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# Combination of Higgs Searches (Lepton Photon 2011)

This is a condensed description with plots for the analysis [LINK TO CDS](#)

## Abstract

The overall combination is presented of eight standard model (SM) Higgs boson searches performed by the CMS Collaboration using the following Higgs boson decay signatures:  $H \rightarrow \gamma\gamma$ ,  $H \rightarrow ZZ$ ,  $H \rightarrow WW$ ,  $H \rightarrow \tau\tau$ ,  $H \rightarrow b\bar{b}$ ,  $H \rightarrow \tau W$ ,  $H \rightarrow Z\gamma$ ,  $H \rightarrow Z\tau$ , and  $H \rightarrow Zq$ . Depending on the analysis, the amount of data used corresponds to 1.1-1.7  $\text{fb}^{-1}$  of integrated luminosity. The SM Higgs boson is excluded at 95% C.L. in three mass ranges 145-216, 226-288, and 310-400  $\text{GeV}/c^2$ . The expected exclusion in the absence of a signal is 130-440  $\text{GeV}/c^2$ . The largest excursion of the observed data from the expected has a probability of 0.4 after taking into account the look-elsewhere effect. At 90% C.L., we exclude the SM Higgs boson in the continuous mass range from 144-440  $\text{GeV}/c^2$ . The reported limits were obtained using the modified frequentist construction known as the CLs method.

## Plots

Figure set	Description	Variants
	<p><b>The CLs value for the standard model Higgs hypothesis as a function of the Higgs boson mass in the range 110-600 <math>\text{GeV}/c^2</math>.</b></p> <p>The observed values are shown by a solid line. The dashed black line indicates the median expected CLs value for the background-only hypothesis, while the green/yellow bands indicate the ranges that are expected to contain 68%/95% of all observed limit excursions from the median. The three red horizontal lines show confidence levels of 90%, 95%, and 99% defined as <math>(1 - \text{CLs})</math>.</p>	<p>linear x (<a href="#">png</a>, <a href="#">eps</a>, <a href="#">pdf</a>)</p> <p>log x (<a href="#">png</a>, <a href="#">eps</a>, <a href="#">pdf</a>)</p> <p>low mass (<a href="#">png</a>, <a href="#">eps</a>, <a href="#">pdf</a>)</p>
	<p><b>The combined 95% C.L. upper limits on the signal strength modifier <math>\mu = \sigma/\sigma_{\text{SM}}</math> as a function of the SM Higgs boson mass in the range 110-600 <math>\text{GeV}/c^2</math>.</b></p> <p>The observed limits are shown by the solid symbols and the black line. The dashed line indicates the median expected limit on <math>m</math> for the background-only hypothesis, while the green/yellow bands indicate the ranges that are expected to contain 68%/95% of all observed limit excursions from the median.</p>	<p>linear x (<a href="#">png</a>, <a href="#">eps</a>, <a href="#">pdf</a>)</p> <p>log x (<a href="#">png</a>, <a href="#">eps</a>, <a href="#">pdf</a>)</p> <p>low mass (<a href="#">png</a>, <a href="#">eps</a>, <a href="#">pdf</a>)</p>
	<p><b>The combined 95% C.L. upper limits on the signal strength modifier <math>\mu = \sigma/\sigma_{\text{SM}}</math> as a function of the SM Higgs boson mass in the range 110-600 <math>\text{GeV}/c^2</math>.</b></p> <p>The observed limits are shown by the solid symbols and the black line. The dashed line indicates the median expected limit on <math>m</math> for the background-only hypothesis, while the green/yellow bands indicate the ranges that are expected to contain 68%/95% of all observed limit excursions from the median. The mass ranges excluded by LEP, by Tevatron and by this result are shown as hatched areas.</p>	<p>linear x (<a href="#">png</a>, <a href="#">eps</a>, <a href="#">pdf</a>)</p> <p>log x (<a href="#">png</a>, <a href="#">eps</a>, <a href="#">pdf</a>)</p> <p>low mass (<a href="#">png</a>, <a href="#">eps</a>, <a href="#">pdf</a>)</p>
	<p><b>The combined 95% C.L. upper limits on the signal strength modifier <math>\mu = \sigma/\sigma_{\text{SM}}</math> as a function of the SM Higgs boson mass in the range 110-600 <math>\text{GeV}/c^2</math>.</b></p> <p>The observed limits are shown by the solid symbols and the black line. The dashed line indicates the median expected limit on <math>m</math> for the background-only hypothesis, while the green/yellow bands indicate the ranges that are expected to contain 68%/95% of all observed limit excursions from the median. The Tevatron observed and expected limits are also shown.</p>	<p><a href="#">png</a>, <a href="#">pdf</a></p>
	<p><b>The 95% C.L. upper limits on the signal strength modifier <math>\mu = \sigma/\sigma_{\text{SM}}</math> as a function of the SM Higgs boson mass in the range 110-600 <math>\text{GeV}/c^2</math> for the eight</b></p>	<p>linear x (<a href="#">png</a>, <a href="#">eps</a>, <a href="#">pdf</a>)</p>

	<p><b>major analyses and their combination.</b>                  The limits are obtained with the CLs method. The solid lines show the observed limits, while the dashed lines indicate the median expected assuming the <i>background-only</i> hypothesis.</p>	<p>log x (png, eps, pdf)                  low mass (png, eps, pdf)</p>
	<p><b>The observed 95% C.L. upper limits on the signal strength modifier <math>\mu = / \sigma_{SM}</math> as a function of the SM Higgs boson mass in the range 110-600 GeV/c<sup>2</sup> for the eight major analyses and their combination.</b>                  The limits are obtained with the CLs method.</p>	<p>linear x (png, eps, pdf)                  log x (png, eps, pdf)                  low mass (png, eps, pdf)</p>
	<p><b>The expected 95% C.L. upper limits on the signal strength modifier <math>\mu = / \sigma_{SM}</math> as a function of the SM Higgs boson mass in the range 110-600 GeV/c<sup>2</sup> for the eight major analyses and their combination.</b>                  The limits are obtained with the CLs method.</p>	<p>linear x (png, eps, pdf)                  log x (png, eps, pdf)                  low mass (png, eps, pdf)</p>
	<p><b>The local <i>p</i>-values (top) and observed best-fit signal strength <math>\mu = / \sigma_{SM}</math> (bottom) vs Higgs boson mass.</b>                  The <i>p</i>-value is an estimated probability of upward background fluctuations as high or higher than the excesses observed in data. After taking into account the look-elsewhere effect (see text), the probability to see an excess at least as large as the one observed in data is 0.4. The <math>\mu</math> value indicates by what factor the SM Higgs cross section would have to be rescaled to best match the observed data.</p>	<p>linear y (png, eps, pdf)                  log y (png, eps, pdf)                  low mass linear y (png, eps, pdf)                  low mass log y (png, eps, pdf)</p>
	<p><b>The overall combined local <i>p</i>-values (solid black line) and contributions of individual channels entering the combination vs. Higgs boson mass.</b>                  The <i>p</i>-value is an estimated probability of upward background fluctuation as high or higher than the excesses observed in data. After taking into account the look-elsewhere effect (see text), the probability to see an excess at least as large as the one observed in data is 0.4.</p>	<p>linear x (png, eps, pdf)                  log x (png, eps, pdf)                  low mass (png, eps, pdf)</p>

## Tables

The following tables are also available as individual files in text format:

- CLs of SM Higgs Hypothesis
- CLs limit on  $\mu = / \sigma_{SM}$
- Local *p*-values

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