PROCEEDINGS OF SCIENCE

Measurement of Heavy-Quark Jet Photoproduction at HERA

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The results from a recent analysis on photoproduction of beauty and charm quarks in events with at least two jets measured with the ZEUS detector at HERA are presented. The fractions of jets containing b and c quarks were extracted using the decay-length significance and invariant mass of the reconstructed secondary decay vertices. Differential cross sections as a function of jet transverse momentum, p_T^{jet}, and pseudorapidity, η^{jet}, were measured and compared with next-to-leading-order QCD predictions.

PoS(EPS-HEP2011)452

The 2011 Europhysics Conference on High Energy Physics, EPS-HEP 2011,
July 21-27, 2011
Grenoble, Rhône-Alpes, France

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1. Introduction

The measurement of heavy flavor production in *ep* collisions at HERA provides a good testing ground for perturbative Quantum Chromodynamics (pQCD) as the high quark masses provide a hard scale. In the analysis [1] presented here, beauty and charm production was studied in the photoproduction regime, i.e. the photon virtuality, Q^2, was required to fulfill $Q^2 \approx 0\,\mathrm{GeV}^2$. The aim of this measurement is to test perturbative QCD with high precision. For this purpose, the long lifetimes of the weakly decaying b and c hadrons as well as their large masses were exploited.

The analysis was performed on a dataset corresponding to an integrated luminosity of $128\,\mathrm{pb}^{-1}$ with photoproduction events containing at least two jets with $p_T^{\mathrm{jet1(2)}} > 7(6)\,\mathrm{GeV}$. The measurements were compared to a leading order plus parton shower Monte Carlo (PYTHIA) [2] as well as QCD predictions at next-to-leading-order (NLO), calculated using FMNR program [3]. This program is based on the fixed-flavor-number scheme (FFNS), in which heavy flavors are generated dynamically in the hard subprocess.

2. Signal Extraction

For the separation of the beauty and charm signal from light-flavor background, a secondary vertexing technique was used, exploiting the long lifetimes of b and c hadrons. Secondary vertices were fitted from well-reconstructed tracks associated to jets. The decay length, d, was calculated as the distance in X-Y between the secondary vertex and the interaction point, which was then projected onto the jet axis in the X-Y plane. In order to further improve the separation between signal and background the decay-length significance, $S = d/\delta d$, where δd is the uncertainty on d, was combined with the invariant mass, m_{vtx}, of the tracks fitted to the corresponding secondary vertex. Figure 1 shows the decay-length significance, S, divided into three mass bins $0.8 \le m_{\mathrm{vtx}} < 1.4\,\mathrm{GeV}$, $1.4 \le m_{\mathrm{vtx}} < 2\,\mathrm{GeV}$ and $2 \le m_{\mathrm{vtx}} < 7.5\,\mathrm{GeV}$. The MC simulation provides a good description of the data in all three bins and an almost pure beauty region can be obtained at high S in the third mass bin. In order to minimize the effect of the light-flavor contribution and to cancel out potential systematic effects, the negative part $(S < 0)$ of the significance distribution was mirrored onto and subtracted from the positive side $(S > 0)$ of the significance distribution and a cut of $|S| > 3$ was applied. The beauty and charm contributions were then extracted using a least-squares fit to the subtracted distributions in the three mass bins. The overall normalization was constrained to the normalization of the data in the significance distribution with $|S| > 3$ and $0.8 \le m_{\mathrm{vtx}} < 7.5\,\mathrm{GeV}$.

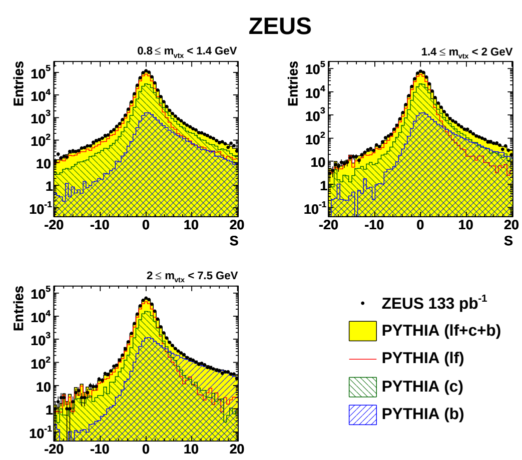

Figure 1: Decay-length significance, S, in three mass bins.

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3. Results

The single-differential beauty- and charm-jet cross sections were measured as a function of $p_{\mathrm{T}}^{\mathrm{jet}}$ and η^{jet}. The measurements are compared to the scaled PYTHIA MC predictions as well as to the NLO QCD predictions. Figure 2 shows differential cross sections as a function of $p_{\mathrm{T}}^{\mathrm{jet}}$ for beauty and charm (right). The NLO QCD predictions are in good agreement with the data and the scaled PYTHIA MC describes the distribution well. In order to enable direct comparisons with other ZEUS measurements given at the *b*-quark or *c*-quark level, the NLO QCD prediction corrected for hadronization was used to extrapolate the dijet cross sections to inclusive *b*-quark or *c*-quark cross sections. Figure 3 shows summary of differential cross sections for *b*-quark production as a function of p_{T}^{b} as measured by the ZEUS collaboration. Good agreement with the NLO QCD prediction is observed for many independent ZEUS measurements over a wide range of p_{T}^{b}. The corresponding summary plot for *c*-quark jet cross sections also shows an agreement with the NLO QCD prediction and a consistent picture with previous ZEUS measurements.

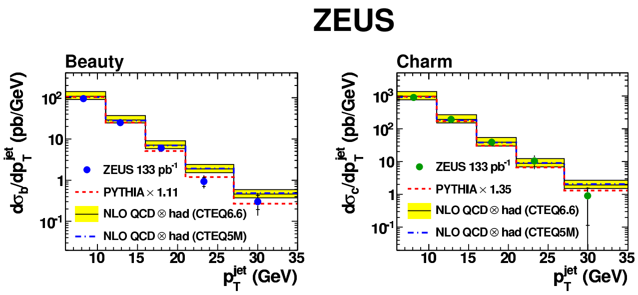

Figure 2: Differential cross sections as a function of $p_{\mathrm{T}}^{\mathrm{jet}}$ for beauty (left) and charm (right).

4. Summary

A recent measurement of beauty and charm production in dijet photoproduction using secondary vertexing technique was presented. Mirrored decay-length significance and mass of secondary vertex were used to extract the heavy-quark content. The measured differential beauty- and charm-jet cross sections are in agreement with NLO QCD calculations. The results were compared with the other ZEUS measurements. The measurements agree with each other and give a consistent picture of heavy-quark photoproduction over a wide kinematic range. The beauty and charm cross sections from this analysis are more precise than previous measurements made by the ZEUS collaboration.

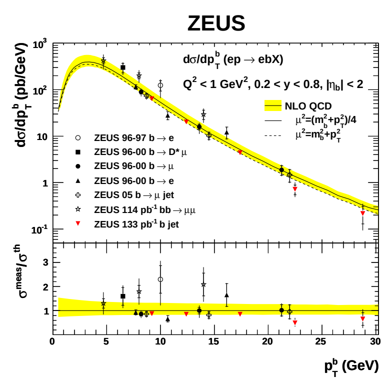

Figure 3: Cross sections for *b*-quark production as a function of p_{T}^{b} from various ZEUS measurements.

References

[1] ZEUS Collaboration, H. Abramowicz et al., Eur. Phys. J. **C 71**, 1659 (2011).

[2] T. Sjöstrand et al., Comp. Phys. Comm. **135**, 238 (2001).

[3] S. Frixione et al., Nucl. Phys. **B 412**, 225 1994.