POLARIZED PROTON AND ANTIPROTON BEAMS AT FERMILAB

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Here we review the design of the 185-GeV/c polarized proton (antiproton) beams and compare the expected versus measured beam intensities. The three following talks will discuss the measurement of the beam polarization.

Prior to receiving 800-GeV/c protons from the accelerator, we received a 30-GeV/c beam for several months. The flux was about 10,000 particles per spill (20 seconds of beam every 60 seconds) of which 20 % were positrons. With this beam, we performed beam tuning, tested various detectors, and calibrated more than 1000 lead-glass counters for the beam polarimeters and first round of experiments. This 30-GeV/c test beam running made it possible to ultilize the ten days of 800-GeV/c primary proton running very effectively.

The beam polarization is obtained from lambda decays. Protons (antiprotons) from $\Lambda \to p\,\pi^-$ ($\overline{\Lambda} \to \overline{p}\,\pi^+$) decay are polarized along the proton momentum in the Λ rest frame. The measured value for this polarization is 64 %. The proton spin direction is almost unchanged in transforming from the Λ rest frame to the proton frame. The secondary beamline is shown in Fig. 1.

Protons strike a 30-cm. long beryllium production target followed by magnets to sweep away the charged particles. The remaining neutral beam is stopped in a neutral dump while the protons from Λ decay are deflected around the dump by the first set of dipoles. The second set of dipoles along with the hodoscopes M1-M3 give momenta with an accuracy of $\Delta p/p = \pm 1.5\%$ (see Fig. 2). The quadrupoles are placed symmetrically about the intermediate focus. The beam is designed to have no net spin precession.[1] The polarization is tagged in the horizontal, $\vec{S} = \vec{N} \times \vec{L}$ (where N and L are in the vertical and longitudinal directions respectively) using POL 1-3 hodoscopes as shown in Fig.2. The Monte Carlo calculated correlation between polarization and the horizontal position at the intermediate focus is shown in Fig. 3.

The S spin can be rotated to either L or N direction by a Siberian snake consisting of 12 dipoles. The snake polarity is reversed every ten minutes to minimize systematic problems. Hodoscopes upstream and downstream of the snake , similar to the hodoscopes in the tagging region indicate that the snake does not appreciably affect the beam position or slope.

The beam is instrumented with proportional wire chambers displayed on a TV monitor for fast diagnostics. The hodoscopes provide a very powerful, detailed diagnostic tool.

The measured beam intensities are given below for 10^{12} 800-GeV/c incident protons per spill:

	Momentum Collimator	Total p ($\bar{p}$) (Not Tagged)	Tagged p ($\bar{p}$) (Pol. > 35%)	Pion Backgrounds
Protons	1.25"	15×10^6	8×10^6	1.5×10^6
Antiprotons	Open	15×10^5	8×10^5	75×10^5
Antiprotons	1.25"	7.5×10^5	4×10^5	38×10^5

There is a ± 15 % uncertainty in the overall beam intensity since we did not have time to carefully calibrate. The measurements are in excellent agreement with expectations based on Monte Carlo studies.

The next speakers will address the question of beam polarization measurements. Possible beam upgrades will be discussed later by Dave Underwood.

REFERENCES

1) D. Underwood, High Energy Polarized Beams from Hyperon Decays, AIP Conference Proceedings 150, Intersections Between Particle and Nuclear Physics, Lake Louise, Canada, 1986, Editor: D. F. Geesaman.

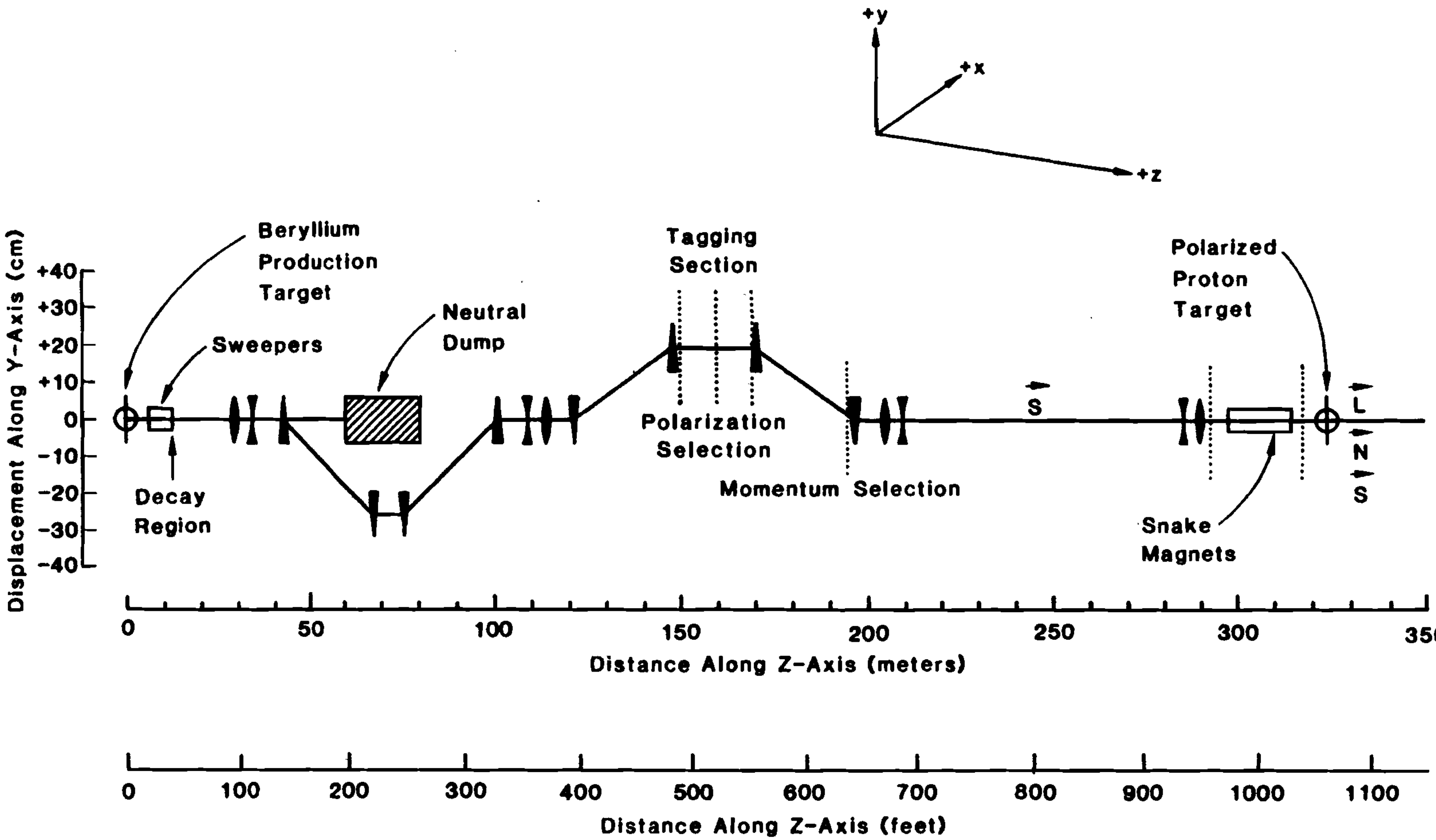

Figure 1. Layout of secondary beam

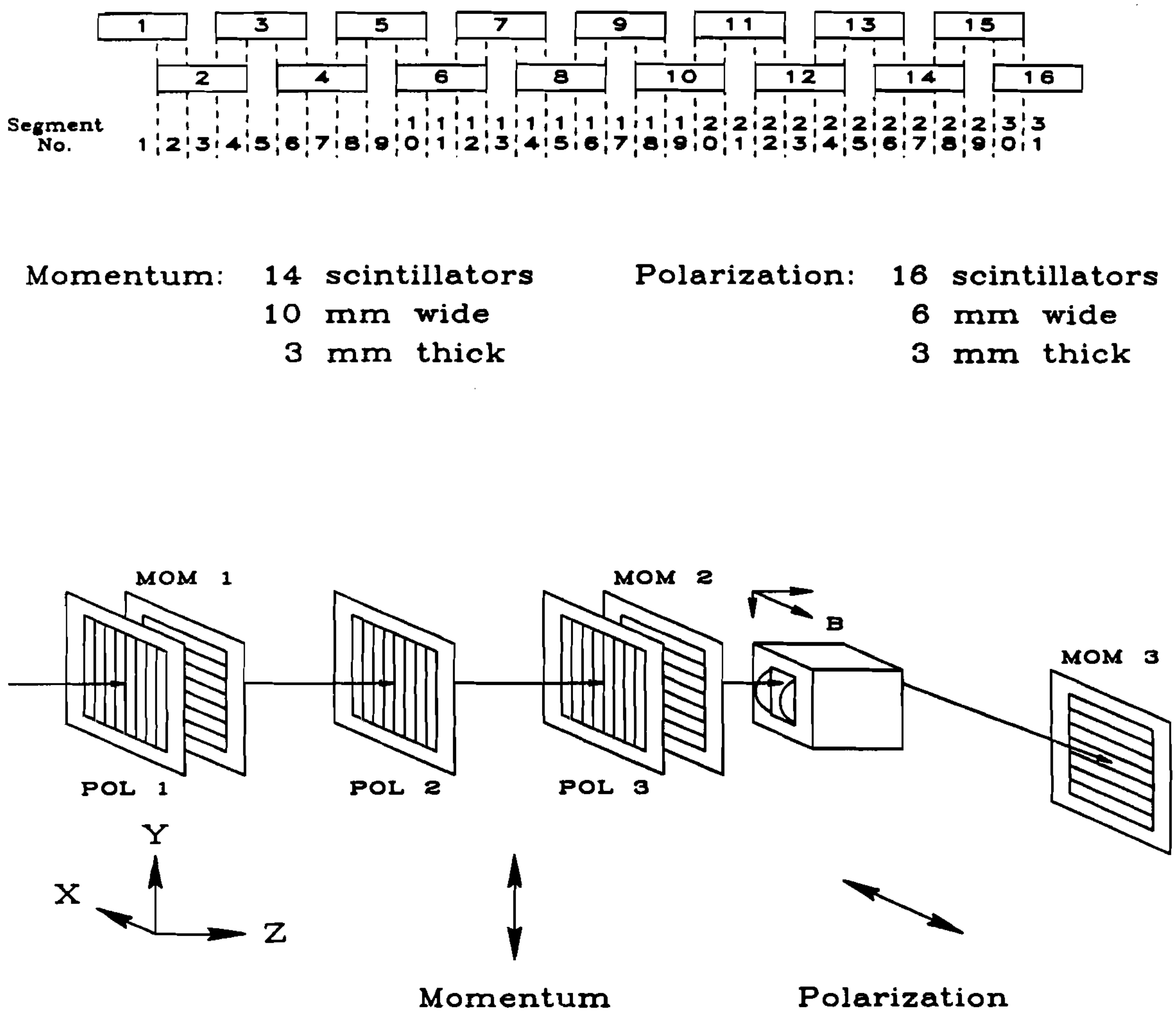

Figure 2. Momentum and polarization tagging hodoscopes

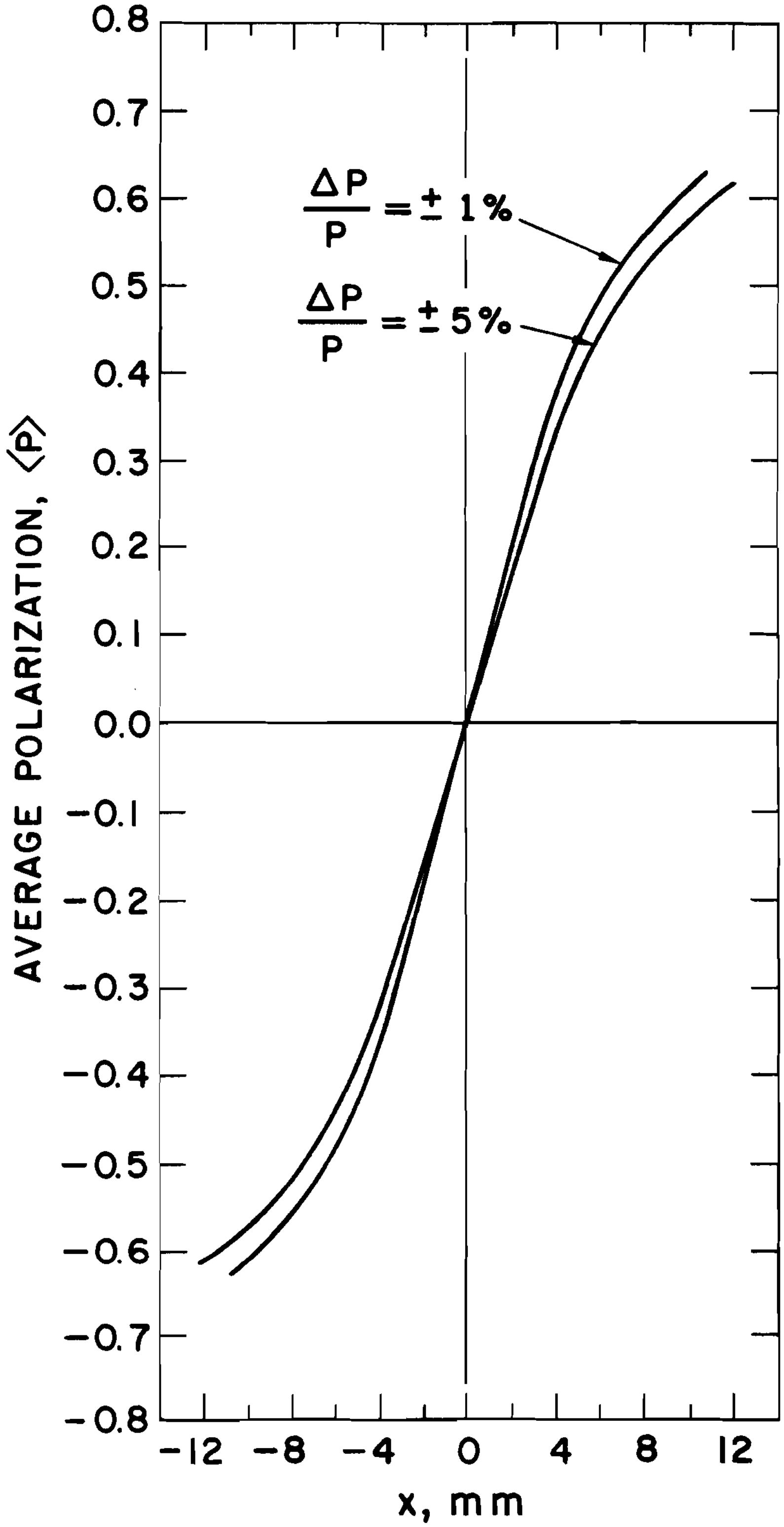

Figure 3. Horizontal position vs polarization at intermediate focus (Monte Carlo calculation)