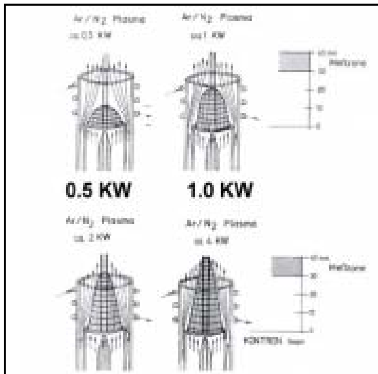
Avio 200 ICP-OES Flat Plate

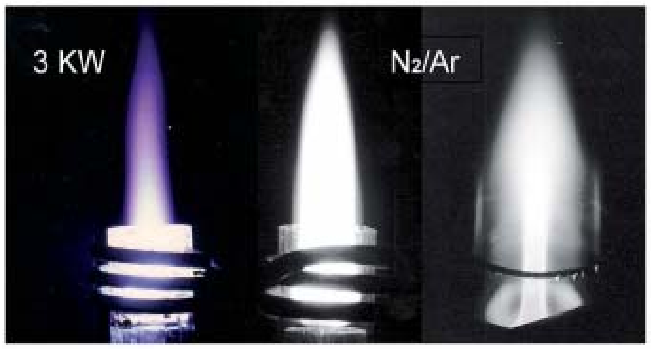
PerkinElmer
For the Better

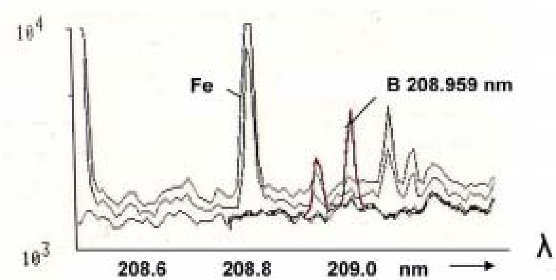
Riccardo MAGARINI, EMEA Sr. Specialist for Atomic Spectroscopy
Budapest 2016, October 17th

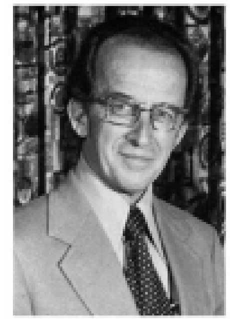
The beginnings (1960s'): Greenfield's and Fassel's plasmas



STAN GREENFIELD

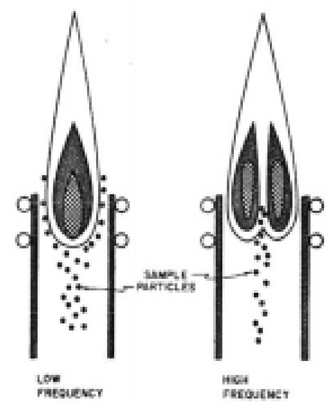




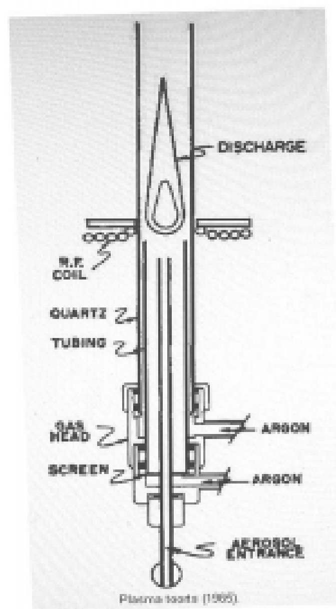


Vermer Arthur Fassel

Inductively Coupled Plasma
Ar/Ar 27 MHz 1-2 KW



Principal of a High Frequency ICP



Torch

ICP combined to a direct reading Spectrometer

PerkinElmer

The standard “helical” load coil

- Temperature of the plasma tends to follow the shape of the helix and creates non-uniform heating, allowing the bottom of the plasma to tip. This provides the possibility for sample to escape around the ou

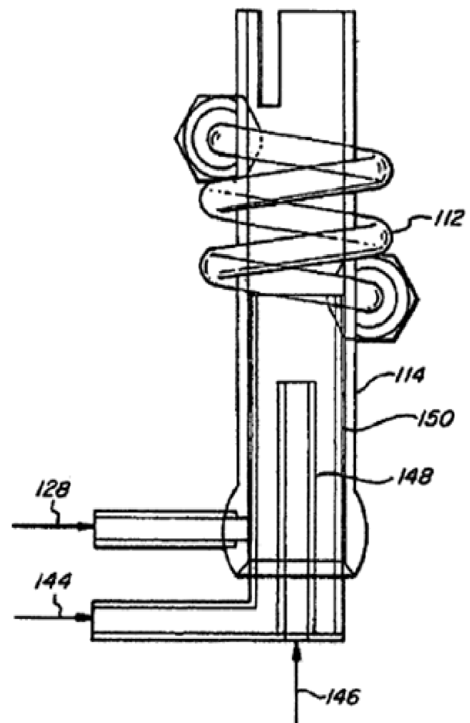
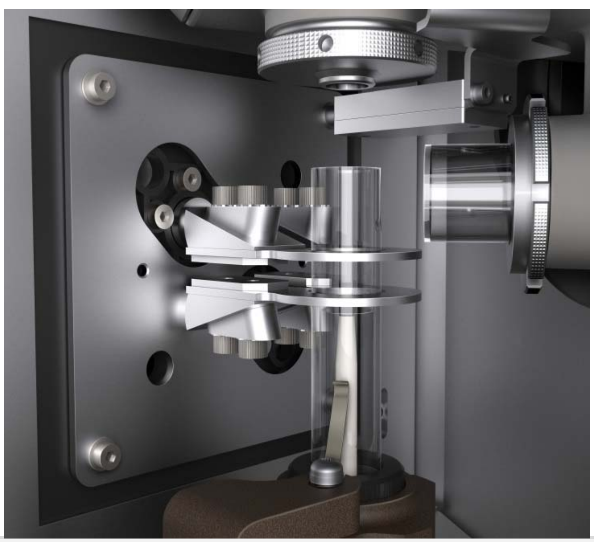
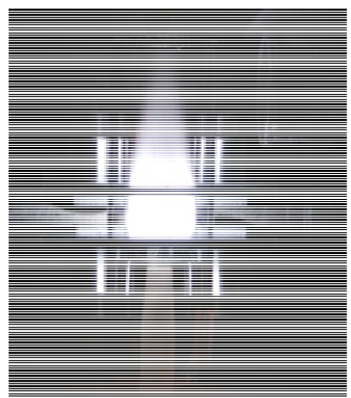


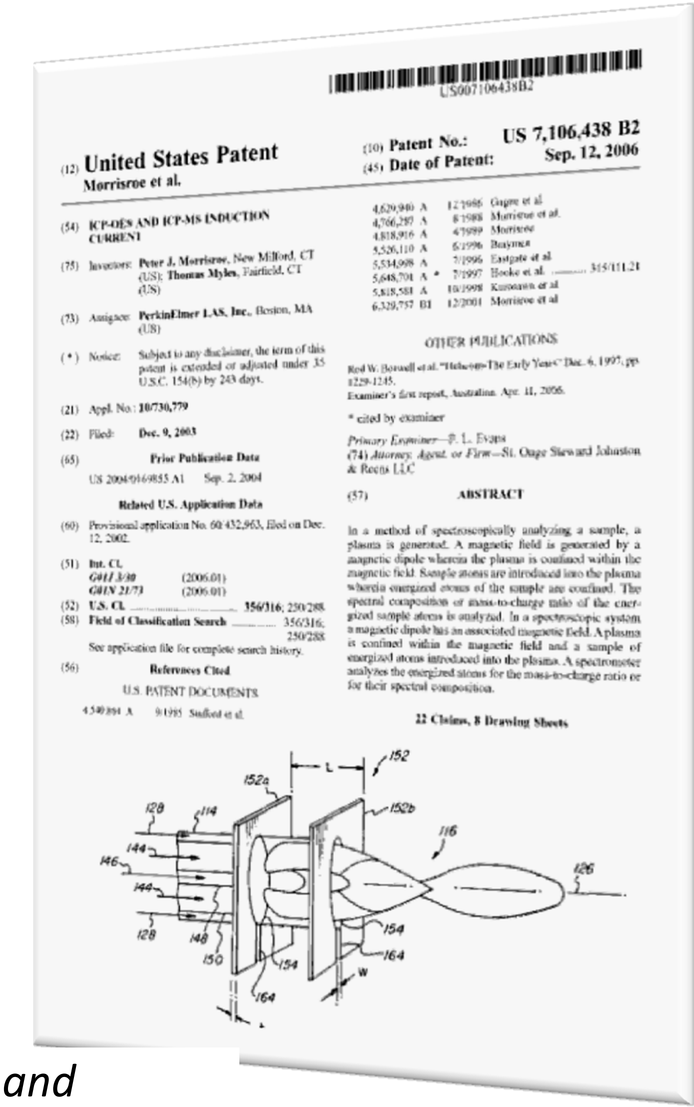
FIG. 13

Avio 200: Flat Plate Technology

- Generates perfectly symmetrical plasma
- Full Power range from 750-1500 W (in 1 W increments) in **both** Axial and Radial modes
- No coil, no bonnet, no cooling
    - *Flat Plate technology achieves greater plasma robustness and stability because of its unique design, leading to less sample loss, greater analytical signal, lower argon consumption, and less maintenance*







US007106438B2

(12) **United States Patent**
Morrisroe et al.

(10) **Patent No.: US 7,106,438 B2**
(45) **Date of Patent: Sep. 12, 2006**

(54) ICP-OES AND ICP-MS INDUCTION CURRENT

(75) Inventors: **Peter J. Morrisroe**, New Milford, CT (US); **Thomas Myles**, Fairfield, CT (US)

(73) Assignee: **PerkinElmer LAS, Inc.**, Boston, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 243 days.

(21) Appl. No.: **10/730,779**

(22) Filed: **Dec. 9, 2003**

(65) **Prior Publication Data**

US 2004/0169855 A1   Sep. 2, 2004

Related U.S. Application Data

(60) Provisional application No. 60/432,963, filed on Dec. 12, 2002.

(51) **Int. Cl.**
G01J 3/30 (2006.01)
G01N 21/73 (2006.01)

(52) **U.S. Cl.** **356/316**; 250/288

(58) **Field of Classification Search** 356/316; 250/288

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,540,884 A	9/1985	Stafford et al.		
4,629,940 A	12/1986	Gagne et al.		
4,766,287 A	8/1988	Morrisroe et al.		
4,818,916 A	4/1989	Morrisroe		
5,526,110 A	6/1996	Braymen		
5,534,998 A	7/1996	Eastgate et al.		
5,648,701 A *	7/1997	Hooke et al.	....	315/111.21
5,818,581 A	10/1998	Kurosawa et al.		
6,329,757 B1	12/2001	Morrisroe et al.		

OTHER PUBLICATIONS

Examiner's first report, Australian. Apr. 11, 2006.

* cited by examiner

Primary Examiner—F. L. Evans
(74) *Attorney, Agent, or Firm*—St. Onge Steward Johnston & Reens LLC

(57) **ABSTRACT**

In a method of spectroscopically analyzing a sample, a plasma is generated. A magnetic field is generated by a magnetic dipole wherein the plasma is confined within the magnetic field. Sample atoms are introduced into the plasma wherein energized atoms of the sample are confined. The spectral composition or mass-to-charge ratio of the energized sample atoms is analyzed. In a spectroscopic system a magnetic dipole has an associated magnetic field. A plasma is confined within the magnetic field and a sample of energized atoms introduced into the plasma. A spectrometer analyzes the energized atoms for the mass-to-charge ratio or for their spectral composition.

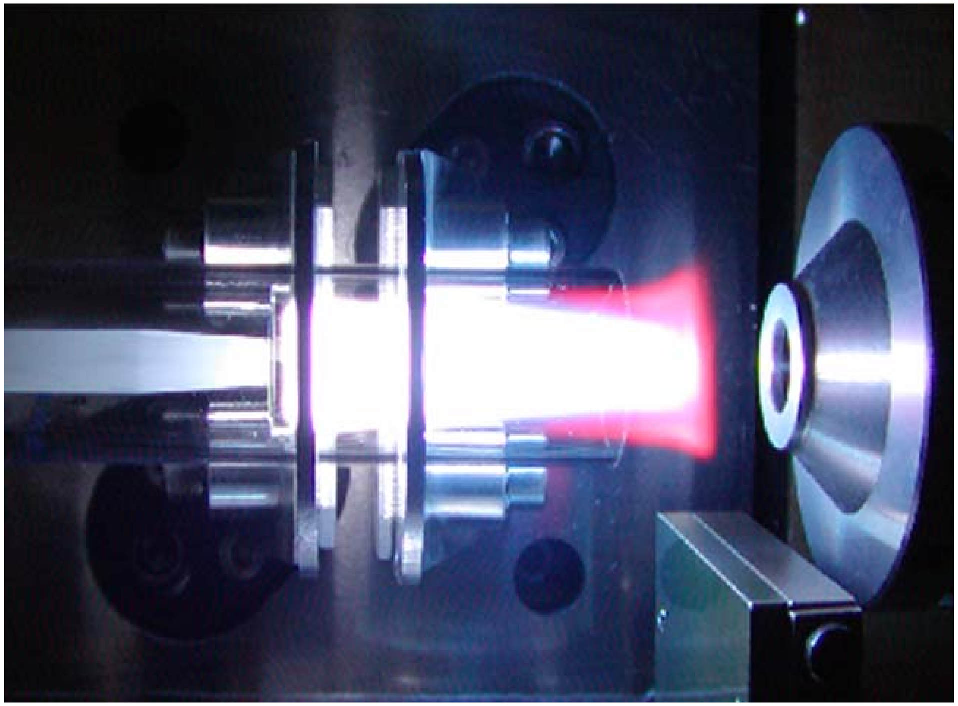
22 Claims, 8 Drawing Sheets

Patents 7106438 and 7511246

New Induction Plates

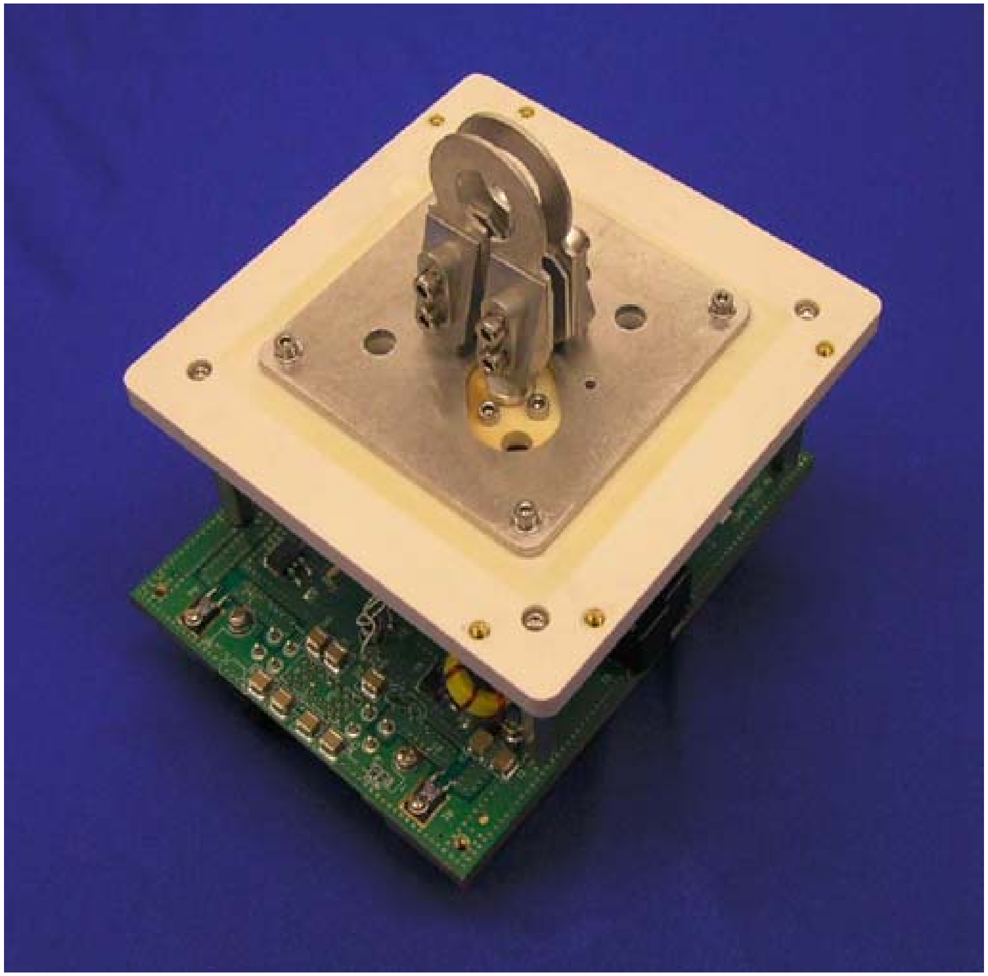
- The new induction plate plasma running at 1500 watts and 8 L/min of argon plasma flow.

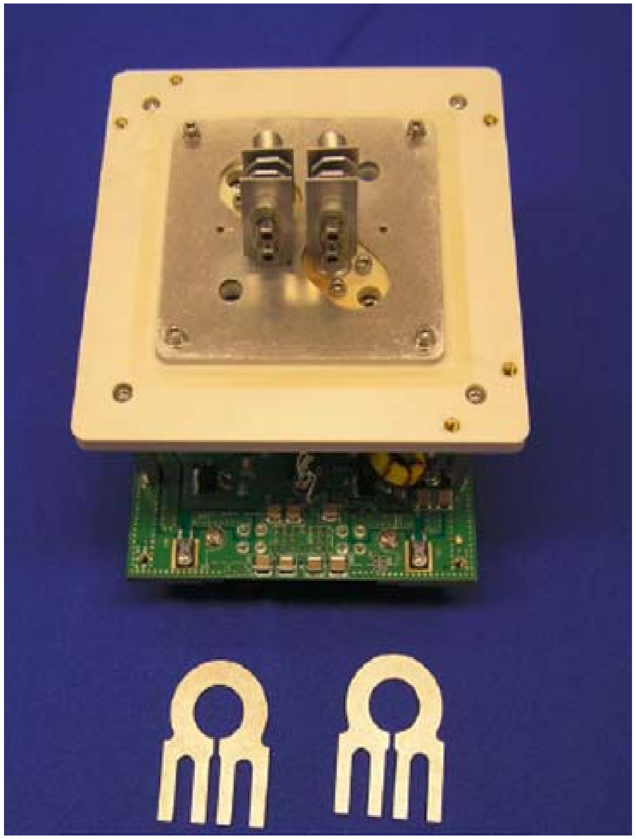
- The new Induction plates do not require cooling
  - Even under prolonged max-power operation, the new aluminum induction plates look like new with no sign of aging.



- For more information see:
  - Patent No. US 7106438 and 7511246 http://free.patentfetcher.com/

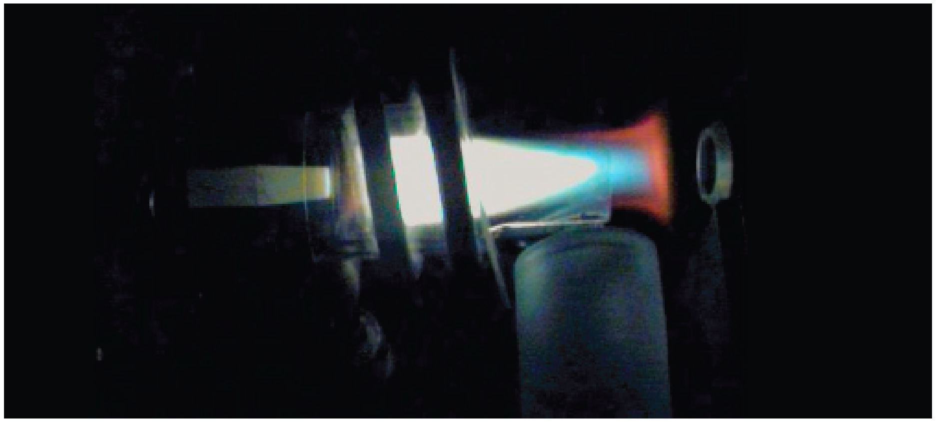
The Flat Plate RF Oscillator





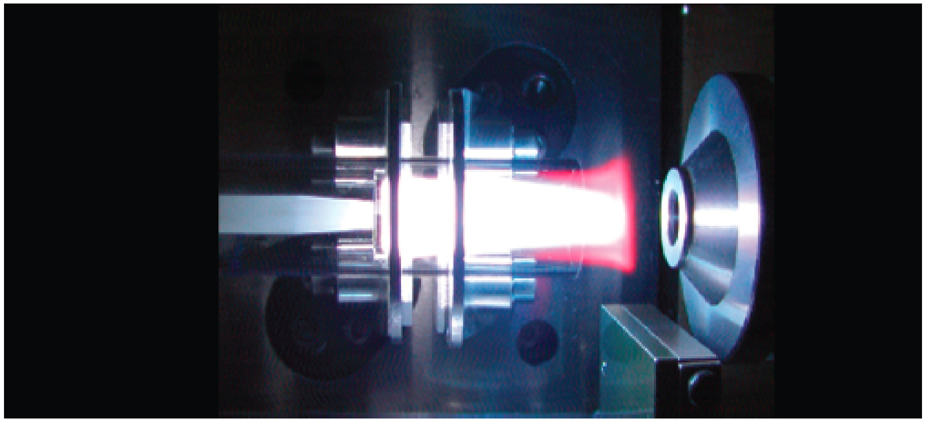
Avio 200: Flat Plate Technology

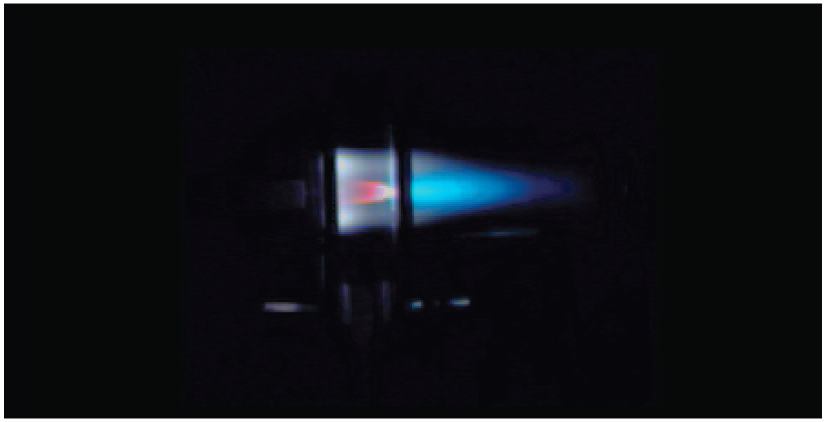
Traditional Helical System (views shown with different camera exposures)



The figure on the left shows the angled base of the plasma which coincides with the angled shape of the load coil. The figure on the right shows the upward tilt of the axial channel and plasma tip as well as the differences in plasma density above and below the central channel.

Innovative Flat Plate System (views shown with different camera exposures)





The figure on the left shows the flatness of the plasma base. It is also broader than the rounded helical plasma base (shown above) which prevents sample escape around the edges. The figure on the right shows the symmetry of the plasma around the axial channel with no distortion in shape.

New Induction Plates

- Plasma running kerosene at full RF power

- 1500 W and 10 Lpm

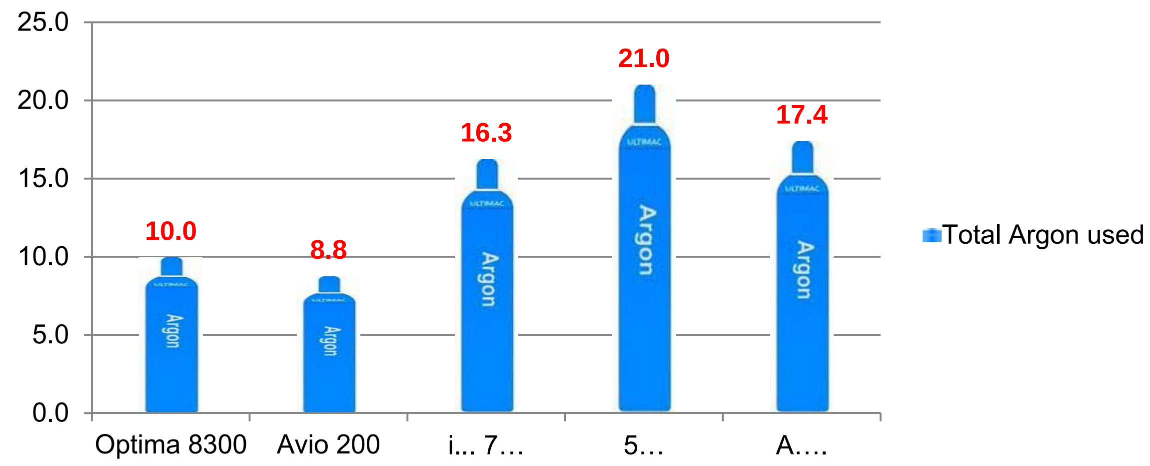
Avio 200: Cutting-edge Innovation

- **Patented Flat Induction Plates operate at half the Argon flow of helical designs**
  - Avio (and Optima) platforms are the only ICP-OES systems capable of running at 8 L/min plasma gas
  - Same robust plasma conditions for all samples
  - Full power range allows the analysis of all sample types
  - No helical load coil needed: eliminates maintenance, consumables cost, downtime and leakage risk

Saves up to € “XX” per year for argon gas

About ICP-OES Argon Gas Consumption (Lpm)

	Plasma On / Running				
	PerkinElmer	PerkinElmer	T….o	A…..t	S…..o
	Optima 8300 DV	Avio 200 DV	i… 7…	5…	A….
Torch - Plasma Flow	8.0	8.0	12.0	12.0	13.0
Torch - Aux Flow	0.2	0.2	0.5	1.0	0.7
Torch - Neb Flow	0.6	0.6	0.7	0.7	0.7
Optic - Detector Purge	1.2	0.0	0.1	0.0	0.0
Optic - Cone, Snout, Trasfer Optics Purge	0.0	0.0	0.0	6.6	3.0
Optic - Polychromator Purge	0.0	0.0	3.0	0.7	0.0
Total Argon used	10.0	8.8	16.3	21.0	17.4



Avio 200

New ICP-OES System – Applications

Riccardo MAGARINI

Budapest 2016, October 17^{th}

Avio 200 ICP-OES Application Notes

- Environmental
  - Analysis of Micronutrients in Soil Using ICP-OES
- Food & Bev
  - Analysis of Micronutrients in Milk Using ICP-OES
  - Analysis of Micronutrients in Fruit Juices Using ICP-OES
- Industrial
  - Meeting the RoHS Directive with M/W Sample Preparation and ICP-OES
- and more to be released shortly.

PerkinElmer

Applications: Soil Analysis with the Avio 200 ICP-OES

Introduction

- Micronutrients in soil are the building blocks for the crops we eat and feed to livestock
- Proper plant nutrition promotes efficient growth and water usage
  - Maximize production amount and quality while minimizing environmental impact
- For consumers and industry, it is important to monitor the micronutrients in soil
  - Variation in soil quality region to region
  - Prevent or monitor soil depletion
  - Proper land custodianship with effective fertilizing and crop rotation
- Nutrients can be monitored with Flame AA, ICP-OES, or ICP-MS
  - ICP-OES provides a good balance between ease-of-use, cost, and speed of analysis

Samples

- The soil samples selected represent residential and agricultural land plots as well as specialized garden soils

  - Residential Yard: a single sample of local soil
  - Agricultural Field: three samples representing:
    - Vineyard
    - Rotational crop field
    - Pasture
  - Home Garden: three samples representing:
    - Amended yard soil
    - Consumer pre-packaged “garden soil”
    - Commercial “garden soil”

Sample Preparation

- Samples are high in carbon (organic matter) and dissolved solids
  - Background interference on elements of interest
  - Plasma loading from carbon impacts element ionization
  - Reduction of nebulization efficiency

- Microwave-assisted digestion as a solution
  - Conversion of carbon to CO_2, removing carbon from the sample solution
  - Rapid heating and cooling for short digestion times
  - Higher temperatures than open-vessel digestion
  - Closed vessels prevent analytes losses

Sample Preparation: Microwave Assisted Digestion

- Titan MPS™ Microwave Sample Preparation System
  - 1 g of sample added to Titan 75 mL digestion vessels
  - Add pre-digestion spikes, as required
  - Add 6 mL HCl (37 %) + 3 mL HNO_3 (70 %)
  - Let sit for 10 minutes, then cap vessels and digest
  - Transfer to auto-sampler tubes and dilute to 50 mL with deionized water

Titan Digestion Program for Soil

Step	Temp (°C)	Pressure Limit (bar)	Ramp Time (min)	Hold Time (min)	Power Limit (%)
1	150	35	5	5	80
2	195	35	2	20	100
3	50	35	1	15	0

- This method was designed for elements leaching
  - No total sample digestion
  - Remaining solids were centrifuged and the solution decanted for analysis

Instrumental Conditions: Avio™ 200 ICP-OES

Method Parameters

Element	Wavelength (nm)	Plasma View	Integration Range (sec)
Al	308.215	Radial	0.1-2
Ba	233.527	Axial	0.1-5
Ca	317.993	Radial	0.1-2
Co	228.616	Axial	0.1-5
Cu	327.393	Axial	0.1-5
Fe	238.204	Radial	0.1-2
K	766.490	Radial	0.1-2
Mg	285.213	Radial	0.1-2
Mn	257.610	Radial	0.1-2
Na	589.592	Radial	0.1-2
Ni	231.604	Axial	0.1-5
P	178.221	Axial	0.1-5
S	181.975	Axial	0.1-5
V	292.464	Axial	0.1-5
Zn	206.200	Axial	0.1-5
Y (int std)	371.029	Radial	0.1-5
Y (int std)	371.029	Axial	0.1-5

Short Integration Times

Instrumental Parameters

Parameter	Value
Nebulizer	Meinhard Glass Type K1
Spray Chamber	Baffled Glass Cyclonic
Sample Uptake Rate (mL/min)	0.8
RF Power (W)	1500
Nebulizer Gas (L/min)	0.70
Auxiliary Gas (L/min)	0.2
Plasma Gas (L/min)	8

Low Argon Flows

Instrumental Conditions: Avio™ 200 ICP-OES

Calibration Standards

Element	Std 1 (mg/L)	Std 2 (mg/L)	Std 3 (mg/L)	Std 4 (mg/L)	Std 5 (mg/L)
Al			25	100	500
Ba	1	10	25		
Ca			25	100	500
Co	1	10	25		
Cu	1	10	25		
Fe			25	100	500
K			25	100	500
Mg			25	100	500
Mn	1	10	25		
Na		10	25	100	
Ni	1	10	25		
P		10	25	100	
S		10	25	100	
V	1	10	25		
Zn	1	10	25		

Calibration Results

Element	Correlation Coefficient	ICV (% Recovery)
Al	0.99999	97
Ba	0.99999	98
Ca	0.99998	101
Co	0.99993	96
Cu	0.99988	96
Fe	0.99999	100
K	0.99992	97
Mg	0.99991	108
Mn	0.99999	102
Na	0.99985	96
Ni	0.99998	97
P	0.99986	98
S	0.99985	98
V	0.99995	99
Zn	0.99990	98

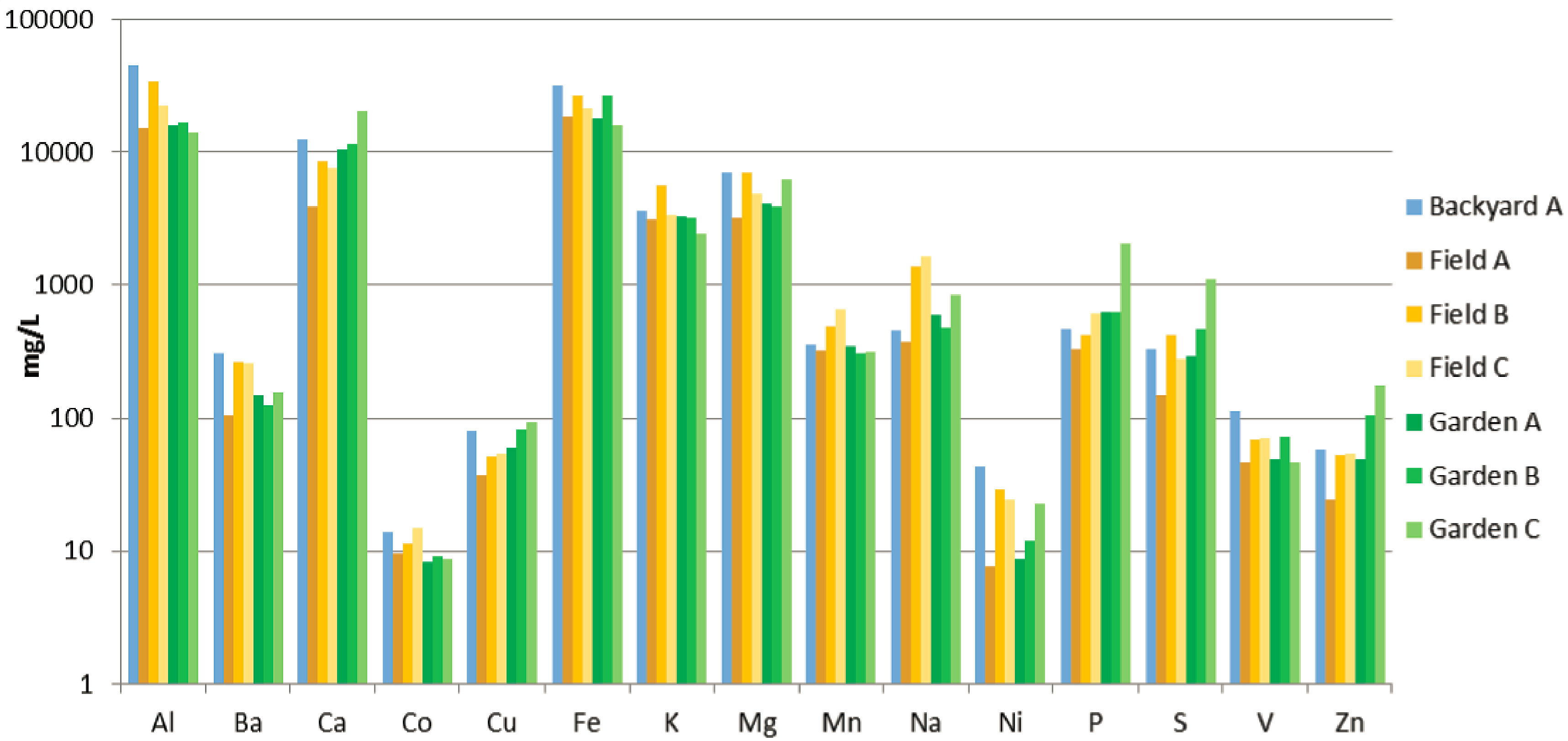
Results & Discussion: Accuracy

Analysis of Reference Soil Solutions

Element	Soil Solution A			Soil Solution B		
	Certified (mg/L)	Experimental (mg/L)	% Recovery	Certified (mg/L)	Experimental (mg/L)	% Recovery
Al	500	459	92	700	662	95
Ba	5	4.75	95	7.00	6.94	99
Ca	350	343	98	125	126	101
Co	---	0.027	---	0.100	0.087	87
Cu	0.300	0.289	96	3.00	3.01	100
Fe	200	201	101	350	356	102
K	200	196	98	210	210	100
Mg	70	73	104	80.0	82.6	103
Mn	0.100	0.110	110	100	95.2	95
Na	70.0	63.8	91	100	92.5	92
Ni	0.300	0.287	96	0.20	0.20	100
P	---	6.72	---	---	6.76	---
S	---	1.86	---	---	2.03	---
V	0.100	0.096	96	0.800	0.772	97
Zn	1.00	1.02	102	70.0	68.9	98

- Recoveries within ± 10 % → accurate methodology
  - *Cobalt outlier due to the trace level concentration*

Results & Discussion: Sample Analysis



- The different soils analyzed for have similar makeup
- Since this is a logarithmic scale, there are significant differences with Ni and Zn having great variability
- This type of analysis is important for truthful labeling.

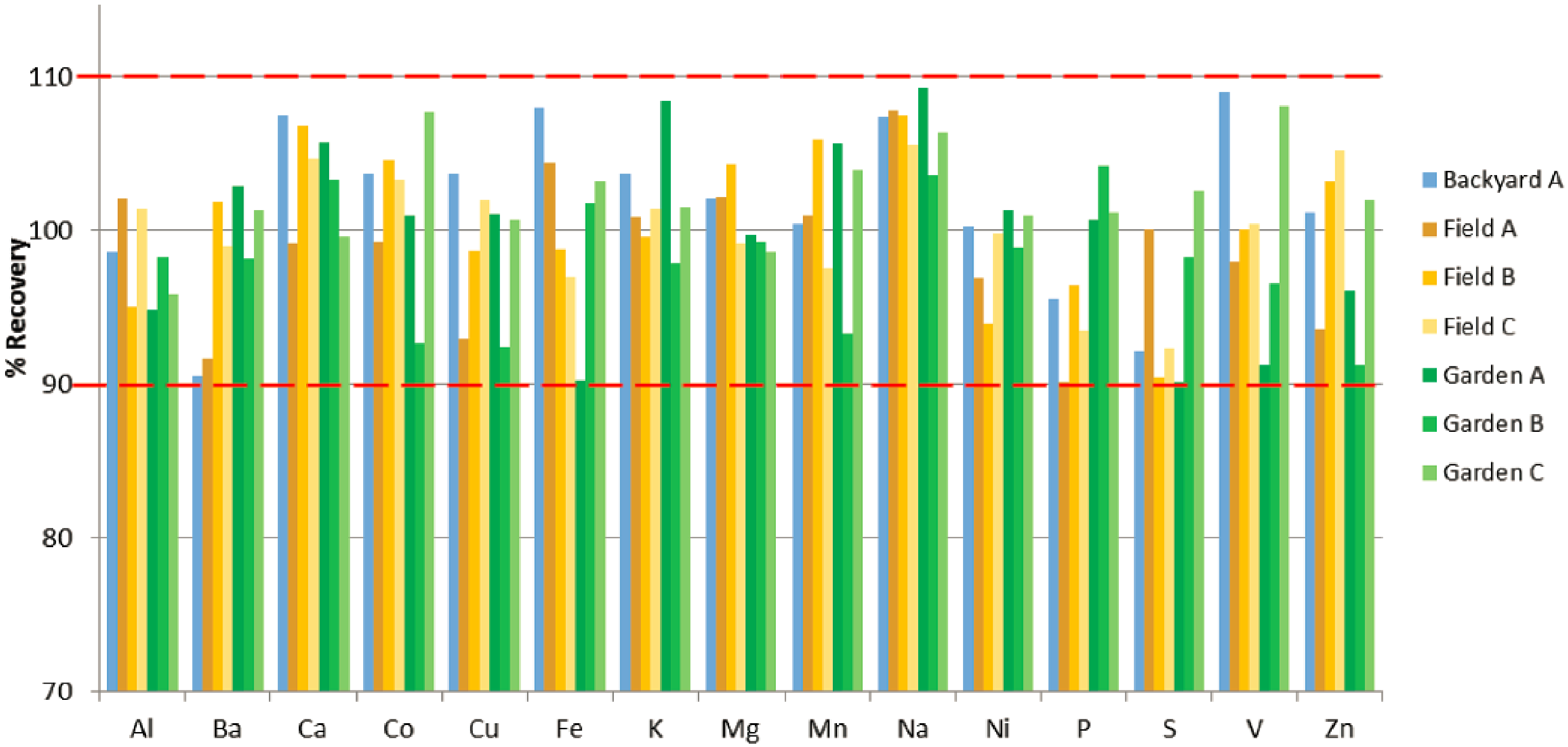
Results & Discussion: Spike Analysis

- Soil samples were spiked prior to digestion
  - Added directly to digestion vessels before the addition of acid
- Spike concentrations were expected to be near the analytical values the elements analyzed so that the spike signal is not overwhelmed by the analytical signal
- Spiked to confirm:
  - No analytes losses during the sample preparation process
  - Elimination or accurate IS compensation for matrix effects

Spike Levels

Element	Al	Ba	Ca	Co	Cu	Fe	K	Mg	Mn	Na	Ni	P	S	V	Zn
Conc.	5000	500	5000	50	100	5000	5000	5000	500	500	50	500	400	50	50

Results & Discussion: Spike Analysis



- All spike recoveries within ±10 %
  - Some variability due to the high TDS
  - With microwave digestion and internal standards, compensation for matrix effects was effective and spike recoveries were successful

Analysis of Micronutrients in Fruit Juice Using the Avio 200 ICP-OES

PerkinElmer
For the Better

Samples

- The fruit juice samples selected represent a variety of commonly available consumer products
  - Orange Juice: Two no-pulp 100% juices. One is Ca fortified
  - Apple Juice: Two 100% juices
  - Cranberry Juice: Two juices. One is a juice-blend (not 100%)
  - Grape Juice: Two 100% juices

Sample Preparation: Microwave Assisted Digestion

- Titan MPS™ Microwave Sample Preparation System
  - 5 mL of sample added to Titan 75 mL digestion vessels
  - Add pre-digestion spikes, as required
  - Add 8 mL HNO_3 (70 %) + 2 mL H_2O_2
  - Let sit for 10 minutes
  - Cap Vessels
  - Digest
  - Transfer to auto-sampler tubes and dilute to 50 mL with deionized water

Titan Digestion Program for Fruit Juice

Step	Target Temp (°C)	Pressure Limit (bar)	Ramp Time (min)	Hold Time (min)	Power Limit (%)
1	150	30	8	5	90
2	200	30	2	20	100
3	50	30	1	20	0

Instrumental Conditions: Avio™ 200 ICP-OES

Method Parameters

Element	Wavelength (nm)	Plasma View	Integration Range (sec)
Ca	317.933	Radial	0.1 - 5
Cu	327.393	Axial	0.1 - 5
Fe	238.204	Axial	0.1 - 5
K	766.490	Radial	0.1 - 5
Mg	285.213	Radial	0.1 - 5
Mn	257.610	Axial	0.1 - 5
Na	589.592	Radial	0.1 - 5
P	178.221	Axial	0.1 - 5
S	181.975	Axial	0.1 - 5
Zn	206.200	Axial	0.1 - 5
Y (int std)	371.029	Radial	0.1 - 5
Y (int std)	371.029	Axial	0.1 - 5

Short Integration Times

Instrumental Parameters

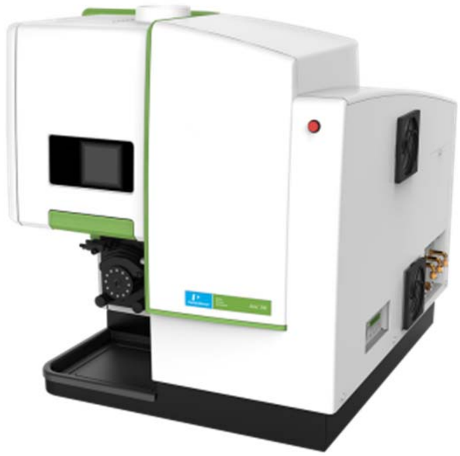
Parameter	Value
Nebulizer	Meinhard Glass Type K1
Spray Chamber	Baffled Glass Cyclonic
Sample Uptake Rate (mL/min)	0.8
RF Power (W)	1500
Nebulizer Gas (L/min)	0.68
Auxiliary Gas (L/min)	0.2
Plasma Gas (L/min)	8

Low Argon Flows

Instrumental Conditions: Avio™ 200 ICP-OES

Calibration Standards

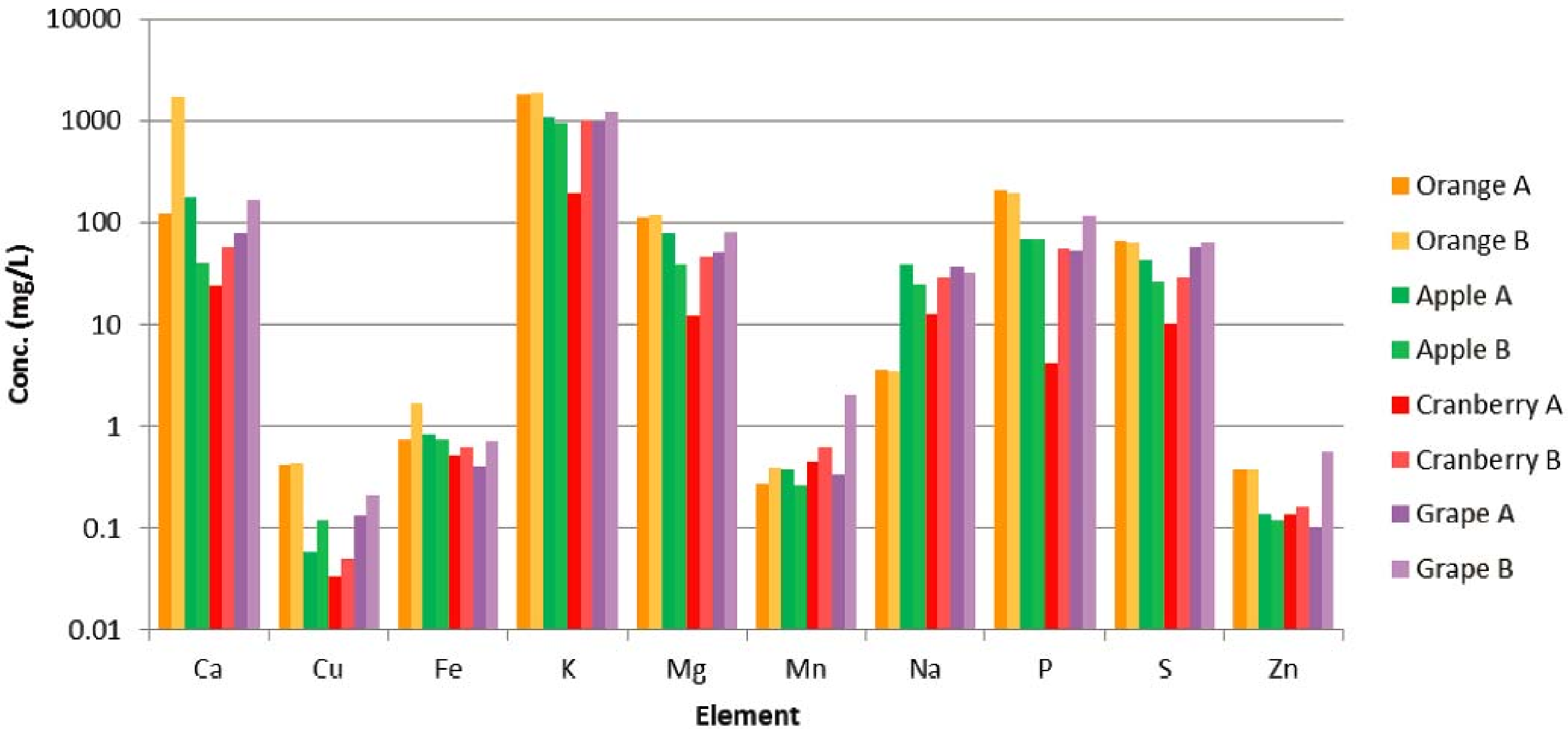
Element	Std 1 (mg/L)	Std 2 (mg/L)	Std 3 (mg/L)	Std 4 (mg/L)
Ca	-	-	10	50
Cu	0.1	1	-	-
Fe	0.1	1	-	-
K	-	-	10	50
Mg	-	-	10	50
Mn	0.1	1	-	-
Na	-	-	10	50
P	-	-	10	50
S	-	-	10	50
Zn	0.1	1	-	-



Element	Correlation Coefficient	ICV Concentration (mg/L)	Measured ICV	ICV (% Recovery)
Ca	0.99998	10.0	10.8	108
Cu	0.99995	0.100	0.106	106
Fe	0.99999	0.100	0.099	99
K	0.99999	10.0	10.6	106
Mg	0.99989	10.0	10.9	109
Mn	0.99999	0.100	0.098	98
Na	0.99999	10.0	10.6	106
P	0.99969	10.0	10.6	106
S	0.99991	10.0	10.5	105
Zn	0.99995	0.100	0.098	98

PerkinElmer

Results & Discussion: Sample Analysis



- The Ca fortified Orange juice “B” is readily identified and confirms labeling
- Different juices do indeed have differing concentrations of micronutrients
- The 100% cranberry and cranberry blend show the greatest differences within a juice family, confirming that 100% juice and juice blends are not the same and that testing for labeling requirements is critical.

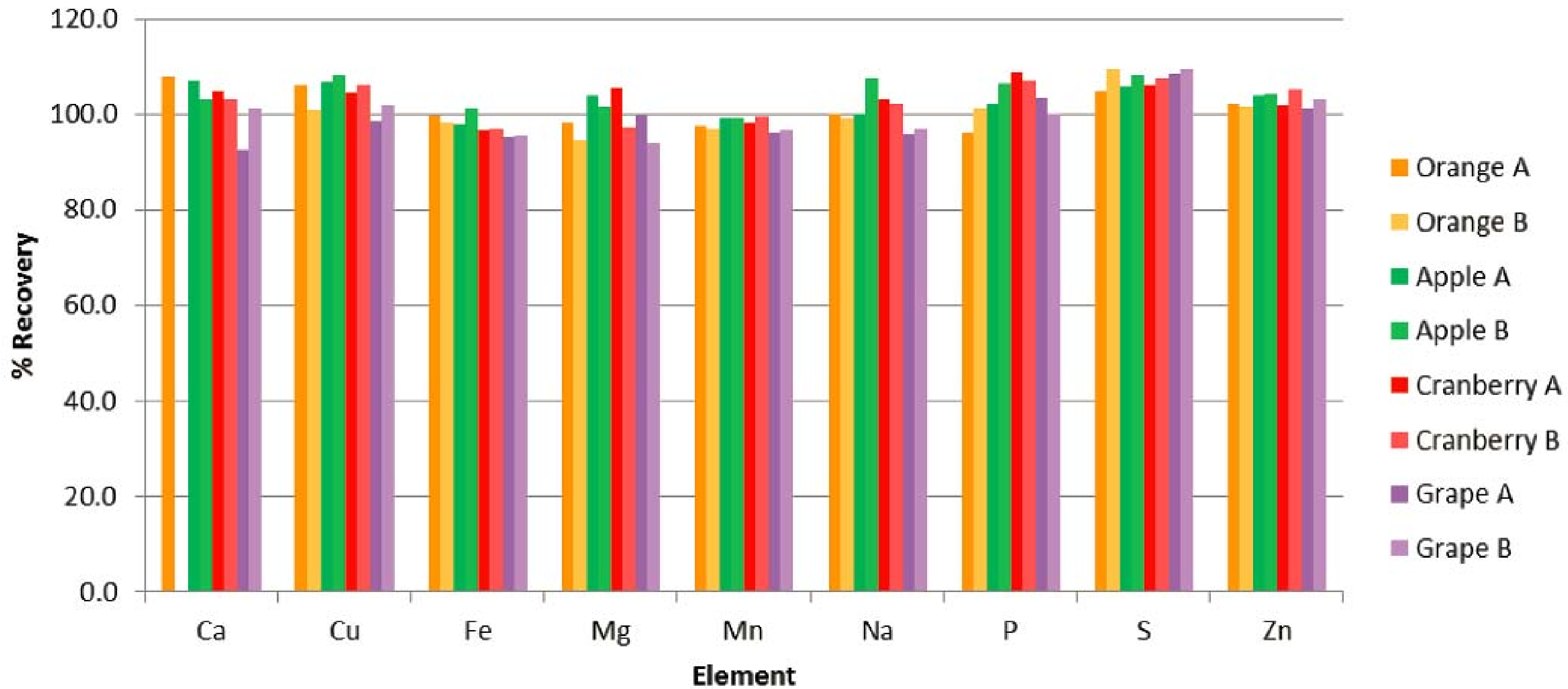
Results & Discussion: Spike Analysis

- Juice samples were spiked prior to digestion
  - Added directly to digestion vessels before the addition of acid
- Spike concentrations were expected to be near the analytical values the elements analyzed
- Spiked to confirm:
  - No analytes losses during the sample preparation process
  - Elimination or accurate IS compensation for matrix effects

Spike Levels

Element	Spike Concentration (mg/L)
Cu, Fe, Mn, Zn	2
Ca, K, Mg, Na, P, S	50

Results & Discussion: Spike Analysis



- All spike recoveries within ± 10 %
  - No matrix effects
  - No analytes losses
    - *K not reported as spike (50 mg/L) was much too low for the K concentration found in the samples (≈1000 mg/L)*

Summary

- The combination of Titan MPS and Avio 200 ICP-OES accurately measures micro and macro nutrients elements in a variety of soil samples and nutritional elements in a variety of fruit juices

- Benefits of using the Titan MPS
  - Easily handles a variety of sample types
  - Faster and more complete digestions than with hot blocks or hot plates
  - Efficient conversion of carbon content to CO_2 to reduce background and matrix effects
  - Effective extraction of elements of interest

- Benefits of using the Avio 200 ICP-OES
  - Significant cost savings by using only 9 L/min of argon
  - Much faster multi-element analysis than Flame AA
  - Able to measure elements which are challenging with Flame AA

APPLICATION NOTE

ICP-Optical Emission Spectroscopy

Author:

Nick Spivey

PerkinElmer, Inc.
Shelton, CT

Meeting the Challenges of Soil Analysis with the Avio 200 ICP-OES

Introduction

Micronutrients contained within soil are the building blocks for the crops we eat, process, or feed to livestock. These micronutrients provide the core for proper growth and development of plants which are then consumed and passed

APPLICATION NOTE

ICP-Optical Emission Spectroscopy

Author:

Nick Spivey

PerkinElmer, Inc.
Shelton, CT

Analysis of Micronutrients in Fruit Juice Using the Avio 200 ICP-OES

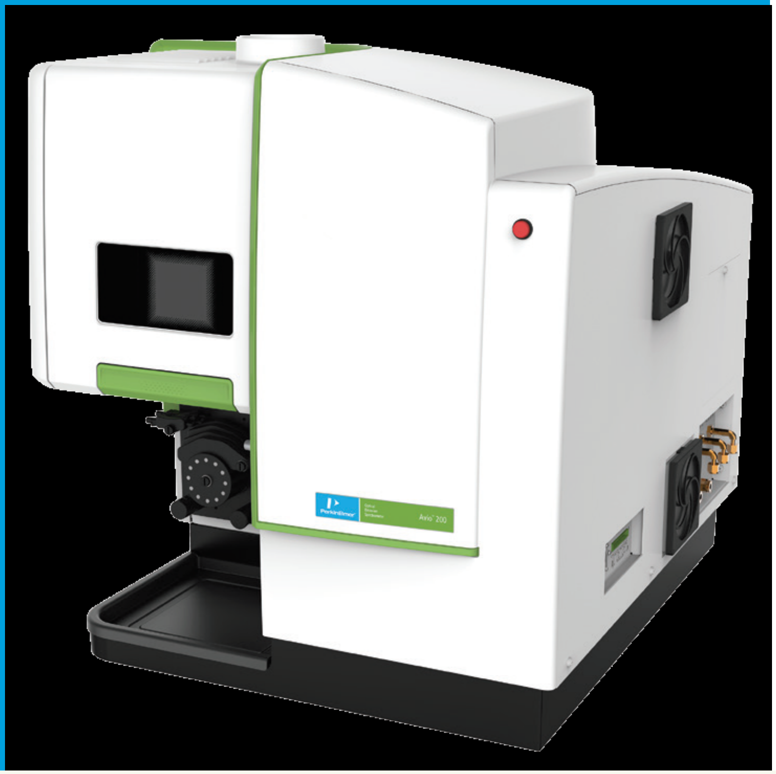
Introduction

Fruit juice continues to be a popular and refreshing beverage and can be a better nutritional alternative than typical carbonated beverages. The nutritional content of 100% fruit juices is derived from the fruit itself, and these valuable nutrients are displayed on the detailed bottle label. Customers use these labels to inform themselves on the nutritional content of the juice and for comparative shopping. While these labels provide a valuable reference for customers, they are also legally required in North America, and the veracity of these labels is the responsibility of the manufacturer.

For food manufacturers and processors, it is imperative that there is a means to quantify the content of food products, including micronutrients, for both safety and quality reasons along with regulatory label-claim requirements. Screening raw materials for elemental contaminants prior to use and then confirming the micronutrient content of the final product are two basic examples of the benefits of analytical testing. Accurate and precise analysis can also help improve the production process by providing rapid results and allowing optimization of the production process to maximize nutrient yield or production volume where appropriate.

PerkinElmer
For the Better

To download the full application notes, visit www.perkinelmer.com/avio200



ASTM Methods D4951 and D5185 for Lubricants using the Avio™ 200 ICP-OES

Two ASTM Methods for Lubricants – D4951 and D5185

Designation: D4951 – 09

Standard Test Method for
Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry[1]

Designation: D5185 – 13$^{\varepsilon 1}$

Standard Test Method for
Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)[1]

D4951 – General Recommendations

- Wavelengths listed in method are only a suggestion
- Samples prepared by weight to weight with oil and solvent to a 1/10 dilution. Solvent to be used is either xylene, kerosene or a mixture of both
- Requires an internal standard – no recommendation for an element
- Run QC every 5 samples, limits are ± 5% (many labs do ± 2 %)
- Rinse 60 seconds between each sample

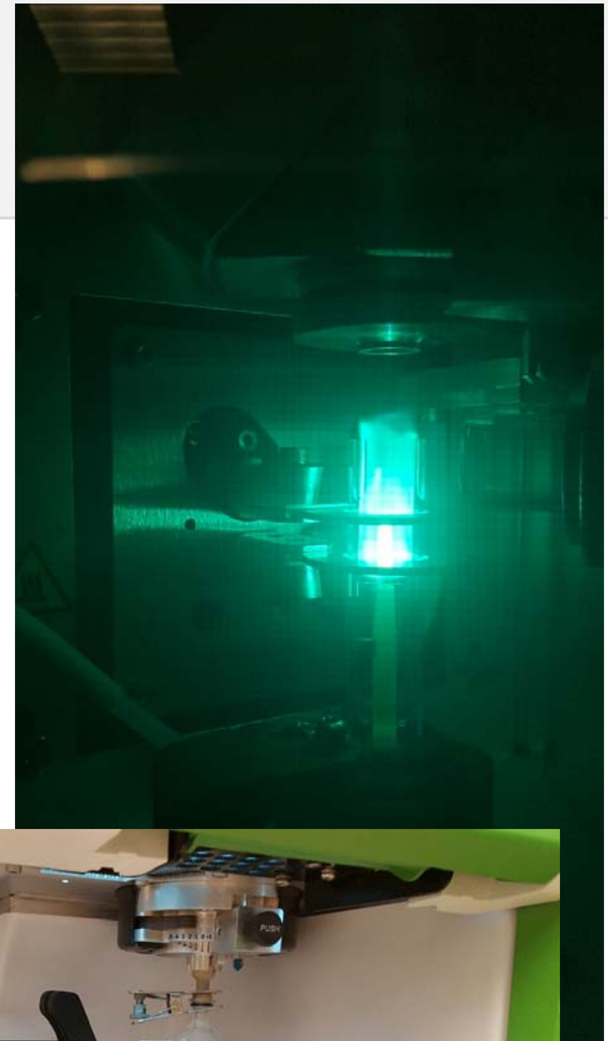
D4951 – 09

TABLE 1 Elements Determined and Suggested Wavelengths[A]

Element	Wavelength, nm
Barium	233.53, 455.40, 493.41
Boron[B]	182.59, 249.68
Calcium	315.88, 317.93, 364.4, 422.67
Copper	324.75
Magnesium	279.08, 279.55, 285.21
Molybdenum	202.03, 281.62
Phosphorus[B]	177.51, 178.29, 213.62, 214.91, 253.40
Sulfur[B]	180.73, 182.04, 182.62
Zinc	202.55, 206.20, 213.86, 334.58, 481.05

[A] These wavelengths are only suggested and do not represent all possible choices.
[B] Wavelengths for boron, phosphorus, and sulfur below 190 nm require that a vacuum or inert gas purged optical path be used.

Instrument Conditions for D4951



- Plasma Gas – 10 L/min
- Aux Gas – 0.8 L/min
- Neb Flow – 0.40 L/min
- Pump Speed – 1.3 mL/min with K-1 nebulizer
- Fast Flush – 10 s at 4 mL/min
- Read Delay – 25 s
- Replicates – 3
- Torch Position - -4
- Autosampler Rinse – 5 s.

- Tip of the green bullet in the central channel should just be short of touching the top flat plate for best performance

PerkinElmer

Typical Blend Plant Run – around 20 samples per day, 3.5 minutes per sample

Method 1: Oil D4951 K-1

Rebuild list | Print list | Insert sample... | Load tray

Run list

Seq.	Loc.	Type	Sample ID	Status
1	1		Blank	Applied
2	2		100 ppm Std	Applied
3	3		500 ppm Std	Applied
4	4		MA4	Applied
5	4	QC	MA4	QC Passed
6	5		Oil Sample 1	Analyzed
7	6		Oil Sample 2	Analyzed
8	7		Oil Sample 3	Analyzed
9	8		Oil Sample 4	Analyzed
10	9		Oil Sample 5	Analyzed
11	4	QC	MA4	QC Passed
12	5		Oil Sample 1	Analyzed
13	6		Oil Sample 2	Analyzed
14	7		Oil Sample 3	Analyzed
15	8		Oil Sample 4	Analyzed
16	9		Oil Sample 5	Analyzed
17	4	QC	MA4	QC Passed
18	5		Oil Sample 1	Analyzed
19	6		Oil Sample 2	Analyzed
20	7		Oil Sample 3	Analyzed
21	8		Oil Sample 4	Analyzed
22	9		Oil Sample 5	Analyzed
23	4	QC	MA4	QC Passed
24	5		Oil Sample 1	Analyzed
25	6		Oil Sample 2	Analyzed
26	7		Oil Sample 3	Analyzed
27	8		Oil Sample 4	Analyzed
28	9		Oil Sample 5	Analyzed
29	4	QC	MA4	QC Passed
30				
31				
32				

First QC

```
-----------------------------------------------------------------------------------------------------
Mean Data: MA4
                       Mean Corrected          Calib.                          Sample
Analyte                     Intensity     Conc. Units       Std.Dev.      Conc. Units        Std.Dev.    RSD
Co 228.616                  8190192.3        95 %               0.91                                    0.95%
Ca 315.887†                 114766628      4994 ppm            60.23       4994 ppm            60.23    1.21%
   QC value within limits for Ca 315.887  Recovery = 99.89%
Mg 279.077†                 5721824.7      1614 ppm            14.02       1614 ppm            14.02    0.87%
   QC value within limits for Mg 279.077  Recovery = 100.88%
P 214.914†                  1157793.8      1602 ppm            15.29       1602 ppm            15.29    0.95%
   QC value within limits for P 214.914  Recovery = 100.10%
Zn 213.857†                34972898.4      1587 ppm            18.76       1587 ppm            18.76    1.18%
   QC value within limits for Zn 213.857  Recovery = 99.17%
All analyte(s) passed QC.

=====================================================================================================
```

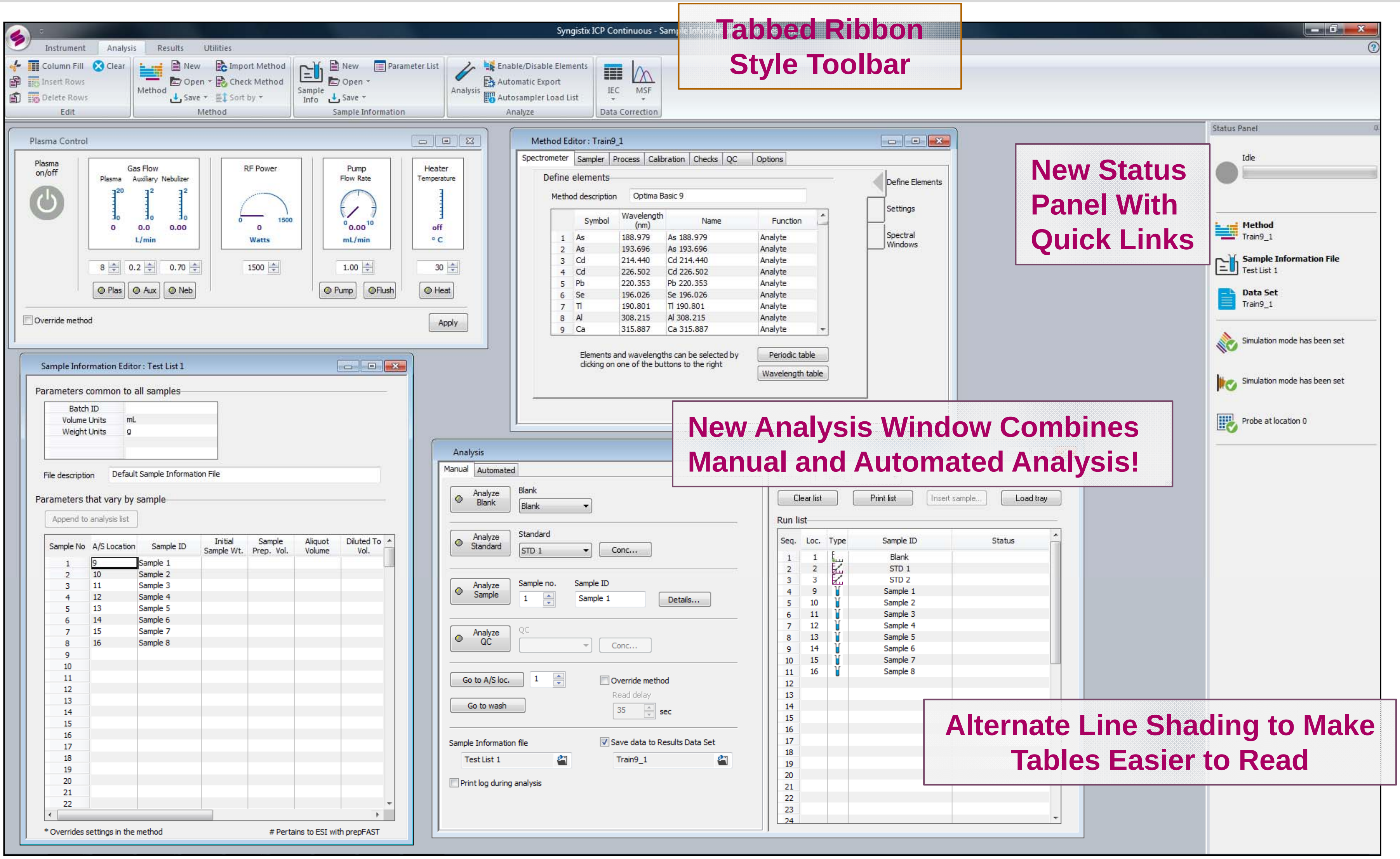
Last QC

```
-----------------------------------------------------------------------------------------------------
Mean Data: MA4
                       Mean Corrected          Calib.                          Sample
Analyte                     Intensity     Conc. Units       Std.Dev.      Conc. Units        Std.Dev.    RSD
Co 228.616                  7866844.9        91 %               0.32                                    0.35%
Ca 315.887†                 117022271      5093 ppm            52.88       5093 ppm            52.88    1.04%
   QC value within limits for Ca 315.887  Recovery = 101.85%
Mg 279.077†                 5782514.3      1631 ppm             2.11       1631 ppm             2.11    0.13%
   QC value within limits for Mg 279.077  Recovery = 101.95%
P 214.914†                  1178517.5      1630 ppm            17.76       1630 ppm            17.76    1.09%
   QC value within limits for P 214.914  Recovery = 101.89%
Zn 213.857†                35827481.9      1625 ppm             3.17       1625 ppm             3.17    0.20%
   QC value within limits for Zn 213.857  Recovery = 101.59%
All analyte(s) passed QC.
```

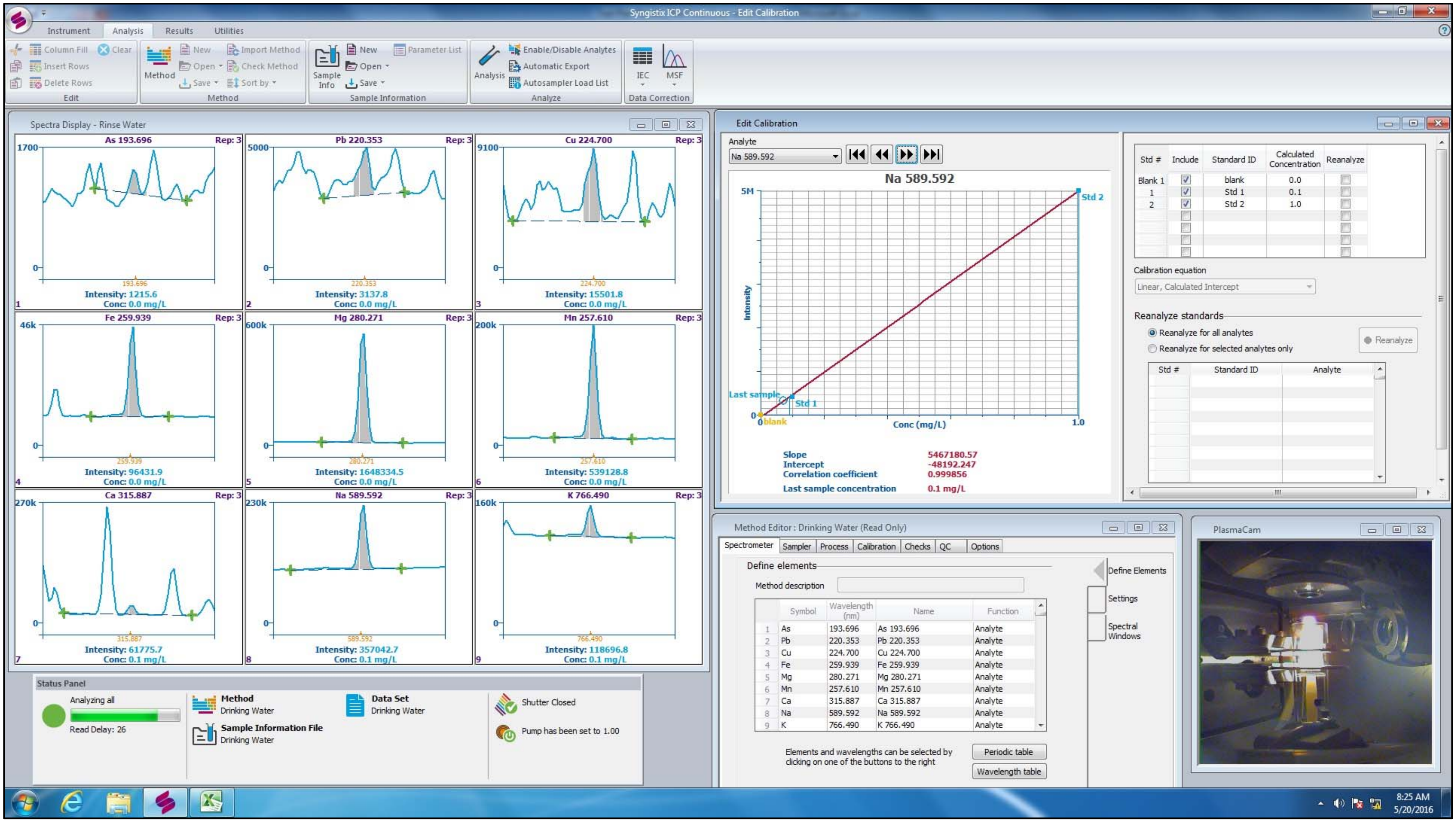

After 20 samples, QC is within ± 2 %

Syngistix software for ICP-OES

Syngistix: New Look and Feel



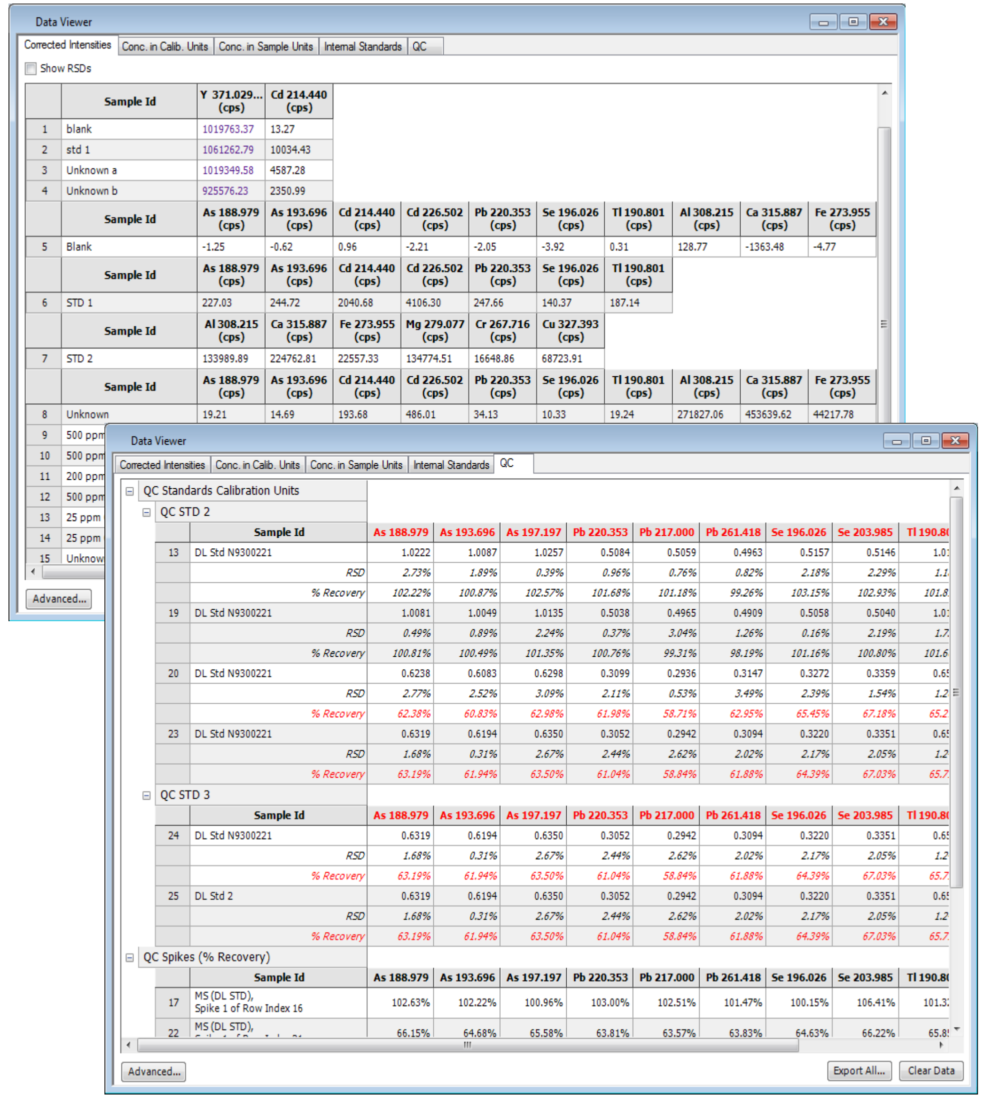
Syngistix for ICP – Version 2.0



PerkinElmer

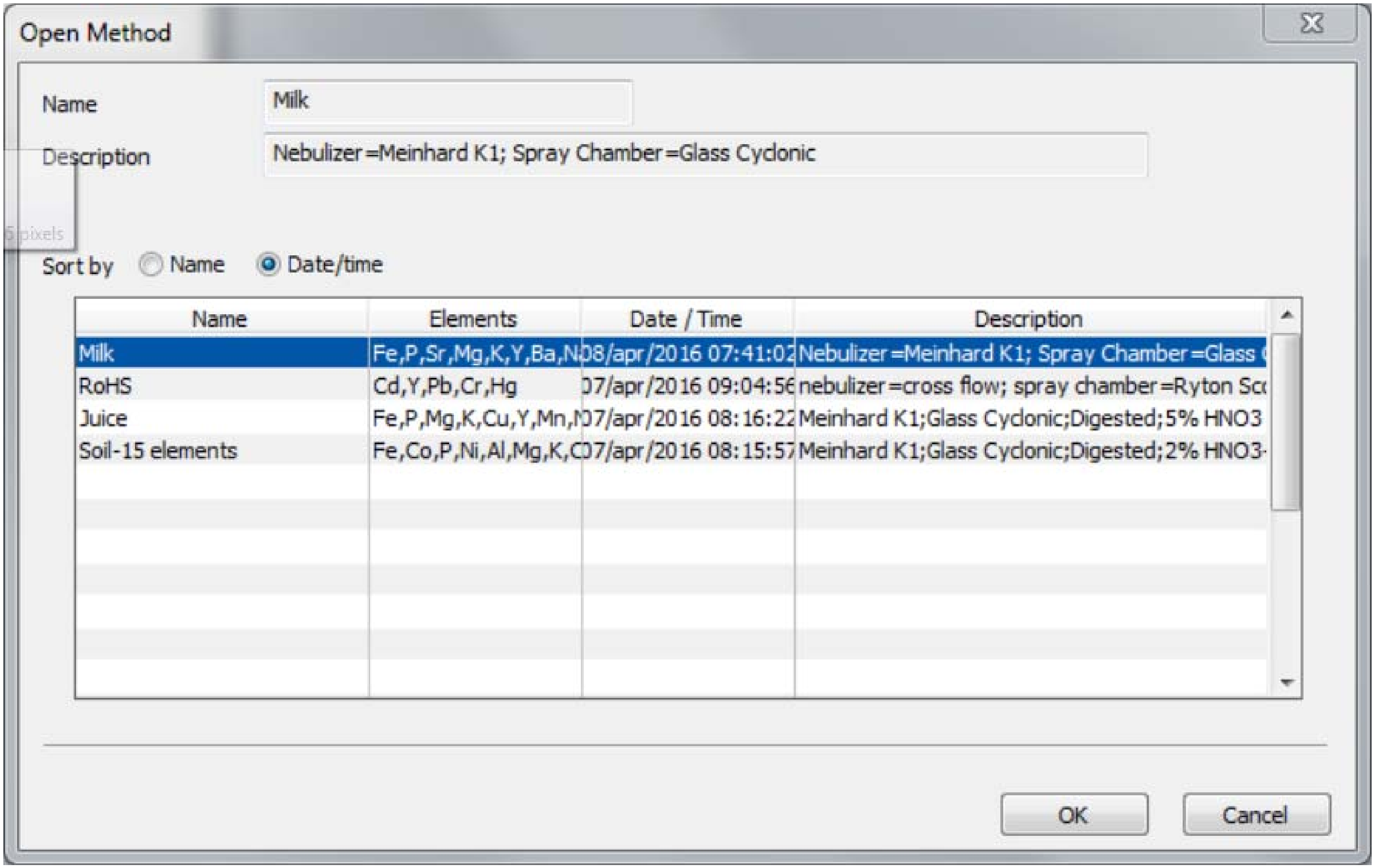
Syngistix: Cross-Tab Data Viewer

- Presents results in tabular format
- 5 separate tabs allow easy data review and quality control
  - Corrected Intensities
  - Concentration In Calibration Units
  - Concentration in Sample Units
  - Internal Standards
  - QC
- One-button function exports data to Excel

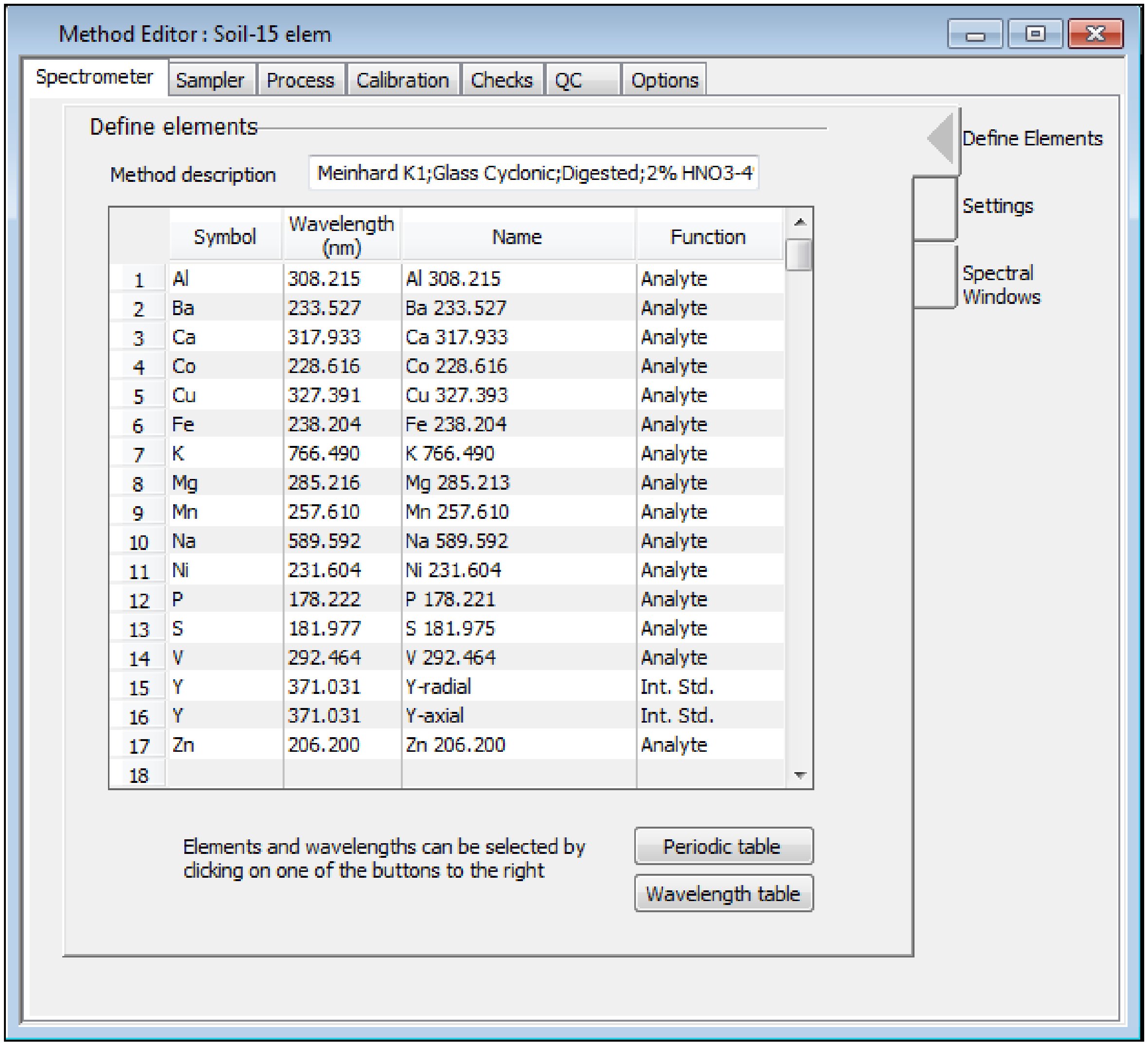


PerkinElmer

Avio 200 ICP-OES Pre-Loaded Methods (1)

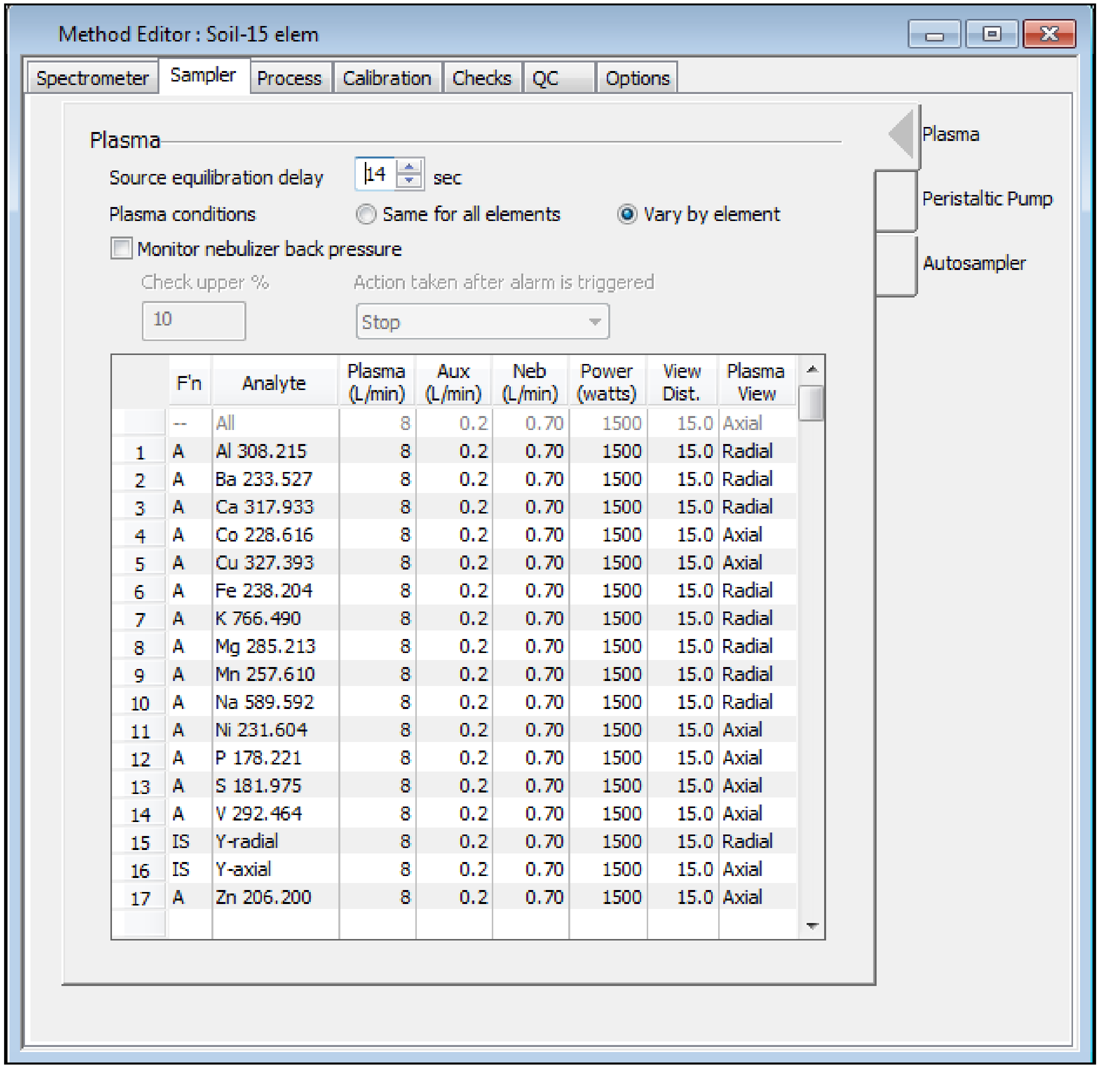


Avio 200 ICP-OES Pre-Loaded Methods (2)



	Symbol	Wavelength (nm)	Name	Function
1	Al	308.215	Al 308.215	Analyte
2	Ba	233.527	Ba 233.527	Analyte
3	Ca	317.933	Ca 317.933	Analyte
4	Co	228.616	Co 228.616	Analyte
5	Cu	327.391	Cu 327.393	Analyte
6	Fe	238.204	Fe 238.204	Analyte
7	K	766.490	K 766.490	Analyte
8	Mg	285.216	Mg 285.213	Analyte
9	Mn	257.610	Mn 257.610	Analyte
10	Na	589.592	Na 589.592	Analyte
11	Ni	231.604	Ni 231.604	Analyte
12	P	178.222	P 178.221	Analyte
13	S	181.977	S 181.975	Analyte
14	V	292.464	V 292.464	Analyte
15	Y	371.031	Y-radial	Int. Std.
16	Y	371.031	Y-axial	Int. Std.
17	Zn	206.200	Zn 206.200	Analyte
18				

Avio 200 ICP-OES Pre-Loaded Methods (3)



Method Editor : Soil-15 elem

Spectrometer | Sampler | Process | Calibration | Checks | QC | Options

Plasma | Peristaltic Pump | Autosampler

Plasma

Source equilibration delay 14 sec

Plasma conditions ( ) Same for all elements (•) Vary by element

[ ] Monitor nebulizer back pressure

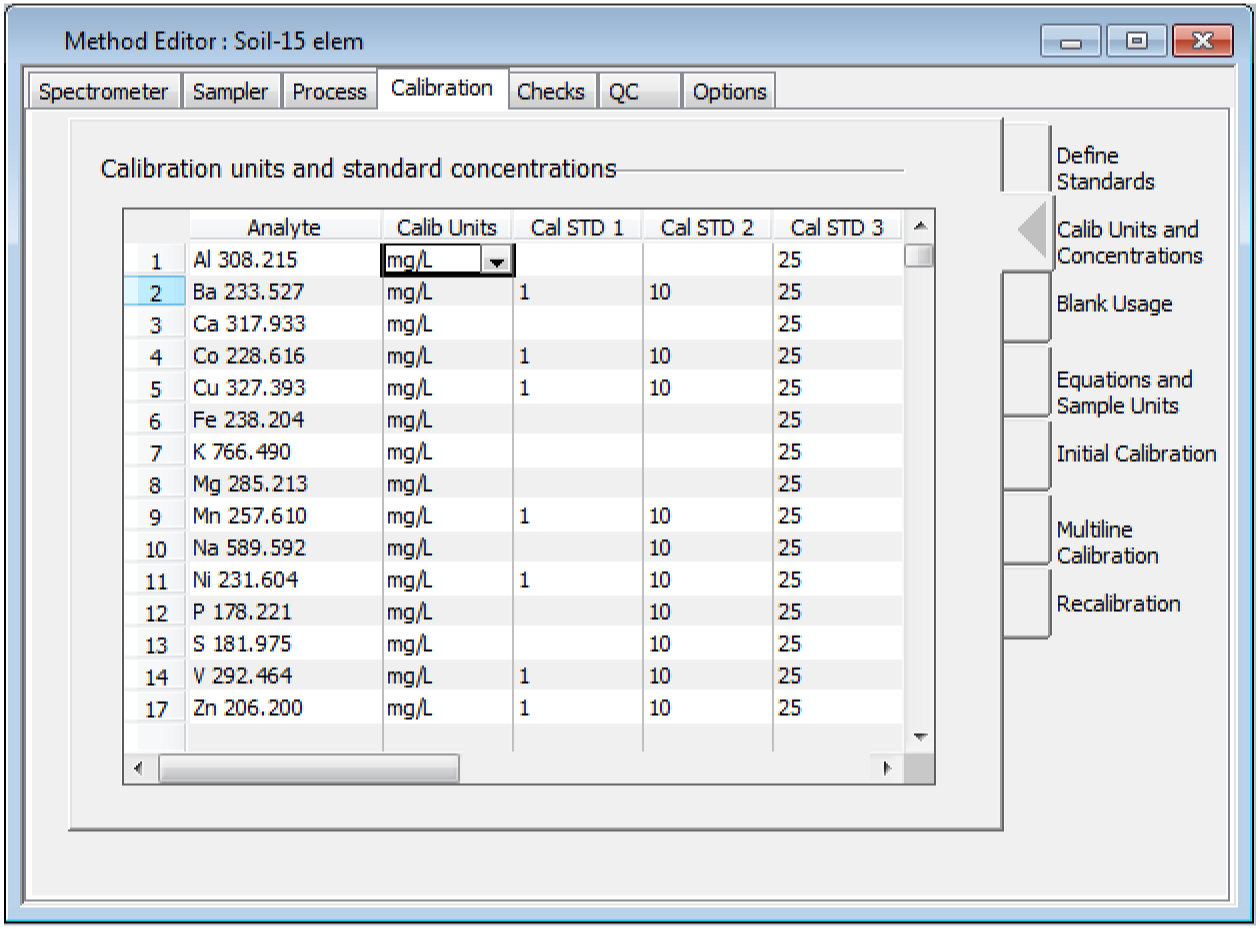
Check upper % 10

Action taken after alarm is triggered Stop

	F'n	Analyte	Plasma (L/min)	Aux (L/min)	Neb (L/min)	Power (watts)	View Dist.	Plasma View
	--	All	8	0.2	0.70	1500	15.0	Axial
1	A	Al 308.215	8	0.2	0.70	1500	15.0	Radial
2	A	Ba 233.527	8	0.2	0.70	1500	15.0	Radial
3	A	Ca 317.933	8	0.2	0.70	1500	15.0	Radial
4	A	Co 228.616	8	0.2	0.70	1500	15.0	Axial
5	A	Cu 327.393	8	0.2	0.70	1500	15.0	Axial
6	A	Fe 238.204	8	0.2	0.70	1500	15.0	Radial
7	A	K 766.490	8	0.2	0.70	1500	15.0	Radial
8	A	Mg 285.213	8	0.2	0.70	1500	15.0	Radial
9	A	Mn 257.610	8	0.2	0.70	1500	15.0	Radial
10	A	Na 589.592	8	0.2	0.70	1500	15.0	Radial
11	A	Ni 231.604	8	0.2	0.70	1500	15.0	Axial
12	A	P 178.221	8	0.2	0.70	1500	15.0	Axial
13	A	S 181.975	8	0.2	0.70	1500	15.0	Axial
14	A	V 292.464	8	0.2	0.70	1500	15.0	Axial
15	IS	Y-radial	8	0.2	0.70	1500	15.0	Radial
16	IS	Y-axial	8	0.2	0.70	1500	15.0	Axial
17	A	Zn 206.200	8	0.2	0.70	1500	15.0	Axial

PerkinElmer

Avio 200 ICP-OES Pre-Loaded Methods (4)



	Analyte	Calib Units	Cal STD 1	Cal STD 2	Cal STD 3
1	Al 308.215	mg/L			25
2	Ba 233.527	mg/L	1	10	25
3	Ca 317.933	mg/L			25
4	Co 228.616	mg/L	1	10	25
5	Cu 327.393	mg/L	1	10	25
6	Fe 238.204	mg/L			25
7	K 766.490	mg/L			25
8	Mg 285.213	mg/L			25
9	Mn 257.610	mg/L	1	10	25
10	Na 589.592	mg/L		10	25
11	Ni 231.604	mg/L	1	10	25
12	P 178.221	mg/L		10	25
13	S 181.975	mg/L		10	25
14	V 292.464	mg/L	1	10	25
17	Zn 206.200	mg/L	1	10	25

Syngistix sw common paltform for AA, ICP and ICP-MS

- Syngistix is the new software platform from PerkinElmer for AA, ICP and ICP-MS

- Syngistix has replaced WinLab32 for AA, WinLab32 for ICP and NexION Software Platforms

AA

ICP

ICP-MS

Questions?