CONSTRUCTION OF A SYNCHROTRON RADIATION (SR) POSITION MONITOR BY MEANS OF X-RAY PHOTOEMISSION

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Abstract

A synchrotron radiation position monitor by means of photoemission has been constructed and tested. The monitor has a pair of electrodes shaped right-triangle which faces the X-ray synchrotron radiation beam at a tilted angle. The intensity of SR beam is proportional to the sum of the two photo currents from the electrodes. The beam position is calculated from the ratio of the difference of the two photo currents to the sum. The monitor was well operated in the vacuum of 10^{-2} Pa. The regular type monitor was constructed and installed in the beam line BL-4C.

1. Introduction

The stability of the position of synchrotron radiation beam is important problem for experimenters. The stabilization of the position by means of feedback method was applied at some synchrotron facilities [1]. At Photon Factory KEK, we started an observation of the position of synchrotron radiation from Feb. 1986. In parallel manner, some studies of stabilization of beam position was also started. We have used two kinds of position detector for the observation of the beam position [2]. One is a split ion chamber which is suitable for X-ray beam lines and the other is two wire monitor by means of photoemission at VUV region [2]. In this paper new position monitor by means of photoemission at X-ray region is described.

2. Prototype Split Photoemission Monitor

A prototype photoemission monitor with its emission electrode split into two right triangles was constructed and mounted into a small test vacuum chamber. A schematic drawing of the structure of the monitor is shown in Fig. 1. Two solder coated copper electrodes are supported on a guard electrode (collector) by insulator (glass molded epoxi). The two emitters face the X-ray synchrotron radiation beam at a tilted angle of 10 degrees. The photo current from each electrode is amplified by a current amplifier (Keithly 427). Two current signals from the upper and lower electrodes are then fed into a difference amplifier in order to obtain a signal proportional to the beam displacement. The block-diagram of the electronics to produce a beam position signal is shown in Fig. 2.. The position response of the monitor measured with the synchrotron radiation beam is shown in Fig. 3. Some difference from linear line in Fig. 3 is caused by a ancertainty of the machining of the emitter.

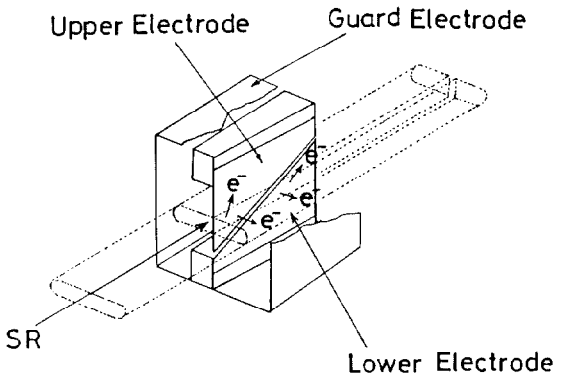

Fig. 1 A schematic drawing of the split emission monitor.

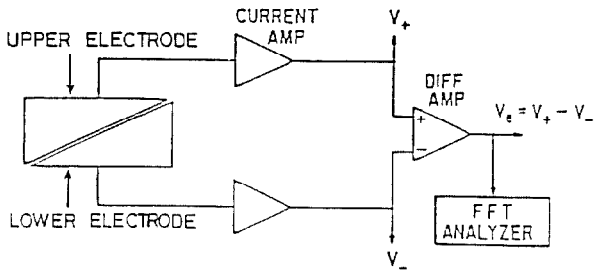

Fig. 2 A block-diagram of the electronics.

The monitor assembly is installed in a small vacuum chamber evacuated by a 150 l/min. oil sealed mechanical rotary pump (RP). Because of the typical beam line at Photon Factory are evacuated by a RP, the inner vacuum of the chamber is chosen for 3×10^{0} Pa. The monitor is well operated in this vacuum.

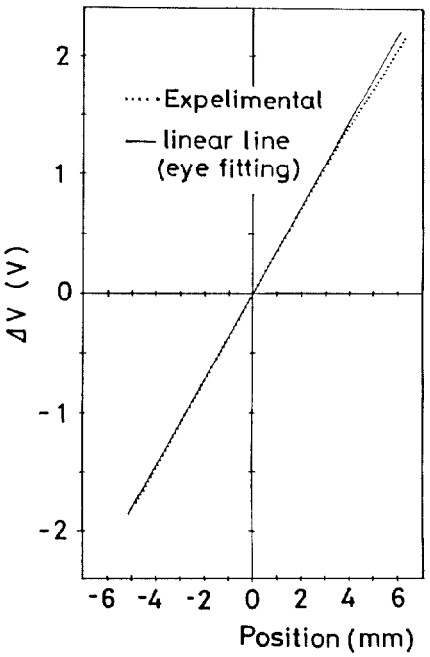

Fig. 3 The position responce of the monitor. The dotted and solid lines are experimental line and a linear line by eye fitting respectively.

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3. Observation of Beam Position Noises

The monitor is mounted in the hutch of the beam line BL-21A (test beam line for monitoring of SR). Position noise spectra were measured using the FFT analyzer. Fig. 4 shows the typical spectrum of the position noise. Most of the noise components are concentrated in the DC to 100 Hz range.

Two wire monitor was already installed in BL-21A[1),2)]. The spectrum obtained from the two wire monitor is shown in Fig. 5. By comparison between Figs. 4 and 5, spectra obtained from two monitors agreed very closely in frequency content, and varied slightly in relative amplitudes.

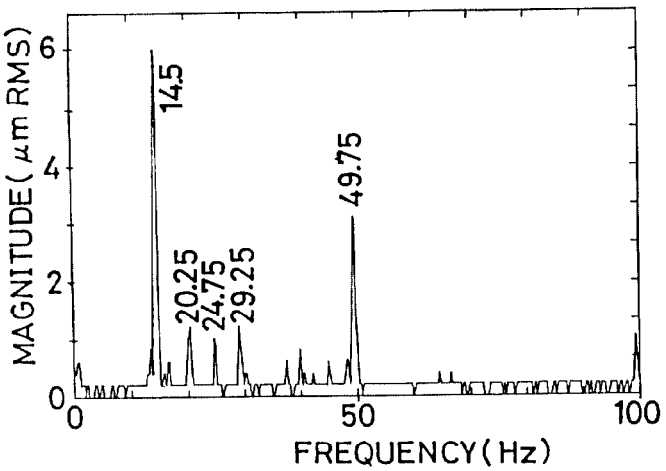

Fig. 4 A position noise spectrum at BL-21A by split emission monitor.

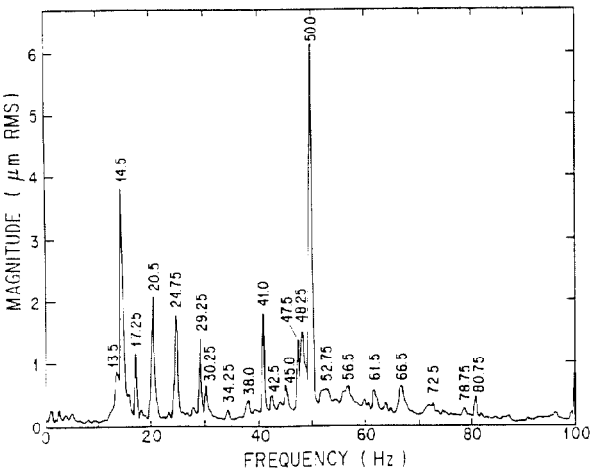

Fig. 5 A position noise spectrum at BL-21A by wire monitor.

4. Split Photoemission Monitor for BL-4C

A regular type split photoemission monitor was constructed for the beam line BL-4C. The layout of the beam line BL-4C and the position of monitor is shown in Fig. 6. The structure of the monitor is shown in Fig. 7 with a device which moves the monitor vertically.

The synchrotron radiation comes 6 mrad wide for BL-4C and the electrodes of the monitor hides only 0.37 mrad at the edge of the beam. The vacuum of BL-4C is about 7×10^{-1} Pa.

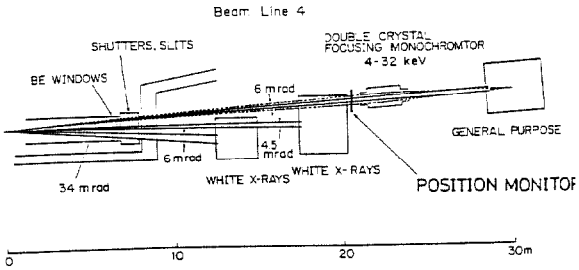

Fig. 6 The layout of beam line BL-4C.

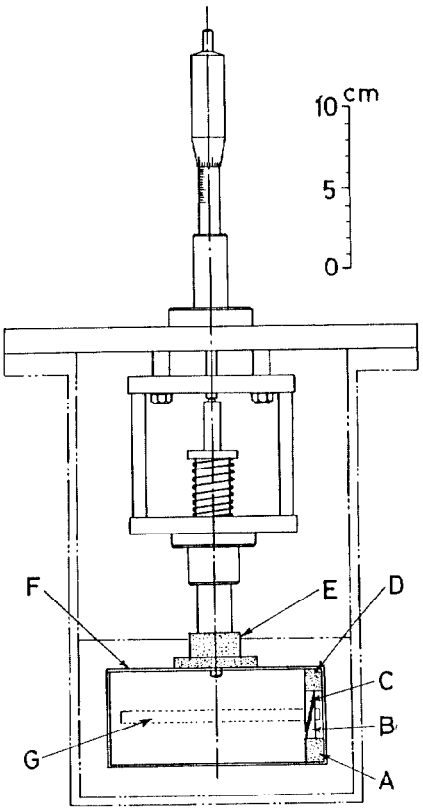

Fig. 7 A schematic drawing of the monitor for BL-4C. A,D: Support insulator for electrode ; B,C: A pair of split electrode (emitter) ; E: Support insulator for electrode assembly ; F: Guard electrode (collector) ; G: Cross section of SR beam coming for BL-4C.

5. Observation of the Beam Position and Its Noise at BL-4C

The monitor was installed in the beam pipe of BL-4C at 21.5m point apart from the source point. The position noise spectra were measured by a same manner used for

the prototype monitor. Obtained spectrum at BL-4C is shown in Fig. 8. Comparing Figs. 4 and 8, noise components at BL-4C and BL-21A are almost same in frequency content. A result of the 26 hours observation of beam position are shown in Fig. 9. From Fig. 9, there exists three types of movements in beam position. One is a slow undulation having a period of one day. We considered this movement in relation to atmospheric temperature. Second is fast oscillation having periods of some minutes. This oscillation is mainly caused by a digital feedback to compensate the first problem. Third is position noise as shown in Figs. 4 and 8. Further discussion of these problems is in reference 3.

Acknowledgements

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References

1. R.O. Hettel, IEEE Trans. on Nucl. Sci., Vol. NS-30, 2228 (1983)
2. T. Katsura, Y. Kamiya, K. Haga, T. Mitsuhashi and R.O.Hettel, KEK Preprint 86-46 August 1986.
3. T. Katsura, Y. Kamiya, K. Haga and T. Mitsuhashi, "A beam position feedback system for beam lines at the Photon Factory", submitted to this conference.

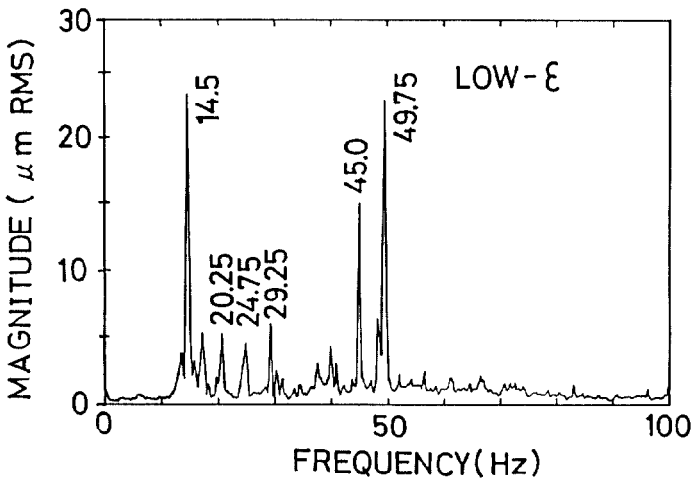

Fig. 8 A position noise spectrum at BL-4C.

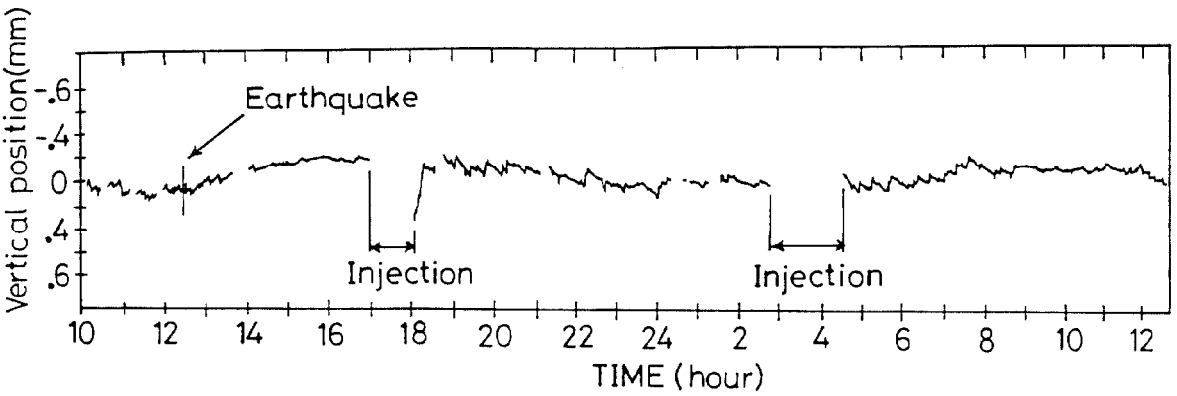

Fig. 9 A result of the 26 hours observation of beam position at BL-4C.