

Agilent 8900 Triple Quadrupole ICP-MS

LEAVE INTERFERENCES BEHIND WITH MS/MS



Agilent Technologies

PUT YOUR ICP-MS RESULTS BEYOND DOUBT

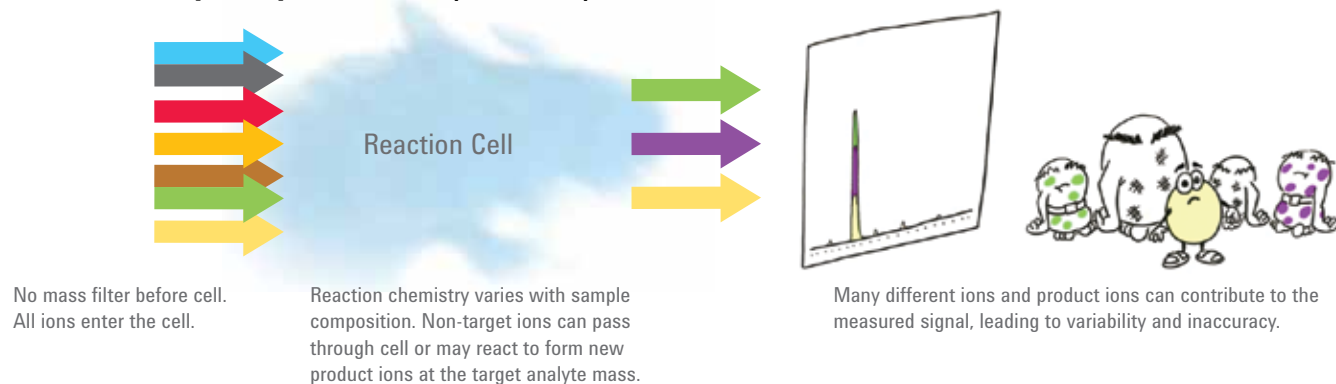
Interference removal is more reliable and easier to achieve with Agilent's 2nd generation 8900 ICP-QQQ

In 2012 Agilent released the Agilent 8800, the world's first triple quadrupole ICP-MS (ICP-QQQ) with MS/MS capability. This ground-breaking instrument opened up new analytical possibilities for analysts in hundreds of laboratories around the world.

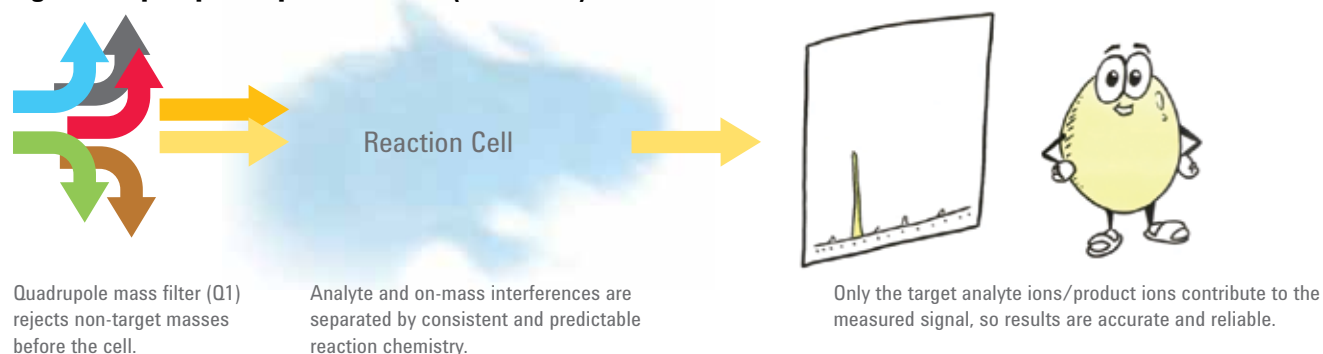
The new 2nd generation 8900 ICP-QQQ offers a range of configurations to cover applications from routine analysis to advanced research and high performance materials analysis. With helium mode performance and productivity to match Agilent's market-leading quadrupole ICP-MS systems, the Agilent 8900 ICP-QQQ adds MS/MS mode for controlled and consistent interference removal in reaction mode, making it the world's most powerful and flexible multi-element analyzer.

The MS/MS advantage for reaction gas methods

Conventional quadrupole ICP-MS (ICP-QMS)

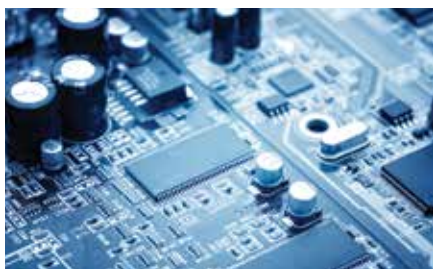


Agilent triple quadrupole ICP-MS (ICP-QQQ)



PROVEN ICP-QQQ TECHNOLOGY

Agilent's unique triple quadrupole ICP-MS uses MS/MS, enabling hundreds of labs around the world to do more than ever before



Dissolved metal and particulate contamination of **process chemicals** is a major issue for semiconductor manufacturing. Triple quadrupole ICP-MS is used to monitor lower levels of ultra-trace contaminants in bulk chemicals and wafer processing baths to ensure high product yield and minimize failure rates.



Manufacturers of **advanced electronic and battery components** need high purity rare earth element raw materials. Triple quadrupole ICP-MS allows suppliers to certify their raw materials at lower levels of other rare earth contaminants, guaranteeing better quality final products.



Now ICP-QQQ can be used to accurately quantify unknown **proteins and peptides**, using MS/MS mode to measure the sulfur and phosphorus heteroelements accurately at low concentrations; this represents a completely new application capability for ICP-MS in life sciences and biopharma.

For Research Use Only. Not for use in diagnostic procedures.



Agilent's triple quadrupole ICP-MS efficiently removes both polyatomic and doubly-charged interferences, so arsenic and selenium can be measured with better accuracy at lower levels in all **food samples**. And the high sensitivity of the ICP-QQQ means that arsenic speciation can be performed at lower levels than ever before.



There's increasing interest in measuring **nanoparticles (NPs)** in the environment, food, and biological systems. But NPs based on silica and titanium are difficult to measure at small enough particle sizes using quadrupole ICP-MS. Triple quadrupole ICP-MS with MS/MS can characterize these NPs in complex samples, even at the sub-50 nanometer scale.



Reaction cell chemistry in Agilent's triple quadrupole ICP-MS can separate direct isobaric overlaps, including mercury 204 on lead 204, and ytterbium and lutetium 176 on hafnium 176, to give access to important isotopic clocks in **geochronology**; this is far beyond the resolution available on sector field high-res ICP-MS.

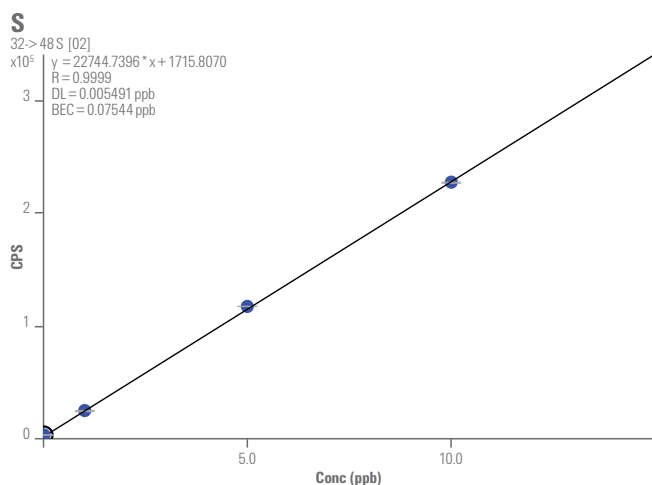
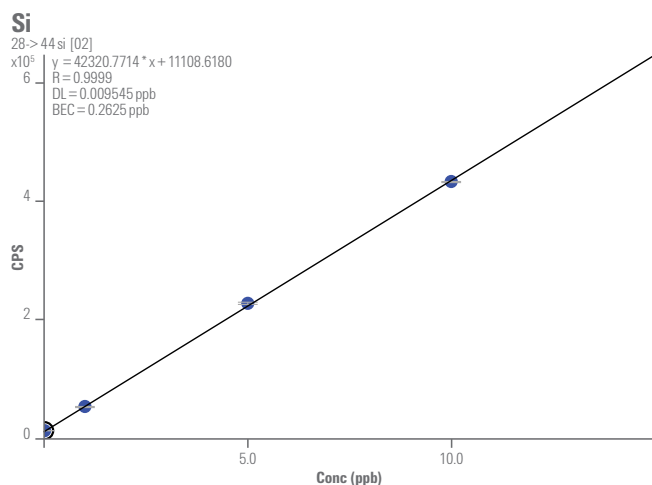
BE SURE WITH ICP-MS/MS

The new Agilent 8900 ICP-QQQ provides outstanding performance for existing multi-element ICP-MS applications. The Agilent 8900 also introduces new analytical capabilities not previously possible using ICP-MS. Low level determination of previously difficult elements, separation of direct isobaric overlaps, and fast, trace analysis of emerging nano-scale materials extend the application of ICP-MS into new fields of analysis.

Ultra-trace analysis of Si and S

Si and S suffer from intense polyatomic interferences and have not previously been possible to measure at ng/L (ppt) levels using quadrupole ICP-MS. ICP-QQQ offers the most reliable approach to resolving interferences using MS/MS and reactive cell gases. The Agilent 8900 ICP-QQQ Advanced Applications and Semiconductor configurations add unprecedented control of background signals for silicon and sulfur, using a new gas flow system to minimize Si and S contamination.

The calibrations below demonstrate detection limits (DLs) of <10 ng/L for Si (top) and S (bottom) using the Agilent 8900 ICP-QQQ in MS/MS mode with O₂ cell gas.

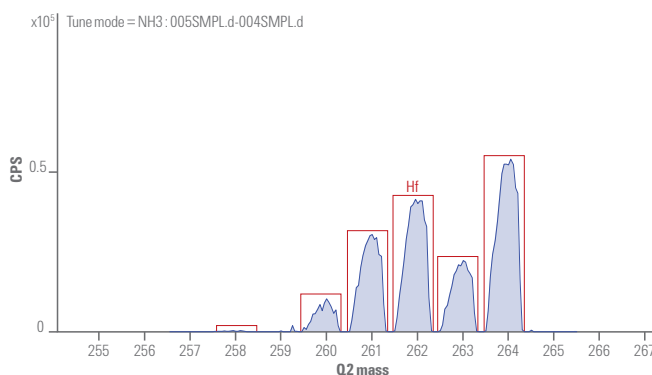


Resolve isobaric overlaps

How can ICP-QQQ, operating at a nominal resolution of 1 amu, provide superior resolution to sector-field high-resolution (HR) ICP-MS? The answer lies in the selectivity of reaction chemistry with MS/MS. By choosing a cell gas that reacts with one element and not another, ICP-QQQ can use MS/MS to separate directly overlapping isobars – isotopes of different elements that occur at the same mass, for example ²⁰⁴Hg on ²⁰⁴Pb. This would require mass resolution (M/DM) far beyond the capability of commercial HR-ICP-MS.

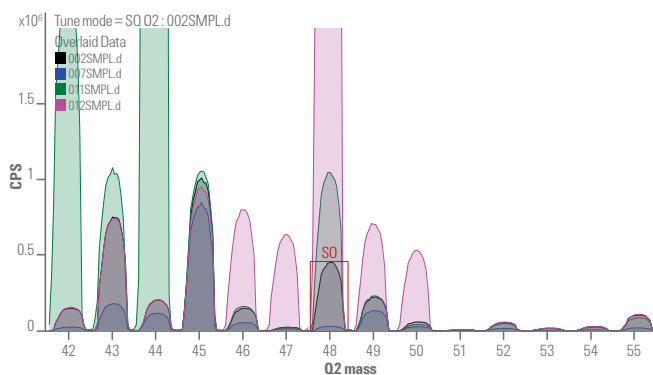
There are several applications in geochemistry, geochronology and nuclear science where isobaric overlaps make accurate analysis difficult. Examples include the accurate determination of ¹⁷⁶Hf/¹⁷⁷Hf ratios, Pb/Pb and Pb/U dating, and Rb-Sr ratio analysis.

The spectrum below shows Hf measured as the product ions Hf(NH₂)(NH₃)₄⁺ using the Agilent 8900 ICP-QQQ. MS/MS allows accurate ¹⁷⁶Hf/¹⁷⁷Hf isotope ratios to be measured in the presence of Lu, Yb and other matrix elements that might overlap at *m/z* 176.

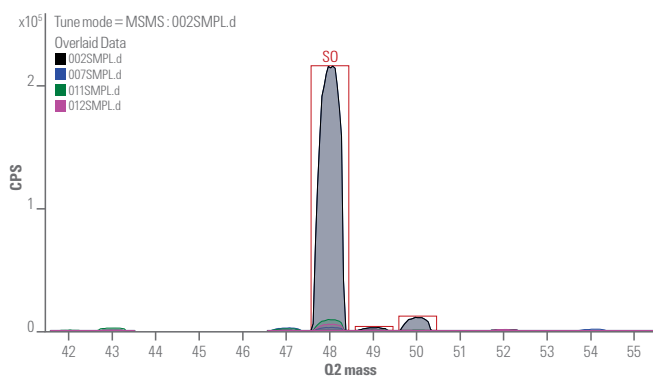


Accurate analysis of sulfur and sulfur isotope ratios using MS/MS

Using O_2 cell gas, S can be measured as the product ion SO^+ at m/z 48 (for the major ^{32}S isotope), 49, and 50. Measurement of multiple isotopes allows S isotope ratio analysis and accurate quantification using isotope dilution (ID). The Agilent 8900 ICP-QQQ with MS/MS is essential for this application, as carbon, calcium and titanium can cause interference on the SO^+ product ions, as illustrated below.



Without MS/MS, Ca (in green), Ti (in pink), and C (in blue) cause severe overlaps on the SO^+ product ions.

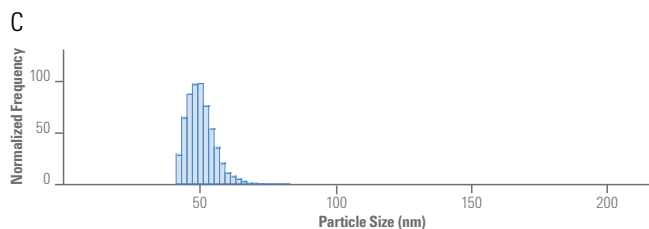
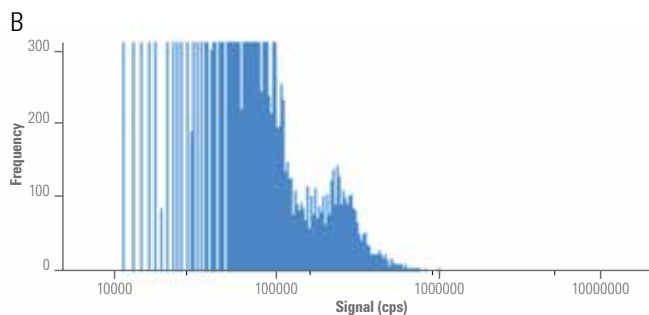
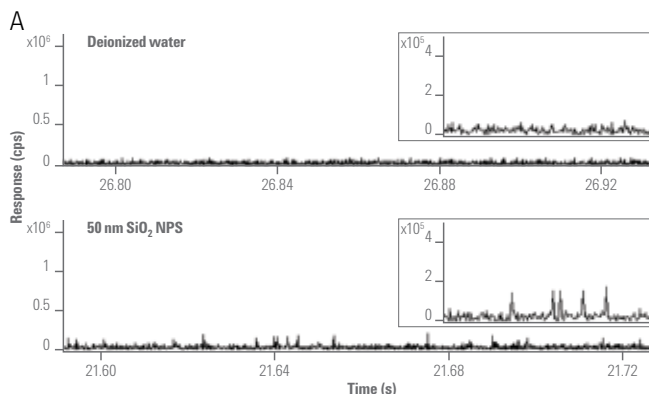


With MS/MS, the Ca^+ , Ti^+ and C^+ ions are rejected by Q1, so the SO^+ product ions are measured accurately and consistently, free from overlap.

Nanoparticle (NP) characterization using single particle ICP-MS (spICP-MS)

The Agilent 8900 ICP-QQQ supports fast time resolved analysis (TRA) with a minimum dwell time of 0.1 ms. High speed is combined with effective interference removal, extending existing ICP-MS NP analysis to include particles composed of elements such as Si, S, Fe and Ti, that are difficult to measure using quadrupole ICP-MS.

The example below shows that 50 nm SiO_2 NPs can easily be distinguished from the signal in the blank DI water (A), allowing the frequency distribution to be plotted (B) and the particle size to be determined accurately (C).



LEAVE INTERFERENCES BEHIND WITH MS/MS

SAMPLE INTRODUCTION

Low-flow, Peltier-cooled sample introduction system provides stability and consistency. Optional Integrated Sample Introduction System (ISIS 3) adds a piston pump and close-coupled 7-port valve for high-speed discrete sampling.



ULTRA HIGH MATRIX INTRODUCTION (UHMI)

UHMI increases matrix tolerance up to 25% total dissolved solids (TDS). UHMI is standard on the 8900 Standard and Advanced Applications configurations, ensuring high matrix samples can be measured routinely, and eliminating matrix suppression.



GAS CONTROL

Four channel argon mass flow control for plasma gases. Advanced and Semiconductor configurations include 5th (option) gas controller and low Si/S argon flow path.

27 MHz PLASMA RF GENERATOR

The fast, frequency-matching RF generator offers the highest power transfer efficiency, tolerating changing sample matrices including volatile organic solvents.

PLASMA AND SHIELD TORCH SYSTEM (STS)

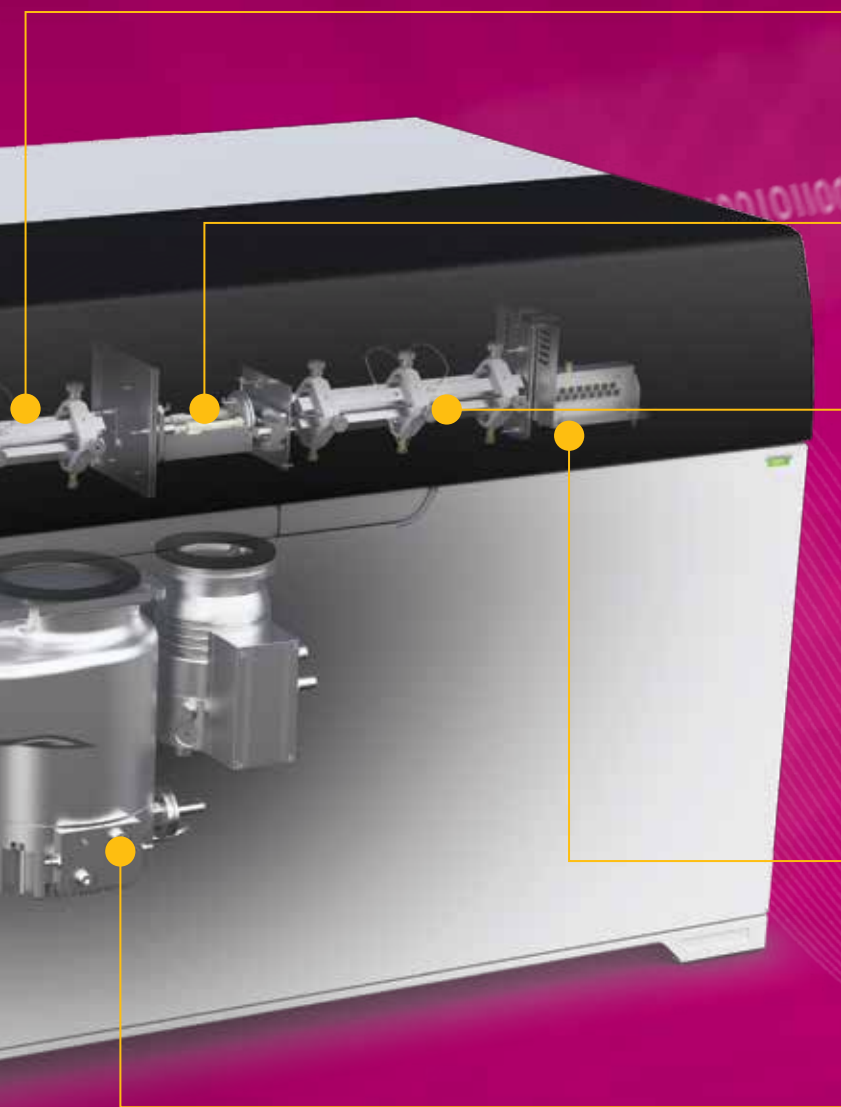
Provides high energy for effective matrix decomposition, and precise ion energy control for efficient interference removal in helium mode. Torch auto-aligns following routine maintenance.

INTERFACE CONES

Ni or Pt-tipped cones deliver exceptional matrix tolerance and high sensitivity. Screw-threaded for easy removal during routine maintenance.



Some items shown are optional at additional cost.
Contact your Agilent Representative for further details.



ION LENS

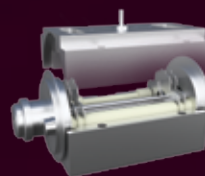
The dual Extraction lens and off-axis Omega lens provide high ion transmission and matrix tolerance in a single optimized interface. The ion lens is located outside the high vacuum region, making it easy to access for routine maintenance.

FIRST QUADRUPOLE (Q1)

High frequency, hyperbolic quadrupole. In MS/MS, Q1 rejects all masses except the target analyte mass, simplifying reaction chemistry in the cell.

4TH-GENERATION OCTOPOLE REACTION SYSTEM (ORS⁴)

Temperature-controlled collision/reaction cell with a 4-channel gas controller for flexibility in cell gas methods. Operates in helium (He) mode and also provides effective, consistent control of interferences in reaction mode with MS/MS. Axial acceleration enhances sensitivity and controls creation of high order product ions.



SECOND QUADRUPOLE (Q2)

The second high-frequency hyperbolic quadrupole filters the ions that emerge from the cell exit, passing only the target analyte ions/product ions to the detector.

ELECTRON MULTIPLIER DETECTOR

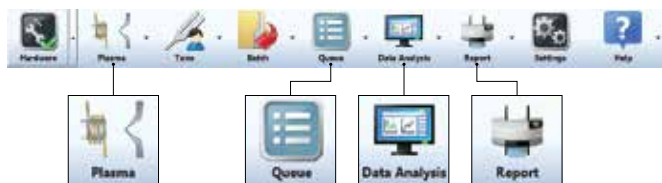
Dual-mode, discrete dynode electron multiplier provides up to 11 orders dynamic range. Short (0.1 ms) minimum dwell time supports fast-transient signal analysis (optimal for Cap-LC, GC, single nanoparticles (sNP) and laser ablation).

VACUUM SYSTEM

High-performance 4-stage pumping system with one split-flow turbo pump, a second turbo pump and a single external rotary pump. The enhanced vacuum performance contributes to the very high sensitivity and low background of the 8900 ICP-QQQ.

The term "triple quadrupole" (or QQQ) is defined by IUPAC as a "Tandem mass spectrometer comprising two transmission quadrupole mass spectrometers in series, with a (non-selecting) RF-only quadrupole (or other multipole) between them to act as a collision cell". IUPAC 2013 Recommendations, Term 538.

POWERFUL, FLEXIBLE, INTUITIVE ICP-MS SOFTWARE



ICP-MS MassHunter software uses an intuitive graphical layout, based on the use of toolbar Gadgets, making it easy to learn and use:

- The hardware pane provides a comprehensive view of hardware configuration and status, performance reports, early maintenance feedback, and system diagnostics.
- The batch pane brings together tune settings, acquisition/data analysis parameters, and sample list, so that all experimental details are accessed through a single convenient interface.
- The queue pane displays current and scheduled tasks, current batch sequence, and a real-time acquisition monitor for the current sample.
- The data analysis pane provides real-time updates of the data batch table during sequencing. The data table is interactive, displaying the currently selected sample spectrum or chromatogram, internal standard recoveries, and calibration plots.
- Customizable outlier flags are included, together with LabQC charts, functionality for spike recoveries, and method-specific performance reports.

Pre-set Methods and automation

Many common applications can be setup with a few mouse-clicks, using ICP-MS MassHunter's pre-defined Pre-set Methods and report templates. For new methods, the Method Wizard builds an optimized method based on your sample type and application.

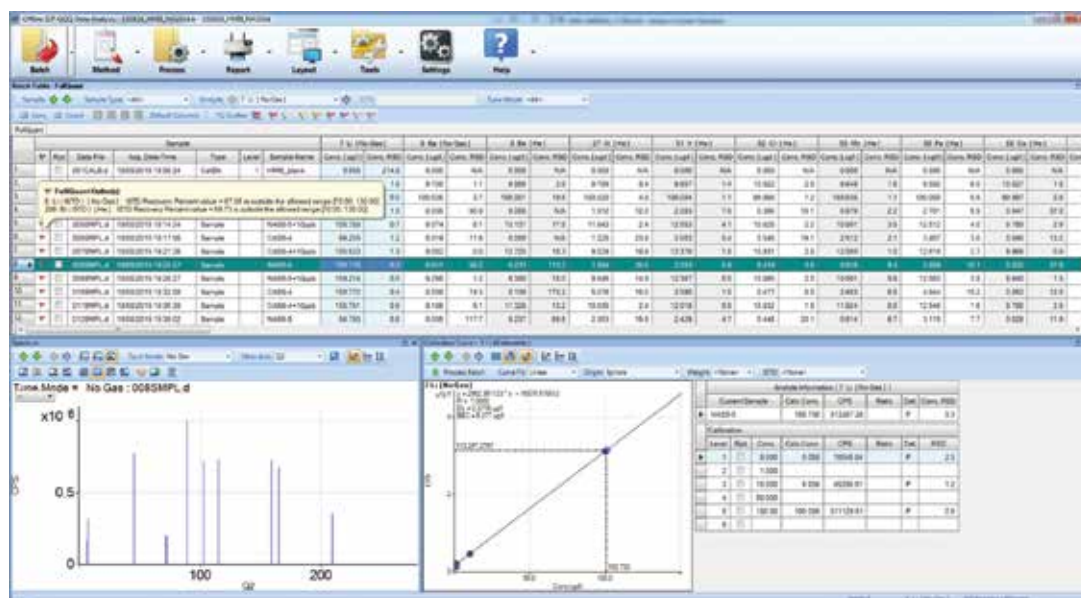
From automated startup checks following plasma ignition, through method setup and sequencing, to integrated data processing and final report generation, ICP-MS MassHunter software ensures your Agilent 8900 ICP-QQQ performs superbly, whatever the analytical needs.

ICP-MS MassHunter software compatibility

For regulated industries such as pharmaceutical manufacturing, ICP-MS MassHunter software can be integrated with Agilent OpenLAB Data Store, ECM or SDA, providing compliance solutions from single workstation to global enterprise level.

ICP-MS MassHunter is also compatible with Agilent's Mass Profiler Professional (MPP), which provides tools for detailed statistical evaluation of ICP-MS data sets.

MassHunter software is used across Agilent MS platforms, simplifying cross training for Agilent quadrupole ICP-MS, ICP-QQQ, LC/MS and GC/MS products.



ICP-MS MassHunter Data Analysis pane, showing interactive batch table, outlier flags, current sample spectrum, and calibration summary.

EXTEND YOUR NANOPARTICLE (NP) ANALYSIS

Pre-set Methods for NP analysis

ICP-MS MassHunter's optional Single Nanoparticle Application Module includes Pre-set Methods for both single particle analysis (spICP-MS) and nanoparticle analysis using field-flow fractionation (FFF-ICP-MS).

The splCP-MS Method Wizard (illustrated below) can automatically calculate and update the important analytical variables, based on a few user-entered parameters, and the measurement of certain sample types specific to splCP-MS analysis.

The method includes an integrated tool to calculate the sample and internal standard flow rates and on-line dilution factor, needed for accurate calculation of nebulizer efficiency.

Single Particle Analysis Configuration

See parameters for Single Particle Analysis.

Sample Pump Tube ID: 1.62 mm

Sample Inlet Flow: 0.346 mL/min

Response Factor Calibration Solution:

Response at 107 amu: 20000 cps/ppb

Reference Material: NIST RM 8152

Reference Element Mass: 157 amu

Mean Reference Particle Diameter: 30 nm

Reference Element Density: 19.22 g/cm³

Mass Concentration of Reference Material: 5.0 ng/l

Unknown Sample:

Target Element Mass: 107 amu

Analyte Mass Fraction: 1.000

Analyte Element Density: 10.50 g/cm³

Units

Agilent's optional Single Nanoparticle Application Module for ICP-MS MassHunter includes a Method Wizard to automate setup for single particle (above) or Field Flow Fractionation (FFF) mode. Integrated data analysis uses MassHunter's batch table (right) taking you from raw signals to quantitative NP characterization.

Integrated NP data analysis

The optional Single Nanoparticle Application Module provides comprehensive data analysis tools for processing sNP signals.

Calculations are included for both peak integration mode (where short integration times are used and multiple measurements are made across each particle signal “plume”), and single scan mode (where the integration time is longer than the duration of the particle signal).

A proprietary algorithm ensures that small particles can be reliably discriminated from the background signal, and calculation of the Background Equivalent Diameter is performed automatically, giving an estimate of the minimum detectable particle size capability of the method.



PROVEN SPECIATION CAPABILITY



Integrated speciation with ICP-QQQ

Environmental, food safety, pharmaceutical and consumer product regulations increasingly require the identification and quantification of elemental species as well as total concentrations. Agilent offers the most comprehensive range of integrated speciation systems and methods for ICP-QQQ, including LC, GC, CE, IC, FFF, and more.

Petrochemical applications require the superior sensitivity and interference control of the Agilent 8900 ICP-QQQ to meet ever lower detection limit requirements for a wider range of analytes. Life science bioanalysis benefits from accurate quantitative analysis of elements such as S, P and Cl, which are difficult to measure using conventional quadrupole ICP-MS.

Pre-configured LC-ICP-MS kits

LC/IC is by far the most common separation technique coupled to ICP-MS, and Agilent can offer a range of pre-configured kits for Capillary and nano-flow LC-ICP-MS as well as conventional HPLC/IC-ICP-MS. With high sensitivity and reliable control of interferences, the Agilent 8900 ICP-QQQ is the ideal solution for advanced LC/IC-ICP-MS applications.

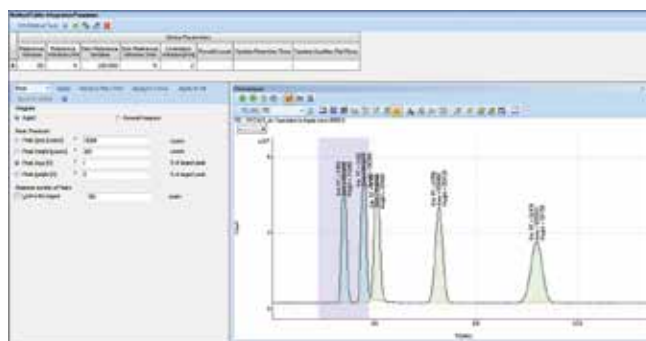


Fully heated GC interface

Agilent's unique GC-ICP-MS interface is heated to the tip of the injector (up to 300 °C) for routine analysis of high-boiling point compounds. In addition, the flexible transfer line and torch injector are inert (Sulfinert® lined) providing unparalleled performance for advanced GC-ICP-MS applications, such as the measurement of siloxanes, brominated flame retardants, and sulfur species in fuels.

Chromatographic data analysis

Equally at home with LC or GC peaks, the new Agile2 integrator provides parameter-less integration for accurate and consistent peak detection, without requiring the operator to manually enter integration parameters.



OPTIONS AND ACCESSORIES

Agilent SPS 4 Autosampler

A great choice for medium- and high-throughput applications, with rack configurations providing up to 360 vial positions. Integrated cover protects samples from dust and airborne contamination.



Agilent I-AS Autosampler with pumped rinse station

Ideal for ultra-trace analysis and small sample volumes (0.5 mL). Flexible rack configurations offer a maximum capacity of 89 vials, plus 3 rinse vials.



Agilent Integrated Sample Introduction System (ISIS 3)

High speed uptake pump, and close-coupled 7-port switching valve provide throughput of more than 1 sample per minute with discrete sampling.



Integrated software for setup and control of third party accessories

Agilent's software developer's kit (SDK) for ICP-MS MassHunter allows third party accessory suppliers to embed their product drivers into ICP-MS MassHunter workflows, to deliver an integrated method setup and run control interface that works seamlessly from the MassHunter workstation PC.

Already applied to autosamplers, on-line sample prep and intelligent autodilution devices, and laser ablation systems, SDK plug-ins extend the scope of the ICP-MS operation by adding the capabilities of the third party accessory.

Optional accessories support a range of configurations and applications

Nebulizer options include low-flow, concentric, inert (HF resistant), and parallel path; a range of alternatives to suit your unique sample types and volumes.

Inert sample introduction kit is O-ring free, and manufactured from PFA for low contamination levels. HF resistant and suitable for high-purity reagents.

Organics kit contains the sample introduction parts you need to run most organic solvents.

Laser ablation (LA-ICP-MS) Integrated software control enables direct solid sample analysis for bulk and time resolved applications, including imaging applications requiring extended acquisition times (more than 24 hours).

Field Flow Fractionation (FFF). When coupled to the Agilent 8900 ICP-QQQ, Asymmetric Flow FFF (A4F) offers an ideal separation and detection approach for characterizing the nanoparticle content of a sample.

Agilent parts and supplies

Manufactured to stringent specifications to ensure top quality, and rigorously tested to maximize instrument performance.

For more information see:

www.agilent.com/chem/specsuppliesinfo



For more information

Learn more

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Agilent ICP-QQQ

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