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Quantified nuclear medicine imaging of theranostic 155Tb

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There has been increasing interest in four radioisotopes of terbium with the potential for use in nuclear medicine: 161Tb emits therapeutic beta and Auger particles; 155Tb emits gamma-rays suited to Single-Photon Emission Computed Tomography (SPECT); 152Tb emits positrons suitable for Positron Emission Tomography (PET); and 149Tb emits alpha particles suitable for therapy. Their identical radiochemistry means they can be used as a theranostic set, combining therapy and diagnostic imaging with a single pharmaceutical. This allows for more personalised therapy, as more accurate patient dosimetry can be achieved.

This work focusses on the diagnostic isotope 155Tb. Samples of 155Tb were produced and collected at CERN-ISOLDE and MEDICIS and were sent to the UK National Physical Laboratory for new primary activity standard measurements. These primary standards permitted traceable activity measurements, which were applied to imaging conducted at The Christie NHS Foundation Trust. This provided the foundation for the first quantitative SPECT imaging of 155Tb.

Solutions of 155Tb were used to perform SPECT studies on a clinical scanner at The Christie NHS Foundation Trust, using energy windows centred on the 45, 87 and 105 keV gamma emissions. Validated Monte Carlo simulations of the full SPECT acquisition were performed to optimise the scatter correction for each window. Imaging measurements were used to compare the activity recovery given by each energy window, to determine the best imaging parameters for clinical quantitative 155Tb SPECT.

Author: Ms PELLS, Sophia (University of Manchester (GB), National Physical Laboratory (GB))

Co-authors: Dr CULLEN, David M. (The University of Manchester); Dr ROBINSON, Andrew P. (The National Physical Laboratory)

Presenters: Ms PELLS, Sophia (University of Manchester (GB), National Physical Laboratory (GB)); Dr CALVERT, Nick (The Christie NHS Foundation Trust,); COCOLIOS, Thomas Elias (KU Leuven - IKS); Mr DOCKX, Kristof (KU Leuven (BE)); STEGEMANN, Simon Thomas (KU Leuven); KOESTER, Ulli (Institut Laue-Langevin (FR)); PIETRAS, Ben (University of Manchester); Mr PRICE, Emlyn (The University of Manchester, The Christie NHS Foundation Trust); Dr COLLINS, Sean (The National Physical Laboratory); Dr DENIS-BACELAR, Ana (The National Physical Laboratory); Mr FENWICK, Andrew (The National Physical Laboratory); Ms FERREIRA, Kelley (andrew.fenwick@npl.co.uk); Dr HAMILTON, David (The Christie NHS Foundation Trust); Dr HELARIUTTA, Kerttuli (University of Helsinki); Dr IVANOV, Peter (The National Physical Laboratory); JAKOBSSON, Ellen Helen Ulrika (Helsinki Institute of Physics (FI)); JOHNSTON, Karl (CERN); Dr KEIGHTLEY, John (The National Physical Laboratory); Dr OLDFIELD, Christopher (The Christie NHS Foundation Trust, The University of Manchester); Ms PAGE, Emma (The University of Manchester, The Christie NHS Foundation Trust); Dr RUSSELL, Ben (The National Physical Laboratory); SCHELL, Juliana (Institut Fur Materialwissenschaft Universität Duisburg-Essen (D); Dr TIPPING, Jill (The Christie NHS Foundation Trust); Mr WEBSTER, Ben (The National Physical Laboratory, University of Surrey); Dr WEVRETT, Jill L. (The National Physical Laboratory, Royal Surrey County Hospital)

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