HIGGS SEARCHES AT TEVATRON

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We present the searches for the standard model and minimal super-symmetric standard model Higgs bosons at CDF and DØ experiments. We start combining several Higgs boson searches and showing a prospect for the Tevatron Higgs searches in the near future.

1. Introduction

The Higgs boson is the only particle which is predicted by the standard model (SM) and yet discovered. Unfortunately, the SM cannot predict the exact mass of it. However, the renormalization theory predicts that it would be as light as the range of a hundred GeV or new physics lies. The LEP experiments excluded the Higgs boson whose mass is less than 114GeV [1]. The global fits based on the experimental results which has been measured by the past experiments predicts that the mass of the Higgs boson would be between about 100GeV and 200GeV. Tevatron is currently the only place where we can search for the SM Higgs boson. CDF and DØ have looked for them, using possible production and decay channels at Tevatron. In this proceedings, we present the search for the SM Higgs boson, using 14 independent production and decay channels.

Tevatron is also looking for the Higgs boson with the extension of the SM. One example is two-Higgs-doublet model of electroweak symmetry breaking, such as the minimal super-symmetric model (MSSM). In this model, there are five physical Higgs bosons: two neutral CP-even scalars, h and H; a neutral CP-odd state, A; and two charged states, $H^{\pm}$. The lightest Higgs boson, h, is predicted the mass of it to be less than 135GeV. We present the search for the neutral MSSM Higgs boson from DØ and

CDF, and for the charged Higgs boson search from CDF.

2. SM Higgs boson searches

If the mass of the Higgs boson is lighter than 135 GeV, associated production with Z or W(WH or ZH production), where H decays to $b\bar{b}$, and Z decays to $\nu\bar{\nu}$ or W decays to $l\nu$, is most sensitive way to search for SM Higgs boson. In these analysis, the lepton identification is used for the selection of the W+jets candidate, and the large missing transverse energy is used for selection of the Z+jets candidate. To be b flavor jets is crucial to identify whether the dijet comes from H decay or not. We required b-tagging to the jets in the W or Z+jets candidates, and searched for the Higgs boson signature from the dijet invariant mass distribution. CDF studied single b-tagged jets, where at least one jet passed through the b-tagging requirement. DØ studied the both single b-tagged jets and the double b-tagged jets, where two leading jets passed through the b-tagging requirement.

If the mass of the Higgs boson is heavier than 135 GeV, the decay of Higgs boson to WW is dominant process. Therefore, we can use $H \to WW$ decay with associated production with W (WWW final state), and with the gluon fusion production from $p\bar{p}$ collision (WWX final state) [3]. Selecting two opposite and same charge leptons from two W decays can select WWX and WWW signals, respectively, with suppressing the SM backgrounds.

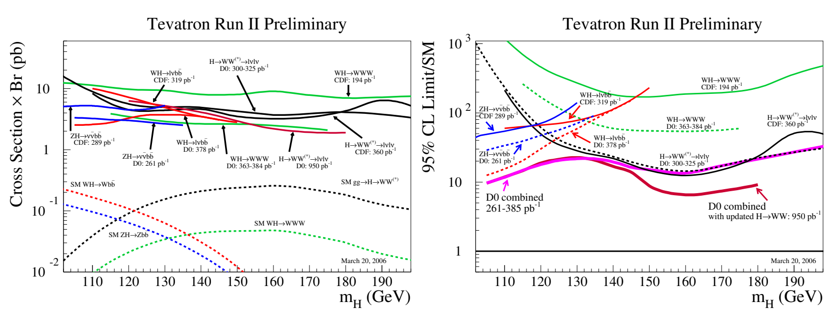

Figure 1. 95% upper limits on SM Higgs boson. Left shows limits of the cross section times branching fraction for the individual channels, DØ combined result, and SM expectation. Right shows the cross section scale factor defined by the ratio of 95% limit devided to SM expectation.

Since no evidence of the Higgs boson was found, we set the 95% confidence level upper limits on the cross section times branching fraction for each decay channels as shown in Figure 1. The several Higgs productions, the Higgs decay channels, and the analysis method like b-tagging requirements give us 14 independent analysis for the SM Higgs boson search. DØ started combining all of these SM Higgs boson searches using between 261pb^{-1} and 385pb^{-1} of the data, and set 95% confidence level upper limit of the combining Higgs boson production. So far, the limit is a factor of 10 to 20 away from SM prediction. This result indicated that we may start seeing more than what LEP measured, when the luminosity reaches at a few fb^{-1}. To achieve it, we need advanced analysis like the neural net analysis, improved jet energy resolution using information of tracks as well as energy deposit in the calorimeter, additional new channels, and combination with CDF results.

3. MSSM Higgs boson searches

DØ and CDF reported neutral MSSM Higgs boson ($A/h/H$), using $hb\bar{b} \rightarrow b\bar{b}b\bar{b}$ [4] and $A \rightarrow \tau^+\tau^-$ final state [5,6]. The production rate of them are enhanced by $\tan\beta$, which is the ratio of two vacuum expectation values of two Higgs boson fields (i.e. v_u/v_d). Therefore, Tevatron has capability of the search of them for large $\tan\beta$. Figure 2 shows the 95% C.L. exclusion space as a function of $\tan\beta$ and the mass of the MSSM Higgs boson (M_A). DØ limits show the combination between $hb\bar{b}$ and $A \rightarrow \tau^+\tau^-$ analysis. CDF limits show the limits for the $A \rightarrow \tau^+\tau^-$ analysis. We already started excluding large part of parameter space, especially, the region of high $\tan\beta$.

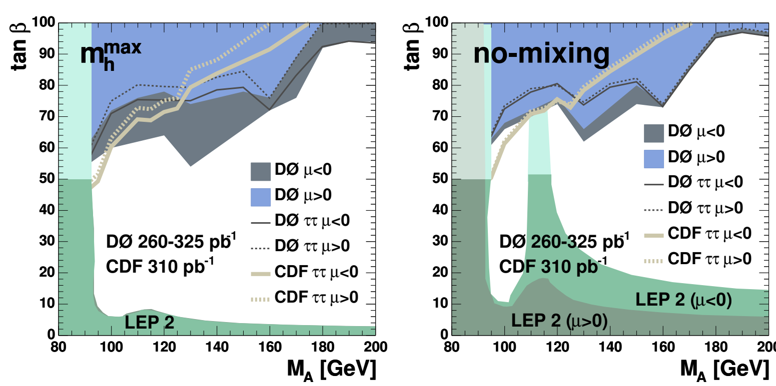

Figure 2. The 95% C.L. exclusion space as a function of the $\tan\beta$ and mass of the MSSM Higgs boson (M_A) from the neutral Higgs boson searches. Two benchmark scenarios are performed (no mixing and maximum mixing scenarios).

Since Tevatron is only place where can produce the t-quark, the search for the difference from SM t-quark decay can tell us the indication of the charged Higgs boson. CDF searched for it using dilepton and lepton plus jets decays. Since no evidence was found, CDF set 95% C.L. exclusion space as a function of the mass of the charged Higgs boson (M_{H^+}) and $\tan\beta$ as shown in Figure 3. We already started excluding some parameter space.

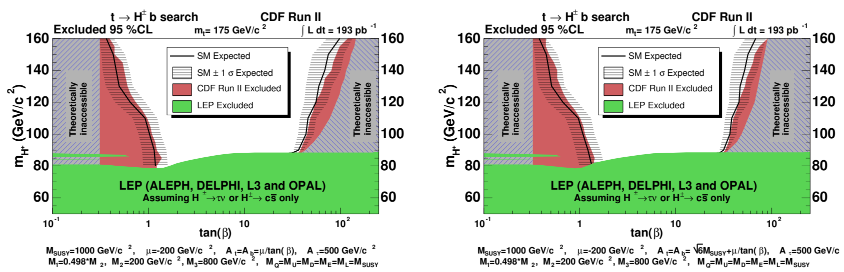

Figure 3. The 95% C.L. exclusion space as a function of the $\tan\beta$ and mass of the CDF MSSM Higgs boson (M_{H^+}) from charged Higgs boson search. Two benchmark scenarios are performed (no mixing and maximum mixing scenarios).

4. conclusion

DØ and CDF have searched for the SM Higgs boson and MSSM Higgs boson, using a lot of possible production and decay channels at Tevatron. We started combining Higgs searches using the several channels. So far, our sensitivity for SM Higgs boson is a factor of 10 to 20 away from SM prediction, and we started excluding significant parameter space for MSSM. The sensitivity of our result is encouraging for a discovery at Tevatron, if we collect the foreseen luminosity, and if Nature is friend to us.

References

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