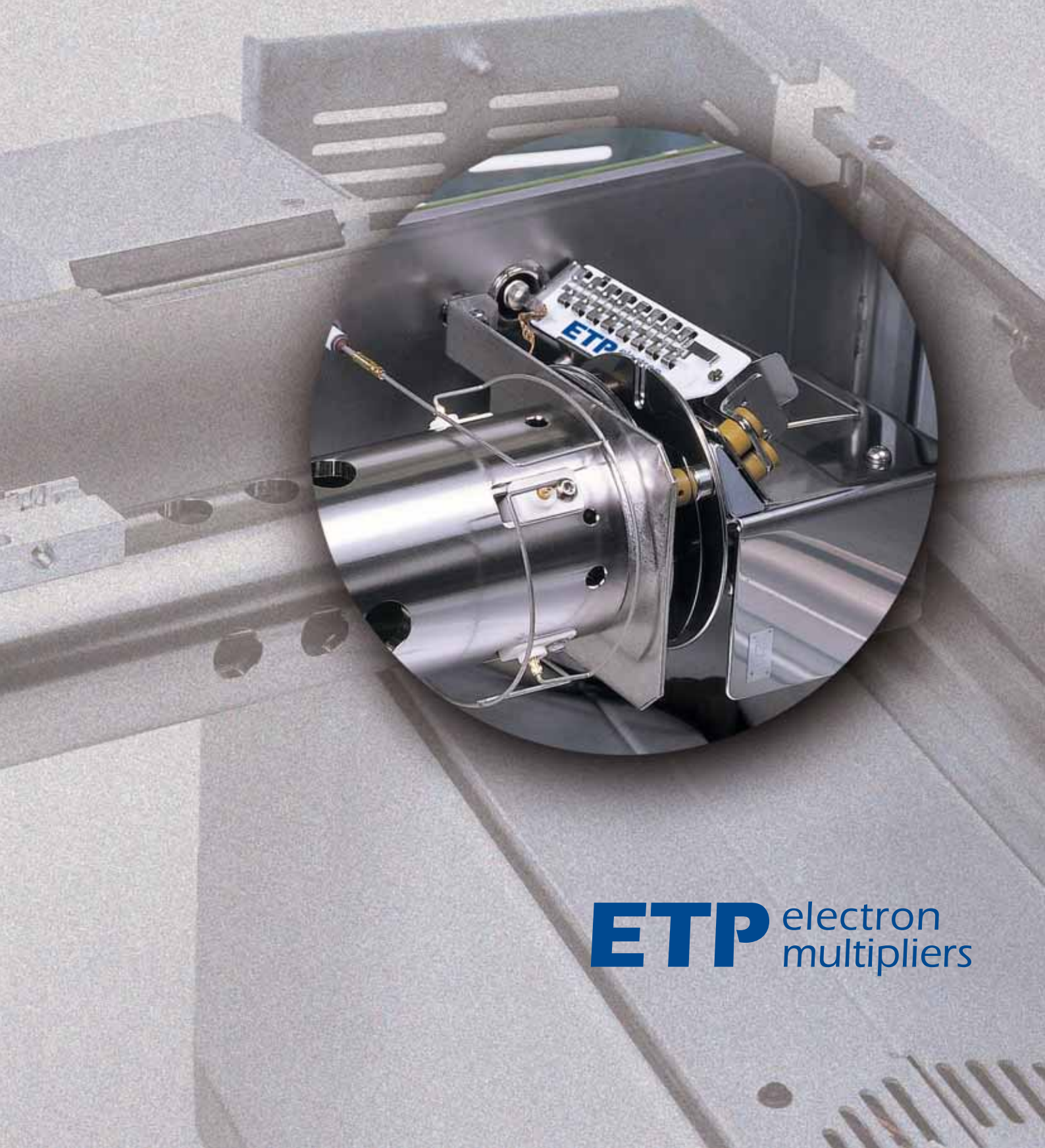


ELECTRON MULTIPLIERS FOR MASS SPECTROMETRY



ETP electron
multipliers

How Electron Multipliers Work

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An electron multiplier is used to detect the presence of ion signals emerging from the mass analyzer of a mass spectrometer. It is essentially the ‘eyes’ of the instrument (see **Figure 1**). The task of the electron multiplier is to detect every ion of the selected mass passed by the mass filter. How efficiently the electron multiplier carries out this task represents a potentially limiting factor on the overall system sensitivity. Consequently the performance of the electron multiplier can have a major influence on the overall performance of the mass spectrometer.

The basic physical process that allows an electron multiplier to operate is called secondary electron emission. When a charged particle (ion or electron) strikes a surface it causes secondary electrons to be released from atoms in the surface layer. The number of secondary electrons released depends on the type of incident primary particle, its energy and characteristic of the incident surface (see **Figure 2**).

There are two basic forms of electron multipliers that are commonly used in mass spectrometry: the discrete-dynode electron multiplier, and the continuous-dynode electron multiplier (often referred to as a channel electron multiplier or CEM). All ETP electron multipliers are of the discrete-dynode type (see **Figure 3**).

A typical discrete-dynode electron multiplier has between 12 and 24 dynodes and is used with an operating gain of between 10^4 and 10^8 , depending on the application. In GC-MS applications, for example, the electron multiplier is typically operated in analog mode with a gain of around 10^5 . For a new electron multiplier this gain is typically achieved with an applied high voltage of ~1400 volts.

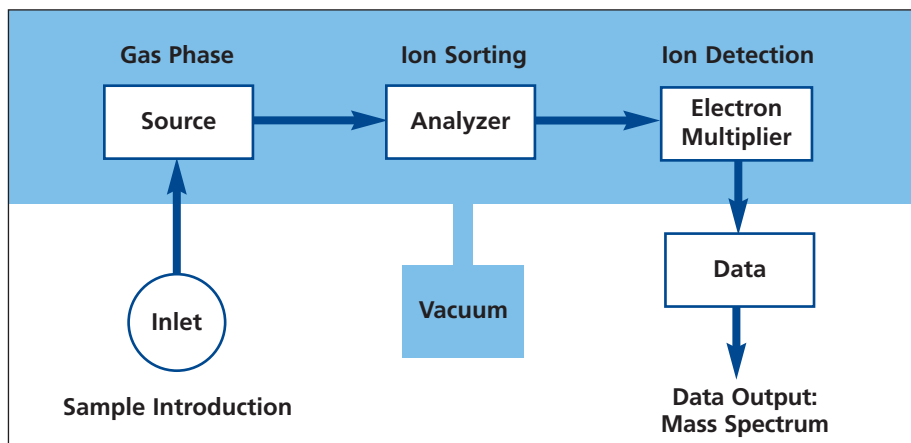
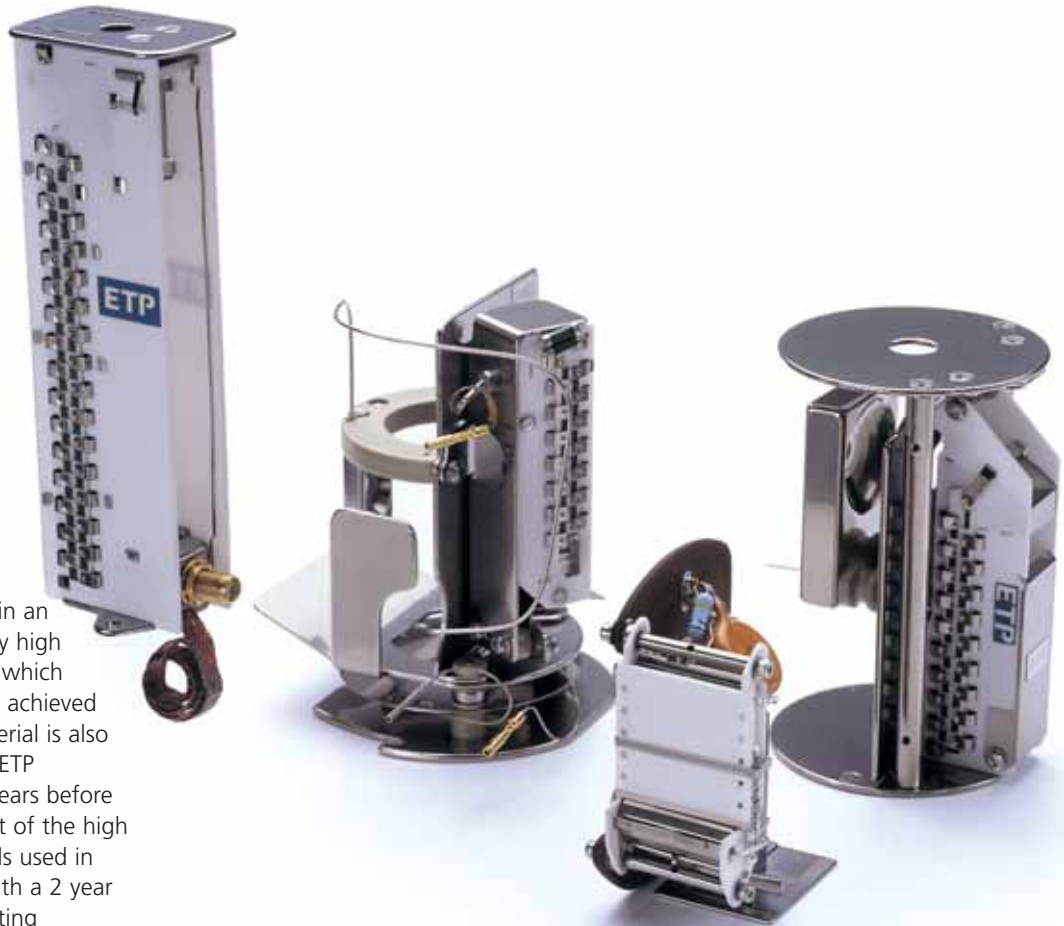


Figure 1. Components of Mass Spectrometry. The general layout of a mass spectrometer consists of the following elements; Sample introduction and separation system, Ion source, Mass analyzer, Ion detection system, Data processing.



Features of ETP Electron Multipliers

The electron multipliers manufactured by ETP use a proprietary dynode material. This material has a number of properties that make it very suitable for use in an electron multiplier. It has very high secondary electron emission, which allows exceptional gain to be achieved from each dynode. This material is also very stable in air. In fact, an ETP multiplier can be stored for years before being used. As a direct result of the high stability of the active materials used in ETP multipliers, they come with a 2 year shelf life warranty. Many testing laboratories take advantage of this long shelf life by keeping a replacement ETP multiplier on hand, ready for immediate installation. This keeps the instrument down time to a minimum.

ETP Electron Multipliers:

- Proprietary specialized surface material resulting in very high secondary electron emission
- Air stable
- 2 year shelf life guarantee
- Discrete dynode design results in extended operating life

For a typical ETP electron multiplier for GC-MS, the total active dynode surface area is ~1000mm². This can be compared to a standard continuous-dynode multiplier that has a total channel surface area of only around 160mm² (for a channel with 1mm diameter and 50mm length). This increased surface area spreads out the 'work-load' of the electron multiplication process over a larger area, effectively slowing the aging process and improving operating life and gain stability.

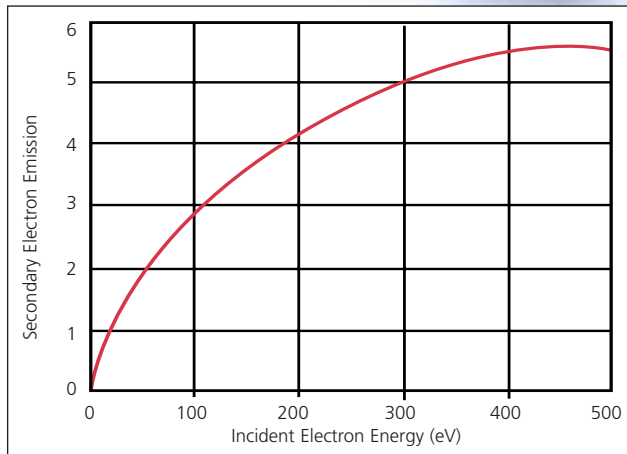


Figure 2. Secondary Electron Emission. The average number of secondary electrons emitted from the surface of an ETP electron multiplier plotted against the energy of the incident primary electron.

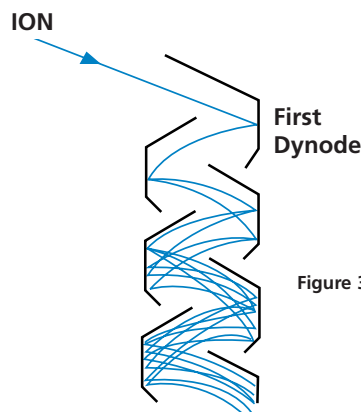


Figure 3. Ion-optics of an ETP discrete-dynode electron multiplier showing the electron gain at each successive dynode. This electron cascading process results in gains up to 10⁸ being achieved with ~21 dynodes.

Improved Linearity of the Agilent 5973 with the ETP 14617 Electron Multiplier

The exceptional sensitivity of the the Agilent 5973 MSD system often results in reduced system linearity due to the limitation of the electron multiplier supplied as original equipment. The ETP 14617 detector system from SGE overcomes this limitation as demonstrated in identical performance comparisons undertaken at independent laboratories.

Detector Design

The new ETP detector combines innovations in both ion optics and dynode materials to enhance sensitivity and linear system response. The 5973 MSD incorporates a high energy conversion dynode (HED) to convert incoming ions to electrons. Electrons are then input to the detector for further amplification.

Detailed analysis reveals that conventional HED systems do not take full advantage of the technology. For example, ion detection efficiencies for 500amu ions are typically limited to between 45% and 70%. Sophisticated ion optics modelling has been used to develop a focused conversion dynode for more efficient collection of incoming ions and subsequent transfer of secondary electrons to the electron multiplier. **Figure 1** illustrates the ion optical design of the new detector.

Discrete-dynode technology allows fabrication of dynodes incorporating different materials depending upon anticipated electron flux exposure. This, in turn, allows a detector to be designed for maximum output current linearity while also improving detection efficiency and operational lifetime. The new ETP detector incorporates several different materials along the dynode chain, which has resulted in significantly improved performance.

Performance Comparison

EPA Method 8270 was used to compare the performance of the original manufacturer-supplied detector with the ETP 14617. **Figure 2** displays data taken for Tetrachlorophenol. As shown, linearity improvement greater than 250% over the original detector was achieved. Similar results were obtained with other compounds using the same methodology.

ETP's new electron detector for the Agilent 5973 MSD significantly improves system performance for high concentration samples. The combination of a focused HED and multiple dynode materials improves both efficiency and operational lifetime.

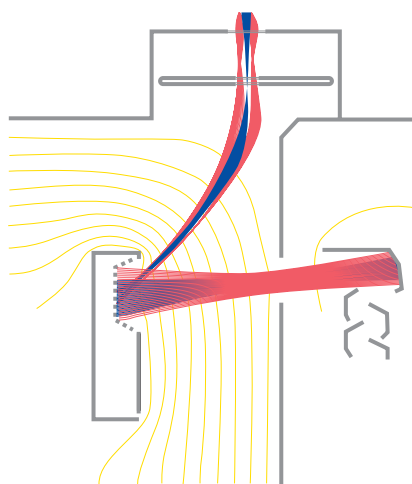


Figure 1. Ion/electron optical design of the ETP 14617 electron multiplier detector.

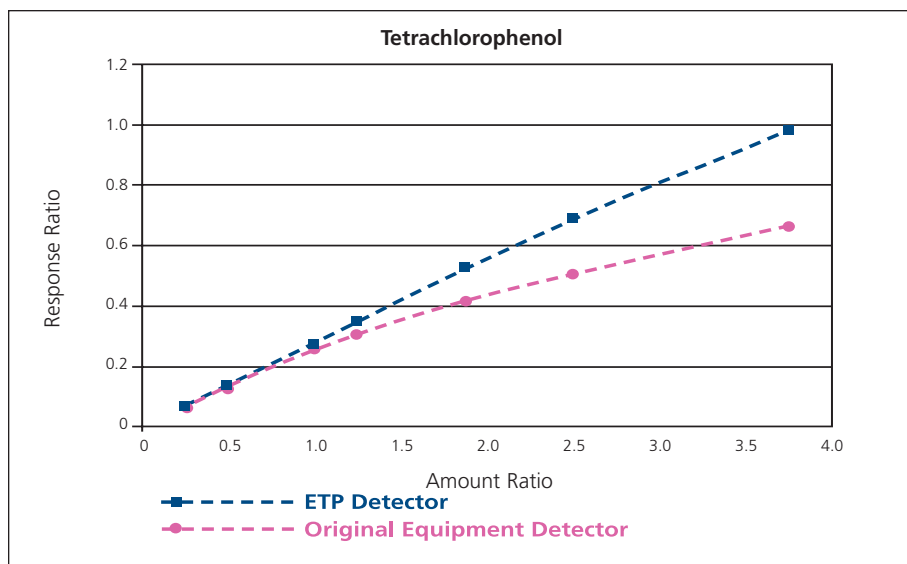
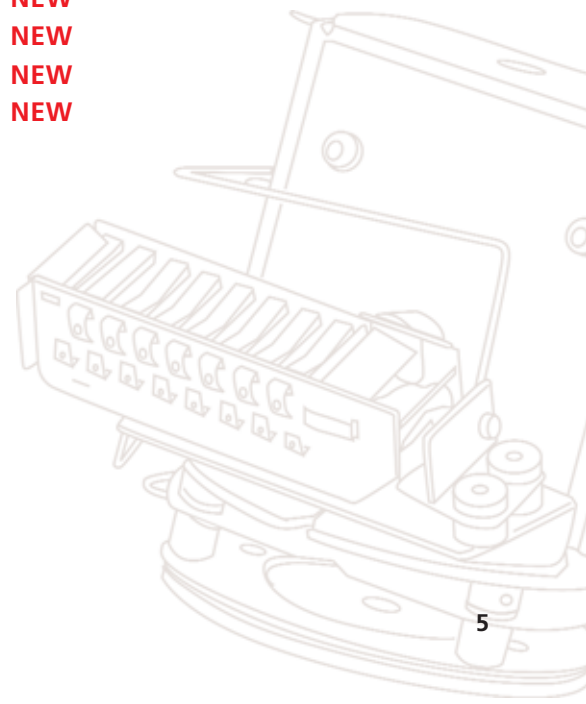


Figure 2. Detector Response Comparison for Tetrachlorophenol.

GC-MS & LC-MS

Instrument	Analyzer Type	Technique	Part No.
Agilent Technologies (HP)			
5970 (All)	Quadrupole	GC-MS	14511
5971, 5972, GCD	Quadrupole	GC-MS	14516
5973 (For initial installation - includes mount)	Quadrupole	GC-MS	14617
5973 (Replacement multiplier)	Quadrupole	GC-MS	14616
5988 ± ions	Quadrupole	GC-MS / LC-MS	14612
5988 + ions only	Quadrupole	GC-MS / LC-MS	14512
5989 (HED) (For initial installation - includes mount)	Quadrupole	GC-MS / LC-MS	14627
5989 (Replacement multiplier)	Quadrupole	GC-MS / LC-MS	14625
5989 (No HED)	Quadrupole	GC-MS / LC-MS	14613
599x	Quadrupole	GC-MS	14511
LC-MSD (For initial installation - includes mount)	Quadrupole	LC-MS	14639 * NEW
LC-MSD (Multiplier only)	Quadrupole	LC-MS	14616 * NEW
Applied Biosystems (Sciex)			
API 2000	Quadrupole	LC-MS	14610
API 300, 3000 & 4000	Quadrupole	LC-MS	14636 * NEW
Inficon			
Auditor	Quadrupole	GC-MS	14532
JEOL			
AX, HX, SX Series	Magnetic Sector	Multiple	14185
Kratos			
MS25, MS50 & MS80	Magnetic Sector	Multiple	14132
PerkinElmer			
Ion Trap GC-MS	Ion Trap	GC-MS	14138
Q-Mass	Quadrupole	GC-MS	14532
Thermo Finnigan			
Trace DSQ (For initial installation - includes mount)	Quadrupole	GC-MS	14635 * NEW
Trace DSQ (Multiplier only)	Quadrupole	GC-MS	14633 * NEW
Polaris-Q (For initial installation - includes mount)	Ion Trap	GC-MS	14640 * NEW
Polaris-Q (Multiplier only)	Ion Trap	GC-MS	14633 * NEW
4000 (PPINCI) Incos 50	Quadrupole	GC-MS	14139
Bench-top ion traps (pre-GCQ)	Ion Trap	GC-MS	14138
Varian			
Saturn (Pre-2000)	Ion Trap	GC-MS	14138
Saturn 2000, 2100 & 2200	Ion Trap	GC-MS	14147

*Available in 2005.



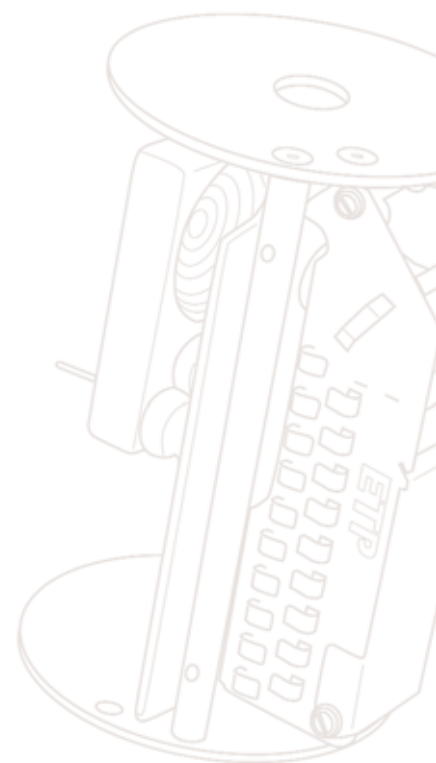
PRODUCT SELECTION

ICP-MS

Instrument	Analyzer Type	Part No.
Agilent Technologies (HP)		
4500	Quadrupole	14573
7500	Quadrupole	14222
PE-Sciex		
ELAN 5000	Quadrupole	14570
ELAN 5000A	Quadrupole	14571
ELAN 6000/6100	Quadrupole	14210
Sciex/PE-Sciex		
ELAN 500	Quadrupole	14561
Thermo Elemental		
PQ (12-12 rods)	Quadrupole	14562
PQ (SXP rods)	Quadrupole	14562A
PQ-3, Excel (sequential)	Quadrupole	14562A
PQ-3, Excel (simultaneous)	Quadrupole	14214
Thermo Jarrell Ash		
POEMS	Quadrupole	14574
Varian		
UltraMass	Quadrupole	14566
VG Elemental		
Genesis	Quadrupole	14568H

MAGNETIC SECTOR

Instrument	Analyzer Technique	Part No.
Cameca		
SIMS 3F, 4F	SIMS	14133
JEOL		
AX, SX Series	Multiple	14185
Kratos		
MS25, MS50, MS80	Multiple	14132
Thermo Finnigan MAT		
MAT 261	Thermal Ionization	14131
VG Analytical		
ZAB, 7070 Series	Multiple	14130



SELECTION BY INSTRUMENT

Manufacturer	Instrument	Analyzer Type	Technique	Part No.
Agilent Technologies (HP)	4500	Quadrupole	ICP-MS	14573
	5973 (For initial installation - includes mount)	Quadrupole	GC-MS	14617
	5973 (Replacement multiplier)	Quadrupole	GC-MS	14616
	5970 (All)	Quadrupole	GC-MS	14511
	5971, 5972, GCD	Quadrupole	GC-MS	14516
	5988 + ions only	Quadrupole	GC-MS / LC-MS	14512
	5988 ± ions	Quadrupole	GC-MS / LC-MS	14612
	5989 (HED) (For initial installation - includes mount)	Quadrupole	GC-MS / LC-MS	14627
	5989 (Replacement multiplier)	Quadrupole	GC-MS / LC-MS	14625
	5989 (No HED)	Quadrupole	GC-MS / LC-MS	14613
	599x	Quadrupole	GC-MS	14511
	7500	Quadrupole	ICP-MS	14222
	LC-MSD (For initial installation - includes mount)	Quadrupole	LC-MS	14639 *
	LC-MSD (Multiplier only)	Quadrupole	LC-MS	14616 *
Applied Biosystems (Sciex)	API 2000	Quadrupole	LC-MS	14610
	API 300, 3000 & 4000	Quadrupole	LC-MS	14636 *
Bruker	Various TOF	TOF	TOF-MS	14820
Cameca	SIMS 3F & 4F	Magnetic Sector	SIMS	14133
CaSE/P.K. Morgan Medical	Respiratory Gas Analysis	Quadrupole	RGA	14134
Comstock	MiniTOF	TOF	MALDI-TOF	14824
Inficon	Auditor	Quadrupole	GC-MS	14532
JEOL	AX, SX Series	Magnetic Sector	Multiple	14185
Kratos	Kompact MALDI (I-IV)	TOF	MALDI-TOF	14820
	MS25, MS50 & MS80	Magnetic Sector	Multiple	14132
PerkinElmer	Ion Trap GC-MS	Ion Trap	GC-MS	14138
	Q-Mass	Quadrupole	GC-MS	14532
PE-Sciex	ELAN 500	Quadrupole	ICP-MS	14561
	ELAN 5000	Quadrupole	ICP-MS	14570
	ELAN 5000A	Quadrupole	ICP-MS	14571
	ELAN 6000/6100	Quadrupole	ICP-MS	14210
Senser/Larson-Davis	TOF 2000	TOF	TOF-MS	14823H
Thermo Elemental	PQ (12-12 rods)	Quadrupole	ICP-MS	14562
	PQ (SXP rods)	Quadrupole	ICP-MS	14562A
	PQ-3, Excel (sequential)	Quadrupole	ICP-MS	14562A
	PQ-3, Excel (simultaneous)	Quadrupole	ICP-MS	14214
Thermo Finnigan	Trace DSQ (For initial installation - includes mount)	Quadrupole	GC-MS	14635 *
	Trace DSQ (Multiplier only)	Quadrupole	GC-MS	14633 *
	Polaris-Q (For initial installation - includes mount)	Ion Trap	GC-MS	14640 *
	Polaris-Q (Multiplier only)	Ion Trap	GC-MS	14633 *
	4000 (PPINCI) Incos 50	Quadrupole	GC-MS	14139
	Bench-top ion trap (pre-GCQ)	Ion Trap	GC-MS	14138
Thermo Finnigan MAT	MAT 261	Thermal Ionization	Multiple	14131
Thermo Jarrell Ash	POEMS	Quadrupole	ICP-MS	14574
Varian	Saturn (pre-2000)	Ion Trap	GC-MS	14138
	Saturn 2000, 2100 & 2200	Ion Trap	GC-MS	14147
	UltraMass	Quadrupole	ICP-MS	14566
VG Analytical	ZAB, 7070 Series	Magnetic Sector	Multiple	14130
VG Elemental	Genesis	Quadrupole	ICP-MS	14568H

For the complete listing of specialized research and development multipliers, visit the OEM section at www.etpsci.com. ETP Multipliers for other major MS systems are available on request
*Available in 2005.

ETP electron multipliers

A division of The SGE Group



For the latest ETP product listing, technical information and on-line ordering visit www.etpsci.com

SGE International Pty. Ltd.

Toll Free: 1800 800 167
Tel: +61 (0) 3 9837 4200
Fax: +61 (0) 3 9874 5672
Email: support@sge.com

SGE, Incorporated (USA)

Toll Free: (800) 945 6154
Tel: (512) 837 7190
Fax: (512) 836 9159
Email: usa@sge.com

SGE Japan Inc.

Tel: +81 45 222 2885
Fax: +81 45 222 2887
Email: japan@sge.com

SGE Europe Ltd (UK)

Tel: (0) 1908 568 844
Fax: (0) 1908 566 790
Email: uk@sge.com

SGE Italia Srl.

Tel: 06 4429 0206
Fax: 06 4429 0724
Email: sge.italia@tin.it

SGE India

Tel: +91 (022) 2471 5896
Fax: +91 (022) 2471 6592
Email: sgeindia@vsnl.com

SGE Europe (France)

Tel: +33 (0) 1 6929 8090
Fax: +33 (0) 1 6929 0925
Email: france@sge.com

SGE GmbH (Germany)

Tel: +49 (0) 6151 860486
Fax: +49 (0) 6151 860489
Email: germany@sge.com

SGE China

Tel: +86 (10) 6588 8666
Fax: +86 (10) 6588 6577

Product Warranty

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