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Search for a Standard Model Higgs boson in the decay channel H to ZZ to 2l2tau

Abstract

A search for the standard model Higgs boson in the decay mode $ H \to ZZ \to 2l2\tau$, where $l = {\mu, e}$ is presented based on CMS data corresponding to an integrated luminosity of 1.1 fb^{-1} at $\sqrt{s}=7$ TeV. No evidence is found for a significant deviation from standard model expectations anywhere in the ZZ mass range considered in this analysis. An upper limit at 95\% C.L. is placed on the product of the cross-section and decay branching ratio for the Higgs boson decaying with standard model-like couplings, which excludes cross-sections of about ten times the expected value for Higgs boson masses in the range $200 < m_{\rm H} < 400 \, \rm{GeV/c^2}$.
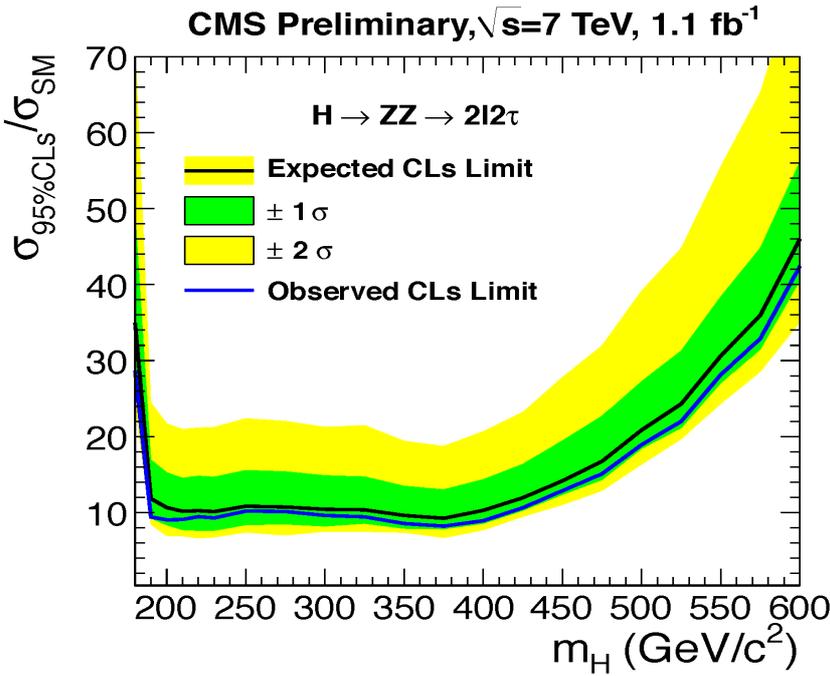
Main Results

In $1.1 \fbinv$ of data one event isobserved in the 8 search channels, in the $eee\tau$ state, as compared to 2.5 background events expected. The reconstructed $2l2\tau$ invariant mass for all decay channels is presented i n Fig.~\ref{figure:invmass}. The stacked background shapes are simulated using MC and normalized to the values obtained using the method outlined above. The expected mass distributions for the SM Higgs with masses $m_{\rm H} = 200$ and $m_{\rm H} = 400 \, \rm{GeV/c^2}$ are also shown. No evidence is found for a significant deviation from standard model expectations anywhere in the ZZ mass range considered in this analysis. The total signal acceptance, which also includes the branching ratios of individual tau channels, varies between 0.01--0.02 for a Higgs mass of 200 GeV and various tau decay channels and increases by factor of three to four towards 450 GeV. This is expected since the final-state leptons produced in tau decays are softer than those from direct $Z \to ll$ production and the selection requirements and lepton reconstruction become more efficient at high Higgs masses.
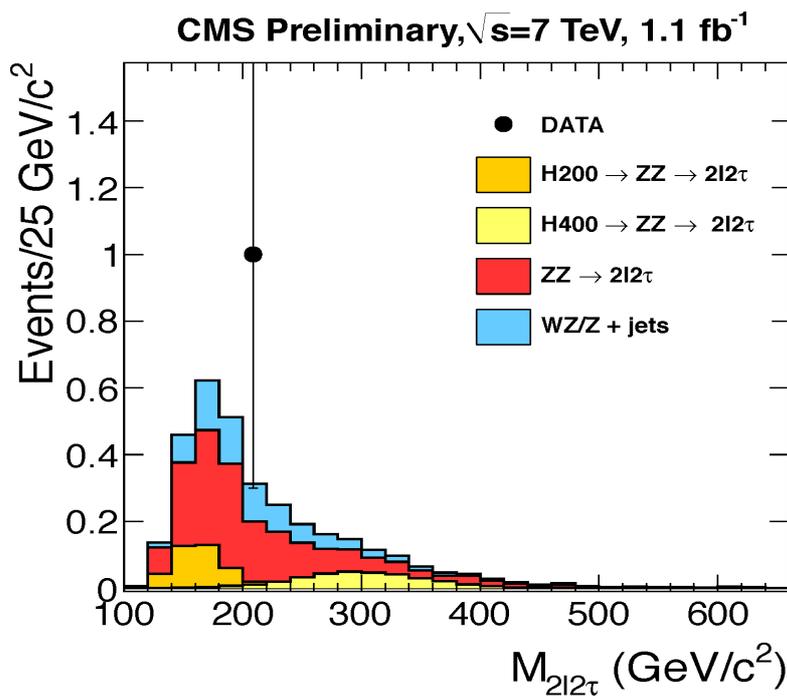
Expected and observed 95\% C.L. (confidence level) upper limits are set on the cross-section ratio to the nominal SM Higgs cross-section using the modified frequentist construction CL$_{\rm{s}}$$~\cite{CLS1, CLS2}. They are presented as a function of the Higgs mass in Fig.~\ref{figure:limitPlot}. The bands represent the 1σ and 2σ probability intervals around the expected limit. The upper limit on the cross-section is approximately ten times the SM cross-section in the range of $200 < m_{\rm H} < 400 \, \rm{GeV/c^2}$.

Figures from HIG-11-013

| Figure	Label	Description
	pdf	The expected and observed 95\% C.L. upper limits on the product of the production cross-section and decay branching ratio for a Higgs boson normalized to the SM expectation as a function of $m_{\rm H}$. At $m_{\rm H} = 180\, \rm{GeV/c^2}$ the less restrictive limit is due to the rapidly decreasing branching ratio of $H \to ZZ$ in the SM.

CMS Preliminary,$\sqrt{s}$=7 TeV, 1.1 fb^{-1}

$H \to ZZ \to 2l2\tau$

Expected CLs Limit
$\pm 1\sigma$
$\pm 2\sigma$
Observed CLs Limit

$\sigma_{95\%CLs}/\sigma_{SM}$

m_H (GeV/c^2)

The one- and two-standard-deviation ranges are also shown.

CMS Preliminary,$\sqrt{s}$=7 TeV, 1.1 fb^{-1}

Events/25 GeV/c^2

DATA
H200 $\to$ ZZ $\to$ 2l2τ
H400 $\to$ ZZ $\to$ 2l2τ
ZZ $\to$ 2l2τ
WZ/Z + jets

$M_{2l2\tau}$ (GeV/c^2)

pdf | The four-lepton reconstructed mass summed for all $2l2\tau$ final states. The data corresponds to an integrated luminosity of 1.1 \fbinv. The stacked background shapes are the result of a MC simulation and normalized to the values obtained using the data--driven techniques explained in the text. The expected mass distributions for the SM Higgs boson with a mass 200 or 400 GeV are also shown.

pdf | Comparison between data and simulation for the background estimation in same-sign, anti-isolated control region for $\mu \mu \tau \tau$ (left plot) events.

Comparison between data and simulation for the background estimation in same-sign, anti-isolated control region for $ee \tau \tau$ (right plot) events.
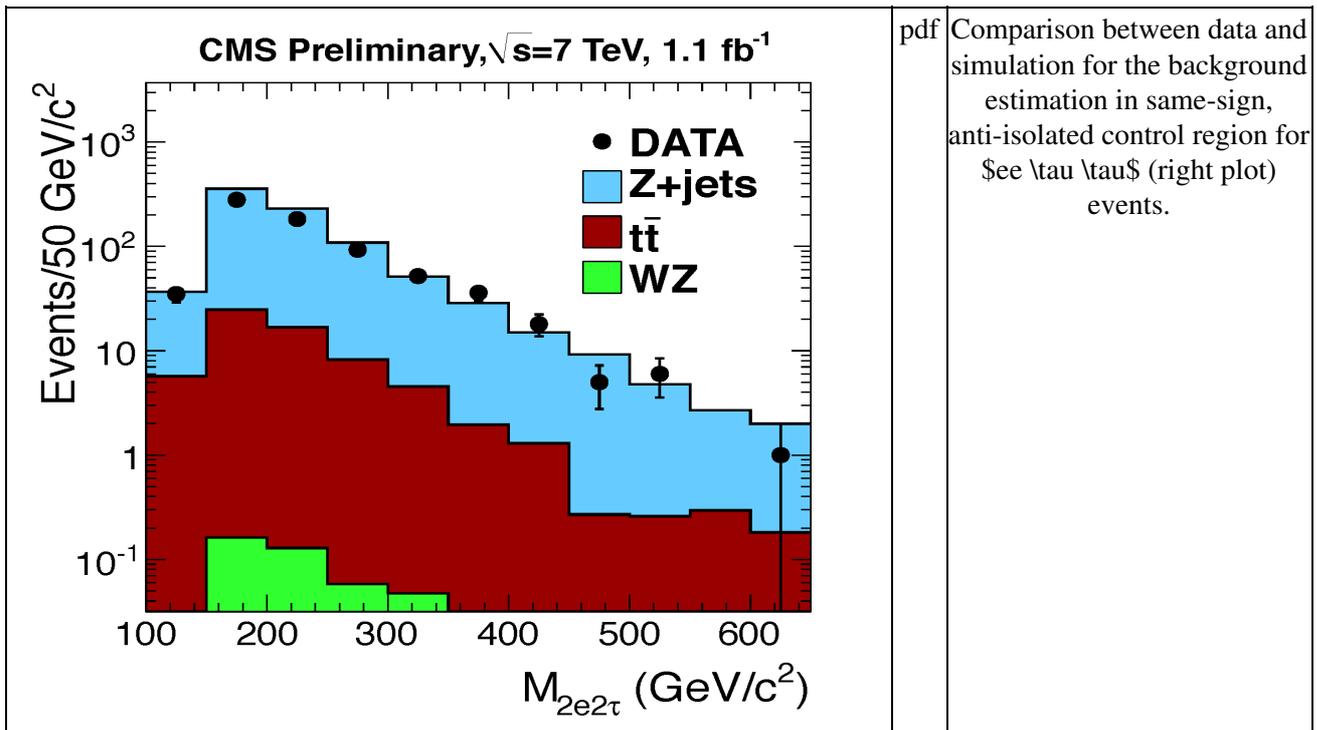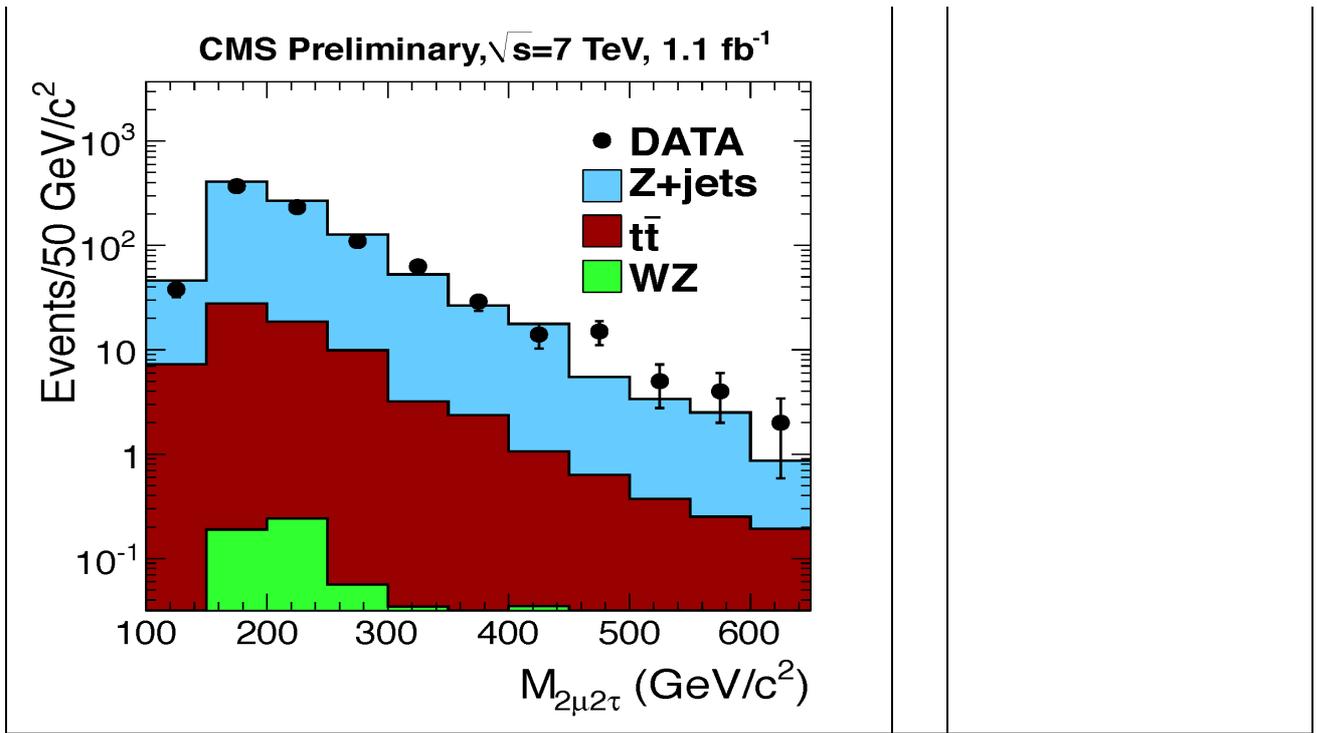
-- AlexanderSavin - 21-Aug-2011

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