PhotoAcoustic-Fluorescence Tomography (PAFT) 3D Imaging – How Does it Work?

Applications and Basic Definition

PhotoAcoustic-Fluorescence Tomography is a 3D multi-modality imaging concept designed for noninvasive *in vivo* investigation of small laboratory animals. It combines high-resolution photoacoustic imaging with the high contrast fluorescence optical tomography allowing anatomical, functional, and molecular imaging in one system.

This combination allows for high molecular sensitivity, deep tissue imaging, 3D imaging and anatomical references. Additionally, there are many commercial biomarkers and absorption biosensors available that are compatible with PAFT.

Applications of PAFT include but not limited to:

- Cancer research
- Developmental biology
- Neuroscience
- Morphology of internal organs
- Non-contrasted angiography
- Stem cell research
- Development of contrast agents

Advantages of PAFT:

- Can penetrate deeper and sustain high spatial resolution within the entire field of view compared to purely optical tomography
- Rich intrinsic and extrinsic optical contrasts and is free of speckle artifacts compared to traditional ultrasound imaging
- Uses nonionizing laser illumination, unlike X-ray CT and PET

What Images and Data can be generated using the PAFT?

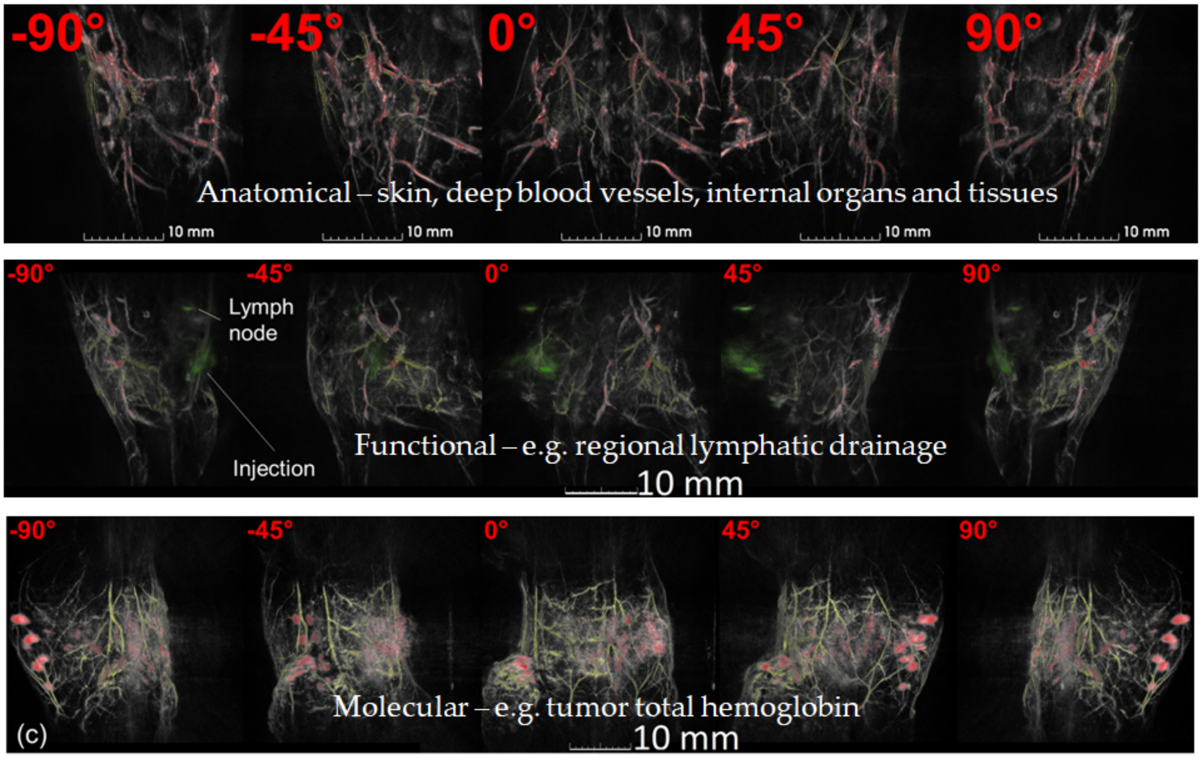
PAFT can generate 3D photoacoustic and fluorescence data. These are done simultaneously from the same volume of the subject. Tomographic reconstruction of the acquired data creates a volumetric graphical representation of the subject and contains high-resolution information about the spatial distribution of optical contrast.

PAFT enables anatomical, functional, and molecular imaging, which are co-registered for the same animal. Utilizing both fluorescence and photoacoustic responses allow for enhanced fluorescence molecular tomography reconstruction provides superior resolution, 3D localization, and quantification of the spatial distribution of fluorophores. In addition, multi-wavelength optical excitation enables spectroscopic analysis within the spatially resolved regions of interest such as injection sites, blood vessels, internal organs, and contrast agents.

Functional imaging of PAFT includes tumor/metastasis development, blood/water/lipid content, and blood oxygenation.

Key Applications:

- Cancer research
- Developmental biology
- Neuroscience
- Morphology of internal organs
- Non-contrasted angiography
- Stem cell research
- Development of contrast agents



How does PAFT work?

PAFT is based on nonionizing laser pulses that are delivered to live biological tissues. When the energy is absorbed, the tissue's temperature rises slightly and causes the resulting thermal expansion to generate acoustic waves.

The pulsed wave and fluorescence emission information are detected with a photoacoustic detector and camera that provides data that then leads to images.

An aqueous medium is used as the acoustic coupling solution to enable the detection of the propagating photoacoustic waves without a significant reduction of sensitivity.

The attenuation coefficient for ultrasound/photoacoustic waves is 750 times more in the air as compared to water. The transmission of photoacoustic waves at the tissue-air interface is roughly 1000 times less than the tissue-water interface. PAFT combines both photoacoustic tomography (PAT) and fluorescent molecular tomography (FMT). PAT has high spatial resolution, but relatively low sensitivity, whereas FMT has high sensitivity but low spatial resolution.

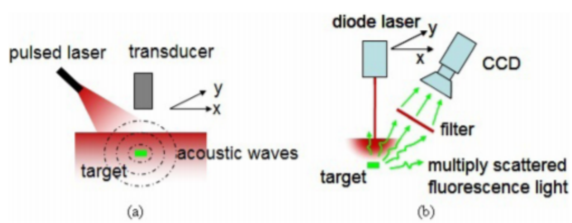


FIG. 1. Schematic of the (a) PAT and (b) FMT systems.

From Wang et al. 2012.

The animal is typically submerged up to the chin in a neutral buoyancy upward position for the TriTom system.

PhotoSound's TriTom

TriTom is a dual-modality system that acquires high-resolution photoacoustic imaging and high contrast fluorescence optical tomography simultaneously from the same volume of the subject.

Several scans may be performed with the subject repositioned along the axis of rotation, allowing for a larger volume to be investigated. The rotational configuration of the photoacoustic tomography unit allows the reconstruction of the volumetric images with isotropic spatial resolution on the order of 100-200 μm.

Utilizing an innovative and compact design, simultaneous co-registration of orthogonal photoacoustic and fluorescent optical data can be acquired.

The TriTom has a camera to observe the animal during the imaging procedure in order to maintain animal safety. As animals are typically submerged up to the chin, the TriTom comes with a water modulator that circulates temperature-controlled, filtered, and degassed deionized water around the animal to facilitate imaging.

TriTom provides a compact tabletop design with a software suite for scan control, data acquisition, and image reconstruction.

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We have many resources available, from scientific webinars to journal citations, to help you.

Please visit our website (www.scintica.com) or contact us via email at info@scintica.com or by phone at 832-548-0895 for more information or assistance.