

AXION 2 TOF MS DETECTOR



Maintenance Guide



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Maintenance Guide

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Introduction



About This Manual

This hardware guide is divided into following chapters:

Chapter 1 Introduction

This chapter contains a brief introduction on the instrument, the conventions and warnings used in the manual.

Chapter 2 Safety Practices

Important safety information is provided in this chapter.

Chapter 3 Preparing Your Laboratory

The preparation of your laboratory needed for the AxION 2 TOF MS Detector. Laboratory requirements for the instrument are reviewed in this chapter.

Chapter 4 System Description

This chapter contains information on the components of the instrument, how it works and instrument specifications.

Chapter 5 Maintenance

Maintenance and cleaning procedures for the various components of your instrument are provided.

Chapter 6 Troubleshooting

Performance checks, troubleshooting information, software and system error messages are provided for the instrument.

Instructions for use: Operating instructions are included in the AxION 2 TOF User Manual (PerkinElmer Part Number 09931007). It is important that you familiarize yourself with the operation of the instrument prior to turning on the system.

Conventions Used in this Manual

Normal text is used to provide information and instructions.

Bold text refers to text that is displayed on the screen.

UPPERCASE text, for example ENTER or ALT, refers to keys on the PC keyboard. '+' is used to show that you have to press two keys at the same time, for example, ALT+F.

All eight digit numbers are PerkinElmer part numbers unless stated otherwise.

Notes, cautions and warnings

Three terms, in the following standard formats, are also used to highlight special circumstances and warnings.

NOTE: *A note indicates additional, significant information that is provided with some procedures.*

CAUTION

We use the term **CAUTION** to inform you about situations that could result in **serious damage to the instrument** or other equipment. Details about these circumstances are in a box like this one.

D**Caution (Achtung)**

Bedeutet, daß die genannte Anleitung genau befolgt werden muß, um einen **Geräteschaden** zu vermeiden.

DK**Caution (Bemærk)**

Dette betyder, at den nævnte vejledning skal overholdes nøje for at undgå en **beskadigelse af apparatet**.

E**Caution (Advertencia)**

Utilizamos el término **CAUTION (ADVERTENCIA)** para advertir sobre situaciones que pueden provocar **averías graves en este equipo** o en otros. En recuadros éste se proporciona información sobre este tipo de circunstancias.

F**Caution (Attention)**

Nous utilisons le terme **CAUTION (ATTENTION)** pour signaler les situations susceptibles de provoquer de **graves détériorations de l'instrument** ou d'autre matériel. Les détails sur ces circonstances figurent dans un encadré semblable à celui-ci.

I**Caution (Attenzione)**

Con il termine **CAUTION (ATTENZIONE)** vengono segnalate situazioni che potrebbero arrecare **gravi danni allo strumento** o ad altra apparecchiatura. Troverete informazioni su tali circostanze in un riquadro come questo.

NL**Caution (Opgelet)**

Betekent dat de genoemde handleiding nauwkeurig moet worden opgevolgd, om **beschadiging van het instrument** te voorkomen.

P**Caution (Atenção)**

Significa que a instrução referida tem de ser respeitada para evitar a **danificação do aparelho**.



WARNING

We use the term **WARNING** to inform you about situations that could result in **personal injury** to yourself or other persons. Details about these circumstances are in a box like this one.

D

Warning (Warnung)

Bedeutet, daß es bei Nichtbeachten der genannten Anweisung zu einer **Verletzung** des Benutzers kommen kann.

DK

Warning (Advarsel)

Betyder, at brugeren kan blive **kvæstet**, hvis anvisningen ikke overholdes.

E

Warning (Peligro)

Utilizamos el término **WARNING (PELIGRO)** para informarle sobre situaciones que pueden provocar **daños personales** a usted o a otras personas. En los recuadros como éste se proporciona información sobre este tipo de circunstancias.

F

Warning (Danger)

Nous utilisons la formule **WARNING (DANGER)** pour avertir des situations pouvant occasionner des **dommages corporels** à l'utilisateur ou à d'autres personnes. Les détails sur ces circonstances sont données dans un encadré semblable à celui-ci.

I

Warning (Pericolo)

Con il termine **WARNING (PERICOLO)** vengono segnalate situazioni che potrebbero provocare **incidenti alle persone**. Troverete informazioni su tali circostanze in un riquadro come questo.

NL

Warning (Waarschuwing)

Betekent dat, wanneer de genoemde aanwijzing niet in acht wordt genomen, dit kan leiden tot **verwondingen** van de gebruiker.

P

Warning (Aviso)

Significa que a não observância da instrução referida poderá causar um **ferimento** ao usuário.

Warning Signs on the Instrument



Caution, hot surface.



Caution, risk of electric shock.



Indicates alternating current



Indicates the *off* position of the main power switch



Indicates the *on* position of the main power switch



Indicates the protective conductor terminal

WEEE Instructions for PerkinElmer Products



or



A label with a crossed-out wheeled bin symbol and a rectangular bar indicates that the product is covered by the Waste Electrical and Electronic Equipment (WEEE) Directive and is not to be disposed of as unsorted municipal waste. Any products marked with this symbol must be collected separately, according to the regulatory guidelines in your area.

The objectives of this program are to preserve, protect and improve the quality of the environment, protect human health, and utilize natural resources prudently and rationally. Specific treatment of WEEE is indispensable in order to avoid the dispersion of pollutants into the recycled material or waste stream. Such treatment is the most effective means of protecting the customer's environment.

Requirements for waste collection reuse, recycling, and recovery programs vary by regulatory authority at your location. Contact your local responsible body (e.g., your laboratory manager) or authorized representative for information regarding applicable disposal regulations. Contact PerkinElmer at the web site listed below for information specific to PerkinElmer products.

Web address:

<http://www.perkinelmer.com/pages/010/onesource/environmental-health-and-safety/environmental-directives-compliance.xhtml>

For Customer Care telephone numbers select "Contact us" on the web page.

Products from other manufacturers may also form a part of your PerkinElmer system. These other producers are directly responsible for the collection and processing of their own waste products under the terms of the WEEE Directive. Please contact these producers directly before discarding any of their products.

Consult the PerkinElmer web site (above) for producer names and web addresses.

Decontamination and Cleaning

Before using any cleaning or decontamination methods except those specified by PerkinElmer, users should check with PerkinElmer that the proposed method will not damage the equipment.

Decontamination

Customers wishing to return instrumentation and/or associated materials to PerkinElmer for repair, maintenance, warranty or trade-in purposes are advised that all returned goods must be certified as clean and free from contamination.

The customer's responsible body is required to follow the "Equipment Decontamination Procedure" and complete the "Certificate of Decontamination". These documents are available on the PerkinElmer public website:

Procedure:

http://www.perkinelmer.com/Content/technicalinfo/dts_instrumentdeconprocedure.pdf

Certificate form:

http://www.perkinelmer.com/Content/technicalinfo/dts_perkinelmercertificationofdecontaminationform.pdf

If you do not have access to the internet and are located in the U.S., call toll free at 1-800-762-4000 or (+1) 203-925-4602, 8:30 a.m. - 7 p.m. EST and speak to Customer Support.

In Canada, call toll free 800-561-4646 and speak to Customer Support.

If you are located outside of the United States or Canada, please call your local PerkinElmer sales office for more information.

Cleaning the Instrument

Exterior surfaces may be cleaned with a soft cloth, dampened with a mild detergent and water solution. Do **not** use abrasive cleaners or solvents.



Safety Practices



Overview

This chapter describes the general safety practices and precautions that must be observed when operating the AxION 2 TOF MS Detector.

This advice is intended to supplement, not supersede, the normal safety codes in the user's country. It is also a supplement to the PerkinElmer standard Safety and Health Policy. The information provided does not cover every safety procedure that should be practiced. Ultimately, maintenance of a safe laboratory environment is the responsibility of the analyst and the analyst's organization.

Please consult all manuals supplied with the AxION 2 TOF MS Detector and accessories before you start working with the instrument. Carefully read the safety information in this chapter and in the other manuals supplied. When setting up the instrument or performing analyses or maintenance procedures, strictly follow the instructions provided.

This equipment requires no specified inspection or preventive maintenance to ensure the continuous functioning of its safety features.

Precautions for Instrument



WARNING

Be sure that all instrument operators read and understand the precautions listed below. It is advisable to post a copy of the precautions near or on the instrument shelf.



WARNING

Do not operate the instrument with any covers or parts removed. Disconnect the power supply whenever cover is removed.



WARNING

Do not attempt to make adjustments, replacements or repairs to this instrument except as described in the accompanying user documentation.



WARNING

Dispose of waste in accordance with the regulations applicable to your locality, state and/or country.



The protection provided by this equipment may be impaired if the equipment is used in a manner not specified by PerkinElmer.

The following precautions must be observed when using the AxION 2 TOF MS Detector:

- Before the instrument is installed, the area around, under and behind the instrument's planned location is to be cleared of any dirt and dust to prevent their entry into the instrument's interior which could cause a negative effect on performance.
- Be sure that the voltage of the AxION 2 TOF MS Detector corresponds to the voltage used in your laboratory.

- Never remove the side panels of the AxION 2 TOF MS Detector without shutting down the instrument and disconnecting the instrument power cord from line power.
- Do not immerse the purge gas exit line in a liquid, as the liquid may be drawn back into the sample holder.
- Only high quality, hydrocarbon free nitrogen gas should be used with the AxION 2 TOF MS Detector. Minimum purity of 97.5% is recommended. A hydrocarbon trap accessory (PerkinElmer Part Number N9301208) is recommended for the removal of any organics from the nitrogen supply.
- In order to easily turn the system on or off, allow air to circulate freely around, and allow for service and maintenance procedures, it is recommended to leave 60 cm (24 inches) free space beside the system. Make sure that the right side rear section of the instrument where the circuit breaker is located is accessible.

Precautions for Customers



WARNING

The laboratory manager is responsible for warning operators of this instrument about biohazardous materials that are processed in this instrument and about wastes that result from the operation of this instrument.



WARNING

The laboratory manager is responsible for disposing of any biohazardous materials and minimizing any biohazards before the equipment is removed from use, transported or processed for disposal.

- Most analytes entering the instrument will exit through the source exhaust line (into the waste bottle) or be deposited into the foreline pump oil. If analyzing potentially infectious or dangerous substances (such as human samples or reagents), suitable protective gloves must be worn by the instrument operator.
- Appropriate venting, sample and waste collection needs to be provided.
- Waste oil when changed must be appropriately handled and disposed of.
- The waste bottle must be connected and positioned below the exhaust hose. See page 55 for the proper positioning of the waste bottle.
- The drying gas will push volatile mobile phase and sample waste through the source exhaust line, so the waste bottle must be appropriately vented. See Figure 4 on page 38 for the correct connection of exhaust lines.
- The AxION 2 TOF MS Detector weighs 500 lb (227 kg) and the roughing pump weighs 44 kg (97 lbs).
- Never remove the side panels of the AxION 2 TOF MS Detector without shutting down the instrument and disconnecting the instrument power cord from line power

General Operating Conditions

The AxION 2 TOF MS Detector has been designed and tested in accordance with PerkinElmer specifications and in accordance with industry safety requirements.

This equipment requires no specified inspection or preventive maintenance to ensure the continuous functioning of its safety features.

The AxION 2 TOF MS Detector is only for indoor use under the following conditions:

- The location must be free of smoke, dust, corrosive fumes, direct sunlight and excessive vibration.
- Temperature: +10°C to +35°C (+50°F to +95°F)
- Relative humidity: 20% to 80%, without condensation
- Altitude: in the range -400 m to 2,000 m (sea level to 6,562 feet)

If possible, avoid any adjustment, maintenance and repair of the opened, operating instrument. If any adjustment, maintenance and repair of the opened instrument is necessary, this must be done by a skilled person who is aware of the hazard involved.

Whenever it is likely that the AxION 2 TOF MS Detector is unsafe, make it inoperative. The AxION 2 TOF MS Detector may be unsafe if it:

- shows visible damage
- fails to perform the intended measurement
- has been subjected to prolonged storage in unfavorable conditions
- has been subjected to severe transport stresses.

Environmental Conditions



WARNING

If the equipment is used in a manner not specified herein, the protection provided by the equipment may be impaired.

The instrument has been designed to be safe under the following conditions:

- Indoor use
- Altitude in the range of -400 m to 2000 m
- Ambient temperatures of 21 ± 5 °C (70 ± 9 °F)
- Relative humidity: 20% to 80%, without condensation
- Mains fluctuations not exceeding $\pm 10\%$ of the nominal voltage.

Storage conditions:

- Ambient temperature: -20°C to $+60^{\circ}\text{C}$ (-4°F to $+140^{\circ}\text{F}$)
- Relative humidity: 20% to 80%, without condensation
- Altitude: in the range -400 m to 12,000 m (sea level to 39,370 feet)

Electrical Safety

The instrument has been designed to protect the operator from potential electrical hazards. This section describes some recommended electrical safety practices.



WARNING

Lethal voltages are present at certain areas within the instrument. Installation and internal maintenance of the instrument should only be performed by a PerkinElmer service engineer or similarly authorized and trained person. When the instrument is connected to line power, opening the instrument covers is likely to expose live parts. Even when the power switch is off, high voltages can still be present. Capacitors inside the instrument may still be charged even if the instrument has been disconnected from all voltage sources.

The instrument must be correctly connected to a suitable electrical supply. The supply must have a correctly installed protective conductor (earth ground) and must be installed or checked by a qualified electrician before connecting the instrument.



WARNING

Any interruption of the protective conductor (earth ground) inside or outside the instrument or disconnection of the protective conductor terminal is likely to make the instrument dangerous. Intentional interruption is prohibited.



WARNING

Grounding circuit continuity is vital for safe operation of the equipment. Never operate the equipment with the grounding conductor disconnected. Grounding is accomplished by the use of an IEC 60309 instrument power plug furnished by the factory. It is **not** to be removed during or after installation.

When working with the instrument:

- Connect the instrument to a correctly installed line power outlet that has a protective conductor connection (earth ground).
- Do not operate the instrument with any covers or internal parts removed.
- Do not attempt to make internal adjustments or replacements except as directed in the manuals.
- Disconnect the instrument from all voltage sources before opening it for any adjustment, replacement, maintenance, or repair. If afterwards, the opened instrument must be operated for further adjustment, maintenance, or repair, this must only be done by a PerkinElmer Service engineer.
- Whenever it is possible that the instrument is no longer electrically safe for use, make the instrument inoperative and secure it against any unauthorized or unintentional operation. The electrical safety of the instrument is likely to be impaired if, for example, the instrument shows visible damage; has been subjected to prolonged storage under unfavorable conditions; or has been subjected to severe stress during transportation.

EMC Compliance

EMC Directive

This product has been designed and manufactured, having regard to the state of the art, to ensure that:

- a) the electromagnetic disturbance generated does not exceed the level above which radio and telecommunications equipment or other equipment cannot operate as intended;
- b) it has a level of immunity to the electromagnetic disturbance to be expected in its intended use which allows it to operate without unacceptable degradation of its intended use.

United States - FCC Compliance

This device complies with part 15 of the FCC Rules.

Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) this device must accept any interference received, including interference that may cause undesired operation.

Use of this product in residential areas may cause interference and such use should be avoided unless special measures are taken by the user to restrict emissions to a level that allows the reception of broadcast emissions.

Europe

All information concerning EMC standards is in the Declaration of Conformity, and these standards may change as the European Union adds new requirements.

Pollution Degree

This product will operate safely in environments that contain nonconductive foreign matter up to Pollution Degree 2 in EN/IEC 61010-1.

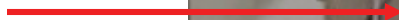
Warning Labels



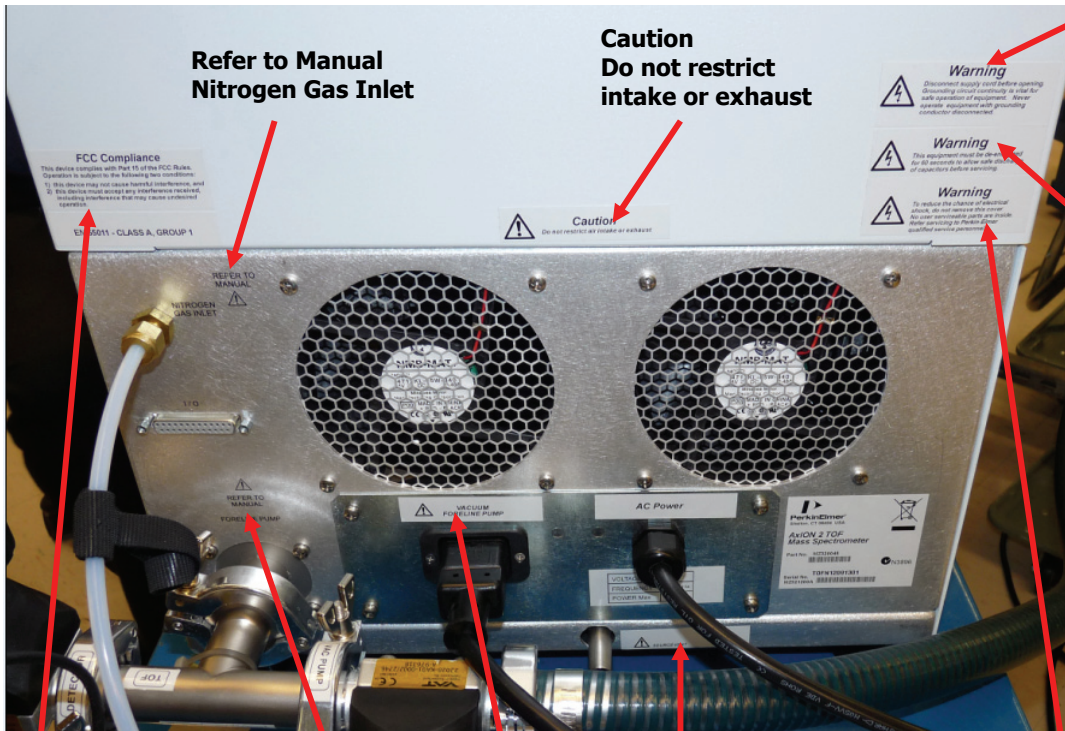
When this label is attached to an instrument it means refer to the manual.

Front of Instrument

**Warning
Hot Surface**



Back of Instrument



Refer to Manual
Nitrogen Gas Inlet

Caution
Do not restrict
intake or exhaust

Warning
Disconnect supply
cord before opening.
Grounding circuit
continuity is vital for
safe operation of
equipment. Never
operate equipment
with grounding
conductor
disconnected.

Warning
This equipment
must be discharged
for 60 seconds to
allow safe discharge
of capacitors before
servicing.

FCC Compliance
This device complies with
Part 15 of the FCC Rules.
Operation is subject to the
following two conditions:
1) This device may cause
harmful interference
and,
2) This device must
accept any interference
received, including
interference that may
cause undesired
operation.

Refer to Manual
Foreline Pump

Vacuum
Foreline Pump

Source Vent

Warning
To reduce the chance of
electrical shock, do not
remove this cover. No user
serviceable parts are inside.
Refer to PerkinElmer or
other qualified service
personnel.

Safe Handling of Gas Cylinders

Nitrogen is the only gas required for use with the AxION 2 TOF MS Detector. The major hazard associated with this gas is suffocation. This can occur if the gas is allowed to escape in an enclosed area and displaces the oxygen in the air. Nitrogen is neither explosive nor combustible.

Because of the high consumption of nitrogen required for LCMS operation, the use of a nitrogen generator is strongly recommended. PerkinElmer offers a wide variety of nitrogen generators designed to meet the needs of any laboratory, large or small, and for single or multiple instrument installations. Please consult with a PerkinElmer Sales Representative for more information on nitrogen generators.

Alternatively, many large laboratories may have in-house nitrogen supplied from the blow off of a nitrogen dewar. As long as the supply can provide the hydrocarbon free purity, pressure and capacity required, this is an acceptable alternative. See Table 7 on page 38 for the nitrogen supply specifications.

The final alternative for supplying nitrogen gas is from gas cylinders. This is not recommended since the nitrogen consumption will typically require the changing of cylinders several times a week, depending on usage and this is a major inconvenience. However, cylinders are an acceptable means of delivering nitrogen and may be required in certain situations.

The following section is provided in case gas cylinders are used to supply nitrogen to the AxION 2 TOF MS Detector.



WARNING

Contact the gas supplier for a material safety data sheet (MSDS) containing detailed information on the potential hazards associated with the gas. Carefully use, store, and handle compressed gases in cylinders. Gas cylinders can be hazardous if they are mishandled.

NOTE: *The permanent installation of gas supplies is the responsibility of the user and should conform to local safety and building codes.*

Listed below are some general safety practices for the proper identification, storage, and handling of gas cylinders. Consult the following references for more detailed information and additional guidelines.

- Compressed Gas Association (USA), "Safe Handling of Compressed Gases in Containers," pamphlet no. P-1, 1984.
- Compressed Gas Association (USA), "The Inert Gases – Argon, Nitrogen and Helium," pamphlet no. P-9, 1992.

Identification of Gas Cylinders

Legibly mark cylinders to identify their contents. Use the chemical name or commercially accepted name for the gas.

Storing Cylinders

Review the following precautions with the customer to ensure the safe use and storage of gas cylinders.

- Cylinders should be stored in accordance with the regulations and standards applicable to the customer's locality, state, and country.
- When cylinders are stored indoors in storage rooms, the storage room should be well ventilated and dry. Ensure that the ventilation is adequate to prevent the formation of dangerous accumulations of gas. This is particularly important in small or confined areas.
- Do not store cylinders near elevators, gangways, or in locations where heavy moving objects may strike or fall against them.
- Use and store cylinders away from exits and exit routes.
- Locate cylinders away from heat sources, including heat lamps. Compressed gas cylinders should not be subjected to temperatures above 52 °C (126 °F).
- Do not allow ignition sources in the storage area and keep cylinders away from readily ignitable substances such as gasoline or waste, or combustibles in bulk, including oil.
- Store cylinders standing upright, fastened securely to an immovable bulkhead or permanent wall.
- When storing cylinders outdoors, they should be stored above ground on a suitable floor and protected against temperature extremes (including the direct rays of the sun).
- Mark gas cylinders clearly to identify the contents and status (full, empty, etc.).
- Do not attempt to refill gas cylinders.
- Arrange gas hoses where they will not be damaged or stepped on where things will not be dropped on them.

Perform periodic gas leak tests by applying a soap solution to all joints and seals.

Handling Cylinders

Review the following precautions with the customer to ensure the safe use and handling of gas cylinders.

- If it becomes necessary to move cylinders, do so with a suitable hand truck after insuring that the container cap is secured and the cylinder is properly fastened to the hand truck.
- Use only regulators, tubing and hose connectors approved by an appropriate regulatory agency.
- Arrange gas hoses where they will not be damaged or stepped on and where objects will not be dropped on them.
- Do not refill cylinders.
- Remind the customer to check the condition of pipes, hoses and connectors regularly. Perform gas leak tests at all joints and seals of the gas system regularly, using an approved gas leak detection system.
- Remind the customer that when the equipment is turned off, close all gas cylinder valves tightly at the cylinder. Bleed the remainder of the line before turning the exhaust vent off.

Preparing Your Laboratory



Chapter Overview

Introduction

This high performance MS should provide you with many years of use if you prepare your laboratory appropriately and ensure proper maintenance. This chapter will provide you with the information you will need to prepare your laboratory for the installation of the AxION 2 TOF MS Detector.

This chapter describes how to properly prepare your site for a new AxION 2 TOF MS system. Follow these instructions carefully as delays due to improper site preparation may result in loss of instrument use during the warranty period.

Customer Responsibilities

You should ensure that necessary operating supplies, consumables, and usage dependent items such as vials, syringes, pipettes, and solvents are available. You are responsible for the preparation of laboratory before the arrival of your instrument. Failure to have the site prepared properly will result in additional charges by the service team.

Before the AxION 2 TOF MS system can be installed, the site must be properly prepared. Site preparation includes, but is not limited to, ensuring that adequate facilities are available.

- Adequate space is available for the AxION 2 TOF MS system.
- A suitable supporting bench is available.
- Adequate electrical power is available at the correct voltages and frequencies.
- Environmental control systems are adequate to maintain a correct, stable operating environment.
- An adequate source of clean, dry nitrogen gas for up to 25 L/min of continuous flow.
- Adequate exhaust venting for up to 25 L/min of nitrogen gas and vapor.
- Exhaust venting fore-line pump.
- Supplies necessary for instrument operation are available.
- **Lifting Crane.**
- **Transport Trolley.**

See Table 8 for required materials.

PerkinElmer Responsibilities

- Unpacking the AxION TOF MS system and verifying that all components are present and undamaged.
- Connecting the carrier gas line to the instrument from the tank, regulators, and lines installed by the customer.
- Installing, connecting, and turning on AxION 2 TOF MS system components.
- Verifying that the system meets PerkinElmer published performance specifications.
- Basic user familiarization for system hardware and software.

Storage

It is your responsibility to store the containers until installation. The environment in the storage area should be between -20 °C and +60 °C (-4 °F and 140 °F), 20% to 80% relative humidity, non-condensing and non-corrosive.

Instrument Identification

Each PerkinElmer AxION 2 TOF MS Instrument is identified by a unique 12 character serial number starting with TOFN followed by 8 numbers. This serial number is located on a label on the rear panel lower right hand side of the instrument looking from the rear. When corresponding with PerkinElmer about this instrument, you must include the model number and the full 12 character serial number.

Receiving the System

When your AxION 2 TOF MS system is delivered, it is your responsibility to provide for removal of the shipping containers from the truck and their storage until installation. Contact your PerkinElmer service representative as soon as your shipment arrives to arrange an installation date.

Space Requirements and Instrument Access

NOTE: *Doors, corridors and elevators should have a minimum width of 1 meter (~40 inches) to allow for transporting the boxes to the laboratory. Allow additional room for maneuvering around corners.*

Laboratory ceiling height must be at least 96 inches (245 cm) to allow placing the AxION 2 TOF MS system on a 35 inches (90 cm) high bench, and allowing at least 8 inches (20cm) above the instrument for proper ventilation. The bench must be clean, flat, and stable to support the weight of the AxION TOF MS. The roughing pump is typically placed on the floor. There must be adequate space around it to allow heat dissipation.

A custom designed PerkinElmer wheeled 20 inch wide, 36 inch deep, 18 inch high cart is provided to support the AxION 2 MS and help position it in the laboratory. Also available is an optional custom cart to support a PerkinElmer HPLC system, if purchased with the AxION 2 MS. This cart is 30 inches deep and 40 inches wide. It is listed in **Table 10: Optional Customer Accessories**. Contact your PerkinElmer Sales representative for more information.

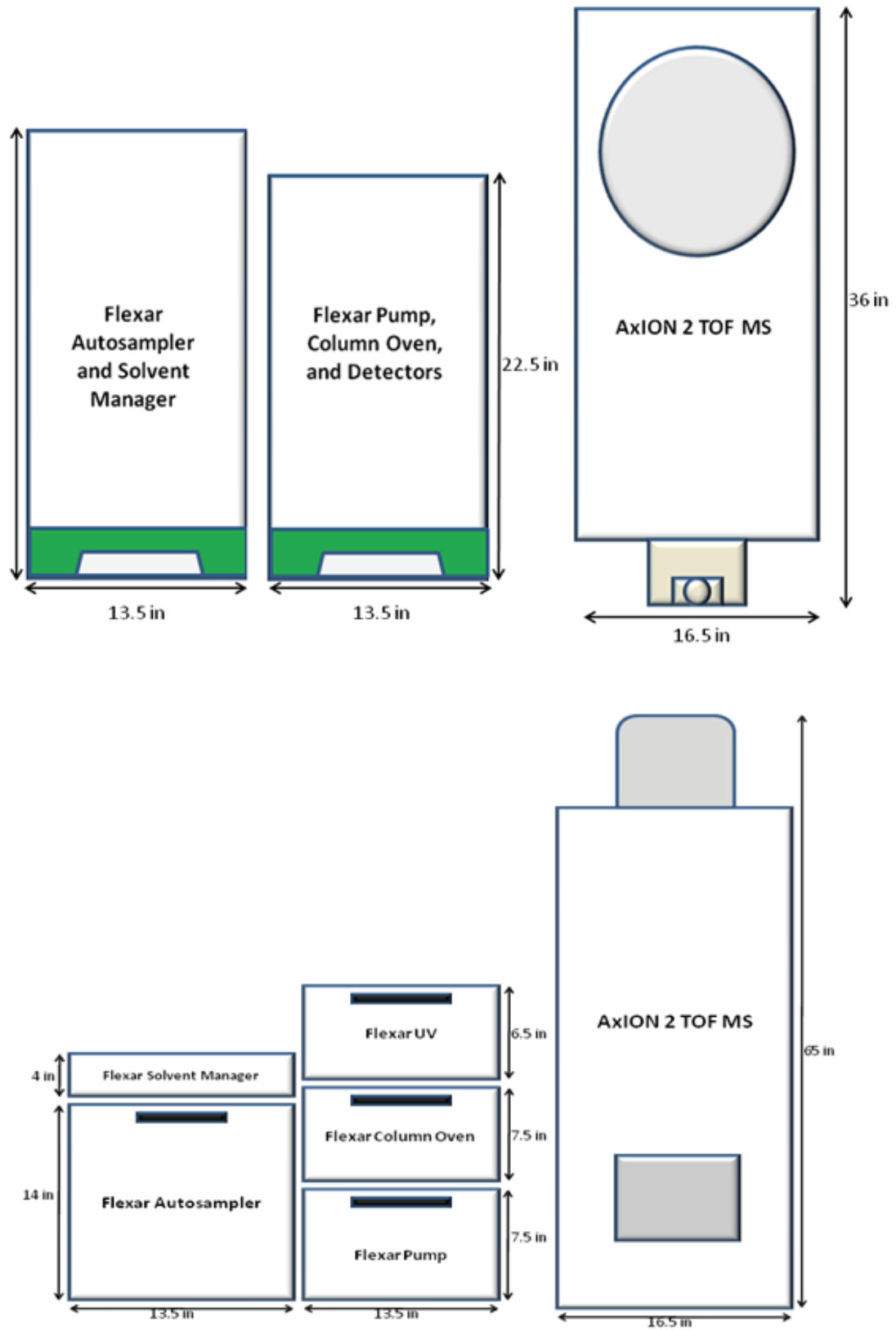


Figure 1. Space required – Top and front views of AxION 2 TOF MS with Flexar UHPLC system

The AxION 2 TOF MS may also be sold in a stand-alone configuration with the DSA™ (Direct Sample Analysis) ion source. In this case, the top and front view of the AxION 2 would be as shown in the following figure.

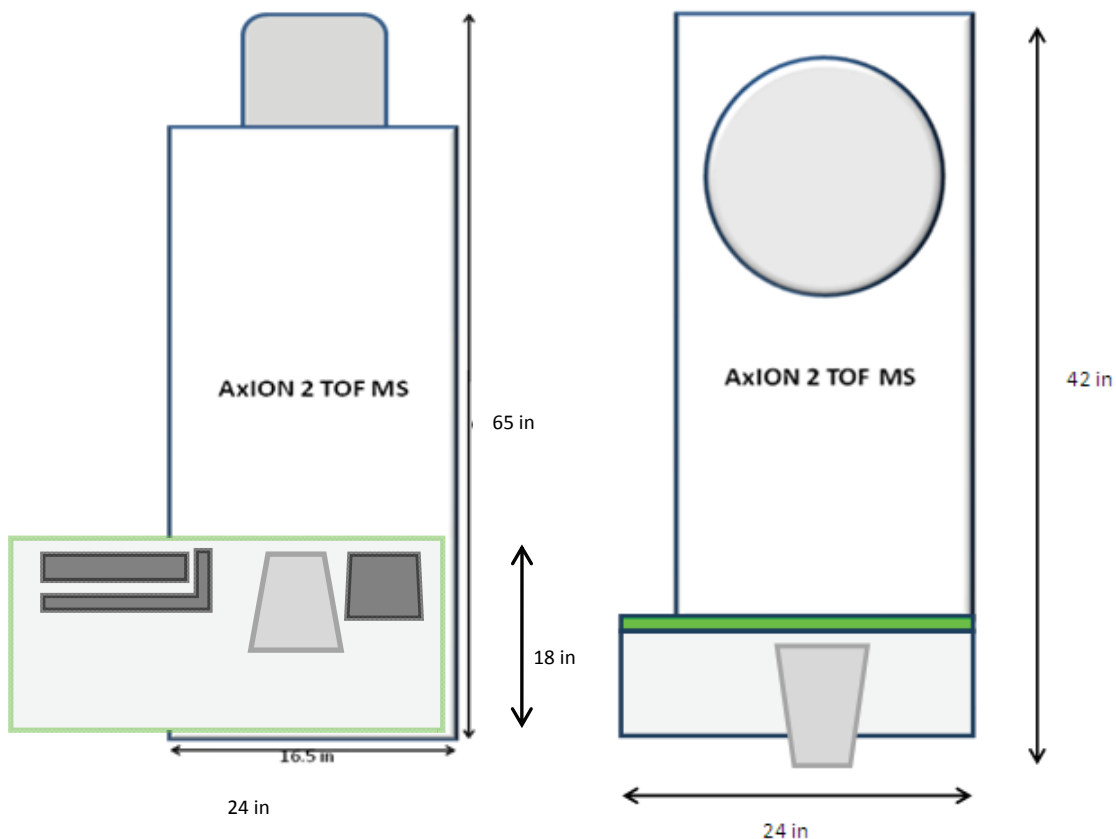


Figure 2. Top and front views of AxION 2 TOF MS with the DSA

Service Access Area

To allow for service and maintenance operations, it is recommended to leave 25 inches (63.5 cm) of free space beside each side of the system.

Nitrogen Supply

If a nitrogen supply is not available in the laboratory, space is required for a gas cylinder or nitrogen generator.

Due to the high consumption of nitrogen we recommend the use of a nitrogen gas generator. PerkinElmer offers several models depending on your laboratory's requirements that are specifically designed to meet the needs of your AxION 2 TOF MS. Contact your PerkinElmer Sales representative for more information.

Equipment Dimensions and Weights

The dimensions of the AxION 2 TOF MS are shown in Figure 1.

16.5 inches (42 cm) Wide
65 inches (165 cm) Tall
31.5 inches (80 cm) Deep without Source Housing
36 inches (92 cm) Deep with Source Housing

Table 1. AxION 2 TOF MS Dimensions

Component	Weight
AxION TOF MS	500 lb (227 kg)
AxION TOF MS with packaging	600 lbs (272 kg)
Roughing pump	97 lbs (44 kg)


Table 2. AxION 2 TOF MS Component Weights

Noise Reduction

The overall noise from a running instrument is below 70 dB.

Moving or Relocating the AxION 2 TOF MS

IMPORTANT: It is essential that you provide suitable equipment for lifting the instrument. The installation cannot be implemented unless this equipment is made available prior to the installation.

 <p>WARNING</p>	<p><i>Risk of injury through lifting. The instrument weighs approximately 500 lbs. (227 kg).</i></p> <p><i>A forklift truck or A-frame hoist is recommended for lifting and transporting the instrument. The lifting crane and transport trolley must be able to lift 500 pounds (227kg) to the height of the laboratory table.</i></p>
---	---

Required Equipment

- 1. Lifting Crane**
- 2. Transport Trolley**

A lifting device is needed to attach to the 4 circular bolts connected to the AxION 2 TOF MS top frame, to lift the instrument out of the box and place it on a transport trolley.

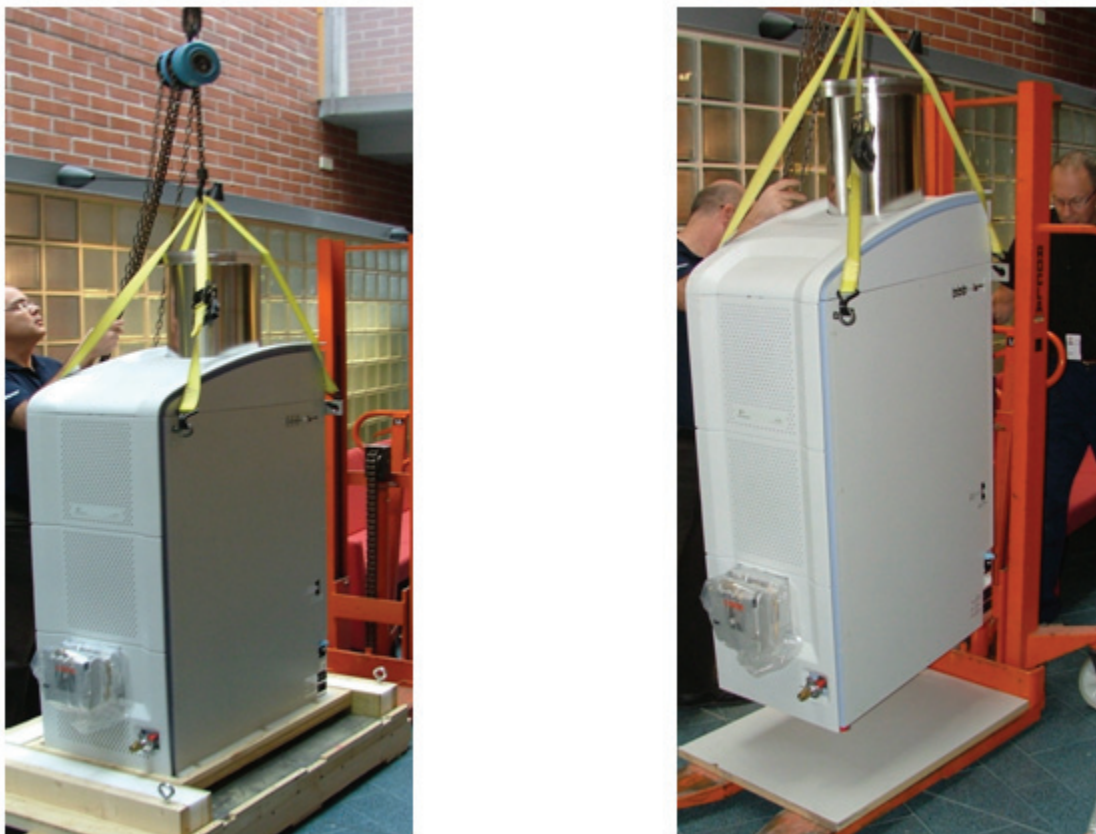


Figure 3. Lifting and Transporting the AxION 2 TOF MS

Vibration-Damping Constructions

If the instrument must be placed on a table instead of the cart provided, the table must be capable of handling 500 lb (227 kg) of weight without any movement. The AxION 2 TOF MS instrument is sensitive to sideway movements and vibration during operation. Do not run the AxION 2 TOF MS while moving the instrument. The instrument should not be placed close to heavy machinery such as compressors or generators, which generate excessive floor vibration.

Environment and Ventilation Considerations

Before the instrument is installed, the instrument's planned location is to be cleared of any dirt and dust to prevent its entry into the instrument's interior which could cause damage to the instrument. The ventilation and air conditioning systems must be capable of maintaining reasonably constant temperature and humidity within the specified limits (see Table 3).

Room Climate

Table 3 lists the environmental requirements for installation of the AxION TOF MS Detector. The instrument **should not be exposed to direct sunlight or open windows.**

Ambient temperature, operating	21 ±5 °C (70 ±9 °F)
Relative humidity, operating	20-80% non-condensing
Atmospheric pressure	840-1060 mbar (84-106 kPa)
Altitude	-400 to 2000 m
Ventilation, if fume hood is used	Independent venting of API source and fore-line vacuum pump, at least 25 L/min each. <i>Typical laboratory fume hoods are adequate given that the small oil droplets (oil mist) emanating from the pump due to large air displacement are not harmful to its environment.</i>
Ventilation, if tubing is connected directly to the system	At API source: Tygon tubing 1/2" (12.8 mm) connection to bottom of source. At fore-line vacuum pump exhaust: Tygon tubing 1/2" (12.8 mm) on top of pump nipple.

Table 3. Environmental requirements

Exhaust Outlets

CAUTION

Severe contamination of the instrument may result if the source exhaust line is connected to the rotary pump exhaust line. The damage will occur when the nitrogen supply is turned off, or when the nitrogen runs out, as any rotary pump oil vapour will migrate via the source exhaust to the ion source and then through the sample cone into the analyzer.

The rotary pump exhaust gases must be vented to the atmosphere outside the laboratory via a user-supplied fume hood or industrial vent. The exhaust may be connected to an existing laboratory vent carrying other gases.

The source exhaust line must be vented to the atmosphere outside the building via a line that is separate to the rotary pump exhaust line. The point at which this line exits the building should be at least 0.5 m (20 in) from any other vent.

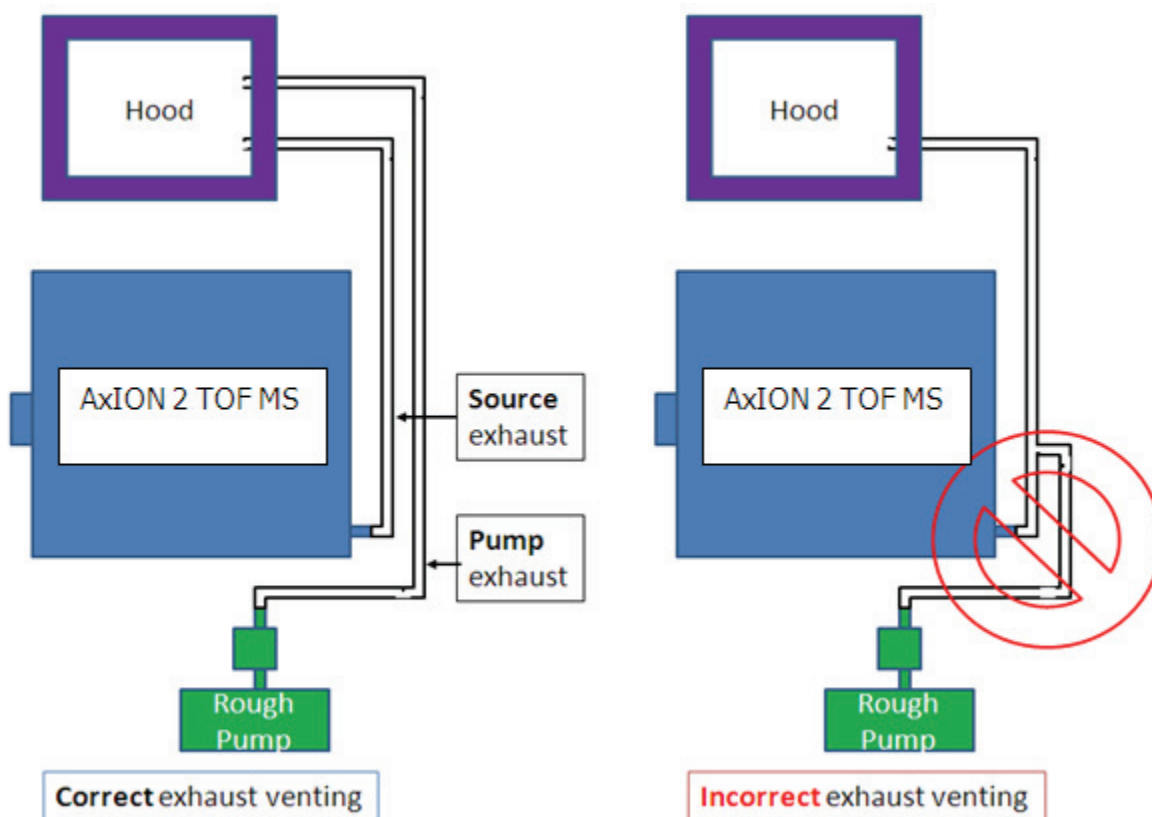


Figure 4. Correct and incorrect exhaust configurations for the AxION 2 TOF MS

Power and Receptacle Needs for Installation

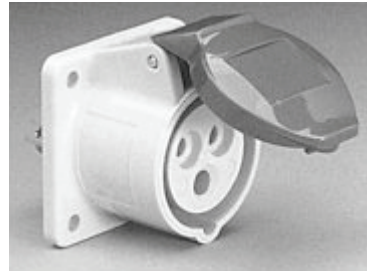
Mains Power Supply

The AxION 2 TOF MS Detector requires a stable 230 V AC +/-10% 50/60Hz +/-1% power supply. Grounded mains power outlets must be provided for each of the system units. See Figure 5.

A receptacle (PerkinElmer Part No. 09290304) is required and must be installed by an electrician. This receptacle is part of the Flexar SQ 300 MS Detector Installation Kit. Grounding is accomplished by the use of an IEC 60309 instrument power plug furnished by the factory. It is not to be removed during or after installation.



PerkinElmer Part No. MZ108718



PerkinElmer Part No. 09290304

(Outside housing can also be blue)

Figure 5. Plug and Receptacle

Electrical Requirements

Your laboratory must meet the following electrical requirements before installing the receptacle.

Unit	Mains Voltage	Max. current /power
AxION 2 TOF MS system	230 V +/-10% 50/60 Hz +/-1%, single phase Transient over-voltages: 1500 V peak (category II rating)	15 A (Circuit breaker: 15 A, magnetic, complies with IEC 380, 435 and 601)

Table 4. Mains power requirements



WARNING

If the AxION 2 TOF MS is connected to a voltage that differs from the preset voltage, the system can be severely damaged.

Voltage	230 Volts ~
Frequency	50/60 Hz
Power, Max	2.5 KVA

Table 5. Rating label for 230 V**Quality of Power**

The mains power supply must be stable and within specifications at all times to ensure reliable operation of the AxION 2 TOF MS system. There should be no transients or slow changes in average voltage outside the limits specified above. **Failure to comply with power requirements voids the warranty.**

Uninterruptible Power Supply (UPS)

In areas where power interruptions or fluctuations can be expected PerkinElmer recommends the use of a UPS rated for 5 kVA for at least 20 minutes.

Using a UPS protects the instruments from damage and your data from loss caused by unexpected power failures, surges, or AC line fluctuations.

NOTE: *A UPS will probably require electrical connections on the wall that differ from those of the TOF system. Contact the UPS manufacturer for detailed site preparation information when using a UPS. **You can order a UPS from PerkinElmer Part number N0777511***

Gas Supply

The AxION 2 TOF MS system requires a supply of nitrogen gas for proper operation. The nitrogen supply must be equipped with an appropriate pressure regulator.

Nitrogen supply requirements	<i>High purity ($\geq 97.0\%$), water free, < 0.1 ppm hydrocarbon with the remaining gas being oxygen. Note: specific analyses may require more stringent gas requirements beyond what is stated here. <u>It is up to the customer to determine if there are specific gas requirements required for their specific needs.</u></i> <i>A hydrocarbon trap (Part No. N9301208) is strongly recommended to reduce the hydrocarbon content of the nitrogen supply.</i>
Recommended Nitrogen source and pressure	Liquid nitrogen blow-off or a commercial nitrogen gas generator. The commercial generator must be able to deliver an outlet pressure of ~ 7 bar (100 psig) which typically requires a compressed air inlet pressure of ~ 8 bar (~ 115 psig) if a membrane type generator is used. (See Table 10 for PerkinElmer nitrogen gas generator options.)
Recommended flow	20-25 l/min (maximum) with a minimum of 4 l/min at all times
Nitrogen delivery	The TOF system is shipped with a 3 m (10 foot) long and 6.4 mm ($\frac{1}{4}$ " O.D. Teflon tubing for the delivery of the nitrogen.

Table 6. Gas supply specifications

Storage Requirements

The containers should be stored at a protected location indoors until the service engineer arrives for the installation.

Ambient temperature	-20 to +60 °C
Relative humidity	20- 80%, non-condensing
Altitude	-400 to 12,000 m

Table 7. Storage requirements

Required Materials

Tools, accessories, and solvents must be provided by the customer at the installation. Facilities to prepare solvents and standards must be available.

Tool/Accessory	Specification
General lab. equipment	Gloves, pipettes etc
Forklift	For standard pallets
Trolley for instrument transport	At least 32 x 22 inches (81 x 56 cm) surface area, Capable of lifting at least 500 lbs (227 Kg) Adjustable height, 16-40 inches (40–100 cm)

Table 8. Tools and accessories required at installation

Solvents Required

Solvent	Specification
Water	LCMS grade (Optima preferred)
Methanol	LCMS grade (Optima preferred)
Ammonium Formate	Ammonium formate, 97% or better

Table 9. Chemicals required at installation

Airborne Dust

PerkinElmer recommends a maximum airborne particle density of 55 mg/m³.

Accessory	Description	PerkinElmer Part Number
TOF Rolling Bench (TOF only)	Rolling bench for AxION TOF MS	MZ311000
LC Rolling Bench	Rolling bench for LC System	MZ301005
UPS	Uninterrupted Power Supply	N0777511

Table 10. Optional Customer Accessories

Part #	Description	# MS sys	Comments
N9306285	N2- Whisper-0/40L	(1-2 MS)	The Whisper-0 series (sourced from Italy) <u>requires</u> a supply of clean, dry, hydrocarbon and oil free compressed air at a recommended pressure of 7+ bar or >100 psi (6+ bar or 85-99 psi acceptable).
N9306286	N2- Whisper-0/80L	(3-4 MS)	
N9306287	N2- Whisper-0/120L	(5-6 MS)	
N9306281	N2- Whisper-1/20L 60 Hz	(1 MS)	The Whisper-1 or-2 series refers to the number (1 or 2) of built-in air compressors in the unit itself, so no compressed air supply is required.
N9306282	N2- Whisper-2/35L 60 Hz	(2 MS)	
N9306283	N2- Whisper-1/20L 50 Hz	(1 MS)	
N9306284	N2- Whisper-2/35L 50 Hz	(2 MS)	
N9306210	N2-22 Nitrogen Generator	(1 MS)	These generators (sourced from USA or UK) also require clean, dry, hydrocarbon and oil free compressed air at a recommended pressure of 7+ bar or >100 psi (6+ bar or 85-99 psi acceptable).
N9306211	N2-35 Nitrogen Generator	(2-3 MS)	
N9306212	N2-45 Nitrogen Generator	(3-4 MS)	
N9306213	NITROFLOW Lab (120 V)	(1 MS)	These generators all have dual built-in air compressors, but different form factors.
N9306214	NITROFLOW Lab (230 V)	(1 MS)	
N9303223	N2 Generator 120V	(1 MS)	

Table 11. Nitrogen Generator Options



Customer Site Preparation Sign-off Page

This sheet must be completed, signed, dated and provided to the service engineer (via email or fax) prior to his arrival for the installation. If the service engineer arrives and finds that the site has not be prepared in accordance with the requirements listed below, the customer will be held liable for all service expenses, at normal billing rates, related to his visit.

The following requirements must be completed prior to the arrival of the installation engineer:

- Suitable equipment for lifting the instrument.
- Space requirements for instrument, computer and LC components are met.
- Instrumentation bench capable of supporting 500 lbs present for LCMS.
- Ventilation requirements for rough pump and ion source exhaust are present (e.g., fume hood).
- Nitrogen source providing hydrocarbon free (≤ 0.1 ppm), high purity ($\geq 99\%$), high pressure (min. 90 psi) with minimum capacity of 25 l/min installed with shut-off valve and 1/4" Swagelok fitting.
- Line Voltage verified to be within 230 VAC +/-10%, 50/60 Hz +/-1%
- LCMS grade solvents and chemicals specified in Table 9 on hand.
- General laboratory equipment including pipettes, gloves, and clean glassware on hand.
- Lifting Crane.
- Transport Trolley.

The undersigned hereby confirms that the list of requirements specified above and described in this manual (Preparing Your Laboratory for the AxION 2 Time of Flight Mass Spectrometer) has been completed, and the site is ready for the installation of the AxION 2 TOF MS. He/she understands that they will be responsible for all service expenses, at normal billing rates, associated with an installation that cannot be performed due to one of the requirements on this sheet not being completed.

Please sign and date below.

Signature of responsible party

Date



System Description



Overview

The AxION 2 TOF MS Detector is intended to be used to measure the mass-to-charge (m/z) ratio of charged chemical and molecular species introduced into the system through an ion source / interface and are separated based on the flight times of the charged species.

Mass spectrometers are powerful instruments that can measure the atomic mass of atoms or molecules. The mass is reported in u, the unified atomic mass unit (defined as 1/12 the mass of carbon 12) or daltons (Da) which is more prevalent in the biochemistry world. Prior to 1993, masses were typically reported in atomic mass units (amu) which was defined as 1/16 the mass of oxygen 16.

Mass spectrometry can be used for quantitative and qualitative analysis; the latter being generally employed for compound identification and for structural elucidations. A mass spectrometer actually determines the mass to charge ratio (m/z) of the atom or molecule, where m is the mass of the atom or molecule and z is the number of charges on it. An atom or molecule must have a charge in order for it to be detected by the mass spectrometer.

For many organic molecules, with the exception of macromolecules, the charge on the atom or molecule is usually plus or minus one, so m/z equals $m/1 = m$. If the molecule or atom is positively charged it will be detected in positive ion mode. Conversely if the molecule or ion is negatively charged it will be detected in negative ion mode.

Mass spectrometry has become so important that it is widely employed in many clinical, research and testing laboratories across the globe. Some of the places where mass spectrometers are employed include;

- Forensic Laboratories
- Food and Beverage Industries
- Analytical Laboratories
- Pharmaceutical Laboratories
- Toxicological Laboratories
- Drug Testing Facilities
- Fundamental Research and Development Laboratories
- Water and Air Testing Facilities
- Waste Management Laboratories
- Hospitals

Major Components

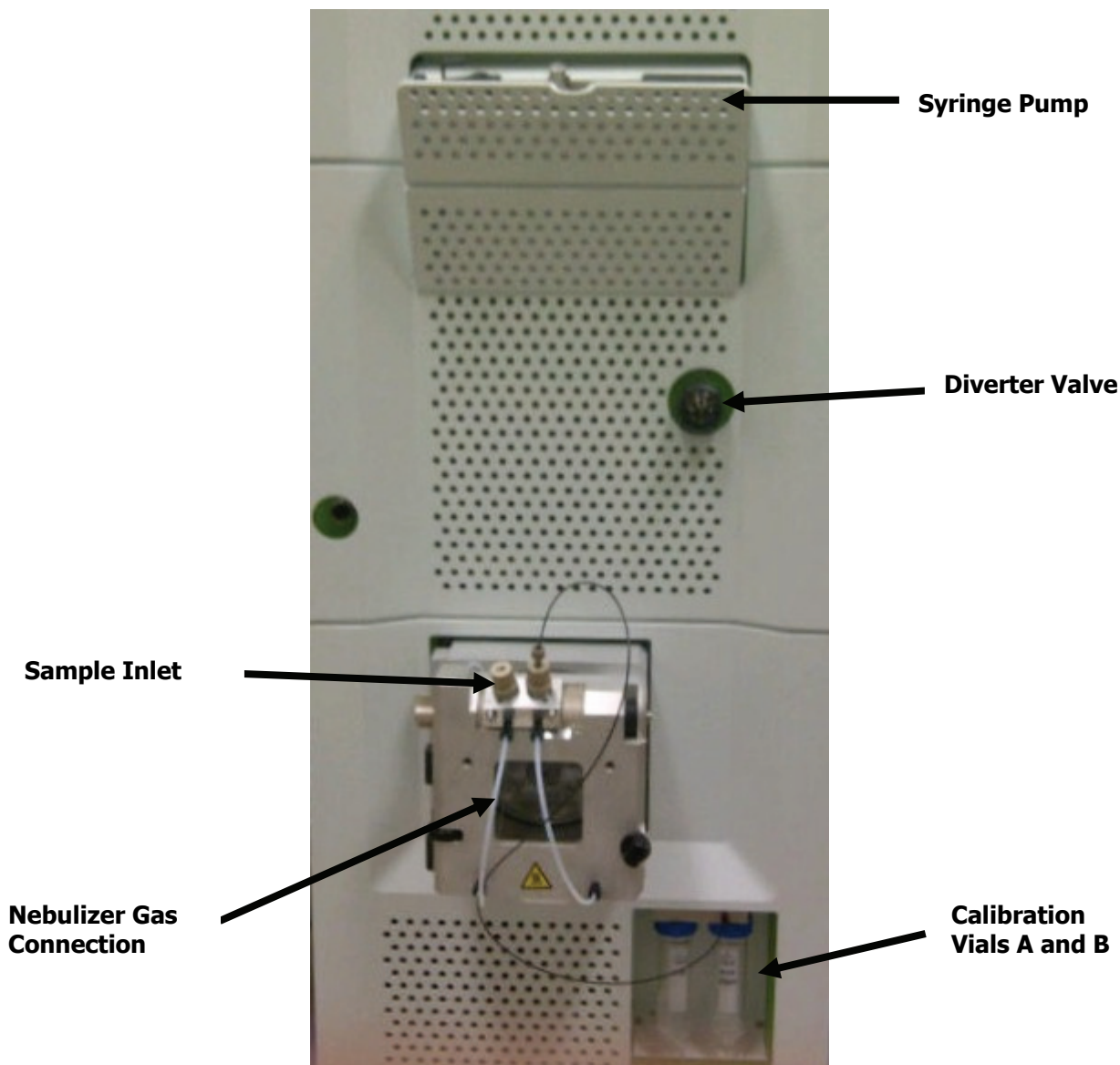


Figure 3. AxION 2 TOF MS Detector with an ESI Source, Diverter Valve and Syringe Pump

This instrument is composed of the following main components.

A sample inlet.

An ion source to provide sample ionization.

An ion transfer component. The transfer component used in the AxION 2 TOF MS is called a hexapole. There are two hexapoles and a series of exit lenses.

An electrostatic voltage accelerating system, which is a series of cones and plates with voltages applied to them to control the ions within the mass spectrometer.

Ion detector. The AxION 2 TOF MS uses an electron multiplier with conversion dynode to detect the ions transmitted through the mass filter.

Theory

Basic LCMS Using a Time of Flight Mass Analyzer

When high performance liquid chromatography (HPLC) is coupled to mass spectrometry (MS), the technique is referred to as LCMS. A sample is carried with the HPLC eluant through a transfer line into the mass spectrometer's ion source. The tremendous excess of solvent must be eliminated so the charged analytes (ions) can be transferred into the MS and detected.

There are several ways that an analyte can become ionized. The two most widely used ionization techniques in LCMS are: electrospray ionization (ESI) and atmospheric pressure chemical ionization (APCI). In ESI, the analyte molecules are typically already charged before they enter the mass spectrometer (ions in solution). In the case of APCI, the molecules become charged in the ion source through chemical reactions triggered by a corona discharge.

The liquid eluant from the HPLC enters the mass spectrometer's ion source (which sits at atmospheric pressure). It is sprayed through a small diameter needle and nebulized by pneumatic assistance into a fine mist. Each droplet in the mist contains many charged species, along with excess solvent molecules. The excess solvent molecules must be stripped away from the analyte ions before the ions can enter the mass spectrometer and be detected. This is accomplished by driving the droplets through a counter current drying gas (CCDG) which is typically nitrogen. The counter current drying gas is heated, and the warm nitrogen gas evaporates off the excess solvent (desolvation). As the droplets shrink, they eventually rupture and individual ions are "ejected" from the droplet.

In the source chamber the ions are drawn toward the capillary entrance of the mass spectrometer by a strong electric field present in the source region. As the ions approach the capillary entrance they are drawn into the capillary (along with the nitrogen gas) due to the vacuum pulling on the other end of the capillary. The vacuum in the source region and the low and high vacuum regions of the ToF analyzer are created by a turbo molecular pump and a rough pump.

Keep in mind that the source vent removes the evaporated solvent and excess CCDG. The rough pump evacuates the capillary exit region and also backs up the turbo molecular pump. Note that only a very small fraction (about 0.01%) of the ions leaving the sprayer tip actually enter the mass spectrometer.

As shown in Figure 4, a five stage vacuum system is used in the AxION 2 TOF MS. The first stage is called the foreline and the vacuum is around 2.5 millibar (1.88 Torr). The vacuum in the fifth stage ToF analyzer region is typically around 5×10^{-7} millibar.

The analyte ions (and nitrogen CCDG) are pulled through the capillary and exit at supersonic speeds toward the skimmer lens. The ions that make it through the skimmer's orifice enter the transfer hexapole region.

The transfer hexapole region focuses and guides the ions toward the ToF analyzer chamber where they are accelerated by voltages applied to a stack of lenses into the Flight Tube. In the Flight Tube, the ions fly at different speeds based on their mass-to-charge, and strike a detector, producing peaks.

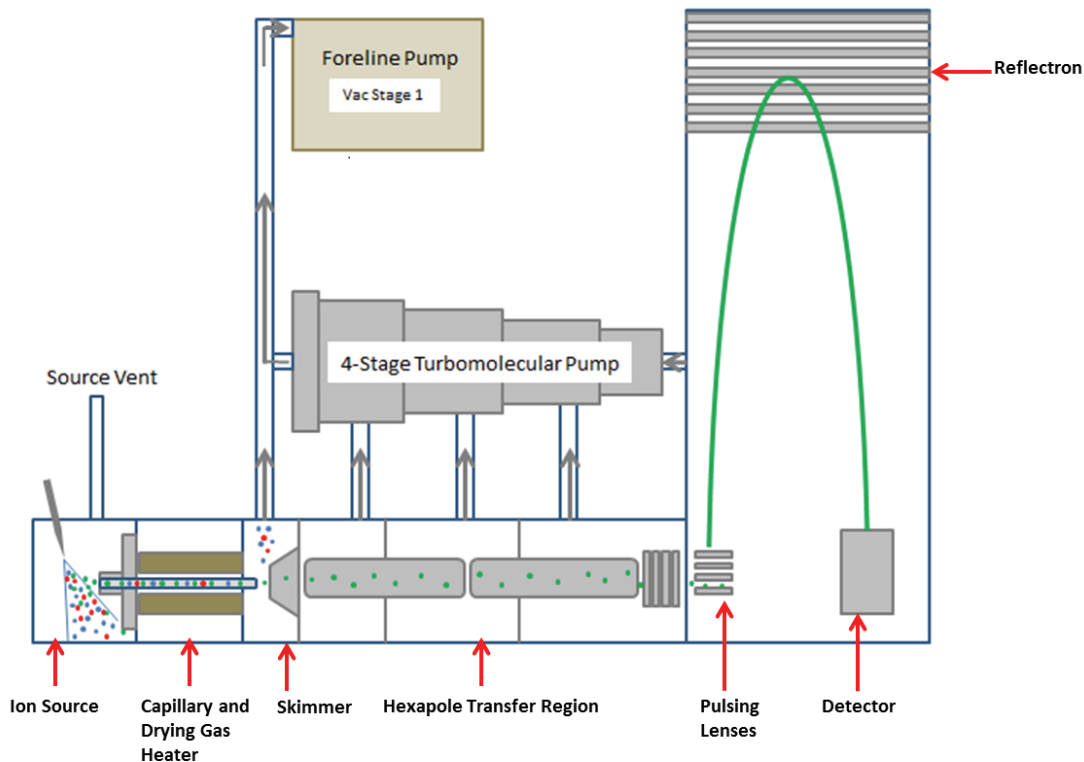


Figure 4. Schematic of AxION 2 MS Detector

Time of Flight Theory

The mass separation, more accurately the m/z separation, of the various ions is based on a basic physical property that relates the velocity of a given ion to the ratio of its mass and charge.

Given a fixed energy 'push',

- The higher the mass the slower it will move.
- The higher the charge the faster it will move.

Ions with different masses and charges will move with different velocities, and will take different times to pass through a fixed region of field-free space. A mass spectrum is collected by monitoring the output of the detector over time. This time spectrum is then converted to a mass spectrum through a calibration function.

A Time of Flight (TOF) instrument has three sections:

- The first delivers an equal energy push simultaneous to all the charged samples.
- The second allows samples to drift and to separate due to their different velocities.
- The third offers a means of detecting the arrival of the charged samples as they pass a fixed position (the time of their arrivals at this detector being a measure proportional to the ratio of their mass and charge.)

As the ion beam enters the region between Repeller Pulse Lenses (known as the pulsing region) it is still a mixture of all the various compounds found within the sample.

To impart a fixed energy 'push' on all the ions, the voltage level of the Repeller Pulse Lenses is rapidly raised. All of the ions within the region are exposed to a high electric field that accelerates the ions at right angles to Repeller Pulse Lenses, ejecting them into the Flight Tube. As mentioned above, this is the area where the ions become segregated as a function of mass-to-charge ratio.

The Flight Tube is divided into two sections, separated by an array of lenses known as the Ion Reflector. This array consists of lens elements spaced equal distances and maintained at consistent voltage spacing. The effect of this structure is threefold:

- To reverse the direction of the ions allowing for a more compact instrument design.
- To reduce the energy spread of ions who has the same value of m/z .
- To better focus the charged sample onto the detector surface.

The Ion Reflector acts as a trampoline where the depth of penetration of an ion depends on how hard the initial energy 'push' (determined by the voltage applied to Repeller Pulse Lenses and the flight tube voltage as well) is, coupled with the amount of 'spring' given by the Ion Reflector voltage.

After passing out of the flight tube, the separated ions move to the Post Acceleration Region. Then they impact the detector and allow for greater instrument sensitivity.

The detector installed is a magnetron electron multiplier. The ions impact a High Energy Dynode, producing secondary electrons which are bent 90° by the magnetic field and land on the multiplier unleashing a cascade of electrons by each dynode.

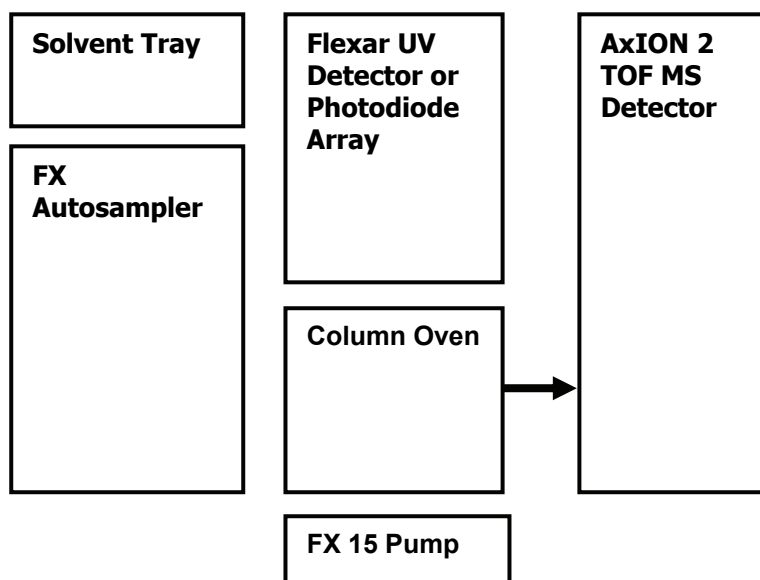
The signal created by this event passes through the Attenuator and on to the Data Acquisition unit, producing spectra.

Connections

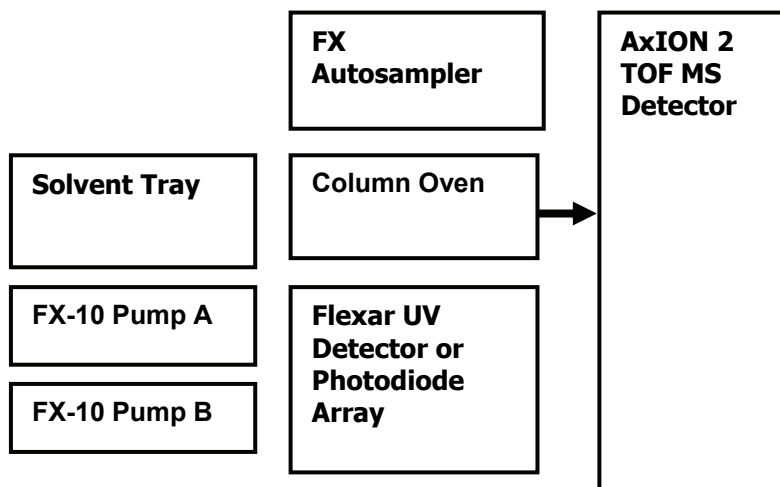
Two instrument configurations are possible, with a single or double wide HPLC stack. There are multiple ways to configure the double wide HPLC stack, two of which are shown below. A double wide HPLC stack may be required if an alternate detector or the FX 10 (or Model 275 HRes) micro pumps are part of the configuration. The mass spectrometer can be located on either side of the HPLC components, but it is preferable to have it on the right side to minimize the distance from the column (oven) outlet to the ion source. Minimizing this distance will provide the least peak broadening of the HPLC peak, which will maximize the intensity of the MS signal.

If a second detector (UV or PDA) is to be used along with the MS detector, it is strongly recommended that the column eluant be split and sent to each detector separately. If the alternate detector is plumbed in a serial configuration before the MS, the additional volume associated with the flow cell and transfer line will significantly degrade the HPLC separation, peak shape and MS signal intensity.

Double wide HPLC configuration 1:

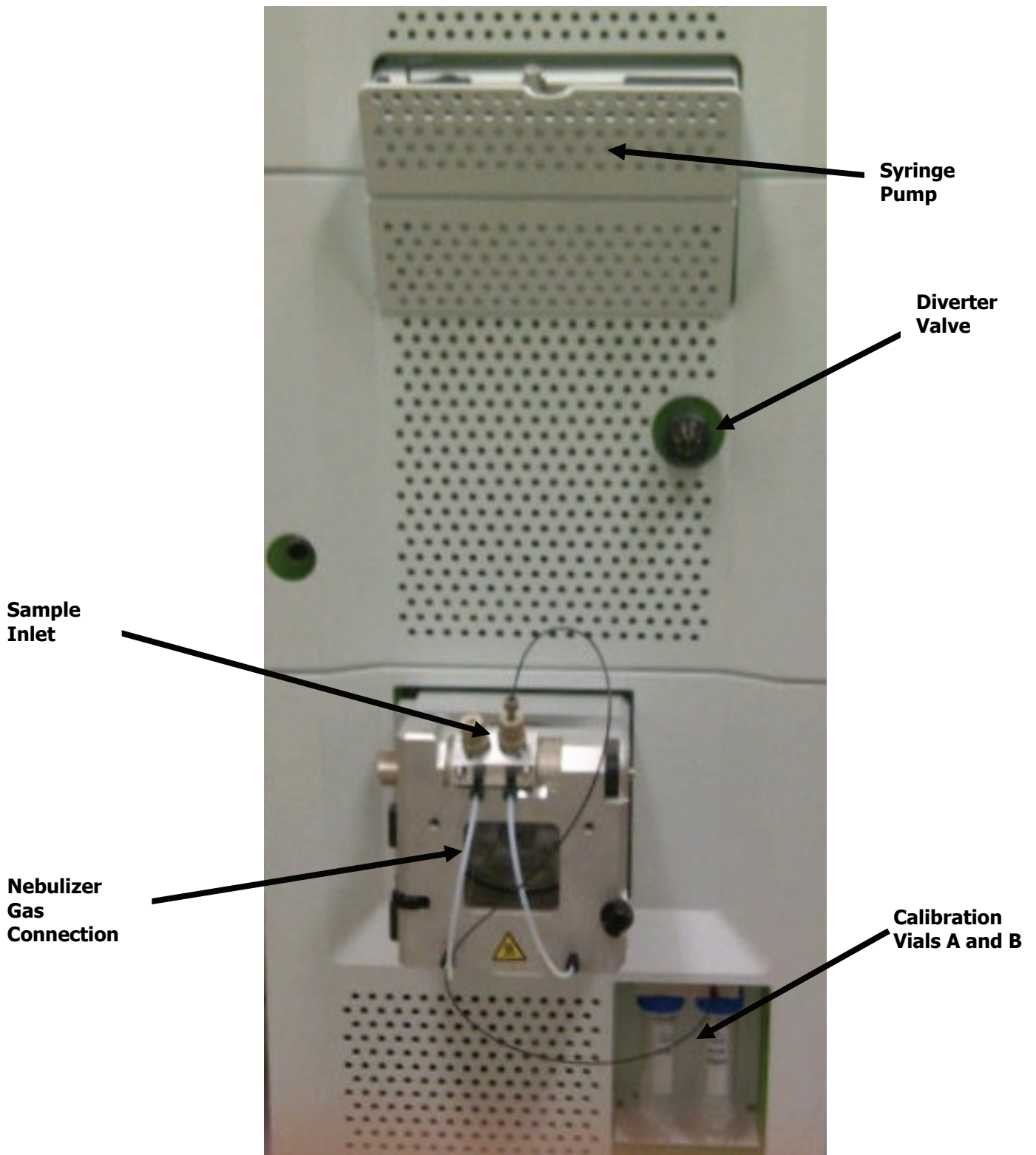


Double wide HPLC configuration 2:

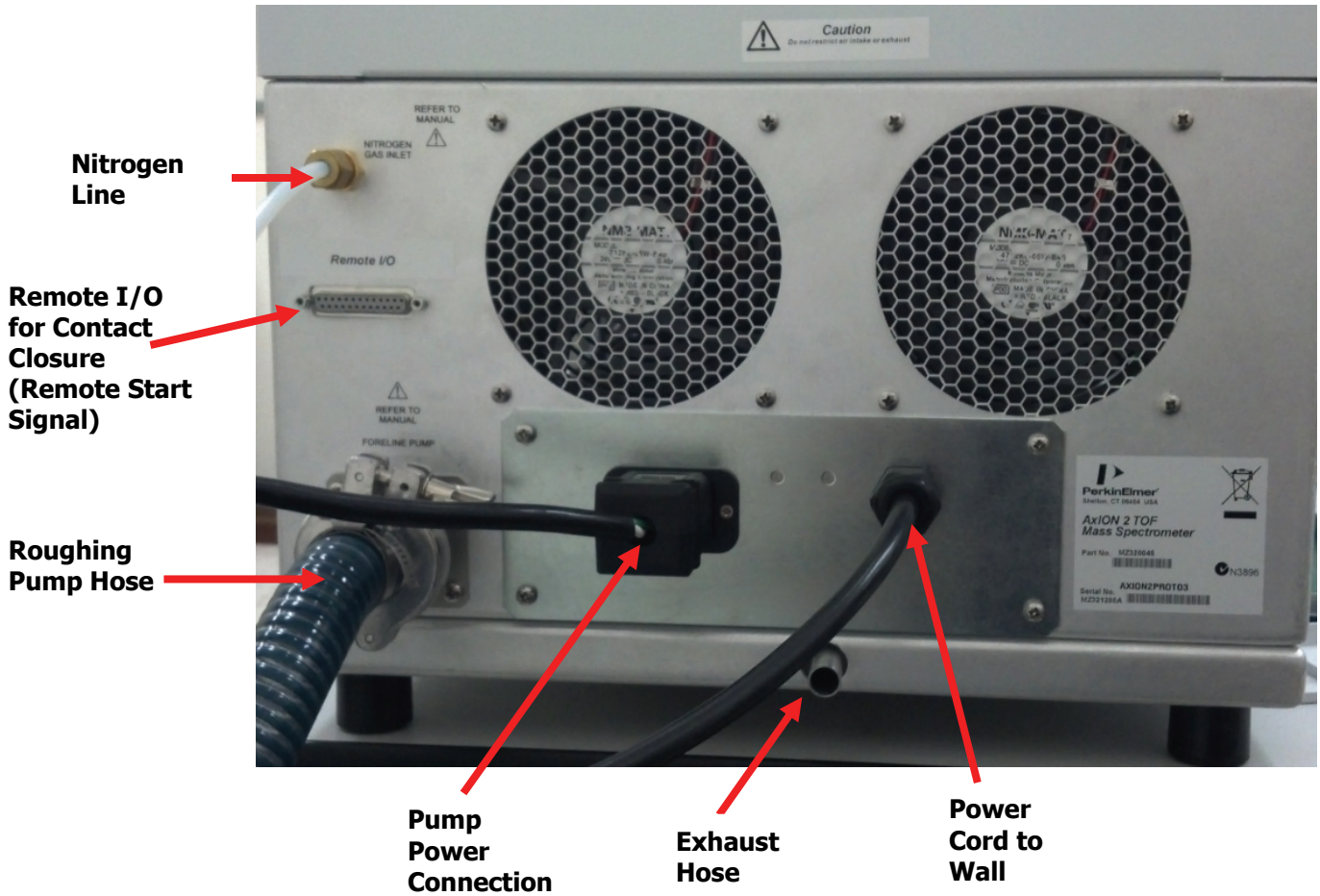


Instrument Component Connections

Front of Instrument

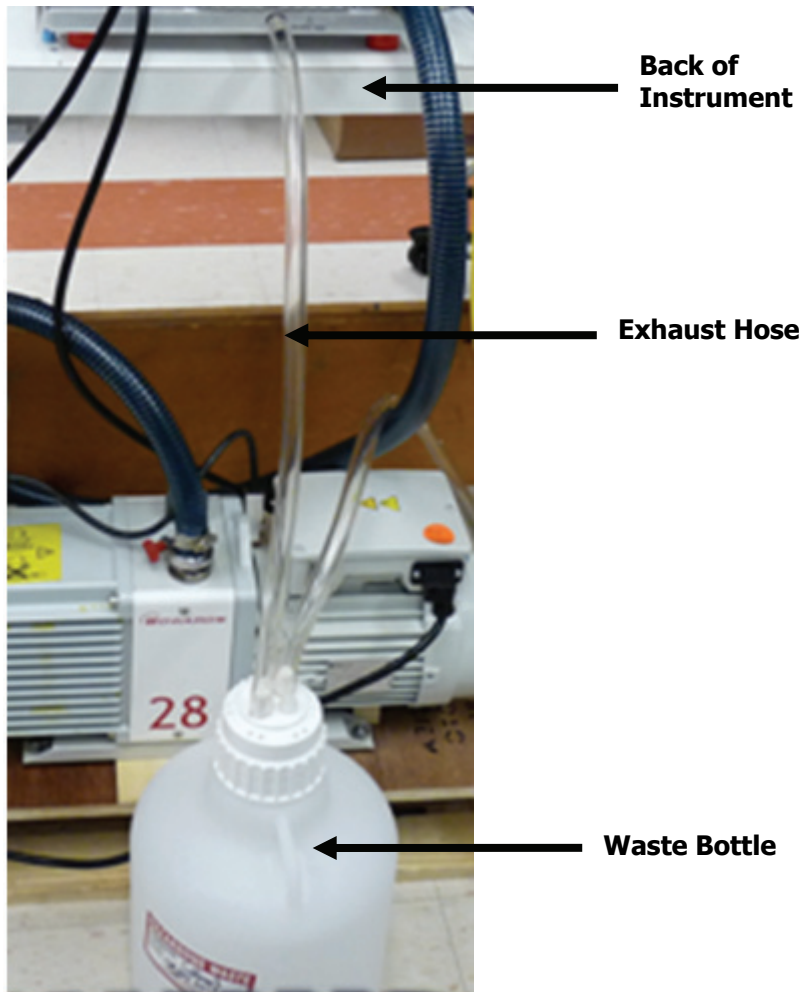


Back of Instrument



Rear of AxION 2 TOF MS Detector connections

Waste Bottle



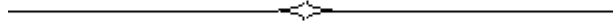
The waste bottle must be connected and positioned below the exhaust hose.

Specifications

The following are the current specifications for the AxION 2 TOF MS Detector. They are subject to change without notice.
PerkinElmer AxION 2 TOF MS is an orthogonal TOF featuring a dual probe ESI ion source.

Dimensions:	16.5 inches (42 cm) Wide
	65 inches (165 cm) Tall
	31.5 inches (80 cm) Deep without Source Housing
	36 inches (92 cm) Deep with Source Housing
Weight:	500 lb (227 kg)
	600 lbs (272 kg) with packaging
Mass range:	18-16,000 u
Mass Measurement Accuracy	≤2 ppm at 1,000 m/z with internal mass calibration
Resolution:	≥12,000 FWHM at 922 m/z
Max. Acquisition Rate:	≤20,000 spectra/sec. Acquired spectra are summed to generate a mass spectrum saved to disk at ≤70 spectra/sec
Linear Dynamic Range	10 ⁵
Sensitivity +ESI:	S/N ≥ 40:1 RMS for 1pg reserpine
Sensitivity –ESI:	S/N ≥ 50:1 RMS for 2pg p-nitrophenol
Performance	
Mass Range	18-16,000 m/z
Mass Measurement Accuracy	≤2 ppm at 1,000 m/z with internal mass calibration
Max Acquisition Rate	≤20,000 spectra/sec. Acquired spectra are summed to generate a mass spectrum saved to disk at ≤70 spectra/sec
Resolution	≥12,000 FWHM at 922 m/z
Linear Dynamic Range	10 ⁵
Sensitivity	ESI (+): S/N≥40:1 1 pg/μl reserpine @400 μl/min MeOH/H ₂ O ESI (-): S/N≥50:1 2 pg/μl p-nitrophenol @400 μl/min MeOH/H ₂ O
Ion Sources Available	Ultraspray™ ESI 0.004-1.4 ml/min Ultraspray2™ ESI 0.004-1.4 ml/min Field-Free APCI 0.05-1.5 ml/min DSA- D irect S ample A nalysis
Operation/Other	
Software	TOF Driver V6.0 (preinstalled and included at no charge)
Operating System	Win 7, 32-bit

Vacuum System	5 stage pumping system
Operating Temperature	21 +/- 5 °C (79 +/- 9 °F)
Power Required	230 VAC, 50/60 Hz., 2.5 KVA max.
Footprint	40.6 x 76.8 x 152.4 cm (16 x 30 x 60 in) with ion source extending 7.6 cm (3 in) from front panel



Maintenance



Introduction

This chapter describes the routine maintenance procedures required to keep your instrument in proper working condition and to ensure the highest possible level of performance. It includes maintenance checks that should be done on a daily basis and maintenance procedures that should be done periodically depending on instrument use. This chapter is divided into several sections, each section covering maintenance procedures for a particular component of the system.

You should perform only the maintenance procedures described in this chapter. If additional maintenance is required, contact a PerkinElmer Service Engineer.



WARNING

***To reduce the chance of electrical shock, do not remove covers that require tool access.
No user serviceable parts are inside. Refer servicing to PerkinElmer or other qualified service personnel.***



WARNING

To avoid electrical shock, disconnect power cord before servicing.

CAUTION

Before using any cleaning or decontamination methods except those specified by the manufacturer, users should check with the manufacturer that the proposed method will not damage the equipment.

Periodic Maintenance

The frequency of maintenance required will be determined by the amount of use the system receives, the cleanliness of the environment, and the number and nature of the samples being analysed.



WARNING

When the door is open to the instrument all voltages are shut down. Do not defeat the switch or you could be exposed to high voltages.



Figure 6 Interlock Switch

Periodic Source Cleaning

On a periodic basis clean the:

- Probe plate
- Clean around the source
- Clean the end plate cap
- Clean the capillary entrance

Keeping the probe plate, the source area, the end plate cap and capillary entrance clean will keep sensitivity high and maintain a steady signal in your instrument. A full source cleaning will be done by your PerkinElmer Service Engineer every year during your preventative maintenance visit.

CAUTION *To prevent contamination always wear powder free gloves while doing these procedures.*

CAUTION *Never block off the capillary entrance hole. This will cause a backup of oil into the vacuum chamber and this can damage the instrument.*

CAUTION *Never spray methanol or any solvent directly into the capillary entrance as this can damage the instrument.*

1. Place the instrument into Standby and turn the counter current drying gas temperature to 50 °C. It will take about 30 to 40 minutes for the instrument to cool down enough to handle. Disconnect the power cord before continuing.

CAUTION *Take care not to damage the probe tip when removing the probe from the probe plate.*

2. Turn the nebulizer pressure to zero and carefully remove the probe from the probe plate.

1. Firmly hold the probe and press the button in completely
2. Pull the probe from the housing

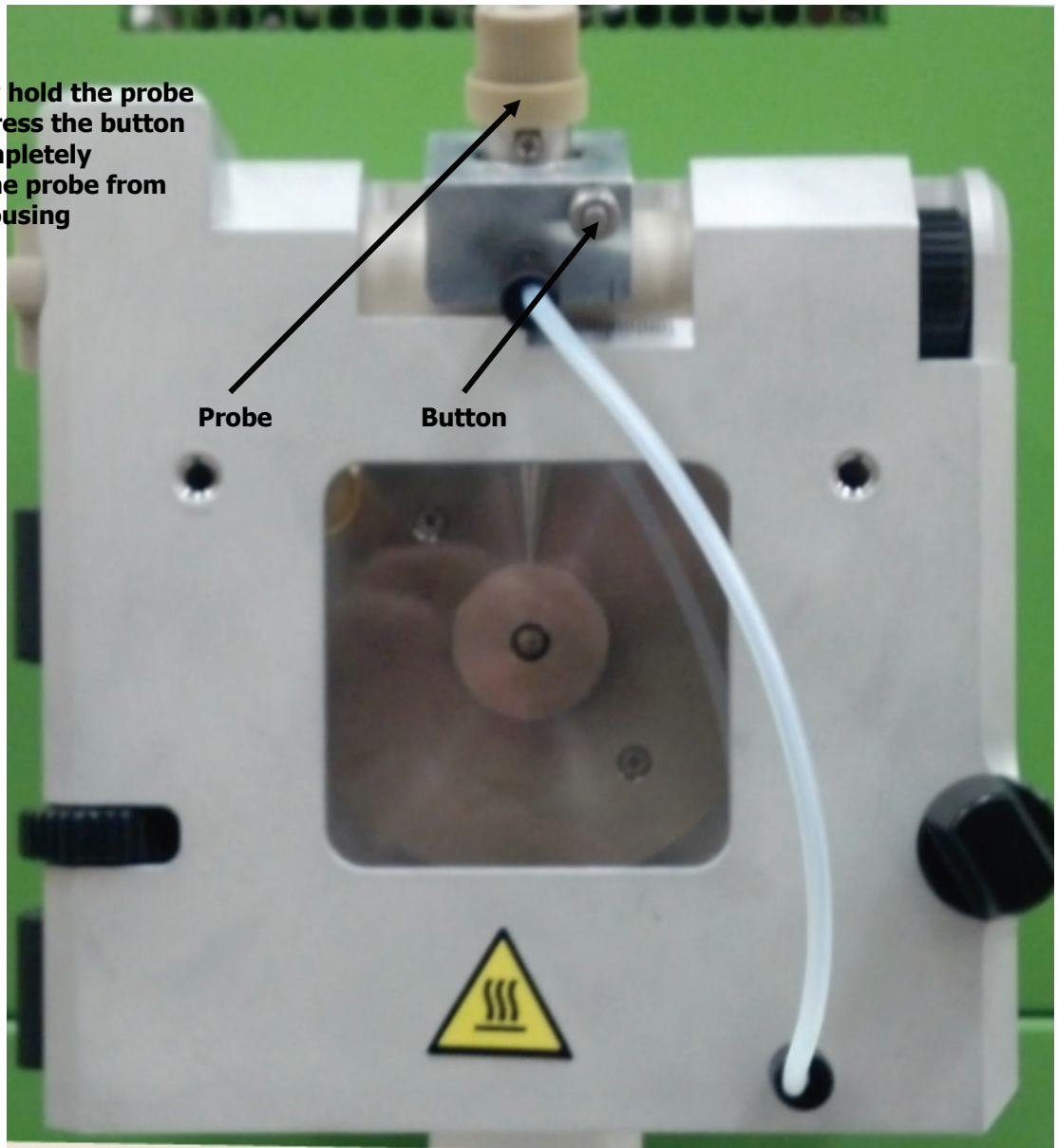


Figure 7 Removing the probe from the probe plate

3. Spray kimwipe with methanol and thoroughly wipe the inside of the probe plate clean.
4. Spray methanol on a kimwipe and thoroughly clean the inside of the source.

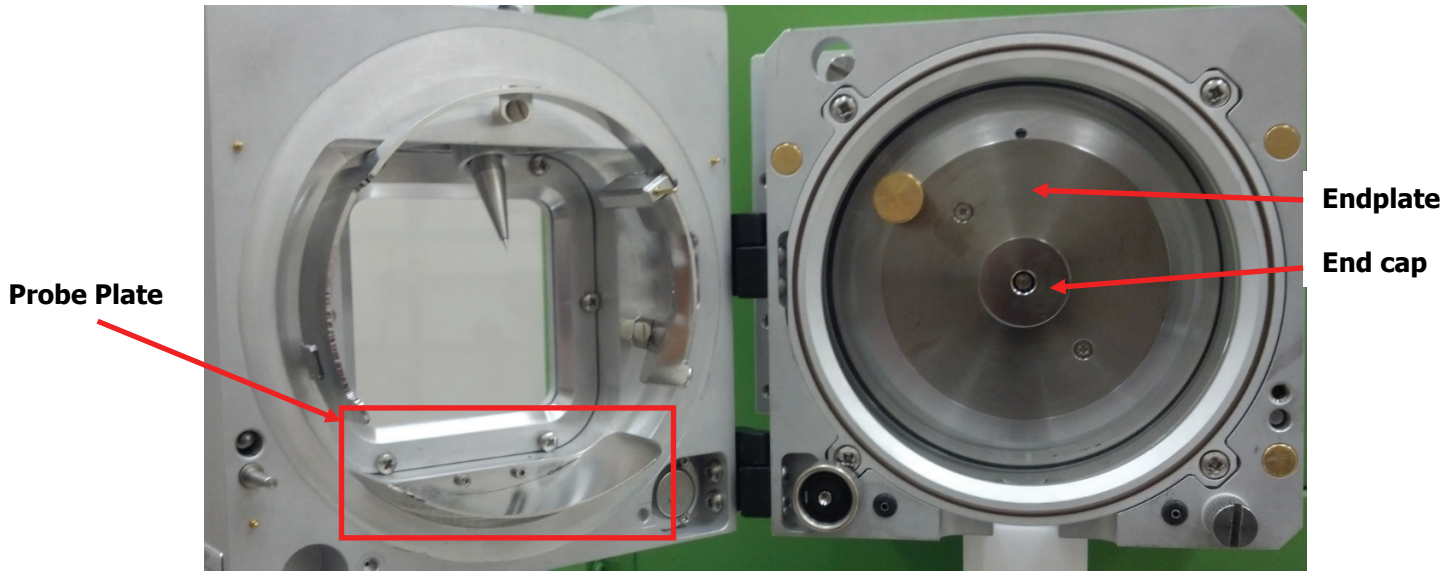


Figure 8 Cleaning the probe plate and source

Remove the end plate cap and clean the front surface of the end cap. The end cap slides straight off the source

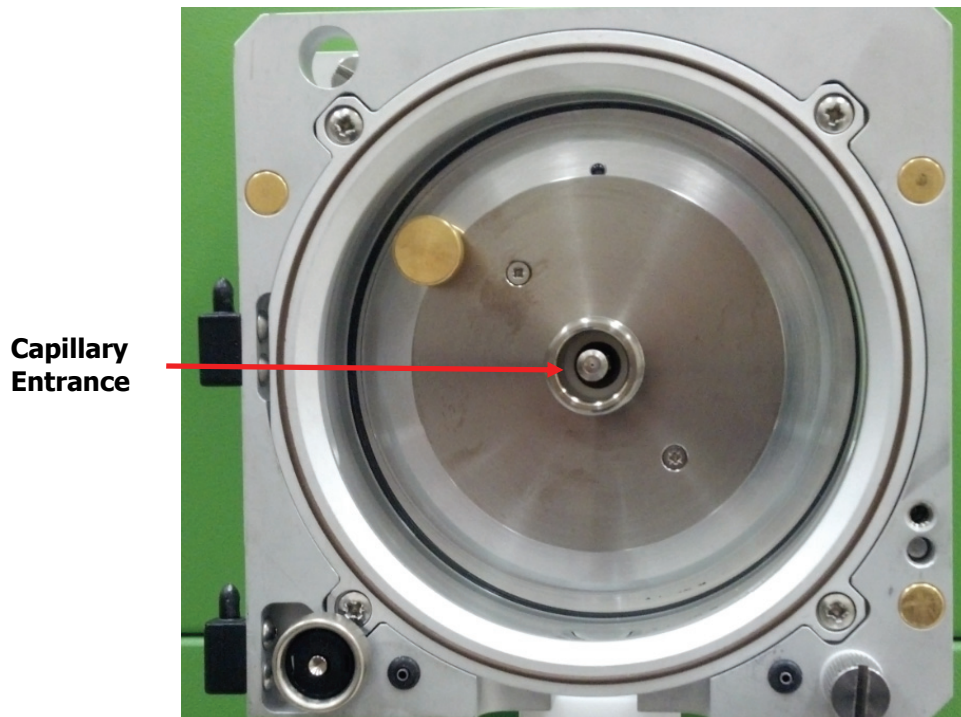


Figure 8 Source with End Cap removed

5. After you remove the end plate cap dampen a kimwipe with a small amount of methanol and clean the end plate cap.

6. Lightly dampen a kimwipe with a small amount of methanol and gently clean the front end of the capillary entrance. If the system is under vacuum, too much methanol can cause the instrument to vent.
7. Replace the end cap.
8. Put the source door back on
9. Close the door and secure the door shut with the finger tight screw
10. Replace the probe.

Replacing or Cleaning the Capillary

The AxION 2 TOF MS does not need to be vented to clean or replace the Capillary

If the instrument is vented, make sure to vent the instrument for a minimum of 30 minutes before opening any components to atmosphere.

The capillary will need to be changed or cleaned if it is dirty or clogged.

CAUTION *To prevent contamination always wear powder free gloves while doing these procedures.*

CAUTION *Do **not** sonicate the capillary.*

Removing the Capillary

1. If you vent the mass spectrometer, you must wait at least 30 minutes to fully vent the system
2. Turn the dissolution heater to 50 °C. It will take about 30-40 minutes to cool down enough to handle.
3. Loosen the screw that secures the probe plate to the source and swing the door open.

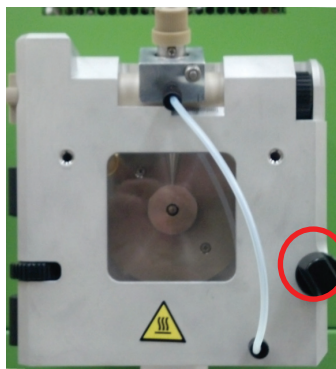


Figure 10 Probe plate captive screw

4. Lift the probe plate up and off the hinges on the right side of the source housing.

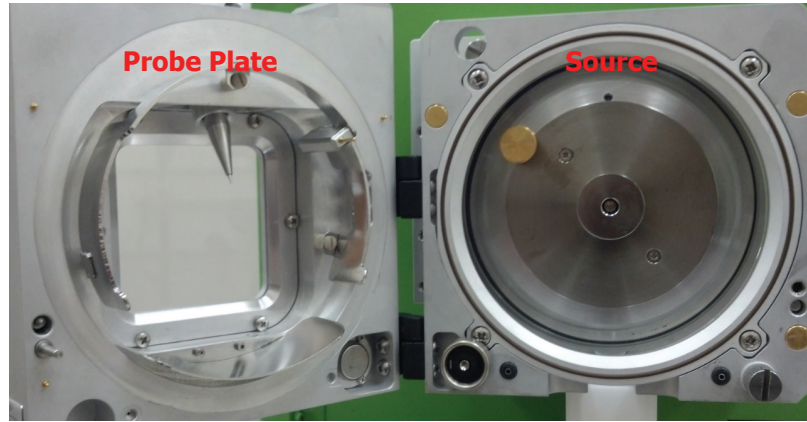


Figure 11 Probe plate and Source

5. Loosen the 2 screws that secure the source to the instrument housing.

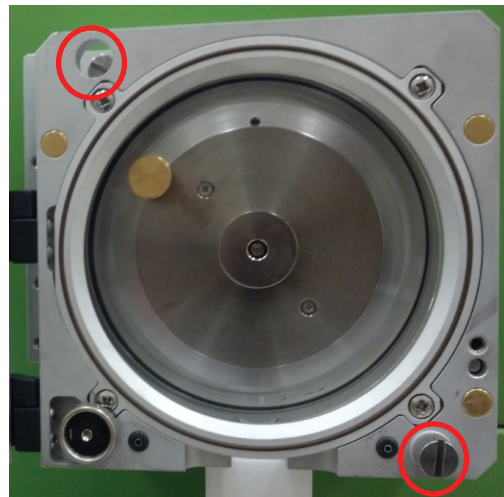


Figure 12 Source screw locations

6. Slide the Source to the end of the rails. It will come off the rail by lifting it up and towards the back of the instrument.



Figure 13 Source housing rails

7. Remove the Capillary Sheath by sliding it straight off the Capillary.
8. Remove the Peek Locking Screw

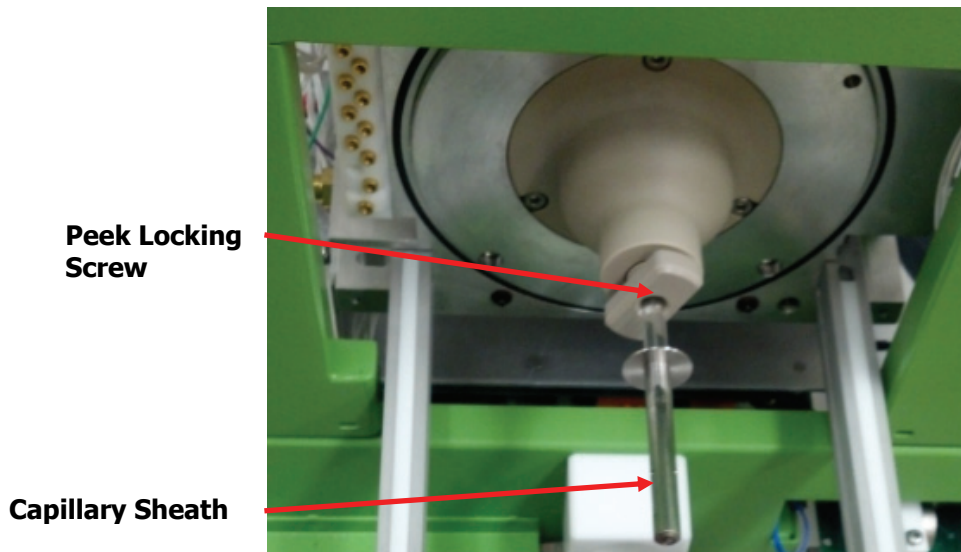


Figure 14 Capillary Sheath and Locking screw

9. Slowly slide the Capillary straight out of the housing. Care must be taken not to pull the capillary at an angle, as it may break.



WARNING

*Capillary glass will break if you do **not** remove it carefully.*

10. Inspect the Capillary O-ring for any wear or damage

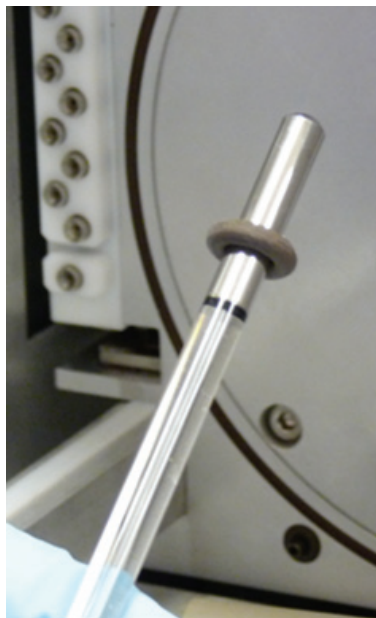


Figure 15 Capillary and O-ring

Cleaning the Capillary

1. Take the capillary to the vent hood.
2. Under a vent hood and over a waste bottle, spray methanol through the hole of the capillary.
3. Obtain a dry nitrogen line with a hose and blow out the excess methanol from the capillary.
4. After you have cleaned the capillary place the original O-ring back or replace with a new one on the capillary if the O-ring was damaged, worn or cracked.



Figure 16 Cleaning the capillary under the hood

Returning the Capillary

1. Gently push the capillary with the o-ring straight in without it bending until it stops moving.
2. In a clockwise direction, gently screw in the peak locking screw until just snug. When just snug the O-ring will complete the seal. Over tightening will crack the capillary.
3. Put the sheath on the capillary.
4. Slide the source housing onto the rails. Push the source into place until it stops.

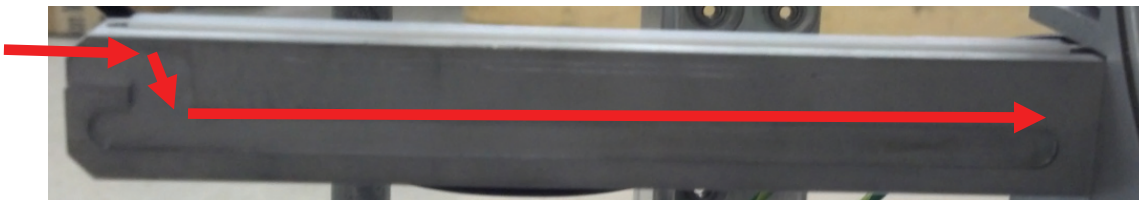


Figure 17 Source Housing Rails

5. Secure the source housing to the instrument via the 2 screws in the upper right and lower left corner (Figure 12)

6. Place the Probe plate back onto the Source housing hinges, close the plate, and secure the plate to the housing via the Screw on the bottom right of the Probe plate (Figure 10)
7. If the instrument was vented, it can now be pumped down. If it was not vented, voltages may now be applied.

Replacing the Probe Needle

When adjusting the probe needle position, the spray should be even and not in a spitting pattern. If you notice a spitting pattern the probe needs to be cleaned, replaced or adjusted.

There are two different probes in the field – each has a different length capillary tube. Care should be taken to order the correct length tube for the probes in use. The easiest way to tell the difference is to note whether or not there is a screw on the body of the probe. They are only on the new-style probes

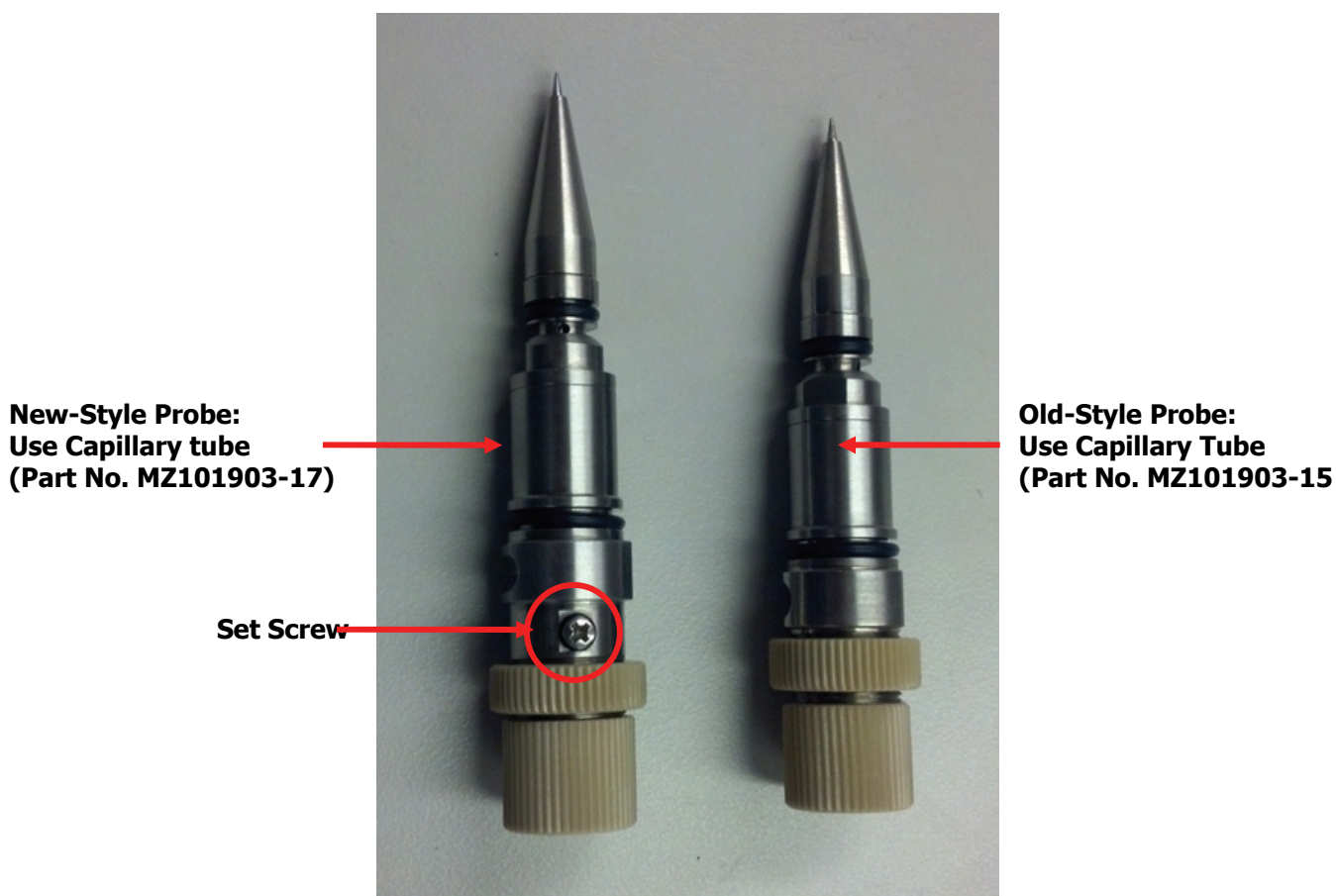


Figure 18 Comparison of old and new style probes

1. Turn the outer nut (needle depth adjuster) clockwise until it unscrews completely.



Figure 19 Location of the outer nut

2. Unscrew the needle depth adjuster clockwise until it comes off.
3. Remove the set screw from the Probe body completely.
4. Remove the slotted metal insert.

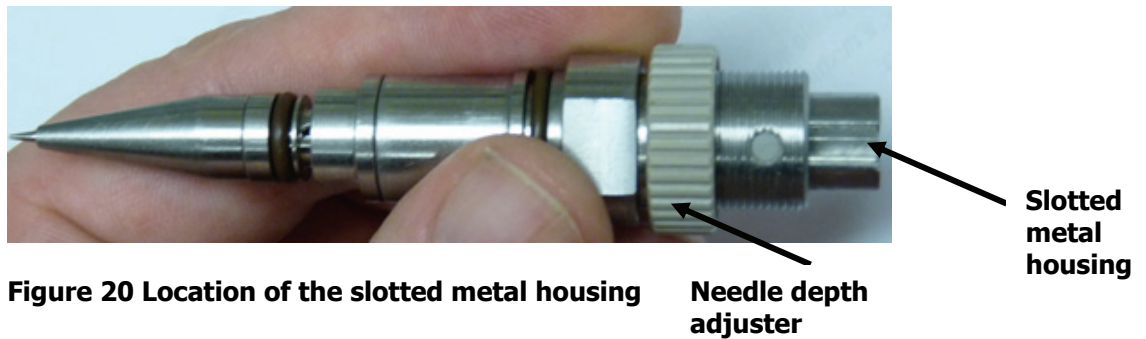


Figure 20 Location of the slotted metal housing

5. The inner needle housing is now exposed.
6. Remove the old needle.
7. Use a ¼ inch wrench and turn the nut counter clockwise to loosen.



Figure 21 The wrench loosening nut on needle

8. Take the new needle and place it into the fat side of the black fitting
9. Thread the needle through the fastening screw.



Figure 22 The needle through back fitting and fastening screw

10. Push the needle flat against the rubber surface of the black fitting. This creates a stopping point for the needle and will prevent dead volume.



Figure 23 Push the needle flat against the rubber surface

11. Screw in the red or back PEEK tubing into one side of the slotted metal insert.



Figure 24 Red PEEK tubing into one end of slotted metal insert

12. At the other side where the probe needle is flush, screw the probe needle into the slotted metal insert.



Figure 25 Screwing in the probe needle

13. Gently screw in the probe needle until it becomes just snug.
14. To avoid dead volume, gently pull the probe needle out slightly then push the probe needle in until the needle stops against the back side of the PEEK tubing on the other side.
15. Fingers tighten the outer screw. Use a ¼ inch wrench to turn the outer screw 1/8 turn clockwise to complete the tightening.



Figure 26 Tightening the outer screw

16. Verify that the probe needle is snug and not loose.

17. Remove the PEEK tubing and finger tight.
18. Push the needle into the small hole at the base of the needle probe. Gently twist and turn needle until it falls through the hole.

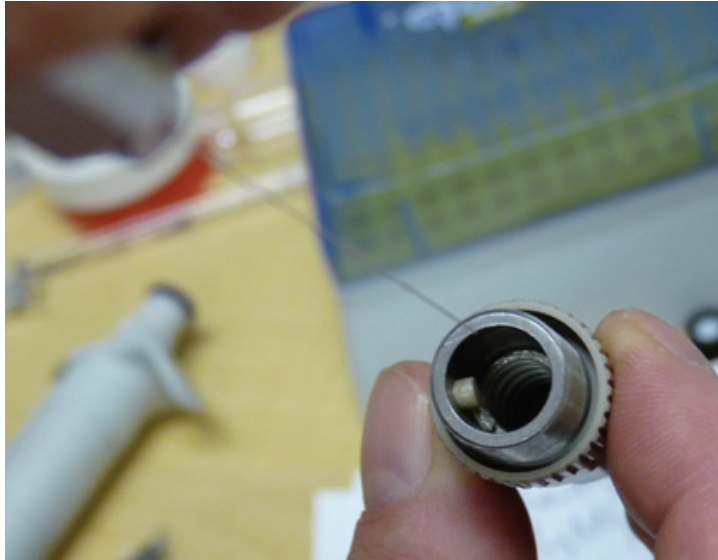


Figure 27 Tightening the outer screw

19. Place the slot into the groove on the probe.
20. Press the slotted metal insert down with your finger and check to see that the needle goes in and out.
21. Fit the Set Screw to the Probe Body
22. Screw in the needle depth adjuster until the needle pops out 1/8 inch.



Figure 28 Needle is out 1/8 inch

23. Turn the locking cap counter clockwise to lock in the needle depth screw.

Maintenance of the Roughing Pump

You should never service the roughing pump. All maintenance of the roughing pump should be performed by a qualified service technician during the Preventative Maintenance visits. Also please, review the manuals that accompany your for additional important information.

Gas Ballasting the Roughing Pump

CAUTION *Before venting the Mass Spectrometer make certain that the gas ballast valve is closed on the roughing pump otherwise oil from the pump may back up into the instrument causing damage.*

Once a month you should ballast the roughing pump otherwise gas will build up in the oil filter chamber.

1. Slowly open the gas ballast by turning the valve with a screwdriver.

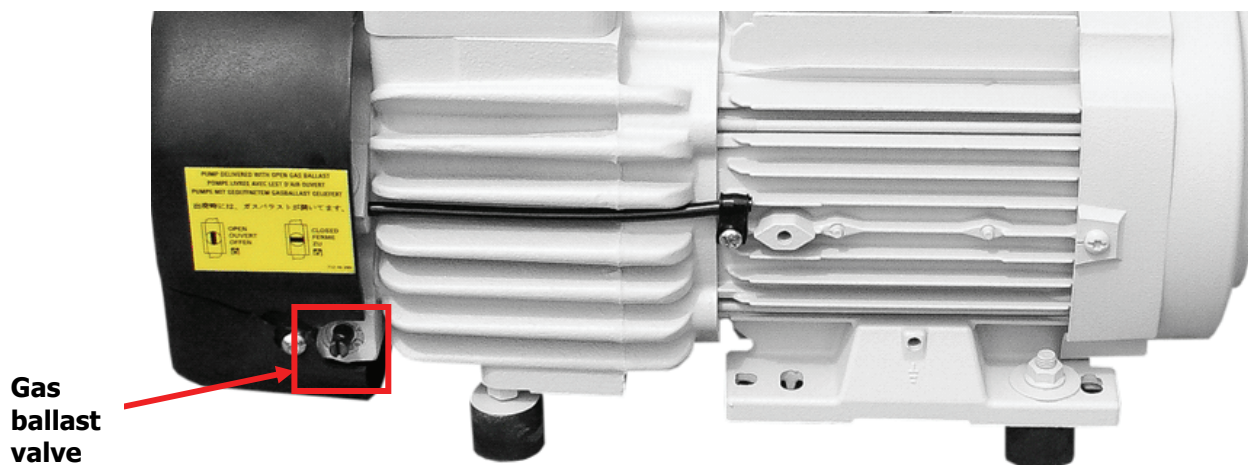


Figure 29 Location of gas ballast valve on the roughing pump

2. Leave the ballast valve open for ~30 minutes.
3. Return the ballast valve to the closed position.

Spare and Replacement Parts

We recommend that you have the following spare parts and tools in your laboratory.

Spare Parts

Part No.	Description
MZ105057-60180	Dielectric Capillary
MZ101362-202	Capillary o-ring
MZ101903-17	Probe Needle (for new-style probes)
MZ101903-15	Probe Needle (for old-style probes)
MZ107126	Probe Sealtight Fitting
MZ104437	Plug-In Removal Tool (Jack Tool)

Tools

Part No.	Description
09220122	Peek Replacement Needle for Syringe (pk/5)
09220121	Fiberglass Pen
09220120	Syringe
09220119	Bench Top Cutter



Troubleshooting



Introduction

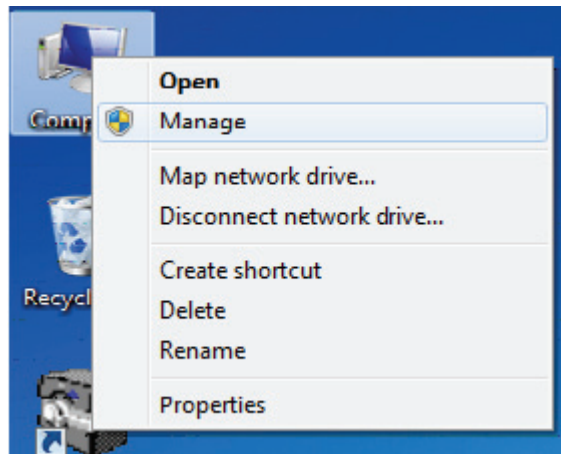
The section lists the most common instrument performance problems and software error messages for the AxION 2 TOF MS Detector.

Performance Problems: Communications

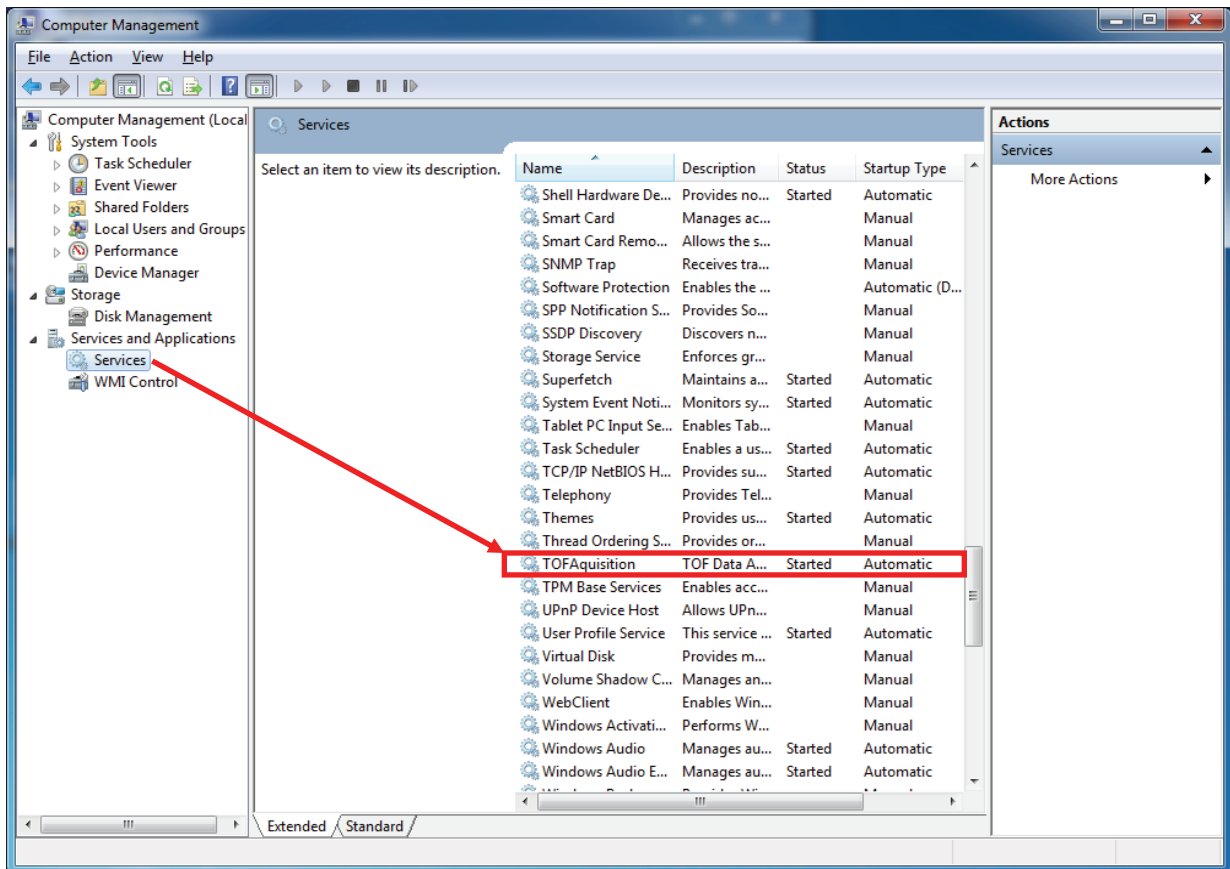
- Check that all Cables are properly connected
- The TOF PC is powered on
- The TOF Acquisition service is not running

Checking the status of the TOF Acquisition service:

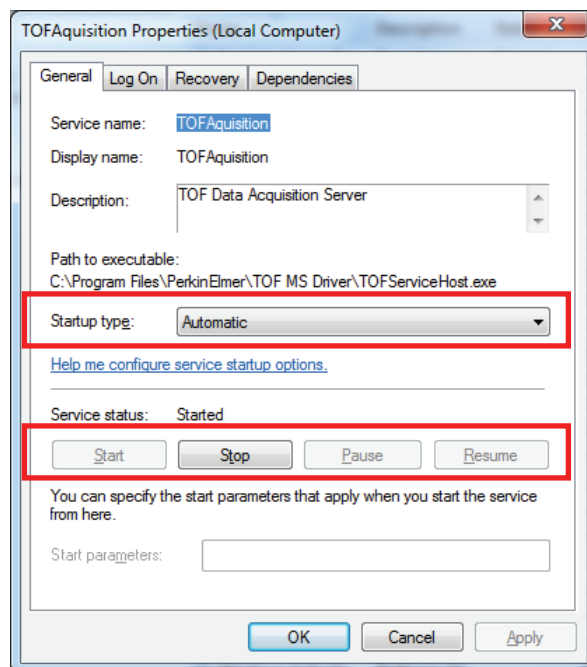
1. Right-click on Computer, and select Manage



2. On the left side of the Management window, select Services. The main window will populate with all services on the PC.
3. Scroll down to find the TOF Acquisition service. This should be started, and set to start automatically.



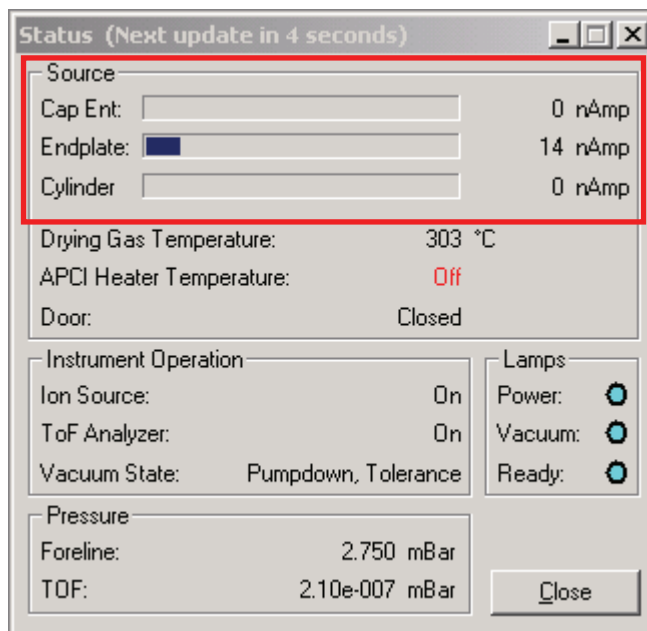
4. If the TOFAquisition service is not running, or if it is not set to start automatically, right-click on the TOFAquisition service and select Properties
5. If the service has been stopped, press the Start button to activate it. If the Startup Type was set to anything other than Automatic, change it to Automatic.



Performance Problems: No Signal

If no signal is present when acquiring, the status of the following should be confirmed

- Proper Tune file parameters have been applied
- There is sufficient, steady solvent flow from the LC inlet.
- The source probe is not plugged or damaged
- There is an appropriate current readback on the Endplate and Capillary. If there is appropriate current, but still no signal, the capillary may be dirty or plugged
 - The currents can be monitored in the Status window:



- Gas delivery is steady and at a proper flow
- All cables are properly connected

Performance Problems: Unstable Signal

If the signal is present, but unstable, the following should be confirmed:

- There is sufficient, steady solvent flow from the LC inlet
- The source probe is not plugged or damaged
- Gas delivery is steady and at a proper flow
- The probe is not pointed directly into the capillary. Too much solvent flow into the instrument will cause signal drop-out
- The capillary is clean and unplugged

Performance Problems: Signal Degredation

If the signal is good, but deteriorates over time, charging is occurring, and the likely cause is a dirty source. To confirm charging, switch the tune's polarity, then switch it back again. If the signal is returned to its original intensity, then slowly drops off, it is charging. Clean the source.

Error Log Codes and Explanations

The Error Log is available by selecting TOF Status > Error Log. An Error Log window will open. The log can be exported as a tab-delimited file to the clipboard and pasted into a spreadsheet. A list follows of all errors generated by the embedded software in response to a failed test condition, listed under the "Instrument" process. Included with each code is a detailed explanation of the nature of the test and troubleshooting suggestions to correct the problem.

Fault Code	Description	Test Section	Troubleshooting Suggestion
1014	The Timing to Pulser Card cable is either disconnected or damaged.	Power-up Test	The Timing and Control Computer generates a logic signal that is passed to the Switcher Card, then to the Dynamic Lens Card and finally read by the micro wire network. A disconnection of any of these cables, damage to the micro wire network, or to any of the boards, could cause this error. The most likely error involves the disconnection or damage to the cable, which connects the Computer Box to the Pulser assembly.
1015	A problem has been found with the microwire communication cables.	Power-up Test	The micro wire network cabling contains a logic signal which is monitored on the System Control Card. This signal is used as part of the high voltage interlock system: the loss of this signal will prevent all high voltage generation. Under some circumstances the loss of this signal can still be monitored and reflected in this error code. Disconnection of the micro wire cable or damage to the network will prevent the signal from being read by the diagnostic software.
1024	Drying Gas flow rate regulator malfunction.	Source Tolerance Check	The Dry gas flowrate is not operating within the ± 0.8 l/min limit. Check that the drying gas is being supplied to the input.
1026	No Drying Gas Flow present. Drying Gas Heater is switched off.	Drygas/heater interlock Test	The dry gas flow had dropped below 5% of the maximum flow (less than 2 l/min) and the dry gas heater has been disabled. The gas flow must be restored before software will allow the heater to operate.
1028	Drying Gas Heater fuse is missing.	Power-up Test / Source Tolerance Check	The AC voltage supplying the Dry gas Heater circuit exceeds the $\pm 20\%$ limit. A damaged or missing 'Drying' fuse will also cause this error. This fuse is located on the side panel next to the power switch 8 amp. This voltage is sensed on the System Control Card.
1029	Drying Gas Heater thermocouple disconnected or missing. The Drying Gas Heater is switched off.	Source Tolerance Check	System Control Card will detect a missing thermocouple and automatically shut off the Dry gas heater. This is only checked if the Dry gas heater is being operated. 8 ohms resistance at ambient temperature.

1050	Inlet high voltages and gases turned off because the Source door is open.	ESHV interlock Test	When the Source door hardware interlock is activated all the high voltages accessible within the Source are turned off. The nebulizing gas and Drying gas heaters are switched off. The dry gas is programmed to be delivered at 1.8 l/min flowrate as a means of cooling the heater. As a precaution source, heater and gas should be switched off before opening the source cover.
1059	Cylinder voltage out of tolerance.	Source Tolerance Check	Cylinder voltage is not operating within the $\pm 325V$ limit.
1064	Len 1 Trap voltage out of tolerance.	Vacuum (2) Tolerance Check	Len 1 Trap voltage is not operating within the $\pm 10V$ limit.
1069	Len 1 Eject voltage out of tolerance.	Vacuum (2) Tolerance Check	Len 1 Eject voltage is not operating within the $\pm 10V$ limit.
1074	Lens 2 voltage out of tolerance.	Vacuum (2) Tolerance Check	Lens 2 voltage not operating within the $\pm 10V$ limit.
1079	Pulse Lens 3 Bias voltage out of tolerance.	Vacuum (2) Tolerance Check	Pulse Lens 3 Bias voltage is not operating within the $\pm 10V$ limit.
1084	Pulse Lens 1 voltage out of tolerance.	Vacuum (2) Tolerance Check	Pulse Lens 1 voltage is not operating within the $\pm 15V$ limit.
1089	Pulse Lens 1 Bias voltage out of tolerance.	Vacuum (2) Tolerance Check	Pulse Lens 1 Bias voltage is not operating within the $\pm 0.5V$ limit
1095	Flight Tube voltage out of tolerance.	Vacuum (1) Tolerance Check	Flight Tube voltage is not operating within the $\pm 200V$ limit.
1100	Reflectron voltage out of tolerance.	Vacuum (1) Tolerance Check	Reflectron voltage is not operating within the $\pm 100V$ limit.
1104	EndPlate voltage out of tolerance.	Source Tolerance Check	EndPlate voltage is not operating within the $\pm 325V$ limit.
1108	Detector voltage out of tolerance.	Vacuum (1) Tolerance Check	Detector voltage is not operating within the $\pm 35V$ limit.
1113	Post Accelerator voltage out of tolerance.	Vacuum (1) Tolerance Check	Post Accelerator voltage is not operating within the $\pm 350V$ limit.
1117	Capillary Entrance voltage out of tolerance.	Source Tolerance Check	Capillary Entrance voltage is not operating within the $\pm 325V$ limit.
1121	Capillary Exit voltage out of tolerance.	Vacuum (2) Tolerance Check	Capillary Exit voltage is not operating within the $\pm 10V$ limit.
1126	Lens 3 voltage out of tolerance.	Vacuum (2) Tolerance Check	Lens 3 voltage is not operating within the $\pm 10V$ limit.
1131	Lens 4 voltage out of tolerance.	Vacuum (2) Tolerance	Lens 4 voltage is not operating within the $\pm 10V$ limit.

1136	Skimmer voltage out of tolerance.	Vacuum (2) Tolerance Check	Skimmer voltage is not operating within the $\pm 10V$ limit.
1141	RF Offset Voltage out of tolerance.	Vacuum (1) Tolerance Check	RF Offset Voltage is not operating within the $\pm 1.0V$ limit.
1145	Positive or Negative 400V Lens power supply is out of tolerance.	Vacuum (2) Tolerance Check	Either the + or – 400 rails on the Dynamic Lens Card are not operating within their $\pm 25V$ limit. These rails are supplied by the high voltage power supplies.
1148	No Nebulizer Gas flow present. Nebulizer Gas Heater is switched off.	Nebgas/heater interlock Test	The nebulizer gas flow has dropped below 5% of the maximum flow (less than 2 l/min) and the nebulizer gas heater has been disabled. The gas flow must be restored before software will allow the heater to operate.
1160	Nebulizer Gas Pressure regulator malfunction.	Source Tolerance Check	The Nebgas pressure is not operating within the ± 4 psi limit. When this error is generated the inlet gas pressure is also checked to determine if the cause of the problem is insufficient inlet gas pressure
1161	P5V switching power supply is out of tolerance.	Power-up Test	The 5 VDC SW power supply is not operating within the $\pm 10\%$ limit.
1162	P5V ISO2_ON power supply is out of tolerance.	Power-up Test	The isolated 5 VDC power supply is not present. This supply is used on the System Control Card, and as power to the remote circuits such as: Turbo-molecular pump controller, Pumpdown & Vent switches, and Contactor sense.
1163	N5V power supply is out of tolerance.	Power-up Test	The -5 VDC power supply is not operating within the $\pm 10\%$ limit.
1164	P15V power supply is out of tolerance.	Power-up Test	The +15 VDC power supply is not operating within the $\pm 10\%$ limit.
1165	N15V power supply is out of tolerance.	Power-up Test	The -15 VDC power supply is not operating within the $\pm 10\%$ limit.
1166 1167	P24V SW1 power supply is out of tolerance.	Power-up Test	The +24 VDC (switching) power supply is not operating within the $\pm 10\%$ limit. .
1168	P24V LIN2 power supply is out of tolerance.	Power-up Test	The +24 VDC (linear) power supply is not operating within the $\pm 10\%$ limit.
1169	24 VAC power supply is out of tolerance.	Power-up Test	The AC voltage supplying the instrument exceeds the $\pm 20\%$ limit.

1172	RF Voltage is out of tolerance.	Vacuum (1) Tolerance Check	RF Voltage is not operating within the $\pm 5\%$ limit.
1192	WARNING: Power Failure. Automatic vacuum restart initiated.	Power-up Test	In the event of a short (approximately 10 second or less) interruption of mains power, the instrument will automatically re-start its vacuum system upon restoration of power. Upon detecting this situation, the internal computer initializes into a Pumpdown state and notifies the host computer of the condition.
1224	Vacuum high voltages turned off because of an Instrument Software detected a software detected fault condition.	VacHV interlock Test	When the vacuum high voltage hardware interlock is activated all the high voltages associated with the vacuum system are turned off. This fault condition can be caused by excessive stage four vacuum pressures (Above 8.4 E-6 mBar), failure of the cold cathode vacuum gauge, a failure of the micro wire network or a software initiated high voltage over ride. All of these faults, aside from the last have their own unique errors that are logged independently.
1227	Vacuum high voltages turned off because the Cold Cathode Gauge is faulted.	VacHV interlock Test	When the cold cathode gauge is faulted all the high voltages associated with the vacuum system are turned off. The instrument should be loaded with the Vent/Standby tune file before a repair is attempted: the gauge abruptly switching back on could damage the detector without controlling the application of voltage.
1228	Vacuum high voltages turned off because high vacuum is reported in stage 4. Cold Cathode Gauge has been switched off. To reset the Cold Cathode Gauge, set the Detector voltage to 0V, and then apply the desired Detector voltage value.	VacHV interlock Test	When the cold cathode gauge measures a pressure in excess of 8.4 E-6 mBar , all the high voltages associated with the vacuum system are turned off. The instrument should be loaded with the Vent/Standby tune file before a repair is attempted: the gauge abruptly switching back on could damage the detector without controlling the application of voltage.
1229	Dynamic Lens card (MZ108687) vacuum high voltages are turned off because the interlock or microwire connection has been faulted.	VacHV Tolerance Check	The Dynamic Lens Card has two interlock signals that effect high voltage generation. This error code indicates that one of these connections is missing.
1253	TP1 is below operational speed. This prevents Cold Cathode Gauge (CCG) operation.	VacHV(1) interlock Test	The turbo pump has dropped below 85% operational speed, shutting down the CCG and vacuum high voltages.

1261	Timing Computer restrictions force trap time (D7) to increase by 1usec.	CATCH Test	The Timing Computer cannot generate a timing pattern where the delays D8-D7 = 1usec
1265	Timing Computer Record interval programming has exceeded 512usec. Timing is not as programmed.	CATCH Test	The Timing Computer cannot generate a timing period that exceeds 512 usecs (1.953KHz), but has been incorrectly programmed. A reset of the host computer should eliminate this error. If not, a clean installation of both the OS and Driver are recommended.
1273	CCG is not responding properly and remains off.	Tune File Test	The CCG has not responded with an in-operational range reading (3.17 +/- .30V (6E-8 Torr) to 5.45 +/- .22V (1E-6 Torr)) within five minutes of the ON request being sent. This error will be reported every five minutes, or until a CCG OFF request is sent.
1274	Vacuum high voltages turned off because TP1 is below operational speed.	VacHV(1) interlock Test	This error occurs only if the CCG has been disabled. Follow suggestions detailed in error 1253.
1275	Vacuum high voltages turned off because the Cold Cathode Gauge is switched off by the Control Computer.	VacHV(1) interlock Test	The CCG has been switched off because the electronic latch on the System Control Card has been (incorrectly) reset. This is most likely due to EMI (static discharge), and may indicate arcing within the instrument.
1276	Installed firmware is designed for a different FPGA version. Some functionality may not be available.	Power-up Test	The embedded software installed on the instrument was designed to operate with a different Timing and Control Computer configuration. Generally, this will have no functional effect on instrument operation. To eliminate this error, the embedded software needs to be changed, or the Timing and Control Computer needs to be returned to PKI for a FPGA configuration upgrade.
1277	Rotary pump contactor has opened. Instrument Autovented.	Autovent Test	When the instrument was forced to vent due to high Foreline pressure (as measured by the Pirani gauge), the embedded software recorded a Rotary Pump contactor open condition. This could indicate a contactor failure or a loss of the 24 VAC contactor power. If an error 1169 is also reported the cause is likely a damaged 'Internal' fuse. If no other source is identified, the System Control Card, which is the source of the contactor control and monitor, may be defective.

1279	Pirani gauge detected foreline pressure above 4.4 mBar. Instrument Autovented.	Autovent Test	The instrument was forced to vent due to high Foreline pressure. The most likely cause is a breach in the Foreline connection between the instrument and the rotary pump. An internal leak is possible, as would be a broken capillary or poorly seated plug-in assembly. If no other source is identified, the System Control Card, which contains the Pirani gauge sense, may be defective.
1280	Second stage turbo-molecular pump (TP1) controller is faulted. Instr Auto vented.	Autovent Test	The instrument was forced to vent due to a fail condition, as reported from TP1. The cause could be either the pump itself, or from a failure of the controller or controller power supply.
1281	Pirani gauge, which monitors the Foreline Pressure, is faulted. Instr Autovented.	Autovent Test	The instrument was forced to vent due to out of range Foreline pressure. If an error 1166 is also reported the cause is likely a failed 24 VDC power supply.
1282	Instrument Vented through software or VENT button pressed.	Autovent Test	The instrument was forced to vent by the hardware VENT button, located at the bottom left corner of the System Control board. If not pressed intentionally, an errant cable or other object could have depressed the switch.
1283	Instrument Autovented. No vent mechanism captured	Autovent Test	The instrument was forced to vent but no results were captured in the hardware latch. This is most likely due to EMI (static discharge), and may indicate arcing within the instrument
1284	D8 adjusted to 4usec minimum resolution of the Timing Computer.	CATCH Test	

Diagnostics

The Diagnostics window can be accessed by selecting TOF Status > Diagnostics. This window displays all current readbacks in the instrument. It can be read in the window that is displayed, or if Export is clicked, the information will be moved to the clipboard, and can be pasted into a word document.

Below is a list of the readbacks in the diagnostics, with a short explanation for each

TimeStamp	Time and Date Diagnostics were accessed
--- Instrument Firmware ---	
Firmware Version	Current Firmware revision loaded
Additional Information	
--- Instrument Status ---	
Ready On	1 = pumpdown state with no interlocks violated. 0 = pumpdown state with one or more interlocks violated, or vented.
Ready Blink	1 = the firmware has detected an error. 0 = the firmware has not detected an error.
CTC Status	1 = indicates no errors since last reboot.
Source Closed	1 = source door is closed. 0 = the door is open
Hardware VAC HV Shutdown	1 = all vacuum voltages may be switched on. 0 = all vacuum voltages may not be switched on
Hardware VAC HV Shutdown 2	1 = all vacuum voltages may be switched on. 0 = all vacuum voltages may not be switched on
Hardware ES HV Shutdown	1 = all ESI voltages, heaters and gases may be switched on. 0 = all ESI voltages and heaters may not be switched on
Software HV Shutdown Check	1 = Vacuum and ESI operation ia allowed. 0 = Vacuum and ESI operation is not allowed.
--- Power Supplies ---	
+5V DC Power	Readback of the +5V Power
+15V DC Power	Readback of the +15V Power

-15V DC Power	Readback of the -15V Power
+48V DC Power	Readback of the +48V Power
24V 1 fuse	State of 24V fuse
24V 2 fuse	State of 24V fuse
--- Vacuum System ---	
CCG On	1 = the CCG is switched on. 0 = the CCG is switched off.
CCG Vacuum (OK = 3.0..5.2)	Stage 4 vacuum level. Tolerance: $\pm 100\%$ of the linear reading.
CCG OK	1 = the CCG is switched on and operational. 0 = the CCG is either faulted or switched off
CCG Set Point Check	1 = acceptable vacuum level achieved to operate high voltages. 0 = insufficient vacuum level to operate high voltages
CCG Interlock Disable	1 = the CCG interlock is disabled. 0 = the CCG interlock is enabled.
TCG Vacuum (OK = 7.0..8.0)	Stage 1 (foreline) vacuum level. Tolerance: $\pm 100\%$ of the linear reading.
TCG OK	1 = the foreline gauge is switched on and operational. 0 = the gauge is either faulted or switched off.
TCG Set Point Check	1 = acceptable vacuum level achieved to operate the turbo pump. 0 = insufficient vacuum level to operate the turbo pump.
Pump Down Pulse	Momentary signals; should always read '0'.
Vent Pulse	Momentary signals; should always read '0'.
--- Turbo Pump ---	
Pumps OK	1 = vacuum pumps, standby heaters and gases are on. 0 = vacuum pumps, standby heaters and gases are off.
Rotary Pump Contactor Close Check	1 = the mains contactor is closed. 0 = the mains contactor is open.
Turbo Pump RPM (max speed%/2)	Readback of the turbopump as a percentage of maximum speed/2. Tolerance: $\pm 2\%$.
Turbo Pump OK	1 = the turbo pump speed is $> 80\%$. 0 = the

	turbo pump speed is < 80%.
---	Data Acquisition Unit ---
DAU I_Offset	Bias offset voltage setting of the I channel input of the DAU A/D converter. In volts.
DAU I_Voltage	Bias voltage setting of the I channel input of the DAU A/D converter. In volts.
DAU Q_Offset	Bias offset voltage setting of the Q channel input of the DAU A/D converter. In volts.
DAU Q_Voltage	Bias voltage setting of the Q channel input of the DAU A/D converter. In volts.
DAU Attenuator	Attenuator setting programmed into the signal path between the detector and the DAU A/D converter. In dB of attenuation.
---	Lenses ---
TOF Set Polarity	Readback of the polarity of the Flight Tube, Ion Reflector and Post Accelerator supplies
Cylinder Or Corona Needle Set Polarity	Readback of the polarity of the Cylinder Or Corona Needle.
Cylinder Or Corona Needle Set Amplitude	Readback of the magnitude of the Cylinder Or Corona Needle
Cylinder Voltage Or Corona Set Current	Readback of the Cylinder Or Corona Needle Voltage.
Cylinder Or Corona Needle Current	Readback of the Cylinder Or Corona Needle Current.
End Plate Voltage Set Polarity	Readback of the polarity of the End Plate Voltage
End Plate Voltage Set Amplitude	Readback of the magnitude of the End Plate Voltage
End Plate Voltage	Readback of the End Plate Voltage.
End Plate Current	Readback of the End Plate Current.
Capillary Entrance Voltage Set Polarity	Readback of the polarity of the Capillary Entrance Voltage
Capillary Entrance Voltage Set Amplitude	Readback of the magnitude of the Capillary Entrance Voltage

Capillary Entrance Voltage	Readback of the Capillary Entrance Voltage.
Capillary Entrance Current	Readback of the Capillary Entrance Current.
HV Positive Set Voltage	Readback of the Pulsing Card lens power supply rails
HV Positive Rail for Static Voltage	Readback of the Pulsing Card lens power supply positive rail.
HV Negative Rail for Static Voltage	Readback of the Pulsing Card lens power supply negative rail.
Capillary Exit Set Voltage	Readback of the Capillary Exit Set Voltage
Capillary Exit Voltage	Readback of the Capillary Exit Voltage.
Skimmer Set Voltage	Readback of the Skimmer Set Voltage.
Skimmer Voltage	Readback of the Skimmer Voltage.
Ion Guide Offset Set Voltage	Readback of the Ion Guide Offset Set Voltage
Ion Guide Offset Voltage	Readback of the Ion Guide Offset Voltage.
Lens 1 Trap Set Voltage	Readback of the Lens 1 Trap Set Voltage
Lens 1 Trap Voltage	Readback of the Lens 1 Trap Voltage.
Lens 1 Eject Set Voltage	Readback of the Lens 1 Eject Set Voltage
Lens 1 Eject Voltage	Readback of the Lens 1 Eject Voltage.
Lens 2 Set Voltage	Readback of the Lens 2 Set Voltage
Lens 2 Voltage	Readback of the Lens 2 Voltage.
Lens 3 Set Voltage	Readback of the Lens 3 Set Voltage .
Lens 3 Voltage	Readback of the Lens 3 Voltage.
Lens 4 Set Voltage	Readback of the Lens 4 Set Voltage .
Lens 4 Voltage	Readback of the Lens 4 Voltage.
Pulse Lens Set Voltage	Readback of the Pulse Lens 1 Set Voltage .
Pulse Lens Voltage	Readback of the Pulse Lens 1 Voltage.
Pulse Lens 1 Bias Set Voltage	Readback of the Pulse Lens 1 Bias Set Voltage .
Pulse Lens 1 Bias Voltage	Readback of the Pulse Lens 1 Bias Voltage.

Pulse Lens 2 Bias Set Voltage	Readback of the Pulse Lens 3 Bias Set Voltage .
Pulse Lens 2 Bias Voltage	Readback of the Pulse Lens 3 Bias Voltage.
Flight Tube Set Voltage	Readback of the Flight Tube Set Voltage .
Flight Tube Voltage	Readback of the Flight Tube Voltage.
Flight Tube Polarity Check	Readback of the Flight Tube Polarity.
Ion Reflector Set Voltage	Readback of the Ion Reflector Set Voltage .
Ion Reflector Voltage	Readback of the Ion Reflector Voltage.
Ion Reflector Polarity Check	Readback of the Ion Reflector Polarity.
Detector Set Voltage	Readback of the Detector Set Voltage .
Detector Voltage	Readback of the Detector Voltage.
Post Accelerator Set Voltage	Readback of the Post Accelerator Set Voltage .
Post Accelerator Polarity Check	Readback of the Post Accelerator Polarity.
--- RF Driver ---	
RF Set Amplitude	Readback of the RF Set Amplitude .
RF Amplitude Check	1 = the RF Driver is within +/-5% of the set amplitude, 0 = the RF Driver is below +/-5% of the set amplitude
--- Gases and Heaters ---	
Nitrogen Pressure Switch On	1 = the inlet pressure is >5.6 barr, 0 = the inlet pressure is < 5.6 barr.
Drying Gas Set Flow Rate	Readback of the Drying Gas Set Flow Rate . Value is divided by 3.87 to convert to l/min.
Drying Gas Flow Rate	Readback of the Drying Gas Flow Rate. Value is divided by 3.87 to convert to l/min.
Drying Gas Heater On	1 = the heater is switched on. 0 = the heater is switched off.
Drying Gas Heater Set Temperature	Readback of the Drying Gas Heater Set Temperature .

Drying Gas Heater Temperature	Readback of the Drying Gas Heater Temperature.
Aux Gas Set Flow Rate	Readback of the Auxilliary Gas Set Flow Rate
Aux Gas Flow Rate	Readback of the Auxilliary Gas Flow Rate
Nebulizer Gas Set Pressure	Readback of the Nebulizer Gas Set Pressure . Value is in psi.
Nebulizer Gas Pressure	Readback of the Nebulizer Gas Pressure. Value is in psi.
APCI Heater On	1 = the heater is switched on. 0 = the heater is switched off.
APCI Heater Set Temperature	Readback of the APCI Heater Set Temperature . Value is in °C.
APCI Heater Temperature	Readback of the APCI Heater Temperature. Value is in °C. Tolerance: ±25°C.

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