Investigating the effect of different CT protocols on material maps for preclinical PET imaging

Dániel Réti[1,2], Axel Montagne[3,4], Maurits A. Jansen[5], Péter Major[1], Adriana A.S. Tavares[2,3]

(1) Mediso Ltd, Laborc utca 3., Budapest 1037 Hungary

(2) Centre for Cardiovascular Science, University of Edinburgh, Edinburgh EH16 4TJ, UK

(3) UK Dementia Research Institute, University of Edinburgh, Edinburgh EH16 4SB, UK

(4) Centre for Clinical Brain Sciences, University of Edinburgh, Edinburgh EH16 4SB, UK

(5) Department of Radiology and Medical Imaging, School of Medicine, University of Virginia, Charlottesville, Virginia 22903, USA

Every Positron Emission Tomography (PET) reconstruction needs a material map of the imaged object to estimate the attenuation and scatter. In the preclinical setting, this is a Computed Tomography (CT)-based binary map. The dose delivered needs to be compliant with animal welfare requirements[1]. Currently, there is limited literature on preclinical CT-based material maps optimisation[2,3]. This study aimed to evaluate the effect of different CT acquisition and reconstruction protocols on the material maps generated and, consequently, on the quality of the PET image.

A 3D printed (tango-black) hollow rat phantom with a 3 cm diameter NEMA IQ phantom[4] was used (**Fig.1A)** with 3.7 MBq activity. Helical (H), semi-circular (SC), and Zig-Zag (Z) trajectories were investigated. The projection number for SC1, SC3, H1, Z1 and Z2 was 360, while for SC2 it was 720. All of the non-helical scans were full scans, except the SC3 and Z2 as they were half scans. The helical pitch was 1. The tube voltage was 50 kV and the tube current was 980 mA for all the scans, expect for Z2 where these numberers were 35 kV and 180 mA. The dose of each protocol was measured by an ionizing chamber-based detector. FBP (Filtered-Back-Projection), MLTR (Maximum-Likelihood-Transmission-Reconstruction), and MSIRT (Modelled-Simultaneous-Iterative-Reconstruction-Technique) reconstruction were used. The generated maps were subtracted from each other to quantify the differences. The PET image was reconstructed with all the material maps, and the NEMA image quality phantom analysis was carried out.

The low dose protocols (SC3, Z2) (**Fig.1B**) with FBP reconstruction resulted in slightly different maps (**Fig.1C**), which also influenced the uniformity and accuracy (**Fig.1D-E**). The iterative reconstructions (MLTR, MSIRT) helped to overcome this issue (**Fig.1B-E**).

With iterative reconstruction even low dose CT protocols (SC3 and Z2) can produce accurate material maps for PET imaging.

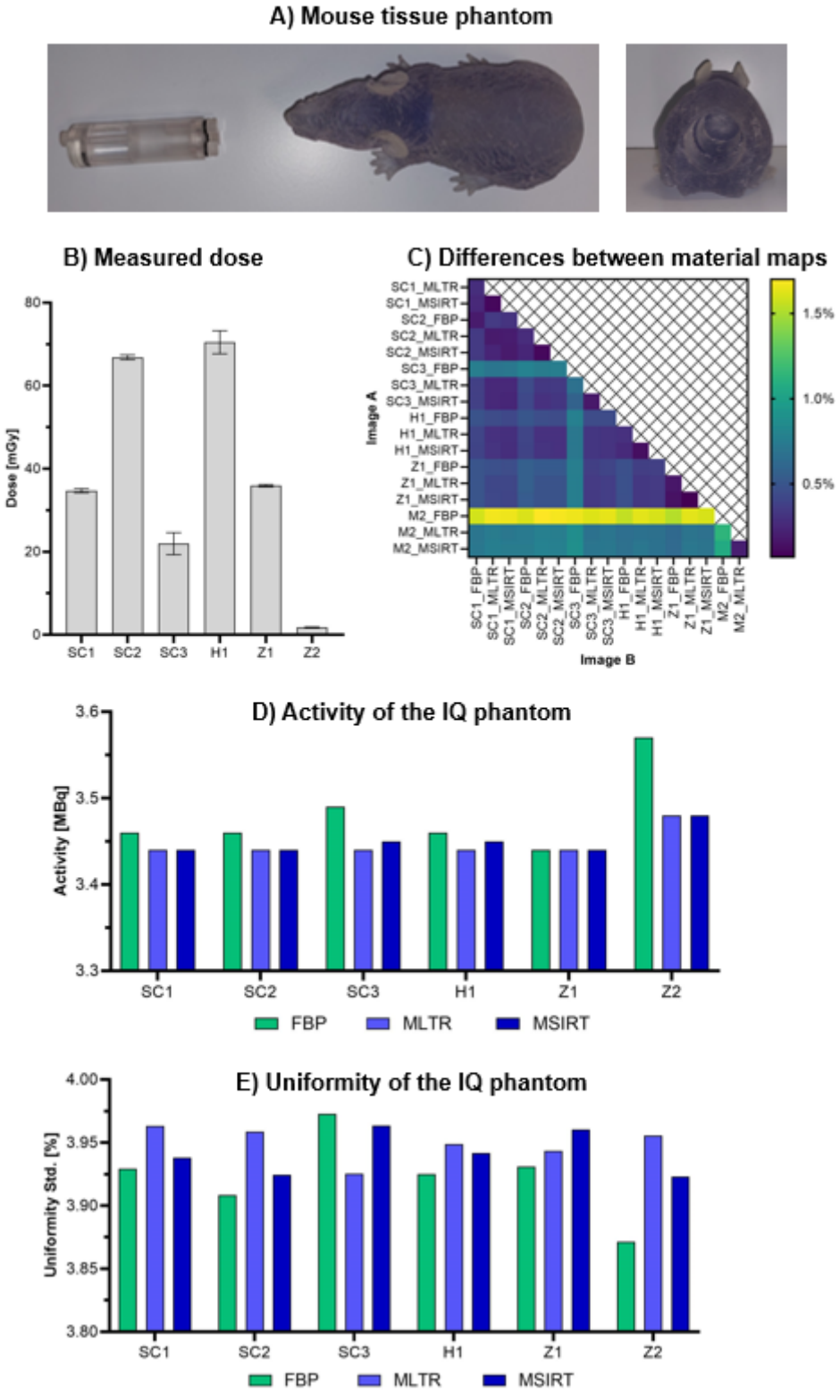

Figure. 1 A) Rat tissue phantom used in the measurements. Designed by Wendy Anne McDougald **B**) The dose of each CT protocol measured by an ionizing chamber. **C**) The percentage of non-zero voxels after Image B were subtracted from image A. The images were 1-0 material maps generated from the different CT sequences. **D**) The measured activity of the IQ phantom. **E**) The measured uniformity of the phantom.

References:

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