Search for the Standard Model Higgs decaying to two photons in CMS

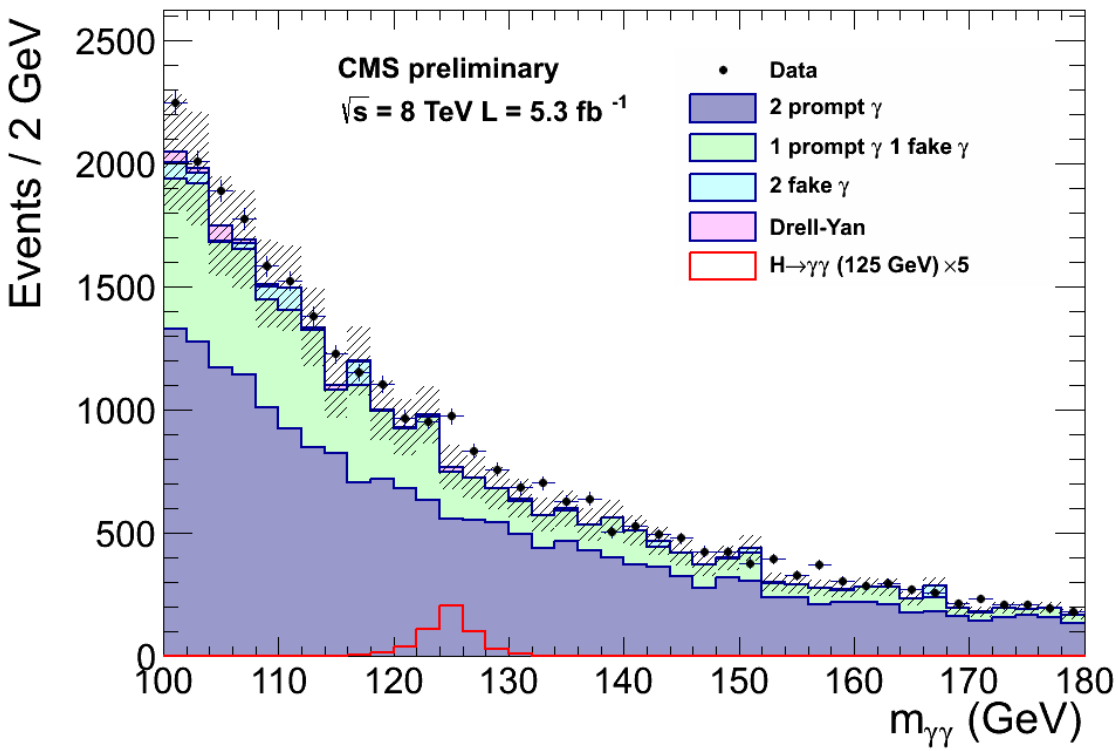
Alex Mott

Caltech

For the CMS collaboration

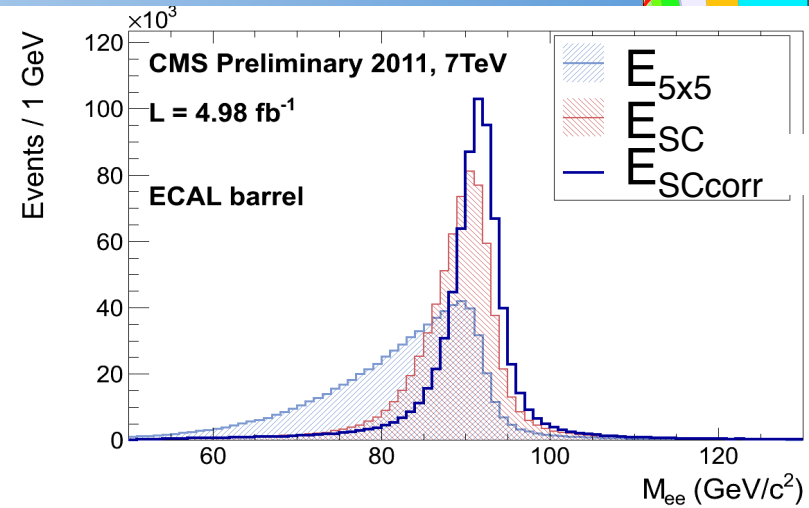
Motivation

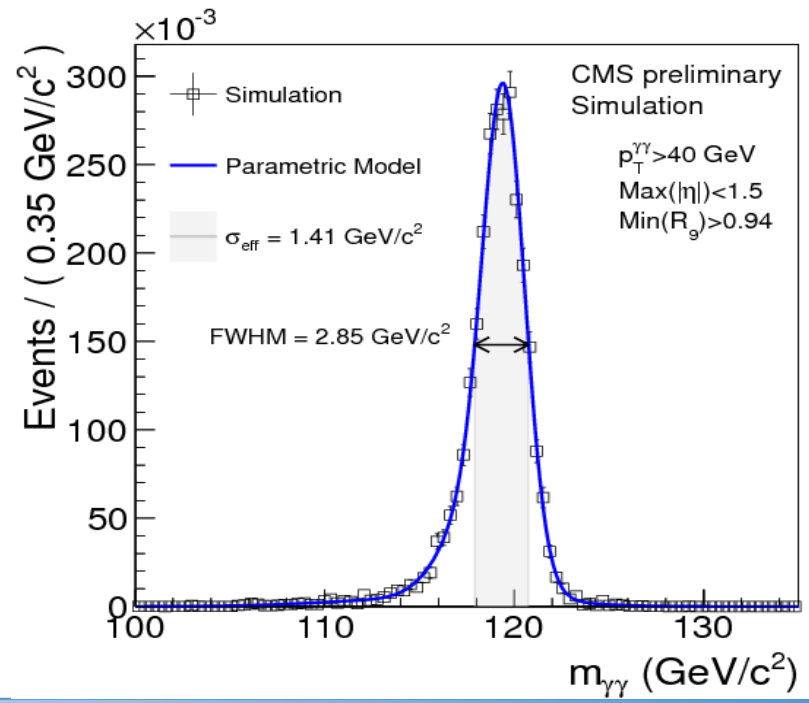
- Excellent photon energy resolution
- Narrow peak
- Isolated, high-p_T photons → small SM background
- High purity sample for properties measurements



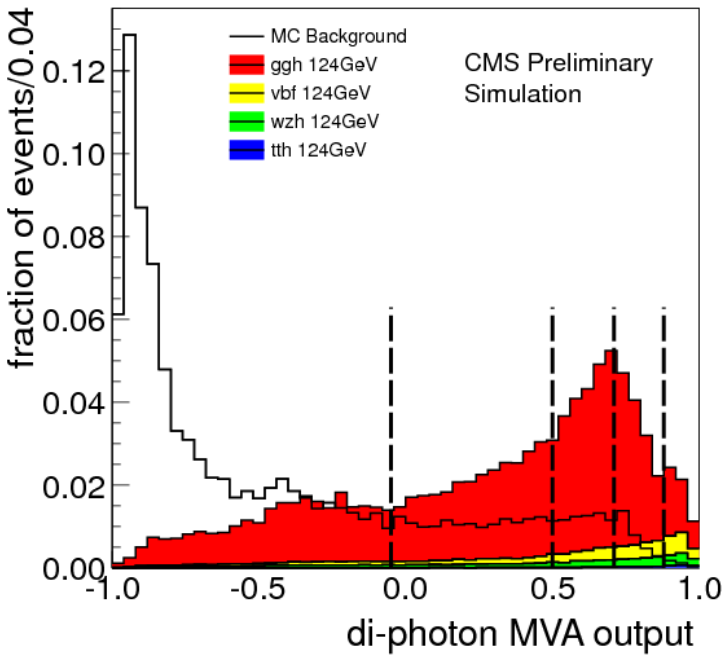
Energy Resolution

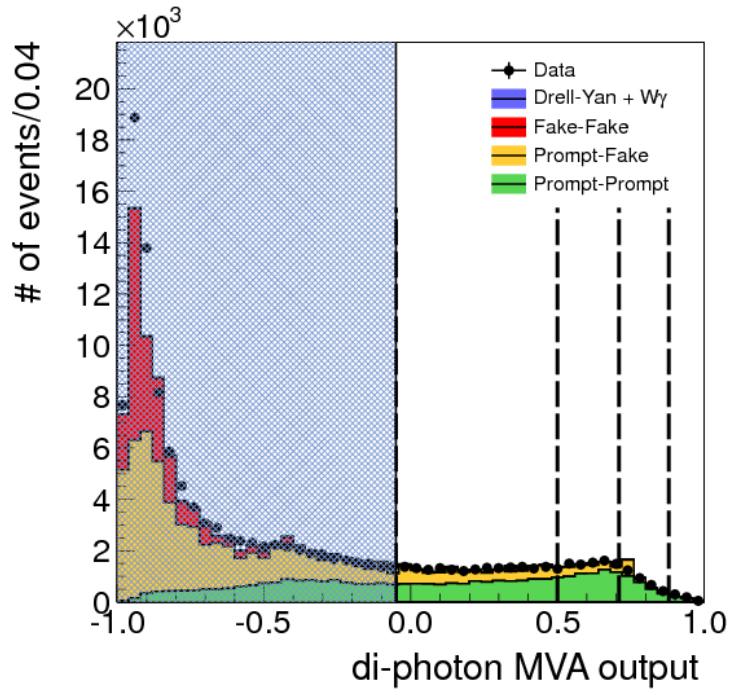
- MC-trained regression to correct photon energies
  - Cluster shape
  - ECAL position
  - Pileup energy
- Improves resolution of Z peak in data and H→γγ MC
- Photon energy scale pileup independent
- Provides per-photon energy resolution





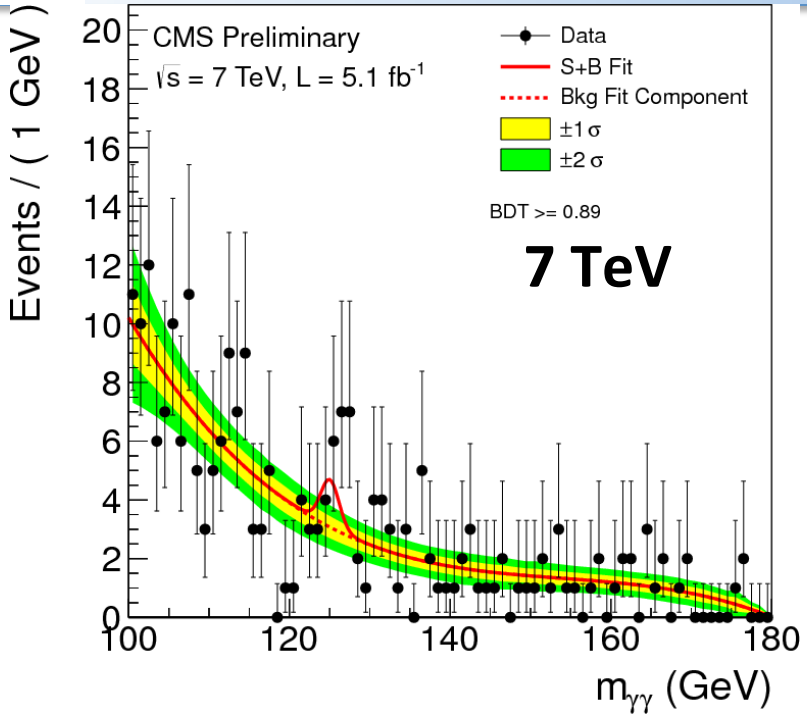
Di-photon MVA

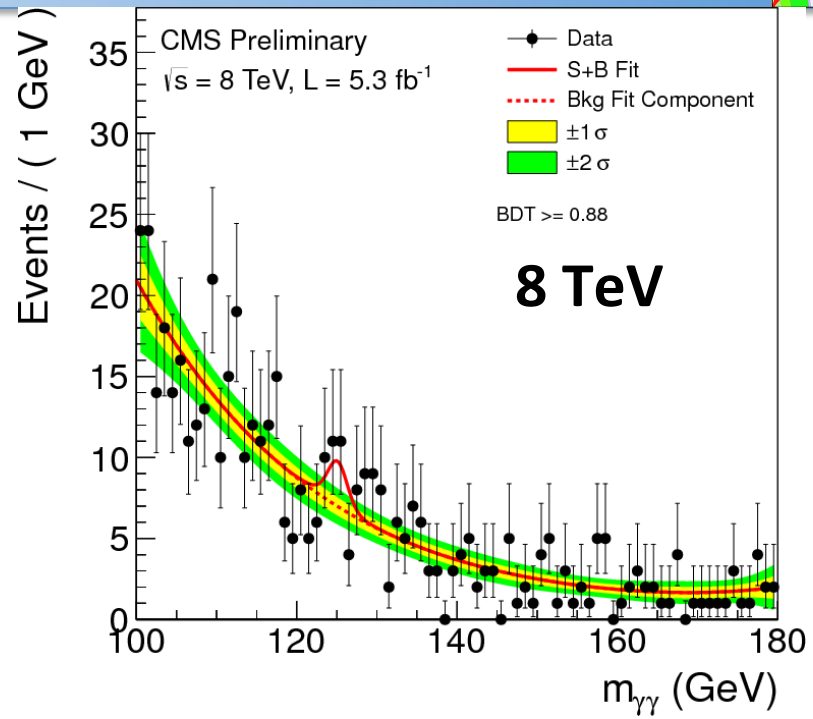




- Trained on MC to discriminate signal and background
- Uses photon kinematics, per-event mass resolution, photon ID MVA scores and per-event vertex likelihood
- Remove low score events
- Divide into 4 categories

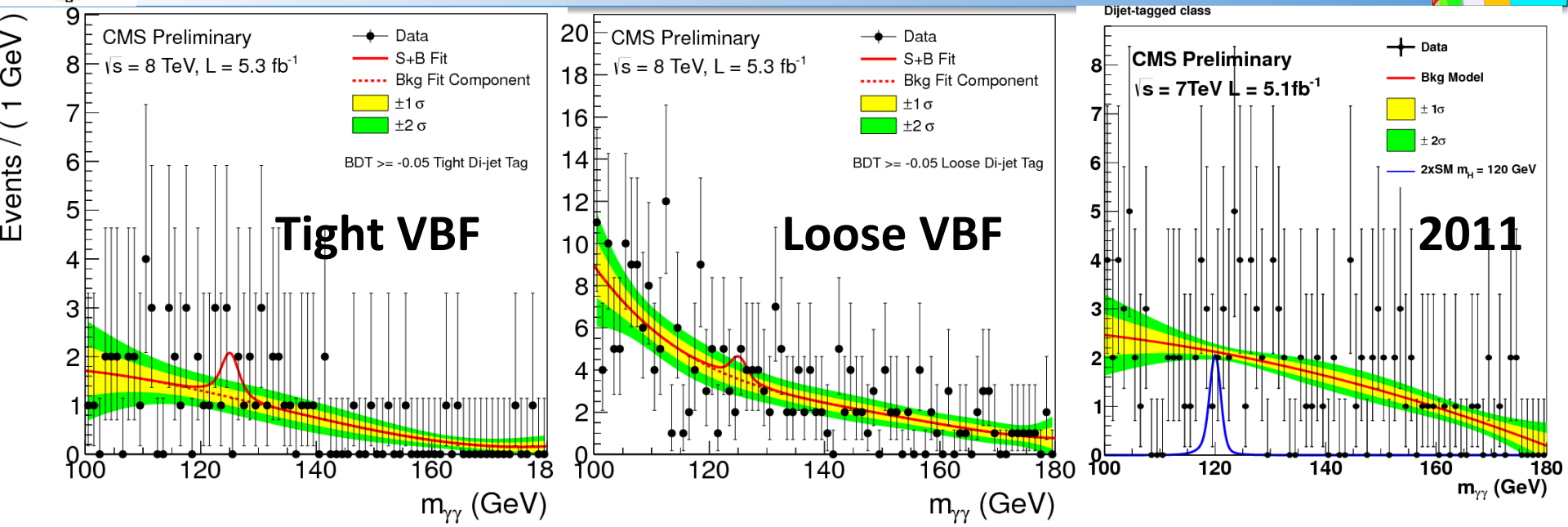
Mass Distributions





- Fit in MVA categories
- polynomial background model
- Signal model taken from MC

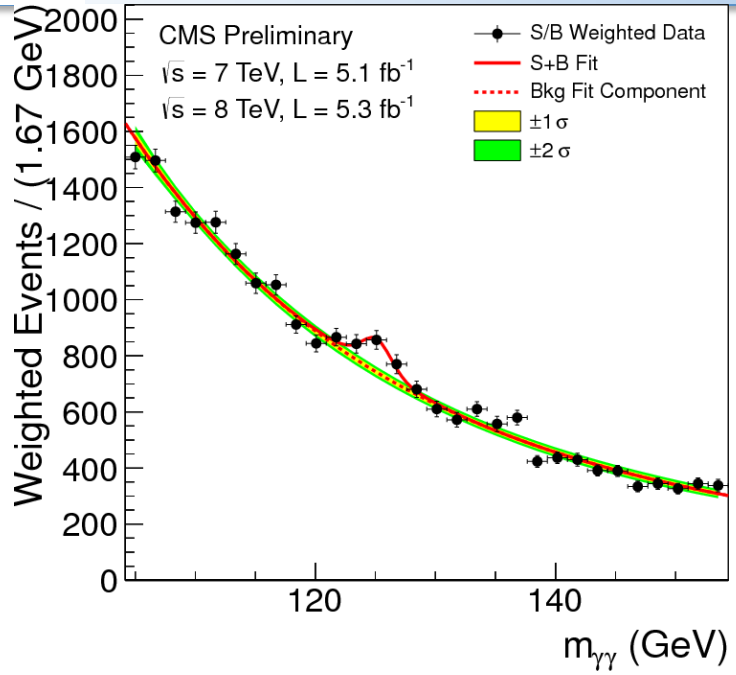
Vector Boson Fusion

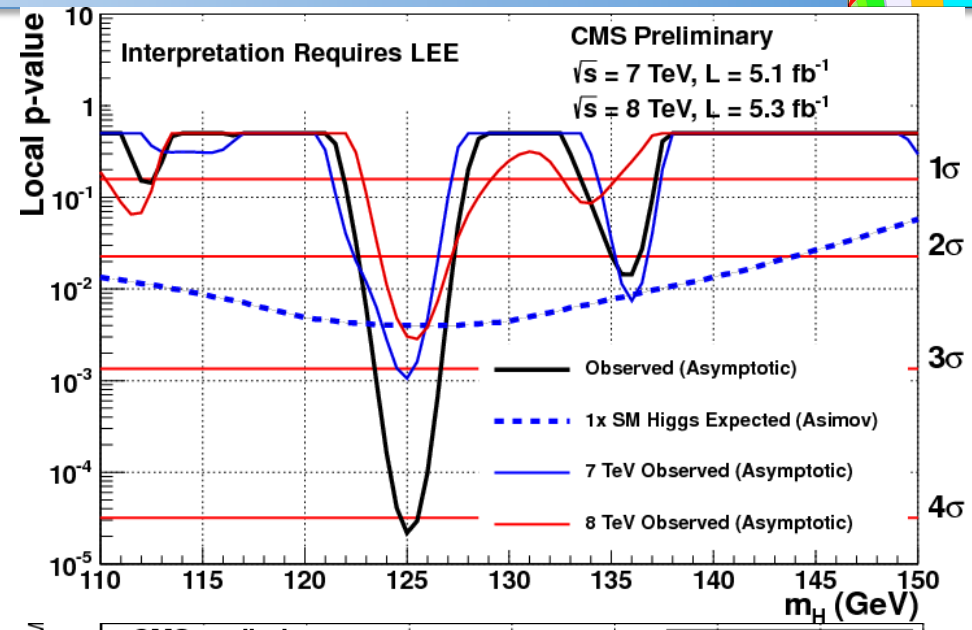


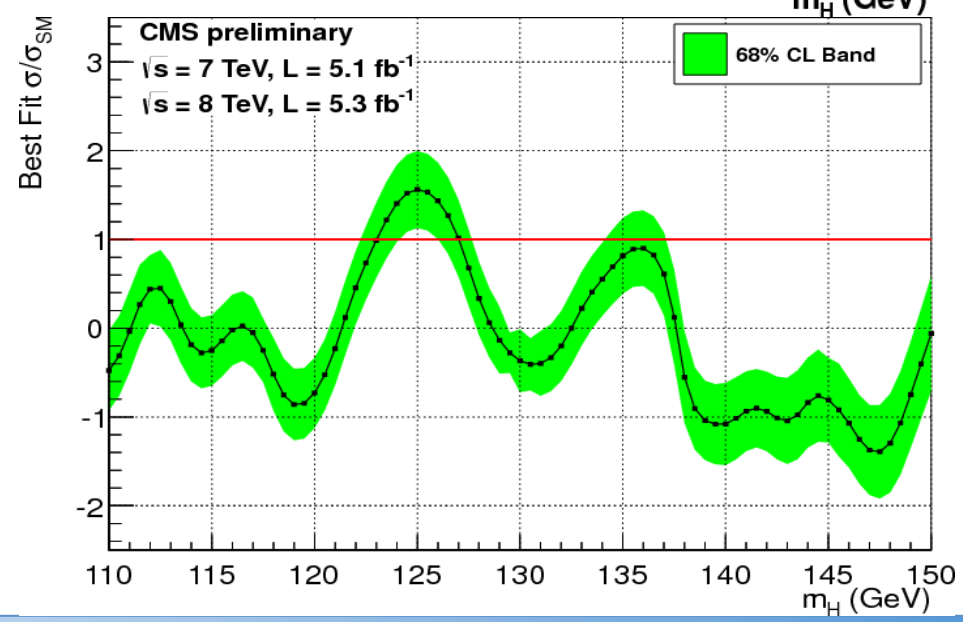
- Tag events with forward jets
- Enhance VBF contribution

Variable	2011	2012	
		Loose	Tight
$p_T(j_1)$	> 30 GeV		
$p_T(j_2)$	> 20 GeV		> 30 GeV
$\Delta\eta(j_1, j_2)$	> 3.5	> 3.0	
$\lvert\eta_{\gamma\gamma} - \frac{1}{2}(\eta_{j1} + \eta_{j2})\rvert$	< 2.5		
$\Delta\phi(jj, \gamma\gamma)$	> 2.6		
m_{jj}	> 350 GeV	> 250 GeV	> 500 GeV

Results

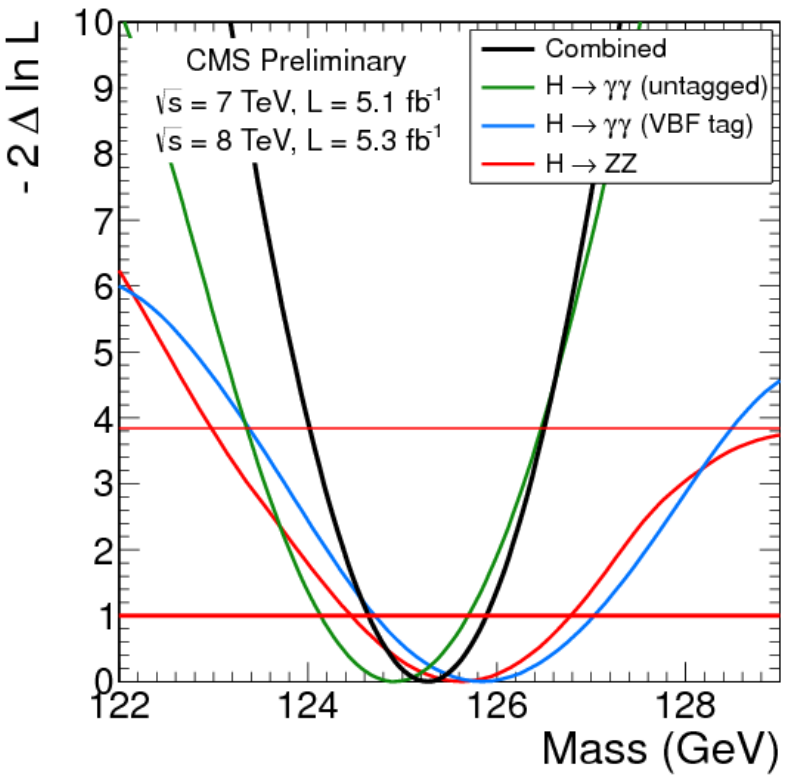


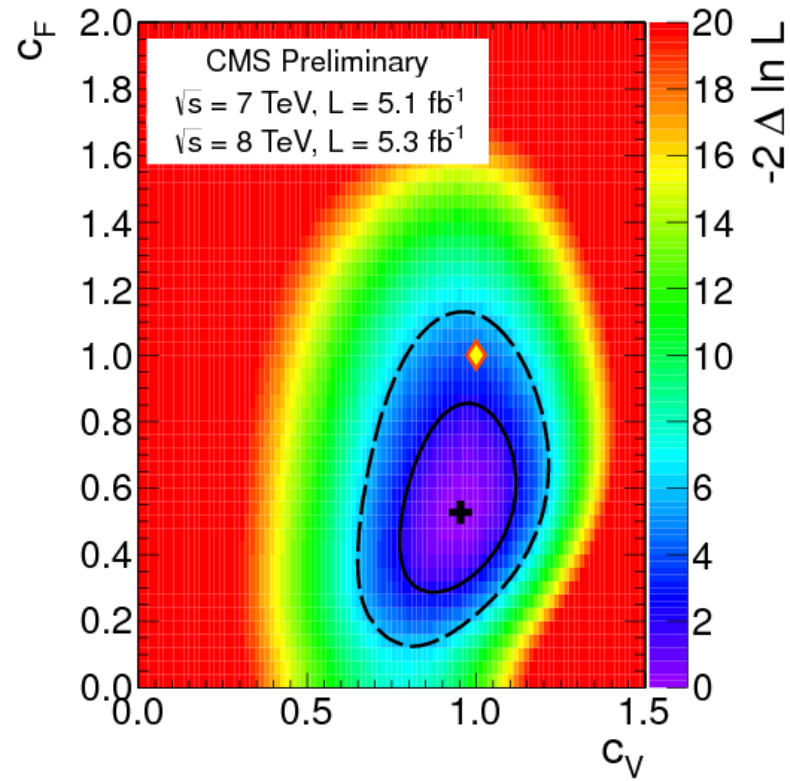




- 4.1 σ local significance at m_H = 125 GeV
- 3.2 σ global significance
- Signal strength = 1.56 ± 0.43 x SM

Properties





- Need to measure the properties of this boson
- Mass: 125.3 ± 0.4 (stat) ± 0.5 (syst)
- σ/σ_{SM} = 1.56 ± 0.43 (γγ only)
- (c_V, c_F) = (1.0, 0.5)
- Spin = ??

Conclusion

- The Higgs to γγ takes advantage of the excellent CMS ECAL resolution and multivariate techniques
- We have seen a 4.1σ excess in the γγ mass spectrum near $m_{\gamma\gamma}$ = 125 GeV
- This excess is consistent with a SM Higgs Boson
- Need more work to measure properties
  - Reduce errors on the mass
  - Measure signal strength and coupling
  - Measure spin

BACKUP

SM Higgs Boson

Cross-section

M_H=125	pp→H	pp→qqH	pp→VH	pp→ttH
7 TeV	15.3 pb	1.2 pb	0.89 pb	0.08 pb
8 TeV	19.4 pb	1.6 pb	1.09 pb	0.13 pb

Branching Ratio (@ 125 GeV)

bb	WW	ττ	ZZ	γγ	Zγ
57.7%	21.5%	6.3%	2.6%	0.23%	0.15%

- 5.1/fb @ 7 TeV
- 5.3/fb @ 8 TeV
- Expect 460 H→ γγ
- 32 from VBF