TRITOM S10 Specification Table

Description

The **TRITOM** platform based on Photoacoustic Fluorescence Tomography (PAFT) technology provides unparallel capabilities for whole body imaging and in vivo characterization of small animal biomedical models. The platform integrates three complimentary 3D imaging modalities into a single powerful instrument by enabling co-registered Photoacoustic Tomography (PAT) and Fluorescence Molecular Tomography (FMT) or Bioluminescence Tomography (BLT). The platform utilizes innovative, compact configuration designed for simultaneous co-registered collection of orthogonal photoacoustic and optical projections of the specimen. The boost in imaging performance is associated with decreased noise levels for fluorescence detection and enhanced photoacoustic sensitivity for low level signals generated by internal organs and blood vessels. Image reconstruction algorithms utilize photoacoustic tomography confined to the regions of high fluorescence. The platform provides high-resolution robust anatomical registration of optical biomarkers, while maintaining high molecular sensitivity. A broad spectrum of preclinical research applications benefits from the **TRITOM** platform, including cancer, toxicology, tissue engineering and regeneration, cardiovascular and developmental biology.

Tomography Platform

3D Imaging Modes	Photoacoustic Fluorescence Bioluminescence
Co-registration	Simultaneous optical imaging (fluorescence or bioluminescence) and photoacoustic imaging scans
Anatomical targets	Vasculature Internal Organs Skin
Imaging Resolution	100 µm x,y plane, 200 µm z direction
Detection Threshold	OD 0.1 cm^{-1}
Image Field of View	30 x 30 x 30 mm (photoacoustics) 50 x 50 x 50 mm (fluorescence/bioluminescence)
Scan Duration	36 seconds
Scan Mode	Continuous, multi-wavelength scans

Curved Transducer Array

Number of elements (no dead elements)	96
Center frequency (-6 dB)	6 MHz ± 10%, optimized sensitivity in receive mode at 6 MHz

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Bandwidth (-6 dB)	≥ 55% in transmit/receive mode
Homogeneity in sensibility in transmit/receive mode	± 5 dB
Inter-element coupling between adjacent element	< -30 dB
Acoustical matching	Water (1.5 MRayl)
Elementary active dimensions located along centerline	1.3 x 1.3 mm^2
Pitch	1.4 mm
Inter-element spacing	0.1 mm
Angular active aperture	~ 118 degrees
Focusing	Cylindrical
Radius of curvature	65 mm ± 2 mm
Material	PEEK
Shielding	Inner housing metalized and connected to ground Outer housing partially metalized with gold
Cable	40 cm length, 85Ω, TE6565199-1 connector
Utilization	Continuous immersion in water at 0.5 m depth and temperature range of 10 to 40°C

Data Acquisition

Number of channels	128
Resolution	12-bit
Sampling Rate	40 MSPS

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Max Trigger / Frame Rate	50 Hz / fps
Maximum points	4096 per frame per channel
Preamplifiers	Compact 2 x 20 mm per channel
Preamplification	40 dB
Internal trigger generator	Optical / Electrical external triggers Continuous mode operates at highest frame rate
PC Connection	USB 3.0

Optical Imaging

Detector type	sCMOS, 16-bit
Wavelength sensitivity	200 to 1000 nm, 20% or higher QE (95% at 550 nm)
Number of pixels	2048 x 2048
Frame Rate	25 fps
Cooling method	Peltier
Exposure	Manual adjustable aperture and focusing objective
Optical filtering	Motorized, 11-position filter wheel preloaded with 500 nm short pass for viewing specimen during photoacoustics and 800 nm long pass for blocking laser light during fluorescence
PC Connection	USB 3.0

Imaging Chamber

Water reservoir	Optically clear glass cylinder with integrated overflow sensor, thermocouple, resistive heating and fill/drain ports
Specimen rotation	Compact closed-loop rotary stage, programmed to move in steps or continuous with integrated magnetic mount for easy specimen holder loading

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Fiber bundle ports	Two sets of linear fiber bundle output holders situated orthogonal and epi-illumination positions
Chamber access	Dual door access to imaging chamber with safety interlocks on each door to prevent unintended exposure to laser light

Life Support

Anesthetics access port	Integrated into top of imaging chamber thru specimen rotation motor
Specimen adjustment	Height adjustment of anesthetics access port to accommodate different size specimens
Specimen observation	Real-time monitoring of specimen using built-in camera
Anesthetics exhaust port	Connector with tubing connected to an integrated vacuum pump for pulling off excess gas

Fiber Bundles

Number of fiber bundles provided	2 (one for 650-2600 nm and one for 532 nm)
Fiber bundle protection	Plastic to prevent RF antenna noise
Fiber bundle length	2.0 m
Fiber bundle input diameter	5 mm (650-2600 nm); 2.5 mm (532)
Fiber bundle input arrangement	Randomized
Fiber bundle output geometry	Two arms with individual fibers fused and situated in line for homogeneous illumination of specimen
Optical trigger	SMA connected pigtail for delivering < 1% of laser light to photodiode trigger in data acquisition unit

Tunable Laser System

Wavelength range	650 to 2600 nm, no gaps, 0.1 to 1 nm step resolution across range
Peak pulse energy	Over 100 mJ after fiber bundle transmission

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Pulse-pulse stability	< 2.0% RMS
Pulse length	5 ns (FWHM)
Repetition Rate	10 Hz
Skin imaging wavelength	532 nm
Energy meter	Real-time pulse energy monitoring Data Normalization Harmonics auto-optimization
Fiber bundle delivery	> 70% transmission across wavelength range

Water and Temperature Control

Temperature control and monitoring	Dual digital temperature control units for setting temperature of specimen resistive heater and protection against overheating
Thermocouples	2 (one embedded in resistive heater and one submerged in specimen reservoir)
Temperature accuracy	± 0.1° C
Water filtering	Replaceable inline fine particle filter and washable coarse particle filter
Water circulation	Closed-loop circulation to improve thermal and acoustic homogeneity
Water degassing	Replaceable inline degasser for acoustic homogeneity
Fill/drain connectors	Quick-disconnects for easy filling and draining

Specimen Holders

Resolution phantom holder	String phantoms attached to magnetized holder for speed of sound and resolution studies
Sensitivity phantom holder	Fillable tubes attached to magnetized holder for aqueous solutions to analyze contrasting agents and measure sensitivity
Specimen restrainer	Small animal magnetized holder with adjustability for height

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Specimen restrainer preparation station	Mount to facilitate loading specimen onto restrainer
Specimen holder designs	Manufacturer provided 3D CAD drawings to allow end-user to design holders

Computer

Form factor	Desktop ATX (laptop replacement available upon request)
Processor	Intel Core i& Quad Core or higher
Graphics card	Nvidia GTX 1060 or higher (for CUDA optimized reconstruction algorithms)
Memory	16 GB DDR4 or higher
Data storage	1 TB M.2 PCIe SSD (for OS and applications) 4 TB SATA HDD (for data storage)
4K monitor/keyboard/mouse	Included with desktop ATX form factor
Operating system	Windows 10 Pro 64-bit

Software

Data acquisition	Standalone software with scope/scan, ADC, preamplifier, filter wheel, trigger, specimen rotation, laser control panels
File Conversion	*.tdms to *.mat (LabView to MATLAB) *.mat to *.vtk (MATLAB to VolView) *.mat to *.txt (MATLAB to TXT for ImageJ)
Image reconstruction	Signal/image processing, multiple 2D slices, CPU and GPU reconstruction algorithms
Optical imaging	Binning, image processing, HDR adjustment (*.png, *.tif, *.bmp, *.avi, *.raw

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