Photon Beam Diagnostics Using XBPMs

Hideki AOYAGI[1)], Togo KUDO[1)] and Hideo KITAMURA[1, 2)]

1) SPring-8/JASRI, 2) SPring-8/RIKEN

1. Introduction

X-ray Beam Position Monitors (XBPMs) have been installed in the insertion device (ID) beamline front ends [1], and utilized in various photon beam diagnoses. The XBPMs are able to measure photon beam positions in both the horizontal direction and vertical direction, the typical resolutions of which are about 1.0 μm and 0.5 μm, respectively. The readout systems support the wide range of frequency. During user time, the data from the XBPMs are constantly logged every six seconds. For special purposes, such as observation of the beam oscillation, the system is set up to match the high frequency of up to 3kHz or more [2]. Additionally, the XBPMs are also used in routine measurement immediately after every injection with all ID gaps closed.

Here we report the results of the various measurements for the photon beam diagnostics using the XBPM systems.

2. Measurements for Diagnosis

2.1 Synchronous Measurements

The significant progress which has been made in the XBPM system in 1999 is the development of the synchronous beam diagnostic system using cellular telephones [3]. Before the use of this synchronous measurement system, we could not distinguish the difference between real photon beam oscillation and vibration coming from the monitor chamber itself. Judging from the observation of the phase-matched oscillation in different beamlines, it can be concluded that the oscillation is the result of the real beam oscillation. Figures 1 (a) ~ (c) show examples of synchronous measurements at both BL47XU and BL10XU, with data sampling rates of 360, 60 and 6 samples/sec, respectively. After further analysis, we concluded that the resolutions of the XBPM in the horizontal and vertical directions are less than 1.0 and 0.5 μm, respectively.

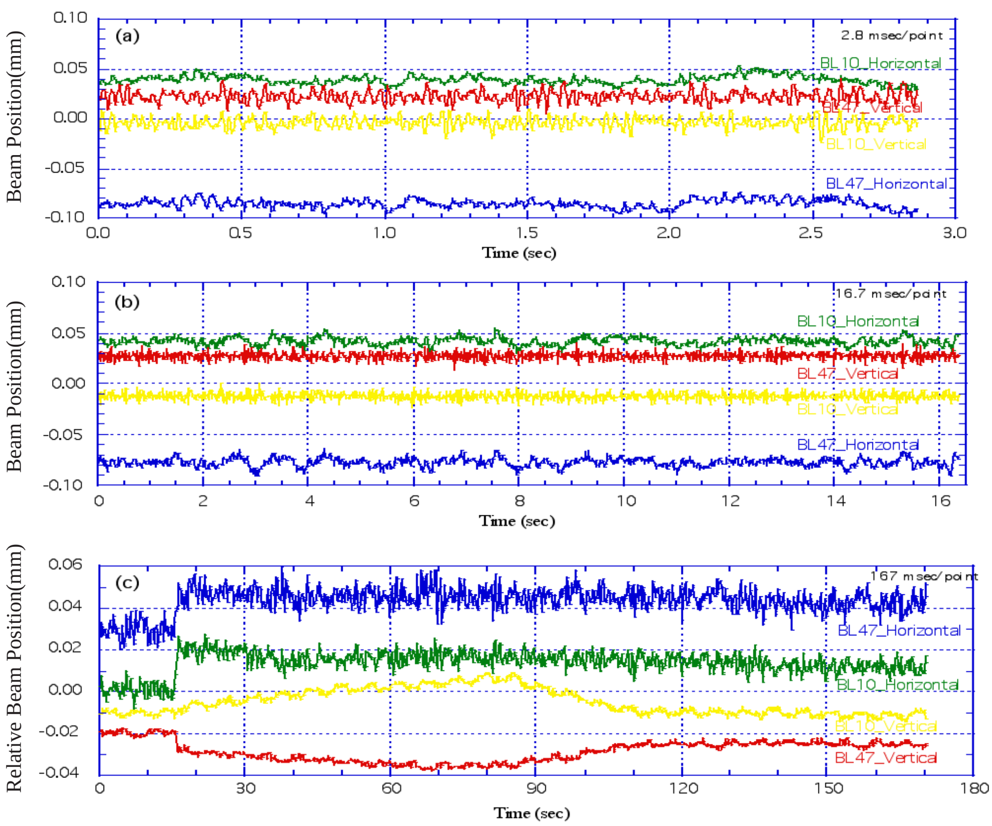

Fig. 1. Results of synchronous measurements using cellular telephones at BL47XU and BL10XU. The sampling rates are (a) 360, (b) 60 and (c) 6 samples/sec. In graphs (a) and (b), the steering magnets and ID were not changed. In graph (c), the electron orbit was steered with a steering magnet (the time is 16 sec.) and the ID gap of BL23 was changed from 40 to 80 mm (the time is 20 to 110 sec).

2.2 Effect of Magnet Excitations in the Experimental Hall

To stabilize the photon beam, the magnetic field is carefully treated. There are various magnets in the experimental hall. The XBPMs have been used to see how the excitations of those magnets affect the photon beam position. Figure 2 shows an example of an observation made during magnet excitation. This measurement was performed without the periodic closed orbit distortion (COD) correction [4]. During user time, the beam drift as seen in this measurement can be suppressed by this correction.

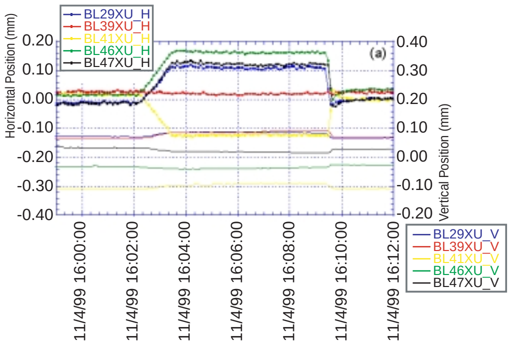

Fig. 2. Observation of the excitation of the dipole magnet in the experimental hutch of BL33LEP. The excitation current was applied with the maximum current from 16:03:40 to 16:09:20.

2.3 Observation of the Photon Beam Drifts

The stability of the photon beam positions have been observed in several beamlines with and without the periodic COD correction as seen in Fig. 3. There were beam drifts of about 20 µm in the horizontal direction and about 10 µm in the vertical while the correction was off. On the other hand, there are some periodic steps while the correction was on. The collection scheme has been improved since then, so there are no significant steps during the recent user time.

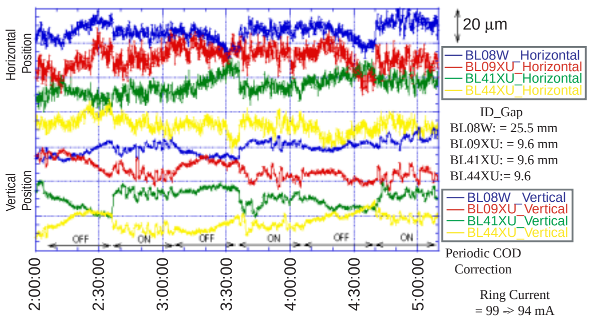

Fig. 3. Photon beam stability with and without periodic COD correction. Recently the correction scheme was improved, so there are no such steps as seen in this graphic.

2.4 Observation of the Electron Beam Perturbations

In order to check the time response of the readout system, we observed the beam oscillation which occurred while the electron beam is perturbed with the steering magnet. The vertical perturbations have been applied in various frequencies. The current amplitude of the steering magnet is about 5 mA, which corresponds to the kick angle of 0.5 µrad in the electron orbit. Figure 4 shows the results of measurements. In this measurement, we used an I/V converter which has a response time of 30 Hz (-3dB), so the oscillation of 10 and 20Hz are detected properly. A relatively large peak is seen at 30 Hz because of real electron beam oscillation. So the effect of the additional perturbation of 30 Hz is obscure.

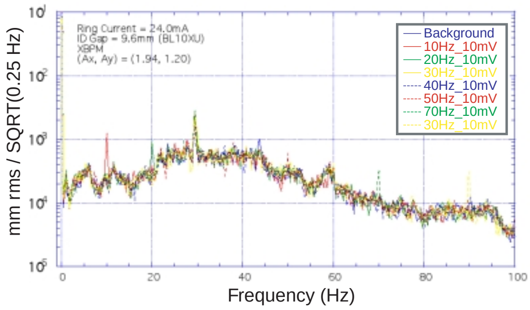

Fig .4. FFT analysis of the vertical photon beam position. The frequencies of 10 and 20 Hz can be observed clearly, but the peaks are suppressed over a frequency of 40 Hz. The large peak seen at 30 Hz is due to real electron beam oscillation.

3. Conclusion

In 1999 we came to make various measurements for photon beam diagnostics using the present XBPM systems. On the basis of this experience we are improving the system, especially the readout system.

Acknowledgments

The measurements presented in this article have been achieved as a result of collaboration with members of the accelerator group, the front end group, beamline scientists and other persons concerned in SPring-8.

References

[1] H. Aoyagi *et al.*, SPring-8 Annual Report 1997 (1997) 220.

[2] T. Kudo *et al.*, SPring-8 Annual Report 1998 (1998) 169.

[3] T. Kudo *et al.*, in this volume.

[4] H. Tanaka *et al.*, SPring-8 Annual Report 1998 (1998) 143.