## **Avio ICP-OES product line**



Helmut Ernstberger 13.6.2019, Budapest Seminar



## **PerkinElmer long history in ICP-OES**

1979 – PerkinElmer Introduces the ICP 5000

1984 – PerkinElmer Plasma II Introduced

1987 – PerkinElmer introduces the Plasma40

1993 – PerkinElmerintroduces Optima 3000

1995 – Optima 3000DV Introduced

2001 – Optima 4300 and Optima 2000

2005 – Optima 5300 and Optima 2100

2007 – Optima 7300 and Optima 7000

2011 – Optima 8x00 Family

2016 - Avio 200

2017 – Avio 500





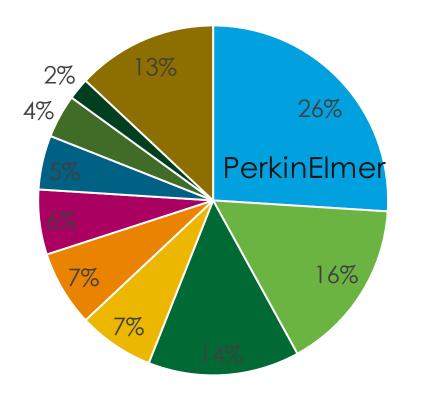




PerkinElme

## **PerkinElmer Continues to Lead the Market for ICP-OES**

#### ICP-OES Vendor Share 2017



- PerkinElmer
- Competitor 1
- Competitor 2
- Competitor 3
- Competitor 4
- Competitor 5
- Competitor 6
- Competitor 7
- Competitor 8

Others

Source: SDI Global Assessment Report 2018



## **New AVIO series**

 Avio 200, launched July 2016



 Avio 500, launched July 2017



#### Scanning array ICP-OES

#### Simultaneous ICP-OES



## What do Avio 200 and 500 have in common?

- Flat Plate technology for low argon consumption
- 40 MHz RF generator for robustness and stability
- PlasmaShear
- Vertical torch
- Easty to use torch mount
- Dual View
- Viewing height selectable element by element
- PlasmaCam
- Interference correction capabilities IEC, MSF
- Syngistix Software
- RoHS compliant
- 4-channel, 12-roller peristaltic pump
- Compact size



#### **Argon saving: Flat Plate Technology**



Patented Flat Induction Plates operate at 40 – 60% of the Argon flow of helical designs



- Avio and Optima platforms are the only ICP-OES systems capable of running a stable plasma 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

#### Load coil vs Flat plate – Performance evaluation

- Side by side comparison
  - Optima 8300 vs Optima 4300 DV
  - Difference: RF generator / Flat Plate
  - Same sample introduction system: GemCone / Cyclonic
- Matrix Robustness according to Mermet's criteria for Mg
  - Mg II (280.270 nm) / Mg I (285.213 nm) > 8 for robust plasma
  - Vary Neb flow and plasma power

Plasma parameters	Load Coil	Flat Plate
Plasma Power [W]	varied	varied
Plasma gas flow [L/min]	15	8
Aux. gas flow [L/min]	0.2	0.2
Neb. gas flow [L/min]	varied	varied

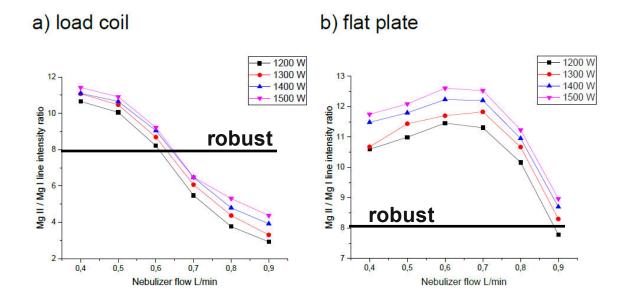
- High Matrix Samples
  - Digested coal fly ash: NIST 1633c
  - Mg in digest = 10 mg/L



#### Load coil vs Flat plate - Plasma robustness

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#### Radial measurement



Determined Mg II / Mg I line intensity ratios (radial) in SRM1633c using a) load coil and b) flat plate plasma with GemCone nebulizer and syclonic spray chamber

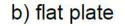
#### **Better efficiency of energy transfer for Flat Plate**

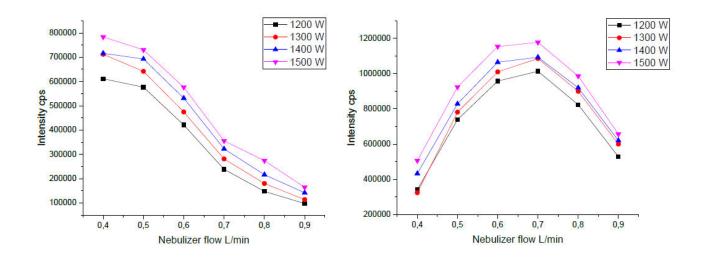


#### Load coil vs Flat plate - Sensitivity

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a) load coil





Determined intensities (radial) of the Mg II 280.270 nm in SRM1633c using a) load coil and b) flat plate plasma

**Higher sensitivity for Flat Plate** 



#### Load coil vs Flat plate – Method detection limits

- MDLs determined according to EPA 200.7
- Axial view
- Matrix: Aqua regia, 1:5 diluted

Element	Wavelength [nm]	Flat Plate MDL [µg/L]	Improvement factor over load coil
As	188.979	8.2	1.5
Со	228.616	1.6	19
Cr	267.716	1.5	23
Cu	324.752	2.7	10
Mn	257.610	2.7	7
Ni	231.604	0.6	23
Pb	220.353	2.1	9
Zn	213.857	0.5	44

#### Flat Plate detection limits on average 17 times lower

Source: University of Jyväskylä, with permission

### **Saving Argon: PlasmaShear**



#### PlasmaShear exclusive to PerkinElmer

- Improved performance
- Efficient removal of the tail plume without the need of argon
- Eliminates self-absorption
- Extended linear range
- Matrix independent
- Increase accuracy
- Reduces maintenance time



## **Vertical Torch Configuration**

#### New Vertical Torch Configuration

- Easy-to-use torch mount with fewer parts
  - No tools required
  - One-handed removal
  - Quick-change components
- Easy and cost-effective maintenance
  - Removable injector independent of torch
- Lockable depth position for repeatable torch insertion
- Adjustable, even while the ICP is running, to ensure optimum results
- Solid design
- Accommodates a vast array of sample introduction accessories that make running sample analysis simple, regardless of sample matrix



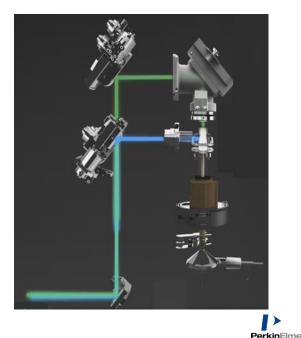


## Dual View: the Best of Both Worlds – No Compromise

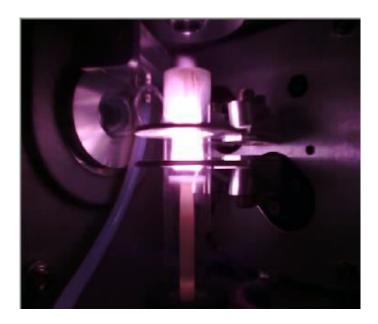
#### Designers of the first Dual View ICP-OES (Optima 3000 in 1995)

- Provides analysis of both low-level and high-level elements in one method
  - Sub-ppb to % level concentration range for all elements across UV and Vis
- Fully-selectable radial viewing height and axial sampling depth
- Delivers flexibility for different sensitivities; i.e. Na and K
- Allows regulatory methods to be run at prescribed wavelength
- Removes EIE interferences
- 1500W in both axial and radial modes

Lower Cost and Time Savings



### **PlasmaCam Viewing Camera**

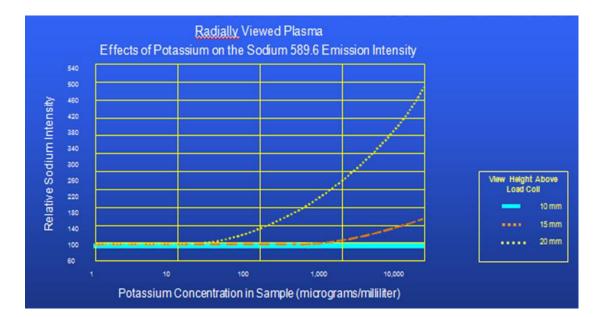


- Real-time plasma viewing
- Verify sample introduction components during analysis
- Simplifies method development
- Perform remote diagnostics
- Ensures maximum up time

# Industry's first integrated color camera for continuous plasma viewing during analysis



#### Adjustable viewing height can eliminate EIE Effects

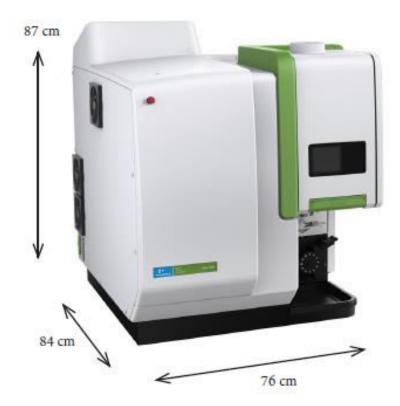


	F'n	Element	Plasma (L/min)	Aux (L/min	Neb (L/min)	Power (watts)	View Dist	Plasi A Vie
10	A	K 766.490 rad I+Srl	15	0.2	0.70	1400	15.0	Radial —
11	A	K 766.490 rad I+Y	15	0.2	0.70	1400	10.0	Radial
12	A	Mg 279.077 rad II+Y	15	0.2	0.70	1400	15.0	Radial
13	A	Mg 285.213 rad I+In	15	0.2	0.70	1400	15.0	Radial
14	A	Mn 260.568 ax II+Y	15	0.2	0.70	1400	15.0	Axial
15	Α	Mn 257.610 ax II+Y	15	0.2	0.70	1400	15.0	Axial
16	Α	Na 588.995 rad I+Srl	15	0.2	0.70	1400	10.0	Radial
17	Α	Na 589.592 rad I+Srl	15	0.2	0.70	1400	15.0	Radial
18	A	P 213.617 rad I+In	15	0.2	0.70	1400	15.0	Radial
19	A	P 213.617 ax I+In	15	0.2	0.70	1400	15.0	Axial 💌



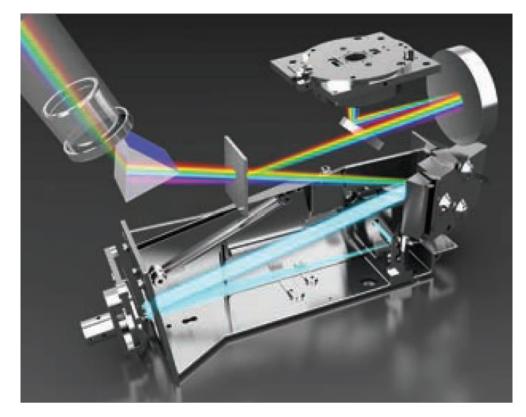
## **Avio 500 ICP-OES Features**

- Simultaneous instrument
- High performance optical system
- Universal Data Acquisition
- Argon Quick Change
- SmartRinse



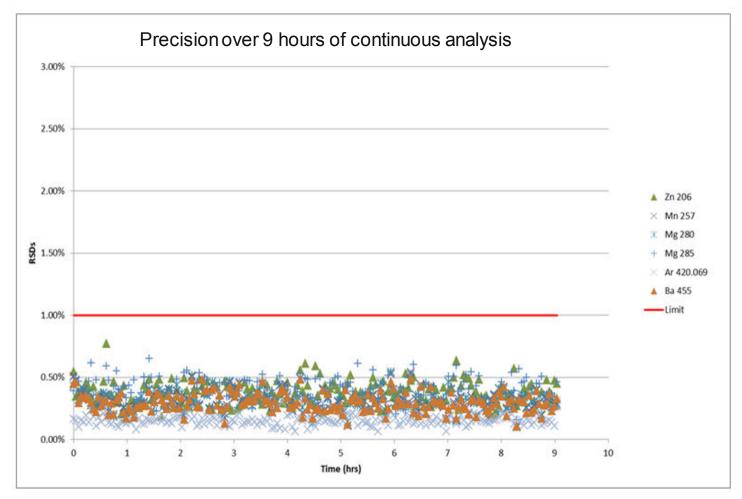
#### **Analysis Speed: Optics & Detector**

- Unique optical system & detector allow simultaneous reading of both the visible and UV regions of the spectrum
- Requires thermally stable optical bench





#### **Avio 500 Performance: Unsurpassed stability**



Meinhard Type K1 and standard baffled cyclonic spray chamber

9-hour stability run results in <1% RSD



#### **Universal Data Acquisition - UDA**

- UDA gathers data for all 6300+ wavelengths available on *both* detectors for each sample
- Simple click to turn on
- Uses approx 80kB
- No time penalty



Live concentration results on screen for every element

#### Benefits

- No need to re-analyse samples for additional elements/ to confirm results
- Saves analyses time (and money) during method development, all of this can be done offline (not using gas, sample.)

#### **UDA for Quantitative Analysis Scenario...**

								Calibration	n Display			As 188.979				
rometer	ditor : Efflue Sampler Pr elements		ation Checks QC	Options		Define Elen		1 ( Cd 228.802	Calib Ecin: Lin, Calc Car Coeff: 0.999979	nc(mg/L) 1	50.0	2 Cd 214.440	Calib Eqn: Lin Corr Coeff: 0.	' conc(mg/L) ' , Calc Int 999960		20.0
Metho	d description	l				Settings		23k				38k				
	Symbol	Wavelength (nm)	Name	Functi	on	Spectral		Intensity				ntensity				
1	Al	396.153	Al 396.153	Analyte		Windows		Ĕ					_/			
2	As	188.979	As 188.979	Analyte												
3	Be	313.107	Be 313.107	Analyte				<b>1</b>		nc(mg/L)	2.0			conc(mg/L)		20.0
4	Cd	228.802	Cd 228.802	Analyte				4 (	Calib Eq'n: Lin, Calc I Corr Coeff: 0.998429	Int 9		5	Calib Eq'n: Lin Corr Coeff: 0.9	i, Calc Int 999931		
5	Cd	214.440	Cd 214.440	Analyte												
6	Co	228.616	Co 228.616	Appleto												
			C0 220.010	Analyte												
7	Со	231.160	Co 231.160	Analyte												
	Cr	231.160 267.716	Co 231.160 Cr 267.716	Analyte Analyte	Dat	a Viewer										
7 8 9	Cr Cu	231.160 267.716 327.393	Co 231.160 Cr 267.716 Cu 327.393	Analyte Analyte Analyte		a Viewer										
7 8 9 10	Cr Cu Cu	231.160 267.716 327.393 324.752	Co 231.160 Cr 267.716 Cu 327.393 Cu 324.752	Analyte Analyte Analyte Analyte		a Viewer ted Intensities Conc. in	Calib. Units	Conc. in Sam	ple Units In		ards QC					
7 8 9 10 11	Cr Cu Cu Fe	231.160 267.716 327.393 324.752 238.204	Co 231.160 Cr 267.716 Cu 327.393 Cu 324.752 Fe 238.204	Analyte Analyte Analyte Analyte Analyte	Correc	ted Intensities Conc. in	Calib. Units	Conc. in Sam	ple Units In		ards QC					
7 8 9 10 11 12	Cr Cu Cu Fe Mn	231.160 267.716 327.393 324.752 238.204 257.610	Co 231.160 Cr 267.716 Cu 327.393 Cu 324.752 Fe 238.204 Mn 257.610	Analyte Analyte Analyte Analyte Analyte Analyte Analyte	Correc		Calib. Units	Conc. in Sam	ple Units In	iternal Standa	ards QC			1		1
7 8 9 10 11 12 13	Cr Cu Cu Fe Mn Mo	231.160 267.716 327.393 324.752 238.204 257.610 202.031	Co 231.160 Cr 267.716 Cu 327.393 Cu 324.752 Fe 238.204 Mn 257.610 Mo 202.031	Analyte Analyte Analyte Analyte Analyte Analyte Analyte	Correc	ted Intensities Conc. in ow RSDs		Al 396.1	As 188	Be 313	Cd 228		Co 228	Co 231		
7 8 9 10 11 12 13 14	Cr Cu Cu Fe Mn Mo Ni	231.160 267.716 327.393 324.752 238.204 257.610 202.031 231.604	Co 231.160 Cr 267.716 Cu 327.393 Cu 324.752 Fe 238.204 Mn 257.610 Mo 202.031 Ni 231.604	Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte	Correc	ted Intensities Conc. in	Calib. Units	AL 206 1	· ·	1		Cd 214 (mg/L)	Co 228 (mg/L)	Co 231 (mg/L)	Cr 267 (mg/L)	
7 8 9 10 11 12 13 14 15	Cr Cu Cu Fe Mn Mo Ni Pb	231.160 267.716 327.393 324.752 238.204 257.610 202.031 231.604 220.353	Co 231.160 Cr 267.716 Cu 327.393 Cu 324.752 Fe 238.204 Mn 257.610 Mo 202.031 Ni 231.604 Pb 220.353	Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte	Correc	ted Intensities Conc. in ow RSDs		Al 396.1	As 188	Be 313	Cd 228					
7 8 9 10 11 12 13 14 15 16	Cr Cu Cu Fe Mn Mo Ni Pb Y	231.160 267.716 327.393 324.752 238.204 257.610 202.031 231.604 220.353 371.029	Co 231.160 Cr 267.716 Cu 327.393 Cu 324.752 Fe 238.204 Mn 257.610 Mo 202.031 Ni 231.604 Pb 220.353 Y 371.029	Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte Int. Std.	Correct She	ted Intensities Conc. in ow RSDs Sample Id blank	<b>Y 371.0</b> 100.0%	Al 396.1 (mg/L) 0.000	As 188 (mg/L) 0.000	Be 313 (mg/L) 0.000	Cd 228 (mg/L) 0.000	(mg/L) 0.000	(mg/L) 0.000	(mg/L) 0.000	(mg/L) 0.000	(mg/L) 0.000
7 8 9 10 11 12 13 14 15 16 17	Cr Cu Cu Fe Mn Mo Ni Pb	231.160 267.716 327.393 324.752 238.204 257.610 202.031 231.604 220.353	Co 231.160 Cr 267.716 Cu 327.393 Cu 324.752 Fe 238.204 Mn 257.610 Mo 202.031 Ni 231.604 Pb 220.353	Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte	Correc Sho	ted Intensities Conc. in w RSDs Sample Id blank Trade Std#1	<b>Y 371.0</b> 100.0% 99.1%	Al 396.1 (mg/L) 0.000 10.000	As 188 (mg/L) 0.000 4.000	Be 313 (mg/L) 0.000 0.400	Cd 228 (mg/L) 0.000 0.400	(mg/L) 0.000 4.000	(mg/L) 0.000 4.000	(mg/L) 0.000 4.000	(mg/L) 0.000 4.000	(mg/L) 0.000 4.000
7 8 9 10 11 12 13 14 15 16 17 18	Cr Cu Cu Fe Mn Mo Ni Pb Y	231.160 267.716 327.393 324.752 238.204 257.610 202.031 231.604 220.353 371.029	Co 231.160 Cr 267.716 Cu 327.393 Cu 324.752 Fe 238.204 Mn 257.610 Mo 202.031 Ni 231.604 Pb 220.353 Y 371.029	Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte Int. Std.	Correct She	ted Intensities Conc. in ow RSDs Sample Id blank	<b>Y 371.0</b> 100.0%	Al 396.1 (mg/L) 0.000	As 188 (mg/L) 0.000	Be 313 (mg/L) 0.000	Cd 228 (mg/L) 0.000	(mg/L) 0.000	(mg/L) 0.000	(mg/L) 0.000	(mg/L) 0.000	(mg/L) 0.000
7 8 9 10 11 12 13 14 15 16 17	Cr Cu Cu Fe Mn Mo Ni Pb Y	231.160 267.716 327.393 324.752 238.204 257.610 202.031 231.604 220.353 371.029	Co 231.160 Cr 267.716 Cu 327.393 Cu 324.752 Fe 238.204 Mn 257.610 Mo 202.031 Ni 231.604 Pb 220.353 Y 371.029	Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte Int. Std.	Correc Sho	ted Intensities Conc. in w RSDs Sample Id blank Trade Std#1	<b>Y 371.0</b> 100.0% 99.1%	Al 396.1 (mg/L) 0.000 10.000	As 188 (mg/L) 0.000 4.000	Be 313 (mg/L) 0.000 0.400	Cd 228 (mg/L) 0.000 0.400	(mg/L) 0.000 4.000	(mg/L) 0.000 4.000	(mg/L) 0.000 4.000	(mg/L) 0.000 4.000	(mg/L) 0.000 4.000
7 8 9 10 11 12 13 14 15 16 17 18	Cr Cu Cu Fe Mn Mo Ni Pb Y Zn	231.160 267.716 327.393 324.752 238.204 257.610 202.031 231.604 220.353 371.029 206.200	Co 231.160 Cr 267.716 Cu 327.393 Cu 324.752 Fe 238.204 Mn 257.610 Mo 202.031 Ni 231.604 Pb 220.353 Y 371.029	Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte Int. Std.	Correct She 1 2 3	ted Intensities Conc. in w RSDs Sample Id blank Trade Std#1 Trade Std#2	<b>Y 371.0</b> 100.0% 99.1% 98.9%	Al 396.1 (mg/L) 0.000 10.000 30.000	As 188 (mg/L) 0.000 4.000 12.000	Be 313 (mg/L) 0.000 0.400 1.200	Cd 228 (mg/L) 0.000 0.400 1.200	(mg/L) 0.000 4.000 12.000	(mg/L) 0.000 4.000 12.000	(mg/L) 0.000 4.000 12.000	(mg/L) 0.000 4.000 12.000	(mg/L) 0.000 4.000 12.000
7 8 9 10 11 12 13 14 15 16 17 18	Cr Cu Cu Fe Mn Mo Ni Pb Y Zn Elements a	231.160 267.716 327.393 324.752 238.204 257.610 202.031 231.604 220.353 371.029 206.200	Co 231.160 Cr 267.716 Cu 327.393 Cu 324.752 Fe 238.204 Mn 257.610 Mo 202.031 Ni 231.604 Pb 220.353 Y 371.029 Zn 206.200	Analyte Analyte Analyte Analyte Analyte Analyte Analyte Analyte Int. Std. Analyte	Correc Shu 1 2 3 4	ted Intensities Conc. in w RSDs Sample Id blank Trade Std#1 Trade Std#2 Trade Std#3	<b>Y 371.0</b> 100.0% 99.1% 98.9% 99.2%	Al 396.1 (mg/L) 0.000 10.000 30.000 50.000	As 188 (mg/L) 0.000 4.000 12.000 20.000	Be 313 (mg/L) 0.000 0.400 1.200 2.000	Cd 228 (mg/L) 0.000 0.400 1.200 2.000	(mg/L) 0.000 4.000 12.000 20.000	(mg/L) 0.000 4.000 12.000 20.000	(mg/L) 0.000 4.000 12.000 20.000	(mg/L) 0.000 4.000 12.000 20.000	(mg/L) 0.000 4.000 12.000 20.000

			ation Checks QC	Options						
Defi	ne elements					Define Elements				
Me	thod description				(	Settings	)	Cr 267 (mg/L)	Cu 327 (mg/L)	Cu 32 (mg/
	Symbol	Wavelength (nm)	Name	Function	^	Spectral		0.000	0.000	0.000
	1 Al	396.153	Al 396.153	Analyte		Mindaur		4.000	4.000	4.000
	2 As	188.979	As 188.979	Analyte	Period	ic Table				
	3 As	193.696	As 193.696	Analyte	renou					
	4 Be	313.107	Be 313.107	Analyte						7
	5 Cd	214.440	Cd 214.440	Analyte	H Li Be				He	
	5 Cd	228.802	Cd 228.802	Analyte	Na Ma			B C Al Si	P S CI Ar	-
	7 Co	231.160	Co 231.160	Analyte		Sc Ti V Cr Mn Fe Co	Ni Cu		As Se Br Kr	
	3 Co	228.616	Co 228.616	Analyte	Rb Sr	Y Zr Nb Mo To Ru Rh	Pd Ag	Cd In Sn	Sb Te I Xe	
	9 Cr	267.716	Cr 267.716	Analyte	Cs Ba	La Hf Ta W Re Os Ir	Pt Au	H9 TI Pb	Bi Po At Rn	
1	0 Cu	324.752	Cu 324.752	Analyte	Fr Ra	Ao				
1	1 Cu	327.393	Cu 327.393	Analyte	6	Ce Pr Nd Pm Sm Eu Gd	ТЬ Dу	Ho Er Tm	Yb Lu	
1	2 Fe	238.204	Fe 238.204	Analyte		Th Pa U NP Pu Am Cm	Bk Cf	Es Fm Md	No Lr	
_1	3 Mn	257.610	Mn 257.610	Analyte						
1	4 Mo	202.031	Mo 202.031	Analyte						
	5 Ni	231.604	Ni 231.604	Analyte						
	6 Pb	220.353	Pb 220.353	Analyte		Enter in Method		λΤα	hla	
	7 Y	371.029	Y 371.029	Int. Std.		Enter in Method		× 18	DIe	
	8 Zn	206.200	Zn 206.200	Analyte						
1	9				Active ro	w in Method Editor	19	<b>÷</b>		
			s can be selected by ons to the right	Periodic table	Element	Arsenic (As)	~		elength	
		and the second second		Wavelength table		1		1	100	.979

#### Enter calibration concentrations and reprocess data

Spectrometer	Sampler Process	Calibration C	hecks QC	Options		
Calibra	ition units and s	tandard con	centrations	;		Define Standards
	Analyte	Calib Units	Trade Std#1	Trade Std#2	Trade Std#3 ^	Calib Units and
1	Al 396.153	mg/L	10	30	50	Concentrations
2	As 188.979	mg/L	4	12	20	Blank Usage
3	As 193.696	mg/L	4	12	20	H
4	Be 313.107	mg/L	0.4	1.2	2	Equations and
5	Cd 214.440	mg/L	4	12	20	Sample Units
6	Cd 228.802	mg/L	0.4	1.2	2	Initial
7	Co 231.160	mg/L	4	12	20	Calibration
8	Co 228.616	mg/L	4	12	20	Multiline
9	Cr 267.716	mg/L	4	12	20	Calibration
10	Cu 324.752	mg/L	4	12	20	
11	Cu 327.393	mg/L	4	12	20	
12	Fe 238.204	mg/L	10	30	50	
13	Mn 257.610	mg/L	4	12	20	
14	Mo 202.031	mg/L	4	12	20	
15	Ni 231.604	mg/L	4	12	20	
16	Pb 220.353	mg/L	4	12	20	
18	Zn 206.200	mg/L	10	30	50	

## **Quantitation with UDA standard sets**

- UDA Standard set
  - Covers a wide element range (69 elements)
  - Include UDA standards in run
- ALL wavelengths info is collected with UDA
- Retrospective quant analysis
  - Calibrate any UDA element not part in your original standards mix
  - Assign internal standard
  - Reprocess with UDA solution as standard
  - Quantitative analysis result however only 1 concentration level

# Answer questions about your samples which are asked in hindsight!



#### **Argon Quick-Change**

- A mode in the software that allows Ar tanks to be changed without powering off the Avio 500
- Instrument goes into Stand-by Mode
- The user has 30 minutes to change the Ar tank
- After the tank is changed, start up time is 15 minutes
  - Time required to purge the detector

dvanced Spectrometer Functions	<u> </u>
Argon Quick Change	
This feature allows the user to shut down the necessary components of allow for the argon gas tank to be changed without powering off the ins	
If the tank is changed in less than 30 minutes, the system will be read	dy in 15 minutes.
If changing the tank takes more than 30 minutes, then the system wi	ill be ready in 75 minutes.
Click on Argon Quick Change to put the spectrometer in stand-by to ch	ange the argon tank.
	Argon Quick Change
	Argon Quick change

## **Analysis Speed**

• Sample:

1 ppm mixed element standard

- Number of wavelengths: 20
  - Elements: Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Se, Sr, V, Zn
    - Some elements with low sensitivity (i.e. As, Se, Pb, etc.)
    - Some elements with high sensitivity (i.e. Mg, Na, Sr, etc.)
- Default Read Time Range: 1 5 seconds
  - Software automatically selects best integration time within the range based on a pre-shot
  - Time selected per wavelength
  - Integration Time based on signal intensity
- Views: axial & radial
- Analysis Time: 30 seconds



#### **Analysis Speed: Sample Washout**

- Sample washout can be the longest time going from sampleto-sample
- A variety of sample introduction components are available to minimize washout
  - ESI FAST
  - Cetac ASXpress
  - Glass Expansion Niagara
- A variety of rinse options are available in Syngistix



#### Sample Washout: SmartRinse

- User-defined concentrations for each element in the method
- When the concentrations are below the user-defined thresholds, rinsing is complete

ectrometer	Sampler	Process	Calibration	Checks	QC	Options	SmartRin	ise Co	oncentration Lim	nits	L	Σ
	mpler wa	ish				_	Targe	t cond	centrations to read	ch before ending v	vash	
	martRinse ever				Se	t		F'n	Analyte	Units	Concentration	-
							1	A	Ag 328.068	mg/L		
() В	etween sar	nples					2	A	Al 396-rad	mg/L		
~ 0	nlv after s	amples wh	ose concentr	ations	100		3	A	Al 308-rad	mg/L		
	xceed limits				Se	<u>t</u>	4	Α	Al 394-rad	mg/L		
~ 4	fter everv	sample +	extra time if	sample			5	A	As 188.979	mg/L		
	oncentratio			sample	Se	t	6	Α	As 193.696	mg/L		
Rate				March 1	ocation		7	Α	B 249.677	mg/L		
1000				- Anna anna anna anna anna anna anna ann			8	Α	Ba 493.408	mg/L		
1.0	00 🚖 mL/	min		0	-		9	Α	Be 313.107	mg/L		4
1.00	time - samp 20 🚔 se			1000		lib. solutions ec	Conce	entrati	ion units 💿 C	alibration © S	ample	4

#### Sample Washout: Upper Limits-1

 User-defined upper-limit concentrations for each element to determine if washing is required

Spectrometer	Sampler	Process	Calibration	Checks	QC	Options					
Autosa	mpler wa	ash					Extra Wa	sh Concentratio	n Limits		?
🔘 Sr	martRinse				Se	t		Analyte	Calibration Units	Concentration	
© N	ever						1	Ag 328.068	mg/L	5	-
( B	etween sa	moles					2	Al 396-rad	mg/L	5	
							3	Al 308-rad	mg/L	0	
			ose concentra	ations	Se	t	4	Al 394-rad	mg/L	0	
e e	xceed limit	s			1.000		5	As 188.979	mg/L	5	
			extra time if s	ample	Se	t)	6	As 193.696	mg/L	5	
α	oncentratio	ons exceed	d limits		( DC	<u>un</u>	7	B 249.677	mg/L	5	
Rate				Wash lo	ocation		8	Ba 493.408	mg/L	5	
1.000	10.000			1000000			9	Be 313.107	mg/L	5	
1.0	00 🚖 mL,	/min		0	-		10	Ca 315-rad	mg/L	5	Ŧ
Norm	nal time			Extra ti	me						
	50 🌲 se	ec		60	<u>^</u> 5	ec					
				00	7					ок 🛛	Cance
							8				

#### Sample Washout: Upper Limits-2

 User-defined upper-limit concentrations for each element to determine if extra washing is required

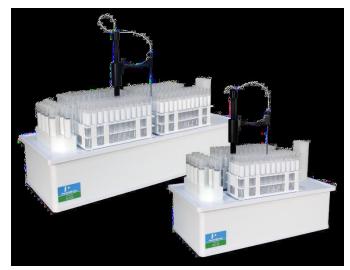
A deservation and	-				
Autosampler wash	Extra Wa	ash Concentration	n Limits	Ľ	?
SmartRinse		Analyte	Calibration Units	Concentration	
🔘 Never	1	Ag 328.068	mg/L	5	
🔘 Between samples	2	Al 396-rad	mg/L	5	
	3	Al 308-rad	mg/L	0	
Only after samples whose concentrations	4	Al 394-rad	mg/L	0	
exceed limits	5	As 188.979	mg/L	5	
After every sample + extra time if sample Concentrations exceed limits	6	As 193.696	mg/L	5	
concentrations exceed limits	7	B 249.677	mg/L	5	
Rate Wash location	8	Ba 493.408	mg/L	5	
	9	Be 313.107	mg/L	5	
1.00 📩 mL/min 0 📩	10	Ca 315-rad	mg/L	5	Ŧ
Normal time Extra time					
60 🔹 sec 60 🛬 sec					
				ок 🛛 🕻 🤇	Cancel
	<u> </u>				_

#### **Full Range of Intelligent Autosamplers and Diluters**













## prep3

- Automatic calibration from stock standard solution(s)
- Automatic sample dilution
- Automatic over-range dilution
- Automatic internal standard out-of-range dilution
- Analyze samples from undiluted to up to 25x diluted
- Fully supported by PerkinElmer Syngistix software



https://www.youtube.com/watch?v=yvWly-fDyuA

P1 = Sample, P2 = Diluent, P3 = Internal Standard

P1+ P2 = Constant, P1/(P1+P2) = Dilution Factor











## Avio 200...

- Scanning Array Spectrometer
- Does not require to be thermostated
- Designed to turn off when not in use
- OFF is OFF
- Optical system with very high light throughput allows short read times
- Fastest start up from cold (10 min)
- DWS for best stability
- Smallest ICP on the market at 65x76x81cm





## **Fastest Start up**

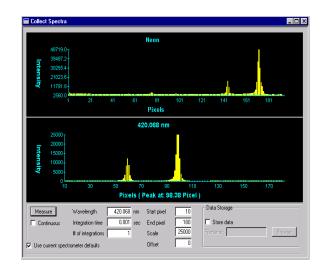
- 10 minutes from cold
  - No gas
  - No electricity
- How? DWS Dynamic Wavelength Stabilisation
  - Use of the Neon reference source corrects for any peak shift due to temperature and purge (or lack of)

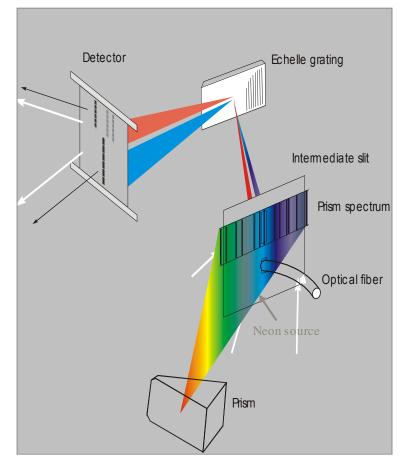
#### Benefits

- Excellent stability despite changing laboratory environment
- Best precision and accuracy

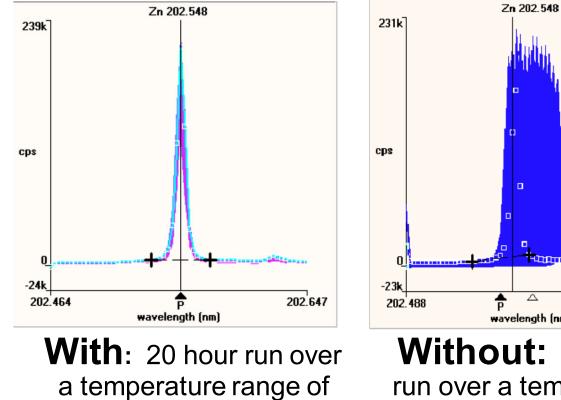
## **Dynamic Wavelength Stabilisation (DWS)**

- All wavelengths are automatically referenced to Neon to eliminate wavelength drift
- done in real time for every replicate of every measurement
- Temperature fluctuations allowed





#### With and Without DWS



10-35 °C

The second s 202.671 wavelength (nm)

Without: 20 hour run over a temperature range of 10-35 °C



## Avio 200 Speed – 6 wavelengths, radial

Sample to sample times with autosampler without FAST valve

	Read time 0.5-2s	Read time 0.2-0.2s
Flush and read delay (typical)	40-50 s	40-50 s
Analytical time	72 s	48
Washout (typical)	20 s	20 s
Sample to sample time	137	113

#### Sample to sample times with autosampler with FAST valve

	Read time 0.5-2s	Read time 0.2-0.2s
Flush and read delay (typical)	10-15 s	10-15 s
Analytical time	72 s	48
Washout (typical)	10-15 s	10-15 s
Sample to sample time	97	73

Analytical time is average for solutions with range 0 – 100 ppm analyte

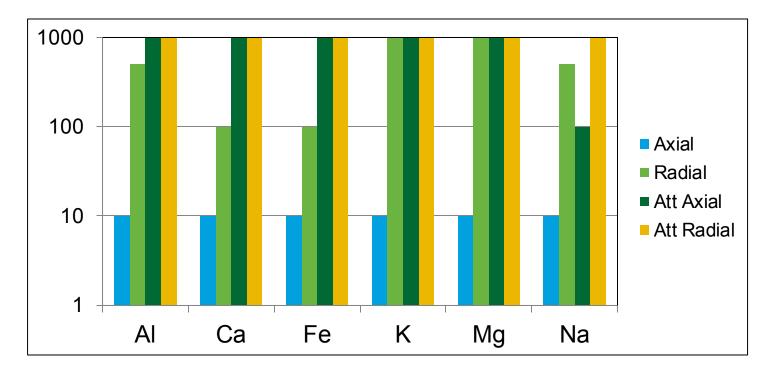


### Attenuation mode

- Ability to extend the dynamic range is valuable for the analysis of high concentration samples.
- Attenuation Mode provides a simple way to dramatically extend the dynamic range (ca. 50x)
- Eliminate the need for additional sample prep or repeat analyses.
- Avoids the efforts involved with validating alternate wavelengths.
- Freely selectable, element by element.
- Allows measurement of both high & low concentration elements in the same method, using a mix of attenuated and unattenuated modes.

#### **Attenuation mode**

 Comparison of detector saturation limits for Attenuated and Normal modes Axially and Radially



Attenuation Mode allows concentrations greater than 1000 mg/L to be measured without dilution



## The Avio Series

#### • When to choose an Avio 500?

- Simultaneous instrument
- High sample throughput regardless of number of wavelengths
- Instrument used continuously or in planned intervals -Continuously ON
- Backup quantitation with UDA

#### • When to choose an Avio 200?

- Scanning array instrument
- High sample throughput for < 10 wavelengths</li>
- medium sample throughput for > 10 wavelengths
- Instrument used intermittently or ad hoc OFF is OFF, short startup
- versatility



#### Thank you for your attention!

#### Helmut Ernstberger

Product Specialist Inorganic EMEA EMT and Spain helmut.ernstberger@perkinelmer.com

