Measurement of mass and width of the Higgs boson at HL-LHC

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Abstract

- The only free fundamental parameter of the Higgs sector in SM, completely determines the SM Higgs properties
- Measured from the mass peak in the two high resolution channels, $H \rightarrow ZZ \rightarrow 4\ell$ and $H \rightarrow \gamma\gamma$, with a foreseen integrated luminosity 3000 fb^{-1}

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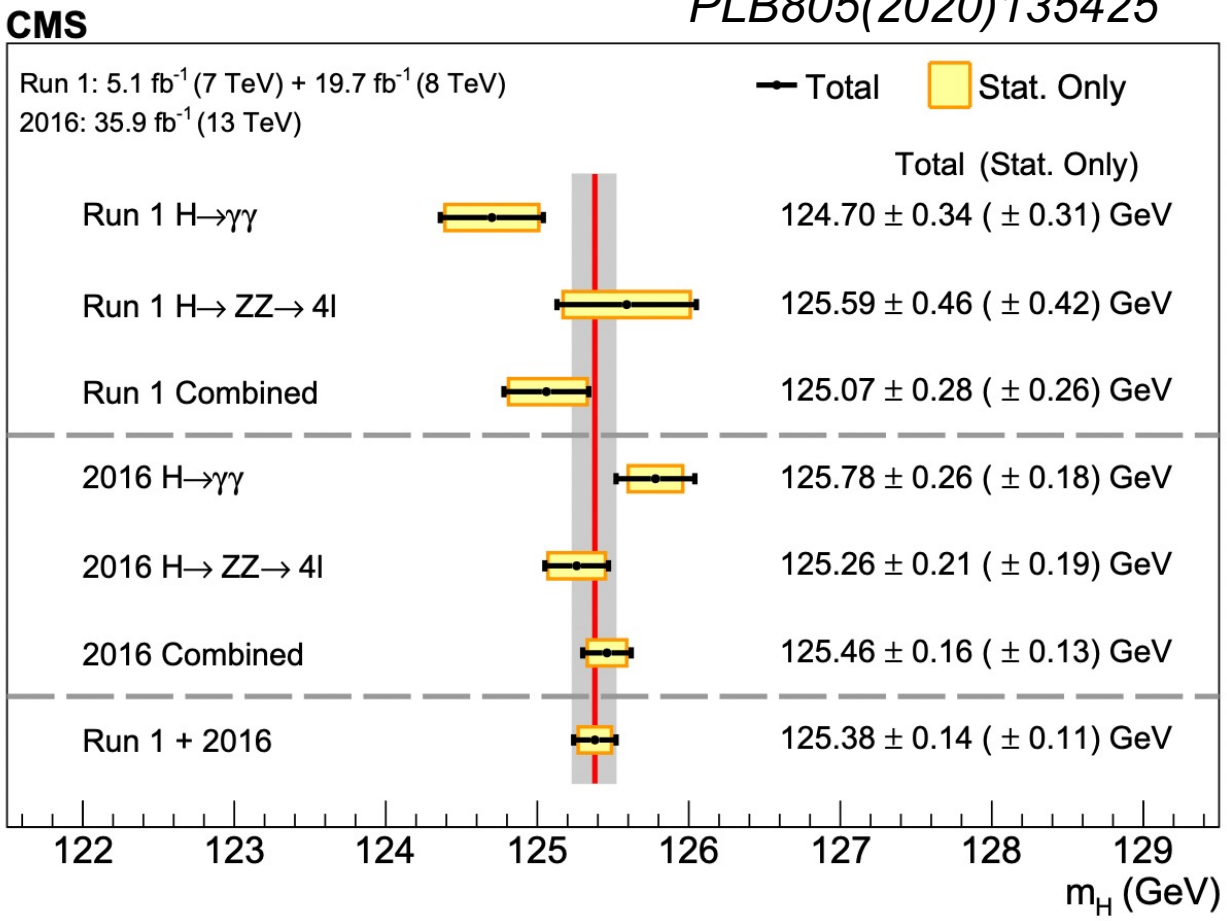
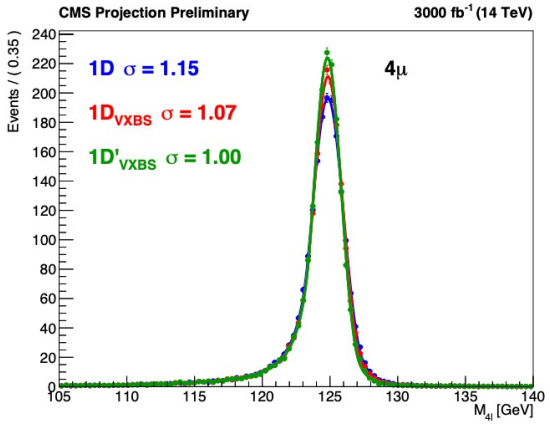
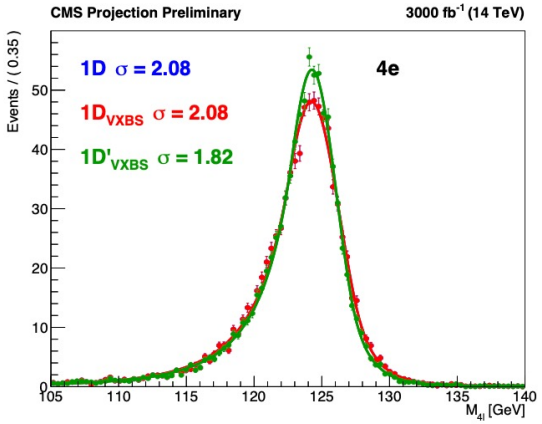
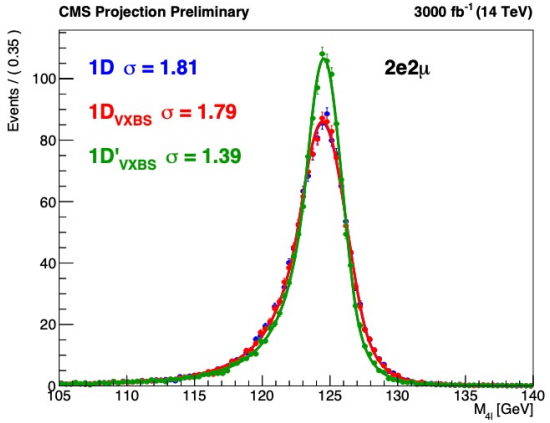


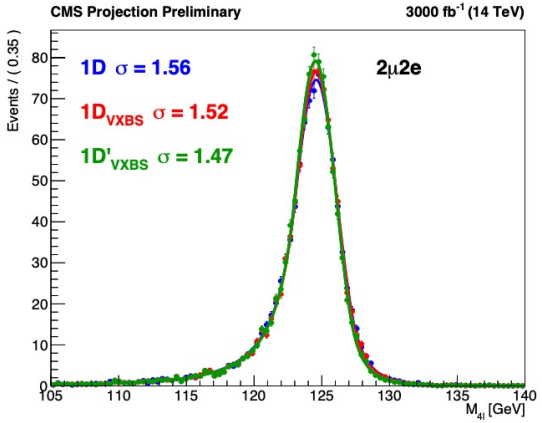
Analysis strategy($H \rightarrow ZZ \rightarrow 4\ell$)

- Detector performance such as acceptance, efficiency and resolution are considered to have the same values as for Run2.
- Scale integrated luminosity to 3000fb^{-1}
- Cross sections are scaled to 14TeV









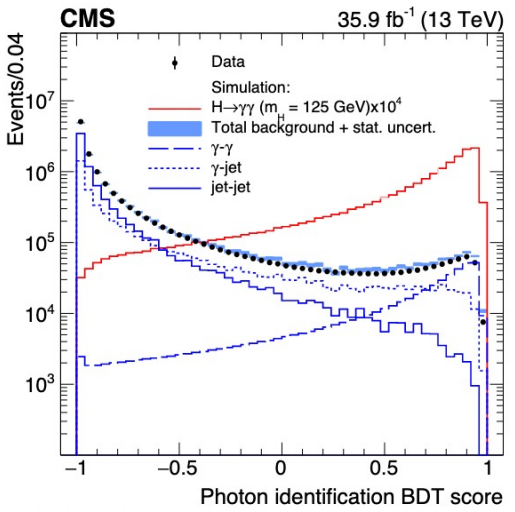
- The same strategy as Run2 analysis
  - Mass error categorisation
  - On-shell Z mass constraint
  - Beam spot constraint
  - N-2D likelihood

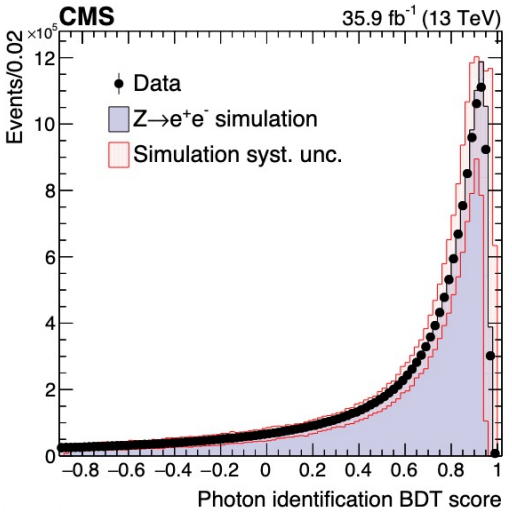
- Several scenarios for dominant systematics
  -

Systematic uncertainty	Baseline	Optimistic	Pessimistic	YR
Muon momentum scale	0.01%	0.005%	0.01%	0.05%
Electron momentum scale	0.15%	0.05%	0.15%	0.10-0.30%
Lepton momentum resolution	10%	5%	10%	5%

Analysis strategy($H \rightarrow \gamma\gamma$)

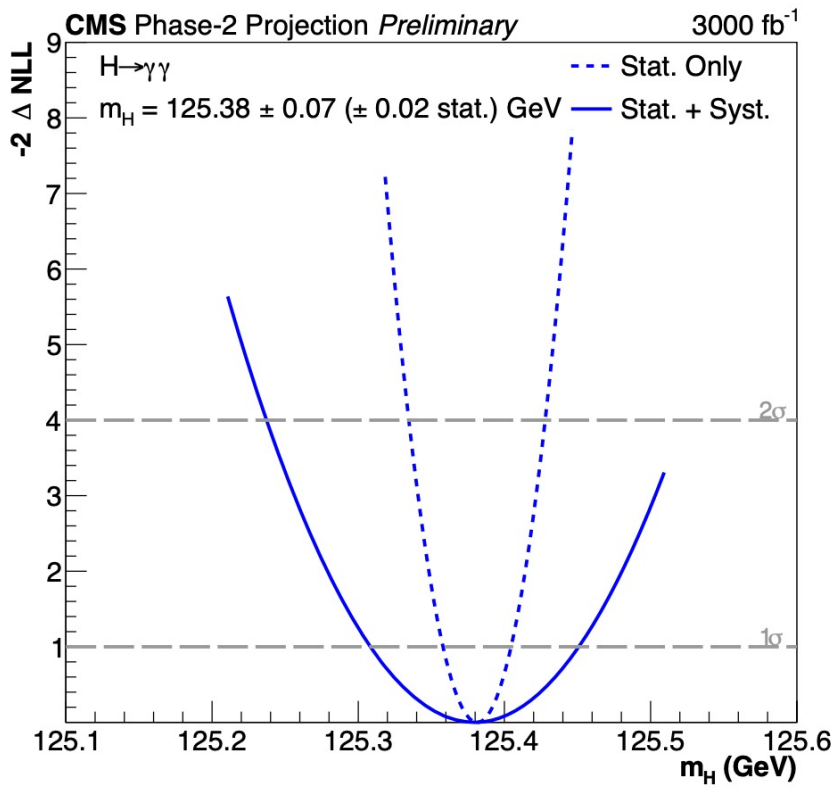
- The strategy followed here is to project the existing measurement of MH in the diphoton channel with 2016 dataset to HL-LHC.
  - The main assumptions are that the conditions such as trigger performance, detector acceptance, efficiency and resolution are considered to be the same as those for Run2.
  - Also, a few key improvements have been incorporated in this projection.(photon energy scale and resolution)
- Photon identification BDT
  - Separate prompt photons from misidentified jet fragment
- Diphoton vertex identification
  - Impact on diphoton mass resolution a lot
  - Dedicated BDT used
- Special efforts made to correct the energy scale more precisely than before.
  - By increasing the granularity of the correction.

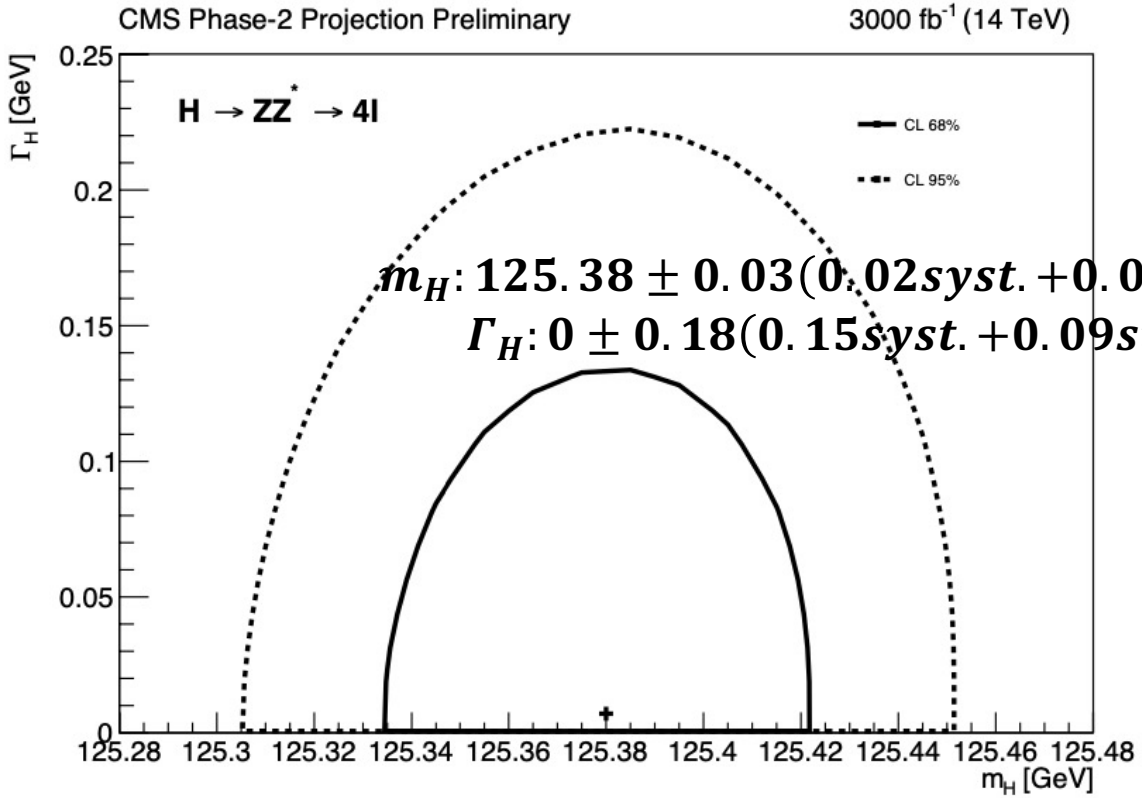




Sources of systematic uncertainty	Contribution [GeV]
Electron energy scale and resolution corrections	0.06
Residual p_T dependence of the photon energy scale	0.05
Modelling of the material budget	0.02
Statistical uncertainty	0.02
Total uncertainty	0.07

CMS Phase-2 preliminary results





$$m_H: 125.38 \pm 0.03(0.02syst. + 0.022stat.)GeV$$
$$\Gamma_H: 0 \pm 0.18(0.15syst. + 0.09stat.)GeV$$

Summary

- Higgs mass measurement have entered a precison era at LHC
  - Current most precise $\boldsymbol{m_H}$ measurement ~0.11%
  - CMS Phase-2 will give us more accurate results ~0.05%