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Proposal to Study Pion-Nucleus Interactions in Emulsion Plates with Embedded Metal Powder Granules at Highest Available Energy >300 GeV

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ABSTRACT

We propose to prepare nuclear emulsion plates containing embedded microgranules of several heavy metals, which would be exposed to negative pions at the highest available energy greater than 300 GeV. After exposure and development, the plates would be searched for multiparticle production events in the metal granules. For events found, the charged multiplicities and angular distribution of secondaries will be determined.

General Description

We propose to prepare nuclear emulsion plates containing embedded microgranules (typical diameter $\sim$15 μm) of several heavy metals (^{52}Cr, ^{108}Ag, ^{184}W) which would be exposed to π^- at the highest available energy >300 GeV. After exposure and development, the plates would be scanned for hadronic multiparticle production events in the microgranules. In this way the advantages of nuclear emulsion (fine spatial resolution, 4π sensitivity) can be employed to study events occuring in elemental targets.

Physics Motivation and Objectives

The proposed experiment is part of a comprehensive series designed to map out the features of the multiparticle production process as a function of energy, projectile type, and target mass. Table I lists previous experiments in the series, their current status, and results. Data from the proposed experiment will be compared with that of other π^- experiments at different energies (e.g., E178 (Busza), E163A (Walker), E387 (Wilkes)), and with experiments employing different beam particles at similar energies (e.g., E171 (Lord), E338 (Moriyasu), E237 (Lord)).

Our experimental technique permits the observation of
1) the number of fast (β >0.7) particles produced, n_s;
2) the number of heavily-ionizing particles, N_h;
3) the pseudorapidity distribution ($-\ln \tan[\theta_{lab}/2]$) for fast particles.

In addition, we can detect production of short-lived particles ($c\tau$<1000 μm) indicating charm or heavy-leptons.

The quantities listed above represent the standard parameters of multiparticle production, measured by most experiments and predicted by most models.

The current theoretical and experimental situation has been comprehensively reviewed by Otterlund.[1] Rather than repeat his discussion, we will make the following general comments:

1) Since nuclear multiplicities are greater than hadron-hadron multiplicities at equal energy,but less than those predicted by naive cascade models, some form of limited intranuclear cascading must occur.
2) The "extra" particles produced in nuclear collisions predominantly populate the lower part of the rapidity spectrum.
3) The number of heavy tracks N_h is correlated in some way with the number of intranuclear collisions.

Models of the Gottfried type[2] are the most promising candidates for explaining these phenomena, but considerable refinement is required before a true theory can be established.

Experimental Technique

Our method for preparing nuclear emulsion plates with embedded powder granules has been described in detail elsewhere.[3] Fig. 1 shows a cross-section of a typical plate, and fig. 2 shows an example of an event in a granule.

We would expect to prepare 6 plates for each of 3 elements: Cr, Ag, and W. Each plate measures 10 x 10 cm x 600 microns and contains about 0.1 g of metal powder and 6 cc of emulsion (23 g).

In addition, we would like to prepare several plates -- up to a dozen -- for"detector development" purposes, containing a variety of embedded materials (other metals, wires, pure gelatin).

The emulsion plates will be exposed in stacks of 4 to 6, with the beam as parallel as possible to the emulsion plane (except for stacks with gelatin layers, which are to be exposed at a slight tilt angle, using holders supplied by us). We would therefore plan to expose six stacks, as detailed in table II.

Beam Requirements and NAL Facilities Needed

Our needs are the usual ones for emulsion experiments:

a) an exposure table whose surface is parallel to the beam direction;

b) a beam monitor system capable of indicating the net integrated flux delivered;

c) use of a darkroom as close as possible to the exposure area (e.g., the 30" BC).

The total beam dose required for each of the six stacks is indicated in table II. We are requesting the highest available energy. Note that 360 GeV would be especially interesting, for comparison with $\pi^- d$ (E338).

Estimate of Event Rate and Analysis Time

We expect each plate to yield 20-25 events; thus we would have a total of 100-150 events per element. We plan to have one graduate student working full time on this experiment, with one physicist and one to three student scanners assisting on a half time basis.

Our experience indicates that preliminary results will be available within one year, and final publication within about 30 months of the exposure date.

REFERENCES

1. Otterlund, I., "Inclusive Production in Emulsion with Accelerator Beams", invited talk at Topical Meeting on Multiparticle Production at Very High Energy, Trieste, June, 1976 (University of Lund preprint LUIP-CR-76-07)

2. Gottfried, K., Physical Review Letters 32 957 (1974)

3. Florian, J.R., *et al*, Physical Review D13 558 (1976)

TABLE I: STATUS AND RESULTS OF PREVIOUS EXPERIMENTS IN THIS SERIES

Experiment/Spokesman	beam	status	publications & theses
E-171 / Lord	200 GeV p	completed	Florian, et al, Vanderbilt Conf. (1973) p. 126 J.R. Florian, PhD thesis, U. of Wash. (1974)
E-237 / Lord	300 GeV p	completed	Florian, et al, Phys. Rev. D13, 558 (1976)
E-387 / Wilkes	200 GeV π^-	preliminary results available	M.Y.Lee, et al, Bull. APS 21 #1 M.Y.Lee, PhD thesis, U. of Wash. (work in progress)
E-471 / Lord	400 GeV p	analysis in progress	- - -

TABLE II: SUMMARY OF EMULSION STACK CONTENTS AND EXPOSURE REQUIRED

Stack	Contents	Exposure Requested
1	2 plates each of Cr, Ag, W	75,000 particles/cm^2
2	"	100,000/ cm^2
3	"	200,000/ cm^2
4	4 experimental plates	75,000/ cm^2
5	"	100,000/ cm^2
6	4 plates containing a layer of pure gelatin	200,000/ cm^2

NUCLEAR EMULSION PLATES

WITH EMBEDDED METAL GRANULES

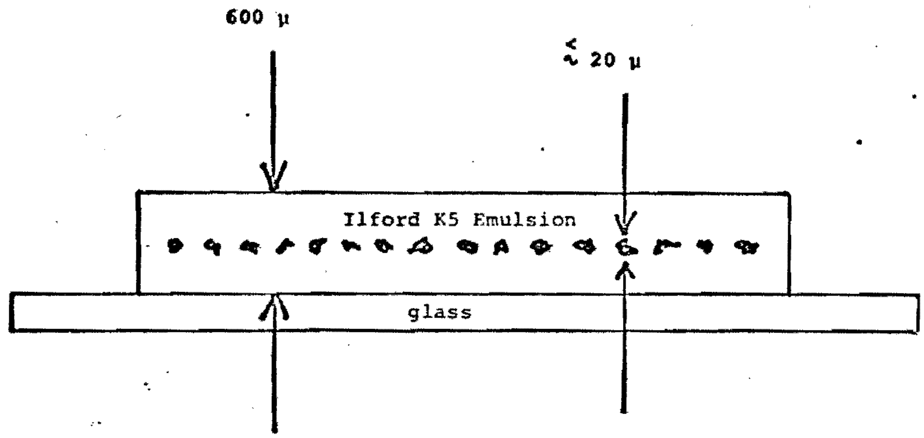

FIG. 1

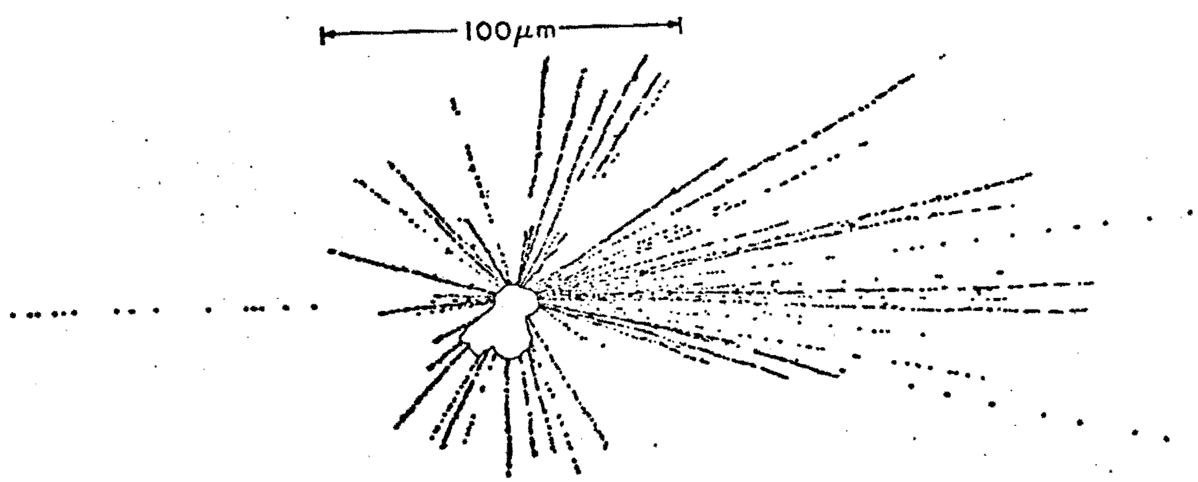

FIG. 2