

$H \rightarrow AA$ at TEVATRON

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TeV4LHC Workshop
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ongoing work with

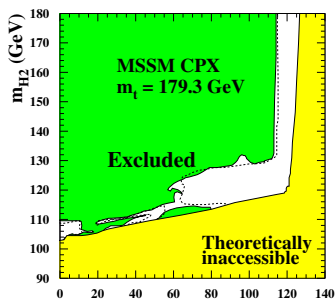
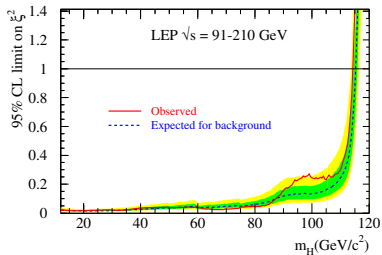
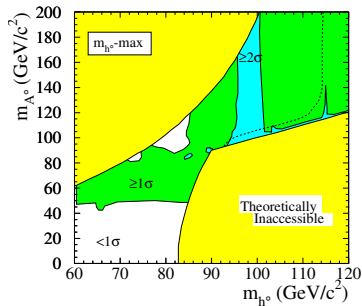
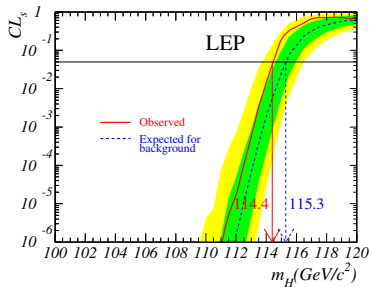
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Outline

- 1 Motivation
 - Exploring Further
 - LEP's Exclusion, and Escape
 - Models
- 2 Light h , A Detection at Tevatron
 - Production
 - Decay Channels
 - Relevant Parameters
- 3 Signals vs Background
 - Background
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Moving Beyond

- Standard Model
- Extending SM
Extended Higgs-sector, SUSY,
Extra Dimension, Little Higgs, ...
- Extending MSSM (μ problem, little hierarchy, fine tuning)
NMSSM, nMSSM, UMSSM, CPX...



To Achieve the Escape

Many Possibilities!

e.g. Seventeen distinct sectors in MSSM

[G.Kane,B.Nelson,L.Wang,T.Wang](#) hep-ph/0407001

Reduced production?

Higgs couplings suppressed with richer Higgs structure

e.g. $\cos^2(\beta - \alpha)$ in MSSM

Missed Routes?

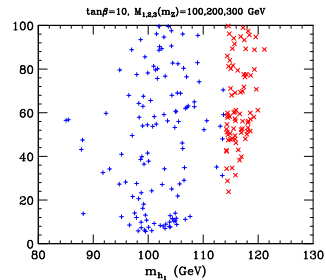
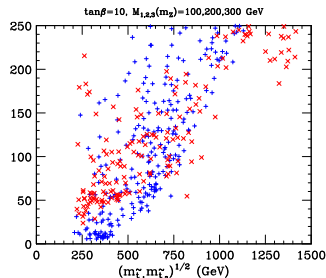
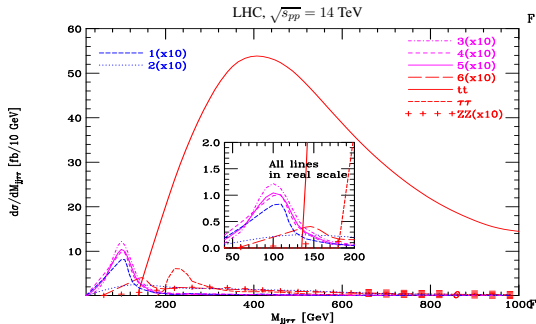
Non-Standard Higgs Decay Modes

e.g. $H \rightarrow AA$. NMSSM, MSSM with CPV

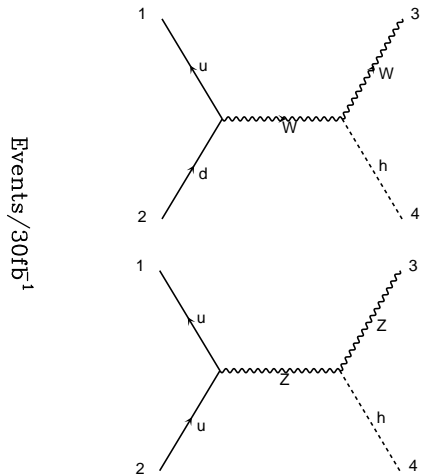
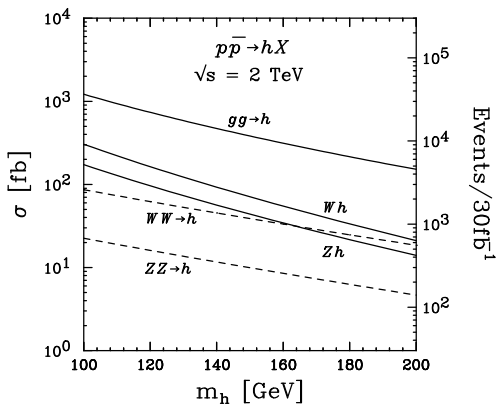
$H \rightarrow AA$

In the context of NMSSM

- Emphasized by [J.Gunion, H.Haber, T.Moro](#)
hep-ph/9610337
- Studied by [B.Dobrescu, G.Landsberg, K.Matchev](#)
hep-ph/0005308, hep-ph/0008192
 $BR(h \rightarrow AA) \sim 1$ not very restrictive for c in
trilinear term $\frac{cV}{2} hAA. \sim \mathcal{O}(1)$
- and [Ellwanger, Gunion, Hugonie, Moretti](#)
hep-ph/0305019, hep-ph/0401228
- and [R.Dermisek, J.Gunion](#)
hep-ph/0502105
- ...

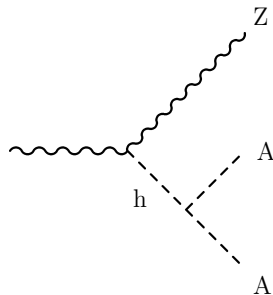


W/Z Associated Production



W/Z: Leptonic, H: (pseudo)scalar pair ($M_H > 2M_A$)

- $W/Z \rightarrow l\nu_l/l^+l^-$
lepton (e, μ) signature
- Higgs to scalar pair AA
- $A, A \rightarrow b\bar{b}, \tau\bar{\tau}$ respectively



Typical Parameter Choices

- $M_H = 80 \sim 120 \text{ GeV}$ $M_A < M_H/2, \sim 30 \text{ GeV}$ (flexible)
- $\kappa_{HWW} \sim 0.7$, ALMOST at full (SM) strength
- $\mathcal{B}(H \rightarrow aa) \sim 0.85$
- $\mathcal{B}(a \rightarrow b\bar{b}) \sim 0.92$, $\mathcal{B}(a \rightarrow \tau\bar{\tau}) \sim 0.08$

Cross section modified from SM by:

$$2\kappa_{HWW}^2 \mathcal{B}(H \rightarrow aa) \mathcal{B}(a \rightarrow b\bar{b}) \mathcal{B}(a \rightarrow \tau\bar{\tau})$$

Similar to $C_{h \rightarrow 2b2\tau}^2$ defined by e.g. [DELPHI hep-ex/0410017](#).
Consistent with C^2 constraints.

No New Interactions Enter

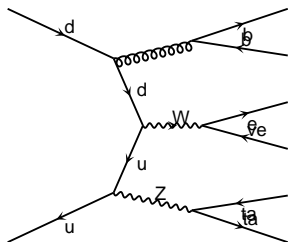
SM contribution, dominantly ($> 90\%$) from:

$W (\rightarrow l\nu)$

$Z (\rightarrow l + l^-)$

bb (via gluon)

(W/Z almost on shell)



Rather Independent of Higgs mass/couplings.

Acceptance Cuts

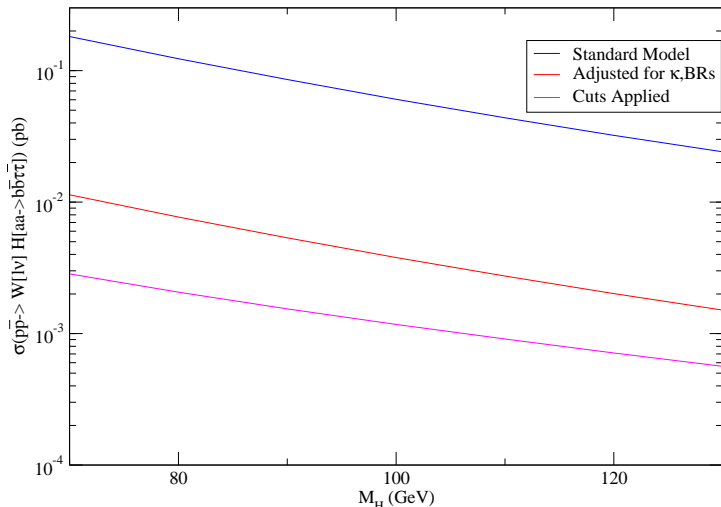
- $P_T > 10\text{GeV}$ (b, τ, l, ν)
- $|y| < 3.0$ (b, τ, l). for b can be relaxed
- $\Delta R > 0.4$ ($bb, \tau\tau, \tau l$)
- $m_{inv} : m(b\bar{b}), m(\tau\bar{\tau}) > 20\text{GeV}$. not essential

After cuts, $\sigma_{background} \sim 20 \times 10^{-3}\text{fb}$

Signal: Cross section

Higgs Production/Detection at Tevatron

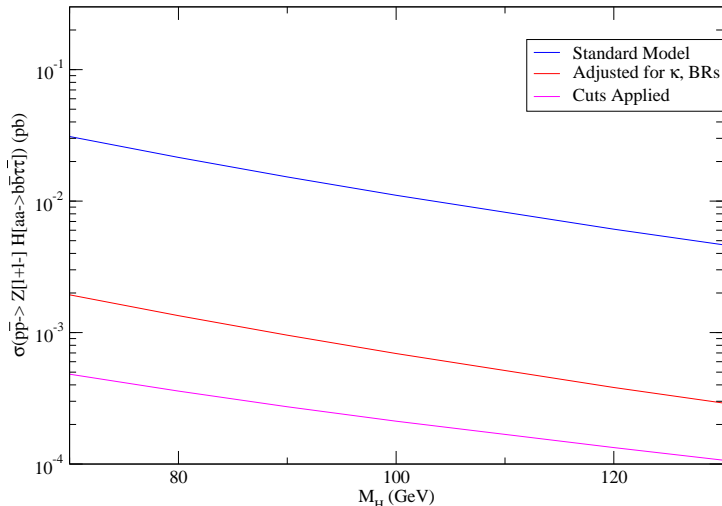
in association with a W boson [$l\nu$, $l=e,\mu$]



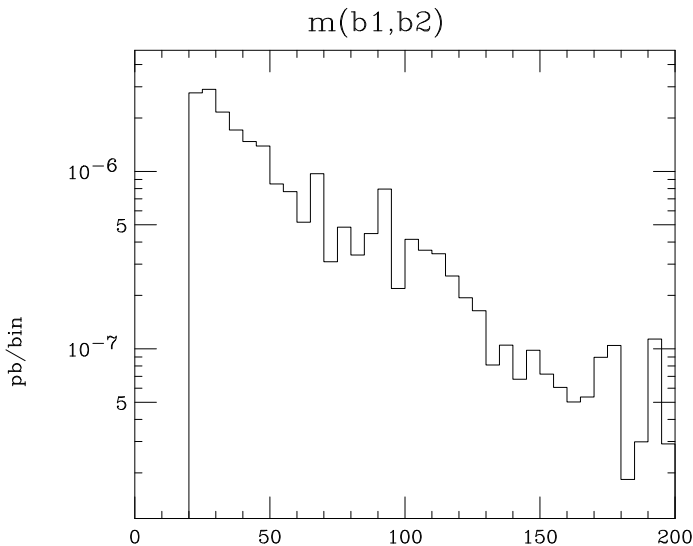
Signal: Cross section

Higgs Production/Detection at Tevatron

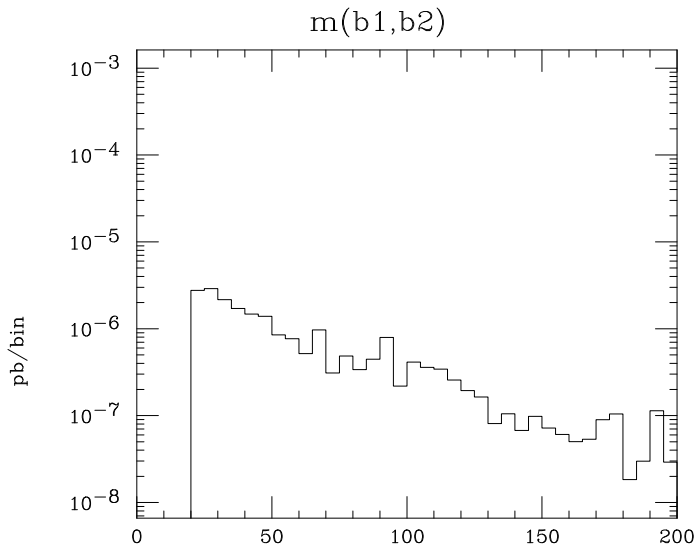
in association with a Z boson [$l+l-$, $l=e,\mu$]

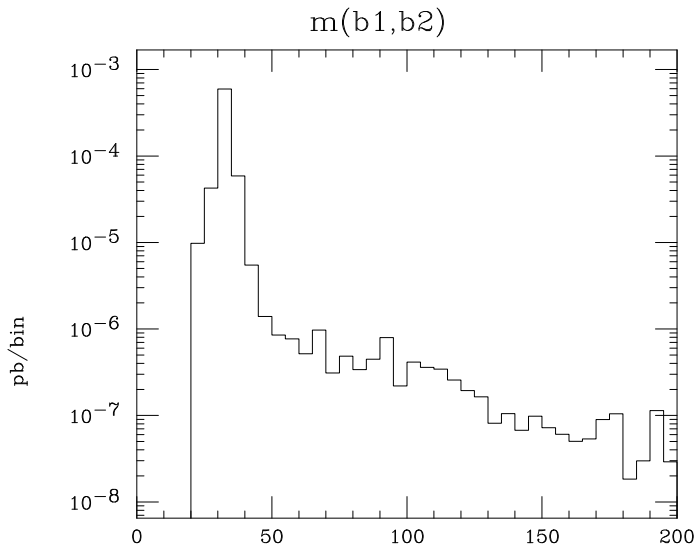


$b\bar{b}$ Invariant Mass: Background



$b\bar{b}$ Inv Mass: Signal vs Background



$b\bar{b}$ Inv Mass: Signal vs Background

- Good Signal/Background Ratio
- Readily Detectable with Sufficient Luminosity
- Determination of h , A masses
- Other Channels ($4b$, 4τ)
- Other Colliders