

# Thermo Scientific iCAP TQe ICP-MS

Redefining triple quadrupole technology  
with unique ease of use

Keywords: Ease of use, elemental analysis,  
interference removal, applied markets,  
triple quadrupole ICP-MS

## Benefits

- Provides a new level of interference removal for ICP-MS analysis.
- Increases the confidence in data accuracy.
- Removes the complexity from TQ-ICP-MS.
- Decreases method development time.

Enter the world of Triple Quadrupole (TQ) ICP-MS and experience a new level of interference removal. The Thermo Scientific™ iCAP™ TQe provides incredible accuracy and significantly improved detection limits for challenging applications. Enjoy the confidence of 'right first time' results in any sample matrix without the complexity of a research level instrument.

Ease of use is the core concept behind the iCAP TQe ICP-MS, which has been specifically designed for laboratories working in applied analytical testing. The system combines straightforward hardware design and an operator-focused software to streamline workflows.



Equipped with the Reaction Finder method development assistant, method setup enables leveraging the full potential of triple quadrupole technology from day one. Integrated control for a wide range of peripherals to automate sample handling allow for further optimization of common laboratory routines.

Expand your applications and enhance your laboratory efficiency with a breakthrough TQ-ICP-MS system, so easy to use that it is accessible to any operator.

## **iCAP TQe ICP-MS hardware summary**

### **Sample introduction**

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

### **Spraychamber**

- Peltier cooled high purity quartz or PFA, low-volume, baffled cyclonic or double pass spraychambers, efficiently filter out larger aerosol droplets for improved plasma stability.
- Compatible with all 6 mm OD nebulizers.

### **Nebulizer**

- High performance, concentric nebulizers for optimal sample consumption.
- Optional nebulizers in a range of flow rates, total dissolved solids tolerance and resistance to organics or aggressive mineral acids.

### **Torch**

- Push-in, demountable single piece quartz torch.
- All connectivity (argon gas supplies and plasma ignition) designed into the torch holder, reducing complexity and improving usability.
- Proprietary, screw-in, self-aligning injector for simplicity and reproducibility.
- Multiple injector designs available to allow dry aerosol introduction for bulk quantitation, enhanced sensitivity or improved transient signals.

### **Peristaltic pump**

- Compact, low pulsation, low noise, 12 roller, four channel mini-pump with inert rollers for improved reliability.
- Drain Sensor – Automatic drain flow control – assuring user notification and automated action upon failure of the sample delivery system.

### **Additional gas modules**

- Two additional mass flow controllers (0-250 or 0-1000 mL·min<sup>-1</sup>) 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. O<sub>2</sub> for the analysis of organic solvents or Ar for Gas Dilution) or to supply gases for coupled accessories.

### **Inductively coupled plasma**

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

### **RF generator**

- Argon ICP ion source with digital, solid state RF generator.
- Dynamic frequency impedance matching the plasma at ~27 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 with PTFE coating for improved lifetime and reliable plasma ignition.

### **Plasma TV**

- Remote monitoring of plasma status via integrated camera.

### **Inert tubing**

- Deactivated, inert gas transfer tubing for lower backgrounds.

### **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.

### **Cooling plate**

- Polymer coated cooling plate for enhanced resistance against aggressive solutions.

### **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**

- Fully software controlled to maintain vacuum in the analyzer housing during standby or shutdown: defaults to closed position when plasma is off or in the event of a power failure.

### **Ion optics**

- Unique 90° cylindrical ion lens – the RAPID lens: Right Angular Positive Ion Deflection, providing high ion transmission across the entire mass range.
- Open lens stack eliminates lens cleaning maintenance and a completely off-axis design delivers class-leading background noise.
- Electrical connections with gold spring contacts inside the analyzer chamber for improved reliability.

### **Q1 quadrupole**

- High frequency (4 MHz) quadrupole mass analyzer with pre and post filter for isolation of wanted ions.
- User-definable resolution in all TQ modes. Switch between intelligent Mass Selection (iMS) and High Resolution (<1u) mass resolution for optimal performance in all matrices.
- Mass calibration automatically assessed and updated.

### **Q2 QCell collision/reaction cell (CRC)**

- Zero maintenance, small volume collision/reaction cell with proprietary flatpole rods.
- High transmission, low mass cut off, and highly flexible gas usage provides powerful interference removal for a cleaner mass spectrum in all sample types.
- Two gas specific mass flow controllers with dedicated flow ranges deliver O<sub>2</sub> and He in a safe and compliant manner.

### **Q3 quadrupole**

- Quadrupole mass analyzer driven by a solid state, 2 MHz supply ensures low abundance sensitivity and class leading mass stability.

- User-definable mass resolution accessible in all analysis modes.
- Mass calibration automatically assessed and 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.

### **Standard 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 for a single isotope.
- Automated optimization of operating voltages and cross-calibration. Cross calibration factors can be automatically updated per measurement sequence to increase data quality in total element quantitation.
- Cradle design for ease of detector exchange.



## iCAP TQe ICP-MS standard configuration and performance specifications

Configuration	iCAP TQe ICP-MS
Nebulizer (default flow rate)	Glass, concentric (400 $\mu\text{L}\cdot\text{min}^{-1}$ , pumped)
Spraychamber	Quartz, cyclonic
Torch	Quartz, demountable, no shield
Injector	Quartz, 2.5 mm ID
Cones/Interface	Nickel, high performance
Plasma Gas Flow Controllers	Three
QCell (Q2) Mass Flow Controllers	Two
Additional Plasma Mass Flow Controllers	Optional (total of two)

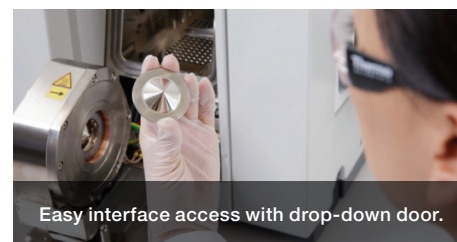
SQ mode		
Sensitivity (kcps/ $\mu\text{g}\cdot\text{L}^{-1}$ ) <sup>a</sup>	<sup>7</sup> Li	65
	<sup>59</sup> Co	150
	<sup>115</sup> In	300
	<sup>238</sup> U	330
Detection Limits (ng $\cdot\text{L}^{-1}$ ) <sup>b</sup>	<sup>9</sup> Be	<0.5
	<sup>115</sup> In	<0.1
	<sup>209</sup> Bi	<0.1
Oxides (%) <sup>a</sup>	CeO/Ce	<2.0
Doubly Charged (%) <sup>a</sup>	Ce <sup>++</sup> /Ce <sup>+</sup>	<4.0
Background (cps) <sup>a</sup>	<i>m/z</i> 4.5	<1.0
Stability (%RSD)	10 mins <sup>a</sup>	<2.0
	2 hrs <sup>b</sup>	<3.0
Isotope Ratio Precision (%RSD) <sup>b</sup>	<sup>107</sup> Ag/ <sup>109</sup> Ag	<0.1

SQ-KED mode		
Sensitivity (kcps/ $\mu\text{g}\cdot\text{L}^{-1}$ ) <sup>a</sup>	<sup>59</sup> Co	40
Background (cps) <sup>a</sup>	<i>m/z</i> 4.5	<0.5
Detection Limits (ng $\cdot\text{L}^{-1}$ ) <sup>b</sup>	<sup>9</sup> Be	<0.5
	<sup>115</sup> In	<0.1
	<sup>209</sup> Bi	<0.1

TQ mode		
Detection Limits (ng $\cdot\text{L}^{-1}$ ) <sup>b</sup>	<sup>32</sup> S (as SO <sup>+</sup> )	<100
	<sup>31</sup> P (as PO <sup>+</sup> )	<30
	<sup>78</sup> Se	<1
Isotope Ratio Precision (%RSD) <sup>b</sup>	<sup>107</sup> Ag/ <sup>109</sup> Ag	<0.1

<sup>a</sup>Demonstrated on installation. Note that installation specifications are only conducted with the default sample introduction components listed in the Table above.

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



## iCAP TQe ICP-MS hardware specifications

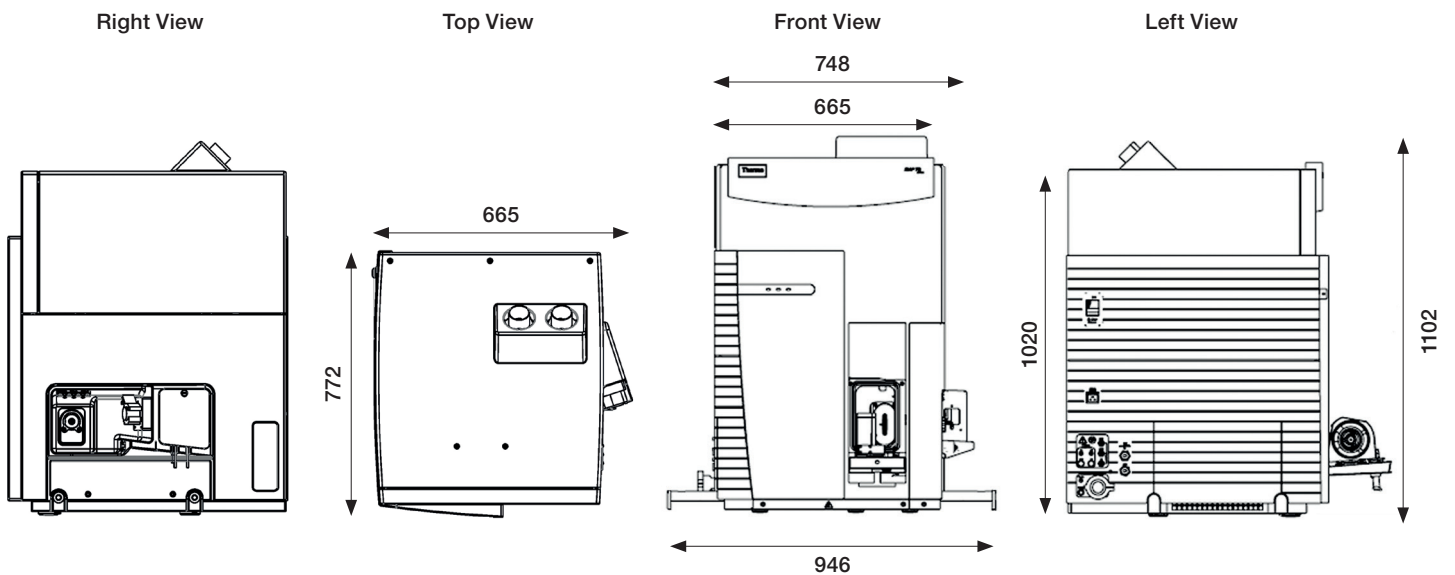
Sample introduction	
Access	Bench height, externally mounted, torch axis parallel to bench, minimized distances
Peristaltic Pump	Software controlled 12 roller 4 channel mini-pump, inert rollers, low noise and pulsation
	Three-stop flared PVC pump tubing as standard
Nebulizer	Concentric glass, PFA microflow and high TDS options
Spraychamber	Baffled cyclonic, high purity quartz; PFA cyclonic and double pass options; peltier cooled
	Compatibility with all 6 mm OD nebulizers
Peltier Cooler	Software control in range -10 °C to +20 °C
Injector	Screw-in, self-aligning
	No o-rings required
	Multiple internal diameters and injector materials available
	Multiple injector designs available to allow dry aerosol introduction for bulk quantitation, enhanced sensitivity or improved transient signals
Plasma ion source	
Torch	Push-in, single piece, quartz
	Automatic gas coupling
	Horizontal and vertical position: +/- 2 mm, 0.02 mm step width
	Sampling depth: 3-15 mm, 0.025 mm step width
RF Generator	Digital, solid state RF generator, ~27 MHz
	Dynamic frequency matching
	RF power range: 400 W to 1600 W
	No plasma shield required
Load Coil	Water-cooled, PTFE coated, silver-sheathed, copper load coil
Ar Gas Flow Controllers	Three channels: coolant, auxiliary, nebulizer
Additional Gas Flow Controllers	Capacity for two additional MFCs for gas dilution, oxygen addition, 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 min after maintenance (<1·10 <sup>-6</sup> mbar)

Interface	
Access	Bench height, easy access from drop-down door
Sample Cone	Ni or Pt-tipped, 1.1 mm diameter orifice
Skimmer Cone	Ni or Pt-tipped, 0.5 mm diameter orifice; insert or cold plasma versions available
Skimmer Inserts	High sensitivity insert as standard; Robust and High Matrix interface option supplied
Extraction Lens	Low voltage, easy access, conical; single as standard, dual for cold plasma
Injector	Multiple injector designs available to allow dry aerosol introduction for bulk quantitation, enhanced sensitivity or improved transient signals
Slide Valve	Software controlled, power failure interlock
Ion optics	
RAPID Lens	90° ion lens at a single, fixed voltage
Electrical Connections	Cable free, fixed position, spring mounted gold contacts
Q1 quadrupole	
Frequency	4 MHz
Mass Range	2-240 u
Resolution	User definable in all TQ modes. Switch between intelligent Mass Resolution (iMS) and High Resolution (<1u) mass resolution for optimal performance in all matrices
Q2 QCell CRC	
QCell	Non-consumable, zero maintenance
	Automatic low mass cut off
Standard MFCs	He – max. flow 12 mL·min <sup>-1</sup> O <sub>2</sub> – max. flow 1.2 mL·min <sup>-1</sup>
Q3 quadrupole	
Frequency	2 MHz
Mass Range	2-290 u
Scan Speed	>3700 u/s; Li to U with 40 interval masses
Mass Stability	<± 0.025 u per day
Resolution	User-definable across all modes
Mass analyzer	
Abundance Sensitivity in TQ Mode	<0.005 ppm
Ion detection system	
Detector	Dual mode discrete dynode electron multiplier
	Simultaneous pulse/analog over four orders of magnitude
	Cradle design for simplified exchange
Minimum Dwell Time	100 µs in pulse and analog
Dynamic Range	>10 orders of magnitude (<1 - >5·10 <sup>9</sup> cps)

## Site requirements and dimensions

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. flow rate tailored to gas
	Pressure	0.1 - 0.15 MPa (1 - 1.5 bar; 15 - 22.5 psi)
Plasma Exhaust	Port Dimensions	60.3 mm (recommended 63 mm ID ducting)
	Flow Rate (63 mm ID ducting)	6 - 8 m·s <sup>-1</sup> (67 - 90 m <sup>3</sup> ·h <sup>-1</sup> ; 39.4 - 53.0 cfm)
Heat Exhaust	Port Dimensions	60.3 mm (recommended 63 mm ID ducting)
	Flow Rate (63 mm ID ducting)	4 - 6 m·s <sup>-1</sup> (45 - 67 m <sup>3</sup> ·h <sup>-1</sup> ; 26.5 - 39.4 cfm)

## Dimensions of the iCAP TQe 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 provides full functionality to support FDA 21 CFR Part 11 compliance. Features such as audit trails, access control, e-signatures and secured data enable full confidence in FDA or GMP/GLP compliant environments.

### **Supplied PC specifications**

- Intel® i7 Quad Core CPU
- 16 GB RAM
- 512 GB SSD Drive
- 64 bit Microsoft™ Windows™ 10 Operating System

### **Supported operating systems**

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

### **Licensing**

1 instrument seat and 3 desktop seats are provided with each software license.

## **iCAP TQe 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. From small, fully-enclosed units that reduce contamination of high purity samples, to large multi-rack systems in high-throughput 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.

### **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, powered via 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 can be analyzed routinely with the organics kit comprising 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 (e.g. HF or  $\text{H}_2\text{SO}_4$ ), this kit contains a PFA cyclonic spraychamber, a 2.0 mm ID sapphire injector and Pt tipped cones.

**How does triple quadrupole technology work?**

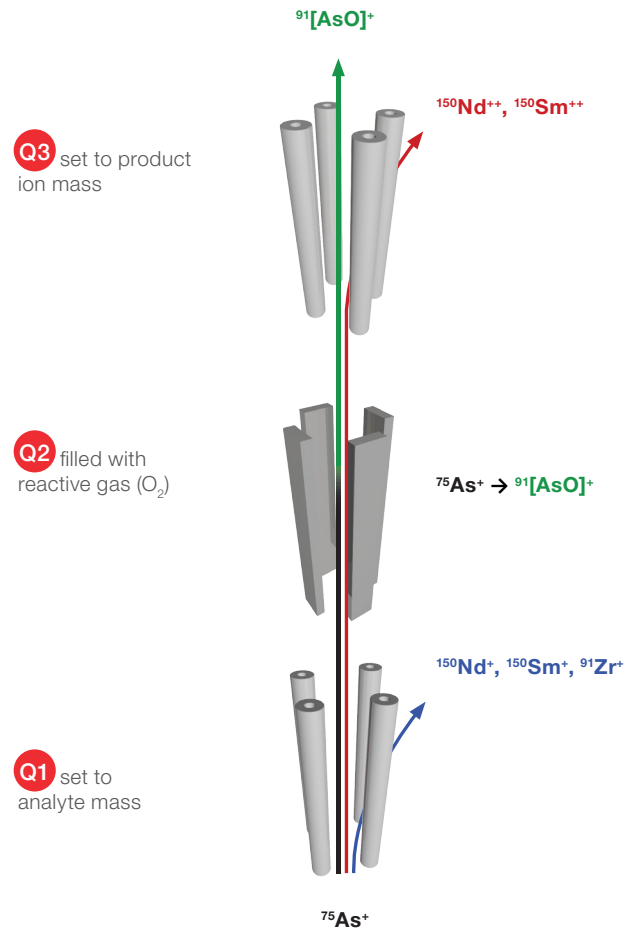
Advanced interference removal with triple quadrupole technology is enabled through the combination of two mass filters, Q1 and Q3 that isolate ions and a Q2 CRC, situated between Q1 and Q3 that generates specific reaction products. This technology can be used in several ways to achieve the most effective interference removal:

**SQ mode:** Routine single quadrupole operation for multi-elemental analysis in standard mode (no cell gas) or collision cell with Helium and kinetic energy discrimination.

**TQ on mass mode:** Triple quadrupole on mass mode for detection of the analyte with no change in the analyte mass. The reactive gas is used to selectively eliminate the interference at the analyte mass.

**TQ mass shift mode:** Triple quadrupole mass shift mode for detection of the analyte as a product ion at a different mass compared to the original ion. The reactive gas is used to selectively shift the analyte to a mass range that does not overlap with the interference.

TQ mass shift mode



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