If a much heavier Higgs

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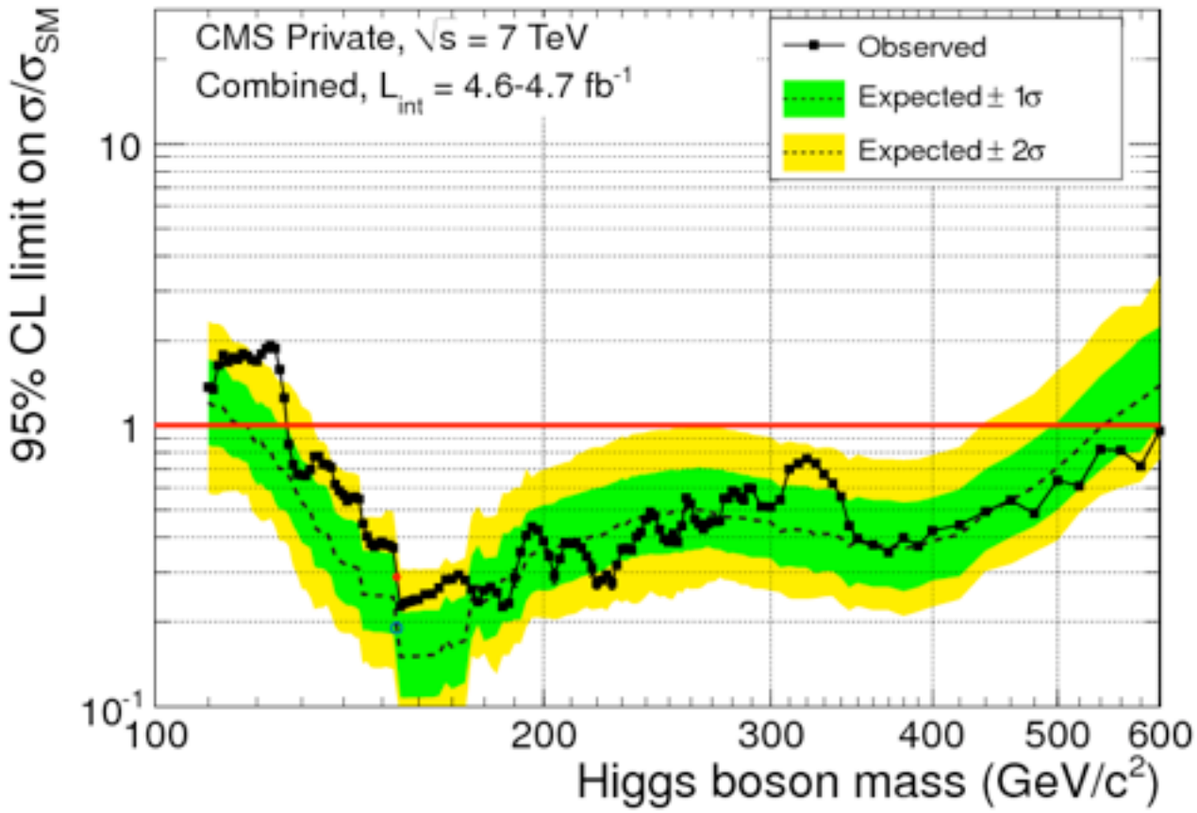
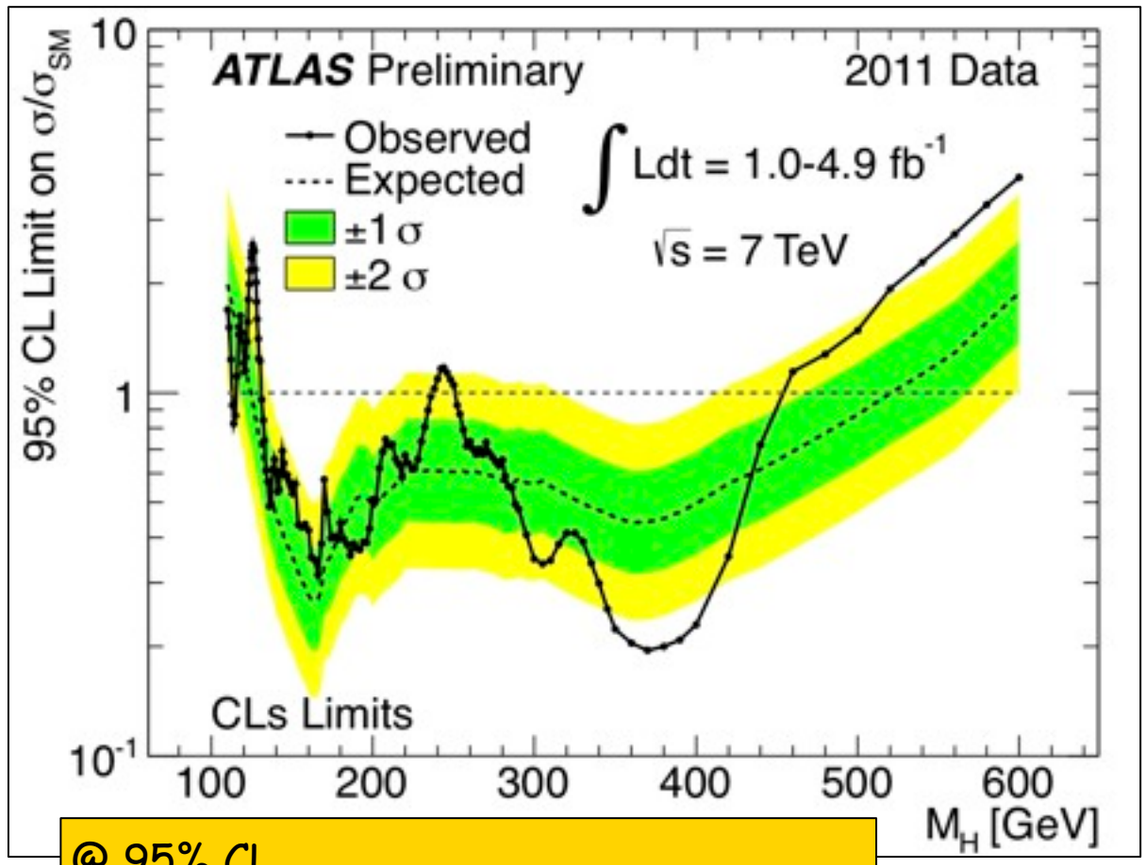
Introduction

- LHC present updated results on SM Higgs on Dec. 13, 2012
- Extended the exclusion range with some excess in low mass region



95%CL: obs 127-600 GeV, exp:117-543 GeV

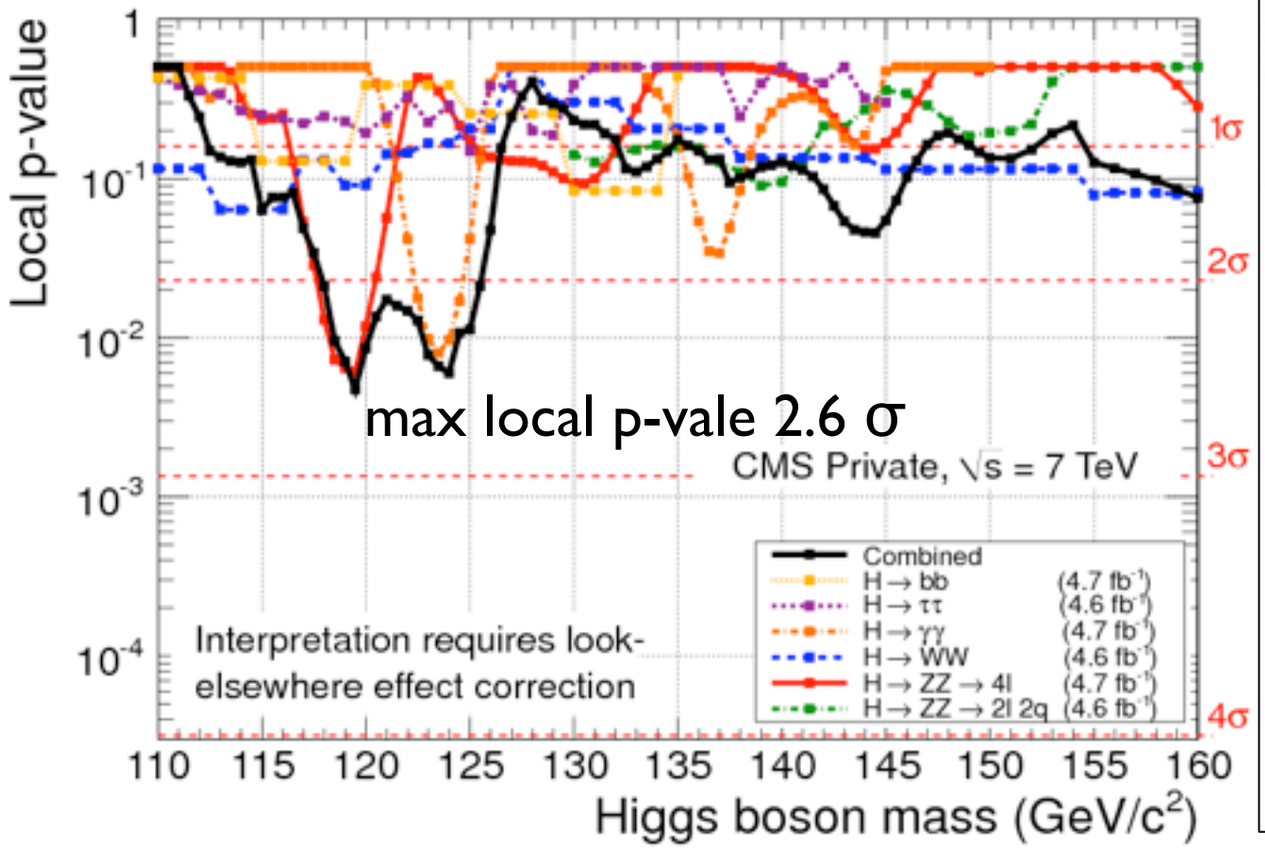


@ 95% CL,
$112.7 < m_H < 115.5$ GeV
$131 < m_H < 453$ GeV, except 237-251 GeV

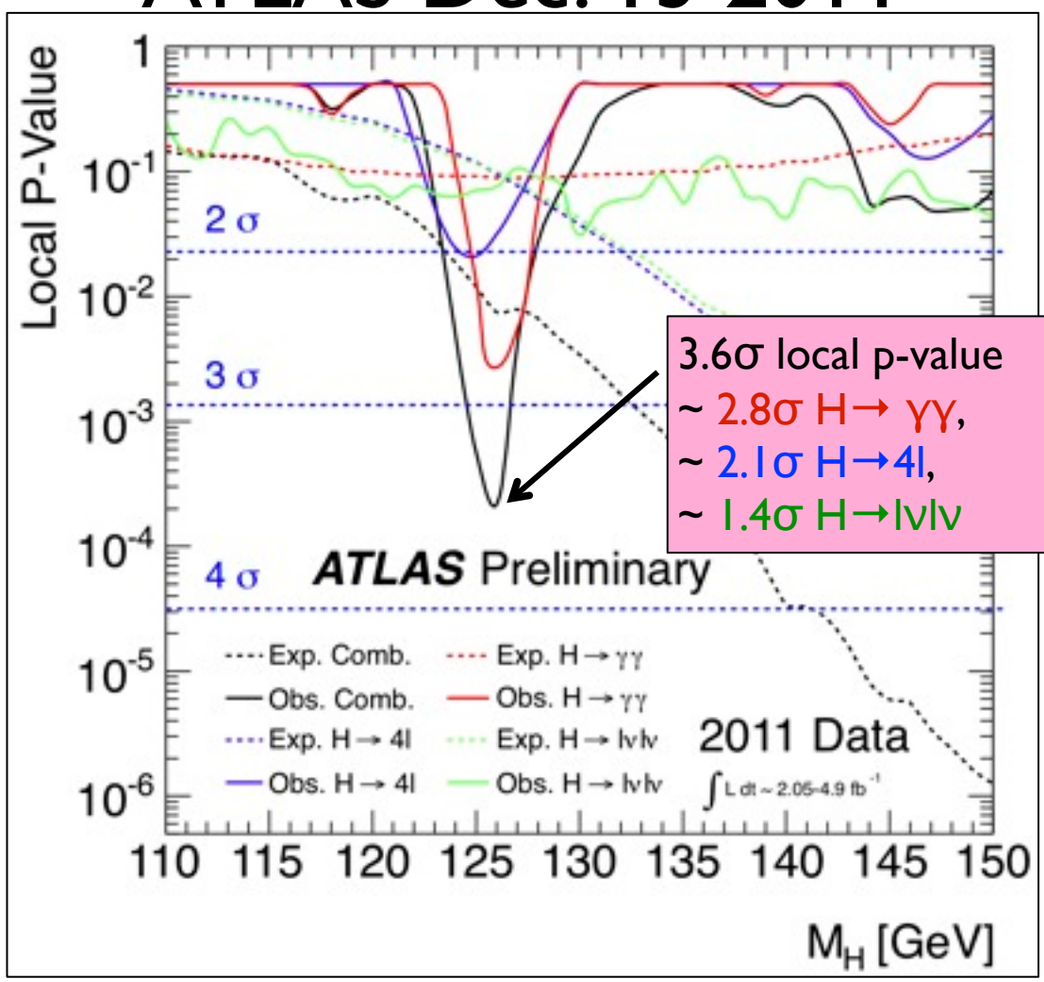
Excess in low mass

- Hint with local p-vale around 2~3 sigma from a few channels
- Considering LEE, the excess is reduced to less than 2 sigma.
- Consistent with background fluctuation.
- Not all channels supporting each other

CMS Dec. 13 2011



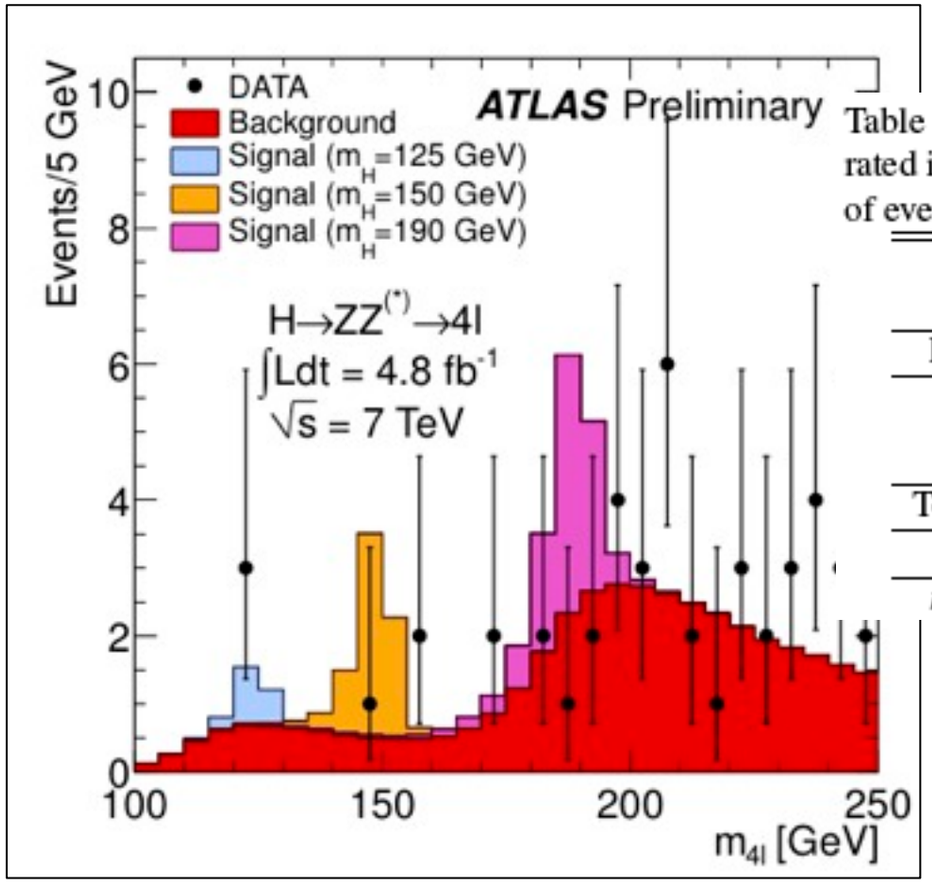
ATLAS Dec. 13 2011



3.6σ local p-value
~ 2.8σ H→ γγ,
~ 2.1σ H→4l,
~ 1.4σ H→lνlν

Higgs → ZZ (4ℓ)

- Not same mass between ATLAS (124) and CMS (119)
- ATLAS has 3 events in same bin which create large local p-value.



ATLAS-CONF-2011-162

Table 3: The expected number of signal and background events, with their systematic uncertainty, separated into "Low $m_{4\ell}$" ($m_{4\ell} < 180$ GeV) and "High-$m_{4\ell}$" ($m_{4\ell} \geq 180$ GeV) regions. The observed numbers of events are also presented.

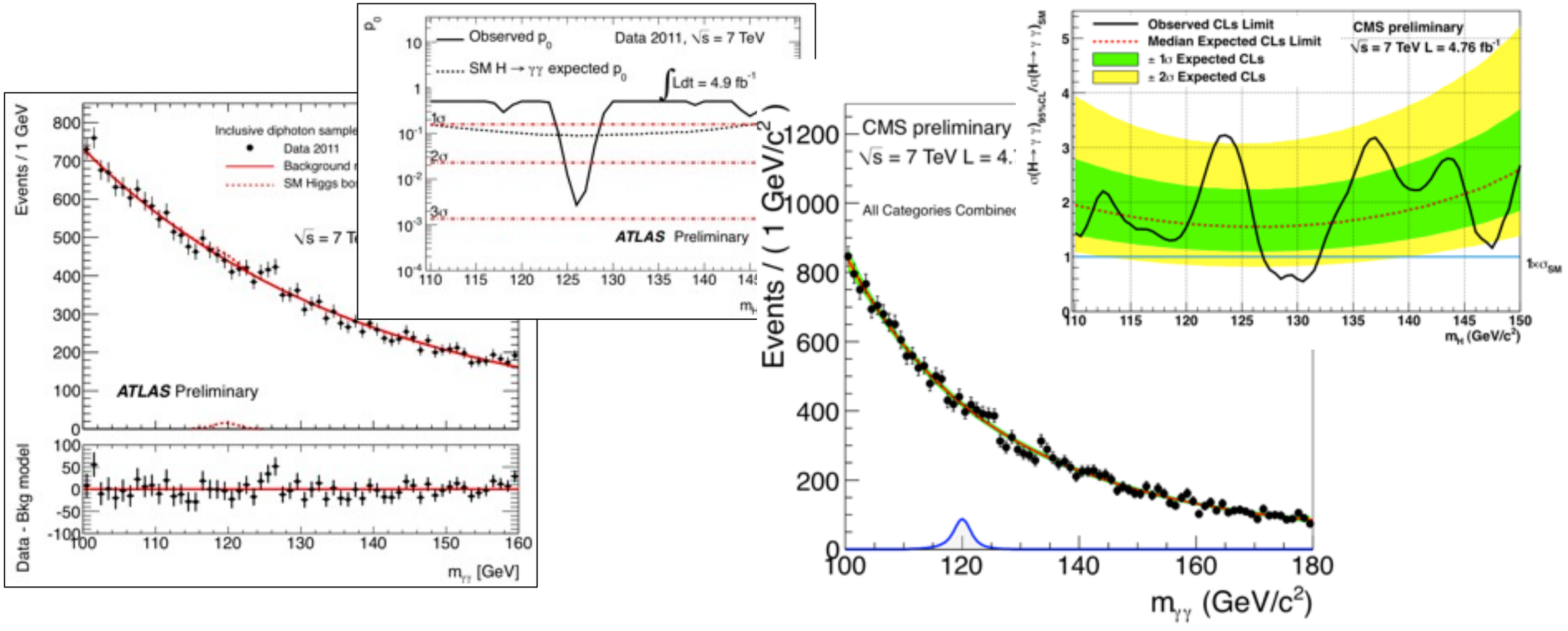
	$\mu\mu\mu\mu$		$ee\mu\mu$		$eeee$	
	Low $m_{4\ell}$	High $m_{4\ell}$	Low $m_{4\ell}$	High $m_{4\ell}$	Low $m_{4\ell}$	High $m_{4\ell}$
Int. Luminosity	4.81 fb^{-1}		4.81 fb^{-1}		4.91 fb^{-1}	
$ZZ^{(*)}$	2.0±0.3	16.3±2.4	2.8±0.6	25.2±3.8	1.3±0.3	10.3±1.5
$Z, Zb\bar{b}$, and $t\bar{t}$	0.16±0.06	0.02±0.01	1.4±0.5	0.17±0.08	1.6±0.7	0.18±0.08
Total Background	2.2±0.3	16.3±2.4	4.2±0.8	25.4±3.8	2.9±0.8	10.5±1.5
Data	3	21	3	27	2	15
$m_H = 125$ GeV	0.58 ± 0.10		0.73 ± 0.13		0.25 ± 0.05	

In the region 117< m_{4l} <128 GeV (containing ~90% of a m_H=125 GeV signal) expect:

~1.5 events background: 0.26 4μ + 0.86 2e2μ + 0.64 4e
~1.4 events signal: 0.53 4μ + 0.66 2e2μ + 0.23 4e

Higgs→γγ; ATLAS vs CMS

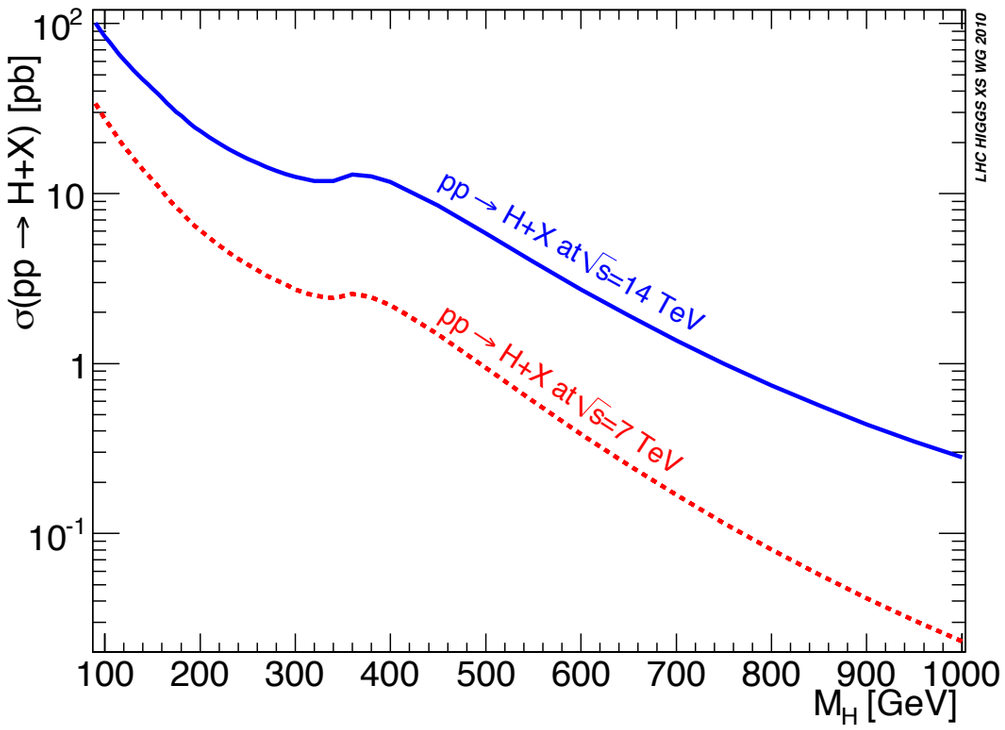
- Higgs →γγ, 124 or 126?
- Both exp. claim to calibrate energy scale well.
- Mass different by 2GeV is larger than energy scale error and width (again, if you believe there is Higgs there. Otherwise, BKG fluctuation no need to have E scale discussion)

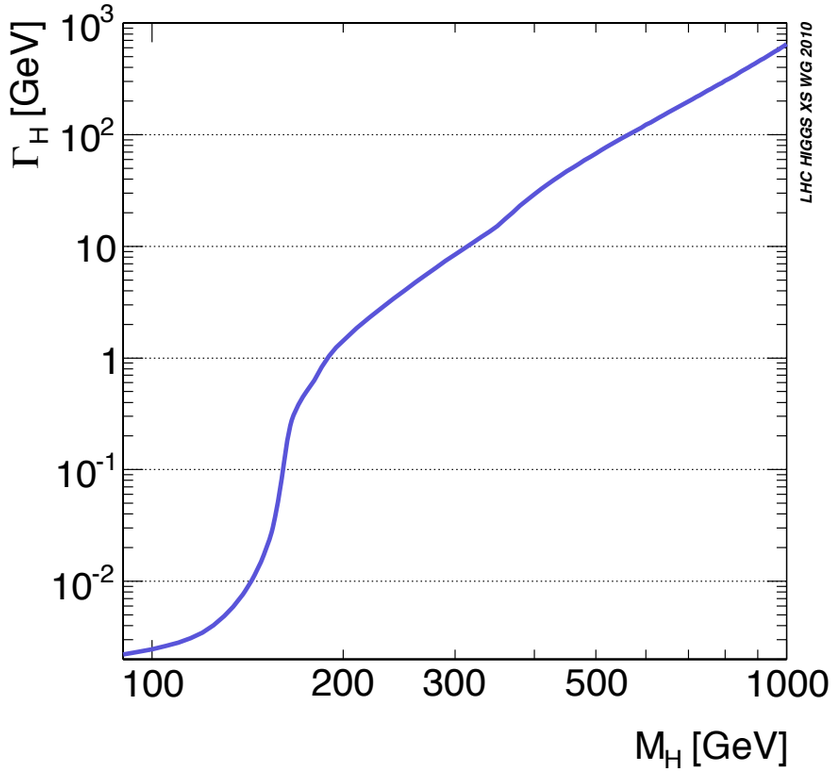


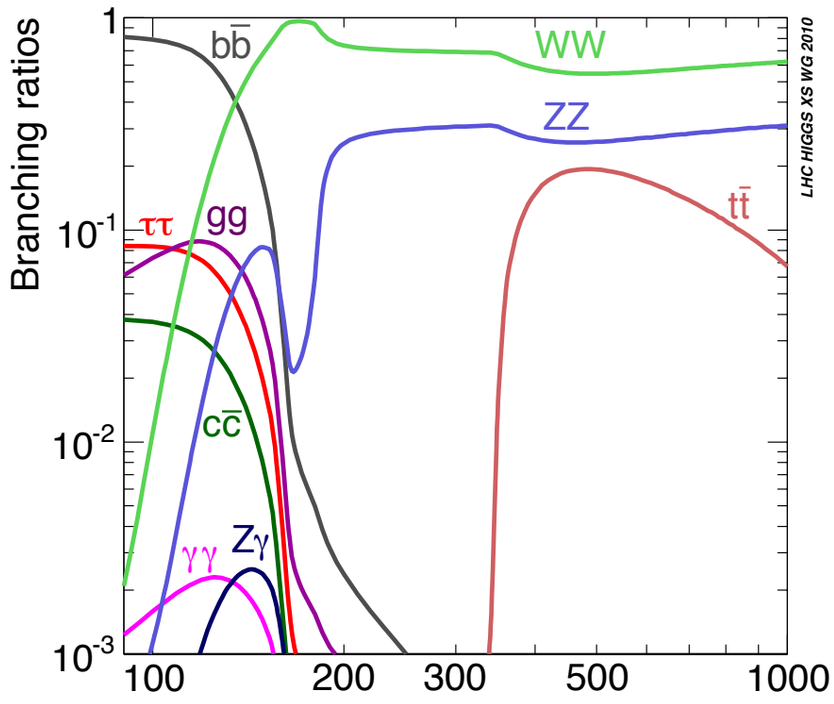
Maybe SM Higgs is above 600 GeV?

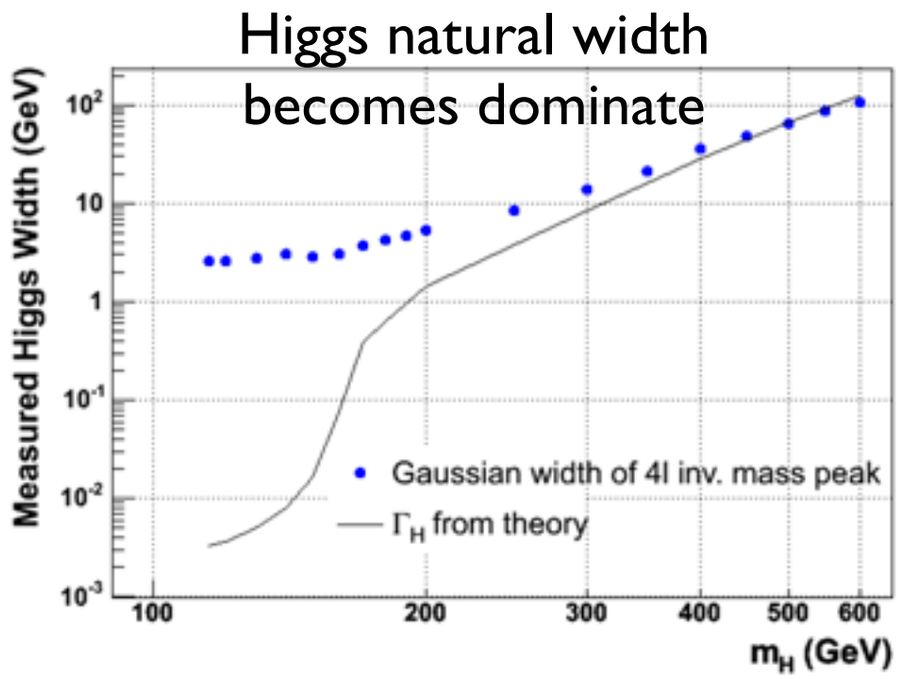
- Most experimentalist assume SM Higgs, if exists, should have mass below 600GeV
- Limited studies above 600 GeV

Heavy SM Higgs



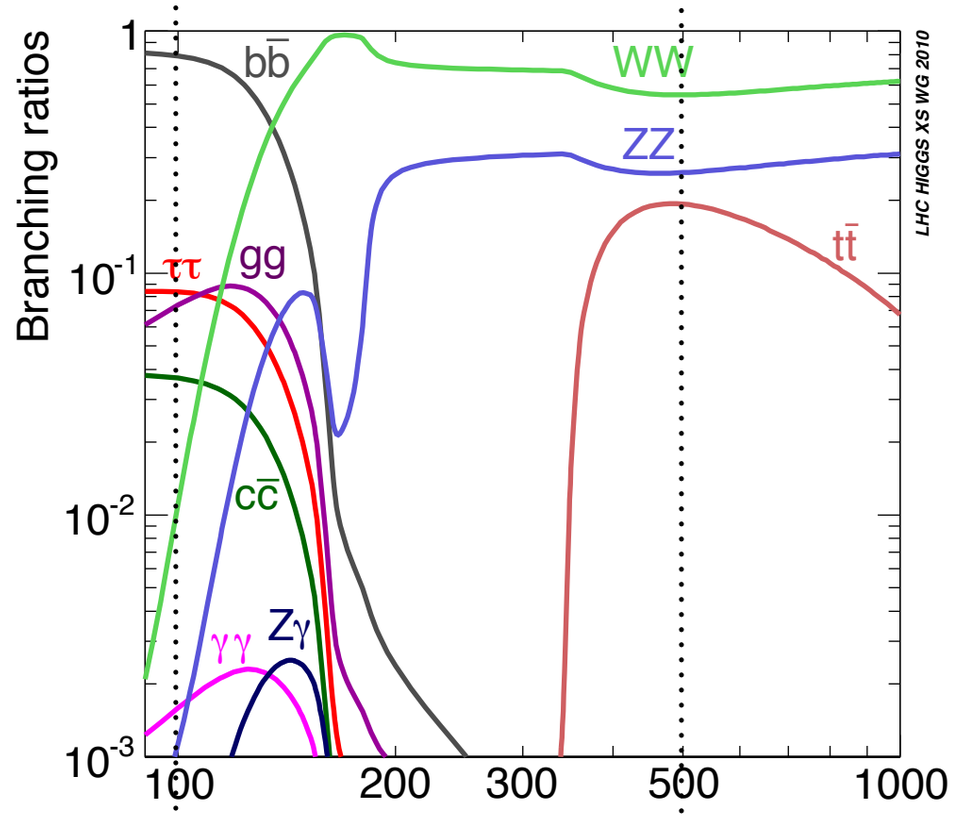


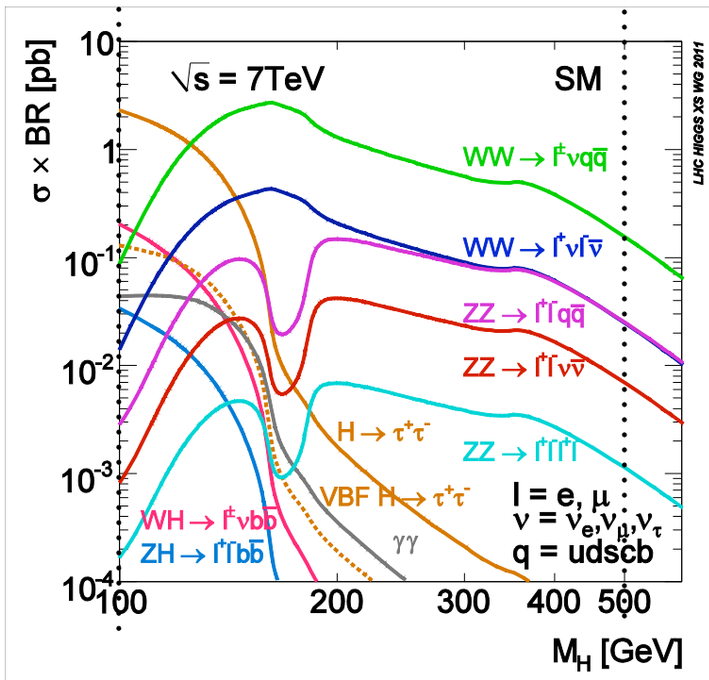




Heavy Higgs

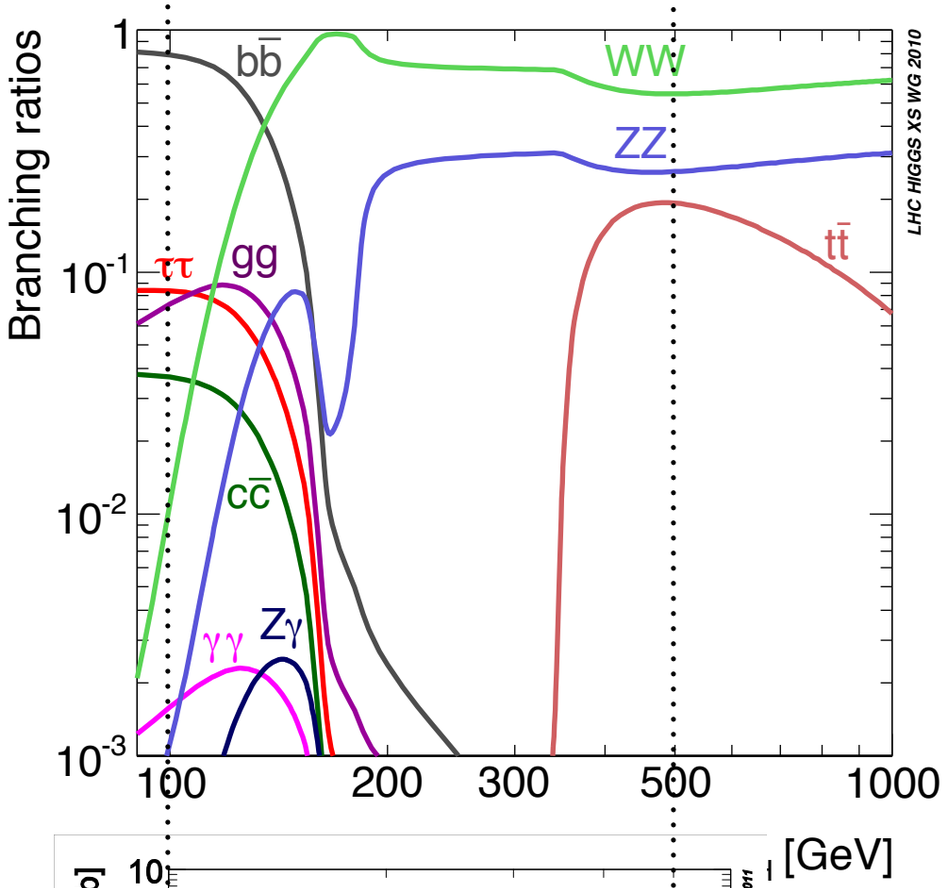
- Above 700 GeV, H→ZZ (4ℓ) becomes rate-limited, fewer than 20 signal events @600GeV with 30fb^{-1}. (CMS expects to see 3.2 (4ℓ) signal events @500GeV with 5fb^{-1})
- H→WW($\ell\nu$jj) : large rate, challenge on reconstruct W from jj; S/N ~ 3 @800GeV. No results shown from LHC on 2011.

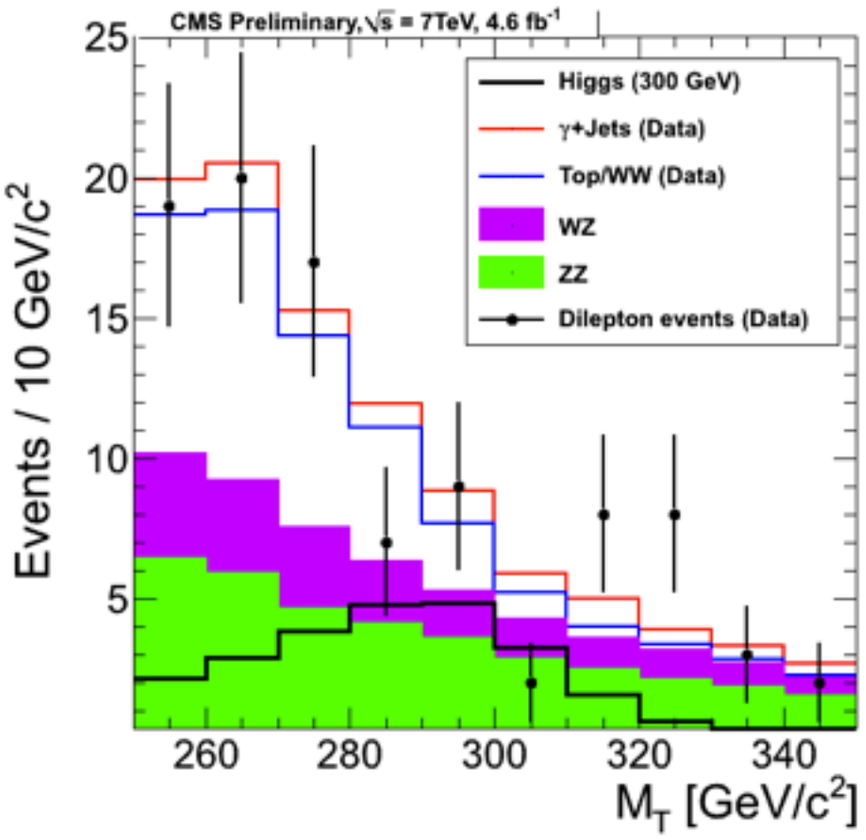


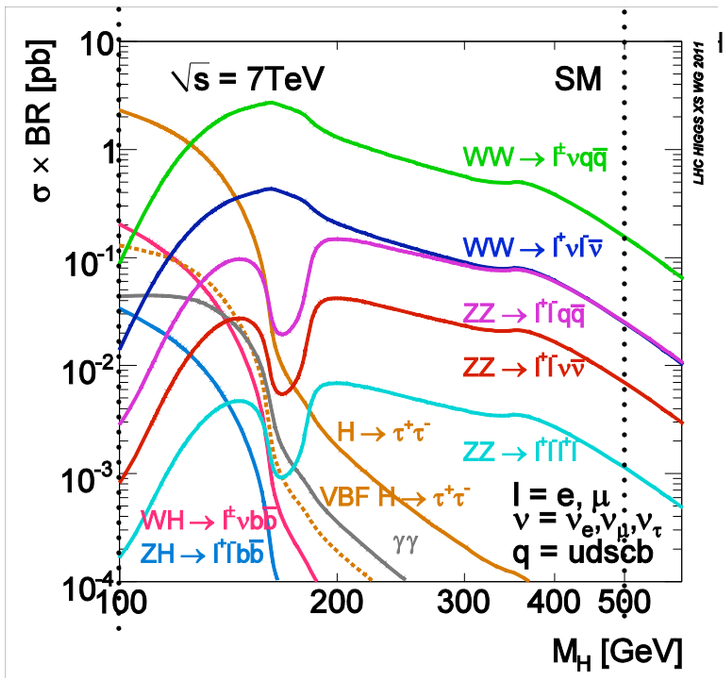


Heavy Higgs

- $H \to ZZ(2\ell 2\nu)$: challenge on understanding MET and M_T; May need to do VBF to have S/N > 1 above 500GeV.

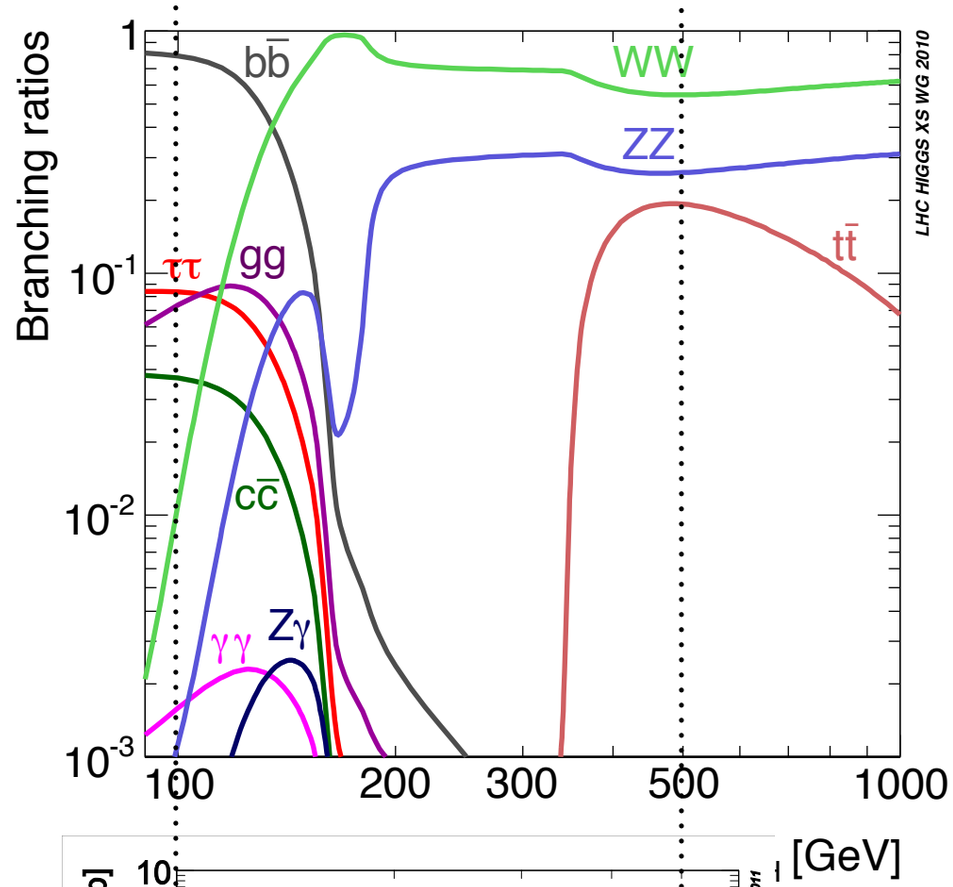


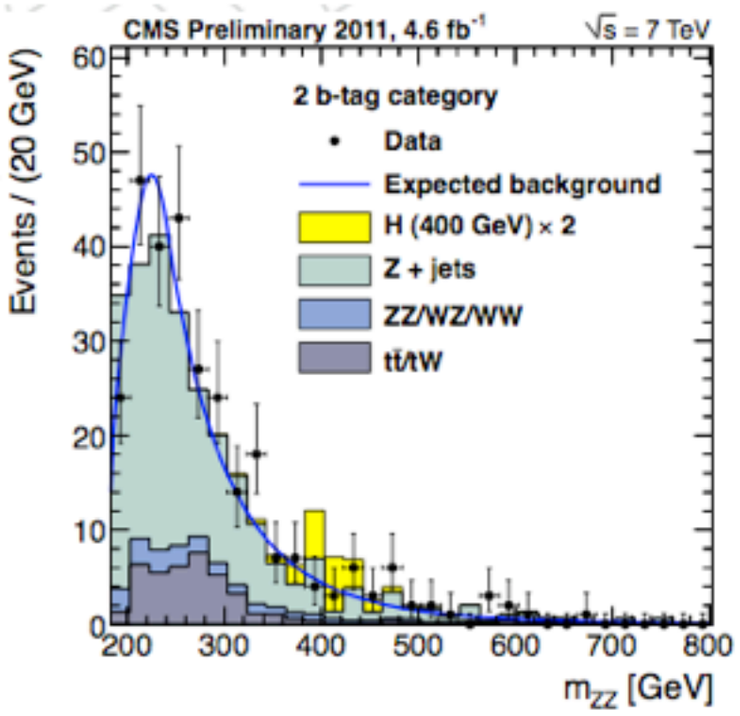


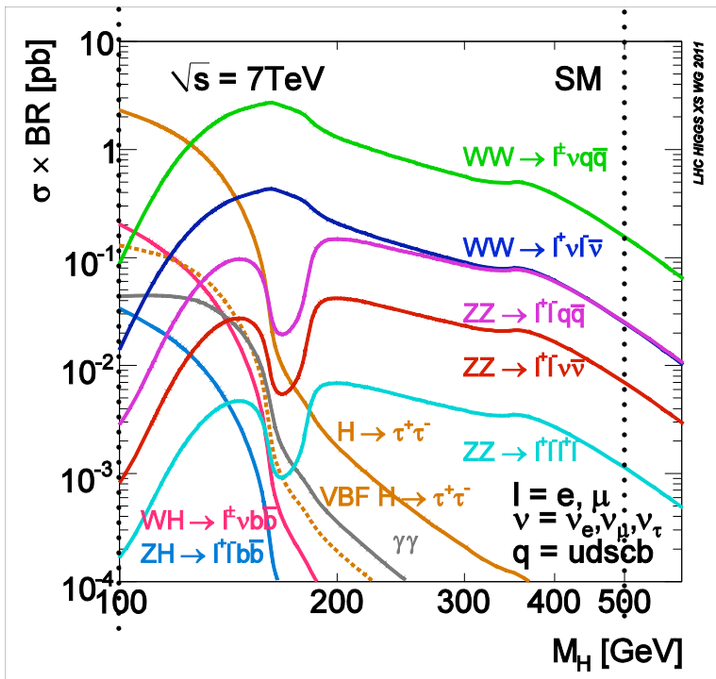


Heavy Higgs

- $H \to ZZ(2\ell 2j)$ has small rate and will need about $100fb^{-1}$ for heavy Higgs

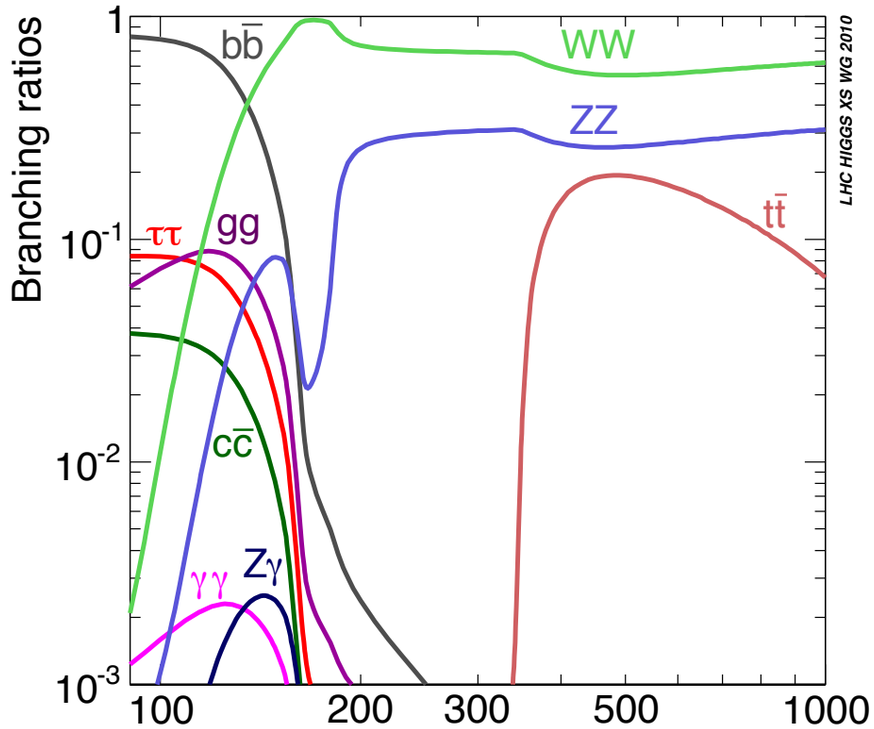


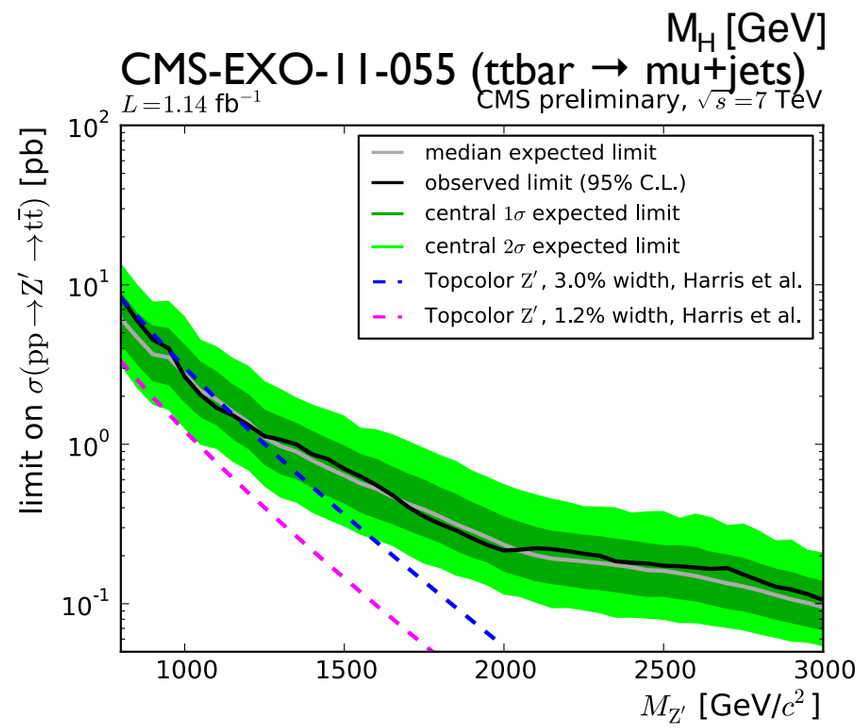




Heavy Higgs

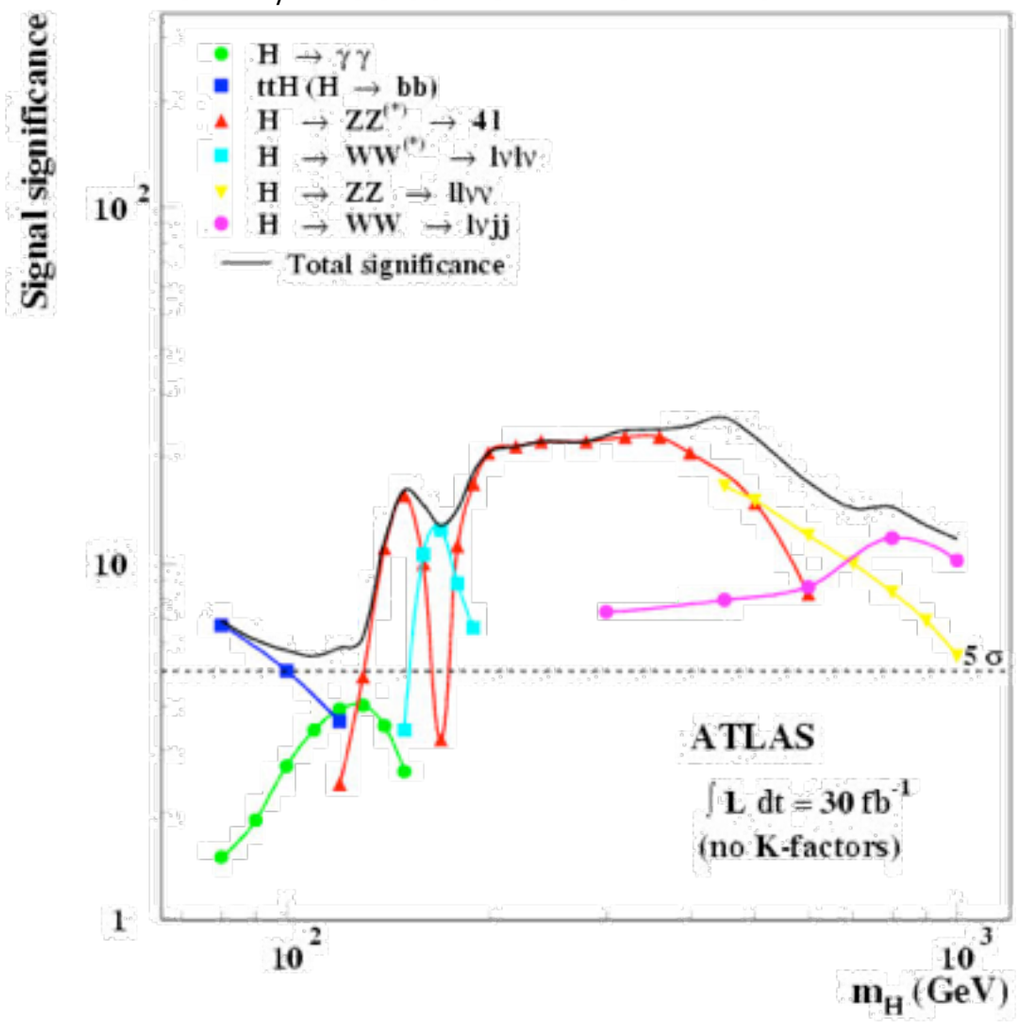
- H→ttbar has little sensitivity. @1TeV, the effective XS is 0.2pb @14TeV.
- CMS search for narrow resonance to ttbar yields limit of 2.7pb @1TeV. Will need 100 times of data to reach 0.2pb.



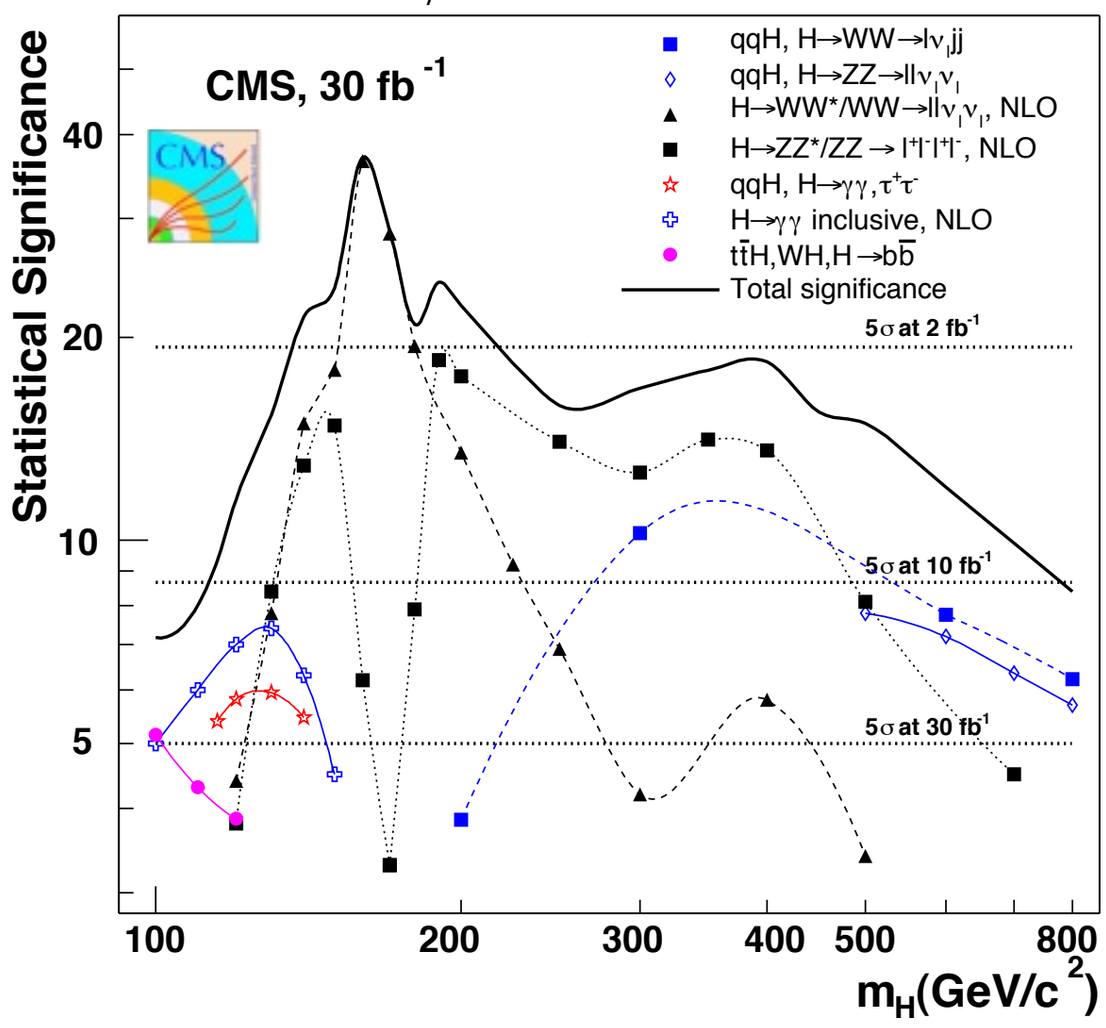


LHC prospect

CERN/LHCC 99-15 ATLAS TDR 15



CMS NOTE 2003/033



- Assuming both detectors are well understood and calibrated.

$H \to WW(\ell\nu jj)$

- leptons, jets and W mass window cuts
- two jets tag for VBF process
- veto additional central jets to remove ttbar or W+jets

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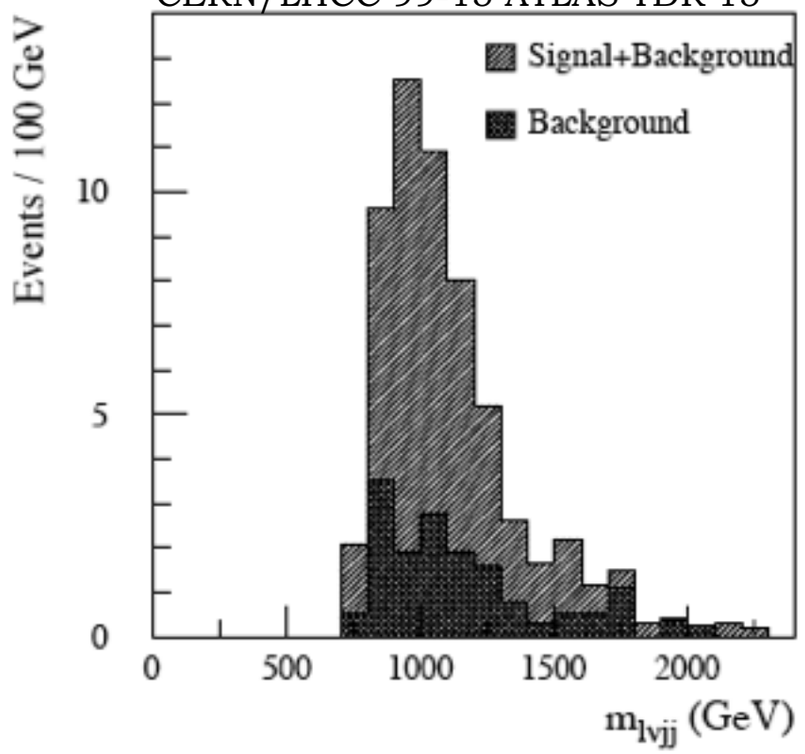

CERN/LHCC 99-15 ATLAS TDR 15 **Figure 19-39** For an integrated luminosity of 30 fb^{-1}

Table 19-26 For an integrated luminosity of 30 fb^{-1} and for the $H \to WW \to l\nu jj$ channel with $m_H = 1$ TeV and 800 GeV, expected numbers of produced and accepted signal and background events, signal-to-background ratios and signal significances. The events are accepted if they pass all cuts, namely the high-p_T central cuts, the central jet veto and a double jet tag $E_{tag} > 300$ GeV (see text).

	Higgs signal	$t\bar{t}$ ($p_T > 300$ GeV)	W+jets ($p_T > 250$ GeV)	WW ($p_T > 50$ GeV)	S/B	$S/\sqrt{B}$
Events produced		192 000	448 000	255 000		
$m_H = 1$ TeV	486					
$m_H = 800$ GeV	1000					
Events accepted						
$m_H = 1$ TeV	37.9	3.3	9.2	1.0	2.8	10.3
$m_H = 800$ GeV	43.5	3.3	9.2	1.0	3.2	11.8

Discussion