Search for low-mass Higgs boson in the diphoton final state at CMS

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Introduction

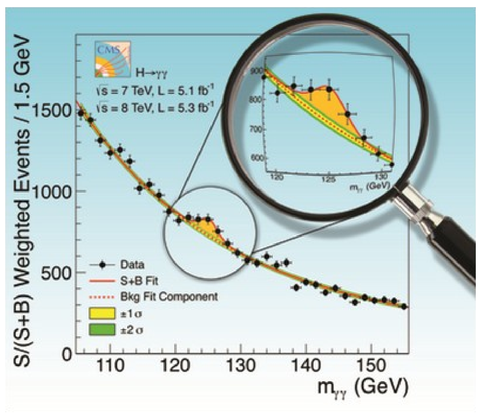
✓ In 2012 both the ATLAS and the CMS collaborations observed a new boson with a mass of approximately 125 GeV whose properties are at present compatible with those of the SM Higgs boson.

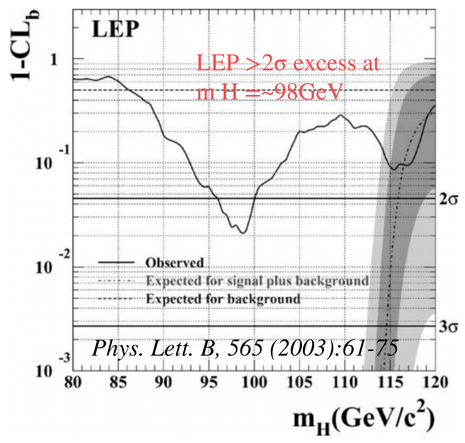
✓ New physics beyond the SM (BSM) can also provide a Higgs state which is compatible with the observed 125 GeV boson

✓ The extended parameter space of some BSM models gives rise to a rich and interesting phenomenology including several Higgs bosons (could have masses below 125 GeV):

✘ The next-to-minimal supersymmetric model (NMSSM), generalized two-Higgs-doublet models (2HDM)

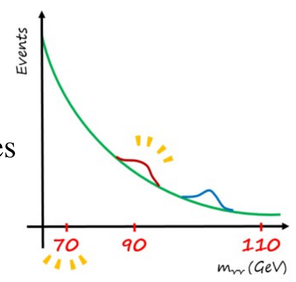
✘ Such models provide good motivation for extending searches for Higgs bosons to masses as far below m_H = 110 GeV as possible.





Analysis strategy

✓ Search for a narrow signal peak on a falling background in the invariant mass ($m_{\gamma\gamma}$) spectrum : two highly energetic photons and fully reconstructed final state with high resolution; large backgrounds from γγ, γ+jet and di-jet; relic dielectron → diphoton background from Z→ee



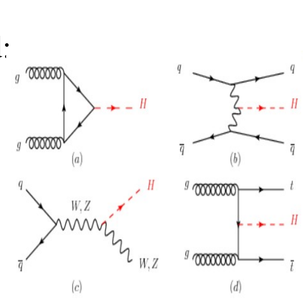
✓ Production processes assumed in SM proportions include gluon-gluon fusion (ggH), vector boson fusion(VBF), ttH and VH modes

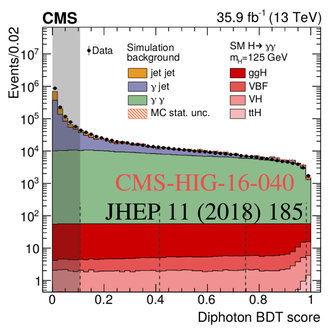
✓ Inherit many analysis elements from standard H→γ analysis (*JHEP 11 (2018)* 185, photon and event reconstruction/selection, signal modeling and part of background modeling techniques, and statistical analysis)

✓ Entire 2016 dataset (35.9 fb^{-1}) analyzed: arXiv:1811.08459 (submitted to PLB)

✓ 3 inclusive event classes based on diphoton BDT

✓ Signal are extracted by a simultaneous maximum-likelihood fit to the diphoton mass in all event classes



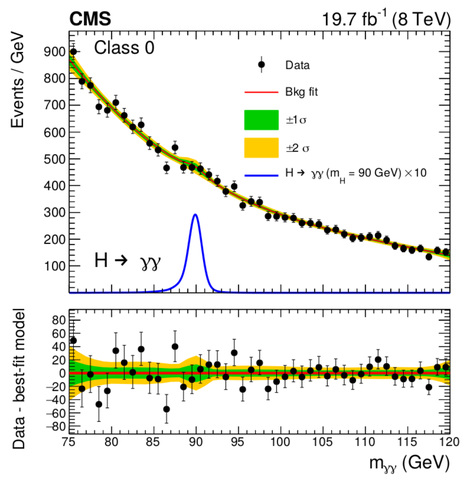


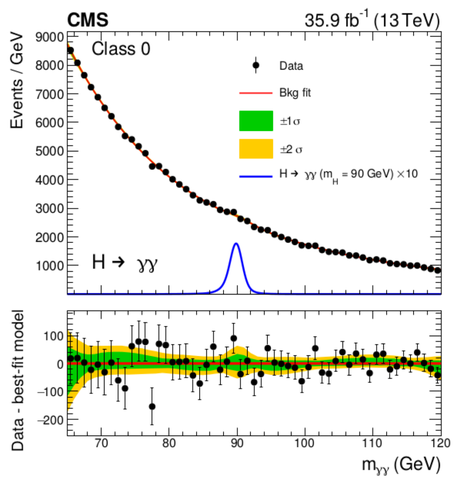
Background Parametrizaion

✓ Discrete profiling ("Envelope") method used;

✓ Fit model : four families of analytic functions (sum of exponentials, sum of Bernstein polynomials, Laurent series, sum of power laws) + DCB (fraction left floating);

✓ Built directly from data using the diphoton mass spectrum (65-120GeV) in each event class;



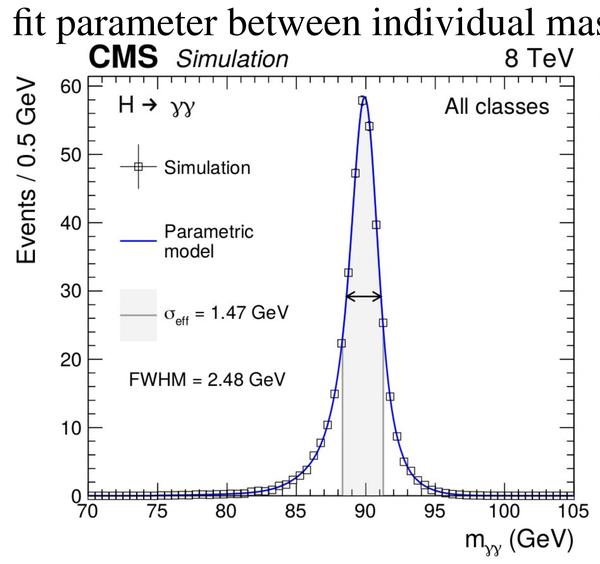


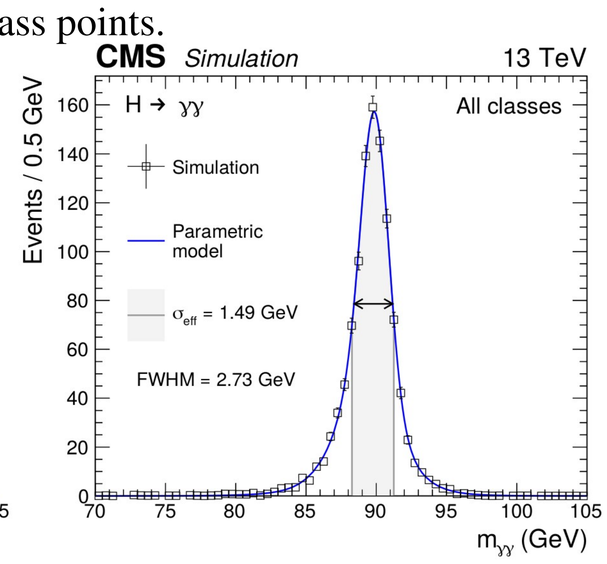
Signal Parametrization

✓ A parametric model is used to describe the shape of the signal in each event class;

✓ A sum of Gaussian functions to fit signal MC at each mass point;

✓ Full signal model is constructed by taking linear interpolation of each fit parameter between individual mass points.



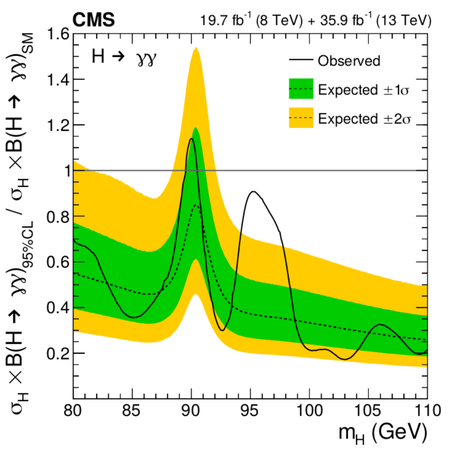


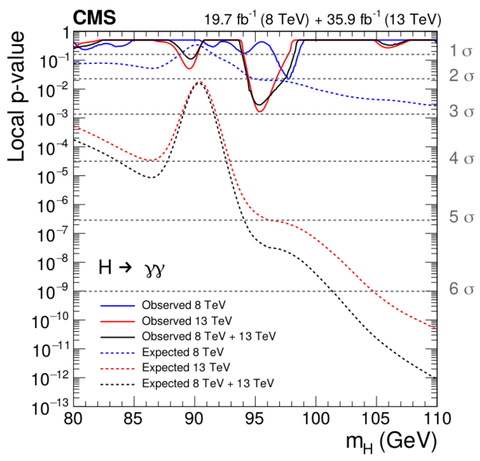
Results

✓ CMS run1(8 TeV): Modest excess with maximum local significance 2.0σ at m_H =97.6GeV;

✓ CMS run2(13 TeV 2016 data): Modest excess with maximum local significance 2.9σ at m_H =95.3GeV;

✓ CMS combination (run1+run2 2016 data): Excess with 2.8σ local (1.3σ global) significance at m_H=95.3 GeV.





Conclusions

✓ A search for an additional, SM-like, low-mass Higgs boson decaying into two photons has been presented.

✓ No significant (>3σ) excess with respect to the expected number of background events is observed.

➢ Looking forward to the results of 13TeV 2017 data !

References

[1] Technical Report CMS-PAS-HIG-17-013, CERN, Geneva, 2017: arxiv:1811.08459, submitted to Physics Letters B

[2] Technical Report CMS-PAS-HIG-14-037, CERN, Geneva, 2015

[3] Technical Report CMS-PAS-HIG-16-040, CERN, Geneva, 2017: arxiv:1804.02716, *JHEP 11 (2018) 185*

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