CORRECTION OF CLOSED ORBIT DISTORTION BY BACKLEG WINDING OF MAIN RING MAGNET IN KEK-PS

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1. Introduction

The closed orbit distortion(COD) is induced by the error field and misalignment of magnet along the ideal orbit. In the KEK 12 GeV PS, the COD of about 11 mm in the horizontal plane arise from these errors in 48 bending magnets and 56 quadrupole at injection field, which is playing a major role in process of beam loss at injection porch. About 6 mm in the COD are due to the random fluctuation(σ=0.064%) of $\int Bdl$ in bending magnets. We,then,corrected the error field of each magnet by using backleg coil,and improved the beam loss.

2. Closed orbit distortion and its correction

When error dipole field($\Delta B(\psi_j)$) is only present at the position(ψ_j), the displacement($y(\phi_k)$) of the orbit at position (ϕ_k) is given by [1)]

$$y(\phi_k)=\sum_{j=1}^{N} A_{kj}\cdot D_j \qquad (1)$$

$$D_j=\Delta B(\psi_j)l/(B\rho) \qquad (2)$$

$$A_{kj}=\frac{\sqrt{\beta_j\beta_k}}{2\sin(\pi\nu)}\cos\nu(\pi-|\phi_k-\psi_j|) \qquad (3)$$

,where D_j is deflection angle due to jth error field, the number of betatron oscillations per revolution and β_j and β_k is betatron function at position ψ_j and at position ϕ_k, respectivery. From eq.1, if all of the error field are corrected to zero, the displacement can be zero at any position along the ideal orbit. The purpose of backleg coil is to correct the error field of each magnet.

3. System layout

The schematic relation of this backleg correction system is shown in fig.1. This system consists of the following three parts:

1) Coil system in main ring
2) Digital programable bipolar constant current power supply(DPPS)
3) Interface for computer control

The coil system is made of backleg coil and its backing coil which are wound by 3 turns around the return yoke of bending magnet with couper conductor of 2 mmϕ shielded by polyethylene. In order to reduce the load of DPPS, both coil systems were couplied by transformer out phase. The 48 backleg coil systems are combined by 22 mm^2 twisted pair cable to 48 DPPS in M1 service house,respectivery. The DPPS supplies DC current with the current resolution of 10 mA to backleg coil to keep the COD within 1 mm. The maximum current of 10 A creates the maximum correction-field of 6.75 Gauss, whose field strength corresponds to 0.47% of injection field of 1440 Gauss. To provide the orbit correction from control room, the DPPS is combined to satellite computer in M2 service house. The data of correction current are transfered through the DMA channel of accelerator control computer(ACC) and stored in D/I memory of the interface. One data is composed of 16 bits. 1~10th bit are used for correction data and 11th bit for polarity. The stored data are serially transfered to each DPPS. Excitation current of the backleg coil is monitored periodically(~10 min) with digital voltmeter(DVM). Its scanning time per one channel is about 1 sec. The monitored current is stored in D/O memory and read out to ACC through the DMA channel.

4. Results

Figure 2 shows output voltage of slow intensity monitor before and after the correction of $\int Bdl$. After correction, it finds out that fast decay in beam intensity is decreased, and the accumulation-efficiency is improved about 10~20%.

Reference

1) A. Ando and K. Endo, KEK-75-4(1975)

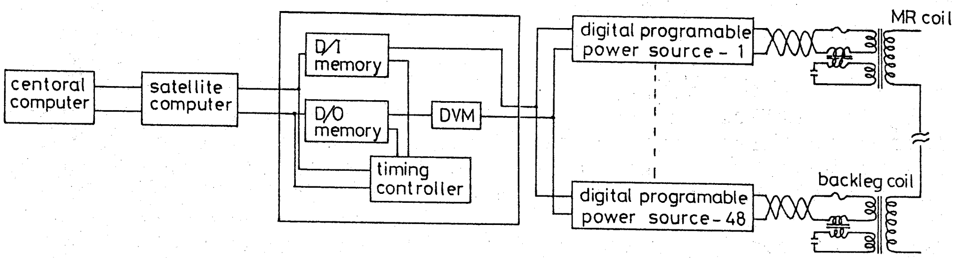

Fig.1 Schematic diagram of backleg correction system

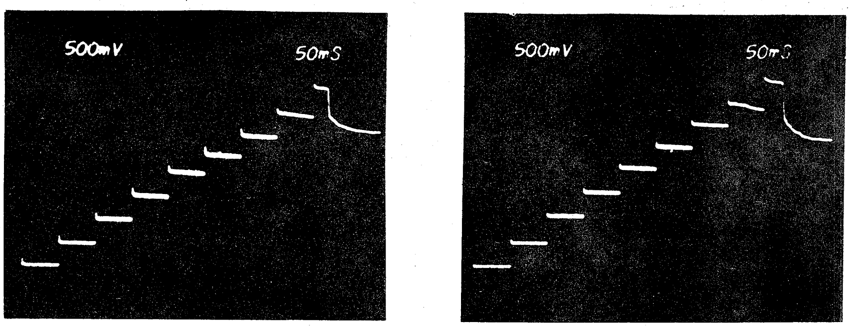

Fig.2 left: before correction, right: after correction