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Recent Highlights on Higgs Physics from the LHC

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Abstract

Many of the Higgs boson production and decay channels, predicted by the Standard Model, have been observed since its 2012 discovery. Today, measurements of the Higgs boson's properties in these channels deepen our understanding of the nature of this fundamental particle by providing better information about its mass, production kinematics, and CP structure. Increasing precision also enables targeting rare Higgs boson decay modes and probing di-Higgs-boson production. In addition, searches for beyond Standard Model physics in the Higgs sector are performed. This article presents the latest Higgs boson measurement highlights from the ATLAS and CMS collaborations using LHC proton-proton collision data at a centre of mass energy of 13 TeV.

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1 Introduction

The Standard Model (SM) describes the interaction of elementary particles via three fundamental forces. The Higgs boson plays a fundamental role in the SM, since its field is required to generate the masses of the $W^{\pm}$ and Z bosons through the Brout-Englert-Higgs (BEH) mechanism [1,2]. The masses of fermions are introduced in the SM via interactions of the fermions with the Higgs field in the form of Yukawa terms. Excitations of the Higgs field are observable as the Higgs boson. The Higgs boson is predicted to be a scalar particle (S=0) with no electromagnetic charge and its mass is a free parameter of the theory. In 2012 a new particle was discovered by the ATLAS [3] and CMS collaborations [4] that is consistent with the Standard Model Higgs boson, with a mass of approximately 125 GeV. In the following, recent highlights from Higgs boson measurements performed by the ATLAS and CMS collaborations are presented. Section 2 briefly introduces the ATLAS and CMS experiments. Section 3 presents the measurements that target SM Higgs boson production and decays. Section 4 describes recent searches for beyond Standard Model (BSM) effects. A conclusion is drawn in Section 5.

2 The ATLAS and CMS Experiments

The ATLAS and CMS experiment both utilise multi-purpose detectors designed to collect the high luminosity data provided by the proton-proton collisions of the LHC. During the data taking period of 2015 to 2018, so-called "Run 2", the LHC operated at a centre of mass energy of $\sqrt{s} = 13\,\text{TeV}$. The Run 2 data sets collected by both experiment correspond to around $140\,\text{fb}^{-1}$ each. The measurements discussed here make use of the full Run 2 data sets unless stated otherwise. The general structure of the ATLAS and CMS detectors are similar. They have cylindrical layouts and are symmetric with respect to the LHC beam pipe. The layers closest to the beam pipe are dedicated to the reconstruction of interaction vertices and the trajectories of charged particles. A magnetic field enables the determination of charged particles' momenta via measurements of their bending radius. The tracking systems of both detectors cover a pseudo-rapidity range of about $|\eta| < 2.5$. The next layers are dedicated to calorimetry: the inner calorimeters measure the energy of photons and electrons whereas the outer calorimeters are designed to measure the energy of hadrons. The calorimeter systems cover up to $|\eta| < 5.0$. As their outer-most layers both detectors have dedicated systems to measure and detect muons. Additional magnetic fields provide supplementary muon momentum measurements. More detailed descriptions of the detectors can be found in [5] and [6]. To identify collision events of interest for physics analysis both experiments use two-level trigger systems, which consist of hardware based triggers for fast pre-selection followed by a software based trigger selection using more event information [7,8]. The trigger rates are on average 1 kHz in both experiments.

3 Standard Model Higgs Boson Measurements

Higgs boson candidates are identified from the expected decay products in various decay channels. In addition, many measurements target specific Higgs boson production channels, most commonly: gluon-induced production via a top-quark loop (ggF), the fusion of two vector bosons into a Higgs boson (VBF), associated production with a vector boson (VH) and associated production with a pair of top quarks (ttH).

3.1 $H \to \gamma\gamma, ZZ^*, WW^*$

Measurements of Higgs boson decays to bosons reach the highest experimental precision to date. Photons (γ), electron (e) or muons (μ) final states are recorded with high trigger efficiencies. The identification efficiencies for these particles are high and their kinematics are measured with excellent experimental resolution. In addition, high signal-to-background ratios are obtained.

Higgs boson mass

The Higgs boson mass is measured in the $\gamma\gamma$ and $ZZ^* \to 4e, 4\mu, 2e2\mu$ decay channels offering final states that can be fully reconstructed. The Higgs boson mass (m_H) is reconstructed from the two photons or 4 leptons[1] with the highest transverse momentum in the event. The measurements require either at least 2 isolated photons or 4 isolated leptons. In the ZZ^* measurement the invariant mass of one of the leptons pairs has to be compatible with the Z boson mass. The Higgs boson mass is extracted from the peak in the invariant mass distribution of

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[1] convention used in the following: "lepton" (ℓ) = electron or muon

the di-photon or 4-lepton system via a fit to data. The shape of the contributions from SM background processes is fitted simultaneously. The most recent mass measurement performed by the ATLAS collaboration uses the full Run 2 data set and is performed in the ZZ^* channel [9]. The CMS collaboration uses a partial Run 2 data set of 35.9 fb^{-1} to measure the mass in the $\gamma\gamma$ and ZZ^* channels. These measurements are combined with equivalent measurements carried out in an earlier data taking period ("Run 1") in the same decay channels [10]. The measured Higgs boson masses are:

$$m_H = 124.92 \pm 0.19(\text{stat.})^{+0.09}_{-0.06}(\text{syst.})\ \text{GeV} \qquad (\text{ATLAS}) \tag{1}$$

$$m_H = 125.38 \pm 0.14\ \text{GeV} \qquad (\text{CMS}). \tag{2}$$

The measurements are compatible and both reach a precision of $\mathcal{O}(0.1\%)$. The precision is limited by the size of the available data sets. The leading systematic uncertainties originate from the measurement of the photon and lepton energy and momentum scales.

Differential measurements

Recent cross section measurements as a function of production kinematics and event topologies have been performed in the $H \to ZZ^* \to 4e, 4\mu, 2e2\mu$ by the ATLAS [11] and CMS [12] collaborations. The event selection, analysis strategy and signal model for these measurements are similar to those implemented for the Higgs boson mass measurement in the ZZ^* channel. A wide range of differential distributions are probed, including two dimensional measurements. More details and a description of the procedure to unfold the measurements to the fiducial regions are described in [11, 12]. The measured distributions are carefully selected. For example, the transverse momentum of the Higgs boson is sensitive to new physics while the number of additional jets detects higher order cross section corrections. In all probed distributions, no significant deviations from the SM expectations are found and the measurements are in good agreement with the predictions of different simulation models within uncertainties.

$H \to WW^*$ measurements

The ATLAS collaboration measures the decay of Higgs bosons to $W^{\pm}$ bosons in two production channels, ggF and VBF [13], with the decay of $H \to WW^* \to e\nu\mu\nu$. The event selection requires an isolated electron, an isolated muon, and missing transverse energy ($E_{\mathrm{T}}^{\mathrm{miss}}$) from the undetected neutrinos. Since VBF events are characterised by two jets in the forward direction, the VBF analysis category is constructed from events with 2 or more jets with large pseudorapidities. The $H \to WW^*$ cross section is measured in several bins of Higgs boson transverse momentum and jet multiplicities in the ggF category and several categories of di-jet invariant mass in the VBF category as devised by the STXS framework. The results are compatible with the SM prediction with a p-value of 52%.

The CMS collaboration provides a complementary $H \to WW^*$ measurement in the VH production channel [14]. Four analysis channels targeting different decays of the 3 vector bosons are defined: $WH(WW^*) \to 2\ell 2\nu qq$, $WH(WW^*) \to 3\ell 3\nu$, $ZH(WW^*) \to 3\ell 1\nu qq$, and $ZH(WW^*) \to 4\ell 2\nu$. The measurement categories are defined by the number of isolated leptons and jets in the event. Requirements on the charge of the leptons are imposed based on the expected charge of VH events in the various analysis categories. The $WH(WW^*) \to 2\ell 2\nu qq$ channel explicitly targets only events with leptons of the same charge to suppress background processes. The ZH categories require one lepton pair with an invariant mass that is compatible with the Z boson mass. Based on the analysis category, either the output score of a Boosted Decision Tree (BDTs) or a proxy for the Higgs boson mass measured using final state objects are used as analysis discriminant.. The combined observed (expected) significance for the

$VH(WW^*)$ process is 4.7σ (2.8σ). The inclusive $VH(WW^*)$ signal strength[2] μ is determined to:

$$\mu = 2.11^{+0.46}_{-0.43} \tag{3}$$

which corresponds to a 2.5σ deviation from the SM expectation.

3.2 STXS Combination

If differential cross section measurements are not feasible due to low signal-to-background ratios and complex signal and background topologies an intermediate step is provided by the Simplified Template Cross Section (STXS) framework. The STXS framework defines discrete bins of Higgs boson production phase spaces for each of the four major Higgs boson production channels. The splitting takes into account the characteristics of these production channels. It is motivated by enhancing sensitivity to deviations from the SM and minimising uncertainties on the SM predictions. The expected SM signal yield in a given STXS bin is parametrised as templates of cross section times branching ratio ($\sigma \times$ BR). STXS measurements still exhibit some model dependence but less so than inclusive cross section or signal strength measurements. Measurements performed within the STXS framework allow for easy combination due to the common definitions of the STXS binning and the signal yield per bin can be re-parametrised in terms of beyond SM modifiers. The ATLAS collaboration recently performed a combination of STXS measurements [15]. This combination includes ggF, VBF, VH and ttH STXS measurements from the $H \rightarrow \gamma\gamma$ and $H \rightarrow ZZ^*$ channels and VH measurements from the $H \rightarrow bb$ channel[3] as shown in Figure 1. The same STXS bins enter an anomalous couplings reinterpretation within the framework of Effective Field Theories (EFT). Since multiple channels and STXS bins are sensitive to the same coupling modifiers the combination is setting some of the most stringent limits achieved at a hadron collider. No significant deviations from the SM have been observed and the measured $\sigma \times$ BR values in the various STXS bins are compatible with the hypothesis of a SM Higgs boson with a p-value of 91%.

3.3 H-Fermion Couplings

The coupling of the Higgs boson to fermions has been observed for the three heaviest fermions: bottom quarks (b), τ-leptons and top quarks (t). Experimentally more challenging signal signatures with jets and higher background rates leads to limited experimental sensitivity compared to measurements of the Higgs boson couplings to bosons.

$H \rightarrow bb$ measurements

The decay of the Higgs boson to a pair of bottom quarks is the channel with the highest predicted branching ratio of 58%. However, the two-jet final state is experimentally challenging. The best experimental sensitivity is reached in the VH production channel, which targets three distinct decay channels: $ZH \rightarrow 2\nu 2b$, $WH \rightarrow \ell\nu 2b$ and $ZH \rightarrow 2\ell 2b$. The advantage of these channels are efficient triggers and reduced contributions from background processes due to the vector boson decay. Events of interest contain two jets and are categorised based on the number of isolated leptons. Dedicated algorithms allow to distinguish b-jets from jets induced by the fragmentation of lighter quarks or gluons. The recent $VH(bb)$ measurement by the ATLAS collaboration [16] uses the output scores of BDTs as the discriminant of the analysis to enhance signal-to-background ratios. The measurement reports observation of ZH production with a significance of 5.3σ and an evidence for WH production with a significance of 4.0σ. The $H \rightarrow bb$ channel provides the most precise measurement of VH production to

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[2] μ = (observed cross section)/(expected cross section), $\mu = 1$ for SM

[3] The $VH, H \rightarrow bb$ measurement is described in Section 3.3

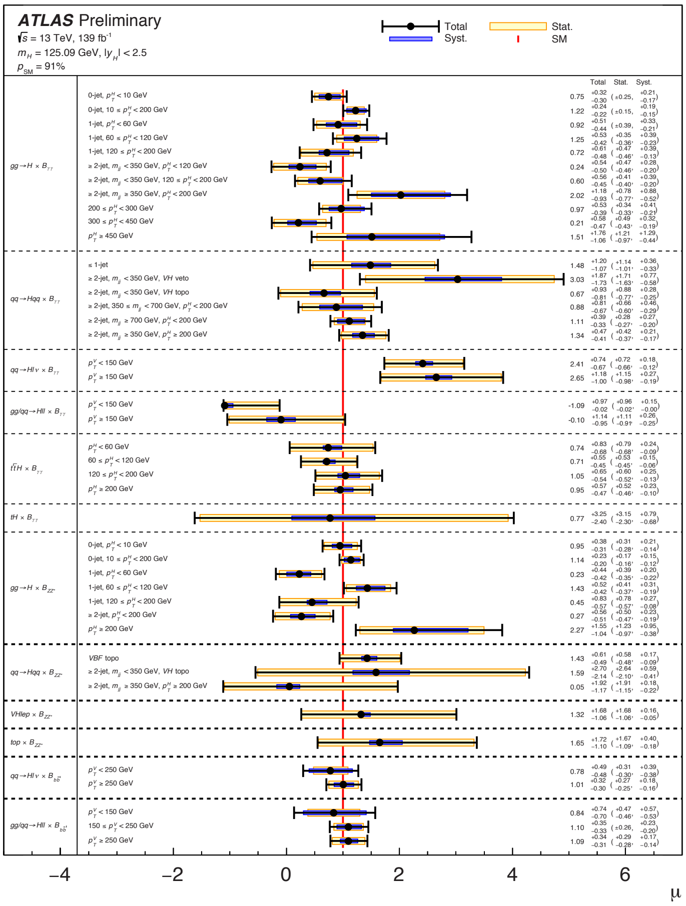

Figure 1: The ATLAS collaboration's STXS measurements of ggF, VBF, VH and ttH production in the $H \to \gamma\gamma$ and $H \to ZZ^*$ channel and VH production in the $H \to bb$ channel that enter in the statistical combination [15].

date. Its sensitivity is limited by systematic uncertainties, with the signal prediction being the largest factor. The $VH(bb)$ measurement is further categorised into 3 (2) different regimes of Z (W) boson transverse momentum, p_T^V, to provide cross section measurements within the STXS framework. Good agreement with the SM expectation is observed in all p_T^V categories and the measurement is included in the ATLAS collaboration's STXS combination, see Figure 1.

Large transverse momentum regimes of Higgs boson production are accessible in fully hadronic $ggF, H \to bb$ measurements due to large cross sections and branching ratios. The ATLAS [17] as well as the CMS [18] collaborations perform measurements in this channel. At high transverse momenta the two b-jets from the Higgs boson decay are expected to overlap in the detector. Dedicated techniques reconstruct the Higgs candidate as a single jet with large radius. The substructure of the large radius jet is used to identify di-b-jet events. The reconstructed mass of the large radius jet is used as the discriminant. Fiducial cross sections are measured in three bins of high transverse momentum of the large radius jet, p_T^H. The highest p_T^H bins probe up to $\mathcal{O}(1\,\text{TeV})$. The measurements are severely limited by the available data statistics and are mostly compatible with SM expectations within uncertainties. However, the CMS collaboration reports a local deviation from the SM of 2.6σ for the $p_T^H > 650\,\text{GeV}$ category, which is not observed in the ATLAS collaboration's measurement.

$H \rightarrow \tau\tau$ measurements

The CMS collaboration recently updated their measurements in the $H \rightarrow \tau\tau$ decay channel using the full Run 2 data set [19]. Four analysis categories, $\tau_h\tau_h$, $e\tau_h$, $\mu\tau_h$, $e\mu$, are defined based on the decays of the τ-leptons[4]. The analysis categories are identified based on the number of leptons and τ_h candidates. Dedicated identification algorithms are utilised to distinguish τ_h candidates from jets induced by quark or gluon fragmentation. Missing transverse momentum ($p_{\mathrm{T}}^{\mathrm{miss}}$) due to the undetected neutrinos is expected in all τ-lepton decay channels. The Higgs boson candidate mass $m_{\tau\tau}$ is reconstructed using a simplified matrix element method combining the four-momentum vectors of the visible decay products and $\vec{p}_{\mathrm{T}}^{\mathrm{miss}}$. The signal strength μ is measured:

$$\mu = 0.85^{+0.12}_{-0.11}. \tag{4}$$

The sensitivity of the μ measurement is limited by systematic uncertainties with those related to the signal prediction playing the largest role. Additional cross section measurements in the STXS framework are provided by defining ggF and VBF enriched categories based on the number of forward jets. Measurements in several bins of Higgs boson transverse momentum and jet multiplicities or di-jet invariant mass are performed. A good agreement with the SM expectation within uncertainties is observed.

The $H \rightarrow \tau\tau$ channel provides sensitivity to the CP structure of the Higgs boson via the angle ϕ between the reconstructed τ-lepton decay planes. The SM expects a purely CP-even Higgs boson, $\phi = 0°$. A purely CP-odd Higgs boson has already been excluded but an admixture, with the mixing angle ϕ between CP-even and CP-odd contributions, is not excluded yet. The CP sensitive measurement [20] targets only the $\tau_h\tau_h$ and $\mu\tau_h$ channels and uses machine learning based multivariate techniques to enhance the experimental sensitivity. The mixing angle is found to be:

$$\phi = 4 \pm 36° \tag{5}$$

at the 95% confidence level, which is compatible with the SM expectation.

ttH production

The coupling of the Higgs boson to the heaviest known SM particle, the top quark (t), is directly accessible in ttH production. The small cross section of this production channel, the complex final states containing the top quarks' and the Higgs boson's decay products and the large uncertainties on the estimates of the background processes impose significant challenges on these measurements. The most recent measurement by the CMS collaboration targets multilepton final states [21]. Such final states are enriched in $ttH(WW^*)$, $ttH(ZZ^*)$ and $ttH(\tau\tau)$ events. The general event topology comprises of at least 2 b-jets from top quark decays and electrons, muons or τ-leptons. Additional jets or missing transverse momentum are expected in certain event topologies. Several analysis categories are defined based on the number of leptons, their charge and the number of τ_h candidates. Further requirements are imposed depending on the ttH decay topology and machine learning algorithms are used to define the analysis discriminant to optimise the signal-to-background ratio. The ttH signal strength from the combination of all measurement categories is:

$$\mu = 0.92 \pm 0.19(\text{stat.})^{+0.17}_{-0.13}(\text{syst.}) \tag{6}$$

which is compatible with the SM expectation and corresponds to an observed significance of 4.7σ above the background only hypothesis.

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[4] $\tau \rightarrow \nu_\tau + \text{hadrons}$ ("τ_h"), $\tau \rightarrow \nu_\tau e \nu_e$ ("e"), $\tau \rightarrow \nu_\tau \mu \nu_\mu$ ("μ")

3.4 Rare Higgs Boson Decays

The large Run 2 data sets enable searches for rare SM Higgs boson processes. The latest successes are recently found evidence for two rare Higgs boson decay channels, which will be described in the following.

$H \rightarrow \mu\mu$

The SM branching ratio for Higgs boson decays to muons is 0.02% since the coupling strength to the Higgs boson is expected to be weak due to the smallness of the muon's mass. In addition, large rates from background processes are expected. The CMS collaboration's measurement [22] targets all major Higgs boson production channels to improve signal acceptance. Events of interest are expected to contain two isolated muons. Additional objects according to the production channel are expected in the final states as well. Machine learning techniques are used to enhance the signal-to-background ratios. The combination of all search channels yields an evidence for $H \rightarrow \mu\mu$ decays with a significance of 3σ and the measured signal strength is compatible with the SM expectation:

$$\mu = 1.19^{+0.40}_{-0.39}(\text{stat.})^{+0.15}_{-0.14}(\text{syst.}). \tag{7}$$

This is the first evidence for Higgs boson couplings to 2^{nd} generation fermions.

$H \rightarrow \ell\ell\gamma$

The ATLAS collaboration measures Higgs boson final states with two isolated leptons and one isolated photon [23]. The invariant mass of the di-lepton system is required to be lower than 30 GeV, thus being dominated by $\gamma \rightarrow \ell\ell$ processes complementing $H \rightarrow Z\gamma$ measurements. The expected branching ratio for such decays is $\mathcal{O}(10^{-5})$. Dedicated event reconstruction and categorisation algorithms are developed for the $H \rightarrow ee\gamma$ channel, where overlapping showers in the electro-magnetic calorimeter occur. The combination of $ee\gamma$ and $\mu\mu\gamma$ events yields a significance of 3.2σ above the background only hypothesis. The signal strength of the $H \rightarrow \ell\ell\gamma$ process is determined:

$$\mu = 1.5 \pm 0.5. \tag{8}$$

3.5 Higgs Boson Pair Production

The SM production of Higgs boson pairs via $gg \rightarrow H \rightarrow HH$ contains a HHH vertex and is sensitive to the Higgs boson self-coupling strength λ. This provides a probe of the shape of the Higgs field's potential. The expected production cross section for SM di-Higgs-boson production is small and the experimental sensitivity to this process is severely limited by the size of the available data set. The currently highest sensitivity is reached in the $HH \rightarrow \gamma\gamma bb$ channel, which provides a good balance of efficient triggering ($H \rightarrow \gamma\gamma$), high resolution ($H \rightarrow \gamma\gamma$) and high branching ratios ($H \rightarrow bb$). Both, the ATLAS [24] and CMS [25] collaborations search for this process. The measurements of both collaborations set experimental limits on the Higgs boson self-coupling modifier κ_λ (=1 for SM) at the 95% confidence level:

$$-1.5 < \kappa_\lambda < 6.7 \qquad \text{(ATLAS)} \tag{9}$$

$$-3.3 < \kappa_\lambda < 8.5 \qquad \text{(CMS)}\,. \tag{10}$$

Due to analysis optimisation, e.g. the usage of machine learning, the obtained results significantly improve the experimental limits on κ_λ with respect to previous measurements. The measurements are compatible with the SM and can be translated to upper limits on the $HH \rightarrow \gamma\gamma bb$ signal strength of $\mu < 4.1$ and $\mu < 7.7$, respectively. These are the most stringent limits on SM HH production to date. The measurement of the CMS collaboration includes an additional analysis channel that targets di-Higgs-boson production in vector boson fusion. The experimental signature of this process is characterised by two jets in the forward direction. This production channel has access to the $VVHH$ vertex and sets upper limits on the coupling modifier c_{2V} (=1 for SM) at the 95% confidence level:

$$-1.3 < c_{2V} < 3.5. \tag{11}$$

4 Search for New Physics

The Higgs sector provides an opportunity to search for beyond Standard Model (BSM) effects, which would indicate the presence of new physics as predicted by various theories. In the following, a selection of recent direct searches for BSM effects in the Higgs sector is presented.

4.1 BSM Higgs Boson Searches

The presence of an extended Higgs sector, where the discovered Higgs boson with a mass of 125 GeV is only one of multiple Higgs bosons, is part of several theories, such as the Minimal Supersymmetric Standard Model.

Heavy Higgs bosons

Most searches for additional heavy neutral Higgs bosons target decays to a pair of bosons, which subsequently decay into observable fermions. The ATLAS collaboration recently searched for a heavy Higgs boson A in decays to a Z boson and another Higgs boson H [26]. The considered masses for the A boson range from 230 GeV to 800 GeV and between 130 GeV to 700 GeV for the H boson. This search targets $Z(\ell\ell)H(bb)$ and $Z(\ell\ell)H(WW^* \to 4q)$ final states. The invariant mass of the di-lepton system is required to be compatible with the Z boson mass and the invariant mass of the di-b-jet or 4-jet system is required to be compatible with the assumed H boson mass. Additional requirements are imposed based on the expected signal kinematics to suppress background processes. The analysis discriminant is the invariant mass of the leptons+jets system. No excess above the background only hypothesis is observed and 95% confidence level upper limits are set on the $\sigma \times \mathrm{BR}$ of the $A \to ZH \to \ell\ell bb, \ell\ell WW^*$ process. The most stringent limits are achieved for high A/H masses.

A recent measurement of the CMS collaboration searches for a heavy Higgs boson H in decays to another new Higgs boson h_S and a Higgs boson h with mass 125 GeV [27]. The final state targeted in this search is $\tau\tau bb$ with the explicit requirement that the di-τ invariant mass is compatible with 125 GeV within a given window. A large range of masses is probed starting from 240 GeV (60 GeV) up to 3 TeV (2.8 TeV) for the H (h_S) boson. Neural nets are trained for various mass hypotheses. They are used for further event classification and provide the analysis discriminant. No excess above the background only hypothesis is found and 95% confidence level upper limits are set on the $H \to h_S h \to \tau\tau bb$ process. The results are further interpreted in the next-to-Minimal Supersymmetric Standard Model (NMSSM) to set exclusion limits on the cross section times branching ratio of the probed process for combinations of H and h_S masses, shown in Figure 2a. The most stringent limit is set for $m_H = 450\,\mathrm{GeV}$ and $60 \le m_{h_S} \le 80\,\mathrm{GeV}$.

Charged Higgs bosons

Searches for Higgs bosons that carry electromagnetic charge are performed by both the ATLAS and CMS collaborations. Recent searches target singly or doubly charged Higgs boson in decays to W and Z bosons in multi-lepton final states. The probed masses of the charged Higgs boson reach up to 3 TeV for the production of a single charged Higgs boson (CMS [28]) and up to 700 GeV for the production of pairs of charged Higgs bosons (ATLAS [29]). No significant deviations from the SM expectation are found in either search and 95% confidence level upper limits are set. The most stringent limits are achieved for high mass hypotheses of the charged Higgs boson.

4.2 Exotic Higgs Boson Decays

Searches for exotic Higgs boson decays target lighter yet unobserved particles that occur in decays of the SM Higgs boson with a mass of 125 GeV. These searches can probe undiscovered particles that do not interact via any of the know three forces of the SM but gain their masses by interactions with the Higgs field. The ATLAS collaboration searches for Higgs boson decays to a pair of new spin-0 particles a, which subsequently decay to SM particles, in multiple decay channels. A summary is shown in Figure 2b. The measurement in the $H \rightarrow aa \rightarrow bb\mu\mu$ has recently been updated with the full Run 2 data set [30]. It searches for excesses in the invariant di-muon mass probing a masses between 16 GeV and 62 GeV. A local (global) excess of 3.3σ (1.7σ) is found for $m_a = 52\,\text{GeV}$.

Dedicated searches for invisible Higgs boson decays target decays to dark matter. It is assumed that dark matter does not interact with the detector and hence is only reconstructed indirectly via missing transverse energy. The most stringent limit on the branching ratio for $H \rightarrow invisible$ decays is obtained from a combination of Run 1 and full Run 2 measurements in the ttH and VBF production channels by the ATLAS collaboration [31]. Events for searches for invisible Higgs boson decays are selected based on the expected kinematics of the particles produced in association with the Higgs boson depending on the production channel. In addition, significant missing transverse energy is expected because of the presences of the dark matter candidates. The 95% confidence level upper limit is determined to:

$$\mathrm{BR}(H \rightarrow invisible) < 11\%. \tag{12}$$

The best sensitivity is provided by the Run 2 measurement in the VBF channel.

5 Conclusion

Recent highlights on Higgs boson measurements from the ATLAS and CMS collaborations have been presented. The available full Run 2 data sets enable large programmes of SM and BSM measurements reaching unprecedented precision. All measurements to date confirm the SM nature of the Higgs boson that was first observed in 2012 with a mass of $m_H \approx 125\,\text{GeV}$ and no new physics have been observed in Higgs boson interactions.

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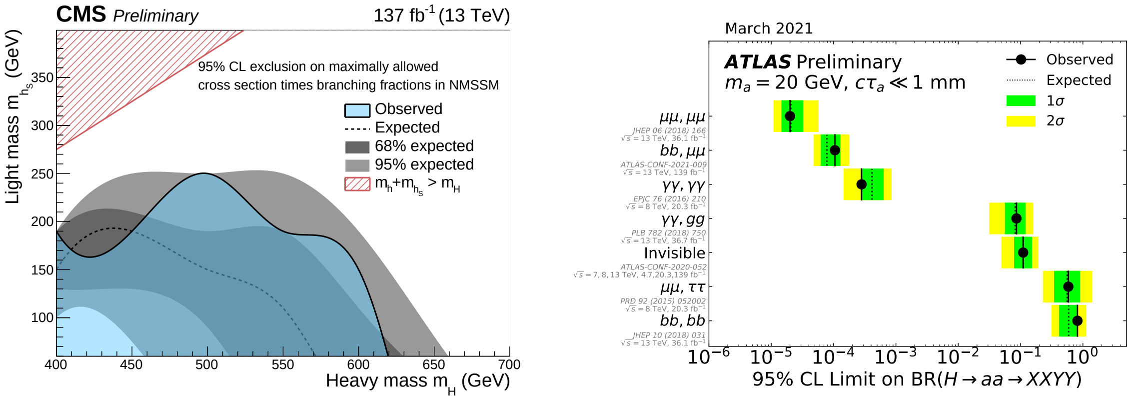

(a) (b)

Figure 2: Measured 95% confidence level exclusion limits of searches for BSM physics. Left: Exclusion limits for the production of new Higgs bosons H and h_S as a function of their respective mass in $H \to h_s h \to \tau\tau bb$ events interpreted within the NMSSM model (CMS [27]). Right: Summary of upper limits on SM Higgs boson decays to new light scalars in various decay channels (ATLAS [32]).

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