NAL PROPOSAL No. 137

Scientific Spokesman:
F. R. Huson
Experimental Facilities
National Accelerator Laboratory
Batavia, Illinois 60510

FTS/Commercial: 231-6600 Ext. 242

STUDY OF π^-+p INTERACTIONS AT HIGH ENERGY

F. R. Huson, S. Pruss
National Accelerator Laboratory

B. Daugeras, G. Goldhaber
Lawrence Radiation Laboratory

H. H. Bingham, W. B. Fretter
University of California

April 30, 1971

STUDY OF π^-+p INTERACTIONS AT HIGH ENERGY

F. R. Huson, S. Pruss, National Accelerator Laboratory
B. Daugeras, G. Goldhaber, Lawrence Radiation Laboratory
H. H. Bingham, W. B. Fretter, University of California

We propose an experiment in the 30" hydrogen bubble chamber consisting of 30,000 π^-+proton interactions (~50,000 pictures). This would be an exploratory type of experiment to look for new phenomena and study diffraction dissociation.

Beam. Negative beam of 150 GeV/c

$\Delta p/p$ = 0.1%

$\Delta\theta$ = 0.2 mrad

10 - 15 beam tracks per picture (15 gives 46% of the photos with 0 interactions, 37% with 1 interaction and 17% with 2 or more)

Optional

Čerenkov for distinguishing $\bar{p}$ and possibly K. This information can be stored in the 30" data box.

This should be quite feasible (SP).

Physics.

1. Search for new phenomena. Physicists will scan all of the film.

2. Diffraction dissociation. This group of physicists has studied diffraction dissociation by π, K and protons. Our aim in this experiment will be to measure all events with a proton between 140 MeV/c (1 cm range) and 350 MeV/c (25 cm range) and

three or more pions. This includes ~50% of the diffraction dissociation events. For this range of momentum the error on the invariant mass M (for the system of all outgoing particles except the p) is mostly due to $\Delta\theta$

$$\Delta M \approx p_i p_p \sin\theta \; \Delta\theta / M$$

where θ is the angle between the outgoing proton and the beam (p_i, p_p are the incident π and the outgoing proton momenta respectively). With the small error on the beam direction and the stopping proton angle measured to ~10 milliradians we can obtain an error on the missing mass of 130 MeV for the A_1 region, 100 MeV for the A_3 and 60 MeV for M above 3 GeV (for steeply dipping tracks the error is 20 milliradians). This means that the A_1 can easily be separated from the A_3, and that any higher mass diffraction enhancement produced with a cross section $\gtrsim$20% of the A_1 cross section will be easily seen. Thus we will measure the total $\pi \rightarrow 3\pi$ diffraction dissociation cross section (from t = .02 to ~ .10 GeV^2)and its rough mass and t dependence. Even though the outgoing mesons are in a very small cone, the number of outgoing charged pions can be determined by track counting and/or bubble density. Thus we can similarly determine $\pi \rightarrow 5\pi$, $\pi \rightarrow 7\pi$ etc.

The cross section for $A_1^- \rightarrow \pi^-\pi^+\pi^-$ production in hydrogen is 340 ± 20[1] μb, or 2.0% of the πp total inelastic cross section and is approximately independent of beam momentum in the 8-20 GeV/c range. Therefore, we should be able to measure this cross section to better than 10% and compare it to the cross section below 30 GeV/c to see if it remains constant. Similar comparisons can be done for A_3, 5π, 7π, etc. The diffraction events are easy to identify by their t distribution and mass near the low end of phase space. Since we only measure the proton angle and momentum and count the outgoing mesons by track separation or bubble density, we can use a 20" fiducial length.

3. Search for antiproton interactions. If the Cerenkov counter is ready we would like to note those pictures that have an antiproton or K^- in the beam. If the protons targeted are 300 GeV/c and the negative beam is 150 GeV/c we might expect the order of 1% or more antiproton interactions.[2]

4. We also intend to measure and analyze other topologies in the film if this is feasible in terms of unique results.

Scan and Measurements.

The groups involved can scan and measure this film rapidly to obtain the results very quickly. The intention is to divide the film evenly among the 3 laboratories.

1. K. Paler, Nuclear Physics B18, 1970 (211).
2. Physics Letters 30B, 7 (1969).