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# MSSM Charged Higgs

The Charged Higgs group has been merged into the Extended Higgs Sector Group in Summer 2018.

## Group Coordinators

ATLAS: Xiangyang Ju, Jana Schaarschmidt CMS: Raffaele Gerosa, Martin Flechl Theory: Heather Logan, Rui Santos, Shufang Su.

Theory until Summer 2018: Maria Ubiali, Marco Zaro

## Available Tools

- **FeynHiggs** (*S. Heinemeyer et al.*)
- **HDecay** (*M Spira et al.*)
- **Prospino2** (*T. Plehn et al.*)

## Recent results

- H+ plots in the gallery
- in: Yellow Report 4, arXiv:1610.07922

## H+ production through cs fusion (s-channel)

- MSSM: Camargo-Molina, Mandal, Pasechnik, Wessen
- 3HDM: Dittmaier, Hiller, Plehn, Spannowsky

## Light charged Higgs

### Uncertainty analysis

- Relative uncertainty in Gamma(t -> H+ b) assuming a 3% residual uncertainty in Delta_b: Db-unc-003.dat

Format: tan_beta, Delta_b, variation from +0.03 in Delta_b, variation from -0.03 in Delta_b

Ranges: tan_beta = 1... 60 (1), Delta_b = -0.8 ... 0.8 (0.05)

Other parameters: mt(mt) = 166.8 GeV, mb(mt) = 2.31 GeV

sigma(tt) = 164.57 +4.30 - 9.27 (scale) + 7.15 -6.51 (PDF) pb; the PDF uncertainty was obtained with MSTW2008 at the 68% CL.

The plot shows the relative uncertainty of Gamma(t -> H+ b) induced by Delta_b: dGammatHpb_01.eps.gz

- Uncertainty for the light charged Higgs in the mhmax scenario

We evaluate sigma(tt) * BR(t -> H+ b) * BR(t -> W+ b) * 2.

Uncertainties included: sigma(tt) uncertainty from scale variation and 68% CL PDF uncertainties, 5% for missing one-loop EW, 2% for missing two-loop QCD, Delta_b induced uncertainties (see above), all added linearly; parametric uncertainties are neglected so far. The plots the central values and the uncertainties for various tan beta values. sigmatt_BRtHpb_02B.eps.gz sigmatt_BRtHpb_03B.eps.gz

The data files contain the following: MHp, tan beta, si x BR, si x BR^up, si x BR^down, BR(t -> H+b), BR(t -> H+b)^up, BR(t -> H+b)^down, si x BR refers to sigma(tt) * BR(t -> H+ b) * BR(t -> W+ b) * 2: mhmax-tb.tar.gz

The additional uncertainties for the decay H+ -> tau nu are negligible in the mhmax scenario. The BR(H+ -> tau nu) is very close to one with an uncertainty below 1%. Consequently, the uncertainty plots/data can be viewed as the full uncertainty on sigma(tt) * BR(t -> H+ b) * BR(H+ -> tau nu).

# Intermediate-mass (145-200) charged Higgs NLO cross sections, Update Jul 2016

Contact: Maria Ubiali, Marco Zaro

The input parameters are as in (LHCHXSWG-INT-2015-006); the computation is carried out in the 4FS using the PDF4LHC15 PDFs (PDF4LHC15_nlo_nf4_30). The complex-mass scheme is employed for the top quark, with a top width computed at NLO QCD for each (mass, tanbeta) point. Cross sections are computed at NLO QCD accuracy, for the 13 TeV LHC and mH+ in the range 145 GeV -> 200 GeV (steps of 5 GeV). The attached tarballs contain total cross sections as well as scale and PDF uncertainties for various values of tanbeta ([0.1, 1] range in steps of 0.1 and [1, 60] range in steps of 1):

* Type-II 2HDM: cH_145-200.tgz

* Type-I 2HDM: typeI_cH_145-200.tgz

## Citation guide

Please refer to this paper if you use the intermediate-mass numbers:

- [1] C. Degrande, R. Frederix, V. Hirschi, M. Ubiali, M. Wiesemann, M. Zaro, Phys. Lett. B772 (2017) 87-92, arXiv:1607.05291 .

# Heavy charged Higgs NLO cross sections without SUSYQCD corrections, Update Feb 2016

Contact: Martin Flechl, Steve Sekula, Maria Ubiali, Marco Zaro

New (13 TeV): mass range extended up to 2 TeV; PDF4LHC15 recipe; tan beta-dependence direct, not via interpolation; ...

New (8 TeV): mass range extended with mass points 1200 and 1400 GeV

A grid of Santander-matched cross sections in tan beta and mH+ is available. Also given are total uncertainties (PDF, alphas, scale, mb). Numbers are for 2HDM type-II (a la MSSM), but without SQCD corrections. For how to transform this into MSSM cross sections, see below. Contact Martin Flechl for questions of format etc, and Maria Ubiali, Michael Krämer, Steve Sekula, Michael Spira, Marco Zaro, Martin Flechl for physics-related questions.

- 8 TeV
- 13 TeV (YR4)
- 14 TeV

### Citation guide

Please quote **as a minimum** these papers if you use the numbers:

- [1] C. Degrande, M. Ubiali, M. Wiesemann, M. Zaro, Heavy charged Higgs boson production at the LHC. JHEP 1510 (2015) 145 , arXiv:1507.02549
- [2] M. Flechl, R. Klees, M. Kr\"amer, M. Spira, M. Ubiali, Improved cross-section predictions for heavy charged Higgs boson production at the LHC. Phys. Rev. D 91, 075015, arXiv:1409.5615
- [3] LHC Higgs Cross Section Working Group, Handbook of LHC Higgs Cross Sections: 4. Deciphering the nature of the Higgs sector. arXiv:1610.07922
- [4] S. Dittmaier, M. Kr\"amer, M. Spira, M. Walser, Charged-Higgs-boson production at the LHC: NLO supersymmetric QCD corrections. Phys.Rev., D83:055005, 2011
- [5] E. L. Berger, T. Han, J. Jiang, T. Plehn. Associated production of a top quark and a charged Higgs boson. Phys.Rev., D71:115012, 2005

### Type I/III/IV 2HDM

The numbers for type-II 2HDM can also be applied to type I/III/IV, if you follow the recipe outlined at the end of Section 6 of arXiv:1409.5615.

## Heavy charged Higgs cross sections for MSSM scenarios

Contact: Martin Flechl

SUSY-QCD NLO corrections can be added to the NLO cross sections at very good approximation by including the so-called delta_b corrections. The delta_b values for the scenarios lightstau, lightstop, lowMH, mhmaxup, mhmodm, mhmodp and tauphobic using FeynHiggs 2.9.5 are provided here. The scenarios are used as shipped with FeynHiggs-2.9.5 (which means updated versions may exist!). Note that this is not an official recommendation from the H+ sub group but only an additional service. It is your responsibility to make sure these numbers do not violate any LHCHXSWG rules if you use them for any official business.

Heavy charged Higgs NLO cross sections without SUSYQCD corrections, Update3Feb 20

Recipe to add delta_b corrections, for a point with charged Higgs mass mhp and tan beta tb (recipe from Sven Heinemeyer):

- Find the delta_b value corresponding to tb
- Calculate tbeff = tb/sqrt{1 + delta_b}
- Using the cross sections without SUSY-QCD NLO corrections, get the cross section which corresponds to tbeff (!)
- Multiply the result from the previous bullet with 1/(1 + delta_b) => this is your cross section [Note: corrected on 2014-01-27 thanks to Alexandre Nikitenko]

Note that this typically is not sufficient at low tan beta, where other SQCD-related corrections on top of delta_b corrections are not negligible. There is no official recipe on how to deal with this, but a conservative way would be to assign an extra relative uncertainty of 10% for tan beta<10 -- but of course these additional contributions depend heavily on the scenario.

scenarios_feynhiggs.tar: FeynHiggs input files for MSSM scenarios, as shipped with FeynHiggs-2.9.5 (which means updated versions may exist!)

## Meetings

- CERN InDico Agenda
- minutes 05.07.2011

- cH_145-200.tgz: Charged Higgs boson total cross section in the intermediate-mass range

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This topic: LHCPhysics > LHCHXSWGMSSMCharged
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