PRODUCT SUPPORT BULLETIN

Improved Sensitivity Through Enhanced Ion Transmission Using an S-Lens on the LTQ Velos Linear Ion Trap

PSB 128

Efficient transfer of ions from the ion source to the mass analyzer is one of the most crucial aspects of atmospheric pressure ionization (API) mass spectrometry. Most ion losses occur during this transfer, and those losses directly affect a mass spectrometer's limits of detection and quantification. The Thermo Scientific LTQ Velos dual-pressure linear ion trap mass spectrometer features a stacked-ring ion guide that significantly improves transmission of ions from the ion source to the ion trap mass analyzer.

Enhanced ion optics

The stacked-ring ion guide (Figure 1), called the S-lens, replaces the tube lens and skimmer found in previous LTQ ion trap instruments. The S-lens is very similar in design to the stacked-ring ion guide used in the Thermo Scientific TSQ Vantage triple quadrupole mass spectrometer.

The S-lens is a radio frequency (RF) only device that efficiently captures and focuses the ions into a tight beam without needing a DC gradient to propel them forward. It consists of a series of flat ring electrodes to which RF voltages are applied, with opposite phases applied to even- and odd-numbered electrodes. This generates confining RF electric fields that focus the ion beam as it travels through the device. Orifice diameters of the ring electrodes at the entrance of the S-lens are larger to capture as many of the ions emanating from the ion transfer tube as possible. Orifice diameters of the ring electrodes in the rest of the S-lens are smaller to focus the ion bean through the exit lens. Starting at the entrance, spacing between each ring electrode increases.

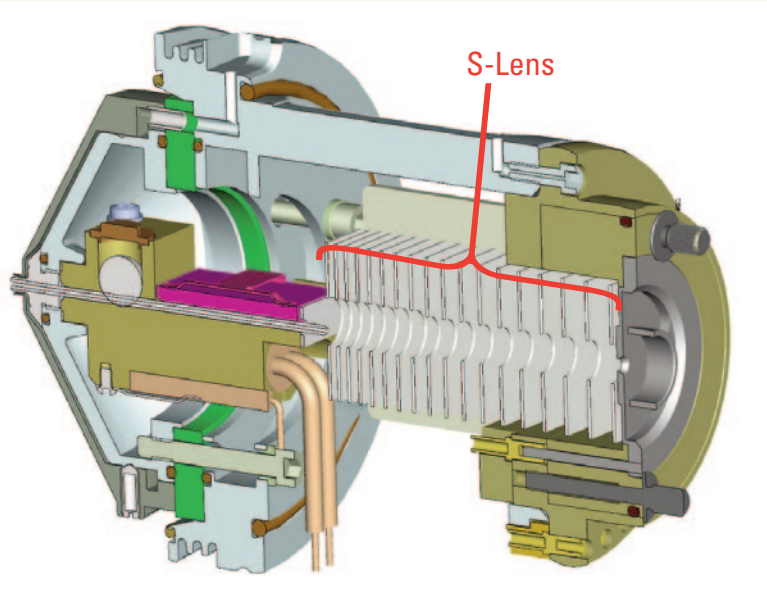

Figure 1: S-lens and associated ion source/ion optics components.

Easy control

The S-lens is controlled by a single, user-adjustable parameter in the instrument software. The S-lens eliminates mass discrimination found in some other ion optics designs (Figure 2).

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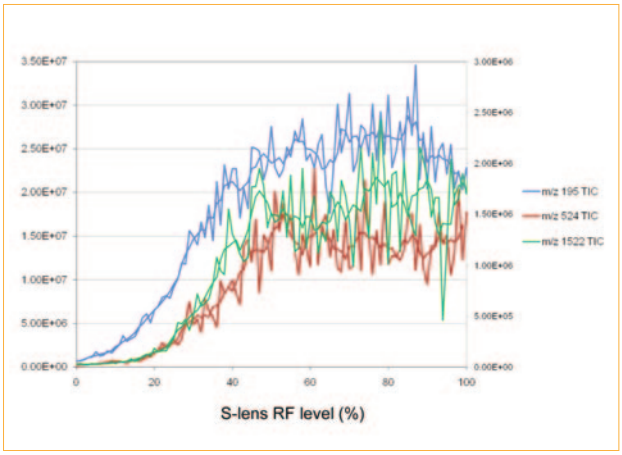

Figure 2: S-lens tuning for different masses of the calibration mixture

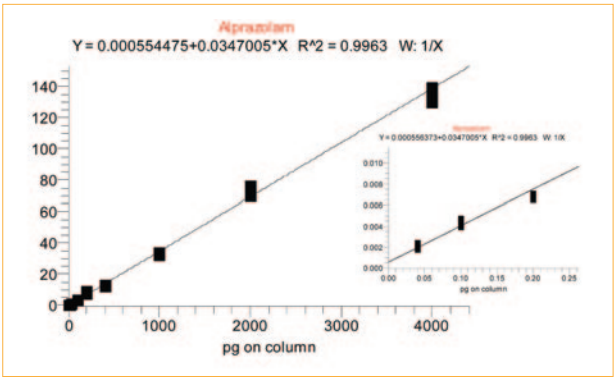

Figure 3: LTQ Velos ion trap achieves a dynamic range of five orders of magnitude for analysis of alprazolam in plasma, normalized to internal standard.

Superior performance

As a result of its improved transmission characteristics, the S-lens increases the limits of detection and quantification by up to 10 times. Figure 3 demonstrates the dynamic range of five orders of magnitude achievable on the LTQ Velos dual-pressure linear ion trap. Table 1 contrasts the LTQ Velos performance with that of the earlier LTQ XL linear ion trap.

Reduced maintenance

The very open design of the stacked ring electrodes in the S-lens facilitates efficient removal of solvent-laden gas.

The stainless steel S-lens is rugged and easy to clean. The entire assembly can easily be removed, without the use of tools, and sonicated in a methanol/water solution for a few minutes.

Conclusion

The S-lens is a significant advance over high-pressure, skimmer-based ion optics designs. By collecting and focusing more of the ions, it significantly increases instrument sensitivity.

pg on column	LTQ XL (%RSD)	LTQ Velos (%RSD)
0.04		12.8
0.1		9.4
0.2		4.6
0.4	7.4	5.7
4	4.2	6.1
40	3.8	2.2
400	2.0	4.3
4000		1.4

Table 1. Relative standard deviation and limit of quantitation for Alprazolam in plasma (normalized to internal standard, 5 injections per level) as detected in the LTQ XL vs. LTQ Velos.