Optical Tomographic (OT) Device for Combination with MR in Preclinical Imaging (P-734)

Key facts

- micro-lens array with a plurality of micro-lenses
- detector: CMOS sensor with high sensitivity
- combination MR-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 magnetic resonance imaging (MRI). This technology provides the possibility to study simultaneously tracer/marker kinetics of both optical (OT) and NMR-induced signals.

The device characterizes and quantifies functional and/or molecular biological processes at the cellular and sub-cellular levels, and anatomical structures (primarily through the MR signal) in animal studies. The invention describes an imaging system that is highly sensitive in identifying location, magnitude and time variation of specific molecular events (e.g. gene expression and enzyme activity) by simultaneously detecting optical markers *in vivo.* During the same acquisition procedure this spatially low-resolution (generally 500 m) optical information is superimposed over the spatially high-resolution (generally 50 m) anatomical details of the imaged object, improving the diagnostic accuracy of optical imaging by magnetic resonance imaging.

The device can be used to detect and stage tumors, to image specific cellular and molecular processes (e.g. gene expression, or more complex molecular interactions such as protein-protein interactions), to monitor multiple molecular events simultaneously, to track single- or dual-labeled cells using reporter genes or dual-modal labels visible to both optical and MR imaging, to optimize drug and gene therapy, to image drug effects at a molecular and cellular level, to assess disease progression at a molecular pathological level, especially to create the possibility of achieving all of the above goals of imaging in a single, rapid, reproducible, and quantitative manner.

Advantages

- no necessity for contact between detector and object
- thin CMOS detector (option for small device)
- high resolution/sensitivity
- combination MR-OT possible
- identical imaging geometries and animal positioning
- shorter acquisition time and better study management

Applications

- optimizing drug and gene therapy
- imaging drug effects at a molecular and cellular level
- monitoring multiple molecular events near-simultaneously
- monitoring time-dependent therapeutic influences on gene products in the same animal
- studying the interaction between tumor cells and the immune system

Development Stage
An OT prototype has been developed, established and tested successfully in animal studies in combination with an MR system.

Inventors
The invention was jointly conceived by Jörg Peter, Michael Bock and Rainer Umathum, department of Medical Physics in Radiology, E020 of DKFZ.

Intellectual Property
P-734, [MR-OT], "Dual-modality Imaging", WO2008028904; CA2662548, EP2062032 (granted), US12440129 and JP2009-527127.

Reference
"Iterative reconstruction of projection images from a microlens-based optical detector." By Cao L, Peter J. published in Opt Express. 2011 Jun 20;19(13):11932-43. doi: 10.1364/OE.19.011932. PMID: 21716427

"Image formation with a microlens-based optical detector: a three-dimensional mapping approach." By Unholtz D, Semmler W, Dössel O, Peter J. published in Appl Opt. 2009 Apr 1;48(10):D273-9. PMID: 19340119

"A novel optical tomographic instrument for multimodal imaging application in mice" in J. Nucl. Med. 2011; 52 (Supplement 1):1958; by Joerg Peter and Liji Cao; Medical Physics in Radiology, German Cancer Research Center, Heidelberg, Germany; Abstract No. 1958

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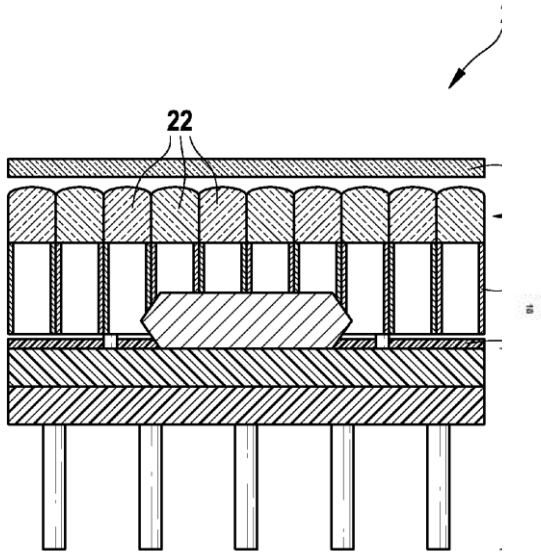

Figure 1: Optical detector with micro lenses

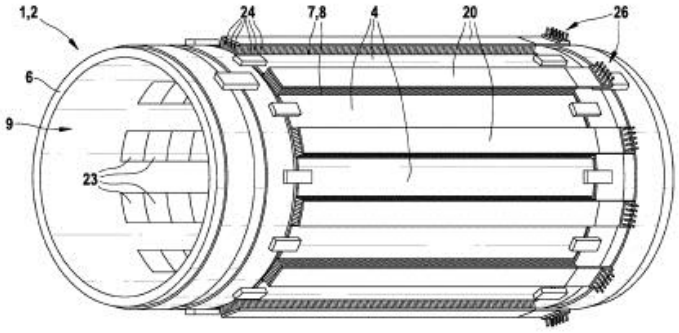

Figure 2: Schematically perspective view of a section of a dual-modality imaging system with micro-lens arrays and photo detectors at the focal planes of the micro lens arrays.

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