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Double parton scattering via photon-proton interactions and the transverse proton structure

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In this contribution, we present possible appealing advantages offered by double parton scattering (DPS) processes via photon-proton interactions. In fact, as discussed in the proton-proton collisions framework, the DPS cross section depends on the double parton distribution functions (dPDFs) of the protons. These new quantities encode new information on the 3D partonic structure of the proton, complementary to TMDs and GPDs. In fact, dPDFs are sensitive to unknown double parton correlations in hadrons which cannot be accessed through, e.g., GPDs. However, dPDFs are almost unknown and, in particular, their dependence on the transverse distance of partons. In our analyses [1, 2, 3, 4] we investigated the relevance of both perturbative and non perturbative double parton correlations in dPDFs. Moreover, our collaboration studied the impact of these effects on the experimental observable called effective cross section, σ_{eff} [5, 6]. However, as proved in Refs. [7, 8] in proton-proton collisions, only limited information on the partonic proton structure can be extracted from data due to the lack of information on dPDFs and their relative first moment called effective form factor (eff), the latter entering the definition of σ_{eff}. Therefore, in Ref. [12], we studied the possibilities offered by DPS initiated by quasireal photons. In fact, in this case, the offshellness of the photons is controlled by measuring leptons, proton or ions from the impinging beam scattered at low angle. At such low virtualities, the photon will fuctuate hadronically and/or electromagnetically in a $q-\bar{q}$ pair which then initiates the double parton scattering with the proton. In this scenario, the photon transverse size could be almost controlled by measuring the virtuality and, in turn, the interaction rate in the DPS mechanism. Such a condition leads to the extraction of information on the transverse proton structure. In Ref. [12] we prove that the dependence of $\sigma_{eff}^{\gamma p}(Q^2)$ on the photon virtuality Q^2 could be related to the mean transverse distance between two partons in the proton active in the DPS process. In addition, different models of the photon and proton effs have been used to calculate, for the first time, $\sigma_{eff}^{\gamma p}(Q^2)$. These results have been then used to estimate the DPS cross section for the four jets production via DPS for the HERA kinematics. In fact, the ZEUS collaboration reported significant MPI effects in this channel for the four jets cross sections, and exposed in their analyses possible contamination of the DPS processes. By estimating the expected number of events at given integrated luminosity, we conclude that DPS process in photoproduction gives a significant fraction of the four jet production cross section if cuts on transverse momenta of the jets are low enough.

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