Methods: 1st step: The selected peptide precursor was loaded onto the microfluidic chip activated with 2 ml of water and 2 ml of EtOH and then flushed with 0.1 M MES mobile phase at pH 5.5. As a model peptide we chose DOTA-TOC that was injected in a 500 µl volume (12.5 µg) and deposited on the sorbent matrix (C18t, 20 mg in a volume of 100 µl).
2nd step: The microfluidic chip was heated up to 95 °C and a chosen radiometal was injected into the system (64Cu, 300 MBq, 1 MBq/µl in 0.1 MES buffer). The free radiometal was eluted to waste, while the chelated radiometal remained on the chip.
3rd step: The radiolabelled product was eluted from the system into the organic phase (injection of 100 µl of EtOH).
Results: More than 90 % of the 64Cu activity was absorbed on the chip. The radiolabelled product was then eluted with 100 µl of EtOH in amount of 180 MBq, i.e. in the overall yield of 60 % in ca 25 minutes. Radiochemical purity determined via HPLC was found to be > 98 %.
Conclusion: We tested a newly designed microfluidic chip system suitable for radiometal labellings. It was demonstrated on a particular example of DOTA-TOC and 64Cu that the system allows for rapid radiolabelling in three simple steps providing high radiochemical purity product. The chip may be easily operated in GMP-compliant mode and modified for various couples radiometal-precursor.

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OP11

PET20.0: Design of a monolithic Total Body PET with 2.00 mm spatial resolution and 20 x higher sensitivity

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Aim: The aim of this system is to simultaneously improve sensitivity and resolution with a major step compared to current state-of-the art PET while maintaining a reasonable cost for the total system. The first aim of this study is to show the potential of high resolution monolithic LYSO scintillator with SiPM readout for a compact Total Body (TB) PET design with only 3-4 times the detector material of a current PET-CT scanner. The second aim of this study is the design of a long axial TB-PET system and the determination of its sensitivity gains for different types of objects. The transverse diameter of the system is fixed at 65 cm (which fits nearly all patients) as we expect that the whole bore can be reconstructed by making use of the Depth-of-interaction capabilities of the monolithic detector.
Methods: This system is characterised with regards to point and line sensitivity for typical detector settings in current clinical PET systems. In this study the effects of changing the axial length of the scanner are studied in detail. Finally two options for imaging long objects (above 1 m) with the same compact system are described.
Results: The system results in excellent spatial resolution at the system level. The sensitivity gains for point sources and small objects (brain type) are limited and are comparable to the increase in cost of the system. For longer objects (1-2m) the gains go up to a factor 15-20 x. Scanners in the range of 70 cm-1m20 match well with the typical region of interest for PET imaging and have an optimal sensitivity gain.
Conclusion: PET20.0 combines high and uniform spatial resolution at the system with a major increase in sensitivity (close to a factor 20) for total body imaging. This is accomplished by increasing the detector material by a factor 3-4.

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OP12

Clinical validation of EARL-compliant reconstruction of digital photon counting PET/CT: An intra-individual clinical comparison study to conventional photomultiplier tube-based PET/CT

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Aim: Digital photon counting serves to improve both visual and quantitative performance of PET/CT through advances in system sensitivity, count statistics and time of flight timing resolution. Fitting this data to a normalization curve such as with EARL requires a reconstruction protocol secondary to the default high definition protocol. We validated a vendor suggested EARL-compliant protocol for clinical data sets acquired with digital photon counting PET via intra-individual comparison to images acquired on a conventional system.
Methods: 26 patients underwent PET/CT imaging on a conventional system (Philips Gemini TF 64, cPET) approximately 75 minutes post-injection of 480 MBq 18F-FDG and 55 minutes on a pre-commercial release digital photon counting PET/CT system (Philips Vereos, DPC dPET). Listmode data were reconstructed with default settings: cPET – 4mm isometric voxel, 3 iterations, 33 subsets; DPC dPET – 2mm isometric voxel, 3 iterations, 11 subsets, point spread function correction and 4.1 mm Gaussian filter applied. DPC dPET data were further reconstructed with an EARL-compliant protocol – 4mm isometric voxel, 3 iterations 13 subsets, 5mm Gaussian filter which was previously validated with phantom data (1). Regions of interest (ROIs) were placed over target lesions and in a variety of background tissues for quantitative comparison.
Results: The average SUVmax of target lesions for default DPC dPET reconstructions was 9.74. The cPET data presented a substantially lower average SUVmax at 6.47, as anticipated due to lower recovery coefficients. The EARL dPET reconstruction revealed quantitative values comparable to cPET with an average SUVmax of 6.49. The decrease was due to an increase in partial volume effects by use of a smaller reconstruction matrix/larger voxel size as well as the smoothing introduced by the use of a Gaussian filter alone. In background tissues, the SUVmean varied by less than 5% among all reconstruction settings.
Conclusion: The EARL-compliant reconstruction of DPC dPET clinical cases as applied to intra-individual comparison data lead to quantitative results which match conventional EARL PET/CT values. It was demonstrated and validated that while DPC dPET imaging has substantially improved recovery coefficients, secondary reconstructions can be performed to enable comparable quantification with conventional PET systems and existing databases or inclusion in clinical trials.

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