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Informal Report

LOW MOMENTUM ANTIPROTON FLUX ENHANCEMENT IN THE LESB

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ABSTRACT

The use of energy degraders to enhance the low momentum antiproton flux in the LESB has been studied. Degrading at the production target produced large flux increases below 600 MeV/c and extended the useful antiproton momentum range of the beam to below 450 MeV/c.

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In connection with our interest in the narrow width resonance observed in the $\bar{p}$-p total cross section at a mass of 1932 MeV by Carroll et.al.[1], we have studied the problem of enhancing the low momentum $\bar{p}$ flux in the LESB[2] by momentum degradation while maintaining good optical quality. Degraders of sufficient material to reduce the momentum of 700 MeV/c antiprotons to 450 MeV/c were placed at 1) the mass slit, 2) 1.1 meters upstream of our target, and 3) at the production target "C" in the slowly extracted primary proton beam.

A coincidence between a timing counter, T, located directly at the mass slit, a counter, S1, 1m upstream of the final focus, and a counter, S2, at the final focus, determined the incident particle rate. The final focus was located 2m from the exit of the last quadrupole in the beam. Counter S2, 2-in. wide by 1½-in. high by ¼-in. along the beam, was used to require a minimum dE/dx for the incident particles: dE/dx for antiprotons of 700 MeV/c momentum is greater than two times minimum ionizing, and that of 450 MeV/c greater than 3.5 times minimum ionizing.

The timing of the antiproton signal was determined by increasing the resolving time of the T·S1·S2 coincidence and examining the time of flight spectrum between T and S2, see Fig. 1. Antiproton plus accidental rates were measured by gating the spectrum on the antiproton time peak, and accidentals were determined by gating the spectrum in a region to exclude antiprotons and pions.

1. Degrading the antiproton momentum at the mass slit is advantageous for three reasons:
   a. Degraded $\bar{p}$'s are momentum analyzed after degradation,
   b. pion contamination is reduced since the momentum loss of pions is significantly less than that of $\bar{p}$'s and the downstream half of the beam does not pass these high momentum particles, and
   c. the mass slit is a nominal double focus so that the effects of multiple scattering are reduced.
2. Degrading near the final focus, with sufficient distance between the degrader and the focus to permit determination of particle trajectories has none of the above advantages; however, effects of multiple scattering may be less if there is not a true focus at the mass slit.

For both methods 1 and 2, multiple scattering is a large factor, thus a low Z material, carbon, was used. Nuclear absorption was approximately 70% in degrading from 700 MeV/c to 450 MeV/c.

3. Degrading at the production target has five advantages:
   a. The target and degrader are in focus so multiple Coulomb scattering is minimized except in that it tends to smear out the angular distribution of secondary particles - a dense, high Z material of short length along the beam direction assures good optics,
   b. since the LESB uses a 10.5^{o} production angle and the angular distribution of secondary particles is sharply peaked at smaller angles, it is likely that multiple Coulomb scattering will lead to more antiprotons scattered into the beam acceptance than scattered out,
   c. tertiary production in the degrader may lead to a further enhancement of the antiproton flux,
   d. the antiprotons are fully momentum analyzed in the beam,
   e. the degraded flux can be optimized by moving the degrader transverse to the primary proton beam.

A hevimet target-degrader sketched in Fig. 2 was employed. Antiproton flux was optimized by moving the beam laterally across the target.

The "C" station 90^{o} monitor was recalibrated with the new target by putting the entire slowly extracted beam on the "C" target and normalizing to the SEB secondary emission chamber.

Results of degrading in each of the three ways discussed above are plotted in Fig. 3 with the curve of Carroll, et. al.[3] The latter curve was obtained with a 4-in. Cu target, whereas we used platinum and hevimet which are expected to yield a larger flux. The curve also was obtained with a momentum acceptance of ±1%. In our case, the momentum slits were fully open to ~ ±2%.

It is clear that degrading at the target produces a large increase in low momentum antiproton flux and gives a significant yield below 500 MeV/c, thereby extending the momentum range available to experiment with antiprotons.

It is strongly recommended that a platinum-target degrader be installed at the "C" target station on a transversing mechanism which would enable the LESB flux to be optimized without disturbing other "C" station users.

We are pleased to express our appreciation to Woody Glenn, Lou Repeta, and the Target Group for providing us with the required target-degrader on short notice and to the Main Control Room personnel for their help in steering the beam across the target and recalibrating the 90^{o} "C" monitor. We also thank members of Experiment #618 for interrupting their run to provide the necessary cool down time for changing the "C" target.

Distribution: B2

References

1. A.S. Carroll, et.al., Phys. Rev. Lett. 32, 247, 1974.

2. M.E. Zeller, L. Rosenson, and R.E. Lanou, Jr., BNL Summer Study on AGS Utilization 1970, p. 193.

3. A.S. Carroll, et.al., EP&S Technical Note 64, 1973.

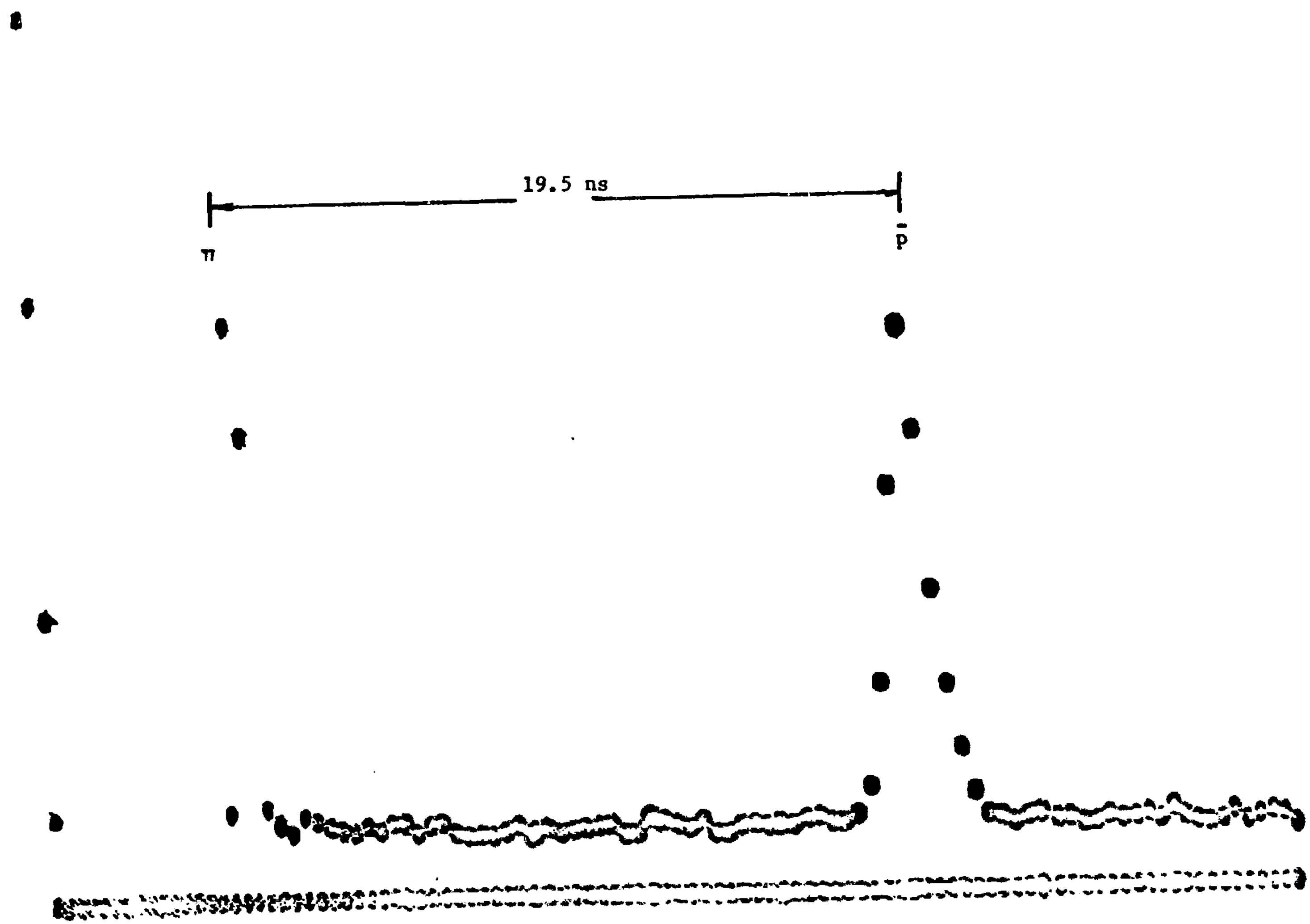

FIG. 1

Time of flight spectrum from mass slit to final focus at 525 MeV/c gated by a dE/dx requirement. 19.5 ns separates the π's from $\bar{p}$'s.

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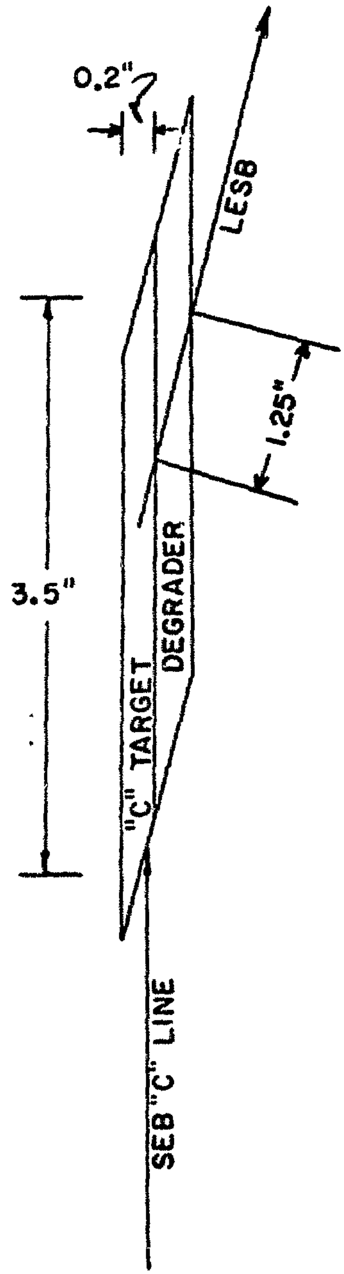
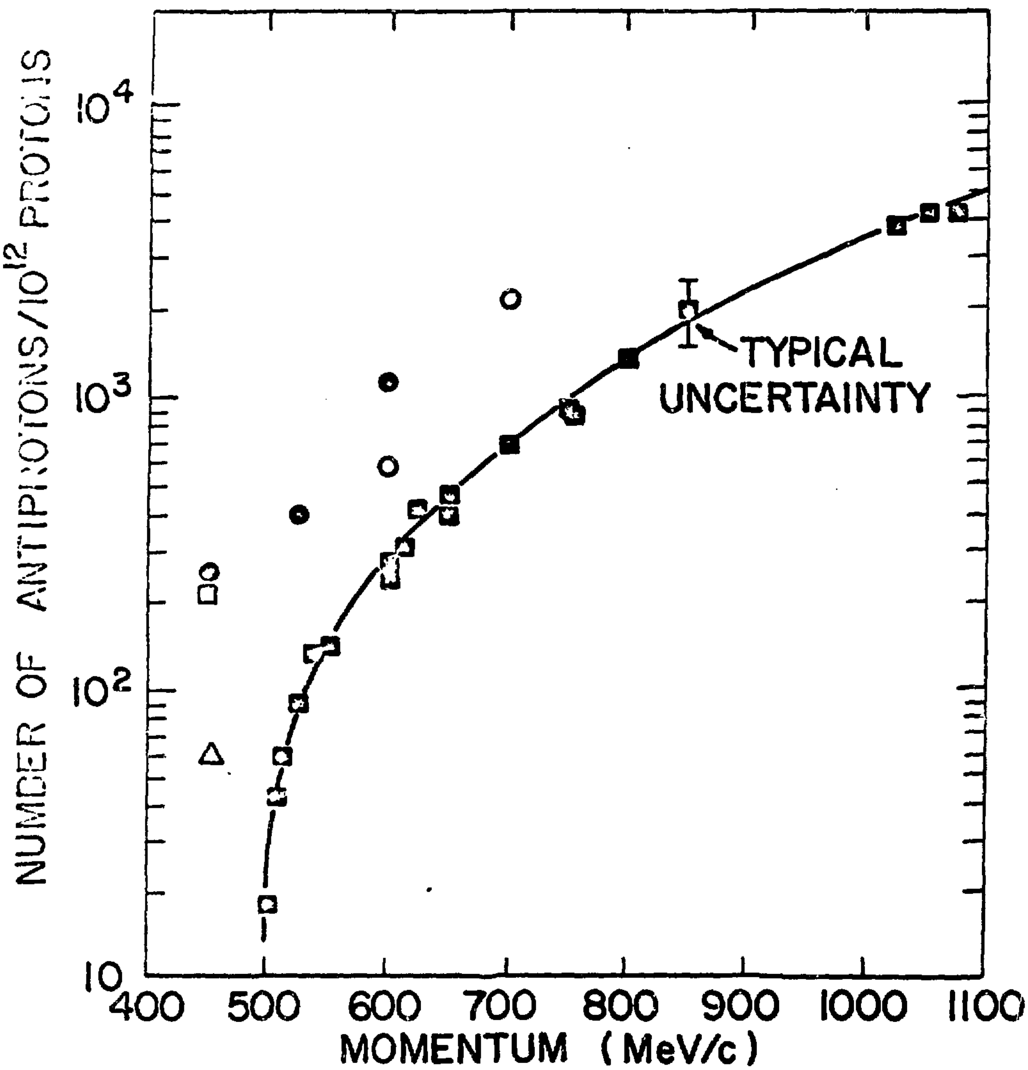


"C" HEVIMET TARGET - DEGRADER

Fig.2



□ 4" Cu target, no degrader, $\frac{\Delta P}{P} = \pm.01$, Ref.3

○ 3.5" Pt target, no degrader, $\frac{\Delta P}{P} = \pm.02$

△ 3.5" Pt target, C degrader at mass slit, $\frac{\Delta P}{P} = \pm.02$

■ 3.5" Pt target, C degrader at experimental apparatus, $\frac{\Delta P}{P} = \pm.02$

● 3.5" Hevimet target, Hevimet degrader at target, $\frac{\Delta P}{P} = \pm.02$

FIG. 3 - ANTIPROTON FLUX VS. MOMENTUM