Guidelines for Trouble Shooting and Maintenance of ICP-MS Systems

Presented by Dr. Gareth Pearson
ICP-MS Supplies Product Manager

Agilent
Trusted Answers

The Agilent Atomic Spectroscopy Lineup
An Instrument for Any Customer Application!

55B Flame AA

240FS/280FS Flame AA

240Z/280Z Furnace AA

4210 MP-AES

5110 ICP-OES

7800 ICP-MS

7900 ICP-MS

NEW! 8900 ICP-QQQ

Leading the way in atomic spectroscopy innovation

www.agilent.com/chem/atomic

Agilent ICP-MS at a Glance

Quadrupole ICP-MS (ICP-QMS) Agilent 7800 and Agilent 7900

- High matrix tolerance with HMI/UHMI
- He mode removes common polyatomics
- Wide dynamic range
- Applications from routine to research

Triple Quadrupole ICP-MS (ICP-QQQ) Agilent 8900

- MS/MS for controlled reaction chemistry
- Unmatched interference removal
- High sensitivity and low backgrounds
- Superior Abundance Sensitivity

Agilent 7800 and 7900 ICP-MS

Agilent 8900 ICP-QQQ

Top 5 Tips for Flawless ICP-MS Performance

Prevent nebulizer blockage

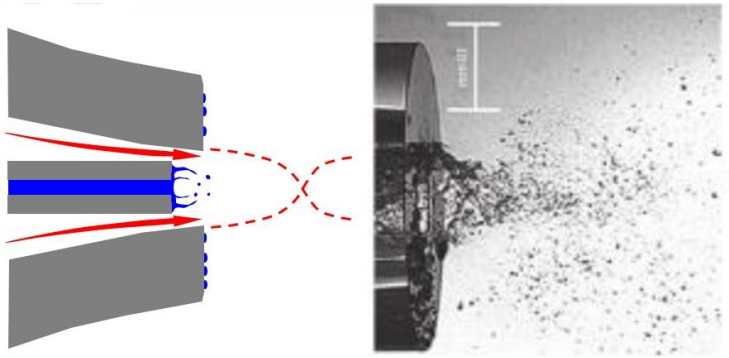
Pay attention to the interface cones

Keep it clean

Set high standards

Don’t neglect the pump tubing

How to Prevent Nebulizer Blockage?



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

Micro-flow nebulizers

–Zero tolerance to undissolved solids

–Plugging of annulus and/or capillary

Rinse at least 10 minutes with a reagent blank before extinguishing plasma

Filter/Centrifuge/gravitational settling

Use only lint less wipes

Autosampler enclosures

Autosampler probe height

Think "**PREVENTION**"

Improve Efficiency of Sample Filtering

Most users <u>should</u> filter samples prior to analysis

- Reduces maintenance and downtime from blockages in the sample introduction system

Agilent Captiva syringe filters provide an efficient solution

- Captiva filters provide the industry's highest flow rates and loading capacities
- Available in a variety of membrane types and pore sizes, to suit your application
- Recommended for spectroscopy applications:
  - Captiva Premium, 100/pk
    - PTFE, 0.45um Pore, 15mm dia. (5190-5085) or 25mm dia. (5190-5087)
  - Captiva Econofilters, 1000/pk
    - PTFE, 0.45um Pore, 13mm dia. (5190-5266) or 25mm dia. (5190-5268)

http://www.agilent.com/cs/library/brochures/5991-1230EN_Filtration%20Bro.pdf

Instructions for use – Captiva Syringe Filters

Follow these steps to realize the full benefits of filtration

https://www.agilent.com/en/products/sample-preparation/sample-preparation-methods/filtration/stepbystep

Before filling with sample, draw approximately 1 mL of air into the syringe. This will minimize fluid retention.

→

Draw your sample into the syringe, then draw in about 1 mL of air. Invert the syringe and wipe residue off tip.

→

Connect the syringe to the syringe filter using a luer connection. Twist gently to ensure a secure seal.

→

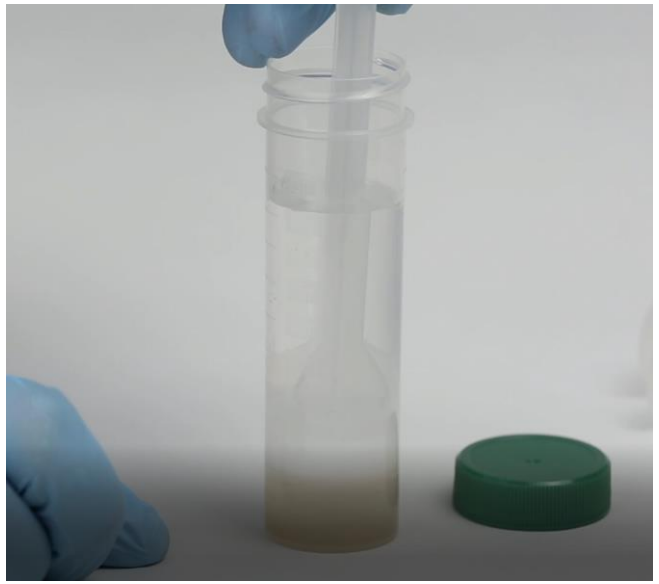
Filter syringe contents into a vial. Afterwards, remove the syringe filter, draw air into the syringe, re-attach the syringe filter, and press the plunger to filter the residual sample. This will maximize sample recovery.

Warning: Use caution with syringes smaller than 10 mL. They can easily generate enough pressure to burst the syringe filter. Agilent syringe filters are for laboratory use only. Pre-wetting the filter, while not mandatory, can be performed as an extra step.

Improve Efficiency from Digestion to Filtration to Analysis

The **FilterMate™ Filtration System** provides a convenient, economical method for digestion, filtration and analysis, improving sample preparation efficiency by eliminating transfers.

- Weigh sample directly into the vessel and use the graduations to accurately add reagents
- Digest in the Hot Block, Dilute to volume, Filter directly and place on the autosampler rack for analysis



190048000	**FilterMate™ 2 micron PTFE, 100/pk**
190048100	**FilterMate™ 0.45 micron PTFE, 100/pk**
190047900	**Digestion Tubes, Polypropylene for 36- and 54- well hot block, 500/pk**

https://www.agilent.com/en/products/sample-preparation/sample-preparation-methods/filtration/filtermate

Cleaning the Nebulizer

https://www.agilent.com/en/products/lab-supplies/nebulizertips

Never sonicate or attempt to clean with wire!

For normal cleaning:

- Soak in 5% nitric acid for ~10 mins.

To remove a nebulizer blockage:

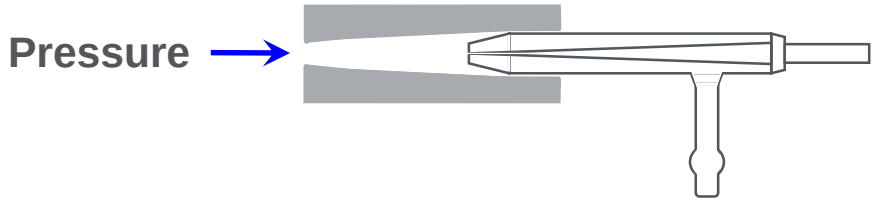
- Use a dedicated nebulizer cleaning tool to force methanol solution through the tip; OR
- Reverse pump the nebulizer with the tip in solvent; OR
- Apply suction from the wide end of the capillary using a vacuum aspirator; OR
- Apply high pressure clean air via a tubing snugly fitted over the nebulizer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

For salt deposits:

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

For “stubborn” deposits:

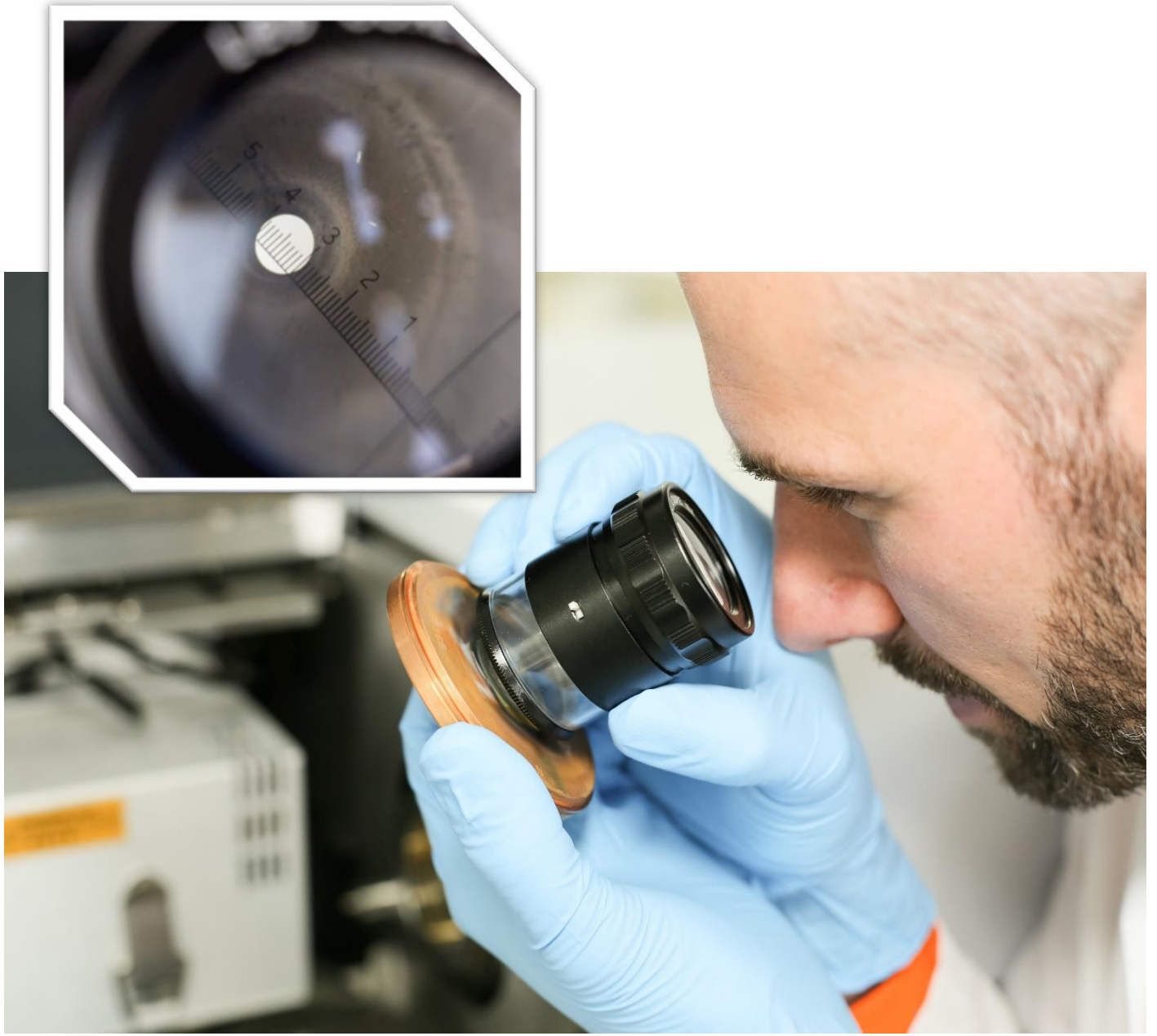
- Soak the nebulizer overnight in conc. nitric acid. Use a pipette to ensure there are no air bubbles in capillary. Rinse with pure water



Nebulizer cleaning tool
Agilent pn G3266-80020

http://www.agilent.com/en-us/promotions/icp-ms-resource

Pay attention to the Interface Cones



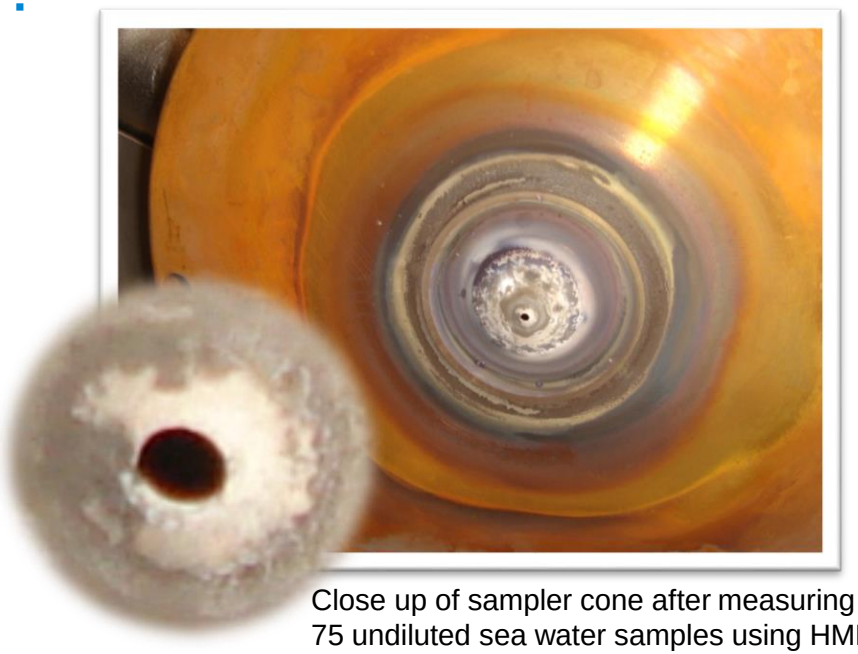
- Visually inspect the cones
  - Agilent's LED measuring magnifier (pn 5190-9614) is a tool to help user's achieve optimum ICP-MS instrument performance and maximum cone life

- ICP-MS users can use the magnifier to:
  - Visually inspect a cone to evaluate its condition (e.g. check for excess matrix build-up at the tip)
  - Check if a cone has a damaged orifice and needs to be replaced (e.g. enlarged or damaged orifice)
  - Confirm if maintenance procedures and cleaning have been successful

Why and When to Clean Your Interface Cones?

The necessity to clean the cones depends on your (in)tolerance limits for:

- Sensitivity
- Long term precision
- Elevated background (cps)
- Interface vacuum changing



Close up of sampler cone after measuring 75 undiluted sea water samples using HMI

Other reasons to clean the cones?

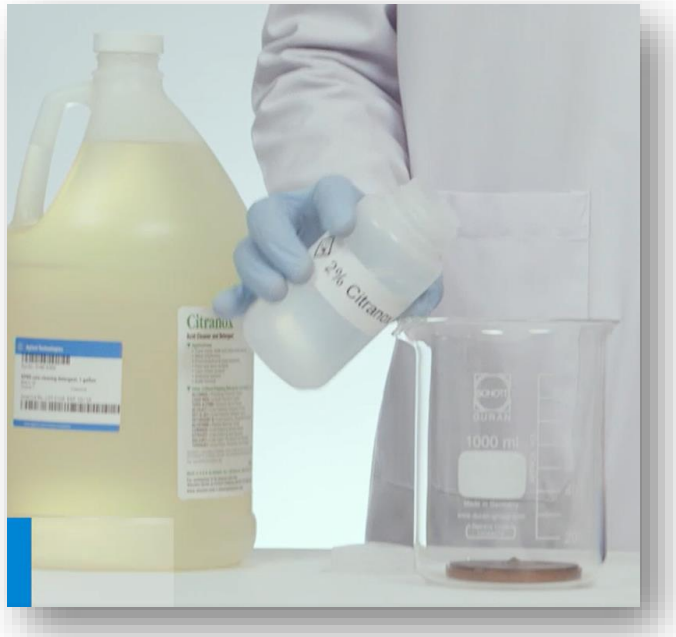
- If there is an excessive build up of deposits on the orifice (should be circular and free of deposits)
- If the orifice of the cone is blocked / non-circular / unusually discolored

If analyzing the same type of samples, clean to remove only superficial deposits. Ultrapure water clean may be all that is required

A conditioned cone has a uniform coating that leads to long term stability

If analyzing different sample types where a major element in the first sample type is a trace element in the second, more than one cleaning step is required

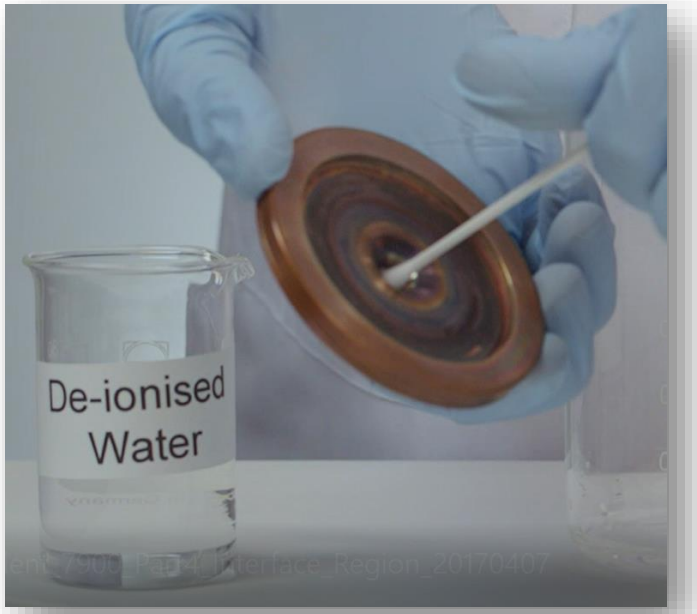
What's the Right Way to Clean Interface Cones?



Routine Cleaning:

Simple clean with pure water

- Dip a cotton swab (pn 9300-2574) in pure water and clean both sides of the cone
- Rinse with pure water
- Ultrasonicate the cones in pure water for >5 mins (typ. 20 mins)
- Repeat as required (aim for water to stay clean)



Only if performance is still not satisfactory, clean with a 2% Citranox solution (pn 5188-5359)
(NOT MORE THAN 2%)

- Ultrasonicate in a 2% Citranox solution for max. 2-3 mins
- Rinse with pure water
- Ultrasonicate in pure water for >5 mins

http://www.agilent.com/en-us/promotions/icp-ms-resource

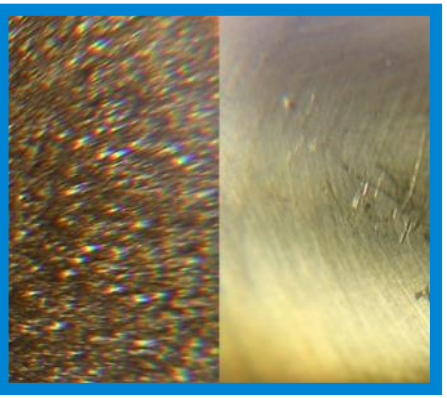
What's the Right Way to Clean Interface Cones?

ONLY For more severe contamination:

Clean with a 2% nitric acid solution

- Dip a cotton swab in 2% HNO_3 and clean both sides of the cone
  (DO NOT SOAK IN ACID)
- Rinse with pure water
- Ultrasonicate in pure water for 2 - 3 mins
- Rinse with pure water
- Ultrasonicate again in pure water for an additional 2 - 3 mins

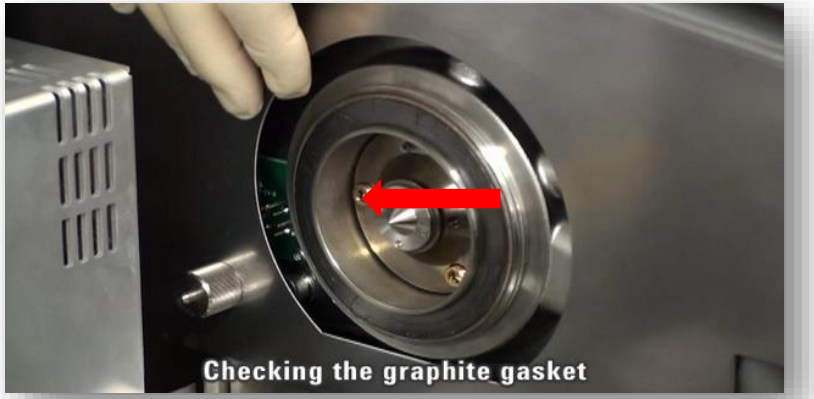
Pitted nickel cone from effect of HNO_3 soak (left side) and clean machined metal on right.

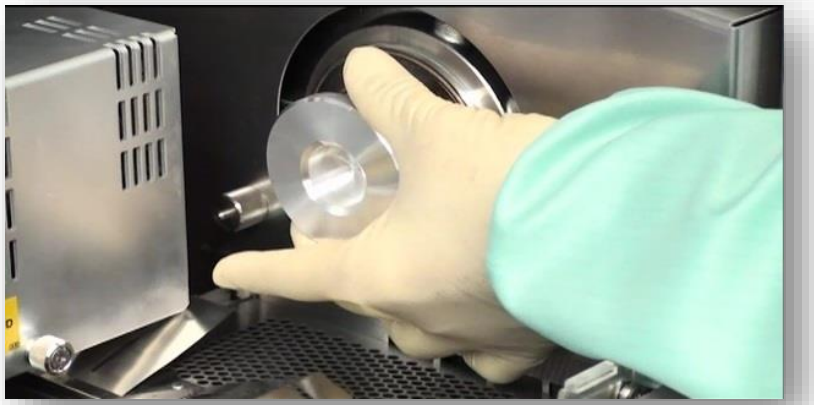


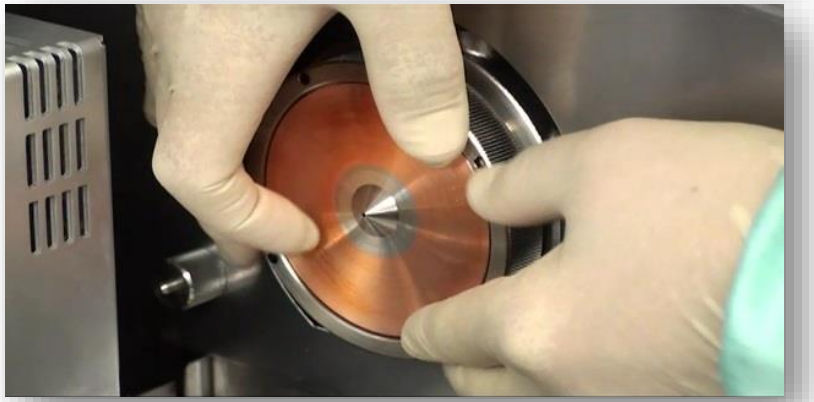
http://www.agilent.com/en-us/promotions/icp-ms-resource

Re-installing the Cleaned Cones

- Check the condition of the graphite gasket and replace if necessary
- Refit the skimmer cone using the removal tool
- Refit the sample cone and tighten by hand
- Check the vacuum levels to confirm correct installation
  - Interface pressure: 500 Pa (~4 torr, 0.005 atm)
  - Analyzer pressure: 0.002 Pa (~1.5 x10^{-5} torr, 2 x10^{-8} atm)







Common Interface Cone Issues

Cones are fragile (esp. skimmer cone) – Handle with care!

- Poor handling, harsh cleaning or physical abuse can irreversibly damage cones
- Never place tip down on any surface or during cleaning
- Don't try to clean back to original condition

Check that you're using the right skimmer base

- Increases deposition on the cone
- Using the wrong skimmer base can overheat and damage the cone
  - Ni cones – use the stainless steel base
  - Pt cones – use the brass skimmer base

Condition new or cleaned cones prior to use

- Reduces drift due to initial deposition of sample matrix on the clean cone surface
- Aspirate your highest matrix sample for >30mins and then your blank / rinse solution for 10 mins.
- Alternatively aspirate 6020 Interference Check solution A (pn 5188-6526) diluted 10 times in General Purpose mode for 30 mins.; follow with a 5% HNO_3 solution for 10 mins.

Choose from three Cone Care Kits—each includes our LED measuring magnifier

Nickel Cone Care Kit
(Part No. 5067-0294)

Order now

Nickel-plated Cone Care Kit
(Part No. 5067-0295)

Order now

Platinum Cone Care Kit
(Part No. 5067-0296)

Order now

Each kit contains:

2 sampler cones

1 LED measuring magnifier

1 package of sampling cone graphite gaskets (3/pk)

1 package of cotton swabs for cleaning (100/pk)

Remember...
You can save 25% on all skimmer cones ordered with any Cone Care Kit

https://www.agilent.com/en/promotions/icpms-conecare-online

Product flyer

Take a closer look at our exclusive Cone Care Kits.

https://www.agilent.com/cs/library/flyers/public/5991-8673_icpms_conecarekit_flyer.pdf

Are You Using the Right Interface Cone?

Type of Cone	For which Model ICP-MS?	Skimmer Base Required	Recommended Applications
Nickel sample / skimmer cones	Standard on 7500a/i/c/ce/cx, 7700x/e, 7800/7900 and 8800/8900 with x-lens	Stainless steel	Suitable for most common applications. Good thermal and chemical resistance Provides most economical operation Typically use 3-5/year (based on ~350 samples/day)
Nickel plated sampling cone	Optional for all 77/78/7900 and 88/8900 models	-	For samples containing > 0.5% HCl, or for routine operation with (U)HMI with max. aerosol dilution ratio
Platinum sample / skimmer cones	Standard on 7500s/cs, 7700s, 7900 with s-lens, and 8800/8900 semicon configuration. Optional for all other models	Brass	Required for analysis of aggressive acids (esp. HF) and when O_2/Ar option gas is used for analysis of organic solvents Use sample cone with larger 18mm insert for high viscosity & high boiling point acids e.g. H_2SO_4 or H_3PO_4
Platinum skimmer with Copper base	Standard on 7700s, 7900, 8800/8900 semicon configuration and 8900c	Brass	Recommended for the lowest LODs and for higher matrix samples Typically use 1-2/year (based on ~350 samples/day)
Platinum skimmer with Nickel base	Standard on 8900m	Brass	Recommended for organics analysis

Skimmer cone, Nickel

Skimmer base, Stainless Steel

Skimmer cone, Platinum

Skimmer base, Brass

SAVE MONEY AND REDUCE YOUR ENVIRONMENTAL IMPACT WITH THE AGILENT PLATINUM CONE TRADE-IN PROGRAM

The Measure of Confidence

Agilent ICP-MS Platinum Cones – cut costs & go green by returning your used cones

- ICP-MS interface cones are expensive and need regular replacement
- User's purchasing new Agilent platinum cones can return their used cones
- You can receive a trade-in credit on your order
- The value of the credit is based on the reclaim value of the platinum
- This program lowers the net cost of purchasing a new cone, and enables recycling of the precious Pt metal in the cone

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

Keep it clean
Sample Introduction System

Spray chamber

Routine cleaning:

- Soak the end cap and spray chamber in 5% nitric acid or Citranox for >30 mins
- Rinse, dry and refit

If you see precision problems or droplet formation on the walls of the spray chamber (beading):

- 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.

Cleaning the Torch

Visually check the torch, bonnet and shield when removing the torch

- Replace if deformed or chipped

Do not sonicate!

For routine cleaning:

- Soak in >5% nitric acid for ~30 mins

For more stubborn stains:

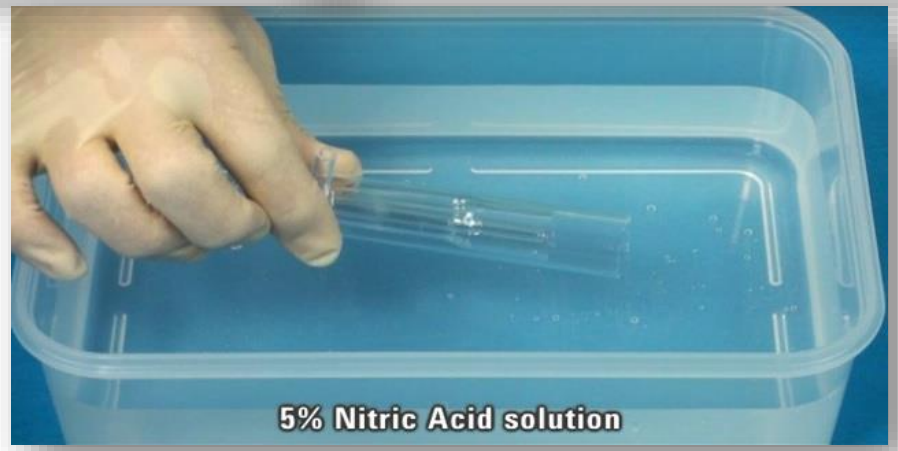
- Soak in bleach (e.g. Chlorox ©) overnight
- Soak in aqua regia (1:3 HNO_3:HCl)

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



Torch damage due to incomplete drying

Re-installing the Torch

Refit the torch shield & torch bonnet

Replace the torch into the torch holder

Ensure the torch projection fits into the slot on the torch holder

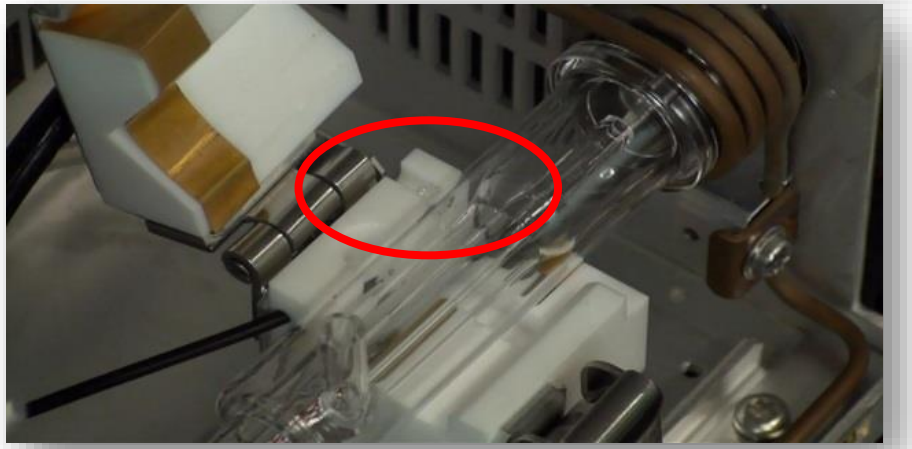
Can check the alignment of the RF coil when re-installing the torch

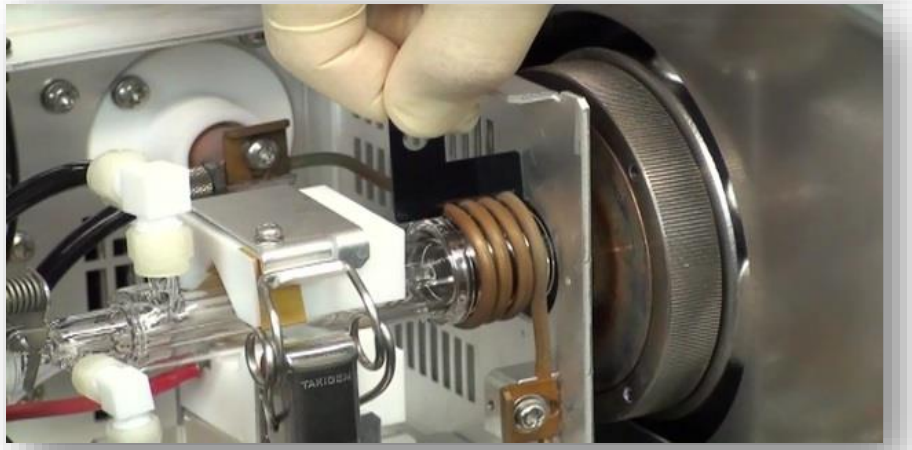
Reconnect gas fittings and transfer tube from spray chamber

Check torch alignment – esp. sampling depth (z position)

Test plasma ignites and instrument switches to “analysis” mode

- If plasma fails to ignite, check all connections for possible air leaks





Set high standards
Prepare accurate standards using Certified Reference Materials

Most atomic spectroscopy techniques need a standard of "known" composition to calibrate the instruments; then you can determine the "unknown" in your sample.

What's in my sample?

The result of your analysis is largely dependent on the accuracy of your "known" standard.

How can I be sure these results are accurate?

I don't have the extra time or money to redo this work…
I can't risk my results by using inaccurate standards!

Errors during preparation or contamination of your "known" standard leads to:

- Inaccurate results
- Lost time through trouble shooting
- Instrument downtime
- Preparation of new standards and re-analysis of samples
- Premature replacement of instrument supplies
- Failed audits & potential loss of ISO accreditation

The Value of Agilent's Certified Reference Materials

Highest ISO Accreditation!	• Manufactured in an ISO 9001, ISO Guide 34 facility and certified in an ISO 17025 testing laboratory
High purity	• Manufactured from high purity raw materials and solvents which are tested for impurities
NIST traceable	• Certified using the NIST high performance ICP-OES test protocols • Directly traceable to the NIST 3100 Series of SRMs
Contamination free	• Packaged in pre-cleaned, high purity HDPE bottles • Shipped in poly sealed bags
Long shelf life	• Most offer a shelf life of 18 months • Supported by short and long term stability studies
Thorough confirmation	• Trace impurities assayed using Agilent ICP-MS • Actual concentration reported on CoA for up to 68 trace impurities

https://www.agilent.com/cs/library/catalogs/public/5991-5678EN_Chemical_Stnds_Catalog_LR.pdf

Table of Contents

Custom Inorganic Standards for ICP-MS, ICP-OES, AA, and MP-AES

Element Concentration (Click here for instructions)

Ag		Nd	
Al		Ni	
As		Os	
Au		P	
B		Pb	
Ba		Pd	
Be		Pr	
Bi		Pt	
Ca		Rb	
Cd		Re	
Ce		Rh	
Co		Ru	
Cr		S	
Cs		Sb	
Cu		Sc	
Dy		Se	
Er		Si	
Eu		Sm	
Fe		Sn	
Ga		Sr	
Gd		Ta	
Ge		Tb	
Hf		Te	
Hg		Th	
Ho		Ti	
In		Tl	
Ir		Tm	
K		U	
La		V	
Li		W	
Lu		Y	
Mg		Yb	
Mn		Zn	
Mo		Zr	
Na			

FOR OFFICE USE ONLY

Company PN | SPQ# | Comments | SUBMIT

Name
Company
Address 1
Address 2
City, State Zip
Phone
Email
Preferred Matrix: Please select
Units of Concentration: Please select
Bottle Size: Please select
Quantity
Intended Use (instrument/technique): Please select
Previous Quote # (if applicable)

Email this form >

Your Summary:

Name:
Company:
Address 1:
Address 2:
City, State, ZIP:
Phone:
E-mail:

Element concentration:
Preferred Matrix:

Additional Notes (optional):

Design your own standard for your unique sample and Agilent experts will guide you through stability and compatibility while maintaining the highest quality for precise, accurate calibration data.

All custom standards are of the highest quality - manufactured in an ISO Guide 34 facility and certified in an ISO/IEC 17025 testing laboratory. Each standard will be accompanied with Certificate of Analysis (CoA) highlighting ISO conformity, actual concentration, measurement uncertainty, and NIST traceability.

All Agilent's Certified Reference Materials can be used with Agilent, or any other brand (PerkinElmer, and Thermo) instruments.

To Submit a Custom request (For US/Canada Only):

1. **Complete the order form for a quote. Please complete all fields in the form.**
2. **Submit form by using "E-mail this form" button in the order form. This button compiles an e-mail message, which can be sent immediately**

https://www.agilent.com/en-us/custom-inorganic-standards

Tips to Improve Standard Preparation

How are they prepared?

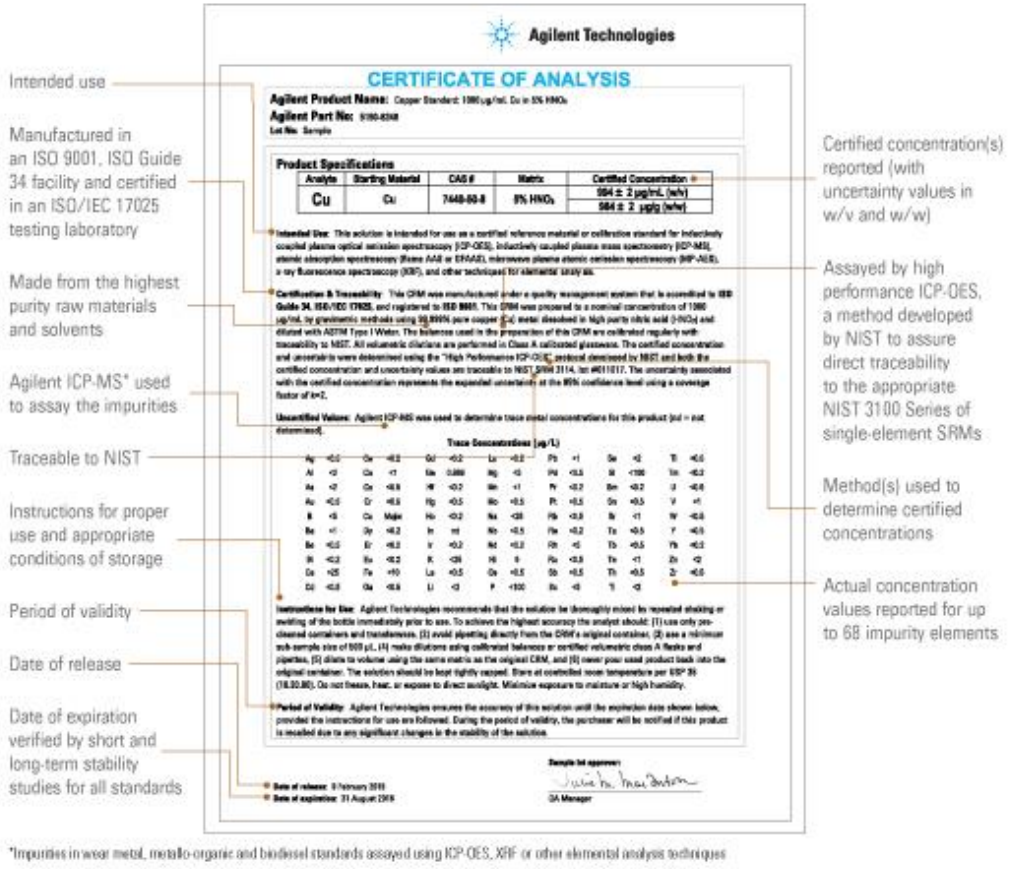
- Ensure purchased standards are still within “Use By” date
- Avoid all use of glassware for ICP-MS
- Perform dilutions by weight using a 4-decimal place balance
- Use calibrated pipettes and class ‘A’ volumetric flasks for dilutions
  - Calibrate and Periodically, check accuracy & reproducibility of 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 1,000 ppm stock
  - Please don’t do large dilutions (> 1:10,000) in 1 step

What concentration are they?

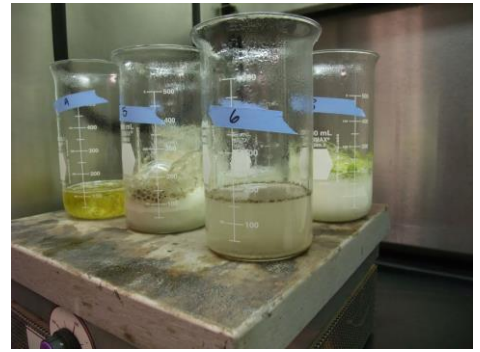
- Low concentration standards have a finite life
  - Prepare ppb and sub ppb (ug/L) concentration standards daily from high conc. stock
  - Prepare low ppm (mg/L) concentration standards weekly

How are they stored?

- Plastic vessels ensure better stability (PFA or FEP)
- Stabilize with acid – low pH ensures better stability



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

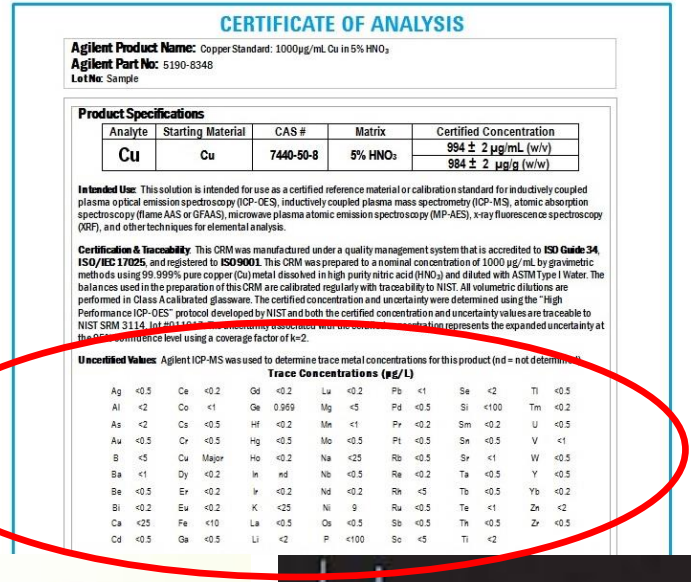
Tips to Reduce Contamination

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

Agilent Technologies

- **Check reagent purity**
  - Always buy the best reagents – use high purity or ICP-MS grade
  - 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

- **Other common contamination sources**
  - Reagent water
  - FEP containers preferred
    - Borosilicate glass can contribute Boron contamination
  - Airborne dust in the lab.
  - Pipette tips
    - Don’t insert pipette tips into your acids
    - Use natural tips – colored tips may increase contamination (esp. with Cu, Fe, Zn, Cd)
  - Powdered gloves (esp. for Zn)



CERTIFICATE OF ANALYSIS

Agilent Product Name: Copper Standard: 1000µg/mL Cu in 5% HNO_3
Agilent Part No: 5190-8348
Lot No: Sample

Product Specifications

Analyte	Starting Material	CAS #	Matrix	Certified Concentration
Cu	Cu	7440-50-8	5% HNO_3	994 ± 2 µg/mL (w/v)
				984 ± 2 µg/g (w/w)

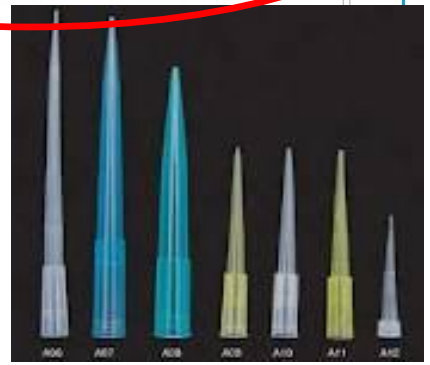
Intended Use: This solution is intended for use as a certified reference material or calibration standard for inductively coupled plasma optical emission spectroscopy (ICP-OES), inductively coupled plasma mass spectrometry (ICP-MS), atomic absorption spectroscopy (flame AAS or GFAAS), microwave plasma atomic emission spectroscopy (MP-AES), x-ray fluorescence spectroscopy (XRF), and other techniques for elemental analysis.

Certification & Traceability: This CRM was manufactured under a quality management system that is accredited to **ISO Guide 34**, **ISO/IEC 17025**, and registered to **ISO 9001**. This CRM was prepared to a nominal concentration of 1000 µg/mL by gravimetric methods using 99.999% pure copper (Cu) metal dissolved in high purity nitric acid (HNO_3) and diluted with ASTM Type I Water. The balances used in the preparation of this CRM are calibrated regularly with traceability to NIST. All volumetric dilutions are performed in Class A calibrated glassware. The certified concentration and uncertainty were determined using the "High Performance ICP-OES" protocol developed by NIST and both the certified concentration and uncertainty values are traceable to NIST SRM 3114 lot [illegible]. The uncertainty associated with the [illegible] represents the expanded uncertainty at the 95% confidence level using a coverage factor of k=2.

Uncertified Values: Agilent ICP-MS was used to determine trace metal concentrations for this product (nd = not determined).

Trace Concentrations (µg/L)

Ag	<0.5	Ce	<0.2	Gd	<0.2	Lu	<0.2	Pb	<1	Se	<2	Tl	<0.5
Al	<2	Co	<1	Ge	0.969	Mg	<5	Pd	<0.5	Si	<100	Tm	<0.2
As	<2	Cs	<0.5	Hf	<0.2	Mn	<1	Pr	<0.2	Sm	<0.2	U	<0.5
Au	<0.5	Cr	<0.5	Hg	<0.5	Mo	<0.5	Pt	<0.5	Sn	<0.5	V	<1
B	<5	Cu	Major	Ho	<0.2	Na	<25	Rb	<0.5	Sr	<1	W	<0.5
Ba	<1	Dy	<0.2	In	nd	Nb	<0.5	Re	<0.2	Ta	<0.5	Y	<0.5
Be	<0.5	Er	<0.2	Ir	<0.2	Nd	<0.2	Rh	<5	Tb	<0.5	Yb	<0.2
Bi	<0.2	Eu	<0.2	K	<25	Ni	9	Ru	<0.5	Te	<1	Zn	<2
Ca	<25	Fe	<10	La	<0.5	Os	<0.5	Sb	<0.5	Th	<0.5	Zr	<0.5
Cd	<0.5	Ga	<0.5	Li	<2	P	<100	Sc	<5	Ti	<2		



5 Don’t neglect the pump tubing

Tubing diameters
- Waste to be larger ID than sample ID

Chemical compatibility
- Ensure tubing is resistant to the solvent being used

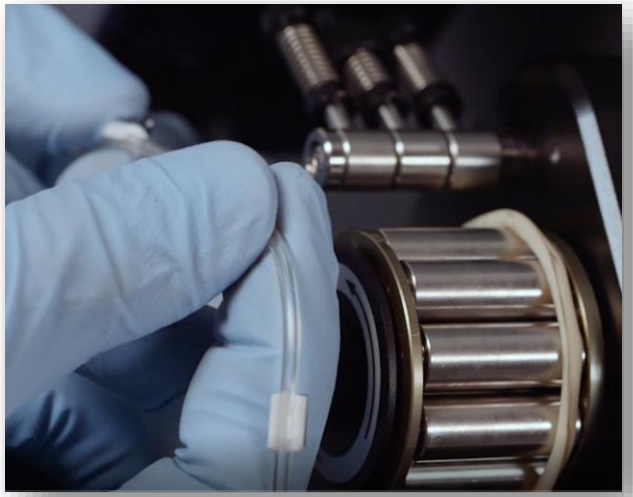
Replace frequently
- Pre-clean new tubing to remove potential contamination
- Using “old” tubing can lead to problems with precision and stability
  – Can also contribute to nebulizer blockage (if inside lining breaks down)
- Typical lifetime is ~5 days based on normal 8 hour working day
  – Detach from 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

Drain tubing 1.52 mm ID
Agilent P/N G1833-65570

Sample tubing 1.02 mm ID
Agilent P/N G1833-65569



Peri Pump Tubing Tips

Symptoms:

Peri pump tubing that looks/feel worn or has a strange colour

IF IN DOUBT, CHANGE IT

Erratic liquid flow

- Check tension from clamps

Bubbles in the liquid stream

- Check all gas fittings, tubing and connectors – deposits, burrs, damage

Spurting Nebuliser or disconnecting tubing segments

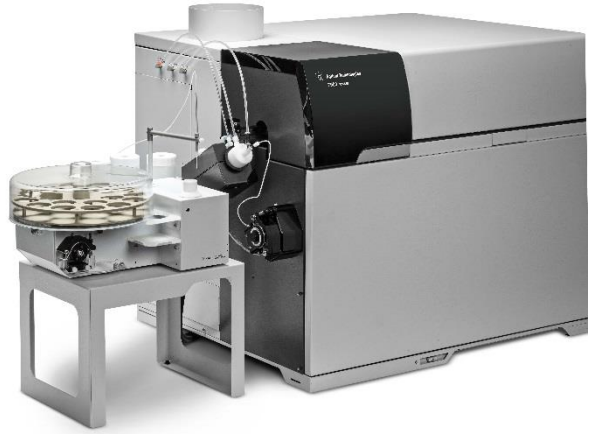
- Plugging in the transfer line. Requires cleaning or replacement.

Bad recovery or carryover on "indicator" elements that tend to become unstable first when the pump tubing has got an "active" coating.

- Ag and PGE (Platinum group elements. Ru, Rh, Pd, Os, Ir, Pt)

ICP-MS – Potential Autosampler Issues

More customers use autosamplers for automation

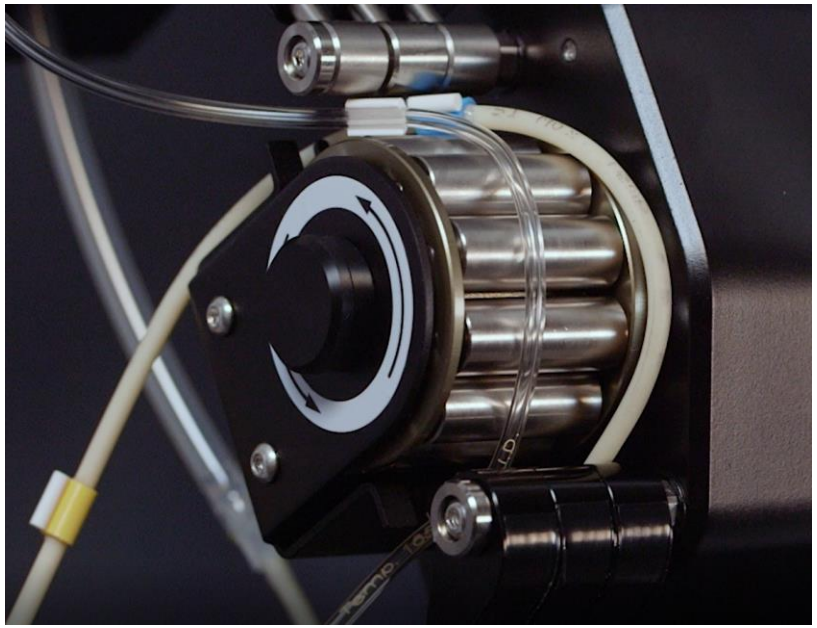


Issues to consider:

- Longer transfer tube between sampler and ICP-MS
  - May need to program a longer sample uptake delay
  - May exacerbate problems with memory effects
- 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-MS 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. Close the current worksheet – leave Mass Hunter S/W running
7. Leave mains power and argon on
   - Keeps instrument in stand-by mode (ensures fastest start-up)



ICP-MS – Recommended Maintenance Schedule

Daily:

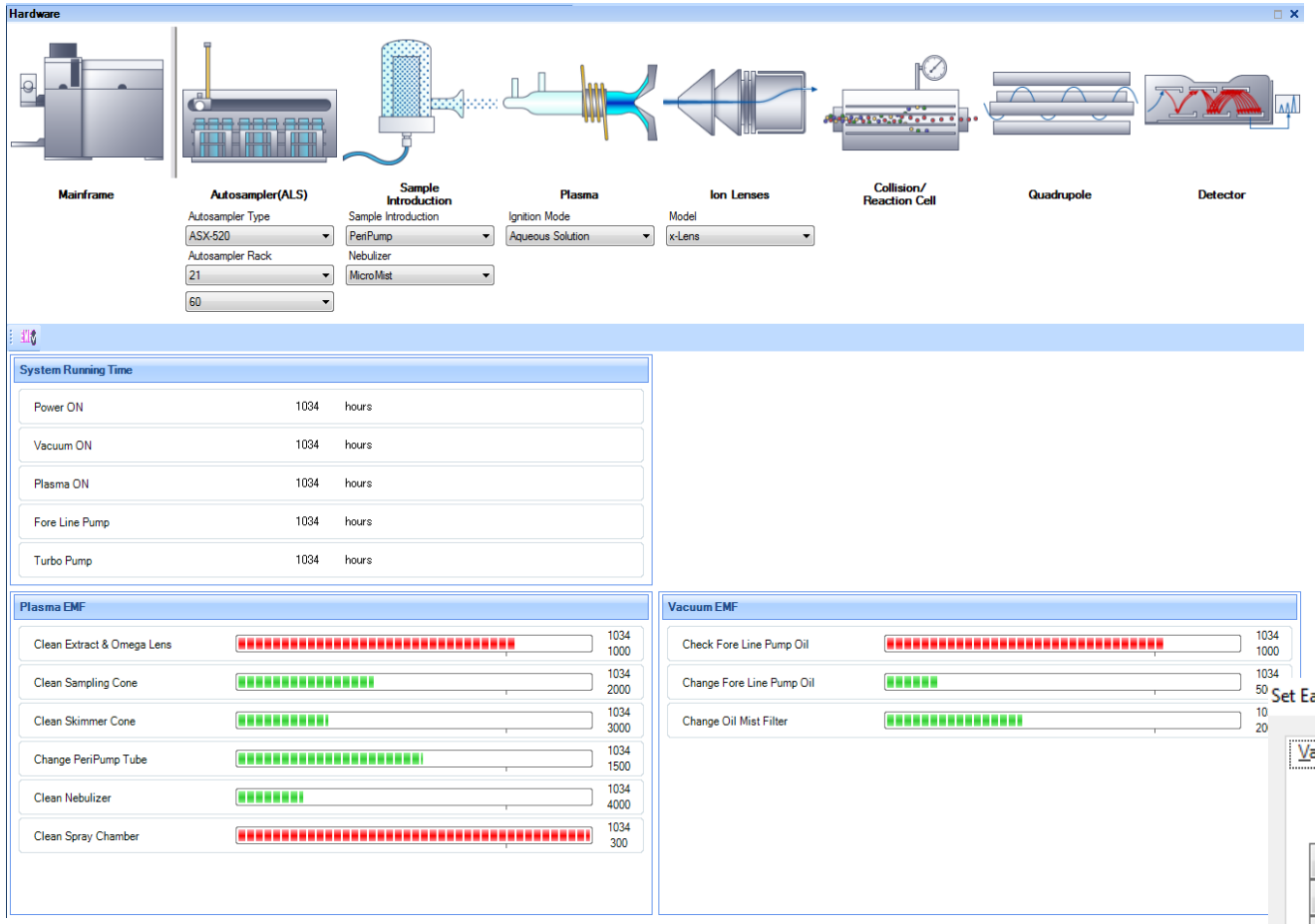
- Argon and cell gas (He, H_2, …) pressures
- Check peristaltic pump tubing for damage/deterioration
- Visual check of glassware
  (connections OK, no filling of spray chamber or connector)
- Visual inspection of sample cone exterior (orifice shape & deposition)

Frequently, as needed - perform these operations:

- Empty the drain reservoirs
- Thorough visual inspection of interface cones
- Check nebulization
- Replace peristaltic pump tubing
- Clean/replace torch
- Check recirculation water level

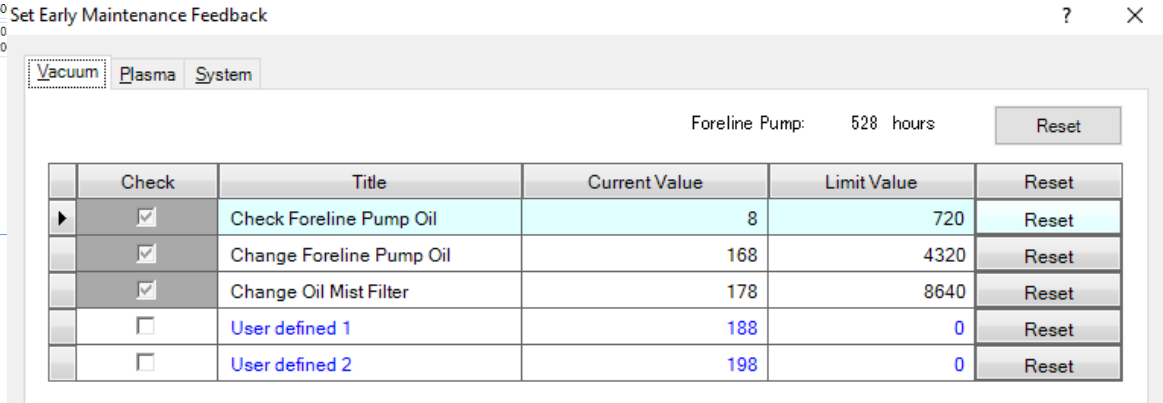
Frequency and extent of maintenance depends on the usage of the instrument: this overview assumes daily use, 8 hours/day.
For systems run 24/7, more frequent maintenance is required.

EMF (Early Maintenance Feedback)



EMF window shows usage of various components and predicts when to perform maintenance

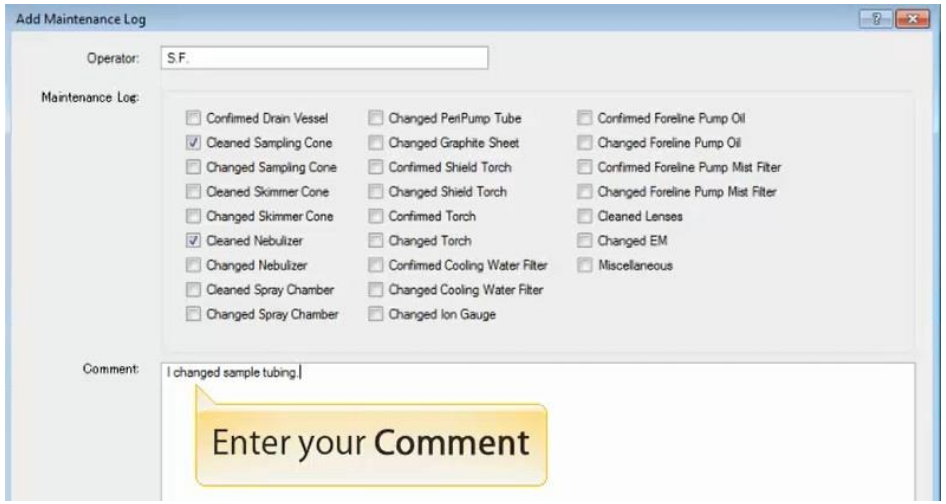
All gauges and limit values are user definable

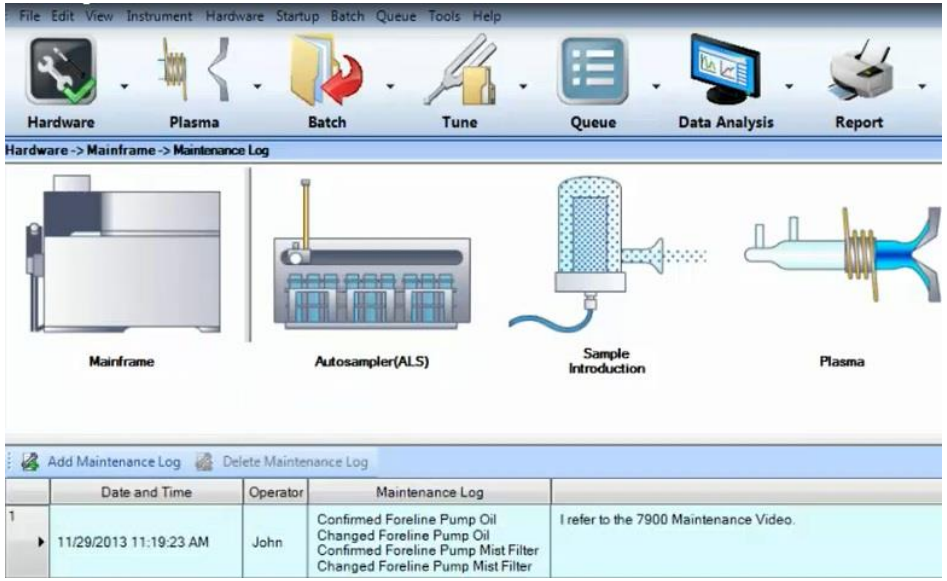


ICP-MS System Tips – User Log

- Use the “Maintenance Log” to record routine and non routine maintenance activities

- Maintenance log can track:
  - When the maintenance activity was completed
  - Operator who completed the maintenance
  - Type of maintenance activity
  - Any operator comments





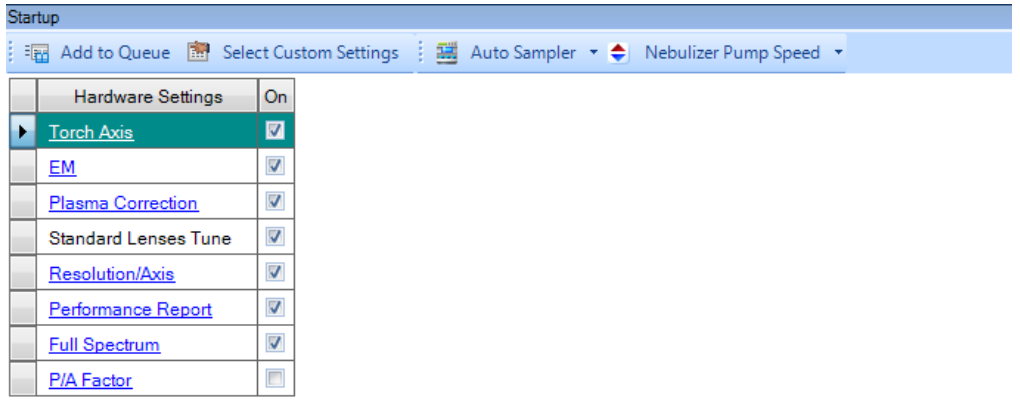
ICP-MS System Optimization

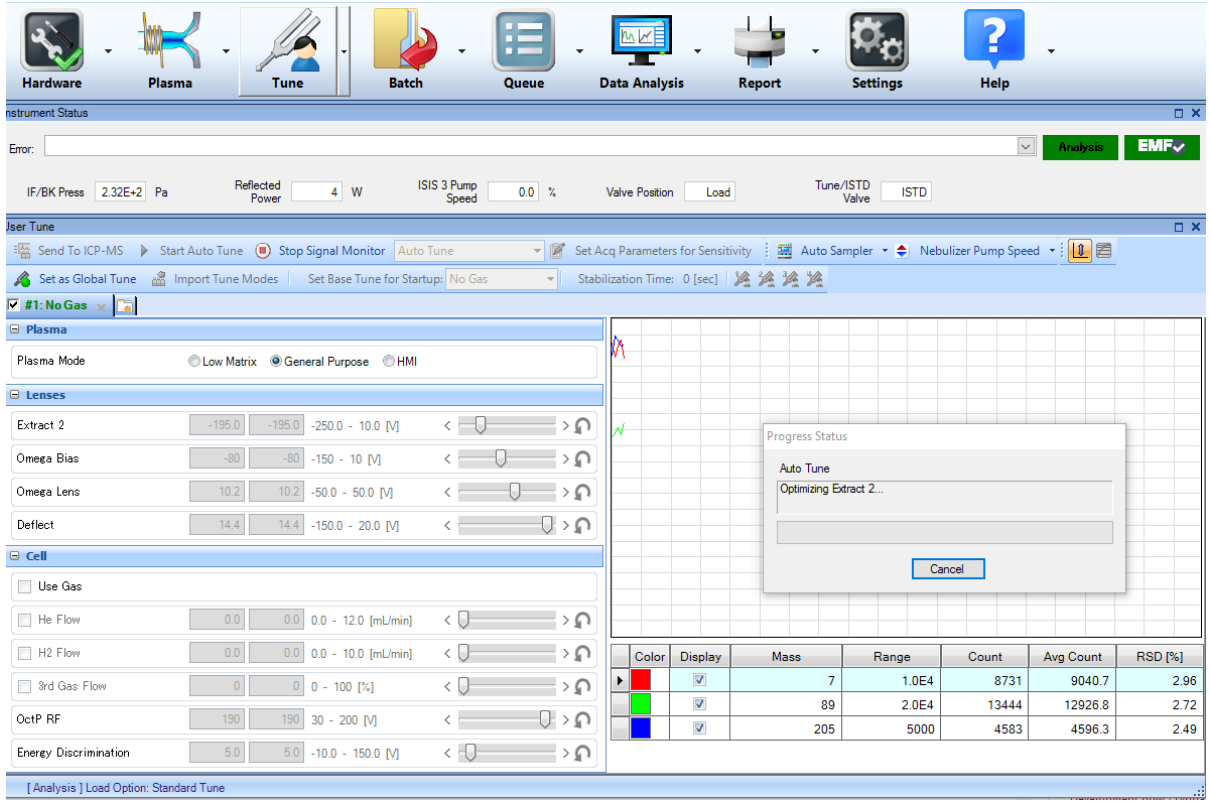
Startup provides a simple, user-configured schedule of system optimization and performance checks

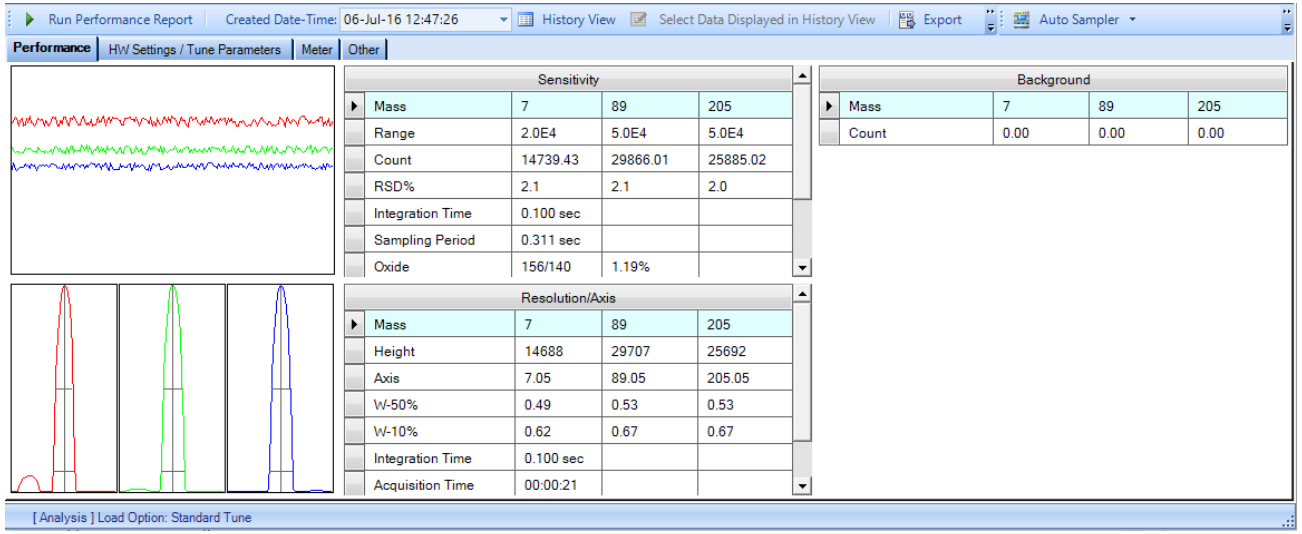
- Automatically generate a Performance Report
- Provides a continuing record of system performance

One-click expert AutoTune for simple optimization

- Ensures consistent performance from day to day
- Independent of operator experience







Key Consumables for ICP-MS

Sample preparation/presentation:

- Peristaltic pump tubing
- Transfer and drain tubing
- ICP-MS standard solutions
- Internal Standard solutions
- Torches
- Spray chambers
- Nebulizers

Ion Extraction:

- Sampler and skimmer cones

Autosampling:

- Sample tubes, racks, probes and transfer tubing

ISIS:

- Peristaltic pump tubing, ferrules & fittings

Agilent ICP-MS Consumable Kits

Reduce costs while ensuring long-term confidence in your results

Your Agilent ICP-MS instrument was engineered and manufactured to deliver superb performance. Don't risk the quality and reliability of your results, as well as possible instrument downtime, by using non-Agilent supplies. You'll find that using authentic **Agilent ICP-MS operating supplies kits** will enable you to:

- Maintain accurate analysis
- Save as much as 15% over the cost of purchasing supplies individually
- Keep your instruments running for up to 12 months (depending on use) without worrying about reordering supplies

On the following pages you'll find a full portfolio of genuine Agilent ICP-MS operating supplies, listed by instrument. Identify the model you are using and make your selections.

Increase flexibility with Agilent configurable operating supplies kits

In addition to time and cost savings, you can configure the contents of these kits for your specific instrument configuration and application. That means you can select the type and quantity of sampling cones, skimmer cones, and other supplies you need.

These flexible supplies kits are available for:

- **Agilent 7700/7800/7900 Single-Quadrupole ICP-MS systems** fitted with x-lens
- **Agilent 8800/8900 Triple-Quadrupole ICP-QQQ systems**
- **Agilent 7700s/7900s and 8800/8900 semiconductor ICP-MS systems** fitted with s-lens

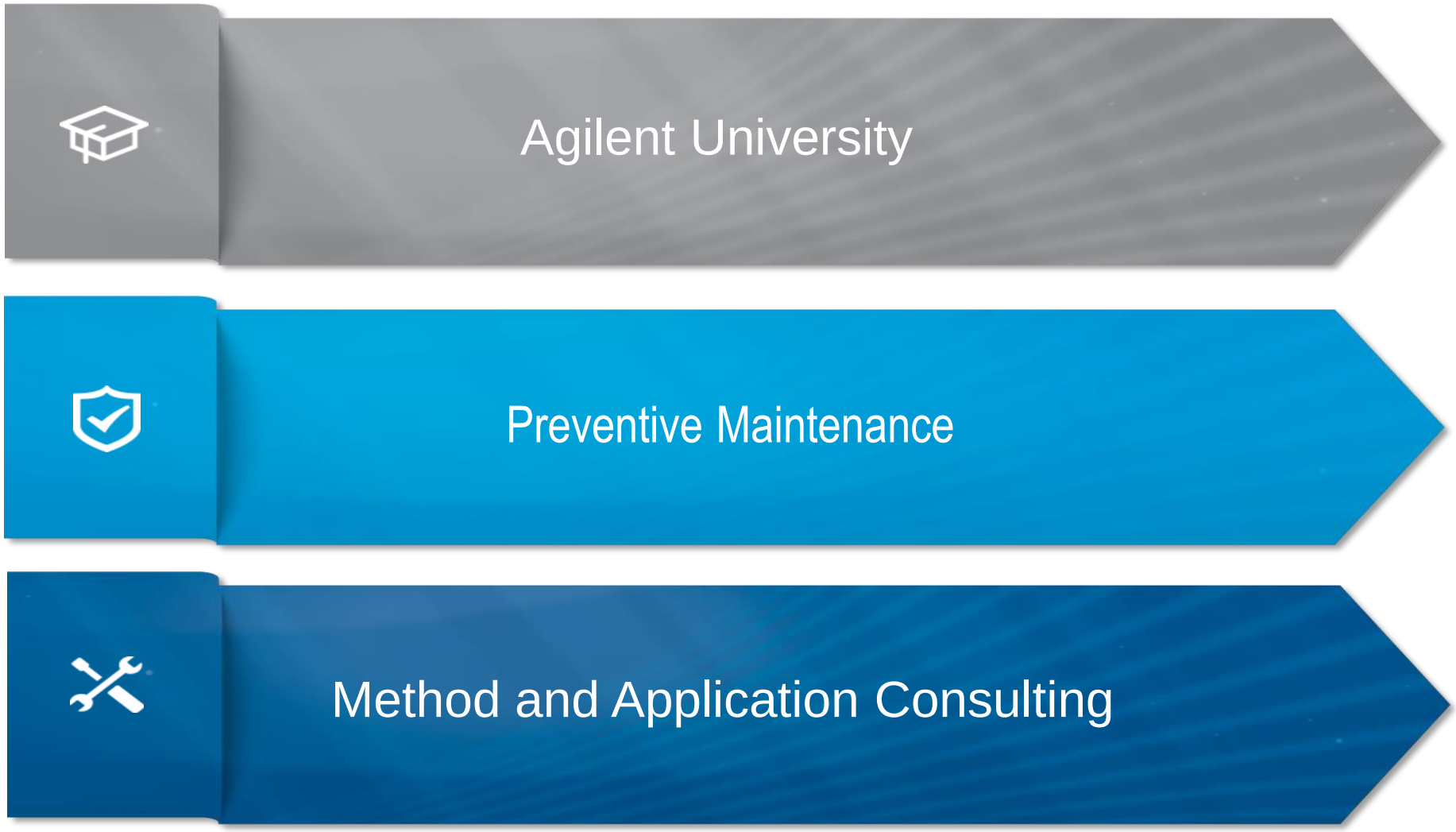
These are not just parts and supplies, they are essential components which guarantee the performance, reliability, and longevity of your instrument.

Agilent offers configurable kits for all current Agilent ICP-MS systems, that allow you to select which key components are supplied in the kit
e.g. type and quantity of interface cones

- G1131A for 7900 ICP-MS fitted with x- or s- lens
- M5141A for 7800 ICP-MS fitted with x-lens
- G1091A for 8900 ICP-MS fitted with x- or s- lens
- G3690A for 7700x/e and 8800 ICP-MS fitted with x-lens

Ask your Agilent representative for more information

If you need more help – count on the experts

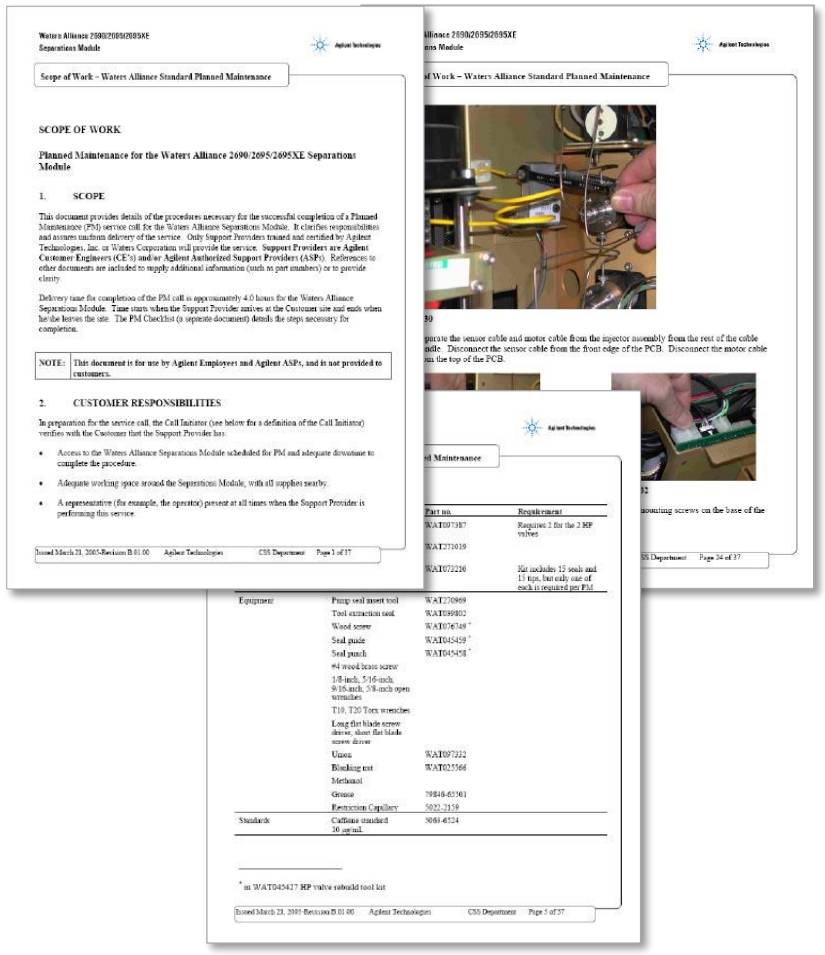


Agilent Preventative Maintenance Services

Studies show that 60% of instrument failures can be traced to a single cause – lack of preventive maintenance*. These studies also show that failure rates decrease by up to 25% for all mechanical systems when a laboratory implements a preventive maintenance program.

This service includes:

- **Inspection:** Perform general inspection of the complete system.
- **System Cleaning:** Remove covers and clean dust from fans and vent covers.
- **Pump Maintenance:** Replace oil mist filter, drain and replace mechanical pump oil. Verify proper pump operation.
- **Lens Cleaning:** Remove and clean surfaces of the ion lens. Sonicate ion lens parts.
- **Vacuum System Maintenance:** Inspect vacuum hoses and exhaust tubes for possible problems. Check pump for evidence of leakage.
- **Verification:** Check quadropole matching. Replace octopole and perform octopole matching. Perform system auto-tune.
- **Documentation:** Record maintenance in instrument service logs.



ICP-MS Resource

Featured technique:
Agilent ICP-MS Online Resource Library

We're committed to bringing you the world's best ICP-MS systems... plus the critical information you need to keep them running at peak performance

To minimize costly downtime—and achieve the best results from your ICP-MS system—you must stay up to date with the best practices for instrument maintenance and operation.

The Agilent ICP-MS Online Resource Library makes it easy by giving you instant access to the latest how-to videos, maintenance procedures, training opportunities, and much more. So you can maximize your daily productivity—and positively impact your lab's success over time.

Top 5 tips for flawless ICP-MS performance

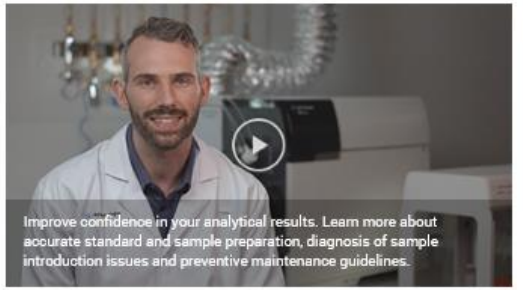
Set high standards

Ensure precise, accurate calibration data by preparing standards fresh from certified reference materials with known uncertainty. Only use high-purity reagents and de-ionized water to reduce contamination. Learn more

http://www.agilent.com/en-us/promotions/icp-ms-resource

ICP-MS maintenance and troubleshooting videos

Part 1: Overview



Part 2: Sample Introduction

Part 3: Torch Box

Part 4: Interface Region

ICP-MS workflow

Maximize data quality and productivity with the complete workflow and genuine Agilent supplies for your ICP-MS analysis.

ICP-MS Supplies | Captiva Syringe Filters | ICP-MS Standards | Interface Cones | Agilent ICP-MS | Agilent ICP-QQQ

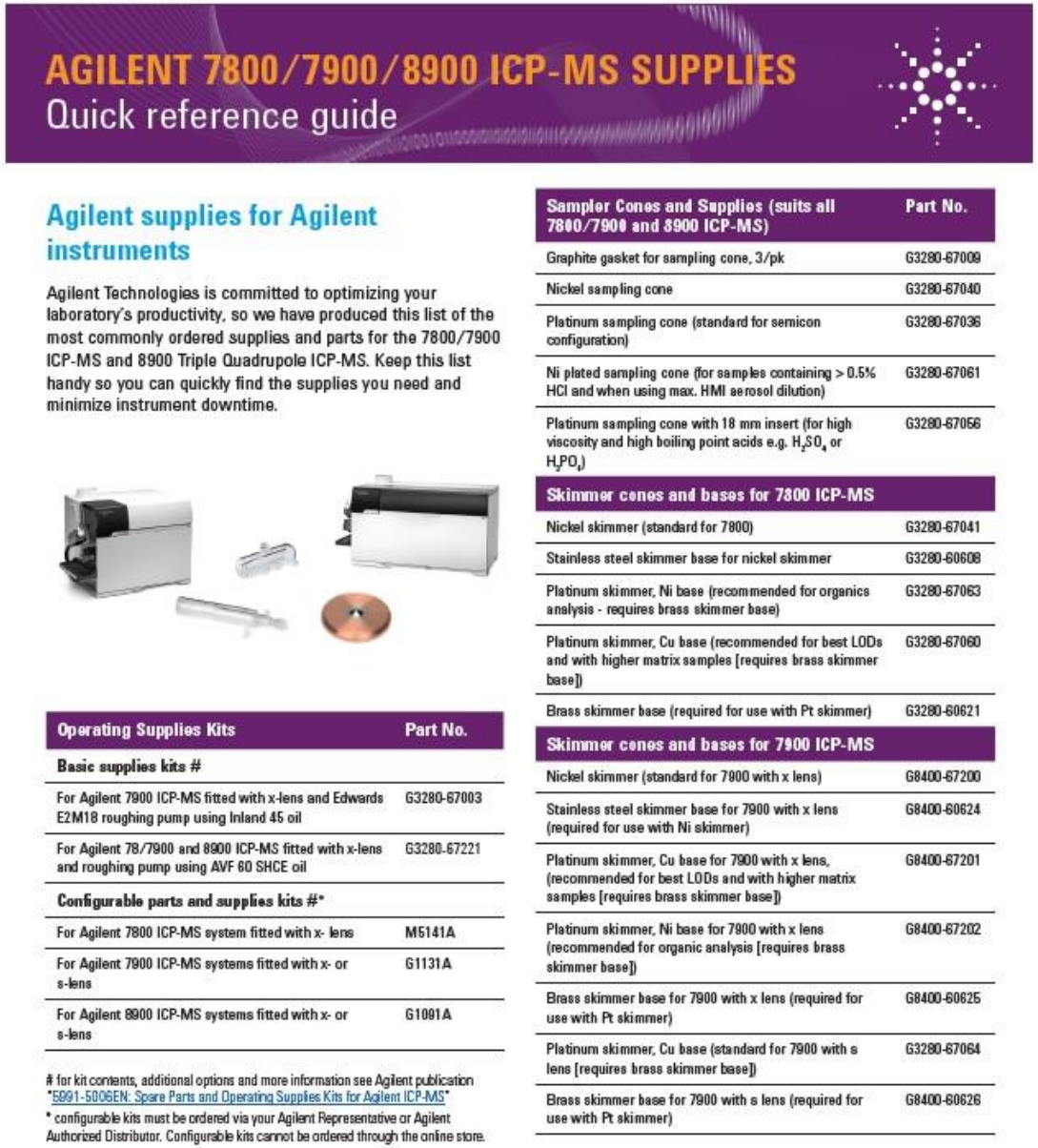
Interface Cones

Trade-in your used Agilent, Spectron or Glass Expansion platinum interface cones when you purchase replacements from Agilent—save money and help the environment!*

Recycle now Learn more

* The trade-in program may not be available in all geographies. Contact your local Agilent representative for more details.

Links to Other Useful ICP-MS Resources



AGILENT 7800/7900/8900 ICP-MS SUPPLIES
Quick reference guide

Agilent supplies for Agilent instruments

Agilent Technologies is committed to optimizing your laboratory's productivity, so we have produced this list of the most commonly ordered supplies and parts for the 7800/7900 ICP-MS and 8900 Triple Quadrupole ICP-MS. Keep this list handy so you can quickly find the supplies you need and minimize instrument downtime.

Operating Supplies Kits	Part No.
Basic supplies kits #	
For Agilent 7900 ICP-MS fitted with x-lens and Edwards E2M18 roughing pump using Inland 45 oil	G3280-67003
For Agilent 78/7900 and 8900 ICP-MS fitted with x-lens and roughing pump using AVF 60 SHCE oil	G3280-67221
Configurable parts and supplies kits #*	
For Agilent 7800 ICP-MS system fitted with x- lens	M5141A
For Agilent 7900 ICP-MS systems fitted with x- or s-lens	G1131A
For Agilent 8900 ICP-MS systems fitted with x- or s-lens	G1091A

for kit contents, additional options and more information see Agilent publication "5991-5006EN: Spare Parts and Operating Supplies Kits for Agilent ICP-MS"
* configurable kits must be ordered via your Agilent Representative or Agilent Authorized Distributor. Configurable kits cannot be ordered through the online store.

Sampler Cones and Supplies (suits all 7800/7900 and 8900 ICP-MS)	Part No.
Graphite gasket for sampling cone, 3/pk	G3280-67009
Nickel sampling cone	G3280-67040
Platinum sampling cone (standard for semicon configuration)	G3280-67036
Ni plated sampling cone (for samples containing > 0.5% HCl and when using max. HMI aerosol dilution)	G3280-67061
Platinum sampling cone with 18 mm insert (for high viscosity and high boiling point acids e.g. H_2SO_4 or H_3PO_4)	G3280-67056
Skimmer cones and bases for 7800 ICP-MS	
Nickel skimmer (standard for 7800)	G3280-67041
Stainless steel skimmer base for nickel skimmer	G3280-60608
Platinum skimmer, Ni base (recommended for organics analysis - requires brass skimmer base)	G3280-67063
Platinum skimmer, Cu base (recommended for best LODs and with higher matrix samples [requires brass skimmer base])	G3280-67060
Brass skimmer base (required for use with Pt skimmer)	G3280-60621
Skimmer cones and bases for 7900 ICP-MS	
Nickel skimmer (standard for 7900 with x lens)	G8400-67200
Stainless steel skimmer base for 7900 with x lens (required for use with Ni skimmer)	G8400-60624
Platinum skimmer, Cu base for 7900 with x lens, (recommended for best LODs and with higher matrix samples [requires brass skimmer base])	G8400-67201
Platinum skimmer, Ni base for 7900 with x lens (recommended for organic analysis [requires brass skimmer base])	G8400-67202
Brass skimmer base for 7900 with x lens (required for use with Pt skimmer)	G8400-60625
Platinum skimmer, Cu base (standard for 7900 with s lens [requires brass skimmer base])	G3280-67064
Brass skimmer base for 7900 with s lens (required for use with Pt skimmer)	G8400-60626

- ICP-MS parts and supplies (On-line Store): http://www.chem.agilent.com/store/en_US/Cat-SubCat1ECS_30319/ICP-MS
- Agilent atomic spectroscopy application notes: https://www.agilent.com/en-us/library/applications?N=129+900007284
- Agilent ICP-MS Quick Reference Guide (lists most common consumables items): http://www.agilent.com/cs/library/flyers/public/5991-7990EN_ICP-MS_Supplies_QRG.pdf
- 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

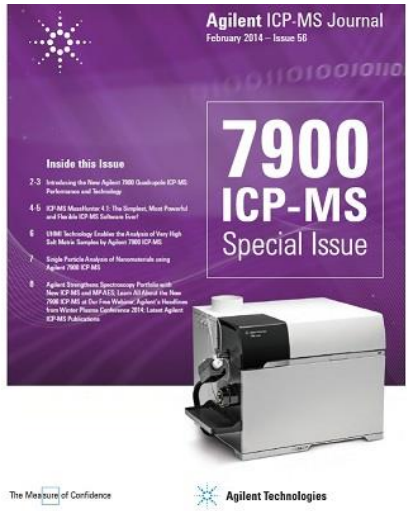
Agilent ICP-MS Journal

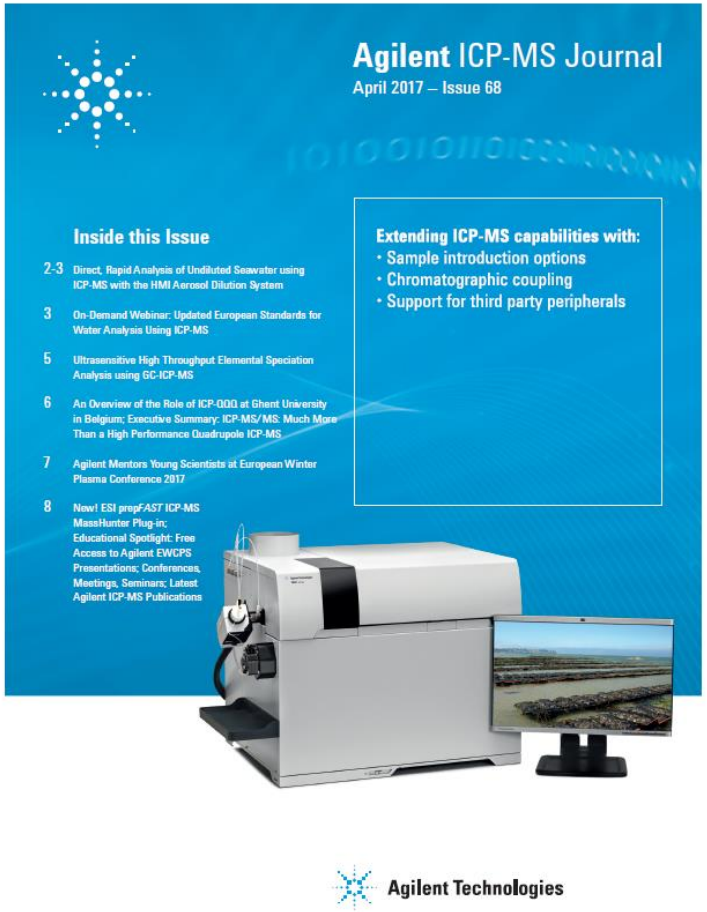
Are you a subscriber to the Agilent ICP-MS journal?

- An ICP-MS specific journal produced 4 times/year
- Includes applications, techniques, “real” user stories, news updates and other product information

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/icpmsjournal





Summary – To Achieve Quality Data

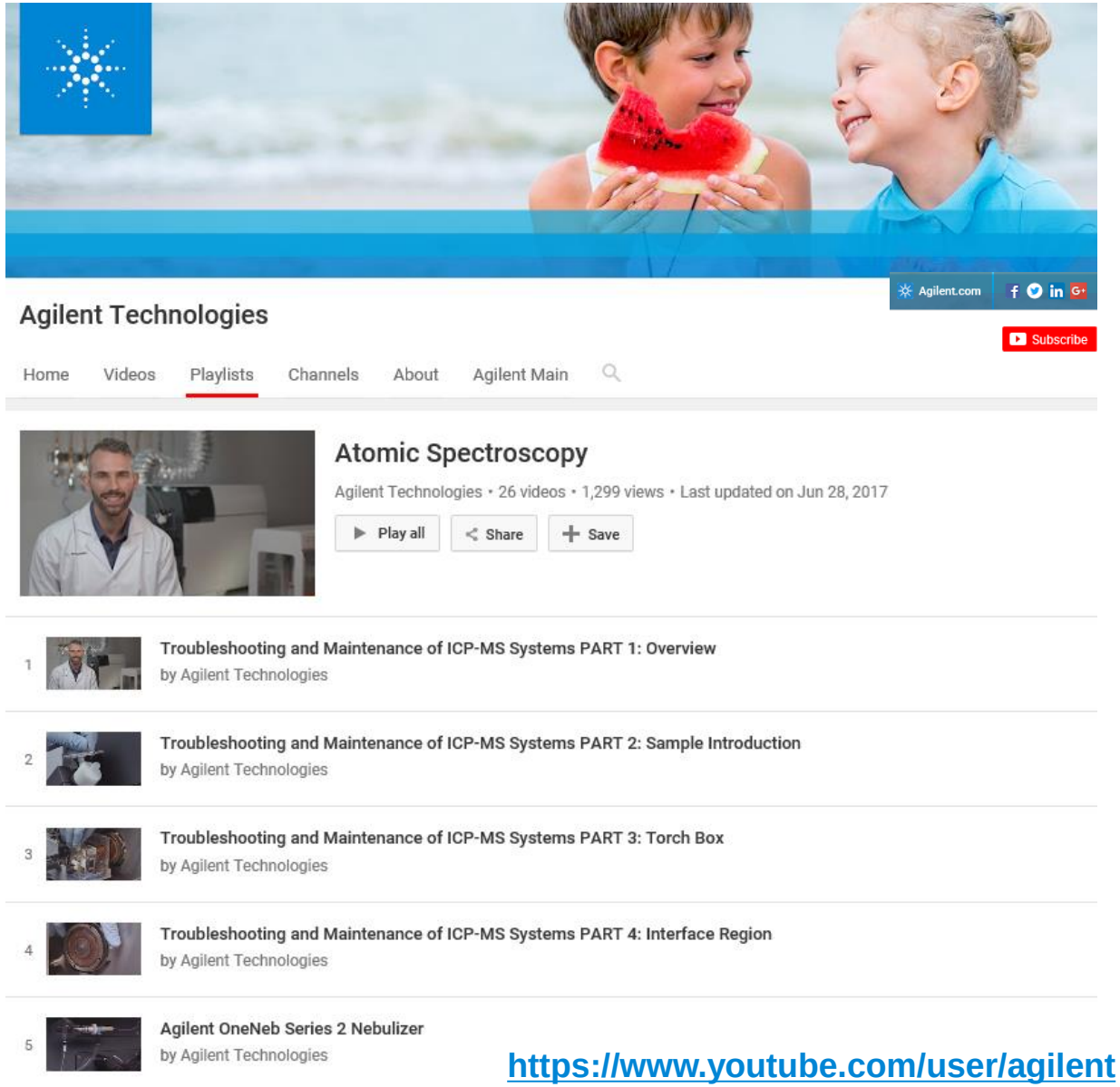
Most “instrument” failures occur in the sample introduction area:

- Interface cones
- Peristaltic pump tubing
- Drain Assembly
- Torch
- Spray chamber
- Nebulizer

Improper maintenance of this area can result in poor data quality

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

Establishing good routine maintenance procedures can prevent problems



https://www.youtube.com/user/agilent

Thank you for your attention. Question & Answer session.

Prevent nebulizer blockage

Pay attention to the interface cones

Keep it clean

Set high standards

Don’t neglect the pump tubing

https://www.agilent.com/en/promotions/icp-ms-resource