ELECTROPRODUCTION MEASUREMENTS AT CORNELL (#'s 388, 420, 942, 949, 952)

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I have been asked to report on five coincidence electroproduction papers submitted by groups working at the Wilson Electron Synchrotron at Cornell University.

The Cornell Electron Scattering group has submitted three papers to the conference.[1] They have measured the cross section for the detection of an inelastically-scattered electron in coincidence with a hadron emerging at large angles to the virtual photon direction. This coincident hadron, either a pion or a proton, was emitted backwards in the center-of-mass of the virtual photon-proton system.

Figure 1 shows the distribution in transverse momentum squared of the pion events. The slopes are all about 9.5 GeV^{-2} with no immediately obvious trend in either Q^2 or x. For all events, W, the total virtual photon-proton center-of-mass energy was 3.0 GeV. These distributions can be integrated over all angles and normalized by $\sigma_{tot}(\gamma_v p)$ to give an average multiplicity of pions in the x range specified. This average multiplicity shows little or no increase with Q^2 as some models might predict.

Figure 2 shows the missing-mass distribution obtained when the proton is the coincident hadron. Notice that the ρ is acting quite differently as a function of Q^2 from the background. Let us sidestep the problem of separating the ρ from the background and look instead at the distributions of proton events which have a missing mass greater than 1 GeV.

Figure 3 shows the t-distribution of the proton events for four bins in missing-mass squared and for three different values of Q^2. The change in slopes of the fits is gradual, essentially independent of m^2 and decreasing somewhat with Q^2.

Figure 4 indicates the slopes obtained for all the high mass recoil protons plotted versus Q^2. The slope is probably decreasing slowly with Q^2.

Now I would like to move on to the data of the Harvard-Cornell collaboration. This group detected an inelastically-scattered electron in coincidence with a fast hadron emerging forward along the direction of the virtual photon. The group has analyzed data taken at two points in the deep-inelastic scaling region. Notice

Point 6 $W = 2.15$ $Q^2 = 1.2$ $\omega = 4.1$

Point 7 $W = 2.67$ $Q^2 = 2.0$ $\omega = 4.1$

the points lie on a line of constant ω.

Figure 5 shows the missing-mass spectrum obtained from electron-pion coincidences at the higher energy point. The shape of the spectrum at the lower energy point, scaled down by a factor 2.34, is indicated by the curve.

There is a strong signal at both points from the two-body pion electroproduction channel.

$$\gamma_v + p \rightarrow \pi^+ + n$$

The data in this peak have been analyzed using a Born-type theory in order to extract the value of the pion form factor.[2]

The shape of the inclusive part of the π^+ spectrum is displayed in Fig. 6 plotted as a function of the Feynman scaling variable x. Note the structure functions are normalized by the total virtual photon-proton cross section. The conclusion is at constant ω, the structure function scales in x and has roughly a form 1/x.[3] In the region $0.5 < x < 0.9$ the pions have an exponential distribution in transverse momentum with a slope of about 6.5 GeV^{-2} at both data points.

The group also has data on π^- at the higher data point only. Figure 7 shows the ratio of the structure functions of π^+'s to π^-'s as a function of x. The ratio is close to 1 for $x < 0.3$ but is consistently greater than 1 for large x.

Turning now to Fig. 8 we see the missing-mass spectrum for kaon electron coincidences. There is a slight proton contamination in this spectrum which accounts for the events above the physical end of the spectrum at the Λ mass. The two-body channels $K^+\Lambda^\circ$, K^+Y° (1385), K^+Y° (1520) are quite prominent at both data points but the continuum of kaons does not appear large or unusual at the two data points.

The group also presented data on the proton spectrum which indicated that the identifiable two-body channels, 180° $p\pi^0$ and 180° pV^0 were dropping rapidly with energy and that the continuum of protons was being emitted in the backward hemisphere in the center-of-mass. Some theories would predict that protons should become more copious in the forward hemisphere as Q^2 increases; this was not seen in the data.

References

1. D. G. Cassel et al., Inclusive Pion Distributions in Electroproduction, #388; D. G. Cassel et al, Inclusive Proton Distributions in Electroproduction, #942; D. G. Cassel et al., Inelastic Proton Distributions in Coincidence Electroproduction, #949.
2. F. M. Pipkin et al, A Measurement of the Pion Form Factor at $k^2 = 2.0$ GeV^2, #420.
3. F. M. Pipkin et al., Preliminary Report on a Study of Scaling in the Inclusive Electroproduction Reactions $e^- + p \rightarrow e^- + \pi^\pm + X$, #952.

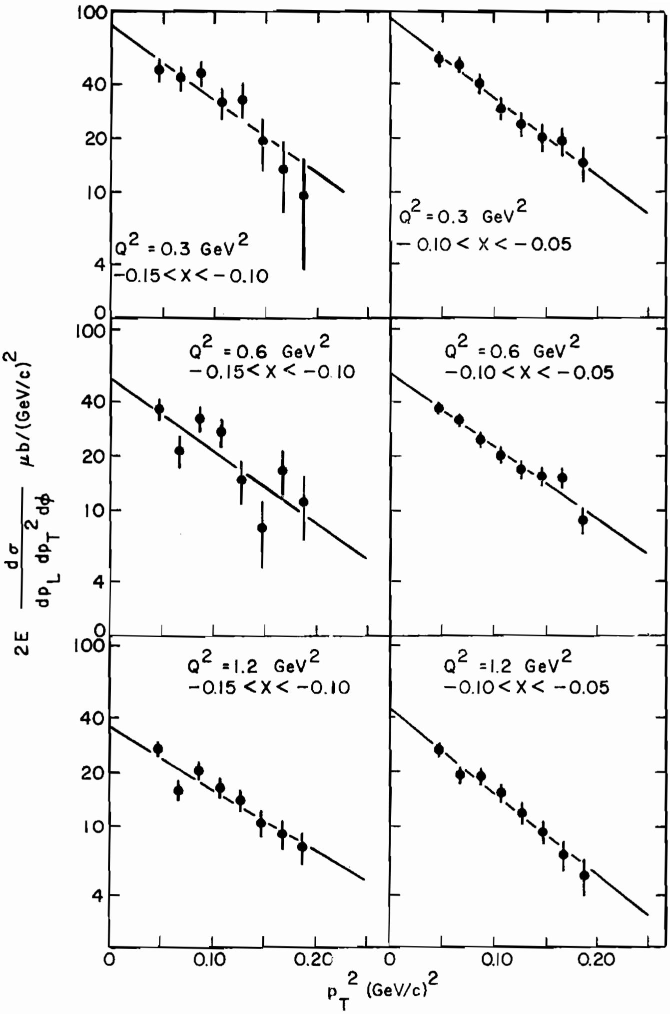

Fig. 1. p_T^2 distributions of pion events for different Q^2 and x bins, W = 3.0 GeV.

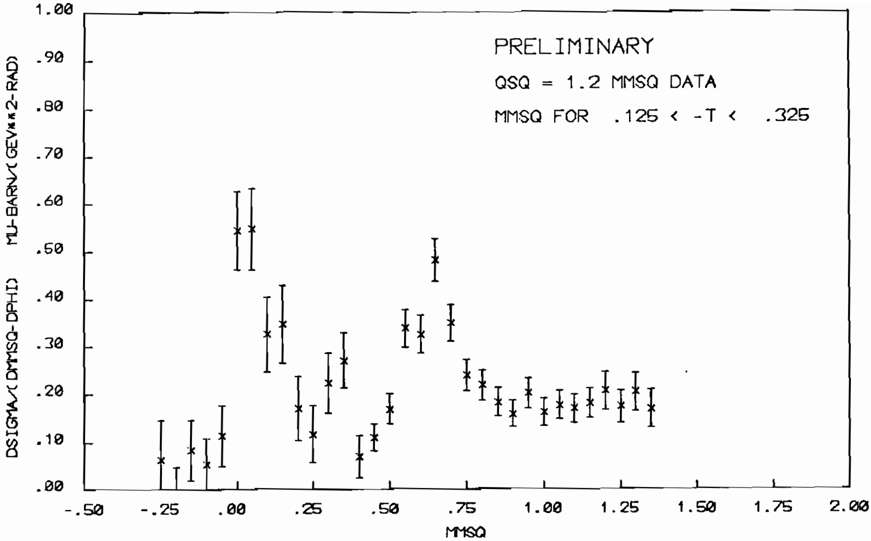

Fig. 2(a)

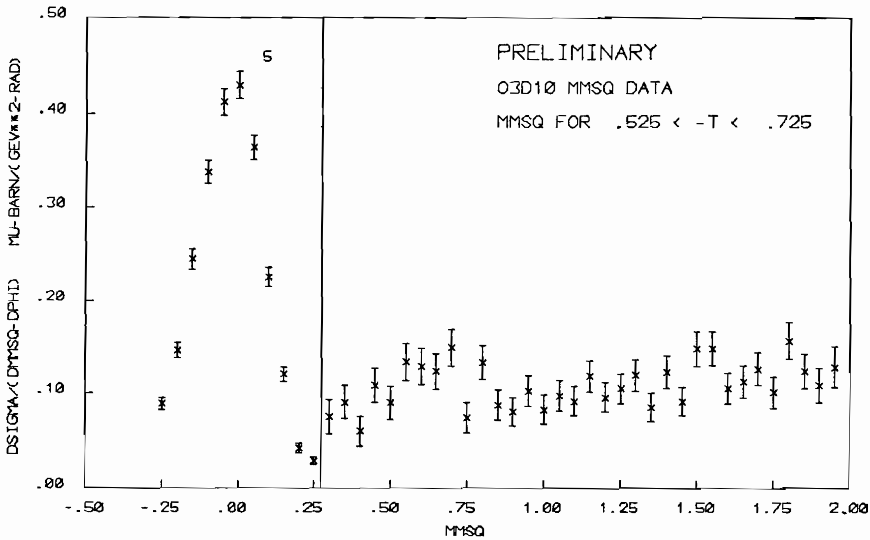

Fig. 2(b)

Fig. 2. Missing-mass squared distribution of proton events for two different angular bins; Q^2 = 1.2 GeV, W = 3.0 GeV.

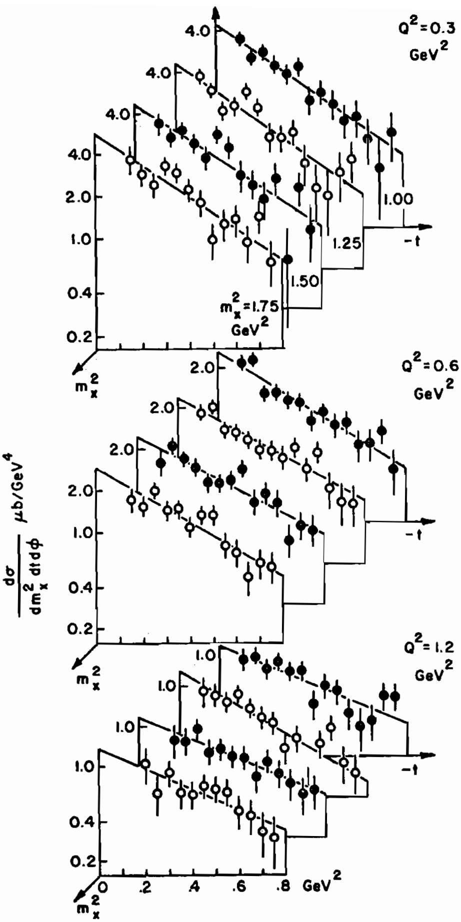

Fig. 3. Semilogarithmic plot of distributions in m_x^2 and t for three Q^2 values, W = 3.0 GeV.

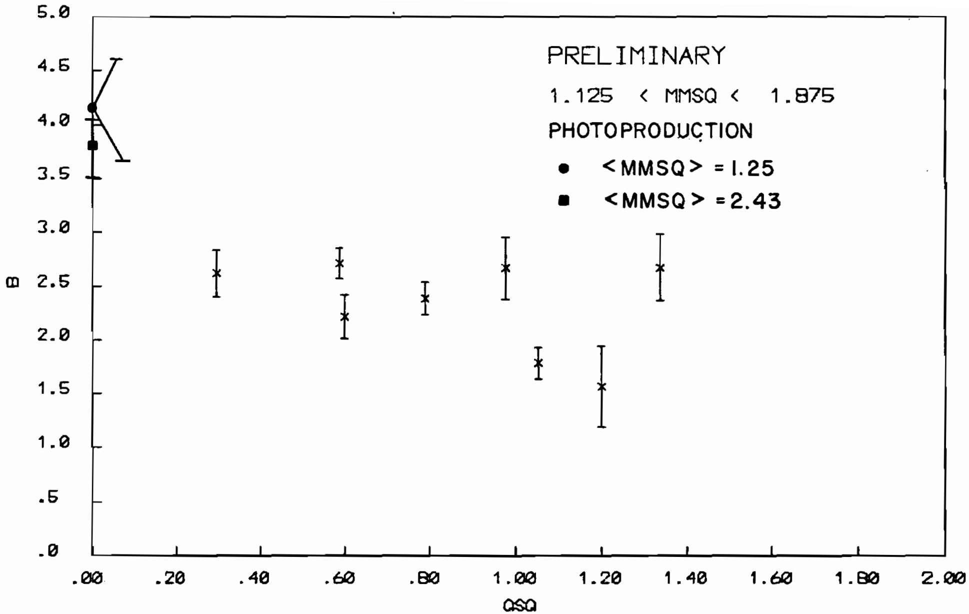

Fig. 4. Slope B(GeV^{-2}) as a function of Q^2 for an exp(Bt) fit of proton events with $1.125 < MM^2 < 1.875$.

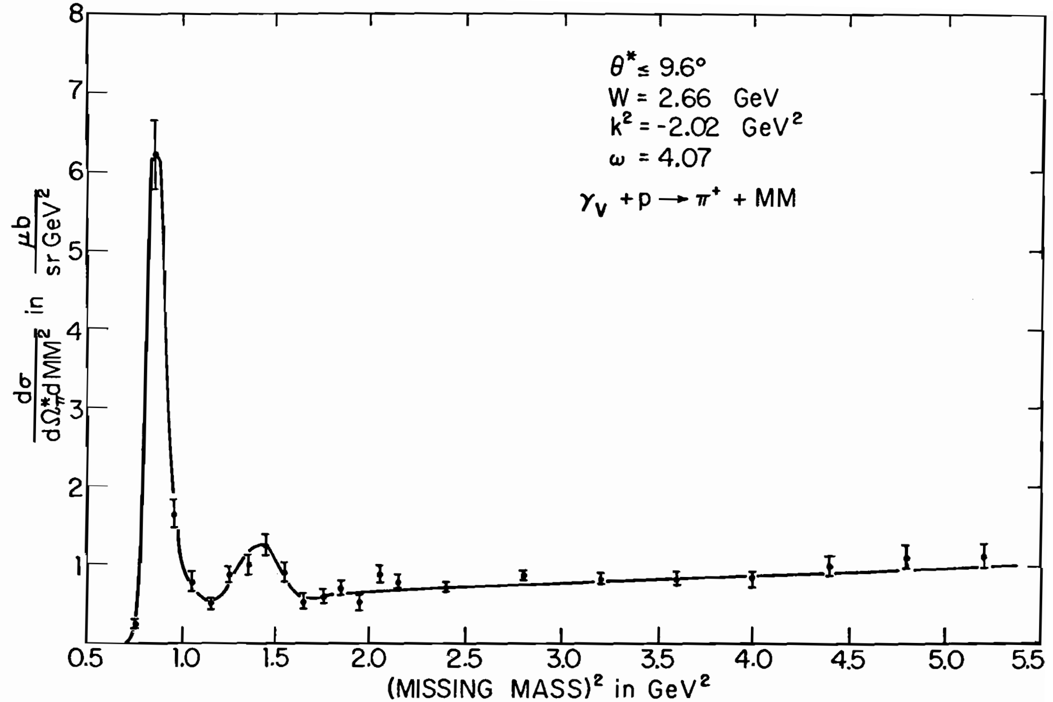

Fig. 5. Missing-mass distribution of forward positive pion events.

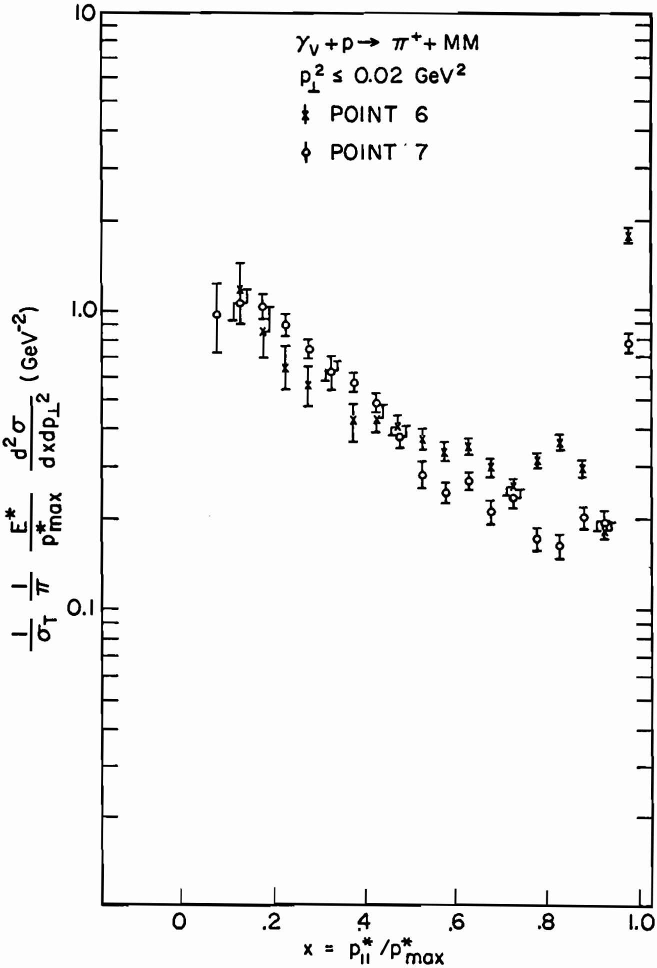

Fig. 6. Feynman scaling of forward positive pion events for two data points each having W = 4.1.

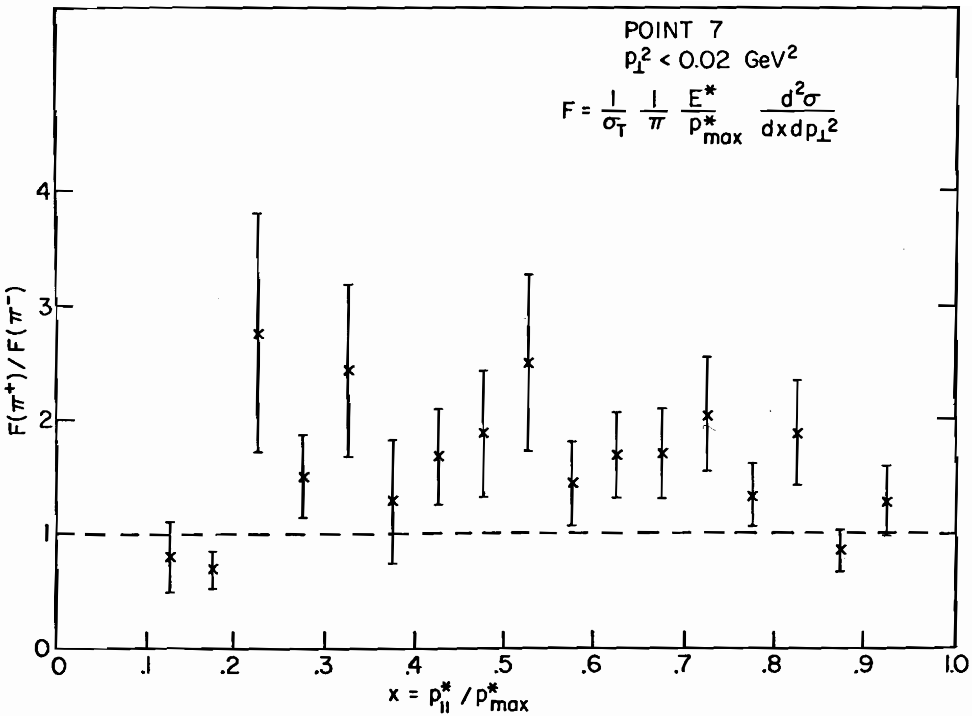

Fig. 7. π^+/π^- ratio for higher-energy forward pion events.

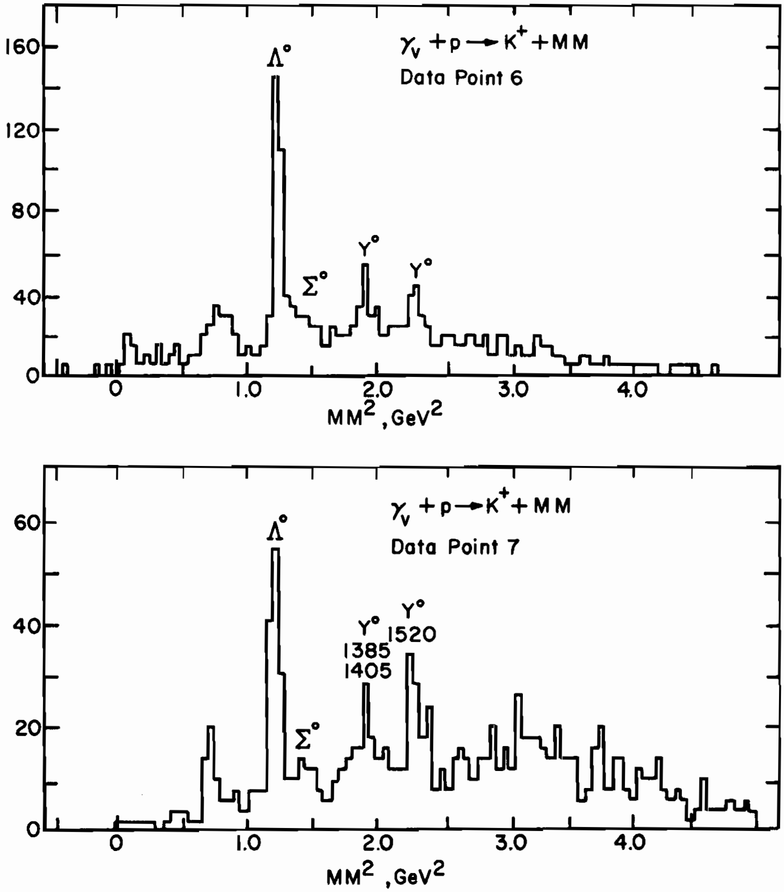

Fig. 8. Missing-mass spectrum for forward K^+ events.