Entry Housing
- I/R Tool and Guide Bar
- Inlet Valve Plug
- Inlet Valve Seal

### Description

The Inlet Valve mounts on the front of the Vacuum Manifold and is the vacuum interlock mechanism for the *TRACE DSQ*. The Inlet Valve is a vacuum sealed valve through which you insert and remove the Ion Volume Assembly using an I/R (Insertion/Removal) Tool.

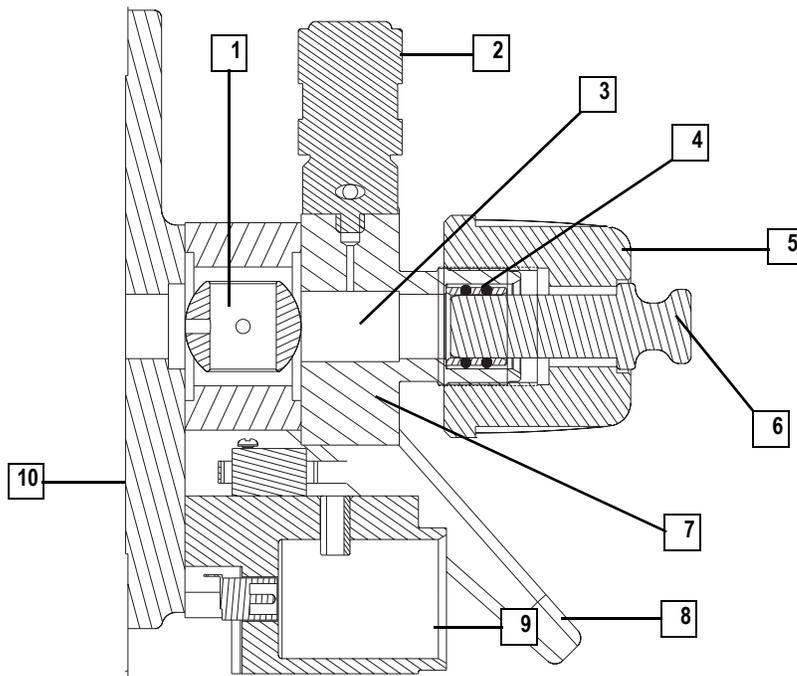


**Figure 5-8. Inlet Valve Components (I/R Tool Not Shown)**

## Theory of Operations

With the use of the I/R Tool and Guide Bar, the Inlet Valve lets the Ion Volume Assembly be removed or installed in the Ion Source without having to vent the Vacuum Manifold to atmospheric pressure. Once excess pressure is removed by opening the Inlet Valve Solenoid, the Inlet Valve can be opened which allows the I/R Tool to be inserted into the Vacuum Manifold. Excess pressure introduced into the Inlet Valve when inserting the I/R Tool is removed through the Foreline Hose Connection back to either a secondary rotary-vane pump or the primary rotary-vane pump.

## Ball Valve



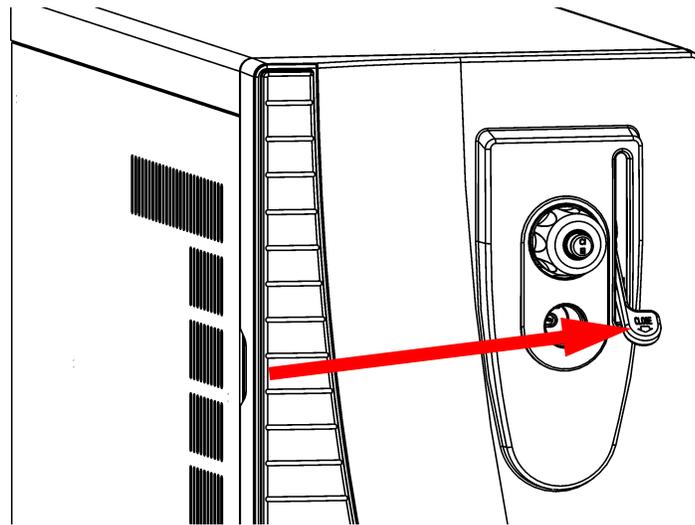
1	Ball Valve	6	Inlet Valve Plug
2	Inlet Valve Solenoid	7	Inlet Valve Block
3	Inlet Valve Chamber	8	Ball Valve Lever
4	Inlet Valve Seal	9	Entry Housing
5	Inlet Valve Knob	10	Vacuum Manifold

**Figure 5-9. Inlet Valve Components (Left Side Cross Section)**

A Ball Valve is a ball with a hole through it and is located inside the Inlet Valve. The Ball Valve is open when the hole in the ball is aligned with the opening between the Vacuum Manifold and the Inlet Valve Chamber. When the Ball Valve is closed, it prevents the Vacuum Manifold from venting to atmosphere.

### *Inlet Valve Lever*

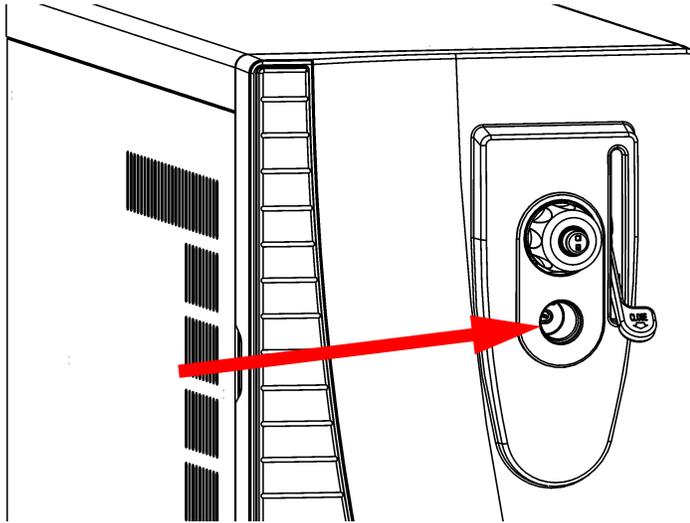
---



**Figure 5-10. Inlet Valve Lever**

Open and close the Ball Valve with the Inlet Valve Lever. When the Inlet Valve Lever is up, the Ball Valve is open. The Ball Valve is closed when the Inlet Valve Lever is in the down position. The lever turns the Ball Valve to allow a probe device (sample probe or I/R Tool) to enter the Vacuum Manifold.

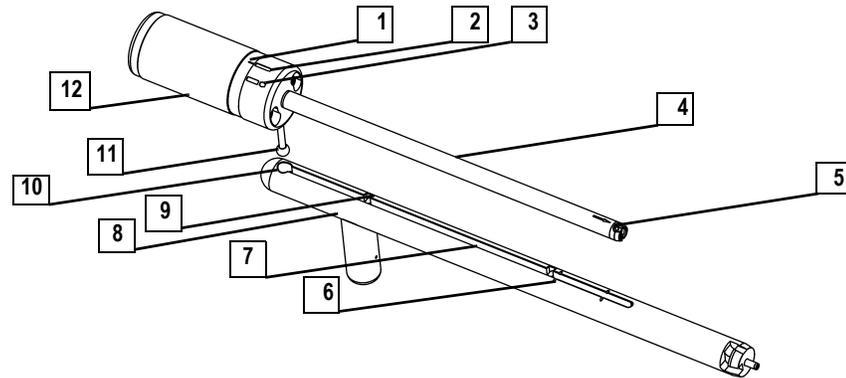
## Entry Housing



**Figure 5-11. Entry Housing**

The Entry Housing is an aluminum chamber mounted on the Vacuum Manifold. The Entry Housing has an opening for the Guide Bar.

## I/R Tool and Guide Bar

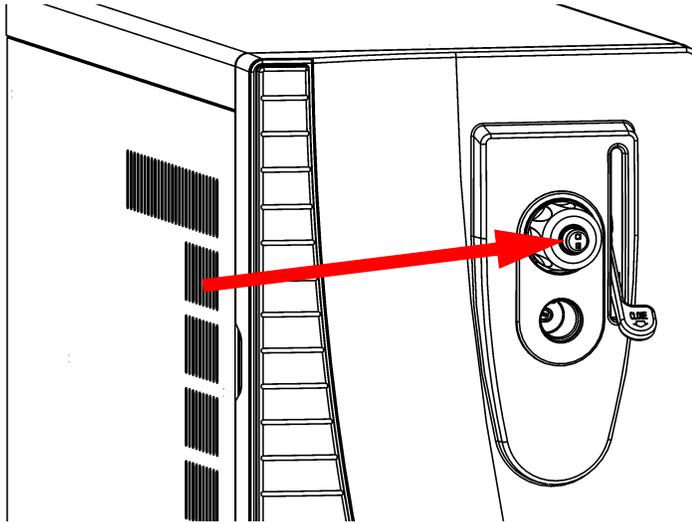


1	Alignment Line	7	Guide Bar Track
2	Hold Position	8	Guide Bar
3	Release Position	9	Guide Bar First Stop
4	I/R Tool	10	Guide Ball Hole
5	Bayonet Lock	11	Guide Ball
6	Guide Bar Second Stop	12	Handle

**Figure 5-12. I/R Tool and Guide Bar**

The I/R Tool is used to insert and remove Ion Volume Assemblies, and consists of a Shaft, Handle, and Guide Ball. The I/R Tool is designed to be used with the Guide Bar. The Guide Ball located on the I/R Tool fits inside a hole located on the Guide Bar, then slides forward along the Guide Ball Track. The Guide Bar is designed to accurately stop the I/R Tool the correct distance within the Inlet Valve in order to evacuate atmospheric pressure before opening the Ball Valve. Once the Ball Valve is opened, the I/R Tool is slid along the Guide Bar Track all the way into the Vacuum Manifold.

## Inlet Valve Plug

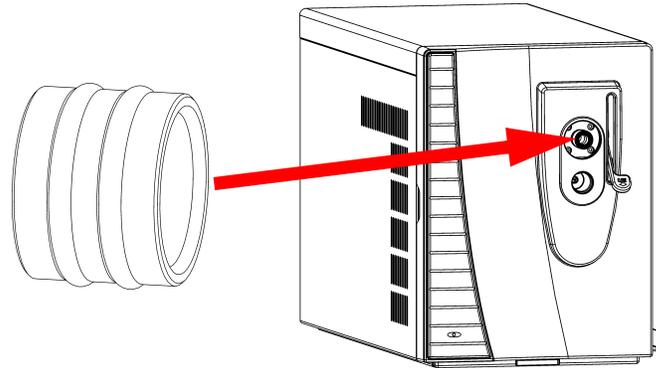


**Figure 5-13. Inlet Valve Plug**

The Inlet Valve Plug seals the opening of the Inlet Valve when it is not in use. The Inlet Valve Plug is etched with "EI" on one side and "CI" on the other to remind you whether an EI or CI Ion Volume is installed.

## Inlet Valve Seal

---



**Figure 5-14. Inlet Valve Seal**

An Inlet Valve Seal forms a vacuum-tight seal over the shaft of the I/R Tool when it is inserted into the Inlet Valve. The Inlet Valve Knob allows you to tighten the seal against the I/R Tool to form a vacuum-tight seal. Or, you can loosen it to allow the I/R Tool to be inserted and removed. You should replace the Inlet Valve Seal periodically.



# 6 *Prefilter and Quadrupole Assembly*

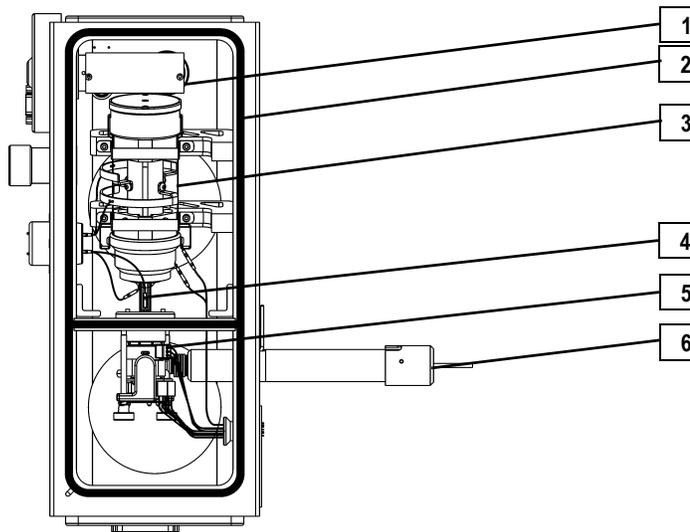
This chapter contains theory of operations for the prefilter and quadrupole mass filter.

## In This Chapter

[6.1 Prefilter and Quadrupole, pp. 224](#)



Analyze • Detect • Measure • Control™



1	Ion Detector Assembly	4	Prefilter
2	O-Ring	5	Ion Source Assembly
3	Quadrupole Assembly	6	Transfer Line

**Figure 6-1. Vacuum Manifold Components**

## 6.1 Prefilter and Quadrupole

Quadrupole primary components:

- Prefilter
- Entrance Lens
- Quadrupole Mass Filter
- Exit Lens

## Description

After ions leave the Ion Source Lenses, they pass through the Prefilter. The Prefilter is mounted to the back side of the Baffle Wall and consists of four metal rods held in a square array. The Prefilter is curved to prevent neutral species (like helium) from reaching the Ion Detector Assembly. Ions next pass through the Entrance Lens and into the Quadrupole Mass Filter. The Quadrupole Mass Filter, like the Prefilter, is composed of four metal rods held in a square array. However, these rods are precision aligned so the assembly should be handled with care. Finally, ions pass through the Exit Lens and to the Ion Detector Assembly.

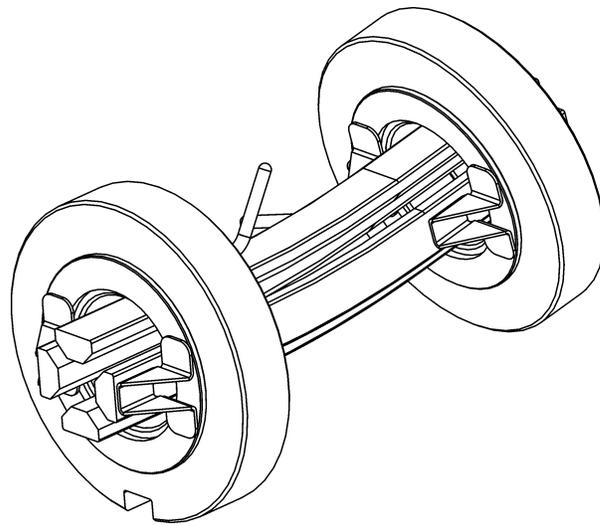
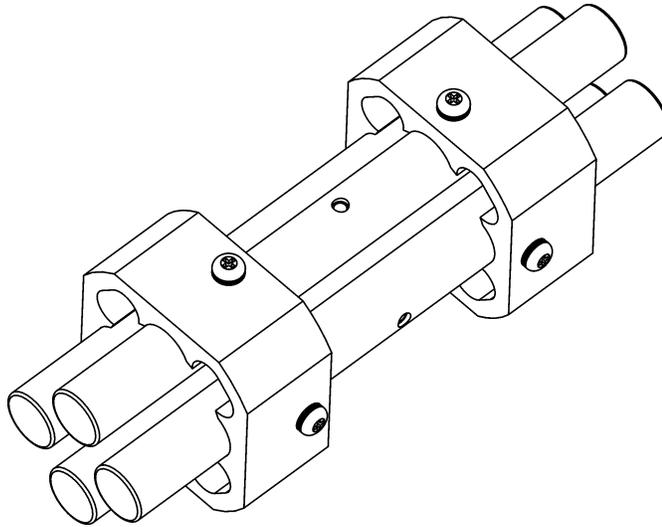


Figure 6-2. Prefilter



**Figure 6-3. Quadrupole Mass Filter**

## *Theory of Operations*

The four Quadrupole Mass Filter rods are charged with a combination of radio frequency (RF) and direct current (DC) voltages. The magnitudes of these voltages give stable oscillations to ions with a specific  $m/z$  ratio and unstable oscillations to all others. The unstable ions strike one of the rods, become neutralized, and are pumped away. The Quadrupole Mass Filter behaves as a filter allowing only ions with a certain  $m/z$  ratio to reach the Ion Detector Assembly. As the RF and DC voltages are ramped, ions of different  $m/z$  ratios are transmitted through the Exit Lens to the Ion Detector Assembly. This produces the mass spectrum.

The ratio of the RF and DC voltage determines the range of  $m/z$  ions that pass through the Quadrupole Mass Filter at one time. This determines the width of mass peaks and is called resolution. Resolution can be adjusted. Higher resolution produces narrower mass peaks but lower sensitivity.

Ion offset controls the how fast ions fly through the Quadrupole Mass Filter. Lower ion offsets produce better resolution since ions spend a longer time in the Quadrupole Mass Filter. Higher ion offsets often produce higher sensitivity because ions are focused better.

Rod DC (A or B) sets the polarity of the DC that is applied to each pair of Quadrupole Mass Filter rods. The Rod DC that works best for your instrument has been selected at the factory. To ensure the best performance, do not change the Rod DC. Also, be sure to reinstall the Quadrupole Mass Filter in the same orientation as when it was removed.

To improve the performance of the Quadrupole Mass Filter a Prefilter is used before the Quadrupole Mass Filter. The Prefilter also has a combination of RF and DC voltages applied to it. The Prefilter serves two main purposes. First, the efficiency of the Quadrupole Mass Filter is impaired after a build up of ions impacting on them. The Prefilter removes many of the low  $m/z$  ions that would have otherwise struck the Quadrupole Mass Filter rods. Since the Prefilter does not have precision electric fields like the Quadrupole Mass Filter, it is not strongly affected by ions striking the surface. This increases the time needed between routine cleaning of the instrument.

Second, helium atoms (not ions) coming from the ion source cause noise if they reach the Exit Lens or Ion Detector Assembly. This is known as neutral noise. Helium atoms cannot negotiate the bend in the Prefilter. Therefore, the noise is virtually eliminated. This leads to better signal-to-noise ratio and lower limits of detection. In addition, higher GC helium flows can be used without causing excessive amounts of noise that would blind an instrument without a curved Prefilter to low-level signals.



# 7 *Ion Detector Assembly*

This chapter contains theory of operations for ion detector assembly components.

## In This Chapter

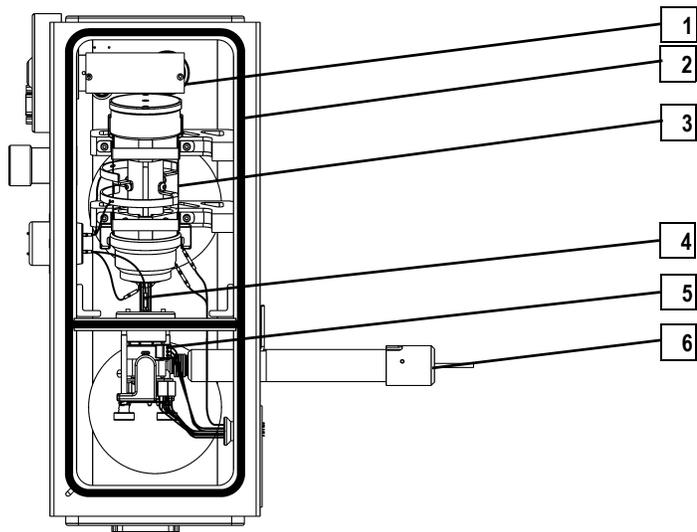
---

*7.1 Conversion Dynode, pp. 231*

*7.2 Electron Multiplier, pp. 234*



Analyze • Detect • Measure • Control™

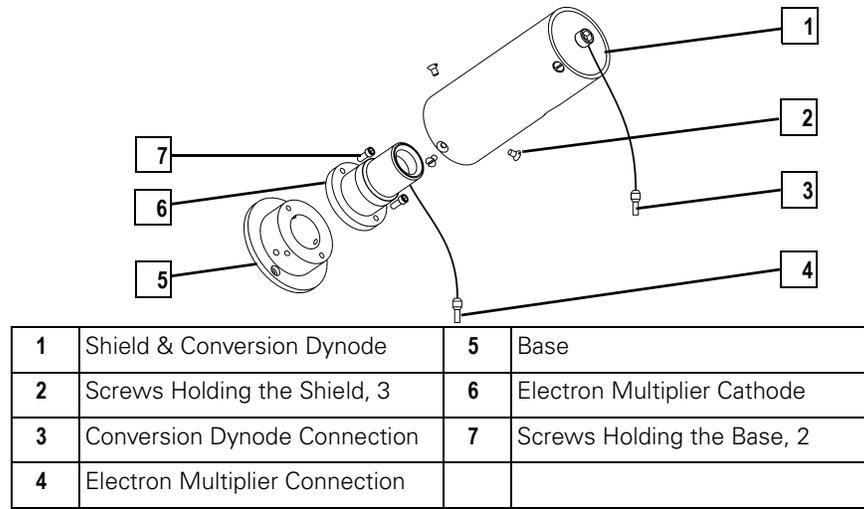


1	Ion Detector Assembly	4	Prefilter
2	O-Ring	5	Ion Source Assembly
3	Quadrupole Assembly	6	Transfer Line

**Figure 7-1. Vacuum Manifold Components**

## 7.1 Conversion Dynode

The Conversion Dynode is part of the Ion Detector Assembly. The Ion Detector Assembly is mounted inside the Vacuum Manifold, directly behind the Quadrupole Assembly.

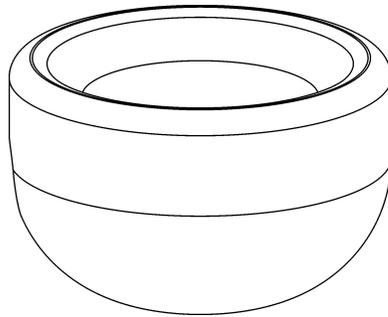


**Figure 7-2. Ion Detector Assembly**

## Description

The Conversion Dynode is a concave metal surface located at a right angle to the ion beam. A potential of +10 kV for negative ion detection or -10 kV for positive ion detection is applied to the Conversion Dynode.

The Conversion Dynode increases signal and decreases noise. 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.



**Figure 7-3. Conversion Dynode**

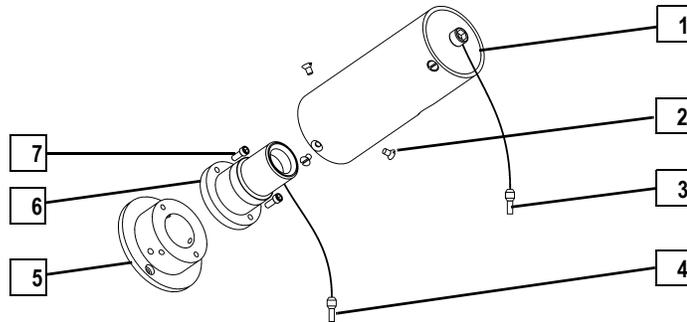
## *Theory of Operations*

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, protons, electrons, and neutrals. When positive ions strike a negatively charged Conversion Dynode, the secondary particles are negative ions and electrons. When negative ions strike a positively charged Conversion Dynode, the secondary particles are positive ions and protons. These secondary particles are focused by the curved surface of the Conversion Dynode and accelerated toward the Electron Multiplier.

Because of the off-axis orientation of the Ion Detector Assembly relative to the Quadrupole Assembly, neutral molecules from the mass analyzer tend not to strike the Conversion Dynode or Electron Multiplier. Thus, neutral noise reduces.

## 7.2 Electron Multiplier

The Electron Multiplier is another part of the Ion Detector Assembly. The Ion Detector Assembly is mounted inside the Vacuum Manifold, directly behind the Quadrupole Assembly.



1	Shield & Conversion Dynode	5	Base
2	Screw Holding the Shield, 3	6	Electron Multiplier Cathode
3	Conversion Dynode Connection	7	Screw Holding the Base, 2
4	Electron Multiplier Connection		

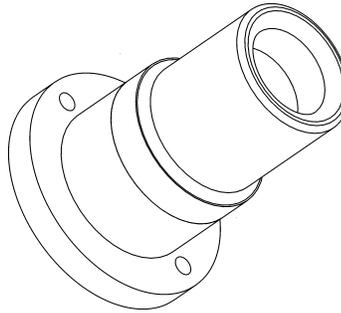
**Figure 7-4. Ion Detector Assembly**

## Description

An Electron Multiplier is a device that amplifies a current by generating an electron cascade from an oxide-coated surface of an electrode. The two primary components of an Electron Multiplier are the Cathode and Anode.

Cathodes serve as the electrode the electron multiplier uses to generate the electron cascade. It is a lead oxide funnel-like resistor, which receives a potential of up to -2.5 kV from the high voltage ring. The exit end of the Cathode is near ground potential.

The Anode collects electrons produced by the Cathode. It is a cup located at the exit end of the Cathode and is part of the Anode Feedthrough on the left side of the Vacuum Manifold.



**Figure 7-5. Electron Multiplier**

## Theory of Operations

Secondary particles from the Conversion Dynode strike near 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 its inner surface, 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 has a gain of about  $10^5$ . If the current of ions and electrons entering the Electron Multiplier from the Conversion Dynode is  $10^{-12}$  A, and the gain of the Electron Multiplier is  $10^5$ , then a current of  $10^{-7}$  A leaves the Electron Multiplier through the Anode. This current is converted to a voltage by the electrometer circuit and recorded by the data system.

# Appendix A *Replaceable Parts*

This appendix contains *TRACE DSQ* drawings and part numbers for replaceable parts and consumables.

To ensure proper results in servicing the *TRACE DSQ* system, order only the parts listed or their equivalent. Contact Thermo Electron Austin at 1 512 251 1494. Please have your *TRACE DSQ* serial number ready when calling.

## In This Chapter

---

- [A.1 Vacuum Manifold, pp. 238](#)
- [A.2 Ion Source Assembly, pp. 240](#)
- [A.3 Ion Source Block Assembly, pp. 242](#)
- [A.4 Lens Assembly, pp. 244](#)
- [A.5 Quadrupole Assembly, pp. 246](#)
- [A.6 Gas Inlets and Gauges, pp. 248](#)
- [A.7 PCBs and Cables, pp. 250](#)
- [A.8 Turbomolecular Pump, pp. 258](#)
- [A.9 Split-Flow Turbomolecular Pump \(Upgrade Option\), pp. 260](#)
- [A.10 Inlet Valve \(Upgrade Option\), pp. 262](#)
- [A.11 Power Module, pp. 264](#)
- [A.12 Installation Kit, pp. 265](#)
- [A.13 Document Set, pp. 266](#)
- [A.14 Miscellaneous Items, pp. 267](#)

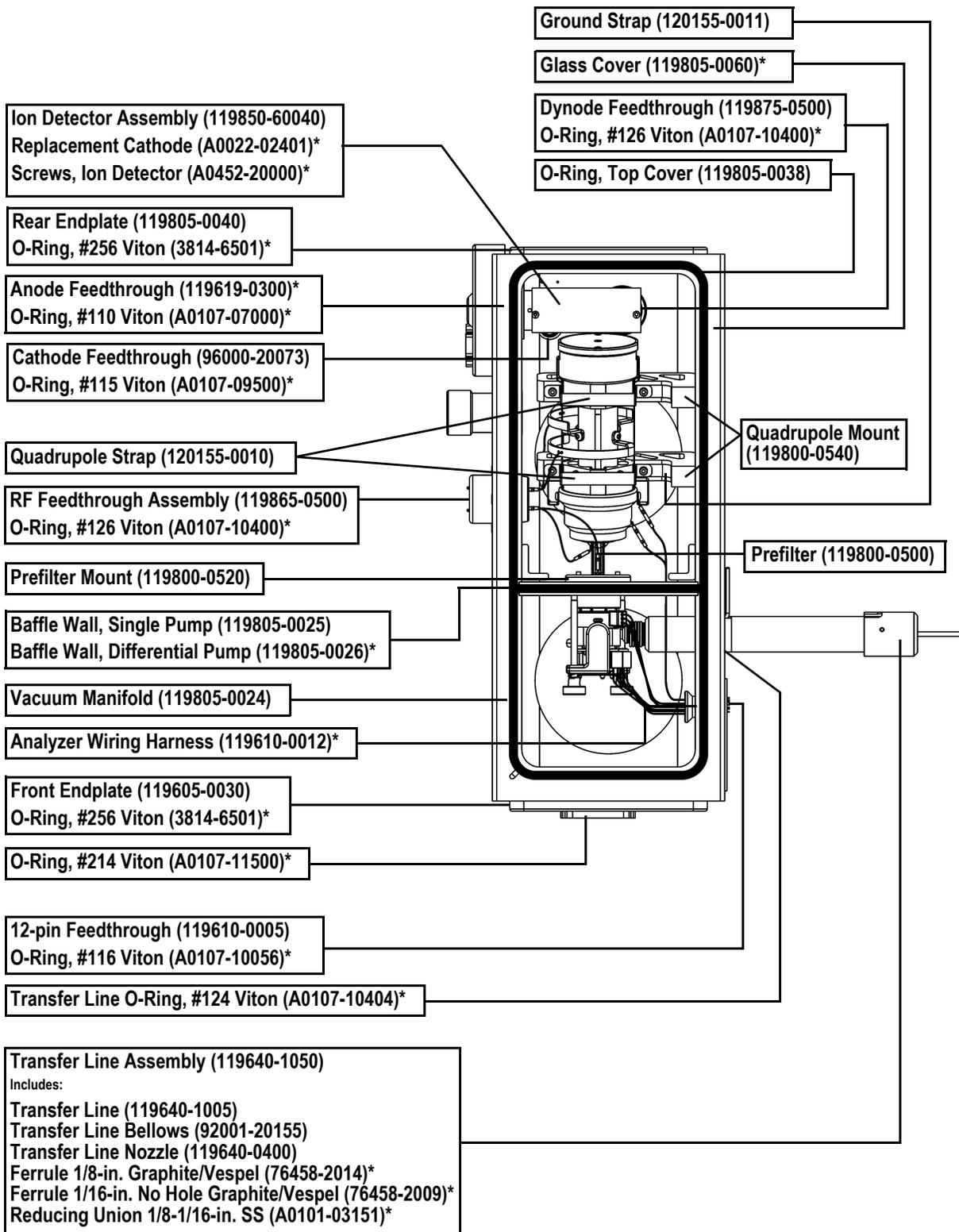


Analyze • Detect • Measure • Control™

## A.1 Vacuum Manifold

**Table A-1. Vacuum Manifold**

Description	Part Number
12-Pin Feedthrough	119610-0005
Analyzer Wiring Harness	119610-0012
Anode Feedthrough	119619-0300
Baffle Wall, Differential Pump	119805-0026
Baffle Wall, Single Pump	119805-0025
Cathode Feedthrough	96000-20073
Dynode Feedthrough	119875-0500
Electron Multiplier, Replacement	A0022-02401
Glass Cover	119805-0060
Ion Detector Assembly	119850-60040
O-Ring, Top Cover	119805-0038
Prefilter	119800-0500
Prefilter Mount	119800-0520
Quadrupole Mount	119800-0540
Quadrupole Strap	120155-0010
RF Feedthrough Assembly	119865-0500
Transfer Line Assembly	119640-1050
Vent Valve Solenoid	76461-1003



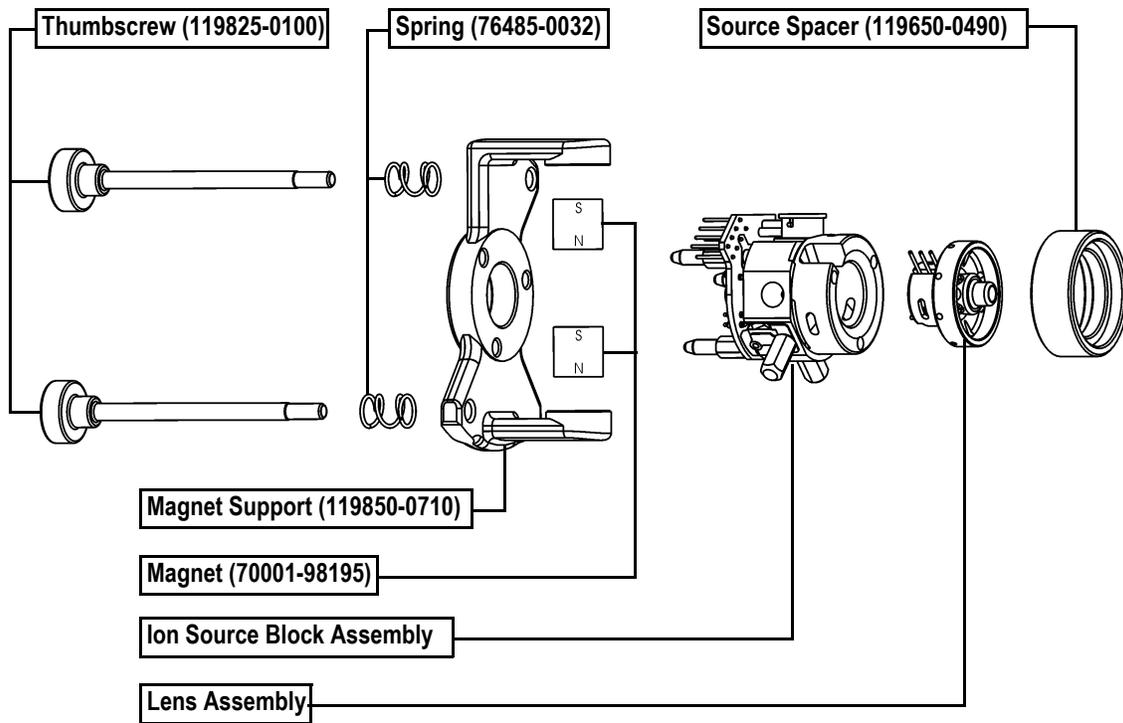
\* - Not Shown

## A.2 Ion Source Assembly

**Table A-2. Ion Source Assembly**

Description	Part Number
Ion Source Assembly (Complete) includes:	119850-0250
<ul style="list-style-type: none"> <li>• Ion Source Block Assembly</li> </ul>	—
<ul style="list-style-type: none"> <li>• Lens Assembly</li> </ul>	—
<ul style="list-style-type: none"> <li>• Magnet</li> </ul>	70001-98195
<ul style="list-style-type: none"> <li>• Magnet Support</li> </ul>	119850-0710
<ul style="list-style-type: none"> <li>• Source Spacer</li> </ul>	119650-0490
<ul style="list-style-type: none"> <li>• Spring</li> </ul>	76485-0032
<ul style="list-style-type: none"> <li>• Thumbscrew</li> </ul>	119825-0100

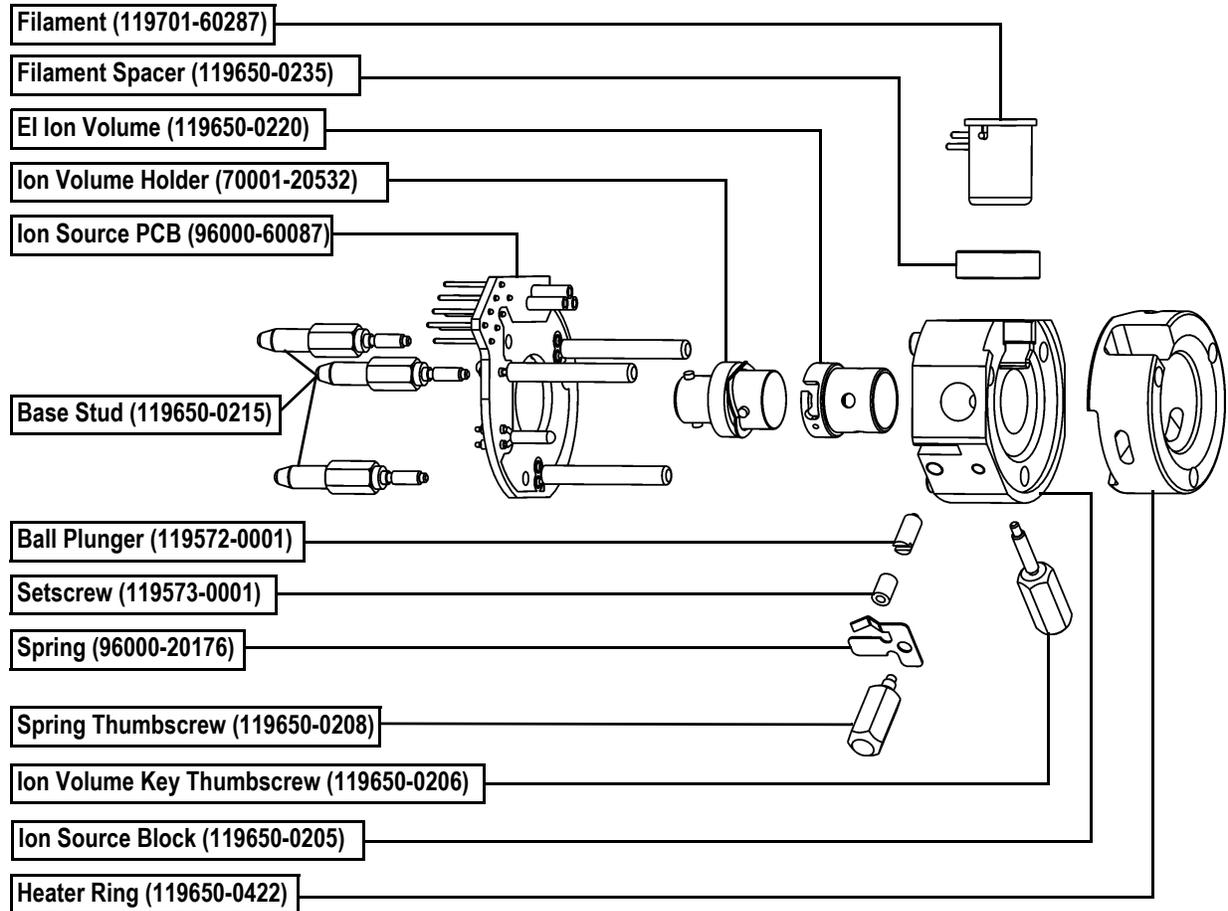
**Ion Source Assembly, Complete (119850-0250)**



## A.3 Ion Source Block Assembly

**Table A-3. Ion Source Block**

Description	Part Number
Base Stud	119650-0215
Ball Plunger	119572-0001
Filament	119701-60287
Filament Spacer	119650-0235
Heater Ring	119650-0422
Ion Source Block	119650-0205
Ion Source PCB	96000-60087
Ion Volume, CI	119650-0230
Ion Volume, EI	119650-0220
Ion Volume, EI/CI Combo	119650-0240
Ion Volume Key Thumbscrew	119650-0206
Ion Volume Holder	70001-20532
Setscrew	119573-0001
Spring	96000-20176
Spring Thumbscrew	119650-0208

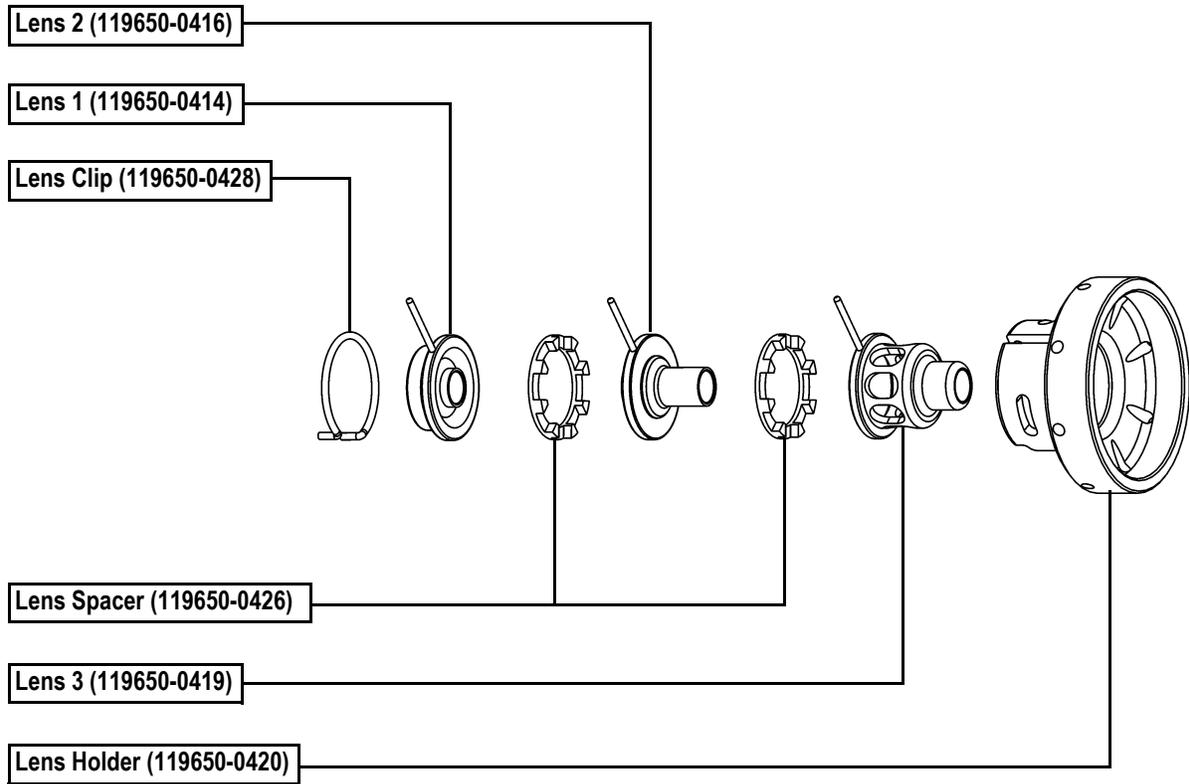


## A.4 Lens Assembly

---

**Table A-4. Lens Assembly**

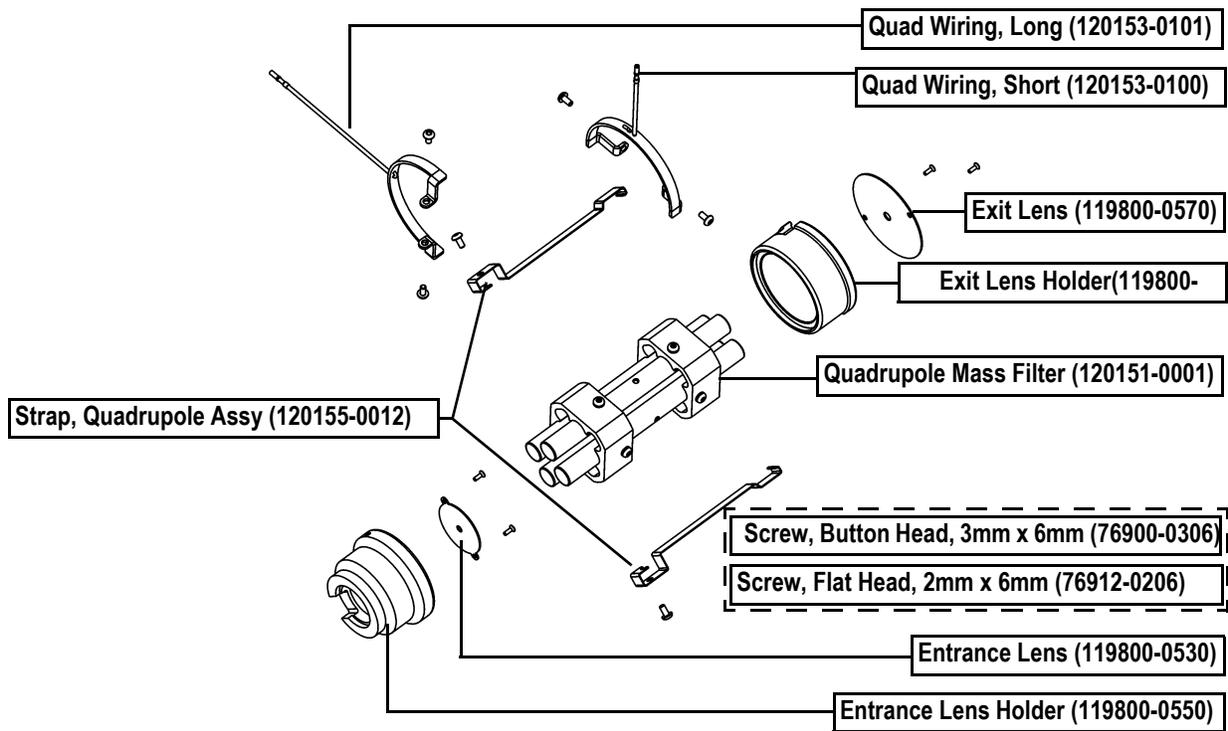
Description	Part Number
Lens 1	119650-0414
Lens 2	119650-0416
Lens 3	119650-0419
Lens Clip	119650-0428
Lens Holder	119650-0420
Lens Spacer	119650-0426



## A.5 Quadrupole Assembly

**Table A-5. Quadrupole Assembly**

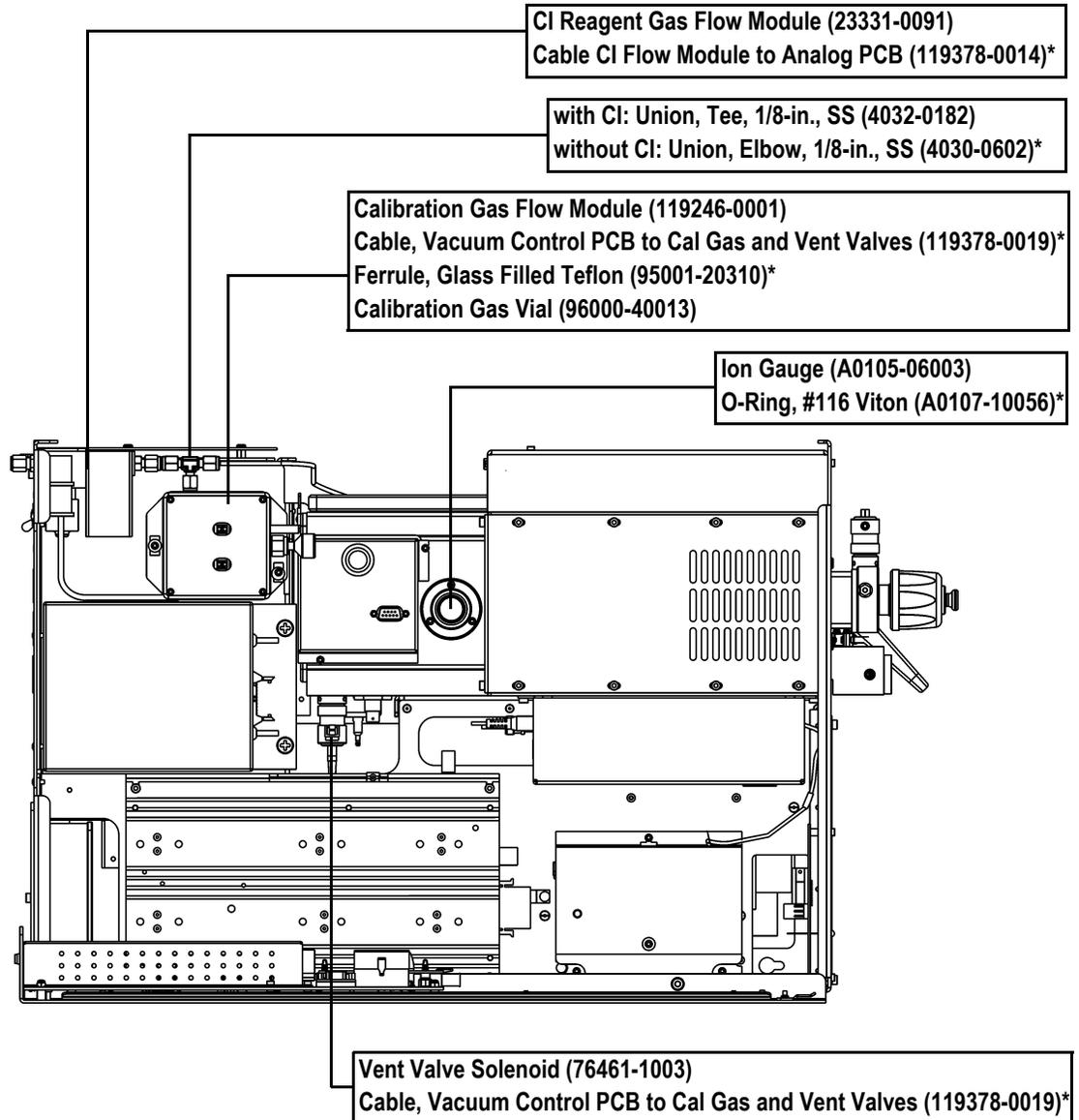
Description	Part Number
Quadrupole Assembly (Complete) includes:	120151-0100
• Entrance Lens	119800-0530
• Entrance Lens Holder	119800-0550
• Exit Lens	119800-0570
• Exit Lens Holder	119800-0560
• Quad Wiring, Long	120153-0101
• Quad Wiring, Short	120153-0100
• Quadrupole Mass Filter	120151-0001
• Strap, Quadrupole Assembly	120155-0012



## A.6 Gas Inlets and Gauges

**Table A-6. Gas Inlets and Gauges**

Description	Part Number
Cable, CI Flow Module to Analog PCB	119378-0014
Cable, Vacuum Control PCB to Calibration Gas and Vent Valves	119378-0019
Calibration Gas Flow Module	119246-0001
Calibration Gas Vial	96000-40013
CI Reagent Gas Flow Module	23331-0091
Ferrule, Glass Filled Teflon	95001-20310
Ion Gauge	A0105-06003
O-Ring, # 116 Viton	A0107-10056
Union, Elbow, 1/8-in., SS (Without CI)	4030-0602
Union, Tee, 1/8-in., SS (With CI)	4032-0182
Vent Valve Solenoid	76461-1003

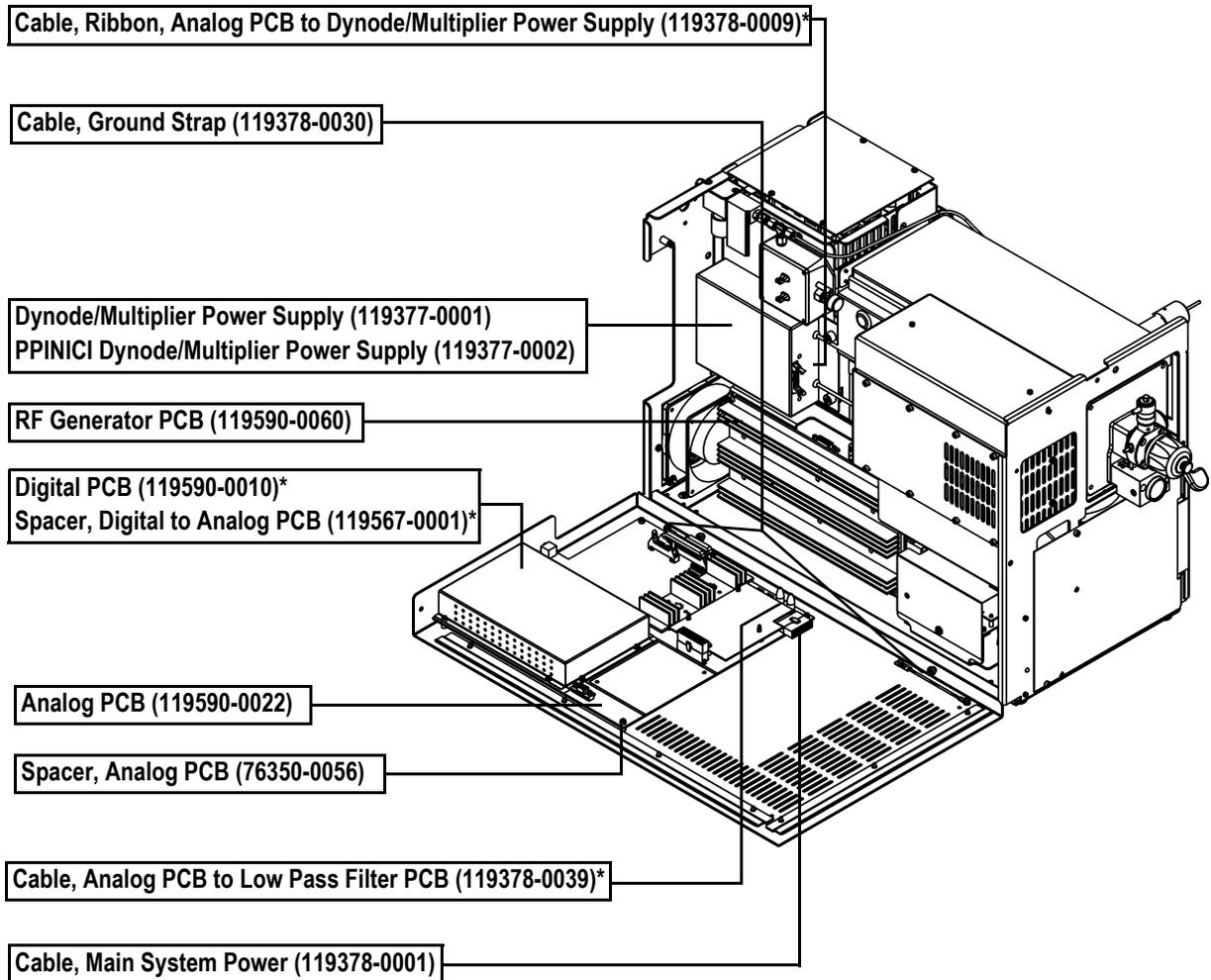


\* - Not Shown

## A.7 PCBs and Cables

**Table A-7. PCBs and Cables (Left Side)**

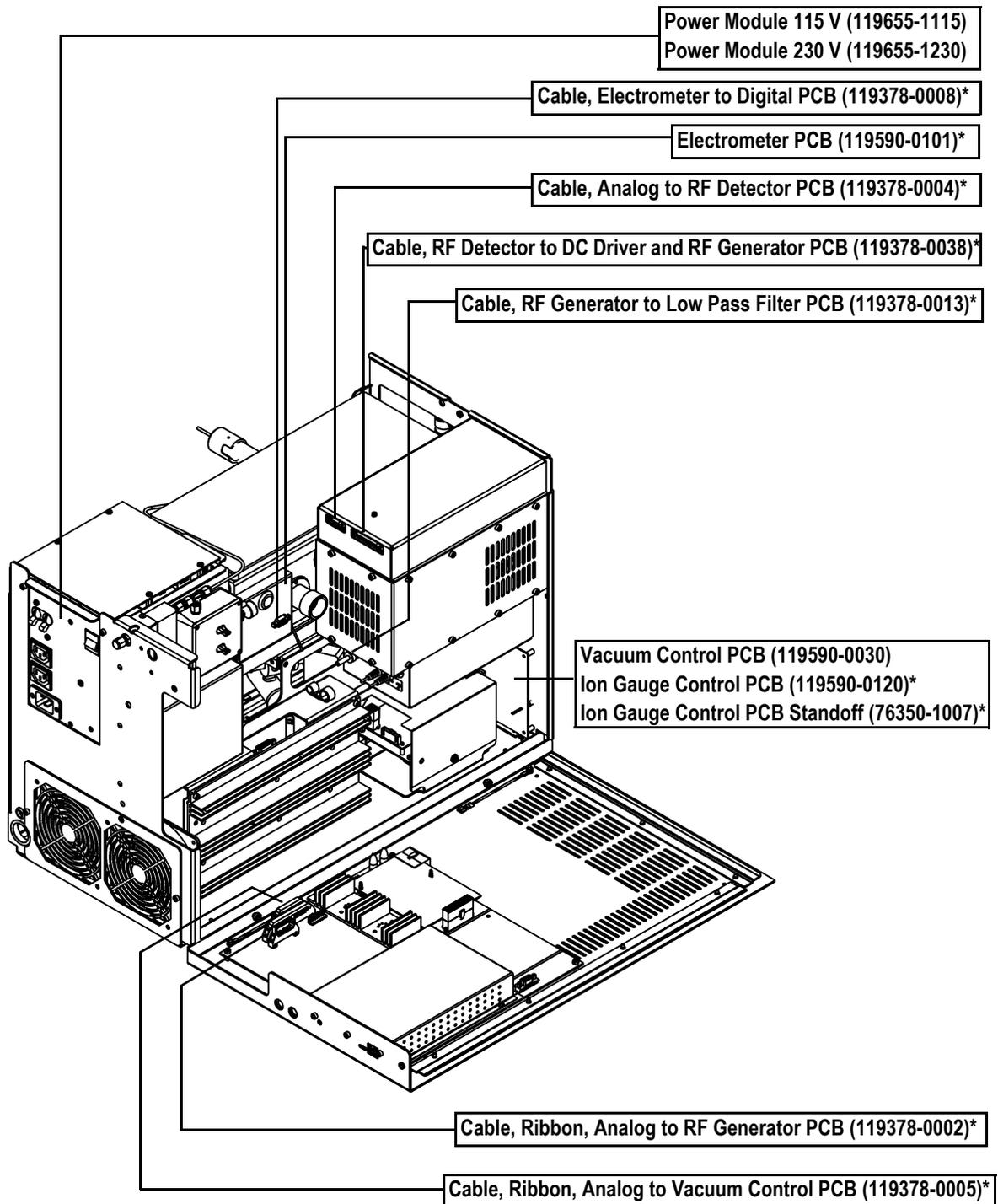
Description	Part Number
Analog PCB	119590-0022
Cable, Analog PCB to Low Pass Filter PCB	119378-0039
Cable, Ground Strap	119378-0030
Cable, Main System Power	119378-0001
Cable, Ribbon, Analog PCB to Multiplier/Dynode Power Supply	119378-0009
Digital PCB	119590-0010
Dynode/Multiplier Power Supply	119377-0001
PPINICI Dynode/Multiplier Power Supply	119377-0002
RF Generator PCB	119590-0060
Spacer, Analog PCB	76350-0056
Spacer, Digital to Analog PCB	119567-0001



\* - Not Shown

**Table A-8. PCBs and Cables (Left Side)**

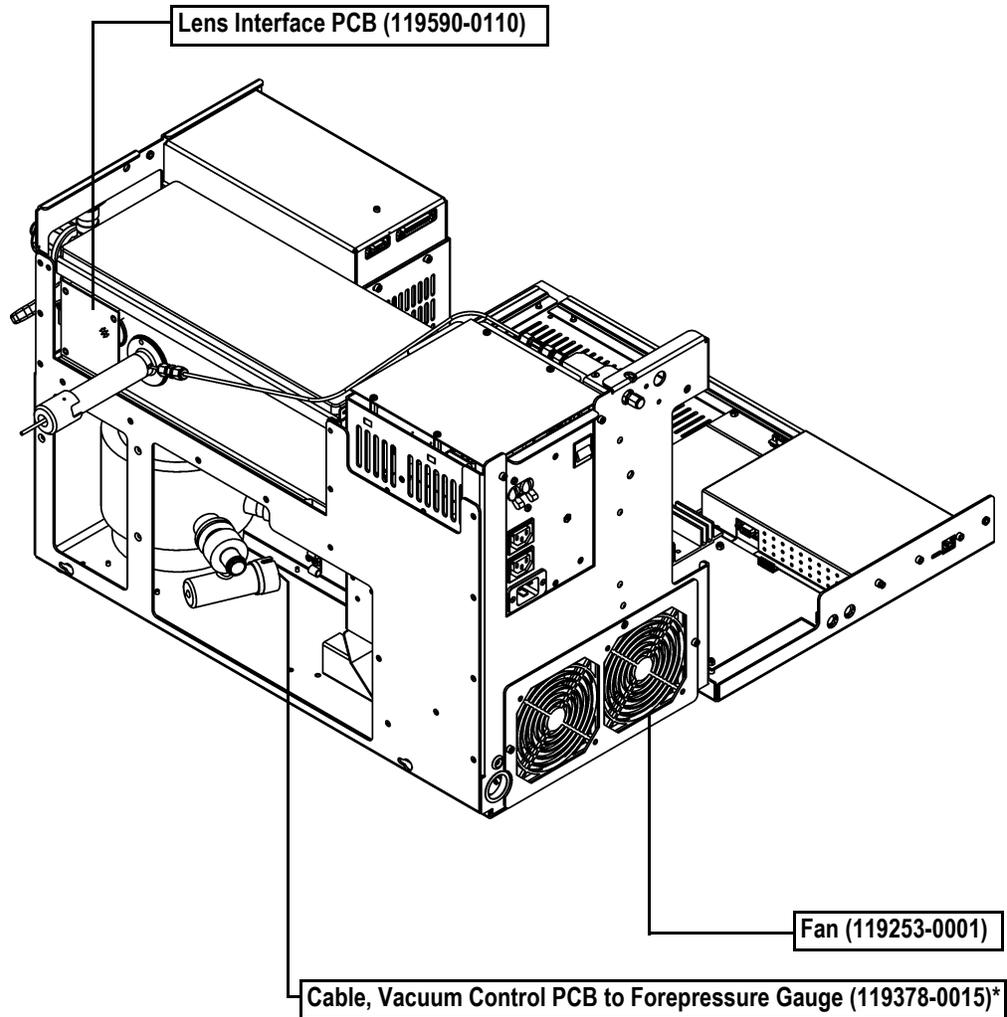
Description	Part Number
Cable, Analog to RF Detector PCB	119378-0004
Cable, Coax, RF Generator to Low Pass Filter PCB	119378-0013
Cable, Electrometer to Digital PCB	119378-0008
Cable, RF Detector to DC Driver and RF Generator PCB	119378-0038
Cable, Ribbon, Analog to RF Generator PCB	119378-0002
Cable, Ribbon, Analog to Vacuum Control PCB	119378-0005
Electrometer PCB	119590-0101
Ion Gauge Control PCB	119590-0120
Ion Gauge Control PCB Standoff	76350-1007
Power Module 115 V	119655-1115
Power Module 230 V	119655-1230
Vacuum Control PCB	119590-0030



\* - Not Shown

**Table A-9. PCBs and Cables (Right Side)**

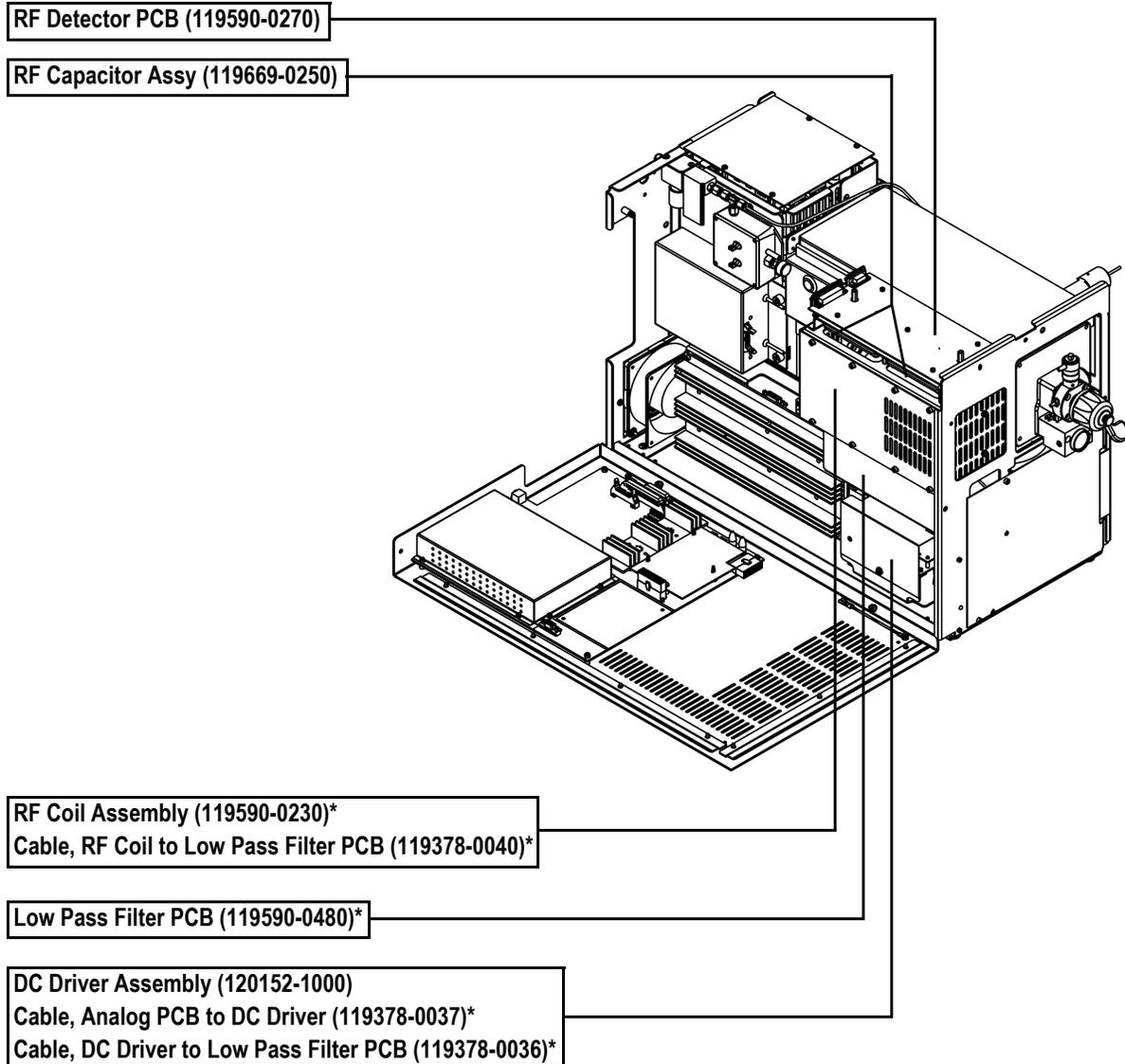
Description	Part Number
Cable, Vacuum Control PCB to Forepressure Gauge	119378-0015
Fan	119253-0001
Lens Interface PCB	119590-0110



\* - Not Shown

**Table A-10. PCBs and Cables (Under the RF Detector Cover)**

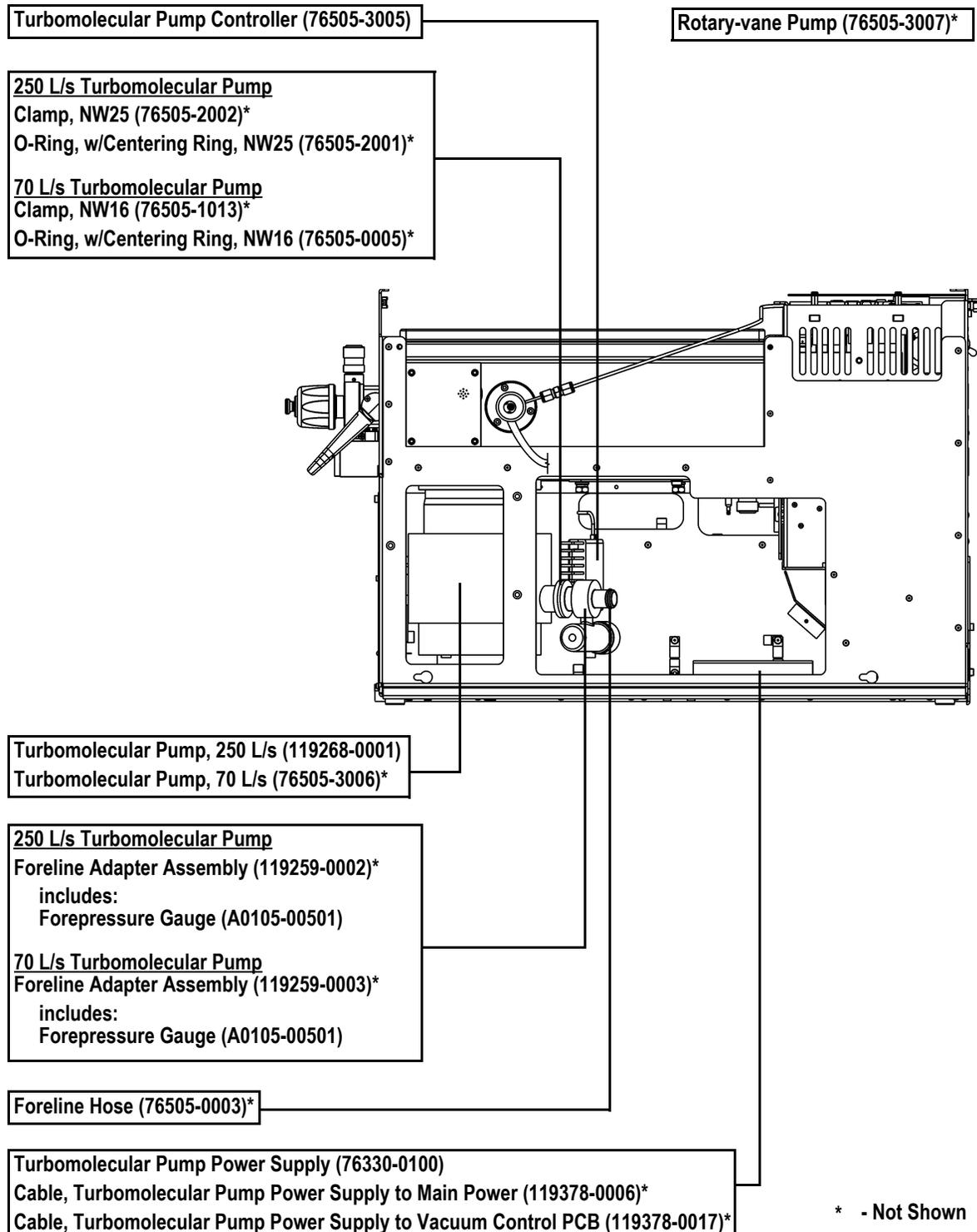
Description	Part Number
Cable, Analog PCB to DC Driver	119378-0037
Cable, DC Driver to Low Pass Filter PCB	119378-0036
Cable, RF Coil to Low Pass Filter PCB	119378-0040
DC Driver Assembly	120152-1000
Low Pass Filter PCB	119590-0480
RF Detector PCB	119590-0270
RF Capacitor Assembly	119669-0250
RF Coil Assembly	119590-0230



## A.8 Turbomolecular Pump

**Table A-11. Turbomolecular Pump**

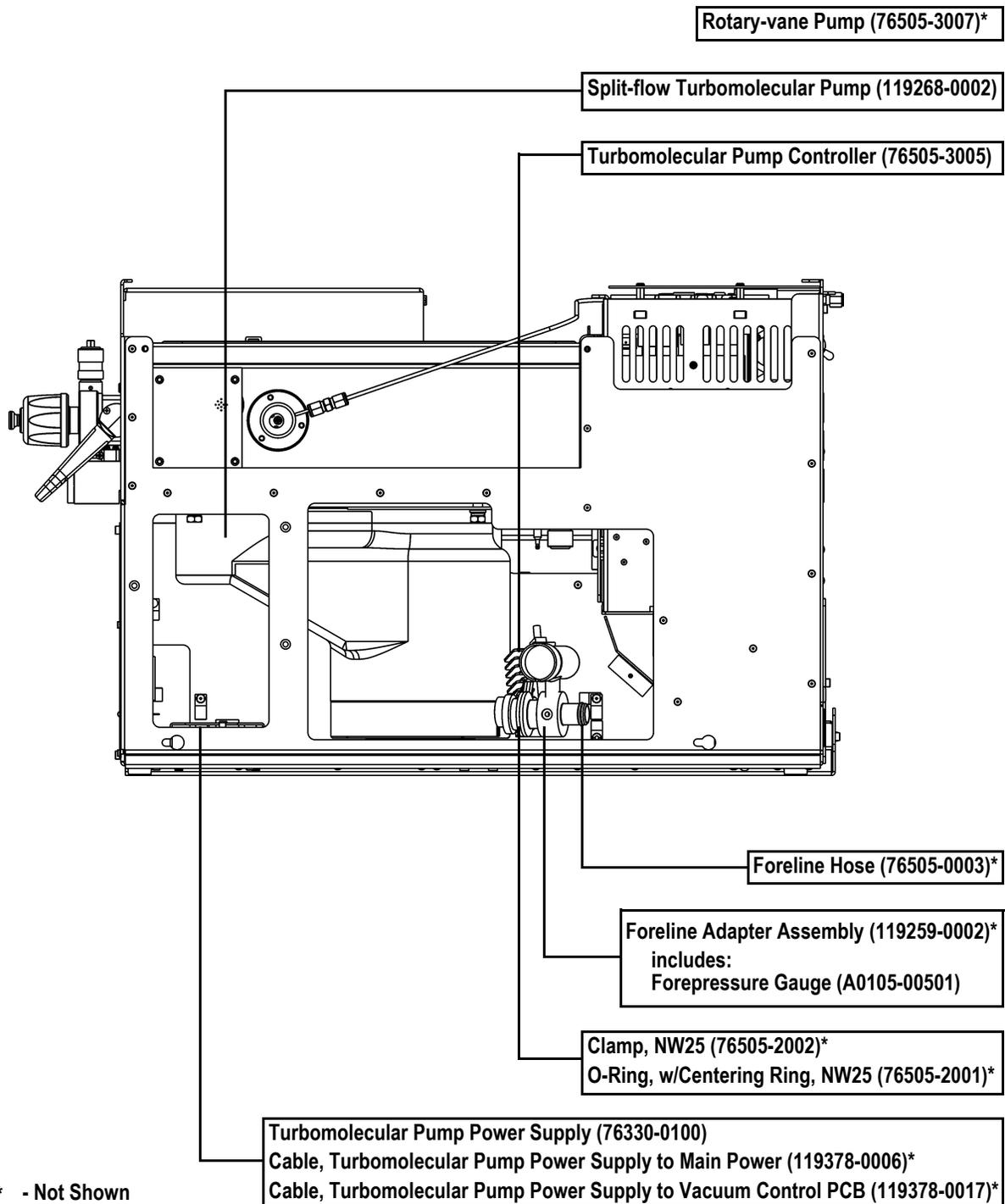
Description	Part Number
Cable, Turbomolecular Pump Power Supply to Main Power	119378-0006
Cable, Turbomolecular Pump Power Supply to Vacuum Control PCB	119378-0017
Clamp Nut, NW16	76505-1013
Clamp Nut, NW25	76505-2002
Foreline Adapter Assembly (70 L/s Turbo Pump) includes:	119259-0003
<ul style="list-style-type: none"> <li>Forepressure Gauge</li> </ul>	A0105-00501
Foreline Adapter Assembly (250 L/s Turbo Pump) includes:	119259-0002
<ul style="list-style-type: none"> <li>Forepressure Gauge</li> </ul>	A0105-00501
Foreline Hose	76505-0003
Oil, Rotary-Vane Pump, 1 L	A0301-15101
O-Ring, w/centering ring, NW16	76505-0005
O-Ring, w/centering ring, NW25	76505-2001
Rotary-Vane Pump	76505-3007
Turbomolecular Pump, 70 L/s	76505-3006
Turbomolecular Pump, 250 L/s	119268-0001
Turbomolecular Pump Controller	76505-3005
Turbomolecular Pump Power Supply	76330-0100



## A.9 Split-Flow Turbomolecular Pump (Upgrade Option)

**Table A-12. Split-Flow Turbomolecular Pump**

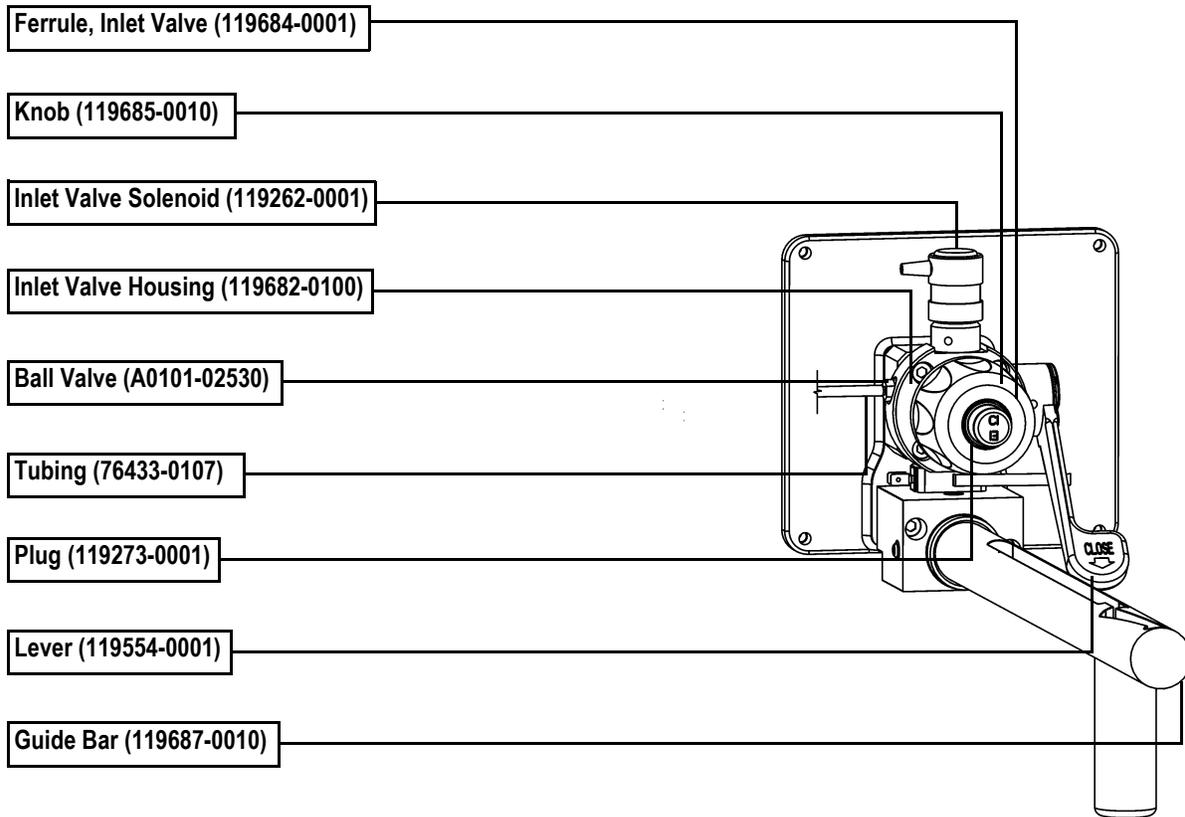
Description	Part Number
Foreline Adapter Assembly includes:	119259-0002
<ul style="list-style-type: none"> <li>Forepressure Gauge</li> </ul>	A0105-00501
Cable, Turbomolecular Pump Power Supply to Main Power	119378-0006
Cable, Turbomolecular Pump Power Supply to Vacuum Control PCB	119378-0017
Clamp, 250 L/s Turbo Pump, NW25	76505-2002
Foreline Hose	76505-0003
O-Ring, w/centering ring, NW25	76505-2001
Oil, Rotary-Vane Pump, 1 L	A0301-15101
Rotary-Vane Pump	76505-3007
Split-Flow Turbomolecular Pump	119268-0002
Turbomolecular Pump Controller	76505-3005
Turbomolecular Pump Power Supply	76330-0100



## A.10 Inlet Valve (Upgrade Option)

Table A-13. Inlet Valve

Description	Part Number
Ball Valve	A0101-02530
Ball Valve Seal Replacement Kit	76461-2002
Ferrule, Inlet Valve	119684-0001
Guide Bar	119687-0010
I/R Tool	96000-60057
Inlet Valve Housing	119682-0100
Inlet Valve Seal Replacement Kit	119265-0003
Inlet Valve Solenoid	119262-0001
Knob	119685-0010
Lever	119554-0001
Plug	119273-0001
Tubing	76433-0107



\* - Not Shown

## A.11 Power Module

**Table A-14. Power Module**

Description	Part Number
Power Module <ul style="list-style-type: none"> <li>• 115 V</li> <li>• 230 V</li> </ul>	119655-1115 119655-1230
Circuit Breaker, 15 A, 115 V	A0019-00520
Circuit Breaker, 10 A, 230 V	A0019-00505
Fuse, 3.15 A SB, 5x20 mm, 250 V (F1, F2)	A0006-10510
HV Regulator PCB	119590-0050
Line Filter	A0007-18349
Power Cord, 115 V (NEMA 5-20P plug)	96000-98034
Power Cord, 230 V (no plug)	96000-98036
Power Supply 1 (+5, $\pm 15$ , +24 V)	76330-0225
Power Supply 2 (+36, -28 V)	76330-0226
Power Supply 3 (+5, $\pm 12$ V)	76330-0080
Transformer	119376-0002

## A.12 Installation Kit

**Table A-15. Installation Kit**

Description	Part Number
Kit, Installation includes:	119255-0002
• Allen Wrench Kit, Metric	3812-0100
• Aluminum Oxide	32000-60340
• Back Ferrule, 1/8-in., Brass	A0101-02500
• Cable, PC to Instrument (15 ft Ethernet crossover)	76396-0052
• Calibration Compound	50010-30059
• Copper Tubing, Precleaned, 25 ft	76381-0041
• Column Measuring Tool	119640-0550
• Gloves, Nitrile, Medium	23827-0008
• Gloves, Nitrile, Large	23827-0009
• Forceps	76360-0400
• Cotton Tipped Applicators (1 pack)	A0301-02000
• Filament	119701-60287
• Front Ferrule, 1/8-in., Brass	A0101-08500
• Fuse, 2A Microfuse	76339-0008
• Fuse, 0.315 A SB	A0006-04550
• Fuse, 0.8 A SB	A0006-06075
• Fuse, 0.5 A	A0006-07608
• Fuse, 1.0 A	A0006-07610
• Ion Volume Tool	119270-0001
• Nut, 1/8-in., Brass	A0101-15500
• Oxygen, Hydrocarbon, Moisture Trap (with quick change base)	A0950-01600
• Oxygen, Hydrocarbon, Moisture Trap (replacement for use without a quick change base)	A0950-01500
• Oxygen, Hydrocarbon, Moisture Trap (replacement for use with a quick change base)	A0950-R1600
• Preinstallation Guide	120156-0001
• Syringe, 10 $\mu$ L with 70 mm Needle	36500103
• Test Mix, octafluoronaphthalene, benzophenone	120150-TEST
• Transfer Line Ferrule, 1/16-in. to 0.4 mm, Graphite/Vespel	A0101-18100
• Union, Tee, 1/8-in., Brass	4032-0082

## A.13 Document Set

**Table A-16. Document Set**

Description	Part Number
<i>TRACE DSQ</i> Hardware Manual	120156-0002
<i>TRACE DSQ</i> Preinstallation Guide	120156-0001
<i>FOCUS DSQ</i> Preinstallation Guide	120156-0007
<i>TRACE DSQ</i> or <i>FOCUS DSQ</i> User's Guide	120156-0003
<i>Xcalibur</i> Getting Productive: Merlin the Custom Report Writer	Xcali-97065
<i>Xcalibur</i> Getting Productive: Processing Setup	Xcali-97064
<i>Xcalibur</i> Getting Productive: Qual Analysis	Xcali-97061
<i>Xcalibur</i> Getting Productive: Quan Analysis	Xcali-97063
<i>Xcalibur</i> Getting Productive: Libraries	Xcali-97062

## A.14 Miscellaneous Items

---

**Table A-17. Miscellaneous Items**

Description	Part Number
Cable, TRACE GC to PC	230 980 00
Cable, TRACE GC to DSQ Remote Start	76396-0050
Capillary Column, 5MS, 0.25 mm ID, 15 m, 0.25 $\mu$ m	76317-3015
Injector Ferrule, for 0.25 mm ID Column	290 134 88
Syringe, 10 $\mu$ L with 70 mm Needle	365 001 03
Transfer Line Ferrule, 1/16-in. to 0.4 mm, Graphite/Vespel	A0101-18100



# *Appendix B* **Functional Block Diagrams**

This appendix contains functional block diagrams for the *TRACE DSO* system and its subsystems.



Analyze • Detect • Measure • Control™

www.thermo.com

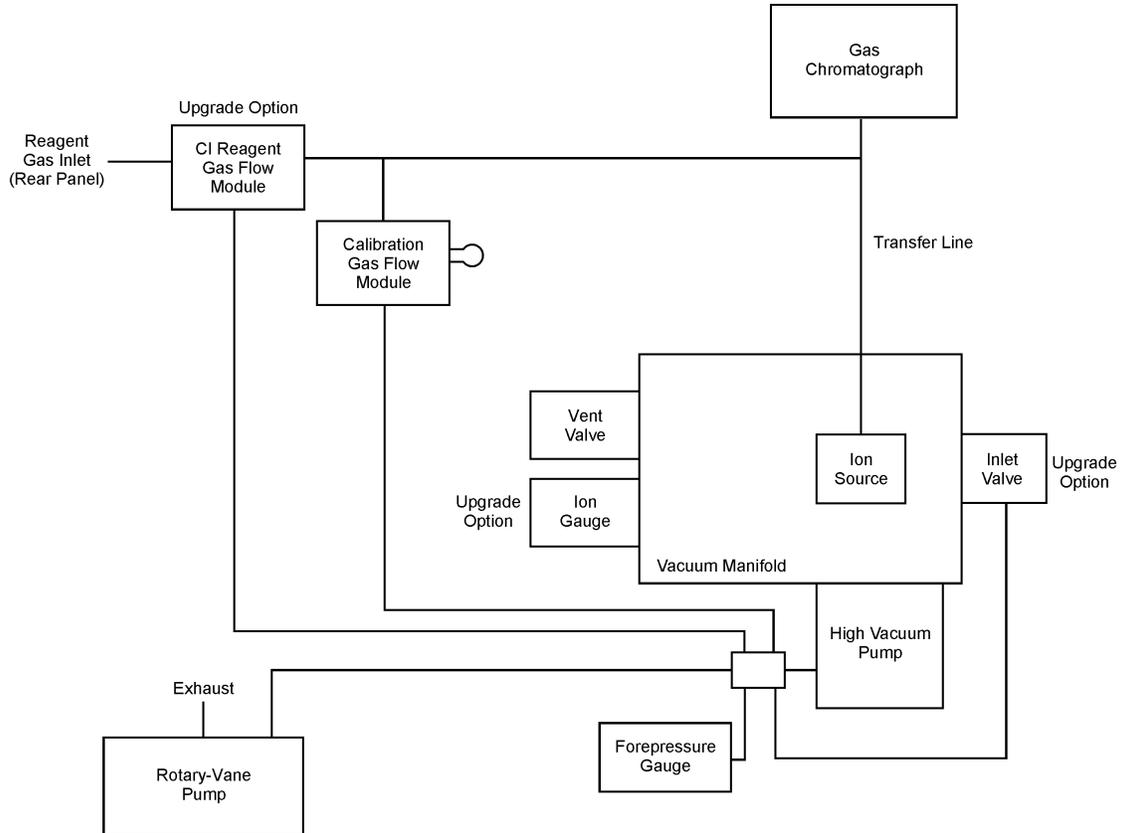


Figure B-1. Vacuum System and Gas Inlets

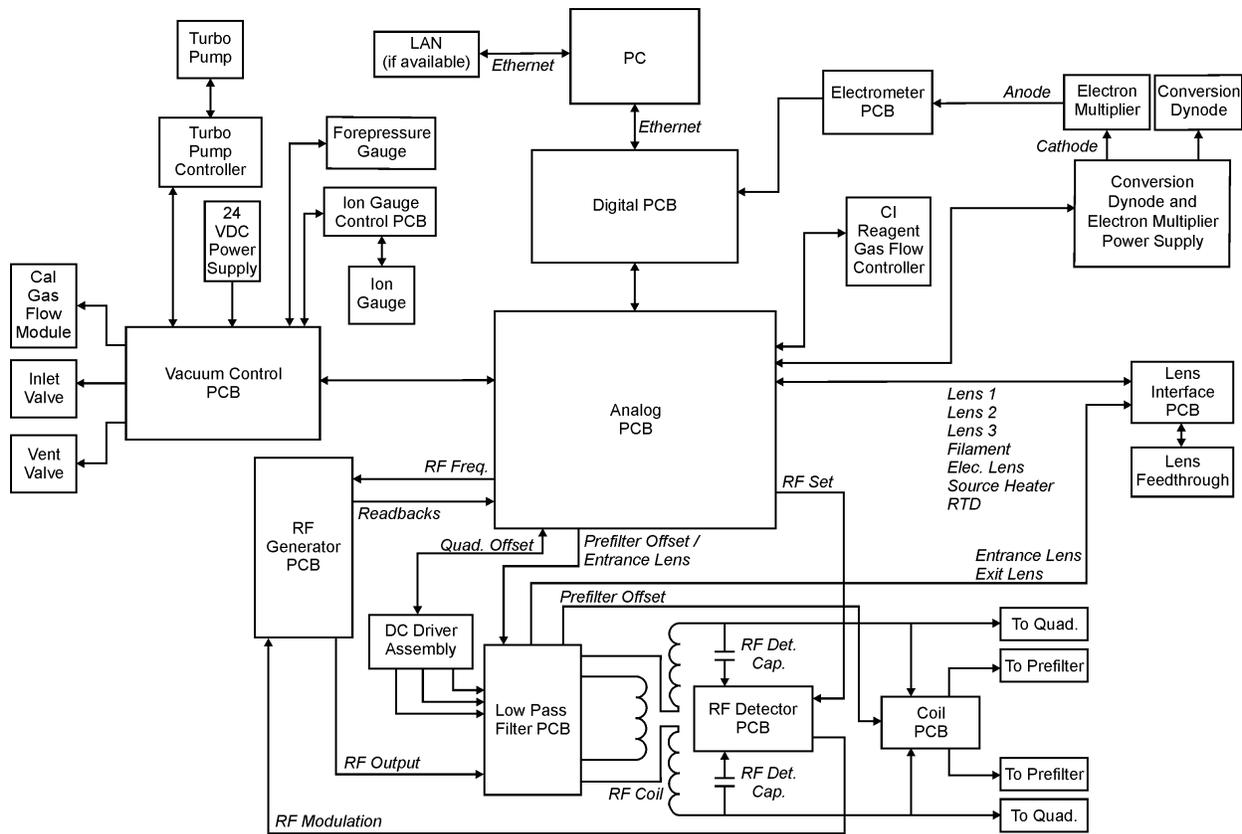


Figure B-2. Electronic Assemblies

www.thermo.com

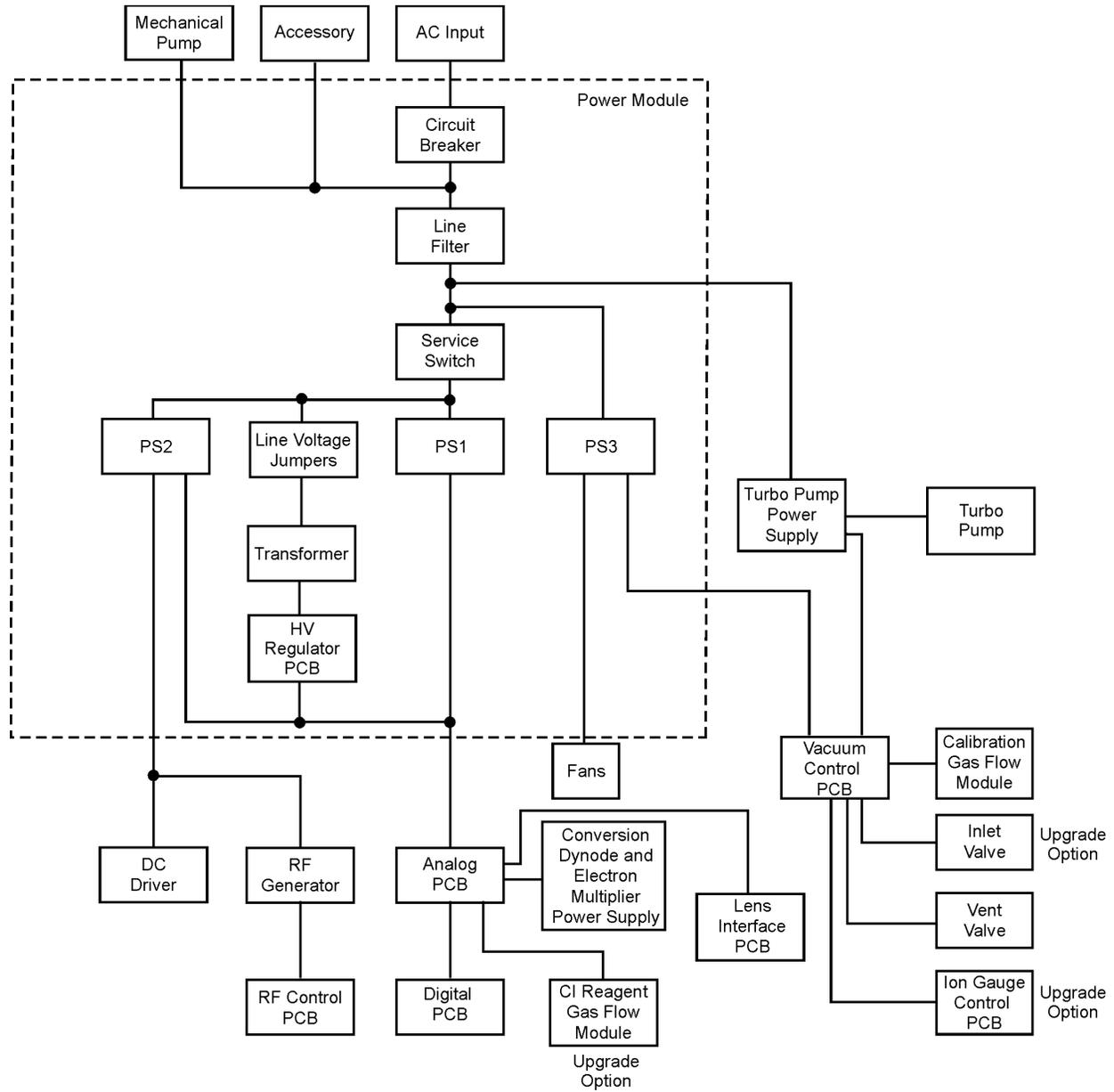
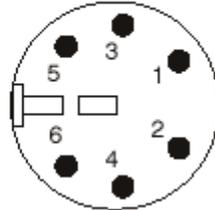


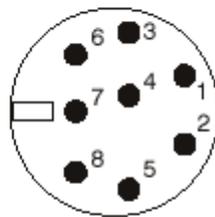
Figure B-3. Power Distribution

## Accessory Start



Trigger Bit 0 *	1
Trigger Bit 1 *	2
Trigger Bit 2 *	3
Trigger Bit GND **	4
Remote Start In ***	5
GND	6

## GC Start



N/C (Not Connected)	1
Inhibit Ready Out with High Signal	2
GND	3
Remote Start In ***	4
N/C	5
N/C	6
N/C	7
Inhibit Ready Out with Low Signal	8

\* For electromagnetic compatibility (EMC), use a shielded cable. Tie the shield to the metal can of the connector.

\*\* Use only with trigger bits (pins 1-3)

\*\*\* Polarity set in instrument configuration. Default is start when signal is low.

**Figure B-4. Remote Start Cable Connections (Back)**

The *TRACE DSO* offers two connections to start remote injections; Accessory Start and GC Start.

Use these connections to determine which connection to plug the remote start cable into. Plug one end of the remote start cable into the back of the *TRACE DSO* and the other end into the device you intend to use to start injections.



# Index

## A

accessory start [273](#)  
aluminum, cleaning [27](#)  
analog PCB, replacing [81](#)  
analog PCB, replacing fuse [83](#)  
anode [235](#)  
    cleaning [60](#)  
Automatic Tune troubleshooting [188](#)

## B

ball valve [216](#)  
block diagrams [269](#)

## C

cable parts list [250](#), [252](#), [254](#), [256](#)  
cables, remote start [273](#)  
calibration troubleshooting [188](#)  
calibration curves, troubleshooting [166](#)  
calibration gas flow module [203](#)  
calibration gas flow module, replacing [87](#)  
calibration gas, refilling [85](#)  
cathode [235](#)  
    replacing [63](#)  
CE compliance [iii](#)  
ceramic, cleaning [27](#)  
Cl ion volume [212](#)  
Cl reagent gas flow module [204](#)  
Cl reagent gas flow module, replacing [90](#)

cleaning  
    aluminum [27](#)  
    anode [60](#)  
    ceramic [27](#)  
    gold-plated [27](#)  
    ion source [33](#)  
    ion volume with an inlet valve [34](#)  
    ion volume without an inlet valve [44](#)  
    lenses [47](#)  
    prefilter [27](#)  
    quadrupole [59](#)  
    stainless steel [24](#)  
cleaning supplies [265](#)  
column characterization [4](#)  
column installation [2](#)  
column removal [14](#)  
combo EI/CI ion volume [212](#)  
communication, troubleshooting [144](#)  
compliance, FCC [iii](#)  
compliance, safety [iv](#)  
contamination, prefilter [227](#)  
contamination, quadrupole [227](#)  
contamination, troubleshooting [151](#)  
Convectron gauge [196](#)  
conventions, typographical [xv](#)  
conversion dynode [231](#)  
    description [232](#)  
    theory of operations [233](#)  
conversion dynode/electron multiplier power  
    supply, replacing [93](#)  
cooling fans, replacing [122](#)  
copyright [iii](#)  
covers  
    removing the front cover [22](#)  
    removing the left cover [23](#)  
    removing the right cover [22](#)  
    removing the top cover [22](#)

## D

DC control troubleshooting 172  
DC driver fuse, replacing 97  
DC driver, replacing 95  
detector  
    conversion dynode 231  
    electron multiplier 234  
diagnostics 142  
digital PCB, replacing 100  
document set 266  
DSQ Features xi

## E

EI ion volume 212  
EI/CI combo ion volume 212  
electrometer PCB, replacing 102  
electron lens 210  
electron multiplier 234  
    anode 235  
    cathode 235  
    description 235  
    replacing 63  
    theory of operations 236  
electronic assemblies 271  
EMC regulatory compliance iii  
entrance lens 225  
entry housing 218  
exit lens 225, 226

## F

fans, replacing 122  
FC-43 203  
FCC compliance iii  
features xii  
filament 210  
    replacing 55  
    troubleshooting 154  
filament spacer 210  
foreline adapter 196  
foreline adapter, replacing 104  
forepressure gauge 196  
forepressure gauge, replacing 104  
front cover, removing 22  
fuse  
    analog PCB 83  
    DC driver assembly 97  
    power module 120  
    RF generator PCB 129

## G

gas inlets 193, 202  
    block diagram 270  
    calibration gas flow module 203  
    CI reagent gas flow module 204  
    description 202  
    parts list 248  
    theory of operations 203  
    vent valve solenoid 205  
gauges parts list 248  
GC  
    column characterization 4  
    Column Eval 4  
    column installation 2  
    column removal 14  
    leak check 4  
GC start 273  
GC supplies 267  
gold-plated, cleaning 27  
guide bar 219

## H

handshaking 273  
heater, ion source 211  
heaters, troubleshooting 157  
high energy dynode 231  
high vacuum troubleshooting 161  
high vacuum pump parts list 258, 260

## I

I/R tool 219  
important information iii  
inlet valve 215  
    ball valve 216  
    description 215  
    entry housing 218  
    guide bar 219  
    I/R tool 219  
    lever 217  
    operating 34  
    parts list 262  
    plug 220  
    seal 221  
    theory of operations 216  
insertion/removal tool 219  
installation kit parts list 265

- ion detector
  - anode [60](#)
  - conversion dynode [231](#)
  - electron multiplier [63, 234](#)
  - maintenance [60](#)
- ion detector assembly [229](#)
- ion gauge [199](#)
- ion gauge, replacing [109](#)
- ion source [208](#)
  - description [209](#)
  - filament [55, 210](#)
  - heater [211](#)
  - ion source block assembly [211](#)
  - ion volume [34, 44, 212](#)
  - lenses [47, 213](#)
  - magnets [214](#)
  - parts list [240, 242](#)
  - temperature sensor [211](#)
  - theory of operations [210](#)
  - troubleshooting [157](#)
- ion source block assembly [211](#)
- ion source lenses parts list [244](#)
- ion source, maintenance [33](#)
- ion volume [212](#)
  - cleaning with an inlet valve [34](#)
  - cleaning without an inlet valve [44](#)
- ion volume, CI [212](#)
- ion volume, EI [212](#)
- ion volume, EI/CI combo [212](#)

## L

- leak check, GC [4](#)
- leaks, troubleshooting [161](#)
- left cover, removing [23](#)
- lens interface PCB, replacing [111](#)
- lens, entrance [225](#)
- lens, exit [225, 226](#)
- lenses [213](#)
  - cleaning [47](#)
  - parts list [244](#)
  - troubleshooting [154](#)
- linearity, troubleshooting [166](#)
- low pass filter PCB, replacing [113](#)

## M

- magnet support [214](#)
- magnets [214](#)
- maintenance [17](#)
  - adding rotary-vane pump oil [68](#)
  - anode [60](#)
  - benchmark tests [20](#)
  - changing the rotary-vane pump oil [72](#)
  - checking the rotary-vane pump oil [67](#)
  - column removal [14](#)
  - electron multiplier [63](#)
  - filament [55](#)
  - GC column installation [2](#)
  - ion detector assembly [60](#)
  - ion source [33](#)
  - ion volume with an inlet valve [34](#)
  - ion volume without an inlet valve [44](#)
  - lenses [47](#)
  - prefilter [47](#)
  - purging the rotary-vane pump [70](#)
  - quadrupole [59](#)
  - refilling calibration gas [85](#)
  - rotary-vane pump [67](#)
  - schedule [18](#)
  - shutting down [12](#)
  - starting up [10](#)
  - vacuum manifold [30](#)
- manuals [266](#)
- mass analyzer [226](#)
- multiplier [234](#)

## N

- neutral noise [227](#)
- noise, neutral [227](#)

## O

- options [xii](#)
- ordering parts [237](#)

## P

part numbers 237  
parts list  
  cables 250, 252, 254, 256  
  cleaning supplies 265  
  document set 266  
  fuses 265  
  gas inlets 248  
  gauges 248  
  GC supplies 267  
  inlet valve 262  
  installation kit 265  
  ion source 240, 242  
  lenses 244  
  miscellaneous 267  
  PCBs 250, 252, 254, 256  
  power module 264  
  pump 258  
  quadrupole assembly 246  
  split-flow turbomolecular pump 260  
  turbomolecular pump 258  
  vacuum manifold 238  
  vacuum system 258, 260  
parts, ordering 237  
PCBs  
  analog 81, 83  
  block diagram 271  
  DC driver 95, 97  
  digital 100  
  electrometer 102  
  lens interface 111  
  low pass filter 113  
  parts list 250, 252, 254, 256  
  RF detector 125  
  RF generator 127, 129  
  vacuum control 136  
performance benchmark tests 20  
plug, inlet valve 220  
polarity, DC 226  
power distribution 272  
power module  
  block diagram 272  
  parts list 264  
power module fuses, replacing 120  
power module, replacing 118  
power supplies 272  
power supply troubleshooting 168

prefilter 223, 227  
  cleaning 47  
  description 225  
  theory of operations 226  
prefilter, cleaning 27  
probe lock 215  
pump parts list 258  
pump, primary 200  
pump, rotary-vane 67, 200  
pumping down 10

## Q

quadrupole 226  
  cleaning 59  
  contamination 227  
quadrupole assembly 223  
  description 225  
  exit lens 226  
  parts list 246  
  prefilter 227  
  theory of operations 226  
quadrupole mass filter 223, 226  
quantitation, troubleshooting 166, 177, 186

## R

Read This First ix  
reagent gas 204  
rear cooling fans, replacing 122  
reflector 210  
regulatory compliance iii  
remote start cables 273  
replaceable parts 75, 237  
  back 80  
  left 77  
  left panel 78  
  right 79  
  top 76  
replacing  
  analog PCB 81, 83  
  calibration gas flow module 87  
  CI reagent gas flow module 90  
  conversion dynode/electron multiplier power supply 93  
  DC driver 95  
  DC driver fuse 97  
  digital PCB 100  
  electrometer PCB 102  
  electron multiplier 63  
  filament 55

- foreline adapter 104
- forepressure gauge 104
- ion gauge 109
- ion volume with an inlet valve 34
- ion volume without an inlet valve 44
- lens interface PCB 111
- low pass filter PCB 113
- power module 118
- power module fuses 120
- rear cooling fans 122
- RF detector PCB 125
- RF generator PCB 127
- RF generator PCB fuses 129
- transfer line 132
- turbomolecular pump power supply 134
- vacuum control PCB 136
- vent valve solenoid 139
- reproducibility, troubleshooting 186
- RF control troubleshooting 172
- RF detector PCB, replacing 125
- RF generator PCB fuses, replacing 129
- RF generator PCB, replacing 127
- right cover, removing 22
- rod DC 226
- rotary-vane pump 200
  - adding oil 68
  - changing oil 72
  - checking oil 67
  - maintenance 67
  - purging oil 70
- RTD, ion source 211

## S

- safety compliance iv
- seal, inlet valve 221
- sensitivity, troubleshooting 177
- shutting down 12
- spare parts 237
- specifications xii
- split-flow turbomolecular pump 198
  - parts list 260
- stability, troubleshooting 186
- stainless steel, cleaning 24
- standard curves, troubleshooting 166
- starting up the TRACE DSQ 10
- system performance 20

## T

- temperature sensor, ion source 211
- tools 265
- top cover, removing 22
- top cover, removing vacuum manifold 30
- trace analysis, troubleshooting 177
- TRACE DSQ
  - shutting down 12
  - starting up 10
- transfer line troubleshooting 157
- transfer line, replacing 132
- troubleshooting 141
  - communication 144
  - contamination 151
  - filament and lens control 154
  - heated zones 157
  - high vacuum 161
  - leaks 161
  - linearity 166
  - power supply 168
  - RF and DC control 172
  - sensitivity 177
  - stability 186
  - tuning 188
- tuning troubleshooting 188
- turbomolecular pump parts list 258
- turbomolecular pump power supply, replacing 134
- turbomolecular pump, single 196
- turbomolecular pump, split-flow 198
- typographical conventions xv

## V

- vacuum control PCB, replacing 136
- vacuum lock 215
- vacuum manifold 201
  - maintenance 30
  - parts list 238
- vacuum system 193
  - block diagram 270
  - description 195
  - foreline adapter 196
  - forepressure gauge 196
  - high vacuum pump 196, 198
  - ion gauge 199
  - rotary-vane pump 200
  - theory of operations 195
  - troubleshooting 161
  - vacuum manifold 201

vent valve solenoid [205](#)  
vent valve solenoid, replacing [139](#)  
venting [12](#)

## W

warranty [iv](#)

## X

Xcalibur data system  
shutting down the TRACE DSQ [12](#)  
starting up the TRACE DSQ [10](#)