Annual Progress Report for JFY 2011

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CDF Experiment

Spokespersons
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The Fermilab Tevatron proton-antiproton collider and the CDF experiment ceased their operations on September 30, 2011. It marks an end of an era for experimental particle physics after thirty years of history and rich physics results.

The year 2011 was special on its own. Tevatron achieved records in instantaneous luminosity, which is 4.31×10^{32} cm^{-2} s^{-1}, as well as in integrated luminosity in a single store, integrated luminosity in a week, and integrated luminosity in a year.

In Run II, which started in 2001, Tevatron delivered 12 fb^{-1} and CDF recorded 10 fb^{-1}. CDF has continued to produce many physics results. We list only two here. One is the most precise measurement to date of the W boson mass,

$$M_W = 80387 \pm 19 \ \ \text{MeV}/c^2,$$

which surpasses the precision of all previous measurements combined (23 MeV/c^2). The W boson mass, combined with precision top quark mass measurements, provides useful constraints on the Higgs boson mass (Figure 1).

The other is the direct searches for the Higgs boson. CDF has improved sensitivity over previous searches and now is capable of excluding the almost entire region of the Higgs boson mass below 180 GeV/c^2 if it is not there. At the Tevatron energy most of the sensitivity comes from the final states involving $b\bar{b}$ for low mass Higgs, and it is unlike and complementary to the LHC experiments. New results, combined with the D0 experiment, exclude the mass region $147 < M_H < 175$ GeV/c^2 at a 95% confidence level (Figure 2(left)). More interestingly, CDF observes an excess of events that are consistent with the Higgs boson with a mass of 107 to 142 GeV/c^2, with a local significance corresponding to 2.6 standard deviations (σ) at 120 GeV/c^2. When combined with the results by the D0 experiment, the significance is at 2.8 σ. When we consider the possibility that such an excess can appear at any mass due to background fluctuations, the corresponding significance is at 2.2 σ. The production cross section, if the excess is assumed to be signal, is consistent with standard model predictions (Figure 2(right)).

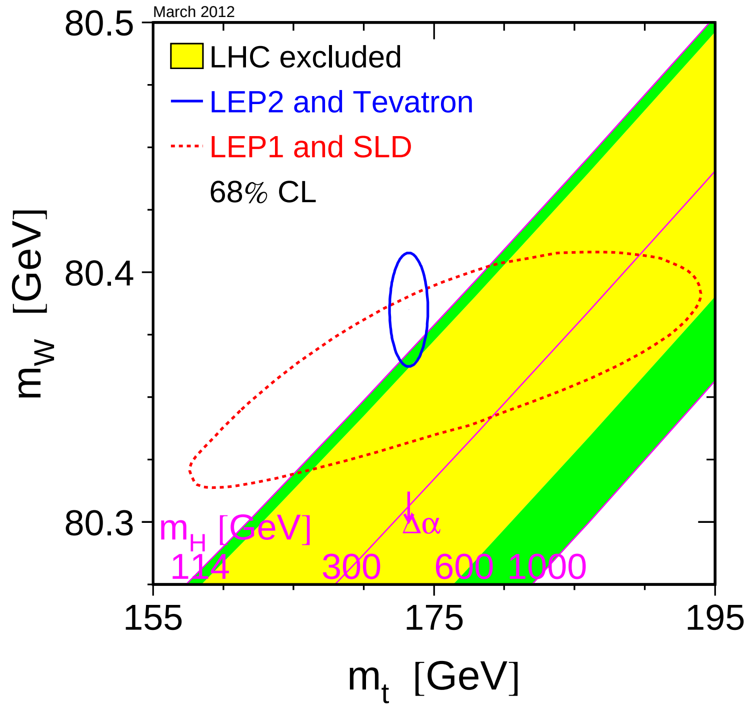

Figure 1: W boson and top quark masses and constraints on the Higgs boson.

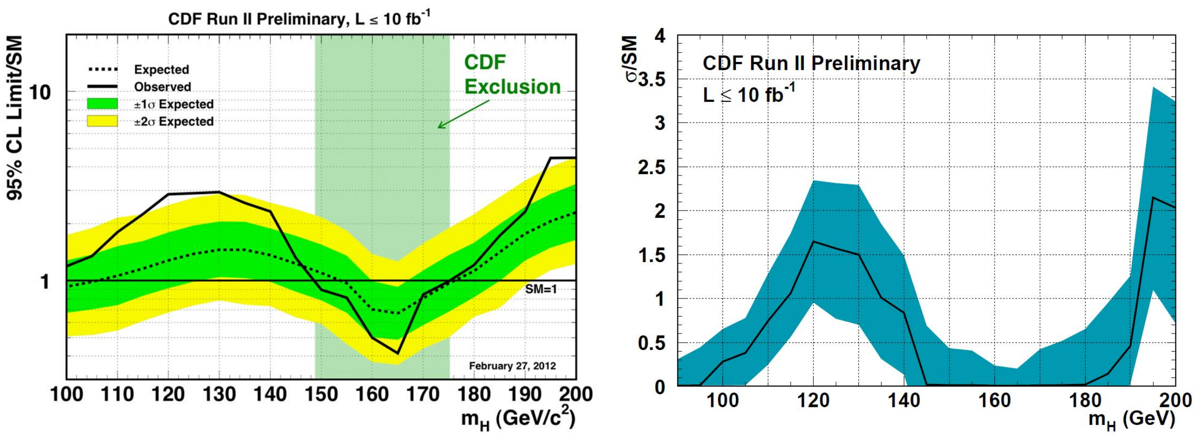

Figure 2: Higgs searches at CDF. Left: upper limits on Higgs boson production normalized to standard model predictions. Right: strength of possible Higgs boson signal.