



Search for a Neutral MSSM Higgs Boson Decaying into a Pair of Tau Leptons at 13 TeV with the CMS Experiment

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(on behalf of the CMS Collaboration)

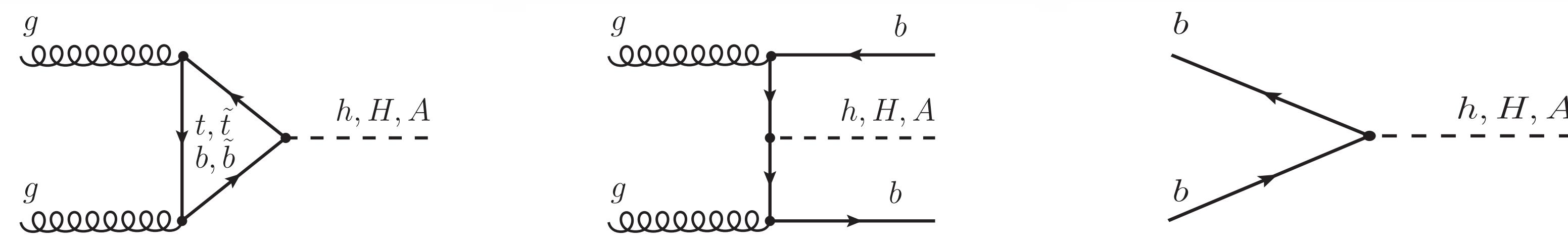


Abstract

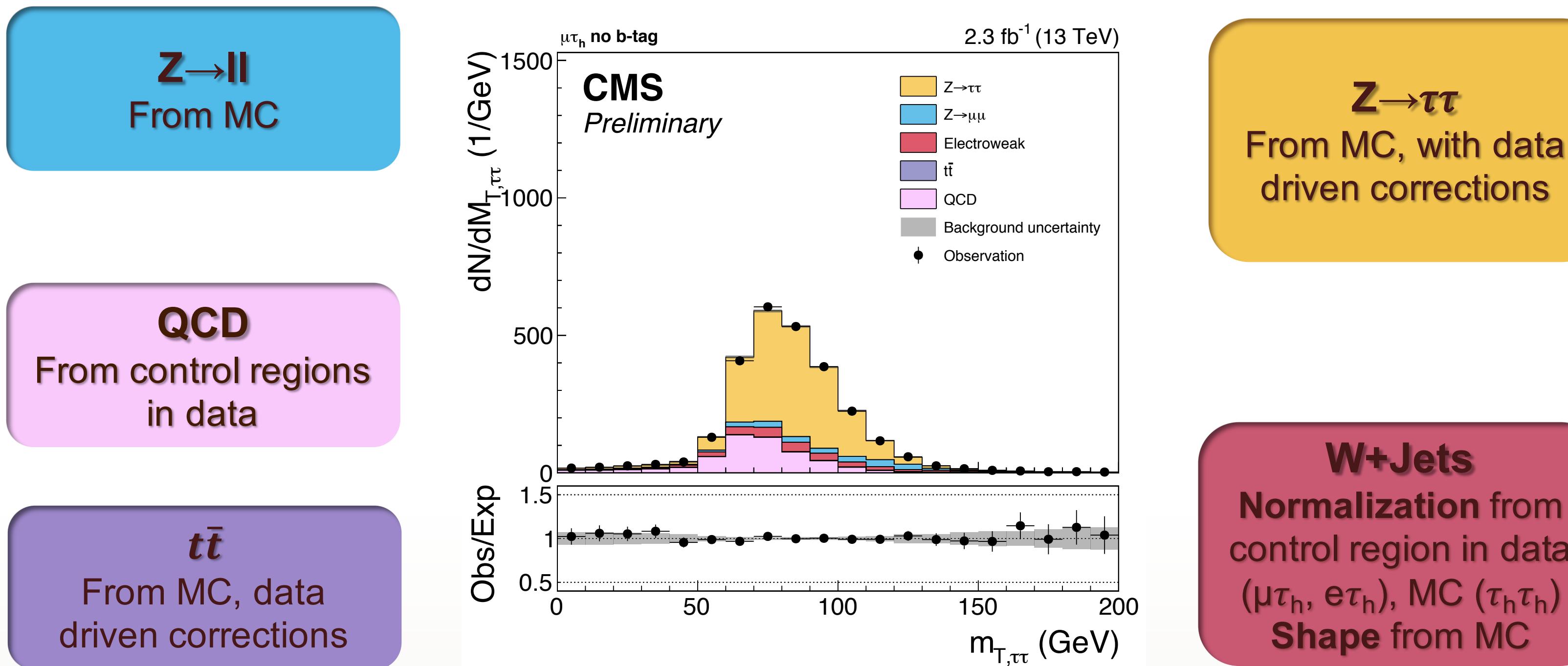
A search for a neutral Higgs boson decaying into a pair of tau leptons is presented. The analysis is performed with proton-proton collision data collected with the CMS experiment in 2015 using 2.3 fb^{-1} of integrated luminosity. Results are interpreted within the context of the minimal supersymmetric extension to the standard model.

MSSM Higgs Boson

- The Minimal Supersymmetric Standard Model (MSSM) invokes a symmetry between bosons and fermions.
- The MSSM Higgs sector consists of **two Higgs doublets**:
up-type fermions $H_u = \begin{pmatrix} H_u^+ \\ H_u^0 \end{pmatrix}$, down-type fermions $H_d = \begin{pmatrix} H_d^0 \\ H_d^- \end{pmatrix}$
- Resulting in **five** physical Higgs Particle:
Two charged H^\pm , Neutral Higgs (ϕ), Two Scalar h, H and one Pseudoscalar A .
- The Higgs sector of the MSSM can be expressed in terms of the **mass** of the **pseudoscalar Higgs Boson m_A** , and the ratio of the vacuum expectation values of the two doublets $\tan \beta$.



Overview of Background Model



Transverse Invariant Di-tau Mass

- The **transverse invariant mass of a pair of tau leptons ($m_{T,\tau\tau}$)** is used to search for a possible neutral MSSM Higgs Boson signal over the expected background

$$m_{T,\tau\tau} = \sqrt{(E_T^{\tau_1} + E_T^{\tau_2})^2 - (p_x^{\tau_1} + p_x^{\tau_2})^2 - (p_y^{\tau_1} + p_y^{\tau_2})^2}$$

where E_T , p_x , and p_y are the transverse energy and x and y component of the momentum of τ_1 and τ_2 . It is computed for $\mu\tau_h$, $e\tau_h$, $\tau_h\tau_h$, and $e\mu$ channels in **2 event categories**:

No b-tag and b-tag.

- Secondary Vertex Fit (SVFit) algorithm** is used to compute this transverse mass using the **maximum likelihood approach** which combines the information on the missing transverse energy E_T^{miss} and its resolution with the visible products of the tau decay.

Uncertainty Model

Normalization Uncertainties

- Background Normalization
 - Statistical
 - Uncertainties on sideband extrapolation factor
 - Cross section
- ID/Isolation/Trigger efficiency
- Jet Energy Scale
- MET resolution and response

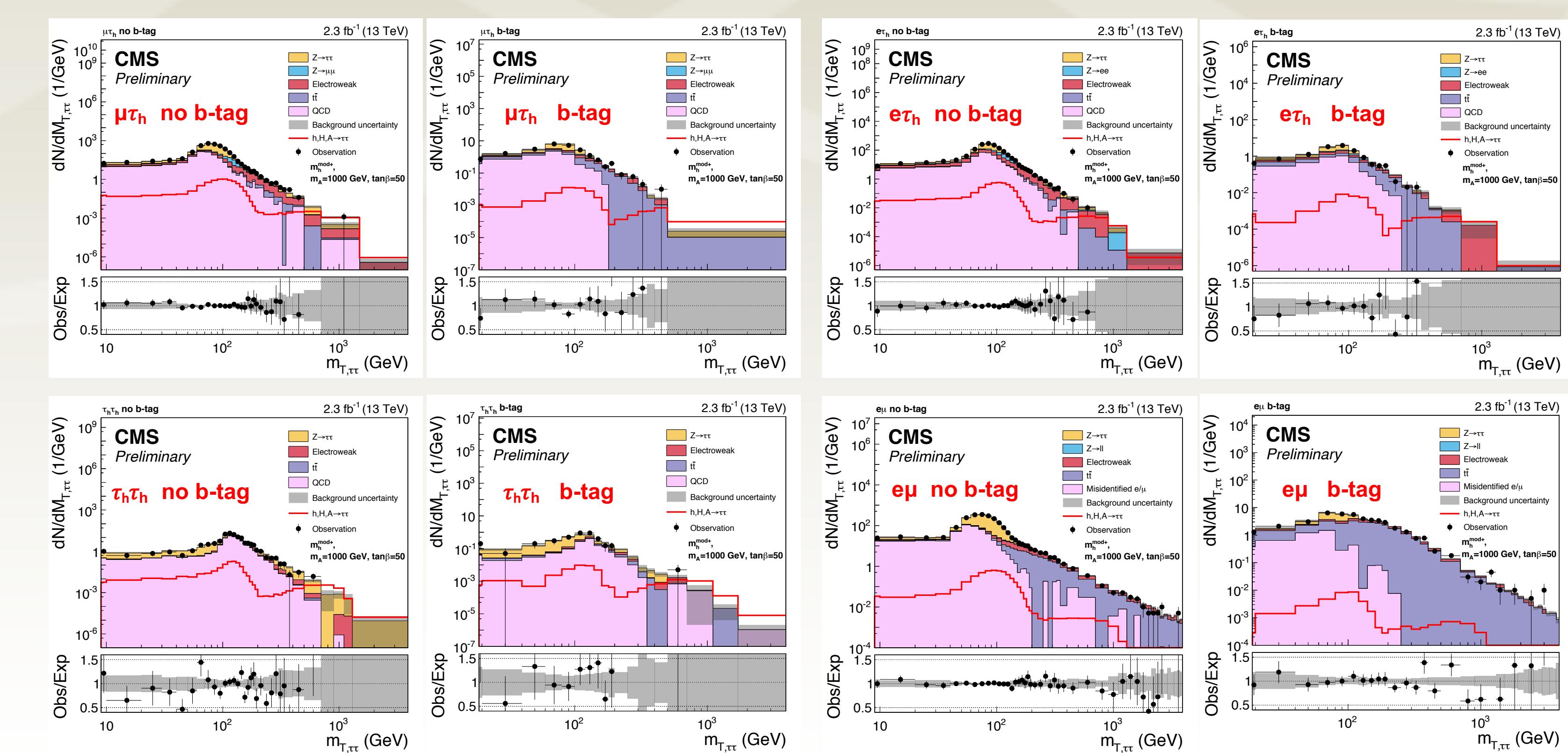
Shape Uncertainties

- τ Energy Scale
- High P_T ID efficiency
- Top quark P_T reweighting
- DY reweighting shape uncertainty

Events Yield

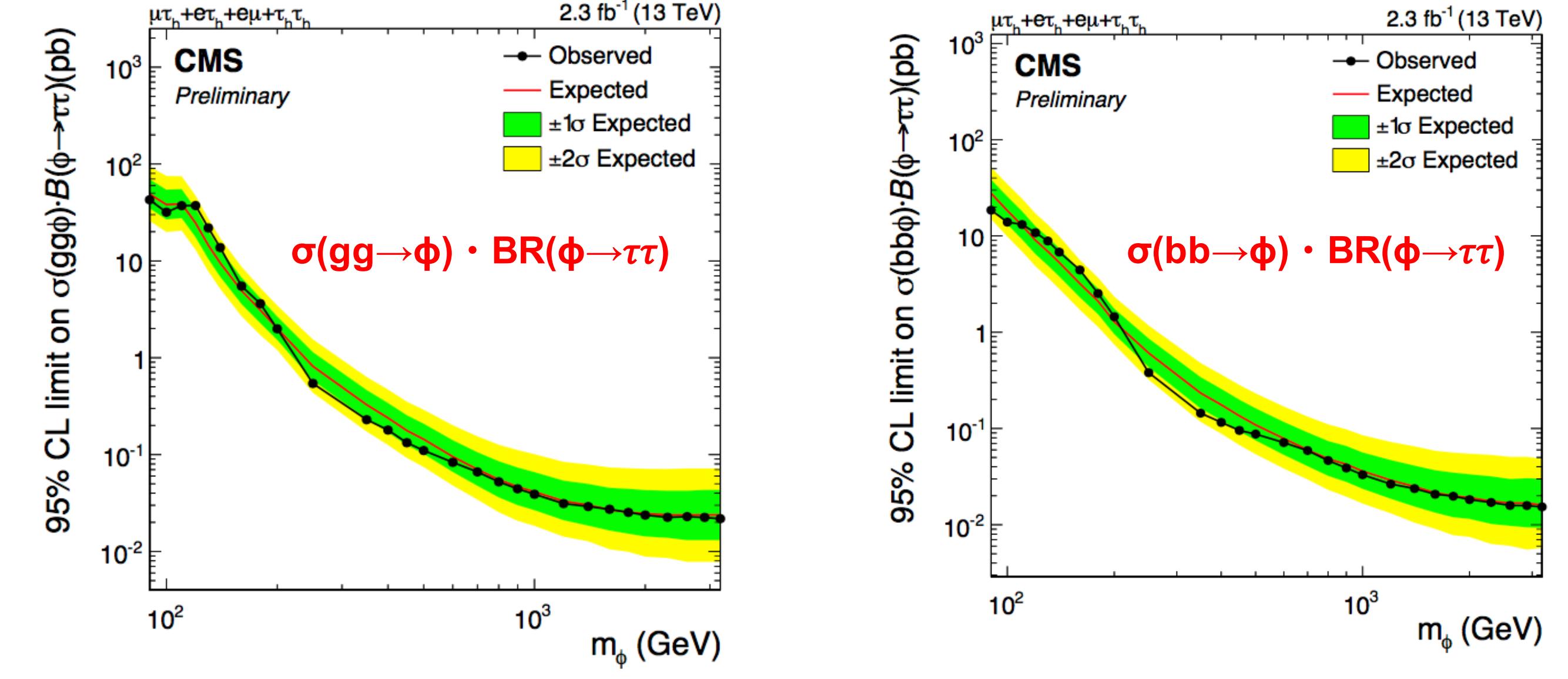
- Number of events observed in the data in the $\mu\tau_h$ channel compared with background expectation.
- Uncertainties are evaluated post fit.

$\mu\tau_h$ -channel		
Process	No b-tag	B-tag
QCD	5490 ± 324	136 ± 22
$t\bar{t}$	163 ± 14	73 ± 4
Diboson + single top	135 ± 7	22 ± 1
W+jets	2128 ± 280	24 ± 8
Z+jets (jet faking τ)	342 ± 59	2.3 ± 0.4
Z+jets (l faking τ)	1350 ± 238	14 ± 2
$Z \rightarrow \tau\tau$	17093 ± 328	192 ± 12
Total Background	26702 ± 178	463 ± 19
$A, H, h \rightarrow \tau\tau$	70 ± 7	1.4 ± 0.1
Data	26720	459

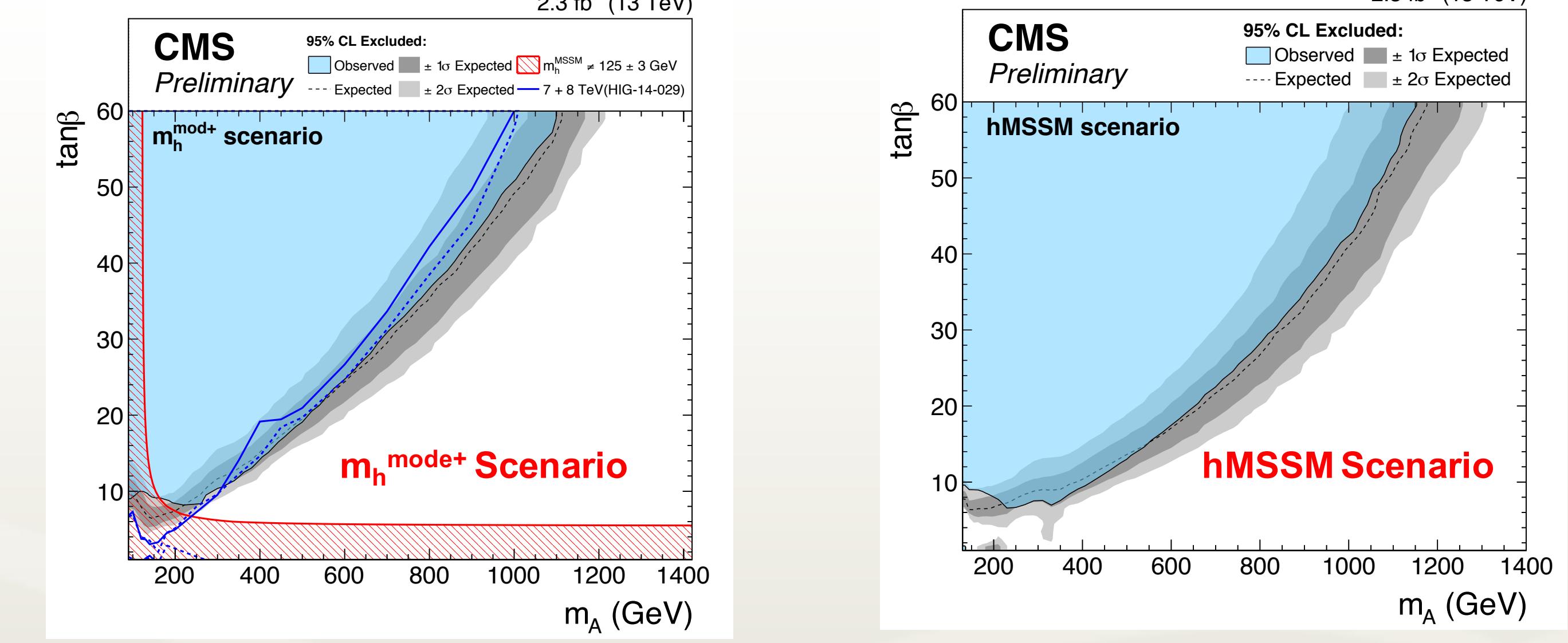


Expected and Observed Limits

Model Independent Limits on $\sigma(gg \rightarrow \phi) \cdot BR(\phi \rightarrow \tau\tau)$ and $\sigma(bb \rightarrow \phi) \cdot BR(\phi \rightarrow \tau\tau)$



Model Dependent Limits as a Function of m_A and $\tan \beta$



Summary and Outlook

- A search for a **neutral MSSM Higgs boson decaying into a pair of τ leptons** is presented, using the events in $\mu\tau_h$, $e\tau_h$, $\tau_h\tau_h$, and $e\mu$ channels.
- No evidence for a signal has been found.
- The exclusion limits on $\sigma(gg \rightarrow \phi) \cdot BR(\phi \rightarrow \tau\tau)$ and $\sigma(bb \rightarrow \phi) \cdot BR(\phi \rightarrow \tau\tau)$ are presented as a function of m_A and $\tan \beta$.
- A similar analysis is currently in progress that uses the same decay mode to calculate the cross-section of the **Standard Model (SM) Higgs Boson**. Along with the above mentioned channels, this second analysis will include $\mu\mu$ channel.
- Stay tuned for 2016 data!!

Reference

- CMS Collaboration, "Search for a neutral MSSM Higgs boson decaying into $\tau\tau$ at 13 TeV," CMS Physics Analysis Summary (CMS PAS) HIG-16-006

