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 $\gamma\gamma$, $\gamma$+jet and di-jet; relic dielectron → diphoton background from $Z\rightarrow ee$
- Production processes assumed in SM proportions include gluon-gluon fusion (ggH), vector boson fusion (VBF), tH 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 Parametrization

- 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;

### Results

- CMS run1 (8 TeV): Modest excess with maximum local significance 2.0σ at $m_h = 97.6$ GeV;
- CMS run2 (13 TeV 2016 data): Modest excess with maximum local significance 2.9σ at $m_h = 95.3$ GeV;
- 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