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Measurement of the Cross Section for Prompt Isolated Diphoton Production in $p\bar{p}$ Collisions at $\sqrt{s} = 1.96$ TeV

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The production of prompt photon pairs with large invariant mass in hadron collisions is a large irreducible background in searches for a low mass Higgs boson decaying into a photon pair, as well as in searches for new phenomena, such as new heavy resonances, extra spatial dimensions or cascade decays of heavy new particles. Precise measurements of the diphoton production differential cross sections for various kinematic variables and their theoretical understanding are thus very important for these searches. Diphoton production is also used to check the validity of perturbative quantum chromodynamics (pQCD) and soft-gluon resummation methods implemented in theoretical calculations. Diphotons are expected to be dominantly produced by quark-antiquark annihilation and in kinematic regions with high gluon luminosity, especially at low invariant mass, by gluon gluon fusion through a quark loop diagram. Prompt photons may also result from quark fragmentations in the hard scattering, although a strict photon isolation requirement significantly reduces the fragmentation contributions.

The diphoton production cross section, differential in kinematic variables sensitive to the reaction mechanism, is measured using 5.4/fb of data collected with the CDF II detector. The high statistics of the measured sample allows for a higher precision scan over a much more extended phase space than previous measurements. The overall systematic uncertainty is limited to about 30%. The results of the measurement are compared with three state-of-the-art calculations, applying complementary techniques in describing the reaction. All three calculations, within their known limitations, reproduce the main features of the data. By including photon radiation in the initial and final states, a parton shower MC suitable for background simulations in searches for a low mass Higgs boson and new phenomena proves competitive with full NLO calculations.

Summary

We report a measurement of the cross section of prompt isolated photon pair production in $p\bar{p}$ collisions at a total CM energy of 1.96 TeV using data of 5.4/fb integrated luminosity collected with the CDF II detector at the Fermilab Tevatron. The measured differential cross section is compared with three perturbative QCD predictions, a Leading Order (LO) parton shower Monte Carlo and two Next-to-Leading Order (NLO) calculations. The NLO calculations reproduce most aspects of the data. By including photon radiation from quarks before and after hard scattering, the parton shower Monte Carlo becomes competitive with the NLO predictions.

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