PROJECT OF POLARIZED PROTON ACCELERATION IN KEK PS

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Abstract

The project of polarized proton acceleration in KEK PS is described. The depolarizations due to depolarizing resonance in 500 MeV booster and 12 GeV main ring have been estimated and the resonance crossing has been investigated. The improvement of the control system for the closed orbit is in progress to suppress the imperfection resonance and the polarimeters are under construction.

Acceleration of polarized protons in booster

The polarization of polarized beam in the accelerator is depolarized passing through the depolarizing resonance. The strong resonances are the intrinsic resonance and the imperfection one. In the booster there are one intrinsic resonance at $\gamma G = \nu_z$ ($G = g/2-1$) and one imperfection one at $\gamma G = 2$.[1] Fig. 1 shows the resonance strength ε of depolarizing resonances. In this calculation vertical emittance of the beam is assumed to be 49π mm mrad at injection energy and $\nu_z = 2.25$. The intrinsic resonance is so strong that the spin will be almost completely flipped passing through the resonance. The beam polarization averaged over the betatron oscillation amplitude is expected to be $(P/P_0) = -0.97$ after passing through the resonance for the uniform distribution in phase space and the initial polarization of P_0. The strength of imperfection resonance is also shown in Fig. 1 for the vertical COD's of 1 mm (rms) and 5 mm (rms) respectively. The large depolarization is expected even if COD is corrected to less than 1 mm. On the other hand spin-flip seems to be feasible for the imperfection resonance if COD is larger than 5 mm. So the dipole magnet with the maximum $B\ell = 4.4$ KG cm will be installed in the booster to produce the maximum vertical COD of 7 mm (rms). As the first step we will try the first acceleration test in the booster in 1983.

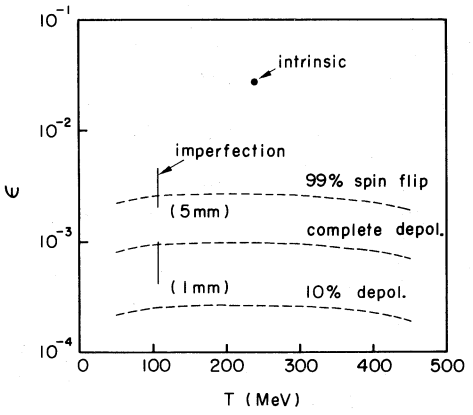

Fig. 1 Strength of depolarizing resonances in the booster.

Acceleration of polarized protons in main ring

During acceleration from 500 MeV to 12 GeV in the main ring, we have to pass through 11 intrinsic resonances for $\nu_z = 7.25$ and 22 imperfection ones.[1] Table 1 shows the beam polarization averaged over the betatron oscillation amplitude for the intrinsic resonances,[2] in which the vertical emittance is assumed to be 20π mm mrad at 500 MeV. $(P/P_0)_1$ is the expected beam polarization for the uniform distribution in phase space and $(P/P_0)_2$ is for the quadrutic one. It is expected that 7 strong resonances can be passed through by spin-

flip in the normal operation condition. On the other hand there is significant depolarization in passing through 4 "weak" resonances. The depolarization by these weak resonances can be reduced by the method of rapidly changing ν_z (tune jump). A prototype of the pulsed quadrupole magnet for tune jump has been constructed. In our present plan the rise time of the quadrupole is 40 - 200 μsec and the maximum change of ν_z is $\Delta\nu_z \sim 0.2$. Fig. 2 shows the resonance strength of intrinsic resonances and imperfection ones. In the calculation of imperfection resonance the vertical COD is assumed to be 1 mm (rms). It seems that we have no serious problem of the depolarization up to 10 GeV ($\gamma G = 21$) for imperfection resonance. The depolarization at $\gamma G = 21$ can be suppressed by reducing the seventh harmonic of COD.[3] In order to correct the COD during acceleration, the improvement of the control system of the correction dipole magnets is in progress. The acceleration test in the main ring is planned after the long shutdown scheduled for the construction of TRISTAN tunnel.

Table 1

γG	$(P/P_0)_1$	$(P/P_0)_2$
$-4 + \nu_z$	-0.37	-0.09
$12 - \nu_z$	0.57	0.70
ν_z	-0.99	-0.98
$16 - \nu_z$	0.32	0.51
$4 + \nu_z$	-0.96	-0.92
$20 - \nu_z$	0.26	0.47
$8 + \nu_z$	-0.97	-0.93
$24 - \nu_z$	-1.0	-1.0
$12 + \nu_z$	-0.98	-0.96
$28 - \nu_z$	-1.0	-0.995
$16 + \nu_z$	-0.99	-0.98

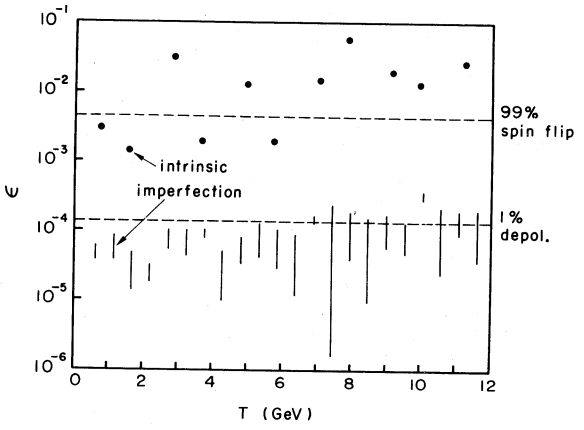

Fig. 2 Strength of depolarizing resonances in the main ring.

Polarimeter

A 500 MeV polarimeter will be used to measure the beam polarization extracted from the booster. This polarimeter detects the recoil proton in p-p elastic scattering using a polyethylene target.

The main ring polarimeter which will be installed in the main ring is planned to measure the absolute polarization from 500 MeV to 7 GeV. The present plan is to put the polarimeter at the II-2F long straight section with the moving string target of polyethylene. The scattered and recoil protons from p-p elastic scattering are detected in the coincidence method. Above 7 GeV we need the absolute polarimeter which will be installed in the extracted beam line but we have not yet the schedule for the construction of this polarimeter.

References

1) S. Hiramatsu et al.: Proc. of 5-th Int. Symp. on High Energy Spin Phys., BNL, 1982. (KEK Preprint 82-11)
2) T.K. Khoe: KEK Report, KEK-81-15, 1981.
3) H. Sato et al.: contribution to this conference.