

Table of Contents

SM Higgs production cross sections at $\sqrt{s} = 13, 14$ and 27 TeV (update in CERN HL-LHC YR 2019)...	1
Gluon fusion.....	1
Vector boson fusion.....	1
VH production.....	1
tH and tH production.....	2

SM Higgs production cross sections at $\sqrt{s} = 13, 14$ and 27 TeV (update in CERN HL-LHC YR 2019)

Cross sections are computed for $m_H=125.09$ GeV by using the YR4 input parameters. More details can be found on the LHCHSWG-INT-2019-0xx note and in Sec. 2.2 of the HL-HE report.

Gluon fusion

- Cross sections are calculated at N³LO QCD and NLO EW accuracy using the program iHixs.

\sqrt{s} (TeV)		+ (theory)	- (theory)	\pm (PDF)	+ ()	- ()
13	48.61 pb	4.27%	6.49%	1.85%	2.59%	2.62%
14	54.72 pb	4.28%	6.46%	1.85%	2.60%	2.62%
27	146.65 pb	4.53%	6.43%	1.95%	2.69%	2.64%

Vector boson fusion

- Cross sections are calculated at NNLO QCD with the program proVBFH while the EW and photon contributions have been computed at NLO with HAWK. The reference cross section is $\sigma_{DIS}^{*}(1+\delta_{ELWK})$

\sqrt{s} (TeV)		+ (scale)	- (scale)	Δ_{PDF+}	σ_{DIS}	δ_{ELWK}	
13	3766 fb	0.43%	0.33%	$\pm 2.1\%$	3939 fb	-5.3%	35.3 fb
14	4260 fb	0.45%	0.34%	$\pm 2.1\%$	4460 fb	-5.4%	40.7 fb
27	11838 fb	0.66%	0.36%	$\pm 2.1\%$	12483 fb	-6.2%	129 fb

Theoretical uncertainties of integrated cross sections originating from unknown higher-order EW effects can be estimated by $\Delta_{EW} = \max\{0.5\%, \sqrt{\sigma_{EW} / \sigma_{VBF}}\}$

VH production

- Cross sections are calculated at NNLO QCD and NLO EW with the program HAWK. The reference results include the photon contribution where appropriate

* WH production

\sqrt{s} (TeV)	σ_{WH}	+ (scale)	- (scale)	Δ_{PDF+}
13	1.358 pb	0.51%	0.51%	$\pm 1.35\%$
14	1.498 pb	0.51%	0.51%	$\pm 1.35\%$
27	3.397 pb	0.29%	0.72%	$\pm 1.37\%$

* W+H production

\sqrt{s} (TeV)	σ_{W+H}	+ (scale)	- (scale)	Δ_{PDF+}
13	0.831 pb	0.74%	0.73%	$\pm 1.79\%$
14	0.913 pb	0.64%	0.76%	$\pm 1.78\%$
27	1.995 pb	0.43%	1.04%	$\pm 1.84\%$

* W-H production

\sqrt{s} (TeV)	σ_{W-H}	+ (scale)	- (scale)	Δ_{PDF+}
13	0.527 pb	0.59%	0.63%	$\pm 2.03\%$

SM Higgs production cross sections at $\sqrt{s} = 13, 14$ and 27 TeV (update in CERN HL-LHC YR 2019)

14	0.585 pb	0.55%	0.68%	$\pm 1.98\%$
27	1.402 pb	0.36%	0.93%	$\pm 2.03\%$

* $1^+ H$ production

\sqrt{s} (TeV)		+ (scale)	- (scale)	$\Delta_{\text{PDF}+\sqrt{s}}$	
13	0.094 pb	0.71%	0.70%	$\pm 1.72\%$	$4.1 \cdot 10^{-3}$
14	0.104 pb	0.61%	0.73%	$\pm 1.70\%$	$4.7 \cdot 10^{-3}$
27	0.232 pb	0.40%	0.97%	$\pm 1.72\%$	$1.5 \cdot 10^{-2}$

* $1^- H$ production

\sqrt{s} (TeV)		+ (scale)	- (scale)	$\Delta_{\text{PDF}+\sqrt{s}}$	
13	0.0598 pb	0.57%	0.60%	$\pm 1.94\%$	$2.6 \cdot 10^{-3}$
14	0.0666 pb	0.52%	0.64%	$\pm 1.89\%$	$3.1 \cdot 10^{-3}$
27	0.1628 pb	0.34%	0.87%	$\pm 1.90\%$	$1.1 \cdot 10^{-2}$

* ZH production

\sqrt{s} (TeV)		+ (scale)	- (scale)	$\Delta_{\text{PDF}+\sqrt{s}}$
13	0.880 pb	3.50%	2.68%	$\pm 1.65\%$
14	0.981 pb	3.61%	2.94%	$\pm 1.90\%$
27	2.463 pb	5.42%	4.00%	$\pm 2.24\%$

* ZH production (without loop induced contribution)

\sqrt{s} (TeV)		+ (scale)	- (scale)	$\Delta_{\text{PDF}+\sqrt{s}}$
13	0.758 pb	0.49%	0.61%	$\pm 1.78\%$
14	0.836 pb	0.51%	0.62%	$\pm 1.82\%$
27	1.937 pb	0.56%	0.74%	$\pm 2.37\%$

* ZH production (loop induced contribution)

\sqrt{s} (TeV)		+ (scale)	- (scale)	$\Delta_{\text{PDF}+\sqrt{s}}$
13	0.123 pb	24.9%	18.8%	$\pm 4.37\%$
14	0.145 pb	24.3%	19.6%	$\pm 7.47\%$
27	0.526 pb	25.3%	18.5%	$\pm 5.85\%$

The loop induced contribution is evaluated at LO and rescaled with the NLO corrections obtained in the $m_t \rightarrow \infty$ limit, and supplemented by the soft-gluon effects at NLL

* $11H$

\sqrt{s} (TeV)		+ (scale)	- (scale)	$\Delta_{\text{PDF}+\sqrt{s}}$	
13	$2.97 \cdot 10^{-2}$ pb	3.49%	2.67%	$\pm 1.64\%$	$1.4 \cdot 10^{-4}$
14	$3.31 \cdot 10^{-2}$ pb	3.59%	2.92%	$\pm 1.89\%$	$1.6 \cdot 10^{-4}$
27	$8.32 \cdot 10^{-2}$ pb	5.39%	3.97%	$\pm 1.85\%$	$5.4 \cdot 10^{-4}$

* H production

\sqrt{s} (TeV)		+ (scale)	- (scale)	$\Delta_{\text{PDF}+\sqrt{s}}$
13	0.177 pb	3.50%	2.68%	$\pm 1.65\%$
14	0.197 pb	3.59%	2.92%	$\pm 1.89\%$
27	0.496 pb	5.41%	3.99%	$\pm 2.24\%$

tH and tH production

- Cross sections for tH are calculated at NLO QCD and NLO EW while for tH they are at NLO QCD

* ttH

\sqrt{s} (TeV)		+ (scale)	- (scale)	Δ_s	Δ_{PDF}	Δ_{PDF+s}
14	612.8 fb	6.0%	9.2%	$\pm 1.9\%$	$\pm 2.9\%$	$\pm 3.5\%$
27	2860 fb	7.8%	9.0%	$\pm 1.8\%$	$\pm 2.1\%$	$\pm 2.8\%$

* tH+ tH

\sqrt{s} (TeV)		+ (scale)	- (scale)	Δ_s	Δ_{PDF}	Δ_{PDF+s}
14	90.12 fb	6.4%	14.7%	$\pm 1.2\%$	$\pm 3.4\%$	$\pm 3.6\%$
27	417.9 fb	5.0%	12.5%	$\pm 1.3\%$	$\pm 2.6\%$	$\pm 2.9\%$

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