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HIDEN ANALYTICAL

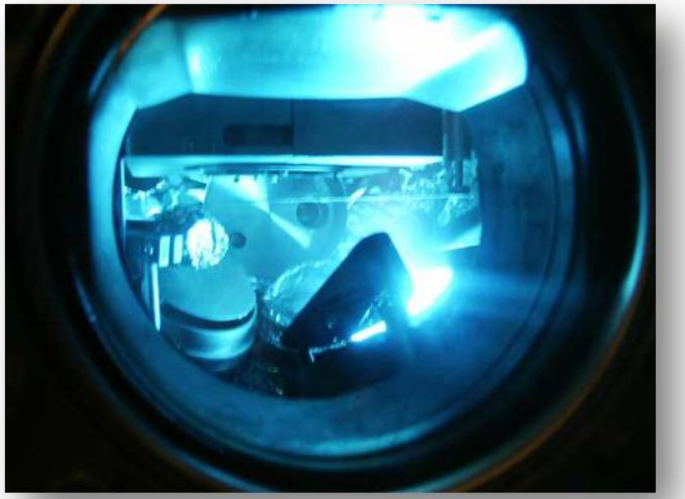
Hiden EQP Series

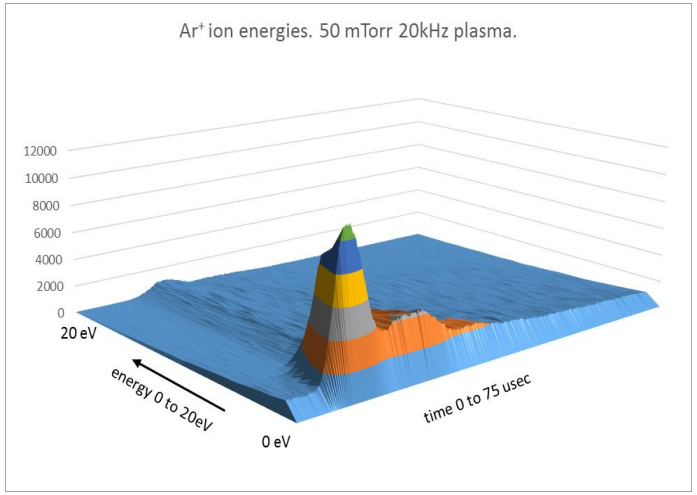
Mass/Energy Analysers for Plasma Diagnostics and Characterisation

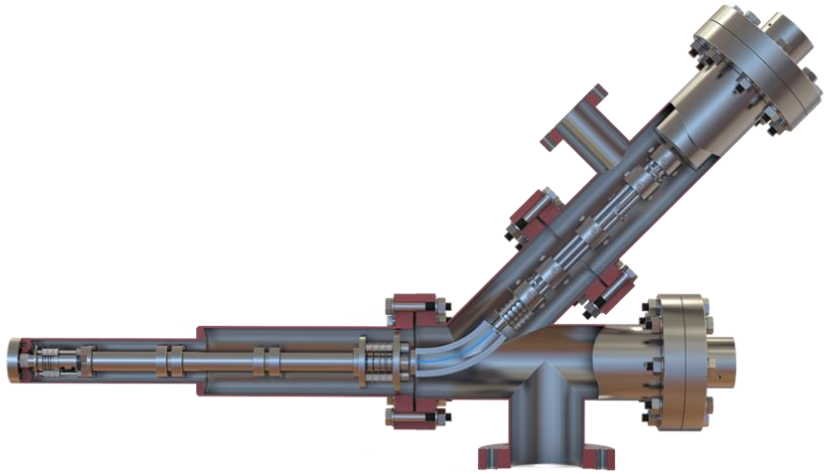
EQP Series Overview

The Hiden EQP Series are advanced plasma diagnostic tools 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 EQP series includes a range of quadrupole mass spectrometers with a choice of mass range and performance for a variety of plasma applications.







EQP Series Overview

The Hiden EQP Series is expanded to include new mass range options as well as Hiden's highest performing, 20mm rod diameter quadrupole.

EQP-6 – 300, 510 amu
The most cost effective of the series, the 6 mm diameter EQP-6, for high sensitivity and stability measurements of plasma species.

EQP-9 – 50, 300, 510, 1000, 2500, 5000 amu
Mass range options for ultra high stability or high mass measurements.

EQP-20 – 20/200 amu
Features Hiden's 20 mm quadrupole with dual zone operation for ultra high resolution low mass analysis.

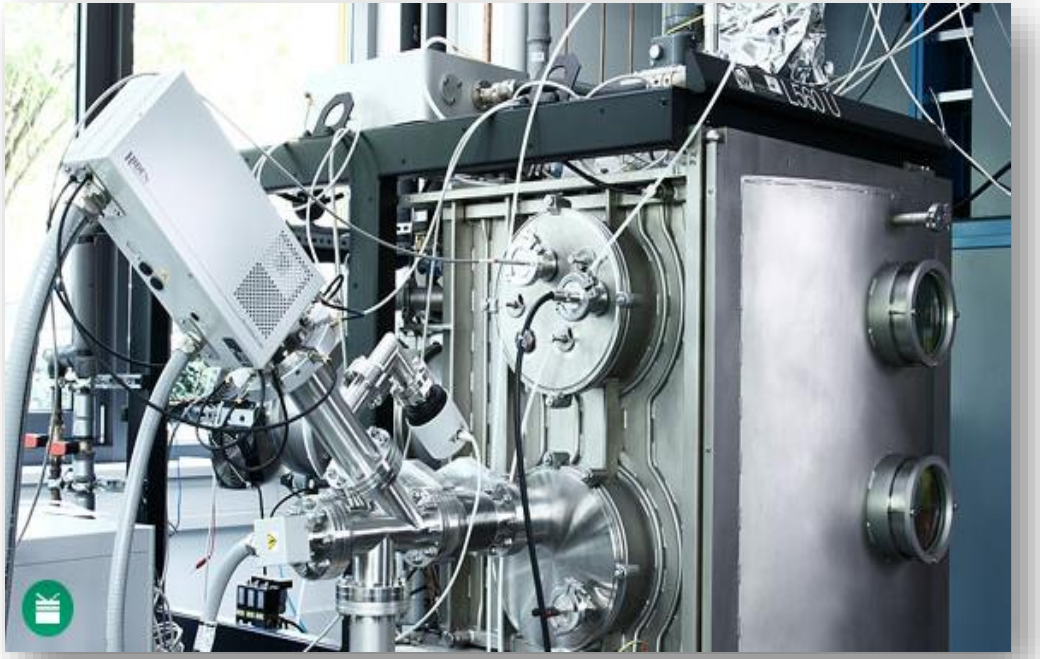
Features

- Sub PPM detection of plasma ions, neutrals and radicals.
- Ion Energy Analysis, 0-100 eV and 0-1000 eV 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: 20, 50, 200, 300, 510, 1000, 2500 or 5000 amu.
- A standard TTL signal gating input is included for time resolved studies.

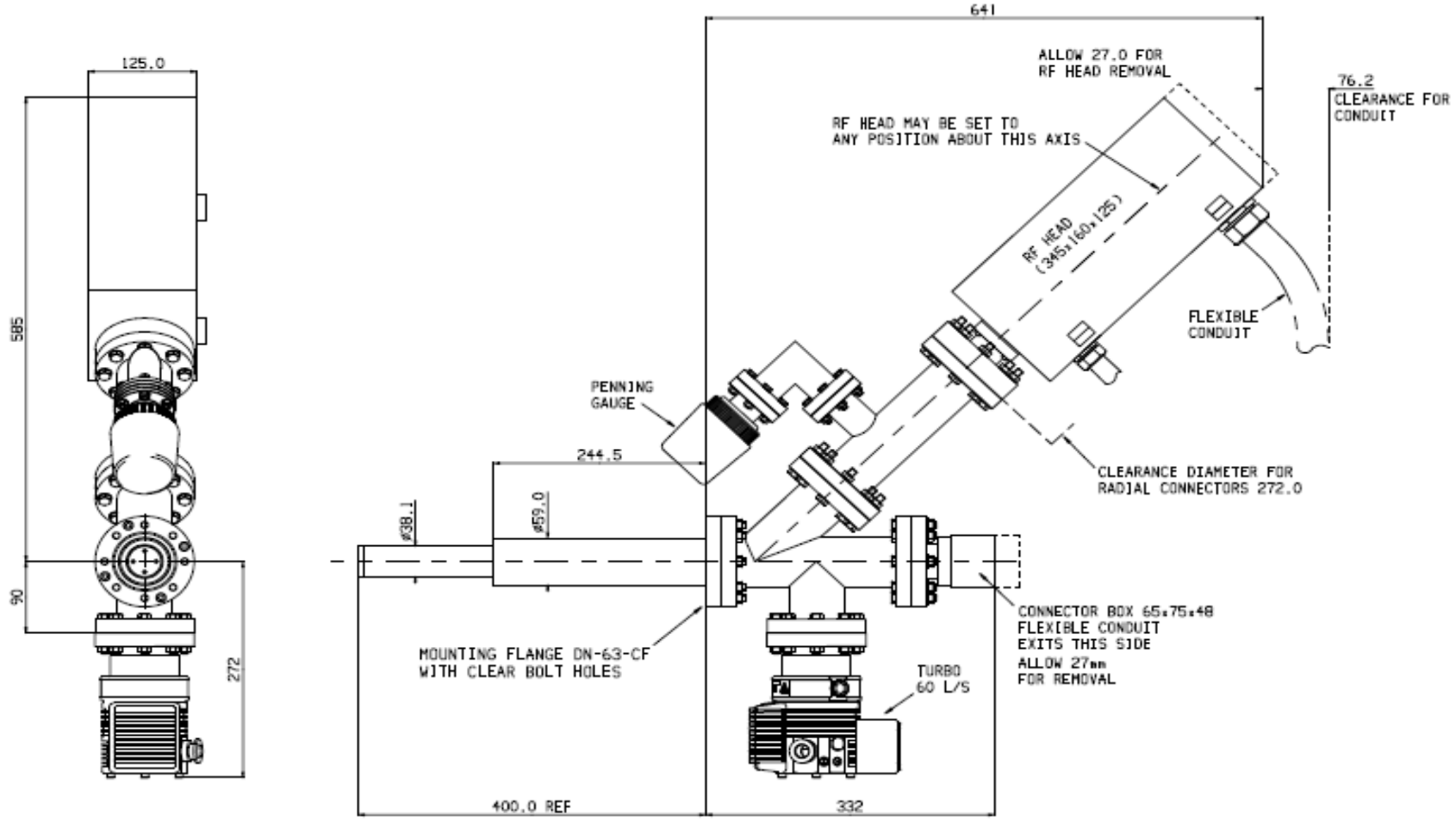
Applications

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:

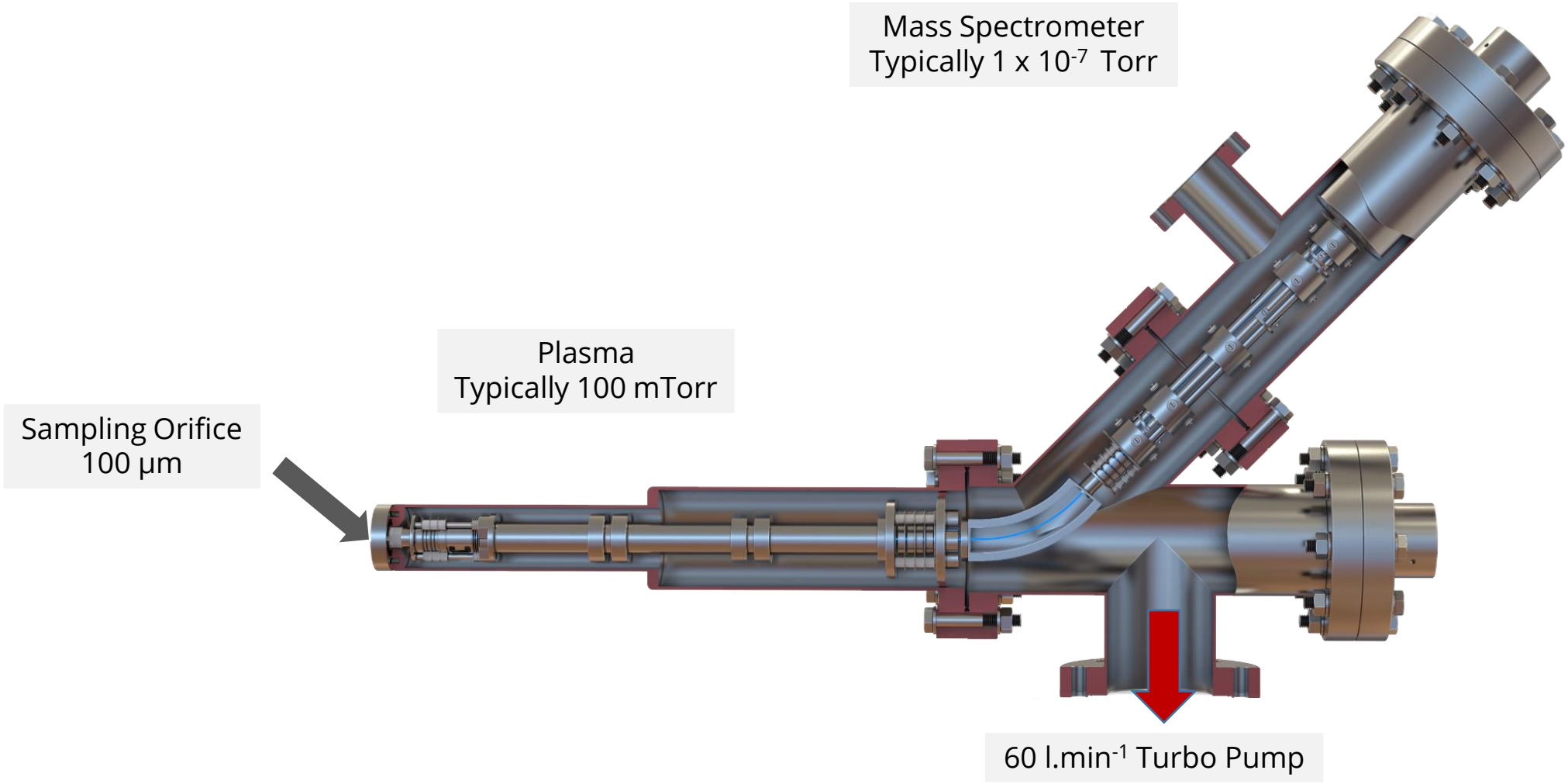
- ECR- Electron Cyclotron Resonance
- HIPIMS
- Magnetron Discharge
- Helicon Source
- DC Glow Discharge Plasma
- Pulsed Plasma & Laser Ablation
- Parallel Plate - RF Plasma
- ICP- Inductively Coupled Plasma



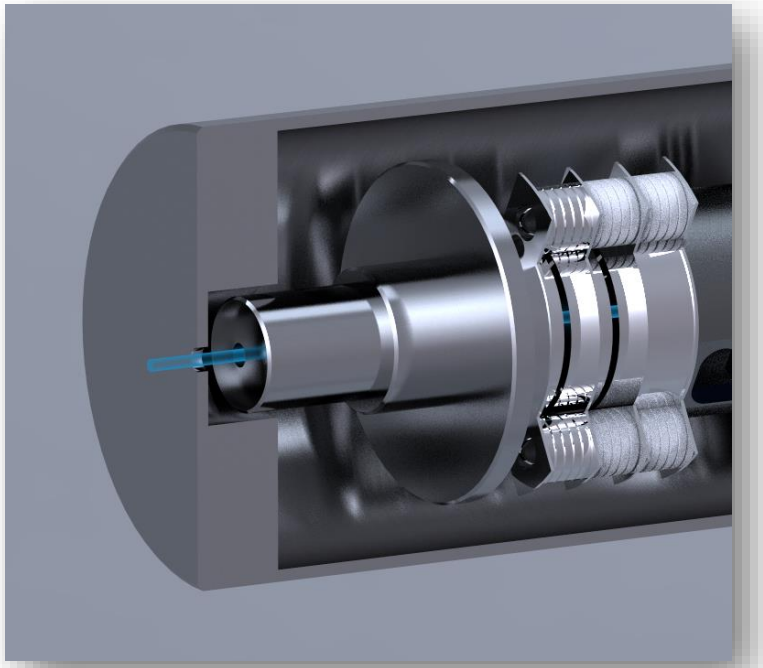
EQP System Schematic



Typical Operating Configuration



Laser Drilled Orifice



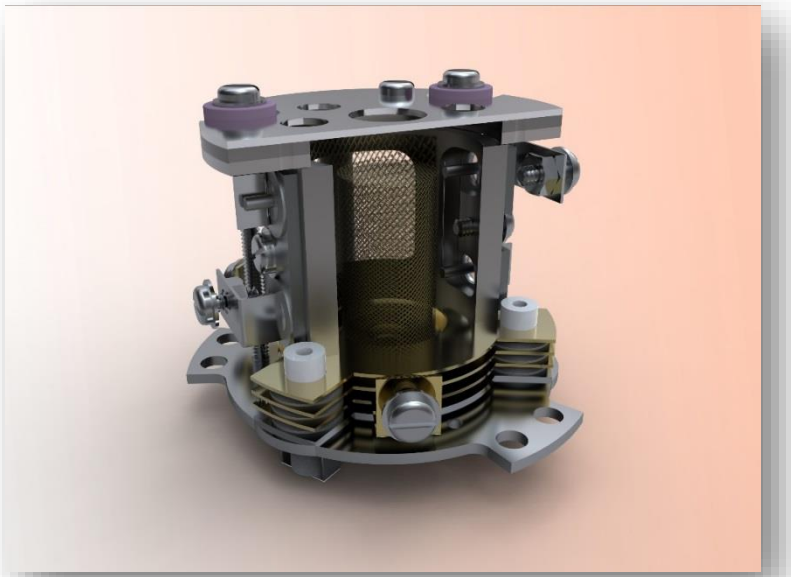
- User selected dimension from 30 - 300 μm.
- +ve / -ve ions, neutrals or radicals.
- Pre-thinned for optimum sampling.
- Plasma electrode coupling option – allows the user to configure the orifice to exactly follow electrode conditions during operation.

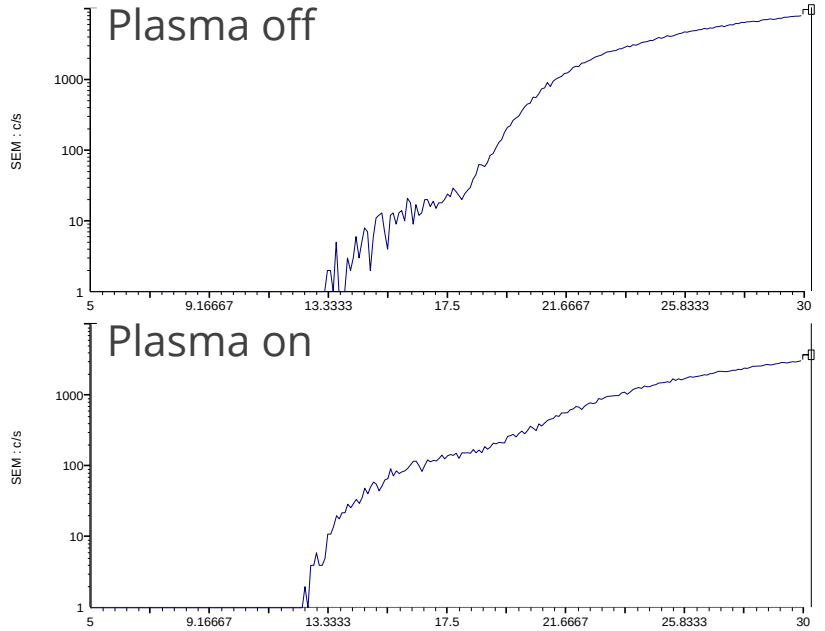
Extraction Optics

- 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.

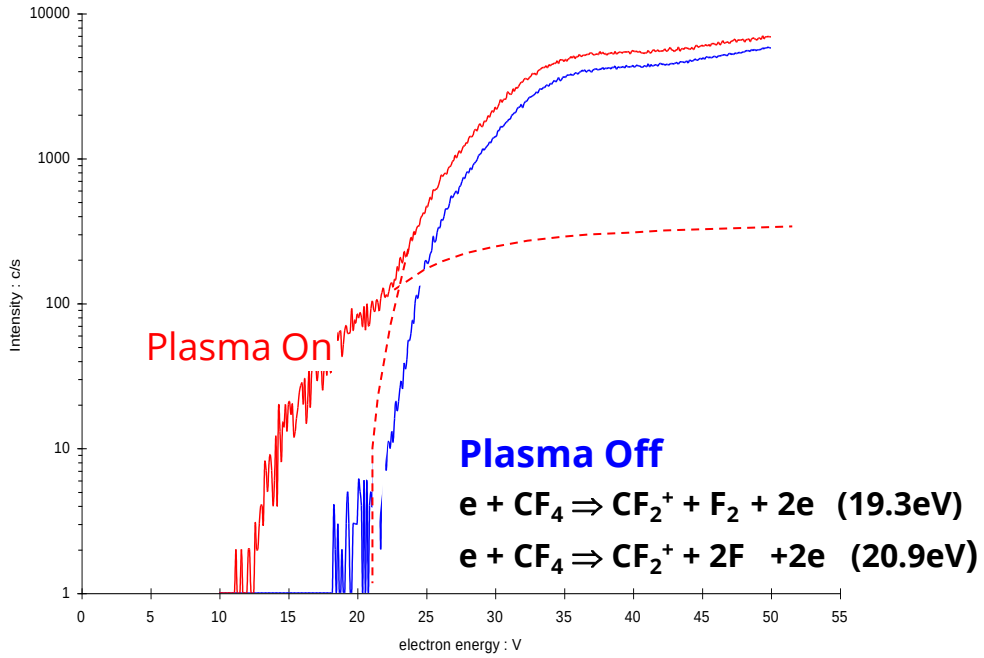




Ion Source Control

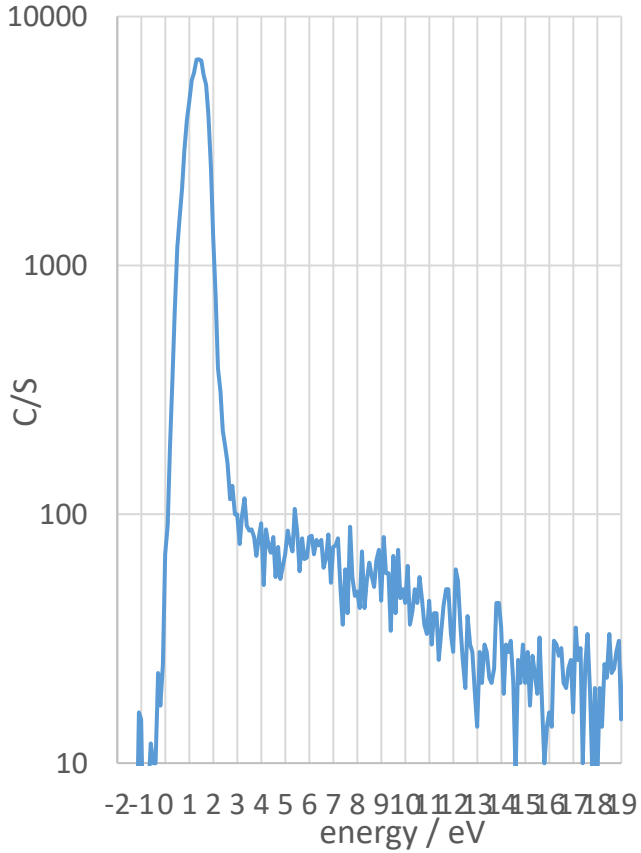
Electron Energy Scans

Plasma On/Off comparison of the production of CF_2 ions.



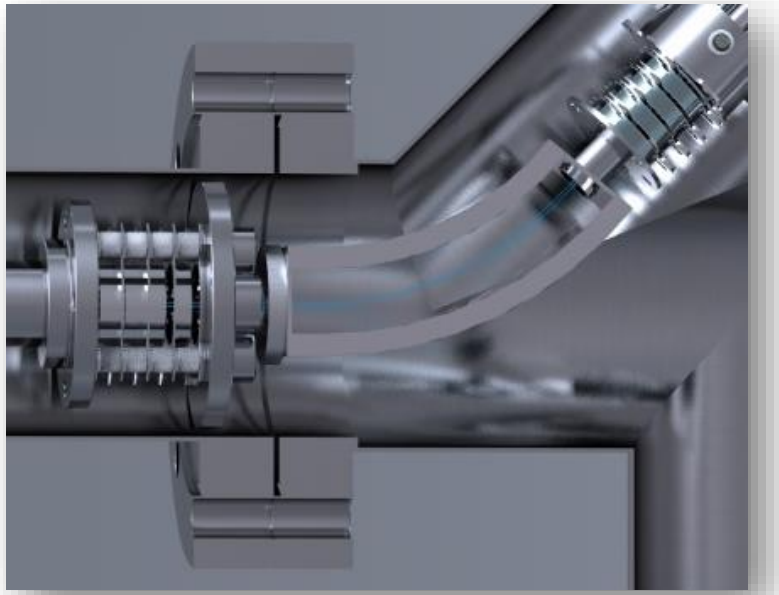
Energy Scan of Fast Neutrals

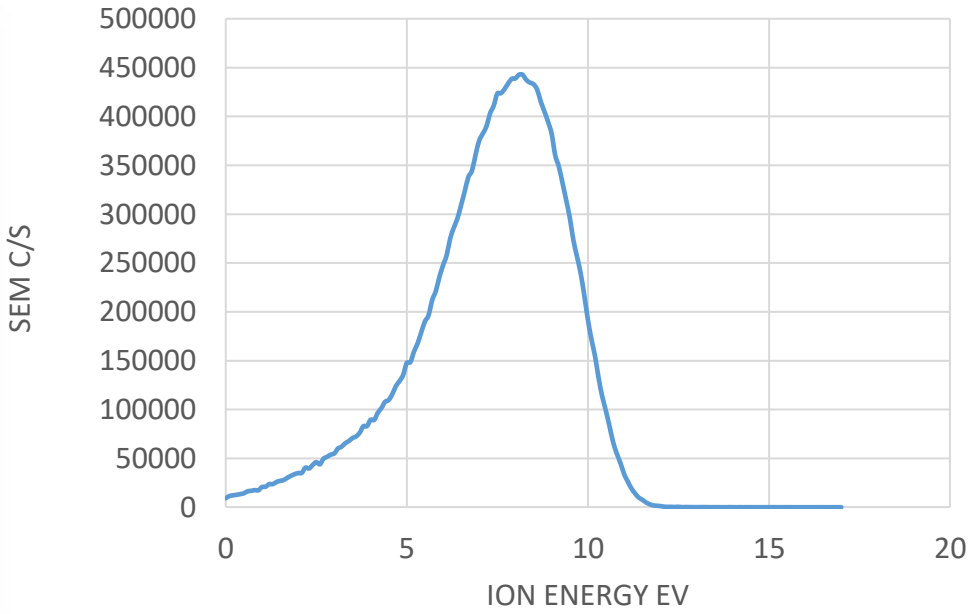
Cu Atom Energy Distribution from a DC magnetron discharge.



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.

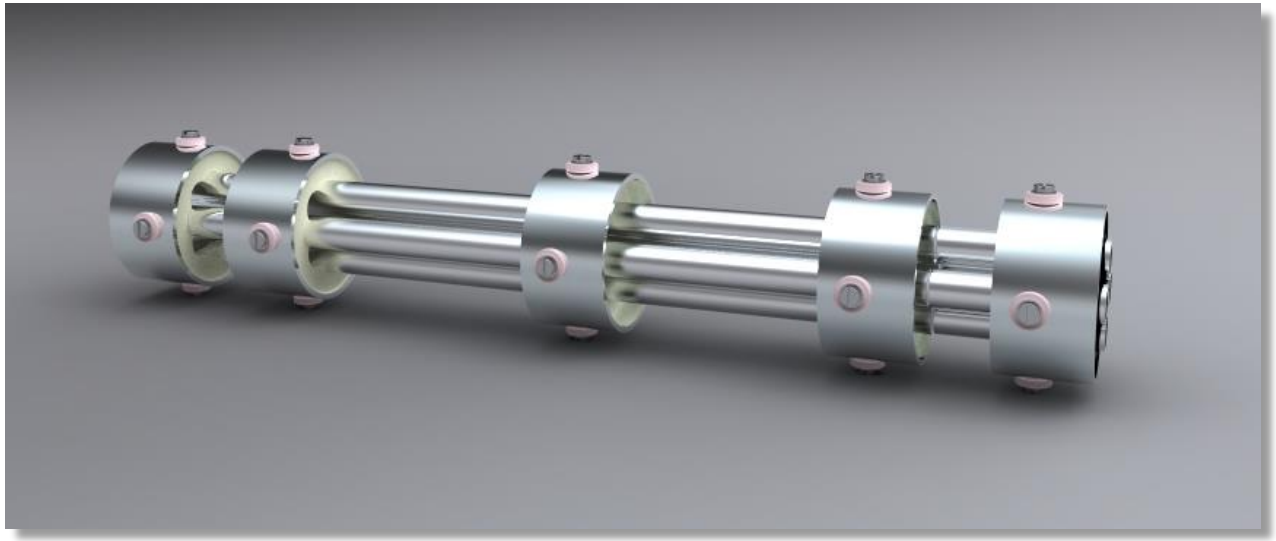




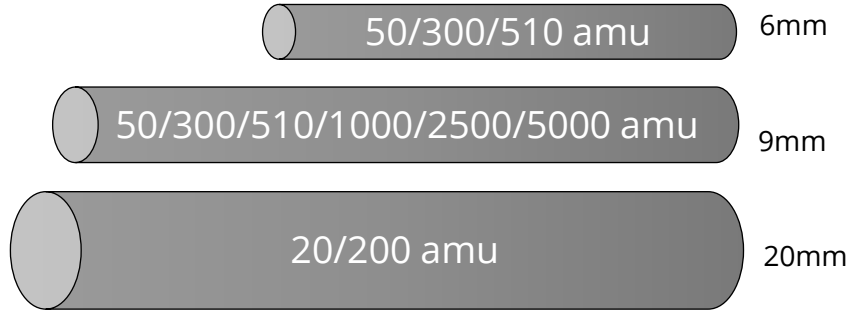
Triple Filter Mass Spectrometer

- 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



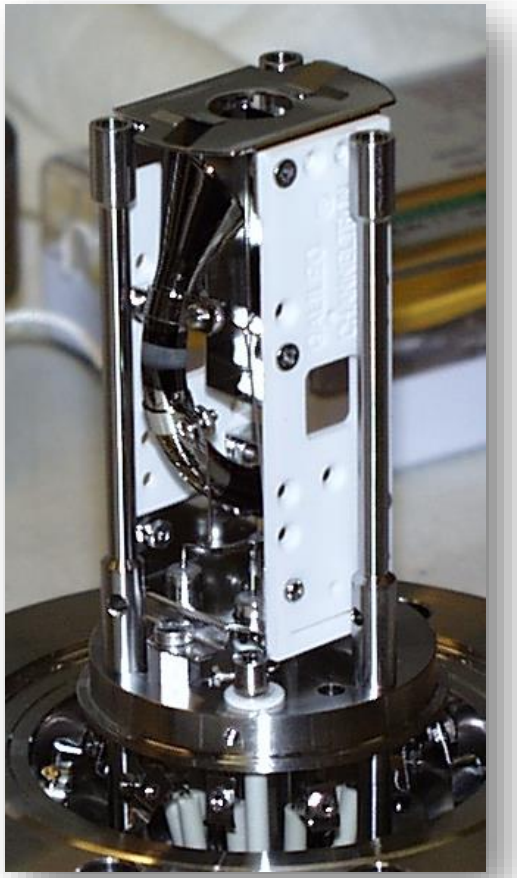
- Configured with 6mm or 9mm

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



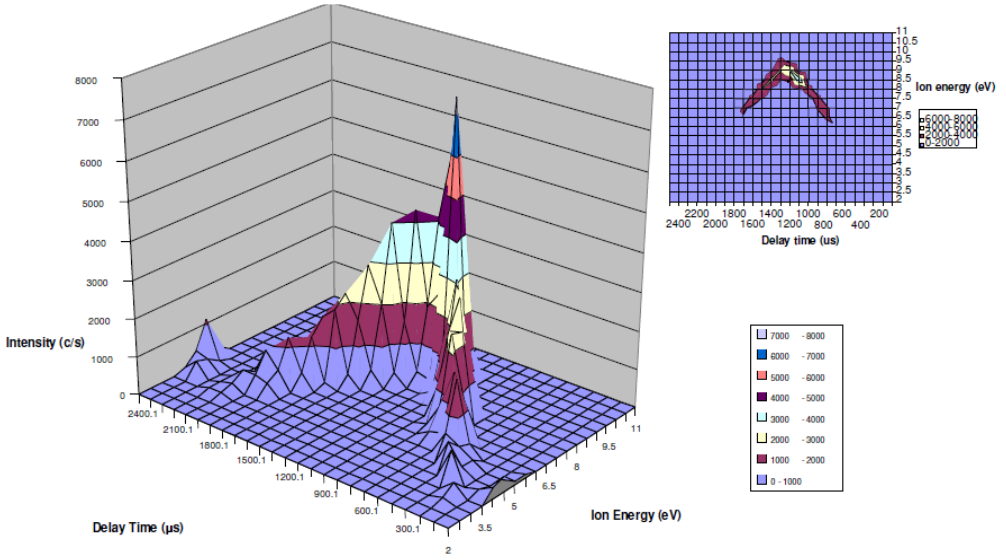
- 7 decade continuous dynamic range.
- 24 bit counter for 1 c/s resolution.
- Faraday Cup option for high density plasmas.
- Signal gating with 50 ns time resolution for energy & mass distributions.
- Comprehensive data export options.

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.

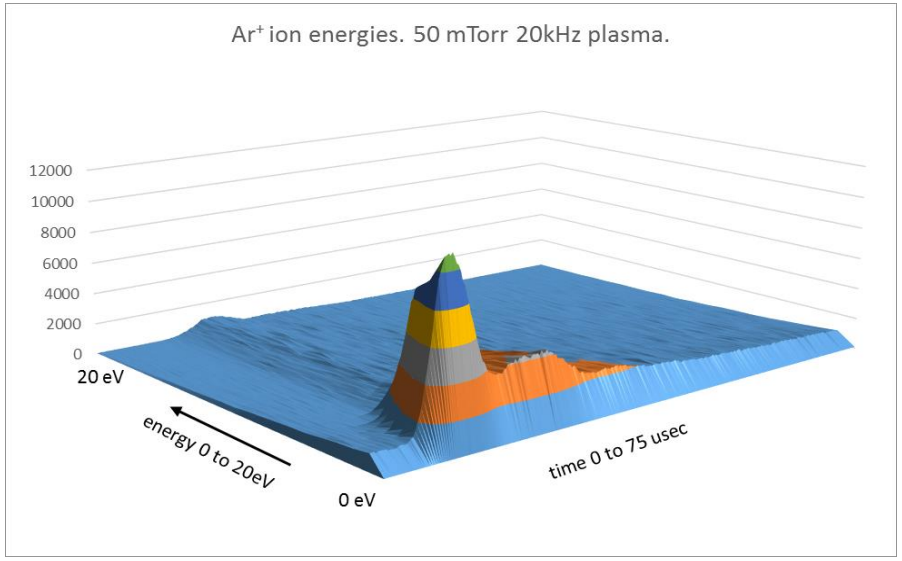
Features:

- 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 Professional 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

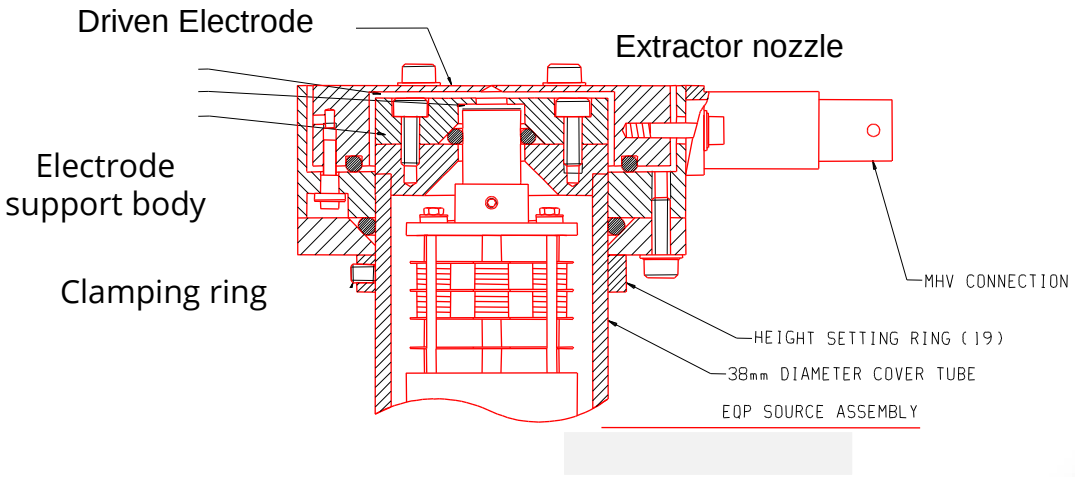
- Analysis through:
  - viewport
  - grounded electrode
  - driven electrode
- High pressure plasmas with double differential pumping.
- Magnetically confined plasmas with optional Mu-metal & radio-metal shielding.
- Analysis of high mass (1000 amu).
- Analysis of high energy (1000 eV).

Configuration Options

1000 amu EQP with z drive

EQP with RF driven electrode

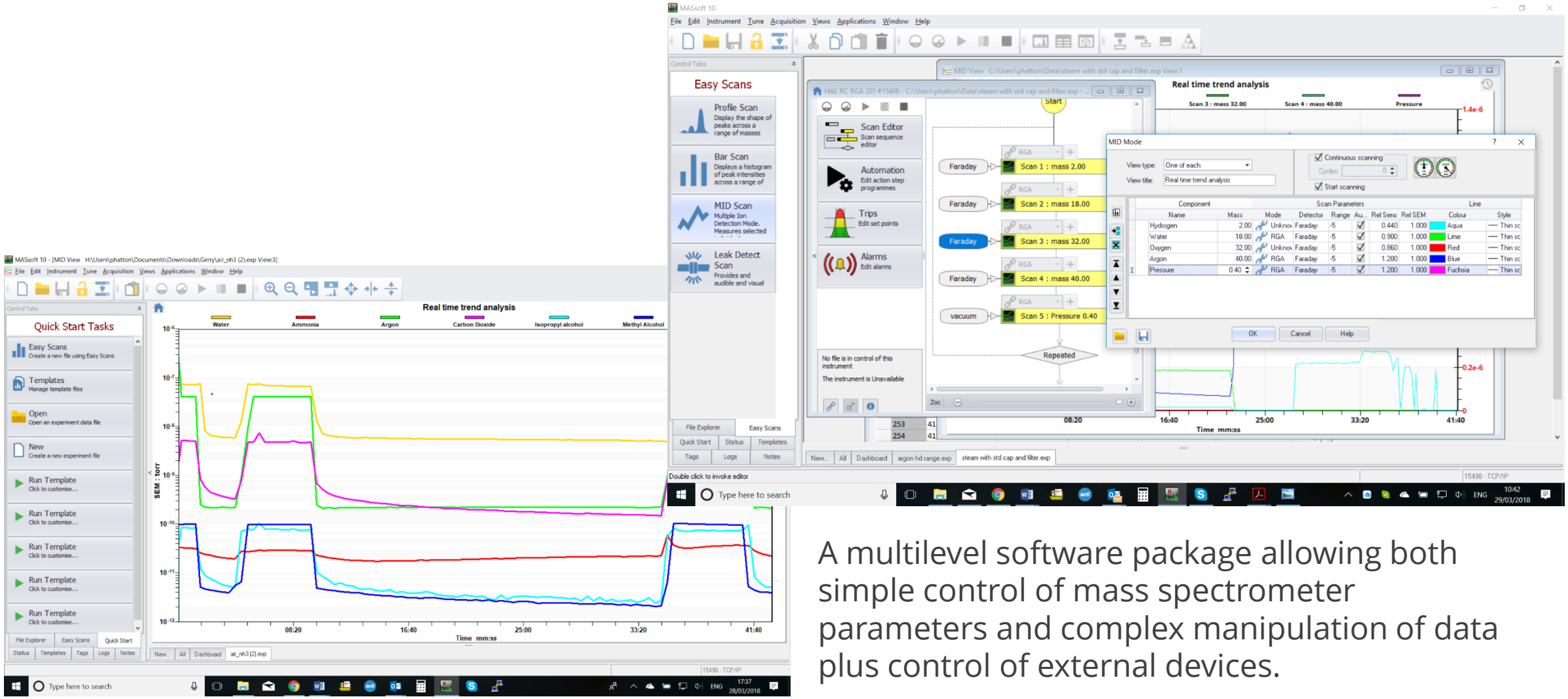
Configuration Options



Driven Electrode

Controllable Orifice Cover

MASsoft 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

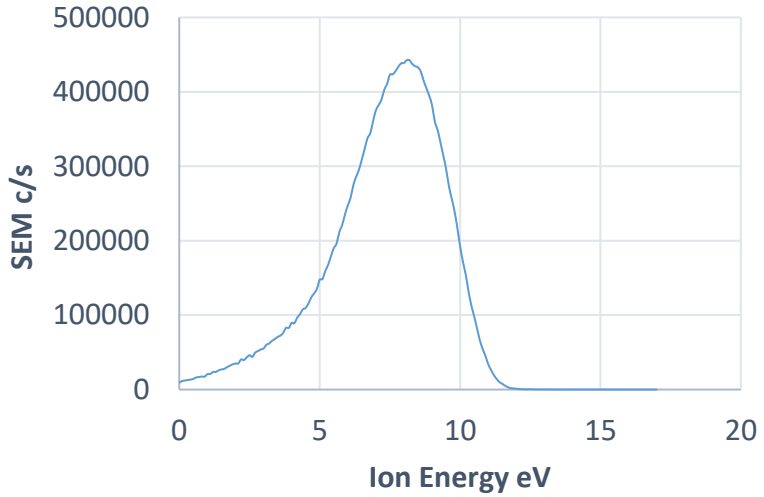
- Latest publications
- Negative-ion surface production in hydrogen plasmas: modelling of negative-ion energy distribution functions and comparison with experiments. 2013. A Ahmad et al. *Plasma Sources Sci. Technol.* **22** 025006
- Spacially enhanced Langmuir probe measurements of a magnetically enhanced 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

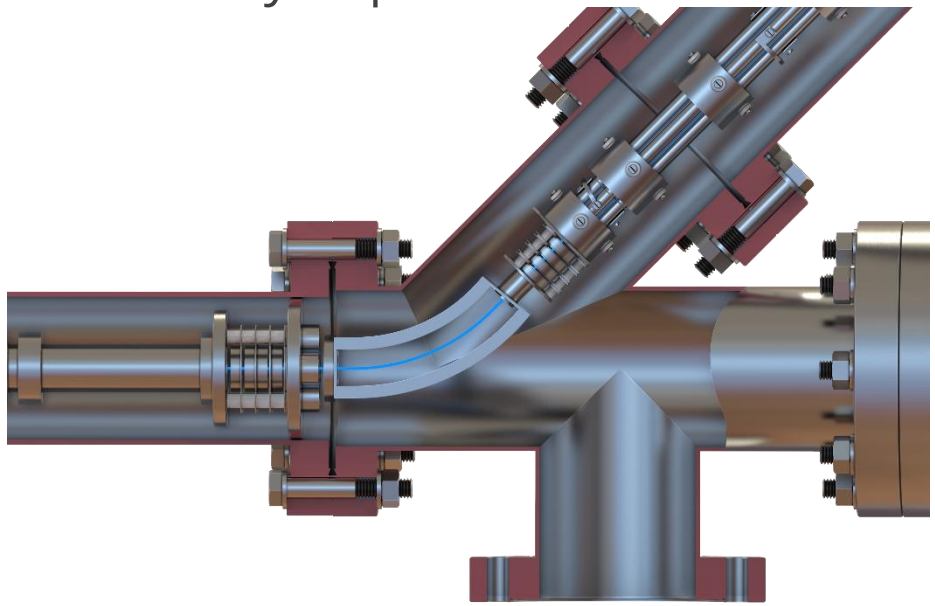
Selected Hiden EQP Users

- 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.





- www.HidenAnalytical.com
- The Hiden website is an excellent resource with product pages, brochures, catalogues, product pages with some application notes, presentation and other information.
- Contact +44 1925 445225 for direct support.