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TITLE: Design and simulations of a Multi-Lofthole MicroSPECT Imager Using Minifying Projections

BODY:

Objectives : We are currently building a stationary desktop microSPECT system using minifying projections. The system is based on our previously developed modular scintillation detectors [1] and lofthole collimators [2]. Both system optimization and simulations are discussed.

Methods : We modified the formulas from Nillius [3] for a cylindrical instead of a spherical detector arrangement. Furthermore, we also modified the optimization to include loftholes instead of pinholes. Since loftholes have a rectangular projection area, they are more efficient in covering a cylindrical detector surface.
Our optimization considerations resulted in a pentagonal arrangement of 5x5cm2 detectors, each with 20 pinholes (500µm). The system uses a pinhole distance of 20 mm and a detector distance of 36 mm resulting in a 0.8 magnification factor. The pinholes were arranged in 5 axial rings of 20 pinholes, each looking to a different portion of the field-of-view (FOV) as proposed by Funk [4]. Furthermore, we accurately simulated the complete system, using multi-ray tracing and modelling of pinhole and detector resolution, sensitivity and pinhole edge penetration. We simulated a Derenzo phantom with hot rods ranging from 0.7-1.4 mm. A Defrise phantom in axial and transaxial direction verified sampling completeness. Images are reconstructed with 200 MLEM iterations including full system modelling.

Results : In this arrangement, we are able to achieve a point sensitivity of 0.3% in combination with an analytical system spatial resolution of 1.4 mm. The transverse FOV is 3 cm in diameter and 1 cm in axial direction. Using resolution recovery in the reconstruction, we are able to achieve a reconstructed resolution ~900µm in the Derenzo phantom. Visual inspection of the Defrise phantoms phantom ensured sampling completeness in axial and transverse direction.

Conclusions : These results are encouraging to build the actual system. The low resolution is mainly due to limited detector resolution and is expected to improve in the future.

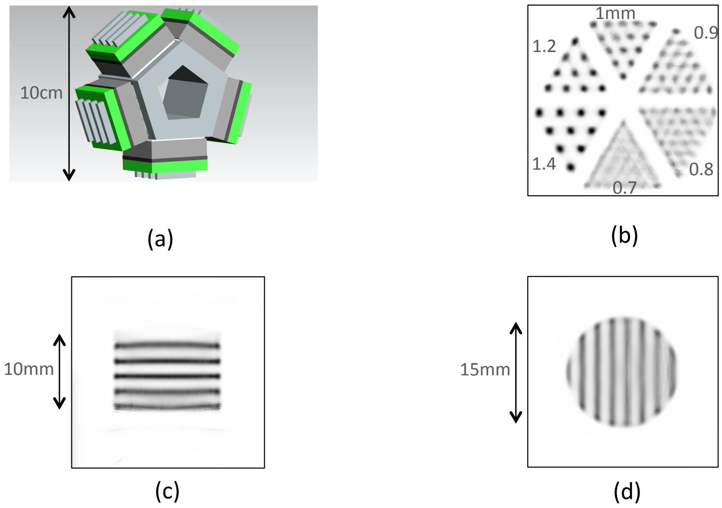

Figure 1: In (a) the pentagonal system is shown. (b) is a transverse slice through the reconstructed Derenzo (25mm diameter). (c) shows an axial slice through the axial defrise phantom and (d) shows a transverse slice through the transverse defrise phantom