Optical Tomography (OT), SPECT and CT combinations for preclinical imaging (P-560, 725, 794)

**Key facts**
- Micro-lens array for optical tomography
- Detector: CMOS sensor with high sensitivity
- Possible combinations: SPECT-OT and SPECT-OT-CT
- Multimodal imaging generating images simultaneously in DICOM standard

**Background**

Single photon emission computed tomography (SPECT) is a clinical and experimental imaging modality that permits the use of photon-labeled molecular or functional imaging probes for non-invasive assays of biochemical processes. Clinical key objectives of SPECT in oncology are to determine and grade tumor mass, to establish whether a tumor is benign or malignant, to locate the site of primary disease, to detect metastatic disease, to identify multi-focal lesions, to determine the extent of tumors for treatment planning, to direct biopsy, to verify prognosis, to monitor response to treatment, to detect local or distant recurrence, and to assess residual mass.

X-ray computed tomography (CT) is an existing powerful non-invasive imaging technique for producing three-dimensional cross-sectional images of an object from two-dimensional x-ray images.

Optical planar imaging / tomography (OT) detects light propagated through tissue at single or multiple projections. OT has been demonstrated to localize and quantify fluorescent probes in deep tissues at high sensitivities at millimeter resolutions, allowing for applications such as imaging of breast cancer, brain function and gene expression in vivo. The major advantage of OT is the availability of activatable probes that produce signal only when they interact with their target(s).

**Technology**

DKFZ has developed an optical imaging detector for fluorescence and bioluminescence in small animal imaging that is compatible with SPECT and CT and provides the following combinations:

**SPECT-OT**: The dual-modality imaging system proposes SPECT and OT as two detectors in combination, where the optical detector (OT) is described as an optical CCD camera. In that realization, a SPECT and an optical camera are mounted in a common gantry, and both signal-generating photon classes are acquired simultaneously, and also from identical projection angles. However, this design uses a specifically designed single pinhole collimator in connection with a set of mirrors to enable this type of data acquisition.

**SPECT-OT-CT**: The triple-modality imaging system proposes SPECT, CT and OT as three detectors in combination, where the optical detector (OT) is described as an optical CCD camera mounted in a common gantry.

**Advantages**
- Direct comparison of sub-tracer/marker kinetics
- Shorter acquisition time and improved study management
- Identical imaging geometries/positioning
- Sub-modalities can be used separately, maintaining highest possible sub-intrinsic performance characteristics

**Applications**
- Imaging drug effects at a molecular level
- Assessing disease progression at a molecular pathological level
- Monitoring multiple molecular events 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
A prototype of both imaging systems, PET-OT and PET-OT-CT, has been assembled and successfully tested at the DKFZ.

Inventor
The invention was conceived by Jörg Peter, Department of Medical Physics in Radiology, E020 of DKFZ.

Intellectual Property

P-725 [SPECT-OT-CT] “Triple-Modality Imaging System”, WO2008049773; further equivalents in Europe (EP 2080039) and USA (US 12/446,925).

P-794, [SPECT-OT], “Combination of single photon emission computed tomography and optical imaging detector”, see WO2009047328; further equivalents in Europe (EP 08837353.5) and US (US 12/681,839).

References


“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: SPECT-OT-CT triple imaging device
Figure 2: SPECT-OT dual imaging device with 2 SPECT detectors and 2 CCD cameras