Guidelines for Trouble Shooting and Maintenance of ICP-OES Systems

Today's Agilent: Atomic Spectroscopy

World's best, most complete atomic spectroscopy portfolio!

ICP-OES

ICP-MS

ICP-QQQ

Flame AAS

Graphite Furnace AAS

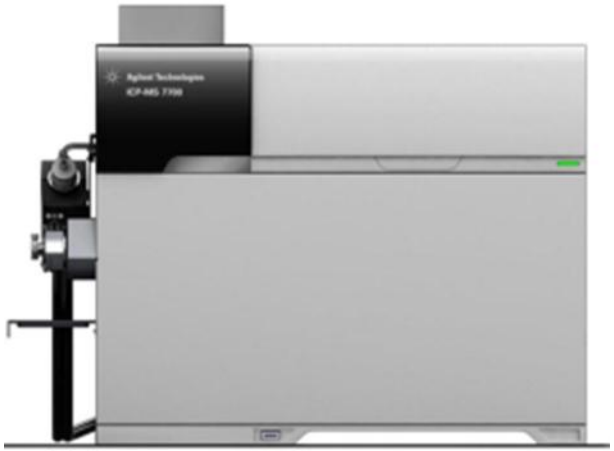
4200 MP-AES

New Agilent 7900 ICP-MS Performance Highlights
Rewriting the rules on ICP-MS

Better Analytical performance experience
- Ultra high matrix tolerance
- Superior sensitivity and lower background noise
- Wider dynamic range
- New Productivity Option (ISIS 3)
- Ultra fast scan speed for Single Nanoparticle analysis

Better Software experience
- ICP-MS MassHunter 4.1
- Method Wizard
- Mobile device support

Better Support experience
- Familiarization Tutorials/Videos
- Remote Advisor support



Next Generation 4200 MP-AES Performance Highlights
Change is in the Air!

Better Analytical performance experience
- 2nd generation of proven MP-AES technology
- Robust torch design for superior analytical performance with complex matrices
- Mass flow control of nebulizer gas and robust sample introduction
- Enhanced accuracy and long term stability with tough samples
- Expands the application range of MP-AES

Better Software experience
- MP Expert V1.2
- Intuitive software interface
- Advanced features in the ‘PRO’ pack

Better after sales experience
- No flammable gases or ongoing gas costs
- Runs from Nitrogen extracted from air using Agilent’s nitrogen generator

Agilent's Atomic Spectroscopy Portfolio - Features

Flame AA

Lowest price

- Single element
- DLs typically ~100's ppb
- Fast (for 1 element)
- Good elemental coverage
- Low running cost

MP-AES

Lowest running cost

- Multi element
- DLs typically single to 10's ppb
- Faster
- Broader elemental coverage
- Lowest running cost

Graphite Furnace AA

Trace levels at lowest price

- Single element
- DLs typically 10's to 100's ppt
- Very slow
- Limited elemental coverage
- Moderate running cost

ICP-OES

Fastest measurement

- Multi element
- DLs typically single ppb
- Very fast
- Can measure most elements
- High running cost

ICP-MS

Broadest coverage

- Multi element
- DLs typically single or sub-ppt
- Fast
- Can measure almost all elements
- Highest running cost

Lowest ← **Selling Price** → **Highest**

Common ICP Problems Reported by Customers

Sensitivity:

- Sensitivity is worse than it used to be
- I have a new application and I can't get the sensitivity I need
- How come I can't get the instrument to meet published detection limits?

Precision

- Sensitivity is acceptable but precision is terrible

High noise

- Can get the "right answers", but very noisy signal – this is also giving bad precision.

Accuracy

- Instrument does not give the "right" results.

Poor Sample Throughput

- The instrument throughput needs to improve
- Nebulizer and/or injector of the torch blocks too quickly

Causes of Poor ICP-OES Sensitivity

Sample introduction system

- Worn pump tubing
- Blocked nebulizer
- Blocked injector in torch

Optimization

- Poor optimization – especially the neb. flow
- Method setting – using right wavelength?
- Wrong tubing type
- Interferences

Standard (& sample) preparation

- High blank level
- Standards prepared correctly?
- Samples prepared correctly? – ionization suppressant

- Optics purge – UV wavelengths only
- Spray chamber type

Causes of Poor ICP-OES Precision

Sample introduction system

- Worn pump tubing
- Beading in spray chamber
- Nebulizer condition and performance
- Air leaks in transfer tubing

Optimization

- Torch alignment
- Poor optimization – especially the neb. flow
- Nebulizer choice for your samples

Standard (& sample) preparation

- Wash-out (memory effects)

Causes of Poor Accuracy in ICP-OES

Sample introduction system

- Worn pump tubing
- Blockage in nebulizer and/or torch

Optimization

- Wrong wavelength choice - interferences
- Poor optimization – especially the neb. flow
- Choice of internal standard
- Insufficient stabilization time

Standard (& sample) preparation

- Standard preparation
- Incomplete digestion – particles in solution
- No matrix matching
- Wash-out (memory effects)

ICP-OES Sample Introduction System Tips

Do:

Check optimization each analysis

Check/monitor the nebulizer uptake

Check/adjust the peri pump tubing

Check the blank reading

Rinse between samples & at the end of the run

- Rinse should match sample matrix

Clean the torch/nebulizer regularly

- Inspect condition of the nebulizer tip

Follow analytical recommendations in “cookbook”

Don’t:

Assume system is still optimized

Assume nebulizer flow rate is the same

Overtighten the pressure adj. screw

Use a simple water blank

Wait until you have blockage before cleaning

Peri Pump Tubing Tips

- Tubing diameters
  - Want tubing used for waste to be larger ID than sample ID
- Chemical compatibility
  - Ensure tubing is resistant to the solvent being used
- Replace frequently
  - Using “old” tubing can lead to problems with precision and stability
  - Typical lifetime is 1-2 weeks based on normal 8 hour working day
    - Detach from tube holder after use – allows tube to “relax”

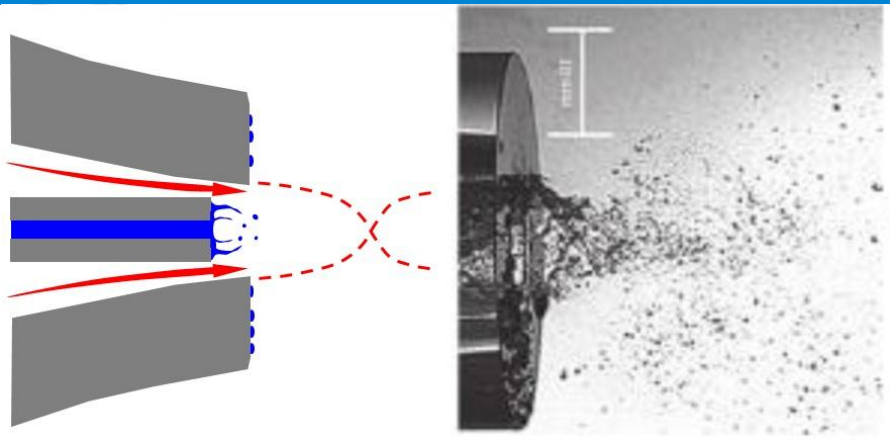
- Maintaining tubes – What to check?
  - Check 2 key things on pump tubing
    - Roundness of tube – should not be any “flat” spots
    - Tubing should still be elastic – replace if obviously stretched
  - Don’t over tighten – just need smooth and even sample flow
- Remember to check other tubing for wear, leaks and crimps

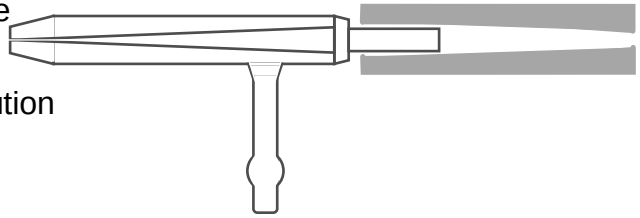
Cleaning the Nebulizer

Never sonicate or attempt to clean with wire!

For normal cleaning:

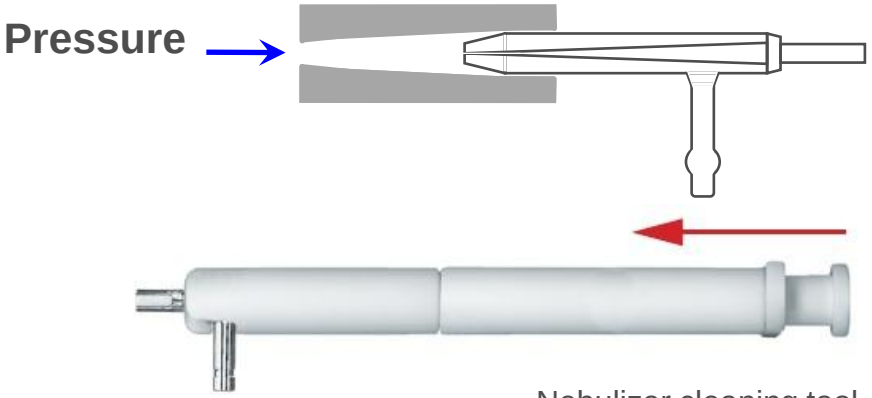
- Reverse pump the nebulizer with the tip in solvent; OR
- Apply suction from the wide end of the capillary using a vacuum aspirator; OR
- Apply high pressure clean air via a tubing snugly fitted over the nebulizer tip (use with caution); OR
- Use a dedicated nebulizer cleaning tool to force methanol solution through the tip





For salt deposits:

- Soak the nebulizer overnight in a beaker of 25% Fluka RBS-25 detergent. Rinse with pure water



For “stubborn” deposits:

- Soak the nebulizer overnight in conc. nitric acid. Use a pipette to ensure there are no air bubbles in capillary. Rinse with pure water

Nebulizer cleaning tool
P/N G3266-80020

1. Image modified from *“Pneumatic Nebulisers and Spray Chambers for Inductively Coupled Plasma Spectrometry. A Review, Part 1. Nebulisers“* by Barry Sharp, *JAAS*, vol.2, p. 613-652, 1988
2. Image provided by Meinhard Glassblowing Products

Performance Characteristics of Common Nebulizers

Nebulizer Type	Aerosol Efficiency	Achieved Precision	Dissolved Solids Tolerance	HF Resistance	Organics Compatibility	Self Aspirates	Ideal Sample Type
OneNeb	Excellent	Excellent	Good (max. 150 um particles)	Excellent	Excellent	No	Handles most samples
SeaSpray concentric	Good	Good	Medium (max. 75 um particles)	Poor	Good	Yes	Environmental, soil & food digests
Conikal concentric	Good	Excellent	Poor to Medium (max. 75 um particles)	Poor	Excellent	Yes	Clean oil samples and organic solvents
V-groove	Medium	Medium	Excellent	Excellent	Medium	No	HF digests, fusions, high TDS or used oil samples

Refer Access Agilent article titled "Tips on choosing – and using – the best nebulizer for your ICP-OES"
http://www.chem.agilent.com/en-US/Newsletters/accessagilent/2013/jul/pages/nebulizer.aspx?cid=7652

Universal inert OneNeb

Routine usage concentric type

High Solids capable (V-Groove)

Universal OneNeb: A Quick Review

Innovative design extends longevity, reduces blockage, improves LODs and throughput

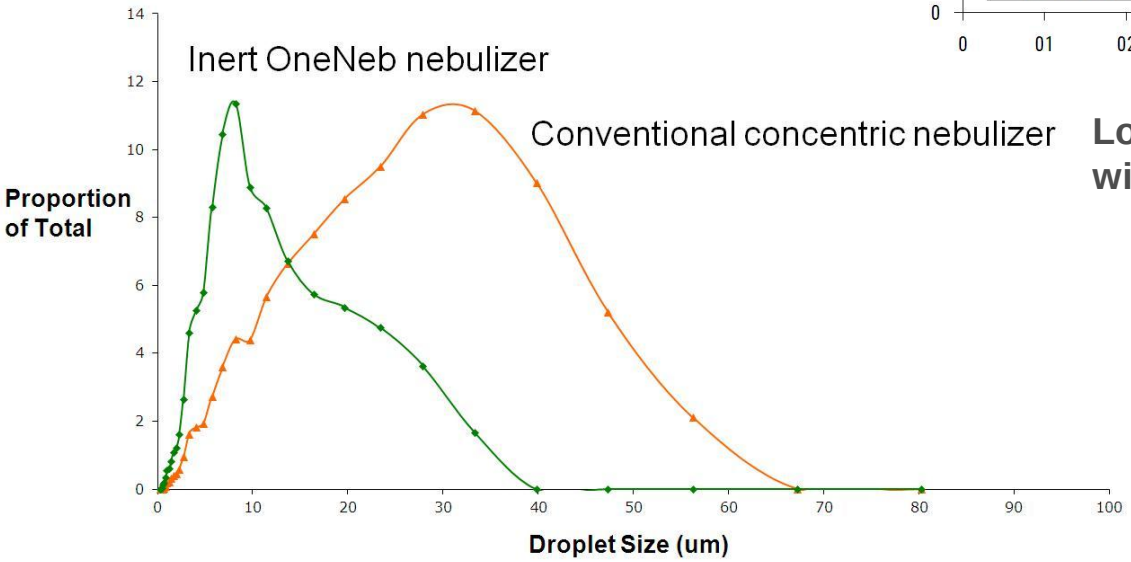
- PEEK and PFA construction
  - Virtually unbreakable
  - HF & organics resistance
- Less blockage from high TDS samples
  - Constant bore tubing, improves throughput
- Improved sensitivity
  - Flow Blurring for narrow droplet distribution and smaller droplet size
  - Improves precision and sensitivity.

OneNeb Performance Overview

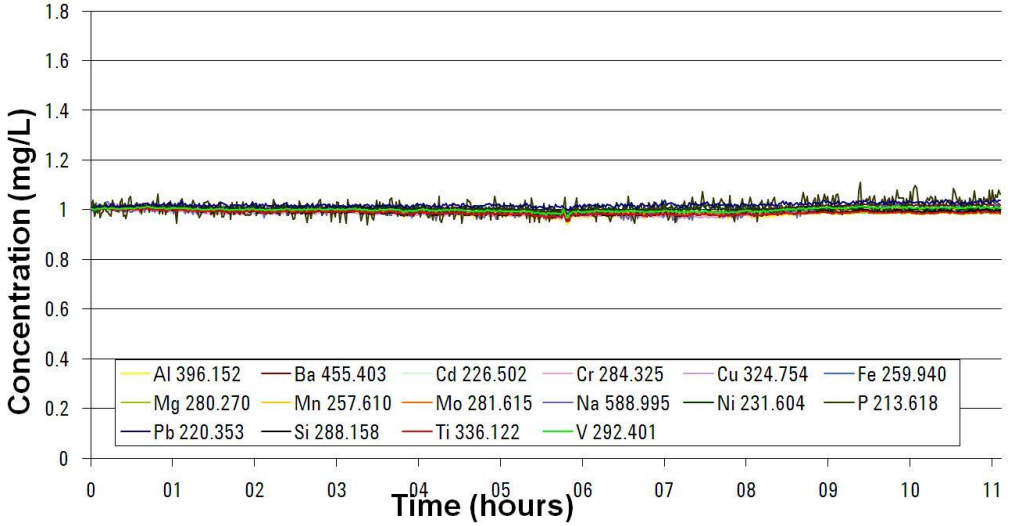
Droplet Size Comparison

Unique Flow Blurring design increases nebulization efficiency

- **Produces tighter and smaller droplet size**
- **Improved sensitivity and precision c.f. conventional concentric nebulizer**



Long Term Stability

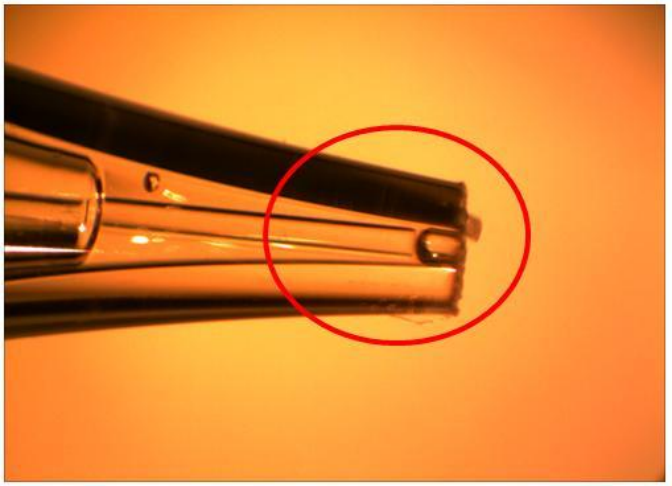


Long term stability of the OneNeb with continuous aspiration of ShellSol

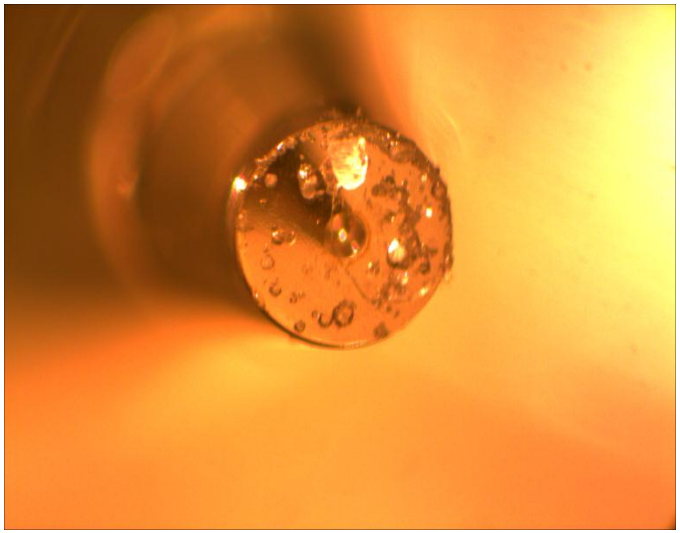
Performance Proof:

Why the OneNeb Outperforms Conventional Nebulizers?

- Geochemical application
  - Measuring trace Au in cyanide leach (0.3% CN, 0.8% NaOH)
- Run with Standard Sample intro system
  - Blockage of the sample introduction occurs within 4 hours
    - Nebulizer tip and injector of the torch



Tip of the concentric nebulizer – blocked!



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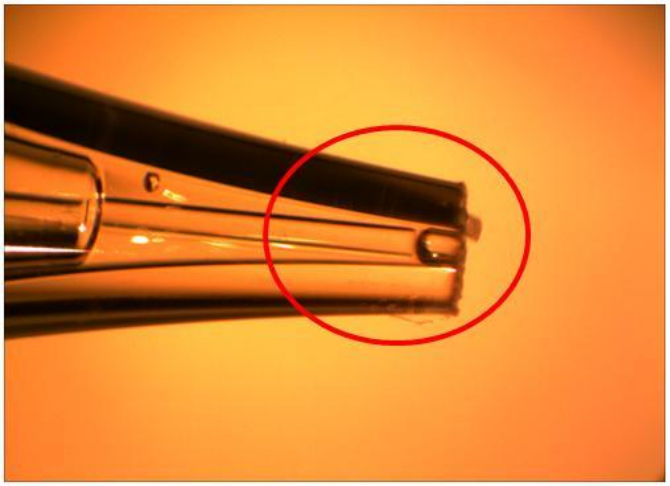
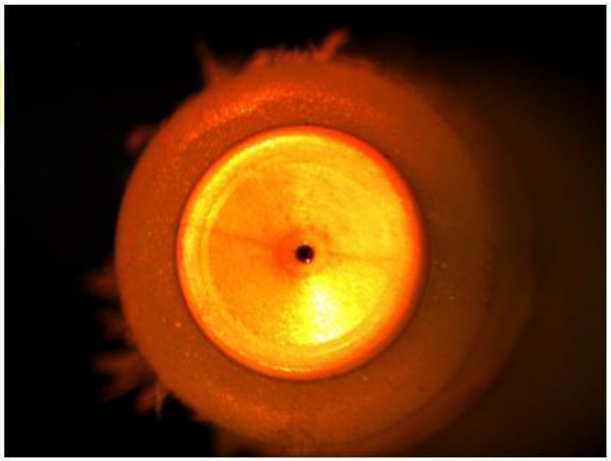
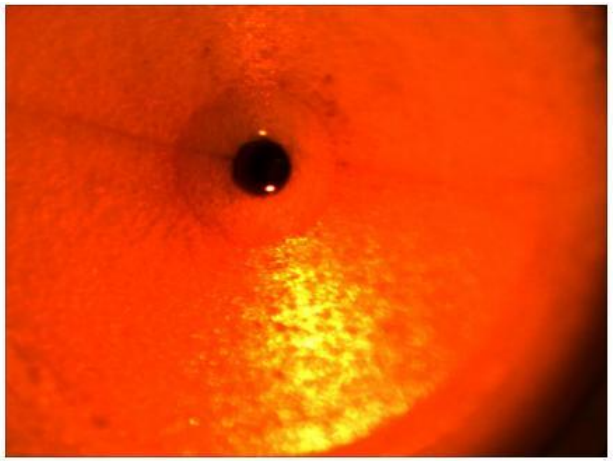


Tip of the concentric nebulizer – blocked!

Tip of the OneNeb nebulizer after 37 hours of operation!





OneNeb Support Resources

Description	Part number
OneNeb inert concentric nebulizer for HF digests, high TDS samples, and organic solvents. Includes snap-on connector for nebulizer gas inlet	2010126900
Application Kits for Agilent Axial ICP-OES Systems	
Double-pass glass cyclonic spray chamber, mounting bracket, OneNeb inert concentric nebulizer, and transfer tube	9810046590
Single-pass glass cyclonic spray chamber, mounting bracket, OneNeb inert concentric nebulizer, and transfer tube	9810046690
Application Kits for Agilent Radial ICP-OES Systems	
Inert Sturman-Masters double-pass cyclonic spray chamber, mounting bracket, OneNeb inert concentric nebulizer, and transfer tube	9810046390
Double-pass glass cyclonic spray chamber, mounting bracket, OneNeb inert concentric nebulizer, and transfer tube	9810046490

OneNeb Flyer, 5991-0131EN

Application Note, 5990-8340EN

Ordering Information listed above
Dedicated web-page available. See this link:

www.agilent.com/chem/OneNeb

OneNeb video also available

Performance Characteristics of ICP Spray Chambers

Spray Chamber Type	Aerosol Efficiency	Achieved Precision	Dissolved Solids Tolerance	HF Resistance	Organics Compatibility	Ideal Sample Type
Single pass glass cyclonic	Excellent	Good	Poor to Medium	Poor	Good	Environmental, food digests
Double pass glass cyclonic	Good	Excellent	Good	Poor	Good	Soil digests, clean oil samples and organic solvents
Inert Sturman-Masters (double pass)	Good	Excellent	Excellent	Excellent	Excellent	HF digests, fusions, high TDS or used oil samples
Cooled spray chamber	Good	Good	Poor to Medium	Poor	Excellent	Highly volatile organic solvents e.g. gasolene

Single pass glass cyclonic

Double pass glass cyclonic

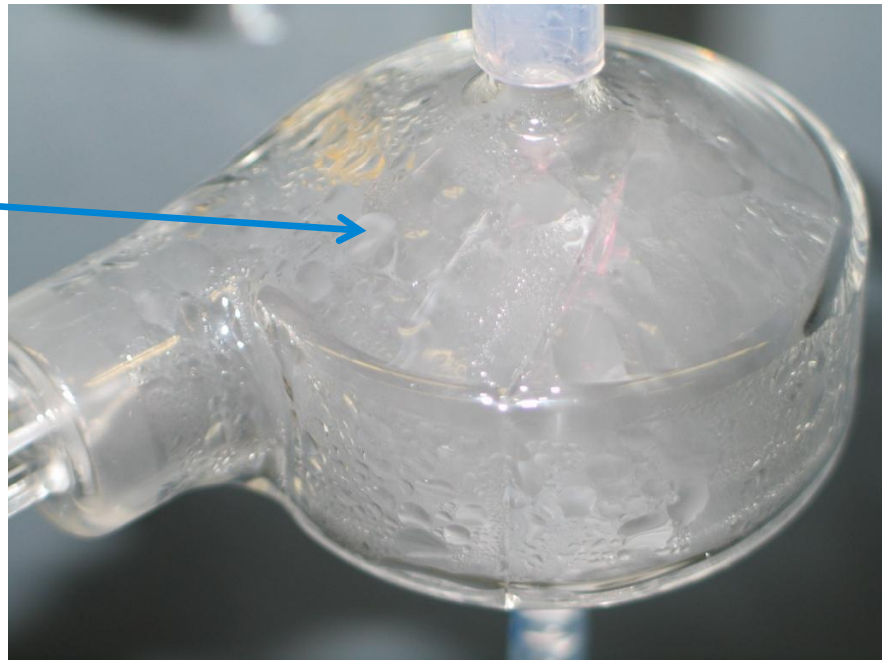
High Solids & HF capable (Sturman-Masters)

Cleaning the Spray Chamber

Can sonicate in a detergent solution (with care), rinse and dry

Must clean the spray chamber when you see “beading” or droplet formation on the walls (or if precision degrades):

- Soak overnight in a 25% detergent solution
  - Best to leave it soaking for 24 hours
  - Use any laboratory detergent e.g. Fluka RBS25, Triton X-100, Decon 90 etc
- Rinse, allow to dry and refit



Tips on Torch Selection

One piece quartz torch

- Simple to use
  - Narrow bore injectors – organics
- Recommended for most applications

Semi-demountable torch

- Injector is removable and changeable
- Gives greater flexibility.
  - Alumina injector -fusions and HF digests
  - Quartz injectors for other solutions

Fully demountable torch

- Can replace all parts of torch individually
  - e.g. torch body, intermediate tube & injector
  - Gives greater flexibility
- Can reduce operating cost

Cleaning the Torch

Do not sonicate!

Soak in conc. aqua regia (3:1 HCl: HNO_3) overnight

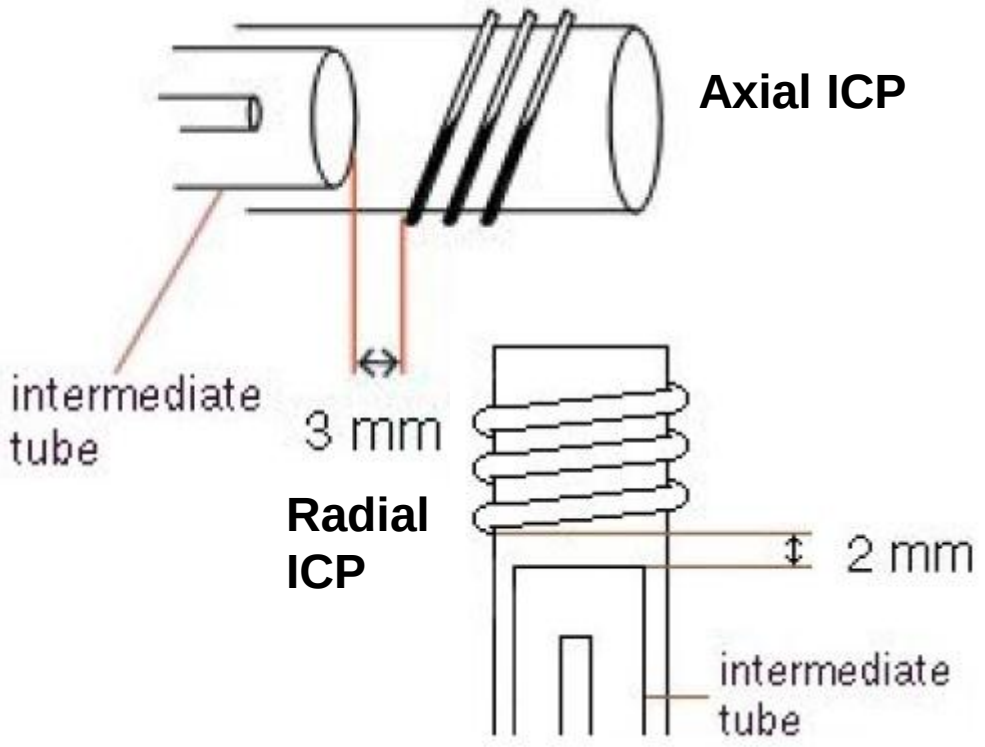
- Use a pipe cleaner dipped in aqua regia to remove persistent compounds from the injector tube

- For salt deposits:
  - Rinse with water to remove deposits
  - Soak the torch overnight in a beaker of 25% Fluka RBS-25 detergent

Rinse and allow to dry

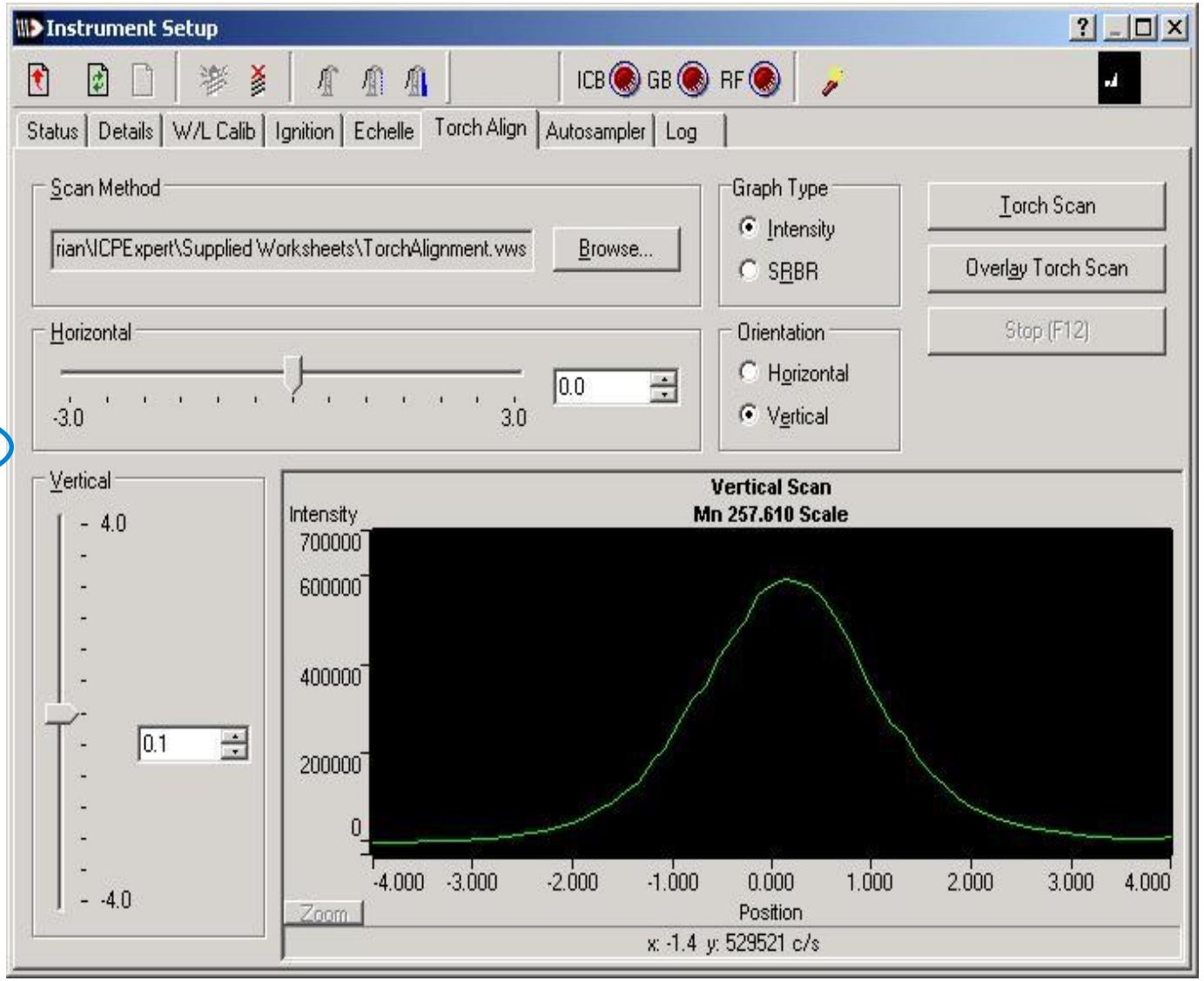
Caution! Reinstall only when dry

Re-install with the intermediate tube 2-3mm from the RF (induction) coil



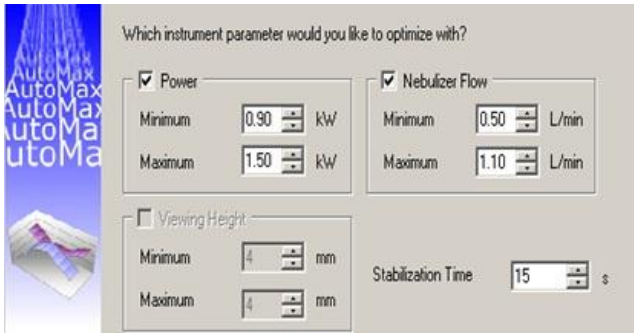
ICP-OES System Optimization – Torch Alignment

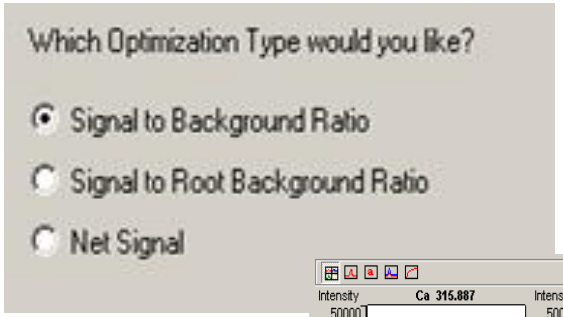
- Torch alignment required after removing/replacing the torch
- Ensures optics viewing highest emission signal from the plasma
- Also useful as a quick performance check
- Monitor the max. intensity
- Positions for optimum Vertical & Horizontal position should not shift dramatically

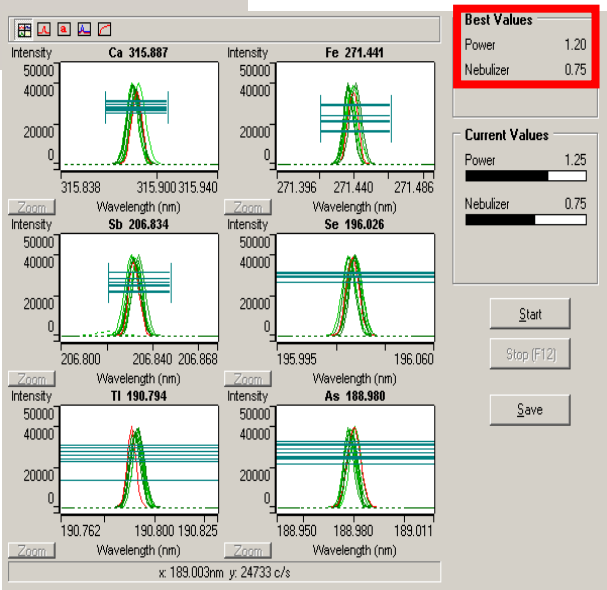


ICP-OES System Tips – Method Optimization

- “Automax” optimization routine automates optimization of key method settings
- Optimizes RF power, neb. Flow & viewing height (radial ICP only)
- For best results:
  - Select SBR as the optimization criteria
  - Plasma should be warmed up
  - Optics purge should be stable
  - Solution used for optimization should give good signal levels
- Automatically creates a method using recommended conditions
- Reduces training requirements for new users







ICP-OES System Tips – Wavelength Calibration

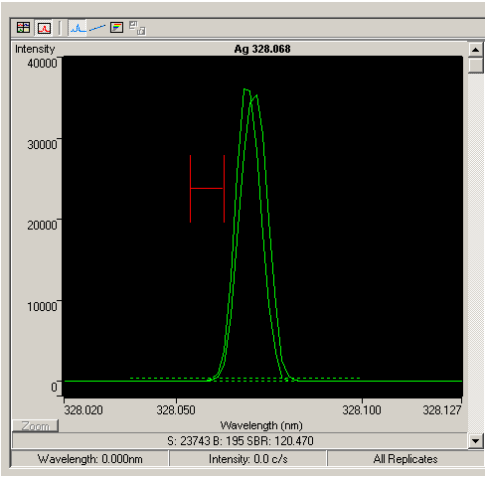
- "Wavelength Calibration" co-relates actual emission peak to the pixels on the detector chip

- Periodic calibration required – typically once/month
  - Monitor peak position w.r.t. peak marker to determine if calibration required

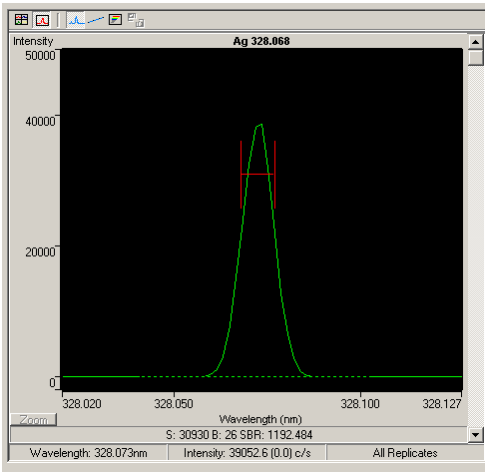
- For best results:
  - Use Agilent's prepared wavelength calibration solution (P/N 6610030100)
    - Improves productivity –no "missing " components to troubleshoot
    - Improve reproducibility
    - Convenience – the pre-mixed solution has long shelf life, so you can use it as required
    - Also suitable for use when completing torch alignment
  - Plasma should be warmed up and stable
  - Optics boost purge should be enabled and stable (also requires the snout purge on the radial ICP)

- If the percentage value for "Calibration lines used" is < 100%, then:
    - Check that tuning solution had reached plasma
    - Check that purge enabled and stable – then repeat

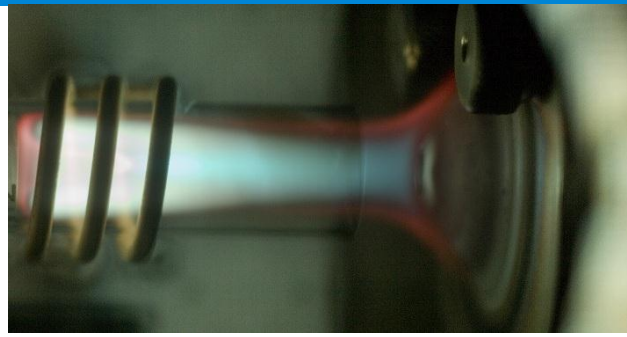
Needs wavelength calibration



Peak display after successful wavelength calibration



ICP-OES System Tips – Plasma Ignition Problems



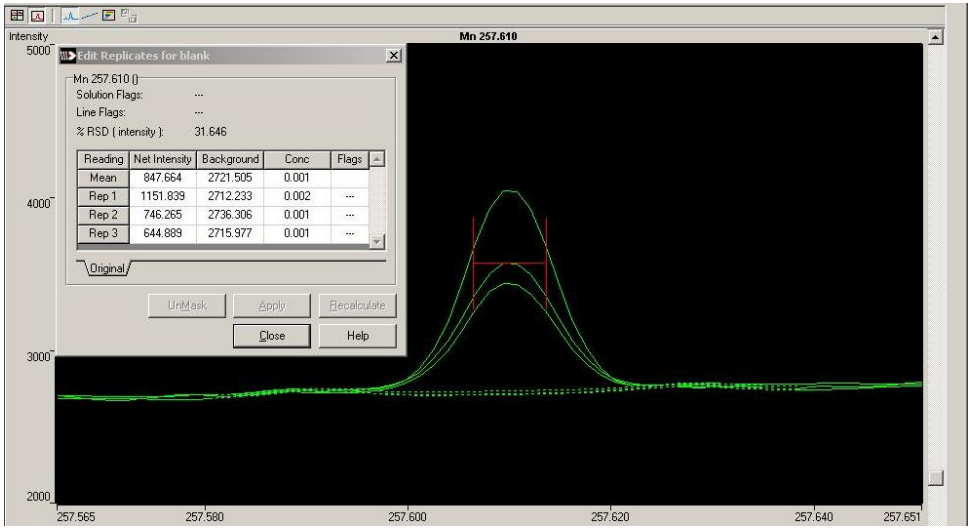
In most cases, the plasma will ignite first time.
If not, check the following (failure usually indicates presence of air):

- First, try repeating the ignition step again
- Have you changed argon cylinders recently?
  - Check the grade of argon
  - Try another cylinder
- Check all connections in the sample introduction system for cracks, loose fittings, missing or damaged items
  - Check that the plasma and auxiliary gas connections to torch were not reversed
- Check that the torch is sitting correctly w.r.t. RF coils (top of intermediate tube should be 2-3mm from edge of coil)
- Are you running a different sample type? e.g. higher RF power required for organic solvents
- Check the emergency off button on the front of the instrument
- Check the RF supply circuit breaker (on the rear panel of the instrument)

ICP-OES System Tips - Memory Effects

- Typically observed when measuring high concentrations of selected analytes
  - Usually see high intensity for first replicate – subsequent replicates are more consistent
  - Common culprits:
    - Ag, Au, B, Hg, Mo, Si, Sn, W, Zn, Zr

- The fix?
  - Check the rinse time used is adequate (30-40s is typical)
  - Use an acidified (matrix matched) rinse solution
  - Switch to a spray chamber that has smaller internal volume
  - Use a "switching valve" to improve wash-out characteristics
  - Use "Smart Rinse" to optimize rinse time
    - Varies the rinse time based on the measured intensity
    - Extends rinse time when required
    - Doesn't increase rinse for low concentration analytes



ICP-OES – Potential Autosampler Issues

- More customers use autosamplers with ICP for automation

- Issues to consider:
  - Long transfer tube between sampler and ICP-OES
    - May need to program a longer sample uptake delay
    - May exacerbate problems with memory effects
    - Use “Fast Pump” during sample uptake delay
      - Caution! – not always possible
        Not recommended with high %TDS samples and organics
  - Ensure probe diameter is appropriate for sample matrix
    - Use wider bore for high % TDS or viscous samples
  - Sample stability - potential for sample changes while uncovered in racks – impacts accuracy
    - Dust ingress can introduce contamination
    - Sample evaporation may occur during long unattended runs
    - Sediment in the sample may settle out, esp. with wear metals or suspensions
  - Ensure transfer line to ICP-OES is in good condition
    - Kinks in the line may cause poor uptake, or pulsing in the sample
    - Impacts on precision and accuracy

Recommended Procedures at End of the Day

1. Aspirate acid rinse solution for a few minutes before shutting off the plasma
   - Helps to prevent sample deposition inside the nebulizer after the run

2. Extinguish the plasma and switch off the chiller

3. Remove the sample capillary from the rinse, start the pump again and pump any remaining rinse solution from the spray chamber

4. Release the pressure bars on the pump tubing and remove the bridges from the securing slot
   - Ensure the tubes are no longer stretched over the pump rollers

5. Empty waste vessel

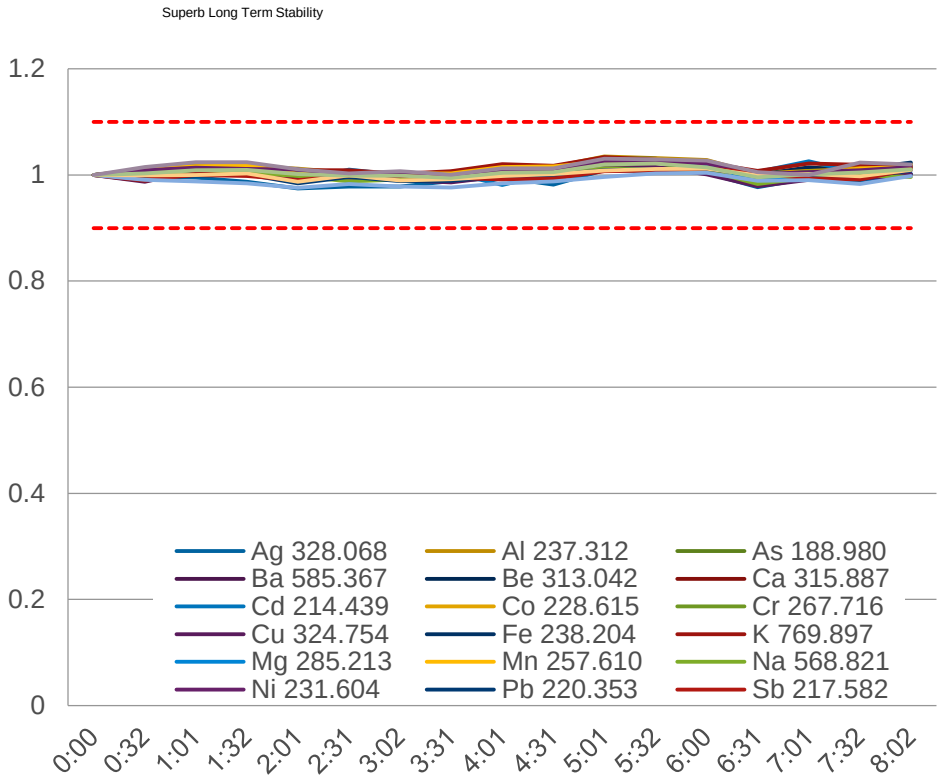
6. a) Close the current worksheet – leave ICP Expert S/W running

   b) Leave mains power and argon on
   - Keeps instrument in stand-by mode (ensures fastest start-up)

Agilent ICP-OES Performance - Benefits

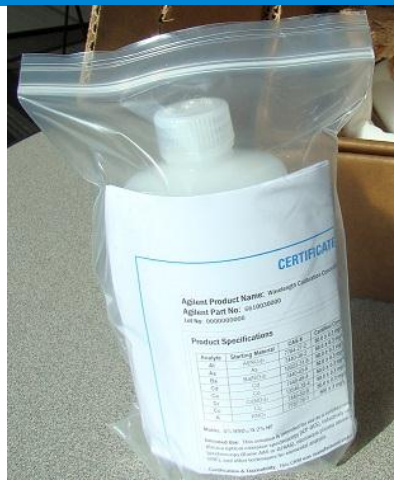
Robust, stable analysis

- Copes easily with difficult sample matrices such as organic solvents
- Continuous wavelength coverage ensures flexibility and gives you confidence in your results:
  - Extend the linear range by using λ of different sensitivities (in the same run) – no time penalty
  - Eliminate interferences
- One view, one step measurement of major, minor and trace elements for highest productivity
  - Fastest warm-up time
  - Fastest measurement speed



Agilent 720 ICP-OES Long-term precision over 8 hours: < 1 % RSD Max.

Tips to Improve Standard Preparation



- How are they prepared?
  - Ensure purchased standards are still within “Use By” date
  - Use calibrated pipettes and class ‘A’ volumetric flasks for dilutions
    - Periodically, check accuracy & reproducibility of your pipettes
  - Use de-ionized water (Type I - conductivity $\geq$ 18 MΩ/cm^3)
    - Lower grades may have contamination
  - Use serial dilutions for preparing low concentrations from 10,000 ppm stock
    - Please don’t do large dilutions (> 1:10,000) in 1 step

- What concentration are they?
  - Low concentration standards have a finite life
    - Prepare ppb (ug/L) concentration standards daily from high conc. stock
    - Prepare low ppm (mg/L) concentration standards weekly

- How are they stored?
  - Plastic vessels ensure better stability
  - Stabilize with acid – low pH ensures better stability

Tips to Reduce Contamination

Contamination can come from anything that comes into contact with your sample during storage, digestion (dilution) and analysis

- Check reagent purity
  - Always buy the best reagents
  - Always check the certificate of analysis for elevated levels
  - Caution if buying in large quantities
    - Worst case – can use contaminated acid for cleaning
    - Ensure still within “use by” date
  - Reseal immediately after use

CERTIFICATE OF ANALYSIS

BASELINE® Nitric Acid

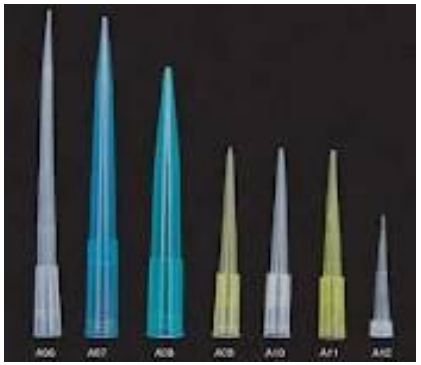
PRODUCT NUMBER: S020101 LOT NUMBER: 1211120 ASSAY (HNO_3, w/w): 68%

Most elements are determined by high resolution ICP-MS using sample preconcentration. The results are an average of three aliquots subsampled from three samples representative of the lot. The samples are slowly evaporated to dryness. The resulting residue is reconstituted in a small volume of SEASTAR™ BASELINE® 2% Nitric Acid / 2% Hydrogen Peroxide. Operations are conducted under Class 100 or better clean-room conditions. For volatile elements (indicated by *), the acid samples are diluted then directly injected into the ICP-MS. Values below 3 times the standard deviation of the blank are shown with '<', no blank value is subtracted.

1A	2A	3B	4B	5B	6B	7B	8	1B	2B	3A	4A	5A	6A	7A
3 Li < 0.5	4 Be < 1									5 B < 10				
11 Na < 5	12 Mg < 5									13 Al < 10				
19 K < 1	20 Ca < 5	21 Sc < 1	22 Ti < 5	23 V < 0.5	24 Cr < 10	25 Mn < 1	26 Fe < 10	27 Co < 1	28 Ni < 10	29 Cu < 1	30 Zn < 1	31 Ga < 0.1	32 Ge < 0.1	33 As < 10	34 Se < 5	
37 Rb < 1	38 Sr < 1	39 Y < 0.1	40 Zr < 0.5	41 Nb < 1	42 Mo < 1		44 Ru < 1	45 Rh < 1	46 Pd < 5	47 Ag < 0.5	48 Cd < 0.1	49 In < 0.1	50 Sn < 5	51 Sb < 5	52 Te < 0.5	
55 Cs < 0.05	56 Ba < 1	57 La < 0.05	72 Hf < 0.05	73 Ta < 10	74 W < 1	75 Re < 0.1			78 Pt < 1	79 Au < 1	80 Hg < 10	81 Tl < 0.05	82 Pb < 0.5	83 Bi < 0.05		

ALL VALUES ARE REPORTED IN PARTS PER TRILLION (PPT)

- Other common contamination sources
  - Reagent water
  - Clean glassware?
  - Airborne dust in the lab.
  - Pipette tips
    - Don’t insert pipette tips into your acids
    - Use natural tips – colored tips may increase contamination (Cu, Fe, Zn, Cd)
  - Powdered gloves (esp. for Zn)



Tips to Improve Accuracy of Results

- Sample preparation
  - Is the most appropriate digestion being used?
  - Are all of the analytes being quantitatively (and reproducibly) extracted and dissolved?
    - Many digestions are only partial extracts – efficiency will vary with the sample matrix
    - Some volatile analytes may be “lost” during digestion
      - Confirm by taking a solid certified reference material through your preparation and analysis procedure
  - Is the digest stable – or are you seeing any precipitates or a suspension?
  - Do you see any potential contamination from either reagents or the digestion equipment? e.g. especially with Si, B or Ca
      - Include a “Reagent Blank” with every sample batch to monitor

ICP-OES – Recommended Maintenance Schedule

Daily:

- Check exhaust system operating (smoke test)
- Inspect torch for injector blockage/other damage
- Check nebulizer for blockage/pulsation
- Inspect peristaltic pump tubing for stretching or flatness
- After analysis is complete:
  - Aspirate rinse solution for 5-10 mins. before shutting down (minimizes sample deposits)
  - Release pressure bar and detach peristaltic pump tubes from holder
  - Empty waste vessel
  - Leave ICP-OES in stand-by mode (gas and power on; software shutdown)

Weekly:

- Clean torch (or earlier if required)
- Check the other sample introduction tubing and O-rings
- Inspect cone (axial) or snout (radial); clean if req. by sonicating in dilute detergent
- Inspect torch bonnet for cracks or sample deposition (radial)
- Wipe down exterior surfaces of your ICP-OES (esp. sample compartment)

ICP-OES – Recommended Maintenance Schedule

Monthly:

- Clean spray chamber (or earlier if “beading” in spray chamber)
- Clean nebulizer
- Check the other sample introduction tubing and O-rings
  - Look for excessive wear, poor sealing or kinks and replace as necessary
  - Especially look at the transfer tube from spray chamber to torch and the spray chamber waste outlet
- Inspect/clean cone (axial ICP)
- Inspect/clean bonnet and/or snout (radial ICP)
- Inspect the state of induction coil
- Clean/check the air filter for the cooling air inlet (behind chimney)
- Clean/check air filter on the water chiller/recirculator
- Check the water level in the water chiller/recirculator & top-up if required

Periodically (every 6-12 months?):

- Clean water particulate filter on back of instrument
- Replace the water in the water chiller and dose with algaecide
- Change argon filters on argon gas supply (if using gas cylinders)

These functions (and more!) are completed as part of a Preventative Maintenance program by an Agilent Field Service Engineer

Overview – Key Consumables for ICP-OES

Sample introduction:

- Peristaltic pump tubing
- Torches
- Transfer and drain tubing
- Nebulizers
- Spray chambers
- Application kits (adapt your instrument to a new application)
- ICP standard solutions
- Ionization suppressant / buffer solutions

Autosampling:

- Sample tubes, racks, probes and transfer tubing

Vapor generation systems:

- Peristaltic pump tubing
- Connecting tubing

Agilent ICP-OES Consumable Kits

Part Number	Description	Content
9910112800	**Extended Value Pack – Axial ICP**	7 x standard axial torches 1 x SeaSpray nebulizer 1 x Tubing and connectors kit 2 x Spray chamber O-ring kits 1 x Double pass glass cyclonic spray chamber (incl. mounting bracket) 2 x Single pass glass cyclonic spray chamber 1 x packet of GasFit torch fittings 1 x packet of EzyFit nebulizer connectors
9910112600	**Matrix Value Pack – Axial ICP**	High solids and semi-demountable torches (1 of each) Sturman-Masters & Double pass glass cyclonic spray chamber (incl. mounting bkts) V-groove nebulizer All injector sizes, types and holder for semi-demountable torch Tubing and connectors kit 1 x Spray chamber O-ring kit 1 x Packet of GazFit torch fittings 1 x Packet of EzyFit nebulizer connector
9910112700	**Extended Value Pack – Radial ICP**	4 x standard radial torches 1 x torch bonnet 2 x V-groove nebulizers 1 x Sturman-Masters inert spray chamber 2 x Tubing and connectors kits 2 x Spray chamber O-ring kits 1 x packet of GasFit torch fittings
9910112900	**Matrix Value Pack – Radial ICP**	Standard radial and semi-demountable torches (1 of each) Torch bonnet Sturman-Masters and Double pass glass cyclonic spray chamber (+ holders) V-groove and slurry nebulizer (1 of each) All injector sizes, types and holder for semi-demountable torch Tubing and connectors kit 1 x Spray chamber O-ring kit 1 x Packet of GazFit torch fittings

There are also a range of tubing kits available, specific to your application – refer to pages 47-42 of the Spectroscopy Consumables Catalog (Agilent publication # 5991-1060EN)

Where to Find the Right Consumable?

Analytical Consumables: Consumables & Supplies

1-800-227-9770 (Option 1,1)
www.agilent.com/chem/contactus

Agilent Assist: Instrument Sales &Services

1-800-227-9770 (Option 1,3)
www.agilent.com/chem/contactus

On-Line resources:

ICP-OES Parts & Supplies

Atomic Absorption Supplies

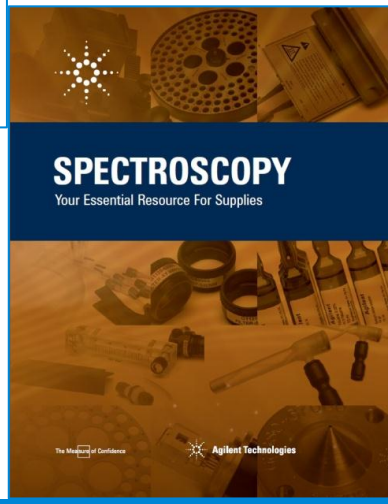
AA FAQs

ICP-MS Supplies

Instrument Parts & Supplies

Atomic Spectroscopy Application Notes

Recorded Agilent e-Seminars



Agilent Quick Reference Guide for Axial ICP (pub. # 5990-9475EN)

Agilent Quick Reference Guide for Radial ICP (pub. # 5990-9474EN)

Agilent Spectroscopy Supplies Catalogue (pub # 5991-1060EN)

Instrument User Manuals

Other Support Resources for Agilent ICP-OES Users

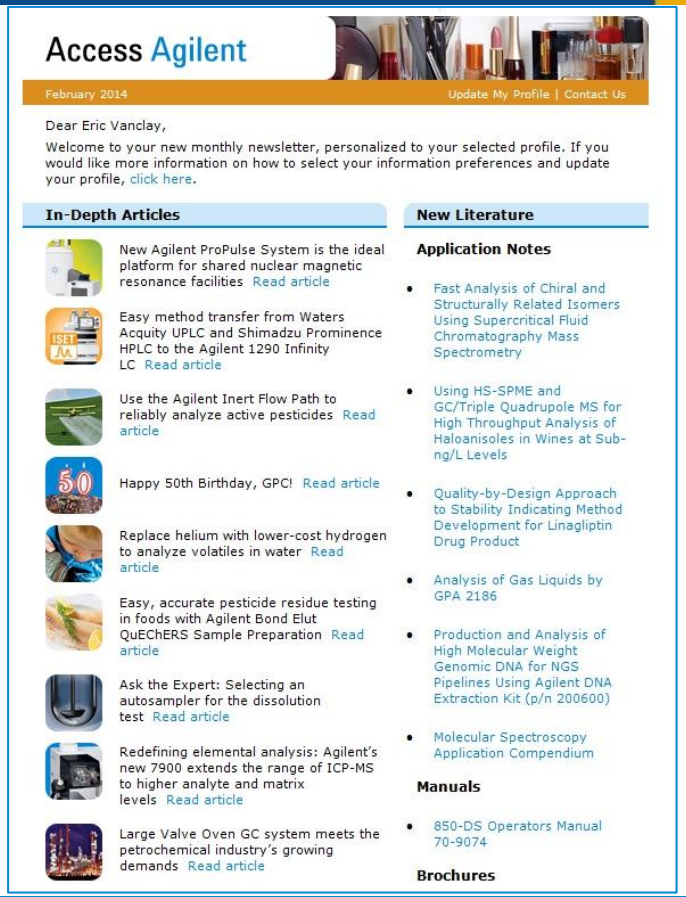
- Are you a member of Agilent's PlasmaNet email forum?
  - This is a direct email link to other Agilent ICP-OES users worldwide
- PlasmaNet allows you to:
  - Ask a question and get responses from other users doing the same application and/or Agilent Specialists worldwide
  - Share your knowledge and experience with other users
- To register, use this link to the registration form on the Agilent website (or ask your Agilent representative):

  http://www.chem.agilent.com/en-US/Technical-Support/Pages/PlasmaNetForumRegistration.aspx

- Are you a subscriber to the Access Agilent newsletter?
  - A monthly e-newsletter newsletter tailored to your preferences
  - Includes in-depth articles, new products, literature, offers and events
- To register, use this link to the registration form on the Agilent website (or ask your Agilent representative):

  http://www.chem.agilent.com/en-US/newsletters/access-agilent/Pages/default.aspx

PlasmaNet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Redefining elemental analysis: Agilent's new 7900 extends the range of ICP-MS to higher analyte and matrix levels Read article

Large Valve Oven GC system meets the petrochemical industry's growing demands Read article

New Literature

Application Notes

- Fast Analysis of Chiral and Structurally Related Isomers Using Supercritical Fluid Chromatography Mass Spectrometry
- Using HS-SPME and GC/Triple Quadrupole MS for High Throughput Analysis of Haloanisoles in Wines at Sub-ng/L Levels
- Quality-by-Design Approach to Stability Indicating Method Development for Linagliptin Drug Product
- Analysis of Gas Liquids by GPA 2186
- Production and Analysis of High Molecular Weight Genomic DNA for NGS Pipelines Using Agilent DNA Extraction Kit (p/n 200600)
- Molecular Spectroscopy Application Compendium

Manuals

- 850-DS Operators Manual 70-9074

Brochures

Summary – To Achieve Quality Data

- Most “instrument” failures occur in the sample introduction area
  - Includes
    - Torch
    - Spray chamber
    - Nebulizer
    - Peristaltic pump tubing
    - Drain Assembly

- Improper maintenance of this area can result in poor data quality

- Frequently less experienced analysts can fail to recognize problems resulting in productivity losses

- Establishing maintenance procedures can prevent problems

Questions?

Agilent MP-AES

Agilent AAS

Agilent ICP-OES

Agilent ICP-MS

The Market Leaders in Atomic Spectroscopy