



Accurate and precise quantification of metals at ultra-trace levels in open ocean seawater remains a difficult task. This is due to low dissolved analyte concentration (single digit  $\text{ng L}^{-1}$ ) and a complex matrix (3.5% TDS). The seaFAST-pico™ is an ultra-clean, inline, automated, low-pressure ion chromatography system capable of picogram  $\text{L}^{-1}$  detection limits. The automated method buffers 9 mL of acidified seawater inline before loading it onto a column, where matrix is removed and the concentrated sample is eluted directly to an ICP-MS. Rapid sample loading rates combined with low elution volumes provides high preconcentration factors (~200 fold) and unprecedented detection limits ( $\text{pg L}^{-1}$ ). The whole process is complete within 9 minutes with real-time data providing invaluable insight for blank reduction and other aspects of method development.

#### Features:

- Inline or offline operation
- Configured inline: 9 minutes per sample
- All-fluoropolymer flow paths
- Seamlessly integrated with ICP-MS
- Compact footprint
- High capacity (up to 240 samples)
- S400V syringe unit handles all solutions
- Load column rapidly (up to  $4 \text{ mL min}^{-1}$ )
- Elute column in small volumes ( $\sim 30 \mu\text{L}$ )
- Triple 6-port valves
- ULPA enclosure

**Figure 1.** Elution profiles for Rare Earth Elements (REEs) and first row transition metals (2 point running average). Adjusting the elution syringe dispense rate (slower, REEs) results in broader transient profiles when measuring a greater number of isotopes.



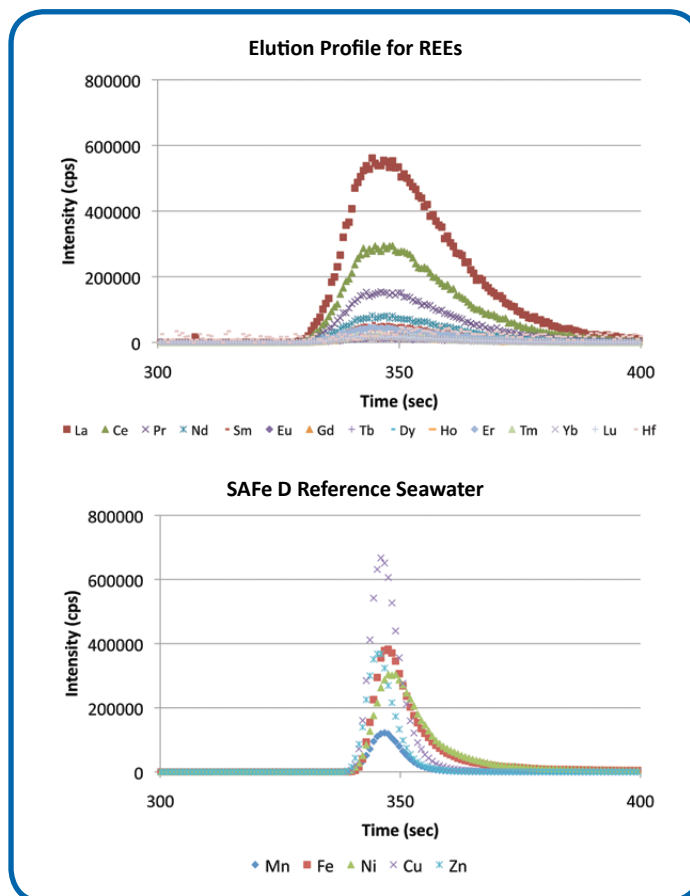
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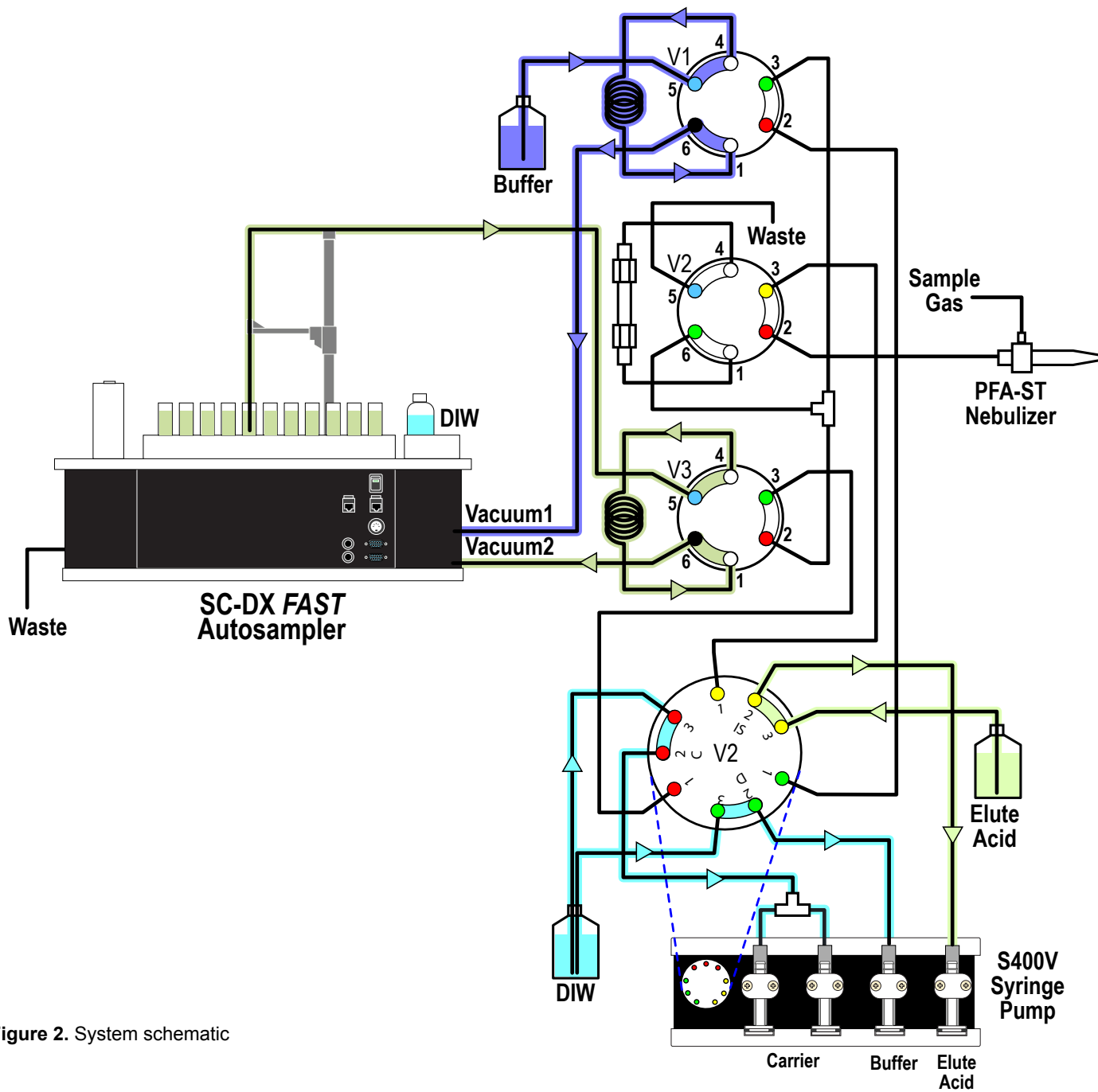
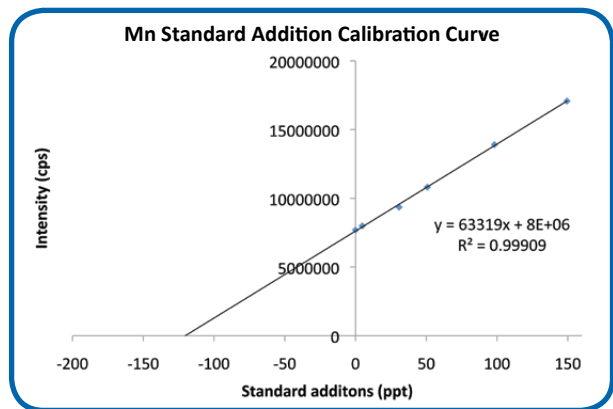
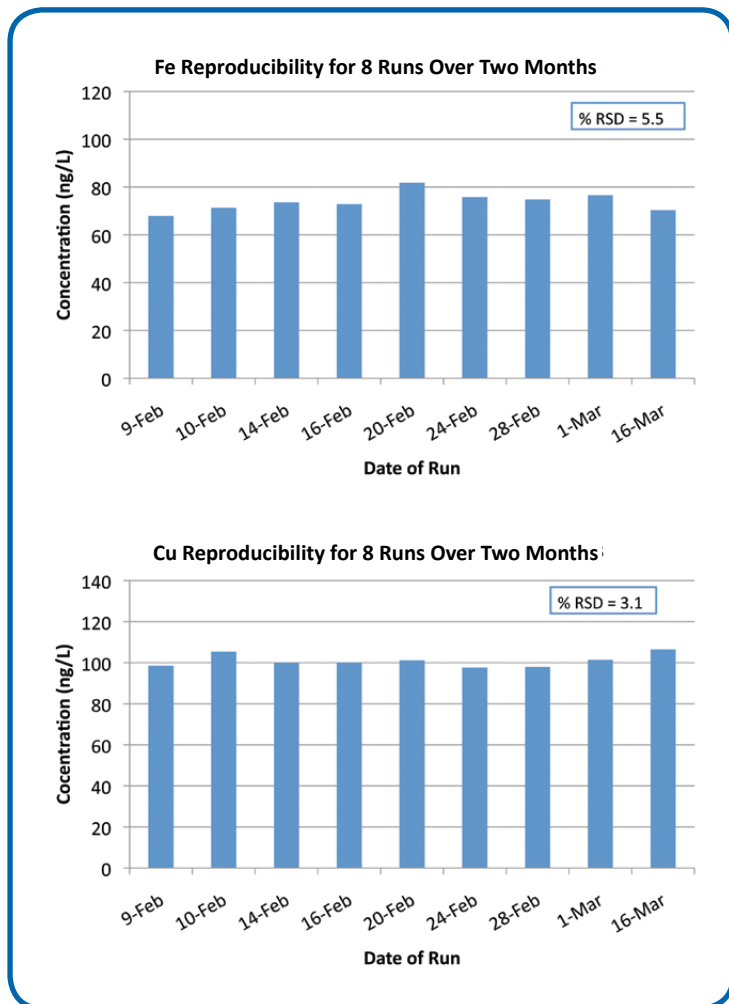


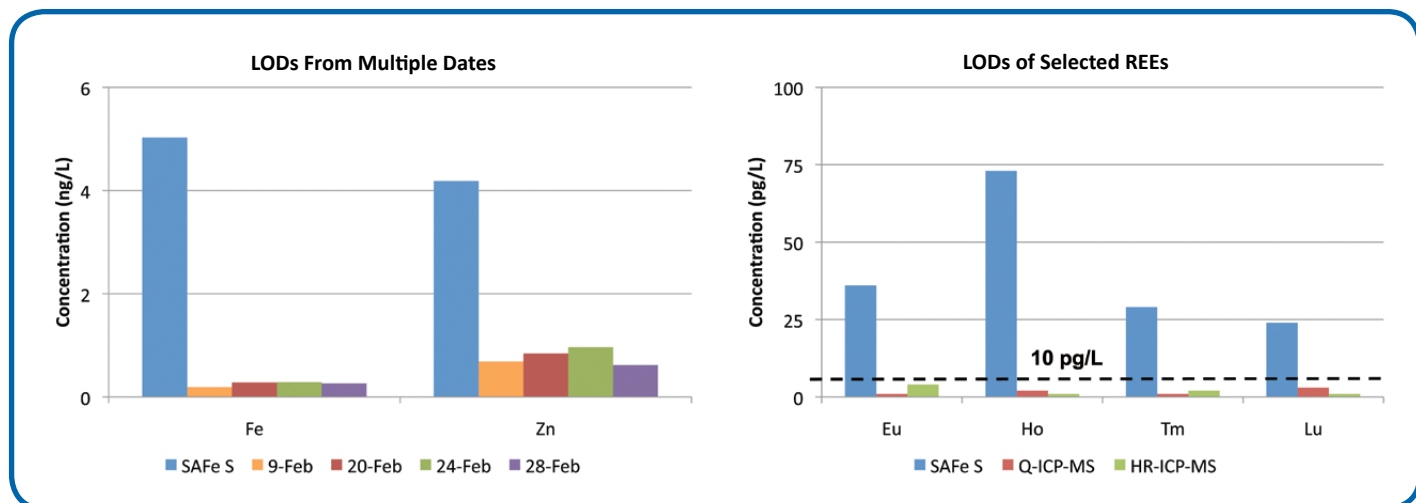
Figure 2. System schematic



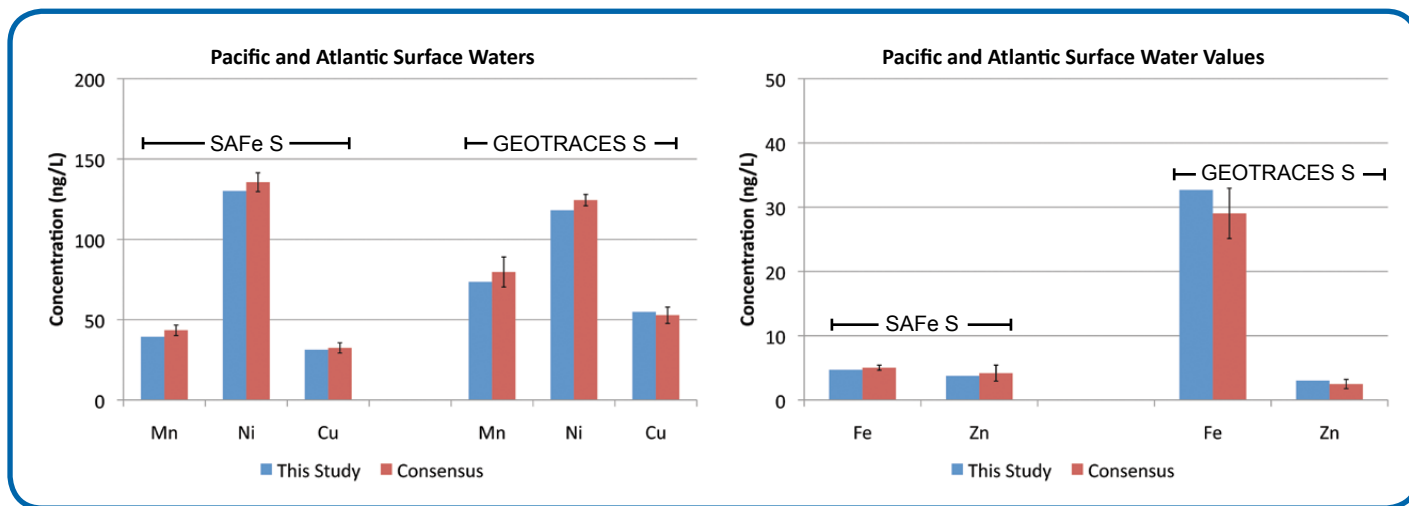
**Figure 3.** Unknown concentrations are quantified using both isotope dilution and pseudo-standard additions techniques. Very linear ( $r^2 > 0.999$ ) standard addition curves attest to the reproducibility of the fully-automated seaFAST-pico. Given the similar matrix of all seawater samples, the slope of one standard addition curve is used to calculate the concentration of unknown samples.



**Figure 4.** An internal laboratory standard of Ross seawater collected from the Southern Ocean is run several times on each of 9 discrete analytical dates. Excellent day-to-day reproducibility is illustrated for Fe and Cu.



**Figure 5.** Limits of detection for contaminant-prone elements (Fe and Zn) are in the high picogram L<sup>-1</sup> range and in the single digit picogram L<sup>-1</sup> range for less abundant elements (REEs). These limits of detection are reproducible on a day-to-day (Fe and Zn) basis, on different instruments (REEs), and are appropriate for determination of ultra-trace metal concentrations in the open ocean.

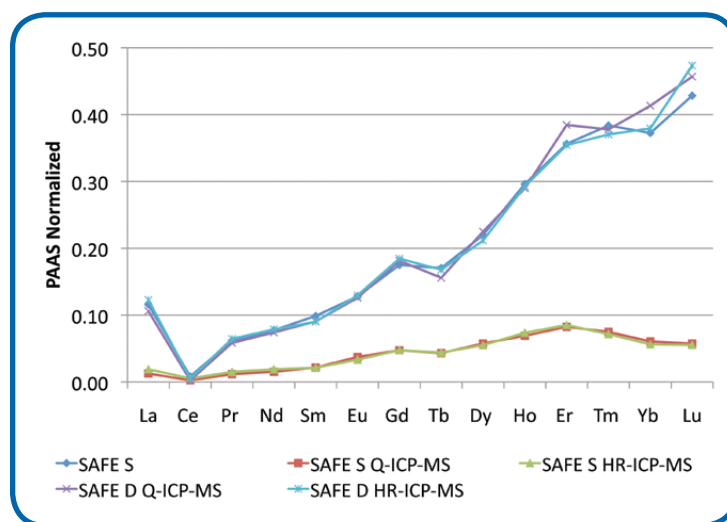


**Figure 6.** Accuracy of first row transition metals at very low concentrations typical of the open ocean is demonstrated for SAFE and GEOTRACES surface water.

**Figure 7.** Although consensus values for REEs in SAFE and GEOTRACES samples have yet to be established, PAAS normalized patterns for SAFE surface and deep water are consistent with oceanographic data and in good agreement with previous data for 1000m depth in the Pacific (Alibo and Nozaki, 1999).

**Benefits:**

- Inline or offline operation
- Inert, fluoropolymer, chemically-resistant flow paths ensure low blanks
- Software automation greatly improves efficiency and reproducibility
- Easily fits next to the ICP-MS and can replace dedicated HEPA hood procedures
- Determination of multiple elements with flexible standardization techniques
- Accurate and precise down to the 10s of picogram L<sup>-1</sup> range
- Accurate/precise syringe control ensures exact volumes and flow rates for very reproducible preconcentration and elution
- Small elution volumes provide the highest preconcentration factors for small volumes (9 mL) of sample
- Small volume sample requirements combined with rapid column loading result high throughput (9 mins/sample)
- Inline analysis provides real-time insight into blank control and method development
- Labs with good blank control can obtain picogram L<sup>-1</sup> detection limits



seaFAST-pico System  
Note: ULPA enclosure not shown

