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Elemental Analysis in Yeast Cells and Selenium Enriched Yeast Cells by ICP-MS with Automated Micro-Flow Sample Introduction

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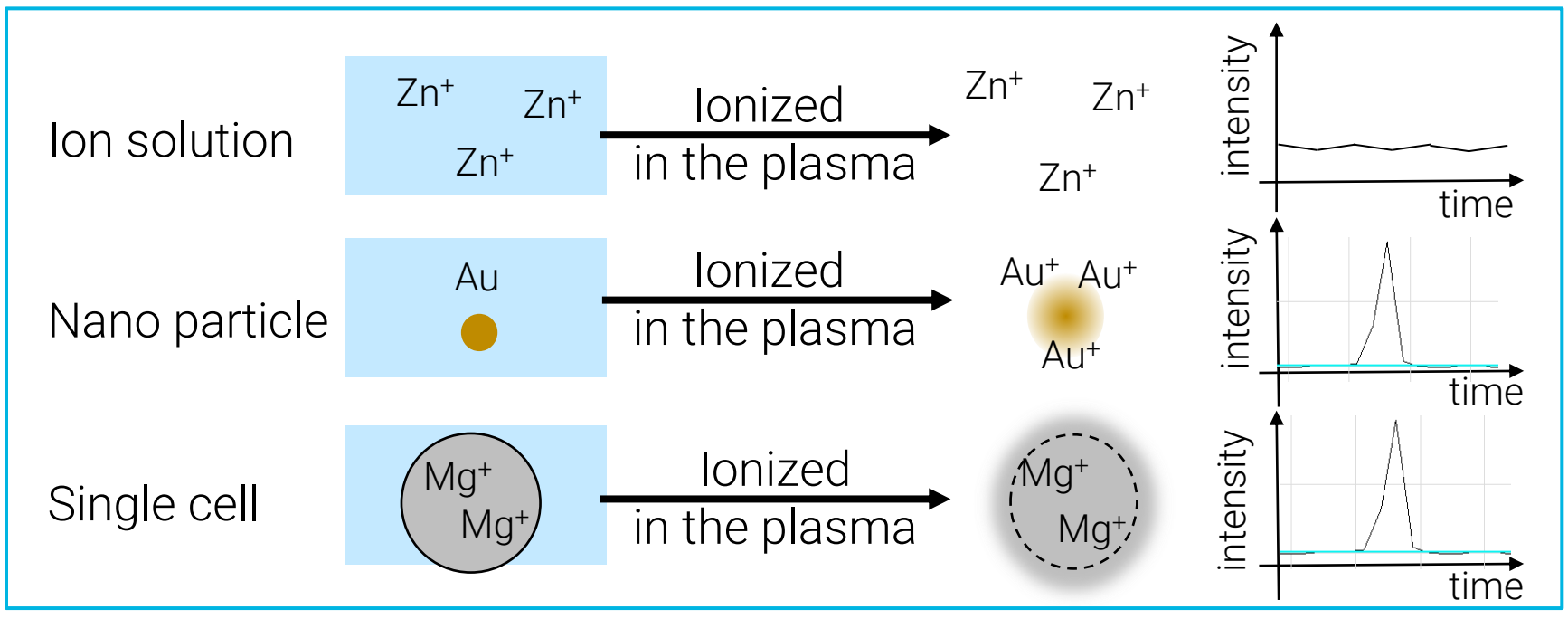
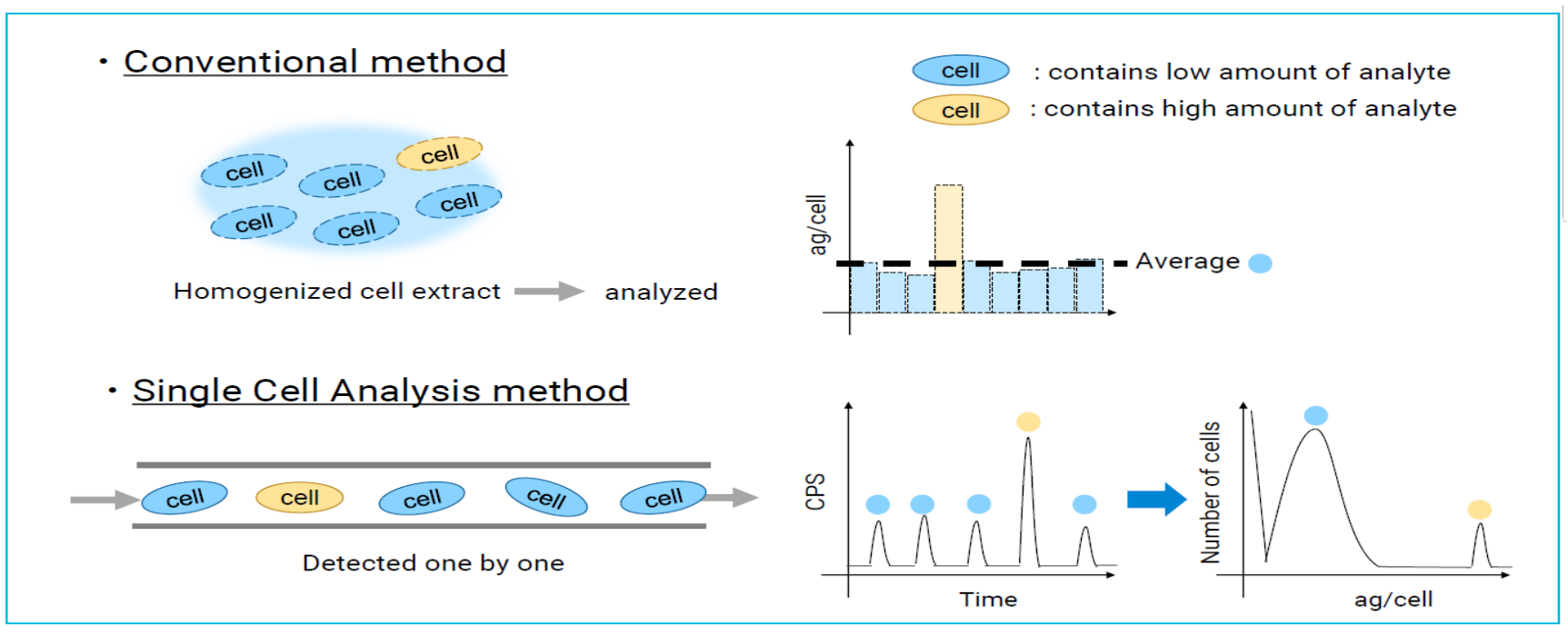
Introduction

Nanoparticle and single cell elemental analysis by ICP-MS has become popular in recent years due technological advancements in ICP-MS, as well as increasing needs for many other advancing fields of applications (1). In the current study, an automated, micro-flow autosampler in combination with an Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) is used in the elemental analysis of nanoparticles and yeast cells. The sample introduction system is designed to deliver intact single cells or cell clusters to the plasma, while the ICP-MS offers high sensitivity for elemental determination within the cell or cell cluster. The preliminary results from this current study can potentially be applied to other applications, offering an easy and efficient way for high-throughput sample analysis.

Single cells are ionized and detected as pulse NP signals



Why Do Single cell ICP-MS?

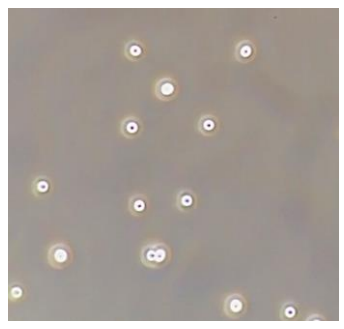


Experimental

Sample Preparation

- Nanoparticles were diluted with DI water before analysis
- Yeast samples were serial diluted with DI water (see diagram below)

Yeast 25 mg



Dried yeast (3~5 µm)
(*Saccharomyces cerevisiae*)

Cell wash: Add 25 mg of dried yeast to 10 mL DI water, Shake, centrifuge, and decant liquid, Repeat 2 more times.

Add washed yeast cells to 50mL DI water
Shake well
Take 1-2mL; dilute to another 50mL DI water

Single Cell Analysis

Instrumentation

Table 1. ESI microFAST autosampler Operating Conditions

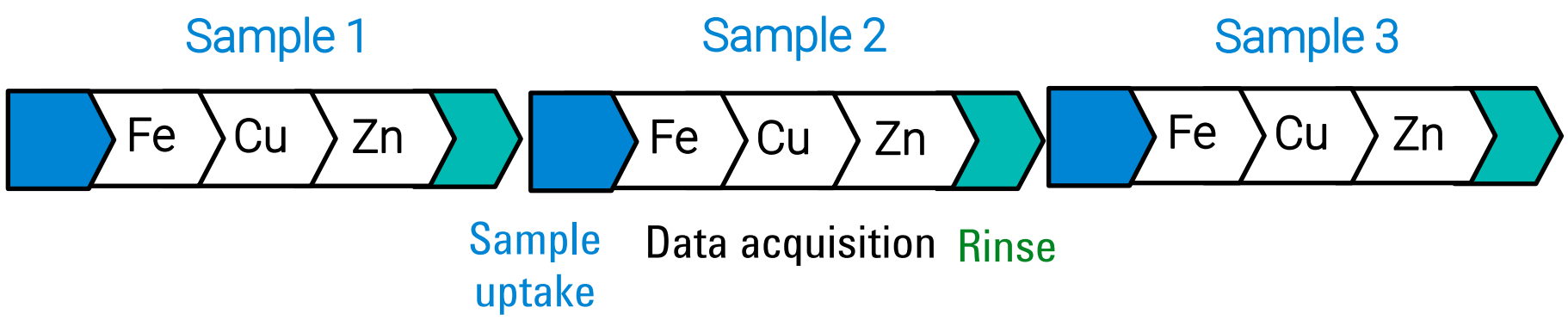
Sample Injection Rate	10 µL/min
Loop Size	100 µL
Nebulization Efficiency	> 80%

T
Operating Conditions

Plasma Power	1550 w
Sampling Depth	8 mm
Nebulizer Gas	0.63 L/min
Makeup Gas	0.2 L/min
Reference Material	Pt NP 50 nm

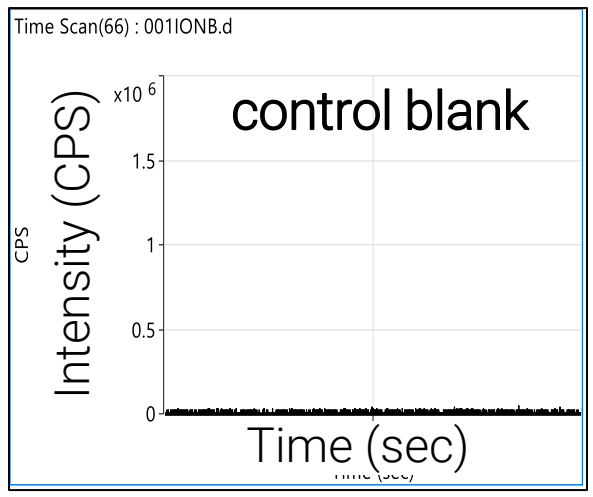
ESI microFAST-Agilent 8900 ICP-QQQ

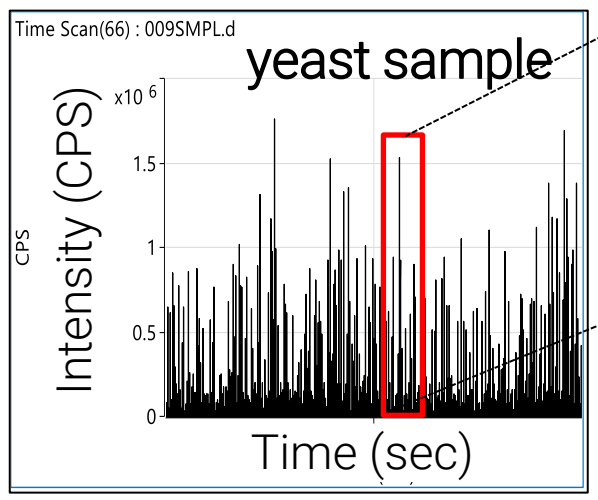
Rapid Multi-Element Nanoparticle Analysis Mode in ICPMS



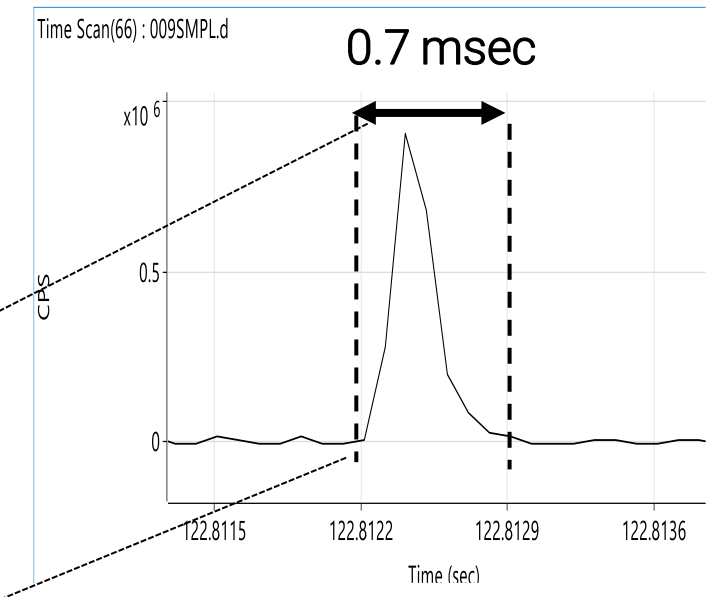
Results and Discussion

Single Cell Analysis



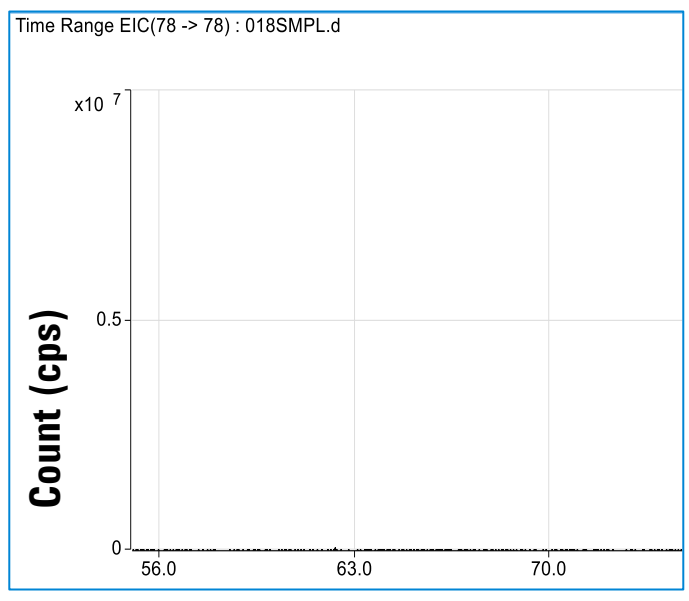


Zn Signal Intensity

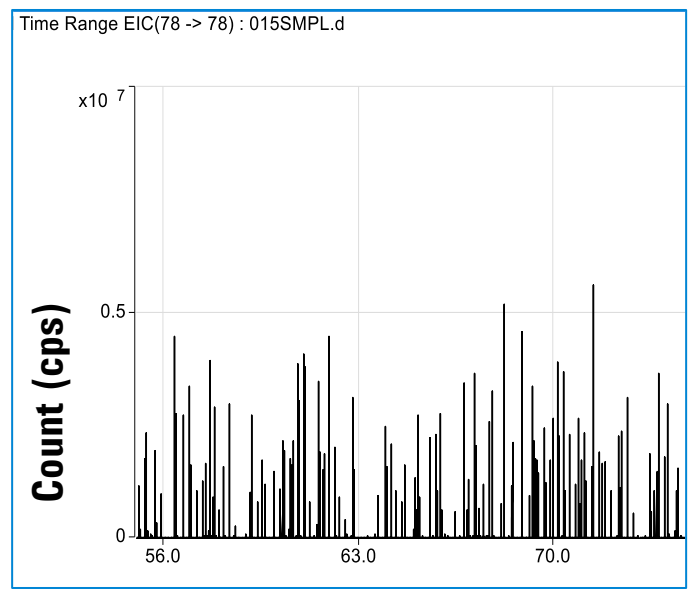


Selenium analysis in Yeast and Se-enriched Yeast

Yeast



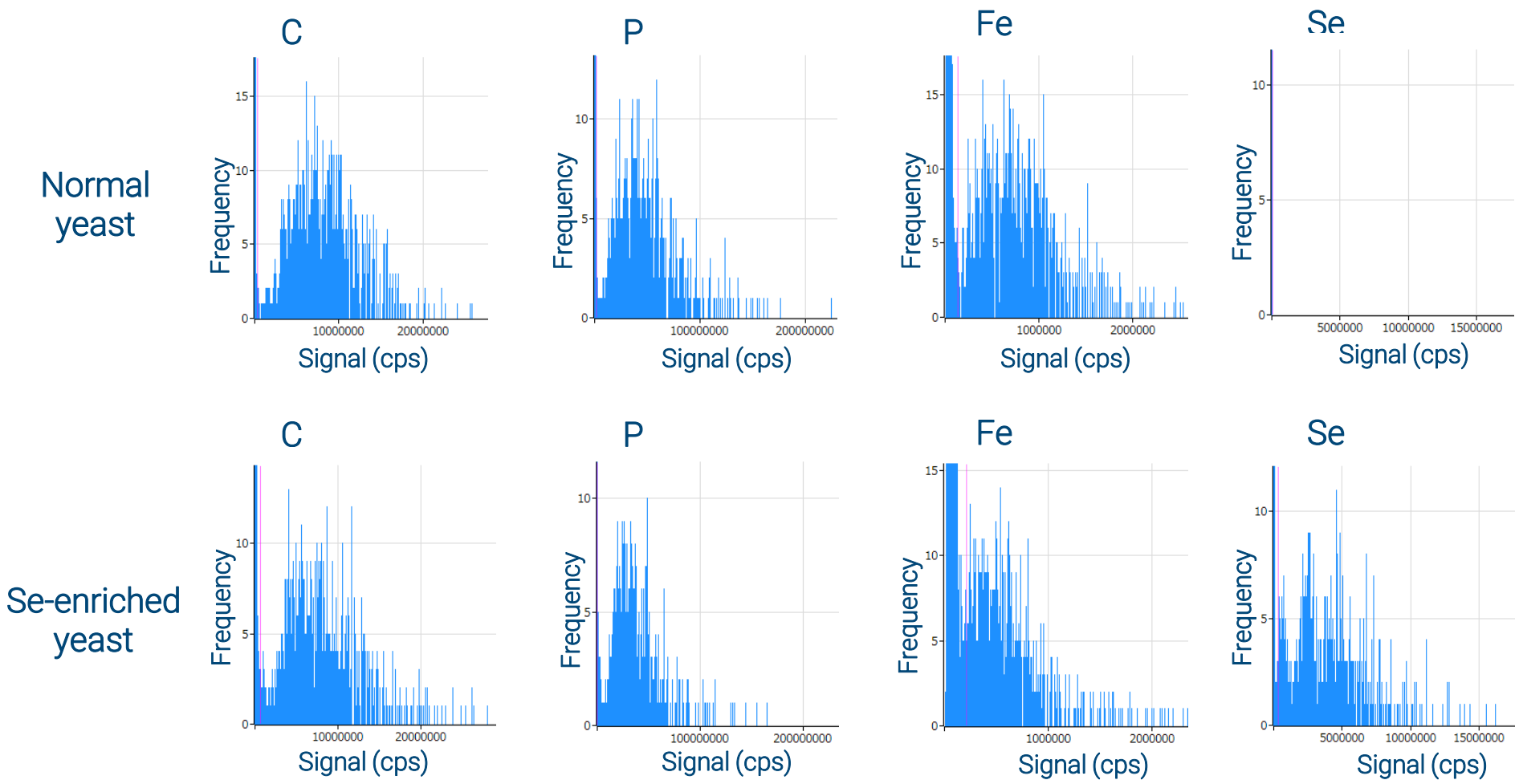
Se-enriched yeast



Selenium single cell signal was observed in Se-enriched yeast cell samples, which such signal was absent in regular yeast cell samples, indicating the accurate detection of single cells.

Results and Discussion

Signal Distribution Plots for C, P, Fe, and Se in Both Yeast Samples



Number of Detected Cells of Yeast and Se-yeast

	Number of Detected Cells			
Sample	**C**	**P**	**Fe**	**Se**
Yeast - 1	1186	1022	1100	0
Yeast - 2	1096	937	1028	0
Se-enriched yeast - 1	1003	1183	1032	829
Se-enriched yeast - 2	1097	1234	1059	803

Conclusions

There is good agreement in the number of detected cells that contained the four elements, confirming the feasibility of the scICP-MS method for the measurement of multiple elements in single cells.

Reference

(1) Theiner, S., et al. (2020). "Single-cell analysis by use of ICP-MS." Journal of Analytical Atomic Spectrometry 35(9): 1784-1813.

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