VHG™

Tuning Process for ICP-MS

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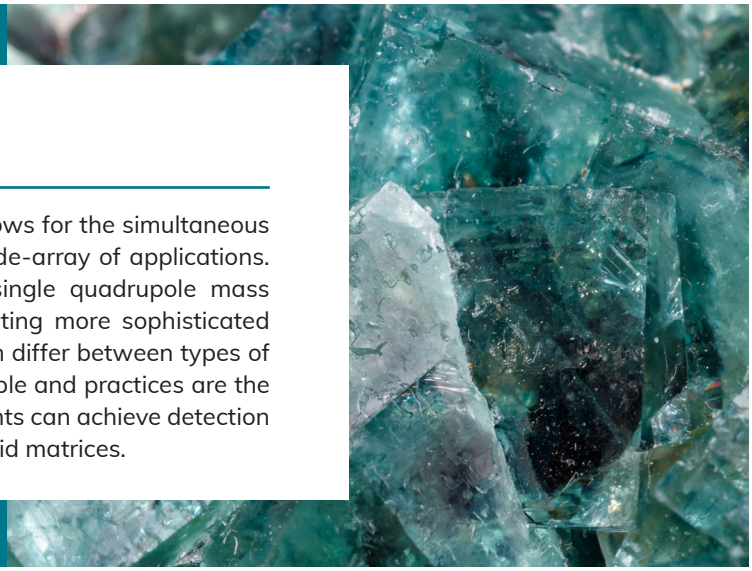
Our Quality: ISO 17043 | ISO 17034 | ISO/IEC 17025 | ISO 9001

LGC

Introduction

ICP-MS is a powerful elemental analysis technique that allows for the simultaneous measurement of multiple analytes and is suitable for a wide-array of applications. The primary installed base of ICP-MS systems is the single quadrupole mass spectrometer; however laboratories are increasingly adopting more sophisticated systems, including the "triple-quad." The tuning process can differ between types of systems and applications, however, the fundamental principle and practices are the same. When configured correctly, modern ICP-MS instruments can achieve detection limits of less than 1 part per trillion for most elements in liquid matrices.



Tuning

The array of actions that make up tuning are currently done using software-driven "autotuning" procedures that only require the analyst to load the tuning standard into the autosampler rack and provide its position. Autotuning adjusts the instrument's lens voltages, flowrates, ICP electronics and quadrupole voltages accordingly to achieve performance specifications developed per the instrument model. Solutions used for tuning (or optimization) of the system are commonly called "tune-solutions" and are typically delivered as low concentration (1 to 10 µg/L) solutions. In nearly every case they will have elements at low mass (<20 amu), mid-mass (89-115 amu) and high-mass (>200 amu) in order to fully optimize and validate the entire mass range of the instrument. It is important that the tune solution not have impurity elements since many of the actions performed involve the measurement (via the autotune algorithm) of background masses or neighboring masses of the analytes. *If an incorrect solution or one with impurities is utilized, it can result in severe de-optimization of the instrument.*

The requirements for the tuning standard and contents of the tune report expand as regulatory and compliance demands increase. However, the universal requirement is that the tuning solution have consistent composition. This is achieved through careful selection of the standard delivered to the system. Solution selection should be driven by stability and confidence in the concentrations of the tuning analytes. Quality of a tune solution, as with calibration standards, is established by the item being a Certified Reference Material (CRM) with traceability to an accepted reference body and suitable accreditation. For a CRM, the accreditation most important for confidence is ISO 17034. For optimal results, the solution used for the Tune Report or Daily Performance Check should be a true CRM that is within the certified shelf life and has reliable traceability.

The action of tuning the instrument is important, but the record of performance as demonstrated in the Tune Report or Daily Performance Check is the key component to verify performance and supply compliance to regulations that may exist. It is possible that this also is a component of secure records control.

TIPS: Instrument Qualification & Good Laboratory Practices

Compliance to regulation is a common requirement for many analyses, particularly in the fields of pharmaceuticals, environmental analysis, or other legally defensible data. For analytical instrumentation, qualification protocols made up of the "Q's" are useful terminologies to categorize compliance areas. User tuning of the system and Tuning Reports that follow typically fall under OQ and PQ ("operational qualification" and "performance qualification," respectively).

Analytical Goals

ICP-MS instrumentation inherently requires that certain performance goals are met to ensure that analytical measurements are accurate. Tuning of ICP-MS instruments is considered by most users to be a daily, if not more frequent, activity, and a prerequisite for achieving optimal results. The current generation of quadrupole-based instruments have tremendous performance and built-in automation; however, just as with older systems, *they will operate and deliver numerical data even if not tuned and operating at expected levels*. The considerations that exist for the analytical goals required by most laboratories, as well as how those considerations relate to tuning, are summarized in Table 1. Current ICP-MS configurations have a vast range of modes for cell gas, cool plasma, flow injection, etc.; as a result, there is not always a "one size fits all" choice for a tuning solution standard. In addition to the listed items, cell gas modes (e.g. O_2) based on mass shift may utilize a tuning solution or other reference standard to set up or validate the mass shift performance.

	Analytical Goal	Calibration Action Required	Purpose of Action	Typical Key Parameter	Calibration Standard Used
Signal	Adequate countrate / within spec	Tuning / autotune	Detectability	Sample introduction and proper system assembly	Tuning solution with composition recommended by manufacturer
Specificity	Peak location and shape optimized	Mass calibration and resolution tuning	Accurate analyte measurement	Quadrupole electronic settings	Tuning solution with composition recommended by manufacturer
Stability	Low signal noise	Short term stability test (commonly part of autotune)	Good precision and repeatability	Sample introduction	Tuning solution with composition recommended by manufacturer
Oxides	Robust sample performance and low oxide interferences	Tuning / autotune	Critical for more complex samples	Plasma conditions	Tuning solution with composition recommended by manufacturer
Doubly Charged (M^{++}) Ions	Doubly charged ions low and within spec	Tuning / autotune	Goal of low M^{++} interferences	Plasma conditions and condition of system cones	Tuning solution with composition recommended by manufacturer
Interferences	Low or eliminated interferences	Cell mode(s) tuning / autotune	Complex samples: reduce polyatomic and some elemental interferences	Cell gas flow and electronic conditions	Same or different tuning solution as used above
Background	Minimize of check on-peak background countrate	Tuning / autotune	Critical for measurements near the MDL	Cleanliness of system	Blank solution
Linearity	Documented performance report	Detector calibration	Accurate results at both low and high concentration	Detector voltages / software "crosscal" values	Detector calibration solution
Validation	Demonstrated compliance with method	Tune report	Compliance with SOP or regulation	Overall quality of tune and time stamp / traceability of tune standard	Tuning solution with composition recommended by manufacturer
Regulatory Validation	Doubly charged ions: low and within spec	Tune check (e.g. U.S. EPA 200.8 and 6020)	Validates signal, specificity, stability, mass calibration, and resolution	Overall quality of tune and time stamp / traceability of tune standard	Tune check sample specified per regulation

Table 1. Considerations for analytical goals and how they relate to tuning

Tuning Solutions available from VHG™

VHG™, part of the larger LGC Standards family, manufactures a complete line of tuning, mass calibration & wavelength calibration standards for most commercially available ICP/ICP-MS instruments. Many tuning standards are listed in the table below; for a full list of ICP-OES and ICP-MS Start Up Solutions, click here to visit our webshop.

Tuning and Mass Calibration Solutions for ICP-MS

Description	Composition	Product No.	mL	Suitable for use with
Tuning / Mass Calibration Multi-Element Mix 1 *(concentrate)*	^{7}Li, Y, Ce, Tl @ 10 µg/mL in 5% HNO_3	VHG-LMSTNG1-500	500	All models
Tuning / Mass Calibration Multi-Element Mix 1A *(concentrate)*	^{7}Li, Co, Y, Ce, Tl @ 10 µg/mL in 1% HNO_3, 0.5% HCl	VHG-LMSTNG5CONC-500	500	All models
Tuning / Mass Calibration Multi-Element Mix 2 *(concentrate)*	Be, Mg, Co, In, Ce, Pb @ 10 µg/mL in 1% HNO_3	VHG-LMSTNG2Z-500	500	All models
Tuning / Mass Calibration Multi-Element Mix 3 *(concentrate)*	^{7}Li, Be, Mg, Co, Y, In, Ba, Ce, Tb, Pb, U @ 10 µg/mL in 5% HNO_3	VHG-LMSTNG3Z-500	500	All models
Tuning Solution *(see composition)*	Ce, Co, Li, Tl, Y @ 10 µg/mL in 2% HNO_3	VHG-LAGTSTK1-100	100	Agilent® ICP-MS: 7500, 7700, 7800, 7900, 8800, 8900
Tuning Solution 2	Ce, Co, Li, Mg, Tl, Y @ 10 µg/mL in 2% HNO_3	VHG-LAGTSTK2-100	100	Agilent® ICP-MS: 7500, 7700, 7800, 7900, 8800, 8900
Tuning Solution *(see composition)*	Ce, Co, Li, Mg, Tl, Y @ 1 µg/L in 2% HNO_3	VHG-LMSTNG101-500	500	Agilent® ICP-MS: 7500, 7700, 7800, 7900, 8800, 8900
Tuning Solution *(see composition)*	^{7}Li, Co, Y, Ce, Tl @ 10 µg/L in 2% HNO_3	VHG-LMSTNG5DIL-500	500	Agilent® ICP-MS: Various Models
Tuning Solution *(see composition)*	Be, Mg, Fe, Co, In, Ce, Pb, Th, U @ 1 µg/L; Ba @ 10 µg/L in 2% HNO_3	VHG-LMSTNG8-500	500	PerkinElmer ® ICP-MS: DRC, DRCII
Setup / Stability / Masscal Solution	Ba @ 10 µg/L; Al, Cd, Ce, Cr, Cu, In, Mg, Mn, Pb, Rh, Th @ 1 µg/L in 0.5% HCl	VHG-LPEMCAL-500	500	PerkinElmer® ICP-MS: E6100DRC, DRCII
Setup Solution *(see composition)*	Be, Ce, Fe, In, Li, Mg, Pb, U @ 1 µg/L in 1% HNO_3	VHG-LPENXSUSDIL-500	500	PerkinElmer® ICP-MS: NexION™
KED Setup Solution	Co @ 10 µg/L; Ce @ 1 µg/L in 1% HNO_3	VHG-LPENXKED-SUS-250	250	PerkinElmer® ICP-MS: NexION™
Setup Solution *(see composition)*	Be, Ce, Fe, In, Li, Mg, Pb, U @ 10 µg/L in 1% HNO_3	VHG-LPENXSUS-500	500	PerkinElmer® Instruments: NexION™
Tuning Solution 1	Ba, Be, Ce, Co, In, Li, Mg, Pb, Rh, Tl, U, Y @ 10 µg/mL in 2% HNO_3, 5% HCl	VHG-LPETSOL1-100	100	PerkinElmer® ICP-MS: DRC, DRCII, NexION™
Tuning Solution *(see composition)*	^{7}Li, Be, Mg, Co, In, Ba, Ce, Pb, Bi, U @10 ug/L in 2% HNO_3	VHG-LMSTNG6-100	100	Thermo Scientific™ ICP-MS: X-Series
Tuning Solution *(see composition)*	Be, Mg, Co, In, Ba, Ce, Tl, Pb, Th @ 250 µg/L in 2% HNO_3	VHG-LMSTNG9-500	500	Varian® ICP-MS: Various models