ORO-3065-31

Subject: Progress Report for Contract AT-(40-1)-3065 between the U.S. Atomic Energy Commission and Duke University.

Period: 1 July 1973 through 30 June 1974.

I. OVERALL PROGRESS

This year has been a year of steady progress in our experimental work and also in our efforts in instrumentation. RIPPLE has been in steady use in the course of the year. We have been measuring on the order of 500 events per week. These events are rather complicated and the measuring rate is several times what could be accomplished with a manual measuring system. Several improvements have been made in the technical operations of RIPPLE. These will be described later.

A. New Pictures

In October 1973 we had an additional run at SLAC. At that time we obtained more pictures using 10.5 GeV/c π^+ incident on our standard hydrogen neon mixture in the 82" bubble chamber. In addition, we took pictures using 5 and 15 GeV/c π^+ incident on the chamber as well as 10.5 GeV/c π^-. In this way we should be able to obtain a rather comprehensive picture of π interactions in neon. In April 1974 we had our long postponed 200 GeV/c π^- run at NAL. The chamber and accelerator worked in an exemplary fashion and we were able to obtain our scheduled 120,000 pictures in slightly over one week. We are scheduled for a run at NAL using 200 GeV/c π^- on the 30" bubble chamber to be filled with our standard neon hydrogen mixture. This run will make additional new information available on π neon interactions.

B. Scanning and Measuring at Duke

A very sizeable fraction of our manpower at Duke is tied up in scanning our hydrogen-neon pictures. These pictures are complicated for several reasons. One is the basic complexity of the π-neon interactions. Generally several protons and quite a few π's and π^o's are produced in each interaction. Thus the scanner must count tracks for each sign of particles, identify protons, as well as looking for γ-ray conversions in the vicinity of the interaction. The hydrogen events are likewise complicated by the presence of the pairs produced by the conversion of γ-rays. In the course of the year, we have completed our initial scan of our initial 10.5 GeV/c hydrogen-neon run at SLAC. We have also begun scanning the more recent π^- and π^+ ru[illegible].5 GeV/c. The initial scan of the 10.5 GeV/c π^- run is being done [illegible]ensboro by our collaborators at UNC-Greensboro. Our measuring effort at Duke likewise absorbed a sizeable fraction of our total effort.

RIPPLE has worked very well for our measurements of the neon and hydrogen events. While the total number of events measured from October to May of this year is not terribly great (approximately 10,000) the results are impressive. RIPPLE can measure a 14 prong neon collision in 4 - 5 minutes. To do such an event on a manual machine would be a truly formidable task. It would require at least 30 - 40 minutes to measure and 50 - 60 percent of the events would fail in reconstruction. (This is the result of experience measuring multiple events at Wisconsin.) The hydrogenic events have also been slow because of having large numbers of γ-rays in addition to the main vertex. Having a neon-hydrogen mixture presents special problems in measuring because the multiple scattering makes automatic track following more difficult. This has required special software for the neon measuring.

C. RIPPLE Improvements

During the last year several software improvements were made, mostly to the track following part of the system. In January a major improvement was made to the hit detection electronics. This modification, detailed in the enclosed report presented at the recent Oxford Conference on Computer Scanning, has improved resolution of closely spaced tracks.

Although the RIPPLE is still measuring two or three times below its potential rate, the quality of the events measured has been very high. We are finding 80 - 85 percent of even our complicated events are correctly and completely measured on the first try.

Hardware and software modifications have been recently completed which allow RIPPLE to measure the three film strip, sprocketed, 35 mm film from the FNAL 30" bubble chamber. The first small sample of events has been measured and processed through TVGP reconstruction. The results are good and plans are to measure a large sample of the earlier run in the near future.

However, it is clear that many of the very high energy events cannot be measured by the present RIPPLE track following algorithm. This is because of the closeness of the tracks in the forward jet. In many cases, these tracks do not separate by more than a bubble width over the length of the chamber. A completely new and unique track measuring strategy has been devised and is being programmed at the present time. If this new procedure performs as expected, it should be in use by the end of the present contract period.

D. Physics with $Ne-H_2$

We have been doing two parallel experiments with the $Ne-H_2$ pictures. In one of these we are studying π-Ne collisions in an inclusive fashion and in the other we are studying $\pi^+ + p - \gamma's + X^{++}$. Neither of these experiments have been done before with the detail and precision available here. We include here two papers that have been submitted to the London Conference on these two subjects.

We believe that both of these papers represent real innovation in their fields.

E. Physics at NAL

We have begun scanning 200 GeV/c π^- pictures from NAL. A considerable effort has gone into both mechanical and software work on RIPPLE in preparation for measuring the NAL events. The film format at NAL is not very well suited to RIPPLE and required sizeable modifications.

F. Projection Chamber Development

In the course of the year we have made considerable progress in our program on developing projection chambers. Previous difficulties with spurious sparking and erratic behavior were thought to be due to gas contamination. These difficulties were greatly decreased by building an efficient molecular sieve purifier. We are currently devising better means of constructing the chambers. A report of our set-up for the projection chambers is included.