Conf-710816--26

Submitted to the International Symposium
on Electron and Photon Interactions at High Energies Aug-23-27, 1971
Ithaca, New York
1971

INCLUSIVE YIELDS OF π^+, π^-, K^+ and K^- FROM H_2 PHOTOPRODUCED AT 18 GeV AT FORWARD ANGLES

A. M. Boyarski, D. Coward, S. Ecklund, B. Richter
D. Sherden, R. Siemann, and C. Sinclair

Stanford Linear Accelerator Center
Stanford University, Stanford, California 94305

Abstract

We present here preliminary measurements of the invariant cross section $E\,(d^3\sigma/d^3P)$ for $\gamma p \rightarrow \pi^{\pm} X$ and $\gamma p \rightarrow K^{\pm} X$, for transverse momenta up to 2 GeV and for values of x $(= 2\,P_{\parallel}^{cm}/\sqrt{s})$ between -0.1 and 0.8. A bremsstrahlung subtraction was used to obtain 18 GeV cross sections. The cross section falls off exponentially with transverse momenta from approximately 0.5 to 2 GeV/c. The longitudinal dependence is slowly varying, being nearly constant near $x = 0$ and dropping typically by a factor of 2 at $x = 0.8$.

In a recent experiment, we measured charged particle yields of pions, kaons and protons from hydrogen and deuterium for laboratory angles between 1.5 and 21 degrees, and laboratory momenta greater than 3 GeV for 18 GeV incident photons. We present here preliminary results for the pion and kaon cross sections off hydrogen.

The SLAC 20 GeV Spectrometer[1] was used with a bremsstrahlung beam incident on a 6 inch liquid hydrogen target. The detection system included scintillation trigger counters and hodoscopes, a threshold Cherenkov counter for π identification, a differential Cherenkov counter for K identification, a shower counter for electron identification and a range telescope for μ identification.

DISCLAIMER

In order to determine the cross section at a definite photon energy of 18 GeV, bremsstrahlung beams of endpoints 17 and 19 GeV were alternately used, and the yields subtracted. Some points, particularly at larger angles, were done with a larger 16 and 20 GeV subtraction. To minimize systematic errors in the subtraction, the endpoint was switched at least once an hour and runs were repeated to check the stability of the detection system. The subtracted yields are due to photons with energies between the two endpoints with a small correction due to lower energy photons. This correction has not been made in the data presented here, but is estimated to amount to between -15% and +4% and vary smoothly from point to adjacent point. The secondary emission quantameter which served as our beam monitor, was also periodically calibrated against a silver calorimeter at the two beam energies.

The cross sections are presented in Figs. 2-4 for the kinematic points illustrated for the cm system in Fig. 1. In addition to the aforementioned systematic error, there is an overall normalization uncertainity of ± 10%. We choose to present out results in a form invariant to Lorentz transformations, namely

$$E \frac{d^3\sigma}{d^3P} = f\,(s,\, x,\, P_\perp).$$

This is related to other forms of the cross section commonly used by:

$$f = \left[\frac{E}{P^2} \frac{d^3\sigma}{d^2\Omega\, dP} \right]_{lab} = \left[\frac{E}{P^2} \frac{d^3\sigma}{d^2\Omega\, dP} \right]_{cm}$$

$$= \frac{1}{\pi} E \frac{d^2\sigma}{dP_{\parallel}\, dP_\perp{}^2} = \frac{1}{\pi} \sqrt{x^2 + 4 \frac{m^2+P_\perp{}^2}{s}} \frac{d^2\sigma}{dx dP_\perp{}^2} .$$

The transverse momentum dependence falls off rapidly with increasing $P_\perp$ but not as fast as for hadron inclusive processes such as π's, K's or protons from proton-proton collisions[2] or π^- from K^+ p collisions.[3] The longitudinal dependence is nearly constant for small x and large $P_\perp$. Data at smaller $P_\perp$ are more peaked at or near x = 0, as also seen in hadron interactions.[2-3] Kaons are produced more copiously (relative to pions) in the photon initiated reaction; the π^-/K^- ratio is 5 - 10 while it is typically 40 (at the same x) in p-p collisions.[2]

References

1. The apparatus is similar to that described in A. Boyarski et al., Phys. Rev. Letters 20, 300 (1968).

2. C. Akerlof et al., Phys. Rev. D3, 645 (1971).

3. W. Ko and R. Lander, Phys. Rev. Letters 26, 1064 (1971).

4. J. Ballam et al., contribution to this conference.

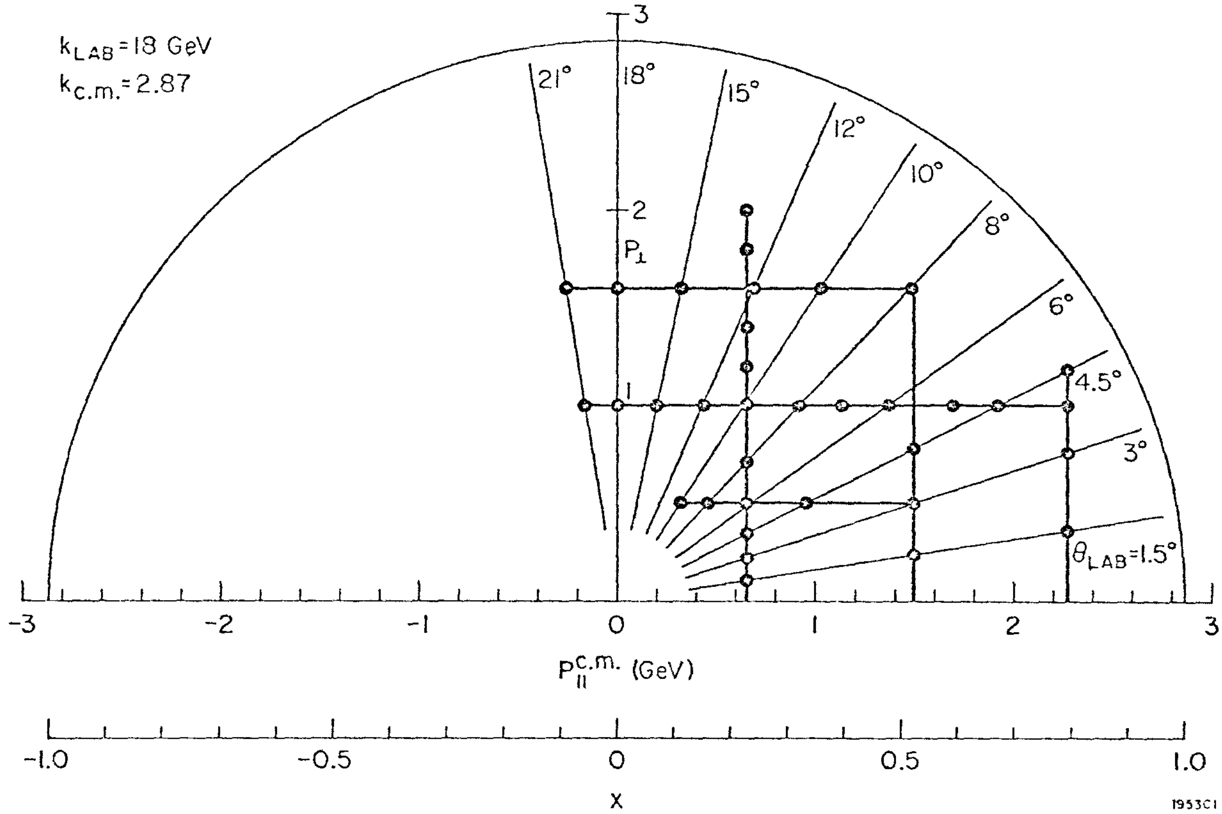
Figure Captions

1. Location of measurements in the cm system for the processes $\gamma p \to \pi^{\pm}$ + anything and $\gamma p \to K^{\pm}$ + anything.

2. Invariant cross section vs transverse momentum at fixed x = 0.2.

3. Invariant cross section vs transverse momentum squared at fixed x = 0.2.

4. Invariant cross section vs. x.



k_LAB = 18 GeV
k_c.m. = 2.87
21°
18°
15°
12°
10°
8°
6°
4.5°
3°
θ_LAB = 1.5°
3
2
P⊥
1
-3
-2
-1
0
1
2
3
P∥ c.m. (GeV)
-1.0
-0.5
0
0.5
1.0
x
1953C1

FIG. 1

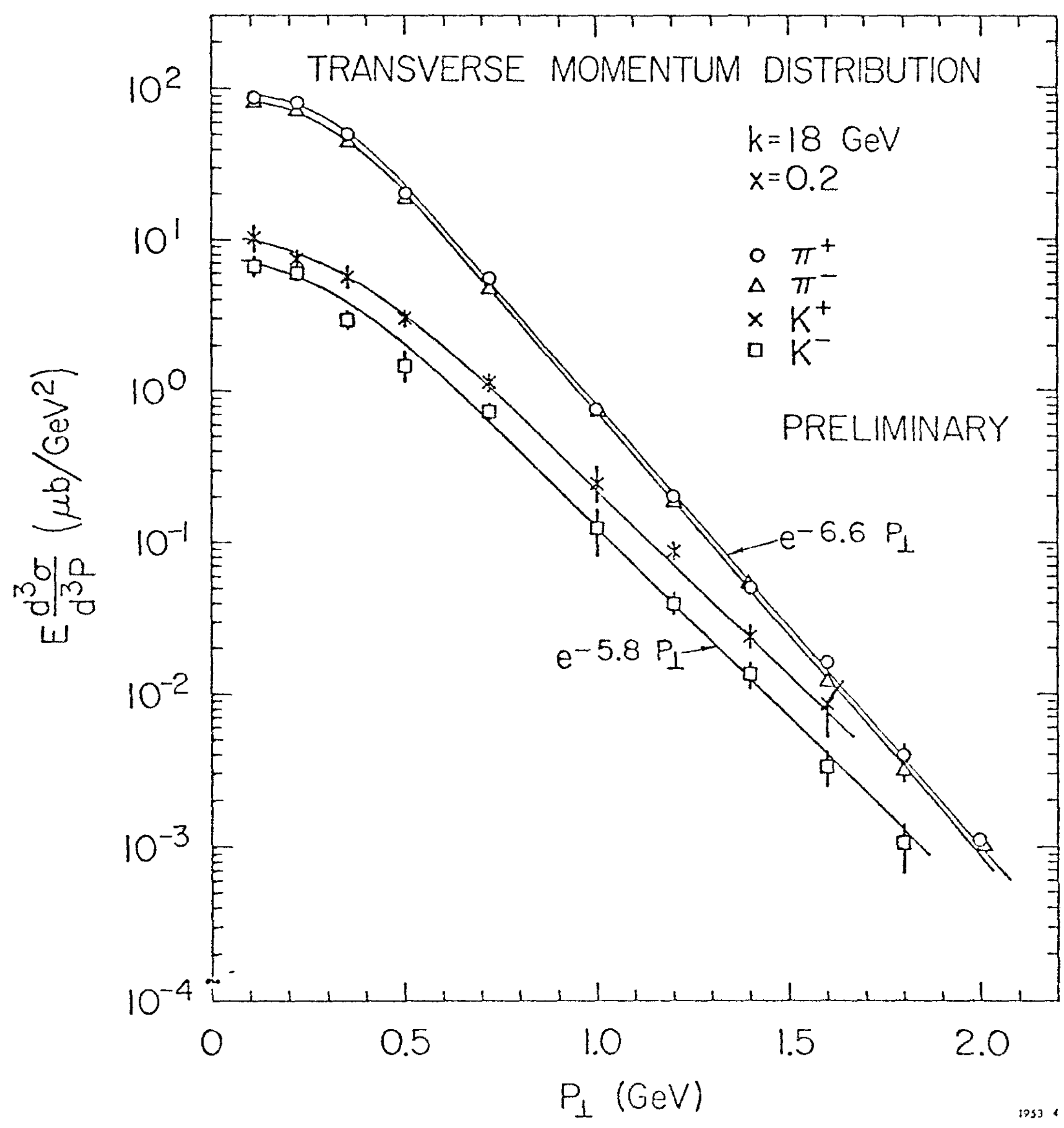
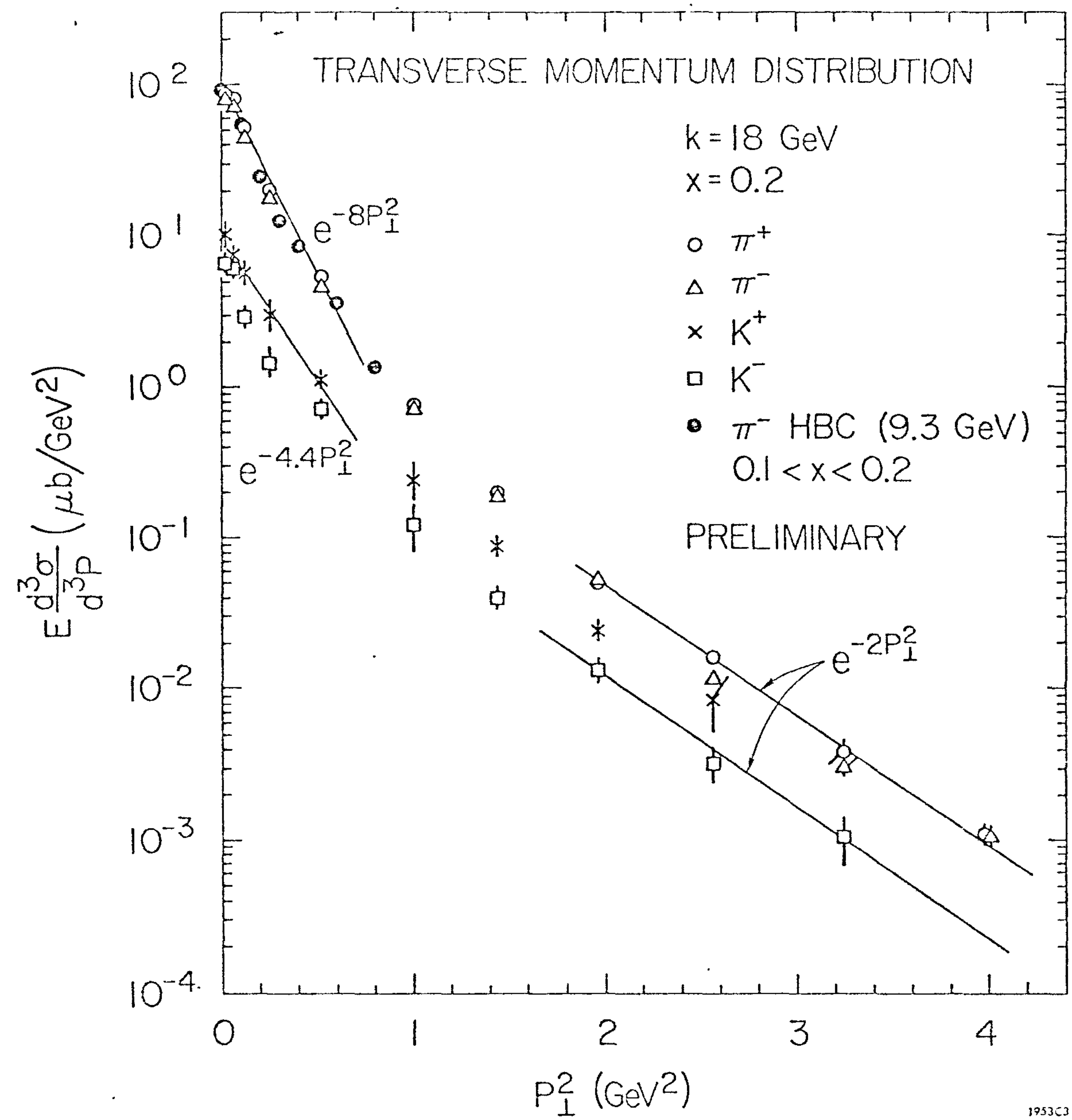
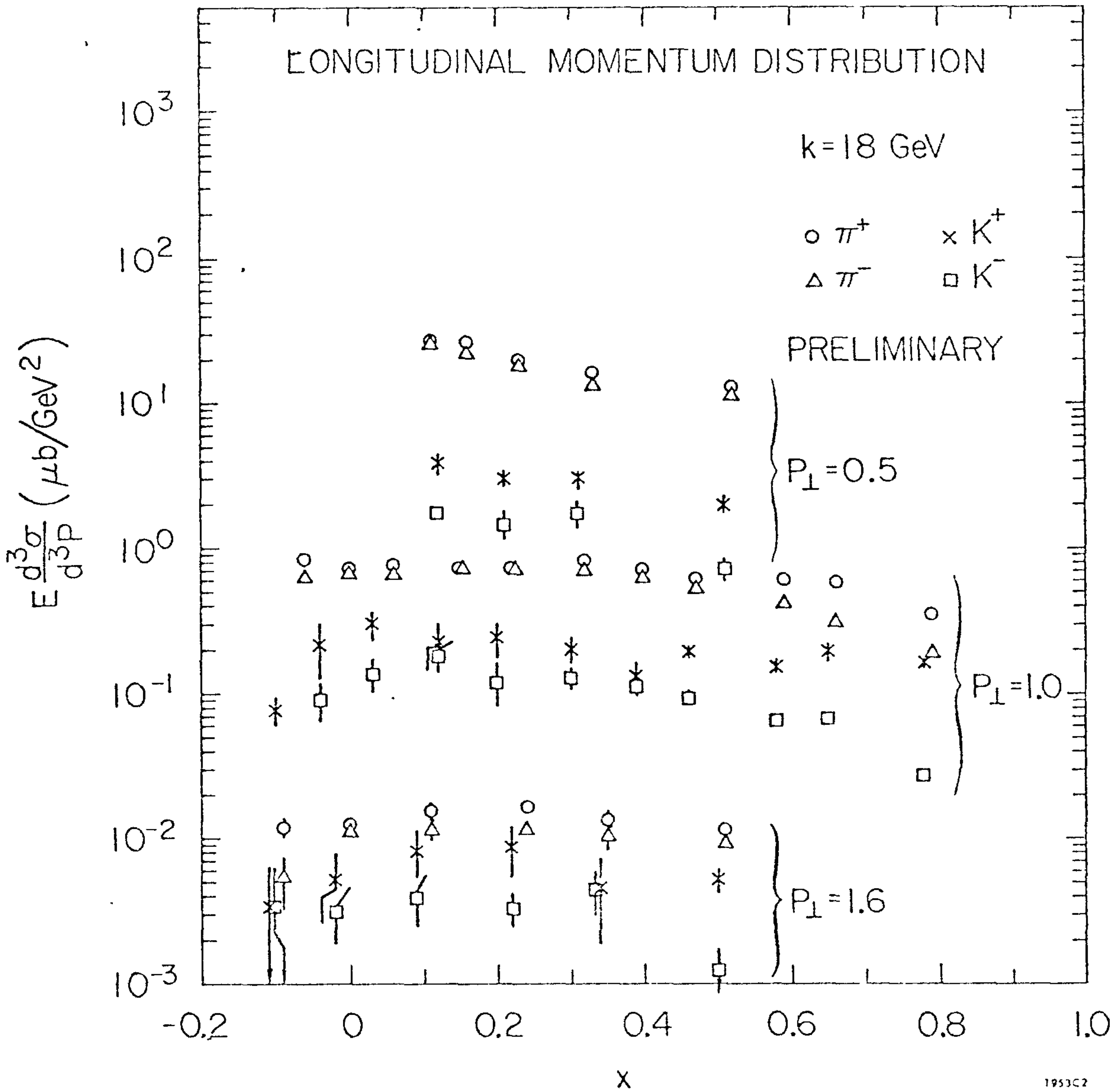

TRANSVERSE MOMENTUM DISTRIBUTION
k=18 GeV
x=0.2
○ π+
△ π−
× K+
□ K−
PRELIMINARY
e−6.6 P⊥
e−5.8 P⊥
E d3σ/d3P (μb/GeV2)
P⊥ (GeV)
1953 4

FIG 2



TRANSVERSE MOMENTUM DISTRIBUTION
k = 18 GeV
x = 0.2
π+
π−
K+
K−
π− HBC (9.3 GeV)
0.1 < x < 0.2
PRELIMINARY
e−8P⊥2
e−4.4P⊥2
e−2P⊥2
E d3σ/d3P (μb/GeV2)
P⊥2 (GeV2)
10^2
10^1
10^0
10^-1
10^-2
10^-3
10^-4
0
1
2
3
4
1953C3

FIG. 3



LONGITUDINAL MOMENTUM DISTRIBUTION
k=18 GeV
π+
K+
π−
K−
PRELIMINARY
P⊥=0.5
P⊥=1.0
P⊥=1.6
10³
10²
10¹
10⁰
10⁻¹
10⁻²
10⁻³
E d³σ/d³p (μb/GeV²)
-0.2
0
0.2
0.4
0.6
0.8
1.0
x
1953C2

FIG. 4