LIGHT SOURCE

Longitudinal Active Damper for Storage Ring

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A longitudinal coupled-bunch instability had already observed when the routine operation of the UVSOR storage ring was started. It was also found that a coupling element of the instability was the RF acceleration cavity. Two methods to cure this kind of instability have been reported : damping of cavity higher-order-mode resonances and a feedback method. It is difficult for us to adopt the former because there is no port for antennas of the higher-order-mode damper in the cavity. Therefore, we installed a feedback system which is called the longitudinal active damper. The blockdiagram of the feedback system is shown in Fig. 1. A signal from a button monitor is distributed to 16 channels with a gate circuit in order that a signal in a channel corresponds to a certain bunch. The phase oscillation of the bunch is detected by means of a DBM and an active bandpass filters. After the phase of the signal is shifted to indicate the energy deviation of the bunch, it is gated not to affect other bunch. These 16 signals are combined again and modulate the RF signal from the acceleration cavity. The phase oscillation of each bunch is corrected through a wideband acceleration gap. The phase oscillations without and with the feedback system at the beam current of 100 mA in the full bunch mode are shown in Fig. 2. A signal from a button monitor was displayed on a oscilloscope triggered by a signal synchronized to a certain bucket. The oscillogram is widened by the phase oscillation : the width of the trace corresponds to the double of the amplitude of the oscillation. The instability of which amplitude was about 400 ps (Fig. 2a) was completely suppressed with this system (Fig. 2b).

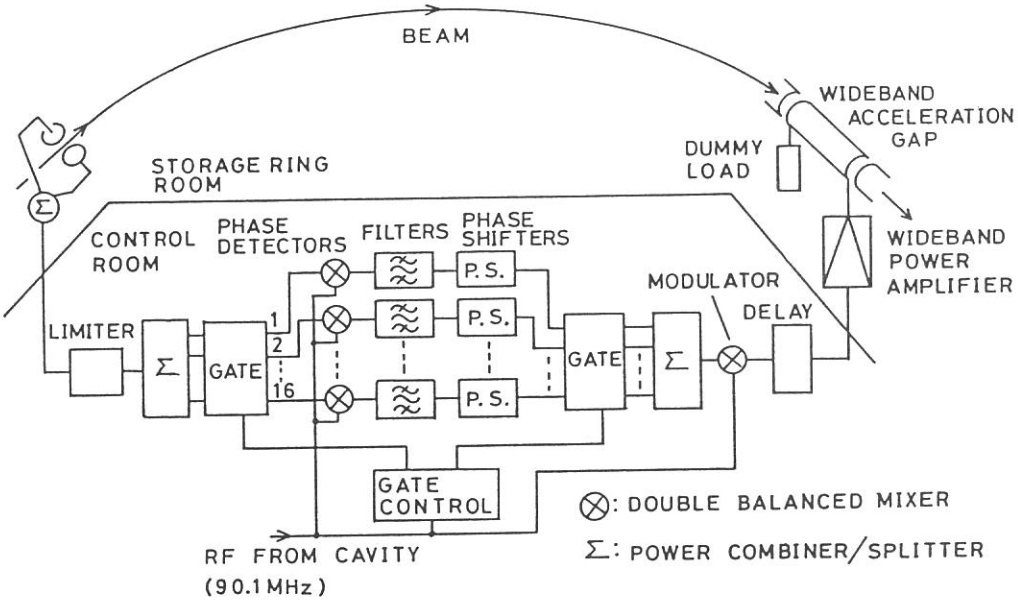
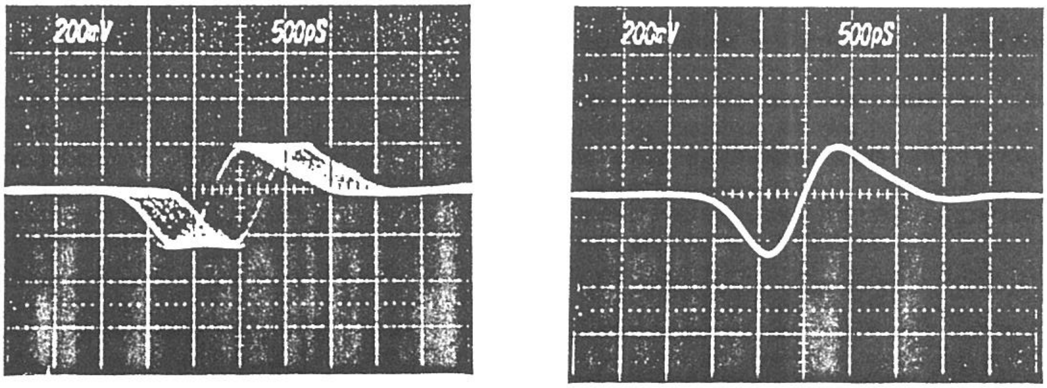


Fig. 1 Block-diagram of feedback system.



a

b

Fig. 2 Phase oscillation. (a) Feedback off, (b) feedback on.

TUNE SHIFT DUE TO UVSOR UNDULATOR

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Undulators have been installed in many electron storage ring in order to provide high brilliance, tunable, quasi-monochromatic synchrotron radiation. In the UVSOR, there are two undulators, one of them is used for the fundamental study of free-electron laser (FEL) and the other supplies the users with the radiation. We studied the insertion effect of the undulator for the FEL on the horizontal and vertical tune shifts.

Considering tune shifts due to field error of the undulator magnet, we estimated not only a quadratic term of the magnetic field 1) but also radial displacement errors of the magnetic center 2). The horizontal and vertical tune shifts, ΔQ_h and ΔQ_v, can be written as

$$\Delta Q_h = \frac{-1}{4\pi}\left(\frac{0.3}{E}\right)^2 \langle\beta_h\rangle \frac{aB_0^2 L}{q^2} + \frac{1}{2\pi}\left(\frac{0.3}{E}\right)\langle\beta_h\rangle aB_0 \langle\varepsilon \sin(qs)\rangle L \qquad (1)$$

and

$$\Delta Q_v = \frac{1}{4\pi}\langle\beta_v\rangle\left(\frac{0.3}{E}\right)^2 \frac{B_0^2 L}{2} - \frac{\langle\beta_v\rangle}{\langle\beta h\rangle}\Delta Q_h \qquad (2)$$

$$(q = 2\pi/\lambda_0)$$

where E is the electron energy in GeV, β_h and β_v the horizontal and vertical betatron functions, B_0 the peak field, a the coefficient of the quadratic term, L the undulator length, ε the horizontal displacement of the magnetic center from the undulator axis, s the distance along the beam axis, and λ_0 the complete period of the undulator. Measurements of the magnetic field yield the quadratic term a of 54 m^{-2} and the average value $\langle\varepsilon \sin(qs)\rangle$ of 1.54×10^{-4} m. The contribution of the second term in eq. (1), which is reduced from the displacement errors of the magnetic center, is found to be larger by about one order of magnitude than the first. The undulator field and the beam-energy dependences of the actual tune shifts are shown in Figs. 1 and 2 with the calculated values as described above. These values are in good agreement with each other and we conclude that the tune shifts by the undulator originate mainly in the small displacement of the magnetic center of magnet blocks in the radial direction.

References
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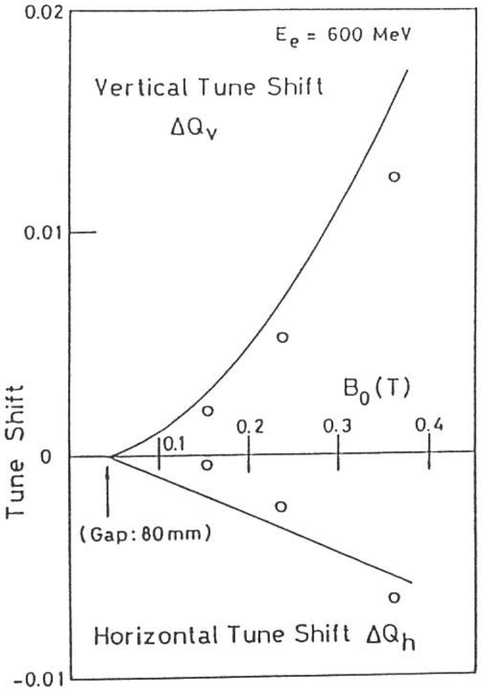

Fig. 1. Undulator field dependence of the tune shifts at an electron energy of 600 MeV. Solid lines show the calculated values as a function of the peak magnetic field B_0 (in T) of an UVSOR undulator. Circles show measured values. These values are obtained by subtracting the tune values at an undulator gap of 80 mm with those at every gap. An arrow shows the magnetic field corresponding to the undulator gap of 80 mm.

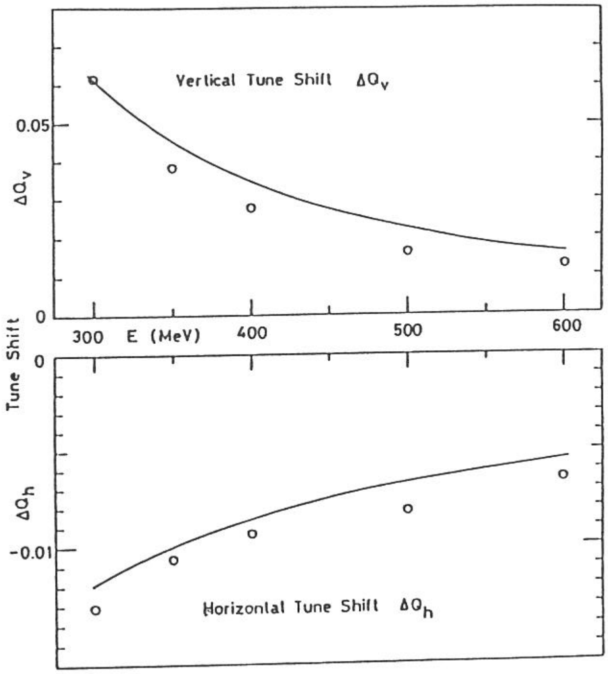

Fig. 2. Beam-energy dependence of the tune shifts at a peak magnet of 0.361 T. Solid lines show the calculated and circles the measured tune shift values.