ANNUAL REPORT

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Purdue - U. S. Energy Research and Development Administration Contract
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Principal Investigator: Earle C. Fowler

The period covered by this report is from October 1, 1975, through August 31, 1976. During this period our group consisted of Dr. Earle C. Fowler, principal investigator; Dr. Neil V. Baggett; and Mr. Dennis Hood.

SLAC E-103**MASTER**

Running of SLAC Experiment E-103, "A Search for exotic meson production in baryon exchange processes," as modified by adding some time for π^+d and even a short run with π^+p , was completed by the end of August 1975. Work with our collaborators at Vanderbilt and Indiana has been concentrated on measuring those streamer-chamber pictures labelled by the triggering counters as containing one and only one beam-target interaction. The total of such pictures is about 90,000, and at this writing somewhat more than one-half of such events have been measured. The P. E. P. R. at Indiana is now working pretty well so that it is expected that all these pictures will have been measured before about December 1976. We are presently discussing whether or not to use the P. E. P. R. to pull clean events from the sample with two interactions in the same picture. This would roughly double our total, we believe. Our analysis effort which includes the space reconstruction and kinematic fitting of the streamer-chamber tracks and adding the information from the wire chambers of the downstream spectrometer is centered at SLAC. Professor Panvini is leading the effort (while on sabbatical leave from Vanderbilt) and Mr. Dennis Hood is staying at SLAC to carry forward the effort from Purdue's side. He has been there full-time since about April 1, 1976, and is likely to remain until some time in early Spring of 1977. The primary experiment is, of course, the search

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for the production of a doubly-charged meson in baryon exchange. We have a number of π^-d events corresponding to more than 500 events/microbarn and we have a good chance to find such a particle if it exists and if its width is not too great (say $\Gamma < 100$ MeV). We ran a second parallel trigger which detects π^- in the forward direction which have nearly the full 13.5 GeV energy of the π^- bombarding the deuterium. This experiment for production of meson resonance states is of considerable interest and we are carrying its analysis forward simultaneously. Our collaboration presented two contributed papers at the Washington meeting of the American Physical Society in April 1976 and we have sent two contributions to the coming XIV International Conference on High Energy Physics to be held in July 1976 in Tbilisi, USSR. These papers were solicited by Dr. K. Lanus, who will be the rapporteur of the Meson and Baryon Spectroscopy Sessions. Please see Appendix A for copies of our abstracts and submitted papers from E-103. Though we have not yet found evidence for the exotic meson, we are still optimistic and we intend to pursue its production via baryon exchanges - which seems to be the most likely process.

Fermilab E-254

This attempt to test the identity between the neutrinos from K-decay and those from π -decay by running the Fermilab dichromatic beam at ~ 250 GeV and ~ 80 GeV in the drift space and detecting neutrinos in the Fermilab - Cal Tech calorimeter of Fermilab E-21 has been run to the approved number of events. Last runs were completed by about November 1975 and the necessary new computer programs have been debugged within the past few weeks. Though Dr. Baggett has spent some time on SLAC E-103, he has been spending most of his time in this contract period on the analysis of E-254. We were diverted from our initial goal somewhat by the fact that we were able to make a time-of-flight measurement of neutrino velocity with this experimental set-up. A copy of our letter in Physical Review Letters is attached as Appendix B. Briefly, it is a comparison between the positive muons from the 250 GeV beam (they are able to penetrate the long shield upstream of the detector) and the negative

muons produced in the calorimeter by 80 GeV neutrinos. The timing of both groups of particles is looked at in the same counter of the muon detector train. Both groups reproduce the time structure of the protons in the accelerator (1 nanosecond "buckets" spaced at about 19-nanosecond intervals) verifying that the neutrinos have the velocity of light to a precision of about 3 parts in 10,000. So far, in this timing study we have seen no indication of "out of time" neutrino-like events which is evidence against heavy (1-3.5 GeV) neutral leptons. We are continuing this analysis throughout all the E-254 and recent E-21 runs to make these statements as precise as we reasonably can.

To make the comparison between the cross sections of the " π -type" and "K-type" neutrinos, it is very important that all the data be processed in exactly the same way. Consequently, it cannot really be completed until the Cal Tech group has its whole system for the analysis of the new running of E-21 completed. We expect to have our result before January 1977. Surely, all the analysis and papers will be completed within the coming contract period. Incidentally, more recent studies by the Fermilab, Harvard, Pennsylvania, Wisconsin collaboration indicate that the simple 3:1 ratio for ν to $\bar{\nu}$ cross section on nuclei (for charged currents) is not holding up at energies from about 70 GeV or so. They attribute this to a threshold for new particles. The observation could be related to a difference between " π -type" and "K-type" neutrinos, however. If we see a significant difference in the cross sections, it will be extremely important to study specific channels. This will probably require a bubble-chamber experiment with a dichromatic beam. Currently we believe it would be most appropriate at Brookhaven National Laboratory.

LAMPF E-53

Again during this contract period it has not been possible to contribute very much to the Los Alamos Meson Physics Facility study of the production of Ar^{37} from Cl^{37} by electron-type neutrinos. This experiment, being done in collaboration with Dr. John C. Evans and Dr. Raymond Davis, Jr. (BNL) and Dr. Stuart Meyer (Northwestern and NSF) is still active. The

latest excitement is that the last three runs which Drs. Davis and Evans have made with the Solar neutrino detector in the Homestake Mine at Lead, South Dakota, have shown appreciably higher levels, so that their latest summary is characterized by the flux of $\sim 1.5 \pm 0.2$ SNU. This is still far below what the solar astrophysicists predict, but changes Davis' position from observing just an upper limit (still consistent with zero) to observing a definite effect. We feel the Los Alamos experiment is very important and still hope to run soon. We must have more cosmic-ray shielding and the full design intensity of the accelerator, however.

Again we are pleased to take this opportunity to acknowledge the help from ERDA which has made this research possible. Also, we could not possibly have done this work without the existence of the larger Task A group at Purdue, and we wish to acknowledge its help.