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MSSM Neutral Higgs

Group Members

In case of questions or problems, please report them to all the conveners.

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Bibliography

If you use the ROOT files from 2016 and earlier provided on this webpage, please follow the citation guide shifted to this file.
If you use the ROOT files from 2018 and later provided on this webpage, you must cite a fraction of the subsequent technical papers.
Which papers need to be cited depends on which cross sections and branching ratios your analysis is using, see the citation guide right after the list of bibliography. If you are in doubt, ask the group members!
Also don't forget to cite the publications that suggested the benchmark scenarios. Those are listed next to the ROOT files.
Relevant publications given in terms of their inSPIRE texkeys are:

1. FeynHiggs program
    - \cite{Heinemeyer:1998yj, Heinemeyer:1998np, Degrassi:2002fi, Frank:2006yh, Hahn:2013ria, Bahl:2016brp, Bahl:2017aev}
2. HDECAY
    - \cite{Djouadi:1997yw, Djouadi:2018xqq}
3. Work of the BR subgroup, which is based upon the publications given in this tex-file. This in particular includes also PROPHECY4f with the publications
    - \cite{Bredenstein:2006rh, Bredenstein:2006ha}
4. SusHi program
    - \cite{Harlander:2012pb, Harlander:2016hcx}
5. ggH NLO massive
    - \cite{Spira:1995rr}
6. (N)NLO (S)QCD corrections for h/H/A
    - \cite{Harlander:2004tp} (NLO-stop scalar mh=0)
    - \cite{Harlander:2005rq} (NLO-top/bottom)
    - \cite{Degrassi:2010eu} (NLO-sbottom scalar)
    - \cite{Degrassi:2011vq} (NLO-stop/sbottom pseudo mA != 0)
    - \cite{Degrassi:2012vt} (NLO-stop scalar mH != 0)
7. ggH NNLO for scalar Higgs
    - \cite{Harlander:2002wh, Anastasiou:2002yz, Ravindran:2003um}
8. ggH NNLO for pseudoscalar Higgs
    - \cite{Harlander:2002vv, Anastasiou:2002wq}
9. ggH N3LO for scalar Higgs in threshold expansion
    - \cite{Anastasiou:2014lda, Anastasiou:2015yha, Anastasiou:2016cez}
10. Electroweak corrections by light fermions
    - \cite{Aglietti:2004nj, Bonciani:2010ms}
11. bbh@nnlo (5FS) program
    - \cite{Harlander:2003ai}
12. bbH NLO (4FS)
    - \cite{Dittmaier:2003ej, Dawson:2003kb}
13. bbH matched predictions

- \cite{Bonvini:2015pxa, Bonvini:2016fgf, Forte:2015hba, Forte:2016sja}

14. Charged Higgs cross sections
    - \cite{Berger:2003sm, Dittmaier:2009np, Flechl:2014wfa, Degrande:2015vpa, Degrande:2016hyf}

Please copy the relevant inSPIRE texkeys into inspirehep.net to access the publications including BibTex entries, etc.
You may also export the above list into a text file, which in turn can be uploaded to the BiblioTools webpage to retrieve all BibTex entries.

Citation guide

In the first place, please cite the LHC Higgs cross-section working group for providing cross-sections and BRs (by citing the Yellow Reports).

We now provide recommendations on how to cite the above publications (the recommended sentences are highlighted in blue):

Citations relevant for the calculation of Higgs masses, mixing and branching ratios:
For all scenarios except the hMSSM, Higgs masses and mixing (and effective Yukawa couplings) have been calculated with the code Feynhiggs [1]. Whereas in the hMSSM branching ratios are solely computed with HDECAY [2], all other scenarios combine the most precise results of FeynHiggs [1], HDECAY [2] and PROPHECY4f [3].
A more detailed description how to cite the individual references relevant for the calculation of branching ratios is given in LHCHXSWG-2015-002, page 10 bottom.

If your analysis makes use of gluon-fusion cross sections, please cite the corresponding block of references as follows:
For the gluon-fusion process inclusive cross sections are obtained with SusHi [3], which includes NLO QCD corrections [5], NNLO QCD corrections for the top-quark contribution in the effective theory of a heavy top quark [7,8] and electroweak effects by light quarks [10].
For all scenarios but the hMSSM and the EFT scenarios please add:
SusHi includes NLO supersymmetric-QCD corrections [6] in expansions of heavy SUSY masses.
If you make use of the cross sections of the SM-like Higgs boson at 125 GeV please add:
For the SM-like Higgs boson SusHi adds N3LO corrections in the effective theory of a heavy top quark in a threshold expansion [9].

Citations relevant for bottom-quark-initiated Higgs production:
Cross sections for bottom-quark initiated Higgs production rely on matched predictions [13], which are based on the five flavour NNLO QCD calculation [11] and the four flavour NLO QCD calculation [12].

Citations relevant for charged-Higgs production:
Charged Higgs cross sections for charged Higgs masses in the window 200-1400 GeV at 8 TeV, 145-2000 GeV at 13 TeV and 200-600 GeV at 14 TeV are determined from the predictions provided in Refs. [14] by applying the reweighting procedure provided by the charged Higgs subgroup of the LHC Higgs cross-section working group.
We refer to the webpage of the charged Higgs subgroup for more information on the reweighting procedure.

Also don't forget to cite the publications that suggested the benchmark scenarios. Those are listed next to the ROOT files.

Current recommendation for interpretation

- 2018 MSSM benchmark scenarios are recommended to be used for for interpretations.
- ROOT file version from 2016 is still the recommended for hMSSM.

2018 Content of the ROOT files

Higgs masses, cross sections (including uncertainties) and branching ratios for different MSSM benchmark scenarios are provided in terms of 2 dimensional ROOT histograms usually scanning over the m_A-tan plane. In detail the histograms contain:

- masses and widths of the scalar bosons h/H/A/Hp.
- cross sections for gluon-gluon fusion h/H/A production (top at N^3LO QCD, bottom and top-bottom interference at NLO QCD, partially with SUSY QCD (SQCD) and electroweak (EW) contributions) including scale and PDF(+ _s) uncertainties.
- cross sections for b-associated h/H/A production in the SCET/FONLL scheme including uncertainties.
- cross sections for charged Higgs production including uncertainties (charged Higgs masses between 200-1400GeV at 8TeV, 145-2000GeV at 13TeV and 200-600GeV at 14TeV).
- branching ratios of h/H/A/Hp to various SM and SUSY particles, see also BR subgroup.

The structure of the histograms is rather complicated. To ensure that the numbers are extracted properly, a simple C++ class is provided. Details can be found below.

Access tool for the ROOT files

For the benchmark scenarios released in 2018 we provide a new version of the access tool v2.2, which is not compatible with the old ROOT files. We keep the old access tool for compatibility.

Please note that for all access tools the cross section predictions (and uncertainties) are consistently **provided in pb** .

- Access tool version 0.5 (for 7 and 8 TeV): Download the header file and the implementation file. For information about the usage, please consult the header file, or use the help() method of the class, which will explain all available methods. On initialization with an input file, some information on the used MSSM parameters is also printed out on screen. The accessor tool has been tested with ROOT stand-alone and was tested to be compiled stand-alone GCC4.4. Please remove the "v_1.0" tag at the end of the files. To work with the access tool you have to include the corresponding C++ class. help() gives you a list of the available commands. Example calls can be found here.

- Access tool version 1.0 (for (8,) 13 and 14 TeV): Download the header file and the implementation file and the python wrapper. Please remove the "v_1.0" tag at the end of the files. To work with the access tool you have to include the corresponding C++ class. First a shared library has to be compiled. Example calls can be found here.

- Access tool version 2.3 (for 8, 13 (and 14 TeV)): Download the header file and the implementation file and the python wrapper. Please remove the "_v2.2/2.3" tag at the end of the files. To work with the access tool you have to include the corresponding C++ class. First a shared library has to be compiled. The ROOT files were generated with ROOT 6.13. Older ROOT versions might have problems in reading the content. The routines are mostly identical to tool version 1.0 with the following exceptions: The 4FS/5FS/Santander matched cross sections for bottom-quark annihilation are replaced with SCET/FONLL numbers, which are accessed through bbH_A/H/h. Also charged Higgs cross sections are available now. For the naming conventions and the implemented uncertainties please check the routines that can be found in mssm_xs_tools.h. From 2.0 to 2.1 the python wrapper was updated. From 2.1 to 2.2 new readout routines for relative Yukawa couplings were added. From 2.2 to 2.3 we added routines to access the data stored in the scenario with CP violation.

```
root -l
.L mssm_xs_tools.C++
```

Then either the python wrapper or the .C file could be used:

```
mssm=mssm_xs_tools("mh125_13.root",true,0)   // "true" enables interpolation between
mssm.mass("H",300,3)
mssm.width("H",300,3)
mssm.br("H-->tautau",300,3)
mssm.xsec("gg->H",300,3)
```

ROOT histograms: 2018 and beyond MSSM benchmark scenarios for 8, 13 (and 14 TeV) - Access tool version 2.0/2.1/2.2/2.3

Subsequently you find ROOT histograms for the MSSM benchmark scenarios defined in:
"MSSM Higgs Boson Searches at the LHC: Benchmark Scenarios for Run 2 and Beyond"
Emanuele Bagnaschi, Henning Bahl, Elina Fuchs, Thomas Hahn, Sven Heinemeyer, Stefan Liebler, Shruti Patel, Pietro Slavich, Tim Stefaniak, Carlos E.M. Wagner, Georg Weiglein
arXiv:1808.07542
inSPIRE texkey: \cite{Bahl:2018zmf}

Most scans in the m_A-tan -plane have been made between m_A=70 GeV and m_A=2600 GeV and between tan =0.5 and 60.
ROOT histograms:

January 2019: Updated to include Yb*Yt term in bbh XS.
No further changes to be expected. Only additional information will be added, like branching ratios of the heavy Higgs bosons into individual pairs of electroweakinos.

March 2020: An issue in the decays of the light Higgs boson was identified in the ROOT files of the subsequent five scenarios. Please for now do not make use of the light Higgs-boson branching ratios in these files. We expect an update within a few weeks.

- M_h^{125}
    - This scenario is characterized by relatively heavy superparticles, so the Higgs phenomenology at the LHC resembles that of a THDM with MSSM-inspired Higgs couplings.
    - mh125_8.root: 8 TeV, tan = 0.5-60, mA = 70-2600 GeV
    - mh125_13.root: 13 TeV, tan = 0.5-60, mA = 70-2600 GeV
    - mh125_14.root: 14 TeV, tan = 0.5-60, mA = 70-2600 GeV

- $M_h^{125}(\tilde \chi)$
    - This scenario is characterized by all charginos and neutralinos being relatively light, with significant higgsino-gaugino mixing. This affects the decays of the heavier Higgs bosons, weakening the exclusion bounds from H/A->tau tau searches, as well as the decay of the SM-like Higgs boson to photons. On the other hand, the possibility to look for additional

Higgs bosons through their decays to charginos and neutralinos opens up.
- mh125_lc_8.root: 8 TeV, tan = 0.5-60, mA = 70-2600 GeV
- mh125_lc_13.root: 13 TeV, tan = 0.5-60, mA = 70-2600 GeV
- mh125_lc_14.root: 14 TeV, tan = 0.5-60, mA = 70-2600 GeV

- $M_h^{125}(\tilde\tau)$
    - This scenario is characterized by light staus and light gaugino-like charginos and neutralinos. The effect of the light staus on the decays of the heavier Higgs bosons, as well as on the decay of the SM-like Higgs boson to photons, is most relevant at large tan . Compared with the previous scenario, a larger mass for the higgsinos implies that the decays of the heavier Higgs bosons to charginos and neutralinos become relevant at larger values of mA.
    - mh125_ls_8.root: 8 TeV, tan = 0.5-60, mA = 70-2600 GeV
    - mh125_ls_13.root: 13 TeV, tan = 0.5-60, mA = 70-2600 GeV
    - mh125_ls_14.root: 14 TeV, tan = 0.5-60, mA = 70-2600 GeV

- M_h^{125}(alignment)
    - This scenario is characterized by the phenomenon of "alignment without decoupling", in which, for a given value of tan , one of the two neutral CP-even scalars has SM-like couplings independently of the mass spectrum of the remaining Higgs bosons. In particular, for tan around 7 the properties of the lighter scalar h are in agreement with those of the observed Higgs boson also for relatively low values of mA.
    - [NOTE: In contrast to the definition in arXiv:1808.07542, the ROOT files start only at mA > 120 GeV due to a theoretically inaccessible region at low mA < 120 GeV and tan >10].
    - mh125_align_8.root: 8 TeV, tan = 1-20, mA = 120-1000 GeV
    - mh125_align_13.root: 13 TeV, tan = 1-20, mA = 120-1000 GeV
    - mh125_align_14.root: 14 TeV, tan = 1-20, mA = 120-1000 GeV

- $M_{h_1}^{125}$(CPV)
    - This scenario incorporates CP violation in the Higgs sector and gives rise to a strong admixture of the two heavier neutral states, leading to significant interference effects in their production and decay which weaken the exclusion bounds from tau tau searches.
    - [NOTE: the scenario contains three neutral Higgs bosons H1, H2 and H3 rather than h, H and A. H1 is understood as the SM-like Higgs boson with a mass at 125 GeV in large parts of the parameter space. The input parameters are tan and the charged Higgs mass mHp rather than mA. Please consider mssm_xs_tools.h for new access functions for the cross sections, masses and branching ratios. In contrast to the CP conserving scenarios we do not provide relative Yukawa couplings as those do have a real and imaginary contribution to both the vector and axial-vector component. On the other hand, we do provide interference factors eta(bb->H2/H3->bb/tau tau) as in such channels large destructive interferences between H2 and H3 appear. When interpreting a search in those final states, do not forget to multiply sigma(bb->H2/H3)*BR(H2/H3->bb/tautau) with the corresponding (1+eta) factor! This scenario needs access tool version 2.3 or higher.]
    - mh1125_CPV_8.root: 8 TeV, tan = 1-20, mHp = 130-1500 GeV
    - mh1125_CPV_13.root: 13 TeV, tan = 1-20, mHp = 130-1500 GeV
    - mh1125_CPV_14.root: 14 TeV, tan = 1-20, mHp = 130-1500 GeV

Subsequently you find ROOT histograms for the MSSM benchmark scenarios defined in:
"MSSM Higgs Benchmark Scenarios for Run 2 and Beyond: the low tan region"
Henning Bahl, Stefan Liebler, Tim Stefaniak
arXiv:1901.05933
inSPIRE texkey: \cite{Bahl:2019ago}

Both scans in the m_A-tan -plane have been made between m_A=70 GeV and m_A=3000 GeV and between tan =1 and 10.

They are extended beyond 2600 GeV as the squarks are heavier and no thresholds appear in gluon fusion between 2600 and 3000 GeV.
The scenarios provide a light CP-even Higgs mass of 125 GeV almost throughout the whole parameter plane by adjusting the SUSY scale to very high values.
They supplement the above scenarios, as they have a correct Higgs mass of 125 GeV at low tan , and can be used in direct comparison to the hMSSM.
The scenarios supersede the "low-tb-high" scenario.

- $M_{h,\text{EFT}}^{125}$
    - mh125EFT_8.root: 8 TeV, tan = 1-10, mA = 70-3000 GeV
    - mh125EFT_13.root: 13 TeV, tan = 1-10, mA = 70-3000 GeV
    - mh125EFT_14.root: 14 TeV, tan = 1-10, mA = 70-3000 GeV

- $M_{h,\text{EFT}}^{125}(\tilde \chi)$
    - mh125EFT_lc_8.root: 8 TeV, tan = 1-10, mA = 70-3000 GeV
    - mh125EFT_lc_13.root: 13 TeV, tan = 1-10, mA = 70-3000 GeV
    - mh125EFT_lc_14.root: 14 TeV, tan = 1-10, mA = 70-3000 GeV

Charged Higgs cross sections have a limited range in the charged Higgs boson masses, see above. Scenarios named in orange are obtained with the setup that will be described in a public note of the LHCHXSWG. The setup equals mostly the one presented in arXiv:1808.07542. Similarly, scenarios named in purple are obtained with the setup described in 1901.05933.

ROOT histograms: 2013-2016 MSSM benchmark scenarios for (8,) 13 and 14 TeV - Access tool version 1.0

This section includes ROOT histograms for the benchmark scenarios recommended for the analysis of (8,) 13 and 14 TeV data before 2018. The citation guide for the scenarios is as follows:

The "low-tb-high" scenario was defined in LHCHXSWG-2015-002,
inSPIRE texkey: \cite{Bagnaschi:2015hka}

The "hMSSM" approach was proposed in four 2013-2015 publications:
inSPIRE texkey: \cite{Djouadi:2013vqa, Maiani:2013hud, Djouadi:2013uqa, Djouadi:2015jea}

The remaining six scenarios listed below were defined in:
"MSSM Higgs Boson Searches at the LHC: Benchmark Scenarios after the Discovery of a Higgs-like Particle"
M. Carena, S. Heinemeyer, O. Sta l, C.E.M. Wagner, G. Weiglein
arXiv:1302.7033
inSPIRE texkey: \cite{Carena:2013ytb}

Most scans in the m_A-tan -plane have been made between m_A=90 GeV and m_A=2000 GeV and between tan =0.5 and 60.
ROOT histograms for 13 and 14 TeV as well as for the low-tan -high scenario/hMSSM:

27.05.2016: Update of the (8,) 13 and 14TeV ROOT histograms with corrected bbH cross sections .

- low-tb-high files
    - low-tb-high_8TeV.root: 8 TeV, tan = 0.5-10, mA = 150-500 GeV (updated 27.05.2016)
    - low-tb-high_13TeV.root: 13 TeV, tan = 0.5-10, mA = 150-500 GeV (updated 27.05.2016)

- hMSSM files: Produced with SusHi 1.4.1 (with 2HDM input)+ bbH (4FS) (including Yt*Yb terms)

and green ggH and bbH choices
    - hMSSM_8TeV.root: 8 TeV, tan = 0.8-60, mA = 130-1000 GeV (updated 27.05.2016)
    - hMSSM_13TeV.root: 13 TeV, tan = 0.8-60, mA = 130-1000 GeV (updated 27.05.2016). Bug found in May 2018: Please be aware that the heavy Higgs gluon-fusion cross section (`xs_gg_H` histogram in the .root file) contains some duplicated values along tanb (tanb having a stepsize of 0.1 at lower tanb). If you need cross section values at this resolution, please contact the MSSMNeutral team to request the original ASCII file.

- mh-max files
    - newmhmax_mu200_13TeV.root : 13 TeV, tan = 0.5-60, mA = 90-2000 GeV (updated 27.05.2016)
    - newmhmax_mu200_14TeV.root : 14 TeV, tan = 0.5-60, mA = 90-2000 GeV (updated 27.05.2016)

- mh-mod+ files
    - mhmodp_mu200_13TeV.root: 13 TeV, tan = 0.5-60, mA = 90-2000 GeV (updated 27.05.2016)
    - mhmodp_mu200_14TeV.root : 14 TeV, tan = 0.5-60, mA = 90-2000 GeV (updated 27.05.2016)

- mh-mod- files
    - mhmodm_13TeV.root: 13 TeV, tan = 0.5-60, mA = 90-2000 GeV (updated 27.05.2016)
    - mhmodm_14TeV.root : 14 TeV, tan = 0.5-60, mA = 90-2000 GeV (updated 27.05.2016)

- light stau files
    - lightstau1_13TeV.root: 13 TeV, tan = 0.5-60, mA = 90-2000 GeV (updated 27.05.2016)
    - lightstau1_14TeV.root : 14 TeV, tan = 0.5-60, mA = 90-2000 GeV (updated 27.05.2016)

- light stop files : The scenario differs from the original one in arXiv:1302.7033 by M1=350 GeV, M2=μ=400 GeV to avoid bounds from direct stop searches.
    - lightstopmod_13TeV.root: 13 TeV, tan = 0.5-60, mA = 90-650 GeV (updated 27.05.2016)
    - lightstopmod_14TeV.root : 14 TeV, tan = 0.5-60, mA = 90-650 GeV (updated 27.05.2016)

- tauphobic files
    - tauphobic_13TeV.root: 13 TeV, tan = 0.5-50, mA = 90-2000 GeV (updated 27.05.2016)
    - tauphobic_14TeV.root : 14 TeV, tan = 0.5-50, mA = 90-2000 GeV (updated 27.05.2016)

- mhmodp (For the time being, you may use the old access tool version 0.5 for these scenarios, although you have no access to uncertainties. An update of the scenarios compatible with v1.0 will follow.)
    - mhmodp_mu-1000_8TeV.root: 8 TeV, μ= -1000 GeV (tan <40 only)
    - mhmodp_mu-500_8TeV.root: 8 TeV, μ=-500 GeV
    - mhmodp_mu-200_8TeV.root: 8 TeV, μ=-200 GeV
    - mhmodp_mu500_8TeV.root: 8 TeV, μ=500 GeV
    - mhmodp_mu1000_8TeV.root: 8 TeV, μ=1000 GeV

Scenarios named in green are obtained with the following setup:
FeynHiggs 2.10.2 with default flags + SusHi 1.4.1 (=1.5.0) + bbH (4FS) (including Yt*Yb terms)

- ggH choices:
    - μ_R=μ_F=m_Phi/2.
    - Scale uncertainties: Seven combinations of scales μ_R=μ_F={m_Phi/4,m_Phi/2,m_Phi} with the constraint 1/2 ≤ μ_R/μ_F ≤ 2
    - PDF(+ _s) uncertainties: obtained for a SM Higgs boson with corresponding mass using

    MSTW2008
- bbH (5FS) choices:
    - μ_R= m_Phi, μ_F=0.25*m_Phi.
    - Scale uncertainties: Seven combinations of scales μ_R={m_Phi/2,m_Phi,2m_Phi} and μ_F={m_Phi/8,m_Phi/4,m_Phi/2} with the constraint 2 ≤ μ_R/μ_F ≤ 8
    - PDF(+ _s) uncertainties: obtained for a SM Higgs boson with corresponding mass using MSTW2008
- For the SM input to FeynHiggs and SusHi we refer to the bottom of the page.

ROOT histograms: <2013 MSSM benchmark scenarios for 7 and 8 TeV - Access tool version 0.5

The scans in the m_A-tan -plane have been made between m_A=90 GeV and m_A=1000 GeV and between tan =1 and 60. For lower values of tan   between 0.5 and 0.9 seperate ROOT histograms are available. Differences with respect to this procedure are highlighted.

- mhmodm
    - out.mhmodm-7TeV-tanbHigh-nnlo.root: 7 TeV, tan =1 - 60
    - out.mhmodm-7TeV-tanbLow-nnlo.root: 7 TeV, tan =0.5 - 0.9
    - out.mhmodm-8TeV-tanbHigh-nnlo.root: 8 TeV, tan =1 - 60
    - out.mhmodm-8TeV-tanbLow-nnlo.root: 8 TeV, tan =0.5 - 0.9

- mhmodp (with μ=200 GeV)
    - out.mhmodp-7TeV-tanbHigh-nnlo.root: 7 TeV, tan =1 - 60
    - out.mhmodp-7TeV-tanbLow-nnlo.root: 7 TeV, tan =0.5 - 0.9
    - out.mhmodp-8TeV-tanbHigh-nnlo.root: 8 TeV, tan = 1 - 60
    - out.mhmodp-8TeV-tanbLow-nnlo.root: 8 TeV, tan =0.5 - 0.9

- low mH (Variation in μ-tan -plane)
    - out.lowmH-7TeV-tanbHigh-nnlo.root: 7 TeV, tan =1.5 - 9.5, μ= 300 - 3500 GeV
    - out.lowmH-8TeV-tanbHigh-nnlo.root: 8 TeV, tan =1.5 - 9.5, μ= 300 - 3500 GeV

- lightstau
    - out.lightstau1-7TeV-tanbHigh-nnlo.root: 7 TeV, tan =1 - 60
    - out.lightstau1-7TeV-tanbLow-nnlo.root: 7 TeV, tan =0.5 - 0.9
    - out.lightstau1-8TeV-tanbHigh-nnlo.root: 8 TeV, tan = 1 - 60
    - out.lightstau1-8TeV-tanbLow-nnlo.root: 8 TeV, tan =0.5 - 0.9

- lightstopmod (tan   below 0.7 is not used due to problematic two-loop stop mass corrections SUSY QCD corrections above m_A> 600 GeV are not reliable due to the stop quark threshold.)
    - out.lightstopmod-7TeV-tanbHigh-nnlo.root: 7 TeV, tan =1 - 60
    - out.lightstopmod-7TeV-tanbLow-nnlo.root: 7 TeV, tan =0.7 - 0.9
    - out.lightstopmod-8TeV-tanbHigh-nnlo.root: 8 TeV, tan = 1 - 60
    - out.lightstopmod-8TeV-tanbLow-nnlo.root: 8 TeV, tan =0.7 - 0.9

- tauphobic
    - Please find below the tauphobic scenario with A_ =A_t and μ=2000GeV, available since 18.11.2014:
        - tauphobic_7TeV_tanbHigh_ataueqat_mu2000.root: 7 TeV, tan =1 - 60
        - tauphobic_7TeV_tanbLow_ataueqat_mu2000.root: 7 TeV, tan =0.5 - 0.9
        - tauphobic_8TeV_tanbHigh_ataueqat_mu2000.root: 8 TeV, tan =1 - 60
        - tauphobic_8TeV_tanbLow_ataueqat_mu2000.root: 8 TeV, tan =0.5 - 0.9
    - Please find below the tauphobic scenario with A_ =0 and μ=2000GeV, available since

24.12.2014. For the first time tan =0.5 - 0.9 and tan =1 - 60 are combined in a single file:
        - tauphobic_7TeV_ataueq0_mu2000.root: 7 TeV
        - tauphobic_8TeV_ataueq0_mu2000.root: 8 TeV
    - The tauphobic scenario originally suffered from an inconsistent choice of μ between cross sections (μ=2000GeV) and branching ratios (μ=500GeV). Below you can find for comparison the inconsistent (!) ROOT histograms, which include the official numbers for the tauphobic scenario between March and November 2014 (BRs at tan =7 and tan =8 have a numerical instability. Interpolation needed):
        - tauphobic_7TeV_tanbHigh.root: 7 TeV, tan =1 - 60
        - tauphobic_7TeV_tanbLow.root: 7 TeV, tan =0.5 - 0.9
        - tauphobic_8TeV_tanbHigh.root: 8 TeV, tan =1 - 60
        - tauphobic_8TeV_tanbLow.root: 8 TeV, tan =0.5 - 0.9

- mhmax
    - out.mhmax-mu200-7TeV-tanbHigh-nnlo.root: 7 TeV, tan =1 - 60
    - out.mhmax-mu200-7TeV-tanbLow-nnlo.root: 8 TeV, tan =0.5 - 0.9
    - out.mhmax-mu200-8TeV-tanbHigh-nnlo.root: 7 TeV, tan =1 - 60
    - out.mhmax-mu200-8TeV-tanbLow-nnlo.root: 8 TeV, tan =0.5 - 0.9

Scenarios named in red are obtained with the following setup:
FeynHiggs 2.8.6 with default flags + SusHi 1.0.6 + bbH (4FS) scans

- ggH scale choices:
    - μ_R=μ_F=m_Phi.
    - Scale variation: 0.5*m_Phi < μ_R, μ_F < 2*m_Phi
- bbH (5FS) scale choices:
    - μ_R= m_Phi, μ_F=0.25*m_Phi.
    - Scale variation: 0.2*m_Phi < μ_R < 5*m_Phi ; 0.1*m_Phi < μ_F < 0.7*m_Phi

Scenarios named in blue are obtained with the following setup:
HIGLU + ggH@NNLO + bbH@NNLO (5FS) + bbH (4FS) scans

- ggH scale choices:
    - μ_R=μ_F=m_Phi.
    - Scale variation: 0.5*m_Phi < μ_R, μ_F < 2*m_Phi
- bbH (5FS) scale choices:
    - μ_R= m_Phi, μ_F=0.25*m_Phi.
    - Scale variation: 0.2*m_Phi < μ_R < 5*m_Phi ; 0.1*m_Phi < μ_F < 0.7*m_Phi

Please use v5 of the access tool (remove "_v0.5" tag): header file and implementation file.

ROOT histograms: 'traditional mhmax' benchmark scenario - Access tool version 0.4

Subsequently you may find the numbers for the 'traditional mhmax' scenario, which is defined by the parameter choice:
μ = 200GeV, M_Susy = 1000GeV, X_t = 2000GeV, M_2 = 200GeV, M_3 = 800GeV
It is known to provide a light Higgs with m_h>126GeV in large parts of the m_A-tan plane.

We present the ROOT histograms produced by the MSSM subgroup at an early stage in the m_A-tan -plane for 7 TeV and for 14 TeV. The scans have been made between m_A=90 GeV and m_A=1000 GeV and between tan =1 and 60 (5 and 70 for the 14 TeV scan). For very low tan , the scan is done between tan =0.5 and 0.9 in steps of 0.1. They are kept for documentation:

FeynHiggs 2.7.4 with default flags + HIGLU + ggH@NNLO + bbH@NNLO (5FS) + bbH (4FS) scans

- ggH scale choices:
    - μ_R=μ_F=m_Phi.
    - Scale variation: 0.5*m_Phi < μ_R, μ_F < 2*m_Phi
- out.mhmax_7.root: mhmax, 7 TeV
- out.mhmax_7.root: mhmax, 14 TeV (no bbh 4FS and thus no Santander-matched XS and no PDF uncertainties! You obtain unreasonable results by the access tool!)

For 7 and 8 TeV please make use of the subsequent ROOT histograms:
HIGLU + ggH@NNLO + bbH@NNLO (5FS) + bbH (4FS) scans

- ggH scale choices:
    - μ_R=μ_F=m_Phi.
    - Scale variation: 0.5*m_Phi < μ_R, μ_F < 2*m_Phi
- bbH (5FS) scale choices:
    - μ_R= m_Phi, μ_F=0.25*m_Phi.
    - Scale variation: 0.2*m_Phi < μ_R < 5*m_Phi ; 0.1*m_Phi < μ_F < 0.7*m_Phi
- out.mhmax_mu200_7_nnlo.tanBeta_gte1.root: mhmax, 7 TeV, tan =1 - 60
- out.mhmax_mu200_7_nnlo.low_tanBeta.root: mhmax, 7 TeV, tan =0.5 - 0.9
- out.mhmax_mu200_8_nnlo.tanBeta_gte1_FHv274.root: mhmax, 8 TeV, tan =1 - 60
- out.mhmax_mu200_8_nnlo.low_tanBeta_FHv274.root: mhmax, 8 TeV, tan =0.5 - 0.9

The scenario is availabe for other (negative) values of μ as well, see attachments!

To read these files please use the old tool (v4): header file and implementation file.

Tools and Programs

If you aim to get cross sections and branching ratios for other scenarios than the ones on this webpage, you may use the following codes, which were also used to calculate the provided numbers:

- Higgs mass calculation and branching ratios: **FeynHiggs**:
- Gluon fusion cross section: **ggh@nnlo**
- Gluon fusion cross section: **HIGLU**
- Bottom-quark annihilation (5FS) cross section: **bbh@nnlo**
- Gluon fusion (incl. SQCD and EW) and bottom-quark annihilation (5FS) cross section: **SusHi**

Discussion of MSSM scenarios with low tan and Heavy SUSY

Please check the dedicated twiki page here and the information provided in:

"Benchmark scenarios for low tan in the MSSM"
E. Bagnaschi, F. Frensch, S. Heinemeyer, G. Lee, S. Liebler, M. Mühlleitner, A. Mc Carn, J. Quevillon, N. Rompotis, P. Slavich, M. Spira, C. Wagner, R. Wolf
LHCHXSWG-2015-002

Meetings

- CERN InDico Agenda

Outdated discussions (kept for the sake of completeness)

Considerations on H->tautau (~2011)
Choice of input parameters (<2016)

This topic: LHCPhysics > LHCHXSWGMSSMNeutral
Topic revision: r143 - 2020-10-08 - EmanueleAngeloBagnaschi1