Medical Applications

NE5A/2010G055

Development of transmission CT imaging system for slice positioning and attenuation correction in fluorescent x-ray CT

Hideaki KUROSAWA[2], Tohoru TAKEDA[1], Tetsuya YUASA[2],
Kazuyuki HYODO[3], Takao AKATSUKA[2]
[1]Kitasato University, Sagamihara, Kanagawa, Japan
[2]Yamagata University, Yonezawa, Yamagata, Japan
[3]High Energy Acceleration Research Organization, Tsukuba, Japan

Introduction

The fluorescent x-ray computed tomography (FXCT) using synchrotron radiation is being developed to depict the distribution of specific elements inside the biomedical object [1-5]. So far, we have successfully imaged cerebral perfusion of small rodents in vivo as well as ex vivo, and myocardinal fatty acid metabolism of cardiomyopathic animal model ex vivo, after injecting non-radioactive iodine labeled cerebral perfusion agent (IMP), and fatty acid metabolic agent (BMIPP), respectively [6-10].

Transmission CT (TCT) images are indispensable for more reliable FXCT imaging. The one reason is that attenuation correction should be performed based on the distributions of linear attenuation coefficients obtained from TCT images in order to obtain quantitative information with respect to specific element from FXCT images because the measurement process includes some attenuation effects. The other reason is that transmission CT images are useful for slice positioning, because transmission CT can acquire detailed morphological information while FXCT images cannot obtain it. In this research, we develop a TCT imaging system for the above purposes.

Method and material

The imaging system was constructed at the bending-magnet beam line BLNE-7A of the Tristan accumulation ring (Fig. 1). The photon flux rate in front of the object was approximately 9.3×10^7 photons/mm^2/s for a beam current of 40 mA. FXCT system consists of a Si double crystal monochromator, an x-ray slit system, a scanning table, fluorescent x-ray detector, and CCD camera for TCT. The white x-ray beam was monochromated to 37 keV. For FXCT imaging, the monochromatic x-ray is collimated into a thin pencil beam. Fluorescent x-rays are detected in an HPGe detectors oriented perpendicular to the incident monochromatic x-ray beam.

TCT imaging should be performed in advance. Here, the incident beam is a solid beam to cover the object, and thus the CCD camera acquires a 2-dimensional projection image at once, while data acquisition in FXCT is sequential due to use of pencil beam. The projections are collected by rotating the object over 180 degrees.

Result and discussion

The exposure time at each data point was 20 ms, and we completed data acquisition for a 3-D TCT image within 5 s. We came to be able to decide a specific slice of object for FXCT in such a short time from the 3-D TCT image.

Futuristic work will be to apply linear attenuated coefficients estimated from the TXT image to attenuation correction in FXCT.

This research is supported by a Grant-in-Aid for Scientific Reseach (B) 21390339.

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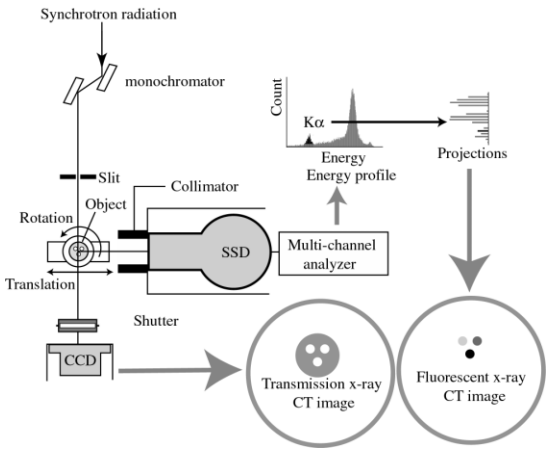

Fig. 1 Schematic of FXCT system