

LHC Higgs Cross Section Working Group

1. CERN Yellow Report
2. New activity on Higgs exclusive cross sections
3. Bari workshop (Nov. 4-5)

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1. CERN Yellow Report

Current working group structure

Group	ATLAS	CMS	LHCb	THEORY	
1. <u>ggF</u>	<u>Jianming Qian (Michigan)</u>	<u>Fabian Stöckli (CERN)</u>		<u>Massimiliano Grazzini (Firenze)</u>	<u>Frank Petriello (Wisconsin)</u>
2. <u>VBF</u>	<u>Daniela Rebutti (Pavia)</u> <u>Sinead Farrington (Oxford)</u>	<u>Christoph Hackstein (Karlsruhe)</u>		<u>Ansgar Denner (PSI)</u>	<u>Carlo Oleari (Milano-Bicocca)</u>
3. <u>WH/ZH</u>	<u>Giacinto Piacquadio (CERN)</u>	<u>Jim Olsen (Princeton)</u>	<u>Clara Matteuzzi (Milano-Bicocca)</u>	<u>Stefan Dittmaier (Freiburg)</u>	<u>Robert Harlander (Wuppertal)</u>
4. <u>ttH</u>	<u>Simon Dean (UCL)</u>	<u>Chris Neu (Virginia)</u>		<u>Laura Reina (Florida)</u>	<u>Michael Spira (PSI)</u>
5. <u>MSSM neutral</u>	<u>Markus Warsinsky (Freiburg)</u>	<u>Monica Vazquez Acosta (IC)</u>		<u>Michael Spira (PSI)</u>	<u>Georg Weiglein (DESY)</u>
6. <u>MSSM charged</u>	<u>Martin Flechl (Freiburg)</u>	<u>Sami Lehti (Helsinki)</u>		<u>Michael Krämer (Aachen)</u>	<u>Tilman Plehn (Heidelberg)</u>
7. <u>PDF</u>	<u>Joey Huston (Michigan State)</u>	<u>Kajari Mazumdar (TIFR)</u>		<u>Stefano Forte (Milano)</u>	<u>Robert Thorne (UCL)</u>
8. <u>Branching ratios</u>	<u>Daniela Rebutti (Pavia)</u>	<u>Ivica Puljak (Split)</u>		<u>Ansgar Denner (PSI)</u>	<u>Sven Heinemeyer (IFCA)</u>
9. <u>NLO MC</u>	<u>Jae Yu (Texas)</u>	<u>Marta Felcini (UCLA/IFCA)</u>		<u>Fabio Maltoni (Louvain)</u>	<u>Paolo Nason (Milano-Bicocca)</u>
10. <u>Pseudo-observables</u>	<u>Michael Dührssen (CERN)</u>	<u>Marta Felcini (UCLA/IFCA)</u>		<u>Sven Heinemeyer (IFCA)</u>	<u>Giampiero Passarino (Torino)</u>

- Higgs production oriented group organization.
- We keep this structure to keep up the progress in inclusive Higgs cross section calculations.
- Inclusive Higgs cross section and branching ratio calculations are mature.
 - Prepare CERN Yellow Report as the 1st publication of our group.

CERN Yellow Report

- Title: "Handbook of LHC Higgs Cross Sections"
- Editors: S. Dittmaier, C. Mariotti, G. Passarino and R. Tanaka
- Authorship: Those who made contributions in our working group.
Contact persons in each working group will decide whom to be put on the list.

Chapter	# of pages	~ 100 pages in total
Introduction	7-8	
1. ggF	12-13	
2. VBF	12-13	
3. WH/ZH	7-8	
4. ttH	7-8	
5. MSSM neutral	12-13	
6. MSSM charged	7-8	
7. PDF	7-8	
8. BRs	7-8	
9. NLO MC	12-13	
10. POs	7-8	

Contents

- 1) Contact persons in each subgroup are in charge of drafting corresponding sections.
- 2) Short description of state-of-the-arts on Higgs inclusive XS and BRs should be given.
- 3) Explicit numbers at least 7 and 14 TeV.
All official numbers will be put on TWiki page.
- 4) Complete list of references should be given.

- LaTeX: Instructions for preparing CERN Report can be found at <http://cern.ch/dtp/dtpcernreport.asp>
 - SVN in preparation.
 - Official numbers (LaTeX format) and figures (eps) should be put on our Twiki page (should be updated).
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- First draft by October 1st , final approval at Bari workshop (Nov. 4-5).
 - Please send us the compilation of REFERENCES before Oct. 22 (Wed.) .

Higgs cross sections

- Standard Model Input Parameters at LHC
<https://twiki.cern.ch/twiki/bin/view/LHCPhysics/SMInputParameter>
 - Higgs Cross Section Calculation at 7 and 14TeV
<https://twiki.cern.ch/twiki/bin/view/LHCPhysics/CrossSections7TeV>
 - PDF4LHC Recipe ... solution for CERN Yellow Report
<http://www.hep.ucl.ac.uk/pdf4lh/>
 - Higgs cross section central values
 - NNLO - use MSTW2008NNLO
 - NLO - follow PDF4LHC recipe, take mid-point of MSTW, CTEQ and NNPDF.
 - PDF+ α_s error at 68%C.L.
 - NNLO - follow PDF4LHC recipe, MSTW(NNLO)*envelope(NLO)
 - NLO - follow PDF4LHC recipe, take "envelope" of MSTW, CTEQ and NNPDF
- Roughly $\pm 10\%$ for gg initiated and $\pm 5\%$ for qq initiated total uncertainties.
- If you have any difficulties in calculations, please let us know .
We shall ask our PDF(PDF4LHC) people for help.

Instruction for Higgs Cross Section Calculation at 7 TeV

<https://twiki.cern.ch/twiki/bin/view/LHCPhysics/CrossSections7TeV>

● Cross section central values

1. For NLO, take the midpoint of CTEQ6.6, MSTW2008 and NNPDF2.0 envelope following the [recommendation](#) from [PDF4LHC](#) group.
2. For NNLO, take MSTW2008 result.

● QCD scale uncertainty

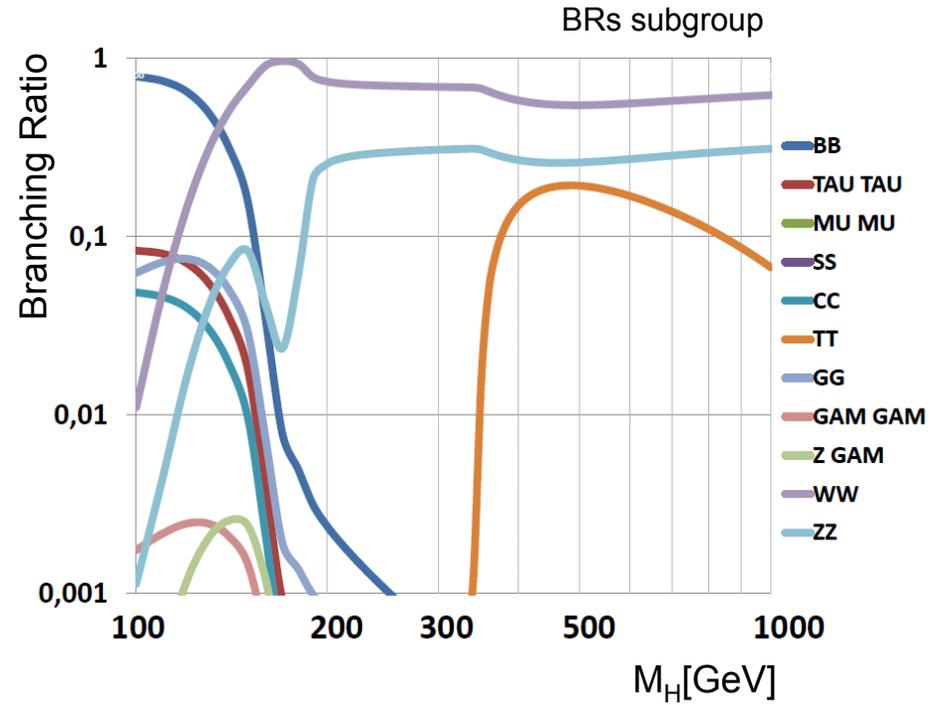
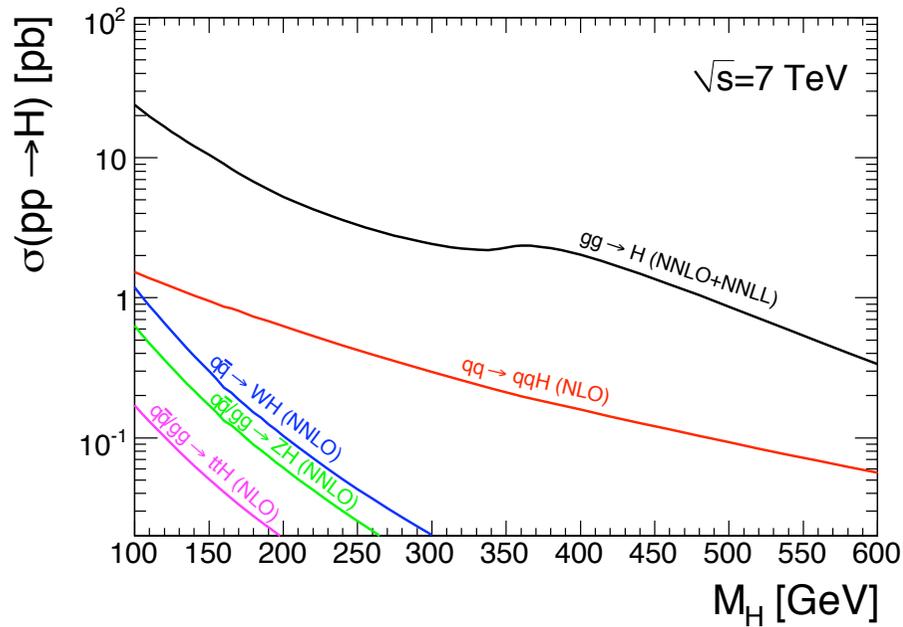
The factorization and the renormalization scales are process dependent and should be defined by each subgroup. The scale uncertainty should also be defined by each group, (e.g.. $1/2M_H < \mu_R, \mu_F < 2M_H$, do 2D scan with $1/2 < \mu_R/\mu_F < 2$)

● PDF+ α_s uncertainties ([PDF4LHC](#) group [recommendation](#))

- $\Delta\alpha_s = \pm 0.0012$ for 68% C.L. and $\Delta\alpha_s = \pm 0.0020$ for 90% C.L.
 - If calculations only at 90% C.L. calculation exist (CTEQ), we shall translate (i.e., by dividing 90% C.L. error by 1.645).
 - PDF+ α_s uncertainties should be calculated both at 68% C.L. (priority) and at 90% C.L..
- a. The total PDF+ α_s uncertainty can be evaluated by adding the variations in PDFs due to α_s uncertainty in quadrature with the fixed α_s PDF uncertainty,
 - b. For NNPDF, more efficiently taking a Gaussian distribution of PDF replicas corresponding to different values of α_s .
 - c. For MSTW, the PDF+ α_s uncertainties should be evaluated using their prescription which better accounts for correlations between the PDF and α_s uncertainties when using the MSTW dynamical tolerance procedure for uncertainties. Adding the α_s uncertainty in quadrature for MSTW can be used as a simplification but generally gives slightly smaller uncertainties.

1. For NLO, use the envelope provided by the central values and PDF+ α_s errors from the MSTW08, CTEQ6.6 and NNPDF2.0 PDFs, using each group's prescriptions for combining the two types of errors. Take the symmetric error following the [recommendation](#) from [PDF4LHC](#) group.
2. For NNLO, multiply the MSTW uncertainty at NNLO by the factor obtained by dividing the full PDF+ α_s uncertainty obtained from the envelope of MSTW, CTEQ and NNPDF results at NLO by the MSTW PDF+ α_s uncertainty at NLO (~ factor 2 at 7 TeV).

Example official plots



2. New activity on Higgs exclusive XS

July 22, 2010

1) HIGGS SIGNAL

- Compute cross sections within plausible acceptance cuts; preferably one set to give the feeling for both ATLAS and CMS. → The cuts will be posted on the TWiki.
- Check how the K-factor from (N)LO to (N)NLO is changing after cuts.
- Compare with what is expected from NLO MC (i.e. compare and work with NNLO codes that can give differential distributions and MC at NLO that generate events.)

2) SM BACKGROUND

For the most important background sources we want to estimate the control required of the theoretical predictions. Do this with an example analysis as follows:

- Define the "model control region" in which the experiment will measure it directly from data.
- If exist use a NLO MC.
- Check how the K-factor is changing with those kinematical cuts.
- Understand if the model "control region" is really in the tail of the SM process, or it sample the "bulk" of it.
- Define the precision with which the SM background will be measured and the TH precision as of today for that model "control region" i.e. define the precision needed for the 7 TeV run 1fb⁻¹ of lumi.
- While going back to the signal region (using the TH expectation) estimate the theoretical error.
- Compute the interference between signal and background (at LO. But how will change at NLO?).
- Also for the Background compare and work with NNLO codes that can give differential distributions and MC at NLO that generate events.
- For the SM background that cannot be measured with data driven methods, the theoretical uncertainty should be carefully estimated in the "signal region".

Cautions: **No ongoing ATLAS/CMS data analyses shall be discussed in this forum.**
Also this forum is not for ATLAS/CMS data analyses optimization with new ideas.
Published ATLAS/CMS results can be provided in the electric form (histograms).

New working group contacts

Higgs Decay	ATLAS	CMS
$\gamma\gamma$	Marumi Kado (LAL)	Susan Gascon-Shotkin (Lyon)
$ZZ^{(*)}$	Stathes Paganis (Sheffield)	Nicola De Filippis (Bari)
$WW^{(*)}$	Tiesheng Dai (Michigan)	Javier Cuevas (Oviedo)
$\tau^+\tau^-/\mu^+\mu^-$	Markus Schumacher (Freiburg)	Sasha Nikitenko (Imperial College)
bb	(Chris Collins-Tooth (Glasgow))	Jim Olsen (Princeton)
$H^\pm (\tau\nu, cs, tb)$	Martin Flechl(Freiburg)	Sami Lehti (Helsinki)

- Higgs decay oriented group organization supervised by NLO MC subgroup.
- We do not create "new subgroups", but assign contact person for each Higgs decay mode and he/she organize the work btw ATLAS and CMS.
- We do not assign theorists to these new activities, but we will invite theorists for each topics.

Proposal for Bari meeting: Each of the "final state" should give,

- 1) Plan of the activity (topics to be studied) including both Higgs and SM bkg.
- 2) Overview of the common cuts among ATLAS and CMS.
- 3) First results if any.

New group meeting

- We suggest to avoid too much fragmented meetings.
- We therefore suggest following meeting organization.
It is VERTICALLY organized, inviting people (theorists) from related Higgs production processes.
- For example, people from VBF, MSSM Neutral Higgs, and new contact/people in tau+tau can meet together.
- We should start organizing regular meetings, bi-weekly for example.
- Please use our InDico at <http://indico.cern.ch/categoryDisplay.py?categId=2792>

	$\Upsilon\Upsilon$	ZZ	WW	$\tau\tau/\mu\mu$	bb	H^\pm
ggF	1	2	3	4		
VBF	1	2	3	4		
WH/ZH					5	
ttH					5	
MSSM h/H/A				4		
MSSM H^\pm						6

3. Bari workshop (Nov. 4-5)

- Registration before Oct. 4 (Mon.)
 - <http://webcms.ba.infn.it/cms-software/higgs/workshop/higgs/>Please join us!
- Agenda
 - 1st day devoted for new exclusive Higgs XS activities,
 - 2nd day (morning session only) for CERN Yellow Reports.

