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DIMUON PRODUCTION BY PIONS AND PROTONS AT FERMILAB*†

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ABSTRACT

Recent results from measurements of $\mu^+\mu^-$ pairs produced by incident π^-'s of 200 GeV and protons of 240 GeV on an Fe target are reported.

As a result of the very limited space in these proceedings the physics discussed in this paper will be limited to only the most recent results from our experiments. Other results of our measurements and details of the techniques can be found elsewhere.(1-3)

The reactions studied were:

$$\pi^- + Fe \rightarrow \mu^+ + \mu^- + \text{anything}, \; P_B = 200 \text{ GeV} \qquad (1)$$

and

$$p + Fe \rightarrow \mu^+ + \mu^- + \text{anything}, \; P_B = 240 \text{ GeV} \qquad (2)$$

where P_B is the monoenergetic beam momentum.

In Fig. 1 we plot the measured cross section $d\sigma/dM_{\mu\mu}$ versus $M_{\mu\mu}$ (dimuon mass) for $1.2 \leq M_{\mu\mu} \leq 5.0$ GeV. Since the π^- and p data were taken at somewhat different beam momenta, the cross sections in Fig. 1 correspond to events in the same X range, $X \geq 0.375$ where $X \equiv P_L/P_B$ and P_L is the total laboratory dimuon momentum

It is of interest that for this X region, the π^- and p cross sections have essentially the same dependence on dimuon mass. In the region $1.2 \leq M_{\mu\mu} \leq 2.0$ GeV the cross sections for both the π and p data are well represented by the form: $d\sigma/dM_{\mu\mu} \propto M^{-N}$ where $N \sim 7$. However, in the interval $1.2 \leq M_{\mu\mu} \leq 5.0$ GeV and for $X \geq 0.375$ the π^- cross section (reaction (1)) is a factor of ~ 3.4

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times larger than the p cross section (reaction (2)). We have also examined the behavior of the cross sections $d\sigma/dP_\perp^2$ (where $P_\perp$ is the dimuon laboratory transverse momentum) for $1.2 \leq M_{\mu\mu} \leq 2.5$ GeV and $X \geq 0.375$. We find that for both the π and p data this cross section takes the form $d\sigma/dM_{\mu\mu} \propto \exp(-bP_\perp^2)$ where for both reactions (1) and (2) $b \sim 1.\ \mathrm{GeV}^{-2}$. In this same $M_{\mu\mu}$ and X region the cross sections $d\sigma/dX$ are well represented by the form $d\sigma/dX \propto \exp(-aX)$ where $a_\pi \sim 3.$ and $a_p \sim 6.$ Thus, it appears that in this $M_{\mu\mu}$ and X region the $M_{\mu\mu}$ and $P_\perp^2$ dependencies of the cross sections are approximately the same independent of whether the incident particle is a π^- or a p whereas the X dependencies are quite different.

The results discussed above for $M_{\mu\mu} < 2.5$ GeV are still tentative since the analysis is still incomplete. The distortions of the data which result from the limited resolution of the apparatus are still being studied. For example, the predominant feature of the dimuon mass spectra from reactions (1) and (2) is a large peak[1-3] in the region of the ρ. As a result of the limited mass resolution of the apparatus, many of the events in the $1.2 \leq M_{\mu\mu} \leq 2.5$ GeV region may be due to the ρ.

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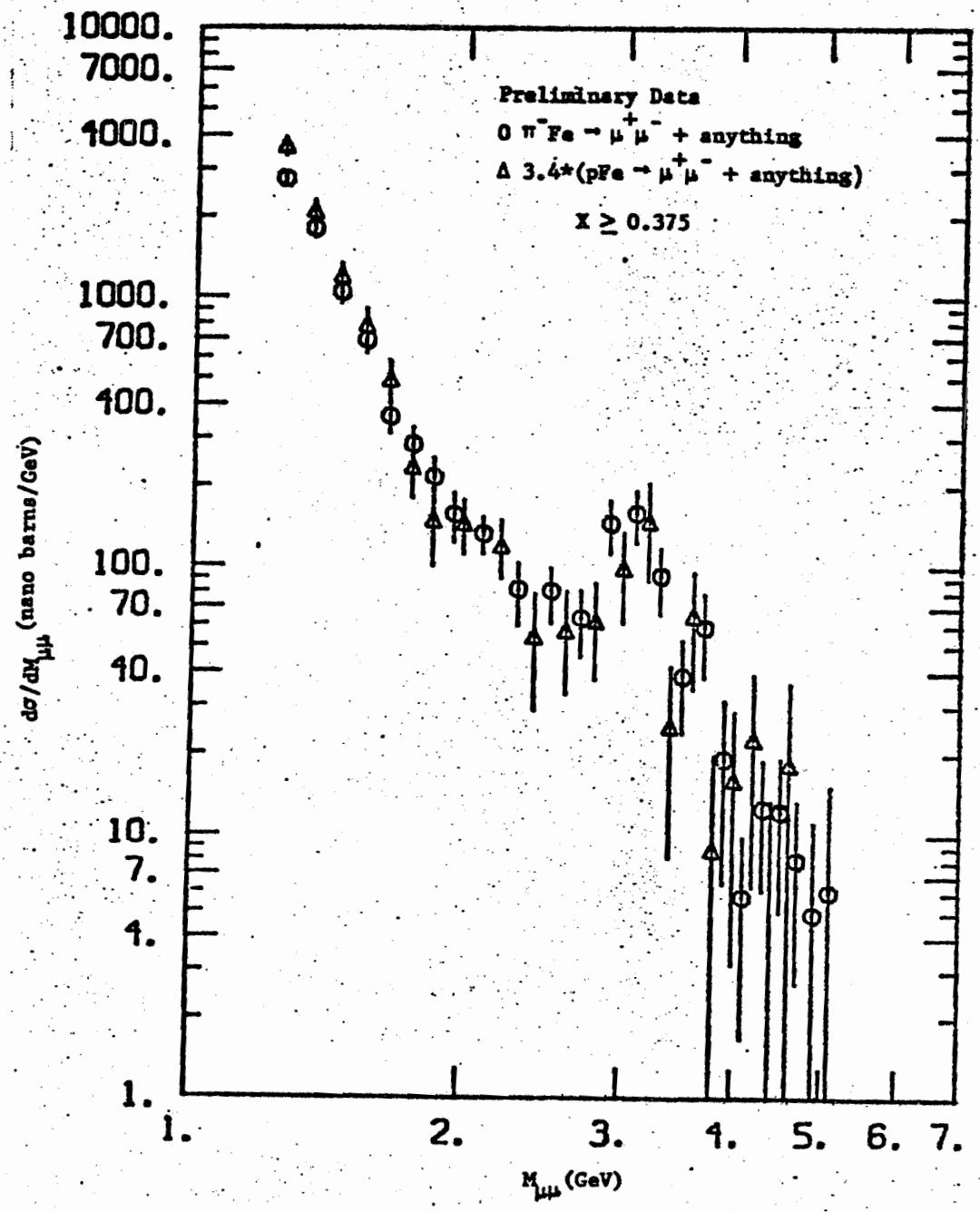
Fig. 1. The cross section for reactions (1) and (2) versus $M_{\mu\mu}$. The cross sections are derived assuming total πFe and pFe inelastic cross sections of ~ 0.7 barns. For the cross sections plotted above, the relative normalization uncertainty between the πFe and pFe cross sections is estimated to be less than ± 20%, and the uncertainty in the overall scale for the cross sections is estimated to be ± 50%.