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Hard Photons in Hadroproduction of Top Quarks with Realistic Final States

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We present a complete description of top quark pair production in association with a hard photon in the dilepton channel. Our calculation is accurate to NLO in QCD. It is based on matrix elements for $e^+\nu_e\mu^-\bar{\nu}_\mu b\bar{b}\gamma$ production and includes all resonant and non-resonant diagrams, interferences, and off-shell effects of the top quarks and the W gauge bosons. This calculation constitutes the first full computation for top quark pair production with a final state photon in hadronic collisions at NLO in QCD. Numerical results for total and differential cross sections are presented for the LHC at a centre-of-mass energy of $\sqrt{s}$=13 TeV. For some new physics observables we observe shape distortions of more than 100%. In addition, we confirm that the size of the top quark off-shell effects for the total cross section is consistent with the expected uncertainties of the narrow-width-approximation. Triggered by ongoing experimental analyses, we also report on the cross section ratio to the $pp\to e^+\nu_e\mu^-\bar{\nu}_\mu b\bar{b}$ process. Not only is the ratio more stable against radiative corrections but it also has reduced scale dependence as compared to the $pp\to e^+\nu_e\mu^-\bar{\nu}_\mu b\bar{b}\gamma$ cross section alone. Thus, it represents an interesting observable to probe new physics at the LHC.

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