Brief report (updated)
January 2014

Xiaohu SUN, IHEP, Beijing, 21-01-2014

Updates on **Hhh** combination

- Previously
  - ✔The machinary of combining workspaces is done
  - ✔The profile likelihood fit on the combined workspaces works very well for expectations
- Now (to be shown in this talk)
  - The standard nuisanse parameter checks are being implemented
  - The upper limit setting is being realized
- Near future (to-do-list)
  - To be mentioned in the end of this talk

What we have now

- Preliminary workspace from bbbb group
- Preliminary com note from bbyy group

RSG_hh_allsyst_m1000_combined_GaussExample_model.root
RSG_hh_allsyst_m1100_combined_GaussExample_model.root
RSG_hh_allsyst_m1200_combined_GaussExample_model.root
RSG_hh_allsyst_m1300_combined_GaussExample_model.root
RSG_hh_allsyst_m1400_combined_GaussExample_model.root
RSG_hh_allsyst_m1500_combined_GaussExample_model.root
RSG_hh_allsyst_m500_combined_GaussExample_model.root
RSG_hh_allsyst_m600_combined_GaussExample_model.root
RSG_hh_allsyst_m700_combined_GaussExample_model.root
RSG_hh_allsyst_m800_combined_GaussExample_model.root
RSG_hh_allsyst_m900_combined_GaussExample_model.root

From **bbbb**
The signal template is graviton
The sys considered:
JES, JER, BtagSF, QCDshape/norm

Draft version 1.0

ATLAS NOTE

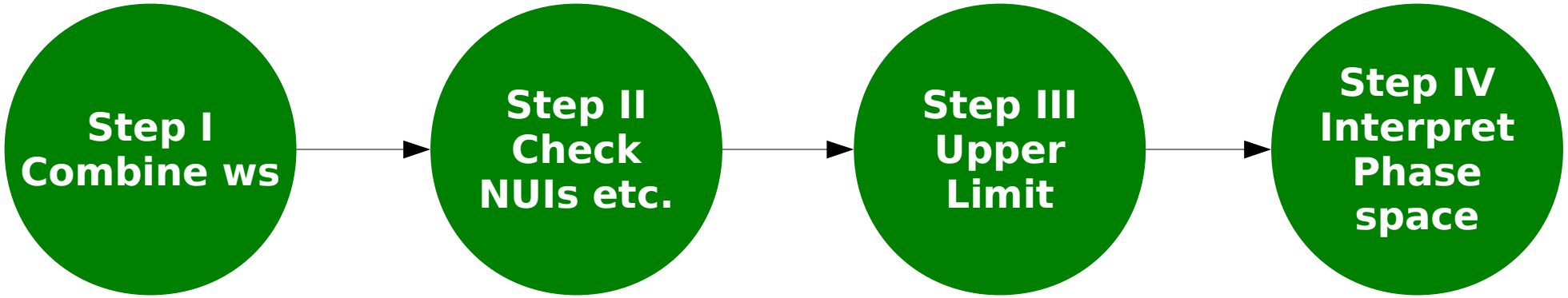
January 10, 2014

https://cds.cern.ch/record/1642374

From **bbyy**
A preliminary note contains syst
Well, there is no
Signal/bkg evt yield after final cuts
Syst on DD bkgs
So I calculate sig/bkg according to cut efficiencies they provide

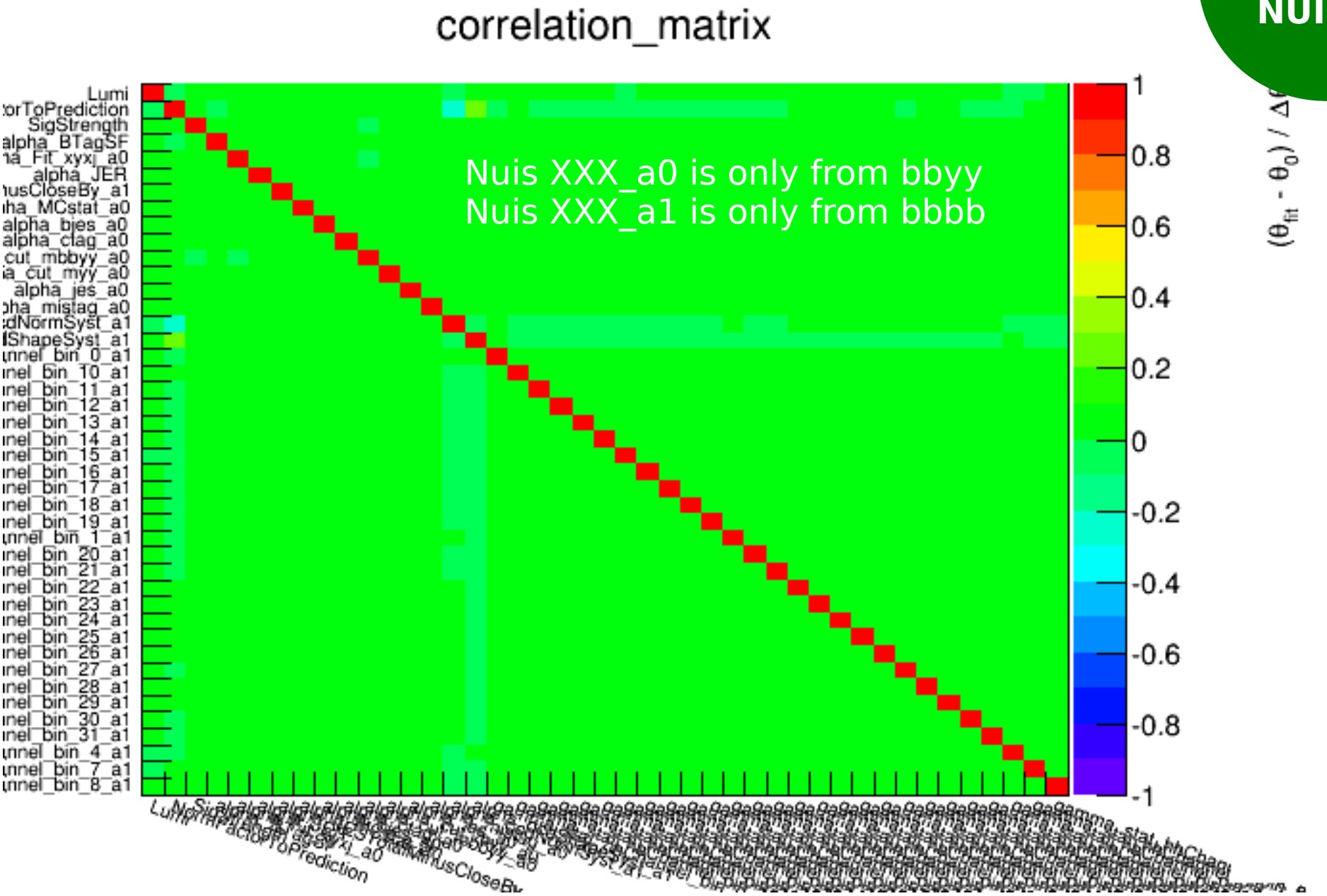
Search for resonant dihggs and enhanced non-resonant dihiggs production in the $\gamma\gamma b\bar{b}$ channel with 20.3 fb^{-1} of data at 8 TeV

Basic steps


Step I
Combine ws
Step II
Check
NUIs etc.
Step III
Upper
Limit
Step IV
Interpret
Phase
space

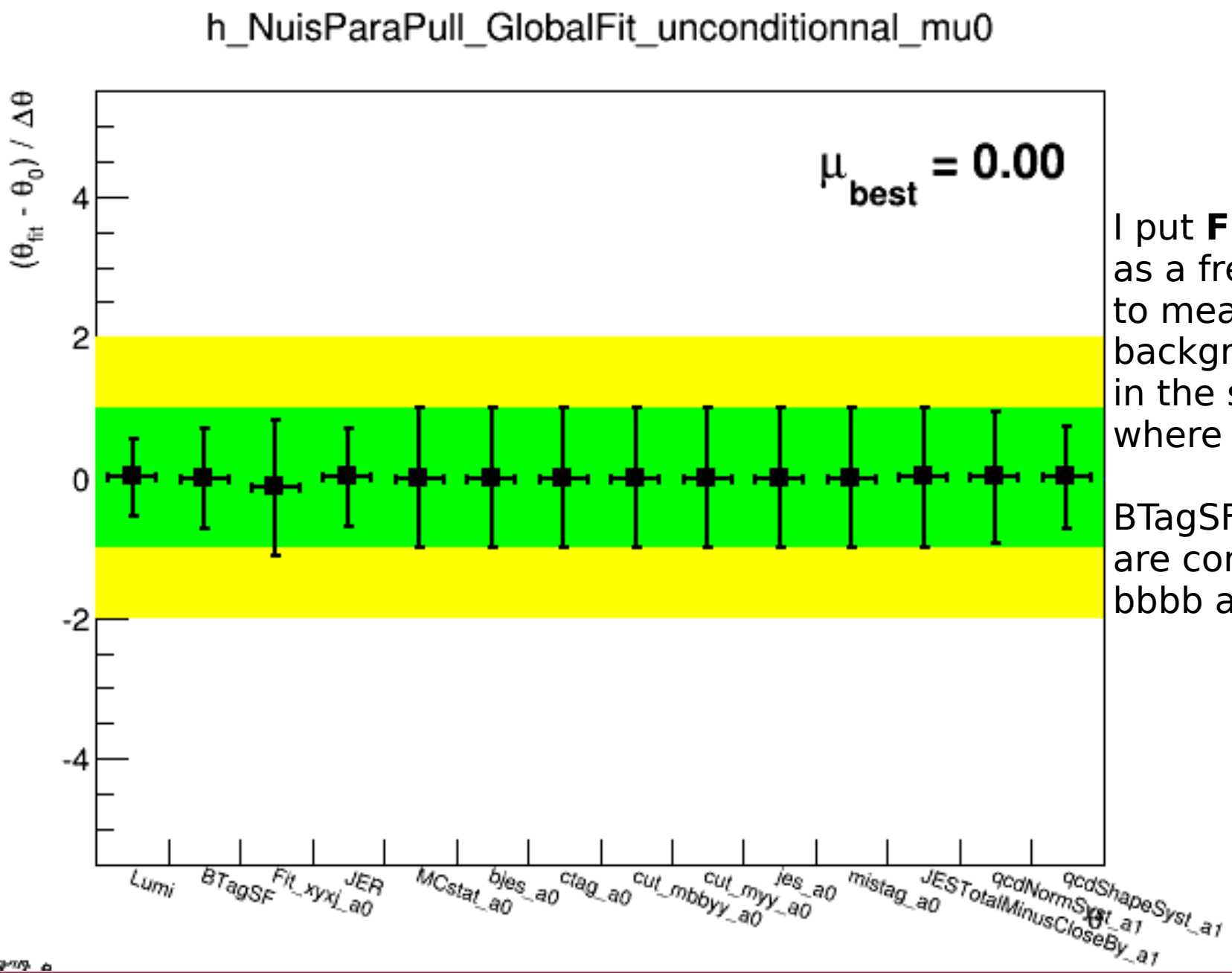
Checks on nuisance parameters

Step II Check NUIs ...



Checks on nuisance parameters

Step II Check NUIs ...



I put **Fit_xyxj_a0** as a free parameter to measure xyxj background in bbyy in the second bin where xyxj is enriched

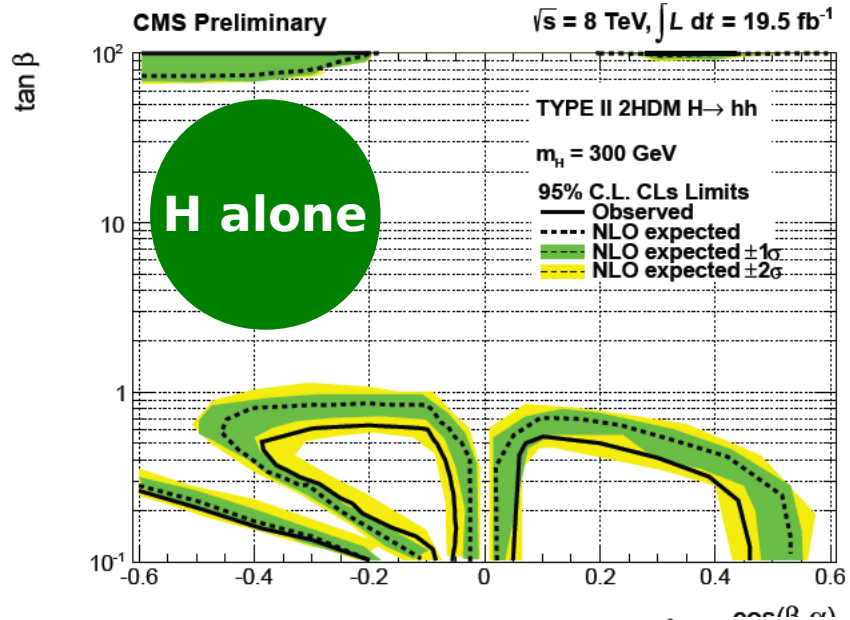
BTagSF and JER are correlated between bbbb and bbyy

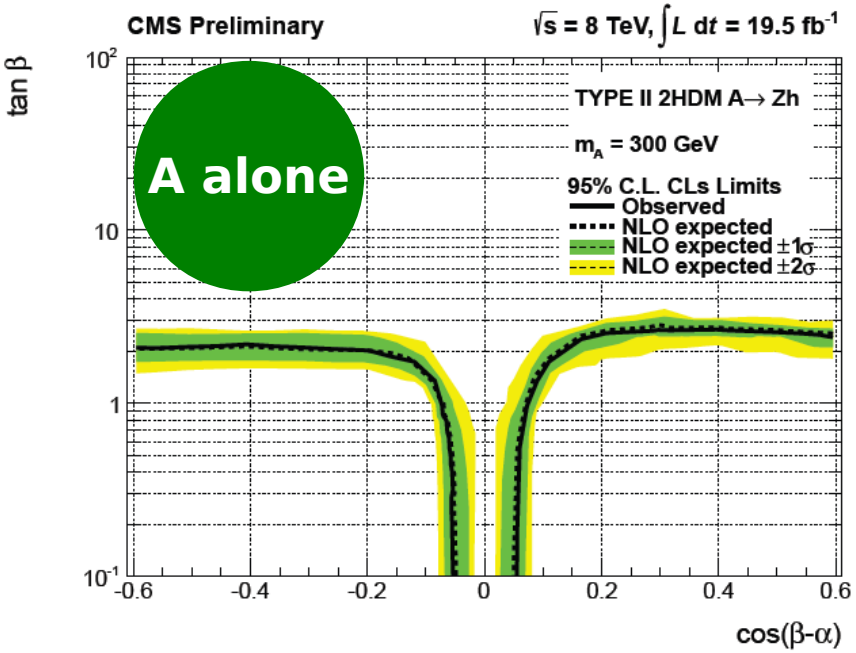
Updates on combination

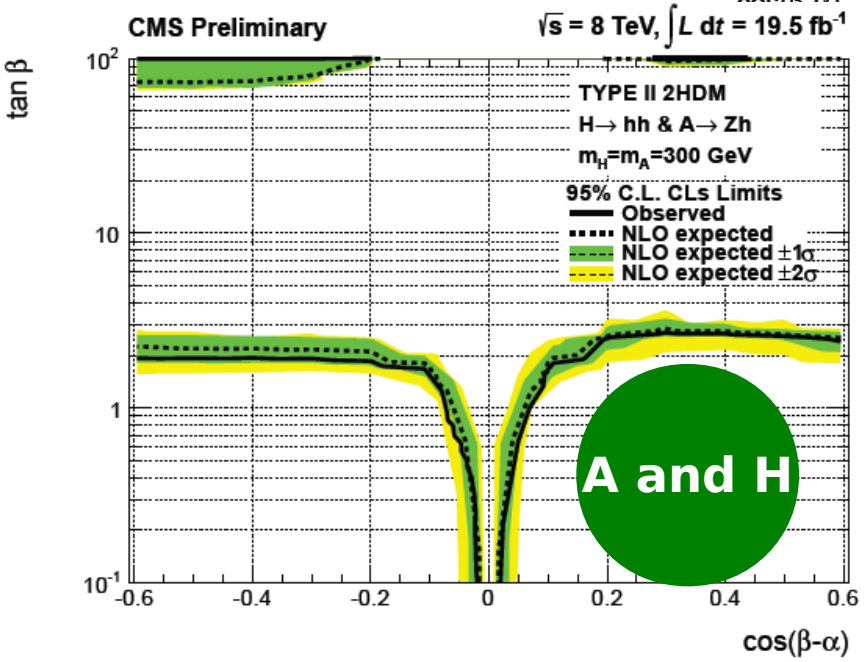
- Near future (to-do-list)
  - The interpretation codes is being constructed and tested
    - 2-D phase space **tanβ-cos(β-α) constrained by the upper limit of H xs with assume mH and m12_2**
    - Problem: the phase space file (v4) provided by Niklos has poor grids for now
    - Waiting for the next version (v5 buggy now)
  - Ask or push bbbb/bbyy analysis group to provide full syst
  - **Contribute to validate MG5 samples**, since no signal samples, neither of bbbb and bbyy can provide any upper limits
  - Think about combination of AZh and Hhh (tough work)
    - Hhh bbbb bbyy are what we are doing now
    - AZh llbb and vvbb are relative easy with help from Jike
    - AZh tau-involved analyses are still in a mess themselves

More on A/H combination

- **CMS** results, for example, type II here







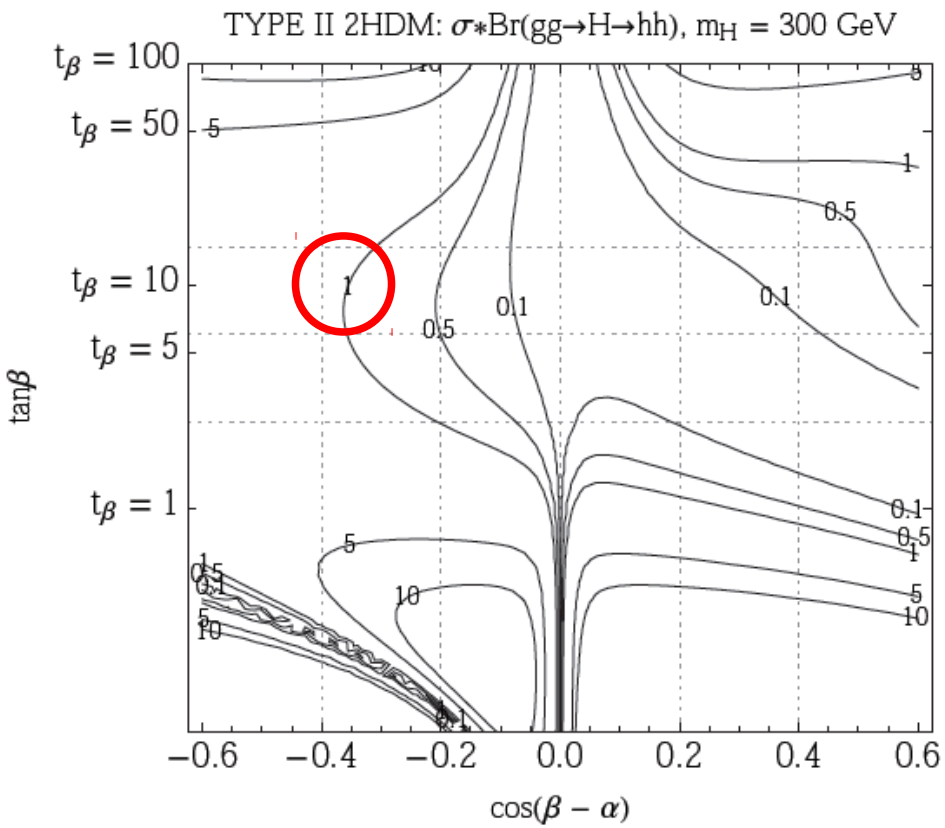
It seems that the combined exlusion mainly comes from **contributions of A**

Well, it is hard to say, since xs(gg>A>Zh)<1.5pb, xs(gg>H>hh)<7pb
Different presicions on A/H measurements!

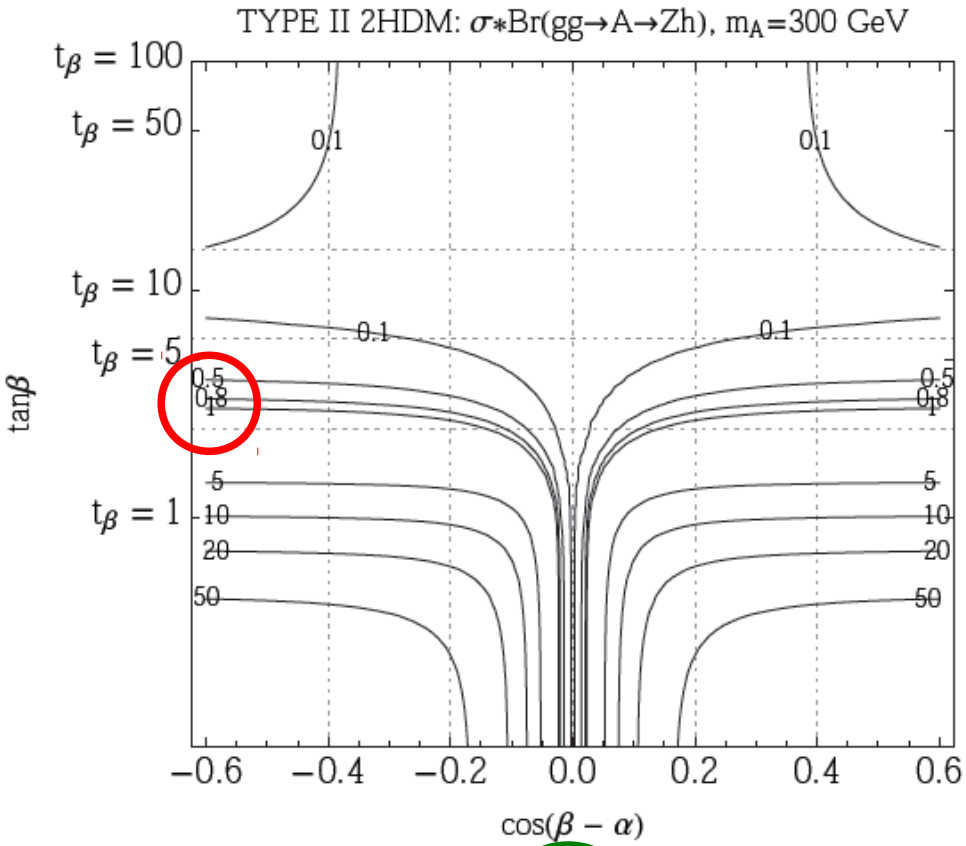
There is no details of the comb in CMS note
Our tanb scan reach only 50 for now

More on A/H combination

- Theoretically, the contours are shown
- If both upper limits of A and H are measured at 1pb, one exclude by the contour marked in red circles



H



A

BTW, there is no theoretical prediction on A/H combined contour or the like

Open question

- One open question: how do we combine A/H?
  - One signal strength for all channels
    - Hhh > bbyy, bbbb; AZh > llbb, lltautau, vvbb
  - Two signal strengths for H and A separately
    - How was the combination of the SM Higgs production modes? gg-fusion and VBF?

$$g_{hZA} = \frac{1}{2}\sqrt{g^2 + g'^2}\cos(\beta - \alpha)$$

$$\begin{aligned} g_{Hhh} = \frac{\cos(\beta-\alpha)}{v}\Bigg[& \left(3m_A^2 + 3\lambda_5 v^2 - 2m_h^2 - m_H^2\right)\left(\cos(2\beta-2\alpha) - \frac{\sin(2\beta-2\alpha)}{\tan(2\beta)}\right) \\ & - m_A^2 - \lambda_5 v^2 + \frac{\lambda_6 v^2}{2}\left(-\cot\beta + 3\sin(2\beta-2\alpha) + 3\cot\beta\cos(2\beta-2\alpha)\right) \\ & + \frac{\lambda_7 v^2}{2}\left(-\tan\beta - 3\sin(2\beta-2\alpha) + 3\tan\beta\cos(2\beta-2\alpha)\right)\Bigg] \end{aligned} \tag{2.11}$$

Still under investigation

N. Craig et al. arXiv:1305.2424