Observation of Photon Beam Oscillation by XBPM

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1. Introduction

The X-ray beam position data of the SPring-8 beamlines are obtained by X-ray beam position monitors (XBPMs), and are stored in a data base every few seconds by BL control system [1]. The data taking speed is enough for usual point observation at every beam injection time. However, the XBPM itself is expected to have much higher response ability ($t \approx ns$). Then, the XBPMs are possible to give other valuable information, such as high frequency photon beam oscillation and bunch train structures *etc.*, which had not yet been utilized in SPring-8. Then, we tried to observe the vertical and horizontal oscillation of the photon beam from the insertion device (ID) at BL47XU by a blade type XBPM [2] in a frequency range from 0 to 3 kHz.

2. Experimental Setup

The current signals from three blades (UL, UR and DR) of the XBPM were inputted into high speed current amplifiers (Keithley 428:fc=35kHz) after passing through 50 m of low noise coaxial cables, and converted into voltage signals. The difference between the voltage signals of UR and UL (UR and DR) were calculated and analyzed by an FFT analyzer (HP 35670A), which reflected the horizontal (vertical) SR beam oscillation. (Fig. 1)

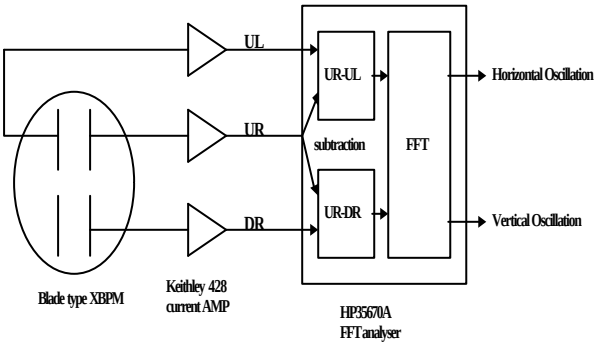

Fig. 1. Experimental setup for the observation of the photon beam oscillation.

3. Results

The observed spectrum of the horizontal and the vertical oscillation are shown in Figs. 2.1 and 2.2 respectively. Both of them were obtained at same time. As shown in Fig. 2.1, the horizontal spectrum has a significant peak at about 1.4 kHz. The vertical spectrum also has the peak, but it is very small.

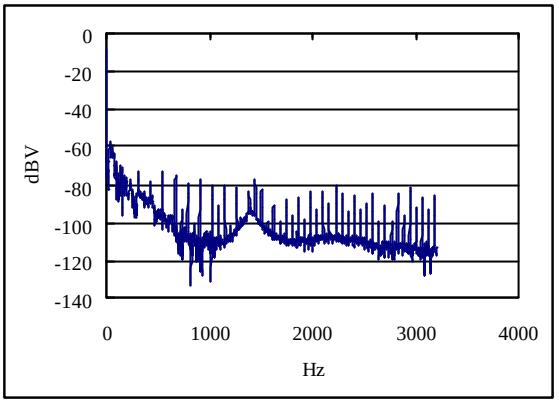

Fig. 2.1 Oscillation spectrum for horizontal direction measured by XBPM.

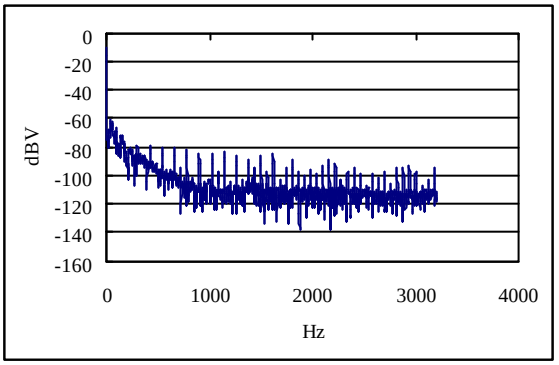

Fig. 2.2 Oscillation spectrum for vertical direction measured by XBPM.

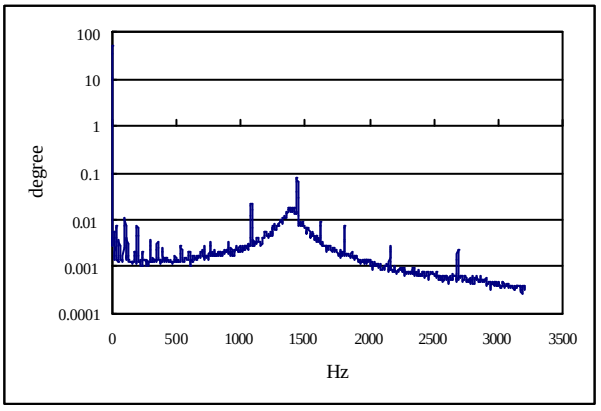

Fig. 3. Synchrotron oscillation spectrum measured by the phase oscillation measuring system using the button electrode at the No. 3 Cell of the storage ring [3].

Figure 3 shows the electron beam phase oscilla-

tion spectrum at the No. 3 cell of the storage ring, which is measured by the phase oscillation measuring system using a button electrode beam position monitor (BPM) [3]. It also has a peak at about 1.4 kHz, which is the peak of a synchrotron oscillation.

4. Discussion

Even though the storage ring was designed not to have any dispersion function at the center point of ID, there is practically some dispersion function leak at this point. Then, the X-ray beam is oscillated mainly horizontally in the frequency of synchrotron oscillation, which is possible to be detected by XBPM.

The peak at 1.4 kHz in Fig. 2.1 is similar to the peak in Fig. 3, and so that the peak in Fig. 2.1 might be the synchrotron oscillation.

For examining the observation, the amplitude of the horizontal synchrotron oscillation at the point of XBPM is estimated by the equation (1).

$$A = \sqrt{\eta_x^{\,2} + \eta_x'^{\,2} l^2}\,\frac{\Delta p}{p} \quad \text{(m)} \qquad (1)$$

where; A is the amplitude of the synchrotron oscillation at the point of XBPM, η_x the horizontal dispersion functions at the center of ID 47, p the momentum of accelerated electron, l the distance between the light source and the XBPM at BL47XU, and;

$$\eta_x' = \frac{d\eta_x}{ds}.$$

The values of these parameters were shown in Table 1. The values of η_x and η_x' are estimated from the data of the button electrode BPMs before and next to the ID.

η_x (m)	-0.0016
η_x' (rad)	-0.00067
$\Delta p / p$	10^{-4}
l (m)	20.3

Table 1. Values of the parameters of the storage ring and BL47XU.

Then, the amplitude of the horizontal synchrotron oscillation is estimated as approximately 1.4 μm by use of these values and the Eq. (1). As for the vertical oscillation, the vertical dispersion function is almost one digit less than that of horizontal one, and then the amplitude is small.

The horizontal position resolution of XBPM is less than 2 μm [1], and so that the estimated amplitude is comparable to the XBPM sensitivity. Therefore, it was confirmed that the XBPM could detect the synchrotron oscillation as horizontal X-ray beam position oscillation.

We are planning to construct the control system containing the XBPM, which can effectively utilize the high speed data for operation of the beamlines and the accelerator.

Acknowledgement

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References

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