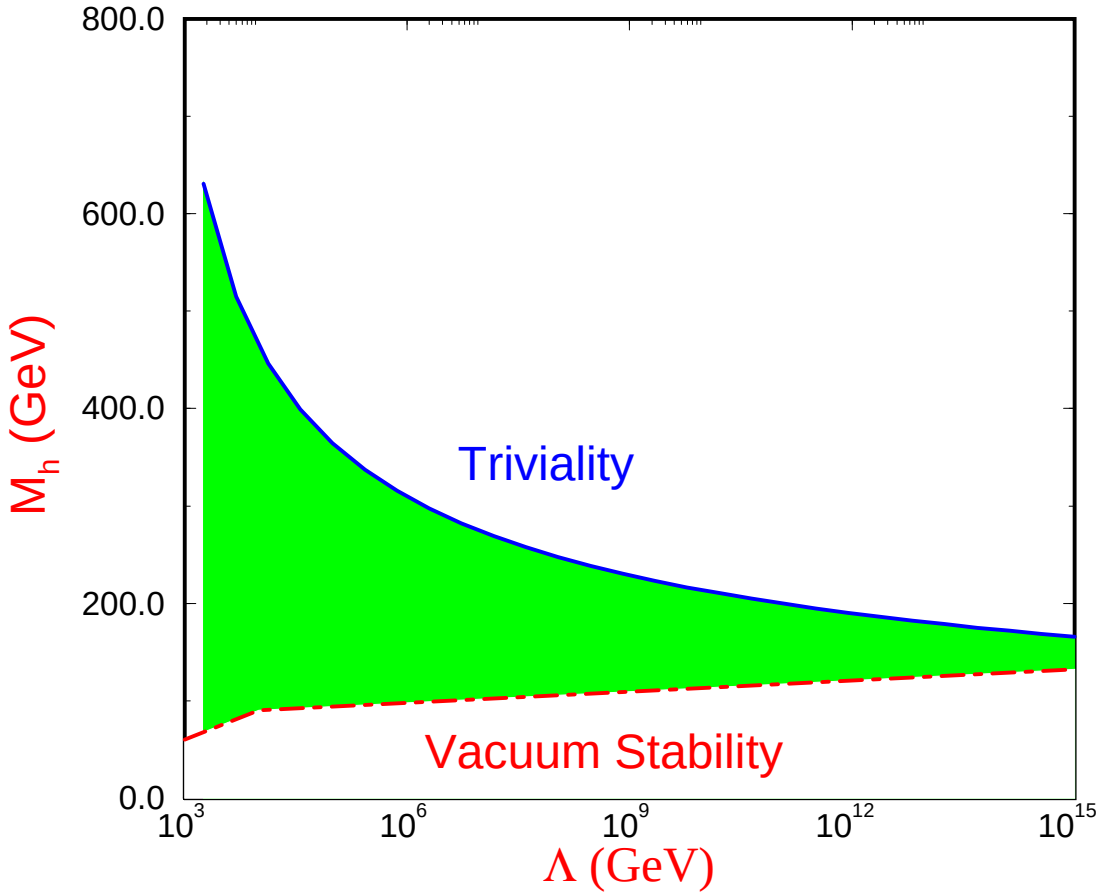
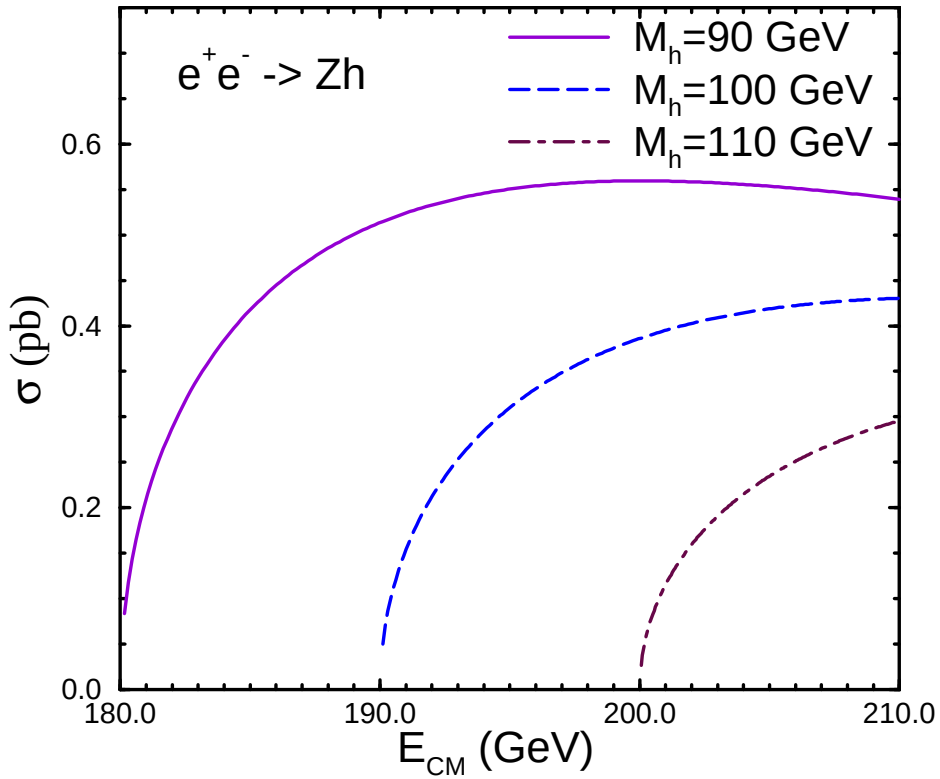
Indirect *theoretical* bounds on m_h



Higgs Production at e^+e^-

$$\sigma(e^+e^- \to Zh) = \frac{\pi\alpha^2\lambda_{Zh}^{1/2}[\lambda_{Zh} + 12\frac{M_Z^2}{s}][1 + (1 - 4\sin^2\theta_W)^2]}{192s\sin^4\theta_W\cos^4\theta_W(1 - M_Z^2/s)^2}$$

$$\lambda_{Zh} \equiv (1 - \frac{M_h^2 + M_Z^2}{s})^2 - \frac{4M_h^2M_Z^2}{s^2} \qquad s = (p_{e^+} + p_{e^-})^2$$



Searches at LEP (e^+e^- $\sqrt{s} = 90 - 210$ GeV) $\Rightarrow M_H \leq 114.4$ GeV

The Higgs Decay Modes

$$\Gamma(h \to f\bar{f}) = \frac{G_F m_f^2(N_c)}{4\sqrt{2}\pi} M_h (2 - r_f)^{\frac{3}{2}} \qquad r_i \equiv \frac{4M_i^2}{M_h^2}$$

$$\Gamma(h \to W^+W^-) = \frac{G_F M_h^3}{8\pi\sqrt{2}} \sqrt{1 - r_W}(1 - r_W + \tfrac{3}{4} r_W^2)$$

$$\Gamma(h \to ZZ) = \frac{G_F M_h^3}{8\pi\sqrt{2}} \sqrt{1 - r_Z}(1 - r_Z + \tfrac{3}{4} r_Z^2)$$

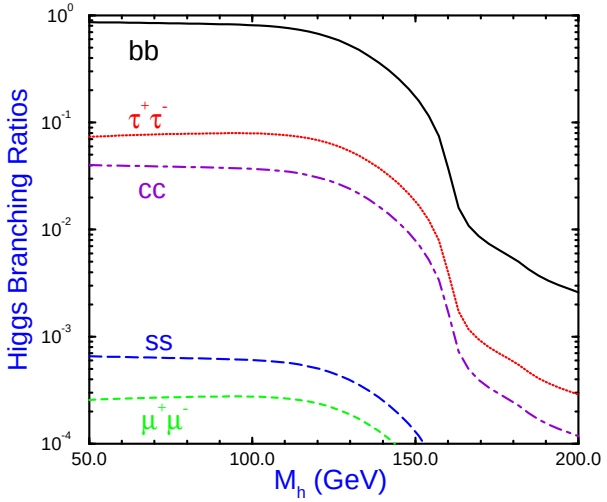
$$\Gamma_0(h \to gg) = \frac{G_F \alpha_s^2 M_h^3}{64\sqrt{2}\pi^3} \mid \sum_q F_{1/2}(r_q) \mid^2 \qquad \Gamma(h \to \gamma\gamma) = \frac{\alpha^2 G_F}{128\sqrt{2}\pi^3} g_V M_h^3 \mid \sum_{q,W} N_{ci} Q_i^2 F_i(r_i) \mid^2$$

$$F_{1/2}(r_q) \equiv -2r_q[1 + (1 - r_q) f(r_q)]$$

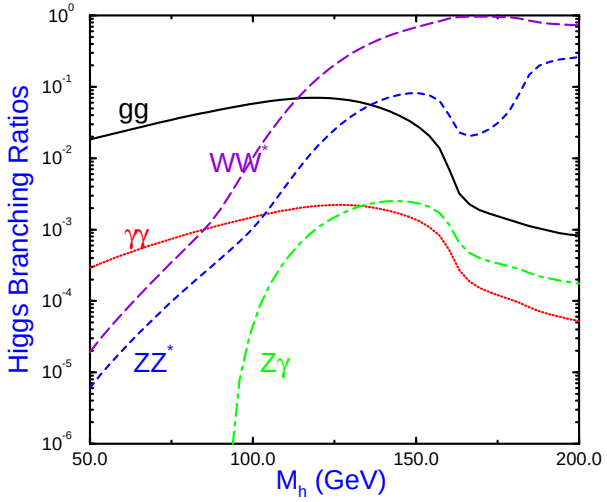
$$F_W(r_W) = 2 + 3r_W[1 + (2 - r_W) f(r_W)]$$

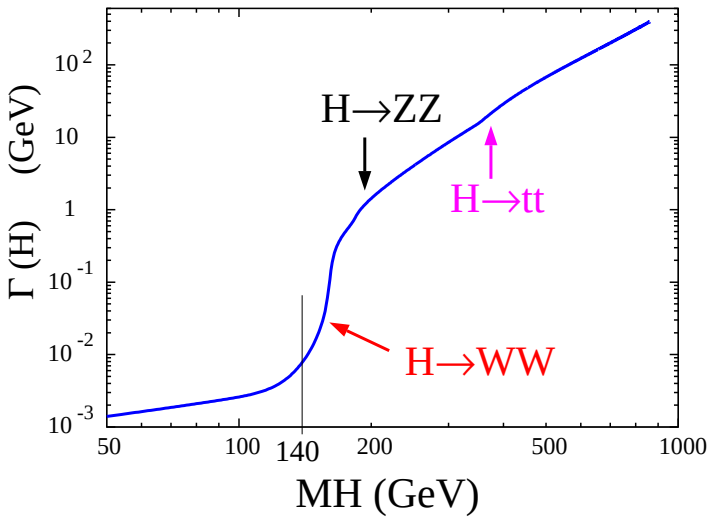
$$f(x) = \begin{cases} \sin^{-2}(\sqrt{1/x}), & \text{if } x \geq 1 \\ -\frac{1}{4}\left[\log\left(\frac{1+\sqrt{1-x}}{1-\sqrt{1-x}}\right) - i\pi\right]^2, & \text{if } x < 1, \end{cases}$$

Higgs Branching Ratios to Fermion Pairs

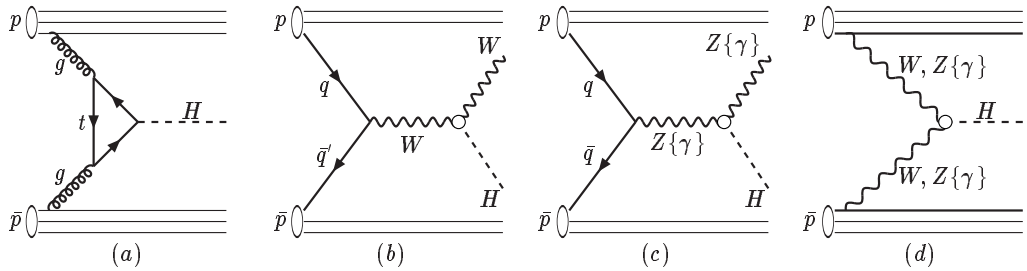


Higgs Branching Ratios to Gauge Boson Pairs

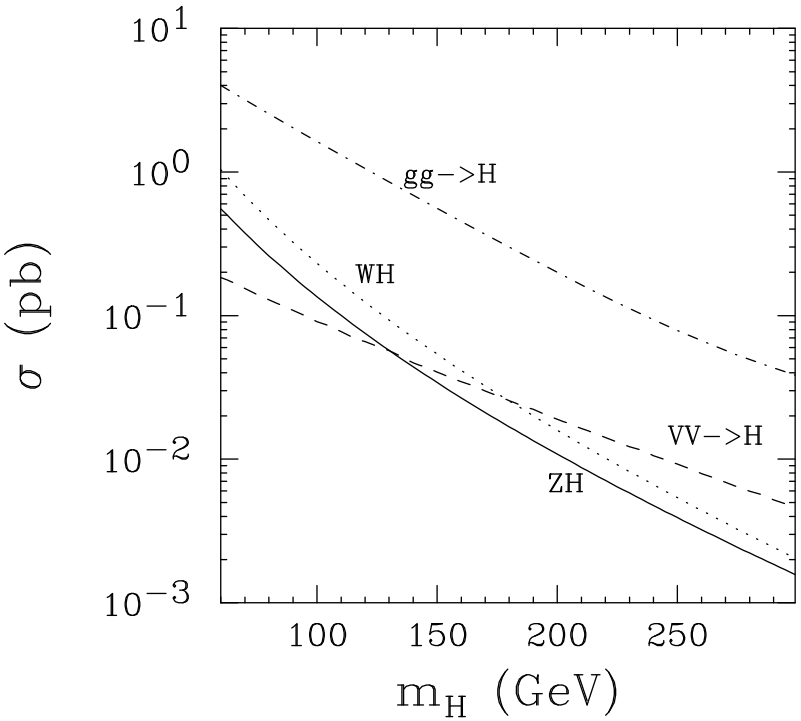




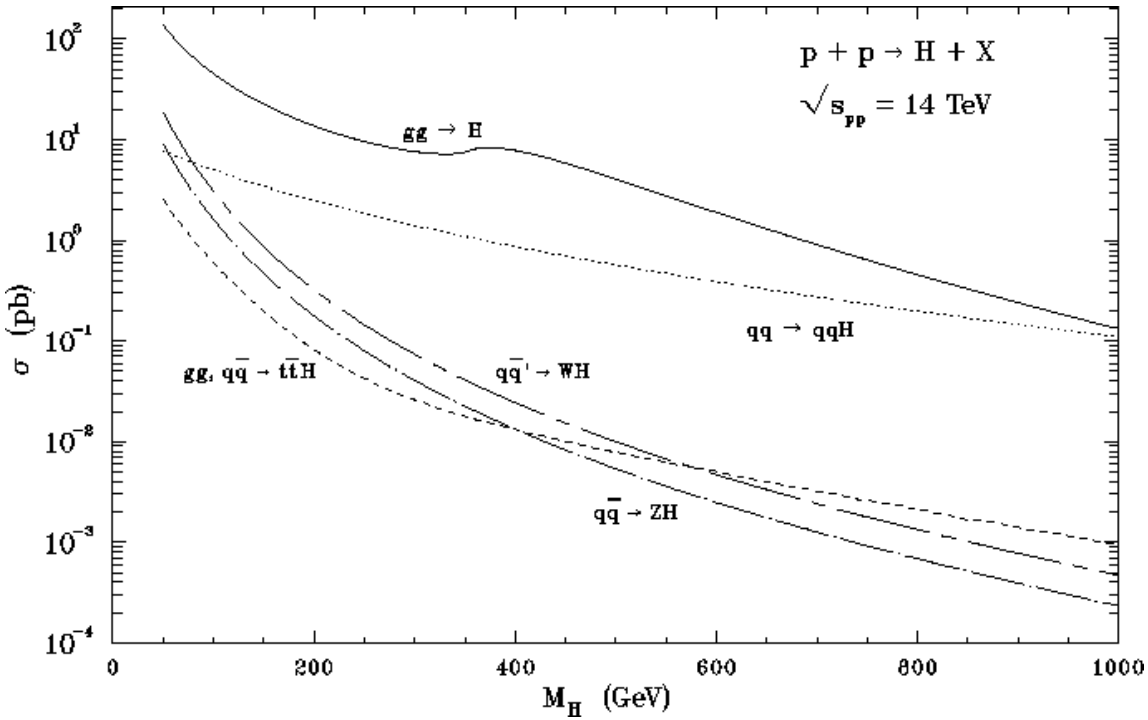
Higgs Production at Hadron Colliders



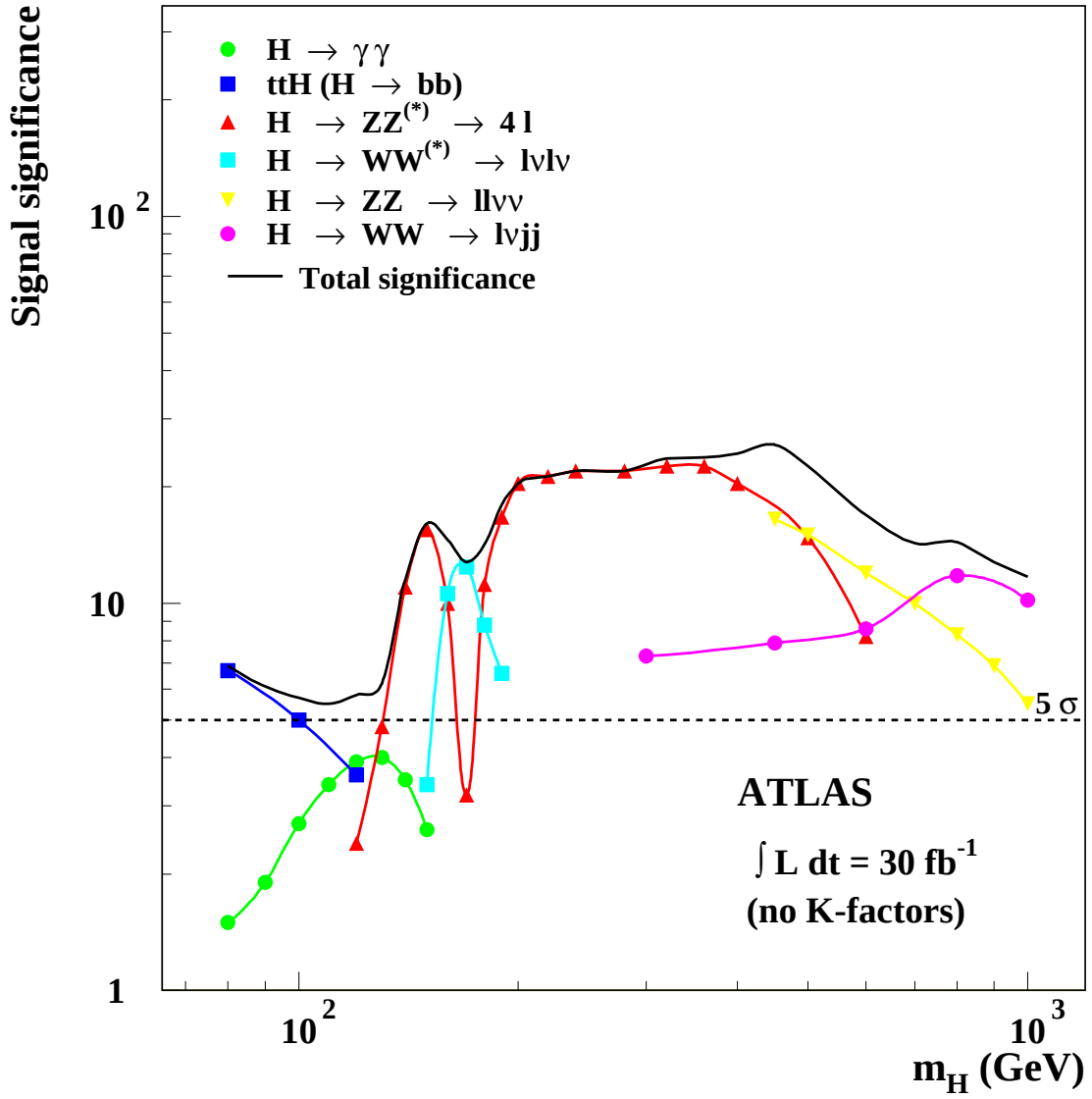
Tevatron ($p\bar{p}$ $\sqrt{s} = 2$ TeV)



LHC (pp $\sqrt{s} = 14$ TeV)



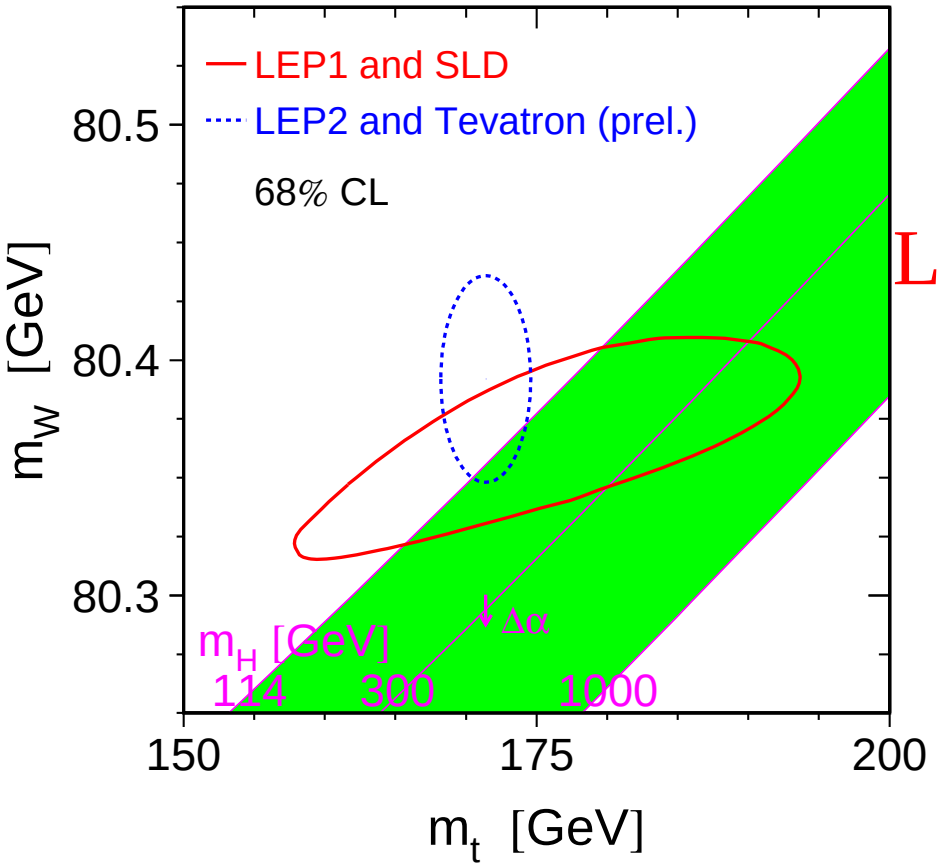
Discovery Potential at LHC for SM Higgs



Indirect bound on m_h from M_W versus m_{top}

At one loop

$$M_W^2 \left(1 - \frac{M_W^2}{M_Z^2}\right) = \frac{\pi\alpha}{\sqrt{2}G_F} \frac{1}{1 - \Delta r(m_{top}, m_h)}$$



Light higgs favoured