PROCEEDINGS OF SCIENCE

Measurement of the Drell-Yan transverse momentum dependence over a wide mass range at 13 TeV from CMS

Itana Bubanja on behalf of the CMS collaboration[1,2,*]

[1] *Interuniversity Institute for High Energies (IIHE), Université libre de Bruxelles, Boulevard du Triomphe, 1050 Brussels, Belgium*

[2] *Faculty of Natural sciences and Mathematics, University of Montenegro, Bulevar Dzordza Vasingtona BB, 81000 Podgorica, Montenegro*

E-mail: itana.bubanja@cern.ch

In this report, measurements are presented of the differential cross section for opposite-charge electron or muon pairs as a function of transverse momentum. The measurements are done in several invariant mass bins, from 50 GeV to 1 TeV. Also, the ratios of cross sections in these mass bins to the on-shell mass bin are analysed. The results are obtained from proton-proton interactions recorded with the CMS detector at the LHC at a centre-of-mass energy of 13 TeV during 2016. The luminosity of the data is 36.3 fb^{-1}. The measurements are compared with theory predictions.

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[*] Speaker

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1. Introduction

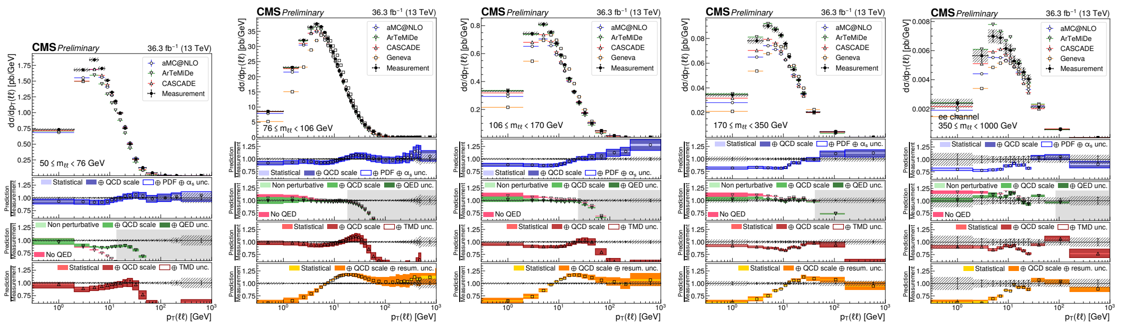
Drell-Yan process at CMS [1] occurs when quark from one proton anihillates with anti-quark from a proton traveling in the opposite direction. The Z boson or γ^* is produced which then decays into two opposite-charged same flavor leptons. This process helps in understanding of hadronic substructure and is important for testing parton distributions. In this report the Drell-Yan differential cross section in several invariant mass ranges as a function of the exchanged boson transverse momentum for inclusive Drell-Yan production is presented. The results are obtained for several invariant mass ranges: $50 < m_{ll} < 76$ GeV, $76 < m_{ll} < 106$ GeV, $106 < m_{ll} < 170$ GeV, $170 < m_{ll} < 350$ GeV, and $350 < m_{ll} < 1000$ GeV. The cross sections are first obtained for muons and electrons separately and then combined to reduce statistical uncertainties. The data is collected during 2016 with CMS detector from proton-proton interactions at centre-of-mass energy 13 TeV. The luminosity of collected data is 36.3 fb^{-1}.

2. Event selection and data sets

For the results shown in this report the events with exactly two isolated opposite-charged same flavor leptons are analysed. In addition, the transverse momentum of the leading lepton is greater than 25 GeV, while the transverse momentum of the subleading lepton is required to be greater than 20 GeV. The absolute value of lepton pseudorapidities is set to be less or equal 2.4, $|\eta| \leq 2.4$. For muons, either the double muon trigger with 18 and 7 GeV thresholds in transverse momentum, p_T, or the single muon trigger with p_T threshold of 24 GeV is used. For electrons, the double electron trigger with 23 and 12 GeV thresholds is used. Events are vetoed if the third lepton with p_T greater then 10 GeV exists in the range $|\eta| \leq 2.4$.
For the simulation of the Z/γ^* process MadGraph5_aMC@NLO using the FxFx merging scheme [2] is used. Pythia8 [3] tune CUETP8M1 [4] is used for simulation of parton showers, hadronisation, and QED final state radiation. The next-to-leading order (NLO) NNPDF 3.0 [5] is used for the matrix element calculation.
The background processes with same final state are: WW, WZ, ZZ, $\gamma\gamma$, $t\bar{t}$ and single top quark production.

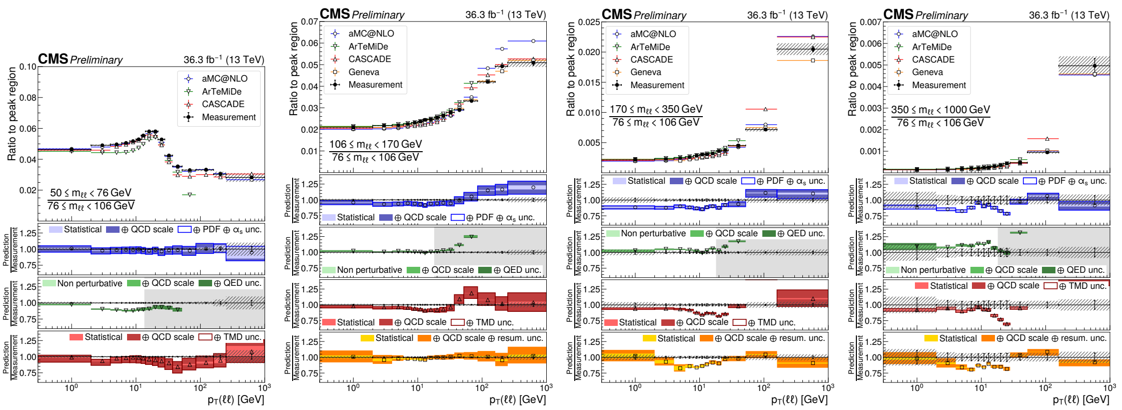
3. Results

The measurements are also compared with several predictions: Cascade [7], arTeMiDe [8] and GENEVA [9]. The comparisons are presented in Fig. 1 and Fig. 2. CASCADE is a prediction based on parton branching (PB) TMD method [6]. arTeMiDe is an independent TMD approach which is obtained from next-to-next-to-leading order (NNLO) based calculations fitted to Drell-Yan and Z boson measurements at different energies. GENEVA is the prediction obtained by combining higher-order resummation with a Drell-Yan calculation at NNLO. As shown in the figures MadGraph5_aMC@NLO predicts a smaller cross section for $p_T(ll)$ values lower than 30 GeV. The disagreement is more visible for higher mass bins, $m_{ll} > 170$ GeV. Although, the large $p_T(ll)$ distributions are well described by MadGraph5_aMC@NLO, it predicts too high cross sections for the highest values of $p_T(ll)$ values in the mass range $106 < m_{ll} < 170$ GeV. The



(a) (b) (c) (d) (e)

Figure 1: Differential cross sections in $p_T(ll)$: (a) 50 < m_{ll} < 76 GeV (b) 76 < m_{ll} < 106 GeV (c) 106 < m_{ll} < 170 GeV (d) 170 < m_{ll} < 350 GeV (e) 350 < m_{ll} < 1000 GeV [10].



(a) (b) (c) (d)

Figure 2: The ratios of the differential cross sections in $p_T(ll)$ for invariant masses outside the Z peak over the differential cross section in the Z peak region: (a) 50 < m_{ll} < 76 GeV (b) 106 < m_{ll} < 170 GeV (c) 170 < m_{ll} < 350 GeV (d) 350 < m_{ll} < 1000 GeV [10].

prediction from ARTEMIDE is in the good agreement with the data for lower p_T values. For the highest masses, the data has more limited statistics and exhibits a less smooth distribution. The distribution at low p_T is well described by CASCADE, but the CASCADE prediction for high p_T region is not presented because of missing higher fixed-order calculations. For GENEVA prediction, p_T spectrum dependence on α_s value choice is in detail discussed in Ref. [11].

4. Conclusion

MADGRAPH5_AMC@NLO sample is in good general agreement but in a disagreement with data at low p_T. At low pair transverse momenta, TMD based predictions (ARTEMIDE, CASCADE) improve the description. GENEVA does not describe the distributions correctly. The cross section ratios can be predicted even by models that fail to predict the absolute cross section. QED final state radiation effects are significant, especially just below the Z peak.

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