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A PROPOSAL TO STUDY MULTIPARTICLE PRODUCTION IN INTERACTIONS OF 1 TeV PROTONS WITH EMULSION NUCLEI

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Beam:	At or near 1 TeV protons of flux $\sim 5 \times 10^4$ protons/cm^2 over an area of (8X3)cm^2
Detector:	Emulsion stack of 40 G5 pellicles each of dimensions 10cm x 8cm x .06cm

I. INTRODUCTION

Ever since the discovery of the phenomenon of multiparticle production, nuclear emulsion has been used to study the particle production at high energies. In recent years, its importance as a detector has been increasingly recognised. The reason being that the nucleus acts as an excellent detector for space-time development of hadronic cascade produced in the collision. Such a study is expected to give a better understanding of the fundamental hadron-hadron interaction. The advantage of emulsion lies in its excellent spatial resolution which allows us to determine the angular distribution of the secondary particles to a fair degree of accuracy. The rapidity values of the secondary particles can thus be obtained. It is proposed to study the characteristics of secondary particles in semi-inclusive reactions.

The behavior of the following parameters will be studied.

a. Rapidity distribution,

b. Two particle and higher particle number correlations among the secondary particles, and

c. Distribution of i) shower tracks (n_s, fast particles having ionization $I<1.4\ I_{min}$); ii) grey tracks (n_g, medium energy particles having ionization $10\ I_{min}>I>1.4\ I_{min}$) and iii) black tracks (n_b, low energy particles having ionization $I>10\ I_{min}$).

The ratio (R) of the multiplicity of secondary particles produced in hadron-nucleus interactions to that produced in hadron-hadron interactions and its dependence on rapidity. Nuclear emulsion consists of H, C, N, O (light) and Ag, Br (heavy) nuclei. The interactions belonging to either group of nuclei can be broadly differentiated whilst those belonging to heavy nuclei ($n_h>8$) can be unambiguously identified. Thus the nuclear effects on the various parameters can also be studied.

A brief outline of the importance of the above parameters is given below.

II. PARAMETERS OF INTEREST

a. Rapidity distribution It would be of interest to determine if the single particle rapidity distribution shows a plateau in the central region.

According to Feynman's scaling hypothesis[1] the particle distributions should approach energy independent limits at very high energies. Even the multiperipheral model[2] predicts that the particles in the central region should be uncorrelated with particles produced elsewhere in the chain, and hence independent of both the projectile and the target. We have found that the behavior of the secondary particles in the central region at 50 GeV[3] π^- and at cosmic ray energies[4] is in agreement with this prediction. The behavior of the central region with increase in the primary energy can also be studied. By comparison of the rapidity distribution at 1 TeV with the available data at lower energies (100 GeV, 200 GeV, and 400 GeV), it would be determined if the rapidity distribution shifts towards higher values with increase in primary energy, as predicted by the multiperipheral model[2]. Also the width of the distribution as a function of the primary energy would be investigated.

b. Multiparticle rapidity correlations The subject of correlations among the secondary particles is an area of profound interest. The existence of correlations shows that the secondary particles are produced via the formation and decay of clusters[5]. The parameters that will be studied are the strength of correlation and the cluster size[6]. Correlations among the secondary particles have been studied up to primary energy of 400 GeV on fixed targets. At 400 GeV,[7] the two-particle correlations have been found to dominate. There have been suggestions from cosmic ray interactions[6] at ~1 TeV that besides the two-particle correlations, even three-particle correlations also exist. This means the production of higher mass clusters. Thus there is ample justification to explore the characteristics of cluster production when the primary energy is in the TeV region. At cosmic ray energies (TeV region), it has been shown[8] that there is no change in the value of the strength of correlation with increase in the primary energy. These can at best be treated as trends since the cosmic ray interactions suffer from the usual uncertainties of primary energy and non-monoenergetic primary particles. However, these suggestions can be clearly verified at the Tevatron energy. Azimuthal correlations among the secondary particles is another parameter of interest. All these cluster characteristics can be determined for C, N, O and Ag, Br groups of nuclei, present in emulsion. Thus the nuclear effects upon the clustering phenomena will be investigated.

c. Multiplicity distributions Experimentally, multiciplicity (n) is the most accurately known and easily determinable parameter in high energy interactions. From the theoritical point of view, the special merit of twice the average number of pion pairs ($<n(n-1)>$) and that of f_2 ($<n(n-1)>-<n>^2$) lies in their being highly model dependent.[9] These features single out multiplicity and the other derived parameters as highly attractive candidates for understanding the particle production mechanism in high energy interactions. Although such a study has been done at cosmic ray energies,[10] yet due to the large errors in such events, the results also suffer from uncertainties. With the availablity of the high energy particle beams, it has now become possible to study these parameters at high machine energies. It is attractive not only to study the above parameters but to do so at higher energies is crucial in order to understand the region of applicability of any model.

The distributions of the number of shower tracks (n_s), grey tracks (n_g) and black tracks (n_b) in the events will be determined. By comparing the distribution of n_b with that at lower energies, it will be known whether the evaporation process which determines n_b is dependent upon the primary energy even in the TeV region. The number of grey prongs in an interaction is a monitor of the number of collisions suffered by the primary inside the nucleus. The low values of $R = \frac{n_s(h-A)}{n_s(h-h)}$ observed until 400 GeV[7] shows that the nucleus is mostly transparent at high energies. It will be interesting to determine this value at 1 TeV and also to determine if there is a correlation between the nuclear transparency and the primary energy.

Correlations among n_s, n_g and n_b will also be determined to find the relation between the various processes inside the nucleus which are responsible for the production of such particles.

Finally, a comprehensive comparison of the above parameters resulting from emulsion measurements from 10 GeV-1 TeV will be done.

III. SCANNING AND MEASUREMENT

It is proposed to scan about 4000 interactions (same statistics as in our 400 GeV P-emulsion work)[7] by area scanning. The n_h=0,1 events that are most likely to be missed by this procedure belong mainly to P-nucleon type of events and will not prejudice our results, since we are interested in P-nucleus collisions. However, corrections for this loss will be made by comparing a sample of events obtained from area scan with that obtained by line scan. Angle measurements of the shower tracks will be done by the co-ordinate method. This method is the same as followed in our 400 GeV work[7] and has been given in detail there.

IV. TIME SCHEDULE

We intend to employ five students and scanners for this work. Assuming a scanner to obtain 40 events per day, and considering 20 effective working days in a month, the total number of scanned events per month would be ∿4000. For measurement purposes, assuming 10 events per day per person, the whole scanned data of 4000 events can be measured in four months. The total time for scanning and measurements will thus take about 5 months and we expect to report the first results in about 6-7 months after the exposure.

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