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8.38 POLARIZED PROTON ACCELERATION AT KEK BOOSTER SYNCHROTRON

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Depolarization of the polarized proton beam accelerated in the 500 MeV booster synchrotron was investigated as the first step of polarized proton acceleration program at the KEK proton synchrotron (PS) in 1983[1]. The polarized H^- beam is produced in the high current polarized H^- ion source by a charge-exchange reaction with Na vapor which is optically pumped by dye lasers[2]. The polarized H^- beam at 20 MeV from the linac is converted to the polarized proton beam by a charge-exchange injection in the booster. This beam is accelerated up to 500 MeV and then transferred into the main ring. The beam polarization is measured at 20 MeV in the beam transport line from the linac to the booster and at 500 MeV in the main ring[3]. After the first acceleration test, PS was shutdown from March 1984 to May 1985 for the construction of e^+-e^- collider. The next acceleration test will begin from June 1985.

Beam polarization is depolarized during acceleration in a synchrotron by crossing depolarizing resonances. In the booster of KEK PS, two strong depolarizing resonances, one intrinsic resonance ($\gamma G = \nu_z$) at about 260 MeV and one imperfection resonance ($\gamma G = 2$) at 108 MeV, are crossed. Depolarization by crossing these resonances is expected to be small because the beam polarization flips its direction (spin-flip) and its absolute value is almost kept by crossing a strong depolarizing resonance[4]. In crossing a resonance by spin-flip, synchrotron oscillation depolarizes the beam polarization. It is necessary to make the accelerating rf voltage as small as possible in order to reduce the depolarization.

The accelerating rf voltage of the booster in the acceleration test of polarized protons was reduced to 9 - 10 kV which is 1/2 - 1/3 of the rf voltage in the usual operation. The polarization of the booster beam almost completely depolarized at the rf voltage of $\sim$ 20 kV. The measured beam polarizations in this acceleration test at 20 MeV and 500 MeV were

$$\text{LINAC} \quad P(\text{LINAC, 20 MeV}) = 47 \pm 6 - 56 \pm 8\ \% ,$$
$$\text{MR} \quad P(\text{MR, 500 MeV}) = 12 \pm 2 - 15 \pm 2\ \% .$$

About 25 % of the linac beam polarization was kept at 500 MeV.

In order to investigate the strength of the imperfection resonance, the dependence of the beam polarization on the vertical closed orbit (COD) was measured by exciting the vertical deflection magnet. Figure 1 shows the beam polarization at 500 MeV for various excitation currents of the deflection magnet. The beam polarization was negative at the excitation current of + 69 A and was kept in positive value for the reversed excitation of the magnet. On the other hand the beam polarization after crossing the intrinsic resonance depends on the amplitude of betatron oscillation. Figure 2 is the beam polarization at 500 MeV for the various vertical beam sizes. Beam polarization was kept in positive value for the large amplitude of betatron oscillation and was depolarized for the small amplitude. It is expected from these results that two strong depolarizing resonances would be crossed by spin-flip with small depolarization. However the large depolarization was observed at 500 MeV. In order to investigate the depolarization by other depolarizing resonances in the booster, the vertical betatron tune ν_z was changed in the energy range above $\sim$ 250 MeV. The polarization increased to $\sim$ 1.5 times and $\sim$ 40 % of the linac beam polarization was kept at 500 MeV for $\sim$ 0.01 increase of ν_z near the top energy. It is ex-

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pected from this result that the large depolarization in the booster would be due to the weak resonance of $\gamma G = 5 - \nu_z$ at $\sim$ 450 MeV.

For the next acceleration test in 1985, two pulsed quadrupole magnets for the "tune jump" was installed in the booster to avoid depolarization by weak depolarizing resonances. The rf knock-out system was also installed to increase the amplitude of the vertical betatron oscillation in order to investigate the completeness of spin-flip in crossing the $\gamma G = \nu_z$ resonance.

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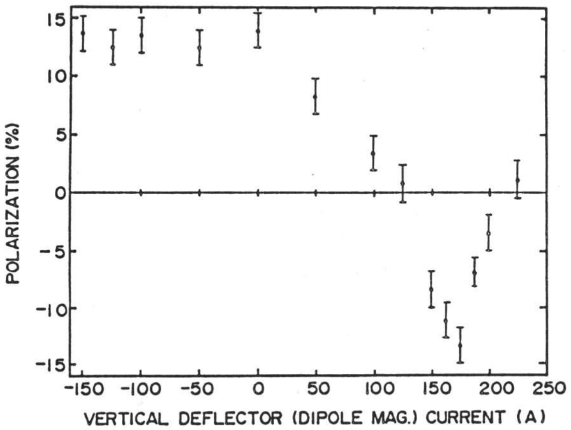

Fig. 1 Dependence of beam polarization at 500 MeV on the excitation current of the vertical deflection magnet in the booster.

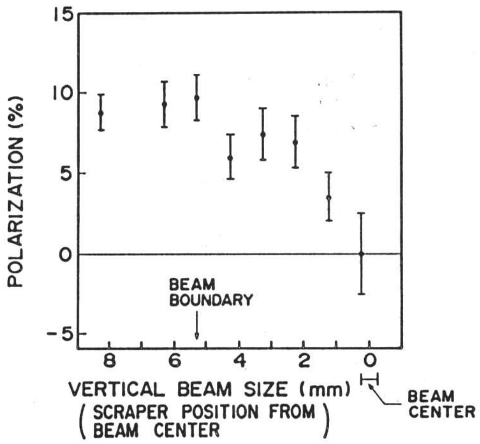

Fig. 2 Dependence of beam polarization at 500 MeV on the vertical beam size in the booster.

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