#### **HH pair searches**

combination with wwyy, bbyy, bbττ, bbbb

Xiaohu SUN 01-06-2015 IHEP [wwyy]https://cds.cern.ch/record/1967498 [bbTT]https://cds.cern.ch/record/1967500

[combination]https://cds.cern.ch/record/1984111/

Higgs approval: https://indico.cern.ch/event/387805/

## hMSSM interpretation

- In hMSSM, we do not have width large enough challenging our mass resolution; we can safely use the currently limit obtained with NWA in signal (giving up 2HDM due to width previously)
- mH is NOT equal to mA, instead, mH is spreading around, giving us exclusions in even lower mA; but our interpretation is still
  <sup>60</sup>/<sub>40</sub>/<sub>30</sub>
  <sup>20</sup>/<sub>40</sub>/<sub>30</sub>
  <sup>20</sup>/<sub>40</sub>/<sub>30</sub>
- Non-SM BR(h->WW/yy/bb/tautau) must be taken into account





	-		n	1,	4					A	17	Γ	_/	4	S		r	It	e	r	n	a		h		M	S	S	3	V		
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1	1.8	240	246	253	260	268	276	285	293	302	311	320	329	338	348	367	366	376	385	396	404	414	423		443						501	
		244	249	256	263	271	279	287	295	304	313	322	331	340	349	359	368	377	387	396	406			494							502	
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#### hMSSM h decay BRs

- We take into account of non-SM BRs of h decays in all channels: bbyy, bbtautau, wwyy and bbbb
- BRs are set to non-SM values as a function of mH (not mA)
- BRs are not constant for all phase points with the same mH in tb-vs-mA plane (a same mH appears several times from different tb,mA and they have different BRs)
- Use always the smallest BRs; this simplifies the parametrization (less limits less toys to run, making this feasible) and is conservative (smaller BRs, smaller yields, high limits, less exclusions)

#### BR(h→γγ)/SM

#### ATLAS Internal hMSSM



#### BR(h→WW)/SM ATLAS Internal hMSSM







# low-tb-high interpretation

- Similar to hMSSM, we do not have width large enough challenging our mass resolution in low-tbhigh; we can safely use the currently limit obtained with NWA in signal
- mH is NOT equal to mA, instead, mH is spreading around, giving us exclusions in even lower mA
- Non-SM BR(h->WW/yy/bb/tautau) must be taken into account





	0																									•			-				
lηβ	2	229	237	246	254	262	271	280	289	298	307	316	326	335	345	364	364	373	383	392	402	411	421		440						499		500
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	1 0	233	241	249	258	266	275	283	292	301	310	319	328	338	347	367	366	376	386	396	404	414	423	433	442						500		
	1.0	233	241	249	258	266	275	283	292	301	310	319	328	338	347	367	366	376	386	396	404	414	423	433	442						500		450
		236	244	252	260	268	277	285	294	303	312	321	330	339	349	359	368	377	387	396	405	415	424	434	444						501		
	1.7	236	244	252	260	268	277	285	294	303	312	321	330	339	349	359	368	377	387	396	405	415	424	434	444						501		
	4 0	239	246	254	262	271	279	288	296	306	314	323	332	341	361	360	370	379	386	397	407	416	426		445	464					502		
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		242	249	257	265	274	282	290	299	306	316	325	334	343	363	362	372	381	390	399	409	418	427		446						504		
	1.5	242	249	257	265	274	282	290	299	306	316	325	334	343	363	362	372	381	390	399	409	418	427		446						504		
		246	253	261	269	277	285	294	302	310	319	328	337	346	366	365	374	383	392	401	411	420	429	439	448						506		350
	1.4	246	253	261	269	277	285	294	302	310	319	328	337	346	366	366	374	383	392	401	411	420	429	439	448						506		
		250	257	265	273	281	289	297	306	314	322	331	340	349	358	367	376	386	394	404	413	422		441							507		
	1.3	260	257	265	273	281	289	297	306	314	322	331	340	349	358	367	376	386	394	404	413	422		441							507		
		256	263	270	278	285	293	301	309	317	326	334	343	352	361	371	379	388	397	406	415	425	434	443							509		300
	1.2	266	263	270	278	285	293	301	309	317	326	334	343	352	361	371	379	388	397	406	415	425	434	443							509		
		263	270	277	284	292	299	307	314	322	330	338	347	356	365	374	383	392	401	409	418	427	437	446							511		
	1.1	263	270	277	284	292	299	307	314	322	330	338	347	356	365	374	383	392	401	409	418	427	437	445							511		250
		271	278	284	291	299	306	312	319	327	335	343	361	360	369	378	387	396	404	413	422	431	440	449	458	467	476	485	495	504	513		
	$2^{1}$	00				2	50				30	0				3	50				4(	00				4	50				50	0	
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m<sub>H</sub>



#### ATLAS Internal hMSSM



#### BR(h→WW)/SM ATLAS Internal hMSSM







# Theoretical uncertainties - reminder

- Theoretical uncertainties estimated with variations on PDF/scale/radiation are being reproduced with a larger number of events
- Procedures are not changed since last time
- Now we produced 1.2M events -> 10 times of the the statistics of last time, since the beginning of this week
- /afs/cern.ch/work/x/xiaohu/public/HH-TheoUncer/
  - MERGED/: all samples merged into a single file
  - **BAK**/: separated samples

\* all follows instructions from Paul T as used in AZh

- evaluate **grouped** uncertainties with the script pointed by Carl
- Previously, fit to **obsData** -> small mu, leading to the relative uncertainties very large... sigma/small\_mu
- Now, fit to asimovData with mu=1 (1pb injected signal)

Set of nuisa	nce parameters	Impact on signal strength
	Total	1.230
the gamma_terms	DataStat	1.000
	FullSyst	0.706
	TemplateStat	0.427
JUGev	Jets	0.242
low mass	Leptons	0.229
Symmetrized by	Signal theory	0.145
(un+down)/2	Btagging	0.106
	MET	0.081
	Lumi	0.063
	Photons	0.006

• 500 low mass: lower stat+syst uncertainties

Set of nuisance parameters	Impact on signal strength
Total	0.466
DataStat	0.310
FullSyst	0.344
Jets	0.202
TemplateStat	0.132
Leptons	0.119
Signal theory	0.097
Btagging	0.029
MET	0.024
Lumi	0.015
Photons	0.002

500 high mass: introducing bbbb, more statistics
-> lowers stat uncert

Set of nuisance parameters	Impact on signal strength
Total	0.216
DataStat	0.126
FullSyst	0.176
Jets	0.139
Btagging	0.083
TemplateStat	0.043
Signal theory	0.032
Lumi	0.024
Leptons	0.018
MET	0.001
Photons	0.000

nonres (bbbb+bbyy+bbtt+wwyy)

Set of nuisance parameters	Impact on signal strength
Total	0.285
DataStat	0.238
FullSyst	0.156
Btagging	0.081
Jets	0.051
TemplateStat	0.038
Signal theory	0.025
Leptons	0.011
Photons	0.007
MET	0.005
Lumi	0.000

## hMSSM Interpretation

- Many thanks to Nikos and Allison, we have another new map file for hMSSM last week
  - the strangely small BR\_H\_hh is fixed
- The non-SM BR of h decays should be taken into account in the combined limits
- BR(h->yy/ww/bb/tautau) is a function of mH but NOT
  dependent on tb, we can simplify the parametrization<sup>40</sup>
- Limit is a function of
  - mH
  - BR(h-yy/ww/bb/tt)
- BRs are a group of *fixed* values according to mH









#### In SVN paper draft





#### hMSSM – BR rescales

• Parametrization grid definition on mH,BRs

	260	300	350	400	500	800/1000
BR(yy)	0.6	0.7	0.8	0.8	0.9	1.0
BR(ww)	0.6	0.7	0.8	0.8	0.9	0.9
BR(bb)	1.2	1.2	1.2	1.1	1.1	1.0
BR(tauta u)	1.2	1.2	1.2	1.1	1.1	1.0

\* rounding to 0.1

#### hMSSM – channel rescales

• translate BR rescales into channel rescales

	260	300	350	400	500	800/1000
bbyy	0.72	0.84	0.96	0.88	0.99	-
wwyy	0.36	0.49	0.64	0.64	0.81	-
bbtautau	1.44	1.44	1.44	1.21	1.21	1.0
bbbb	-	-	-	-	1.21	1.0

## low-tb-high

- BR map in plain files from Sven
  - tb~1, numeric instability, missing points;
  - inspired by Nikos, ask Sven to run the calculation with tb=1.01;
  - merged into the map file
- Similarly, we do the parametrization on limit by mH and group of fixed Brs(h-bb/tt/ww/yy)
- Using the same BRs configuration as hMSSM, since the BRs are quite similar
- Actually low-tb-high BRs seem to be a bit higher, so using hMSSM BRs is conservative in limits

#### https://twiki.cern.ch/twiki/bin/view/LHCPhysics/HXSWG3LowTanB



30% variation on BR h bb

31



#### https://twiki.cern.ch/twiki/bin/view/LHCPhysics/HXSWG3LowTanB



https://twiki.cern.ch/twiki/bin/view/LHCPhysics/HXSWG3LowTanB

## Summary

Reminder: 1.2M events, for signal theoretical uncertainty estimation

 Uncertainty table with symmetrized errors; 1pb injected asimov data is used; in general, uncertainties decrease along mass

 hMSSM & low-tanb-high, updated with smoother graphs and corrected BRs, already in SVN draft in svn





ggF H xsec





BR H->hh

BR\_Hhh=6.3e-11 BR\_HWW=0.60 BR\_HZZ=0.24

BR\_Hbb=0.14 BR\_Htautau=0.017 BR\_Hmumu=6.0e-5



×10⁻́





m<sub>H</sub>/m<sub>A</sub>

## ATLAS Internal hMSSM

10 10 10 10 1.0 1.0 1.0 1.0 10 10 10 1.0 10 10 10 1.0 50 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 10 10 1.0 1.0 1.0 1.0 10 10 10 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 10 10 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 10 10 10 10 10 10 10 1.0 40 1.0 30 1.0 10 10 10 10 10 10 1.0 20 1.0 -1.0 -1-0 1.0 1.0 1.0 1.0 1.0 1.0 10 10 10 10 10 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 10 1.0 10 10 10 10 10 10 10 10 1.1 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 6.9 500 700 200 300 400600 800 900 spreading around mA ~10%

ATLAS Internal hMSSM m\_ [%] 6.5 6.5 6.4 6.3 6.3 6.2 6.1 6.1 6.0 6.0 5.9 62 6.1 6.0 5.9 5.9 5.8 5.7 5.7 5.5 5.5 5.5 5.5 5.4 5.4 5.4 5.3 5.3 5.3 5.3 5.2 5.2 5.2 5.2 5.1 5.1 5.1 5.1 5.1 5.0 5.0 5.0 5.0 5.0 5.0 5.0 4.9 5.4 5.4 5.3 5.3 5.2 5.2 5.2 5.2 5.1 5.1 5.1 5.1 5.0 5.0 5.0 5.0 5.0 4.9 4.9 4.9 4.9 4.9 4.8 4.8 4.8 4.8 6.0 5.9 57 57 5.5 4.8 4.8 4.8 4.7 4.7 KK KK 4.9 4.9 4.9 4.8 4.8 4.8 4.7 4.7 4.7 4.7 4.7 4.6 4.6 4.6 4.6 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.6 4.4 4.4 **K D** 5.0 5.3 5.3 5.2 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 47 47 44 44 44 44 4.4 4.3 4.3 4.3 4.3 4.3 4.3 4.3 4.2 4.2 4.2 4.2 4.2 4.1 4.1 4.1 4.1 4.1 4.1 4.0 4.9 4.9 4.0 4.0 44 4.0 4.0 4.0 4.0 3.9 3.9 3.9 3.9 3.9 3.9 50 🛥 4.3 4.3 42 42 4.2 4.2 41 41 41 41 4.0 4.0 3.9 3.8 3.8 3.8 4.4 4.3 4.3 4.2 4.2 3.8 3.8 3.8 3.7 3.7 3.7 3.7 3.7 3.7 3.6 3.6 3.6 3.6 3.6 3.6 3.6 3.9 3.9 3.9 3.8 3.6 3.5 3.5 3.5 35 35 35 4.0 3.9 42 41 41 40 40 39 39 39 38 3.8 3.8 -8-8 3.8 3.7 3.7 3.7 3.5 3.5 3.5 3.5 3.5 3.5 3.4 3.4 3.3 3.3 3.3 3.3 3.2 3.2 3.2 3.2 3.2 3.1 3.1 3.1 3.1 3.1 3.1 3.1 3.1 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 29 29 29 34 34 33 33 32 2.9 2.9 2.9 2.9 2.9 2.8 2.9 2.9 2.8 2.8 28 28 28 28 2.7 2.7 2.7 3.2 3.1 3.1 3.1 2.9 28 28 27 27 27 27 27 27 27 27 27 26 26 26 26 26 40 30-2.7 2.7 2.7 2.6 2.6 2.6 2.6 2.6 2.6 2.6 2.6 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.4 2.7 2.7 2.7 2.6 2.6 2.5 2.5 2.5 2.4 2.4 1.9 1.9 1.9 1.9 1.8 1.8 1.8 1.8 1.6 1.6 1.5 1.8 1.8 1.8 1.8 1.7 1.7 1.7 1.7 1.7 1.6 1.6 1.6 1.6 30 115-1.6 1.3 1.3 1.0 1.0 0.9 1.0 1.0 1.0 1.0 1.0 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.9 0.9 0.9 0.8 0.8 0.8 0.8 0.7 0.7 0.7 0.7 0.7 0.7 0.6 0.6 0.6 0.6 0.6 0.6 20 0.7 0.7 0.5 0.5 0.6 0.6 0.5 0.5 0.6 0.6 0.6 0.5 0.5 0.6 0.6 0.5 0.5 0.5 0.5 0.5 0.5 0.4 04 04 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 04 04 0.4 0.4 0.3 0.8 0.3 0.3 0.3 0.3 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 10 0.2 0.1 0.1 6.2 0.2 02 02 02 02 0.1 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.1 0.1 0.1 0.2 02 02 0.2 0.2 0.2 0.1 0.1 0.2 0.3 0.3 0.3 0.3 0.3 0.3 0.1 0.1 0.1 0.1 0.2 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.4 0.4 0.5 0.5 0.5 0.5 0.1 0.2 0.2 0.3 0.3 0.3 0.4 0.4 0.4 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 02 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.3 0.4 0.5 200 300 400 500 700 600 800 900 below tb=25 width<1%m(H)

#### **BR(h** $\rightarrow\gamma\gamma$ )/0.00228 ATLAS Internal hMSSM

0.4 0.5 0.6 0.5 0.7 0.7 0.7 0.8 0.8 0.8 0.8 0.9 0.9 0.9 0.9 1.0 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 074 0.5 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.5 0.9 0.9 0.9 09 09 09 10 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.5 0.9 0.9 0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 04 0.5 1.0 1.0 1.0 1.0 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 50 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.5 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.9 0.9 0.9 0.4 0.5 0.9 0.9 0.9 0.9 0.9 1.0 0.9 0.9 0.9 1.0 1.0 1.0 10 10 10 10 10 10 1.0 1.0 0.4 0.5 6.9 0.9 0.9 09 09 09 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.5 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 40 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 1.0 1.0 1.0 1.0 1.0 0.5 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.9 0.9 0.9 0.9 0.9 0.9 1.0 1.0 0.4 0.5 0.9 0.9 0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 09 09 09 09 09 09 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.9 0.9 0.9 09 09 09 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.5 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 30 ..... 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 0.4 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.9 0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 0.4 0.5 0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.5 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 20 04 0.5 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0:4 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.4 0.5 0.5 0.9 0.9 0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 04 0.5 09 09 09 10 10 10 10 10 10 10 10 10 10 10 10 10 0.9 1.0 1.0 1.0 1.0 0.4 0.5 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 10 0.4 0.5 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 10.4 1.0 1.0 1.0 1.0 1.0 0.4 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.9 0.4 0.5 0.9 1.0 1.0 0.7 1.0 0.9 0.9 0.5 0.5 0.5 0.7 0.7 0.9 0.9 0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.7 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 500 700 200 300 400 600 800 900

40% variations away from SM BR

#### BR(h→WW)/0.215 ATLAS Internal hMSSM

0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 0.9 6.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 0.5 0.8 0.8 0.9 0.9 0.9 0.9 6.9 0.9 0.5 04 05 0.8 0.8 0.9 0.0 0.9 0.9 09 09 0.9 0.9 07 08 0.8 0.9 0.9 0.9 04 05 6.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 50 0.4 0.9 0.5 0.8 0.9 0.5 0.4 0.5 0.4 0.5 0.5 0.6 0.6 0.7 0.8 0.8 0.8 0.8 0.9 6.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 04 05 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 0.9 0.4 0.5 0.9 0.9 6.9 0.9 0.9 0.9 0.5 0.4 0.5 0.0 0.9 0.9 0.9 40 0.4 0.9 6.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 04 05 05 0.5 0.5 8.0 0.8 8.0 0.8 8.0 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.7 0.8 0.9 0.9 074 0.5 0.7 0.7 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 0.8 0.8 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 0.9 0.9 0.9 09 09 0.9 0.9 0.4 0.5 0.9 0.9 0.9 0.9 0.9 0.9 0.9 30 0.4 0.5 0.9 0.9 0.9 0.5 0.4 0.5 6.9 0.9 0.9 0.4 0.5 0.6 0.6 0.7 0.7 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 05 05 0.7 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 0.5 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.7 0.8 0.8 0.8 0.8 0.8 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 0.9 0.9 0.9 0.9 0.9 0.9 0.9 20 0.4 0.5 0.9 0.9 0.5 0:4 0.5 0.9 0.9 0.4 0.6 0.6 0.7 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.5 04 05 0.7 0.7 0.8 0.8 0.8 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 0.5 0.8 0.8 0.5 0.5 0.7 0.7 0.7 0.8 0.8 0.8 0.8 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 6.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 04 0.5 0.9 0.9 0.9 09 09 0.9 0.9 0.9 0.9 0.9 0.9 0.5 0.4 0.5 0.9 0.9 0.9 0.9 0.9 0.9 0.9 10 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.4 0.5 0.4 0.9 0.9 0.9 0.9 0.4 0.5 0.6 0.6 0.9 0.9 0.9 0.9 0.4 0.5 0.5 0.6 0.7 0.7 0.8 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 6.9 0.9 0.9 0.9 0.7 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.5 | 0.5 | 0.5 | 0.7 | 0.7 | 0.8 | 0.8 0.8 0.8 6,9 6,9 6,9 0.8 0.8 6.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.8 0.8 0.8 0.9 0.9 0.9 0.9 0.9 0.9 0.91 0.9 0.9 0.9 0.9 0.9 0.9 1.0 200 300 400 500 600 700800 900 50% variations away from SM BR

#### BR(h→bb)/0.577 ATLAS Internal hMSSM

50 1.3 1.3 40 1.4 1.3 1.3 1.2 1.2 1.2 1.2 1.2 1.1 30 13 13 13 12 12 12 12 12 11  $20 \frac{14}{14} \frac{13}{13} \frac{12}{12} \frac$ 10 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.3 1.3 1.3 1.2 1.2 1.2 1.2 1.1 1.1 1.0 1.0 1.0 1.0 1.1 1.1 1.1 1.1 1.1 1.1 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.3 1.3 1.2 1.2 1.2 1.2 1.2 1.1 1.1 1.1 1.1 1.1 111 111 111 1.4 500 700 200 300 400 600 800 900

30% variations away from SM BR

#### **BR(h\rightarrowtt)/0.0632 ATLAS Internal hMSSM**

50 1.4 1.3 1.3 40 1.0 1.0 1.0 1.0 1.0 1.0 20 10 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.3 1.3 1.3 1.2 1.2 1.2 1.2 1.2 1.1 1.1 1.1 1.1 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.1 1.1 1.1 300 400500 700800 200 600 900 30% variations away from SM BR

#### hMSSM Interpretation - BR\*BR

- bbyy is rescaled by BR(bb)BR(yy)
- bbtautau is rescaled by BR(bb)\*BR(tautau)
- wwyy is rescaled by BR(yy)BR(WW)
- bbbb is rescaled by BR(bb)^2
- these BR products make the rescaling in each channel quadratically larger/smaller
  - e.g. BR variation=30% -> limit variation=69%
- if the couplings are rescaled in the same way, the rescaling on products will be "squared", such as hbb/htautau, hww/hyy
  - affecting channels: bbtautau, bbbb, wwyy

BR(h $\rightarrow\gamma\gamma$ )/0.00228 \* BR(h $\rightarrow$ bb)/0.577 ATLAS Internal hMSSM

0.5 0.6 0.7 0.8 0.8 0.9 05 05 07 08 08 0.9 50 1.0 0.5 0.6 0.7 -0-5 0.5 0.7 0.8 0.8 0.8 0.9 0.5 0.5 0.7 0.8 0.8 0.5 0.5 0.7 0.8 0.8 40 0.5\_0.5 0.7 1.0 0.9 1.0 0.5 0.6 0.7 0.8 0.8 0.5 0.5 0.7 0.8 0.8 30 0.5 0.6 0.7 0.5 0.5 0.7 0.8 0.8 1.0 20 0.5 0.6 0.7 0.8 0.8 0.5 0.6 0.7 0.8 0.8 0.5 0.5 0.7 10 0.5 0.7 0.8 0.8 0.9 0.9 0.9 300 200 400 500 600 700800 900 scales on hyy and hbb cancel

fortunately. bbyy variates < 30%

#### BR( $h \rightarrow \tau \tau$ )/0.0632 \* BR( $h \rightarrow bb$ )/0.577 ATLAS Internal hMSSM

1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.8 1.7 1.5 1.5 1.4 1.4 1.3 1.3 1.3 1.3 1.2 1.2 1.2 1.2 1.2 12 11 11 11 11 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 

60% variation on BRtt\*BRbb

## low-tb-high

- BR map in plain files from Sven
  - some incomplete phase points in very low tanb and mA region (theoretically unstable)
  - some duplicated phase points due to technical issues
- I have stripped out all duplicated phase points and converted available points into **ntuple and map** formats

- XS map from Stefan, but the current numbers are only used for giving an idea of xs and scale uncertainties
- I have merged them into our **map** files



https://twiki.cern.ch/twiki/bin/view/LHCPhysics/HXSWG3LowTanB









#### ATLAS Internal low-tanβ-high

1.2

tanβ	0	1.0 1.0 1.0 1.0 1.0 1.0	1.0 1.0 1.0	_	1.2																										
-	9 1.0 1.0	1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	1.0 1.0 1.0	1.0 1.0 1.0 1.0																											
	1.0 1.0 1.0 1.0	1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	1.0 1.0 1.0	1.0 1.0 1.0 1.0		1																									
	1.0 1.0 1.0	1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	1.0 1.0 1.0 1.0																												
	1.0 1.0 1.0	1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	1.0 1.0 1.0	1.0 1.0 1.0 1.0	1.0 1.0 1.0	_	0.8																								
	6 1.0	1.0 1.0 1.0 1.0 1.0 1.0	1.0 1.0 1.0																												
	5 1.0	1.0 1.0 1.0 1.0 1.0 1.0	1.0	1.0	1.0 1.0 1.0	1.0	1.0 1.0 1.0	1.0	1.0 1.0 1.0	-	0.6																				
	4 10	1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	1.0 1.0 1.0 1.0		0.4																										
	1222	1.1 1.0 1.1 1.0 1.1 1.1	1.0 1.0 1.0		0.4																										
	3 11	14 14 14 14 14 14	11	11	1.0 1.1 1.1	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.0 1.0		0.2																					
	2 11 12 12	1.1 1.1 1.1 1.1 1.2 1.2	11	11	10 10 10	11	11	10 10 10	11	11	11	1.0 1.1 1.1	1.0 1.1 1.1	1.0 1.1 1.1	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.0 1.0	1.0													
	200	1.2 1.2 1.3 1.2	1.2	25	12 50	1.2	1.1	1.1	30	11 10 )()	1.1	1.1	1.1	35	50	1.1	1.1	1.1	11 11 4		1.1	1.1	1.1	1.0 1.1 4.5	10 1.1 50	1.0	1.0	1.0	50	0	0
	200			n	nH	11	ha	as	3	0	%		sp	ore	22	ad	in	g	<b>a</b>	W	a	у	fr	or	n	m	٦A		m <sub>A</sub>	<b>v</b>	

m<sub>H</sub>/m<sub>▲</sub>

$\Gamma_{\rm H}/{\rm m}_{\rm H}$	[%]
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#### ATLAS Internal low-tanβ-high

	10					••																					-						
ğ	10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		
۲		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		
Ť,		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		
	a	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	_	4
	3	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		-
		0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		
	g	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		35
	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2		0.0
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2		
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2		
	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2		2
	-T	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2		3
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2		
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2		
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2		0 E
	6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	_	2.5
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2		
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2		
	_	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2		~
	- 51	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2		2
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		
	4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		1.5
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3		
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3		
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4		
	- 31	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4		1
	Ŭ	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5		•
		0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6		
		0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7		
	2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.5	0.7	0.7	0.7	0.8	0.8	0.8	0.8		0.5
	-	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.7	0.7	1.0	1.0	0.9	0.9	0.9	1.0	1.0	1.0		0.0
		0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.4	1.5	1.5	1.6	1.6	1.7		
		0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.0	2.1	2.2	2.2		
	_ 1!	-nan	-nan	-nan	-nan	-nan	-nan	0.3	0.3	0.3	0.2	0.0	1.7	0.0	1.0	1.3	1.5	1.7	1.9	2.1	2.2	2.3	3.9	2.7	2.9	3.0	3.1	3.2	3.3	3.4	4.5		
	20	0				25	50				-30	)()				-3!	50				- 40	nn				4!	50				50	0	
						-`					00					0.					- 11	00									m	•	
											•	<b>^/</b>	2	th			11	h r		Cr	$\mathbf{n}$									I	''A		
													U			3	VC		У	21		al	1C										

BR( <b>N→DD)/U.5/</b> /
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#### ATLAS Internal low-tanβ-high

~	10																										-						
É	10	1.4	14	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	11	11	14	14	11	11	11	11	11	11	1.1		1.4
ы		14	14	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1		1.1		14	1.1	1.1	1.1	1.1	11	1.1		
ţ		1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
	0	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
	9	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
		1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		12
		1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		1.2
	-	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	14	1.1	1.1	1.1	14	1.1	1.1	1.1		
	8	1.4	14	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	11	11	11	11	11	11	11	11	11	11	11	11		
	-	1.4	14	1.3	1.3	1.8	1.3	1.3	4.9	4.0	4.9	4.9	4.9	4.9	4.9	4.9	4.9	1.2	4.9		12		11		11		11	12	11	÷.	1.1		
		1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
		1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		1
	7	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		•
	1	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
		1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
		1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
	-	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		<u> </u>
	6	1.4	14	1.3	1.8	1.3	1.3	1.8	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	11	11	11	11	11	11	11	11	11	11	11	11	11	_	0.8
	Ŭ	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	11	1.1	11	11	11	14	11	12	11	14	12	11	11	11		
		1.4	14	1.3	1.3	1.3	1.3	1.3	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9		4.9				1.1										
		1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
	F	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
	Э	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		06
		1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		0.0
		1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
		1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
	4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
	-	1.4	1.4	1.3	1.8	1.8	1.8	1.8	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	11	11	11	11	11	11	11	11	11	11	11	11		
		14	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2		10		1.1				1.1		10	11	1.1		04
		1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		0.1
	0	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
	3	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
		1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
		1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		~ ~
		1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		0.2
	2	1.4	1.8	1.3	1.8	1.3	1.8	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		-
	-	1.4	14	1.3	1.8	1.8	1.8	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	11	11	11	11	11	11	11	11	11	11	11	11	11		
		1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2		14	14	1.1	1.1		1.1	14	14		14	14	1.1		
		1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	. 1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
	- 1			1	I	I		1.3	1.2	1.2	1.3	0.3	0.2	0.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.9	0.0	1.2	1.2	1.1	1.2	1.1	1.1	1.1	0.0		0
	പറ	50				25	50				20	20				26	50				10	'nn				AE	50				EÓ	<u> </u>	0
	20	50				23	50				30	10				33	90				4(	50				40	90				50	0	
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										って		0/_	1	2	ria	<b>לב</b>	in	n	$\mathbf{O}$	n	R	P	r		h	า					A		
												/0	V		(	コレ	IU		U		D					<b>)</b>							

**BR(h** $\rightarrow \gamma \gamma$ )/0.00228 *ATLAS* Internal low-tan $\beta$ -high

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B	
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10																												-				
10	0.4	0.4	0.4	0.5	0.5	0.6	0.5	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9		
	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9		00
	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9		0.9
0	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9		
9	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9		
	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9		0.0
	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9		0.8
~	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9		
8	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9		
	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9		~ 7
	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9		0.7
	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9		
7	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9		
'	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9		~ ~
	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.0	0.6	0.8	0.0	0.8	0.8	0.8	0.8	0.0	0.8	0.9	0.9	0.9	0.9	0.9	0.9		0.6
	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9		
e	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9		
0	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9		
	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9		0.5
	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9		0.0
_	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9		
- 5	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9		
-	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9		0.4
	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9		···
	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9		
Λ	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9		
4	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9		03
	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9		0.0
	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9		
~	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9		
- 3	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9		02
	0.4	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9		0.2
	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9		
	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9		
2	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9		0 1
~	0.5	0.6	0.5	0.5	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9		U. I
	0.5	0.6	0.5	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9		
	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0		
-	<b>—</b> 1		1	1	1		0.9	0.9	0.9	0.8	0.9	0.4	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.0	0.9	0.9	0.9	0.9	1.0	1.0	1.0	0.0		^
2	50		-		0	50				20	10				01	50				N	50				A	50				EÓ	0	0
20	50				23	50				30	10				3	50				40	50				43	50				50	0	
									_		~ ′					•														m.		
									- 4	.()'			a	ria	at	10	n	$\mathbf{O}$	n	В	R	r	ר ו	V١	/					A		



**BR(h**→ττ)/0.0632

ATLAS Internal low-tanβ-high

**BR(h\rightarrowWW)/0.215 ATLAS Internal low-tan\beta-high** 

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ta	

10	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8		2 5
	0.3	0.4 0.4	0.4 0.4	0.5 0.5	0.5 0.5	0.5 0.5	0.6 0.6	0.5 0.5	0.6 0.6	0.6 0.6	0.5 0.7	0.6 0.7	0.7 0.7	6.7 6.7	0.7 0.7	0.7 0.7	0.7 0.7	0.7 0.7	0.7 0.7	0.8 0.7	0.8 0.8		3.5									
~	0.3	0.4 0.4	0.4 0.4	0.5 0.4	0.5 0.5	0.5 0.5	0.6 0.6	0.6 0.6	0.6 0.6	0.6 0.6	0.7 0.7	0.7 0.7	0.7 0.7	0.7 0.7	0.7 0.7	0.7 0.7	0.8 0.7	0.7 0.8	0.7 0.8	0.7 0.8	0.8 0.8											
9	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9		
	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8		3
2	0.3	0.4 0.4	0.4 0.4	0.5 0.5	0.5 0.5	0.5 0.5	0.6 0.6	0.6 0.6	0.6 0.6	0.6 0.6	0.6 0.6	0.7 0.7	0.8 0.8																			
°	0.3	0.4 0.4	0.4 0.4	0.5 0.4	0.5 0.5	0.5 0.5	0.6 0.6	0.6 0.6	0.6 0.6	0.6 0.6	0.5 0.7	0.6 0.7	0.7 0.7	0.8 0.8																		
	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8		~ -
7	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8		2.5
- 1	0.3	0.4 0.4	0.4 0.4	0.5 0.5	0.7 0.7	0.7 0.7	0.7 0.7	0.7 0.7	0.7 0.7	0.7 0.7	0.8 0.8																					
	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8		
6	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8		2
	0.3	0.4 0.4	0.4 0.4	0.5 0.5	0.5 0.5	0.5 0.5	0.6 0.6	0.5 0.5	0.6 0.6	0.6 0.6	0.5 0.5	0.7 0.7	0.7 0.7	0.7 0.7	0.7	0.7 0.7	0.7 0.8	0.8 0.7	0.8 0.7	0.7 0.8	0.8 0.8		2									
	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8		
5	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8		
Ŭ	0.3	0.4 0.4	0.4 0.4	0.5 0.5	0.7 0.7	0.7 0.7	0.7 0.7	0.7 0.7	0.7 0.7	0.8 0.7	0.8 0.7	0.8 0.8		1.5																		
	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6 0.6	0.7	0.7 0.7	0.7 0.7	0.7 0.7	0.7	0.7	0.7 0.7	0.8 0.7	0.8 0.7	0.8 0.8	0.9 0.8	0.9 0.6	0.9		-							
4	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8		
-	0.4 0.4	0.4 0.4	0.4 0.4	0.5 0.5	0.5 0.5	0.5 0.5	0.5 0.5	0.6 0.6	0.6 0.6	0.5 0.7	0.7 0.7	0.8 0.8																				
	0.4	0.4 0.4	0.5 0.4	0.5 0.5	0.5 0.5	0.5	0.6 0.6	0.6 0.6	0.6 0.6	0.7 0.7	0.8 0.8		1																			
3	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8		
Ŭ	0.4 0.4	0.4 0.4	0.5 0.5	0.7 0.7	0.7 0.7	0.7 0.7	0.7 0.7	0.7	0.7	0.7 0.7	0.7 0.8	0.7 0.8	0.8 0.8																			
	0.4	0.4	0.5 0.5	0.5 0.5	0.5	0.6 0.6	0.6 0.6	0.6 0.6	0.6 0.6	0.7 0.7	0.8 0.7	0.8 0.8	0.9 0.8	0.9 0.6	0.8		0 E															
2	0.3	0.4	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8		0.5
-	0.3 0.3	0.4 0.3	0.4 0.4	0.5 0.5	0.5	0.5 0.6	0.5 0.5	0.5 0.5	0.5 0.7	0.7 0.7	0.7 0.8	0.8 0.8																				
	0.2	0.3	0.4	0.4	0.5	0.6	0.5	0.7 0.7	0.7 0.7	0.7 0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8 0.8	0.8	0.8	0.8	0.8	0.8	0.8 0.8	0.8	0.8 0.8	0.8 0.8	0.8 0.8	0.8	0.8 0.8	0.8		
- 1 <sup>_</sup>							0.7	0.7	0.7	0.3		3.6		0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.5		0.8	0.8	0.8	0.8	0.8	0.8	0.8			0
20	0				25	50				30	00				3	50				4(	00				45	50				50	0	•
										0/		1-	ri	~	-:-		~			ח		h	+-	<b>.</b>		<b>.</b>				m₄		
									ŧU	70	) \	/d		d	LIC	וונ		] ]		או			LC	JU	ILC	コし				~		

BR(h→γγ)/0.00228 \* BR(h→bb)/0.577

ATLAS Internal low-tanβ-high

	10.	_																															1
Ę		0.5	0.5	0.5	0.5	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0		
a		0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0		
÷		0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0		
	q	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0		1
	~	0.5	0.5	0.6	0.5	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0		•
		0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0		
		0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0		
		0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0		
	9	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0		
		0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0		~ ~
		0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0		0.8
	7	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0		
	-T	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	_	
		0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
		0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
	6	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
	b	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0		06
		0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0		0.0
		0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0		
	_	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0		
	5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
		0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
		0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0		
		0.5	0.5	0.5	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		0.4
	4	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		••••
		0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
		0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
		0.6	0.5	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
	- 31	0.5	0.5	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
	Ŭ	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		0.0
		0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		0.2
		0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
	2	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
	-	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
		0.8	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
		0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1		
	- 1 <sup>[</sup>							1.1	1.1	1.1	1.1	0.3	0.1	0.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.9	0.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.0		0
	20	)U				25	50				30	)U				24	50				40	n				45	50				50	0	0
	20	0				2					00					0.										-τ.					20	0	
						21	10	1	<b>\</b>	<mark>n</mark> r		÷.			or			<b>)</b>	h	•	$\mathbf{N}$	*C			h	h	h				III <sub>A</sub>		
						J	JŽ	<b>'</b> 0	V	ai	IC		U		U		DГ			y y	V V	' C	JГ			D	N				~		

BR(h $\rightarrow$ tt)/0.0632 \* BR(h $\rightarrow$ bb)/0.577 ATLAS Internal low-tan $\beta$ -high



# bbyy exclusions low-tb-high

- make a preliminary exclusion plot for bbyy on the value of xsec(ggHhh)BR(bb)BR(yy)\*2
- the exclusion is seen in very low tanb region
- maybe better to use logY





500

m₄

# bbtt exclusions low-tb-high

- make a preliminary exclusion plot for bbtautau on the value of xsec(ggHhh)BR(bb)BR(tautau) \*2
- the exclusion is seen in very low tanb region
- maybe better to have logY





# bbtt exclusions low-tb-high

- In very low tb, there are theoretically *unstable* phase points -> contour failures ...
- justify the exclusion script itself does not have any problem. assume limit is 10 times better, i.e. 1/10\*current limit (plot on the right)





450

500

m₄

## **Theoretical uncertainties**

_	The uncertainties do not have	bbtautau	P	DF	ISR,	SFR	Sc	ale
•	The uncertainties do not have		Low	High	Low	High	Low	High
	a specific pattern along mass	Resonant(260)	1.1	18.2	14.8	54.5	15.2	54.5
•	but fluctuation seems to be	Resonant(300)	4.7	8.0	9.9	14.7	10.3	32.0
	large	Resonant(350)	21.6	12.7	36.3	21.7	22.5	30.7
		Resonant(400)	20.8	2.3	41.7	14.3	47.9	20.5
•	in agreement to use averaged	Resonant(500)	4.2	2.2	25.0	7.2	33.3	12.6
	value in all masses	Resonant(1000)	33.3	5.0	33.3	11.5	33.3	5.2
		non-resonant	11.8	3.5	29.4	5.8	39.2	12.7

Mass	260	300	350	400	500	Sm_hh	
wwyy							
SCALE	2.2%	2.8%	3.2%	1.6%	2.3%	2.2%	
PDF	4.6%	2.7%	7.0%	6.9%	1.9%	4.0%	
ISRFSR	6.7%	4.1%	2.7%	3.7%	3.2%	1.7%	65



## Channel limits [res]



# Interpolated mass points

 In both low mass and high mass regions, more mass points are interpolated from available points



Local p<sub>0</sub>

10<sup>-1</sup>

10<sup>-2</sup>

 $10^{-3}$ 

PREVIOUS

- WWyy obs bbtt obs

-A-- bbbb obs

ATLAS

Internal

√s = 8 TeV

# Theoretical uncertianties

- Theoretical uncertainties are estimated with variations on PDF/scale/radiation → three nuisance parameter are created for them respectively
- For PDF uncert, compare MSTW2008lo68 and NNPDF to nominal sample cteq6l1
- For factorization/renormalization uncert, compare
  - cteq6l1\_facDn\_renDn
  - cteq6l1\_facNo\_renDn
  - cteq6l1\_facUp\_renNo
  - cteq6l1\_facDn\_renNo
  - cteq6l1\_facNo\_renUp
  - cteq6l1\_facUp\_renUp
- For ISR/FSR uncert, compare isr\_up/dn and fsr\_up/dn
  - \* all follows instructions from Paul T as used in AZh



#### hMSSM – compared to other channels

