

Clearing the Way: ICP WASHOUT & SPRAY CHAMBER TACTICS

**INORGANIC
VENTURES'
PARTNER WEBINAR
SERIES:
A SPECTRUM
OF DIALOGUE**



Ryan Brennan, PhD
Glass Expansion
CEO, USA



Mike Booth
Inorganic Ventures
Technical Director

TUESDAY, MARCH 19 | 9:00–9:45AM EST

Introduction

For more than 40 years, Glass Expansion has been designing and manufacturing high quality ICP-OES and ICP-MS sample introduction components.

Three Glass Expansion offices providing global support:

Asia Pacific

6 Central Boulevard
Port Melbourne Vic 3207
Australia

Phone: +61 3 9320 1111
Email: enquiries@geicp.com

Americas

31 Jonathan Bourne Dr.
Unit 7, Pocasset MA 02559
USA

Phone: 508 563 1800
Email: geusa@geicp.com

Europe

Friedenbachstrasse 9
35781 Weilburg
Germany

Phone: +49 6471 3778517
Email: gegmbh@geicp.com

www.geicp.com

Industry Standard Trademark Designs

You will find Glass Expansion products within every instrument manufacturers catalog.



Tracey™ & Twister™
Cyclonic Spray Chambers



SeaSpray™ & MicroMist™
Nebulizers



Helix™ CT Interface



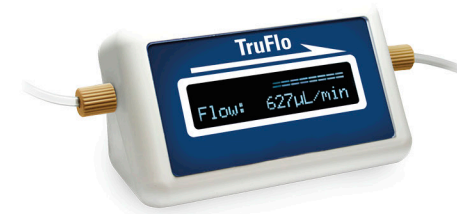
Guardian™ Inline Particle Filter



D-Torch™



IsoMist™ XS



TruFlo™

Manufacturers Supported

- Agilent®
- Analytik Jena
- GBC Scientific
- Hitachi
- Horiba
- Nu Instruments
- PerkinElmer®
- Shimadzu®
- SPECTRO (Ametek)
- Standard BioTools™ (Fluidigm)
- Teledyne CETAC
- Teledyne Leeman
- Thermo™

Helpful ICP Resources

- Webinars
- Application and Technical Notes
- Product Assembly Guides
- Full Color Catalog Organized by ICP Model



Glass Expansion Cyclonic Spray Chambers



Cinnabar™



Tracey™



Twister™



Twinnabar™



PTFE (Tracey™ & Twister™)



IsoMist™ XS



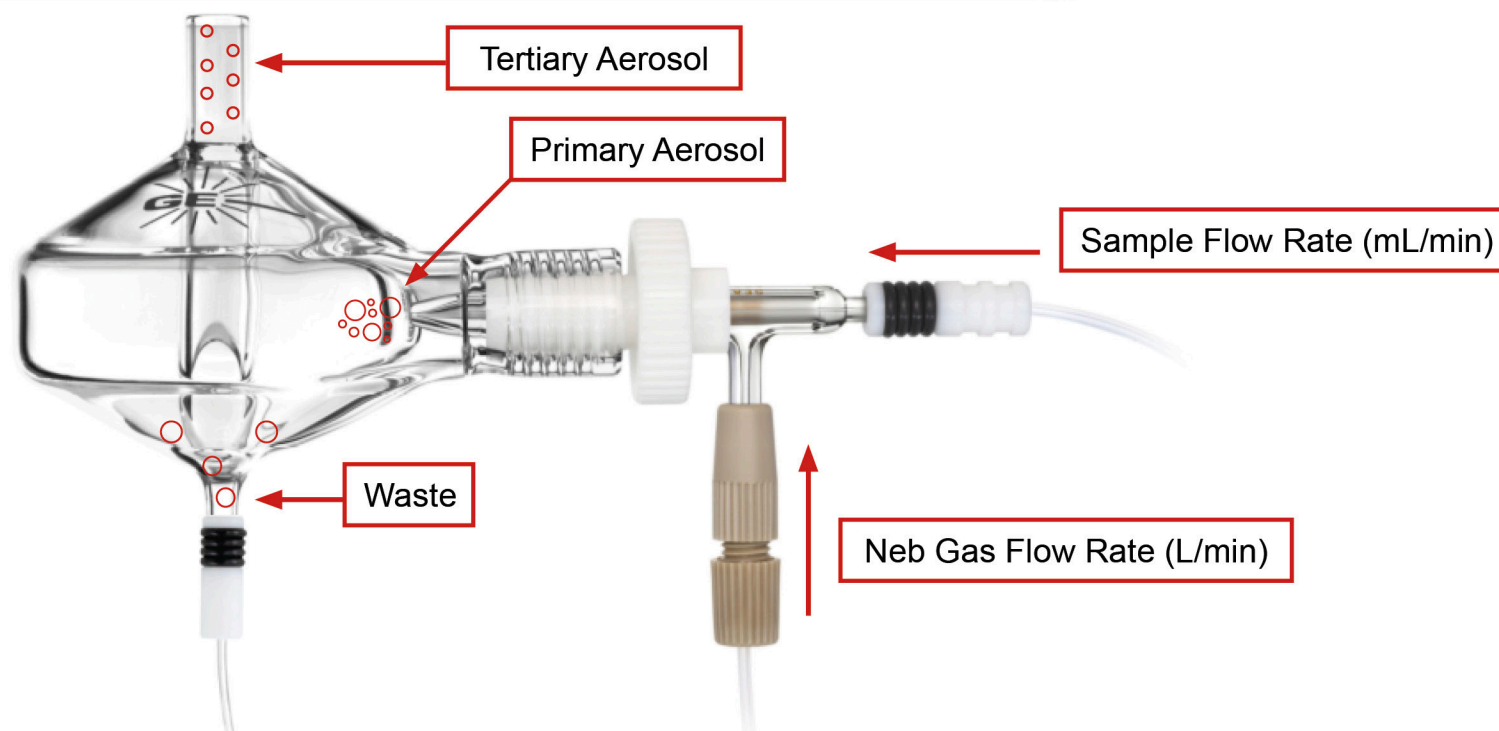
PCC™



PFA Tracey™

Basics of Aerosol Generation

- Smaller diameter droplets are good (<10 μm).
- Spray chambers remove >10 μm droplets
- Desolvation \rightarrow Vaporization \rightarrow Atomization \rightarrow Ionization \rightarrow Detector Signal
- Smaller Droplets require \downarrow Energy = Efficient Ionization
- Cyclonic spray chambers incorporate two means of filtering large droplets:
 1. Gravity (all spray chambers)
 2. Centrifugal Force (only cyclonic)



Quality of Aerosol \propto Quality of Results

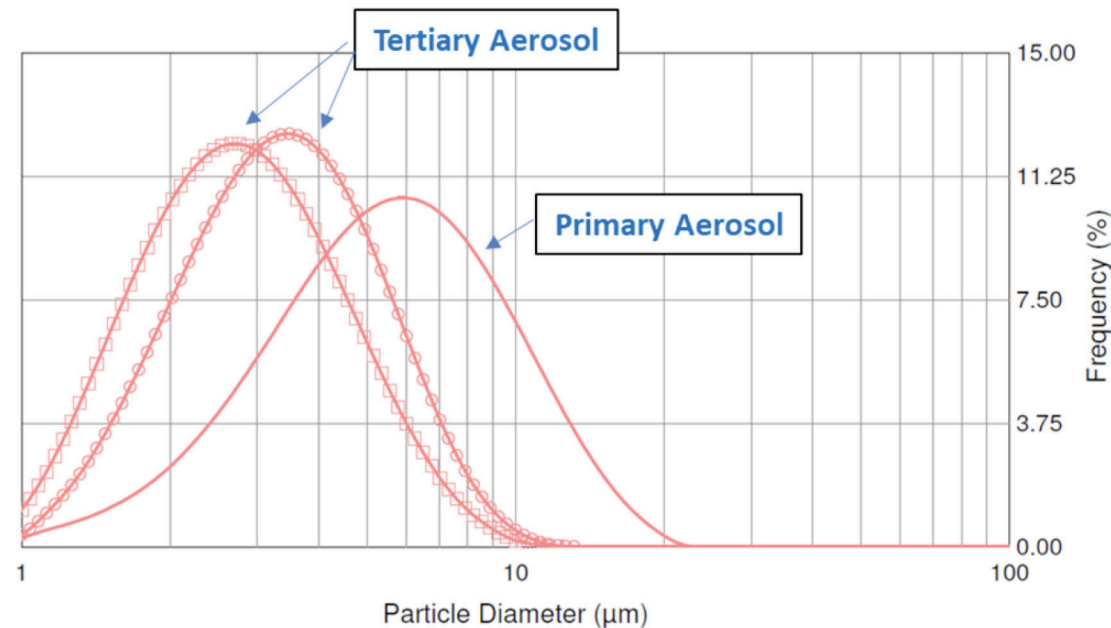
Basics of Aerosol Generation

- Droplet size
- Primary Aerosol
- Tertiary Aerosol

Sample Introduction System	
—	MicroMist™ - Primary Aerosol
—○—	MicroMist & Tracey™ - Tertiary Aerosol
—□—	MicroMist & Twister™ - Tertiary Aerosol

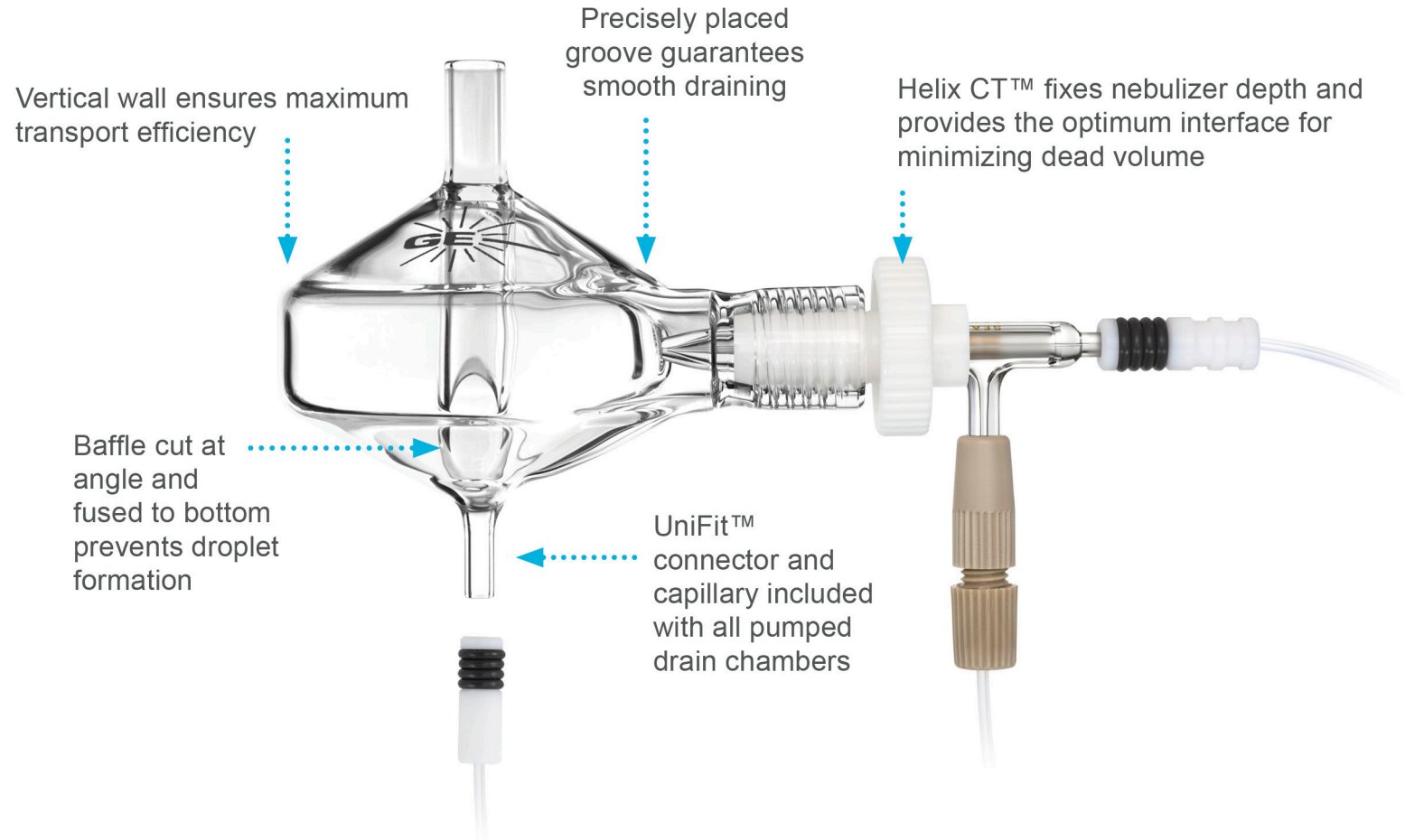


Tracey™



Twister™

Spray Chambers



Helix CT™ Interface

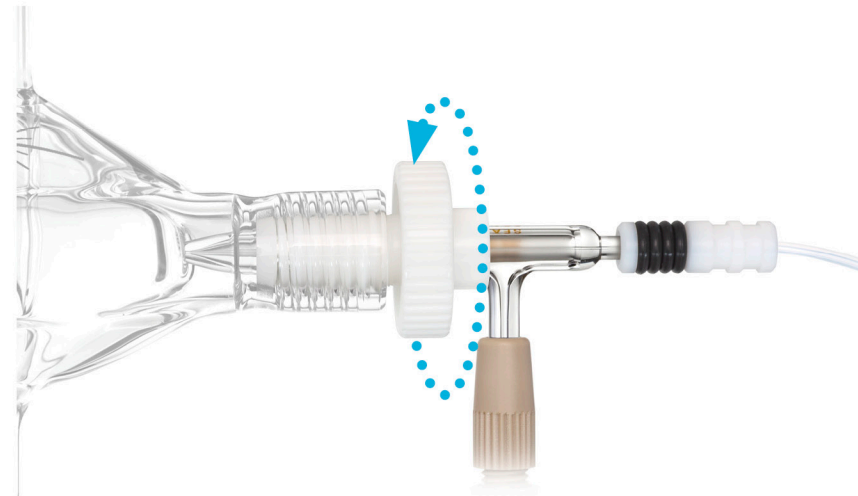
The new Helix™ locking screw with built-in torque control mechanism allows for a consistent seal of the PTFE ferrule against the nebulizer - making it impossible to overtighten or undertighten while ensuring a gas-tight seal each and every time.



Helix CT Locking Screw

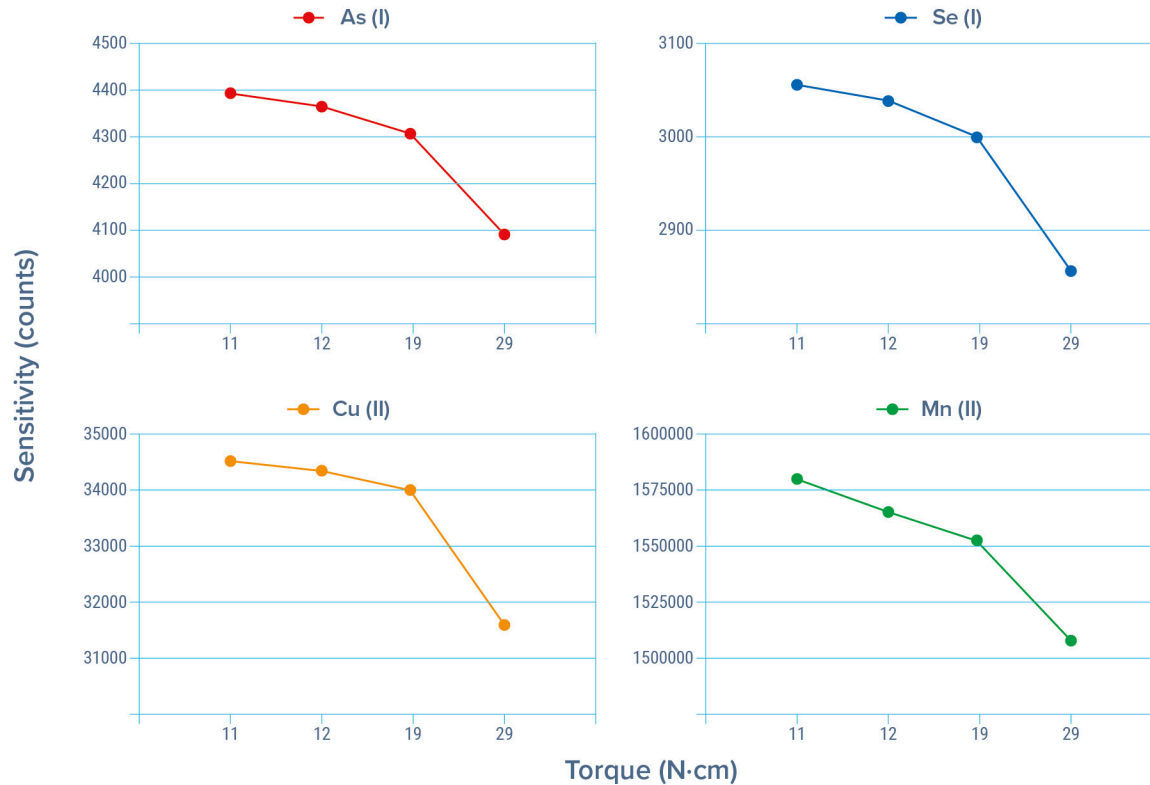


Helix CT Seal



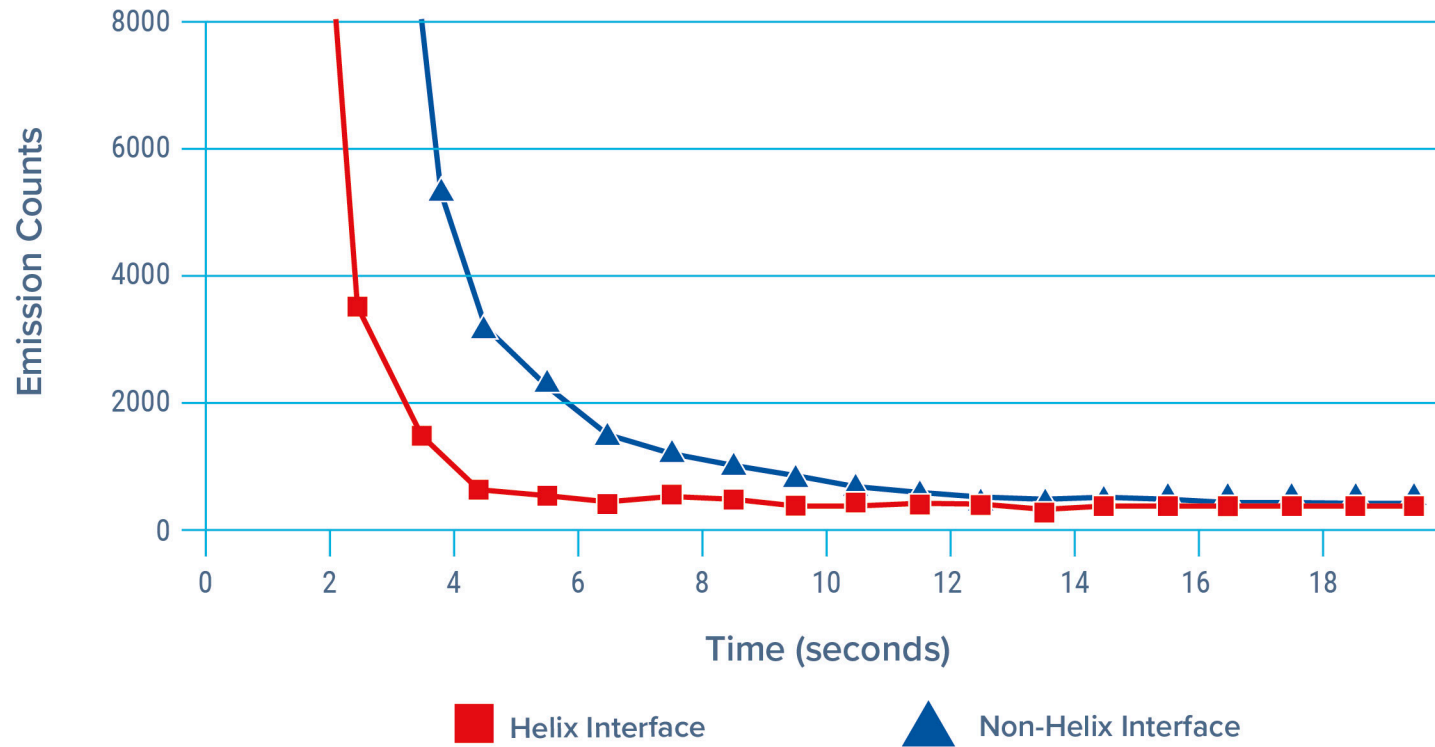
Tighten the nebulizer in place and seal the spray chamber by turning the knurled knob of the Helix CT further clockwise by hand until the ratchet mechanism clicks.

Helix CT™ Constant Torque



- Constant Torque control
- Provides unparalleled, reproducible day-to-day ICP performance.

Helix CT™ Washout Comparison



Non-Helix Interface

Twister™ vs Tracey™

- Tracey™ provides approximately 15% increase in counts (on average)
- Twister™ provides improved signal to noise ratio (SNR)
- Negligible difference in signal-to-root background ratio (SRBR)
- Baffle of Twister provides narrower droplet distribution and smaller particle size
- Twister more suitable for high matrix samples and improved short-term precision



Twister™



Tracey™

Twinnabar™ vs Cinnabar™

- Low volume (20 mL) for application rate of 400 uL/min or less
- Provides fast washout for low flow applications
- Excellent sensitivity and precision
- Cinnabar™ provides approximately 15% increase in counts (on average)
- Twinnabar™ more suitable for higher matrix samples and improved short-term precision



Twinnabar™



Cinnabar™

Inert Spray Chambers



PFA – ICP-MS

- PFA Material
 - » Inert
 - » Ultra high purity
 - » Stediflow surface treatment
- 44mL internal volume

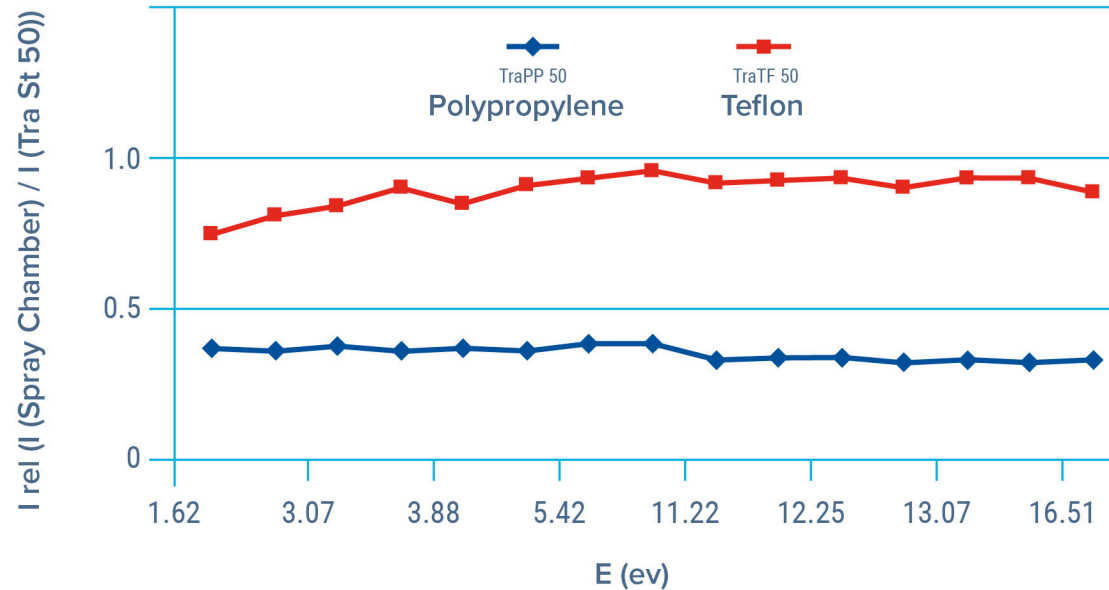


PTFE – ICP-OES

- PTFE Material
 - » Inert
 - » High purity
 - » Stediflow surface treatment
 - » 50mL internal volume
- Tracey™ and Twister™ models available

Inert Spray Chambers - Stediflow

- Improves wettability of spray chamber surface
- Ensures efficient drainage
- Improves sensitivity and precision
- Treatment can be regenerated



StediFlow Surface Treatment



Spray Chambers

Limitations of Room Temperature Spray Chambers

- Sensitivity drift as temperature changes
- Excessive plasma loading (volatile solvents)
- Excessive oxide formation (ICP-MS)
- Insufficient control of analyte transport

IsoMist™ XS and PCC™



Glass



Quartz



PFA



IsoMist™ XS



PCC™

IsoMist™ XS

- Programmable from -25 to 80oC in 1oC increments.
- Time taken to pass below 0°C from 25°C <15 minutes.
- Enables the analysis of volatile organics.
- Enhances sensitivity for limited volume samples.
- Reduces isobaric oxide interferences.
- Increases the chance of passing QC checks.
- Provides a record for regulatory compliance.
- Eliminates drift (2oC change equals 10% shift in sensitivity).



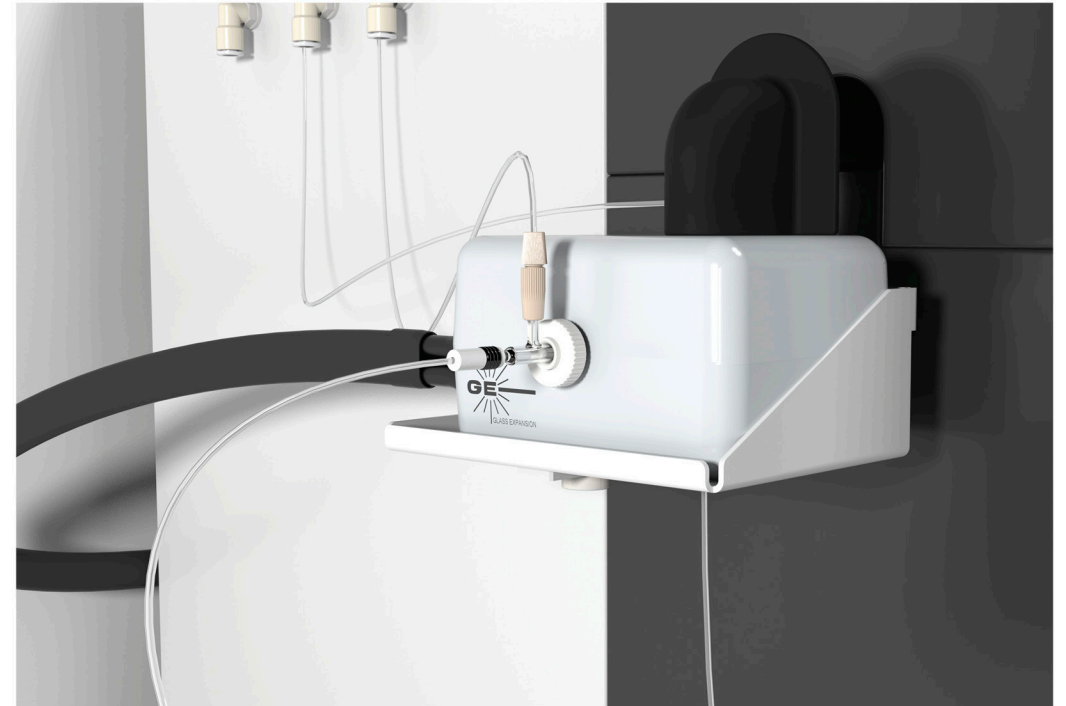
IsoMist XS Flyer



IsoMist XS Application Note

PCC™ Kit

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



PCC™ Kit

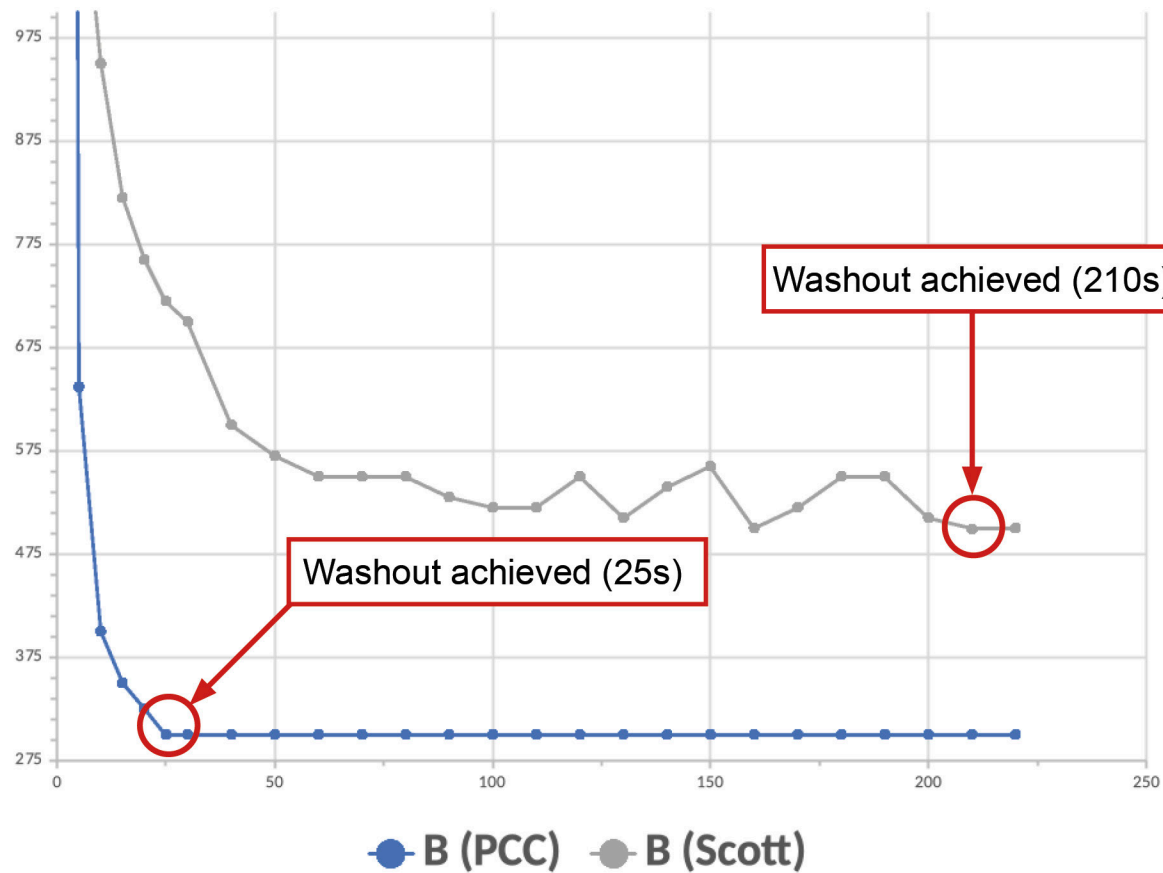


Scott style Spray Chamber

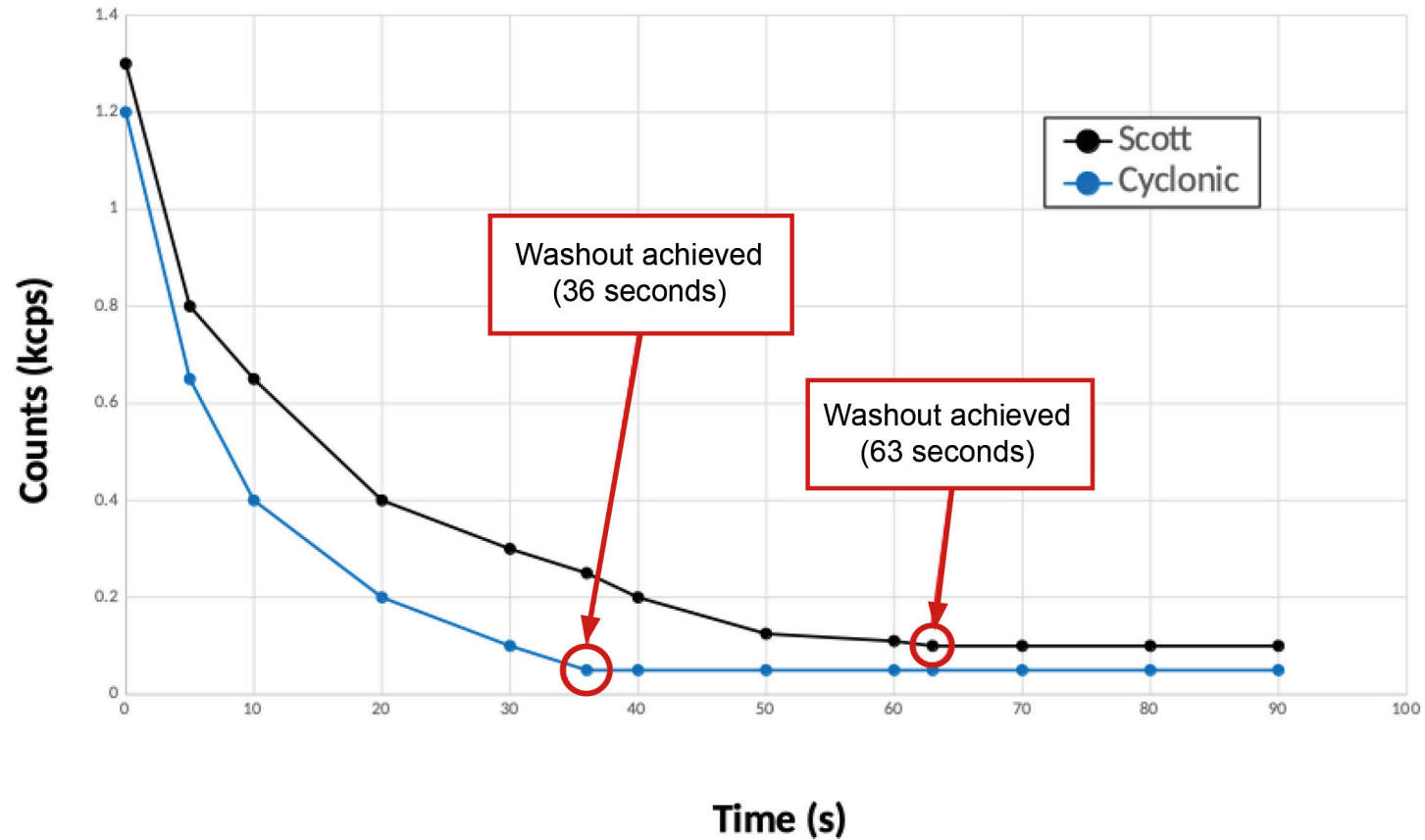


Tracey Spray Chamber

Washout Comparison (200 ppb Boron)



Washout Comparison (100 ppb Mercury)



NEW – High Efficiency Tracey Direct Connect (DC) Spray Chamber

- No o-rings.
- DC connection is inert all PEEK construction.
- Eliminates ball joint clamps that rust over time.
- Guarantees perfect alignment each and every time for improved precision and better transport efficiency.
- Low volume (30mL) cyclonic spray chamber for faster washout with Helix CT technology.
- Tracey DC Spray chamber design is available in Glass and PEEK.
- Lower cost structure.



P/N 20-809-4880



P/N 20-809-4801

Tracey[™] DC PEEK Spray Chamber

- HF resistance up to 5%
- Excellent wetting characteristics of PEEK ensure the spray chamber wetting properties are retained with general laboratory cleaning maintenance.
- Compact lightweight design avoiding the need of spray chamber brackets.
- Spray chamber doesn't require internal surface treatment compared to TFE or PFA spray chamber designs.
- Lower cost structure compared to other HF spray chamber designs.



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



Tracey™ DC and DC Injector Adapter Alignment

- Guarantees perfect alignment each and every time.
- Improved precision and better transport efficiency.



Available for most common Glass Expansion D-Torch, SDT, & FDT Designs

Requires compatible DC Injector Adaptor



P/N 31-808-4253



P/N 31-808-4293



P/N 31-808-4408



P/N 31-808-4374



P/N 31-808-4374

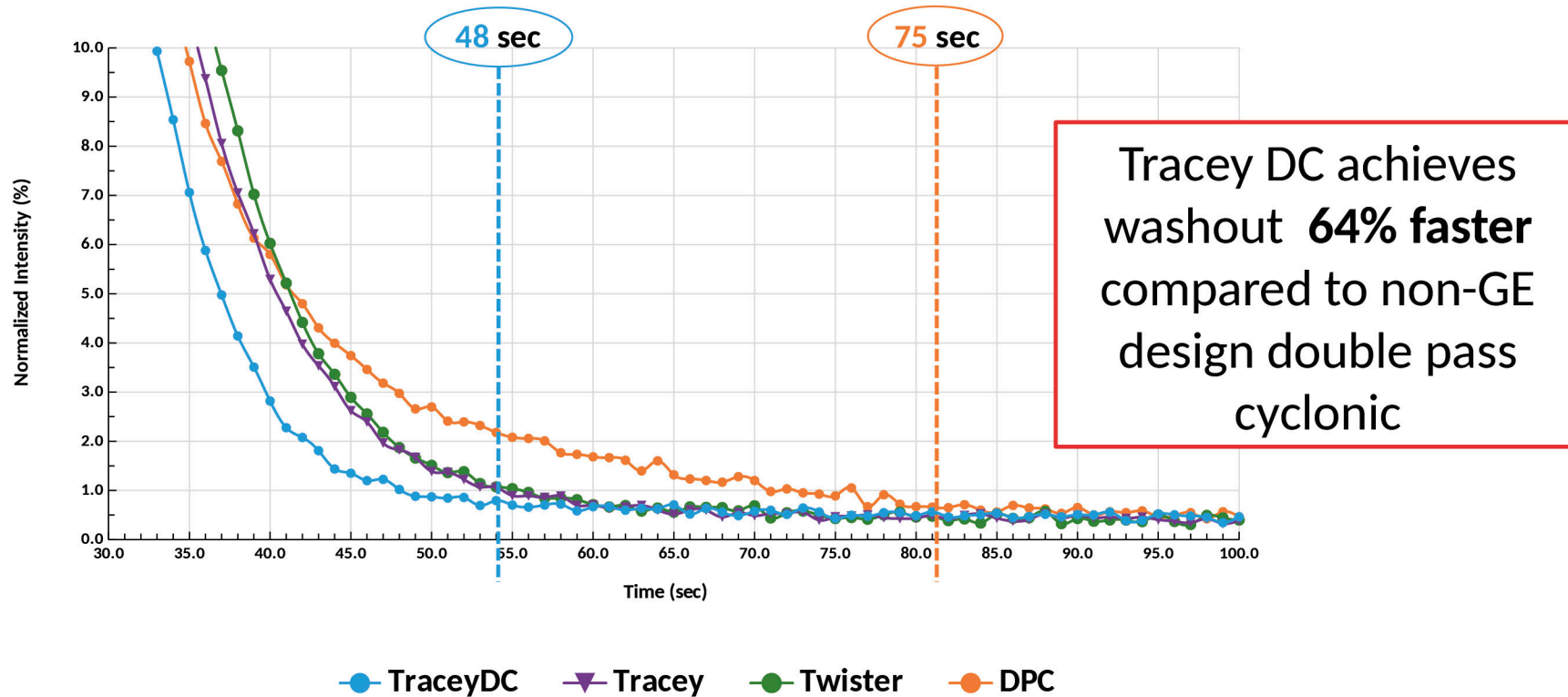
Tracey™ DC Currently Compatible ICP-OES Instruments



Instrument Model	Tracey DC Compatible
Agilent® 5100/5110/5800/5900 ICP-OES	✓
Analytik Jena® PQ9X00 Series ICP-OES	✓
PerkinElmer® Avio 200/220/500/550 ICP-OES	✓
Radom MICAP® OES 1000	✓
Thermo Fisher Scientific® PRO/PRO Duo ICP-OES	✓
Thermo Fisher Scientific® 6000/7000 Radial ICP-OES	✓

*Instrument not listed, contact Glass Expansion about future availability.

Washout Profiles for 1ppm Hg



Jet Vortex Interface

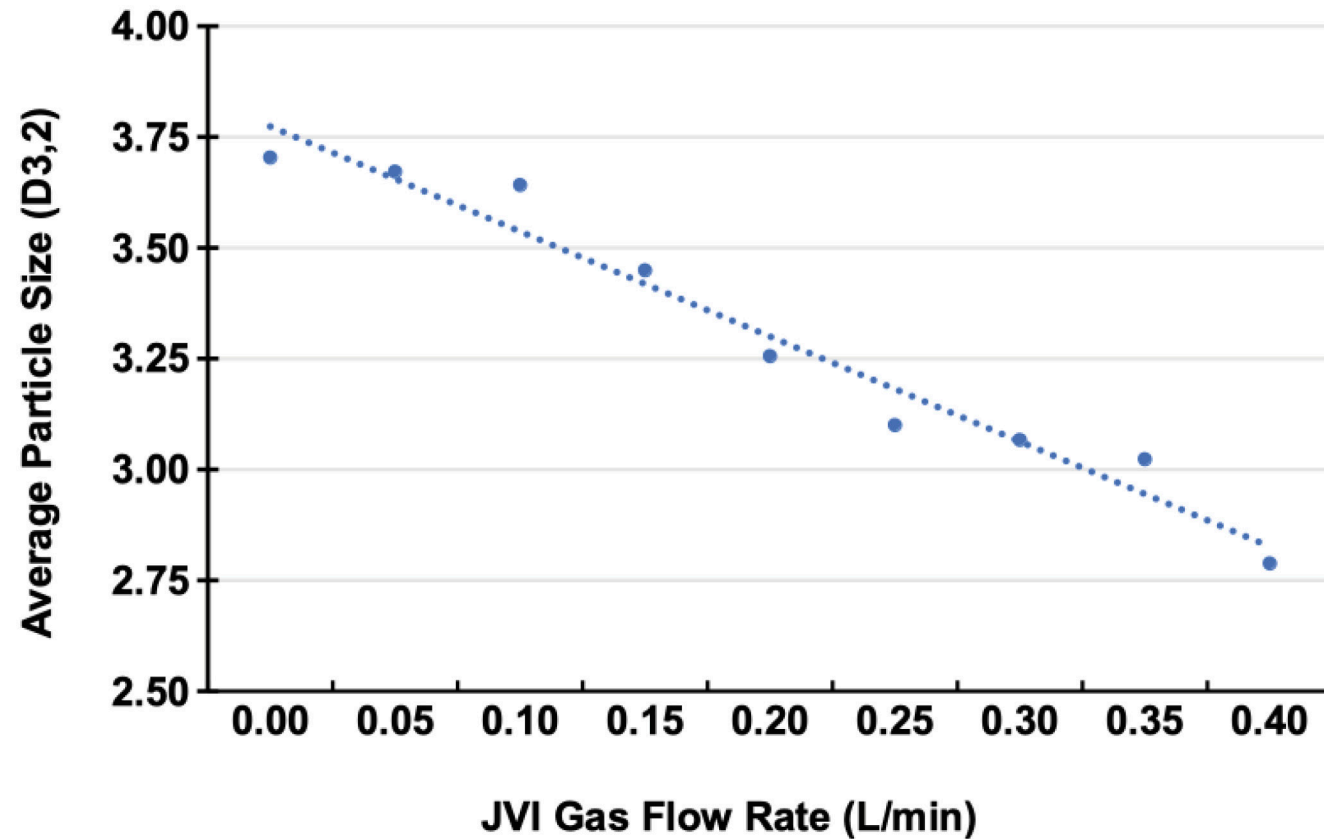
A novel design (Patent Pending), providing highly efficient Aerosol Filtration. Simple and straightforward installation, the JVI works in conjunction with the existing “Make-Up” or “Dilution/Auxiliary ” gas option of your ICP and Glass Expansion DC gas connector. Compatible with any Glass Expansion DC spray chamber. For use with ICP-OES and ICP-MS applications.

Benefits

- Reduces average particle size by 3-4% for every 0.05 L/min flow of JVI.
- Chemically inert, made from PEEK.
- Secure connection to gas supply, torch & DC spray chamber.
- Improved life of torch & interface cones.
- Reduce build-up on injector & interface cones.
- More robust plasma conditions.

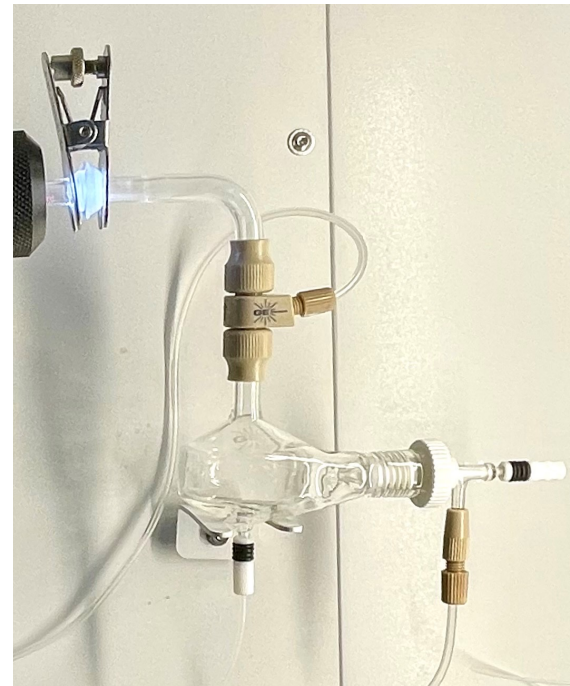


JVI™ Gas Flow Rate Effect on Particle Size



Lithium Analysis in Undiluted IPA (neat)

- Collaboration with Pure Lithium (Charlestown, MA)
- Instrument used – Spectro Arcos II (EOP)
- Evaluation of standard sample introduction to Tracey DC + JVI + SeaSpray DC
- Washout comparison and analytical figures of merit

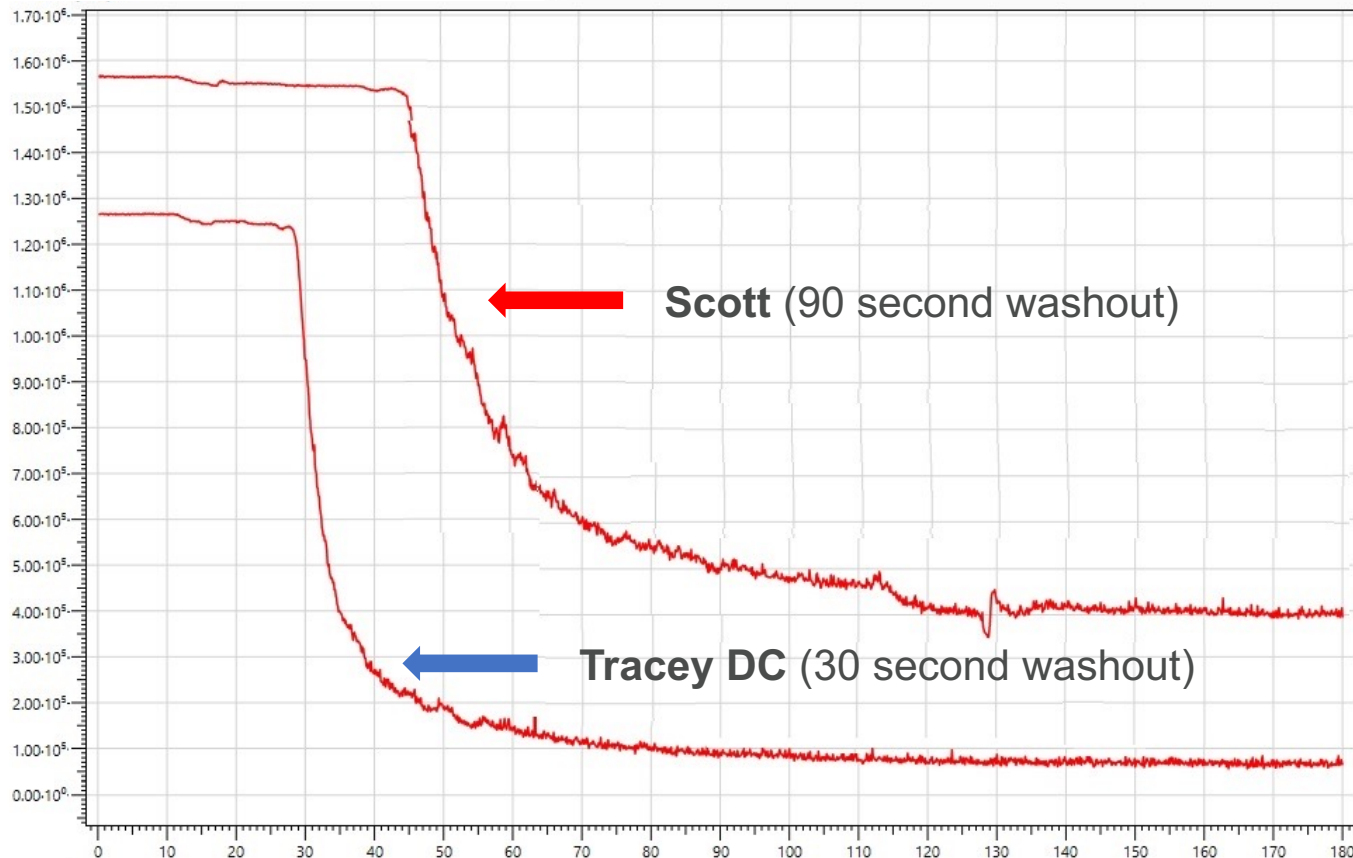


Tracey DC + JVI + SeaSpray DC



Scott + CrossFlow

100ppm Li Washout in Undiluted IPA (neat)



Benefits of Tracey DC

- Washout improved by 67%

	Scott + CrossFlow	Tracey DC + JVI + SeaSpray DC
	Li 323.261	Li 323.261
Mean Blank	74,108 CPS	36,567 CPS
Mean RSD	2.33%	0.632%

Benefits of Tracey DC

- Blank for Li decreased by approximately 50%
- More stable plasma
- 3x improvement in RSD
- Improved LOD for Li

	Tracey DC + JVI + SeaSpray DC
Li 323.261	Mean RSD (%)
0 ppm	0.38
2 ppm	0.23
4 ppm	0.28
100 ppm	1.33

Thank You

Asia Pacific

6 Central Boulevard
Port Melbourne Vic 3207
Australia

Phone: +61 3 9320 1111
Email: enquiries@geicp.com

Americas

31 Jonathan Bourne Dr.
Unit 7, Pocasset MA 02559
USA

Phone: 508 563 1800
Email: geusa@geicp.com

Europe

Friedenbachstrasse 9
35781 Weilburg
Germany

Phone: +49 6471 3778517
Email: gegmbh@geicp.com

www.geicp.com

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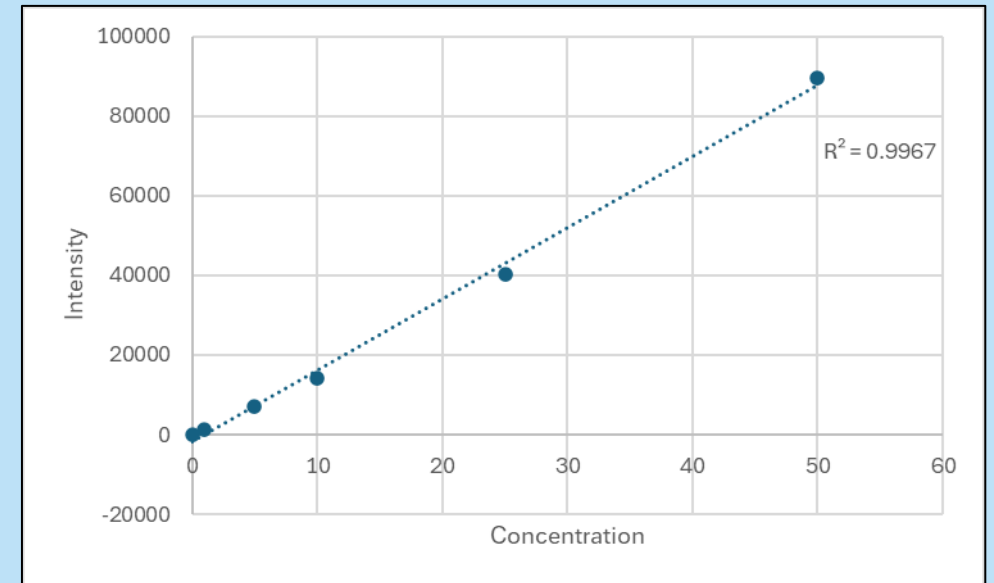
Mike Booth
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Washout Concerns

Poor washout can cause many issues during your analysis:

- Inaccurate calibration due to cross contamination between standards
- Inaccurate results due to cross contamination between samples
 - Including possible risk of interference(s)
- Long analysis times due to non-optimal rinse solution choice



What Elements are “Sticky”?

H			Oxidation state may make it sticky		HNO ₃ makes it sticky												He	
Li	Be		Lack of HF makes it sticky		HCl makes it precipitate						B	C	N	O	F	Ne		
Na	Mg										Al	Si	P	S	Cl	Ar		
K	Ca		Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr		Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	*	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	**	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og
		*	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb		
		**	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No		

Common Rinse Solutions

- **HNO₃**

- 5-10% on an OES
- 1-2% on a MS

- **HCl**

- 5-10% on an OES
- 1-2% on a MS

- **RBS-25**

- 2.5% on an OES
- Not Recommended on MS due to high Sodium

- **H₂O**

- Can be effective enough for Na, K, Ca, etc.

Rinse Solutions with HF

- **HNO₃**

- 5-10% on an OES
- 1-2% on a MS

- **HF**

- 0.1-2% on an OES
- 0.05-0.5% on a MS

If using borosilicate glass nebulizer and spray chamber

- Limit HF to a max of 0.2%
- B and Si results will be unreliable

If using an HF resistant nebulizer and spray chamber

- Can go up to 2-3%
- >3% HF will degrade the coating

Specialty Rinse Solutions

- **HCl / Hydroxylamine·HCl**

- 10% HCl
- 0.5% NH₂OH·HCl
- Use for Os

- **NH₄OH**

- 1-5% for OES or MS
- Use for B, Br, I, Hg

- **HCl / Thiourea**

- ICP-TRUE-RINSE
- Good for most elements due to HCl
- Useful for especially sticky elements like Hg, Au, Os, etc.

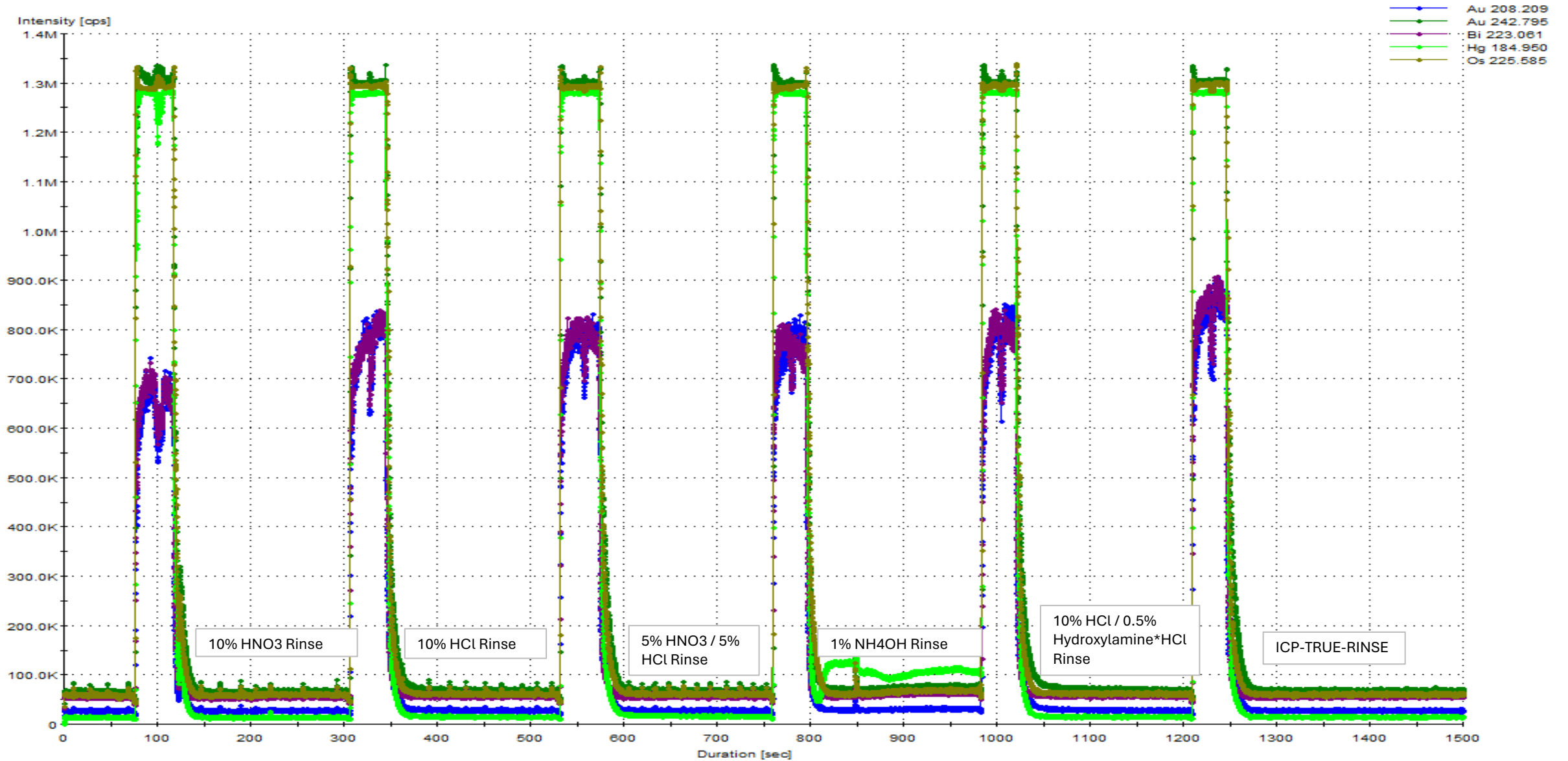
ICP-TRUE-RINSE Washout Study

Experiment Design

- Samples of 10 $\mu\text{g/g}$ Hg, Au, Os, & Bi in 10% v/v HCl were aspirated on an ICP-OES.
- Six different rinse solutions were tested, and washout times were recorded.

Rinse Solutions

- 10% HNO_3
- 10% HCl
- 5% HNO_3 / 5% HCl
- 1% NH_4OH
- 10% HCl / 0.5% Hydroxylamine·HCl
- ICP-TRUE-RINSE



Washout Study Results

Washout Times Comparison				
Rinse Solution	Time to Washout (s)			
	Au 208.209 nm	Bi 223.061 nm	Hg 184.950 nm	Os 225.585
10% HNO3	50	30	175	170
10% HCl	40	80	45	100
5% HNO3 / 5% HCl	70	170	110	120
1% NH4OH	60	60	130	60
10% HCl / 0.5% HydroxylamineHCl	50	80	50	75
ICP-TRUE-RINSE	35	25	35	30

ICP-TRUE-RINSE decreased washout time for all four elements in the study.

ICP-TRUE-RINSE

Claim your Free 125mL Sample



Tackles the Stickiest
Elements



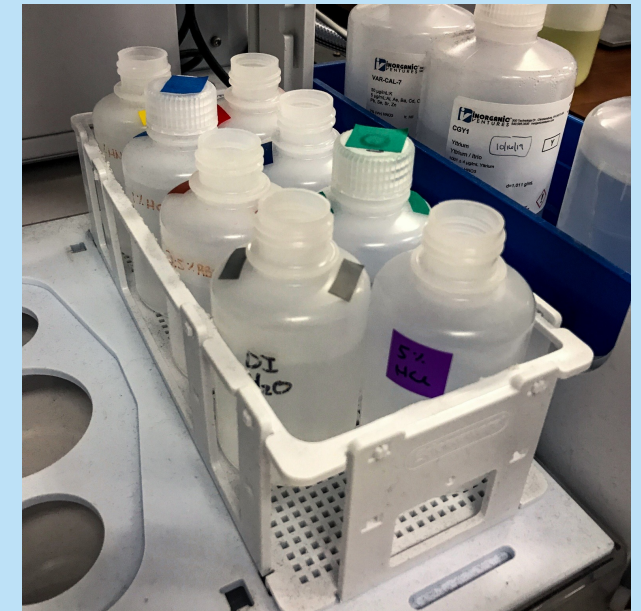
Works Fast, Saving
Time and Hassle



Ready to Use

Conclusions

- Shorter washout time leads to better efficiency
 - Run more samples in less time
 - Ensure accurate calibrations
 - Lower risk of cross contamination between samples
- Make sure to run blanks throughout your run to help assist with possible troubleshooting
- Keep several different rinse solutions on hand to clean your instrument between runs



Other Resources Available!

IV Ignite is the official virtual training academy of Inorganic Ventures!



Our Bench Boost Podcast releases new episode every Tuesday!



Visit [inorganicventures.com](https://www.inorganicventures.com) to access free educational resources for chemists!

