PERIODIC POLARIZATION SWITCHING FOR MCD MEASUREMENTS

Light polarization has become increasingly important for such soft X-ray spectroscopic techniques as magnetic circular dichroism (MCD) and circular dichroism (CD) measurements. Such experimental methods require good polarization quality and the fast switching of photon helicity. To promote high-sensitivity studies and to improve the signal-to-noise ratio for circular dichroism, we have developed a new MCD measurement system coupled with the right and left circular polarizations (RCP and LCP) switching [1].

BL23SU is a soft X-ray beamline used for spectroscopic studies for a wide variety of applications, such as surface chemistry, biology, and condensed matter physics [2]. The light source (ID23) is an APPLE-2 type undulator [3]. Figure 1 shows the structure and motion of permanent magnet rows of the undulator. This planar double-array undulator generates any kind of elliptical polarization of light by adjusting the relative position of pairs of magnet rows (phase shift) and changes the photon energy in the soft X-ray range by varying the gap distance between the upper and lower jaws.

Figure 2 provides an outline of the MCD-measurement-control system at beamline **BL23SU**, which is based on the SPring-8 public beamline model [4]. Experiments using MCD measurements can be performed with a personal computer (MCD-PC) by using sophisticated applications software. The beamline workstation (BL-WS) is connected to the MCD-PC and controls the beamline insertion device (ID23-gap/phase) and the monochromator [5], which establishes the selected monochromatized photon energy, maintaining the robustness of the system.

The MCD sample current (I_1) and monitor current (I_0) are collected by the MCD-PC. During the MCD measurements, the undulator control, the monochromator control, and the data accumulation

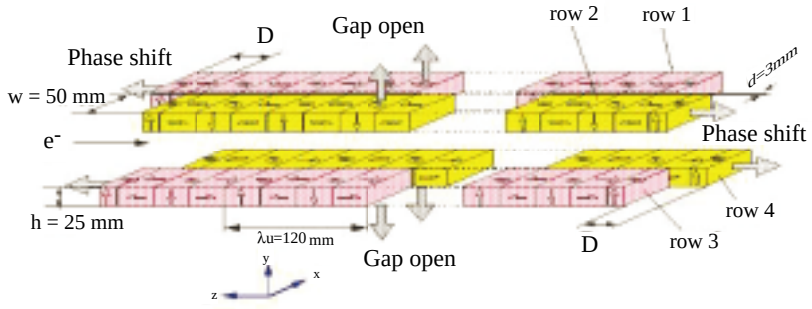

Fig. 1. The magnetic structure and movement of the double-array undulator. λu and D indicate the magnetic period length and the phase shift distance, respectively.

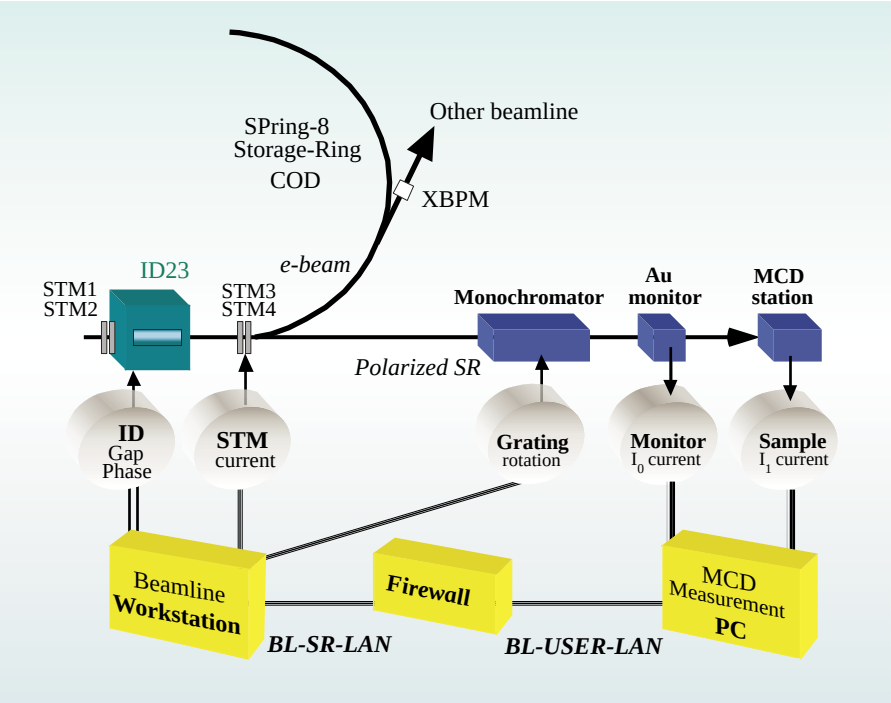

Fig. 2. Schematic illustration of the MCD measurement control system at beamline BL23SU with ID23. Experimenters can carry out the MCD measurements via several SPring-8 networks, including BL-SR-LAN and BL-USER-LAN. VMEs and BL-X-terminals are omitted.

are operated simultaneously. For instance, a measurement cycle proceeds as follows: (i) photon energy tuning; (ii) ID23 phase-shift to provide RCP X-rays; (iii) simultaneous sampling of I_0 and I_1; (iv) ID23 phase-shift to provide LCP X-rays; and (v) sampling again of I_0 and I_1. At this point the cycle returns back to (i) to be continued. Figure 3 shows the first results of MCD measurements, made for the of Fe2*p* absorption of Fe metal in a magnetic field of 0.4 T excited by RCP and LCP soft X-rays with a polarization switching frequency of 0.1 Hz. We believe that this circular dichroism measurement system with periodic photon-helicity switching by a variably-polarizing undulator provides great opportunities for the study of a very weak circular dichroism signals in the soft X-ray region.

It should be noted that the closed orbit distortion of the storage ring caused by the ID23 drive is minimized using the steering magnets installed in the upstream and downstream of the undulator.

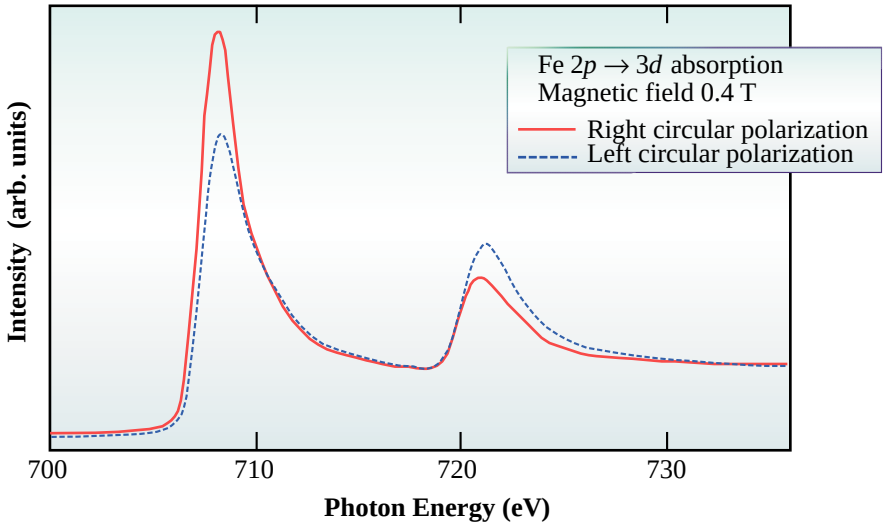

Fig. 3. Fe $L_{2,3}$ absorption spectra of Fe metal in a magnetic field 0.4 T excited by right and left polarized X-rays with a polarization switching frequency of 0.1 Hz.

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References

[1] A. Agui, A. Yoshigoe, A.Yokoya, Y. Saitoh, Y. Hiramatsu, T. Shimada, T. Nakatani, T. Matsushita, Y. Miyahara, H. Tanaka, M. Takeuchi, T. Bizen, S. Sasaki, M. Takao, H. Aoyagi, T.P. Kudo, K. Satoh, S. Wu, and H. Ohkuma, to be published in Rev. Sci. Instrum.

[2] A. Yokoya *et al.*, J. Synchrotron Rad. **5** (1998) 10.

[3] S. Sasaki, Nucl. Instrum. Meth. A **347** (1994) 83.

[4] T. Nakatani *et al.*, J. Synchrotron Rad. **5** (1998) 536.

[5] Y. Saitoh, Y. Teraoka, A. Agui, A. Yoshigoe, A. Yokoya, to be published Nucl. Instrum. Meth. (2000).