Optical Tomographic (OT) Device for combination with PET in preclinical imaging (P-655)

Key facts

- micro-lens array with a plurality of micro-lenses
- detector: CMOS sensor with high sensitivity
- combination PET-OT
- multimodal imaging generating images simultaneously in DICOM standard

Background

Optical techniques, such as bioluminescence and fluorescence, are emerging as powerful new modalities for molecular imaging in disease and therapy. Combining innovative molecular biology and chemistry, researchers have developed optical methods for imaging a variety of cellular and molecular processes *in vivo*, including protein interactions, protein degradation, and protease activity.

Technology

DKFZ has developed an optical imaging detector for fluorescence and bioluminescence in small animal imaging that is compatible with positron electron tomography (PET).

Compatibility of light detection with PET has been accomplished by the development of an optical detector that consists of a 25 mm x 100 mm photon sensor (liquid cooled) for light detection, a microlens array for field-of-view definition, a septum mask for cross-talk suppression, and a transferable filter for wavelength selection. A single detector possesses an effective thickness of less than 8 mm and is operated at close proximity to the imaged object. Multiple detectors are arranged so as to form a hexagonal detector geometry allowing circumferential data acquisition through 360°. Adjacent to each detector, optical components for single spot and total object light illumination are integrated to facilitate fluorescence imaging and tomography. The outer diameter of the overall light-tight cylinder housing is 118 mm. All materials of the instrument have been selected for low attenuation and scattering of high-energy (isotopic) photons. Hence, this system is fully insertable into any PET system with a minimum bore diameter of 120 mm. Acquired optical sensor data are back-projected onto the animal's surface via an inverse mapping algorithm to form projection surface images. FMT data reconstruction is guided by priors from the reconstructed PET data.

The instrument has been evaluated regarding its optical performance, including radiation durability, using various phantoms and measurement setups, and was successfully used in a number of preclinical studies such as simultaneous positron (18F-FDG, 68Ga-RGD) - bioluminescence (PC-3-hVEGF-Luc) imaging of reporter gene expression and receptor targeting in mice or simultaneous imaging of fluorescent XenoLight-RediJect-2-DG-750 and radio-labeled FDG probes.

Advantages

- no necessity for contact between detector and object
- thin CMOS detector (option for small device)
- high resolution/sensitivity
- combination PET-OT possible

Development Stage

An OT prototype has been developed, established and tested successfully in animal studies in combination with a PET system.

Inventors

The invention was jointly conceived by Jörg Peter and Ralf Schulz, department of Medical Physics in Radiology, E020 of DKFZ.

Intellectual Property

Patent applications for “Dual-Modality Imaging” are pending based on the international PCT

(WO2006111485) as US 7,786,443 (granted), JP2008-538312, EP05008552.1, CA2665980

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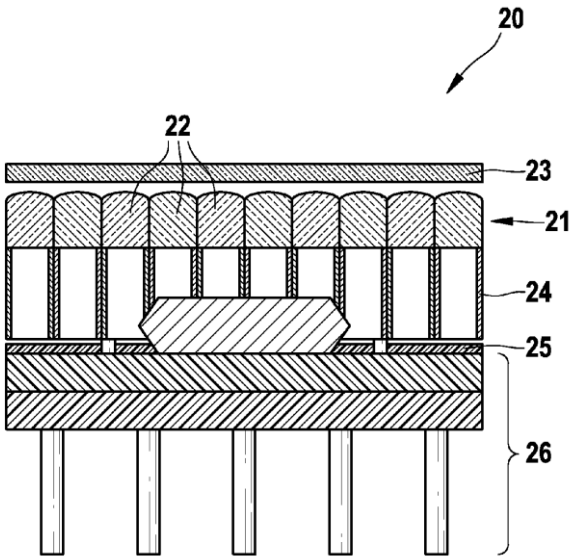

Figure 1: Optical detector with micro lenses

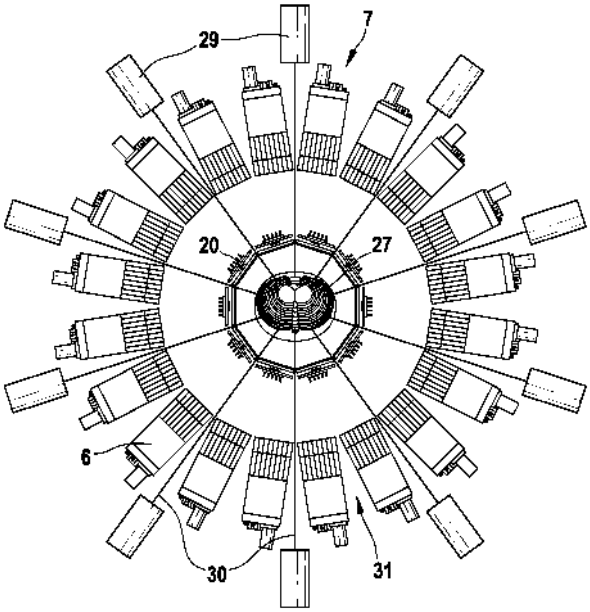

Figure 2: Transaxial view of a dual-modality imaging system

Figure legend: the elements in detail:
(20) Detector block, (21) Micro-lens array, (22) Micro-lenses, (23) Filter, (24) Optical collimator. (25) Photo detector, (26) Electronic parts and signal transmission elements, (27) Imaged object, (28) Light sources, (29) Light ray, (30) Gaps