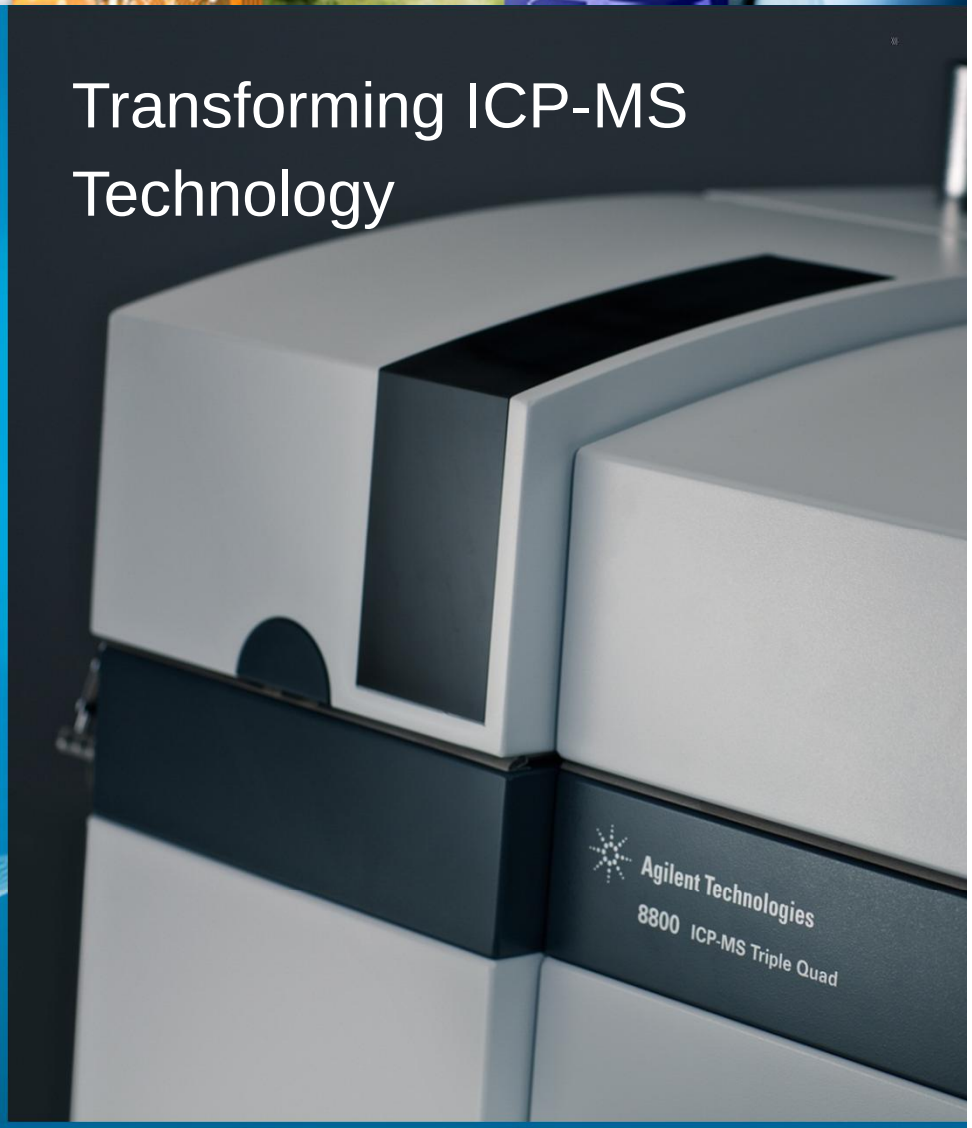
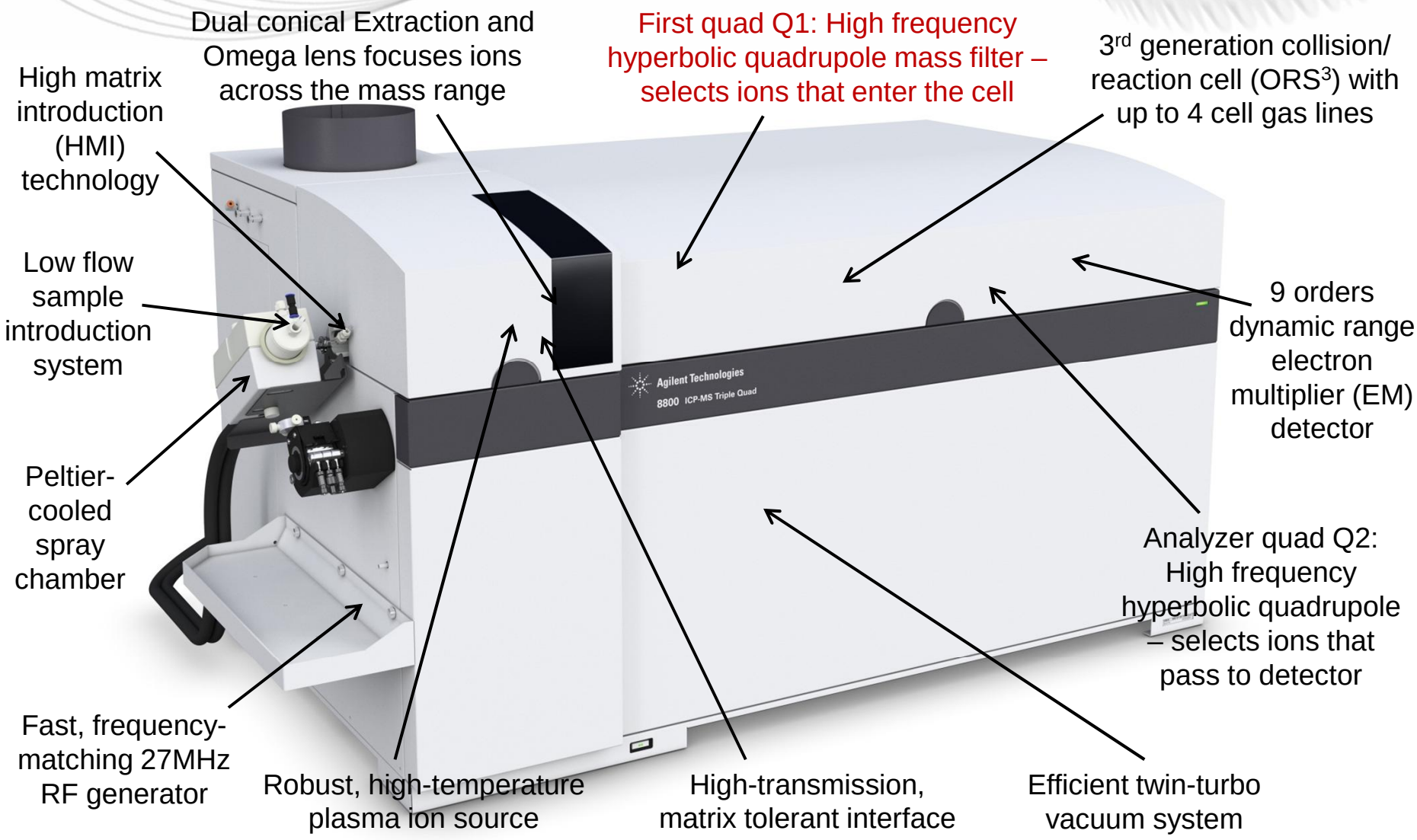
Agilent's New 8800 ICP-QQQ

Transforming ICP-MS Technology



8800 ICP-QQQ Key Product Hardware



Presenting the World's First ICP-QQQ

§ World's first **Triple Quadrupole ICP-MS (ICP-QQQ)**

§ New modes of operation and performance not possible with quadrupole ICP-MS

§ Joins the Agilent 7700, the highest performing quadrupole ICP-MS system

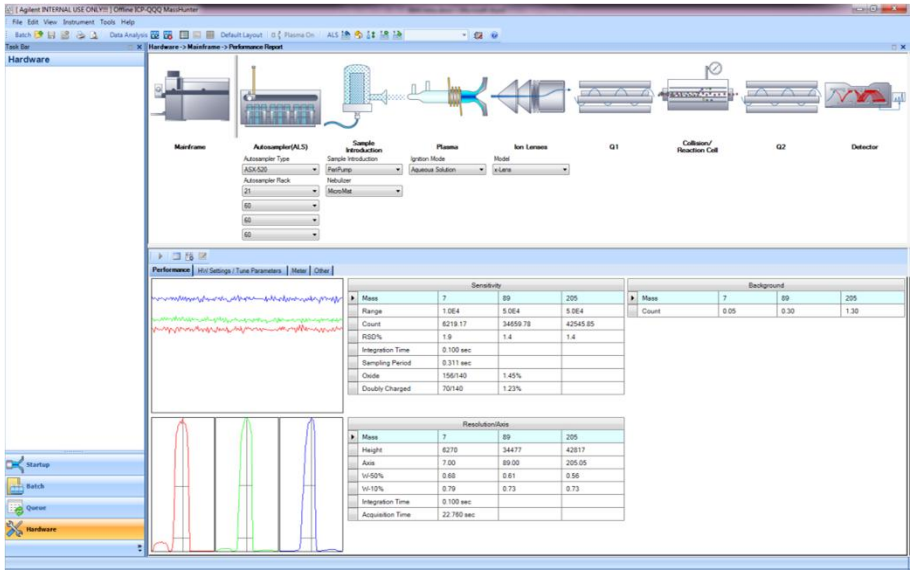
§ Unique capabilities, based on proven technology

New Agilent 8800 **ICP-QQQ**

ICP-QQQ and 7700 Series Hardware/Software

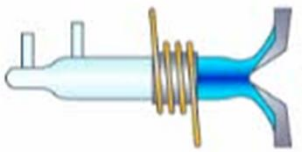
Agilent ICP-QQQ is a completely new instrument configuration, but shares much hardware and its software platform with the proven 7700.

- Sample introduction system
- Plasma RF generator and gas controller
- Torchbox x/y/z stage
- Interface
- Extraction lens; x-lens and s-lens.
- ORS^3 cell
- Quadrupole
- Detector
- Most of vacuum pump system

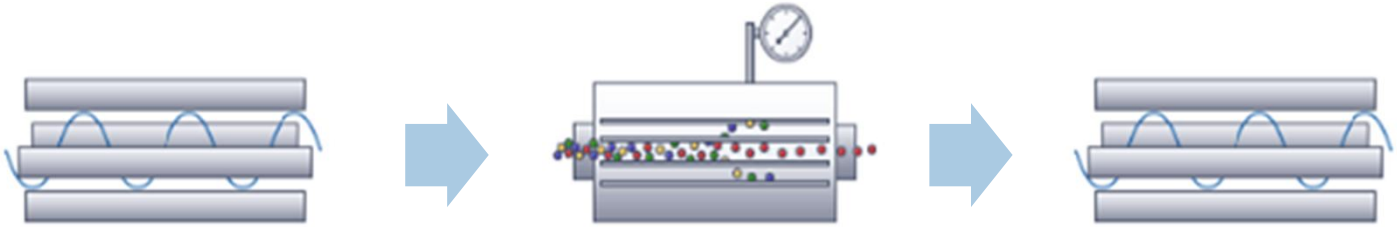


Common, field-proven hardware and software ensures reliability and supportability. Use of common sample introduction and peripherals allows familiar operation – many 7700 methods can be transferred.

ICP-QQQ: *How Does it Work?*



ICP (plasma) and Interface: Forms and extracts ions from the sample (just like the 7700)



Q1 – controls ions that enter the cell

- Consistent reactions even if sample composition changes

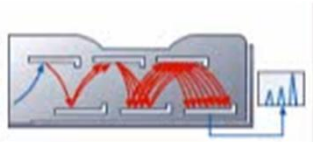
ORS^3 – collision/ reaction gas added

- Ions react and are neutralized or moved
- Product ions are formed

Q2 – selects the target analyte mass

- Interference-free analyte ions passed to EM

EM (detector): Measures the ions that are scanned by Q2 (just like the 7700)



ICP-QQQ: *What Can It Do?*

ICP-QQQ can function in Single-Quad Mode

Q1 operates as an ion guide or bandpass filter; can be used in no gas, helium collision mode, reaction mode (just like single quad ICP-MS).

Two "single-quad" modes of operation are available with ICP-QQQ:

A. Q1 as an ion guide

Allows all ions through, so system works like a conventional ICP-QMS

- **Functions like ICP-QMS with a "passive" cell**

B. Q1 as a bandpass filter

Allows a "window" of masses through, above/below the Q2 set mass (mass range can be adjusted by the user)

- **Functions like a single-quad with a "scanning" cell, except masses outside the bandpass window are rejected before the cell**

Agilent 8800 ICP-QQQ has ~2x higher sensitivity and >5x lower background than 7700, so DLs are improved even for elements with no interferences

"ICP-QQQ does everything ICP-QMS can, only better!" ***Plus…***

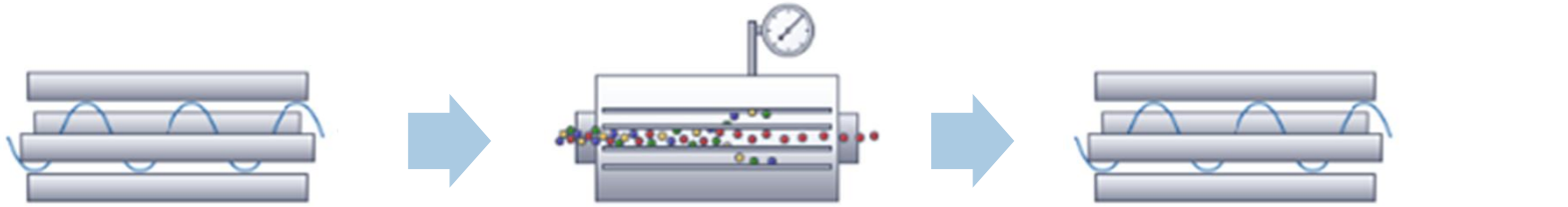
ICP-QQQ: *What Else Can It Do?*

ICP-QQQ configuration enables MS/MS Mode

Q1 set to 1amu resolution, allowing only target ions to enter cell and react:

1. MS/MS On-Mass Mode (Q1 and Q2 both set to the target mass):

Q1 allows only the precursor ion mass to enter the cell (analyte and on-mass polyatomics). ORS separates analyte from interference(s). Q2 measures the analyte ion after the on-mass interferences have been removed by reactions in the cell



Q1 – Rejects all masses except analyte mass (analyte and on-mass interferences)

ORS^3 – Separates (unreactive) analyte and (reactive) interferences by neutralizing interference or moving it to new mass

Q2 – Rejects all cell-formed ions apart from target analyte ion, leaving analyte free from overlap

ICP-QQQ: *MS/MS for High-Purity Materials*

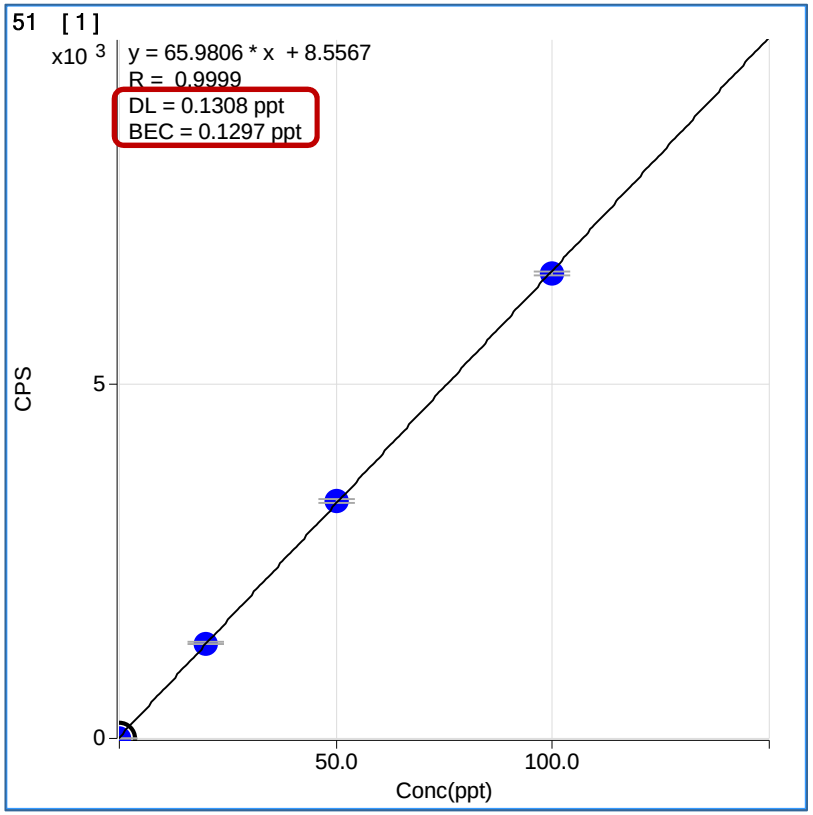
In high-purity materials, the interferences are typically known and consistent. In 10x diluted (9.8%) H_2SO_4, 2 of the key interfered elements are Ti and V. Ti reacts quickly with NH_3, so a new Ti-NH_3 product ion can be measured, but V reacts slowly, so on-mass measurement is a better solution:

Removal of $^{33}S^{18}O^+$ and $^{34}S^{16}OH^+$ overlaps on $^{51}V^+$ using NH_3 cell gas

ICP-QQQ in MS/MS mode allows very effective removal of SO/SOH interferences in NH_3 reaction mode.

No new analyte- or matrix-based NH_3 cluster ions can be created at mass 51, as no other ions are able to enter the cell

BEC and DL for V measured directly at mass 51 were both 0.13ppt (130ppq)

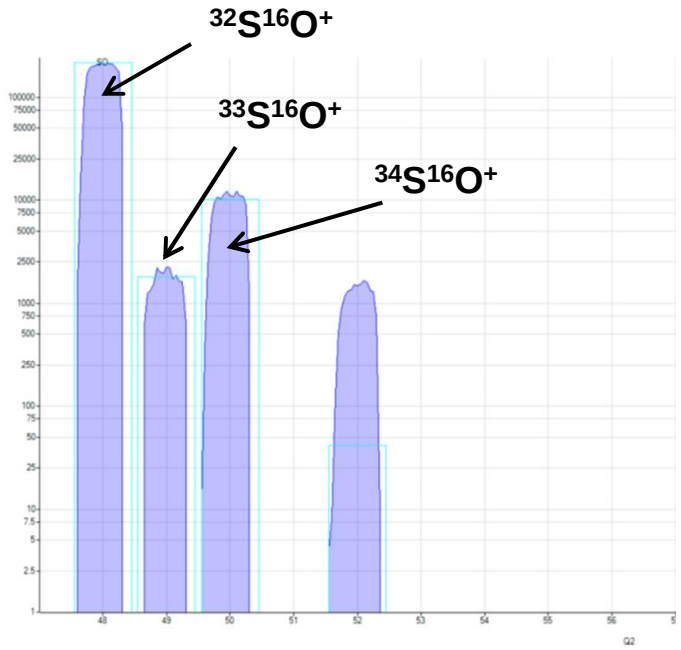


ICP-QQQ: *What Else Can It Do?*

2. MS/MS with "Mass-Shift" (Q1 and Q2 at different mass):

Q1 is set to precursor ion mass, controlling the ions that enter ORS. Q2 is set to mass of reaction product ion (Q1 + 16amu in O_2 mode):

e.g. Conversion of $^{32}S^+$ to $^{48}SO^+$ using O_2 cell gas



Single-quad can also do SO mass-shift to move S (as SO^+) away from the O_2^+ interference.

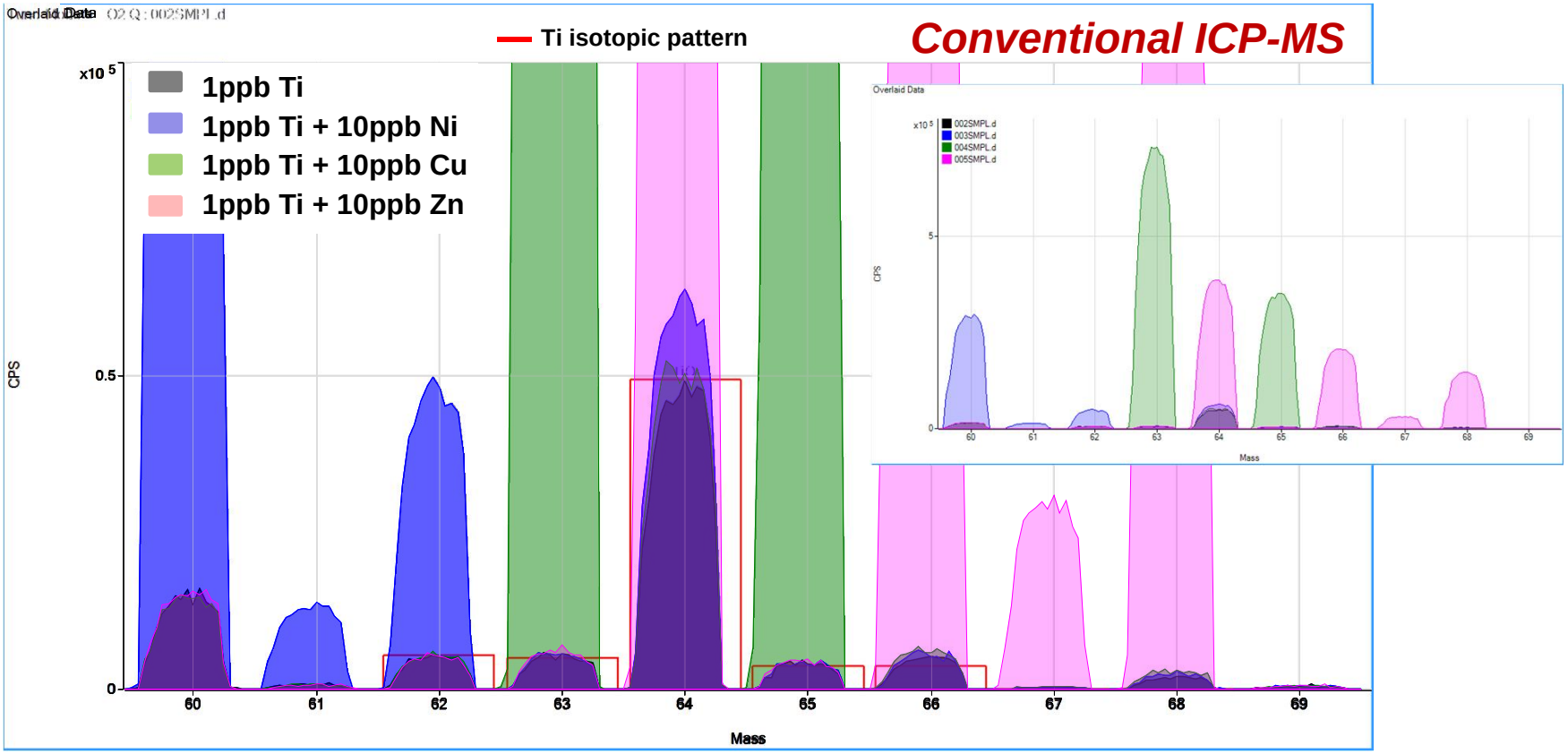
BUT single quad cannot remove the ^{48}Ca/^{48}Ti and $^{36}Ar^{12}C$ overlaps on $^{48}SO^+$

Also, $^{32}S^{18}O^+$ and $^{34}S^{16}O^+$ both appear at mass 50 on single-quad ICP-MS; ICP-QQQ with 16amu mass-shift enables S isotope analysis as only the target S isotope is measured

MS/MS provides benefits to both research and real applications and is unique to ICP-QQQ configuration (not possible with single-quad)

TiO^+ Measurement in Conventional ICP-QMS

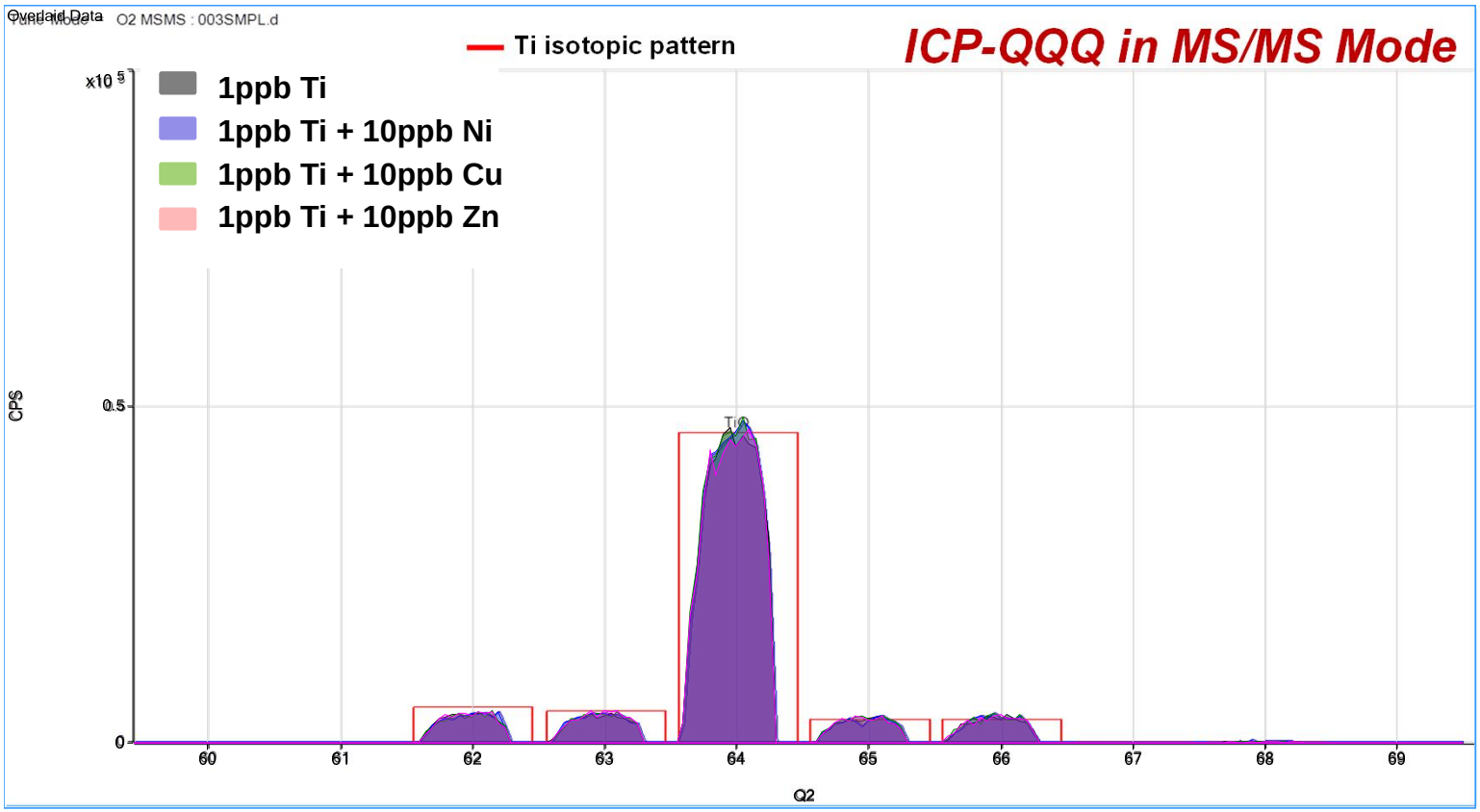
O-atom addition can be used in conventional ICP-QMS as well – Ti^+ **à** TiO^+ reaction cell chemistry with O_2 cell gas still works without MS/MS



All TiO^+ peaks are overlapped when Ni, Cu & Zn are present

ICP-QQQ: Neutral Gain Scan for TiO; O_2 Cell Gas

O-atom addition: Q2 scanned at Q1 mass + 16 to monitor Ti + ^{16}O transition (for all Ti isotopes). $^{46}Ti^+$ **à** $^{62}TiO^+$, $^{47}Ti^+$ **à** $^{63}TiO^+$, $^{48}Ti^+$ **à** $^{64}TiO^+$, etc.

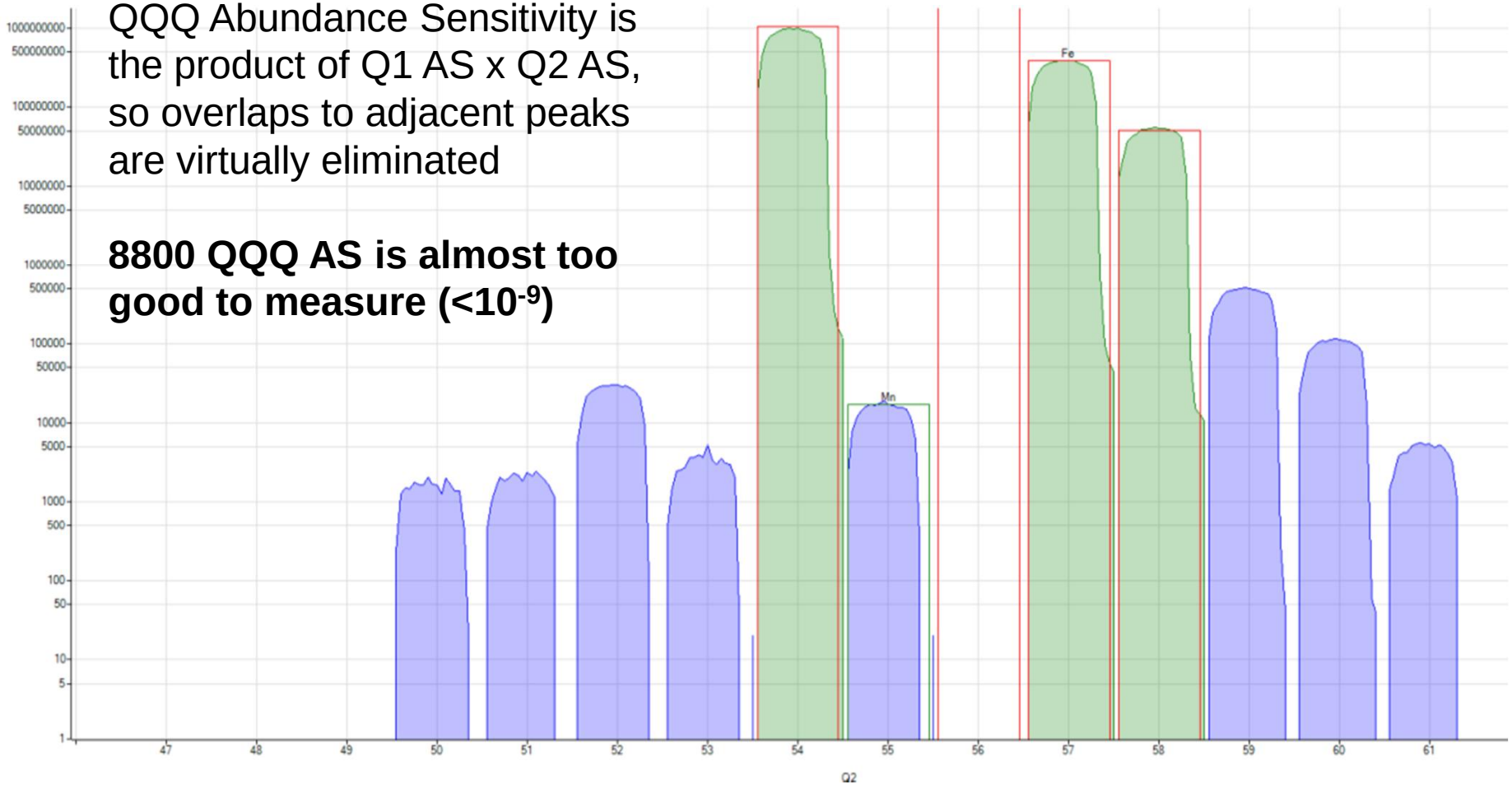


MS/MS mode allows Ti to be measured as TiO with no overlap from Ni, Cu, Zn

8800 Abundance Sensitivity in MS/MS Mode
^{55}Mn is free from overlap by ^{56}Fe in 1000ppm Fe

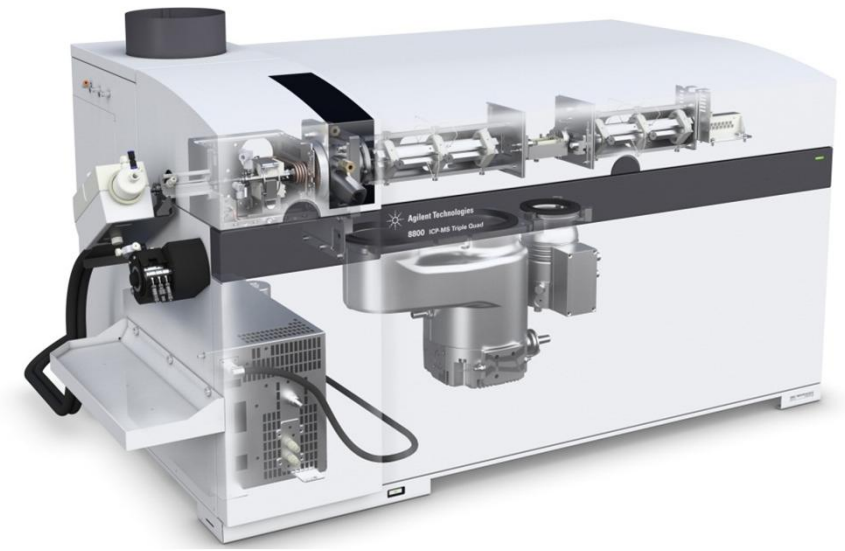
QQQ Abundance Sensitivity is the product of Q1 AS x Q2 AS, so overlaps to adjacent peaks are virtually eliminated

8800 QQQ AS is almost too good to measure (<10^{-9})



Agilent 8800 ICP-QQQ – Key Features

- Outperforms quadrupole ICP-MS for conventional applications
- Provides unique, high-performance MS/MS mode
- QQQ configuration ensures control of ions that enter the cell; controlled reaction processes deliver reliable results
- Offers ultimate flexibility for problem solving and advanced research
- Utilizes critical hardware and same MassHunter software platform as the proven 7700, ensuring reliability and supportability (global network of service and applications support)



THANK YOU