Survey and alignment of Photon Factory Storage Ring at KEK

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ABSTRACT

The heights of the magnets for both the ring and the beam transport line (BT-line) have been periodically measured at the Photon Factory. The accumulated data showed that the ring was considerably declined due to the construction of the large experimental hall and the tunnel of the TRISTAN project, and that the BT-line also sank several centimeters at some locations. These displacements of the magnets produces a significantly large closed orbit distortion and the vertical dispersion.

(1)Introduction

The Photon Factory Storage Ring has been successfully operated since the end of its construction in 1982. In the early stage of the Ring operation, the constructions of the tunnel and the experimental halls of the TRISTAN project was started. The effects of this constructions are clearly appeared in the data of the displacements of the magnets which has been periodically measured since the construction of the Photon Factory Storage Ring was completed. In this paper, the history of the displacements of the magnets are described. The effect of the displacements on the orbit parameters are also presented.

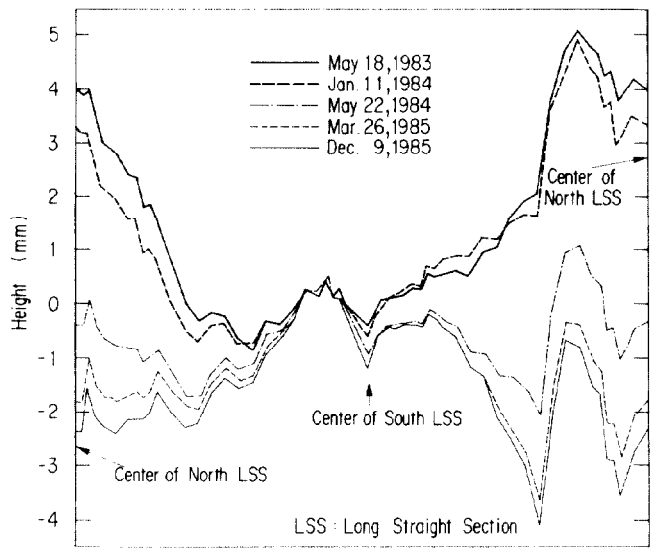

Fig. 1 The variation of the vertical heights of the quadrupole magnets. The unknown absolute heights are properly adjusted to clearly determine the variation.

(2)The History of the displacements of the magnets

The precise alignments of the Ring and of the BT-line were carried out in 1982, six month before the beginning of the Ring operation. During this six month, the displacements of the magnets due to the distortion of the building of the Ring had already observed. They affected on the orbit in the very early stage of the Ring operation as mentioned in the next section.

The displacements of the magnets since 1983 are shown in Fig. 1. During 1983 and 1984, the northern part of the ring rose by several mm against the southern part. In this period, a large amount of soil was excavated to house the experimental hall and the tunnel of the TRISTAN project, which are neighboring to the northern area of the Photon Factory. As a result, the whole building of the Photon

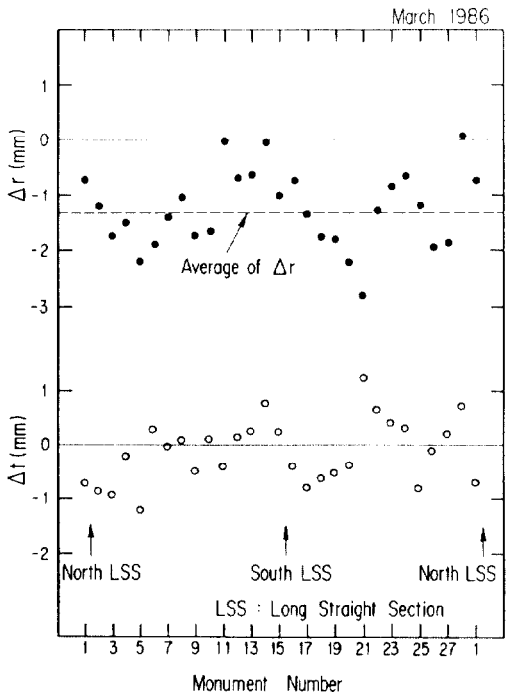

Fig. 2 The horizontal displacements of the ring monuments. The Δr and Δt are the deviations in the transverse direction and in the vertical direction respectively. The average value of Δr is below the design value. This is due to the contraction of the ring caused by the change of the surrounding weather temperature.

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Factory was inclined, as can be seen clearly in Fig. 1. After the construction of the TRISTAN buildings was completed, the Ring began to return to its original upright position. However there still remained the distortions of about ±2 mm.

The horizontal positions of the magnets were surveyed in 1986, for the first time after the construction of the ring. The survey was done by measuring the positions of the monuments which were placed nearby each magnets as primary standards for their alignment. The positions were shifted by about ±1 mm, as shown in Fig. 2.

The BT-line was also sank by several cm during the construction of the tunnel of the TRISTAN project, as shown in Fig. 3. This large sinking has never been restored. This is because there is much less underpinning for the BT-line than for the Ring.

In 1986, the realignments of both the BT-line and the Ring were carried out, accompanied with the modification of the Ring for preparing the new low emittance optics[1].

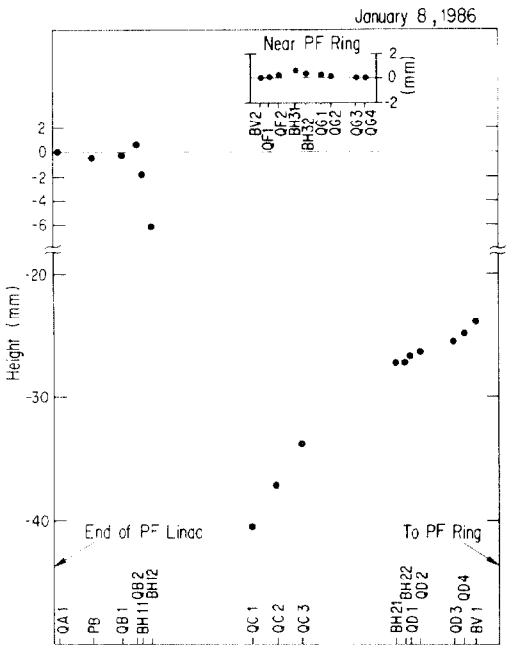

Fig. 3 The vertical heights of the magnets in the beam transport line with their names.

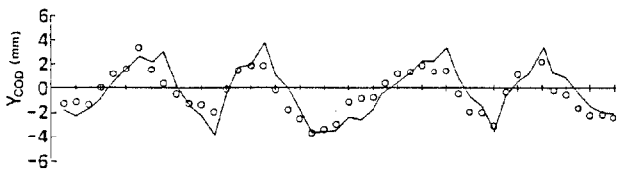

Fig. 4 COD in the vertical direction measured in 1982. The solid line is the results of the simulation by using the measured vertical displacements of the magnets.

(3)The effects on the orbit

In the very early stage of the Ring operation, the positions of the magnets were already shifted as mentioned in the previous section. The closed orbit distortion (COD) in the vertical direction, which is

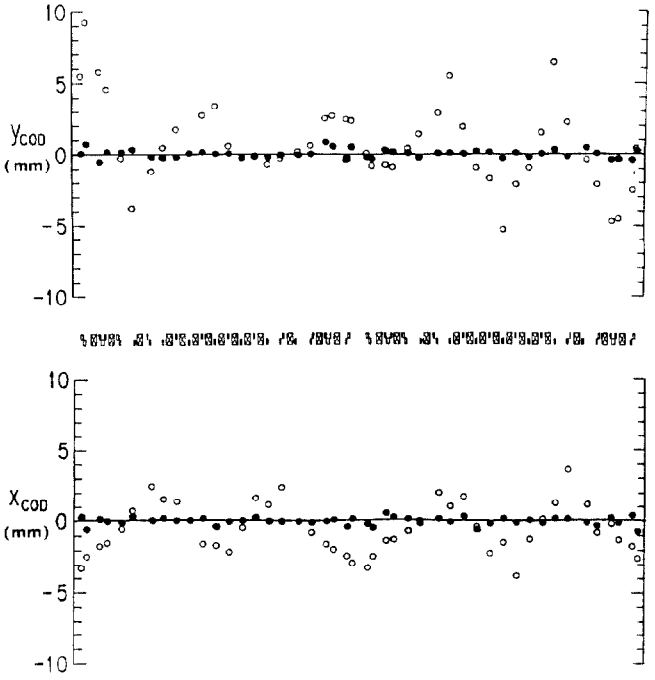

Fig. 5 COD in the old optics, measured in 1986 just after the realignment of the Ring. The open and closed circles are the data before and after the correction respectively.

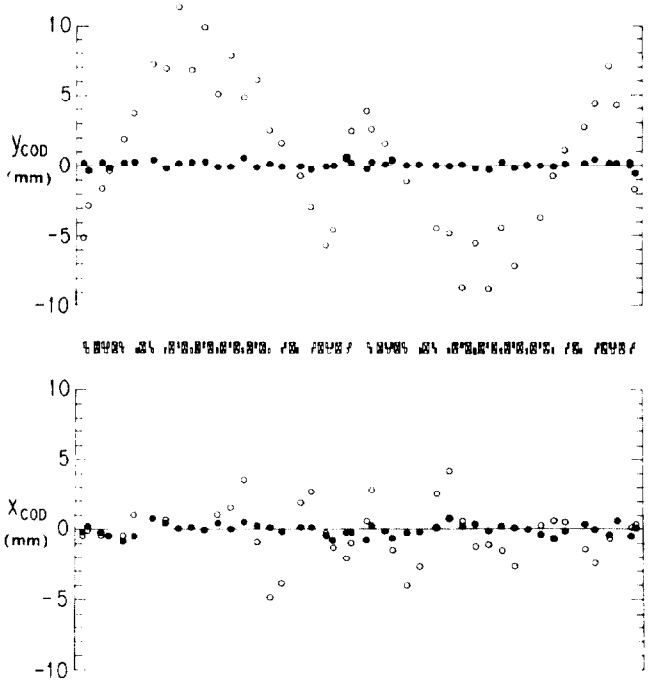

Fig. 6 COD in the new low emittance optics, measured in 1986 after the realignment of the Ring. The open and closed circles are the data before and after the correction respectively.

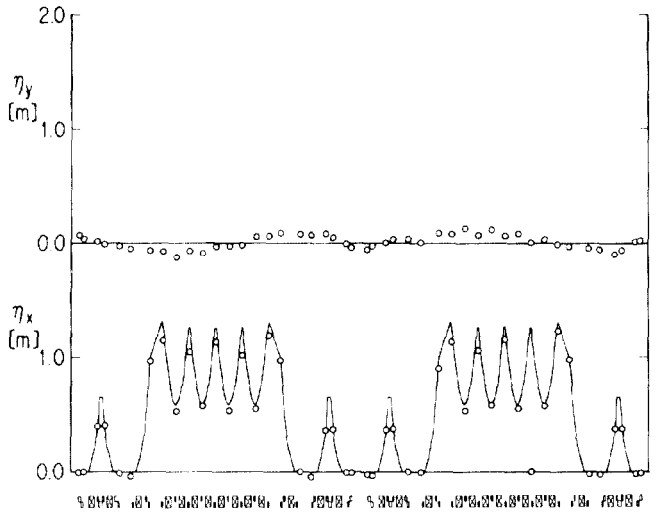

Fig. 7 The dispersion function in the new low emittance optics, measured in 1986 after the realignment of the Ring. The solid lines represent the design value.

measured in 1982, is shown in Fig. 4. The closed orbit is distorted by about ±4 mm. The result of a simulation of COD by using the measured values of the displacements of the magnets shows a fairly good agreement with the measured COD data.

Since the construction of the TRISTAN buildings was started, the COD had become larger and the field strength of the steering magnets had to be increased to correct the COD. In addition, some bumps on the orbit were required to take out the synchrotron light at some beam lines, although the COD was corrected fairly well. This is due to the misalignments between the magnets and the beam lines, which was produced by the distortions of the buildings.

The COD data after the alignments in 1986 are shown in Fig. 5 for the old optics and in Fig. 6 for the new low emittance optics. The values of COD's are somewhat larger than expected. The reason of this is now under investigation.

The dispersion functions are also affected by the displacements of the magnets and the steering magnets which are excited to correct the COD. The dispersion functions are shown in Fig. 6, which is measured in the new low emittance optics after the COD was corrected. The maximum value of dispersion function in the vertical direction is about ±0.1 m.

The displacements of the magnets were considered to produce much larger COD in the new low emittance optics, than in the old optics. The alignments in 1986 were carried out mainly for this reason. As a result, in the first operation of the new low emittance optics, we succeeded to store the beam within only a few hours.

ACKNOWLEDGMENT

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REFERENCE

[1] Y. Kamiya, M. Katoh, I. Honjo, A. Araki and M. Kihara, in these proceedings.