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Applikationsbericht

Improved MALDI Imaging Quality and Speed Using the MALDI SYNAPT G2-*Si* HDMS

Waters Corporation

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This is an Application Brief and does not contain a detailed Experimental section.

Abstract

A new laser with an improved laser focus profile has been incorporated into the MALDI SYNAPT G2-*Si* HDMS System, resulting in enhanced ion imaging quality and higher sensitivity for imaging with sub-50-micron pixel sizes. The instrument control has also been optimized so that, combined with the higher laser repetition rates, data is acquired faster.

Benefits

With a new laser, the MALDI SYNAPT G2-*Si* HDMS offers improved MALDI imaging capabilities, with faster analysis of tissue sections and higher data quality for high spatial resolution experiments.

Introduction

The use of solid-state lasers such as diodepumped ND:YAG lasers has been critical in the development of

MALDI imaging applications, providing higher repetition rates than could be achieved with nitrogen lasers. The MALDI SYNAPT G2-*Si* laser provides higher repetition rates, up to 2.5 kHz, increasing analytical speed. It also has a longer laser life-span, of typically several billion shots.

For high spatial resolution imaging, the main limitation is defined by the diameter of the laser focus, although oversampling can partially overcome this constraint. The improved beam profile of the MALDI SYNAPT G2-*Si* laser allows a tight focus to be produced.

Results and Discussion

The MALDI SYNAPT G2-*Si* HDMS Mass Spectrometer introduces a new laser system that offers several enhancements, including:

- Faster maximum laser repetition rate, maximizing analytical speed
- Variable laser repetition rate control, from 100 Hz to 2.5 kHz
- Sharper and rounder beam profile with low eccentricity
- Increase in data quality for high spatially resolved MALDI imaging experiments
- Improved synchronization between the laser firing and the stage movement results in significantly shorter acquisition times

Figure 1 illustrates the focus profile of the laser included with the MALDI SYNAPT G2-*Si* HDMS. It is circle-shaped with a minimal degree of eccentricity. The profile has an approximate diameter of 30 microns at FWHM, which is significantly smaller than the previous laser. The laser fluence, which also affects the ion desorption area, can be controlled using the built-in variable neutral density filter.

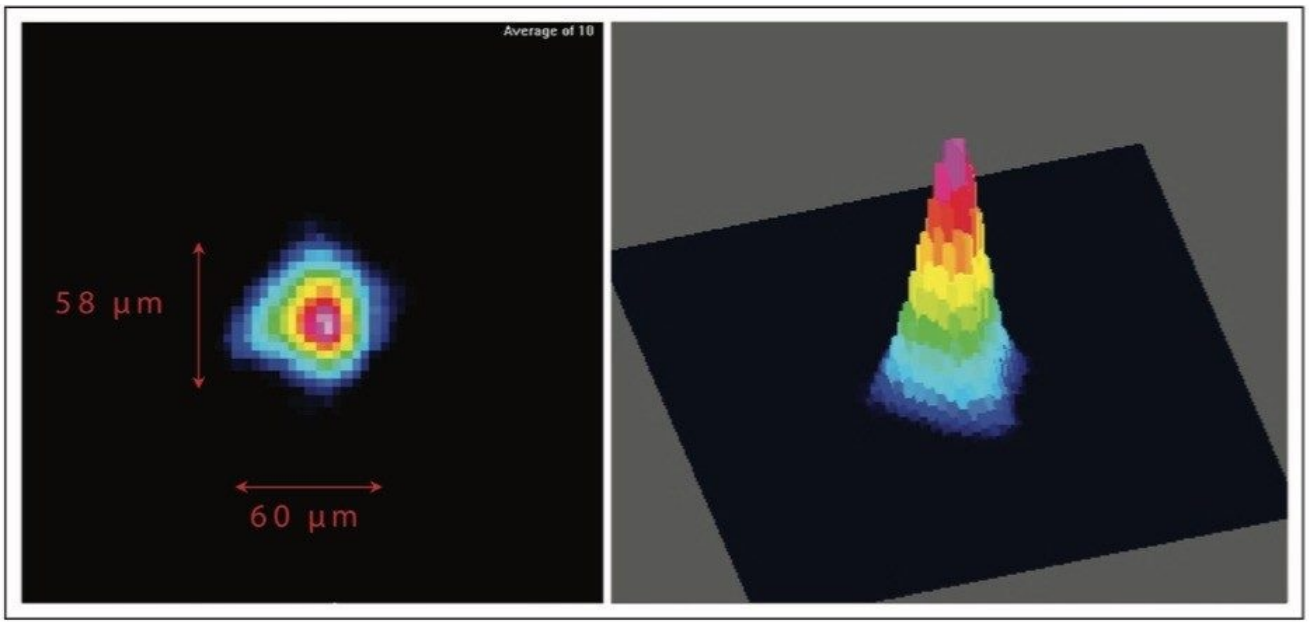

Figure 1. The focused laser beam profile of the new MALDI SYNAPT G2-Si laser

MALDI imaging experiments were carried out using a rat whole body tissue section comparing the quality of the data obtained using the previous laser system and the new laser system (same sample, sample preparation, and mass spectrometer).

The sample target plate was programmed to move in 15, 20, and 50 micron pixel sizes (pitches) while maintaining the minimum laser focus diameter possible for both lasers. The total image summed spectra for each experiment are displayed in Figure 2. In all three cases, the background noise is clearly less abundant, while the lipid peak intensities are higher with the MALDI SYNAPT G2-*Si* laser, especially for the 15 and 20 micron pixel sizes.

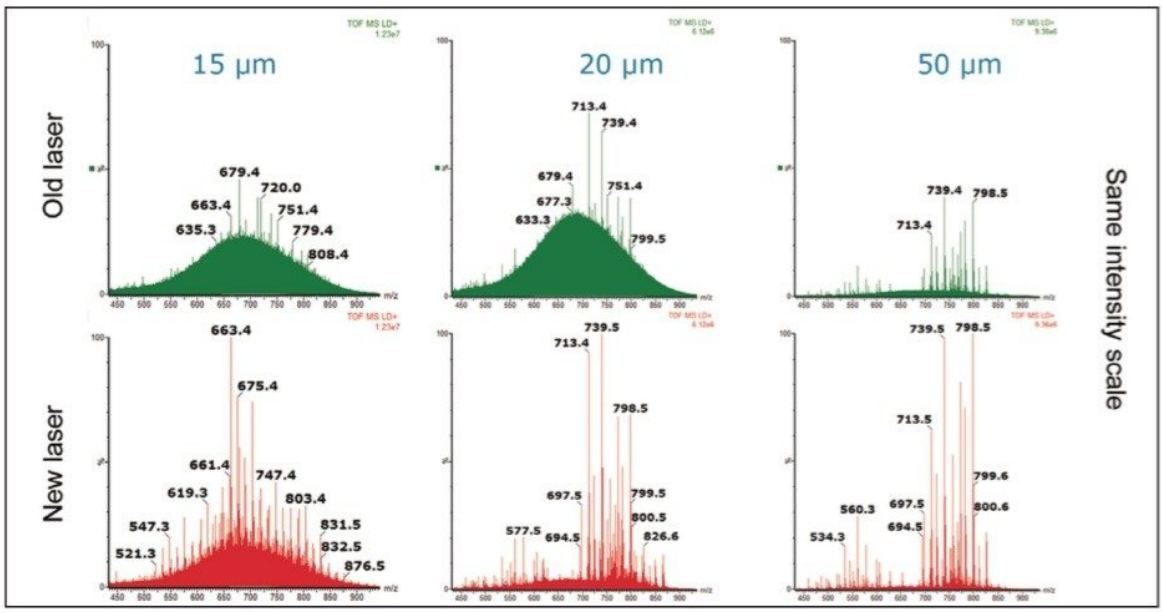

Figure 2. Comparing the summed spectra quality obtained for MALDI imaging experiments carried out with pixel sizes of 15, 20, and 50 microns. Overall, the background noise is lower, and the intensity of lipid species peaks higher with the MALDI SYNAPT G2-Si laser, particularly at spatial resolution sub-50 microns.

Figure 3 shows the overlay of three lipid species that are distributed in very specific anatomical regions of the cerebellum rat brain. The red ion image represents a lipid that is more concentrated in the grey matter of the cerebellum, whereas the blue ion image shows localization of the sample lipid, as an example, in the white matter. The green ion image represents a lipid more specific to the pia matter. It is noticeable that the white matter layer and the pia matter layer are distinguished although their cross sections are less than 100-200 microns.

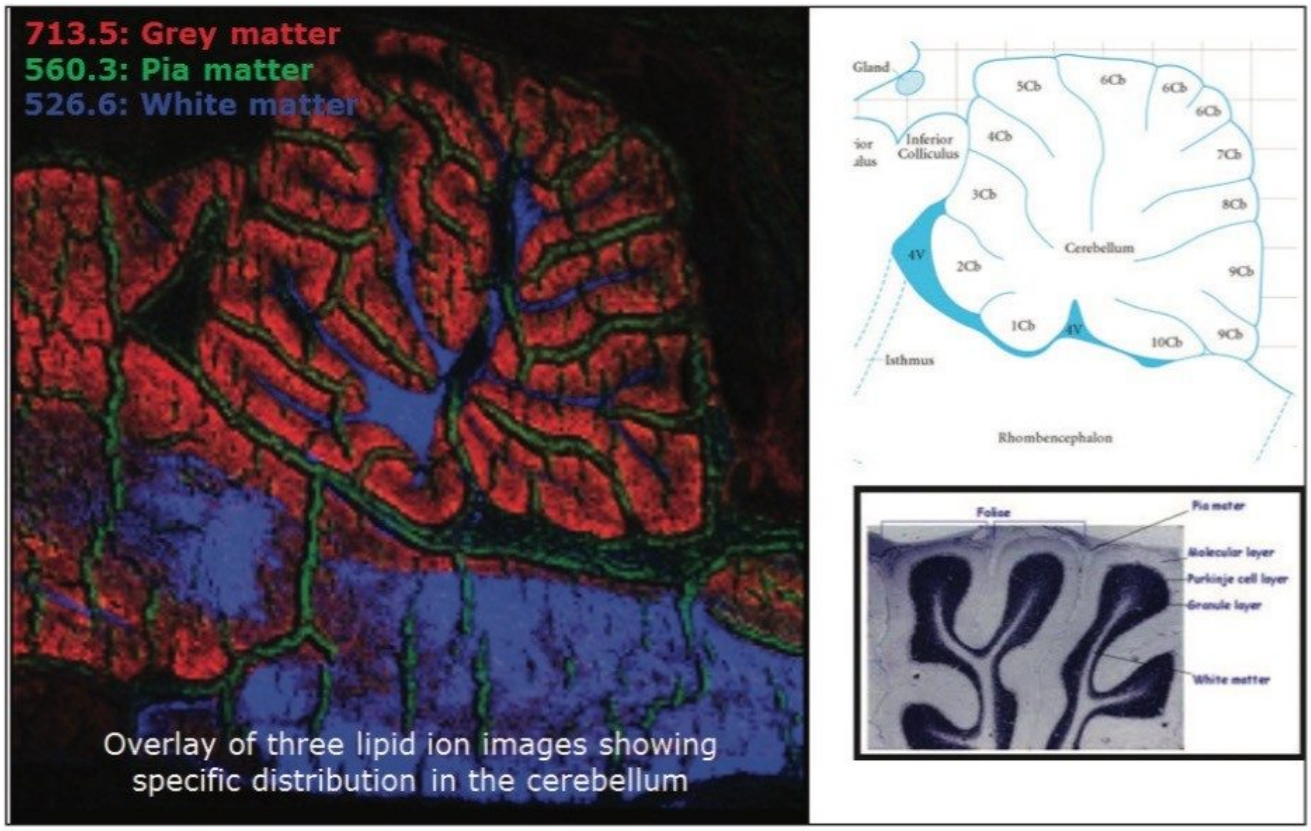

Figure 3. Overlay of three lipid ion images that are distributed to very explicit parts of rat cerebellum. Lipid m/z 713.5 is specific to the grey matter, lipid m/z 560.3 to the pia and lipid m/z 526.6 to the white matter.

Conclusion

For high spatial resolution MALDI imaging experiments, the MALDI SYNAPT G2-*Si* HDMS can acquire both faster and with greater signal to noise. The enhancements are directly attributed to the improved laser focusing and pulse synchronization.

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