

## SPECT imaging with rotating slat collimation

Traditionally, Single Photon Emission Computed Tomography (SPECT) uses parallel-hole collimators. These collimators are mandatory to obtain spatial information on the origin of the detected photons and thus to produce images. Nevertheless, they compromise the quality of SPECT images, which are typically affected by noise and blur.

We investigated the performance of an alternative type of collimation, namely rotating-slat collimators, because they impose a lighter sensitivity versus resolution trade-off. The collimation in planes - as opposed to lines for a standard collimator - results in the detection of photons with less information content. Nevertheless, the number of recorded photons typically increases by a factor of 40. The question is whether this higher sensitivity is able to compensate for the lower information content per measured photon.

First, we investigated the spatial resolution and sensitivity behavior of the collimator. Measurements with a prototype rotating slat collimator and cross-validation with a detailed Monte Carlo model confirmed the accuracy of our derived model. In a next step, planar image reconstruction was addressed whereafter a new iterative scheme was developed for speeding up both the calculation and the convergence of the slow tomographic reconstruction from plane integral measurements. Compared to MLEM and OSEM, respective speedup factors of 400 and 20 were found. Consequently, image quality was compared to a traditional parallel hole collimator for both planar and tomographic imaging. For planar imaging, a shorter scan time of a factor of 3 to 12 was found for hot lesion imaging, depending on lesion size and contrast. For tomographic imaging, we found a decrease in scan time of a factor 5 and 2.5 for respectively cold and hot lesions. Finally, an attractive application of rotating slat collimators, namely imaging of isotopes with high energy contaminants like I-123, was investigated. We found that image quality was not affected by the high energy contamination for the rotating slat collimator while a contrast drop of more than 10% was found for the parallel hole collimator.

A final conclusion of this work is that it is advantageous to use a rotating slat collimator in combination with iterative reconstruction including a system model (i) for planar hot lesion imaging, even in large objects and low contrast; (ii) for tomographic hot and cold lesion imaging, when there is limited activity in the neighborhood of the area of interest; (iii) for isotopes with high energy emissions, especially if there is a lot of contamination arising from these high energy emissions.

## References

**Van Holen R**, Vandenberghe S, Staelens S, De Beenhouwer J and Lemahieu I 2009 Fast 3D iterative image reconstruction for SPECT with rotating slat collimators Phys. Med. Biol. 54 715-729

**Van Holen R**, Vandenberghe S, Staelens S and Lemahieu I 2008 Comparing planar image quality of rotating slat and parallel hole collimation: influence of system modeling Phys. Med. Biol. 53 1989-2002

**Vandenberghe S**, Van Holen R, Staelens S and Lemahieu I 2006 System characteristics of SPECT with a slat collimated strip detector Phys. Med. Biol. 51 391-405