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Benchmark points

Notice: this twiki summarizes the benchmark points that were discussed in the context of the Yellow Report 4. For the post-YR4 points please look at NMSSMBenchmarksPostYR4

SM input parameters

New (according to LHCHXSWG-INT-2015-006) , (previous values)

m_charm(3 GeV) = 0.986 ± 0.026 GeV, m_charm^OS = 1.51 ± 0.13 GeV (m_charm = 1.4 GeV)

m_bottom(m_bottom) = 4.18 ± 0.03 GeV, m_bottom^OS = 4.92 ± 0.13 GeV (m_bottom = 4.75 GeV)

m_top^OS = 173.3 ± 0.8 GeV (current world average). However, several ATLAS and CMS analyses still based on m_top^old =172.5 GeV. Recommendation: Use 173.3 GeV only in cases where no significant inconsistencies with bkg simulations etc. are expected, stick to m_top^old =172.5 GeV otherwise. (m_top = 172.5 GeV)

G_F = 1.1663787(6) 10-5 GeV -2 (G_F = 1.16637 10-5 GeV -2)

MZ = 91.1876 ± 0.0021 GeV (MZ = 91.1876 GeV)

Added: Gamma_Z = 2.49436 GeV

MW = 80.385 ± 0.015 GeV (MW = 80.398 GeV)

Added: Gamma_W = 2.08718 GeV

mb(mb) = 4.18 ± 0.03 GeV (mb(mb) = 4.16 GeV)

alpha_s(MZ) = 0.119 For the default value of alpha_s(MZ) and the estimates of the uncertainties follow the latest PDF4LHC recommendation

alpha_em(MZ)^-1 = 127.92 (MSbar), 128.94 (OS)

If alpha_em(MZ), GF, MZ are inputs, then MW is output. (SLHA convention)

If GF, MZ, MW are inputs alpha_em(MZ) is not needed.

Added: lepton masses (from the PDG):

m_e = 0.510998928 ± 0.000000011 MeV

m_mu = 105.6583715 ± 0.0000035 MeV

m_tau = 1776.82 ± 0.16 MeV

Overview - Classification of Benchmark Points

H_125=SM-like Higgs boson, a1=singlet-like pseudoscalar, h1=singlet-like scalar, A=doublet-like pseudoscalar, H=doublet-like scalar

Overall feature	Signature	Benchmark Points
I) Higgs-to-Higgs Decays		
1) SM H_125 production and decays		
a) H_125 -> a1 a1 or h1 h1	various h1, a1 decays -> bb / tau tau / mu mu	BP2_P1, BP9_P1 BP4_P1, BP4_P2
	possibly a1 very light	
b) H_125 -> h1 h1 -> 4a1	various a1 decays -> bb / tau tau / mu mu	BP4_P2
	possibly a1 very light	
Comment	*Limited by present or future signal rates of H_125 into SM channels,*	
	will be searched for in any case, except perhaps for a1 very light	
c) H_125 -> chi0_2 + chi0_1 -> h1 + chi0_1 + chi0_1		?
d) H_125 -> a1 a1 -> 4 photons or 4 electrons	Comment: This was briefly discussed at the end of the last meeting, where it was mentioned that this type of signature is of interest in ATLAS and that a benchmark point for the difficult phase space corner for m_a1 ~ 1 GeV would be useful.	
2) Direct h1, a1 production and decays		
a) h1,a1 -> SM	h1 -> bb, tau tau, mu mu, diphoton	BP1_P1,2, BP4_P1,2, BP7_P1,2, BP8_1,2, BP9_1,2
b) h1 -> non-SM	h1 -> a1 a1, a1 possibly very light	BP2_P1,2, BP3, BP4_2, BP7_P2, BP9_P2
c) h1 -> H_125 H_125		BP9_P2
d) a1 -> Z h1	Z+bb	BP8_P1,2
e) a1 -> chi0_1 chi0_1		BP4_P1,2, BP8_P2, BP9_P2
3) Heavy H/A production via ggF, decays into 2 Higgs or Higgs+gauge final states		
a) Scalar -> gauge Higgs	H -> Z a1 or A -> Z h1 ...	BP2_P2, BP7_P1, BP8_P1, BP8_P2
b) Scalar -> 2 light scalars	H -> h1 h1	BP7_P1, BP7_P2, BP8_P2
c) Scalar -> H_125 light scalar	H -> H_125 h1	BP7_P1, BP7_P2,

		BP8_P1, BP8_P2
d) Scalar -> 2 light pseudoscalars	H -> a1 a1 -> bb + diphoton, -> 4 photon -> 2tau 2photon	BP7_P2
e) Pseudo -> scalar pseudoscalar	A -> a1 h1, a1 H_125 -> 4b, 2b 2gam, 2tau 2gam or invisible	BP7_P1, BP7_P2
f) H -> H_125 H_125		BP7_P2
Comment	*Possible search channels bb+bb, bb+diphoton, bb+2 tau, bb+ll (on-Z)*	
	possibly with E_T_miss, vetos (?)	
	peaks in bb / diphoton / 2 tau inv. masses at or below 125 geV, total inv mass	
4) Heavy H/A production via ggF, decays into >= 3 Higgs or Higgs+gauge		
a) Scalar -> multi-Higgs	H -> H_125 Hs -> H_125 a1 a1	BP7_P2
b) Pseudo -> multi-Higgs	A -> a1 + Hs -> a1 a1 a1	BP7_P2
c) Pseudo -> gauge di-Higgs	A -> Z Hs -> Z a1 a1	BP7_P2
Comment	*Possible search channels bb+bb+bb, bb+bb+diphoton, bb+bb+2tau, bb+bb+ll (on-Z)*	
	bb+4photon, tautau+4photon, bb+tautau+2photon, possibly with E_T_miss, vetos (?)	
	peaks in bb / diphoton / 2 tau inv masses at or below 125 geV, total inv mass	
II) Other (non-)SM Higgs Decays		
1) Invisible final states		
a) H_125 -> invisible	H_125 -> chi1^0 chi1^0	BP9_P1, BP9_P2
b) H/A -> invisible	H/A -> chi1^0 chi1^0	BP7_P1,P2, BP8_P1,P2, BP9_P2
c) H/A -> SM	H/A -> tt	BP8_P1
d) H/A -> SUSY	H/A -> chi+ chi-, chi1^0 ch2^0, ...	BP7_P1,P2, BP8_P1,P2
III) Gluino/Squark production and decays		
1) Unusual decay chains via singlino		
a) Many taus		BP1_P2, BP3
b) More ?		
2) Higgs bosons in each decay cascade		
a) SM Higgs	2 H_125	BP5_P4
b) light scalar	2 h1, with h1 -> bb, tau tau, ...	BP5_P9
c) light scalars+pseudos	2 h1 with h1 -> a1 a1	BP3
d) very low E_T_miss	like a)-c) but with very low E_T_miss	BP5_P4, BP5_P9
Comment	*Possible search channels jets + [bb+bb, bb+diphoton, bb+2tau, bb+ll (on-Z)]*	
	with or without E_T_miss	
	peaks in bb / diphoton / 2 tau inv mass at or below 125 geV	
3) Jets + displaced vertices		BP1_P2
IV) EWino production and decays		

1) Gaugino decay cascades		
chargino/neutralino	chargino_1 + neutralino_x production	BP3, BP6
	with Higgs(es) in neutralino_x decay cascades	
Comment	*Possible search channels >= 1 lepton + [bb+bb, bb+diphoton, bb+2tau, bb+ll (on/below-Z)]*	
	with or without E_T_miss	
	peaks in bb / diphoton / 2 tau inv masses at or below 125 geV	
2) Leptons		
Leptons + displaced vertices		BP1_P1
V) Stop Production		
stop production w/ H_125 / Hs in decay cascade		?

BP1_P2, BP1_P5 by Allanach/Badziak/Hugonie/Ziegler

BP2_P1, BP2_P2 by Aggleton/Barducci/Bomark/Moretti/Nikitenko/Sheperd

BP3_h'60 by Potter

BP4_P1, BP4_P2 by Barducci/Belanger/Hugonie

BP5_P3, BP5_P4 by Ellwanger/Teixeira

BP6_LSP1 by Han/Kim/Munir/Park

BP7_P1, BP7_P2 by King/Muhlleitner/Nevzorov/Walz

BP8_P1, BP8_P2 by Beskidt/de Boer/Kazakov

BP9_P1, BP9_P2 by Christensen/Han/Liu/Su

Description of Benchmark Points

BP1

BP1 by B. Allanach, M Badziak, C. Hugonie and R. Ziegler	
Main Features	Minimal Gauge Mediation combined with Z_3-invariant NMSSM (gravitino LSP)
	2 points (P1, P2), spectrums computed with NMSSMTools v4.7.0 for m_top=172.5 and 173.1 GeV
	ggF cross sections obtained with private HIGLU version adapted to the NMSSM by M. Muhlleitner
BP1_P1	
Spectrum	Mh1(singlet) = 93 GeV, Mh2(SM-like) = 123 GeV, Mh3(doublet) = 891 GeV,
	Ma1(singlet) = 26 GeV, Ma2(doublet) = 891 GeV
	Mchi_1^0(singlino, NLSP) = 102 GeV, mstau1(NNLSP) = 332 GeV
Signatures/Rates	
A1	ggF(a1) = 10 fb, a1 -> bb (91%) and tautau (8%)

H1	ggF(h1) = 15 pb, h1 -> bb (84%) and tautau (8%)
chi_1^0	Decays to gravitino + a1 (100%) inside the detector (displaced vertex)
stau1	Decays to chi_1^0 + tau (100%)
Maximum / Unique signature	Possibility to produce directly a 93 GeV scalar
	The 26 GeV pseudo-scalar will appear at the end of every sparticle decay chain
BP1_P2	
Spectrum	Mh1(singlet) = 93 GeV, Mh2(SM-like) = 124 GeV, Mh3(doublet) = 1.4 TeV,
	Ma1(singlet) = 32 GeV, Ma2(doublet) = 1.4 TeV
	Mchi_1^0(singlino, NLSP) = 103 GeV, mchi_2^0(bino, NNLSP) = 397 GeV
Signatures/Rates	
A1	ggF(a1) = 0.1 fb, a1 -> bb (91%) and tautau (9%)
H1	ggF(h1) = 15 pb, h1 -> bb (84%) and tautau (8%)
chi_1^0	Decays to gravitino + a1 (100%) but long lived (quasi stable)
chi_2^0	Decays to chi_1^0 h1 (22%), chi_1^0 h2 (78%)
Maximum / Unique signature	Possibility to produce directly a 93 GeV scalar
	which can also appear at the end of every sparticle decay chain
Provided Material	P1_#mtop#.inp, P1_#mtop#.spectr, P1_#mtop#_A1.out, P1_#mtop#_H1.out
	P2_#mtop#.inp, P2_#mtop#.spectr, P2_#mtop#_A1.out, P2_#mtop#_H1.out
	Paper 1502.05836 (where other points are discussed) and Benchmarks_NMGMSB.pdf

BP2

BP2 by R. Aggleton, D. Barducci, N-E. Bomark, S. Moretti, A. Nikitenko, C. Shepherd-Themistocleous	
BP2_P1	
Main Features	Light pseudoscalar, mA1 ~ 8 GeV.
Spectrum	MH1=Mh (SM-like) = 123.3 GeV, MH2=480 GeV, MA1=8.6 GeV,
	MH3=2254 GeV, MA2=2255 GeV
	tanbeta=28, lambda=0.2, kappa=0.24, mueff=200 GeV
Signatures/Rates	
H1	ggF(H1) = 43.16 pb at 13 TeV
	BR(H1 -> A1 A1) = 0.0969
	BR(A1 -> tau tau) = 0.884
	BR(A1 -> mu mu) = 0.00343
	ggF(H1) -> A1 A1 -> 4 tau = 3.27 pb
	ggF(H1) -> A1 A1 -> 2 tau + 2 mu = 0.0254 pb
Maximum / Unique signature	Considerable cross-section for very light pseudoscalar boson production with 4-tau final state, with possibility for 2tau+2mu final state for resonance search, free from Upsilon contamination.
Provided Material	h1_a1_8_inp.slha/h1_a1_8_spectr.slha as input/output for NMSSMTools, h1_a1_8_sushi.[in/out] as input/output

	for SusHi for ggF(H1)
Additional Information	ggF cross-section obtained with SusHi 1.5.0 at NNLO, spectrum and BR obtained with NMSSMTools 4.7.0
BP2_P2	
Main Features	GMSB model, lightest scalar is SM-like, light pseudoscalar just above Mh/2.
Spectrum	MH1=Mh (SM-like)=125.9 GeV, MH2=201 GeV, MA1=65 GeV,
	MH3=448 GeV, MA2=440 GeV
	tanbeta=2.266, lambda=0.644, kappa=0.351, mu_eff=178 GeV, A_kappa=100 GeV, A_lambda = -312 GeV
Signatures/Rates	
H2	ggF(H2) = 0.857 pb at 13 TeV
	BR(H2 -> A1 A1) = 0.91
	BR(A1 -> bb) = 0.906
	BR(A1 -> tautau) = 0.0876
	ggF(H2) -> A1 A1 -> 4b = 0.641 pb
	ggF(H2) -> A1 A1 -> 2b+2tau = 0.124 pb
	ggF(H2) -> A1 A1 -> 4tau = 6 fb
H3	ggF(H3) = 1.254 pb at 13 TeV
	BR(H3 -> Z A1) = 0.0376
	gg -> H3 -> ZA1 -> ll + bb = 2.88 fb
Maximum / Unique signature	H3 -> ZA1 of particular interest, could potentially use fat b-jet techniques for A1->bb as in http://arxiv.org/abs/1409.8393, http://arxiv.org/abs/1503.04228,
Provided Material	h1_a1_65_inp.slha/h1_a1_65_spectr.slha as input/output for NMSSMTools, h1_a1_65_sushi_ggh[2/3].[in/out] as input/output for SusHi for ggF(H2) and ggF(H3)
Additional Information	ggF cross-section obtained with SusHi 1.5.0 at NNLO, spectrum and BR obtained with NMSSMTools 4.7.0

BP3

BP3 by C. T. Potter	
BP3_h'60	
Main Features	Natural NMSSM light h1, a1, singlino, higgsinos with sensitivity at 8 TeV and discovery at LHC13
Spectrum	MH2=Mh (SM-like) = 122.8 GeV, MH1=MHs (singlet) = 55.7 GeV, MA1=MAs (singlet) = 10.0 GeV,
	MH3=MH (doublet) = 1063 GeV, MA2=MA (doublet) = 1061 GeV
	tanbeta=15.5, lambda=0.035, kappa=0.006
Signatures/Rates	
	gluino pair production @14TeV: 5.8pb (Pythia8)
	gluino -> stop1 top: 0.94
	stop1 ->chi3 top: 0.15
	chi3 -> h1 chi1: 0.80
	h1 -> 2a1: 0.72
	a1->mu+mu-: 0.003
	a1->tau+tau-: 0.81
	gluino pair production with 4tops and up to 4 a1

Maximum / Unique signature	
Provided Material	h60p.slha
Additional Information	

BP4

BP4 by D. Barducci, G. Belanger and C. Hugonie	
Main Features	nMSSM (k=0) with universality at MGUT in the gaugino/sfermion sector
	2 points (P1, P2), spectrums computed with NMSSMTools v4.7.0 for m_top=172.5 and 173.1 GeV
	ggF cross sections obtained with private HIGLU version adapted to the NMSSM by M. Muhlleitner
BP4_P1	
Spectrum	Mh1(singlet) = 37 GeV, Mh2(SM-like) = 122 GeV, Mh3(doublet) = 2.1 TeV,
	Ma1(singlet) = 7 GeV, Ma2(doublet) = 2.1 TeV Mchi_1^0(singlino, LSP) = 3 GeV
Signatures/Rates	
A1	ggF(a1) = 113 pb, a1 -> chi_1^0chi_1^0 (73%) and tautau (25%)
H1	ggF(h1) = 12 pb, h1 -> bb (85%) and tautau (7%) chi_1^0chi_1^0 (7%)
Maximum / Unique signature	Possibility to produce directly 2 light states (a1, h1)
	The SM-like Higgs state (h2) can also decay to a1a1 (8%)
BP4_P2	
Spectrum	Mh1(singlet) = 44 GeV, Mh2(SM-like) = 122 GeV, Mh3(doublet) = 2.4 TeV,
	Ma1(singlet) = 7 GeV, Ma2(doublet) = 2.4 TeV Mchi_1^0(singlino, LSP) = 3 GeV
Signatures/Rates	
A1	ggF(a1) = 112 pb, a1 -> chi_1^0chi_1^0 (73%) and tautau (25%)
H1	ggF(h1) = 1.6 pb, h1 -> bb (65%), a1a1 (27%) and tautau (6%)
Maximum / Unique signature	Possibility to produce directly 2 light states (a1, h1)
	The SM-like Higgs state (h2) can also decay to h1h1 (9%)
Provided Material	P1_#mtop#.inp, P1_#mtop#.spectr, P1_#mtop#.omega, P1_#mtop#_A1.out, P1_#mtop#_H1.out
	P2_#mtop#.inp, P2_#mtop#.spectr, P2_#mtop#.omega, P2_#mtop#_A1.out, P2_#mtop#_H1.out
	Motivation.pdf

BP5

BP5 by U. Ellwanger and A. M. Teixeira	
BP5_P4	
Main Features	A light singlino-LSP; all squark/gluino decay cascades end with bino -> H2 + singlino where H2 is SM-like, the singlino carries little ETmiss
Spectrum	MH2=Mh (SM-like) = 125.0 GeV, MH1=MHs (singlet) = 91.2 GeV, M_LSP (singlino) = 3.2 GeV, M_NLSP (bino) = 130 GeV, M_squarks ~ 1.5 TeV, M_gluino ~ 1.3 TeV, M_stops/sbottoms ~ 2 TeV
Signatures/Rates	
Squark + gluino production	Jets + H2 + H2, H2 + H2 -> bb + bb: 63.1 fb
	Jets + H2 + H2, H2 + H2 -> bb + tau+ tau-: 13.9 fb
	Jets + H2 + H2, H2 + H2 -> gamma + gamma + X: 0.8 fb
Maximum / Unique signature	Hard jets, little ETmiss, invariant masses of b+b/tau+tau/gamma+gamma peak at the SM Higgs mass
Provided Material	BP5_P4.spectr (SLHA-format)
Additional Information	Spectrum and decays from NMSSMTools_4.7.0, squark/gluino Xsects from prospino (NLO), simulations in JHEP 1504 (2015) 172, arXiv:1412.6394
BP5_P9	
Main Features	A light singlino-LSP; all squark/gluino decay cascades end with bino -> H1 + singlino where H1 is a light NMSSM-like state, the singlino carries little ETmiss
Spectrum	MH2=Mh (SM-like) = 125.1 GeV, MH1=MHs (singlet) = 82.3 GeV, M_LSP (singlino) = 5.3 GeV, M_NLSP (bino) = 88.7 GeV, M_squarks ~ 1.1 TeV, M_gluino ~ 900 GeV, M_stops/sbottoms ~ 2 TeV
Signatures/Rates	
Squark + gluino production	Jets + H1 + H1, H1 + H1 -> bb + bb: 1.34 pb
	Jets + H1 + H1, H1 + H1 -> bb + tau+ tau-: 272 fb
	Jets + H1 + H1, H1 + H1 -> gamma + gamma + X: 3.7 fb
Maximum / Unique signature	Hard jets, little ETmiss, invariant masses of b+b/tau+tau/gamma+gamma peak at the new NMSSM-like Higgs mass of 82.3 GeV
Provided Material	BP5_P9.spectr (SLHA-format)
Additional Information	Spectrum and decays from NMSSMTools_4.7.0, squark/gluino Xsects from prospino (NLO), simulations in JHEP 1504 (2015) 172, arXiv:1412.6394

BP6

BP6 by C. Han, D. Kim, S. Munir and M. Park	
Main Features	Singlino-like LSP with a mass just above 1 GeV, accompanied by a singlet-like pseudoscalar that can be probed at the 14 TeV LHC in the di-muon decay channel
Spectrum	MH2=Mh (SM-like) = 123.8 GeV, MH1=MHs (singlet) = 14.8 GeV, MA1=MAs (singlet) = 2.97 GeV,
	MH3=MH (doublet) = 1504 GeV, MA2=MA (doublet) = 1504 GeV

	LSP (singlino) mass = 1.34 GeV, Neutralino2 (higgsino) mass = 131.7 GeV
	Neutralino3 (higgsino) mass = (-)166.8 GeV, Chargino1 (higgsino) mass = 147.2 GeV
Signatures/Rates	
Final state	mu+ + mu- + charged lepton + missing transverse energy
Total cross section	XS(pp -> Neutralino2/3 + Chargino1 -> A1,LSP + W,LSP -> mu+,mu-,LSP + lepton,neutrino,LSP) = 3.16 fb
Total XS after cuts	0.126 fb
No. of events (300/fb)	38
Maximum / Unique signature	S/B ~ 8, significance ~ 16 in the proposed channel with L=300/fb; much larger than in the trilepton channel
Provided Material	BP6_SLHA.dat, BP6_table.pdf (BP3 in the tables)
Additional Information	Spectrum and BRs with NMSSMTools-v4.7.0, NLO production XS with Prospino-v2.1
	Events for the 14 TeV LHC with Madgraph 5, hadronisation with Pythia-6.4, detector simulation with Delphes 3
	Relic density for the point = 0.111, calculated with MicrOMEGAs -v4.1.5 (default settings for the NMSSM)
	Point consistent with B-physics, tested with SuperIso -v3.3, and with LHC Run-I Higgs boson data, tested with HiggsBounds -v4.2.0
	Analysis method and simulations in JHEP 1507 (2015) 002, arXiv:1504.05085

BP7

BP7 by S.F. King, M. Mühlleitner, R. Nevzorov and K. Walz	
BP7_P1	
Main Features	natural NMSSM overall light Higgs spectrum, can be tested at LHC13
Spectrum	MH2=Mh (SM-like) = 124.4 GeV, MH1=MHs (singlet) = 95.6 GeV, MA1=MAs (singlet) = 108 GeV,
	MH3=MH (doublet) = 299 GeV, MA2=MA (doublet) = 298 GeV
	tanbeta=1.60, lambda=0.600, kappa=0.144
Signatures/Rates	
H1	ggF(H1) = 3.337 pb with MH1 = 95.6 GeV and H1 singlet
	gg -> H1 -> bb: 2.477 pb
	gg -> H1 -> tau tau: 0.255 pb
	gg -> H1 -> gam gam: 0.013 pb
H3	ggF(H3) = 4.633 pb with MH3 = 299 GeV and H3 doublet
	gg -> H3 -> WW: 54.49 fb
	gg -> H3 -> ZZ: 24.16 fb
	gg -> H3 -> A1 Z -> bb Z: 614 fb / tau tau Z: 64.17 fb / gam gam Z: 0.48 fb
	gg -> H3 -> H1 H1 -> bb bb: 310 fb / bb tau tau: 63.71 fb / 4 tau: 3.27 fb / bb gam gam: 3.21 fb

	gg -> H3 -> H1 H2 -> bb bb: 187 fb / bb tau tau: 39.42 fb / 4 tau: 2.08 fb / bb gam gam: 1.63 fb
	gg -> H3 -> chi1^0 chi1^0: 1662 fb / chi1^0 chi2^0: 336 fb / chi2^0 chi2^0: 575 fb / chi1+ chi1-: 195 fb
A1	ggF(A1) = 2.407 pb with MA1 = 108 GeV and A1 singlet
	gg -> A1 -> bb: 2.102 pb
	gg -> A1 -> tau tau: 0.220 pb
	gg -> A1 -> gam gam: 1.633 fb
A2	ggF(A2) = 11.182 pb with MA2 = 298 GeV and A2 doublet
	gg -> A2 -> bb: 57.50 fb
	gg -> A2 -> tau tau: 7.43 fb
	gg -> A2 -> H1 A1 -> 4b: 878.30 fb / bb tau tau: 182.07 fb / 4 tau: 9.44 fb / bb gam gam: 5.23 fb
	gg -> A2 -> H2 A1 -> 4b: 702.66 fb / bb tau tau: 149.35 fb / 4 tau: 7.93 fb / bb gam gam: 3.04 fb
	gg -> A2 -> Z H1 -> bb Z: 391.70 fb / tau tau Z: 40.27 fb / gam gam Z: 2.03 fb
	gg -> A2 -> chi1^0 chi1^0: 3699 fb / chi1^0 chi2^0: 2.81 fb / chi2^0 chi2^0: 1017 fb / chi1+ ch1-: 3110 fb
Maximum / Unique signature	Large Higgs-to-Higgs, Higgs-to-gauge+Higgs decay rates
Provided Material	inp_1488_mod.dat, slha_decay_1488_mod.out
Additional Information	ggF cxns obtained with private HIGLU version adapted to the NMSSM, spectrum and BRs with NMSSMCALC
BP7_P2	
Main Features	cascade Higgs-to-Higgs decays, spectacular signatures, not present in the MSSM
Spectrum	MH1=Mh (SM-like) = 126.6 GeV, MH2=MHs (singlet) = 172.0 GeV, MA1=MAs (singlet) = 85.9 GeV,
	MH3=MH (doublet) = 316.8 GeV, MA2=MA (doublet) = 306.7 GeV
	tanbeta=1.859, lambda=0.66199, kappa=0.34839
Signatures/Rates	
H2 = Hs	ggF(H2) = 90.39 fb with MH2 = 172.0 GeV and H2 singlet
	gg -> H2 -> WW: 61.50 fb
	gg -> H2 -> ZZ: 1.70 fb
	gg -> H2 -> bb: 6.15 fb
	gg -> H2 -> tau tau: 0.69 fb
	gg -> H2 -> A1 A1: 20.29 fb
	gg -> H2 -> A1 A1 -> bb bb: 13.32 fb
	gg -> H2 -> A1 A1 -> bb tautau: 1.82 fb
	gg -> H2 -> A1 A1 -> bb gamgam: 4.12 fb
	gg -> H2 -> A1 A1 -> 4gam: 0.32 fb
H3 = H	ggF(H3) = 3.00 pb with MH3 = 316.8 GeV and H3 doublet
	gg -> H3 -> WW: 91.60 fb
	gg -> H3 -> ZZ: 41.11 fb
	gg -> H3 -> bb: 164.89 fb
	gg -> H3 -> tau tau: 21.35 fb
	gg -> H3 -> chi1^0 chi1^0: 391.04 fb
	gg -> H3 -> chi1+ chi1-: 337.20 fb
	gg -> H3 -> h Hs -> h + As As -> bb + 4gam: 2.41 fb

	gg -> H3 -> h Hs -> h + As As -> 4b + 2gam: 29.68 fb
	gg -> H3 -> h Hs -> h + As As -> tautau + 4gam: 0.25 fb
	gg -> H3 -> h Hs -> h + As As -> 4tau + 2gam: 0.21 fb
	gg -> H3 -> h Hs -> h + As As -> 6gam: 0.012 fb
	gg -> H3 -> h Hs -> h + As As -> bb + tautau + gamgam: 5.15 fb
	gg -> H3 -> h h -> 4b: 203.69 fb
	gg -> H3 -> h h -> 2b+2gam: 2.14 fb
	gg -> H3 -> h h -> 2tau+2gam: 0.23 fb
	gg -> H3 -> As As -> 4b: 6.78 fb
	gg -> H3 -> As As -> 2b+2gam: 2.10 fb
	gg -> H3 -> As As -> 4gam: 0.16 fb
A1 = As	ggF(A1) = 7.71 fb with MA1 = 85.9 GeV and A1 singlet
	gg -> A1 -> bb: 6.25 fb
	gg -> A1 -> tau tau: 0.43 fb
	gg -> A1 -> gam gam: 0.97 fb
A2 = A	ggF(A2) = 8.80 pb with MA2 = 306.7 GeV and A2 doublet
	gg -> A2 -> bb: 289.38 fb
	gg -> A2 -> tau tau: 36.91 fb
	gg -> A2 -> chi1^0 chi1^0: 3458.46 fb
	gg -> A2 -> chi1+ chi1-: 996.97 fb
	gg -> A2 -> Hs As -> As As As -> 6gam: 0.68 fb
	gg -> A2 -> Hs As -> As As As -> bb + 4gam: 13.12 fb
	gg -> A2 -> Hs As -> As As As -> 4b + 2gam: 84.78 fb
	gg -> A2 -> Hs As -> As As As -> tautau + 4gam: 0.90 fb
	gg -> A2 -> Hs As -> As As As -> 2b + 2tau + 2gam: 11.60 fb
	gg -> A2 -> Hs As -> As As As -> 4tau + 2gam: 0.40 fb
	gg -> A2 -> h As -> 4b: 210.00 fb
	gg -> A2 -> h As -> 2b + 2gam: 33.59 fb
	gg -> A2 -> h As -> 2tau + 2gam: 3.51 fb
	gg -> A2 -> Z Hs -> bb As As -> bb + 4gam: 0.97 fb
	gg -> A2 -> Z Hs -> bb As As -> 4b + 2gam: 12.48 fb
	gg -> A2 -> Z Hs -> bb As As -> 2b + 2tau + 2gam: 0.85 fb
	gg -> A2 -> Z Hs -> ll/tautau As As -> ll/tautau + 4gam: 0.21 fb
	gg -> A2 -> Z Hs -> ll/tautau As As -> ll/tautau + 2b + 2gam: 2.78 fb
	gg -> A2 -> Z Hs -> ll/tautau As As -> ll/tautau + 2tau + 2gam: 0.19 fb
Maximum / Unique signature	Cascade Higgs-to-Higgs decays lead to multi-photon and multi-fermion final states
	sig(ggA)*BR(A->Hs As->As As As->6gam)=0.68 fb,
	sig(ggA)*BR(A->Hs As->As As As->2b+4gam)=13.12 fb,
	sig(ggA)*BR(A->Hs As->As As As->4b+2gam)=84.78 fb
Provided Material	inpb1.dat, slha_decayb1.out
Additional Information	ggF cxns obtained with private HIGLU version adapted to the NMSSM, spectrum and BRs with NMSSMCALC,

	with sqrt(lambda^2+kappa^2)=0.75 additional new matter will be required to insure perturbativity up to the GUT scale.

BP8

BP8 by C. Beskidt, W de Boer and D. Kazakov	
BP8_P1	
Main Features	Light Higgs spectrum with heavier Higgs bosons just above ttbar threshold, so main decay into ttbar (absent in CMSSM)
Spectrum	MH2 (SM-like) = 125.5 GeV, MH1 (singlet) = 90.0 GeV, MA1 (singlet) = 300.0 GeV,
	MH3 (doublet) = 450.0 GeV, MA2 (doublet) = 446.2 GeV
	tanbeta=2.14, lambda=0.647, kappa=0.301
Signatures/Rates	
H1	ggF(H1) = 1.111 pb with MH1 = 90.0 GeV and H1 singlet
	gg -> H1 -> bb: 1.002 pb
	gg -> H1 -> tau tau: 0.103 pb
H3	ggF(H3) = 1.814 pb with MH3 = 450.0 GeV and H3 doublet
	gg -> H3 -> tt: 1025.65 fb
	gg -> H3 -> H1 H2: 406.57 fb
	gg -> H3 -> A1 Z: 26.56 fb
	gg -> H3 -> WW: 2.14 fb
	gg -> H3 -> ZZ: 1.02 fb
	gg -> H3 -> chi1^0 chi1^0: 162.03 fb / chi1^0 chi2^0: 18.65 fb / chi1^0 chi3^0: 72.04 fb / chi1+ chi1-: 29.25 fb
A1	ggF(A1) = 0.143 pb with MA1 = 300 GeV and A1 singlet
	gg -> A1 -> Z H1: 118.93 fb
	gg -> A1 -> bb: 18.79 fb
	gg -> A1 -> tau tau: 2.37 fb
A2	ggF(A2) = 3.955 pb with MA2 = 446.2 GeV and A2 doublet
	gg -> A2 -> tt: 2618.83 fb
	gg -> A2 -> Z H1: 447.90 fb
	gg -> A2 -> bb: 20.60 fb
	gg -> A2 -> tau tau: 2.67 fb
	gg -> A2 -> chi1^0 chi1^0: 518.96 fb / chi1+ ch1-: 165.90 fb
Maximum / Unique signature	H3, A2 produced simultaneously, heavy scalar decay mostly (57%) into ttbar, also A2 decay dominantly (66%) into ttbar -> large fraction of ttbar final states -> search for broad bump around 450 GeV in tail of ttbar invariant mass spectrum, A1 decays largely into Z+H1 -> events with two Z bosons and H1 of 90 GeV with practically SM decay modes
Provided Material	BMPs_final.pdf, inp_tt.dat, spectr_tt.dat
Additional Information	Model: NUH-CNMSSM, Spectrum obtained with NMSSMTools 4.6.0
BP8_P2	
Main Features	Light Higgs spectrum, can be tested at LHC14,

	Higgs-to-Higgs decays not present in the MSSM
Spectrum	MH2 (SM-like) = 125.2 GeV, MH1 (singlet) = 90.0 GeV, MA1 (singlet) = 300.0 GeV,
	MH3 (doublet) = 349 GeV, MA2 (doublet) = 342 GeV
	tanbeta=1.98, lambda=0.635, kappa=0.361
Signatures/Rates	
H1	ggF(H1) = 1.374 pb with MH1 = 90.0 GeV and H1 singlet
	gg -> H1 -> bb: 1.241 pb
	gg -> H1 -> tau tau: 0.127 pb
H3	ggF(H3) = 3.327 pb with MH3 = 349 GeV and H3 doublet
	gg -> H3 -> H1 H2: 2123.89 fb
	gg -> H3 -> WW: 30.62 fb
	gg -> H3 -> ZZ: 14.02 fb
	gg -> H3 -> bb: 104.24 fb
	gg -> H3 -> tau tau: 13.51 fb
	gg -> H3 -> H1 H1: 308.10 fb
	gg -> H3 -> chi1^0 chi1^0: 285.43 fb / chi1+ chi1-: 158.23 fb
A1	ggF(A1) = 0.182 pb with MA1 = 300.0 GeV and A1 singlet
	gg -> A1 -> Z H1: 2.05 fb
	gg -> A1 -> chi1^0 chi1^0: 179.69 fb
A2	ggF(A2) = 12.309 pb with MA2 = 342 GeV and A2 doublet
	gg -> A2 -> bb: 278.02 fb
	gg -> A2 -> tau tau: 98.33 fb
	gg -> A2 -> Z H1: 4833.82 fb
	gg -> A2 -> chi1^0 chi1^0: 5073.67 fb / chi1^0 chi2^0: 28.46 fb / chi1+ ch1-: 1926.52 fb
Maximum / Unique signature	H3, A2 produced simultaneously, heavy scalar decay mostly (64%) into H1 H2, A2 decay (39%) into H1+Z remaining decay modes largely gauginos
Provided Material	BMPs_final.pdf, inp_h1h2.dat, spectr_h1h2.dat
Additional Information	Model: NUH-CNMSSM, Spectrum obtained with NMSSMTools 4.6.0

BP9 - Light Higgs and Light Dark Matter in the NMSSM

BP9 by N. Christensen, T. Han, Z. Liu and S. Su	
BP9_LDM1	
Main Features	Around 30 GeV neutralino LSP serves the full dark matter.
	DM candidate is Singlino-like and annihilates resonantly through light CP-odd Higgs, mainly into bb.
	Two singlet-like Higgs states below 100 GeV, decay mainly into bb.
	SM Higgs can decay into H1H1 and chi10 chi10 with around 10% BR.
Spectrum	MH2=Mh (SM-like) = 126 GeV, MH1=MHs (singlet) = 19.1 GeV, MA1=MAs (singlet) = 73.2 GeV,
	MH3=MH (doublet) = 2340 GeV, MA2=MA (doublet) = 2340 GeV
	tanbeta=11.9, lambda=0.283, kappa=0.0253

Signatures/Rates	
H2	MH2 = 126 GeV and H2 SM-like
	Br(H2->H1H1) 13%
	Br(H2->chi10 chi10) 1%
H1	MH1 = 19.1 GeV and H1 singlet
	Br(H1->bb) 89%
	BR(H1->tautau) 7.7%
A1	MA1 = 73.2 GeV and A1 singlet
	BR(A1->bb) 90%
	BR(A1->tautau) 9.4%
Dark Matter	Singlino-like neutralino dark matter
	m(DM)= 36.7 GeV
	relic abundance 0.113
	SI direct detection: 2.11*10^{-11} (pb)
	indirect detection: 1.15*10^{-25} (cm^3/s), bb (91%), tautau(9%)
Provided Material	BP9_LDM1.spectr, BP9_LDM1.omega, BP9_LDM_report.pdf
BP9_LDM2	
Main Features	Around 30 GeV neutralino LSP serves the full dark matter.
	DM candidate is Bino-like and annihilates resonantly through light CP-odd Higgsi, mainly into bb.
	One very singlet-like Higgs bosons below 100 GeV, decay mainly into bb.
	SM Higgs can decay into chi10 chi10 with around 10% BR.
	M_H2=430 GeV, very singlet-like (production below 1% comparing to SM), dominant decay into A1A1 -> 4b/2b2tau/4tau final states.
Spectrum	MH1=Mh (SM-like) = 125 GeV, MH2=MHs (singlet) = 430 GeV, MA1=MAs (singlet) = 65.7 GeV,
	MH3=MH (doublet) = 2480 GeV, MA2=MA (doublet) = 2480 GeV
	tanbeta=12.9, lambda=0.0730, kappa=0.0645
Signatures/Rates	
H1	MH1 = 125 GeV and H1 SM-like
	Br(H1->chi10 chi10) 10%
H2	MH2 = 430 GeV and H2 singlet
	Br(H2->A1A1) 85%
	Br(H2->H1H1) 3.5%
	Br(H2->WW) 5.7%
	Br(H2->ZZ) 2.7%
	Br(H2->tt) 1.8%
	ggF(H2) 0.90 fb (LHC 14 TeV)
A1	MA1 = 73.2 GeV and A1 singlet
	BR(A1->bb) 88%
	BR(A1->tautau) 9.0%
	BR(A1->chi10 chi10) 2.7%
Dark Matter	Bino-like neutralino dark matter
	m(DM)= 32.3 GeV
	relic abundance 0.120
	SI direct detection: 1.99*10^{-10} (pb)

	indirect detection: 4.73*10^{-30} (cm^3/s), bb (87%), tautau(8%)
Provided Material	BP9_LDM2.spectr, BP9_LDM2.omega, BP9_LDM_report.pdf

-- EricFeng - 2018-02-28

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