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Synchrotrons radiation stability measurement and improvement

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Abstract In the 3rd generation synchrotron light source, beside the orbit, air disturbance and ground vibration also could affect the position stability of photon beam in synchrotrons radiation measurement. In the condition of implementation of orbit feedback system at SSRF, the measured position stability of photon beam in synchrotrons radiation measurement station was presented in this paper. And then the improvement methods of position stability of photon beam were discussed. Finally the measured result was shown when the designed feedback system is implemented to improve the position stability of photon beam.

Key words Synchrotrons radiation measurement, Position sensitive detector

1 Introduction

Beside the beam orbit, ground vibration and temperature-related changes in air density could also affect the position of photon beam in the synchrotron radiation station. The orbit feedback system is used in the SSRF storage ring[1,2] to stabilize the electron beam orbit. However, there are many optical devices on the path from accelerator to the synchrotron radiation station. Any vibration of these devices will affect the photon beam on the target. Due to the above reason, orbit feedback system could not completely solve the position stability problem of photon beam. In this paper, the position stability of photon beam spot was measured in the synchrotrons radiation measurement station (SRMS), and the feedback system is design to improve the position stability.

In general, the mirror is adopted as adjusted device in the photon beam stability system. In order to get a stable photon beam on the final target, the target will trance the photon beam on time through the feed back loop. The experiment result is illustrated in this paper.

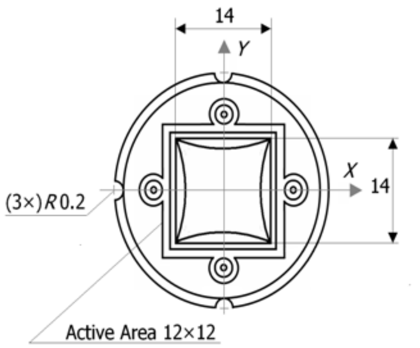

Fig.1 The 2-D position sensitive detector.

2 Measurement of stability on the SRMS

Two-dimensional position sensitive detector (PSD)[3,4] (Fig.1) is applied to measure position of the photon beam in the SRMS. PSD is an optoelectronic position sensor by using photodiode surface resistance to monitor the photon beam position with a resolution of 1 μm in high-speed response.

The beam spot data are measured in the long term and in the short term. The PSD analog outputs signal is sampled by the rate of 10 kHz.

In the short term in 40 seconds, horizontal and vertical position of the photon beam spot is shown in Fig.2a. The spots vibrate around its centre in a range

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of less than ±0.05 μm. In the long term, the 400-s data are shown in Fig.2b.

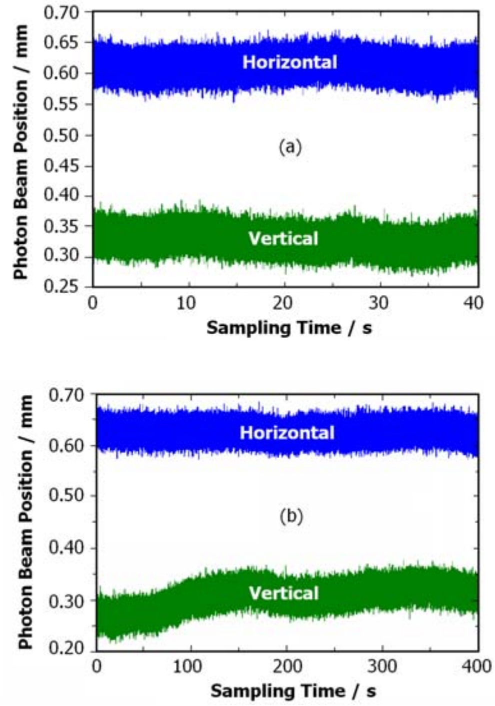

Fig.2 The photon beam position in (a) 40 s and (b) 400 s (before improvement).

3 Feedback system

Figure 3 shows the feedback system for improving the position stability of photon beam. A digital PID controller is applied in the feedback system. The actor of feedback system is the multi-axis piezoelectric platform. The range of piezoelectric platform is 200 μm.

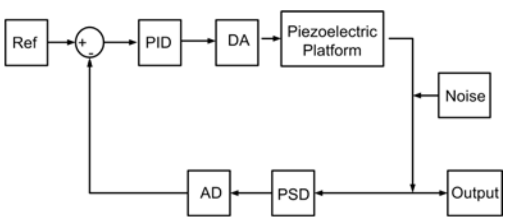

Fig.3 The feedback system diagram.

The A/D and D/A modules work at 10 kHz, and PSD has a –3 dB bandwidth at frequencies of over 100 Hz. The piezoelectric platform can work at frequencies above 20 Hz in either *X* direction or *Y* direction, which measured frequency spectrum, was shown Fig.4. In order to build model in feedback system simulation, the measured spectrum of the piezoelectric platform was fitted into a 2-pole/1-zero system, or a 2-pole/0-zero system.

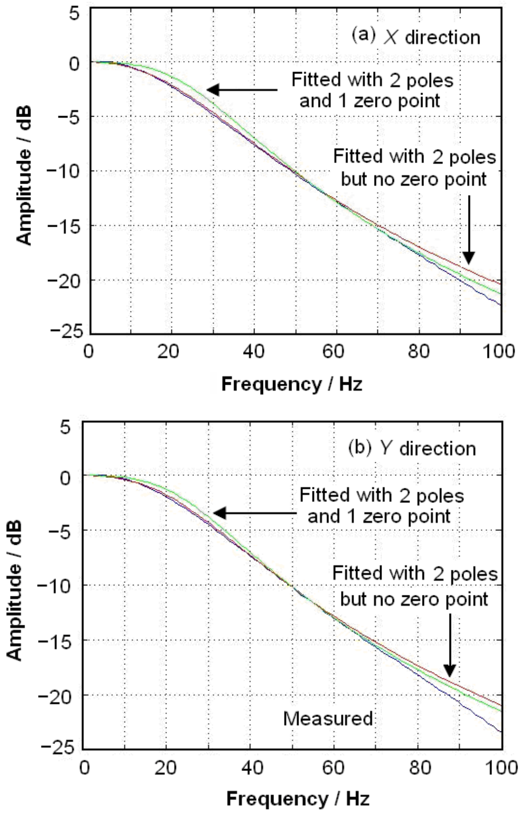

Fig.4 Frequency spectra of multi-axis piezoelectric platform.

The simulated performance of feedback system in MATLab is shown in Fig.5 by applying different digital PID parameters, in which the suitable PID parameters could be found (K=0.04 and a=0.99).

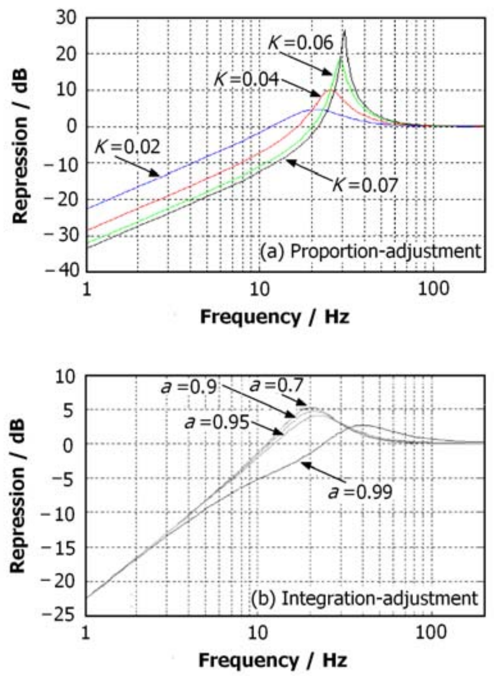

Fig.5 Simulated feedback system performance.

After setting the suitable PID parameters, the measured result by implementing feedback system in the SRMS is shown in Fig.6. By comparing with Fig.2, the position stability of photon beam in low frequency is largely improved.

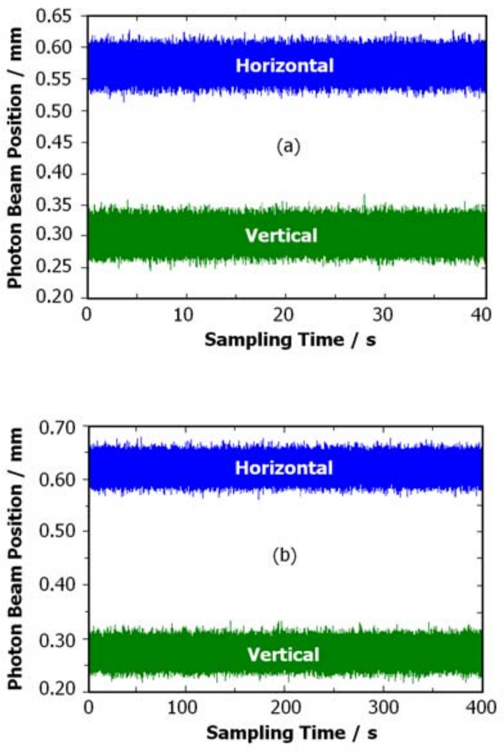

Fig.6 The photon beam position in (a) 40 s and (b) 400 s (After improvement).

4 Conclusion

The feedback system could improve the position stability of photon beam in low frequency. By considering the multi-axis piezoelectric platform's frequency spectrum, it could be reasonably expected that the position disturbance in high frequency could not suppress by the feedback system.

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