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# Multi-Pinhole Based X-Ray Fluorescence Computed Tomography: Imaging Experiments Using Rat Head Phantoms

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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 a living body by using 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. One of the potential applications is to image brain of small animals for development of treatment techniques and new drugs of brain disease in preclinical study. However, the measured photons are limited because a brain is covered with a skull which is a highly absorbing object. In this research, in order to investigate the applicability to brain imaging, we performed imaging experiments with phantoms to simulate a rat head using an actual mp-XFCT system, constructed at beamline AR-NE7A in KEK (Fig.1).

## 2 Experiment

We imaged two kinds of physical phantoms imitating rat's head. One was an acrylic (PMMA) cylinder with 15 mm in diameter and 40 mm in height, which was covered with Al with 1 mm in thickness. It had three cavities with 3 mm in diameter and 15 mm in depth, which were filled with different concentration of I. The other was a rat skull including an I solution in the cerebral ventricle. The acrylic phantom and the rat skull phantom were rotated at an angular step of 2° and 4° over 360°, respectively. The measurement time per projection were 180 s and 60 s for the acrylic phantom and for the rat skull phantom, respectively. Namely, the number of projections for the former and for the latter were 180 and 90, respectively. Each phantom was measured two times while changing the concentration of I.

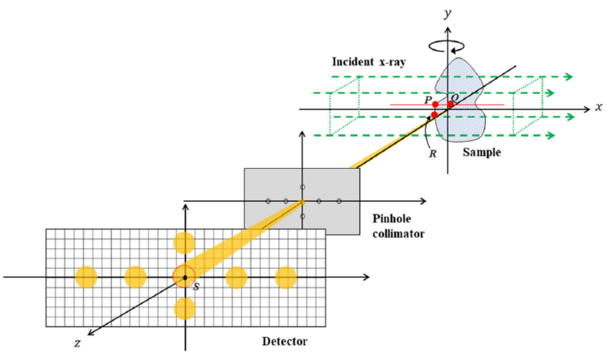
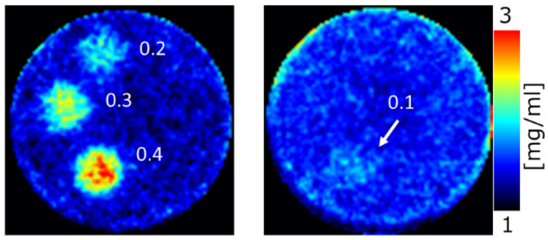
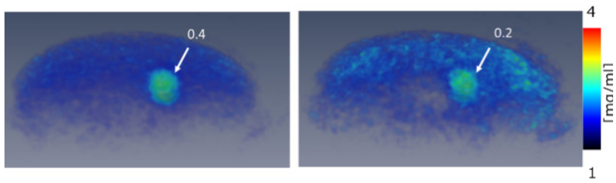



Fig. 1: Schematic of mp-XFCT




(a) (b)

Fig. 2: Reconstructed images of the acrylic phantom.




(a) (b)

Fig. 3: Reconstructed images of the rat skull phantom in MIP representation.

## 3 Results and Discussion

Figures 2(a) and (b) are a cross section of the reconstructed image of the acrylic phantom; The former had an I solution of relatively higher concentration than the latter. Although the concentration higher than 0.2 mg/ml was depicted, the concentration less or equal to 0.1 mg/ml could not be detected. The results show that the limit of detection of this phantom is 0.2 mg/ml. Figures 3(a) and (b) are reconstructed images of the rat skull phantom in MIP (Maximum Intensity Projection) representation; The former and the latter had I solution of 0.4 mg/ml and 0.2 mg/ml, respectively. In the both cases, the iodine regions are satisfactorily reconstructed. From the results, the iodine regions are satisfactorily reconstructed by mp-XFCT even if they are covered with a highly absorbing object, although the limit of detection decreases compared to the case without a highly absorbing cover.

## References

[1] T. Yuasa *et al.*, *IEEE Trans. Nucl. Sci.* **44**, 54 (1997).
[2] T. Sasaya *et al.*, *Sci. Rep.* **7**, 22143 (2017).
[3] T. Sasaya *et al.*, *Sci. Rep.* **7**, 5742 (2017).

## Research Achievements

1. T. Sasaya et al., *LNCS* 10884, 205 (2018).

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