PROCEEDINGS OF SCIENCE

Measurement of initial state radiation using Drell-Yan Events at CDF

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A study of the initial state gluon radiation (ISR) measurement in proton-antiproton collisions at $\sqrt{s}$ = 1.96 TeV is presented. This analysis uses Drell-Yan ($Z/\gamma^* \to ee, \mu\mu$) events in the CDF data sample, corresponding to an integrated luminosity of 9.4 fb^{-1}. We find that the mean value of the transverse momentum distribution of the Drell-Yan system ($\langle p_T^{\mathrm{DY}} \rangle$) is a good observable to measure the effect of the ISR. This observable has a logarithmic dependence on the mass square of Z/γ^* boson (m_{DY}^2), which is parameterized as a linear function of $\langle p_T^{\mathrm{DY}} \rangle = (-7.57 \pm 0.69) + (2.15 \mp 0.08) \log m_{\mathrm{DY}}^2$. This measurement provides a way to estimate the effect of softly evolving ISR at very high mass region, and it can be used to control the ISR effect in other physics processes.

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We measure the size of initial state gluon radiation (ISR) using the mean of Z/γ^* transverse momentum (p_T) at various mass ranges of the Drell-Yan (DY) process. We use CDF Run II data corresponding to an integrated luminosity of 9.4 fb^{-1} and the Monte-Carlo simulation samples of DY, W, dibosons, and $t\bar{t}$ process. The samples are generated using the PYTHIA6 [1] program and processed by the CDF detector [2] simulation. The samples are reweighted to match the number of primary vertices and their position with data. The lepton energy/momentum correction [3] and Z/γ^* boson p_T correction are also applied to the simulation samples to describe the data correctly. We apply online and offline criteria to select high quality of dimuon [4] and dielectron [5] events. For the ISR measurement, the DY events with $p_T^{\ell\ell} < 100$ GeV are used.

The mean p_T of dilepton ($\langle p_T^{\ell\ell}\rangle$) in DY process is measured in various dilepton mass bins. To get unbiased average of Z/γ^* p_T ($\langle p_T^{\mathrm{DY}}\rangle$) and mass ($\langle m_{\mathrm{DY}}\rangle$) at generator level, multiplicative corrections are applied to the reconstructed $\langle p_T^{\ell\ell}\rangle$ and $\langle m_{\ell\ell}\rangle$. The corrections are derived from the ratios of the $\langle p_T^{\mathrm{DY}}\rangle$ ($\langle m_{\mathrm{DY}}\rangle$) to the $\langle p_T^{\ell\ell}\rangle$ ($\langle m_{\ell\ell}\rangle$) for acceptance, efficiency, and QED FSR effects. The systematic uncertainties for this measurements are estimated, and the dominant sources of systematic uncertianty are found to be the Z/γ^* p_T correction and modeling of the QED FSR.

The measurements of $\langle p_T^{\mathrm{DY}}\rangle$ and $\langle m_{\mathrm{DY}}\rangle$ are summarized in Table 1 and Table 2 for dimuon and dielectron final states, respectively. Figure 1 shows the logarithmic dependence of $\langle p_T^{\mathrm{DY}}\rangle$ against m^2_{DY} of the form $\langle p_T^{\mathrm{DY}}\rangle = (-7.57\pm 0.69) + (2.15\mp 0.08)\log m^2_{\mathrm{DY}}$. As ISR activity occurs universally in hadron collisions with logarithmic dependency, the ISR activity at high collision energy scale of physics processes can be estimated by extrapolating the observed ISR activity at low collision energy.

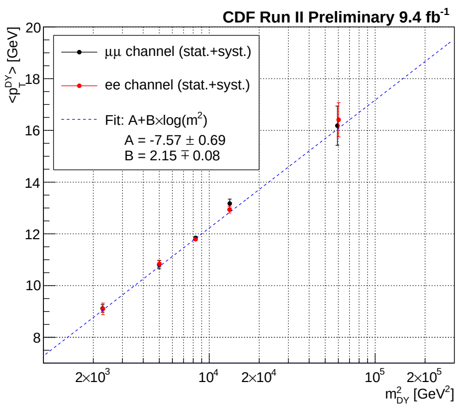

Figure 1: Average of p_T^{DY} as a function of m^2_{DY}

(GeV)

Mass bin	$\langle m_{\mathrm{DY}}\rangle \pm stat. \pm syst.$	$\langle p_T^{\mathrm{DY}}\rangle \pm stat. \pm syst.$
[40,60]	$47.72 \pm 0.05 \pm 0.04$	$9.12 \pm 0.09 \pm 0.12$
[60,80]	$70.66 \pm 0.04 \pm 0.07$	$10.81 \pm 0.08 \pm 0.14$
[80,100]	$90.99 \pm 0.01 \pm 0.08$	$11.84 \pm 0.03 \pm 0.03$
[100,200]	$115.29 \pm 0.18 \pm 0.14$	$13.17 \pm 0.12 \pm 0.12$
[200,350]	$243.33 \pm 1.63 \pm 0.41$	$16.18 \pm 0.61 \pm 0.46$

Table 1: Average of p_T^{DY} and m_{DY} in $\mu\mu$ events

(GeV)

Mass bin	$\langle m_{\mathrm{DY}}\rangle \pm stat. \pm syst.$	$\langle p_T^{\mathrm{DY}}\rangle \pm stat. \pm syst.$
[40,60]	$47.83 \pm 0.05 \pm 0.07$	$9.10 \pm 0.13 \pm 0.18$
[60,80]	$70.76 \pm 0.04 \pm 0.04$	$10.84 \pm 0.08 \pm 0.10$
[80,100]	$90.98 \pm 0.01 \pm 0.07$	$11.79 \pm 0.02 \pm 0.02$
[100,200]	$115.11 \pm 0.13 \pm 0.14$	$12.93 \pm 0.09 \pm 0.08$
[200,350]	$245.46 \pm 1.29 \pm 0.36$	$16.41 \pm 0.56 \pm 0.27$

Table 2: Average of p_T^{DY} and m_{DY} in *ee* events

References

[1] T. Sjöstrand *et al.*, Comput. Phys. Commun. **135**, 238 (2001)

[2] A. Abulencia *et al.* (CDF Collaboration), J. Phys. G: Nucl. Part. Physics. **34**, 2457 (2007)

[3] A. Bodek *et al.*, Eur. Phys. J. C **72**, 2194 (2012)

[4] T. Aaltonen *et al.* (CDF Collaboration), Phys. Rev. D **89**, 072005 (2014)

[5] T. Aaltonen *et al.* (CDF Collaboration), Phys. Rev. D **93**, 112016 (2016)