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Abstract of Paper for Session A1

Elastic Scattering at 100 and 200 GeV/c[†]

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In an experiment at FNAL elastic differential cross sections for $\pi^{\pm}$, $K^{\pm}$ and $p^{\pm}$ have been measured in the range $.07 < -t < 1.0(GeV/c)^2$. Data will be presented at momenta of 100 and 200 GeV/c. The cross sections deviate substantially from exponentials at $-t > .3(GeV/c)^2$.

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Elastic Scattering at 100 and 200 GeV/c

In an experiment at Fermilab we are measuring the elastic differential cross sections of $p^{\pm}$, $K^{\pm}$, and $\pi^{\pm}$ on hydrogen over an extended t range. The first results of these measurements at 100 and 200 GeV/c between $.07 < -t < 1.0(GeV/c)^2$ are presented in this paper.

The apparatus consists of a double arm spectrometer with magnetic analysis in the forward arm. The direction of the beam is defined by counter hodoscopes to .09 mr and the transverse position to 1.5 mm. The forward geometry is determined by three sets of spark chambers plus magnets which bend the particles through 20 mr. The drift distances used for momentum measurement before and after the magnet are approximately 15 m each. A fourth set of chambers measures the position and direction of the recoil proton.

An elastic event is defined by opening angle, coplanarity and missing mass as measured by the momentum in the forward arm. Employing these criteria, there is negligible background.

Particle identification is done by means of one threshold and two differential Cerenkov counters in the beam. In addition, there are two threshold counters in the forward arm. The spark chambers are triggered by requiring a particle in both the forward and recoil arm of the spectrometer.

Data is collected over the entire t range at one time. Azimuthal angular acceptance is determined by the recoil geometry. It is therefore virtually independent of energy and particle type and varies by less than 10% over the t range under consideration.

The simple geometry and trigger requirement minimizes the possibility of systematic energy and t dependent bias.

The differential cross sections for the six particles are shown in Fig. 1 (at 200 GeV/c the K^- and $\bar{p}$ flux was low and the data were not considered statistically significant enough to present). The outstanding feature of the data is the non-exponential behavior of the cross sections. The deviation from exponential behavior is characteristic of all the data except for $\bar{p}p$. The lines shown on Fig. 1 are best fits to an exponential for $-t < .3$. The absolute normalization is still being considered. The errors shown are only statistical.

The data on pp scattering does not extend to small enough angles to clearly observe the forward peaking for $-t < .1(\text{GeV/c})^2$ which is seen at ISR energies. In the angular range covered, only $\bar{p}p$ elastic scattering is consistent with a pure exponential. The slope for $\bar{p}p$ is a natural extrapolation of the slopes measured at lower energies and the exponential behavior is in agreement with the Serpukov data.[3] The pp slopes fall on the line interpolated from the ISR and low energy data.[1,4,7]

While the meson-proton data is inconsistent with a pure exponential the nature of the deviation is not clear. The region $.07 < -t < .3(\text{GeV/c})^2$ can be fit by an exponential Ae^{bt}. The slope parameters, b, determined from such a fit are shown in Fig. 2. The short range of -t results in rather large errors on the slope parameter, however the shrinkage with energy is

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evident for all reactions. A likely possibility is that a continuous curvature exists, that is the value of b decreases continuously as -t increases. Any number of different mathematical expressions might be used to parameterize this behavior.

We would like to thank the crew of the accelerator and the meson laboratory for their effort and cooperation.

References

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3. Yu. Antipov et al., Nucl. Phys. B57, 333 (1973).
4. D. Harting et al., Il Nuovo Cimento 38, 60 (1965).
5. A. Derevchekov et al., Phys. Letters 48B, 367 (1974).
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7. G. Barbiellini et al., Phys. Letters 39B, 663 (1972).

Figure Captions

1. Differential cross sections for various particles on protons at 100 and 200 GeV/c.
2. The slope parameter b for a fit to the form e^{bt} in the range $.07 < -t < .3 (GeV/c)^2$. Data from References 1-7. The ISR data in Reference 7 are for $.138 < -t < .24 (GeV/c)^2$.

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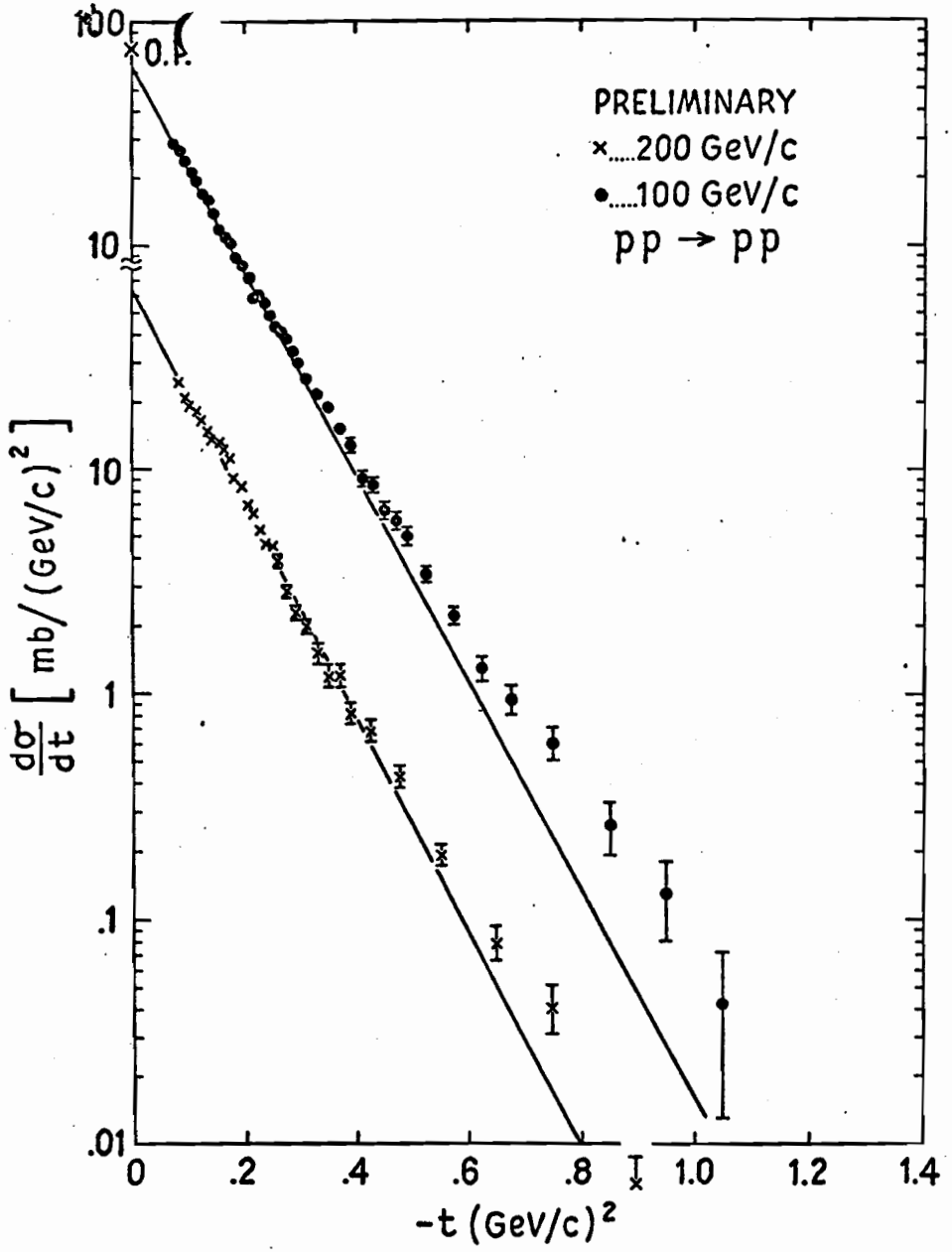

Figure 1a

p-p data does not extend low enough to see forward peaking for $|t| < 0.1$ as at ISR

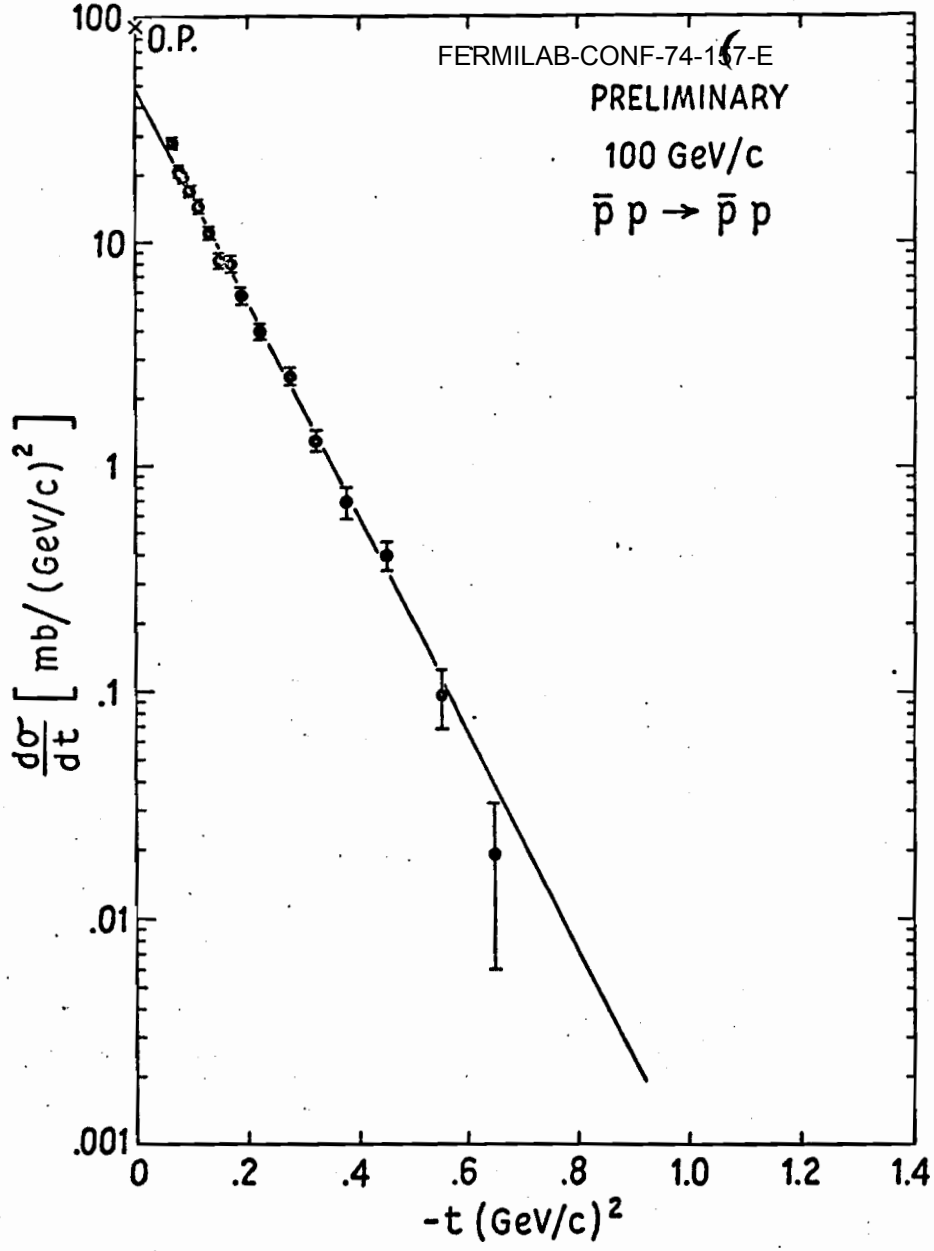

Figure 1b

200 GeV fluxes too low and data not statistically significant enough

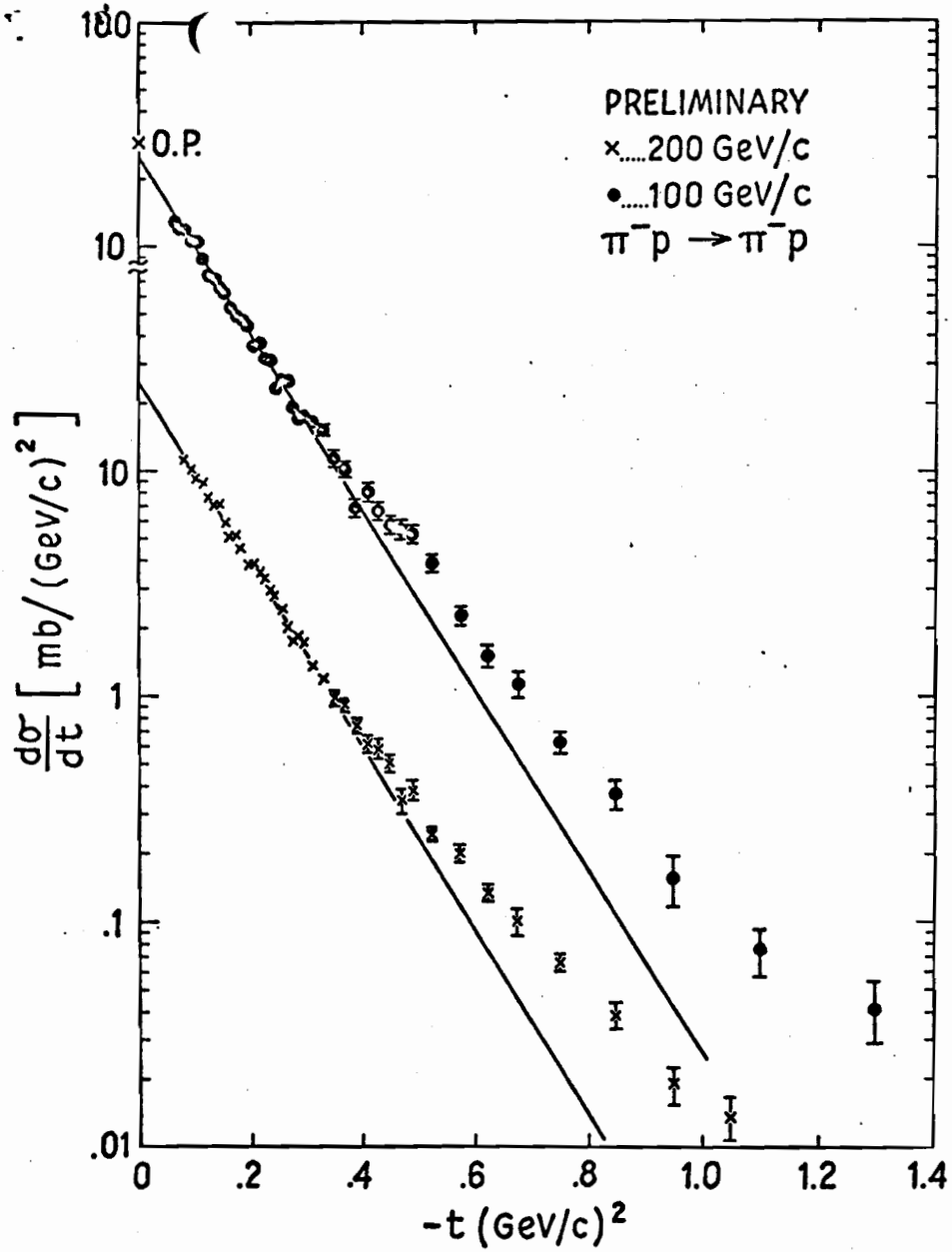

Figure 1c

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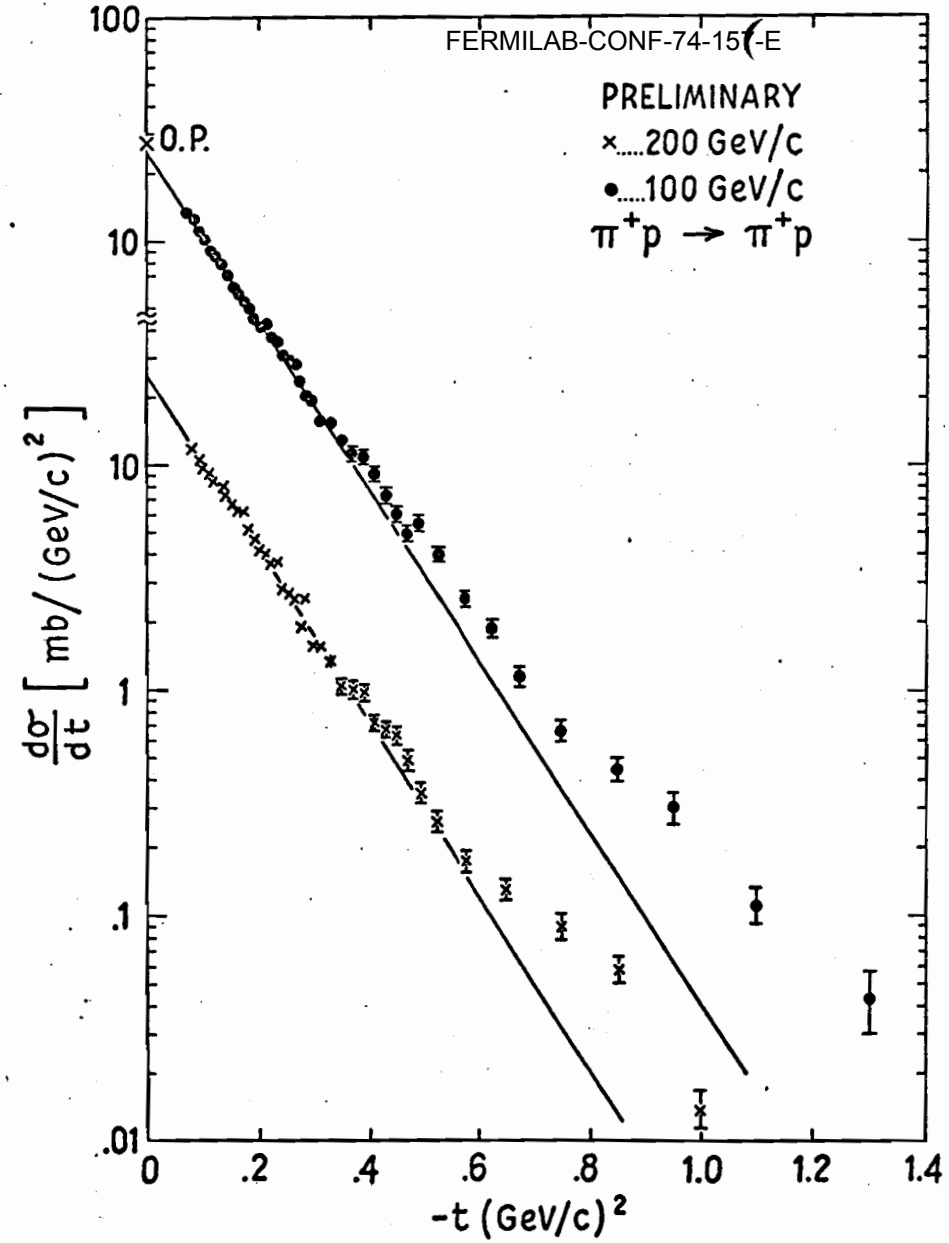

Figure 1d

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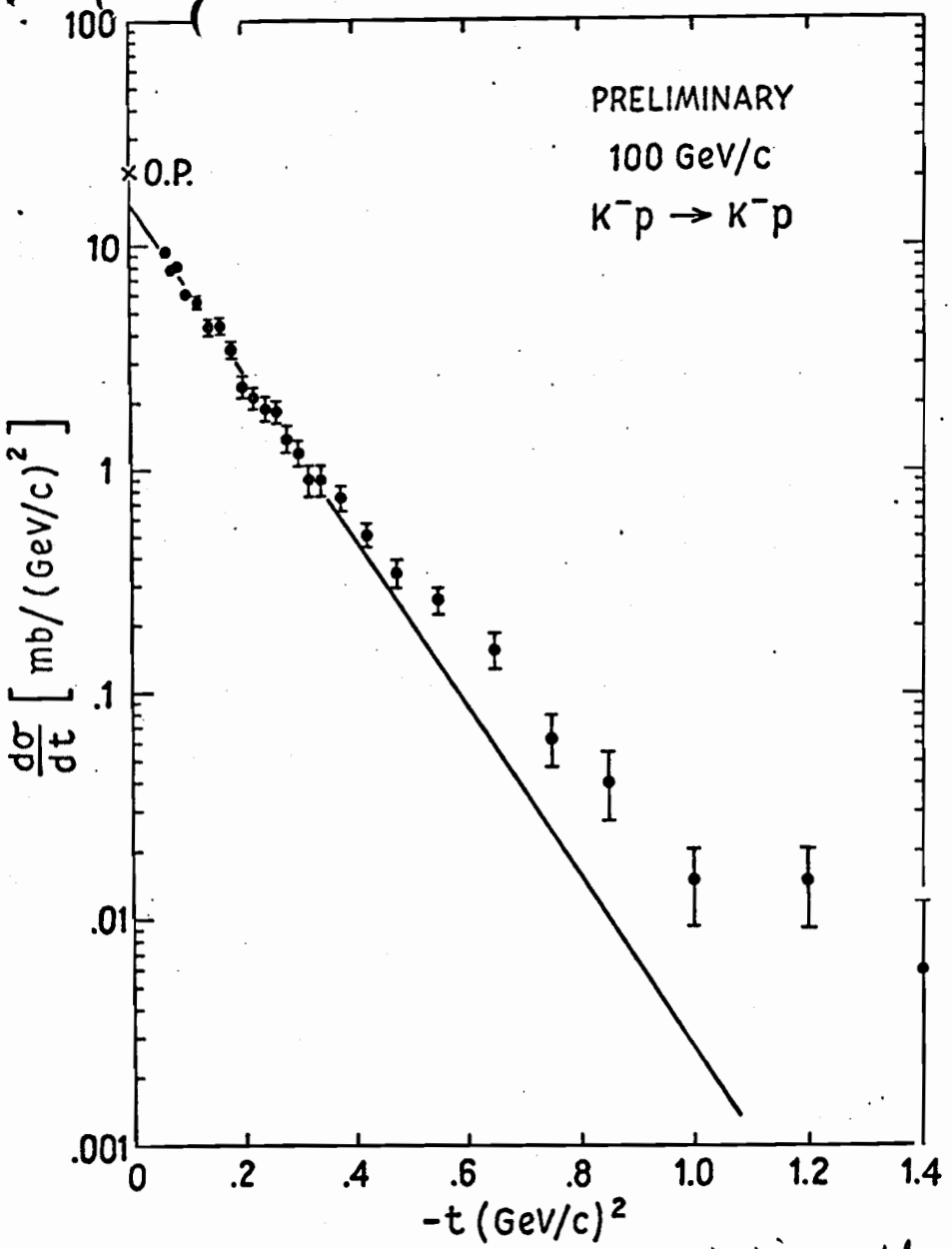

Figure 1e

statistics problems @ 200

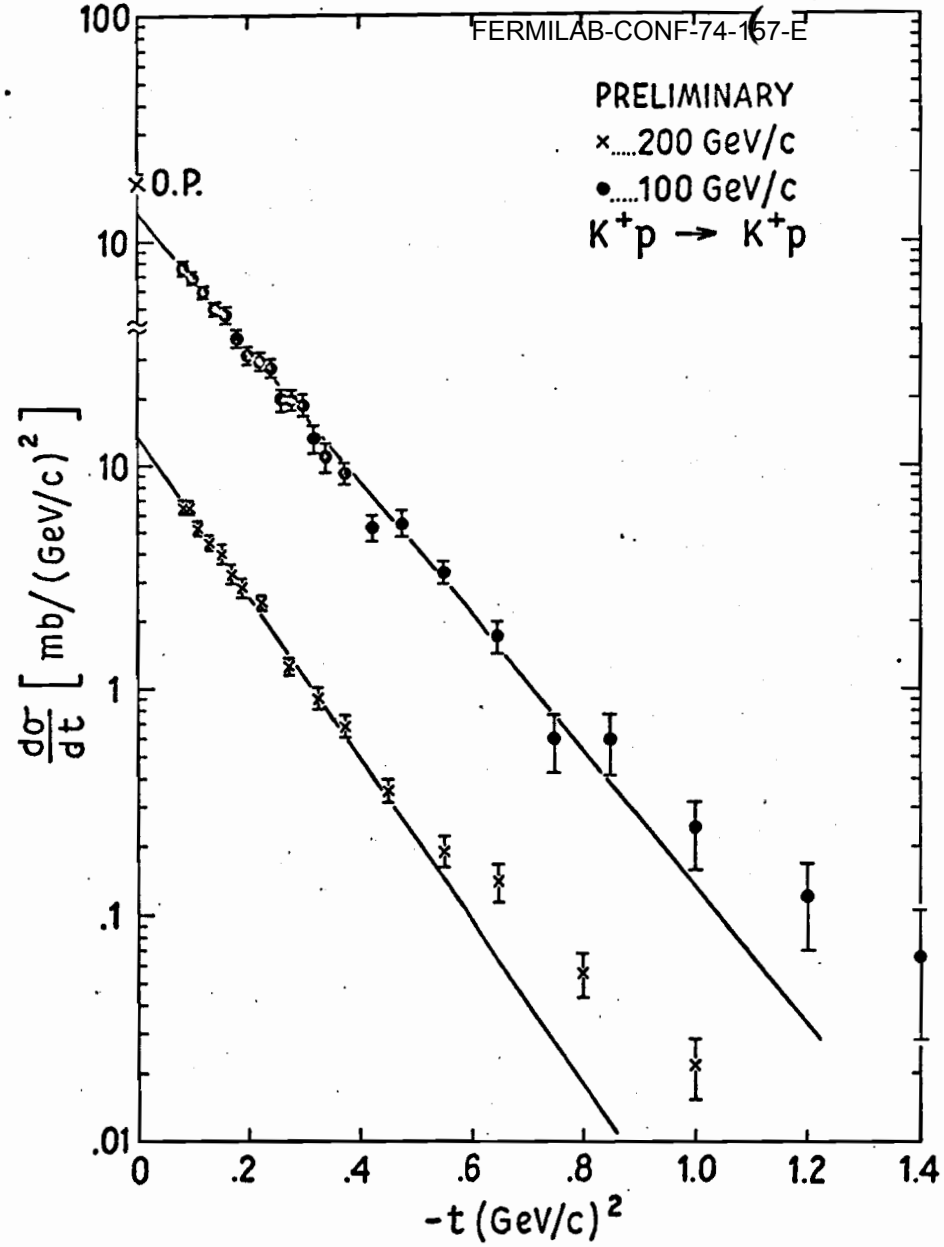

Figure 1f

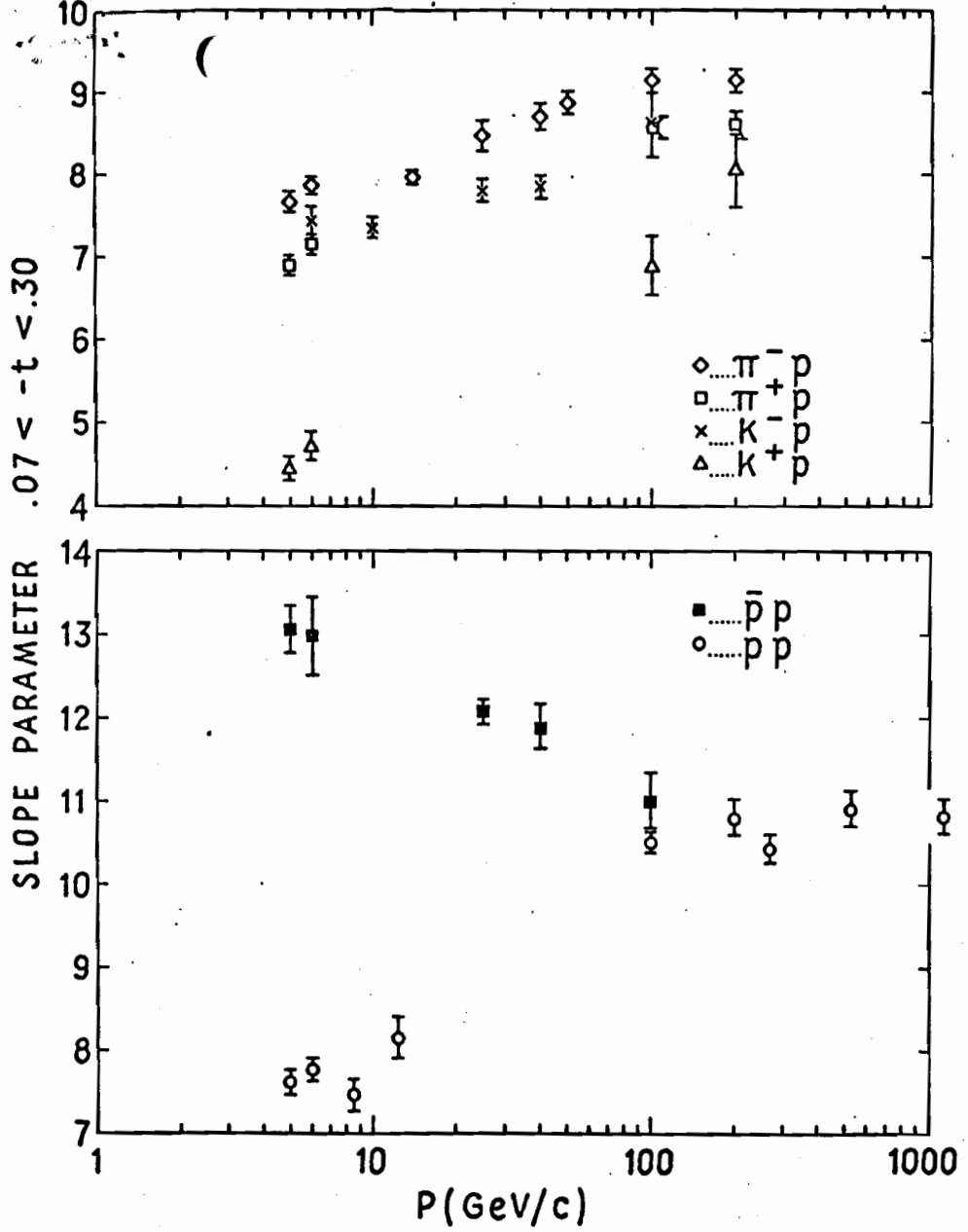

Figure 2

Possible continuous curvature of slopes for meson data

pp slopes fall on line interpolated from ISR and low energy data

$\bar{p}p$ slopes are natural extrapolation of lower energy data & in agreement with Serpukhov

General:

1) Outstanding feature - non exponential behavior
2) Lines are best fits for $|t| < 0.3$
3) Normalization still being considered. Errors are only statistical