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Study of Proton-Nucleus Interactions in Pure Emulsion Stacks and Emulsion Chambers at Energy Above 800 GeV

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Request

We are asking for an exposure of pure emulsion stacks and emulsion chambers with different targets to a proton beam at energy of 800 GeV or preferably higher.

Physics Motivation and Objectives

It was recognized many years ago [1] and is now generally accepted that the interactions of high energy hadrons with nuclei offer a unique possibility to study the space-time development of the hadronic production process. A nucleus can be treated as a detector which due to its extremely high time resolution can provide an information which cannot be obtained from hadron-hadron collisions. However, in spite of a considerable progress in the study of hadron-nucleus interactions, we are still far from understanding the underlying mechanism. In order to distinguish between the various models it is necessary to go higher with energy where different models give more diverse predictions and comparison with experimental data is expected to be less obscured by phase space effects.

Until now we have done four exposures of pure emulsion stacks at Fermilab, namely: E90 (200 GeV protons), E249 (400 GeV protons), E339 (200 GeV pions), E574 (300 GeV pions). Using the data obtained from these exposures, our already published papers [2 - 15] tackled the following topics:

- multiplicity of both fast produced particles and slow particles emitted from the struck nucleus,
- correlations between the particles produced,
- correlations between various parameters describing the hadron-nucleus interaction,
- inclusive pseudorapidity distributions,
- comparison of our data with different models.

Our analyses [7 - 15] favor the models considering hadron-nucleus interactions as a superposition of independent collisions with nucleons of a struck nucleus. This and other conclusions have to be verified at higher energies. Also we would like to check

our old observations concerning central collisions of nucleons with heavy nuclei at energies higher than 1 TeV [16]. Our findings were based on scarce data from pure emulsion stacks (ICEF, Brawley) exposed to cosmic rays at high altitudes. Especially an observation of bimodality of angular distribution of particles produced in collisions with emulsion nuclei (not observed in proton- proton collisions e.g. at ISR) should be scrutinized. Therefore we are asking for an exposure of pure emulsions to Fermilab proton beam at energy higher than 800 GeV.

To study the mass number (A) dependence of various parameters and spectra we would like to expose also emulsion chambers with different target elements in front and lead-emulsion shower detectors downstream. The shower detector will be used to measure the energy going into gammas i.e. inelasticity coefficient K_{π^0} and π^0 transverse momenta.

Technical Details

We would like to expose the following stacks and chambers to 800 - 1000 GeV proton beam at Fermilab:

1. Three stacks consisting of about 25 emulsion pellicles (600 microns thick) with dimensions 4 x 6 cm^2. The emulsion surfaces will be oriented parallel to the beam within the accuracy of 10 mrad. The accumulated beam density should be about 5 x 10^4 protons / cm^2 (a total of $\sim 10^6$ protons).

The stacks dimensions and beam requirements are the same as in our previous experiments (E90, E249, E339, E574).

2. Five emulsion chambers with dimensions of 6 x 6 x 4 cm^3, consisting of plates of different elements sandwiched between emulsion pellicles. Each of these target chambers will be augmented by a spacer and a shower detector chamber, 10 c.u. (7 cm) in depth and transverse dimensions 6 x 6 cm^2, consisting of lead plates and emulsion pellicles. The chambers are similar to those used in experiments E336 [17] and E503 [18].

The chambers will be exposed with their ingredient plates

perpendicular to the beam direction. The accumulated beam density should be about 5×10^3 protons / cm^2 (a total of $\sim 10^6$ protons).

Scanning, measurements and analysis of data will be performed in the Laboratory of High Energy Physics of the Institute of Nuclear Physics at Krakow, Poland.

From pure emulsion stacks we intend to collect 1000 - 2000 of unbiased interactions by systematic following the primary proton tracks. From emulsion chambers we aim to have samples of 100 - 200 interactions with each of the target elements used.

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