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8.39 INTERNAL POLARIMETERS FOR THE POLARIZED PROTON BEAM AT THE KEK 12 GeV PS

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Both the booster and the main ring of KEK PS are strong focusing synchrotrons and therefore strong depolarizing resonances are expected during acceleration[1-2]. So, it is quite necessary to measure the beam polarization before and after each resonance during acceleration. For this purpose, two internal polarimeters (we call them the main ring polarimeter and the injection polarimeter) are installed in the straight section II-2F and II-1F of the 12 GeV PS main ring.

The design philosophies of the internal polarimeters are as follows.

1) The main ring polarimeter can be operated at any energy from 500 MeV to 12 GeV to study each resonance in the main ring.
2) The absolute value of the beam polarization at low energy can be measured with good accuracy by the main ring polarimeter.
3) For the tuning of the accelerator, the beam polarization should be measured in a short period.
4) The injection polarimeter is operated for the exclusive use of measurement of the polarization at 500 MeV to tune the beam through depolarizing resonances in the booster.
5) Polarimeters must be reliable and easy to operate and free from maintenance.

The main ring polarimeter consists of a polyethylene string target and scintillation counter telescopes. The beam polarization can be obtained by measuring the left-right asymmetry of the proton-proton elastic scattering in the polyethylene target.

The target mechanism which is shown in Fig. 1 is mounted on a top plate of the scattering chamber. The target is rotated to the scattering position at beginning of the flat top. Two target frames mount a 150 μm polyethylene string target and a 220 μm carbon fiber target, respectively. The target string can be automatically wound up in order to avoid the burn-out of the string due to the beam heating.

Figure 2 shows a schematic of the counter telescope. The distance between F2 and the target is variable from 900 mm to 3000 mm. The forward arm can be rotated from 0° to 23°, and the minimum detection angle is 3°. The distance between B2 and the target is varied from 300 mm to 450 mm. The backward arm is rotated from 57° to 83°. These can be driven by a remote controller from the center control of the accelerator. The proton-proton elastic scattering at $t = -0.15$ $(GeV/c)^2$ can be measured from $T_p = 0.5$ to 7 GeV by varying the angles and positions of both counter telescopes. Above 7 GeV, measurement should be done in higher $|t|$ region than 0.15 $(GeV/c)^2$. L(R) denotes the coincidence count corresponding to the left (right) forward scattered proton and right (left) backward scattered proton.

$$L, R = (F1 \cdot F2U \cdot F2D \cdot B1 \cdot B2U \cdot B2D \cdot \overline{B3}).$$

F2U (B2U) and F2D (B2D) denote two photomultiplier output signals from F2 (B2) counter. The position of the detected particle in the F2 counter is obtained by the time difference (τ_F) between F2U and F2D signals. And τ_B is the time difference between B2U and B2D signals. Thus the correlation between the two time differences (τ_F and τ_B) gives the coplanarity of the event. The beam polarization P is given by

$$P = \frac{1}{A_y} \frac{L - R}{L + R} \quad ,$$

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where A_y is the analyzing power. The contamination from carbon in the polyethylene is checked by the measurement with using the carbon target. The systematic left-right asymmetry is checked by the measurement with unpolarized beam.

The polarization was measured at 500 MeV coasting beam in the main ring to investigate the depolarization in the 500 MeV booster synchrotron as the first step of polarized proton acceleration at KEK PS[3]. The effective analyzing power including the contamination can be calibrated by the coplanarity measurement. At 500 MeV, most of the coincidence events are the coplanar events. The beam polarization was measured in a few minutes with $\leq$ 2 % statistical accuracy. The asymmetry for the unpolarized beam was less than $\overline{0}$.2 %.

The beam from the booster is sharply bunched so that the measurement of the beam polarization by the counting method is very difficult in the beam line from the booster to the main ring. The injection polarimeter for the polarization measurement of the booster beam is designed as follows. One more bunch is injected into the main ring from the booster before normal 9 pulse injection for acceleration. The polarimeter is operated at 500 MeV coasting beam with $t = -0.15$ $(GeV/c)^2$ by using this extra beam. The 150 μm diameter polyethylene target is preset on the beam line before the extra beam injection, and it is removed off immediately after the polarization measurement. Because of the decay constant of the coasting beam is about 15 msec and the accelerating cycle of the booster is 50 msec, this extra beam does not interfare the normal beam injection. The proton-proton elastic scattering is defined by a coincidence method of two forward counters and one backward counter. The effective analyzing power is calibrated by using the main ring polarimeter.

The injection polarimeter is useful to tune and monitor the depolarizing resonances in the booster, and the main ring polarimeter should make full use of tuning the polarized beam acceleration in the main ring.

References

1. S. Hiramatsu et al., Proc. 5th Int. Symp. on High Energy Spin Physics, Brookhaven, 1982 (AIP Conf. Proc., No.95, 1982, p.419).
2. T.K. Khoe, KEK Report, KEK-81-15, 1981.
3. S. Hiramatsu et al., Proc. 6th Int. Symp. on High Energy Spin Physics, Marseille, 1984, to be published.

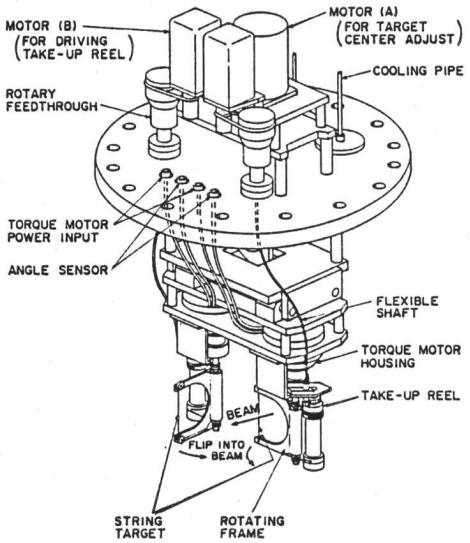

Fig. 1 Target mechanism of the main ring polarimeter.

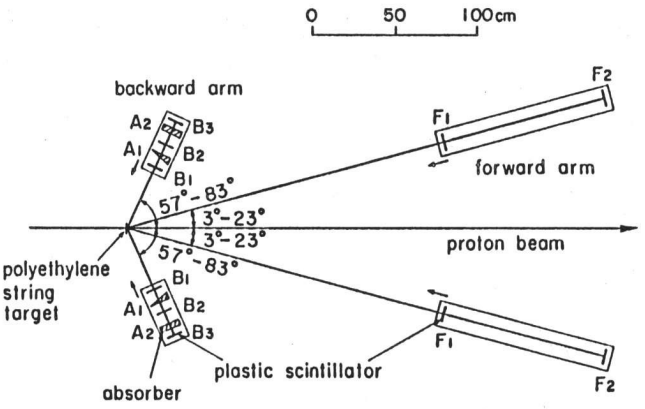

Fig. 2 Schematic of the counter telescope.