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A High Purity Germanium detector for Compton imaging in nuclear medicine

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Single Photon Emission Computed Tomography (SPECT) systems employ a gamma camera to locate a radioactive tracer which has been administered to a patient to study specifically targeted physiological processes. A typical system is composed of scintillation detectors coupled to a mechanical collimator which allows the distribution of the radiation to be inferred. However, use of the collimator results in only a small fraction of the patient dose being used to generate an image.

The ProSPECTus project aims to improve image quality, provide shorter data acquisition times and lower patient doses by replacing the gamma camera with a high-sensitivity Compton camera. The ProSPECTus system is composed of a Si(Li) detector and HPGe detector, a configuration deemed optimum using a validated Geant4 simulation package. The Si(Li) and HPGe detectors are (60x60x9) mm and (60x60x20) mm, electronically segmented with orthogonal strips of 4 mm pitch and 5 mm pitch, respectively. The typical energy resolution at 122 keV is 2.0 keV for the Si(Li) detector and 1.4 keV for the HPGe detector. Utilising position and energy sensitive detectors is essential as Compton kinematics are employed to reconstruct the paths of incident gamma rays using the interaction positions and energy depositions within the two detectors, to identify the location of the radiation source.

Characterising the response of the detectors to gamma irradiation is essential in maximising the sensitivity and image resolution of the Compton imaging system. To this end, the performance of the HPGe detector has been measured at the University of Liverpool. Results show that the detector performs well at the energy of interest, 122 keV. However, poorer spectroscopic performance is observed at higher energies, such as 662 keV. An investigation of this degradation of performance is underway and will be presented alongside the characterisation measurements.

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Author: Dr HARKNESS, Laura (Department of Physics, University of Liverpool)

Co-authors: Dr BOSTON, Andrew (Department of Physics, University of Liverpool); Dr JUDSON, Daniel (Department of Physics, University of Liverpool); Dr SCRAGGS, David (Department of Physics, University of Liverpool); Dr KEMP, Graham (MARIARC, University of Liverpool); Dr BOSTON, Helen (Department of Physics, University of Liverpool); Mr BURROWS, Ian (STFC Daresbury Laboratory); Mr LAZARUS, Ian (STFC Daresbury Laboratory); Ms GROVES, Janet (STFC Daresbury Laboratory); Ms SAMPSON, Janet (Department of Physics, University of Liverpool); Dr CRESSWELL, John (Department of Physics, University of Liverpool); Prof. SIMPSON, John (STFC Daresbury Laboratory); Mr HEADSPITH, Jon (STFC Daresbury Laboratory); Mr CORDWELL, Mike (STFC Daresbury Laboratory); Prof. NOLAN, Paul (Department of Physics, University of Liverpool); Mr BIMSON, William (MARIARC, The University of Liverpool)

Presenter: Dr HARKNESS, Laura (Department of Physics, University of Liverpool)

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