Custom Mass Spectrometer Detectors and Inlet Tubes for use in Portable Security and Forensic Applications

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Introduction

Portable mass spectrometry is becoming widely used in security and forensic applications to quickly identify on-scene suspicious substances, chemical threats or contraband. These instruments provide quick and reliable analysis when fast answers are needed. Yet portable mass spectrometers pose unique challenges to instrument designers. Accurate analysis needs to be fast, the instrument needs to be small yet robust, and due to power constraints, often the vacuum is poor. Inlet and capillary tubes are small, limiting the size of sample available for analysis. Small sample sizes and inefficient sample introduction result in wider ranges of uncertainty than with larger samples that are processed by large machines.

PHOTONIS offers a wide range of standard and custom detectors that are ideal for operating in poor vacuum and elevated pressure environments. PHOTONIS detectors support a wide range of mass spectrometry types, including quadrupole, ion trap, Time of Flight, and sector mass filters. We also manufacture patented inlet and capillary tubes which preferentially draw more ions into the mass spectrometer, increasing sample size and improving the reliability of results.

Electron Multipliers Designed for Poor Vacuum Operation

Discrete dynode style electron multipliers do not operate in poor vacuum environments. Secondary electrons collide with the residual gas molecules and in the large areas between dynodes, producing feedback noise. MAGNUM[®] Electron Multipliers are specifically designed to offer tolerance to poor vacuum, optimum mass resolution, long life, dynamic range,

and high sensitivity in mass spectrometry measurements. Their compact size, and high performance makes them ideal solutions for portable and compact analytical instruments.

This performance boost is a result of PHOTONIS Spiraltron[™] technology that uses six individual spiral multiplier channels fed by a single integral ion collection aperture (Figure 1). The high degree of channel curvature ensures that ion feedback noise is virtually eliminated. This technology ensures that these compact detectors can still achieve high gain while maintaining low noise.



Figure 1: The MAGNUM[™] detector features special construction that allows for six individua channels to be contained in the same footprint of a traditional detector. The result is a 6X increase in output current capability.

Spiraltron[™] Electron Multipliers are specifically designed for poor vacuum applications, such as portable mass spectrometers. Spiraltron[™] Electron Multipliers can operate effectively at pressures well into the 10⁻³ Torr range, while compact MegaSpiraltron[™], XPR MCP, and Daly detectors can all operate at 10⁻² Torr (Figure 2). Let PHOTONIS custom-design your next detector for your portable mass spectrometer requirements for superior poor vacuum performance and analysis.



Figure 2: PHOTONIS offers a wide range of miniature and custom electron multipliers specially designed for operation in poor vacuum environments.



Resistive Glass Capillary and Inlet Tubes

Resistive Glass Capillary and Inlet Tubes (Figure 3) are designed to improve ion transmission in atmospheric pressure ionization applications. Voltage applied across the tube creates an electric field that preferentially attracts ions - either positive or negative - into the inlet tube, while the non-conductive area ensures a resistive path on the inside of the tube only. The result is that more ions are drawn into the inlet tube and forced into the mass spectrometer. This significantly improves ion transfer efficiency when compared to traditional quartz inlet tubes or a sample orifice, providing a more reliable analysis.

PHOTONIS provides custom manufacture of our Resistive Glass Tubes. Our tubes can be manufactured with inner diameters as small as 0.5mm and with wall thicknesses as small as 1mm. Additionally, the tubes can be fritted, sandblasted or metallized to match most portable instrument requirements, while providing an increase in sample throughput.

Other types of Resistive Glass products can be manufactured, such as reflectron lenses, circular plates, resistive washers, collision cells, conversion dynodes and voltage dividers (Figure 4).

Miniature and High Mass Time-of-Flight Detectors

PHOTONIS is the world's largest manufacturer of Microchannel Plates, offering the greatest range of options including geometries, sizes and coatings. PHOTONIS TruFlite™ Microchannel Plates optimize pore size and bias angle to reduce time jitter and improve time-of-flight mass resolution. Our Long-Life[™] Microchannel Plates provide sustained output up to five times longer than other MCPs.

PHOTONIS Time of Flight Detectors provide maximum mass resolution for portable mass spectrometry. PHOTONIS offers TOF detectors with MCP pore sizes as small as 2µm, and miniature TOF detectors with detector apertures ranging from 42mm to 8mm (Figure 5). Patented Bi-Polar Time of Flight detectors feature electro-optical isolation which protects instrument digitizers during polarity switching.

High Mass Time of Flight Detectors from PHOTONIS improve the detection efficiency of very high mass ions with significantly less complexity compared to traditional high-mass TOF detection solutions. This detector features a high sensitivity microchannel plate, a high-speed scintillator, and a photomultiplier which can detect both positive and negative ions with 30kV of isolation. This innovative solution features a gridless optic system that offers high sensitivity detection for mass ranges in excess of 100kDa. Ask us how we can design a custom detector for your next MCP-based Mass Spectrometer and maximize your mass resolution.



Figure 3: A full sized Resistive Glass capillary tube is displayed next to a set of miniature detectors and Resistive Glass inlet tubes optimized *for portable mass spectrometry.*



Figure 4: Resistive Glass can form a wide variety of MS components.

Figure 5: Miniature TOF detector pictured next to a high-mass TOF detector. Both provide high sensitivity detection in Time-of-Flight Instruments.

Channeltron[®] Electron Multipliers



custom Channeltrons[®] are on display.

detectors of positive and negative ions as well as electrons and photons. We can custom design a detector for your next instrument as a complete assembly to efficiently facilitate service. PHOTONIS offers a wide range of standard OEM detector replacements or complete replacement assemblies (Figure 6). Start using a genuine Channeltron[®] for the highest dynamic range and detector efficiency to improve instrument performance.

Ion Mobility Spectrometer Engine



inhomogeneities and ease of use. In addition, the single-piece construction allows uniform counter flow of drift gas without the need for additional containment. This allows PHOTONIS' IMS engine to provide a resolving power of 64-150. It can also be custom-designed or scaled to operate with any number of ionization sources, such as DESI, Electrospray, Corona Discharge or Radiation, or the unit can be operated as a stand-alone unit.

Neutron and Gamma Detectors for Radiation Leak Detection

PHOTONIS manufactures neutron and gamma detectors which can be used for radiation detection in order to assess the severity of a leak or other event. PHOTONIS detectors are certified for use in many of the world's best nuclear power plants and research facilities for fast, accurate detection (Figure 8).



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Channeltron[®] is the original brand name in continuous Electron Multiplication. Today, PHOTONIS manufactures over 150 models that are custom-designed for the unique footprint and detection requirements of each specific instrument. Only genuine Channeltrons[®] can enhance detection efficiency, extending the linear operating range, while offering extended lifetime for a lower total cost of ownership.

Channeltron[®] Electron Multipliers are durable and efficient

Ion mobility spectrometry (IMS) has become widely accepted for the detection of chemical warfare agents, explosives and narcotics. Currently available commercial IMS instruments have resolving power between 10-60, but offer a high frequency of false-positive

The PHOTONIS Ion Mobility Spectrometer Engine (Figure 7) is a patented platform that can be customized for a variety of specific applications where samples need to be quickly identified and can effectively provide accurate results, even at room temperature.

Resistive Glass drift tubes provide key benefits to the PHOTONIS IMS Engine, such as uniform electric fields with minimal radial



Figure 8: Neutron and Gamma detectors for highly sensitive radiation detection.