The SC-*FAST* system for ICP and ICPMS:
Versatile automation for routine and advanced environmental applications

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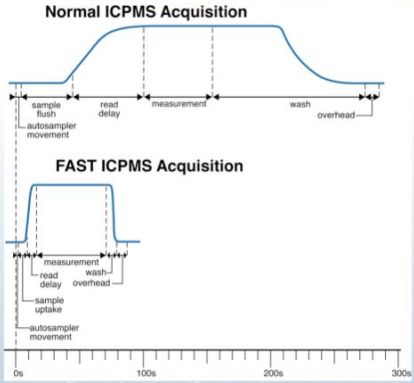
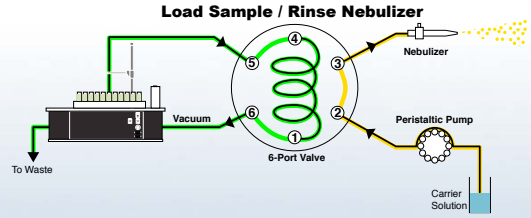
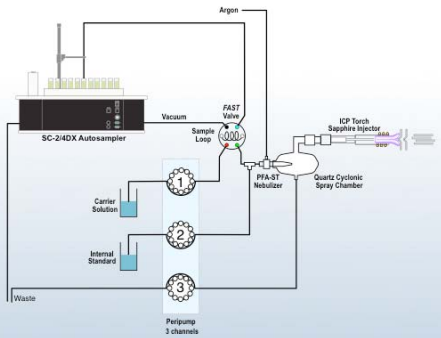
Introduction to the *FAST* system



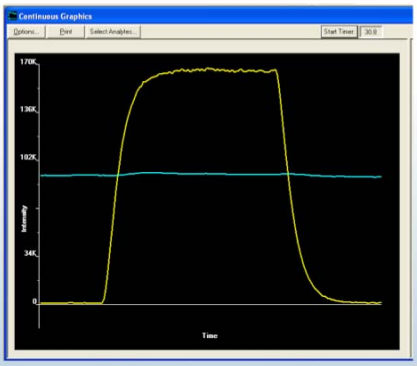
Introduction to the *FAST* system



SC-*FAST*



Injection Profile



New SC-DX Autosamplers

- Enhanced chemical resistance
- Dual X-rails and heavy duty Z-rail
- Precise sampling, even on microtiter plates
- Optional enclosures and mobile stands improve cleanliness and convenience
- Easy integration of accessories

SC-DX Accessories

MP² Pump
Micro peristaltic pump
(< 1µL/min to > 10mL/min)

SYRIX Syringe Pump
O-ring-free programmable syringe pump system

Single and Dual *FAST* Valves
High throughput valve modules

Chelation Columns
sea*FAST* and brine*FAST* applications

continuum
Enclosed dual valve, dual syringe pump accessory

PC³
Peltier cooled cyclonic chamber (+2°C/-5°C)

apex *FAST*
Compact, high performance introduction system

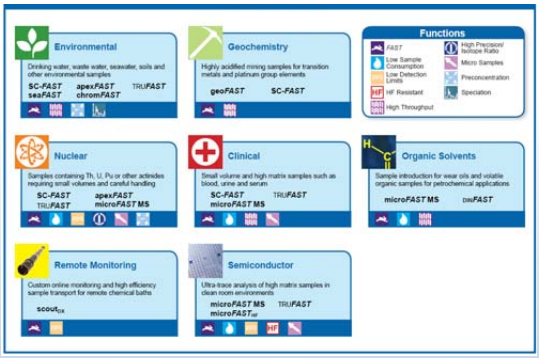
PC³ *FAST*
High throughput Peltier cooled cyclonic chamber

MP² Micro peristaltic pump

- Low pulsation
- Addition of IS with low dilution factor
- Shorter analysis time with same precision
- Optimized for low flow rates
- Excellent for mixing and online dilution

- Available as a direct replacement for the standard pump on many ICP/ICPMS instruments and as a standalone version

ESI Application Solutions



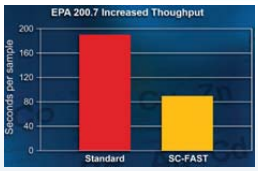
Sample ICPOES Applications

	Geological Au, Pt, Pd	Environmental 200.7 Norm.	Environmental 200.7 High Sens.	Clinical Al/Zn	Soil Testing
Loop Size	0.2 mL	2 mL	4 mL	0.5 mL	0.1 mL
Loop Fill Time (Timer A)	3 s	6 s	12 s	3 s	1 s
Total Time	30 s	120 s	240 s	25 s	7-10 s
Carrier	Blk-Blk	Org-Yel		Org-Yel	Red-Red
Int. Std.	Org-Grn	Org-Grn		Org-Yel	----
Nebulizer	PFA-ST	PFA-ST		PFA-ST	PFA-ST

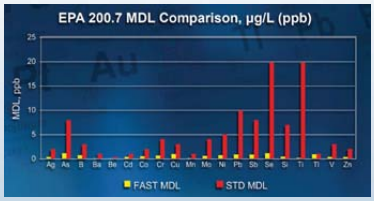
Sample ICPMS Applications

	Geological On Line Dilution	Environmental	Clinical	Clinical
Method	41 Metals	US EPA 200.8	Full Panel	Pb in Blood
Loop Size	0.2 mL	1 mL	1 mL	0.2 mL
Loop Fill Time	3 s	8 s	10 s	3 s
Total Time	52 s	95 s	58 s	24 s
Carrier	Grn-Org	Blk-Blk	Blk-Blk	Blk-Blk
Int. Std.	Red-Red	Grn-Org	----	----
Nebulizer	PFA-ST	PFA-ST	PFA-ST	PFA-ST

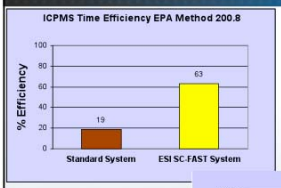
FAST Improvement for EPA 200.7



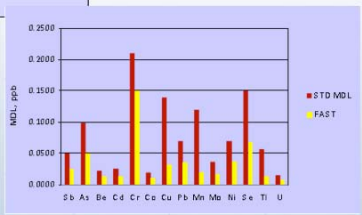
- Higher throughput
- Lower consumables cost
- Less maintenance
- Better stability and MDLs



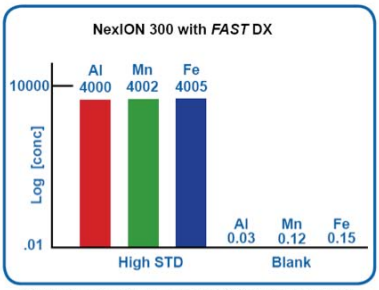
FAST Improvement for EPA 200.8



- Up to 5x higher throughput
- Lower consumables cost
- Less cone maintenance
- Better stability and MDLs



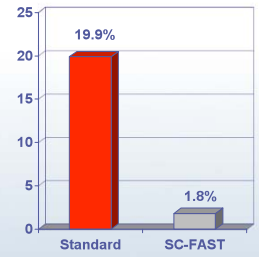
Washout Characteristics



Sequential analysis of a 4000 ppb high standard followed by a matrix blank demonstrates unprecedented ICPMS rinse factors of 4 to 5 orders of magnitude.

Reduced ICPMS QC Failure - 30 Day Comparison

Non-cell Instrument



Number of ICPMS CCV Failures

	Standard	SC-FAST
Be	82	1
Cr	14	2
Mn	20	3
Co	18	2
Ni	15	1
Cu	13	0
Zn	28	7
As	10	0
Tl	17	2
Pb	15	0

Rate of ICPMS CCV Failures per Billable Analyte

72% Increase in Samples Analyzed by EPA Method 200.8 with SC-FAST

Selected *FAST* Applications

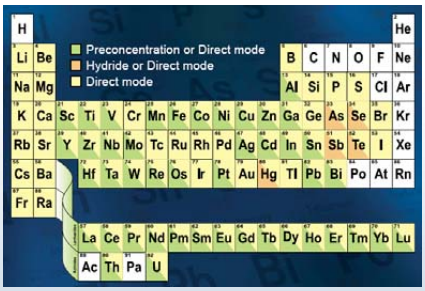
Advanced *FAST* Applications:

- sea*FAST*: Multimode analysis of undiluted seawater by ICPMS
- brine*FAST*: Multimode analysis of undiluted brines by ICPOES

sea*FAST*3

- sea*FAST*^{3} uses 3 modes of analysis for undiluted seawater or other high-matrix environmental waters:
  - Direct analysis with online dilution
  - Hydride generation
  - Preconcentration and matrix removal
- No sample preparation required
- Simple, external calibration with acid standards
- ~10 minutes, sample-to-sample
- All fluoropolymer sample path
- Full automation through ICPMS software

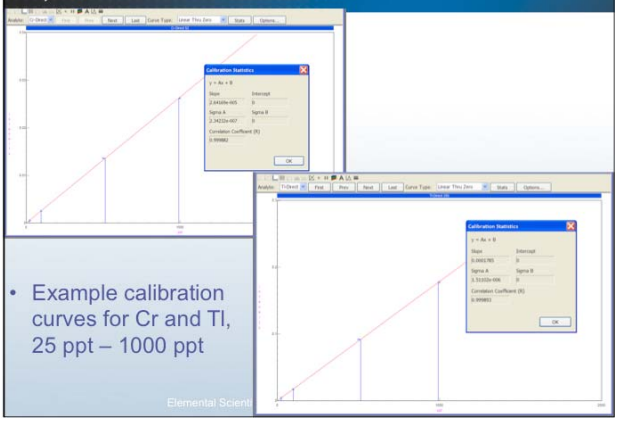
Modes for sea*FAST*3



1) Direct Mode

- Online dilution
  - Reduces matrix effects
  - Reduces procedural blanks
- Online addition of internal standard
- Low-ppt calibrations

1) Direct Mode

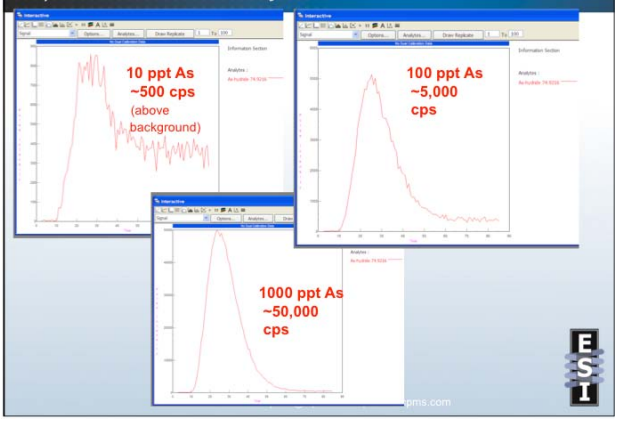


- Example calibration curves for Cr and Tl, 25 ppt – 1000 ppt

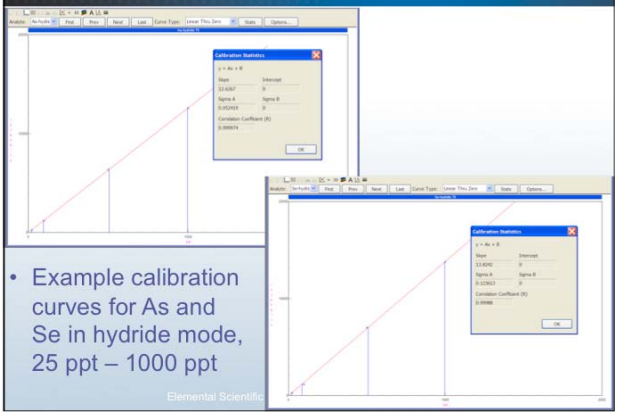
2) Hydride Mode

- Specially designed batch hydride generation chamber
- High sensitivity transport efficiency
- High sensitivity for As, Se, and Sb
- High purity syringe pumps automatically deliver the needed solutions at the required flow rates

2) Time Profiles – Hydride Generation



2) Hydride Mode

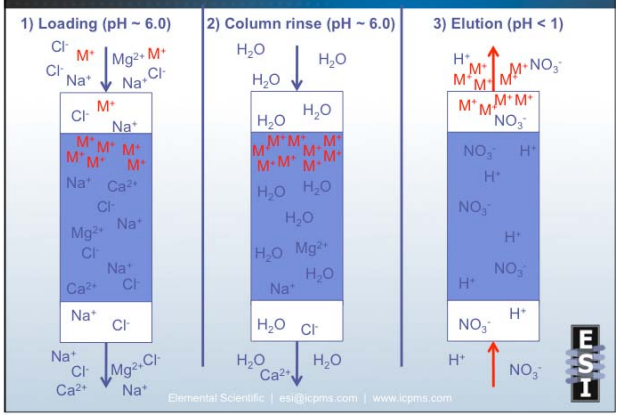


- Example calibration curves for As and Se in hydride mode, 25 ppt – 1000 ppt

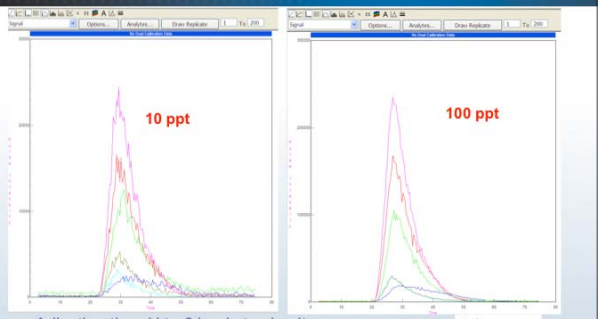
3) Preconcentration and matrix removal

- Mixed resin containing iminodiacetate (IDA) resin
- Low affinity for alkali metal cations, alkali earth metal cations, and anions
  e.g. Na^+, Mg^{2+}, Ca^{2+}, and Cl^-
- High Affinity for many transition metal cations, M^+

Mixed Resin Preconcentration - Seawater



seaFAST Elution Profiles



- Adjusting the pH to 6 leads to simultaneous elution of elements of interest
- Quantification is achieved by the average peak height

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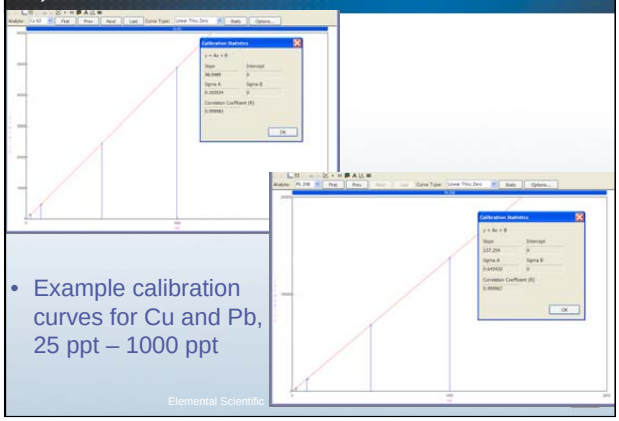
3) Preconcentration Mode



- Example calibration curves for Cu and Pb, 25 ppt – 1000 ppt

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seaFAST3 - NASS-5 Recoveries with External Calibration

		Measured by seaFAST3 NASS-5	Certified (Reference)
Direct	Ag	312	n/a
	Ba	5382	(5100)
	Tl	12	n/a
Hydride	Se	14	(18)
	As	1146	1270 ± 120
	Sb	142	n/a
Preconcentration	V	1290	(1200)
	Mn	978	919 ± 57
	Fe	212	207 ± 35
	Co	12	11 ± 3
	Ni	259	253 ± 28
	Cu	287	297± 46
	Zn	183	102 ± 39
	Cd	25	23 ± 3
	Pb	7	8 ± 5

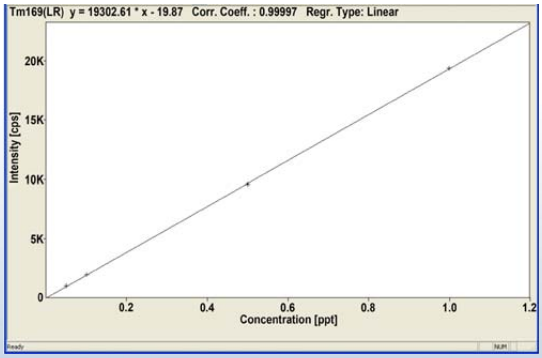
PerkinElmer Elan DRC

Method Detection Limits

Mode	Analyte	MDL, 25 ppt (ppt)
Direct	Ag	5
	Ba	8
	Tl	2
Hydride	Se	7
	As	3
	Sb	2
Preconcentration	V	2
	Mn	6
	Fe*	21
	Co	2
	Ni	7
	Cu	3
	Zn*	23
	Cd	3
	Pb	3

* Elements measured at 250 ppt, PerkinElmer Elan DRC

Calibration below 1 ppt – Rare Earth Elements



Rare Earth Element Determination with sea*FAST*

HRICPMS

Detection Limits (3σ) for Rare Earth Elements	
Analyte	LOD (ppq)
Y	12
La	29
Ce	16
Pr	5
Nd	21
Sm	11
Eu	4
Gd	6
Tb	3
Dy	6
Ho	5
Er	7
Tm	3
Lu	4
Yb	5

Comparison of reference NASS-5 results and ESI sea*FAST* results (ppt)		
Analyte	Reference[1]	sea*FAST*
Y	22.00 ± 2.90	24.17
La	12.19 ± 1.14	12.55
Ce	5.72 ± 0.69	5.93
Pr	2.09 ± 0.19	2.13
Nd	8.43 ± 0.65	8.80
Sm	4.74 ± 0.34	4.54
Eu	0.33 ± 0.03	0.32
Gd	1.83 ± 0.15	1.95
Tb	0.27 ± 0.03	0.25
Dy	1.82 ± 0.20	1.88
Ho	0.47 ± 0.06	0.42
Er	1.43 ± 0.20	1.40
Tm	0.21 ± 0.04	0.20
Lu	1.29 ± 0.38	1.14
Yb	0.19 ± 0.06	0.20

[1] M. G. Lawrence and B. S. Balz, Geostand. Geoanal. Res., 2007, 31, 95-101.

Thermo ELEMENT2 HRICPMS

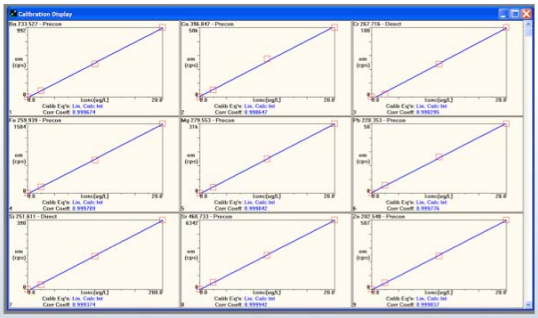
brine*FAST* for ICPOES

- Similar chemistry to the sea*FAST*, except with a column that has retention for Ca and Mg, along with many other metals
- Ideal for ChlorAlkali plants or applications where Mg and Ca are analytes in high matrix samples
- Analyze undiluted, 30% brine without sample preparation
- Analyze caustic soda or bleach with minor sample preparation.

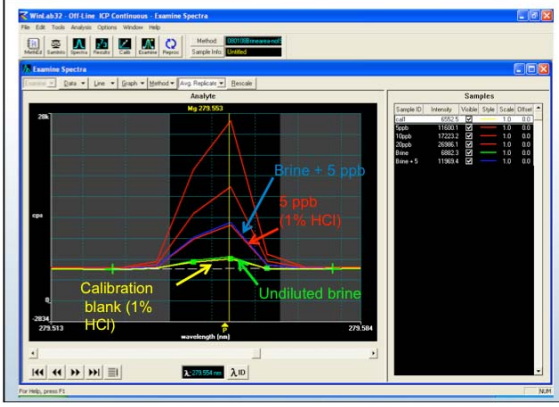
Calibration

- Simple calibration in acid standards
  - Low ppb calibration for ultrapure brines
  - May calibrate higher, 1ppm or more for more concentrated samples
- Same response in acid and brine
  - Spectral overlays
  - Spike recoveries

Low-ppb Calibration Curves



Mg (279.553) Spectral Overlay



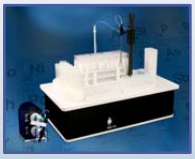
brine*FAST* - 5 ppb Spike Recoveries

Preconcentration Spike Recoveries in Undiluted Brine	
Analyte	% Spike Recovery brine*FAST* (5 ppb)
Al	94
Ba	91
Ca	118
Cd	91
Co	91
Cu	85
Fe	98
Mg	90
Mn	91
Ni	90
Pb	94
Sr	89
Zn	81

Method Detection Limits Comparison		
Analyte	Traditional (ppb)	brine*FAST* (ppb)
Mg	1.7	0.2
Ca	8.0	0.4
Mn	1.2	0.2
Fe	6.3	0.3
Sr	1.1	0.1
Ba	1.4	0.3
Al		2.0
Si*		8.6
Ti*		0.7
V		2.6
Cr*		2.1
Co		0.8
Ni		1.0
Cu		0.7
Zn		0.3
Cd		0.3
Pb		3.2

SC-*FAST* for ICP and ICPMS

- **Ideal for both high throughput labs and labs needing advanced automation or customization**
- Work on any ICP or ICPMS instrument
- Reduce operational costs
- Completely customizable
- Application solutions are available for advanced automation and flexibility
- Advanced online chemistries, hardware, and software overcome matrix effects
- Hardware and software can be configured for other applications as needed
- **Turnkey solutions for a wide variety of environmental analyses**



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