

INTEGRAL AND DIFFERENTIAL CROSS SECTIONS OF MUON PAIR-PRODUCTION IN pp COLLISIONS AT THE LHC

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The integral cross sections and the transverse momentum distributions for the Z/γ^* boson production in proton-proton collisions are calculated at energy 13 TeV. The parton processes $p + p' \rightarrow \mu^+ \mu^- + n j$ with Z/γ^* in the intermediate states, where p and j are gluons, u, d, c, s massless quarks or antiquarks and $n = 0, 1, 2$, and 3, are generated by MadGraph5_aMC@NLO [1,2] at next-to-leading order perturbative QCD. Following [3,4] the parton events are re-weighted to determine renormalization and factorization scale uncertainties δ of the observables and ones originating from NNPDF model. Parton showers are simulated within Pythia 8 [5,6], matching and merging are provided by MLM and FxFx methods.

The cross sections $\sigma_N = \sum_{n=0, \dots, N-1} \sigma_n(\text{exclusive}) + \sigma_N(\text{inclusive})$ increase as $\sigma_N/\sigma_{N=0} = 1.048$, 1.055, and 1.056 for $N = 1, 2$, and 3, respectively. The most essential contributions originate from $n = 0$ and 1. The cross section $\sigma_{N=0}$ changes from $\delta = +3\%$ down to -5% for independent renormalization and factorization scale variations with factor μ in envelope $\{1/2, 1, 2\}$ with respect to $\mu = 1$. For $N > 0$ values of δ do not decrease visibly.

Calculated cross sections are compared with the data obtained by ATLAS [7] and CMS [8], and by LHCb [9] collaborations in the central and forward rapidity regions. Deviations of $\sigma_{N=3}$ from the cross sections measured by ATLAS, CMS(2025), and LHCb are less than 4, 3, and 2%.

The present study compliments research [10].

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