Electroweak Corrections to Higgs Boson Pair Production

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One of the main objectives of the current and future runs of the LHC is to improve the constraints on the trilinear Higgs boson self-coupling. The present limits, $-1.2 < \kappa_\lambda < 7.2$ from ATLAS and $-1.4 < \kappa_\lambda < 6.4$ from CMS, are expected to be narrowed to $0.1 < \kappa_\lambda < 2.3$ during the High Luminosity phase of the LHC.

A key process in this study is Higgs pair production via gluon fusion. With the inclusion of N^3LO QCD corrections, the QCD scale uncertainty has been reduced to about 3%. Furthermore, a recent study achieved a reduction in the top-quark mass renormalization uncertainty from 40% to 4%. With these two main sources of theoretical uncertainty under control, electroweak (EW) corrections now become increasingly relevant.

Significant progress has been made in the evaluation of EW corrections to Higgs pair production. The Yukawa and self-coupling contributions have been computed independently by three collaborations, including our own, and we have recently completed the calculation of the light-quark contributions. In addition, a numerical evaluation of the full EW corrections was published in November 2023. Although a complete result is already available, our aim is to provide an independent calculation as a robust cross-check.

In the remainder of this summary, I will focus on the light-quark contributions, which form a gauge-invariant and finite subset. Since each diagram involves only a single internal mass, the corresponding Feynman integrals can be evaluated analytically using the method of differential equations. The boundary conditions are determined by explicitly computing the integrals in the large-mass limit of the gauge bosons.

Our results show that the NLO light-quark EW corrections have a substantial impact on the shape of key observables, such as the invariant mass and transverse momentum distributions shown in Fig. 1 and Fig. 2, with effects reaching up to -15% near the production threshold.

Looking ahead, we plan to complete the full NLO EW calculation and make the results available in the form of a POWHEG package. Furthermore, we aim for an extension of the Standard Model results to a consistent EFT framework, thereby providing a foundation for precise BSM studies of Higgs pair production via gluon fusion.

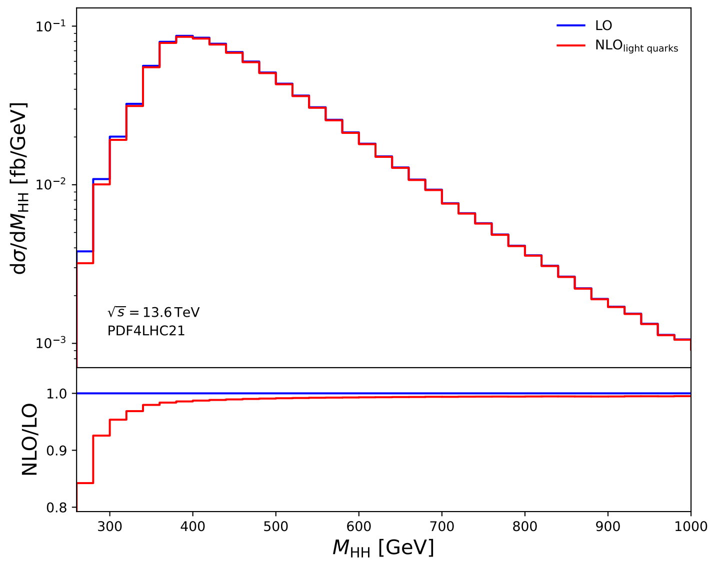

Figure 1: Effect of the NLO EW light-quark corrections on the invariant mass distribution.

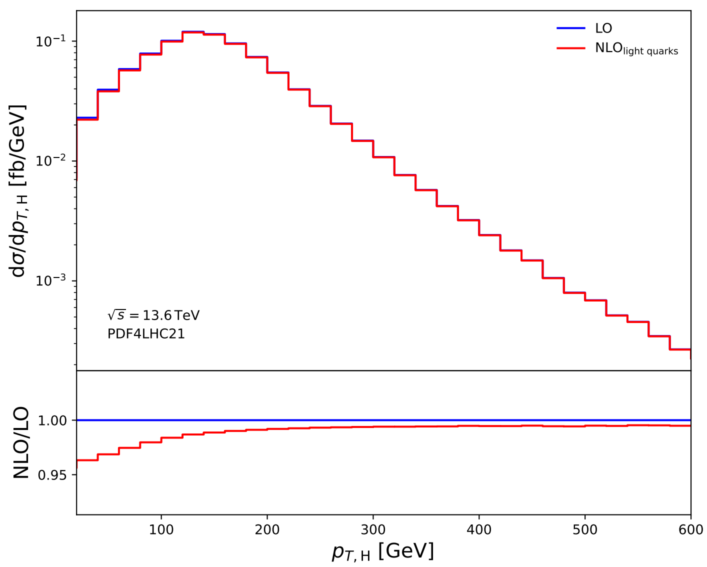

Figure 2: Effect of the NLO EW light-quark corrections on the transverse momentum distribution.