

# CMSDAS 2016

VH → Vbb

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# OUTLINE

- Motivation, context in CMS and previous experiment

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- VHbb topology

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- Strategy / Selection

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- FOM Method

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- Background estimation

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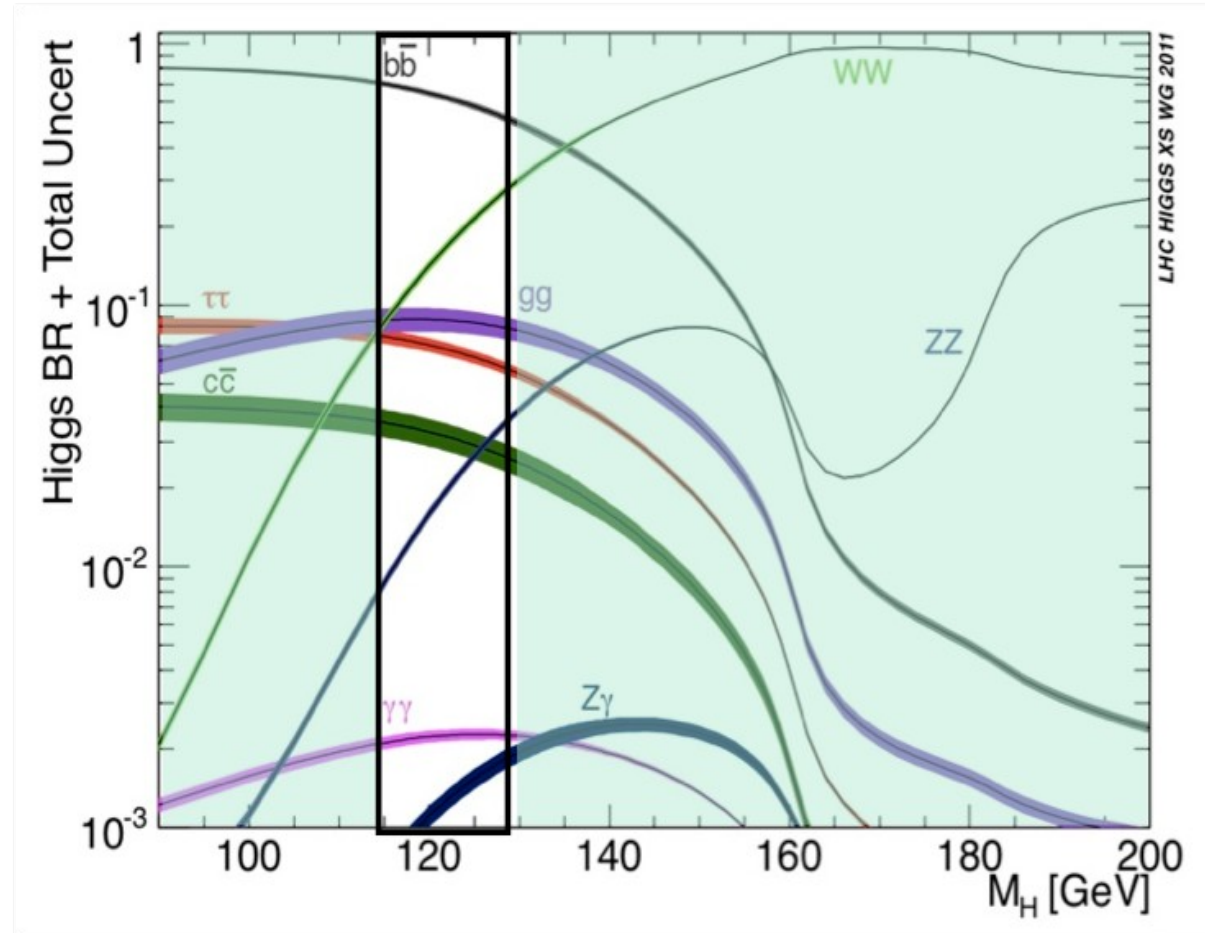
- Results

- 

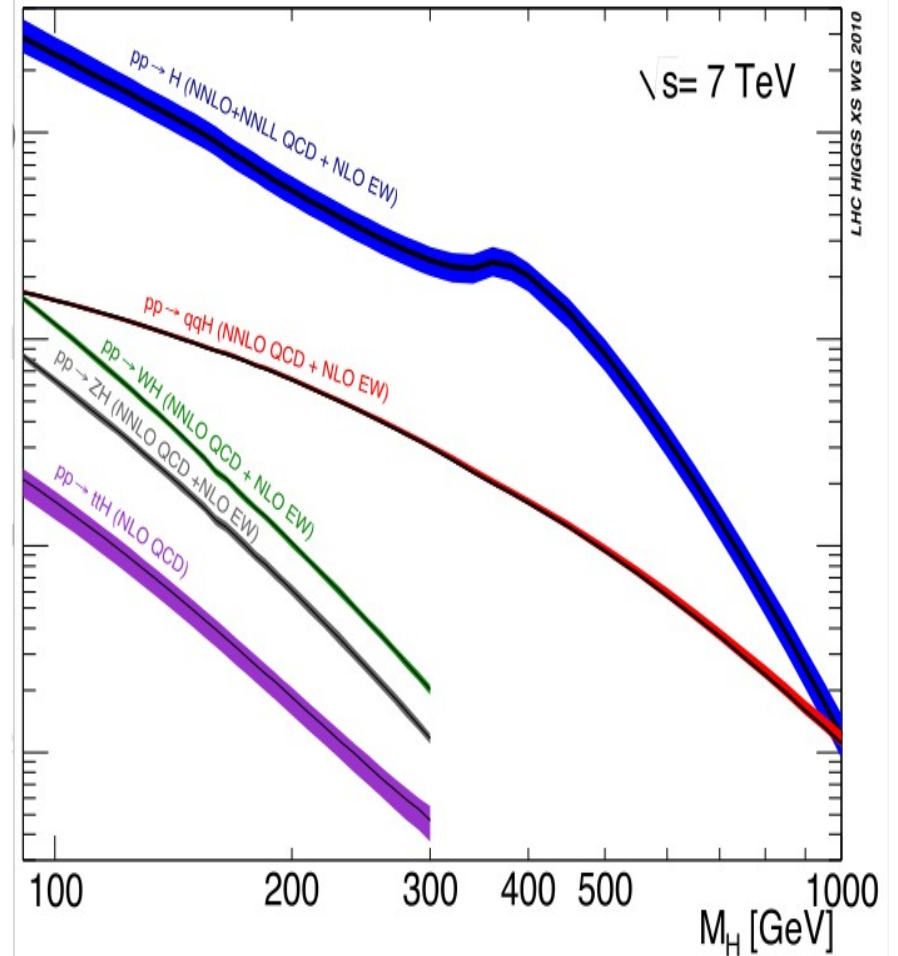
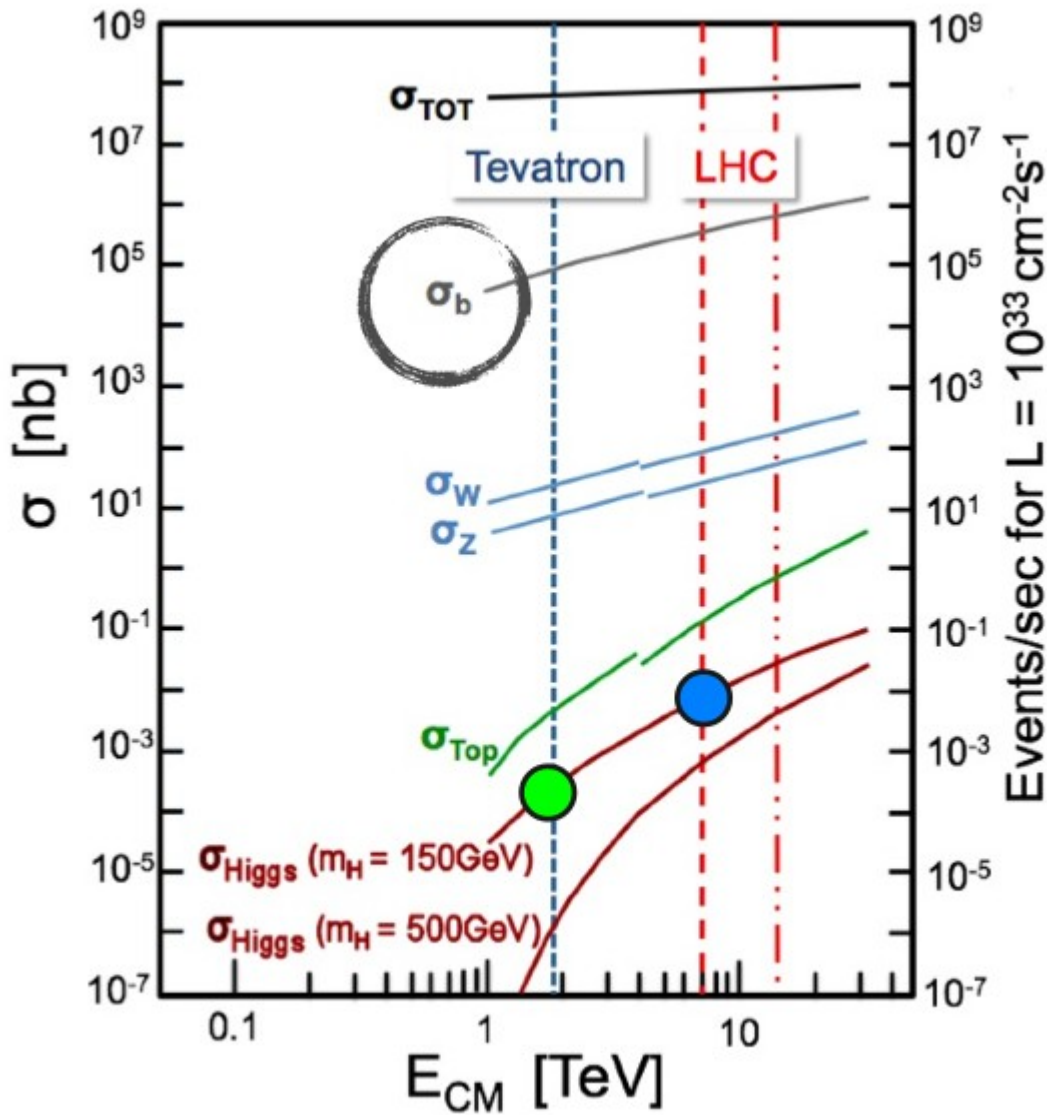
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# Why $b\bar{b}$ ?

$BR(H \rightarrow b\bar{b}) \sim 58\%$   
 $BR(H \rightarrow WW) \sim 22\%$   
 $BR(H \rightarrow \tau\tau) \sim 6\%$   
 $BR(H \rightarrow ZZ^*) \sim 3\%$   
 $BR(H \rightarrow \gamma\gamma) \sim 0.22\%$

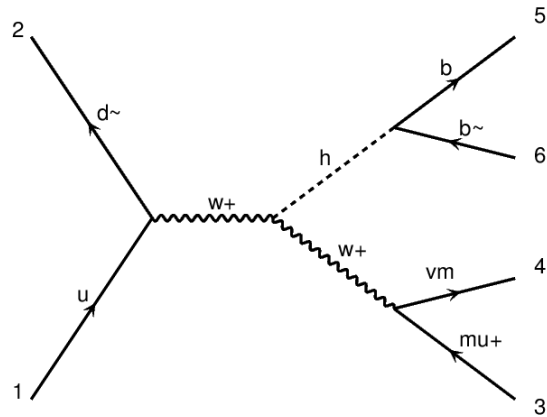


# Search strategy VH(bb)



# Search strategy

## targeted final states



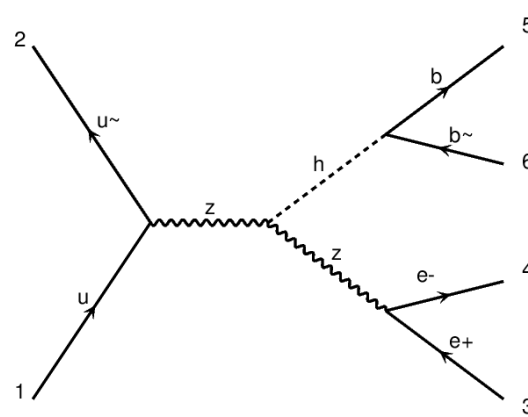
□  $W(\mu\nu)H(bb)$

□ H mass window

□ 1 isolated lepton

□ 2 b-tagged jets

□ additional



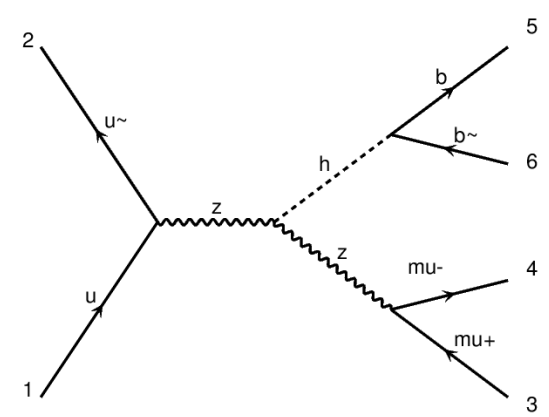
□  $Z(ee)H(bb)$

□ Z mass window

□ H mass window

□ 2 isolated lepton

□ lepton



□  $Z(\mu\mu)H(bb)$

□ Z mass window

□ H mass window

□ 2 isolated lepton

□ lepton

# Analysis Strategy

- Cut and count
  - Select H mass window
  - Highly boosted V
  - Count data events versus scaled MC background
  - Used “combine” tool to determine limits and significance
- Background estimation
  - Select control region
  - Scale background to data

# Mjj Analysis, cut and count

Main ingredients:

- Boosted
- b-tagging
- Topology
- QCD rejection

Variable	W( $\ell\nu$ )H	Z( $\ell\ell$ )H	Z( $\nu\nu$ )H
$m_{\ell\ell}$	-	$75 < m_{\ell\ell} < 105$	-
$p_T(j_1), p_T(j_2)$	$> 30, > 30$	$> 20, > 20$	$> 60 > 30$
$p_T(jj)$	$> 100$	-	$> 110$
$p_T(\ell)$	$> 30$	$> 20$	-
$p_T(V)$	$> 150$ (e) $> 180$ ( $\mu$ )	$> 150$	$> 170$
CSV( $j_1$ ), CSV( $j_2$ )	CSVT, $> 0.5$	CSVM, $> 0.5$	CSVT, $> 0.5$
$\Delta\phi(V, H)$	$> 2.95$	-	$> 2.95$
$\Delta R(jj)$	-	$< 1.6$	-
$N_{aj}$	$= 0$	-	$= 0$
$N_{al}$	$= 0$	-	$= 0$
$E_T^{\text{miss}}$	$> 45$	$< 60.$	-
$\Delta\phi(E_T^{\text{miss}}, \text{jet})$	-	-	$> 0.5$
$\Delta\phi(E_T^{\text{miss}}, \text{trkMET})$	-	-	$< 0.5$
$\Delta\phi(E_T^{\text{miss}}, \text{lep})$	$< \pi/2$	-	-

Cuts optimized according to the following Figure Of Merit (FoM):

$$S/(n_{\sigma}/2 + \sqrt{(B) + \Delta B}), \text{ where } n_{\sigma} = 3$$

# Channel cut

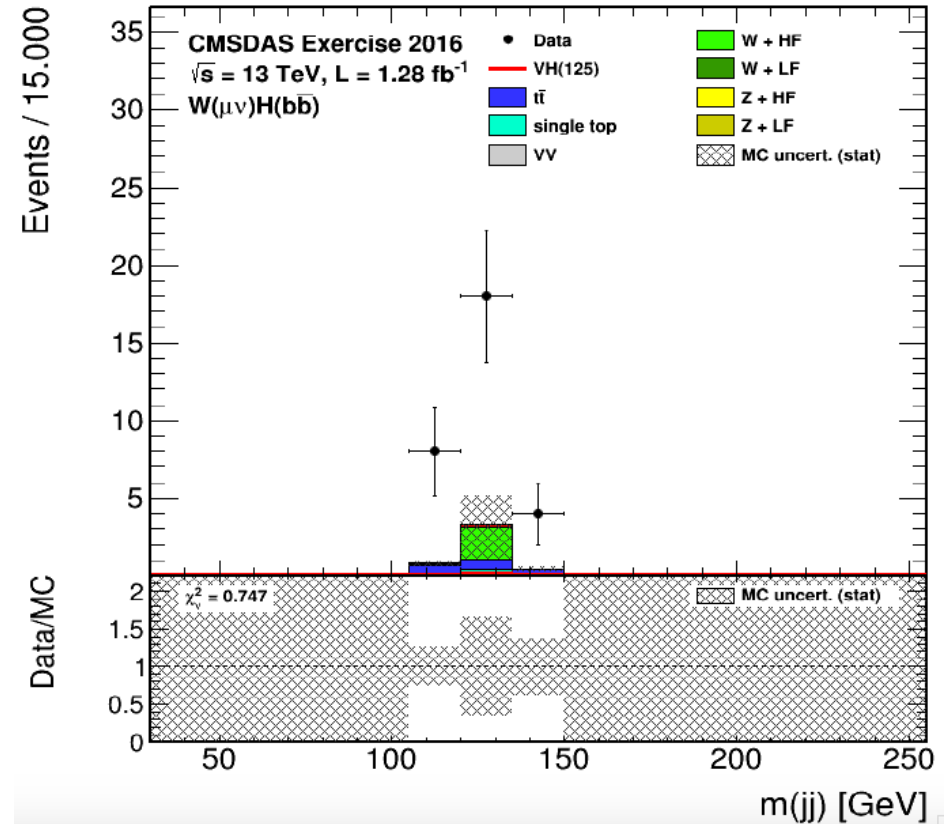
	ZH->eebb	ZH->mmbb	WH->mnbb
Vpt	80	150	150
Hpt	110	0	120
maxCSV	0.898	0.9	0.82
minCSV	0.5	0.4	0.55
dPhi	2.98	2.9	2.96



# FOM

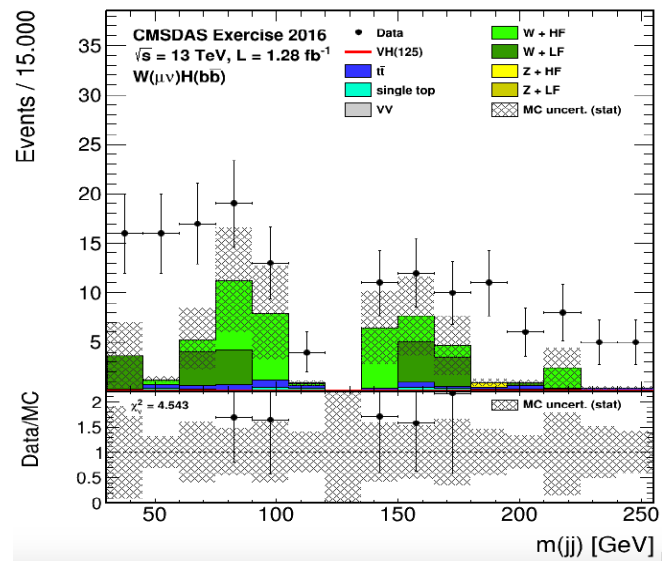
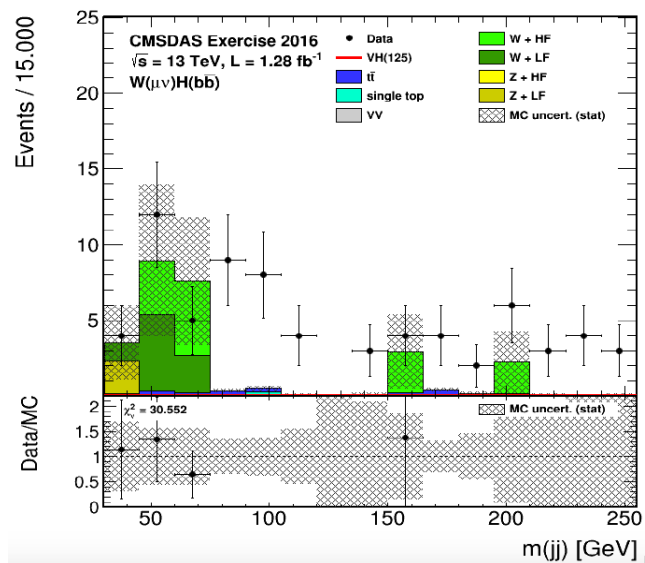
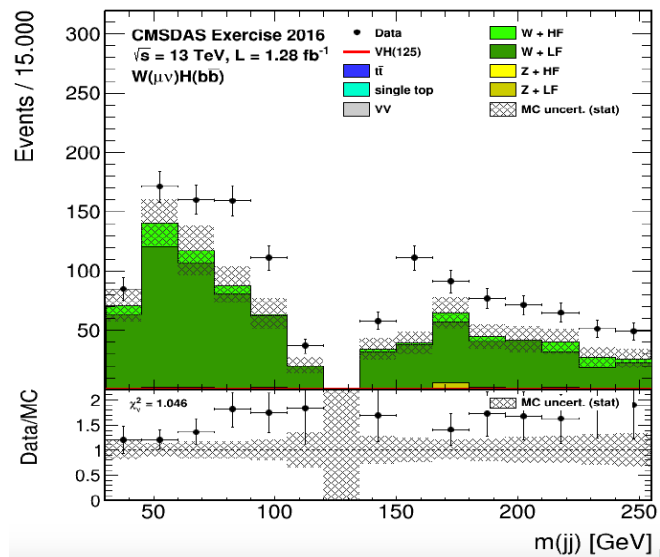
Weight factor = 1

$S/(\sqrt{B} + a/2 + 0.2B)$



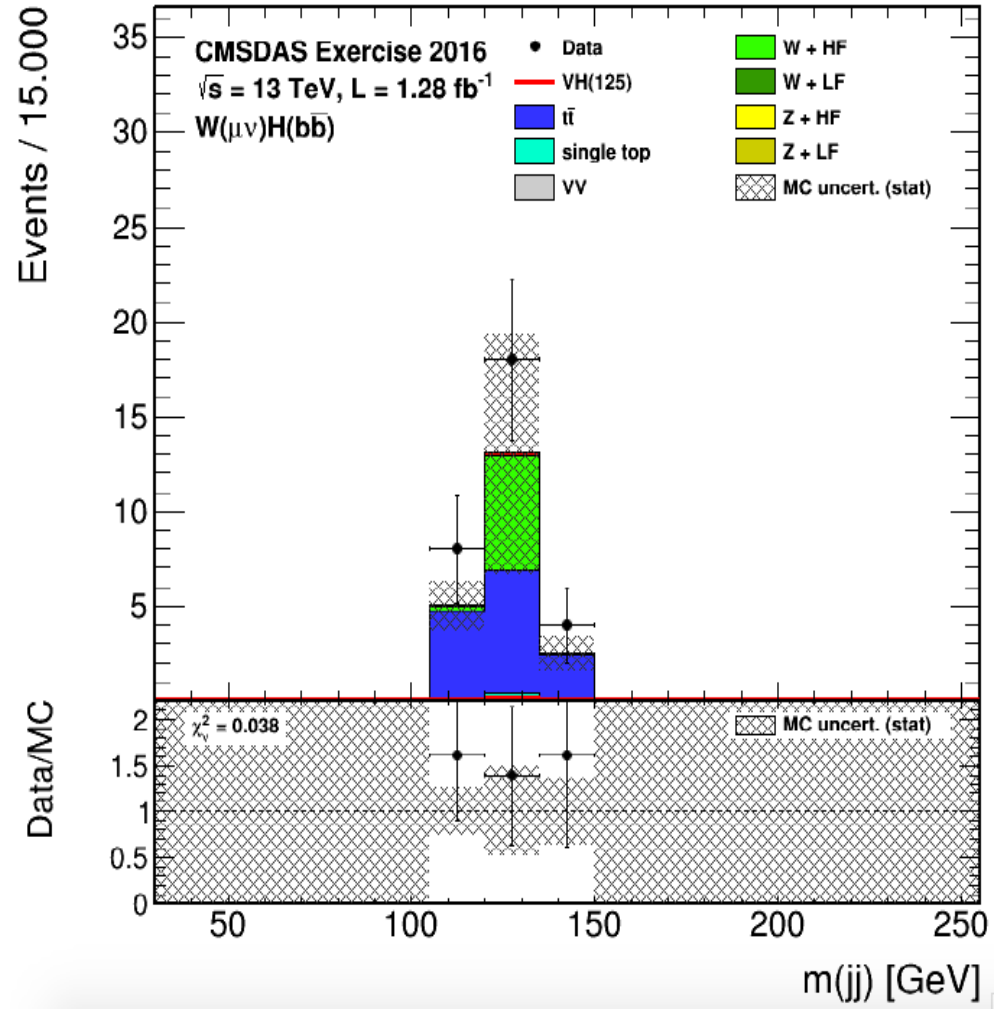
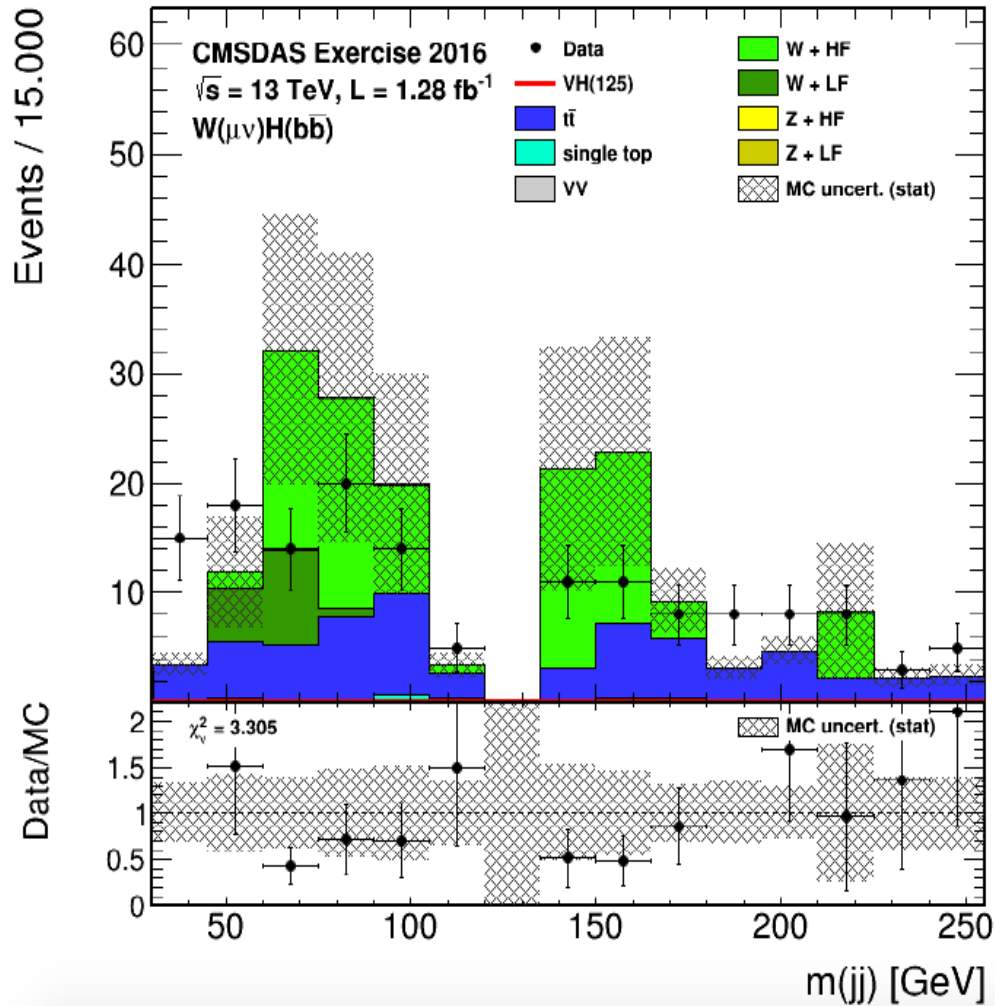
# Background Estimation: Control Region

- Monte Carlo needs to be scaled to the data
- Major backgrounds that must be scaled
  - •  $Z \rightarrow ll$ : Z plus light jets, Z plus heavy jets,  $t\bar{t}$
  - •  $W \rightarrow lv$ : W plus light jets, W plus heavy jets,  $t\bar{t}$
  - •  $Z \rightarrow \nu\nu$ : Z plus light jets, W plus light jets,  $t\bar{t}$
- Each of these channels were scaled individual by making appropriate cut inversions to enter a control region
- Example: Looking at the  $Z \rightarrow ll$  Z plus light jets control region
  - • Invert the CSV btag requirement to exclude the heavy jets
  - • Additional exclude events with more than one additional jet



# Sideband & Unblinded Result

## W( $\mu\nu$ )H(bb)



**BACKUP**

# Scale Factors

channel	W+LF	W+HF	Z+LF	Z+HF	TTbar
Z(ee)H(bb)	--	--	1.98	1.27	9.73
Z( $\mu\mu$ )H(bb)	--	--	2.01	0.8446	0.9236
W( $\mu\nu$ )H(bb)	1.4615	2.9895	--	--	9.5582