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Modification of a Medical PET Scanner for engineering PEPT

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Over the last 20 years, positron emission tomography (PET) has developed as the most powerful functional imaging modality in medicine. Over the same period, the University of Birmingham Positron Imaging Centre has developed the use of positron emitting tracers to study flow in engineering systems. Much of this work has used the technique of positron emission particle tracking (PEPT) which was developed at Birmingham. In PEPT, a single radioactively-labelled tracer particle is tracked by detecting simultaneously the pairs of back-to-back photons arising from positron/electron annihilation.

Since 1999 this work has used an ADAC Forte "positron camera" consisting of two planar gamma camera heads, each containing a crystal of sodium iodide 50⊠40 cm2 and 16mm thick, operated in coincidence. This system can record up to 100k events per second, allowing a tracer particle to be located to within approximately 1mm 1000 times per second. This camera has been used to study a wide range of engineering processes, by means of PEPT, tracking tracer particles down to 100μm diameter.

Medical PET scanners consisting of rings of hundreds of small bismuth germanate detectors have high sensitivity and can operate at high count rate. We have adapted such a scanner for PEPT use. The Ecat931 scanner was previously operated at Hammersmith Hospital until 2002, and comprises 32 detector modules ("buckets"), each consisting of 128 detection elements. The buckets have been remounted on a rectangular frame and the data acquisition system has been modified to record fully-3D data in list mode for subsequent processing by the PEPT algorithm.

This paper presents initial results from this system. Count rates of over 250k events per second have been achieved, but the sensitivity varies significantly within the field of view. Fast moving tracer particles can be accurately located every 0.8ms.

This system has a flexible geometry which can be optimised to suit the object being studied. Another advantage of this system is that it is in principle transportable. In the near future we plan to use it to perform PEPT studies on an industrial site.

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