

1 Introduction

Lorem ipsum dolor sit amet [1] , consectetur adipiscing elit. Ut purus elit vestibulum ut [2], placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, [3, 4, 2, 5], magna. Donec [?] vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. tristique senectus et netus et malesuada fames Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla. Aliquam pellentesque, augue quis sagittis posuere ultrices. Phasellus eu tellus sit amet tortor gravida placerat [6, 7]. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo Nam lacus libero, pretium at, lobortis vitae, ultricies ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pul Etiam facilisis. Nunc elementum fermentum wisi. vinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci Nam lacus libero, pretium at, lobortis vitae, ultricies eget risus. [8, 9] Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, [10, 11] sollicitudin vel, wisi.auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies Nunc eleifend consequat auctor lorem non justo et, tellus [?]. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet iaculis in, pretium quis, viverra ac, nunc magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. iaculis in, pretium quis, viverra ac, nunc Suspendisse ut massa. Cras nec ante [12, 13]. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. In hac habitasse platea dictumst consectetur id, vulputate a Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque donec et mi. Nam vulputate metus.

Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat Morbi Curabitur auctor semper nulla. Donec varius orci at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque Phasellus eu tellus sit amet tortor gravida placerat ante [14, 15]. Phasellus adipiscing semper elit. Proin fermentum nulla vitae enim. Pellentesque tincidunt purus massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Phasellus eu tellus sit amet tortor gravida placerat Morbi blandit ligula feugiat magna. Nunc eleifend consequat auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. tristique senectus et netus et malesuada fames Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam donec felis erat, congue non iaculis in, pretium quis, viverra ac, nunc in tellus[16, ?, 17]. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim.

Vestibulum pellentesque felis eu massa. Aliquam pellentesque, augue quis sagittis posuere Nunc eleifend consequat auctor lorem non justo Quisque ullamcorper placerat ipsum. Cras nibh. Morbi vel justo vitae enim sed gravida sollicitudin, felis odio placerat q lacus tincidunt ultrices. Lorem ipsum dolor sit amet, consectetur adipiscing elit[18, 19].

Lorem ipsum dolor sit amet, consectetur adipiscing eli In hac habitasse platea dictumst. Integer tempus convallis augue. Etiam facilisis. Nunc elementum fermentum wisi. Aenean placerat. Ut im Integer tempus convallis augue perdiet, enim sed gravida sollicitudin, felis odio placerat quam, ac pulvinar Nunc eleifend consequat auctor lorem non justo [20, 2, 21, 5, 22, 23, 18, 24, 25, 26] Nunc vitae tortor. Proin tempus nibh sit amet nisl [8, 9]. Morbi vitae ornare odio metus donec et mi. Nam vulputate metus.

Vivamus quis tortor vitae risus porta vehicula. Integer tempus convallis augue Phasellus eu tellus sit amet tortor gravida placerat Fusce mauris. Vestibulum luctus nibh at lectus. Sed bibendum, nulla Nunc eleifend consequat auctor lorem non justo a faucibus semper, leo [27] velit ultricies tellus, ac venenatis arcu wisi vel nisl. Lorem ipsum dolor sit amet, consectetur adipiscing eli Vestibulum diam. Aliquam pellentesque, augue quis sagittis posuere, turpis in hendrerit risus eros eget felis Phasellus eu tellus sit amet tortor gravida placerat lacus congue quam, in hendrerit risus eros eget felis. Maecenas eget erat in Aliquam pellentesque, augue quis sagittis posuere sapien mattis porttitor. Vestibulum porttitor. Nulla facilisi [11].

Lorem ipsum dolor sit amet, consectetur adipiscing eli In hac habitasse platea dictumst. Integer tempus convallis augue. Etiam facilisis. Nunc elementum fermentum wisi. Aenean placerat. Ut im Integer tempus convallis augue ac venenatis arcu wisi vel nisl

References

- [1] F. Wilczek, *Quantum Time Crystals*, *Phys. Rev. Lett.* **109** (2012) 160401, [1202.2539].
- [2] J. Ellis, D. S. Hwang, K. Sakurai and M. Takeuchi, *Disentangling Higgs-Top Couplings in Associated Production*, *JHEP* **04** (2014) 004, [1312.5736].
- [3] R. Zhou and L. Bian, *Gravitational wave and electroweak baryogenesis with two Higgs doublet models*, *Phys. Lett. B* **829** (2022) 137105.
- [4] J. Brod, U. Haisch and J. Zupan, *Constraints on CP-violating Higgs couplings to the third generation*, *JHEP* **11** (2013) 180, [1310.1385].

- [5] F. Boudjema, R. M. Godbole, D. Guadagnoli and K. A. Mohan, *Lab-frame observables for probing the top-Higgs interaction*, *Phys. Rev. D* **92** (2015) 015019, [1501.03157].
- [6] ATLAS, CMS collaboration, G. Aad et al., *Measurements of the Higgs boson production and decay rates and constraints on its couplings from a combined ATLAS and CMS analysis of the LHC pp collision data at $\sqrt{s} = 7$ and 8 TeV*, *JHEP* **08** (2016) 045, [1606.02266].
- [7] G. Bhattacharyya, D. Das and P. B. Pal, *Modified Higgs couplings and unitarity violation*, *Phys. Rev. D* **87** (2013) 011702, [1212.4651].
- [8] J. F. Gunion, B. Grzadkowski and X.-G. He, *Determining the top - anti-top and Z Z couplings of a neutral Higgs boson of arbitrary CP nature at the NLC*, *Phys. Rev. Lett.* **77** (1996) 5172–5175, [hep-ph/9605326].
- [9] P. S. Bhupal Dev, A. Djouadi, R. M. Godbole, M. M. Muhlleitner and S. D. Rindani, *Determining the CP properties of the Higgs boson*, *Phys. Rev. Lett.* **100** (2008) 051801, [0707.2878].
- [10] D. Faroughy and E. Camargo-Molina, *In Preparation*, .
- [11] S. Fajfer, J. F. Kamenik and B. Melic, *Discerning New Physics in Top-Antitop Production using Top Spin Observables at Hadron Colliders*, *JHEP* **08** (2012) 114, [1205.0264].
- [12] A. Butter et al., *The Machine Learning landscape of top taggers*, *SciPost Phys.* **7** (2019) 014, [1902.09914].
- [13] K. Kołodziej, *carlomat_4.0, a new version of the general purpose Monte Carlo program*, *Comput. Phys. Commun.* **276** (2022) 108330.
- [14] G. Corti and M. Karacson, *Radiation environment of the LHCb Calorimeters during LHC Run 1 (2010-2013)*, .
- [15] A. Angelescu, D. A. Faroughy and O. Sumensari, *Lepton Flavor Violation and Dilepton Tails at the LHC*, *Eur. Phys. J. C* **80** (2020) 641, [2002.05684].
- [16] B. Coleppa, M. Kumar, S. Kumar and B. Mellado, *Measuring CP nature of top-Higgs couplings at the future Large Hadron electron collider*, *Phys. Lett. B* **770** (2017) 335–341, [1702.03426].
- [17] ATLAS collaboration, *Search for high-mass resonances in final states with a tau lepton and missing transverse momentum with the ATLAS detector*, .

- [18] A. V. Gritsan, R. Röntsch, M. Schulze and M. Xiao, *Constraining anomalous Higgs boson couplings to the heavy flavor fermions using matrix element techniques*, *Phys. Rev. D* **94** (2016) 055023, [1606.03107].
- [19] S. Glashow, *Private Communication*, .
- [20] B. Grzadkowski and J. F. Gunion, *Using decay angle correlations to detect CP violation in the neutral Higgs sector*, *Phys. Lett. B* **350** (1995) 218–224, [hep-ph/9501339].
- [21] F. Demartin, F. Maltoni, K. Mawatari, B. Page and M. Zaro, *Higgs characterisation at NLO in QCD: CP properties of the top-quark Yukawa interaction*, *Eur. Phys. J. C* **74** (2014) 3065, [1407.5089].
- [22] M. R. Buckley and D. Gonçalves, *Boosting the Direct CP Measurement of the Higgs-Top Coupling*, *Phys. Rev. Lett.* **116** (2016) 091801, [1507.07926].
- [23] N. Mileo, K. Kiers, A. Szynekman, D. Crane and E. Gegner, *Pseudoscalar top-Higgs coupling: exploration of CP-odd observables to resolve the sign ambiguity*, *JHEP* **07** (2016) 056, [1603.03632].
- [24] J. Li, Z.-g. Si, L. Wu and J. Yue, *Central-edge asymmetry as a probe of Higgs-top coupling in $t\bar{t}h$ production at the LHC*, *Phys. Lett. B* **779** (2018) 72–76, [1701.00224].
- [25] S. Amor Dos Santos et al., *Probing the CP nature of the Higgs coupling in $t\bar{t}h$ events at the LHC*, *Phys. Rev. D* **96** (2017) 013004, [1704.03565].
- [26] D. Gonçalves, K. Kong and J. H. Kim, *Probing the top-Higgs Yukawa CP structure in dileptonic $t\bar{t}h$ with M_2 -assisted reconstruction*, *JHEP* **06** (2018) 079, [1804.05874].
- [27] C. H. Albright and S. Nandi, *An Explicit $SO(10) \times U(1)$ -F model of the Yukawa interactions*, *Mod. Phys. Lett. A* **11** (1996) 737–748, [hep-ph/9505383].