TRANSVERSE MOMENTUM OF DILEPTONS

NA3 Collaboration

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ABSTRACT

Transverse momentum produced by π^- et 150, 200 and 280 GeV are compared with QCD predictions.

RESUME

Les impulsions transverses de dimuons produits par des π^- de 150, 200 et 280 GeV, sont comparées aux prédictions de CDQ.

Incident π^- of 150 GeV, 200 GeV and 280 GeV producing muon pairs on a platinum target were studied in the NA3 spectrometer. The distribution of the transverse momentum p_t is expected to be described by the convolution of two functions : the first one is the distribution of the quark intrinsic momentum k_t ; the second is deduced from QCD calculations. In terms of mean squared values, one has :

$$\langle p_t^2\rangle = \langle k_t^2\rangle + \langle p_t^2\rangle_{QCD}$$

Without scaling violations, one expects :

$$\langle p_t^2\rangle_{QCD} = S\ f(\tau,y),\ \tau = M^2/S$$

y is the rapidity and M the mass of the dimuon.

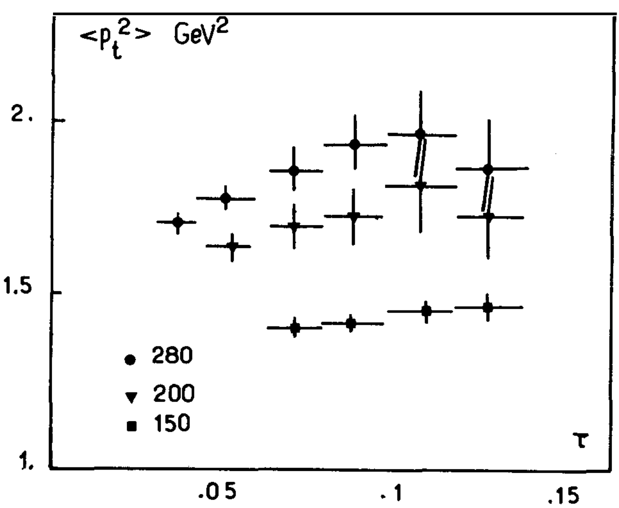
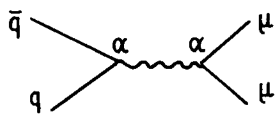


Fig. 1 : $\langle p_t^2\rangle$ versus $\tau = M^2/S$

The τ dependance of $<p_t^2>$ is presented in figure 1, after integration over y in the range [-.3, 1.1]. The quoted errors are statistical only, but systematic effects of the order of .1 GeV^2 have to be added. They are essentially induced by the beam spread in the target. The data are consistent with the expected form :

$$<p_t^2> = .85 + S\,F\,(\tau)$$

In figure 2, one has plotted the quantity : $(<p_t^2> - .85)/S$. A comparison with QCD calculations may be performed. One calls σ_{DY} the cross section corresponding to the graph :



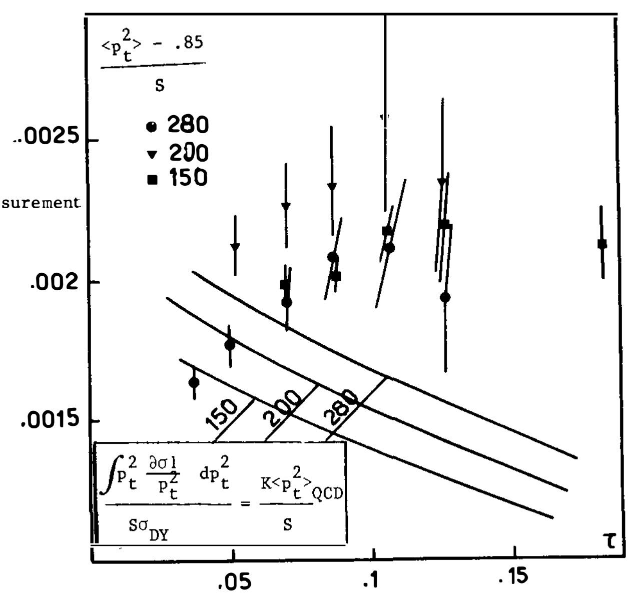
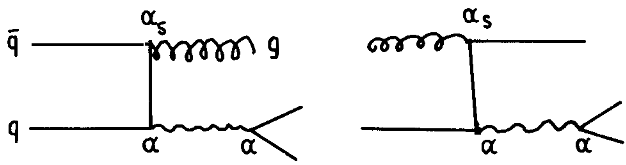


Fig. 2
Experimental measurement compared to QCD calculations.

It is possible to calculate $\frac{d\sigma l}{dp_t^2}$ corresponding to the first order in α_s. It involves external gluons as in the graphs :



annihilation Compton

In π^- interactions, the annihilation term is predominant contrary to the proton case. The total cross section is related to σ_{DY} by the K factor[2)]

$$\sigma_{tot} = K\ \sigma_{DY}$$

Then, at the first order in αs :

$$<p_t^2>_{QCD} = \frac{\int p_t^2 \frac{d\sigma l}{dp_t^2}\, dp_t^2}{K\ \sigma_{DY}}$$

In order to take into account scaling violation, one has choosen :

$$\alpha_s = 12\ \pi/25\ \mathrm{Log}\ \ (1 + 4\ Q^2)$$

The quarks structûre functions are deduced from deep inelastic [3)] and Drell-Yan [4,5)] experiments :

Proton :

$u = 2A\ (\alpha,\beta)\ x^{\alpha}(1-x)^{\beta} + \bar{u}$

$d = A(\alpha,\beta+1)\ x^{\alpha}(1-x)^{\beta+1} + \bar{d}$

$\bar{u} = \bar{d} = 2\lambda = 2\bar{\lambda} = A(1-x)^{n}$

$\alpha = .52 - .16\ \bar{S}$

$\beta = 2.79 + .77\ \bar{S}$

$A = .26 + .18\ \bar{S}$

$n = 7.80 - .78\ \bar{S}$

$$\bar{S} = \mathrm{Log}\ \frac{\mathrm{Log}\ 4\ Q^2}{\mathrm{Log}\ 80}$$

Pion :

$\bar{u} = d = A(\alpha',\beta')x^{\alpha'} + u$

$u = \bar{d} = 2\lambda = 2\bar{\lambda} = A'(1-x)^{n'}$

$\alpha' = .5 - .1\ \bar{S}$

$\beta' = 1. + .7\ \bar{S}$

$A' = .12 + .7\ \bar{S}$

$n' = 5.$

$$A(\alpha,\beta) = \frac{\Gamma(\alpha + \beta + 1)}{\Gamma(\alpha)\ \Gamma(\beta + 1)}$$

The smaller contribution due to the compton-graphs is computed with gluon structure functions of the form : $Ag(1-x)^{ng}$, with : $Ag = 3.49 + 4.1\ \bar{S}$, $ng = 5.75 \pm 7.5\ \bar{S}$ for the nucleon and $Ag = 2.$, $ng = 3.$ for the pion.

The results of the calculation are displayed in figure 2, where $<p_t^2>_{QCD}$ is multiply by the K factor. The confrontation with experimental values suggests that $\frac{d\sigma 1}{dp_t^2}$ has to be corrected by a factor greater than this K factor. Furthermore, the QCD estimations decrease with τ, whereas experimental values increase. In conclusion, one has :

$$<p_t^2> = <k_t^2> \frac{\int p_t^2 \frac{d\sigma 1}{dp_t^2} dp_t^2 + \int p_t^2 \frac{d\sigma_n}{dp_t^2} dp_t^2}{K\ \sigma_{DY}}$$

with $<k_T^2> = .85 \pm .1$

$$\frac{d\sigma_n}{dp_t^2} > K \frac{d\sigma 1}{dp_t^2}$$

$\frac{d\sigma_n}{dp_t^2}$ represents all the contributions which have to be added to the first order of QCD.

In figure 3, $<p_t^2>$ is displayed as a function of y, after integration over τ, in the range [.06, .14]. Shapes agree with theoretical ones resulting essentially from phase space.

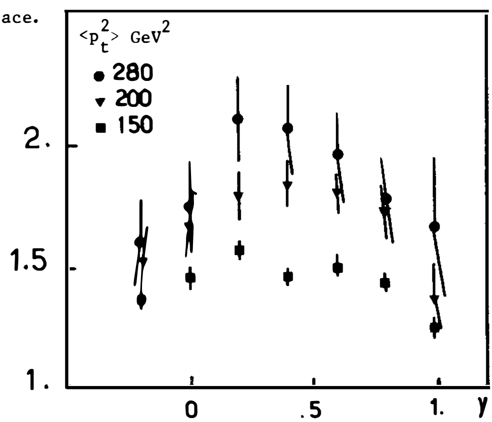


Figure 3
$<p_t^2>$ versus center of mass rapidity

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