LOIS 3D Advantages

Image Contrast and Image Resolution

This system offers a staggering image contrast enabled by the proprietary illumination/detection mode combined with full 3D view of 28800 virtual transducers. The image resolution is better than 300 micron through the entire field of view. This means that highly contrasted features (microvessels) as small as 50 microns can be visualized by LOIS-3D.

Depth of Imaging

Scans capturing organs situated up to 5 cm deep inside the body of the animal or phantom to be imaged.

Imaging Time

The data acquisition times may vary between 20s and 300s, and the image reconstruction time may vary between 10s and 40s, depending on the number of averages per scan and the required image resolution, respectively.

Functional Imaging

Through multi-wavelength spectroscopic imaging, oxygen saturation and total hemoglobin content maps can be produced. This information aids in the assessment of tumor angiogenesis, angiography, detection and characterization of stroke and traumatic injury of the brain.

Molecular Imaging

LOIS-3D can be used to study the distribution of cellular receptors targeted with contrast agents such as nanoparticles, molecular dyes or fluorescent proteins. Kinetics of drug accumulation and biodistribution of contrast agents can be studied. It also allows monitoring of reporter gene activity in live animals.

Selected Publications

1. Brecht, H. –P., Su, R., Fronheiser, M., Ermilov, S. A., Conjusteau, A., and Oraevsky, A. A. Whole body three-dimensional optoacoustic tomography system for small animals, *J. Biomed. Optics* 2009; **14**(6): 0129061-8.
2. Tsyboulski D., Liopo A., Su R., Ermiov S., Bachilo S., Weisman, R.B., Oraevsky, A. A. Enabling in vivo measurements of nanoparticle concentrations with three-dimensional optoacoustic tomography, J. BioPhotonics 2014; **7**(8): 581-588.
3. R. Su, S.A. Ermilov, A. Liopo, A.A. Oraevsky, Laser optoacoustic tomography: towards new technology for biomedical diagnostics, Nuclear Inst. and Methods in Physics Research-A. 2013; **720**: 58-61.
4. R. Su, SA Ermilov, A. Liopo, A.A. Oraevsky: Three-dimensional optoacoustic imaging as a new noninvasive technique to study long-term biodistribution of optical contrast agents in small animal models, J. Biomed. Opt. 2012; **17**(10): 101506.
5. P. Beard, Biomedical photoacoustic imaging, Interface Focus. 2011; **1**(4): 602-31.

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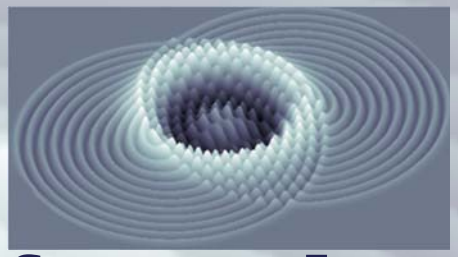
TomoWave



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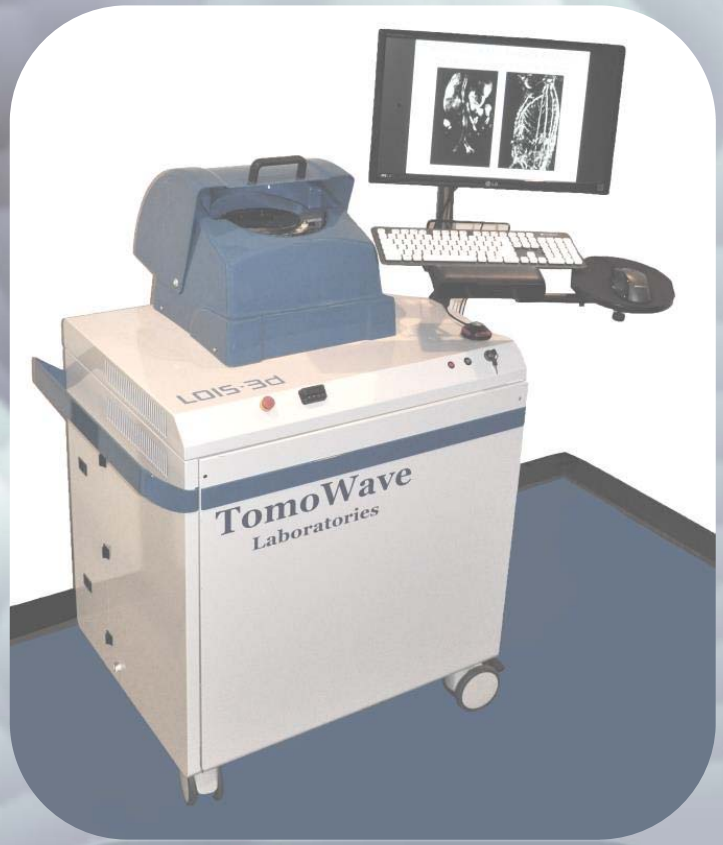

Laser Optoacoustic Imaging System LOIS-3D

3D Optoacoustic Imaging Technology

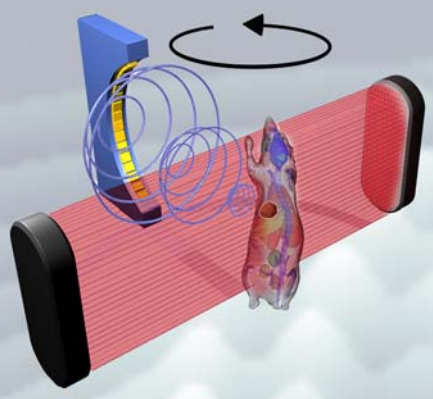

Fig. 1 Schematic diagram of a mouse being imaged with LOIS 3D

LOIS-3D is an optoacoustic imaging system specifically designed for in-vivo imaging of small animals. The subject is positioned in the special holder and placed inside imaging module, where it is scanned in orthogonal imaging mode using 4 optical fiber bundles. Absorption of optical energy leads to generation of thermo-acoustic (ultrasound) waves. The subject is rotated 360 deg. about the vertical axis, and the received ultrasonic signals are used to reconstruct a volumetric optoacoustic 3D image of high contrast and resolution.

System Design Specifications

Laser Specifications

- Wavelengths tunable 750 nm — 850 nm with about equal pulse energy, 1064 nm with higher pulse energy
- Max pulse energy within tunable range of NIR — 120 mJ / 240 mJ
- Pulse duration — 6 ns
- Repetition rate of laser pulses — 10 Hz / 20 Hz

Transducer Specifications

- Concave shaped arc with 96 transducer elements
- Ultra-wide ultrasonic frequency range 50 kHz — 8 MHz
- 115 degree arc, 65 mm array radius

System Electronics

- 96 low-noise 70 dB wide-band amplifier channels
- 96 12-bit A to D converters
- 96 channel Digital Data Acquisition Boards with FPGA
- Ethernet data transfer 10/100/1000 MB/s

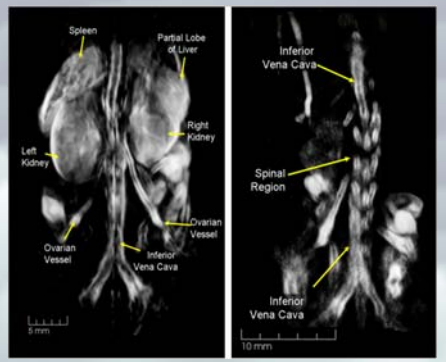

Fig. 2. Internal organs (L) and vasculature of the spine (R) imaged with LOIS 3D

Anatomical optoacoustic imaging

Combining the advantages of optical contrast of blood and ultrasound detection within an ultra-wide frequency band, LOIS-3D offers high contrast and resolution for the visualization of large and small anatomical features. Selection of orthogonal vs backward illumination beams along with a wide range of wavelengths allow the user to image deep or shallow structures of interest such as internal organs, vasculature, spine, bones and skin.

Functional Imaging

Oxy- and desoxy- hemoglobin exhibit different optical absorption properties in the near infrared spectral range. Using 3-wavelengths spectroscopy at 757-802-840 nm, LOIS-3D can be used to create maps of oxygen saturation levels and total hemoglobin content which are critical in many biomedical and clinical applications.

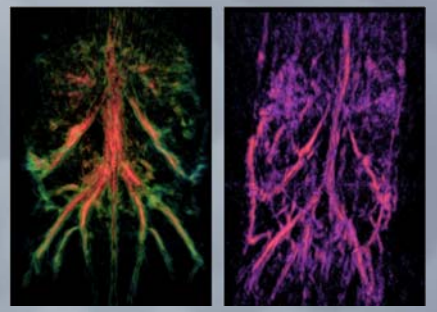

Fig. 3. (L) Veins at 760 nm; (R) Arteries at 1064 nm

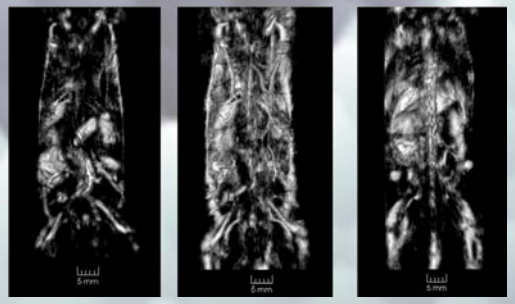

Fig. 4. 0 hour (L); 1 hour (M); 24 hours (R)

Molecular Imaging

LOIS-3D allows visualization molecular content of various tissues using optical and acoustic contrast agents. By comparing images taken prior and after injection at different times one can study kinetics of biodistribution of drugs and contrast agents from vasculature to various organs. Software permits segmentation of organs or tumors and calculation of dimensions and contrast.

Brain Imaging

A mouse's brain vasculature was imaged with LOIS-3D.

1. Dorsal Sagittal Sinus
2. Transverse Sinuses
3. Cerebellum