Effect of Bunch Mode of Storage Ring on X-ray Magnetic Diffraction Experiment

Masahisa Ito※, Keiichi Hirano[1], Motohiro Suzuki[2], Etsuo Arakawa[3], Shunji Kishimoto[1], Naomi Kawamura[4], Shigeyuki Murayama, Hiroshi Maruyama[4] and Shunji Goto[5]

Faculty of Science, Himeji Institute of Technology
[1]Institute of Material Structure Science, KEK
[2]Harima Branch, Institute of Physical and Chemical Research
[3]Faculty of Education, Tokyo Gakugei University
[4]Faculty of Science, Okayama University
[5]Japan Synchrotron Radiation Research Institute, SPring-8

The storage ring of the SPring-8 has been operated in various bunch modes, for example, full-fill 2436-, 21- and 12-bunch modes. Emittance of the electron beam could be dependent on these bunch modes. On a beam line of insertion device of an undulator, which emits linearly polarized radiation, emittance of the electron beam would affect the degree of linear polarization P_l of the radiation. The smaller is the vertical emittance, the higher would be P_l. Nonresonant X-ray magnetic diffraction of ferromagnets, which utilizes a scattering angle of 90° at a specimen, is sensitive to the polarization of the radiation. We performed X-ray magnetic diffraction experiment in two bunch modes, 21- and 12-bunch, on an undulator beamline, BL39XU.

Linearly polarized X-rays from the undulator were monochromatized by a pin-post type monochromator. The X-rays passed through a phase plate of a diamond single crystal and were converted to elliptically polarized X-rays which are needed to the magnetic diffraction experiment. The degrees of linear and circular polarization of the elliptically polarized X-rays, P_l and P_c, are dependent on an offset angle $\Delta\theta$ from a Bragg angle of the phase plate crystal. In order to enhance the magnetic effect we used a linear polarizer(extinction ratio of 500) in front of the phase plate.[1)] The magnetic effect R of Fe 220 diffraction intensity was measured for various $\Delta\theta$'s with magnetic field applied along the direction of diffracted X-rays. R is proportional to $P_c/(1-P_l)$.

In Fig. 1 the observed profile of R vs.$\Delta\theta$ is shown which was measured in the 12-bunch mode. In Fig. 2 is shown the profile of R vs.$\Delta\theta$ measured previously in the 21-bunch mode. It is clearly seen that the profiles are quite different; the maximum R in the 12-bunch mode is smaller than the one in the 21-bunch mode, and the maximum R occurs at smaller $\Delta\theta$ in 12-bunch mode than in 21-bunch mode. The solid lines in the Figs.1 and 2 are calculated using $1-P_l$ of the incident X-rays on the phase plate, 2×10^{-4} and 1×10^{-5} respectively. The calculated curves represent the observed profiles well. Fairly asymmetric character in the observed profiles would be due to slightly inclined polarization plane from the horizontal plane, and such effect is taken into account in the calculation. Larger $1-P_l$ in the 12-bunch mode than in the 21-bunch mode would imply larger vertical emittance. More detailed analysis in these profiles will reveal the properties of the synchrotron radiation. It should be noted that the X-ray magnetic diffraction is useful for diagnostics of the synchrotron radiation.

1) M. Ito and K. Hirano, J. Phys: Condens. Matter **9** (1997) L613.