Quantum Analytics

# Increasing Your Workflow Efficiency with Miniaturized Mass Detection


## Abstract

This whitepaper will explore how to increase your workflow efficiency with miniaturized deployable mass detection. It will begin with an overview of Microsaic's unique miniaturized mass detection products. Then, we'll explain what mass detection can offer the laboratory and also discuss a few of the application areas where Microsaic mass detection systems are currently deployed.


## Introduction

Miniaturized mass detection was developed by combining market needs and the requirements of a modern-day laboratory. Market research showed a desire for smaller, compact mass detectors. This is because physical space can be an issue in the modern-day laboratory. Reducing the power and gas consumption was another desired feature. Plus, a lower cost of ownership both for operation, training, and maintenance was also required. Overall, there was a need for an easy-to-use, versatile system for multiple applications.

The 4000 MiD from Microsaic is an instrument that takes this desired feature set into account. It offers one of the smallest footprints on the market. It is a fully integrated, versatile mass detector designed for the bench chemist. The compatibility and portability of the 4000 MiD has been achieved by miniaturizing key components of a traditional mass detector with chip-based technology. The ionchip™ (quadrupole), the spraychip™ (ion source), and the vac-chip™ (vacuum interface). Our system also includes a PC and pump, all fully-integrated into one box. There's no additional air conditioning required and no additional soundproofing. The system can be started up and ready for sample analysis within 30 minutes.

**Figure 1:** Microsaic 4000 MiD miniaturized mass detector

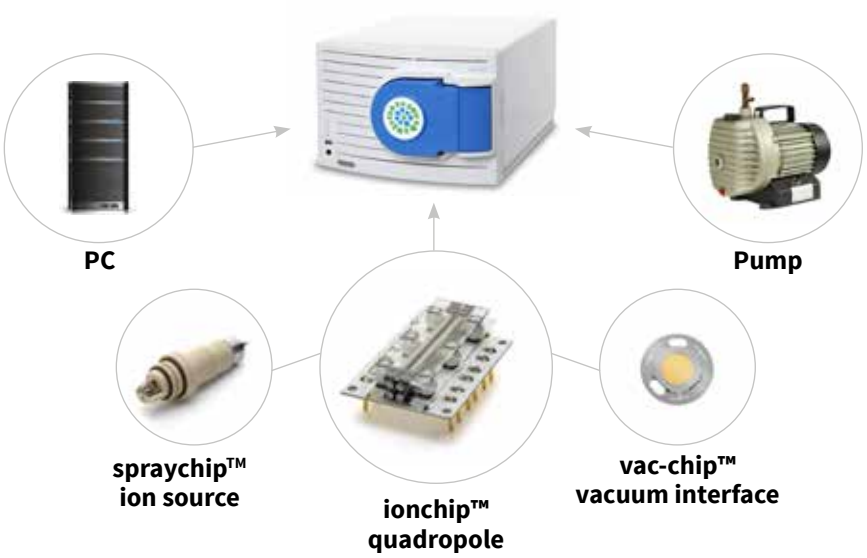


**Figure 2:** The fully integrated 4000 MiD includes the ionchip™ quadrupole, the spraychip™ ion source, the vac-chip™ vacuum interface, PC and pump.

Compare this to traditional mass detectors, which have an additional floor-standing pump and an additional computer. These elements are all integrated into one box in the 4000 MiD, giving the ability to sit nicely into a standard fume hood. This gives it the flexibility and versatility for multiple applications.

**Figure 3:** The compact footprint of the 4000 MiD allow it to fit into a standard fume hood.

**Figure 4:** The ionchip micro-engineered quadrupole filter

Now, let's take a look at the Microsaic system's unique chipset. The ionchip is an advanced micro-engineered quadrupole filter. When compared to traditional quadrupoles used in traditional mass detectors, there is a considerable size difference. This reduction in size leads to a reduction in running cost.

The spraychip is a plug-and-play pre-aligned microspray ion source that operates at atmospheric pressure. This is a replaceable and reusable item and can be replaced by the user and does not require a skilled technician or the associated expense and delay.

The spraychip ion source can be replaced within 15 seconds following a simple four-step process. There's no experience necessary and no tools required. In addition, there's no tuning or source alignment required. Ion sources in traditional mass detectors involve multiple steps for maintenance and require the experience and tools of a trained technicians. For instance, if you crimp the capillary during this process, you have to start all over again. This all adds up to a huge amount of time compared to the 15 seconds it takes to replace the spraychip in the 4000 MiD. The 4000 MiD's spraychip is pre-aligned, meaning it's reusable and replaceable in less than 15 seconds.

**Figure 5:** Plug-and-play spraychip ion source.

The 4000 MiD uses a tenth of the power than traditional mass detectors and also uses considerably less nitrogen gas. This means the system can run off a nitrogen cylinder and does not require the need for a nitrogen generator like traditional mass detectors. The reduction in power and gas consumption reduces the cost of ownership of the 4000 MiD. With the integrated pump system, there's no need for an external roughing pump and no need for the servicing and maintenance cost required for this.

Replacing of this spraychip takes considerably less time than replacing the ion source in a traditional mass detector. This decreases the downtime for any maintenance that's required on the system, which can add up to $5,000 to $25,000 in savings – depending on your system and the usage. These savings over time add up, allowing you to invest in other areas in your laboratory.

It's not just money that is being saved. Enhancing your workflow with the 4000 MiD benchtop mass detector saves you time, giving you conclusive answers at the point of need. With online mass detection, you can reduce the need for offline analysis. With reduced complexity and the plug-and-play technology, less downtime is needed for any maintenance, taking a complex workflow and simplifying it.

Next, we'll explore a few of application areas and discuss how mass detection can help improve the efficiency. The 4000 MiD is currently deployed in several application areas, including online flow reaction, batch reaction monitoring, mass-directed prep and flash purification, online TLC-MS analysis, and direct injection analysis.

**Figure 6:** MiDas compact fluidics module adds flexibility and versatility to the 4000 MiD mass detector.

The versatility of the 4000 MiD is enhanced by the addition of the MiDas, a compact fluidics module. The MiDas enables direct injection and automated online dilution, which provides

the versatility for multiple applications in the laboratory. The MiDas is designed to sit directly on top of the 4000 MiD, while still being able to fit inside a standard fume hood.

## Mass-Directed Purification (Prep and Flash LC-MS)

The 4000 MiD and MiDas can be used for mass-directed purification or prep and flash LC-MS. Traditionally for prep and flash, optical detectors are used, such as UV or visible light. These detectors show the presence of something, but they don't identify what the compound is, and we don't identify if the separation has worked properly. If we collect off our UV data, we collect all into one fraction, which then has to be taken off for offline analysis to determine what's contained within the fraction. If we use online mass detection analysis, we can determine the different compounds and their masses that are in the mixture. We can then collect, using the masses, and better identify what's present in each fraction. This eliminates the need for offline analysis.

## Direct Injection Mass Analysis

There is also a second role for the 4000 MiD in the purification process. It can be used to for direct injection analysis of crude samples for starting mixtures and the fractions collected. This example is a direct injection analysis of our starting mixture. We can see that there are two masses, and we can concern the mass presence and monitor these during the mass-directed purification of this mixture.

Direct injection mass analysis is done with a loop injection by the MiDas. This can be used to perform direct chemical analysis from a sample in a syringe or TLC plate. As you can see here, we have a direct injection analysis and can see the masses that are contained within our sample mixture. We can also determine the presence of any target compound within our sample mixture.

**Figure 7:** The 4000 MiD and MiDas configured for mass-directed purification or prep and flash LC-MS applications.

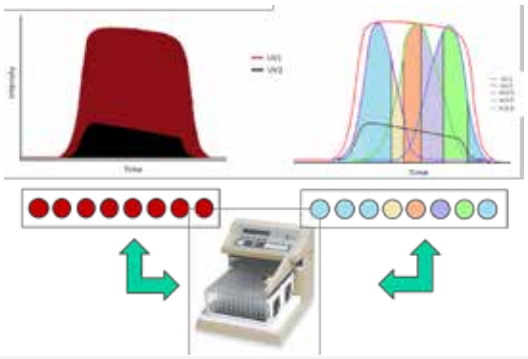

**Figure 8:** Mass detection vs. Optical detection

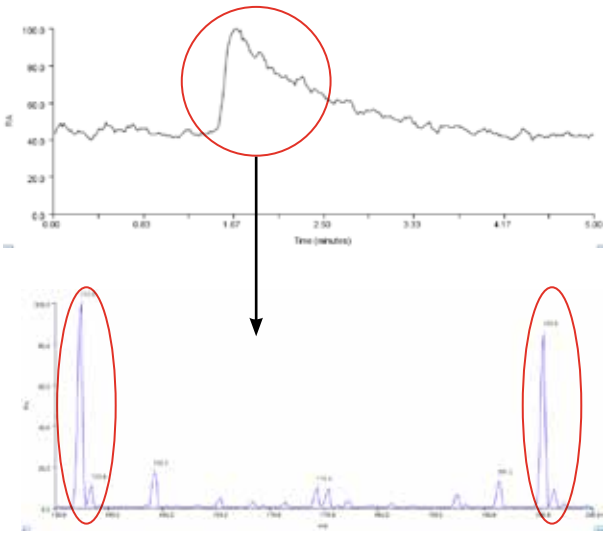

**Figure 9:** Direct injection of crude samples/fractions.

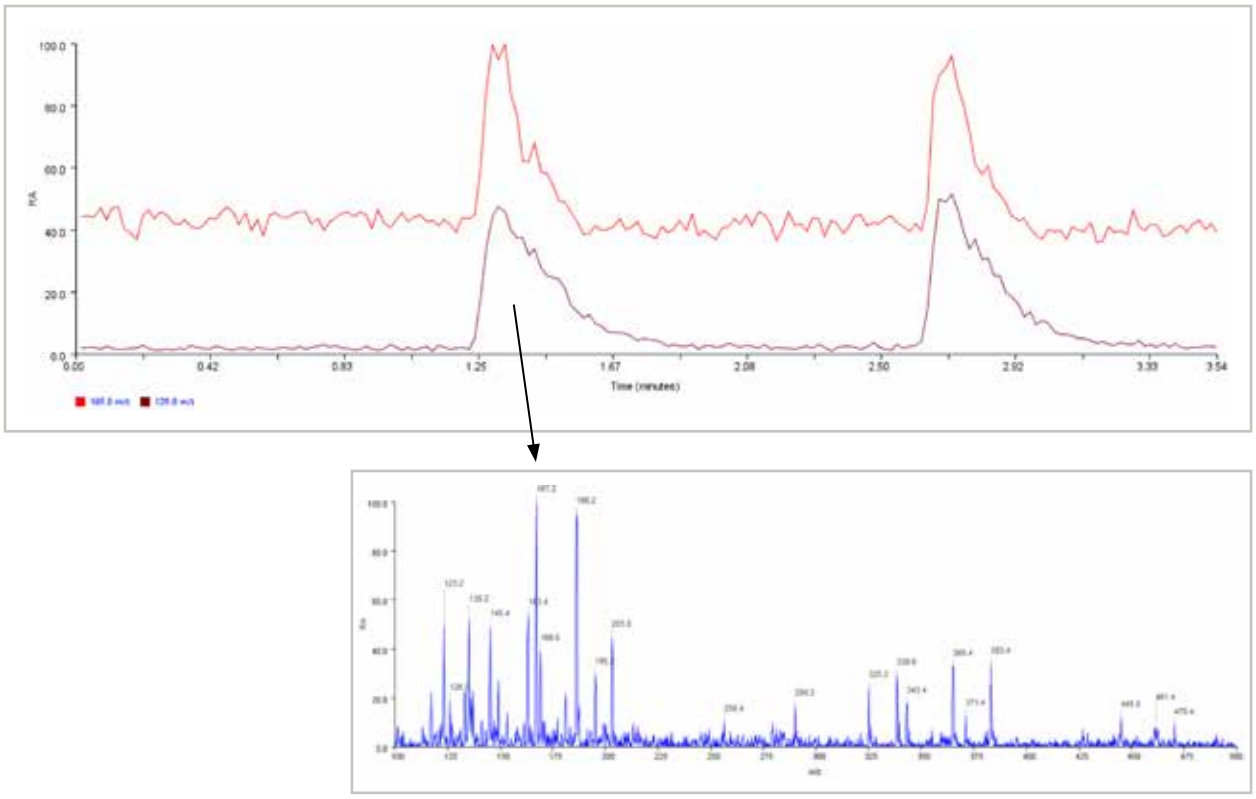


**Figure 10:** Direct chemical analysis via loop injection of a sample from a syringe or TLC plate.

## Online Reaction and Process Monitoring

Another application area is online reaction and process monitoring. We have the 4000 MiD and the MiDas next to a batch reactor. Online reaction monitoring with mass detection can be used to analyze in real time the composition of the reaction taking place.

The 3D graph shows a mass chromatogram of our reagent (blue trace), our inter-media (red trace), and our product (green trace). This is done as a function of time at the different temperatures the reactions were taking place. Using this data, we can determine the steady state conditions and optimize the reaction yields for our different reactions. This has the potential to be upscaled to larger batch reactors.

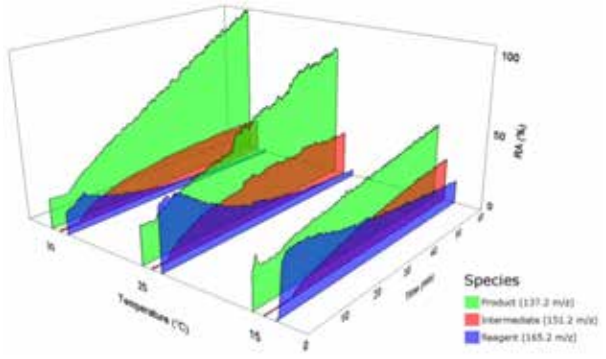


**Figure 11:** 3D graph of mass chromatograms of product, intermediate and reagent.

| Reaction Monitoring | Direct Injection | Mass Directed Purification |
|---|---|---|
| • Batch or flow reactions<br>• Increase productivity<br>• Increase safety<br>• Reduce cycle times | • Immediate mass indentification<br>• Minimal sample handling<br>• Small instrument footprint | • Overcome detection limitations of optical detectors<br>• Removes off-line LCMS analysis<br>• Saves time and money |

Now, if we just do an overview of the different application areas I've talked about, we have online reaction monitoring, we have direct injection analysis and mass-directed purification. For online reaction monitoring, we can monitor both batch and flow reactions. We can increase the productivity by reducing cycle times, and we can also increase the safety for the bench chemist by minimizing the sample handling. For direct injection analysis, we can immediately identify our compounds based on their math. Again, with minimal sample handling and with its small footprint, the instrument can be deployed in the lab at the point of need for the bench chemist. With mass-directed purification, we can overcome the detection limitations of optical detectors and eliminate the need for offline LC-MS analysis. This saves us time and money.

**Summary**

So who really benefits from miniaturized mass detection? Well, if you require additional specificity or confirmation sooner in your process or in real time, then mass detection can benefit you. With optical detectors, we can tell there's something there, but we can't identify what that compound is. With mass detection, we can identify our compounds based on their math.

The 4000 MiD is a simple to operate, versatile, and cost-effective mass detector. It can be operated required specialized skills and deployed in a multiple of laboratory applications. With reduced running costs, you don't need to have the extensive budget that is required to operate and maintain traditional mass detection systems. The 4000 MiD is the only mass detector with everything integrated into one box. The instrument can be installed in a fume cupboard, and its compact size means pump down to sample analysis can be done within minutes.

## Frequently Asked Questions

**What is the most common application you see to this type of technology?**
The most common application is prep LC-MS analysis or online reaction monitoring.

**Who is the ideal user for the 4000 MiD?**
The 4000 MiD was designed for non-specialist users. It is an easy-to-use, simple instrumentation with easy maintenance by non-trained technicians. No specialized mass detection knowledge is required to operate the instrument.

**Can you affect the mass range for different applications like peptides?**
There is the capability to modify the 4000 MiD to a particular application. This obviously has to be done within reason, but there is the ability to increase the mass range and to change the capability of the 4000 MiD depending on the particular application.


## About Microsaic Systems

Microsaic Systems plc is a high technology company focused on the development of chip-based, bench-top mass spectrometry instruments for improved efficiency in pharmaceutical research and development. Their products bring routine MS analysis to pharmaceutical scientists, and provide powerful methods of analysis to enable earlier decision making related to product identification, purity and bioactivity. Microsaic Systems was established in 2001 by a team including founders from Imperial College London, and was admitted to AIM in 2011 (ticker: MSYS).

# About Quantum Analytics

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