



Thermo Scientific iCAP RQ ICP-MS with IMR

## Robust ICP-MS with ease of use and high productivity for routine laboratories

### Benefits

- User-friendly operation.
- Simple method development with comprehensive interference removal.
- Reduced user maintenance with improved matrix tolerance.
- Accelerated productivity with fully integrated sample handling solutions.

The Thermo Scientific™ iCAP™ RQ ICP-MS is built for total reliability, advanced performance and assured accuracy. A design inspired by real laboratory needs, simplifies the user experience and dramatically improves productivity and efficiency.

This innovative single quadrupole (SQ) ICP-MS analyzer is the ideal solution for a wide range of sample types and industries; from demanding 24/7 routine analysis to advanced applications in research. User-friendly Thermo Scientific™ Qtegra™ ISDS Software manages entire workflows from 'Get Ready' to data reporting. This intuitive software platform is common to other Thermo Scientific trace elemental techniques, so operators can seamlessly switch between instruments.

### Keywords

Ease of use, elemental analysis, comprehensive interference removal, productivity

Assure your applications with the reliability, robustness and analytical performance demanded by high-throughput, routine laboratories.

## iCAP RQ ICP-MS with iMR hardware summary

### Sample introduction

The bench height sample introduction system is positioned to optimize user accessibility to all parts.

#### **Spraychamber**

- Peltier cooled high purity quartz or PFA, low-volume, baffled cyclonic spraychamber, efficiently filters out larger aerosol droplets for improved plasma stability.
- Reduced surface area improves sample washout.
- Compatible with all 6 mm OD nebulizers.

#### **Nebulizer**

- High performance, concentric nebulizers with  $\sim 0.4 \text{ mL}\cdot\text{min}^{-1}$  sample consumption.
- Optional nebulizers in a range of flow rate sizes, total dissolved solids tolerance and suitability for organics or HF.

#### **Torch**

- Push-in, demountable single piece quartz torch.
- All connectivity (argon gas supplies and plasma ignition) designed into the holder, reducing torch complexity and improving usability.
- Proprietary, screw-in, self-aligning injector for ease of use and reliability.

#### **Peristaltic pump**

- Compact, low pulsation, 12 roller, four channel mini-pump with inert rollers for improved reliability.

#### **Additional gas kits**

- Two additional mass flow controllers (0-250 or 0-1000  $\text{mL}\cdot\text{min}^{-1}$ ) available as options.
- Coupled closely to the sample introduction system with quick fit connectivity.
- Fully software controlled allowing for introduction of gases into the spraychamber (e.g.  $\text{O}_2$  for the analysis of organic solvents or Ar for Gas Dilution) or to supply gases for coupled accessories (for example He during Laser Ablation).

### Inductively coupled plasma

The iCAP RQ ICP-MS plasma is designed to rapidly adapt to changing matrices and provide unparalleled robustness even for challenging samples such as highly volatile organic solvents.

#### **RF generator**

- Digital, solid state RF generator operating with dynamic frequency impedance matching the plasma at  $\sim 27 \text{ MHz}$ .
- Low ion energy spread for optimum ion focusing and transmission, without the need of a grounded shield between torch and load coil.
- Highly stable and robust cold plasma operation.

#### **Load coil**

- Water cooled load coil for improved lifetime and reliable plasma ignition.
- Accessible at bench height for ease of maintenance.

#### **Plasma TV**

- Remote monitoring of plasma status via integrated HD camera.

#### **Interface**

Unique front opening interface provides rapid, simultaneous access to cones and extraction lens, to facilitate routine maintenance and minimize downtime.

#### **Cones**

- Optimized sample (1.1 mm diameter orifice) and skimmer (0.5 mm diameter orifice) cone geometries for reduced matrix deposition and maintenance.
- Ni cones as standard; Pt tipped as option for specialized applications.
- Cones are rapidly removed by a single (magnetic) tool.
- Proprietary skimmer insert design reduces memory effects and a range of inserts allows the user to balance the needs of matrix resistance against absolute sensitivity.
- Robust Interface specifically designed for minimal drift during long-term analysis of high matrix samples.
- High Matrix Interface for typical sample types provides the optimal balance between sensitivity and tolerance.
- High Sensitivity Interface provides excellent signal to noise ratio for ultratrace analysis and advanced applications.

### **Extraction lens**

- Single extraction lens operated at low voltages for optimum ion extraction and focusing into the ion optics – bayonet mounted for easy handling.

### **Slide valve**

- Software controlled: defaults to closed position when plasma is off or in the event of a power failure, maintaining vacuum in the analyzer housing.

### **Ion optics**

- Unique 90° cylindrical ion lens – the RAPID lens: Right Angular Positive Ion Deflection, providing high ion transmission across the entire mass range.
- RAPID lens dimensions significantly larger than ion beam and neutrals, eliminates lens cleaning maintenance.
- Off-axis design delivers class-leading background noise.
- Electrical connections with gold spring contacts from the analyzer housing to ions optics improve reliability.

### **QCell collision/reaction cell (CRC)**

- Zero maintenance, small volume collision/reaction cell with proprietary flatpole rods.
- High transmission, even in He KED mode, enabling complete single measurement mode analysis of all analytes including Li and Be.
- Low mass cut off for improved interference reduction than KED alone.
- Choice of 1 or 2 gas specific mass flow controllers for He and flexibility to work with reactive gases such as H<sub>2</sub>, O<sub>2</sub>, or a mixture of NH<sub>3</sub>/He.

### **Quadrupole**

- Quadrupole mass analyzer driven by a solid state, 2 MHz supply ensure low abundance sensitivity and class leading mass stability.
- User definable mass resolution in the mass range 2-290 u (enabled with intelligent Mass Resolution (iMR)).
- Mass calibration assessed and automatically updated.

### **Vacuum system**

- High vacuum is maintained in the event of a power failure: the rotary and turbo pumps automatically restart as soon as power is restored.
- A stable vacuum, obtained in less than 15 minutes pumping time, enables fast return to service after routine maintenance.

### **Turbo pump**

- Single split flow turbo molecular pump.

### **Interface pump**

- External, high performance pump to provide backing to the turbo pump and evacuation of the expansion region for improved sampling from the plasma.
- Supplied with synthetic, chemically stable, temperature resistant rotary pump oil as standard.

### **Detector**

- Long lifetime detector designed for ICP-MS requirements.
- Dwell times of 100 µs in both analog and counting detection modes.
- Linear dynamic detection range: > 10 orders of magnitude.
- Automated optimization of operating voltages and cross-calibration.
- Cradle design for ease of detector exchange.



## iCAP RQ ICP-MS with iMR configuration and performance specifications

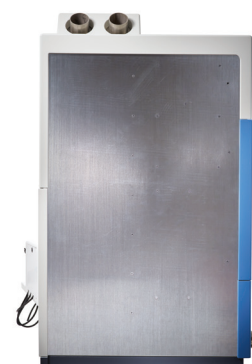
Configuration		
Nebulizer	Glass, concentric	
Spraychamber	Quartz, cyclonic	
Torch	Quartz, demountable, no shield	
Injector	Quartz, 2.5 mm ID	
Cones/Interface	Ni, high matrix interface	
Digitally Controlled Plasma Gas Flows	Three	
Additional Mass Flow Controllers (e.g. O <sub>2</sub> for organics, He for laser)	Optional (Two)	
iCAP RQ Configurations	C1	C2
He Cell Gas MFC	Yes	Yes
Additional Cell MFC e.g. H <sub>2</sub> , O <sub>2</sub> etc.	*FUO	Yes
STD Mode		
Sensitivity (kcps/ppb) <sup>b</sup>	<sup>7</sup> Li	55
	<sup>59</sup> Co	100
	<sup>115</sup> In	240
	<sup>238</sup> U	330
Detection Limits (ppt) <sup>a</sup>	<sup>9</sup> Be	< 0.5
	<sup>115</sup> In	< 0.1
	<sup>209</sup> Pb	< 0.1
Oxides (%) <sup>b</sup>	CeO/Ce	< 2
Doubly Charged (%) <sup>b</sup>	Ba <sup>++</sup> /Ba <sup>+</sup>	< 3
Background (cps) <sup>b</sup>	m/z 4.5	< 1
Stability (%RSD)	Short Term <sup>b</sup>	< 2 (10 min)
	Long Term	< 3 (2 h)
Isotope Ratio Precision (%RSD)	<sup>107</sup> Ag/ <sup>109</sup> Ag	< 0.1
He KED Mode		
Sensitivity (kcps/ppb) <sup>b</sup>	Co	30
Background (cps) <sup>b</sup>	m/z 4.5	< 0.5

\* FUO - Field upgrade option.

<sup>a</sup> Typical values, dependent on cleanliness of chemicals.

<sup>b</sup> Demonstrated on installation.

Note that installation specifications are only conducted with the default sample introduction components listed in the Table above.





## iCAP RQ ICP-MS with iMR hardware specifications

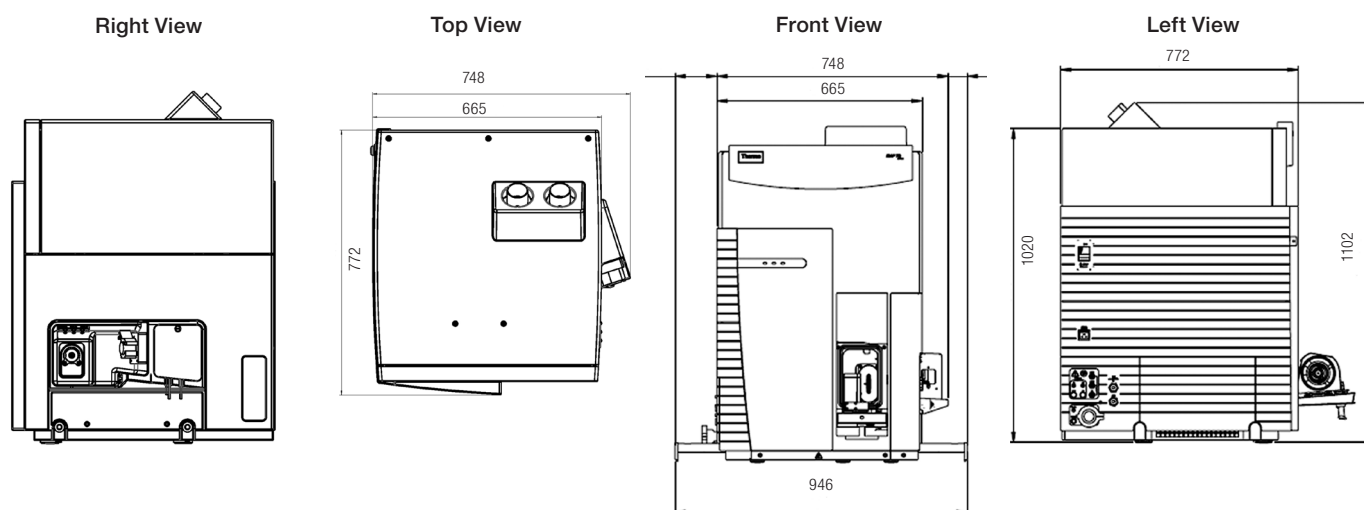
Sample Introduction	
Access	Bench height, torch axis parallel to bench, minimized distances
Peristaltic Pump	Software controlled 12 roller, 4 channel mini-pump, inert rollers, low pulsation
	Three stop flared PVC pump tubing as standard
Nebulizer	Concentric borosilicate glass with 400 $\mu\text{L}\cdot\text{min}^{-1}$ flow rate; PFA and high TDS optional
Spraychamber	Baffled cyclonic, high purity quartz; PFA optional
	Compatibility with all 6 mm OD nebulizers
Peltier Cooler	Software control in range $-10\text{ }^{\circ}\text{C}$ to $+20\text{ }^{\circ}\text{C}$
Injector	Screw-in, self-aligning
	No O-rings required
	Wide 2.5 mm internal diameter quartz as standard
	Optional internal diameters and injector materials are available
Plasma Ion Source	
Torch	Push-in, single piece, quartz
	Automatic gas connectivity
	Horizontal and vertical position: $\pm 2\text{ mm}$ , 0.02 mm step width
	Sampling depth: 0-15 mm, 0.025 mm step width
RF Generator	Digital, solid state RF generator, $\sim 27\text{ MHz}$
	Dynamic frequency matching
	RF power range: 400 W to 1600 W (default hot plasma power 1550 W)
	No plasma shield required
Load Coil	Automated in-sample switching between hot and cold plasma
	Water-cooled, PFA/silver-coated, copper load coil
Ar Gas Flow Controllers	Three channels: coolant, auxiliary, nebulizer
Additional Gas Flow Controllers	Capacity for two further MFCs for gas dilution, oxygen addition, laser ablation etc.
Plasma TV	HD camera for remote monitoring of plasma status
Vacuum System	
Configuration	Three stage, differential pumping
Vacuum Pumps	Split-flow turbo molecular pump
	External backing rotary pump (common to interface)
Pump Down Time	$< 15\text{ min}$ after maintenance ( $< 1\cdot 10^{-6}\text{ mbar}$ )

Interface	
Access	Bench height, easy access from drop down door
Sample Cone	Solid Ni, 1.1 mm diameter orifice; Pt tipped optional
Skimmer Cone	Ni, 0.5 mm diameter orifice; Pt tipped optional
Skimmer Inserts	High matrix insert as standard; Robust interface option supplied; High sensitivity option available
Interface Pump	External, high performance rotary pump
Extraction Lens	Single, low voltage, conical
Slide Valve	PC controlled
Ion Optics	
RAPID Lens	$90^{\circ}$ ion lens operating at a single, fixed voltage
Electrical Connections	Cable free, fixed position, spring mounted gold contacts
Collision/Reaction Cell	
QCell	Non-consumable, zero maintenance
	Automatic low mass cut off
Standard MFC	Pure He collision gas
Optional MFC	Reaction gas mixtures: $\text{H}_2$ , $\text{O}_2$ , $\text{NH}_3/\text{He}$
Quadrupole Mass Analyzer	
Frequency	2 MHz
Mass Range	2-290 u
Scan Speed	$> 3700\text{ amu}\cdot\text{s}^{-1}$ Li to U with 40 interval masses
Mass Stability	$< \pm 0.025\text{ u}$ per day
Abundance Sensitivity	$< 0.5\text{ ppm}$ at m-1 (m= $^{238}\text{U}$ )
Resolution	User definable in mass range 2-290 u
Ion Detection System	
Detector	Dual mode discrete dynode electron multiplier
	Simultaneous pulse/analog over four orders of magnitude for reliable cross calibration
	Cradle design for simplified exchange
Minimum Dwell Time	100 $\mu\text{s}$ in pulse and analog
Dynamic Range	$> 10$ orders of magnitude ( $< 1 - > 5\cdot 10^9\text{ cps}$ )

## Site requirements

Environmental		
Temperature	Range	15-35 °C
	Rate of Change	< 2 °C·h <sup>-1</sup>
Humidity	Range	20-80% (non-condensing)
Utilities		
Electrical	Supply	200-240 V AC, 50/60 Hz single phase
	Power	Apparent: 3000 VA; Effective: 2200 W
Cooling Water	Supply temperature	20 to 30 °C, optimum at 21 °C
	Supply rate	> 5.5 L·min <sup>-1</sup>
	Pressure	0.25 - 0.6 MPa (2.5 - 6 bar; 36 - 86 psi)
Argon Gas Supply	Purity	> 99.996%
	Typical Flow Rate	16 L·min <sup>-1</sup>
	Pressure	0.55-0.6 MPa (5.5 - 6.0 bar; 82.5 - 90 psi)
Cell Gas Supply	Purity	> 99.999%
	Flow rate	max. 10 L·min <sup>-1</sup>
Plasma Exhaust	Pressure	0.1 - 0.15 MPa (1 - 1.5 bar, 15 - 22.5 psi)
	Port Dimensions	60.3 mm (recommended 63 mm ID ducting)
Heat Exhaust	Flow rate	6 - 8 m·s <sup>-1</sup> (67 - 90 m <sup>3</sup> ·h <sup>-1</sup> 39.4 - 53.0 cfm)
	Port Dimensions	60.3 mm (recommended 63 mm ID ducting)
Heat Exhaust	Flow rate	4 - 6 m·s <sup>-1</sup> (45 - 67 m <sup>3</sup> ·h <sup>-1</sup> 26.5 - 39.4 cfm)
	Port Dimensions	60.3 mm (recommended 63 mm ID ducting)

## Dimensions of the iCAP RQ ICP-MS (mm)



## Thermo Scientific™ Qtegra™ Intelligent Scientific Data Solution (ISDS) Software

With centralized control and simplified workflows, Qtegra ISDS Software delivers quality and drives productivity. The platform, common to other Thermo Scientific ICP techniques, is intuitive and easy to use for routine, high-throughput analyses, yet offers all the flexibility required for the most demanding applications.

### Languages supported

English (default). Support for additional languages (for example Simplified Chinese and Japanese) is available through the use of specific Language Packs.

### Integrated control of peripherals

The unique architecture in Qtegra ISDS Software allows for the control of peripheral devices via plug-ins, ensuring full implementation of all features within a single window.

### Regulatory compliance

Qtegra ISDS Software supports Title 21 CFR Part 11 compliance. Features such as system audit trails, access control, e-signatures and secured data enable full confidence in FDA or GMP/GLP compliant environments.

### Supplied PC specifications

- Intel® i5 Quad Core CPU
- 16 GB RAM
- 1 TB Hard Drive
- 64 bit Microsoft Windows 10 Enterprise LTSB

### Supported operating systems

- Windows 7 Professional (32 & 64 bit)
- Windows 10 Professional and Enterprise LTSB (32 & 64 bit)

### Licensing

1 instrument seat and 3 desktop seats are provided with each software license. iMR additional license with 1 seat provided with each iCAP RQ ICP-MS with iMR.

## iCAP RQ ICP-MS accessories

### Autodilution systems

Automated prescriptive and intelligent dilution are the most flexible approaches for handling highly varied and complex samples. Fully inert autodilution systems provide accurate and dynamic dilution of samples and facilitate unattended operation. Qtegra ISDS Software triggers the re-analysis of high matrix or over range samples for a completely automated and hands-free workflow.

## Autosamplers

A wide range of Teledyne CETAC Technologies and Elemental Scientific autosamplers are supported with the iCAP RQ ICP-MS. From small, fully-enclosed units that reduce contamination of high purity samples, to large multi-rack systems in high-throughput environmental and geochemical exploration laboratories.

### Argon gas dilution

On-line gas dilution delivers a significant improvement in plasma robustness for the analysis of high matrix samples. Argon humidifier is included.

### Laser ablation

Laser ablation systems are directly supported via a dedicated plug-in within the Qtegra ISDS Software. With both powerful data evaluation (trQuant) and flexible data export, the iCAP RQ ICP-MS is a truly routine laser ablation analysis solution.

### Speciation

Seamless integration of a range of IC, LC and GC systems for speciation analysis of elements in a variety of sample matrices and applications is delivered via the Thermo Scientific ChromControl Plug-in. The ChromControl Plug-in is powered by SII, the Thermo Scientific Chromeleon CDS Software device control interface. Comprehensive data acquisition and processing features in the tQuant evaluation module simplify the identification and quantification of critical trace elemental species.

### Nanoparticle characterization

Accurately and reliably characterize nanoparticles from single particle ICP-MS analysis utilizing the Thermo Scientific npQuant Plug-in for Qtegra ISDS Software.

### Organics kit

Organic solvents (e.g. as used in reversed phase LC applications) can be analyzed routinely with the organics kit comprising of a 1.0 mm ID quartz injector, a 50  $\mu\text{L}\cdot\text{min}^{-1}$  PFA microflow nebulizer and organic solvent resistant waste pump tubing.

### Acid resistant kit

For the analysis of aggressive sample matrices, for example HF or H<sub>2</sub>SO<sub>4</sub>, this kit contains a PFA cyclonic spraychamber, a 2.0 mm ID sapphire injector and Pt tipped cones.

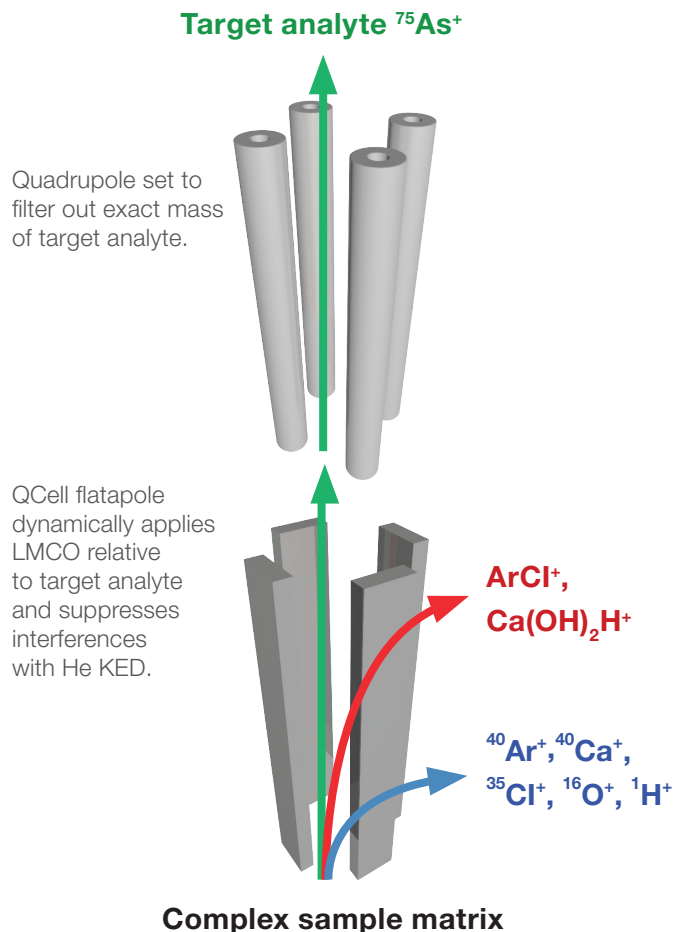
## How does comprehensive interference removal work?

With proprietary QCell technology, comprehensive single mode interference removal is achieved using pure He as a collision gas with Kinetic Energy Discrimination (KED). He KED filters out unwanted polyatomic interferences, based on difference in cross-sectional diameter of the analyte and polyatomic.

Save time and simplify method development by using He KED mode for the entire mass range. High transmission ensures the sensitivity and LODs needed, even on low mass analytes such as Li and Be. Rely upon predictable, reproducible interference reduction in all sample types from unique low mass cut off (LMCO). The iCAP RQ is the only ICP-MS that specifies elemental sensitivity in the He KED mode used in modern ICP-MS analysis.

When matrix complexity demands more targeted interference removal, easily switch to reactive mode for efficient, accurate analysis.

Low mass cut off filters out unwanted precursor ions which are then unable to recombine later in the QCell; further reducing backgrounds than He KED alone.



Mass	LMCO	Interferences	Precursors		Mass	LMCO	Interferences	Precursors
$^{51}\text{V}$	35	$^{35}\text{Cl}^{16}\text{O}$ , $^{37}\text{Cl}^{14}\text{N}$ , $^{34}\text{S}^{16}\text{OH}$	H, N, O, S, Cl	Apply low mass cut off →	$^{51}\text{V}$	35	$^{35}\text{Cl}^{16}\text{O}$ , $^{37}\text{Cl}^{14}\text{N}$ , $^{34}\text{S}^{16}\text{OH}$	H, N, O, S, Cl
$^{56}\text{Fe}$	39	$^{40}\text{Ar}^{16}\text{O}$ , $^{40}\text{Ca}^{16}\text{O}$	O, Ar, Ca		$^{56}\text{Fe}$	39	$^{40}\text{Ar}^{16}\text{O}$ , $^{40}\text{Ca}^{16}\text{O}$	O, Ar, Ca
$^{63}\text{Cu}$	45	$^{40}\text{Ar}^{23}\text{Na}$ , $^{12}\text{C}^{16}\text{O}^{35}\text{Cl}$ , $^{31}\text{P}^{32}\text{S}$	C, N, O, Na, P, S, Cl, Ar		$^{63}\text{Cu}$	45	$^{40}\text{Ar}^{23}\text{Na}$ , $^{12}\text{C}^{16}\text{O}^{35}\text{Cl}$ , $^{31}\text{P}^{32}\text{S}$	C, N, O, Na, P, S, Cl, Ar
$^{75}\text{As}$	47	$^{40}\text{Ar}^{35}\text{Cl}$ , $^{40}\text{Ca}^{35}\text{Cl}$ , $^{40}\text{Ar}^{34}\text{SH}$ , $^{37}\text{Cl}^2\text{H}$	H, S, Cl, Ca, Ar		$^{75}\text{As}$	47	$^{40}\text{Ar}^{35}\text{Cl}$ , $^{40}\text{Ca}^{35}\text{Cl}$ , $^{40}\text{Ar}^{34}\text{SH}$ , $^{37}\text{Cl}^2\text{H}$	H, S, Cl, Ca, Ar

Find out more at [thermofisher.com/SQ-ICP-MS](https://thermofisher.com/SQ-ICP-MS)