GLASS EXPANSION
Quality By Design

ICP Sample Introduction: Best Practices for Component Selection and Optimization

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Who is Glass Expansion?

GE have been specializing in sample introduction components
from the probe to the cones — for ICPs since the early 1980s

- **Many ICP vendors package GE parts as part of the standard configuration.**
- **Manufacturers Supported:** Agilent®, Analytik Jena®, Horiba®, PerkinElmer®, Shimadzu®, SPECTRO™, Thermo®, Others

Products offered:

Overcoming ICP Sample Introduction Challenges

Key Challenges in ICP SIS:

1. Data Quality:

1. Accuracy
2. Sensitivity
3. Precision

2. Sample Throughput:

1. Efficiency in Analysis
2. Minimizing Downtime

3. Product Care and Maintenance:

1. Longevity of components
2. Consistent Performance

Click here to view our Product Care Page

Steps to Optimize Your ICP SIS:

1. Select the Right SIS Components for Your Application

1. Tailored Solutions for Different Needs

2. Inspect and maintain key components:

1. Nebulizer
2. Spray Chambers
3. Torch and Injector
4. Cones

3. Additional Accessories and Enhancements

1. Use of helpful tools that can improve your ICP analysis

Is Your Sample Introduction Optimized for Your Application?

Your application works best with a tailored solution — not a default setting.

Optimization depends on your priorities:

- Maximum sensitivity
- Improved precision and reproducibility
- Robustness for high-matrix samples
- Minimal carryover
- Faster washout for high throughput
- Low-volume or low-flow sample compatibility
- Compatibility with challenging acids or solvents

Note: 99% of analytical problems occur within the sample introduction configuration.

Application Dedicated SIS solutions:

www.geicp.com Click here: **View Recommended Products for your Application**

Instrument Applications

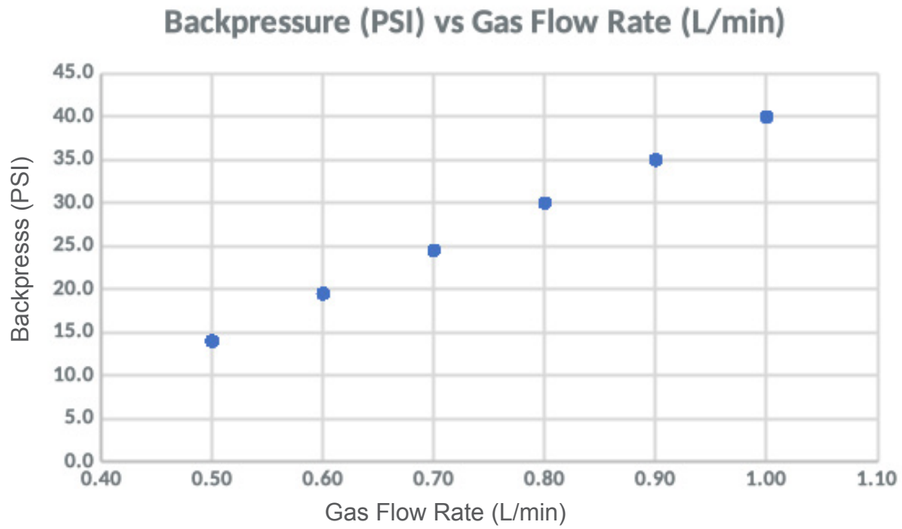
- Animal feed
- Brines and salts
- Chemicals and fertilizers
- Clinical and forensic materials
- Drinking, ground and surface water
- Food and drink
- Geological with HF
- Geological without HF
- Isotopic Analysis of Minerals
- Metals
- Petrochemicals
- Plants
- Semiconductors
- Soil and sediment with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

Nebulizer Selection

Selecting the right nebulizer requires careful consideration of various factors:

Nebulizer	Dead Volume V0 (µL)	TDS (%)	Particulates (µm)	HF	Precision	Purity	Material
SeaSpray™ 	4	20	200 for USS1&2	No	High	Good	Glass
MicroMist™	1.1	15	*100 for UM04	No	High	Good	Glass
Conikal™	4.5	5	210	No	High	Good	Glass
Slurry™	11	1	280	No	High	Good	Glass
Quartz SeaSpray™	4.5	20	210	No	High	Excellent	Quartz
OpalMist™ 	4.2	15	*200 for PFA2	Yes	High	Excellent	PFA
DuraMist™ 	4.2	30	*200 for DM2	Yes	High	Good	PEEK
VeeSpray™ 	100	30	550	Yes	Moderate	Good	Ceramic

* Varies with nebulizer uptake



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

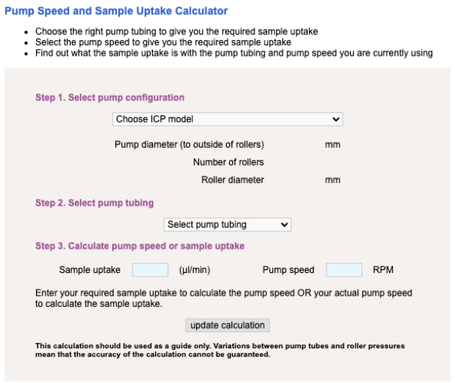
How to Identify Nebulizer Issues

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.

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

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


Pump Speed and Sample Uptake Calculator

- Choose the right pump tubing to give you the required sample uptake
- Select the pump speed to give you the required sample uptake
- Find out what the sample uptake is with the pump tubing and pump speed you are currently using

Step 1. Select pump configuration

Choose ICP model

Pump diameter (to outside of rollers) mm

Number of rollers

Roller diameter mm

Step 2. Select pump tubing

Select pump tubing

Step 3. Calculate pump speed or sample uptake

Sample uptake (µl/min) Pump speed RPM

Enter your required sample uptake to calculate the pump speed OR your actual pump speed to calculate the sample uptake.

update calculation

This calculation should be used as a guide only. Variations between pump tubes and roller pressures mean that the accuracy of the calculation cannot be guaranteed.

Click here to view our Pump Speed and Uptake Calculator

Magnifier Inspection Tool
P/N 70-803-1923

Conikal™
SeaSpray™
MicroMist™
Slurry™

P/N 70-ELUO

DuraMist™

OpalMist™

P/N 70-ELUO-OPD

Product Improvements to Help Address Low Nebulizer Backpressure:

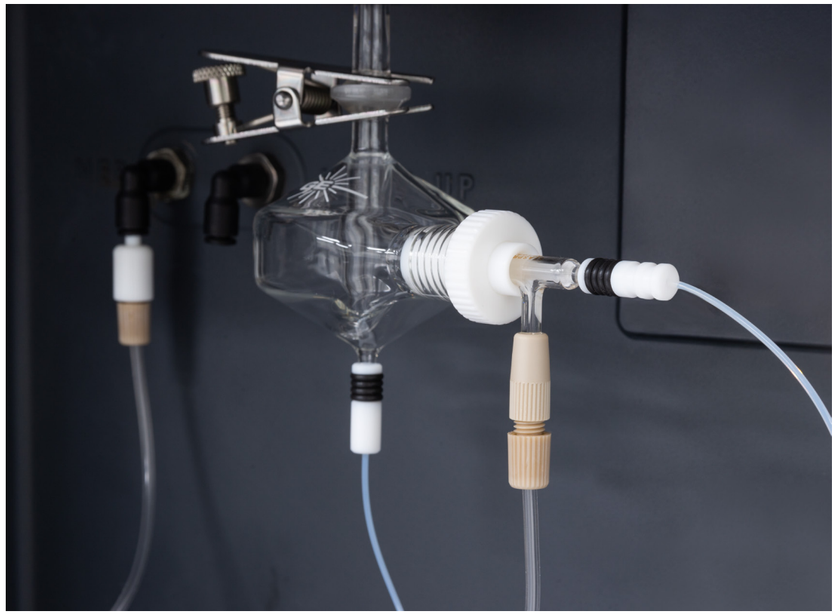
Why it matters:

- Often linked to **loss of sensitivity** in ICP measurements
- Can indicate a **gas leak** in the system

How to address it:

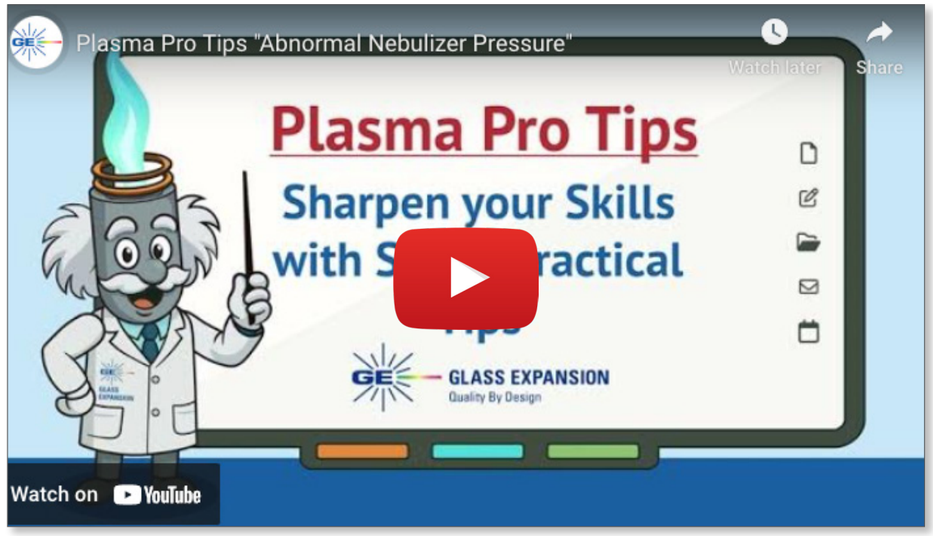
- **Check tubing and connections** at both the instrument and nebulizer
- Use **Direct Connect (DC) fittings** with built-in torque control for a secure, easy-to-replace connection
- **Large, soft-walled tubing** prevents kinks and fatigue common with rigid capillaries

SeaSpray DC Nebulizer 2mL/min
P/N A13-07-USS2



Recommendation for frequent Nebulizer Blockages

- **Identify the root cause of blockages:**
  1. Particulates
  2. Salt Deposits
- **Take preventive actions:**
  - Use “Plasma Pro Tips” guidelines
  - Regular Maintenance
  - Helpful Accessories: **(1) For Particulates; (2) For High TDS;** (3) Eluo Nebulizer Cleaner



Reducing Nebulizer Blockages Caused by Particulates (1/2)

Particulates can enter the sample line or nebulizer, causing partial or complete blockages.

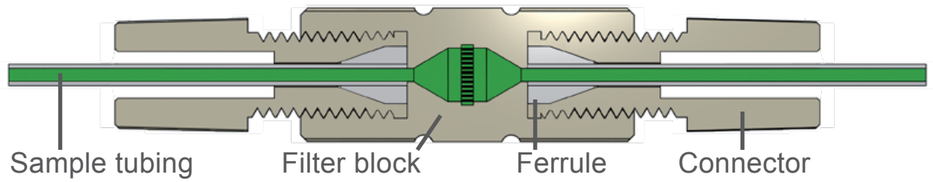
They may originate from:

- Incomplete sample digestion
- Precipitation of certain elements
- Environmental dust or contamination

How to solve it?

1a. Guardian In-Line Particle Filter (P/N 70-803-1108) between probe and nebulizer

- **120µm filter** with seals for both 1.6mm and 1.3mm OD tubing
- **Clog-resistant PEEK** design — easily cleaned by back-flushing or ultrasonics



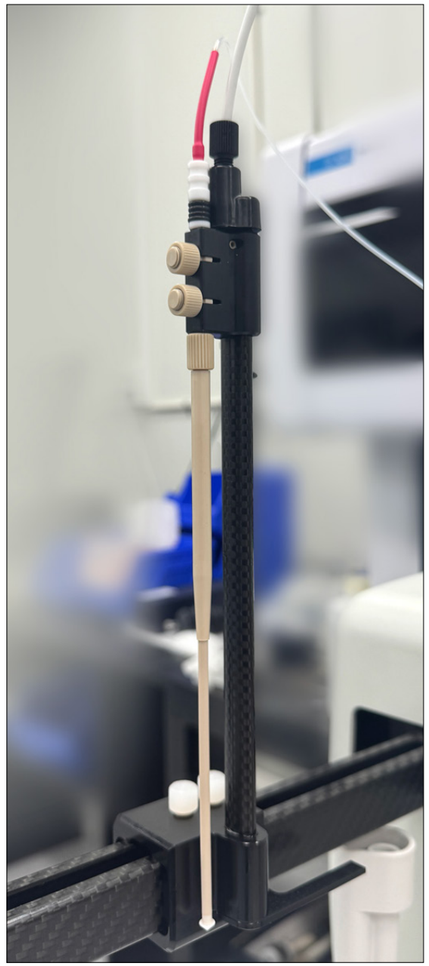
In-Line particle filter: *"By the way, the particle filters that we have purchased are working out very well with our soil sample analyses on our ICP-OES units, have saved a lot of headaches with blocked nebulisers!"*

Soil & Plant Laboratory - Australia

Reducing Nebulizer Blockages Caused by Particulates (2/2)

1b. Guardian Autosampler Probe:

- **Robust tip design** prevents crushed or damaged tips from misalignment
- **Drip-resistance** prevents cross contamination of samples, especially with oils
- **Built-in particle filtering** holds back particulates from blocking the line
- **Completely inert design** Ceramic, PEEK and PTFE construction
- **Interchangeable UniFit™ sample lines** available in various IDs (e.g. 0.3, 0.50, 0.75 & 1.0mm)
- Designed to suit Teledyne Cetac®, Agilent®, PerkinElmer®, Shimadzu®, Aim Lab and Thermo Fisher Scientific™ Autosamplers
- ***Click here to view the Guardian Probe Flyer***



Guardian Autosampler Probe
for Cetac ASX-200/500/800 Series

Reducing Nebulizer Blockages Caused by Salt Build-Up

Why address high TDS issues?

- Salt deposits form when high-TDS or acidic solutions evaporate at the nebulizer or injector tip
- Leads to analytical drift or even plasma extinguishing

How to solve it?

1. Elegra™ Argon Humidifier

- Adds moisture to argon gas → prevents salt build-up and reduces maintenance
- Operates without heating or electricity using efficient **membrane humidification technology**
- Flexible configurations: single- or dual-channel versions with custom gas fittings
- Complements a high-TDS sample intro setup: **SeaSpray™ /DuraMist™ nebulizer, Twister™ spray chamber, and wide-bore injector**

(In reference to the Elegra: *"Talking with my operators that are here today neither of them has changed a nebulizer since we put it on... We had been replacing nebulizers after about a week and a half... I will be ordering 2 more.*

Contract Laboratory - USA

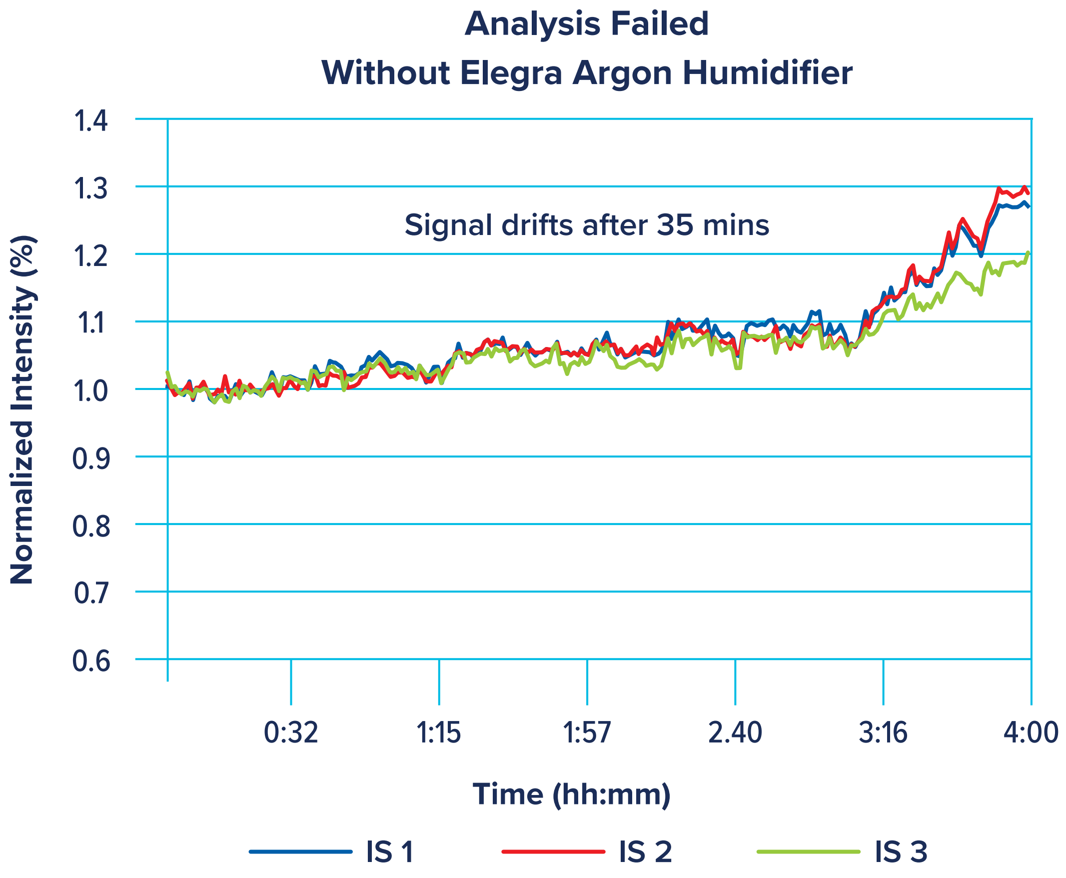
SeaSpray™

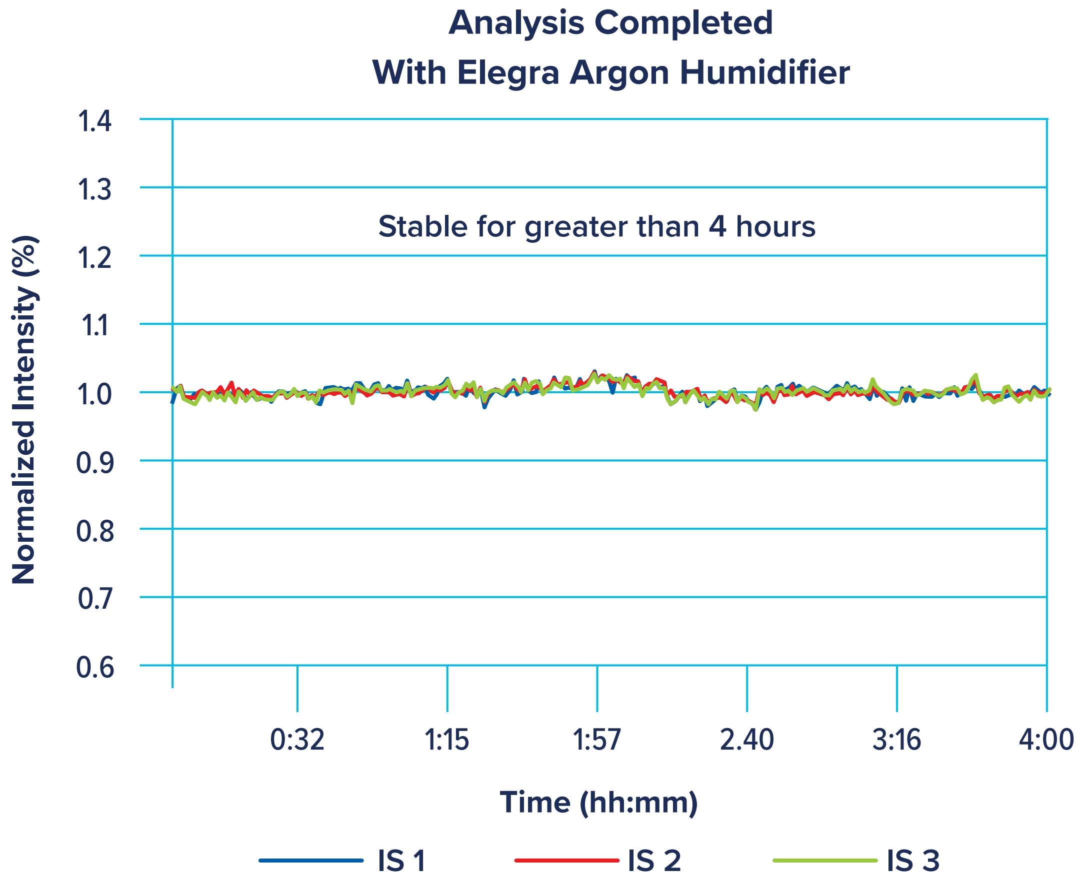
DuraMist™

Samples With High TDS: Argon Humidifier

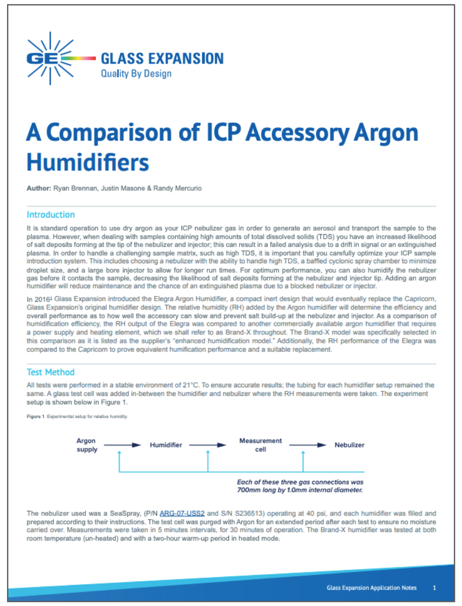
Performance

- Includes easy-use bypass switch to disable humidification without disconnecting lines
- Tested to deliver over **4 hours of stable internal standard signal with high-salt samples,** outperforming other humidifiers
- Superior performance: up to 60% more effective relative humidity than competing models

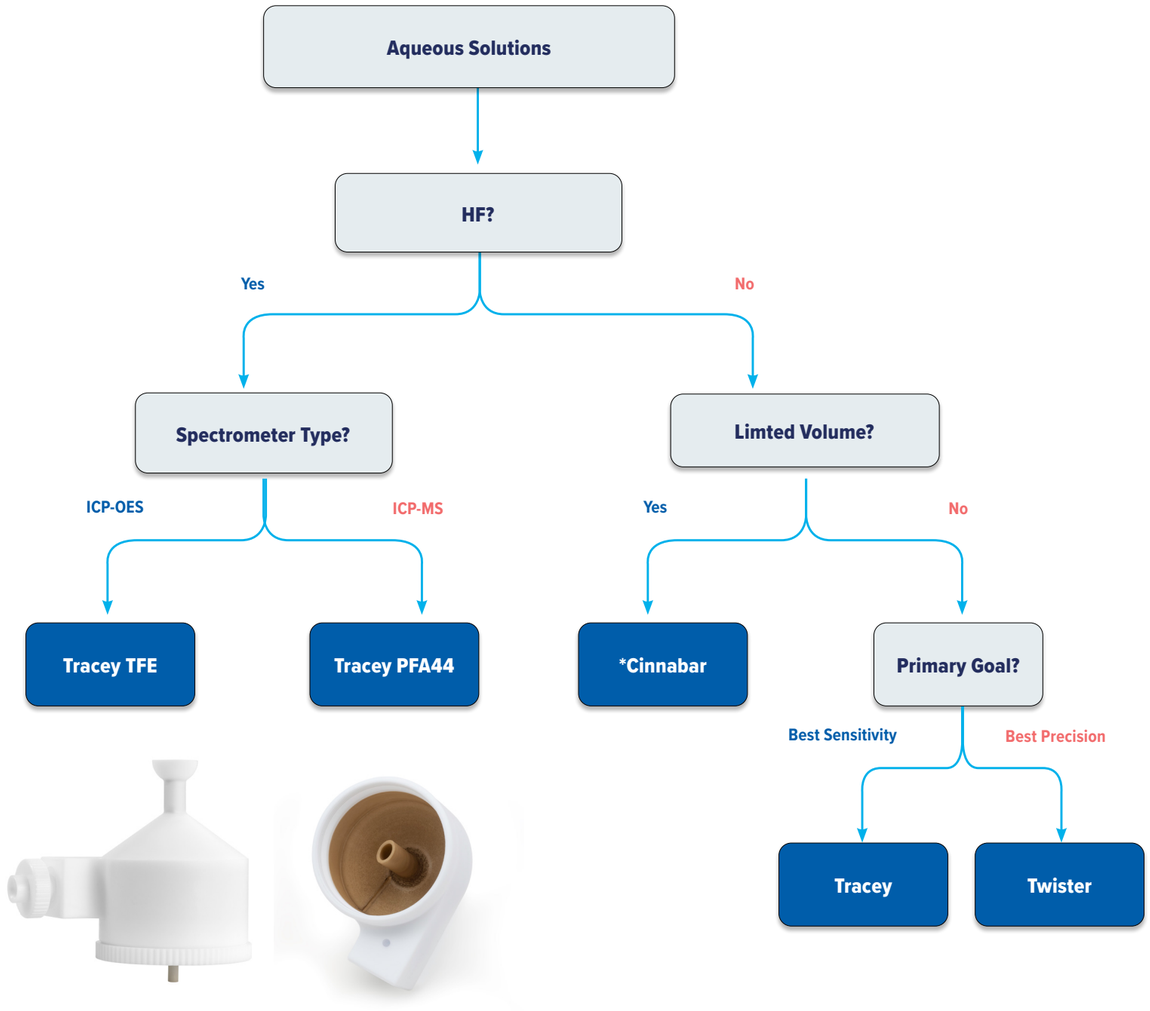


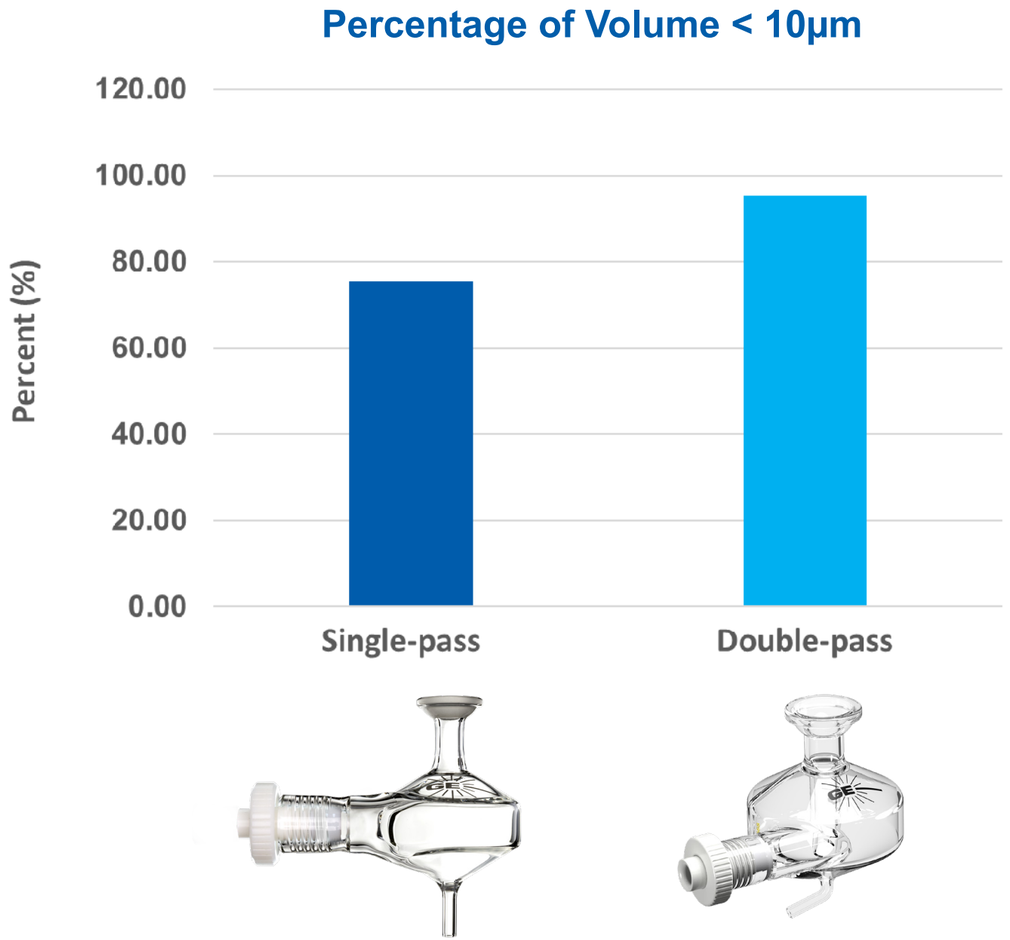


Elegra Application Note



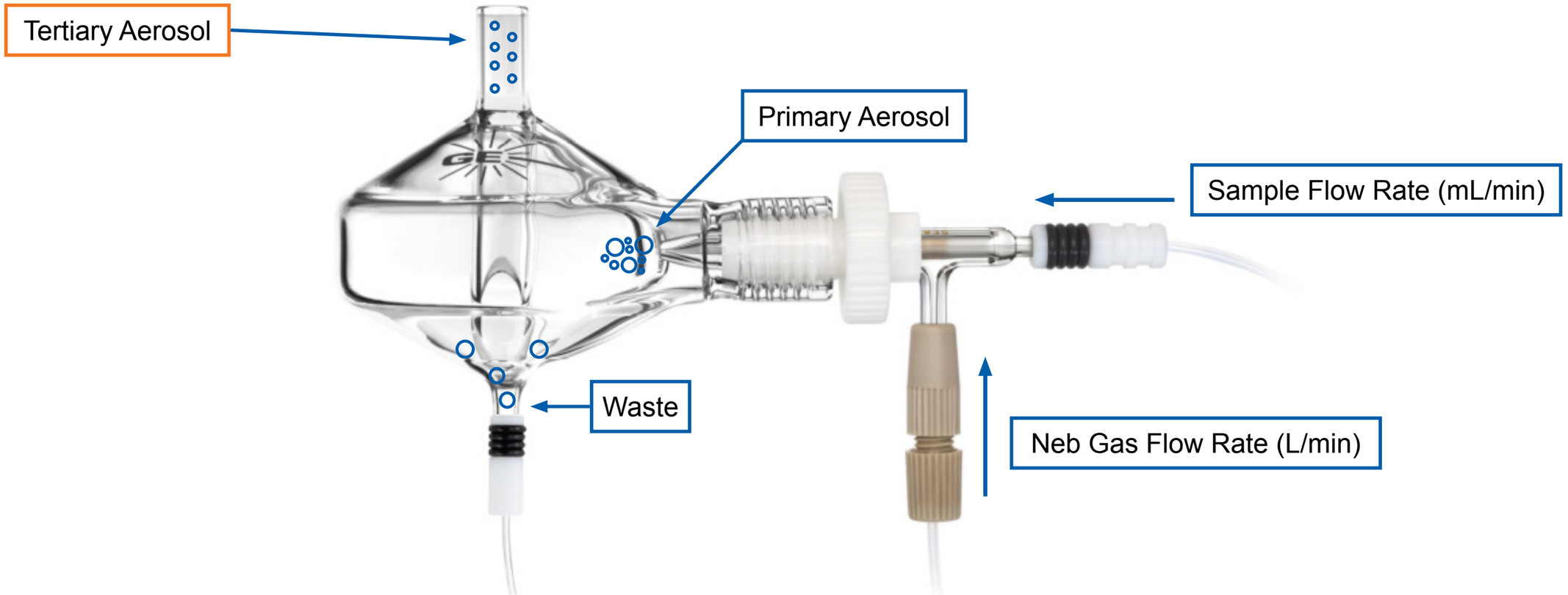
Spray Chambers: Selection





Precision & Sensitivity: Design Considerations

Quality of Aerosol ∝ Quality of Results

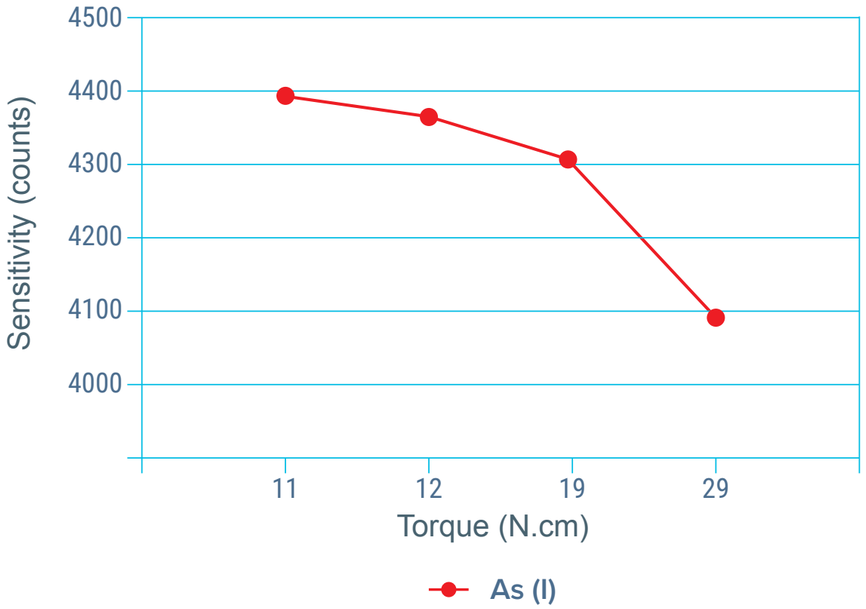


Smaller Droplets Require Less Energy = Efficient Ionization

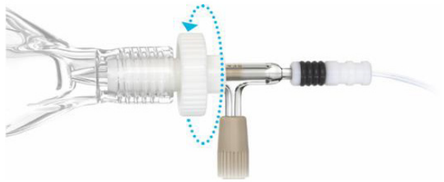
Spray Chambers: Helix CT Interface

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

Optimum Sensitivity

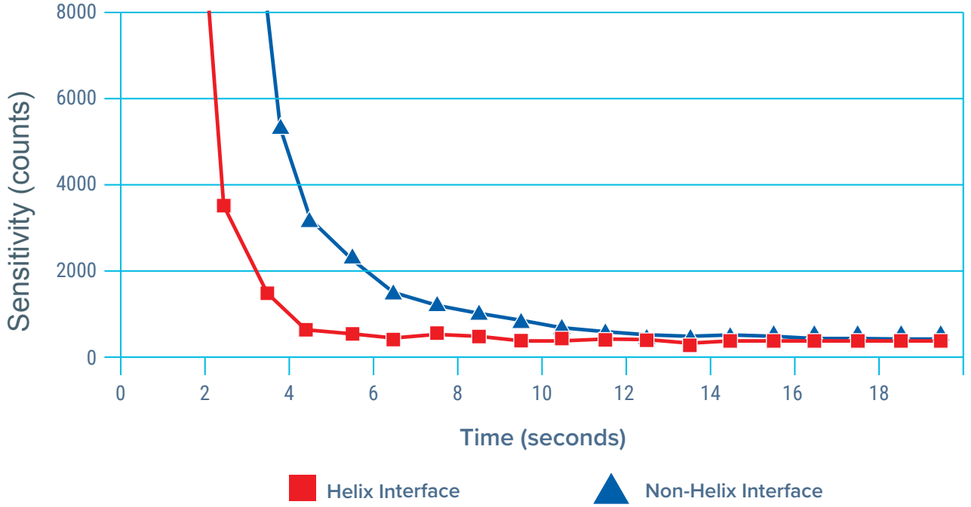


Built-in torque control mechanism



Non-Helix Interface

Improved Washout



Download the Helix CT ICP Spray Chamber Application Note

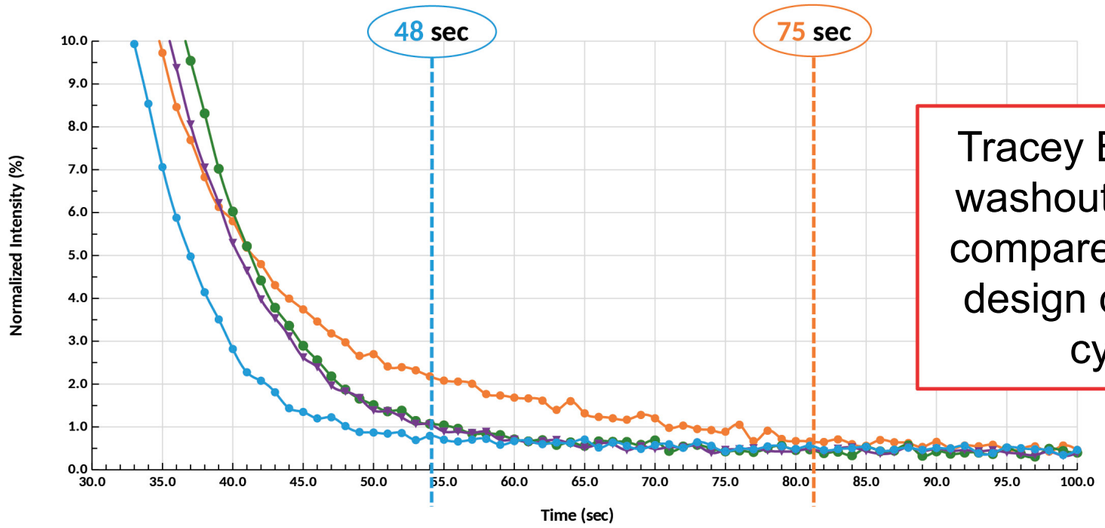
Tracey™ BC Spray Chamber: Design Considerations

Challenges in Routine ICP Work

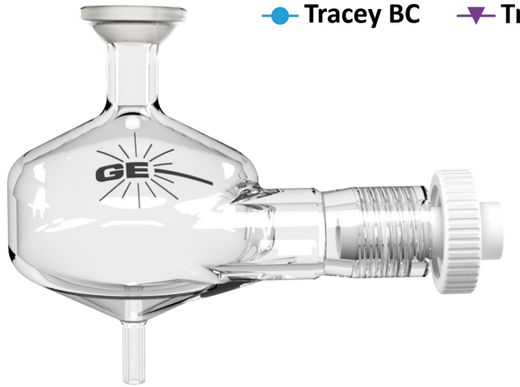
- Frequent O-ring wear and replacement
- Long washout times and memory effects
- Poor wetting or carryover with HF or harsh matrices

How the BC Design Helps

- **No O-rings** → Less maintenance, faster washout
- **Low-Volume 30mL Cyclonic** → Shorter stabilization, better throughput
- **Broad Compatibility** → Fits E-Torch, D-Torch, SDT/FDT
- **Cost-Effective** → Practical choice for routine analysis
- **Improved reproducibility** in maintaining tighter overall size specifications



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



Tracey™ Ball Joint Connection (BC) Spray Chambers

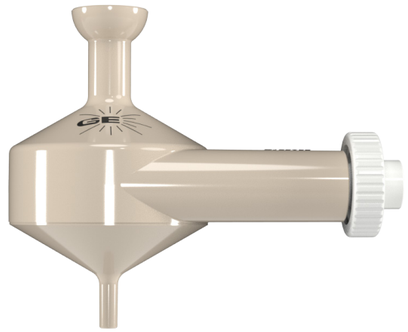
Exploring the Tracey™ BC PEEK Spray Chamber for Your Workflow

- **PEEK Construction** → Good chemical resistance (up to 5% HF)
- **Superior Wetting:** PEEK material maintains excellent wetting properties with routine laboratory cleaning.
- **No Internal Surface Treatment:** Unlike TFE or PFA, this spray chamber requires no internal surface treatment.

Comparison of Tracey BC PEEK to the PTFE Tracey

Below are the average intensity and RSD results from 41 optimization checks using the PEEK and PTFE spray chambers.

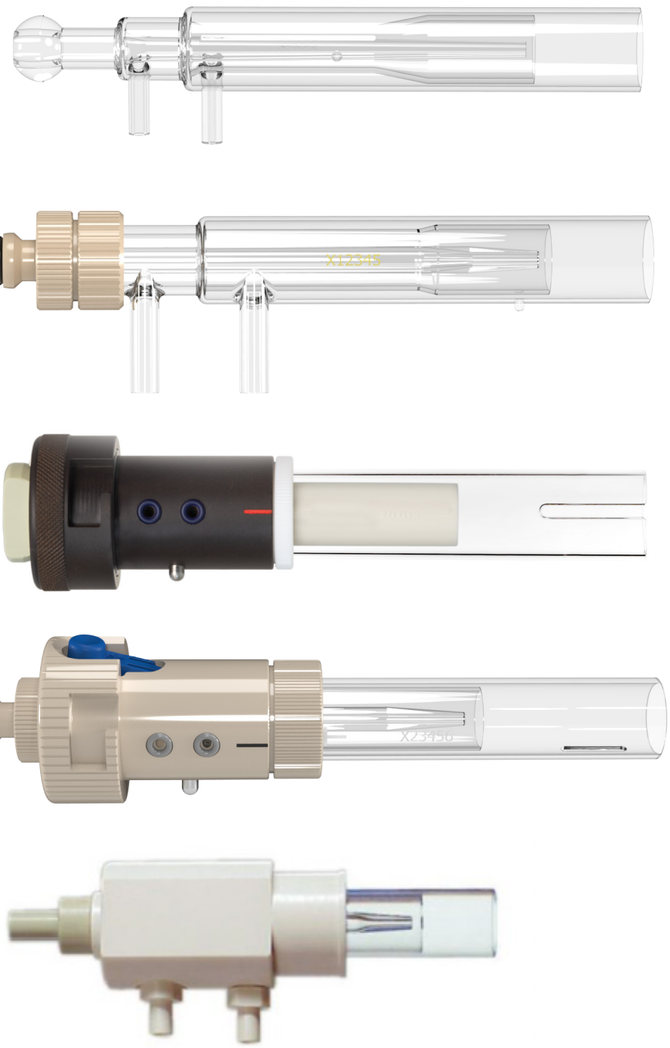
- The Optimization Solution contains 2 ppm Pb, As, and Mn in 1% HNO_3.



	% Increase in intensity	%RSD
Pb	74%	0.65
As	90%	0.69
Mn	68%	0.68

**Comparison conducted by Specialty Chemicals Manufacturer – USA*

Torch: Selection



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:
   - *Narrow bore quartz: 1.0mm or less:* volatile organics
   - *Large bore quartz, 2.0mm or greater:* High TDS
   - *Ceramic (alumina):* HF-containing samples
   - *Platinum/Sapphire Injectors:* Inert applications

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

4. **E-Torch:** Removable: Injector, outer tube. Outer tube can be cleaned in muffle furnace

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

Recommendation for frequent Torch Replacements (1/2)

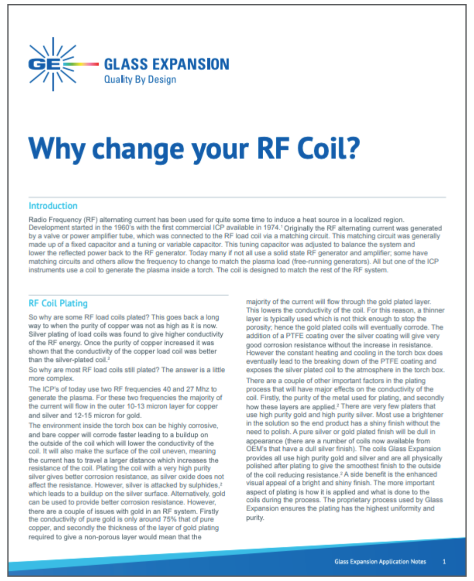
Identify the root cause:

1. Torch Contamination

- **Cause:** Salt, organic, or metal deposits on quartz surface reduced torch life, especially under high temperatures
- **Mitigation:** Clean torch regularly using appropriate methods for organics, salts, and metals [Click Here for Torch Care]

2. RF Coil Condition:

- **Optimal Alignment & Cleanliness:** Properly aligned, clean, and well-plated RF coil improves energy transfer to the plasma
- **Signs of Issues:** Misaligned torch or RF coil can cause instant torch meltdown, arcing, or unstable plasma
- **Mitigation:** Regular cleaning, temperature control, and timely RF coil replacement help extend torch life and maintain stable plasma operation


GLASS EXPANSION
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Why change your RF Coil?

RF Coil Application Note

Recommendation for frequent Torch Replacements (2/2)

Identify the root cause:

3. Aggressive Sample Matrices

- **Causes:** Aggressive sample matrices with high TDS, salts, organics, or fusions
- **Examples:** Soils, wastewater, brines, high-acid digests, lithium fusions

  High Salt deposits and high plasma temperatures lead to faster devitrification of quartz outer tubes
- **Mitigation:** Use a demountable D-Torch → replace only the outer tube, lowering cost of ownership
  - **Upgrade:** Optional ceramic outer tube → resists devitrification, lasts longer, and maintains plasma stability
  - **Benefits:** Ideal for high-TDS, salty, or organic samples; hotter, more robust plasma improves sensitivity

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

ICP-MS Cone Material Selection

Nickel Cones:

- **Balanced cost & performance;** standard for many applications
- Good **thermal & chemical resistance;** less prone to corrosion and deposition
- Runs **hotter** than copper, stays cleaner longer, more stable signals
- Suitable **for routine aqueous samples** (<5% acid, non-HF, non-organic)

Nickel-Plated Cones:

- Ideal for samples with >5% acid concentration
- Nickel plating boosts chemical resistance while **retaining copper's efficient heat transfer**
- **Helps prevent overheating** and rapid orifice degradation, preserving sensitivity and stability

Platinum Cones:

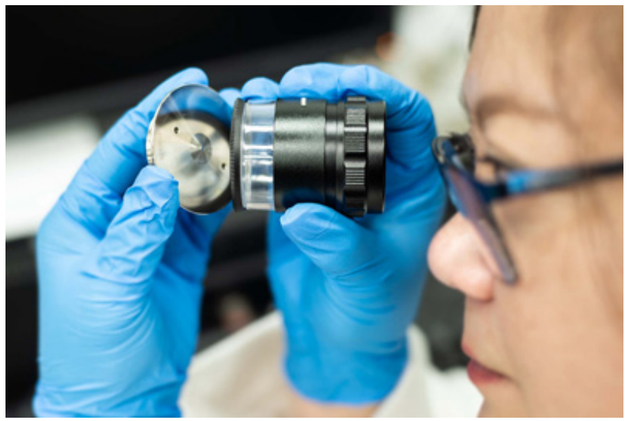
- Most durable, longest-lasting, but highest cost
- Excellent chemical resistance - ideal for **high-matrix, high acid,** or organic **solvent samples**
- Least efficient heat transfer → runs **hotter**, but stays **cleaner longer**
- Can be **refurbished 2-3 times** and **recycled** for reclaim value towards future purchases

ICP-MS Cone Resource Guide

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:

3 recommended methods, from gentlest to most aggressive:

- Method A **(Soak in Citranox);**
- Method B **(Sonicate in Citranox);**
- Method C **(Sonicate in Nitric Acid)**

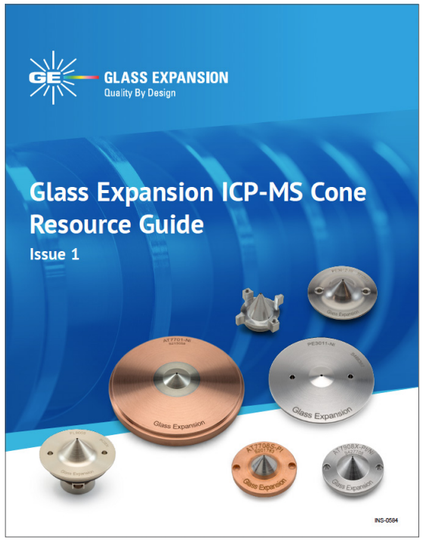
Order of severity (Don't use aggressive cleaners if it isn't needed):

1. **Fluka RB-25**
2. Citranox
3. HNO3

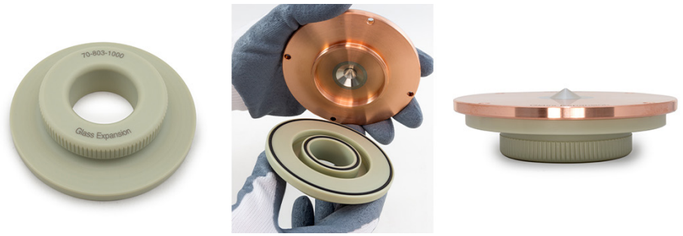
Use of a ConeGuard is highly recommended:

Damage to the threads, whether by corrosion or distortion, can lead to premature failure of the cone or worse - damage to the interface housing

Tips on Care & Maintenance



"Click here"
to view the Cone Resouce Guide

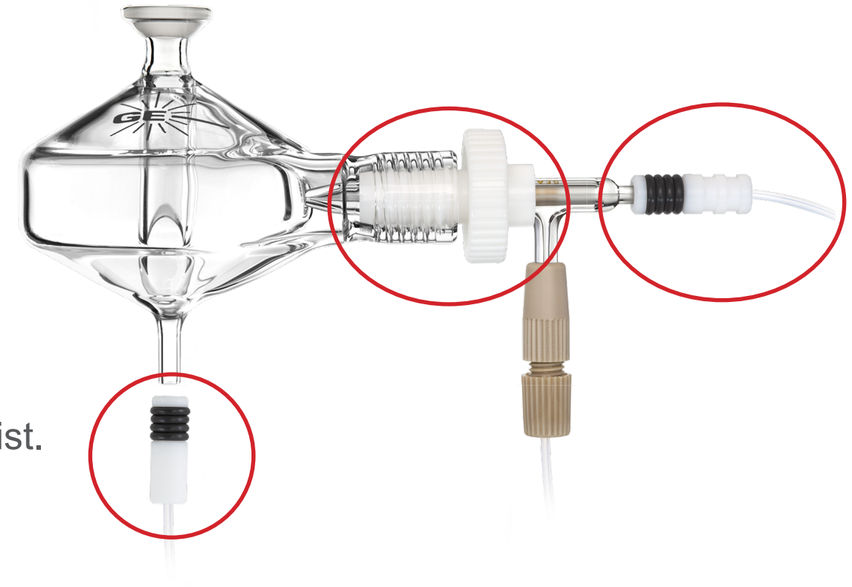


ConeGuard™ ***protects the threads during the cleaning process***

Avoiding Common Connection Problems in ICP Systems

Common Connection Issues:

- **Leaks or loose fittings** between components
- **Air bubbles** in PTFE tubing → indicate poor sealing
- **Improperly seated waste drain** → causes unstable flow and poor precision
- **Worn tubing** → leads to air leakage
- **Blocked or kinked lines** → restrict sample flow



Quick Checks:

- **Free-Flow Test:** Disconnect nebulizer from spray chamber and check for a fine, steady mist.
- **Drain:** ensure smooth drainage.
- **Visual Inspection of sample pathway:** Look for any small bubbles or wet fittings.

Practical Tips:

- Replace stretched or worn pump tubing regularly.
- Use tight, clean, and compatible connectors:
- **Zero Dead Volume Connections:**
  - Between Sample line and nebulizer: Unifit connector
  - Between Waste tubing and spray chamber: Unifit connector
  - Between nebulizer and spray chamber: Helix CT

OLD DESIGN:

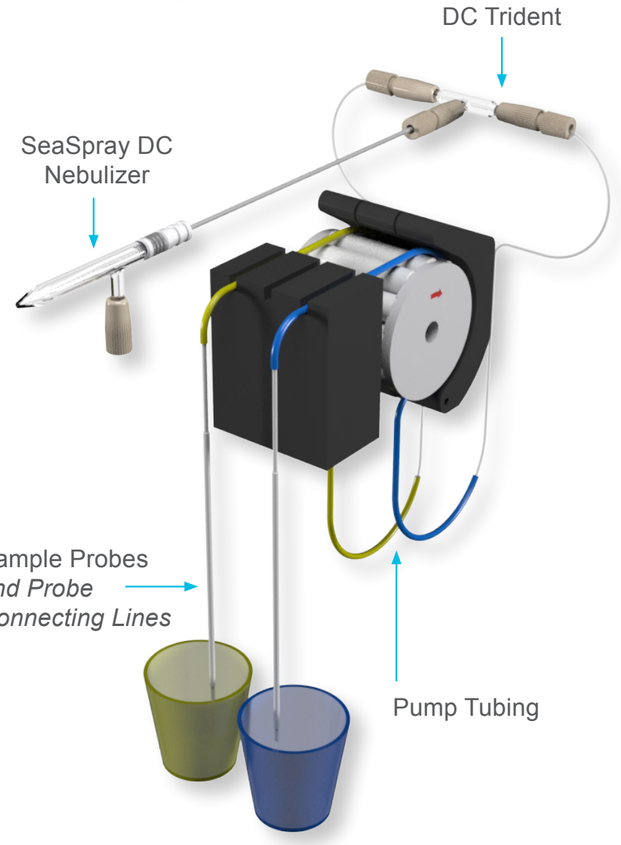
EzyFit sample tube connector

Non-Helix Interface

Enhancing ISTD Recovery by Minimizing Leaks and Contamination

1. Trident CT™ Internal Standard Addition Kit

- 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.



Trident CT Internal Standard Kit
P/N 60-703-1179

Trident Dilution Factor Calculator

Do you need to know how much your sample and internal standard are diluted?

Simply select your peristaltic pump tubing and our Dilution Factor Calculator will show you.

Sample pump tubing: orange/green, 0.38mm ID

Internal standard pump tubing: orange/black, 0.13mm ID

Sample is diluted by **10.5%**
ie Final conc. of sample is **0.895** times initial concentration

Internal standard is diluted by **89.5%**
ie Final conc. of internal standard is **0.105** times initial concentration
or Internal standard is diluted by a factor of **9.5**

This calculation should be used as a guide only. Variations between pump tubes and roller pressures mean that the accuracy of the calculation cannot be guaranteed.

Trident Dilution Factor Calculator

Thank You

Glass Expansion - Europe
Weilburg, Germany

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