HIGH-THROUGHPUT AND ACCURATE GD-MS ANALYSIS OF NI-BASED SUPERALLOYS USING THE ASTRUM SWIFT

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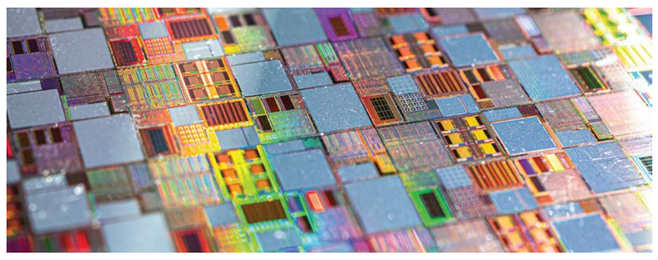
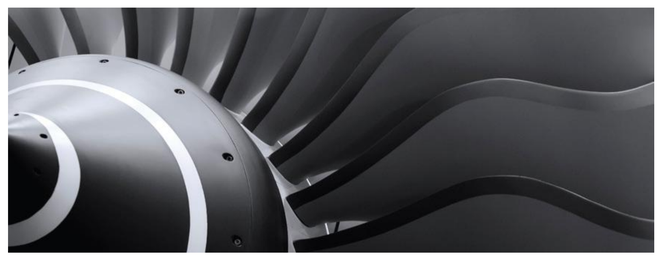
Introduction

Ni-based superalloys are critical materials in aerospace and advanced manufacturing, where performance depends on precise chemical composition. Control of both major alloying elements and trace-level impurities is essential to meet stringent quality requirements. Glow discharge mass spectrometry (GD-MS) is widely recognised as a reference technique for superalloy analysis, offering direct solid sampling, minimal sample preparation and a dynamic range spanning matrix to sub-ppm impurities. However, conventional GD-MS workflows often require long analysis times to achieve the required precision and accuracy, limiting analytical throughput.

The Astrum Swift was developed to address this challenge by combining the inherent stability and low background of a low-flow glow discharge with optimised electronics, rapid data acquisition and efficient software. This enables significantly reduced analysis times while preserving the performance advantages of low-flow GD-MS. In this work, the performance of the Astrum Swift is evaluated using the BAS SS346A Ni-based superalloy certified reference material, comparing standard and high-throughput ("Swift") acquisitions to demonstrate that rapid analyses can be performed without compromising precision or accuracy.





High-Throughput Analysis with Astrum Swift

The Astrum Swift GD-MS was developed to increase throughput while preserving the stability and performance of a low-flow GD, enabling rapid alloy analysis without compromising data quality.

Key features enabling high-throughput analysis:

- Reduced Faraday and ion counter integration times
- Faster repeat cycles enabled by optimised magnet and electronics design
- Automated source control and data acquisition via CoDaq software
- Standard glow conditions and RSFs maintained for quantitative consistency

Resulting performance:

- Up to 4× reduction in total analysis time for full mass-range GD-MS methods
- No compromise in precision or accuracy for major and trace elements

Swift operation combines the analytical confidence of low-flow GD-MS with the speed required for modern superalloy development and quality control workflows.

Advantages of Low-Flow GD-MS

Low-flow glow discharge operation reduces plasma-gas background and improves discharge stability, delivering robust quantitative performance for solid-state analysis.

Key benefits include:

- Lower gas-phase background and improved detection limits
- Stable sputtering and ionisation conditions
- Reliable RSFs maintained across analyses

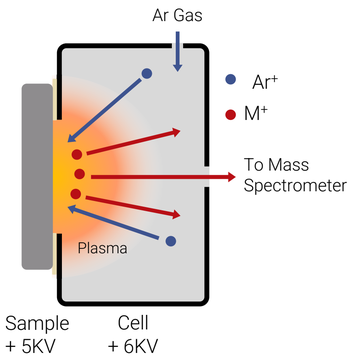


Figure 3. Schematic of a low-flow GD ion source.

These characteristics enable accurate, high-precision measurements even at reduced integration times, making low-flow GD-MS ideally suited to high-throughput alloy analysis.

Precision at High Throughput

Repeatability evaluated using SS346A CRM under standard and Swift conditions (5 replicates).

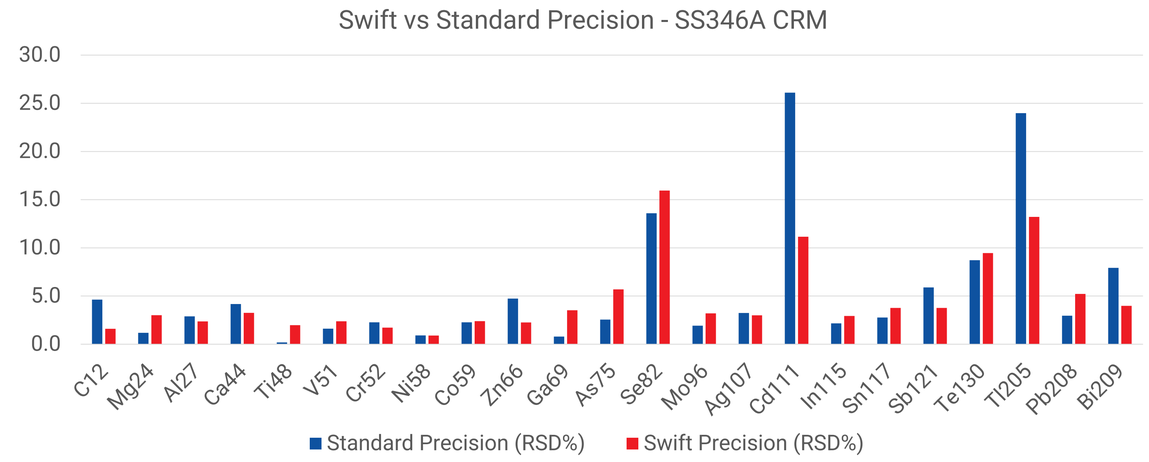


Figure 2. Precision for SS346A CRM under standard and Swift conditions: equivalent repeatability across all concentrations.

High-throughput operation delivers equivalent analytical precision to standard GD-MS conditions across matrix, minor and trace elements.

Accuracy at High Throughput

Accuracy assessed by comparison of measured concentrations with certified values for the BAS SS346A CRM.

Element Group	Concentration Range	Typical Recovery – Standard	Typical Recovery – Swift
Matrix elements	> 0.1 wt%	98 – 102%	97–103%
Minor elements	0.1 wt%–10 ppm	95–105%	95–108%
Trace elements	< 10 ppm	90–110%	92–114%*

Figure 3. Measured vs certified concentrations for SS346A CRM under standard and Swift conditions.

* Cd has been excluded at <1ppm. For ultra-trace elements we recommend longer integration times to ensure optimum accuracy and precision.

Swift operation preserves quantitative accuracy across matrix, minor and trace elements, with trace-level deviations dominated by counting statistics rather than systematic bias.

Relative Sensitivity Factors

Low-flow plasma stability preserves RSF validity, enabling quantitative GD-MS analysis without re-calibration at high throughput.

Element	C	Mg	Al	Ca	Ti	V	Cr	Ni	Co	Zn	Ga	As	Se	Mo	Ag	Cd	In	Sn	Sb	Te	Tl	Pb	Bi
RSF	2.15	1.03	1.2	0.41	0.55	0.52	1.54	1.0	0.70	3.10	2.44	3.35	1.84	0.92	2.66	0.25	2.63	1.91	3.17	3.05	6.83	2.38	3.29

ASTRUM SWIFT: PRECISION AND ACCURACY IN SUPERALLOYS AND ADVANCED MATERIALS ANALYSIS

The Astrum Swift GD-MS enables rapid analysis of Ni-based superalloys using a stable low-flow glow discharge:

- High-throughput ("Swift") operation delivers precision equivalent to standard analytical conditions across matrix (> 0.1 wt%), minor (10 ppm–0.1 wt%) and trace (< 10 ppm) elements
- Quantitative accuracy is maintained, with strong agreement to certified values for the SS346A CRM and no systematic bias introduced at reduced integration times
- Stable RSFs are preserved under Swift and standard conditions, confirming robust quantitative performance without re-calibration
- The low-flow glow discharge underpins stable plasma conditions and low background, enabling high-throughput analysis without compromising precision, accuracy or RSF validity.

To find out more, please scan the QR code.