

thermoscientific



# Utilize the Gold Standard in Isotope Ratio MS

Robustness, Sensitivity, Precision

**ThermoFisher**  
SCIENTIFIC



# Utilize the Gold Standard in Isotope Ratio MS







The Thermo Scientific™ 253 Plus™ 10 kV IRMS is the gold standard in high performance stable isotope ratio mass spectrometry (IRMS). It builds on the robustness, linearity, and sensitivity only available in the Thermo Scientific 10 kV IRMS technology.

- ROBUSTNESS
- SENSITIVITY
- PRECISION

### Key features of the 253 Plus 10 kV IRMS

- 10 kV acceleration voltage for highest sensitivity
- “Extra bright” ion source combining highest sensitivity and linearity
- Variable ion source conductance (VISC) for enhanced pumping of “sticky” gases
- All-metal sealed analyzer with gold gaskets for ultra high vacuum
- Differential pumping for lowest analyzer backgrounds
- Monolithic ion optical bench for highest ion beam stability
- Mass range  $m/z$  1-150 at full 10 kV acceleration voltage
- Mass resolution  $> 200$  with a Mass Resolving Power  $> 900$  ( $m/\Delta m$ )
- Up to 12 Faraday cups
- Unique shielded “clumped isotope” collector design for lowest baseline contribution
- Removal of scattered ions for high precision measurement of all minor isotopes
- $10^{13}$  ohm amplifiers for smallest signals with best signal/noise
- Analytical dynamic range  $>10^7$
- Fast amplifiers with low noise technology
- Computer switchable amplifier gains
- Dedicated hydrogen collector for dual inlet and continuous flow applications
- Unique energy filter built into the  $m/z$  3 cup for interference-free continuous flow HD applications
- Driven by Thermo Scientific™ Qtegra™ Intelligent Scientific Data Solution (ISDS) Software

# Robustness

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The 253 Plus 10 kV IRMS's features and functionalities improve sample utilization, stability, background and signal-to-noise resulting in ultimate precision on smallest sample sizes.

## **“Extra bright” ion source**

The “extra bright” electron impact ion source with 10 kV acceleration voltage delivers the highest sensitivity in IRMS while giving the tightest and most comprehensive performance for linearity and stability. Illumination of the whole ion source region ensures that all gas wetted surfaces are heated, which results in lowest backgrounds.

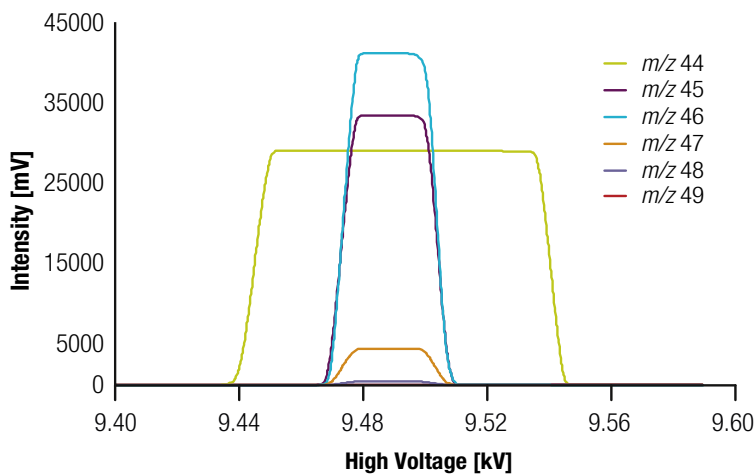
The unique variable ion source conductance window (VISC) allows the ion source conductance to be optimized for applications requiring faster pumping of the ion source, to avoid accumulation of sticky gases and reduce ion-molecule reactions. The electro-polished monolithic ion source manifold is machined from a single piece of stainless steel and is weld-free and all-metal sealed, a prerequisite for achieving the lowest backgrounds and least memory effects. The ion source is pumped with a hybrid two-stage turbo molecular pump, giving high pumping capacity for H<sub>2</sub> and helium, while guaranteeing lowest backgrounds and a low and stable H<sub>3</sub><sup>+</sup> factor.

## **Compact 10 kV analyzer**

The compact 10 kV design of the 253 Plus 10 kV IRMS with its complete analyzer on one monolithic metal cast plate guarantees outstanding long term stability and robustness. The analyzer geometry with stigmatic focusing (y- and x-directions) and a constant mass dispersion of 460 mm is the foundation of the 253 Plus 10 kV IRMS analytical performance and robustness. The magnetic sector field is generated by a uniquely shaped electromagnet. The field strength is controlled by a high precision current regulator, which is under full data system control. Perfect peak shapes and unrivaled mass resolving power over the whole focal plane plus a mass range, which covers all stable isotope ratio applications, translate directly into sensitivity, precision, stability and robustness.

The analyzer can be equipped with an optional differential pumping module, ensuring optimal vacuum conditions even with a high He load in the ion source, which allows highest continuous flow transfer and sensitivity.

**The Thermo Scientific 253 Plus 10 kV Isotope Ratio Mass Spectrometer delivers the highest precision for the determination of D/H, <sup>13</sup>C/<sup>12</sup>C, <sup>15</sup>N/<sup>14</sup>N, <sup>18</sup>O/<sup>16</sup>O, <sup>34</sup>S/<sup>32</sup>S (from SO<sub>2</sub> and SF<sub>6</sub>), <sup>28</sup>Si/<sup>29</sup>Si as well as Ar, Kr and Xe isotope ratios.**



Sharp, flat top CO<sub>2</sub> peak shapes. Monitoring cup at m/z 47.5.

## Enhanced focussing magnet

### Unmatched peak stability

The special shaping of the magnet pole pieces guarantees sharp peak shapes and isotope ratio stability over the whole deflection range. The outstanding long-term peak stability supports very long integration times and highest precision on smallest signal intensities.

- Excellent isotope ratio stability resulting from outstanding peak shapes
- Superb flat peak tops over the whole simultaneous mass range
- Enhanced resolving power for best isotope ratio stability with steep sides contributing to the improved abundance sensitivity

The 253 Plus 10 kV IRMS with Qtegra ISDS Software provides a flexible and open platform for the connection of any custom inlet systems and preparation devices.





# Precision

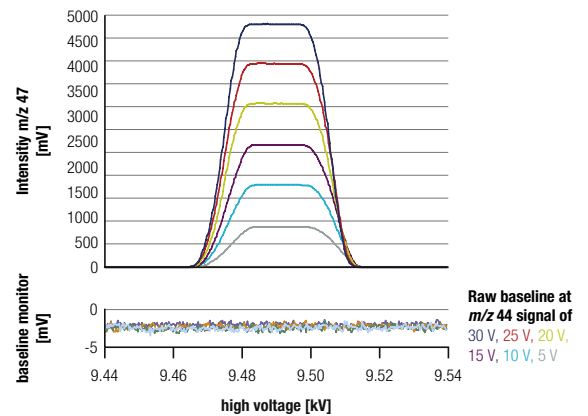
The 253 Plus 10 kV IRMS is unique in its capability to achieve high precision measurements from the smallest amounts of sample and smallest ion beams even from complex isotopologue systems while providing the widest dynamic range in class. The 253 Plus 10 kV IRMS addresses all requirements for clumped isotope analysis making it a powerful tool in isotope ratio MS.

## Individually shielded collectors

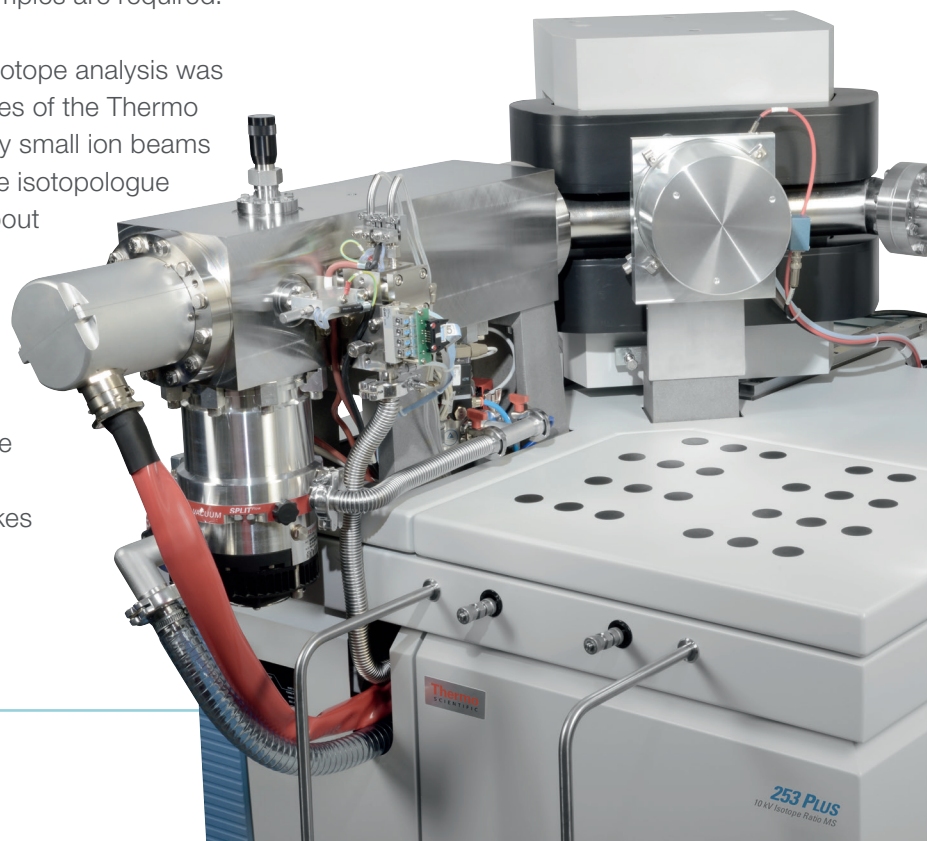
Collectors for C, N, O, S, Si, Ar, Kr, and Xe are located at the focal plane of the full deflection radius. They use deep, individually shielded Faraday cups with secondary electron suppression. Signals from up to eight individual cups can be acquired simultaneously.

H<sub>2</sub> and HD are measured on the small radius of the magnet with a dedicated collector system with an integrated energy filter removing all low energy He ions from the mass 3 signal. This ensures unsurpassed high performance for D/H analysis by continuous flow applications, especially in GC-IRMS, in which smallest samples are required.

The development of clumped isotope analysis was based on the design and features of the Thermo Scientific 10 kV technology. Very small ion beams and a high dynamic range of the isotopologue systems require special care about minor secondary effects that can be amplified together with the minor ion beams. Few scattered ions from the cardinal mass can result in depletion of the baselines on the minor ion beams. The 253 Plus 10 kV IRMS collector design takes care of these requirements.



Baseline monitoring of clumped CO<sub>2</sub>



## Collector configurations for challenging isotopologue systems including $10^{13}$ $\Omega$ Amplifier Technology

### Clumped $\text{CO}_2$ Isotopes

$^{12}\text{C}^{16}\text{O}^{16}\text{O}$   $^{13}\text{C}^{16}\text{O}^{16}\text{O}$   $^{12}\text{C}^{18}\text{O}^{16}\text{O}$   $^{13}\text{C}^{18}\text{O}^{16}\text{O}$  **baseline control**  $^{12}\text{C}^{18}\text{O}^{18}\text{O}$   $^{13}\text{C}^{18}\text{O}^{18}\text{O}$

### Triple and Clumped Oxygen

$^{16}\text{O}^{16}\text{O}$   $^{16}\text{O}^{17}\text{O}$   $^{16}\text{O}^{18}\text{O}$   $^{17}\text{O}^{18}\text{O}$   $^{18}\text{O}^{18}\text{O}$

### $\text{N}_2\text{O}$ Isotopomers

$^{14}\text{N}^{16}\text{O}$   $^{15}\text{N}^{16}\text{O}$  and  $^{14}\text{N}^{14}\text{N}^{16}\text{O}$   $^{14}\text{N}^{15}\text{N}^{16}\text{O}$   $^{14}\text{N}^{14}\text{N}^{18}\text{O}$

### Isotopes of Noble Gases

$^{36}\text{Ar}$   $^{38}\text{Ar}$   $^{40}\text{Ar}$

$^{124}\text{Xe}$   $^{126}\text{Xe}$   $^{128}\text{Xe}$   $^{129}\text{Xe}$   $^{130}\text{Xe}$   $^{132}\text{Xe}$   $^{134}\text{Xe}$

### Rare Sulfur Isotopes

$^{32}\text{S}^{19}\text{F}_5$   $^{33}\text{S}^{19}\text{F}_5$   $^{34}\text{S}^{19}\text{F}_5$   $^{36}\text{S}^{19}\text{F}_5$

■ Boosted by  $10^{13}$   $\Omega$  Amplifier Technology

## Shielded clumped isotope collectors

### Breakthrough in baseline contribution and baseline control

The unique shielded clumped isotope collector design is the breakthrough for accurate clumped isotope ratio measurements.

- Lowest scattered ion baseline for all minor isotopes - even at maximum ion source load
- Simultaneous baseline monitoring using half mass detector positions
- Uncompromised linearity and stability for all clumped isotope measurements

### Unique clumped isotope collector design

The unique shielded clumped isotope collector design takes care of any effects from the cardinal mass (e.g.  $m/z$  44 for  $\text{CO}_2$ ), for all minor isotopes, ( $m/z$  45 –  $m/z$  49 for  $\text{CO}_2$ ), in any isotopologue system. The collector array can also be equipped with baseline monitoring Faraday cups for monitoring baseline stability and, if required, be used to make corrections by the Qtegra ISDS Software. This ensures uncompromised linearity and stability for all clumped isotope systems resulting in high precision results.



# Sensitivity

The Thermo Scientific  $10^{13} \Omega$  Amplifier Technology extends the linearity and stability of Faraday cups towards the sensitivity of secondary electron multipliers. The technology provides improved signal to noise ratio on small ion beams by amplifying the signal by a factor of 10 while the Johnson noise is only amplified by the  $\sqrt{10}$ . Hence, very small ion beams can now be analyzed with a factor 3 better signal to noise ratio.

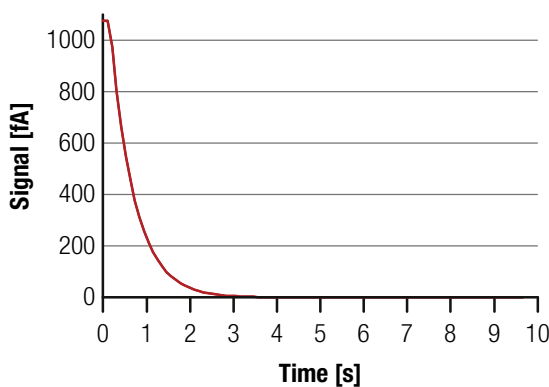
## Low noise amplifiers

The unmatched dynamic range of the 253 Plus 10 kV IRMS extends high precision isotope analysis into clumped isotope, triple isotope and isotopomer applications. The amplifiers cover a dynamic range of  $> 10^7$  with resistors up to  $10^{13} \Omega$ .

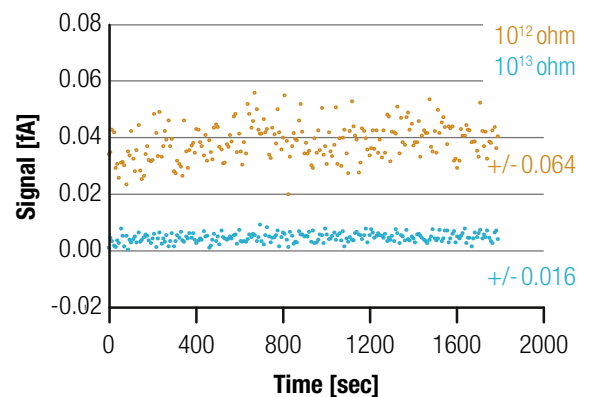
All amplifiers are located in an evacuated housing ensuring lowest background noise and highest stability. Each amplifier has a linear dynamic range of  $> 500$  and direct low noise connection. Fully software controlled amplifier switching allows application-specific configurations to be easily implemented.

Each Faraday cup is individually connected to an amplifier. The amplifier design ensures highest stability, fast decay times and lowest noise. Even the  $10^{13} \Omega$  resistors show excellent decay times while providing a 10 times higher gain than any other IRMS.

The 253 Plus 10 kV IRMS delivers the broadest range of high-level research applications providing highest Continuous Flow and Dual Inlet sensitivity.



Fast decay of the  $10^{13} \Omega$  amplifier



Heavily reduced signal to noise with  $10^{13} \Omega$  amplifier



## Full automation for smallest carbonate samples

The Thermo Scientific™ Kiel IV Carbonate Device provides fully automated long term performance at ultimate isotope precision and can be combined with clumped isotope analyses on low abundance isotopologue signals. High precision analysis of carbonate samples as small as 10 µg can be achieved with this high through-put system, processing up to 15,000 carbonate samples per year. The Kiel IV Carbonate Device uses the principle of the individual acid bath in septum-free vials for each sample. Storage, transfer and chemical reaction of phosphoric acid at elevated temperatures operate in a unique temperature controlled cabinet. Highest throughput is ensured by two independent reaction lines with unique inert, low dead volume acid dosing valves. Laboratories show routine operation with up to 15,000 analyses per year with the only consumable being LN<sub>2</sub>. Qtegra ISDS Software provides total process control and data log file for complete insight into all preparation and measurement processes.

## Highest Sensitivity in GC-IRMS

The Thermo Scientific™ GC Isolink II™ IRMS System utilizes the high sensitivity and unmatched isotope ratio linearity of the 253 Plus 10 kV IRMS providing best in class compound specific isotope ratio results. The unique conversion technologies allow analyzing C, N, O and H isotope ratios in a fully automated way, driven by Qtegra ISDS Software.



## 10<sup>13</sup> Ω amplifier technology

### Leading edge technology

The amplifier technology extends the dynamic range in IRMS with 10<sup>13</sup> Ω resistors, faster decay times and reduced electronic noise.

- Outstanding signal-to-noise ratio on small ion beams (e.g. *m/z* 47-48-49)
- Unmatched precision for the measurement of rare isotopologues
- Fast decay time on all amplifier gains

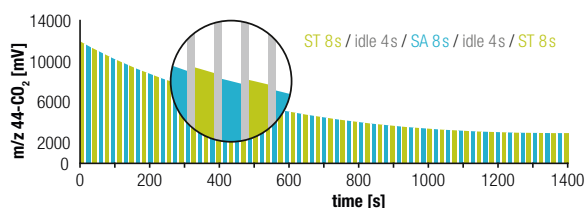
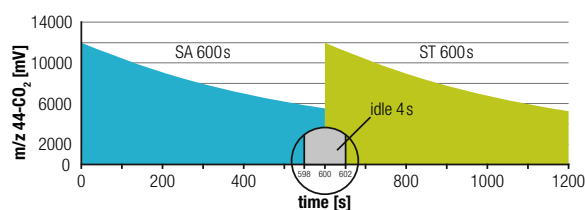


# Stability

The Long Integration Dual Inlet (LIDI) workflow merges the conventional dual inlet strategy, which has been based on short term sample/standard comparisons, with referencing techniques developed for Continuous Flow IRMS. LIDI improves the sample utilization up to a factor of three.

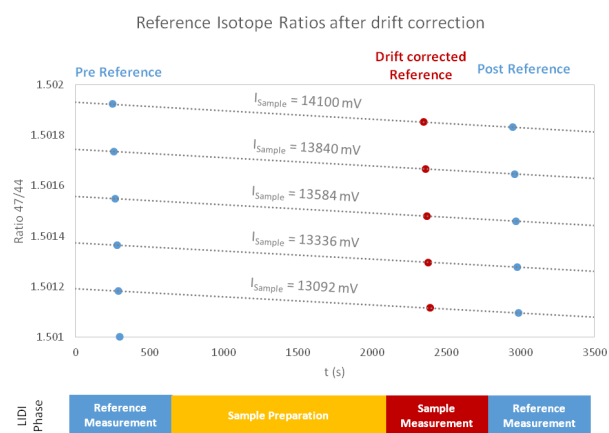
## LIDI workflows

The outstanding signal and system stability of the 253 Plus 10 kV IRMS utilizes a much bigger part of the sample gas by using the LIDI methodology. In LIDI, the sample gas is analyzed until its signal intensity has no significant contribution to the achievable precision anymore. Only after that, the changeover valve switches to the standard gas for acquisition with the benefit that high precision can be reached after much shorter analysis time. The traditional dual inlet strategy results in > 50 % loss of the sample, incurred while analyzing the standard. Consequently LIDI provides analysis of much smaller samples with high precision for clumped isotope systems and analysis of very small carbonate samples.



Comparison of conventional Dual Inlet mode with LIDI

Further improvements of accuracy and precision of  $\Delta_{47}$  measurements from carbonates in limited sample sizes are achieved through the new Thermo Scientific™ LIDI 2 Software Workflow. Challenges of temperature stability in the laboratory and the matching of crimping of the sample and reference capillaries are overcome by using the LIDI 2 Software Workflow which offers drift correction by standardization of the sample data with two reference data sets (“Bracketing”).



**LIDI 2 Software Workflow bracketing:** By applying a linear function, interpolated reference isotope ratios are calculated for each sample beam intensity and at the time of sample measurement.



## Dual Inlet System

The Thermo Scientific Dual Inlet System builds on monolithic all-metal valve blocks with gold-sealed and gold-seated valves for showing no detectable argon background nor analyte memory with ultra high vacuum conditions. It can be heated to achieve high purity sample introduction. The Dual Inlet System is integrated into the 253 Plus 10 kV IRMS cabinet and the changeover valve block is mounted directly to the ion source housing.

This proven design results in minimal dead volume, shortest transit distance and minimum gas path length. The waste line from the changeover is pumped by a dedicated turbo molecular pump. Adjustment of the variable bellows follows our "Fast Bellows" strategy for better sample utilization. The Dual Inlet System can be expanded by one or two multiports (10 ports each). A cryogenic micro volume inlet system can be added for maximum utilization of very small samples.

## Qtegra ISDS Software

The Qtegra ISDS Software enables the 253 Plus 10 kV IRMS to be easily set up, tuned, and operated fully automated. Auto-focusing of the ion source, storage of parameter sets and automatic use by any acquisition method makes operation of the 253 Plus 10 kV IRMS easy and reliable. The Qtegra ISDS Software supports routine operation as well as an open structure for user specific changes, allowing development of entirely new peripherals, measurement and evaluation protocols. A fully automated suite of diagnostic software documents the system performance.

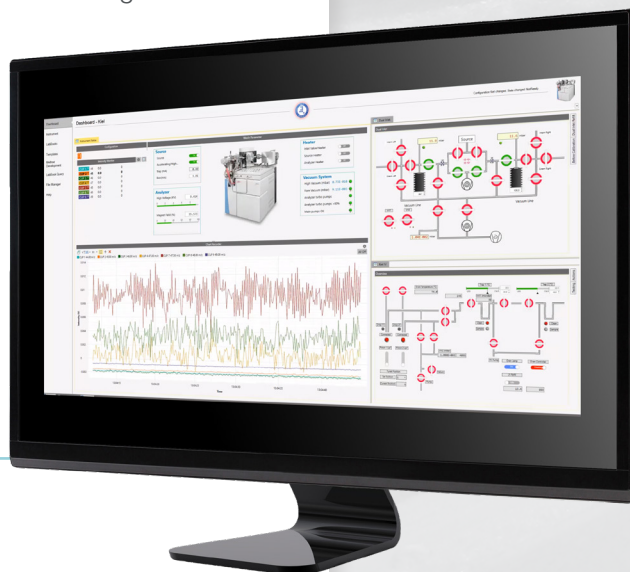
- Fully integrated workflow solutions
- Unique long integration dual inlet workflow (LIDI) for uncompromised sample utilization
- Fully automated suite of diagnostic software
- Remote control and diagnostics



## LIDI Workflow uncompromised sample utilization

The long integration dual inlet (LIDI) workflow allows a long integration of the sample followed by an intensity-matched long integration of the standard. LIDI is fully integrated into the Qtegra ISDS Software.

- Threefold reduction in sample utilization
- Three times smaller sample sizes
- Ultimate precision in half the measurement time
- Improved accuracy and precision through LIDI 2 Software Workflow



# Discover more with the leader in isotope analysis

For over 70 years Thermo Fisher Scientific has been the leading supplier of isotope ratio instrumentation to scientists throughout the world.

Our products have enabled some of the most exciting pioneering discoveries with isotopic measurement, many in geochemical applications. The 253 Plus 10 kV IRMS continues the journey by opening new avenues into isotope ratio measurements.

All our products are built to exacting standards and supported globally by our international service network. Our goal is to support your success.



DELTA Q™  
Isotope Ratio MS



253 Plus™ 10 kV  
Isotope Ratio MS



Element 2/XR High  
Resolution ICP-MS

## Thermo Scientific Isotope Ratio Analyzers



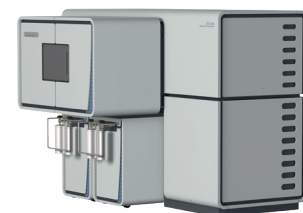
Helix MC Plus™  
Noble Gas MS



Triton Plus™  
Thermal Ionization MS



Neoma™  
MC-ICP-MS



Ultra™ High Resolution  
Isotope Ratio MS

Find out more at [thermofisher.com/253Plus](https://thermofisher.com/253Plus)

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