

ggH

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The 16th Workshop of the LHC Higgs Cross Section Working Group

<https://indico.cern.ch/event/826136/>

- Summarized in the twiki page:
https://twiki.cern.ch/twiki/bin/view/LHCPhysics/LHCHXSWG_GGF_RUN2
- Want to write us: lhc-higgs-ggf-convener@cern.ch
- Main focus:
 - **Boosted Higgs boson p_T spectrum** description
 - Study of **bottom quark mass effects** in the Higgs transverse momentum distribution
 - Production cross section for **different center of mass hypotheses**

E_{CM}	σ	$\delta(\text{theory})$	$\delta(\text{PDF})$	$\delta(\alpha_s)$
2 TeV	1.10 pb	+0.05pb (+4.17%) -0.09pb (-8.02%)	± 0.03 pb ($\pm 3.17\%$)	+0.04pb (+3.69%) -0.04pb (-3.36%)
7 TeV	16.87 pb	+0.70pb (+4.17%) -1.14pb (-6.76%)	± 0.31 pb ($\pm 1.89\%$)	+0.44pb (+2.66%) -0.45pb (-2.68%)
8 TeV	21.45 pb	+0.90pb (+4.18%) -1.43pb (-6.69%)	± 0.40 pb ($\pm 1.87\%$)	+0.56pb (+2.63%) -0.56pb (-2.66%)
13 TeV	48.68 pb	+2.07pb (+4.26%) -3.16pb (-6.48%)	± 0.89 pb ($\pm 1.85\%$)	+1.25pb (+2.59%) -1.26pb (-2.62%)
14 TeV	54.80 pb	+2.34pb (+4.28%) -3.54pb (-6.46%)	± 1.00 pb ($\pm 1.86\%$)	+1.40pb (+2.60%) -1.42pb (-2.62%)
28 TeV	154.63 pb	+7.02pb (+4.54%) -9.93pb (-6.42%)	± 2.98 pb ($\pm 1.96\%$)	+4.10pb (+2.70%) -4.03pb (-2.65%)
100 TeV	808.23 pb	+44.53pb (+5.51%) -56.95pb (-7.05%)	± 19.98 pb ($\pm 2.51\%$)	+24.89pb (+3.12%) -21.71pb (-2.72%)

- Dedicated meetings:
 - <https://indico.cern.ch/event/675782/>
 - <https://indico.cern.ch/event/810995/>
- More details in **Pier Monni's** presentation on Friday
- Prescription to calculate the most accurate prediction of the Higgs boson p_T spectrum for **ggF** production
- Contributions from **other production mechanisms** important at high p_T

$p_{\perp}^{\text{cut}} [\text{GeV}]$	$\Sigma_{\text{ggF}}^{\text{NNLO}_{\text{approx}}} (p_{\perp}^{\text{cut}}) [\text{fb}]$	$\Sigma_{\text{VBF}}^{\text{NNLO}} (p_{\perp}^{\text{cut}}) [\text{fb}]$	$\Sigma_{\text{VH}}^{\text{NLO}} (p_{\perp}^{\text{cut}}) [\text{fb}]$	$\Sigma_{\text{ttH}}^{\text{NLO}} (p_{\perp}^{\text{cut}}) [\text{fb}]$
400	$33.30^{+10.89\%}_{-12.91\%}$	$14.23^{+0.15\%}_{-0.19\%}$	$11.16^{+4.12\%}_{-3.68\%}$	$6.89^{+12.62\%}_{-12.97\%}$
450	$18.08^{+10.78\%}_{-12.79\%}$	$8.06^{+0.24\%}_{-0.23\%}$	$6.87^{+4.6\%}_{-3.49\%}$	$4.24^{+12.84\%}_{-13.15\%}$
500	$10.17^{+10.67\%}_{-12.74\%}$	$4.75^{+0.33\%}_{-0.29\%}$	$4.39^{+4.43\%}_{-4.04\%}$	$2.66^{+12.85\%}_{-13.22\%}$
550	$5.87^{+10.54\%}_{-12.60\%}$	$2.90^{+0.34\%}_{-0.36\%}$	$2.87^{+4.44\%}_{-3.74\%}$	$1.76^{+14.23\%}_{-13.93\%}$
600	$3.48^{+10.35\%}_{-12.49\%}$	$1.82^{+0.41\%}_{-0.39\%}$	$1.91^{+5.22\%}_{-4.71\%}$	$1.11^{+12.99\%}_{-13.4\%}$
650	$2.13^{+10.22\%}_{-12.44\%}$	$1.17^{+0.49\%}_{-0.39\%}$	$1.30^{+4.67\%}_{-4.28\%}$	$0.72^{+12.6\%}_{-13.26\%}$
700	$1.32^{+10.01\%}_{-12.31\%}$	$0.77^{+0.57\%}_{-0.45\%}$	$0.90^{+4.15\%}_{-5.4\%}$	$0.47^{+11.42\%}_{-12.74\%}$
750	$0.84^{+10.02\%}_{-12.29\%}$	$0.51^{+0.69\%}_{-0.56\%}$	$0.62^{+5.15\%}_{-4.66\%}$	$0.32^{+11.53\%}_{-12.84\%}$
800	$0.54^{+9.86\%}_{-12.20\%}$	$0.35^{+0.71\%}_{-0.6\%}$	$0.44^{+5.64\%}_{-4.13\%}$	$0.22^{+11.42\%}_{-13.3\%}$

- **ggF** prediction from dedicated calculations reported up to **1.3 TeV** of Higgs p_T
- **VH, VBF, ttH** p_T spectra reported → based on **public code** and generators already used by experiments
- The theory in the ggF prediction of the note has been made more consistent
- Currently under revision → expect it on CDS relatively soon

$p_{\perp}^{\text{cut}} [\text{GeV}]$	$\Sigma_{\text{ggF}}(p_{\perp}^{\text{cut}}) [\text{fb}]$
400	33.30 ^{+10.89%} _{-12.91%}
410	29.34 ^{+10.86%} _{-12.85%}
420	25.95 ^{+10.78%} _{-12.80%}
430	22.97 ^{+10.79%} _{-12.80%}
440	20.39 ^{+10.80%} _{-12.82%}
450	18.08 ^{+10.78%} _{-12.79%}
460	16.01 ^{+10.68%} _{-12.74%}
470	14.27 ^{+10.67%} _{-12.73%}
480	12.77 ^{+10.76%} _{-12.79%}
490	11.39 ^{+10.75%} _{-12.76%}
500	10.17 ^{+10.67%} _{-12.74%}
1200	
1250	

- Prescription to experiments about what to use as nominal distribution for ggF Higgs

We observe that the predictions obtained with the more accurate generators used in the study (HJ-MiNLO and MG5_MC@NLO) are in very good agreement with one another. Moreover, they both reproduce, within uncertainties, the best prediction obtained in the previous section. We conclude that the above two generators can be safely used to perform accurate studies in the boosted regime.

Uncertainty: measurement and interpretation

- The so called “ad interim” uncertainty scheme should be used for the **interpretation of the STXS** measurements
 - Current values refers to STXS Stage 1.0
 - See this afternoon discussion for the current and future developments

- For the **STXS cross sections, inclusive and differential measurements** standard uncertainty evaluation should be considered
 - **Scale** variation
 - **Parton shower** (big discussion among different working groups ongoing)
 - **PDF**

- Is there something you would like to ask your experimental friends about ggF Higgs?
 - <http://cern.ch/go/6vcG>
- We have setup a survey where you can drop your question/comment/suggestion

Questions and requests to the experiments (ATLAS/CMS) about GGF Higgs

Feel free to ask questions to the experiments about GGF Higgs.
E.g.:

- please provide systematic uncertainties effects on the final results split into sub-component
- it would be quite interesting to have a cross section measurement in this particular phase space because in our model we foresee an enhancement [reference]

The questions you have will help in improving experimental results.

In particular questions about ggH produced results/analysis.

We ask you an email address, for sake of being contacted later in case some follow up is needed.
If you don't want to leave your name/email address, your question will be considered with less priority

*Required

Name and Email address *

Your answer _____

What do you want to ask/suggest? *

Your answer _____

SUBMIT

- Some suggestions about areas where a **deeper understanding of theory** is needed to improve exp results
 - **Parton shower** systematics
 - Improvement in **number of jets** description for ggH: ggH+N-jets **generators**
 - Essential for different measurements and contamination studies (e.g. ggF in ttH phase space)
 - **ggH + bb** : what is the best prediction for this final state?
 - improvement in the expected contribution important for HH searches
 - List of **agreed among theory community set of paper** to be cited for full Run II results for ggF
 - YR4 is ok, but it's not a paper and does not give full praise to the big effort from theory community to improve predictions and accuracy
 - https://twiki.cern.ch/twiki/bin/view/LHCPhysics/LHCHXSWG_GGF_RUN2

References

[TBU]