Guidelines for Trouble Shooting and Maintenance of ICP-OES Systems

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Agilent's Atomic Spectroscopy Portfolio

Flame AA	MP-AES	ICP-OES	ICP-MS	ICP-QQQ
				
Agilent's **55** and **200 Series** includes *Fast Sequential flame AA* and *high performance furnace.*	Agilent's **4210 MP-AES** runs on air for the *lowest cost of ownership* and *improved safety.*	Agilent's **5110 ICP-OES** includes the *world's most productive, and only Synchronous Vertical Dual View* ICP-OES.	Agilent's **7800** & **7900 ICP-MS** are *robust, sensitive, accurate, and easy to use quadrupole ICP-MS*	Agilent's **8900 ICP-QQQ with MS/MS mode** provides *unique control of interference removal in reaction mode*

Leading the way in atomic spectroscopy innovation

Agilent 5110 SVDV ICP-OES Performance Highlights

Dual View Minus the Wait!

Lowest Cost of Ownership

- Fastest sample throughput
- Low gas consumption
- Longer component life
- Reduced maintenance costs

Enhanced Analytical Performance

- No compromise on speed, precision or stability
- System robustness and reliability
- Rapid qualitative screening

Simple Operation

- Easy setup
- Faster method development
- Easy access to sample introduction components
- Fully integrated valve hardware

Agilent 4210 MP-AES Performance Highlights

Lower Cost of Ownership
- Uses nitrogen for the emission source
- No hollow cathode lamps and no deuterium lamps

Safer
- No flammable gases
- No manual cylinder handling

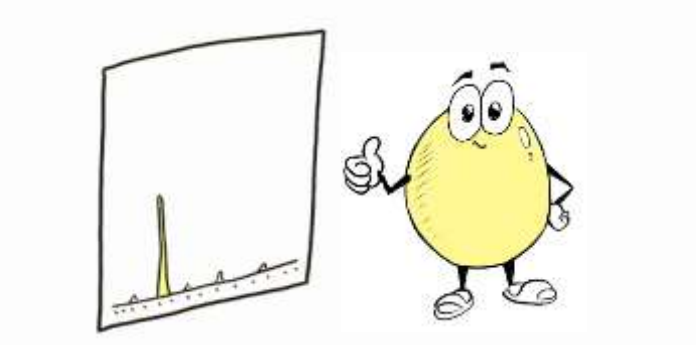
Higher Performance
- Lower detection limits compared to FAAS
- Larger linear dynamic range compared to FAAS

Easier to Use
- Intuitive software with auto optimization
- Plug and play sample introduction

Agilent 8900 Triple Quadrupole ICP-MS

LEAVE INTERFERENCES BEHIND WITH MS/MS

Put your results beyond doubt with the Agilent 8900 ICP-QQQ



Superior Performance

Controlled reaction chemistry for consistent, reliable results

Resolution of isobaric overlaps (beyond capability of high-resolution ICP-MS)

Lowest detection limits, even for previously “difficult” elements: S, Si, P…

Unparalleled Flexibility

4-channel cell gas control as standard

Unique MS/MS scan modes for research and method development

The most exciting and versatile ICP-MS for research and method development!

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
- I need lower detection limits for As & Se
- 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
- My check standards "drift"

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”

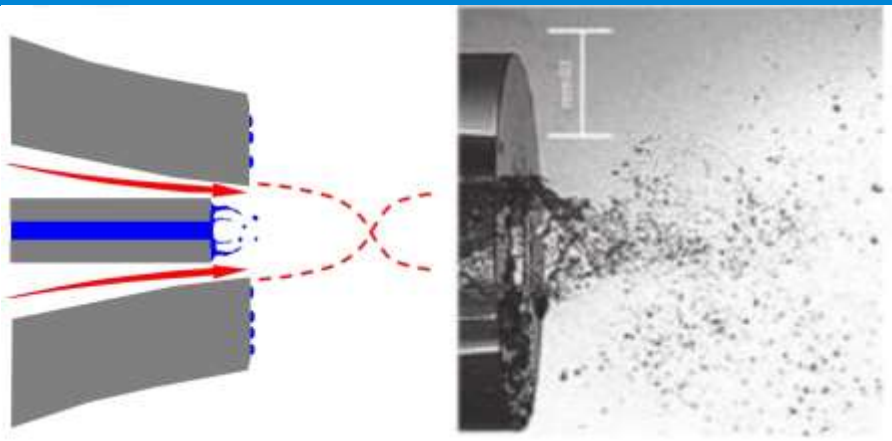
- Maintaining tubes – What to check?
  - Check 2 key things on pump tubing
    - Roundness of tube – should not be any “flat” spots
    - Tubing should still be elastic – replace if obviously stretched
  - Don’t over tighten – just need smooth and even sample flow
- Remember to check other tubing for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

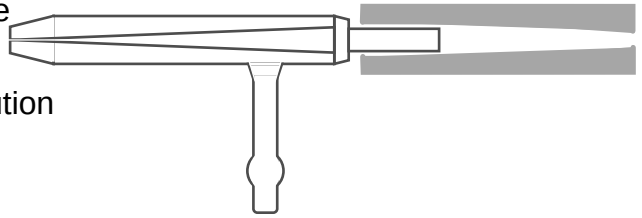
Cleaning the Nebulizer

Never sonicate or attempt to clean with wire!

For normal cleaning:

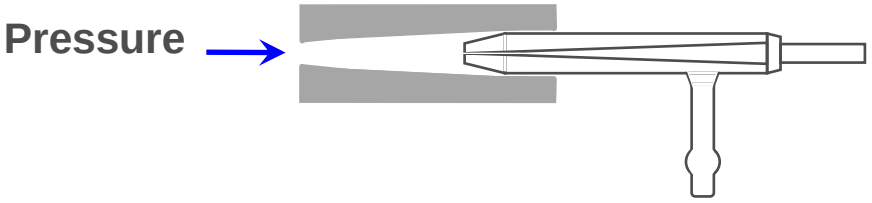
- Reverse pump the nebulizer with the tip in solvent; OR
- Apply suction from the wide end of the capillary using a vacuum aspirator; OR
- Apply high pressure clean air via a tubing snugly fitted over the nebulizer tip (use with caution); OR
- Use a dedicated nebulizer cleaning tool to force methanol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

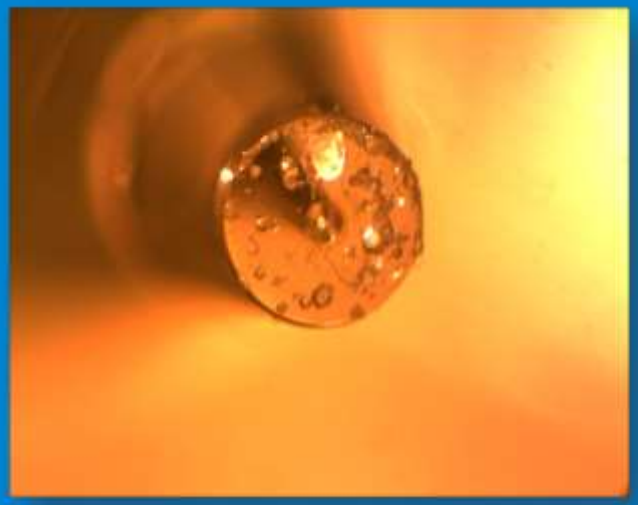
Refer Access Agilent article titled "Tips on choosing – and using – the best nebulizer for your ICP-OES"
http://www.chem.agilent.com/en-US/Newsletters/accessagilent/2013/jul/pages/nebulizer.aspx?cid=7652

Universal inert OneNeb

Routine usage concentric type

High Solids capable (V-Groove)

Performance Challenges of a Concentric Nebulizer



- Desolvation of a high TDS sample occurs due to the high flow rate of nebulizer gas through the small nebulizer orifice – leads to deposition of the sample matrix in the orifice
- High Total Dissolved Solids samples can lead to poor precision.

- Tip of the OneNeb nebulizer after 37 hours of operation measuring trace Au in cyanide leach (0.3% CN, 0.8% NaOH)
- The OneNeb provides improved resistance to blockage with high TDS samples. There is no deposition in the nebulizer tip

Universal OneNeb Nebulizer: A Quick Review

Innovative design improves performance, reduces maintenance, enhances sample throughput, and reduces operating costs.

- Direct replacement for a conventional concentric nebulizer
  - Virtually indestructible (even if dropped)
  - Resistant to HF & organic solvents
- Improves sensitivity and precision
  - Sensitivity improved up to 4 times (depending on nebulizer type you're using today)
  - Provides high efficiency at low sample uptake rates
- Less blockage from high TDS samples
  - Constant bore sample capillary, improves throughput

For more on the OneNeb including links to the video, flyer and application note, see: **www.agilent.com/chem/OneNeb**

And Now… Agilent's OneNeb Series 2 Nebulizer

- Improved version of the inert OneNeb universal Nebulizer
  - User replaceable capillary
  - ETFE body for improved robustness
  - Thicker wall sample capillary
    - Reduces kinking
    - Less chance of damage when connecting the peristaltic pump tubing
  - Suitable for use with Agilent ICP-OES/MP-AES and PerkinElmer Optima ICP-OES
    - PerkinElmer versions supplied with appropriate gas connector ensuring "plug and play" connection
  - Retains all the other performance features and benefits of the "original" OneNeb

Why Switch to the OneNeb?

1. Provides the ultimate flexibility
   - Handles different applications
   - Eliminates need to change nebulizers when changing applications

2. It's inert – use it with any solution type (incl. HF & organics)
3. It's virtually indestructible!
4. Easy to use – direct replacement for a conventional concentric nebulizer
   - "Plug and Play" installation with most ICP-OES models

5. Flow Blurring nebulization provides high efficiency, which means…
   - Up to 4 times more sensitivity
   - Improved (lower) detection limits
   - Improved precision (typically < 1 % RSD)
   - Better resistance to blockage with high dissolved solids solutions
   - Excellent long term stability

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 double pass cyclonic	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

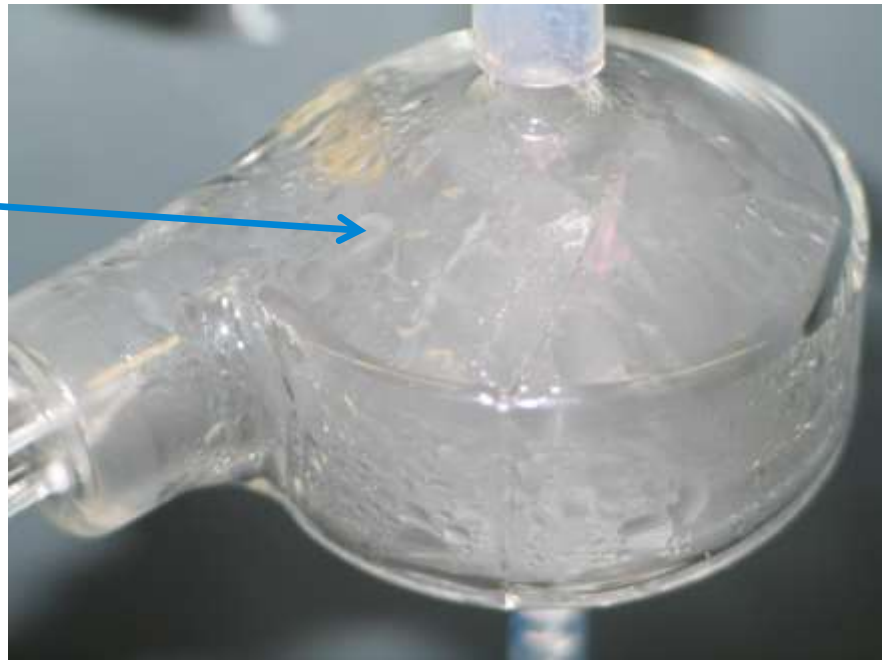
Inert for high solids & HF capable (Sturman-Masters)

Cleaning the ICP 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



700 Series ICP 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

700 Series ICP Torch Cleaning

Do **NOT** sonicate!

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

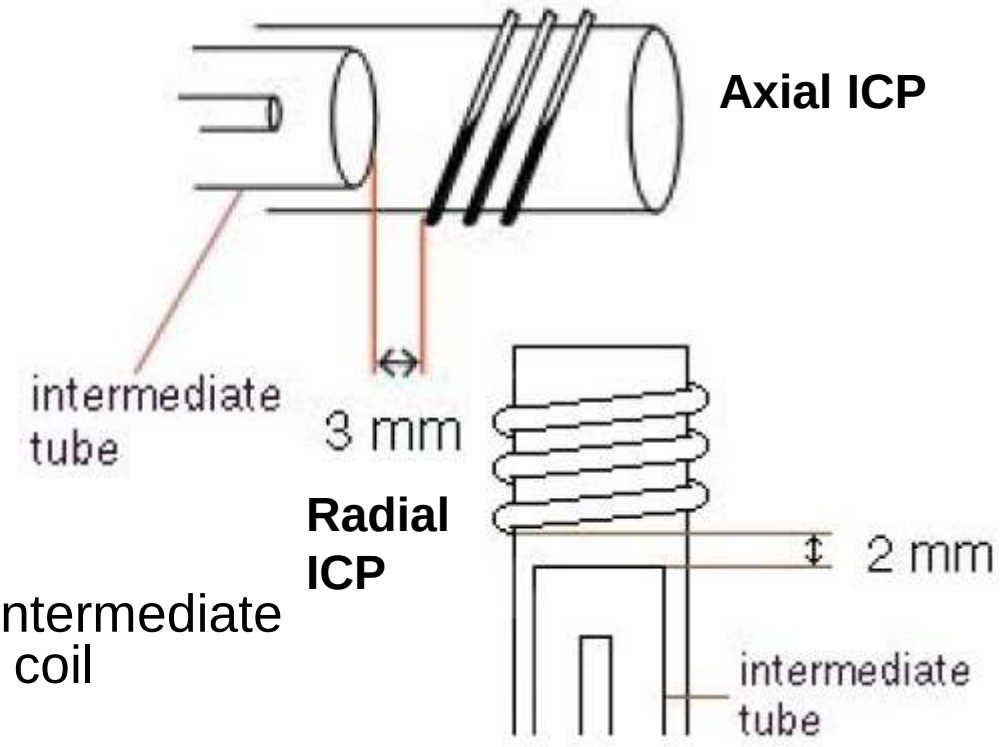
- Use a pipe cleaner dipped in aqua regia to remove persistent compounds from the injector tube

- 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

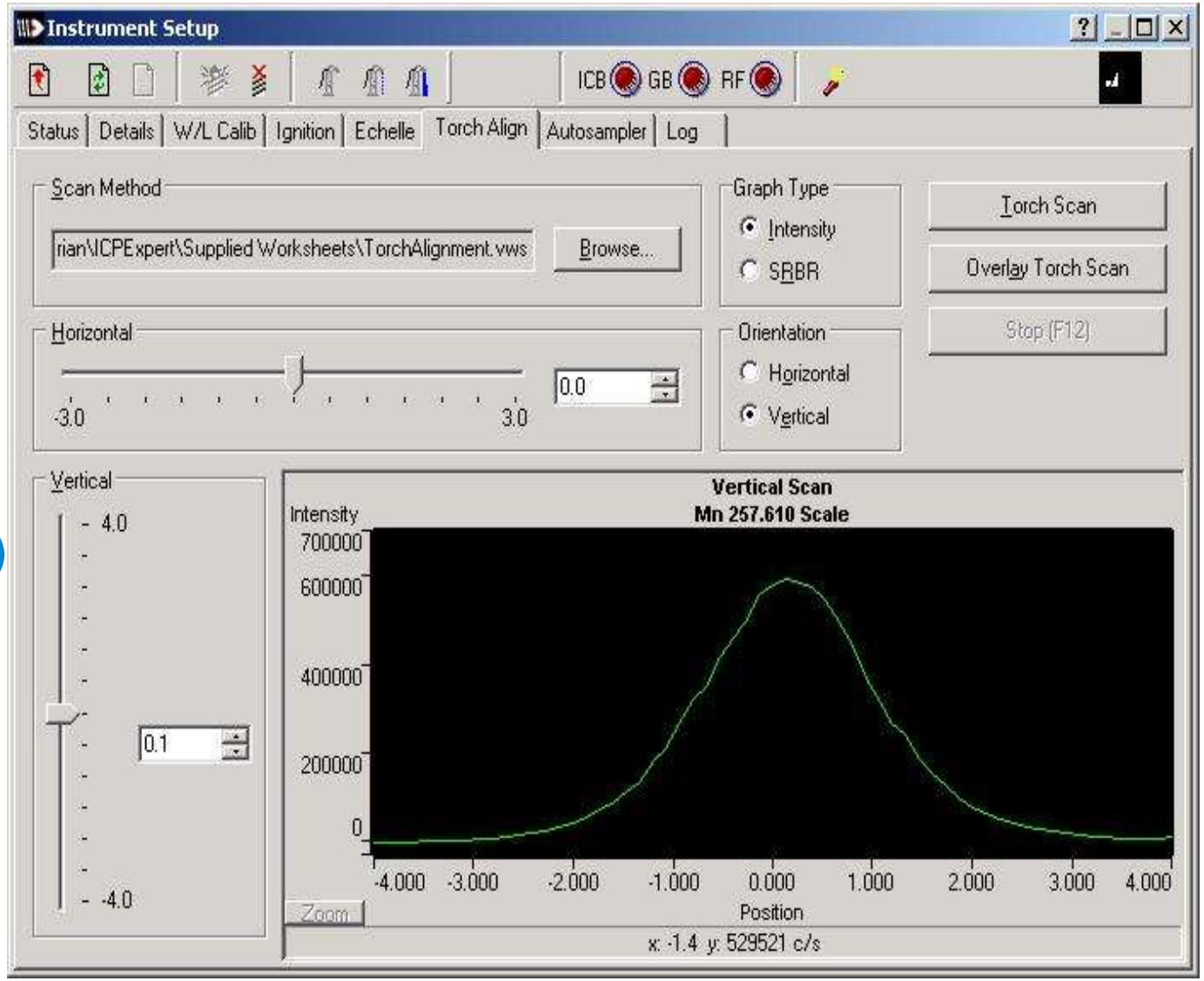
Caution! Reinstall only when dry

For 700 Series - Re-install with the intermediate tube 2-3mm from the RF (induction) coil



700 Series ICP 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



5100 Series ICP Torch Selection

Features moulded torch base designed for “plug and play” loading

- Easy to install (3 steps)
- Automatic torch alignment - no torch scanning required
- Automatic gas connection to eliminate confusion around gas line fitting
- Not compatible (interchangeable) with 700 Series ICP-OES torch designs

One piece quartz Easy-fit torches

- Simple to use
  - 1.8mm id injector (SVDV and VDV models)
  - 1.4mm id injector (Radial)
- Recommended for most applications

Demountable Easy-fit torches

- Gives greater flexibility & lower costs
  - 1.8mm injector (Standard - aqueous applications)
  - 2.4mm injector (High solids samples)
  - 1.4mm injector (Organics; also standard with radial)
  - 0.8mm injector (Volatile organics)
  - Alumina injector 1.8mm (Fusions and HF digests)

SVDV= Simultaneous Vertical Dual View

Demountable torches have replaceable outer tube

5100 Series ICP-OES Torch Cleaning

3 easy steps to cleaning the torch (see the torch cleaning guide (Agilent pub# G8000-90019) for more details):

1. Soak in 50% aqua regia for 1 hour
2. Thoroughly flush inside & outside using de-ionized water
3. Blow clean compressed air or nitrogen through the three gas supply ports

CAUTION

Ensure torch is dry before re-installation!

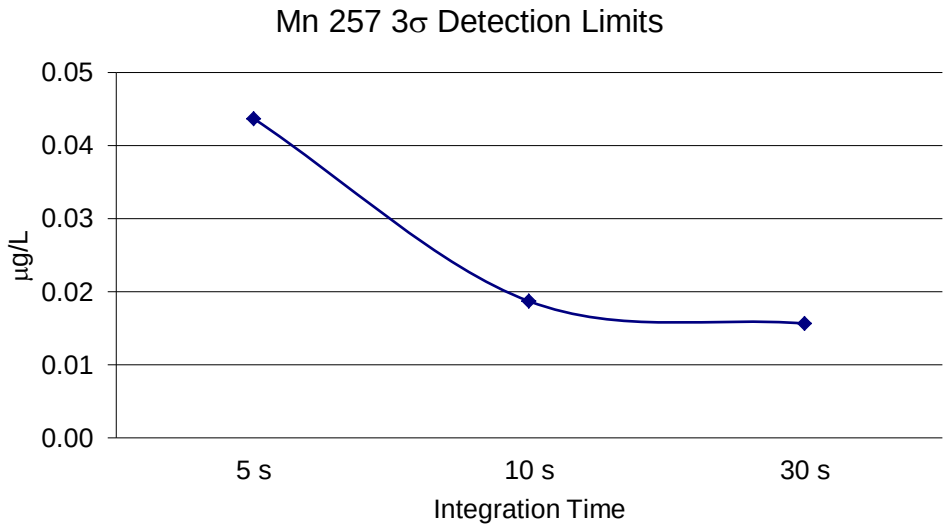
5100 Series ICP-OES Torch Cleaning

Agilent's torch cleaning stand (pn G8010-68021) provides a convenient, alternative way for users to clean their torches

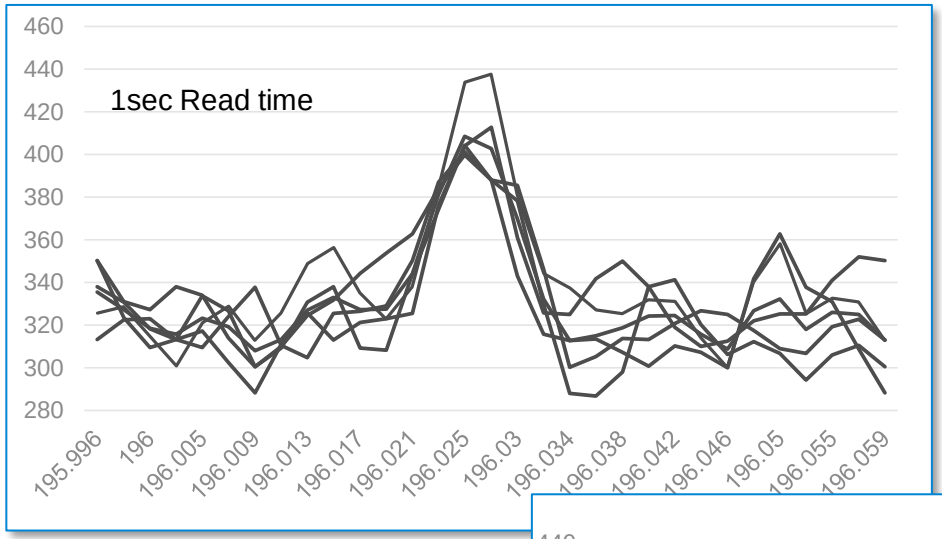
- Provides a stable platform to enable either the complete torch assembly or the bare injector/base assembly to be suspended in the acid cleaning solution
- Encloses the container for the acid cleaning solution, reducing the chance of accidental spillage
- Prevents damage to the fragile end of the outer tube/injector from contact with the base of the container
- Reduces premature degradation of the elastomer materials on the torch body, by limiting exposure to acid fumes

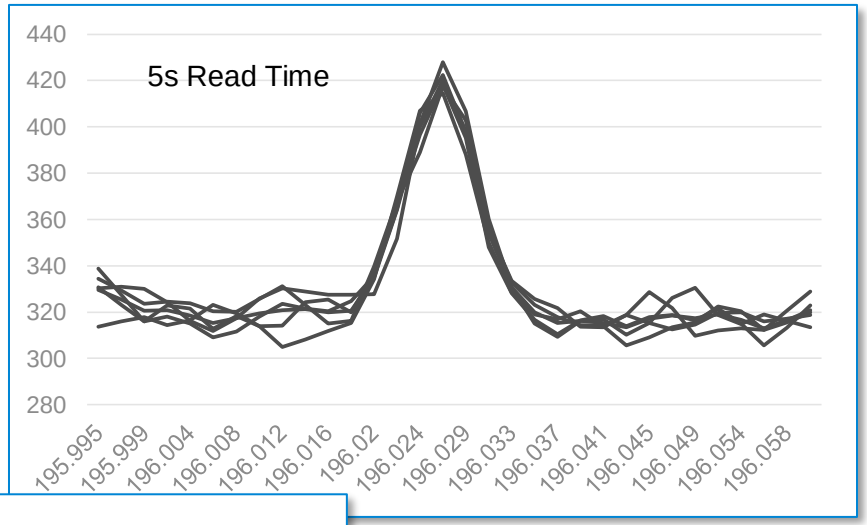
Improving Sensitivity – Integration Time

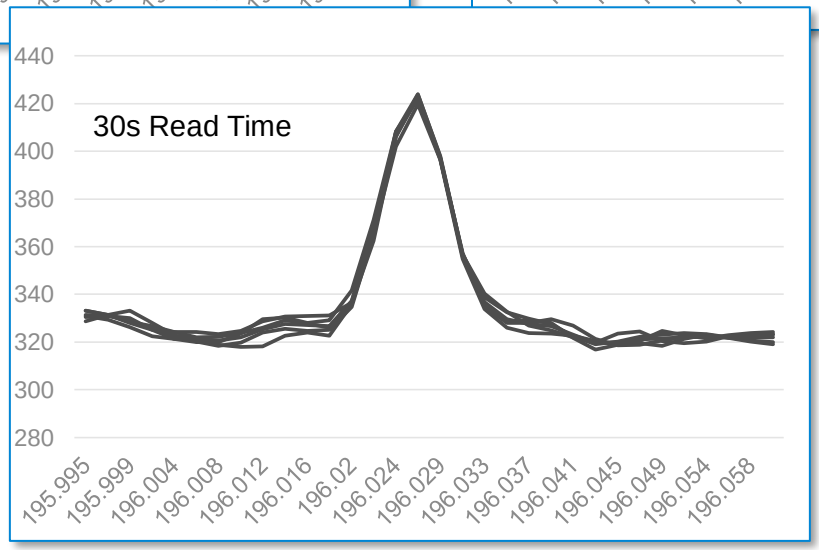
- Solid-state detectors such as the VistaChip2 CCD detector
  - Improve S/N and detection limits by averaging noise over time
  - DL α 1/√t



Improving Sensitivity – Integration Time





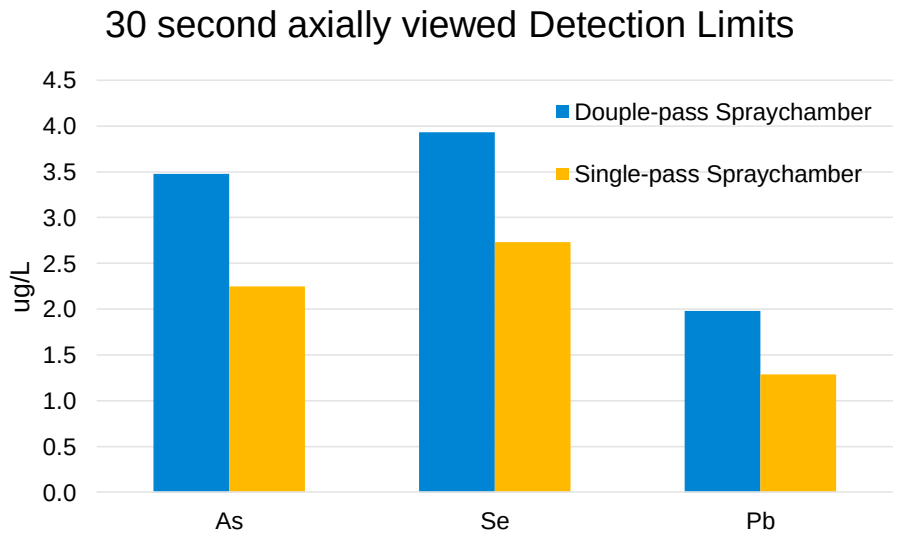


Overlay multiple 50ppb readings of Se at 196.026nm

DL α STDEV

Improving Sensitivity – Sample Introduction

- Single-pass spraychambers enhance sample transport efficiency
  - Improves S/N and detection limits
  - No degradation in short term precision when viewed axially

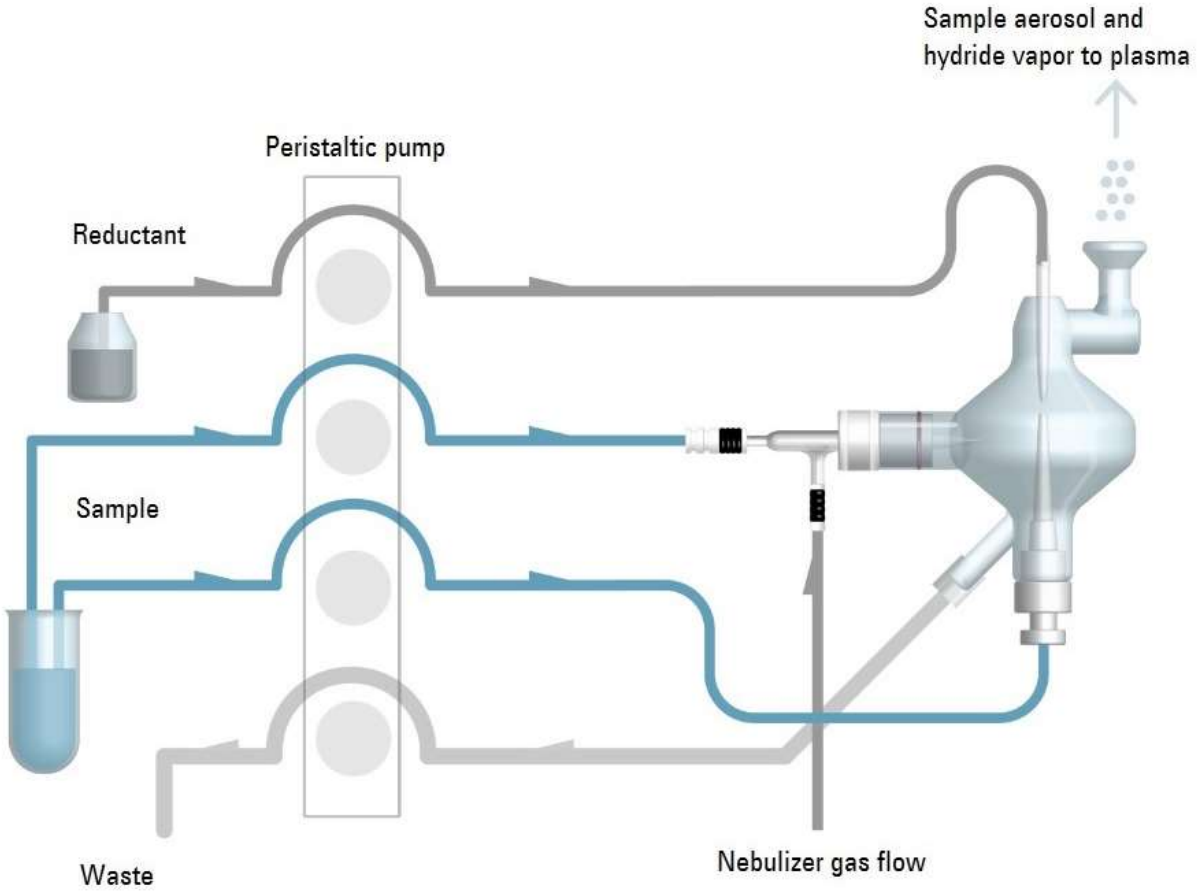


Improving Sensitivity – MSIS Sample Introduction

- Use the Multi-mode Sample Introduction System (MSIS) - A unique spray chamber for ICP-OES/MP-AES systems
  - Provides better sensitivity for determination of As, Se and Hg (& other hydride elements)
  - Simultaneous determination of routine elements and hydride elements using same set-up
  - Eliminates the need to shut down an instrument to switch between “routine” & hydride analysis
  - Reduces sample preparation – measure all elements from a single digest
  - Eliminates the need for a dedicated hydride generation system

Improving Sensitivity - MSIS Operating Principle

One system for analysis of even the most difficult elements.
Prep and run your entire analysis on one system.
Eliminates the need for multiple systems & batch testing of As, Hg, Se and others
Improved productivity and cost/ labor savings



Improving Sensitivity - MSIS Performance with 5100

Element	IDL using Conv. Nebulization ug/L	IDL using MSIS ug/L
As	2.0	0.23
Se	2.4	0.1
Hg	1.0	0.037
Sb	2.4	0.075
Sn	1.1	0.29

Configuration	MSIS in dual mode		Standard nebulization*
Element & wavelength	4 % HCl and 1 % L-Cysteine (ppb)	50 % HCl (ppb)	1% HNO_3 (ppb)
Cd 214.439 nm	0.22	0.24	0.1
Co 238.892 nm	0.51	0.51	0.6
Cr 267.716 nm	0.32	0.36	0.2
Cu 327.395 nm	0.33	1.7	0.2
Fe 259.940 nm	0.52	0.66	-
Mn 257.610 nm	0.056	0.069	0.1
Mo 202.032 nm	0.64	0.66	0.5
Ni 231.604 nm	1.0	1.2	0.9
P 213.618 nm	4.1	4.6	2.9
Pb 220.353 nm	2.7	2.4	2.2
Zn 213.857 nm	0.25	0.36	0.2

Detection limits for non-hydride elements in simultaneous mode are equivalent to those achieved using conventional nebulization

ICP-OES System Tips – Wavelength Calibration

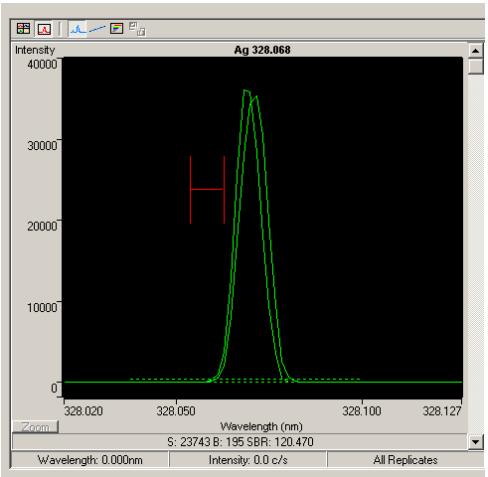
- "Wavelength Calibration" co-relates actual emission peak to the pixels on the detector chip

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

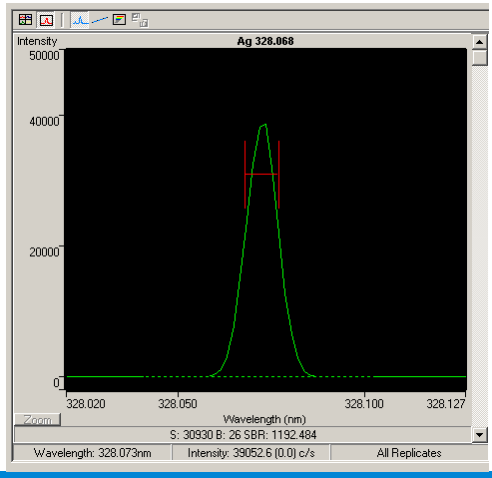
- For best results:
  - Use Agilent's prepared wavelength calibration solution (pn 6610030100)
    - Improves productivity –no "missing " components to troubleshoot
    - Improve reproducibility
    - Convenience – the pre-mixed solution has long shelf life, so you can use it as required
    - Also suitable 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%:
    - 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

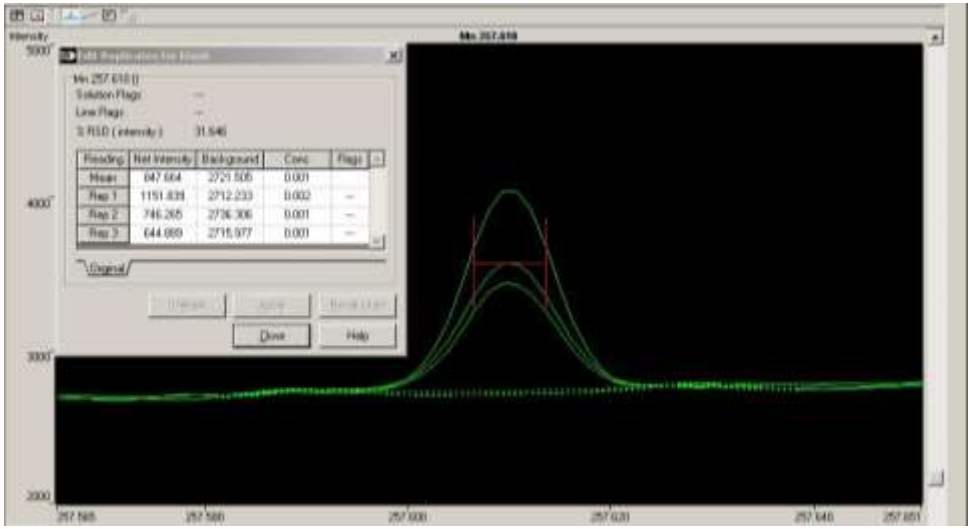
In most cases, the plasma will ignite first time.
If not, check the following (failure usually indicates presence of air):

- 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:
  - Confirm samples loaded in correct sample locations
  - 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
- Measure all wavelengths in one measurement for best precision and highest productivity
  - Fastest warm-up time
  - Fastest measurement speed

Long Term Stability
250 ppb multi-element in 25% NaCl with VDV configuration (axial only mode)

Agilent 5110 ICP-OES Long-term precision over 4 hours: < 2.4% 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

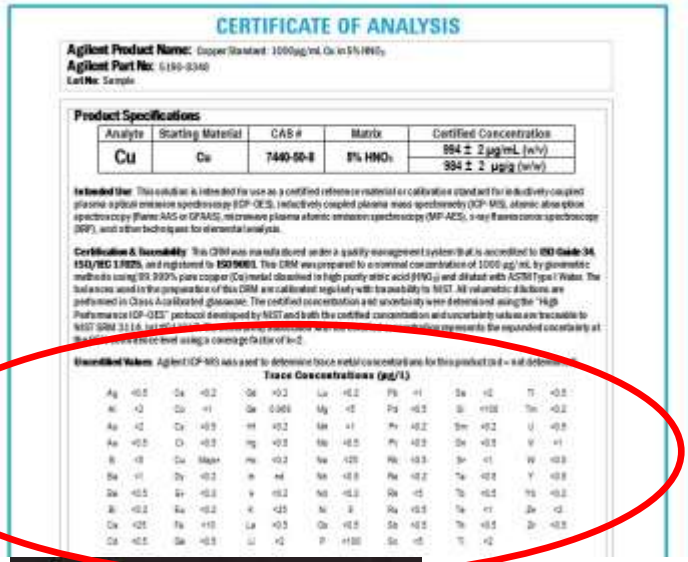
- What concentration are they?
  - Low concentration standards have a finite life
    - Prepare ppb (ug/L) concentration standards daily from high conc. stock
    - Prepare low ppm (mg/L) concentration standards weekly

- 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

Agilent Product Name:

Agilent Part No:

Lot No:

Product Specifications

Analyte	Starting Material	CAS #	Matrix	Certified Concentration
Cu	Cu	7440-50-8	5% HNO_3	994 ± 2 µg/mL (w/v)
				994 ± 2 µg/g (w/w)

Trace Concentrations (µg/L)

- 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 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

700 Series ICP-OES Consumables 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

There are also a range of tubing kits available, specific to each application
– refer to pages 57-61 of the Spectroscopy Consumables Catalog (Agilent pub # 5991-5455EN)

5100 Series ICP-OES Consumable Kits

Order one of the “ICP-OES Consumables Kits”

- Each kit contains all the essential and common supplies required for routine operation of the new 5100 ICP-OES
  - For SVDV / VDV models, use: part # G8010-67001
  - For radial RV models, use: part # G8012-67001

- Users can re-order regularly to ensure they have all the essential supplies on hand
  - Minimizes downtime
  - Reduces operating costs through discounted pricing

Components in the Operating Supplies Kit
1 Easyfit demountable torch with 2 spare outer tubes
4 packs pump tubing (for sample + waste)
1 pack int. standard pump tubing & connectors
SeaSpray nebulizer (U series)
1 pk of 0.75mm id Unifit sample connectors for neb.
1 x Ezylok gas connector for nebulizer
Twister spray chamber with Helix seal
1 pack of Unifit connectors for spray chamber drain
Spare torch clamp for the s/chamber ball joint socket
Spare pre-optic window (axial kit incl. an extra window for the radial view)
Spare O-ring or washer for the pre-optic window
Capillary tubing for sample inlet
Nebulizer gas supply tubing
Drain tubing for s/chamber with 2 x barb connectors
Drain tubing for instrument spill tray
1 pack of Helix seals for s/chamber neb. inlet

Links to Useful ICP-OES Resources

- ICP-OES parts and supplies (On-line Store):
  http://www.chem.agilent.com/store/en_US/Cat-SubCat1ECS_30364/ICP-OES?navAction=push&navCount=0
- ICP-OES troubleshooting videos:
  http://www.agilent.com/en-us/products/icp-oes/icp-oes-supplies/nebulizers/icp-oes-nebulizers-accessories/overview
- Agilent atomic spectroscopy application notes:
  http://www.chem.agilent.com/en-US/search/library/Pages/LibrarySearchResult.aspx?k=atomic&a=Scope:"Library"&w="Language"%20=%20'English'
- ICP-OES supplies inventory checklist:
  http://www.agilent.com/cs/library/brochures/OwnersChecklist_ICP_OES_LR.pdf
- Agilent Quick Reference Guides (lists most common consumables items):
  http://www.agilent.com/search/?Ntt=quick reference guides&N=164
- Agilent Spectroscopy consumables catalog:
  http://www.agilent.com/cs/library/catalogs/public/5991-5455EN_Spectroscopy_Catalog_LR.pdf
- Agilent high quality Inorganic and Metallo-Organic standards for Atomic Spectroscopy:
  http://www.chem.agilent.com/Library/catalogs/Public/5991-5678EN_Chemical_Stnds_Catalog_LR.pdf
- Agilent supplies for PerkinElmer ICP-OES & ICP-MS systems catalog:
  http://www.chem.agilent.com/Library/catalogs/Public/5991-6789EN_ICP_MiniCatalog_Offset_LR.pdf
- Agilent “Make Productivity Happen” workflow webpage:
  http://www.agilent.com/en-us/promotions/make-productivity-happen-spectro#home
- Agilent recorded webinars for atomic spectroscopy:
  http://www.agilent.com/en-us/training-events/eseminars

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.agilent.com/en-us/newsletters/accessagilent

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

DISCOVER OUR ATOMIC SPECTROSCOPY PORTFOLIO


AGILENT AA


AGILENT MP-AES


AGILENT ICP-OES


AGILENT ICP-MS


AGILENT ICP-QQQ


AGILENT PARTS & SUPPLIES

Agilent CrossLab
AGILENT SERVICES

http://www.agilent.com/chem/atomic