C.O.D. CORRECTION FOR POLARIZED PROTON ACCELERATION

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The major problem is the resonant depolarization due to the betatron oscillation and closed orbit distortion (C.O.D.) in order to accelerate the polarized proton beam by synchrotron. For the strong focusing synchrotron as KEK P.S., different types of strong depolarizing resonances must be crossed during accelerating cycle. The control system of C.O.D. to reduce the depolarization and the results of simulation for C.O.D. control are described in this report.

A particle may be in the effective horizontal field component which causes a vertical closed orbit distortion. These will come from the quadrupole magnets and the horizontal error fields. Imperfection depolarizing resonances due to these horizontal field components occur at $\gamma G = n$, where n is an integer. The strength of a particular imperfection resonance will depend on the harmonic component k near ν_V. The properties of the various imperfection resonances of KEK P.S. have been calculated by Hiramatsu.[1] Several strong depolarizations which must be corrected are existing.

At present we have a closed orbit control system for injection porch for 12 GeV P.S..[2] Thus the correction dipoles and power supplies may be still used. The control system is as follows, maximum exciting current: 3.0 A, mximum field: 293 G, maximum kick angle: 1.62 mrad at injection energy, power supply: $\pm$35 V and $\pm$3 A. Improved control system is composed of a master controller in the center control room, four slave controllers in each four auxiliary rooms, and the B clock timing generator. The block diagram of control system is shown in Fig. 1. The master controller has next functions, 1) CRT display and print out of output current data and sampling data, 2) data read from paper tape and data input from key board, 3) transfer of the output current data to slave controllers, 4) receiving the sampling current data from slave controllers. Slave controllers have next functions, 1) receiving the output current data from master controller, 2) transfer of the sampling current data to master controller, 3) output and sampling of the current data syncronized with B clock timing. B clock generator has next functions, 1) counting the signal (1 pulse/1 G) from the main ring field monitor, 2) generating 24 B clock timing pulses corresponding to each resonance. Data which is read by PTR are marked of Q-magnet location number and resonance timing, and are memorized on th RAM of master controller. Data modified by an operator from key board are transfered to slave controllers and memorized on the RAM's of slave controllers. Each slave controller controls the correction dipole magnets synchronized with B clock timing. Master controller, slave controllers and B clock generator are initialized at the start of main ring cycle. The timing chart of control system is shown in Fig. 2.

Simulation of the depolarization due to C.O.D. was performed for the KEK 12 GeV P.S.. C.O.D. was calculated from random error field and expanded in Fourier series, then an effective harmonics was eliminated. An imperfection resonance was calculated using this C.O.D. amplitude. The result is shown in Table 1 for $\nu_H = 7.25$ and $\nu_V = 6.25$. The 6th harmonic of C.O.D. is effective to the depolarizing resonance at $\gamma G = 22$ and the depolarization is reduced by eliminating the 6th harmonic. The similar calculation using the measured C.O.D. at injection porch was performed. The results are shown in Table 2. The depolarization by imperfection resonance without operating the correction dipoles are reduced by operating the correction dipoles to eliminate the error fields. The present correction magnet has the maximum kick angle of 1.62 mrad at injection porch (1.1 GeV/c), so an ability of correction 0.16 mrad at 10 GeV/c can be expected. From above concideration, it is satisfactory to correct C.O.D. from injection to 10 GeV using the present correction dipole system under the improved control system.

References

1) S. Hiramatsu et al.: Proc. of 5th Int. Symp. on High Energy Spin Phys., BNL, 1982. (KEK Preprint 82-11)
2) K. Endo and A. Ando, IEEE Trans. Nucl. Sci. NS-26, 3328 (1979).

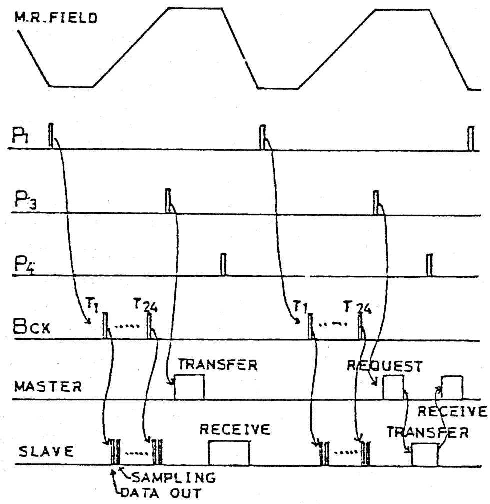


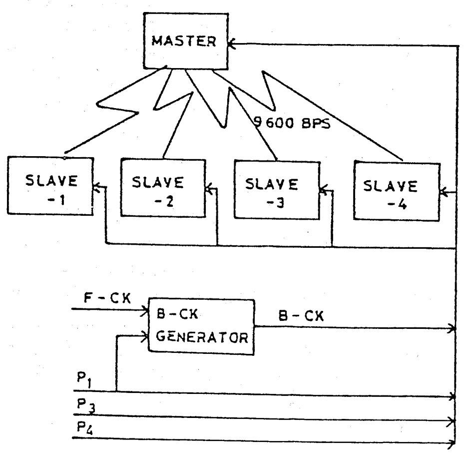
Fig. 2

GAMMA*G	T(GEV)	(P/P_0)	(P/P_0)
10	4.295	0.9992	0.9994
11	4.819	0.9988	0.9988
12	5.342	0.9990	0.9990
13	5.865	0.9994	0.9994
14	6.389	0.9912	0.9955
15	6.912	0.9969	0.9969
16	7.435	0.9998	0.9998
17	7.959	0.9961	0.9961
18	8.482	0.9785	1.0000
19	9.006	0.9991	0.9991
20	9.529	0.9996	0.9996
21	10.052	0.9957	0.9957
22	10.576	0.8240	0.9992
23	11.099	0.9864	0.9864
24	11.622	0.9985	0.9985
	Z_{rms} =	1.00mm	0.24mm
	Z_{6th} =	0.62	0.21

Table 1

GAMMA*G	T(GEV)	(P/P_0)	(P/P_0)
10	4.295	0.9844	0.9979
11	4.819	0.9978	0.9992
12	5.342	0.9959	0.9997
13	5.865	0.9992	0.9990
14	6.389	0.9184	0.9922
15	6.912	0.9961	0.9980
16	7.435	0.9665	0.9902
17	7.959	0.9976	0.9990
18	8.482	0.9897	0.9905
19	9.006	0.9769	0.9987
20	9.529	0.9482	0.9983
21	10.052	0.9932	0.9923
22	10.576	0.8172	0.9459
23	11.099	0.9937	0.9956
24	11.622	0.9934	0.9909
	Z_{rms} =	2.61 mm	0.35 mm
	Z_{6th} =	0.91	0.24

Table 2



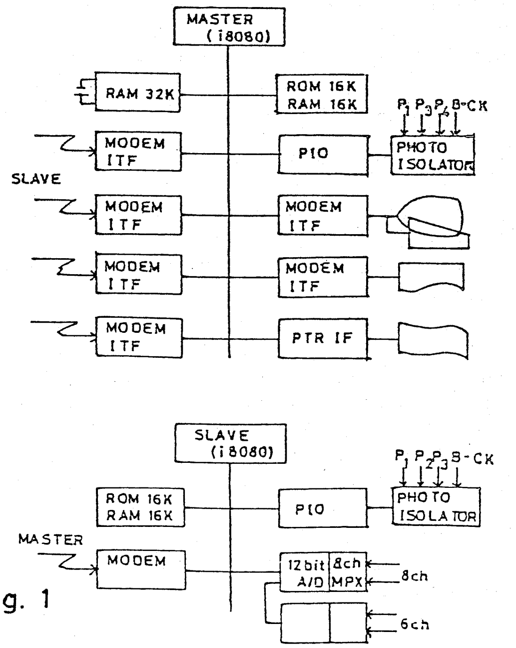


Fig. 1