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Prospects for MSSM Higgs Search at High Tevatron Luminosity in the bbA Production Mode

DØ Higgs group

With high integrated luminosity, the Tevatron discovery potential for the higgs boson increases significantly. This has been studied in detail for the Standard Model Higgs boson, and this is also true for the Higgs bosons in the Minimal Supersymmetric Model (MSSM), as briefly described in this document.

The Higgs sector of the MSSM is richer than its Standard Model counterpart. Instead of one SM Higgs boson, there are 5 bosons in the MSSM: 3 neutrals one, noted h, H and A (this last being CP-odd), and 2 charged ones ($H^{+/-}$).

The couplings of these neutral bosons with the b quarks are in general stronger than in the Standard Model, hence the search of their production in association with b quarks is more favorable in the MSSM. Compared to the SM, the rate for a higgs boson produced in association with 2 b quarks increases proportionally to $\tan\beta^2$, so we are particularly sensitive to high values of $\tan\beta^2$ ($\tan\beta$ is the ratio of the vacuum expectation values of the two higgs doublets, from which originate the 5 higgs bosons of the MSSM)

The DØ experiment has recently submitted for publication its first results on this type of search, based on 260 pb^{-1} of Run II data. The prospects presented here are based on this analysis, and assume that the CDF experiment will reach similar performances. Since such MSSM Higgs bosons will decay preferentially in $b\bar{b}$, we expect 4 b quarks in the final state, hence a relatively moderate background. To increase the efficiency of our search we require "only" 3 jets identified as b quarks by our secondary reconstruction vertex algorithm, and these jets must be at high momenta (at least 35 GeV for the leading jet). The background which originates mainly from mistagging of b quarks, is derived from the data, as described in Ref. [1]. So far no signal over the background has been observed in the mass windows centered around the searched Higgs masses, allowing to place limits on $\tan\beta$ of the order of 50-80, for a Higgs mass m_A between 100 and 150 GeV.

The increase in luminosity will allow to restrict further the allowed domains for $\tan\beta$ as shown in the figure. The prospects presented here have been derived assuming a reduction of the overall systematic error from 21% to 10% and an increase in the b-tagging efficiency from 30 to 40%, as expected in Run IIb (note that higher b-tagging efficiencies are already realized in other Higgs or Top analyses which are less sensitive to multiijet QCD background).

With 8 fb^{-1} on integrated luminosity, values close to $\tan\beta$=20 can be achieved for low Higgs masses, which will allow to exclude (or make a discovery in) a crucial part of the parameter space since LEP has already excluded the lower values of $\tan\beta$. At higher values of m_A, the exclusion will also be significant, down to values of approximately 50 in $\tan\beta$ for m_A up to 250 GeV.

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[1] http://www-d0.fnal.gov/Run2Physics/WWW/results/final/HIGGS/H05A/H05A.pdf

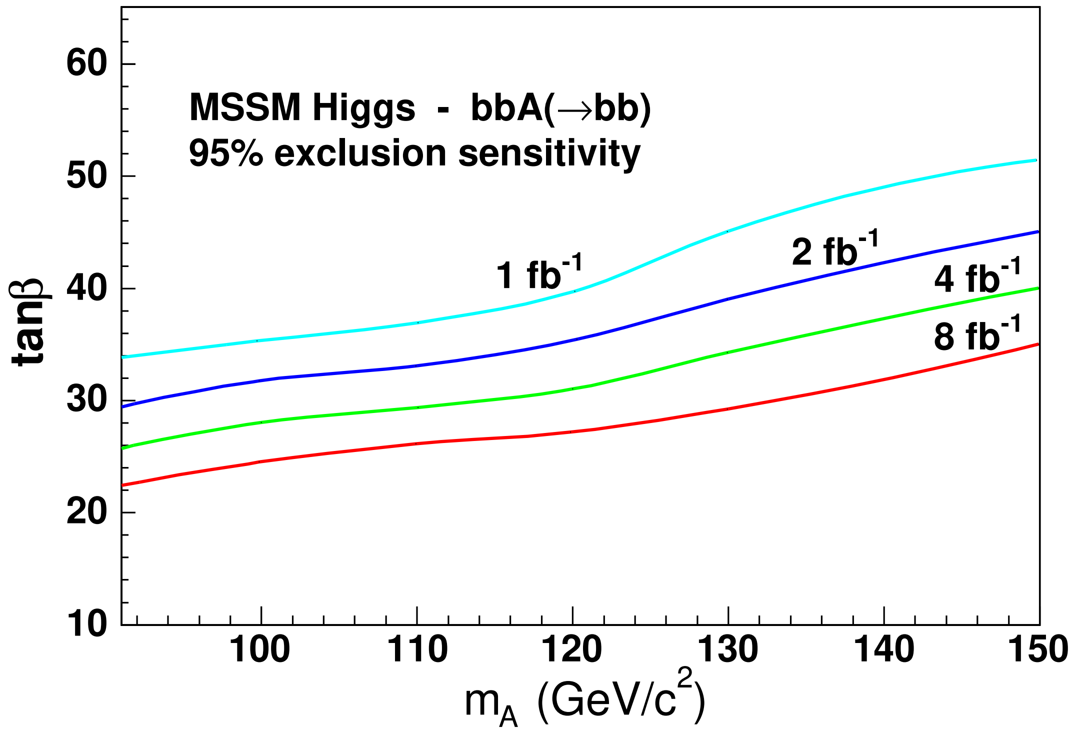

FIG. 1: Sensitivity Prospects for MSSM Higgs searches, as a function of the Tevatron integrated luminosity, in the $(m_A, \tan\beta)$ plane.