Optimization of collimator combinations for brain SPECT

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I. Introduction

Single Photon Emission Computed Tomography (SPECT) is a frequently used biomedical imaging technique which visualizes functional processes based on the emission of γ-rays from within the body. A SPECT camera consists of two main functional components: the collimator (to select photons from a certain direction) and the radiation detector. It is mainly the collimator that defines sensitivity and spatial resolution, two important measures of image quality. Typically, a higher resolution results in a lower sensitivity.

The goal of this project is to realize a new specialized SPECT system for brain imaging with a better image quality compared to existing systems by focussing on innovative collimator design.

II. Methods

Previous research has shown that the quality of SPECT images can be improved by combining a high-resolution (HR) collimator with a high-sensitivity (HS) collimator, instead of a system with only HR or only HS [1]. In this project, three collimators will be designed and combined (see Figure 1): a multi-pinhole collimator for high-resolution, a cone-beam collimator with ultra-short focal length for high sensitivity [2] and a fan-beam collimator to solve the problem of data-incompleteness. To investigate the different designs and combinations, a Monte Carlo simulator will be used.

Some simulations where already performed to study sensitivity for tilted pinholes. The results show that penetration plays an important role (up to 15% for a pinhole with an opening angle of 45°) and is highly dependent on the pinhole design. The simulations will be validated by measurements on a prototype multi-pinhole collimator.

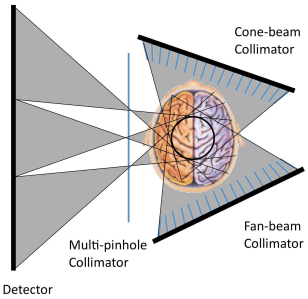

Figure 1. Combination of a multi-pinhole, cone-beam and fan-beam collimator.

III. Conclusions

A high-sensitivity collimator, a high-resolution collimator and a collimator for data sufficiency will be designed and optimally combined in order to achieve a better image quality than with existing brain SPECT systems.

References

[1] R. Van Holen, *Combined high-resolution and high-sensitivity collimation provides better image quality in SPECT* Abstract book 56th SNM annual meeting. supplement1, 2009.

[2] M. Park, S. C. Moore and M. F. Kijewski, *Brain SPECT with short focal-length cone-beam collimation* Medical Physics, volume 32, 2005.

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