Results are summarized from searches for the standard model Higgs boson in $pp$ collisions at $\sqrt{s} = 7$ and 8 TeV in the CMS experiment at the LHC. The measurements of mass, cross section, and properties of the narrow resonance recently observed are presented. The searches beyond standard model Higgs boson, in the CMS experiment at the LHC, are highlighted.

1 Introduction

Earlier this year the ATLAS and CMS collaborations announced the observation of a narrow resonance with mass near 125 GeV [1,2] with properties consistent with that of the Higgs boson predicted in the standard model (SM) of particle physics [3,4,5]. After a short review of the CMS detector, we summarize the results from searches for the SM Higgs boson in $pp$ collisions at $\sqrt{s} = 7$ and 8 TeV in the CMS experiment at the LHC and the measurements of mass, cross section, and properties of the narrow resonance recently observed. The searches beyond SM Higgs boson are highlighted.

2 CMS detector and event reconstruction

The CMS detector comprises a superconducting solenoid, providing a uniform magnetic field of 3.8 T in the bore, equipped with silicon pixel and strip tracking systems ($|\eta| < 2.5$) surrounded by a lead tungstate crystal electromagnetic calorimeter (ECAL) and a brass-scintillator hadronic calorimeter (HCAL) ($|\eta| < 3.0$). A steel/quartz-fiber Cherenkov calorimeter extends the coverage ($|\eta| < 5$). The steel return yoke outside the solenoid is instrumented with gas ionization detectors used to identify muons ($|\eta| < 2.4$). A detailed description of the detector is given in Ref. [6].

The CMS “particle-flow” event description algorithm [7,8] is used to reconstruct and identify each single particle with an optimized combination of all subdetector information. In this process, the identification of the particle (photon, electron, muon, charged hadron, neutral hadron) plays an important role in the determination of the particle momentum.

where $\eta = -\ln[\tan(\theta/2)]$ and $\theta$ is the polar angle with respect to the direction of the proton beam

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3 Searches for the standard model Higgs boson

Four main mechanisms are predicted for Higgs boson production in $pp$ collisions: the gluon-gluon fusion mechanism, which has the largest cross section, followed in turn by vector-boson fusion (VBF), associated $WH$ and $ZH$ production ($VH$), and production in association with top quarks ($ttH$).

The particular set of sensitive decay modes of the SM Higgs boson depends strongly on $m_H$. The results presented here are based on the five most sensitive decay modes: $H \rightarrow \gamma\gamma$; $H \rightarrow ZZ$ followed by $ZZ$ decays to $4\ell$; $H \rightarrow WW$ followed by decays to $2\ell 2\nu$; $H \rightarrow bb$ followed by $b$-quark fragmentation into jets; and $H \rightarrow \tau\tau$ followed by at least one leptonic $\tau$ decay. This list is presented in Table 1 and comprises the full set of decay modes and subchannels, or categories, for which both the 7 and 8 TeV data sets have been analysed at the time of PIC 2012 conference. New preliminary results, analyzing more integrated luminosity, have been recently produced by the CMS collaboration [9,10,11,12,13], they are not included in this proceeding.

Table 1: Summary of the subchannels, or categories, used in the analysis of each decay mode.

| Decay mode | Production tagging | No. of subchannels | Int. Lum. ($fb^{-1}$) |
|------------|--------------------|--------------------|-----------------------|
|            |                    |                    | 7 TeV | 8 TeV |
| $\gamma\gamma$ | untagged | 4 | 5.1 | 5.3 |
| | dijet (VBF) | 1 or 2 | | |
| $ZZ$ | untagged | 3 | 5.1 | 5.3 |
| $WW$ | untagged | 4 | 4.9 | 5.1 |
| | dijet (VBF) | 1 or 2 | | |
| $\tau\tau$ | untagged | 16 | 4.9 | 5.1 |
| | dijet (VBF) | 4 | | |
| $bb$ | lepton, $E_T^{miss}$ (VH) | 10 | 5.0 | 5.1 |

For a given value of $m_H$, the search sensitivity depends on the production cross section, the decay branching fraction into the chosen final state, the signal selection efficiency, the mass resolution, and the level of background from identical or similar final-state topologies. For low values of the Higgs boson mass, the $H \rightarrow \gamma\gamma$ and $H \rightarrow ZZ \rightarrow 4\ell$ channels play a special role due to the excellent mass resolution for the reconstructed diphoton and four-lepton final states, respectively. The $H \rightarrow WW \rightarrow 2\ell 2\nu$ channel provides high sensitivity but has relatively poor mass resolution due to the presence of neutrinos in the final state. The sensitivity in the $bb$ and $\tau\tau$ decay modes is reduced due to the large backgrounds and poor mass resolutions. In the high mass range, the sensitivity is driven by the $WW$ and $ZZ$ modes. In the following subsections a brief description of each decay mode is presented.
Higgs searches at CMS

3.1 $H \rightarrow \gamma\gamma$ decay mode

In the $H \rightarrow \gamma\gamma$ analysis \[2,14\] a search is made for a narrow peak in the diphoton invariant mass distribution in the range 110–150 GeV, on a large irreducible background from QCD production of two photons. There is also a reducible background where one or more of the reconstructed photon candidates originate from misidentification of jet fragments.

To enhance the sensitivity of the analysis, candidate diphoton events are separated into mutually exclusive categories of different expected signal-to-background ratios, based on the properties of the reconstructed photons and on the presence of two jets satisfying criteria aimed at selecting events in which a Higgs boson is produced through the VBF process. The analysis uses multivariate techniques for the selection and classification of the events.

The background is estimated from data, without the use of MC simulation, by fitting the diphoton invariant mass distribution in each of the categories in a range $(100 < m_{\gamma\gamma} < 180 \text{ GeV})$ extending slightly above and below that in which the search is performed. The choices of the function used to model the background and of the fit range are made based on a study of the possible bias in the measured signal strength. Polynomial functions are used.

The expected 95% CL upper limit on the signal strength $\sigma/\sigma_{\text{SM}}$, in the background-only hypothesis, for the combined 7 and 8 TeV data, is less than 1.0 in the range $110 < m_H < 140$ GeV, with a value of 0.76 at $m_H = 125$ GeV. The observed limit indicates the presence of a significant excess at $m_H = 125$ GeV in both the 7 and 8 TeV data. The local $p$-value is shown as a function of $m_H$ in Figure 1(a) for the 7 and 8 TeV data, and for their combination. The expected (observed) local $p$-value for a SM Higgs boson of mass 125 GeV corresponds to $2.8 (4.1) \sigma$. The best-fit signal strength for a SM Higgs boson mass hypothesis of 125 GeV is $\sigma/\sigma_{\text{SM}} = 1.6 \pm 0.4$.

In order to illustrate, in the $m_{\gamma\gamma}$ distribution, the significance given by the statistical methods, it is necessary to take into account the large differences in the expected signal-to-background ratios of the event categories. The events are weighted according to the category in which they fall. A weight proportional to $S/(S+B)$ is used where $S$ and $B$ are the number of signal and background events. Figure 1(b) shows the data, the signal model, and the background model, all weighted. The unweighted distribution, using the same binning but in a more restricted mass range, is shown as an inset. The excess at 125 GeV is evident in both the weighted and unweighted distributions.

3.2 $H \rightarrow ZZ \rightarrow 4\ell$ decay mode

In the $H \rightarrow ZZ \rightarrow 4\ell$ decay mode \[2,15\] a search is made for a narrow four-lepton mass peak in the presence of a small continuum background. Since there are differences in the reducible background rates and mass resolutions between the subchannels 4e, 4$\mu$, and 2e2$\mu$, they are analysed separately. The background sources include an irreducible four-lepton contribution from direct ZZ production via $qq$ and gluon-gluon processes. Reducible contributions arise from $Z + b\bar{b}$ and $t\bar{t}$ production where the final states contain two isolated leptons and two $b$-quark
jets producing secondary leptons. Additional background arises from $Z$+jets and $WZ$+jets events where jets are misidentified as leptons.

The event selection requires two pairs of same-flavour, oppositely charged leptons. The pair with invariant mass closest to the $Z$ boson mass is required to have a mass in the range 40–120 GeV and the other pair is required to have a mass in the range 12–120 GeV. Electrons are required to have $p_T > 7$ GeV and $|\eta| < 2.5$. The corresponding requirements for muons are $p_T > 5$ GeV and $|\eta| < 2.4$. Both muons and electrons are required to be pass identification requirements, based on a multivariate technique, and to be isolated. The electron or muon pairs from $Z$ boson decays are required to originate from the same primary vertex. Final-state radiation from the leptons is recovered and included in the computation of the lepton-pair invariant mass. The $ZZ$ background is evaluated from MC simulation studies. The reducible and instrumental backgrounds are estimated from data selecting events in a background control region, well separated from the signal region, by relaxing the isolation and identification criteria for two same-flavour reconstructed leptons. The combined signal reconstruction and selection efficiency, with respect to the $m_H = 125$ GeV generated signal with $m_{\ell\ell} > 1$ GeV as the only cut, is 18% for the $4e$ channel, 40% for the $4\mu$ channel, and 27% for the $2e2\mu$ channel.

The $m_{4\ell}$ distribution is shown in Figure 2(a). There is a clear peak at the $Z$
boson mass where the decay $Z \to 4\ell$ is reconstructed. This feature of the data is well reproduced by the background estimation. The Figure 2(a) also shows an excess of events above the expected background around 125 GeV. The kinematics of the $H \to ZZ \to 4\ell$ process in its centre-of-mass frame is fully described by five angles and the invariant masses of the two lepton pairs $[16,17,18]$. The variables provide significant discriminating power between signal and background. A kinematic discriminant is constructed based on the probability ratio of the signal and background hypotheses, $K_D = \frac{P_{\text{sig}}}{P_{\text{sig}} + P_{\text{bkg}}}$. The likelihood ratio is defined for each value of $m_{4\ell}$. The $m_{4\ell}$ distribution of events satisfying $K_D > 0.5$ is shown in the inset in Figure 2(a).

The expected 95% CL upper limit on the signal strength $\sigma/\sigma_{\text{SM}}$, in the background-only hypothesis, for the combined 7 and 8 TeV data, falls steeply between 110 and 140 GeV, and has a value of 0.6 at $m_H = 125$ GeV. The observed upper limit indicates the presence of a significant excess in the range $120 < m_H < 130$ GeV. The local $p$-value is shown as a function of $m_H$ in Figure 2(b) for the 7 and 8 TeV data, and for their combination. The minimum local $p$-value in the data occurs at $m_H = 125.6$ GeV and has a significance of 3.2 $\sigma$ (expected 3.8 $\sigma$). The combined best-fit signal strength for a SM Higgs boson mass hypothesis of 125.6 GeV is $\sigma/\sigma_{\text{SM}} = 0.7^{+0.4}_{-0.3}$.

3.3 $H \to WW \to \ell\nu\ell\nu$ decay mode

The decay mode $H \to WW \to \ell\nu\ell\nu$ is highly sensitive to a SM Higgs boson in the mass range around the $WW$ threshold of 160 GeV $[2,19]$. This decay mode is analysed by selecting events in which both $W$ bosons decay leptonically, resulting in a signature with two isolated, oppositely charged leptons (electrons or muons) and large missing transverse energy due to the undetected neutrinos.

Events are classified according to the number of jets (0, 1, or 2) with $p_T > 30$ GeV and within $|\eta| < 4.7$ ($|\eta| < 5.0$ for the 7 TeV data set), and further separated into same-flavour ($ee$ and $\mu\mu$) or different-flavour ($e\mu$) categories. Events with more than two jets are rejected. To improve the sensitivity of the analysis, the selection criteria are optimized separately for the different event categories since they are characterised by different dominating backgrounds. The zero-jet $e\mu$ category has the best signal sensitivity. Its main backgrounds are irreducible nonresonant $WW$ production and reducible $W+\text{jets}$ processes, where a jet is misidentified as a lepton. The one-jet $e\mu$ and zero-jet same-flavour categories only contribute to the signal sensitivity at the 10% level because of larger backgrounds, from top-quark decays and Drell–Yan production, respectively. Event selection in the two-jet category is optimized for the VBF production mechanism. This category has the highest expected signal-to-background ratio, but its contribution to the overall sensitivity is small owing to the lower cross section relative to inclusive production. Yields for the dominant backgrounds are estimated using control regions in the data.

One of the most sensitive variables to discriminate between $H \to WW$ decays and nonresonant $WW$ production is the dilepton invariant mass $m_{4\ell}$. This quantity
Figure 2: (a) Distribution of the four-lepton invariant mass for the $H \rightarrow ZZ \rightarrow 4\ell$ analysis. The points represent the data, the filled histograms represent the background, and the open histogram shows the signal expectation for a Higgs boson of mass $m_H = 125$ GeV, added to the background expectation. The inset shows the $m_{4\ell}$ distribution after selection of events with $K_{D} > 0.5$, as described in the text. (b) The observed local $p$-value for the ZZ decay mode as a function of the SM Higgs boson mass. The dashed line shows the expected local $p$-values for a SM Higgs boson with a mass $m_H$. 

is shown in Figure 3(a) for the zero-jet $e\mu$ category after the full selection for $m_H = 125$ GeV, except for the selection on $m_{\ell\ell}$ itself. The 95% CL expected and observed limits for the combination of the 7 and 8 TeV analyses are shown in Figure 3(b). A broad excess is observed that is consistent with a SM Higgs boson of mass 125 GeV. This is illustrated by the dotted curve in Figure 3(b) showing the median expected limit in the presence of a SM Higgs boson with $m_H = 125$ GeV. The expected significance for a SM Higgs of mass 125 GeV is 2.4 $\sigma$ and the observed significance is 1.6 $\sigma$.

3.4 $H \rightarrow bb$ decay mode

The $H \rightarrow bb$ analysis [2,20] selects events produced in association with a W or Z decaying via $Z \rightarrow ll, Z \rightarrow \nu\nu$, or $W \rightarrow l\nu$. The selection requires two b-tagged jets and either two leptons, one lepton and missing transverse energy, or large missing transverse energy. The events are selected with a high transverse momentum of the di-jet system in order to improve the mass resolution and to suppress background processes. A multivariate classifier (BDT) is trained for different $m_H$ values and its output is used as the final discriminant.

Figure 4(b) shows as an example the BDT scores for the high-$p_T$ subchannel of the $Z(\nu\nu)H$ channel in the 8 TeV data set, after all selection criteria have been
Figure 3: (a) Distribution of $m_{\ell\ell}$ for the zero-jet $e\mu$ category in the $H \rightarrow WW$ search at 8 TeV. The signal expected from a Higgs boson with a mass $m_H = 125$ GeV is shown added to the background. decaying, via a W boson pair, to two leptons and two neutrinos, for the combined 7 and 8 TeV data sets. The symbol $\sigma/\sigma_{SM}$ denotes the production cross section times the relevant branching fractions, relative to the SM expectation. The background-only expectations are represented by their median (dashed line) and by the 68% and 95% CL bands. The dotted curve shows the median expected limit for a SM Higgs boson with $m_H = 125$ GeV. applied. No significant deviation from the background expectation is observed.

3.5 $H \rightarrow \tau\tau$ decay mode

The $H \rightarrow \tau\tau$ analysis [2,21] searches for a broad excess in the reconstructed di-tau invariant-mass distribution. Events are classified according to the tau-lepton decay modes. Depending on the final state the event samples are further divided into exclusive subcategories, which are optimized for the sensitivity to a particular production mode. The category optimized for the VBF signature provides the largest sensitivity. Events failing these selection requirements are separated further, in a category with two jets optimized for associated production $HW(HZ)$, with one jet with large transverse momentum for associated production and production in gluon fusion, and with either no jets or with one with a small transverse momentum aiming at the gluon-fusion production process. The mass $m_{\tau\tau}$ is reconstructed with an algorithm [21] combining the visible $\tau$ decay products and the missing transverse energy, achieving a resolution of about 20% on $m_{\tau\tau}$.

The main irreducible background arises from $Z \rightarrow \tau\tau$ production, whose di-tau invariant-mass distribution is derived from data by selecting $Z \rightarrow \mu\mu$ events, in which the reconstructed muons are replaced with reconstructed particles from the
decay of simulated $\tau$ leptons of the same momenta. The reducible backgrounds from $W^+\text{+jets}$, Drell–Yan, and multi-jet production are also evaluated from control samples in data. The distribution of the di-tau mass distribution is shown in Figure 4(a). No significant deviation from the background expectation is observed.

![Figure 4: (a) Distribution of $m_{\tau\tau}$ in the combined 7 and 8 TeV data sets for the $\mu\tau_h$ VBF category of the $H \rightarrow \tau\tau$ search. The signal expected from a SM Higgs boson ($m_H = 125\text{ GeV}$) is added to the background. (b) Distribution of BDT scores for the high-$p_T$ subchannel of the $Z(\nu\nu)H(bb)$ search in the 8 TeV data set after all selection criteria have been applied. The signal expected from a Higgs boson ($m_H = 125\text{ GeV}$) is shown added to the background and also overlaid for comparison with the diboson background.](image-url)

4 Observation and anatomy of a new particle

The individual results for the channels analysed for the five decay modes, summarised in Table I, are combined using the methods outlined here [22]. The combination assumes the relative branching fractions predicted by the SM and takes into account the experimental statistical and systematic uncertainties as well as the theoretical uncertainties, which are dominated by the imperfect knowledge of the QCD scale and parton distribution functions. The $CL_{s}$ method is used to compute the exclusion limit. The median expected exclusion range of $m_H$ at 95% CL in the absence of a signal is 110-600 GeV. In most of the explored Higgs boson mass range, the differences between the observed and expected limits are consistent with statistical fluctuations since the observed limits are generally within the 1$\sigma$ and 2$\sigma$ bands of the expected limit values. However at low mass, in the range $122.5 < m_H < 127\text{ GeV}$, an excess of events is observed which makes the observed limits
considerably weaker than expected in the absence of a SM Higgs boson and, hence, does not allow exclusion.

The consistency of the observed excess with the background-only hypothesis may be judged from Figure 5(a), which shows a scan of the local $p$-value for the 7 and 8 TeV data sets and their combination. In the overall combination the significance is $5.0\sigma$ for $m_H = 125.5$ GeV. Figure 5(b) gives the local $p$-value for the five decay modes individually and displays the expected overall $p$-value. The largest contributors to the overall excess in the combination are the $\gamma\gamma$ and $ZZ$ decay modes. They both have very good mass resolution, allowing good localization of the invariant mass of a putative resonance responsible for the excess. Table 2 summarises the expected and observed local $p$-values for a SM Higgs boson mass hypothesis of 125.5 GeV for the various combinations of channels.

To measure the mass of the observed state, we use the $\gamma\gamma$ and $ZZ \rightarrow 4\ell$ channels that have excellent mass resolution and for which we observe the excess with a high significance. Figure 6 shows 2D 68% confidence level regions for two parameters of interest, the signal strength $\mu$ and mass $m_X$ for the three channels (untagged $\gamma\gamma$, VBF-tagged $\gamma\gamma$, and $ZZ \rightarrow 4\ell$). The three channels are consistent and thus can be combined. The combined best-fit mass is $m_X = 125.3 \pm 0.4({\text{stat}}) \pm 0.5({\text{syst}})$ GeV.

We then performed a limited number of compatibility test with the SM Higgs boson hypothesis. A first test of the compatibility of the observed boson with
Table 2: The expected and observed local $p$-values, expressed as the corresponding number of standard deviations of the observed excess from the background-only hypothesis, for $m_H = 125.5$ GeV, for various combinations of decay modes.

| Decay mode/combination | Expected ($\sigma$) | Observed ($\sigma$) |
|-------------------------|---------------------|---------------------|
| $\gamma\gamma$         | 2.8                 | 4.1                 |
| $ZZ$                    | 3.8                 | 3.2                 |
| $\tau\tau + bb$        | 2.4                 | 0.5                 |
| $\gamma\gamma + ZZ$    | 4.7                 | 5.0                 |
| $\gamma\gamma + ZZ + WW$ | 5.2               | 5.1                 |
| $\gamma\gamma + ZZ + WW + \tau\tau + bb$ | 5.8               | 5.0                 |

Figure 6: The 68% CL contours for the signal strength $\sigma/\sigma_{SM}$ versus the boson mass $m_X$ for the untagged $\gamma\gamma$, $\gamma\gamma$ with VBF-like dijet, $4\ell$, and their combination. The symbol $\sigma/\sigma_{SM}$ denotes the production cross section times the relevant branching fractions, relative to the SM expectation. In this combination, the relative signal strengths for the three decay modes are constrained by the expectations for the SM Higgs boson.

The SM Higgs boson is provided by examination of the best-fit value for the signal strength relative to the SM expectation, $\sigma/\sigma_{SM}$. Figure 7(a) shows the values of $\sigma/\sigma_{SM}$ for individual decay modes and their combination. The horizontal bars indicate the ±1 standard deviation uncertainties, statistical and systematic uncertainties are included. Electroweak symmetry breaking via the Higgs mechanism sets a well-defined ratio for the couplings of the Higgs boson to the W and Z bosons, $g_{WW}^H/g_{ZZ}^H$, protected by the custodial symmetry. To quantify such consistency, we introduce two event rate modifiers $\mu_{ZZ}$ and $R_{wz}$. The expected $H \rightarrow ZZ \rightarrow 4\ell$ event yield is scaled by $\mu_{ZZ}$, while the expected untagged $H \rightarrow WW \rightarrow \ell\nu\ell\nu$ event yield is scaled by $R_{wz} \times \mu_{ZZ}$. A scan of the test statistic $q(R_{wz})$, while profiling all
other nuisances and the signal strength modifier $\mu_{ZZ}$, yields $R_{wz} = 0.9^{+1.1}_{-0.6}$. Given that $R_{wz}$ is consistent with unity, we now assume that the ratio of the couplings of the observed state to the W and Z bosons is as required by the custodial symmetry. Under this assumption, we can check the compatibility of the observation with the standard model Higgs boson by introducing and fitting for two free parameters $c_V$ and $c_F$. The first, $c_V$, scales the standard model Higgs boson couplings to the W and Z bosons, while preserving their ratio. The other, $c_F$, scales all couplings to fermions by one constant factor. The 2D likelihood scan and the 68% and 95% confidence regions for $c_V$ and $c_F$ are shown in Figure 7(b). In this scan $c_V$ and $c_F$ are constrained to be positive. The data are compatible with the expectation for the SM Higgs boson, the point $(c_V, c_F) = (1,1)$ is within the 95% confidence interval defined by data.

![Figure 7](image-url)

Figure 7: (a) Values of $\sigma/\sigma_{SM}$ for the combination (solid vertical line) and for individual decay modes (points). The symbol $\sigma/\sigma_{SM}$ denotes the production cross section times the relevant branching fractions, relative to the SM expectation. The horizontal bars indicate the ±1 standard deviation uncertainties in the $\sigma/\sigma_{SM}$ values for individual modes, statistical and systematic uncertainties are included. (b) The 2D-scan test statistic $-2\ln(Q)$ vs the $(c_V, c_F)$ parameters. The cross indicates the best-fit values. The solid and dashed contours show the 68% and 95% CL ranges, respectively. The yellow diamond shows the SM point $(c_V, c_F) = (1,1)$.

5 Searches beyond standard model Higgs boson

The CMS collaboration is strongly active in searches for beyond SM Higgs boson. At the moment there is no evidence for any excess above backgrounds but strong constraints are imposed. In following a brief summary is presented.
In an simple extension of the SM two models have been tested. The first one is the SM including a fourth generation of fermions (the SM4 model) where additional heavy quarks in the quark loop associated with the $gg \rightarrow H$ process greatly enhance its production cross-section while other production mechanisms are not affected. The second one includes a fermiophobic (FP) Higgs boson where a Higgs boson couples only to the vector bosons at tree level. In such a model the branching fraction for a low mass FP Higgs boson to decay to two photons is enhanced by an order of magnitude with respect to the SM. For example Figure 8(a) shows the combined 2011 and 2012 exclusion limits on the cross section of a FP Higgs boson decaying into two photons as a function of the boson mass relative to the FP cross section.

Analyses have been performed in the contest both of the Minimal Supersymmetric Standard Model (MSSM) with two Higgs doublets and of the Next-to-Minimal Supersymmetric Standard Model (nMSSM) with additional scalar field. In the search of neutral MSSM Higgs boson produced in association with two spectator $b$-quarks and decaying semi-leptonical to pairs of $b$-quarks, Figure 8(b) shows the observed and expected upper limits with 95% confidence level in the MSSM plane ($M_A$, $\tan\beta$), for $m_{h_{max}}$ benchmark scenario, with $\mu = -200$ GeV, overlaid to the previously published CDF and D0 results.

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Searches have been performed in the extension of the SM which include the
seesaw mechanism of type II, this allows the existent of a doubly charged Higgs boson \cite{29}. The doubly charged Higgs boson is excluded in mass ranges significantly beyond those explored previously by the LEP and Tevatron experiments.

6 Conclusion

Results are presented from searches for the SM Higgs boson in $pp$ collisions at $\sqrt{s} = 7$ and 8 TeV in the CMS experiment at the LHC. An excess of events is observed above the expected background, with a local significance of $5.0\sigma$, at a mass near 125 GeV, signalling the production of a new particle. The results are consistent, within uncertainties, with the expectations for a SM Higgs boson. The searches beyond SM Higgs boson are highlighted and at the moment there is no evidence for any excess above backgrounds but strong constraints are imposed.

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