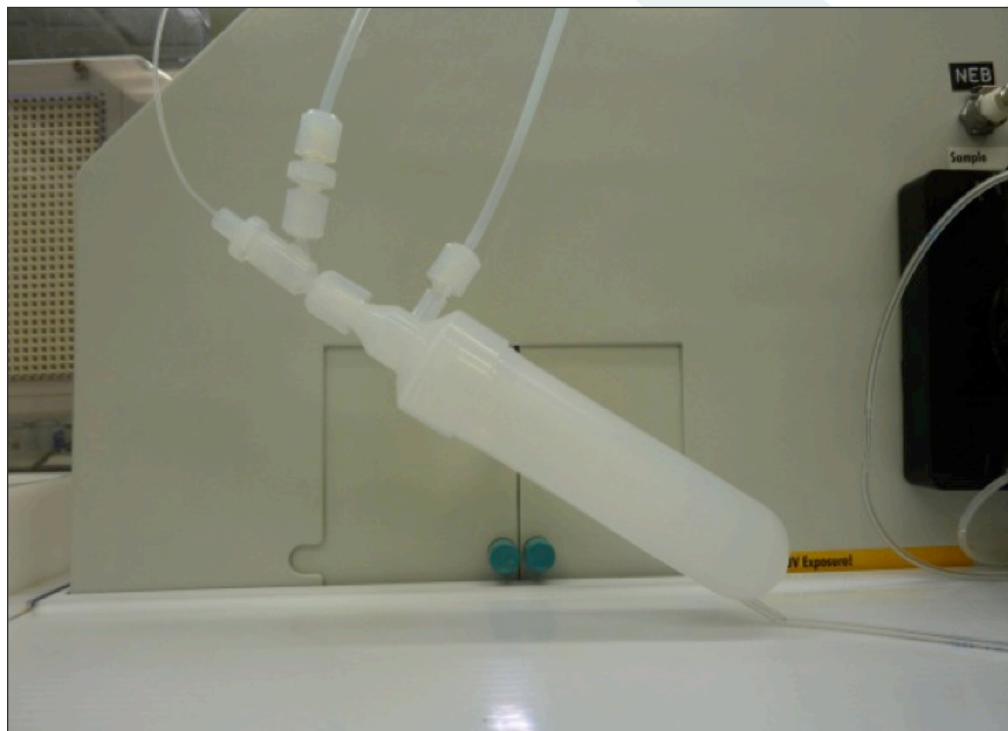


### Summary

The Savillex PFA inert kit for the Thermo Element 2 HR-ICP-MS features a Scott-type spray chamber offering excellent sensitivity, stability and washout. Designed and manufactured in house by Savillex from the highest purity grade PFA resin, the Savillex PFA inert kit has the lowest blank contribution of any sample introduction system, enabling the Element 2 to achieve its full performance potential. The true double pass spray chamber design filters out larger droplets, making the kit equally suited to high matrix applications such as geological. In combination with one of the Savillex C-Flow PFA concentric nebulizers, the PFA inert kit can handle every type of liquid sample that can be measured by ICP-MS.



*Savillex PFA inert kit with C-Flow nebulizer, fitted to an Element 2*

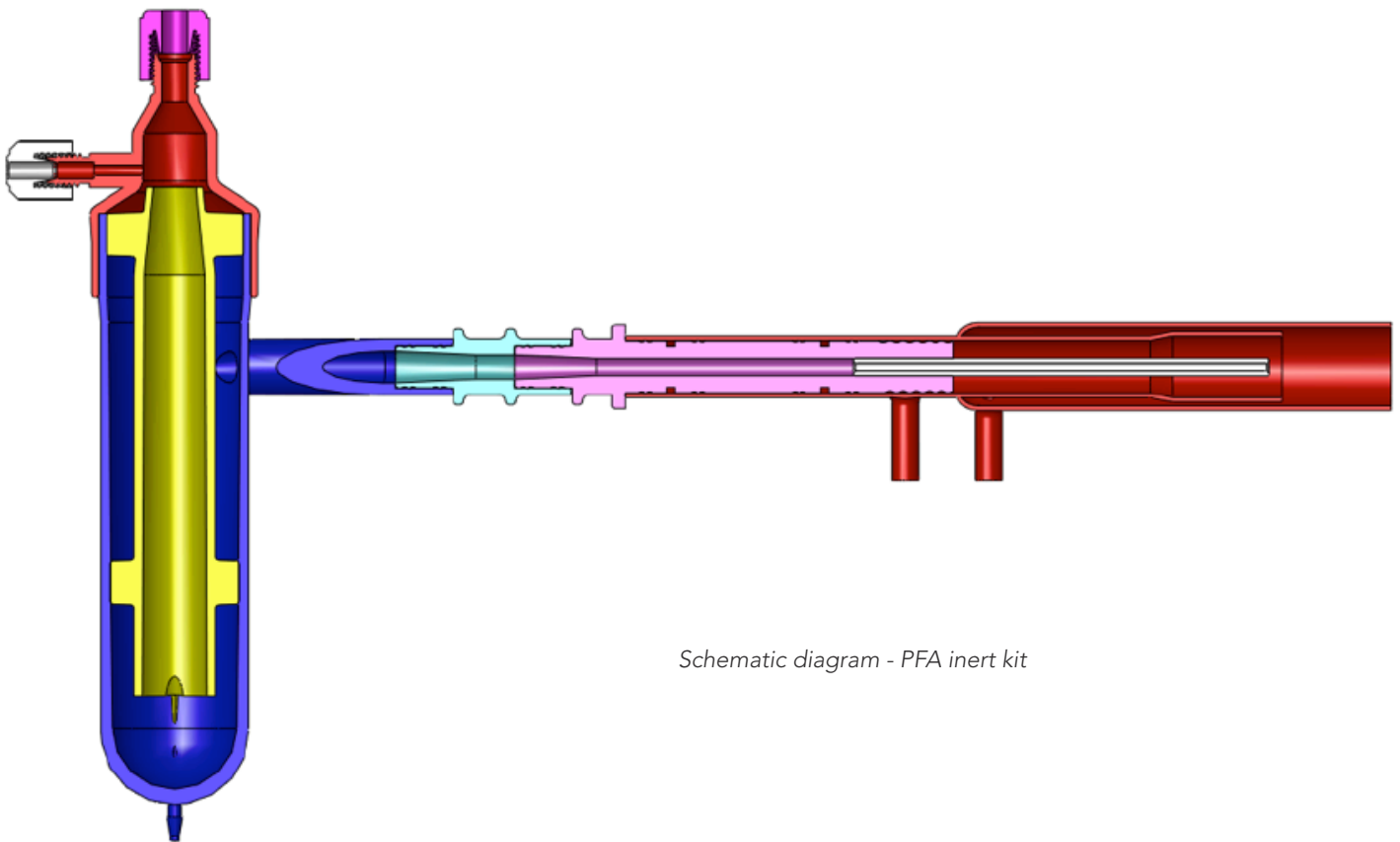
### Savillex Inert Kits - Background

Traditionally, inert (PFA) sample introduction systems used in ICP-MS have not performed as well as standard quartz systems. The design of PFA systems is restricted by limitations in fluoropolymer molding and manufacturing capabilities. Increased plasma loading due to single pass spray chambers, poorer signal stability as a result of inconsistent draining and unreliability over long runs due to droplet build up have all been observed. As a result, PFA sample introduction kits are typically used only when necessary – i.e. with HF-containing samples. In contrast, Savillex manufactures PFA sample introduction systems that can be used for all applications, so analysts don't have to change between systems depending on sample type. By applying its unique expertise in PFA molding and secondary finishing, Savillex has overcome the traditional limitations of PFA sample introduction systems. Savillex's PFA inert kit for the Thermo Element 2 has similar signal stability, sensitivity and long term reliability to a conventional quartz system.

## Technical Features

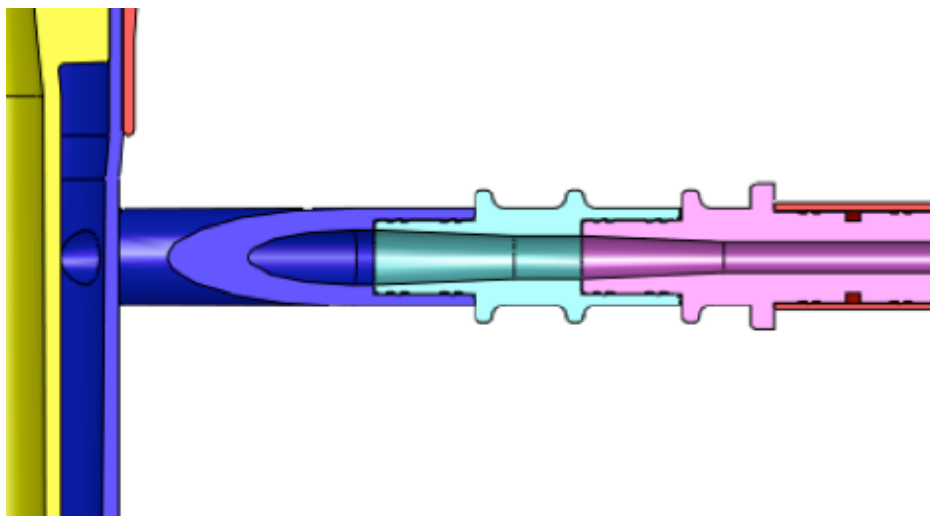
The kit comprises of a PFA double pass Scott-type spray chamber, PFA connecting tube and PFA injector holder, fitted to a semi-demountable quartz torch. The spray chamber is 35mm outer diameter with a removable PFA inner tube located precisely by four fins at each end. Unlike single pass PFA spray chambers, the spray chamber is a true double pass design, which reduces signal fluctuations, improves RSDs and lowers detection limits. The double pass design also removes all sample aerosol droplets greater than 10 $\mu$ m diameter. Removing larger droplets is key to preventing plasma overloading, increasing plasma robustness and reducing oxide levels. While PFA kits have traditionally been used for semicon applications, this kit can be applied equally to non-semicon high matrix sample types.

Protruding from the bottom edge of the inner tube is a flexible, molded drain guide that contacts the outer tube to ensure smooth, consistent drainage of droplets into the drain port positioned below. This eliminates periodic build up and drainage of droplets, which is a common cause of signal fluctuation. The end cap is O-ring free and features a 6mm nebulizer port and a make up gas port. A schematic diagram of the inert kit is shown below.

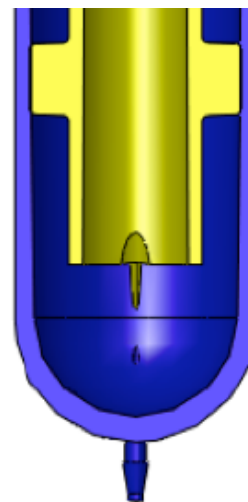


*Schematic diagram - PFA inert kit*

Another important contributor to the performance of the kit is the connector design. In order to eliminate droplet build up in this area, careful attention has been paid to the design of the aerosol flow path. The chamber side arm has a wide inner diameter (ID), tapering to the connector. The connector fitting is O-ring free and is a push fit, and the ID matches precisely the ID of the side arm and of the torch injector holder on the exit side. Because the aerosol flow path is perfectly smooth with no ledges or steps, droplet formation is eliminated (see diagram - next page) and washout is improved.



*Close up of connector (light blue) showing smooth flow path*



*Close up of flexible drain guide protruding from bottom of inner tube (yellow)*

The semi demountable quartz torch fits onto the injector holder with an O-ring seal, which gives a more secure and more easily removed connection than O-ring free torch mounts. Since no sample liquid or aerosol comes into contact with the torch O-ring, there is no risk of increased background contribution. Injectors are available in either sapphire or platinum, with 1.8 mm ID.

Designed, molded and manufactured in house by Savillex from the highest purity grades of PFA resin (Daikin AP211SH or Dupont 440HP) the PFA inert kit has the lowest blank contribution of any sample introduction system, enabling the Element 2 to achieve its full performance potential. All PFA components are precleaned in high purity HNO<sub>3</sub>/HF, so the kit is ready for immediate use with ultratrace analysis. The kit is designed to be used with the Savillex range of C-Flow PFA nebulizers, but can be used with any 6mm nebulizer and also the Savillex X-Flow cross flow nebulizer.

## Applications

For semiconductor applications, the inert kit can be used either with the sapphire or platinum injectors. Select the appropriate Savillex C-Flow concentric nebulizer depending upon sample type and sample volume. Use the C-Flow 200 for process chemicals and the C-Flow 50 for VPD applications, where sample volume is limited. The C-Flow 50 is also the best choice for high/difficult matrix applications such as phosphoric acid analysis and digested photovoltaic (PV) silicon, where lower uptake rates allow the sample matrix to be dissociated more effectively and help prevent interface deposition. In all semiconductor applications, the C-Flow nebulizer is used in free aspiration mode to avoid contamination from peri-pump tubing. The C-Flow is available with or without integrated autosampler probes.

Because the Savillex inert kit is a true double pass design and capable of handling high matrix sample types, it is ideally suited to non-semicon applications such as geological and clinical. Use the kit with the sapphire injector. The perfect nebulizer choice for all non-semicon applications is the Savillex C-Flow 700, which is extremely resistant to high total dissolved solids (TDS) and particulate containing samples. The C-Flow 700 is designed to be used pumped rather than in free aspiration mode, and performs consistently over a wide range of sample uptake rates, from 0.2-1.2mL/min.

## Performance

To assess the performance of the inert kit (sensitivity, stability and background level), data was generated with an Element 2 installed in a semiconductor clean room. A selection of calibration plots plus BEC values obtained for 39 elements are shown below.

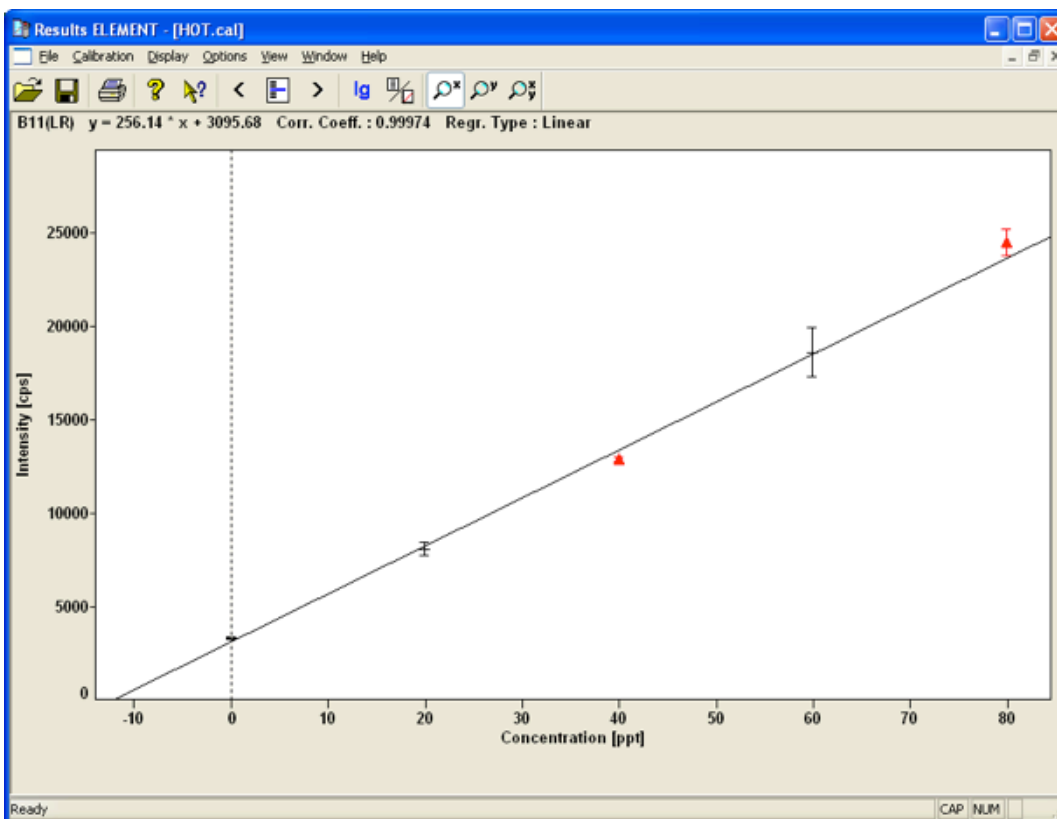
## Operating Conditions

- Thermo Element 2 fitted with Pt cones
- Savillex PFA inert kit (1.8mm Pt injector) fitted with Savillex C-Flow 200 PFA nebulizer, operating in free aspiration mode
- Normal plasma (all elements)
- Low, medium and high resolution used (indicated in the table)

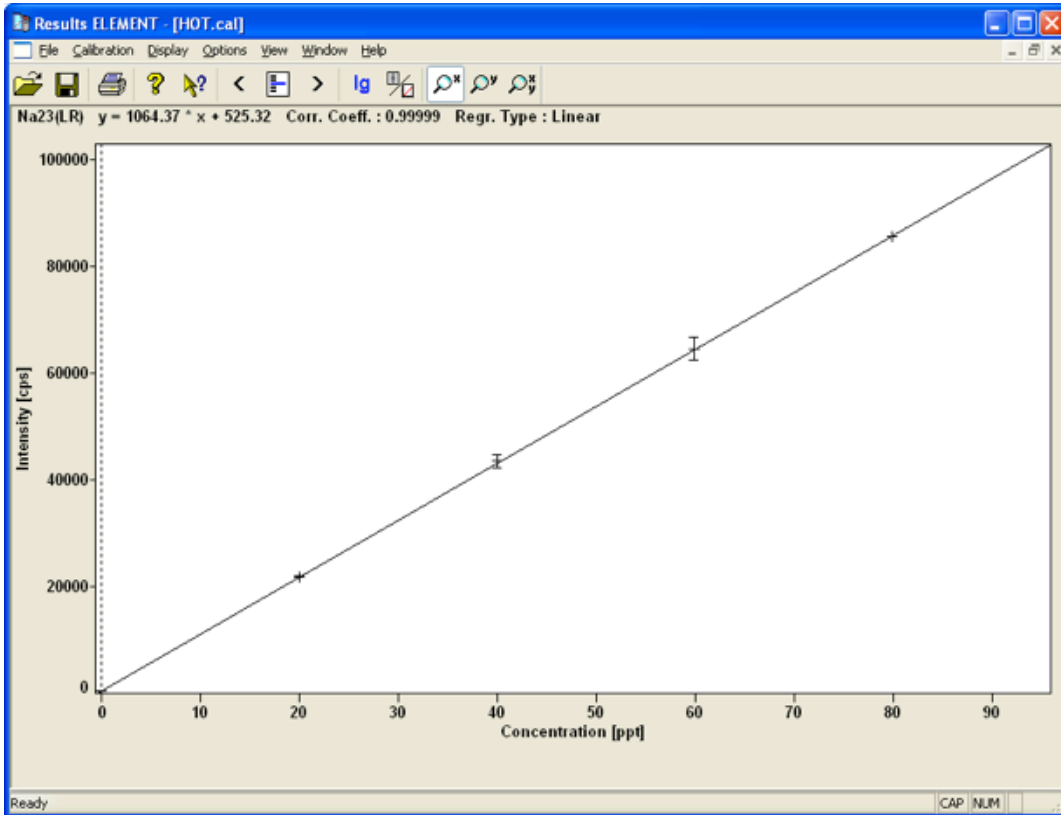
The inert kit and C-Flow 200 were new and were installed without any cleaning. They had been used for approx. 1 hour prior to the acquisition of the data below.

## Calibration Plots

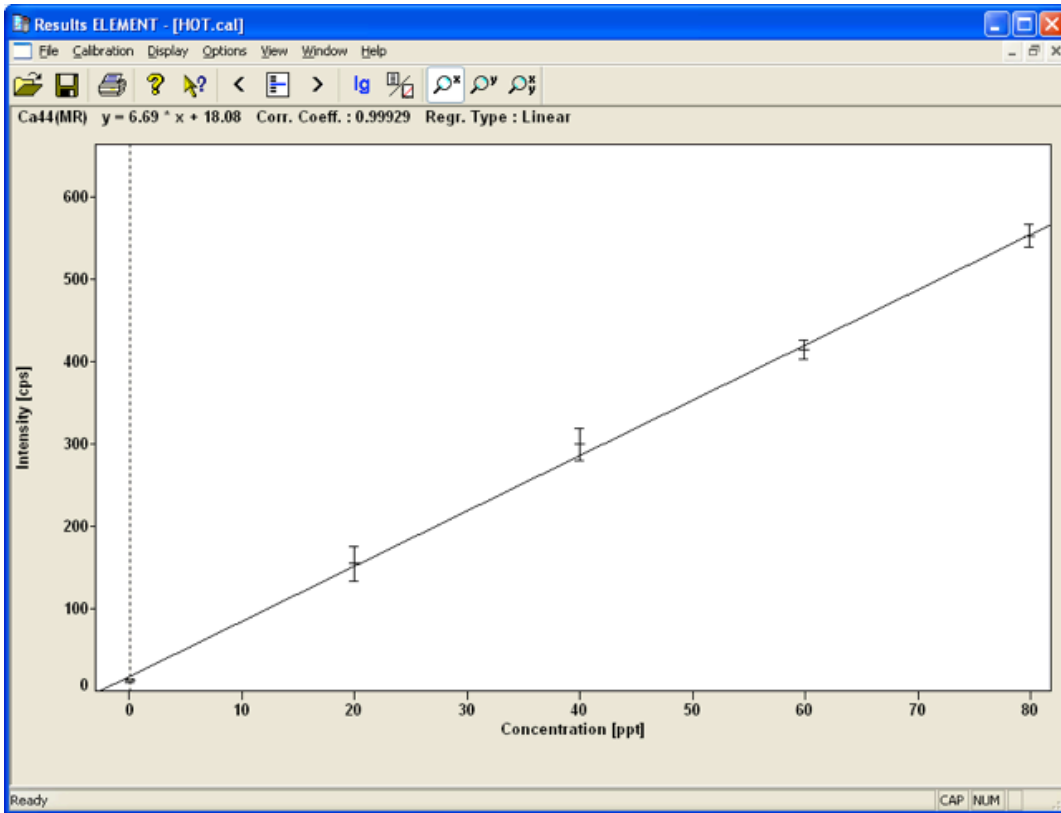
0, 20, 40, 60, 80ppt calibration in DIW with trace (high purity) HNO<sub>3</sub> added.



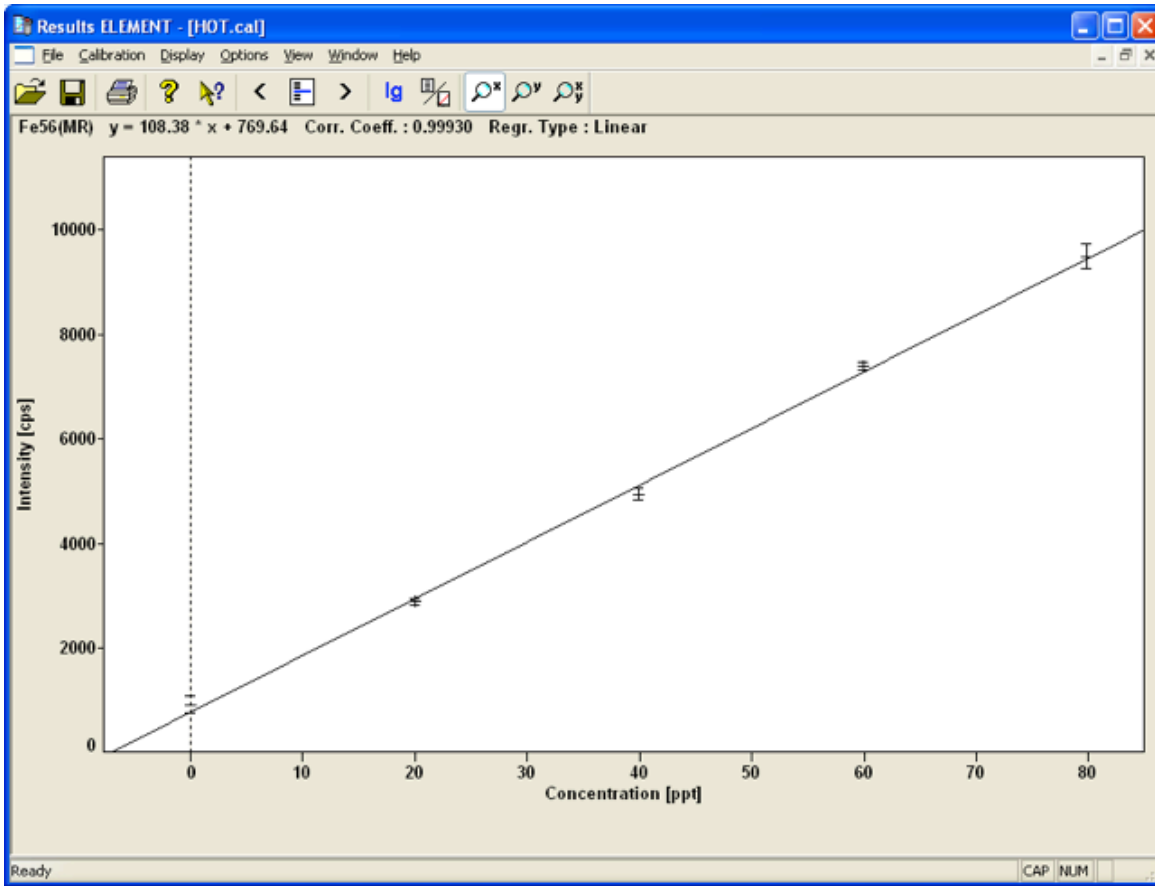
B (11) low res



Na (23) low res



Ca (44) med res



Fe (56) med res

As can be seen above, excellent calibration fit was obtained down to the 20ppt level. BECs were generated from the calibration plots and are given in the list below.

Isotope (res)	BEC	Units	Isotope (res)	BEC	Units	Isotope (res)	BEC	Units	Isotope (res)	BEC	Units
Li7(LR)	1.3	ppt	Ca44(MR)	2.70	ppt	Pb207(LR)	0.8	ppt	Sr88(MR)	0.0	ppt
Be9(LR)	1.6	ppt	Ti48(MR)	0.0	ppt	Bi209(LR)	0.9	ppt	Zr90(MR)	1.3	ppt
B11(LR)	12.1	ppt	V51(MR)	0.0	ppt	Th232(LR)	0.3	ppt	Mo98(MR)	0.0	ppt
Na23(LR)	0.5	ppt	Cr52(MR)	11.9	ppt	U238(LR)	0.9	ppt	Al27(HR)	14.1	ppt
Ag107(LR)	3.6	ppt	Mn55(MR)	1.4	ppt	Hf180(LR)	0.5	ppt	K39(HR)	6.0	ppt
Cd114(LR)	1.1	ppt	Fe56(MR)	7.1	ppt	Mg24(MR)	0.7	ppt	Fe56(HR)	7.6	ppt
In115(LR)	0.3	ppt	Ni58(MR)	2.7	ppt	Al27(MR)	12.0	ppt	Ge74(HR)	0.0	ppt
Sn118(LR)	0.9	ppt	Co59(MR)	0.2	ppt	P31(MR)	109.4	ppt	As75(HR)	2.9	ppt
Sb121(LR)	0.7	ppt	Ni60(MR)	2.7	ppt						
Ba138(LR)	0.2	ppt	Cu63(MR)	1.7	ppt						
Ta181(LR)	0.0	ppt	Zn66(MR)	2.5	ppt						
W184(LR)	0.0	ppt	Zn68(MR)	3.6	ppt						
Au197(LR)	8.5	ppt	Ga69(MR)	0.0	ppt						

## Inert Kit Features

The Savillex PFA inert kit is the highest performing sample introduction system available for ICP-MS and is designed to fit perfectly on the Element 2. When used with one of Savillex's C-Flow nebulizers, it has the following features:

- High sensitivity
- True double pass design gives excellent signal stability and low RSDs
- True double pass design filters out all droplets >10uM diameter: less plasma loading and low oxides (more robust plasma)
- Smooth aerosol flow path prevents droplet build up in connector and promotes fast washout
- Precisely located inner tube with integrated drain guide eliminates spikes and instability due to irregular drainage
- Highest purity PFA resin used - no measureable background contribution
- C-Flow nebulizers free aspirate – can be used for aggressive organics that attack pump tubing
- Very high TDS and particulate tolerance (with C-Flow 700)
- Capable of microvolume sample uptake rates (with C-Flow 50, 100 or 200)
- Compatible with every sample type – inorganic and organic – that could be analyzed by ICP-MS



For additional information on all of our  
PFA Sample Introduction Systems, please visit

[www.savilleX.com](http://www.savilleX.com)

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