NAL Proposal No. 278

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PROPOSAL TO STUDY π^+ INTERACTIONS AT 400 GeV IN THE NAL 30-INCH HYDROGEN BUBBLE CHAMBER

January, 1974

We propose to study π^+p interactions at 400 GeV in the hydrogen-filled NAL 30-inch bubble chamber, using a tagged beam with low proton contamination, produced on a secondary target by an intermediate negative beam. The supplementary visual spectrometer of Experiment 2B would also be used if available. 100K pictures are requested.

Purdue High Energy Physics Group

This proposal is based on the same proton-depleted beam technology as described in the preceding (300 GeV $\pi^+ p$) proposal. We await the advent of a primary proton energy approaching 500 GeV. The final positive beam, at 80% of the original proton energy, will require more proton flux per particle in the bubble chamber,[1] but not an unreasonable amount in view of the interest in obtaining a wide range of $\pi^+ p$ data at such a high energy. Event rates and numbers are roughly the same as in the preceding proposal: 100 K pictures and 25 K events. The existing Cerenkov counter is not capable of fully separating π^+ from K^+ at this energy, but would certainly be used to tag protons as opposed to π^+ and K^+. If the K fraction is less than 10% it will not represent a serious contamination of the π^+ data, even for such studies as total cross section. Also, our knowledge of the K^+ interactions from our 300 GeV run should permit educated corrections for whatever K^+ contamination exists in the 400 GeV beam.

Again we would propose to use the downstream optical spark chambers of Hybrid Experiment 2B if they are available. Much improved momentum resolution on fast forward tracks will be ever more important at progressively higher energies. Gamma showers are detected in the last spark chamber. This will sample a progressively greater fraction of the π^o at higher energies, due to increased forward collimation of produced particles.

1. In our preceding proposal we estimate that 1.6×10^{12} protons at 400 GeV are needed to produce 12 π^+ of 300 GeV at the bubble chamber. We also estimate there that 7×10^{12} protons at 500 GeV are needed to produce a similar π^+ beam at 400 GeV. There is a factor of ten leeway to be had by increasing the momentum bite of the π^+ beam. Further leeway may exist if the targeting is more than 1/3 efficient. It is hoped to make an experimental test of the double targeting scheme in the immediate future.

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(277 & 278 Summaries already filed in notebook

March 11, 1974

Dr. James Sanford
Program Planning
National Accelerator Laboratory
Batavia, Illinois 60510

Dear Jim:

Enclosed are one page summaries of my proposals #277 and 278, and also brief addenda to the two proposals mentioning the possible use of transition radiation detectors (in addition to the existing Cerenkov counter) to separately tag K^+ and π^+ at 400 GeV as well as at 300 GeV. Accordingly I am extending my 400 GeV π^+ proposal to include K^+ interactions as well, if this should prove feasible after the transition radiation devices are tested at NAL. I would encourage the vigorous pursuit of this new technology with a view to its early use in the 30-inch program if it works as well as expected.

As I have mentioned to you, we came exceedingly close to a test of double targeting on February 26, and were forced off by a switchyard failure and by the 200 GeV π^- hybrid experiment which was waiting for such a break to switch polarity in the 30-inch beamline. We eagerly await the next opportunity to test this idea which is crucial to the high energy π^+/K^+ runs. Among other things, it will be most interesting to see if a K^+ fraction can be obtained which is greater than the canonical $\sim$ 5%.

Best regards,

Virgil

Virgil Barnes

VB: jl

Enclosures

ADDENDUM TO NAL PROPOSALS 277 AND 278

March, 1974 V. Barnes, et al. (Purdue)

In view of the prospects for using transition radiation for mass tagging of beams, I wish to add a study of K^+ interactions to the proposal to study 400 GeV $\pi^+ p$ interactions in the 30-inch HBC. Moreover, transition radiation detectors could improve the tagging at 300 GeV. However, we emphasize that the existing differential Cerenkov counter is adequate to separate K from π at 300 GeV provided one is willing to tolerate modest inefficiencies in detecting mesons. Specifically, of one runs the Cerenkov at 2 psia of Helium, protons are below threshold, light from K's forms a ring at 2.5 milliradians, and light from π forms a ring at 3.0 milliradians. (See our Proposal 277, Appendix A.) K's are then detected with 96% efficiency, and π's are detected with 99% efficiency. The undetected mesons are tagged as protons, which we are not interested in, and represent only a modest unbiased loss of beam flux (we count as beam only well tagged particles). At 400 GeV, to obtain 0.5 milliradian separation of the π and K rings, one must work at such a small angle that the detection efficiency is very low.

Coming back to transition radiation detectors, there is considerable promise in various devices which it has been proposed to test at NAL[1,2]. In particular, separation of π from K down to 200 GeV is seriously mentioned. The method improves rapidly with particle momentum. One configuration mentioned may be expected to give a positive signal from π's at high efficiency (99%) with 32:1 signal to noise ratio[1]. The cost of such devices for the 30-inch and/or 15-foot hadron beam lines does not seem prohibitive. I wish to encourage NAL to pursue research and development of transition radiation devices for use soon in the 30-inch bubble chamber program.

1. NAL Proposal #261: "Proposal to Test Transition Counters at NAL," J. Fischer, V. Radeka, C. L. Wang, (BNL) and M. Atac (NAL).
2. NAL Proposal #229: "A Proposal for Testing a Transition Radiation Detector at NAL," P. W. Alley, A. Bamberger, G. F. Dell, Jr., H. Uto, and Luke C. L. Yuan (BNL).