SampleSense *FAST* UHT-S
on the Avio 500 ICP

# Six Second Soil Mehlich-3-ICP SampleSense *FAST* UHT-S

## Introduction

Mehlich-3-ICP is a method for determining bioavailable concentrations of 11 extractable micronutrient elements in soil samples. Mehlich-3-ICP is invaluable for determining the amount of fertilizer to apply to farm fields. Because soil analyses must be completed in a narrow time window, ultra-high sample throughtput with high-reliability is required.

SampleSense *FAST* UHT-S* uses an inert injection valve with built-in optical sensors that automatically detect the liquid sample, inject the valve and trigger the ICP read in a tightly-timed analytical sequence. SampleSense *FAST* UHT-S eliminates wasted time from the ICP method and can double or even triple sample throughput while recording missing or empty tubes.

**SampleSense *FAST* UHT-S Benefits**

- 10 samples per minute Mehlich-3 ICP
- Automatic sensing, injection, and triggering of the ICP analytical read
- Detection and reporting of missing or empty sample tubes as “unsensed” samples
- Adding SampleSense *FAST* UHT-S can double or even triple sample throughput

** Formerly SampleSense Soil*

Elemental Scientific

## SampleSense *FAST* UHT-S Advantages for Mehlich-3-ICP

### Ease of Use

- Optical detection of the filled sample loop automatically triggers ICP analysis
- Removes timing and read delay adjustments
- Eliminates method development when changing sample loop size for other methods

### Automated Compensation of Physical Clogs and Timing Variables

- Reliable timing down to 0.05 s and better
- Compensates for:
  - Partial clogs from filter paper fibers, particles, etc.
  - Accidental line kinks
  - Timing variables caused by high or low sample tube levels
  - ICP computer slow-down from software and data storage

### Increased Productivity

- Produces long analytical runs without operator intervention
- Minimized sample consumption allows reanalysis
- Doubles or triples throughput of ICP instrument
- Reduces argon consumption

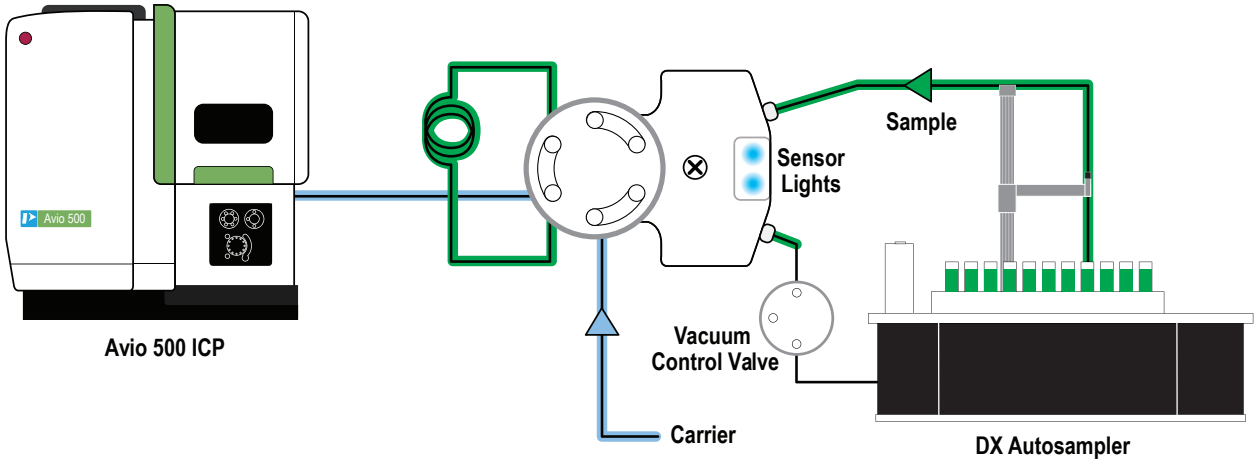
SampleSense valve with dual optical sensors

## SampleSense *FAST* UHT-S for Mehlich-3-ICP Soil Analysis

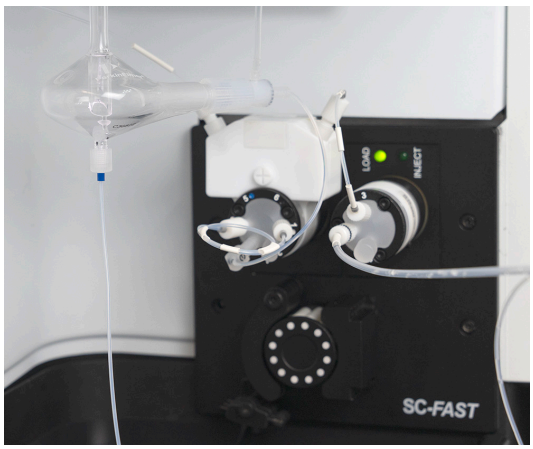
- SampleSense *FAST* UHT-S ICP (Avio 500)
- 11 Elements determined:  B, Ca, Cu, Fe, K, Mg, Mn, Na, S, P, Zn
- ICP read triggered from dual sensor optical sample detection
- 360 samples analyzed in <35 minutes
- 6 second sample-to-sample time
- <2 mL of sample consumed (vacuum control)
- Automatic detection of empty or missing sample tubes
- Most reliable high-throughput system on the market

## SampleSense *FAST* UHT-S

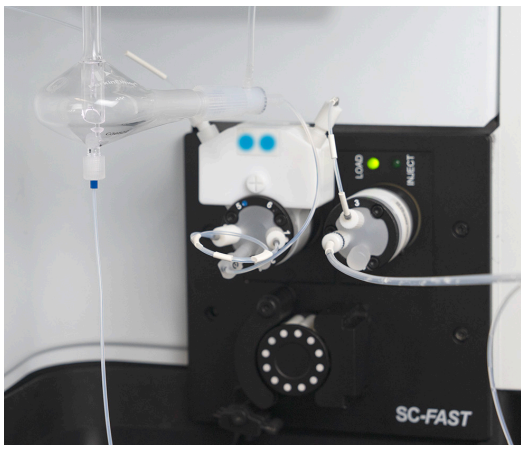
### SampleSense *FAST* UHT-S Flow Diagram



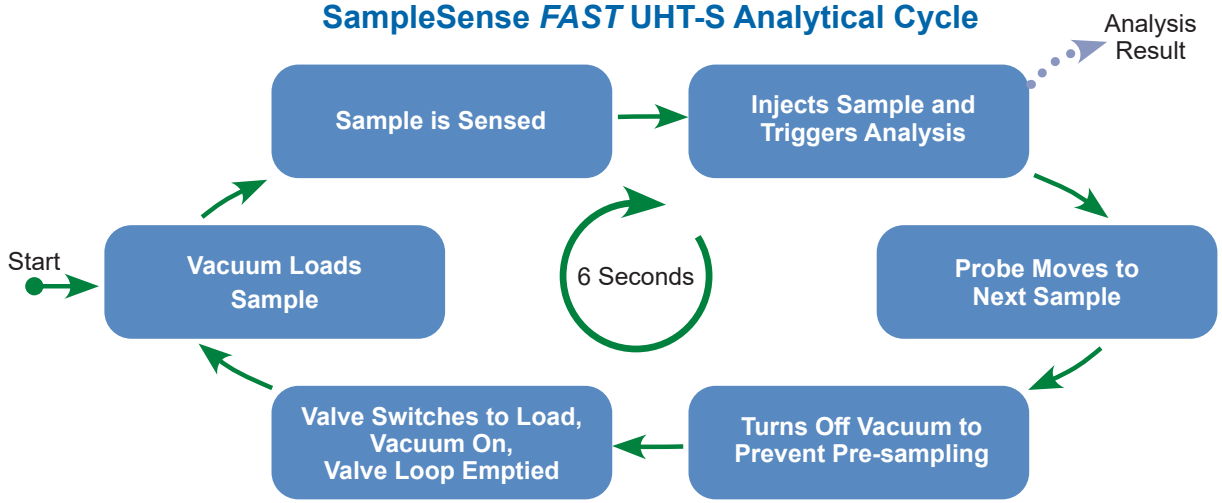

### Sample not present, valve sensors not activated




### Valve sensors activated, sample is sensed




### SampleSense *FAST* UHT-S Analytical Cycle



## ICP Method for Avio 500 ICP

### ICP Conditions

- Plasma Gas Flow: 8 L/min
- Aux Gas Flow: 0.2 L/min
- Nebulizer Gas Flow: 0.6 L/min
- Plasma Power: 1500 W
- Plasma View: Radial
- Replicates: 2
- Total Analysis Time ~6 sec per sample

### Mehlich Soil Analytes (nm):

- B – 249.677
- Ca – 317.933
- Cu – 327.393
- Fe – 238.204
- K – 766.490
- Mg – 279.077
- Mn – 257.610
- Na – 589.592
- P – 214.914
- S – 180.669
- Zn – 213.857

### PerkinElmer Avio 500 ICP Method Conditions

Method Editor : SampleSenseFAST M-3

Spectrometer | Sampler | Process | Calibration | Checks | QC | Options

Plasma

Source equilibration delay 0 sec

Plasma conditions ◉ Same for all analytes ○ Vary by analyte

☐ Monitor nebulizer back pressure

Check upper % 10

Action taken after alarm is triggered: Alarm and Continue

| | F'n | Analyte | Plasma (L/min) | Aux (L/min) | Neb (L/min) | Power (watts) | View Dist. | Plasma View |
|---|---|---|---|---|---|---|---|---|
| | -- | All | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |
| 1 | A | Mg 279.077 | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |
| 2 | A | Ca 317.933 | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |
| 3 | A | K 766.490 | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |
| 4 | A | Na 589.592 | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |
| 5 | A | Fe 238.204 | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |
| 6 | A | Mn 257.610 | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |
| 7 | A | Cu 327.393 | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |
| 8 | A | S 180.669 | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |
| 9 | A | Tm 313.126 | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |
| 10 | A | P 214.914 | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |
| 11 | A | Zn 213.857 | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |
| 12 | A | B 249.677 | 8 | 0.2 | 0.65 | 1500 | 15.0 | Radial |

## Experimental

### Avio 500 Calibration Standards

Method Editor : SampleSenseFAST M-3

Spectrometer | Sampler | Process | Calibration | Checks | QC | Options

Calibration units and standard concentrations

| | Analyte | Calib Units | Bottom | Low Mid | High Mid | Top |
|---|---|---|---|---|---|---|
| 1 | Mg 279.077 | mg/L | 24 | 60 | 120 | 240 |
| 2 | Ca 317.933 | mg/L | 10 | 25 | 50 | 100 |
| 3 | K 766.490 | mg/L | 40 | 100 | 200 | 400 |
| 4 | Na 589.592 | mg/L | 6 | 15 | 30 | 60 |
| 5 | Fe 238.204 | mg/L | 8 | 20 | 40 | 80 |
| 6 | Mn 257.610 | mg/L | 2 | 5 | 10 | 20 |
| 7 | Cu 327.393 | mg/L | 0.8 | 2 | 4 | 8 |
| 8 | S 180.669 | mg/L | 4 | 10 | 20 | 40 |
| 9 | Tm 313.126 | mg/L | 0.1 | 0.1 | 0.1 | 0.1 |
| 10 | P 214.914 | mg/L | 8 | 20 | 40 | 80 |
| 11 | Zn 213.857 | mg/L | 0.4 | 1 | 2 | 4 |
| 12 | B 249.677 | mg/L | 0.2 | 0.5 | 1 | 2 |

The ICP system was calibrated for the 11 elements of interest with a blank and 4 standards at varying concentrations across the PPM range. The additional element Tm was introduced to assess injection completeness and stability. The linearity of the resulting calibrations are shown in the table above.

### Missing Samples Detected

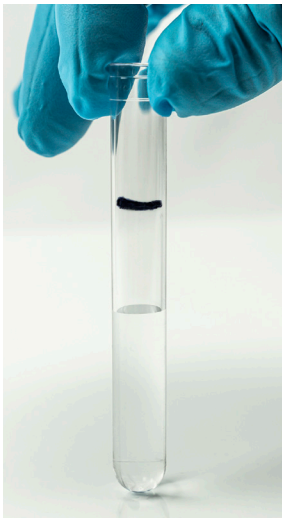
Message

**Unsensed Samples**

| | SC Rack Number | SC Vial Number | Instrument Rack | Instrument Vial | Time |
|---|---|---|---|---|---|
| ▶ | 1 | 45 | 1 | 45 | 20190813 9:05:00 |
| | 1 | 90 | 1 | 90 | 20190813 9:09:34 |
| | 2 | 45 | 2 | 45 | 20190813 9:14:08 |
| | 2 | 90 | 2 | 90 | 20190813 9:18:42 |
| | 3 | 45 | 3 | 45 | 20190813 9:23:16 |
| | 3 | 90 | 3 | 90 | 20190813 9:27:50 |

This table demonstrates the automatic missed sample logging capabilities provided by the SampleSense *FAST* UHT-S sensors. Empty sample vials were placed in the first three sample racks at positions 45 and 90. SampleSense identified the missing samples and provides this information in the software log shown here.

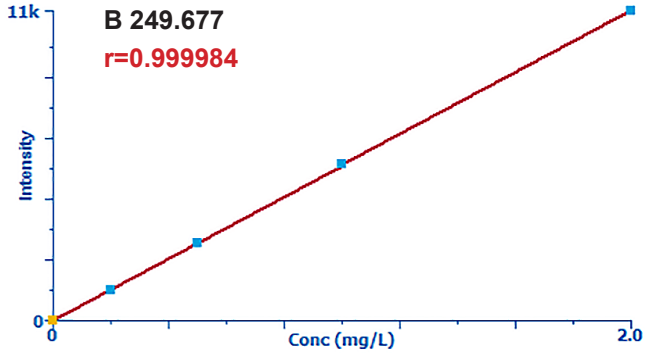
### Low Sample Consumption



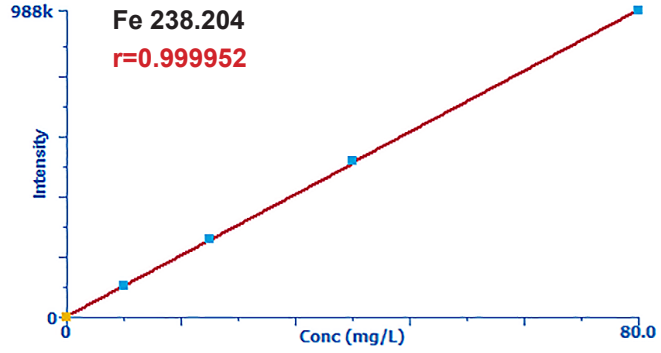
SampleSense *FAST* UHT-S consumes <2 mL of sample. The black line shows the original level of 5 mL extract. Post analysis 3.5 mL remains. Samples can be reanalyzed without re-extraction.

## Experimental *(Continued)*

### Calibration Curves 6 s Soil Method




12

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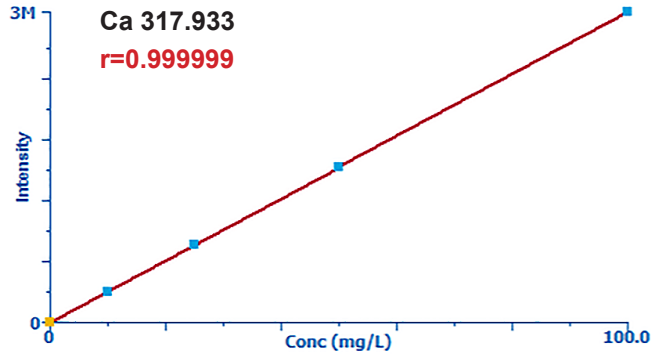


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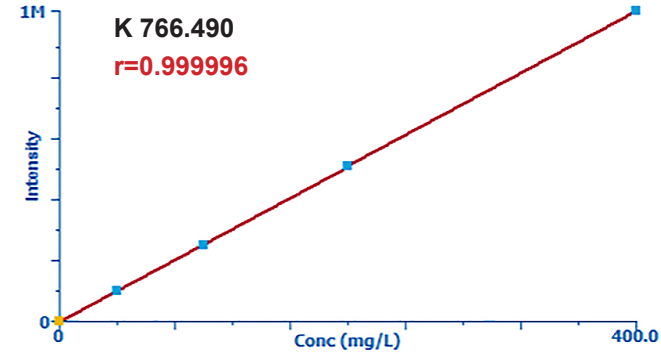
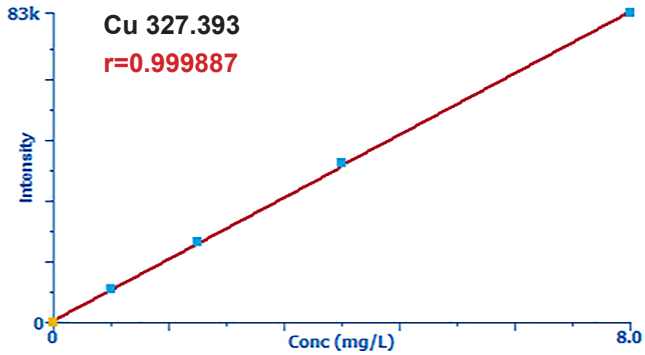



3

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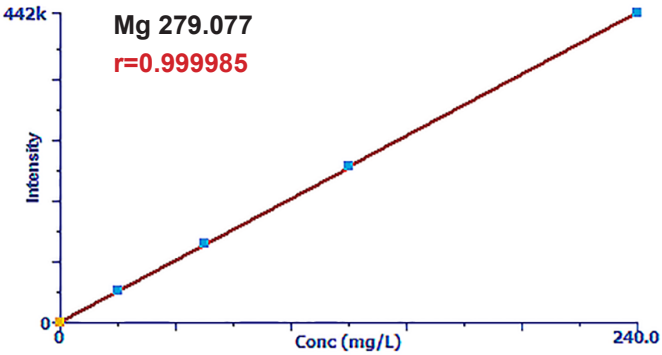


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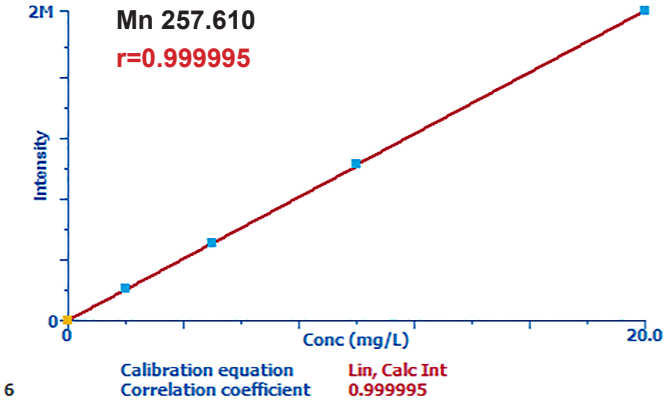
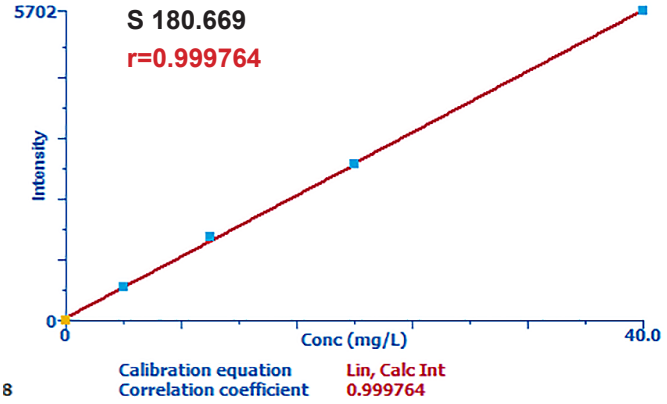
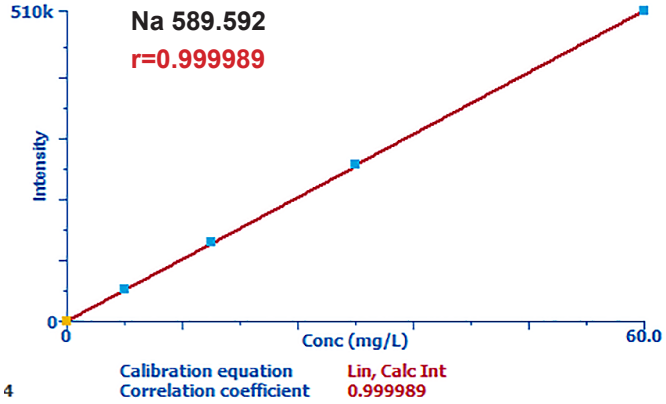
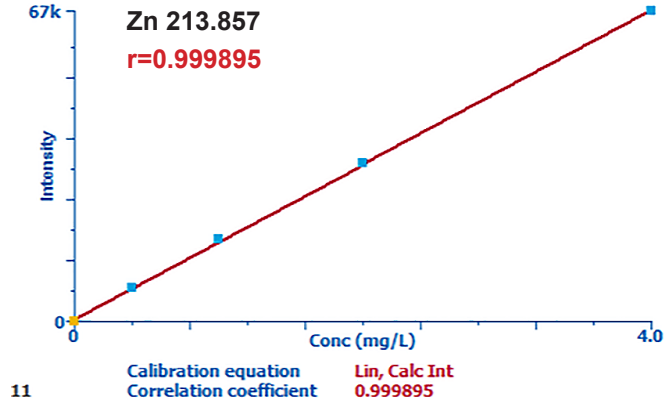
## Experimental *(Continued)*

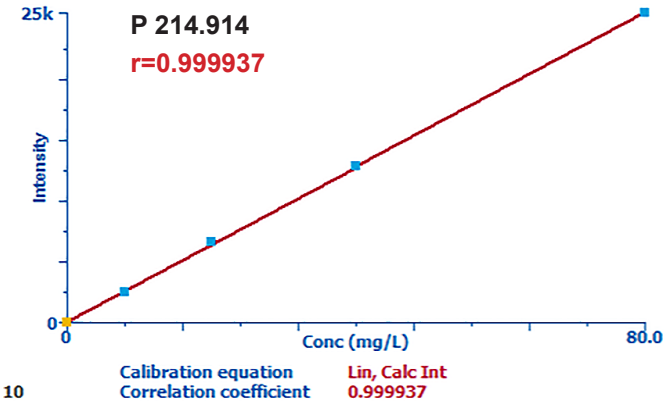
### Calibration Curves 6 s Soil Method



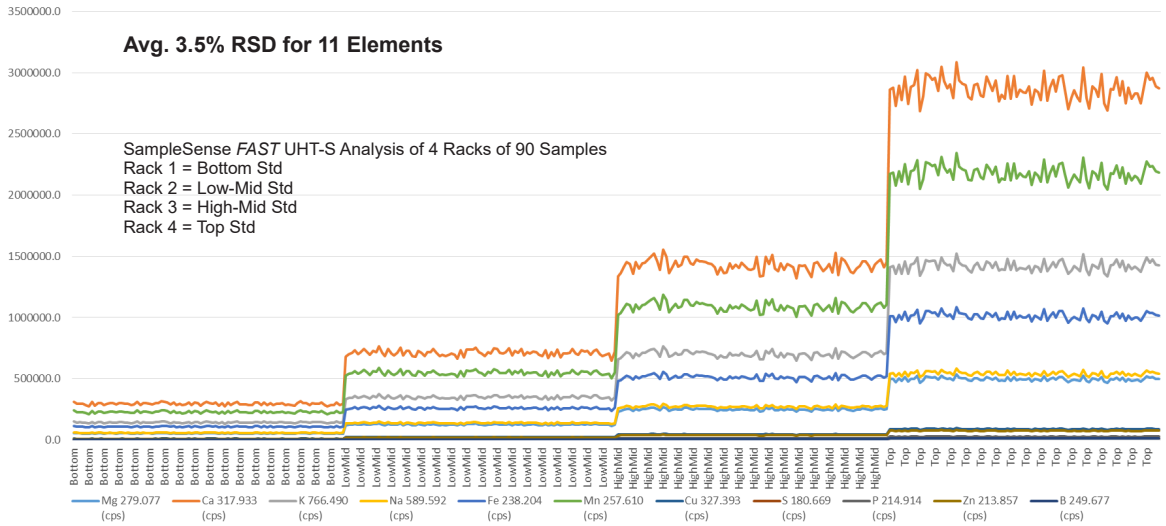




**Calibration Results**

| Element | Correlation Coefficient |
|---|---|
| B | 0.999 |
| Ca | 0.999 |
| Cu | 0.999 |
| Fe | 0.999 |
| K | 1.000 |
| Mg | 1.000 |
| Mn | 1.000 |
| Na | 1.000 |
| P | 0.999 |
| S | 0.999 |
| Zn | 0.999 |

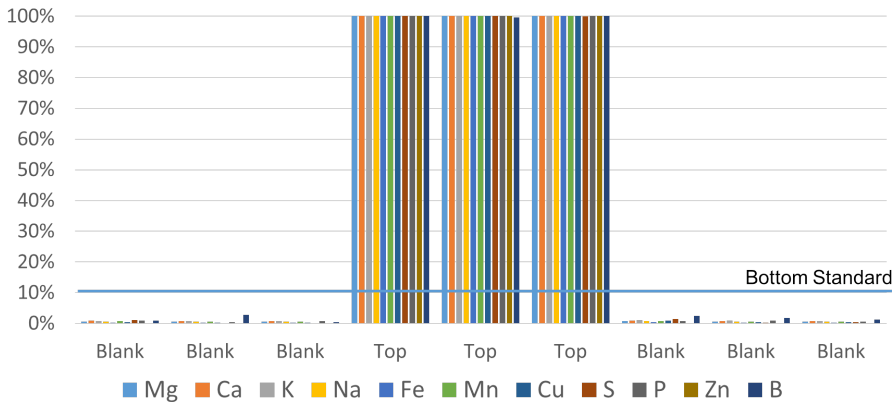
## Results

### 360 samples in 35 minutes




Analysis of 360 samples in 35 minutes. The four levels represent a rack of 90 samples, with each of the four calibration standards levels individually loaded with 5 mL of liquid into each of the 90 positions contained in each rack. Excellent stability observed from within each of the four concentration levels.

### Rinseout




The SampleSense *FAST* UHT-S rinse-out immediately reduces all elements to concentrations well below the bottom standard when using the six second Mehlich-3-ICP procedure. Additional seconds can be added to the rinse-out to meet lab requirements. The system can deliver rinse-out factors of 1,000x, 10,000x or more depending on how clear the spray chamber needs to be before the next sample is introduced.

## Conclusion

At 10 samples per minute, SampleSense *FAST* UHT-S for Mehlich-3-ICP method can more than double the productivity of the ICP instrument. It delivers reliable and reproducible data, while providing quick and effective sample rinse out.

| Description | Part Numbers |
|---|---|
| SampleSense *FAST* UHT-S 2DX | 2F-SS6-UHT-37 |
| SampleSense *FAST* UHT-S 4DX | 4F-SS6-UHT-37 |
| SampleSense *FAST* UHT-S 8DX | 8F-SS6-UHT-37 |
| SampleSense *FAST* UHT-S 14DX | 14F-SS6-UHT-37 |

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