LHCHWG-2024-XXXX

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LHC Higgs Working Group*

Public Note

Predictions for Production Cross Sections of the Higgs Boson at the LHC and HL-LHC

Instructions for authors:

- Add your name on the author list in the appropriate group. Anyone who was/is a convener since we started this work should be listed as such. External people should be listed in the "In collaboration with". All groups should be alphabetical.
- Add your affiliation(s) and *update* the affiliation list appropriately.
- Please respect the formatting of tables etc by looking at previously committed material.

WG1 conveners: Hannah Arnold[1], Alessandro Calandri[2], Alexander Karlberg[3], Bernhard Mistlberger[4]
***ggF* conveners:** Alessandra Cappati[5], Robin Hayes[6], Alexander Huss[3], Stephen Jones[7]
VBF conveners: Gaetano Barone[8], Jiayi Chen[9], Silvia Ferrario Ravsio[3], Mathieu Pellen[10]
***VH* conveners:** Suman Chatterjee[11], Valerio Dao[3], Giancarlo Ferrera[12], Matthew Lim[13]
***$t\bar{t}H/tH$* conveners:** Josh McFayden[13], Valeria Botta[14], Malgorzata Worek[14], Marco Zaro[12]
***$b\bar{b}H/bH$* conveners:**
In collaboration with:

[1]*Brookhaven National Laboratory, PO Box 5000, Upton, NY 11973, USA*
[2]*ETH Zurich—Institute for Particle Physics and Astrophysics (IPA), Zurich, Switzerland*
[3]*CERN, Theoretical Physics Department, CH-1211 Geneva 23, Switzerland*
[4]*SLAC National Accelerator Laboratory, Stanford University, Stanford, CA 94039, USA*
[5]*Laboratoire Leprince-Ringuet, CNRS/IN2P3, Ecóle Polytechnique, Institut Polytechnique de Paris, Av. Chasles, 91120 Palaiseau, France*
[6]*Nikhef, Science Park 105, 1098 XG Amsterdam, The Netherlands*
[7]*Institute for Particle Physics Phenomenology, Durham University, Durham DH1 3LE, UK*
[8]*Brown University, Providence, RI 02912, USA*

*https://twiki.cern.ch/twiki/bin/view/LHCPhysics/LHCHWG

[9] *Department of Physics, Simon Fraser University, Burnaby, BC V5H0G9, Canada*
[10] *Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, D-79104 Freiburg, Germany*
[11] *Institute of High Energy Physics (HEPHY), Austrian Academy of Sciences (ÖAW), Nikolsdorfer Gasse 18, 1050 Vienna, Austria*
[12] *Universitá degli Studi di Milano & INFN, Sezione di Milano, Via Celoria 16, 20133 Milano, Italy*
[13] *Department of Physics and Astronomy, University of Sussex, Sussex House, Brighton, BN1 9RH, UK*
[14] *Institute for Theoretical Particle Physics and Cosmology, RWTH Aachen University, D-52056 Aachen, Germany*

Abstract This note documents state-of-the-art predictions for the production cross sections of the Higgs Boson at the LHC. Specifically, Standard Model predictions for the LHC with centre-of-mass. energy of 7, 8, 13, 13.6 and 14 TeV are presented.

Contents

1 Introduction

Production cross sections for the Higgs boson based on the Standrad Model of particle physics were collected in the CERN Yellow Report "Deciphering the Nature of the Higgs Sector" (YR4) (CERN-2017-002) [1]. Since this document became public many advancements in our abilities to predict production cross sections were achieved. Furthermore, the LHC performed measurements at a higher centre-of-mass energy of 13.6 TeV for which YR4 does not contain any predictions. Looking ahead to Run-3 and the High Luminosity phase of the LHC (HL-LHC) and the associated wealth of data that will be collected an update of the HWG recommendation of all production cross sections to reflect the current state of the art is called for. The aim of this note is to document recent advancements and review the ingredients for the prediction of Standard Model predictions for the production cross sections of the Higgs boson at the LHC (similar in spirit as in YR4). Updated numerical predictions for central values of the production cross sections and associated theoretical and parametric uncertainties are the main result of this article. This note supersedes the interpolation of Ref. [2].
For now, instructions and input parameters for the generation of numerical values can be found here: `https://twiki.cern.ch/twiki/bin/view/LHCPhysics/LHCHWG136TeVxsec`

Acknowledgments

This work was done on behalf of the LHCHWG.

Table 1: Total VBF cross sections in the SM for a LHC CM energy of $\sqrt{s} = 14$ TeV, including QCD and EW corrections and their uncertainties for different Higgs-boson masses M_{H}. For more details see section 4.

M_{H}[GeV]	σ^{VBF}[fb]	Δ_{scale}[%]	$\Delta_{\mathrm{PDF}/\alpha_{\mathrm{s}}/\mathrm{PDF}\oplus\alpha_{\mathrm{s}}}$[%]	Δ_{TU}[%]	$\sigma^{\mathrm{DIS}}_{\mathrm{N3LOQCD}}$[fb]	δ_{EW}[%]	σ_{γ}[fb]	σ_{nf}[fb]	$\sigma_{\mathrm{s/t/u}}$[fb]
120.00	4486	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4694	-5.3	41.7	-9.9	-12.4
122.00	4416	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4620	-5.3	41.3	-9.5	-11.9
124.00	4348	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4549	-5.3	40.8	-9.1	-11.2
124.60	4328	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4527	-5.3	40.7	-9.0	-11
124.80	4322	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4520	-5.3	40.7	-9.0	-11
125.00	4315	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4513	-5.3	40.7	-8.9	-10.9
125.09	4312	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4510	-5.3	40.6	-8.9	-10.9
125.20	4308	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4506	-5.3	40.6	-8.9	-10.9
125.30	4305	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4503	-5.3	40.6	-8.9	-10.8
125.38	4302	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4500	-5.3	40.6	-8.9	-10.8
125.60	4295	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4492	-5.3	40.5	-8.9	-10.6
126.00	4282	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4478	-5.3	40.5	-8.8	-10.5
128.00	4216	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4409	-5.3	40	-8.6	-10
130.00	4152	$^{+0.1}_{-0.1}$	$\pm 2.1/\pm 0.4/\pm 2.2$	± 1.0	4342	-5.3	39.7	-8.4	-9.5

A Reference tables

A.1 ggF

A.2 VBF

A.3 VH

A.4 ttH

A.5 bbH

References

[1] LHC Higgs Cross Section Working Group collaboration, D. de Florian et al., *Handbook of LHC Higgs Cross Sections: 4. Deciphering the Nature of the Higgs Sector*, 1610.07922.

[2] A. Karlberg et al., *Ad interim recommendations for the Higgs boson production cross sections at* $\sqrt{s} = 13.6$ *TeV*, 2402.09955.