PROCEEDINGS OF SCIENCE

Fiducial and differential cross section measurements in the di-photon channel using full Run 2 dataset at ATLAS

Fábio Lucio Alves,[a,*] **on behalf of the ATLAS Collaboration**

[a] *Nanjing University,*
Hankou Road-Gulou Campus, Nanjing, China

E-mail: fabio.lucio@cern.ch

It has been ten years since the Higgs boson discovery by ATLAS and CMS collaborations at CERN. Since then, many measurements have been carried out to understand its nature and so far good agreement with respect to the predictions of the SM was found. Such measurements as the fiducial and differential cross sections play an important role as they test the SM predictions and probe for beyond SM contributions using a wide spectra of physical observables. In the following, both the fiducial and differential cross section measurements as well as the interpretation using the p_{T}^{H} shape information are presented for the $H \to \gamma\gamma$ decay channel using the LHC full Run 2 dataset at 139 fb^{-1} collected with the ATLAS experiment.

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1. Introduction

The Higgs boson was discovered [1, 2] ten years ago by the ATLAS [3] and CMS [4] collaborations. Since then, many measurements of its properties have been performed and shown good agreement with the SM predictions. Measurements of fiducial and differential cross sections are performed within a specific phase space (fiducial region) and provide a model independent measurement due to the minimal number of physical assumptions considered. In the following, an overview of the main results for the measurements of the fiducial and differential cross sections performed by ATLAS experiment using full Run 2 dataset at 139 fb^{-1} are shown for $H \to \gamma\gamma$ decay channel [5]. In addition, the interpretation of the measurements are provided using the p_{T}^{H} shape information in order to indirectly constrain the charm- and bottom-quarks Yukawa couplings.

2. Analysis overview

The measurements of Higgs boson properties in the $H \to \gamma\gamma$ channel [5] benefit from the excellent mass resolution of the di-photon system and the low background contributions. The signature is based on selecting events with the leading and sub-leading photon candidate required to fulfill isolation criteria with the invariant mass in the range 105-160 GeV.

The measured signal yield is extracted from an unbinned maximum-likelihood fit to the the $m_{\gamma\gamma}$ in fiducial regions and in each bin of the differential distributions. The measured cross sections are then obtained by correcting the signal yield for detector effects and accounting for the luminosity of the collected dataset.

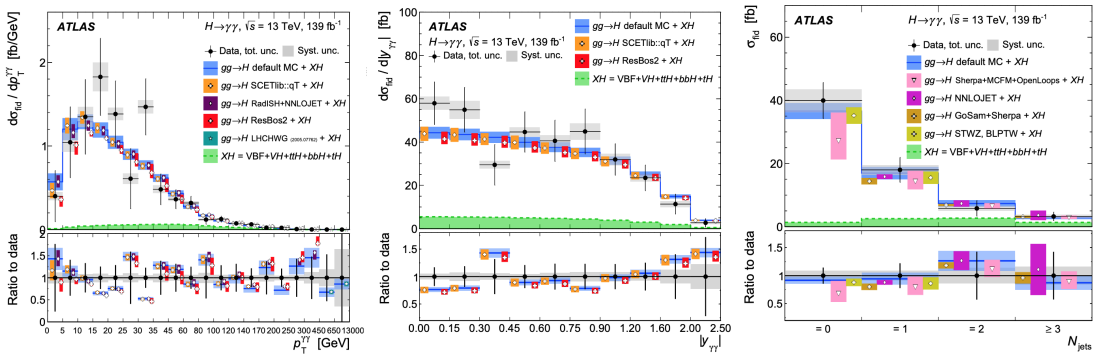
The total cross section measurements are provided in five fiducial regions (inclusive, VBF-enhanced, $N_{\mathrm{lepton}} > 1$, high $E_{\mathrm{T}}^{\mathrm{miss}}$ and ttH-enhanced). The fiducial inclusive cross measurement is reported to be $\sigma_{\mathrm{fid}} = 67 \pm 5(\mathrm{stat.}) \pm 4(\mathrm{syst.})$ fb which is in agreement with the SM prediction of $\sigma_{\mathrm{SM}} = 64 \pm 4$ fb.

The statistical uncertainty dominates the uncertainty in the measurement in the inclusive and differential bins, followed by background modelling and photon energy systematic uncertainties on the scale and resolution.

3. Differential cross section measurements and interpretation

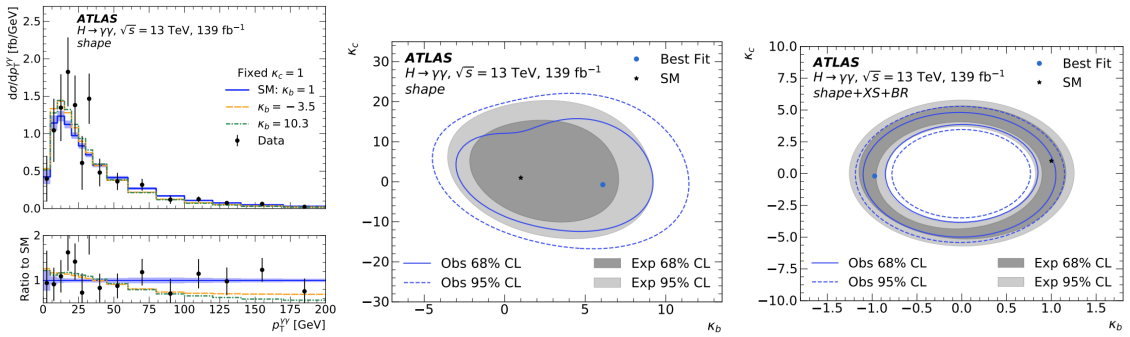
The differential cross sections measured for different observables are shown in the following for the p_{T}^{H} distribution in Figure 1a, $|y_H|$ distribution in Figure 1b and N_{jets} distribution in Figure 1c. Overall, all differential measurements exhibit good agreement with the SM predictions.

Additionally, an interpretation is also performed using p_{T}^{H} shape information (see Figure 2a) to indirectly constrain the Yukawa couplings of the c- and b-quarks , κ_c and κ_b, respectively. The statistical interpretation is performed under two different scenarios: using the p_{T}^{H} shape only and p_{T}^{H} shape plus normalization information. In Figure 2b and Figure 2c, constraints are shown for these two scenarios. In comparison with the direct searches [6], comparable limits are set to κ_b while stronger limits are set on κ_c for shape+normalization scenario at 95% CL.



(a) **(b)** **(c)**

Figure 1: (a) Fiducial differential cross section measurements are shown [5]: (a) p_{T}^{H}, (b) $|y_H|$ and (c) N_{jets}.



(a) **(b)** **(c)**

Figure 2: (a) p_{T}^{H} fiducial differential distribution in data and in different predictions with different values of κ_b [5]. 2D constraints on κ_c and κ_b using (b) p_{T}^{H} shape and (c) p_{T}^{H} shape + normalization informations [5].

4. Summary

The fiducial and differential cross section measurements have been performed in the $H \to \gamma\gamma$ channel with LHC full Run 2 dataset collected by ATLAS. All the measurements obtained in this channel show good agreement with the SM predictions and allow to further interpret the measurements adding constraints on κ_c and κ_b using the differential cross section distribution of the Higgs p_{T}. The statistical uncertainty is the dominant uncertainty source on these measurements. Exciting new results are expected with Run 3 of the LHC, which has just started.

References

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