ON THE BEAM OF PHOTON FACTORY STORAGE RING

Y. Kamiya and M. Kihara

Photon Factory,
National Laboratory for High Energy Physics

Abstract

Since the comissioning of the storage ring in February, some of the orbit parameters have been measured, so that they can be compared with the design values. Although preliminary, the results will be reported here.

1. Closed Orbit Distortions

Due to the magnet imperfection and alignment errors, the actual closed orbit should be displaced from the ideal one. The measured orbits show the peak-to peak values of ±6 mm in the horizontal plane and ±4 mm in the vertical plane. These values are well below the expected maximum closed orbit distortions.

The closed orbit has been corrected by means of steering dipoles. Because of unavoidable errors in the readings of position monitors and the current settings of the correctors, the correction should be made iteratively by the method of the least squares. In the computer simulation, we have already known that eight correctors should be adequate in each iteration process, while there are 28 and 42 correctors in the horizontal and vertical planes, respectively. Concludingly, three iterations are sufficient for the correction and the further iteration can not improve the smoothness of the closed orbit. This shows that the correction of the orbit is ultimately limited by the accuracy in the position monitor and the corrector. The resultant distortion of the closed orbit was within ±1 mm and ±0.5 mm in the horizontal and the vertical directions, respectively.

2. Chromaticities

The variation of the betatron tune as a function of energy is called the chromaticity. The central energy of stored electrons can be varied by changing the rf frequency, while keeping the magnetic field constant. Comparison between theoretical and experimental values is seen in the following table.

Natural chromaticity $\xi = \Delta\nu/(\Delta E/E)$

	Experimental	Theoretical
ξ_x	5.0	5.4
ξ_y	-4.7	-6.6

3. Betatron Function

The focusing system of the storage ring consists of twelve families of quadrupole magnets. Each family contains 4 to 8 magnets, and is energized by an independent power supply. The values of betatron functions β_x and β_y at the position of quadrupole magnet can be obtained experimentally by measuring the variation of betatron tunes ν_x or ν_y as changing the current of that quadrupole family. The difference between theoretical and experimental values is typically 10%.

The dispersion function η_x was experimentally obtained by measuring the variation of closed orbit as changing the rf frequency. The discrepancy between theoretical and experimental values is also less than 10%.

4. Resonances

Although the systematic investigation of the resonances has not yet been performed, we have observed the linear coupling resonances at $\nu_x = \nu_y$ and the third order resonance at $\nu_y = 4.33$. At $\nu_x = \nu_y$ the beam became round but stable, as expected. At $\nu_y = 4.33$ the beam became unstable.

5. Current Dependent Phenomena

We have observed the tune shift and the tune spread depending on the stored current. The tunes in both directions were shifted to higher values with increasing current, which suggests that positive ions are trapped in the path of the electron beam and act as the focusing force onto electrons.

Beam blow-up phenomena have been observed in the horizontal plane during injection. At a certain current value, the beam begins to blow-up suddenly and be lost. It depends on the betatron tune and can be avoided by shifting the horizontal tune to higher values.