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GLOBAL ORBIT FEEDBACK SYSTEM AT THE PHOTON FACTORY STORAGE RING

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Abstract Daily drifting motion of the synchrotron radiation (SR) from the Photon Factory (PF) storage ring under low emittance operation became a serious problem for most users. Horizontal and vertical positions of the SR have been stabilized by a global orbit feedback system.

INTRODUCTION

The synchrotron radiation from a storage ring must be supplied to experimenters with its beam position highly stabilized. Since the low emittance operation of the PF storage ring started, various stored-beam movements, especially daily drifting motion, became very large. As a result, the photon beam also moved with a large amplitude and then its motion became a serious problem for users. The daily drifting motion of the stored beam is closely related to the atmospheric environment around the storage ring building. A study on the causes of the beam movements is now in progress.[1]

In order to suppress the daily drifting motion of the photon beam, a global orbit feedback system has been developed. This system treats the horizontal and vertical motions separately. It has corrected the horizontal motion by compensating the change in circumference of the ring. The compensation is made by varying the RF frequency. The vertical position of photon beam has been stabilized by keeping the stored-beam orbit unchanged from a standard orbit chosen at the beginning of operation. The stored-beam orbit is in turn stabilized by vertical steering magnets installed for this purpose.

HORIZONTAL ORBIT FEEDBACK

A schematical diagram of the global feedback system of horizontal orbit is shown in Figure 1. Horizontal closed-orbit distortion (C.O.D.) is measured every twenty minutes with 45 beam position monitors located around the ring. This system then corrects the difference (Δx_i) between the horizontal C.O.D. and its reference orbit by varying the RF frequency,

$$\frac{\Delta f_{RF}}{f_{RF}} = \alpha \frac{\sum_i \Delta x_i . \eta_i}{\sum_i \eta_i^2} \qquad (i = 1, 2, ..., 45)$$

where η_i is the dispersion function at the i-th position monitor

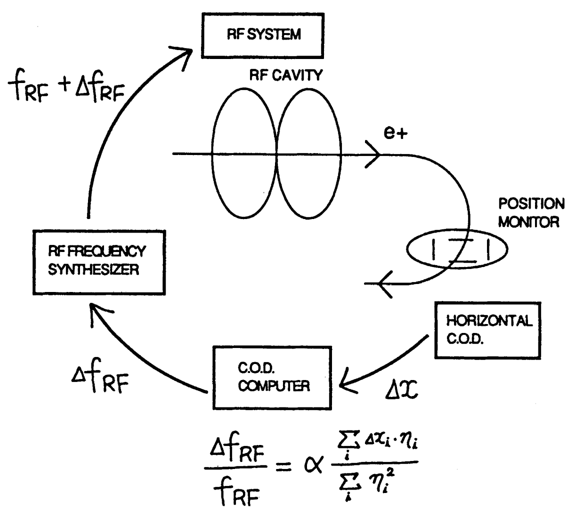

FIGURE 1 A diagram of the global feedback system of horizontal orbit.

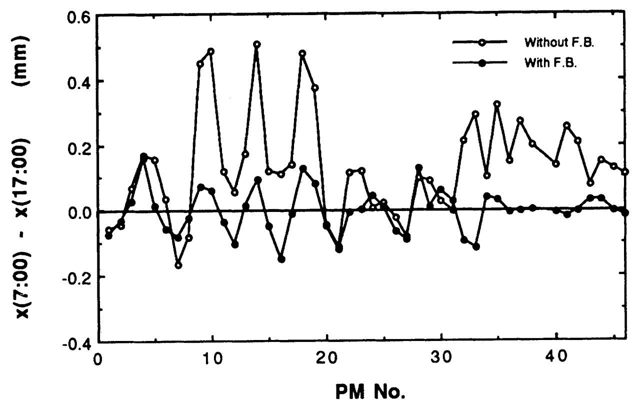

FIGURE 2 Differences of two horizontal C.O.D.'s with and without the global orbit feedback.

and α is the momentum compaction factor.

Figure 2 shows the differences between two horizontal C.O.D.'s measured at 7 o'clock and 17 o'clock in both cases with and without the feedback. Data in both cases are those measured when the daily drifting motion was relatively large. As shown in the figure, the feedback system has reduced the change of the horizontal C.O.D. by a factor of five. In Figure 3, the change in RF

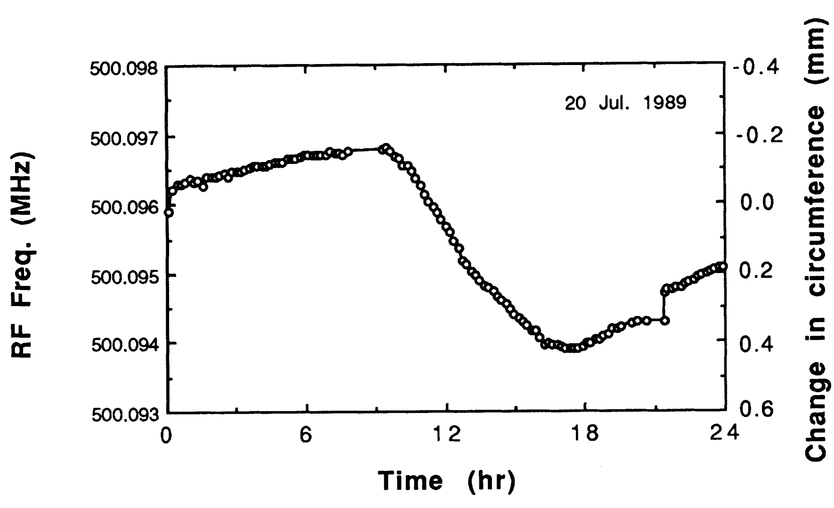

FIGURE 3 The change in RF frequency for one day under the operation of a global orbit feedback system and the corresponding change in circumference of the ring.

frequency for one day under the operation of this feedback system is shown with the corresponding change in circumference of the ring, which was estimated by a relation that $\Delta C/C = -\Delta f_{RF}/f_{RF}$. The RF frequency change has by no means induced any beam instability.

VERTICAL ORBIT FEEDBACK

The global feedback system of vertical orbit consists of vertical photon-beam position monitors, computer control system and steering magnet system. The vertical position of photon beam at Beamline 21 is measured by a wire monitor that detects photo-emission electrons from two tungsten wires. The control computer changes the setting of the currents of twenty steering magnets so as to keep the vertical position at Beamline 21 unchanged. The vertical feedback system is being improved since it was constructed in 1987. Details of this system are described in Ref. 2.

At some experimental beamlines, we have installed several

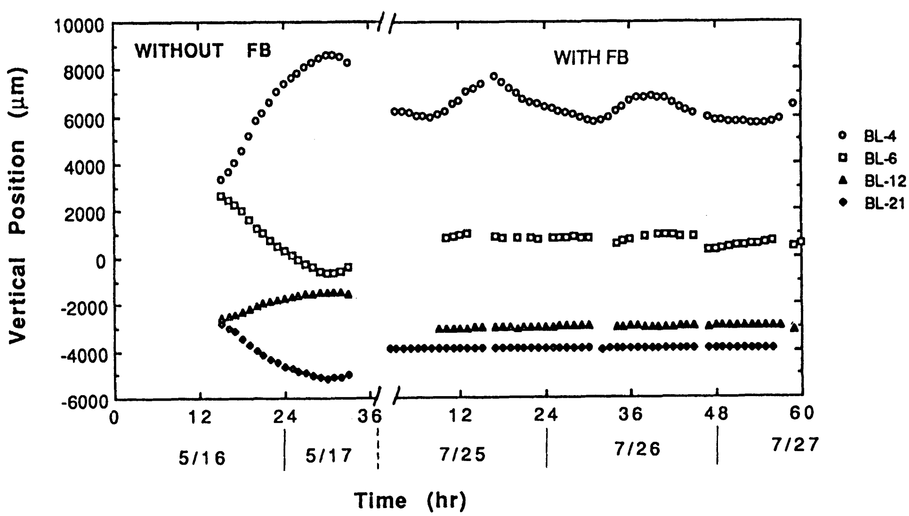

FIGURE 4 The vertical position of the photon beam at several beamlines with and without the global orbit feedback. The vertical position in the figure is in a relative scale.

photon-beam position monitors to measure the vertical beam positions. The variations of the vertical positions at these beamlines with and without the feedback are shown in Figure 4. For example, the vertical position of the photon beam at Beamline 4 drifted about 5 mm between 15 o'clock May 16 and 7 o'clock May 17 when the feedback system was turned off. With the feedback system active, the change of the vertical position was suppressed by a factor of about three.

SUMMARY

Daily drifting motions of SR at the PF storage ring have been reduced by the global orbit feedback system for both horizontal and vertical directions to supply stable SR to the experimenters. We are now planning to directly measure the horizontal position of the photon beam and thereby to make the horizontal photon beam more stable. In order to suppress the fast varying vertical motion of photon beam at each beamline, a feedback system that makes use of a local orbit bump is being tested at several beamlines. This local feedback system together with the global feedback system is expected to stabilize the vertical photon beam position more sufficiently at the beamlines where highly stable photon beams are required.

REFERENCES

1. N. Nakamura et. al, in this conference.
2. T. Katsura, Rev.Sci.Instrum, 60, (1989), to be published.