

QJet™ Ion Guide Technology in the API 5000™ LC/MS/MS System

Key Features

- Greater flow of ions into the system for increased sensitivity
- More efficient separation of ions from non-charged particles and improved focusing of ions into the mass analyzer for improved signal to noise performance
- Easy access and no tools required for simple cleaning

Overview

The first step to achieving maximum sensitivity—and one of the most important—is to efficiently transfer ions from the ion source to the mass spectrometer. Sampling ions from an atmospheric pressure source—such as electrospray or APCI—presents particular challenges, because the ions must be extracted from the source through a small aperture into the vacuum system.

To skim off a portion of the gas and ion beam and focus the ions into the mass spectrometer, conventional sampling systems use differential pumping with an orifice followed by a skimmer. Because the small distance between the orifice and skimmer makes it difficult to focus the ions, this approach has limited efficiency.

The QJet™ ion guide is designed to overcome this limitation by capturing and focusing ions into the high-vacuum chamber using a combination of gas dynamics and radio frequency fields.



QJet™ ion guide

Free Jet Expansion

A supersonic free jet is formed when gas expands through a small orifice or nozzle into a vacuum. The gas rapidly accelerates to several times the local speed of sound; then it suddenly re-compresses and slows down through a shock wave, forming a so-called Mach disc. The radial boundaries of the expansion are defined by a barrel shock structure (Figure 1).

In a mass spectrometer, ions are carried from the ion source into the vacuum by the gas, which expands in a divergent flow. The ions must be re-focused in order to efficiently transmit them into the high vacuum chamber containing the mass filters.

QJet Ion Guide Technology

Applied Biosystems/MDS Analytical Technologies pioneered the development and use of collisional focusing in radio-

frequency ion guides. In fact, Q0 rods using collisional focusing play a key role in maximizing the performance of all our mass spectrometers.

In the API 5000™ system, we use the same proven principle of collisional focusing in the high pressure region directly behind the orifice. The QJet ion guide design allows the free jet to expand into the entrance of the ion guide, where the entrained ions are captured by the RF field. The gas continues to expand outward through the spaces between the rods, and is pumped away by the vacuum pump.

Ions captured by the field are collisionally focused into a narrow beam, so that they efficiently pass through the next aperture into the Q0 chamber.

Pumping is more efficient in the QJet ion guide region than in the orifice/skimmer configuration. Also, the

capture and focusing of ions at high pressure behind the orifice is more efficient with an RF ion guide. As a result, QJet ion guide technology allows use of a larger orifice from the ion source into the mass spectrometer, and a smaller aperture leading into the Q0 chamber. This significantly reduces the gas load on the following stages, and gives the API 5000 system a dramatic boost in sensitivity.

Curtain Gas™ Interface Technology

The counter-flow of pure nitrogen gas protects the QJet™ ion guide from contamination and ensures maximum uptime and high-throughput reliability.

Stress tests with complex matrices have shown that the system is remarkably reliable and resistant to contamination (Figure 2). The RF fields and high gas flow in the QJet ion guide overcome any minor field perturbations from contamination, ensuring very little maintenance or cleaning. If cleaning is required, the ion guide can be easily removed, cleaned and replaced in a matter of minutes, with no tools required.

Summary

QJet ion guide technology is a major breakthrough in mass spectrometer design, resulting in greater signal-to-noise than our industry-standard API 4000™ system. Together with other advanced technology features, the QJet ion guide helps to make the API 5000™ LC/MS/MS system today's most sensitive triple quadrupole mass spectrometer for quantitative small molecule analysis.

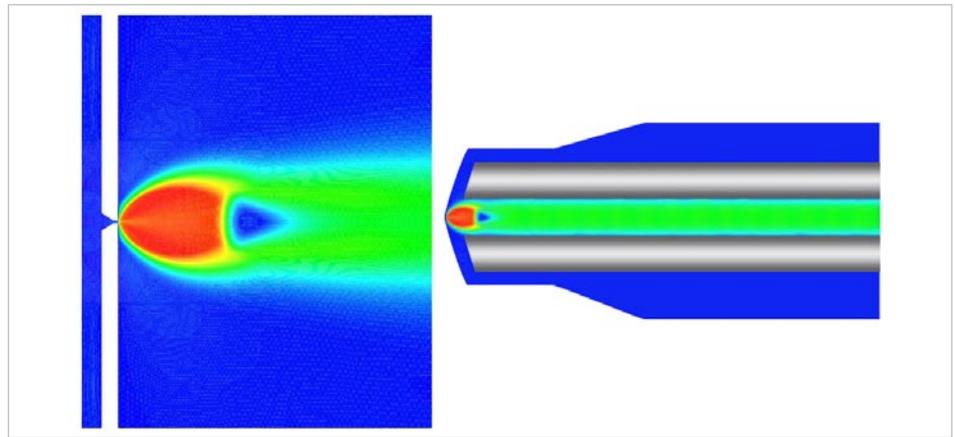


Figure 1 (left) Free jet expansion—supersonic expansion of gas into a vacuum, showing the barrel shock and Mach disc. (right) Free jet expansion into the QJet™ ion guide, allowing ions to be captured from the jet and focused by the RF field.

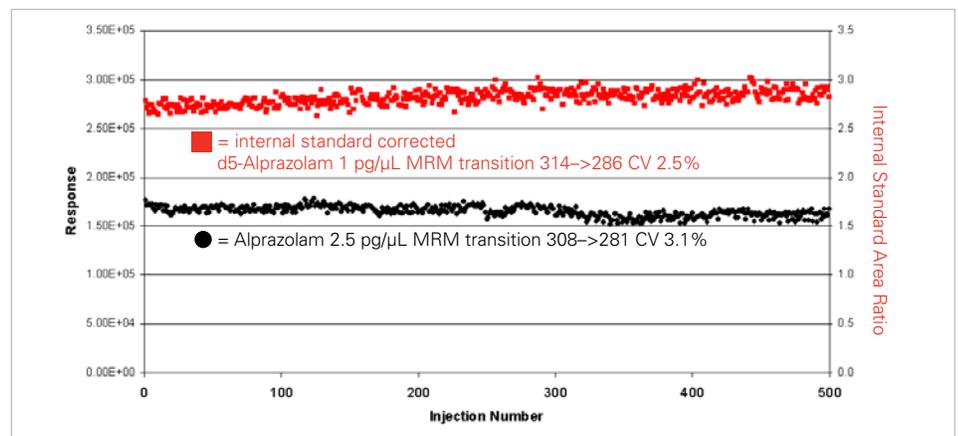


Figure 2 Over two days and 500 plasma sample injections, the API 5000™ system demonstrates excellent reproducibility and stability for the response of the compound and internal standard.

For Research Use Only. Not for use in diagnostic procedures.

Applera, Applied Biosystems and AB (design) are registered trademarks of Applera Corporation or its subsidiaries in the US and/or certain other countries. API 5000, API 4000, Curtain Gas, and QJet are trademarks of Applied Biosystems/MDS Analytical Technologies, a joint venture between Applera Corporation and MDS Inc. All other trademarks are the sole property of their respective owners.

© 2008 Applera Corporation and MDS Inc. Joint Owners. All Rights Reserved. 06/2008 Publication 114PB12-02