Weekly report IHEP

Xiaohu SUN

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21-07-2015

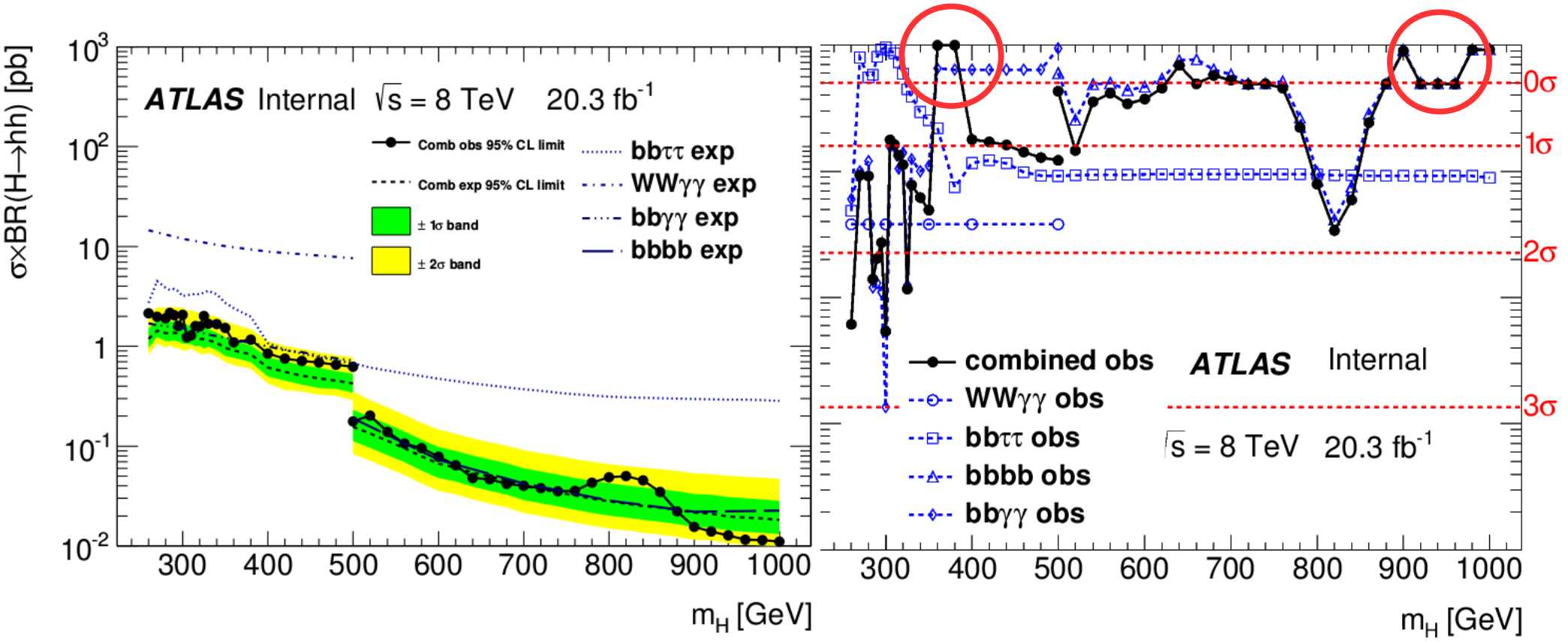
IHEP

CDS entry
[wwyy]https://cds.cern.ch/record/1967498
[bbττ]https://cds.cern.ch/record/1967500
[combination]https://cds.cern.ch/record/1984111/
[paper draft]https://cds.cern.ch/record/2008753/

STATUS – HH combination

- Last Thursday, I presented HH combination on **Higgs plenary** and we had passed **closure approval**
  - https://indico.cern.ch/event/433602/
- **CDS entry**
  - **[wwyy]https://cds.cern.ch/record/1967498**
  - **[bbττ]https://cds.cern.ch/record/1967500**
  - **[combination]https://cds.cern.ch/record/1984111/**
  - **[paper draft]https://cds.cern.ch/record/2008753/**
- All main issues have been solved so far, we can move forward :)

Recall the main issues



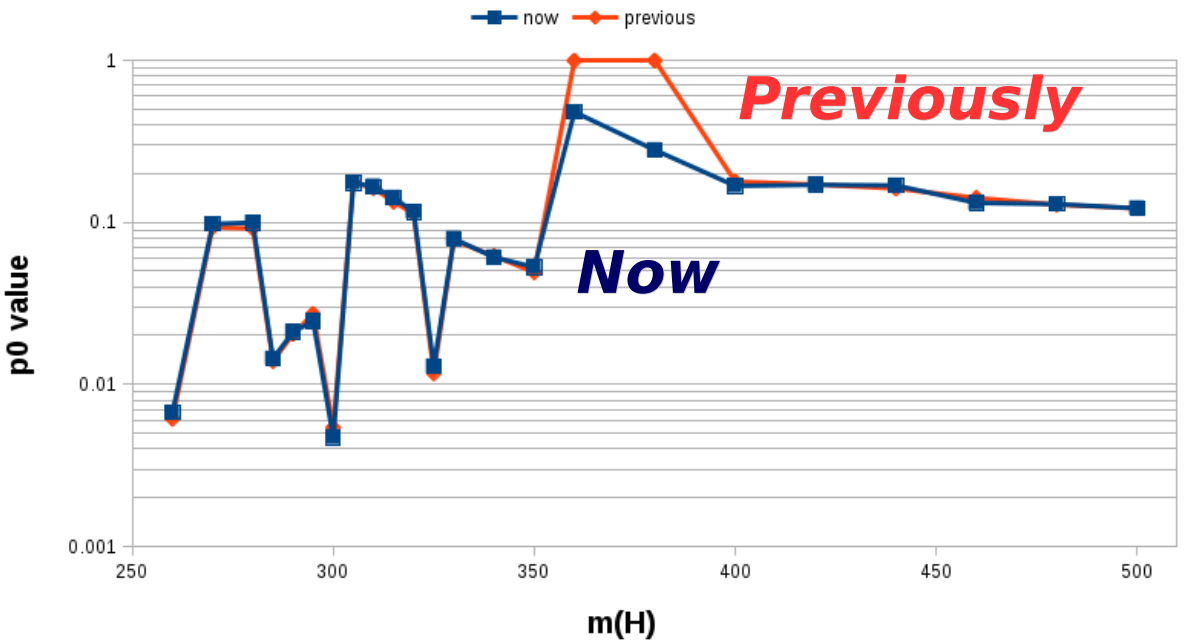
- Issues of:
  - p0 values @ 360 380
  - p0 values @ 920 940 960

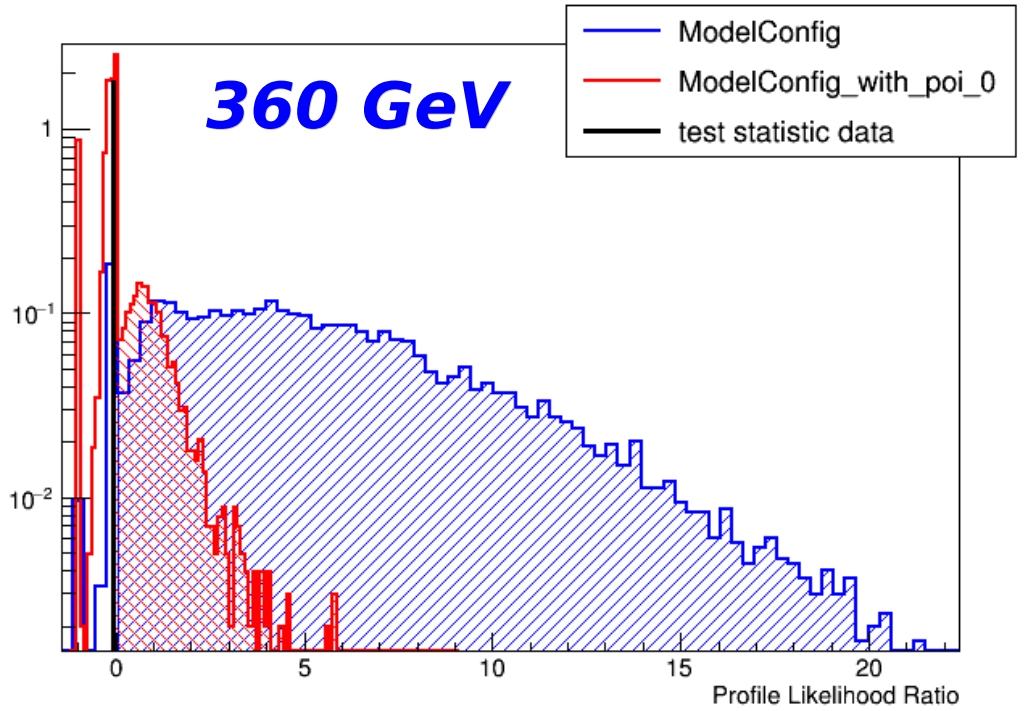
Solved issues and updates

- low mass region (260-500), we had data excess indicated by limits but p0~1 and mu_hat<0 @360,380
  - changed TS definition (signed one-sided discovery)
  - checked PLR curves, understood the destructive inference between bbyy and wwyy+bbtautau (thanks to Aaron)
  - translate bbyy model from hfitter to histfactory in order to have automated protection against negative pdf
- high mass region (500-1000), we had p0 dropping to ~0.5 @920,940,960 which is not consistent with data deficit seen in limits
  - rebinned histogram for fit in bbbb to avoid bins with zero data, zero bkg but non-zero signal (thanks to David)
  - understood the linear and less linear curves in bbbb
- interpretation on hMSSM and low-tb-high has strange structure due to jumping obs limits, after using finer theory map
  - properly draw disconnected obs exclusion regions instead of manually modifying any TGraph

p0 and limits

- One-sided discovery TS is set to 0 when mu_hat < 0
- Signed one-sided discovery TS is not
- In this case, p0 values are less than one
- So now, p0<1 consistent with obs limit>med

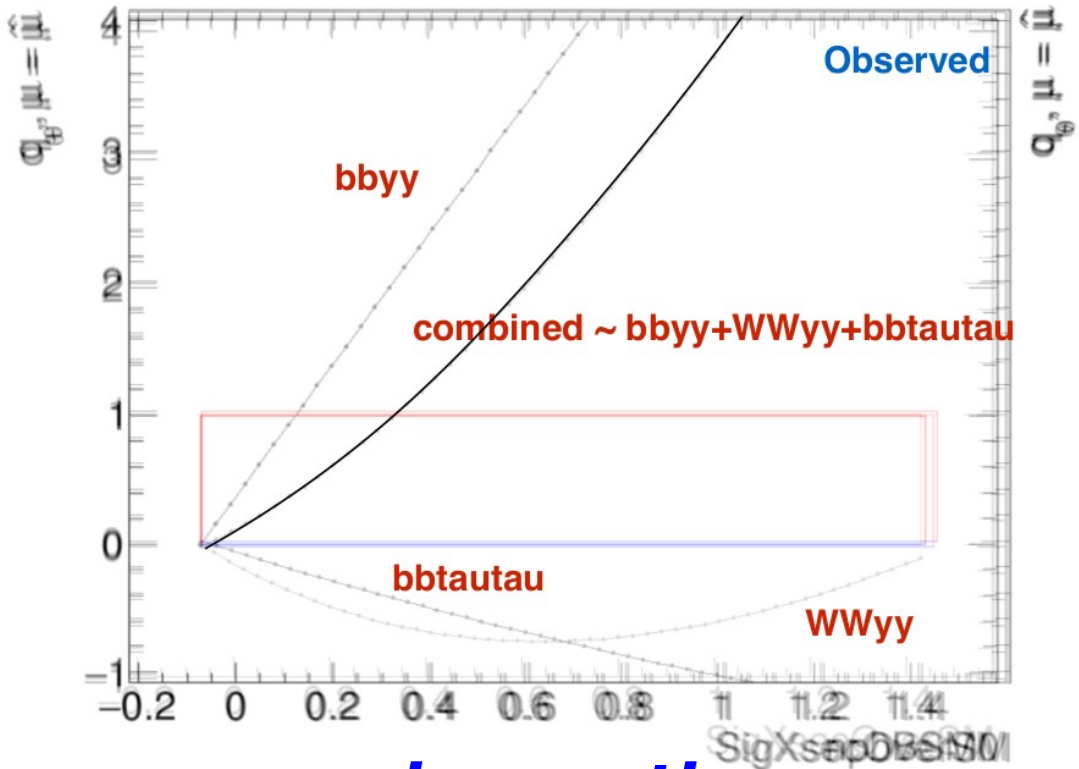




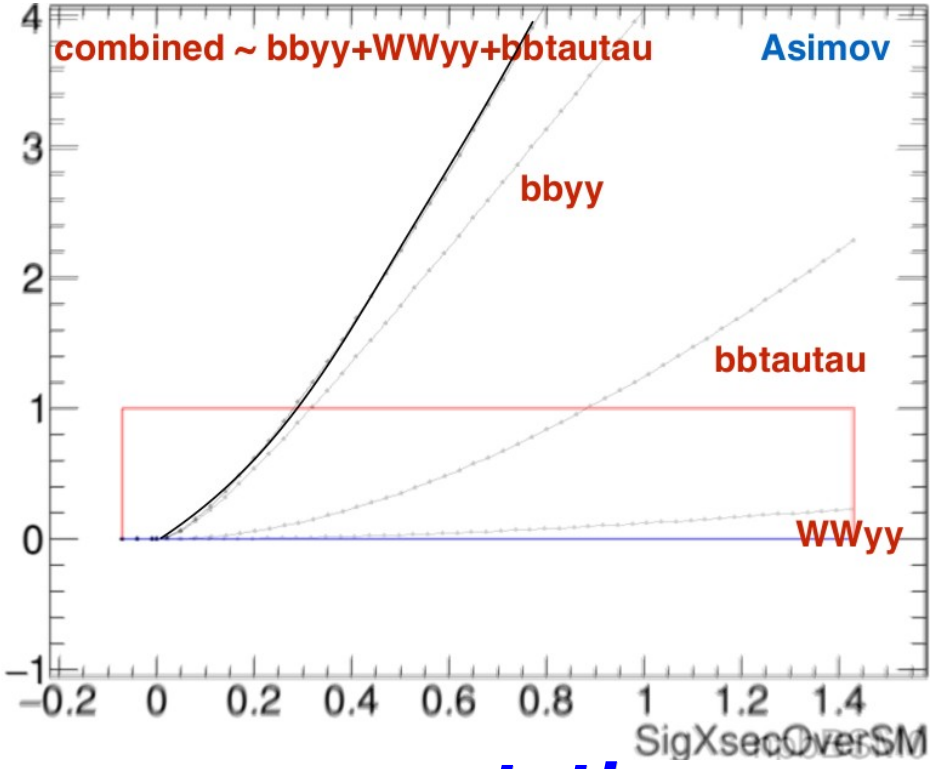
TS

PLR and limits

- Obs limit > exp limit with mu_hat < 0
- Observed bbtautau and WWyy interfere destructively with bbyy and bring the combined curve to lower -ln L values since they favor muhat ~0.6 and ~4.2, while the expected is OK



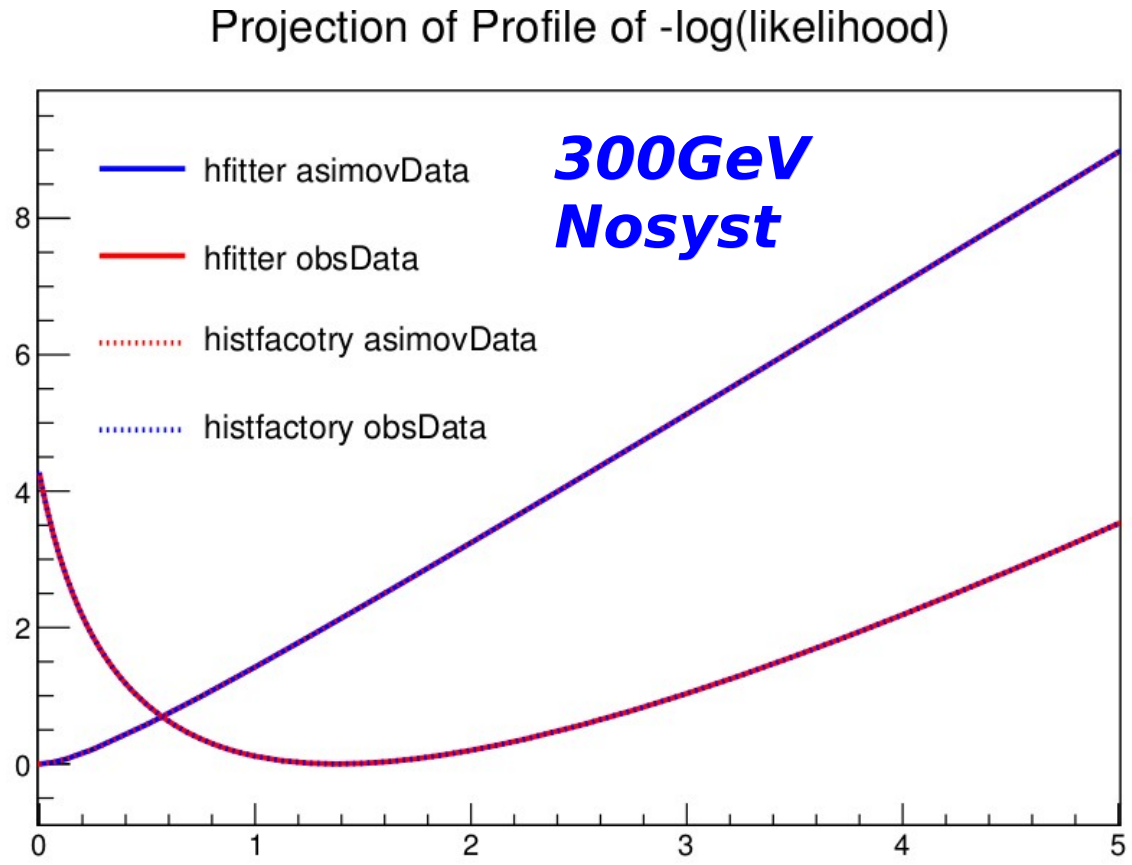
observation



expectation

Change statistical framework - nosyst

- bbyy originally built up its model in hfitter which does not have a protection against negative pdf; so we translate the model into Histfactory
- two bins, signal region and sideband

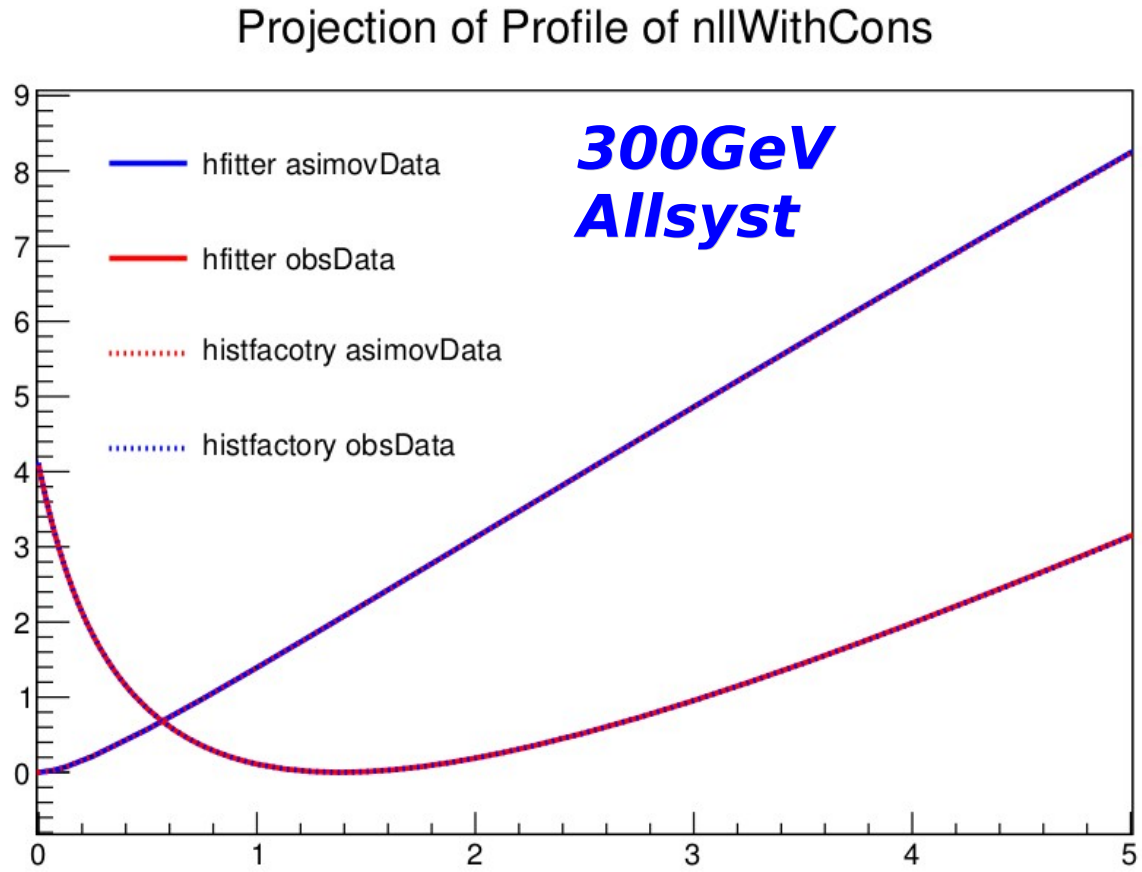


Asymmptotics
hfitter:
Median: 1.27806
Observed: 3.32702
histfactory:
Median: 1.27806
Observed: 3.32702
exactly the same

mu_hat:
hfitter 1.37782
+1.04903 -0.713787
histfactory 1.37852
+1.04833 -0.714492

Change statistical framework - allsyst

- after adding all systematic uncertainties



300GeV Allsyst

Running with asymmptotics

hfitter:
Median: 1.3046
Observed: 3.43874

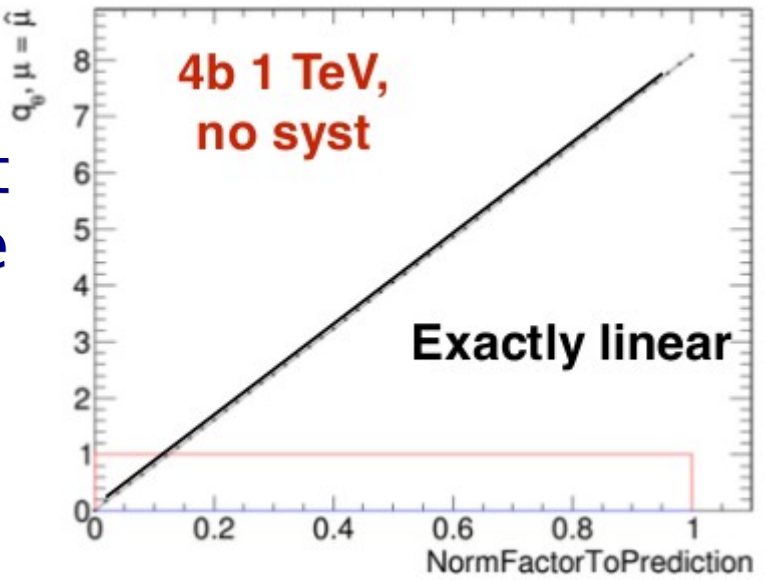
histfactory:
Median: 1.3049
Observed: 3.44047

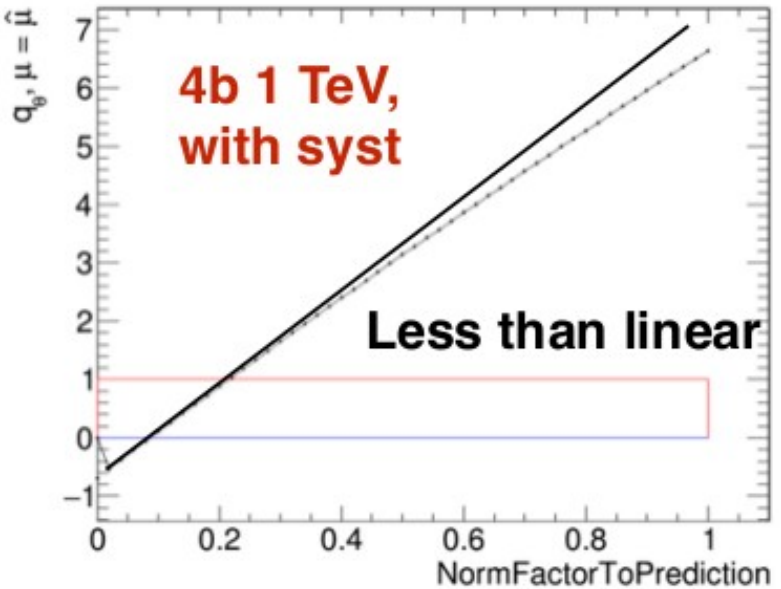
In good agreement

mu_hat:
hfitter 1.37813 +1.09113 -0.721945
histfactory 1.37693 +1.09272 -0.720698

High mass issues

- Limits @ 920 940 960 show data deficit but p0 values do not, this is due to bins with only signal but no background in fitting template
- rebinned the histogram and removed single signal events in very high mass region
- now the p0 values are reasonably close to 1



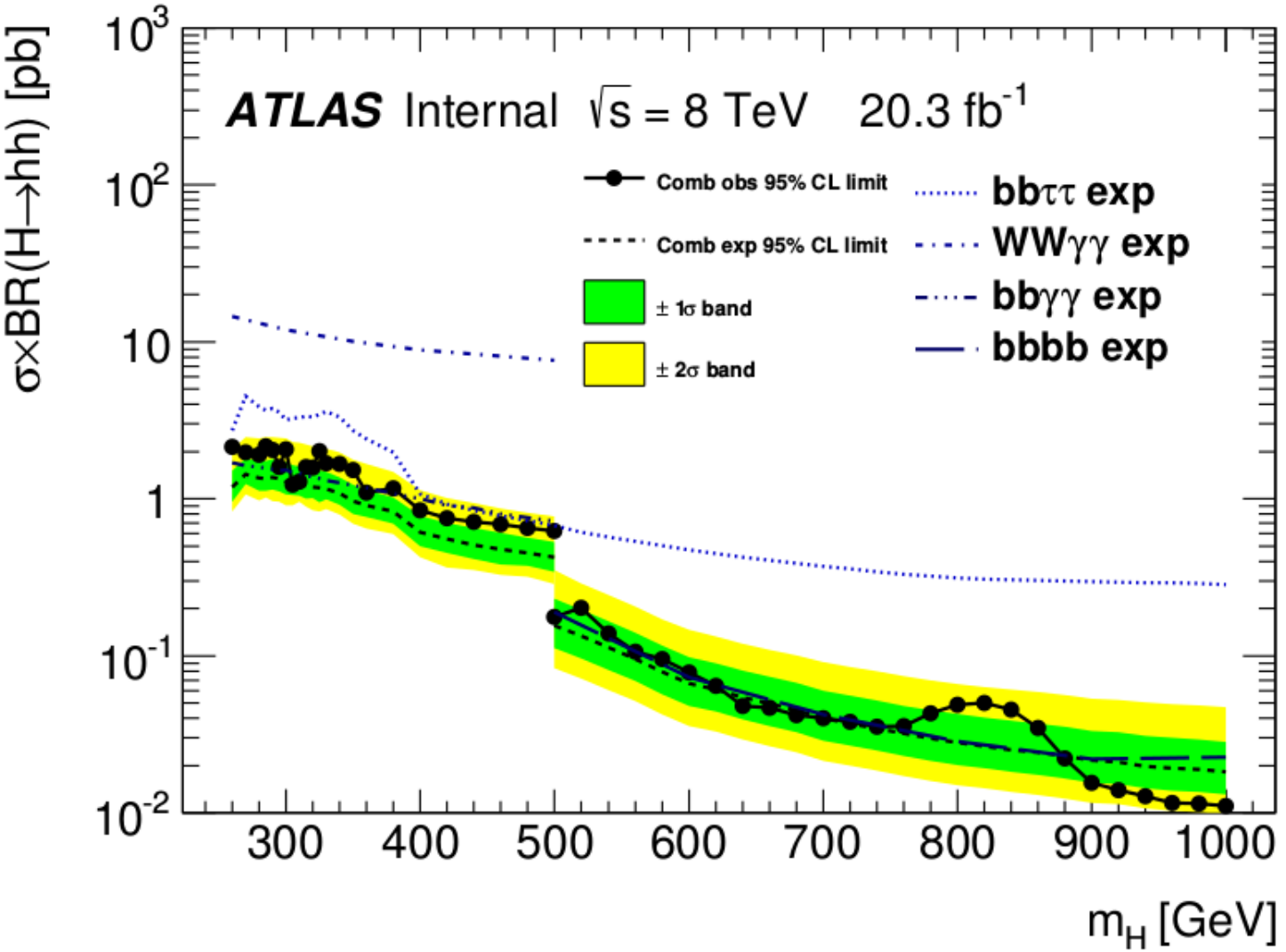


+++ nosyst +++
-ln P(N|E) = -N*ln(E) + E
For N=0 and E = mu*S+B ~ mu*S:
-ln P(0|mu*S) = mu*S

+++ syst +++
-ln P(0|mu*S)*Gaus ~
mu*S*(1+pull*eps) + pull
= mu*S + pull*(1+mu*S*eps)

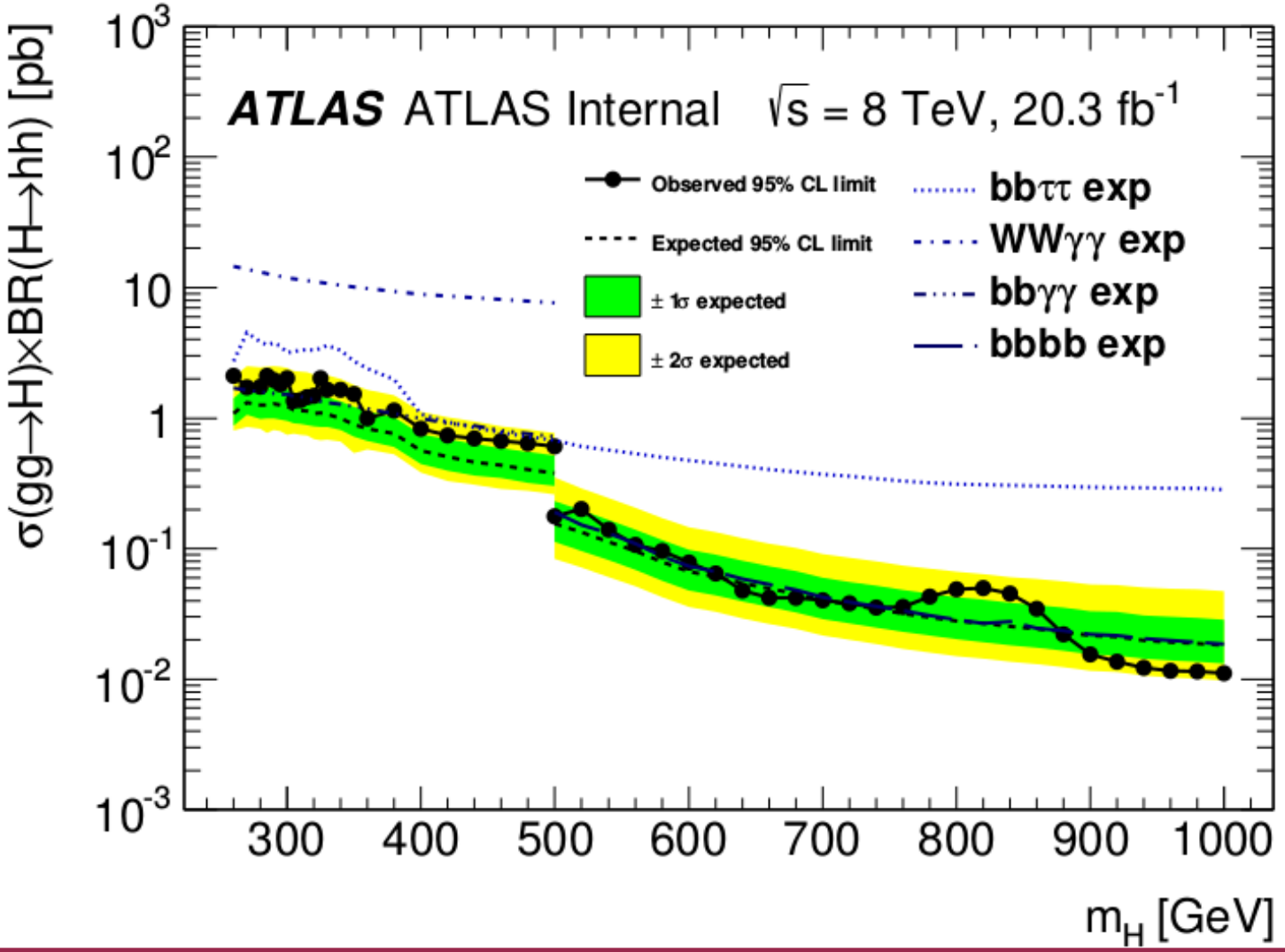
Limit plot (previously)

- Previous limit plot from last Higgs plenary



Limit plot

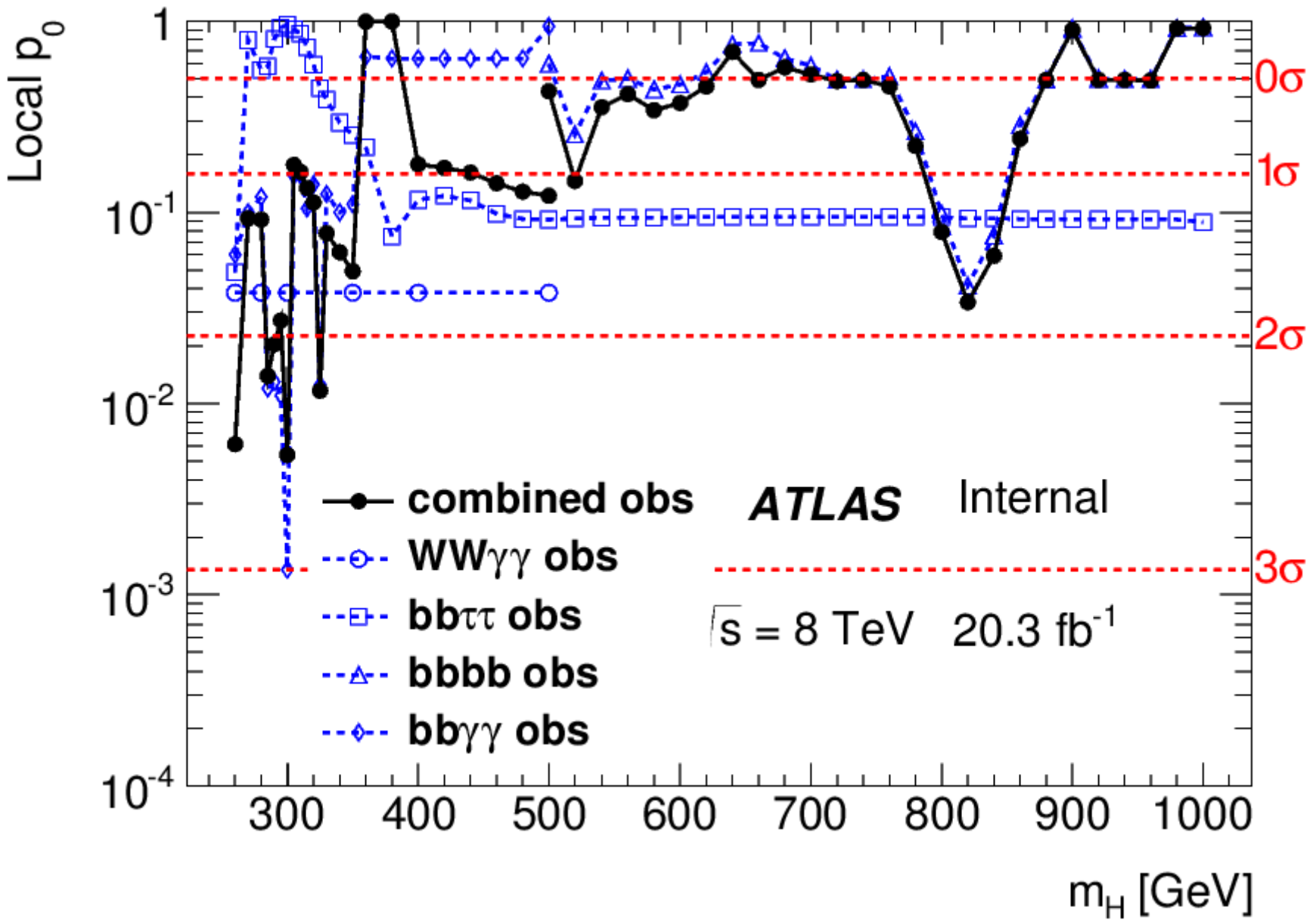
- New limits slightly lower than before



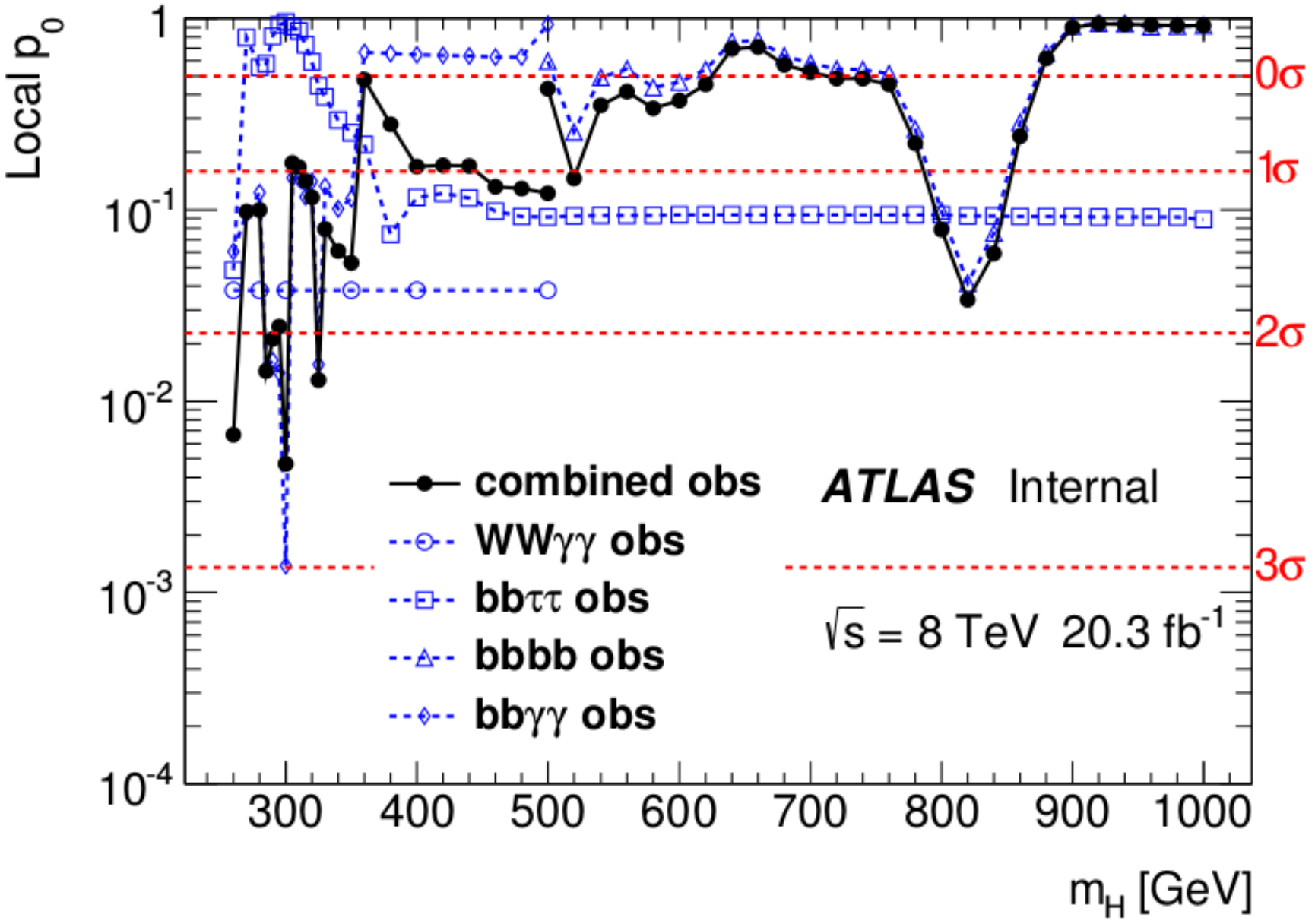
Changes in low mass res

- New limits slightly lower than before after
  - correlating BR(yy) 5% in wwyy and bbyy
  - correlating PH_ISO 2% and PH_ID 2.5% in wwyy and bbyy
  - changing of the statistical framework from hfitter to histfactory which a protection on negative pdf is applied

p0 scan (previously, last Higgs plenary)

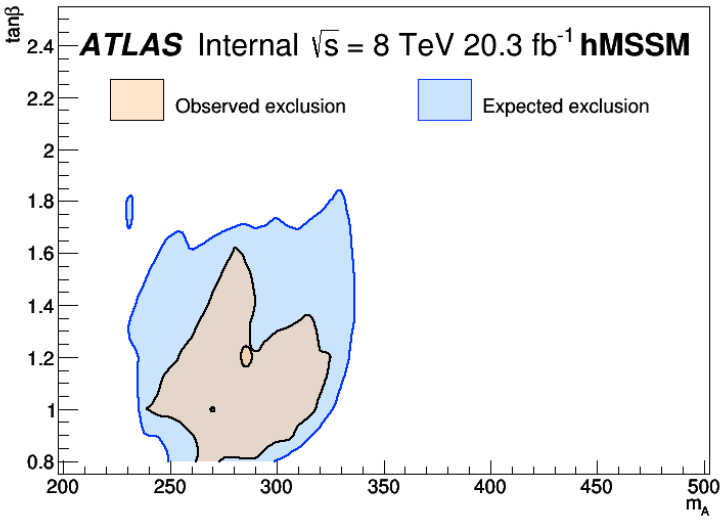


p0 scan


Local p_0
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
0σ
1σ
2σ
3σ
combined obs
WWγγ obs
bbττ obs
bbbb obs
bbγγ obs
ATLAS Internal
$\sqrt{s}$ = 8 TeV 20.3 fb^{-1}
300
400
500
600
700
800
900
1000
m_H [GeV]

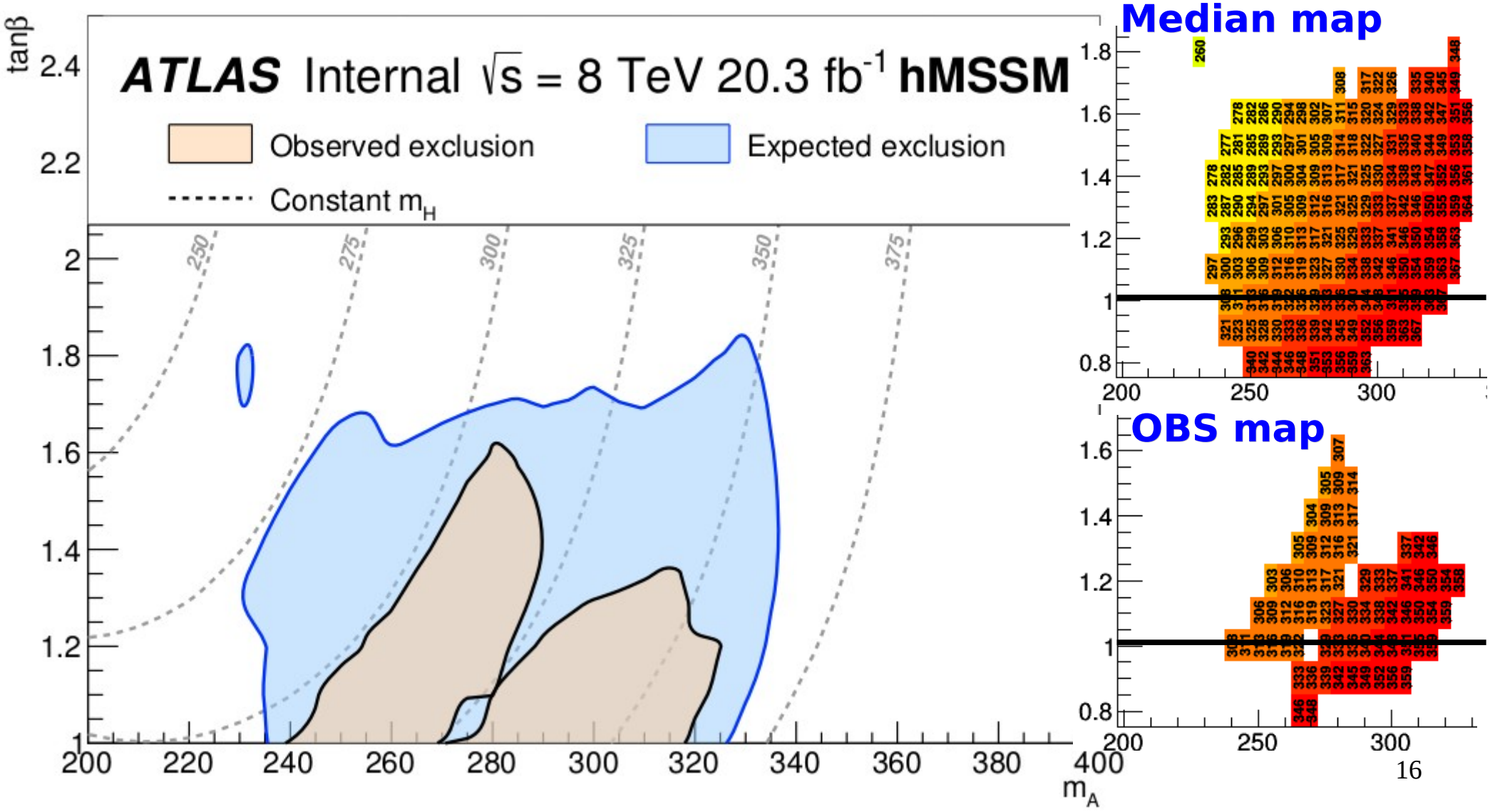
Interpretation updates

- Since last Higgs plenary
  - improve the mA step from 10 GeV to 5 GeV in the theory map file
  - switch off any smooth algorithm
  - small structures are found in obs due to the jumping obs limits, which leads to contour making issue (wrongly interpolated contours)
  - lower limits now leads to fatter exclusions



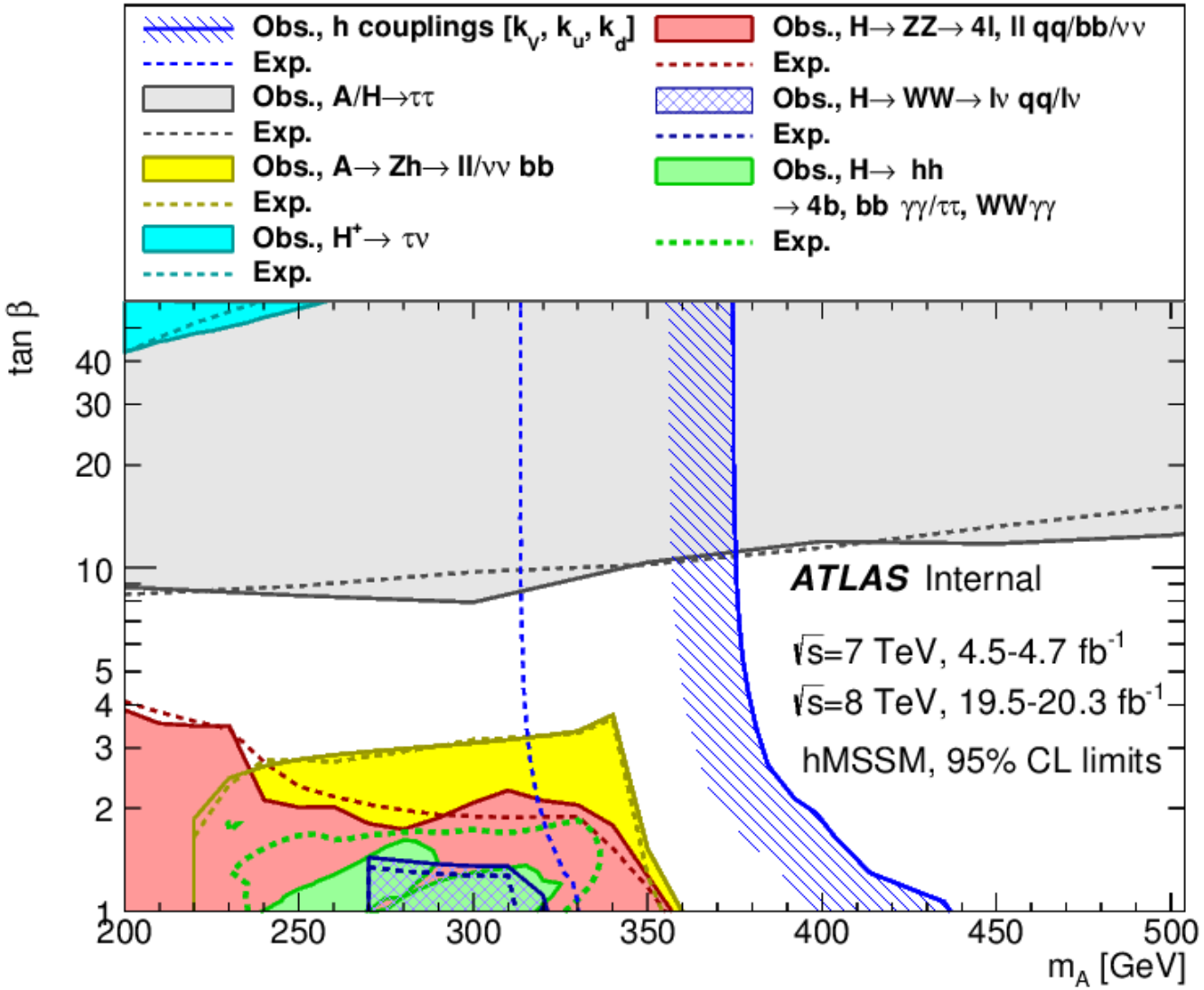
hMSSM interpretation

- By plotting disconnected exclusion area piece by piece, one can have the isolated islands clearly



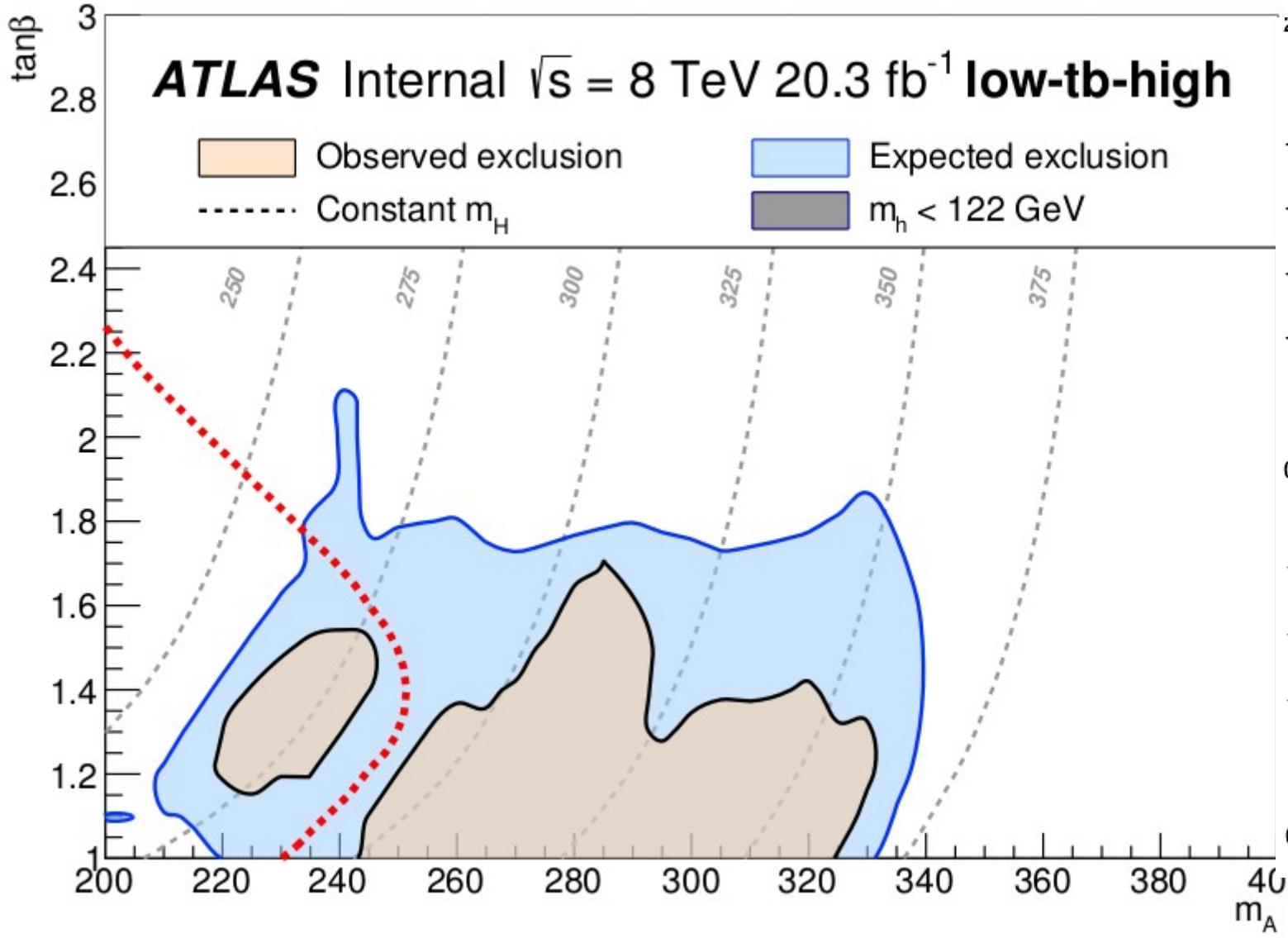
hMSSM interpretation overview

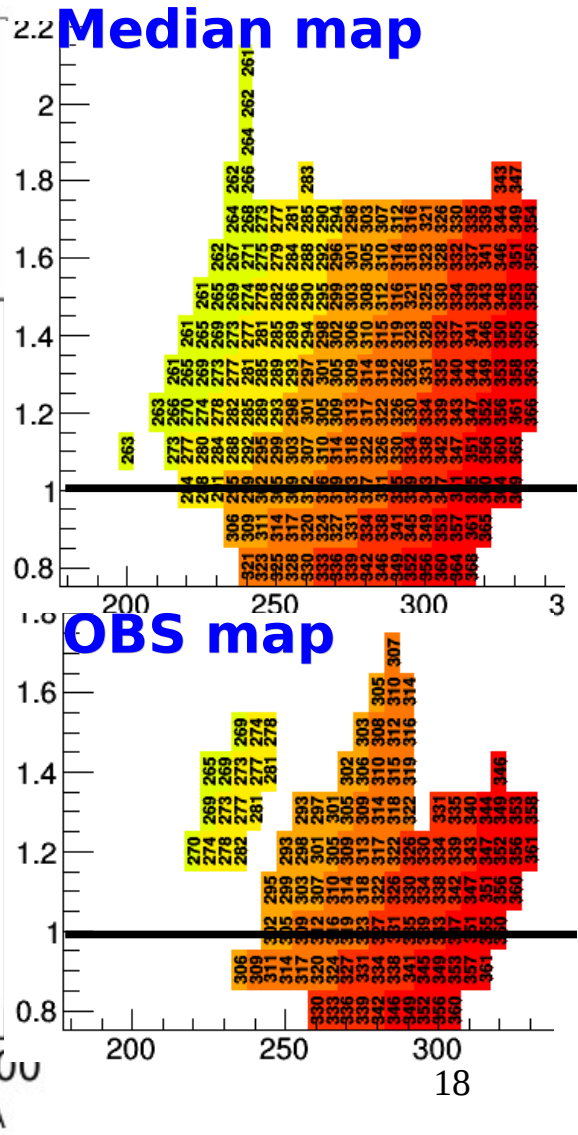
- Thanks to Nikos, the whole picture of hMSSM interpretation from various channels is produced



low-tb-high interpretation

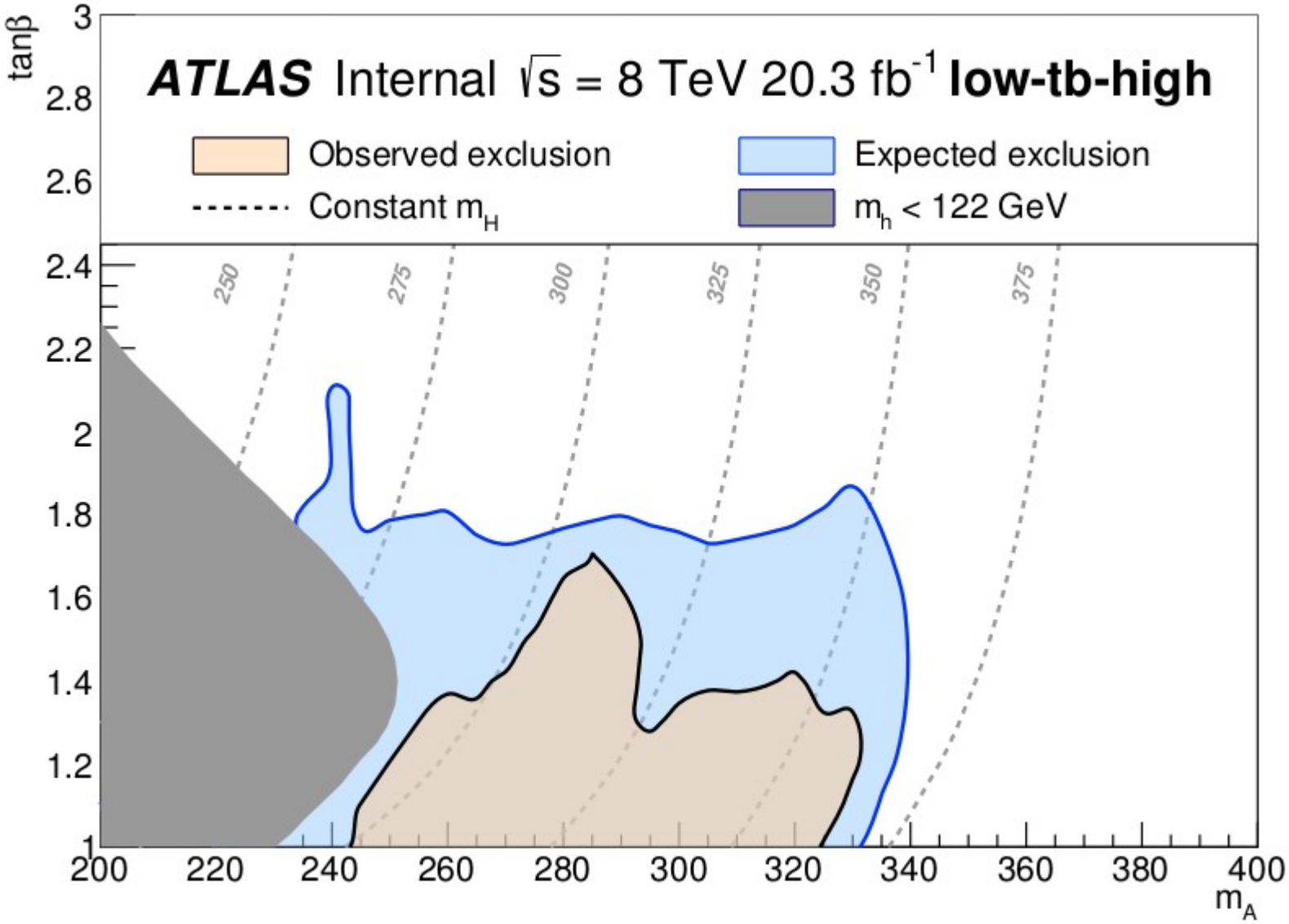
- By plotting disconnected exclusion area piece by piece, one can have the isolated islands clearly





low-tb-high interpretation

- solid mask



Summary of HH

- After fixing the issues, we asked for closure approval for hh combination with the updated contents below:
  - limit plot
  - local p0 value plot
  - hMSSM interpretation
  - low-tb-high interpretation
- And we got approved

HH in RUN II

- I continue to do the combination for HH in **RUN II**
- Progresses had been made in converging object definitions among bbyy, bbtautau and bbbb
  - Bjets: MV2C20
  - Jets: can use EM instead of LC for now (but bbbb would like to look at also LC to compare the performance)
- It is proposed that bbyy and bbtautau run with #jets<=2 since bbbb asks >=3
- Setting up SVN repository to let individual analyzers check in preliminary workspaces
- Building up a twiki to document combination in order to do it in a more collaborative and efficient way

	$M_X = 325$ GeV		$M_X = 400$ GeV		SM	
	2 b-tag	3 b-tag	2 b-tag	3 b-tag	2 b-tag	3 b-tag
85%	3923	12	5498	17	8274	51
77%	3375	5	4669	10	7181	29
70%	2856	5	3991	7	6123	17
60%	2170	1	3003	4	4550	9

bbyy
James

LHC Higgs XS Working Group

- Working group twiki (fully public)
  - https://twiki.cern.ch/twiki/bin/view/LHCPhysics/LHCHXSWG
- **BSM** Higgs (**WG3**) twiki
  - https://twiki.cern.ch/twiki/bin/view/LHCPhysics/LHCHXSWG3
- **ATLAS** conveners
  - ATLAS Steering Committee: Reisaburo Tanaka & Markus Schumacher
  - WG3 (BSM Higgs) overal: Nikolaos Rompotis
    - Neutral MSSM: Allison McCarn
    - Charged Higgs: Steve Sekula
    - **Extended scalar: Xiaohu Sun**
    - Exotics: Shikma Bressler
    - Cross WG: bbh production Matthew Beckingham

Workshop: 15 – 17 July 2015

The 10th Workshop of the LHC Higgs Cross Section Working Group

chaired by Charalampos Anastasiou (ETH, Zurich), Daniel de Florian (Universidad de Buenos Aires), Christophe Grojean (ICREA, Barcelona), Fabio Maltoni (Universite Catholique de Louvain), Chiara Mariotti (INFN Torino), Alexandre Nikitenko (Imperial College), Markus Schumacher (Albert-Ludwigs-Universitaet Freiburg), Reisaburo Tanaka (LAL, Orsay)

from Wednesday, 15 July 2015 at **09:00** to Friday, 17 July 2015 at **17:00** (Europe/Zurich)

Council Chamber / Main Auditorium / Filtration Plant (Check agenda for meeting room!)

Manage

Description

The LHC Higgs cross-section working group (HXSWG) was created in January 2010. The aim of this group was to produce agreements on cross sections, branching ratios and pseudo-observables relevant to SM and MSSM Higgs boson(s). In spring 2012, the group was restructured and new subgroups were added with the goal of discussing Higgs property/measurement and BSM extensions. Three CERN Reports have been completed, "Inclusive Observables" (CERN-2011- 002), "Differential Distributions" (CERN-2012-002), and "Higgs Properties" (CERN-2013-004). These achievements facilitated the comparison and combination of Higgs results at LHC since the beginning of the LHC physics programme.

After 5 years of activities, our group has been reorganized in order to prepare the future run at higher energy. The group is organized in three working groups: (1) cross-sections & branching ratios, (2) Higgs properties and (3) beyond the Standard Model. Each of these groups involve some task-force subgroups.

In this 10th general assembly meeting, we shall review the progresses made in the various groups and we shall finalize the recommendations to conduct the analyses with the LHC RUN-2 data in preparation for Moriond 2016. The guidlines for the CERN Report 4 (YR4) document will be finalized, aiming its publication early 2016.

Material: Bergerie... Bergerie...

LHC Higgs XS Working Group

- I have been giving a talk on "**Extended Scalars Searches and interpretations in ATLAS/CMS**"
  - https://indico.cern.ch/event/350628/session/1/contribution/37/attachments/1126139/1607806/2HDM-ATLAS-CMS-UpTo2015.pdf

- The talk covers recent results from both ATLAS and CMS related to extended scalar searches where interpretations were performed
- The relevant searches without interpretations were not covered in the talk

Relevant searches in ATLAS + CMS

- *Only results with interpretations are presented*
- *ALTAS*
  - **A→Zh**, PLB 744 (2015) 163-183 2HDM
  - **H→hh→bbbb**, arXiv:1506.00285 2HDM
  - **SM Higgs couplings**, ATLAS-CONF-2014-010 2HDM, EW singlet
  - **$H^{\pm}$→WZ**, PRL 114, 231801 (2015) "LHCHXSWG-2015-001 (2015.05.05)" Triplet
- *CMS*
  - **H→hh & A→Zh** PRD 90, 112013 2HDM
  - **A→Zh** arxiv:1504.04710 2HDM
  - **H/A→Z A/H** CMS-PAS-HIG-15-001 2HDM

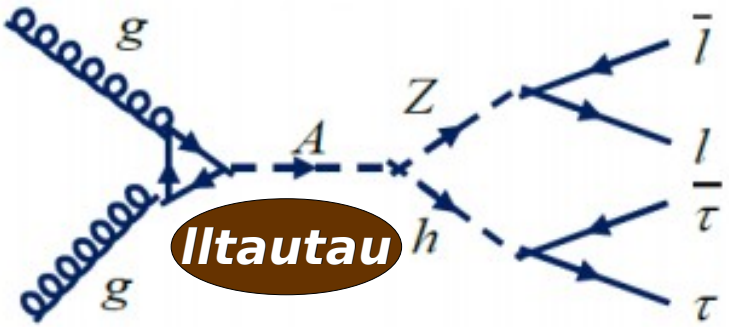
2HDM specification

- In the context of the ***CP-conserving*** 2HDM
- Yukawa coupling arrangements define **four** different 2HDM types: T*ype I, II, Lepton-specific, Flipped*
- Xsec is calculated with ***SusHi*** version 1.3.0 (ATLAS), 1.2.0 (CMS)
- BRs calculated with ***2HDMC*** version 1.6.4 and with the assumption of $m(A) = m(H) = m(H^{\pm})$, $m(h) = 125$ GeV and $m_{12}^2 = m_A^2 \tan\beta/(1 + \tan^2\beta)$
- The ***width*** effects are taken into account, for example, up to 5% of m(A) in A→Zh and 15% of m(H) in H→hh→bbbb (ATLAS)
- ***b-associated*** production is considered and contributes in high tanβ

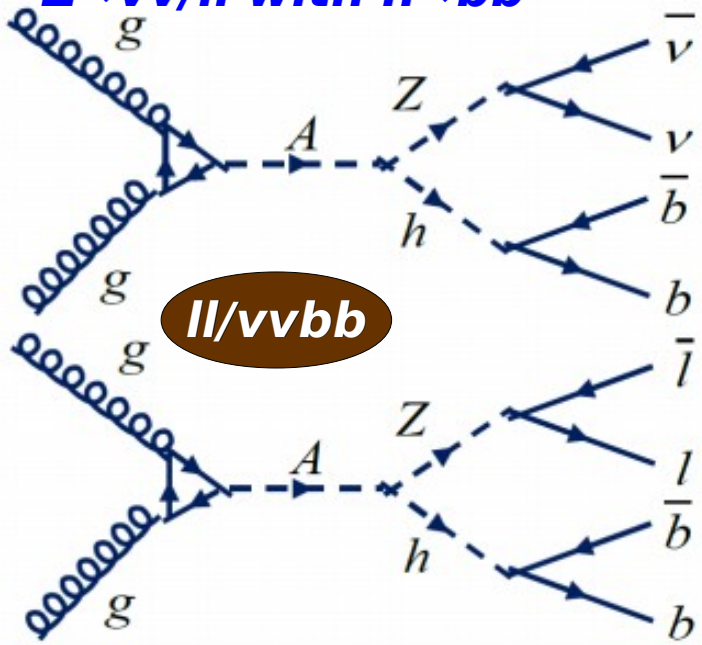
ATLAS A→Zh

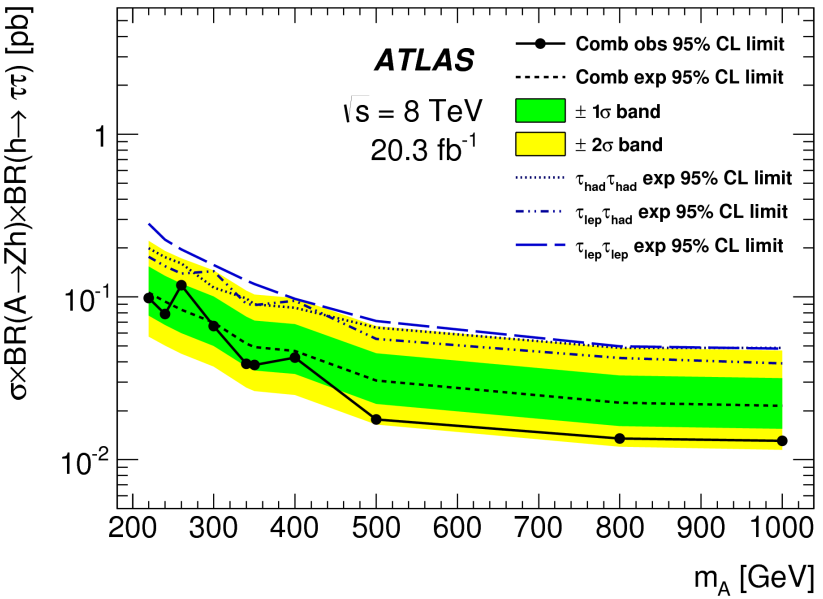
- Look for a CP-odd Higgs boson A decaying to Zh

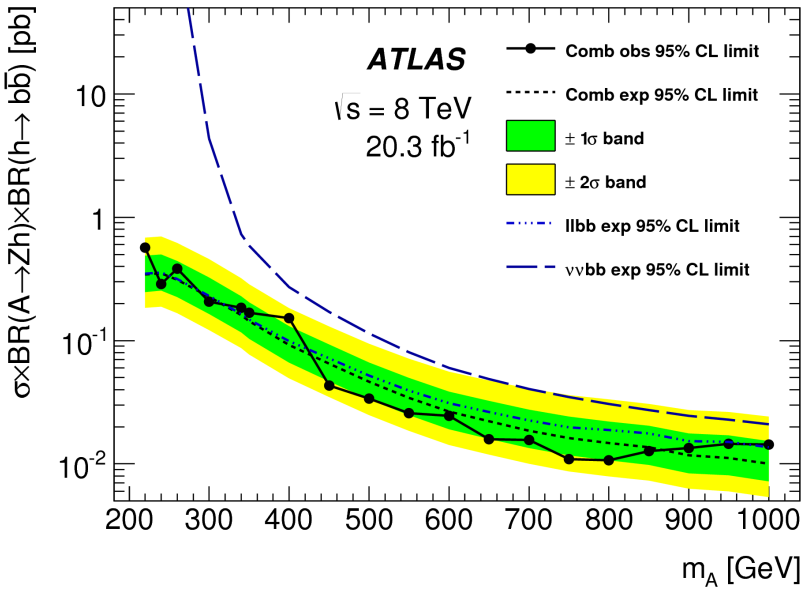
Three channels including Z→ll, hadronic and leptonic tau decays



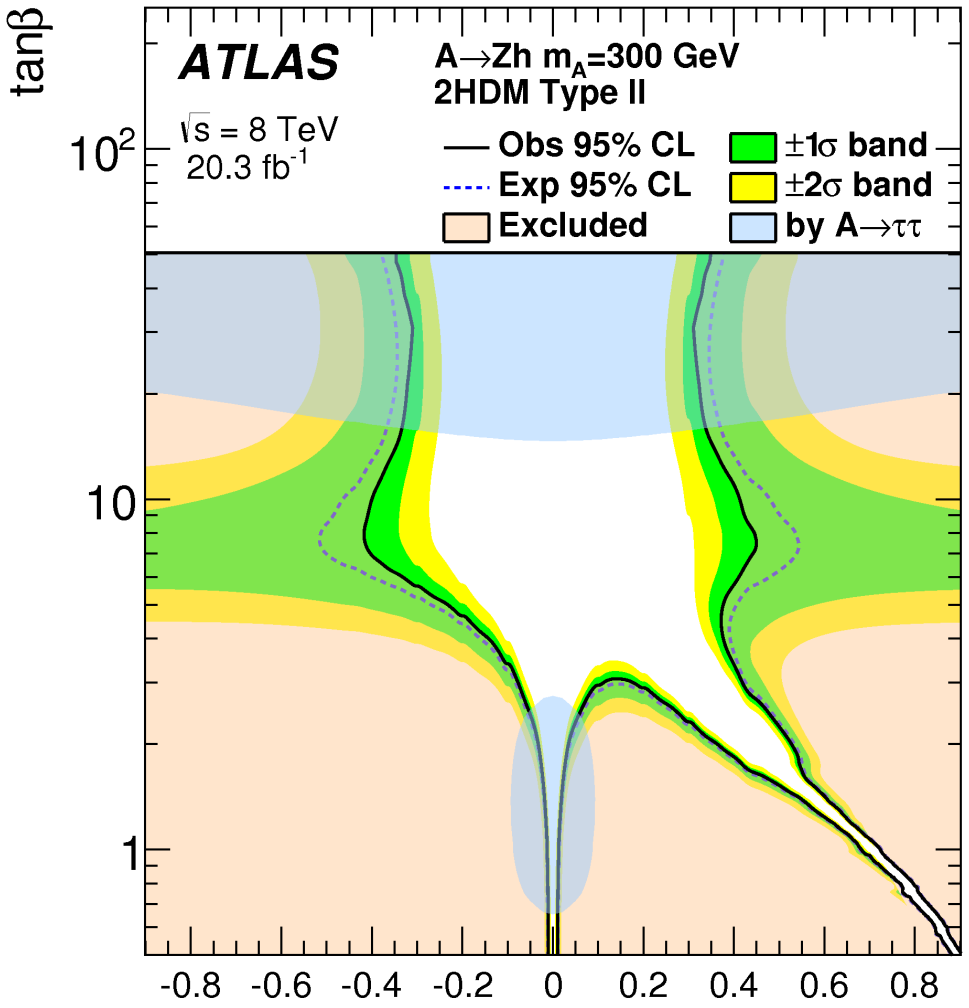
Two channels including Z→vv/ll with h→bb



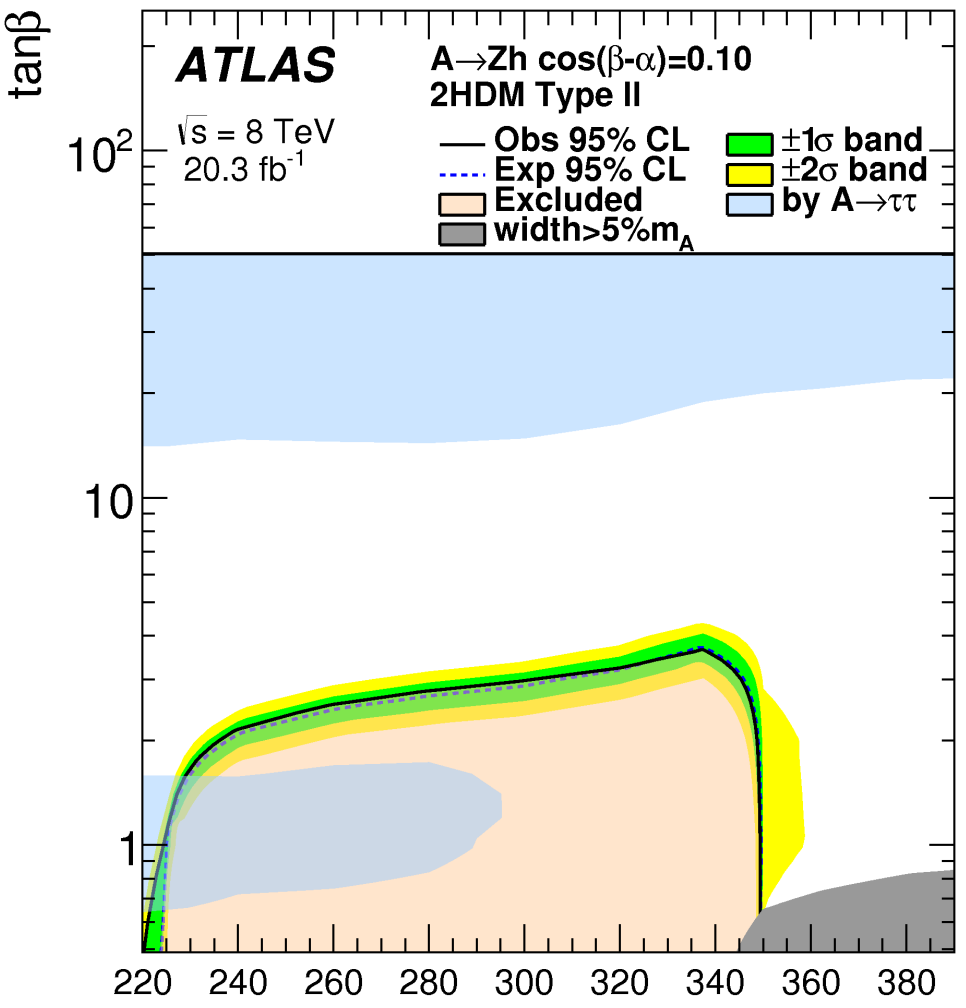




ATLAS A→Zh Type II 2HDM



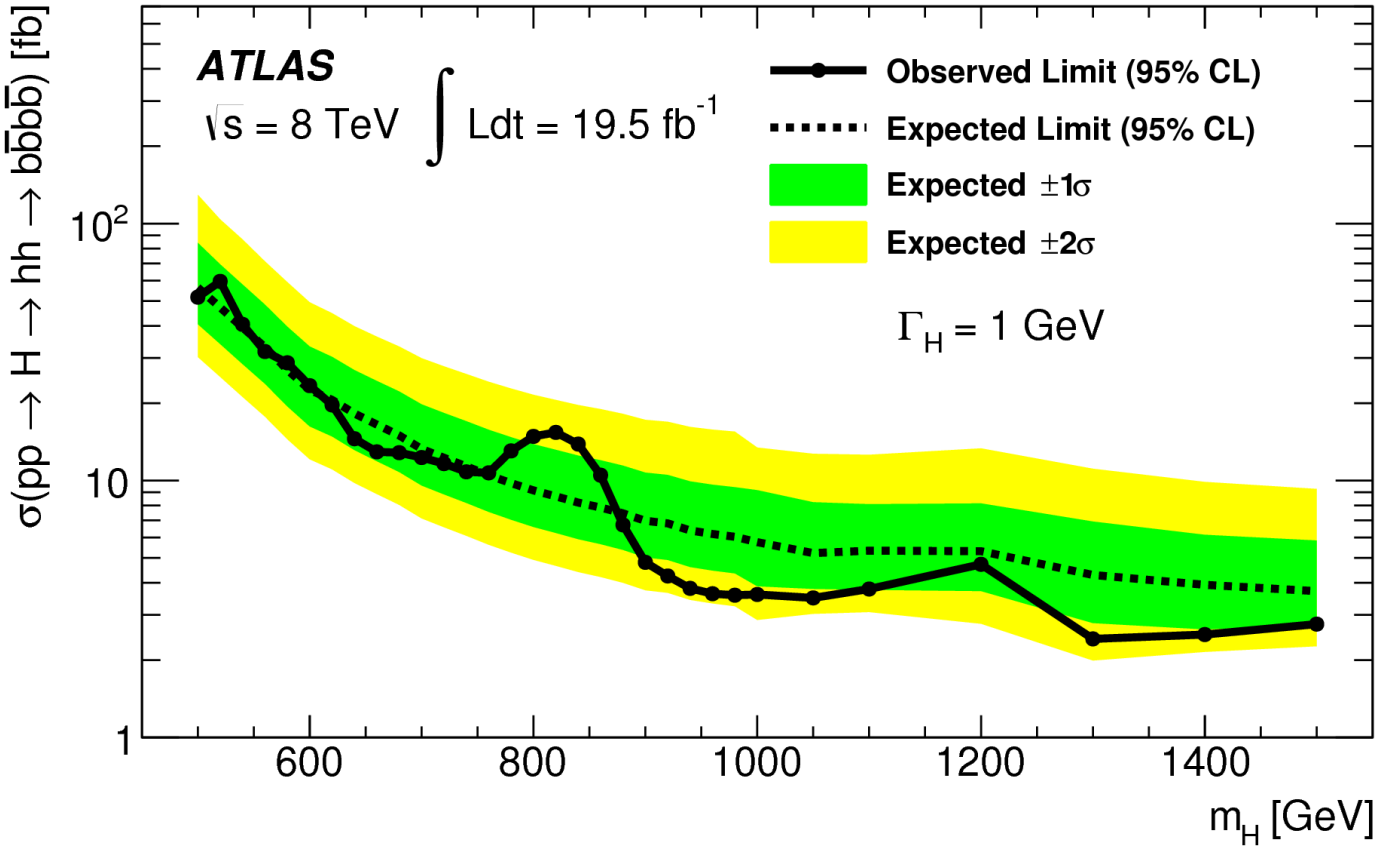
Type II
m(A) = 300GeV



Type II
cos(β-α) = 0.10

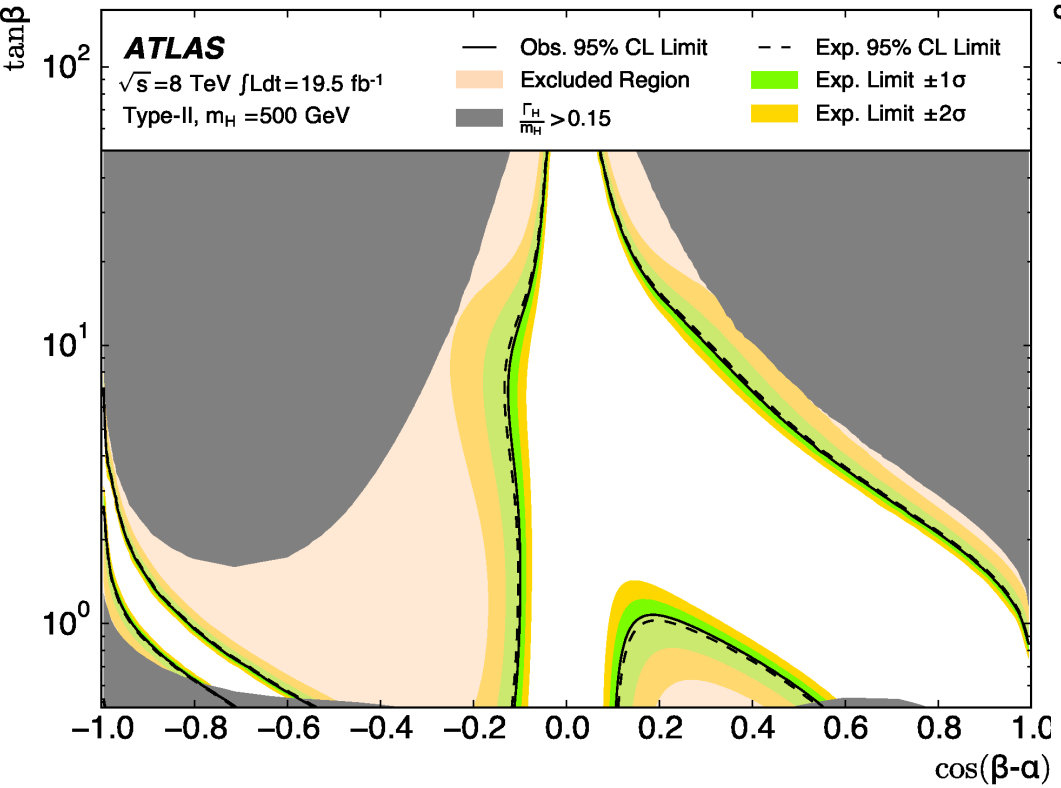
ATLAS H→hh→bbbb

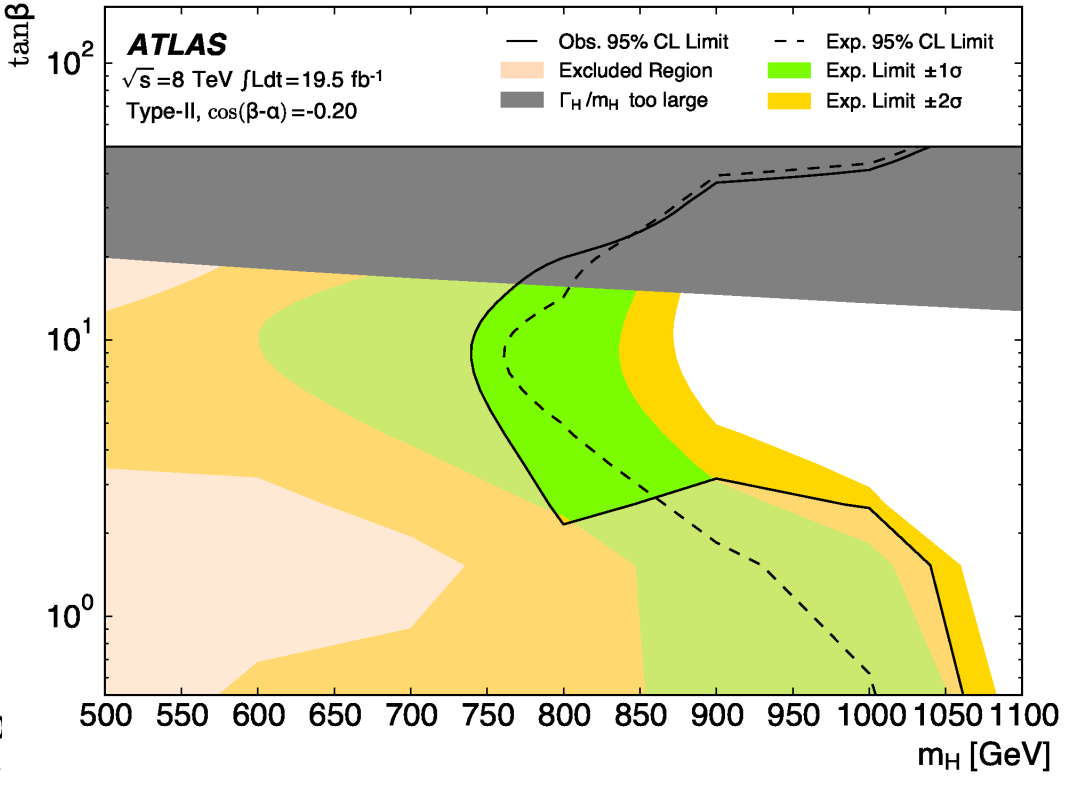
- Look for a CP-even Higgs boson H decaying to **hh→bbbb**
- Sensitive in high mass regime



- Width effects are taken into account up to 15%*m(H) and more

ATLAS H→hh→bbbb Type II 2HDM





Type II
m(A) = 500GeV

Type II
cos(β-α) = -0.20

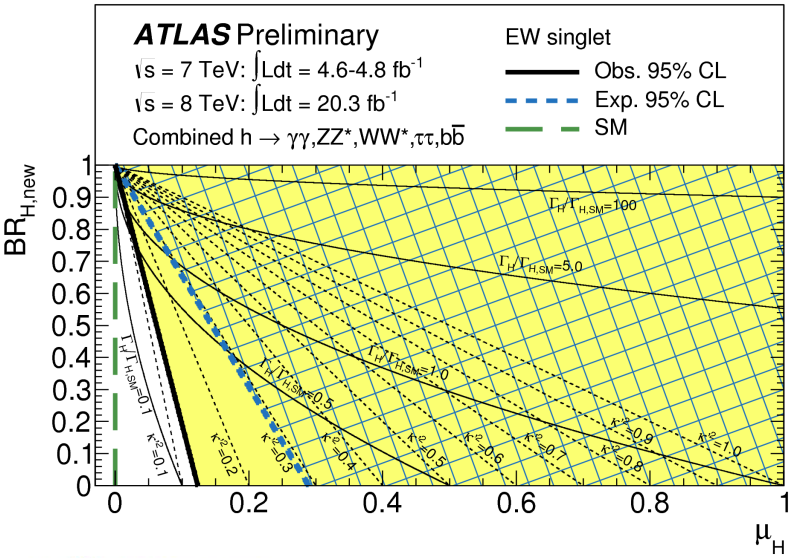
width/m(H)
within 15% for m(H)=500GeV
up to 23% for m(H)=1000GeV

ATLAS SM Higgs couplings

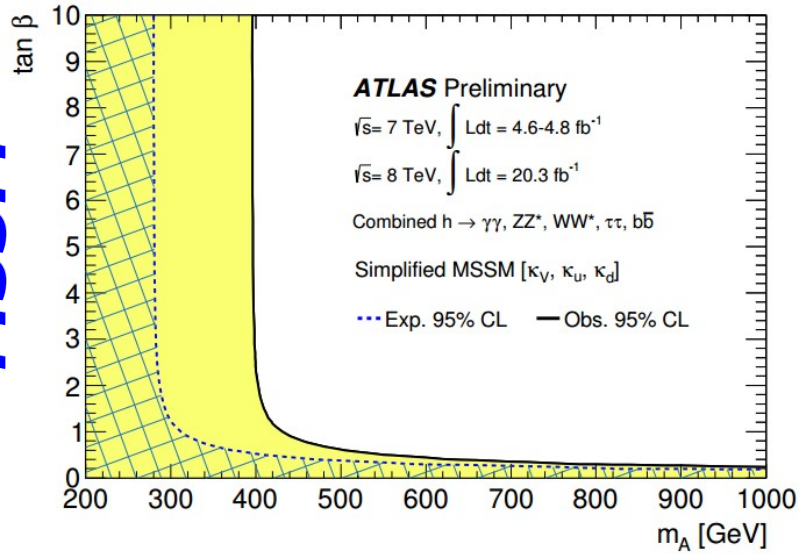
to be updated

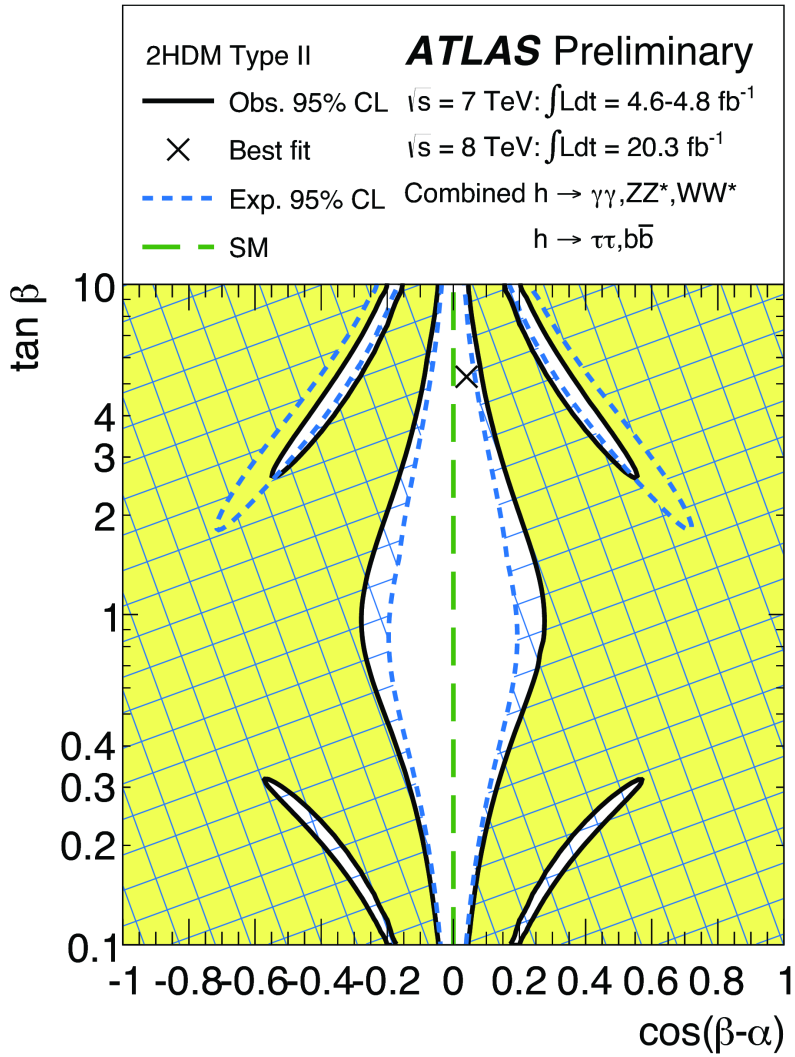
- Indirect constraints on BSM physics via SM Higgs couplings including h→γγ, ZZ, WW, ττ, bb

EW singlet



Simplified MSSM



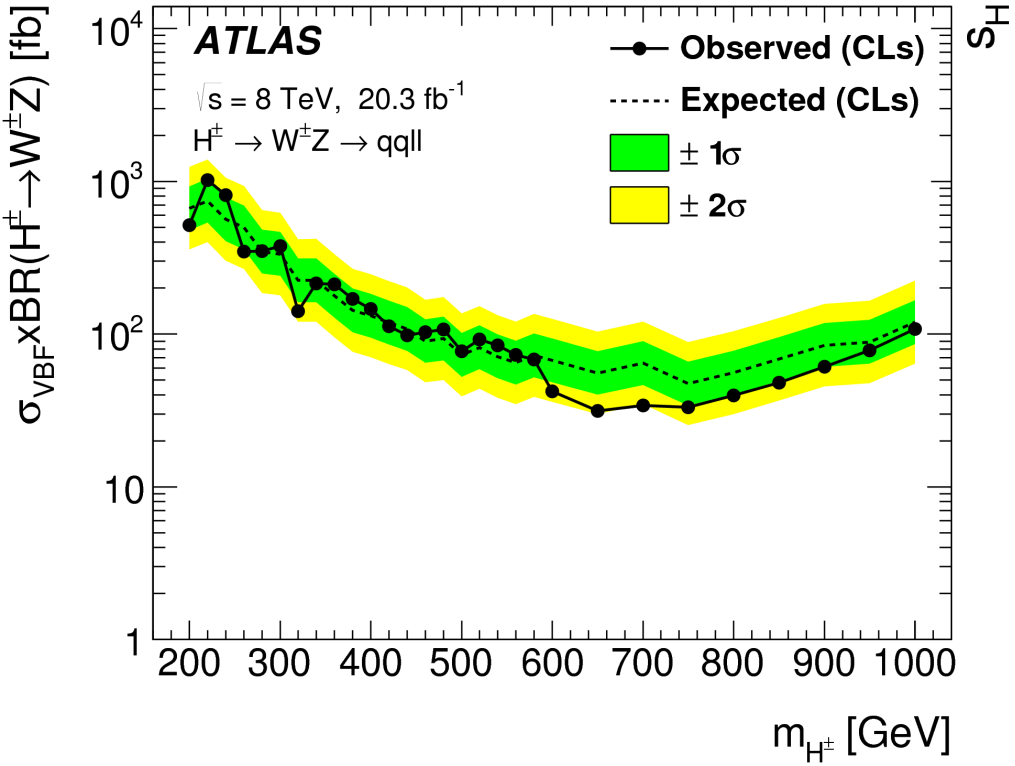


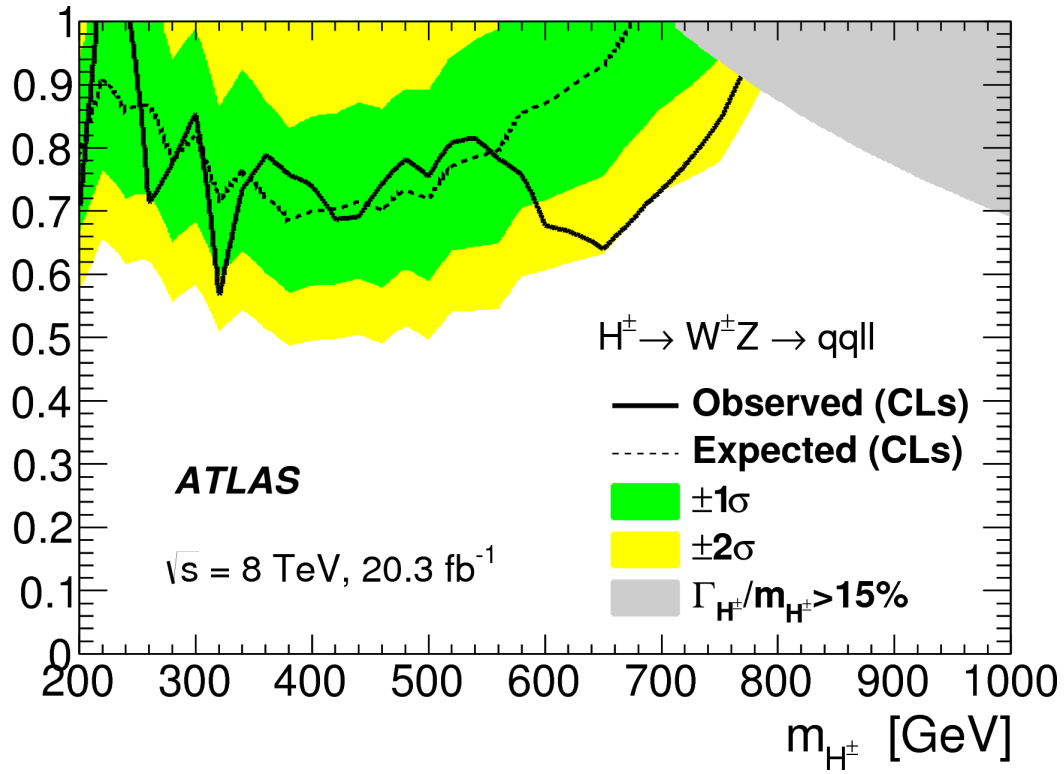
2HDM Type II

ATLAS $H^{\pm}\rightarrow WZ$

LHCHXSWG-2015-001
This May!

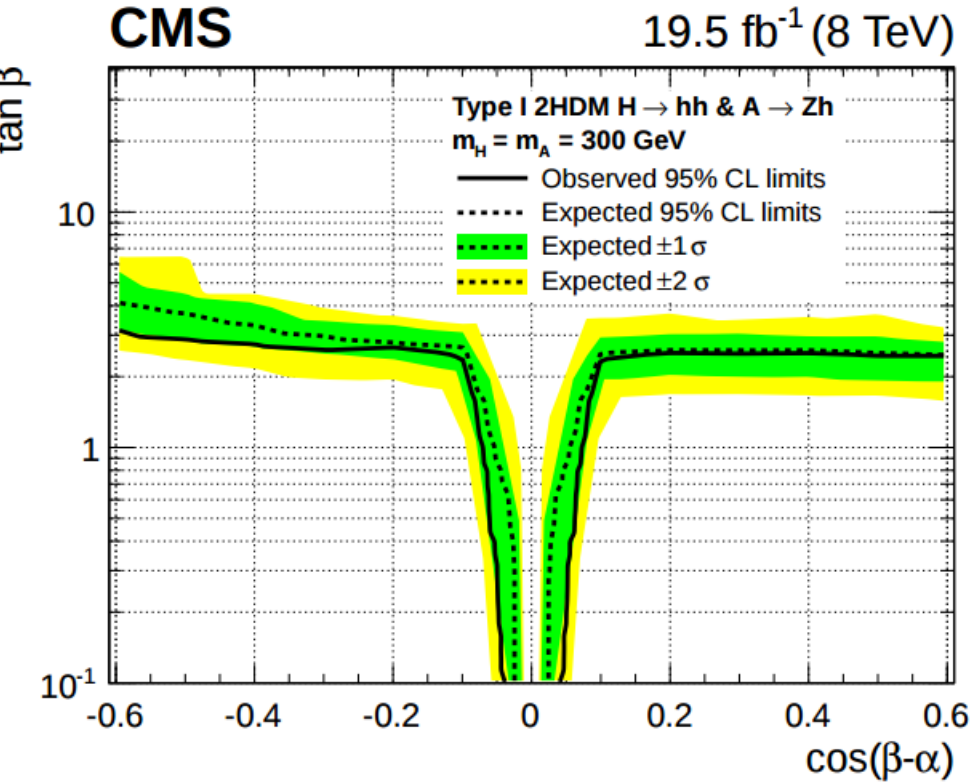
- Search for a charged Higgs boson produced in the VBF Mode with decay of $H^{\pm}\rightarrow WZ$ (tree level), $W\rightarrow qq$ and $Z\rightarrow ee/\mu\mu$
- The data are compared with the Georgi-Machacek Higgs triplet model (GMHTM)



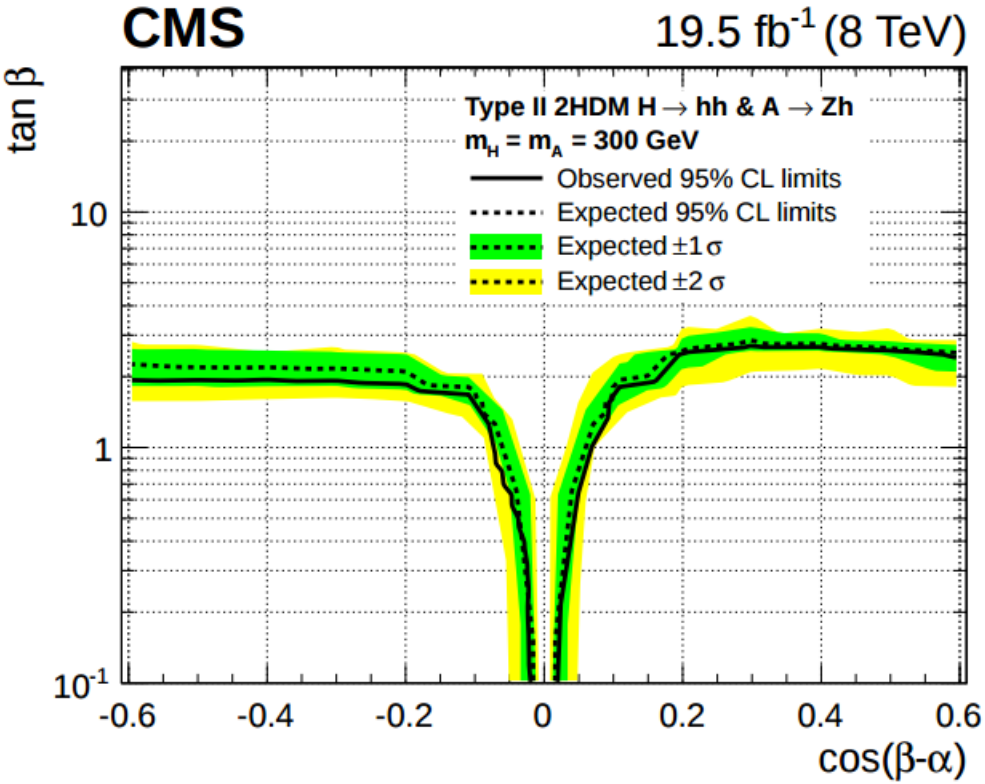


CMS H/A→multilepton/diphoton

- Inclusively search final states with three or four charged leptons and a resonant pair of photon + at least one leptons, for H→hh or A→Zh



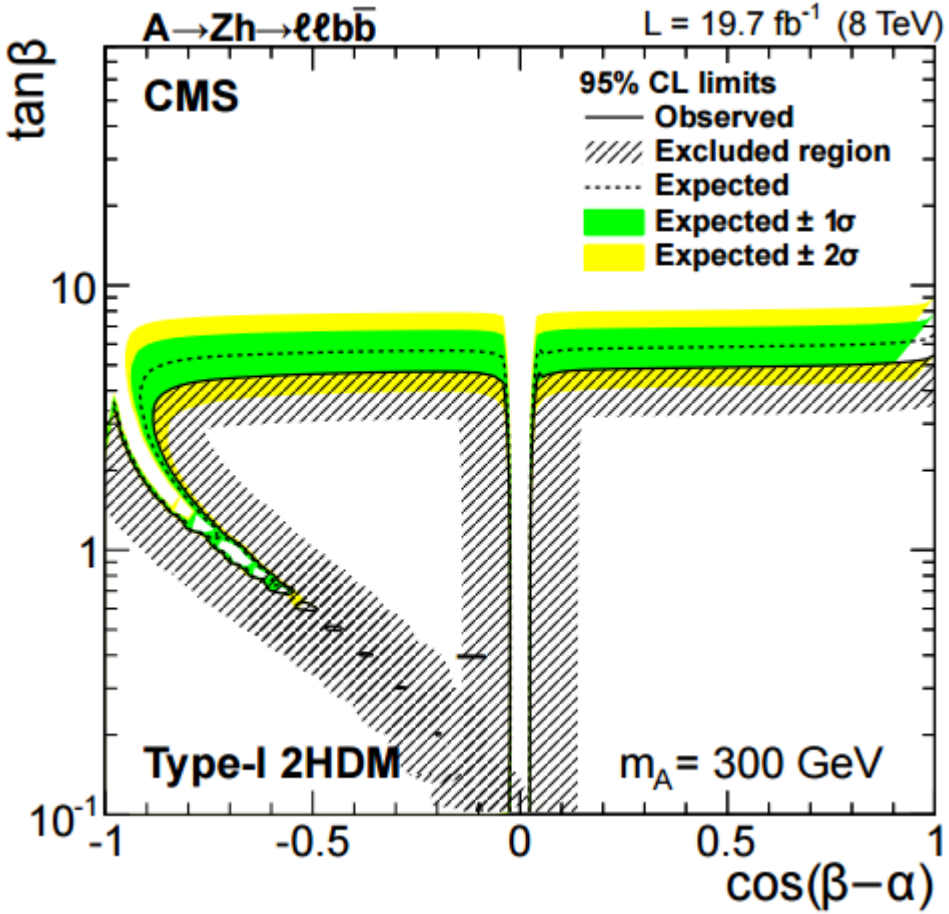
2HDM Type I m(H)=m(A)=300GeV



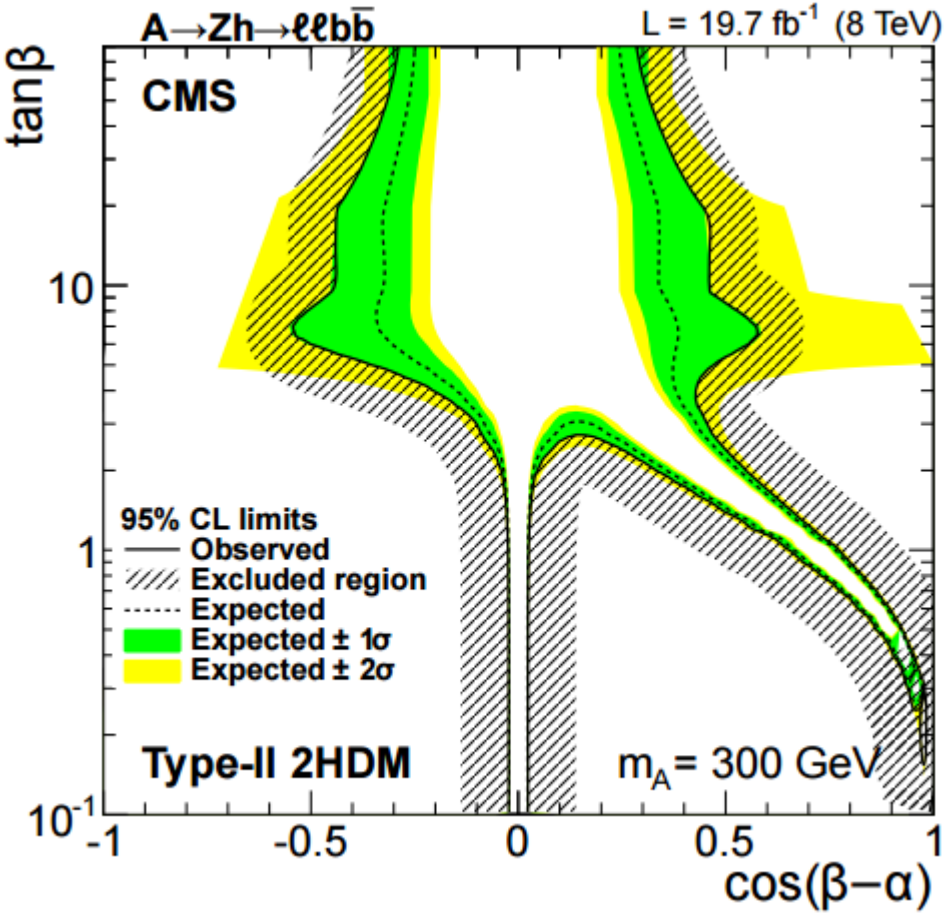
2HDM Type II m(H)=m(A)=300GeV

CMS A→Zh

- Look for CP-odd pseudoscalar A to Zh→llbb



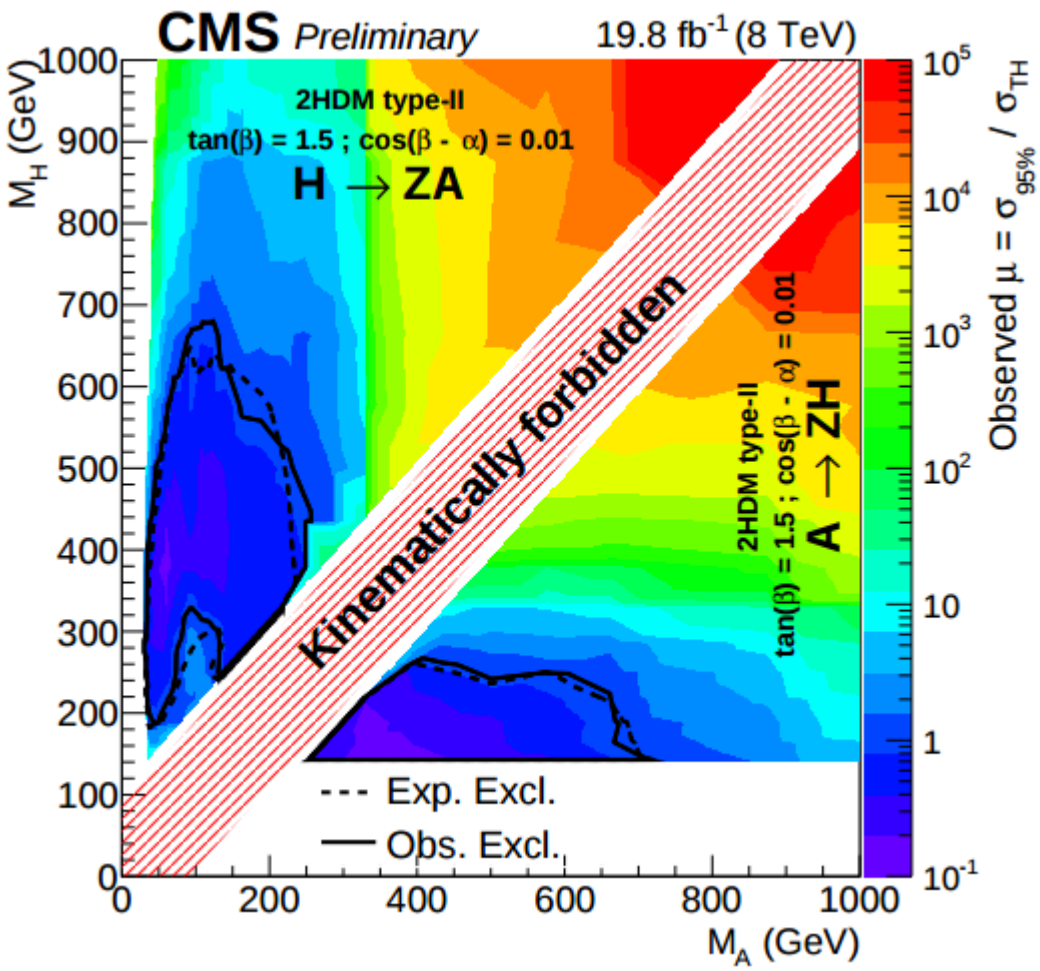
2HDM Type I
m(A)=300GeV



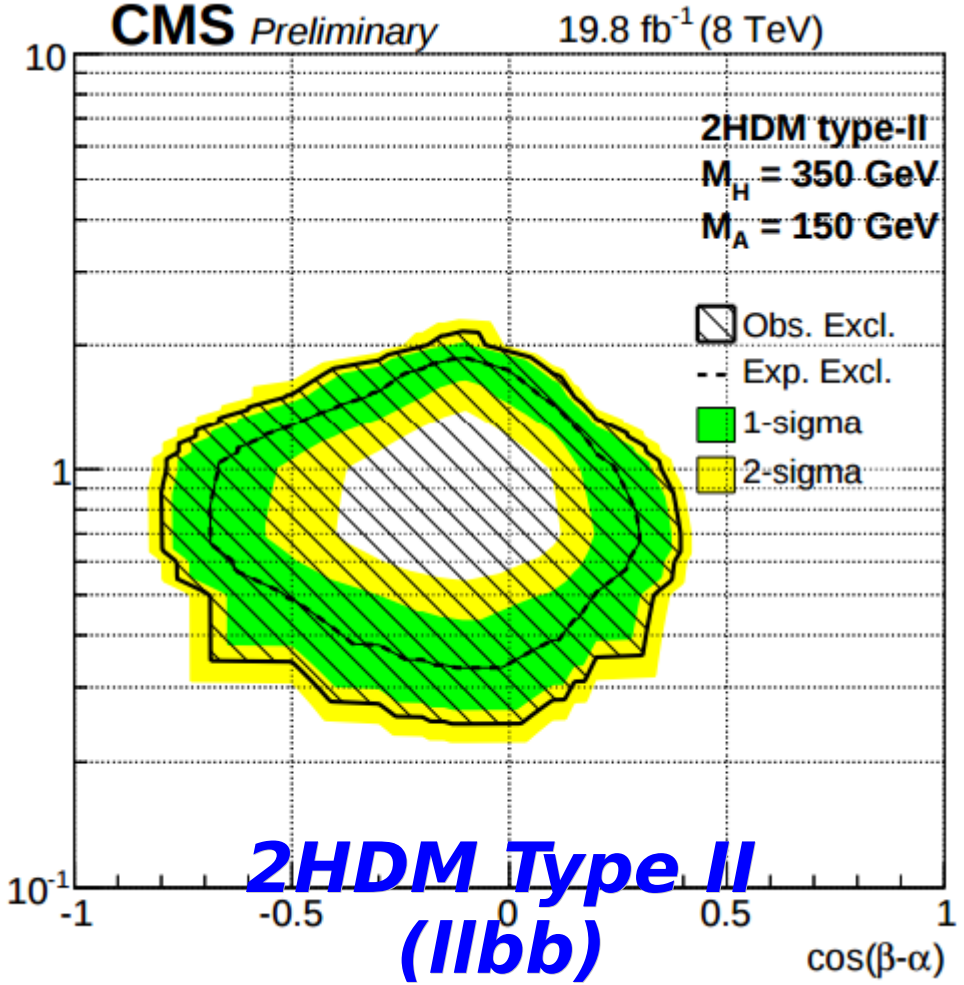
2HDM Type II
m(A)=300GeV

CMS H/A→Z A/H

- Search for H/A→Z A/H →llbb or llττ



2HDM Type II (llbb)

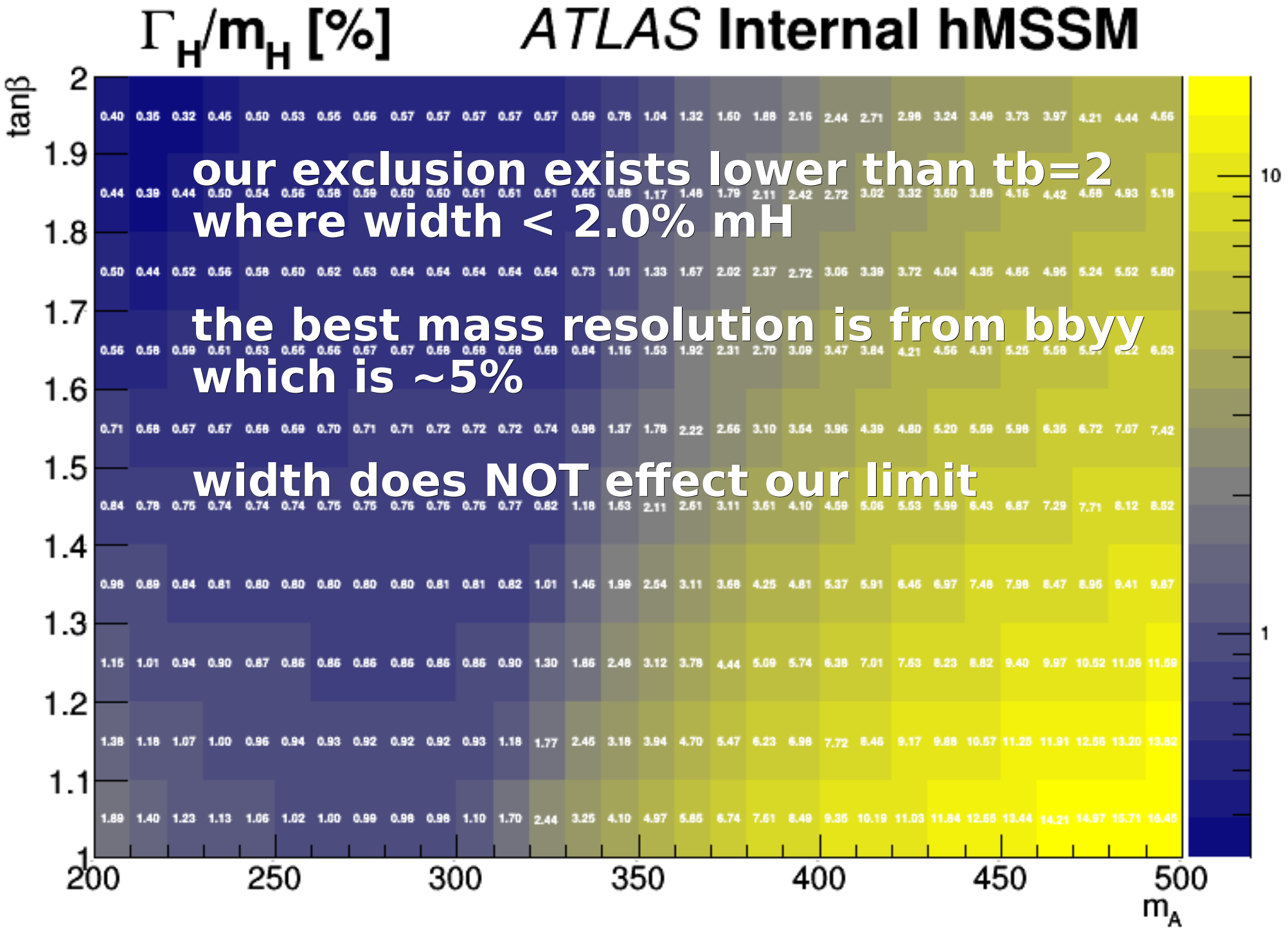


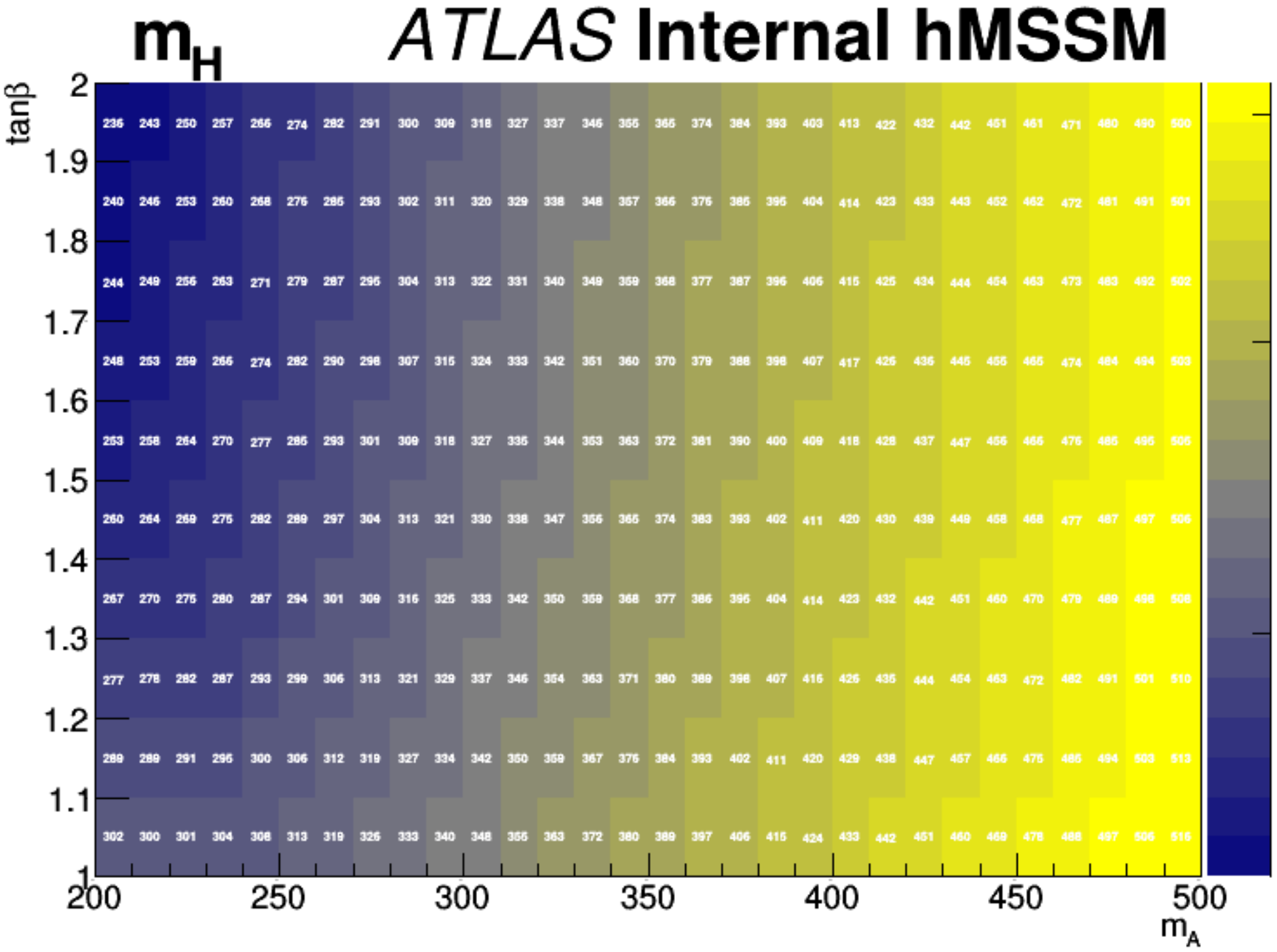
2HDM Type II (llbb) m(H)=350GeV m(A)=150GeV

Summary of the workshop

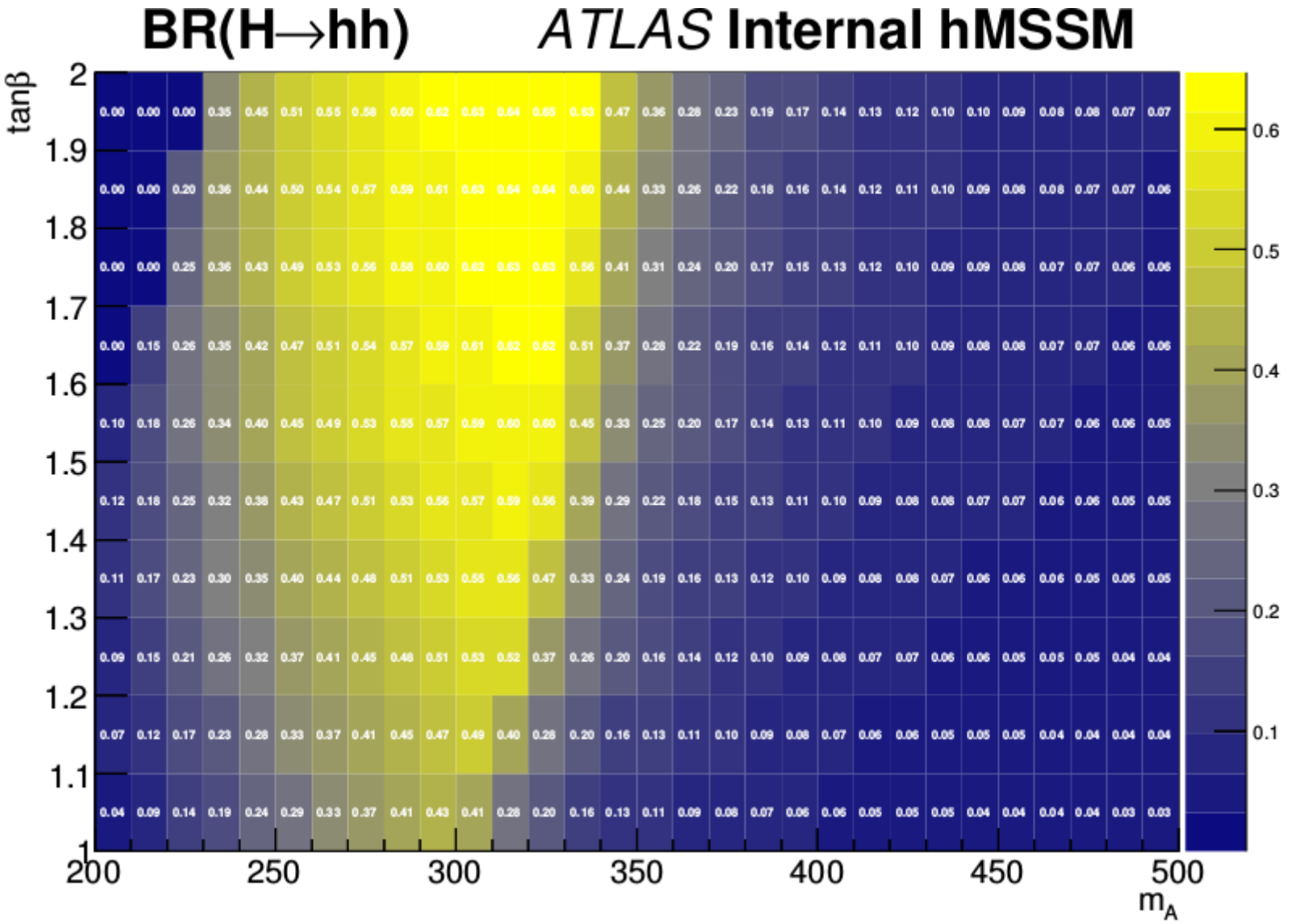
- WG3 domains
  - ◊ Neutral MSSM: **flagship!** in xsec and BR
  - ◊ **Extended scalars**: singlets, doublets, triplets; LHCHXSWG-2013-001 (2HDM), LHCHXSWG-2015-001 (triplet); currently identify benchmarks for 2HDM and centrally produced numbers, width and interference
  - ◊ NMSSM
  - ◊ Exotic Higgs decays
  - ◊ bbH production (with WG1): 4FS and 5FS
- Currently an huge effort to explore benchmarks in the NMSSM and the 2HDM
  - https://twiki.cern.ch/twiki/bin/view/LHCPhysics/LHCHXSWG3Benchmarks2HDM
- NEW May 2015, Low tanβ scenarios, **LHCHXSWG-2015-001 public note**

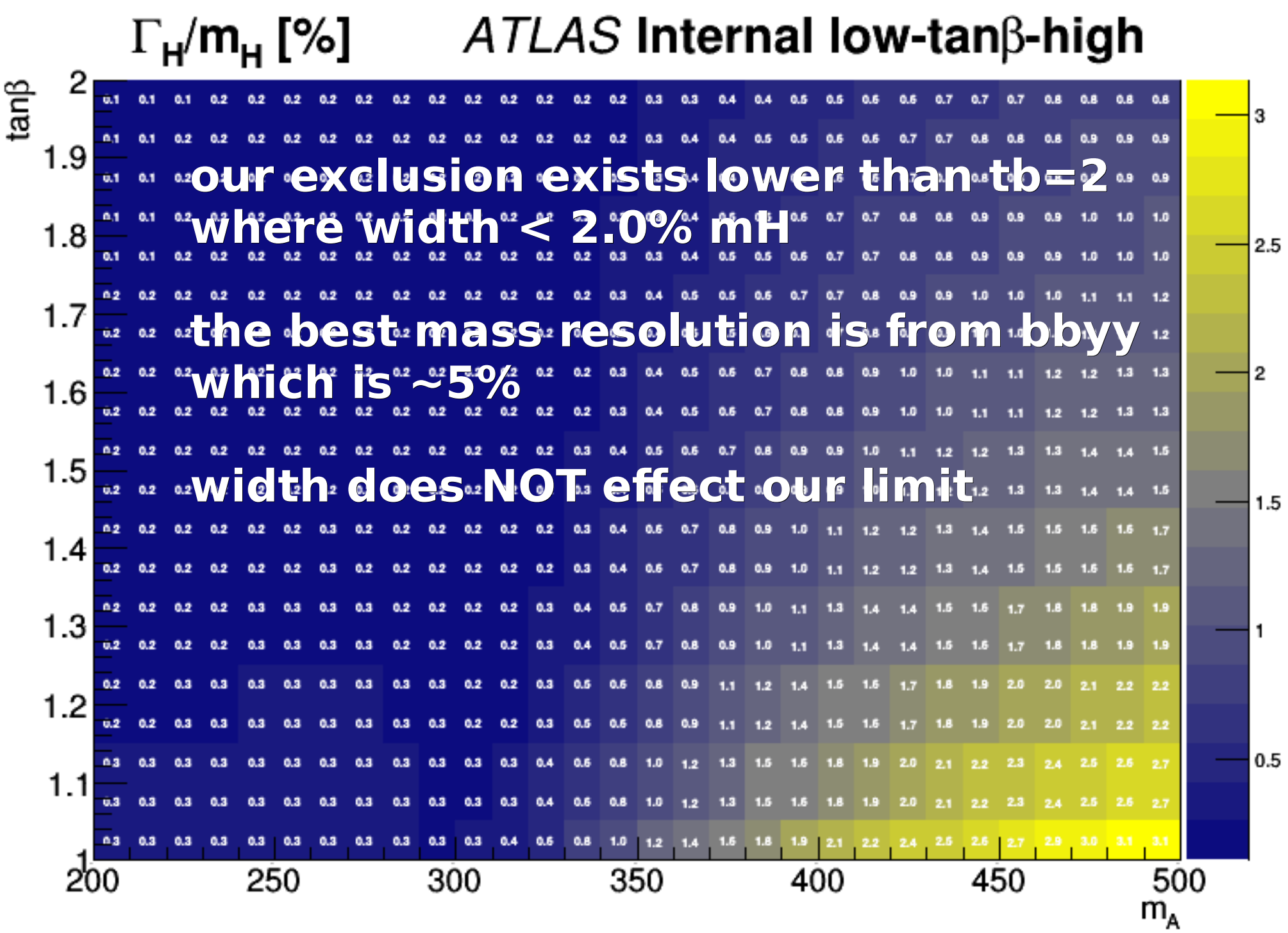
backup

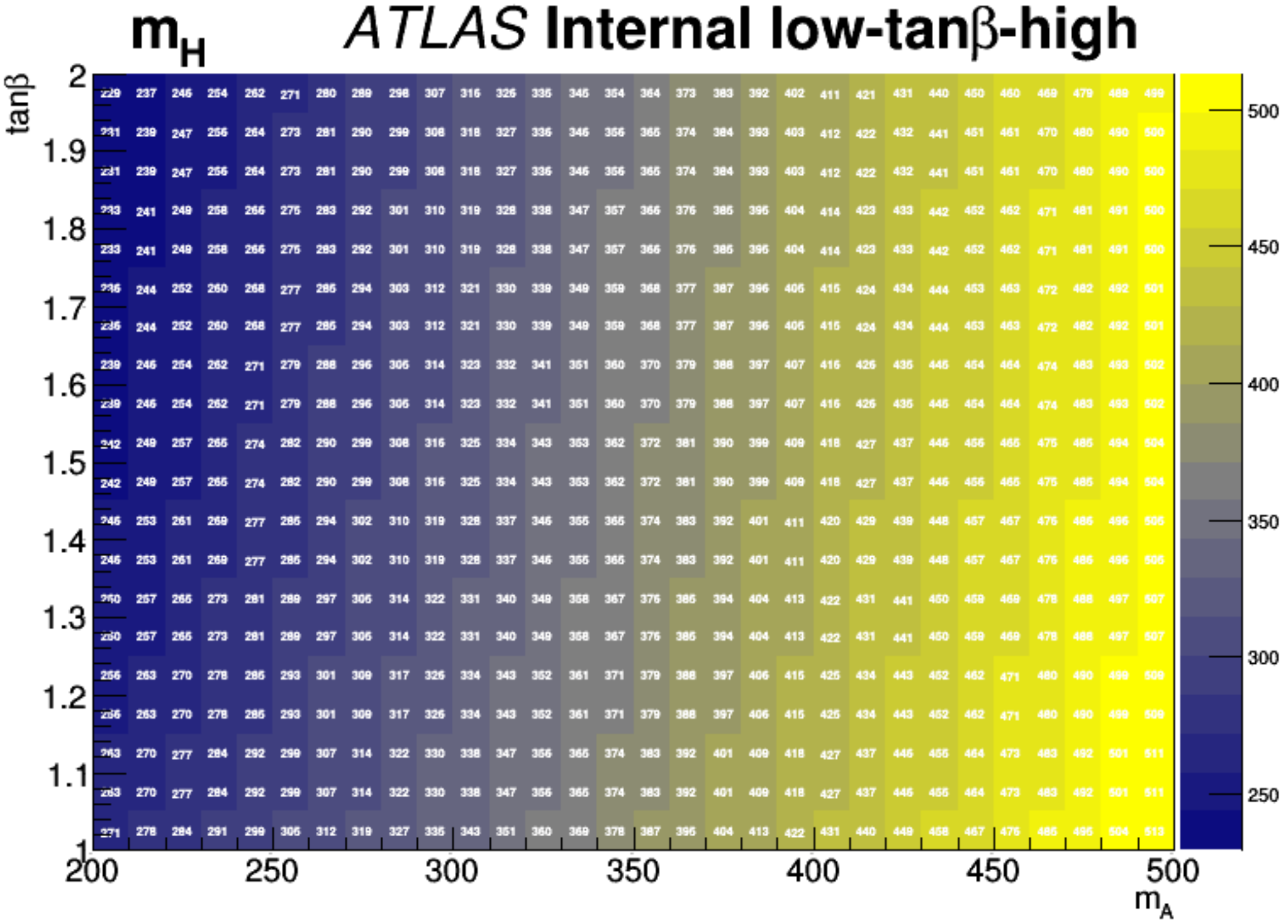

Γ_H/m_H [%]
ATLAS Internal hMSSM
tanβ
m_A
our exclusion exists lower than tb=2 where width < 2.0% mH
the best mass resolution is from bbyy which is ~5%
width does NOT effect our limit


m_H
ATLAS Internal hMSSM
tanβ
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
200
250
300
350
400
450
500
m_A
236 243 250 257 266 274 282 291 300 309 318 327 337 346 355 365 374 384 393 403 413 422 432 442 451 461 471 480 490 500
240 246 253 260 268 276 285 293 302 311 320 329 338 348 357 366 376 385 396 404 414 423 433 443 452 462 472 481 491 501
244 249 256 263 271 279 287 295 304 313 322 331 340 349 359 368 377 387 396 406 415 425 434 444 454 463 473 483 492 502
248 253 259 266 274 282 290 298 307 315 324 333 342 351 360 370 379 388 398 407 417 425 436 445 455 466 474 484 494 503
253 258 264 270 277 285 293 301 309 318 327 335 344 353 363 372 381 390 400 409 418 428 437 447 456 466 476 485 495 506
260 264 269 275 282 289 297 304 313 321 330 338 347 356 365 374 383 393 402 411 420 430 439 449 458 468 477 487 497 506
267 270 275 280 287 294 301 309 316 325 333 342 350 359 368 377 386 396 404 414 423 432 442 451 460 470 479 489 498 508
277 278 282 287 293 299 306 313 321 329 337 346 354 363 371 380 389 398 407 416 426 435 444 454 463 472 482 491 501 510
289 289 291 295 300 306 312 319 327 334 342 350 359 367 376 384 393 402 411 420 429 438 447 457 466 475 485 494 503 513
302 300 301 304 308 313 319 326 333 340 348 356 363 372 380 389 397 406 415 424 433 442 451 460 469 478 488 497 506 516

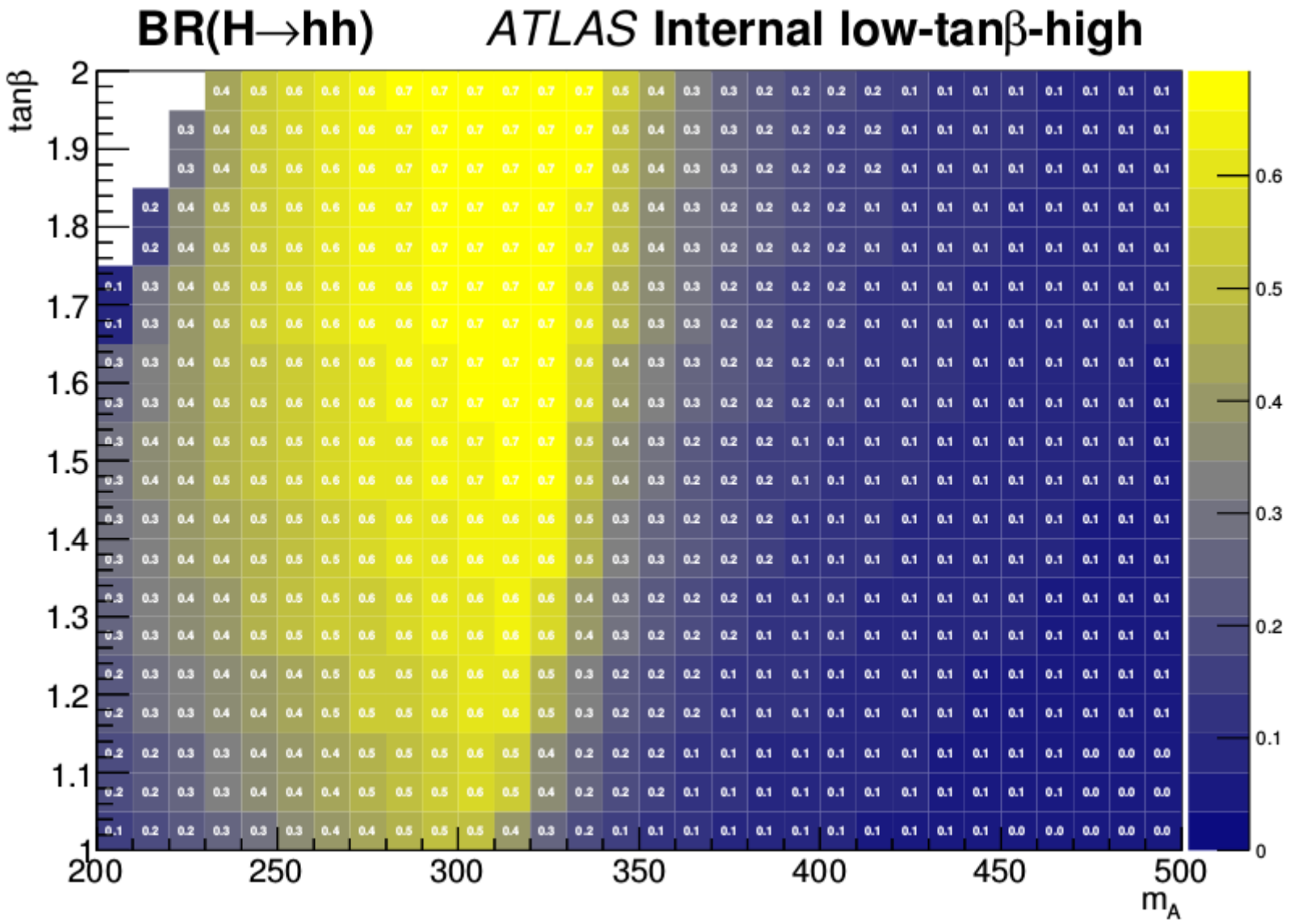
hMSSM BR(H-hh)


BR(H→hh)
ATLAS Internal hMSSM
tanβ
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
200
250
300
350
400
450
500
m_A
0.6
0.5
0.4
0.3
0.2
0.1

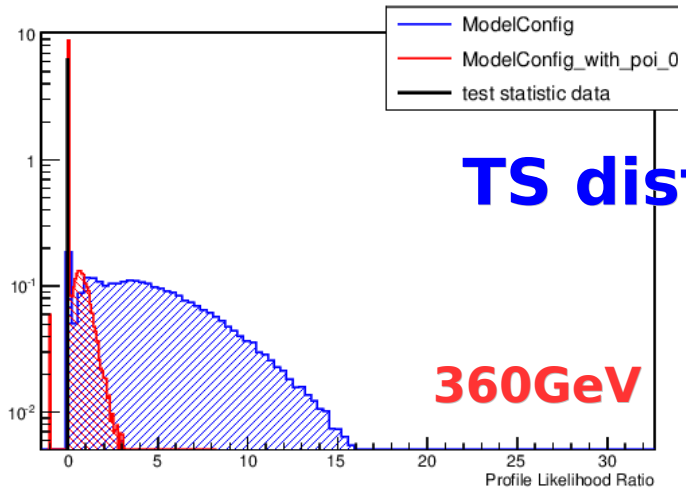

Γ_H/m_H [%]
ATLAS Internal low-tanβ-high
tanβ
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
200
250
300
350
400
450
500
m_A
3
2.5
2
1.5
1
0.5
our exclusion exists lower than tb=2 where width < 2.0% mH
the best mass resolution is from bbyy which is ~5%
width does NOT effect our limit

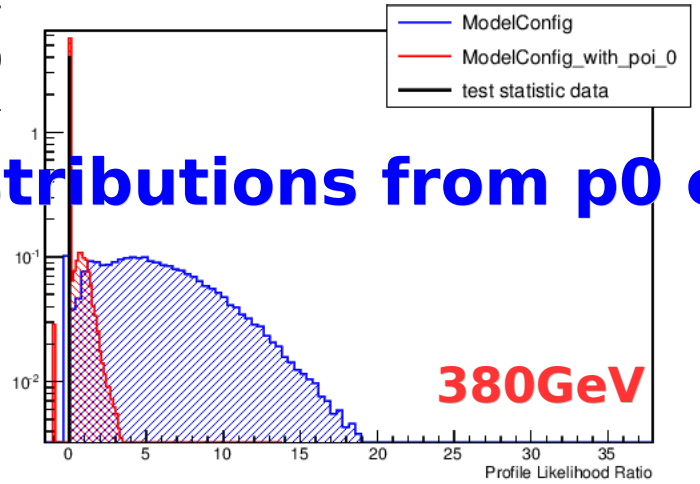

m_H
ATLAS Internal low-tanβ-high
tanβ
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
200
250
300
350
400
450
500
m_A
500
450
400
350
300
250

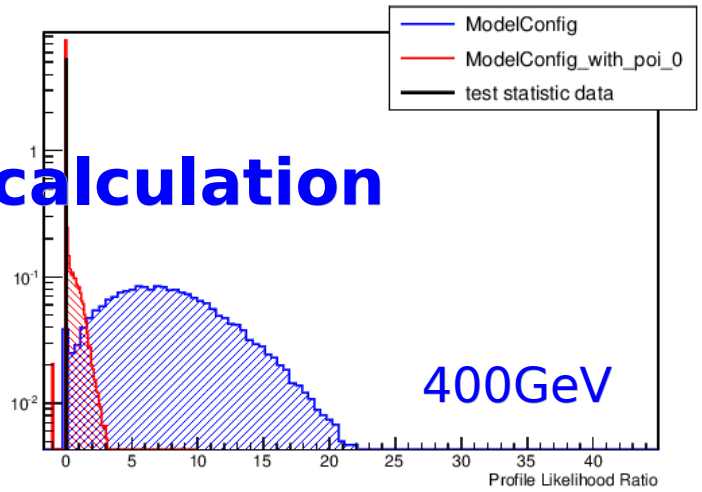
low-tb-high BR(H-hh)



TS distributions (combined)

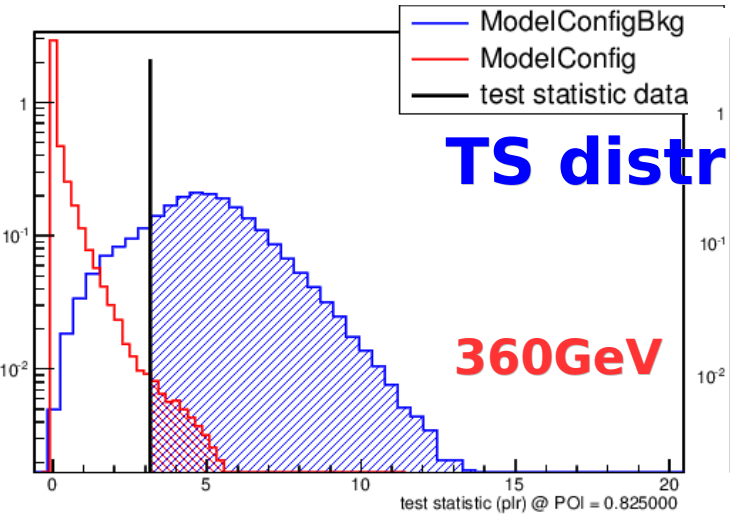


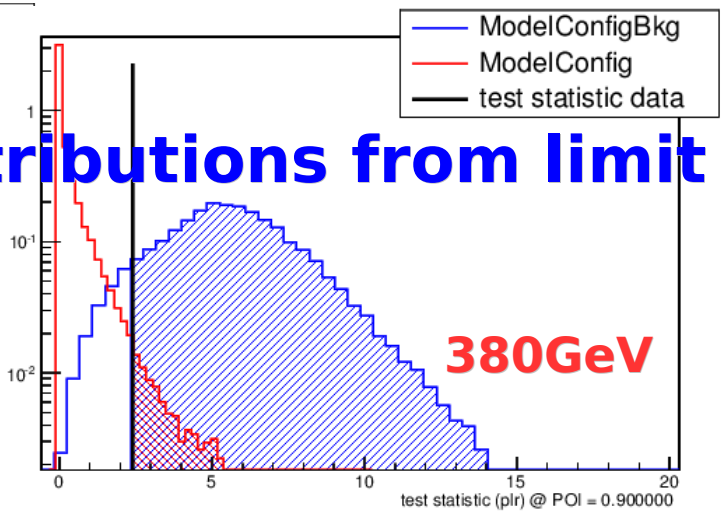


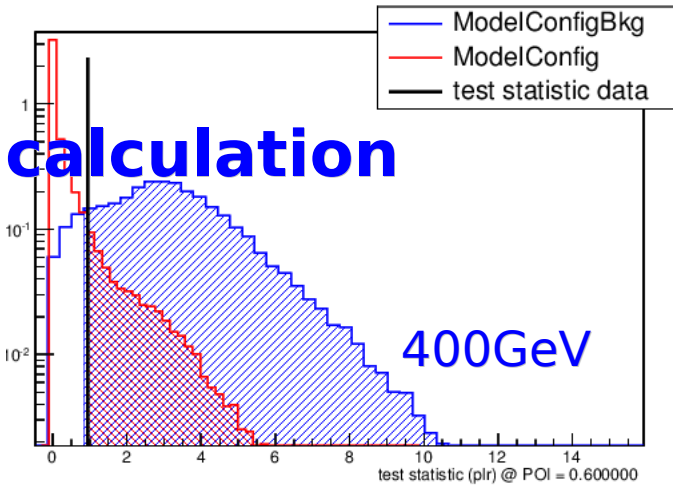


TS distributions from p0 calculation

TS(data)=0 **TS(data)=0** **TS(data)=0.0524729**



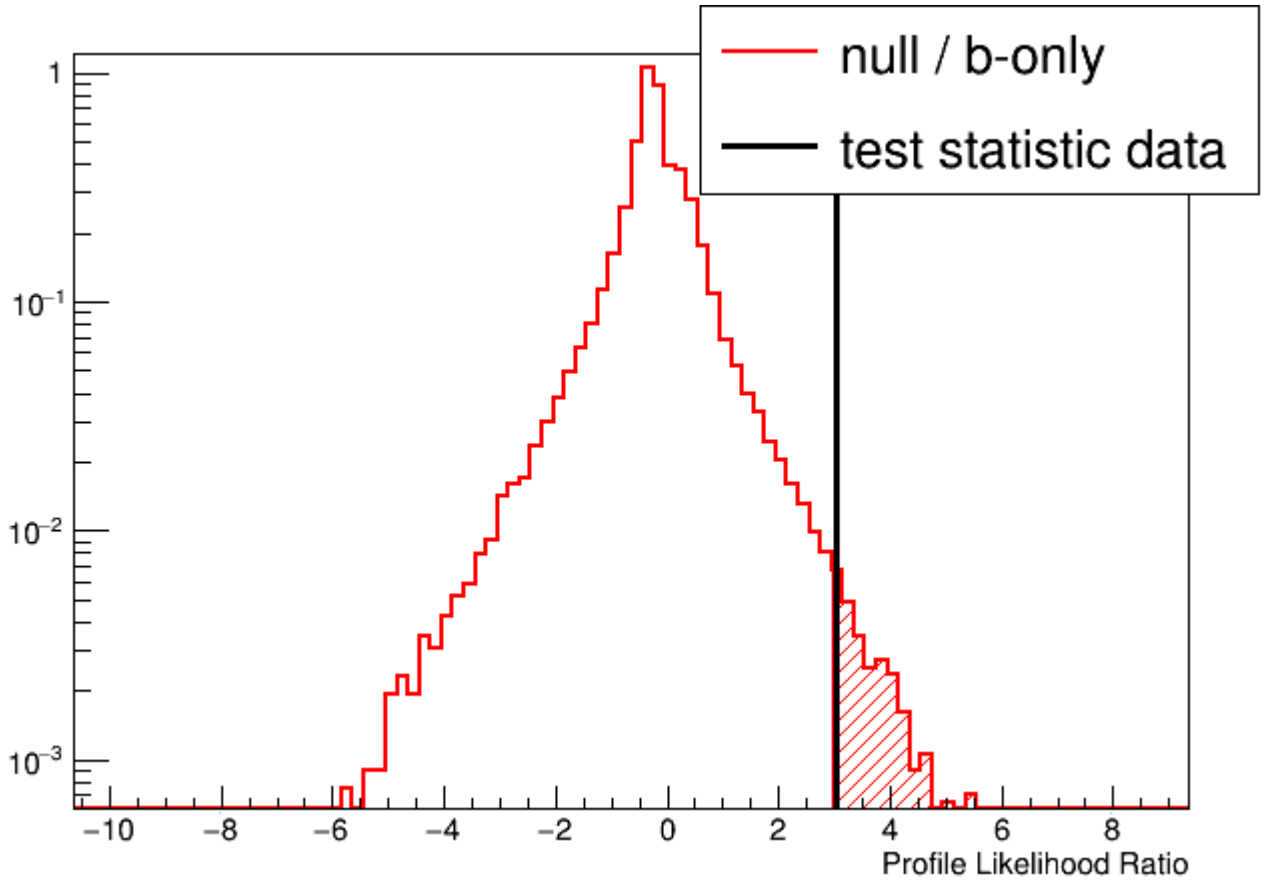




TS distributions from limit calculation

TS distribution (combined)

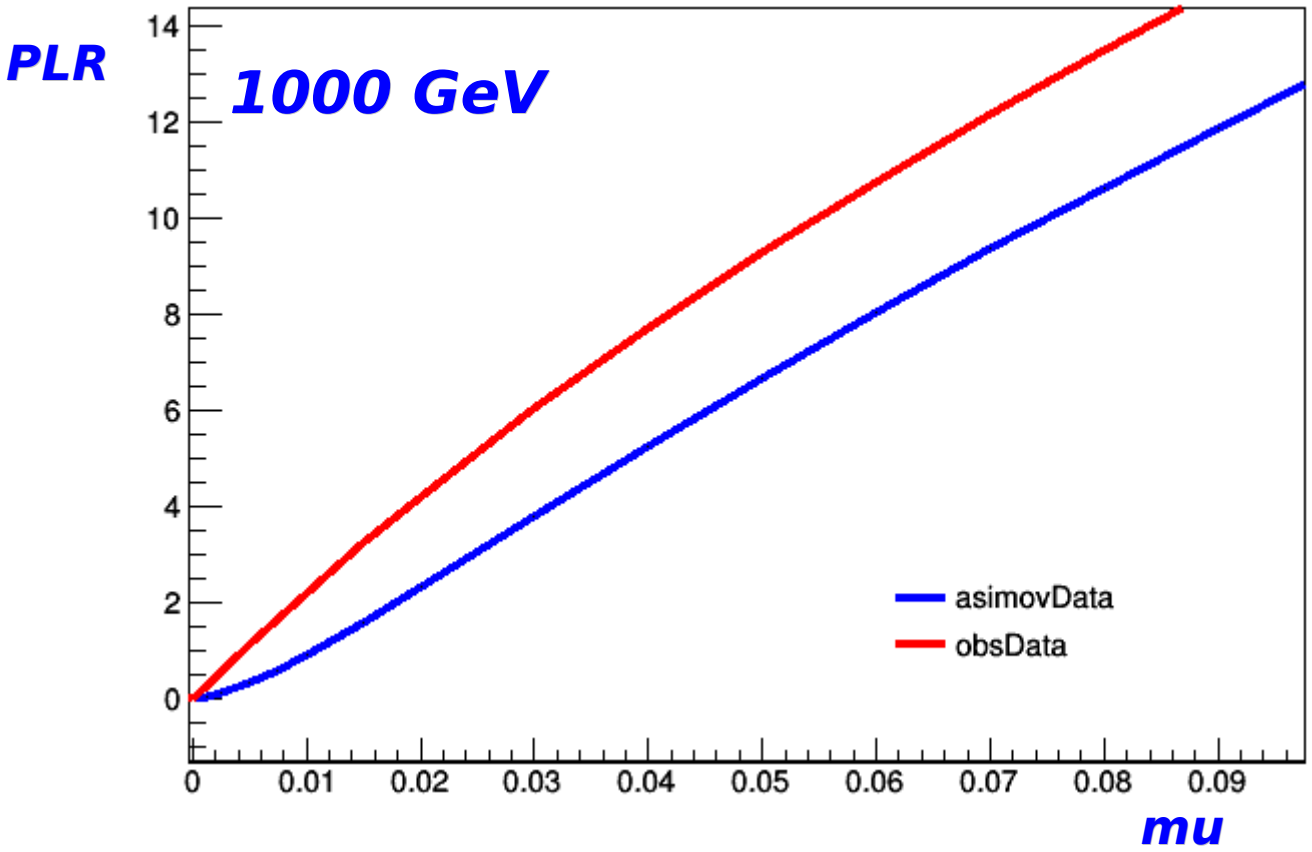
- ts distributions at 300 GeV



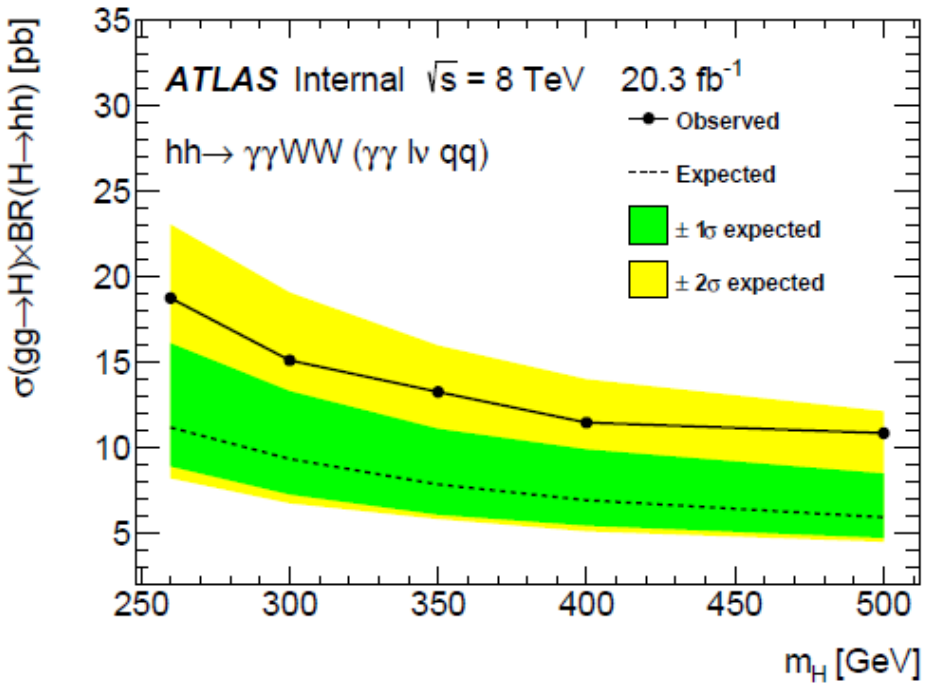
300 GeV
obs ts value: 3.03275
obs p-value: 0.0052399
obs significance: 2.55958

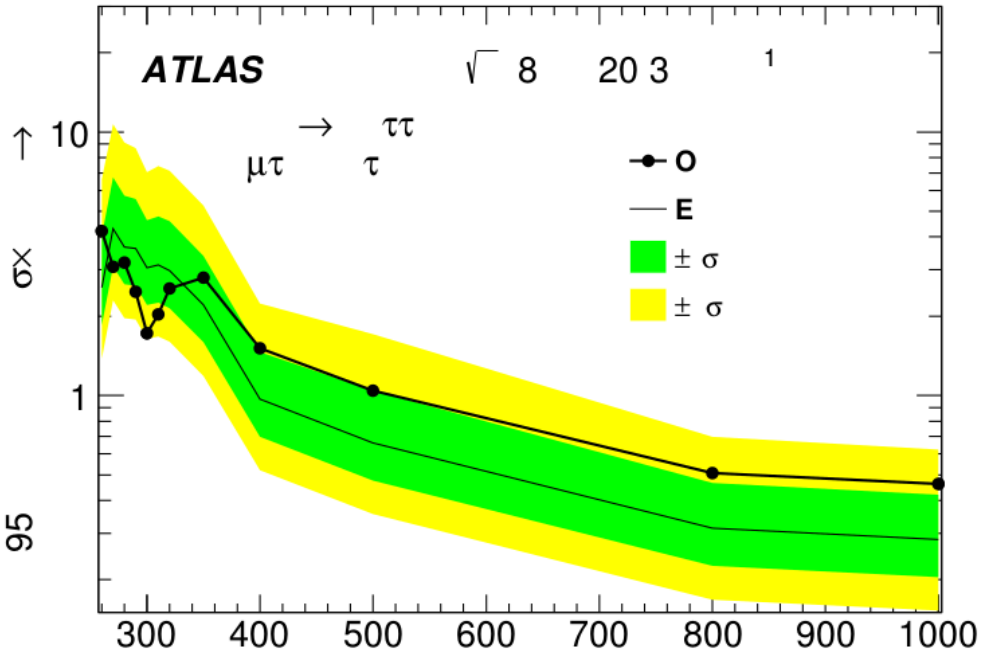
1000 PLR (combined)

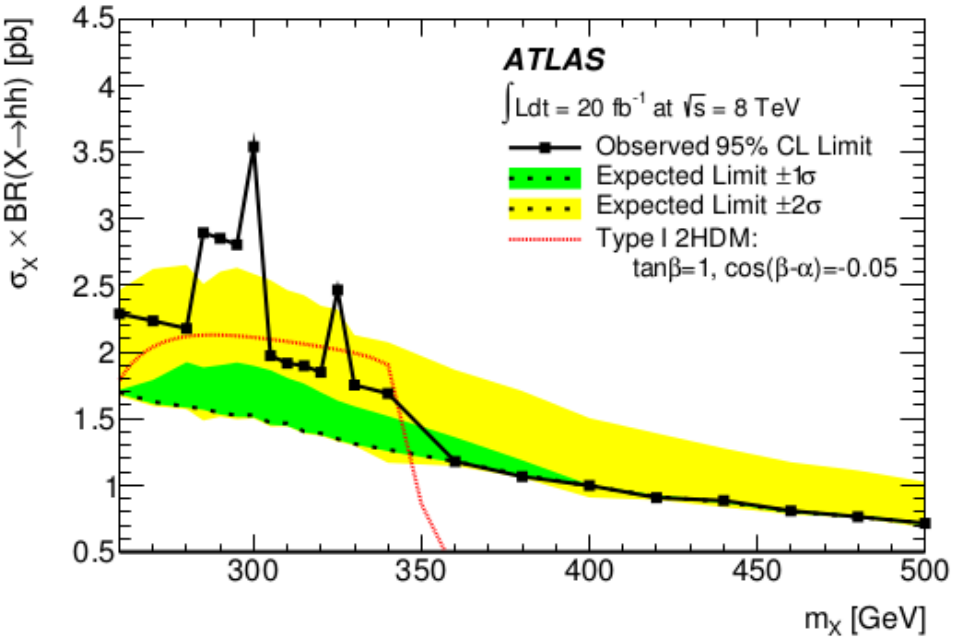
- Scan PLR for 1000 (a point with consistent p0 and limit) from mu 0 to 0.1
- mu_hat (1000) in data = -0.00463018

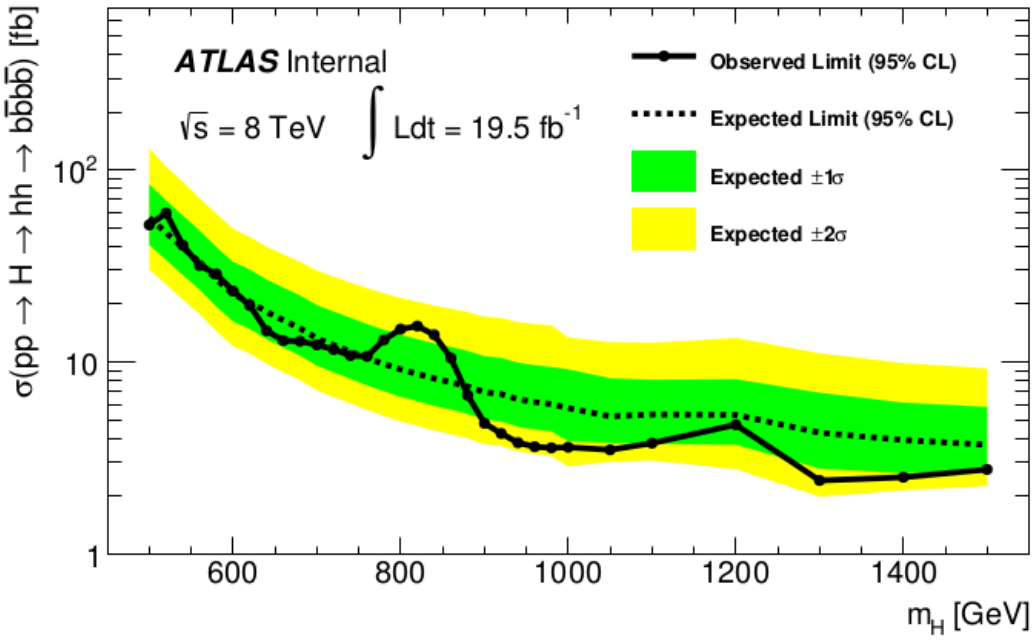


Channel limits [res]



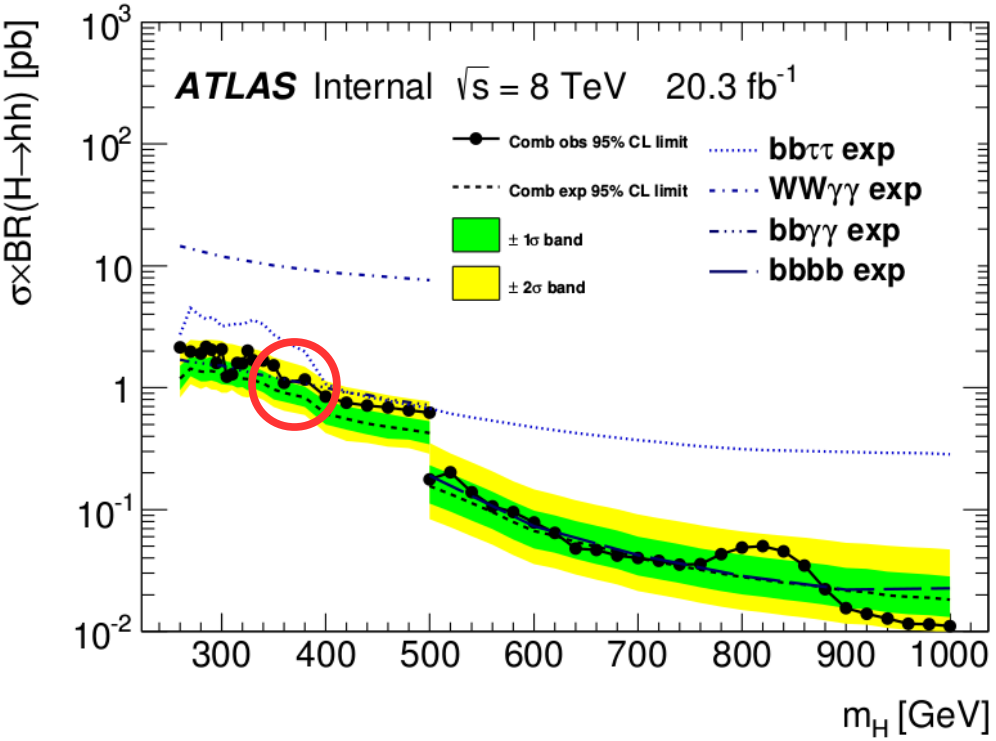


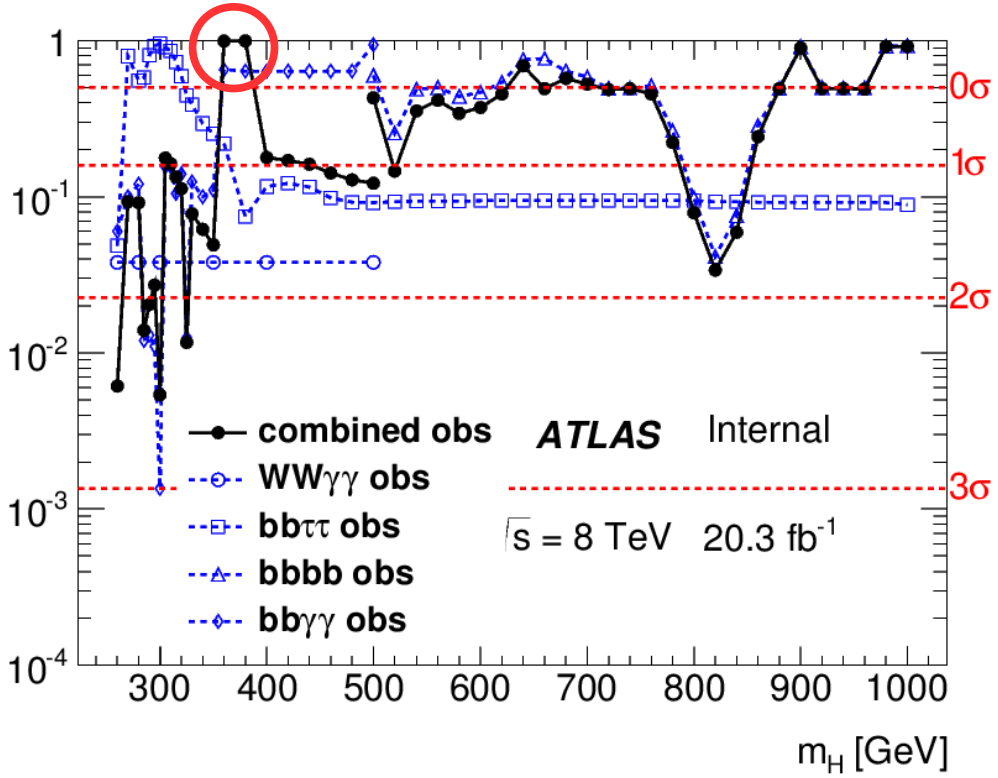




The issue at 360/380

- At 360 380, limits show data excess but p0 value do not seem so





This is actually due to the definition of test statistic with which p0 values are calculated

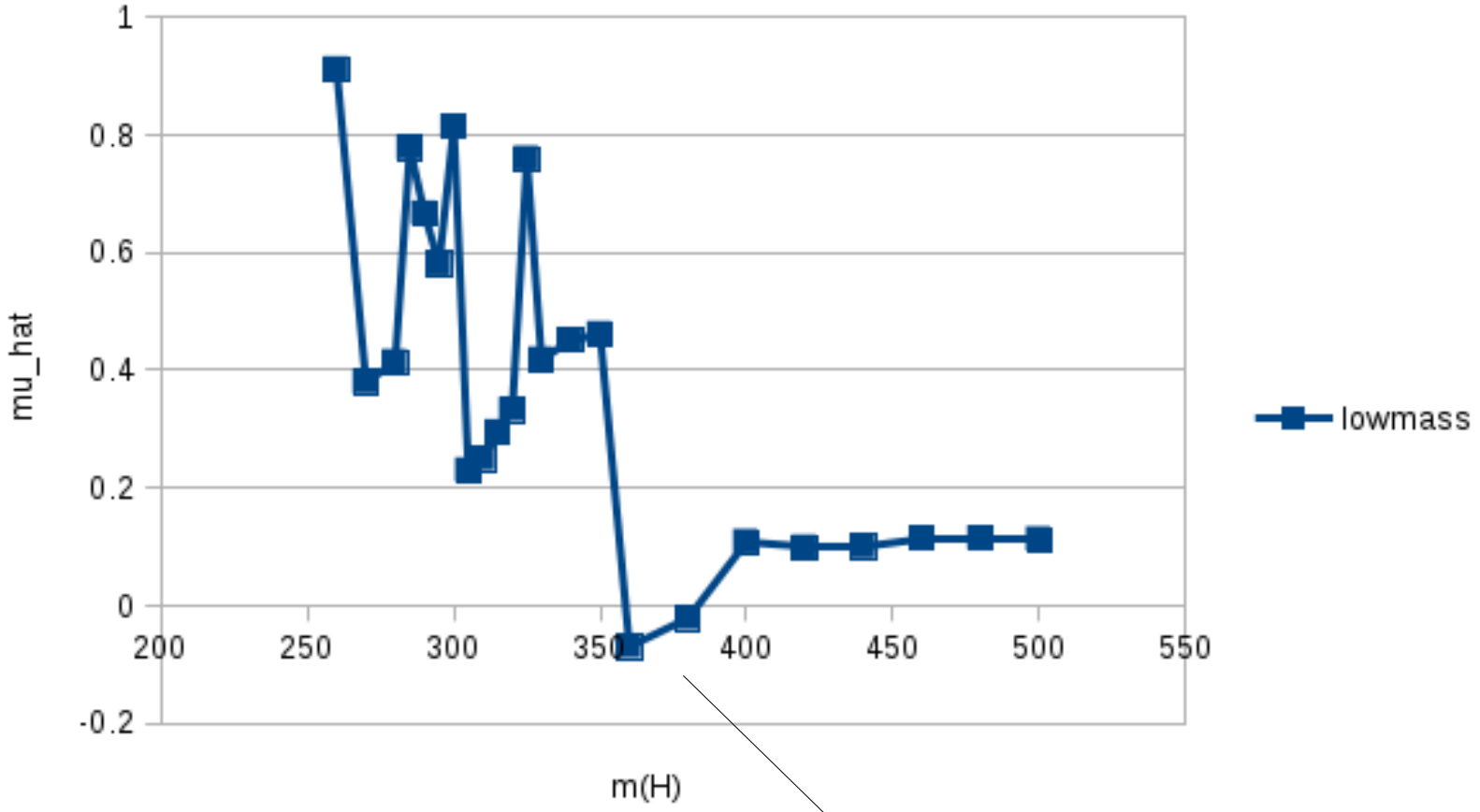
$$q_0 = \begin{cases} -2\ln\lambda(0) & \hat{\mu} \geq 0 \\ 0 & \hat{\mu} < 0 \end{cases}$$

one-sided discovery

*** http://arxiv.org/pdf/1007.1727v3.pdf

mu_hat

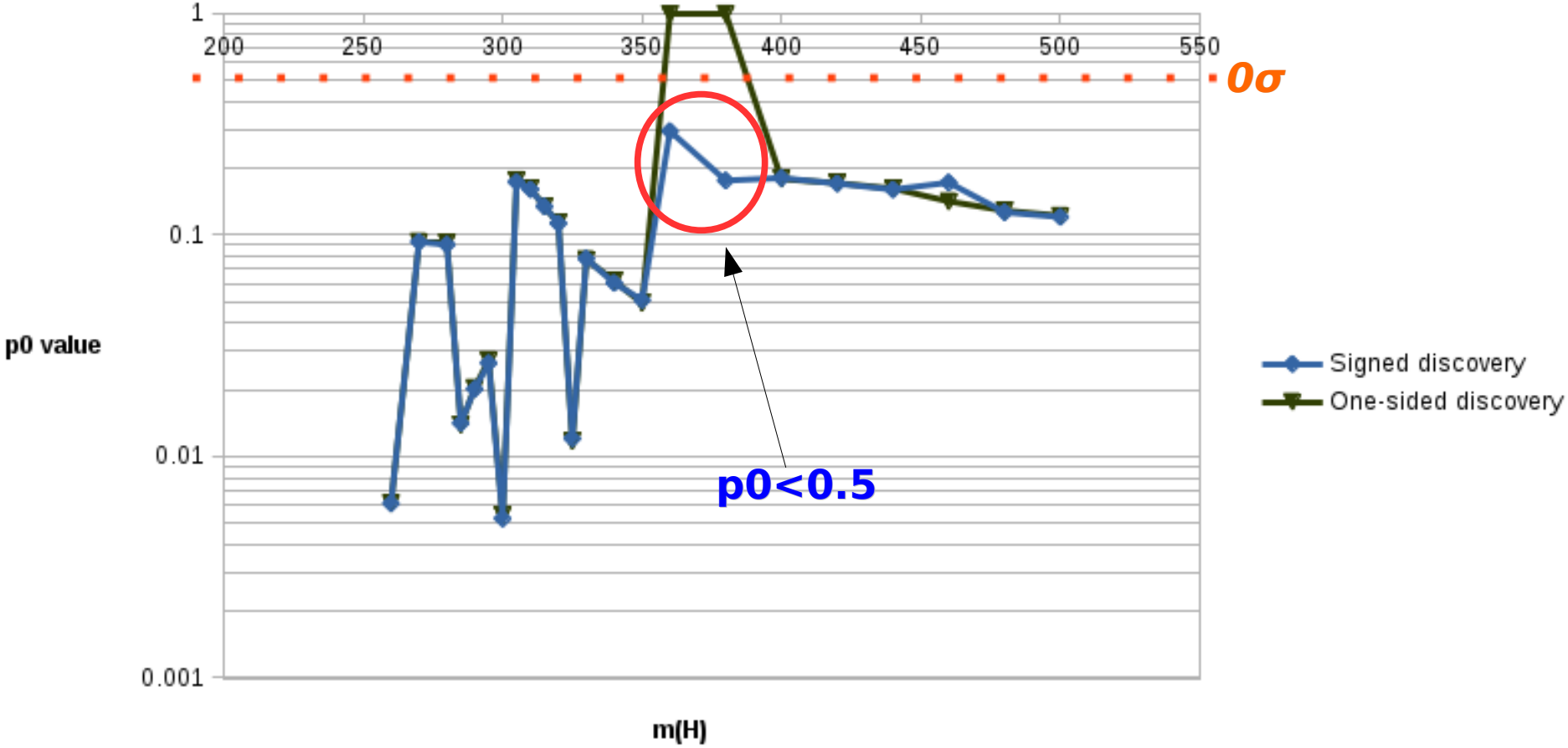
- mu_hat values are plotted as function of mH



360 & 380 have mu_hat <0

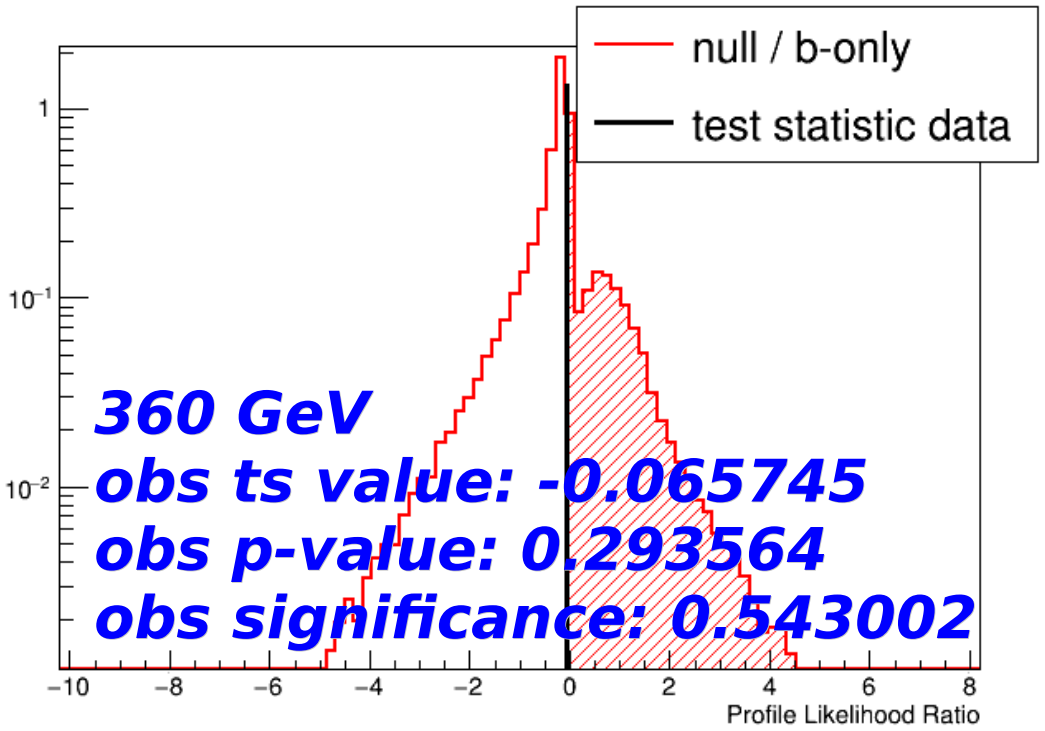
P0 values

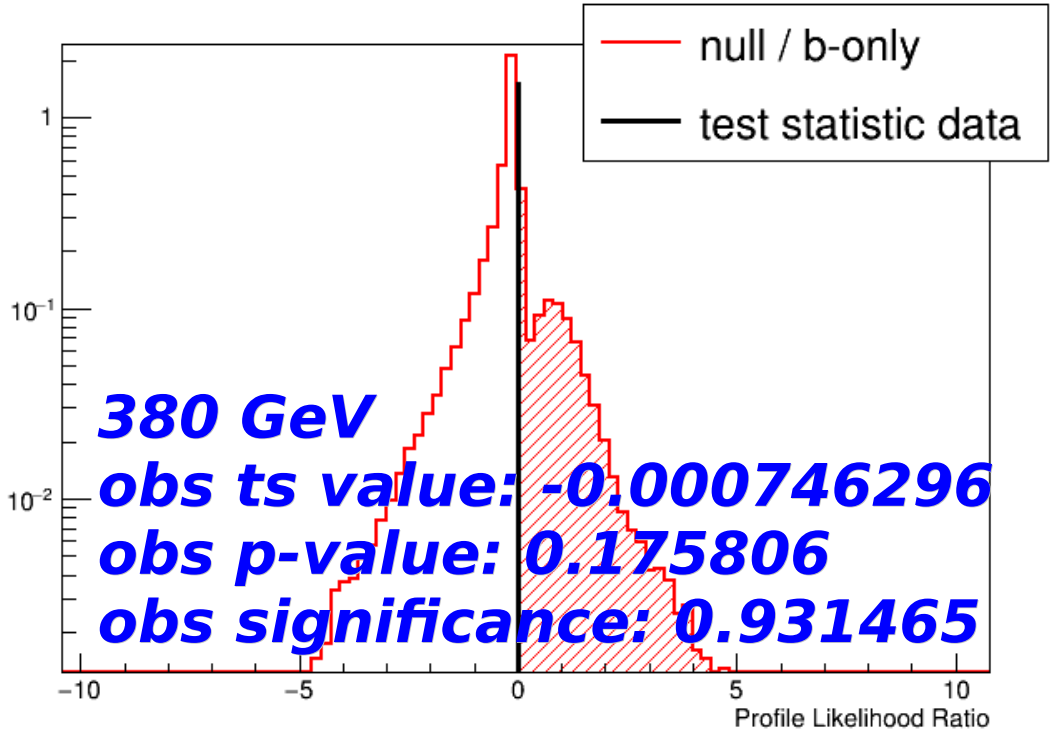
- Now, using a non-zero ts definition (“signed discovery”) when mu_hat<0, we have p0 values < 0.5 at 360 380



TS distribution (combined)

- ts distributions at 360 and 380

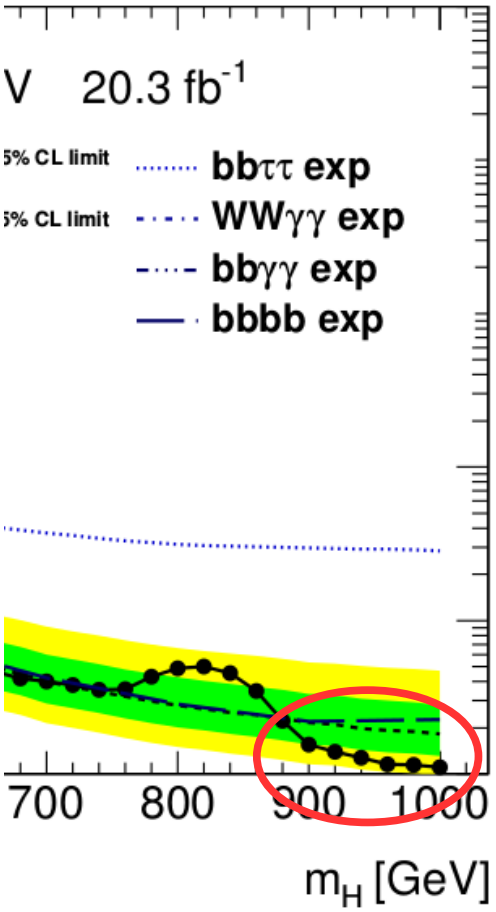


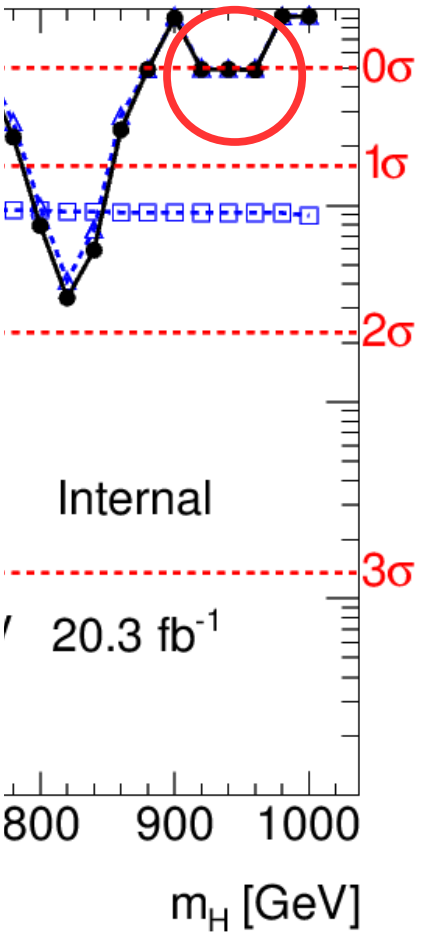


- In general, ts distributions is asymmetric; so even when ts(data) goes to negative, p0 value can still remain below 0.5

The issue at 920/940/960

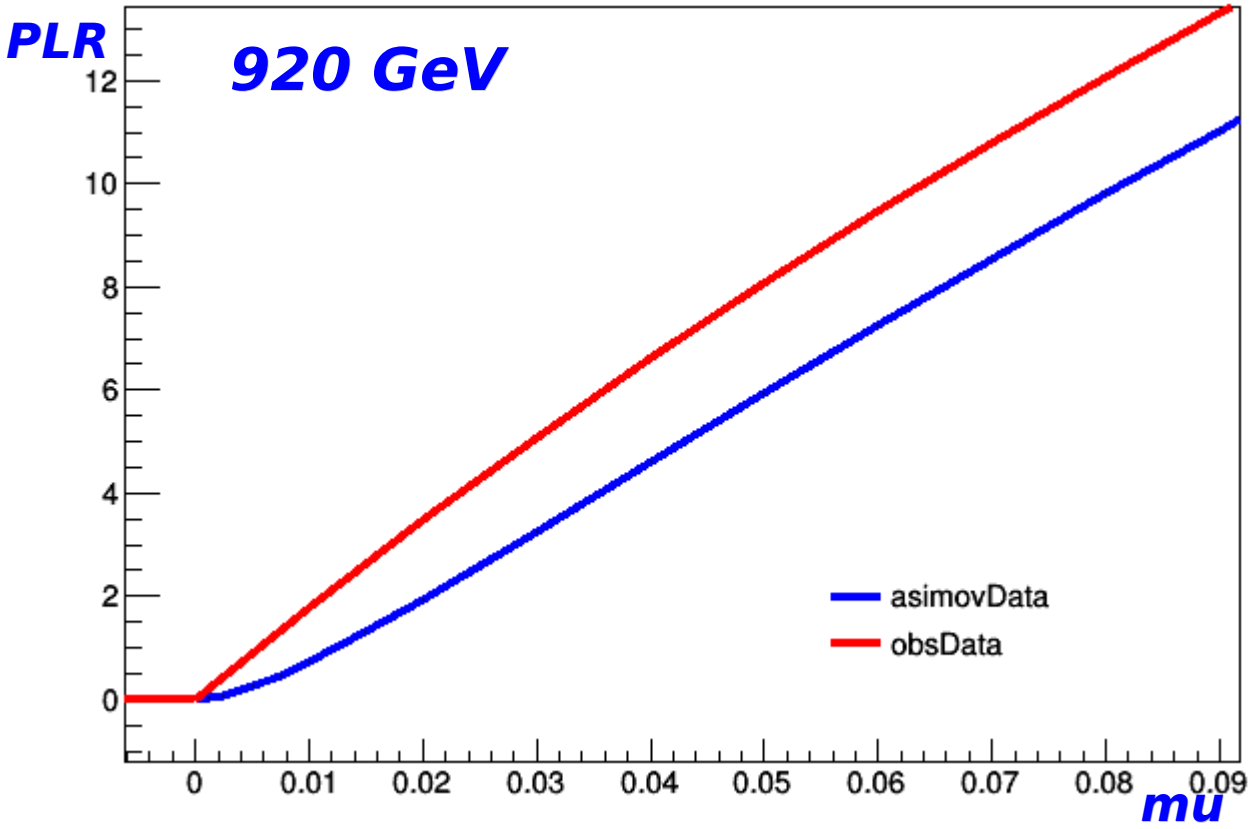
- 920 940 960 have data deficit in limit plot but p0 values seems to be 0.5 ~ 0 sigma
- by now, we have checked with David and have consistent bbbb p0 values





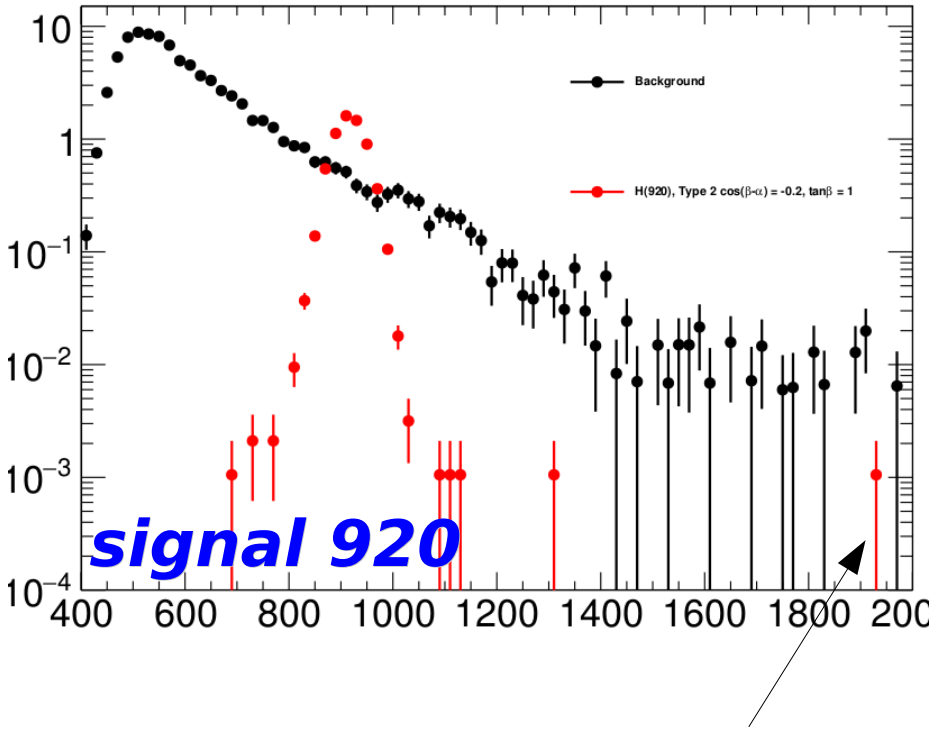
920 PLR

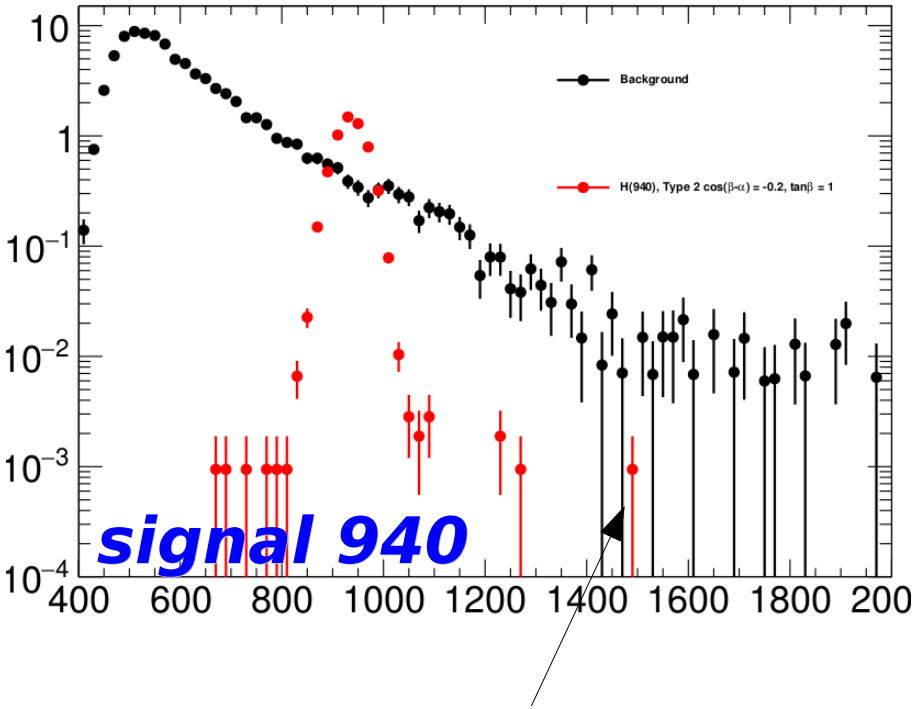
- mu_hat in obs is **positively** close to zero 7.28235e-10, giving p0 values ~0.5
- obs PLR is narrower than expected, this leads to lower limits in data
- but the non-parabolic structures seem strange, we further on check signal/bkg templates



Check bbbb sig&bkg

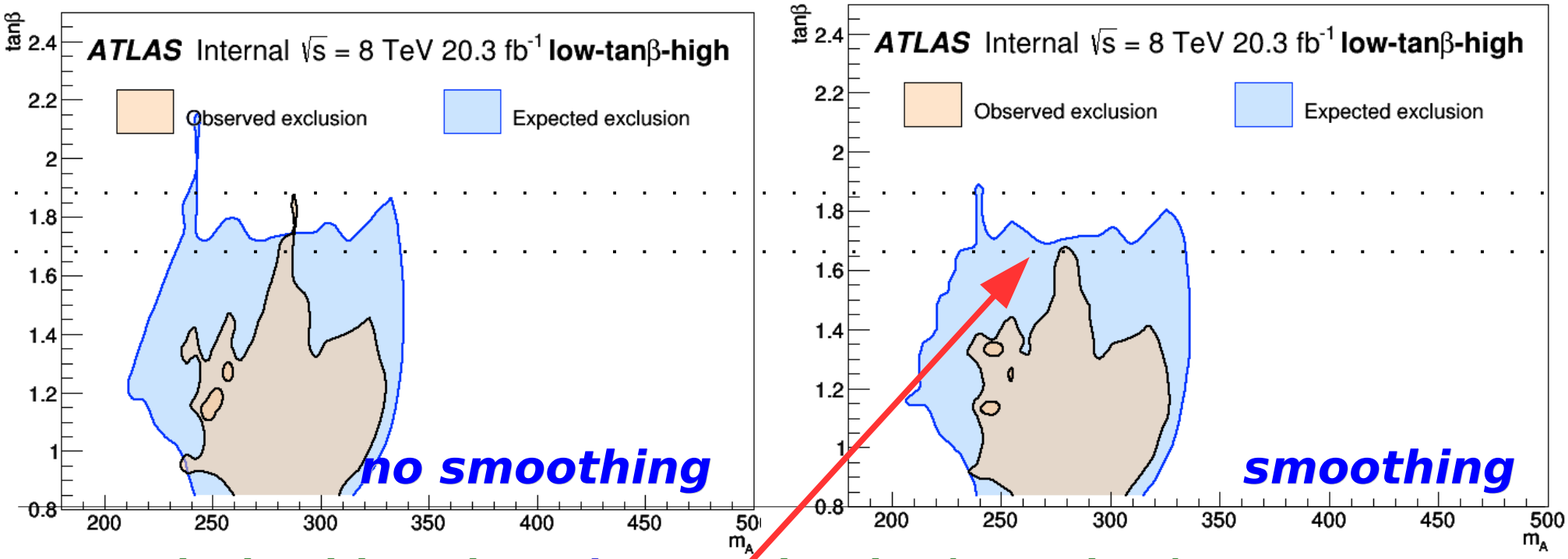
- David checked the signal and background templates used in the fit
- There are bins with only signal but no backgrounds





Current status – low-tb-high

- low-tb-high interpretation:
  - use full resolution in map file: **5 GeV vs 0.1**
  - before, we use mA 10 GeV with smooth, did not notice the fine structures in obs
  - compare no smoothing and smoothing

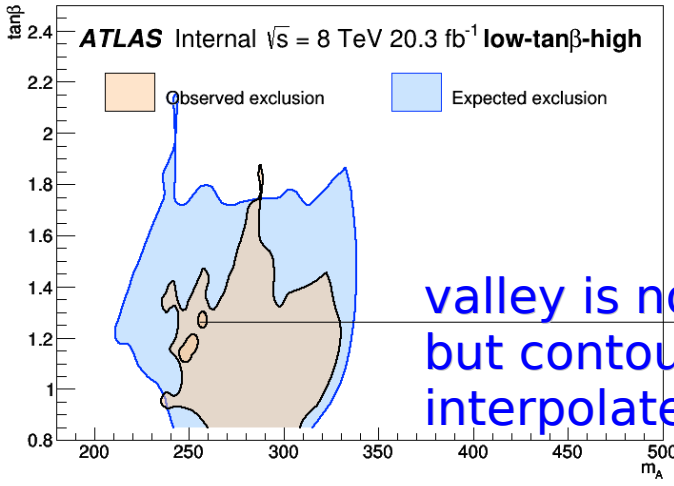


*** smooth algorithm: the Delaunay triangles (TGraph2D)**

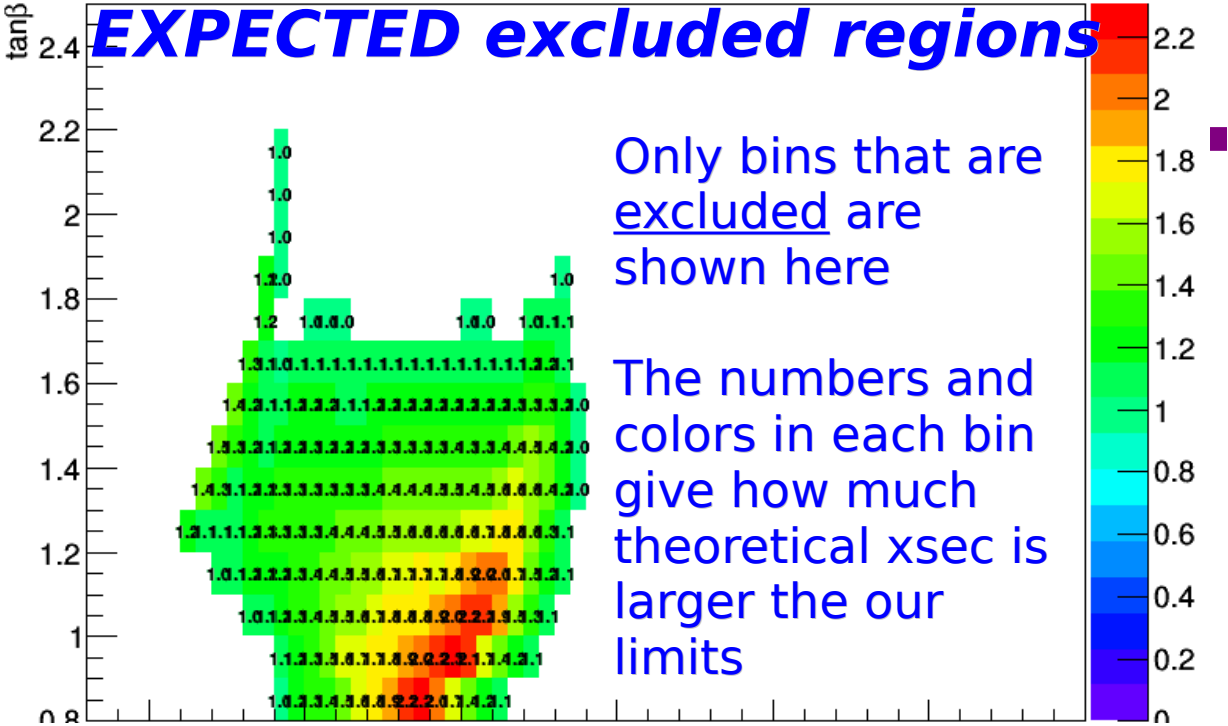
after smoothing, obs shrinks

Excl. maps

- Exclusion map before plotting contours
- Bins are filled with theo/limit, so once the bin content >1, this bin is excluded
- plots only show bins with theo/limit >1

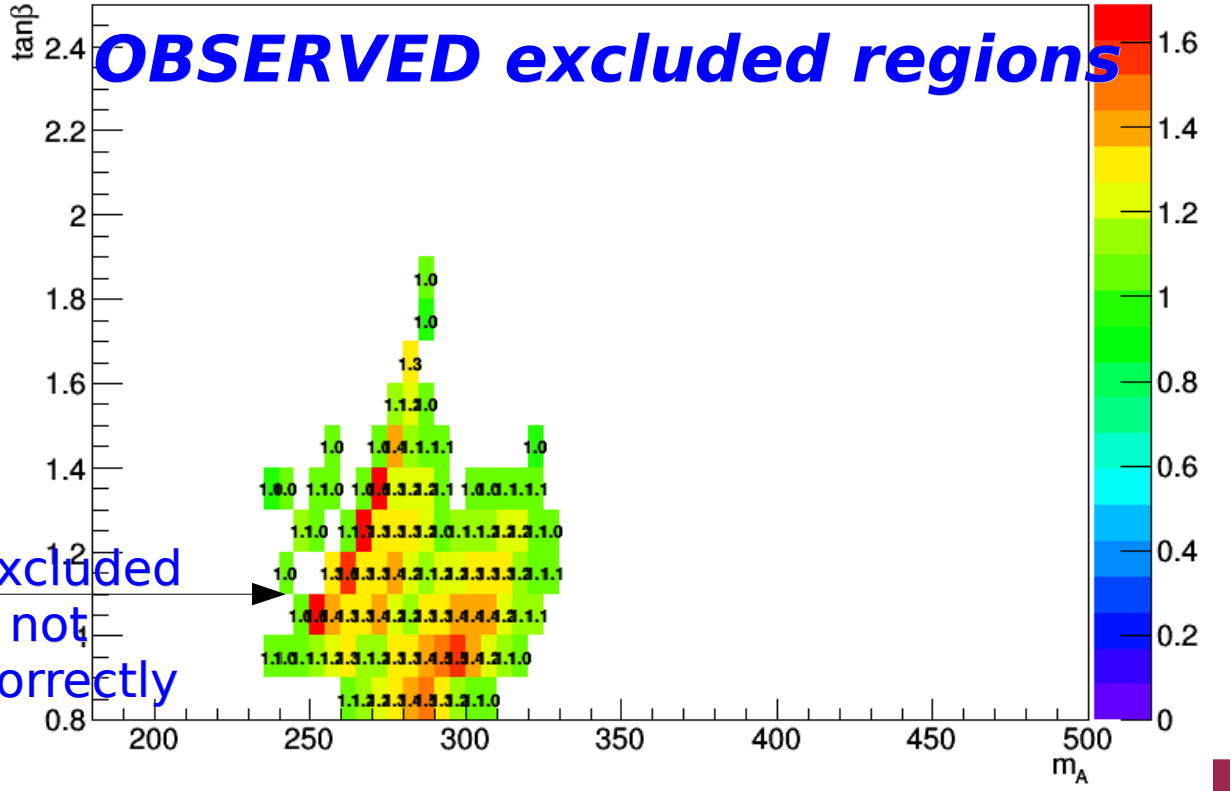


valley is not excluded but contour is not interpolated correctly



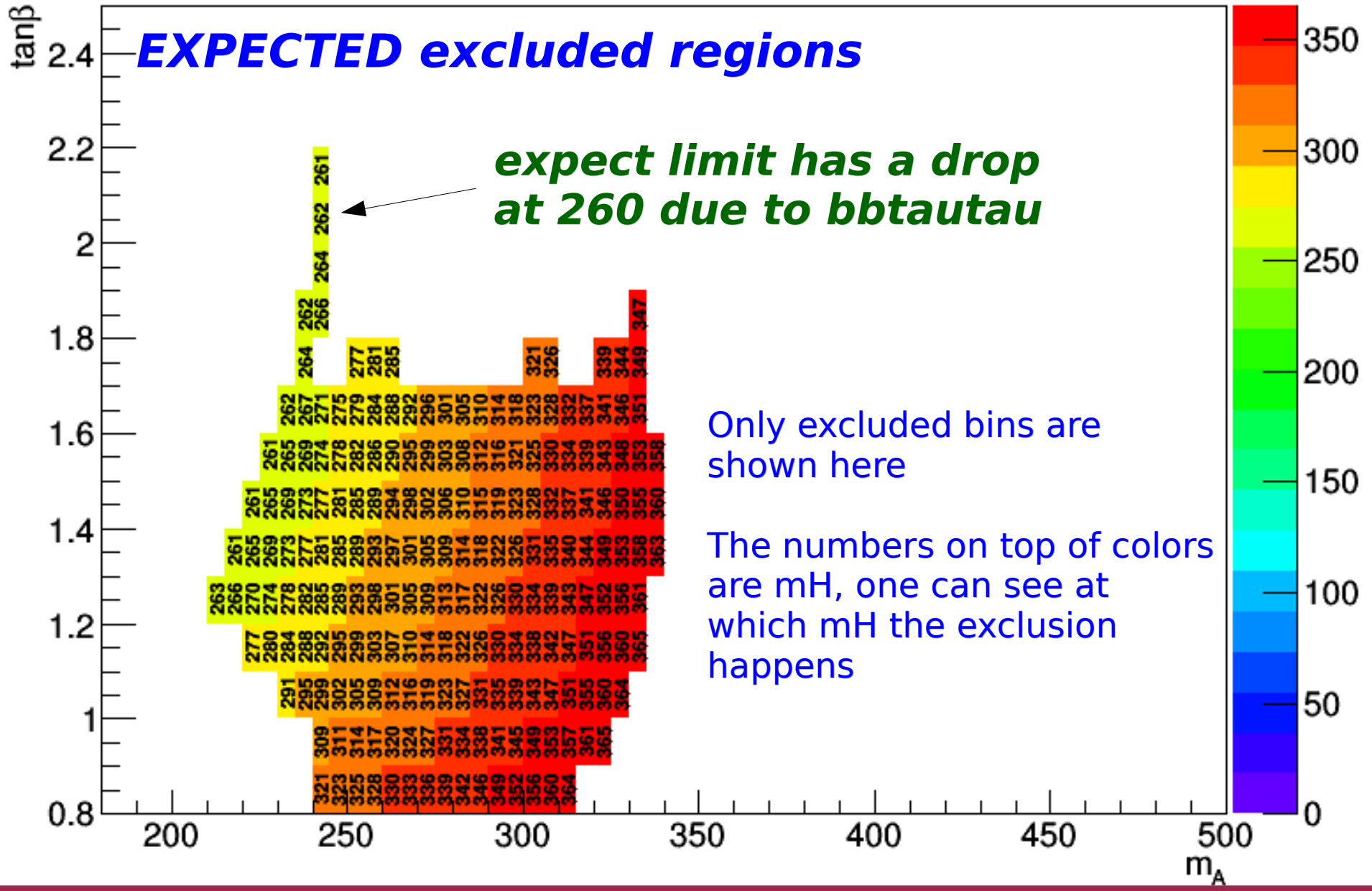
Only bins that are excluded are shown here

The numbers and colors in each bin give how much theoretical xsec is larger the our limits



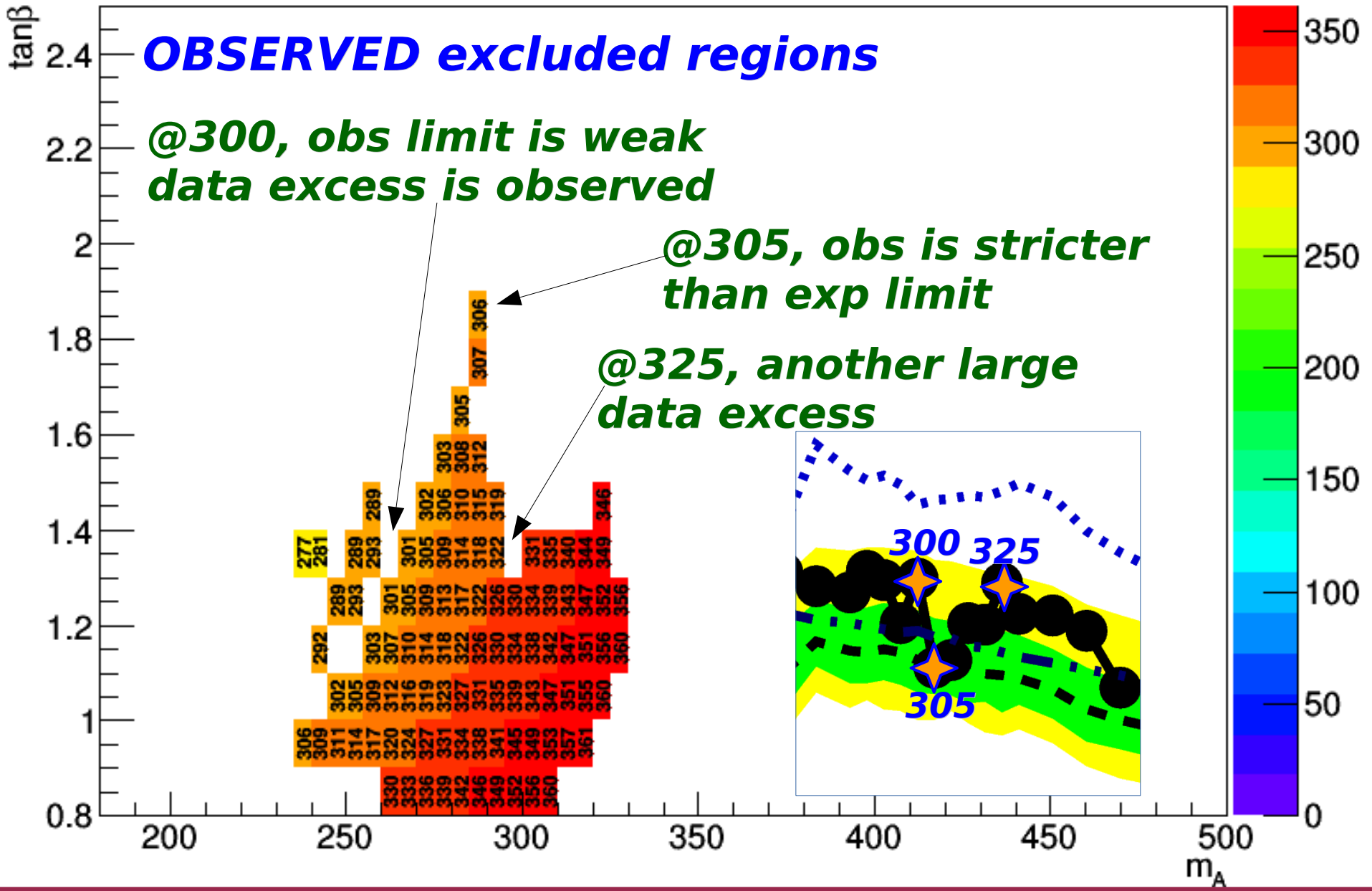
Excl. map (expected, mH)

- Map before contour making: filled with mH



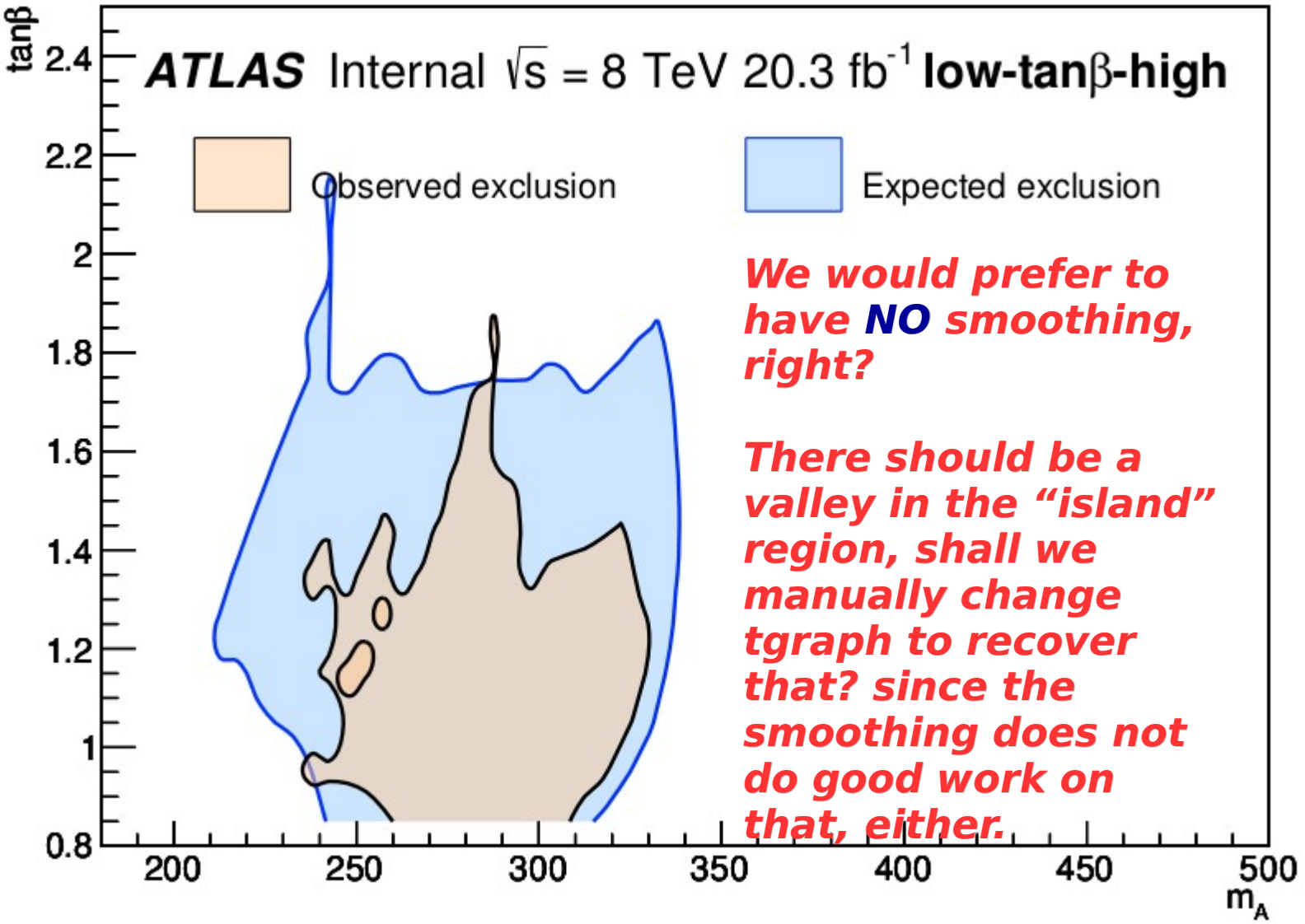
Excl. map (observed, mH)

- Map before contour making: filled with mH



What we have now on low-tb-high 1/3

- No smoothing

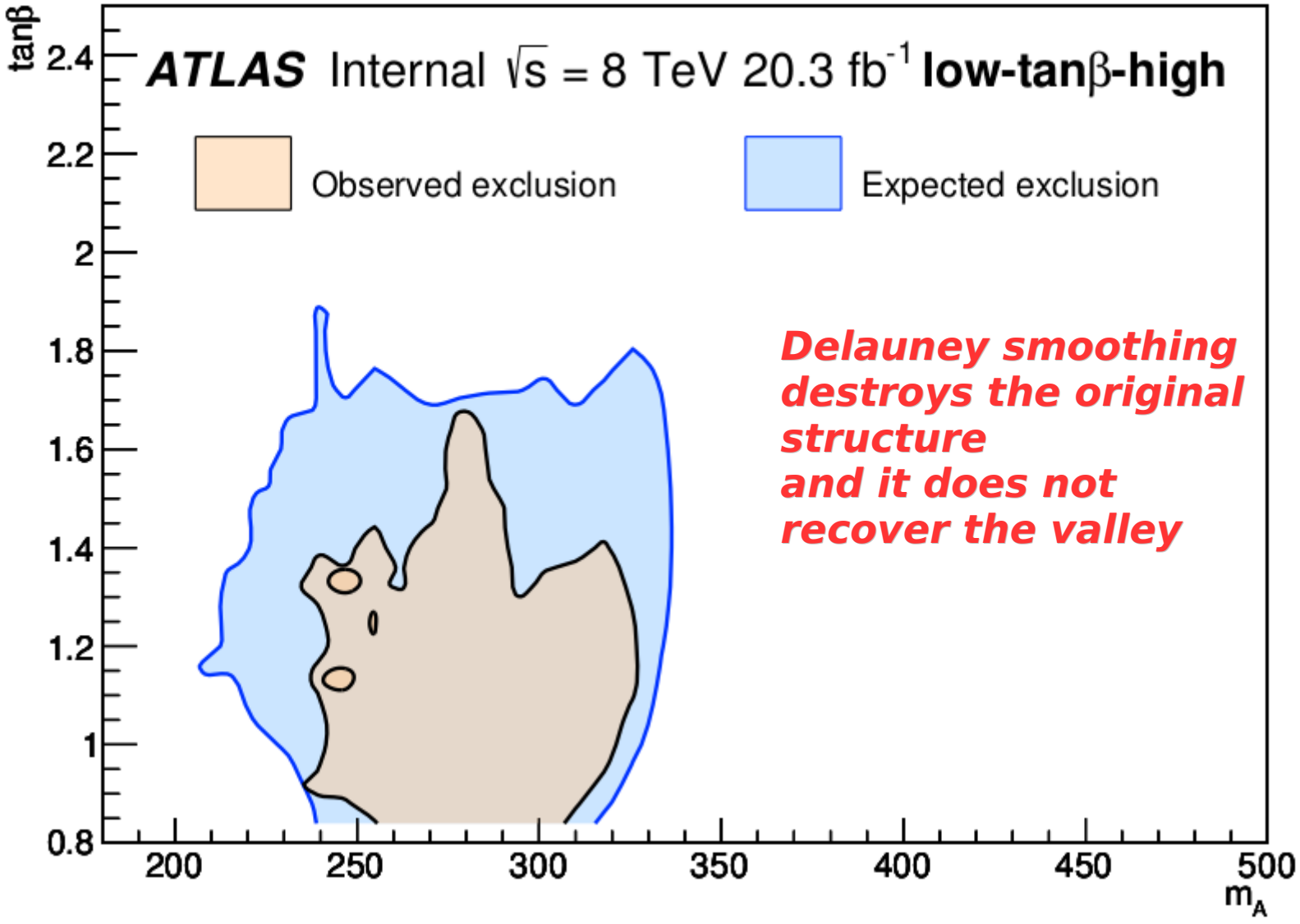


We would prefer to have NO smoothing, right?

There should be a valley in the "island" region, shall we manually change tgraph to recover that? since the smoothing does not do good work on that, either.

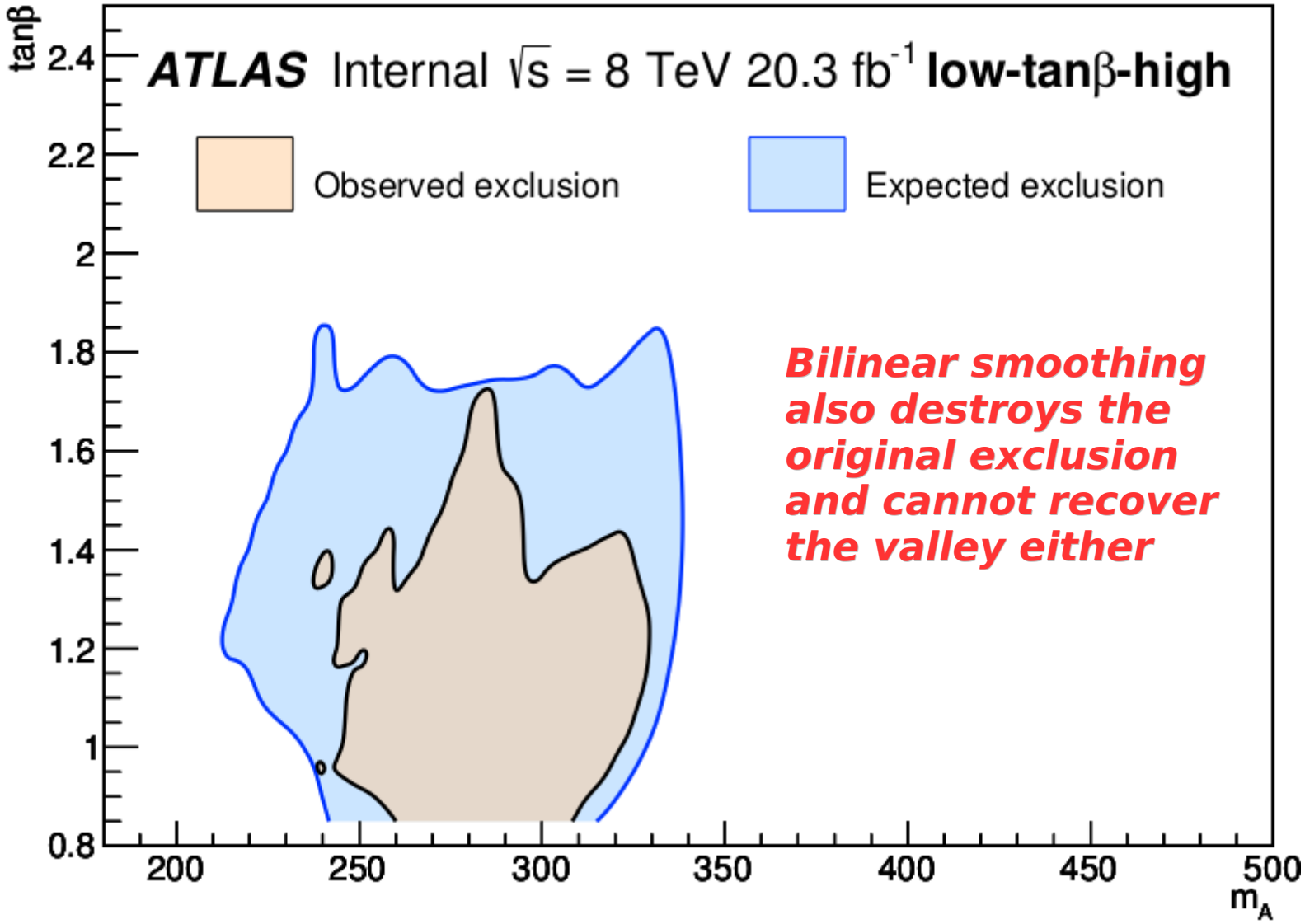
What we have now on low-tb-high 2/3

- Delauney interpolation



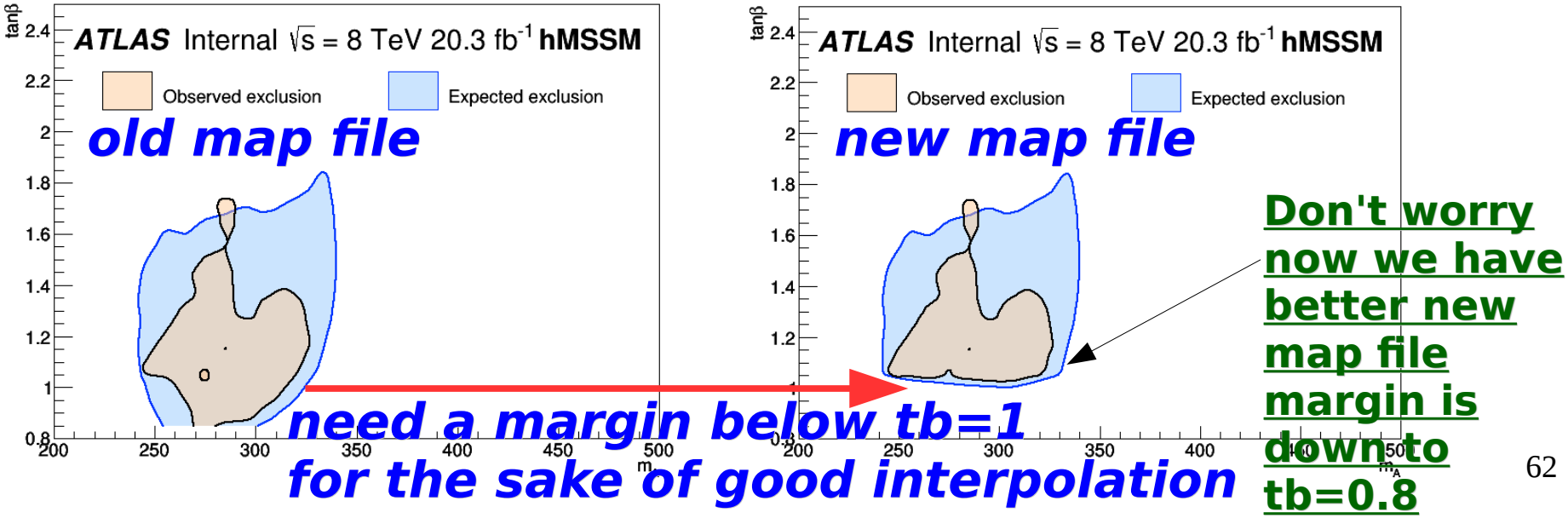
What we have now on low-tb-high 3/3

- Bilinear interpolation (#iteration=5)



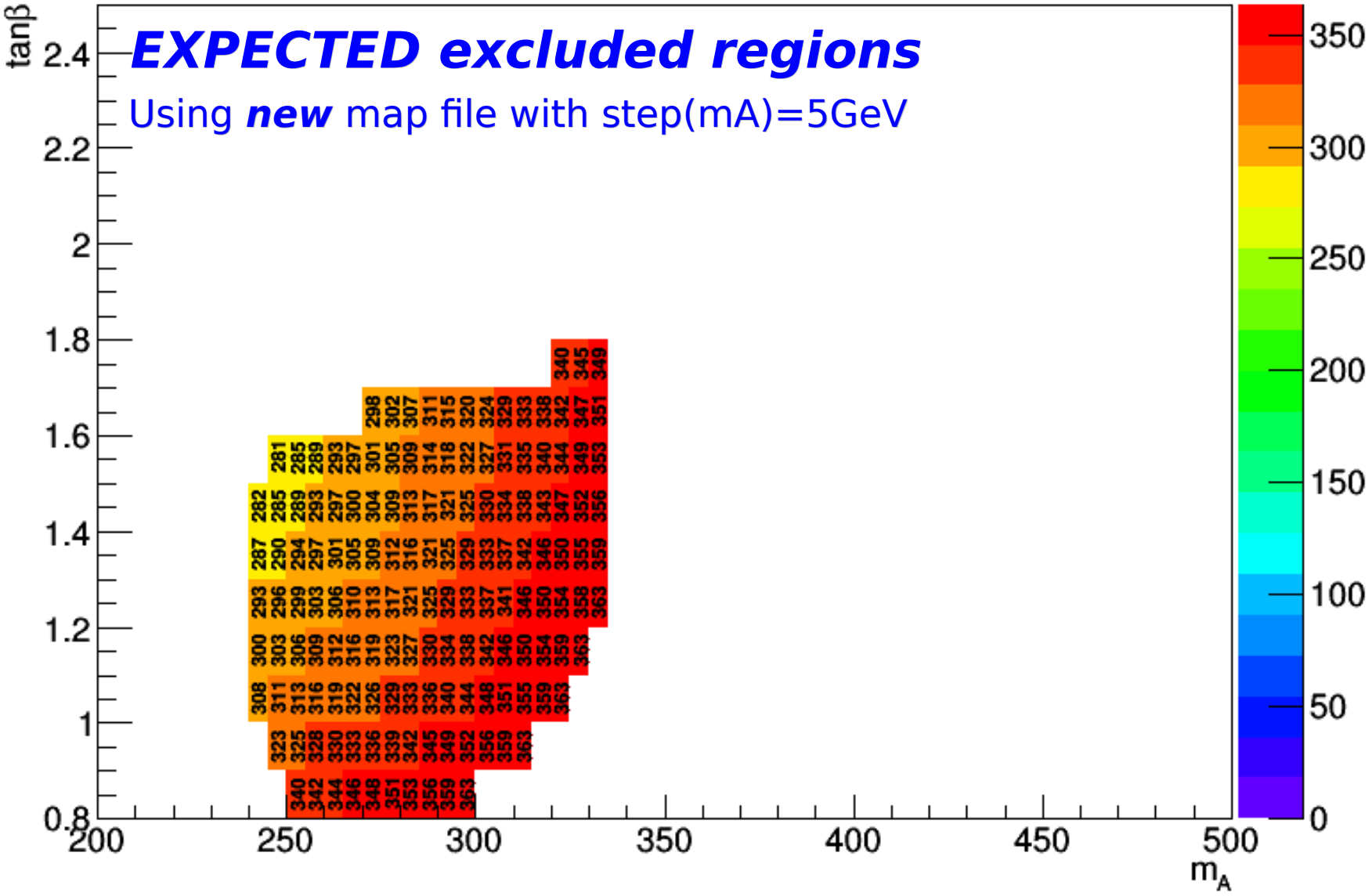
Current status - hMSSM

- hMSSM interpretation:
  - Allison and Nikos produced a new map file with ***5*** GeV on mA step (***10*** GeV previously); but the map file did not have phase points below tb=1.0 which causes interpolation issues in TGraph (closed contours are drawn @ tb~1). We asked for a margin below tb=1. *<- just got the file after our informal meeting*



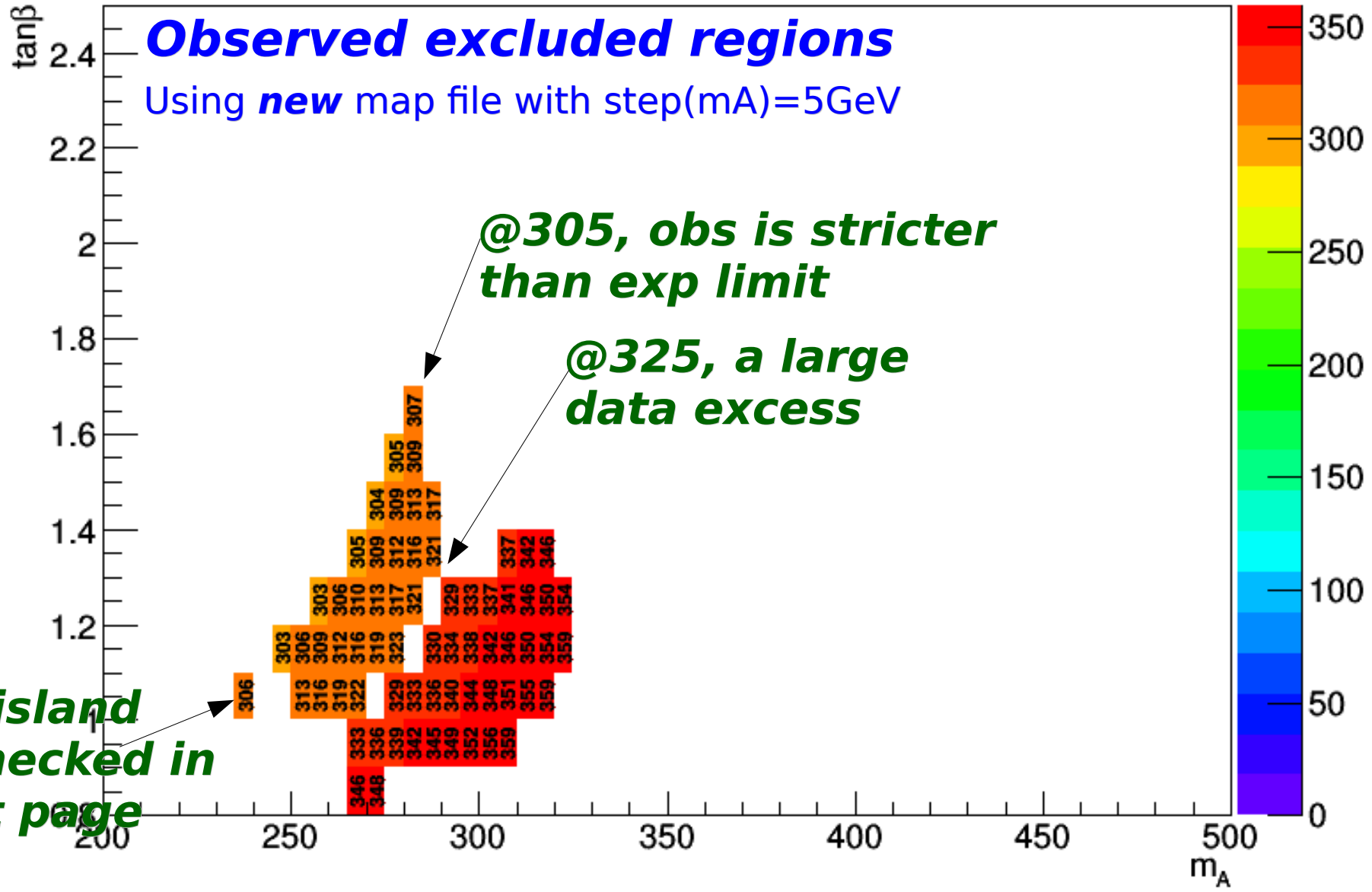
Exclu. map (expected, mH)

- Plot the exclusion maps before contour making



Exclu. map (observed, mH)

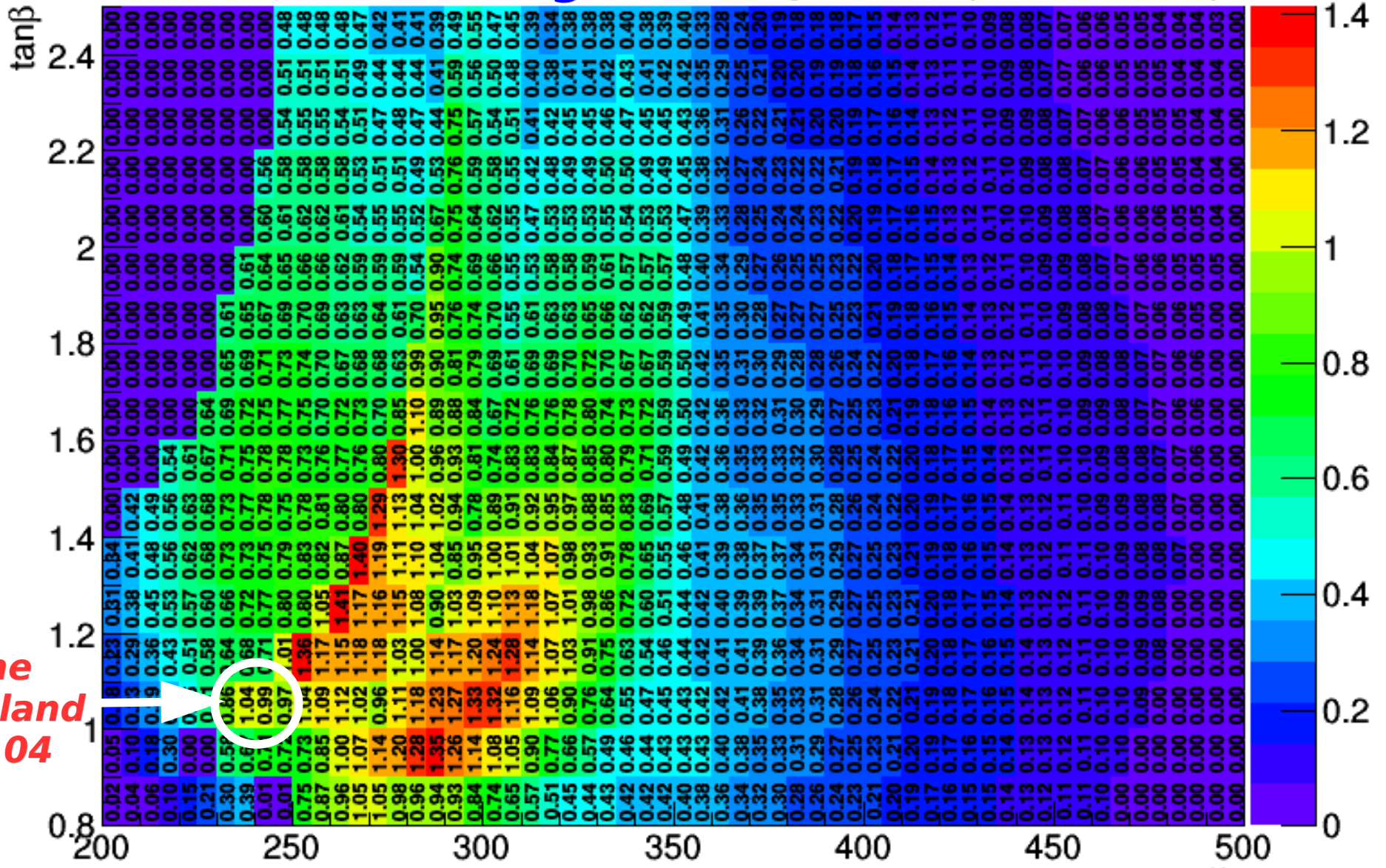
- Plot the exclusion maps before contour making



Exclu. map (observed, theo/limit)

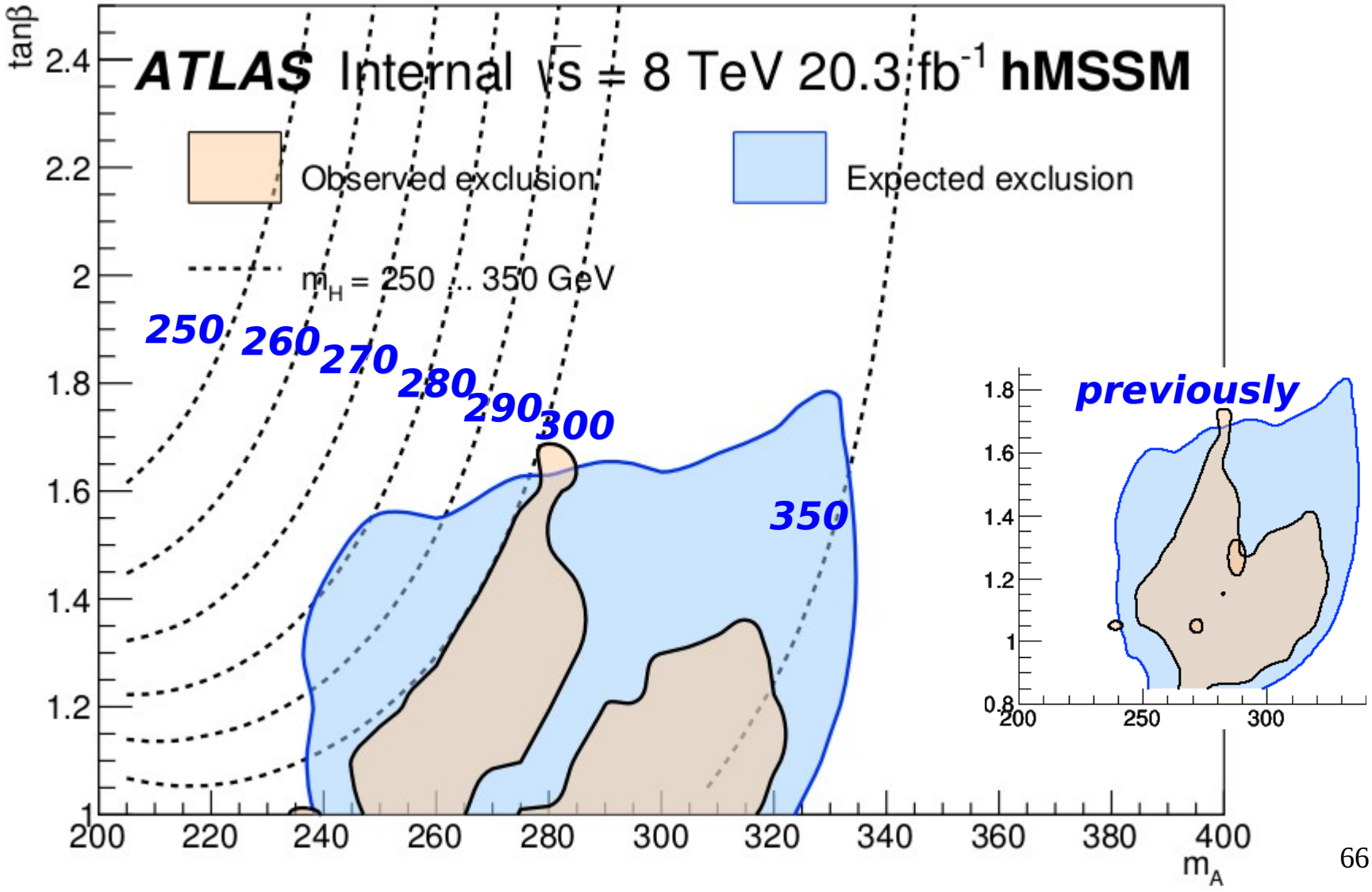
- Again I put theo_xsec/limit in each bin

Observed excluded regions Using ***new*** map file with step(mA)=5GeV



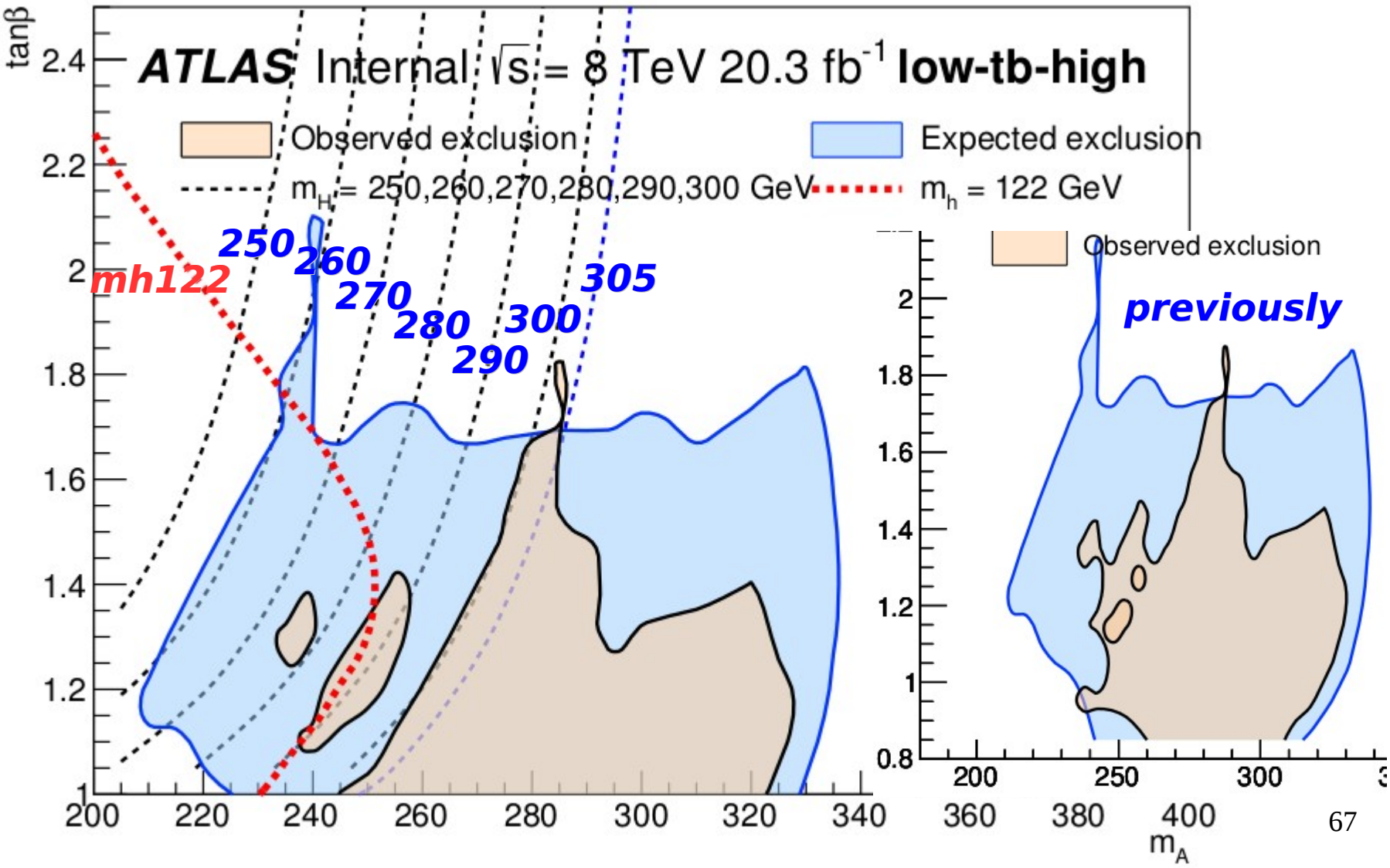
hMSSM interpretation

- By plotting disconnected exclusion area layer by layer, one can have the isolated islands clearly



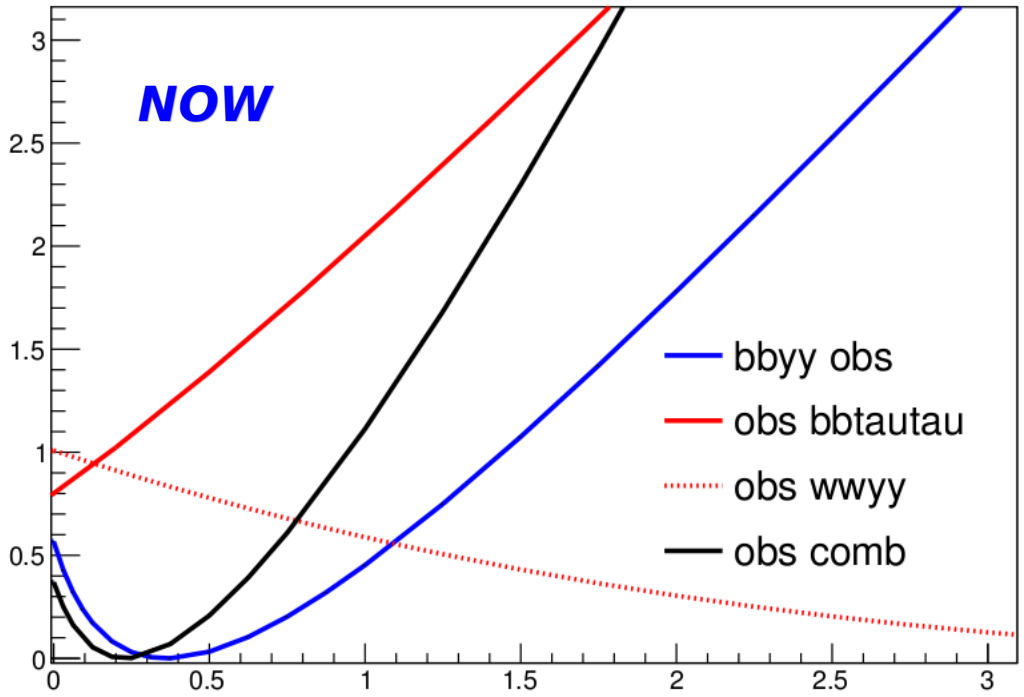
low-tb-high interpretation

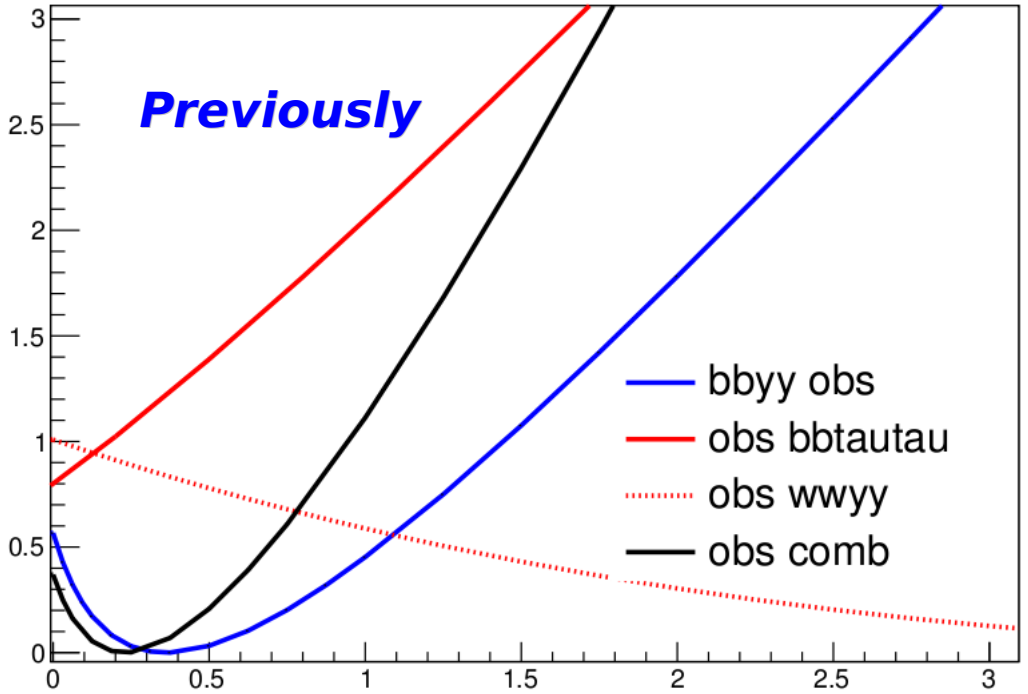
- By plotting disconnected exclusion area layer by layer, one can have the isolated islands clearly



305 GeV

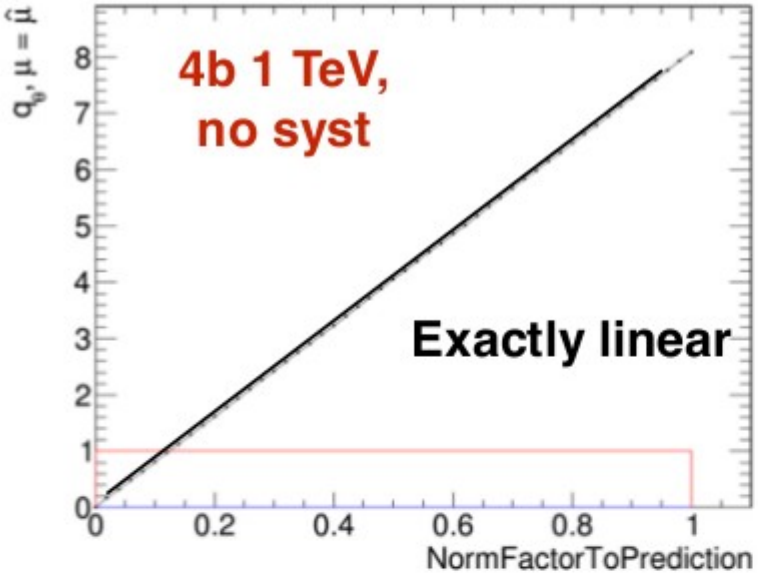
- @ 305GeV, we used to have obs limit 1.24, while now we have 1.36
- Anyway, their PRL curves are quite similar, both indicating obs limits at 1.3~1.4





Investigations from Aaron

Likelihood curves

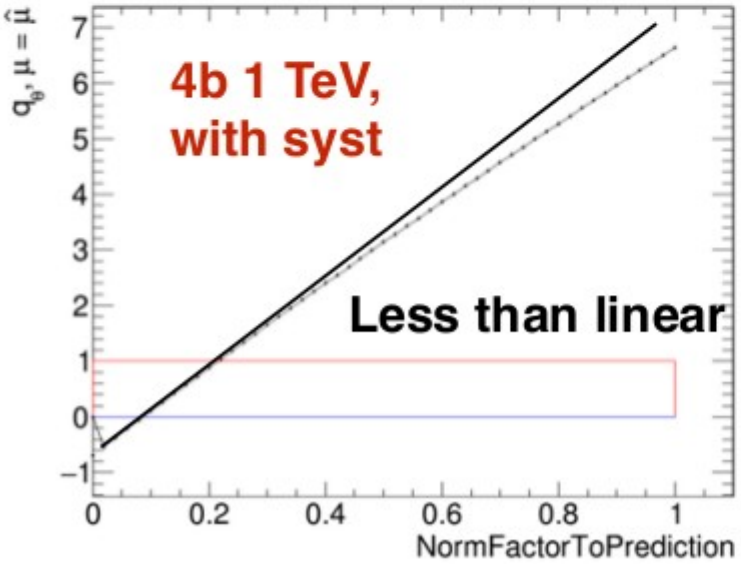


- Solid lines are just to guide the eye.
- Dots are exact -ln L computations

-ln P(N|E) = -N*ln(E) + E

For N=0 and E = mu*S+B ~ mu*S:

-ln P(0|mu*S) = mu*S



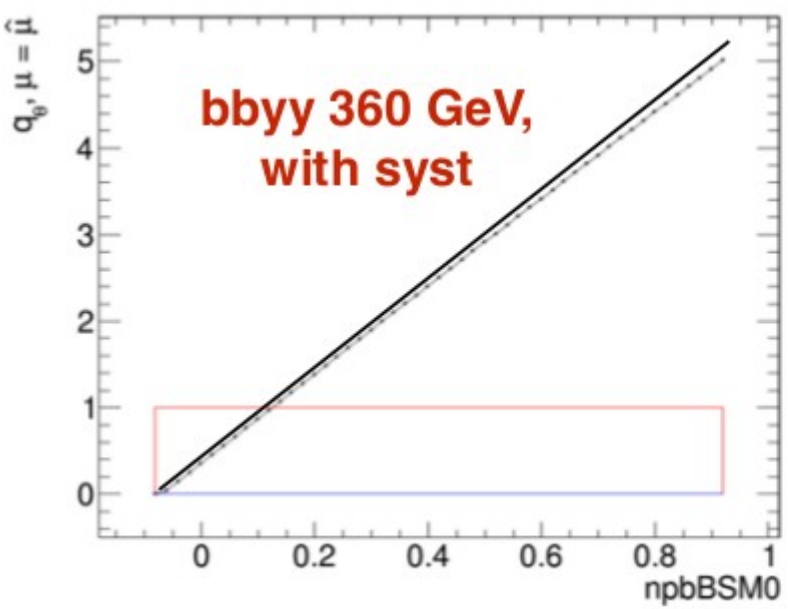
- Systematics cause a curve less than linear since NPs will be pulled negative as mu grows, reducing the effective S:

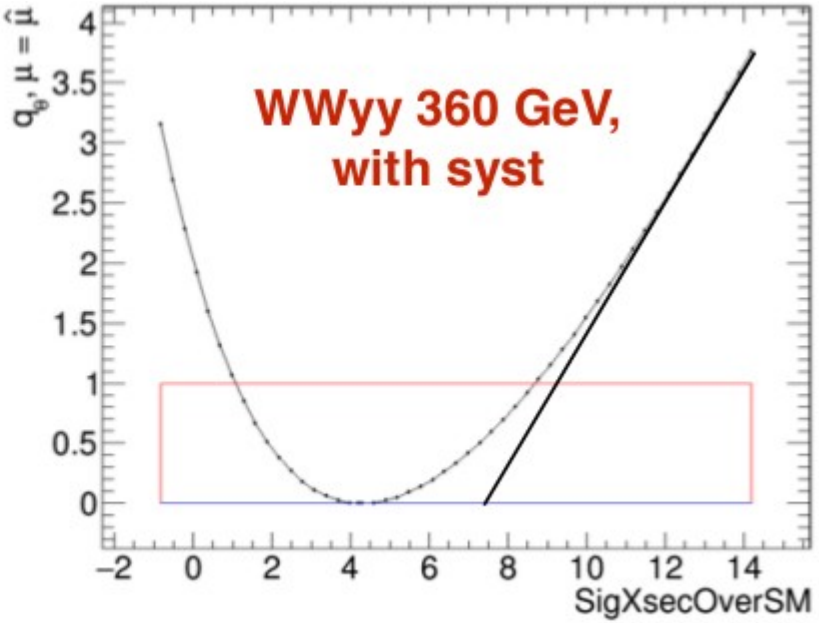
-ln P(0|mu*S)*Gaus ~
mu*S*(1+pull*eps) + pull
= mu*S + pull*(1+mu*S*eps)

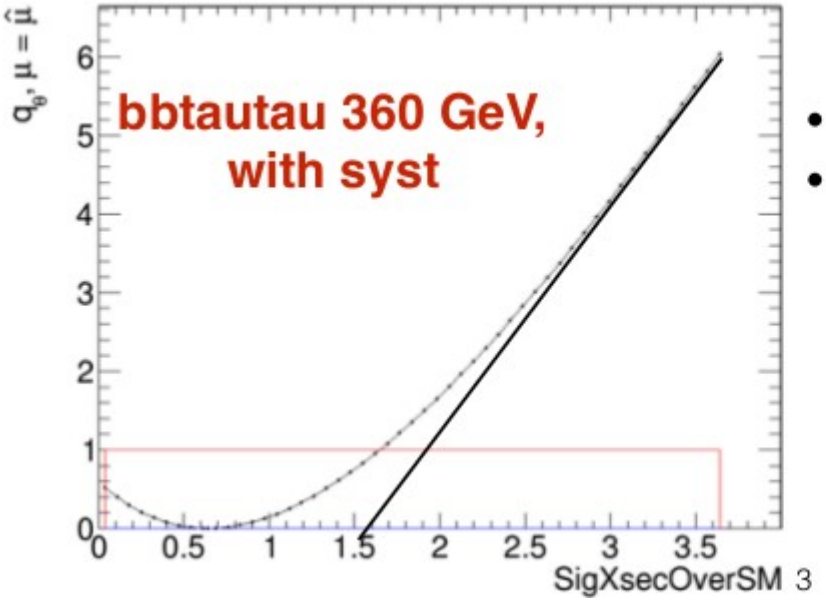
2

Investigations from Aaron

Likelihood curves







- bbyy is linear for the same reason
- WWyy and bbtautau don't have N=0 and are more parabolic, though they flatten out at high mu where the linear term dominates

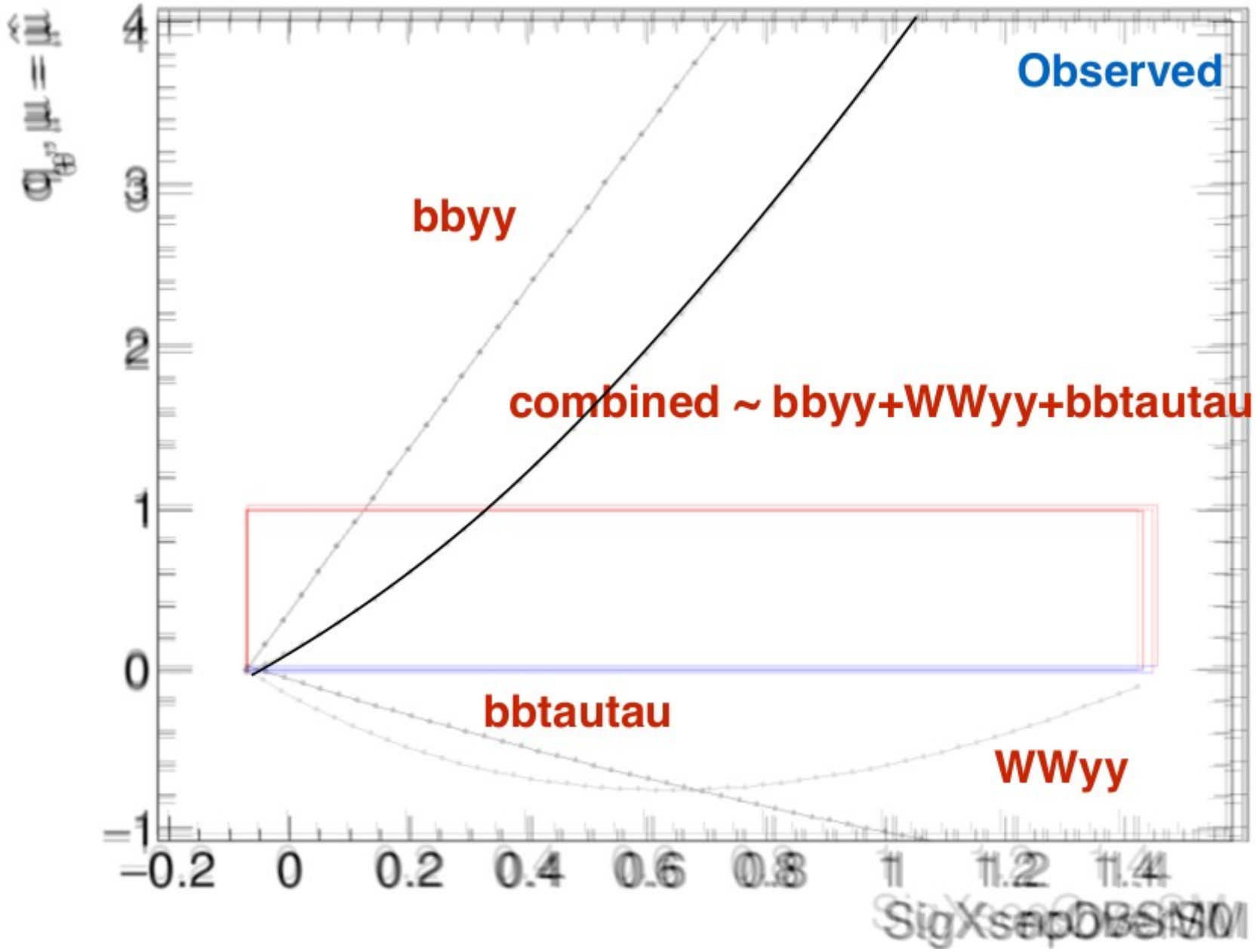
Investigations from Aaron

Obs limit > exp limit with muhat < 0

- The strongest channel, bbyy, shows the strong linear behavior and therefore is relatively weaker the further out you scan in mu, ie the uncertainty on mu grows larger with mu:
  - Linear qmu: sigma(mu)~mu/sqrt(qmu)~mu / sqrt(mu) ~ sqrt(mu)
  - Parabolic qmu: sigma(mu)~mu/sqrt(qmu)~mu/(sqrt(mu^2)~constant
- The weaker WWyy and bbtautau channels are not only parabolic, but have excesses, and play a more important role around mu=mu_up95
- Next two slides show the likelihood curves for observed and asimov data overlayed. The combined -ln L is roughly the sum of the three individual ones
- Observed bbtautau and WWyy interfere destructively with bbyy and bring the combined curve to lower -ln L values since they favor muhat ~0.6 and ~4.2
- The three Asimov datasets are nice and coherent and interfere constructively, giving a nice and tight -ln L curve
- This means that qmu_Asimov will cross the ~3.84 barrier at lower values of mu than qmu_Obs, leading to mu_up_exp < mu_up_obs, even though muhat < 0

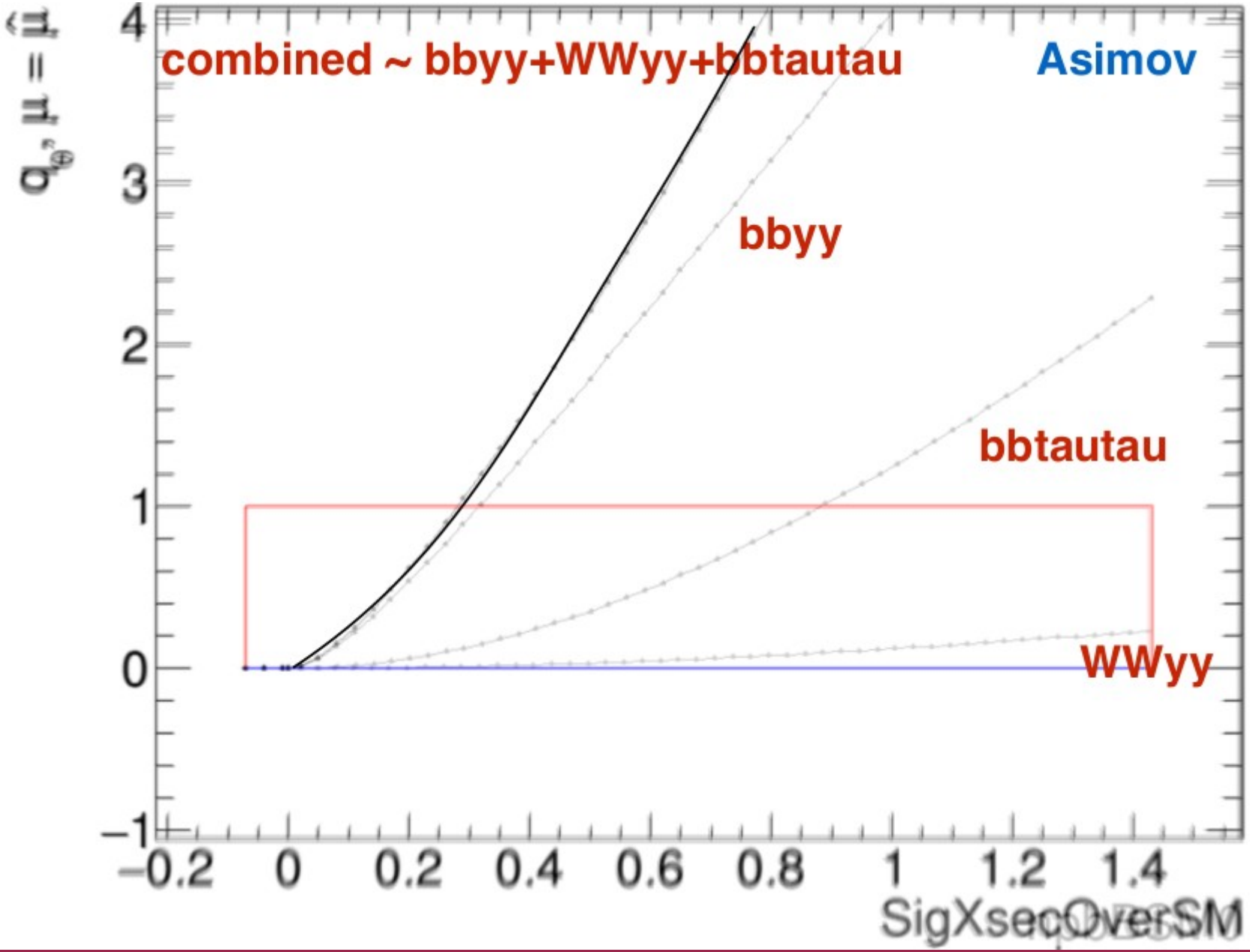
Investigations from Aaron

Obs limit > exp limit with muhat < 0



Investigations from Aaron

Obs limit > exp limit with muhat < 0

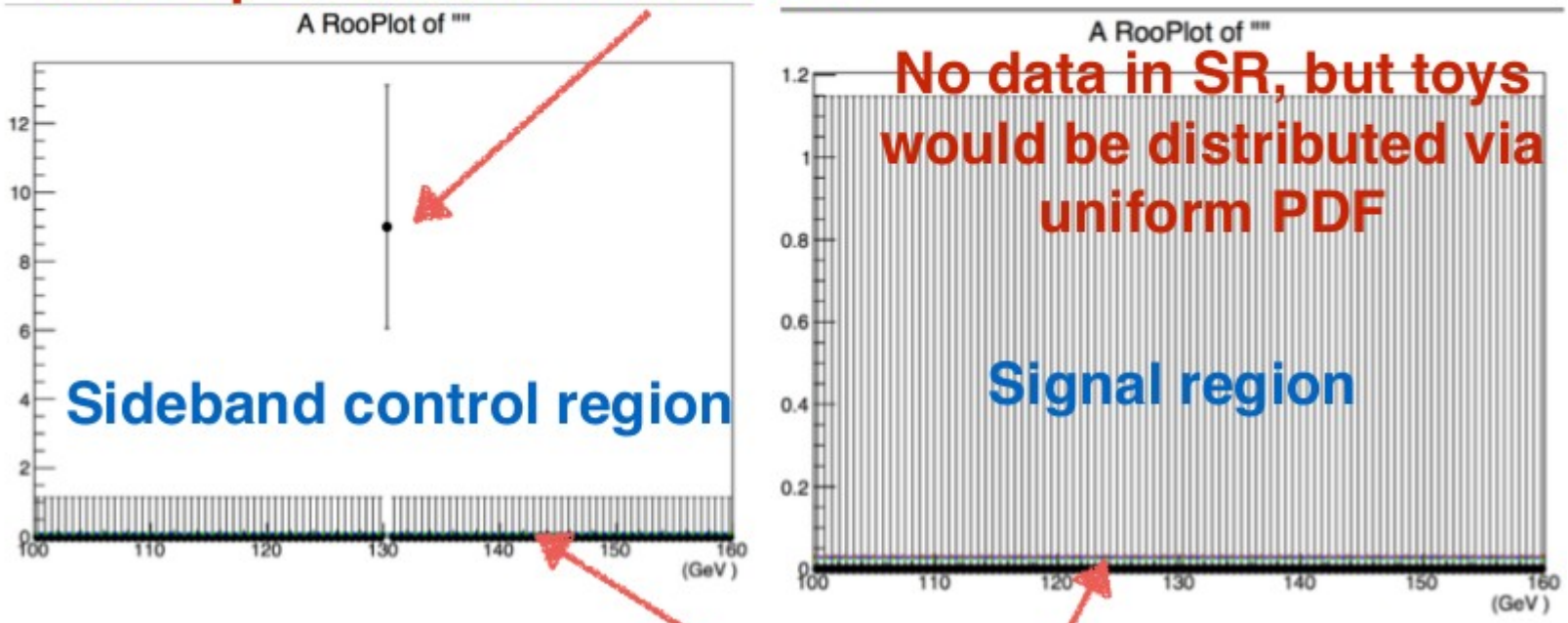


Investigations from Aaron

Other bbyy issues

- bbyy built from similar framework as Hyy
- Hyy of course uses continuous PDFs to describe S and B
- bbyy should be single bin counting experiment, but seems like a it uses a 100 bin uniform distribution in myy due to this framework

Data is a single weighted event at one point in the distribution



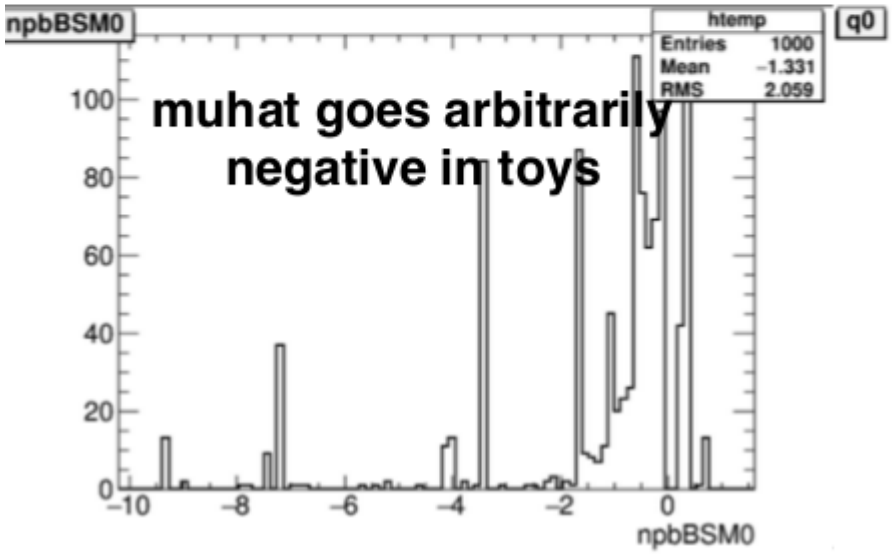
S and B are uniform PDFs here and here

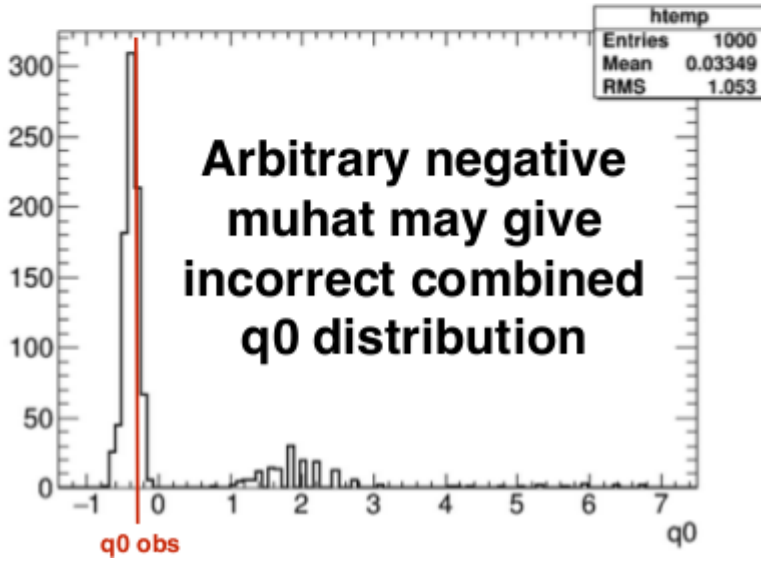
Investigations from Aaron

Other bbyy issues

- Not necessarily an issue for bbyy channel alone. Since the PDF is uniform then it should be mathematicall equivalent to one bin of P(N|E), but it's not very nice
- Also the RooAddPdf that's used doesn't have protection against negative expected events, so ghost events would need to be added to keep the PDF from going negative. HistFactory uses RooRealSumPdf that would protect against this
- Individual channel p0 may be correct, but **combined p0 will for sure be wrong** since bbyy won't tell combined likelihood that the PDF is negative
- Solution is either to add ghost events in toys or switch to RooRealSumPdf

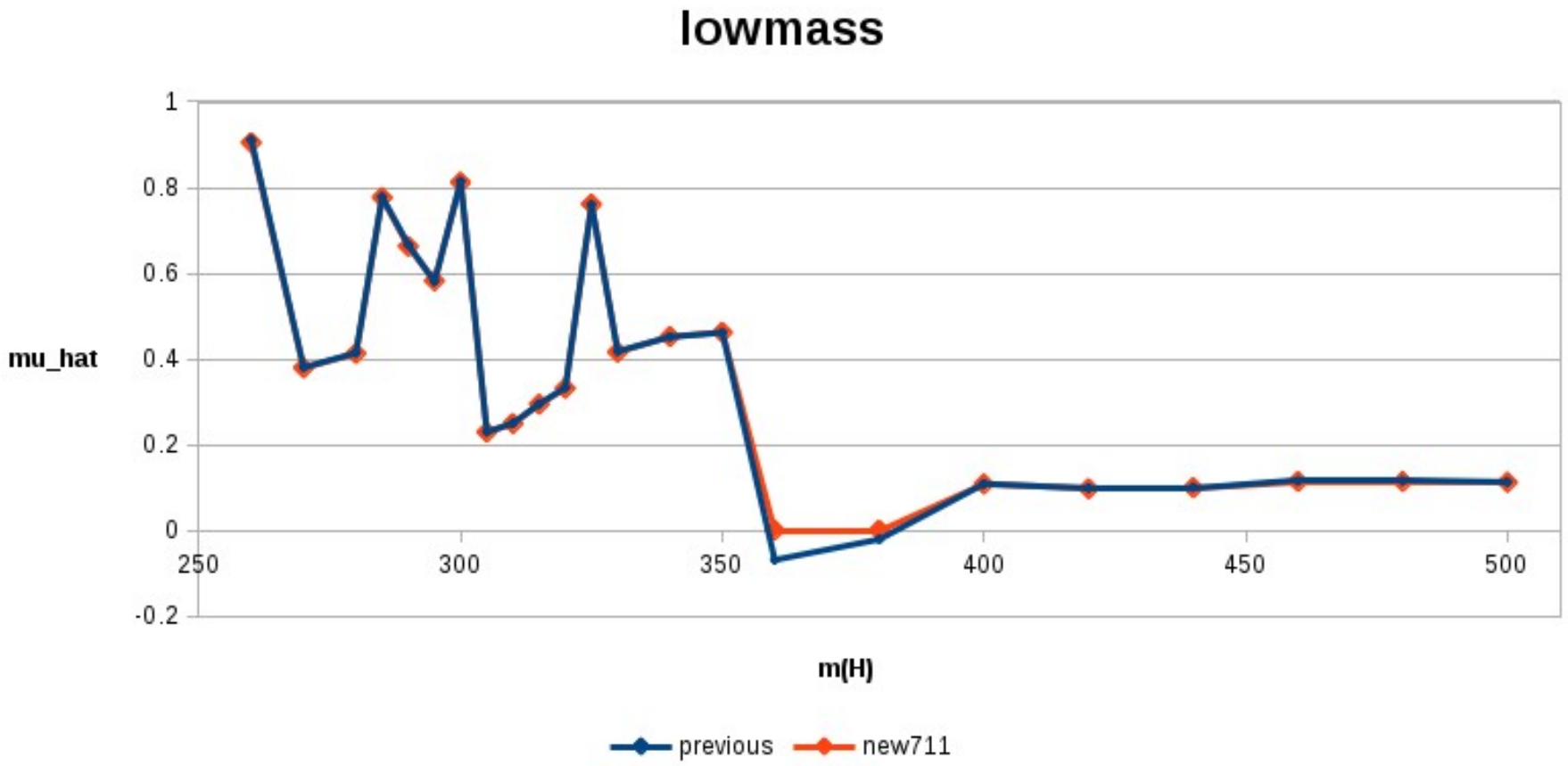
S_SR~2.5, B_SR~0.2 => muhat_min ~ -0.08





mu_hat NEW

- Previously we had 360 380 mu_hat < 0



Now
@360 mu_hat = 9.92759e-10
@380 mu_hat = 8.72088e-07