




Introducing the new Agilent 4210 MP-AES

Low running costs, Simple, High Performing






Elemental analysis that runs on air

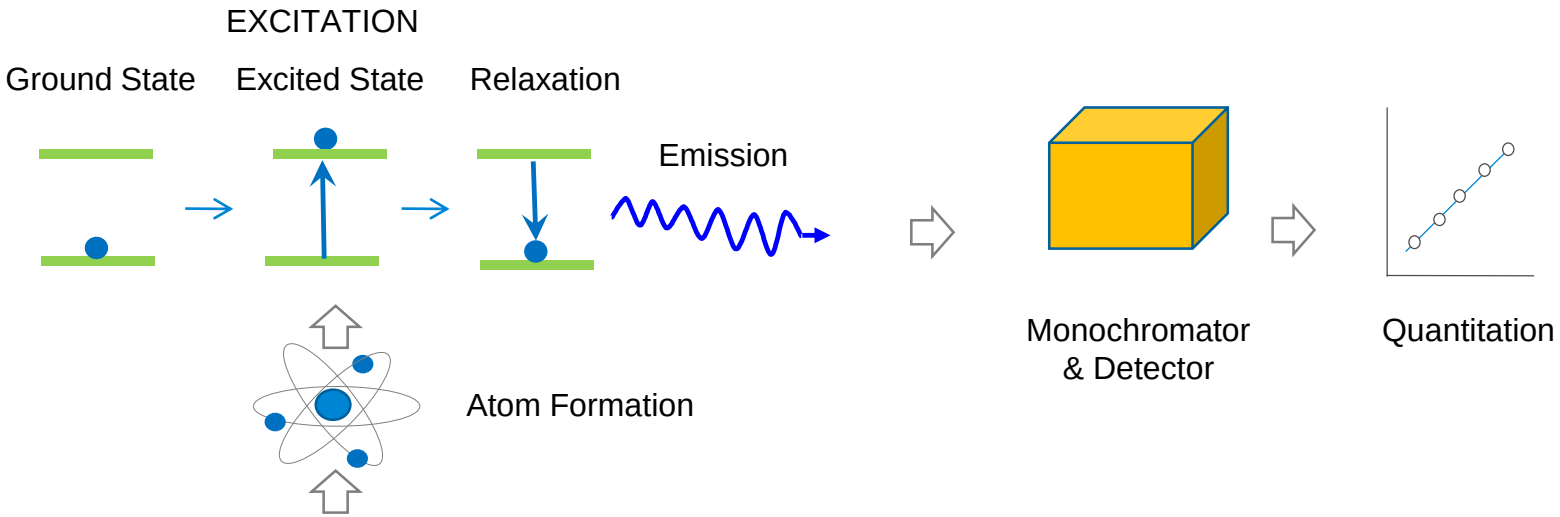


November 2016

Agilent 4210 MP-AES

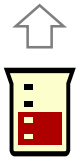


Microwave Plasma Emission Overview





Microwave excited Plasma



Sample

Agilent Technologies

Microwave Plasma - Atomic Emission Spectrometer

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

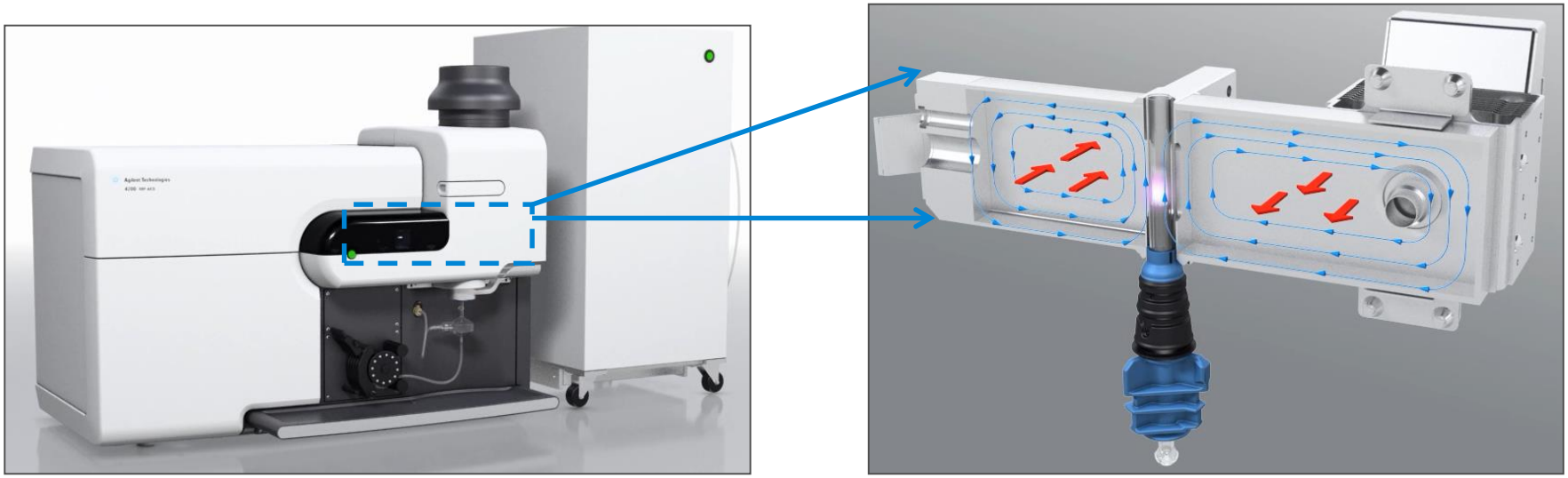
Easier to Use
- Intuitive software with auto optimization
- Plug and play sample introduction

Agilent 4210 MP-AES



How does the MP-AES work?

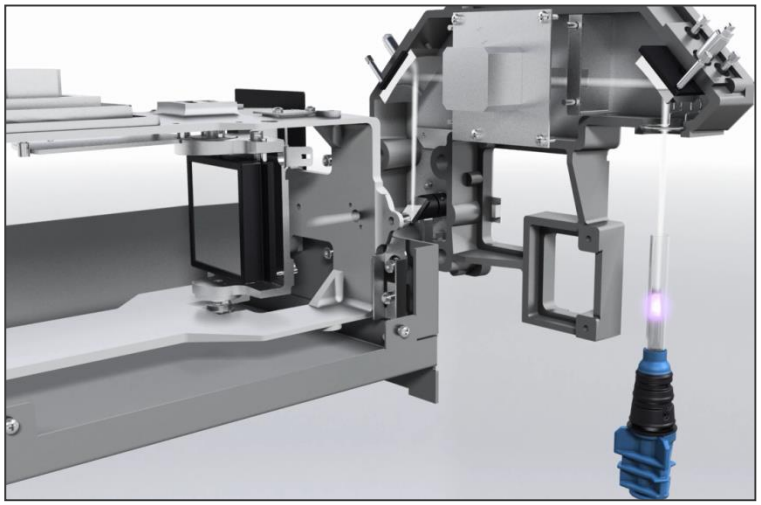
- 4210 MP-AES uses Nitrogen extracted from air using Agilent 4107 Nitrogen Generator

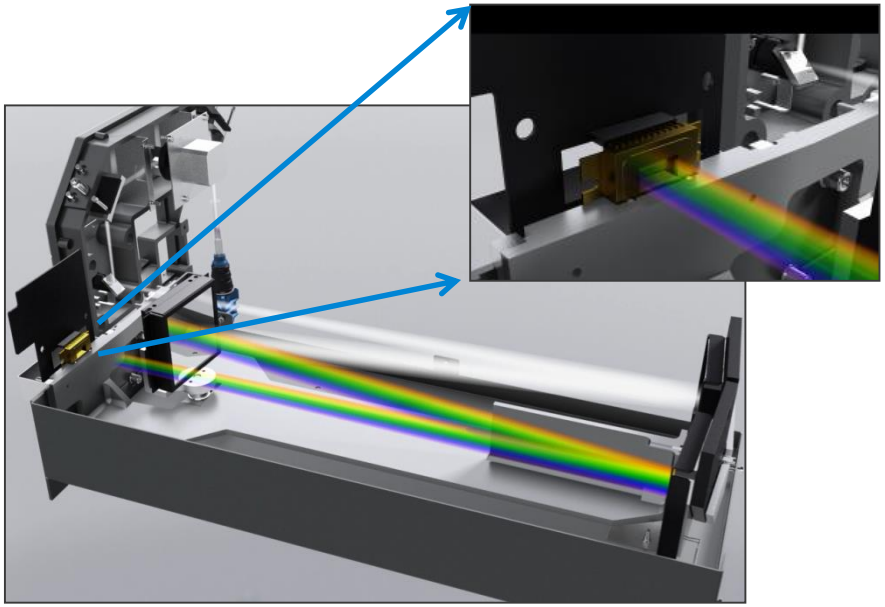


- Axial magnetic and radial electrical fields from magnetron sustain the nitrogen plasma
- Sample aerosol is introduced into nitrogen plasma for atomization.

How does the MP-AES work?

- Axial emission from the sample is directed into the fast scanning monochromator optics





- Wavelength specific atomic emissions are detected using a high efficiency CCD.

MP-AES Low cost of ownership

- Eliminate your largest analysis cost
- Use nitrogen extracted from Air
- How much can save? Use the online cost estimator

www.agilent.com/chem/runsonair

- Example 100 beverage samples per day, 3 elements per sample



MP-AES Safety

Use nitrogen plasma

- Eliminate flammable gases



Extract nitrogen from Air

- No need to change gas cylinders





MP-AES Performance – Detection Limits

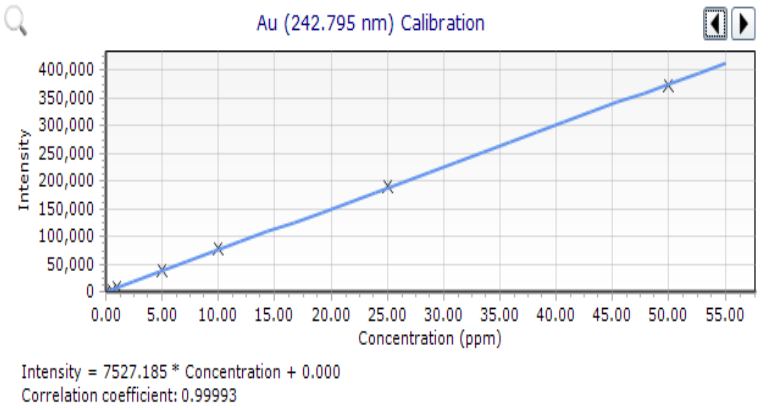
DL's in ppb, clean water samples

Element	Flame AA	4210MP-AES	Element	Flame AA	4210 MP-AES
K	0.8	0.65	As*	60	57
Ca	0.4	0.04	Cd	1.5	1.4
Mg	0.3	0.09	Cr	5	0.3
Na	0.3	0.12	Mn	1.0	1.05
Au	5	2.1	Pb	14	2.5
Pt	76	6.1	Sb	37	12
Pd	15	1.6	Se*	500	77
Ag	1.7	1.2			
Rh	4	0.5			

**** 30 second integration time used for these elements***

3 sigma DLs using a 10 second integration time with dewar nitrogen

MP-AES Performance – Working concentration range



Example: Au 242.8nm calibration for MP-AES

Linear range comparison between FAAS and MP-AES

Element	MP-AES, mg/L	Linear correlation coeft, MP-AES	FAAS, mg/L
Au 242.8	0-50	0.9999	0.1 – 30
Ca 422.6	0-20	0.9999	0.01-10
Mg 518.3	0-100	0.9999	0.15-20 (202.6nm)
Na 589.5	0-20	0.9999	0.01-2
K 767.8	0-100	0.9997	1-6

MP-AES Accessories

Agilent offer a range of accessories to optimize performance



AVS 4

- Fully integrated valve
- High sample throughput
- Reduction in operational costs
- Enhanced long term stability



MSIS

- Hydride analysis for lower DLs for some elements
- Conventional nebulization
- Dual hydride and conventional mode for higher throughput



IsoMist

- Enhance long term stability for organic solvent matrices by using a temperature controlled spray chamber
- Integrated into MP Expert software



SPS 4

- High capacity Autosampler
- Fast
- Compatible with AAS, MP-AES, ICP-OES and ICP-MS from Agilent



EGCM

- Prevent carbon build up on torch when running organic solvents
- Purge optics for low UV analysis

OneNeb Series 2

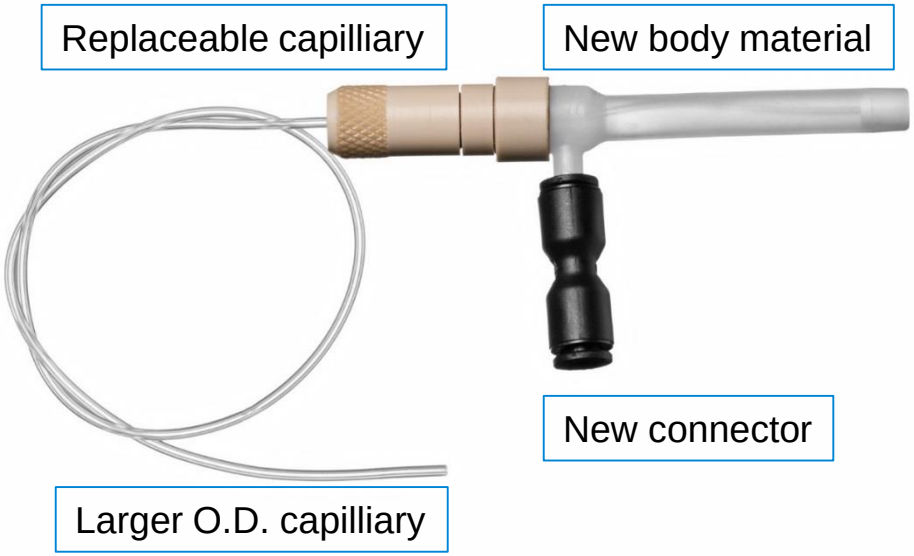
Analytical performance

- Improved precision and sensitivity
- Fast washout
- Lower detection limits



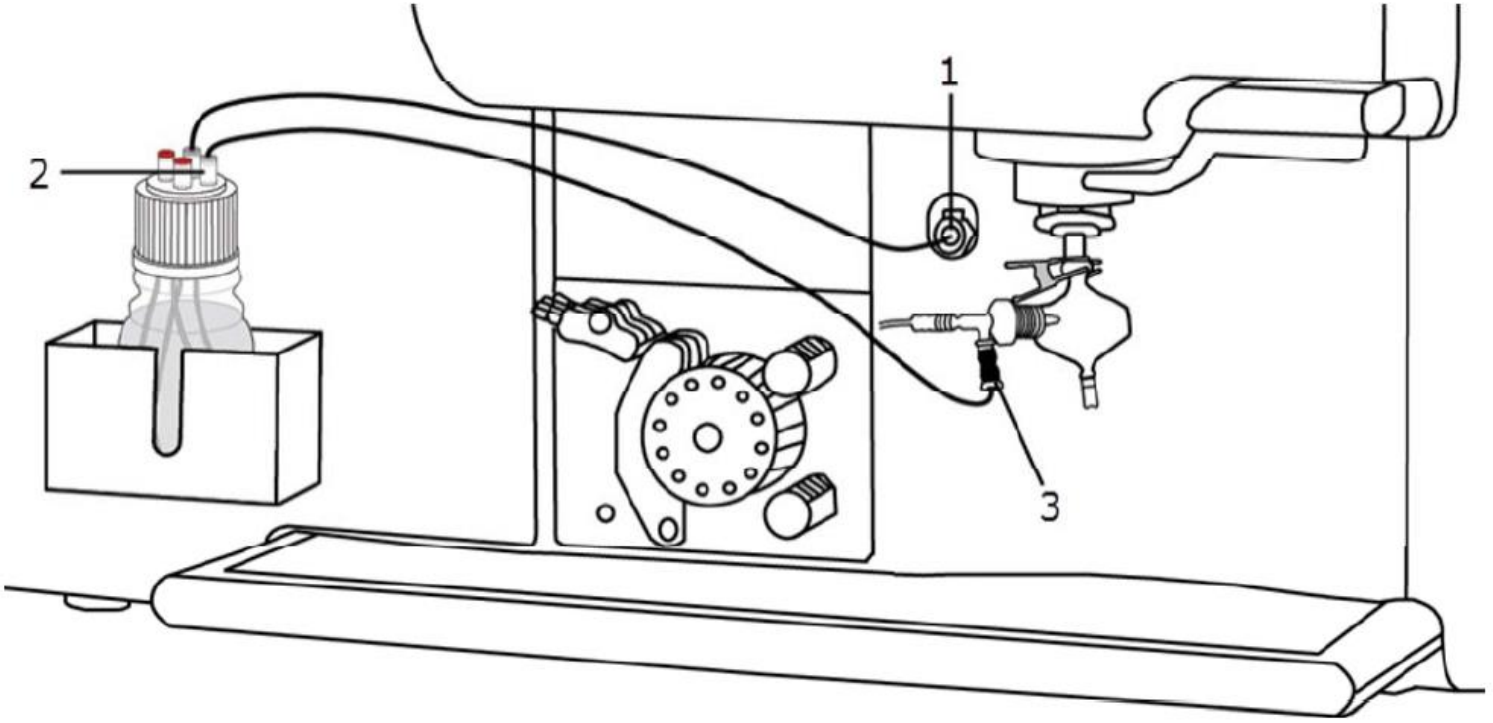
Customer Benefits

- Suitable for any sample
- Robust
- Easier to use
  - Replaceable sample capillary
  - Non crush nut on spraychamber
- Can be used with AVS 4



Improve signal stability with default humidifier

- Simple connection
- Improve signal stability
- Reduce deposits in nebulizer
- Reduce routine maintenance



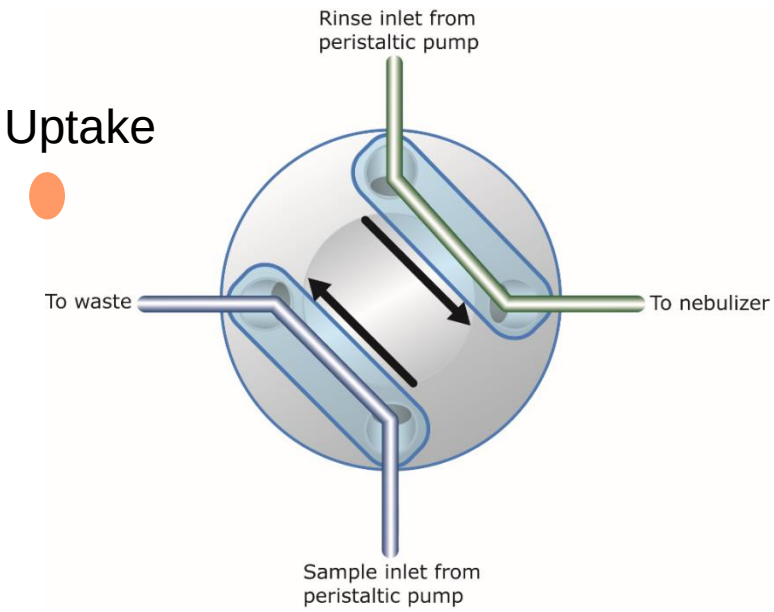
1. Neb gas to grey port
2,3. Grey port to neb side arm

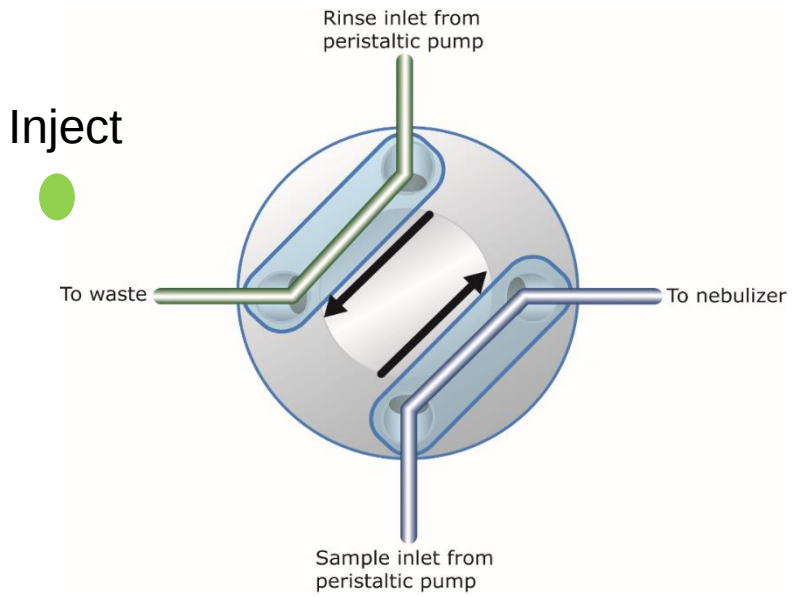
Advanced Valve System 4 (AVS 4) G8493A

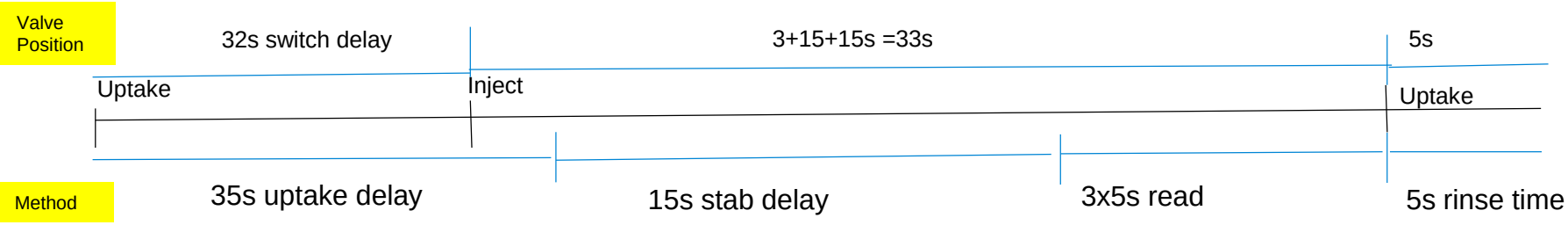


- SIMPLE - Integrated valve hardware and software. No power or comms cables to worry about. Reduced components on the sample tray. Easy plumbing
- ROBUST - Valve head design will last 100’s of thousands of switches.
- ENHANCED PERFORMANCE – Facilitates excellent long term stability. Increases sample throughput.

How does AVS 4 work – 2 position 4 port valve



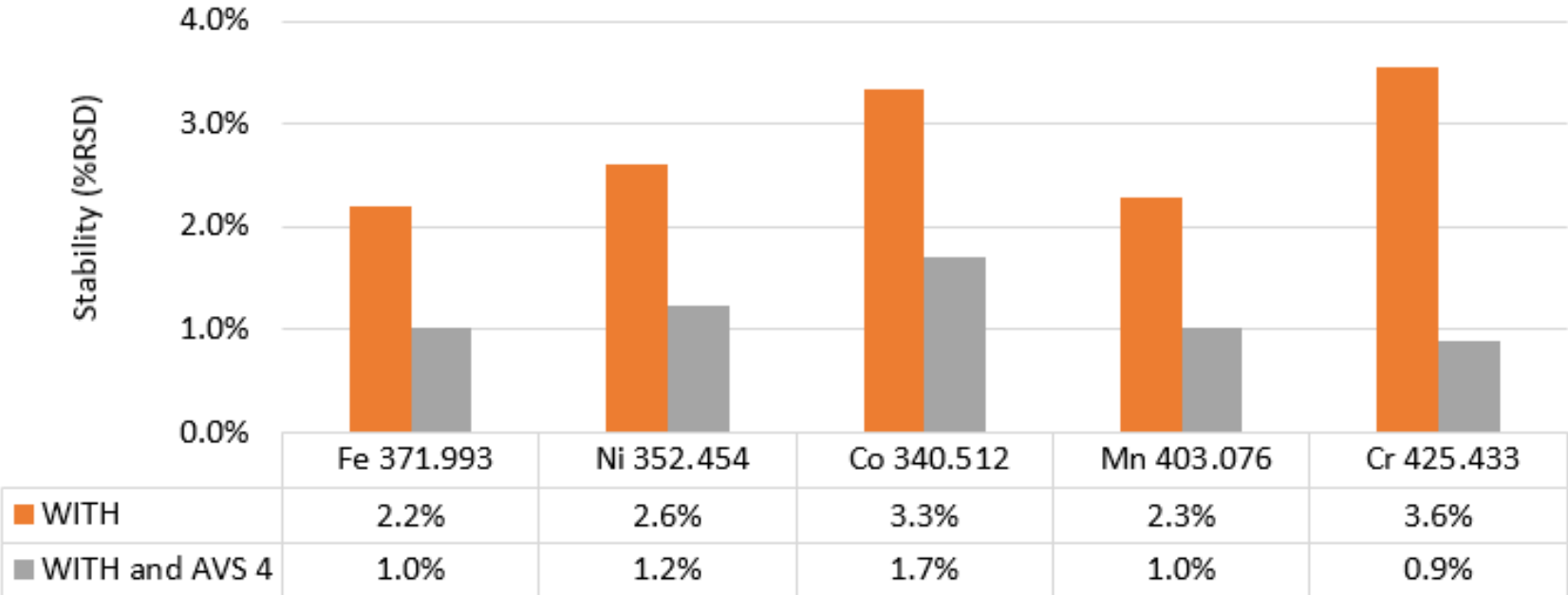




- Optimize throughput time by adjusting uptake delay and rinse times.
- Optimize autosampler capillary length and peristaltic pump tube for uptake delay
- Optimise rinse to ensure the spray chamber is clean before next sample comes through

AVS 4 stability performance proof

%RSD over 8hr analysis time

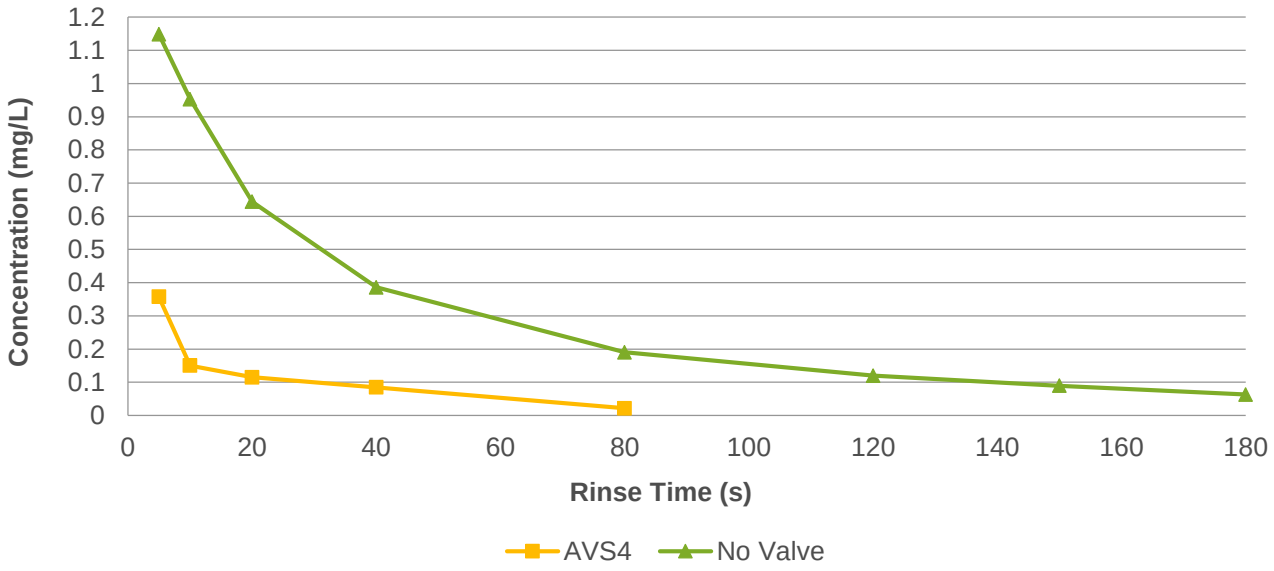


	Fe 371.993	Ni 352.454	Co 340.512	Mn 403.076	Cr 425.433
WITH	2.2%	2.6%	3.3%	2.3%	3.6%
WITH and AVS 4	1.0%	1.2%	1.7%	1.0%	0.9%

%RSD of 3% NaCl matrix spiked at 2ppm

AVS 4 throughput performance proof

Rinse time test with 200ppm B (very absorptive element- worse case scenario)

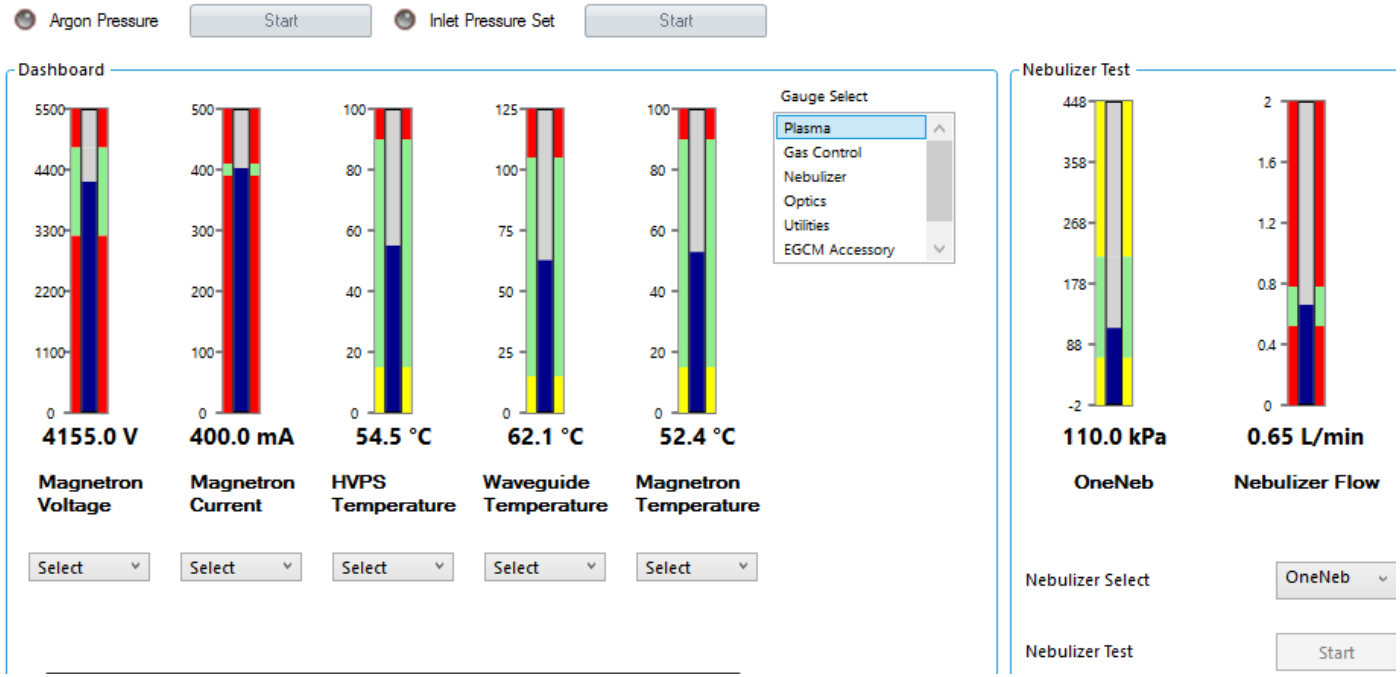


Throughput advantage with B 200ppm

	With AVS 4	No valve
Rinse time	40 s	150 s
Sample to sample time	100 s	217 s

Simplicity – Instrument Dashboard

- Sensors throughout the instrument deliver diagnostic information that makes it easy to find and correct problems
- Automated health checks maximize up time



Instrument Dashboard provides live information






Major elements in Fruit Juice … perfect for MP-AES






Major elements in Fruit Juice …perfect for MP-AES



- Undiluted juice has 11% TDS (mainly sugars) with major elements ranging from 20ppm (Na) -1100ppm (K)
- Diluted 20x and acidified 5% HNO3. (0.6%TDS)
- Dilution required due to high level of sugars slowly blocking sample introduction components.
- Working range for the major elements for the MP-AES at the 20 x diluted levels was 1-55ppm. (This is much higher than AAS)

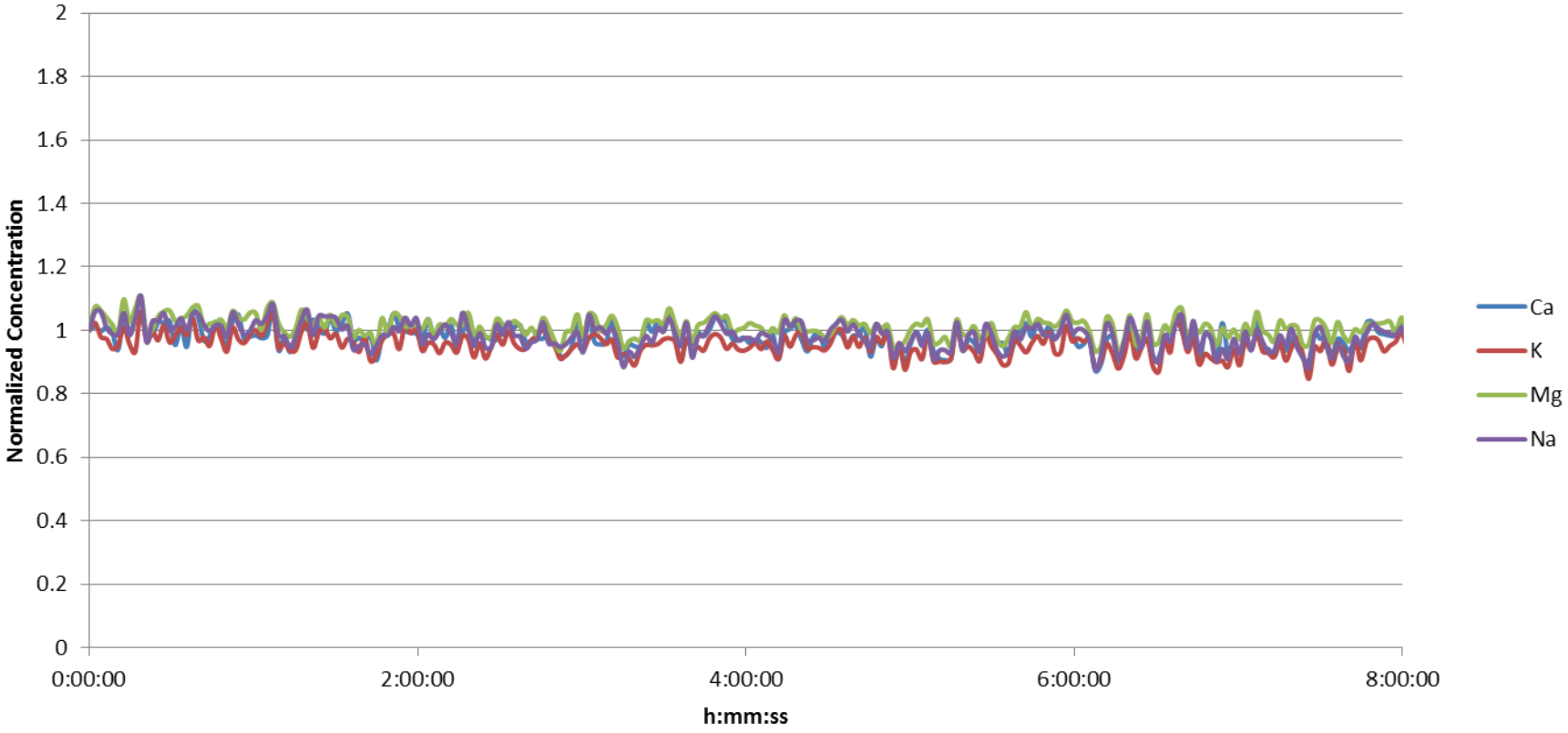
Major elements in Fruit Juice…perfect for MP-AES

Apple Juice T0840QC	Certified Value (mg/L)		Found (mg/L)	%Recovery
	Assigned Value	Range		
Magnesium	49.0	40.3 – 57.8	49.9 ± 0.6	101.9
Sodium	21.2	16.9 – 25.4	22.2 ± 0.5	104.7
Potassium	1044	926 -1161	1039 ± 29.7	99.5

Grapefruit Juice T0842QC	Certified Value (mg/L)		Found (mg/L)	%Recovery
	Assigned Value	Range		
Calcium	145.6	123.6 – 167.6	158.3 ± 3.2	108.7
Magnesium	92.5	77.5 – 107.4	91.1 ± 0.6	98.5
Potassium	1102	979 – 1225	1100 ± 14.7	99.8

Long term stability
<4% RSD over 8 hours

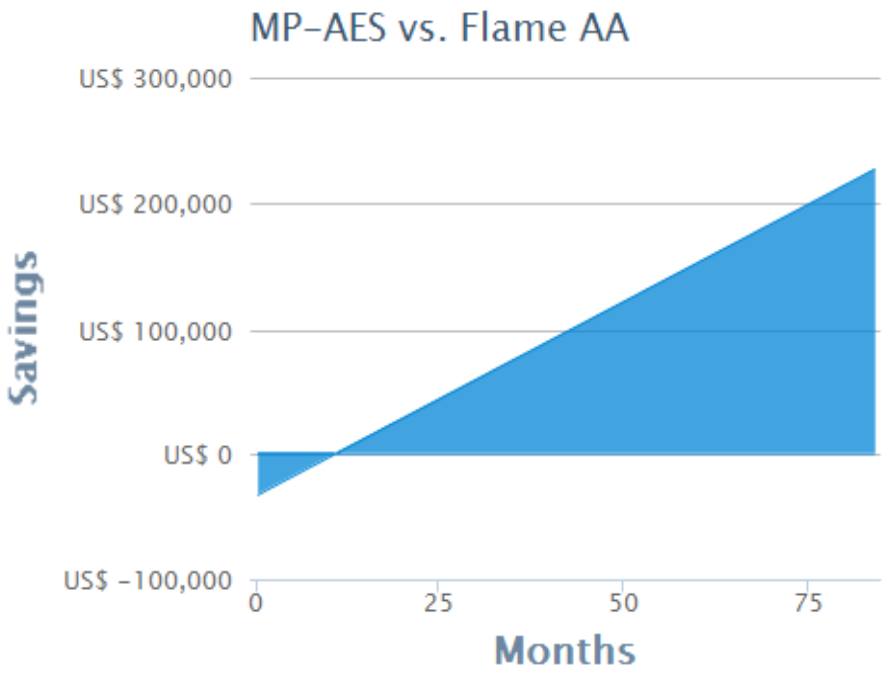
With no flammable gases it is possible run unattended with the instrument and sample introduction system giving excellent long term stability.



Potential cost savings with the 4200 MP-AES

Total savings of more than US $220k over a 7 year evaluation period.

- FAAS with air compressor and 1 year consumables
- MP-AES with air compressor, Nitrogen Generator, SPS 3 and 1 year consumables
- 4 elements measured under method conditions
  - For FAAS, 3 elements with Air/Acetylene, 1 with Nitrous/Acetylene
- 500 samples per week



This example is intended to help you compare the running costs & savings of the MP-AES vs. flame AA. The applied formulas and parameters are correct to the best of our knowledge, but we cannot guarantee the results. Savings may vary depending on factors such as local gas and electricity costs, operator costs, number and types of elements. For this calculation operator labor costs were set to US$25/hour and electricity costs were set to US$0.18 per kW.





Determination of major, minor and trace elements in rice flour using the 4200 (MP-AES)







Sample Preparation
NIES CRM 10c Rice Flour



- Digested in Milestone Ethos microwave using preloaded method
- 0.5g in 7 mL of HNO_3 and 1 mL H_2O_2
- Digested, cooled then diluted to 25 mL
- Final total dissolved solids of 2%

✓ No further sample preparation required

✓ No modifiers or ionization buffers required

Results
Method Detection Limits

Element/ Wavelength (nm)	Ca 422.673	Cd 228.802	Cu 324.754	Fe 438.354	K 766.491	Mg 280.271	Mn 403.076	P 214.915	Zn 213.857
MDL (mg/kg) In soild sample	0.10	0.16	0.05	0.44	3.0	0.06	0.05	13	0.15

Excellent Detection Limits

- 2nd generation waveguide and torch handle the 2% matrix
- Standard, robust sample introduction setup
- High temperature plasma source (~5000K) improves performance

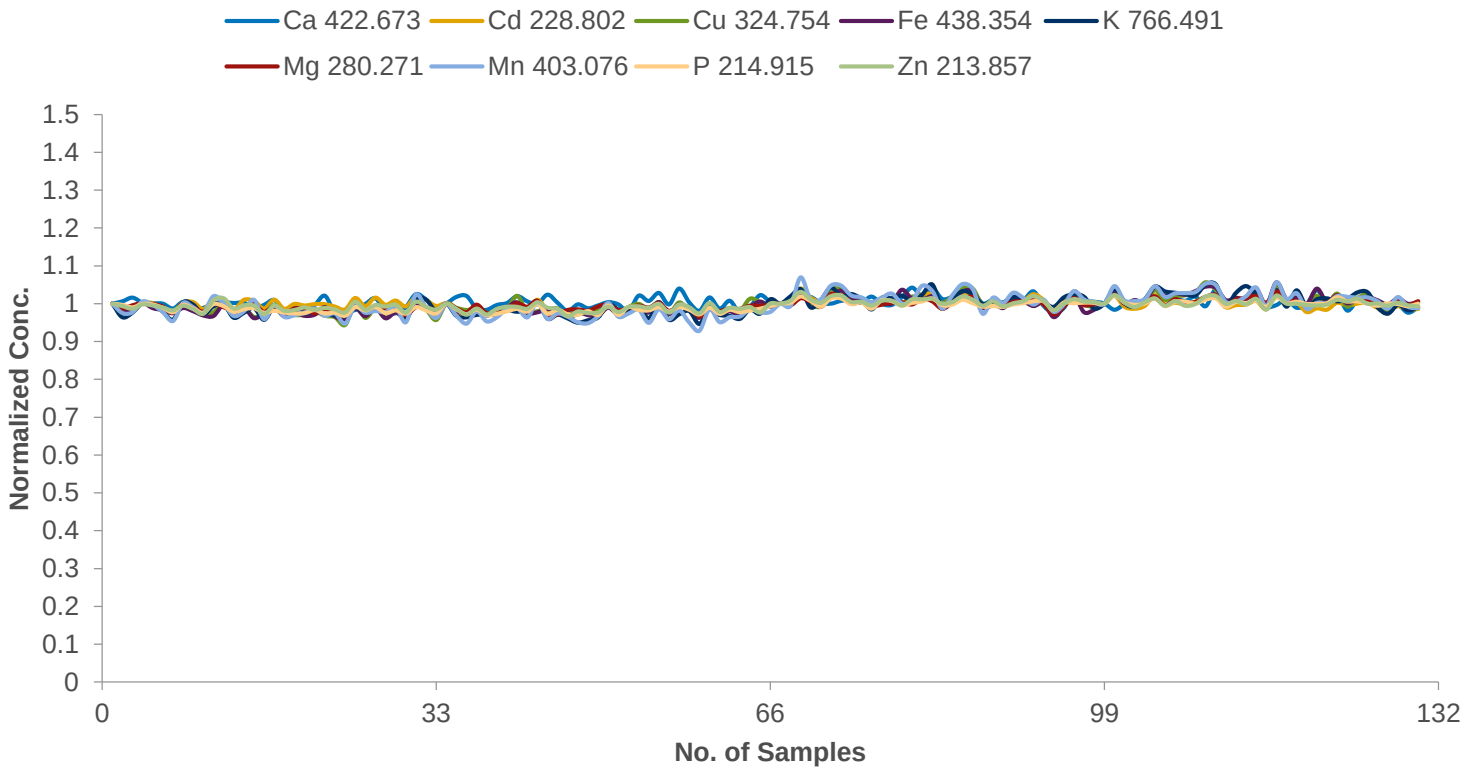
Results
CRM Recoveries

mg/kg in solid	Ca 422.673	Cd 228.802	Cu 324.754	Fe 438.354	K 766.491	Mg 280.271	Mn 403.076	P 214.915	Zn 213.857
Mean	96.0	1.96	4.13	11.50	2700	1174	37.35	3139	22.02
SD	2.5	0.11	0.29	1.03	105	23	1.04	92	0.48
Certified value	95	1.82	4.1	11.4	2750	1250	40.1	3350	23.1
2SD certified	2	0.06	0.3	0.8	100	80	2.0	80	0.9
% Recovery	101.0	107.7	100.8	100.9	98.2	93.9	93.1	93.7	95.3

- Accurate determinations over a wide concentration range
- All in one sample measurement

Long Term Stability
<3% RSD for all elements over 8 hours in 2% TDS

Combination of improved waveguide and torch, robust plasma and sample introduction give excellent long term stability







Total metals analysis of digested plant tissue using an Agilent 4200 Microwave Plasma-AES







Total metals analysis of digested plant tissue using an Agilent 4200 Microwave Plasma-AES

Analysis of plant reference material to determine Cu, Fe, Mn, Zn, Na, K, Ca, Mg, B and P was performed using the Agilent 4200 MP-AES

The outcomes included:

- Accurate determinations over a wide concentration range
- Simplified operation, compared to FAAS

Introduction

Monitoring of plant samples for mineral nutrients often involves analyzing many hundreds of samples per day

Laboratories are constantly looking to improve productivity and reduce operating costs without sacrificing analytical performance or ease-of-use.



Experimental
Operating parameters

Table 1. Agilent 4200 MP-AES operating parameters

Parameter	Value
Replicates	3
Pump rate	15 rpm
Sample uptake delay	35 seconds
Rinse time	30 seconds
Stabilization time	15 seconds
Fast Pump during uptake and rinse	On (80 rpm)
Autosampler	Agilent SPS 3
Sample pump tubing	Orange/green
Waste pump tubing	Blue/blue

Experimental
Samples and sample preparation

Sample
Botanical reference material (RM) ASPAC 80 Pasture

Preparation
Microwave digestion:
- 0.18 g sample + 7 mL of HNO_3 and 1 mL H_2O_2
- Preloaded method for the MARS microwave
- After cooling, the solution was diluted to 50 mL using ultrapure water
- No modifiers
- No ionization buffers

* Purchased from Australasian Soil and Plant Analysis Council (ASPAC, Carapook, VIC, Australia)

Experimental

Wavelength and working calibration concentration range

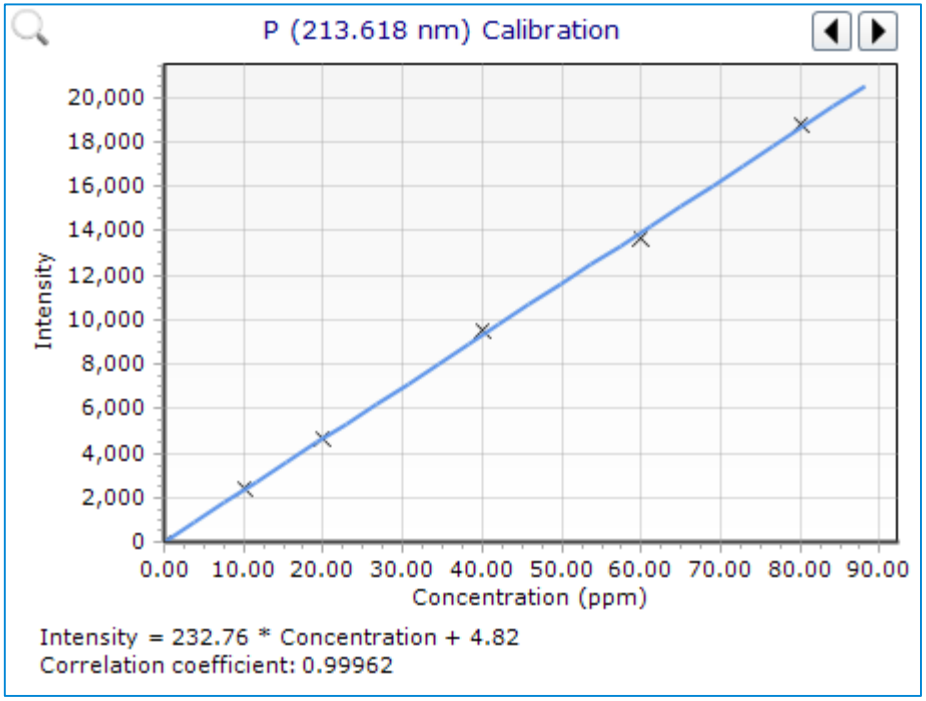
Element and wavelength (nm)	Calibration range (ppm)
Cu 324.754	1–5
Fe 259.940	5–25
Mn 257.610	5–25
Zn 213.857	1–5
Na 568.820	2–100
K 766.491	1–100
Ca 445.478	20–100
Mg 383.829	1–100
B 249.772	0.25–1.0
P 213.618	10–80

Table 2. Wavelength and working calibration concentration range

Continuous wavelength coverage allows lines to be chosen that have appropriate sensitivity for the concentration range, and avoid spectral interferences.

Results and discussion

Linear Dynamic Range



- A typical calibration curve for phosphorus
- The curve shows excellent linearity across the concentration range.
- The large linear dynamic range means:
  - Less sample dilutions
  - Improved productivity
  - Reduced the risk of sample contamination

Figure 4. Calibration curve for phosphorus on the 4200 MP-AES

Results and discussion

Element	Wavelength	Measured value µg/g	Reference value µg/g	Accuracy %
Cu	324.754	13.6	14.7 ± 1.2	93
Fe	259.94	316.13	324 ± 32	98
Mn	257.61	125.8	138 ± 10	91
Zn	213.857	54.6	58.1 ± 5.3	94
Na	568.263	2512	2460 ± 210	102
K	766.491	27302	26700 ± 1850	102
Ca	445.478	10563	11100 ± 600	95
Mg	383.829	3239	3350 ± 220	97
B	249.772	21.65	23.7 ± 3.4	91
P	213.618	3223.35	2970 ± 250	109

- All elements measured in a single measurement
- Good accuracy for all elements over a wide concentration range
- Simplified workflow compared to a FAAS – eliminating lamp changes, measurements in absorption and emission
- B and P can be measured

Table 3. MP-AES results for total metals content of plant reference material ASPAC 80

Conclusion

The Agilent 4200 MP-AES is the ideal FAAS replacement.

Improved performance
- Increased linear working range
- Lower detection limits

Reduced running costs
- Runs on air

Increased safety
- No acetylene
- No nitrous oxide

Ease of use
- MP Expert S/W
- IEC and FLIC interference algorithms
- Simple sample prep



