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30-picoradian stabilization of optical components for X-ray interferometric imaging

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Introduction

X-ray interferometric imaging is a powerful phase-sensitive method for non-destructive observation of biomedical and organic material samples. Since the phase-shift is detected by using X-ray interferometer, the sensitivity is higher than that of other phase-sensitive methods. Therefore, it enables to perform detailed observations of samples mainly composed of light elements, such as biological soft tissues and organic materials without the usage of contrast agents.

In order to improve the imaging sensitivity and shorten the measurement time, a stability of 10-picoradian-order is required for the optical components of the X-ray interferometer. For higher stabilization by reducing the mechanical vibrations from the floor and the thermal drift rotation, we relocated and set up the imaging system [1] to the BL-14C2 [2] for the exclusive usage. In addition, we optimized the feedback system using interference pattern, readjust the active vibration isolator, and made the experimental hatch soundproofed to reduce the noise.

Interference pattern and stability

Figure 1 shows an interference pattern obtained using 17.8-keV X-ray. The width of the pattern was 43 mm and its height was 30 mm. The pattern was detected by a CCD-based fast X-ray imager [3] with a 3 s exposure. The best visibility in the pattern is 75%, which is 15% higher than that of the pattern obtained before the relocation of the system.

Figure 2 shows a chart over time of the phase fluctuation of the interference beam and the voltage applied to a piezo actuator (PZT) driving the rotational table for the optical component. The phase fluctuation was effectively suppressed by the changes in voltage about 3 hours period. The standard deviation of the phase fluctuations was π/20, which corresponds to the stabilization of the optical components of 30 prad and was about 30% high precise than that of the system before the relocation.

These results show that the stability of the imaging system improved and fine observations with practical measurement times have become possible. We plan to perform various observations by using the imaging system.

References

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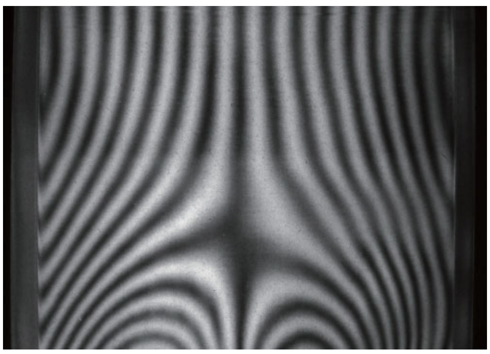

Fig. 1 A 43 x 30 mm interference pattern obtained with 17.8-keV X-ray. The best visibility was 75%.

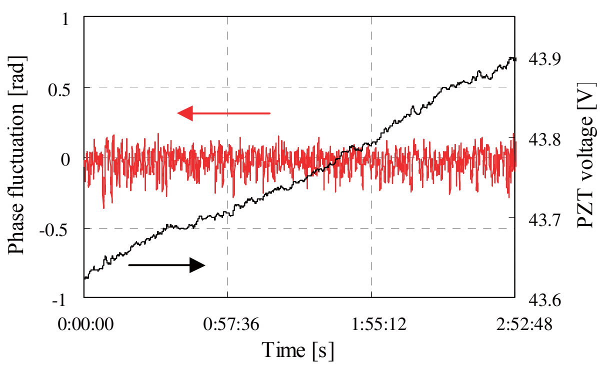

Fig. 2 Chart over time of the phase fluctuation and the voltage applied to the PZT of the rotational table.