

Measurement of Drell-Yan and associated jet cross section at low and high invariant masses

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The first measurement of the Drell-Yan and associated jet cross section as a function of the Drell-Yan mass is presented using an integrated luminosity of 4.9 fb^{-1} in the di-muon channel of proton-proton collisions recorded with the CMS detector. Cross Sections as a function of the Drell-Yan transverse momentum are measured differentially in the Drell-Yan mass. The p_T spectrum of the Drell-Yan allows to study multiple-gluon emissions and resummation effects.

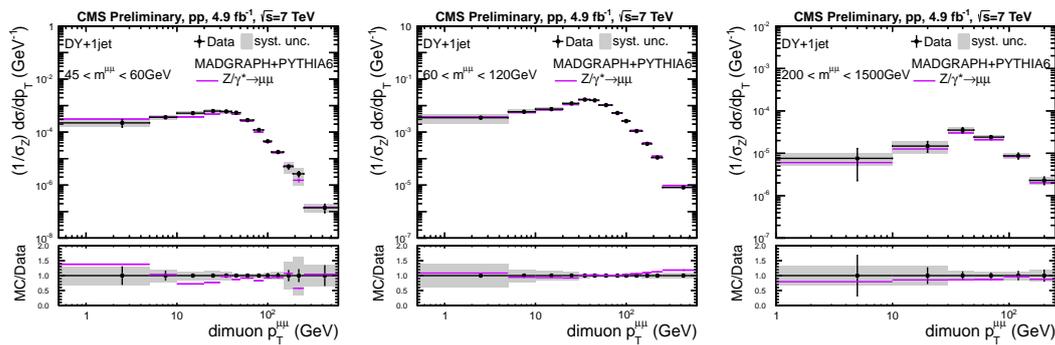


Figure 1: Di-muon p_T distribution at low and high invariant masses for DY+1 jet production. Corrected data is compared to MC predictions.

The production of Drell-Yan (DY) lepton pairs in hadron-hadron collisions is a suitable process to study the effect of the soft-gluon resummation in perturbative quantum chromodynamics (pQCD). While DY lepton pair production at large transverse momenta can be described by fixed order calculations in pQCD, at small p_T resummation of soft gluons to all orders in perturbation theory is required [1].

The detailed measurements of inclusive DY lepton pair production as well as DY lepton pair production in association with jets, especially in the mass range above the Z mass (and in the range of $m^{\mu\mu} \sim 125 \text{ GeV}$), is important for a later comparison with Higgs production, which can be used to determine the differences of soft gluon and multi-jet resummation in a quark or gluon induced process [2].

The p_T spectrum of the DY lepton pair is of special interest to test contributions from perturbative multi-gluon resummation. In the case of the inclusive DY production the maximum of the DY p_T distribution is around 5 GeV. When requiring DY in association with additional jets the maximum shifts to higher p_T and the phase space for multi-gluon emissions is enlarged. In Fig. 1 the comparison of DY production and at least one jet above a p_T of 30 GeV is shown. The first measurement of the differential DY and associated jets cross section as a function of the DY di-muon mass is presented in [3]. The di-muon p_T distribution for DY+1 jet production in the invariant mass regions of 45-60, 60-120, and 200-1500 GeV is presented. The corrected data points are compared to matrix element plus parton shower predictions. The MC generator MADGRAPH+PYTHIA6 is used. MADGRAPH produces the DY boson with maximum four hard partons in the matrix element calculation at leading-order. The underlying event and parton shower is generated by PYTHIA6 using the tune Z2*. The comparison to data presents a good agreement over the whole phase space.

Multi-jet emissions in a rapidity interval between the DY pair and the leading jet is a sensitive probe for multi-gluon emissions. The average jet multiplicity of jets with $p_T > 30$ GeV between the leading jet and the forward DY production ($|\eta^{\mu\mu}| > 2.5$) as a function of the rapidity separation $|\Delta y(\mu\mu, j)|$ is presented in Fig. 2. The average jet multiplicity increases with increasing separation between the DY lepton pair and the leading jet from 0 to 0.3 at large rapidity separation. The general behaviour is reproduced by MADGRAPH simulation.

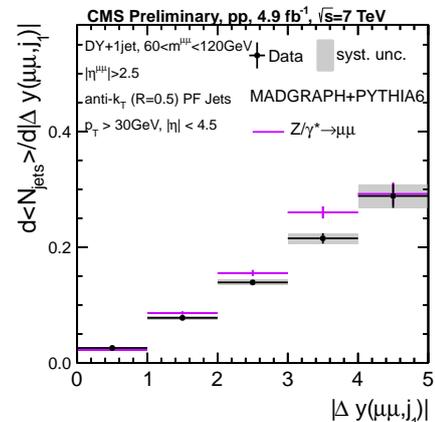


Figure 2: Average jet multiplicity as a function of the rapidity separation between the leading jet and the forward DY production.

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References

- [1] Dokshitzer, Y. L. and Diakonov, D. and Troian, S. I., Phys. Lett. **B79** (1978) 269, Collins, J. C. and Soper, D. E. and Sterman, G. F., Nucl. Phys. **B250** (1985) 199.
- [2] Cipriano, P. and Dooling, S. and Grebenyuk, A. and Gunnellini, P. and Hautmann, F. and Jung, H. and Katsas, P., Phys. Rev. **D88** (2013) 097501.
- [3] CMS Collaboration, CMS-PAS-FSQ-13-003, "Measurement of the double differential Drell-Yan and associated jet cross sections at low and high invariant masses in proton-proton collisions at $\sqrt{s} = 7$ TeV", <http://cds.cern.ch/record/1670353> (2014).