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Development of X-ray DEI system using a channel-cut silicon crystal for phase-contrast imaging

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1 Introduction

X-ray phase-contrast imaging is now the powerful tool for imaging of objects. X-ray diffraction enhanced imaging (DEI) detects slight changes in X-ray propagation directions caused by an object [1]. We have been developing a novel X-ray DEI system using a channel-cut silicon crystal for analyzer of optics, which is placed in the downstream side of an object. This system, which is named multiple-times-diffraction enhanced imaging (M-DEI), is expected to have higher sensitivity to the electronic-density difference in an object than an ordinary DEI system.

2 Method

The incident X-ray beam to a channel-cut silicon crystal undergoes multiple-times diffraction between symmetric parallel crystal surfaces as shown in Figure 1.

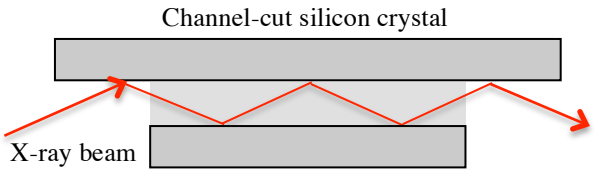

Fig. 1: Schematic view of multiple-times diffraction using a channel-cut silicon crystal.

We simulated the rocking curve obtained at X-ray energy of 17.5 keV in case of channel-cut Si(4,4,0) crystal. Figure 2 shows the simulated rocking curves, where the red line and the blue line correspond to one time diffraction and five times diffraction, respectively. The vertical axis corresponds to the relative X-ray intensity.

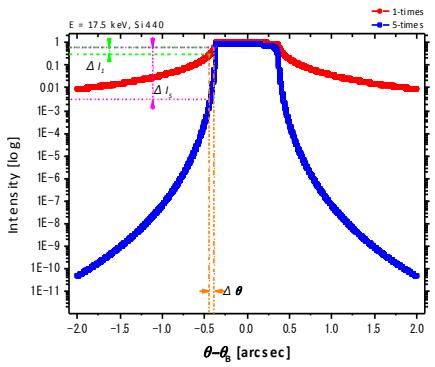

Fig. 2: The simulated rocking curves of multiple-times diffraction.

When the refraction angle $\Delta\theta$ is fixed, the slope $\Delta I/\Delta\theta$ becomes larger in case of five times diffraction. By using the feature of multiple-times diffraction for X-ray phase-contrast imaging, it is expected to get higher sensitivity to the electronic-density difference in an object.

3 Results and Discussion

Figure 3 shows the schematic view of the M-DEI system using a channel-cut silicon crystal.

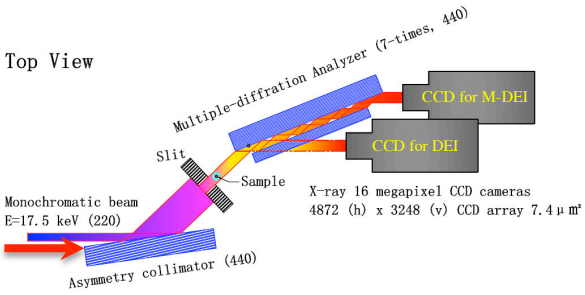

Fig. 3: Schematic view of experimental setup for M-DEI.

Experiments were performed at BL-14C, where one can get the vertically polarized X-ray beam. An asymmetric collimator was used to expand the horizontal beam size as shown in Figure 3 (top view). Sample in a water tank located between the collimator and the analyser. The CCD camera, which pixel size was 7.4μm×7.4μm, was used for obtaining M-DEI images and DEI images. In order to analyze electronic-density resolution in X-ray phase-contrast imaging, novel phantom was made from gelatin solution that was embedded in a certain concentration of agarose gel.

As the results of preliminary experiments, great improvement of image-contrast for the phantom was achieved in M-DEI images [2].

The detailed evaluation between M-DEI and DEI is continuing.

Acknowledgement

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References

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