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PRODUCTION CROSS SECTIONS OF PIONS, KAONS AND PROTONS IN PROTON-PROTON COLLISIONS

D. Dekkers, J.A. Geibel, N.M. King, R. Mermod, G. Weber,
T.R. Willitts, E.J.N. Wilson and K. Winter

CERN - Geneva

B. Jordan, M. Vivargent

Institut du Radium (Orsay)

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PRODUCTION CROSS SECTION OF PIONS, KAONS AND PROTONS IN PROTON-PROTON COLLISIONS

Absolute cross sections for the production of various particles in proton-proton and proton-nucleus collisions at angles of 0 and 100 mrad and at incident momenta of 18.8 and 23.1 Gev/c have been measured.

Only data on pion, kaon and proton production in proton-proton collisions at 18.8 Gev/c incident momentum will be presented here, a full account of the work will be published later.

A scattered proton beam of the CERN proton synchrotron was brought to a focus of 2×3 cm^2, containing some 10^7 protons per burst. The neutron contamination was determined to be less than 1%.

The incident intensity was monitored by a counter telescope looking at secondaries leaving the target at 5° which was calibrated, using a small defining scintillator in front of the target. The calibration was reproducible within ± 3% .

Secondary particles produced in the target were momentum analysed and brought to a focus by a spectrometer consisting of a quadrupole triplet and a bending magnet (Fig.1). Guard counters limited the effective aperture of the quadrupoles and defined an average solid angle of 0.1 msr, over a momentum band of 10%.

In the 0° position the incident proton beam traversed the spectrometer together with secondaries produced in the target and was separated from these by the analysing bending magnet. The guard counters vetoed secondaries produced inside the spectrometer.

Pions, kaons and protons were identified by Čerenkov counters (Fig.1). Electrons were vetoed by a threshold Cerenkov counter and muons by a scintillator placed behind 1 m of iron.

The data presented have been corrected for decay, absorption in the target and in the counters, and for multiple scattering. Errors shown are statistical only. A 10% systematic error is assigned to all points. Individual points have a further systematic error of 10%.

Figure 2 shows the proton spectra at 0 and 100 mrad. In the forward direction the production increases roughly exponentially with momentum between 4 and 12 Gev/c. Similar results have been derived from an analysis of two-prong events in a hydrogen bubble chamber[1]) and from cosmic ray data. This peaking in the vicinity of the maximum momentum reflects the importance of quasi-elastic processes. Comparison with the proton spectrum at 100 mrad gives some information on the transverse momentum distribution.

Figure 3 shows the pion spectra. The high-energy tails are roughly exponential at both angles, but in the forward direction the spectra turn over at about 6 Gev/c. The shape of the spectra for positive and negative pions is rather similar at 100 mrad; in the forward direction, however, there is a strong difference in shape. Also the positive to negative production ratio changes drastically from 0 to 100 mrad. These features are less pronounced in nuclei and tend to disappear with increasing atomic number

The kaon spectra, shown in Fig.4, are similar in shape to the corresponding pion spectra. In the forward direction the spectra of positive and negative kaons are even more different in shape than in the case of pions; the positive to negative ratio is strongly momentum dependent, reaching a value of 20 at 12 Gev/c, and decreasing at the angle of 100 mrad. These features are also attenuated in heavier nuclei.

Figure 5 shows a plot of the ratio of cross sections at 100 mrad and 0 mrad versus momentum. The data are well approximated by an exponential law, suggestive of a transverse momentum distribution as proposed by Cocconi, Koester and Perkins[2]). The mean transverse momentum is always larger for negative particles, the positive particles being more peaked forward.

The mean transverse momenta deduced from this plot are larger than the ones obtained by Cocconi, Koester and Perkins from data at larger angles.

REFERENCES

1 D.R.O. Morrison, Aix-en-Provence International Conference, Proceedings, Vol.I, p. 407.

2 G. Cocconi, L.J. Koester, D.H. Perkins, UCRL - 10022 (1961), p. 167.

FIGURE CAPTIONS

Figure 1 Spectrometer and counter telescope.
M_{1-3} calibration scintillators, Q_{8-10} quadrupoles, B_4 bending magnet, G guard counters, S_{1-6} scintillators, C_1 C_3 threshold Čerenkov counters, Cd differential Čerenkov counter.

Figure 2 Differential cross sections for proton production at 0 and 100 mrad in proton-proton collisions at incident momentum of 18.8 Gev/c.

Figure 3 Differential cross sections for the production of positive and negative pions at 0 and 100 mrad in proton-proton collisions.

Figure 4 Differential cross sections for the production of positive and negative kaons at 0 and 100 mrad in proton-proton collisions.

Figure 5 Ratios of cross sections at 100 mrad and 0 mrad for pions and kaons as a function of momentum.

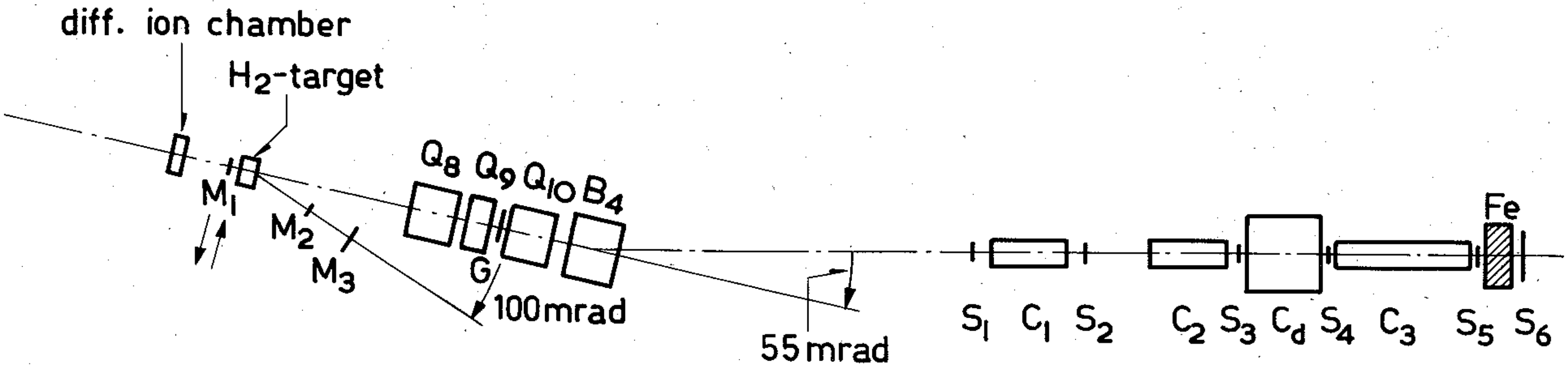

FIG. 1 SPECTROMETER AND COUNTER TELESCOPE

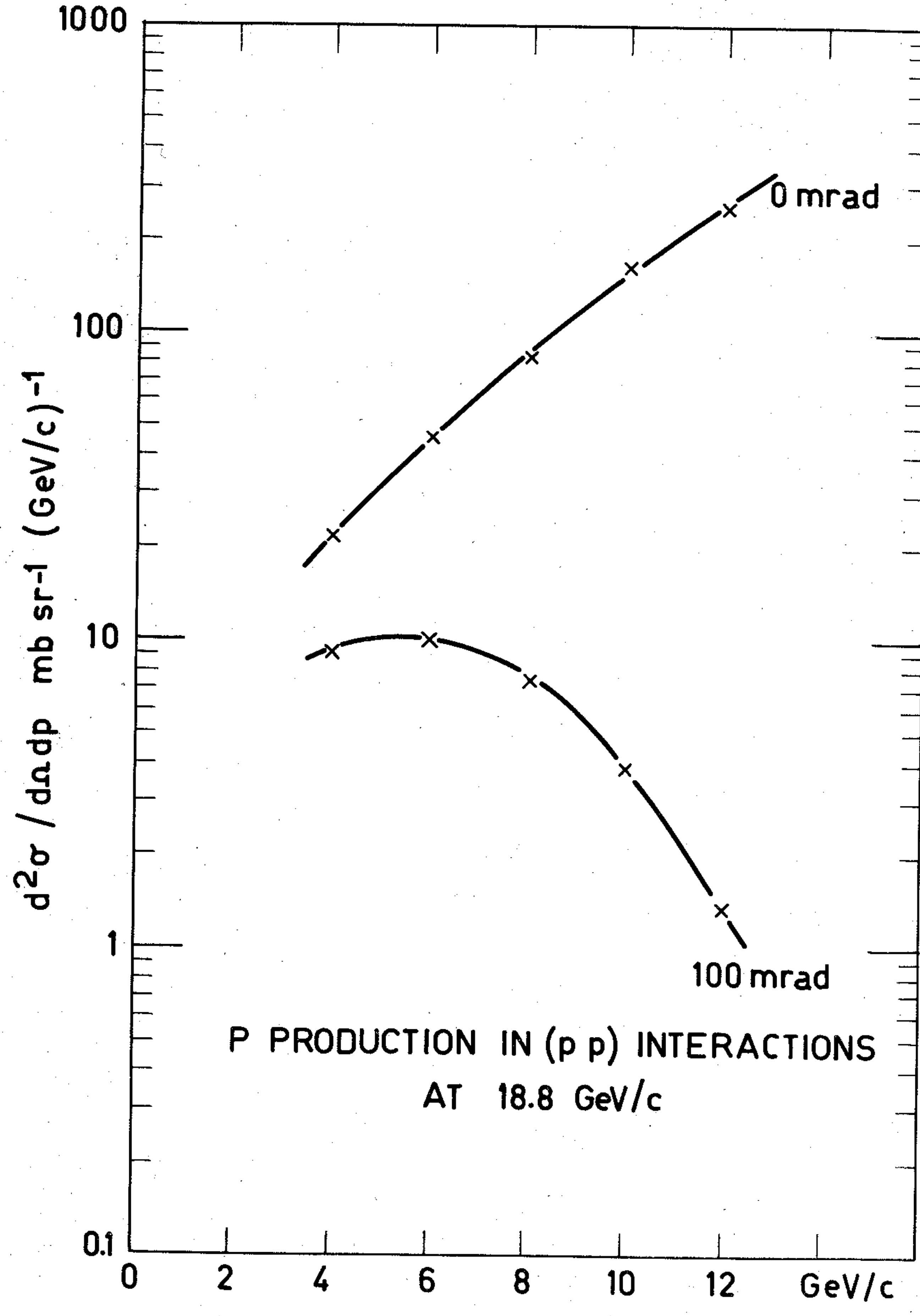

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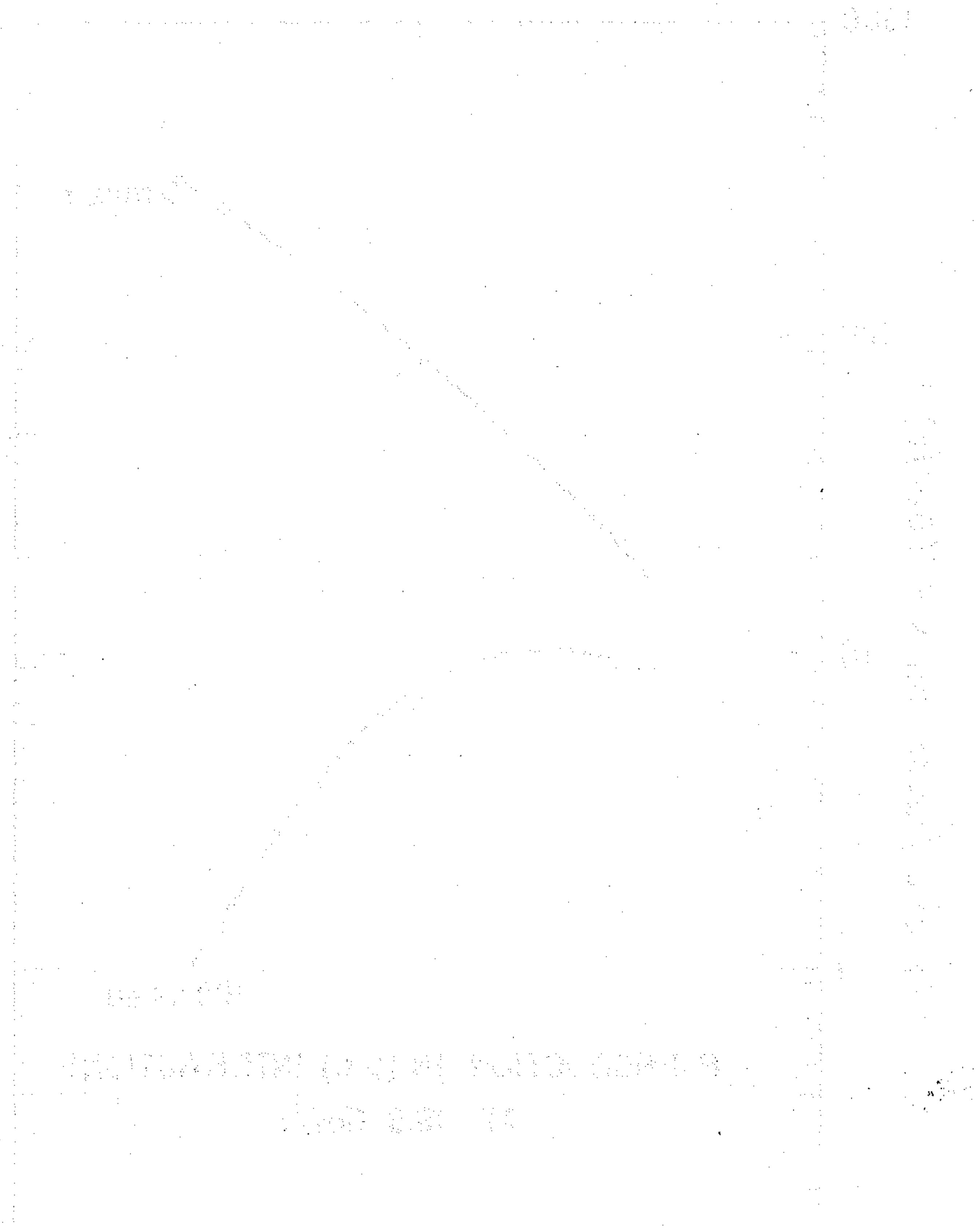
FIG. 2



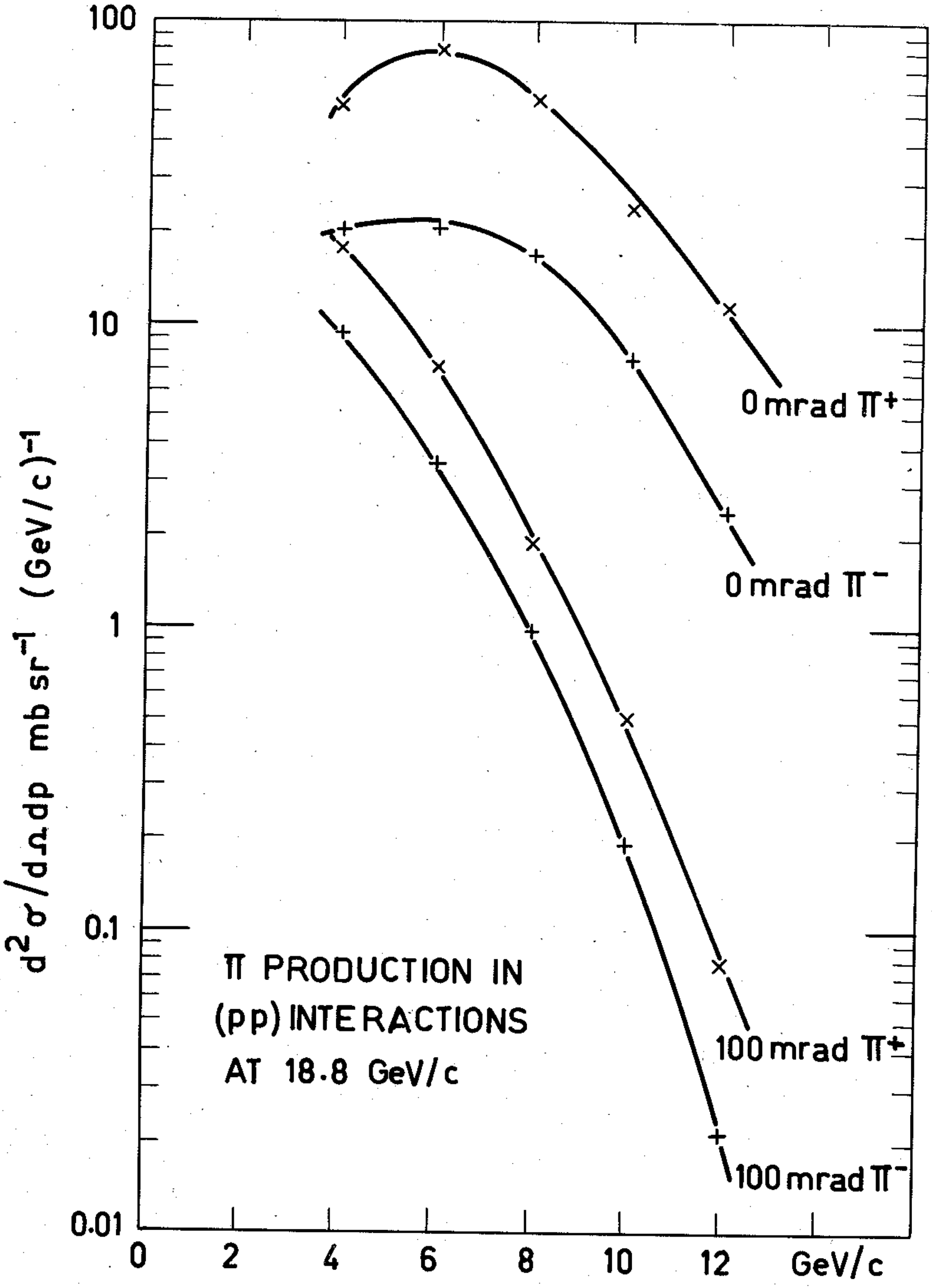
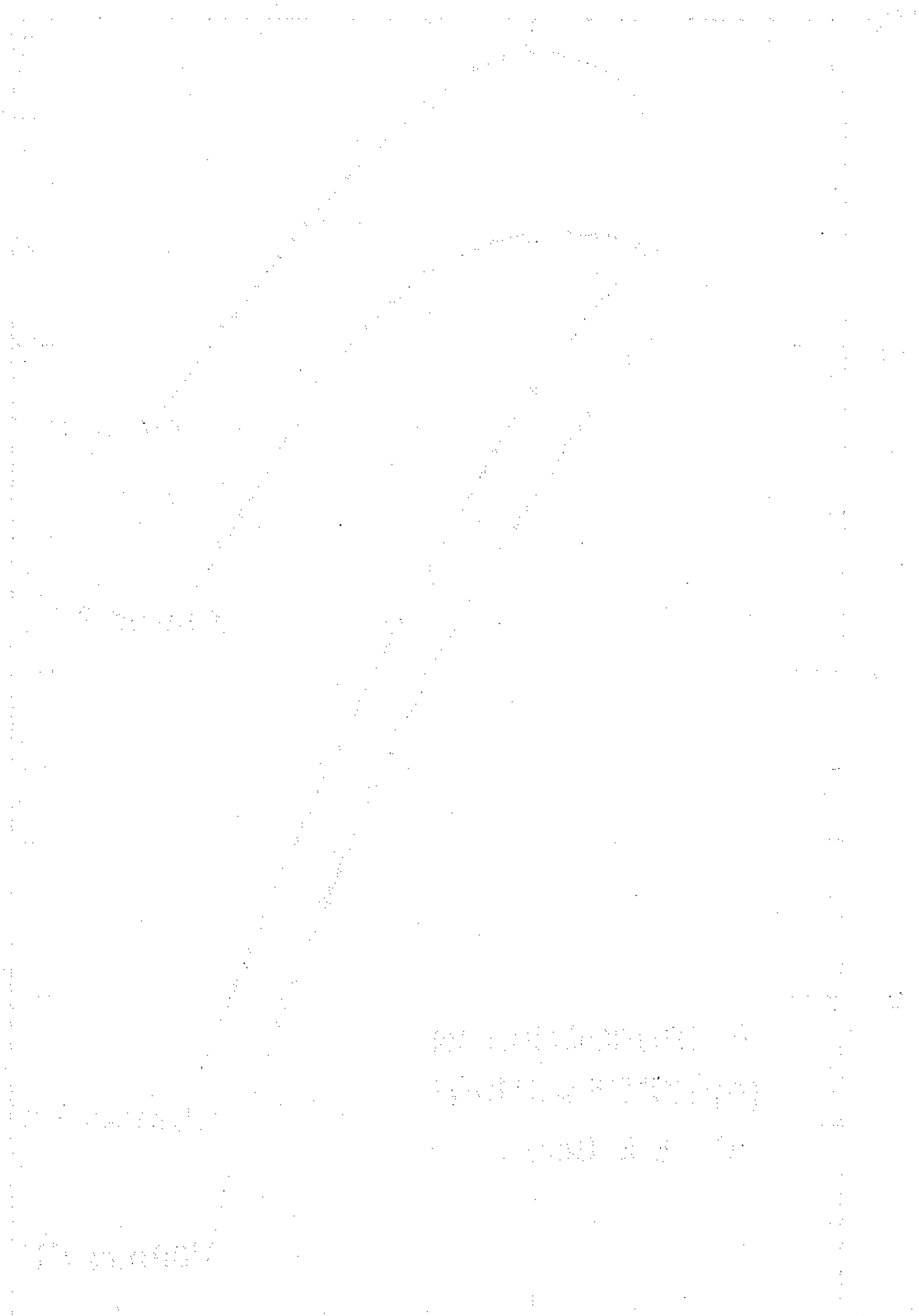

100
10
1
0.1
0.01
0
2
4
6
8
10
12
GeV/c
$d^2\sigma/d\Omega dp$ mb sr^{-1} (GeV/c)$^{-1}$
0 mrad π+
0 mrad π−
100 mrad π+
100 mrad π−
π PRODUCTION IN
(pp) INTERACTIONS
AT 18.8 GeV/c

FIG. 3



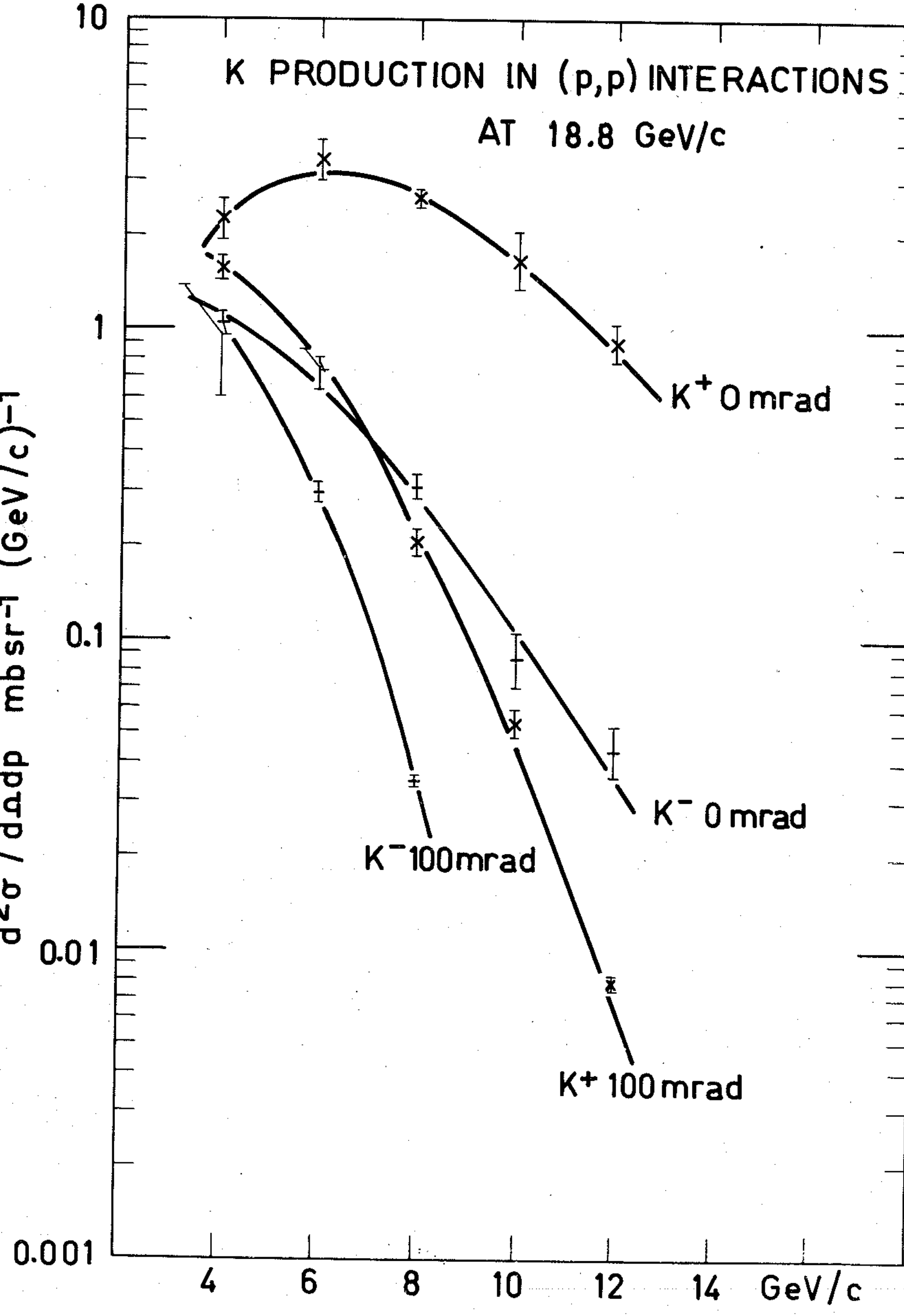


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FIG. 4

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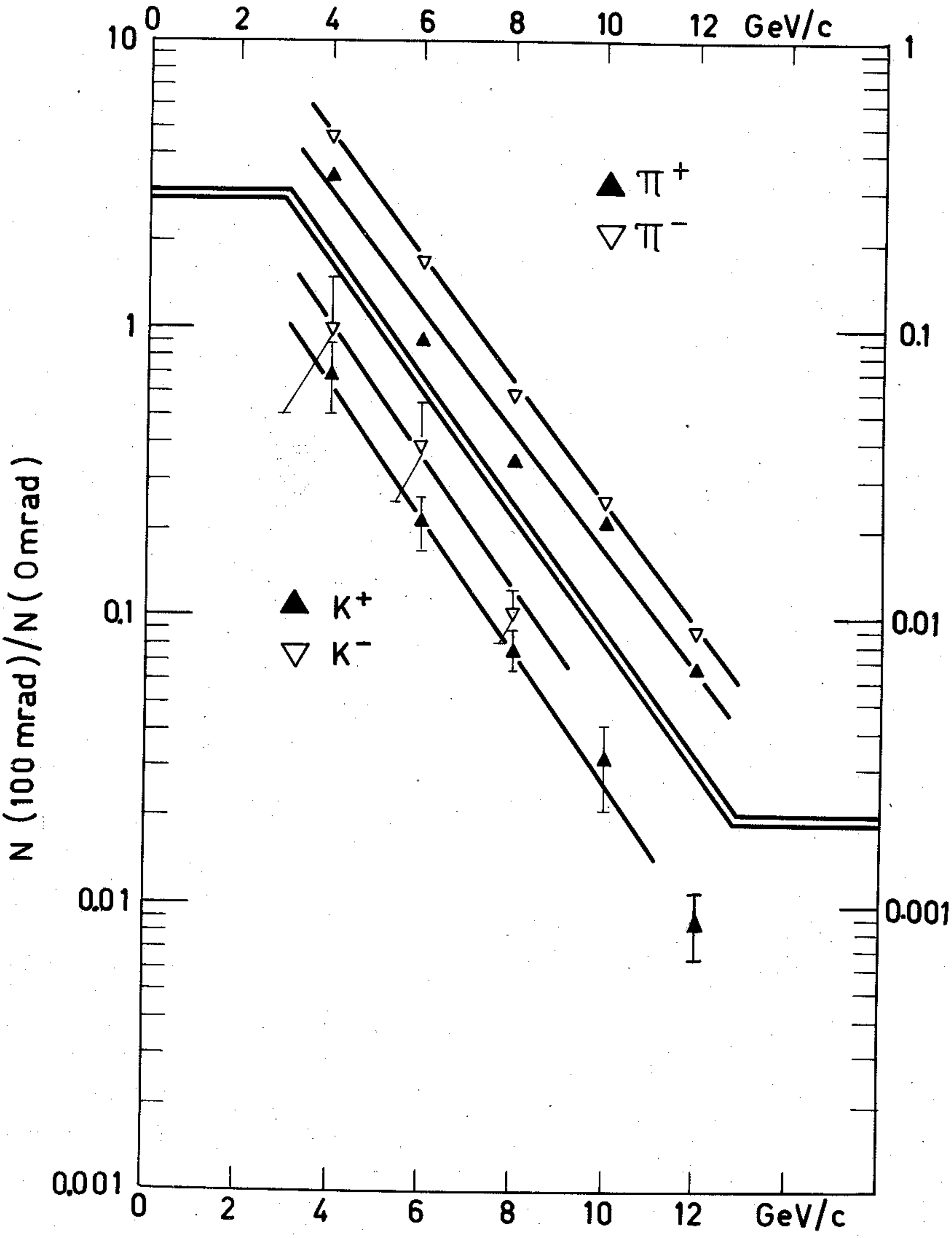

FIG. 5

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