GLASS EXPANSION
Quality By Design

Key ICP Sample Introduction Components: Selection & Optimization

Presenter:

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Introduction: About Glass Expansion

- GE have been specializing in sample introduction components for ICPs since 1983
- Global recognition for manufacturing precision and reliability
- Approximately 100 staff
- Sales Offices Worldwide: Australia, USA and **Germany**
- **Official Distributor for Benelux: Instrument Solutions Benelux BV**

Glass Expansion - Europe
Weilburg, Germany

Glass Expansion - Americas
Cape Cod, Massachusetts

Glass Expansion – Asia-Pacific
Melbourne, Australia

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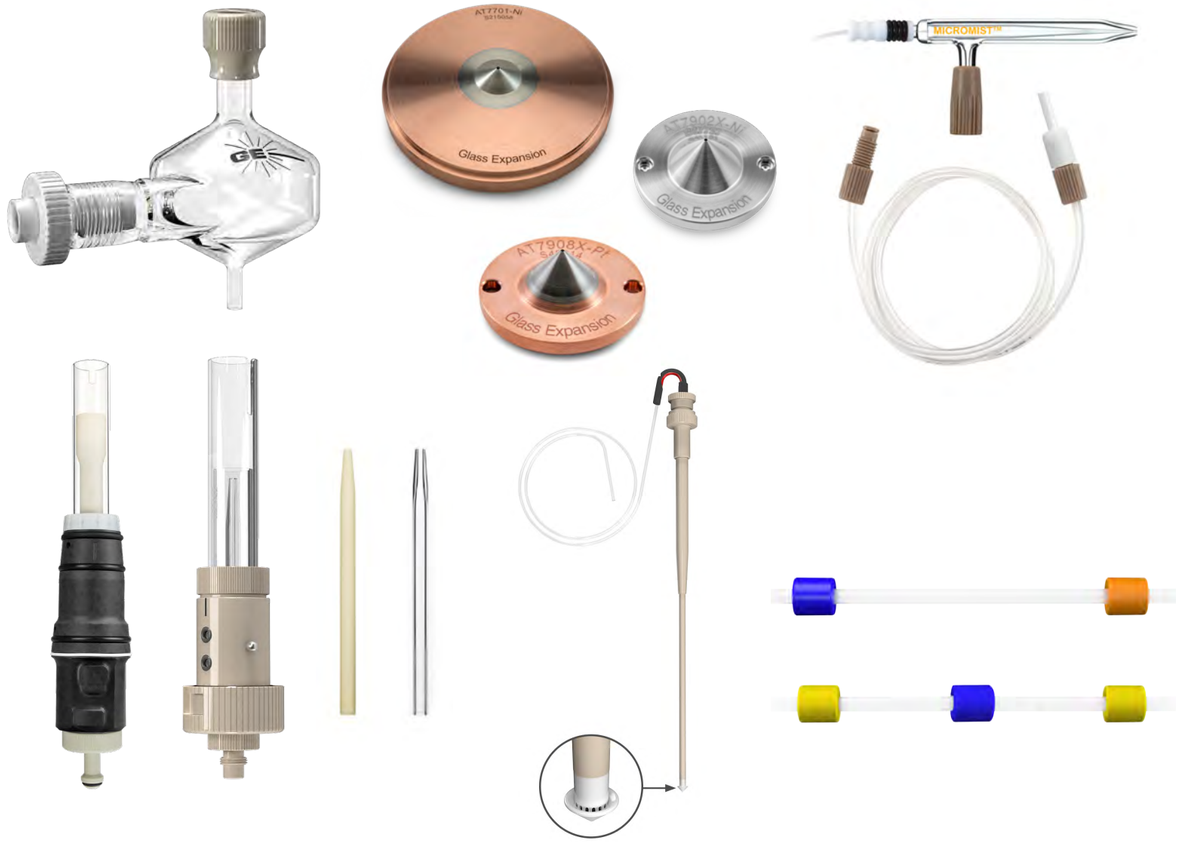
De Liesbosch 50, 3439 LC Nieuwegein, Netherlands

Product Lineup

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



Manufacturers Supported: Thermo®, Agilent®, PerkinElmer®, Shimadzu®, Spectro® , Analytik Jena®, Horiba®, Nu Instruments®, Others

How is Glass Expansion Different?

Our products are designed by our experienced R&D team:

- Invest ~10% p.a. in R&D
- **Specialized equipment for Manufacturing:** Particle analyzers, Electron beam welders, Multiple CNC Machines, 3D Printing & Laser Technology

We provide our customers with full technical support:

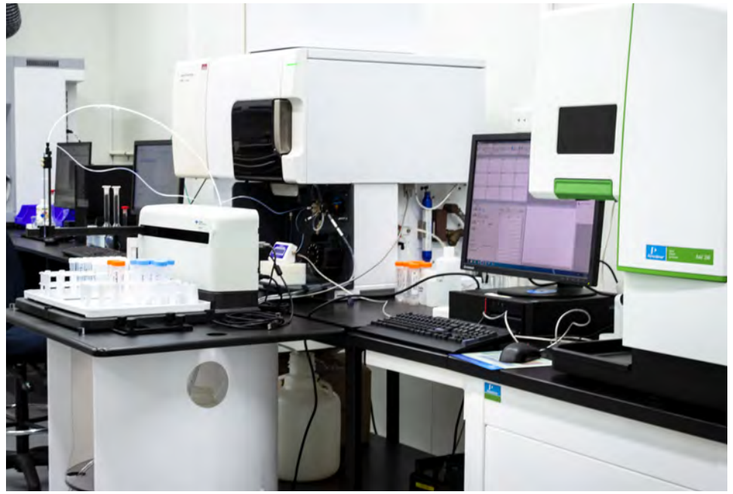
- Diverse industry/research partnerships
- **Extensivley equipped laboratory** with 6 in-house ICPs

Quality Control:

- Control the entire manufacturing process, from raw material to final product
- Manufactured to exacting specifications: **Guaranteed to meet/exceed OEM specifications**

Glass Expansion Warranty:

- All products are supplied with a **CUSTOMER SATISFACTION GUARANTEE**



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

Sample Delivery System

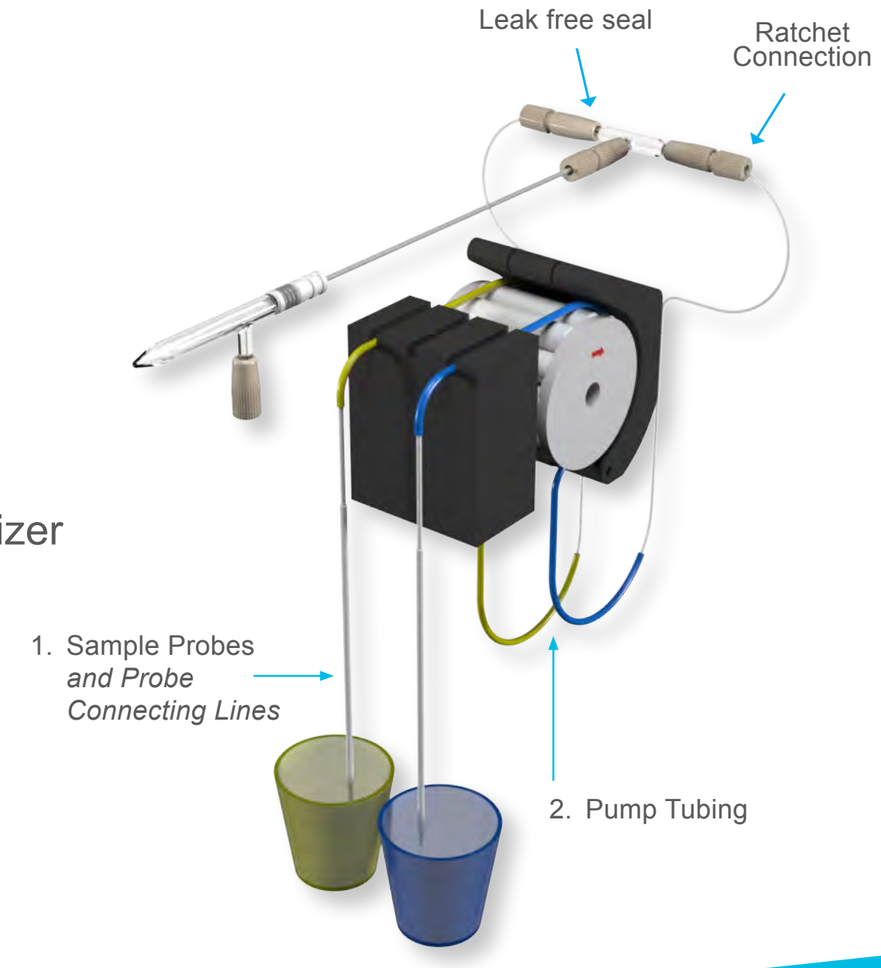
- **Sample Probe**
- **Peristaltic Pump Tubing**
- ***Teflon connecting tubing***
- ***Internal Standard Addition Kit***

Key Functions:

- Consistent and accurate transport of the sample from its container to the nebulizer
- Allows for precise control over sample volume for reproducible measurements

Common Challenges:

1. Ineffective Sample Digestion: Precipitates and undigested particles
2. Clogging and Blockages
3. Cross-Contamination
4. Sample Flow Issues: Variation in sample flow rate results in an unstable signal (poor RSDs)



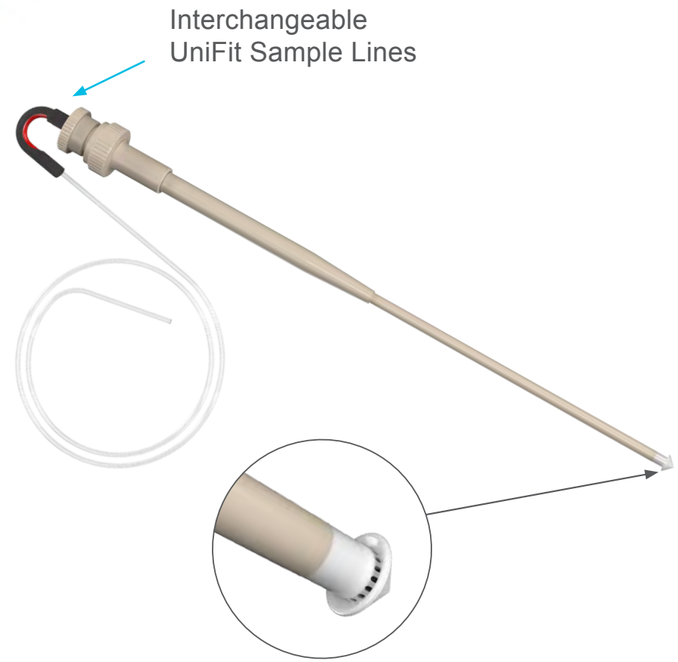
Sample Probe: Selection

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
- **Combines drip-resistance and built in filter** to minimize cross-contamination, while protecting the nebulizer and capillary tubing
- **Interchangeable UniFit™ sample lines** IDs: 0.3, 0.50, 0.75 and 1.0mm
- **Autosamplers:** Teledyne Cetac, Perkin Elmer® S20, Shimadzu®, Aim and Agilent® SPS3/SPS4 autosamplers



Guardian™ Autosampler Probe

Drip-resistance prevents cross contamination of samples, especially with oils:

Customer Testimonials:

- Remarkable performance in environmental laboratories worldwide
- Unclogged operation even with particulate-containing samples
- **Significantly reduces nebulizer blockage** and downtime
- Enhances analytical efficiency

Peristaltic Pump Tubing: Selection

The pump speed together with diameter of the tubing, with cross-sectional area (mm2), determines the flow speed (mm/min), ultimately influencing the flow rate in mL/min.

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

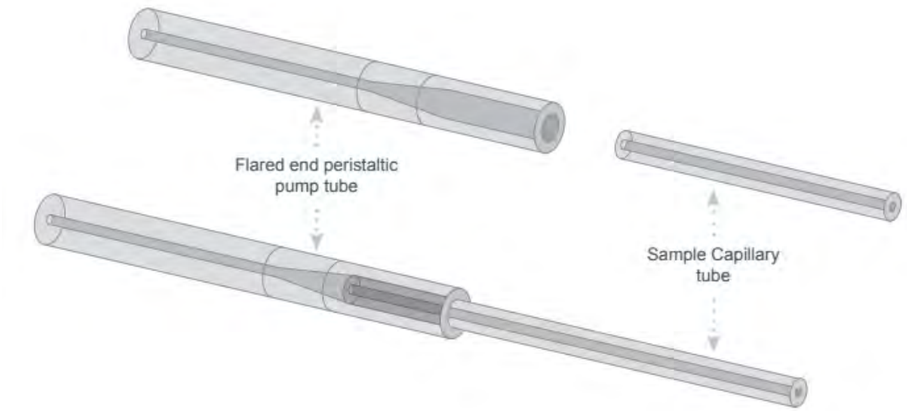
Flared vs. Non-Flared Options:

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

Sample Pump Tubing Selection

Tubing materials vary based on sample properties

Common materials include:

- **PVC Standard** (Tygon ST): Economical and suitable for most routine aqueous samples
- **Solva** (Tygon HC or Solvaflex): Special tubing for hydrocarbons, petroleum products and distillates
- **Tygon MH:** High-purity PVC; no additives or plasticizer; highly solvent-resistant (MIBK)
- **Viton** (Fluran): Fluropolymerelastomer; special tubing for concentrated acids and corrosive solvents

Sample Matrix	Material	Colour	Not recommended
Aqueous	PVC/Tygon	Transparent	DMF, DMSO, Xylene
Premisolve, Oil, Xylene	Solva	Yellow	DMSO
DMF, DMSO	Viton	Black	

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

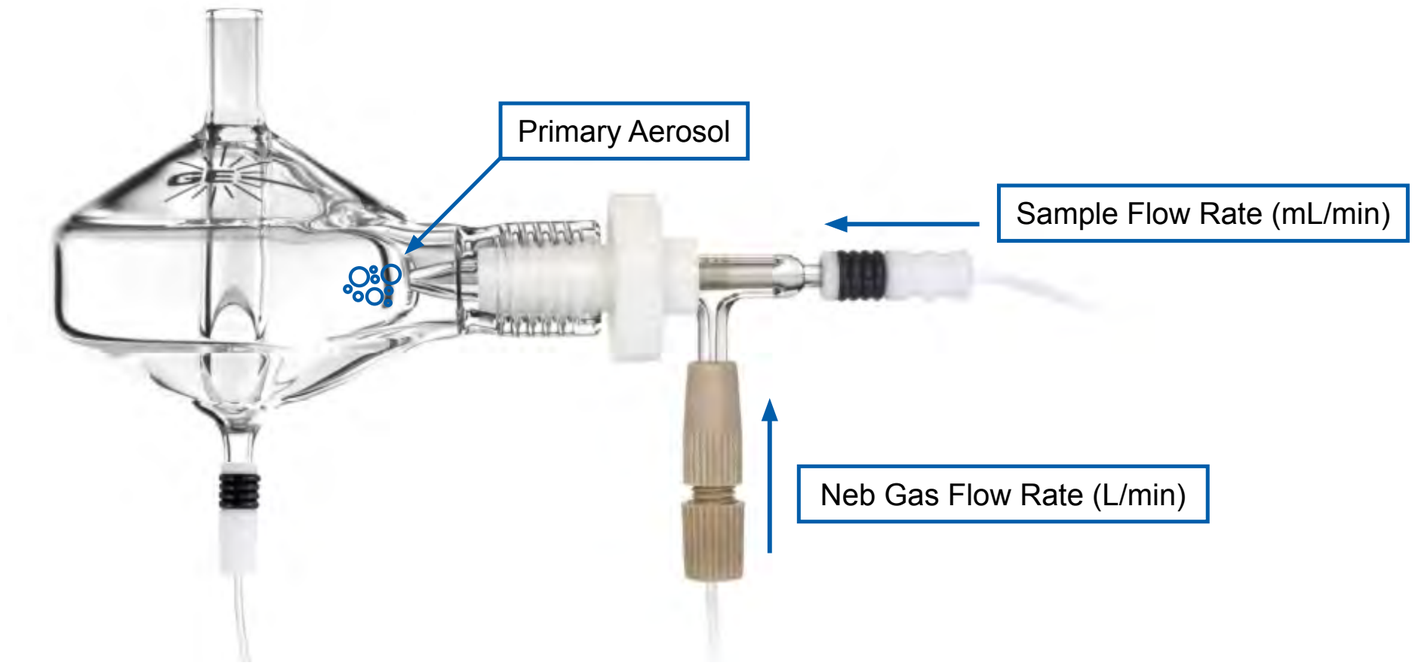
Blockages

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

Sample Cross- Contamination

- Poor connections
- Dead volume
- Affecting analysis accuracy

Nebulizers: Primary Aerosol Generation



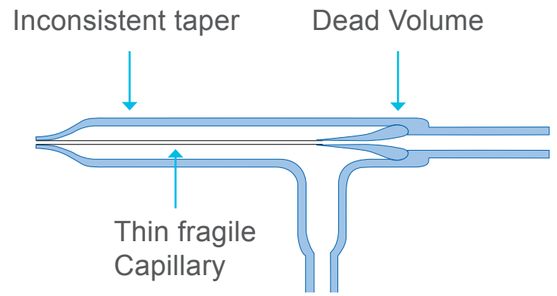
Primary aerosol is produced by the nebulizer

- Droplet size decreases as argon gas velocity increases and sample liquid flow rate decreases
- For optimal performance, **aim for a higher concentration of droplets with a diameter of <10µm**

Quality of Aerosol ∝ Quality of Results

Concentric Nebulizers: Design Considerations

Other Nebulizer Design:



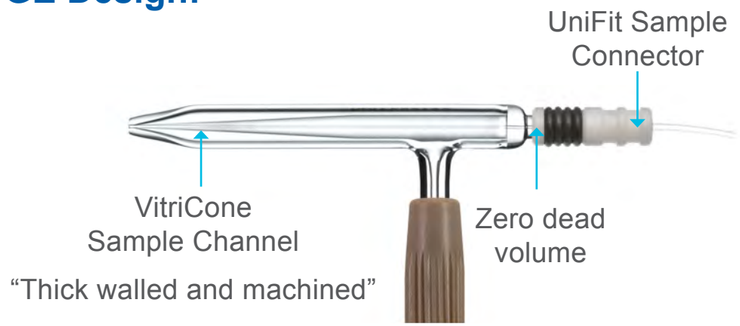
Design Challenges:

All ICP Nebulizers are not created equal: they vary in quality, performance and consistency.

Drawn-out capillary tubing design leads to:

- Narrowing, promoting salt buildup
- Fragility and vibration under high-speed argon flow, reducing precision
- Inconsistent taper affects seal and depth in the spray chamber
- Difficulty in achieving consistent performance across nebulizers

GE Design:



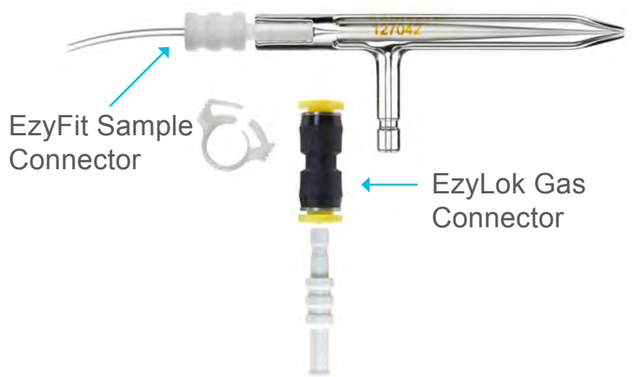
GE DC Nebulizer Benefits:

- **VitriCone™ Technology:** Precision-machined heavy glass capillary ensures reliability
- **Clog-Resistant:** Uniform sample channel prevents particulate buildup
- **Stable & Reliable:** Rugged design minimizes vibration for improved precision

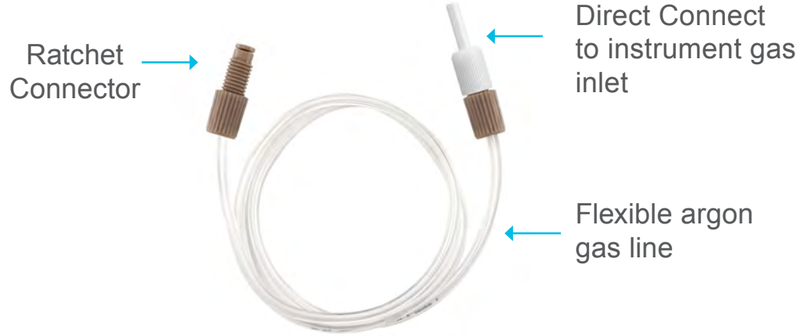
Design Considerations: Nebulizer Sample and Gas Connector

Optimal connection solutions support achieving accurate and reproducible results:

GE Old Design:



Industry standard DC Nebulizer design



UniFit sample line connector:

- UniFit connector slides easily over the sample arm and creates an excellent seal
- Minimizes Dead Volume: Faster washout compared to EzyFit

Inert metal-free argon connector:

- To prevent contamination and false positives (vs. EzyLok)

Instrument-specific Direct Connect flexible argon line:

- Unlike hard tubing, which can restrict gas flow, the DC design ensures efficient, consistent gas flow
- **Reliable ratchet fitting:** Ensures leak-free gas connection

Nebulizer Sample and Gas Connector Design

DC Nebulizer Selection (I)

Concentric nebulizers are widely used for their efficiency, stability, ruggedness, and natural aspiration

MicroMist™

The industry standard for ICP-MS

Highest transport efficiency

Small droplet size

Limited sample volumes

SeaSpray™

High Performance and Tolerance

Optimal for samples with high TDS (seawater, brines, plating baths)

Unique Self-washing tip

Conikal™

Standard option for ICP-OES

Ideal for samples with only moderate concentrations of TDS, no particulates, and no HF

DC Nebulizer Selection (II)

DuraMist™

Ideal for HF and High TDS Samples

Inert nebulization for precise and high sensitivity analysis

OpalMist™

High Purity ideal for ICP-MS

Low background levels, ideal for high-precision and ultra-trace analyses

VeeSpray™

Robust Ideal for High Matrix and Particulates

V-groove design

Analyses that require the greatest resistance to large particulates

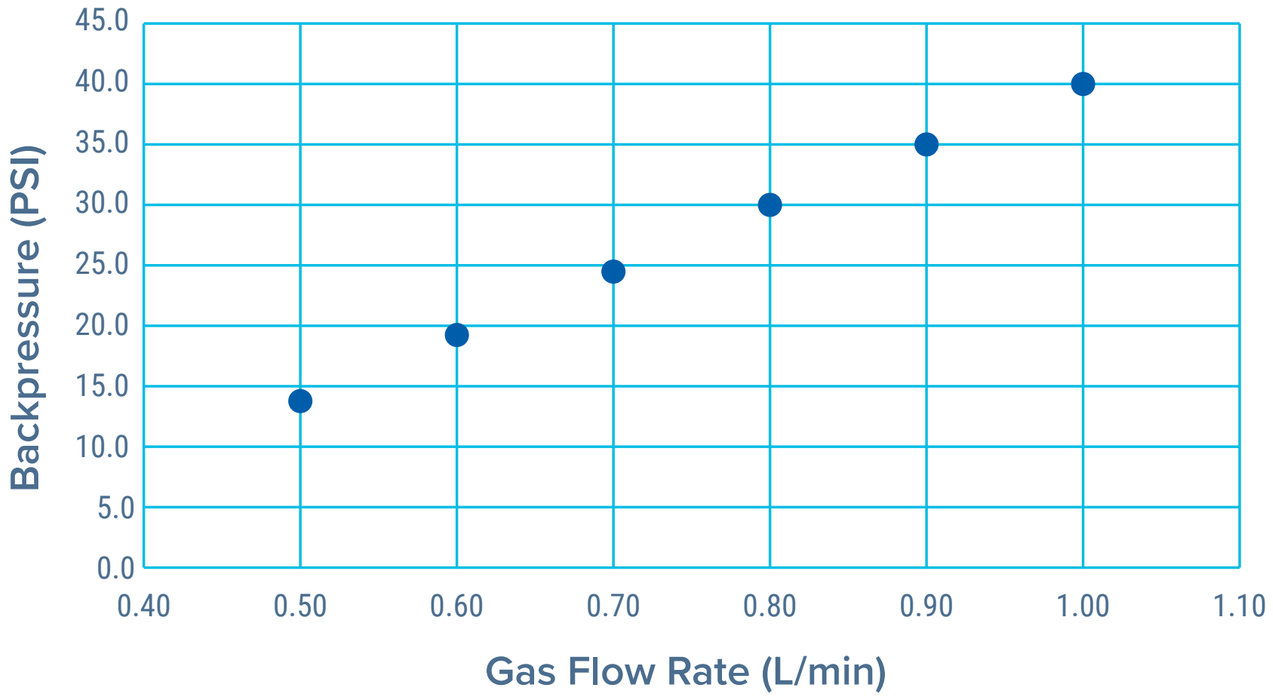
DC Nebulizer Selection (III)

Selecting the right nebulizer requires careful consideration of various factors:

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
Quartz SeaSpray™		20	75	No	High	Excellent	Quartz
OpalMist™		15	75*	Yes	High	Excellent	PFA
DuraMist™		30	75*	Yes	High	Good	PEEK
VeeSpray™		30	300	Yes	Moderate	Good	Ceramic

DC Nebulizer Selection (IV)

Backpressure (PSI) Gas Flow Rate (L/min)



Important Nebulizer Operating Parameters

Example: GE P/N A13-1-UM04

- Optimum nebulizer gas flow = 1.0 L/min (40 psi)
- Sample uptake rate ≤ 0.4 mL/min

Spray Chambers: Introduction

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

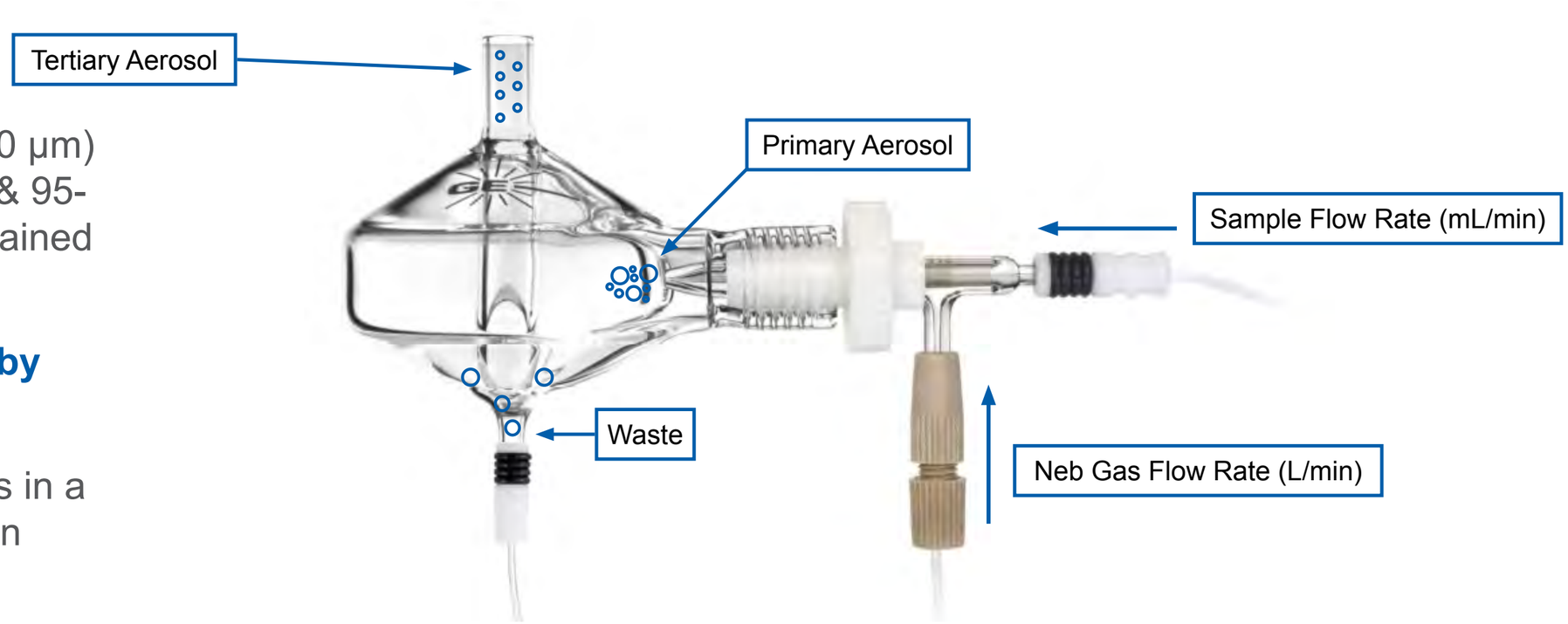
- Poor Precision
- Dead volume
- Compromised analytical results

Profound Effect on: Transport Efficiency, Precision, and Washout

Spray Chambers: Tertiary Aerosol Generation

Only the smallest droplets (<10 µm) are transmitted to the plasma & 95-98% of nebulized sample is drained as waste

- **Tertiary Aerosol "filtered" by Spray Chamber, <10 µm**
- Less energy required, results in a more robust plasma condition

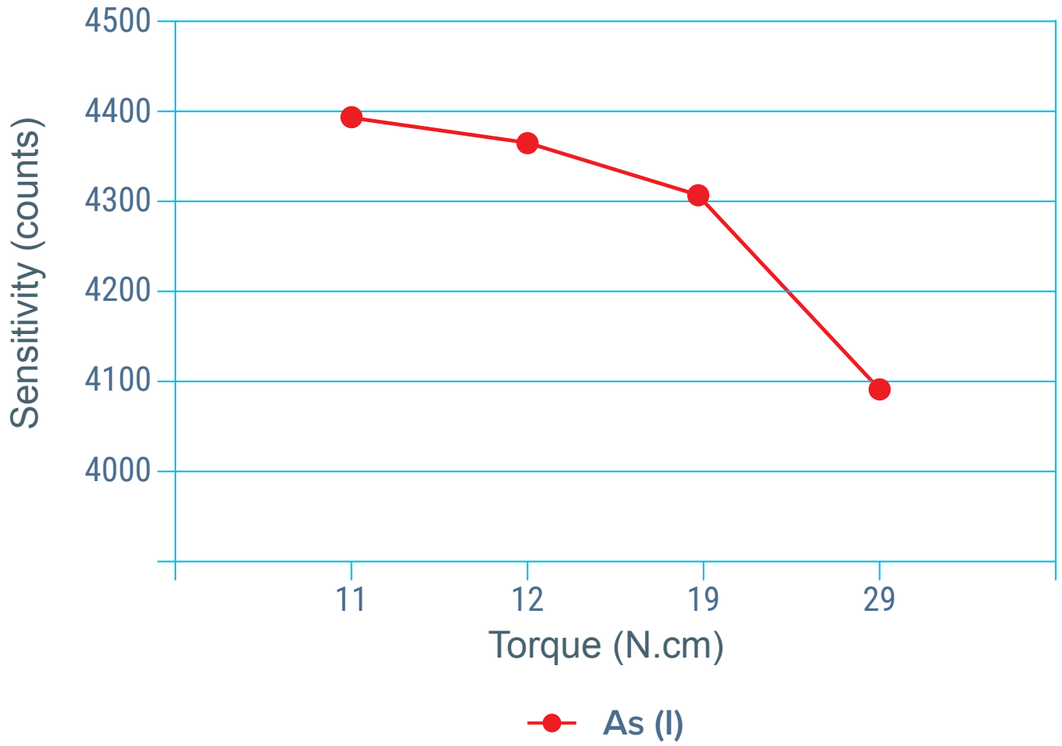


Smaller Droplets Require Less Energy = Efficient Ionization

Spray Chambers: Helix CT Interface (I)

Helix CT: Constant Torque = Reproducible day-to-day ICP Performance

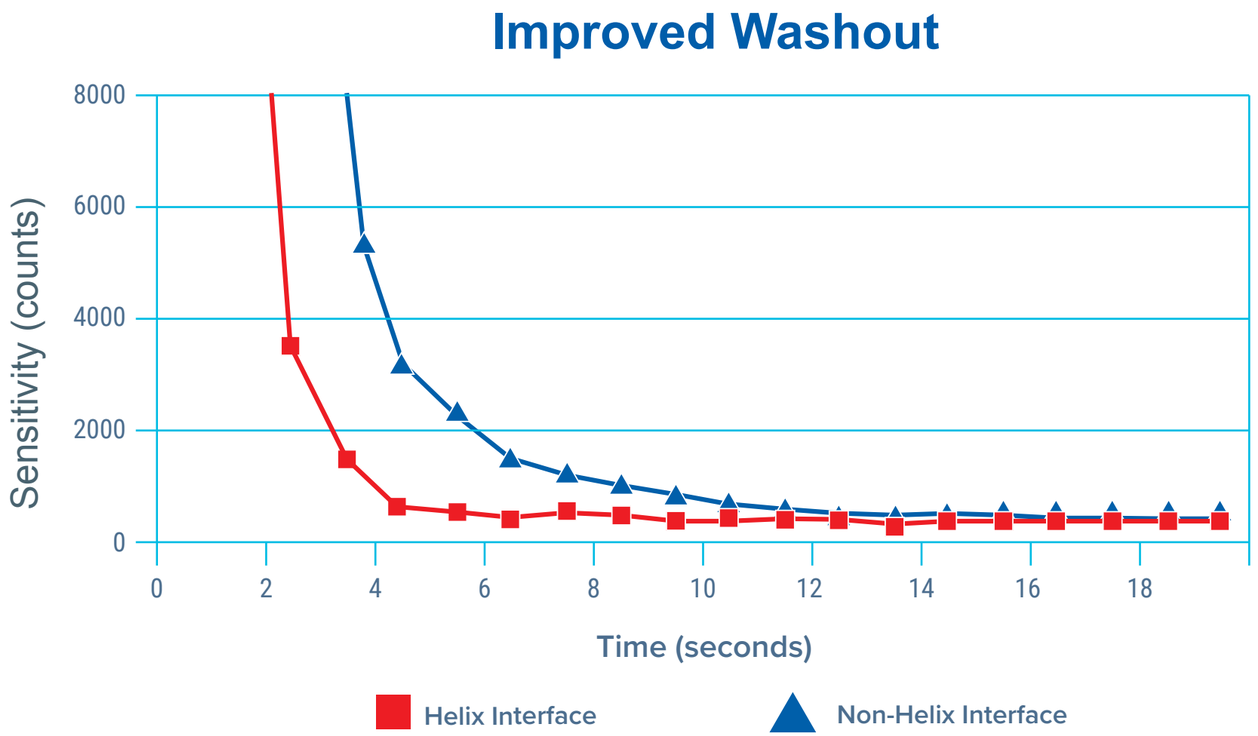
Optimum Sensitivity



- Helix locking screw with CT technology allows for a consistent inert PTFE seal against the nebulizer - making it impossible to overtighten while ensuring a gas-tight seal every time

Built-in torque control mechanism

Spray Chambers: Helix CT Interface (II)



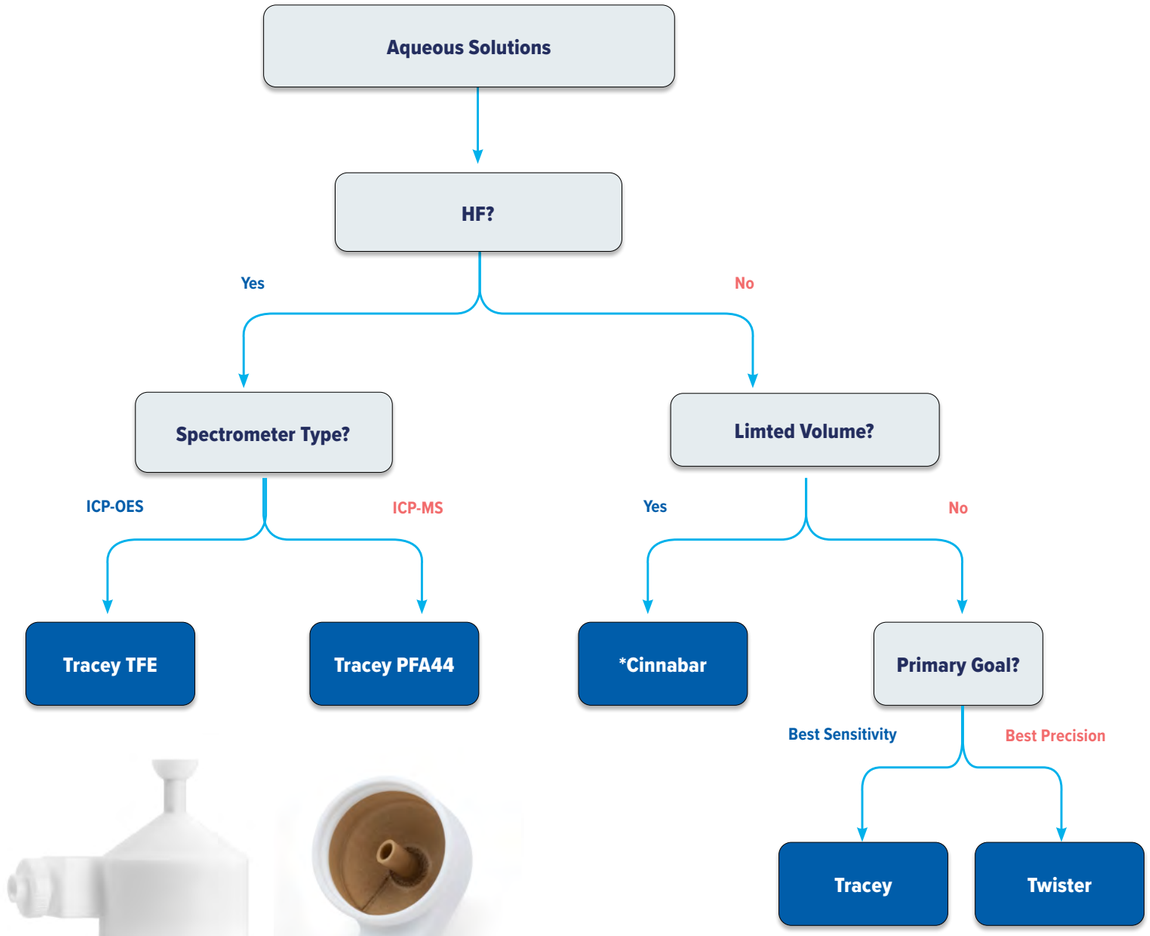
Drawbacks of an O-ring Seal:

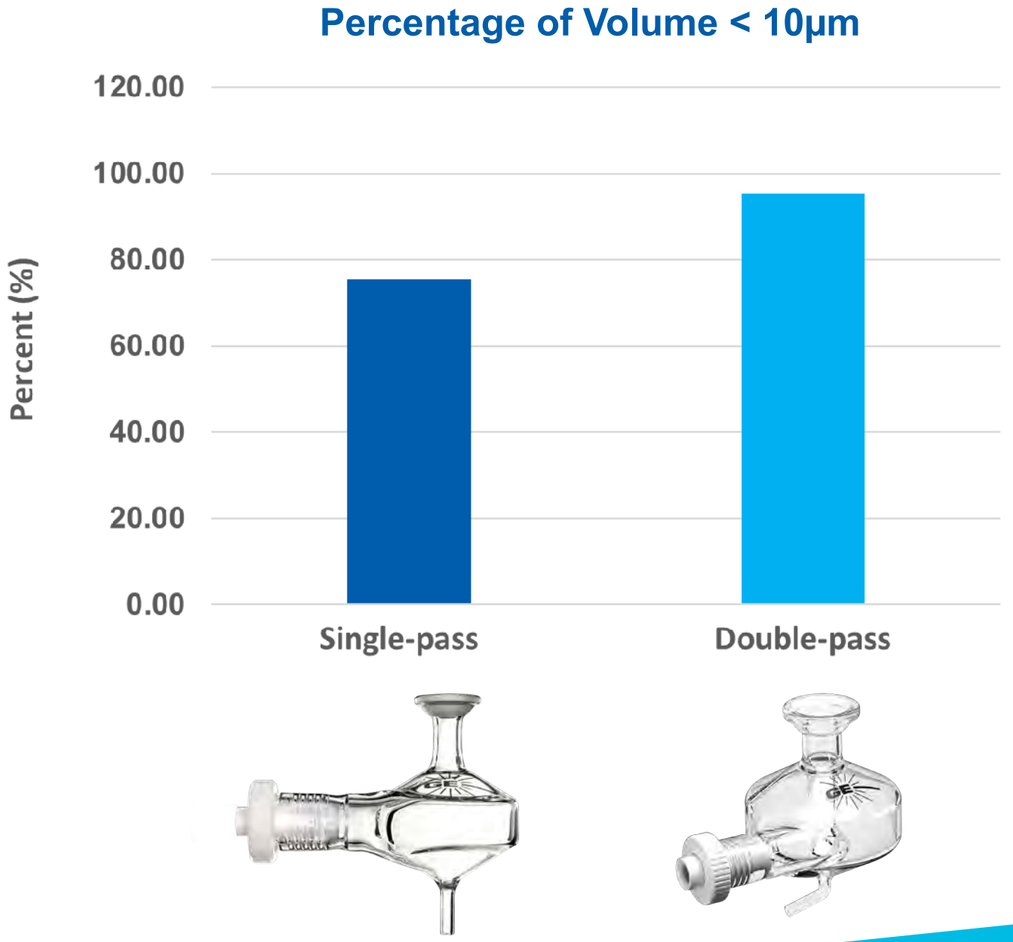
- **Contamination:** Dead volume around the O-ring can trap contaminants
- **Chemical Resistance Limitations:** O-rings may degrade with strong acids or organic solvents
- **Difficult Maintenance & Fragility**

Non-Helix Interface

Spray Chambers: Selection

Profound Effect on: Transport Efficiency, Precision and Washout





Latest Design: Direct Connect (DC) Spray Chambers

Features & Benefits:

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

P/N 20-809-4880

P/N 31-808-4253
DC Injector Adaptor
for Avio ICP-OES

DC PEEK Spray Chamber

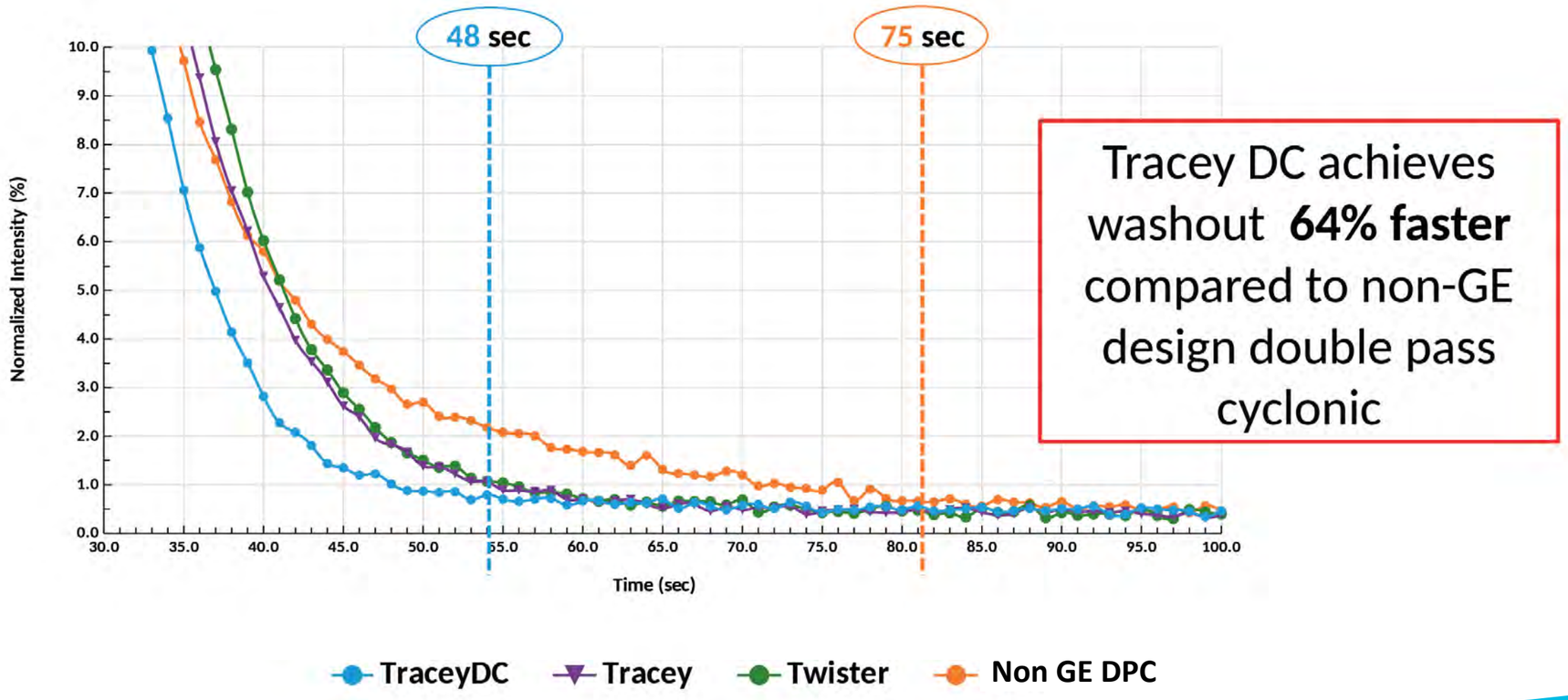
Benefits of Tracey DC PEEK Spray Chamber:

- HF resistance up to 5%
- **Excellent wetting characteristics** of PEEK ensure the wetting properties are retained with general maintenance
- Spray chamber **doesn't require internal surface treatment** compared to TFE or PFA spray chambers
- Lower cost structure vs other HF spray chambers
- No metal clamp required

P/N 20-809-4801

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

Temperature Controlled Spray Chambers

Limitations of Room Temperature Spray Chambers

1. Sensitivity drift as temperature changes
2. Excessive plasma loading (volatile organics)
3. Excessive oxide formation (ICP-MS)
4. Insufficient control of analyte transport

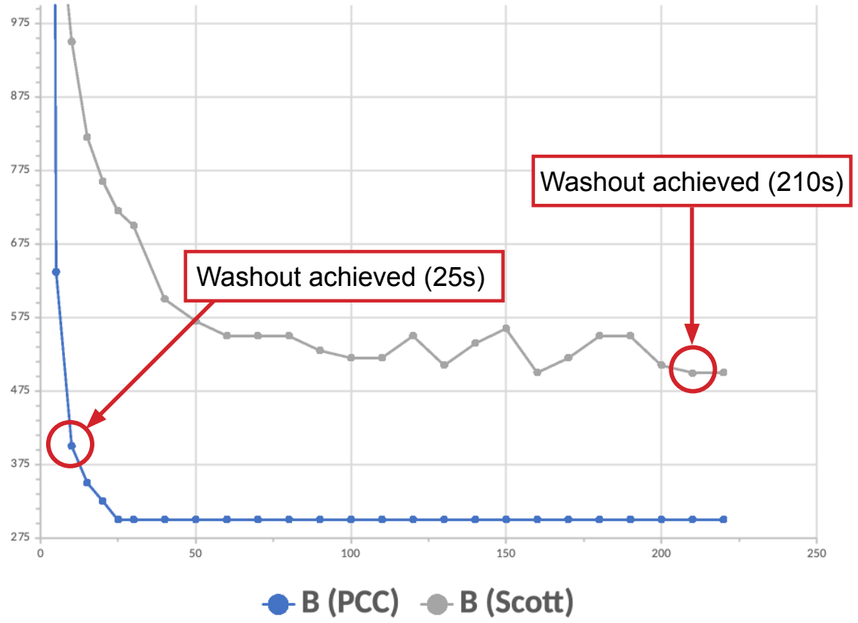
Option 1. IsoMist MS™:
Currently Agilent® 7850/7900/8900

Option 2. PCC™:
Agilent® ICP-MS

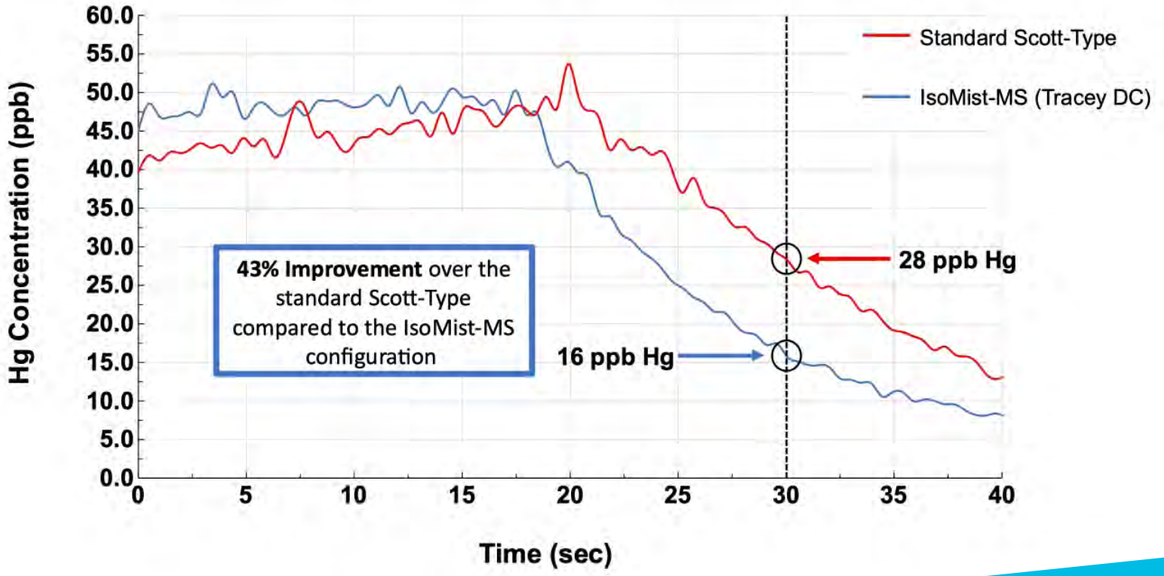
Option 3. IsoMist XR™:
All ICP-OES/MS

ICP-MS Spray Chambers: Washout Comparison

Washout Performance (200 ppb Boron)



Washout Performance (50 ppb Hg)



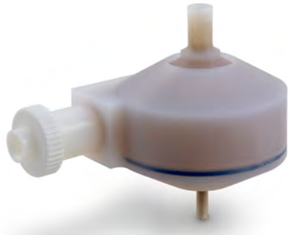
The PCC™ Spray Chamber

Benefits:

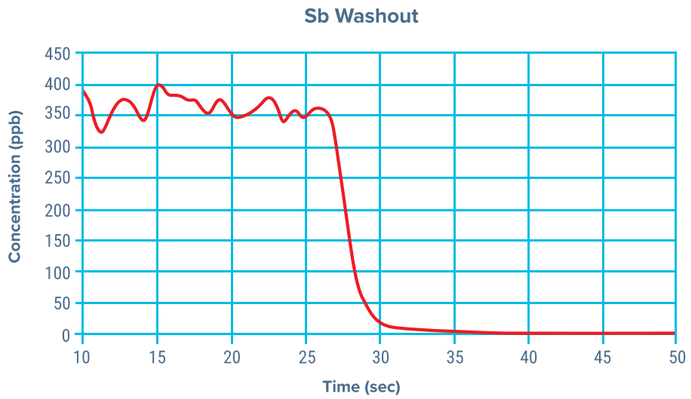
- Minimizes washout time with highly concentrated samples and troublesome elements, such as B, Hg, Pb and Sb compared to the Scott-style spray chamber
- Interfaces directly to the existing electronics and water-cooling system of Agilent ICP-MS
- Compatible with Agilent HMI and UHMI
- Compatible with Agilent ISIS-3

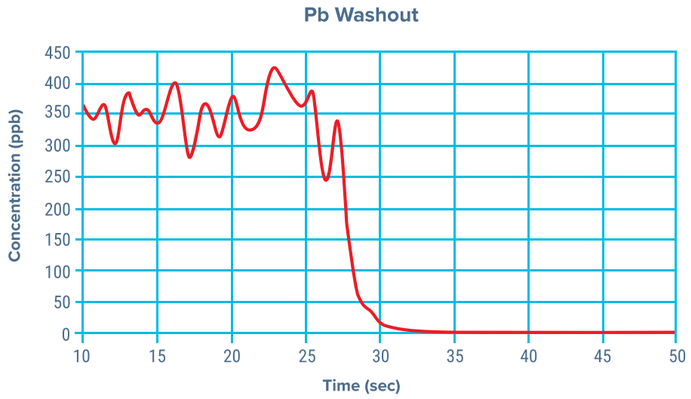
Glass Tracey™ with Helix CT

Quartz Tracey™ with Helix CT



PFA Tracey™ with Helix CT

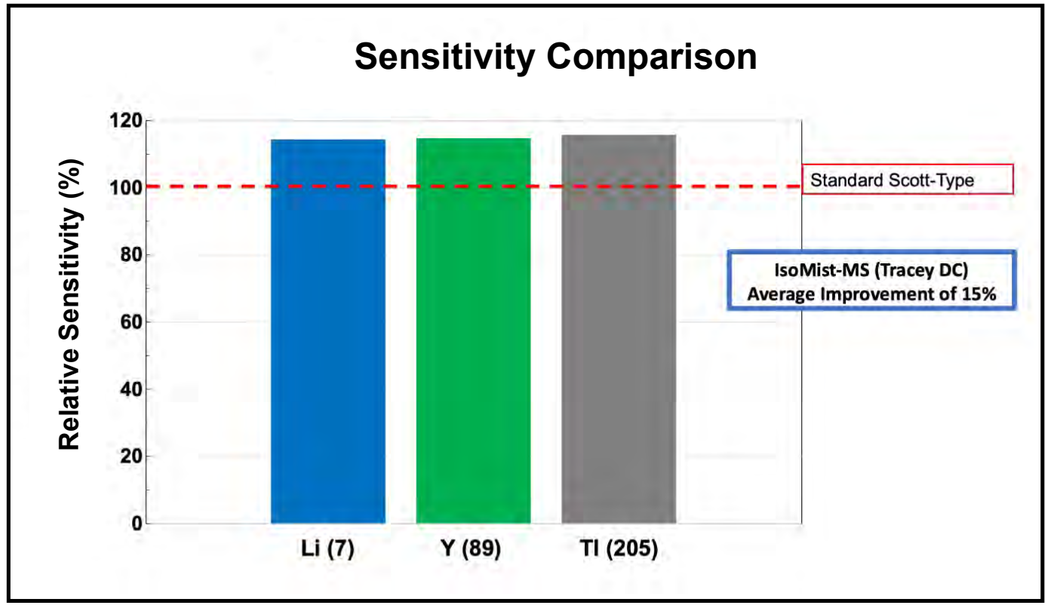


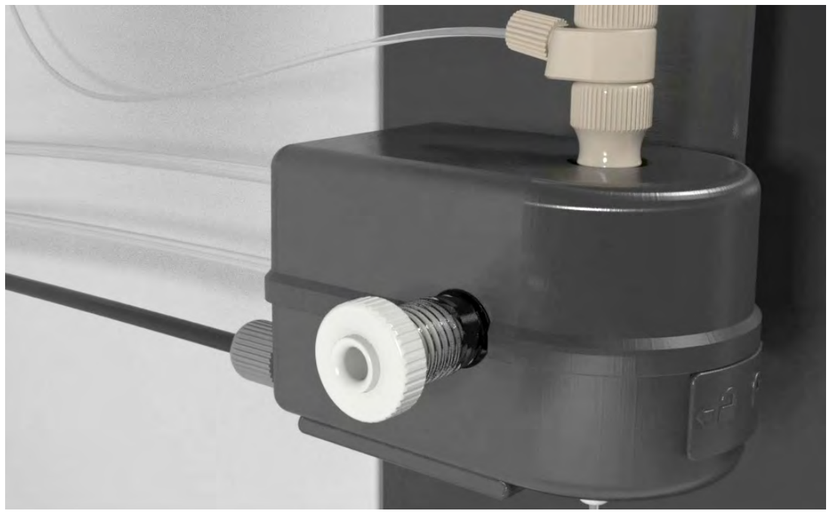


The IsoMist MS™ Spray Chamber

Benefits:

- Next Generation IsoMist-Compact
- **DC (Direct Connection) Spray chamber (Glass, PEEK)**
- Low volume (30mL) cyclonic spray chamber for faster washout
- Improved transport efficiency with reduced sample path length
- Compatible with UHMI or HMI conditions





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Thank You

GLASS EXPANSION
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A Practical Guide to ICP Ionization & Interface Components

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Torch (& Injector)

What are the common challenges encountered when using ICP Torch?

Application Suitability

- HF
- Organics
- High TDS

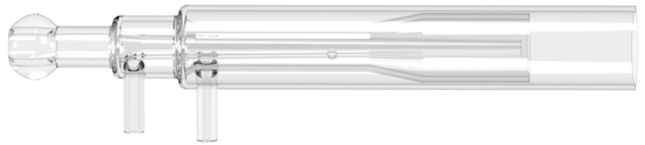
Poor analytical Performance

- **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:

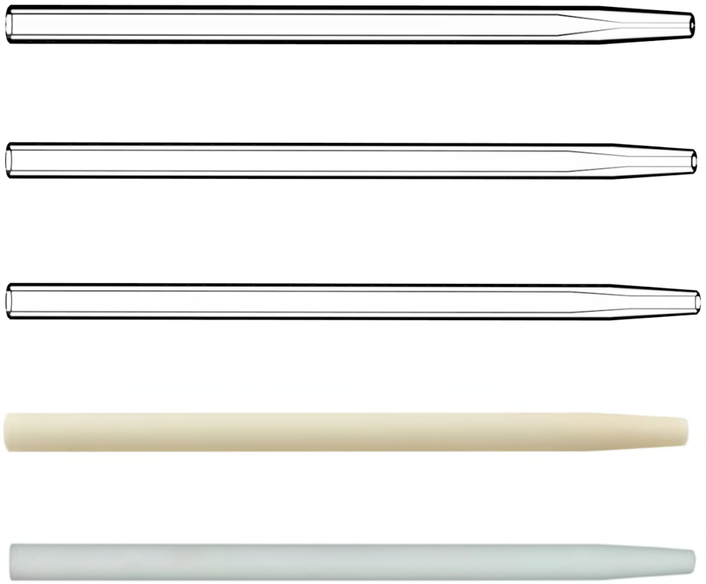
1. **Single piece quartz torch:**
- General use torch: Lower initial cost structure with no removable parts

2. **Semi-demountable torch:**
- Enables injector interchangeability without torch replacement
- Removable torch body (intermediate tube and outer tube one-piece)

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

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

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*

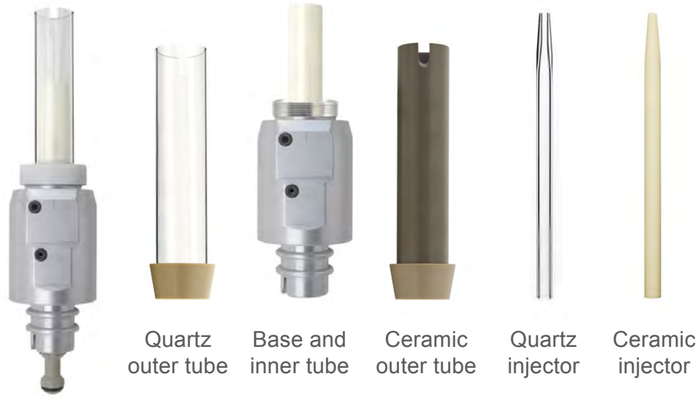
GE D-Torch– Demountable Torch

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

Benefits

- **Extended Lifespan:** Designed for aggressive sample matrices, reducing frequent torch replacements
- **Cost Efficiency:** Replace only the outer tube (fastest to degrade), lowering operating costs
- **Versatility:** Compatible with various sample matrices, eliminating the need for multiple torches
- **Lower Detection Limits:** High-purity ceramic minimizes background, enhancing silicon detection
- **Alumina intermediate tube**, which resists wear and is tolerant to high temperatures, high TDS and acid attack
- In contrast, **other demountable torch designs typically feature quartz intermediate tubes,** which add to consumable costs and diminish economic benefits

** The D-Torch is covered by US Patents*



For PerkinElmer® Avio

For Agilent® 5100/5110/5800/5900

GE D-Torch – Demountable Torch

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

GE D-Torch – Ceramic

D-Torch with ceramic outer tube is ideal for:

- Analyses at the detection limit as the hotter plasma increases sensitivity
- Monitoring of wear metals in engine oils, as quartz outer tubes often suffer cracking and shortened lifetimes due to thermal shock
- **Measuring high TDS samples that will quickly devitrify the quartz outer tube**

> "The D-Torch is performing very well. The ceramic outer has been in **almost constant service 22 hours a day,** 6 days a week since we purchased it and we have had no issues...We are due to purchase a replacement ICP and will certainly be purchasing another D-Torch to go along with it."
>
> **- Lubricating Oils Laboratory**

Six hours of running 10 % NaCl

Standard quartz torch body

Ceramic outer tube

GE D-Torch – Ceramic: Improved Signal Intensity

Ceramic versus Quartz on Agilent® 5000 SDV ICP-OES.

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

GE D-Torch – Ceramic: Improved Detection Limits

Detection Limit (µg/L)		
Element	**Radial Quartz Torch**	**Radial Ceramic Torch**
Al 167	1.6	1.1
Ba 455	0.07	0.12
Cu 324	0.88	0.62
K 766	25.5	11.7
Mg 279	0.05	0.05
Mn 257	0.36	0.25
Ni 221	1.6	1.3
P 177	5.1	5.0
Zn 213	0.23	0.28

***Thermo™ Application Note 43053**

DC Adaptors for Different Torches

P/N 31-808-4253

P/N 31-808-4293

P/N 31-808-4408

P/N 31-808-4374

P/N 31-808-4489

Latest Design: E-Torch

Benefits

- Made from PEEK, PTFE & Quartz
- Shipped with P/N 31-808-2836, Capillary Quartz Injector 2.0mm (EMT)
- Interchangeable injectors, (Quartz, Ceramic, Sapphire)
- Compatible with Tracey™ DC spray chamber which eliminates ball joint clamps
- Performance equivalent to the D-Torch
- Ceramic tube set available on request for HF and high TDS applications
- **Low cost Inner and Outer tube assembly which simplifies deposit removal maintenance and allows for oven cleaning of Carbon deposits**
- Compatible with the Jet Vortex Interface (JVI)

P/N 30-808-4388
E-Torch for Thermo® PRO

D-Torch: Maintenance

Suggestions:

Always wear safety gloves

Carbon Deposits Removal:

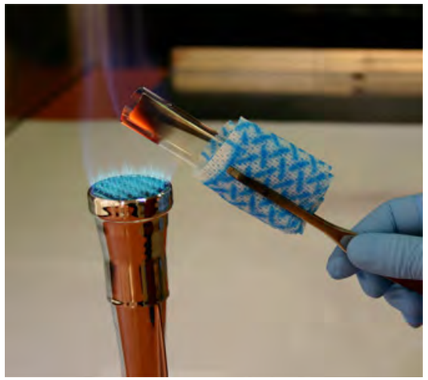
- Use a portable hand-held propane torch to burn off deposits
- Avoid heating the outer tube in a muffle furnace (due to the polymer ferrule)

Salt Deposits Cleaning:

- Soak in a 25% Fluka RBS-25 solution or dilute acid
- Stand the tube upright in a beaker, covering the deposits with cleaning solution

Metallic Films Removal:

- Soak in acid, preferably the same one used for sample preparation
- Ensure the acid covers the metallic deposits while the tube stands upright



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

The Role of the RF Coil

RF Coil Condition: Alignment, plating, and cleanliness improve energy transfer

Key Factors for Energy Transfer:

1. Alignment

- Ensures a well-shaped and consistently positioned plasma

2. Correct Dimensions

- Essential for circuit tuning and stability
- Minor deviations can alter resistance and inductance

3. Base Metal & Plating

- **Copper:** Cost-effective but oxidizes quickly
- **Silver:** Best conductivity but tarnishes
- **Gold:** Best corrosion resistance, slightly less conductive

Corrosion Resistance

Benefits of Maintaining your RF Coil:

Key Challenge: Corrosion

- Caused by heat or chemical oxidation
- Reduces energy transfer efficiency, increasing stress on RF components

Steps for Prolonging Coil Life:

- **Periodic Cleaning:** Removes tarnish and buildup
- **Avoid Acid-Based Polishes:** Use abrasive metal polish to clean without damage
- **Replace When Needed:** Replace coils with copper migration or significant tarnish

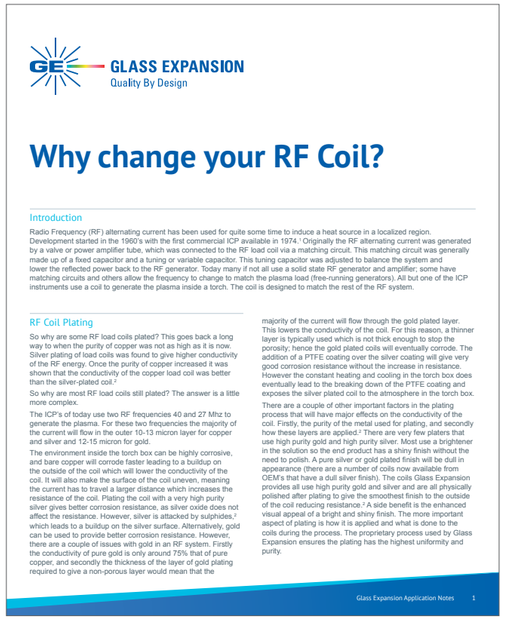
Advantages of GE RF Coils:

- High-quality, consistent plating for longer life
- Supplied on a plastic former for correct dimensions and easier installation
- Proper alignment minimizes devitrification of the outer tube

GE RF Coil:

Why Choose a GE RF Coil?

- High Quality and consistent plating of our coils promotes an extended coil life
- Each coil is supplied on a plastic former ensuing correct dimensions and easy installation
- Each coil is supplied in a protective container to maintain dimensions and prevent corrosion during transportation



GLASS EXPANSION
Quality By Design

Why change your RF Coil?

Introduction

Radio Frequency (RF) alternating current has been used for quite some time to induce a heat source in a localized region. Development started in the 1960's with the first commercial ICP available in 1974.[1] Originally the RF alternating current was generated by a valve or power amplifier tube, which was connected to the RF load coil via a matching circuit. This matching circuit was generally made up of a fixed capacitor and a tuning or variable capacitor. This tuning capacitor was adjusted to balance the system and lower the reflected power back to the RF generator. Today many if not all use a solid state RF generator and amplifier; some have matching circuits and others allow the frequency to change to match the plasma load (free-running generators). All but one of the ICP instruments use a coil to generate the plasma inside a torch. The coil is designed to match the rest of the RF system.

RF Coil Plating

So why are some RF load coils plated? This goes back a long way to when the purity of copper was not as high as it is now. Silver plating of load coils was found to give higher conductivity of the RF energy. Once the purity of copper increased it was shown that the conductivity of the copper load coil was better than the silver-plated coil.[2]

So why are most RF load coils still plated? The answer is a little more complex.

The ICP's of today use two RF frequencies 40 and 27 Mhz to generate the plasma. For these two frequencies the majority of the current will flow in the outer 10-13 micron layer for copper and silver and 12-15 micron for gold.

The environment inside the torch box can be highly corrosive, and bare copper will corrode faster leading to a buildup on the outside of the coil which will lower the conductivity of the coil. It will also make the surface of the coil uneven, meaning the current has to travel a larger distance which increases the resistance of the coil. Plating the coil with a very high purity silver gives better corrosion resistance, as silver oxide does not affect the resistance. However, silver is attacked by sulphides,[3] which leads to a buildup on the silver surface. Alternatively, gold can be used to provide better corrosion resistance. However, there are a couple of issues with gold in an RF system. Firstly the conductivity of pure gold is only around 75% that of pure copper, and secondly the thickness of the layer of gold plating required to give a non-porous layer would mean that the majority of the current will flow through the gold plated layer. This lowers the conductivity of the coil. For this reason, a thinner layer is typically used which is not thick enough to stop the porosity, hence the gold plated coils will eventually corrode. The addition of a PTFE coating over the silver coating will give very good corrosion resistance without the increase in resistance. However the constant heating and cooling in the torch box does eventually lead to the breaking down of the PTFE coating and exposes the silver plated coil to the atmosphere in the torch box.

There are a couple of other important factors in the plating process that will have major effects on the conductivity of the coil. Firstly, the purity of the metal used for plating, and secondly how these layers are applied.[2] There are very few platers that use high purity gold and high purity silver. Most use a brightener in the solution so the end product has a shiny finish without the need to polish. A pure silver or gold plated finish will be dull in appearance (there are a number of coils now available from OEM's that have a dull silver finish). The coils Glass Expansion provides all use high purity gold and silver and are all physically polished after plating to give the smoothest finish to the outside of the coil reducing resistance.[4] A side benefit is the enhanced visual appeal of a bright and shiny finish. The more important aspect of plating is how it is applied and what is done to the coils during the process. The proprietary process used by Glass Expansion ensures the plating has the highest uniformity and purity.

Glass Expansion Application Notes 1

RF Coil Application Note

RF Coil Installation Tool

Ensure correct alignment of the RF coil
Saves you time and the cost of a service

ICP-MS Cones

Cone Environment

- High temperature (6,000 – 8,000 K)
- Thermal degradation
- Chemical degradation (exacerbated by TDS, acid content, organic solvents, etc.)

Key Factors for High Quality Cones:

1. **Purity of Raw Materials:**

- Ensures performance and durability

2. **Advanced Machining:**

- CNC, laser, and electron beam welders for precise manufacturing

Copper Cones

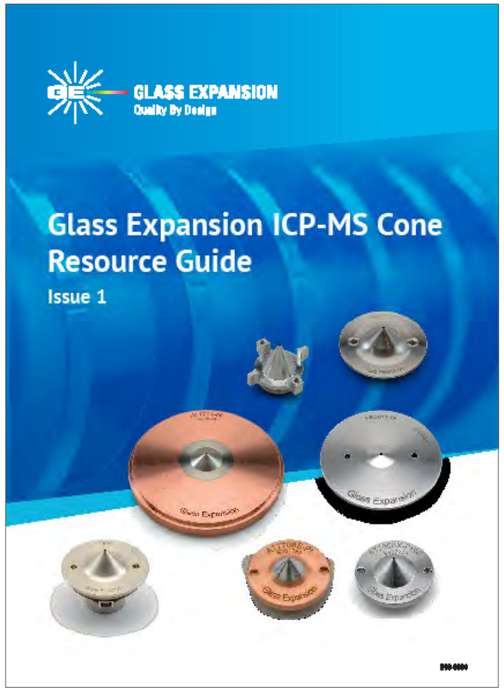
ICP-MS Cones:

Take Advantage of the Glass Expansion Warranty

- Meet or exceed OEM specifications
- Satisfaction guaranteed

Refurbishment program for Pt Cones:

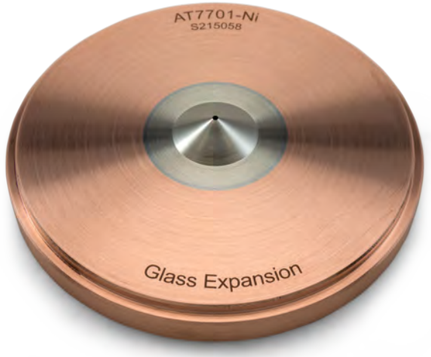
- If your platinum cone cannot be refurbished, we will provide a credit value of Pt in the cone which can be used on the purchase of any GE products, including new cones



ICP-MS Cone Resource Guide

Cone Availability

ICP-MS	Ni	Al	Pt	Pt - Boron Free	Cu
Agilent®	✓	✓	✓		✓
Nu Instruments	✓		✓		
PerkinElmer®	✓	✓	✓	✓	
Shimadzu®	✓		✓		✓
Standard BioTools™	✓				
Thermo®	✓	✓	✓	✓	



Cone Material: Copper

Copper Cones: Pros & Cons

Cost-Effective: Solid copper is often the lowest-cost option

Efficient Heat Transfer: Runs “colder” but is more prone to matrix effects, corrosion, and sample deposition

Shorter Lifespan: Higher risk of orifice clogging, requiring frequent cleaning and replacement

Application: Suitable for low-level Al, Ni, or Pt measurements

Cone Material: Nickel

Nickel Cones: Reliable & Cost-Effective

Standard Choice: Balanced cost and performance

Material Options: Solid nickel or nickel-plated copper

Durability: More resistant to corrosion and deposition than copper

Runs Hotter Than Copper: Higher operating temperature keeps cones cleaner longer, reduces maintenance, and ensures stable signals with lower background

Application: Ideal for routine aqueous samples (<5% acid), excluding HF and organics

Cone Material: Nickel Plated

Ni Plated: Enhanced Chemical Resistance

Ideal for High-Acid Samples: Recommended for acid concentrations >5%.

Optimized Design: Nickel plating protects copper while preserving its heat transfer efficiency

Temperature Control: Copper base helps maintain lower temperatures; optional skimmer base available for specific instruments

Durability & Stability: Prevents rapid degradation at the orifice, ensuring consistent sensitivity and signal stability

Superior Quality: Glass Expansion's electrodeless nickel-plating process ensures precision, reliability, and longevity

Cone Material: Platinum

Platinum Cones: Ultimate Durability & Performance

Longest-Lasting Option: Superior lifespan but highest cost structure

Runs Hotter: Less efficient heat transfer than copper and nickel, but stays cleaner longer

Optimized Configurations: Available with Cu, Ni-plated Cu, or solid Ni bases to balance heat transfer and chemical resistance

Superior Chemical Resistance: Best protection against matrix effects, corrosion, and sample deposition

Ideal for Harsh Applications: Suitable for high-TDS samples, aggressive acids (>5%), volatile organic solvents, and ultra-low detection limits

***Extended Lifespan:** Larger platinum tips (10mm, 15mm, 18mm) increase longevity—customers report up to 24 months with 18mm tips

Refurbishment & Recycling: Can be refurbished 2-3 times and later recycled for Pt reclaim value

Cone Material: Aluminium

Aluminium Cones: Cost-Effective Alternative

Affordable: Similar in cost to copper

Susceptible to Corrosion: Prone to matrix effects, corrosion, and sample deposition, like copper

Ideal for Specific Applications: Suitable for low-level detection of Cu, Ni, and Pt

Preferred for LA-ICP-MS: Commonly used in Laser Ablation ICP-MS

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

How to Clean Cones

Suggestions:

- **Use PPE:** Always wear safety glasses and gloves
- **Handle with Care:** Hold the cone by its edge; avoid applying pressure or using tools
- **Cleaning Expectations:** Removing sample deposits is key—discoloration is normal and can improve signal stability
- 3 recommended methods, from gentlest to most aggressive:
  - Method A **(Soak in Citranox);**
  - Method B **(Sonicate in Citranox);**
  - Method C **(Sonicate in Nitric Acid)**
- Order of severity (Don't use aggressive cleaners if it isn't needed):
  1. **Fluka RBS-25**
  2. Citranox
  3. HNO_3
- Limit nitric acid exposure to prevent cone damage or orifice enlargement

Tips on Care & Maintenance

How to Clean Cones

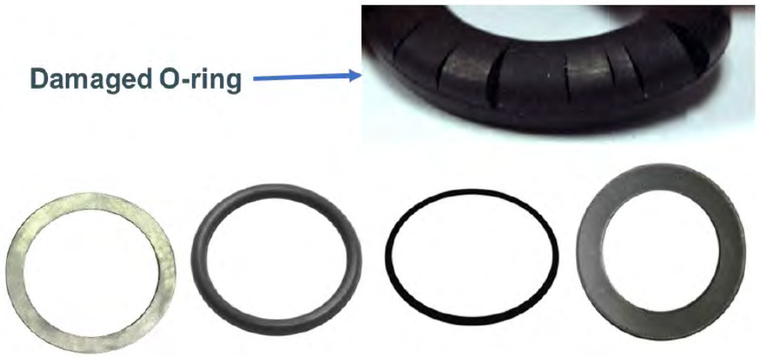
Protecting Threaded Cones During Cleaning

- **Avoid Corrosion:** Ensure threads stay free from corrosive solutions to maintain proper sealing and prevent bonding to the base
- **Extend Cone Life:** ConeGuard Thread Protector seals and protects threads during cleaning, preventing corrosion and wear, especially on platinum cones
- **Preserve Thread Condition:** Helps avoid cross-threading and damage to the instrument housing, ensuring longevity and reliable performance

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
  - 50 ppm calcium in 1% nitric acid
- Install the new cones or cleaned cones into the instrument. Turn on the plasma
  - **Aspirate the 50 ppm calcium solution for 10 minutes**
  - **Change to 1 % Nitric acid blank solution and aspirate for a further 10 minutes**

GLASS EXPANSION GmbH
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Technology for your success

Thank You

GLASS EXPANSION
Quality By Design

Strategies for Long-Term Analytical Performance

Presenter:

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ICP Application Specialist,
Glass Expansion GmbH
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Suggestions for Common Challenges (I)

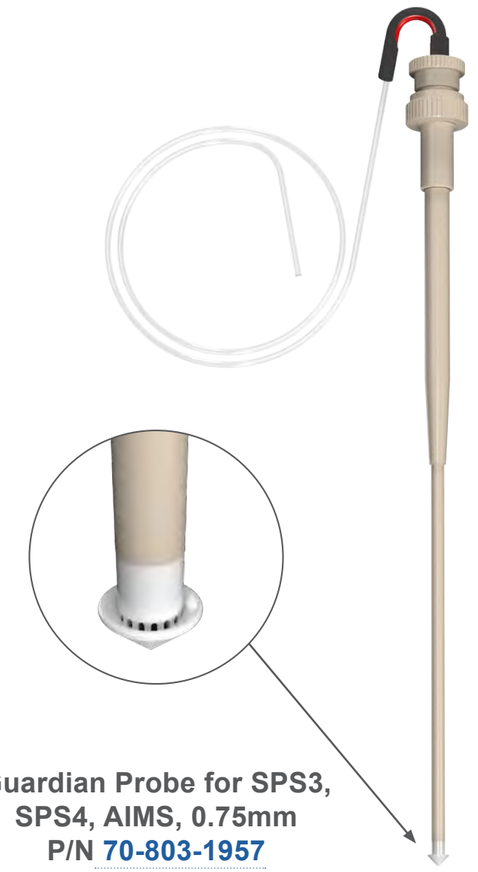
- **Good Digestions:** Clear liquids and consistent results (RSDs and spike recoveries)
- **Bad Digestions:** Precipitates (e.g., Ag, Fe, Si) and undigested particles

Recommendations:

- **Guardian Sample Probe:** Enhances sample introduction and minimizes contamination
- **Guardian In-line Particle Filter:** Helps to remove particulates, reducing blockages in sample lines and nebulizers

Contract lab in Australia-feedback:

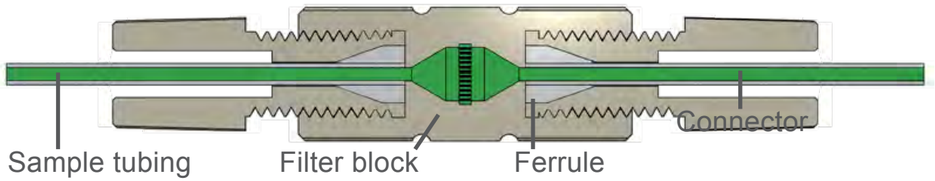
- **Guardian Probe Performance:** Robust and reliable
- **Handling of Particulate Samples:** Remains unclogged
- **Reduced Nebulizer Failures:** Fewer issues compared to regular probes



Guardian Probe for SPS3, SPS4, AIMS, 0.75mm
P/N 70-803-1957

Suggestions for Common Challenges (II)

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

In-Line particle filter: *"By the way, the particle filters that we have purchased are working out very well with our soil sample analyses on our ICP-OES units, have saved a lot of headaches with blocked nebulizers!"*

Soil & Plant Laboratory - Australia

Challenges with Traditional Pump Tubing:

1. Premature Tab Failure:

- **Description:** Tabs on the tubing can become loose or break off prematurely, especially if they are not properly bonded or are of poor quality
- **Impact:** This can lead to detachment of the tubing from the connectors, causing interruptions in sample flow and requiring tubing replacement

2. Tubing Slippage/Displacement:

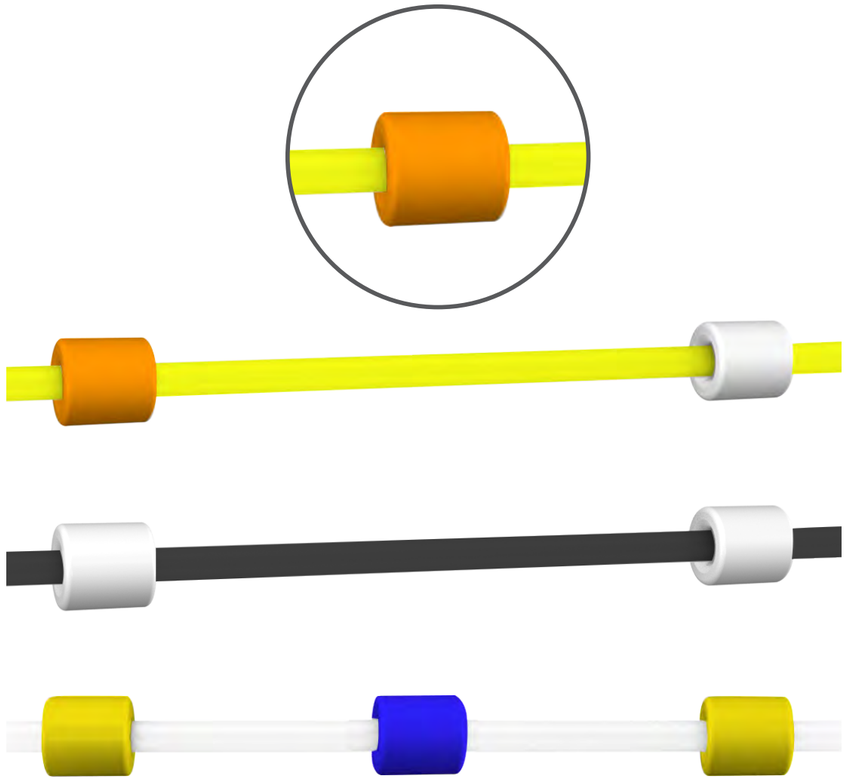
- **Description:** Tubing can slip from the connectors or the pump rollers, particularly if the tubing is not properly fitted or if the connectors are worn
- **Impact:** This can cause interruptions in the sample flow, inconsistent sample delivery and analysis interruptions

Traditional Pump Tubing

ProLok™ Peristaltic Pump Tubing

Features & Benefits:

1. **Enhanced Bonding Strength:** The color tab now features twice the surface area, ensuring a stronger and more secure attachment to the pump tubing.
2. **Durability:** Designed to prevent premature failure, the reinforced tabs eliminate issues with loose tubing connections.
3. **Superior Material Quality:** Crafted from high-quality Tygon® material, this product delivers premium performance and exceptional consistency.
4. **Consistent Compatibility:** Maintains the same GE part numbers for seamless integration.
5. **Precisely controlled tab spacing** designed to meet and exceed industry standards for ICP-OES and ICP-MS peristaltic pumps.



ProLok™ Peristaltic Pump Tubing

Sample Delivery System Maintenance

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

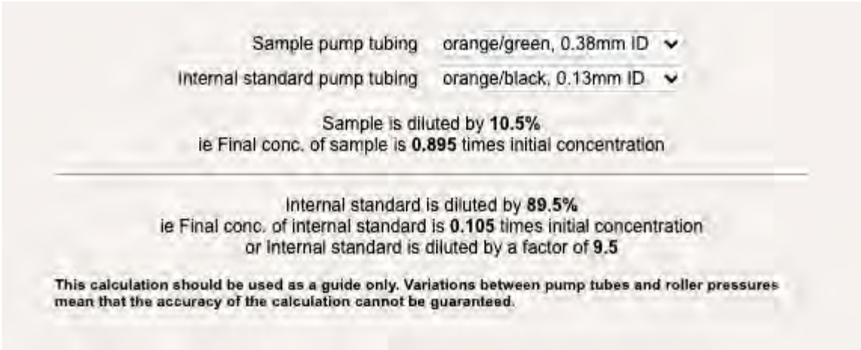
Regular cleaning protocols:

- Implement a rinsing protocol between sample types using dedicated solutions to remove residual materials
- Start and finish each run by aspirating a mildly acidic blank solution or the sample matrix, followed by DIW for 5-10 min

Helpful Tools for Dilution & Sample Uptake

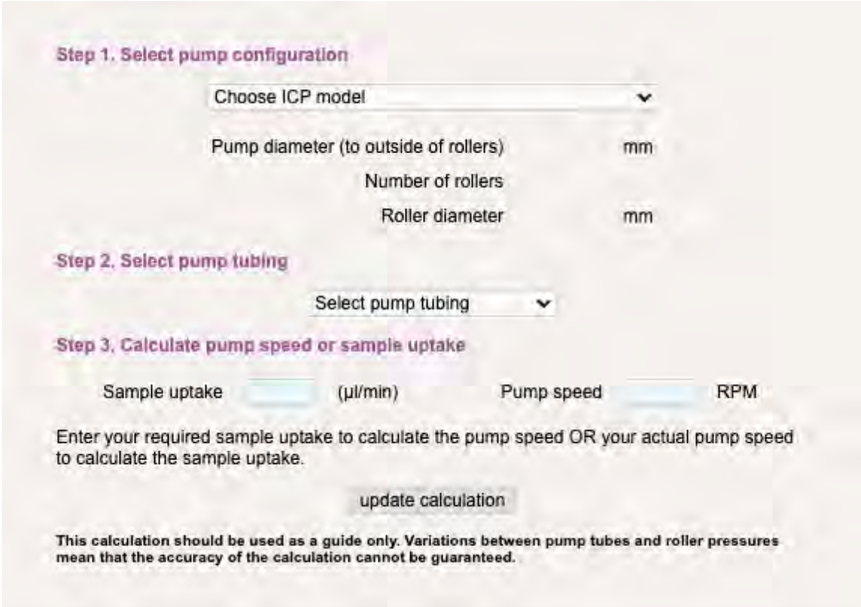
1. Trident Dilution Factor Calculator:

- Determine how much your sample and internal standard are diluted
- *Click here to use the Trident Dilution Factor Calculator*



2. Pump Speed & Sample Uptake Calculator:

- Select the right pump tubing for the required sample uptake
- Choose the correct pump speed for optimal sample flow
- Calculate sample uptake based on your current pump tubing and speed
- *Click here to use the Pump Speed & Sample Uptake Calculator*



Application dedicated SIS Solutions

Agilent®: 5100, 5110, 5800, 5900

View All Products for this Model

Instrument Applications

- Animal feed
- Brines and salts
- Chemicals and fertilizers
- Clinical and forensic materials
- Drinking, ground and surface water
- Food and drink
- Geological with HF
- Geological without HF
- Isotopic Analysis of Minerals
- Metals
- Petrochemicals
- Plants
- Soil and sediment with HF
- Soil and sediment without HF
- Waste water and sludge
- Wear Metals in oil

Application Example: Chemicals and fertilizers

A13-07-USS2

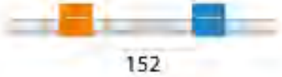
20-809-9199HE

30-808-3560

30-808-3590

31-808-3576

70-900-5100G



0.25-OB-F

0.76-BLK-F

1.14-RED-F

70-803-1108

Recommended Products for Environmental Samples

Challenges:

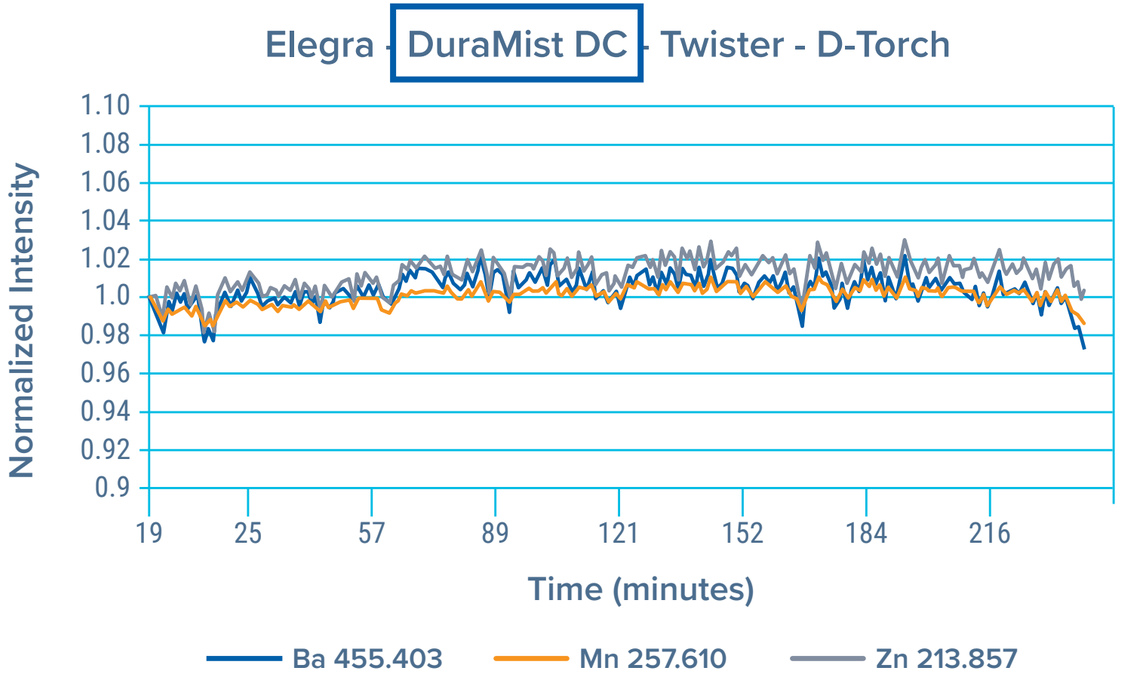
- **Rapid devitrification of torch**
- **Matrix build-up on cones**
- *Signal drift*
- *More frequent maintenance intervals*
- *Higher consumable costs*
- *Longer washout times*

Solutions:

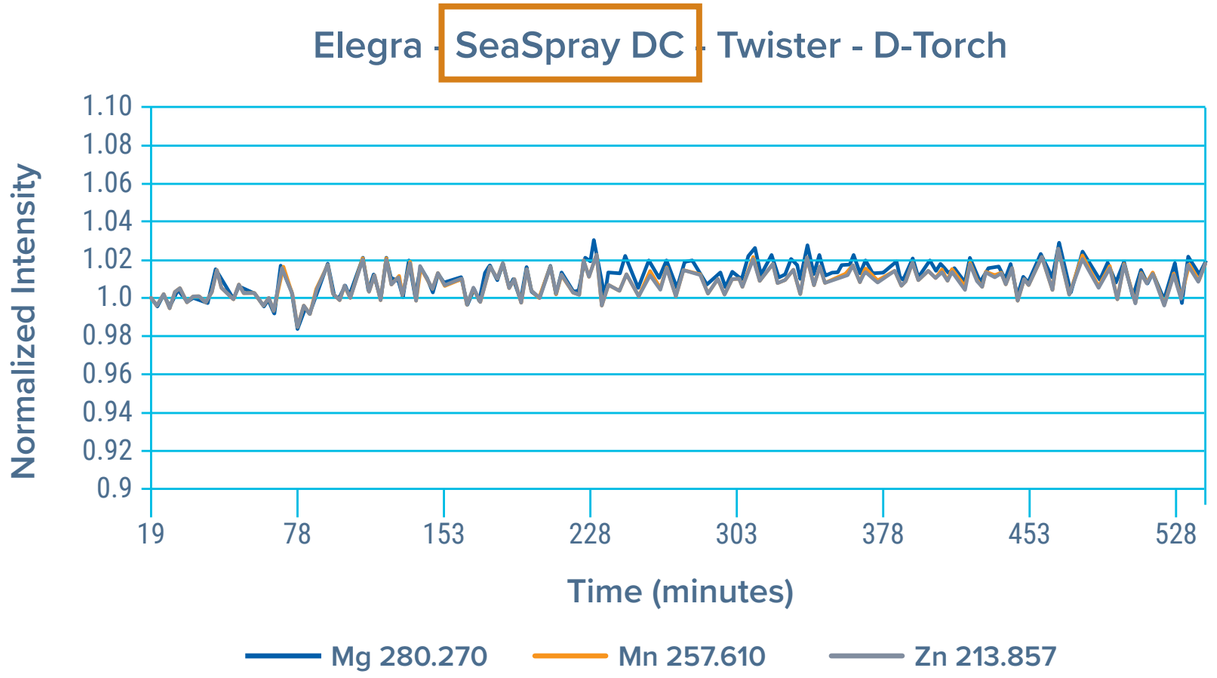
- **Argon Humidifier**
- **High TDS nebulizer**
- **Baffled cyclonic spray chamber**
- **Demountable torch & large ID Injector**
- *Ni-plated or Pt-tipped cones*
- *Increase auxiliary gas flow*
- *Increase rinse times*
- *Regular maintenance schedule*

Performance Evaluation in 3.5% and 10% NaCl

- **Signal drift is a common challenge in testing labs,** often caused by a clogged nebulizer or injector
- Selecting a high TDS nebulizer, baffled cyclonic spray chamber and Ar humidifier can effectively eliminate signal drift

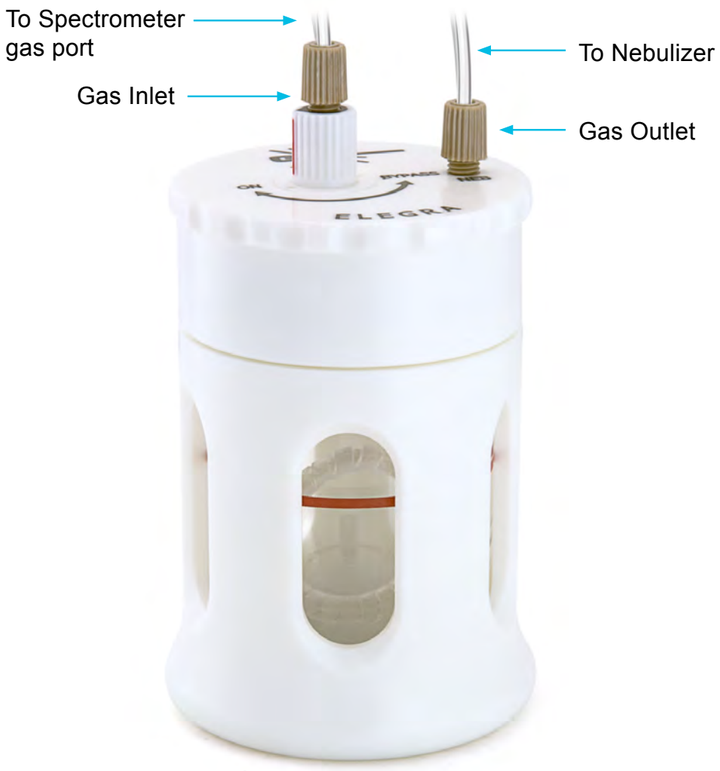


Case Study 1: Long term stability test, 4h analysis of 1 ppm standard in 10 % NaCl (Agilent 5100 SVDV ICP-OES)



Case Study 2: Long term stability test, 9h analysis of 1 ppm standard in 3.5% NaCl (Agilent 5100 SVDV ICP-OES)

Elegra Argon Humidifier



Features:

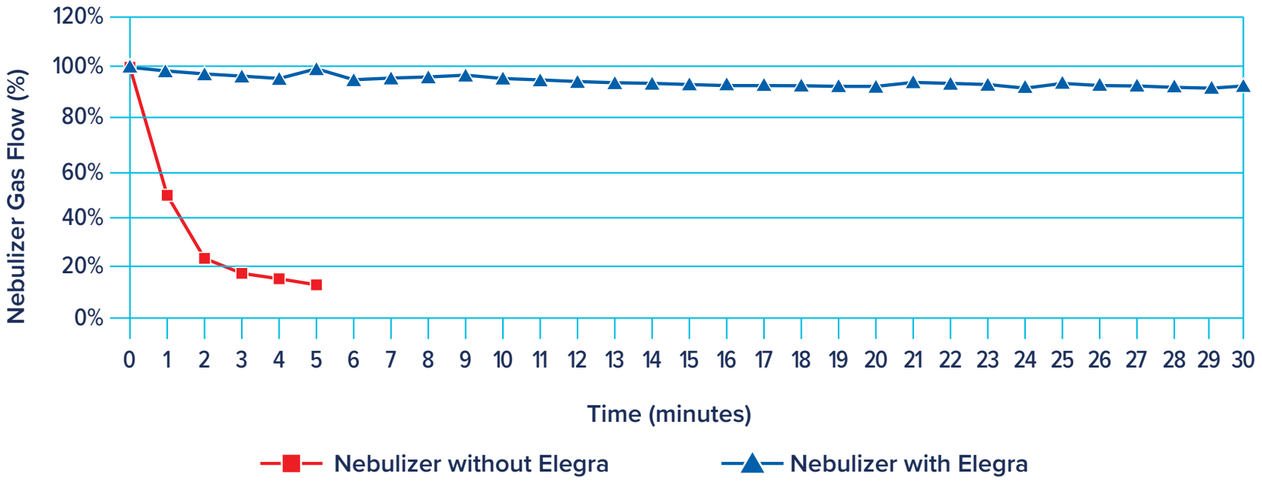
- **No heating or electric power required**
- Membrane humidification technology
- **Improved signal stability for samples with high TDS**
- Inert metal free construction
- **Dual-Channel version** allows simultaneous humidification of nebulizer & aux. gas

Other tips for high TDS:

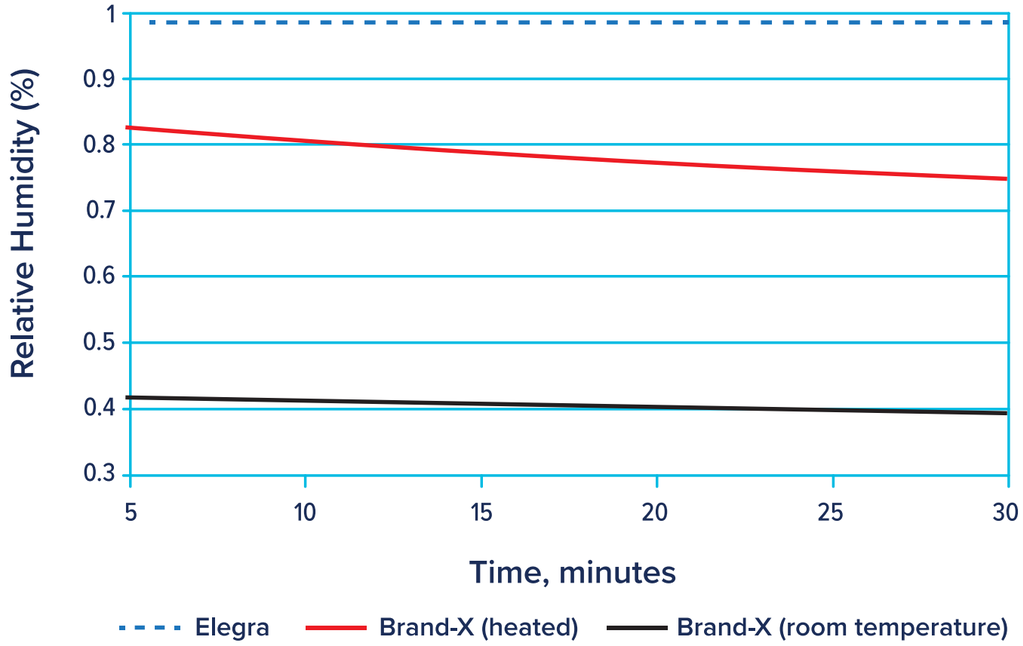
- Increasing the auxiliary argon flow will lift the plasma higher off the injector, slowing salt buildup at the injector tip
- Extended rinses in between each sample are also recommended

Elegra Argon Humidifier: Performance

Concentric Nebulizer with 25% TDS Tolerance

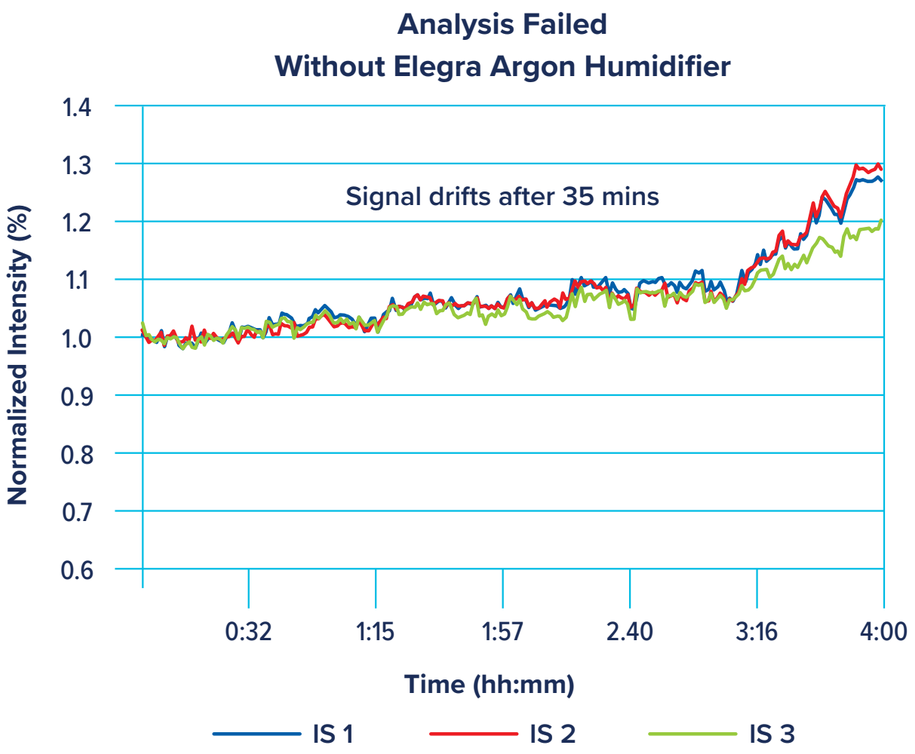


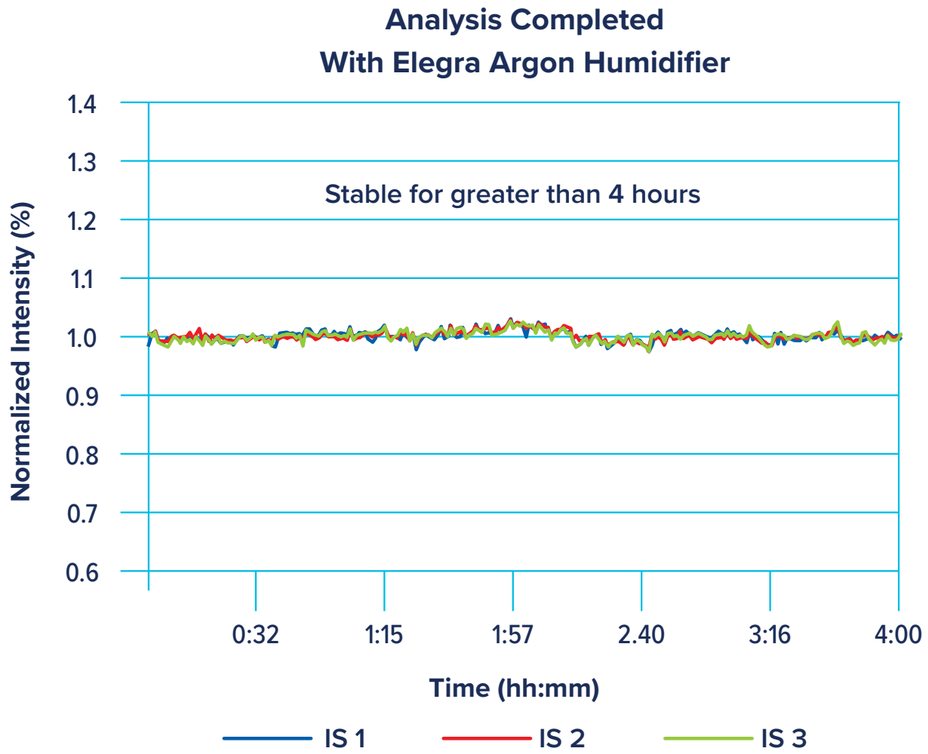
Percent Humidity Relative to Elegra (Elegra=1)



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

Elegra Argon Humidifier: Performance (II)





- High-throughput contract 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

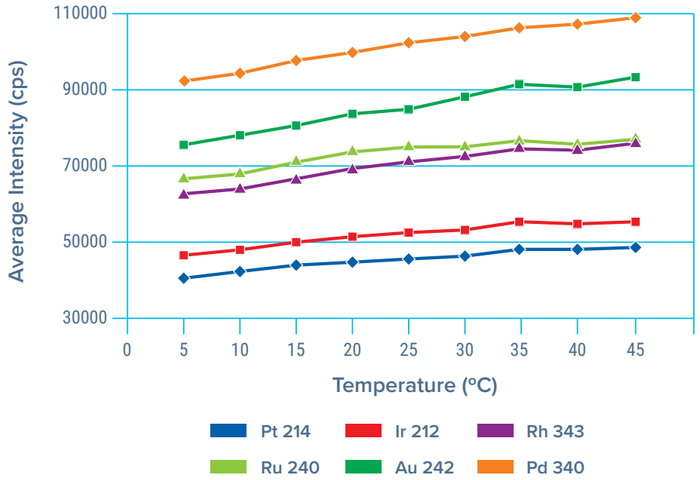
IsoMist XR Spray Chamber: Benefits

Limitations of Room Temperature Spray Chambers

- **Sensitivity drift with temperature**
- Excessive plasma loading (volatile solvents)
- Excessive oxide formation (ICP-MS)

Unique to the IsoMist XR Spray Chambers

- The only temperature-controlled spray chamber that can offer **cooling down to -25°C** or **heating up to +80°C** in one single platform
- Programmable in 1.0°C increments
- Maintaining a stability of +/- 0.1°C



Glass

Quartz

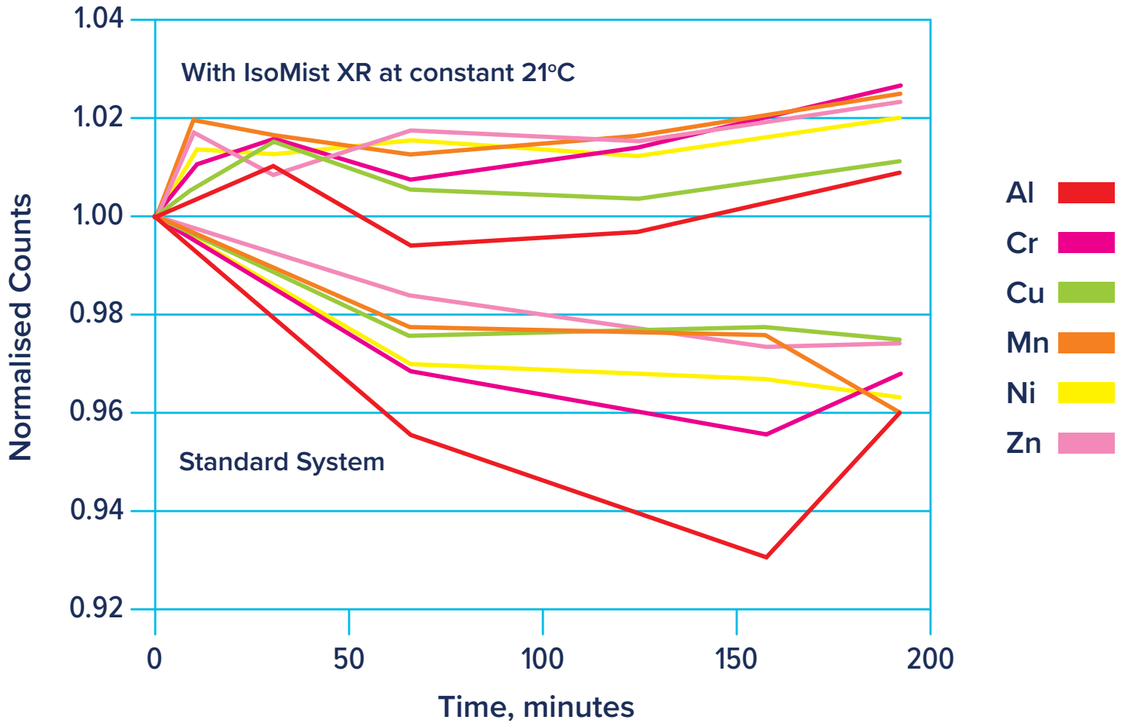
PFA

IsoMist XR™ Spray Chamber

Benefits

- Programmable from -25°C to 80°C in 1°C increments
- Reduces isobaric oxide interferences
- Increases the chance of passing QC checks
- Eliminates drift (2°C change equals 10% shift in sensitivity

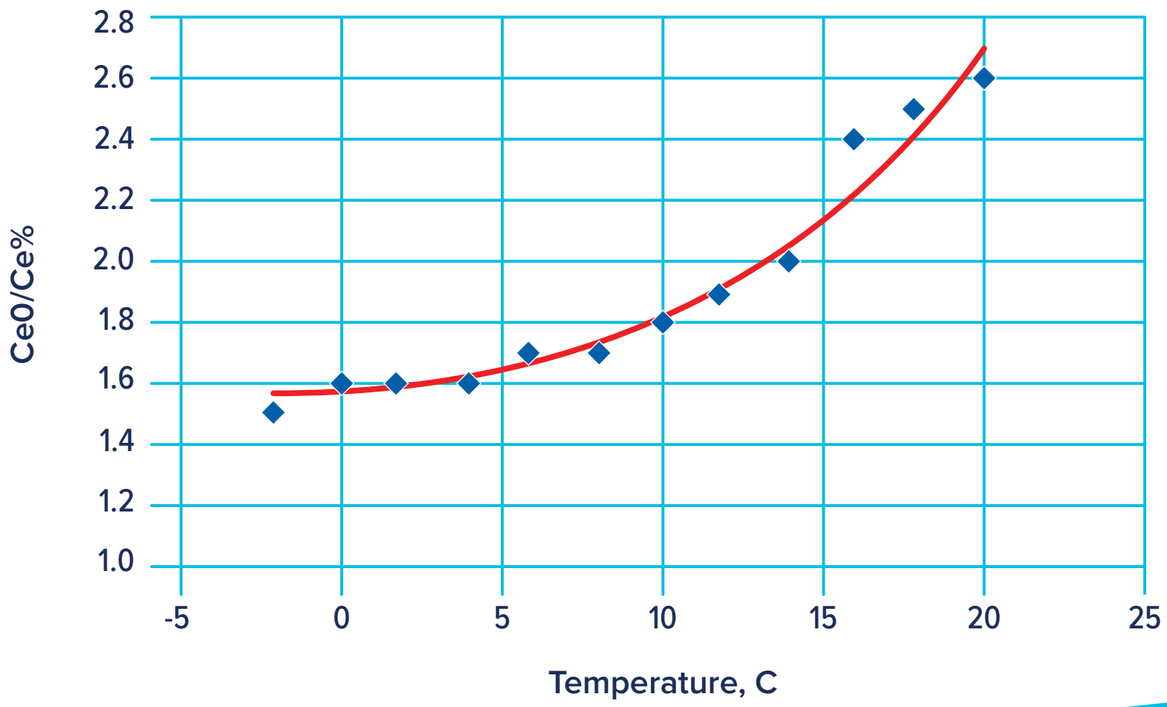
Effect of constant temperature on signal stability



The IsoMist XR™ Spray Chamber: Applications

- **Oil refineries:**
  Light naphthas
- **Solvent manufacturers:**
  Ketones & alcohols
- **Environmental labs:**
  Eliminate re-calibrations
- **Wear metals in used engine oils:**
  Reduce viscosity
- **Precious metal refiners:**
  Greater accuracy
- **ICP-MS users:**
  Oxide reduction
- **Limited volume samples (clinical):**
  Increases Sensitivity
- **Any "hot" determinations:**
  Reduced waste

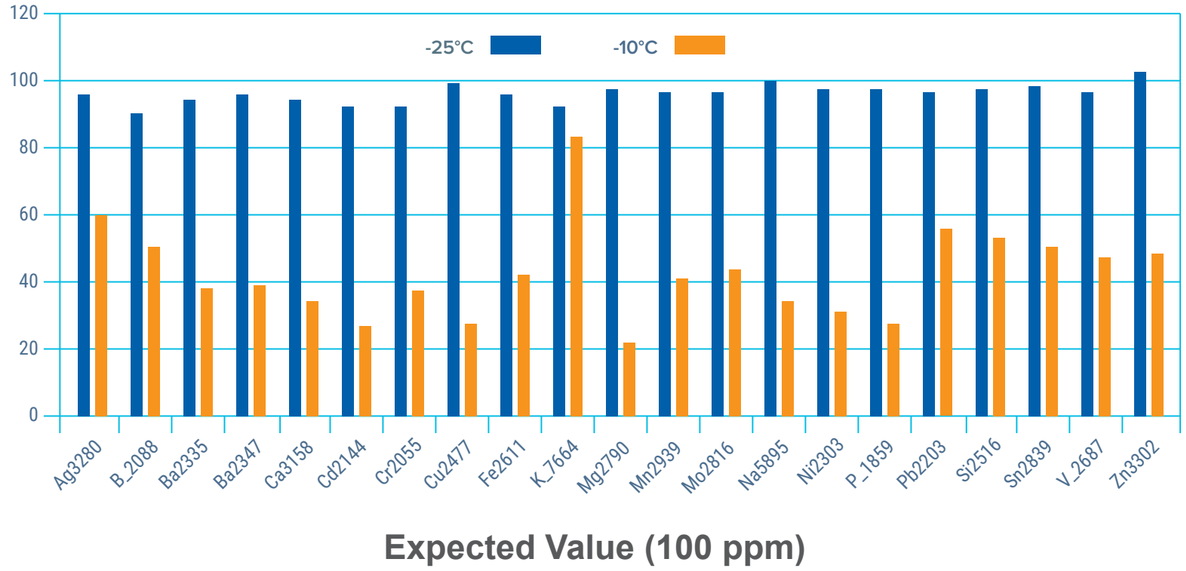
Effect of IsoMist temperature on ICP-MS Oxide Ratio



The IsoMist XR™ Spray Chamber: Effect on Accuracy & Precision

Accuracy

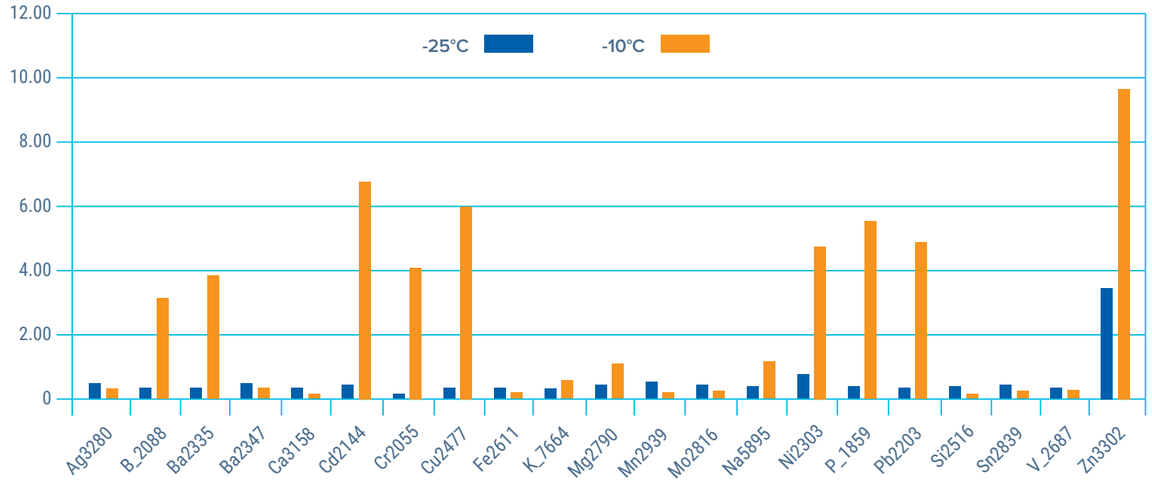
Effect of Spray Chamber Temperature on Accuracy (100 ppm standard)



Expected Value (100 ppm)

Precision

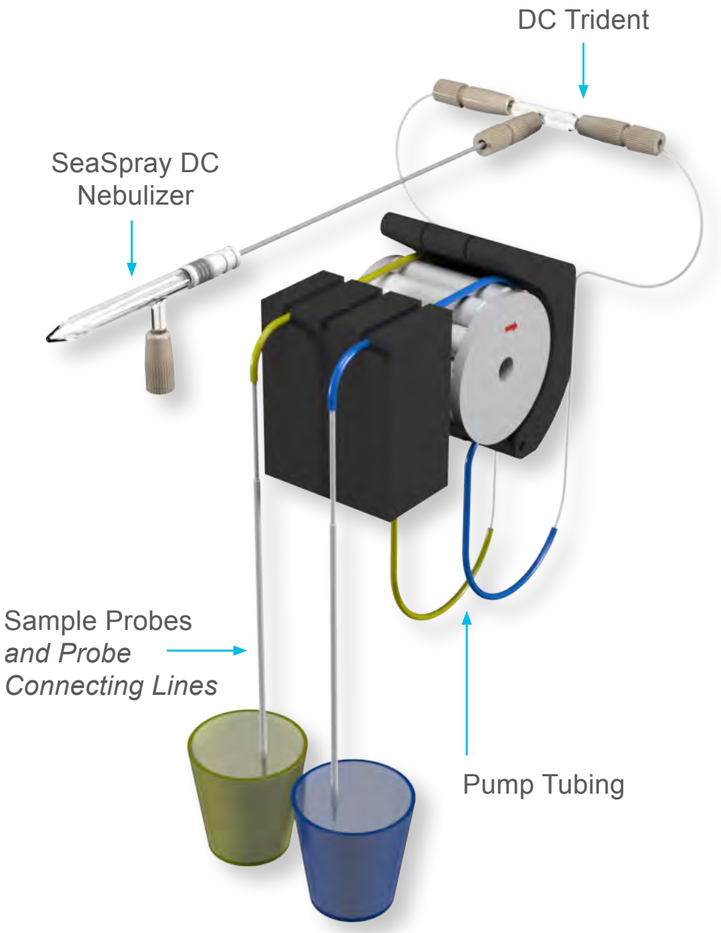
Effect of Spray Chamber Temperature on Precision



Internal Standard Addition Kit

Internal standardization (ISTD) in ICP improves analytical accuracy by compensating for:

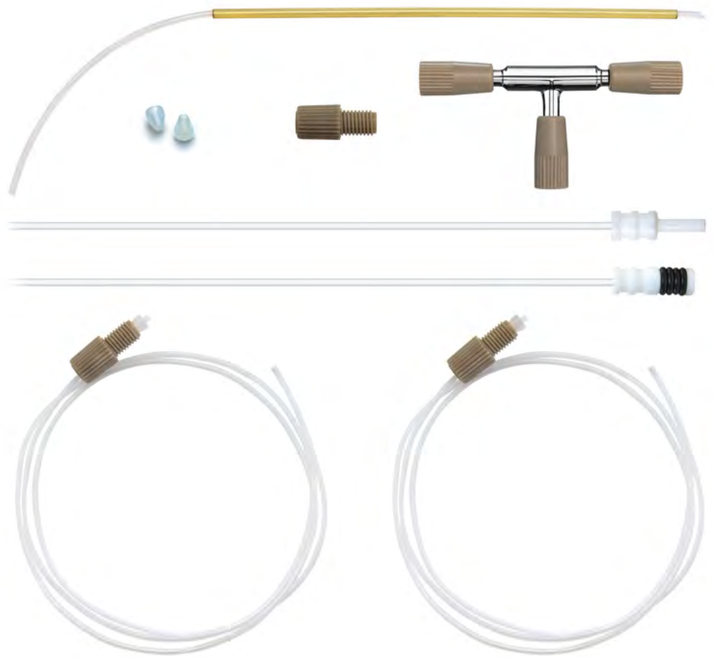
- **Variations in Sample Uptake Rates:** Adjusts for differences in viscosity and total dissolved solids
- **Mass-Space Charge Interferences in ICP-MS:** Reduces signal suppression or enhancement effects
- **Instrument Drift:** Stabilizes long-term signal fluctuations for consistent results
- **Plasma Fluctuations:** Compensates for changes in plasma conditions that may affect sensitivity
- **Improved Precision:** Enhances reproducibility by normalizing response variations



Trident CT™ ISTD Kit

1. Enhancing ISTD Recovery, Preventing Leaks & Cross-Contamination:

- Compact, efficient mixing chamber ensures complete mixing of the sample and reagent
- **ConstantTorque (CT) ratchet fittings** for a durable, leak-free seal on all connections
- Consistency in torque application helps maintain the reliability and performance of the mixing chamber



"I used an older version of the PE Online IS Addition kit for many years. ... I have found a similar kit offered by GE to be a great improvement over the old PE kit. It has a glass T with friction-fit connections that are the same as the GE quick connect nebulizer fittings...."
Government laboratory - USA

2. Zero dead volume connections:

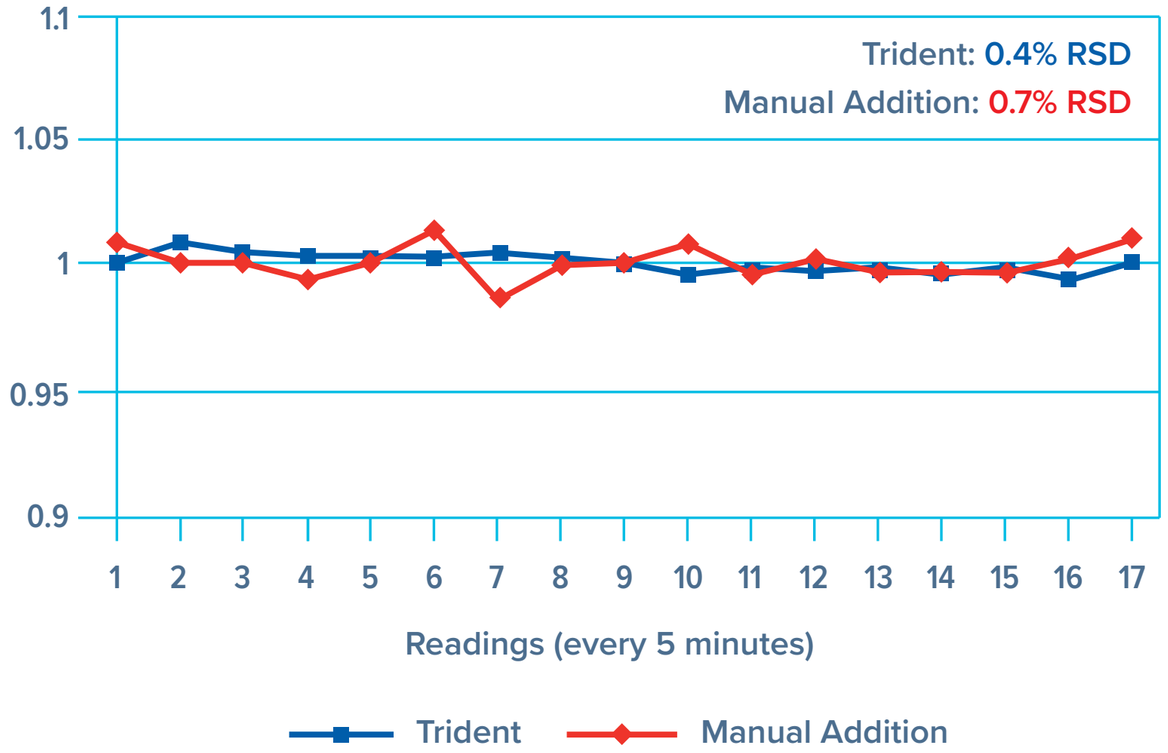
- Between nebulizer and spray chamber: Helix CT
- Between sample line and nebulizer: UniFit connector

UniFit

Helix CT

Trident CT™ ISTD Kit

Comparison of long-term stability of in-line addition versus manual addition of internal standard



Nebulizers: Troubleshooting

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 Ar nebulizer gas connection at the instrument and at the nebulizer gas arm
- Nebulizer gas supply tubing can harden over time, losing their flexible, gas-tight seal
- Argon loss: Even a 1% loss can lead to significant changes in ICP analytical results

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

- Clean nebulizer or replace if necessary

Record your normal sample uptake rate

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

Nebulizers: Cleaning Procedures

Good Practice: To maintain your nebulizer, start and finish each run by nebulizing a mildly acidic blank solution, followed by DIW for 5-10 min

Practices to avoid:

- Avoid inserting wires into the nebulizer orifice
- Never touch the nebulizer tip
- Avoid cleaning glass or quartz nebulizers with HF
- Do not use ultrasonic baths for glass nebulizers

P/N 70-ELUO

Conikal™, SeapSpray™, MicroMist™, Slurry™

P/N 70-ELUO-OPD

Eluo HF (OpalMist™ or DuraMist™)

Nebulizers: Cleaning Procedures

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% HNO_3*
5. Flush 3x with water using the Eluo
6. *For faster drying, flush with methanol*

ICP Nebulizer Maintenance Made Easy Video

Spray Chambers: Maintenance

Suggestions for Glass Spray Chambers:

- **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

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

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

Inert Spray Chambers: Maintenance

Care and Maintenance of PEEK Chambers:

Start & Finish with mildy acidic blank solution

Avoid Metal Tools: Do not use metal or ceramic brushes for cleaning

Fluka ‘RBS-25’ Cleaning: If performance drops, clean with 2.5% Fluka solution for 15 minutes or soak in 25% Fluka solution overnight

PTFE & PFA Spray Chambers:

Surface Treatment: The brown color indicates a treated surface for consistent drainage and wetting (not a coating). The treatment may degrade with prolonged use depending on the samples

Cleaning Guidelines:

- **No H_2O_2:** Avoid H_2O_2 as it accelerates degradation
- **Avoid Contact:** Don’t touch the internal surface with hands or tools
- **Color Fading:** Normal fading doesn’t affect performance

Fluka ‘RBS-25’ Cleaning

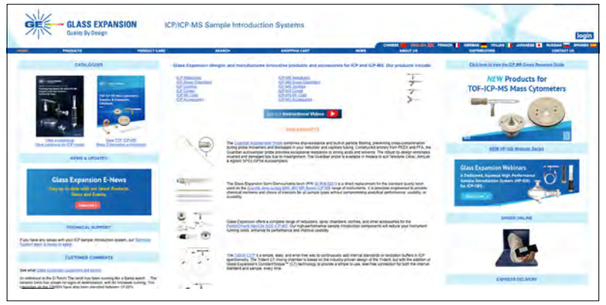
***Re-treatment:** If soaking doesn’t restore performance, return to Glass Expansion for re-treatment

Soak in 25% Fluka RB-25

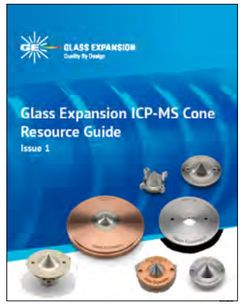
Replace O-Ring Seal **P/N V-044**

Helpful ICP Resources

- Application notes
- Newsletters
- Catalogs
- Product flyers
- Website
- Product care advice
- Operating instructions
- Videos
- Webinars



Website

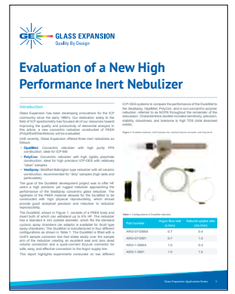


Catalogs

Flyers

Newsletters

Instructions



Application Notes

GLASS EXPANSION GmbH
Quality By Design

instrumentsolutions
Technology for your success

Thank You