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Multi-Pinhole Type Fluorescent X-Ray Computed Tomography

Tenta SASAYA[1], Naoki SUNAGUCHI[2], Kazuyuki HYODO[3], Tsutomu ZENIYA[4], and Tetsuya YUASA[1,*]
[1]Yamagata Univ., 4-3-16 Jonan, Yonezawa, 992-8510, Japan
[2]Gunma Univ., 1-5-1 Tenjin, Kiryu, 376-8515, Japan
[3]Photon Factory, 1-1 Oho, Tsukuba, 305-0801, Japan
[4]Hirosaki Univ., 3 Bunkyo, Hirosaki, 036-8516, Japan

1 Introduction

So far, we have developed a fluorescent x-ray computed tomography (FXCT [1, 2]) using the pinhole effect [3]. However, we have not been able to reach the limit of detection required for *in-vivo* imaging a small animal during anesthesia because of insufficient number of fluorescent x-ray photons. In this research, in order to increase the number of the detected photons we proposed the multi-pinhole based FXCT for *in-vivo* 3D imaging and demonstrated its feasibility using actual data acquired from a physical phantom by the imaging system constructed at beamline AR-NE7A.

2 Experiment

Figure 1 shows a schematic diagram of the proposed imaging system, which was constructed at beamline AR-NE7A. An incident monochromatic volumetric beam (33.4 keV, 35 mm wide × 5 mm high), with photon fluxes (9.3×10^7 photons/mm^2/s) parallel to one another were linearly polarized within a horizontal plane, impinging and covering the object. Imaging agents, such as iodine, were thus excited and isotropically emitted x-ray fluorescent photons on de-excitation. A thin W plate with fifteen pinholes (each 0.1 mm in diameter) were placed between the object and the 2-D detector (PILATUS 100K, 0.172 × 0.172 mm^2 in pixel size, 487 × 195 in image size), such that the plate surface and the detective surface were parallel to the beam propagation. Only fluorescent photons (28.3 keV) passing through the pinholes were detected by the detector. For a single exposure (60 s in exposure time), we obtained independent fifteen projections. The projection acquisition was repeated while rotating the object over 360 degrees at an angular step of 4 degrees to finally obtain independent fifteen sets of projections. A 3-D image was reconstructed form the projections using OSEM (Ordered Sets-Expectation Maximization). We imaged an acrylic cylindrical phantom which was 10 mm in diameter and included seven axial channels of 2 mm in diameter, filled with iodine at seven different concentrations (0.012, 0.025, 0.005, 0.1, 0.2, 0.4, 0.4 mg/ml).

3 Results and Discussion

Figure 2 compares the images reconstructed using a single pinhole and multi-pinholes. The image quality for multi-pinholes is much superior to that for a single pinhole. The minimum detectable limit was about 0.005 mg/ml. The total measurement time was 90 min. The results encourage us to image a mouse head *in vivo* during anesthesia.

References

[1] T. Yuasa *et al.*, *IEEE trans Nul. Sci.* **44**, 54 (1997).
[2] Q. Huo *et al.*, *Opt. Lett.* **33**, 2494 (2008).
[3] N. Sunaguchi *et al.*, *Opt. Comm.* **297**, 210 (2013).

* yuasa@yz.yamagata-u.ac.jp

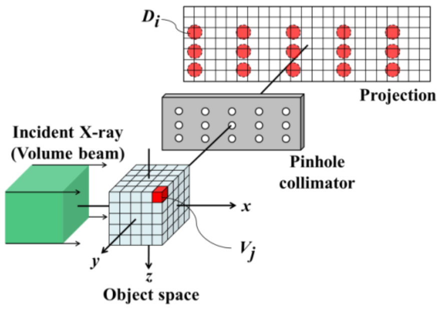

Fig. 1: Schematic of the imaging geometry

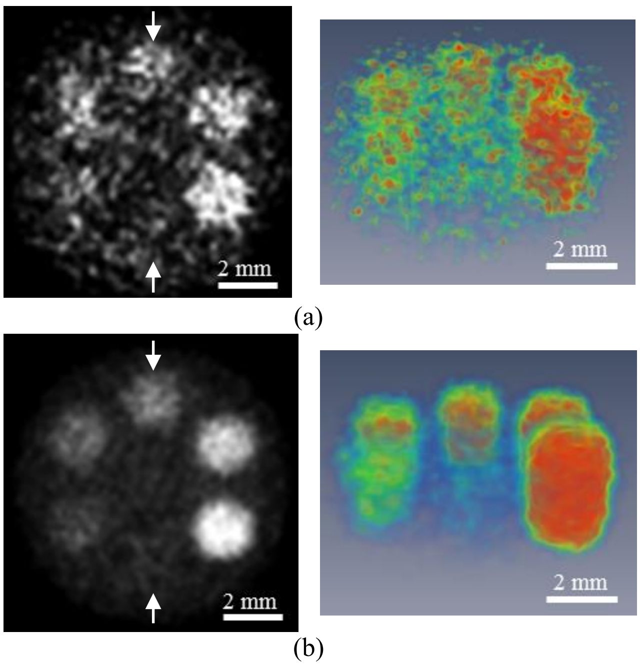

Fig. 2: 2-D and 3-D images reconstructed using (a) single pinhole, (b) 15 pinholes (Left: 2-D image, Right: 3-D image).