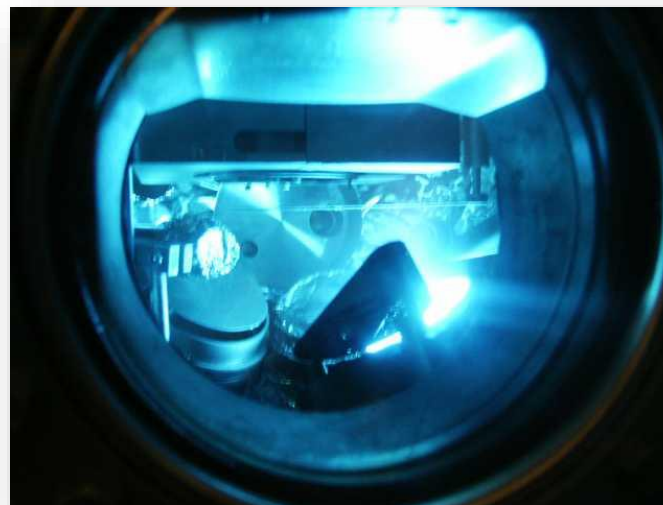
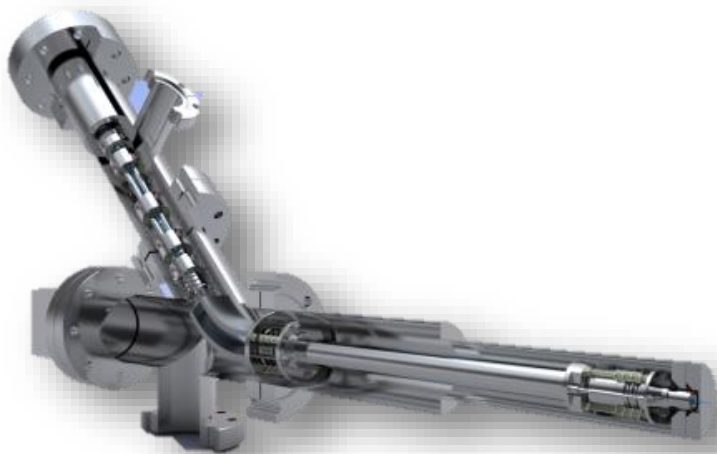


Hidden EQP

**Mass/Energy Analyser for Plasma
Diagnostics and Characterisation**



EQP Overview

The Hiden EQP System is an **advanced plasma diagnostic tool** with combined **high transmission ion energy analyser** and **quadrupole mass spectrometer**, acquiring both mass spectra at specified ion energies and ion energy distributions of selected plasma ions.

The advanced EQP ioniser provides for **neutral and radical detection**, the electron attachment ionisation feature further enhancing the detection capability for radicals in electronegative plasma chemistries.



Features

- Sub PPM detection of plasma ions, neutrals and radicals.
- Ion Energy Analysis, 0-100eV and 0-1000eV energy range versions are available.
- Positive and Negative Ion Analysis.
- Neutral and Radical Species Detection.
- Electron attachment ionisation mode for the study of electro-negative radicals
- Mass range options: 50, 300, 510 or 1000 amu
- For afterglow, pulsed plasma, and laser ablation, a standard TTL signal gating input is included for time resolved studies.

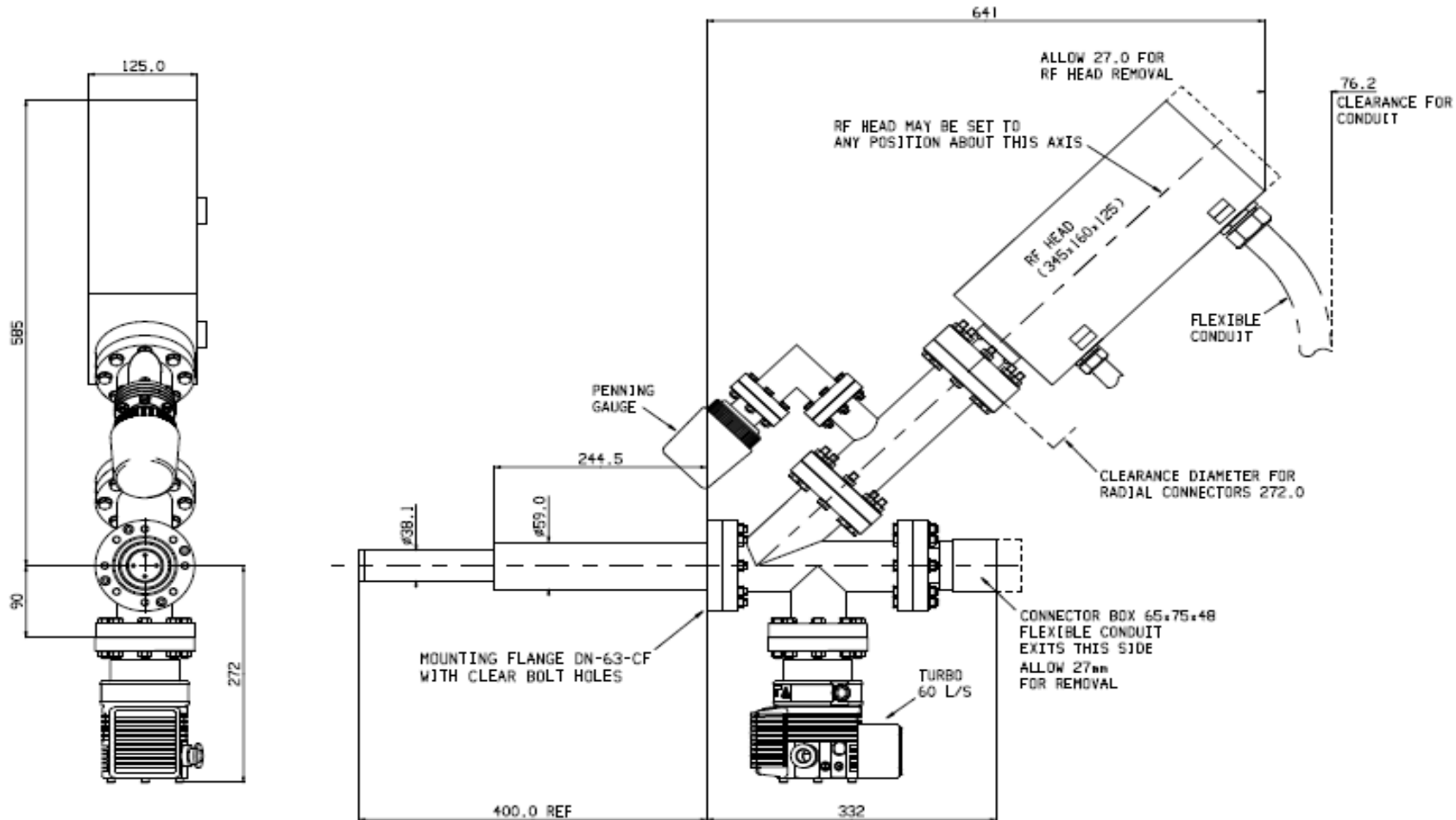
Applications

EQP Systems are offered with a range of standard plasma sampling options to provide a non invasive sampling interface for a broad range of plasma applications including:

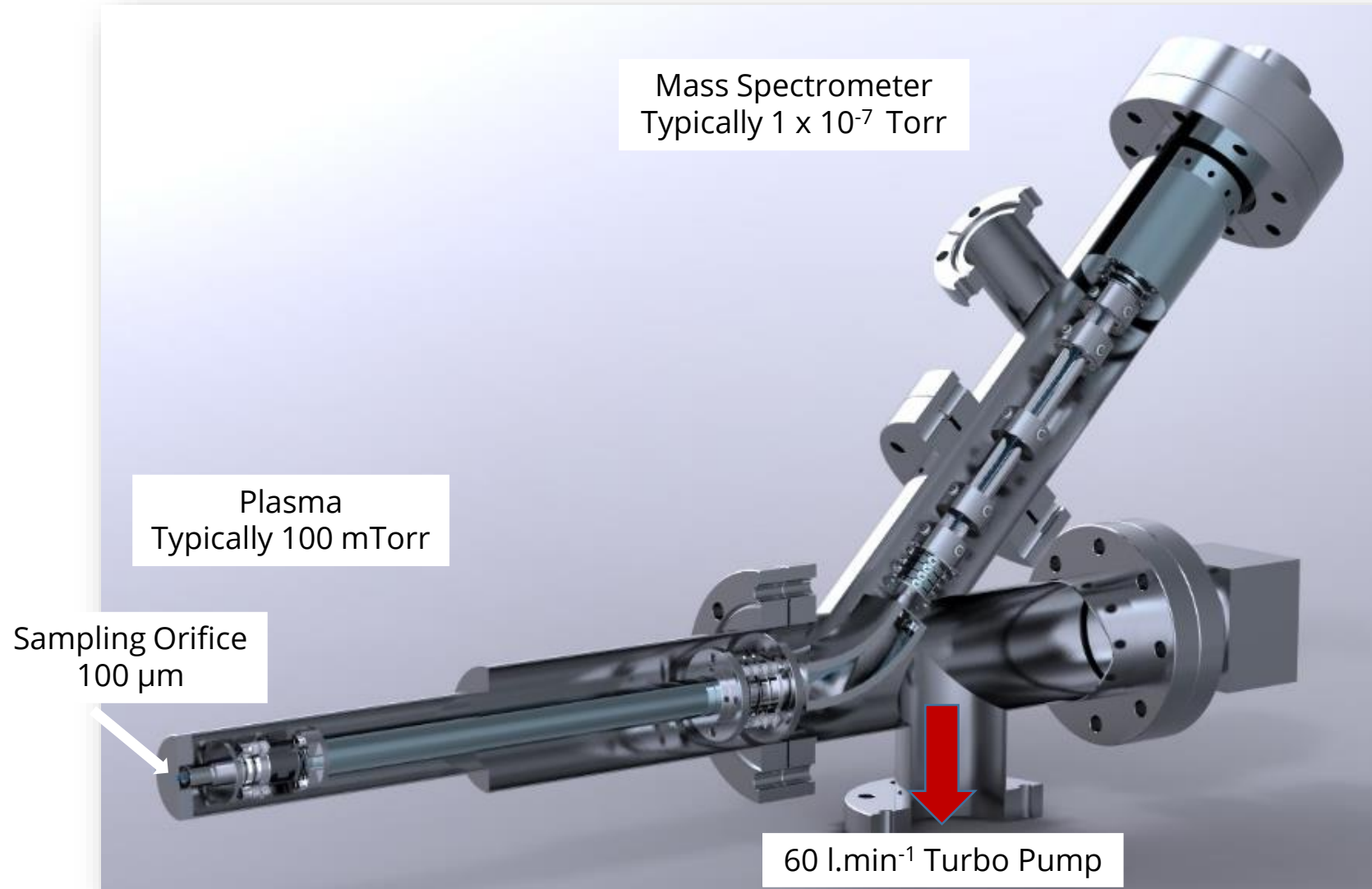
- ECR- Electron Cyclotron Resonance
- HIPIMS
- Magnetron Discharge
- Helicon Source
- DC Glow Discharge Plasma
- Pulsed Plasma & Laser Ablation
- Parallel Plate - RF Plasma
- ICP- Inductively Coupled Plasma



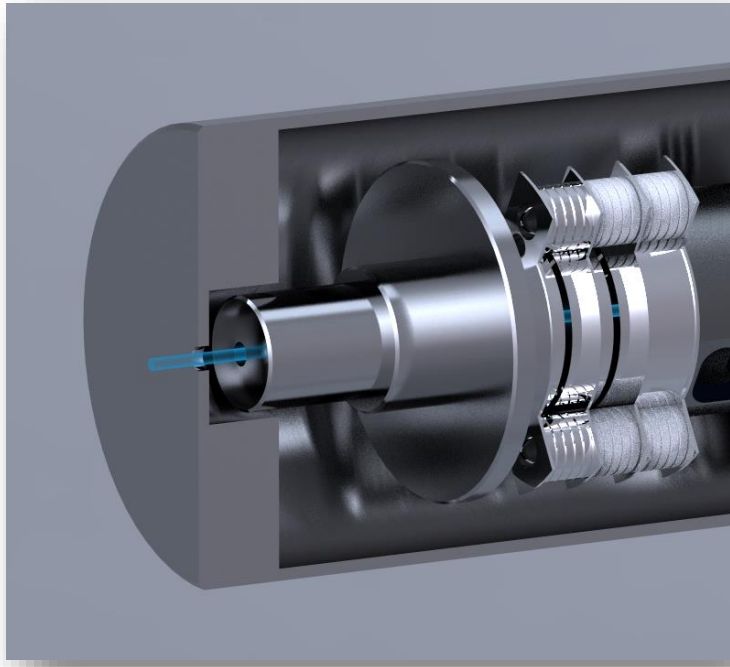
EQP System Schematic



Typical Operating Configuration

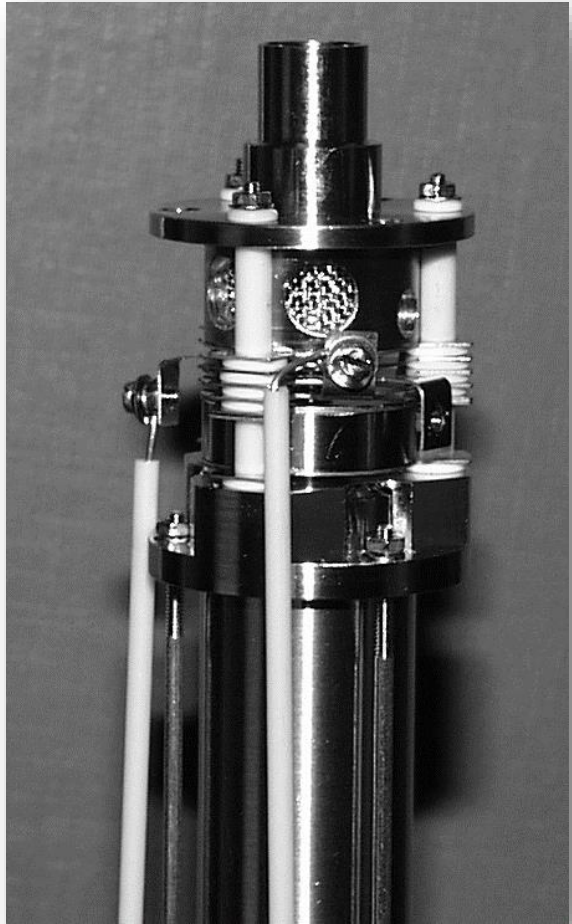


Laser Drilled Orifice



- User selected dimension from 30 - 300 μm .
- +ve / -ve ions, neutrals or radicals.
- Pre-thinned for optimum sampling.
- Plasma electrode coupling option – allows the user to configure the orifice to exactly follow electrode conditions during operation.

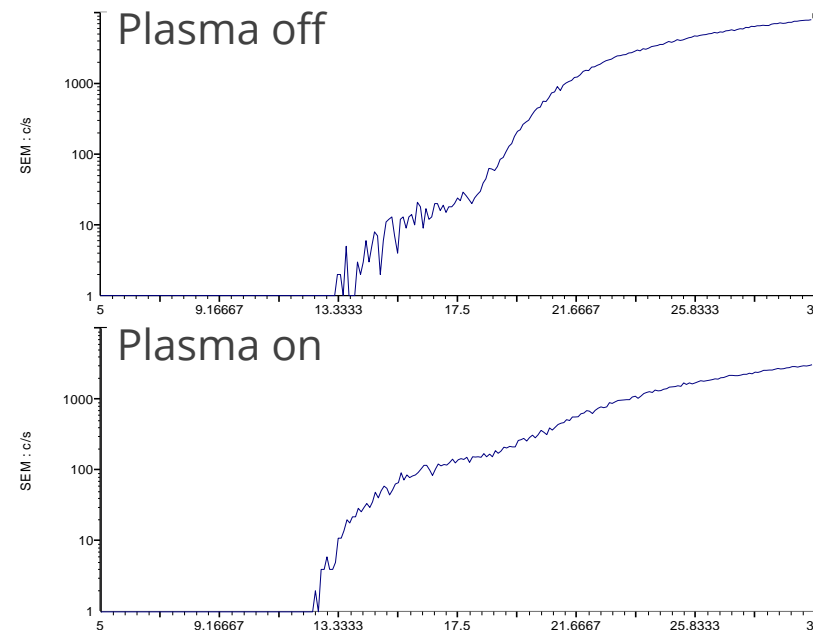
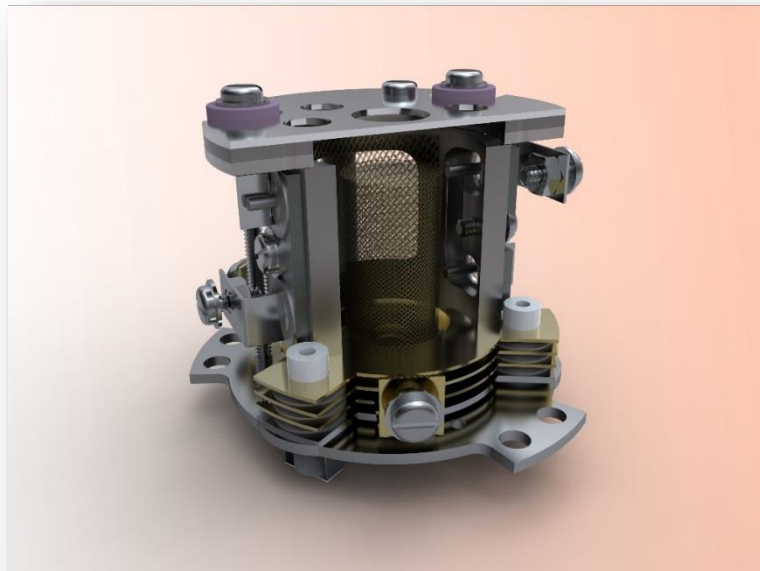
Extraction Optics



- Software controlled and optimised extraction and focussing optics.
- Discriminates **+ve and -ve** ions as well as **e⁻** and **radicals**.
- **Fully tuneable** for optimal detection.
- Integrated ionisation source.

Ionisation Source

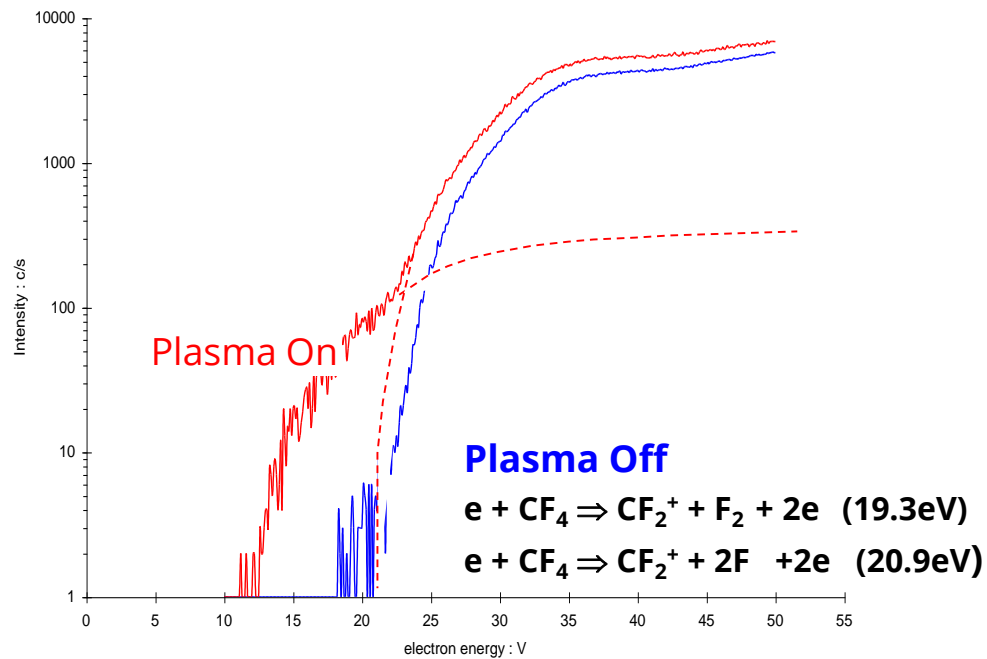
- Fully software controllable **electron energy** (0-150 eV) and thermionic **emission** (0.2-2000 μA).
- **Electron Impact, Appearance Potential, Soft Ionisation** modes allow for powerful characterisation of the neutral and radical species from the plasma.



Ion Source Control

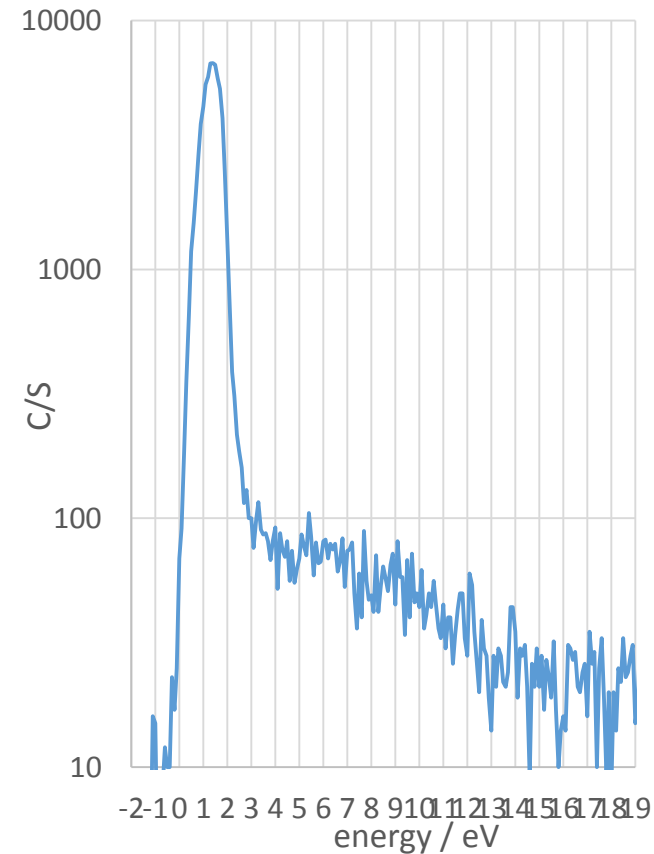
Electron Energy Scans

Plasma On/Off comparison of the production of CF₂ ions.



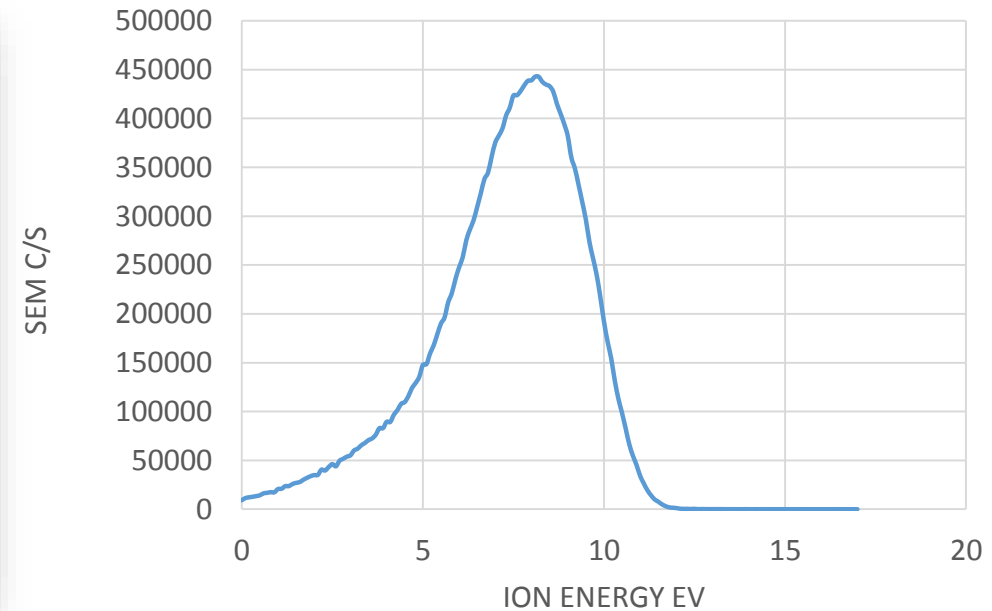
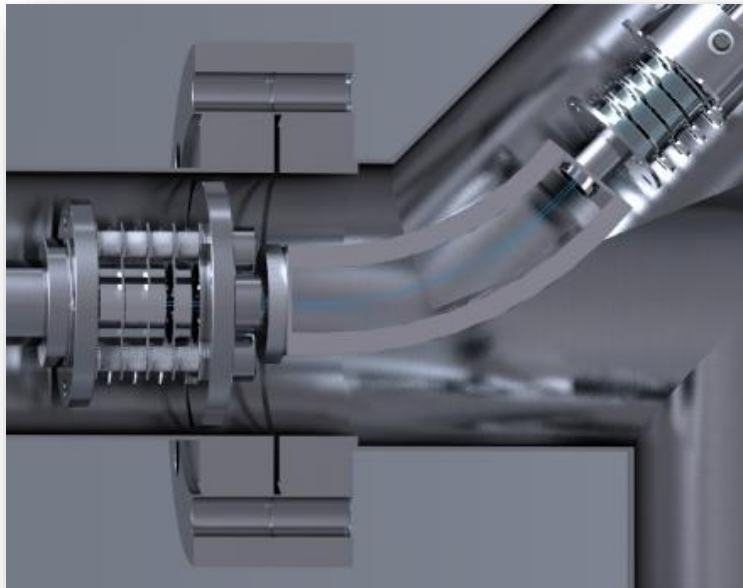
Energy Scan of Fast Neutrals

Cu Atom Energy Distribution from a DC magnetron discharge.



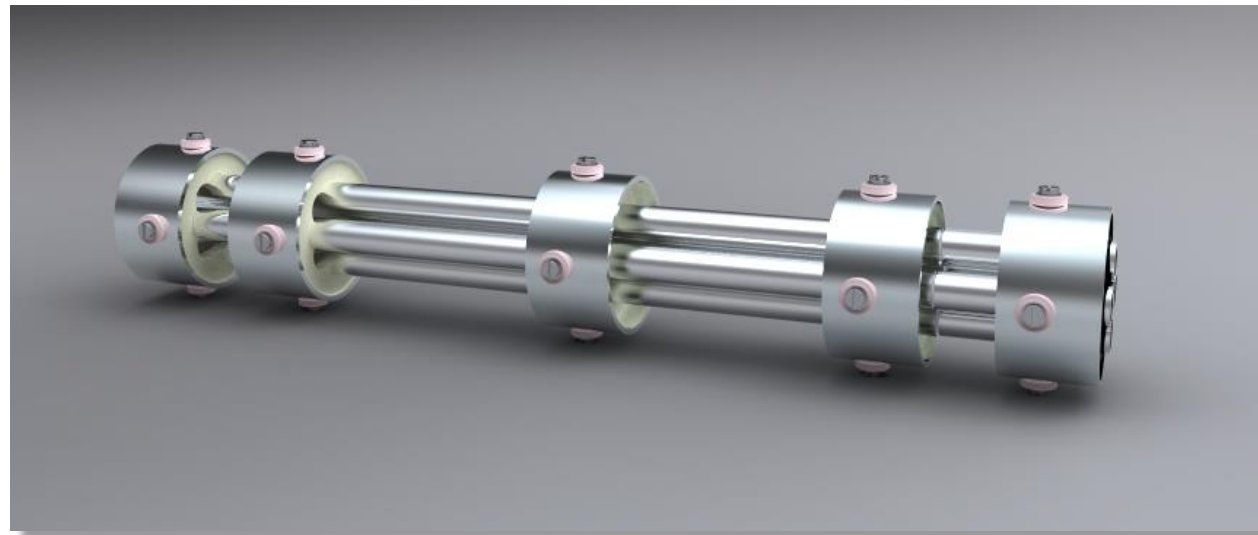
45° Electrostatic Sector Energy Analyser

- Constant transmission at all ion energies.
- Minimum perturbation of ion flight path.
- Energy resolution - 0.25 eV FWHM.
- Energy scan at increments from 0.05 eV.
- Floating option available up to 10 KeV.



Triple Filter Mass Spectrometer

- Strict control over the quadrupole entrance and exit fields provides **enhanced sensitivity** for **high mass transmission** and **increased abundance sensitivity**.
- **Enhanced long-term stability**. The bulk of the deselected ions from the ioniser deposit harmlessly on the RF-only pre-filter stage, minimising contamination on the mass selective primary filter.



Quadrupole Diameter

50/300/510 amu 6mm

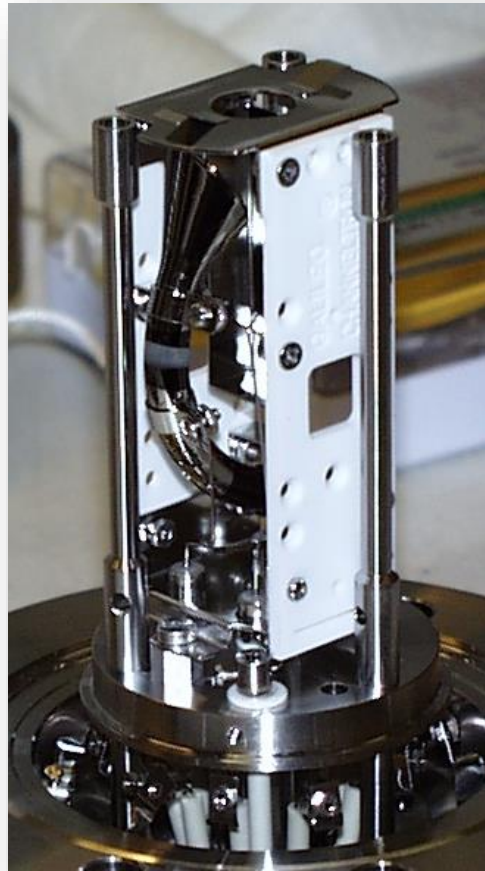
50/300/510/1000/2500 amu 9mm

- Configured with 6mm or 9mm

What pole diameter do I need?

- Total RF output power is fixed for a given generator.
- Power demand increases dramatically with increasing RF frequency:
($\propto \nu^5$)
- For given mass, performance improves with increasing frequency.
- For given tolerances, transmission and mass separation improve with increasing pole diameter.
- Overall size and cost increase with increasing pole diameter.
- Enlarging pole diameter increases assembly capacitance and limits RF range (increases power losses).

Secondary Electron Multiplier (SEM) Detector



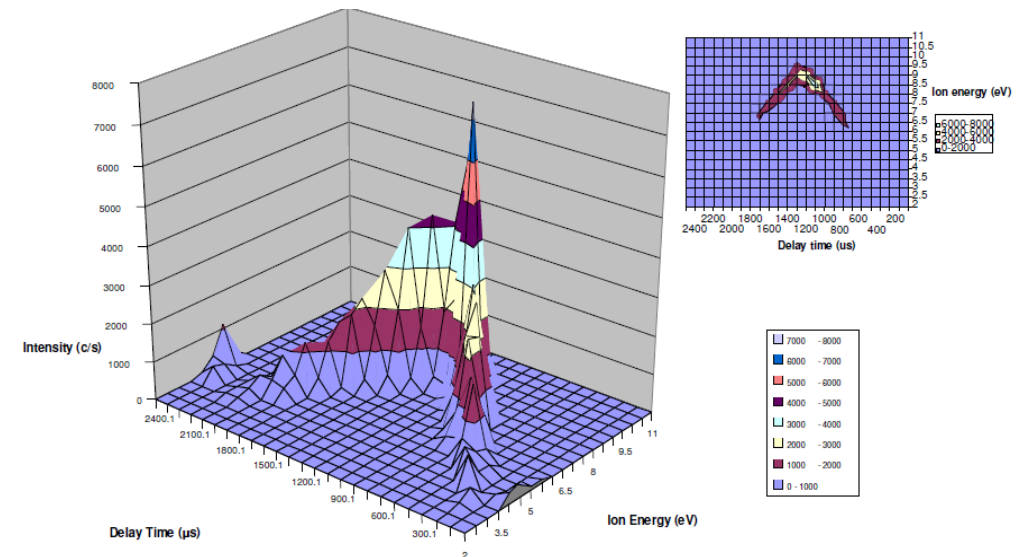
- 7 decade continuous dynamic range.
- 24 bit counter for 1 c/s resolution.
- Faraday Cup option for high density plasmas.
- Signal gating with 50 ns time resolution for energy & mass distributions.
- Comprehensive data export options.

Programmable Signal Gating

- Signal gating input with **0.1 μs** resolution is standard.
- Enhanced signal gating modes including programmable signal gating and MCS are available as system options or upgrades.
- Programmable signal gating includes foreground and background delay timers to **monitor two time zones** with respect to a relative repeated event.

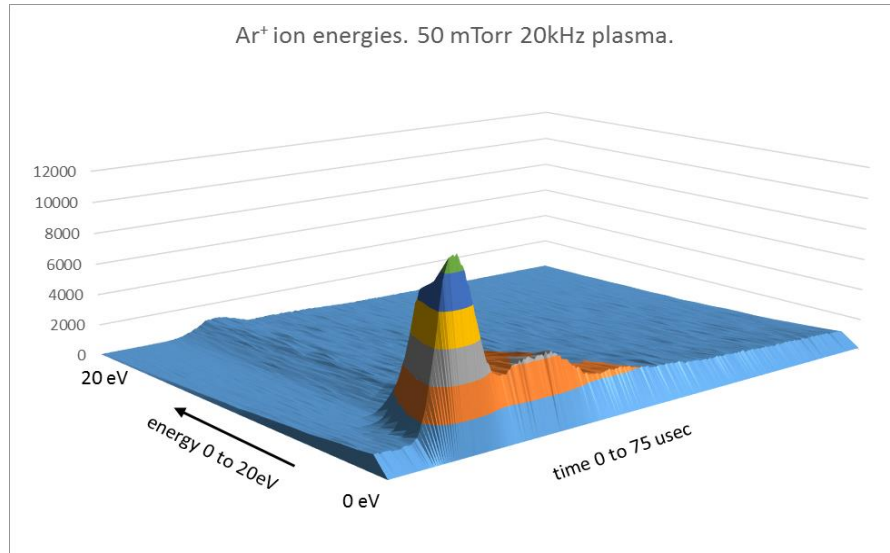
Features:

- **0.1 μs** minimum gate delay and width.
- Automatic **background subtraction** for modulated molecular beam studies.
- **Ion flight time** measurements.



Multi-Channel Scalar (MCS) Device

- Optional innovative Multi-Channel Scalar (MCS) device integrated into controller firmware and MASsoft v7 software.
- 6000-bin multichannel scalar resolution offering 50 ns time resolution.
- Data is *intuitive* to obtain and can be manipulated in external programmes such as Excel and Origin.

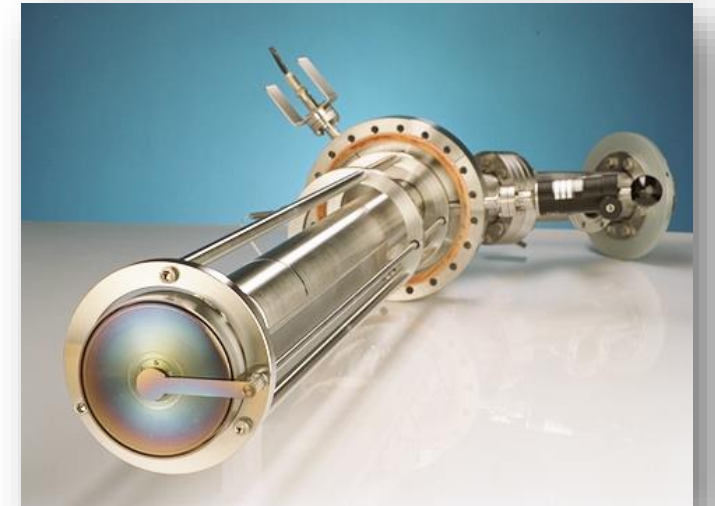


Suitable for transient event analysis applications such as:

- Beam chopper inlets.
- Plasma ignition/modulation/extinction experiments.
- Ion flight time measurements.

Configuration Options

- Analysis through:
 - viewport
 - grounded electrode
 - driven electrode
- High pressure plasmas with double differential pumping.
- Magnetically confined plasmas with optional Mu-metal & radio-metal shielding.
- Analysis of high mass (1000 amu).
- Analysis of high energy (1000 eV).



Configuration Options

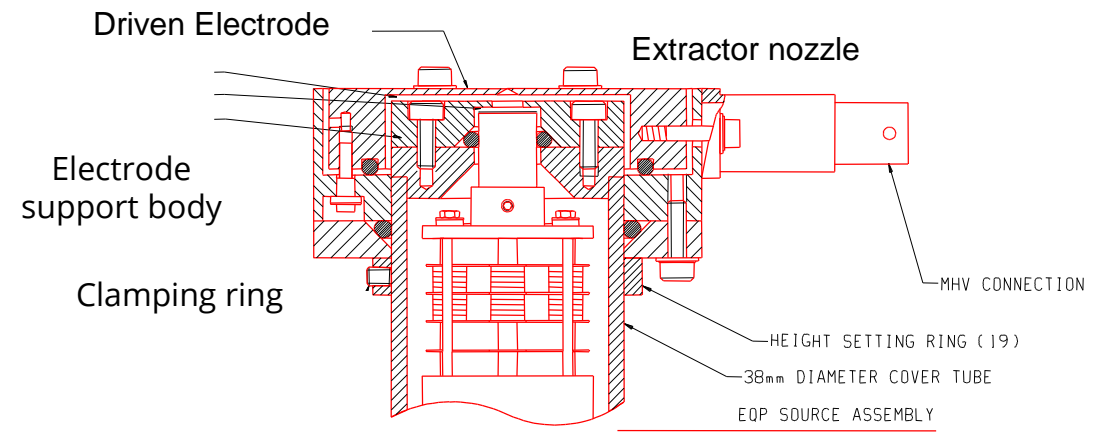


1000 amu EQP with z drive



EQP with RF driven electrode

Configuration Options

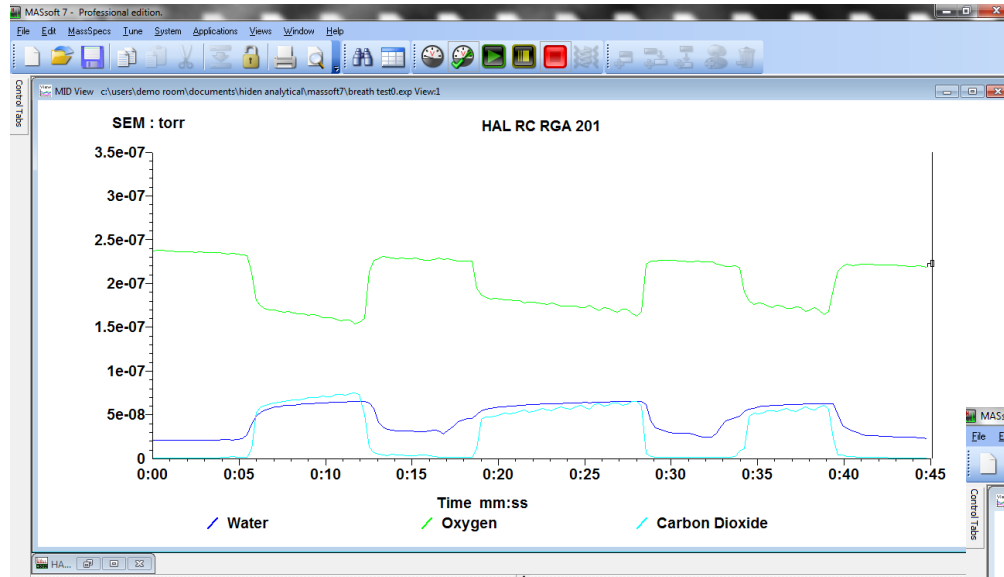


Driven Electrode

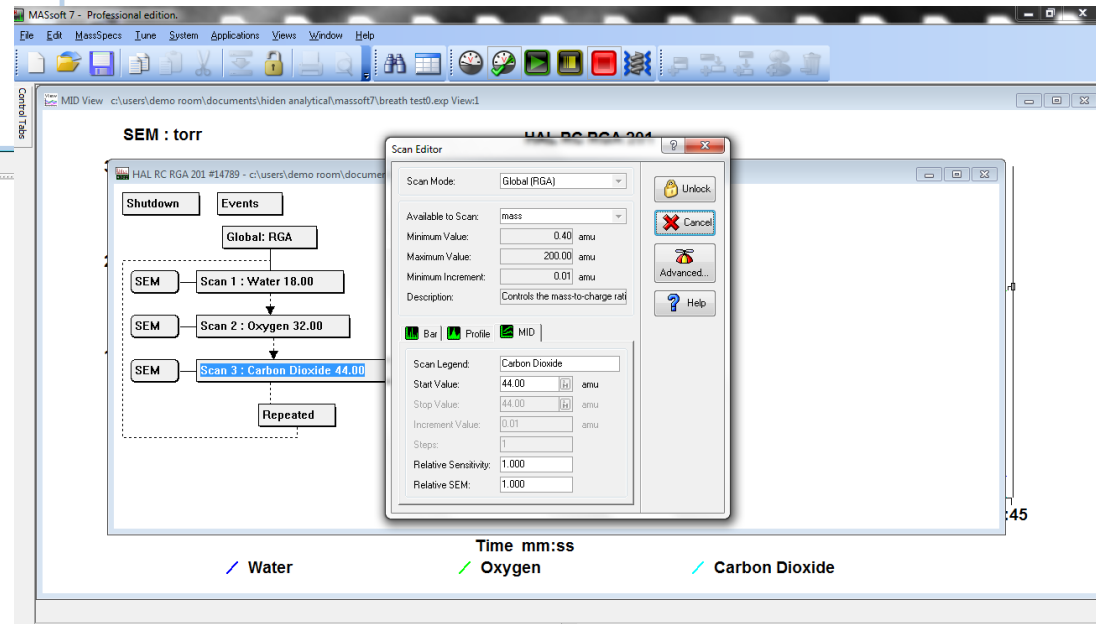
Controllable Orifice Cover



MASsoft 7 Professional control software



A multilevel software package allowing both simple control of mass spectrometer parameters and complex manipulation of data plus control of external devices.



Selected Publications

- [Latest publications](#)
- Negative-ion surface production in hydrogen plasmas: modelling of negative-ion energy distribution functions and comparison with experiments. 2013. A Ahmad et al. *Plasma Sources Sci. Technol.* **22** 025006
- Spatially enhanced Langmuir probe measurements of a magnetically enhanced hollow cathode arc plasma. 2011. B Zimmermann et al. *Surface and coatings technology* **205** 5393-5396
- Quantification of the deuterium ion fluxes from a plasma source. 2011. A Manhard et al. *Plasma Sources Sci. Technol.* **20** 015010
- Advantages of highly ionized pulse plasma magnetron sputtering of silver for improved E. coli inactivation. 2012. O Baghriche et al. *Thin Solid Films* **520** 3567-3573
- Influence of high power impulse magnetron sputtering plasma ionization on the microstructure of TiN thin films. 2011. AP Ehiasarian. *J. Appl. Phys.* **109** 104314

Selected Hiden EQP Users

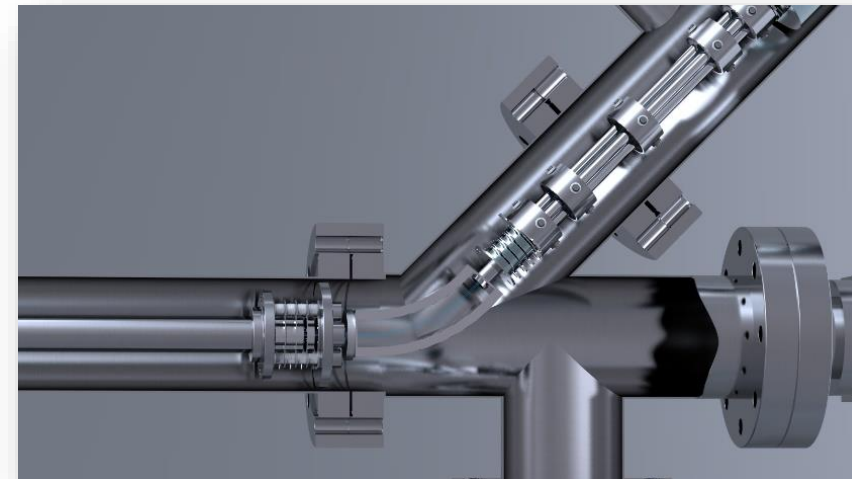
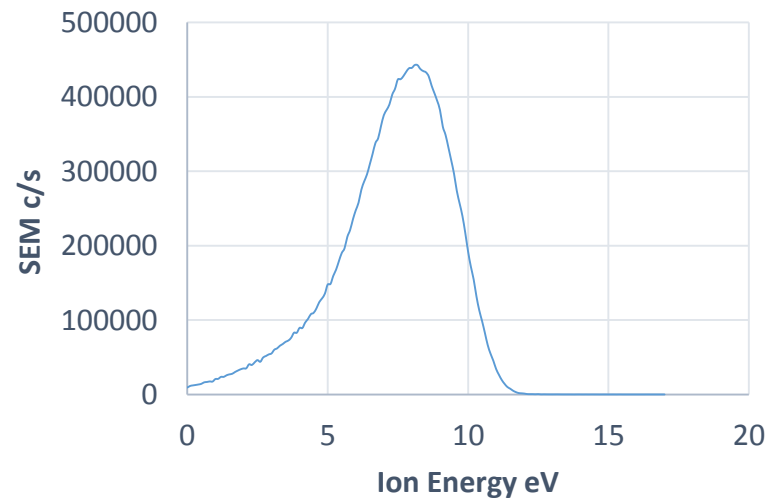


- Xi'an Modern Chemistry Institute
 - University d'Orleans
- Southwest Research Institute
 - KRICT
 - INP Greifswald
 - Applied Materials
 - Fraunhofer IWS
- Ruhr-Universität Bochum



Summary

- High performance probe for mass and energy analysis of ions, radicals and neutrals from a plasma.
- A large number of options are available in order to sample from a variety of plasma types.
- The EQP sees use worldwide in a variety of plasma applications.





Hiden Analytical Ltd.
420 Europa Boulevard
Warrington, WA5 7UN, England

HidenAnalytical.com

info@hiden.co.uk

Tel: +44 (0)1925 445 225

