NAL PROPOSAL NO. 443

Correspondent: J. E. Pilcher
Enrico Fermi Institute
University of Chicago
Chicago, Illinois 60637

Telephone: 312-753-8747
-8744

A PROPOSAL FOR CONTINUED STUDIES OF HADRON INDUCED μ-PAIRS IN A LARGE ACCEPTANCE SPECTROMETER

K. J. Anderson, G. G. Henry, K. T. McDonald, J. E. Pilcher,
E. I. Rosenberg
Enrico Fermi Institute, University of Chicago

J. G. Branson, G. H. Sanders, A. J. S. Smith, J. J. Thaler
Princeton University

September 24, 1975

We propose to complete the study of hadron induced μ-pairs as set out in our original proposal.[1] For reasons of scheduling and to minimize interference with E-98, the running of E-331 has been restricted to nuclear targets and a positive beam almost an order to magnitude less intense than the spectrometer can handle. We wish to extend our studies to hydrogen and deuterium targets and to use a higher quality hadron beam into the Chicago Cyclotron Spectrometer.

The physics goals of the experiment remain the same; namely, to study the hadron production of μ-pairs in a large acceptance detector with a minimum of detection biases. We will study the μ-pair production cross section as a function of x_F, P_T and $M_{\mu\mu}$ for incident pions, protons, and kaons. We will also measure the decay angular distribution of the μ-pair state.

Of special interest are the continuum μ-pair characteristics. We are in a unique position to study the continuum production by protons, as well as pions of both charges, interacting with free nucleons. These data will provide important constraints to any parton model of the hadrons.

Results to Date

Experiment E-331 is scheduled for its second and final data-taking run this fall. Results from our June run have already been presented for $M_{\mu\mu} >$ 2 GeV (copy attached). We are presently preparing a publication of these results. The total E-331 data sample will provide the following results for π^+ and proton collisions with nuclear targets at 2 incident beam energies:

(1) a measurement of inclusive vector meson production (ρ-ω,ϕ,J).

(2) a measurement of the μ-pair continuum for $1 < M_{\mu\mu} < 4$ GeV.

hydrogen target would free the data from any uncertainties associated with a nuclear target.

Finally, the hydrogen and deuterium studies will represent a definitive measurement of inclusive ρ and J production from free nucleons. They form a natural completion of the A dependence studies begun in E-331.

Technical Details

(a) High Rates

We are proposing to use a beam flux of 10^7/pulse. We have already operated the spectrometer and trigger at beam rates of 3×10^6/pulse for periods of one shift with no loss in performance, so that the extrapolation to 10^7 is less than a factor of 4. One should bear in mind that our final 54-counter hodoscope plane is protected from the incident beam by 4.7 m of steel and by a magnetic field of 35 kg-m. Moreover, we demand a 2 counter coincidence within this plane. We discuss below the effect of the higher beam flux on our upstream proportional chambers and on the trigger rate/data acquisition system.

The most rate sensitive detector elements are the MWPC's located between the target and the upstream hadron shield. With a 1-m-long target, they serve two functions. They locate the beam interaction point in the target, and they determine the initial muon directions before the multiple scattering in the shield.

For this experiment, the data taking divides itself naturally into two categories. For low mass μ-pairs ($M_{\mu\mu}$ < 1.5 GeV) the upstream chambers are triggers. Using our present data to test the hodoscope's effectiveness, we find that it reduces the trigger rate by a factor of 5 but leaves the region $M_{\mu\mu} > 2$ GeV untouched. To summarize, we expect to trigger on 8 high mass events/10^7 particles incident on a 1m hydrogen target.

(b) The Beam

During neutrino running, the present N1 hadron beam is derived from the horn target. The beam passes through the horn at a small grazing angle traversing ~1 ft. of aluminum. During antineutrino operation when the hadron plug is installed downstream of the horn target, the N1 beam is derived from a target in the bypass beam to the bubble chamber. In both configurations the first quadrupoles are ~1100 ft. downstream of the target. We urge that both the targeting and solid angle of the beam be improved.

The optimum solution would be a third split of the proton beam into Neuhall and the targeting of this third beam in enclosure 100 using the same techniques as in the Proton Lab. Because of the greatly increased solid angle, the number of protons on target would be relatively modest.

A second solution would use a special neutrino decay pipe triplet recently suggested in a note by Skuja and Stefanski[5] as a way of providing compatible running for the muon and neutrino experiments. The disadvantages here are that there could be no running during periods of antineutrino operation and the 400-m-long hadron decay path would introduce an unwanted muon component in the hadron beam.

We plan to actively pursue these solutions and others with the Neutrino Lab personnel.

References

1. The scope of the experiment is set out in detail in proposal number 308. This number was changed to 331 when the use of the Chicago cyclotron spectrometer was considered.
2. A Special Request for High Priority Running to Study High Mass Muon Pairs, K. J. Anderson *et al.*, a Fermilab proposal submitted September 1975.
3. We observe ∿ 45K events in the interval $0.5 < M_{\mu\mu} < 1.5$ GeV for ∿100 J events.
4. A small region of the chambers can be deadened by painting the anode wires in this region with Glyptol and thus removing the possibility of gas amplification. The Glyptol can be removed later with alcohol.
5. A. Skuja and R. Stefanski, Fermilab internal memo to J. Peoples (9/12/75).