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Recent QCD Results from the DØ

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Abstract. Recent QCD related results from the DØ experiment are presented based on proton anti-proton collision data at sqrt(s) = 1:96 TeV, taken in Run II of the Fermilab Tevatron Collider. Measured observables include vector boson plus jets production, photon plus b-jet production, inclusive multijet production, and angular correlations of jets. The measurements are compared to perturbative QCD calculations and to Monte Carlo model predictions. A determination of the strong coupling constant from jet data is also presented.

Keywords: Jet production, vector boson plus jet production.
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INTRODUCTION

The Run II of the Fermilab Tevatron collider has delivered an integrated luminosity of 12 fb^{-1} of proton-antiproton collisions at a center of mass energy of 1.96 TeV to the CDF and DØ experiments. This contribution presents an overview of the recent QCD results from the DØ [1], based on data sets with integrated luminosities of 0.7 – 8.7 fb^{-1}. In all cases, the data are corrected for instrumental effects and are presented at the particle level. The results are used to test either particle level predictions by Monte Carlo (MC) events generators, or perturbative QCD (pQCD) calculations in fixed order in strong coupling constant (α_s) which are corrected for non-perturbative effects.

W+JETS PRODUCTION

The DØ experiment has published measurements of W($\rightarrow e\nu$) + n jets cross-sections for n=1,2,3 and 4 jets using a data sample of 4.2 fb^{-1} [2]. The measurements include the total inclusive cross section for each jet multiplicity and differential cross sections normalized to inclusive W cross section as a function of n^{th} jet p_T. Events that are consistent with the W boson decays to electrons that contains jets (cone size R=0.5, transverse momentum p_T > 20 GeV and pseudorapidity $|\eta|$ < 3.2) are selected. The measurements improve on the previous results by including the W+4 jet differential cross sections, and by significantly improving the uncertainties on the differential cross sections as well as by performing the first comparison with next-to-leading order (NLO) W+3 jet predictions using BLACKHAT+SHERPA and ROCKET+MCFM. In general, within their uncertainties, the NLO predictions reproduce the data, except in a few regions where disagreements are observed. The LO predictions for W+4 jets describe the data well, but suffer from large scale uncertainties.

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Z BOSON+ B-JET PRODUCTION

The DØ experiment has published the most precise measurement of the ratio of cross-sections for the Z+b-jet to Z+jet production based a data sample of 4.2 fb^{-1} [3]. The measurement of the ratio benefits from cancellations of many systematic uncertainties, and thus allows a more precise comparison with theory. Events that are consistent with the *Z* boson decays to electrons or muons containing at least one jet (cone size R=0.5, p_T > 20 GeV and $|\eta|$ < 2.5) are selected. The jets likely to contain b-quarks are identified by means of a b-tagging algorithm that exploits the characteristics of tracks of particles inside the jet to distinguish b-jets from light jets [4]. The b-jet fraction in the sample enriched with heavy flavors is extracted using another discriminant (constructed from impact parameter significance of tracks and the secondary vertex mass) which has different shapes for b-, c- and light jets. A maximum likelihood fit to the discriminant distribution in data after background subtraction is performed with the jet flavor templates to obtain the b-jet fraction. The measured ratio $\sigma(Z+b)/\sigma(Z+jet) = 0.0193 \pm 0.0022$ (stat) $\pm$ 0.0015 (syst) is in good agreement with the MCFM NLO prediction of 0.0192 ± 0.0022.

PHOTON+B-JET PRODUCTION

The DØ experiment has performed the measurements of the cross section of photon (γ) plus b-jet production as a function of photon p_T using a data sample corresponding to an integrated luminosity of 8.7 fb^{-1} [5]. The large data sample and more advanced photon and b-jet identification tools enable us to perform more precise measurements and to extend them in the kinematic regions previously unexplored. The measurement is performed in central ($|y^\gamma|<1$) and forward ($1.5<|y^\gamma|<2.5$) rapidity regions. The photons are required to have 30< p_T <300 GeV in the central region and < p_T <200 GeV in the forward region. The b-jets are required to have p_T>15 GeV and $|y^{jet}|<1.5$. The measurements are in agreement with the NLO predictions within the uncertainties in the region up to photon p_T < 70 GeV, but show noticeable disagreement for larger photon p_T. The results indicate a need for higher order QCD corrections in the larger photon p_T region, and resummation of diagrams with additional gluon radiation. The predictions from k_T-factorization approach are in better agreement with the data. The best agreement is obtained with the SHERPA generator.

THREE-JET PRODUCTION

Three jet production provides a stringent test of QCD which is less dependent on the parameterization of parton distribution functions (PDFs), and in principle directly probes the α_s. Using an integrated luminosity of 0.7 fb^{-1}, the DØ has published the first measurement of the inclusive three-jet differential cross section as a function of the invariant three-jet mass (M_{3jet}) reaching masses up to 1.1 TeV [6]. The events are required to have p_T of the leading jet larger than 150 GeV and for any pair of jets to be well separated in η-ϕ space. The measurement is performed in three rapidity regions (|*y*|<2.4;1.6;0.8) and in three regions of the third jet p_T (40;70;100 GeV). The measurements are compared with NLO predictions with different PDFs with the scales set to the average value of the three leading p_T jets. Good agreement between data and theory is observed for MSTW2008 and NNPDF2.1 PDFs. To quantify the agreement between data and theory, a χ^2 is computed for different scales, for different PDFs, and for different values of $\alpha_s(M_Z)$ used in the NLO matrix elements and PDFs. The best overall agreement (lowest χ^2values) is obtained for MSTW2008 for the central scale choice and $\alpha_s(M_Z) = 0.121$, and the results for NNPDFv2.1 are very close.

ANGULAR CORRELATIONS OF JETS

The DØ has recently presented the measurement of a new observable at hadron colliders that is sensitive to QCD dynamics and to the α_s, while being only weakly sensitive to PDFs [7]. The observable ($R_{\Delta R}$) measures the angular correlations of jets and is defined as the number of neighboring jets above a given p_T threshold which accompany a given jet within a given distance ΔR in the plane of rapidity y and azimuthal angle ϕ. The ensemble average over all jets in an inclusive jet sample is measured and the results are presented as a function of p_T of the inclusive jets, in different regions of ΔR and for different p_T requirements for the neighboring jets ($p_{T,nbr}$). $R\Delta R$ measurement considers an inclusive jet sample at central rapidities ($|y|<1$) for $p_T>50$ GeV with a cone of size 0.7. The $p_{T,nbr}$ requirements are 30, 50, 70, or 90 GeV, and the different ΔR intervals are $1.4<\Delta R<1.8$, $1.8<\Delta R<2.2$, and $2.2<\Delta R<2.6$. For jets with cone size $R = 0.7$, the lower limit of $\Delta R=1.4$ ensures that a jet does not overlap with its neighboring jets. The upper limit on ΔR is smaller than π, so that contributing neighboring jets stem only from three- (or more) jet topologies. The data for $p_{T,nbr} > 50$ GeV are well-described by NLO predictions. Results for α_s (p_T) are extracted using the data with $p_{T,nbr} \geq 50$ GeV, integrated over ΔR. The extracted $\alpha_s(p_T)$ results from $R_{\Delta R}$ are, to good approximation, independent of the PDFs and thus independent of assumptions on the renormalization group equation (RGE). Therefore, these α_s results provide a test of the RGE at momentum transfers beyond 208 GeV. The results are in good agreement with previous and consistent with the RGE predictions for the running of α_s for momentum transfers up to 400GeV. The combined $\alpha_s(M_Z)$ result, obtained using the data with $p_{T,nbr} \geq 50$ GeV, is $\alpha_s(M_Z) = 0.1191+0.0048 -0.0071$, in good agreement with the world average value [8].

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