DOUBLY DIFFERENTIAL INELASTIC CROSS-SECTION CURVE FITS FOR J/ψ PHOTOPRODUCTION

E160

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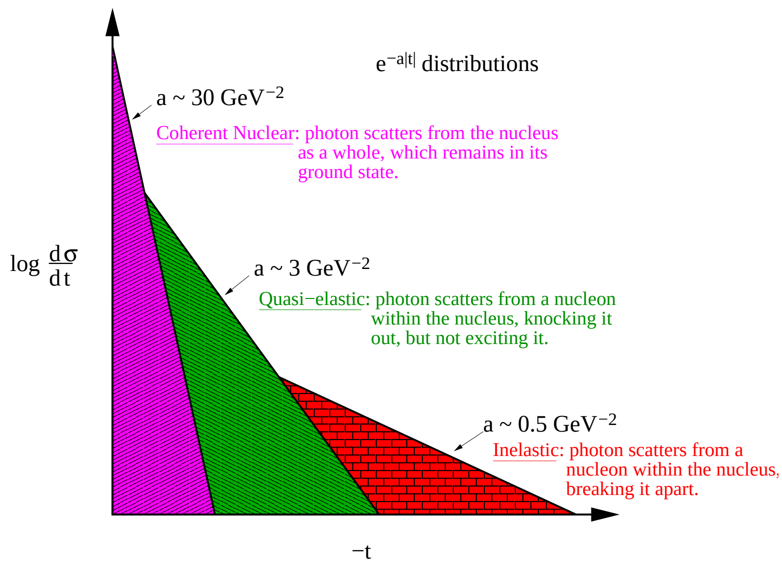
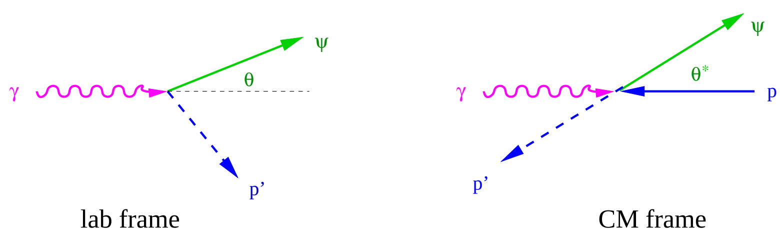
Inelastic J/ψ Kinematics





- Beam Energy in the Center of Mass Frame
- The momentum of the J/ψ perpendicular to the beam line's axis of propagation (z-axis): $p_t^2 = p_x^2 + p_y^2$
- Fraction of the initial beam energy that the J/ψ carries: $z = \frac{E_\psi}{E_\gamma}$

Phenomenological Form for $\frac{d^2\sigma}{dp_t^2 dz}$

- Assume that we are dealing with a separable function

$$\frac{d^2\sigma}{dp_t^2 dz} = f(z)g(p_t^2)h(W) \tag{1}$$

- First find a form for each of the functions
- Make a linear fit to the data from H1 and ZEUS using the model $d^2\sigma/dp_t^2 dz = \alpha \cdot X$
- The compiled data contained values for the doubly differential cross-section over various ranges of the kinematic variables.
- For example $\frac{d^2\sigma}{dp_t^2 dz} = 22.6 GeV$ when $W = 150 GeV, p_t^2 = 1.54 GeV^2, z = 0.83$
- Once we found the form of Eq. 1, it was our task to plug in the numbers for each value and fit using ROOT to find the slope, α

Beam Energy (W) Dependence

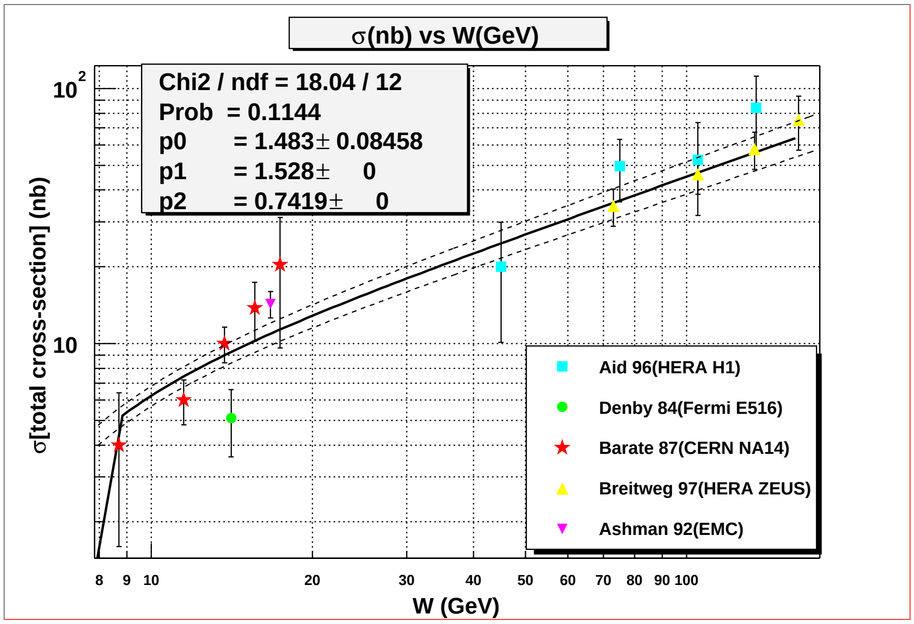


Figure 1: Observed total cross section of inelastic J/ψ production at energies ranging from near-threshold to 200 GeV.

- Only included data with $z < 0.9$
- Eq. 2 from our fits for the total cross-sections of the elastic data was applied holding α_2 and α_3 fixed to values obtained from elastic data

$$\sigma = \alpha_1 \cdot (1 - \frac{W_{th}^2}{W^2})^{\alpha_2} \cdot W^{\alpha_3} \qquad (2)$$

Transverse Momentum (p_t^2) Dependence

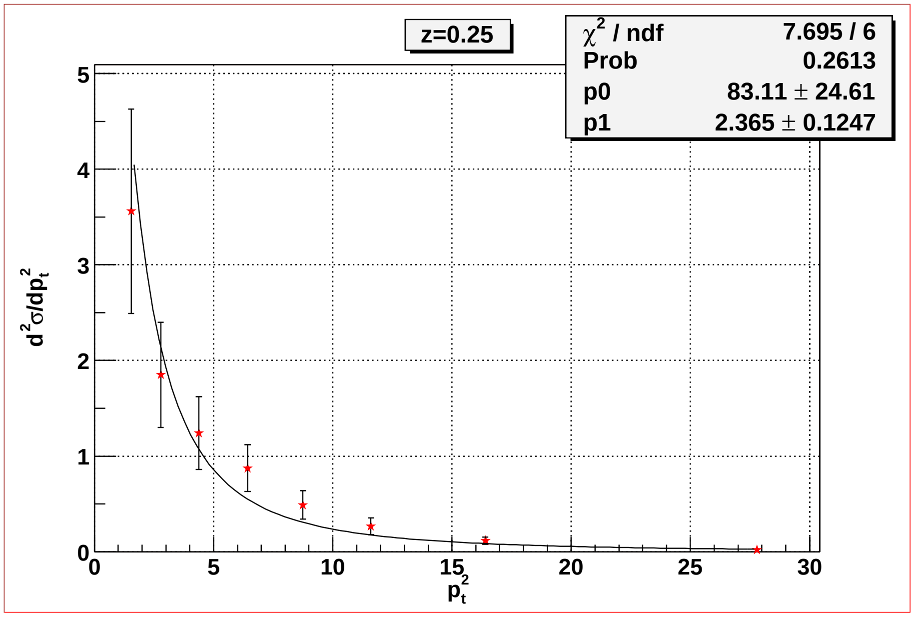


Figure 2: An example of the fit used to determine the exponent n.

- An equation for the p_t^2 dependence was found in the H1 paper we extracted the inelastic data from (C. Adloff, *et al.*, H1 Collaboration, hep-ex/0205064)

$$(p_t^2 + M_\psi^2)^{-n} \tag{3}$$

- Where M_ψ is the mass of the J/ψ and n is some variable with z dependence

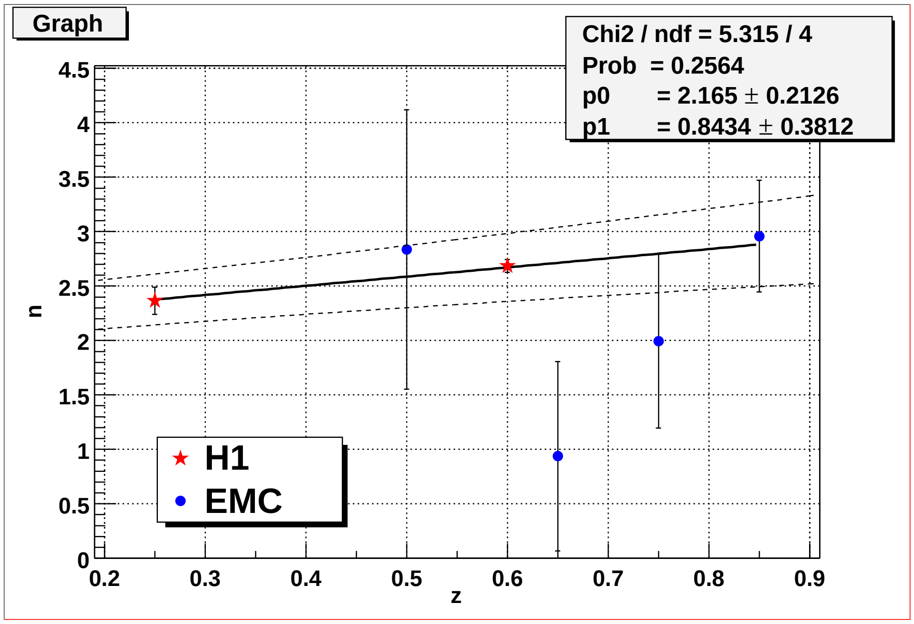


Figure 3: The exponential of the p_t^2 dependence is plotted over the range of z and fit to a line

$$n = \alpha_0 + \alpha_1 z \tag{4}$$

- We fit a line to n vs. z using data included in the H1 paper to measure n's dependence on z but this needed some adjustment for our double differential cross-section fit - more to come on this

Energy Ratio (z) Dependence

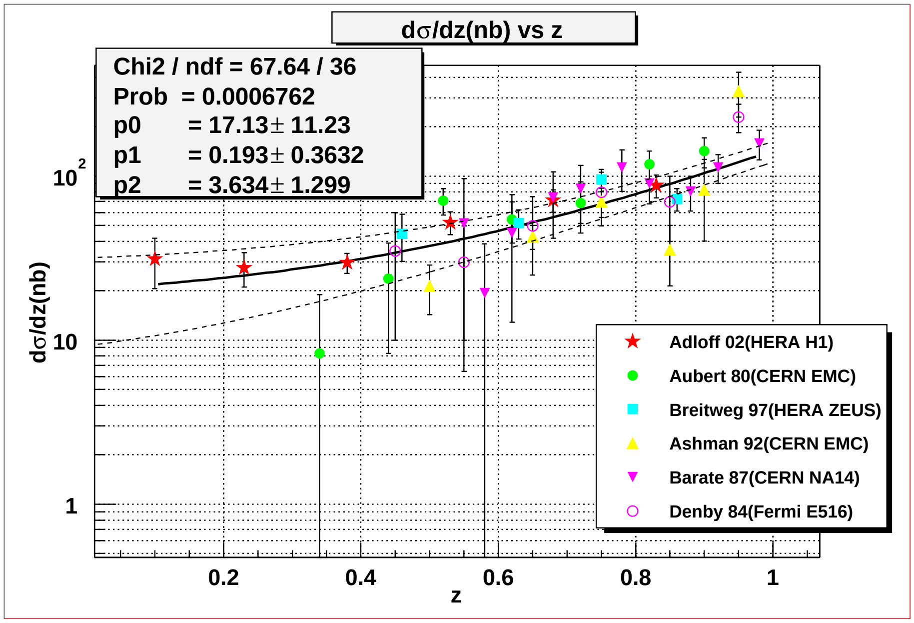


Figure 4: Data for dσ/dz from various sources normalized to the H1 value for $z \approx 0.7$

- We normalized the data to the H1 value for $z \approx 0.7$ and fit to an equation of the form:

$$\alpha_6(1 + \alpha_4 e^{\alpha_5 z}) \qquad (5)$$

- The fit in Figure 4 may not represent what happens for high z values, but it was assumed adequate for our purposes.

X-Fit and Modifications

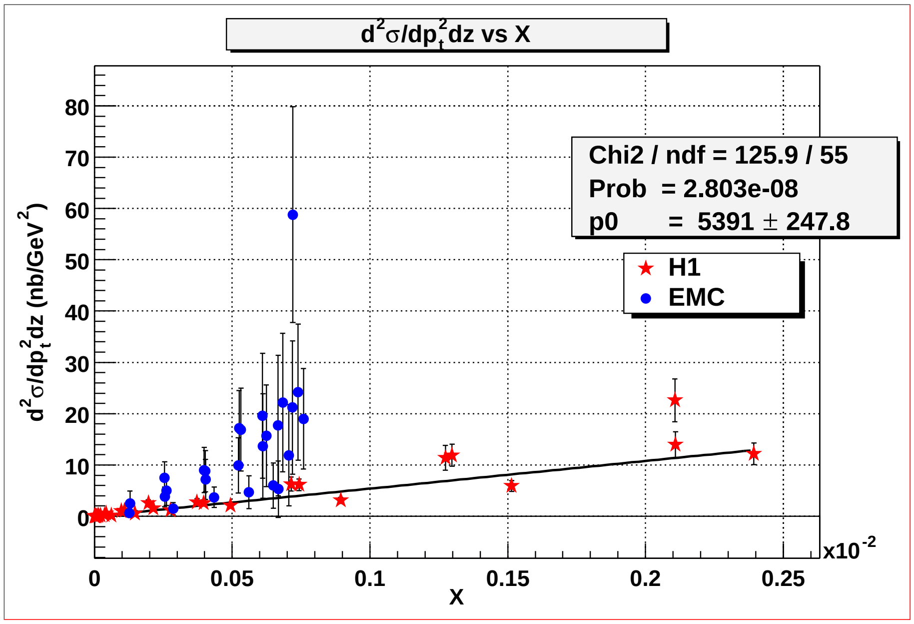


Figure 5: The calculated X values for the EMC data are out of line with the H1 data - leading us to believe that the factor M_ψ is too large for such low values of p_t^2 (this is for $\gamma = 1$)

- We now have a function we believe should fit the data for the doubly differential cross-section that takes into account all three kinematic variables

$$\frac{d^2\sigma}{dp_t^2 dz} = \alpha_6 \frac{(1 - \frac{W_{th}^2}{W^2})^{\alpha_2} W^{\alpha_3}}{(p_t^2 + \frac{M_\psi^2}{\gamma})^{\alpha_0 + \alpha_1 z}} (1 + \alpha_4 e^{\alpha_5 z}) = \alpha_6 \cdot X \tag{6}$$

- We tried values for this factor $1 \leq \gamma \leq 10$ and found that the best line was formed by a factor $\gamma = 2.5$
- Now back to the method used to find α_0 and α_1. The mass parameter was divided by 2.5 and the new best fit for n vs. z was calculated. Using these values for the parameters in Eq. 6 we found that the best fit for X was now $\gamma = 5.0$
- Turn the crank again and obtain the fit shown in Fig. 6 for our doubly differential cross-section
- Now that we have a good phenomenological representation of the data we should check to see how it compares with theoretical predictions.
- See references and more detail at the following website

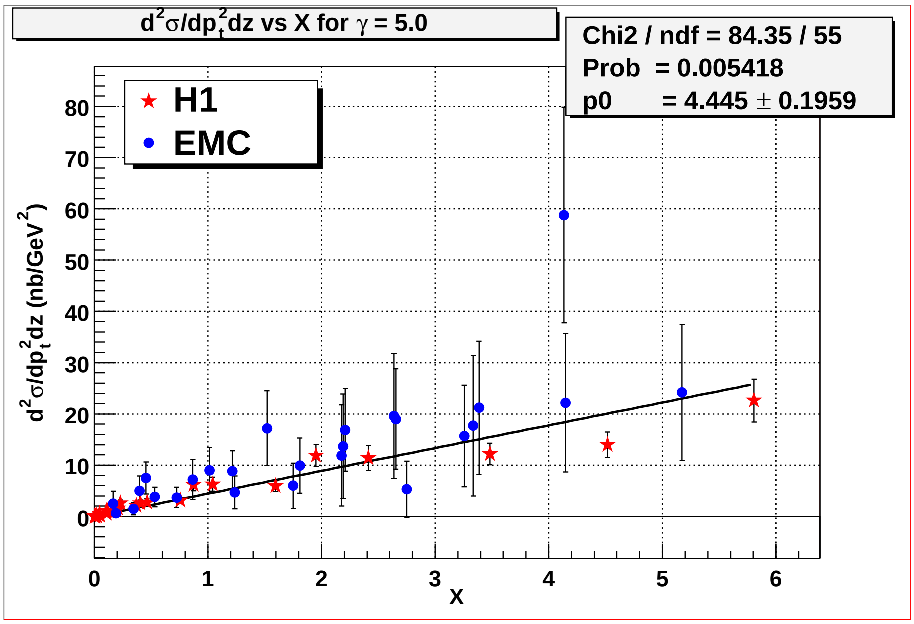


Figure 6: The distribution for $\gamma = 5$, $\alpha_0 = 2.165$ and $\alpha_1 = 0.8434$. Note the χ^2/degrees of freedom is lower because of the recalculated exponential parameters