Workshop Closing

22nd Workshop of the LHC Higgs WG

3rd-5th December 2025, CERN

LHC Higgs Working Group

LHC Higgs WG Steering Committee

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Thank you for this fruitful meeting!

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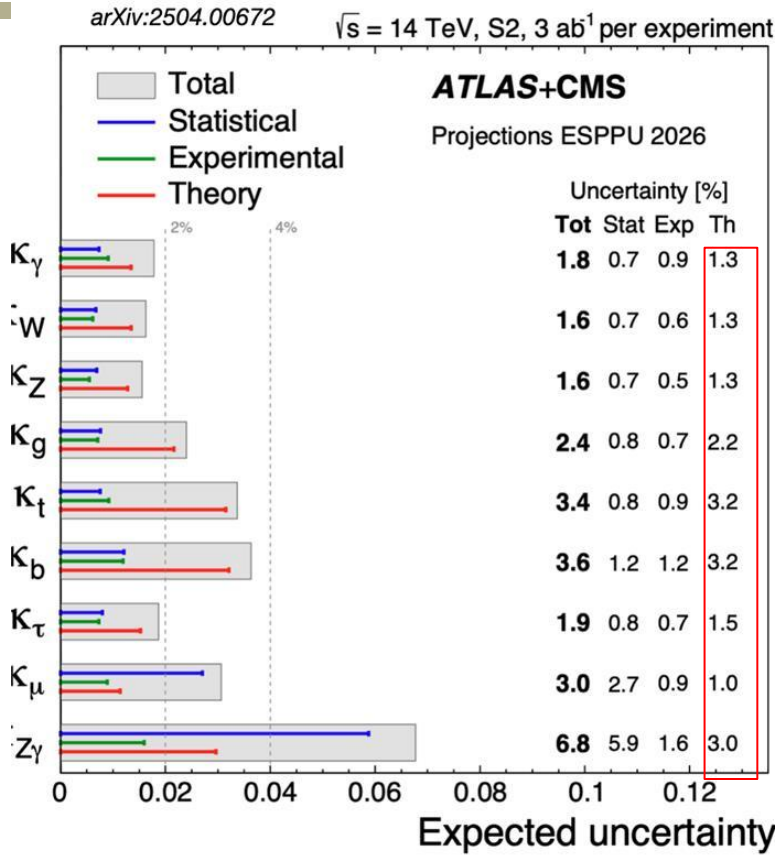
LHCHWG Report 5

- Four Yellow Reports produced by the LHC Higgs WG over its lifetime:
  - *"Inclusive Observables"* [CERN-2011- 002]; *"Differential Distributions"* [CERN-2012-002]; *"Higgs Properties"* [CERN-2013-004]; *"Deciphering the Nature of the Higgs Sector"* [CERN-2017-002]

- HL-LHC data-taking will start in 2030. Aim to collect 1000 fb^{-1} during Run 4 (2030–2033)
  - What can we achieve with this dataset?
  - Modelling uncertainties known to be a bottleneck at Run4 and some are already at Run3.
  - What recommendations are needed for analyses?
  - **Collecting this information in a new Report 5**
  - **Apply these recommendations already at Run-3, through experiment-theory feedback loop.**



LHCHWG Report 5

- 2025 for high priority topics on cross-sections, improved uncertainties, binning schemes (ex STXS), etc [generally efforts well underway since 2023]
- About 30 publications! 4 published, 8 submitted, ~20 close to submission or in LHCWG-wide circulation.
- 2026 for second wave: Incorporation of NL30 pdf in cross sections, uncovered and phase-spaces, rarer processes.

▷ Deadline by June 2026 for convergence on second wave.

- Some of them were presented in lightning session earlier today.

Submissions to this Collection

Awaiting resubmission

- 2510.17413v1, The inclusive Higgs boson cros by Goutam Das, Sven-Olaf Moch (current version)

In refereeing

- 2508.09905v2, $gg \to ZH$: updated predicti by Benjamin Campillo Aveleira, Lo (current version)
- 2511.07905v1, Parametrisation and dictionary by Daniele Barducci, Matthew Fors (current version)
- 2511.02488v1, State-of-the-art electroweak H by Jens Braun, Pia Bredt, Gudrun (current version)
- 2510.24658v1, Higgs-Boson Decays: Updates by Emanuele Bagnaschi, Lisa Bierm (current version)
- 2510.18815v1, Modelling $b\bar{b}H$ producti by Christian Biello, Alessandro G (current version)

Refereeing in preparation

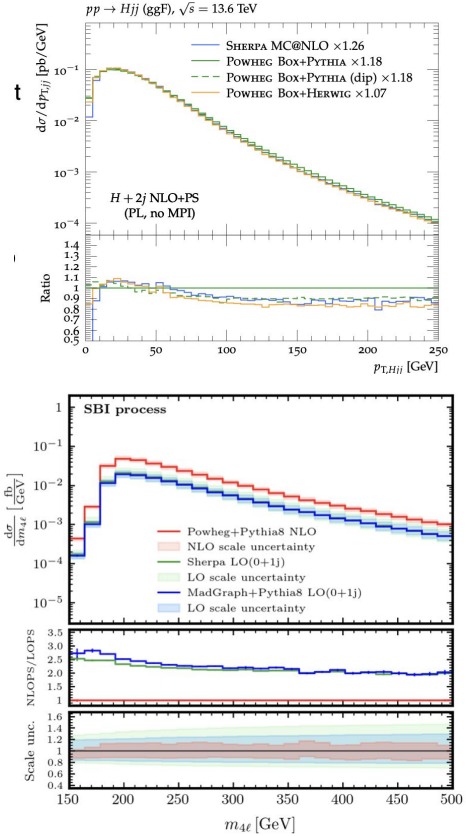
- 2508.00466v2, Rare few-body decays of the St by David d'Enterria, Van Dung Le (current version)

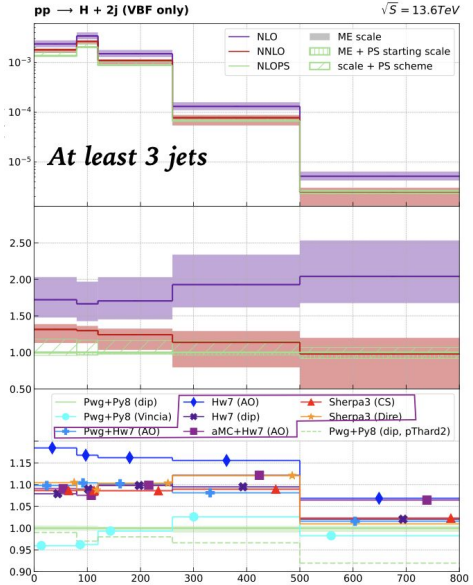
Publications in this Collection

- SciPost Phys. Comm. Rep. 14 (2025), Threshold improved ZH produ by Goutam Das, Chinmoy Dey, Medur, 2025-12-01
- SciPost Phys. Comm. Rep. 13 (2025), Higgs production via vector-bo by Gaetano Barone, Jiayi Chen, St, 2025-11-05
- SciPost Phys. Comm. Rep. 12 (2025), Theoretical modeling of QCD ra by Rafael Coelho Lopes de Sá, Mar, 2025-09-04
- SciPost Phys. Comm. Rep. 10 (2025), State-of-the-art cross section by Roger Balsach, Alessandro Brog, 2025-08-13

LHCHWG Report 5

- Starting to probe more complex regions:
  - VBF NLOPS uncertainties guidelines
  - Interplay between decay channels:
    - VH & VBF Interference
    - ggF and VBF 2-jet interplay
  - Offshell: modelling of QCD radiation in fiducial regions
    - Polarization studies ongoing
  - bbH cross sections with matched 5FS (massless) and 4FS (massive) at FO





LHCHWG Report 5

- First-wave topics identified within WGs:
  - **WG1:**
    - Updated cross-section predictions for all Higgs boson production modes
    - Impact of N3LO PDF on cross-sections (in particular on ggF)
    - Differential and parton shower study of VBF signal / harmonizing fiducial definitions
    - ggF contribution in VBF phase-space
    - Differential NLO for ggZH, include differential K-Factors in PowHeg
    - ttH NNLO cross-section update and comparisons among resummation schemes at NNLL
    - Off-shell: Parton shower and jet merging benchmarking study
    - BR: Include the Dalitz decays in HDECAY (properly)

LHCHWG Report 5

- First-wave topics identified, continued:
  - **WG2:**
    - STXS Stage 1.3
    - CP violation activities: dictionary note for parameterisation, kappa, SMEFT, etc…
    - STXS & CP violation for ttH
    - SMEFT parametrization
  - **WG3:**
    - Scans in the NMSSM at Highest Precision
    - Update on MSSM cross sections for extended mass grid with new PDF recommendations
    - Higgs pT reweighting for MSSM benchmarks
  - **WG4:**
    - Cross sections recommendations for all main HH production modes for SM as well as for anomalous couplings, i.e. k_λ and k_{2V}
    - Higher order corrections to ggHH cross section
    - Recommendations for theory uncertainties on ggHH cross section

Cross sections at 13.6 TeV update

- NL3O predictions are here,
  - Not the end of the story.
  - PDF+alpha_s is now the dominant component
  - Update when PDF4LHC final combination available.

$\sqrt{s}$ [TeV]	Production cross section (in pb) for $m_H = 125$ GeV							
	ggF	VBF	WH	ZH	$t\bar{t}H$	tH	$b\bar{b}H$	total
1.96*	$0.95^{+17\%}_{-17\%}$	$0.065^{+8\%}_{-7\%}$	$0.13^{+8\%}_{-8\%}$	$0.079^{+8\%}_{-8\%}$	$0.004^{+10\%}_{-10\%}$	–	–	$1.23^{+13\%}_{-13\%}$
7	$16.7^{+6.3\%}_{-9.4\%}$	$1.25^{+3.4\%}_{-3.4\%}$	$0.582^{+3.1\%}_{-3.3\%}$	$0.342^{+4.8\%}_{-4.5\%}$	$0.09^{+5.6\%}_{-10.2\%}$	$0.013^{+8.2\%}_{-16.6\%}$	$0.171^{+17\%}_{-17\%}$	$19.2^{+5.5\%}_{-8.2\%}$
8	$21.3^{+6.4\%}_{-9.4\%}$	$1.61^{+3.3\%}_{-3.3\%}$	$0.708^{+2.9\%}_{-3.2\%}$	$0.424^{+4.8\%}_{-4.3\%}$	$0.13^{+5.9\%}_{-10.1\%}$	$0.020^{+8.1\%}_{-16.1\%}$	$0.221^{+16\%}_{-16\%}$	$24.4^{+5.6\%}_{-8.2\%}$
13	$48.4^{+6.9\%}_{-9.5\%}$	$3.81^{+3.4\%}_{-3.4\%}$	$1.38^{+2.4\%}_{-2.6\%}$	$0.893^{+5.4\%}_{-4.8\%}$	$0.531^{+5.5\%}_{-6.3\%}$	$0.076^{+8.5\%}_{-18\%}$	$0.528^{+15\%}_{-16\%}$	$55.6^{+6.0\%}_{-8.3\%}$
13.6	$52.1^{+6.9\%}_{-9.5\%}$	$4.11^{+3.3\%}_{-3.3\%}$	$1.47^{+2.4\%}_{-2.6\%}$	$0.954^{+5.6\%}_{-5.0\%}$	$0.592^{+4.3\%}_{-5.0\%}$	$0.085^{+8.5\%}_{-18\%}$	$0.569^{+12\%}_{-12\%}$	$59.9^{+6.0\%}_{-8.3\%}$
14	$54.5^{+7.0\%}_{-9.5\%}$	$4.32^{+3.3\%}_{-3.3\%}$	$1.52^{+2.3\%}_{-2.5\%}$	$0.995^{+5.6\%}_{-4.9\%}$	$0.639^{+4.3\%}_{-5.0\%}$	$0.092^{+8.0}_{-17\%}$	$0.597^{+14\%}_{-15\%}$	$62.7^{+6.1\%}_{-8.3\%}$

Plans for LHCHWG Report 5

- Second wave topics identified within WGs:
  - ttH NNLO+PS [WG1]
  - ZH and offshell ZZ (two loop corrections) [WG1]
  - NLO QCD SMEFT predictions for ZH [WG1]
  - CPV Benchmarks [WG2]
  - Charged Higgs Pairs at NLO [WG3]
  - Your new ideas and contribution!

LHCHWG Report 5: next steps

- Join work on **second-wave topics** starting now
- Requirement to publish in **SciPost**, especially for junior theorists
- For now, please contact WG Conveners and Sub Group Conveners if interested in contributing
- **June 2026:** target for **submission to CDS for LHCHWG circulation**
  - arXiv + SciPost Physics Community Reports submissions to follow.

23rd workshop in 2026

- Could take place outside CERN, as several other times in the past (Freiburg, Bari, BNL, IJCLab)

- Calling for volunteers to propose a hosting site: please contact the Steering Committee if you would like to host the meeting next year!
  - Deadline end of January 2026

Mattermost

Use the permanent Mattermost channels (moderated by the WG conveners) to continue discussions:

- WG1
- WG2
- WG3
- WG4
- Cross-topic

Have a safe trip back & see you around soon!

LHCHWG Report 5

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- Not a monolithic document, but rather a collection of **many separate reports published in a dedicated *SciPost Physics Community Reports* volume.**
- HL-LHC data-taking will start in 2030. Aim to collect 1000 fb^{-1} during Run 4 (2030–2033)
  - What can we achieve with this dataset?
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LHC Higgs Working Group Reports
a series contained in SciPost Physics Community Reports

Collection Report 5

The LHC Higgs Working Group (LHCHWG) provides recommendations on predictions, modelling, and methods for the study of Higgs physics with data from the current and future LHC runs. The HL-LHC aims to collect about 1000 fb−1 of proton–proton collision data during Run 4 (2030–2033). What can we achieve with this dataset? What recommendations are needed for analyses? This information will be collected in this collection "Report 5", included in the series "LHC Higgs Working Group Reports" of SciPost Physics Community Reports.

Plans for LHCHWG Report 5

- NL3O predictions are here,
  - Not the end of the story.

$\sqrt{s} = 13.6$ TeV						NNLO PDF				aN^{3}LO PDF	
M_H [GeV]	σ [pb]	δ(theory)	δ(scale)	δ(EWK)	δ(t, b, c)	δ(PDF + α_s)	δ(PDF)	$\delta(\alpha_s)$	δ(PDF–TH)	Δ [pb]	δ(PDF + α_s)
120.00	55.54	$^{+1.65}_{-4.66}$%	$^{+0.31}_{-3.32}$%	±1.00%	±0.34%	$^{+2.68}_{-2.27}$%	$^{+1.65}_{-1.65}$%	$^{+2.12}_{-1.57}$%	±2.42%	−2.56	$^{+1.73}_{-1.73}$%
122.00	53.97	$^{+1.66}_{-4.65}$%	$^{+0.32}_{-3.31}$%	±1.00%	±0.34%	$^{+2.68}_{-2.27}$%	$^{+1.65}_{-1.65}$%	$^{+2.11}_{-1.56}$%	±2.40%	−2.49	$^{+1.73}_{-1.73}$%
124.00	52.46	$^{+1.65}_{-4.65}$%	$^{+0.31}_{-3.31}$%	±1.00%	±0.34%	$^{+2.68}_{-2.26}$%	$^{+1.64}_{-1.64}$%	$^{+2.11}_{-1.56}$%	±2.37%	−2.43	$^{+1.74}_{-1.74}$%
124.60	52.02	$^{+1.65}_{-4.65}$%	$^{+0.31}_{-3.31}$%	±1.00%	±0.34%	$^{+2.67}_{-2.26}$%	$^{+1.64}_{-1.64}$%	$^{+2.11}_{-1.56}$%	±2.36%	−2.41	$^{+1.74}_{-1.74}$%
124.80	51.87	$^{+1.65}_{-4.65}$%	$^{+0.31}_{-3.31}$%	±1.00%	±0.34%	$^{+2.67}_{-2.26}$%	$^{+1.64}_{-1.64}$%	$^{+2.11}_{-1.55}$%	±2.36%	−2.41	$^{+1.74}_{-1.74}$%
125.00	51.72	$^{+1.65}_{-4.65}$%	$^{+0.31}_{-3.31}$%	±1.00%	±0.34%	$^{+2.67}_{-2.26}$%	$^{+1.64}_{-1.64}$%	$^{+2.11}_{-1.55}$%	±2.36%	−2.40	$^{+1.74}_{-1.74}$%
125.09	51.66	$^{+1.65}_{-4.65}$%	$^{+0.31}_{-3.31}$%	±1.00%	±0.34%	$^{+2.67}_{-2.26}$%	$^{+1.64}_{-1.64}$%	$^{+2.11}_{-1.55}$%	±2.36%	−2.40	$^{+1.74}_{-1.74}$%
125.20	51.58	$^{+1.65}_{-4.65}$%	$^{+0.31}_{-3.31}$%	±1.00%	±0.34%	$^{+2.67}_{-2.26}$%	$^{+1.64}_{-1.64}$%	$^{+2.11}_{-1.55}$%	±2.35%	−2.39	$^{+1.74}_{-1.74}$%
125.30	51.51	$^{+1.65}_{-4.64}$%	$^{+0.31}_{-3.30}$%	±1.00%	±0.34%	$^{+2.67}_{-2.26}$%	$^{+1.64}_{-1.64}$%	$^{+2.11}_{-1.55}$%	±2.35%	−2.39	$^{+1.74}_{-1.74}$%
125.38	51.45	$^{+1.65}_{-4.64}$%	$^{+0.31}_{-3.30}$%	±1.00%	±0.34%	$^{+2.67}_{-2.26}$%	$^{+1.64}_{-1.64}$%	$^{+2.11}_{-1.55}$%	±2.35%	−2.39	$^{+1.74}_{-1.74}$%
125.60	51.29	$^{+1.65}_{-4.64}$%	$^{+0.31}_{-3.30}$%	±1.00%	±0.34%	$^{+2.67}_{-2.26}$%	$^{+1.64}_{-1.64}$%	$^{+2.11}_{-1.55}$%	±2.35%	−2.38	$^{+1.74}_{-1.74}$%
126.00	51.01	$^{+1.65}_{-4.64}$%	$^{+0.31}_{-3.30}$%	±1.00%	±0.34%	$^{+2.67}_{-2.26}$%	$^{+1.64}_{-1.64}$%	$^{+2.11}_{-1.55}$%	±2.34%	−2.37	$^{+1.74}_{-1.74}$%
128.00	49.62	$^{+1.64}_{-4.63}$%	$^{+0.30}_{-3.29}$%	±1.00%	±0.34%	$^{+2.67}_{-2.26}$%	$^{+1.64}_{-1.64}$%	$^{+2.10}_{-1.55}$%	±2.32%	−2.31	$^{+1.74}_{-1.74}$%
130.00	48.28	$^{+1.64}_{-4.62}$%	$^{+0.30}_{-3.28}$%	±1.00%	±0.34%	$^{+2.67}_{-2.25}$%	$^{+1.64}_{-1.64}$%	$^{+2.10}_{-1.54}$%	±2.30%	−2.25	$^{+1.74}_{-1.74}$%