Nuclear Resonant Scattering

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1. Introduction

BL09XU is a standard SPring-8 beamline with a hard X-ray, in-vacuum, linear undulator (λu=32mm, N=140) and a rotated inclined double-crystal monochromator (Si 111). This beamline is mainly used for Mössbauer spectroscopy, coherent X-ray optics using nuclear resonant scattering, and surface and interface structure analysis.

2. Beamline commissioning

The commissioning of this beamline began in July of 1997 and was finished by October of the same year. It had been thought that the fine-tuning of the inclined double-crystal monochromator, which had 17 precision stages, was going to be one of the more difficult problems. For an easier and more precise alignment, we tried to perform alignment it using simple double-L-shaped tools (Fig. 1) and only a few levels, without X-rays. These tools were used to find the zero angle and to determine the origin or the center of each stage. This, so-called "off-line alignment", worked well and was applied to every other standard beamline.

Before being opened for public use, the beamline was investigated in terms of its performance. The energy spectrum from the inclined monochromator at the ID gap=8mm was measured [1]. The flux, which was measured at a sample point by a p-i-n photo diode, was 2×10^{12} cps at Ib=17mA, ID gap=19.8mm, and E=14.4keV (1^{st} harmonics of the undulator); this value was about one quarter of the calculated value [2]. A slit scan ($0.1 \times 0.1 mm^2$) was used to measure the beam shape (Fig. 2). A doubled profile in the horizontal direction was seen. It was thought that a reduced intensity and expansion in the horizontal direction were mainly caused by distortions of the water-cooled grooves and of a pin-post crystal. To improve the pin-post crystal, R&D is continuing.

3. Several-bunch-mode operation

For most nuclear resonant scattering experiments, it is necessary that the interval between successive incident X-ray pulses be ~100 nsec. Accordingly, few bunches mode operation of the storage ring is required. In November, machine studies on this operation were started, and later that month, a 21-bunch-mode operation (228 nsec equal interval) in terms of the user time was achieved. The bunch impurity, as measured by an avalanche photo diode (APD), was better than 10^{-6} (Fig. 3). This value is sufficient for most nuclear resonant scattering experiments.

References

[1] Y. Yoda et al, in this report.
[2] S. Goto, in this report.

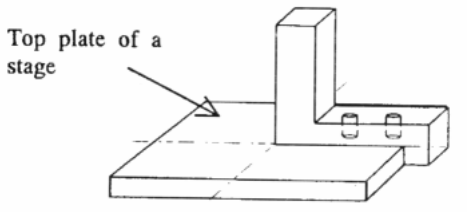

Fig. 1 Double-L-shaped alignment tool for a standard monochromator

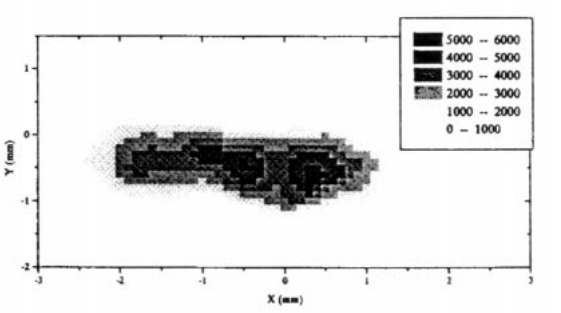

Fig.2 Spatial profile of the beam in an experimental hutch (Ib=18mA, E=14.4 keV)

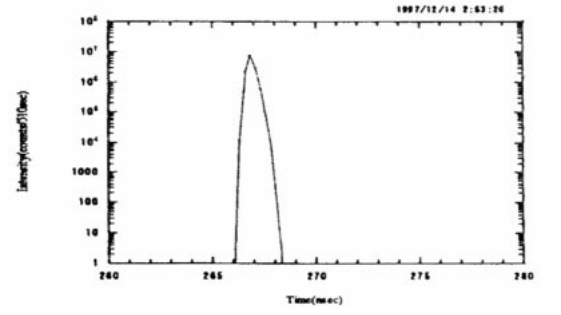

Fig. 3 Bunch profile of the storage ring in 21-bunch-mode operation, detected by APD.