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Diffractive Photoproduction of $\psi(2S)$ Mesons at HERA

H1 Collaboration

Abstract

Results on diffractive photoproduction of $\psi(2S)$ mesons are presented using a data set collected between 1996 and 2000 with the H1 detector at the HERA ep collider corresponding to a luminosity of 77 pb^{-1}. The $W_{\gamma p}$ dependence of the integrated diffractive $\psi(2S)$ cross section is found to be similar to that for J/ψ mesons. The dependences of elastic and proton dissociative $\psi(2S)$ photoproduction the squared momentum transfer t at the proton vertex are measured. The t-dependences, parametrised as e^{bt}, are found to be $b_{el}^{\psi(2S)} = (4.31 \pm 0.57 \pm 0.45)$ GeV^{-2} for the elastic and $b_{pd}^{\psi(2S)} = (0.59 \pm 0.13 \pm 0.12)$ GeV^{-2} for the proton dissociative channels which tend to be similar or somewhat shallower than those for the J/ψ meson.

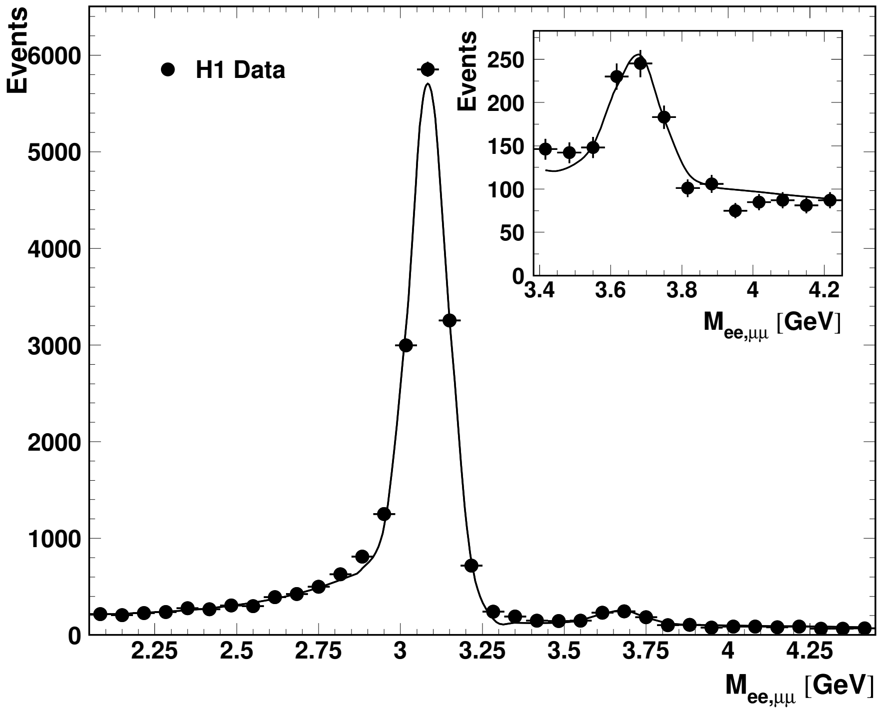

Figure 1: Mass spectrum for the direct decay channel into leptons ($\mu^+\mu^-$ and e^+e^-) after the final selection. The insert shows the mass distribution restricted to the $\psi(2S)$ region. The curve shows the result of a fit combining Gaussian distributions for the J/ψ and $\psi(2S)$ signals, an exponential parametrisation of the radiative tail in the electron decay channel for the J/ψ and a linear background.

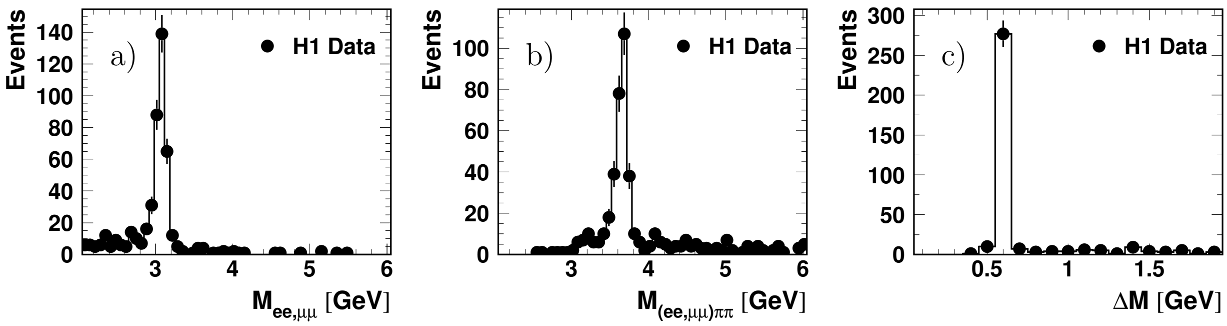

Figure 2: Mass spectra for the cascade decays of $\psi(2S)$ mesons. a) and b) show the ll and $ll\pi^+\pi^-$ invariant mass distributions. c) shows the mass difference $\Delta M = M_{ll\pi\pi} - M_{ll}$ when selecting the ll pairs reconstructed in the J/ψ mass window.

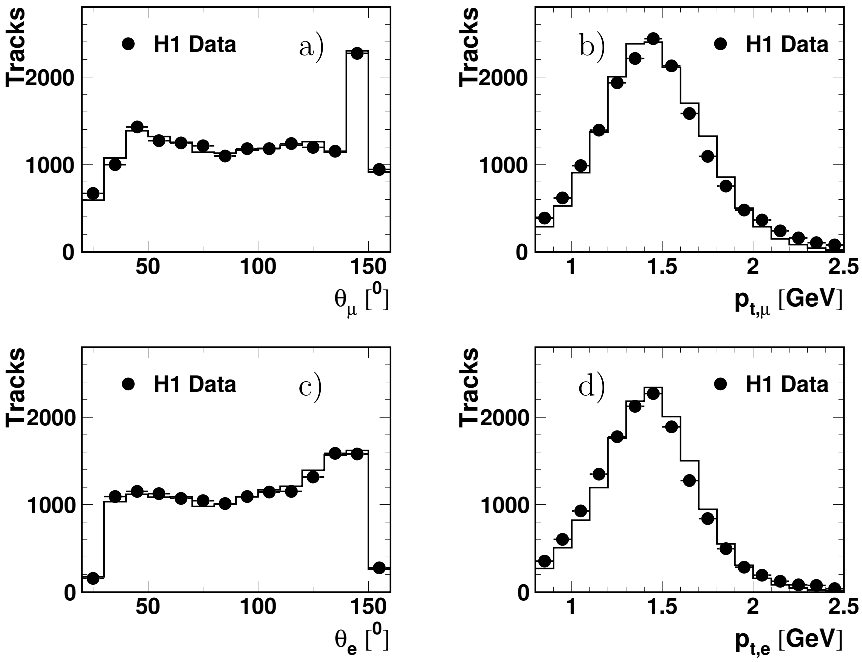

Figure 3: Comparison between data (points) and Monte Carlo simulations (lines) for the polar angular distributions (a,c) and the transverse momentum (b,d) of decay muons (a,b) and electrons (c,d) from J/ψ decays.

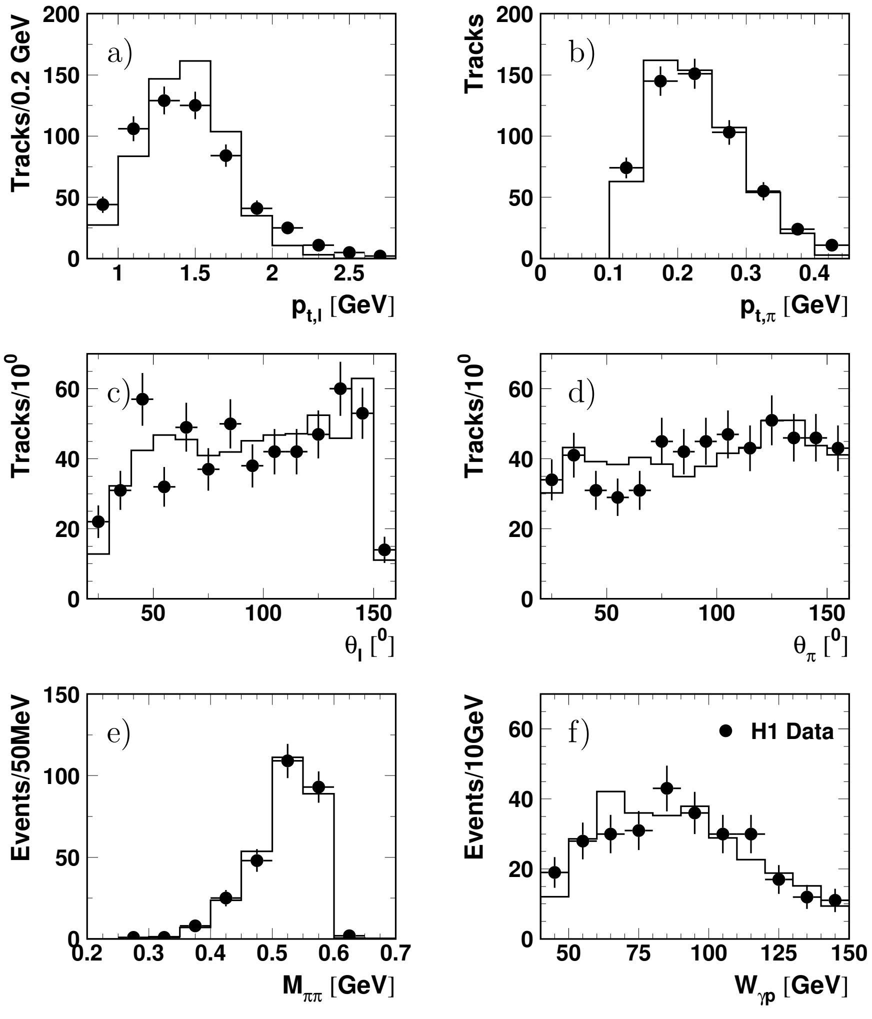

Figure 4: Distributions for the cascade decays of $\psi(2S)$ mesons: a) the transverse momentum of the decay leptons and b) the decay pions, c) the polar angle of the decay leptons and d) the decay pions, e) the two-pion invariant mass, f) the photon proton center-of-mass energy $W_{\gamma p}$. The points show the data, the solid lines the DIFFVM Monte Carlo simulation normalised to the number of events in the data after event reweighting (see text).

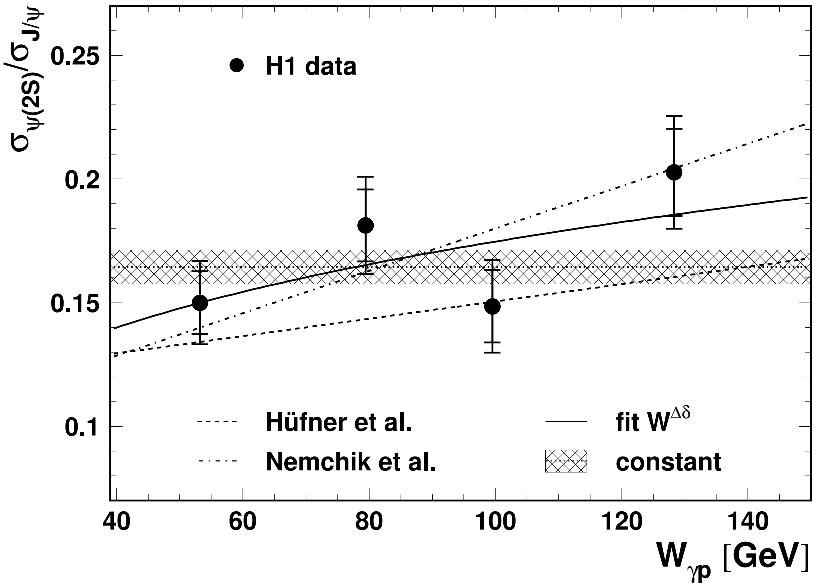

Figure 5: The ratio $R(W_{\gamma p}) = \sigma_{\psi(2S)}(W_{\gamma p})/\sigma_{J/\psi}(W_{\gamma p})$ for events with $z > 0.95$. The error bars contain statistical and uncorrelated systematic errors added in quadrature. The band shows the normalisation uncertainty due to the errors on the branching ratios. Also shown is a fit of the form $N \cdot (W_{\gamma p}/90\ \mathrm{GeV})^{\Delta\delta}$ with a value for $\Delta\delta$ of 0.24 (solid line). Also shown are the predictions by [1] (dashed-dotted line) and [2] (dashed line).

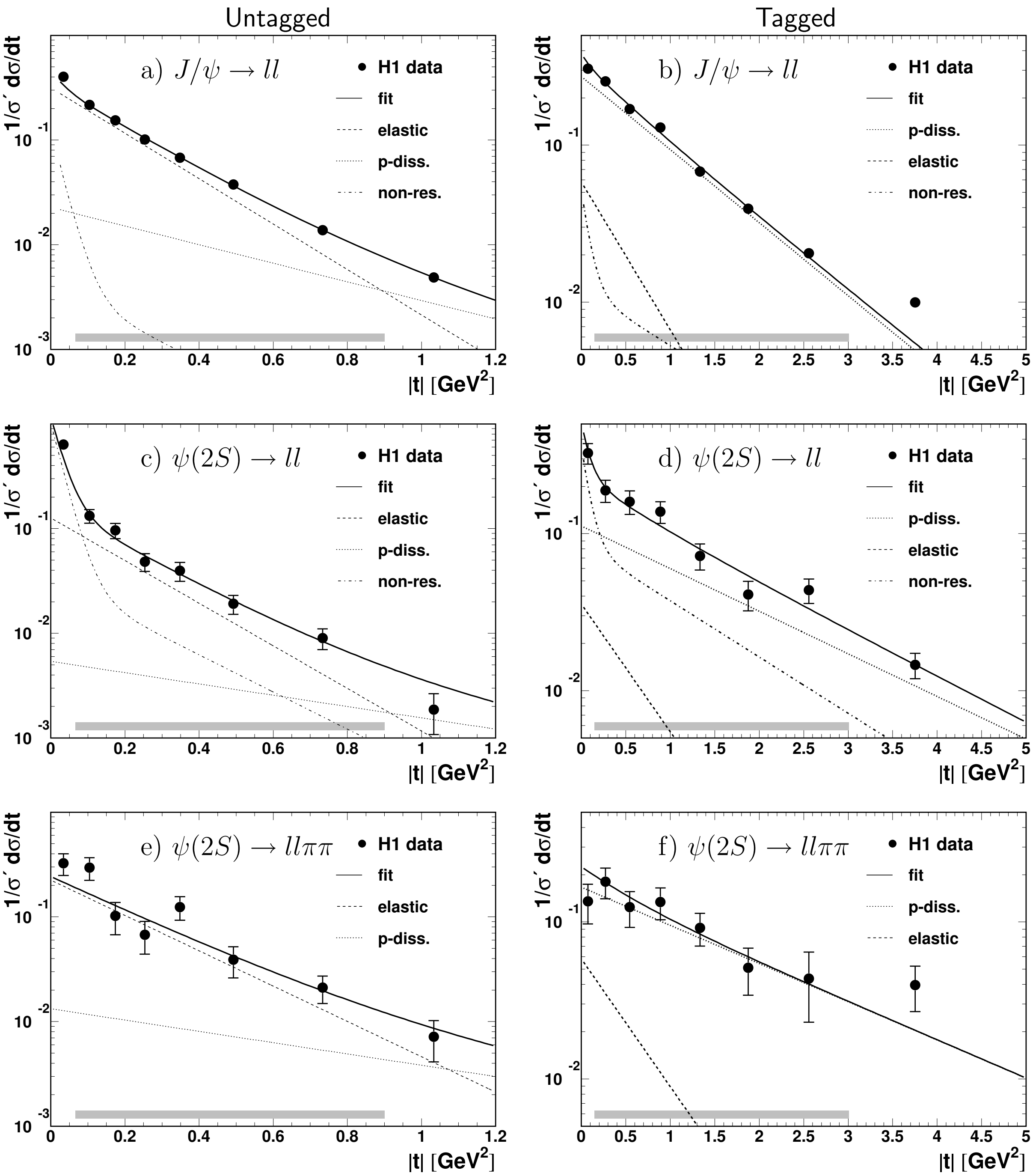

Figure 6: Normalised differential cross section $1/\sigma' \cdot d\sigma/dt$ as a function of $|t|$ for events a) in the J/ψ mass window without a signal in the forward detectors (untagged), b) in the J/ψ mass window with a signal in the forward detectors (tagged), c) untagged and d) tagged events in the $\psi(2S)$ mass window and two leptons in the final state, e) untagged and f) tagged $\psi(2S)$ events with cascade decays. The solid lines show the results of the fits described in the text. The dashed (dotted) curves show the contributions from the elastic (proton dissociative) processes, respectively. For the direct decays into leptons (a-d) the contributions from the non-resonant background (dashed-dotted curves) are also shown. The shaded bands indicate the fit regions.

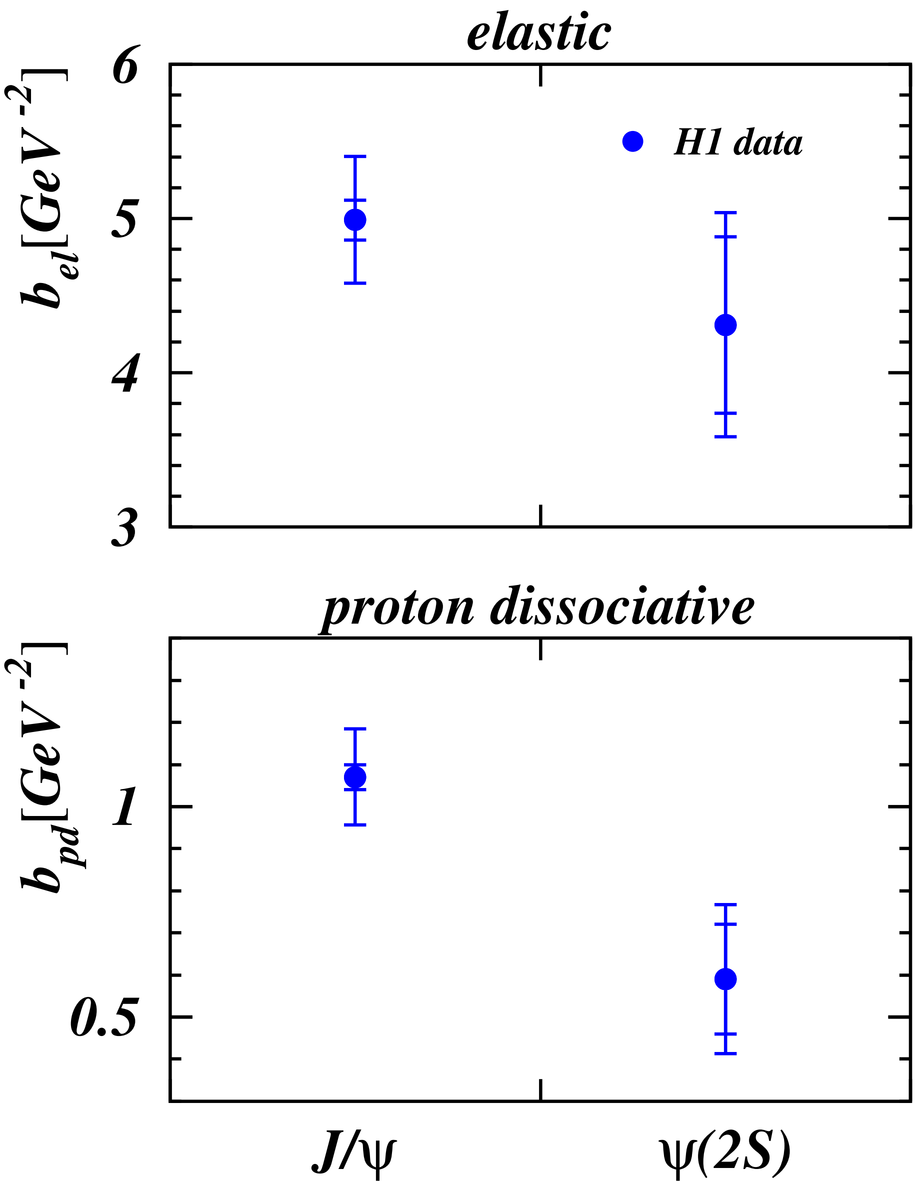

Figure 7: Summary of measured $\psi(2S)$ and J/ψ slope parameters in the elastic and proton dissociative channels.

References

[1] J. Nemchik, N. N. Nikolaev, E. Predazzi, B. G. Zakharov and V. R. Zoller, J. Exp. Theor. Phys. **86**, (1998) 1054. [Zh. Eksp. Teor. Fiz. **113**, (1998) 1930] [hep-ph/9712469].

[2] J. Hufner, Yu.P. Ivanov, B. Z. Kopeliovich and A. V. Tarasov, Phys. Rev. D **62** (2000) 094022 [hep-ph/0007111].