Imaging Mass Microscope

iMScope QT
The One and Only
Next-Generation Mass Spectrometry Imaging Created by iMScope™ QT

Inheriting the concept of a mass spectrometer equipped with an optical microscope from the iMScope series, the iMScope QT is also Shimadzu's flagship model for MS imaging with a Q-TOF MS.

The iMScope QT boasts not only fusion with morphology studies but also excellent speed, sensitivity, and spatial resolution, clearing the way to next-generation mass spectrometry imaging.

• Combined Analysis
  Fusion of MS images with optical microscope observations.

• Quantification and Distribution
  Obtain qualitative and quantitative information from LC-MS as well as position information from mass spectrometry imaging with a single instrument.

• High Resolution, Speed and Accuracy
  Acquisition of accurate, high-speed, high-resolution MS images together with efficient data analysis.
Total System for MS Imaging Analysis

Mass spectrometry imaging is performed in three steps: pretreatment, data acquisition, and data analysis. At each step, the optimal approach accelerates research, while improving the reliability of the results.

Key Points for MS Imaging

<table>
<thead>
<tr>
<th>Pretreatment</th>
<th>Data Acquisition</th>
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<tbody>
<tr>
<td>Repeatability</td>
<td>High Spatial Resolution</td>
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<tr>
<td>Automation</td>
<td>High Speed</td>
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<tr>
<td>Crystal Refinement</td>
<td>Quantification</td>
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</table>

Matrix Spray

- Matrix Vapor Deposition System
  - iMLayer™

Pretreatment, which normally requires know-how to increase ionization efficiency, has been automated.

- Automatic Sprayer for MALDI Imaging
  - iMLayer™ AERO

Imaging Mass Microscope

- iMScope™ QT

Users can easily switch between imaging analysis and LC-MS analysis.

- Quadrupole Time-of-Flight Liquid Chromatograph Mass Spectrometer
  - LCMS-9030

Creation of consecutive sections
The mass spectrometer is equipped with an optical microscope, so data analysis can match the optical microscope images to the MS images.

Overlaying optical microscope images with MS images

Data Analysis

Convenience
Diversity
Universality

The mass spectrometer is equipped with an optical microscope, so data analysis can match the optical microscope images to the MS images.

Overlaying optical microscope images with MS images

Quantitative Analysis

Data analysis with IMAGEREVEAL™ MS

Analyze both distribution information acquired using the iMScope QT and quantitative information obtained with the LCMS-9030 (ideal for quantification).
Measurement Results for the Cerebellum with 5 μm Spatial Resolution

- Sample: mouse cerebellum
- Matrix: 9-AA
- Measurement region: 662 × 595 (393,890 pixels)
- Measurement time: around 2.2 hours

The region in the red frame below (cerebellum) was measured with a resolution of 5 μm. High-resolution MS imaging and morphological observations with the optical microscope support cutting-edge research.

Measurement Results for Whole Brain Sections in Negative Mode

- Sample: Whole mouse brain
- Matrix: 9-AA
- Measurement region: 1126 × 624 (702,624 pixels)
- Measurement time: around 6 hours

The sections of the mouse brain (17 mm × 9.4 mm) were measured at high resolution with a 15 μm pitch (702,624 pixels). The high-resolution analysis of these large brain sections was completed in around 6 hours, enabling testing to proceed efficiently.
Quantification and Distribution

Obtain qualitative and quantitative information from LC-MS as well as position information from mass spectrometry imaging (MSI) with a single instrument.

The combined system, which can perform LC-MS analysis in addition to MSI analysis, provides both distribution information and quantitative analysis.

| Use as an MSI System |

Sections of mouse tissue administered with chlorpromazine were measured with the iMScope QT. The distribution of unaltered chlorpromazine including differences in abundance could be visualized without the need for labeling.

![Unaltered substance](image)

| Use as an LC-MS System |

From the consecutive sections, the positions circled in the figure above were excised using laser micro dissection (LMD), and the extracted liquid was measured with the LCMS-9030.

The results below show a quantitative analysis of the concentration of chlorpromazine in the extracted liquid, carried out with LabSolutions Insight™. In this way, concentration differences of the pharmaceutical agent in the tissue sections indicated by MSI could be confirmed from the quantitative results determined using LC-MS.

In addition, it is possible to estimate the molecular formula of an unknown compound using the LabSolutions Insight Explore™ composition estimation function.

In this case, when the peak at $m/z = 319.10$ determined using MSI was analyzed using the composition estimation function, the molecular formula for the unaltered chlorpromazine substance ($C_{17}H_{19}N_{2}SCl$) was indicated as the most likely with the highest score.

<table>
<thead>
<tr>
<th>Ion Types</th>
<th>Theoretical Value</th>
<th>Measured Value</th>
<th>Difference (mDa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[M+H]⁺</td>
<td>319.10302</td>
<td>319.10317</td>
<td>+0.15</td>
</tr>
</tbody>
</table>

Results: highest score of 98.99, Diff. 0.15 mDa (0.458 ppm), C_{17}H_{19}N_{2}SCl
High Resolution, Speed and Accuracy

Acquisition of accurate, high-speed, high-resolution MS images, together with efficient data analysis

Combination of the high-accuracy, high-speed LCMS-9030* with high-resolution mass spectrometry imaging

Revolutionary, High Performance Analysis System

After scanning with the built-in optical microscope, the sample plate is moved directly to the ionization position, and the imaging process begins.

Designed for Easy Attachment

The iMScope QT can be easily attached or detached from the LCMS-9030 to switch between mass spectrometry imaging and high-sensitivity LC-MS analysis.

User-Friendly Design

Easy sample setting

* The LCMS-9030 is sold separately.
Effortless Performance for Accurate Mass

Excellence in Mass Measurement Accuracy (MMA)

Mass measurement accuracy (MMA) is the key performance attribute underlying all application fields using high-resolution accurate-mass (HRAM) spectrometers. The LCMS-9030 delivers the MMA needed for high-confidence identification of unknown compounds at an unprecedented level of stability. This is made possible by new technologies implemented in the Intelligent Temperature Control System and the UF-FlightTube that accurately offset the changes occurring to both internal and external environments. With the LCMS-9030, Shimadzu aims to totally refashion the HRAM user experience, enabling scientists to run more samples at longer calibration intervals with greater confidence and ease.

Stable MMA Against Temperature Fluctuation

Shimadzu’s Intelligent Temperature Control System ensures stable MMA even in laboratory environments susceptible to temperature changes. To demonstrate, standards ranging from 150 to 1700 Da were analyzed continuously after a single calibration. Normal laboratory temperature fluctuation was observed between 25°C and 28°C.

Without additional mass correction, the measured accurate masses of all compounds remained within 1 ppm of the theoretical mass for the 60-hour duration of the experiment. With the LCMS-9030, laboratory productivity can be increased by running long, calibration-free batches with confidence.

Positive Mode

Negative Mode
Pretreatment Instruments for MALDI Imaging

With mass spectrometry imaging (MSI), suitable pretreatment is important. High quality MSI analysis results are obtained from a combination of the spray method and the vapor deposition method.

### Work Flow

- Derivatization/Enzyme treatment
- Matrix spraying
- MSI analysis
- MSI data analysis

Automation of pretreatments conventionally requiring expertise

### Automatic Sprayer

**iMLayer AERO (Option)**

The iMLayer AERO incorporates a sample stage that moves at a controlled rate while maintaining the same distance from the spray nozzle, enabling stable matrix spraying. Over multiple strokes, the sample becomes laminated with fine matrix crystals, enabling high sensitivity and high spatial resolution.

### Imaging with High Reproducibility

- **Humidity Control**
  Humidity does not impact matrix deposition because the atmosphere within the spray chamber is replaced before pretreatment. Spraying can be performed under more stable conditions than with a hand spray.

- **Clog-Free Reagent Delivery**
  If the matrix clogs the nozzle tip, the spray becomes unstable, which can lead to lower reproducibility. The rinsing mechanism allows for clog-free stable spraying which enables high reproducibility in MALDI analyses.
Matrix Vapor Deposition System

**iMLayer** (Option)

Applying the matrix by the vapor deposition method supports high resolution MALDI imaging.

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**Both Spatial Resolution and Sensitivity Thanks to the Two-Step Vapor Deposition Method**

- **Two-Step Vapor Deposition**
  A two-step vapor deposition method has been developed*, which provides high spatial resolution (5 to 10 μm) and high sensitivity, thanks to a combination of iMLayer (vapor deposition method) and iMLayer AERO (spray method). This unique experiment can only be implemented using Shimadzu sample preparation solutions.

  * Patent No.: JP6153139 and JP6183779

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**Two-Step Vapor Deposition Allows for Very Fine Images with Minimal Blur**

**Hand Spray**
- Matrix: 9-AA
- Volume used: 200 μL

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**Two-Step Vapor Deposition**
1 step: iMLayer (vapor deposition method)
- Film thickness: 1 μm
2 step: iMLayer AERO (spray method)
- Solution delivery volume: 120 μL/min
- Stage speed: 70 mm/sec
- Laminating layers: 4