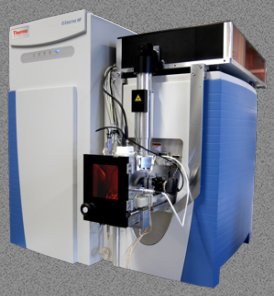
High-performance Mass Spectrometry Imaging

AP-SMALDI5 AF



PRODUCT SPECIFICATIONS

SIMPLY PERFECT

- Highest lateral resolution
- MS imaging at maximum speed as provided by the employed mass spectrometer
- Orthogonal laser irradiation for authentic, high-sensitivity imaging
- Atmospheric pressure operation for artifact-free sample handling without morphology changes
- No vacuum-related sensitivity losses for volatile small molecules
- High resolution in mass and space for imaging analysis of tryptic or endogenous peptides, lipids, carbohydrates, metabolites or drug compounds
- Non-targeted detection, identification and localization of marker compounds

The TransMIT AP-SMALDI5 AF ion source is a high-resolution, high-speed, high-sensitivity mass spectrometry imaging system of unrivaled quality and performance. Built on a fusion of simplicity and perfection, of ergonomics and performance, of form and function, the design of the AP-SMALDI5 AF is breathtaking as much as its analytical results are.

Simple intuitive software immediately enables the user to generate data of highest quality and reproducibility. The high-focusing condition at atmospheric pressure results in maximum sensitivity at lowest sample consumption and practically absent instrument contamination. No memory effects, no source cleaning.

AP-SMALDI5 AF, in combination with the SMALDIPrep matrix preparation system, forms a most reliable platform that has entered laboratories at universities and pharma companies all over the world in all fields of life sciences.

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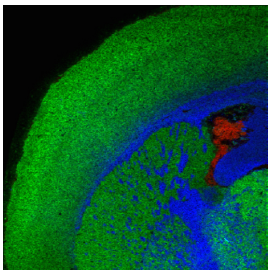

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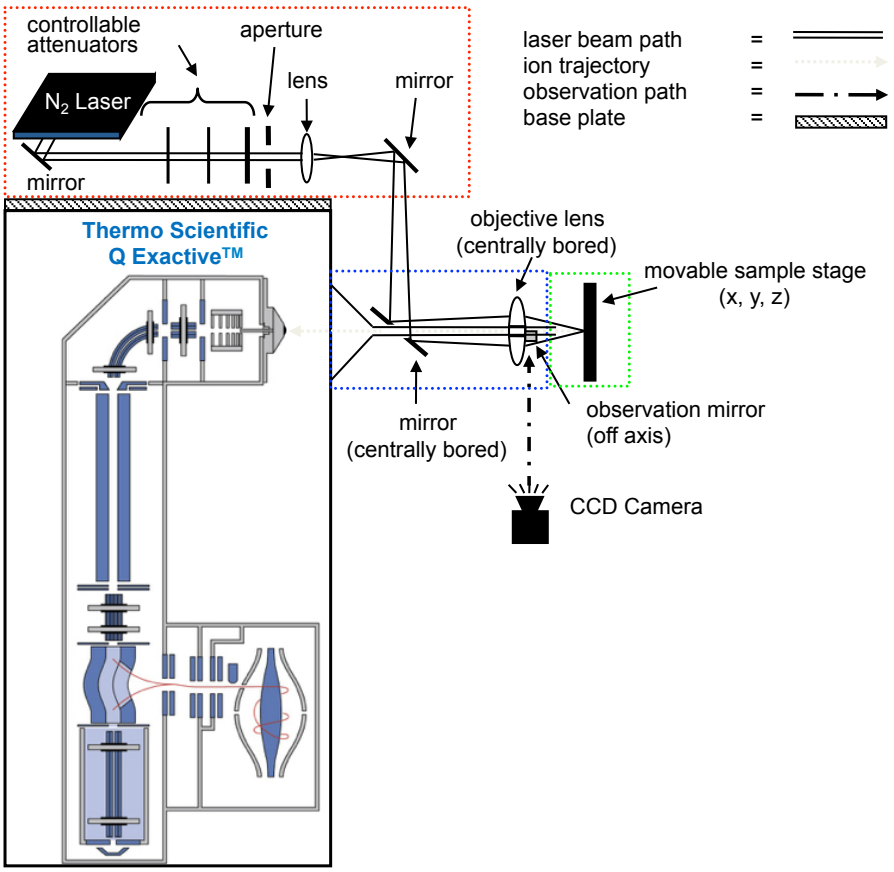
Hardware features



- high-resolution centrally-bored objective lens for laser focusing
- dedicated laser optical setup
- diode-pumped solid state laser (343 nm) at up to 2 kHz repetition rate
- detachable ion source with laser focusing unit
- high-precision high-resolution motorized xyz sample stage with scanning capability for MS imaging operation and autofocusing operation
- sample observation unit with two video cameras
- diode laser for autofocus system
- Windows-based computer and monitor

Software features

- instrument control software for achieving scanning operation and data acquisition in pixel mode, continuous mode, autofocus mode, 3D-surface mode, full-pixel mode and tilt correction mode
- image generation software for fast data analysis and semi-automatic image formation, including image browsing, normalization, mathematical image operations, imzML export and import functions and red-green-blue image generation for three selected signals.

Operation modes

Acquisition speed

Image acquisition speed depends on parameter settings of the ion source and of the mass spectrometer employed, and is better than 0.7 pixels per second in pixelated mode and up to 18 pixels per second in high-speed continuous mode under typical conditions at reduced mass resolution on a Q Exactive HF instrument.

Acquisition speed / pixels * s^{-1}	Mass resolution @ m/z 200	Inlet time / ms
1.9	240,000	500
3.8	120,000	250
5	60,000	185
10	30,000	84
18	15,000	40
All values refer to AP-SMALDI5 AF on Q Exactive HF		

Geometry

Laser illumination is arranged normal to the sample surface and coaxial to ion beam path. Perfect orthogonality guarantees highest precision, authenticity and analytical sensitivity.

Autofocusing mode

allows to adjust the sample height automatically prior to imaging acquisition.

Full-pixel mode

allows for complete analysis of square spots of 25 µm x 25 µm and larger using 5-µm laser spots, in order to improve sensitivity.

Tilt correction mode

allows for adjustment of sample height during image acquisition for tilted tissue samples, in order to achieve constant ion yield and spot size.

3D-surface mode

allows to follow height variations of non-planar objects during imaging acquisition. 3D-surface mode results in reduced acquisition speed due to pixelwise height adjustment.
Pixelwise autofocusing is a prerequisite for quantifiabilty at high spatial resolution.

Performance specifications

	AP-SMALDI10	AP-SMALDI5 AF
Stage operation	x-y-z [1]	x-y-z [1]
Scan modes	x-y	x-y-z
Accuracy of stage	0.2 µm	0.2 µm
Ablation spot diameter (minimum)	10 µm [3]; 5 µm [4]	5 µm [3]
Lateral resolution w/o oversampling [5]	10 µm	5 µm
Lateral resolution with oversampling [6]	5 µm	3 µm
Tilt correction [7]	no	yes
Full pixel mode [8]	no	yes
Autofocusing to 5 µm laser spot size	no	yes
3D-surface mode [9]	no	yes
Highspeed continuous mode [10]	no	yes
Full atmospheric pressure operation [11]	yes	yes
Coaxial, vertical and telecentric optical, laser and ion beam geometry [12]	yes	yes
High mass resolution, high mass accuracy operation	yes, with Exactive or Q Exactive family mass spectrometers (Thermo Fisher Scientific)	yes, with Exactive or Q Exactive family mass spectrometers (Thermo Fisher Scientific)
Imaging in MS/MS mode	yes, with Q Exactive family mass spectrometers (Thermo Fisher Scientific)	yes, with Q Exactive family mass spectrometers (Thermo Fisher Scientific)

Remarks

[1] full control of movement in x and y (lateral) and z (height) direction

[2] most vendors give no or only limited access to height adjustment

[3] routinely

[4] under best focused conditions

[5] routinely achievable lateral resolution with ablation spots on tissue touching each other; non-overlapping ablation spots

[6] achievable lateral resolution with overlapping ablation spots on tissue; oversampling mode results in less reproducible and reduced signal intensities

[7] tilt correction becomes essential at high lateral resolution (small spot sizes), as the depth of focus is small; imperfect mounting of tissue section can be counterbalanced in tilt correction mode

[8] in full pixel mode each pixel area is fully ablated by meandered scanning with multiple highly-focused laser pulses; for pixel sizes ≧ 25 µm

[9] 3D-surface mode allows for a pixelwise autofocusing of the laser spot onto the surface of a non-ideally flat sample or a completely non-flat sample

[10] Highspeed continuous mode allows to run the scanning system at the maximum speed of the acquiring mass spectrometer; laser pulsing and stage movement are not operated pixelwise but continuously, depending on duty cycle of mass spectriometer; maximum speed is achieved at a reduced mass resolving power only.

[11] Atmospheric pressure operation in the ion source allows to investigate volatile compounds (small molecules) which are lost under high-vacuum conditions. It also allows to use volatile matrices, some of which are favorable e.g. for dual-polarity measurements, such as para-nitroaniline (PNA)

[12] Coaxial geometry of ion beam and laser beam, normal to the sample surface, provides highest ion transmission, highest stability of ion currents and minimal abberation of ion images. Laser spot position is independent of laser focusing condition. Telecentric sample observation furthermore results in perfect alignment of optical image and resulting ion image under all conditions.

Installation requirements

Dimensions of AP-SMALDI5 AF ion source

The instrument has to be installed on a Q-Exactive mass spectrometer. The dimensions of the instrument including the mass spectrometer are:

Width (incl. MS):	ca.	950	mm
Depth (incl. MS):	ca.	1100	mm
Height (incl. MS, from table):	ca.	950	mm
Weight (ion source):	ca.	70	kg
Overall weight* (ion source + computer.):	ca.	85	kg

Power

Operating voltage:	230 VAC; + 6%, -10% 110 VAC; + 6%, -10%
Phases:	1 Phase
Frequency:	50 Hz ± 1 % 60 Hz ± 1 %
Input	
Line fuses:	max. 1 x 10 A
Cable cross section:	max. 3 x 1,5 mm^2 Cu
Max. connection length:	max. 10 m
Nominal current:	max. 2 A
Power:	max. 240 VA
Sockets:	
	1 Socket for AP-SMALDI ion source 1 Socket for control computer

Environment

Temperature range:	
Instrument:	+ 15 °C … +30 °C
Electronic box:	+ 15 °C… + 30 °C
Relative humidity:	max. 85 %, not condensing
Max. altitude:	≤ 1.000 m above SL
Storage conditions:	
Lower temperature limit:	- 10 °C
Upper temperature limit:	+ 40 °C
Relative humidity:	max. 85, not condensing
Noise level:	
Acoustic pressure level (2006/42/EG):	L_{PA} < 70 dB(A)
Uncertainty of measurement (L_{PA})	3 dB