INTRODUCING: THE MSOT SCANNER FAMILY.

Multispectral Optoacoustic Tomography (MSOT): The next generation in molecular imaging.

MSOT inSight 64

MSOT inVision 128

MSOT inVision 256-TF

- Optoacoustic scanner for small animal imaging
- Anatomical, functional and molecular contrast
- Real-time image acquisition, 150 µm resolution

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MSOT: MULTISPECTRAL OPTOACOUSTIC TOMOGRAPHY

MSOT technology

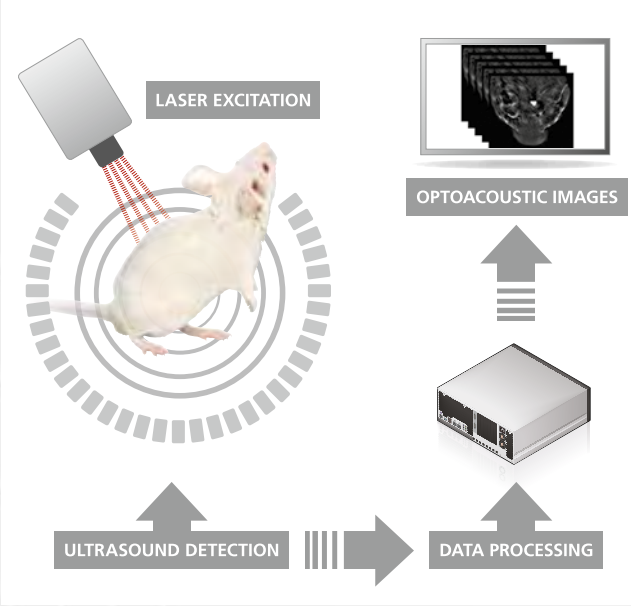
Imaging sequence:

- Illumination of tissue with laser pulses at multiple wavelengths
- Detection of induced ultrasound pressure waves
- Spectral unmixing to analyze individual absorbers

Technology benefits:

Combines the molecular specificity of optical imaging with the depth and spatiotemporal resolution of ultrasound

- **Molecular specificity:**
  Identify and quantify disease-related biomarkers, revealing endogenous absorbers and injected probes
- **Depth & spatiotemporal resolution:**
  Acquire whole-body images of small animals, with in-plane resolution of 150 µm, in vivo and in real time

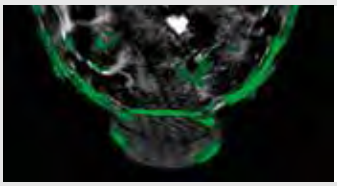


MSOT applications

Broad range of applications including cancer, cardiovascular, neuro and pharmacokinetic imaging

Cancer: Understanding tumors

- Measure probe accumulation, analyze distribution
- Determine oxygenation status
- Visualize and quantify (micro-)vasculature



Vascular perfusion in tumor region

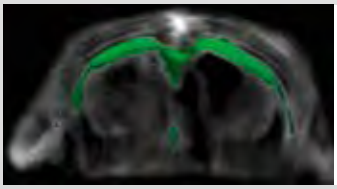
Cardio: Monitoring blood flow

- Visualize blood vessels in all body regions
- Quantify blood oxygenation in vessels and tissue
- Analyze atherosclerotic plaque deposition

Oxygenation in heart region

Neuro: Tapping into the brain

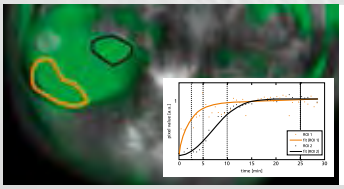
- High resolution imaging of deep brain structures through intact skin and skull
- Determine probe distribution in the brain
- Characterize blood brain barrier integrity



Probe distribution within the brain

Kinetics: Measuring the change

- Follow probe uptake and elimination in real time
- Analyze hepatic and renal function
- Kinetic profiling of multiple probes simultaneously



Probe accumulation and clearance in kidneys

MSOT: SYSTEM OVERVIEW, IMAGING WORKFLOW, ACCESSORIES/ OPTIONS

System overview

- Ergonomic and fully integrated design (no external components)
- Small footprint (< 1 sqm)
- System fully upgradeable

Workflow-oriented software design:

1. Acquisition
2. Reconstruction
3. Spectral processing
4. Visualization and analysis

Imaging workflow

Animal preparation

- Safe animal handling
- Repeatable fixed position (key for longitudinal studies)
- Easy mounting of animal in holder
- Integrated anesthesia supply

Insertion into imaging chamber

- Holder snapped into stage-driven sled
- Optimal animal positioning in three dimensions
- No limitations on regions of interest
- Imaging of entire animal in one session

Image acquisition

- x-sectional scan along the region of interest
- Fully automated image acquisition
- Access for catheter or thermometer
- Maintains animal body temperature

Accessories/ options

Anesthesia system

Animal holder for imaging rats (up to ~150 g)

Additional options include:

- Different laser wavelength ranges
- Advanced software functionality
- CCD camera for live animal monitoring
- Reference mouse anatomy atlas

MSOT: SCANNER FAMILY



Technical specifications	MSOT inSight 64	MSOT inVision 128	MSOT inVision 256-TF
Image acquisition			
Image rate (acquisition and live display)	10 fps (frames per second)		
Acquisition time, cross-sectional image	< 100 ms (single wavelength) / < 1s (multispectral)		
Spatial resolution	150 µm		
Lower limit of quantification (LLOQ), e.g. for:			
ICG	50 nM		
Gold nanoparticles	15 fM		
Key system components			
SpectraPULSE™ illumination system			
Wavelength spectrum (standard)	680-980 nm		
Pulse repetition rate	10 Hz		
Maximum pulse energy	80 mJ	100 mJ	
Wavelength tuning			
Tuning speed	< 100 ms		
Minimum step size	1 nm		
TomoARC™ detection system			
Curvature of detector array	172°	270°	
Center frequency / bandwidth	5 MHz / > 55 %		
Number of detector elements	64	128	256
RapidSCAN™ data acquisition electronics			
Channels for simultaneous acquisition	64 (max: 512)	128 (max: 512)	256 (max: 512)
Sampling rate	40 MSps (mega-samples per second)		
General technical specifications			
Scanner console - hardware	Intel Core i7, 5 TByte HDD, RAID, 24 GByte RAM, 1 GBit Ethernet, 24" TFT screen		
Scanner console - operating system	64-bit Windows 7		
Dimensions (width x depth x height)	89 x 95 x 165 cm		
Safety certification	CE marking (system compliant with IEC 61010-1, 60825-1, 61326-1)		
Laser classification	Class 1		

Software functionality	
ViewMSOT™	Data management, image acquisition, image reconstruction, spectral unmixing, signal quantification, data/image export
FastPK™	Ultrafast multispectral data acquisition, PK analysis toolset, video creation and export
QuantumPRO™	Advanced toolset for signal quantification, component analysis, extraction of measurement reports
PulseCTRL™	Adjustment of pulse energy and repetition rate, advanced laser performance monitoring
CryoMOUSE™	Annotated cryoslice images for anatomical reference, male and female anatomy, synchronization with imaging session

MSOT: SYSTEM CONFIGURATION/ OPTIONS

System configuration/ options	MSOT inSight 64	MSOT inVision 128	MSOT inVision 256-TF
Motorized in-plane object translation (x+y axes)	○	●	●
Extended axial FOV (180 mm; including holder)	○	○	○
Live animal monitoring (CCD camera inside imaging chamber)	○	●	●
Anesthesia flow monitoring	○	○	○
Extended laser wavelength range (410 - 980 nm, 680 - 2.300 nm, 410 - 2.300 nm)	○	○	○
Laser-integrated pulse energy meter	○	●	●
Laser-integrated spectrometer	○	○	●
FastPK™ analysis of fast kinetic processes[1]	○	●	●
QuantumPRO™ advanced data analysis[1]	○	●	●
PulseCTRL™ advanced laser control[1]	○	○	●
CryoMOUSE™ reference anatomy[2]	○	○	●
Legend	●	Standard configuration	
	○	Optional configuration	

[1] Requires laser-integrated pulse energy meter [2] Requires live animal monitoring (CCD camera inside imaging chamber)

MSOT: PUBLICATIONS

Selection of academic publications summarizing the MSOT performance:

- X. Luís Deán-Ben and Daniel Razansky,
  Adding fifth dimension to optoacoustic imaging: volumetric time-resolved spectrally enriched tomography,
  Light: Science & Applications (2014) 3, e137; doi:10.1038/lsa.2014.18.

- Buehler A et al.,
  Real-time handheld multispectral optoacoustic imaging,
  Opt Lett. 2013 May 1;38(9):1404-6. doi: 10.1364/OL.38.001404.

- Stritzker J et al.,
  Vaccinia Virus-mediated Melanin Production Allows MR and Optoacoustic Deep Tissue Imaging and Laser-induced Thermotherapy of Cancer,
  PNAS February 26, 2013 vol. 110 no. 9 3316-3320.

- Taruttis A et al.,
  Multispectral Optoacoustic Tomography of Myocardial Infarction,
  Photoacoustics (Vol. 1, Issue 1, March 2013). DOI: 10.1016/j.pacs.2012.11.001.

- Burton NC et al.,
  Multispectral Opto-acoustic Tomography (MSOT) Brain Imaging and Characterization of Glioblastoma,
  Neuroimage, 2012 Sep 28; pii: S1053-8119(12)00963-9.

- Herzog E et al.,
  Optical Imaging of Cancer Heterogeneity with MSOT,
  Radiology. 2012 May;263(2):461-8.

- Taruttis A et al.,
  Fast Multispectral Optoacoustic Tomography (MSOT) for Dynamic Imaging of Pharmacokinetics and Biodistribution in Multiple Organs,
  PLoS ONE 2012, 7(1):e30491.

- Razansky D et al.,
  Volumetric Real-time Multispectral Optoacoustic Tomography (MSOT) of Biomarkers,
  Nature Protocols 6, 1121-1129 (2011).

- Ntziachristos V and Razansky D,
  Molecular Imaging by Means of Multispectral Optoacoustic Tomography (MSOT),
  Chemical Reviews, 110(5), 2783-2794 (2010).

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