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Measurement of Diffractive Deep-Inelastic Scattering with a Leading Proton at HERA-2

H1 Collaboration

Abstract

The cross section for the diffractive deep-inelastic scattering process $ep \to eXp$ is measured, with the leading final state proton detected in the H1 Forward Proton Spectrometer, using data collected at HERA-2 in years 2005-2007. The analysed data sample corresponds to an integrated luminosity of 156 pb^{-1}. The data cover the range $x_{I\!P} < 0.1$ in fractional proton longitudinal momentum loss, $|t| < 1$ GeV^2 in squared four-momentum transfer at the proton vertex, $4 < Q^2 < 700$ GeV^2 in photon virtuality and $0.001 < \beta = x/x_{I\!P} < 1$, where x is the Bjorken scaling variable. The cross section is measured differentially in $x_{I\!P}, \beta$ and Q^2. The data are compared with QCD predictions at next-to-leading order based on diffractive parton distribution functions previously extracted from measurements of inclusive diffractive deep-inelastic scattering.

References

[1] H1 Collaboration, *"Diffractive Deep Inelastic Scattering with a Leading Proton at HERA"*, DESY-06-048, Eur. Phys. J. C **48** (2006) 749

[2] H1 Collaboration, *"Measurement and QCD Analysis of the Diffractive Deep Inelastic Scattering Cross Section at HERA"*, DESY-06-049, Eur. Phys. J. C **48** (2006) 715

[3] ZEUS Collaboration, *"Deep Inelastic Scattering with Leading Protons or Large Rapidity Gaps at HERA"*, DESY-09-175 Nucl. Phys. B **816** (2009) 1

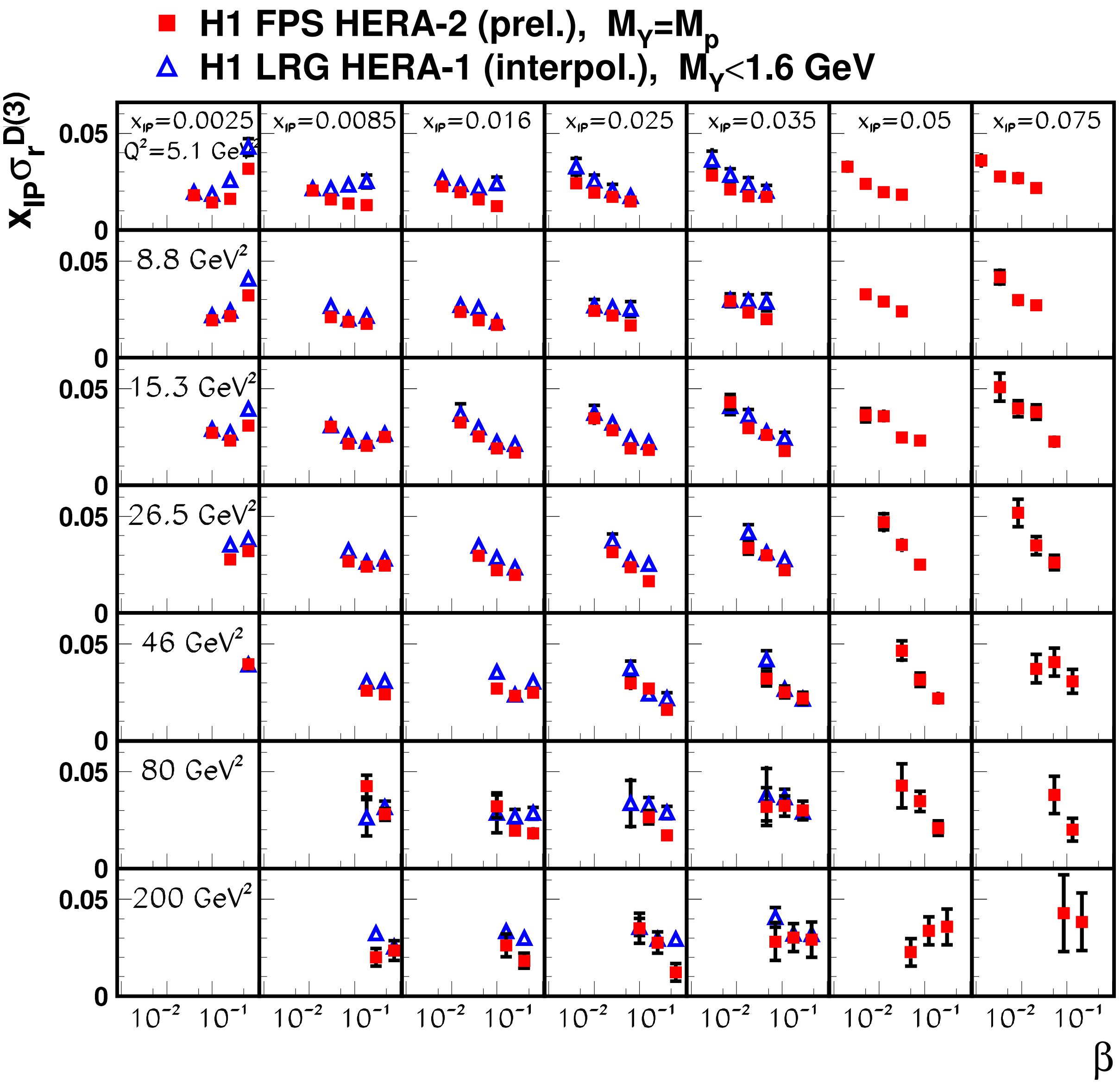

Figure 1: The diffractive reduced cross section $x_{I\!P}\,\sigma_r^{D(3)}(\beta, Q^2, x_{I\!P})$ for $|t| < 1$ GeV^2, shown as a function of β for different values of $x_{I\!P}$ and Q^2. The inner error bars represent the statistical errors. The outer error bars indicate the statistical and systematic errors added in quadrature. An overall normalisation uncertainty of 6% is not shown. The H1 FPS data are compared with the H1 LRG results interpolated to the FPS $\beta, Q^2, x_{I\!P}$ values using a parameterization of the 'H1 2006 DPDF Fit B' [2].

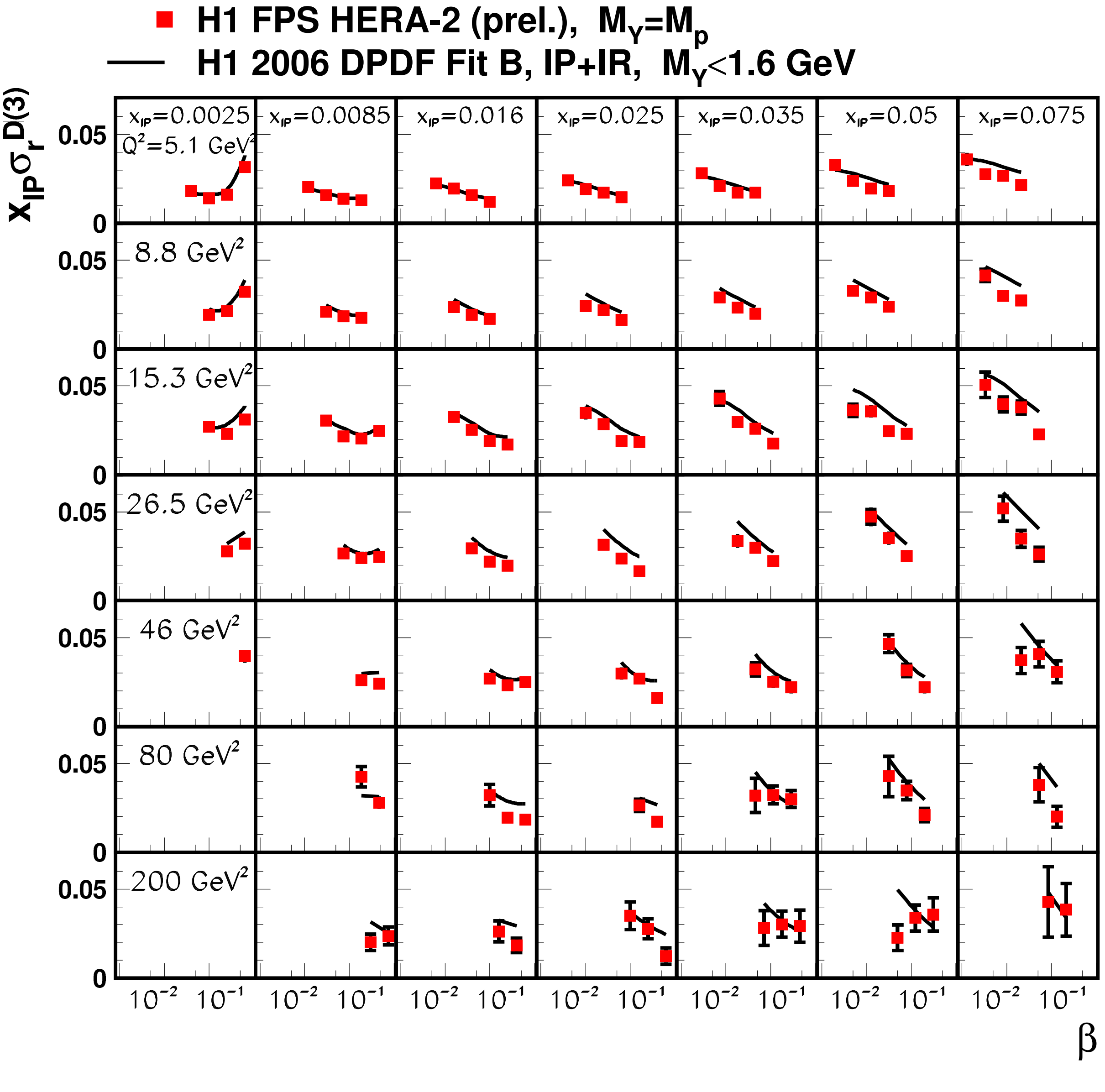

Figure 2: The diffractive reduced cross section $x_{I\!P}\,\sigma_r^{D(3)}(\beta, Q^2, x_{I\!P})$ for $|t| < 1$ GeV^2, shown as a function of β for different values of $x_{I\!P}$ and Q^2. The inner error bars represent the statistical errors. The outer error bars indicate the statistical and systematic errors added in quadrature. An overall normalisation uncertainty of 6% is not shown. The solid curves represent the results of the 'H1 2006 DPDF fit B' to the LRG data [2].

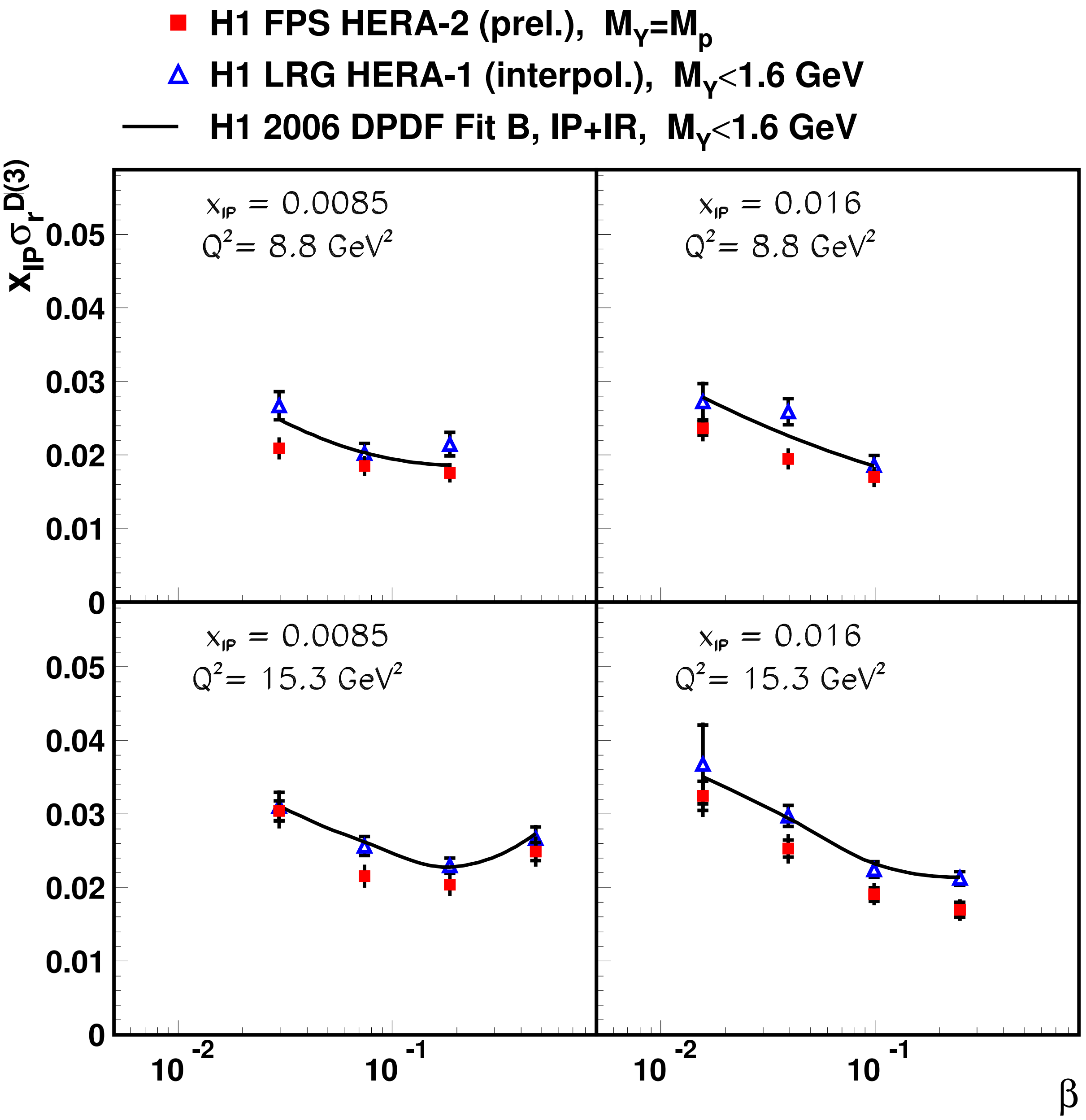

Figure 3: The diffractive reduced cross section $x_{I\!P}\,\sigma_r^{D(3)}(\beta, Q^2, x_{I\!P})$ for $|t| < 1$ GeV^2, shown as a function of β for selected values of $x_{I\!P}$ and Q^2. The inner error bars represent the statistical errors. The outer error bars indicate the statistical and systematic errors added in quadrature. An overall normalisation uncertainty of 6% is not shown. The H1 FPS data are compared with the H1 LRG results interpolated to the FPS $\beta, Q^2, x_{I\!P}$ values using a parameterization of the 'H1 2006 DPDF Fit B' [2]. The solid curves represent the results of the 'H1 2006 DPDF Fit B' to the LRG data.

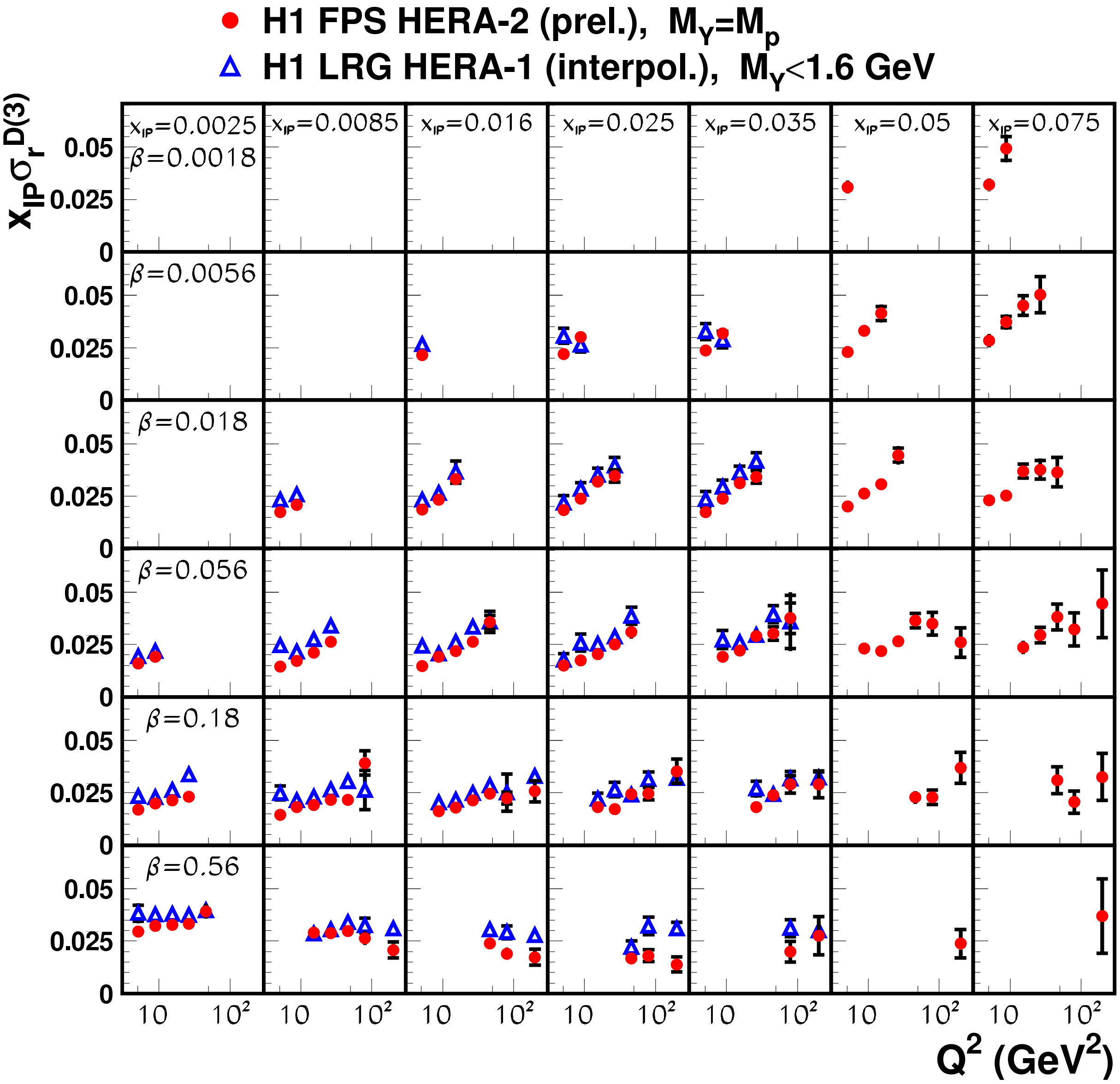

Figure 4: The diffractive reduced cross section $x_{I\!P}\,\sigma_r^{D(3)}(\beta, Q^2, x_{I\!P})$ for $|t| < 1\ \mathrm{GeV}^2$, shown as a function of Q^2 for different values of $x_{I\!P}$ and β. The inner error bars represent the statistical errors. The outer error bars indicate the statistical and systematic errors added in quadrature. An overall normalisation uncertainty of 6% is not shown. The H1 FPS data are compared with the H1 LRG results interpolated to the FPS $\beta, Q^2, x_{I\!P}$ values using a parameterization of the 'H1 2006 DPDF Fit B' [2].

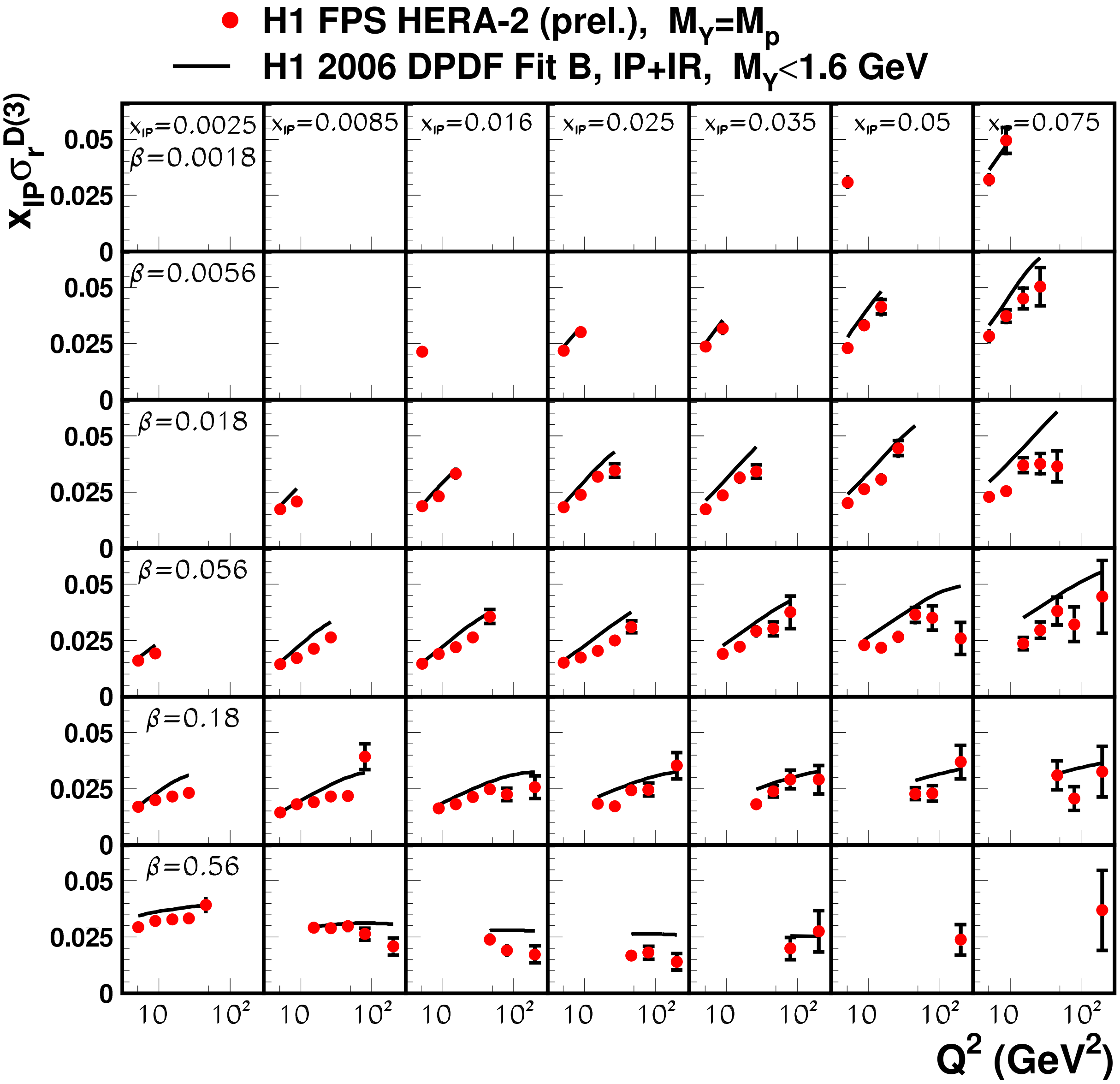

Figure 5: The diffractive reduced cross section $x_{I\!P}\,\sigma_r^{D(3)}(\beta, Q^2, x_{I\!P})$ for $|t| < 1\ \mathrm{GeV}^2$, shown as a function of Q^2 for different values of $x_{I\!P}$ and β. The inner error bars represent the statistical errors. The outer error bars indicate the statistical and systematic errors added in quadrature. An overall normalisation uncertainty of 6% is not shown. The solid curves represent the results of the 'H1 2006 DPDF Fit B' to the LRG data [2].

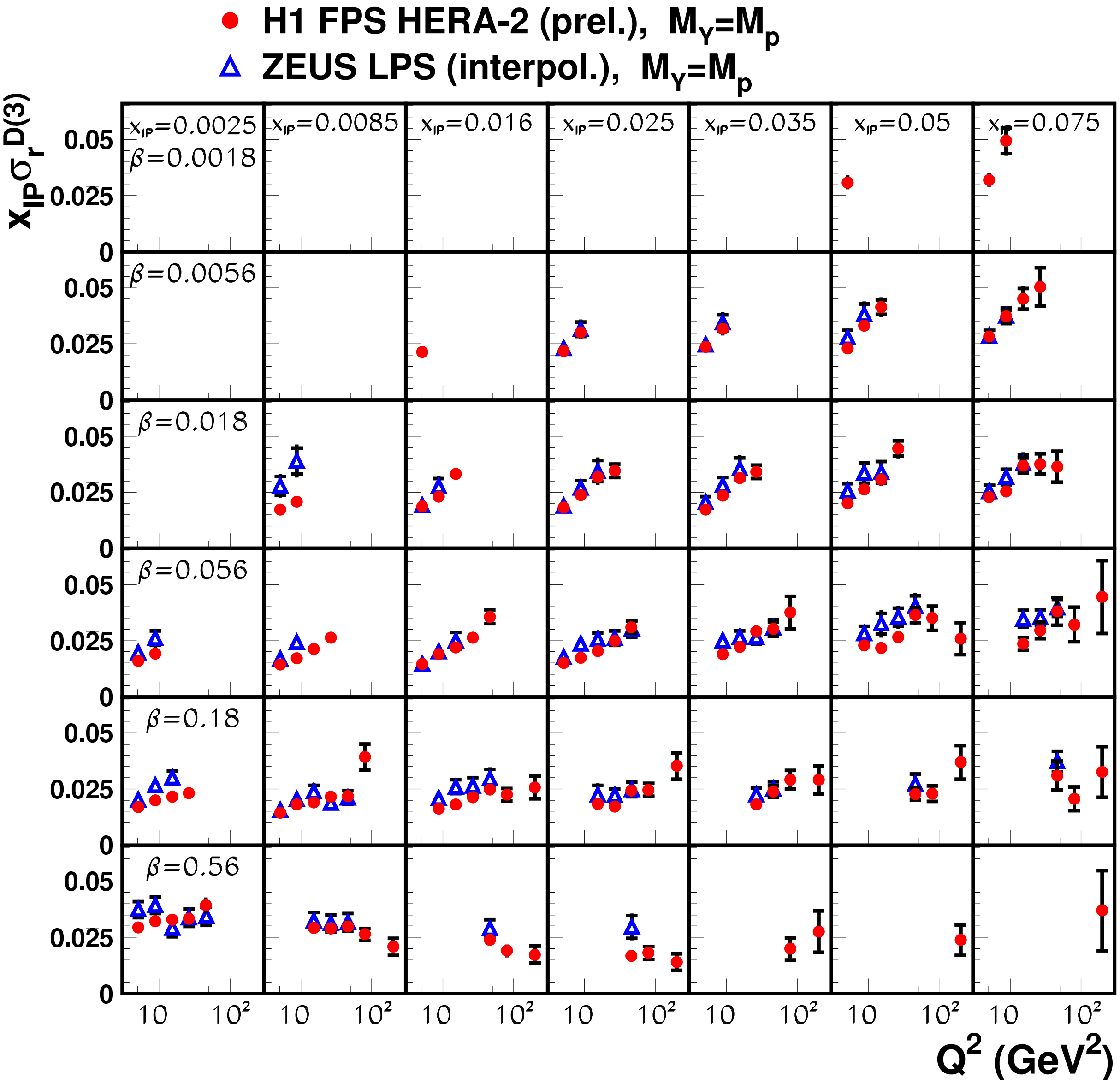

Figure 6: The diffractive reduced cross section $x_{I\!P}\,\sigma_r^{D(3)}(\beta, Q^2, x_{I\!P})$ for $|t| < 1\ \mathrm{GeV}^2$, shown as a function of Q^2 for different values of $x_{I\!P}$ and β. The inner error bars represent the statistical errors. The outer error bars indicate the statistical and systematic errors added in quadrature. An overall normalisation uncertainty of 6% is not shown. The H1 FPS data are compared with the ZEUS LPS results [3] interpolated to the FPS $\beta, Q^2, x_{I\!P}$ values using a parameterization of the 'H1 2006 DPDF Fit B' [2].

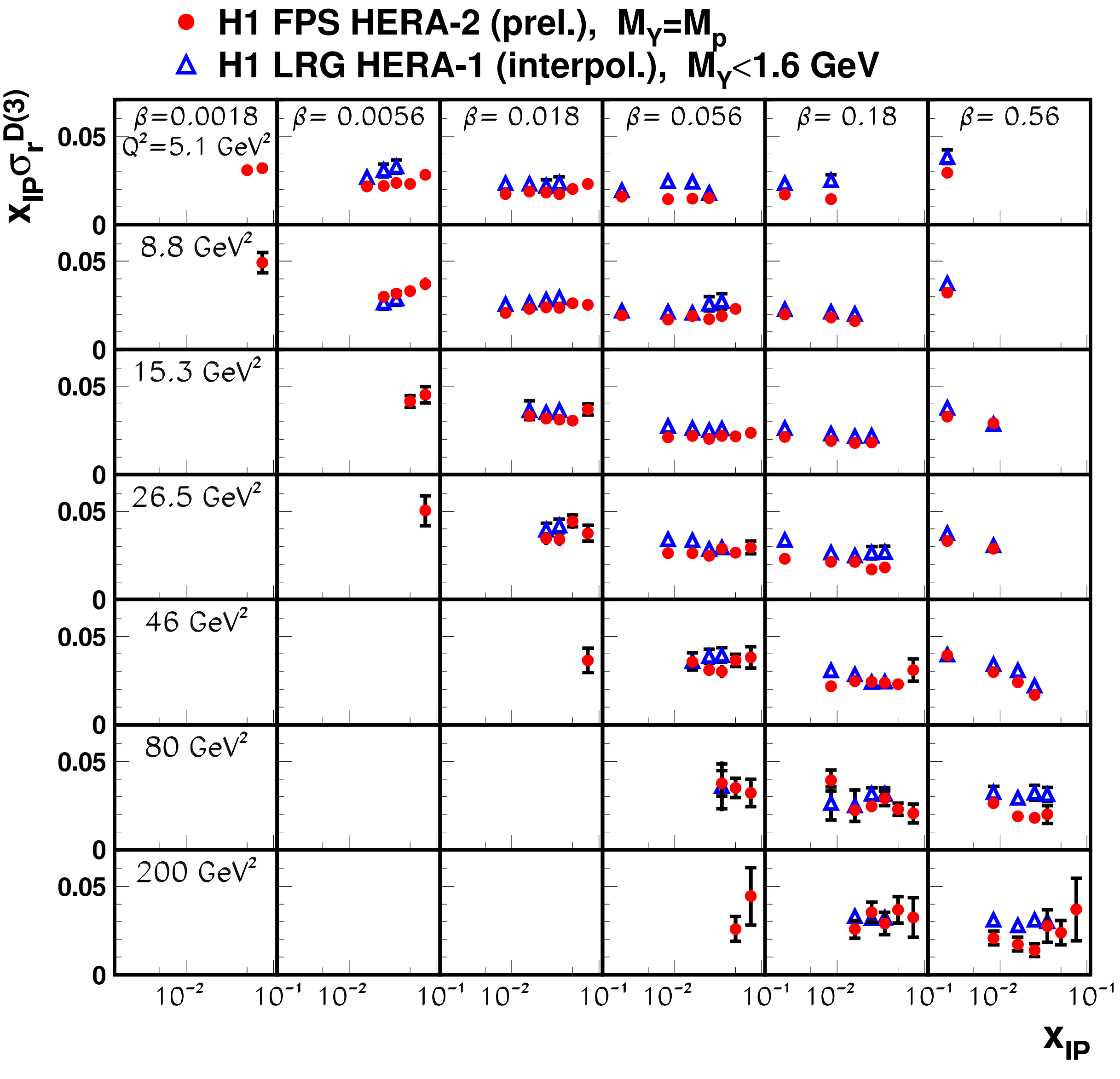

Figure 7: The diffractive reduced cross section $x_{IP}\,\sigma_r^{D(3)}(\beta, Q^2, x_{IP})$ for $|t| < 1\ \mathrm{GeV}^2$, shown as a function of x_{IP} for different values of β and Q^2. The inner error bars represent the statistical errors. The outer error bars indicate the statistical and systematic errors added in quadrature. An overall normalisation uncertainty of 6% is not shown. The H1 FPS data are compared with the H1 LRG results [2] interpolated to the FPS β, Q^2, x_{IP} values using a parameterization of the 'H1 2006 DPDF Fit B' [2].

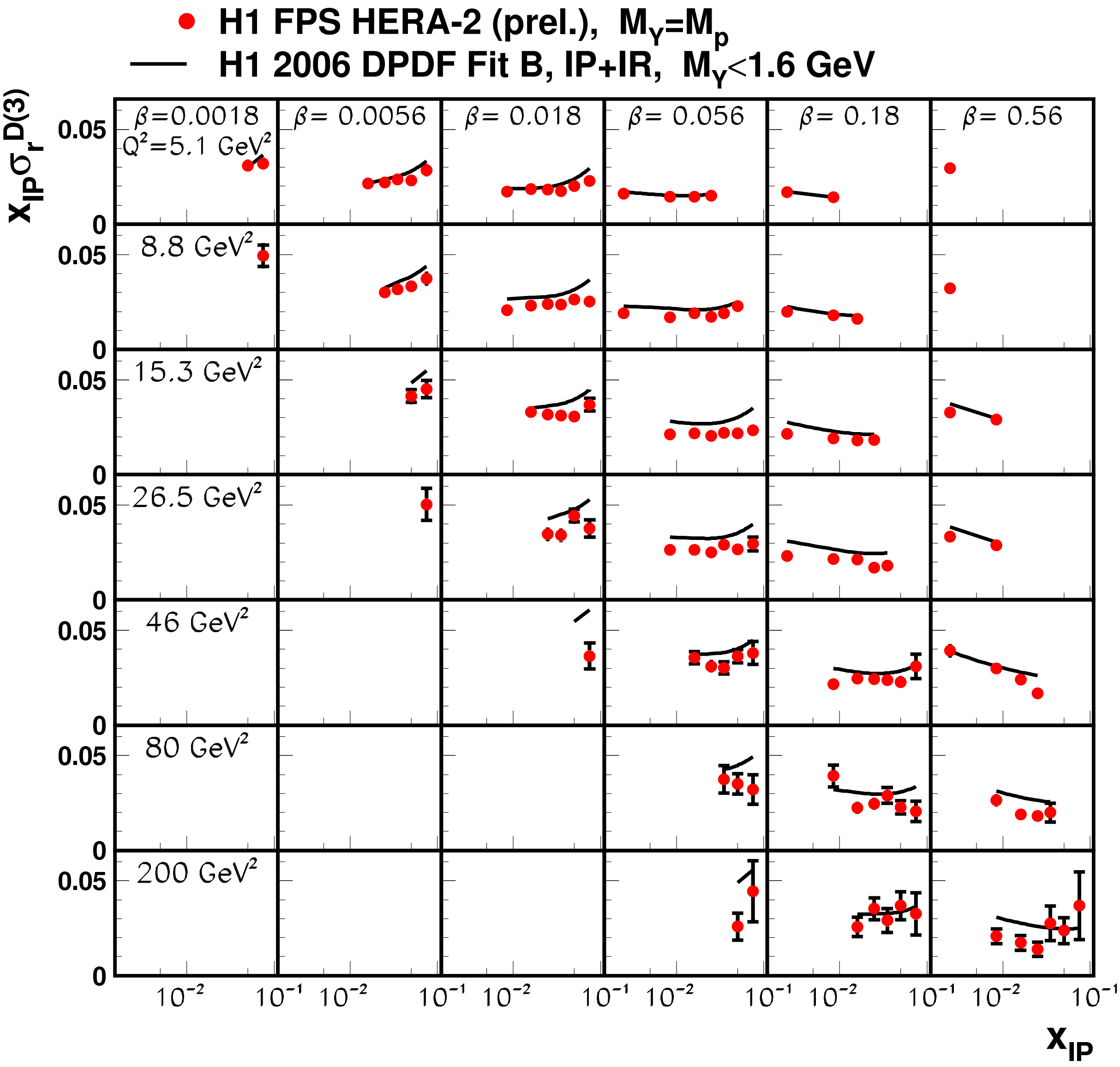

Figure 8: The diffractive reduced cross section $x_{I\!P}\,\sigma_r^{D(3)}(\beta, Q^2, x_{I\!P})$ for $|t| < 1\ \mathrm{GeV}^2$, shown as a function of $x_{I\!P}$ for different values of β and Q^2. The inner error bars represent the statistical errors. The outer error bars indicate the statistical and systematic errors added in quadrature. An overall normalisation uncertainty of 6% is not shown. The solid curves represent the results of the 'H1 2006 DPDF Fit B' to the LRG data [2].

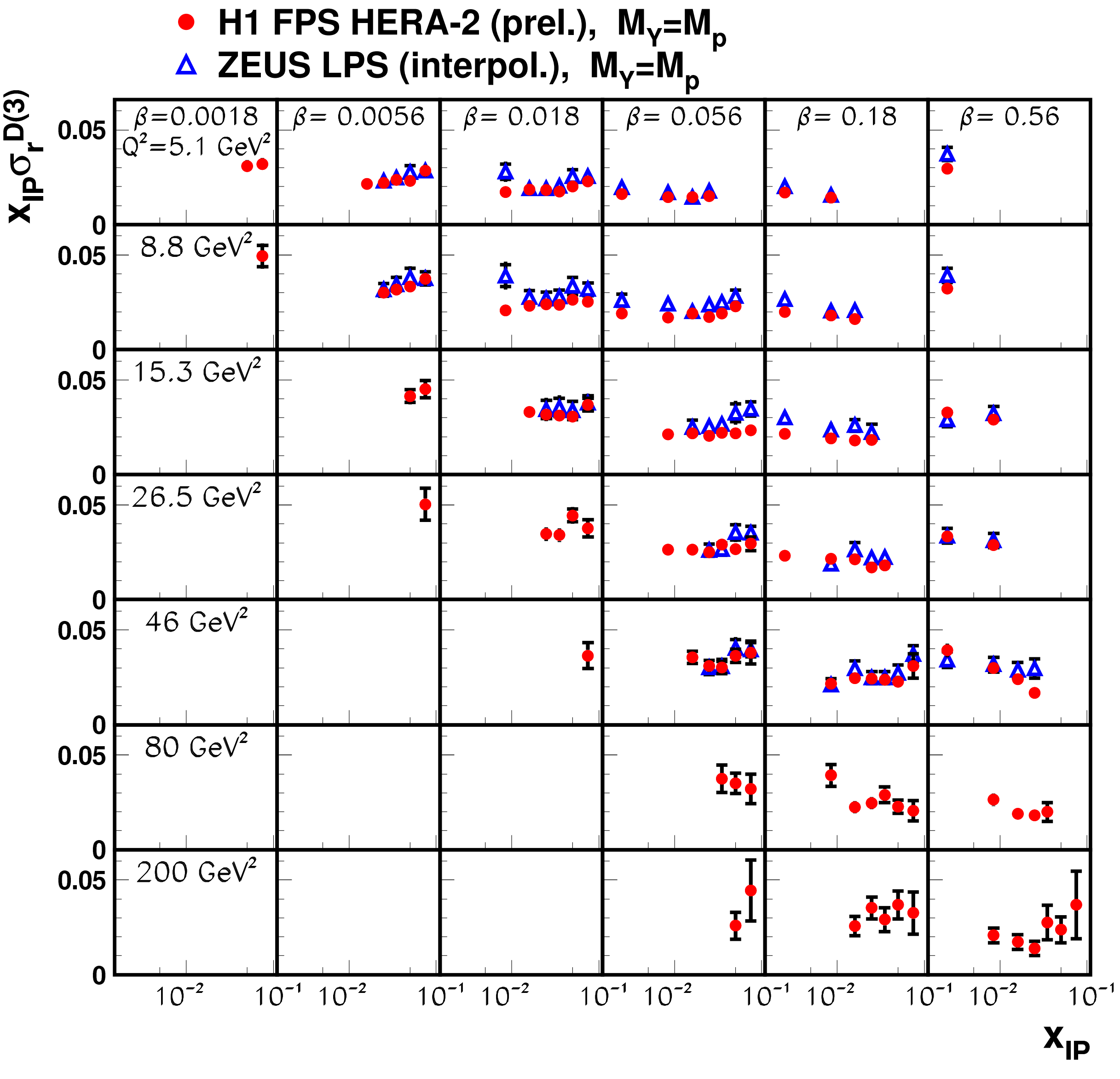

Figure 9: The diffractive reduced cross section $x_{I\!P}\,\sigma_r^{D(3)}(\beta, Q^2, x_{I\!P})$ for $|t| < 1$ GeV^2, shown as a function of $x_{I\!P}$ for different values of β and Q^2. The inner error bars represent the statistical errors. The outer error bars indicate the statistical and systematic errors added in quadrature. An overall normalisation uncertainty of 6% is not shown. The H1 FPS data are compared with the ZEUS LPS results [3] interpolated to the FPS $\beta, Q^2, x_{I\!P}$ values using a parameterization of the 'H1 2006 DPDF Fit B' [2].

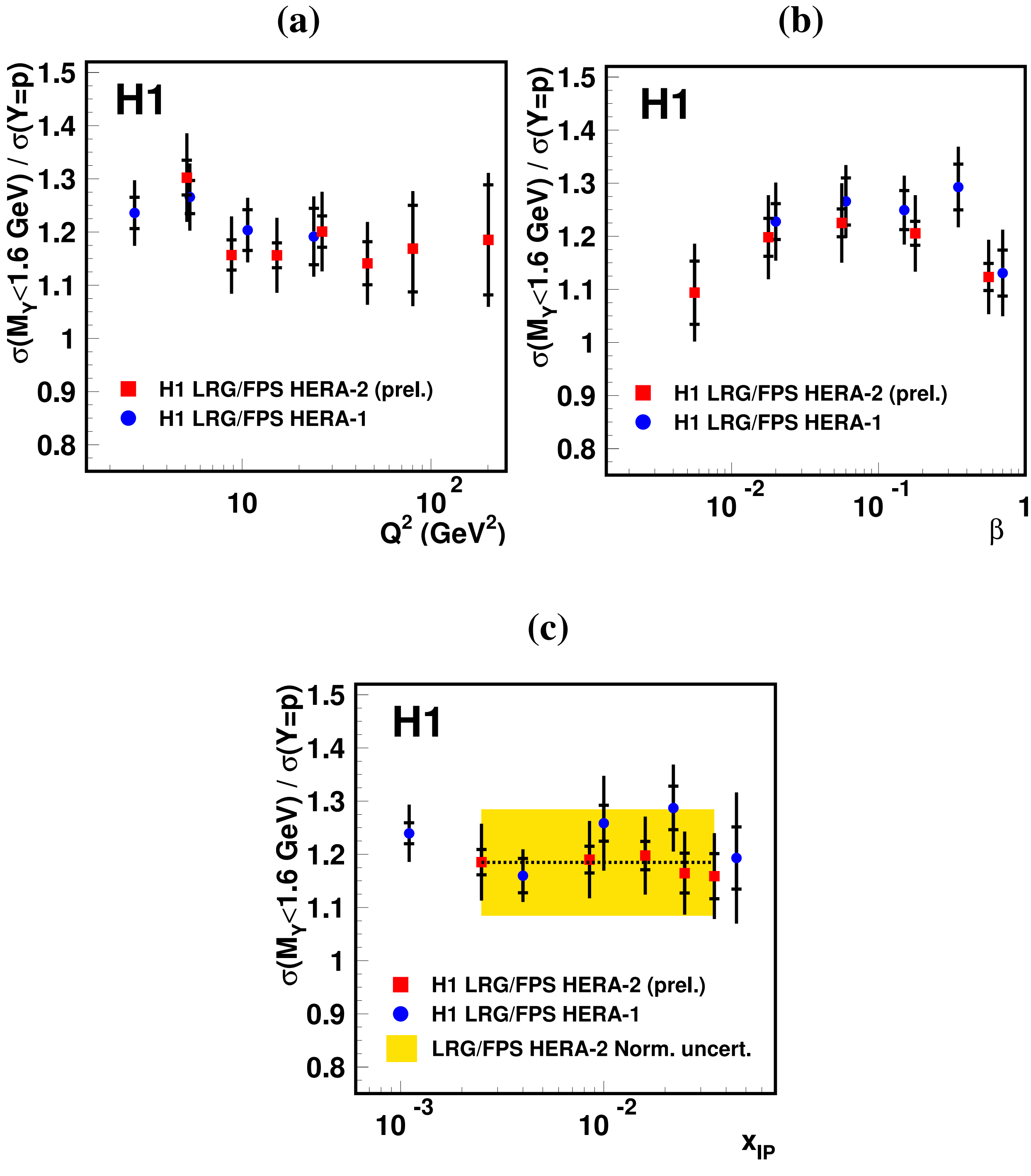

Figure 10: The ratio of the diffractive cross section for $M_Y < 1.6$ GeV and $|t| < 1$ GeV^2 to that for $Y = p$ and $|t| < 1$ GeV^2, obtained from $\sigma_r^{D(3)}$ measurements using the H1 LRG data [2] and the FPS data at HERA-1 [1] and HERA-2. The results are shown as a function of (a) Q^2, (b) β and (c) $x_{I\!P}$, after averaging over the other variables. The inner error bars represent the statistical errors. The outer error bars indicate the statistical and systematic errors added in quadrature. Normalisation uncertainty of 8.5% is shown in figure (c). The dash line in figure (c) represents the result of a fit to the data assuming no dependence on $x_{I\!P}$.