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Multi-Pinhole Based X-Ray Fluorescence Computed Tomography: Ex Vivo Imaging of Mouse Brain

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1 Introduction

Multi-pinhole based x-ray fluorescence computed tomography (mp-XFCT) delineates the spatial distribution of the non-radioactive agent in an object via fluorescent x-ray photons [1-3], which are emitted from the agent on de-excitation soon after extrinsic excitation and acquired with a multi-pinhole collimator and a 2-D detector. The potential application is to image brain of small animals in preclinical study for the purposes of development of treatment techniques and new drugs for brain disease. In this research, in order to investigate the applicability to brain imaging, we performed ex vivo imaging experiment of an excised mouse brain with iodine imaging agent using an mp-XFCT imaging system.

2 Experiment

The mp-XFCT system was constructed at beamline AR-NE7A in KEK. Figure 1 is a schematic of mp-XFCT, in which the distance between the rotational axis and the collimator plane, and between the collimator plane and the detector surface were 27.5 mm, and 30.0 mm, respectively. The collimator made of lead had 7 pinholes of 0.1-mm diameter. The detector was PILATUS 100K manufactured by DECTRIS Ltd; The rotational stage and the detector were controlled by a PC. The measurement time per projection was 180 s. The incidence energy was 33.2 keV just above the K-edge absorption energy of iodine; The cross-section of the incident beam was 35 × 6 mm^2; The flux was approximately 5.0×10^8 photons/mm^2/s in front of the specimen. The brain was removed from a ddY mouse (male, 5 weeks old) 5 minutes after non-radioactive agent, N-isopropyl-4-iodoamphetamine (iofetamine), of 76 mg was intravenously administered, and then fixed in formalin (Fig. 2(a)). The specimen in a plastic container set on the rotational stage was imaged while rotating at an angular step of 2° over 360°. The 3D tomographic image was reconstructed from the 180 projections using OSEM-algorithm. The voxel size of the reconstructed images was 0.172 × 0.172 × 0.172 mm^3.

3 Results and Discussion

The reconstructed cross sections are arranged in a raster-scan manner in Fig. 2(b), in which the upper left and the lower right images correspond to the upper and lower cross-sections of the brain, respectively. The images in the 3rd row show that the relatively iodine-richer regions exist inside the brain, which are guessed to correspond to thalamus. While the fact should be confirmed by further imaging experiments, the result at least demonstrates the applicability of mp-XFCT to brain imaging.

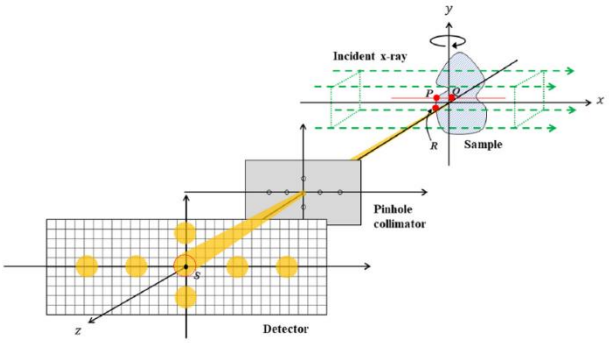
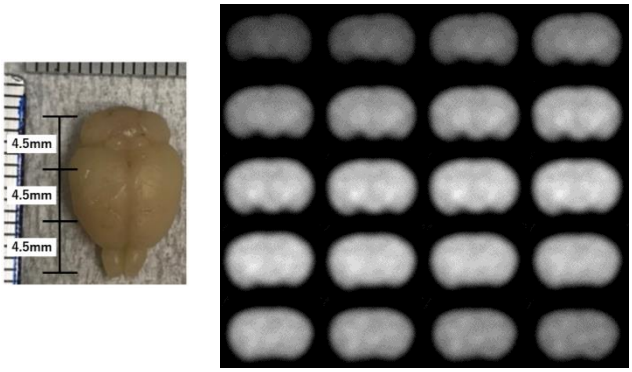


Fig. 1: Multi-pinhole type x-ray fluorescence CT.



(a) (b)

Fig. 2: (a) The excised mouse brain and (b) its reconstructed images.

References
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