
ThermoFisher
SCIENTIFIC
Clean
spectra,
undisputable
results
Thermo Scientific Element 2 and
Element XR High Resolution ICP-MS

Ultimate confidence in results

The Thermo Scientific™ Element™ 2 and Element XR™ High Resolution-ICP-MS provide class-leading sensitivity and physical resolution for best data quality and the highest level of confidence.

Superior analytical performance

- Physical separation of interferences ensures confidence in results
- Outstanding sensitivity for detecting smallest signal intensities
- Sub-ppt limits of detection
- High stability for precise isotope ratio measurements

High productivity and ease of use

- Minimal sample preparation
- Easy operation with simple, reliable method development
- All in one method without the need for collision-reaction technology and reactive gases
- Multi-element determination of major, minor and trace elements in a range of diverse matrices and concentrations (typically mg/L to sub pg/L), benefiting from a linear dynamic range up to >10^{12} cps

Versatility

- Methods applicable to a wide range of natural materials and chemicals
- Quantify trace- to ultra-trace-level concentrations across nearly the entire periodic table and determine precise isotope ratios
- Preferred HR-ICP-MS platform for top-level research and routine analysis laboratories worldwide

Reveal what you can't see

Reliable and accurate multi-element and isotope ratio analysis requires the separation of analyte ions from spectral interferences. The Element 2 and Element XR HR-ICP-MS provide unique, reproducible and stable physical mass resolution, enabling clear separation of analytes from interferences without prior knowledge of the sample matrix. Physical mass resolution enables resolving small mass differences in challenging sample matrices and is frequently used to separate oxide, argide, nitride interferents, and multiply charged ions in common matrices.

Three fixed resolution settings, with switching times of <1s, ensure optimum conditions to reliably remove spectral interferences.

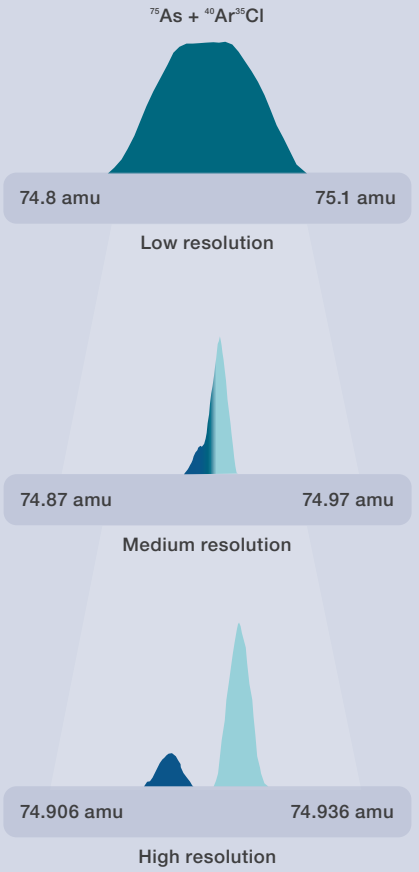
Low resolution (R = 300)
for non-interfered isotopes with the highest sensitivity

Medium resolution (R = 4,000)
for interference-free analysis of most elements in the majority of matrix types

High resolution (R = 10,000)
provides unequivocal separation of analytes and interferences in the most challenging matrices

Physical resolution of spectral interferences

High mass resolution takes advantage of slight mass differences to analyze elements in the most challenging sample matrices. As an example, the high resolution mode of the Element HR-ICP-MS resolves Arsenic (^{75}As) in a chlorine matrix from matrix-related, argon chloride interferences ($^{40}Ar^{35}Cl$, $^{38}Ar^{37}Cl$)

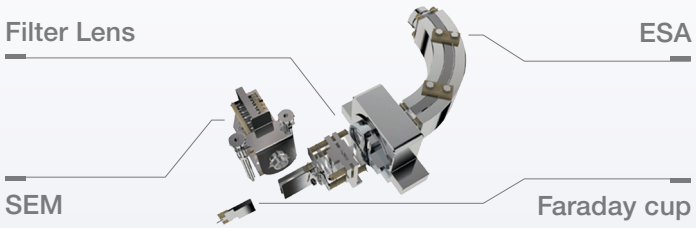


Robust results by high instrument stability

The superior sensitivity, low detector noise and a stable signal combined with excellent matrix tolerance of the Element HR-ICP-MS make it the ideal analytical tool for a wide range of isotopic analyses. Even when the isotopes of interest are of extremely low abundance relative to the other isotopes, the Element XR HR-ICP-MS offers dedicated features to deliver robust results:

- Additional filter lens for improved abundance sensitivity of better than 7 ppm (237/^{238}U) in low resolution
- Additional Faraday detector to measure even the most abundant isotopes relative to the low-abundance isotopes, particularly when the detection sensitivity enhanced by the Thermo Scientific™ Jet Interface results in intensity signals up to >10^{12} cps

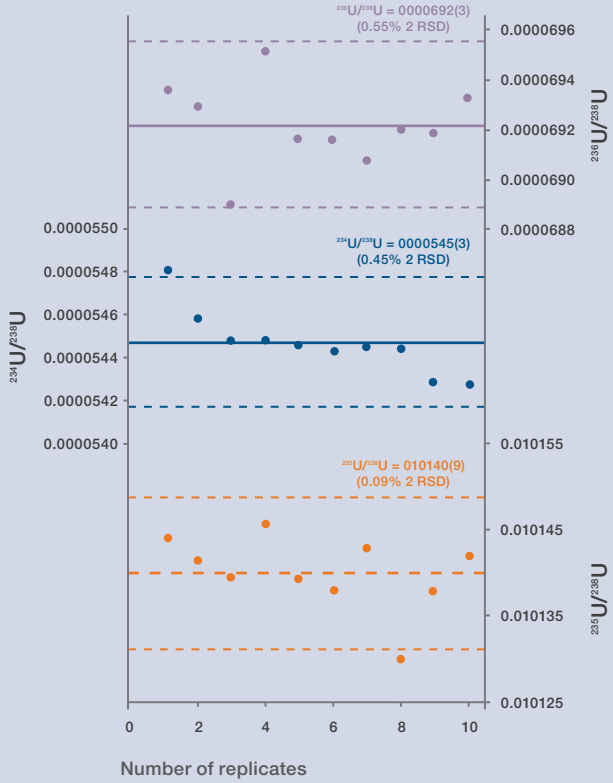
Relative to the Element 2 HR-ICP-MS, the Element XR HR-ICP-MS extends the linear dynamic range by three additional orders of magnitude for maximum flexibility.



Element XR Electrostatic Scanning Analyzer (ESA) and detection system (SEM and Faraday), with additional filter lens for enhanced abundance sensitivity.

Uranium isotope ratios at highest precision

The Element Series HR-ICP-MS allows precise isotope ratio measurements of CRM U010 at 100 ng/g in low resolution mode (n=10).



Raise your data quality to new heights

The Jet Interface is integrated into the Element Series HR-ICP-MS, setting a new standard for sensitivity in elemental and isotope ratio analysis. Excellent signal-to-blank ratios make full use of sensitivity, reaching >3 x 10^6 cps/ppb ^{115}In in wet plasma and >3–5 × 10^7 cps/ppb ^{115}In in dry plasma, with consistently low detection limits for any matrix. The Element Series HR-ICP-MS can achieve less than 0.1 ng/L (i.e., sub-ppt) detection limits for most elements for a wide range of chemicals including ultra-pure water, mineral acids, inorganic chemicals, organic solvents, silanes and VPD samples analyzed with minor method development effort.

The Jet Interface is comprised of:

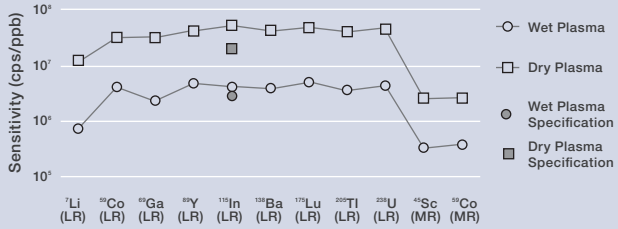
- A high-capacity, air-cooled dry interface pump providing greater pumping capacity at the sample interface
- The Jet sample cone and X skimmer cone, whose geometry is optimized to enhance ion transmission

All Element Series HR-ICP-MS instruments are provided with the high-capacity dry interface pump and with both the Jet sample and X skimmer cone as well as the Standard sample and H skimmer cone for maximum flexibility.

Enhanced sensitivity in wet and dry plasma

The Element Series HR-ICP-MS provides the highest quality data to support analytical excellence.

Typical sensitivity in wet and dry plasma conditions for an Element HR-ICP-MS integrating the Jet Interface. Analysis of a 1 ppb multielement solution. The specified sensitivity per 1 ppb ^{115}In is plotted as a reference.



In wet plasma, the integrated Jet Interface (including the Jet sample cone and X skimmer cone) typically enhances the sensitivity up to 4-5 times for the light mass isotopes, 3 to 2 times for the intermediate and heavy mass isotopes, compared to the Standard sample and H skimmer cone.

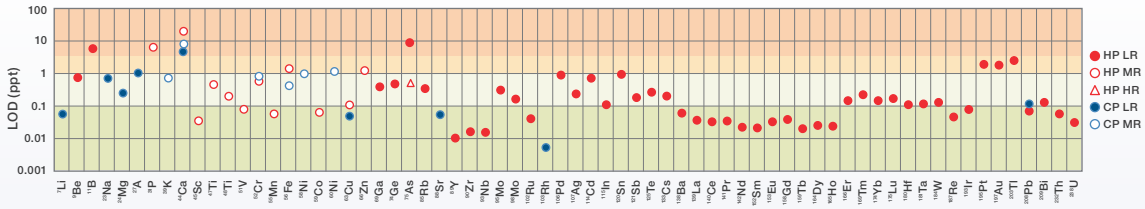
In dry plasma, the sensitivity per 1 ppb ^{115}In is typically in the range of 5 × 10^7 cps/ppb and more.

Outstanding sensitivity and low detection limits

Semiconductor-grade analysis of impurities

With high sensitivity and high selectivity, the Element 2 HR-ICP-MS system is ideally suited for the demands of semiconductor and high-purity chemicals laboratories:

- Direct elemental analysis of nearly every element in the periodic table, including phosphorous and sulfur
- Rapid switching between cold plasma (low plasma power) and hot plasma (high plasma power) operation

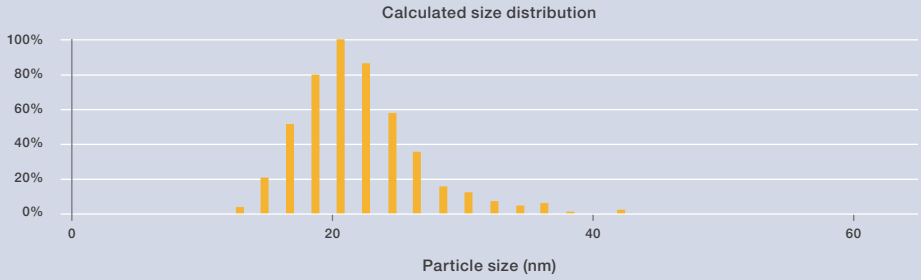


Sub-ppt limits of detection for the majority of 68 elements determined in a 2% HNO_3/ 2% H_2O_2 matrix. HP: hot plasma; CP: cold plasma. LR = low resolution (filled circles), MR = medium resolution (open circles), HR = High resolution (triangles).

Analysis of nanoparticles

The high sensitivity of the Element Series HR-ICP-MS enables detection of smallest natural and engineered nanoparticles that are increasingly incorporated in many products, which threatens human health and can possibly impact natural systems.

- The high sensitivity and low dark-noise enables to detect <20 nm Au and Ag single nanoparticles, as small as 6 nm
- High mass resolution enables analysis of nanoparticles affected by spectral interferences, like TiO_2



Silver nanoparticle size distribution determined in a solution containing 1 ng/L of Ag nanoparticles.

All your elements in one method

The highest sensitivity of any single collector ICP-MS, the reliability offered by physical peak resolution, the superior mass stability (< 25 ppm drift in 8 hours operation) and consistent signal stability (< 1% RSD over 10 minutes; < 2% RSD over 1 hour) are complemented by easy method development irrespective of the sample matrix. This results in shorter analysis times (compared to analytical approaches requiring multiple methods to address multiple spectral interferences), suiting the needs of all customers, even when sample-limited.

Additionally, the extended linear dynamic range of the Element XR ICP-MS makes it the ideal tool for multi-element analysis of unknown samples in a range of diverse matrices and concentrations (from > mg/L to sub pg/L).

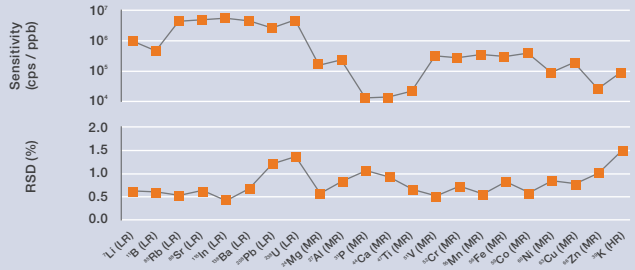
Low cost of analysis

- Less sample preparation: typically no need for complex sample preparation other than dilution
- Faster sample analysis: direct elemental analysis of nearly every element in the periodic table

Multi-element analysis

The Element Series HR-ICP-MS provides the highest quality data to support analytical excellence.

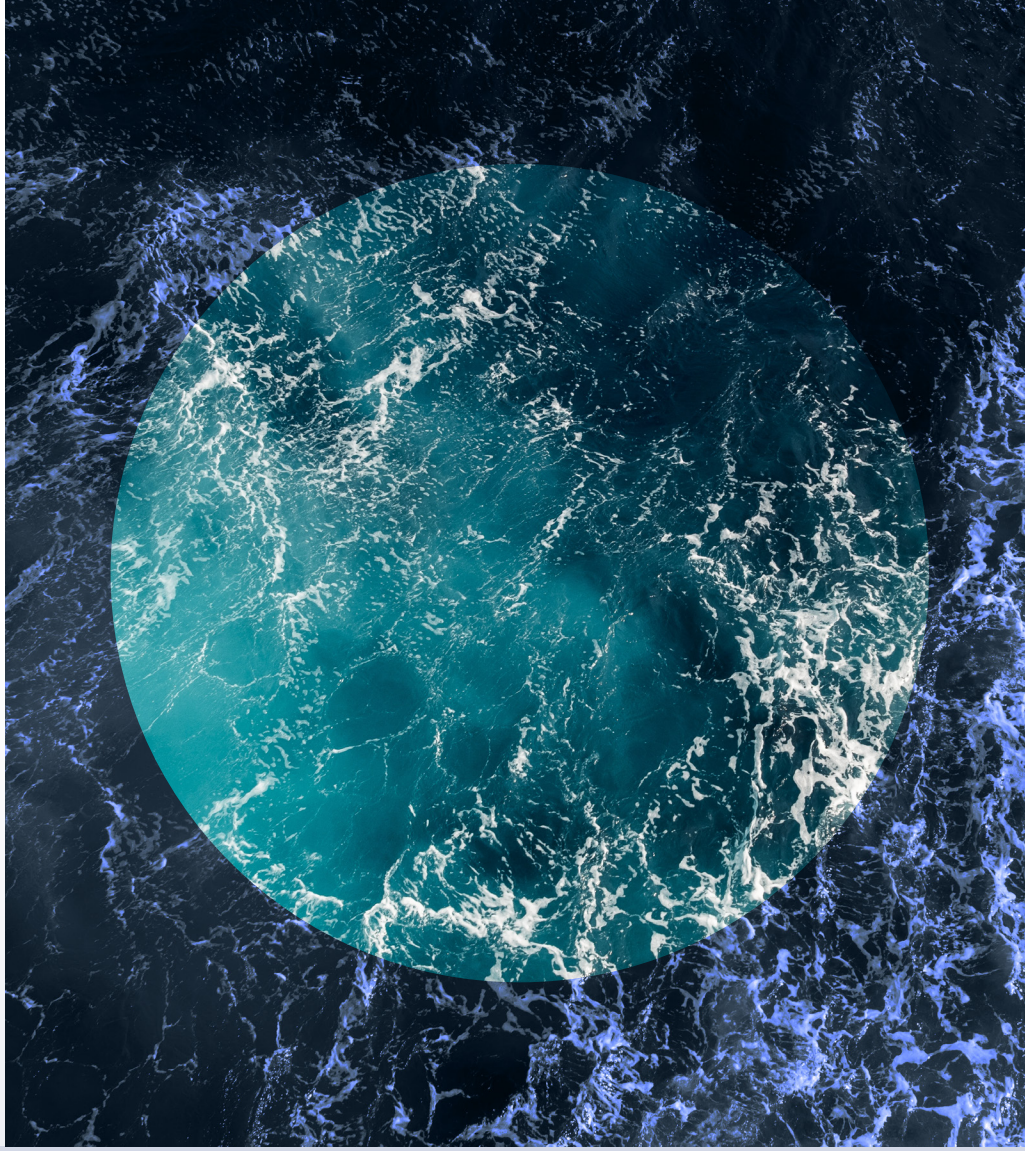
Analysis of a multielement, 1 ppb solution using low, medium and high resolution in one method. Average of 19 sample repeats analyzed over the course of two hours.



Top: typical detection sensitivity. Bottom: typical signal stability. Note that the signal stability is better than 1.5% RSD for all elements in all resolutions.

Versatile technology for research laboratories and production monitoring

The Element Series HR-ICP-MS can analyze liquid samples as waters, digests, acids or solvents, as the nature of the matrix composition is of minor importance when using high mass resolution.



The elemental composition can be measured within many inorganic and biogenic materials like rocks and minerals, soils, waters or ice. The widest range of sample matrices can be targeted, for the most diverse applications, including investigating paleoclimate, geochronology and thermochronology as well as nuclear applications.

- Maximum versatility for commercial laboratories requiring multi-element quantification in a range of diverse matrices and concentrations
- Easy coupling to a range of peripherals (such as laser ablation systems) for the analysis of transient multi-elemental signals

Multi-element analysis in seawater

Trace metals are crucial in marine biogeochemical cycles, making multi-element analysis in seawater essential to understanding the processes controlling the distribution of trace elements and their isotopes. Seawater is a complex matrix including high concentrations of major ions that can interfere with trace metal analysis.

The Element HR-ICP-MS addresses these challenges by offering a straightforward solution including:

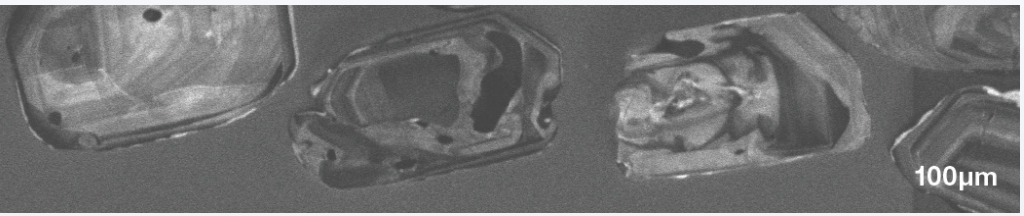
- Matrix robustness: measurements simply carried out in tenfold diluted seawater
- High sensitivity to quantify the smallest concentrations
- A wide dynamic range to measure concentrations varying ~6 orders of magnitude, ranging from ppt (e.g. Co) to ppm (e.g. B)
- Detection limits as low as 0.1 pmol/kg
- High sample throughput

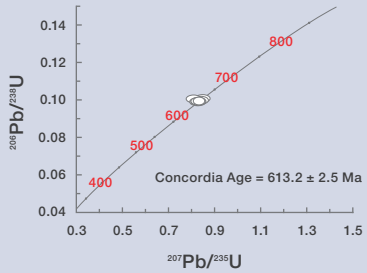
Laser ablation coupling for age determination

In situ U-Pb dating and elemental quantification

Laser ablation systems are routinely coupled to Element Series HR-ICP-MS in many geoscience research laboratories to determine the age of geological samples (e.g., zircon, rutile, garnet, carbonates) by measurement of their U-Pb isotopic system, and/or their trace elemental composition.

- Laser ablation allows the direct sampling of geological solid samples (dry plasma)
- U-Pb dating is carried out in low resolution mode, offering the highest detection sensitivity mode combined with flat peak shapes, allowing determination of precise isotope ratios
- The Jet Interface, by further increasing sensitivity in dry plasma, improves the age resolution and/or the spatial resolution of the LA HR-ICP-MS analytical technique





U-Pb Concordia diagram of GJ-1 zircon (Jackson et al., 2004, Chem. Geol.), 10 static spot analyses.

To achieve the highest sensitivity, the X skimmer cone and Jet sample cone were used.

HR-ICP-MS technology

1 **Electrostatic analyzer**
- Ion energy focusing

2 **Magnet**
- Maximum speed with <150 ms required for a jump from ^{7}Li - ^{238}U - ^{7}Li
- Water cooled magnet coils for maximum mass stability

3 **Ion transfer optics**
- Maximum ion transmission efficiency, mass stability, low mass bias, and low background

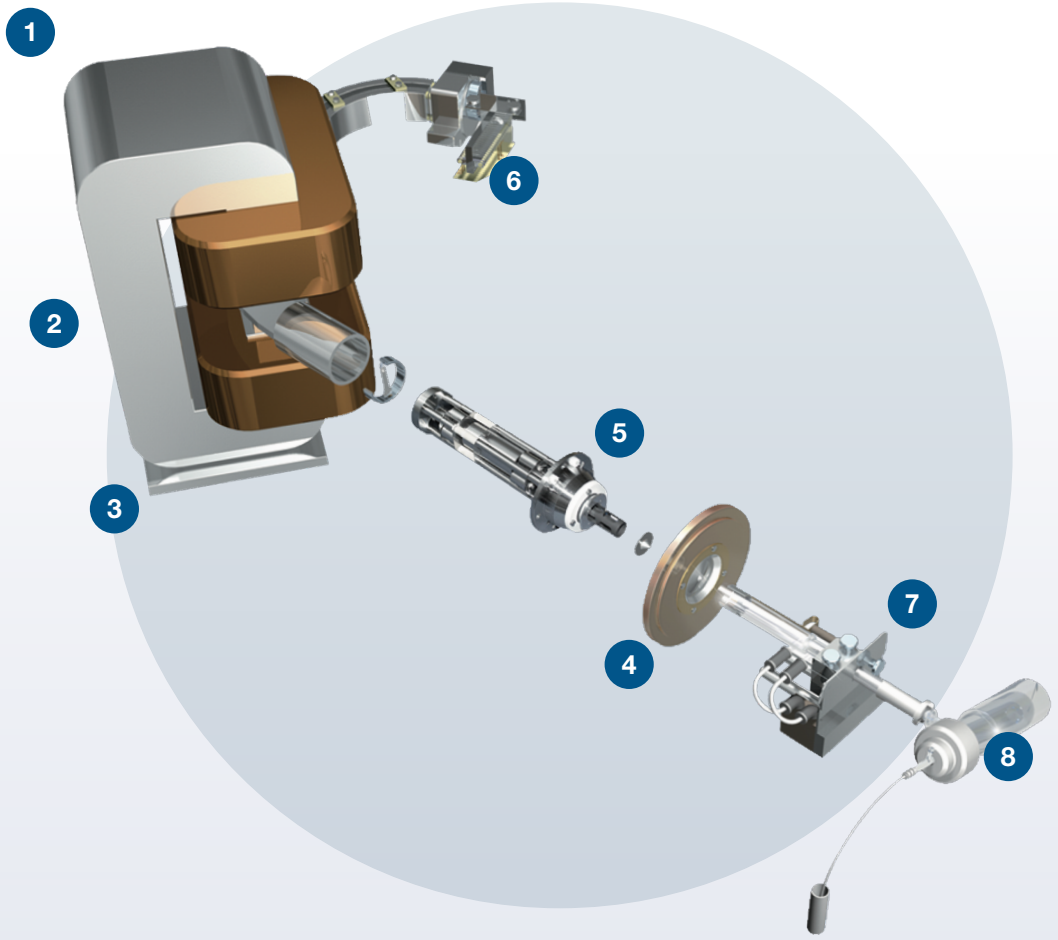
4 **Jet Interface**
- A new standard for sensitivity in elemental analysis

5 **Slit assembly**
- Enabling 300, 4,000 and 10,000 mass resolution

6 **Dual (Element 2 HR-ICP-MS) or Triple (Element XR HR-ICP-MS) detection system**
- Secondary electron multiplier for dual mode detection for the Element 2 HR-ICP-MS or triple mode detection for the Element XR HR-ICP-MS (with additional Faraday detector; automatic switch to Faraday when intensity exceeds the SEM range)
- A linear dynamic range from <0.2 cps up to >10^{9} cps (Element 2 HR-ICP-MS) or extended to >10^{12} cps (Element XR HR-ICP-MS) enables quantification down to sub-ppq concentrations
- Excellent abundance sensitivity measurement of extreme isotope ratios

7 **ICP plasma ion source**
- For hot and cold plasma applications

8 **Sample introduction**
- Easy coupling to liquid sample introduction systems and laser ablation techniques



Confidence in data
Excellence in analysis

Perform accurate and reliable quantitative multi-element analyses at the trace and ultra-trace level, with the highest sensitivity and without complicated sample preparation. The Element 2 and Element XR High Resolution ICP-MS systems cover the mg/L to sub pg/L concentration range in wide spectrum of applications from geoscience and environmental research to the semiconductor and high purity chemicals industry, as well as nuclear sciences.

Element 2 HR-ICP-MS

The robust solution for chemical and semiconductor applications.

Experience a powerful technique with exceptional sensitivity and signal-to-noise ratio for solving specific challenges. The high performance, double-focusing magnetic sector field Element 2 HR-ICP-MS is optimized for ease of use, stability and productivity.

Element XR HR-ICP-MS

The benchmark for full elemental screening in high dynamic range laser ablation and solution analysis, and for large isotope ratios applications.

Analyze any matrix element with minimal dilution allowing the measurement of high intensity signals. The combination of a dual-mode SEM with a Faraday detector increases the linear dynamic range by an additional three orders of magnitude relative to the Element 2 HR-ICP-MS.

Learn more at **thermofisher.com/hr-icp-ms**