1 - State of the art

- Measurements of the production cross section and kinematic properties of the Higgs boson represent an important tool for finding anomalies from the Standard Model (SM).
- The Higgs boson transverse momentum ($p_T^H$) spectrum can be affected by the presence of new physics phenomena and its measurement allows testing the existing theoretical calculations in the SM Higgs sector.
- Higgs $p_T$ differential and fiducial measurements at 8 TeV have been reported by ATLAS and CMS in the $H\rightarrow ZZ\rightarrow 4\ell$ and $H\rightarrow WW$ decay channels.

2 - Measurement basics

- The measurement of the fiducial integrated cross section and transverse momentum spectrum for the Higgs boson production in $H\rightarrow WW\rightarrow 2\ell 2\nu$ decays is performed.
- The results are based on 19.4 fb$^{-1}$ of data collected by the CMS detector at 8 TeV.
- $H\rightarrow WW\rightarrow 2\ell 2\nu$ signature:
  - Two isolated high $p_T$ electrons or muons with opposite charge.
  - Moderate MET.
- Analysis performed looking at opposite flavour leptons ($e\mu$) in the final state.
- With respect to $H\rightarrow ZZ\rightarrow 4\ell$ or $H\rightarrow \gamma\gamma$:
  - Significantly higher $e\mu$BR.
  - Worst $p_T^H$ resolution due to the presence of neutrinos.

3 - Analysis strategy

- Event selection based on the previously published $H\rightarrow WW\rightarrow 2\ell 2\nu$ measurements.
- Important difference: this analysis is performed inclusively in jets multiplicity.
- To measure the differential cross section the $p_T^H$ spectrum is binned.
- Accurate binning definition is needed to avoid too large bin migration effects.
- 2D template fit used to measure signal strengths in each bin.
- di-lepton mass ($m_\ell\ell$) and transverse mass ($m_T$) used to discriminate signal and backgrounds.

4 - Measured spectrum

- Signal extracted subtracting backgrounds with a Maximum Likelihood fit.
- Sources of uncertainty divided in three categories:
  - Experimental uncertainties: luminosity, lepton momentum scale and resolution, MET scale and resolution, jet energy scale, B tagging uncertainty.
  - Background estimation uncertainties: related to the normalization estimation of each background, e.g. $t\bar{t}$ background.
  - Theoretical uncertainties: related to the theoretical models used for simulating signal and background events.
- Each source of uncertainty is propagated as a nuisance parameter through the fit.

5 - Fiducial phase space and unfolding

- Results extrapolated to a fiducial phase space, defined using Born level leptons, with a regularized unfolding procedure.
- Direct comparison with theoretical predictions and other experimental results.

6 - Comparison with theory predictions

- Unfolded spectrum of the Higgs boson transverse momentum shown with statistical, systematic and theoretical uncertainty contributions reported as separate error bands.
- Spectrum compared to two SM-based theory predictions:
  - gg惠 production simulated using the HRes or PowhegV2 programs.
  - Very good level of agreement between data and theory predictions within the uncertainties.
  - Large level of correlation between neighbouring bins after the unfolding.