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DØ HIGGS PHYSICS RESULTS

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We have searched for the Standard Model (SM) and non Standard Model Higgs bosons using of about 200–260 pb^{-1} of data collected with the upgraded Run II DØ detector at Fermilab Tevatron. Low-mass SM Higgs boson is searched in the associated production with W or Z and limits are placed on the cross section and the kinematic properties of the W or Z plus heavy flavor production. SM Higgs boson with mass greater than 135 GeV is searched for in its dominant decay mode WW with W's decaying into electron or muon final states. Non SM Higgs searches are done in the associated production of neutral SUSY Higgs with b quarks. Data are compared to various predictions and the limits are derived on model parameters.

1. Introduction

Deciphering the mechanism that breaks the electroweak symmetry and generates the masses of the known fundamental particles is one of the most important missions of present and future high-energy colliders. These are believed to be generated by Higgs mechanism.

2. Standard Model Higgs boson searches

The strategies for searching for Standard Model Higgs boson is a function production channels and its decay modes. Depending on the mass of Higgs (H) boson there are two search strategies at Tevatron at $\sqrt{s} = 1.96$ TeV:

- Associated production of H with W or Z with $H \to b\bar{b}$ decay mode for $m_H < 135$ GeV
- Gluon fusion $gg \to H$ with $H \to WW^*$ decay mode for $m_H > 135$ GeV

2.1. *Higgs boson search for $m_H < 135$ GeV*

Higgs boson with mass m_H between 105 and 135 GeV is searched in the production channel $p\bar{p} \to WH \to e\nu b\bar{b}$. The expected WH cross section is of the order of 0.2 pb for this mass range.

Assuming that the six observed events are consistent with the SM, without contributions from $Wb\bar{b}$ and WH, we set a 95% C.L. upper limit of 6.6 pb on the $Wb\bar{b}$ cross section, for $p_T^b > 20$ GeV and $\Delta R_{bb} > 0.75$. The expected contribution from the $b\bar{b}$ decay of a SM Higgs boson, with $m_H =$ 115 GeV produced with a W, is also shown in Fig. 1 (left).

In the absence of a signal, we set a limit on the cross section for $\sigma(p\bar{p} \to WH) \times BR(H \to b\bar{b})$ of 9.0 pb at the 95% C.L., for a 115 GeV Higgs boson. The limit on the cross section for other masses along with $m_H = 115$ GeVis shown in Fig. 1 (right).

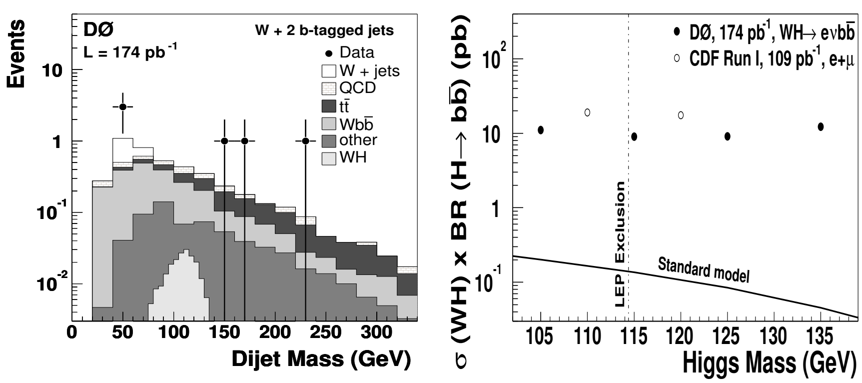

Figure 1. Left: Distribution of the dijet invariant mass for $W + 2$ b-tagged events, compared to expectation (cumulative). The expectation for a 115 GeV Higgs boson from WH production is also shown. Right: 95% C.L. upper limit on $\sigma(p\bar{p} \to WH) \times BR(H \to b\bar{b})$ compared to the SM expectation at $\sqrt{s} = 1.96$ TeV, and to CDF results, which were obtained at $\sqrt{s} = 1.8$ TeV. The predicted WH cross section at 1.96 TeV is approximately 15% larger than that at 1.8 TeV.

We have measured the ratio of inclusive cross sections for $p\bar{p} \to Z + b$ jet to $p\bar{p} \to Z$+jet production. The inclusive $Z + b$-jet reaction is an important background to searches for the Higgs boson in associated ZH production at the Fermilab Tevatron collider. Our measurement is the first of its kind, and relies on the $Z \to e^+e^-$ and $Z \to \mu^+\mu^-$ modes. The combined measurement of the ratio yields 0.023 ± 0.005 for hadronic jets with transverse momenta $p_T > 20$ GeV and pseudorapidities $|\eta| < 2.5$, consistent with next-to-leading order predictions of the standard model.

2.2. *Higgs boson search for* $m_H > 135$ *GeV*

Higgs boson for $m_H > 135\,GeV$ is searched in the channels $H \rightarrow WW^{(*)} \rightarrow l^+\nu l^{*-}\bar{\nu}$ $(l = e, \mu)$. The number of events observed is consistent with expectations from standard model backgrounds. Limits from the combination of the $ee, \mu\mu$ and $e\mu$ channels on the production cross section times branching ratio $\sigma \times BR(H \rightarrow WW^{(*)})$ are shown in Fig. 2.

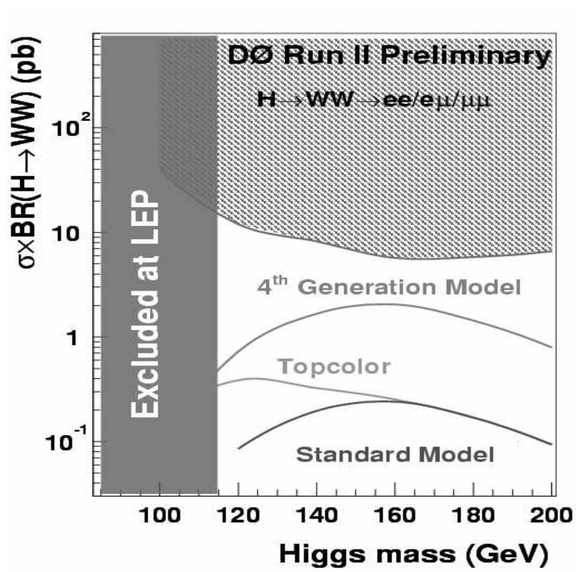

Figure 2. Excluded cross section times branching ratio $\sigma \times BR(H \rightarrow WW^{(*)})$ at 95% C.L. together with expectations, the 4th generation model, and the topcolor model.

3. Non Standard Model Higgs boson searches

We searched for neutral Higgs bosons produced in association with bottom quarks in $p\bar{p}$ collisions, using 260 pb^{-1} of data. The cross sections for these processes are enhanced in many extensions of the Standard Model, such as in its minimal supersymmetric extension (MSSM) at large $\tan\beta$. The results of our analysis agree with expectations from the SM, and we use our measurements to set upper limits on the production of neutral Higgs bosons in the mass range of 90 to 150 GeV.

We search for an excess in the invariant mass distribution of the two leading transverse momentum (p_T) jets in events containing three or more b quark candidates. Fig. 3, shows the expected MSSM Higgs boson production cross section as a function of m_A for $\tan\beta = 80$, and the median expected limit with the background-only hypothesis along with its $\pm 1\sigma$ range. The MSSM cross section shown in Fig. 3 corresponds to no mixing in the scalar top quark sector, or $X_t = 0$, where $X_t = A_t - \mu \cot\beta$, A_t is the tri-linear coupling, and the Higgsino mass parameter $\mu = -0.2$ TeV. We also interpret our results in the "maximal mixing" scenario with $X_t = \sqrt{6} \times M_{\rm SUSY}$, where $M_{\rm SUSY}$ is the mass scale of supersymmetric particles, taken to be 1 TeV. Results for both scenarios of the MSSM are shown in Fig. 3 as limits in the $\tan\beta$ versus m_A plane.

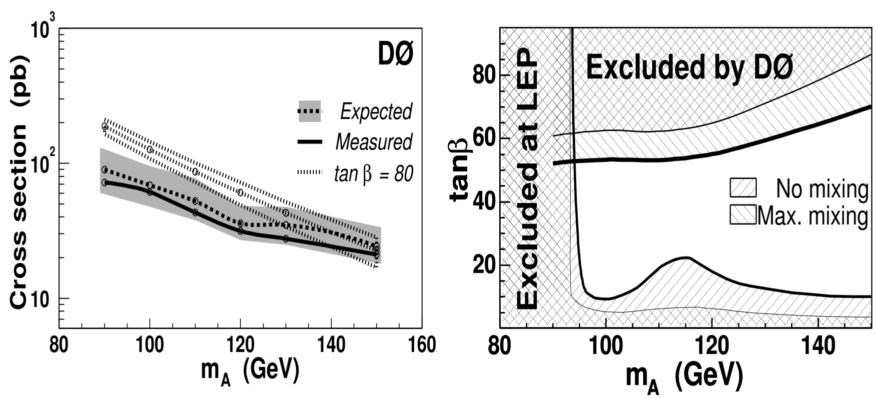

Figure 3. Left: The expected and measured 95% C.L. upper limits on the signal cross section as a function of m_A. The band indicates the $\pm 1\sigma$ range on the expected limit. Also shown is the cross section for the signal at $\tan\beta = 80$ in the "no mixing" scenario of the MSSM, with the theoretical uncertainty indicated by the overlaid band. Right: The 95% C.L. upper limit on $\tan\beta$ as a function of m_A for two scenarios of the MSSM, "no mixing" and "maximal mixing." Also shown are the limits obtained by the LEP experiments for the same two scenarios of the MSSM.

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