prep*FAST* M5
Syringe Driven Autodilution
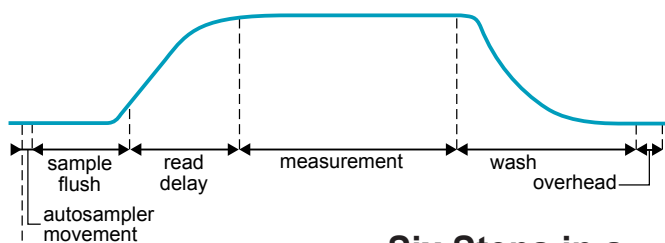
*E*lemental Scientific
ICP | ICPMS | AA

prep*FAST* M5 Inline Autodilution
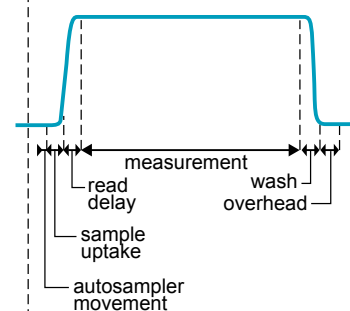
prep*FAST* M5 Automation

The prep*FAST* M5 has an additional syringe for sample loading allowing for precise and accurate loading of micro volume and/or viscous samples. The 5th syringe also provide additional features such as premixing samples and enhanced washout for lower blanks. Combined with the autocalibration, inline sample dilution and automatic overange dilution the capabilities of prep*FAST*, the prep*FAST* M5 is an advanced laboratory automation system.

FAST Uptake & Washout

Normal Analysis

sample flush · read delay · measurement · wash · overhead · autosampler movement

FAST Analysis

measurement · read delay · wash overhead · sample uptake · autosampler movement

0s   100s   200s

Six Steps in a Standard Analysis

1. Autosampler Movement
2. Uptake
3. Stabilization
4. **Measurement**
5. Wash
6. Overhead

prep*FAST* has the quickest signal stabilization and most complete rinse-out of any sample introduction system, reducing uptake and wash times while increasing sample throughput.

Benefits

- Fully Automated
  - Autocalibrate
  - Autodilute
  - QC Autodilute
- Rapid uptake, stabilization and washout
- Inline dilution
- Integrated with ICP/ICPMS Software

S500V2 Syringe Pump

The precise (<± 0.05%) and accurate (<± 0.2%) S500V2 syringe pump provides smooth and balanced delivery of solutions over a wide range of flow rates (1 to 40,000 µL/min) to ensure rapid reliable inline dilutions.

Five Syringes:

1. Rinse
2. Carrier
3. Diluent
4. Internal Standard
5. Sample Uptake

Syringe Loading

- Premix Sample Before Loading
- Precise Loading of Samples
  - Load Micro Volumes of Sample
  - Operate with Microtiter Plates
  - Load Viscous Samples
- Superior Washout
- Lower Blanks

Syringe Dilution

- Clean
- Chemically Resistant
  - Organics
  - Strong Acids
- Low Maintenance
- Accurate and Precise
- Long-Term Stability

# Fluoropolymer P-Series Valves

- PFA rotors for long life and low maintenance
- Chemically resistant compression ring
  - Uniform pressure
  - Keyed for easy assembly
  - Prevents damage from overtightening
- Internal components PTFE coated to prevent corrosion
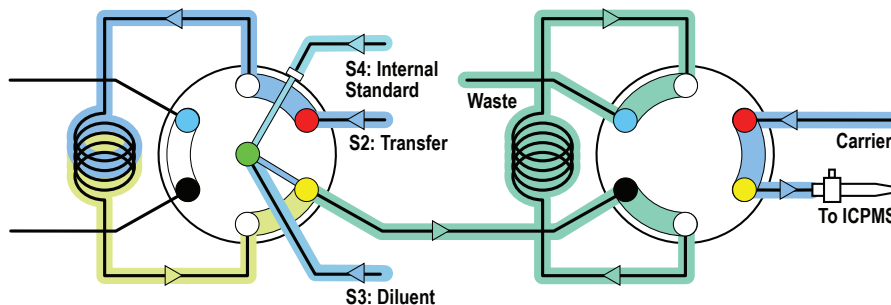- All fluoropolymer flow path
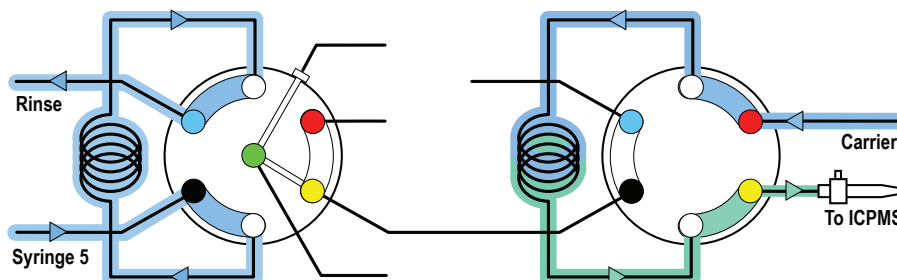
Automated Inline Autodilution

Inline Dilutions

1. Syringe load sample into loop

Sample

Syringe 5

Carrier

To ICPMS
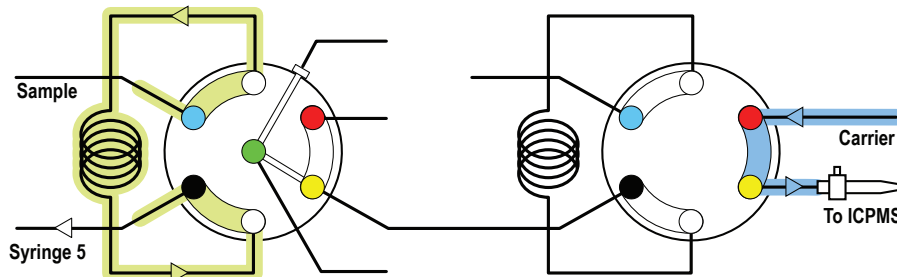
2. Syringes add internal standard, diluent and sample into second loop

S4: Internal Standard

S2: Transfer

S3: Diluent

Waste

Carrier

To ICPMS

3. Diluted sample is injected and sample loop is cleaned

Rinse

Syringe 5

Carrier

To ICPMS

4. Sample and dilution loops are cleaned

S1: Rinse

Waste

Carrier

To ICPMS
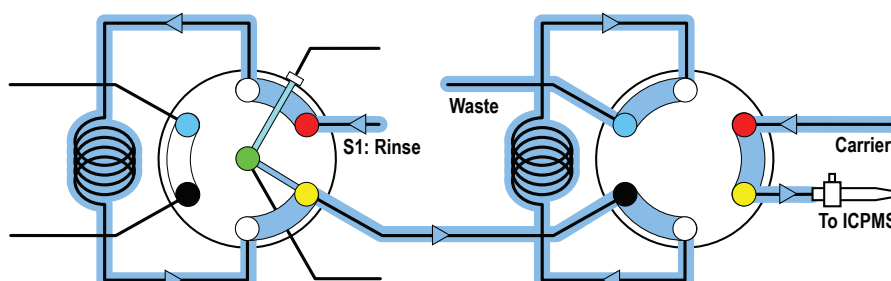
*Patent Pending

Intelligent Autodilution

Automated QC Dilutions

```
Load Sample
   │
   ▼
Autodilute
and Analyze  ──→  QC PASS  ──→  ICP/ICPMS SOFTWARE
   │                             Dilution Correction
   ▼                                  │
QC FAIL                               ▼
   │                             Report Data
   ▼
Re-queue with
Intelligent Dilution
(loops back to Load Sample)

INTELLIGENT DILUTION
```
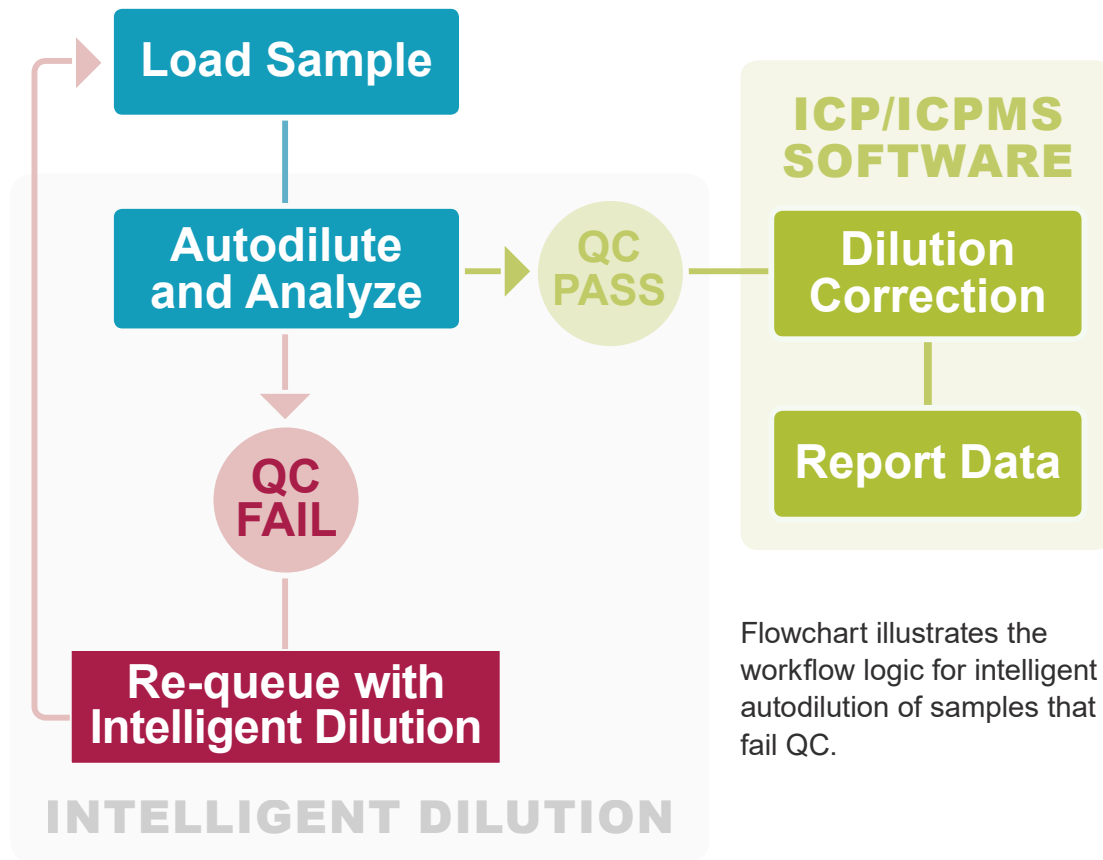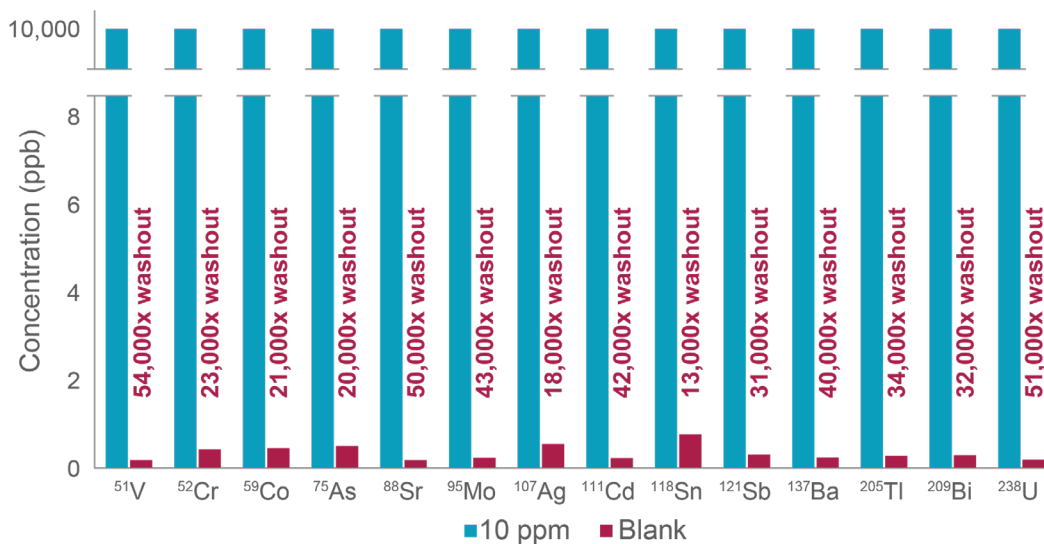
Flowchart illustrates the workflow logic for intelligent autodilution of samples that fail QC.

Enhanced Washout

Concentration (ppb) — bars for:
- ^{51}V — 54,000x washout
- ^{52}Cr — 23,000x washout
- ^{59}Co — 21,000x washout
- ^{75}As — 20,000x washout
- ^{88}Sr — 50,000x washout
- ^{95}Mo — 43,000x washout
- ^{107}Ag — 18,000x washout
- ^{111}Cd — 42,000x washout
- ^{118}Sn — 13,000x washout
- ^{121}Sb — 31,000x washout
- ^{137}Ba — 40,000x washout
- ^{205}Tl — 34,000x washout
- ^{209}Bi — 32,000x washout
- ^{238}U — 51,000x washout

■ 10 ppm   ■ Blank

Washout greater than 20,000x is achieved in 10 seconds. This is more than sufficient to eliminate any carry-over from the high concentration QC over range sample onto the intelligently diluted re-run.

Flexible autocalibration strategies are easily automated and employed with the prep*FAST* M5.

- Simplifies complex calibration routines such as USP bracketing and multiple stock calibrations
- Only prepares calibration standards as needed – improves stability and reduces lab waste
- On-line dilutions remove risk of contamination from laboratory sources

Conventional Calibration vs prep*FAST* Autocalibration

Conventional Calibration
(seven points)

Offline Prep: 1 Blank + 7 Standards

STD Position	Concentration
10	0
1	2.5
2	5
3	12.5
4	50
5	100
6	200
7	500

prepFAST Autocalibration
(seven points)

Inline Prep: 1 Blank + 1 Standard

STD Position	Inline Dilution Factor	Concentration
10	200x	0
2	200x	2.5
2	100x	5
2	40x	12.5
2	10x	50
2	5x	100
2	2.5x	200
2	1x	500

prep*FAST* Calibration: Blank can be analyzed diluted or undiluted.

Multiple Curves from a Single Stock Standard

USP <233>
Conventional Calibration
(4 Dosage Levels)

Offline Prep: 1 Blank + 8 Standards

Daily Dose	STD Position	STD	As Concentration (µg/L)
20g/day	10		0
	1	0.5J	0.075
	2	2J	0.3
10g/day	10		0
	3	0.5J	0.15
	4	2J	0.6
5g/day	10		0
	5	0.5J	0.3
	6	2J	1.2
1g/day	10		0
	7	0.5J	1.5
	8	2J	6

USP <233>
prepFAST Autocalibration
(4 Dosage Levels)

Inline Prep: 1 Blank + 1 Standard

Daily Dose	STD Position	Inline Dilution Factor	As Concentration (µg/L)
20g/day	10	1x	0
	1	80x	0.075
	1	20x	0.3
10g/day	10	1x	0
	1	40x	0.15
	1	10x	0.6
5g/day	10	1x	0
	1	20x	0.3
	1	5x	1.2
1g/day	10	1x	0
	1	4x	1.5
	1	1x	6

prep*FAST* Calibration: Blank can be analyzed diluted or undiluted.
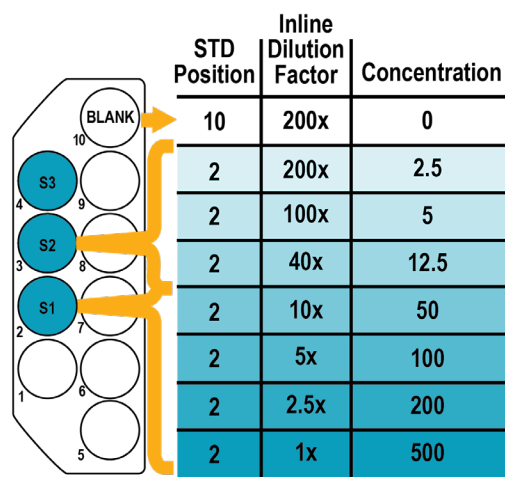
Calibration Using Multiple Standards

Conventional Calibration
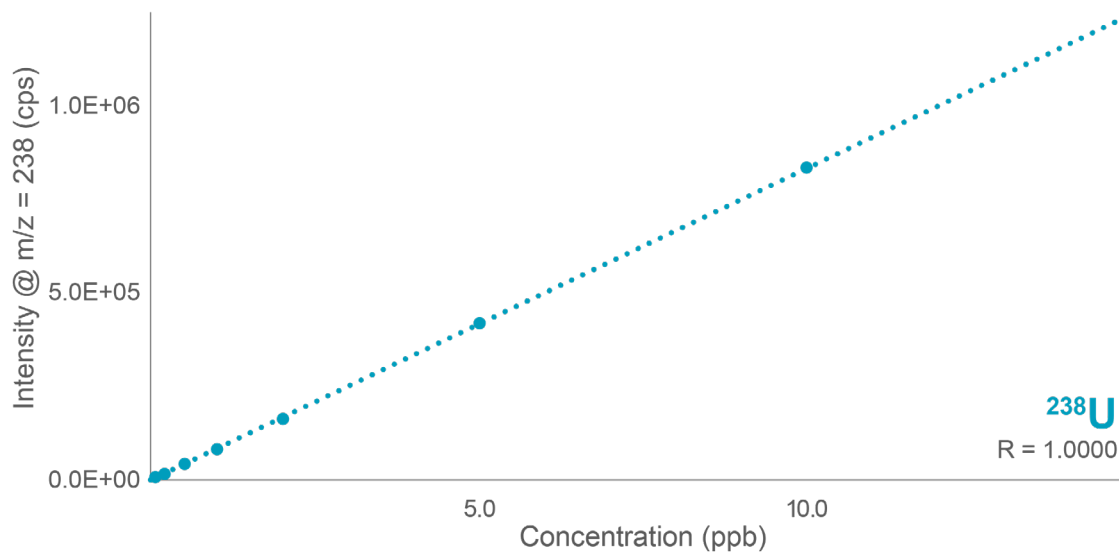### (seven points)
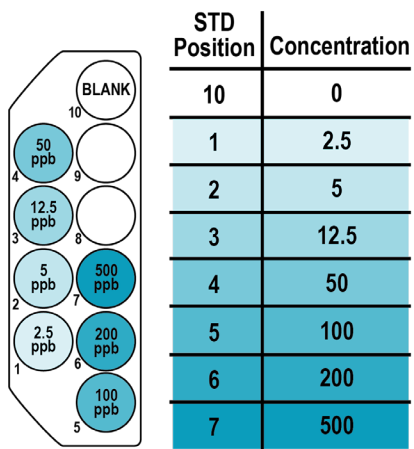
Offline Prep: 1 Blank + 7 Standards

STD Position	Concentration
10	0
1	2.5
2	5
3	12.5
4	50
5	100
6	200
7	500

prepFAST Autocalibration
(seven points)

Inline Prep: 1 Blank + 1 Standard

STD Position	Inline Dilution Factor	Concentration
10	200x	0
2	200x	2.5
2	100x	5
2	40x	12.5
2	10x	50
2	5x	100
2	2.5x	200
2	1x	500

prep*FAST* Calibration: Blank can be analyzed diluted or undiluted.

Autocalibration ^{238}U

^{238}U

R = 1.0000
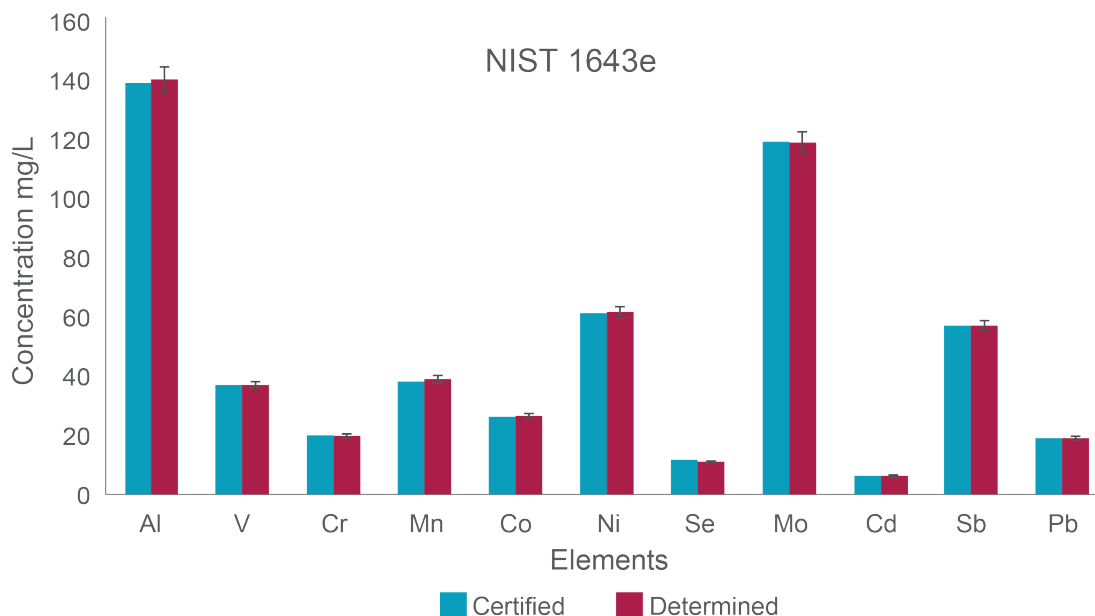
Predefined dilution factors for a single multi-element standard are used to build calibration curves. Accuracy of dilution results in high linearity (R = 1.0000).
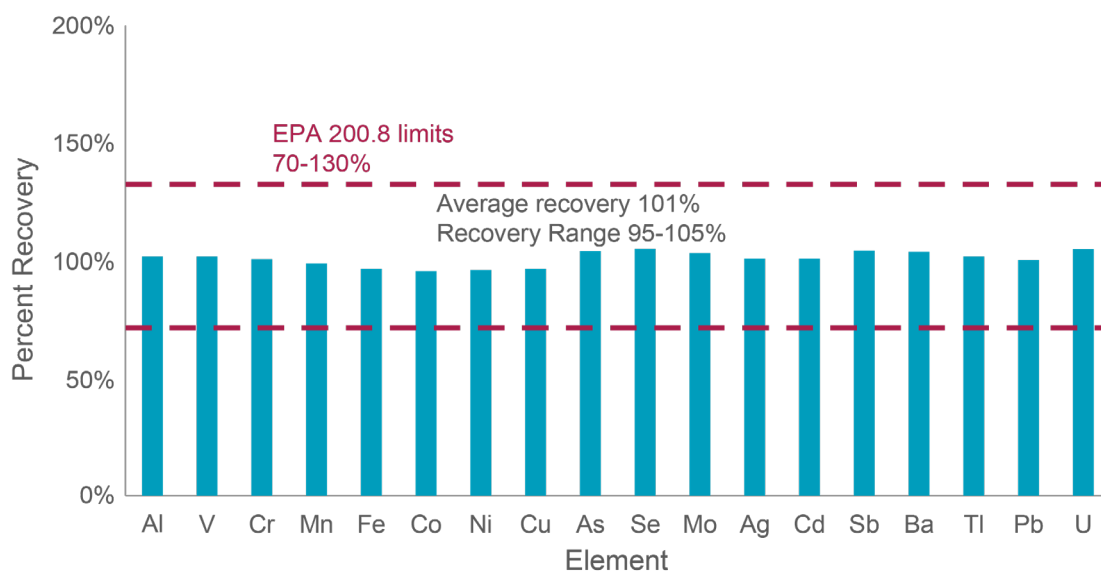
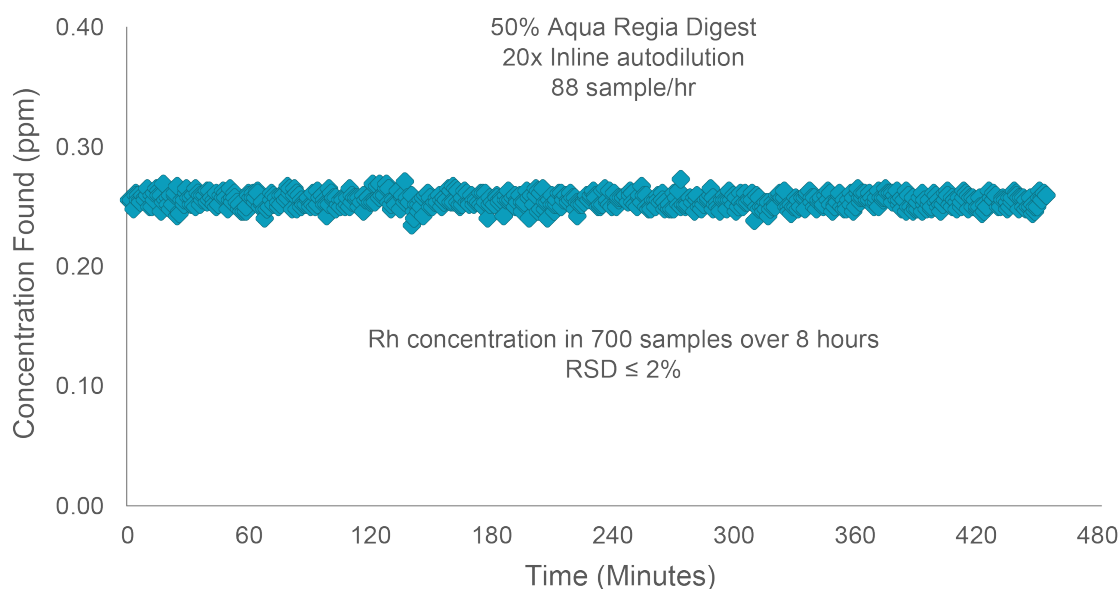# Environmental

Trace Metals in Water CRM

Precise and accurate results for concentrations of metals in a Trace Metals in Water Certified Reference Material (CRM, NIST 1643e) are obtained with prep*FAST* autocalibration and autodilution.

Accurate Spike Recovery

Omaha tap water is used as the EPA 200.8 defined, Laboratory Fortified Matrix (LFM) and Quality Control Standard (QCS). Recovery of 95-105% greatly exceeds EPA requirements of 70-130%.

Sample Stability

50% Aqua Regia Digest
20x Inline autodilution
88 sample/hr

Rh concentration in 700 samples over 8 hours
RSD ≤ 2%

Fire assay digests for precious metals in Aqua Regia require dilution before analysis. prep*FAST* inline 20x autodilution eliminates the manual dilution step.
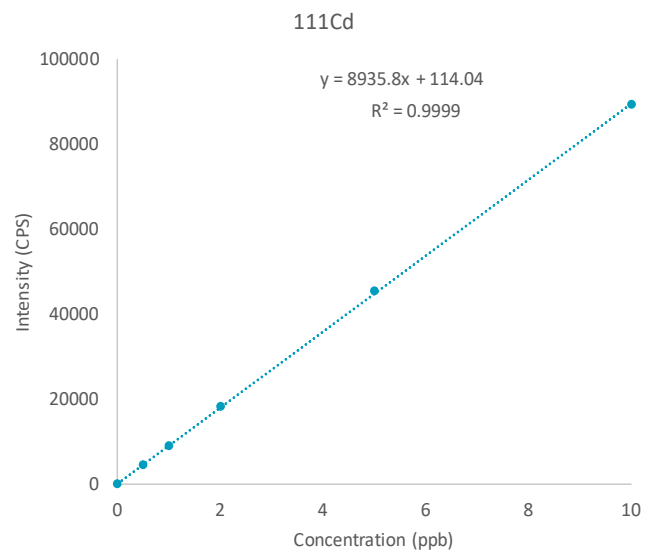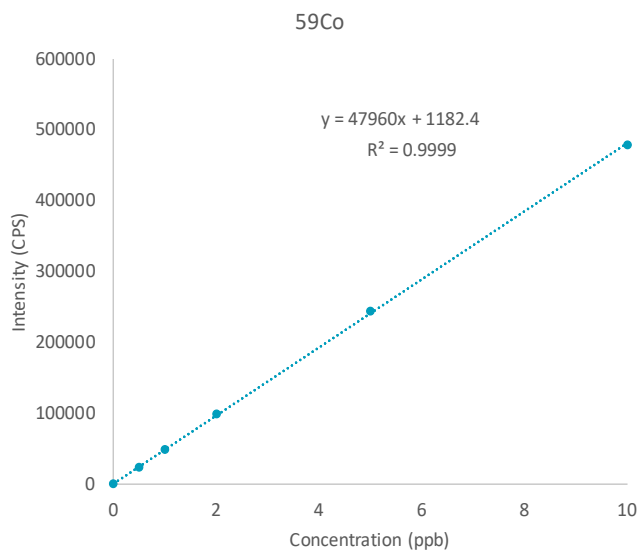
Accuracy

PTC 1b

■ Co ■ Ni ■ Fe ■ Cu

Digestions of PTC 1b (7 replicates, n = 5)
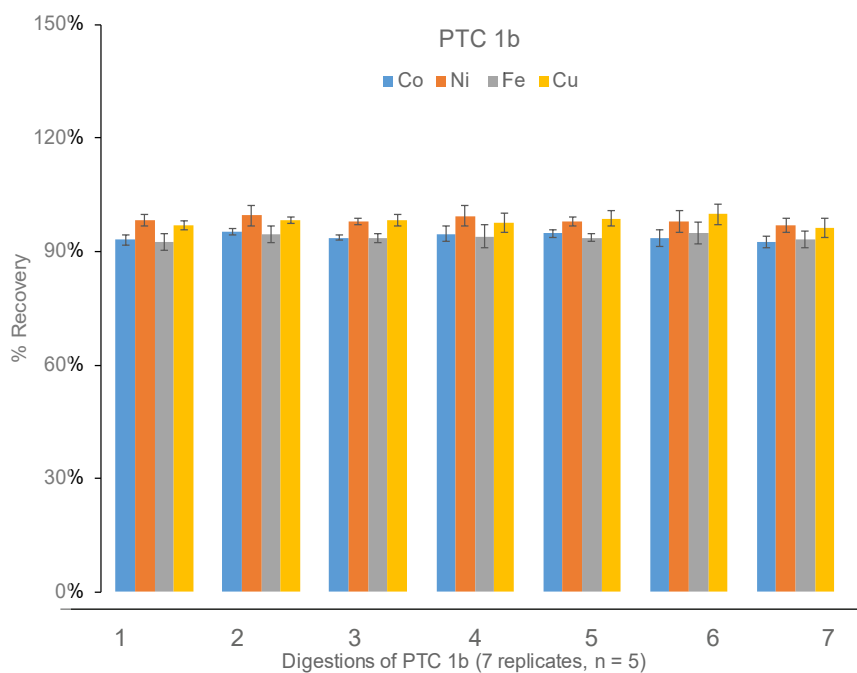
High TDS ore samples (H_2SO_4, HNO_3, HF and H_3BO_3 digests) are placed directly in the prep*FAST* M5 and autodiluted (10x) at time of analysis on ICP. High recoveries are obtained while improving sample throughput and minimizing operator handling of dangerous chemicals.
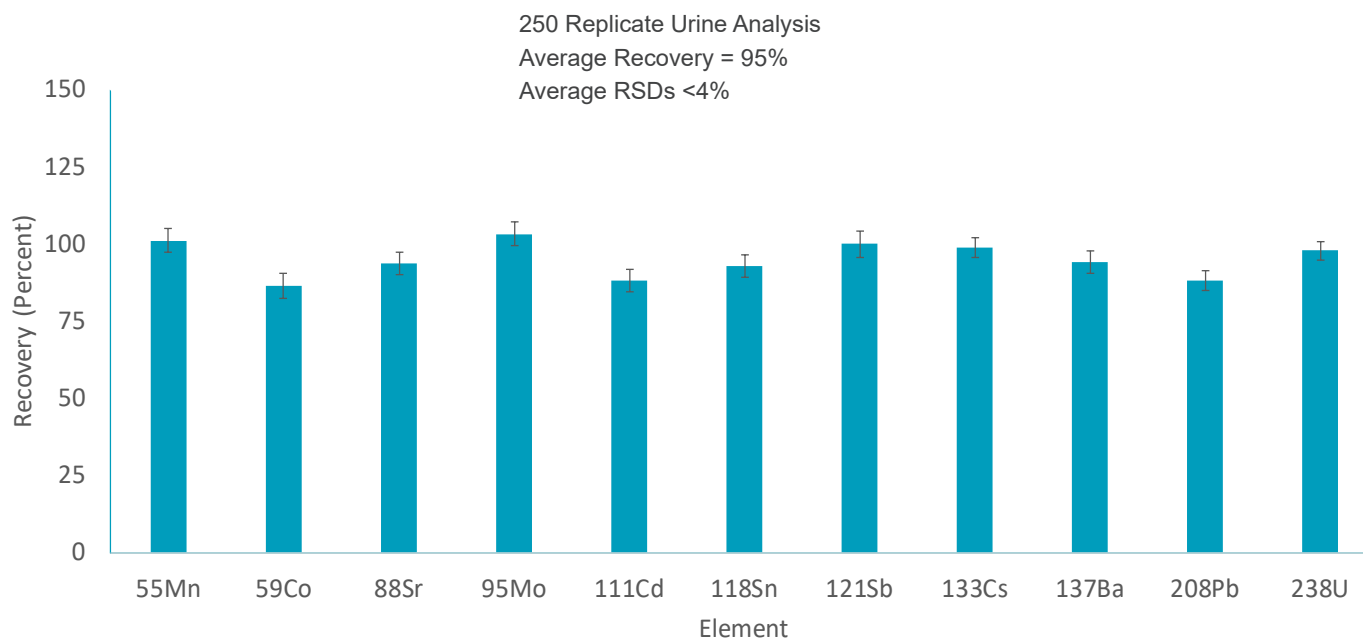
Clinical (Urine)

- **Automated calibration routine with prep*FAST* M5 saves significant operator time**
- **Excellent accuracy and reproducibility demonstrated for urine samples**
- **Samples diluted on-line by 10x, reduces sample handling**

Autocalibration with 100μL Sample Loop

59Co

$y = 47960x + 1182.4$
$R^2 = 0.9999$

Intensity (CPS) vs Concentration (ppb)

111Cd

$y = 8935.8x + 114.04$
$R^2 = 0.9999$

Intensity (CPS) vs Concentration (ppb)

Recovery Using 100μL Urine Samples

250 Replicate Urine Analysis
Average Recovery = 95%
Average RSDs <4%

Recovery (Percent) vs Element

Elements: 55Mn, 59Co, 88Sr, 95Mo, 111Cd, 118Sn, 121Sb, 133Cs, 137Ba, 208Pb, 238U
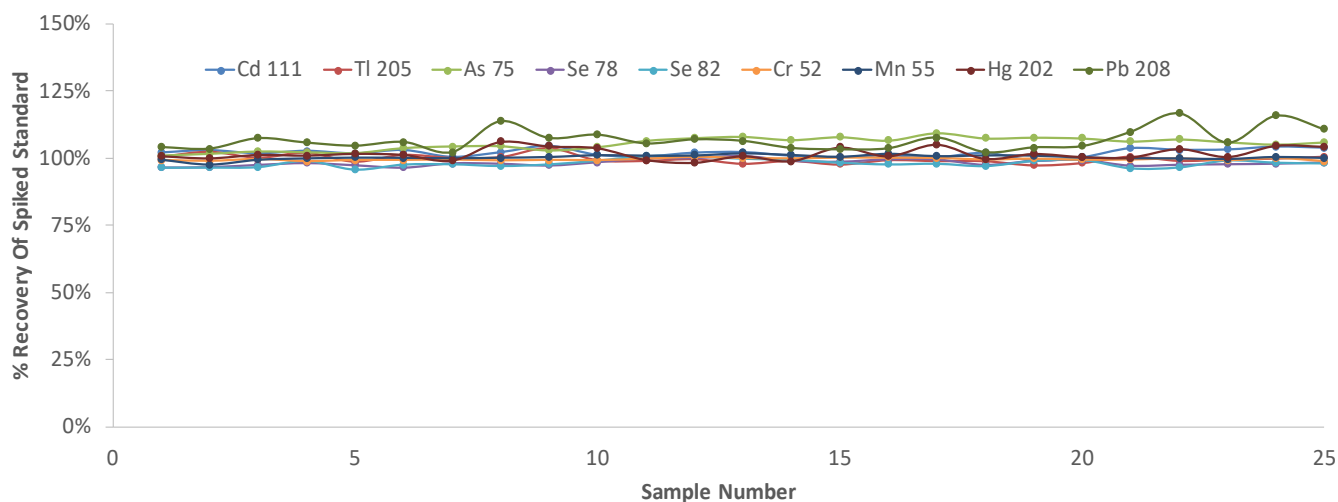
Clinical (Blood)

- Automated calibration and sample handling demonstrate excellent accuracy on sample spikes and reference materials
- Blood samples diluted 50x online; reduced sample handling also improves operator safety
- Automated matrix-matched calibration performed on-line with prep*FAST* M5

Spike Recovery from Undiluted Blood

Spike Blood Sample Recovery Chart

Legend: Cd 111, Tl 205, As 75, Se 78, Se 82, Cr 52, Mn 55, Hg 202, Pb 208

Y-axis: % Recovery Of Spiked Standard (0% to 150%)
X-axis: Sample Number (0 to 25)

UTAK Blood CRM Accuracy and Precision

UTAK Control Level 2

Sample Id	Cr 52 (ppb)	Mn 55 (ppb)	As 75 (ppb)	Se 78 (ppb)	Se 82 (ppb)	Cd 111 (ppb)	Hg 202 (ppb)	Tl 205 (ppb)	Pb 208 (ppb)
Expected Value (ppb)	19.300	30.400	27.600	207.000	207.000	5.300	15.800	11.500	402.000
% Recovery	94%	95%	103%	100%	107%	96%	102%	95%	99%
% RSD	0.8%	1.4%	4.3%	1.8%	2.1%	2.3%	2.2%	1.0%	1.6%

UTAK Control Level 3

Sample Id	Cr 52 (ppb)	Mn 55 (ppb)	As 75 (ppb)	Se 78 (ppb)	Se 82 (ppb)	Cd 111 (ppb)	Hg 202 (ppb)	Tl 205 (ppb)	Pb 208 (ppb)
Expected Value	69.000	90.000	84.500	604.000	604.000	14.300	51.700	45.200	597.000
% Recovery	95%	98%	101%	104%	106%	95%	98%	94%	99%
% RSD	0.3%	0.9%	1.7%	0.6%	0.3%	1.6%	2.6%	2.4%	3.6%

Pharmaceutical

- **prep*FAST* M5** performs required USP bracketing calibrations standards for each sample dosage
- **Provides automated sample dilutions**

Autocalibration

- **Calibration** Blank, 0.5J and 1.5J

## Automated Inline Sample Dilution and J Spiking

- **Suitability** Drift determined at 1.5J
    - NMT 20% after sample analysis

- **Repeatability** determined on six 1J spiked sample replicates
    - NMT 20%

- **Ruggedness** repeatability determined on 2 separate days, operators, instruments
    - NMT 25%

- **Accuracy** determined on six 1J spiked samples
    - NMT 70%-150%

- **Detectability** determined on 0.8J and 1J spiked samples
    - 1J spiked sample must be greater than 0.8J spiked sample

Provides unique calibration protocols for USP elemental impurities analysis.
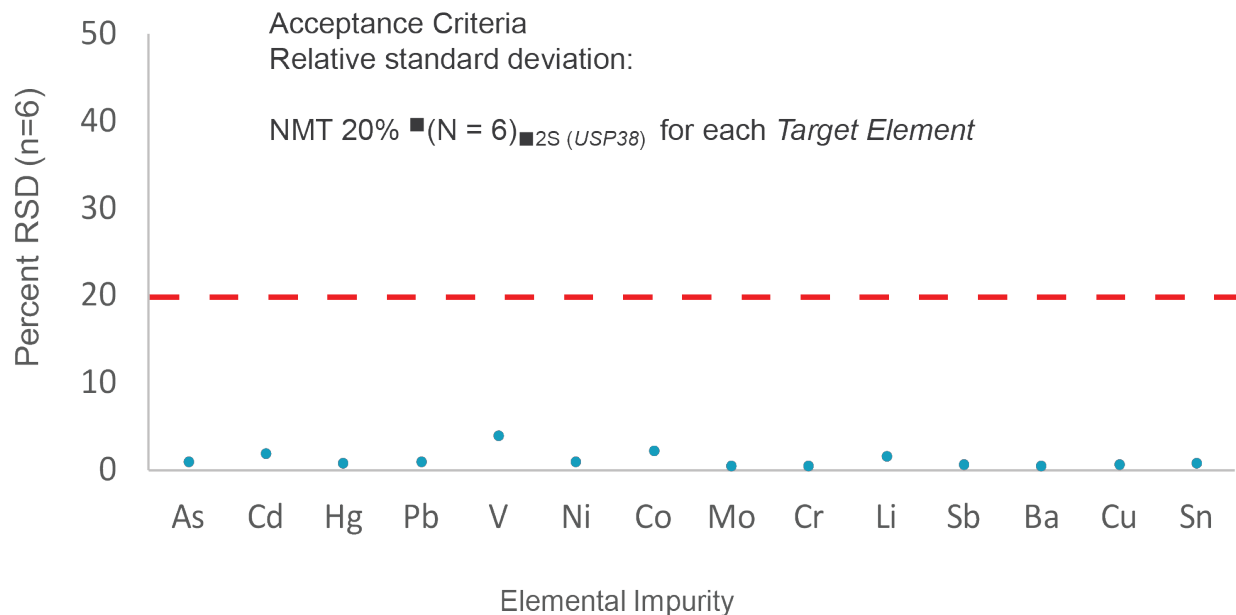
ICH "J" Calibration Coefficients

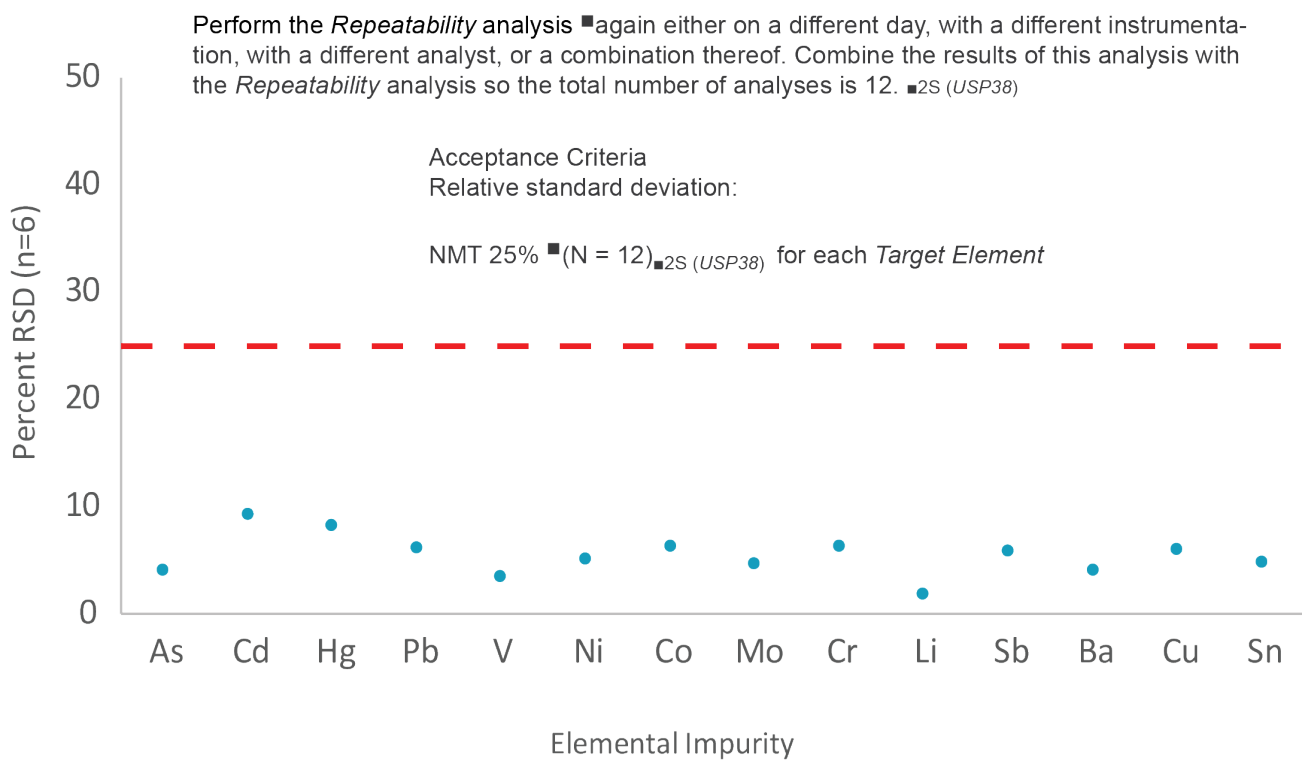|	Class 1	Class 2A	Class 2B
	As Cd Hg Pb	Co Mo Se V	Ag Au Ir Os Pd Pt Rh Ru Tl
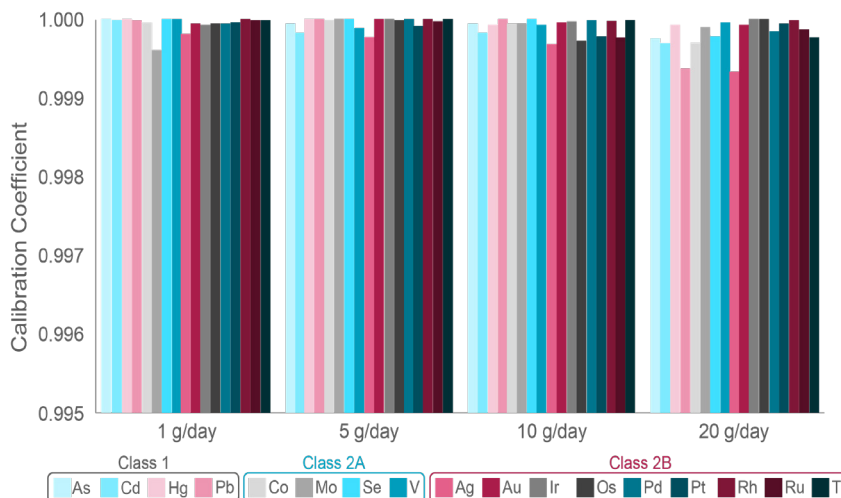
Multiple calibration curves for the USP elements have good linearity for drugs with a large range of daily doses. (ICH = International Conference on Harmonisation)

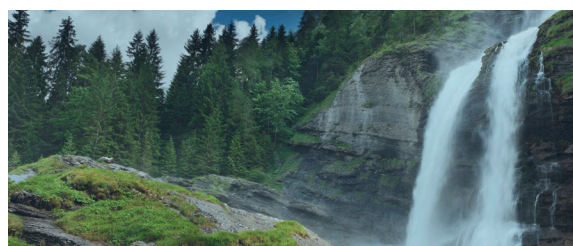## Repeatability Determined on Six 1J Spiked Sample Replicates

Acceptance Criteria
Relative standard deviation:

NMT 20% ■(N = 6)■2S (USP38) for each *Target Element*

Percent RSD (n=6)

Elemental Impurity

Ruggedness Repeatability: 2 Separate Days, Operators, Instruments

Perform the *Repeatability* analysis ■again either on a different day, with a different instrumenta-
tion, with a different analyst, or a combination thereof. Combine the results of this analysis with
the *Repeatability* analysis so the total number of analyses is 12. ■2S (USP38)

Acceptance Criteria
Relative standard deviation:

NMT 25% ■(N = 12)■2S (USP38) for each *Target Element*

Percent RSD (n=6)

Elemental Impurity

Notes

Notes

prep*FAST* M5 Applications

- Environmental
- Pharmaceutical
- Clinical
- Biological
- Geochemical

18185