

Scientific Spokesmen:
H.H. Bingham
W.B. Fretter
Department of Physics
University of California
Berkeley, California 94720
Phone: (415)642-1920
Home: (415)524-3312 (Bingham)

Experimental Proposal to NAL

Study of ~ 500 GeV π^-p Interactions in the 30" HBC

H. H. Bingham, D. M. Chew, W. B. Fretter, W. R. Graves,
L. Stutte, G. P. Yost
University of California, Berkeley

G. Abrams, C. Friedberg, G. Goldhaber, A. D. Johnson,
J. Kadyk, G. Trilling, F. Winkelmann
Lawrence Berkeley Laboratory

D. Bogert, R. Hanft, F. R. Huson, M. E. Johnson, S. Kahn,
D. Ljung, S. Pruss, W. M. Smart, R. J. Walker
National Accelerator Laboratory

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Tests in the 30" hydrogen bubble chamber beam indicate that π^- of up to ~96% of the accelerated proton momentum can be obtained with fluxes sufficient for bubble chamber running. Thus with the machine at ~500 GeV it should be possible to do an exploratory π^- run at ~480 GeV. The richness and importance of the 30" hydrogen bubble chamber experiments done so far, including our 205 GeV π^- p run (experiment No. 137) have amply demonstrated that an exploratory HBC run at the highest available π^- energy should be done with highest priority.

We therefore request an exposure in the 30" HBC of at least 50,000 photos¹ at the highest π^- momentum obtainable (near 500 GeV). Such an exposure should yield some 5,000 events with which we can measure the π^- p total cross section (to ~±2% including systematic errors). Measurement of the total cross section at the highest possible pion energy is of great importance to determine whether or not it rises with energy as observed for the pp cross section. The nearly 500 GeV pion beam available at NAL is unique in this respect.

In addition, we can measure the π^- p elastic scattering cross section and slope (both to ~±10%), and we can study multiplicity distributions, diffractive processes, inclusive distributions and correlations, gross characteristics of copiously produced channels. We can better separate possible double pomeron exchange processes from tails of singly diffractive distributions. We will search

for quarks in the beam and anything unexpected among the outgoing particles¹⁰. We can compare all of the above with lower energy π^-p results and in particular with our 205 GeV/c experiment.²⁻⁹

Only at NAL can 500 GeV π^-p physics be done. Bubble Chamber exploratory studies of this domain are appropriate first experiments. Results of the highest importance, especially on σ_{total} , are assured. Our three groups have completed double scanning of 48,000 photos of 205 GeV π^-p film, measured all events of some topologies and some events of all topologies and have returned the film in the scheduled 6 months. As a result of this experience we have scanning, measuring, and analysing systems which can be applied immediately to this new experiment.

References

- 1 We are asking for 50,000 photos, as usual for a bare 30" HBC exploratory run. Most of our results will be statistics limited, however, and we may have to restrict our fiducial volume to a smaller fraction of the chamber than we could use at 205 GeV/c. Thus we would prefer to take 100,000 photos.
- 2 π^-p Interactions at 200 GeV/c, D.Bogert, et al., NAL-PUB-73/30, April 1973, published at AIP Conference proceedings #12, Particles and Fields Subseries #4. Experiments on

High-Energy Particle Collisions - 1973 (Vanderbilt conference Ed. by R.S. Panvini), p. 60.

- 3 π^-p Interactions at 205 GeV/c: Cross Sections and Charged Particle Multiplicity, D.Bogert, et al., Phys. Rev. Lett. 31, 1271, 1973.
- 4 Pion Diffraction Dissociation in 205 GeV π^-p Interactions, F.C.Winkelmann, et al., LBL-2113, October 1973 and to be published in Phys. Rev. Lett.
- 5 Diffraction Dissociation in 205 GeV/c π^-p Interactions, F.C.Winkelmann, et al., to be published in Proceedings of Berkeley Conference, August 1973, AIP series.
- 6 Diffraction in 205 GeV/c π^-p Two and Four Prong Interactions, G.S. Abrams, et al., LBL-2112, August 1973 (Submitted to the Berkeley and Aix-en-Provence Conferences).
- 7 Search for Pomeron-Pomeron- 2π Events in 205 GeV/c π^-p Interactions, D.M. Chew, et al., LBL-2106, August 1973 (Submitted to the Berkeley and Aix-en-Provence Conferences).
- 8 Search for Double-Pomeron Exchange in the Reaction $\pi^-p \rightarrow \pi^- \pi^+ \pi^- p$ at 205 GeV/c, D.M. Chew, et al., LBL-2464, December 1973, to be submitted to Phys. Rev. Lett.

- ⁹ Pion and Nucleon Diffraction Dissociation in the Reaction $\pi^-p \rightarrow \pi^- \pi^+ \pi^- p$ at 205 GeV/c, L. Stutte, et al., LBL-2460, December 1973, to be submitted to Phys. Rev. Lett.
- ¹⁰ For the quark search we will need to have the upstream tagging system in operation.