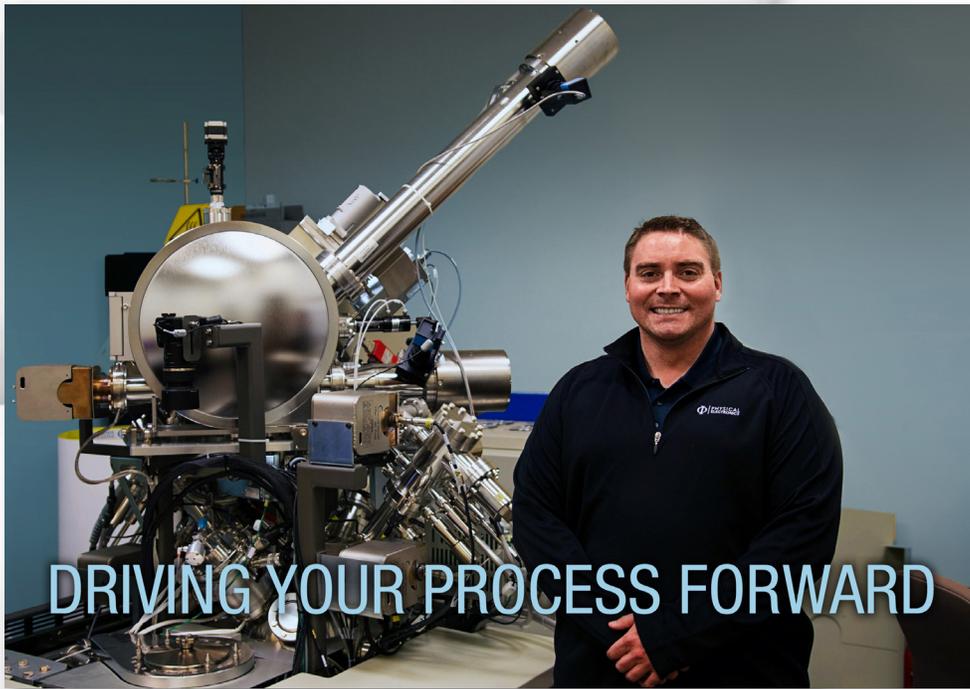




PHYSICAL
ELECTRONICS
A DIVISION OF ULVAC-PHI

MOTION AND MANIPULATION IN MASS SPECTROMETRY

MDC Supplies Critical Vacuum Components for PHI *nanoTOF* II TOF-SIMS



Justin Kruger, Central U.S.
Region Sales Manager
for Physical Electronics
next to the PHI *nanoTOF* II
TOF-SIMS

MDC Vacuum Products, LLC has had the pleasure of working with Physical Electronics (a subsidiary of ULVAC-PHI, PHI.com), the world's leading supplier of UHV surface analysis instrumentation) supplying them with catalog in-vacuum motion and manipulation products for their revolutionary *nanoTOF* II Time-of-Flight Secondary Ion Mass Spectrometer (TOF-SIMS). The *nanoTOF* II provides superior sensitivity, low spectral background, and the unique ability to image highly topographic surfaces.

As an original equipment manufacturer (OEM), PHI needed an established, reliable, and high-quality source for the specialized components on their instruments. With over 40 years' experience as a leading supplier of vacuum technology components to OEMs, MDC had the qualifications and capability to meet PHI's requirements and uphold their high standard of quality and innovation. Every *nanoTOF* II instrument comes equipped with MDC catalog vacuum components, which include a [Pneumatic Linear Motion Feedthrough \(P/N 662002\)](#) and a [Compact XYZ Stage \(P/N 678004\)](#).

MDC VACUUM PRODUCTS, LLC

30962 Santana Street Hayward, CA 94544 USA

Phone: 510.265.3500 | Toll Free: 800.443.8817

sales@mdcvacuum.com | www.mdcvacuum.com





“Our innovative technologies provide our customers with unique tools to solve challenging problems, and accelerate the development of new materials and products.”

- Scott Bryan, President, Physical Electronics USA

Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) provides elemental, chemical state, and molecular information from surfaces of solid materials. The average depth of analysis for a TOF-SIMS measurement is approximately 1 nm. Physical Electronics TOF-SIMS instruments provide an ultimate spatial resolution of less than 0.1 μm . Spatial distribution information is obtained by scanning a micro focused ion beam across the sample surface. Depth distribution information is obtained by combining TOF-SIMS measurements with ion milling (sputtering) to characterize a thin film structure. In addition, the Physical Electronics TOF-SIMS instrument provides a unique 3D analysis capability that combines in-situ focused ion beam sectioning with high-mass resolution and high spatial resolution imaging (HR2) to provide 3D chemical characterization. Information obtained from TOF-SIMS is important for many industrial and research applications where surface or thin film composition plays a critical role in performance including: nanomaterials, photovoltaics, polymer surface modification, catalysis, corrosion, adhesion, semiconductor devices and packaging, magnetic media, display technology, thin film coatings, and medical materials used for numerous applications.

Standard Features

- TRIFT Mass Analyzer
- 30 kV LMIG with Bi, Au, or Ga Emitter
- Dual Beam Charge Neutralization
- 5 Axis Sample Stage
- In-Situ Optical Viewing
- Secondary Electron Detector
- WinCadence Instrument Control and Data Reduction Software Package
- Analysis Chamber with Four Primary Ion Gun Ports
- 350 I/s Turbo Molecular Pump
- Integrated Bakeout Facilities

Optional Features

- MS/MS Analyzer and Electronics Package
- 20 kV C60 Pulsed Ion Gun
- 20 kV Ar2500+ Gas Cluster Ion Gun
- 2 kV Cs Ion Gun
- 5 kV Gas Gun (Ar/O₂)
- Oxygen Flood Module
- 30 kV Ga FIB Gun
- Hot/Cold Sample Stage Module
- Flash Cooling For Sample Intro Chamber
- High Temperature Sample Stage Module
- Sample Transfer Vessel
- Intro Chamber Glove Box



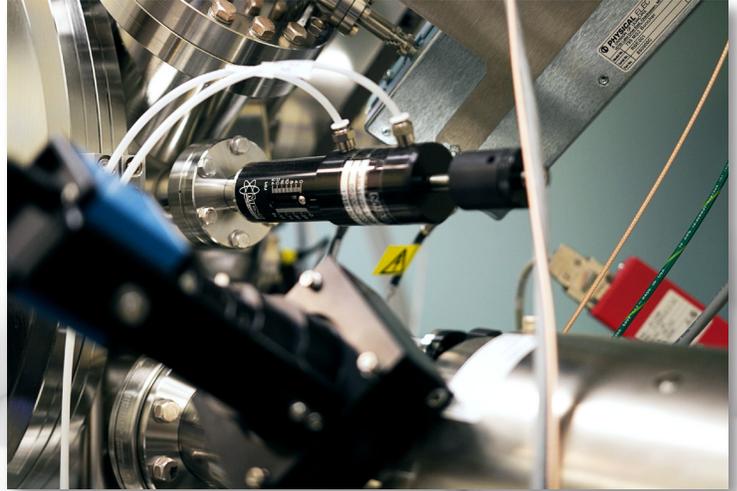
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PHI's *nanoTOF* II time-of-flight SIMS is an extremely sensitive instrument and requires ultra-high vacuum (UHV) conditions to operate. This makes it necessary to implement highly specialized materials and components that can withstand an ultra-high vacuum environment. MDC Vacuum Products, LLC's UHV expertise made them PHI's top choice for sourcing their critical linear motion feedthroughs for their *nanoTOF* II's spectrometer system. MDC's UHV pneumatic linear motion feedthrough ([P/N 662002](#)) incorporates a welded stainless steel bellows and linear bearing shaft supports to deliver quick, accurate, and smooth linear motion in a UHV environment.



MDC's UHV pneumatic linear motion feedthrough ([P/N 662002](#)) shown here on PHI's *nanoTOF* II TOF-SIMS

PHI *nanoTOF* II

Time-of-Flight Secondary Ion Mass Spectrometer
with Parallel Imaging MS/MS for Confident Molecular Identification

"The MDC pneumatic feedthrough is an integral part of the heart of our mass spectrometry imaging instrument...the spectrometer. The MDC pneumatic feedthrough operates and does its job without fail. We never even give it a thought because it's so reliable."

- Gregory L. Fisher, PhD, Principal Scientist at Physical Electronics



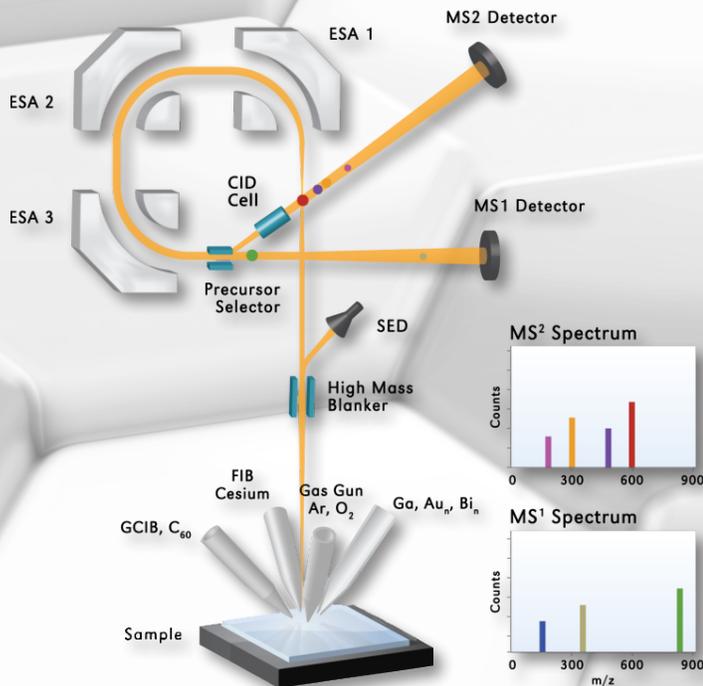
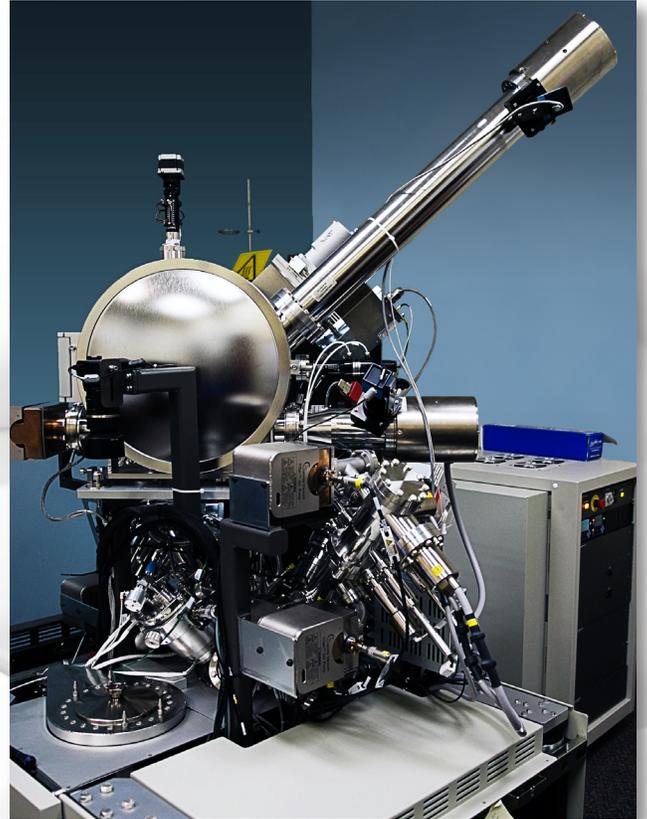
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Physical Electronics TOF-SIMS instruments function in a manner analogous to SEM/EDS instruments that use a finely focused electron beam to create SEM images for sample viewing and point spectra or to create images for compositional analysis. In contrast to SEM/EDS which has a typical analysis depth of 1-3 μm , TOF-SIMS is a surface analysis technique with a typical analysis depth of less than 2 nm and is, therefore, better suited for the compositional analysis of ultra-thin layers and nanoscale sample features. In addition, TOF-SIMS can be used to characterize molecular information from organic materials and tissue sections for medical research that would not be possible with SEM/EDS.



In TOF-SIMS analysis, the ion's mass is calculated based on the time the ion takes to travel through the analyzer. To achieve the ultimate mass resolution (the ability to resolve different ions with very small mass differences) the kinetic energy spread and solid angle of acceptance need to be restricted. The MDC linear motion feedthrough accomplishes this by moving an aperture in or out of the path of the signal. The pneumatic movement allows quick control of the aperture to select high angular acceptance mode or highest mass resolution mode, depending on the application.

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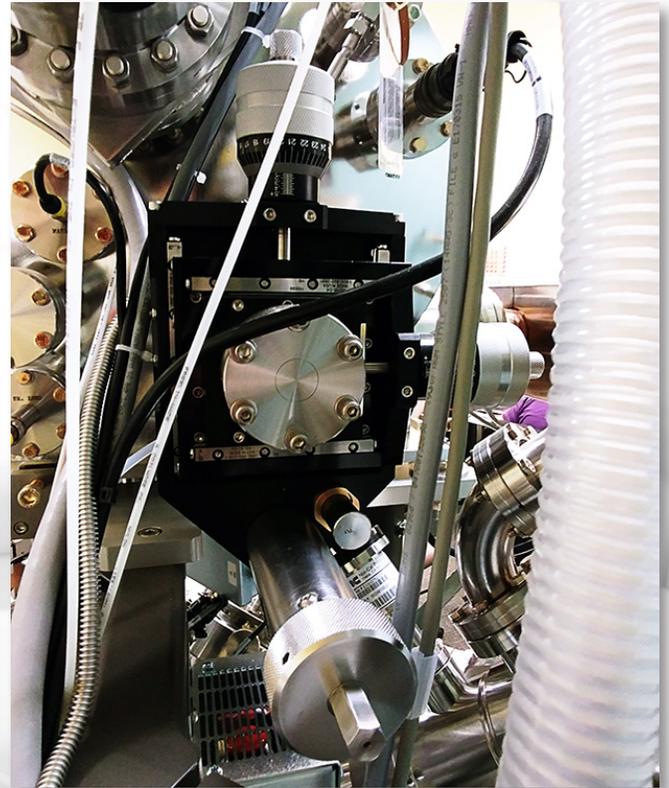
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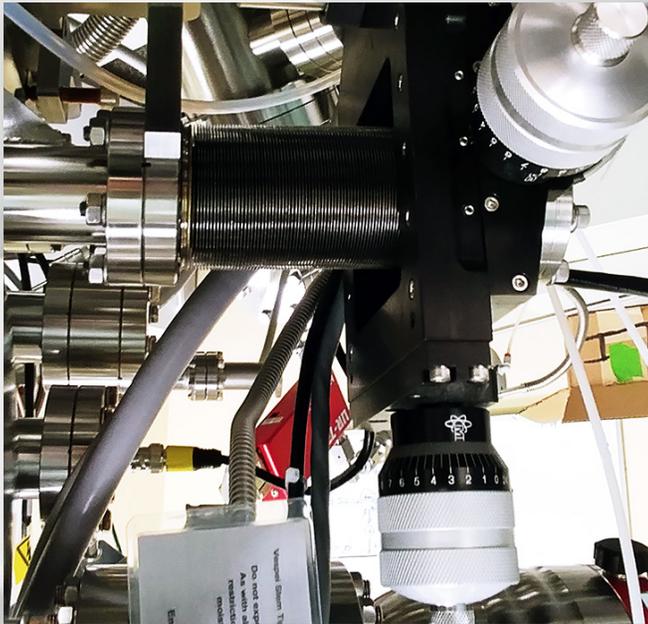


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Due to limitations in mass accuracy and mass resolution, high mass peaks often go unidentified in traditional TOF-SIMS experiments. PHI's new revolutionary Parallel Imaging MS/MS option eliminates this limitation. In the MS/MS mode, a precursor ion is deflected into a high energy collision induced dissociation (CID) cell while the rest of the secondary ions are collected as usual (MS1 data). In the CID cell, the precursor ions collide with argon gas causing fragmentation. The resulting fragment ions are mass-separated in a linear TOF and counted at a second pulse counting detector, producing a full MS/MS spectrum (MS2). Thus, the MS/MS and traditional TOF-SIMS data are collected simultaneously from the same analytical area in a single experiment.



Top and Left: MDC's Compact XYZ stage ([P/N 678004](#)) shown on the *nanoTOFII* TOF-SIMS



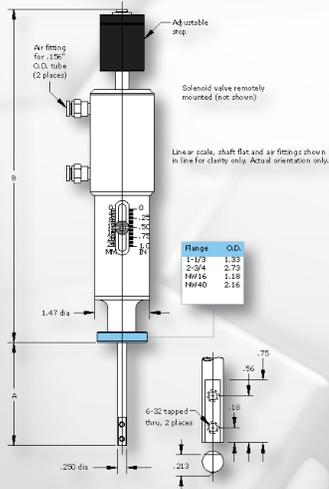
One of the critical components in the Parallel Imaging MS/MS system is the precision optic used for the ion mass selection of the precursor ions. The MDC Compact XYZ stage ([P/N 678004](#)) provides the highest level of accurate and consistent 3-dimensional positioning of the precision optic for ion transmission and resolution optimization.



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Pneumatic linear motion feedthroughs provide two-position fast action linear motion. Typical motion applications would include on-off, open-close, and in-out motions similar to those of in-vacuum shutters. Linear travel can be shortened or lengthened by turning the adjustment knob located at the top end of the pneumatic actuator. Once adjusted the jam nut locks the knob in place. Linear travel adjustment is from 0" to 1" for one-inch travel devices and from 1" to 2" for two-inch travel devices. For quick and easy positioning, the feedthrough body has been laser etched with linear travel graduation marks in increments of 0.025". A black anodized finish provides high contrast and visibility of the laser etched graduated scale. Pneumatic linear motion feedthroughs are offered in travel lengths of 1" and 2".

MDC feedthroughs are constructed from high-grade vacuum compatible materials and welded stainless steel bellows paired with linear bearing shaft supports provide reliability and smooth operation. Pneumatic feedthroughs are available in industry standard Conflat® compatible Del-Seal™ CF metal seal flanges or ISO KF Kwik-Flange™ elastomer seal port mounts.

Standard Features

- 1 to 2 Inch Linear Travel
- Pneumatic Actuator
- Adjustable Linear Travel Stop
- UHV or HV Compatible Materials
- Welded Bellows Seal
- Bakeable to 100°C
- Del-Seal™ CF & Kwik-Flange™ Port Mounts
- Air Control Solenoid Valve
- Solenoid Air Pressure to 100 PSIG Maximum

Specifications

- **Axial Load:** 20 lb Maximum
- **Lateral Load:** 5 lb at 2" Extension Maximum
- **Actuator Pressure:** 60-80 psi
- **Piston Surface Area:** 0.88 in²
- **Solenoid Valve:** 120 VAC 50/60 Hz



- **Flange/Actuator Body:** 304 SS / Anodized Aluminum
- **Shaft Seal:** AM 350 Welded Bellows
- **Piston Seal:** BUNA Low Resistance U-ring
- **Vacuum Range:** HV: 1x 10⁻⁸ Torr | UHV: 1x10⁻¹¹ Torr
- **Temperature Range:** -20° C to 100° C

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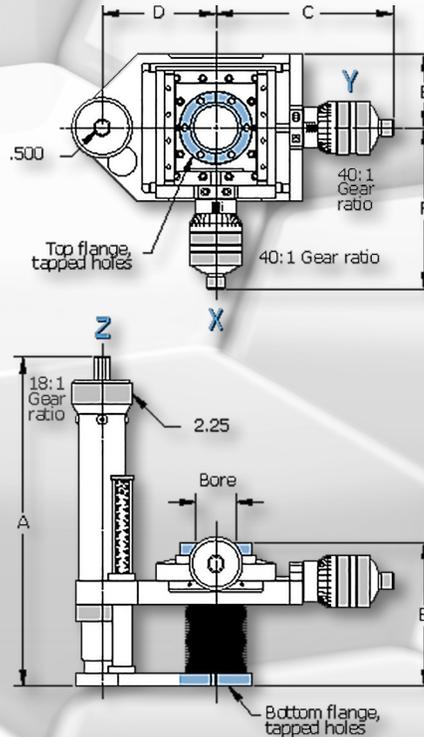
Compact triple axis XYZ stages have smaller footprints than VPlane® stages. They are a practical and economical solution for applications with limited space. Models with two and four inches of linear travel and bore diameters of 1.50" and 2.50" are available. The instruments precision Z drive employs a fine pitch lead screw mechanism with approximate positions measured along a graduated machinist's scale with both inch and millimeter units included. The XY axes are micrometer driven and guided by cross roller bearing slides. Micrometers have unique laser etched plus-minus scales that indicate positive or negative port displacement. MDC triple axis XY stages provide precise motion and manipulation of samples inside ultrahigh vacuum environments. Top and bottom port flanges are available in 2-3/4" and 4-1/2" Conflat® compatible, tapped Del-Seal™ CF metal seal flanges. Edge welded stainless steel bellows are used to connect the port flanges on all XYZ compact stages.

Standard Features

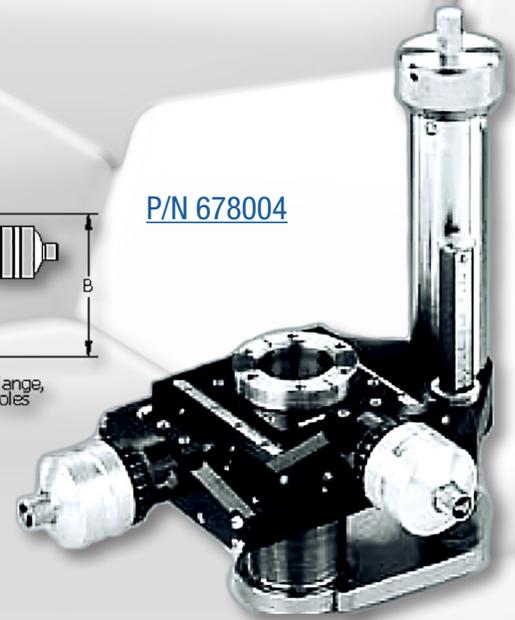
- 2 or 4 inch Z-Axis Travel
- Plus or Minus 1/2 Inch Off Center XY Motion
- 1-1/2 and 2-1/2 Inch Bore Diameters
- Manual or Motorized Actuators
- UHV Compatible Materials
- Welded Bellows Seal
- Bakeable to 230°C
- Del-Seal™ CF Port Mounts

Specifications

- **Flange:** 304ss
- **Actuator Body:** Anodized Aluminum
- **Bellows:** AM 350
- **Vacuum Range:** 1×10^{-11} Torr
- **Temperature Range:** -20°C to 230°C



P/N 678004



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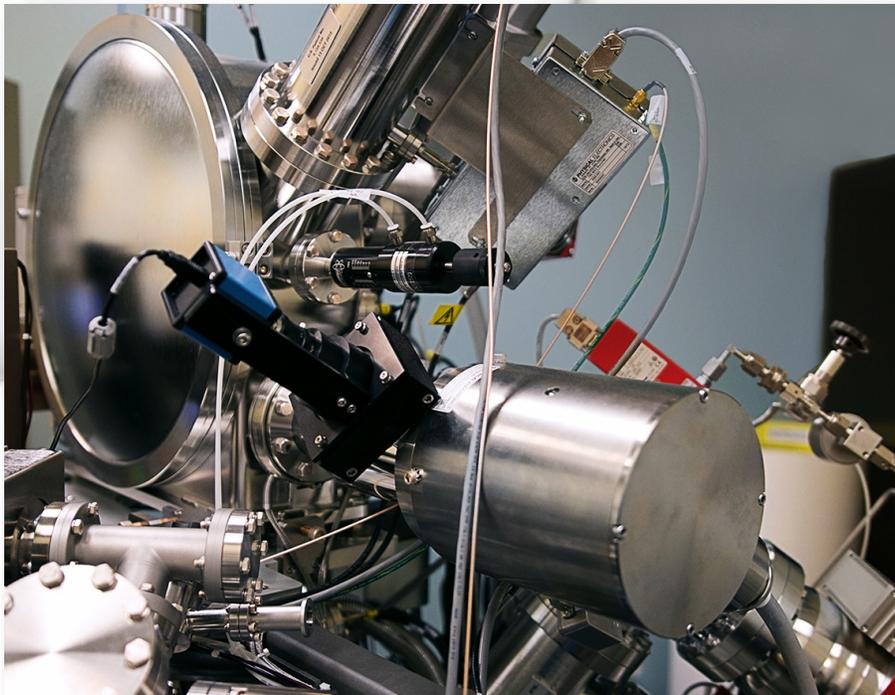




MDC's Compact XYZ stage ([P/N 678004](#)) shown on the *nanoTOFII* TOF-SIMS.

MDC Vacuum Products, LLC, an ISO 9001:2008 registered company, has been committed to providing high-quality and competitively priced vacuum components for over 40 years. MDC combines this extensive experience with dedication to quality, innovation, and customer satisfaction to consistently meet and exceed clients' expectations. They are here for all your vacuum needs, from standard valves, fittings, and feedthroughs, to custom made unique vacuum chambers.

Do you have any OEM vacuum product needs? Let MDC show you why they are an industry leader and how they can drive your process forward!



MDC's UHV pneumatic linear motion feedthrough ([P/N 662002](#)) shown here on PHI's *nanoTOFII* TOF-SIMS.

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