BL-11A, BL-16A/2020G049

Spatial Coherence on Soft X-ray Projection Microscopy

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1 Introduction

We have developed soft X-ray projection microscopy system with the correction technique to improve blurred projection images due to Fresnel diffraction. The iteration procedure was applied to biological samples and their successful corrections were achieved for the soft X-rays of 700eV–1keV. The low coherence of the soft X-ray influences the image resolution.[1] We consider the coherence of the X-ray beam with double pinholes under the projection process in our microscope. BL-11A and 16A are used in this experiment.

2 Experiment

The experimental set up of double pinholes is shown in Fig. 1. The double pinholes are set between the fixed pinhole (1μmϕ) and the back-illuminated CCD camera. The distance D between the pinhole and the double pinholes is changed in the range of 0.5 mm – 8 mm. When the double pinholes are away from the pinhole (near 8mm), the interference will be caused in the center of the beam. On the contrary, as the double pinholes come close to the pinhole (near 0.5mm), they are put into the sides of the beam. That is, the spatial coherence will be evaluated with this experiment.

3 Results and Discussion

Figure 2 shows the results of the interference patterns of the double pinholes of 0.5μmϕ with 2μm distance. Panel (a) is for the distance of D = 6mm and (b) is for that of D=2mm. The intervals of interference fringes are the same because the beam propagation distances to the CCD camera are almost the same. Visibility and coherency $|\gamma_{12}|$ are defined as $I_1 = I_2$ (double pinholes' intensities),

$$V = \frac{I_{max} - I_{min}}{I_{max} + I_{min}} = \frac{2\sqrt{I_1 I_2}}{I_1 + I_2}|\gamma_{12}| \equiv |\gamma_{12}|$$

Figure 3 shows the visibility changes under the experiments of the double pinholes of 0.8μmϕ and 0.5μmϕ with 2μm distance. They have the same change, that is, the visibility rises up with the distance D=1. It is because the diffraction of each pinhole spreads and starts to interfere each other. On the other hand, their visibilities become stable and constant at D>4 because both pinholes pass through the center part of the beam. The visibility of the 0.8μmϕ is higher than that of 0.5μmϕ.

The experiments were conducted with the double pinholes of different diameters and distances under BL-11A and BL-16A, undulator line. We are in the discussion on the difference and varieties of interference patterns and their visibilities. It will be reflected into the image analysis of the soft X-ray projection microscope.

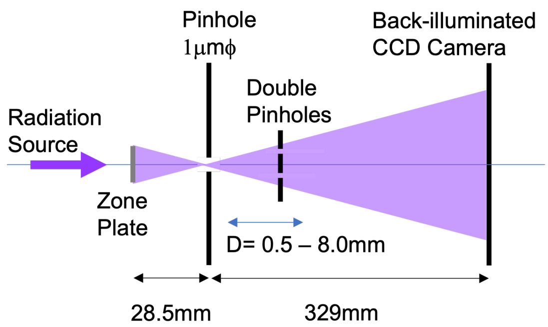

Fig.1 : Duoble pihnholes set up on soft X ray projection microscopy.

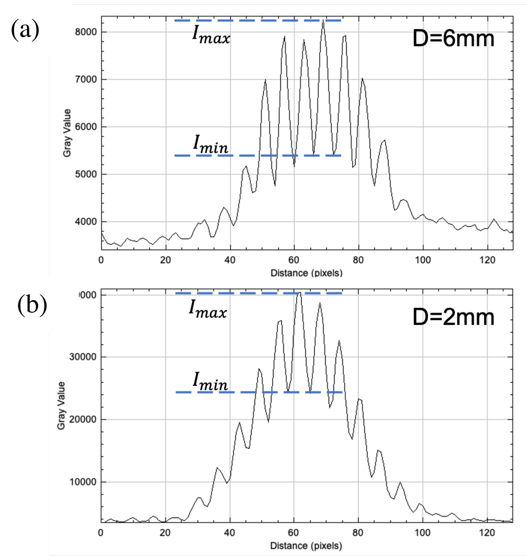

Fig.2 : Interference patterns of double pinholes (0.5μmϕ 2μm distance) observed at BL-11A.

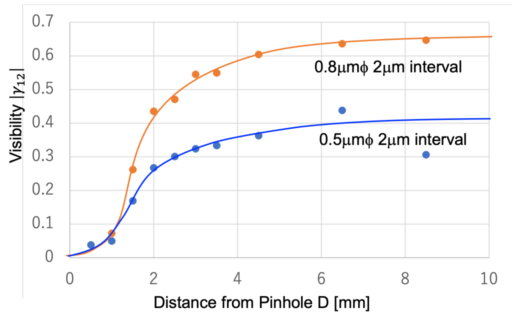

Fig.3 : Visibility change on spatial coherence at BL-11A.

References

[1] T. Shiina et al., PF Activity Report 2017 #35 B No. 296 (2018).

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