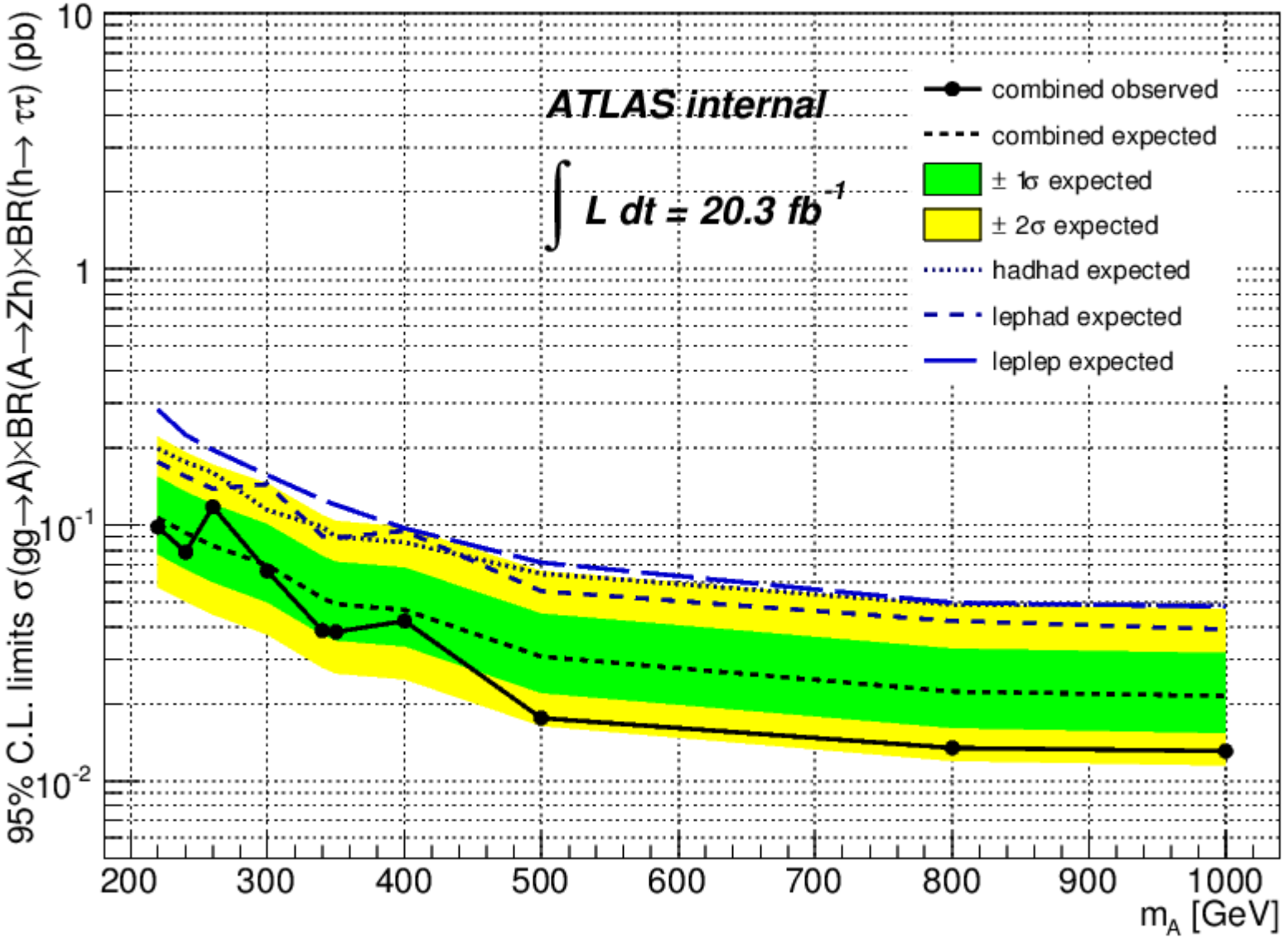
AZh combination
2HDM interpretations
Type I II III IV

A -> Zh -> ll(vv) bb
A -> Zh -> ll tautau

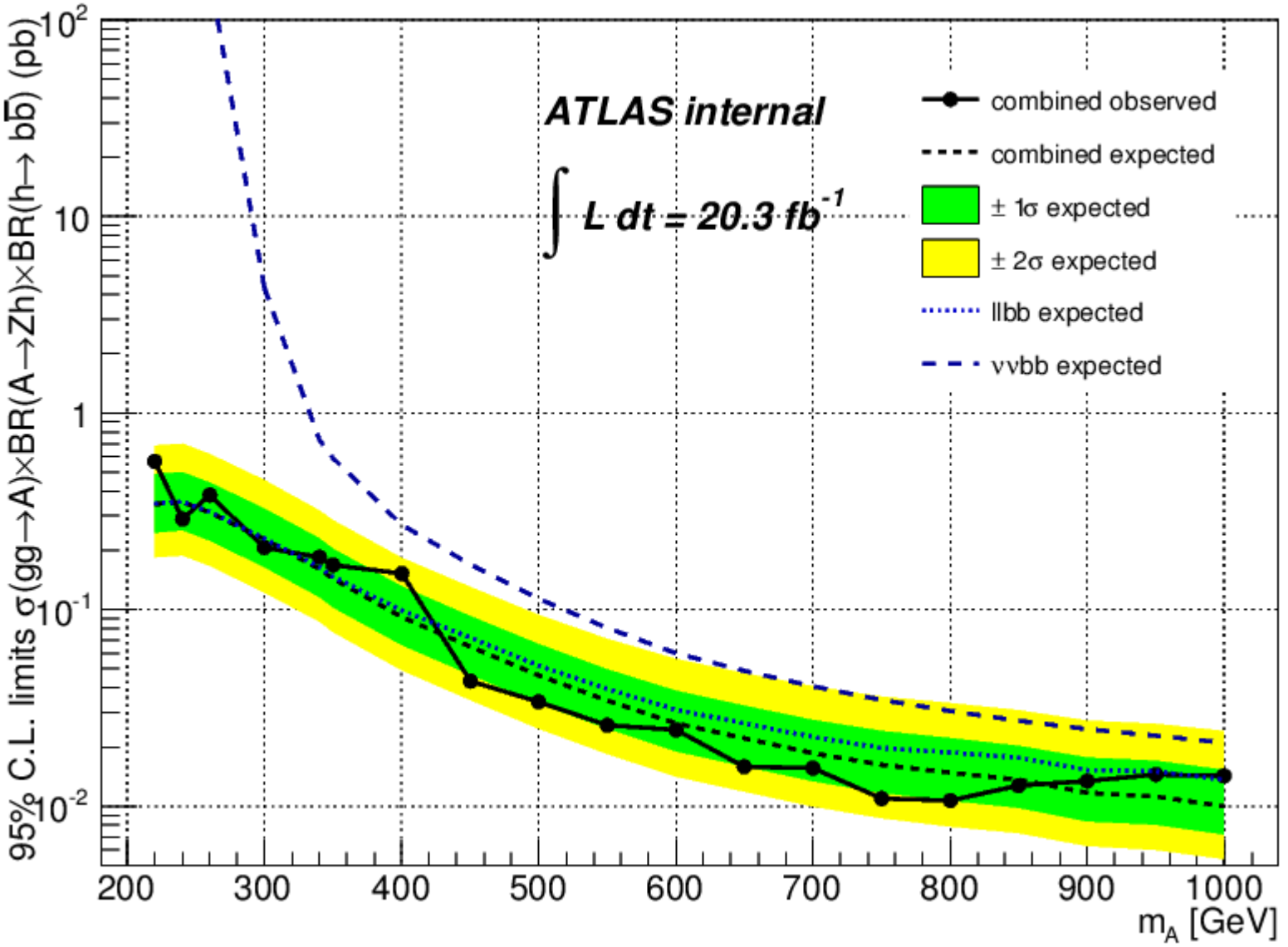
Xiaohu Sun and all AZh people
28-10-2014
IHEP

Combined limits (tautau)

- 

in paper draft

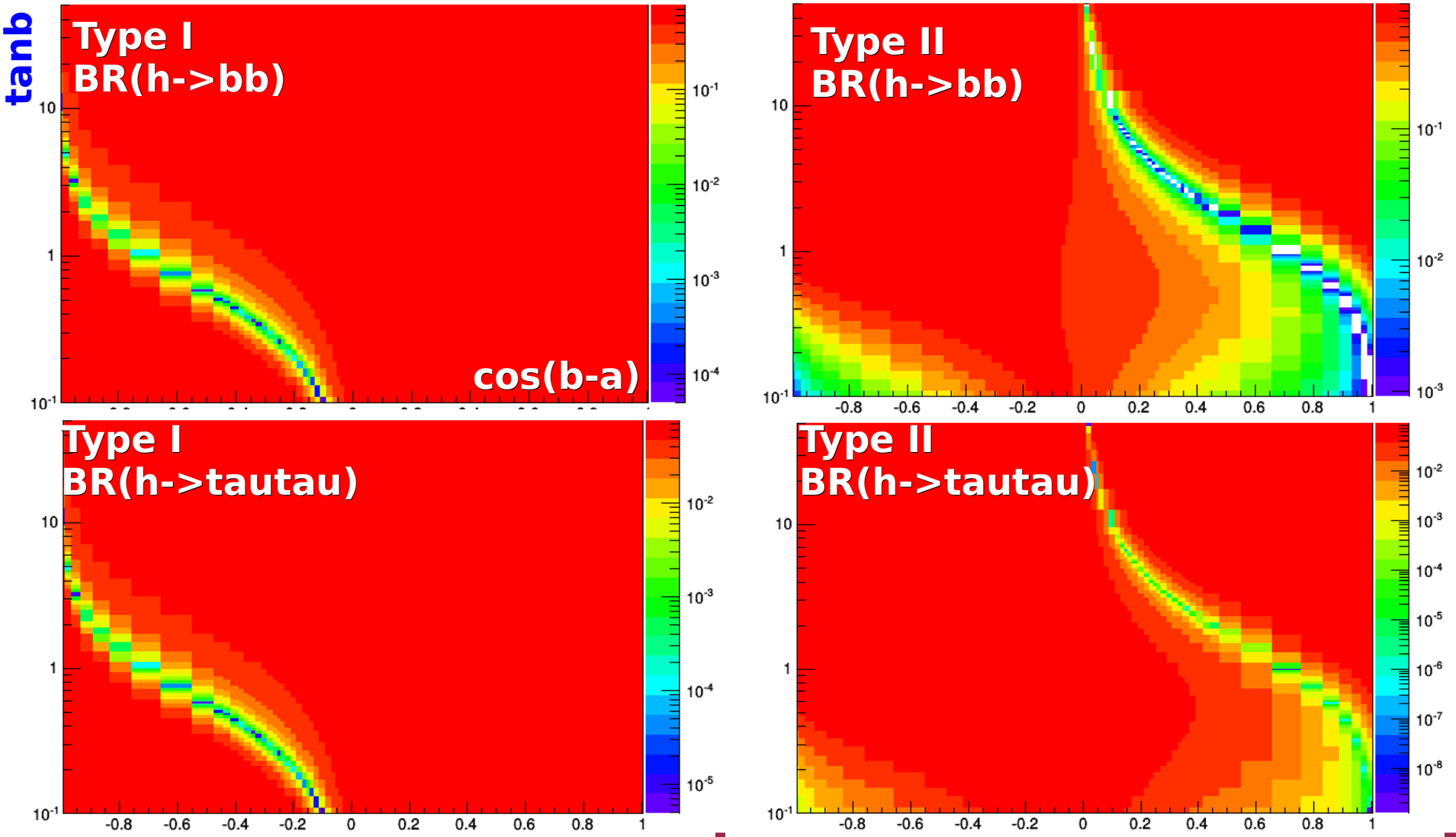
Combined limits (bb)

- 

in paper draft

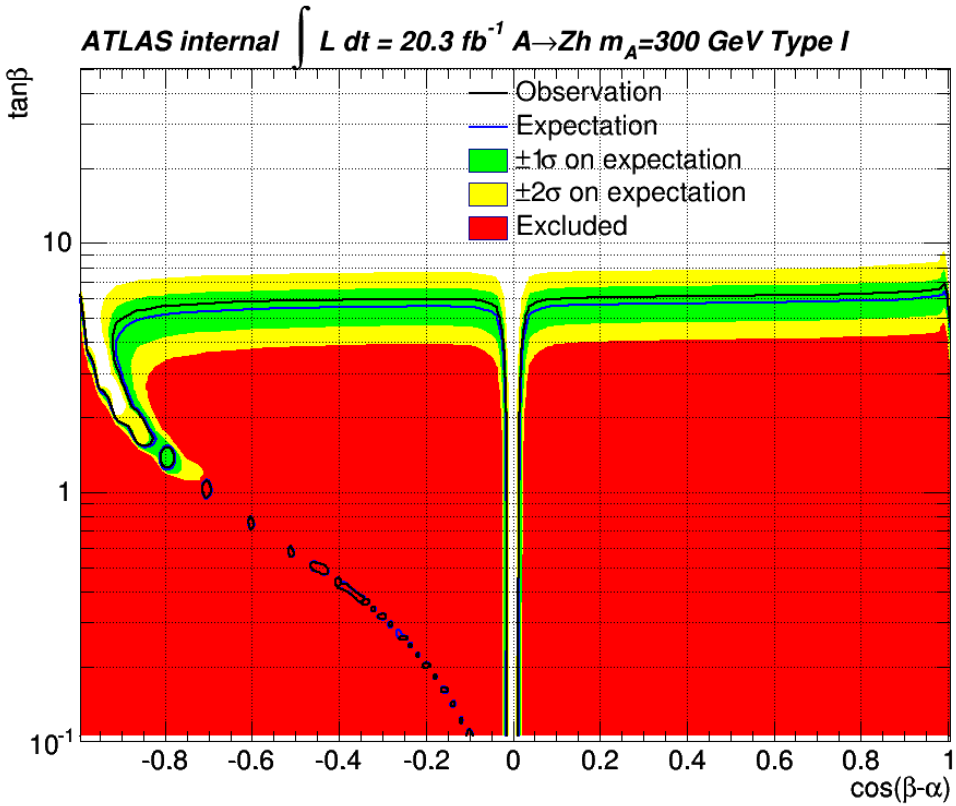
2HDM type I and II

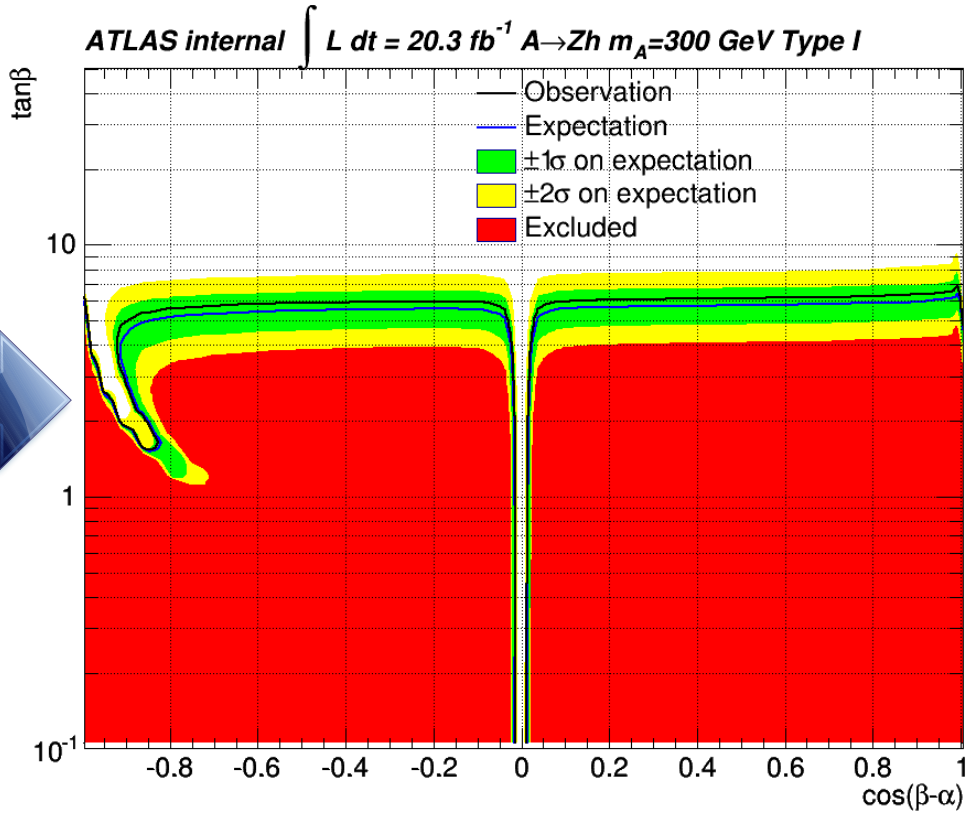
- Non-SM BR(h->bb) and BR(h->tautau) are considered, they scale in the same way in LO, so no need to redo the limits, just simply rescale the upper limits



2HDM – type I

- manually remove the wrongly interpolated islands

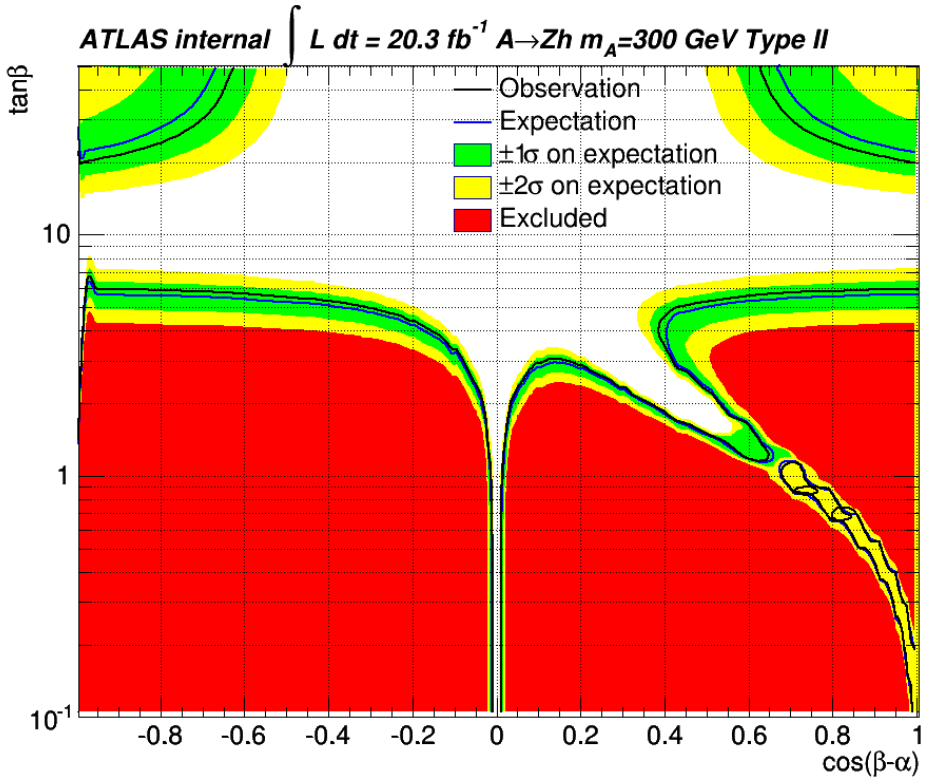


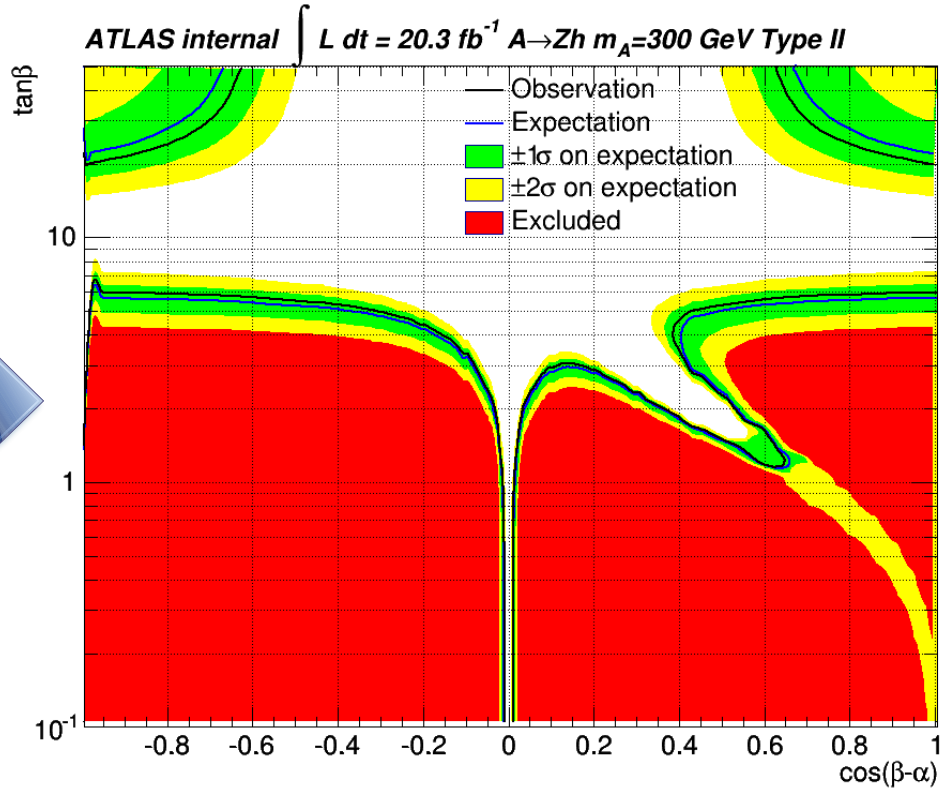


in paper draft

2HDM – type II

- manually remove the wrongly interpolated islands

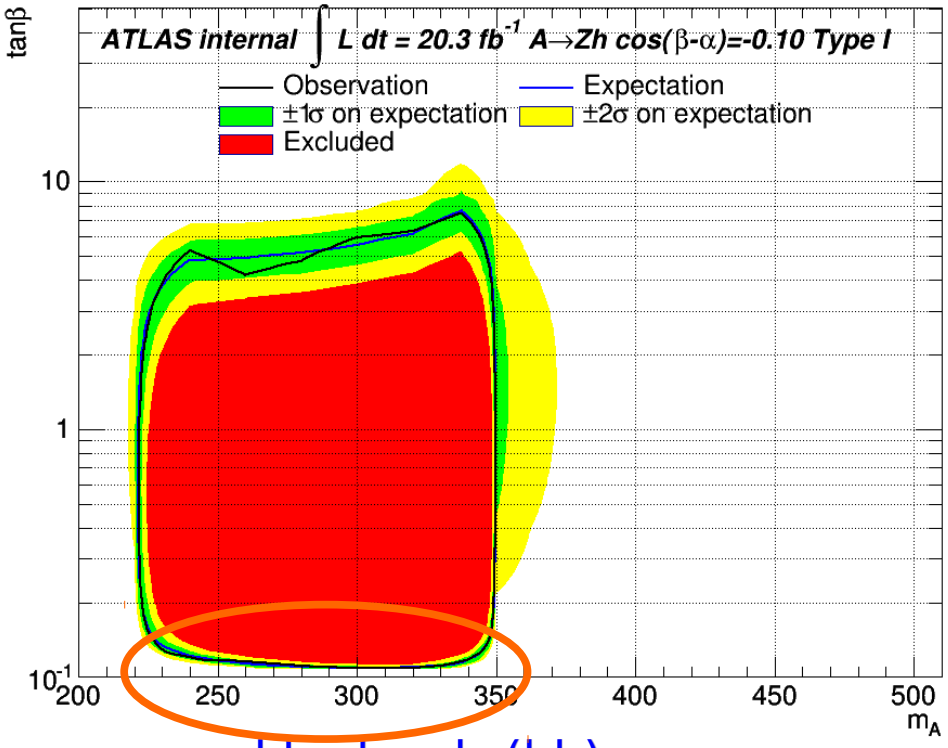




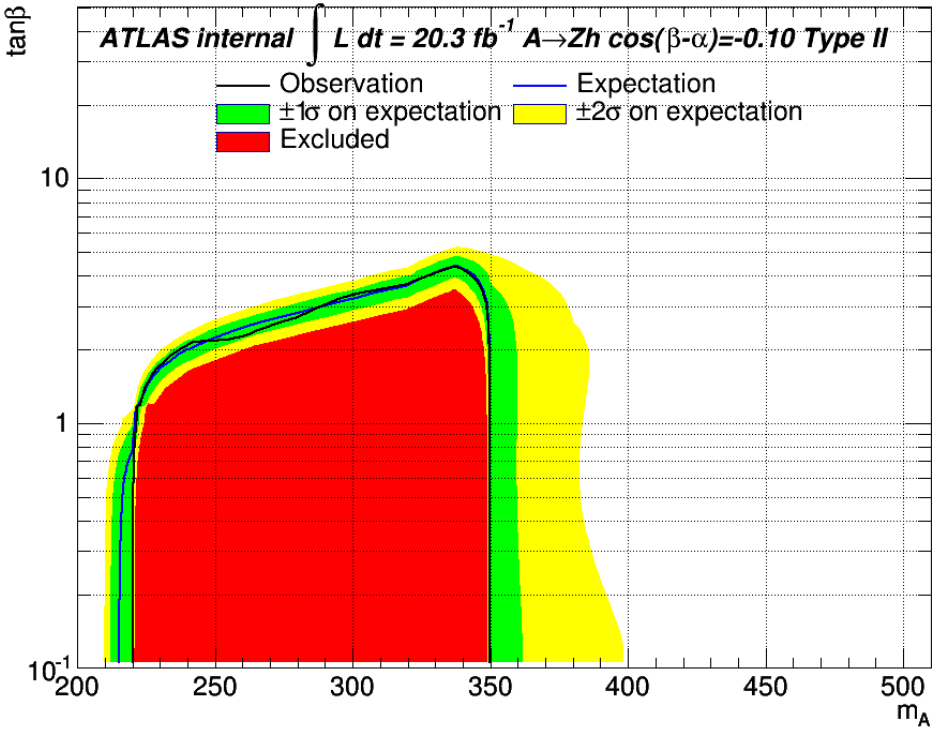
in paper draft

2HDM – type I II in tanb vs mA **cos(b-a)=-0.1**

- The variations from BR(bb/tautau) are also considered in exclusion contours for plane of tanb vs mA



caused by low br(bb)

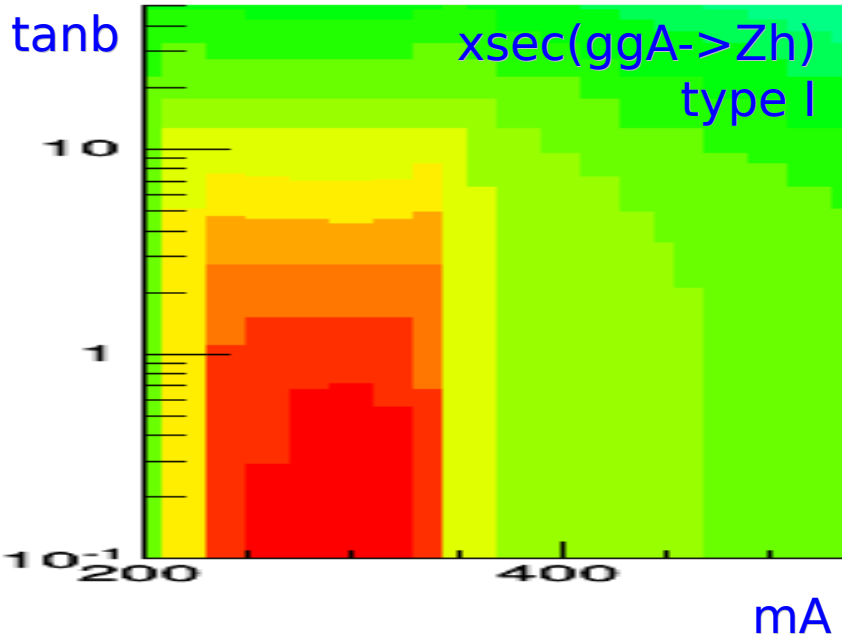


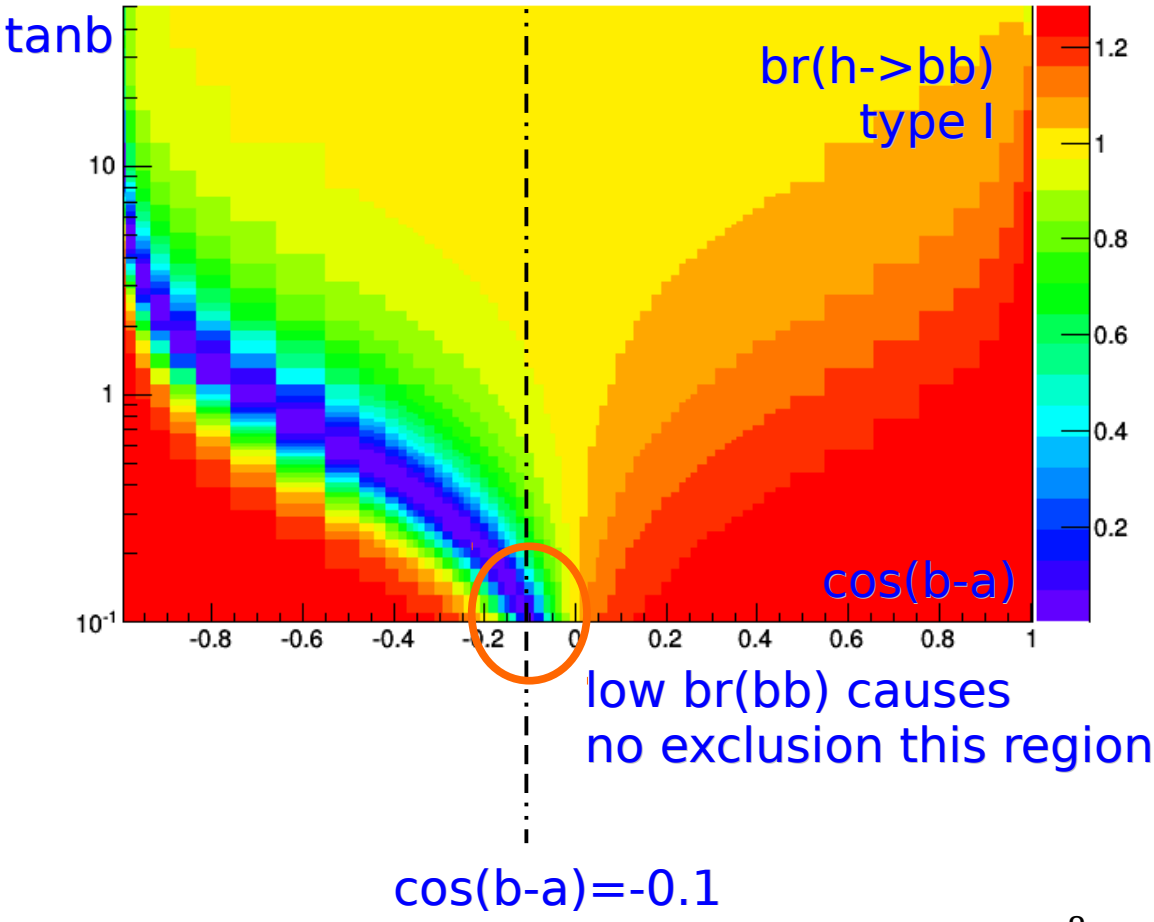
in paper draft

in paper draft

2HDM – type I check in tanb vs mA

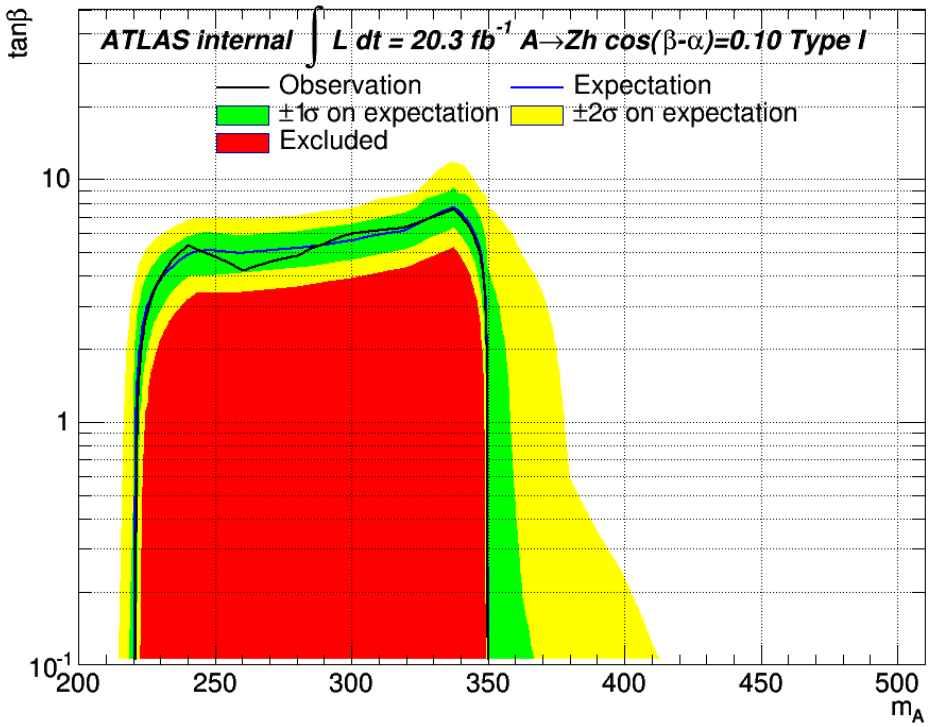
- Check on the contours of xsec(ggH->hh) in tanb vs mA
- The non-excluded areas in low tanb region is caused by the diminishing br(h->bb) at low tanb @ cos(b-a)=-0.1

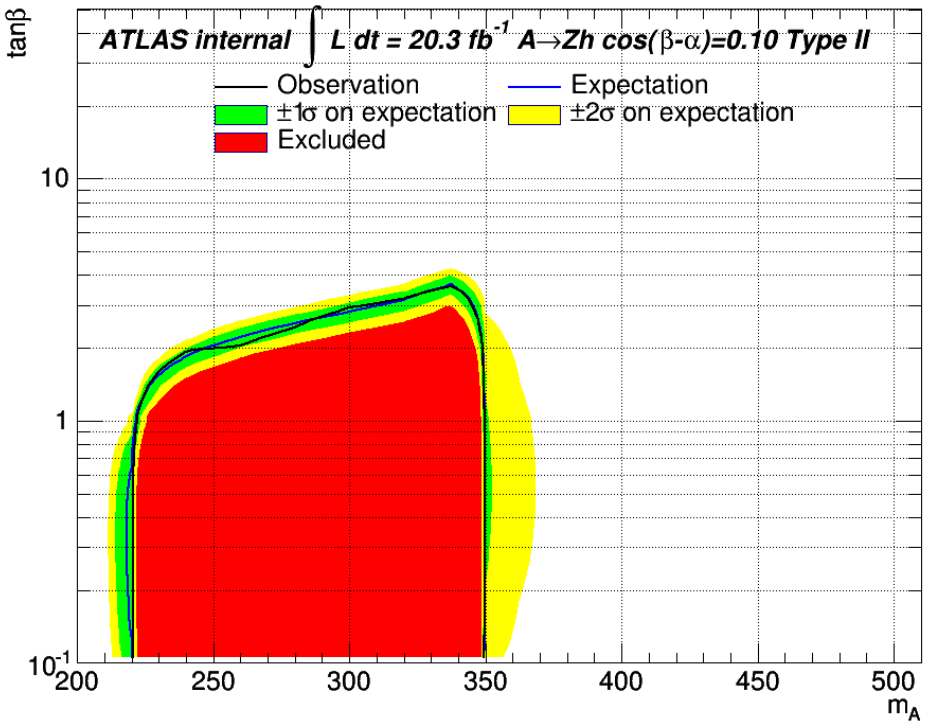




2HDM – type I II in tanb vs mA **cos(b-a)=+0.1**

- The variations from BR(bb/tautau) are also considered in exclusion contours for plane of tanb vs mA



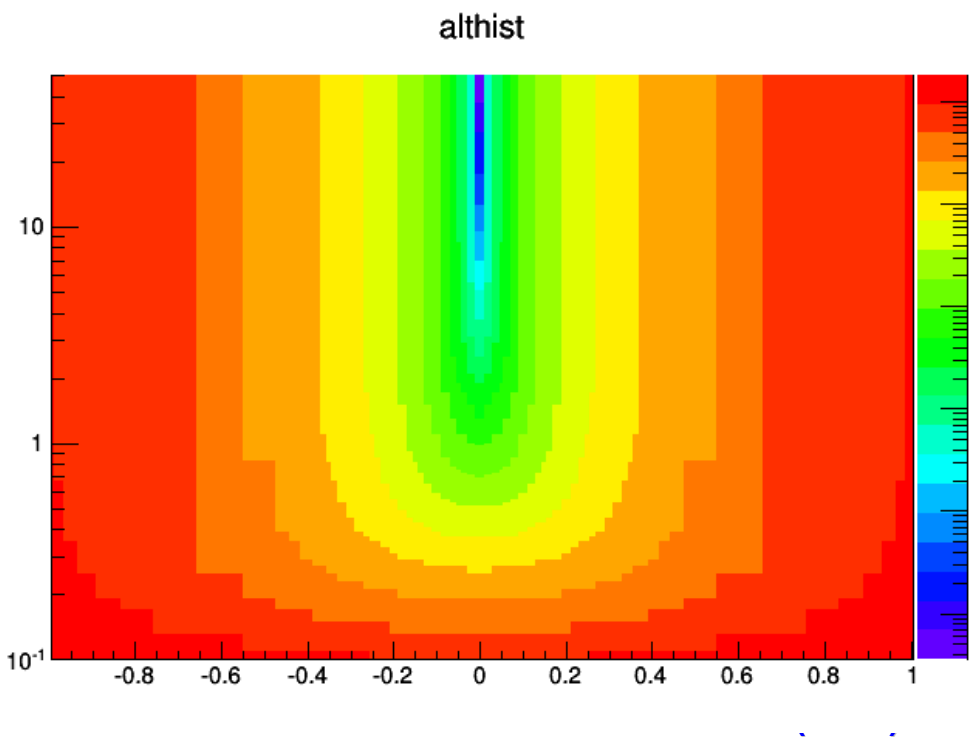


in paper draft

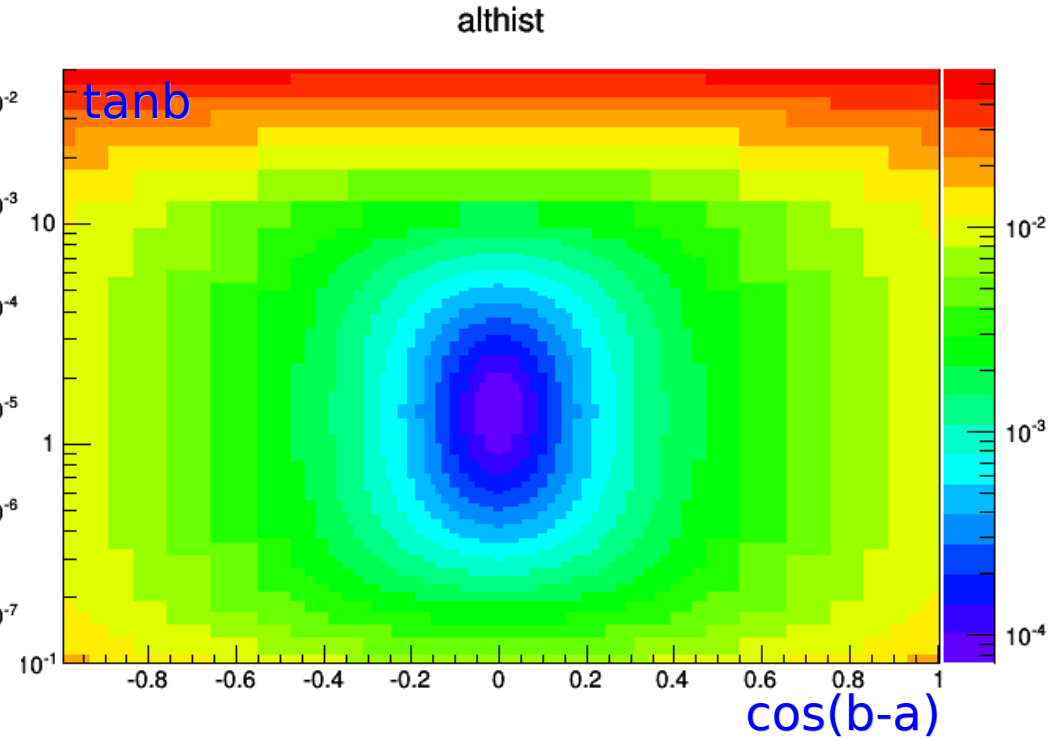
in paper draft

2HDM – type I II check width

type I width_A / mA

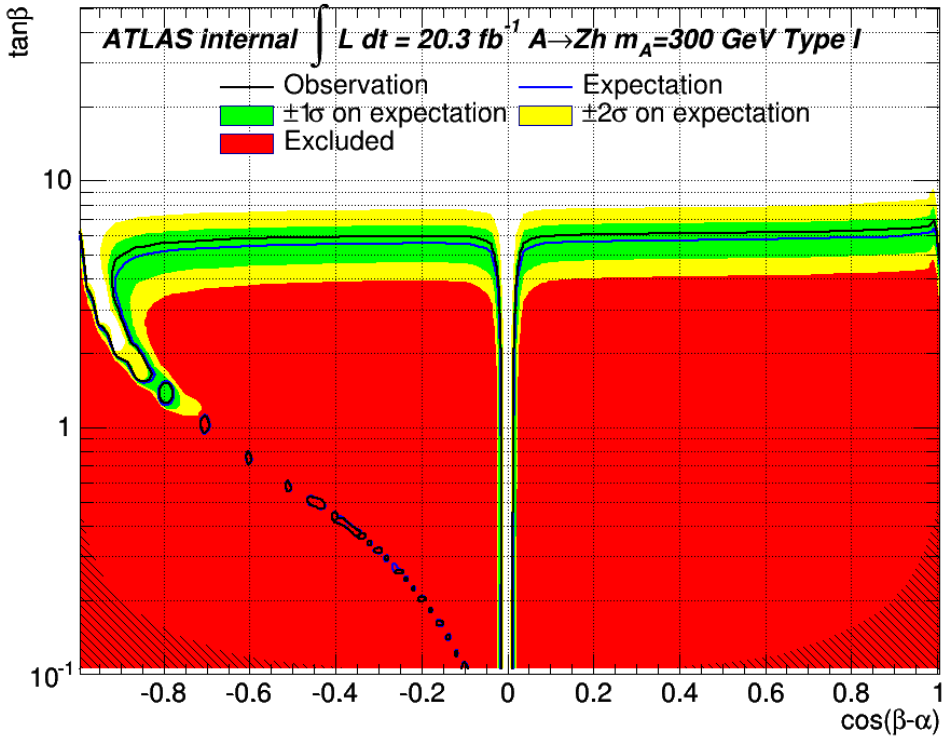


type II width_A / mA

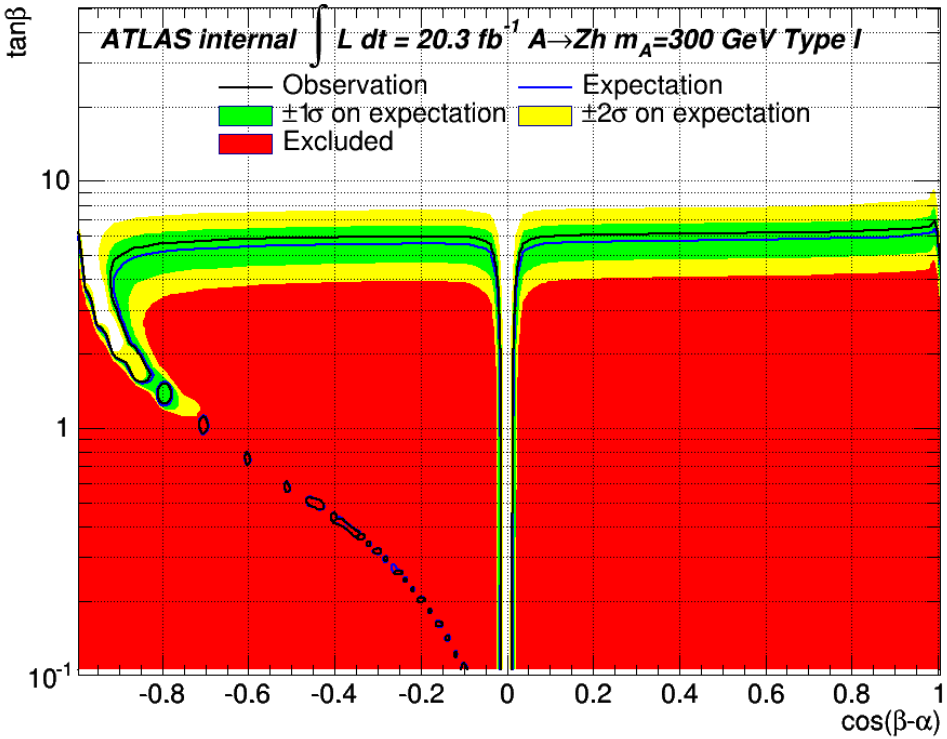


2HDM – type I check width

- type I, our exclusion is valid with narrow width approximation



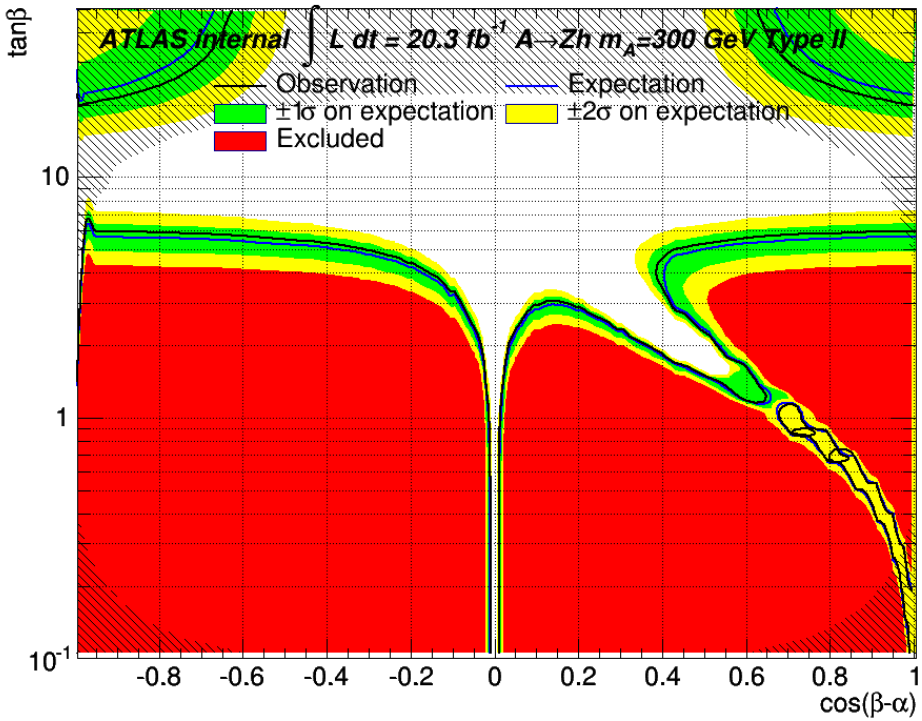
shadow = width(A)/m(A)>1%



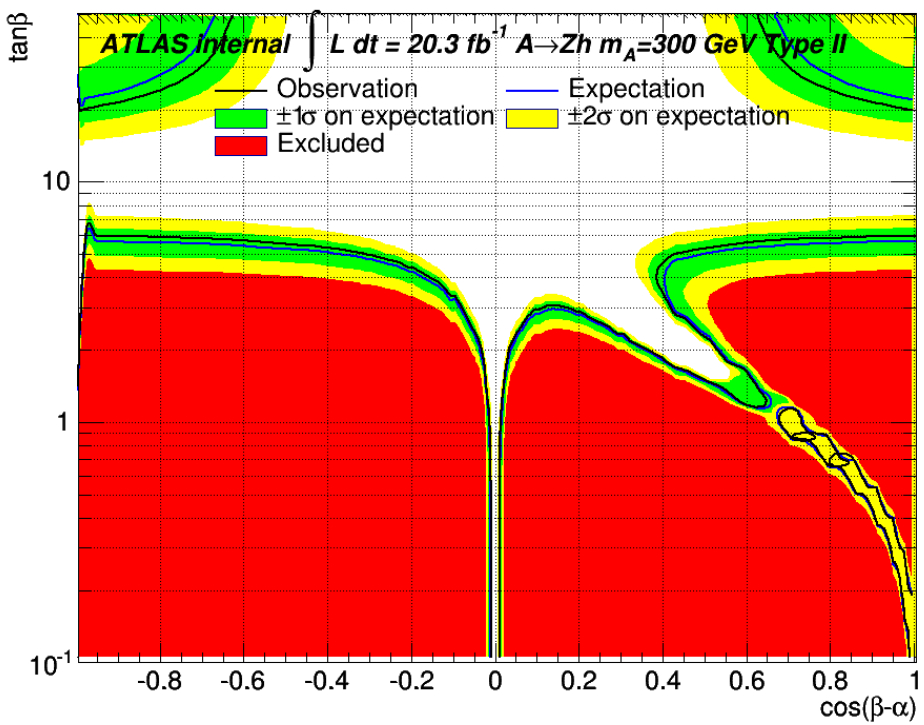
shadow = width(A)/m(A)>5%

2HDM – type II check width

- type II, our exclusion is valid with narrow width approximation



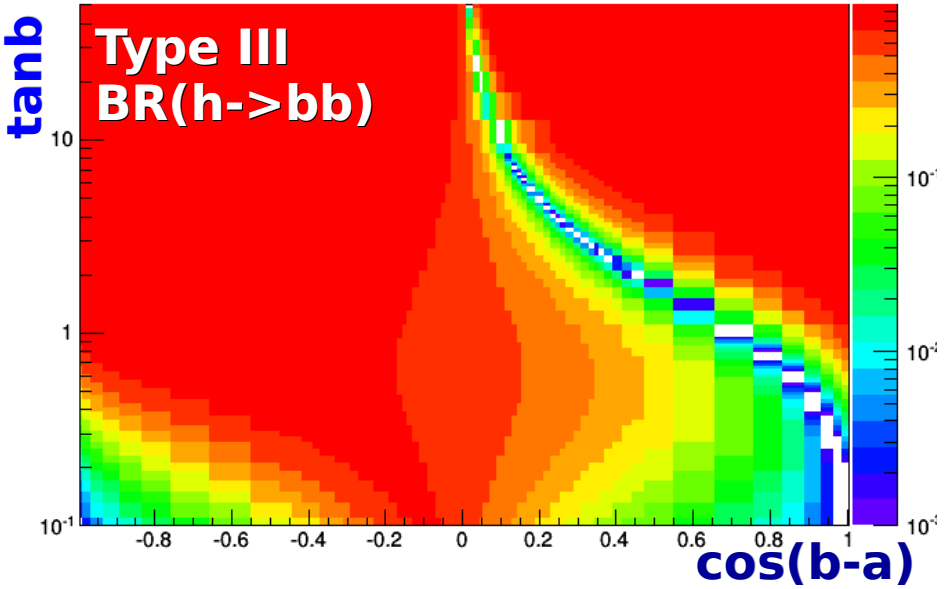
shadow = width(A)/m(A)>1%

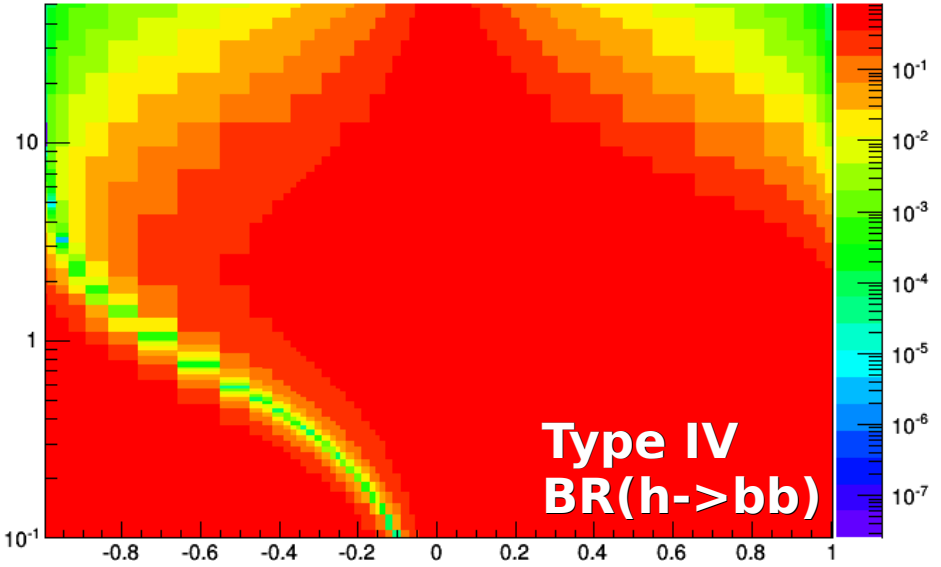


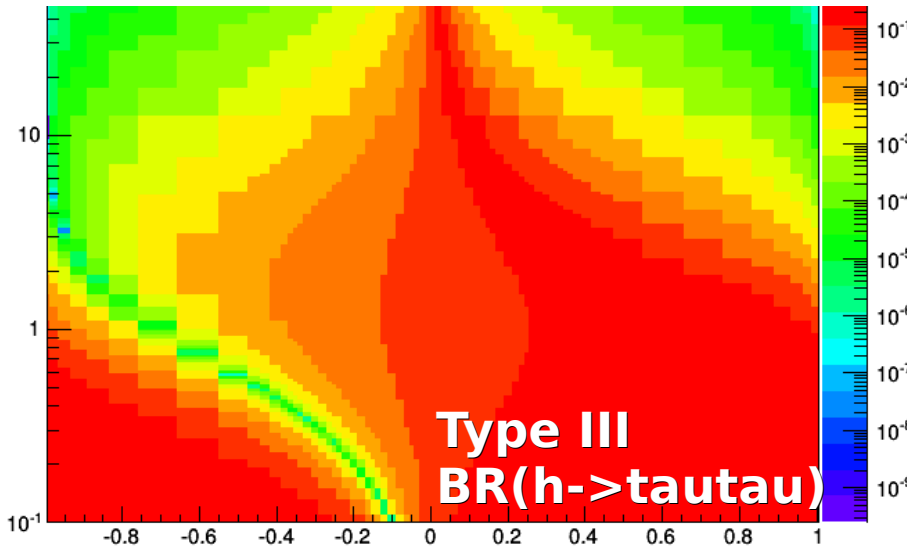
shadow = width(A)/m(A)>5%

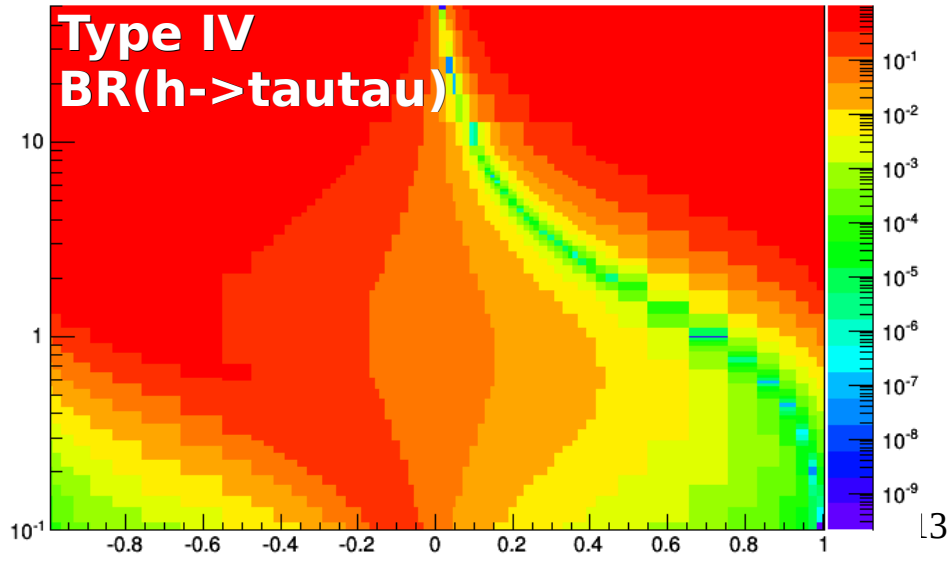
2HDM type III and IV (ongoing)

- BR(h->bb) and BR(h->tautau) are **NOT** scaling in the same way for type III and IV, have to redo the limits









2HDM type III and IV (ongoing)

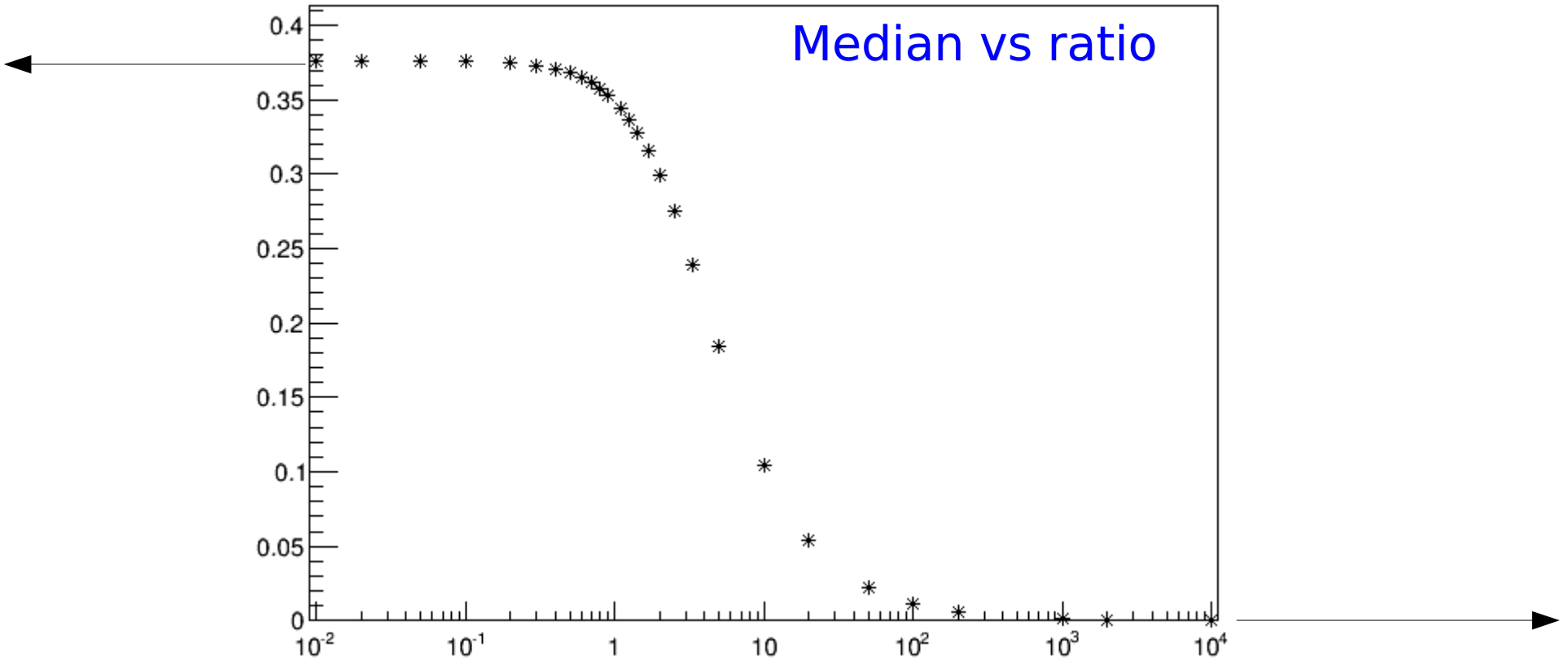
- The idea is to only redo the limits for a certain **ratios** of BR(h->bb) / BR(h->tautau) **(bb is always fixed, only change tautau)**, then rescale the limits to the different BRs
- On the bottom, with help of Andy, these ratios are scanned

$$\textbf{ratio} = \frac{\text{BR(h->tautau)/BR(h->tautau)\_SM}}{\text{BR(h->bb)/BR(h->bb)\_SM}}$$

0.0	1.0/1.0	additionally
0.01	1/0.9	
0.02	1/0.8	1/0.005
0.05	1/0.7	1/0.001
0.1	1/0.6	1/0.0005
0.2	1/0.5	1/0.0001
0.3	1/0.4	
0.4	1/0.3	
0.5	1/0.2	
0.6	1/0.1	
0.7	1/0.05	
0.8	1/0.02	
0.9	1/0.01	

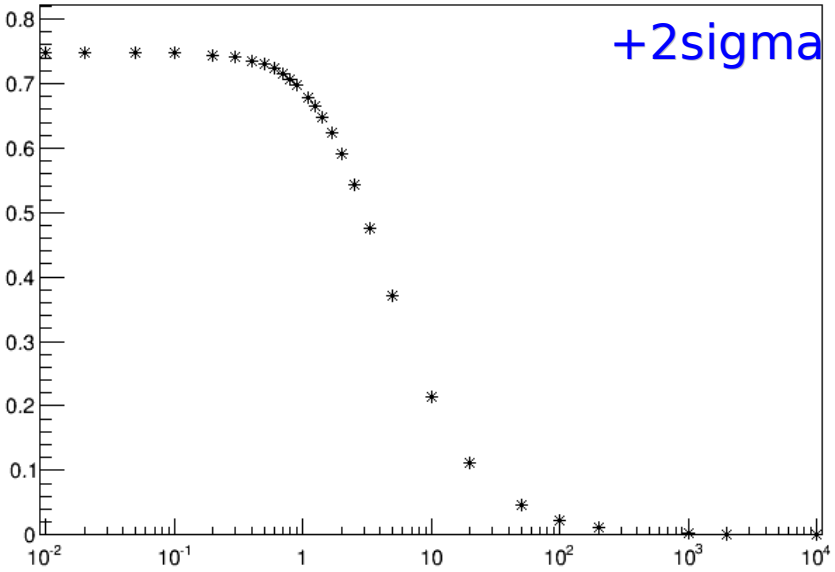
2HDM type III and IV (ongoing)

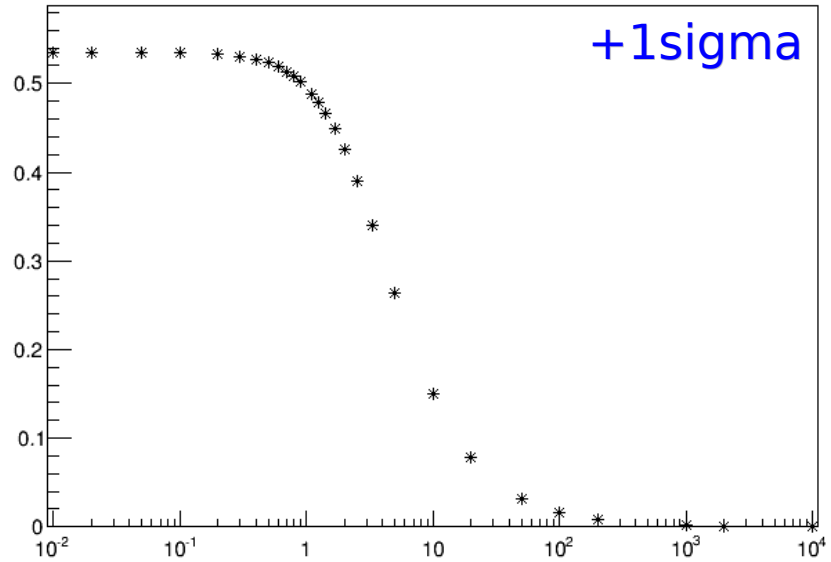
- 300GeV workspace is used

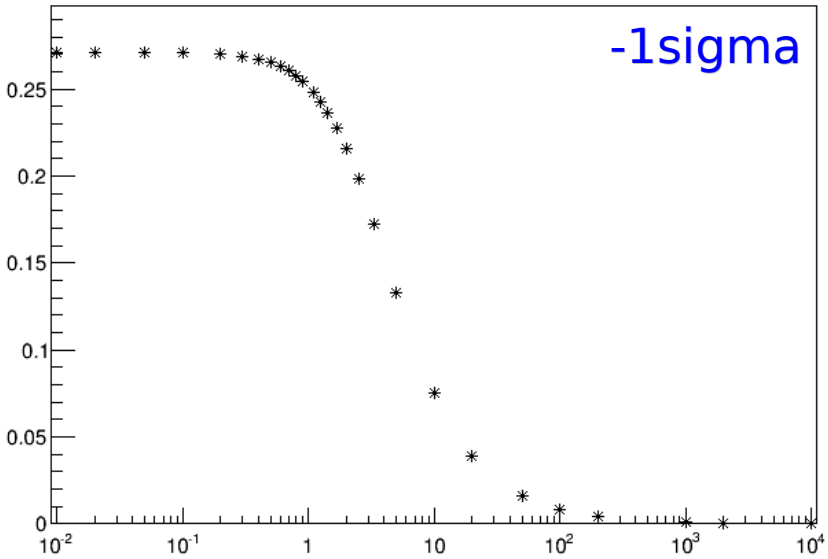


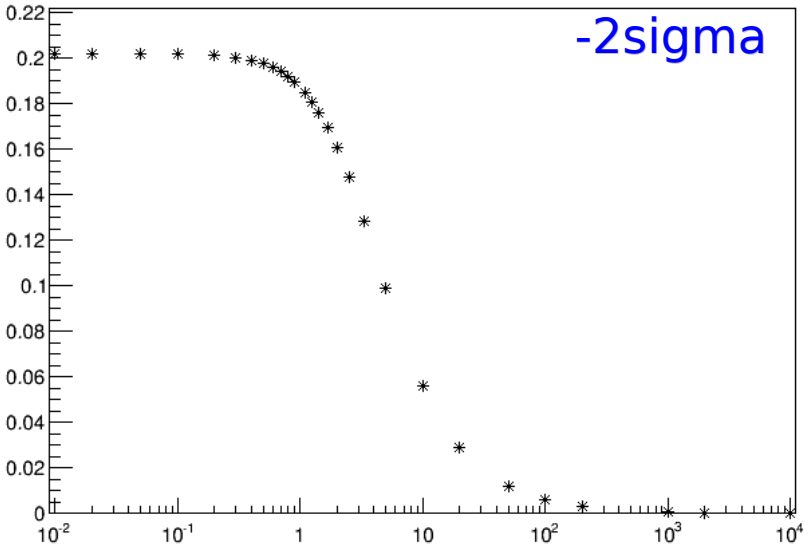
2HDM type III and IV (ongoing)

- Curves for bands



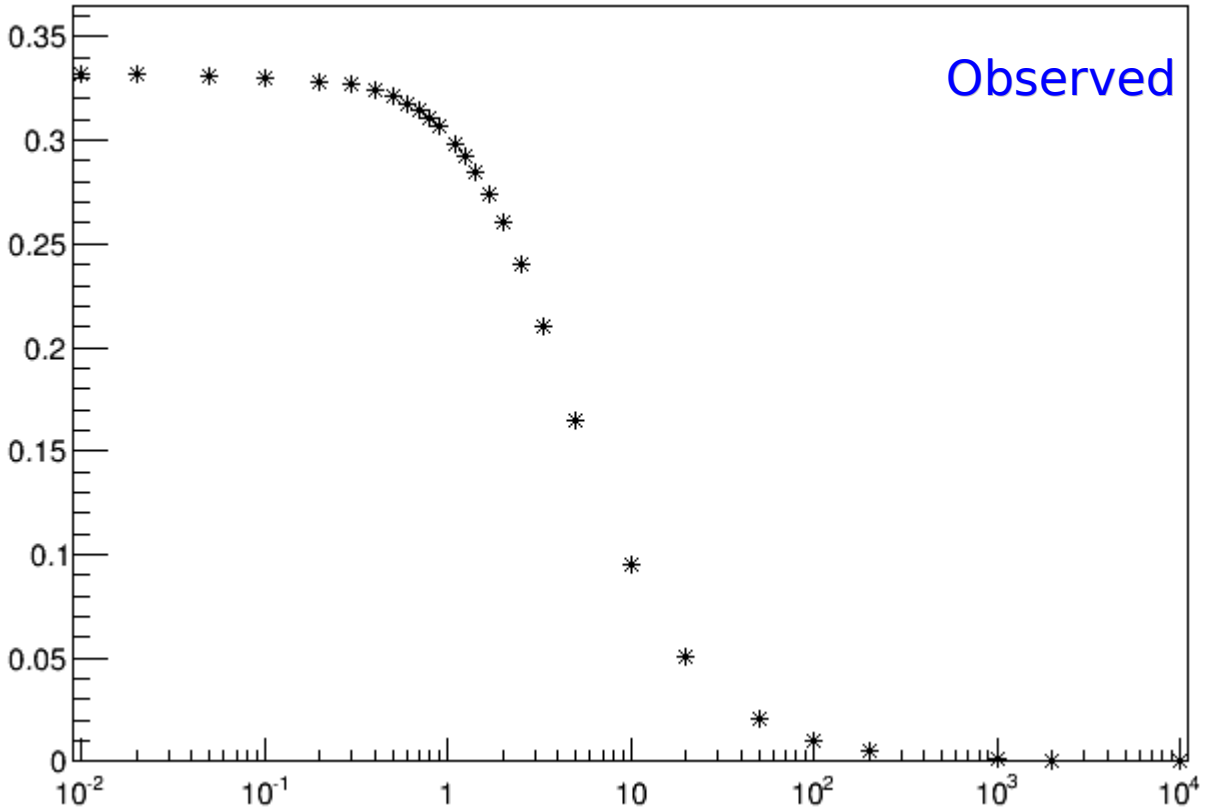






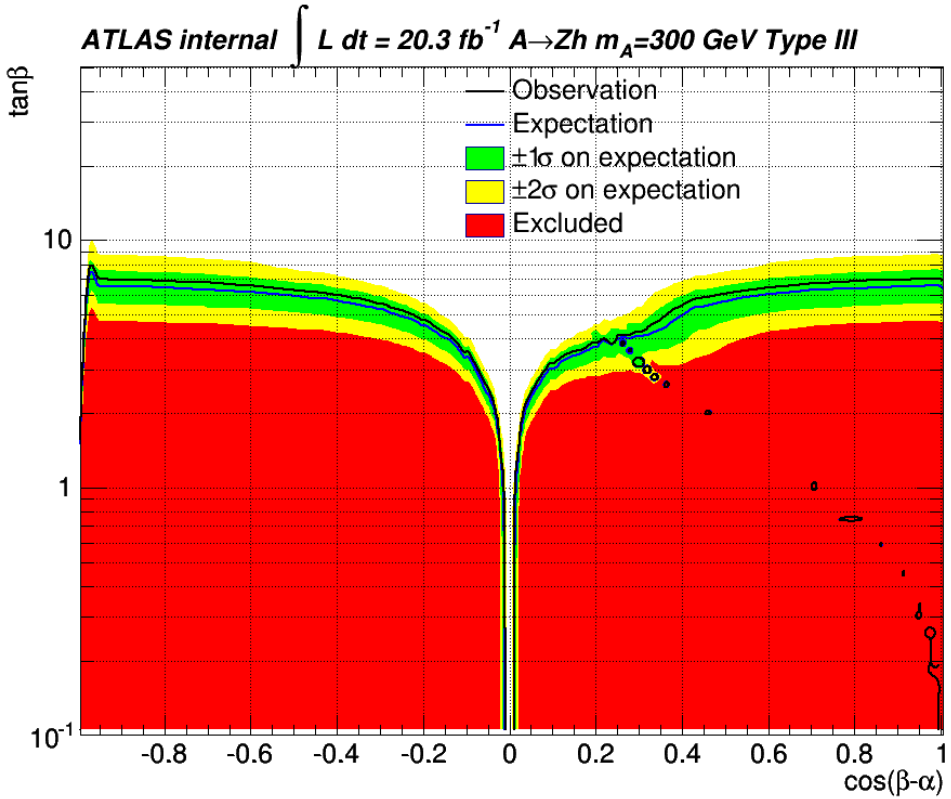
2HDM type III and IV (ongoing)

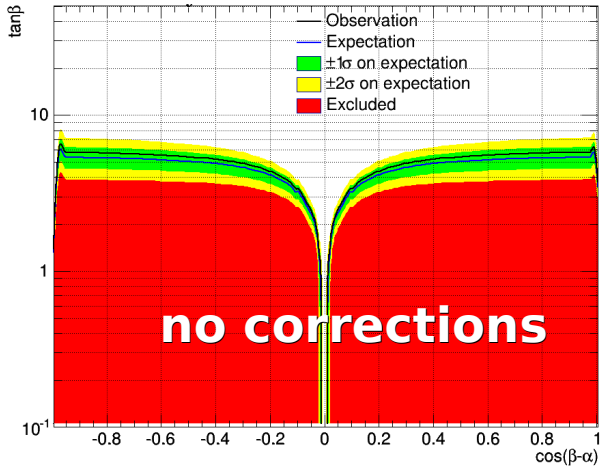
- Curves for observed limits

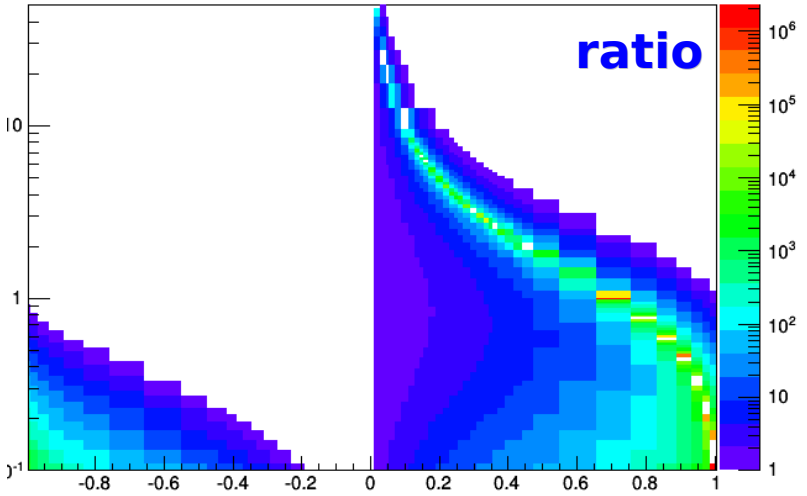


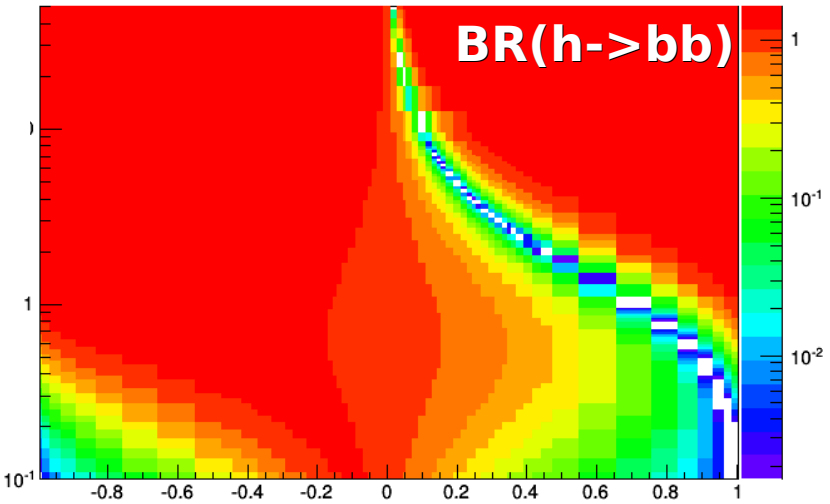
2HDM type III (ongoing)

- Plotting for type III with rescaled limits



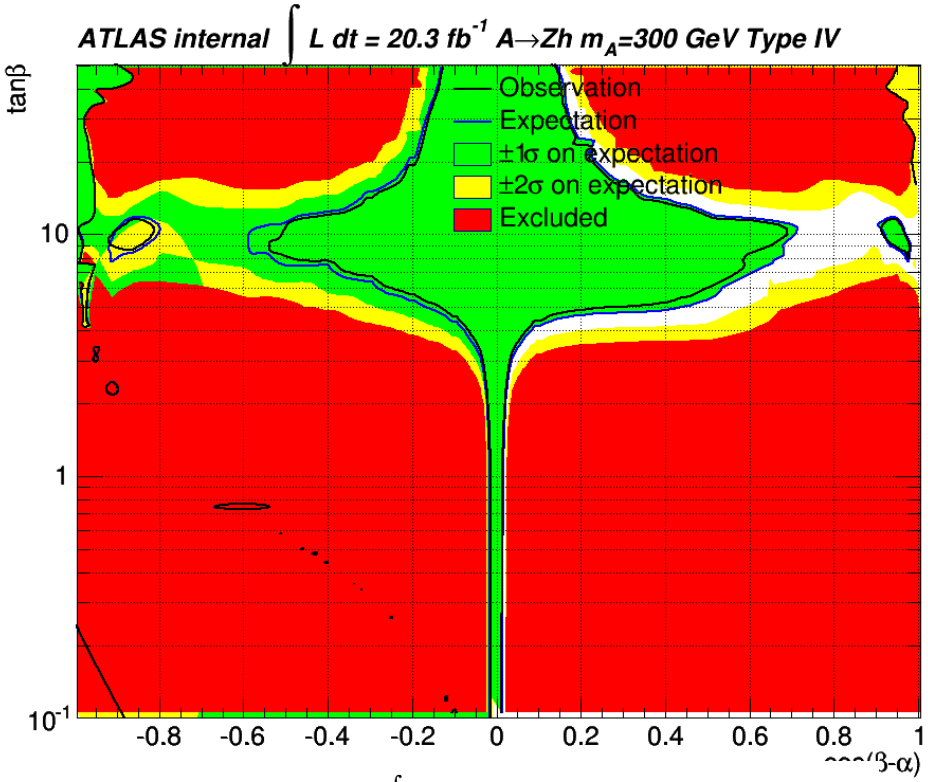


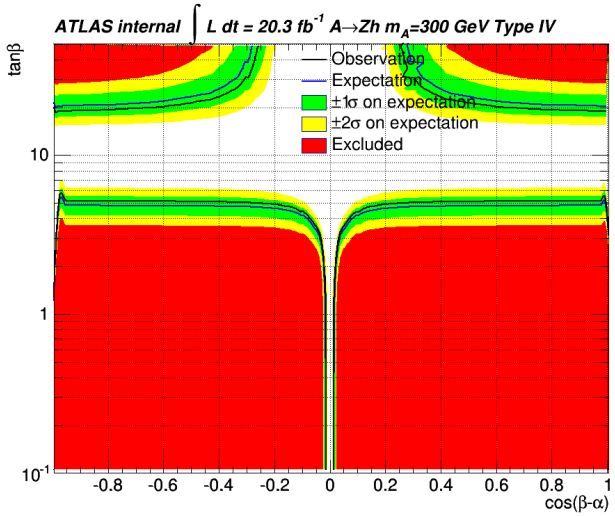


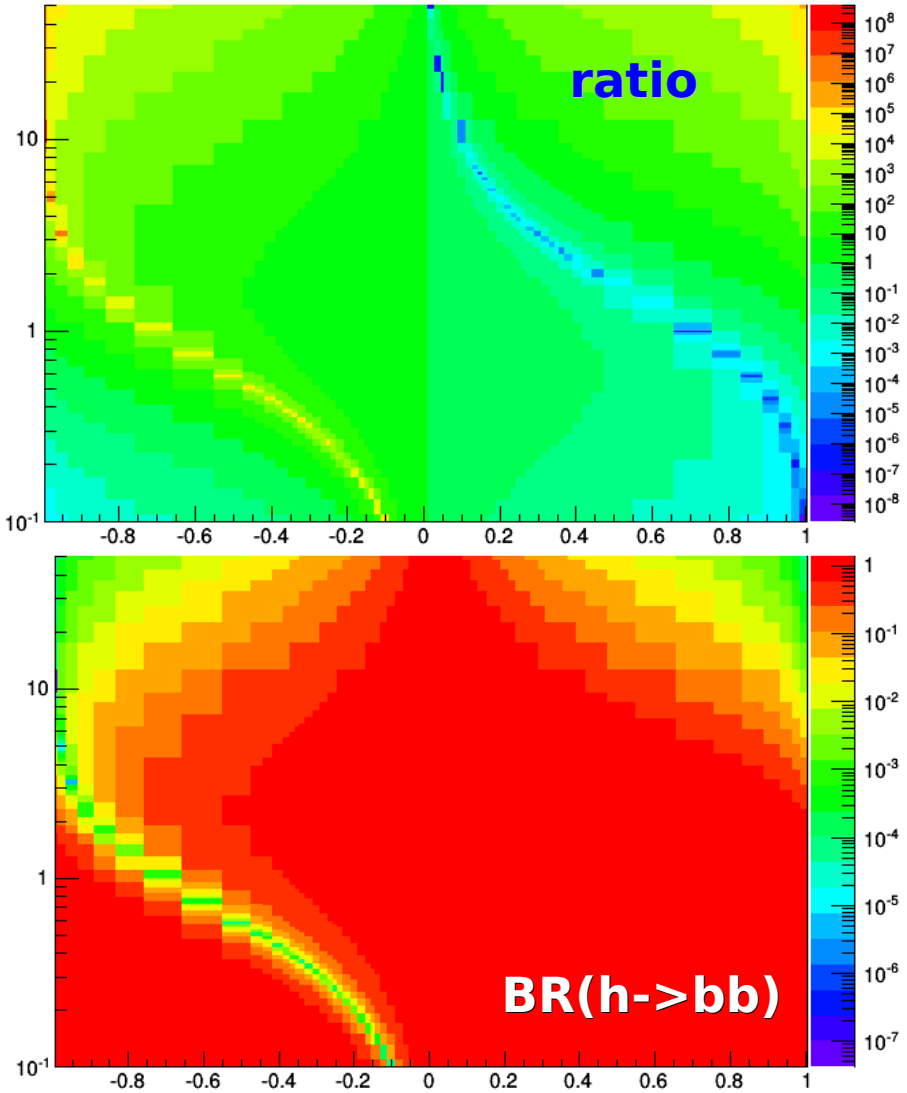


2HDM type IV (ongoing)

- Plotting for type IV with rescaled limits, wrongly interpolated







Summary

- Type I and II are interpreted by simply rescaling the combined limits with the considerations of nonSM Brs of h->bb / tautau
  - have manually removed the wrong interpolated contours (islands) in the exclusion plots
  - should be safe since median exist in the middle of green band, but additional check are needed
- Type III and IV now can be interpreted, the combined limits are re-done as a function of the ratio (tautau/bb) and can be rescaled at different phase points
  - use 2HDMPlottingTool to include this effects, but the plots do not seem to be correct
- Checks on width show that NWA always works in our excluded regions in type I and II
- In paper draft, we have now:
  - type I II, tanb vs cos(b-a)
  - type I II, tanb vs mA @ cos(b-a) = +- 0.1

backup

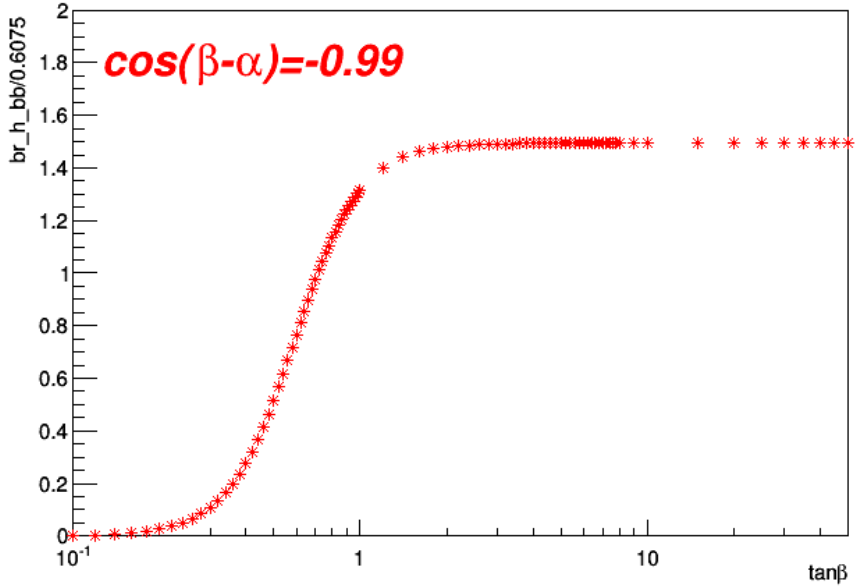
Solutions on type I and II

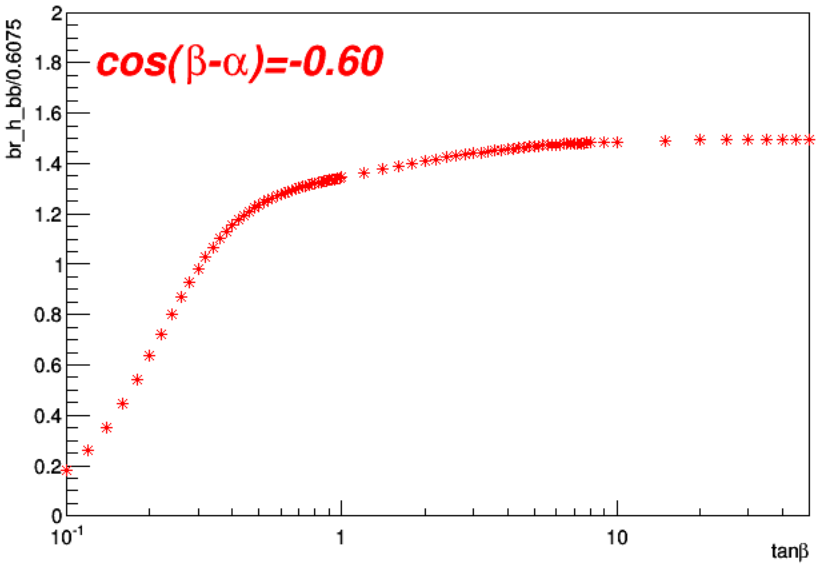
- Triggered by more physics interests, feasible solutions are proposed for type I and II after many discussions with all AZh people
- Due to the same scale on BR(h->bb) and BR(h->tautau) from SM to 2HDM in type I and II, **limits are directly rescaled** by factors due to BR deviation from SM values
  - equivalent to considering all signal rescaled with new BR
  - not considering rescaling backgrounds whose contribution should be small
- Use rescaled limits to make exclusion plots

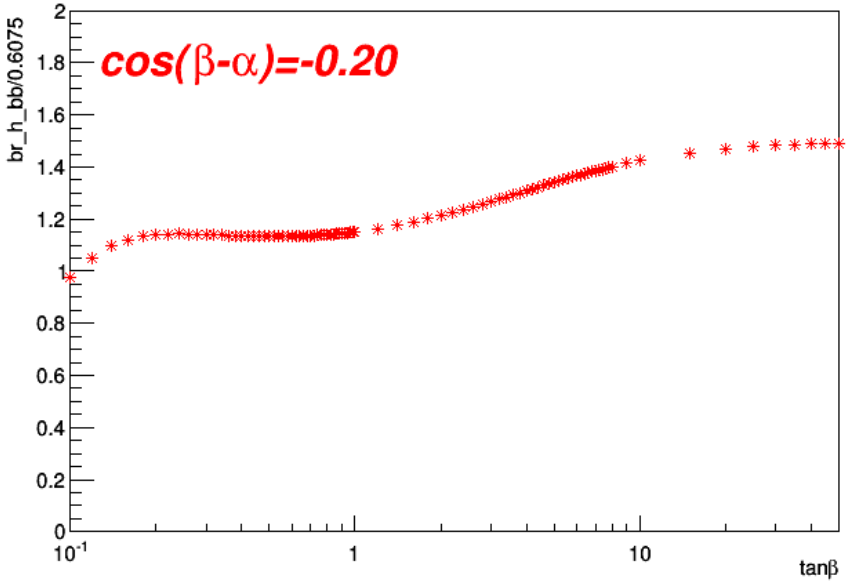
	Type I	Type II	Type III	Type IV
ξ_h^V	$\sin(\beta-\alpha)$	$\sin(\beta-\alpha)$	$\sin(\beta-\alpha)$	$\sin(\beta-\alpha)$
ξ_h^u	$\frac{\cos\alpha}{\sin\beta}$	$\frac{\cos\alpha}{\sin\beta}$	$\frac{\cos\alpha}{\sin\beta}$	$\frac{\cos\alpha}{\sin\beta}$
h->bb ξ_h^d	$\frac{\cos\alpha}{\sin\beta}$	$-\frac{\sin\alpha}{\cos\beta}$	$\frac{\cos\alpha}{\sin\beta}$	$-\frac{\sin\alpha}{\cos\beta}$
h->tautau ξ_h^l	$\frac{\cos\alpha}{\sin\beta}$	$-\frac{\sin\alpha}{\cos\beta}$	$-\frac{\sin\alpha}{\cos\beta}$	$\frac{\cos\alpha}{\cos\beta}$

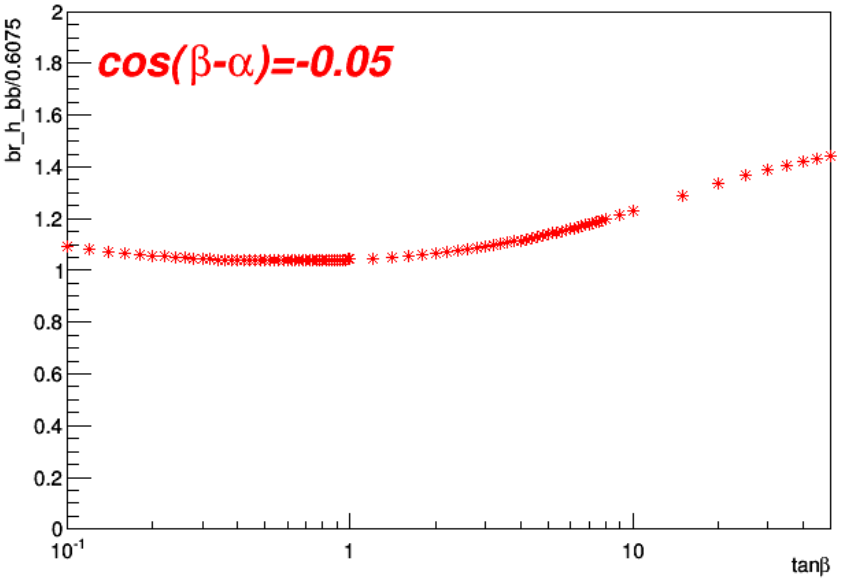
BR(h->hh) type II

- BR(2HDM)/BR(SM) is plotted as a function of tanb



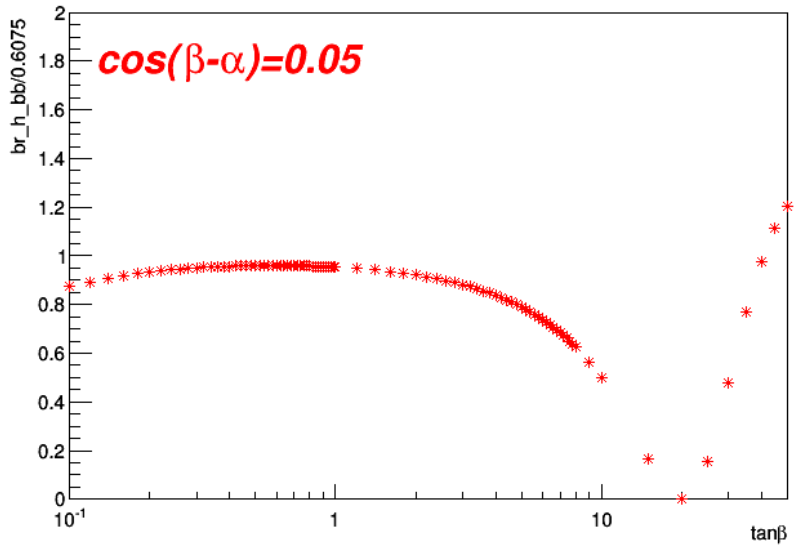


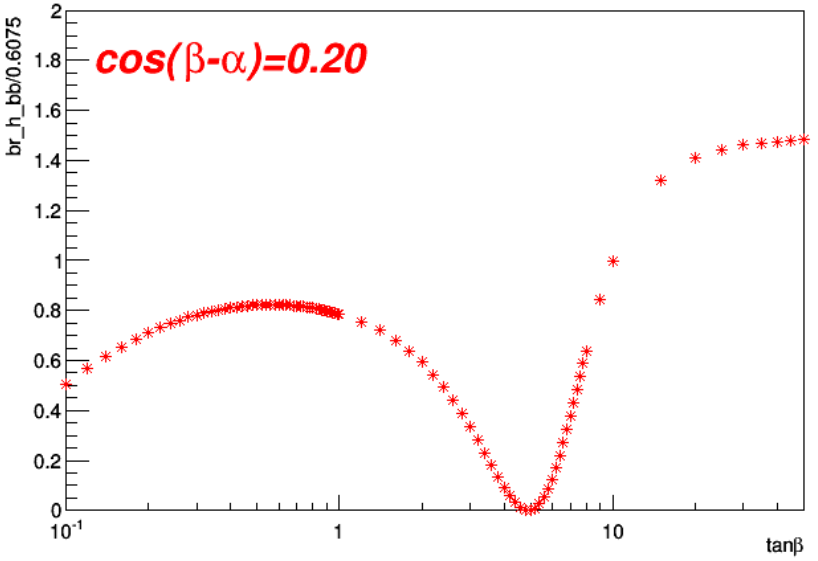


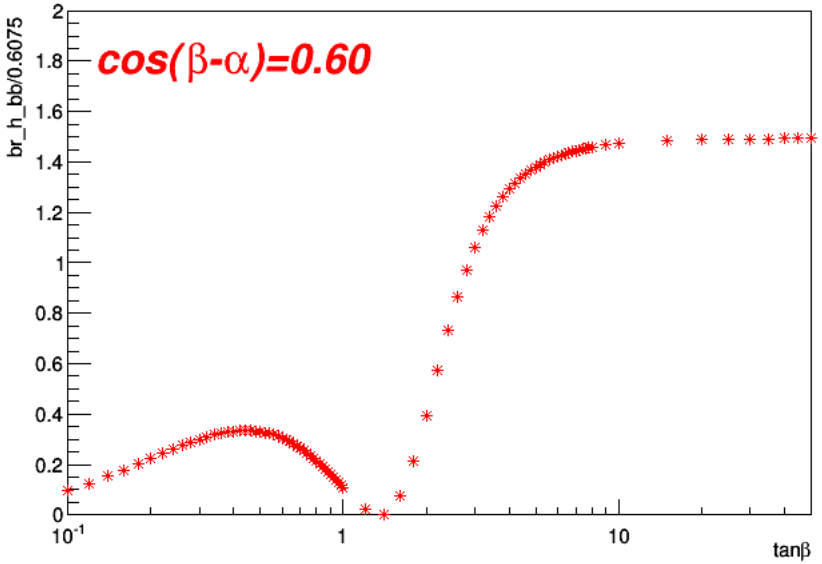


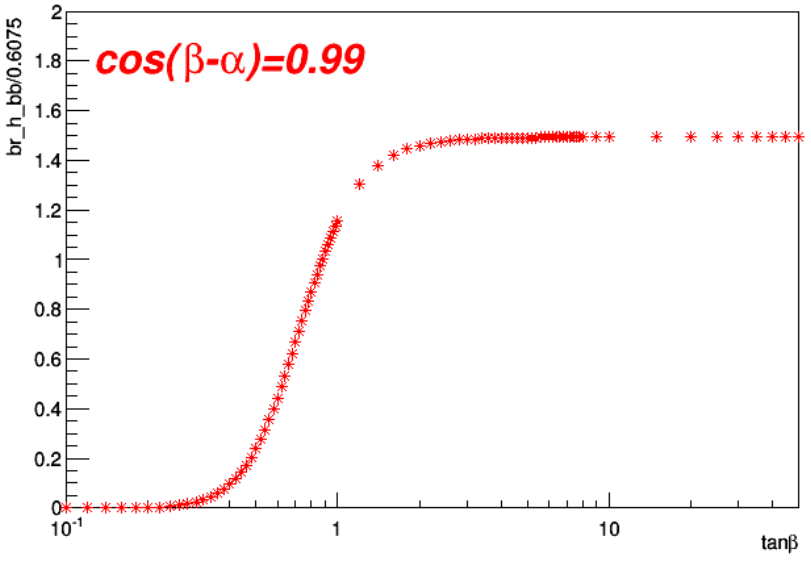
BR(h->hh) type II

- BR(2HDM)/BR(SM) is plotted as a function of tanb



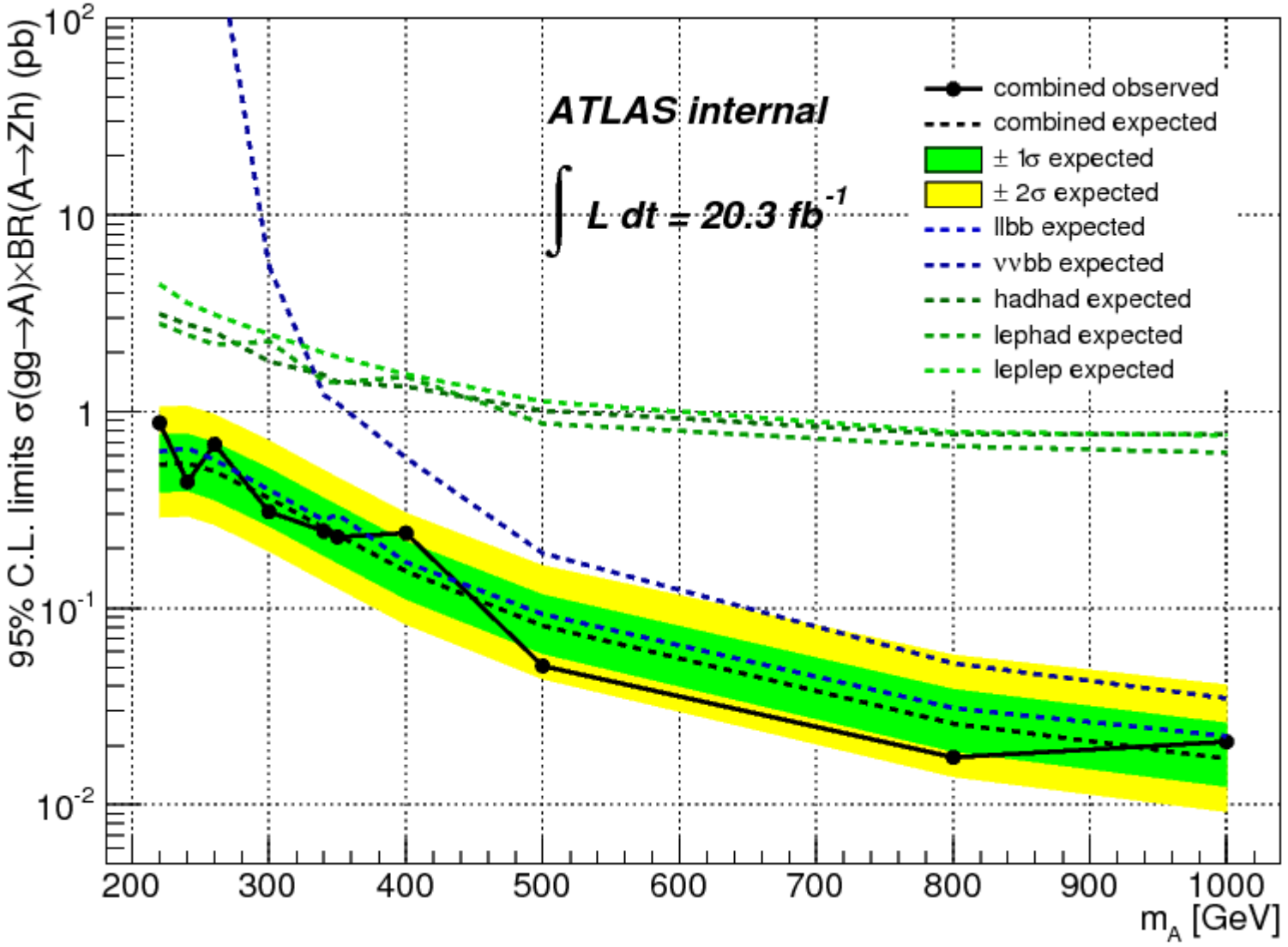






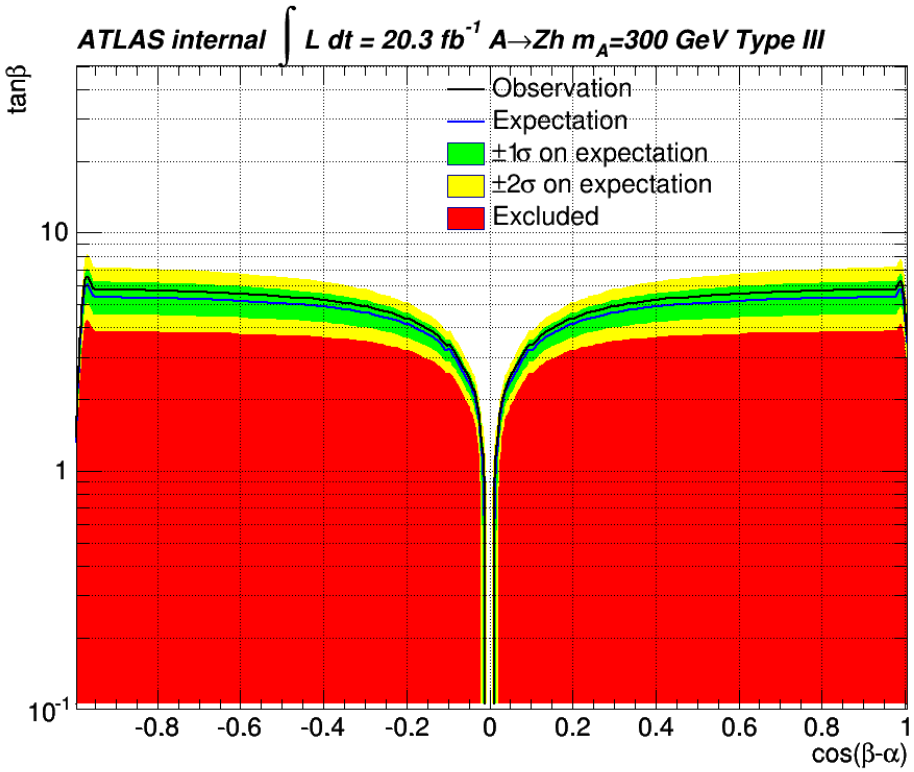
Combined limits

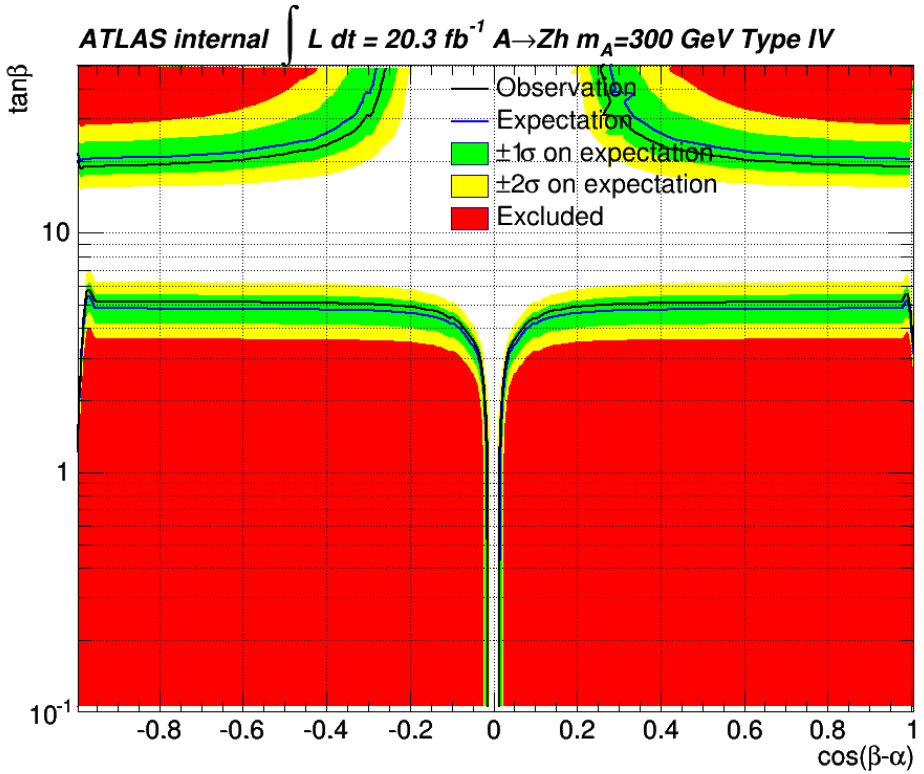
- combination of tautau and bb workspaces



2HDM type III and IV (no rescale)

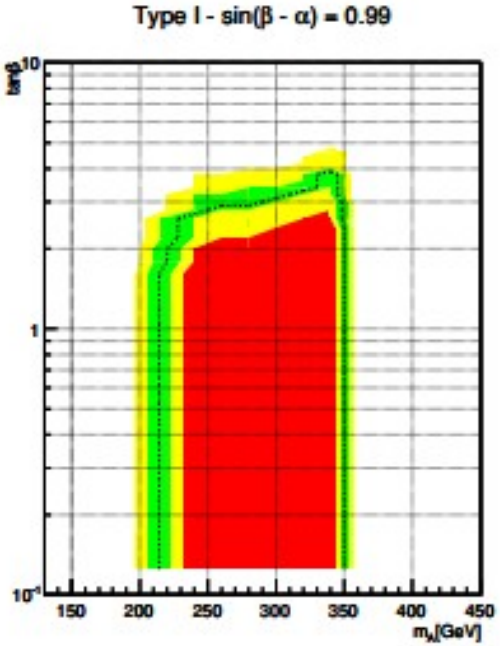
- 2HDM type III and IV without considering the variations on branching ratios of h->bb and h->tautau
- Only SM h->bb and h->tautau are assumed

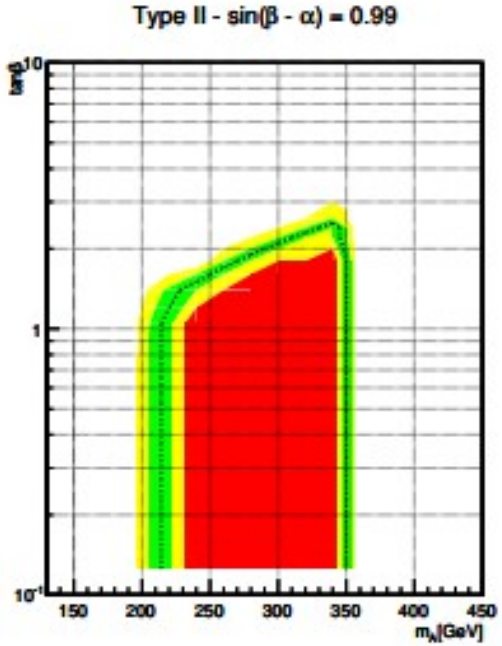


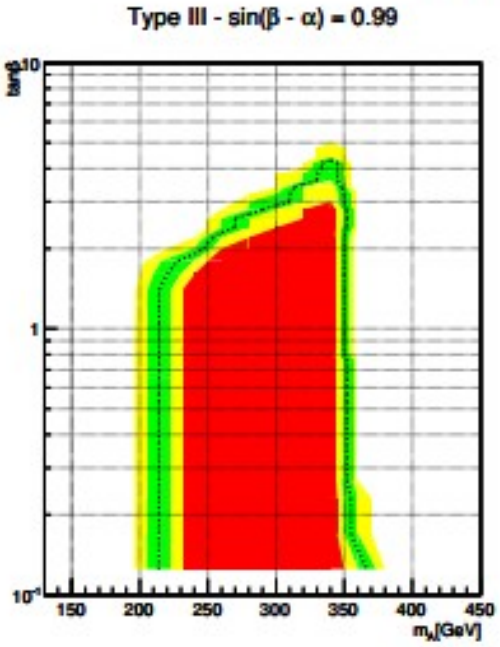


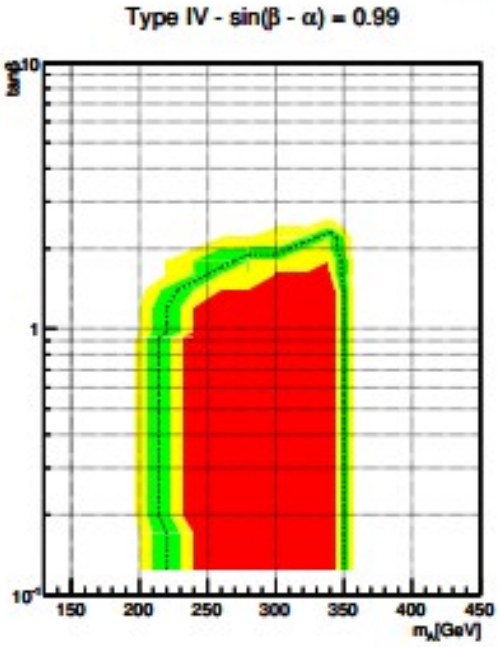
$tan\beta$ vs m_A $sin(\beta - \alpha)$=0.99

Marco, Matteo, Lucrezia









$tan\beta$ vs m_A $sin(\beta - \alpha)$=0.999

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