

Higgs trilinear coupling in the standard model effective field theory at the high luminosity LHC and the FCC-ee

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Motivated by the updated high luminosity (HL)-LHC projections for Higgs pair production from ATLAS and CMS and by the release of the FCC-ee feasibility study, we critically revisit the sensitivity of the global standard model effective field theory (SMEFT) analysis to deformations of the Higgs self-coupling modifier κ_3 . To this end, we quantify the impact of SMEFT operators modifying double Higgs production at the LHC and single Higgs production, including loop corrections, at the FCC-ee, and include renormalization group evolution throughout. We demonstrate that significantly improving on the legacy HL-LHC constraints on κ_3 at the FCC-ee is not possible without the $\sqrt{s} = 365$ GeV run; that individual and marginalized determinations are similar at the HL-LHC while differing by up to a factor 3 at the FCC-ee; and that quadratic EFT corrections cannot be neglected, especially at the (HL-)LHC. This finding fundamentally alters the picture compared to strategic planning often based on one-parameter projections. Overall, the combination of HL-LHC and FCC-ee data offers unique potential to pin down the Higgs self-coupling with $\sim 15\%$ precision.

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I. INTRODUCTION

The observation of Higgs pair production, and the associated constraints on the Higgs self-interactions, represent a cornerstone of the physics program of the high luminosity (HL)-LHC [1,2]. Scrutinizing the Higgs trilinear coupling is also a core goal of many proposed future particle colliders, from the FCC-ee [3,4] and FCC-hh [4,5] to ILC/LCF [6,7], CEPC [8], CLIC [9,10], and the Muon Collider [11,12].

In the standard model (SM), the Higgs trilinear self-coupling is uniquely determined by the Higgs vacuum expectation value (v) and its mass (m_h). Deviations from this prediction represent a smoking gun signal of the presence of new physics beyond the SM (BSM). The

precise determination of the Higgs self-coupling has also profound implications for the vacuum stability of the Universe [13,14] and could offer novel insights towards a solution of the baryon asymmetry puzzle [15–17].

If deviations from the SM are present, the Higgs potential can be parametrized as

$$V(h) = \frac{1}{2}m_h^2 h^2 + \lambda_{\text{SM}}(1 + \delta\kappa_3)vh^3 + \frac{1}{4}\lambda_{\text{SM}}(1 + \delta\kappa_4)h^4,$$

where $\lambda_{\text{SM}} = m_h^2/2v^2$. In the standard model effective field theory (SMEFT) framework [18], the leading deviation in the Higgs trilinear coupling stems from the purely Higgs dimension-six operator

$$\mathcal{O}_\varphi = \left(\varphi^\dagger\varphi - \frac{v^2}{2}\right)^3 \supset v^3 h^3 + \frac{3}{2}v^2 h^4, \quad (1)$$

governed by the Wilson coefficient c_φ . Additionally, in the Warsaw basis, two more operators ($c_{\varphi\Box}$ and $c_{\varphi D}$) modify the Higgs potential via field redefinitions [19]. Hence, in

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the dimension-six SMEFT, the Higgs trilinear coupling shifts from its SM value ($\delta\kappa_3 = 0$) as

$$\delta\kappa_3 = -\frac{2v^4}{m_h^2} \frac{c_\phi}{\Lambda^2} + \frac{3v^2}{\Lambda^2} \left(c_{\phi\Box} - \frac{1}{4} c_{\phi D} \right), \quad (2)$$

with furthermore $\delta\kappa_4 = \delta\kappa_3/6$. By means of Eq. (2), SMEFT results can be translated into constraints on the Higgs self-coupling via bounds on $\kappa_3 = 1 + \delta\kappa_3$.

Constraints on κ_3 at the LHC are provided primarily by Higgs pair production, for which the run 2 bounds are $-1.2(-1.2) \leq \kappa_3 \leq 7.2(7.5)$ for ATLAS (CMS) at the 95% CL [20,21]. Subleading sensitivity is obtained through loop corrections to single Higgs processes [22–25]. At future lepton colliders with $\sqrt{s} \lesssim 500$ GeV, such as the FCC-ee, CEPC, LEP3 [26], or the initial stage of the ILC/LCF, Higgs pair production remains kinematically inaccessible. However, constraints on κ_3 can still be derived from loop-induced corrections to Zh production [27–31]. Above the Zhh production threshold, κ_3 could instead be accessed directly.

In the context of the ongoing European Strategy for Particle Physics Update (ESPPU26), the ATLAS and CMS collaborations have presented new sensitivity projections for Higgs pair production at the HL-LHC [2]. These projections indicate a combined significance of 7.6σ for di-Higgs production, corresponding to $\delta\kappa_3 = {}^{+29\%}_{-26\%}$ at the 68% CL, hence providing a substantial improvement in sensitivity compared to the previous (2019) projections [1,32] which reported $\delta\kappa_3 = {}^{+50\%}_{-48\%}$. Crucially, these bounds are obtained from single-parameter analyses and neglect the correlations with EFT operators deforming both single and double Higgs production as well as other processes. One of the aims of this work is to demonstrate explicitly how the situation changes fundamentally once correlations with the other EFT operators are properly accounted for. Another ESPPU26 milestone has been the completion of the FCC feasibility study [4], which updates and improves previous projections [3,33] and confirms four interaction points (IPs) as the baseline scenario for the FCC-ee.

Motivated by these revised HL-LHC and FCC-ee projections, here we critically revisit the constraints on the Higgs self-coupling κ_3 within a state-of-the-art global SMEFT analysis [34,35]. We quantify the synergies between different input datasets: LHC run 2, HL-LHC, FCC-ee@240GeV (always including the $\sqrt{s} = 91$ and 165 GeV runs), and FCC-ee (full). We determine the interplay between SMEFT operators deforming both single and double Higgs production, evaluate the convergence of the EFT expansion, and assess the impact of marginalization as compared to one-parameter analyses. We also examine the impact of these updated projections on UV completions of the SM that manifest primarily through modifications of the Higgs self-coupling, in particular for the custodial electroweak quadruplet model [36].

II. SETTINGS

Our analysis is based on the SMEFT framework [37–40], in particular the SMEFT3.0 release of [34] extended with renormalization group evolution in [35], and whose matching to UV-complete models is described in [41]. With respect to [35], our fitting basis is extended to $n_{\text{op}} = 56$ dimension-six operators with the addition of the two-quark-two-lepton operators $\mathcal{O}_{te}$, $\mathcal{O}_{t\ell}$, $\mathcal{O}_{Qe}$, $\mathcal{O}_{Q\ell}^{(-)}$, and $\mathcal{O}_{Q\ell}^{(3)}$ which are particularly relevant for $b\bar{b}$ and $t\bar{t}$ electroweak production. Our input dataset follows [34] with the inclusion of the run 2 constraints on hh production from ATLAS [20] and adding up to $n_{\text{dat}} = 446$ observables and cross sections from LEP (electroweak precision observables (EWPO) and diboson) and the LHC (Higgs, top, and diboson) assuming the SM. The analysis is performed at both linear and quadratic order in the EFT expansion, incorporates next-leading-order (NLO) QCD corrections whenever available, and accounts for renormalization group equations evolution throughout.

Projections for top, single Higgs, and diboson observables at the HL-LHC are extrapolated from run 2 analyses with the method described in [34]. The projections for double Higgs production follow the latest HL-LHC studies from ATLAS [42–44] and CMS [45] as well as their combination [2]. We complement the projections for the inclusive signal strength μ_{hh} [42] by incorporating differential information from the dominant $b\bar{b}\gamma\gamma$ and $b\bar{b}\tau^+\tau^-$ final states [43,44], see the Appendix for further details. We verify that the resulting di-Higgs likelihood provides a good approximation to the ATLAS/CMS combination by reproducing their sensitivity to κ_3 in a one-parameter fit. The FCC-ee projections follow [34] based on four IPs [4], and the associated theory predictions account for NLO electroweak corrections to the Zh SMEFT cross sections [30] at $\sqrt{s} = 240$ and 365 GeV. Theory uncertainties are neglected for the FCC-ee observables.

In the following, results are presented for Wilson coefficients at a reference scale of $\mu_0 = 250$ GeV. We report bounds on the EFT coefficients as Bayesian credible intervals (CIs). While these coincide with confidence intervals in the Gaussian limit, they can differ significantly for non-Gaussian distributions. This discrepancy is most pronounced in the (HL-)LHC fits, where CIs tend to produce looser bounds compared to confidence intervals.

III. THE HIGGS TRILINEAR COUPLING AT THE HL-LHC

We consider first the global SMEFT fit at the HL-LHC based on the inputs described above. To quantify the interplay between c_ϕ and other operators entering μ_{hh} as well as single Higgs production, Fig. 1 displays the relative deformations to μ_{hh} for each coefficient c_i together with their 68% CI from the HL-LHC quadratic fit with hh projections excluded. We also show the expected

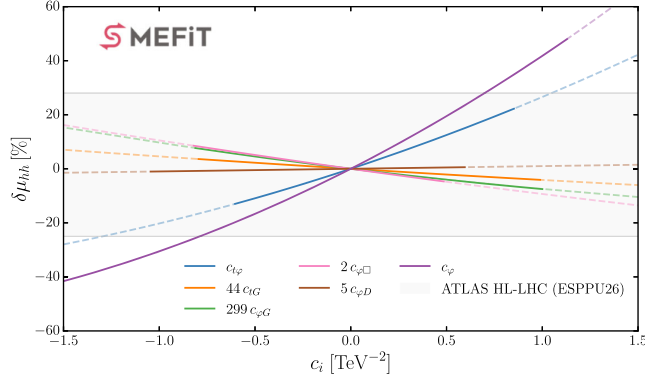


FIG. 1. Relative deformations (dashed) of the inclusive di-Higgs signal strength μ_{hh} for the relevant EFT coefficients c_i and their 68% CI bounds (solid lines) from the HL-LHC quadratic fit (hh excluded). We also indicate the projected experimental bounds.

experimental bound on μ_{hh} from [42]. Figure 1 highlights that the sensitivity of di-Higgs production at the HL-LHC to operators other than c_ϕ is marginal, as these are better constrained by other processes. Given this limited cross-talk, we anticipate that individual and marginalized bounds on c_ϕ and $\delta\kappa_3$ will be similar at the HL-LHC.

The upper (lower) panel of Fig. 2 displays the 68% and 95% CI bounds on c_ϕ ($\delta\kappa_3$) at $\mu_0 = 250$ GeV from individual and global marginalized fits, both at the linear and quadratic EFT levels, at the LHC run 2 and at the HL-LHC, see Tables I and II for the numerical values. From these results, one finds that, first, the HL-LHC will improve the 68% CI marginalized bounds on $\delta\kappa_3$ from run 2 by a factor of 5 for both the linear and quadratic analyses. Second, individual and marginalized bounds are very similar, especially in the linear EFT case. Indeed, the individual linear (quadratic) bound of $|\delta\kappa_3| \leq 0.28$ ($-0.29 \leq \delta\kappa_3 \leq 0.35$) becomes $|\delta\kappa_3| \leq 0.32$ ($-0.26 \leq \delta\kappa_3 \leq 0.49$) in the marginalized case. This result, consistent with Fig. 1, indicates that in the global SMEFT analysis there is a negligible correlation between $\mathcal{O}_\phi$ and other operators. Third, quadratic EFT corrections to the determination of κ_3 at the HL-LHC are small but not negligible, loosening the linear bound by 15%.

IV. THE HIGGS TRILINEAR COUPLING AT THE FCC-EE

As mentioned above, $\mathcal{O}_\phi$ can be constrained at the FCC-ee through NLO electroweak corrections to Zh production [27,29–31]. To illustrate the correlation between c_ϕ and other contributions to Zh at the FCC-ee, Fig. 3 presents the same information as Fig. 1 now for the projected Zh signal strength measurement at $\sqrt{s} = 240$ GeV. The displayed 68% CI constraints are derived from a global quadratic HL-LHC + FCCee@240 fit excluding Zh . Unlike the HL-LHC case, at the FCC-ee several SMEFT

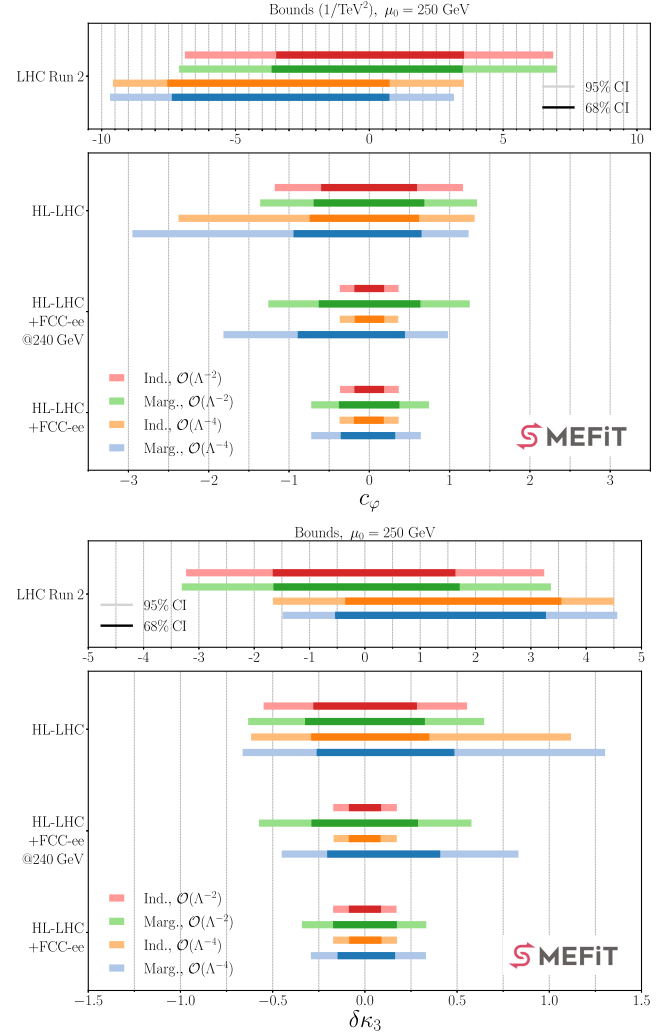


FIG. 2. The 68% (inner) and 95% (outer) CI bounds on c_ϕ (upper) and $\delta\kappa_3$ (lower panel) in linear and quadratic EFT fits to different datasets.

operators will be constrained from Zh at the same time as c_ϕ , in particular $c_{\phi W}$ and $c_{\phi\Box}$, and hence one expects potentially large differences between individual and marginalized constraints for the Wilson coefficient c_ϕ .

TABLE I. Marginalized 68% CI on $\delta\kappa_3$ (for $\mu_0 = 250$ GeV) in linear and quadratic global SMEFT fits.

Input dataset	EFT	$\delta\kappa_3$ (68% CI)
LHC run 2	Linear	$[-1.68, 1.68]$
	Quadratic	$[-0.54, 3.27]$
HL-LHC	Linear	$[-0.32, 0.32]$
	Quadratic	$[-0.26, 0.49]$
HL-LHC and FCC-ee (240)	Linear	$[-0.29, 0.29]$
	Quadratic	$[-0.20, 0.41]$
HL-LHC and FCC-ee	Linear	$[-0.17, 0.17]$
	Quadratic	$[-0.15, 0.16]$

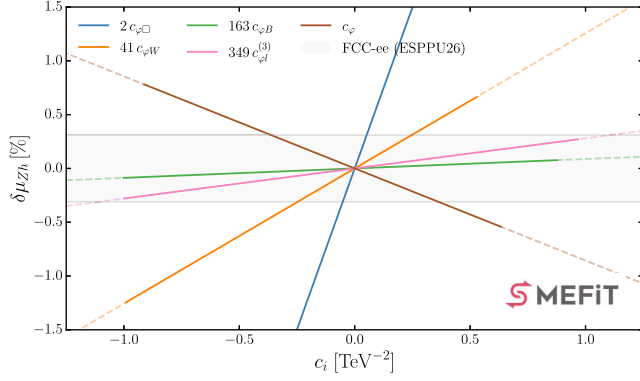


FIG. 3. Same as Fig. 1 for the inclusive μ_{Zh} at the FCC-ee with $\sqrt{s} = 240$ GeV, with the bounds from a HL-LHC + FCCee@240 quadratic fit (with Zh excluded).

These expectations are validated by the results shown in Fig. 2 and Tables I and II. The marginalized 68% CI bound on $\delta\kappa_3$ from the linear global SMEFT analysis at the FCC-ee is $|\delta\kappa_3| \leq 0.29$ without the $\sqrt{s} = 365$ GeV run, and $|\delta\kappa_3| \leq 0.17$ when including it. Comparing with the corresponding projections for the HL-LHC, $|\delta\kappa_3| \leq 0.32$, one finds that the FCC-ee operating at up to $\sqrt{s} = 240$ GeV would not improve significantly on the HL-LHC legacy constraints, while the addition of the $\sqrt{s} = 365$ GeV run enables a factor of 2 improvement. A similar picture holds for the marginalized bound in the quadratic analysis, where the HL-LHC expectation of $-0.26 \leq \delta\kappa_3 \leq 0.49$ improves to $-0.20 \leq \delta\kappa_3 \leq 0.41$ at FCC-ee@240 and $-0.15 \leq \delta\kappa_3 \leq 0.16$ after the full FCC-ee program.

A striking feature of Fig. 2, consistent with Fig. 3, is the large difference between the individual and marginalized bounds on κ_3 at the FCC-ee@240. In the linear analysis, the individual bound of $|\delta\kappa_3| \leq 0.09$ becomes a factor of 3 worse at the marginalized level, $|\delta\kappa_3| \leq 0.29$, with a similar degradation found in the quadratic fits. This effect remains, albeit tamed, for the complete FCC-ee dataset, with individual and marginalized bounds differing by a factor of 2. We conclude that, while di-Higgs production at the LHC essentially corresponds to a direct measurement of κ_3 , at the FCC-ee a global SMEFT interpretation is required to achieve robust constraints on the Higgs self-coupling from Zh production.

In the quadratic FCC-ee fit, $\mathcal{O}_\phi$ is found to be primarily correlated with $\mathcal{O}_{\phi\Box}$, with a correlation coefficient of 0.6, suggesting that a more precise determination of $c_{\phi\Box}$ could significantly reduce the gap between the marginalized and individual bounds. We also find that two-quark-two-lepton operators play an important role in the determination of c_ϕ , particularly before the 365 GeV run is included. In their absence, the 68% CI on κ_3 would already be reduced to about $|\delta\kappa_3| \leq 0.20$ even without the 365 GeV data, while with the full FCC dataset we obtain $|\delta\kappa_3| \leq 0.14$,

a result which further strengthens the case for the $\sqrt{s} = 365$ GeV run.

V. THE ELECTROWEAK CUSTODIAL MODEL

Although many BSM scenarios induce large deformations of κ_3 , it is challenging to obtain such effects without a comparable distortion in single-Higgs production [36,46,47]. One remarkable model which bypasses this limitation is the custodial symmetric $\Theta_1 + \Theta_3$ model, where one extends the SM with scalar electroweak quadruplets Θ_1 and Θ_3 , of hypercharges 1/2 and 3/2, respectively, to form a custodial bi-quadruplet [36]. The interactions between the heavy scalars and the SM, besides the ones mandated by gauge symmetry, are described by

$$\mathcal{L}_{UV} \supset -\lambda_\Theta \phi^* \phi^* (\epsilon \phi) \Theta_1 - \lambda_\Theta \phi^* \phi^* \phi^* \Theta_3 / \sqrt{3} + \text{H.c.}, \quad (3)$$

where ϕ is the Higgs boson and Θ_1 and Θ_3 share the same mass, here assumed to be $m_{UV} = 4$ TeV. Following tree-level matching of Eq. (3) to the SMEFT at dimension-six, only the $\mathcal{O}_\phi$ operator is generated [36,48]. Other operators are generated at one loop, with $\mathcal{O}_{\phi\Box}$ and $\mathcal{O}_{t\phi}$ having the largest matching coefficients among them. Including only one of the quadruplets, e.g., Θ_1 , does not change the situation at tree level, but leads to the custodially violating operator $\mathcal{O}_{\phi D}$ being generated at one loop, with important phenomenological consequences [36].

The 95% CIs on the Higgs-quadruplet coupling $|\lambda_\Theta|$ are reported in Fig. 4 for the same dataset combinations as in Fig. 2, both for the custodially symmetric and custodially violating variants, matched to the SMEFT to either tree- or one-loop level. The tree-level matching results in both models showcase the (individual) sensitivity to the Higgs self-coupling at future colliders, with a factor of 2 improvement going from the LHC run 2 to the HL-LHC and then a

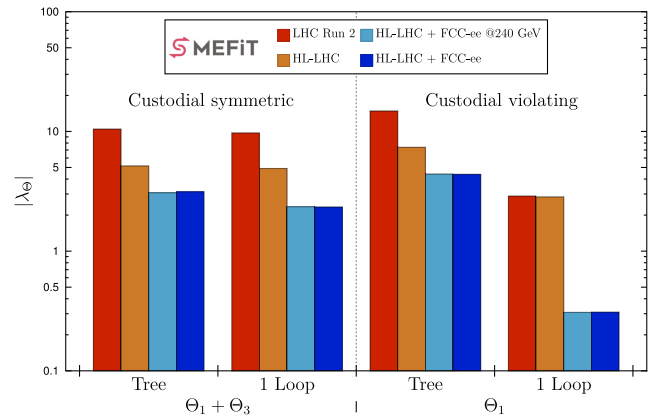


FIG. 4. 95% CI bounds on $|\lambda_\Theta|$ for the custodial quadruplets model, Eq. (3), and the noncustodial model with only the Θ_1 quadruplet, from a global quadratic SMEFT analysis based on the same datasets as Fig. 2 for both three-level and one-loop matching.

further 40% reduction at FCC-ee. This pattern of improvement follows from the individual bounds on c_φ reported in Table II, and are consistent with the result that for one-parameter fits no new constraints are provided by the $\sqrt{s} = 365$ GeV run.

The one-loop matching affects both models differently. In the noncustodial model, the bound tightens by an order of magnitude due to the sensitivity to $\mathcal{O}_{\varphi D}$, which more than compensates the factor ~ 0.1 between the matching coefficients for $c_{\varphi D}$ and c_φ . One-loop matching improves the sensitivity to the custodial model by around 10% and 25% at the HL-LHC and FCC-ee, respectively. The improvement is caused by the tight bounds on $\mathcal{O}_{\varphi\Box}$, despite being generated with a coefficient much smaller than $\mathcal{O}_\varphi$. We note that this UV model correlates c_φ and $c_{\varphi\Box}$ along a direction in the $(c_\varphi, c_{\varphi\Box})$ plane poorly constrained at the FCC-ee unless one includes NNLO EW effects in EWPOs [49].

VI. SUMMARY AND OUTLOOK

In this work we have revisited the sensitivity to the Higgs self-coupling in the global SMEFT analysis at the HL-LHC and the FCC-ee, in light of the most updated ESPPU26 projections. Our main findings are that the FCC-ee with $\sqrt{s} \leq 240$ GeV cannot improve significantly on the legacy HL-LHC constraints; that the addition of the $\sqrt{s} = 365$ GeV run leads to a reduction of the bounds on κ_3 by a factor of 2; that individual and marginalized bounds are similar at the HL-LHC but can differ by up to a factor of 3 at the FCC-ee; and that quadratic EFT corrections are moderate but not negligible. Our analysis demonstrates that the synergy of HL-LHC and FCC-ee data offers unique potential to pin down the Higgs self-coupling with $\sim 15\%$ precision. These findings provide a timely input to the ESPPU26 by sharpening the constraints on the Higgs trilinear coupling achievable at the HL-LHC and FCC-ee.

Our analysis could be extended by including higher order corrections to the predictions for the EWPOs and to the decays of the Higgs boson at the FCC-ee, as well as by exploring the impact of alternative flavor assumptions on the constraints obtained for κ_3 . Another area of future work concerns the addition of dimension-eight operators to our global SMEFT analysis, although their effect at the FCC-ee is expected to be small given the fact that our linear and quadratic EFT projections are very similar there. Furthermore, it would be interesting to integrate in our analysis the constraints on di-Higgs production from high-energy lepton colliders such as LCF/CLIC and MuCol as well as those provided by the FCC-hh.

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DATA AVAILABILITY

The data that support the findings of this article are openly available [50].

APPENDIX: THE HL-LHC LIKELIHOOD FOR HIGGS PAIR PRODUCTION

In this appendix, we describe our implementation of the ATLAS + CMS combined likelihood for Higgs pair production at the HL-LHC for $\mathcal{L} = 3 \text{ ab}^{-1}$, based on the latest projections prepared in the context of the ESPPU26 [2]. For the systematic uncertainties, we work in the so-called scenario S3, described in [42,45], which extends the previously used scenario S2 [1] by considering the 5% improvement in b -jet tagging and hadronic τ reconstruction efficiencies which have already been achieved at run 3. As compared to the previous (2019) ESPPU projections [1], the main improvements in the ESPPU26 ones are those associated to the higher efficiency of the flavored-jet tagging algorithms used for b -jet reconstruction.

Our likelihood for Higgs pair production at the HL-LHC is constructed by combining the projected measurement of the di-Higgs signal strength in ATLAS in S3, $\delta\mu_{hh} = {}^{+28\%}_{-25\%}$ at the 68% CL [42], with the differential information in the $b\bar{b}\gamma\gamma$ [44] and the $b\bar{b}\tau^+\tau^-$ [43] final states also from ATLAS. While CMS does not provide an explicit projection for μ_{hh} in [45], their expected significance for hh production is 4.5σ in S3, which is the same as ATLAS [42], and hence it is justified to assume the same value of $\delta\mu_{hh}$ for CMS as for ATLAS. Concerning the differential measurements, as demonstrated in [42,45], the overall sensitivity to Higgs pair production at the HL-LHC is dominated by the

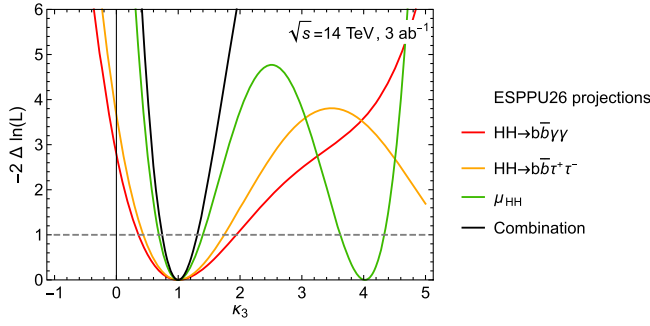


FIG. 5. The log likelihood $\Delta\chi^2(\kappa_3) = -2\Delta\ln L(\kappa_3)$ as a function of the Higgs self-coupling modifier κ_3 for Higgs pair production at the HL-LHC corresponding to $\mathcal{L} = 3 \text{ ab}^{-1}$. Here all SMEFT coefficients other than c_ϕ are set to zero. We display the likelihoods for the differential analyses of $hh \rightarrow b\bar{b}\gamma\gamma$ and $hh \rightarrow b\bar{b}\tau^+\tau^-$, for the inclusive signal strength μ_{hh} , and for their combination. The horizontal dashed line indicates the $\Delta\chi^2 = 1$ boundary.

contribution from the two final states considered, $b\bar{b}\gamma\gamma$ and $b\bar{b}\tau^+\tau^-$. As well known, the inclusion of differential information is necessary to eliminate a second spurious solution in the quadratic EFT fit [51,52]. The ATLAS $b\bar{b}\gamma\gamma$ [44] and $b\bar{b}\tau^+\tau^-$ [43] analysis are provided in two bins of invariant mass, one with $m_{hh} > 350 \text{ GeV}$, which

dominates the SM signal strength, and the other one with $m_{hh} < 350 \text{ GeV}$, which targets BSM applications.

Figure 5 displays the resulting log likelihood $\chi^2(\kappa_\lambda) = -2\ln L(\kappa_\lambda)$ as a function of the Higgs self-coupling modifier κ_λ for Higgs pair production at the HL-LHC. In this likelihood scan, only c_ϕ is varied and all other SMEFT coefficients are set to zero. We show the likelihoods for the differential analyses of $hh \rightarrow b\bar{b}\gamma\gamma$ and $hh \rightarrow b\bar{b}\tau^+\tau^-$ and for the inclusive signal strength μ_{hh} , in all cases corresponding to an integrated luminosity of $\mathcal{L} = 3 \text{ ab}^{-1}$ (hence, adding up to a total of $\mathcal{L} = 6 \text{ ab}^{-1}$ as corresponding to the ATLAS + CMS combination). The likelihood scan of μ_{hh} displays the expected second solution for $\kappa_\lambda \neq 1$, which is lifted by adding the information on hh production differential in m_{hh} in the two dominant final states. The combined HL-LHC likelihood is Gaussian to a good approximation. We have verified that by applying the $\Delta\chi^2 = 1$ criterion we approximately reproduce the projected precision for κ_λ extracted from the exact HL-LHC likelihood of the ATLAS + CMS combination, namely $\delta\kappa_\lambda = {}^{+29\%}_{-26\%}$.

1. Overview of numerical bounds on c_ϕ and $\delta\kappa_3$

Here, we collect the projected bounds on c_ϕ and $\delta\kappa_\lambda$ in Table II. These correspond to the bounds shown in Fig. 2.

TABLE II. 68% and 95% CI for c_ϕ (upper) and $\delta\kappa_3$ (lower) at $\mu_0 = 250 \text{ GeV}$, corresponding to the results shown in Table I. Individual and global marginalized fits are compared for different input datasets.

$c_\phi \text{ [TeV}^{-2}] \text{ } (\mu_0 = 250 \text{ GeV})$		Individual		Marginalized	
		68% CI	95% CI	68% CI	95% CI
LHC run 2	Linear	$[-3.51, 3.51]$	$[-6.88, 6.88]$	$[-3.57, 3.57]$	$[-7.06, 7.06]$
	Quadratic	$[-7.55, 0.76]$	$[-9.57, 3.53]$	$[-7.38, 0.75]$	$[-9.69, 3.16]$
HL-LHC	Linear	$[-0.60, 0.60]$	$[-1.17, 1.17]$	$[-0.69, 0.69]$	$[-1.35, 1.35]$
	Quadratic	$[-0.74, 0.62]$	$[-2.38, 1.31]$	$[-0.94, 0.65]$	$[-2.95, 1.24]$
HL-LHC and FCC-ee@240	Linear	$[-0.19, 0.19]$	$[-0.37, 0.37]$	$[-0.63, 0.63]$	$[-1.25, 1.25]$
	Quadratic	$[-0.18, 0.19]$	$[-0.37, 0.36]$	$[-0.89, 0.44]$	$[-1.82, 0.98]$
HL-LHC and FCC-ee	Linear	$[-0.18, 0.18]$	$[-0.37, 0.37]$	$[-0.38, 0.38]$	$[-0.73, 0.73]$
	Quadratic	$[-0.19, 0.18]$	$[-0.37, 0.37]$	$[-0.36, 0.32]$	$[-0.72, 0.64]$

$\delta\kappa_3 \text{ } (\mu_0 = 250 \text{ GeV})$		Individual		Marginalized	
		68% CI	95% CI	68% CI	95% CI
LHC run 2	Linear	$[-1.65, 1.65]$	$[-3.24, 3.24]$	$[-1.68, 1.68]$	$[-3.34, 3.34]$
	Quadratic	$[-0.36, 3.55]$	$[-1.66, 4.50]$	$[-0.54, 3.27]$	$[-1.49, 4.56]$
HL-LHC	Linear	$[-0.28, 0.28]$	$[-0.55, 0.55]$	$[-0.32, 0.32]$	$[-0.64, 0.64]$
	Quadratic	$[-0.29, 0.35]$	$[-0.62, 1.12]$	$[-0.26, 0.49]$	$[-0.66, 1.30]$
HL-LHC and FCC-ee@240	Linear	$[-0.09, 0.09]$	$[-0.17, 0.17]$	$[-0.29, 0.29]$	$[-0.58, 0.58]$
	Quadratic	$[-0.09, 0.09]$	$[-0.17, 0.17]$	$[-0.20, 0.41]$	$[-0.45, 0.83]$
HL-LHC and FCC-ee	Linear	$[-0.09, 0.09]$	$[-0.17, 0.17]$	$[-0.17, 0.17]$	$[-0.34, 0.34]$
	Quadratic	$[-0.09, 0.09]$	$[-0.17, 0.17]$	$[-0.15, 0.16]$	$[-0.29, 0.33]$

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