Determining $\tan\beta$ from H and A total widths

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Inputs and Results

Inputs

- All results are for the no-mixing scenario with $m_{\mathrm{SUSY}} = 1\ \mathrm{TeV}$.

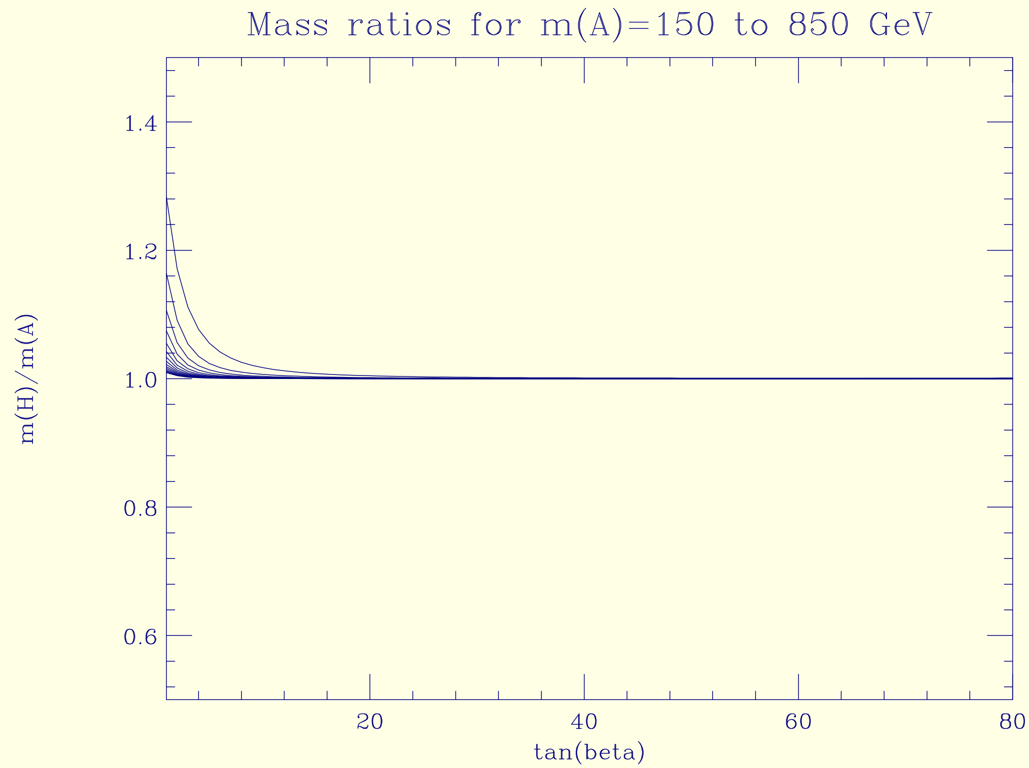
- All SUSY masses have been taken large enough that SUSY decays are not allowed.

  If SUSY decays are present, we presume that the partial width for non-SUSY decays can be determined (no missing energy) and then the error on this partial width should be used for the least model dependent $\tan\beta$ determination.

  However, once $\tan\beta \gtrsim 15$ or so (the main region of interest), the $b\bar{b}$ coupling is so enhanced that SUSY branching fractions will be small, even if kinematically allowed.

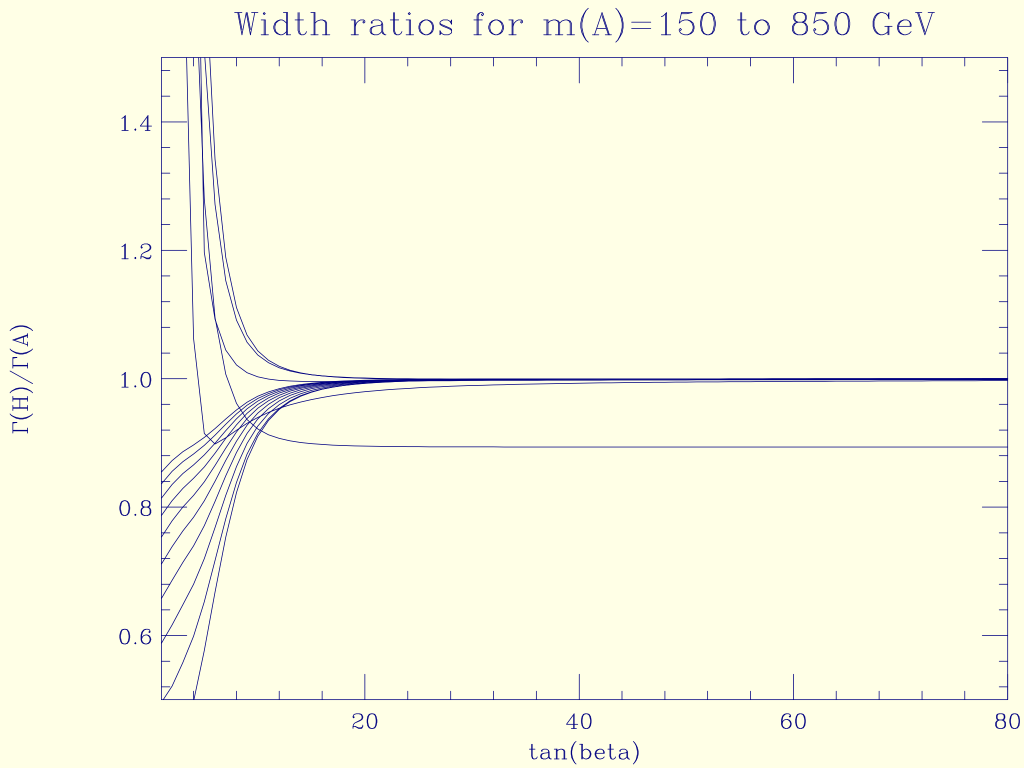
- We will examine results at $m_{A^0} = 150, 200, 250, 300, \ldots, 850\ \mathrm{GeV}$ as a function of $2 < \tan\beta < 80$.

The ratio m_{H^0}/m_{A^0} as a function of $\tan\beta$. Obviously, once $\tan\beta \gtrsim 20$, the H^0 and A^0 are sufficiently degenerate that their signals cannot be separated.



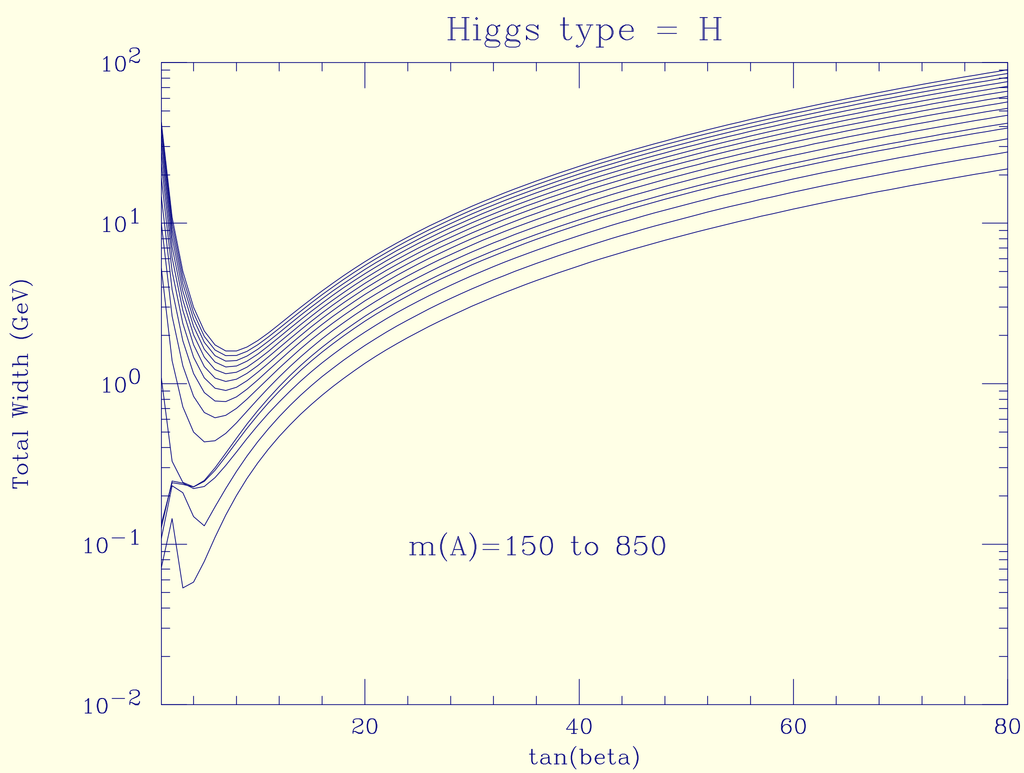
m_{H^0}/m_{A^0} as a function of $\tan\beta$ as m_{A^0} (which determines m_{H^0}) varies from 150 to 850 GeV in steps of 50 GeV.

Does this degeneracy cause a problem? Obviously, once $\tan\beta \gtrsim 20$, the H^0 and A^0 have very similar widths *except for* $m_{A^0} = 350$ *at the* $t\bar{t}$ *threshold to which the* A^0 *is much more sensitive*.

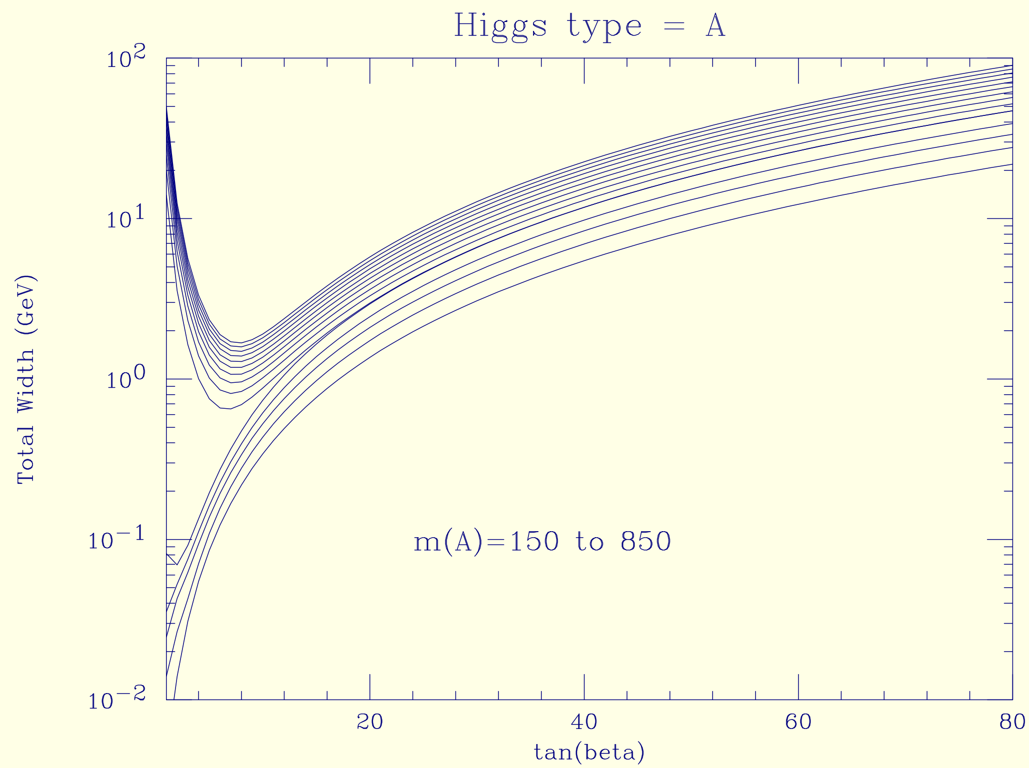


$\Gamma(H^0)/\Gamma(A^0)$ as a function of $\tan\beta$ as m_{A^0} (which determines m_{H^0}) varies from 150 to 850 GeV in steps of 50 GeV.

The total H^0 width. Values large enough for direct reconstruction become possible once $\tan\beta \gtrsim 15-20$, the region for which relatively universal behavior emerges.



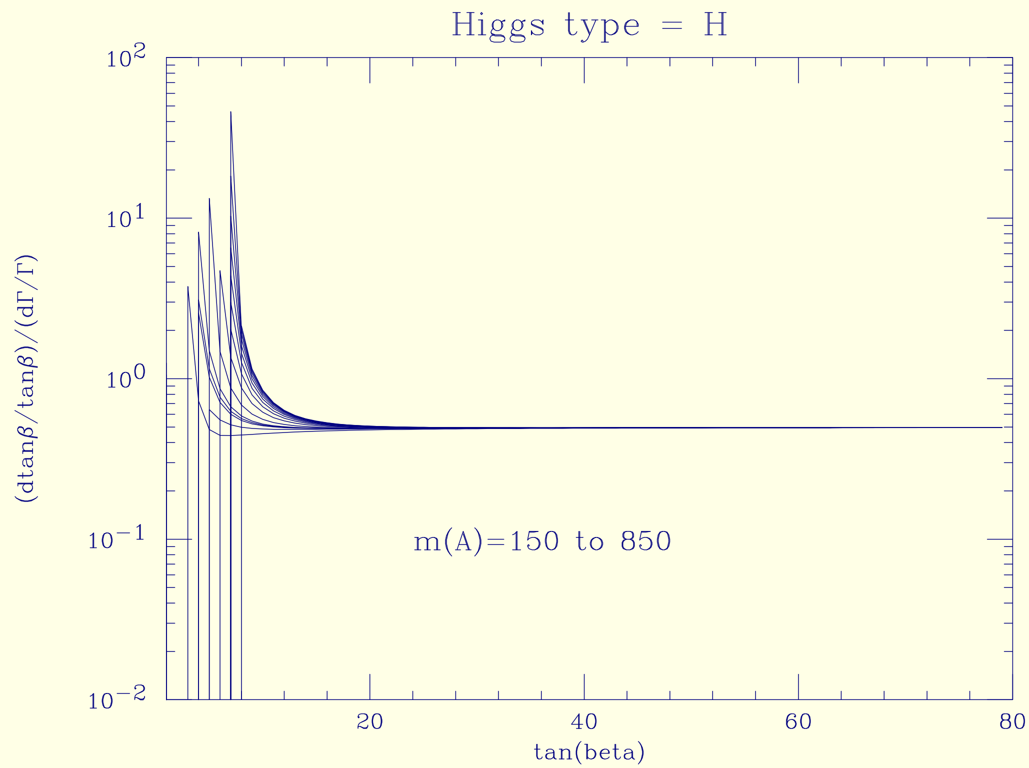
Total width for the H^0 as a function of $\tan\beta$ as m_{A^0} (which determines m_{H^0}) varies from 150 to 850 GeV in steps of 50 GeV.



Total width for the A^0 as a function of $\tan\beta$ as m_{A^0} varies from 150 to 850 GeV in steps of 50 GeV.

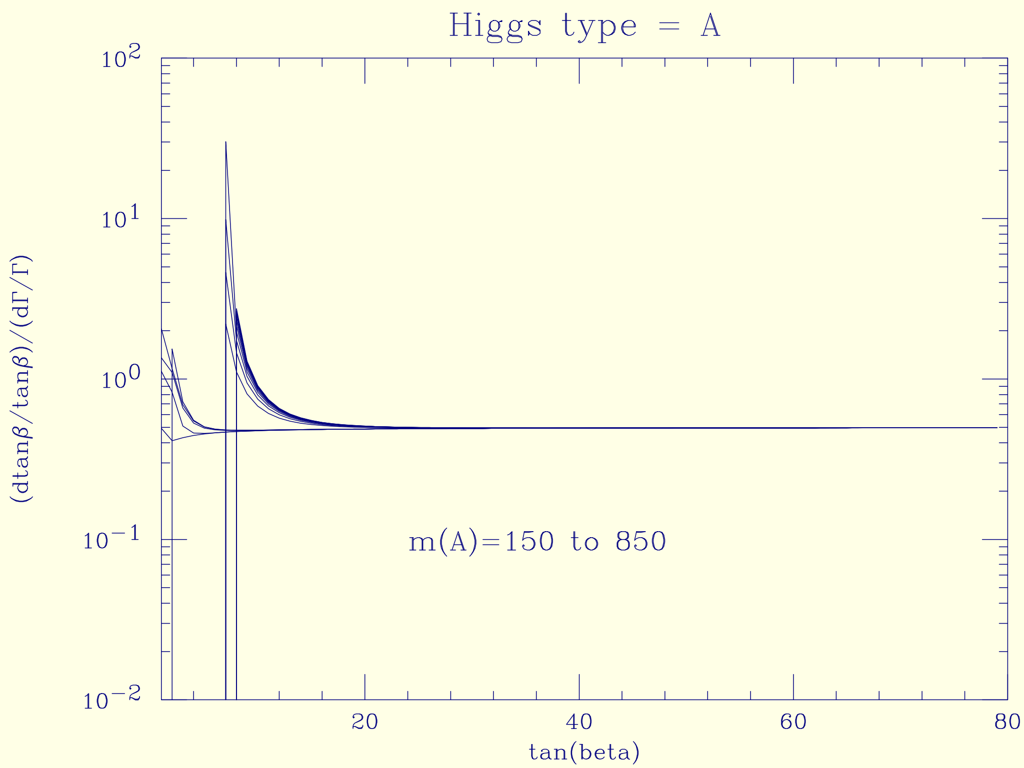
The A^0 total width. Again, large values emerge for $\tan\beta \gtrsim 15-20$.

The sensitivity of the fractional $\tan\beta$ determination to the fractional total width determination for the H^0.



$\frac{d\ln\tan\beta}{d\ln\Gamma}$ for the H^0 as a function of $\tan\beta$ as m_{A^0} (which determines m_{H^0}) varies from 150 to 850 GeV in steps of 50 GeV.

The sensitivity of the fractional $\tan\beta$ determination to the fractional total width determination for the A^0.



$\frac{d\ln\tan\beta}{d\ln\Gamma}$ for the A^0 as a function of $\tan\beta$ as varies from 150 to 850 GeV in steps of 50 GeV.

Conclusions

- The result is nearly universal once $\tan\beta \gtrsim 15$:

$$\frac{d\tan\beta}{\tan\beta} = 0.5\frac{d\Gamma}{\Gamma}\,. \tag{1}$$

  This easily understood from $\Gamma \propto \tan^2\beta$ for the $b\bar{b}$ decay mode.

- For such $\tan\beta$, the A^0 and H^0 are quite degenerate, and have nearly the same width. This means it will be ok, to first approximation, to simply combine their signals as one will be forced to do by limited experimental resolution in any case.

- Even if SUSY modes are allowed, they will probably not be significant for $\tan\beta \gtrsim 15$.

  In any case, they can be identified (and removed) by large missing energy, at least at the LC where we envision H^0A^0 pair production with $b\bar{b}$ or $t\bar{t}$ tagging on one side and measurement of the total width and branching ratios on the opposite side of the event.