C146-E415C

SHIMADZU
Excellence in Science

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 QTOFMS.

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.

iMScope QT

IMAGING MASS MICROSCOPE

DESIGN AWARD 2021

reddot winner 2021

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

Pretreatment

Repeatability
Automation
Crystal Refinement

Data Acquisition

High Spatial Resolution
High Speed
Quantification

Creation of consecutive sections

Matrix Spray

Matrix Vapor Deposition System
iMLayer™

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

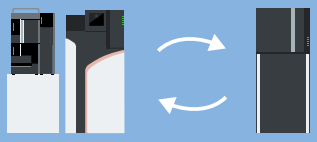
Automatic Sprayer for MALDI Imaging
iMLayer™ AERO

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 QTOF

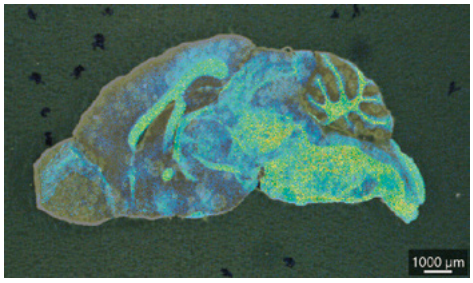
Data Analysis



Convenience

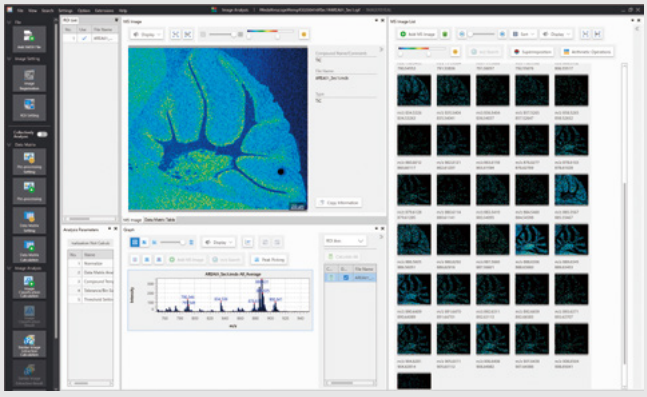
Diversity

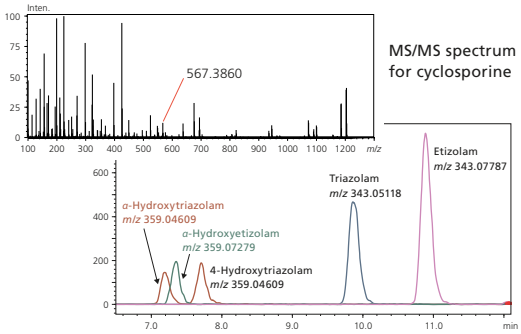
Universality



Overlaying optical microscope images with MS images

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





Mass chromatogram of etizolam, triazolam, and their metabolites, added to whole blood at a concentration of 10 ng/ml

Quantitative Analysis

Data analysis with IMAGEREVEAL™ MS

Analyze both distribution information acquired using the iMScope QT and quantitative information obtained with the LCMS QTOF (ideal for quantification).

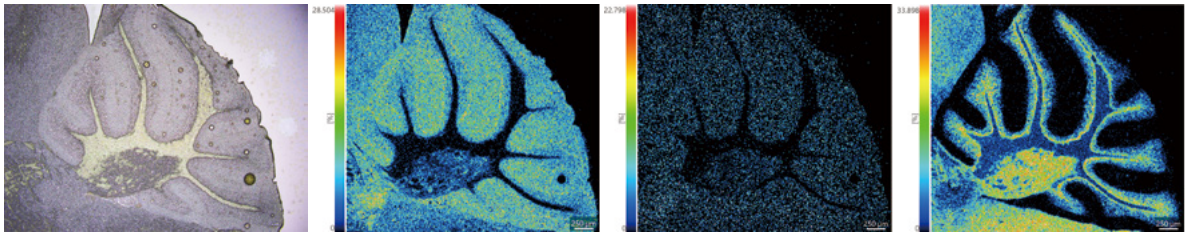
Combined Analysis

Fusion of observations from an optical microscope with MS images (exclusive to Shimadzu)

MS images can be obtained flexibly and matched to observation images, either the entire image area or detailed portions of it.

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

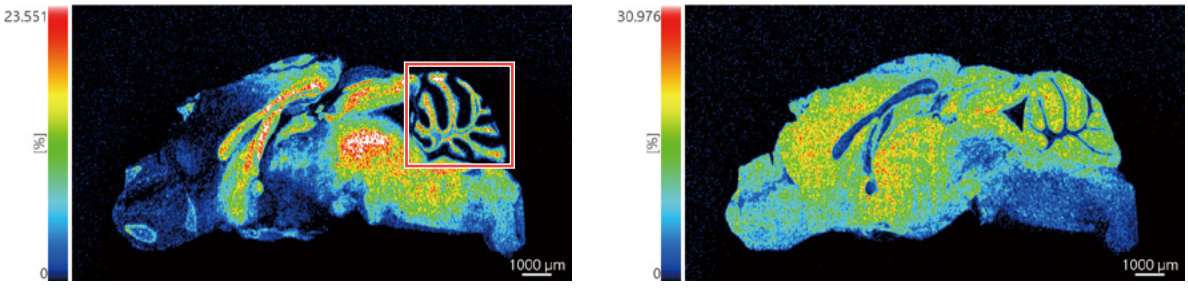


Optical microscope image | *m/z* 885.55 | *m/z* 888.57 | *m/z* 888.63

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



m/z 888.6 | *m/z* 885.5

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.

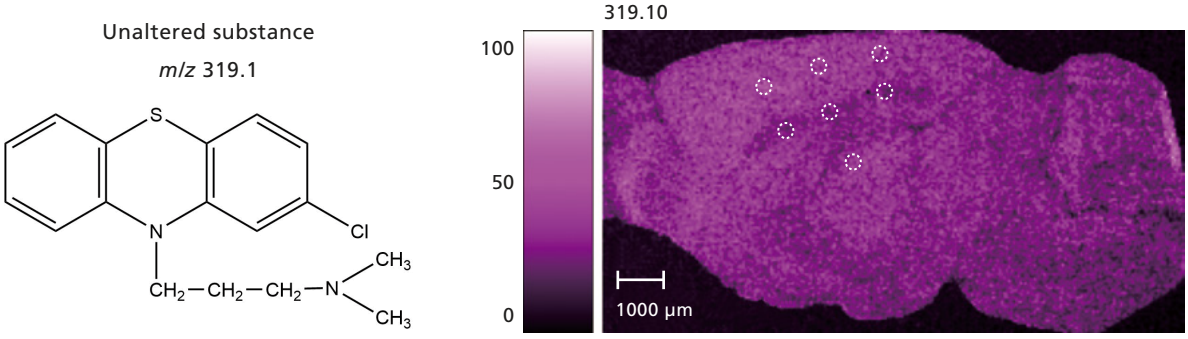
Quantification and Distribution

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

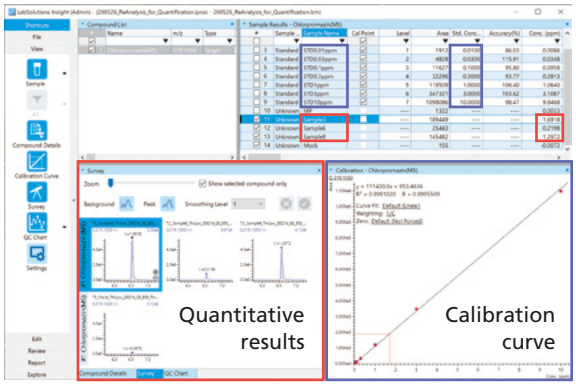
Sections of mouse tissue administered with chlorpromazine were measured with the iMScope QT. The distribution of unaltered chlorpromazine including differences in abundance could be visualized without the need for labeling.



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.



LabSolutions Insight Explore

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 ($C_{17}H_{19}N_2SCl$) was indicated as the most likely with the highest score.

Ion Types	Theoretical Value	Measured Value	Difference (mDa)
$[M+H]^+$	319.10302	319.10317	+0.15

Results: highest score of 98.99, Diff. 0.15 mDa (0.458 ppm), $C_{17}H_{19}N_2SCl$

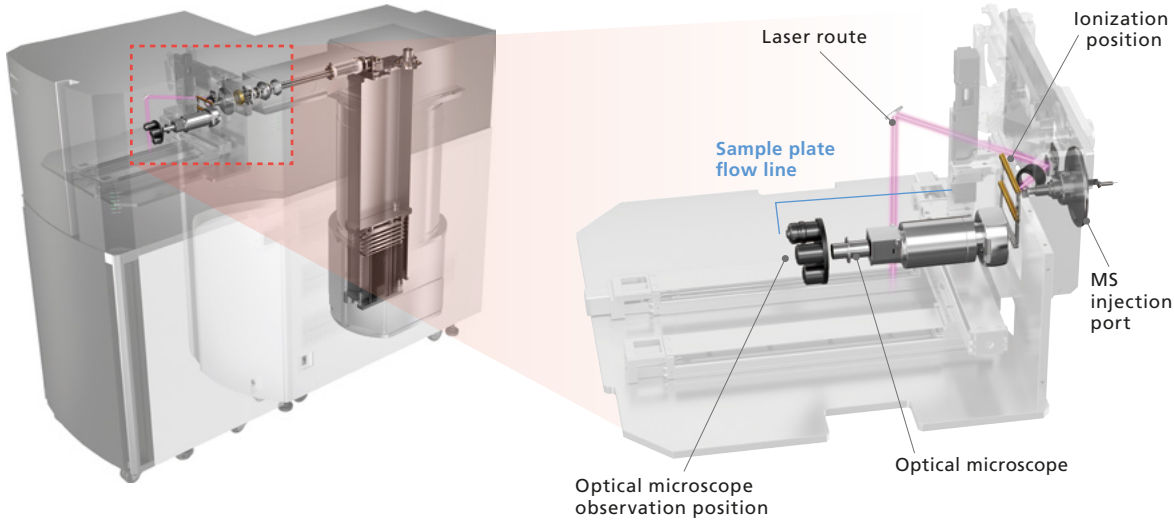
High Resolution, Speed and Accuracy

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

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

Revolutionary, High Performance Analysis System

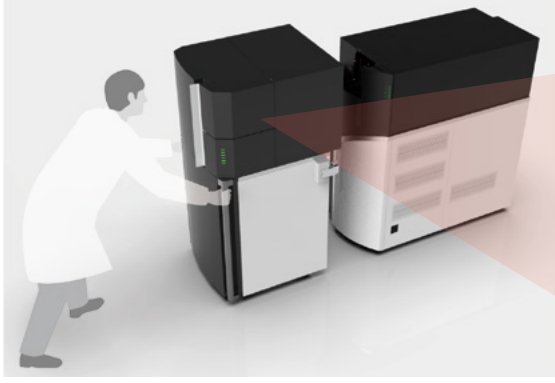
After scanning with the built-in optical microscope, the sample plate is moved directly to the ionization position, and the imaging process begins.



Layout near the ion source unit

Designed for Easy Attachment

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



User-Friendly Design

Easy sample setting

* The LCMS QTOF is required separately.

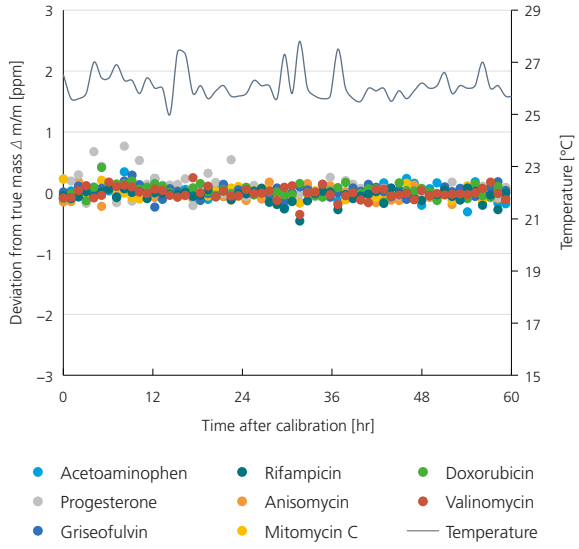
Accurate MS and Structure Analysis

Temperature Control for Accurate Mass Accuracy

Intelligent temperature control system has been adopted to reduce the influence of room temperature changes on precision mass measurements. In this system, a heater and temperature sensor are properly placed in the flight tube to achieve precise and robust temperature control. This system enables stable mass accuracy over a wide mass range for a long period.

To demonstrate, standards ranging from 150 to 1700 Da were analyzed continuously after 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.

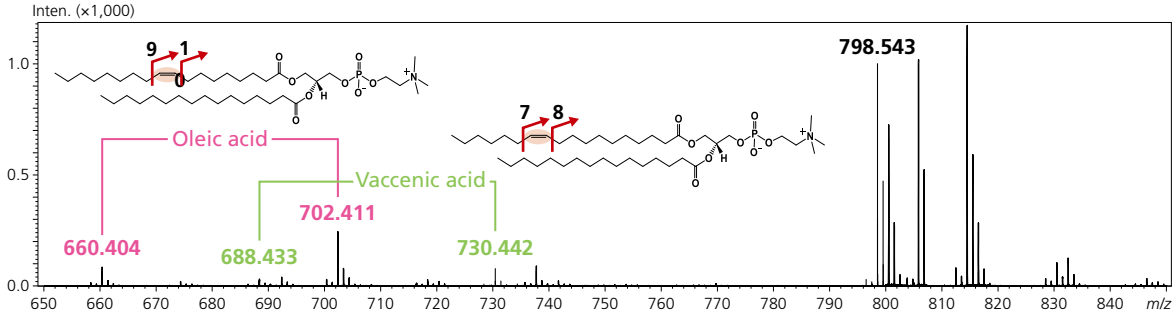


Structure Analysis with OAD-TOF*

OAD (Oxygen Attachment Dissociation) is Shimadzu's original fragmentation technology that can specifically oxidize/dissociate double bonds between carbons, such as lipid. It can be applied to monovalent ions and negative ions, which have been difficult to fragment using electron and anion radical reactions, and provides completely new structural information.

The iMScope QT and OAD-TOF system were combined to analyze oleic and vaccenic acids, which have the same carbon number but different double bond positions.

While using iMScope QT as an ion source, specific fragment ions derived from OAD can be detected and analyzed.



* The optional OAD RADICAL SOURCE I is required separately.

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.

Workflow

Automation of pretreatments conventionally requiring expertise

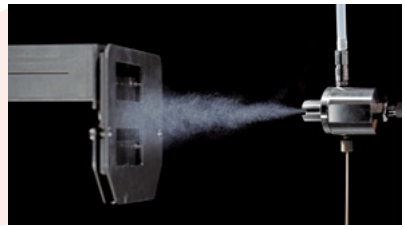
Automatic Sprayer

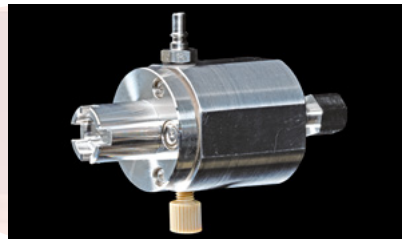
iMLayer AERO (Option)

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.

Sample stage and Spray nozzle

The newly developed spray nozzle provides a fine spray. The distance between the sample and nozzle can be adjusted between 5 and 10 cm.



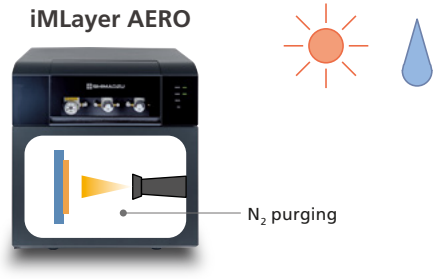


Spray nozzle

Imaging with High Reproducibility

• Humidity Control

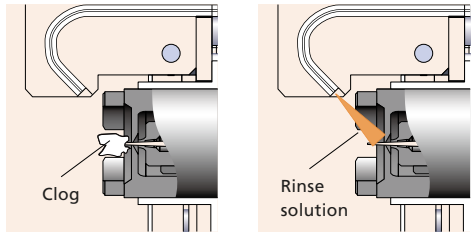
High humidity makes matrix deposition unstable. The influence of humidity can be reduced by replacing the atmosphere within the spray chamber to dry nitrogen gas before pretreatment.



• 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.

* Patent: JP7306180

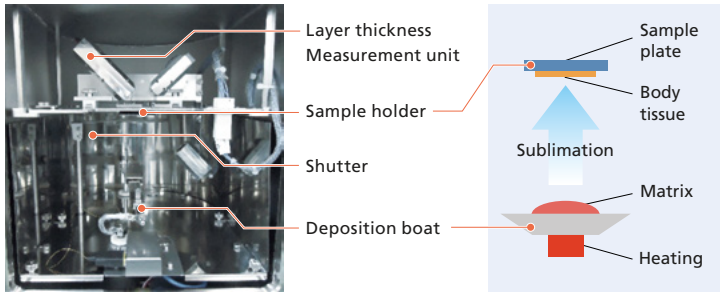


Matrix Vapor Deposition System

iMLayer (Option)

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

Inside iMLayer



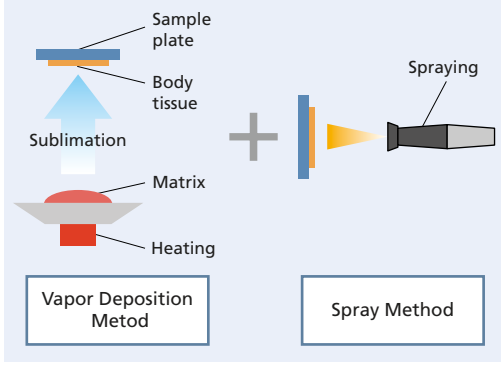
Applying fine matrix crystals by vapor deposition

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

• Two-Step Vapor Deposition

A two-step vapor deposition method** 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.

** Patents: JP6153139 and JP6183779



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

Hand Spray

- Matrix: 9-AA
- Volume used: 200 µL

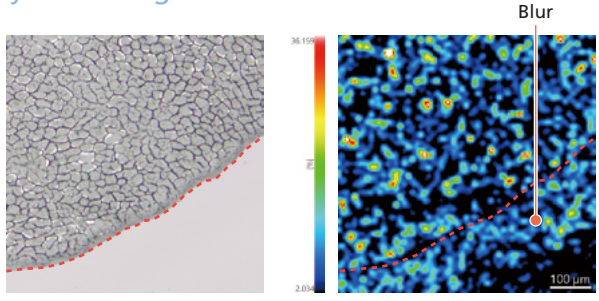
Two-Step Vapor Deposition

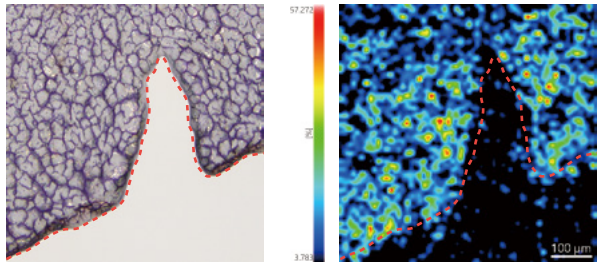
Step 1: iMLayer (vapor deposition method)

- Film thickness: 1 µm

Step 2: iMLayer AERO (spray method)

- Solution delivery volume: 120 µL/min
- Stage speed: 70 mm/sec
- Laminating layers: 4





MS Imaging Analysis

Mass Spectrometry Imaging Data Analysis Software

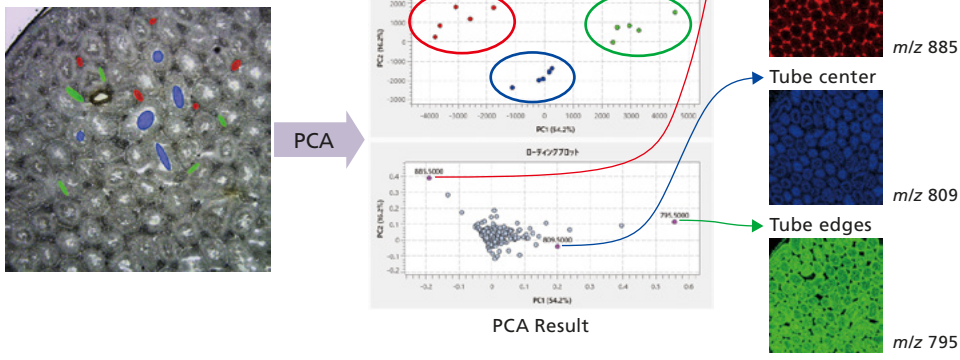
IMAGEREVEAL MS (Option)

IMAGEREVEAL MS automatically analyzes a large amounts of MS image data with simple settings. Automatically obtain MS images with distinctive characteristics thanks to the "Collected analysis" mode with pre-set parameters of "Differential analysis" and "Image analysis".

Differential Analysis: Finds the Molecules, Which Characterize ROIs

PCA with average spectrum of each ROI

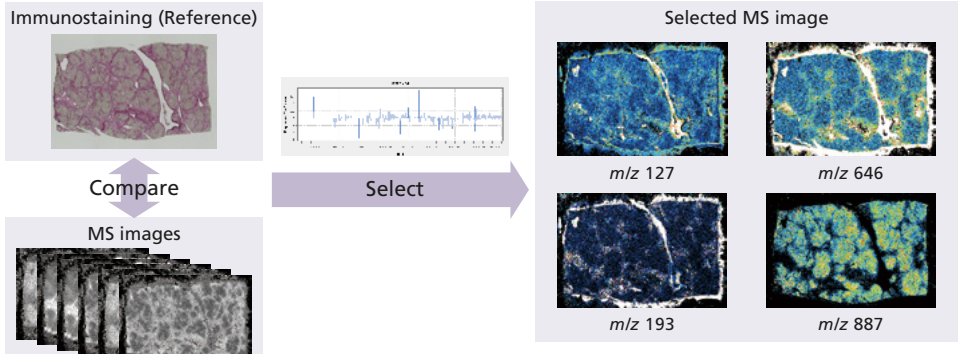
- Sample:
  Mouse testis
- ROI:
  Red: Inter tubes
  Blue: Tube center
  Green: Tube edges



PCA Result

Image Analysis: Search MS Images with Similar Distribution

- Sample:
  Mouse liver with non-alcoholic fatty liver disease



Select MS images with similar distribution to reference

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