GLASS EXPANSION
Quality By Design

Trouble-Free ICP: Maximize Performance and Minimize Downtime

Ryan Brennan
President
Glass Expansion, Inc.

CEM
2024
Seminar Series

www.geicp.com

Introduction: About Glass Expansion

- GE has been specializing in sample introduction components for ICPs since 1985
- Global recognition for manufacturing precision and reliability

Three Glass Expansion offices providing global support:

Glass Expansion – Asia-Pacific
Melbourne, Australia
Email: enquiries@geicp.com

Glass Expansion - Americas
Cape Cod, Massachusetts
Email: geusa@geicp.com

Glass Expansion - Europe
Weilburg, Germany
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www.geicp.com

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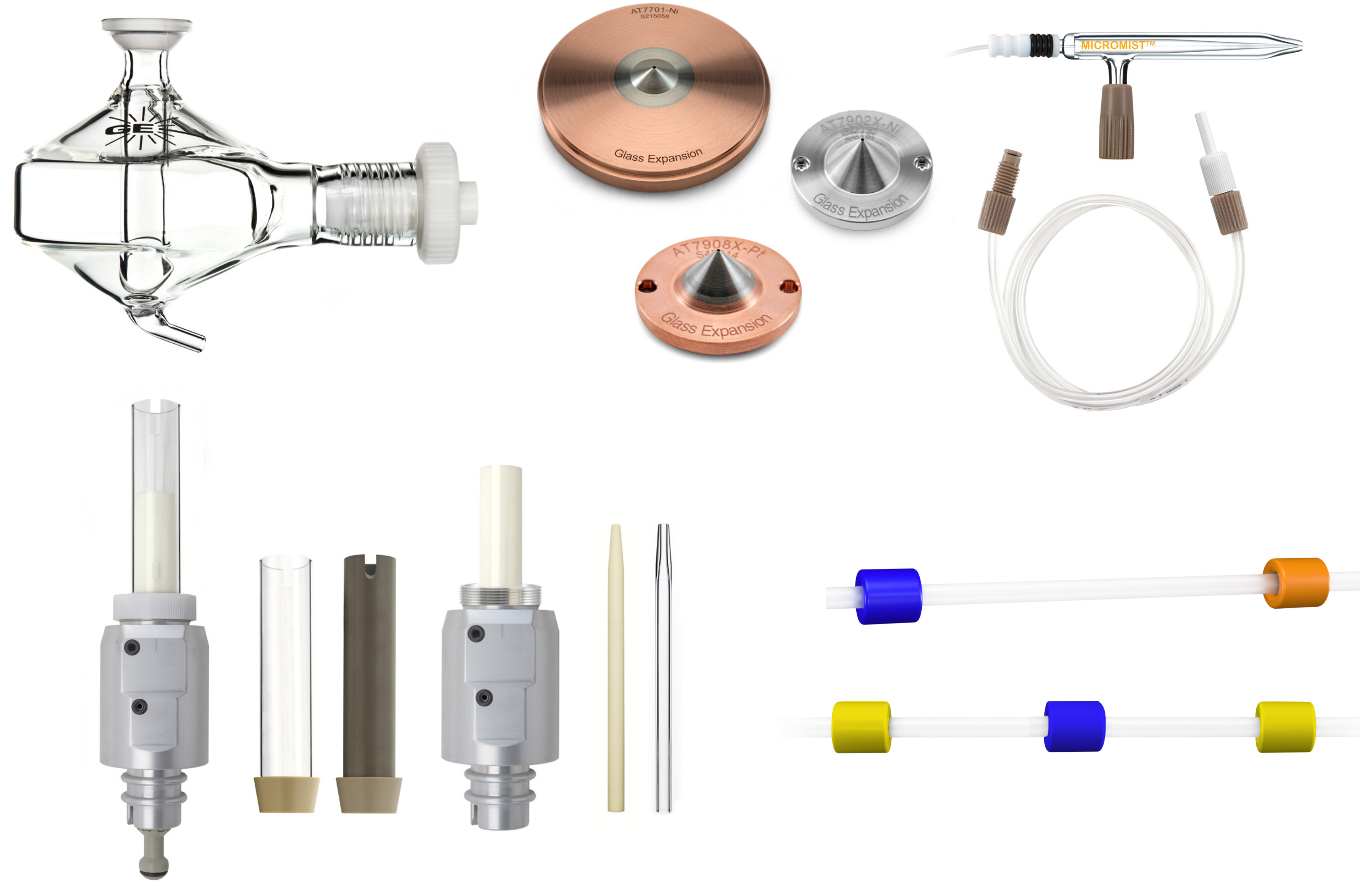
Our Product Offerings

- **Autosampler Probes**
- **Pump Tubing**
- **Nebulizers:** Custom manufactured for optimal performance with each ICP
- **Spray Chambers:** Pioneered cyclonic design
- **Torches:** Introduced the FDT
- **Cones, RF Coils**
- **Other Accessories**



Manufacturers Supported: Thermo®, Agilent®, PerkinElmer®, Shimadzu®, SPECTRO, Analytik Jena®, Horiba®, Others

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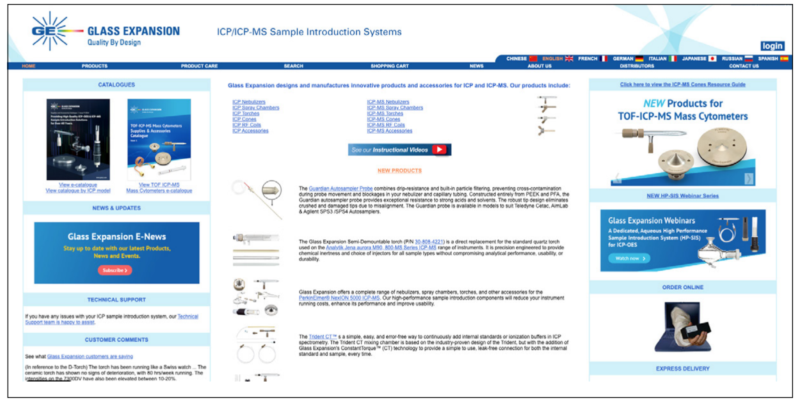
ICP Resources

1. **Sales Support:** Pre-sales, inventory management; Post-sales
2. **Trainings:** Detailed sessions on product features, benefits and application
3. **Technical Support:** Online resources; Newsletters & Customer feedback

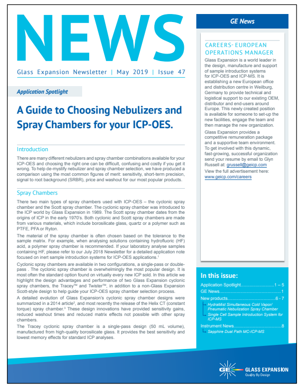
- Application Notes
- Newsletters
- Catalogs
- Product Flyers
- Website
- Product care advice
- Operating instructions
- Videos

Catalogs



Website

Flyers



Newsletters

Instructions

Application Notes

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Overview of Key Components for ICP SIS

*The **sample-introduction area** has been called the **Achilles heel** of ICP because it is considered the weakest component of the instrument, with only 1-2% of the sample finding its way into the plasma.”*

The primary purpose of the SIS is to generate a **consistent aerosol containing fine droplets:**

They key components of a SIS include:

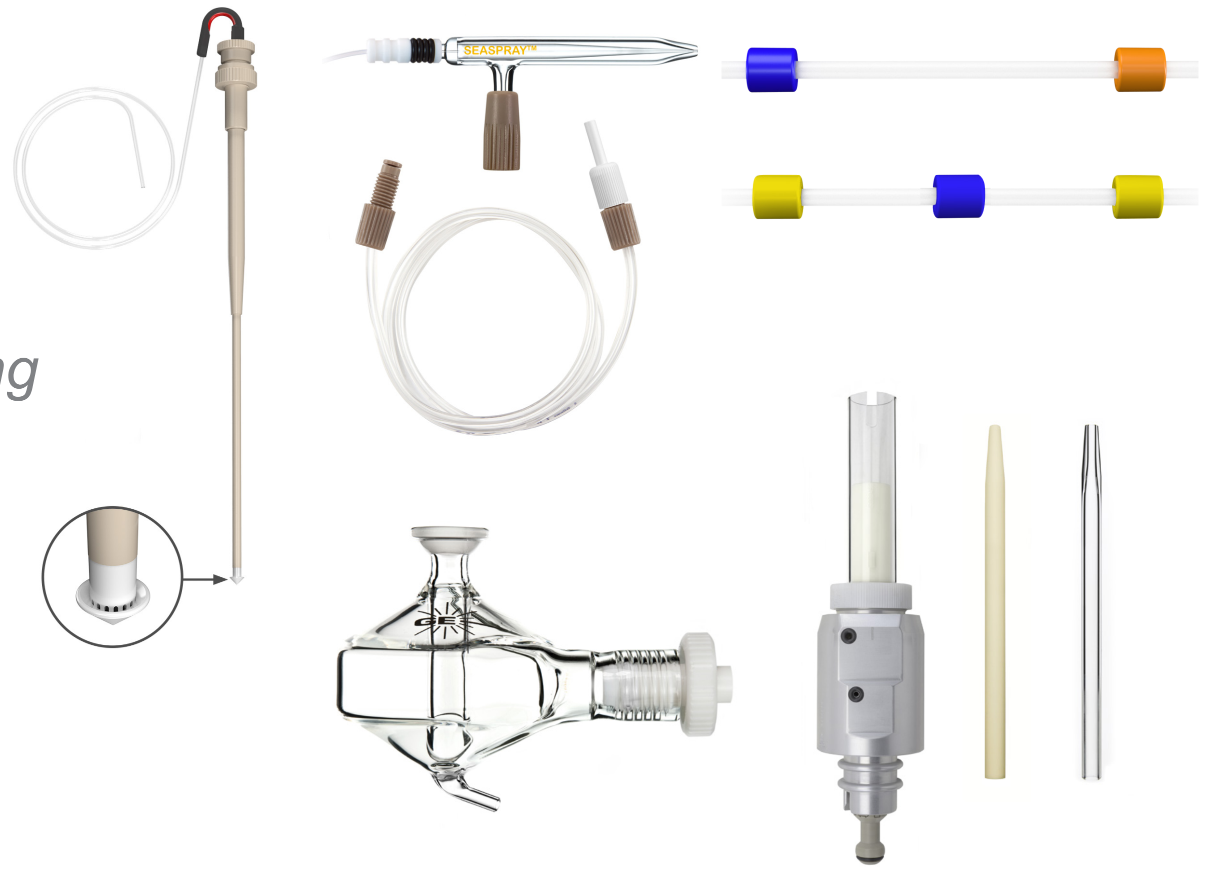
- **Sample Probe** (manual or autosampler)

  **Teflon tubing connecting the sample probe to the persitaltic pump tubing*

- **Peristaltic Pump Tubing** (for sample and waste)

  **Teflon tubing connecting the persitaltic pump tubing to the nebulizer*

- **Nebulizer**
- **Spray Chamber**
- **Torch + Injector**
- **RF Coil**
- **ICP-MS Cones**



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Sample Probe: Common Challenges

- **Effective Sample Digestion:** Clear liquids and consistent results (RSDs and spike recoveries).
- **Ineffective Sample Digestion:** Precipitates (e.g., Ag, Fe, Si) and undigested particles.

1. **Clogging and Blockages:** Particulate matter from anode and cathode materials can obstruct sample flow.
2. **Cross-Contamination:** Residues from different samples, such as anode and cathode, increase the risk of contamination.
3. **Viscosity and Flow Issues:** Slurries or viscous electrolytes can cause uneven sample uptake and inconsistent measurements.

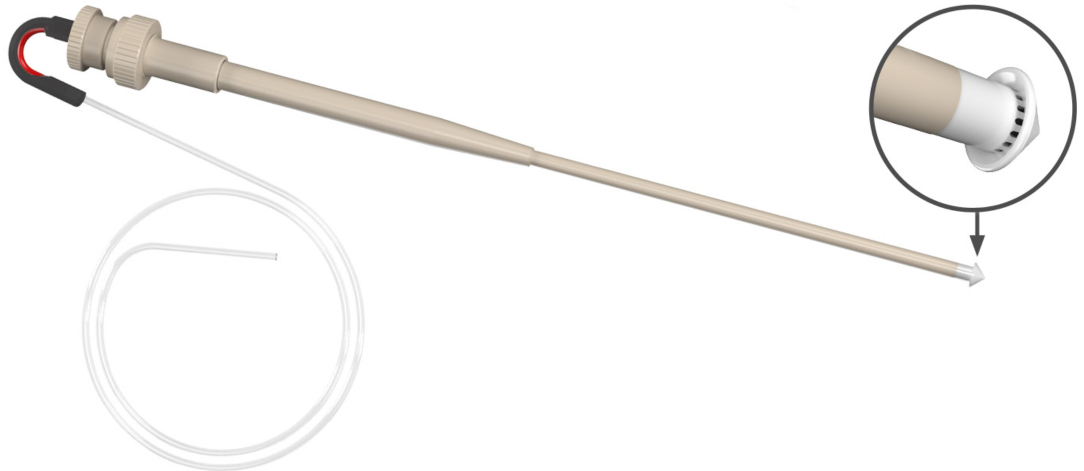
Sample Probe: Selection

1. Standard Option: Carbon Fibre Probe

- Encapsulated carbon fibre tube with continuous PFA tubing
- Available for most common Autosampler models, with IDs of 0.50, 0.75 and 1.00 mm

2. Advanced Option: Guardian Autosampler Probe Features:

- **Robust tip** design eliminates crushed and damaged tips due to misalignment
- **Drip-Resistant** design to **minimize cross-contamination** during probe movement
- **Built-in particle filtering for nebulizer and capillary tubing protection**
- Interchangeable UniFit™ sample lines IDs: 0.3, 0.50, 0.75 and 1.0mm
- Designed for Teledyne Cetac, PE S20, AimLab, and Agilent SPS3/SPS4 autosamplers



Guardian™ Probe Performance Comparison Video

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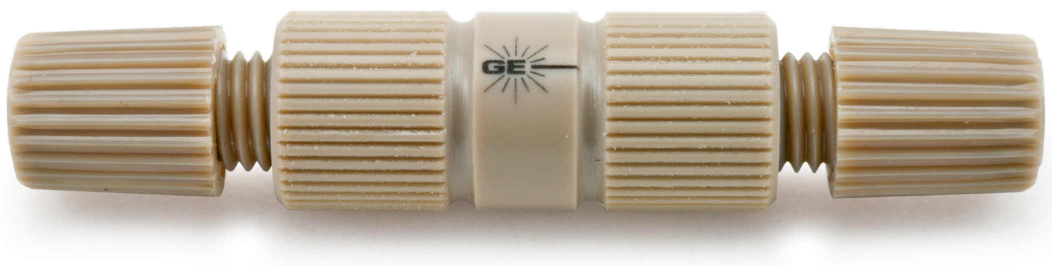
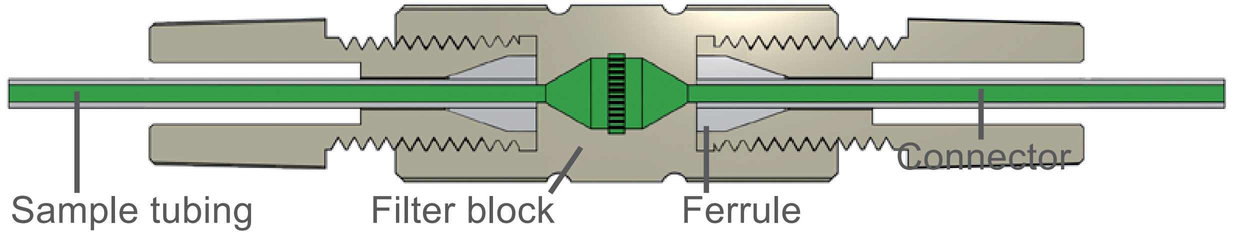
Helpful Tools to Minimize Bloackage In the Sample Path

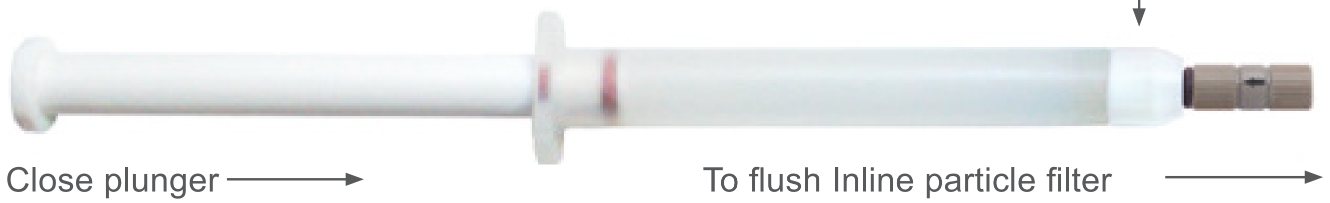
Guardian In-Line Particle FIlter P/N 70-803-1108:





Eluo Nebulizer Cleaning Tool P/N 70-ELUO

P/N 70-803-1160



Benefits

- Prevent large particles from clogging your nebulizer
- Insert between probe and nebulizer
- Re-usable PEEK filter (120 µm)
- Easily backflush to remove build up

In-Line particle filter: *"So far it has worked great, we have noticed significantly less clogged lines."*
Fertilizer manufacturer - USA

If you have the Eluo:

- Add adaptor P/N 70-803-1160

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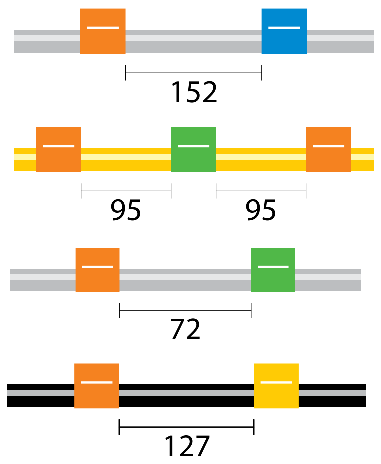
Peristaltic Pump Tubing: Selection



Tubing Material:

- PVC Tubing
- Solva Tubing
- Viton Tubing

2-Tag/Stop vs. 3-Tag/Stop:

3-Tag/Stop: When one section wears out, a fresh section is ready to use, extending tubing life

Flared vs. Non-Flared Options:

Flared-end pump tubing makes it easier to insert larger sample capillary tubing

Internal Diameter (ID):

Smaller ID Tubing (0.2-0.4 mm): Ideal for precise, low-flow applications

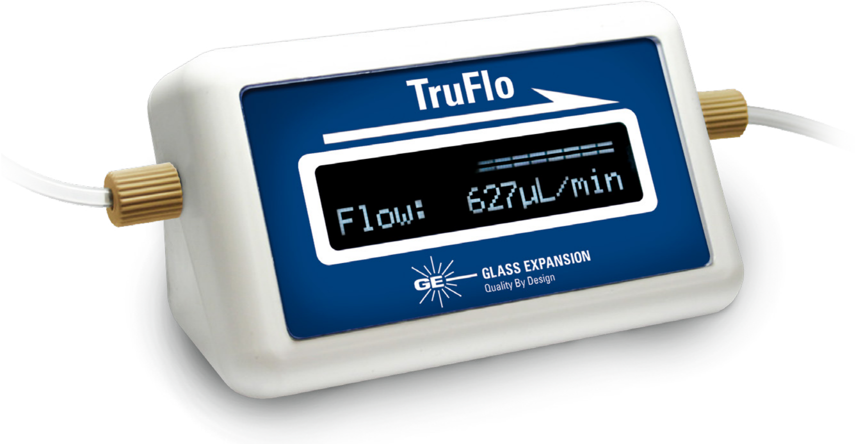
Larger ID Tubing: Suitable for higher flow rates and larger sample volumes

Tag Colours	ID (mm)
orange/black	0.13
orange/red	0.19
orange/blue	0.25
orange/green	0.38
green/yellow	0.44
orange/yellow	0.51
white/yellow	0.57
orange/white	0.64
black/black	0.76
orange/orange	0.89
white/black	0.95
white/white	1.02
white/red	1.09
red/red	1.14
red/grey	1.22
grey/grey	1.30
yellow/yellow	1.42
yellow/blue	1.52
blue/blue	1.65
blue/green	1.75
green/green	1.85
purple/purple	2.06
purple/black	2.29
purple/orange	2.54
purple/white	2.79
black/white	3.17

Pump Tubing: Common Challenges and Suggestions

Common Challenges with Pump Tubing:

- Wear and Tear
- Neglected Maintenance
- Contamination Risk



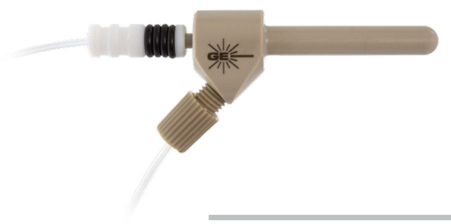
Suggestions for Maintaining Pump Tubing:

- Pre-Stretch Tubing and Maintain the proper tension on tubing
- Frequent Replacements: Pump and capillary tubing can be a source of contamination
- **Lubricate pump rollers (EzyGlide Cloth):**
  - Reduce wear and increase lifespan by minimizing friction
  - Stabilize sample delivery by reducing pulsations
- **TruFlo Sample Monitor:** eliminates guesswork and reduces the need to repeat measurements due to blocked nebulizers, worn pump tubing, or improper clamping.

Nebulizers

What are the common challenges encountered when using nebulizers?

Application Suitability



- HF, high dissolved solids, and suspended solids
- Can lead to reduced DLs, extended washout times, and poor precision

Blockages

- Loss of Sensitivity and Poor Precision
- ICP Backpressure Nebulizer test verifies nebulizer performance

Sample Cross- Contamination

- Poor connections
- Dead volume
- Affecting analysis accuracy

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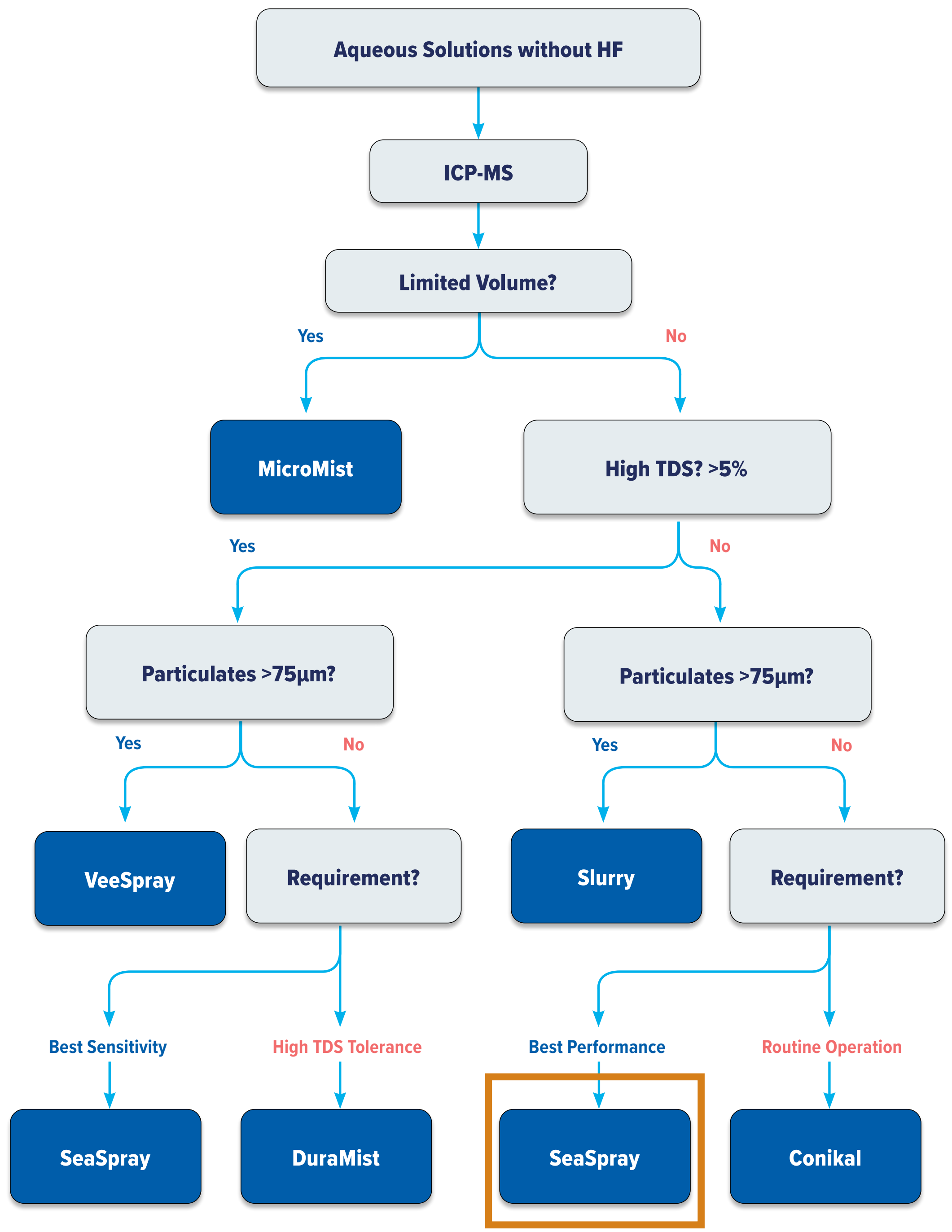
Nebulizer: Selection



Nebulizer		TDS (%)	Particulates (µm)	HF	Precision	Purity	Material
SeaSpray™		20	75	No	High	Good	Glass
MicroMist™		15	40*	No	High	Good	Glass
Conikal™		5	75	No	High	Good	Glass
Slurry™		1	150	No	High	Good	Glass
OpalMist™		15	75*	Yes	High	Excellent	PFA
DuraMist™		30	75*	Yes	High	Good	PEEK
VeeSpray™		30	300	Yes	Moderate	Good	Ceramic

* Varies with nebulizer uptake

Click here for Other Sample Types

SeaSpray™ Direct Connect (DC) Nebulizer

High Performance and Tolerance

- Material: Borosilicate glass.
- High physical reproducibility ~ 1%.
- TDS tolerance, typically up to 20%.
- Standard available uptake: 0.4 and 2.0 mL/min.
  - (1 mL/min uptake available on request)
- Designed for 40psi, 0.7 L/min argon flow.

The SeaSpray™ nebulizer is the best choice when samples contain high concentrations of dissolved solids. Seawater, brines, and plating baths are just a few examples of SeaSpray™ applications. A number of ICP-OES manufacturers also select the SeaSpray™ as part of their standard configuration due to its excellent sensitivity and combined tolerance to dissolved solids.

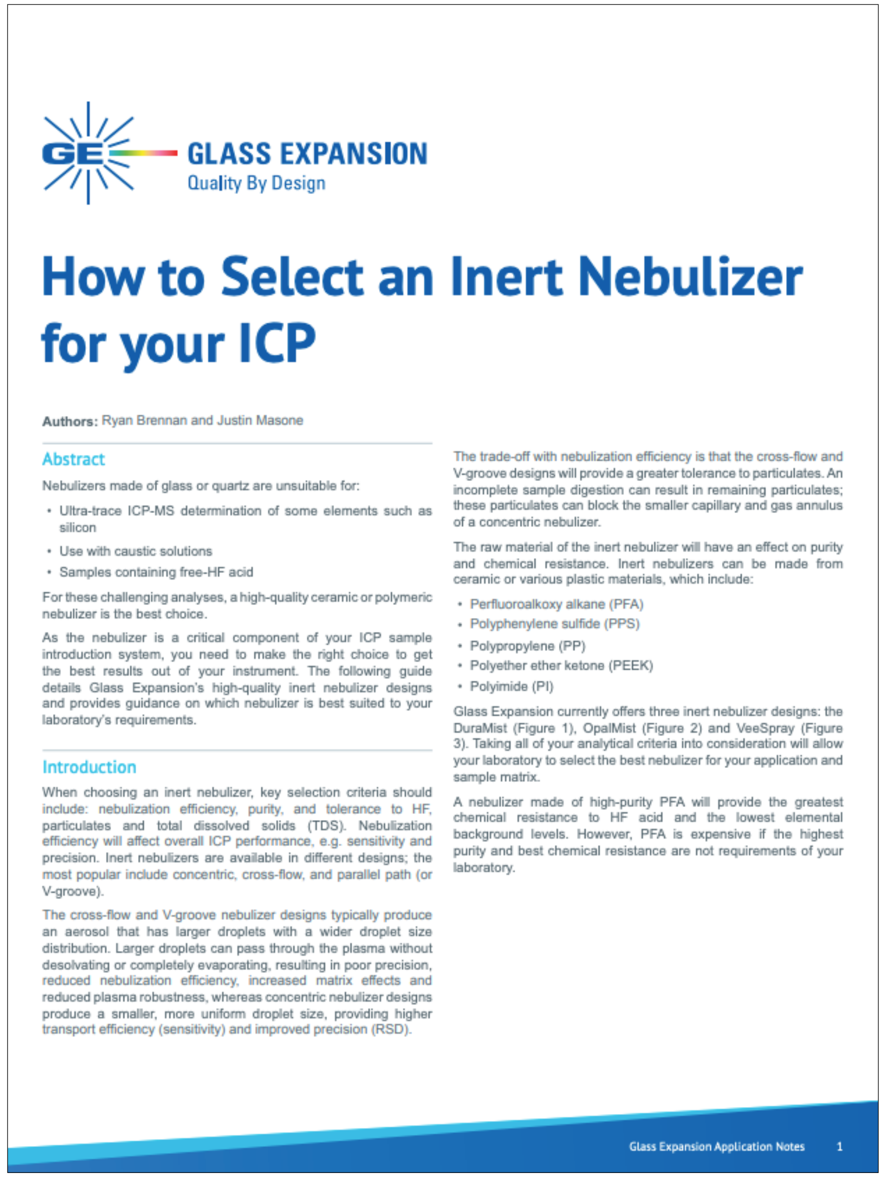
DuraMist™ DC Nebulizer

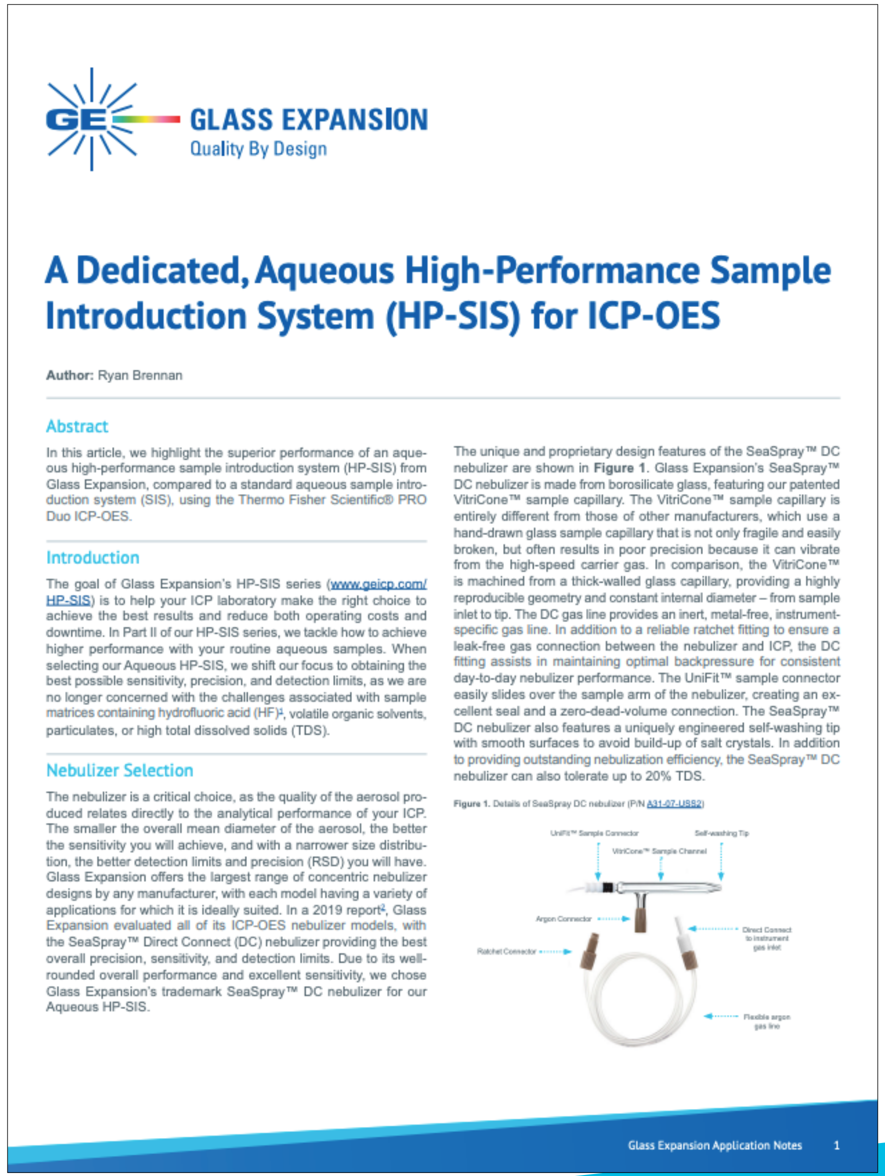
Ideal for HF and High TDS Samples

- PEEK body and capillary.
- Particulates up to 75µm.
- Tolerance to harsh chemicals, up to 5% HF.
- TDS tolerance, typically ~ 30%.
- 0.4 and 1.0 mL/min uptake models.
- Designed for 40psi, 0.7 L/min argon flow.

The DuraMist™ is the most economical inert nebulizer for high-precision analysis. It is highly sensitive, with excellent short-term precision and the highest tolerance to dissolved solids of any concentric nebulizer. It is a great "all-rounder" and ideal for high-throughput labs that require a good balance between durability and sensitivity.

Nebulizer Selection - Glass Expansion eNews





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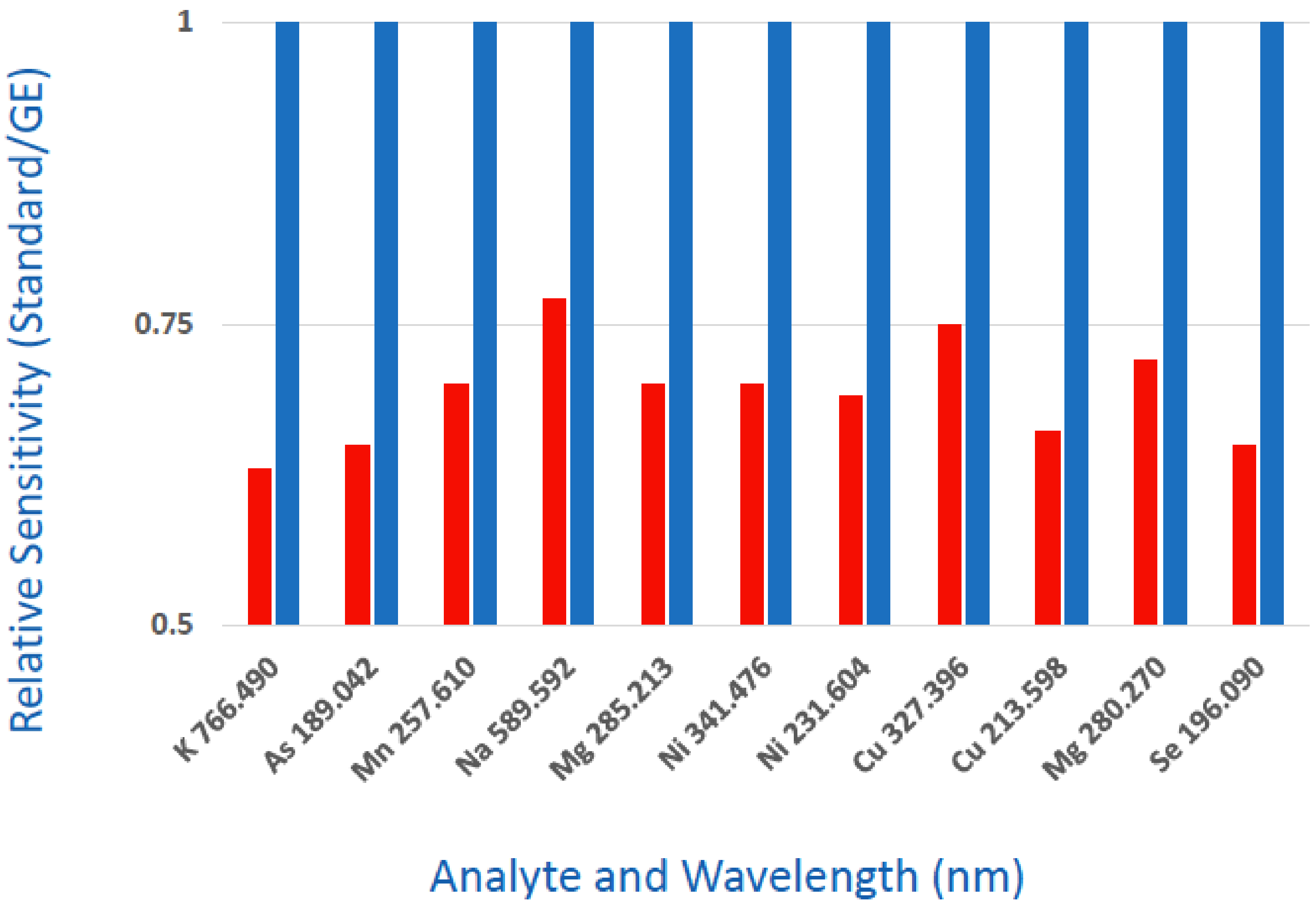
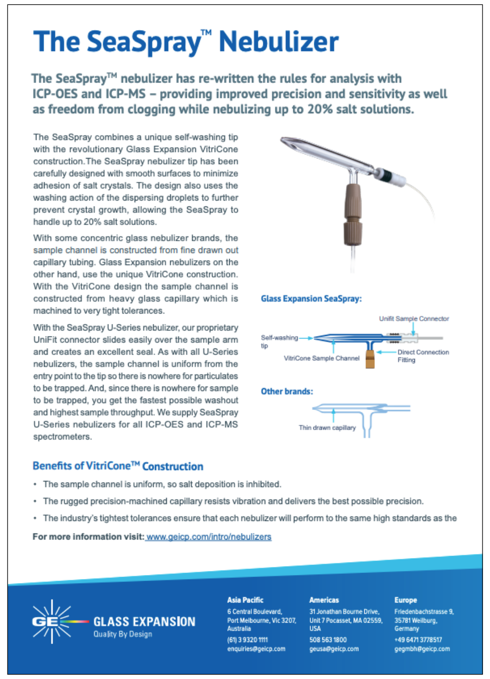
Aqueous HP-SIS - Sensitivity Comparison

Sensitivity of Standard Aqueous SIS relative to Glass Expansion Aqueous HP-SIS (relative sensitivity = 1)



- **Glass Expansion Aqueous HP-SIS**
  - Average improvement of **30%**
- **Standard Aqueous SIS**



The SeaSpray™ Nebulizer

The SeaSpray™ nebulizer has re-written the rules for analysis with ICP-OES and ICP-MS – providing improved precision and sensitivity as well as freedom from clogging while nebulizing up to 20% salt solutions.

The SeaSpray combines a unique self-washing tip with the revolutionary Glass Expansion VitriCone construction. The SeaSpray nebulizer tip has been carefully designed with smooth surfaces to minimize adhesion of salt crystals. The design also uses the washing action of the dispersing droplets to further prevent crystal growth, allowing the SeaSpray to handle up to 20% salt solutions.

With some concentric glass nebulizer brands, the sample channel is constructed from fine drawn out capillary tubing. Glass Expansion nebulizers on the other hand, use the unique VitriCone construction. With the VitriCone design the sample channel is constructed from heavy glass capillary which is machined to very tight tolerances.

With the SeaSpray U-Series nebulizer, our proprietary UniFit connector slides easily over the sample arm and creates an excellent seal. As with all U-Series nebulizers, the sample channel is uniform from the entry point to the tip so there is nowhere for particulates to be trapped. And, since there is nowhere for sample to be trapped, you get the fastest possible washout and highest sample throughput. We supply SeaSpray U-Series nebulizers for all ICP-OES and ICP-MS spectrometers.

Glass Expansion SeaSpray:

Unifit Sample Connector
Self-washing tip
VitriCone Sample Channel
Direct Connection Fitting

Other brands:

Thin drawn capillary

Benefits of VitriCone™ Construction

- The sample channel is uniform, so salt deposition is inhibited.
- The rugged precision-machined capillary resists vibration and delivers the best possible precision.
- The industry's tightest tolerances ensure that each nebulizer will perform to the same high standards as the

For more information visit: www.geicp.com/intro/nebulizers

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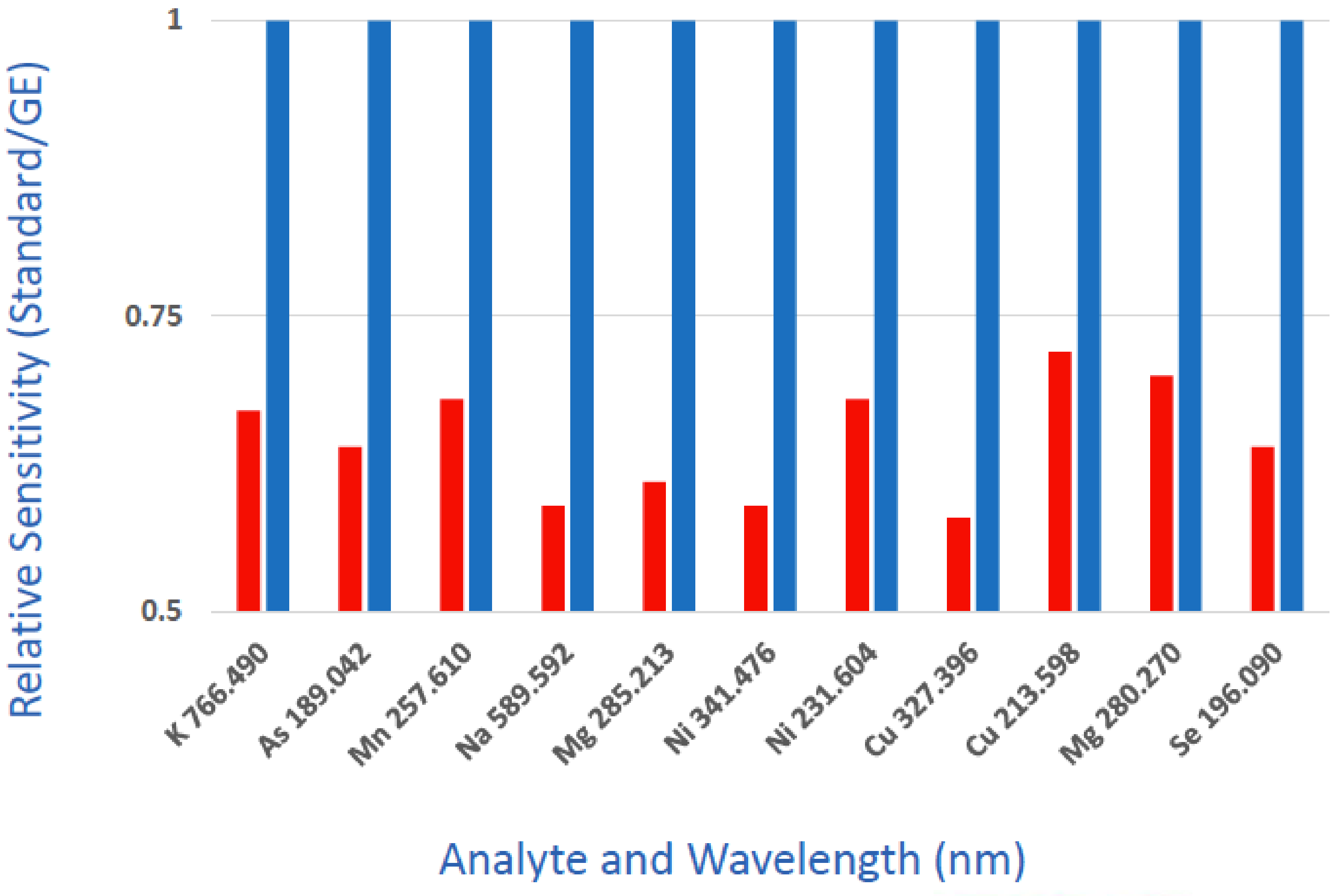
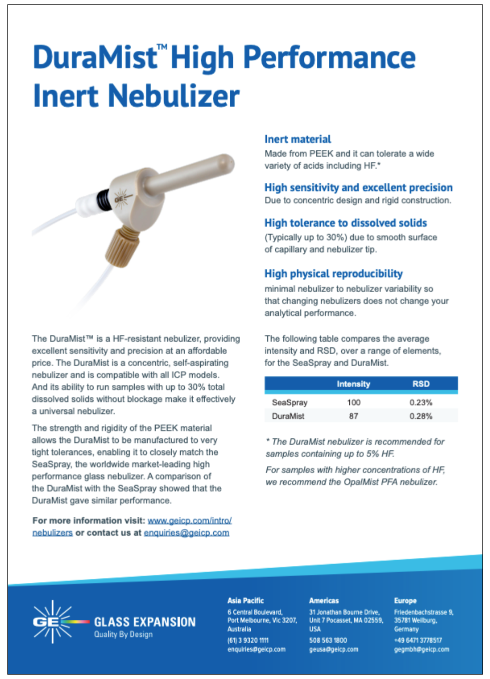
HF-Resistant HP-SIS – Sensitivity Comparison

Sensitivity of Standard HF-Resistant SIS relative to Glass Expansion HF-Resistant HP-SIS (relative sensitivity = 1)



- **Glass Expansion HF-Resistant HP-SIS**
  - Average improvement of **35%**
- **Standard HF-Resistant SIS**



DuraMist™ High Performance Inert Nebulizer

Inert material
Made from PEEK and it can tolerate a wide variety of acids including HF.*

High sensitivity and excellent precision
Due to concentric design and rigid construction.

High tolerance to dissolved solids
(Typically up to 30%) due to smooth surface of capillary and nebulizer tip.

High physical reproducibility
minimal nebulizer to nebulizer variability so that changing nebulizers does not change your analytical performance.

The DuraMist™ is a HF-resistant nebulizer, providing excellent sensitivity and precision at an affordable price. The DuraMist is a concentric, self-aspirating nebulizer and is compatible with all ICP models. And its ability to run samples with up to 30% total dissolved solids without blockage make it effectively a universal nebulizer.

The strength and rigidity of the PEEK material allows the DuraMist to be manufactured to very tight tolerances, enabling it to closely match the SeaSpray, the worldwide market-leading high performance glass nebulizer. A comparison of the DuraMist with the SeaSpray showed that the DuraMist gave similar performance.

For more information visit: www.geicp.com/intro/nebulizers or contact us at enquiries@geicp.com

The following table compares the average intensity and RSD, over a range of elements, for the SeaSpray and DuraMist.

	Intensity	RSD
SeaSpray	100	0.23%
DuraMist	87	0.28%

** The DuraMist nebulizer is recommended for samples containing up to 5% HF.*

For samples with higher concentrations of HF, we recommend the OpalMist PFA nebulizer.

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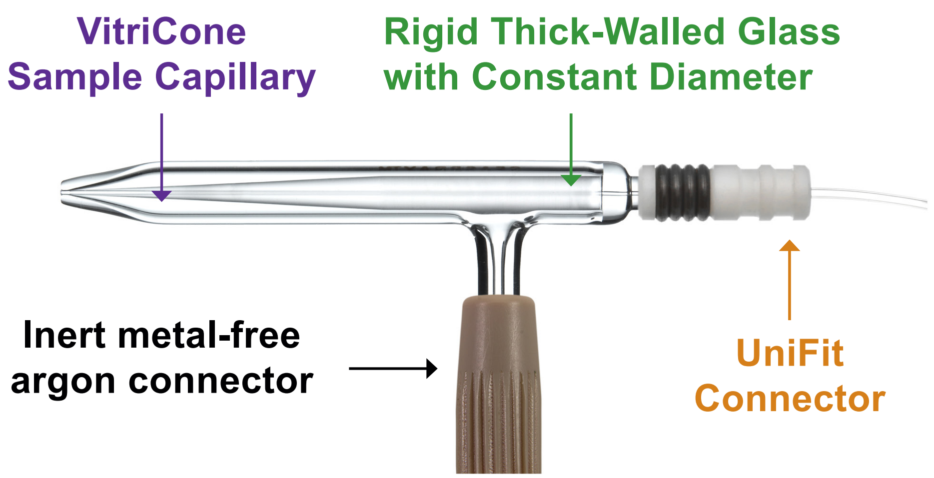
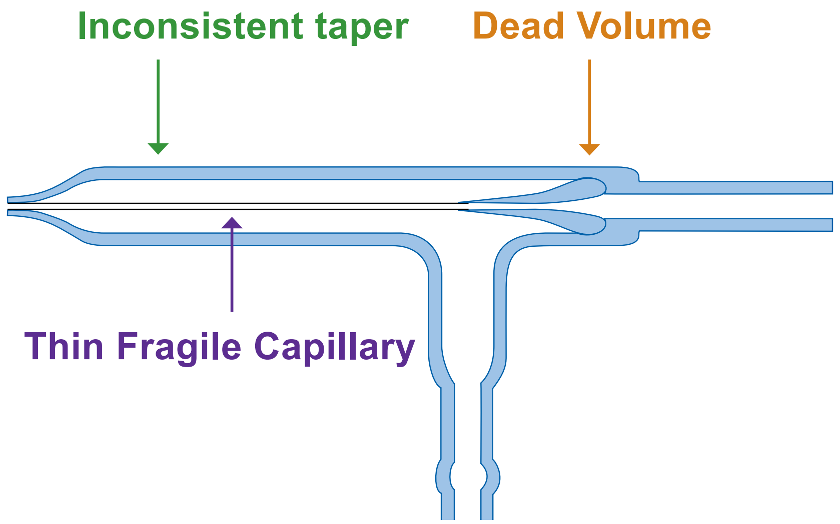
Nebulizers

GE Nebulizer Design



- **Machined from thick-walled tubing:** Highly reproducible geometry.

Other Nebulizer Design



- **Constructed from drawn-out capillary tubing:** Challenging to replicate consistently.

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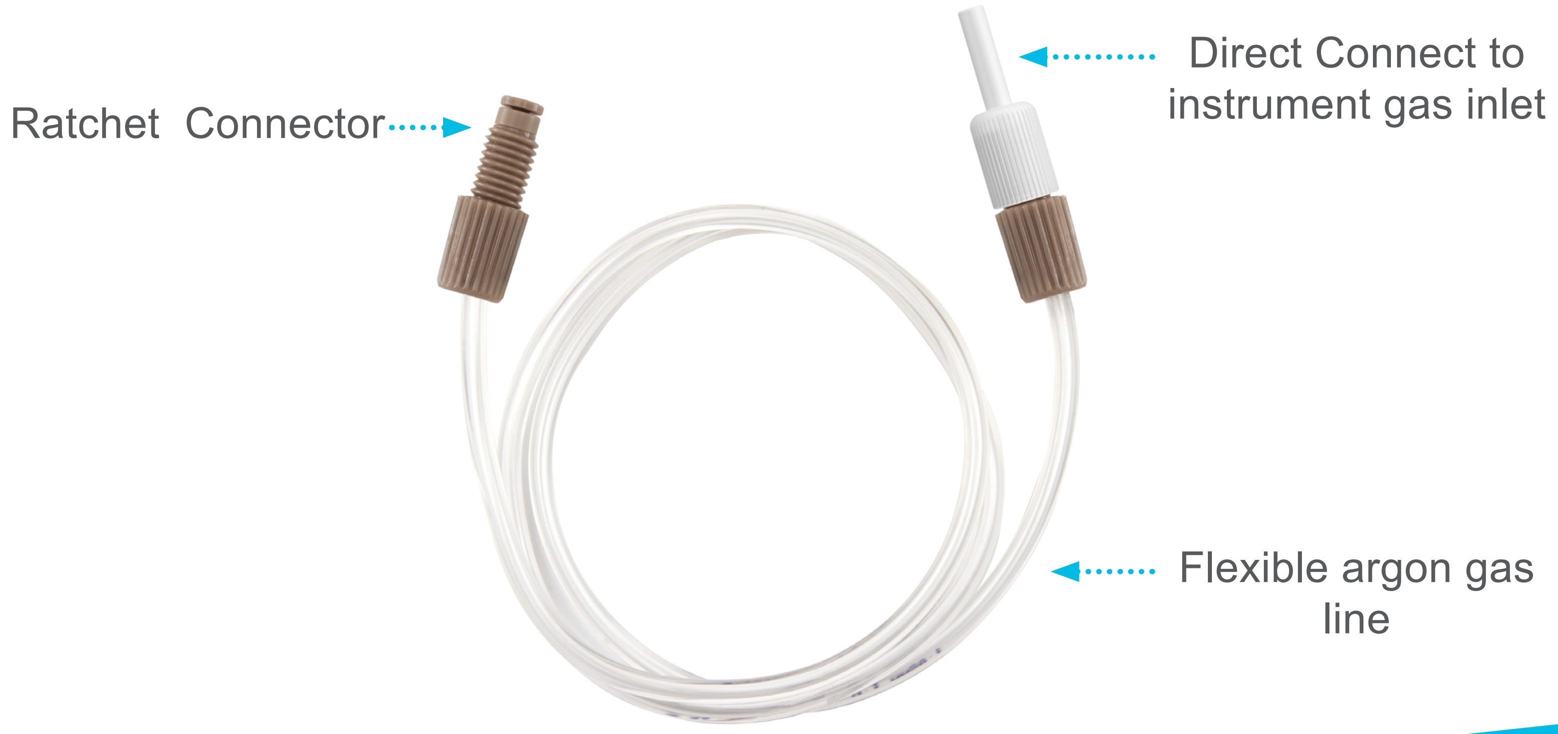
DC Nebulizer - Benefits

- Inert, metal-free argon connector
- Ratchet fitting ensures leak-free gas connection
- Direct plug-in gas line connection to instrument



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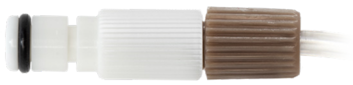
Glass Expansion DC Gas Lines

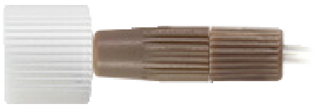
Manufacturer	Model	P/N Prefix	Gas Line Included
Agilent®	4100, 4200	MP11-	70-803-0969
Agilent®	Vista, 700-ES	A11-	70-803-0969
Agilent®	7700, 7800, 7900, 8800, 8900	A13-	70-803-1105
Agilent®	5100, 5110, 5800, 5900	A13-	70-803-1105
Analytik Jena®	ICP-OES	A13-	70-803-1105
Analytik Jena ®	ICP-MS	A61-	70-803-2002
Analytik Jena ®	ICP-OES	A13-	70-803-1105
Horiba ® Jobin Yvon	All Models	A13-	70-803-1105
Leeman	All Models	A11-	70-803-0969
Nu Instruments	ICP-MS	A51-	70-803-1858
Nu Instruments	TOF-ICP-MS	A52-	70-803-2044
PerkinElmer ®	Optima, PE Avio	A21-	70-803-1070
PerkinElmer®	Elan, NexION 300/350	A22-	70-803-1049
PerkinElmer®	NexION 1000, 1100, 2000, 2200, 5000	A23-	70-803-1449
Radom	MICAP® OES™ 1000	A70-	70-803-2054
Shimadzu®	All Models	A41-	70-803-1311
Spectro™	All Models	A21-	70-803-1070
Standard BioTools™ (Fluidigm)	Helios	A21-	70-803-1070
Thermo Scientific™	PRO, 6000/7000, MX Series, Q/RQ/TQ, X-Series & Neoma	A31-	70-803-1105
Thermo Scientific™	Neptune	A11-	70-803-0969


P/N 70-803-0969


P/N 70-803-1105

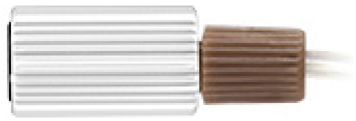

P/N 70-803-1070


P/N 70-803-1049


P/N 70-803-1449


P/N 70-803-1311


P/N 70-803-2002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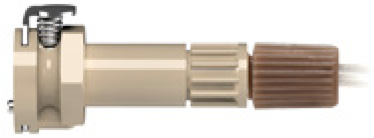
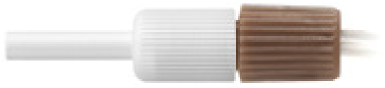

P/N 70-803-2054


P/N 70-803-1858

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How to Identify Nebulizer Issues

Verify the nebulizer back-pressure after instrument warm-up:

1. Low nebulizer back-pressure and a loss in sensitivity can indicate a leak on the supply line:

- Check the Ar nebulizer gas connection at the instrument and at the nebulizer gas arm.
- Inspect for any visible cracks.

2. High nebulizer back-pressure can indicate a partially blocked or clogged nebulizer:

- Clean nebulizer or replace if necessary.

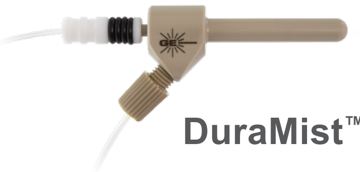
3. Record your normal sample uptake rate

- A change in uptake rate can indicate a blockage, worn pump tubing, or incorrect tension on the pump.

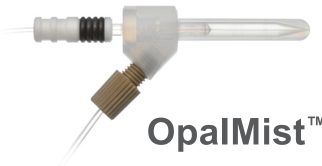
Magnifier Inspection Tool
P/N 70-803-1923

Conikal™
SeaSpray™
MicroMist™
Slurry™

P/N 70-ELUO



DuraMist™



OpalMist™

P/N 70-ELUO-OPD

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Nebulizer Cleaning Procedure

- To maintain your nebulizer, start and finish each run by nebulizing a mildly acidic blank solution, followed by DIW for 5-10 min.
- This prevents sample deposits from forming inside the nebulizer when the solvent dries out.

For Blockages:

1. Initially flush with water using the Eluo
2. Soak nebulizer tip in 25% Fluka for 24 hours.
   An initial flush of 25% Fluka may be required.
3. Flush 3x with water using the Eluo.
4. *Stubborn deposits may require an additional soaking for 2 hours with 5% HN03*
5. Flush 3x with water using the Eluo.
6. *For faster drying, flush with methanol.*

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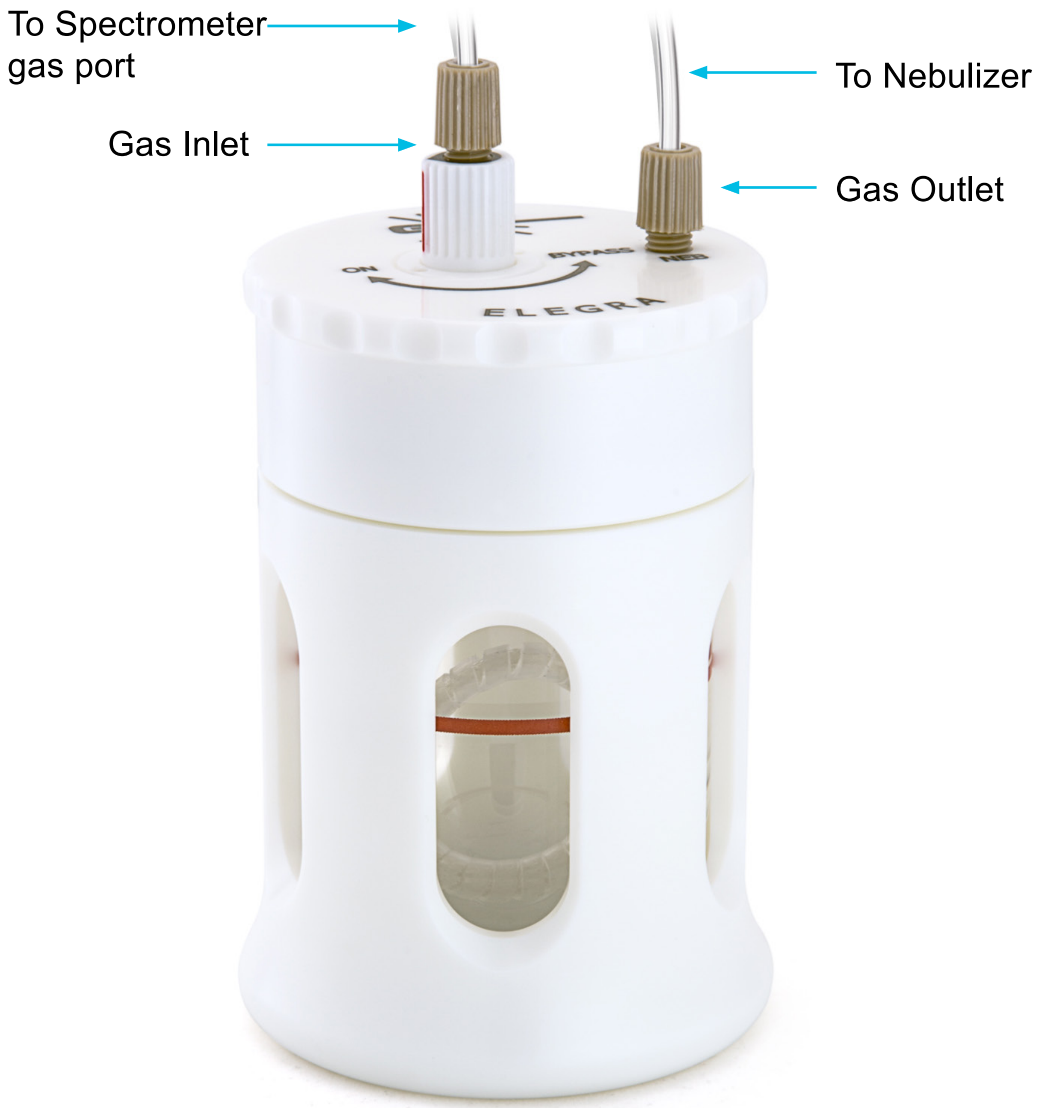
Nebulizer Maintenance Practices to Avoid

- Do not insert anything through the orifice of the nebulizer, including wires and probes. This is most likely to damage the nebulizer beyond repair.
- Never touch the nebulizer tip. Any deposit of body oils can have a detrimental effect on the performance of the nebulizer.
- Do not use any concentration of HF to clean a glass or quartz nebulizer. Even dilute HF can alter the orifice of the internal capillary and deteriorate the performance of the nebulizer.
- Do not place a glass nebulizer in an ultrasonic bath as it may dislodge the internal capillary.
- Do not use hot liquid to flush the sample capillary of an inert nebulizer. The temperature can potentially deform the capillary and affect nebulizer

Improved Stability in High TDS Matrices: Environmental and Mining

Features:

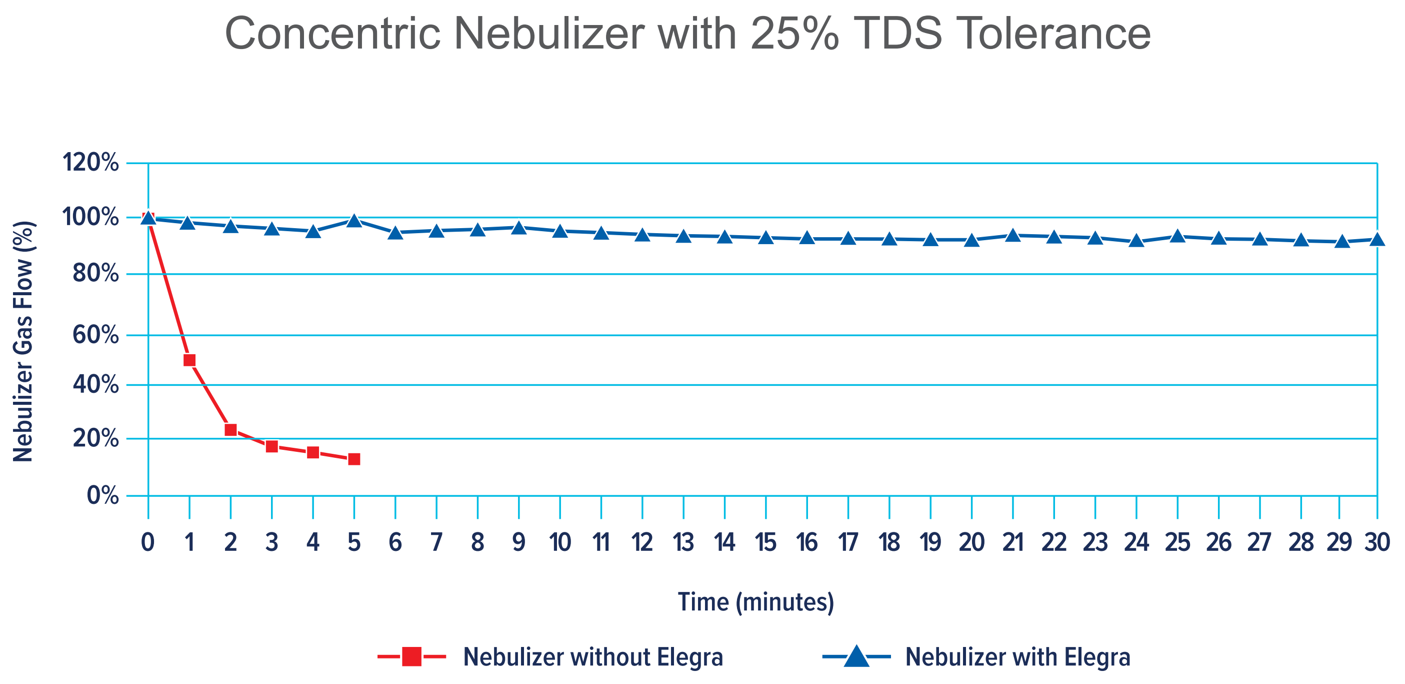
- No heating or electric power required
- Membrane humidification technology
- Improved signal stability for samples with high TDS
- Inert metal free construction
- Dual-Channel version (ICP-MS)

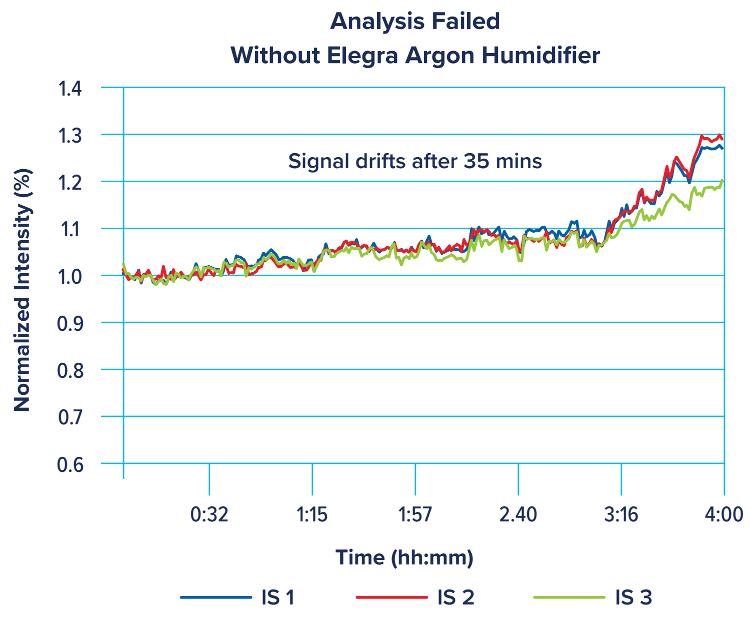


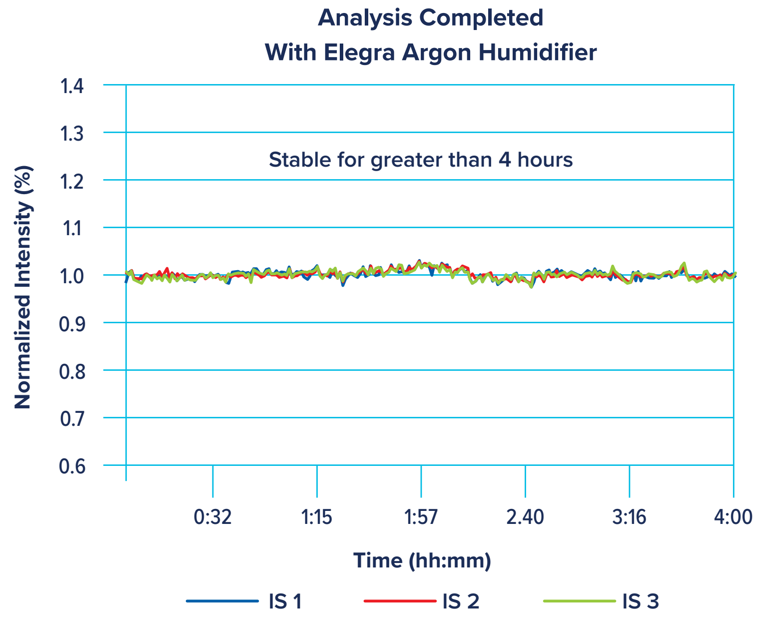
Other tips for high TDS:

- Increasing the auxiliary argon flow will lift the plasma higher off the injector, slowing salt buildup at the injector tip.
- Extended rinses in between each sample.

Recommended Products: Elegra Argon Humidifier





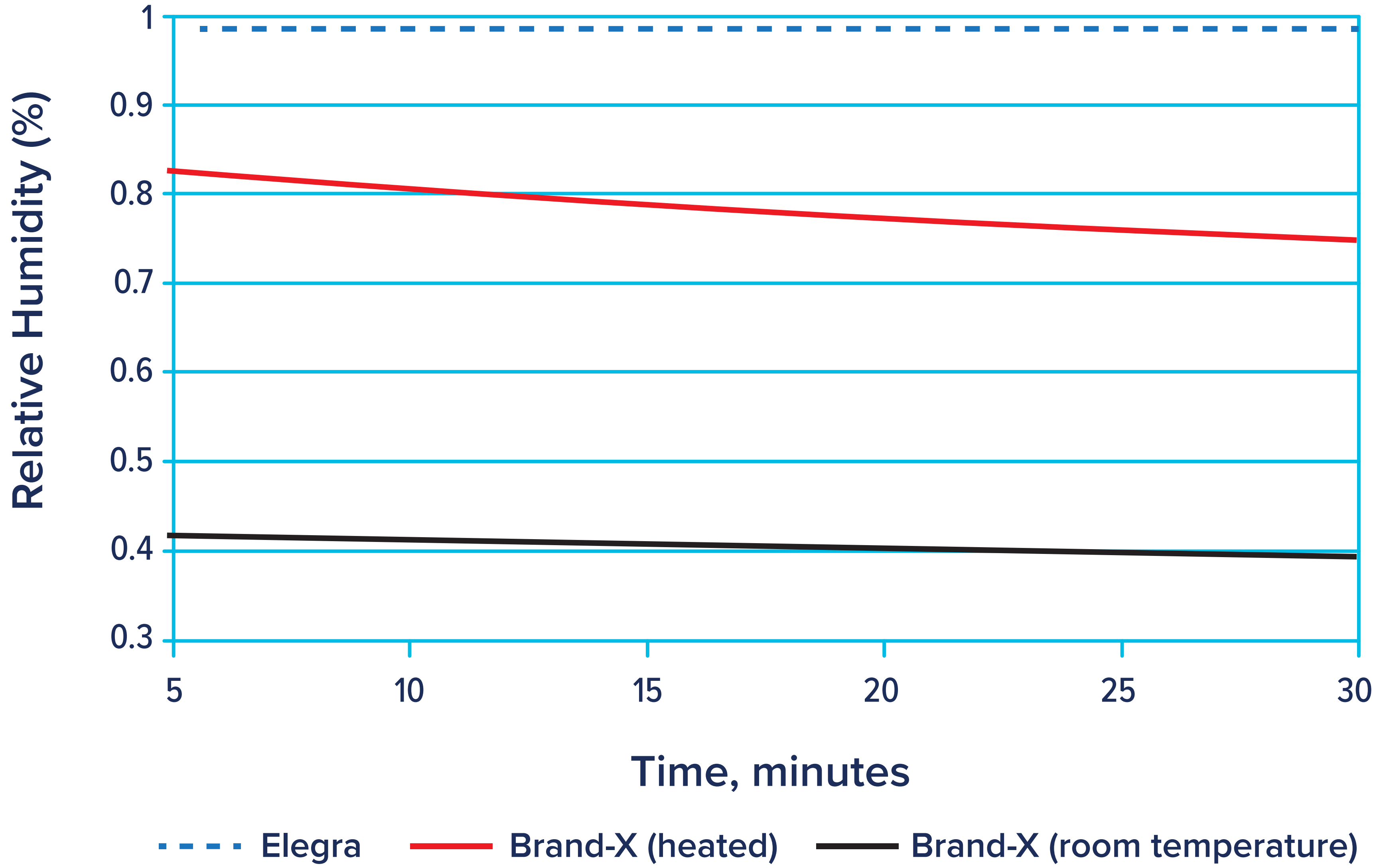


- Conikal nebulizer typically with up 5% TDS tolerance
- **Added moisture from Elegra prevented nebulizer clogging**

- High-throughput contact lab evaluation for Li metaborate
- **Without Elegra:** IS resulting in failed analysis (>10% drift)
- **With Elegra:** no variation in IS signal over-four-hour period

GLASS EXPANSION
Quality By Design

Comparison of Humidifier Designs



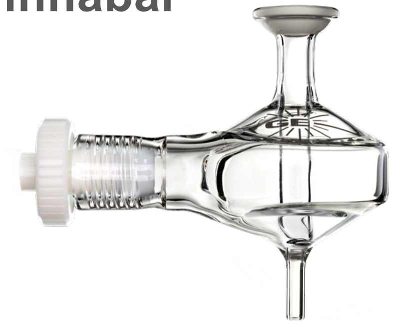
GLASS EXPANSION
Quality By Design

Cinnabar™

Tracey™

Twister™

Twinnabar™



Spray Chamber Optimal Selection and Maintenance

PTFE (Tracey™ & Twister™)

IsoMist XR™

PCC

PFA Tracey™

GLASS EXPANSION
Quality By Design

Spray Chambers

What are the common challenges encountered when using spray chambers?

Application Suitability

- HF
- Organics
- Limited volume samples

Transport Efficiency

- Loss of Sensitivity
- Poor Precision and Accuracy
- Inconsistent Signal Stability

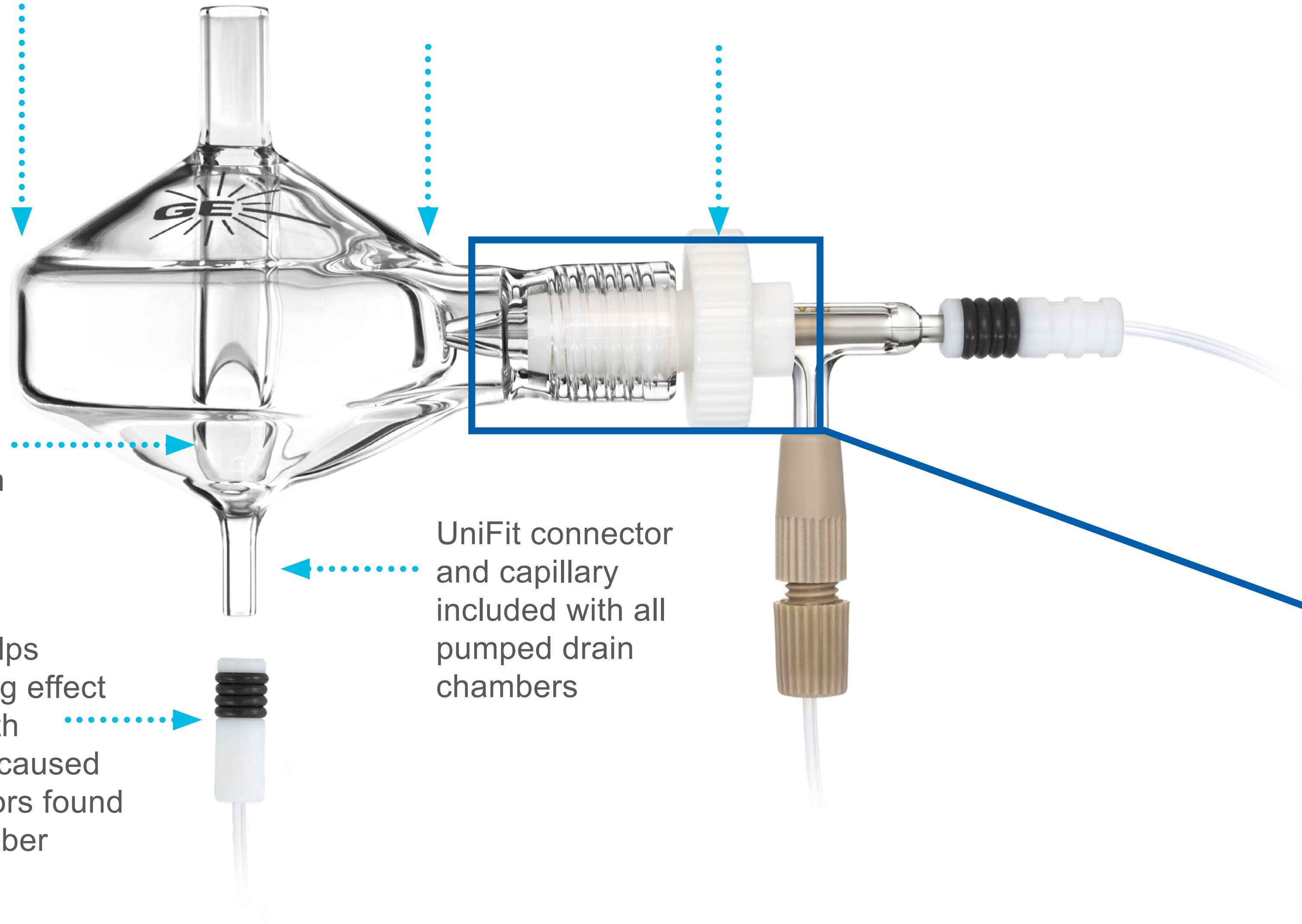
Long washout Carryover

- Poor Precision
- Dead volume
- Compromised analytical results

Profound Effect on: Transport Efficiency, Precision, and Washout

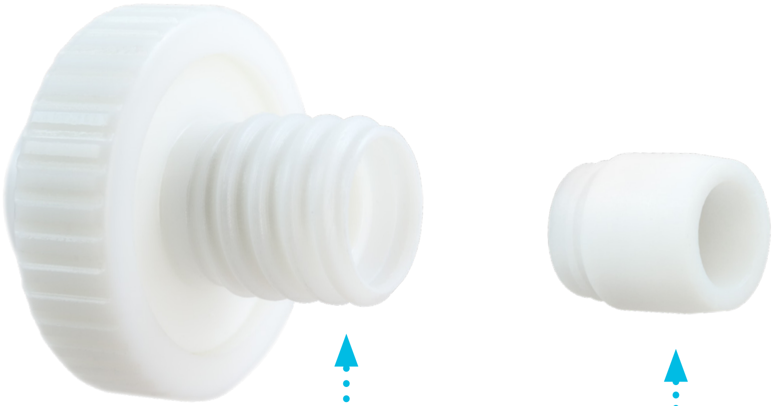
GE Spray Chambers Design Features: Helix CT

Sensitivity Gains + Reduced Washout Times + Reduced matrix effects



Inert PTFE PressFit Seal:

- Chemically inert seal, immune to strong acids and organic solvents
- **Eliminates all drawbacks of o-ring seal**
- Improves user safety, preventing broken glassware



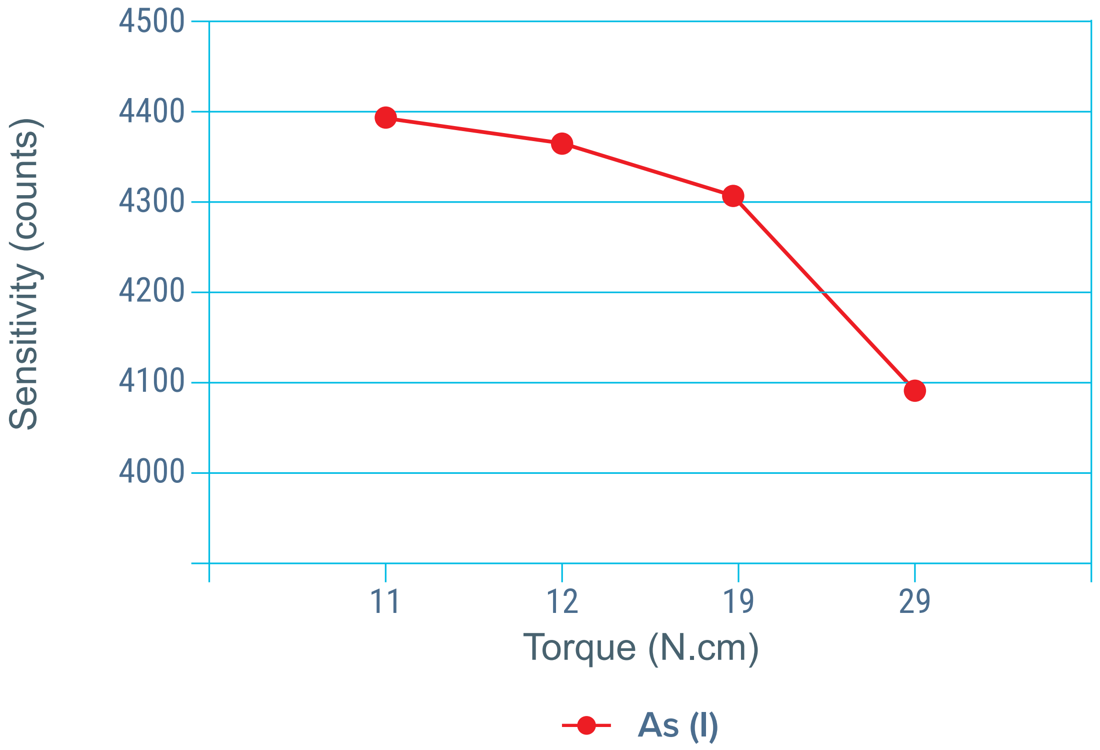
Precision & Sensitivity: Design Considerations

Helix CT: Constant Torque = Constant Performance

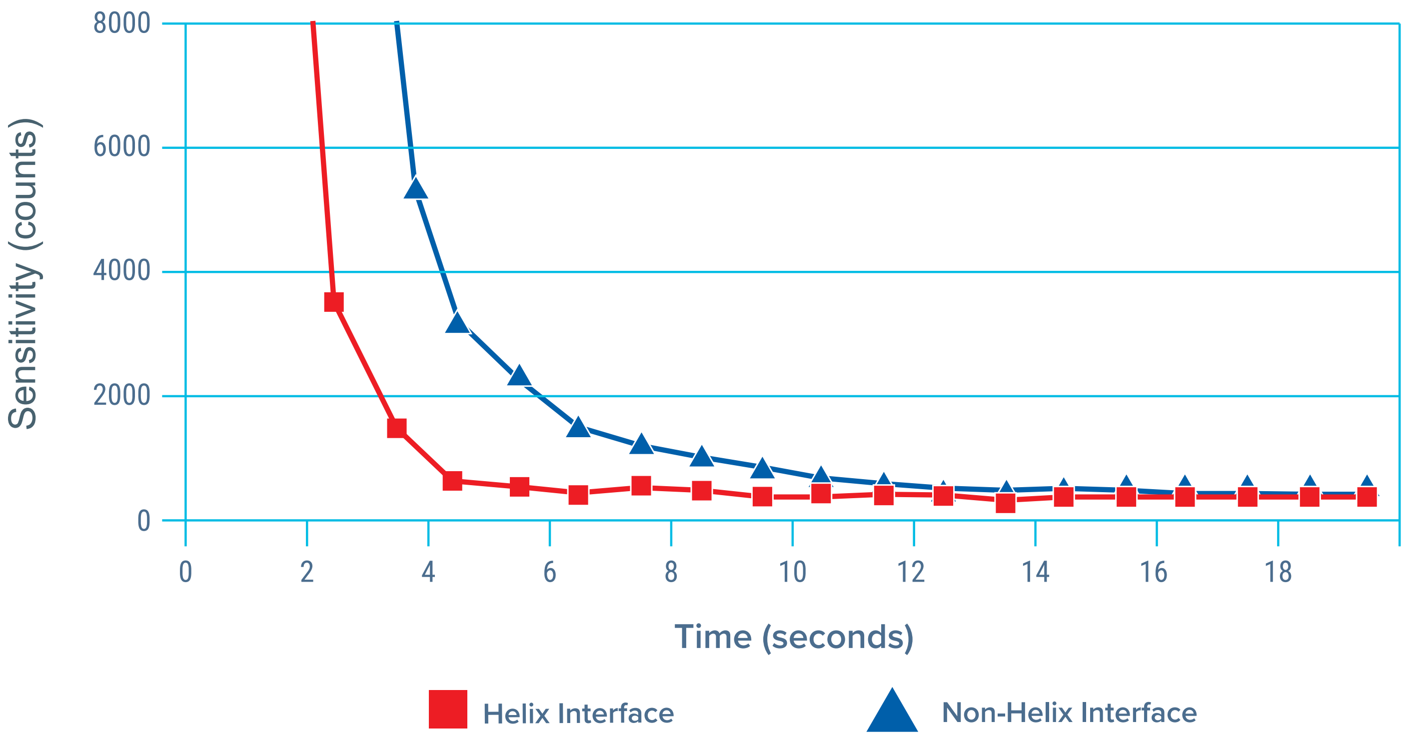
Reproducible day-to-day ICP performance

ICP sensitivity is affected by nebulizer depth within the spray chamber + torque applied to the nebulizer seal.

Optimum Sensitivity

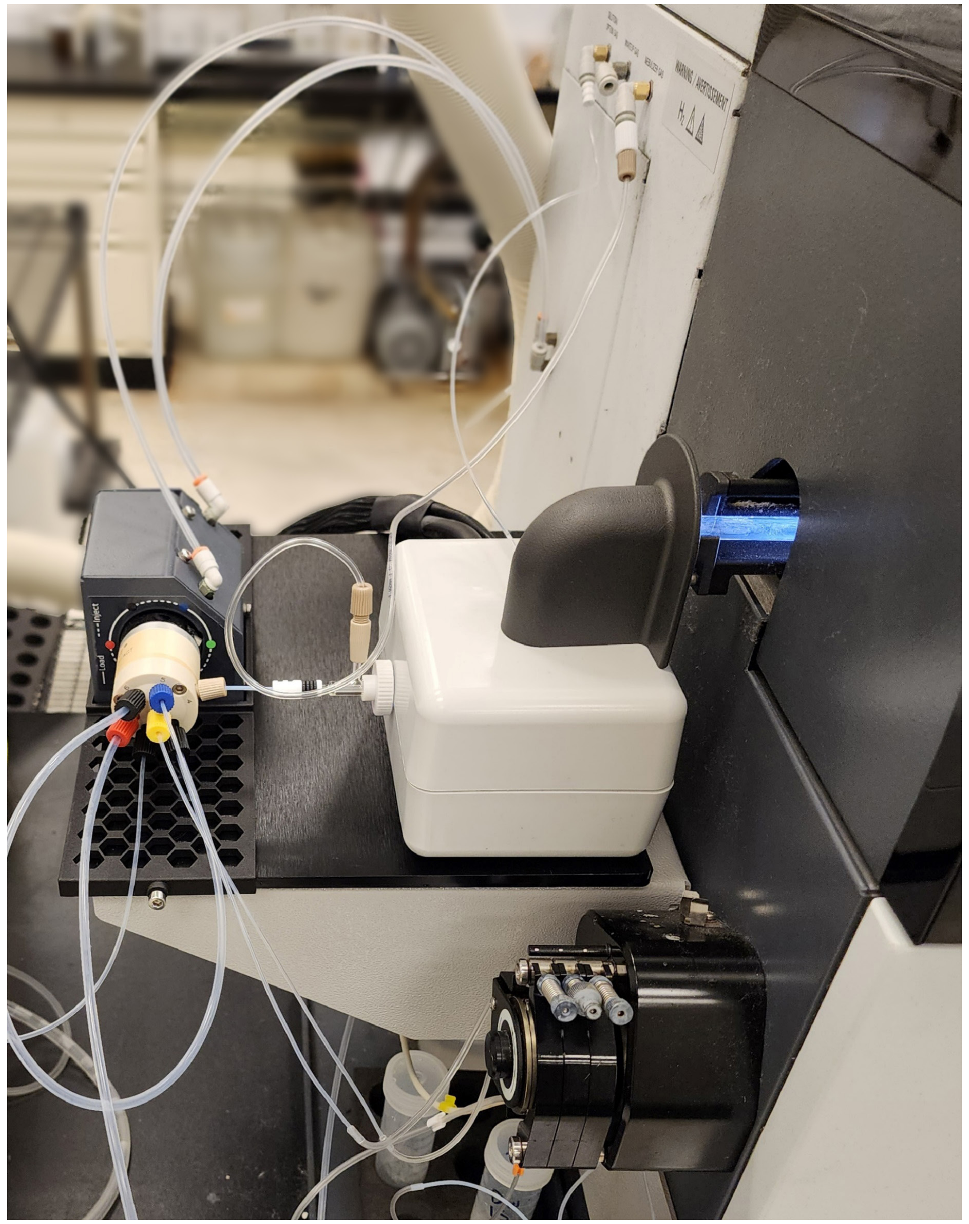


Improved Washout



New PCC™ Kit

- Compatible with Agilent® 7850/7900/8900.
- Compatible with Agilent® HM and UHMI conditions.
- Compatible with Agilent® AVS/ADS2/ISIS-3.
- Interfaces direct to the existing electronics and water cooling system of the Agilent® ICP-MS.
- A convenient mounting bracket allows for fast and simple installation.
- Minimizes washout time with highly concentrated samples and troublesome elements, such as B, Hg, Pb and Sb; compared to the standard Scott-style spray chamber.



Customer Comments

- For our particular application this PCC kit was a great improvement. On specific cases that required four (or more) blank runs to bring the boron level to baseline now we can do it two or one blank run. This allowed us to **increase sample throughput by about 50%**. — Specialty Chemical Manufacturer - USA

PCC™ Kit

Scott style Spray Chamber

Tracey Spray Chamber

GLASS EXPANSION
Quality By Design

Analytical Performance

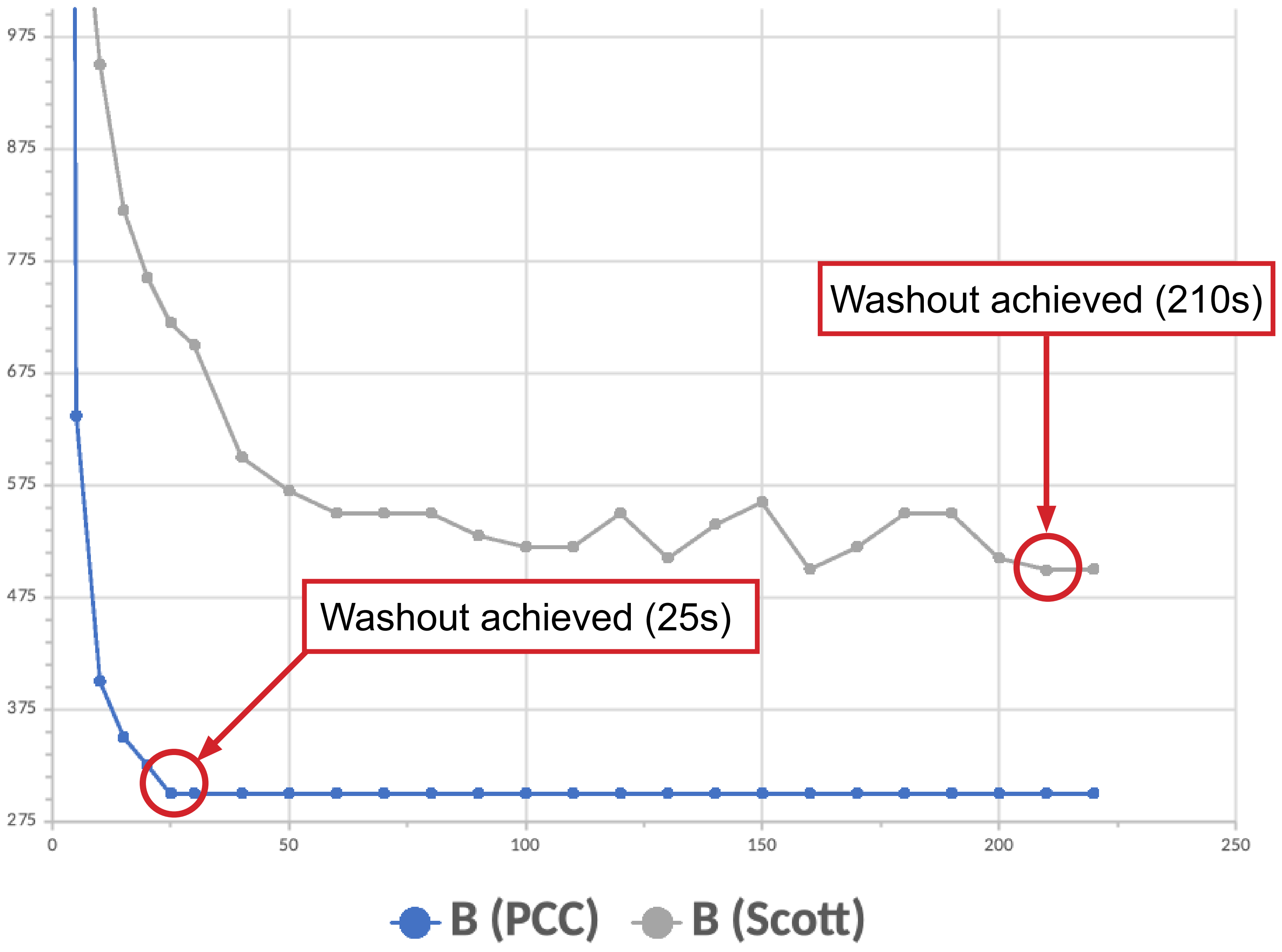
Spray Chamber	Tuned Nebulizer gas flow (L/min)	Sensitivity (CPS)		
		7 Li	89 Y	205 Ti
Scott Style	1.03	5,534	32,852	24,521
PCC Kit	1.05	5,882	32,540	22,801

Spray Chamber	Tuned Nebulizer gas flow (L/min)	Short-term Precision (%RSD)		
		7 Li	89 Y	205 Ti
Scott Style	1.03	2.1	1.5	1.8
PCC Kit	1.05	2.6	2.2	2.4

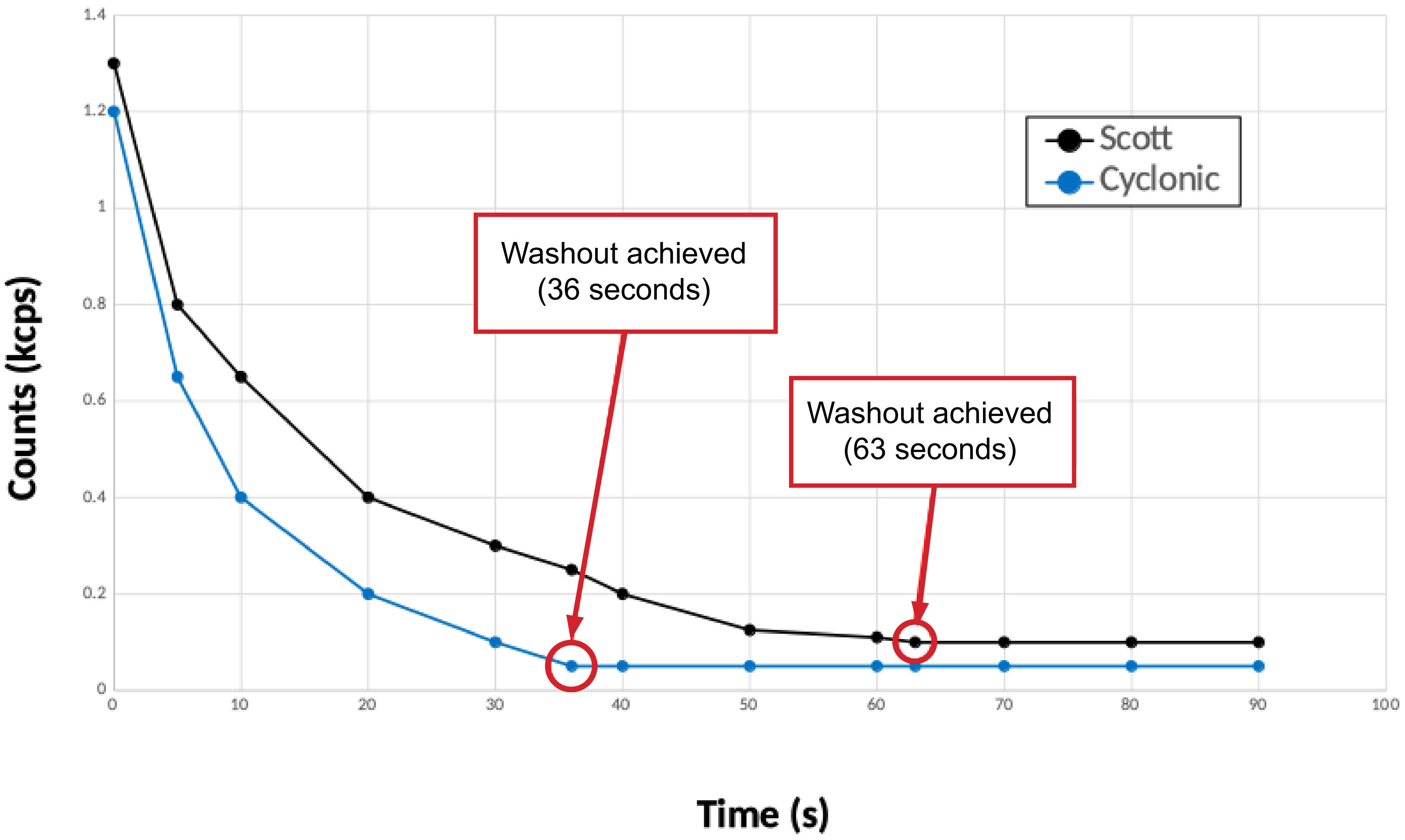
Spray Chamber	Tuned Nebulizer gas flow (L/min)	Oxide Ratio (%)	Charged Ratio (%)
		CeO^+/Ce^+	Ce^{2+}/Ce^+
Scott Style	1.03	0.996	0.896
PCC Kit	1.05	0.905	0.954

GLASS EXPANSION
Quality By Design

Washout Comparison (200 ppb Boron)



Washout Comparison (100 ppb Mercury)



Direct Connect (DC) Spray Chambers

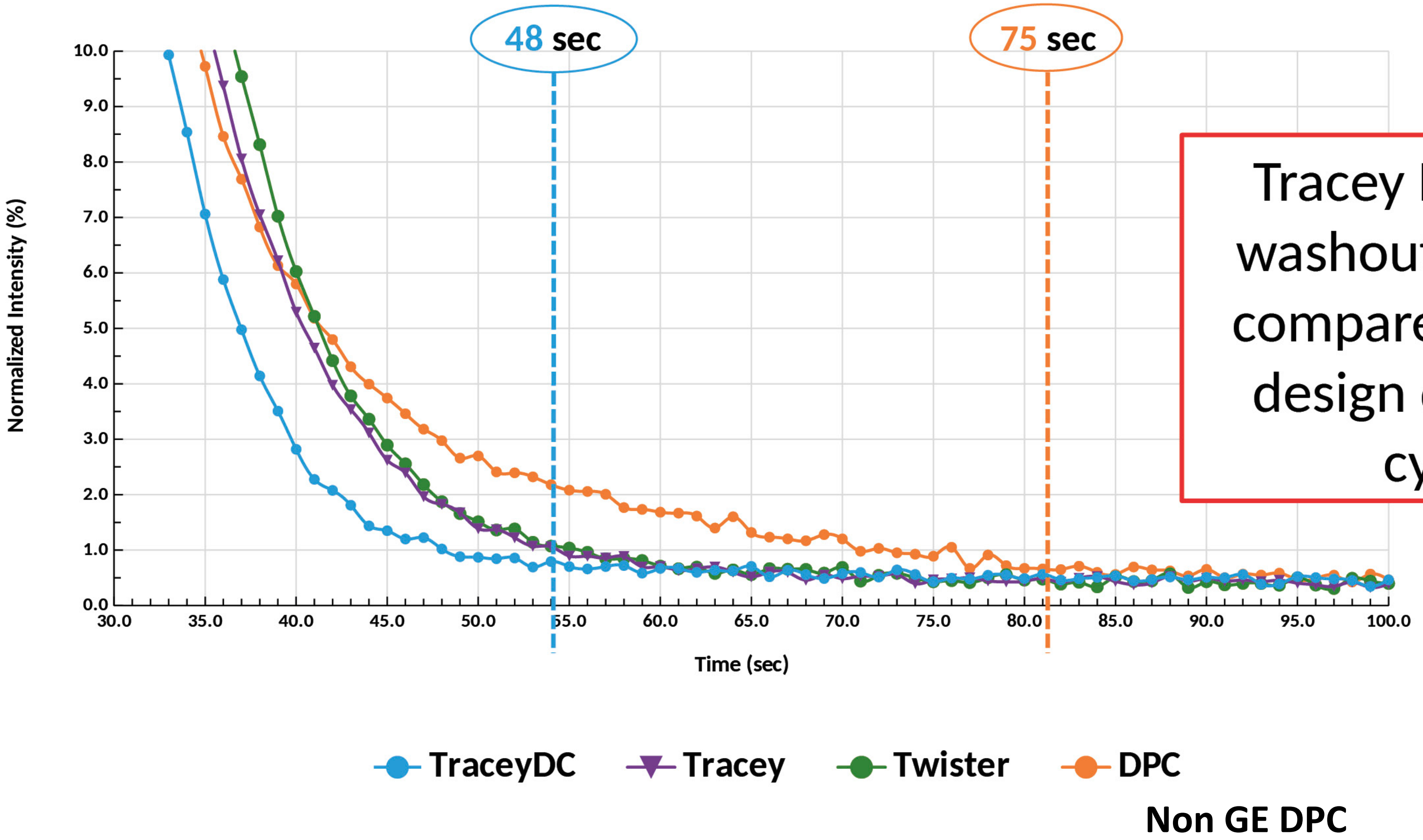
Features & Benefits:

1. **No O-Rings:** Reduces washout times and eliminates frequent replacements due to wear.
2. **Inert DC Connection:** PEEK Construction ensures durability and chemical resistance. No ball joint clamps that corrode over time.
3. **Consistent Alignment:** Provides precise alignment for enhanced accuracy and efficiency.
4. **Efficient Washout:** 30mL low-volume cyclonic chamber with Helix CT technology.
5. **Cost-Effective:** More affordable than traditional glass spray chambers.
6. **Wide Compatibility:** Fits most common ICP-OES models with E-Torch, D-Torch, and SDT/ FDT. Tracey DC spray chamber design is available in Glass and PEEK.

GLASS EXPANSION
Quality By Design

Direct Connect (DC) Spray Chambers

Washout Profiles for 1 ppm Hg:



Tracey DC achieves washout **64% faster** compared to non-GE design double pass cyclonic

GLASS EXPANSION
Quality By Design

Tracey™ DC PEEK Spray Chamber

Features & Benefits:

1. **HF Resistance:** With resistance up to 5%
2. **Contamination-Free:** DC fitting removes the need for metal clamps, reducing contamination risk.
3. **Superior Wetting:** PEEK material maintains excellent wetting properties with routine laboratory cleaning.
4. **Compact Design:** Lightweight and compact, eliminating the need for additional spray chamber brackets.
5. **No Internal Surface Treatment:** Unlike TFE or PFA, this spray chamber requires no internal surface treatment.
6. **IsoMist Compatibility:** Fully compatible with IsoMist MS temperature-controlled spray chambers.
7. **Cost-Effective:** More affordable compared to other HF spray chamber designs.

P/N 20-809-4801
Tracey DC PEEK
Spray Chamber

GLASS EXPANSION
Quality By Design

Spray Chamber Maintenance: Glass

Suggestions:

- **Do not:** use HF, sonicate, nor use metal or ceramic brushes
- **Daily cleaning:** Start and end analysis by nebulizing mildly acidic blank followed by DI water
- **Initial cleaning:** Nebulize 2.5% Fluka RBS-25 for 15 mins followed by DI water
- **Thorough cleaning:** Overnight soak in 25% Fluka followed by DI water rinse
- Check Helix CT seal and UniFit drain line, replace as needed.

Important note: Our glassware nebulizers, spray chambers, and torches are supplied clean and ready to use.

Soak in 25% Fluka RBS-25

Replace Helix CT seal,
e.g. **P/N 70-803-1456**

Replace UniFit drain line,
e.g. **P/N UFT-16-75**

Torch Optimal Selection & Maintenance

GLASS EXPANSION
Quality By Design

Torch (& Injector)

What are the common challenges encountered when using ICP Torch?

Application Suitability

- HF
- Organics
- High TDS

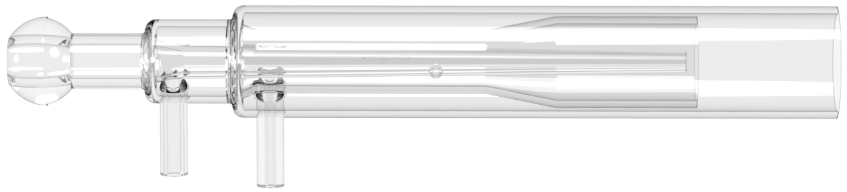
Poor analytical Performance

- **Loss of Sensitivity:** Blocked injector in torch
- Poor Plasma Stability
- **RF coil alignment:** to reduce devitrification

Care & Maintenance

- **Effects of Harsh Matrices:** High TDS; Organics
- Worn or deformed torch
- Devitrification

Torch (& Injector)



ICP Torch Designs:

1. **Single piece quartz torch:**
   General use torch: Lower initial cost structure with no removable parts

2. **Semi-demountable torch:**
   Enables injector interchangeability without torch replacement

3. **D-Torch:**
   Removable: injector, outer tube

4. **Fully demountable torch (FDT):**
   Removable: injector, intermediate tube, outer tube

NEW Semi-Demountable Torch

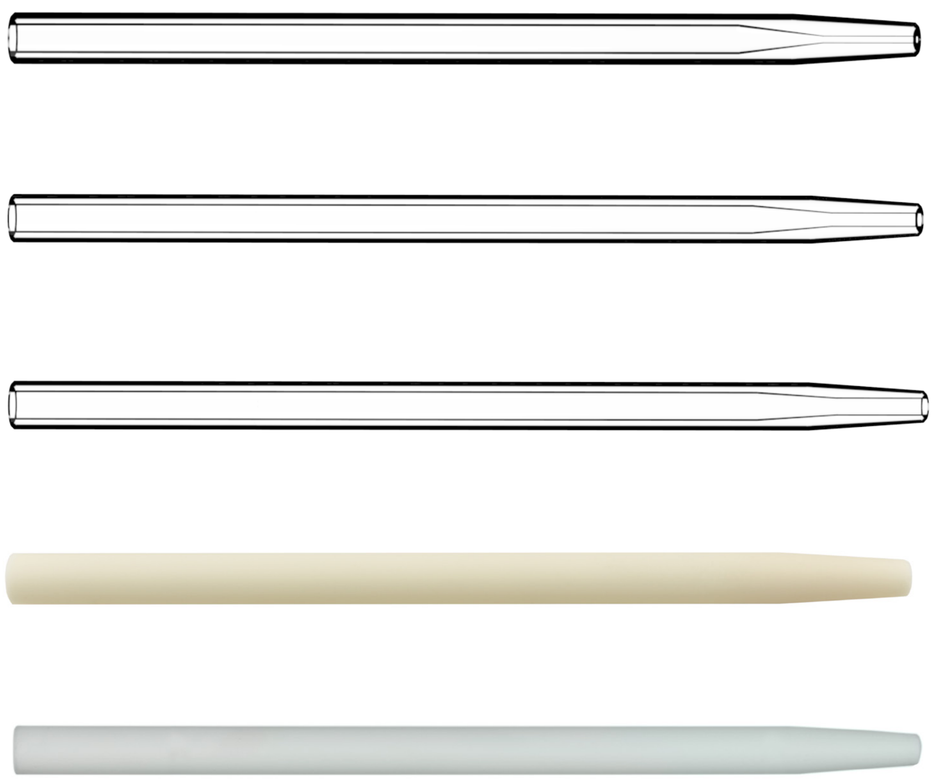
- New semi-demountable torch compatible with Agilent® ICP-MS, P/N 30-808-3853.
- High purity quartz torch body.
- Compatible with interchangeable quartz, alumina or sapphire injectors.

Injector Options:

Part Number	Description
31-808-4172	Tapered Quartz Injector 1.0mm ID
31-808-4173	Tapered Quartz Injector 1.5mm ID
31-808-4168	Tapered Quartz Injector 2.4mm ID
31-808-4169	Tapered Alumina Injector 1.0mm ID
31-808-4170	Tapered Alumina Injector 1.5mm ID
31-808-3855	Tapered Alumina Injector 2.4mm ID
31-808-4159	Sapphire Capillary Injector 2.4mm ID

GLASS EXPANSION
Quality By Design

Multiple Applications with a Single Torch



- Narrow bore quartz, **1.0mm** or less for volatile organics
- **1.5 to 2.0mm** quartz for standard aqueous matrices
- Large bore quartz, **2.0mm** or greater for high TDS
- High grade **alumina for HF** containing samples
- Sapphire for ultra high purity and HF
- *Pt tipped and Sialon injectors are also available for some D-Torch models and by request.*

GE D-Torch– Demountable Torch

The D-Torch is a cost-effective alternative for any laboratory with a moderate workload.

Benefits

- Replace just outer tube (fastest to degrade)
- **Alumina intermediate tube,** which resists wear and is tolerant to high temperatures, high TDS and acid attack
- **Optional ceramic outer tube** which does not devitrify like quartz

* The D-Torch is covered by US Patents 7,847,210 B2 and 8,232,500 B2

Agilent® 5000 Series D-Torch™

D-Torch with Ceramic Outer Tube

Ceramic D-Torch:

- **High Li conc. can degrade the torch's outer tube over time.**
- The demountable option allows for replacing only the outer tube, avoiding the need to replace the entire torch.
- **Injector: Alumina (~1.8 mm)**
- Ceramic outer tubes outlast quartz, reducing maintenance, cleaning, and downtime, especially for high-TDS samples.
- **Provides a higher average signal intensity**

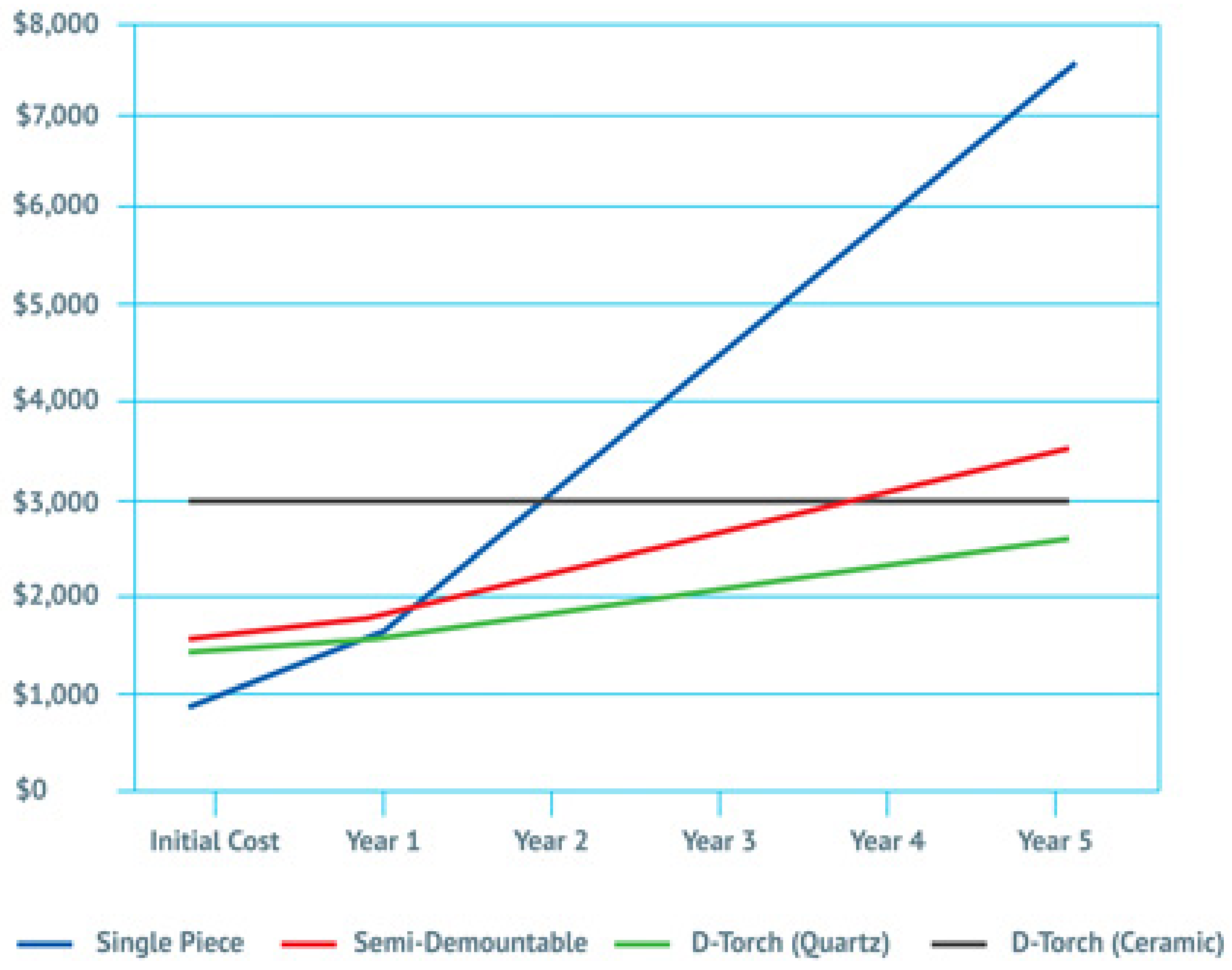
Analyte	Ceramic Outer Tube	Quartz Outer Tube	% Increase
As	173	148	17
Cd	4259	3367	26
Co	1050	855	23
Cr	5490	4435	24
Cu	5258	4558	15
Fe	3408	2767	23
Mn	49529	40237	23
Mo	954	778	23
Ni	721	584	24
Pb	285	226	26
Sb	326	278	17
Se	102	90	13
Ti	185	146	27
V	4677	3815	23

Six hours of running 10 % NaCl

Standard quartz torch body

Ceramic outer tube

Comparitive Torch Ownership Costs

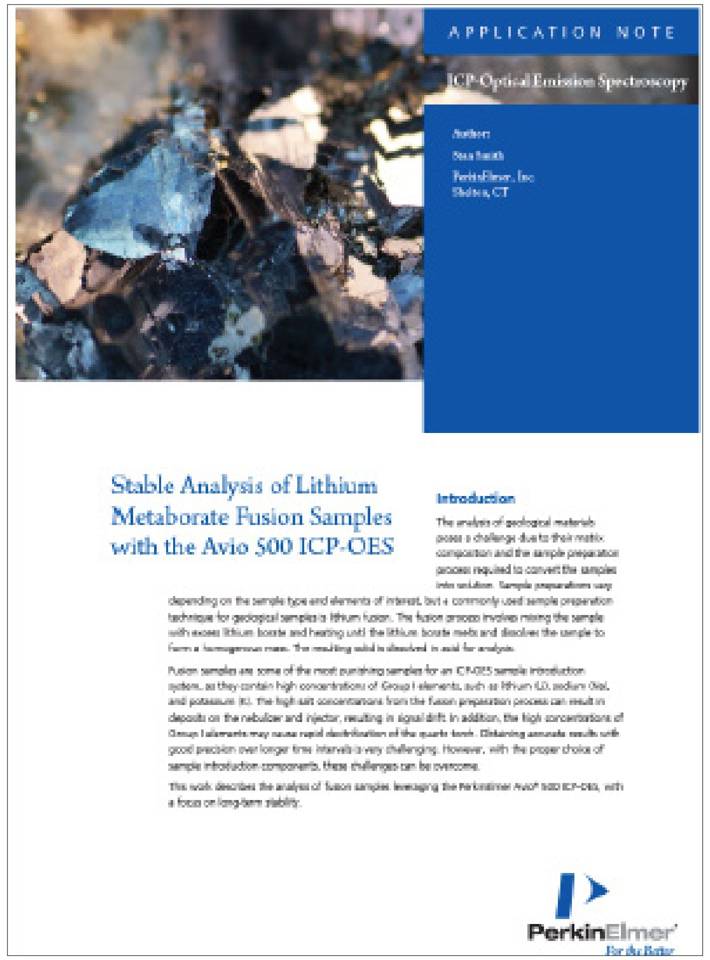


GLASS EXPANSION
Quality By Design

D-Torch Application Notes

Spectroscopy 35 (2) February 2020

Thermo® Application Note 43053



PerkinElmer® Application Note 35847

GLASS EXPANSION
Quality By Design

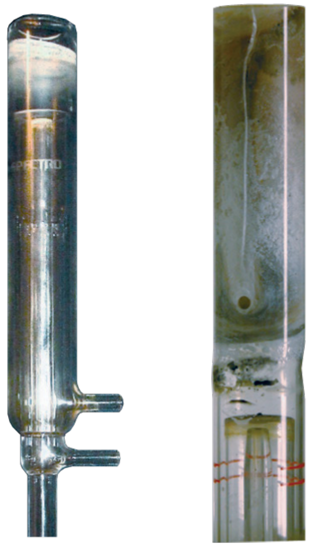
D-Torch Availability

Manufacturer	Model	Ceramic Outer Tube Available
Agilent Technologies ®	5100, 5110, 5800, 5900	✓
Horiba ®	24, 38 & 138 Series, Ultima, Activa	
Nu Instruments™	Nu Plasma	
PerkinElmer ®	AVIO 200, 500	✓
PerkinElmer ®	Optima 8x00 Series	✓
PerkinElmer ®	Optima 4300V, 5300V, 7300V	✓
PerkinElmer ®	NexION 1000, 11000, 2000	
PerkinElmer ®	NexION 300, 350	✓
Spectro™ (Ametek ®)	SpectroBlue™ EOP	
Spectro™ (Ametek ®)	SpectroBlue™ SOP	✓
Spectro™ (Ametek ®)	EOP (Modula, CIROS, Genesis, ARCOS)	✓
Spectro™ (Ametek ®)	SOP (Modula, CIROS, Genesis, ARCOS)	✓
Thermo Scientific™	PRO Duo	✓
Thermo Scientific™	PRO Radial	✓
Thermo Scientific™	6000, 7000 Duo	✓
Thermo Scientific™	6000, 7000 Radial	✓

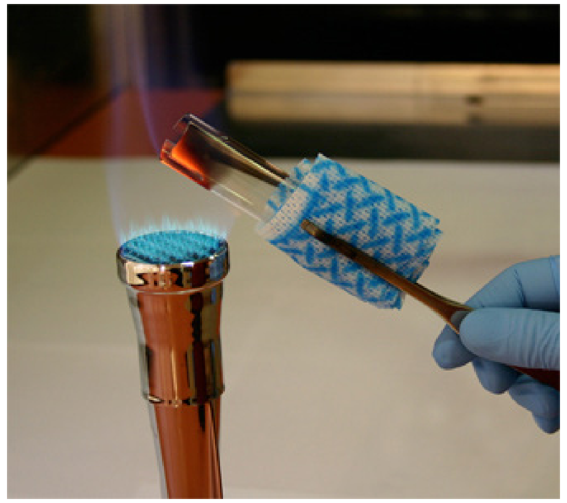
Torch Maintenance

Suggestions:

- Carbon deposits from organic samples can be removed with a portable propane torch.
- **D-Torch outer tube cannot be heated in a muffle furnace since it has a polymer ferrule attached to it.**
- **Salt deposits are best removed by soaking the torch in a 25% Fluka or in dilute acid.**
- Stand the tube upright in a beaker and use sufficient cleaning solution to cover the salt deposits.
- Metallic films are best removed by soaking the tube in acid (usually the one from sample prep).

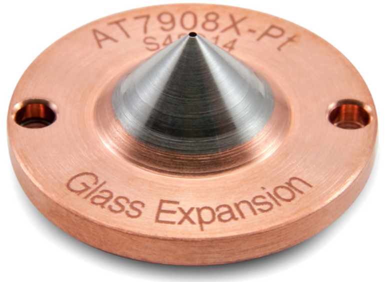


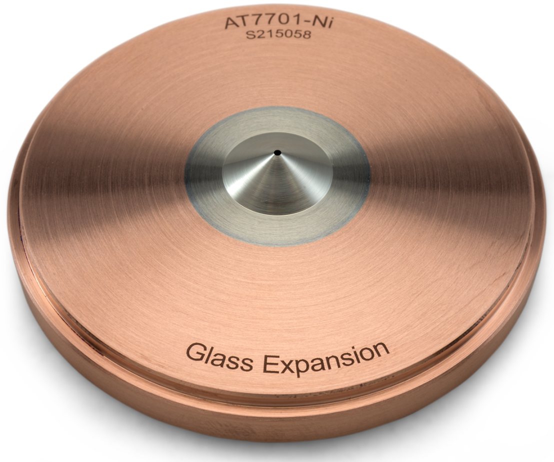
High TDS



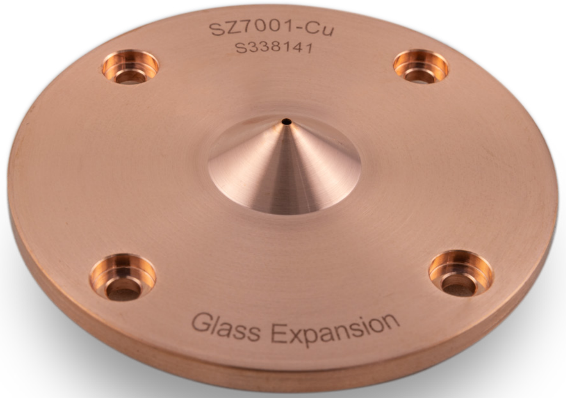
We recommend that the polymer ferrule is not soaked in acid.

Organics





Cones Optimal Selection and Maintenance



GLASS EXPANSION
Quality By Design

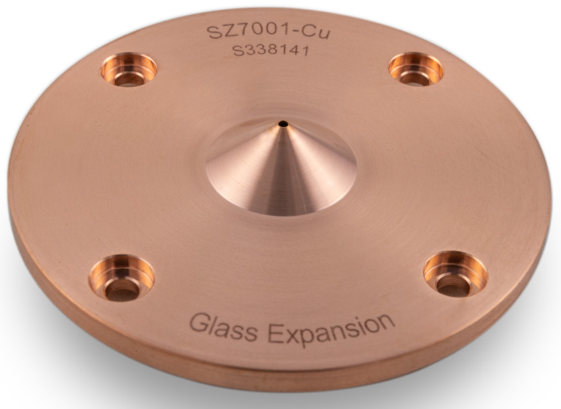
Cone Resource Guide

- **Guidance on cone selection**
  - Advantages of different cone raw materials
  - Selection based on matrix and performance
- **Tips on Care and Maintenance**
- **Organized by ICP-MS Model**
  - Cross-reference OEM product numbers
  - ***Click here to view the Cone Resource Guide***

General Guidelines on Cone Material

Copper:

- Often the **lowest-cost option**
- Most-susceptible to matrix effects, corrosion, and sample deposition
- Most-efficient heat transfer – this means it **“runs colder”**
- Often need more **frequent cleaning**



Nickel:

- Often the **“standard”** option
- Good thermal and chemical resistance–more than Cu but less than Pt
- Moderate heat transfer: runs ”hotter” than Cu but “colder” than Pt.

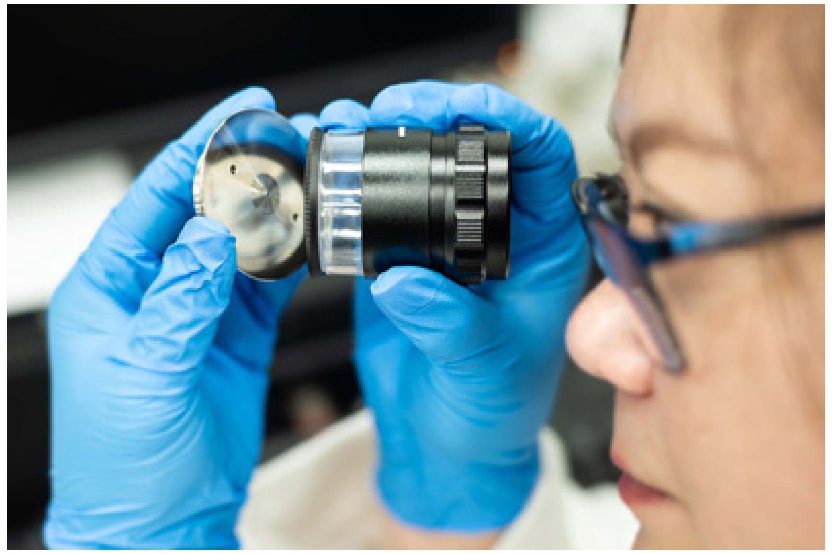
Platinum:

- Typically the most durable and longest-lasting option
- Excellent chemical resistance: **Suitable for aggressive acids or high-matrix samples**
- Least-efficient heat transfer– this means it “runs hotter” than both Cu and Ni
- **Can be refurbished**

When to Clean Cones

Suggestions:

- Physical observation of cone condition using **Magnifier Inspection Tool** (P/N 70-803-1923) or indicated by the data and results
- Sampler cone is more exposed to the plasma: more frequent cleaning
- *Always end the day by aspirating an acidified rinse solutions followed by UPW*



Experimental indicators of cone cleaning:

- Increased background
- Memory effects
- Decreased sensitivity
- Change in vacuum

Observational indicators for cone cleaning:

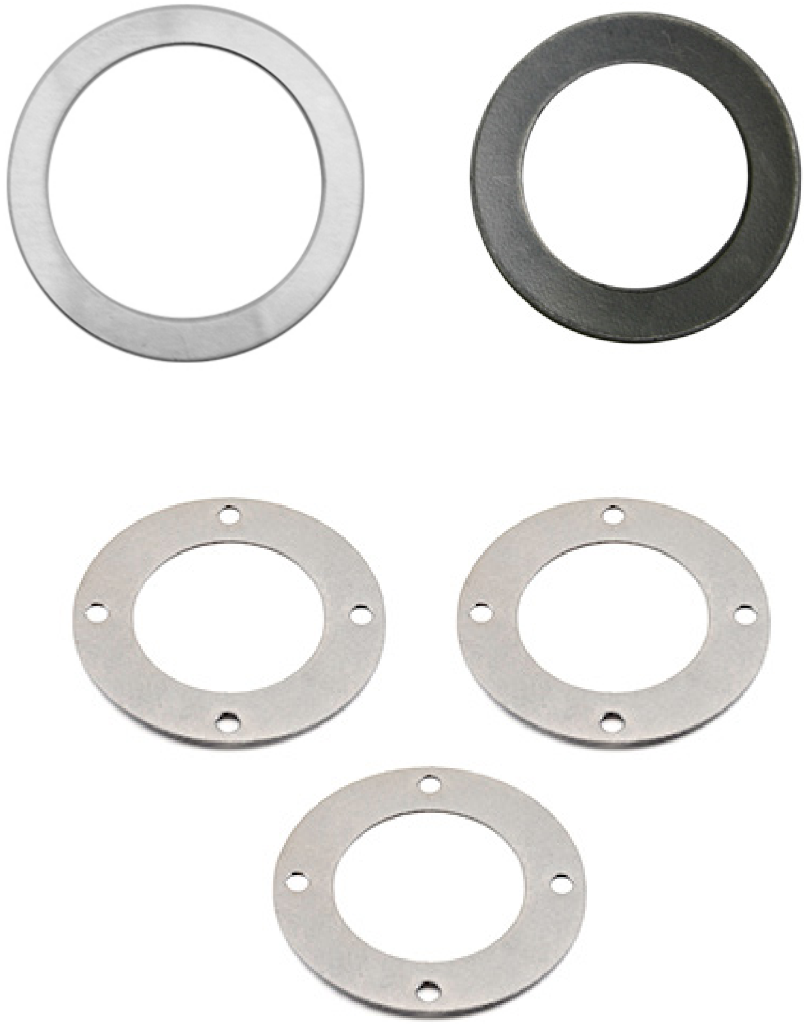
- Visible deposits near or in the orifice
- Distorted Orifice

Magnifier Inspection Tool P/N 70-803-1923

Cones Re-Installation

Suggestions:

Always check gaskets or O-rings before installing cones



Cone Conditioning:

- To ensure the lowest background levels of Cu and Ni, conditioning before use is recommended for **uniform coating that leads to improved long-term stability.**
- To condition your cones, prepare the following conditioning solutions:
  - 1% nitric acid blank
  - 50ppm calcium in 1% nitric acid
- Install the new cones or cleaned cones into the instrument. Turn on the plasma.
  - **Aspirate the 50ppm calcium solution for 10 minutes**
  - **Change to 1% Nitric acid blank solution and aspirate for a further 10 minutes**

Thank You

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