



# TiTan™ ION PUMPS



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Ion pumps are used in a wide variety of high and ultra-high vacuum (UHV) environments. They can reach the lowest possible vacuum for an economical cost. In addition, ion pumps have some technical advantages over other technologies:

- Vibration Free Operation
- Low Maintenance
- Permanent Gas Capture
- Long Operational Life
- Low Operational Cost
- Pressure Indication
- Radiation Tolerance
- Non-contaminating Technology
- Bakeable

## SMALL ION PUMPS

(MINI - 75S)

Small ion pumps come in a wide variety of sizes and configurations. Gamma Vacuum maintains stock of the most common configurations for same-day delivery. These pumps have the added advantage that they can be mounted in any orientation without additional support.



## LOW PROFILE ION PUMPS

(100L - 1200LX)

Low Profile ion pumps are under 12 in. (300 mm) high for standard configurations. Custom built to each order, the closed magnetic loop of these pumps reduces the stray magnetic field created by the pump making these pumps ideal for any type of charged particle application.



## TALL PROFILE ION PUMPS

(150TV - 600TV)

Tall Profile ion pumps are designed for mounting in narrow locations and matching competitive dimensions. These pumps are built to order and designed to fit into locations where a Low Profile ion pump might not fit.



## TiTan™ ION PUMP CHARACTERISTICS

### Lifetime

All Gamma Vacuum ion pumps are designed to operate for 45,000 – 50,000 hours at  $1 \times 10^{-6}$  mbar. Lifetime increases linearly with decreased pressure. At  $1 \times 10^{-9}$ , for example, an ion pump can last for many years.

### Ultimate Pressure

Ion pumps are capable of reaching pressures below  $1 \times 10^{-10}$  mbar. Ultimate pressure of an ion pump is dictated by overall system conditions and materials.

### Vacuum Processing

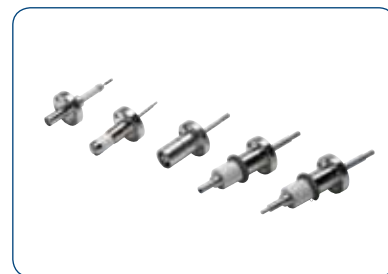
Ion pumps are shipped under vacuum at pressures less than  $1 \times 10^{-10}$  mbar. Certificates of conformance are provided and record all leak check points and pump characteristic values. RGA scans can be provided upon request.

### Port Configurations

Each ion pump can be configured with a variety of pumping port options. Additional ports are available in most designs on the top, bottom, or side and can accommodate TSP or non-evaporable getter (NEG) modules.

### Feedthroughs

Gamma Vacuum has standardized on the commercially available 10kV SHV feedthrough since 1996. For legacy purposes, alternate feedthroughs are available.



### Heaters

Integrated heaters can be added to ion pumps for economical and efficient baking.



### Cables

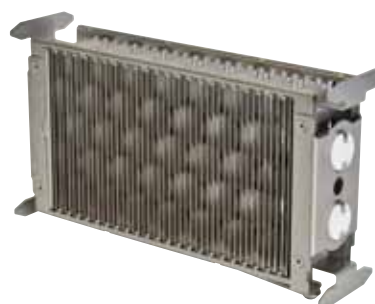
In addition to incorporating the SAFECONN interlock system, high voltage cables are made of flexible silicone materials that are bakeable and have high radiation tolerance.



## TiTan™ ION PUMP ELEMENTS

TiTan™ ion pump elements are “tuned” for specific pumping applications. Surfaces are chemically processed to remove potential surface contaminants and provide maximum adhesion for extended lifetime. Ceramics are optimally shielded to reduce exposure to sputtered material.

- TiTan™ CV (Conventional) – two titanium cathodes for high pumping speed of reactive gases.
- TiTan™ DI (Differential) – a titanium and tantalum cathode for maintained pumping speeds of reactive gases and long term stability of noble gases.
- TiTan™ TR – classic triode element for higher pressure operation



# TiTan™ ION PUMPS

## SPECIFICATIONS

## COMPATIBILITY

	SPEED (l/s)	INLET FLANGE(S)	DIMENSIONS mm (in.) (H x L x W, max)	Weight, kg (lbs)	SPC	LPCe	MPCe	TSP
<b>SMALL ION PUMPS</b>								
MINI	0.2	DN 16 (1.33 in.)	38 x 38 x 51 (1.5 x 1.5 x 2.0)	0.35 (0.8)	X			
3S	2 - 3	DN 16 (1.33 in.)	45 x 45 x 108 (1.8 x 1.8 x 4.3)	0.35 (0.8)	X			
10S	8 - 10	DN 35 (2.74 in.)	107 x 113 x 190 (4.2 x 4.4 x 7.5)	6 (13)	X			
25S	15 - 20	DN 35 (2.75 in.)	202 x 125 x 130 (8.0 x 4.9 x 5.1)	9 (20)	X			
45S	30 - 40	DN 35 (2.75 in.) DN 63 (4.5 in.)	209 x 251 x 130 (8.2 x 9.9 x 5.1)	16 (34)	X	X		
75S	40 - 75	DN 35 (2.75 in.) DN 63 (4.5 in.) DN 100 (6 in.)	277 x 242 x 130 (10.9 x 9.5 x 5.1)	19 (42)	X	X		
<b>LOW PROFILE ION PUMPS</b>								
100L	80 - 100	DN 100 (6 in.)	325 x 325 x 128 (13 x 13 x 5)	29 (62)		X	X	
200L	160 - 200	DN 150 (8 in.)	325 x 413 x 233 (13 x 16 x 9)	49 (108)		X	X	X
300L	240 - 300	DN 150 (8 in.)	325 x 413 x 337 (13 x 16 x 13)	66 (145)		X	X	X
400L	320 - 400	DN 150 (8 in.)	325 x 413 x 413 (13 x 16 x 16)	72 (159)			X	X
400LX	320 - 400	DN 150 (8 in.)	508 x 413 x 233 (20 x 16 x 9)	115 (253)			X	X
600L	480 - 600	DN 150 (8 in.)	325 x 513 x 513 (13 x 20 x 20)	103 (226)			X	X
600LX	480 - 600	DN 150 (8 in.)	508 x 413 x 336 (20 x 16 x 13)	115 (253)			X	X
800LX	640 - 800	DN 150 (8 in.)	508 x 413 x 413 (20 x 16 x 16)	124 (273)			X	X
1200LX	960-1200	DN 150 (8 in.) DN 200 (10 in.)	537 x 513 x 513 (21 x 20 x 20)	206 (452)			X	X
<b>TALL PROFILE ION PUMPS</b>								
150TV	120 - 150	DN 100 (6")	338 x 247 x 231 (14 x 10 x 9)	32 (70)		X	X	X
300TV	240 - 300	DN 100 (6")	345 x 450 x 231 (14 x 18 x 9)	65 (143)		X	X	X
600TV	480 - 600	DN 100 (6")	525 x 450 x 305 (21 x 18 x 12)	109 (243)			X	X

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# DIGITEL™ ION PUMP CONTROLLERS



# DIGITEL™ ION PUMP CONTROLLERS

The DIGITEL family of Ion Pump controllers offers the right balance of performance, power and protection.

## DIGITEL™ SPCe | Small Pump Controller

The SPCe is a versatile way to fully operate ion pumps 0.2 – 75 l/s. An LCD pressure/current/voltage display along with standard serial communications makes the SPCe able to accommodate the needs of basic and advanced users. Nano amp resolution provides gauging capabilities using the appropriate ion pump set-up.



## DIGITEL™ LPCe | Large Pump Controller

Ion pumps 100 l/s and larger require higher currents for starting and higher pressure operation. The LPCe supplies higher currents to a dedicated single ion pump (or up to four ion pumps in parallel) and has an easy-to-read touchscreen LCD display that simultaneously displays pressure, current, and voltage. Standard serial communications and eight set-points allow for easy system integration. The LPCe fits into any rack at just 3U high and 1/2 rack wide.



## DIGITEL™ MPCe | Multiple Pump Controller

### Ion Pump Control

Incorporating the same features as the LPCe, the MPCe allows for high current control of two ion pumps independently or up to four in parallel. At 3U high and a full rack in width, the MPCe is ideal for operating a wide variety of ion pump configurations on any system.



### TSP/NEG Control

A TSP or NEG can be fully operated from the LCD touchscreen of the MPCe. They can be fired manually or automatically based on the pressure of either ion pump the MPCe is monitoring. Timed modes also let the user have full control over exact parameters of operation. A single remote controller can operate up to eight TSP filaments or two NEG pumps.





### Ease of Use

Each DIGITEL™ has a highly visible display. The SPCe has an easy-to-read LCD that displays pressure, current and voltage. The LPCe and MPCe are each fully controlled with an intuitive touch panel LCD. Digital resolution down to 1nA is possible depending on pump size and current requirements.



### Operator Safety

The integrated SAFECONN high voltage interlock system eliminates electrical shocks and false positive pressure readings. The controller automatically shuts off high voltage when the cable is disconnected from the ion pump or controller end. The system is isolated and guarantees ground, high voltage, and safety connectivity that prevents accidental arcing.



### Communications

Serial communications (RS232, RS422, and RS485) are standard on all DIGITEL™ products. Optional Ethernet protocol for advanced facility and instrumentation communications is available on all units.



### Connectivity

Each DIGITEL™ has programmable analog and interlock capabilities. This allows for optimal flexibility when integrating with standard or legacy setpoint and analog monitoring systems.

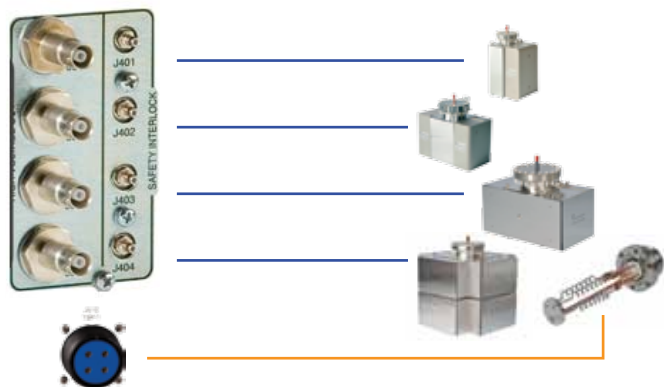
## DIGITEL™ Flexibility

The DIGITEL™ line is flexible enough to control a wide variety of ion pump and TSP/NEG configurations. The LPCe and MPCe can operate up to four ion pumps simultaneously or independent

operation of one or two ion pumps, respectively. The MPCe is capable of controlling one or two TSP/NEG cartridges independently.

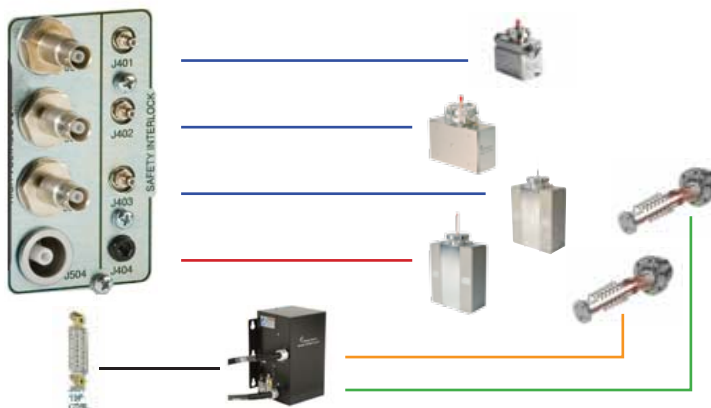
### Example Configuration 1

Four diode ion pumps in and Single TSP operation.



### Example Configuration 2

Three diode ion pumps, in parallel, one triode ion pump and Dual TSP/NEG operation.



## DIGITEL ION PUMP CONTROLLERS

SPECIFICATIONS	SPCe	LPCe	MPCe
<b>INPUT POWER</b>			
Voltage	90-240 vac or 24 vdc	90-130 or 200-240 volts	90-130 or 200-240 volts
Frequency	48-62 Hz	48-62 Hz	48-62 Hz
<b>OUTPUT POWER</b>			
Independent Outputs	1	1	1 or 2
Open Circuit Voltage	3000-7000 vdc (+/- configurable)	+/-5600 or 7000 vdc	+/-5600 or 7000 vdc
Current (maximum)	50 mA	100 mA	100 mA or 500 mA
Watts (maximum)	50	200	1000
Resolution	1 nA	1 nA	1 nA / 0.1 uA
<b>HIGH VOLTAGE CONNECTIONS</b>	One 10kV SHV or Fischer	1-4, 10kV SHV or Fischer	1-4, 10kV SHV or Fischer
<b>DISPLAY</b>			
Type	LCD	1/4 VGA touchscreen LCD	1/4 VGA touchscreen LCD
Readouts	Pressure, current, voltage, and programmable options	Pressure, current, voltage, and programmable options	Pressure, current, voltage, and programmable options
<b>ANALOG OUTPUTS</b>			
Voltage	linear, configurable	linear, configurable	linear, configurable
Current/Pressure	linear or logarithmic, configurable	linear or logarithmic, configurable	linear or logarithmic, configurable
<b>SETPOINTS</b>	One relay, one TTL	Four relay, four TTL	Four relay, four TTL
<b>COMMUNICATIONS</b>	Local/Remote/Full	Local/Remote/Full	Local/Remote/Full
	Ethernet	Ethernet	Ethernet
	Serial: 232, 422, 485	Serial: 232, 422, 485	Serial: 232, 422, 485
<b>CONFORMITY TO NORMS</b>	EN 55011 Class A, IEC 801-2	EN 55011 Class A, IEC 801-2	EN 55011 Class A, IEC 801-2
	EN 801-3, IEC 801-4, EN 61010-1	EN 801-3, IEC 801-4, EN 61010-1	EN 801-3, IEC 801-4, EN 61010-1
<b>WEIGHT, KG (LBS)</b>	1.5 (3.3)	16.8 (37)	16.8 (37) minimum 25.4 (56) maximum
<b>SIZE</b>	2U high, 1/4 rack wide 313 mm (12.3 in.) deep	3U high, 1/2 rack wide 438 mm (17.2 in.) deep	3U high, full rack wide 438 mm (17.2 in.) deep
<b>ADDITIONAL FEATURES</b>	SAFECONN	SAFECONN	SAFECONN
	AUTOSTART/AUTORUN	AUTOSTART/AUTORUN	AUTOSTART/AUTORUN
	High Voltage Enable	High Voltage Enable	High Voltage Enable
	Fowler-Nordheim Calibration		Remote TSP Control
	High-Pot Capability		
<b>COMPATIBILITY (l/s)</b>			
Mini/3S	X		
10-75	X	X	X
100-300		X	X
400-1200			X

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# TITANIUM SUBLIMATION PUMPING (TSP)



## TITANIUM SUBLIMATION PUMPING (TSP)

Titanium Sublimation Pumps (TSPs) are often used in combination with ion pumps or independently to remove reactive gases from the vacuum environment. Combined with an ion pump, the TSP allows for low ultimate pressures in a shorter amount of time. All TSP components are bakeable to 400 °C.

### TSP FILAMENT CARTRIDGE

The filament cartridge is mounted on a 2- 3/4" CFF (NW 35). The feedthrough supports three titanium-molybdenum filaments and a return path for ground isolation. Each filament contains 1.5 grams of usable titanium and averages 20 hours of operation.



### LIQUID CRYOSHROUD

The liquid cryoshroud consists of a double walled, type 304L stainless steel cylinder with two liquid nitrogen feedthroughs (.375 in. diameter) with flare type fittings. It provides 1578 cm<sup>2</sup> (245 in.<sup>2</sup>) of liquid nitrogen cooled surface area that provides pumping speeds up to 12,000 l/s for hydrogen (see table). The shroud is mounted on an 8 in. CFF (NW 150).



### AMBIENT SPUTTER SHIELD

The ambient sputter shield economically maximizes surface area when cooling is not practical or possible. It provides 827cm<sup>2</sup> (128 in.<sup>2</sup>) of ambient temperature surface area that provides pumping speeds up to 2200 l/s for hydrogen (see table). The shield is mounted on an 8 in. CFF (NW 150) or a 6 in. CFF (NW 100).



### DIGITEL™ TSP/NEG CONTROLLER

The TSP/NEG controller has an easy-to-read touchscreen LCD display that displays all manual or programmed firing parameters. Manual operation is as simple as pressing one button. Programming is just as easy by viewing all programming options on one screen. The TSP/NEG controller can operate up to 8 TSP filaments or 2 NEG pumps.





**Ease of Use**

The TSP/NEG and MPCe controllers are each fully controlled with an intuitive touch panel LCD.



**Filaments**

Each titanium molybdenum filament contains 1.5 grams of usable titanium and averages 20 hours of operation.



**Connectivity**

TSP/NEG cables have MS style connectors that are bakeable and radiation resistant.



**Safety**

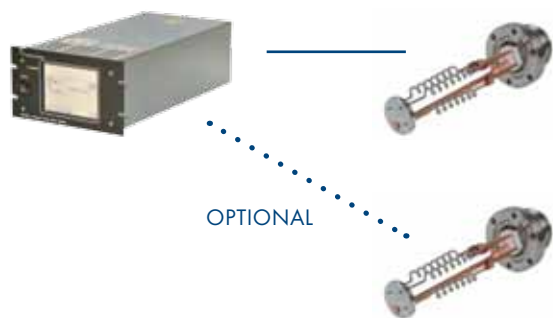
High currents travel over distances up to 10 meters through bakeable and radiation-resistant insulated and strain relief cabling.

**DIGITEL™ FLEXIBILITY**

The DIGITEL™ line is flexible enough to control a wide variety of ion pump and TSP configurations. The LPCe and MPCe can operate up to four ion pumps simultaneously or independent operation of one or two ion pumps respectively. The MPCe is capable of controlling one or two TSP/NEG cartridges independently from the Remote TSP/NEG controller or internal TSP (ITSP).

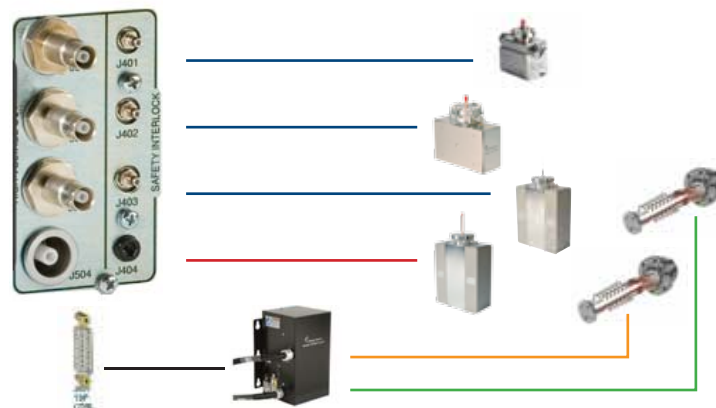
**Example Configuration 1**

Single or dual TSP operation from the TSP/NEG Controller.



**Example Configuration 2**

Three parallel diode ion pumps, one triode ion pump, and dual TSP/NEG operation from the MPCe.



## TSP/NEG CONTROLLER SPECIFICATIONS

SPECIFICATIONS		DIGITEL TSP/NEG	REMOTE TSP/NEG
INPUT POWER	Voltage	90-130 or 200-240 volts	90-130 or 200-240 volts
	Frequency	48-62 Hz	48-62 Hz
OUTPUT POWER	Independent Outputs	1	1
	Open Circuit Voltage	+17 vac	+17 vac
	Current (maximum)	55A	55A
	Watts (maximum)	800 (max)	800 (max)
	Resolution	0.1A	0.1A
HIGH CURRENT CONNECTIONS		1-2 MS Style, Configurable	1-2 MS Style, Configurable
DISPLAY	Type	1/4 VGA touchscreen LCD	1/4 VGA touchscreen LCD via MPCe
	Readouts	Current, on-time, and programmable options	Current, on-time, and programmable options via MPCe
ANALOG OUTPUTS	Voltage	linear configurable	linear configurable
	Current/Pressure	linear or logarithmic, configurable	linear or logarithmic, configurable
CONTROL MODES		Manual, programmed, or remote	Manual, programmed, or remote
COMMUNICATIONS		Local/Remote/Full	Local/Remote/Full via MPCe
		Ethernet	Ethernet via MPCe
		Serial: 232, 422, 485	Serial: 232, 422, 485 via MPCe
CONFORMITY TO NORMS		EN 55011 Class A, IEC 801-2	EN 55011 Class A, IEC 801-2
		EN 801-3, IEC 801-4, EN 61010-1	EN 801-3, IEC 801-4, EN 61010-1
WEIGHT, KG (LBS)		16.8 (37)	13.1 (29)
SIZE		3U high. 1/2 rack wide	293 x 219 x 130 mm (min)
		438 mm (17.2 in.) deep	(12 x 9 x 5 in)
			293 x 219 x 150 mm (max)
			(12 x 9 x 6 in)
ADDITIONAL FEATURES		TSP Enable	TSP Enable via MPCe

## TYPICAL TSP PUMPING SPEEDS

	AREA (cm <sup>2</sup> /in. <sup>2</sup> )	TEMPERATURE (°C)	H <sub>2</sub>		CO		H <sub>2</sub> O	
			RATE (L/S/CM <sup>2</sup> )	SPEED (L/S)	RATE (L/S/CM <sup>2</sup> )	SPEED (L/S)	RATE (L/S/CM <sup>2</sup> )	SPEED (L/S)
LIQUID CRYOSHROUD (8 in.)	709/110	20° C	2.6	1,843	8.2	5,814	7.3	5,176
	1578/245*	-195° C	17	12,053	11	7799	14.6	23,039
AMBIENT SPUTTER SHIELD (8 in.)	827/128	20° C	2.6	2,150	8.2	6,780	7.3	6,037
AMBIENT SPUTTER SHIELD (6 in.)	621/96	20° C	2.6	1,614	8.2	5,092	7.3	4,533

\*Applies to H<sub>2</sub>O speed only.

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# ION PUMPS

Ion pumps remove gases from their environment by turning them into solid materials.



## ION PUMP OPERATION

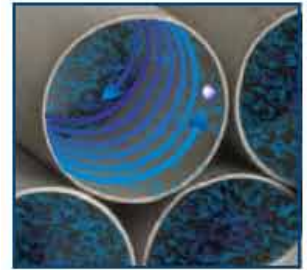
### Step 1: Create a high magnetic field

Permanent magnets located outside the vacuum are used to generate a strong magnetic field. This field is used to contain and guide electrons within circular anode rings.



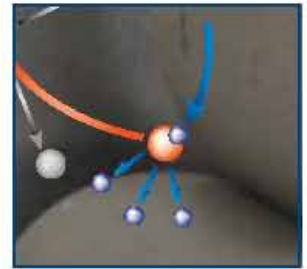
### Step 2: Generate a cloud of electrons

High voltage is applied to the element assembly after rough pumping. Electrons are pulled into the anode tube assembly, generate a cloud of spinning electrons, and become trapped by the high magnetic field.



### Step 3: Ionize gas molecules

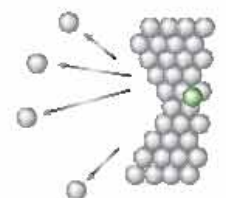
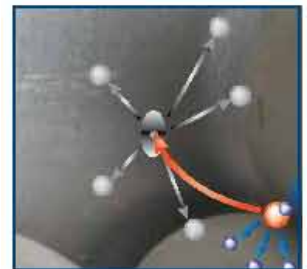
As gases move into the anode assembly, they are struck by electrons. Electrons are removed from the gas molecule's valence shell in the collision and the gas molecule now has a positive charge. This is called a positive ion. The positive ion is forced by the high voltage field at high velocity out of the anode tube toward the cathode plate.



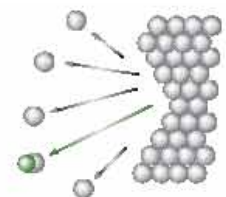
### Step 4: Capture gas ions

When the positive ion reaches the cathode plate, its velocity creates a physical impact called sputtering. Cathode materials are ejected toward the anode tube and the ion behaves in one of two ways:

- Chemical Reaction – reactive gas ions react with cathode materials and form new solid compounds. For example, an ionized oxygen molecule will take an electron from and readily react with a titanium cathode atom creating a solid titanium oxide.
- Physical Reaction – heavier gas ions, like argon, impact the cathode, acquire an electron, and bounce back (reflect) toward the anode assembly. These reflected ions are called high energy neutrals because they still have enough energy to implant themselves physically in pump surfaces and stop contributing to the vacuum environment pressure.



Ion implanted within cathode plate



Ion reflected as a high-energy neutral

## ION PUMP APPLICATIONS

TECHNOLOGY	ION PUMP SIZE (I/S)			
	.2 - 3	3 - 20	20 - 75	100+
<b>INDUSTRY AND MEDICAL PROCESSES</b>				
RADAR	X			
TRAVELING WAVE TUBES (TWT)	X			
KLYSTRONS	X			
X-RAY TUBE EVACUATION	X	X		
X-RAY SOURCES	X	X		
TREATMENT & DIAGNOSTICS		X	X	
<b>SEMICONDUCTOR</b>				
CRITICAL DIMENSION SEM (CD SEM)		X	X	
LITHOGRAPHY			X	X
<b>INSTRUMENTATION</b>				
ELECTRON MICROSCOPES (SEM/TEM)		X	X	
FOCUSED ION BEAM (FIB)		X	X	
SCANNING PROBE MICROSCOPE (SPM)		X	X	X
SURFACE ANALYSIS (AES, XPS, SIMS, EDX)			X	X
MASS SPECTROMETRY (MS)			X	X
MOLECULAR BEAM EPITAXY (MBE)			X	X
<b>HIGH ENERGY PHYSICS</b>				
ACCELERATORS			X	X
BOOSTERS			X	X
STORAGE RINGS			X	X
FRONT ENDS			X	X
BEAM LINES			X	X
END STATIONS			X	X
FREE ELECTRON LASERS (MBE)			X	X
LASER INTERFEROMETERS			X	X



Industry and Medical Processes



Semiconductor



Instrumentation



High Energy Physics

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