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Enhancements to the spatial resolution and sensitivity of the MWPC-based PETRRA

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The PETRRA positron camera is a novel, large-area positron camera based on coupling barium fluoride crystals to a multiwire proportional chamber filled with a photosensitive vapour, tetrakis-dimethylamino ethylene (TMAE). The present camera consist of two detectors each with 600mm x 400mm sensitive area containing sheets of 1cm thick crystals. This camera has a spatial resolution of ˜6-7mm FWHM, a timing resolution of 3.5ns and a sensitivity of 8kcps/kBq/ml. Whilst the former parameters are entirely acceptable, an increase in sensitivity is needed if the camera is to be competitive in a clinical environment. The sensitivity and spatial resolution are defined by the crystal thickness and increasing the latter to improve sensitivity would reduce the spatial resolution unless some form of crystal segmentation is used.

Experiments have been carried out using a small (100mm x 100mm) prototype detector at the Rutherford Appleton Laboratory. Small barium fluoride crystals 50mm x 4.6mm in length and width and thickness of 10mm, 15mm, 20mm and 25mm have been tested suing a Na-22 point source and a NaI(Tl) detector in coincidence with the camera. Preliminary results show that the sensitivity can be increased by more than a factor of two with the thicker crystals whilst the resolution is ˜4-5mm across the width and ˜9-10mm along the length. Based on these results it is proposed that the barium fluoride crystals in the PETRRA detector can be replaced with 25cm thick crystals segmented to ˜5-6m in one dimension. This would increase the coincidence efficiency for two detectors by ˜5-6 whilst retaining the transaxial spatial resolution to ˜5mm.

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