Searches for non-resonant Higgs boson pair production in the bb$\gamma\gamma$ final state

Toyoko Orimoto
Northeastern University
On behalf of the CMS Collaboration
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HH → bbγγ: A Golden Channel for HH

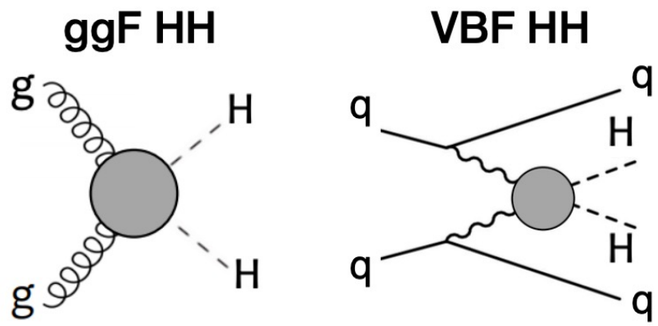
One of most sensitive channels for SM HH production

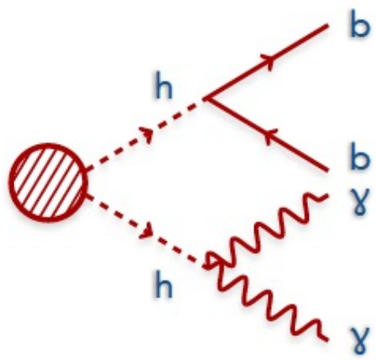
Overview:

- **H→bb**: high branching ratio, but large QCD backgrounds
- **H→γγ**: good mass resolution, low backgrounds
- Analysis optimized to be sensitive to SM HH production, as well as anomalous values of effective BSM couplings (κ_λ, c_2v, etc)

Signal & Background

- **Signal**: Both ggF and VBF modes for SM HH + variety of BSM benchmarks
- **Non-Resonant Background:** QCD
  - Reducible bkg from γ + Jets and irreducible bkg from γγ + Jets
  - Smoothly falling distributions in $m_{\gamma\gamma}$ & m_{jj} → estimated from data
- **Resonant background:** SM single H → γγ
  - 3 orders smaller (primarily ttH); estimated with simulation



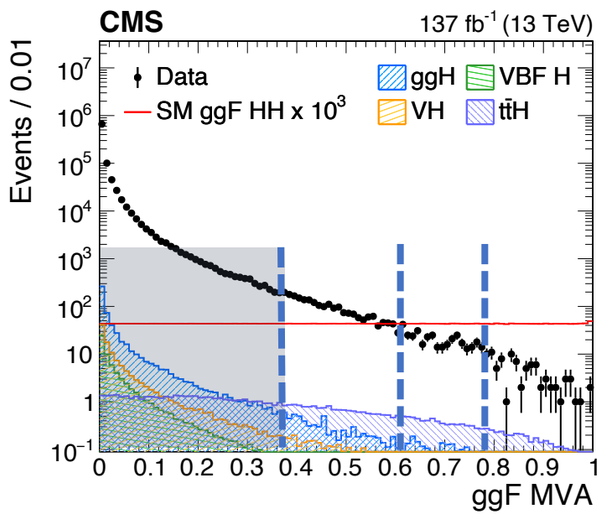


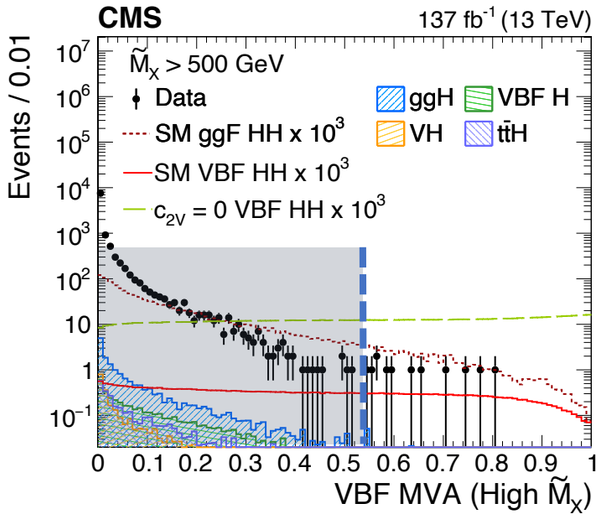
HH → bbγγ: Analysis Strategy

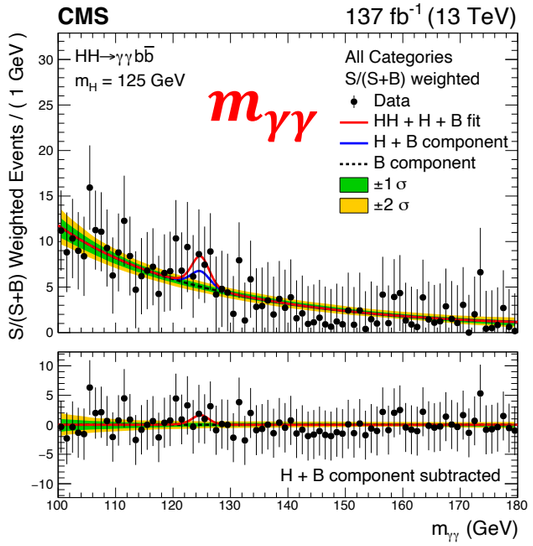
Optimize sensitivity through MVA & $\widetilde{M}_X$ categories

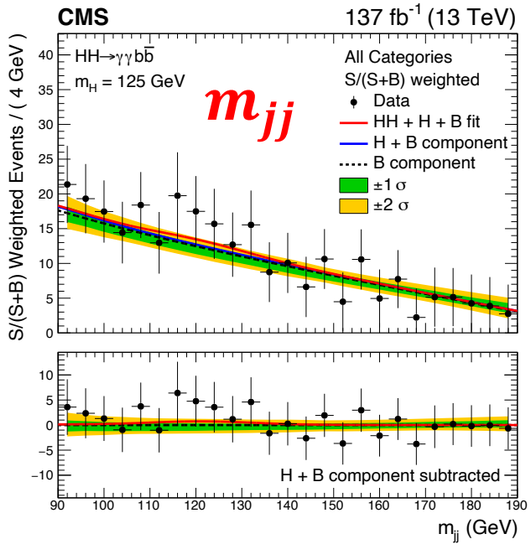
Analysis Strategy:

- MVA for BG suppression: BDT for nonres γγ+Jets & DNN for single Higgs
- Signal regions based on MVA & $\widetilde{M}_X$
  - ggF: 3 MVA x 4 $\widetilde{M}_X$ categories + VBF: 2 MVA for low & high $\widetilde{M}_X$ → 14 total categories (12 ggF + 2 VBF)
- Signal extraction: 2D fit in $m_{\gamma\gamma}$-m_{jj} simultaneous in all categories



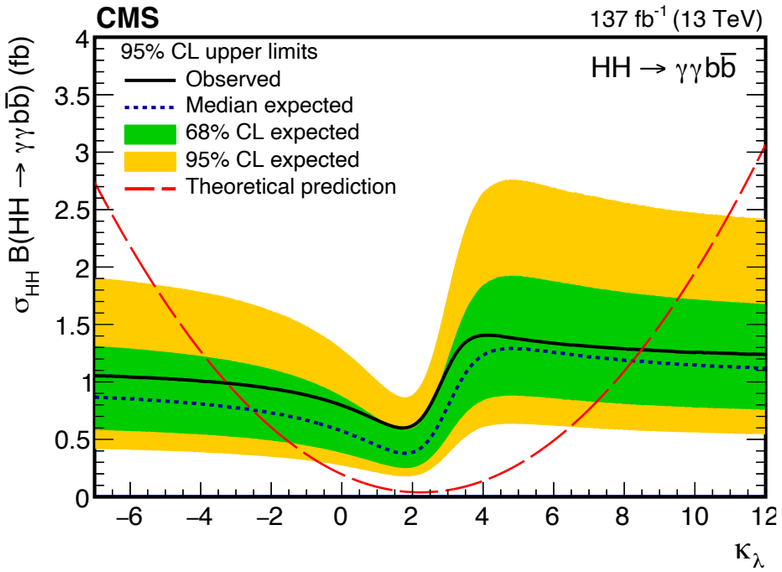


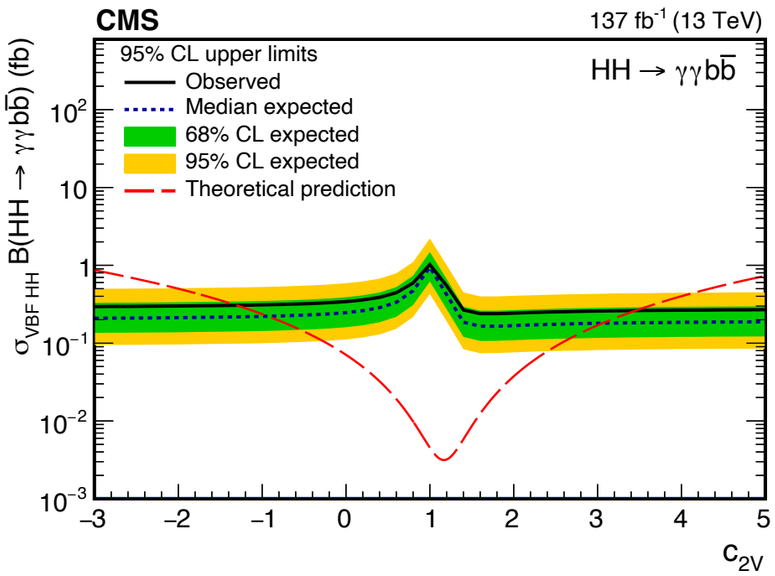


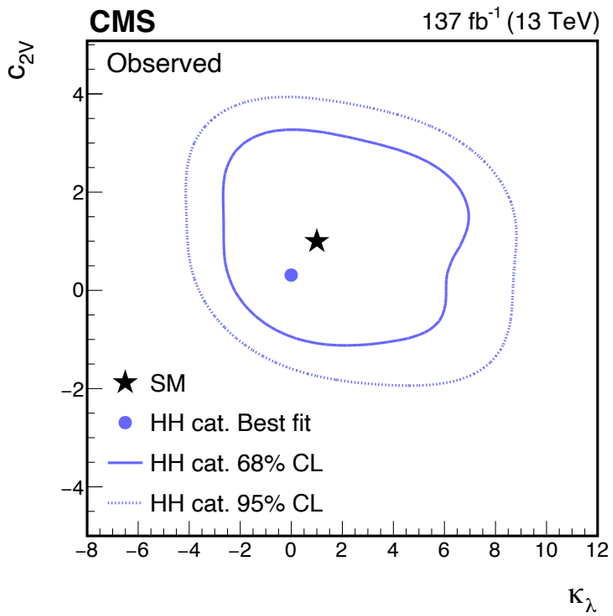


HH → bbγγ: Results

Significant improvement relative to previous results







Inclusive HH
Observed (expected):
$\sigma/\sigma_{SM} < 7.7\ (5.2)$ at 95% CL
$-3.3\ (-2.5) < \kappa_\lambda < 8.5\ (8.2)$

VBF HH
Observed (expected):
$\sigma/\sigma_{SM} < 225\ (208)$ at 95% CL
$-1.3\ (-0.9) < c_{2V} < 3.5\ (3.0)$