SIFT-MS: A HIGHLY REPRODUCIBLE REAL-TIME TRACE GAS ANALYSIS TECHNOLOGY

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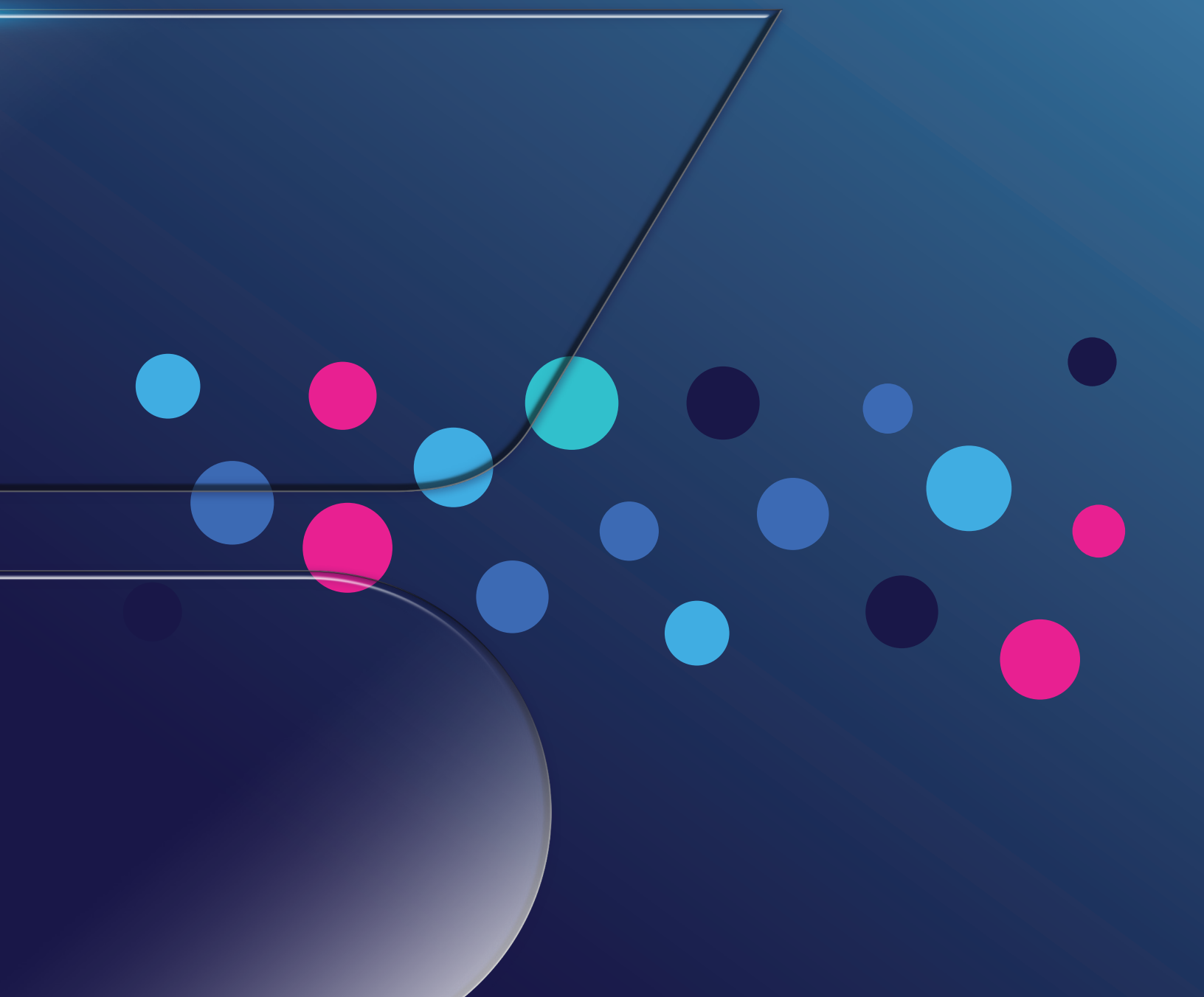


Summary

Syft Technologies market leadership in trace gas analysis for over 20 years is in part derived from its highly robust, reliable, and reproducible selected ion flow tube mass spectrometry (SIFT-MS) instrumentation. This article highlights fleet reproducibility data that was collected using identical analytical methods to isolate the variable of the instrument itself. The following results are from measuring certified standards without applying any external calibration procedures:

- The 95% confidence interval was below 21% for each of the nine different analytes for ten instruments built on the new generation technology platform. This technology represents our Syft Tracer instrument.
- The 95% confidence interval was below 38% for each of the six different analytes for 27 instruments built on the legacy technology platform manufactured over the last five years. This technology represents our now discontinued Voice200infinity analysers.

This shows that users of Syft's instrumentation can expect directly comparable results across different instruments, installations, and time providing them with confidence in quantitation.

Introduction

Applications for SIFT-MS instrumentation often involve deploying multiple instruments across customer sites. Common applications include airborne molecular contamination (AMC) monitoring in semiconductor fabs, environmental analysis across monitoring networks, routine genotoxic analysis for pharmaceutical manufacturers, or analysis of toxic volatiles for worker safety. Trustworthy results are critical for clients who often rely on Syft's instruments for accurate, fast, and routine analysis. Therefore, Syft Technologies is often asked about how performance compares across fleet deployments.

Reproducibility is the capability of an analytical method to accurately and independently return the same measurement under different conditions, in this case across different instruments. This is a combination of the performance of the method, the instrument, and the analyst. As part of Syft's rigorous production processes certified standards are often measured on instruments before shipping to customers. When the analytical methods are the same it is possible to compare these measurements and use them to provide an estimate of the high reproducibility that Syft's SIFT-MS instrumentation enables. While reproducibility is a precision concept it should be noted that on the same instrument and with the same conditions the measurement-to-measurement variation will be significantly better than the values presented here. This sort of precision will be dependent on the method parameters and the concentration measured.

Methods

This work used SIFT-MS instruments operating with nitrogen or helium carrier gas. Samples were prepared by diluting reference standards in clean, humid air to produce a consistent flow at the concentration of interest with 40-50% relative humidity. The reference standards were either certified gas cylinders or permeation tubes. The sample was delivered directly to the inlet from either a Tedlar bag or from a flow-past configuration. The values reported here are the results of multiple measurements, effectively removing the effects of method precision, but because not all parameters can be completely controlled, they represent an upper bound.

There are two data sets in which the analytical method can be held constant to allow comparison:

1. Ten instruments built on the latest technology platform that represents the Syft Tracer for the following compounds: benzene, toluene, methyl bromide, phosphine, ethylene dibromide, ethylene oxide, chloropicrin, hydrogen cyanide, and formaldehyde. These analyses used helium carrier gas.
2. 27 instruments built on the legacy technology platform that represent the discontinued Voice200infinity analysers for the following compounds: sulfur dioxide, ammonia, isopropyl alcohol, trimethylsilanol, toluene and propylene glycol methyl ether acetate (PGMEA). These analyses used nitrogen carrier gas.

The results presented are the sub-set of instruments which had identical analytical tests performed on them, which enables comparability.

Results and Discussions

SIFT-MS is inherently a reproducible technique because it utilizes ultra-soft chemical ionization to selectively quantify targeted analytes. These ion-molecule reactions are very reproducible, optimized by the manufacturing process, ultimately enabling superb fleet performance. Two metrics have been used to quantify the difference of an instrument to the fleet norm. These are:

1. Average instrument variation from fleet (%); defined as the average of the absolute percentage differences between each instrument and the fleet

average per analyte.
2. 95% CI (%); defined as two times the standard deviation across the fleet per analyte.

Table 1 displays these metrics calculated from the first data set of ten instruments built with the latest SIFT-MS technology that underlies the Syft Tracer. All compounds show superb absolute averages with all analytes below 9% and 95% confidence intervals below 21%. This highlights high fleet reproducibility without any external calibration applied. Individual differences per instrument across the different analytes are graphically shown in Figure 1.

A long-term and larger data set of 27 instruments is displayed in Table 2 and Figure 2 for the now discontinued Voice200infinity instrument that has been manufactured over the last five years. The absolute averages are all below 15% and 95% confidence intervals which are all below 40%.

This demonstrates a history of providing highly reproducible instrumentation and an on-going commitment to keep advancing the performance of Syft's instrumentation. The improvements in reproducibility between Syft's legacy and latest technology demonstrate acknowledgement that clients rely on Syft's instrumentation for everyday analysis. Robust, reliable and reproducible analysis is therefore critical. The improvements can be attributable to:

1. A step change in the parameters responsible for generating 8 reagent ions, specifically the control, materials used, and the configured geometry.
2. The new generation Performance Tune sequence which includes advanced software and quantitation features. This enables users to have confidence in their analytical results before they start their day's work.

Table 1. Average instrument variation from fleet (%) and 95% CI (%) of certified concentration measurements across ten instruments for nine different VOCs and Inorganics.

Compound	Average Instrument Variation From Fleet (%)	95% CI (%)
Benzene	4.6	12
Toluene	4.5	12
Methyl bromide	6.5	16
Phosphine	7.2	17
Ethylene dibromide	4.7	11
Ethylene oxide	6.4	19
Chloropicrin	3.8	9.8
Hydrogen cyanide	6.5	18
Formaldehyde	8.3	21

Figure 1. Collation of the variation per instrument from fleet average (%) for ten instruments across nine different VOCs and Inorganics.

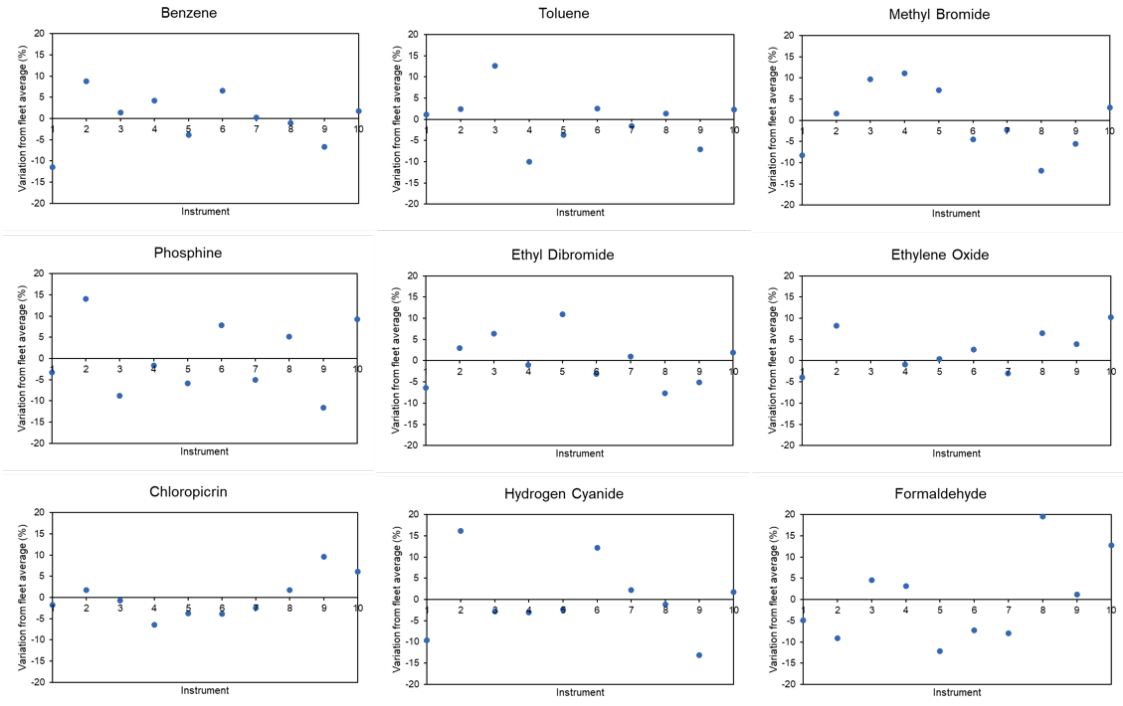
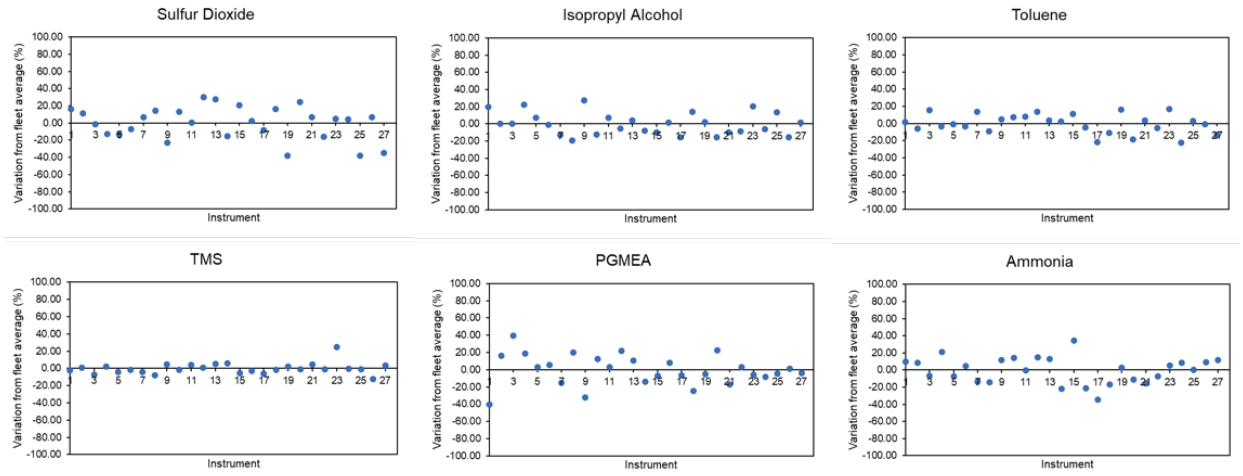


Table 2. Average instrument variation from fleet (%) and 95% CI (%) of certified concentration measurements across 27 instruments for six different VOCs and Inorganics.

Compound	Average Instrument Variation From Fleet (%)	95% CI (%)
Sulfur dioxide	15	38
Ammonia	13	31
Isopropyl alcohol	10	26
Trimethylsilanol	4.3	13
Toluene	8.9	22
PGMEA	14	35

Figure 2. Collation of the variation per instrument from fleet average (%) for 27 instruments across six different VOCs and Inorganics.



Conclusions

Syft has been manufacturing highly reproducible analytical instrumentation for 20 years, continues to do so, and is committed to providing the most robust and fastest direct analysis instrument available. This article demonstrates a history of providing instrumentation that is highly reproducible with a 95% confidence interval of less than 38% across 6 analytes and 27 instruments. Syft's latest technology, which underlies the Syft Tracer instrument, is even better with a 95% confidence interval of less than 21% across nine analytes and ten instruments. The improvement in reproducibility comes mainly from control of parameters that impact reagent ion generation and stability.

Syft can provide excellent reproducibility due to highly controlled ion-molecule reactions that underpin quantitation with SIFT-MS. Not only are these ion-molecule reactions reproducible across a fleet but they are incredibly diverse, allowing selective quantitation across almost any volatile compound. For applications requiring fast, direct, and quantitative analysis Syft Technologies is a highly reproducible and trustworthy instrumentation supplier.

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AN01_No.71_Dec2024_Rev1