NAL PROPOSAL No. 279

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The Interaction $pA \to pAe^+e^-$ at 400 GeV

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ABSTRACT

Observations on direct production of electron pairs by 200-GeV protons in emulsions yield results in disagreement with the predictions of quantum electrodynamics. An experiment to examine electromagnetic effects in proton-nucleus collisions at 400 GeV is proposed.

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FOREGOING RESULTS:

Emulsions have been exposed to 200-GeV protons (#103) and 300-GeV protons (#232) at N.A.L. Among strong-interaction phenomena which show no "black" tracks of nuclear evaporation we find diffraction dissociation collisions, interpreted as coherent particle generation[1], and showing an odd number of emergent tracks. Distinguishable from these, and occurring with about the same cross section[2], direct production of electron pairs by beam protons provides a method for testing quantum electrodynamics of hadrons.[3] In contrast with studies of electromagnetic processes in leptonic cascade showers, the observation of electron pair production by protons is a remarkably clean experiment.

Disagreement of these experimental results with theory arises both in the total cross section and in the spectrum of the created pairs. The different theoretical papers give results in the range 50-120 mb for 200-GeV protons in emulsion, in contrast to the experimental figure $\sim$10 mb. Theoretical pair spectra generally predict a large maximum at $\lesssim$ 5 MeV, but this is not found in the experimental spectrum. Both effects might arise from large systematic errors in collecting the data. Repeating the experiment with a proton energy of 400 GeV, where the cross section should be twice as large, is probably the best way of checking the 200-GeV result. An independent test of experimental validity can be achieved by examination of the energy-angle data for electron-recoils from beam tracks, which has also been done at 200 GeV.

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[1] Serphukov Collaboration, J.E.T.P. Letters 18, 10 (1973).

[2] J. E. Butt and D. T. King, Phys. Rev. Lett. 31, 904 (1973).

[3] V. M. Budnev et al., Nucl. Phys. B63, 519 (1973).

PROPOSED EXPERIMENT:

Two small emulsion stacks will be exposed to 3 x $10^4/cm^2$ 400-GeV beam protons, with the beam direction parallel to the emulsion plane. Proton tridents, coherent pion production events, and electron recoils, will be found by track following methods. Energies and emission angles of the created particles will be recorded. It is notable that coherently-produced pions have energies in the 1-10 GeV region, while electrons from directly-created pairs occur in the 10-100 MeV region.

In our small stacks the desired density will be achieved by exposure of each to $\sim 2 \times 10^6$ protons in a beam of diameter $\sim$2 inches.

The experiment will be carried forward in collaboration with A. S. Cary, of Harvey Mudd College.