

Molecular Beam



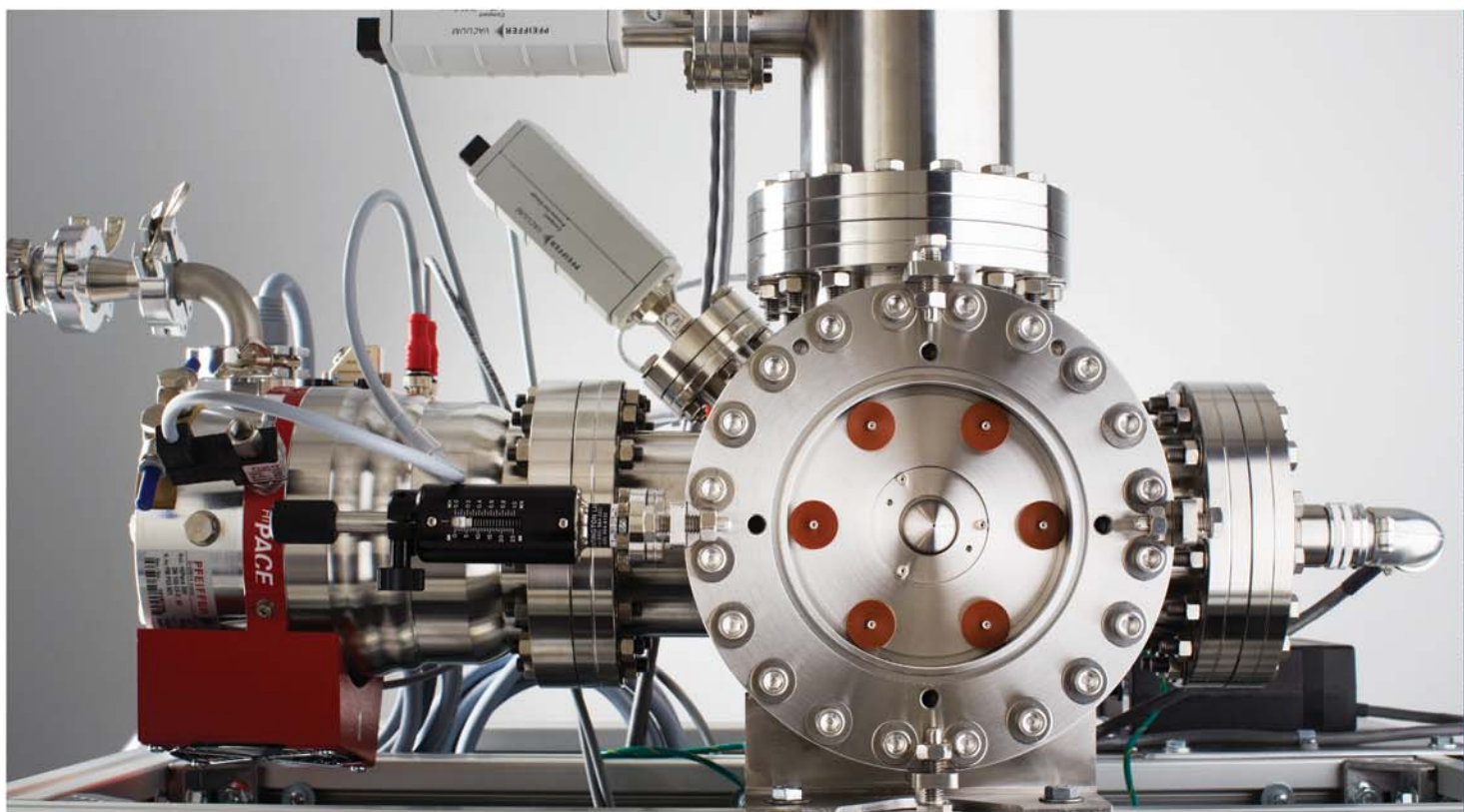
VeraSpec™
MB

P R O D U C T N O T E



VeraSpec™ MB2 and MB3

P R O D U C T N O T E



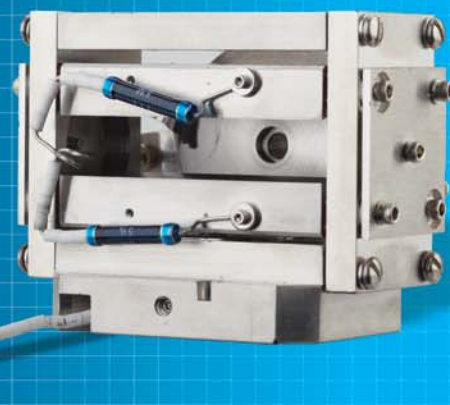
Extrel is widely respected for the quality of mass spectrometer systems that are available to the world's top research scientists. In response to increasing requests for complete turn-key systems built around their well-respected quadrupole mass spectrometer technology, Extrel has introduced the VeraSpec™ line of research grade mass spectrometer systems.

The Extrel VeraSpec™ MB2 and VeraSpec™ MB3 molecular beam mass spectrometer systems are compact systems, which utilize a 2- or 3-stage skimmer inlet with interstage optics for the analysis of gases and ions, including from plasma, from 2 mTorr up to pressures greater than one atmosphere.

With appropriate apertures, fast and accurate measurement of positive ions, negative ions, and neutral species directly from the sample is accomplished. Neutral species detection can be extended to include radicals, with fragment identification, via threshold ionization (appearance potential studies) and dissociative electron attachment ionization. Configured with the optional beam chopper and lock-in amplifier, the signal-to-noise ratio can be significantly improved.



Extrel VeraSpec™ MB systems feature our crossbeam deflector ionizer (below) and can be customized with a chopper and lock-in amplifier (left)



Applications:

- Medium and high pressure plasma diagnostics
- Plasma Enhanced Chemical Vapor Deposition (PECVD)
- Low Pressure Chemical Vapor Deposition (LPCVD)
- Plasma Etch
- Atmospheric Chemistry
- Effusive gas source analysis

System Highlights:

VeraSpec™ MB2

- Sampling from source pressures of 2 mTorr to 100 Torr
- Biasable first aperture with a diameter of 100 μm to 3 mm depending on source pressure

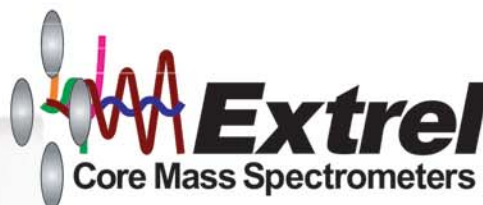
VeraSpec™ MB3

- Sampling from source pressures of 100 Torr to 2 atm
- Biasable first aperture or sampling tube depending on source pressure

MB2 and MB3

Cross Beam Deflector Ionizer deflects ions 90° off-axis, separating ions from common background noise sources such as photons, metastables, particulates, and molecular beam gases.

- Analog and positive ion counting
- Negative ion/electron attachment option
- Signal gating option (beamchopper and lock-in amplifier)
- Merlin Automation™ data system



Molecular Beam Sampling for Gas Analysis

The power of mass spectrometry as an analytical technique is well known, and mass spectrometers have been widely used for residual gas analysis. However, for samples that are not a residual gas contained in the mass spectrometer vacuum chamber, an effective sampling arrangement must be used. Among the possibilities, molecular beam sampling is an effective way to introduce neutral gas or pre-formed ion samples over a wide range of sample conditions. Three molecular beam systems are available to suit the broadest application requirements: the VeraSpec™ MB2, VeraSpec™ MB3, and VeraSpec™ MBx. The MB2 and MB3 systems are 2- and 3-stage molecular beam inlet systems, designed for analysis of neutrals or ions from 2 mTorr up to 2 atm. These systems are ideal for plasma diagnostics, chemical vapor deposition, and other similar applications. The MBx system is a 3-stage discretely pumped gas analysis system for extreme samples. All systems can be modified for an even broader range of sample conditions with the help of Extrel's experienced engineers and application scientists.



MAX Performance

The heart of a VeraSpec™ MB system is Extrel's MAX Series flange mounted quadrupole mass spectrometer system. The MAX system consists of a mass spectrometer probe, including an electron impact ionizer, tri-filter quadrupole mass filter, and electron multiplier detector, the MAX-CS mass spectrometer Control System, and MAX-QCi integrated Quadrupole Control system. The 19 mm

tri-filter quadrupole, with precision machined rod set, RF-only pre- and post-filter stages, and stabilizing rods, combine with the CS control system and the QCi quadrupole control RF supply to deliver excellent transmission, resolution and abundance sensitivity characteristics at all mass ranges. The whole system is operated via Extrel's Merlin Automation™ data system software.

Table 1:
MAX System Mass Range and Performance

System with 19 mm (3/4") tri-filter	Operating Frequency	Mass Range	Relative Transmission	Resolution (M/ Δ M FWHM)	General Sensitivity (mA/Torr)
MAX-4000HT	440 kHz	4-4000	50%	1500	0.75
MAX-1000	880 kHz	1-1000	50%	1800	1
MAX-500HT	1.2 MHz	1-500	60%	2000	2
MAX-120	2.1 MHz	1-120	65%	2500	3
MAX-50	2.9 MHz	1-50	75%	3000	4

Performance shown here are minimum production requirements. Actual performance is typically better.

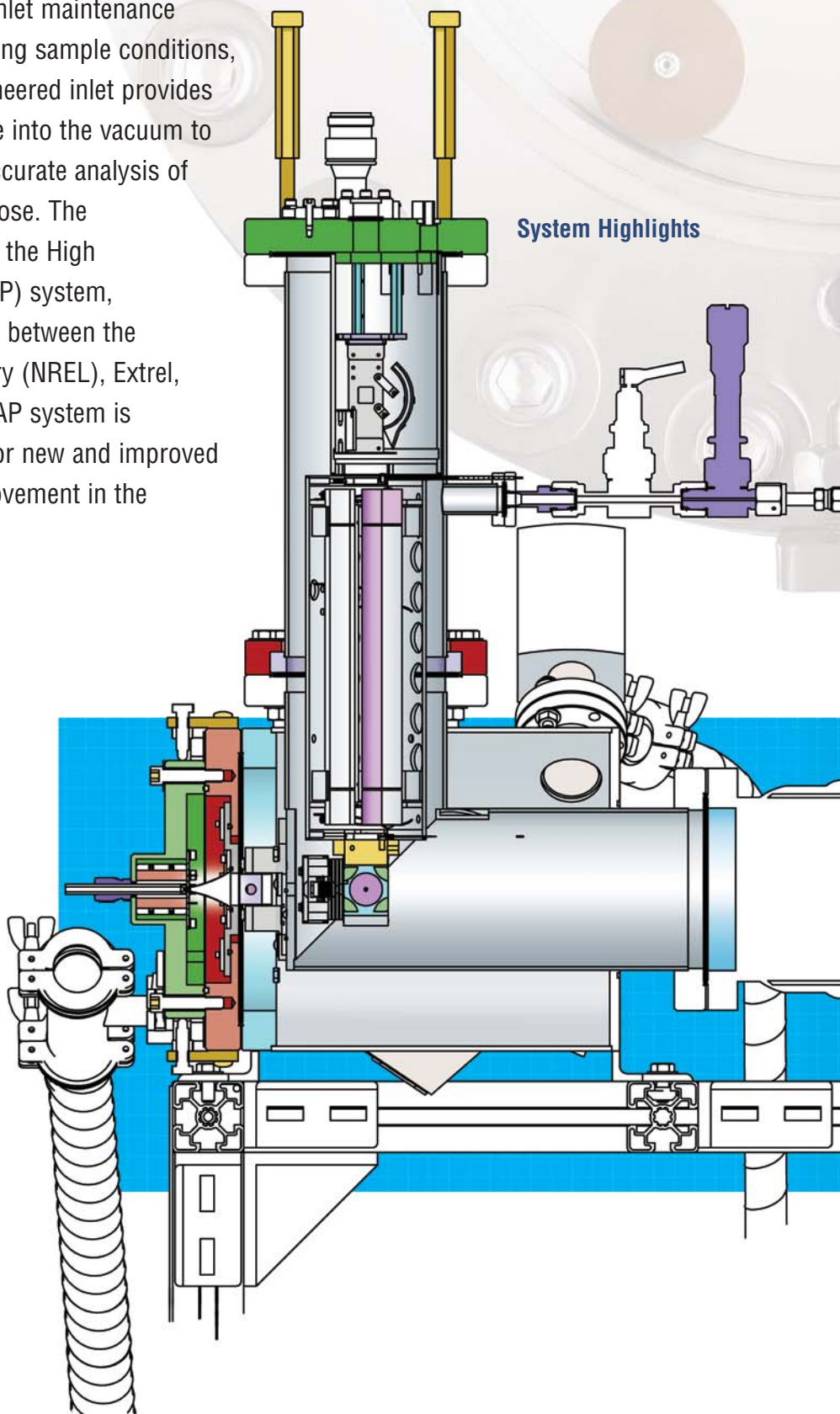


The Extrel VeraSpec™ MBx quadrupole mass spectrometer system is a 3-stage discretely pumped, gas analysis system designed for sampling reactive and condensable gases. The MBx is designed with a heated inlet, easily-changed first aperture and skimmer, and an isolation gate valve, to allow inlet maintenance for applications, which have challenging sample conditions, such as pyrolysis. The carefully-engineered inlet provides a supersonic expansion of the sample into the vacuum to maintain sample integrity ensuring accurate analysis of analytes before they react or decompose. The VeraSpec™ MBx is an integral part of the High Throughput Analytical Pyrolysis (HTAP) system, which was developed in collaboration between the National Renewable Energy Laboratory (NREL), Extrel, ArborGen, and Frontier Labs. The HTAP system is being used to accelerate the search for new and improved biofuel sources and has shown improvement in the analysis of pyrolysis products.

Applications

- Pyrolysis
- Reactive Gas Analysis
- Condensable Gas Analysis
- Super Critical Fluid Sampling

System Highlights



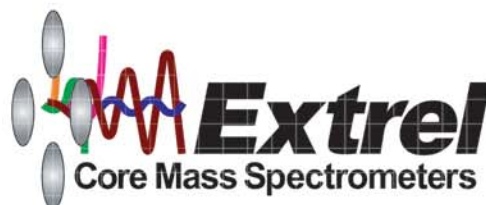
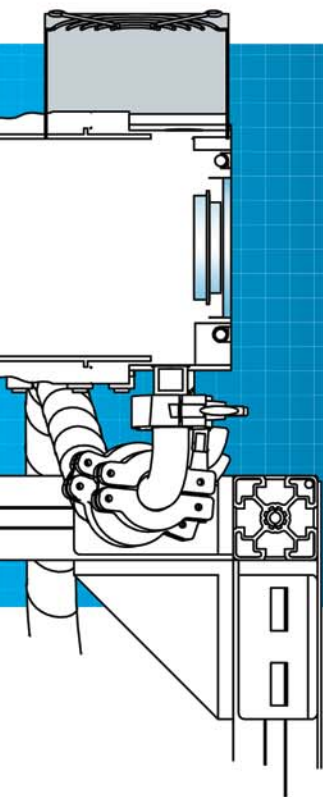
Engineering and Application Support

Extrel recognizes that every analytical requirement for a research project has its own unique demands. As with all of the VeraSpec™ research grade systems, Extrel's salespeople, engineers, and application scientists will work with you to understand your specific configuration needs for the VeraSpec™ MB systems. A variety of aperture sizes and pumping options are available, and custom variations based on the VeraSpec™ MB base systems create a flexible and powerful approach to providing a molecular beam quadrupole mass spectrometer for your research needs.

System Highlights:

VeraSpec™ MBx

- Sampling from source pressures of 100 Torr to 2 atm
- Optional to 100 atm
- Heated first aperture for condensable compounds
- Isolation gate valve to keep MS under vacuum during first stage maintenance
- Cross Beam Deflector Ionizer deflects ions 90° off-axis separating ions from photons, metastables, particulates, and molecular beam gases. This increases signal to noise by filtering out common and controllable causes of background noise.
- Analog and positive ion counting
- Negative ion/electron attachment option
- Signal gating option (beam chopper and lock-in amplifier)
- Merlin Automation™ data system



Extrel MBMS Systems

PRODUCT NOTE

Installation Requirements:

- **Recommended Power Supply:**
(3) 120 VAC, 50/60 Hz, 20 Amp circuit
(3) 220 VAC, 50/60 Hz, 20 Amp circuit
- **Ambient Temperature:**
55° F to 80° F (13° C to 27° C)
- **Relative Humidity:**
0-90% non-condensing
- **Area Classification:**
Laboratory/General Purpose
- **Analyzer Weight:**
450 – 480 lbs.
(200 to 225 kg)
- **Analyzer Dimensions:**
Height: 77" (196 cm)
Depth: 30" (76 cm)
Width: 30" (76 cm)



Merlin Automation™ Data System Software:

- **Control Unit:** Information and control are transmitted and displayed via USB or CAT5E to a PC with Microsoft Windows 7 or XP operating system
- **Analysis Mode:** Scan Mode, Single Ion Monitoring (SIM), Multiple Reaction Monitoring (MRM)
- **Analysis Rate:** Maximum 80 microseconds per point in Scan Mode, typically 5 milliseconds per ion in SIM
- **Number of Ions:** Up to 72 ions with 20 scan segments
- **Analog Inputs/Outputs:** 10 or 20 channel, 12 bit, 0 to 10 V or -10 V to +10 V Outputs, 6 differential Analog Inputs, 12 bit, -10 V to +10 V
- **Digital Inputs/Outputs:** 8 Inputs, 8 Outputs, 16 User Selectable Input/Outputs (all I/O's 1 bit TTL)
- **External Communications:** Some supported, please refer to Extrel for more information

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QUALITY MANAGEMENT SYSTEM
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RPM100B