DEVELOPMENT AND PERFORMANCE OF THE SMALL-ANIMAL R-SPECT PROTOTYPE

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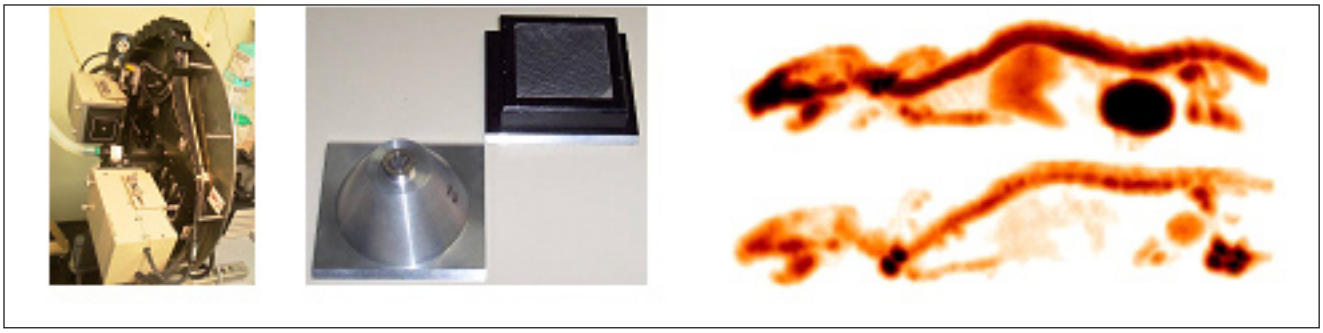
Introduction: In vivo molecular imaging of small animals has become an essential technique in biomedical research since the introduction of dedicated PET and SPECT scanners. However, the capabilities of these typically very expensive machines often exceed the requirements to accomplish common protocols encountered in practice. Accordingly, we have developed a simple and compact small-animal SPECT system, addressed to be used either as an add-on for existing small-animal CT or PET scanners, or as a stand-alone single photon imager.

Methods: The design is based on two small gamma cameras assembled on a rotatory gantry. The cameras are built around a position sensitive photomultiplier (Hamamatsu H8500), a NaI(Tl) 30x30 scintillator array with elements of 1.4 x 1.4 x 6 mm3, and the electronics for amplifying and matching the detector output signals to the data acquisition system. Detectors are assembled in lead-covered cases which allow changing the collimator (pinhole with different apertures or a LEHR parallel-hole collimator) depending on the study requirements. Additionally, the system includes a motorized cradle to enable whole body studies and two linear displacement stages for positioning the detectors at the selected radius of rotation (ROR). The system performance has been evaluated in terms of spatial resolution, sensitivity and energy resolution for different imaging scenarios (LEHR parallel-hole collimator and 0.75 mm-aperture pinhole collimator with 60º aperture angle and 1.42 magnification factor). A user console with FBP and OSEM reconstructions has also been developed.

Results: Intrinsic energy resolution is 10% @ 140 KeV (average) for both cameras. Planar spatial resolution using the parallel-hole configuration ranges from 1.8 mm on the detector surface to 4.2 mm at 45 mm source-to-object distance. System sensitivity is 3.5 cps/µCi/detector (20% energy window). Planar spatial resolution using the pinhole collimator ranges from 1 mm @ 10 mm to 2.4 mm @ 45 mm. Sensitivity using this configuration ranges from 3 cps/µCi/detector (20% energy window, @ 15 mm) to 0.5 cps/µCi/detector (@ 45 mm). Measured tomographic spatial resolution in a mouse study (pinhole collimator) is <1.5 mm (FDK reconstruction). Spatial resolution in rat studies using the LEHR parallel-hole collimator is < 2.5 mm (OSEM-2D reconstruction).



LEFT: Photograph of the r-SPECT prototype. Center: parallel and pinhole collimators.
Right top: MIPS render of a 24 g mouse bone scan (99mTc-MDP) using pinhole collimators.
Right bottom: MIPS render of a 150 g rat scanned using the same compound and parallel-hole collimators

Conclusions: A versatile and low cost SPECT system for small-animals has been constructed and characterized. Our results indicate that the system is adequate for most applications using single-photon labeled tracers in mice and rats.

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