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FXCT imaging for biomedical research

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Introduction

The fluorescent X-ray computed tomography (FXCT) with synchrotron radiation is being developed to depict the distribution of specific elements inside the biomedical object without cutting procedure [1-5]. FXCT system with a spatial resolution less than 0.1 mm and short data acquisition was constructed by using a germanium detector with high efficiency and high count-rate electronics [6]. In-vivo and ex-vivo cerebral perfusion imaging of rat & mice, and ex-vivo myocardial fatty acid metabolism of cardiomyopathic animal model have succeeded by FXCT after injecting non-radioactive iodine labeled cerebral perfusion agent (IMP) and BMIPP, respectively [7-11]. However, long time was required to acquire FXCT data due to point scanning data acquisition technique. For high-speed FXCT imaging, we have improved scanning technique and performed basic phantom experiment.

Methods and material

The experiment was carried out at the bending-magnet beam line BLNE-5A of the Tristan accumulation ring in Tsukuba, Japan. The photon flux rate in front of the object was approximately 9.3 x 10^7 photons/mm^2/s for a beam current of 40 mA. FXCT system consists of a silicon (220) double crystal monochromator, an x-ray slit system, a scanning table for subject positioning, fluorescent X-ray detector, and two pin-diode detectors for incident X-ray and transmission X-ray data. The white X-ray beam was monochromatized to 37 keV X-ray energy. The monochromatic X-ray was collimated into a 20 x 0.5 mm^2 sheet beam. Fluorescent X-rays were detected in a high purity germanium (HPGe) detectors and the HPGe detector was oriented perpendicular to the incident monochromatic x-ray beam. The data acquisition time was set 20-s. Object was 3 holes acrylic phantom filled with 0.1mg/ml iodine solution.

In this preliminary experiment, slit mounted HPGe detector was collimated 0.5 mm width, 5mm hight and 50mm depth. To obtain the profile data, object was scanned 0.5mm to incident beam direction.

The present experiment was approved by the Medical Committee for the Use of Animals in Research of the University of Tsukuba.

Results and discussion

The energy spectrum of iodine within phantom was clearly separated from Compton scattered X-ray. Profile image revealed the region of iodine filled hole within phantom. Using sheet beam data acquisition technique, we could confirm the feasibility to detect iodine within object [12]. To perform faster data acquisition, we are being developed new detector and electronics system with higher count rate capability. The new data acquisition technique might shorten the data acquisition time of FXCT, and in-vivo and ex-vivo biomedical studies would be performed much easily and shortly.

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