

Trusted in research for over 40 years.
www.HidenAnalytical.com

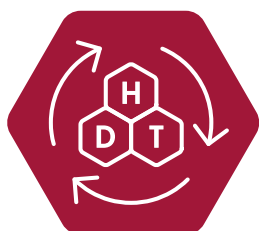


Mass Spectrometry for Nuclear Fusion Research

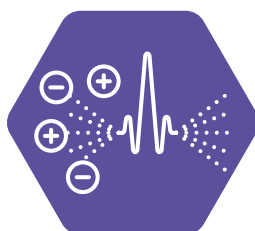
Measure the fuel. | **Characterise the plasma.** | **Understand the materials.**

Hiden Analytical mass spectrometry systems support nuclear fusion research across the fuel cycle, vacuum environment, plasma and plasma-facing materials.

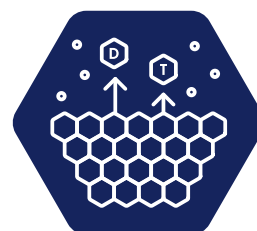
From real-time hydrogen-isotope and residual-gas analysis to species-resolved plasma diagnostics, SIMS depth profiling and thermal desorption studies, our instruments help researchers connect operating conditions with measurable physical and chemical behaviour.



**Fusion Fuel
Cycle & Vacuum
Diagnostics**



**Plasma Diagnostics
with Mass & Energy
Analysis**



**Hydrogen
Isotope Retention
& Release**





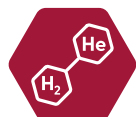
What Do You Need to Measure?
Talk to us about your fusion research.

Fusion Fuel Cycle and Vacuum Diagnostics

Follow hydrogen and helium isotopes through fuel, exhaust and vacuum systems.

Accurate gas analysis helps researchers quantify fuel composition, identify impurities and track vacuum conditions.

Hidden systems provide real-time quantitative gas analysis together with high- and ultra-high-resolution separation of closely spaced light species. For DLS-2/DLS-2X and DLS-20, software-selectable Dual Zone operation combines isotope-focused measurements with analysis of the wider residual-gas environment. Remote analyser configurations support demanding fusion installations where sensitive electronics must be located away from the measurement point.



Hydrogen-isotope analysis



Fusion fuel cycle studies



Vacuum diagnostics and residual gas analysis

What Can You Measure?

- Hydrogen and helium isotopes
- Deuterated compounds and overlapping light species
- Fusion fuel-gas composition and purity
- Residual gases and vacuum contaminants
- Leaks, trends and changes in vacuum conditions

RELEVANT HIDDEN SOLUTIONS

DLS-2 / DLS-2X



Dual Zone Isotope and Vacuum Analysis

- Software-selectable Zone H and Zone 1
- 0.02 or 0.0065 amu real-time separation, depending on configuration
- 10 ppm He-in-D₂ / D₂-in-He sensitivity
- DLS-2X analyser placement up to 140 m from sensitive electronics

DLS-20



Ultra-High-Resolution Isotope Analysis

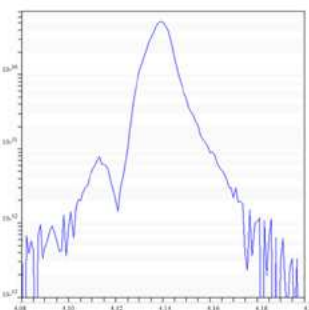
- 0.006 amu real-time mass separation
- Zone H operation up to 22.5 amu
- Zone 1 operation up to 200 amu
- 1 ppm He-in-D₂ / D₂-in-He sensitivity
- Separation of ³He from HD by mass

HAL 101X



Remote Gas and Vacuum Monitoring

- Remote analyser mounting up to 140 m
- Threshold Ionisation Mass Spectrometry (TIMS) mode for fusion fuel-gas purity measurements
- Real-time complex gas and vapour analysis
- Leak detection, trend analysis and vacuum surveys



Resolved ⁴He and D₂ mass signals from a certified 3:97 mixture, measured using the Hidden HAL 101X during ITER diagnostic gas analyser testing ¹.

Reference:

¹ C. Marcus and R. Mellor, "Understanding the Quadrupole Mass Filter and Testing a High-Resolution QMS RGA for ITER," 68th Annual Technical Conference Proceedings, Society of Vacuum Coaters (2025). DOI: 10.14332/svc25.proc.0021. **Fig. 7.**

Plasma Diagnostics with Mass and Energy Analysis

Move from bulk plasma conditions to species-resolved chemistry and energy.

Knowing which species are present is only part of the picture. Their charge state and energy distributions provide insight into plasma formation, transport, sheath behaviour, plasma-surface interactions and ion-source performance.

Hidden plasma diagnostic systems support mass- and energy-resolved analysis of positive and negative ions together with neutral and radical species. Molecular-beam sampling extends this capability across pressure interfaces while minimising reactions and wall interactions after sampling.



Ion species analysis



Ion energy analysis



Measurement of neutrals and radical species

What Can You Measure?

- Positive and negative ion species
- Ion energy distribution functions
- Measurement of neutrals and radical species
- Reactive gas-phase intermediates
- Pulsed and time-dependent plasma behaviour

RELEVANT HIDEN SOLUTIONS

EQP Series



Mass and Energy Analysis of Plasma Species

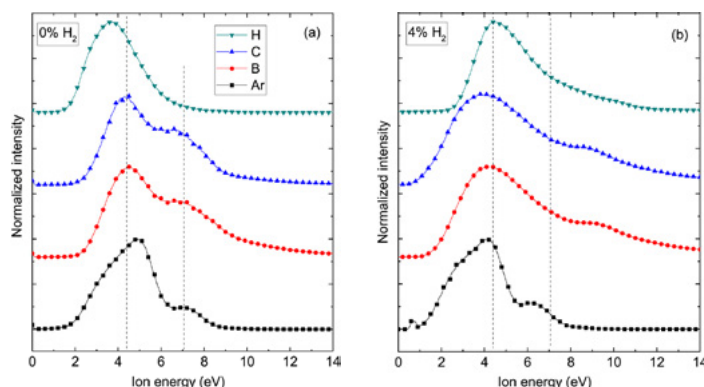
- Positive and negative ion characterisation
- Measurement of neutrals and radical species
- Ion energy analysis up to 1000 eV
- Time resolution to 50 ns for pulsed plasmas

HPR-60 MBMS



Molecular-Beam Sampling of Reactive Plasmas

- Neutrals, radicals and positive/negative ions
- Multistage differentially pumped skimmer inlet
- Minimal species interaction and wall collisions
- Fast response, customisable plasma interfaces



Mass-resolved ion energy distributions measured using a Hidden EQP-6 during magnetron sputtering of boron carbide films, showing species-resolved plasma behaviour relevant to fusion-facing coating development ².

Reference:

² M. S. Wong et al., "Effects of hydrogen on sputter-deposited boron carbide films," *Journal of Applied Physics* 138 (2025) 095301. DOI: 10.1063/5.0272124. **Fig. 4.**



What Do You Need to Measure?
Talk to us about your fusion research.

HIDEN
ANALYTICAL

Hydrogen Isotope Retention and Release

Connect isotope depth profiles with temperature-dependent release.

Hydrogen isotopes can be implanted, trapped, transported and released from plasma-facing materials, structural alloys, coatings and getter systems.

SIMS provides depth-resolved elemental and isotope information, helping researchers understand where species are retained and how their distribution changes through a material. Thermal desorption mass spectrometry complements this by identifying when retained species are released and which gases evolve as sample temperature increases. Together, these techniques provide a more complete picture of isotope uptake, transport, trapping and release in fusion-relevant materials.



Depth profiling



Isotope transport and retention



Thermal desorption studies

What Can You Measure?

- Elemental and isotope depth profiles
- Surface and near-surface composition
- Isotope transport and retention
- Effects of irradiation and surface treatment
- Temperature-dependent desorption
- Evolved hydrogen-isotope species

RELEVANT HIDEN SOLUTIONS

SIMS Workstation



Depth-Resolved Isotope and Materials Analysis

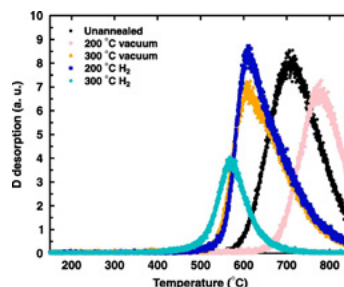
- Isotope and elemental depth profiling
- Dynamic and static SIMS in one system
- Positive and negative secondary-ion detection
- Choice of primary sources and charge neutralisation

TDSLab Series



Temperature-Resolved Isotope Release

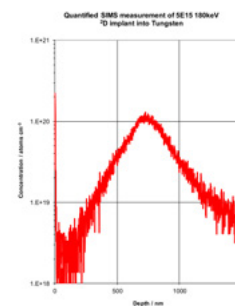
- Controlled sample heating from -100 to 1000 °C
- 0.01 wt ppm H₂ detection
- UHV thermal desorption
- High resolution MS options



Deuterium thermal-desorption profiles from WMoTaNbV measured using a Hiden thermal-desorption workstation, showing temperature-dependent release following vacuum and H₂ annealing [\[3\]](#).

Reference:

[\[3\]](#) T. Vuoriheimo et al., "Hydrogen isotope exchange experiments in high entropy alloy WMoTaNbV," *Nuclear Materials and Energy* 34 (2023) 101348. DOI: 10.1016/j.nme.2022.101348. **Fig. 5.**



Nuclear fusion produces very high energy protons which implant in the reactor walls. Here SIMS has been used to detect deuterium implanted into tungsten as a simulation for the material effects in a fusion reactor wall.