S+B versus B-only Hypotheses

Tevatron RunII Preliminary

$L \leq 8.6 \text{ fb}^{-1}$

July 17, 2011

$m_H \text{ (GeV/c}^2\text{)}$

26 August 2011

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Theoretical Uncertainties

- Latest theoretical cross sections (NNLO) and branching ratios (HDECAY), including the corresponding uncertainties.

- MSTW 2008 NNLO parton distributions (PDF) as recommended by the LHC PDF working group.

- Update with recent developments, e.g., jet multiplicity dependent uncertainties in the WW channel.

- Interference between resonant and non-resonant WW production not yet included.

- Higgs searches at the Tevatron have relied heavily on advances in theoretical calculations and in Monte Carlo modeling.
4\textsuperscript{th} Generation Model

Exclude $124 < M_H < 286$ GeV

Gluon fusion cross section enhanced by up to a factor 9.

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The Future

The Story of Pixar Animation Studios
To Infinity and Beyond!

By Kara Park and Leslie Swartz
Foreword by John Lasseter, Steve Jobs, and Ed Catmull
SM Higgs Search Projections

- Data taking will end on September 30, each experiment will have about 10 fb-1 to analyse, compared to about 8 fb-1 used for current results.
- Including analysis improvements, Tevatron will have sensitivity over entire allowed SM Higgs mass range.
- Tevatron remains unique in its sensitivity to Higgs to bb decays.
Fermiophobic Higgs not produced in gluon fusion process.

CDF uses H to $\gamma\gamma$, WW to exclude $M_H < 114.8$ GeV.

$\not{D}\phi$ uses H to $\gamma\gamma$ only to exclude $M_H < 112.9$ GeV.

Tevatron combination imminent.
Supersymmetric Higgs ($\tau\tau$)

In the MSSM:

- two neutral CP-even Higgs ($h,H$)
- one neutral CP-odd Higgs ($A$)
- two charged ($H^{\pm}$)
  (not covered in this talk)

- $h$ should be light ($<135$ GeV)
- $H,A$ nearly mass degenerate
- $H,A$ decays: $\sim 10\%$ to $\tau\tau$, $\sim 90\%$ to $bb$
Supersymmetric Higgs ($b\tau\tau$)

![Diagram showing $b\tau\tau$ process](image1)

- $\tan\beta$ and $H$ decay into $b\tau\tau$

![Graph showing $M_A$ vs $\tan\beta$](image2)

- $D\bar{O}$, $5.4$ fb$^{-1}$
- $m_{h^\text{max}}, \mu=+200$ GeV
- $D\bar{O}$ exclusion, LEP exclusion

![Graph showing $M_A$ vs $\tan\beta$](image3)

- $D\bar{O}$, $L = 7.3$ fb$^{-1}$
- $m_{h^\text{max}}, \mu=+200$ GeV
- $gb \rightarrow b\phi$

- $D\bar{O}$ expected, $D\bar{O}$ exclusion, LEP exclusion
- CMS obs. 36 pb$^{-1}$ [10], CMS exp. 36 pb$^{-1}$ [10]

**Competitive with LHC at low masses**

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Supersymmetric Higgs (bbb)

- fully hadronic final state, very challenging.
- data driven background model.
- template fits to determine normalisation.

![Graph showing events in GeV](image)

![Graph showing dijet mass](image)

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Supersymmetric Higgs (bbb)

- small excesses at 120-150 GeV
- updates and combinations in progress
Doubly Charged Higgs Boson

- LR symmetric models, Little Higgs models..
- Assumed to decay to lepton pairs (LFV).
- Previous Tevatron limits on $\mu\mu$, $ee$, $e\mu$, $e\tau$, $\mu\tau$

![Decay Diagram]

<table>
<thead>
<tr>
<th>Decay</th>
<th>$H_L^{\pm\pm}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>expected</td>
</tr>
<tr>
<td>$\mathcal{B}(H^{\pm\pm} \to \tau^\pm \tau^\pm)$</td>
<td>1</td>
</tr>
<tr>
<td>$\mathcal{B}(H^{\pm\pm} \to \mu^\pm \mu^\pm)$</td>
<td>1</td>
</tr>
<tr>
<td>Equal $\mathcal{B}$ into $\tau^\pm \tau^\pm, \mu^\pm \mu^\pm, \tau^\pm \mu^\pm$</td>
<td>130</td>
</tr>
<tr>
<td>$\mathcal{B}(H^{\pm\pm} \to \mu^\pm \mu^\pm)$</td>
<td>1</td>
</tr>
</tbody>
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First limits on $\tau\tau$ final states at a hadron collider

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Conclusions

• Tevatron allowed range $109 < M_H < 156$ GeV.
• Tevatron is currently unique – and complementary to the LHC - in having access to the $b\bar{b}$ decay mode.
• Sensitivity expected in all of the allowed mass range with final dataset.
• Competitive results in BSM Higgs searches.