EPA Method 6020 using Shimadzu's ICPMS-2030

Andrew Fornadel, Ph.D.
Shimadzu Scientific Instruments
Columbia, MD

Outline of Presentation

1) Introduction to Shimadzu's ICPMS 2030

2) Brief background on EPA 6020

3) Application data using the ICPMS 2030

4) Features of the ICPMS 2030 for your Environmental Lab

5) Productivity enhancement using the ICPMS 2030

6) Conclusions

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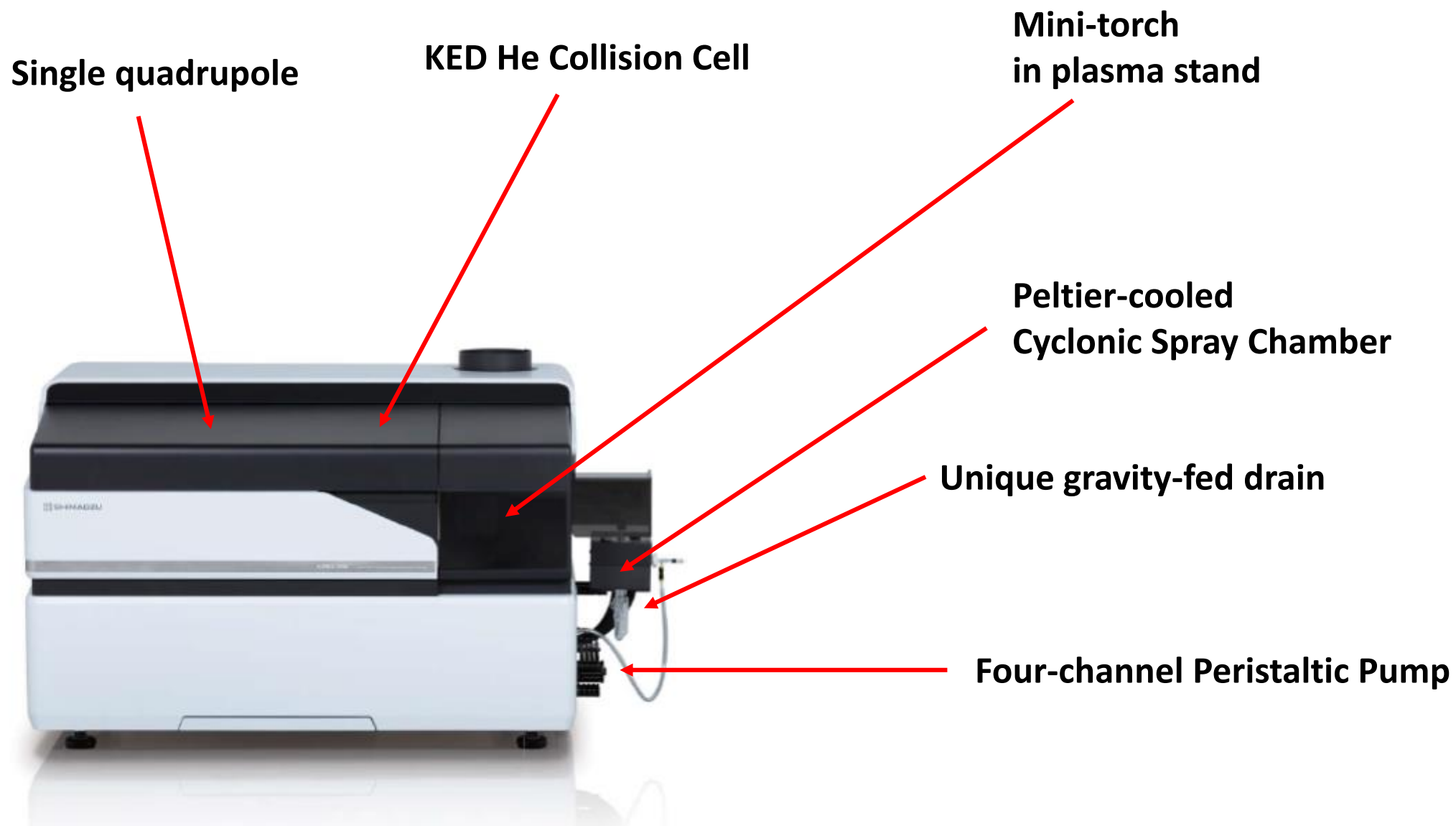
6) Conclusions

Shimadzu's ICPMS 2030

- Shimadzu has been manufacturing ICPs for ~40 years, ICPMSs for ~10 years

- The ICPMS 2030 was released to the US Market in early 2016

- Part of Shimadzu's Mass Spec line-up, including LCMS, LCMS/MS, GCMS, and GCMS/MS
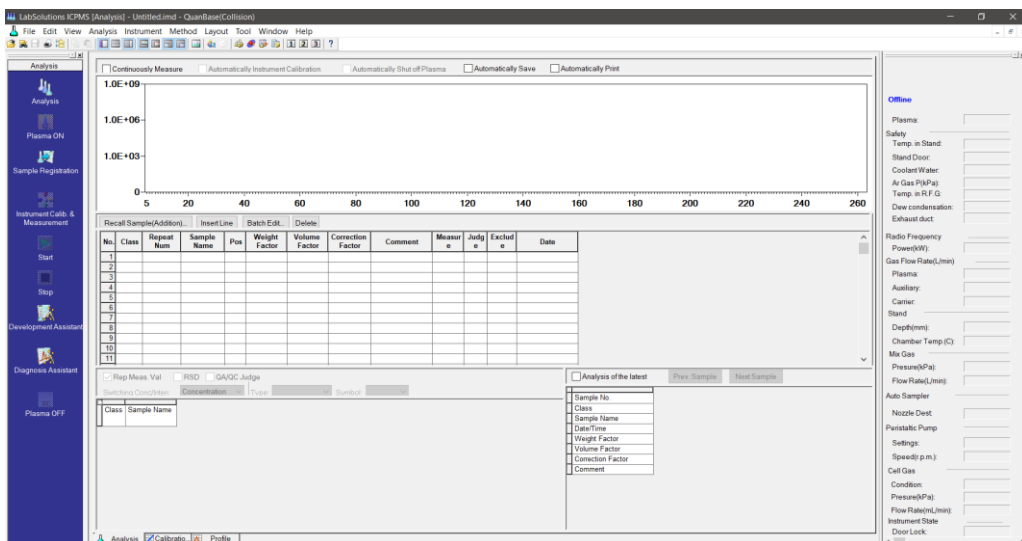
Shimadzu's ICPMS 2030 - Software

- Software built on Shimadzu's LabSolutions platform
  - Offers easy transfer between Shimadzu instruments due to similar UX/UI

- Several features that simplify analysis
  - Fully-automated tuning and optimization
  - Method development and data diagnosis assistant functions

- Can be networked with other instrument platforms and/or made fully compliant in a variety of regulatory environments

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EPA 6020 – A brief primer

ABSTRACT

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846) provides test procedures and guidance which are recommended for use in conducting the evaluations and measurements needed to comply with the Resource Conservation and Recovery Act (RCRA), Public Law 94-580, as amended. These methods are approved by the U.S. Environmental Protection Agency for obtaining data to satisfy the requirements of 40 Code of Federal Regulations (CFR) Parts 122 through 270 promulgated under RCRA, as amended. This manual presents the state-of-the-art in routine analytical testing adapted for the RCRA program. It contains procedures for field and laboratory quality control, sampling, determining hazardous constituents in wastes, determining the hazardous characteristics of wastes (toxicity, ignitability, reactivity, and corrosivity), and for determining physical properties of wastes. It also contains guidance on how to select appropriate methods.

Several of the hazardous waste regulations under Subtitle C of RCRA require that specific testing methods described in SW-846 be employed for certain applications. Refer to 40 CFR Parts 260 through 270, for those specific requirements. Any reliable analytical method may be used to meet other requirements under Subtitle C of RCRA.

- Introduced in Update V of SW-846.

- Elemental analysis for waters and digests of soils / sludges

- Unlike EPA 200.8, allows for the use of modern interference reduction technology, such as collision/reaction cells.

- Also specifies more "common" cations, such as Fe, K, Ca, and Na.

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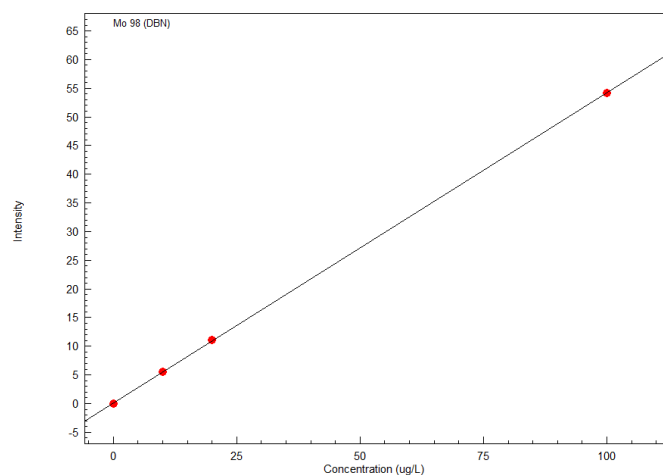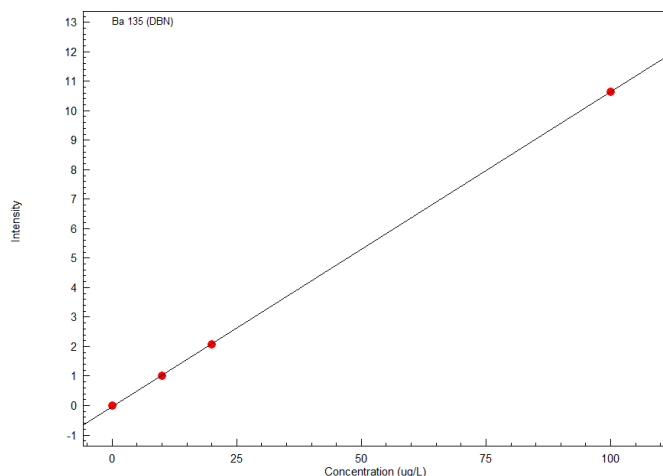
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Implementing EPA 6020 using the ICPMS 2030

- Method run using standard instrument configuration
  - No special hardware needed

- Standards – Multi-element EPA 6020 package from Inorganic Ventures

- Internal Standards – Added in-line using second peristaltic pump channel

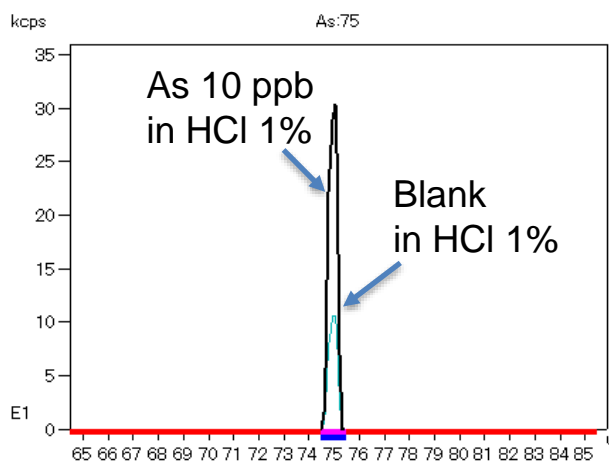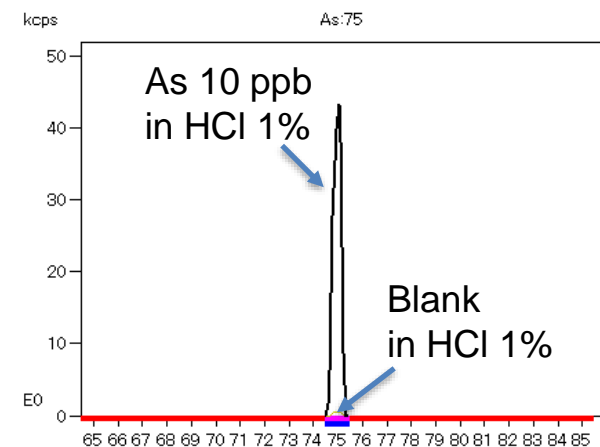- CRMs from High Purity Standards, NIST

Results / Data

- Good linearity across calibration range, including major and trace cations.

- KED He collision cell effective at removing common polyatomic interferences, e.g., oxides, chlorides, etc.
  - Verified using spectral interference check

Non Collision

Collision

As 10 ppb in HCl 1%

Blank in HCl 1%

As 10 ppb in HCl 1%

Blank in HCl 1%

Results / Data

	NIST 1643f	Recovery	HPS Soil A	Recovery
Be	14.3	104.8	*n/a*	*n/a*
Na	17963.8	95.4	73.99	105.7
Mg	7133.5	95.7	667.1	95.3
Al	137.9	103.1	524.5	104.9
K	1845.6	95.5	215	107.5
Ca	32078.7	109.0	357.7	102.2
V	36.7	101.7	0.1075	107.5
Cr	19.1	103.0	n/a	n/a
Mn	40.4	109.8	0.00402	100.5
Fe	93.9	100.5	183.6	91.8
Co	23.2	99.4	*n/a*	*n/a*
Ni	60.3	100.9	0.1019	101.9
Cu	20.9	96.7	0.2721	90.7
Zn	76.4	102.7	1.086	108.6
As	56.6	98.6	0.1998	99.9
Se	10.7	91.1	0.00945	94.5
Mo	125.9	109.2	*n/a*	*n/a*
Ag	0.9	93.3	*n/a*	*n/a*
Cd	5.7	96.0	0.003201	106.7
Sb	57.4	103.6	0.033	110
Ba	513.5	99.1	4.96	99.2
Hg	*n/a*	*n/a*	*n/a*	*n/a*
Tl	35.7	98.9	*n/a*	*n/a*
Pb	17.9	97.0	0.4044	101.1

- All analytes demonstrate acceptable levels of recovery, CRMs show +/- 10% recoveries.
  - Not shown: spike and recovery samples also acceptable

- Long-term stability good over ~10 hour period, with internal standards recovery within 10%.

- Spectral interference checks show minimal interference on analytes from matrix.

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Lowest Operating Costs

33-50% reduction of argon consumption by Mini torch

Approximately 33-50% reduction in argon gas consumption rate.
Conventional torch: ~15-20 L/min; **Shimadzu Mini torch: ~10 L/min**

70% reduction of argon consumption in standby mode

Reduces the RF output to 0.5 kW and the plasma gas about 5 L/min. during standby saves energy and reduces costs.
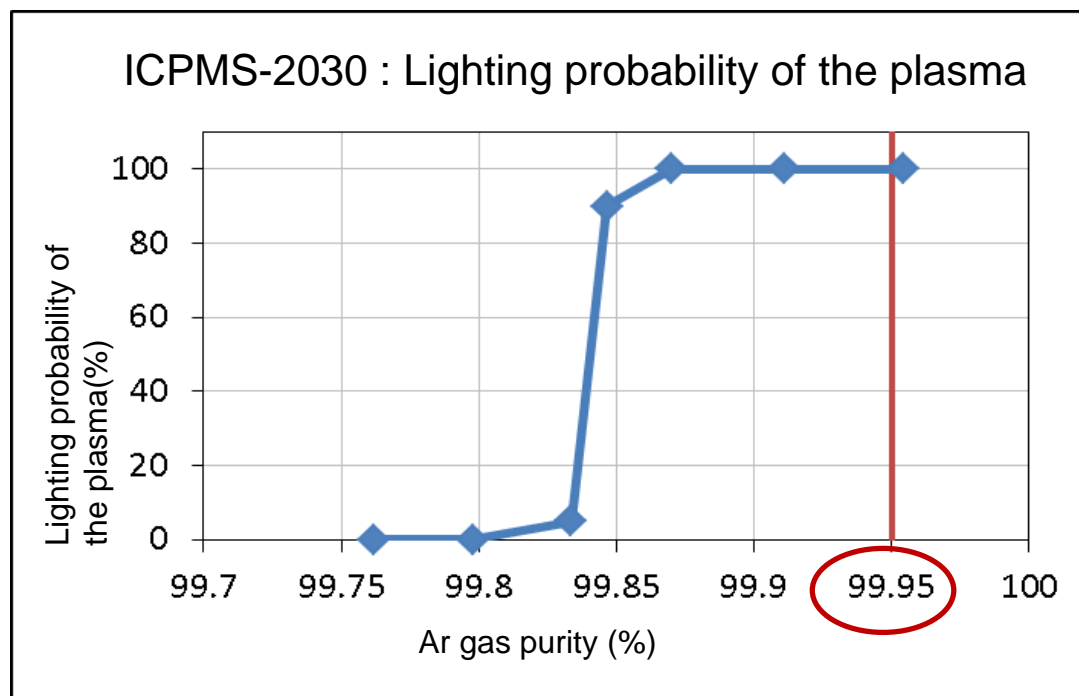
Ar gas of 99.95% or greater purity is sufficient

Using industrial argon with lower price reduces costs. UHP Ar over 99.999% purity used in conventional ICPs is not necessary.

Conventional Torch
15-20L/min.

Mini-Torch
10L/min.

Eco mode
5L/min.
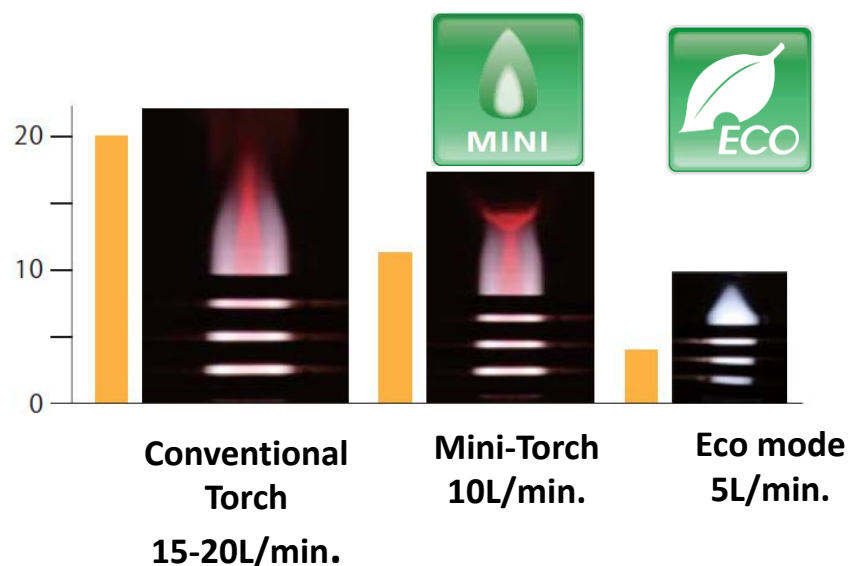
Lowest Operating Costs

ICPMS-2030 can generate plasma using 99.95% Ar gas

ICPMS-2030 : Lighting probability of the plasma

Lighting probability of the plasma(%)

Ar gas purity (%)

Probability of Plasma Ignition

ICPMS-2030 is compatible with lower purity (99.95%) because RF-supply and ignition sequence are optimized.

Method Assistant Functions

Development Assistant

- Run blank and any representative unknowns in qualitative mode

- Select analysis elements

- Software makes mass, calibration, and internal standard recommendations

Diagnosis Assistant

- Software assesses *entire* mass spectrum for interference

- Reports data quality and any 'concerns' (isobarics, polyatomics, *etc.*)

- Independent of QA/QC functionality

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Productivity Enhancement

- The typical environmental laboratory is looking for ways to decrease costs, increase sample throughput, or adapt to other ICPMS analytical methods as a revenue stream.

- Higher throughput, lower downtime, lower operational costs.

- There are several ways in which Shimadzu's ICPMS-2030 can achieve those goals and streamline the analytical process.

Autosamplers

- Full integration with a variety of autosamplers with 60-, 120-, and 240-sample capacities available.

- Autosamplers available from Shimadzu and from Teledyne CETAC

AS-10
60 Samples

ASX-280
120 Samples

ASX-560
240 Samples

Rapid Sample Introduction

- Integration with Teledyne-CETAC's ASXpress can reduce analytical time by ~60%*.

- Rapid sampling, uptake, and injection using vacuum pump and sample loop.

- Reduces the time required to get sample from the autosampler to the nebulizer. The rest of the analysis proceeds as normal.

*Data from Teledyne Cetac

Microwave Digesters

Anton Paar

SHIMADZU
Excellence in Science

- Shimadzu has a unique relationship with Anton Paar to provide microwave digestion capabilities in conjunction with our elemental spectroscopy instrumentation.

- Provides soup-to-nuts solutions for sample preparation and analysis.

LC-ICP-MS

A growing area of interest is LC-ICP-MS as certain elements have different toxicities and bioavailabilities depending on their speciation

- LC-ICP-MS can conduct speciation analyses such as inorganic arsenic and organic arsenic, As^{3+} and As^{5+}, Cr^{4+} and Cr^{6+}.

- In short, use LC to separate species, use ICPMS as detector.

- Complete control of ICPMS and LC system in one simple software package, again built on the LabSolutions platform.
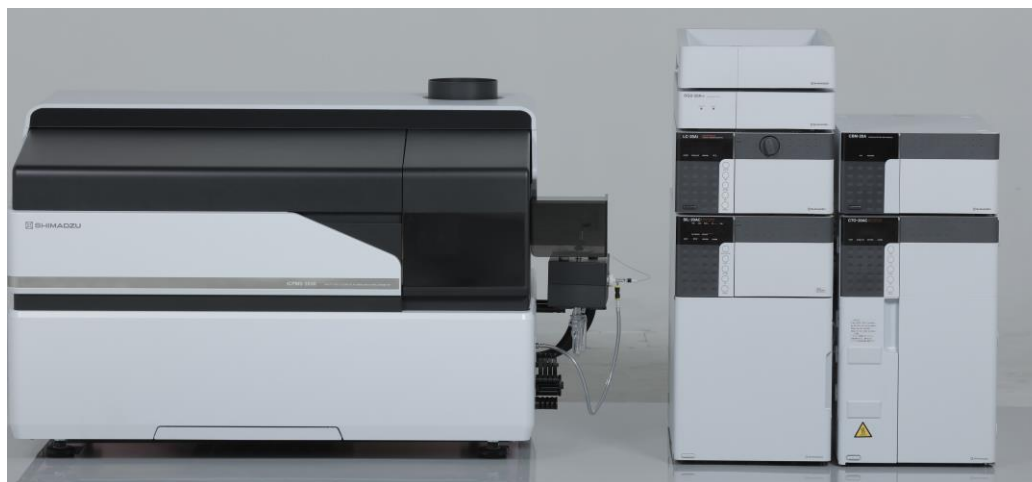
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Conclusions

- Shimadzu's single-quad, collision cell ICPMS 2030 offers full compliance with EPA Method 6020, among other methods for environmental testing

- Built on the LabSolutions Platform, the ICPMS 2030 software is familiar to users of Shimadzu GC, LC, LCMS, UV/Vis, FTIR, *et cetera.*

- The ICPMS 2030 has several features that translate into cost savings, time savings, and versatility / adaptability to other methods
    - Low argon consumption, software assistant functions, ease of maintenance, various accessory components to enhance throughput or expand analytical capabilities

Thank you

Questions? Discussion?