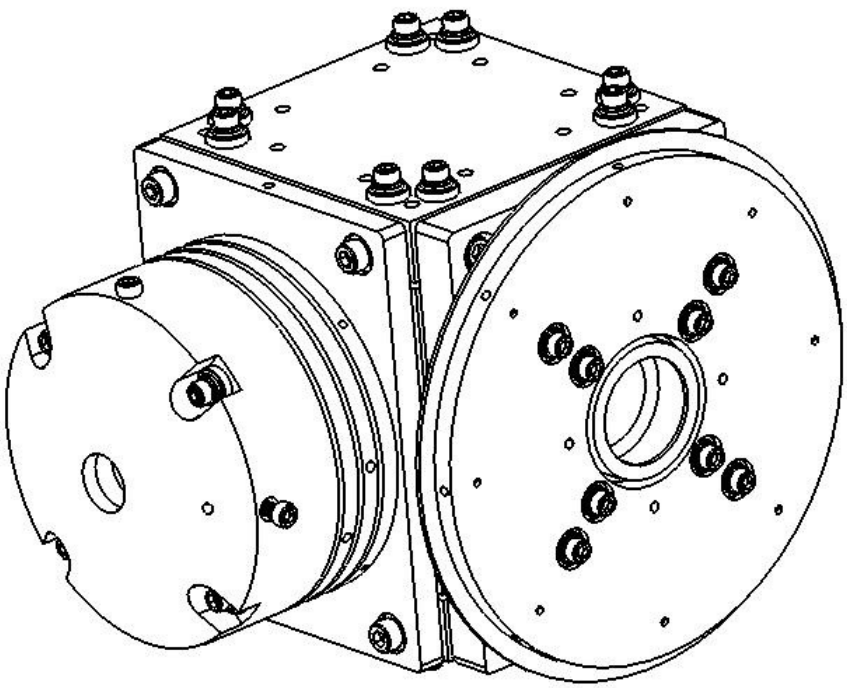
Jumbo Cross Beam Ionizer



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1.0 Packing List

1.1 Packing List for Jumbo Cross Beam Ionizer

The Jumbo Cross Beam Ionizer is shipped with the following items:

Table 1. Jumbo Cross Beam Ionizer Packing List

Quantity	Part Number	Description
1		Jumbo Cross Beam Ionizer for large quadrupoles
4		(spare) Ceramic washer, 0.249 inch o.d., 0.080 inch thick
10		2-56 X ¼ Socket Head Cap Screws
10		2-56 Split Lock Washers

1.2 Optional Accessories for Jumbo Cross Beam Ionizer

The Jumbo Cross Beam Ionizer can be attached to various quadrupole lens-mounting plates, customized to the user's existing quadrupole.

Table 2. Optional Accessories for Jumbo **Cross Beam Ionizer**

Quantity	Part Number	Description
1		Entrance Lens Assembly for Extrel 6 or 9.5 mm Quadrupole
1		Entrance Lens Assembly for Extrel 16 mm Quadrupole
1		Entrance Lens Assembly for Extrel 19 mm Quadrupole

2.0 Product Identification

In all communication with Ardara Technologies, please specify the Ardara Technologies part number for the ionizer from your original purchase order.

3.0 Scope of Manual

This manual applies to the Ardara Technologies Jumbo Cross Beam Ionizers which incorporate an axial molecular beam ionizer and a quadrupole deflector energy filter.

This document is valid as of the date of publication. We reserve the right to make technical changes to the design.

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4.0 Intended Use

The Ardara Technologies Jumbo Cross Beam Ionizer was designed to provide exceptionally high sensitivity for analysis of ions and neutrals from a customer's molecular beam, which is oriented orthogonally to the quadrupole. Specially, designed to better match the large acceptance of larger quadrupoles, especially at higher RF frequencies.

This ionizer is intended for use with molecular beams and ion beams that are reactive, condensable or sampled from a higher-pressure gas source. Its right-angle orientation to the axis of the quadrupole allows for effective separation of the ions of choice from the background gas load, while minimizing the gas flow into the mass analyzer.

5.0 Safety

The Jumbo Cross Beam Ionizer was designed to operate inside a vacuum system, with voltages applied to adjacent electrodes as high as plus or minus 400 volts.

5.1 Vacuum Pressure Considerations

The Jumbo Cross Beam Ionizer was designed to operate inside a vacuum system, with vacuum levels maintained below 10^{-5} torr. Operation at pressures above this maximum pressure may result in dramatically lower filament lifetime, as well as the potential for glow discharge between adjacent high voltage electrodes.

6.0 Liability and Warranty

Ardara Technologies assumes no liability and the warranty becomes null and void if the end user or third parties:

- Disregard the information in this manual
- Use the product in a non-conforming manner
- Make any kind of changes (modifications, alterations, etc.) to the Jumbo Cross Beam Ionizer.

7.0 Product Overview

7.1 Summary

The Ardara Technologies Jumbo Cross Beam Ionizer consists of a molecular beam ionizer coupled to a quadrupole deflector energy filter, which serves to deflect the ions ninety degrees from the entrance aperture of the molecular beam.

The molecular beam ionizer portion of the Ardara Technologies Jumbo Cross Beam Ionizer is a Brink type ionizer, consisting of a metal basket (Platinum wire), which is surrounded by a network of coated molybdenum framework.

The molecular beam ionizer has a filament shield which has an entrance aperture, which defines the maximum cross section of the molecular beam, 0.375 inches.

A customer-supplied filament power supply will provide suitable regulated current and voltage to maintain constant emission current, with the more negative of the two filament connections to be applied to the upper filament plate (closest to the ion beam aperture), and the less negative connection to be applied to the lower filament plate.

The filament shield is maintained at the more negative of the two filament connections by way of a metal washer placed between the filament shield and the upper filament plate.

All electrical connections to the Cross Beam Ionizer are made via 2-56 screw connections to holes threaded radially for the respective lenses.

Typically, copper wires are used for the filament connections, and nickel wire is used for the lens connections.

The Quadrupole Deflector Energy Filter portion of the Jumbo Cross Beam Ionizer is constructed from four hyperbolic rods oriented such that the ion beam is directed between adjacent rods. With suitable voltages applied to the deflector poles, the ion beam can be directed to travel a path ninety degrees from their entrance.

The deflector pole pair that includes the pole which is between the molecular beam ionizer and the quadrupole is identified as the 'Inner Pole' pair, with the other pole pair identified as the 'Outer Pole' pair.

The Quadrupole Deflector Energy Filter utilizes a vacuum compatible resistive voltage divider (5 megaohm) attached between the deflector poles, with the centerline potential of the poles as maintained by the voltage divider applied to the deflector entrance lens, top and bottom pole plates, and in some cases the deflector exit lens. An optional optimization utilizes a separate lens supply to drive the deflector exit lens, instead of the standard configuration of connecting the deflector exit lens to the centerline potential of the deflector.

The Jumbo Cross Beam Ionizer is typically configured with two bipolar 100 volt power supplies for the ion region and extraction lens, and two bipolar 400 volt power supplies for the deflector assembly, although a third bipolar 400 volt power supply is commonly used to drive the deflector exit lens.

The deflector can operate with bipolar 200 volt or 100 volt power supplies with modest reduction in performance.

Under certain tuning conditions (small voltage difference between the pole pairs), the quadrupole deflector can be utilized as an energy filter, with the centerline potential of the deflector indicative of the average energy of the passed ion beam, and the voltage difference between poles controlling ion energy bandpass.

8.0 Installation

8.1 Installing the Jumbo Cross Beam Ionizer

Installation of the Jumbo Cross Beam Ionizer onto a quadrupole requires that the ionizer be first mounted to the quadrupole entrance lens, and then the quadrupole entrance lens is mounted to the quadrupole itself.

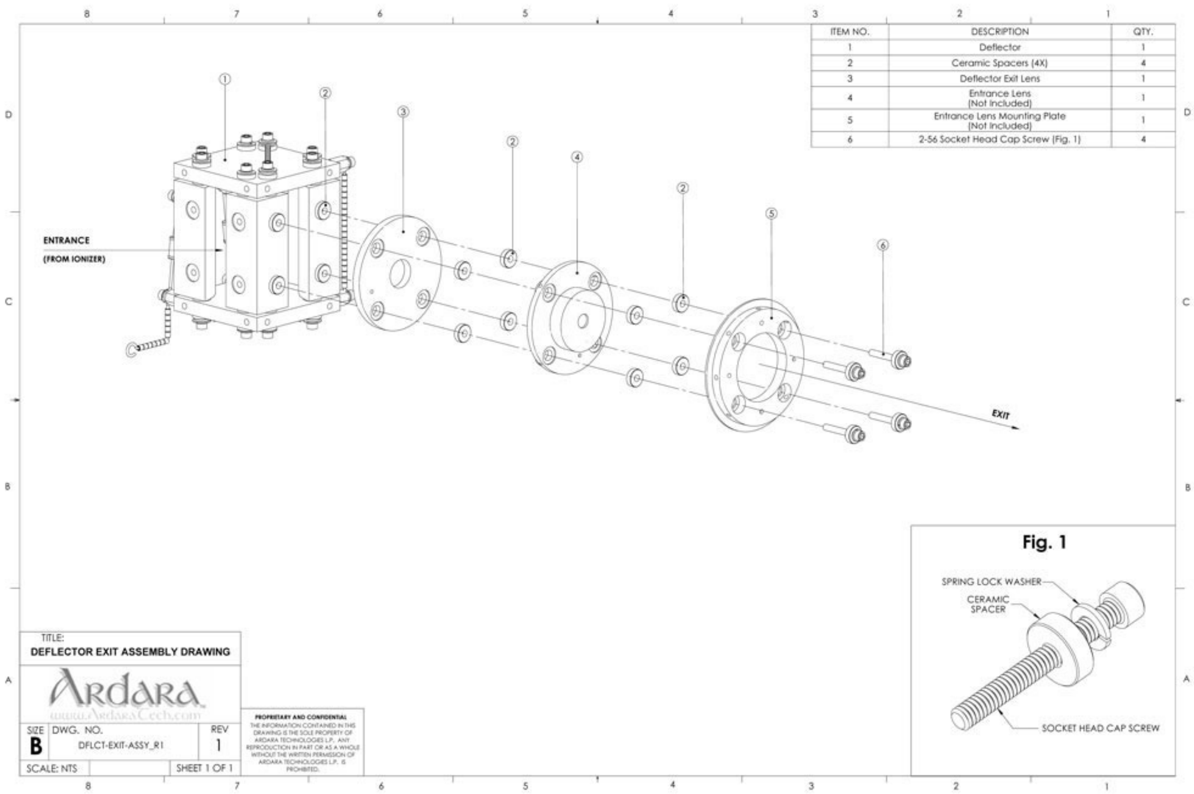


Figure 1. Mounting the Jumbo Cross Beam Ionizer to the Quadrupole Entrance Lens.

8.2 Electrical Connections

A total of six (optionally seven) wires are required to power the Jumbo Cross Beam Ionizer.

See Figure 2 below for a block diagram showing the vacuum wiring for the Jumbo Cross Beam Ionizer.

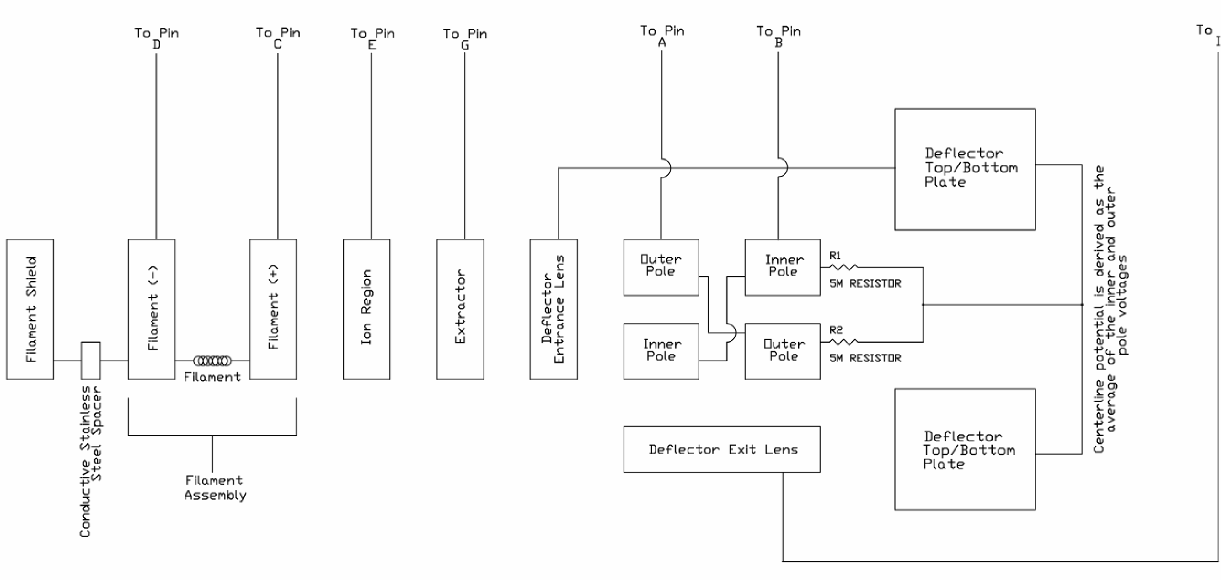


Figure 2. Wiring Block Diagram for Jumbo Cross Beam Ionizer.

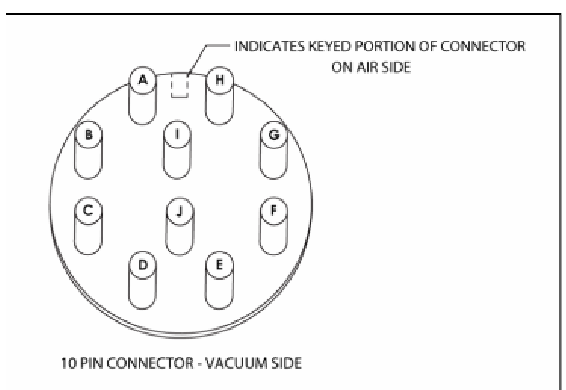


Figure 3. Pinout of Vacuum side of MS-10 Connector.

Table 3. Jumbo Cross Beam Ionizer Electrical Connections when six lens optics supplies are available

MS-10 Connector Pin	Description	Typical Voltage
A	Outer Poles	0 V
B	Inner Poles	-200 V
C	Filament (+)	
D	Filament (-)	100 eV
E	Ion Region	+8 V
F	Exit Lens	-100 V
G	Extractor	-2 V
H	Entrance Lens	-10 V
I	Not Connected	
J	Not Connected	

Table 4. Jumbo Cross Beam Ionizer Electrical Connections when seven lens optics supplies are available

MS-10 Connector Pin	Description	Typical Voltage
A	Outer Poles	0 V
B	Inner Poles	-200 V
C	Filament (+)	
D	Filament (-)	100 eV
E	Ion Region	+8 V
F	Exit Lens	-100 V
G	Extractor	-2 V
H	Entrance Lens	-10 V
I	Deflector Exit Lens	-100 V
J	Not Connected	

Table 5. Jumbo Cross Beam Ionizer Electrical Connections when eight lens supplies are available

MS-10 Connector Pin	Description	Typical Voltage
A	Outer Poles	0 V
B	Inner Poles	-200 V
C	Filament (+)	
D	Filament (-)	100 eV
E	Ion Region	+8 V
F	Exit Lens	-100 V
G	Extractor	-2 V
H	Entrance Lens	-10 V
I	Deflector Exit Lens	-100 V
J	Pre- and Post-filters	-10 V

9.0 Commissioning

9.1 Initial Operation

Once the Jumbo Cross Beam Ionizer is installed onto the quadrupole mass filter, and the electrical connections are made, the unit is ready to install into a vacuum chamber.

When a suitable vacuum is attained, the ionizer is ready for operation.

For Merlin software-based systems, the configuration file should be edited to change the aliases for optics elements 3 and 4, from 'Lens 1/3' and 'Lens 2' to 'Inner Poles' and 'Outer Poles', with the defaults changed to -200 volts for the 'Inner Poles', and 0 volts for the 'Outer Poles'.

The Jumbo Cross Beam Ionizer is not difficult to tune, so long as the initial voltages match the defaults identified in this manual.

Caution: In contrast to typical molecular beam ionizers, it is possible to tune the voltages on the Jumbo Cross Beam Ionizer such that no ions travel to the quadrupole. For example, if the Inner Poles and Outer Poles are set to the same voltage, then ions will not bend ninety degrees to the quadrupole, rather they will travel straight through to the deflector to strike the chamber wall. This feature has been used in some installations to couple a single ion source to multiple analyzers, as well as a gate to selectively inject ions into the quadrupole via some timing sequence on the applied voltages.

9.1 Tuning as a Molecular Beam Ionizer

When the filament is enabled, the Jumbo Cross Beam Ionizer serves as a molecular beam ionizer, ionizing the gas species from a molecular beam passing through the ionizer as well as any residual gas background species present in the vacuum chamber.

The ion region potential and the extraction lens potential have great influence on the ion energy of the ions as they travel through the quadrupole. These voltages should generally be optimized for smooth peak shapes with the highest ion current. Default values of +8 volts for the ion region and -2 volts for the extractor should yield reasonable peak shape and ion signal for a 1.2 MHz quadrupole, although for lower frequency quadrupoles, the ion region potential should be reduced by a volt or two for better peak shapes.

The extraction region typically tunes to a value that is a few to ten volts more negative than the ion region potential, and is generally tuned for maximum signal.

The selection of the Inner Pole potential is generally based on the desired bandpass range of ion energies. Settings in the range of -100 to -400 volts generally tune to yield similar ion intensities, with optimum peak shapes tending towards lower Inner Pole potentials. A good value to use is -200 volts.

Once the Inner pole potential is selected, the outer pole potential is optimized to yield the maximum ion signal, with reasonable peak shape. For ion region potentials just positive from ground, the optimum Inner Pole Potential is typically a few to ten volts positive from ground.

The potential difference between the inner and outer poles defines the energy bandpass of the energy filter. The entrance and exit aperture sizes also have influence on energy bandpass, although the aperture diameters for this design were chosen for highest throughput, minimizing the energy selection capability of the ionizer. Replacing these lenses with ones of smaller diameter would increase energy resolution at the expense of sensitivity.

9.1 Tuning as Focusing Optics for Pre-formed Ions

When the filament is disenabled, the Jumbo Cross Beam Ionizer can serve as focusing optics to bring an ion beam into the quadrupole mass filter.

With the filament disabled, the electron energy control (eV command), can be used as a focusing lens voltage as applied to the filament shield, which doubles as a focusing lens. In Merlin systems, this has a voltage range of -200 to 200 V which is typically maintained 100 volts more negative than the ion region.

Note that the voltage identified on the Merlin tune screen is relative to the ion region potential, not relative to ground. When you change the ion region potential the Filament Shield potential will move with the ion region.

9.2 Tuning the Outer Pole Potential

When the Outer Pole potential is tuned, and ion intensity is plotted as a function of Outer Pole potential, one can identify a smooth broad maximum, as shown in Figure 4.

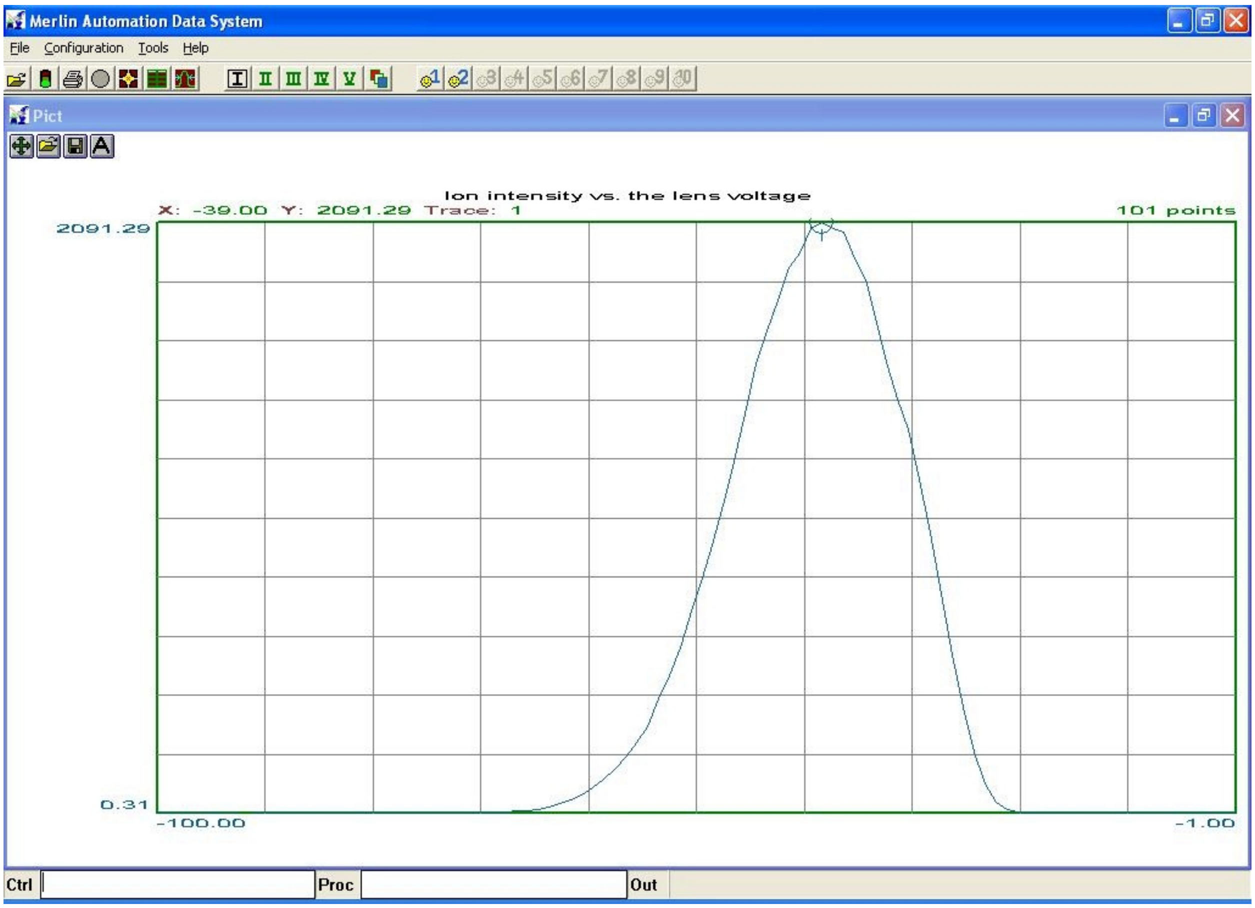


Figure 4. Tuning Curve showing ion intensity as a function of Outer Pole potential with Inner Pole potential maintained at -400 V. Note that the optimum Outer Pole potential is +4 V, and that the vertical grid lines represent ten volt steps. Peak width at half maximum is ~20 Volts.

10.0 Typical Performance Data

10.1 Filament Voltage and Current

Filament Voltage and Filament Current are useful diagnostics. In the Merlin data system, these values can be measured by clicking on the 'Update' button for each element in the tune screen.

The resistance of the filament increases with increasing temperature. The effective resistance of the filament can thus be calculated from the filament voltage and current (V=IR).

Note that the filament voltage is the measured voltage drop across the heated filament, and the filament current is the measured current through the filament itself. In contrast, the Emission Current is the measured current of electrons leaving the filament circuit through vacuum to the ionizer, and the Electron Energy (eV) is the potential difference maintained between the filament circuit and the ion region.

As the chamber vacuum pressure increases, it requires more heat from the filament to maintain emission, and hence the filament temperature increases. (This is the principle behind pirani pressure gauges.)

When the filament is operated at higher emission current, it also requires higher filament temperature. Table 6 illustrates typical measured Filament Voltage and Filament Currents for an ionizer operated in the 10^{-6} torr range.

Table 6. Typical Filament Current and Filament Voltage for different Emission Currents using a Cross Beam Ionizer

Emission Current (mA)	Filament Voltage (amperes)	Filament Voltage (volts)
0.1	5.08	4.10
0.2	5.30	4.20
0.3	5.42	4.25
0.4	5.51	4.30
0.5	5.58	4.35
1	5.81	4.44
2	6.05	4.54
3	6.22	4.59
4	6.33	4.69
5	6.43	4.74
10	6.77	4.83

It is recommended that the user monitor the filament voltage and current as part of their routine daily diagnostics to ultimately use their data as a predictor of filament lifetime.

11.0 Maintenance and Care

11.1 Cleaning

Use standard vacuum cleaning procedures to remove contamination from the stainless steel parts.

A typical cleaning procedure would entail the following:

1. Disassemble ionizer.
2. Mechanically scrub stainless steel components with a slurry of Alconox and aluminum oxide or pumice.
3. Use deionized water to rinse any residue of the Alconox and aluminum oxide.
4. Place parts in a dilute solution of Alconox and water and sonicate in an ultrasonic bath for 20 minutes at 50^{o} C.
5. Use deionized water to rinse the Alconox residue.
6. Place parts in a dilute solution of Citrinox and water and sonicate in an ultrasonic bath for 20 minutes at 50^{o} C.
7. Use deionized water to rinse any Citrinox residue
8. After deionized water rinse of Citrinox solution, perform multiple rinses using small quantities of deionized water, and then air dry.

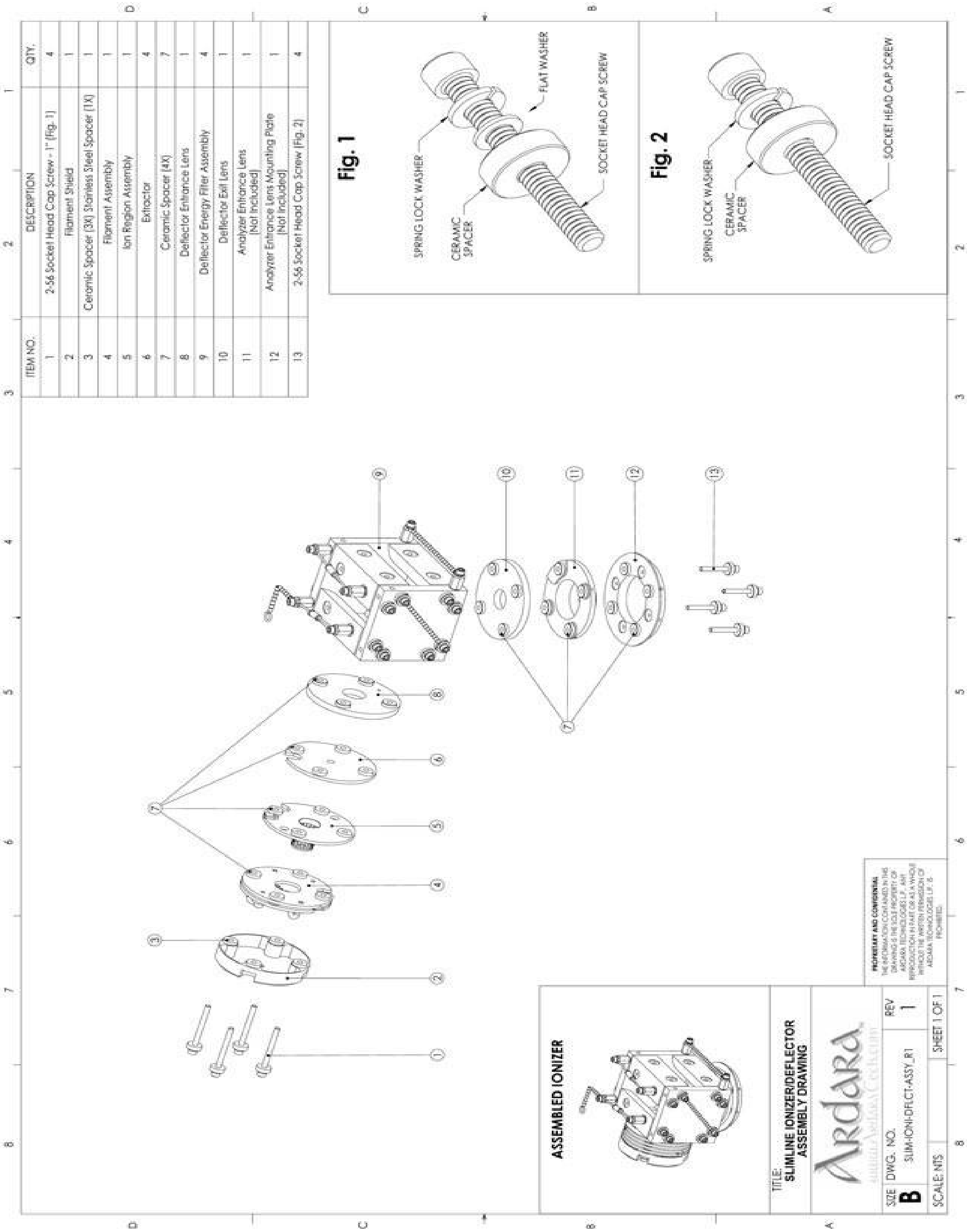
At this point the parts should be clean and free of organic residue. To verify, observe whether deionized water sheets or beads on the flat surface of the steel parts. If the water beads, as if it were on a freshly waxed car, then the part is still contaminated, and the cleaning procedure should be repeated. If the water sheets, as on a dirty car, then the part are clean.

Alternate drying schemes include blowing any residual water away with filtered oil-free air, or placing the parts in an oven.

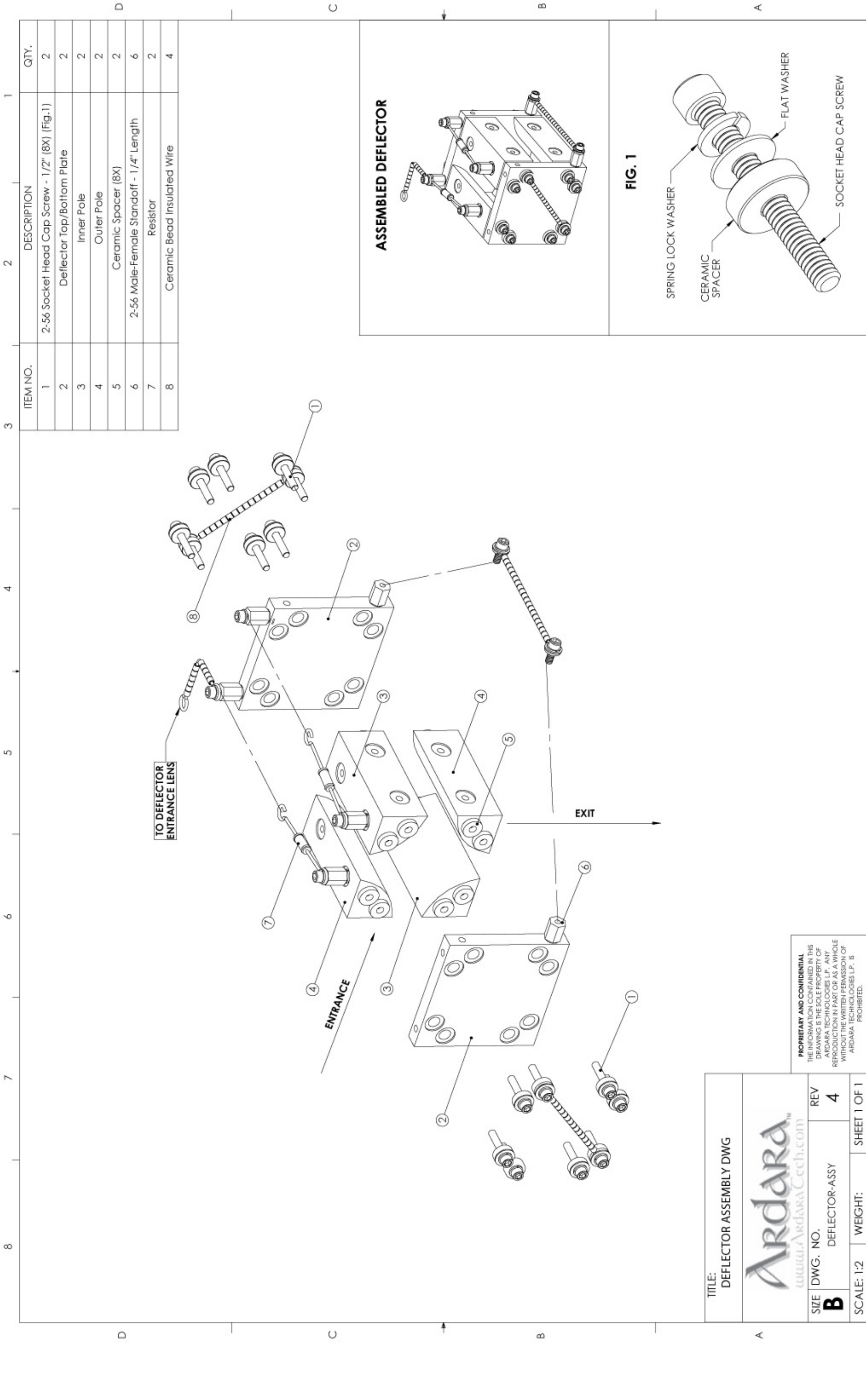
Still another alternative is to boil the parts in deionized water, and then air drying, using the residual heat of the parts to rapidly vaporize the water from the parts.

12.0 Appendices: Assembly Drawings

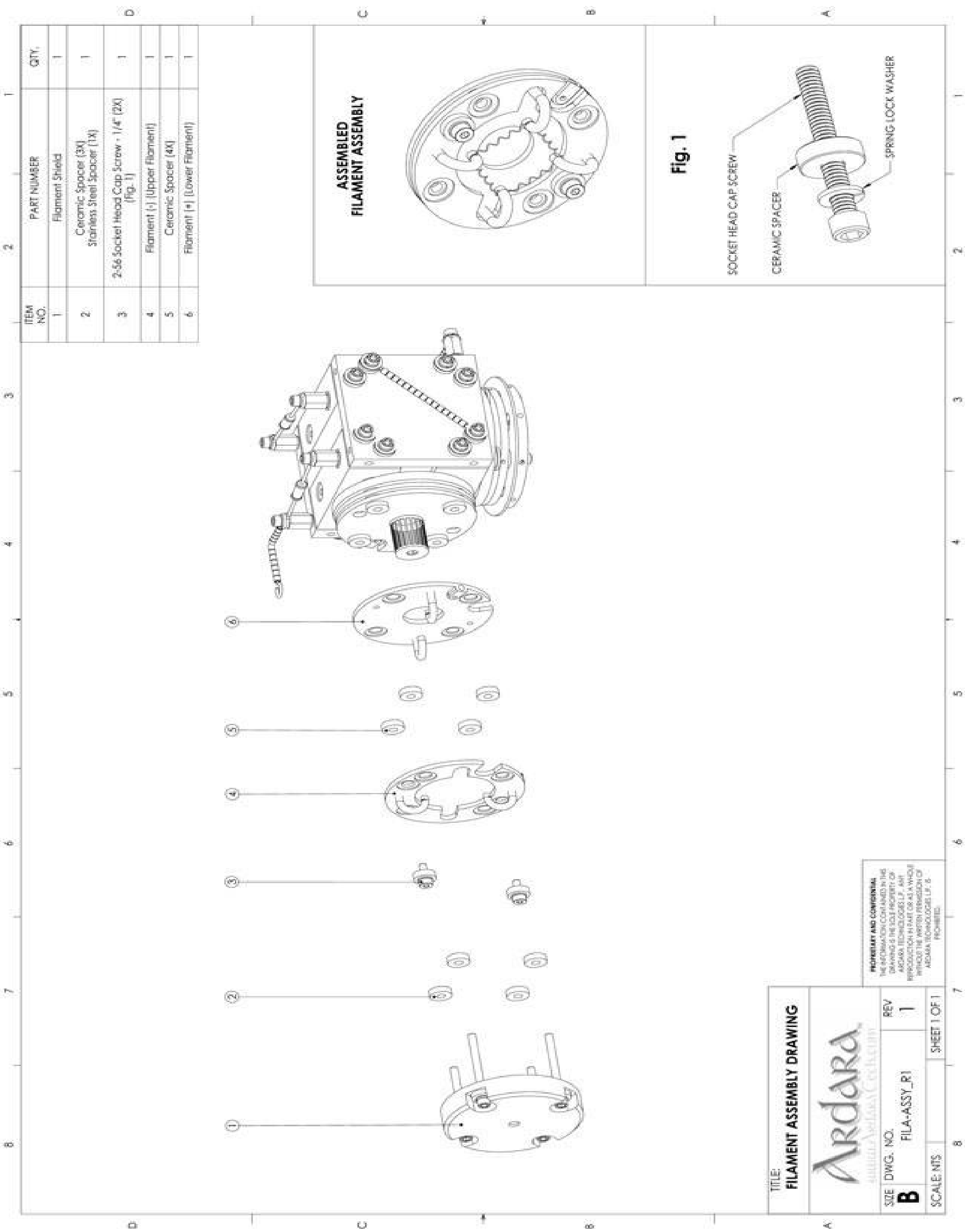
The following pages contain assembly drawings for the various components of the Cross Beam Ionizer.



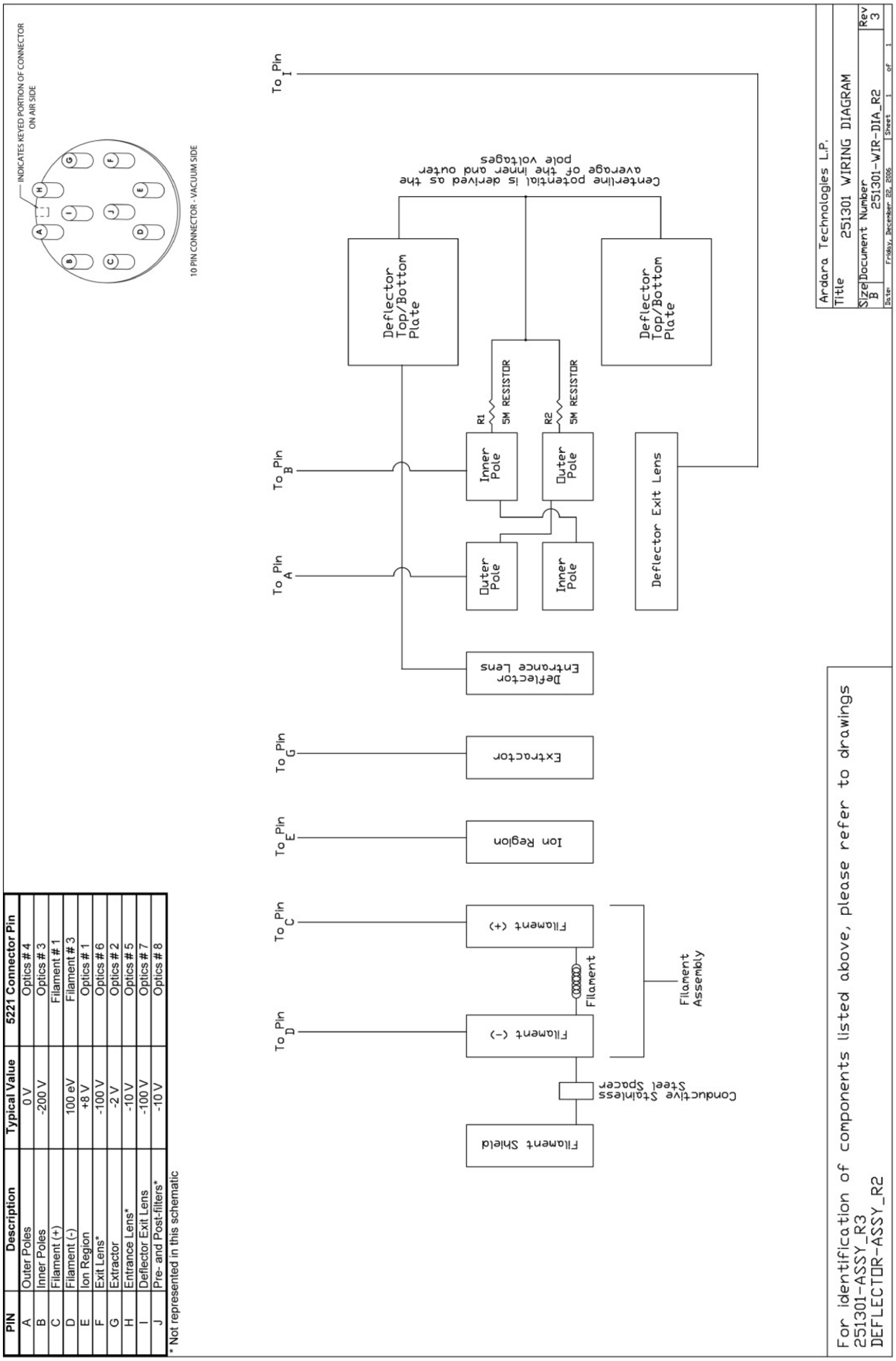
ITEM NO.	DESCRIPTION	QTY.
1	2-56 Socket Head Cap Screw - 1" (Fig. 1)	4
2	Filament Shield	1
3	Ceramic Spacer (3X) Stainless Steel Spacer (1X)	1
4	Filament Assembly	1
5	Ion Region Assembly	1
6	Extractor	4
7	Ceramic Spacer (4X)	7
8	Deflector Entrance Lens	1
9	Deflector Energy Filter Assembly	4
10	Deflector Exit Lens	1
11	Analyzer Entrance Lens (Not Included)	1
12	Analyzer Entrance Lens Mounting Plate (Not Included)	1
13	2-56 Socket Head Cap Screw (Fig. 2)	4



ITEM NO.	DESCRIPTION	QTY.
1	2-56 Socket Head Cap Screw - 1/2" (8X) (Fig.1)	2
2	Deflector Top/Bottom Plate	2
3	Inner Pole	2
4	Outer Pole	2
5	Ceramic Spacer (8X)	2
6	2-56 Male-Female Standoff - 1/4" Length	6
7	Resistor	2
8	Ceramic Bead Insulated Wire	4



ITEM NO.	PART NUMBER	QTY.
1	Filament Shield	1
2	Ceramic Spacer (3X) Stainless Steel Spacer (1X)	1
3	2-56 Socket Head Cap Screw - 1/4" (2X) (Fig. 1)	1
4	Filament (-) (Upper Filament)	1
5	Ceramic Spacer (4X)	1
6	Filament (+) (Lower Filament)	1



PIN	Description	Typical Value	5221 Connector Pin
A	Outer Poles	0 V	Optics # 4
B	Inner Poles	-200 V	Optics # 3
C	Filament (+)		Filament # 1
D	Filament (-)	100 eV	Filament # 3
E	Ion Region	+8 V	Optics # 1
F	Exit Lens*	-100 V	Optics # 6
G	Extractor	-2 V	Optics # 2
H	Entrance Lens*	-10 V	Optics # 5
I	Deflector Exit Lens	-100 V	Optics # 7
J	Pre- and Post-filters*	-10 V	Optics # 8

* Not represented in this schematic

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