BL 29 XUL
A Method of Hard X-ray Focusing with Ultraprecise Mirrors

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1. OVERVIEW

In this course, we will demonstrate hard X-ray focusing with a K-B mirror optical system. X-ray focusing systems are installed for a high spatial resolution analysis in various X-ray microscopic methods. In hard X-ray region, there are several focusing instruments such as zone plates, refractive lenses and K-B mirrors. K-B mirrors are proposed in 1948 by Kirkpatrick and Baez. Two elliptically curved mirrors are used for two-dimensional hard X-ray focusing. This focusing system has characteristics of no achromatic aberration and high efficiency.

In the last decade, X-ray mirror fabrication technology is further improved. The degree of an accuracy of advanced X-ray focusing mirrors is higher than 2 nm (p-v)[1-3]. At the 1 km-long beam line (BL29XUL) of SPring-8, X-ray focusing tests have been carried out. The ideal focusing, so-called diffraction limited focusing, was realized. The focused beam size is achieved to be 7 nm by using multilayer mirrors[4,5]. The 400 mm-long focusing mirror with an ideal performance was also successfully fabricated. Considering these progresses, focusing systems using ultraprecise X-ray mirrors will be widely installed in many beamlines.

However, for two-dimensional X-ray focusing, two focusing mirrors should be aligned precisely. Due to the high degree of freedom in mirror positions, it is difficult for many users to align the mirrors without a certain level of knowledge and skill. From these reasons, there are still high barrier in installing K-B mirror system. The purpose of this course is to understand a method of hard X-ray focusing with K-B mirror. In this course, first we will present the history in the development of X-ray mirrors at SPring-8. Then, we will show the detail procedure of an alignment of two mirrors. We also explain which axis or angles of the mirror are sensitive to the focusing state. Finally, we actually demonstrate the two-dimensional hard X-ray focusing. We have a plan to use a 400 mm-long mirror for vertical forcing and a 200 mm-long mirror for horizontal focusing. X-ray energy will be 15keV.

2. BEAMLINE PRACTICALS

1. Detail explanation of alignment procedure of X-ray focusing.

2. Detail explanation of experimental facility

3. Demonstration of 2 dimensional hard X-ray focusing using a K-B system in fig.1.

4. Explanation of sub-10nm hard X-ray focusing system using adaptive optical system. (Only visit)

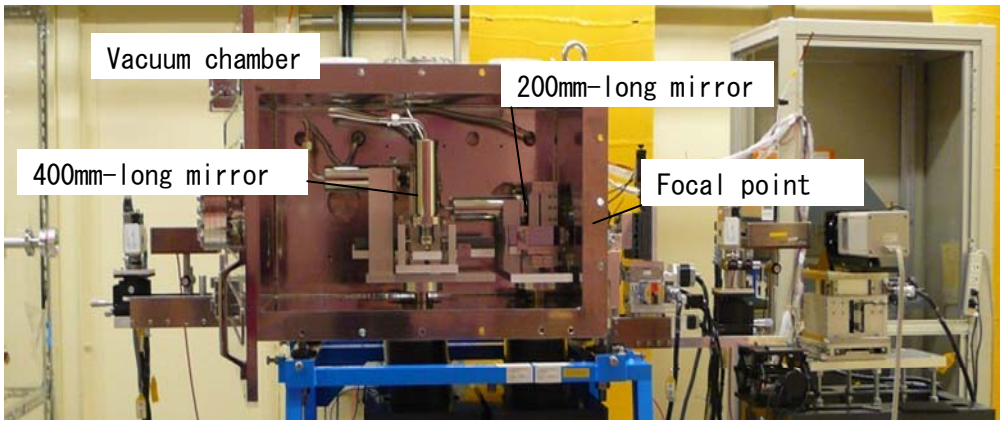

Figure 1 K-B focusing system with 400mm-long mirror and 200mm-long mirror

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(2) K. Yamauchi, et al., "Microstitching interferometry for x-ray reflective optics"., Rev. Sci. Instrum., 74, 2894-2898 (2003).
(3) H. Mimura, et al., "Relative angle determinable stitching interferometry for hard X-ray reflective optics", Rev. Sci. Instrum., 76, 045102 (2005).
(4) H. Mimura et al, "Breaking the 10 nanometer barrier in hard X-ray focusing", Nature Physics 6, 122 - 125 (2010).
(5) H. Mimura et el, "Efficient focusing of hard X-rays to 25nm by a total reflection mirror", Appl. Phys. Lett. 90, 051903 (2007).