From Seawater to Shellfish: Microplastics… Find out what's slowly krilling you, and the best way to stay happy as a clam!

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Quality By Design

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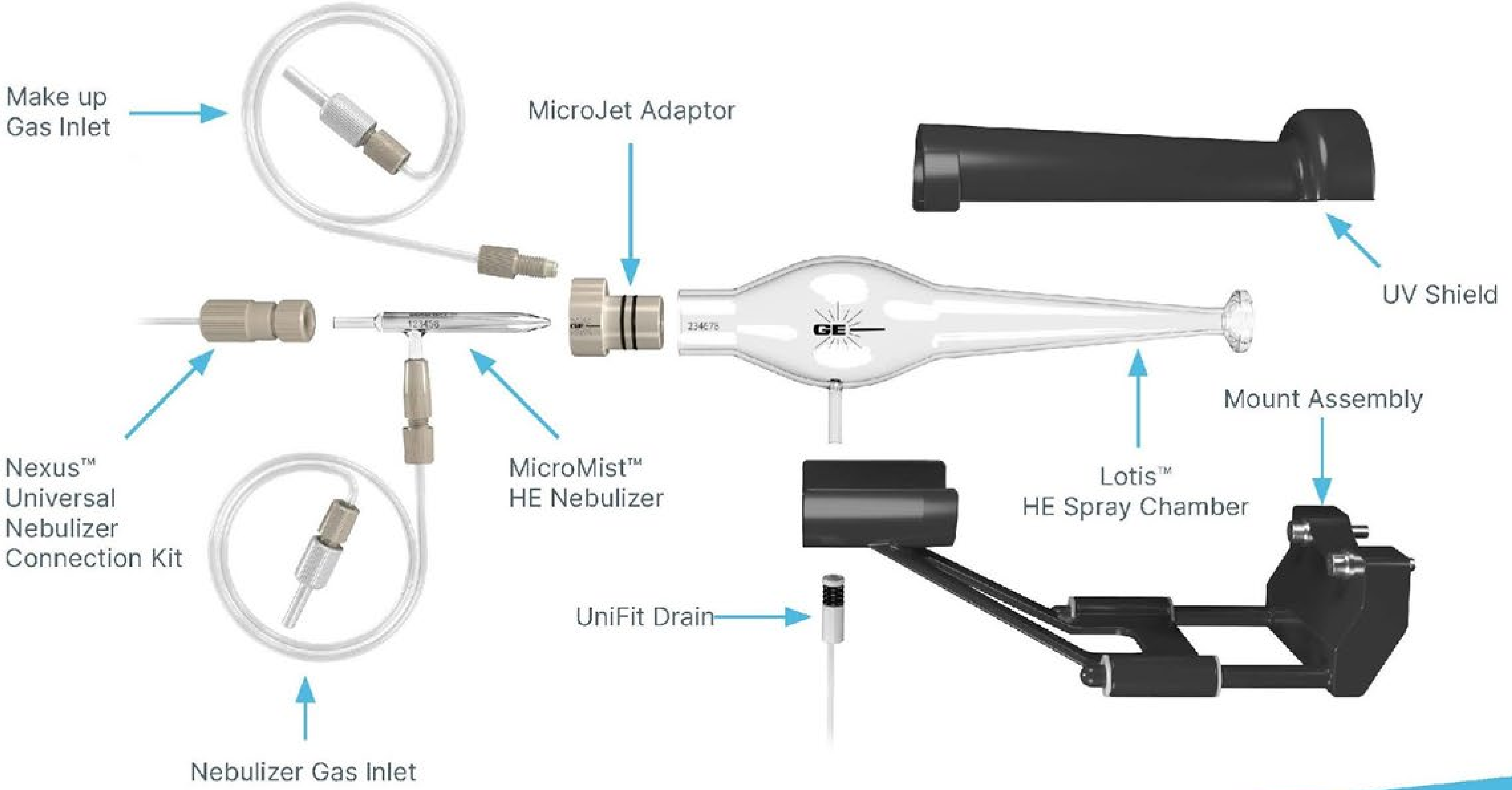
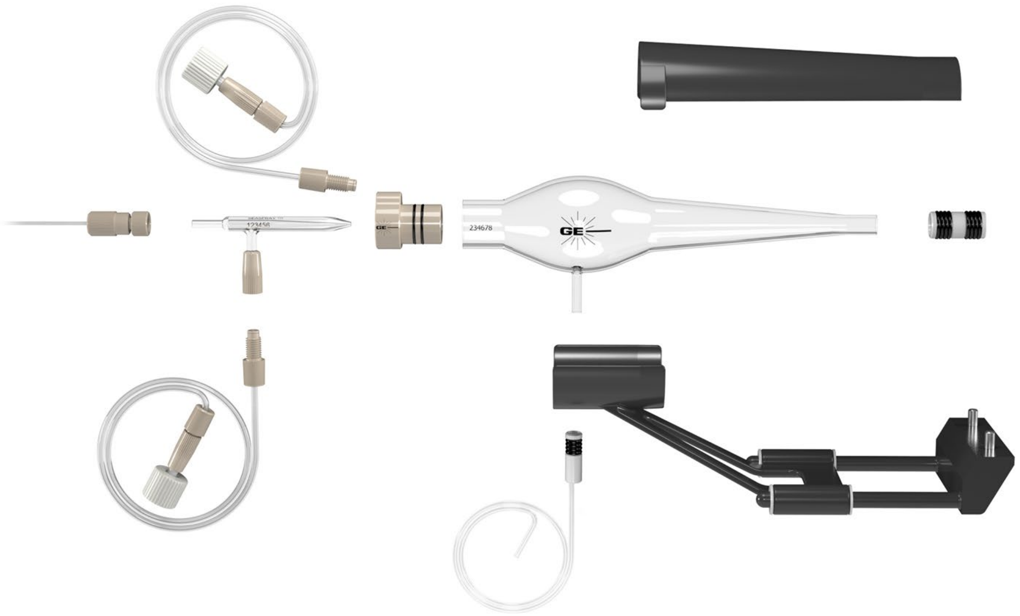
High Efficiency Sample Introduction System (HE-SIS)



HE-SIS Bracket Support

Every HE-SIS is designed to suit a specific instrument model, and includes an instrument-specific mounting bracket support.

Part Number	Description
KT-1155	HE-SIS for Agilent® ICP-MS
KT-1172	HE-SIS for TOFWERK icpTOF
KT-1172	HE-SIS for Thermo Scientific® Q, RQ, TQ ICP-MS
KT-1172	HE-SIS for Thermo Scientific® Neoma MC-ICP-MS
KT-1184	HE-SIS for PerkinElmer® NexION 1000, 1100, 2000, 2200, 5000 ICP-MS
KT-1204	HE-SIS for PerkinElmer® NexION 300, 350 ICP-MS
KT-1205	HE-SIS for NU ATTOM
KT-1213	HE-SIS for Thermo Scientific® X-Series
KT-1215	HE-SIS for Thermo Scientific® Neptune/Element
KT-1219	HE SIS for Nu Vitesse



HE-SIS for NexION 5000 ICP-MS

HE-SIS Kit Features

This specially designed concentric glass nebulizer is based on our popular MicroMist™ design, capable of efficiently nebulizing limited sample volumes at low sample and argon gas flow rates.

Our patent-pending MicroJet™ gas adapter shapes the nebulizer aerosol plume to reduce sample deposition on the spray chamber walls and enhance transport efficiency.

The Lotis™ HE spray chamber directly couples to the ICP-MS torch, providing the highest transport efficiency and excellent washout between samples.

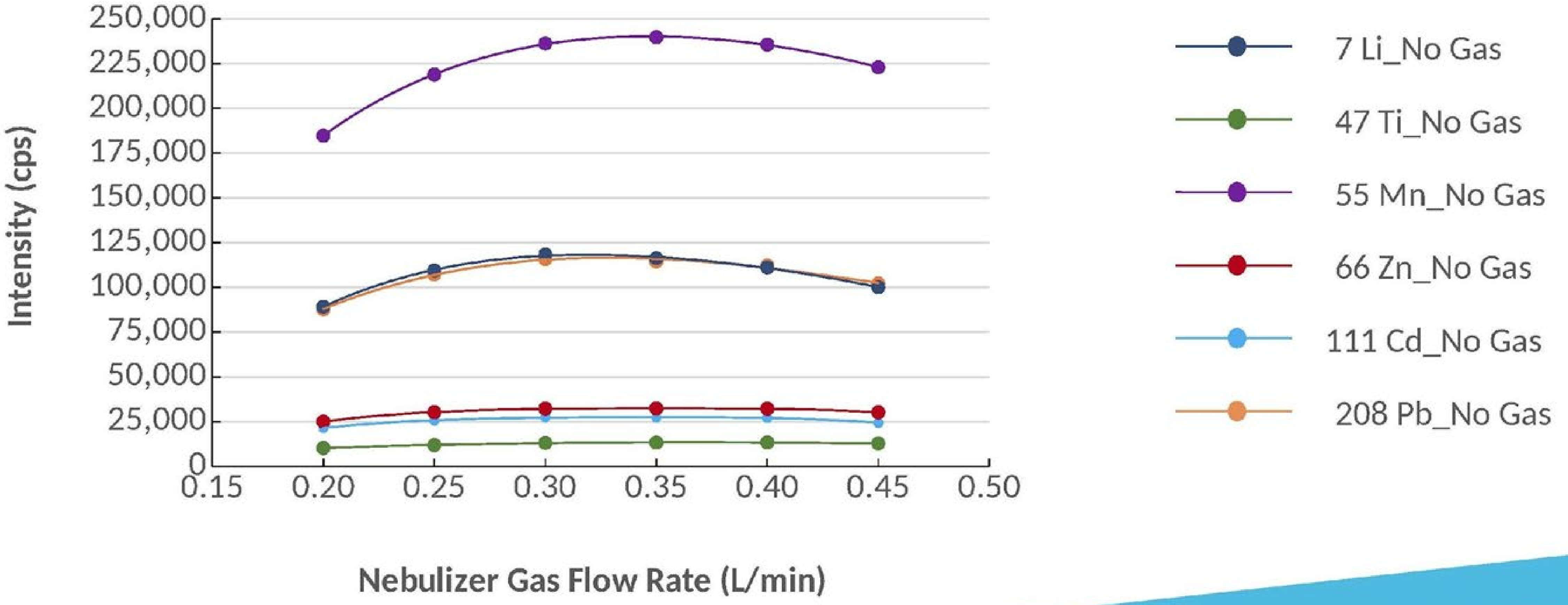
Optimizing Operating Parameters

- Nebulizer gas flow rate (L/min)
- Nebulizer sample flow rate (µL/min)

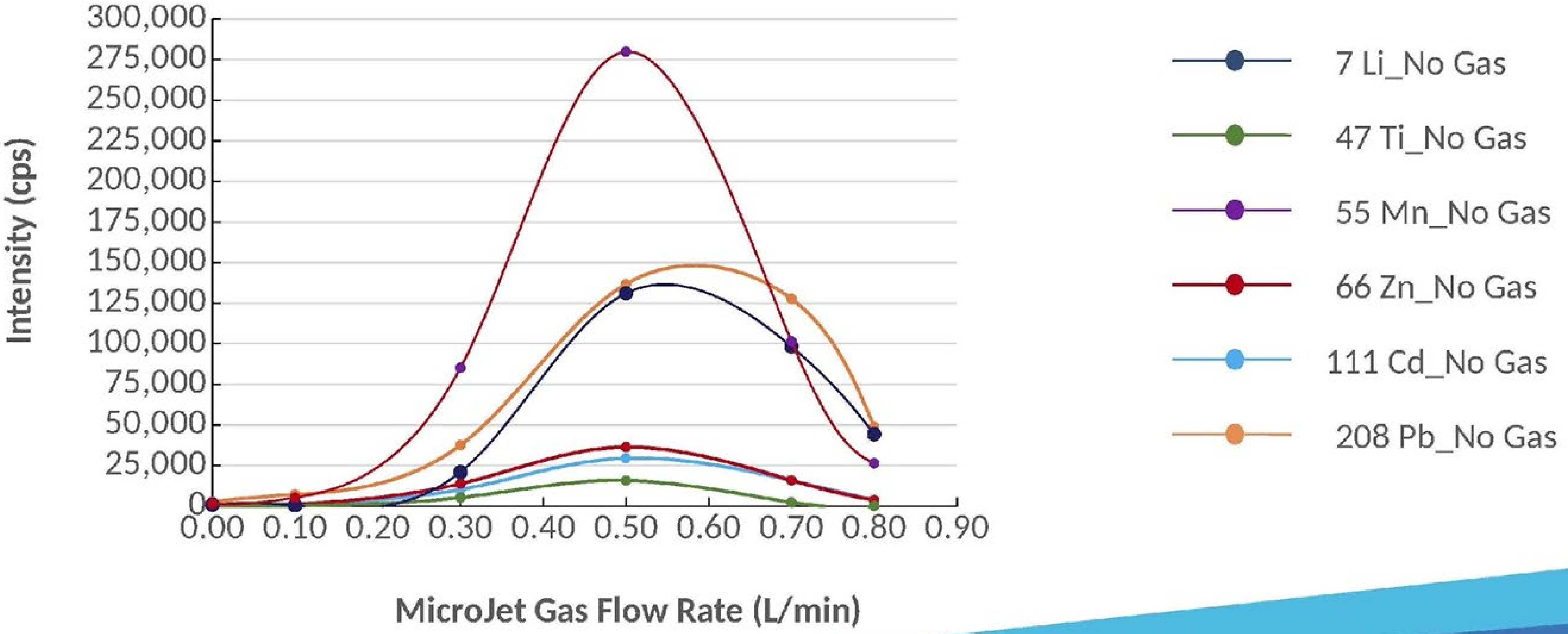
- MicroJet gas flow rate (L/min)

*Combined gas flow rate through the injector is typically close to 1.0 L/min

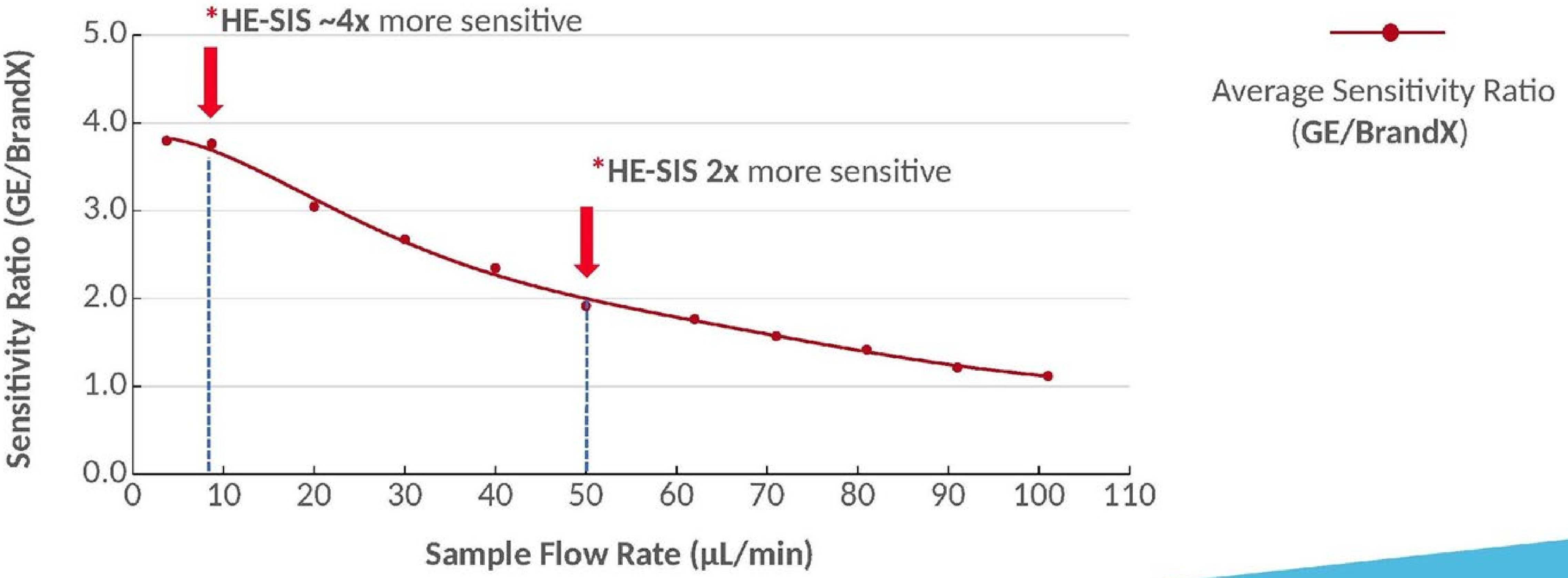
Optimizing Nebulizer Gas Flow Rate



Optimizing MicroJet Gas Flow Rate



Average Sensitivity Ratio – Comparison Brand X

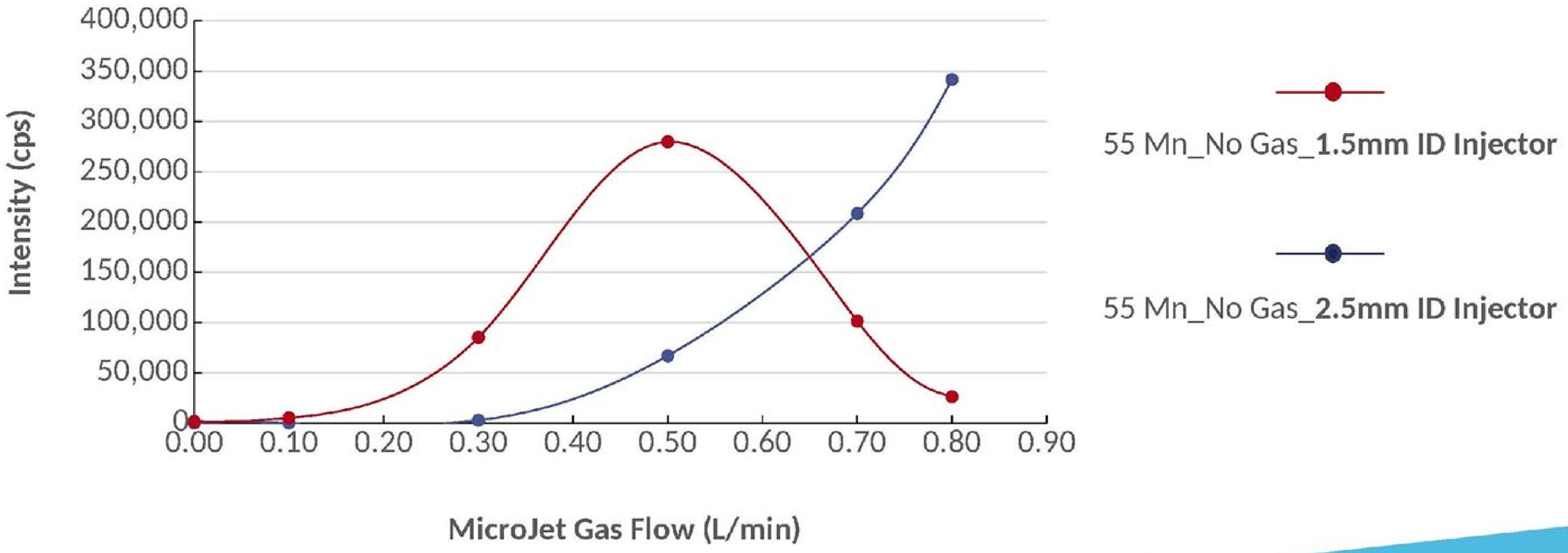


Demountable Torch – Interchangeable Injector

- A demountable torch provides the benefit of interchangeable injectors.
  - 1.5mm and 2.5mm ID quartz studied
  - Other injector ID's and materials available

* D-Torch™ for NexION 2200/5000 ICP-MS shown, P/N 30-808-3927

Sensitivity Comparison – Injector ID



HE-SIS Literature

The HE-SIS has been coupled to many different ICP-MS platforms for a wide variety of applications, including single-cell, single-particle, nanoparticle, and low-volume sample studies, such as nanoplastics and microplastics with up to **95% transport efficiency.**

- *Development of single-cell ICP-TOFMS to measure nanoplastics association with human cells, Environ. Sci.: Nano, 2023, 10, 3439.*
- *Breaking barriers in Microplastic Detection using Single-Particle ICP-TOFMS, Lyndsey Hendriks, TOFWERK.*
- *Towards Automated Routine Analysis of the Distribution of Trace Elements in Single Cells using ICP-MS, Current Trends in Mass Spectrometry, March 2020.*
- *Very low mass isotope data collection with the Nu Vitesse, measurement of microplastic particles, Vitesse Note NT10.*
- In addition to many scientific presentations.

HE-SIS Summary

- In order to achieve optimum performance, it is necessary to optimize all operating conditions for both the instrument and sample introduction system.
- Our example showed the optimum sensitivity was observed at a nebulizer gas flow rate of 0.35 L/min and sample uptake in the range of 20 to 40 µL/min.
- Glass Expansion's HE-SIS is 2–4x more sensitive than another commercially available system.
- Optimum make-up gas flow was dependent on the ID of the injector:
  - Smaller bore injector (1.5mm ID) provided highest sensitivity at a make-up gas flow of 0.50 L/min, combined gas flow of 0.85 L/min.
  - Larger bore injector (2.5mm ID) provided highest sensitivity at a make-up gas flow of 0.80 L/min, combined gas flow of 1.15 L/min.

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Approaches and Strategies for the Detection and Quantification of Microplastics by Single Particle-ICP-MS

Contact Me

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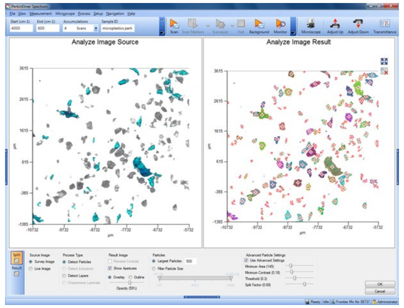
Microplastics

Analytical Techniques

Microbeads in toiletries - Method 623.1

- Microbeads in products are extracted and analyzed to determine the composition of the beads. FT-IR is used to determine and provides confirmation of the presence or absence of plastic microbeads.



TGA-IR-GC/MS

- TGA - measures both the weight loss and the rate of evolution of products, which provides detailed kinetic information of polymers' decomposition.
- IR - quantitation of individual polymers and mixtures, functional group analysis of the volatile products.
- GC/MS - quantitation of polymers mixtures and functional group of the volatile products.

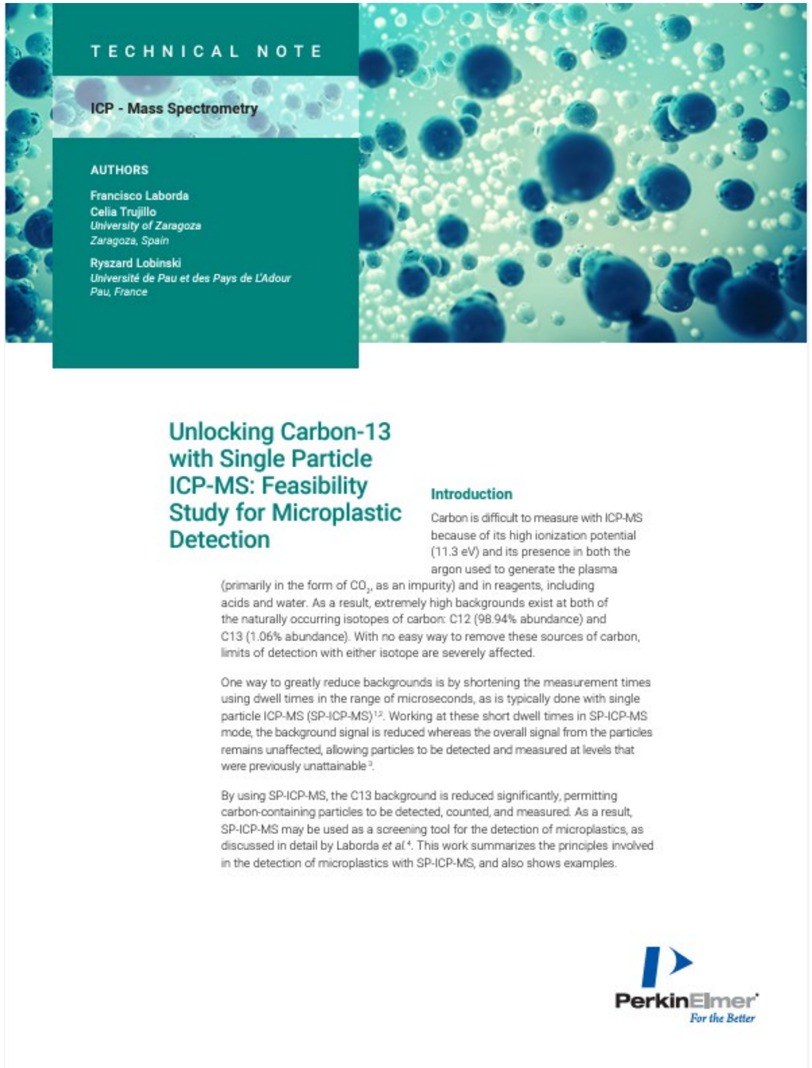
https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/microbeads-in-toiletries-2023.html

Microplastics

Analytical Techniques

Single Particle-ICP-MS

- Detection and counting of carbon-based particles
  - Short dwell times reduce the background
  - Accurate results for particles down to 2 µm
- Linear pass spray chamber is recommended to efficiently transports microplastics to the plasma
- SP-ICP-MS serves as a good screening technique for microplastics
  - Other techniques are required to determine composition


TECHNICAL NOTE

ICP - Mass Spectrometry

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Unlocking Carbon-13 with Single Particle ICP-MS: Feasibility Study for Microplastic Detection

Introduction

Carbon is difficult to measure with ICP-MS because of its high ionization potential (11.3 eV) and its presence in both the argon used to generate the plasma (primarily in the form of CO_2, as an impurity) and in reagents, including acids and water. As a result, extremely high backgrounds exist at both of the naturally occurring isotopes of carbon: C12 (98.94% abundance) and C13 (1.06% abundance). With no easy way to remove these sources of carbon, limits of detection with either isotope are severely affected.

One way to greatly reduce backgrounds is by shortening the measurement times using dwell times in the range of microseconds, as is typically done with single particle ICP-MS (SP-ICP-MS)[1,2]. Working at these short dwell times in SP-ICP-MS mode, the background signal is reduced whereas the overall signal from the particles remains unaffected, allowing particles to be detected and measured at levels that were previously unattainable[3].

By using SP-ICP-MS, the C13 background is reduced significantly, permitting carbon-containing particles to be detected, counted, and measured. As a result, SP-ICP-MS may be used as a screening tool for the detection of microplastics, as discussed in detail by Laborda *et al.*[4]. This work summarizes the principles involved in the detection of microplastics with SP-ICP-MS, and also shows examples.

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Carbon by Single Particle ICP-MS

Approaches and Strategies for Method Development

Platform selection

- ICP-MS vs ICP-MQ

Gas selection

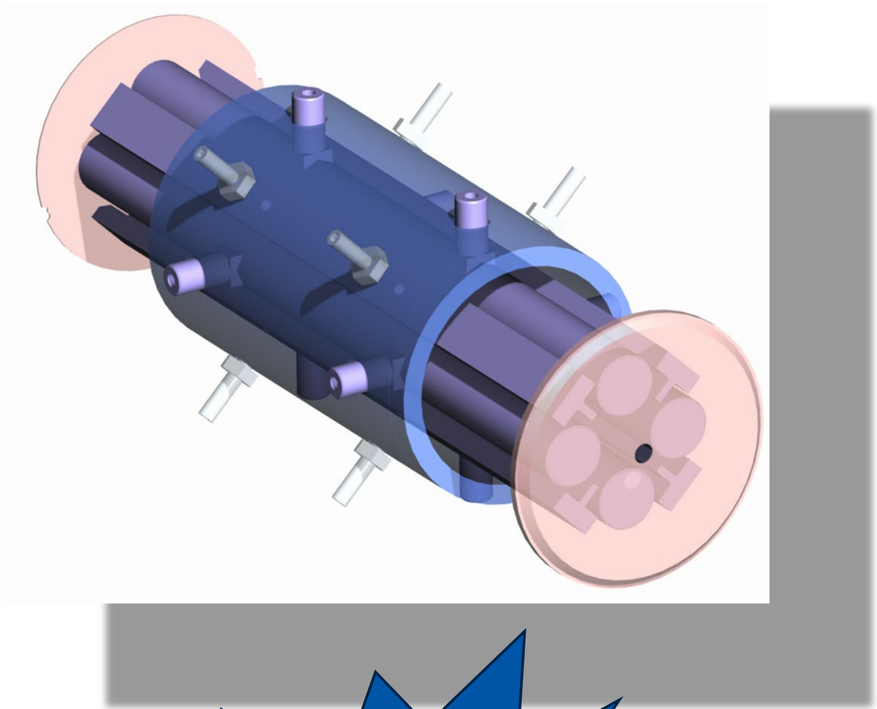
- Std vs NH_3 vs. H_2

Isotope selection

- C_{12} vs C_{13}

Universal Cell Parameters

- Cell gas flow rate => Affect reaction rate
- Rejection parameter q (RPq) => Control product formation
- Rejection parameter a (RPa) => Attenuate selected element signal



Particle size
Detection
Limit

Instrumentation

NexION 5000

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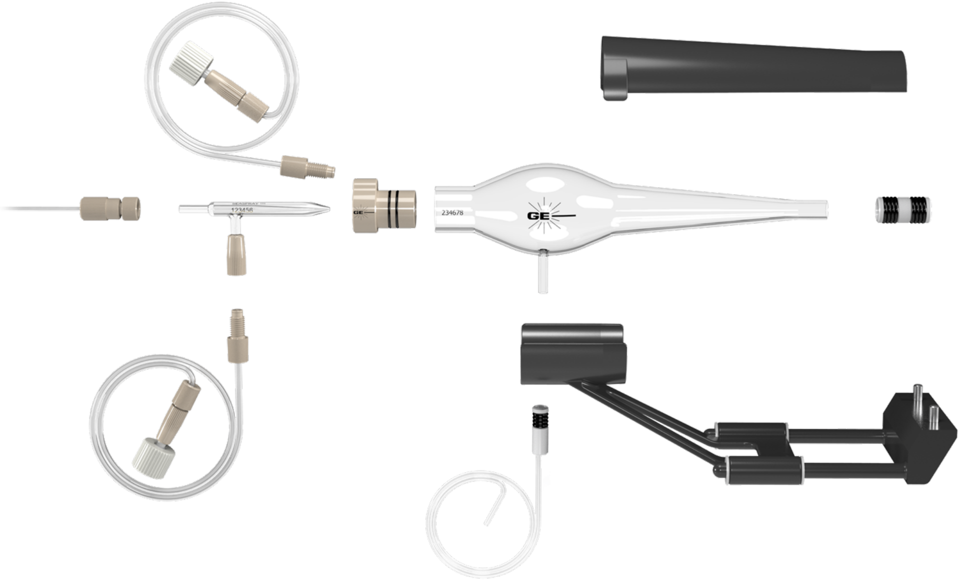

HE-SIS (P/N KT-1184)

Carbon by Single Particle ICP-MS

Operating Conditions

Parameter	Value
Neb Gas Flow (L/min)	0.46
AMS/Carrier Gas Flow (L/min)	0.6
Dwell Time (µs)	25
IGM	Extraction
Scan Time (s)	30 - 180
Sample Flow Rate (µL/min)	13
Transport Efficiency (%)	**89.23**

Carbon by Single Particle ICP-MS

Operating Conditions

Mode	Mass (amu)	Mode	Gas	Gas Flow	RPa	RPq	AFT	LOD (nm)
Standard	C13	MS/MS	-	-	0.017	0.25	150	1819
Standard	C12	MS/MS	-	-	0.02	0.25	150	990
DRC H_2	C13	MS/MS	H_2	1	-	0.45	225	672
DRC H_2	C12	MS/MS	H_2	1	0.043	0.45	200	722
DRC NH_3	C13	MS/MS	NH_3	0.1		0.45	125	1559
DRC NH_3	C12	MS/MS	NH_3	0.1	0.045	0.45	125	824

Carbon by Single Particle ICP-MS

Experimental

Standards

- 100 nm Au NP - N8151036
- Carbon 1000 ppm – Inorganic ventures

Samples

- Negative control - UPW
- 8 um polystyrene beads – positive control
- Tea bag – Sample
- Tap water – Sample blank

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Carbon by Single Particle ICP-MS

Method Validation

Mode	Isotope	4 µm		8 µm	
		Size (nm)	Particle/mL	Size (nm)	Particle/mL
CRM Certified Values		4043	130000	7989	40000
Standard	C13	3426.8	226420*	9000.3	32579
Standard	C12	4035.3	123494	8723.1	31025
DRC H_2	C13	3726.4	130561	8761.0	36371
DRC H_2	C12	3515.3	119638	7636.9	35829
DRC NH_3	C13	3135.6	123580	7834.5	44296
DRC NH_3	C12	4125.9	133319	9095.2	42637

** Inaccurate counting due to low signal / high background*

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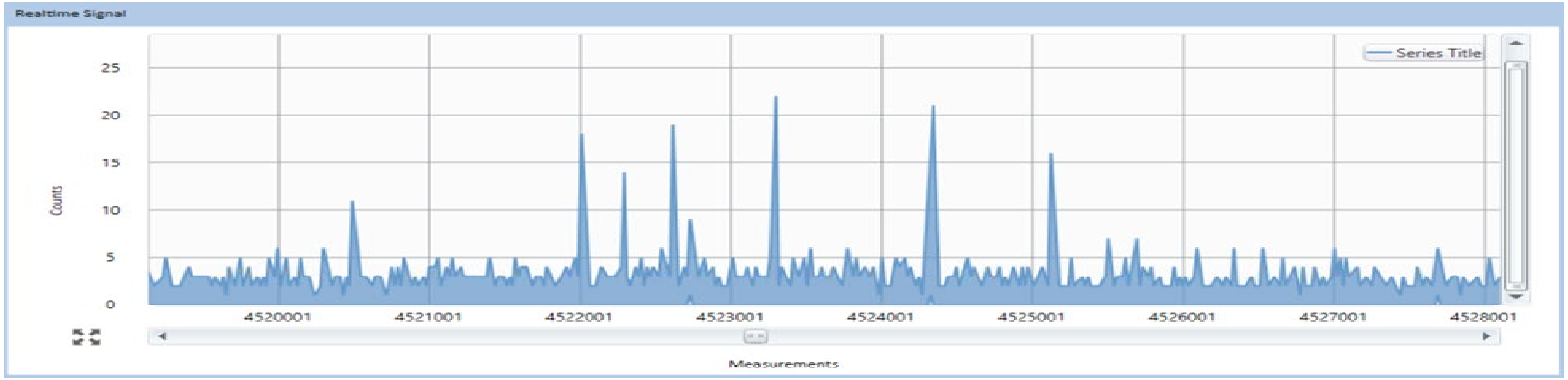
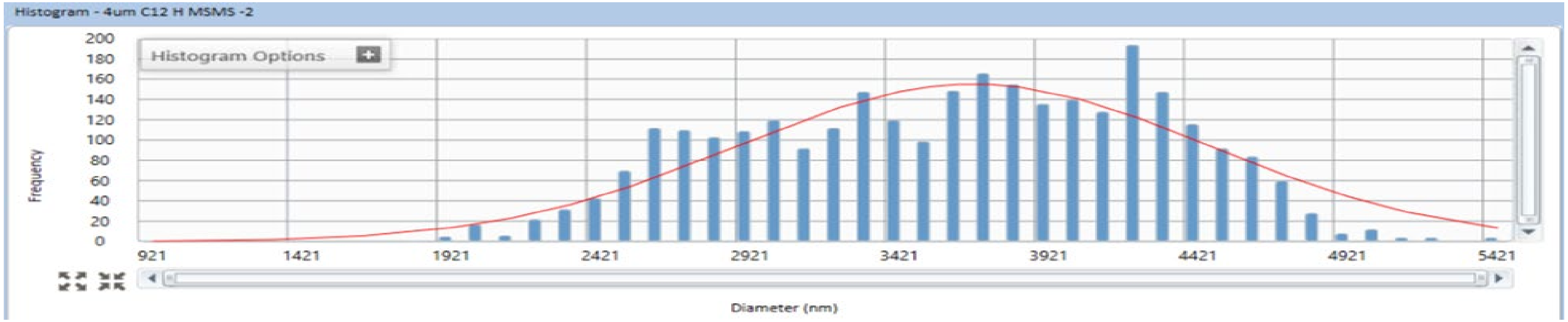
Carbon by Single Particle ICP-MS

Results – 4 μm - C12 MS/MS DRC H_2

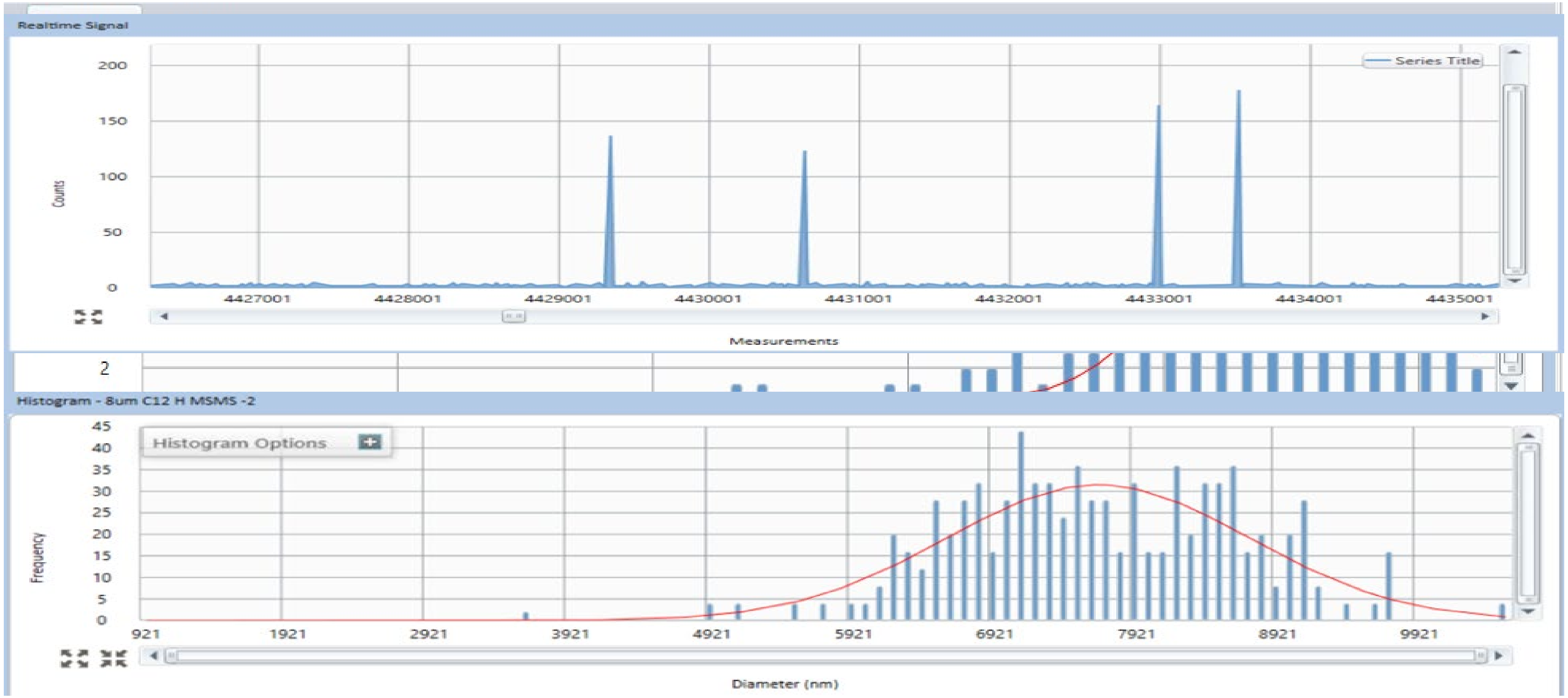




Average = 3.5 μm

Carbon by Single Particle ICP-MS

Results – 8 µm - C12 MS/MS DRC H_2



Average = 7.6 µm

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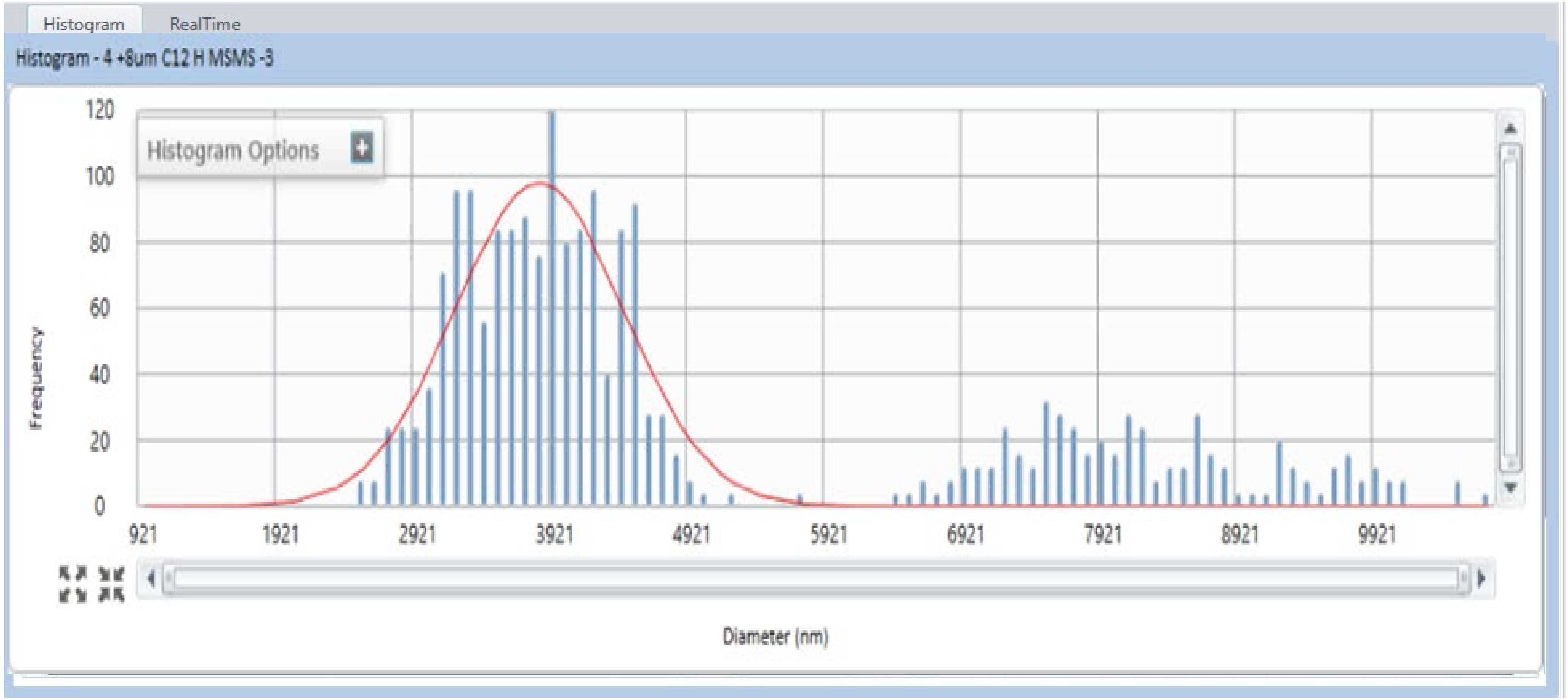
Carbon by Single Particle ICP-MS

Mixed Particle Standards: 4 + 8 µm- C12 MS/MS DRC H_2



Carbon by Single Particle ICP-MS

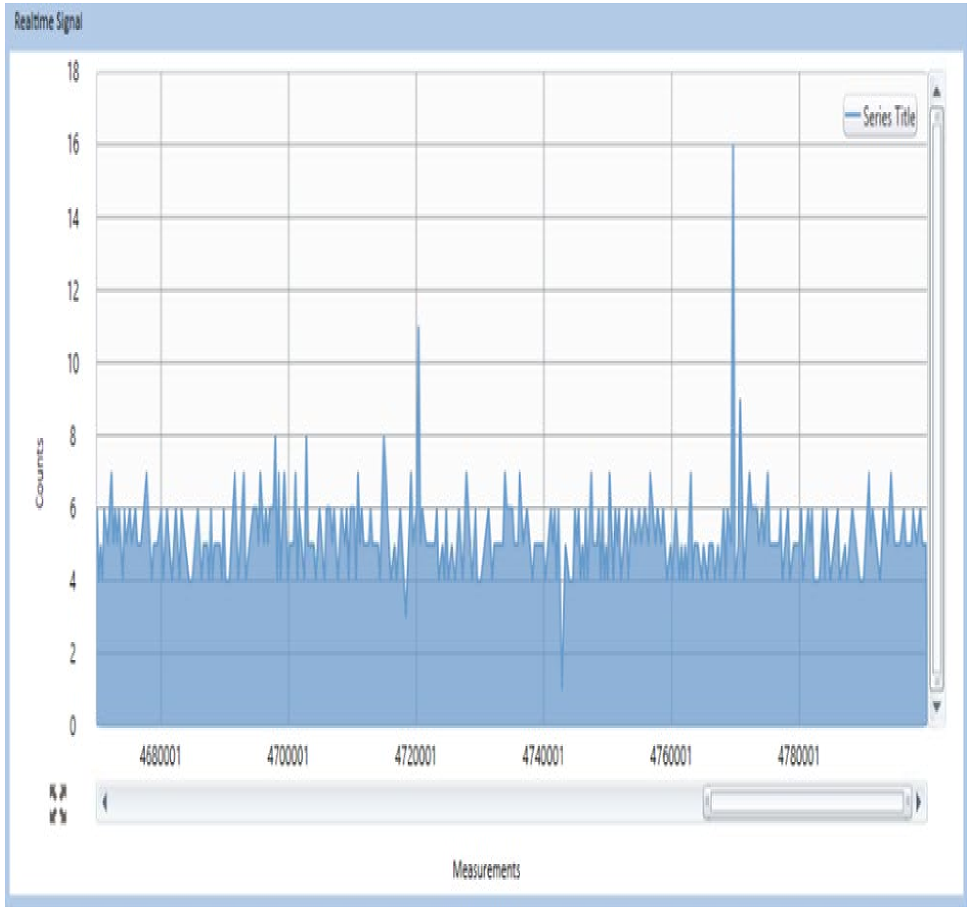
Mixed Particle Standards: 4 + 8 µm- C12 MS/MS DRC H_2

Mode	Isotope	4 µm		8 µm	
		Size (nm)	Particle/mL	Size (nm)	Particle/mL
CRM Certified Values		4043	56500	7989	22500
Standard	C13	4234.2	44210	9046.1	24647
Standard	C12	4134.2	56189	8769.4	22407
DRC H_2	C13	4080.2	75406	9171.8	24992
DRC H_2	C12	3852.3	63543	8262.3	24072
DRC NH_3	C13	3968.6	44899	8271.0	24820
DRC NH_3	C12	4304.2	68943	9601.6	26543

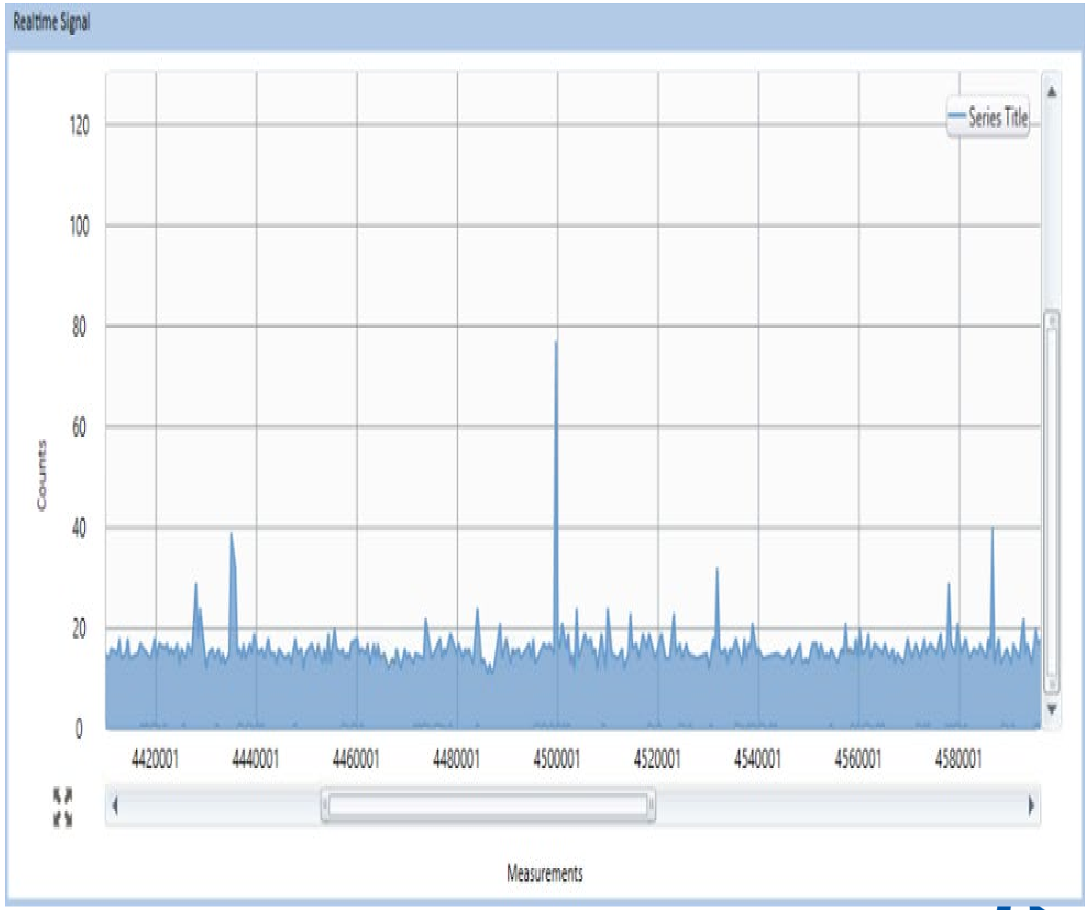
Carbon by Single Particle ICP-MS

Tea Bag Analysis

- Brand 1



- Brand 2



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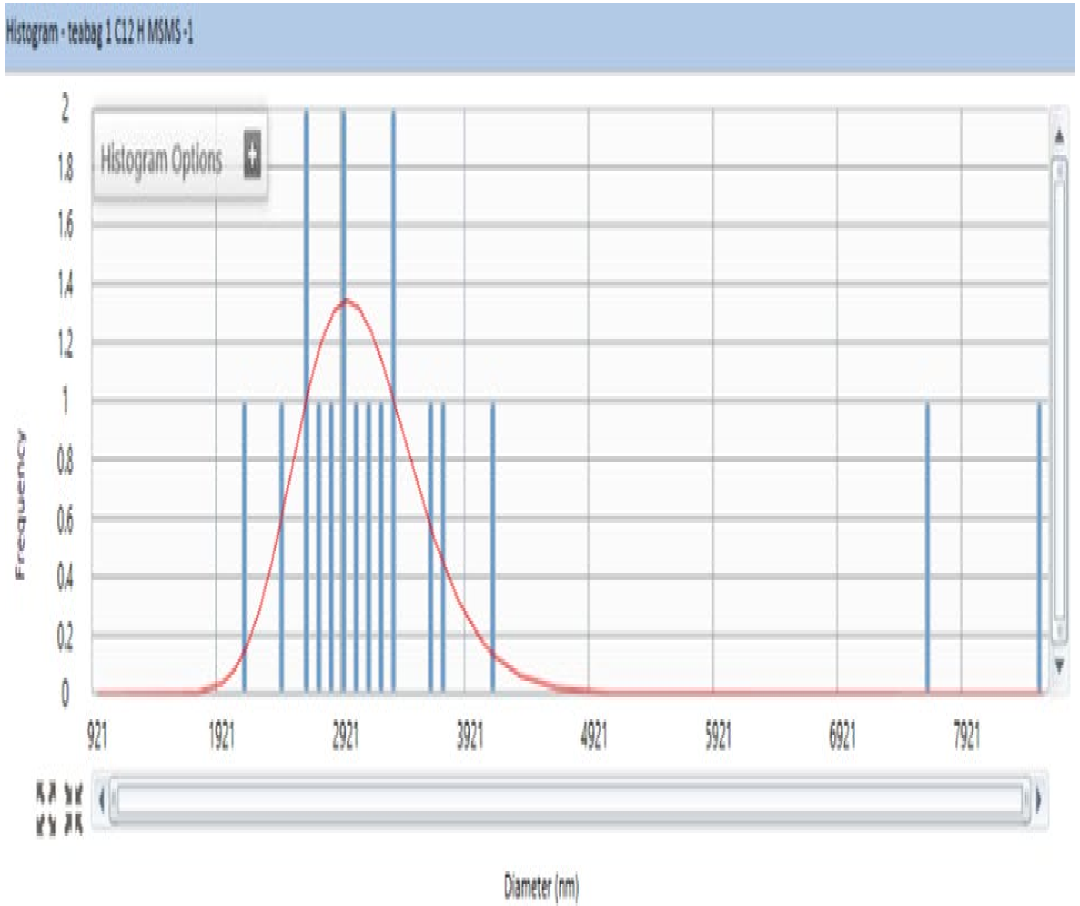
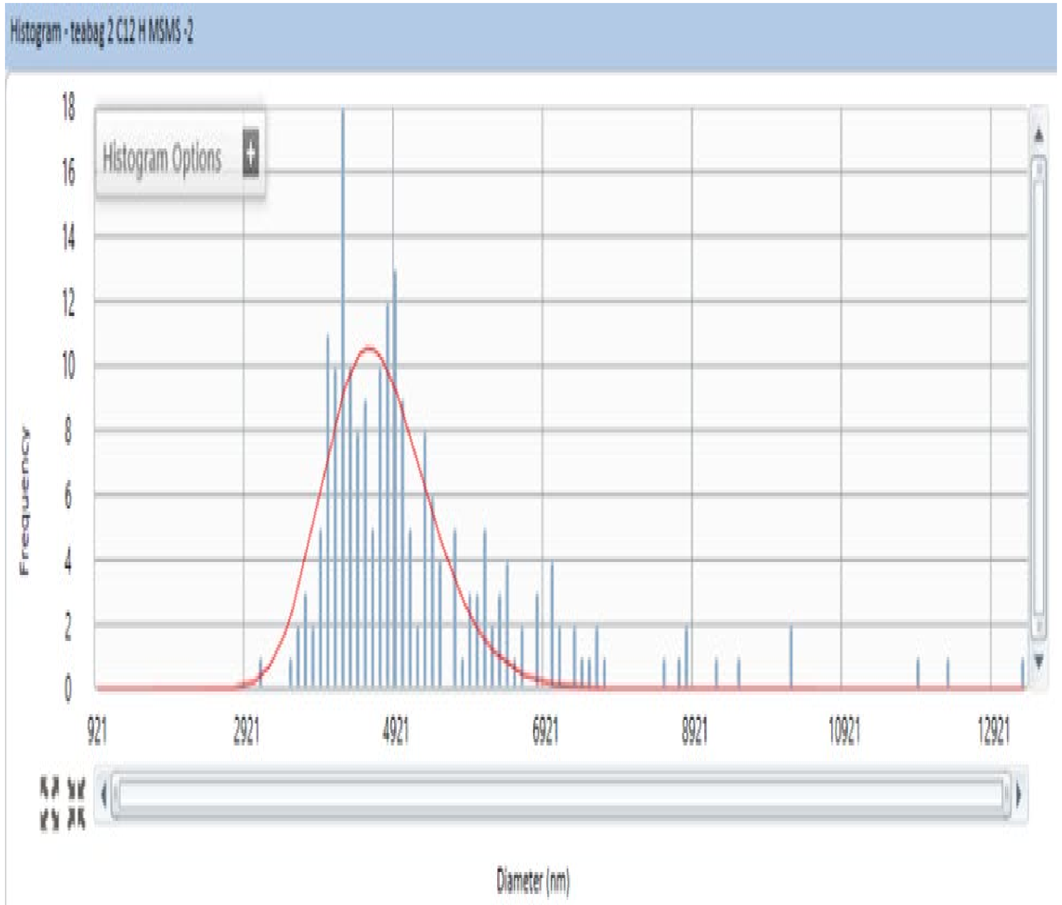
Carbon by Single Particle ICP-MS

Tea Bag Analysis

- Brand 1



- Brand 2



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Carbon by Single Particle ICP-MS

Tea Bag Analysis

Sample	Mode	amu	Start (nm)	End (nm)	Most Freq. Size (nm)	Mean Size (nm)	Part. Conc. (parts/mL)
Matrix Blk	DRC H_2	C12	722	-	-	-	-
Tea Bag 1	DRC H_2	C12	921	8671	3021	3568	3081
Tea Bag 2	DRC H_2	C12	796	11146	3896	4549	10212

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Carbon by Single Particle ICP-MS

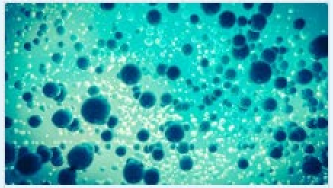
Conclusions

- Carbon quantification by ICP-MS is feasible, various reaction gases, cell conditions, can be used to bring down the background to a measurable level.
  - Validated using DRC technology using 4 um and 8um standards to sub-micron detection limits
- Single particle can be used to screen for microplastics in a variety of matrices
- Improvement in detection limits is needed to achieve nanoplastics analysis
- Improvement in detection limits can be achieved with carbon free reagents and labware
- Microplastics counting can be achieved by SP-ICP-MS, but sizing is a challenge with unknown density
- Sample analysis time 2-3 min SP-ICP-MS vs 40-45 min using imaging FTIR.

More Information Online

Microplastics Analysis Solutions Spotlight

Resources | Applications | Blogs | Webinars | Technologies



Unlocking Carbon-13 with Single Particle ICP-MS: Feasibility Study for Microplastic Detection

Carbon is difficult to measure with ICP-MS because of its high ionization potential and its presence in both the argon used to generate the plasma (primarily in ...

Learn More

Customer Spotlight: Norwegian Institute for Water Research (NIVA)

Representatives from the Norwegian Institute for Water Research (NIVA) discuss their investigation into the presence of microplastics in the Arctic Ocean. The r ...

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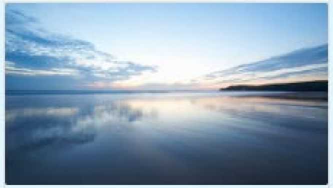

Microplastics Analysis Brochure

PerkinElmer offers comprehensive and innovative solutions for the identification and quantification of microplastics. Our portfolio includes leading technologie ...

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Thank you, questions?

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Atomic Spectroscopy Product Line Leader

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