

Practical Strategies For Faster, More Reliable Oil Analysis



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Common Challenges for Used Oil Analysis

ASTM D5185:

- Particulate restrictions & blockages
- Inconsistent sample uptake rates
- Carbon buildup (soot) on torch & injector
- Unstable or “cool” plasma conditions
- Torch / injector erosion
- Calibration & Internal standard drift
- Carryover & cross-contamination
- Extended rinse / washout cycles
- Increased frequency of torch, injector, and nebulizer replacement



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Sample Introduction Solutions for Used Oil Analysis

1. Guardian Autosampler Probe:

- Particulate restrictions & blockages
- Carryover & cross-contamination
- Increased frequency of nebulizer replacement

2. Slurry Nebulizer:

- Inconsistent sample uptake rates
- Unstable or “cool” plasma conditions
- Calibration & internal standard drift

3. Tracey BC Spray Chamber:

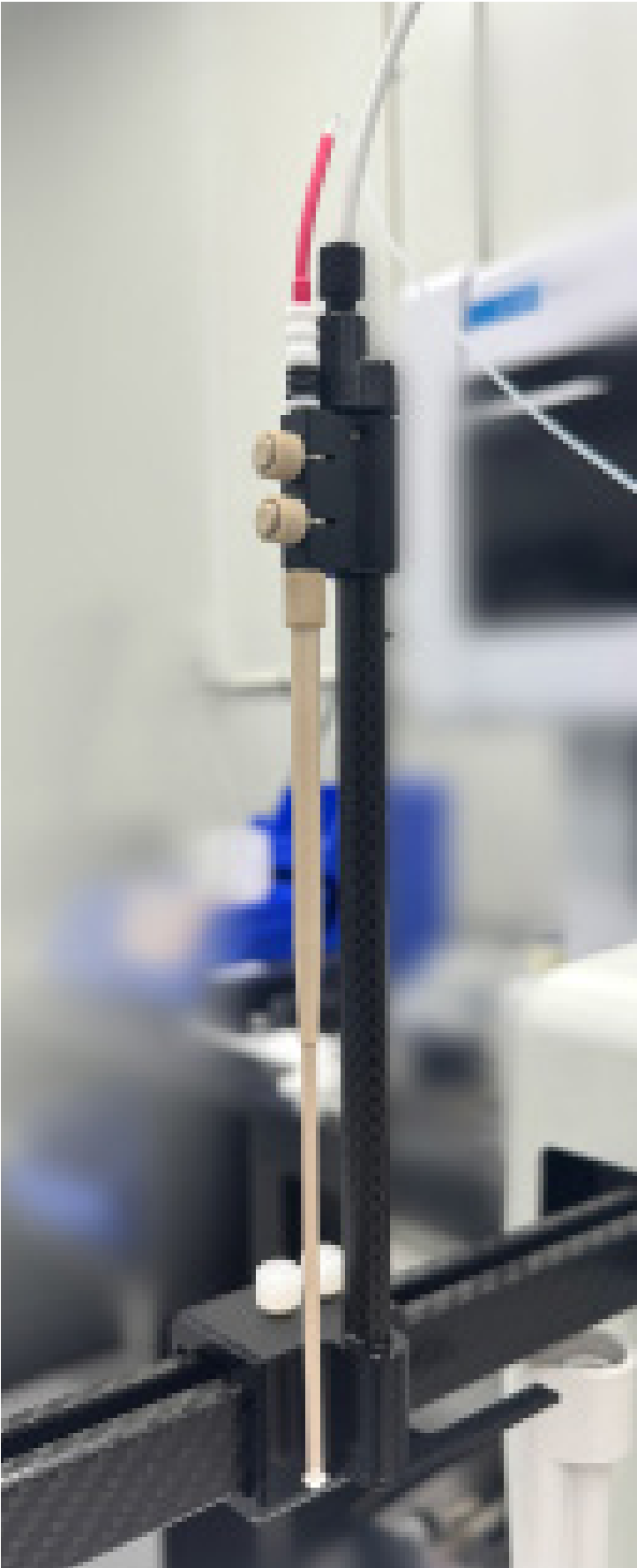
- Extended rinse / Washout cycles
- Calibration & internal standard drift

4. E-Torch:

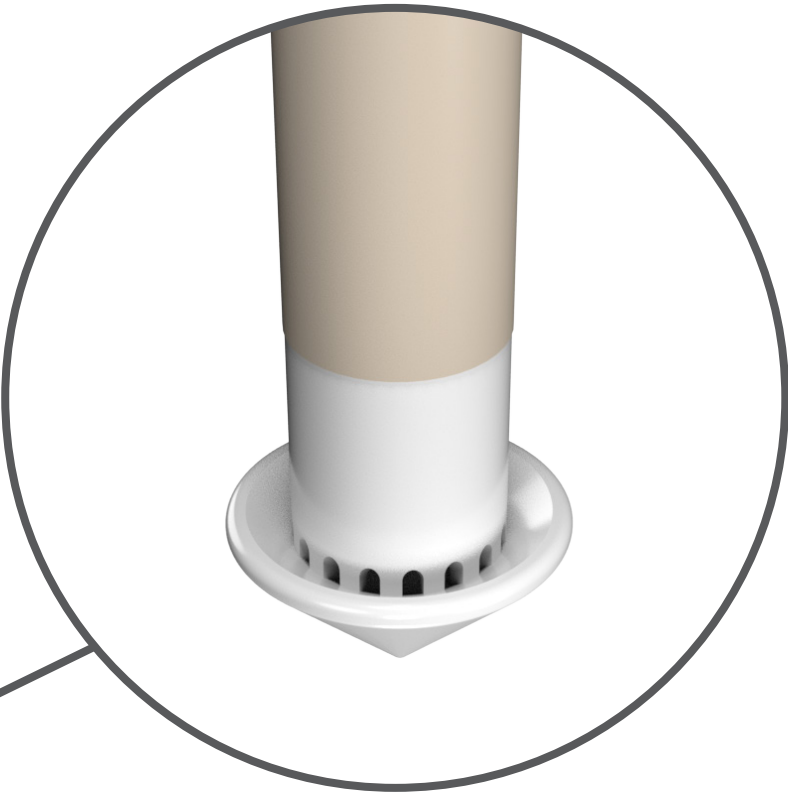
- Carbon buildup on torch & injector
- Torch & injector erosion
- Increased frequency of torch & injector replacement
- Calibration & internal standard drift



How Sample Probe Design Can Influence Sample Delivery Performance and Sample Throughput



Guardian Probe Assembly
for ASX-200, 500, 800 Series
P/N 70-803-1787



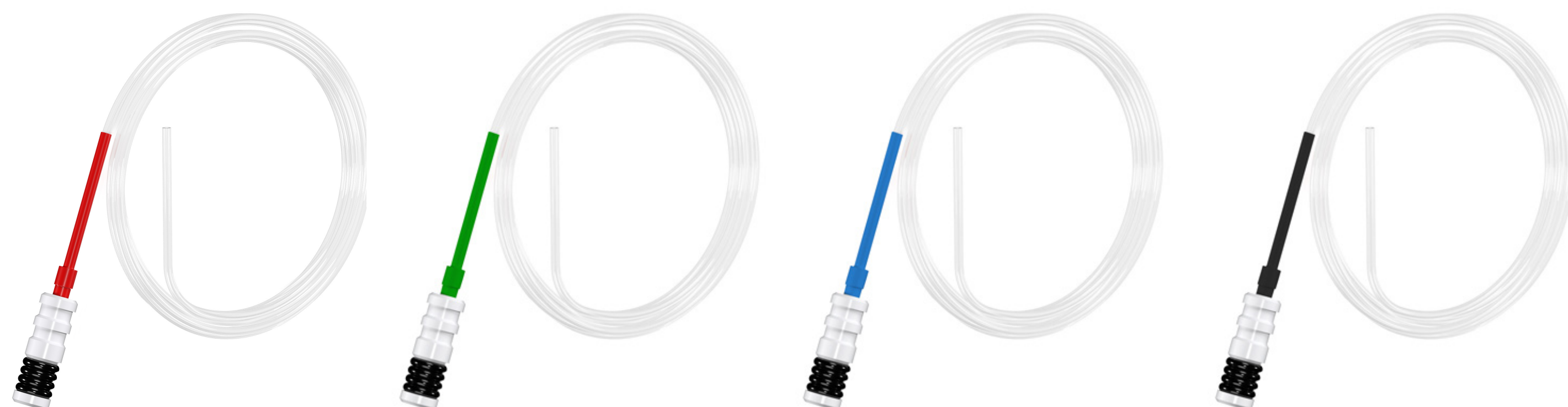
Environmental Laboratory – Denmark: *“We are absolutely in love with this probe. The filter in the tip works perfect.”*

Sample Delivery Challenge	Design Approach	Analytical Benefit
Particle entry into sample line	Ceramic cone tip with a ring of precision formed apertures at the base of the tip	Holds back particulates before they reach the capillary line, helping prevent sample line and nebulizer blockages
Residual droplets on probe surface	Cone-tip design with controlled drainage	Reduced carryover and helps prevent drips from clinging to the tip
Sample transfer between vials	Flared collar skirt	Captures residual sample running down the probe’s length, reducing cross contamination as it moves across other sample vials
Probe tip damage or misalignment during handling	Robust cone tip nose	The pointed cone-tip helps guide the probe into vial openings under minor misalignment, reducing the risk of crushed tip or damaged probe



Guardian™ Autosampler Probe

- Interchangeable UniFit™ sample lines IDs: 0.3, 0.50, 0.75 and 1.0mm - Easy and low-cost to replace and maintain clean sample path.



Optional Fittings



P/N 70-803-0749



P/N 70-803-1350



P/N 70-803-1859

- Color-coded for easy identification and optimization for different applications.
- For use with a high-throughput OEM valve system (high uptake rates), use 1.0 mm.
- For most common ICP-OES applications, choose 0.75 mm.
- For most common ICP-MS applications, choose 0.5 mm.
- For sample flow rates of 0.2 mL/min or lower, 0.3 mm is ideal.
- Optional fittings for convenient connections to a valve or pump tubing.



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Why Guardian™ Autosampler Probe?

Reduced Re-Analysis Time	Dripping between samples, a common cause of failed calibration curves, and QC samples is eliminated. Laboratories report reclaiming hours of previously lost instrument time each week.
Fewer Nebulizer Failures	By intercepting particulates before they reach the nebulizer, the Guardian Probe extends service life and significantly reduces unplanned maintenance.
Fewer Switching Valve Replacements	By intercepting particulates before they reach the switching valve, the Guardian Probe helps extend valve service life and significantly reduces unplanned maintenance. When particulates enter the valve, the repeated back-and-forth rotation of the valve can cause particles to score the internal surfaces of the flow path. Over time, this can lead to leakage, cross-contamination and carryover problems.
Enhanced Robustness Across Sample Types	From dilute aqueous standards to viscous semi-refined oil matrices, the Guardian Probe performs consistently across all sample types.
Improved Data Integrity	By preventing cross-contamination and carryover, the Guardian Probe safeguards the integrity of every data point.
Easy Integration	Designed as a direct drop-in replacement on the most popular autosampler platforms, no modifications, no special tools, and easy installation.
Lower Total Cost of Ownership	Fewer nebulizer replacements, less re-analysis, and reduced downtime translate directly to lower operating costs and higher laboratory throughput.

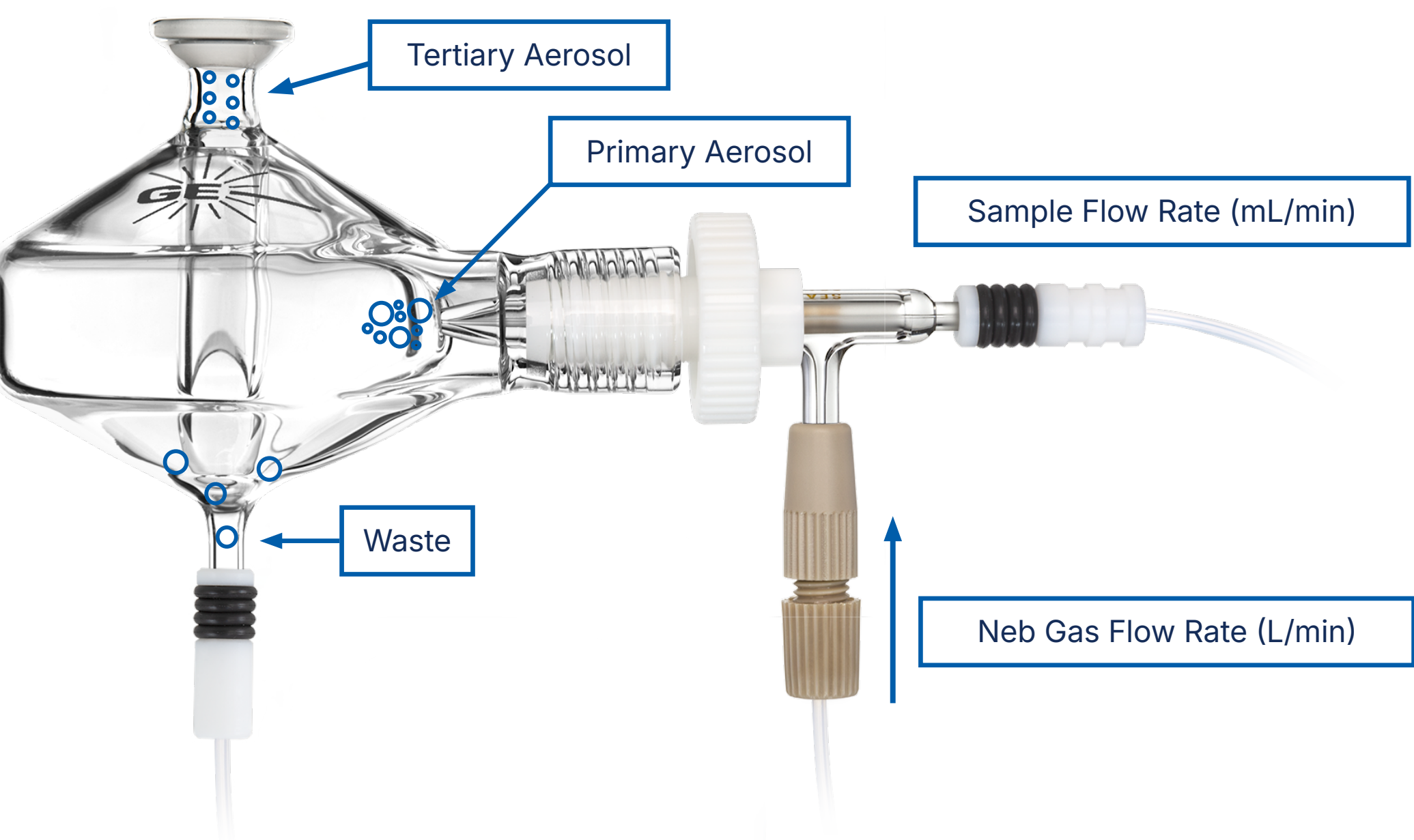


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Nebulizer Aerosol Generation

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



Factor	Effect on ICP Performance	Design/ Operational Considerations
Droplet size distribution	Determines transport efficiency, plasma loading and sensitivity	Nebulizer geometry, gas velocity, liquid flow rate
Aerosol uniformity	Directly affects precision and signal stability	Stable gas/liquid interaction and consistent nebulization
Sample aspiration rate	Changes aerosol production and plasma loading	Pump tubing, uptake rate, nebulizer design
Gas flow conditions	Influences droplet breakup and transport	Optimized nebulizer gas flow and pressure
Matrix properties	Affect atomization and droplet formation	Viscosity, surface tension, dissolved solids

Because only ~1–2% of the sample reaches the plasma, even small disturbances can significantly affect signal stability and sensitivity.

Slurry Nebulizer - Ideal for Wear Metals in Engine Oils

- Material: Borosilicate glass
- A high physical reproducibility (1%) guarantees consistent performance of replacement nebulizers, backed by Glass Expansion's Value Proposition
- TDS tolerance, typically ~ 1%
- **High tolerance to particulates, typically up to 280µm**
- Low RSDs due to highly accurate construction
- Slurry nebulizers have a natural liquid uptake of 4mL/min but **operate best between 1.5 and 2.5mL/min**
- Instrument Suitability: ICP-OES

The Slurry nebulizer excels at exactly what it sounds like, the analysis of slurries or samples with undissolved particulates. The common sample types include slurries, suspensions, oils (including used engine oil, edible oils, and other oil-based lubricants), and organics such as engine coolants and antifreeze. A number of ICP-OES instrument manufacturers recommend the Slurry for used oils.



Common standard testing methods include:

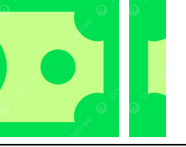
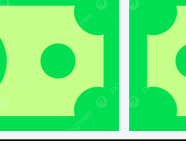
- ASTM D5185 - Used Oils and Wear Metals
- ASTM D6751 - Biodiesel
- ASTM D7691 - Crude Oils
- ASTM D4951 - Unused Lubricating Oils

A Comparison of Nebulizers Using New ASOSolv™

- Inorganic Ventures found the analytical performance of the Slurry™ to be superior when compared to the V-Groove nebulizer using their new bio-based organic solvent (ASOSolv™).
- Used a 5 ug/g (ppm) calibration standard to compare sensitivity and precision.
- Final sample matrix was 1:10 w/w dilution with 10% Organometallic hydrocarbon oil standard (90% ASOSolv™).
- Analysis was performed with Spectro ARCOS III ICP-OES in Radial (SOP) mode.



Slurry™

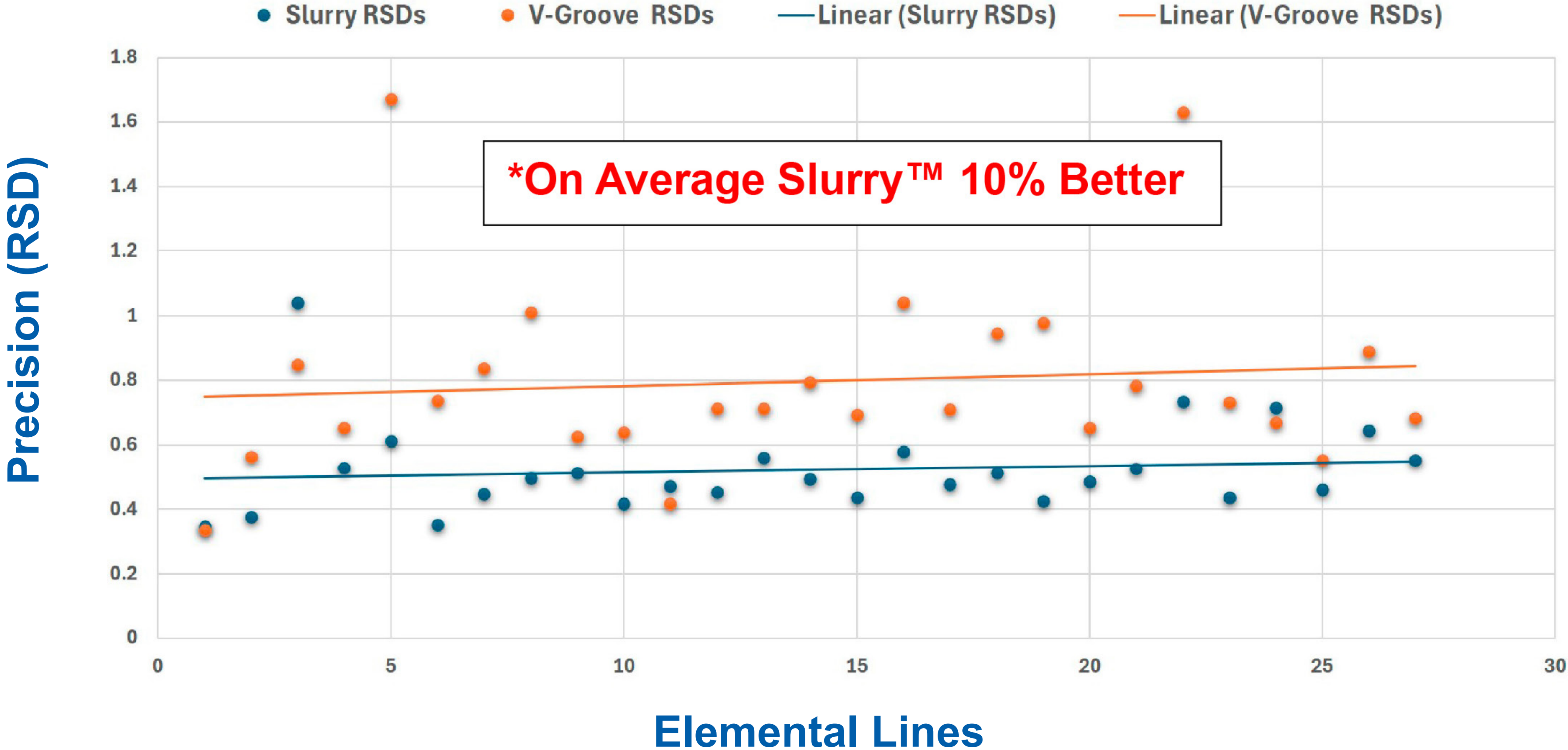
Nebulizer Model	Cost
Slurry™	
V-Groove (Glass)	
Enhanced V-Groove (Glass)	
Enhanced V-Groove (ULTEM)	 
Enhanced V-Groove (PEEK)	  

Slurry™ 36% More Cost Effective than the average cost

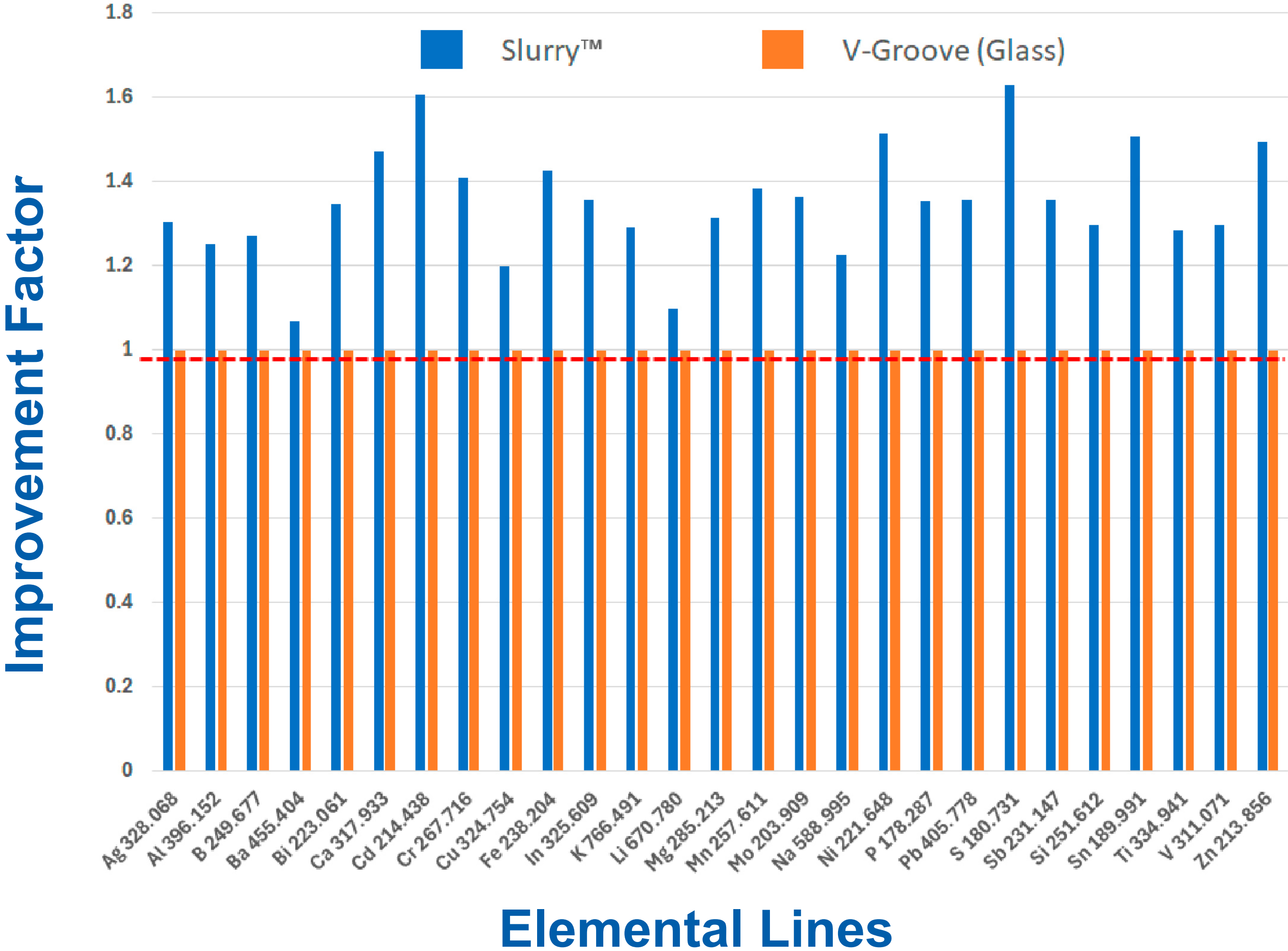


V-Groove Glass

Nebulizer Precision Comparison



Nebulizer Intensity Comparison



***On Average Slurry™
35% Better**

Care of Nebulizers: Other Practical Tips

Check Argon Connections

- Increasing RSDs may indicate a small argon leak at the nebulizer connection.
- Polymer gas tubing can harden over time and lose a gas-tight seal.
- Even **~1% argon loss can significantly affect ICP signals.**

Quick Sample Uptake Check

- Observe the speed of an air bubble in a 10 cm section of uptake tubing.
- Example estimates:
 - 1.0 mm ID tubing: 10 cm in 10 s $\approx$ 470 μ L/min uptake
 - 0.5 mm ID tubing: 10 cm in 10 s $\approx$ 118 μ L/min uptake

Storage Recommendations

- Always **store nebulizers in their protective storage case.**
- Prevent dust or particles from entering the capillary.

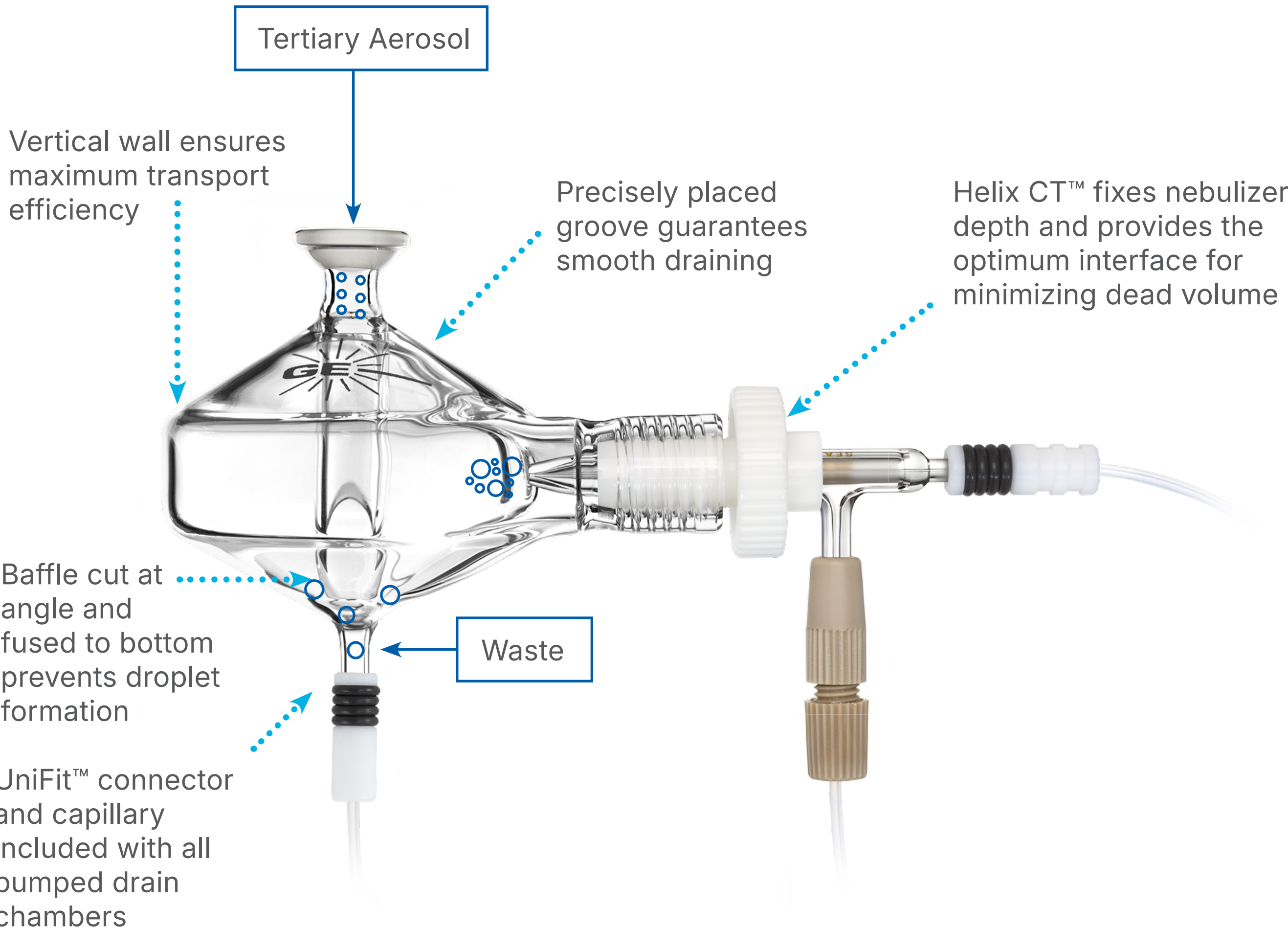


Inspect gas connections



All Glass Expansion nebulizers are supplied in specially designed storage boxes

Spray Chamber Design and Aerosol Filtration



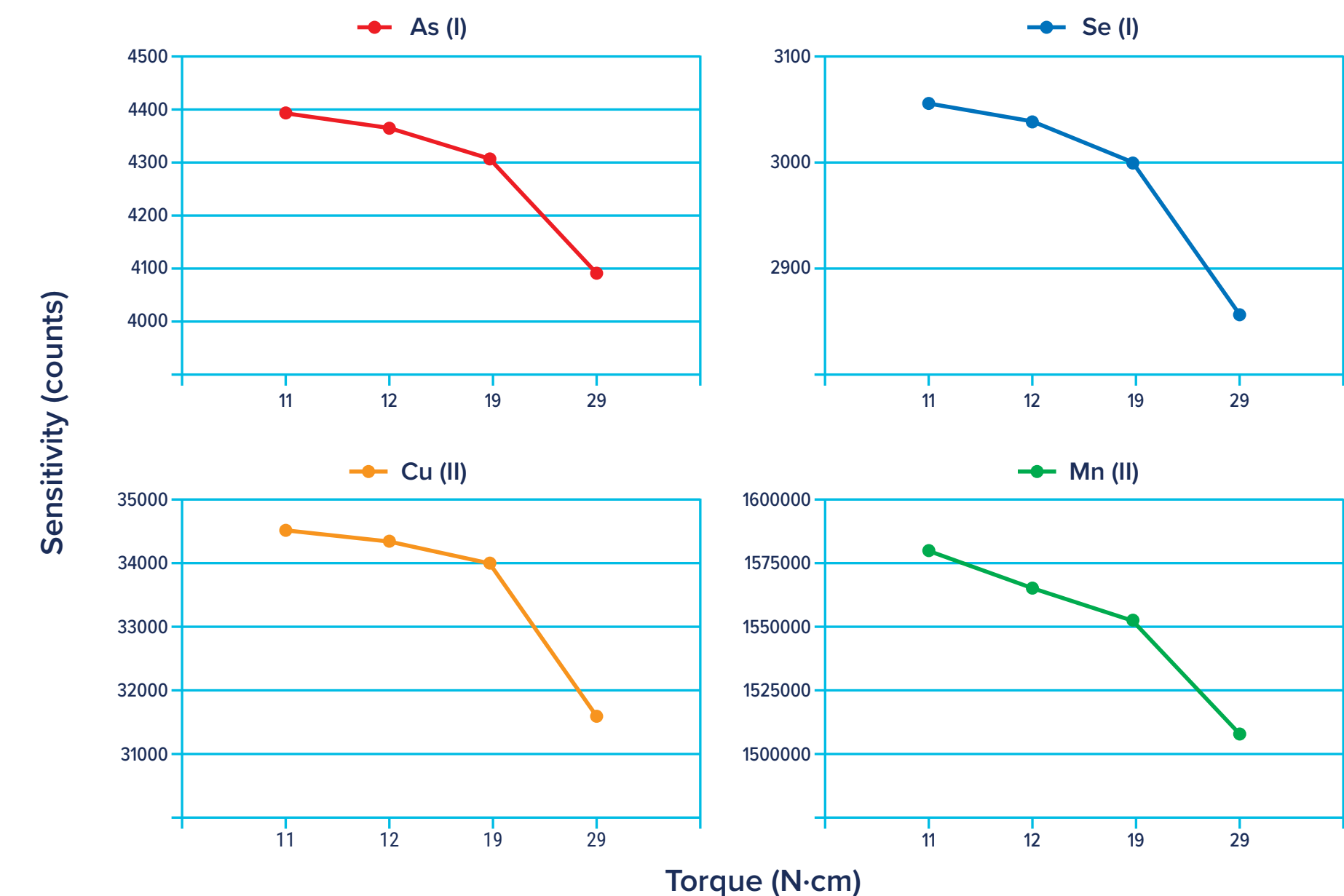
Engineering Parameter	Purpose	Analytical Impact
Droplet seperation efficiency	Removes large droplets	Improved plasma stability
Internal volume	Controls aerosol residence time	Response time and washout
Chamber geometry	Governs aerosol circulation	Precision and transport efficiency
Drainage characteristics	Removes excess liquid	Reduced pulsation and drift



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Benefits of the Helix CT™ - Why Torque Control Matters

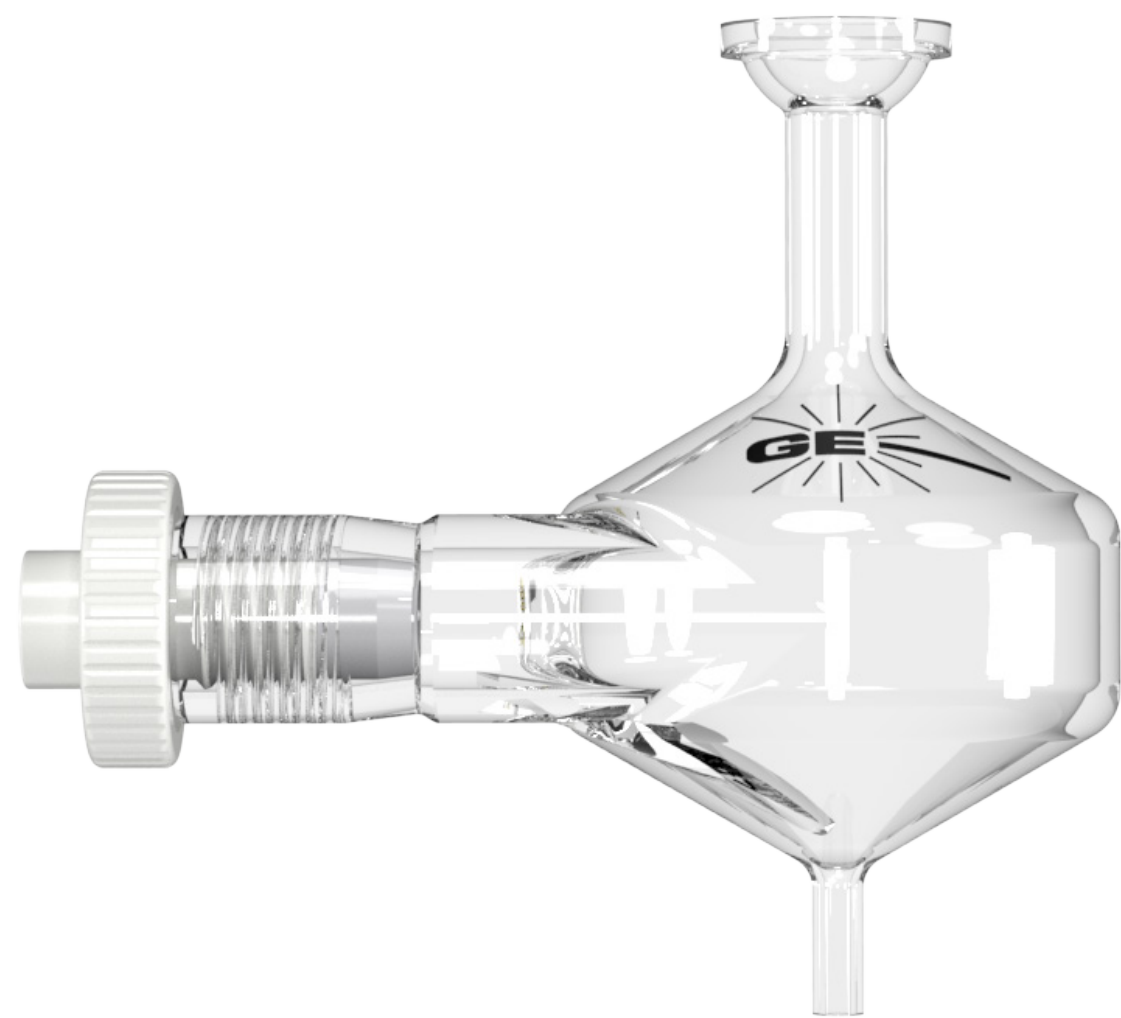
- **Industry-first since 2018**
- **ConstantTorque Locking Screw:** Click-to-seal mechanism makes it impossible to overtighten. Consistent inert PTFE seal every time, protecting nebulizers from excessive installation forces.
- **Inert PTFE PressFit Seal:** Chemically inert PTFE ferrule immune to strong acids and organic solvents. Eliminates all drawbacks of traditional O-ring seals, including broken nebulizers.
- **Zero Dead Volume Interface:** Only interface that significantly reduces dead volume around the nebulizer. Minimizes washout time, reduces carry-over, and improves sample throughput.
- **Optimum Depth & Torque:** Positive stop ensures correct nebulizer depth every time. Combined with ConstantTorque control, delivers unparalleled day-to-day analytical reproducibility and optimum sensitivity.



Tracey™ BC - Optimized Low-volume Design

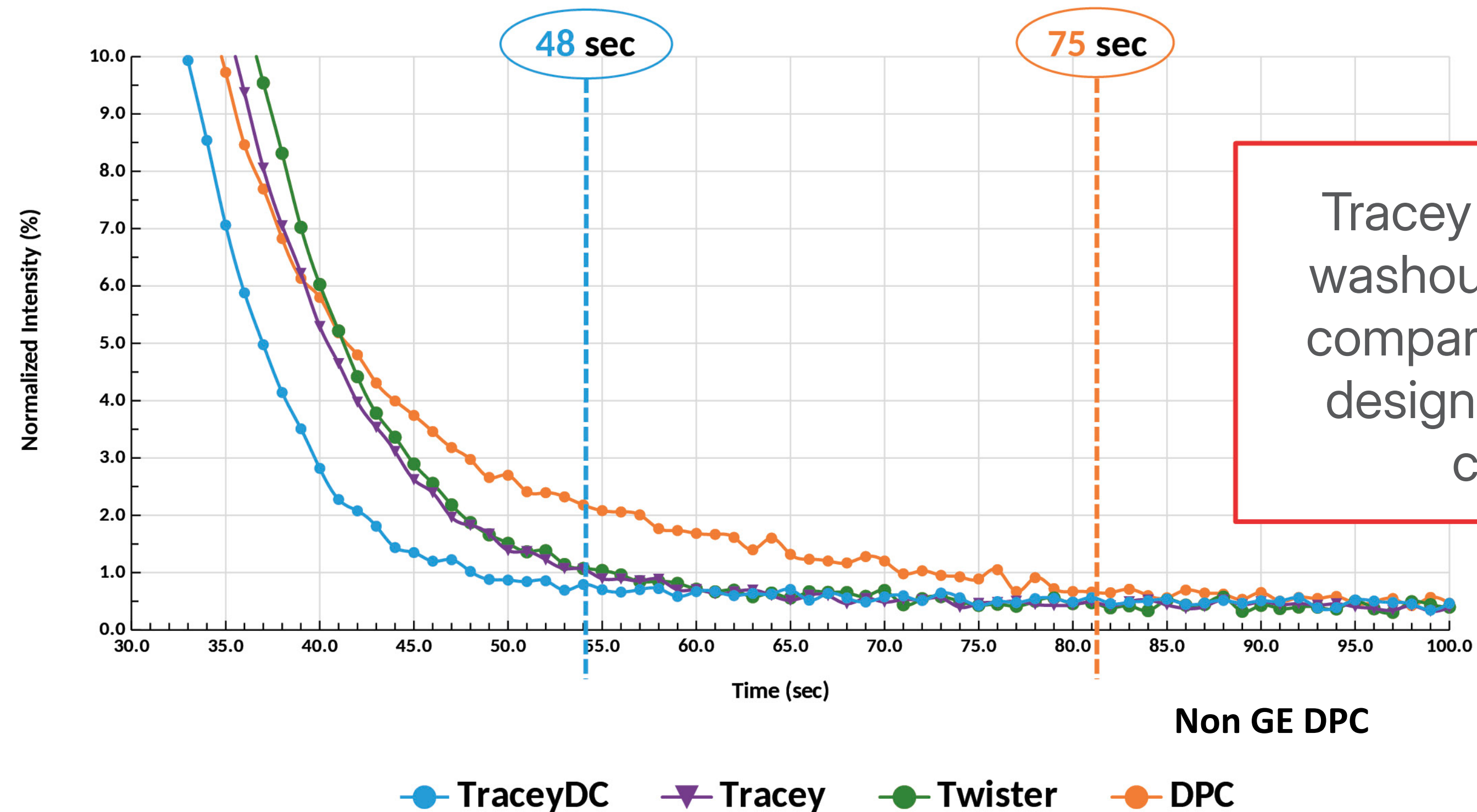
30 mL BC Spray Chamber → Increase the fraction of useful aerosol delivered while reducing unnecessary sample and solvent load.

- Efficient removal of larger droplets
- Reduced aerosol residence time
- Faster stabilization time
- Improved sample throughput



Tracey™ BC Spray Chamber

Washout Profiles for 1 ppm Hg:



Hidden Causes of Instability in ICP Systems

Connection Issues

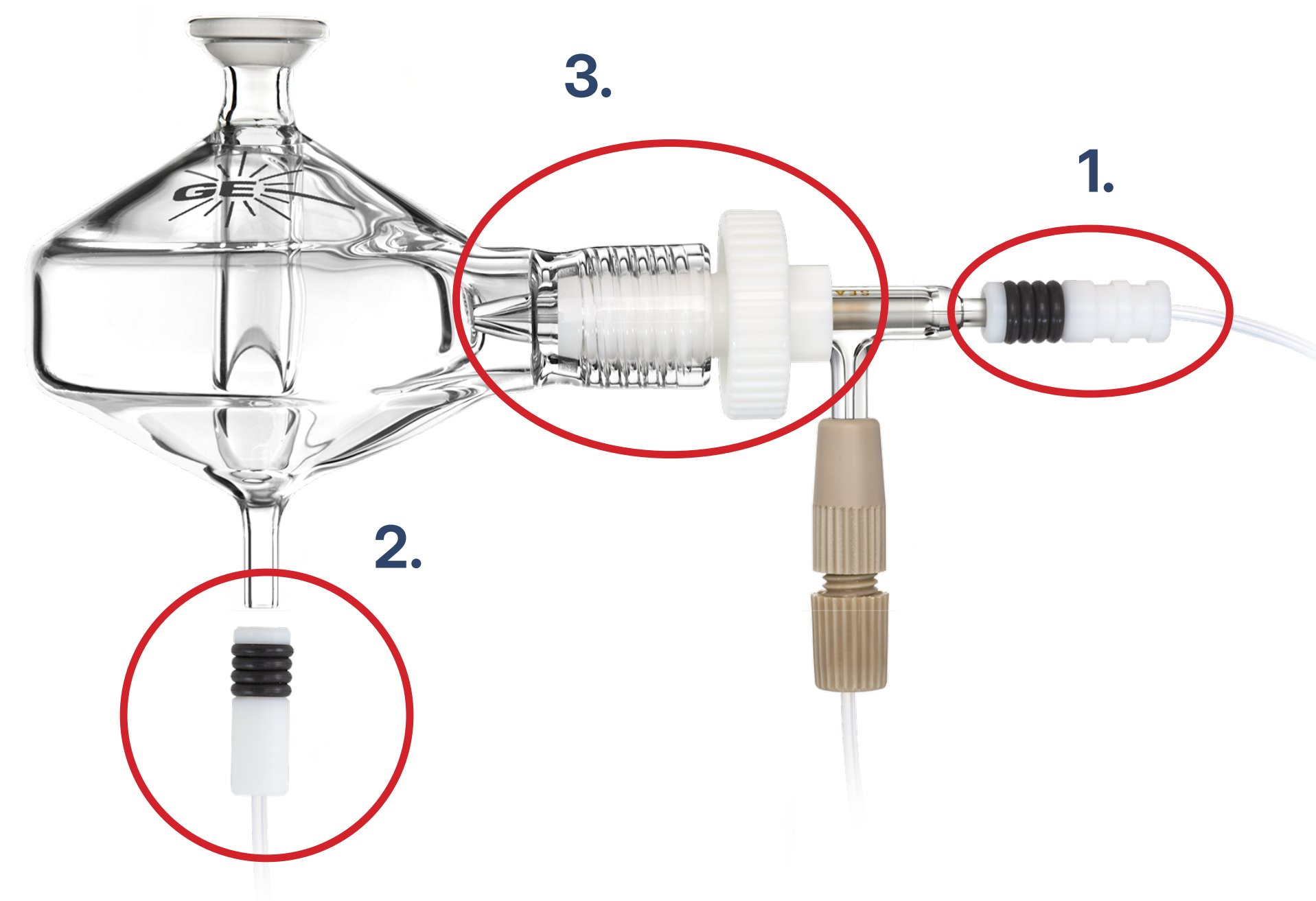
- Leaks or **loose fittings**
- Improper waste drain seating → **unstable flow**
- Worn pump tubing → **air ingress**
- Blocked or kinked lines → **restricted flow**

Zero Dead Volume Connections

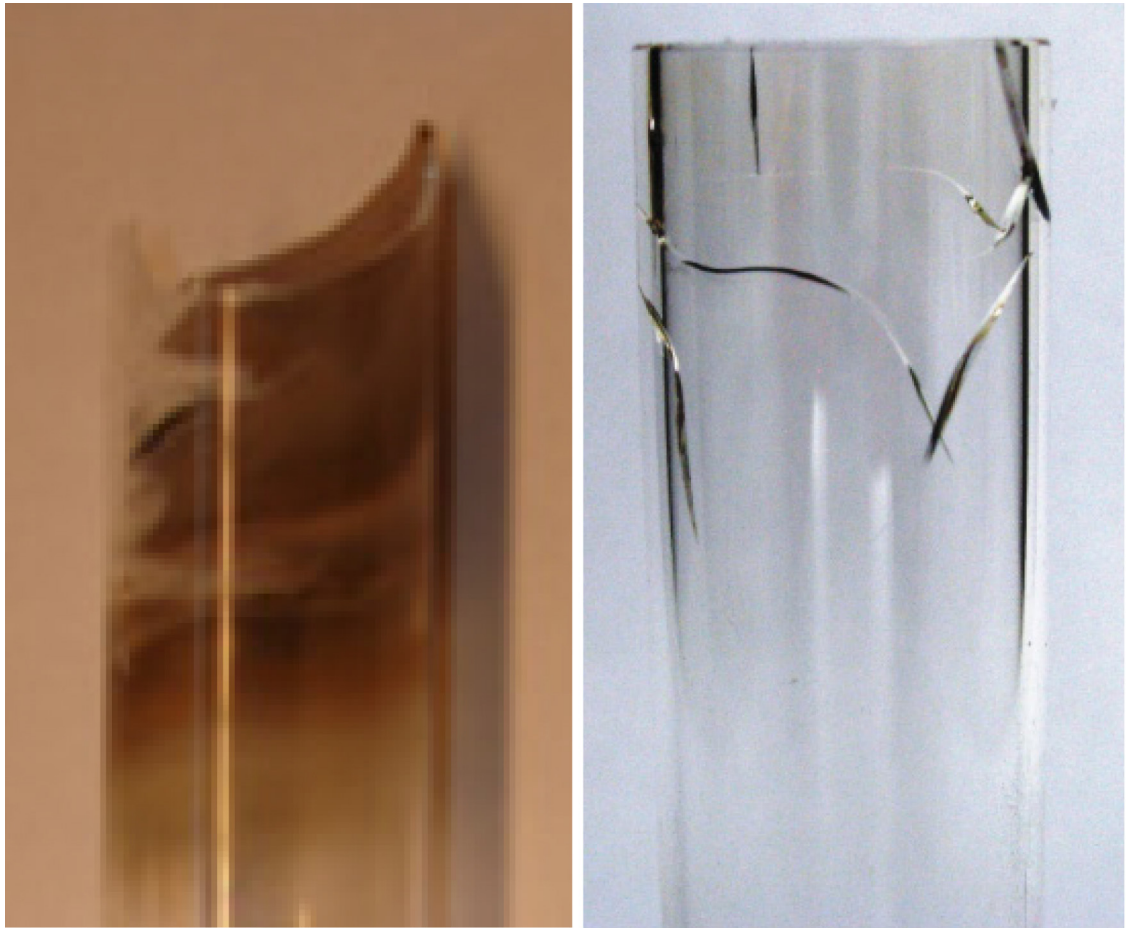
1. Between Sample line and nebulizer: **UniFit connector**
2. Between Waste tubing and spray chamber: **UniFit connector**
3. Between nebulizer and spray chamber: **Helix CT**

Quick Diagnostic Checks

- **Free-flow test:** steady, fine mist from nebulizer
- **Drain check:** smooth, continuous drainage
- **Visual inspection:** bubbles, wet fittings, leaks



Torch Optimization for Extended Life & Improved Performance



Carbon Buildup and thermal shock

Factor	Influence on ICP Variability	Impact on Performance
Injector diameter and geometry	Controls aerosol transport, plasma penetration, and residence time of analyte	Incorrect sizing can lead to poor atomization, reduced sensitivity, or matrix-dependent effects
Injector material	Affects heat resistance, chemical compatibility, and memory effects	Quartz, alumina, and sapphire injectors behave differently with aggressive matrices
Injector blockage or deposits	Changes aerosol pathway and gas flow dynamics	Causes signal drift, increased background, and poor precision
Torch condition	Wear, cracks, or contamination influence plasma stability	Can result in unstable plasma ignition and increased variability

The torch and injector define how efficiently the aerosol is introduced into the plasma and how consistently the plasma can process the sample.

NEW E-Torch for
Thermo® PRO Duo



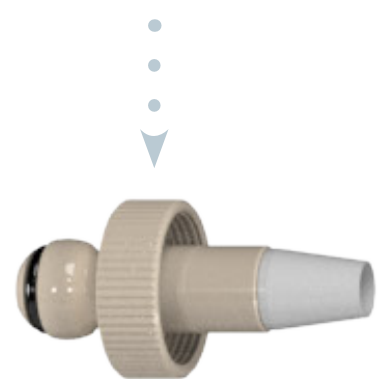
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NEW E-Torch™ for ICP-OES

- **30+ years of demountable torch innovation** make Glass Expansion the preferred choice.
- Maximum plasma stability due to precision annular spacing of the plasma tube.
- Hotter plasma and longer life with the optional ceramic plasma tube.
- Fully interchangeable injectors, Quartz, Ceramic, or Sapphire available in multiple IDs.
- Simplified maintenance with user friendly retainers for quick and reliable assembly.
- Plasma tube can be placed in muffle furnace to easily bake-off carbon buildup.
- **A single torch suited for any application or matrix.**

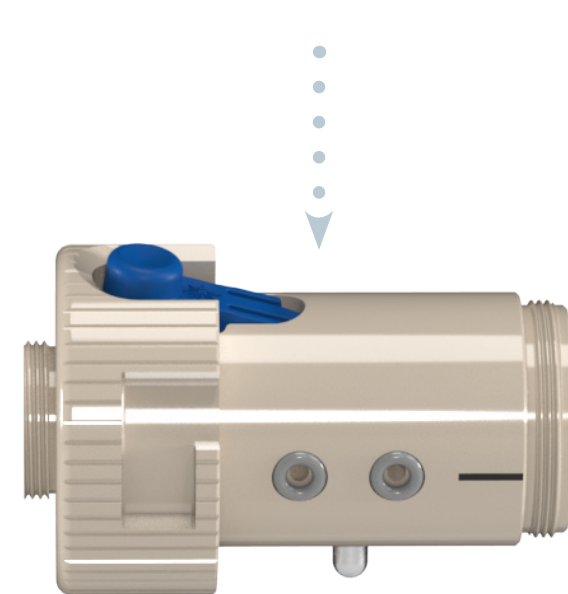
S13 Ball Joint
Injector Retainer
6.5mm



Injectors
(Quartz, Alumina, or Sapphire)



E-Torch Body



Plasma Tube
(Quartz or Ceramic)



Plasma Tube
Retainer 22mm



E-Torch for Thermo
Scientific® PRO
DUO

30-808-4388



E-Torch for Thermo
Scientific® PRO
Radial

30-808-5163



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Ceramic Plasma Tube is Ideal for Oil Analysis

Why?

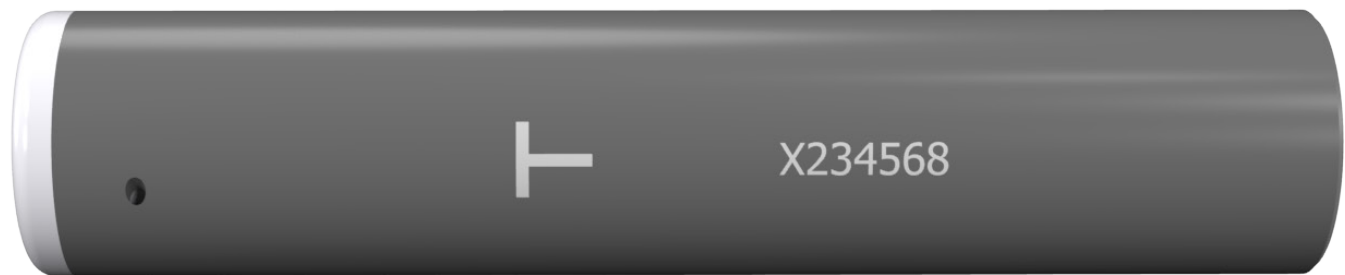
- Thermal shock and carbon buildup shorten quartz torch life.
- Frequent torch replacement increases cost of ownership.
- Ceramic produces a hotter, more robust plasma, which reduces matrix effects, increases sensitivity, and improves detection limits.
- Ceramic resists thermal shock and reduces carbon buildup, providing significantly longer life and reduced maintenance intervals.
- New Plasma Tube can be baked in a muffle furnace and drying oven for improved maintenance.

Glass Expansion pioneered the use of ceramic torches for ICP!

Comparison of Quartz Plasma Tube to Ceramic Plasma Tube		
Element	% Increase in Sensitivity	%RSD
Zn (213) λ	17%	0.36
Ni (231) λ	19%	0.57
Mn (257) λ	14%	0.52



NEW! Ceramic Plasma Tube for PRO DUO
P/N 31-808-4502



NEW! Ceramic Plasma Tube for PRO Radial
P/N 31-808-5165

Summary - Challenges Solved!

1. Guardian Autosampler Probe:

- ✓ Particulate restrictions & blockages
- ✓ Carryover & cross-contamination
- ✓ Increased frequency of nebulizer replacement

2. Slurry Nebulizer:

- ✓ Inconsistent sample uptake rates
- ✓ Unstable or “cool” plasma conditions
- ✓ Calibration & internal standard drift

3. Tracey BC Spray Chamber:

- ✓ Extended rinse / Washout cycles
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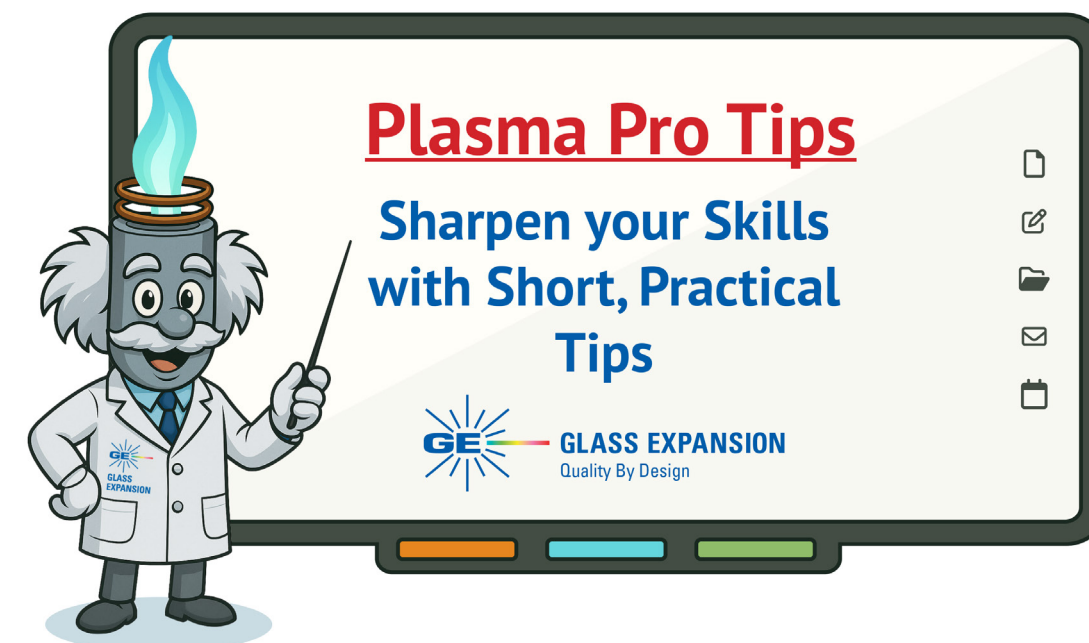
4. E-Torch:

- ✓ Carbon buildup on torch & injector
- ✓ Torch & injector erosion
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Support and Customer Service

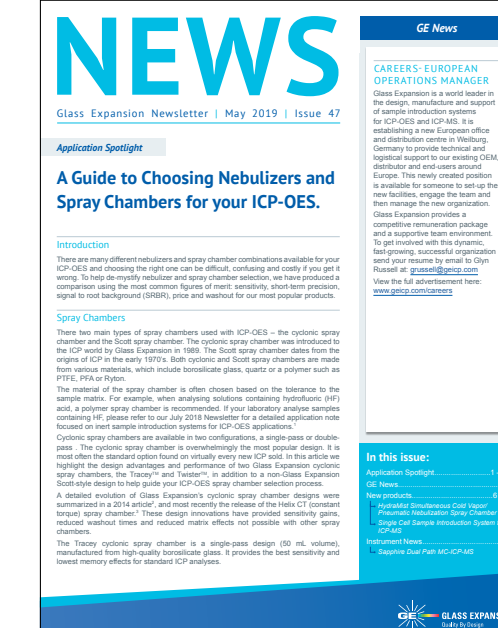
- Over 40 years of expertise
- Fully equipped R&D ICP Laboratory
- Technical team
- Application notes
- Industry News
- Plasma Professor
- Catalogs
- Product flyers
- Website
- Product care advice
- Operating instructions
- Videos



Plasma Professor



Flyers



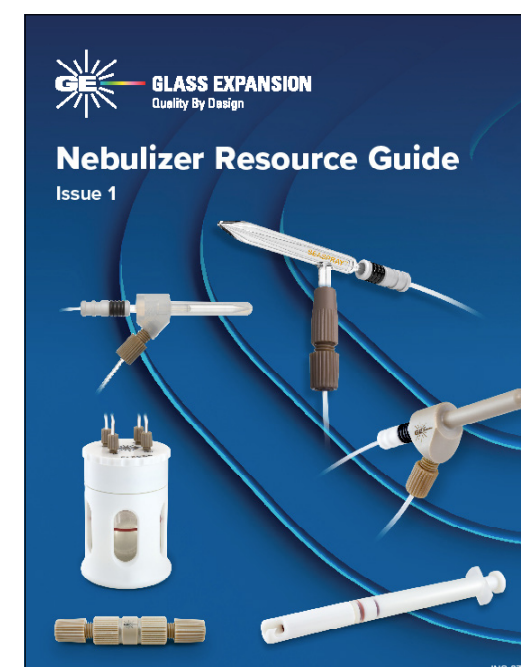
Newsletters



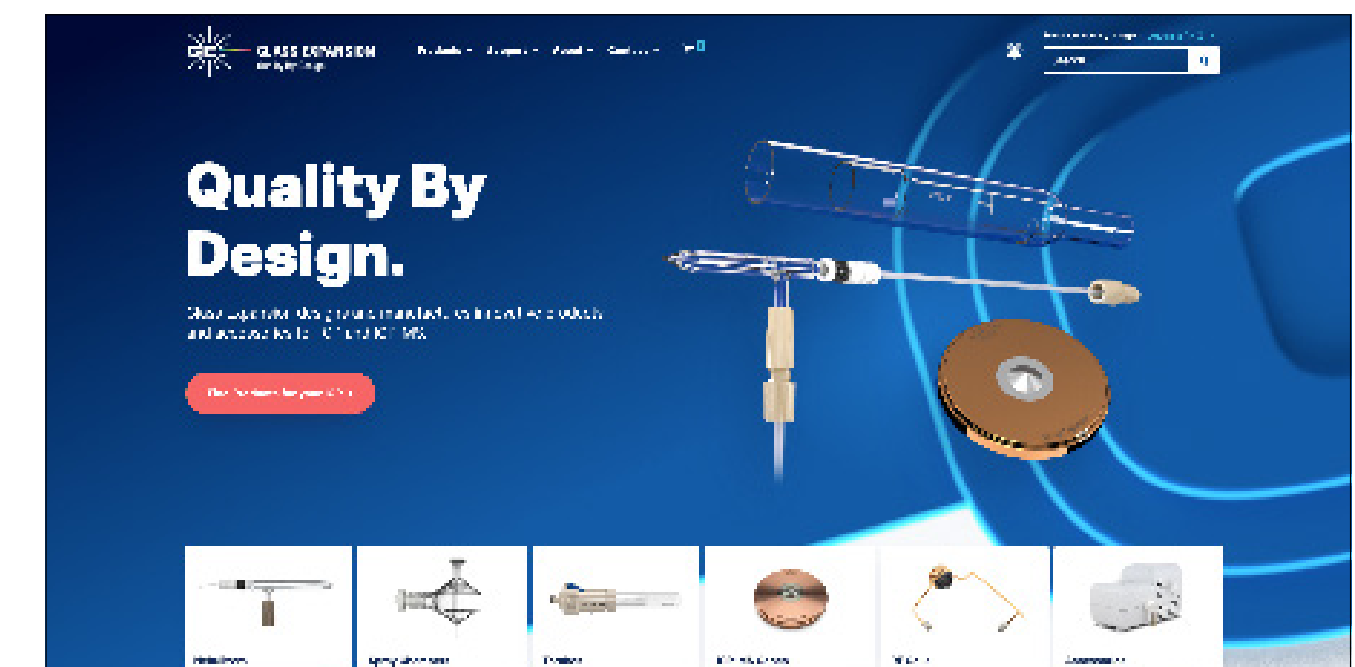
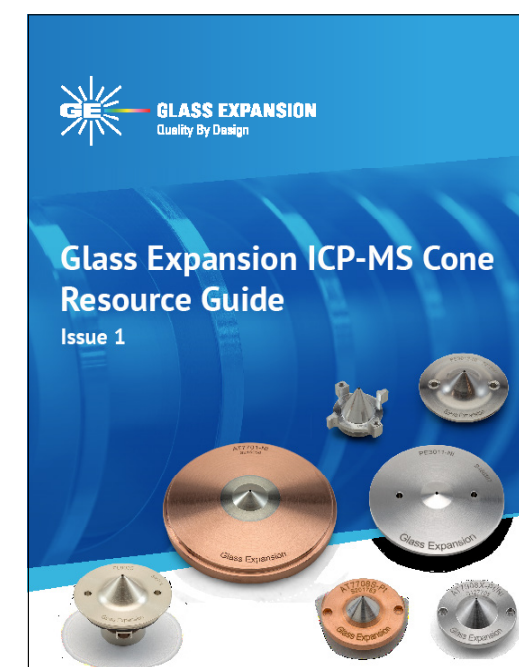
Instructions



Application Notes



Catalogs



Website

Want a FREE review of your Sample Introduction System?

- ✓ Optimize your sample introduction system components
- ✓ Identify other performance enhancing accessories available for your ICP
- ✓ Discuss any sample introduction challenges
- ✓ Explore ways to reduce operating costs
- ✓ Obtain quotes

Contact by email: geusa@geicp.com

Thank You

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