High Throughput Analysis of Drinking Water by ICP-MS According to EPA Method 200.8

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Method: EPA 200.8

- Drinking water is the world‘s most important resource
- Quality control for drinking water is regulated by international and national regulations and norms
- The U.S. Environmental Protection Agency (EPA) has released the Method 200.8, which specifies criteria for the determination of trace elements in waters and wastes by ICP-MS
- The method applies to the determination of the 21 listed elements in ground water, surface waters, and drinking water.

Analyte	
Aluminum	(Al)
Antimony	(Sb)
Arsenic	(As)
Barium	(Ba)
Beryllium	(Be)
Cadmium	(Cd)
Chromium	(Cr)
Cobalt	(Co)
Copper	(Cu)
Lead	(Pb)
Manganese	(Mn)
Mercury	(Hg)
Molybdenum	(Mo)
Nickel	(Ni)
Selenium	(Se)
Silver	(Ag)
Thallium	(Tl)
Thorium	(Th)
Uranium	(U)
Vanadium	(V)
Zinc	(Zn)

Challenge: Speed vs Precision

- For labs with high sample throughput, the more samples analyzed per hour the lower the cost per sample
- Accuracy and precision often come at the cost of speed
- How can we speed up our analyses without sacrificing the required precision?

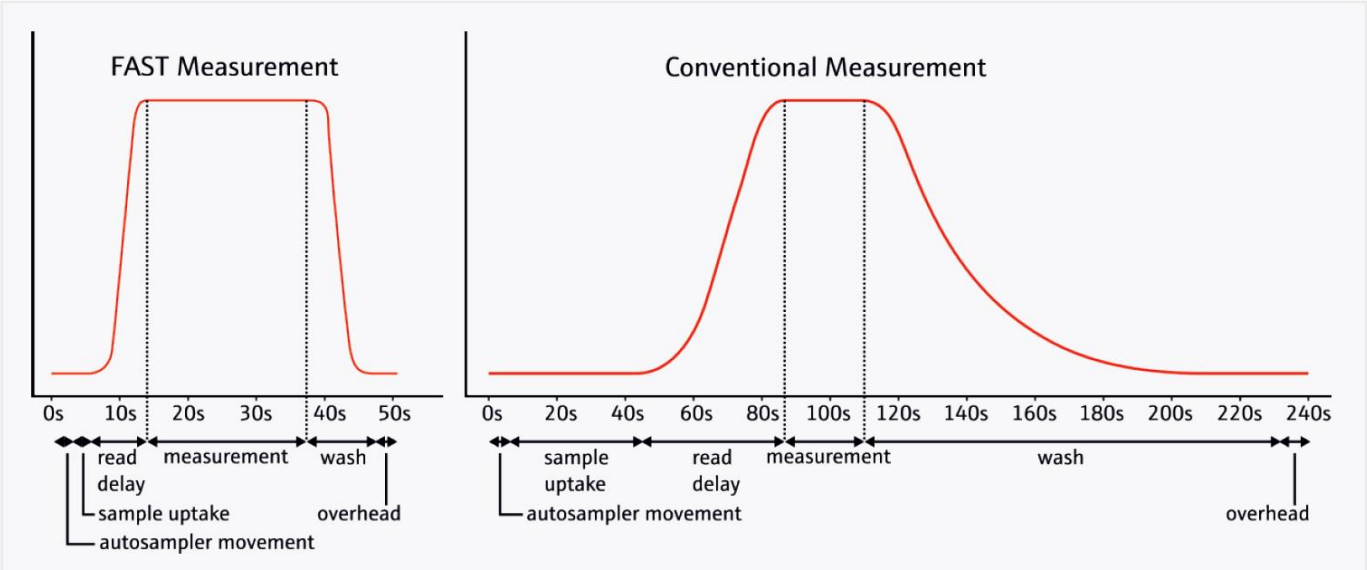
➢ **With Higher Sensitivity**

  - Higher sensitivity translates to more counts/second
  - More counts/second means fewer seconds to achieve the required counts for precise analysis

- With the PlasmaQuant MS, >82 samples per hour was achieved with the method required precision

Sample Introduction

- The PlasmaQuant® MS was equipped with:
  - oneFAST, ESI introduction system
  - ASX 560 (240 sample capacity)
  - standard aqueous sample nebulizer, spray chamber, and torch

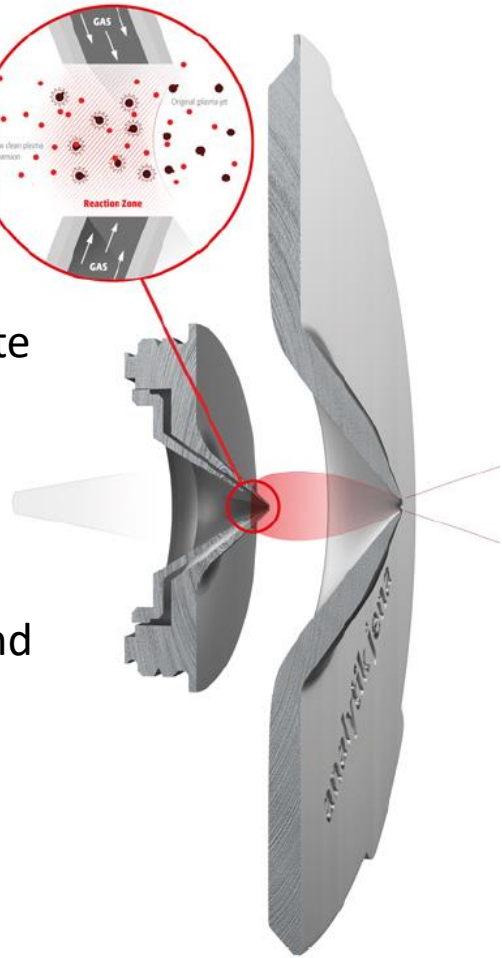


- Non-measurement steps (sample uptake, washout, autosampler movement) are minimized using the ESI oneFAST system
  - Provides a significant boost to sample throughput

Experiment Parameters

Parameter	Specification
Plasma Gas Flow	9 L/min
Auxiliary Gas Flow	1.45 L/min
Nebulizer Gas Flow	1.01 L/min
Spray Chamber Temp	3°C
RF Power	1450 W
Sampling Depth	5.0 mm
Dwell Time	20 ms (50 ms for Be, As, Se)
Scans per Replicate	7 (peak hopping, 1 pt/peak)
No. of Replicates	6
Stabilization Delay	19 s
Sample Load Time	7 s
iCRC Gas Flow	He, 120 mL/min
Detector Attenuation	None

- Total argon usage is <12 L/min
- Dwell time is increased for ions with high ionization energies or low analyte isotope abundance
- iCRC technology moves interference management at the skimmer cone and ahead of the ion optics
  - Increases quadrupole cleanliness and lifetime



The Instrument: PlasmaQuant MS

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- High throughput analysis was carried out with PQ MS
- Discrete Dynode Electron Multiplier (DDEM) as the unique all digital detector
  - In pure ‘pulse-counting’ mode
  - 10 orders of linear dynamic range
  - No separate analog electronics
  - No regular cross-calibrations
- At high concentration, signal can be automatically attenuated

Isotope	Sensitivity of PQ MS Mcps/ppm	Sensitivity of PQ MS Elite Mcps/ppm
^{7}Li	65	250
^{9}Be	20	50
^{59}Co	400	1000
^{115}In	500	1500
^{205}Tl	200	750
^{232}Th	300	1000
^{238}U	300	1000
CeO^{+}/Ce^{+}	**< 2%**	**< 2%**
Ce^{2+}/Ce^{+}	**< 2%**	**< 2%**
Background	**< 0.5 cps**	**< 1 cps**

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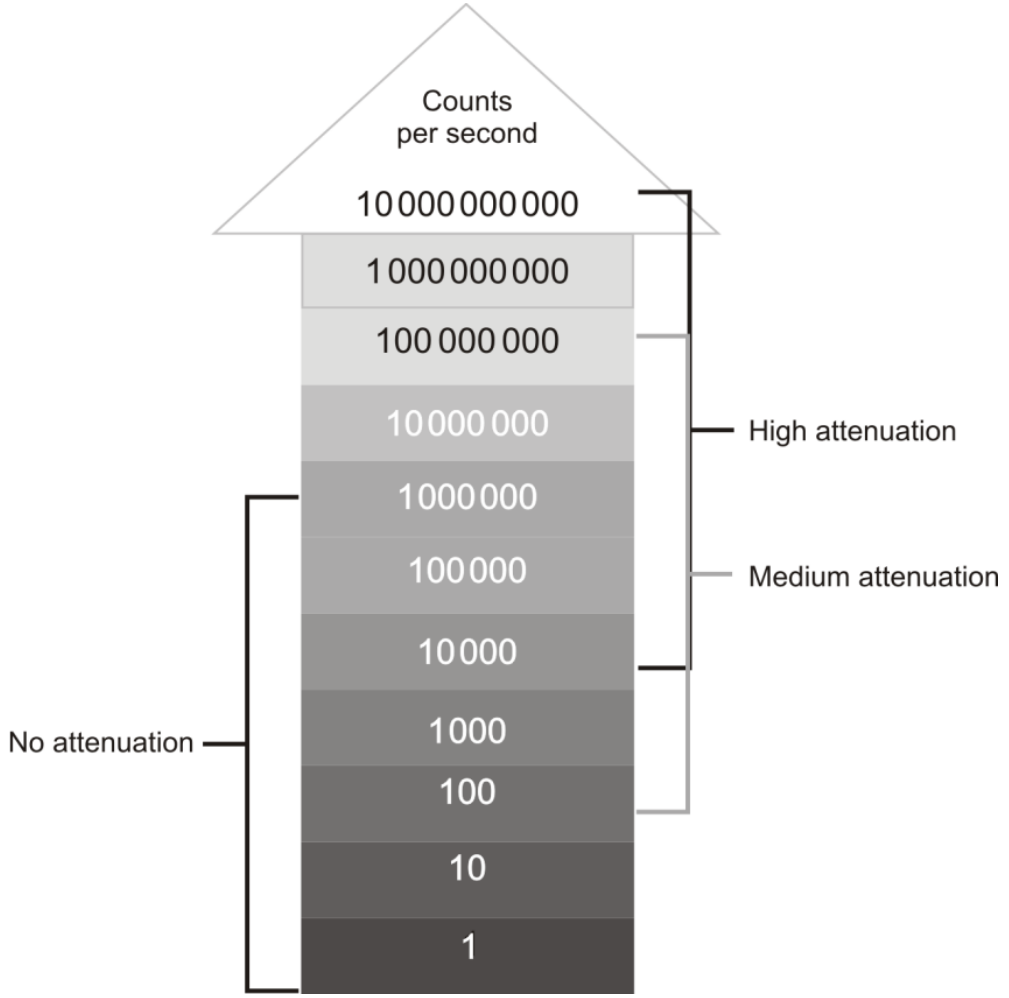
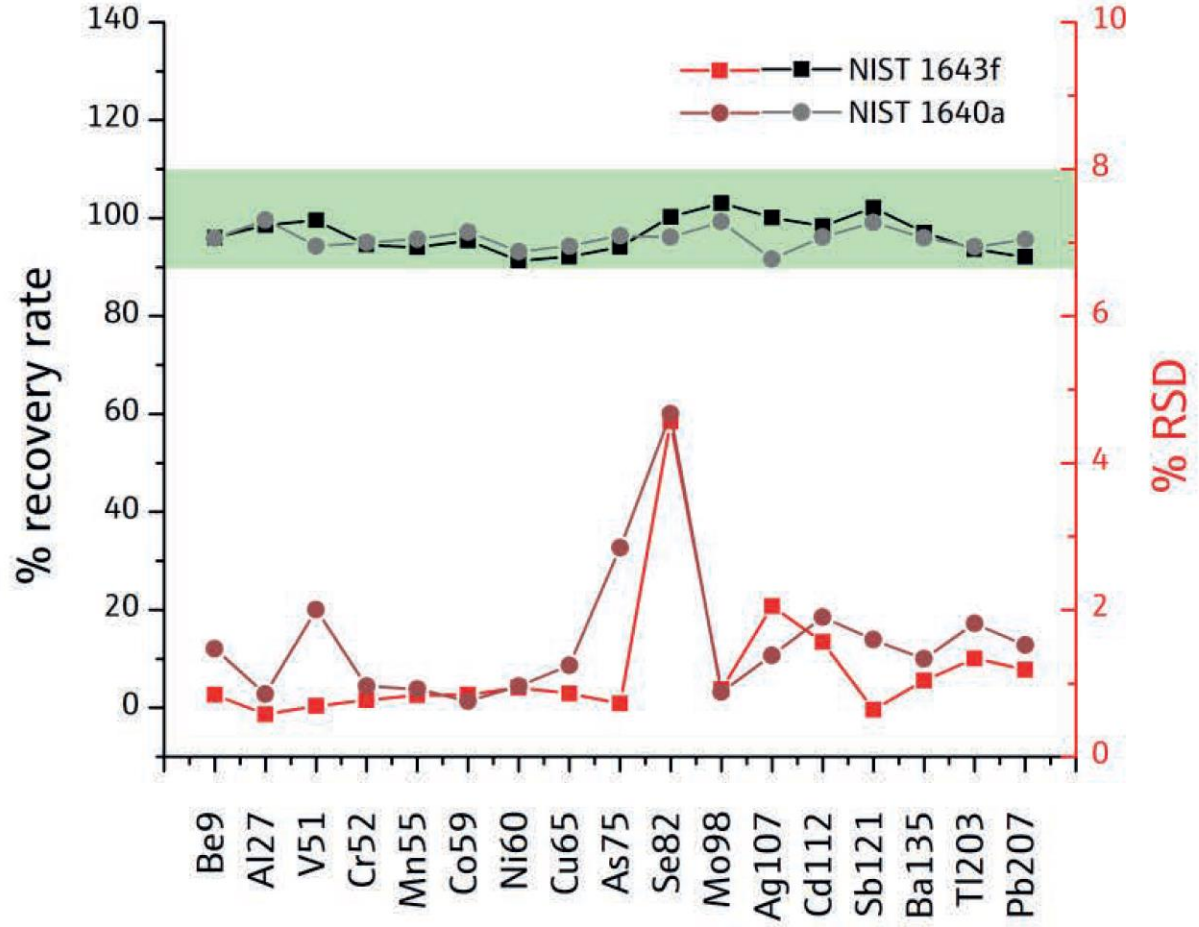


Samples preparation

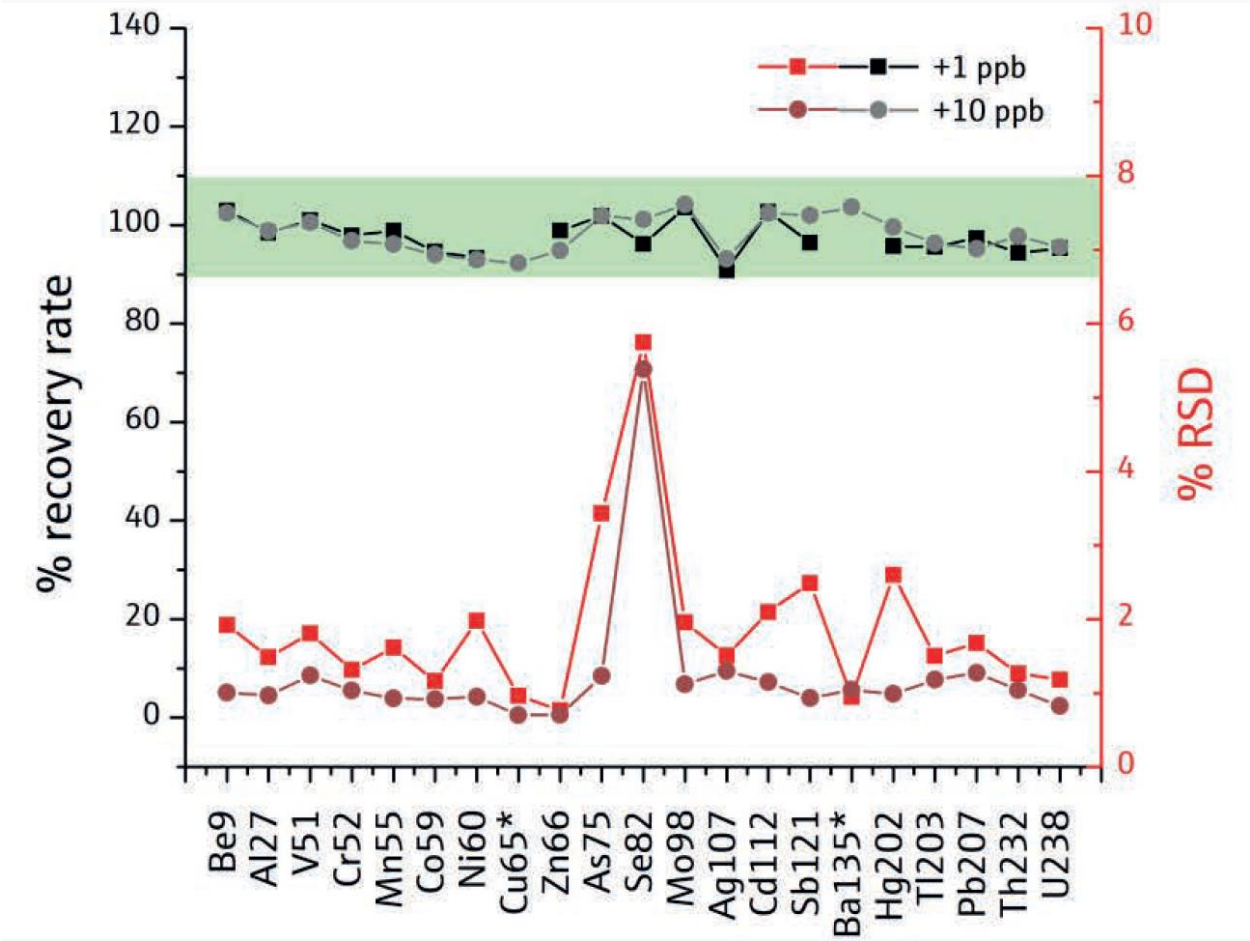
- Samples are tap water from Jena, Germany as well as two certified reference materials
- Only high purity reagents were used in the sample preparation
  - 1:2 dilution in deionized water
  - Samples were acidified to contain 1% nitric acid
- Calibration solutions were prepared from
  - multi-element standard
  - single-element standards for Ag, Sb, Hg

Accuracy

- Certified reference materials were measured in order to verify the accuracy of the method
- Results were within 91 - 103 % of the specified value.
- Additionally, two lab-fortified matrices (+1 ppb and +10 ppb) were measured.
- The recovery rates of the LFMs were between 91 - 104 %.



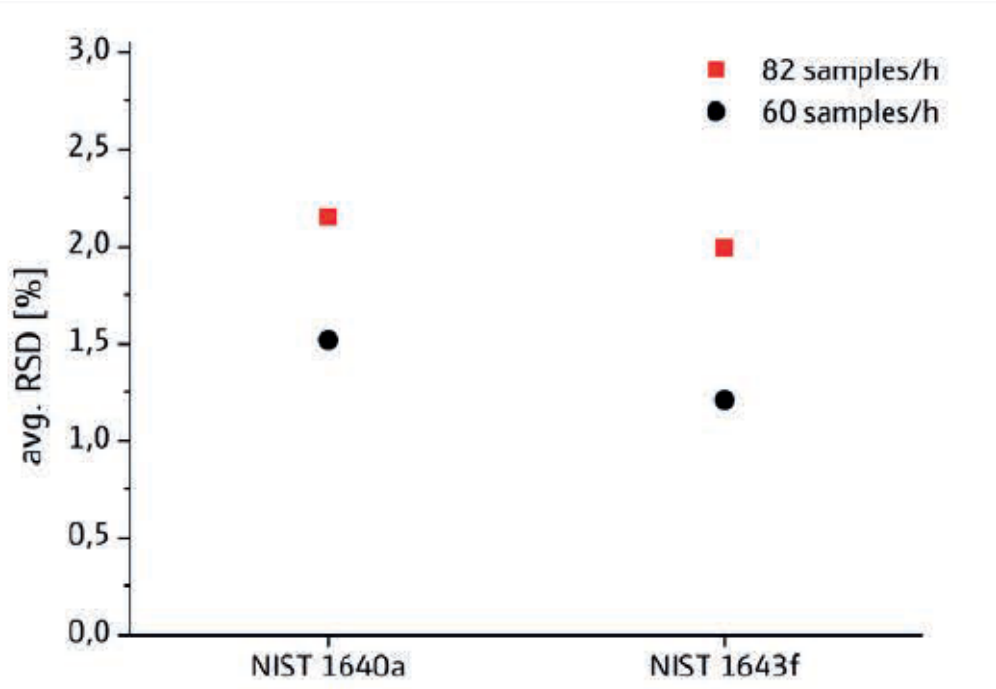
Precision



- The relative standard deviation (RSD) was used to assess measurement precision
- An average RSD of 1.5% was achieved
- Precision and accuracy of the certified reference materials and lab-fortified matrices are shown
- RSD is <2 % for low concentrations, <1 % for higher concentrations
- The required RSD <5 % for a 10 or 100 ppb tuning solution standard (depending on sensitivity) was achieved for all elements verifying instrument stability

Speed

- On the PlasmaQuant MS, 60 samples per hour can be measured with very high precision (mean RSD <1.5 %)
- Results surpass requirements of the U.S. EPA method 200.8, meeting even stricter requirements and more demanding regulations.
- If that level of precision is not the main priority, the spectrometer's unmatched sensitivity allows to further boost sample throughput to **>80 samples per hour** with still competitive precision (mean RSD 2.2 %)



Conclusion

- Unmatched sensitivity of the PlasmaQuant MS enables high sample throughput without sacrificing precision
- The requirements of the U.S. EPA 200.8 regulation are surpassed by far and the performance is maintained for hours proving the instrument's robustness
- Consuming only 50 % argon volume compared to a conventional ICP-MS, and requiring considerably less consumables and maintenance.
- Minimal running costs and high sample throughput gives the lowest costs per sample, making the PlasmaQuant MS the ideal solution for laboratories who need to routinely measure a large number of samples.