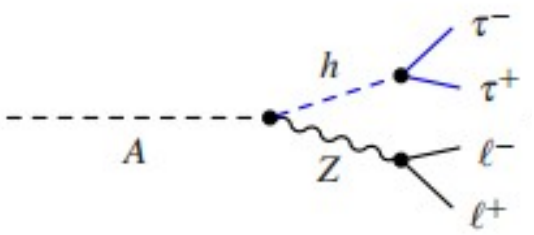
Weekly report

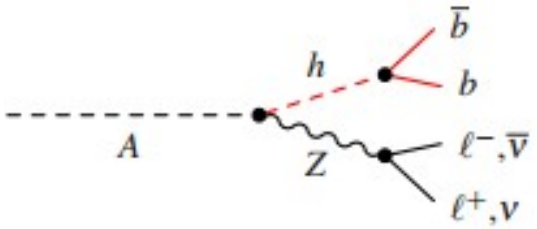
Xiaohu Sun
29-12-2014
IHEP

AZh analysis - introduction

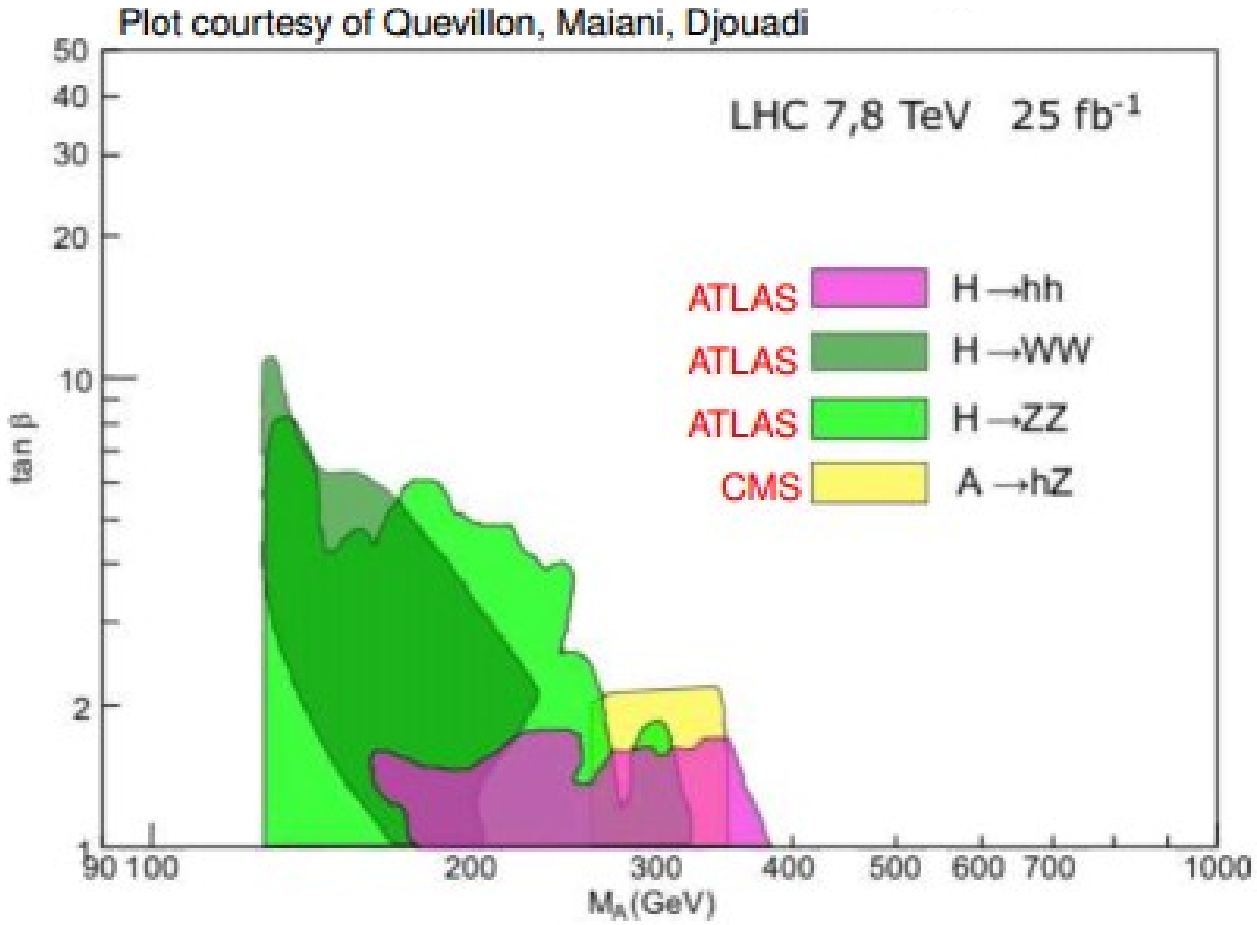
- A → Zh is the dominant decay mode just below the tt threshold
- A → Zh channel is nicely complementary to other Higgs searches and the BSM coupling analysis at the LHC



$A \to Zh \to \ell\ell\tau\tau$

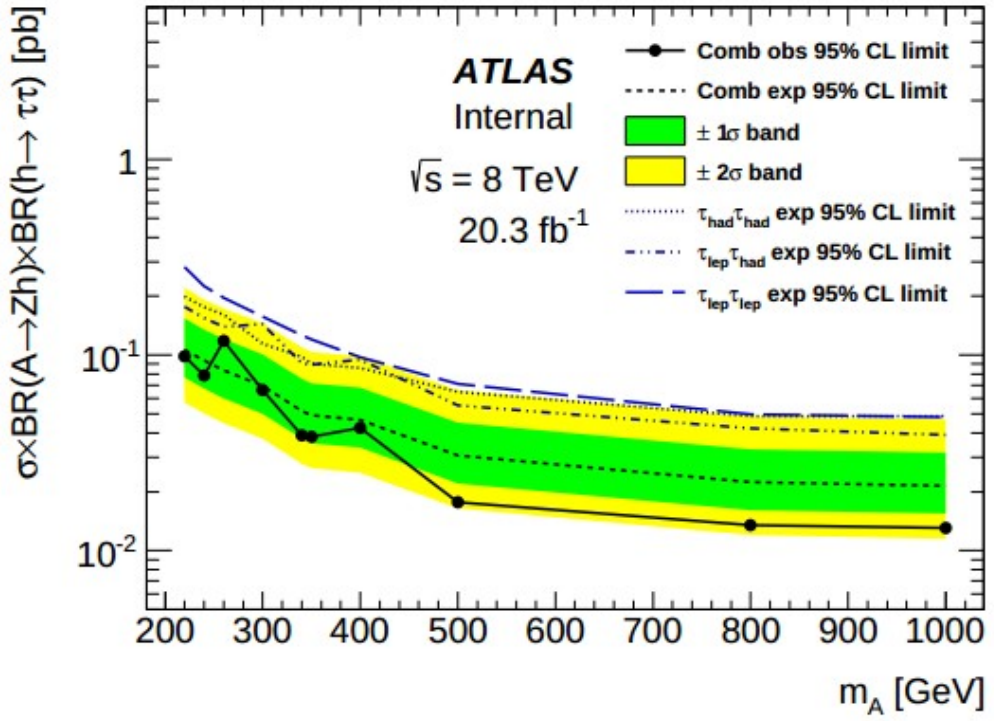


$A \to Zh \to (\ell\ell/\nu\nu)b\bar{b}$

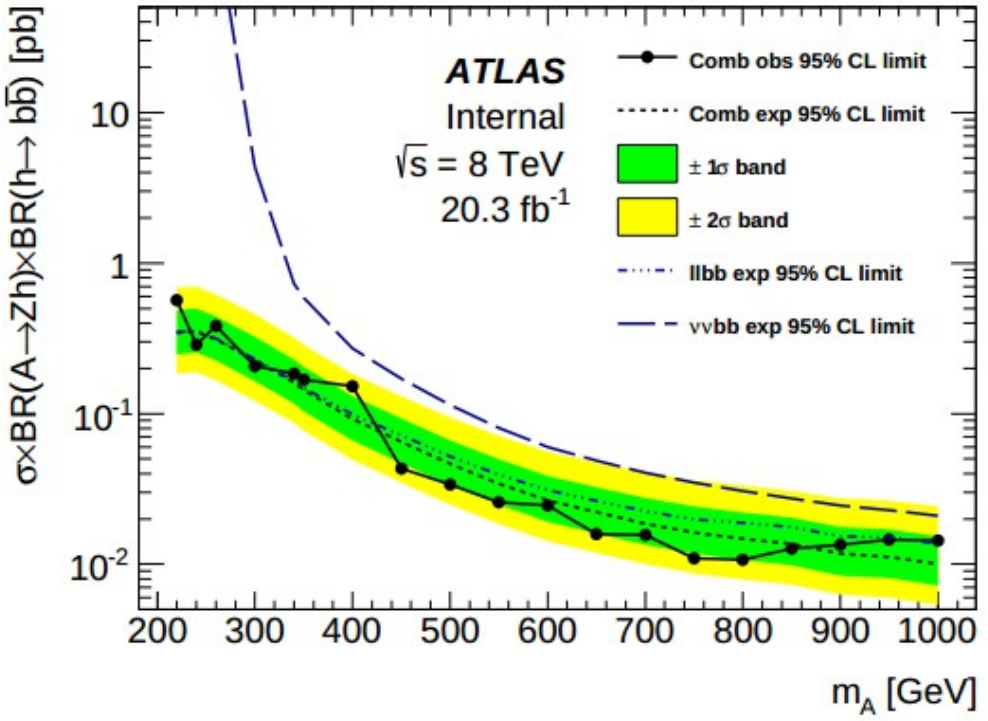


AZh analysis – limits

- combined limits of xsec times BR(h->tautau) or BR(h->bb) directly measured from the experiments, without any assumption of the branching ratios



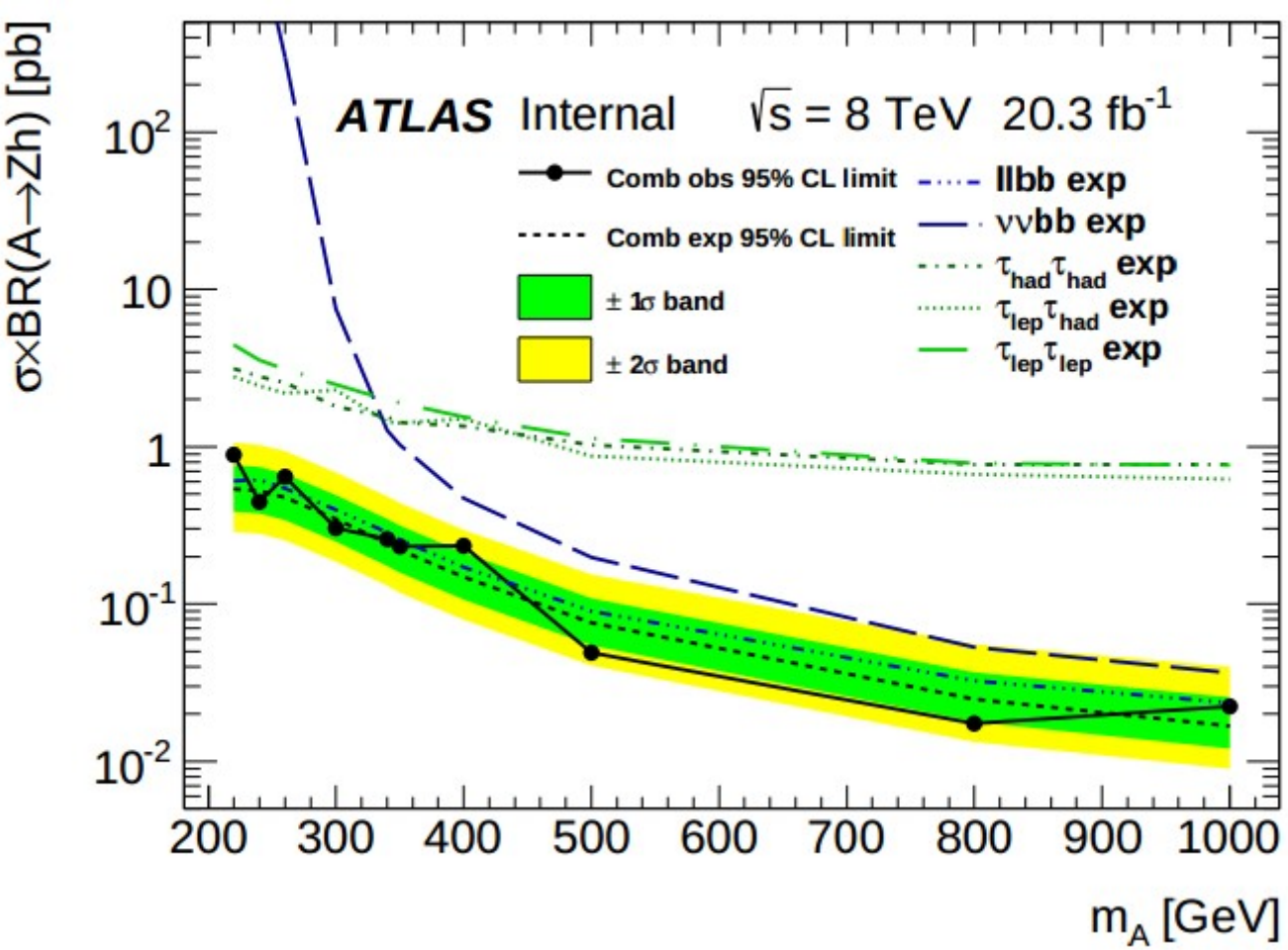
(a) $A \to Zh,\ h \to \tau\tau$



(b) $A \to Zh,\ h \to b\bar{b}$

AZh analysis – limits

- combined limits of xsec, with the assumption of the branching ratios in SM on BR(h->tautau) and BR(h->bb)



2HDM framework

- Predicted Higgs bosons:
  - *h*, *H* : *CP*-even neutral
  - *A* : *CP*-odd neutral
  - $H^{\pm}$: Charged
- Parameters:
  - *m(h)*, *m(H)*, *m(A)*, $m(H^{\pm})$: masses
  - α : mixing angle of *h* and *H*
  - $\tan\beta$: ratio of vev's

	Type I	Type II	Type III	Type IV
$\xi_{\mathbf{h}}^{V}$	$\sin(\beta-\alpha)$	$\sin(\beta-\alpha)$	$\sin(\beta-\alpha)$	$\sin(\beta-\alpha)$
$\xi_{\mathbf{h}}^{u}$	$\frac{\cos\alpha}{\sin\beta}$	$\frac{\cos\alpha}{\sin\beta}$	$\frac{\cos\alpha}{\sin\beta}$	$\frac{\cos\alpha}{\sin\beta}$
$\xi_{\mathbf{h}}^{d}$	$\frac{\cos\alpha}{\sin\beta}$	$-\frac{\sin\alpha}{\cos\beta}$	$\frac{\cos\alpha}{\sin\beta}$	$-\frac{\sin\alpha}{\cos\beta}$
$\xi_{\mathbf{h}}^{l}$	$\frac{\cos\alpha}{\sin\beta}$	$-\frac{\sin\alpha}{\cos\beta}$	$-\frac{\sin\alpha}{\cos\beta}$	$\frac{\cos\alpha}{\cos\beta}$
$\xi_{\mathbf{H}}^{V}$	$\cos(\beta-\alpha)$	$\cos(\beta-\alpha)$	$\cos(\beta-\alpha)$	$\cos(\beta-\alpha)$
$\xi_{\mathbf{H}}^{u}$	$\frac{\sin\alpha}{\sin\beta}$	$\frac{\sin\alpha}{\sin\beta}$	$\frac{\sin\alpha}{\sin\beta}$	$\frac{\sin\alpha}{\sin\beta}$
$\xi_{\mathbf{H}}^{d}$	$\frac{\sin\alpha}{\sin\beta}$	$\frac{\cos\alpha}{\cos\beta}$	$\frac{\sin\alpha}{\sin\beta}$	$\frac{\cos\alpha}{\cos\beta}$
$\xi_{\mathbf{H}}^{l}$	$\frac{\sin\alpha}{\sin\beta}$	$\frac{\cos\alpha}{\cos\beta}$	$\frac{\cos\alpha}{\sin\beta}$	$\frac{\sin\alpha}{\cos\beta}$
$\xi_{\mathbf{A}}^{u}$	$\cot\beta$	$\cot\beta$	$\cot\beta$	$\cot\beta$
$\xi_{\mathbf{A}}^{d}$	$-\cot\beta$	$\tan\beta$	$-\cot\beta$	$\tan\beta$
$\xi_{\mathbf{A}}^{l}$	$-\cot\beta$	$\tan\beta$	$\tan\beta$	$-\cot\beta$

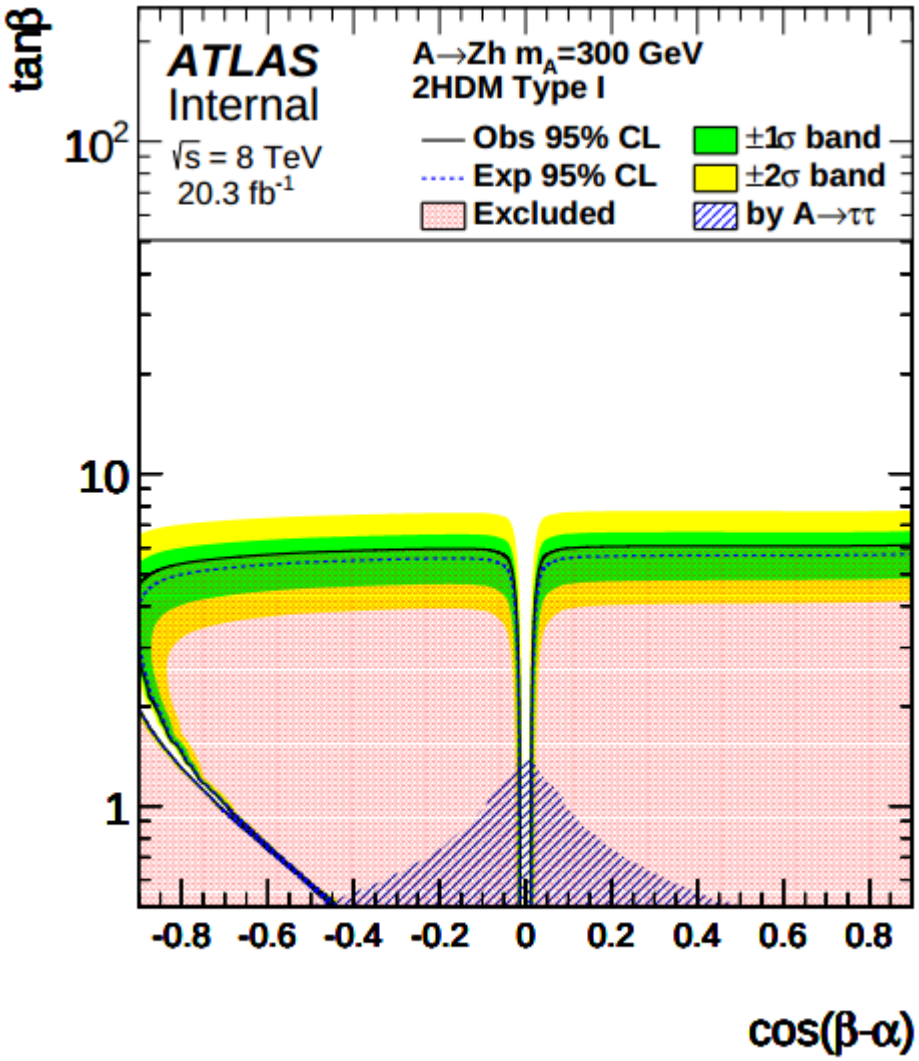
2HDM framework

$$V_{yukawa} = -\sum_{i=1,2} \left(Q\tilde{\Phi}_i y_i^u \bar{u} + Q\Phi_i y_i^d \bar{d} + L\Phi_i y_i^e \bar{e} + \text{h.c.} \right)$$

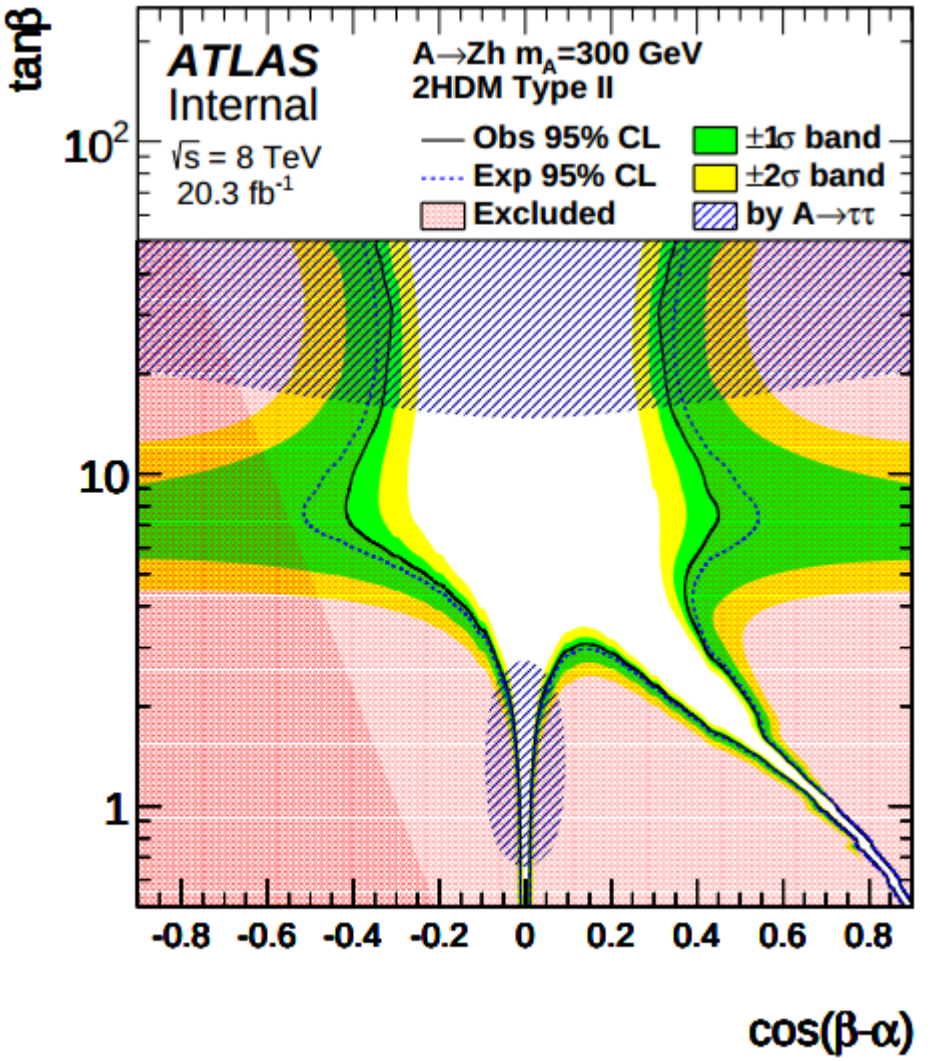
- Type 1, in which $y_1^{u,d,e} = 0$; all fermions couple to one doublet.
- Type 2, in which $y_1^u = y_2^d = y_2^e = 0$; the up-type quarks couple to one doublet and the down-type quarks and leptons couple to the other.
- Type 3, in which $y_1^u = y_1^d = y_2^e = 0$; quarks couple to one doublet and leptons to the other. lepton specific
- Type 4, in which $y_1^u = y_1^e = y_2^d = 0$; up-type quarks and leptons couple to one doublet and down-type quarks couple to the other. flipped

AZh analysis – 2HDM interpretation

- Well considered the effects from BR(h->tautau/bb), width, bbA production



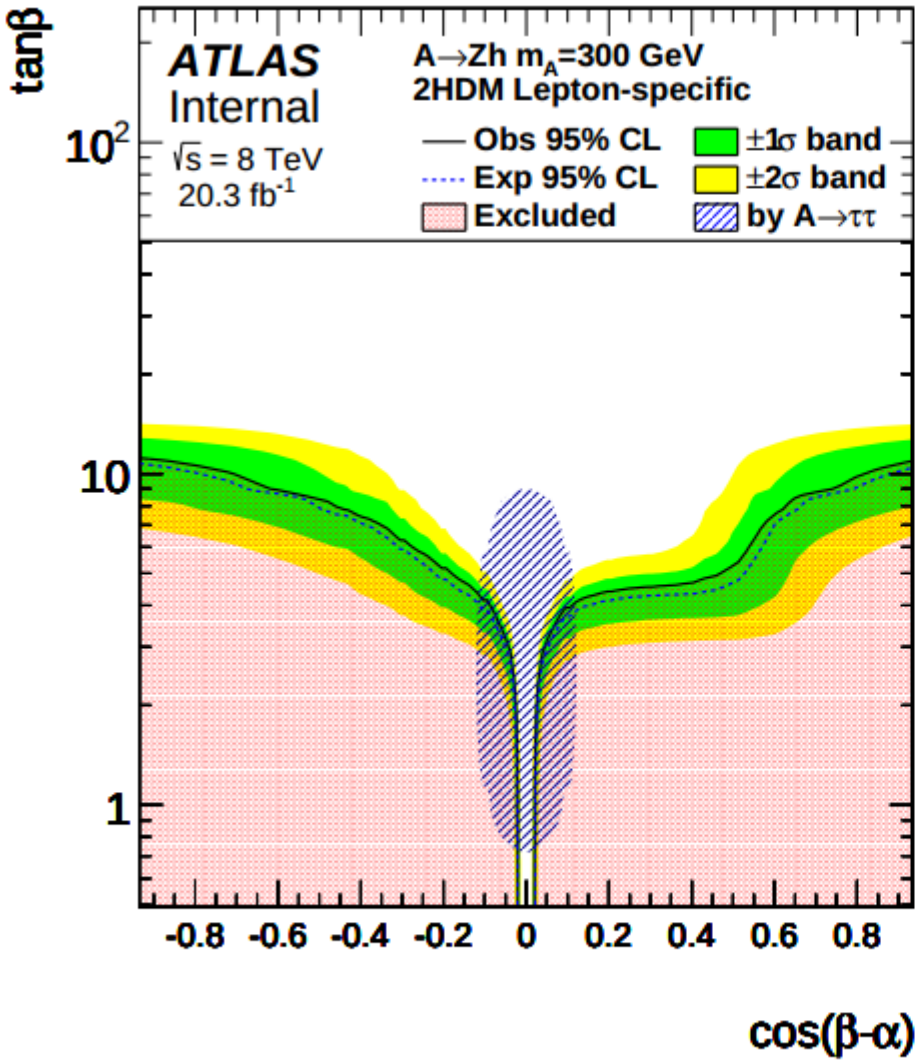
(a) Type-I 2HDM, $m_A = 300$ GeV



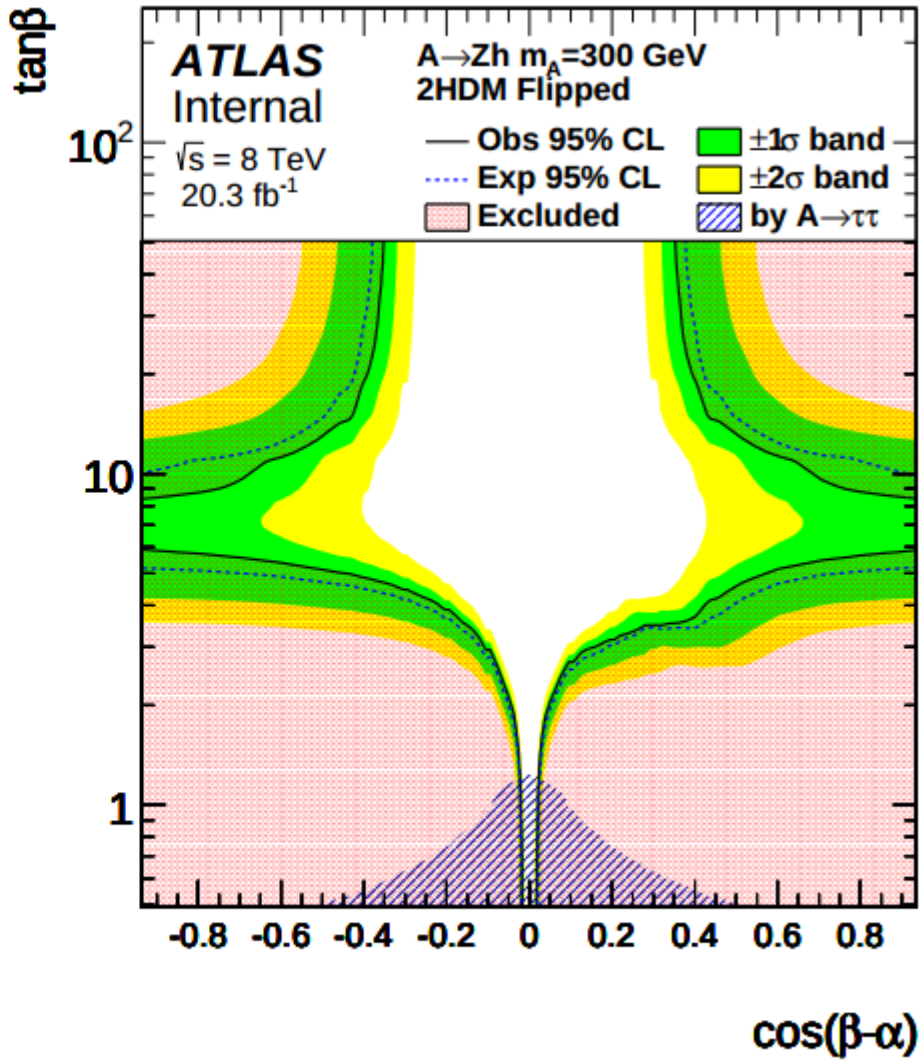
(b) Type-II 2HDM, $m_A = 300$ GeV

AZh analysis – 2HDM interpretation

- Well considered the effects from BR(h->tautau/bb), width, bbA production



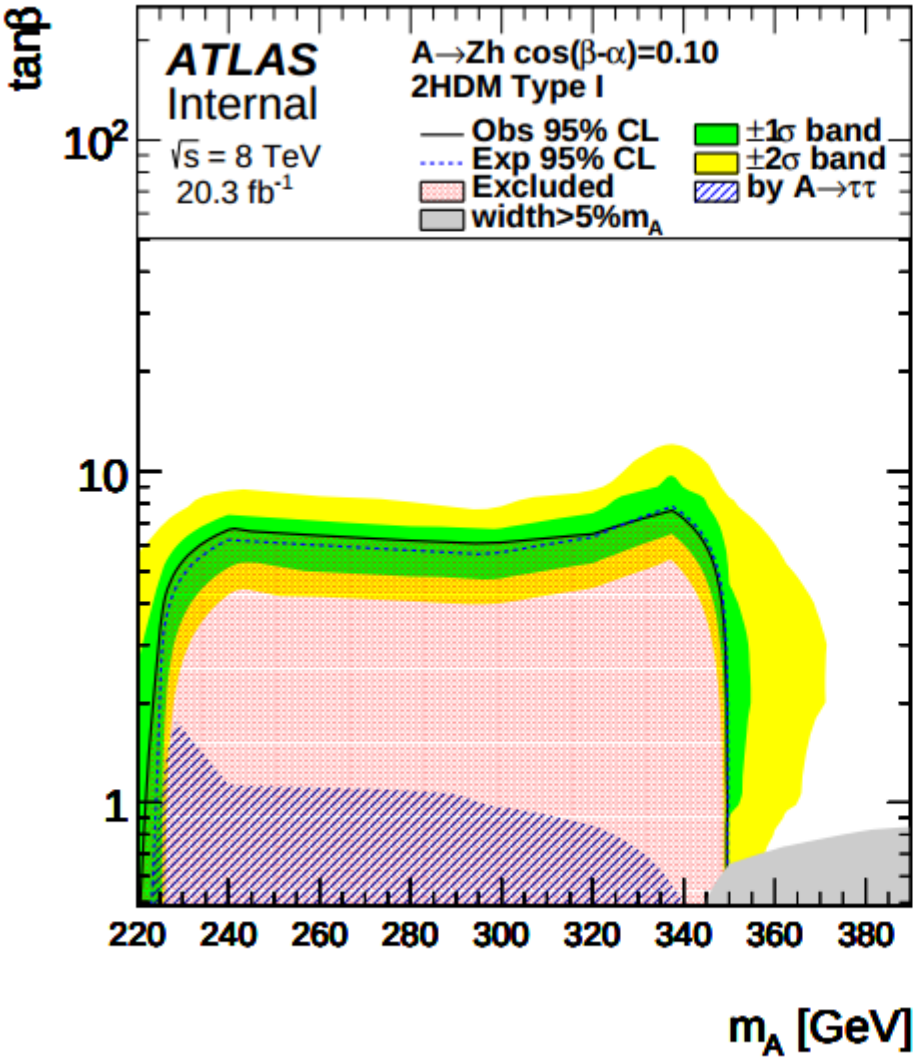
(c) Lepton-specific 2HDM, $m_A = 300$ GeV



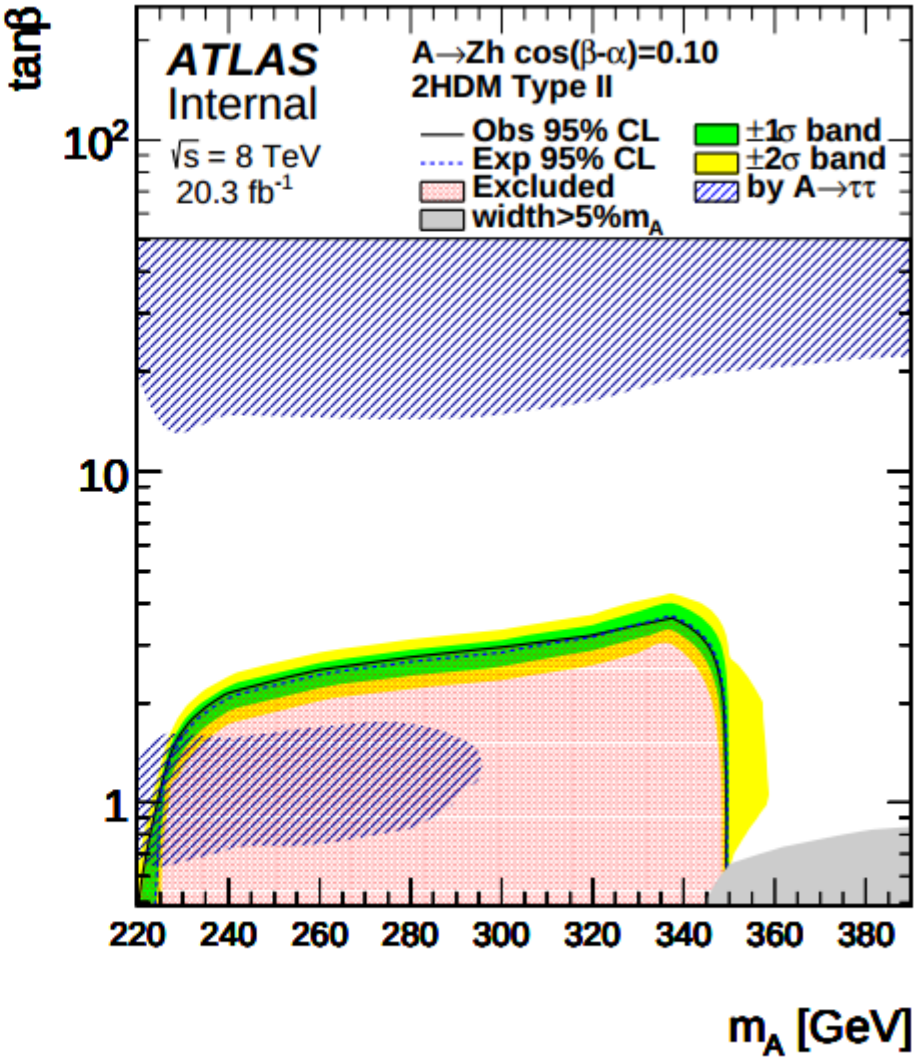
(d) Flipped 2HDM, $m_A = 300$ GeV

AZh analysis – 2HDM interpretation

- Well considered the effects from BR(h->tautau/bb), width, bbA production



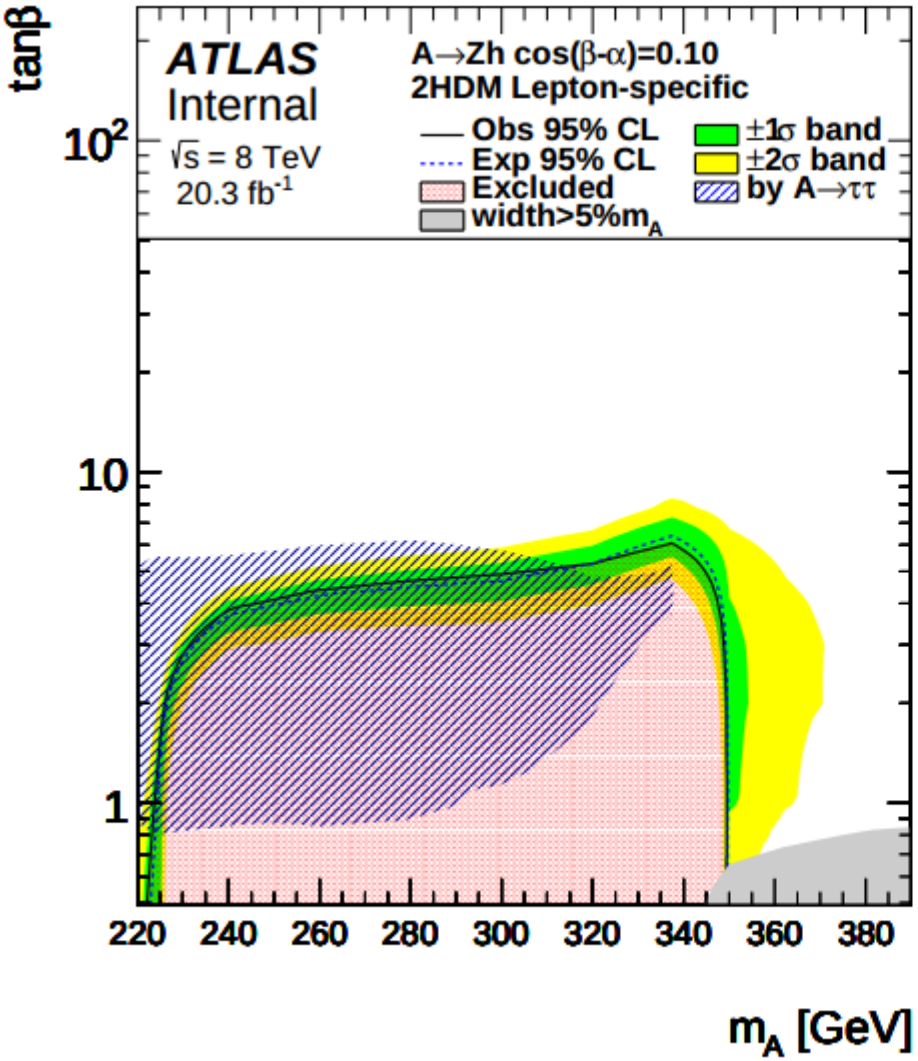
(a) Type-I 2HDM, $\cos(\beta - \alpha) = 0.1$



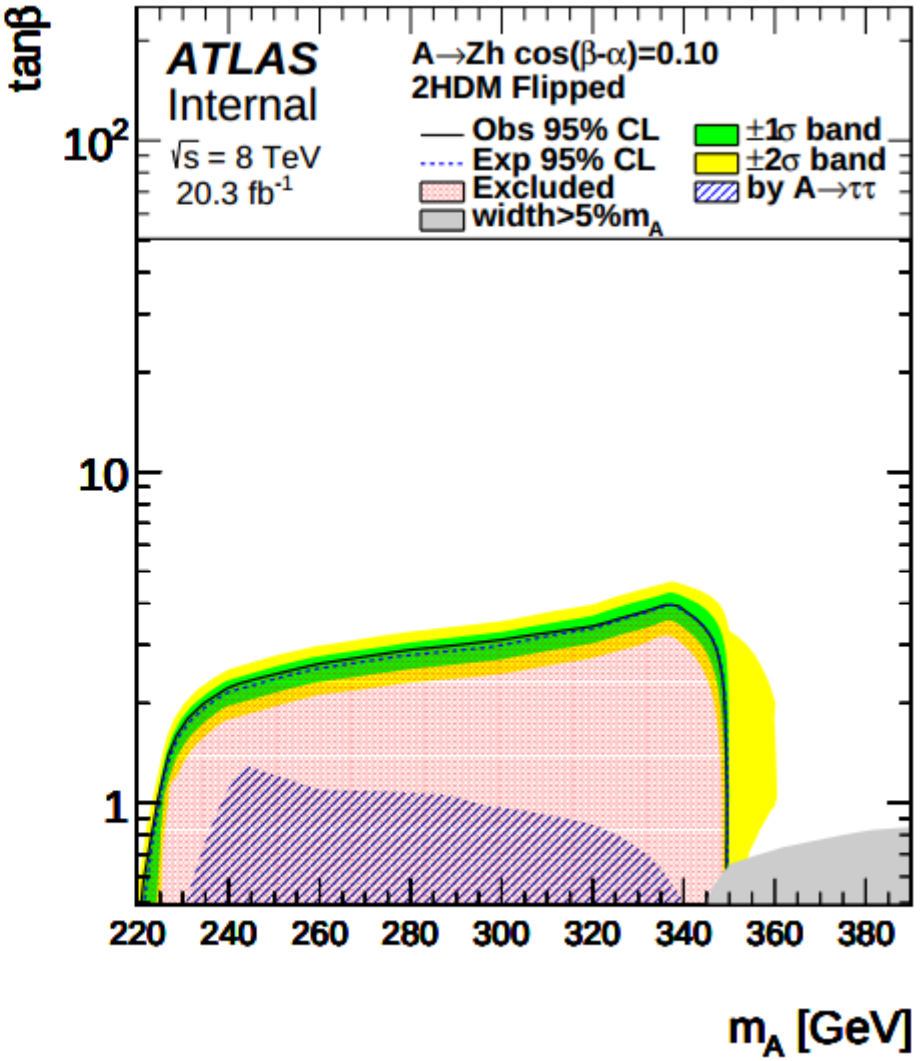
(b) Type-II 2HDM, $\cos(\beta - \alpha) = 0.1$

AZh analysis – 2HDM interpretation

- Well considered the effects from BR(h->tautau/bb), width, bbA production



(c) Lepton-specific 2HDM, $\cos(\beta - \alpha) = 0.1$



(d) Flipped 2HDM, $\cos(\beta - \alpha) = 0.1$

AZh analysis – where are we

- Before Xmas, we finally submitted the paper draft to ATLAS 2nd circulation with all the wanted plots in 2HDM interpretations
- What will be
  - must do: update the bbA effects by introducing the efficiencies extracted from real MC samples (currently we only use A->tautau samples to do the approximation, the MC samples are requested but they did not run as fast as they promised...)
  - might have to do: revisit some parts of interpretations if questions come to them
  - or, everything goes well, then we will have the paper submitted to journal in January