

January 10, 2011

Dear friends,

After completion of our first note "Handbook of LHC Higgs Cross Sections: 1. Inclusive Observables", phase 2 of the **LHC Higgs XS WG** is in front of us. Usually we refrain from sending long messages, nobody reads them to the end. This time we ask you to do so, it's important; thanks! We need to start the second part of our program:

Exclusive Higgs observables

We had already a lot of discussions in 2010; taking into account what ATLAS/CMS/LHCb need and looking into studies already published, we would like to propose a plan of work for 2011. Remember, the phase 1, running-a-code and run-away should be over, now we go for the real McCoy, i.e. the real thing based upon experiments' needs.

I. Goals and Organization in 2011

1. The running centre-of-mass energy in 2011 will be discussed at Chamonix Workshop (Jan. 24-28). It will be also discussed whether LHC will postpone the long shut-down from 2012 to 2013. The decisions on these issues will be taken immediately following the workshop.
2. The LHC Higgs combination working group has been formed in Dec. 2010 in accordance between ATLAS and CMS. Our group is expected to provide the Higgs cross section uncertainties with full correlation study in due time.
3. Target for Phase 2: one or (probably two) publications by the end of 2011 (journal and/or CERN Yellow Report). Everybody understands the problem, doing work on our own (only) or to devote more time for a common project? Is there a payoff for the second option? We think so, but it will be appreciated if you could send us comments (please, avoid offensive statements, we already got enough).
4. Phase 2 of LHC Higgs cross section working group general reminder: we have now a more complex structure in place:
 - subgroups for production mode (mostly TH),
 - subgroups for final states (mostly EXP).

Organizing the work of these groups will not be trivial and requires intense communication. It has been our proposal that the NLOMC group, co-adjuvated by the four overall contact persons, will control the issues related to organizational layers (experimental analysis is done by using NLO MC's).

5. Therefore you are encouraged to organize (EVO) meetings, already starting now. We know you are all busy, but if we want to have some results at the BNL meeting (May 4-5, <http://www.bnl.gov/hcs/>) and for summer conferences, we should start now or it will be too late. Another workshop is scheduled in autumn 2011 in Paris to finalize/prepare for the report(s) in 2011.

II. Working Plan in 2011

This is a list of items for 2011 action; nothing more than general remarks, followed by a list to be discussed and enlarged in each subgroup.

A Higgs Signal

1. Compute cross sections within plausible acceptance cuts; → cuts are posted on TWiki.
2. Study differential K -factor from (N)LO to (N)NLO after cuts, and plot as as a function of the cut (in the region around the applied cut).

3. Study effects of jet-veto or b-jet tag on differential K -factors. Study Higgs p_T and jet p_T spectrum with cuts.
4. Compare with what is expected from NLO MC, also compare and work with NNLO codes that can give differential distributions if available. Employ the most advanced NLO MC codes such as POWHEG, MC@NLO, new SHERPA, etc..

B SM Background

For the most important background sources we want to estimate the level required for theoretical predictions. This could be done with as follows:

1. Define the *model control region* in which the experiment can measure background directly from data. Check how the K -factor is changing with those kinematical cuts.
2. Determine the precision with which the SM background will be measured and the available/required TH precision for that *model control region*, i.e. define the TH precision needed for the 8 TeV run with 1 fb^{-1} (or even $3 - 5 \text{ fb}^{-1}$) integrated luminosity.
3. While going back to the signal region (using the TH expectation) estimate the current theoretical error.
4. Like Higgs signal, use the most advanced NLO MC. Compare and work with NNLO codes if available that can give differential distributions.
5. Compute the interference between signal and background at LO. Investigate how this will change at NLO.
6. For the SM background that cannot be measured with data driven methods, the theoretical uncertainty should be carefully estimated in the *signal region*.
7. ...

C Theory Uncertainties

We are expected to provide the theory uncertainty (THU) for each LHC experiment and possible combination at LHC. Not only for inclusive observables, we also have to calculate the THU for exclusive ones, for both SM Higgs and beyond SM like MSSM Higgs. The proper error correlations should be estimated:

1. THU error correlations between different Higgs production channels: SM (ggF, VBF, WH/ZH and ttH), MSSM($gg \rightarrow \phi, bb\phi$), with/without experimental cuts.
2. THU error correlations between exclusive analyses SM $H + 0, 1, 2 - \text{jets}$, MSSM $\phi + 0, 1, 2 - \text{jets}$, etc..
3. How to treat QCD scale and PDF errors when advanced analysis method like Matrix Element, Boosted-Decision-Tree, Neural Network, is employed.

As we mentioned at the beginning, the plan cannot be completed without full support by all of you; how do you overcome the overwhelming urge to drift away?? Simple: El pueblo unido jamás será vencido. However, through a series of unfortunate circumstances, you could know already now that your contribution will be below threshold; please, let us know urgently. Please remember, for the project the most important thing is your feedback.

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