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Search for BSM Higgs bosons decaying to a $b\bar{b}$ pair at CMS

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HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

Motivation

★ Many BSM theories introduced to solve several phenomena not explained by the SM

- e.g. 2HDM → the simplest extension of the SM Higgs sector

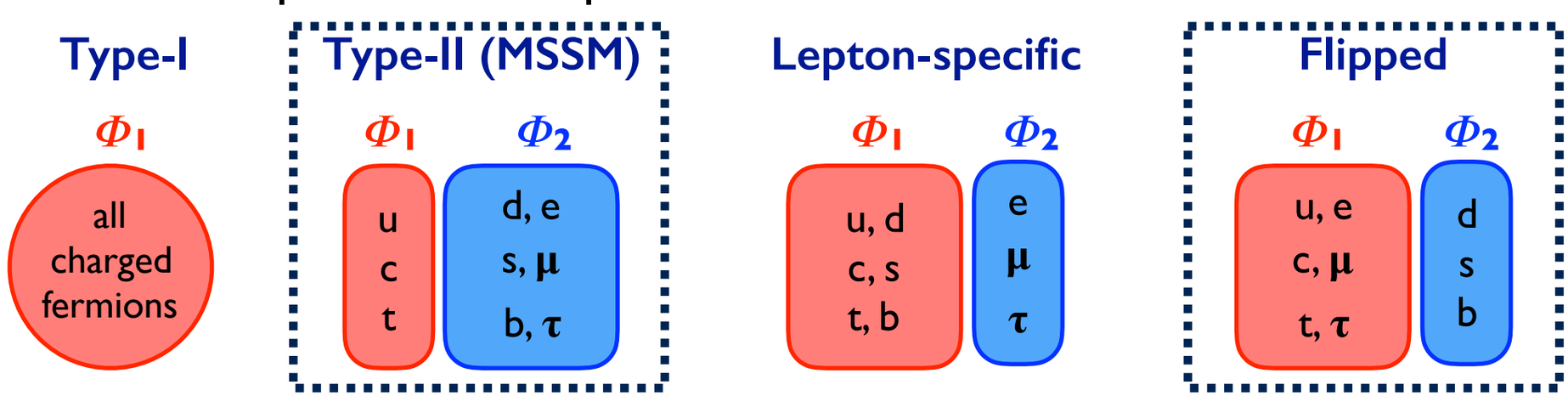
★ **Two Higgs Doublet Models (2HDM)** extend the SM with another scalar doublet

2 doublets		CP-even	CP-odd	Charged
Φ_1	Φ_2	H, h	A	$H^{\pm}$

- $\tan\beta$: the ratio of the vev of the two doublets
- α : the mixing angle of the two doublets

\+ other parameters

★ **4 types of 2HDM** with natural flavor and CP conservation, depending on how two Higgs doublets couple to the SM particles

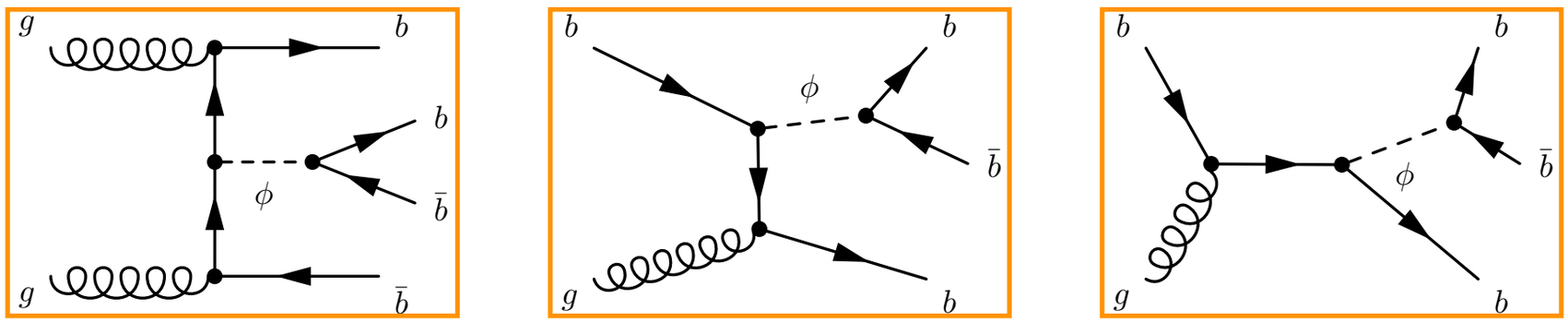


arXiv:1805.12191

A/H→$b\bar{b}$

★ Search for heavy A/H Higgs bosons in bb final state **with 35.7 fb^{-1} at 13TeV**

- unique analysis at the LHC
- dominant decay channel in large parameter space of MSSM and 2HDM



signal processes

★ Sensitivity enhanced with **b-associated production**

- cross-section up to ~2 $\tan^2\beta$

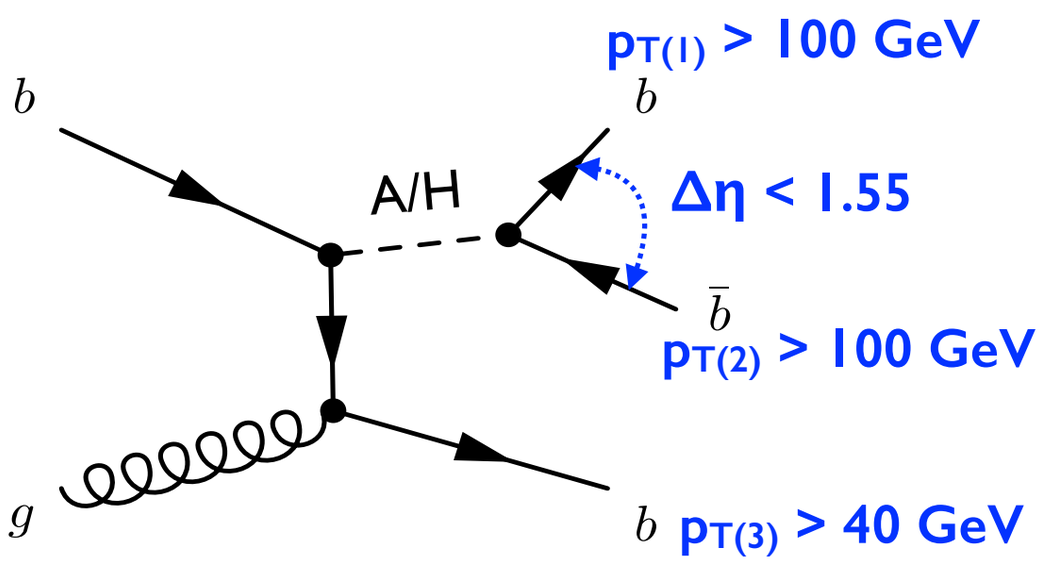
★ Dedicated triggers requiring **two online b-tagged jets**

★ Main challenge from **huge rate of QCD multijet background**

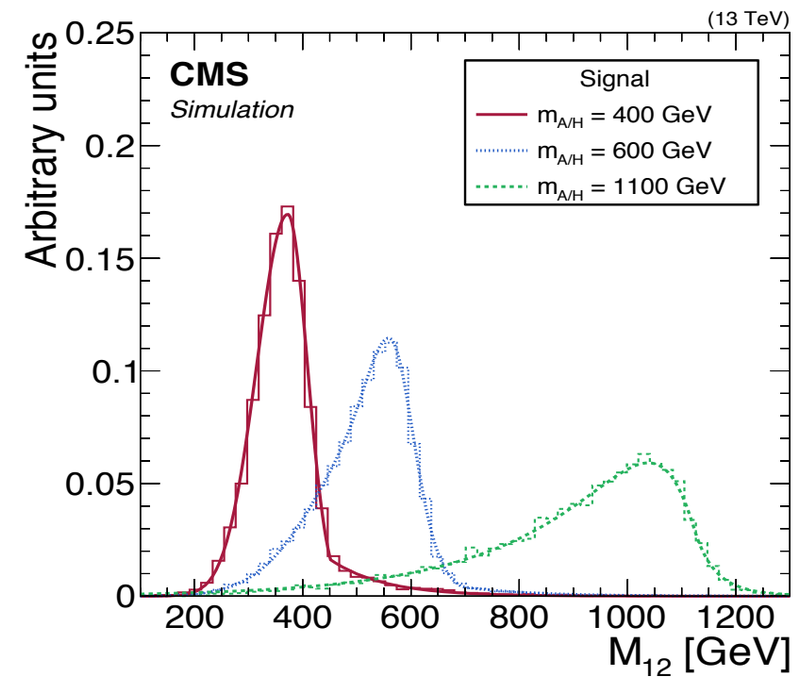
- data-driven parametric approach developed in control region (CR)

A/H → $b\bar{b}$

★ Event offline selection requires at least **3 leading p_T jets to be b-tagged**

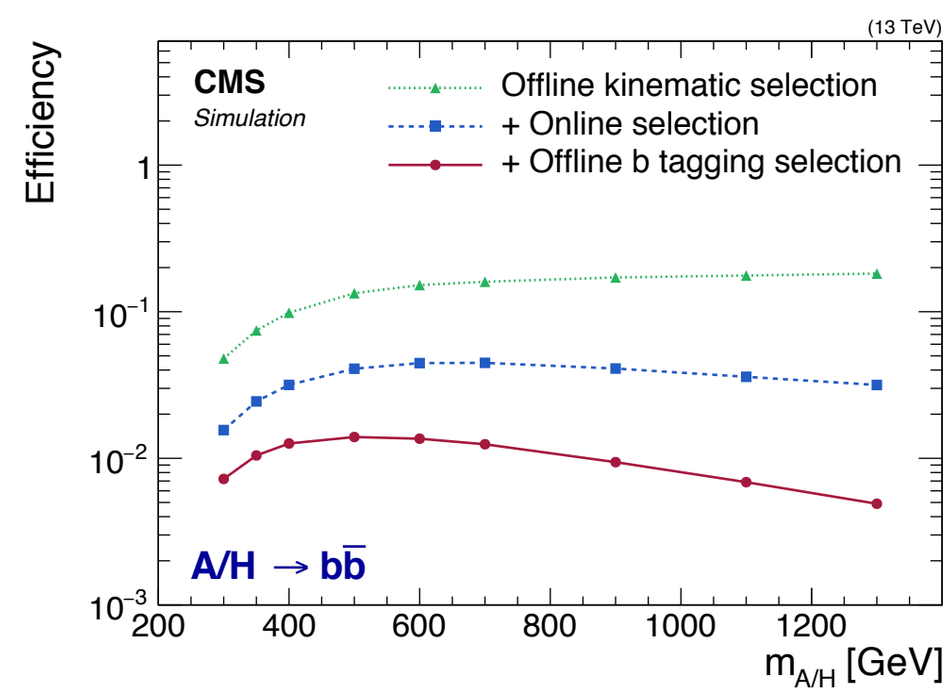


*CR: veto b-tag on the 3rd jet



★ Signal reconstructed from the **invariant mass** of **two leading b-jets (M_{12})**

- signal mass range $m_{A/H}$ from 300 to 1300 GeV



★ Signal efficiency ~ 0.5% up to **1.4% at 500 GeV**

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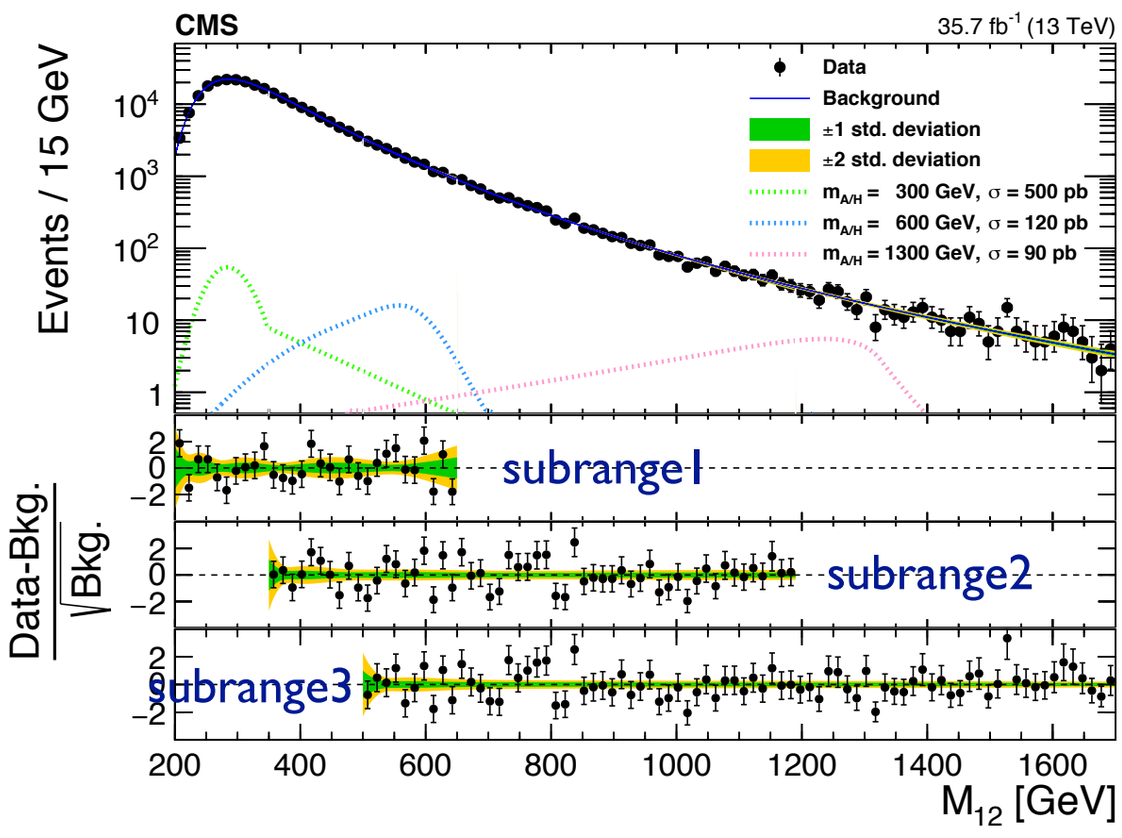
$A/H \rightarrow b\bar{b}$

- ★ Model **QCD multijet background** using **analytical function** developed in CR
  - well described by **Novosibirsk-style functions**
  - **subrange division** designed to reduce bias uncertainty
- ★ **Systematic uncertainties** dominated by trigger efficiency, b-tagging efficiency and background model bias
- ★ Perform a **maximum likelihood fit to M_{12}** distribution
- ★ Data is well fitted by background model
- ★ **No significant excess** is observed



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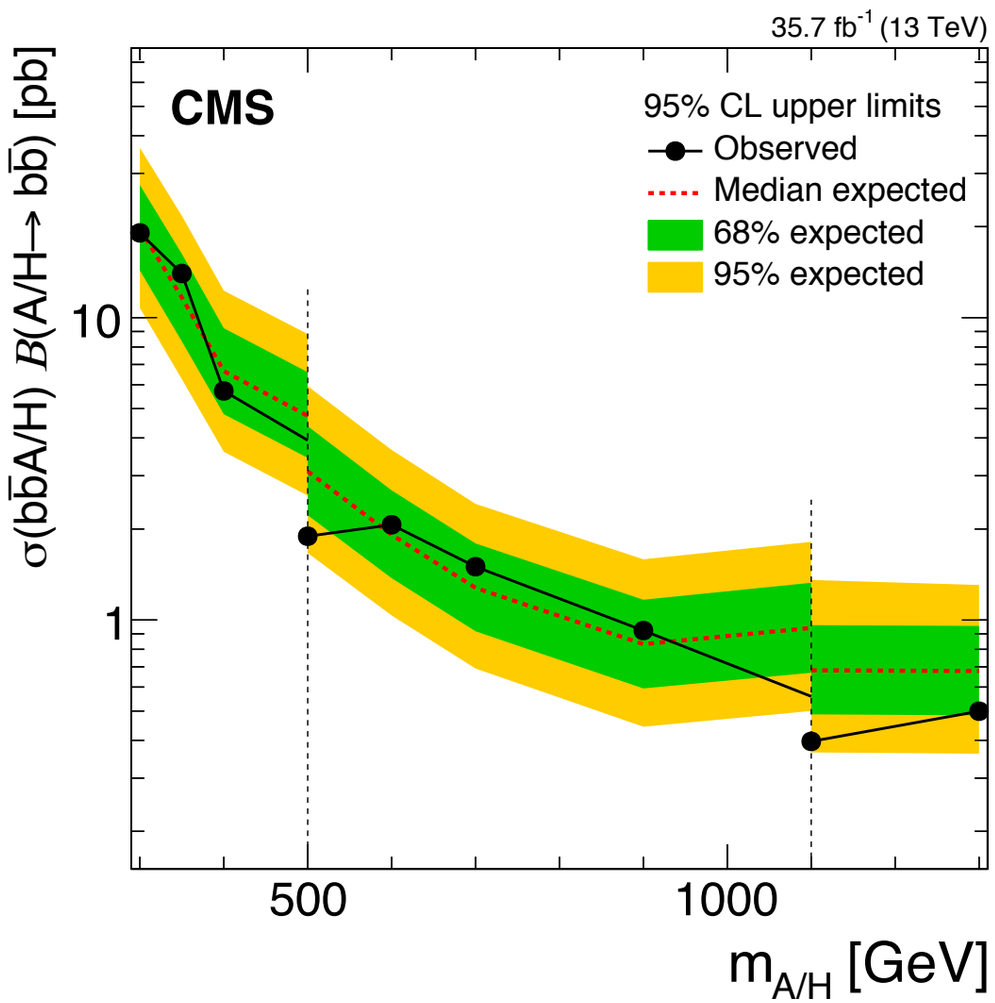
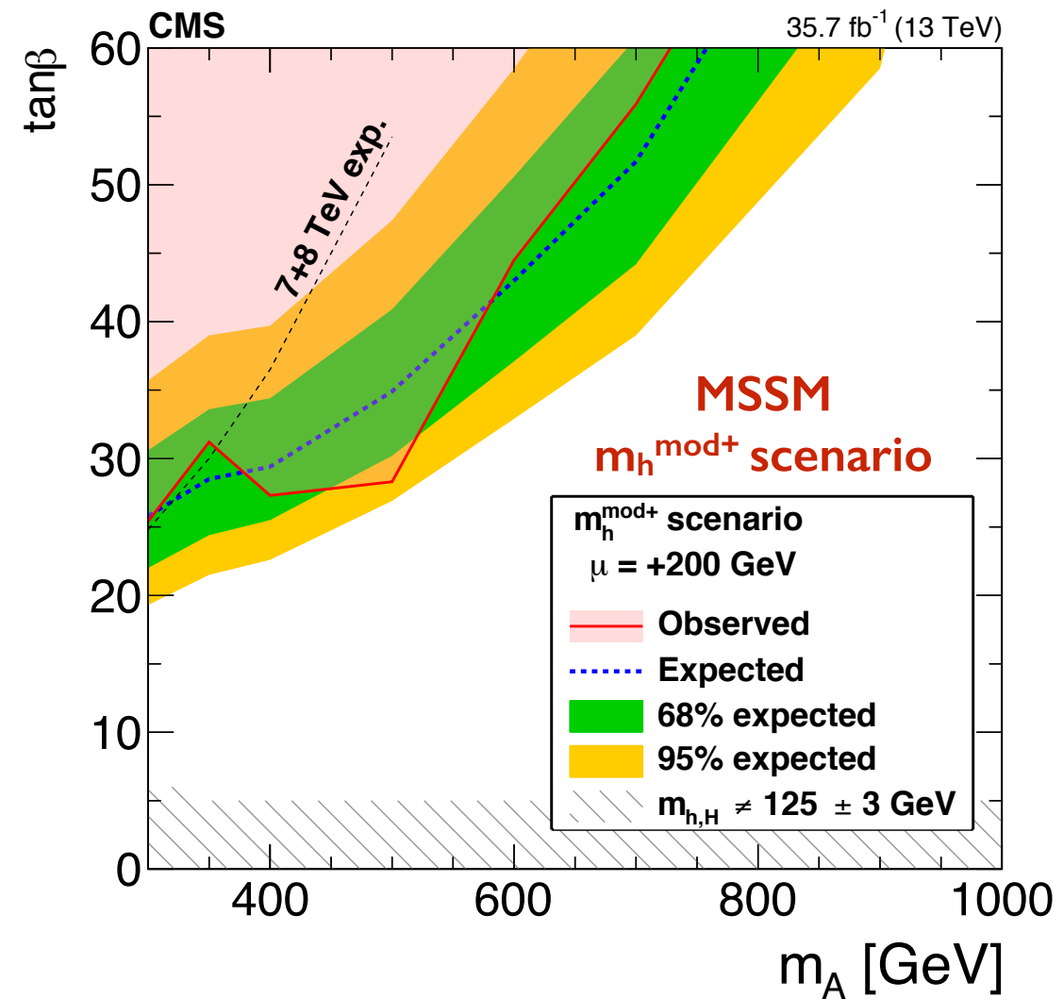
$A/H \rightarrow b\bar{b}$

- ★ Upper limits at 95% CL on the **cross section times branching fraction**
  - 20 pb at $m_{A/H}$ = 300 GeV to 0.4 pb at $m_{A/H}$ = 1100 GeV
  - achieved **the best sensitivity** in this channel to date

- ★ Interpretation in various **MSSM scenarios** e.g. m_h^{mod+} scenario





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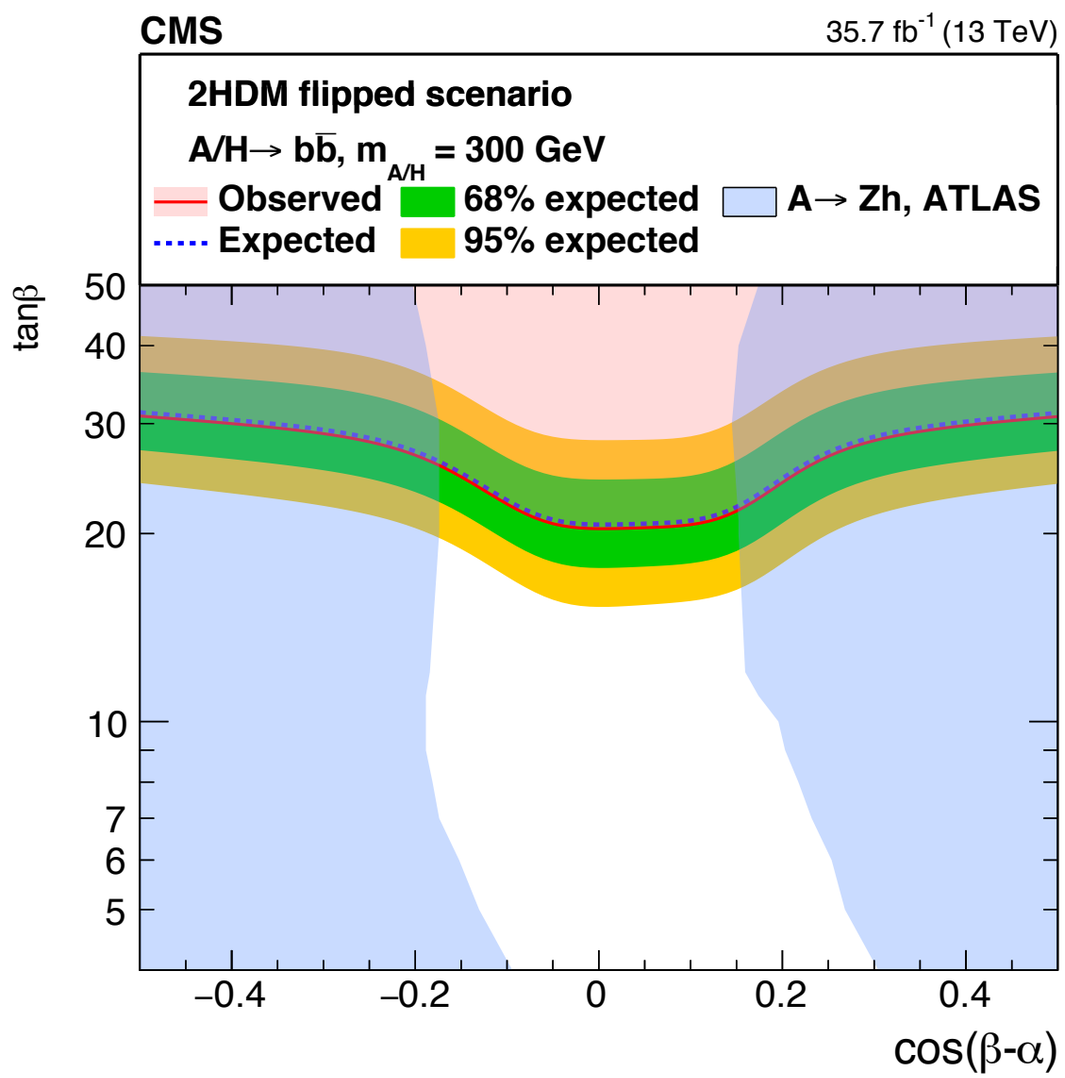
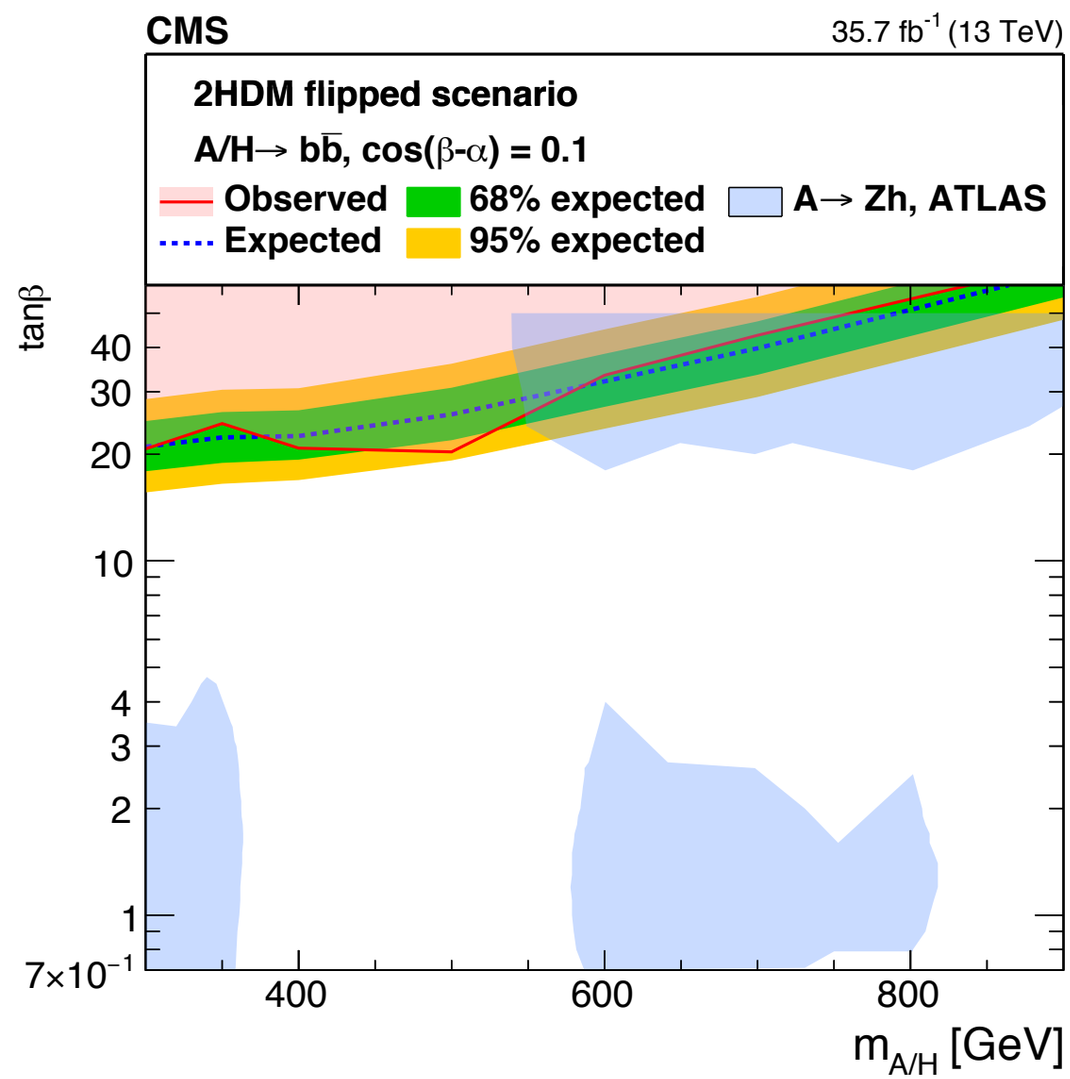
A/H→$b\bar{b}$

★ Interpretation in 2HDM **Flipped model**

- **unique limits** for low cos(β-α) of the Flipped model
- complementary to A→Zh measurements**



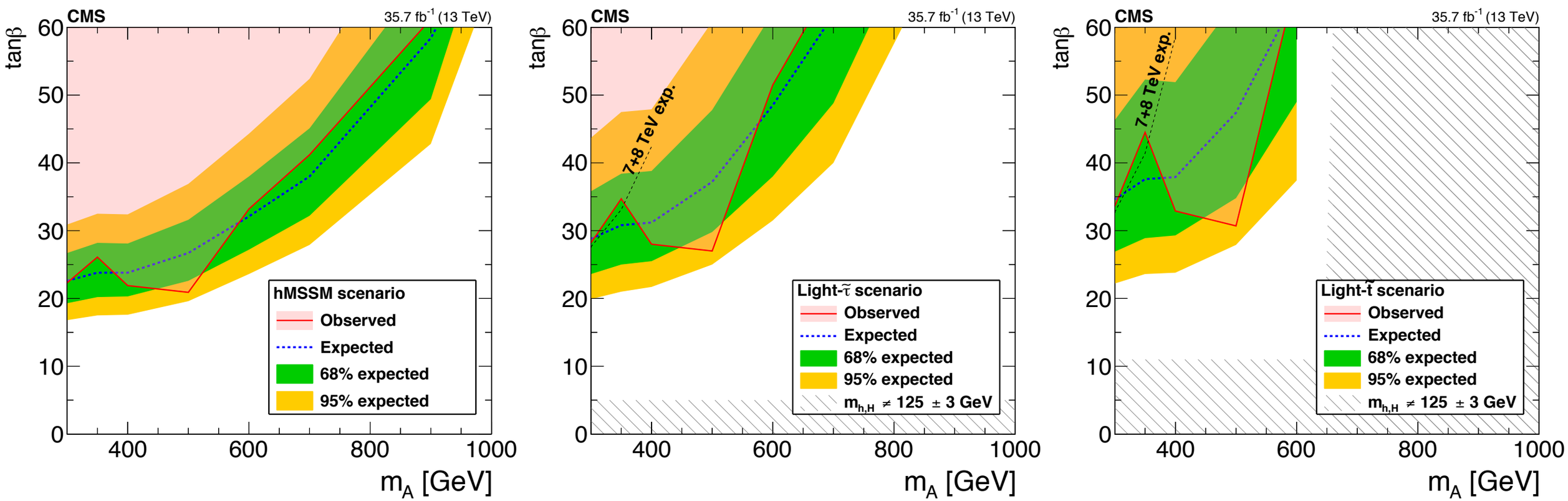


* Type-II in backup slide ** JHEP 03 (2018) 174

Backup

$A/H \rightarrow b\bar{b}$

- ★ Interpretation in MSSM **hMSSM, light stau and light stop scenarios**
  - first exclusion limits for hMSSM scenario in this channel
  - improve sensitivity for light stau and light stop with respect to Run 1



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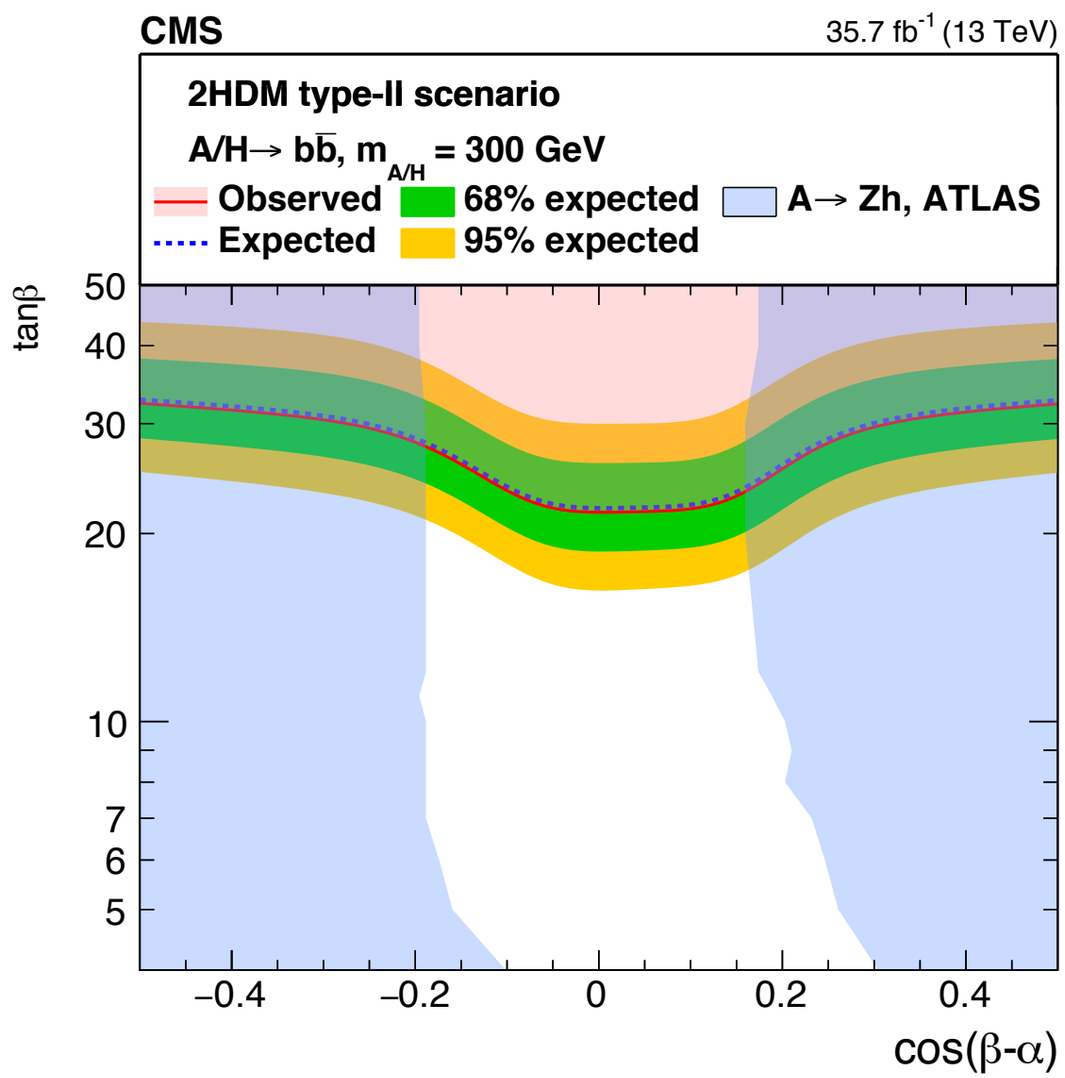
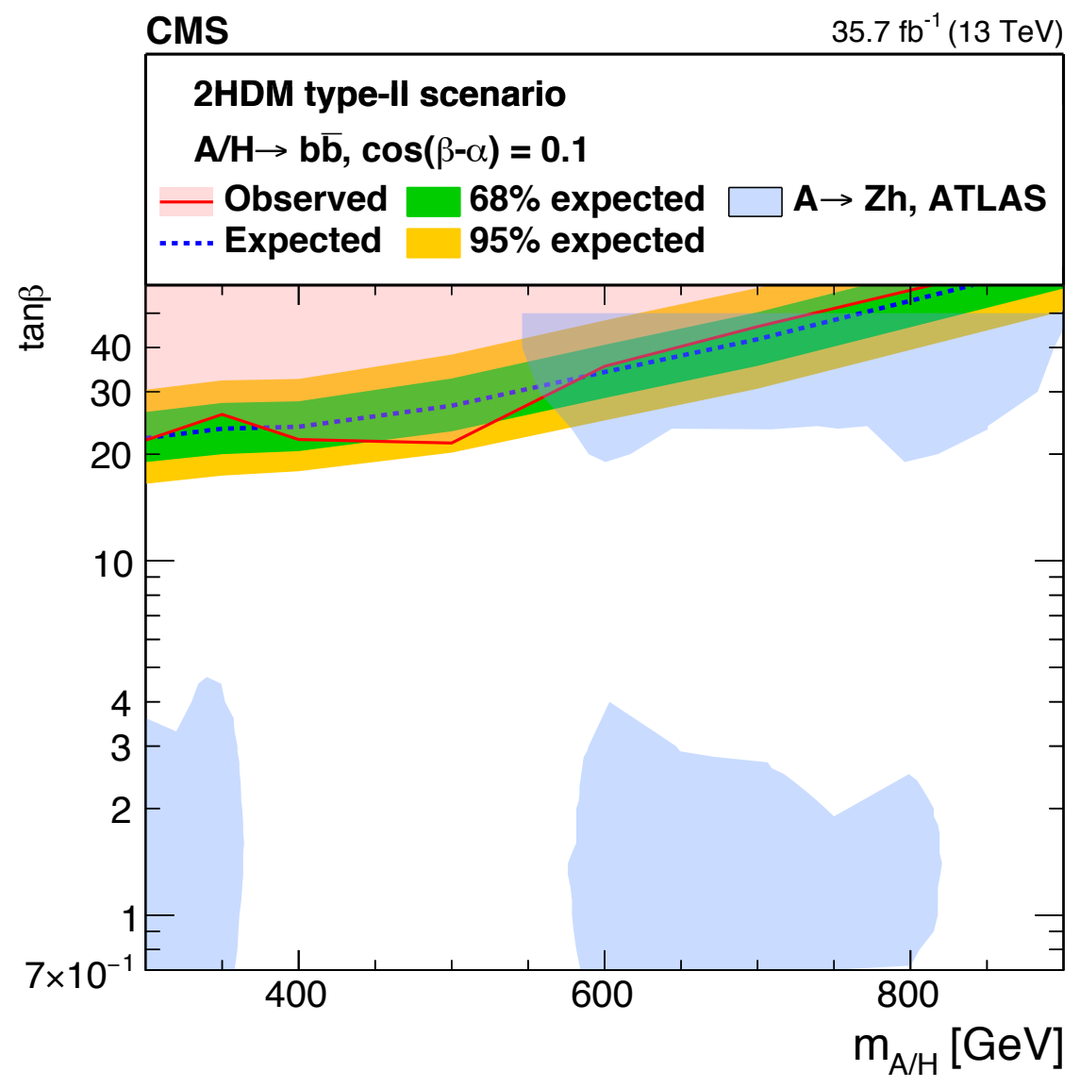
A/H→$b\bar{b}$

★ Interpretation in 2HDM **Type-II model**

◉ complementary to A→Zh measurements*





* JHEP 03 (2018) 174