

ICP-OES and ICP-MS

SC-FAST Benefits

- Increases sample throughput 2-3 times
- Minimizes sample uptake and wash out time
- Eliminates contact with peristaltic pump tubing
- Provides full integration between SC autosampler and SC-FAST technology
- Ability to add Hg to ICP-MS methods without compromising throughput
- Improved stability and reduced build-up on cones and lens system
- No alteration to analytical measurement time
- Reduced stabilization time

ESI Sample Introduction Solutions for Optima ICP-OES and ELAN ICP-MS Systems

PerkinElmer, Inc. has partnered with Elemental Scientific Inc. (ESI) to offer high-speed sample introduction technology to enhance the productivity of the industry-leading Optima™ ICP-OES and ELAN® ICP-MS systems. The integrated systems offer a two to three time improvement in sample throughput for a wide variety of application requirements.

PerkinElmer®'s inorganic analysis products have long been the systems of choice for labs with high-throughput needs because of their inherent high-speed capabilities, superior reliability and minimal maintenance.

When combined with the ESI SC-FAST systems, all instrument functionality is enhanced. Sample throughput is dramatically increased with no loss of detection limits. The combination of lower sample requirements and high-speed sample introduction systems reduce instrument operating time, argon consumption, and instrument maintenance which decreases overall cost of ownership and increases laboratory productivity.

ESI SC-FAST technology

The ESI FAST sample injection system was adapted to work with Optima ICP-OES and ELAN® ICP-MS systems allowing significant improvements in sample throughput speed. The solution is a combination of sample introduction hardware and software control of the timing parameters for the autosampler components.



Figure 1. SC-FAST valve component.

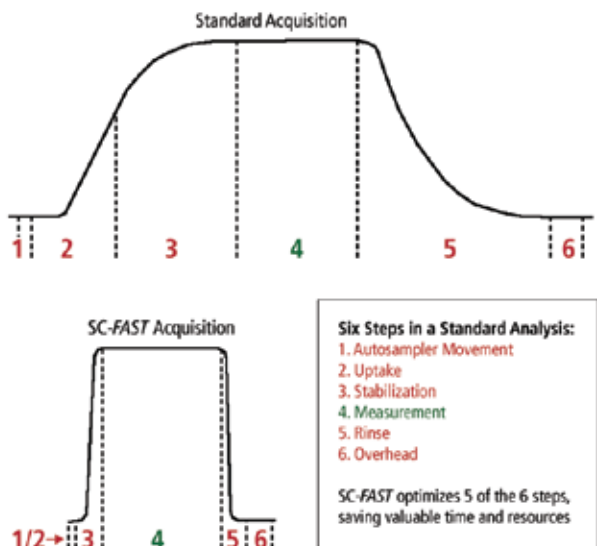


Figure 2. Comparison of a standard acquisition and SC-FAST sample introduction process.

SC-FAST maximizes the productivity of Optima and ELAN instruments by reducing and optimizing all of the unnecessary steps involved in a sample acquisition. The system virtually eliminates sample uptake and wash times with no other alteration to the analytical method. Sample turnaround may be increased two to three fold by eliminating these analysis steps.

The FAST autosampler includes a built-in vacuum pump for moving the solution from the test tube and filling a sample loop of a specific volume, so the sample never touches the pump tubing. Low volume valve technology minimizes contamination from carryover and reduces sample uptake and rinse out time. See the comparison of the FAST technique versus conventional sample introduction processes in Figure 2.

Autosamplers for a Range of Sampling Needs: SC-2, SC-4 and SC-14

The SC series of autosamplers offers a variety of choices for laboratories with different sample and space requirements. SC-Autosamplers can hold the widest range of both large standard racks and micro racks with vials ranging from 500 µL to 250 mL. The combination of dual flow rinse stations and guide-free sample probes are proven to reduce blank contamination and sample carry overs.



Figure 3. SC-2, SC-4 and SC-14 autosampler offerings.

Flexible and Robust

The SC-Autosampler models used with PerkinElmer Optima and ELAN® systems include the SC-2, SC-4 and SC-14. The systems have the flexibility to handle multiple rack options ranging from micro samples (less than 1 mL) to bottles (250 mL) in a single run. User-defined speed controls allow the autosampler to be tuned for each application and a wide variety of probe designs and custom racks are also available. The autosamplers have a simple mechanical design and have a Teflon®-coated X and Z axis and sealed electronics to protect against harsh chemical environments.

Ultraclean, Intelligent Autosamplers

The SC-Autosampler line maintains the integrity of the sample since vials are not exposed to overhead metal or mechanical parts. In addition, an all fluoropolymer sample flow path ensures both acid and solvent resistancy. In addition, a dual flowing rinse station and guide-free sample probe reduce blank contamination and sample carry overs.

Accommodates a Variety of Capacities

The SC-2 and SC-4 have a small footprint to maximize bench space while allowing up to 384x4 mL samples and 576x4 mL, respectively. The SC-14 offers high sample capacity for long unattended or overnight runs with up to 1260 samples, 10 standards and dual flowing rinse.

SC-FAST and ELAN ICP-MS for EPA Method 200.8

The United States Environmental Protection Agency (U.S. EPA) Method 200.8 defines the procedure for measuring trace elements in water and soil/sediment samples by ICP-MS. The method lists five interferences (isobaric elemental, abundance sensitivity, isobaric polyatomic ion, physical and memory) which can affect the efficiency and accuracy of the analysis. Both the physical interferences and the memory interferences are highly affected by the type of sample introduction system used. The use of the SC-FAST 200.8 rapid analysis system gives an average twofold improvement in the method detection limit (MDL) and reduces the memory interference, resulting in a doubling of the sample throughput.

Table 1. Elements Measured in SC-FAST AS 200.8 Method.

⁶ Li	⁴⁴ Ca	⁵⁹ Co	⁸² Se	¹²¹ Sb	²⁰⁹ Bi
⁹ Be	⁴⁵ Sc	⁶⁰ Ni	⁸⁹ Y	¹³⁷ Ba	²³² Th
²³ Na	⁵¹ V	⁶⁵ Cu	⁹⁸ Mo	¹⁶⁵ Ho	²³⁸ U
²⁴ Mg	⁵² Cr	⁶⁶ Zn	¹⁰⁷ Ag	²⁰² Hg	
²⁷ Al	⁵⁵ Mn	⁷¹ Ga	¹¹¹ Cd	²⁰⁵ Tl	
³⁹ K	⁵⁷ Fe	⁷⁵ As	¹¹⁵ In	²⁰⁸ Pb	I.S.

Table 2. Instrument Calibration Blank (ICB) Ran Immediately After 5 µg/L Hg Calibration Standard.

	²⁰⁰ Hg	²⁰² Hg
ICB 1	0.003	0.003
ICB 2	-0.002	0.000
ICB 3	0.001	0.003
ICB 4	0.000	0.001
ICB 5	-0.003	0.002
Std. Dev.	0.0024	0.0013
3 σ	0.007 ppb	0.004 ppb
Ir used as I.S. for Hg calibration		

Table 3. Method Timings (seconds).

Experimental Conditions	Standard	SC-FAST
Sample Uptake Delay	30	10
Sample Stabilization	30	0
Sample Reading	20	20
Replicates	3	3
Sample Wash	120	35
Total Analysis Time	240	110

A total of 33 elements were analyzed using the SC-FAST AS 200.8 method in addition to 27 analytes and 6 internal standards (see Table 1) as compared to a standard sample introduction system for washout, method detection limits and sample throughput.

Uptake and washout

It is important that the nebulizer used also has a low internal dead volume to ensure a rapid rise to steady state signal and return to baseline signal. The time profiles in Figure 4 show that the PFA-ST MicroFlow nebulizer has a much lower dead volume than a standard glass concentric nebulizer; the ST-nebulizer is integral to the improved performance of the SC-FAST AS 200.8 system.

Blanks and detection limits

The improved wash out (Figure 5) and reduced matrix loading of the ICP-MS using the SC-FAST results in improved method detection limits (MDL) compared to the standard introduction system. With the SC-FAST, a rinse time of 30 seconds is sufficient to prevent sample carryover of the 5 µg/L Hg signal (see Table 2). EPA Method 200.8 recommends a sample wash time of 120 seconds to rinse 5 µg/L of Hg from the previous sample before the next sample is analyzed (longer if gold is not added to the rinse solution).

The combined SC-FAST benefits of rapid uptake and rinse out, excellent stability and reduced blanks and DLs improve the performance of EPA Method 200.8 while reducing time for individual sample analysis from 240 s to 110 s (see Table 3).

By reducing the sample uptake time and removing the peristaltic pumping, the SC-FAST lowers the total amount of sample matrix reaching the torch injector and ICP-MS cones¹. The total sample load on the plasma is reduced by 57% (0.54 mL of sample using the SC-FAST compared to 1.25 mL with the standard introduction system) resulting in less matrix deposition on the injector and cones between samples, improving long term stability and reducing maintenance.

The reduced sample uptake and rinse times with the SC-FAST mean the total sequence analysis time is more than halved. The improved efficiency in sampling means the cost of analysis is reduced with savings in argon and other ICP-MS consumables, giving the SC-FAST a rapid return on investment.

Improvement in throughput for biomonitoring samples using SC-FAST

A typical biomonitoring testing laboratory can have over 10,000 samples to be analyzed on a monthly basis for a wide variety of diagnostic tests. In this example, a biomonitoring testing laboratory has 9 panels each with a different ICP-MS method (Table 4). The switch was made to the SC-FAST from standard introduction techniques to improve the laboratory's throughput, without compromising accuracy or data quality.

By reducing the uptake, stabilization and rinse times of an ICP-MS method, the SC-FAST can be used to reduce analysis times. Table 5 shows that all of the methods used were dramatically reduced by the SC-FAST, on average by over 2½ times.

With a daily load of 472 samples, standards, quality control standards and repeats to be run, the ICP-MS needs to be run for over 19 hours per day using standard introduction systems.

By utilizing the SC-FAST, the same number of samples could be run in less than 8 hours, reducing running costs and creating the possibility to have same day turnaround in results.

Key Features

- Multiple rack options ranging from micro samples to bottles
- 6-way valve system for minimal uptake and wash times
- Modular hardware components and identical electronics
- User-defined speed controls
- Wide variety of probe designs and custom racks available
- Acid and solvent resistant components
- No probe guide for reduced cross contamination



Table 4. Method Time Improvement Panel.

Panel	Standard Method Time (sec)	Method Time (sec)	Improvement Factor
Panel 1	140	50	2.8
Panel 2	158	61	2.6
Panel 3	130	53	2.5
Panel 4	134	58	2.3
Panel 5	120	39	3.1
Panel 6	142	49	2.9
Panel 7	120	39	3.1
Panel 8	158	59	2.7
Panel 9	177	95	1.9
Average Improvement: 2.6			

Table 5. Analysis Time Per Day.

	Average # Daily Analyses	Analysis Time per Sample		Analysis Time per Day	
		Standard	SC-FAST	hh:mm:ss	
				Standard	SC-FAST
Panel 1	194	0:02:20	0:00:50	7:32:18	2:41:32
Panel 2	88	0:02:38	0:01:01	3:50:55	1:29:09
Panel 3	65	0:02:10	0:00:53	2:20:00	0:57:05
Panel 4	15	0:02:14	0:00:58	0:33:31	0:14:31
Panel 5	5	0:02:00	0:00:39	0:09:14	0:03:00
Panel 6	5	0:02:22	0:00:49	0:10:55	0:03:46
Panel 7	18	0:02:00	0:00:39	0:36:55	0:12:00
Panel 8	14	0:02:38	0:00:59	0:36:28	0:13:37
Panel 9	69	0:02:57	0:01:35	3:24:14	1:49:37
Total	472	Total Hours/Day:		19:14:31	7:44:17



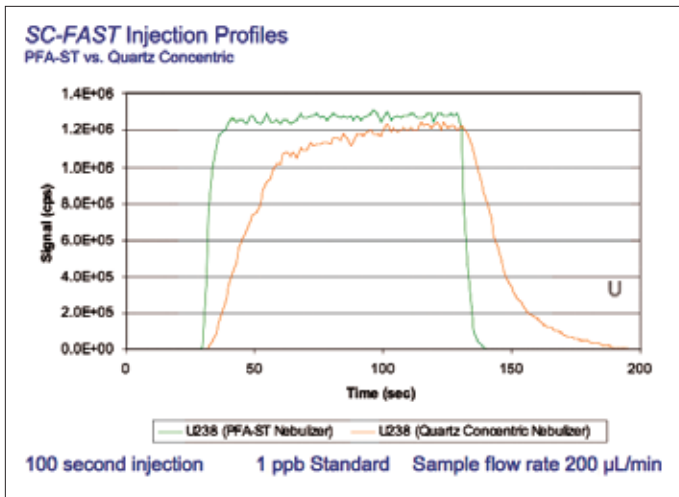


Figure 4. SC-FAST injection profiles: PFA-ST vs. quartz concentric.

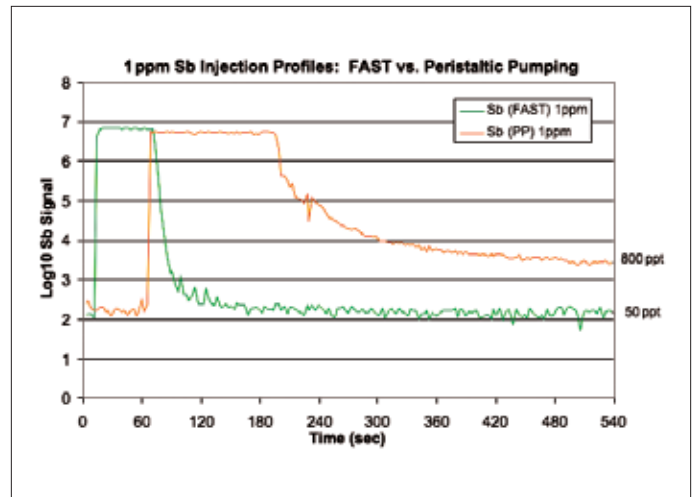


Figure 5. SC-FAST vs. peristaltic pumped antimony flush-in and rinse-out.

Specifications	SC-2	SC-4	SC-14
Communications	RS-232 with USB and IEEE-4388 options; 3 external switches In/Out, 3 drive switches In/Out	RS-232 with USB and IEEE-4388 options; 3 external switches In/Out, 3 drive switches In/Out	RS-232 with USB and IEEE-4388 options; 3 external switches In/Out, 3 drive switches In/Out
Power requirements	100-240 VAC ±10%, 50-60 Hz	100-240 VAC ±10%, 50-60 Hz	100-240 VAC ±10%, 50-60 Hz
Standard positions	10	10	10
Rinse positions	2	2	2
Speed (Sample to rinse)	~3 s	~3 s	~3 s
Number of Racks	2 racks/180 samples	4 racks/360 samples	14 racks/1,260 samples
Dimensions	19" x 21.5" x 11"	19" x 30" x 11"	45.5" x 21.5" x 44"
Weight	15 lbs	26 lbs	23 lbs

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