ACTIVE DAMPER IN KEK BOOSTER

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1. Introduction

An active damper system was developed in KEK booster and operated with success to suppress the beam losses induced by a coherent transverse instability[1] at about 17 msec after beam injection. Usually the damper system is composed in such a way that a position signal is amplified and feedbacked within one revolution. It requires a precise and complicated delay circuit. In KEK booster a slightly different method was employed. Previously we have observed in the RF knockout study[2] that the circulating beam resonates at the frequency $f = (I \pm \eta)f_0$ where I is integer, η the decimal part of the value and f_0 circulating frequency. A reverse process was applied to the damper with the lowest resonant mode whose wave was obtained from the coherent oscillation of the circulating beam through a low pass filter (see Fig.1).

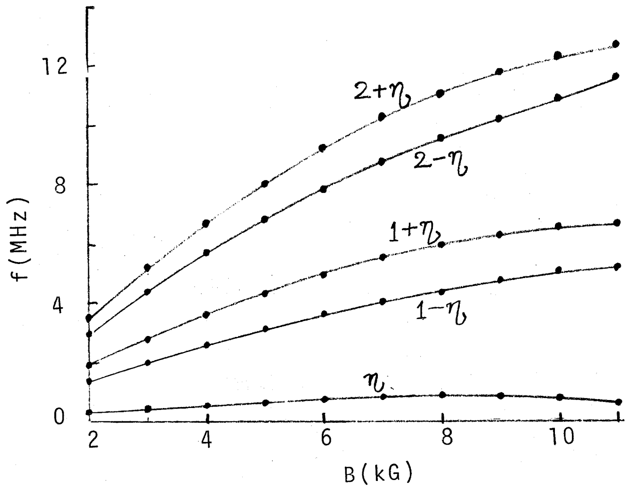

Fig.1 Resonant frequency $f = (1 + \eta)f_0$ of various modes.

The signal was amplified and applied to an electrode in the booster ring. The phase was shifted so as to decrease the coherent oscillation most effectively. Since the wave frequency changes in the range 270 ∿ 810 kHz during the acceleration, an automatic phase shift controller is required for complete operation and now under construction.

2. Damper System

Figure 2 shows the block diagram of the damper system. A position monitor detects the coherent betatron oscillation and converts the beam position to electric signal with a sensitivity about 5 mV per 1 mm oscillation amplitude. The differential amplifier is sensitive down to 0.5 mV. The low pass filter passes the lowest mode but rejects the higher modes. The phase shifter is tentatively composed of four CR circuits and a vector sum circuit. The phase of the wave was adjusted so as to match and damp the coherent oscillation. Without an automatic phase controller the correct phase relation

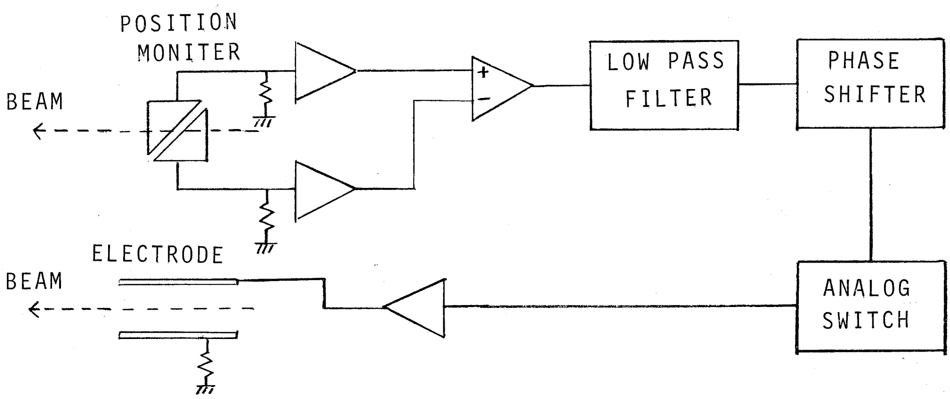

Fig.2 Block diagram of damper system.

could be kept only within a limited time. For the present time the feedback time is confined to the instability region with a use of an analog switch. The phase shifted wave was amplified up to ±200 V and applied to an electrode 50 cm long and 12 cm gapped. The over all loop gain is 90 dB and the kick angle of the deflector is 1.2×10^{-6} radian per 1 mm oscillation amplitude.

3. Results

The damper suppressed the beam loss as shown in Fig.3 but did not completely the coherent oscillation, which is due to the break of the correct phase relation accompanied by the change of the oscillation frequency. It seems necessary to keep the correct phase relation within $\sim$20°.

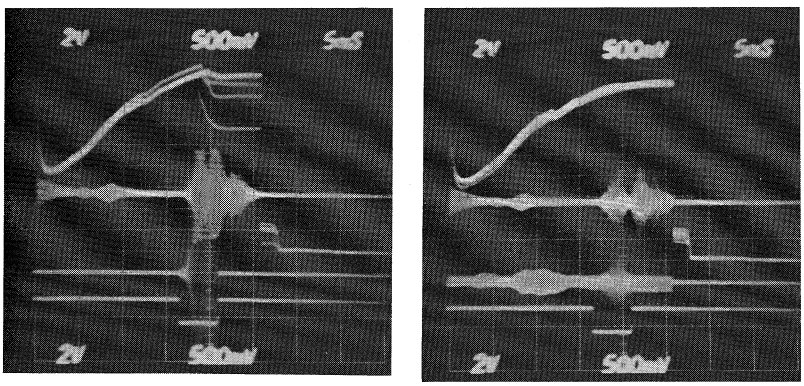

Fig.3 left: Damper OFF, right: Damper ON
top: Beam current, 2nd: Beam position
3rd: Phase shifter output, bottom: Gate
(Five events were overlapped.)

References

1) Y. Kimura et al: submitted to the International Conference on High Energy Accelerators, Serpukhov, 11-17 July 1977.
2) Y. Miyahara et al: KEK 76-16 (1977).