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ICP-MS in Commercial Labs: Trends and Developments

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Users of analytical instrumentation want reliable instruments that produce good quality and reproducible data. For commercial testing laboratories, the stakes are higher, as their success and profitability depend on ease of use and cost of ownership, as well as analytical performance. There has been a long-term trend for contract labs to adopt ICP-MS for elemental analysis. This has been possible due to improvements in ICP-MS usability, running costs, and analytical performance. Advances in matrix tolerance and control of spectral interferences have enabled commercial labs to run a wider range of samples on ICP-MS. At the same time, higher productivity, and lower maintenance and running costs contribute to increased profitability. The impact of these developments is discussed in this issue.

Figure 1. Agilent 7900 fitted with the optional ISIS 3 discrete sampling (DS) accessory and coupled to an Agilent SPS 4 autosampler

Key Factors Affecting ICP-MS Productivity and Cost-of-Ownership in High-Throughput Commercial Laboratories

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Introduction

Commercial laboratories survive and prosper by providing a reliable and accurate analytical service at a cost and with a turnaround time that meets their customers' requirements. For inorganic ("metals") analysis, that typically means offering analysis using a fast, multi-element technique. The low detection limits of ICP-MS are increasingly needed to meet the lower regulated limits being introduced in industries including environmental monitoring, food safety, pharmaceutical manufacturing, and consumer product testing.

High throughput commercial laboratories that use ICP-MS benefit from full elemental coverage for all regulated analytes including mercury, low detection limits, and high sample throughput. But not all ICP-MS systems are equally suited to the needs of commercial laboratories. In this article, we reveal the impact of three key areas where Agilent's 7800 and 7900 ICP-MS systems contribute to improving the overall efficiency – and profitability – of a commercial analytical laboratory by providing:

- Simplified instrument setup and operation using software tools, Application Packs and SOP templates.
- Easier, more reliable analysis of varied sample types using unique 7800/7900 hardware capabilities.
- Productivity gains using ISIS 3 discrete sampling and extended maintenance intervals.

Method Setup and Software Tools

Preset methods and method automation: Agilent's ICP-MS MassHunter software includes Preset Methods for many typical applications. The editable method templates predefine the key parameters required for successful method setup, including analyte/isotope list, plasma conditions, tune/cell mode, internal standard assignments, integration times, etc. As well as speeding up the setup of a new method, Preset Methods also help to minimize method setup errors. For more unusual sample types where no predefined method exists, the Method Wizard can quickly create an optimized method from the analysis of a representative sample.

Agilent ICP-MS systems include comprehensive auto-optimization functions. A well-optimized analytical system provides the obvious benefit of higher performance; but consistency of operating conditions is equally important for commercial contract labs. If instrument optimization is the same every time, regardless of the operator's expertise, labs can ensure that their system's performance is consistent from day to day.

Application packs: Setup, optimization, and validation of a new method may take many days or even weeks after the analytical system is delivered and installed. Commercial laboratories in regulated industries such as environmental, food and pharmaceutical product testing, would prefer to minimize this time.

Agilent has developed validated Application Packs to deliver optimized and performance tested methods for several industries. Because the method development and optimization has already been done by Agilent, these Application Packs allow you to get your new Agilent ICP-MS system into production faster, as illustrated in Figure 1.

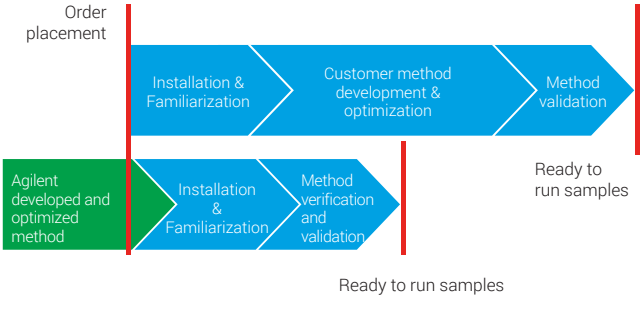


Figure 1. Agilent's ICP-MS Application Packs reduce the time needed for onsite method development and optimization.

Hardware Features Simplify Analysis

High Matrix Introduction (HMI): Matrix tolerance was traditionally seen as a limitation of ICP-MS. Analysts had to ensure that samples were prepared and diluted to give a low and consistent level of total dissolved solids (TDS), or risk errors due to signal suppression and drift. In 2007, Agilent introduced the automated aerosol dilution and plasma optimization tool called HMI. The new technology allowed Agilent ICP-MS systems to run much higher and more variable sample matrix levels. HMI – and the advanced "Ultra" version, UHMI – dilutes the sample aerosol with a precisely controlled flow of argon, reducing the amount of matrix and water vapor reaching the plasma. HMI enables the plasma to tolerate much higher matrices, allowing TDS levels up to 3% (25% for UHMI) to be run routinely, as shown in Figure 2.

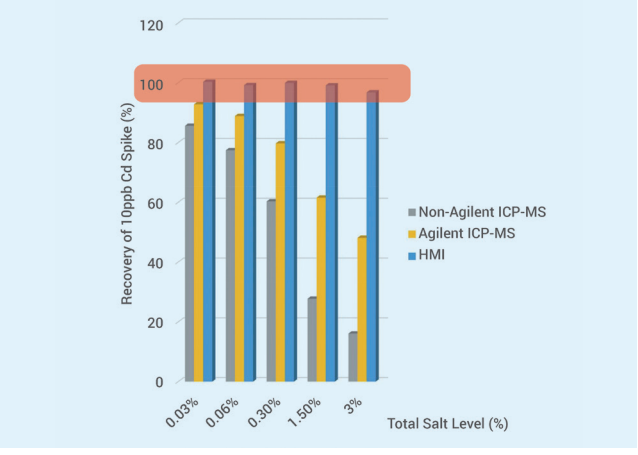


Figure 2. Agilent's HMI system simplifies ICP-MS analysis and ensures consistent Cd recovery in high and variable matrices.

HMI allows analysts to use a standard sample preparation approach without needing to ensure low and consistent levels of TDS. HMI also virtually eliminates matrix suppression, so variable samples can be run against simple, non-matrix matched calibrations. HMI allows faster, simpler, and more consistent method setup and routine analysis, leading to shorter turnaround times, and lower operating costs.

Helium cell mode: Collision/reaction cells (CRCs) have revolutionized ICP-MS accuracy by controlling spectral interferences. Agilent's ORS cell system is uniquely suited to helium (He) collision mode. He mode provides a simple, consistent operating mode that effectively reduces all common polyatomic ions. As well as delivering improved accuracy, He mode provides a consistent cell mode for all analytes across a wide range of typical sample matrices. It also eliminates the need for correction equations. As with HMI, the ability to use a consistent He cell mode greatly simplifies method development and speeds up routine operation.

Detector dynamic range: Early ICP-MS detectors had a dynamic range of about 6 orders of magnitude, allowing measurements from detection limit (DL) at about 10 ng/L (ppt) up to around 10 mg/L (ppm). Concentrations higher than 10 mg/L would be over-range, requiring reanalysis after dilution or with detuned operating conditions.

Most modern, non-Agilent ICP-MS systems have a true detector dynamic range of about 8 or 9 orders of magnitude. However, improved sensitivity means that the range now starts from DLs at about 0.1 ppt. This means that concentrations above ~50 or 100 ppm will still be over-range for fully ionized, mono-isotopic elements. To cope, analysts must set up customized conditions for high-level analytes. For example, users can reduce ion intensities by using "detuned" ion lens or cell voltages, selecting a minor isotope, or by using a lower detector gain. This depends on the high concentration analytes being known in advance and consistent in all samples. This is not usually the case for the varied and unknown samples measured in applications such as environmental monitoring or food testing.

Agilent ICP-MS systems, by contrast, have a unique detector and amplifier circuit that provides 10 or 11 orders dynamic range. This means that analyte concentrations up to 1000s ppm are within range, without requiring any custom tuning or detector setup. Simple, consistent methodology can be used for the variable samples types encountered in many routine applications.

Boosting ICP-MS Productivity

ICP-MS is a fast, multi-element technique. But, as well as the data acquisition time, the sample uptake and stabilization time must be considered, along with the rinse time between samples. If these steps occur sequentially, the sample-to-sample time may be 4.5 minutes or more, even for an analysis that requires less than 1 minute for data acquisition.

Discrete sampling (DS) can speed up the analysis by separating the sample uptake and rinse steps from the acquisition step, using a loop and valve system. Agilent's third-generation Integrated Sample Introduction System (ISIS 3) is optimized for high throughput ICP-MS applications. ISIS 3 uses a high-flow piston pump to load the loop, and a robust, 7-port switching valve to inject the sample and add the internal standard.

The optimized configuration of ISIS 3 provides significantly faster analysis compared to other discrete sampling devices. An improvement of around 10% allows an extra 100 billable samples to be analyzed in a 20-hour day, assuming a 15% QC overhead (illustrated in Figure 3).

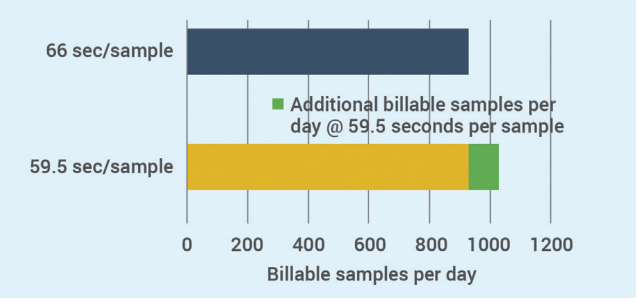


Figure 3. ISIS 3 reduces sample-to-sample run time by 10%, allowing more than 100 additional billable samples to be run each day compared to alternative discrete sampling systems.

Real-World Maintenance Intervals

ISIS DS minimizes the time the system is exposed to the sample. The robust plasma of the Agilent ICP-MS systems then ensures that the sample matrix is decomposed effectively in the plasma. Reducing the amount of undecomposed matrix that deposits on the interface and ion lens means that the ICP-MS can be productive for longer before maintenance is required.

Most routine maintenance tasks are quick and easy to perform on Agilent ICP-MS systems. These tasks do not require access to the high vacuum region, and so cause minimal downtime. Exchanging the Electron Multiplier (EM) detector is one of the more disruptive and costly maintenance tasks. Consequently overall ICP-MS running costs can be significantly impacted by the operating lifetime of the detector.

Agilent ICP-MS systems use a proprietary detector and amplifier circuit to deliver a unique combination of high sensitivity, low background, and long lifetime.

Agilent engineers have estimated the EM lifetime for the 7900 ICP-MS in two typical high-throughput contract analysis scenarios: routine drinking water analysis and high concentration multi-element solutions, such as wastewaters or environmental sample digests. Assuming a suite of around 30 analytes and 10 internal standard elements was measured in 300 drinking water samples per day for 20 days per month, a laboratory running an Agilent 7900 ICP-MS can typically expect their EM detector to last more than 10 years. Even laboratories running high matrix samples with 30 analytes at levels between 100 µg/L (ppb) and 10 mg/L (ppm) can expect almost six years of operation from the detector.

The Agilent 7800 ICP-MS is optimized for more routine applications, where factors such as stability, sample throughput and low operating costs are typically more important than achieving the highest sensitivity. So, the voltage settings and thresholds of the 7800 detector are optimized for extended life with lower sensitivity than on the 7900. These settings mean that the Agilent 7800 ICP-MS detector lifetime is typically around twice as long as the figures quoted above for the 7900.

A survey of Agilent 7700 ICP-MS users conducted four years after the 7700 was launched supported these estimates, by indicating that ~80% of users had not changed the detector. The long lifetime detector also contributes to reduced maintenance downtime, further enhancing productivity.

Conclusions

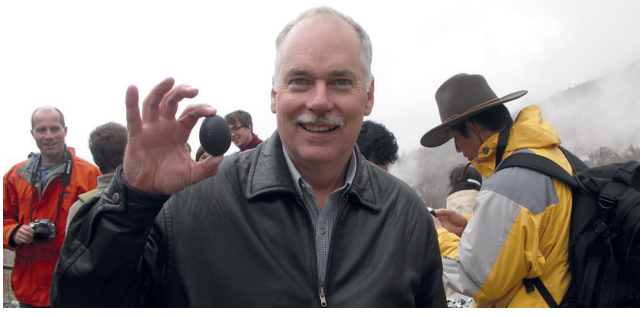
Agilent ICP-MS systems are perfectly suited to the needs of commercial laboratories looking to maximize their return on investment. The 7800 and 7900 allow you to:

- Speed up method development and simplify routine analysis using Preset Methods, auto-optimization, and Application Packs.
- Run your varied, high-matrix samples more easily using standard, consistent operating conditions with HMI, He mode, and a wide-dynamic-range EM detector.
- Use ISIS-DS to speed up analysis time and analyze more billable samples per day.
- Minimize maintenance downtime and control overall running costs with Agilent's long-life consumables.

A Fond Farewell to Agilent's Steve Wilbur

The ICP-MS Team, Agilent Technologies, Tokyo Analytical Division, Hachioji, Japan

From GC/MS To ICP-MS And Beyond



After a long and distinguished career at Hewlett Packard (HP) and Agilent, Steve Wilbur is retiring. He is hoping to spend more time on travelling for pleasure, and perfecting the art of wine making.

Following five years as a GC/MS chemist for an environmental lab, Steve joined HP in 1989 as a GC/MS applications engineer (AE). His long association with ICP-MS began with the launch of the HP 4500 in 1994, when he became the second ICP-MS AE in the US.

Steve was influential in the on-going development of the 4500 ICP-MS, joining a small team focussed on introducing the instrument to the world market. It was at this time he made the first of many trips to Japan.

Some Standout Achievements

ISIS: In 1995 Steve became interested in alternate sample introduction systems as a way to improve performance and expand the capability of the 4500 in the environmental market. The outcome was the Integrated Sample Introduction System (ISIS). ISIS was very well received in commercial labs looking for better matrix tolerance and higher productivity.

Speciation solutions: Steve brought his knowledge of GC/MS to develop a prototype GC-ICP-MS interface. This formed the basis of the world's first commercial GC-ICP-MS interface, introduced by Agilent in 2002.

Sample introduction: Steve's interest in sample introduction systems has continued throughout his 23 years with the ICP-MS team. He was involved in refining the GC interface, developing new applications. for LC-ICP-MS, and launching the SPS 4 autosampler. He also worked closely with third party manufacturers to integrate control of their products into ICP-MS MassHunter software. Examples include:

- ESI – prep*FAST* discrete sampling systems
- IAS - automated semiconductor process analysis
- New Wave Research – laser ablation ICP-MS

Software: as software and peripherals product manager for ICP-MS products at Agilent, Steve worked on software projects including Intelligent Sequencing QC software, and "PlasmaChrom" for speciation studies. More recently he managed the development of the powerful nanoparticle analysis software for ICP-MS MassHunter.

We all wish Steve and his family well.

Rebranding of Agilent Vacuum Fluids

Foreline pump oil changes: To simplify Agilent's range of lubricant oils and improve ease of ordering, the names of the oils used with ICP-MS foreline pumps are changing.

Part No.	Current Name	New Name	Used In
X3760-64004	AVF 60 SHCE	AVF Platinum	Agilent MS40+
6040-0834	Inland 45, 1 L.	AVF Gold, 1 L.	Edwards E2M18 & Agilent DS402
6040-0798	Inland 45, 1 Gal.	AVF Gold, 1 Gal.	Edwards E2M18 & Agilent DS402

The chemical composition of the oil and all associated part numbers remain the same. Old and new oils can be mixed, and foreline pumps do not require flushing or any special action to switch over.

We hope you like the new look; please provide any feedback or concerns to gareth.pearson@agilent.com

Maintain ICP-MS Performance with Quick, Easy, and Reliable Inspection of Interface Cones

Gareth Pearson, ICP-MS Supplies Product Manager, Agilent Australia

Close Inspection of Interface Cones using the New Agilent LED Measuring Magnifier

Dirty, blocked, or damaged interface cones adversely impact the sensitivity, precision, and background of your ICP-MS results. That's why you should inspect your sampling and skimmer cones regularly — paying close attention to the condition of the orifice.

You can make this important task easier with the new Agilent LED measuring magnifier. This convenient tool allows you to:

- Inspect the condition of your sampling and skimmer cones in the lab.
- Check for matrix build up at the tip.
- Confirm whether cleaning/maintenance procedures have been successful.
- Check if a cone needs replacing—particularly due to an enlarged or damaged orifice.

The LED measuring magnifier can be bought using Agilent part number 5190-9614. Alternatively, the magnifier is included free with every Sampling Cone Care Kit.

Choose from Three Sampling Cone Care Kits

The Agilent Sampling Cone Care Kit contains all the items required to make cone maintenance and sampling cone replacement quick and simple.

Three Cone Care Kits are available, depending on the type of sampling cones you use:

- Part no. 5067-0294: Contains two nickel sampling cones
- Part no. 5067-0295: Contains two nickel-plated sampling cones
- Part no. 5067-0296: Contains two platinum tipped sampling cones

Each kit also contains:

- One pack of sampling cone graphite gaskets (3 gaskets per pack).
- One pack of cotton swabs for cone orifice cleaning (100 swabs per pack).
- One LED measuring magnifier.

The Sampling Cone Care Kits are suitable for all Agilent 7700, 7800, 7900, 8800, and 8900 ICP-MS instruments.

More Information

Visit our dedicated webpage for more information or to place an order: www.agilent.com/en/promotions/icpms-conecare-orderform

Agilent Spectroscopy Supplies Catalog

New version out now: For all your ICP-MS supplies, take a look at the comprehensive Agilent Spectroscopy Supplies Catalog - 2018/2019 , 5991-5455EN.

On-Demand Webinars on ICP-QQQ in a Commercial Lab and The Impact of ICP-MS in Geochemistry

Hakan Gurleyuk, Brooks Applied Labs, Washington, US, and Prof. Thomas Meisel, Montanuniversitaet Leoben, Austria

Why ICP-MS/MS? How Tandem MS Solves Analytical Problems and Improves Data Quality in a Commercial Metals Laboratory

Brooks Applied Labs (BAL) is a commercial laboratory that specializes in trace metal and speciation analysis. In a recent webinar, Hakan Gürleyük, Technical Director, explained why the lab now uses Agilent triple quadrupole ICP-MS (ICP-QQQ) for all its total metals analyses.

BAL has specialized in elemental analysis for over 30 years and has built up a wealth of experience in inorganic chemistry. Such is BAL's reputation, other commercial labs send their "difficult" samples to the company for analysis. With over 50,000 samples to analyze each year, Gürleyük said that instrument reliability was the most important characteristic of an analytical technique.

Data quality is a priority at BAL, so analysts collect more data than is needed and use qualifier ions whenever possible. All data is fully evaluated before it is reported. The lab rarely knows what a sample contains before analysis so often uses QuickScan semiquantitative analysis to get a better understanding of the sample.

Gürleyük presented case studies from environmental and pharmaceutical applications to illustrate the benefits of ICP-MS/MS with unit mass resolution. The MS/MS solves problems that can't be addressed using conventional single quad or bandpass ICP-MS. He also explained how unique MS/MS method development tools can be used to identify interferences and validate methods.
Watch the webinar at your convenience.

Has ICP-MS Helped to Improve the Quality of Data Obtained from Geological Samples?

In his recent webinar, Prof. Thomas Meisel, Chair, General and Analytical Chemistry at the University of Leoben, talked about proficiency testing and sample preparation techniques for zirconium and chromium.

According to Prof. Meisel, there are various factors that influence a measurement result including sampling, the selection of reference materials, and choice of method. In most cases, sampling must be done in solution. To get a rock sample into solution, either acid digestion or fusion/sintering must be used. A complete dissolution can be obtained with sintering or fusion but impurities in any reagents can cause contamination. There may be a tradeoff between complete digestion and low levels of contamination. The selection of reference materials is also important as the matrix can have an enormous influence on the measurement result during method validation or calibration.

Method selection affects how interferences are managed. Each method should be thoroughly validated with matrix matched calibration standards.

Collaboration between analytical chemists and earth scientists is necessary to obtain accurate and understandable data sets. However, it is only with the right matrix-matched sample preparation techniques and improved knowledge that analysts can fully benefit from the latest developments in geochemistry research. Many of the new possibilities are driven by innovations in analytical ICP-MS instrumentation.

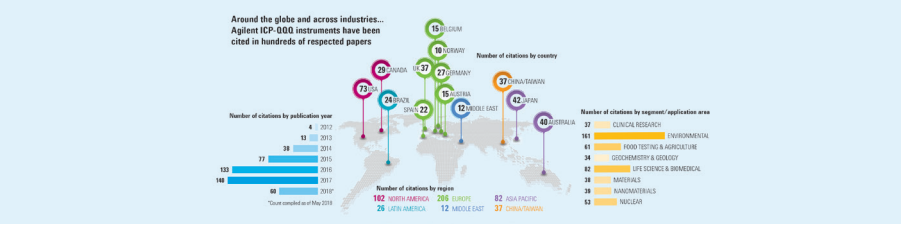
Watch the webinar at your convenience.

You can also download an executive summary of the webinar:

Has ICP-MS Helped to Improve the Quality of Data Obtained from Geological Samples?

Educational Spotlight: Learn About Novel Applications of ICP-QQQ with Agilent's Comprehensive Bibliography

Agilent's online ICP-QQQ bibliography provides a unique resource for scientists and users wanting to learn what triple quadrupole ICP-MS and MS/MS operation can offer. The bibliography has been updated to include almost 180 new papers published since the original list was compiled in early 2017. Since triple quadrupole ICP-MS was introduced in 2012, Agilent's ICP-QQQ instruments have been cited in more than 460 peer-reviewed journal articles. ICP-QQQ is increasingly used in environmental, life science, and food testing applications.



On the bibliography webpage, papers are organized by industry segment or application area, and listings include a full reference, title, author information, institution, and country – plus a link to the abstract or full paper.

See how MS/MS technology has enabled hundreds of labs around the world to push the boundaries of their analytical and scientific capabilities: www.agilent.com/chem/trust-qqq

Conferences and Events

2nd European ICP-QQQ Forum, Munich, Sept 19-21, 2018.

Agilent ICP-MS Publications

To view and download the latest ICP-MS literature, go to www.agilent.com/chem/icpms

- **Technical note:** Critical Factors Affecting Cost-of-Ownership of ICP-MS: The impact of sample throughput and real-world maintenance intervals, 5991-9342EN
- **Application note:** Fast Analysis of Arsenic Species in Rice Cereals for Infants using LC-ICP-QQQ: Routine determination of inorganic arsenic in less than two minutes, 5991-9488EN
- **Application note:** Automated Analysis of Semiconductor Grade Hydrogen Peroxide and DI Water using ICP-QQQ: Online MSA calibration using a prep*FAST* S sample introduction system and Agilent 8900, 5991-9487EN
- **Application note:** Single Nanoparticle Analysis of Asphaltene Solutions using the Agilent 8900 ICP-QQQ: ICP-MS MassHunter software module simplifies spICP-MS analysis, 5991-9498EN

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