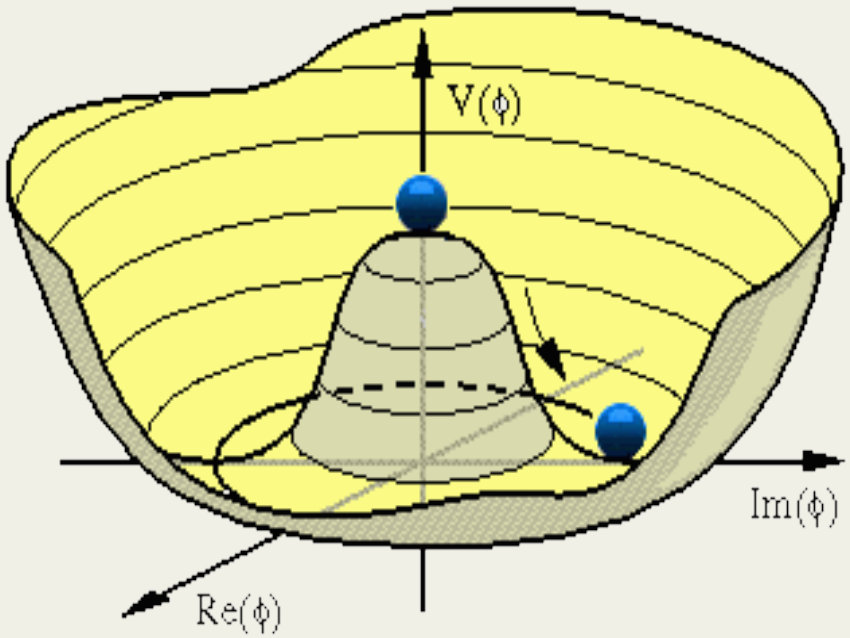
Electroweak Symmetry Breaking

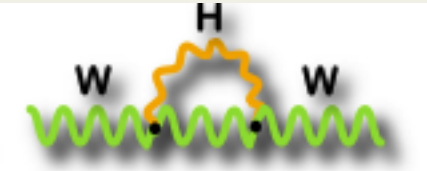


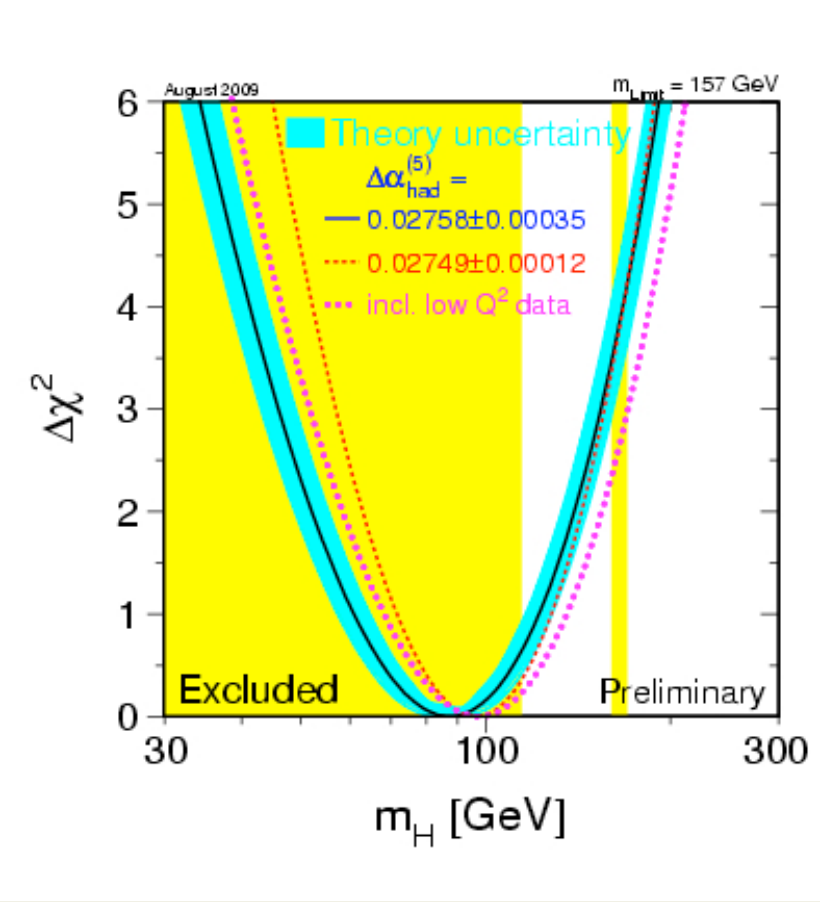
Physics Advisory Committee Meeting, Aspen, 22 June 2010

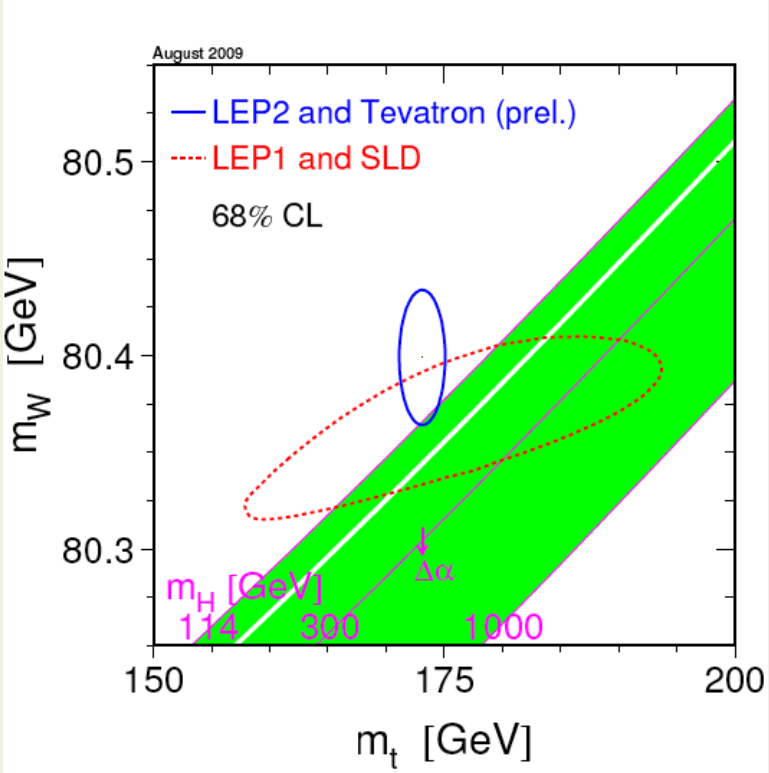
D. Denisov, G. Punzi, R. Roser, S. Söldner-Rembold,

Squeezing the Higgs

$$M_H = (87 \pm {}^{35}_{26})\ \mathrm{GeV}$$



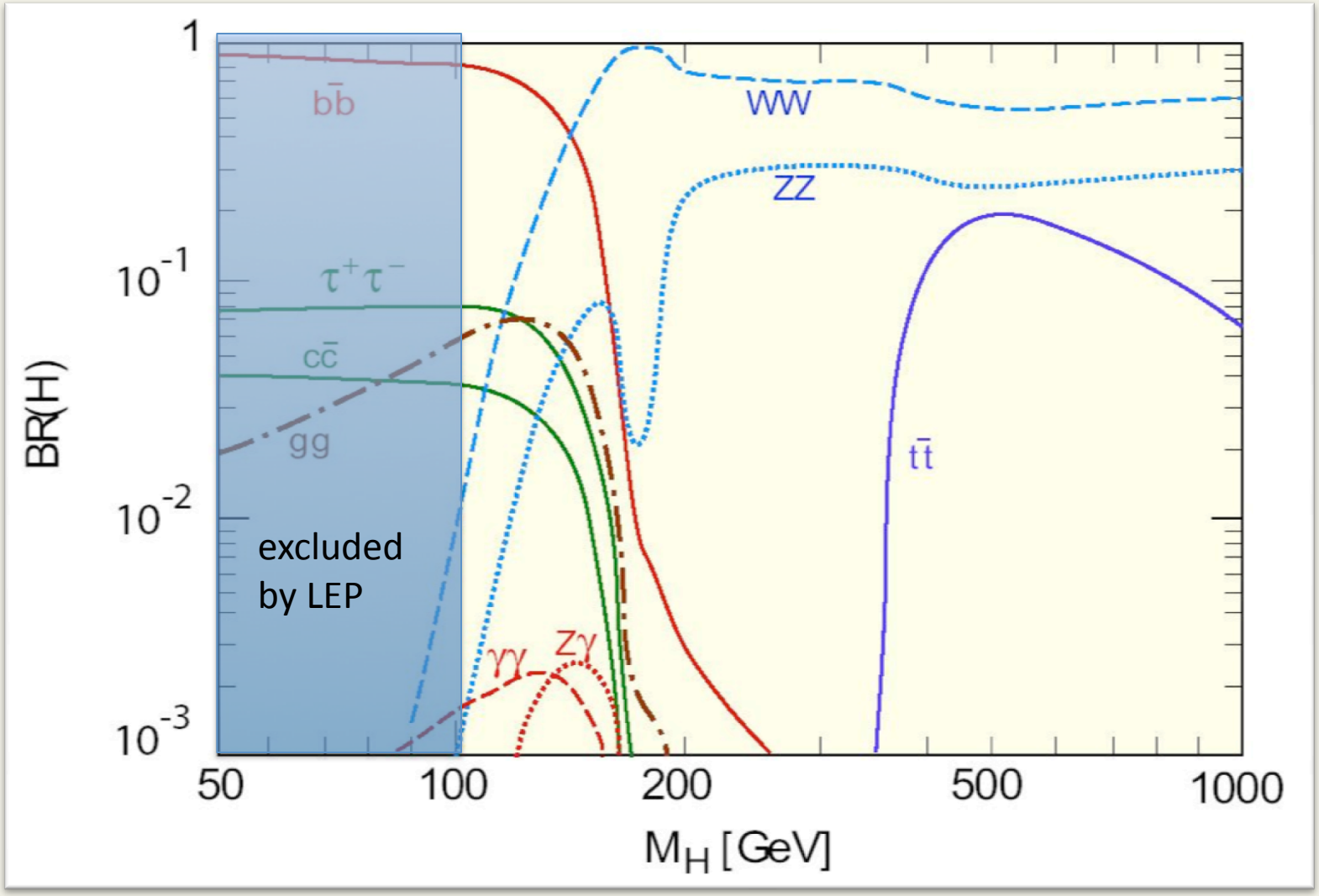




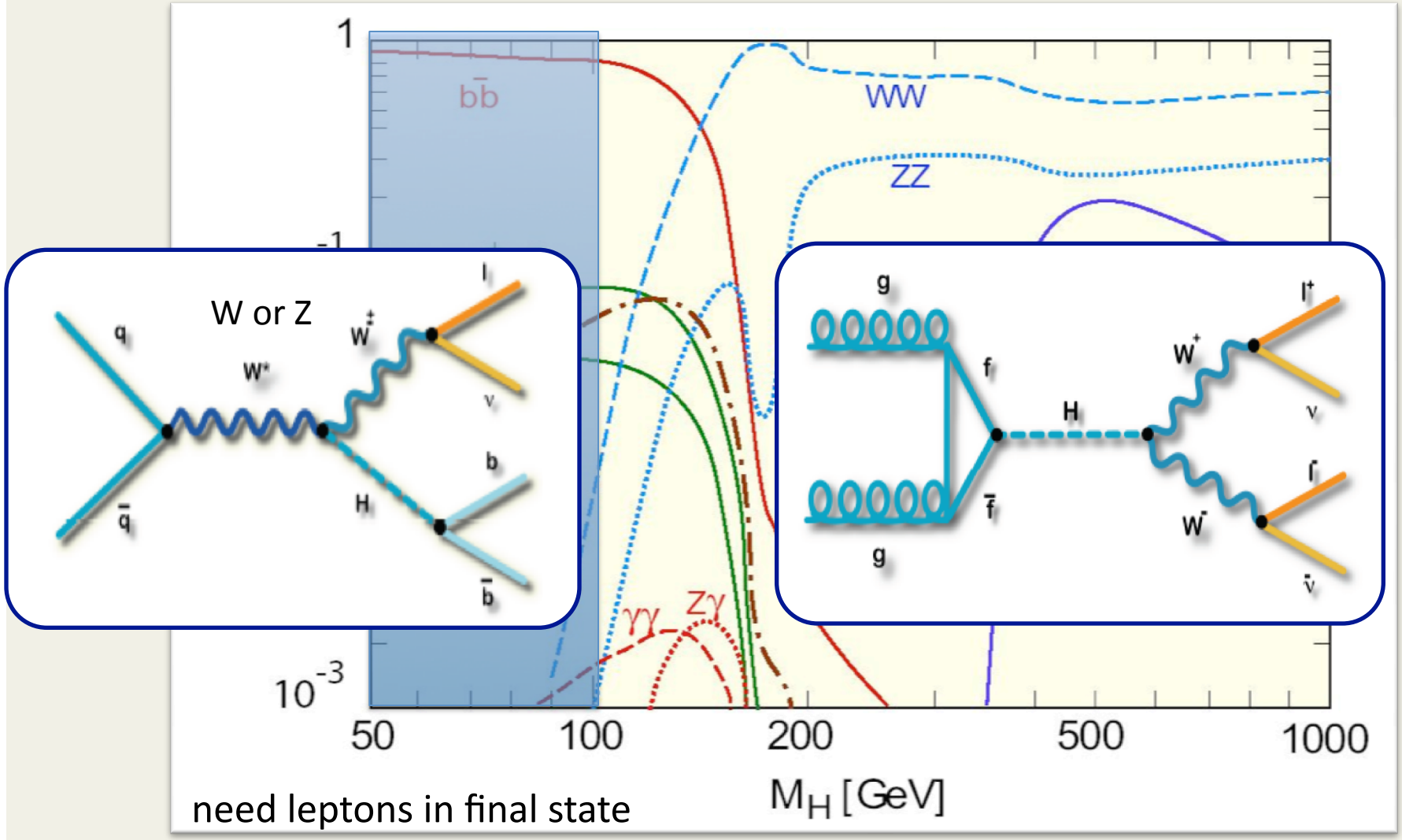
$$M_H < 186\ \mathrm{GeV}, \text{ including LEP limit}$$

A light Higgs is favoured by the precision data..

Higgs Decays

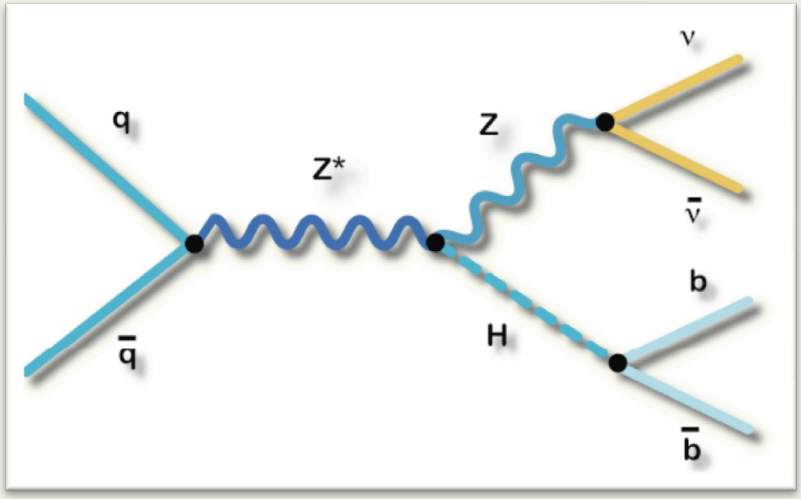


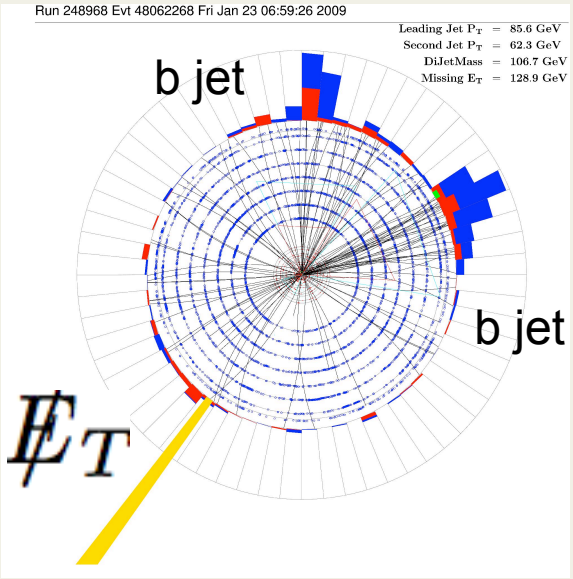
Higgs Search Strategy

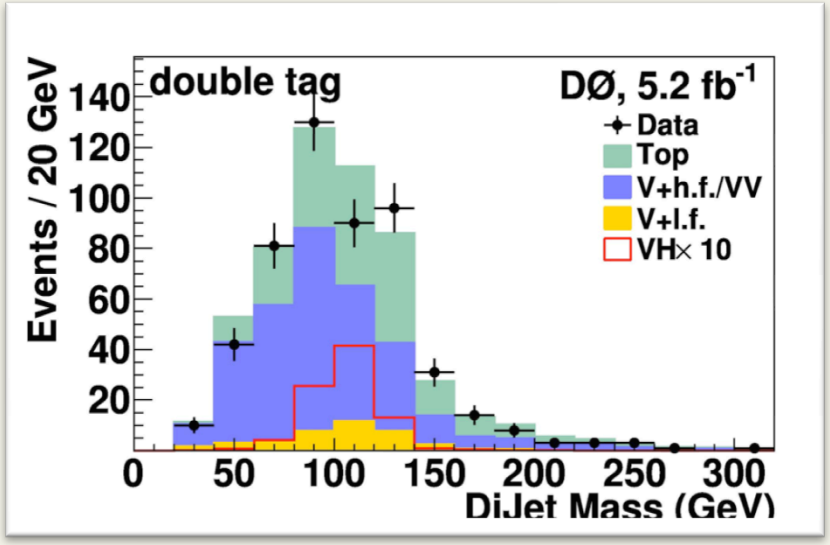


need leptons in final state

Example: Low Mass





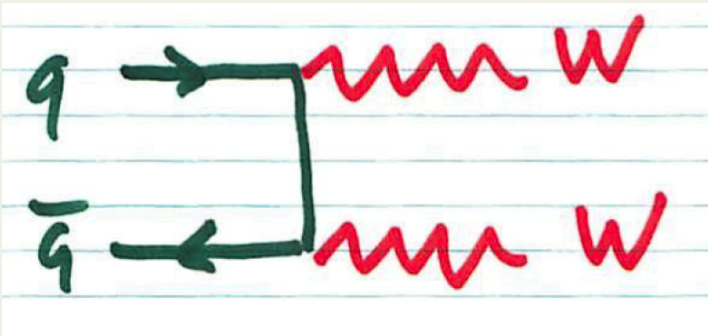


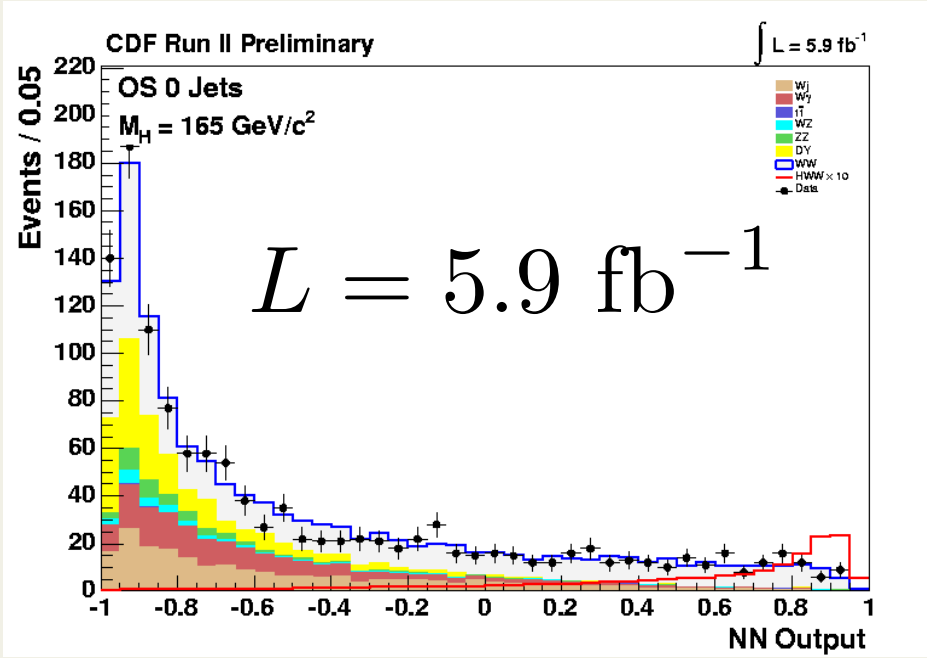
Typical selection:
- two acoplanar b-jets
- large missing energy

Dijet mass one of many variables – improve s/b with multivariate techniques

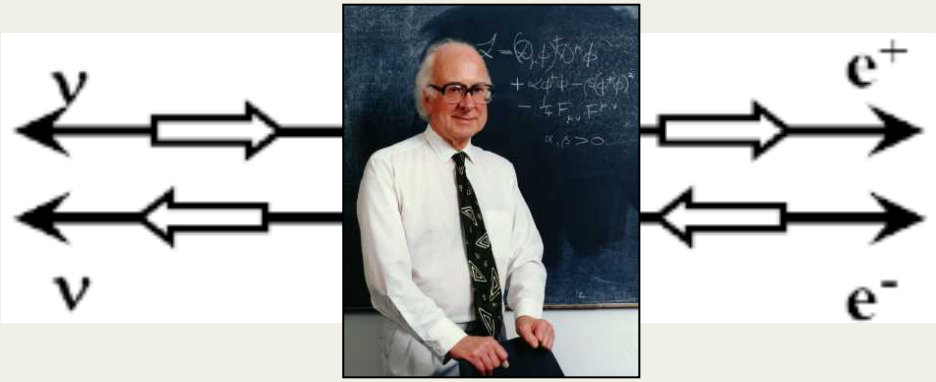
Example: High Mass

Main background



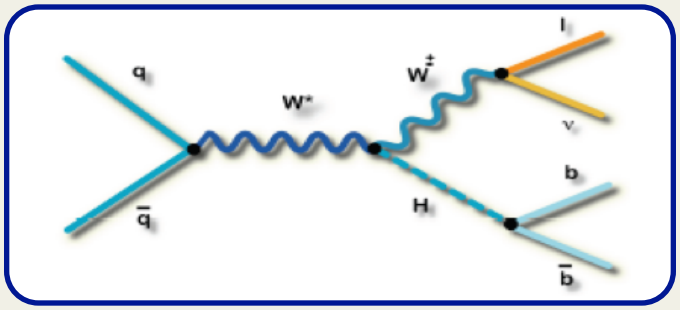


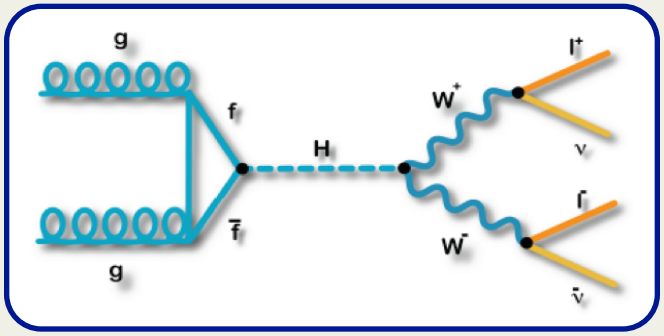
Higgs is scalar
– use angular correlation

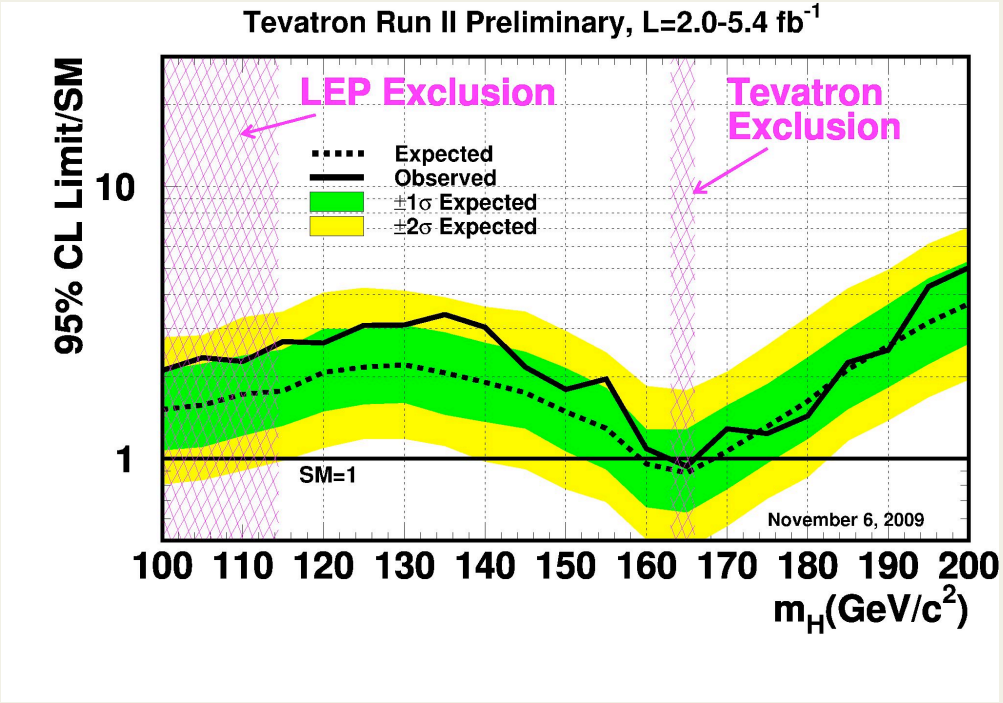


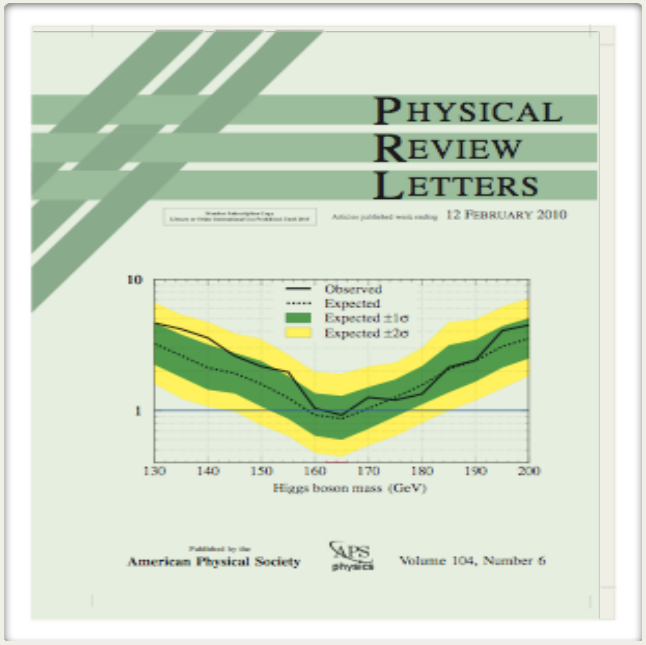
New CDF result presented last Friday, not included yet in Tevatron combination

SM Higgs Searches



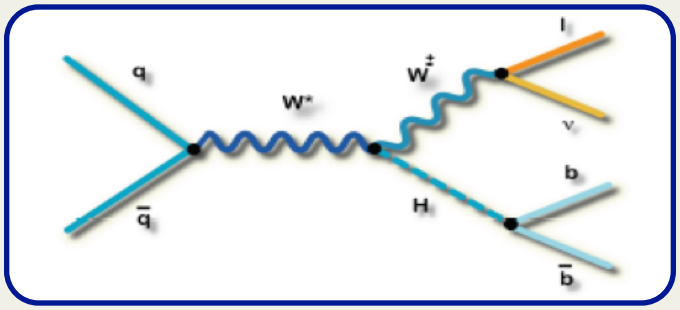


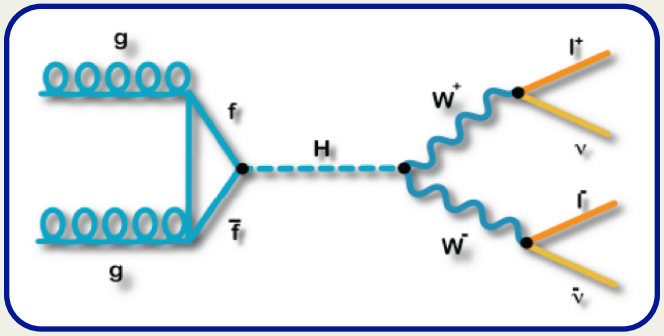




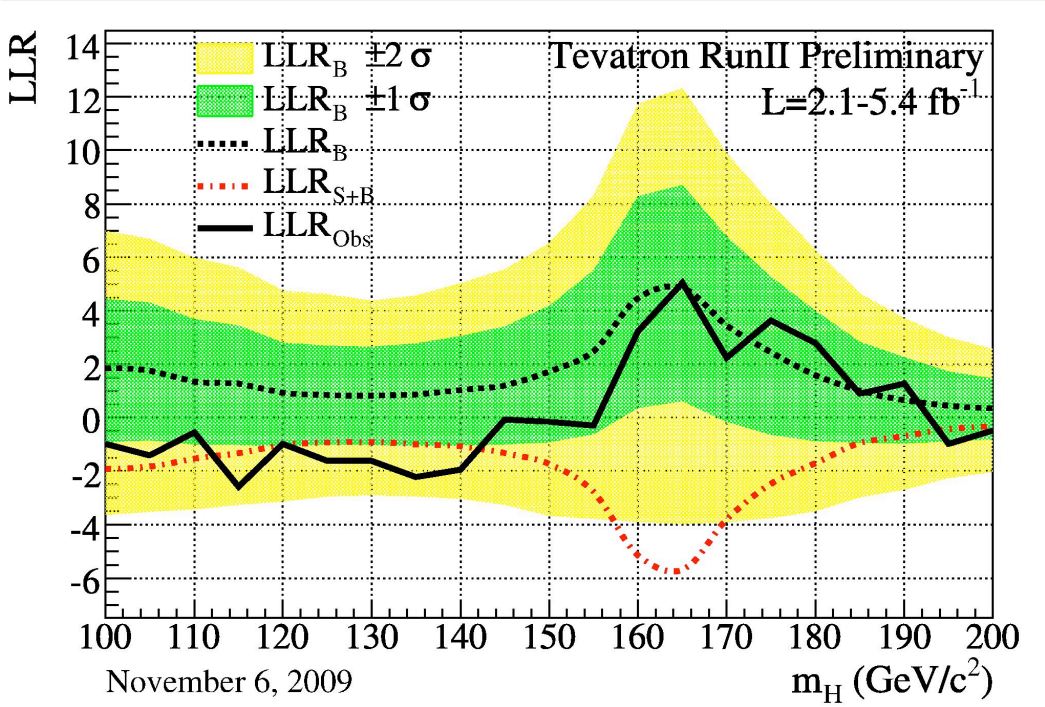
Joint CDF-DØ Publication

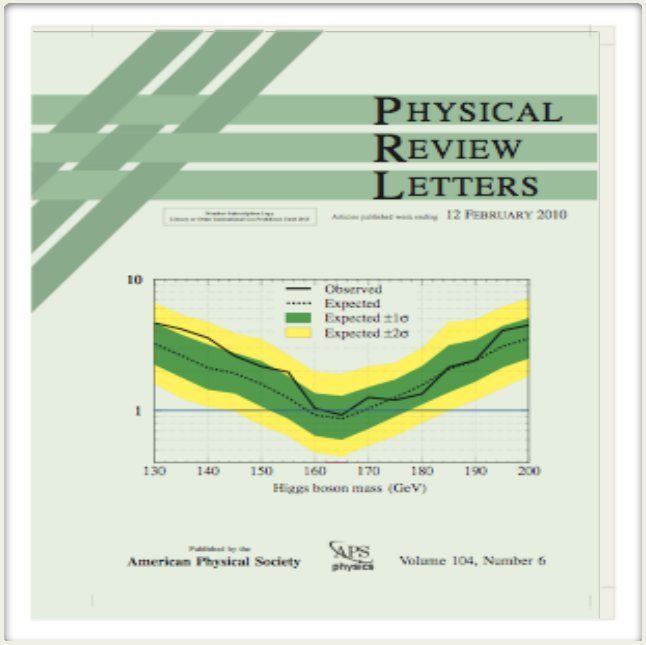
SM Higgs Searches





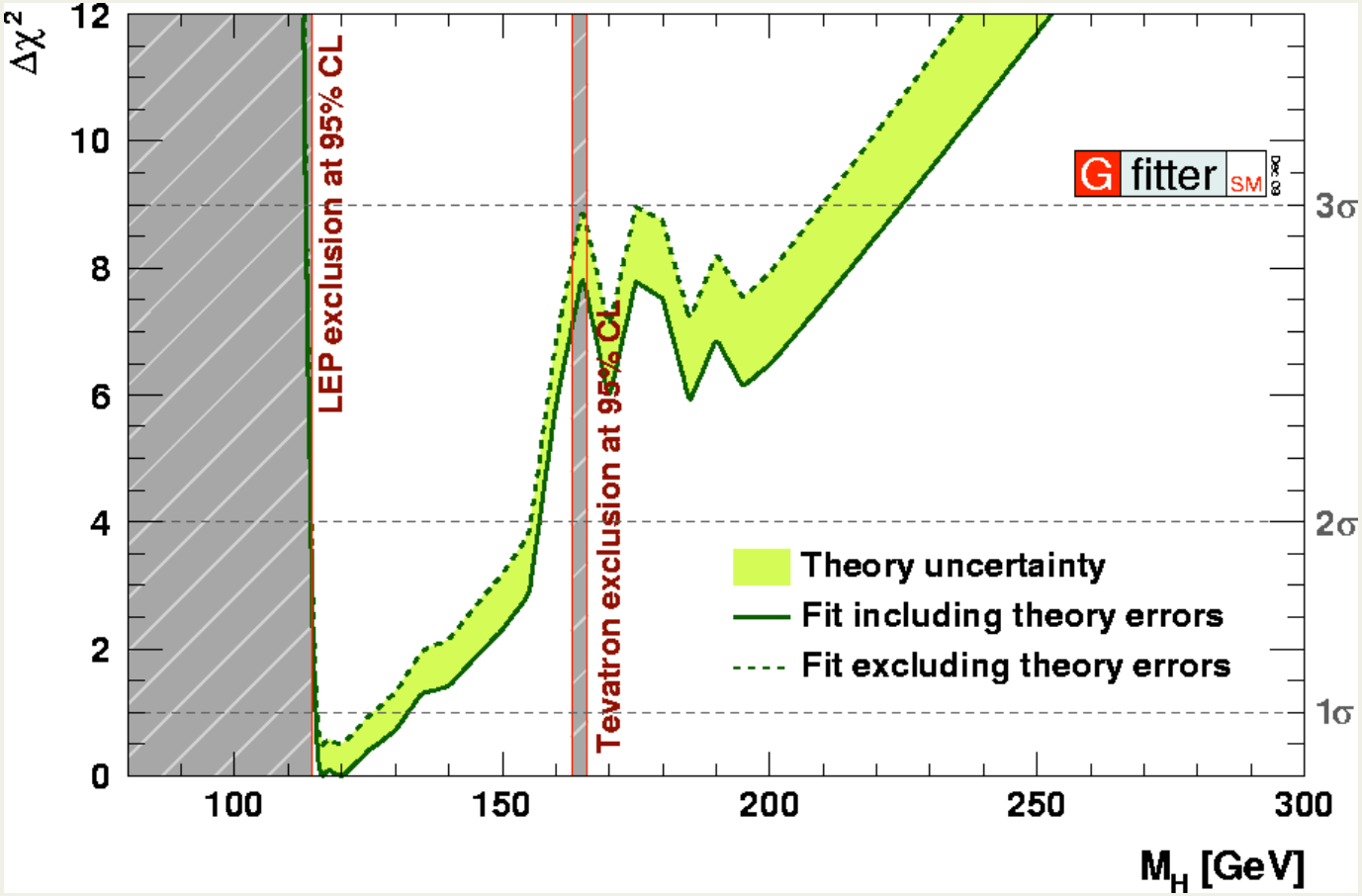
LLR=Likelihood Ratio





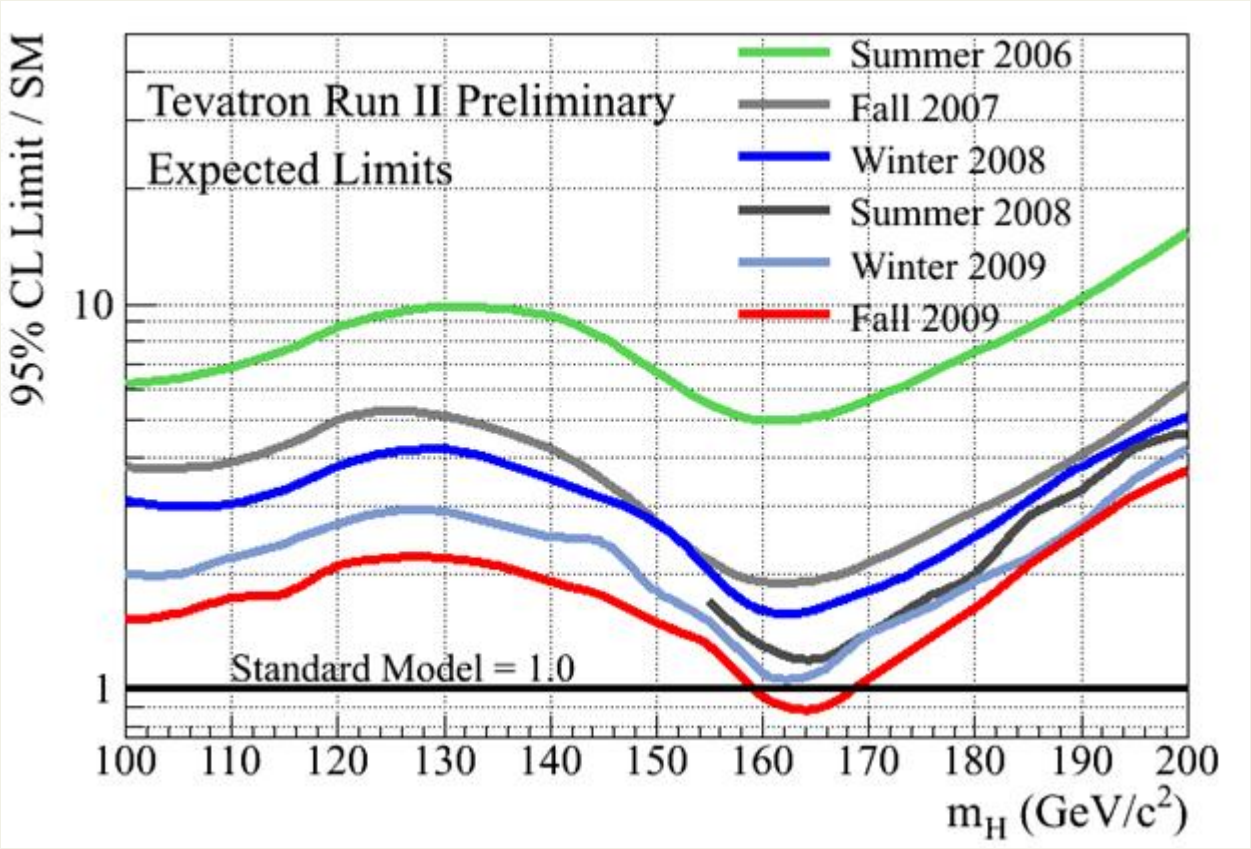
Joint CDF-DØ Publication

Including the Direct Limits



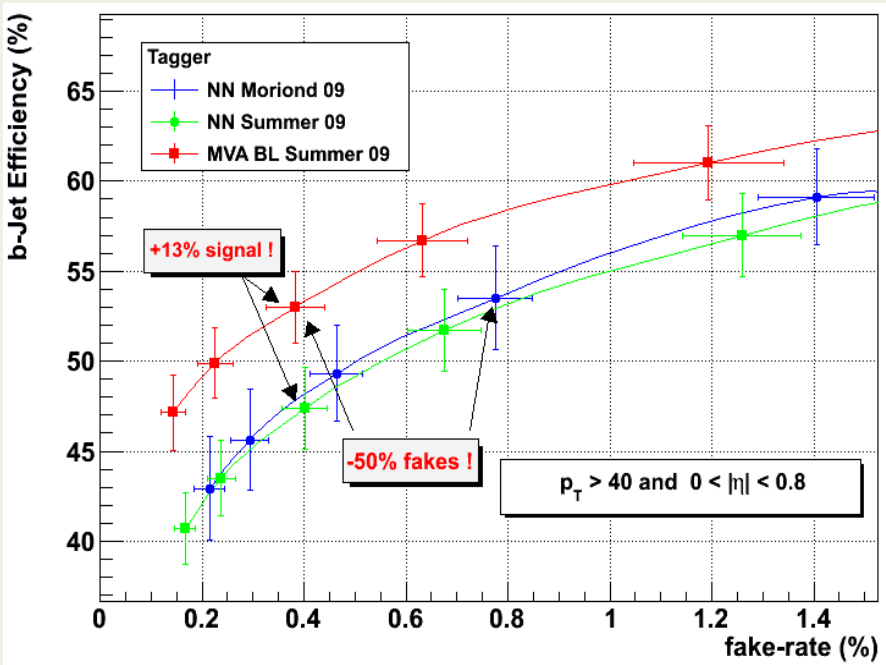
- Gfitter combines direct and indirect constraints
- If SM is correct, light Higgs is almost unavoidable

Historic Progress

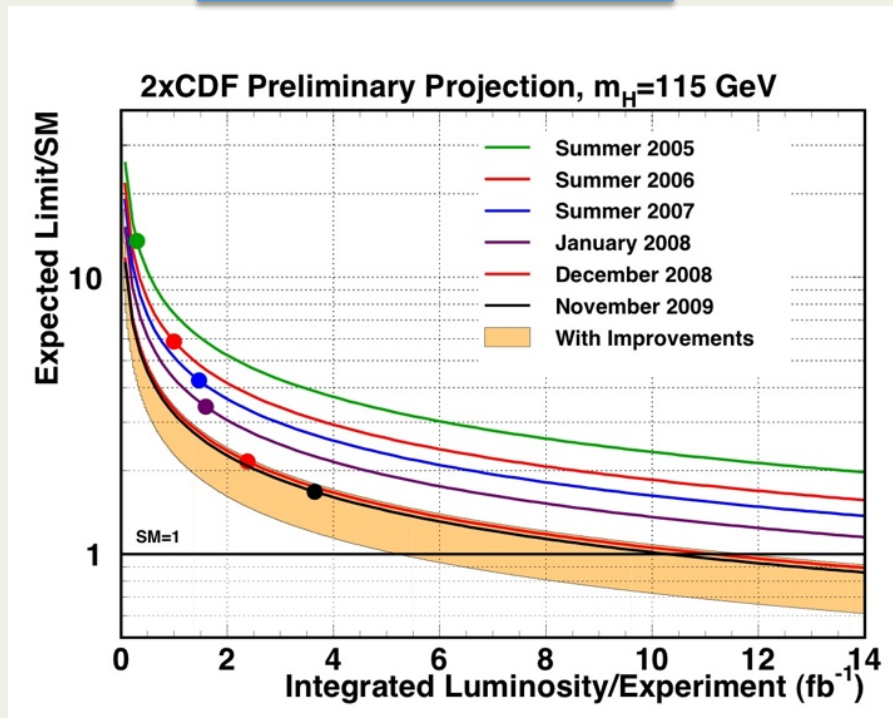


- Expected limits are the measure of experimental sensitivity
- The Tevatron expected limits have made impressive progress since 2006

Improvements are happening



- Dijet mass resolution
- b tagging
- lepton id
- more channels
-...

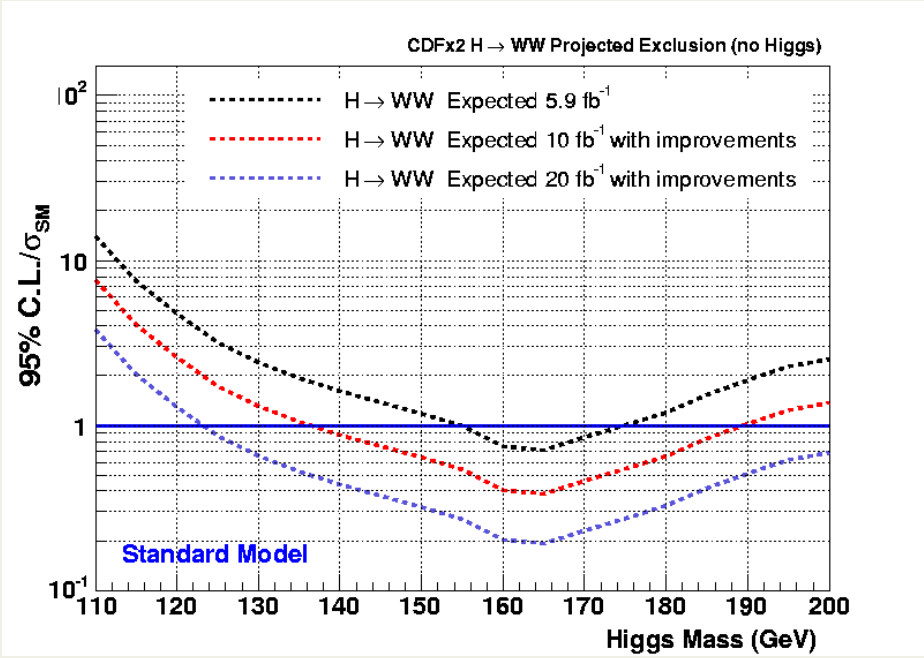


Future Extrapolations assume improvements in analysis techniques

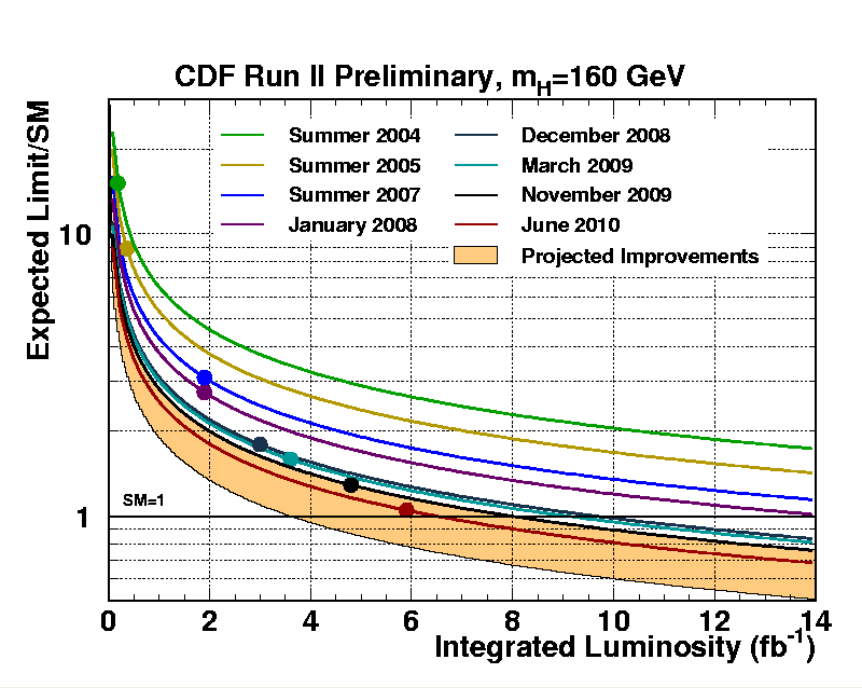
Even with improvements, we need to go beyond 10 fb^{-1} to have significant probability for evidence

Status 2009, update at ICHEP

WW Channel

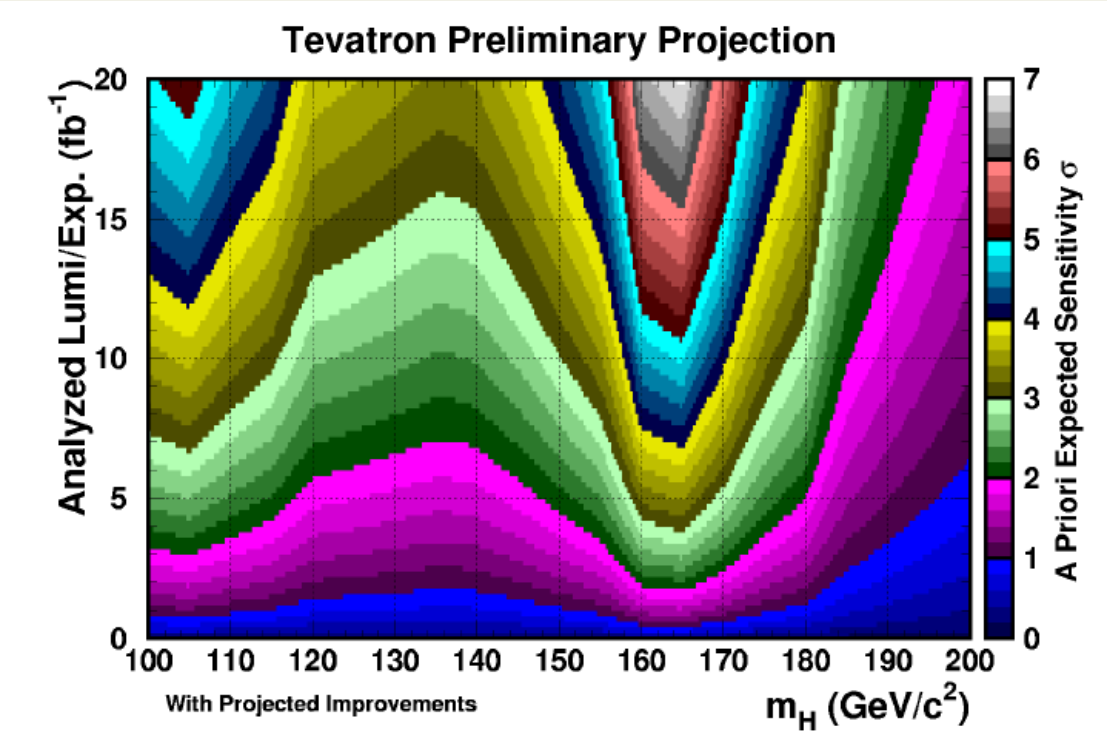


Based on CDF's newest result presented last Friday



With more integrated luminosity the WW channel will make significant contributions at medium and low mass.

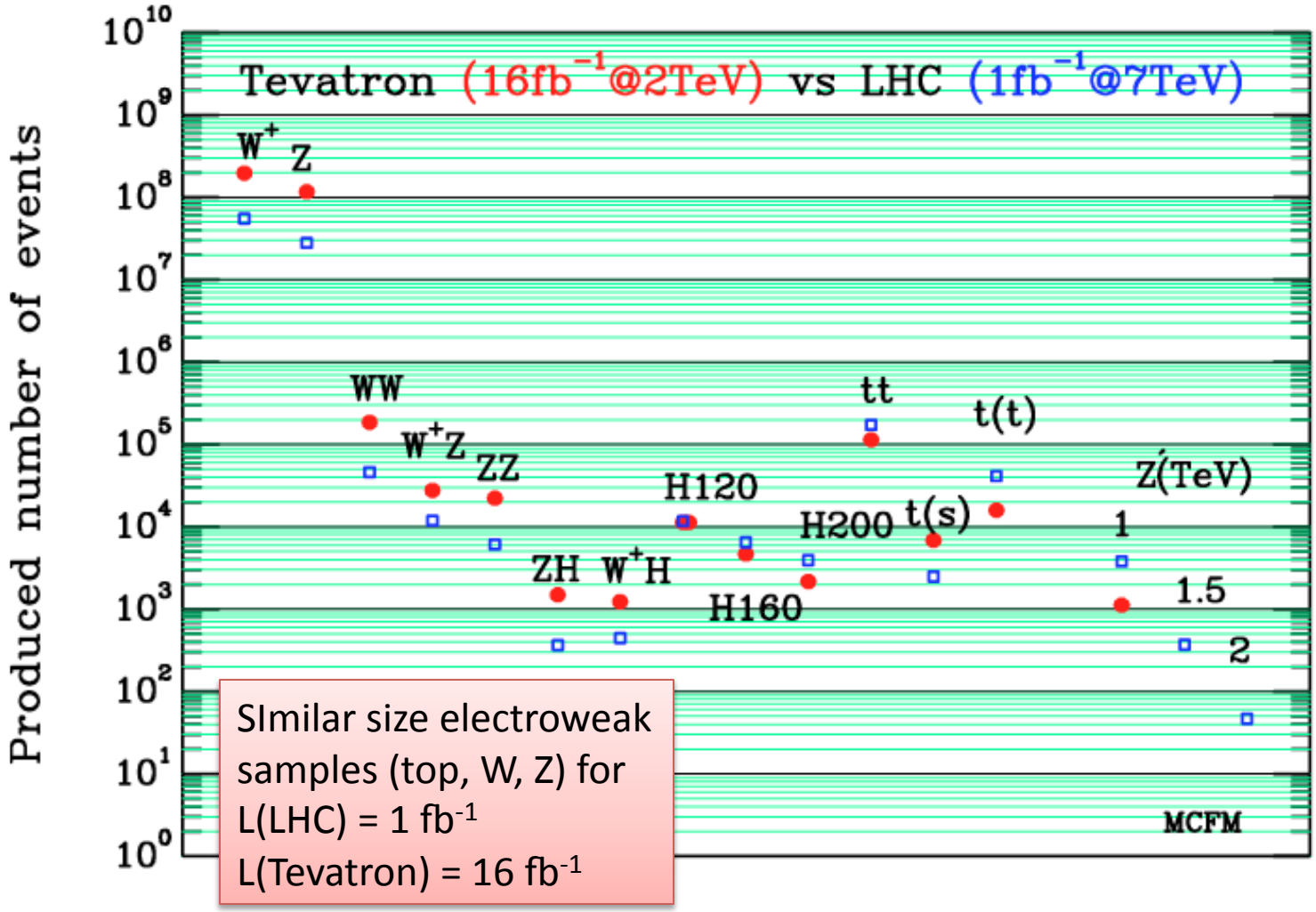
Higgs Projection



With 16 fb-1, the Tevatron has sensitivity to find 3 sigma evidence or to exclude the SM Higgs boson in the allowed region below ~190 GeV.

Tevatron has sensitivity to dominant decay channels (bb, WW)

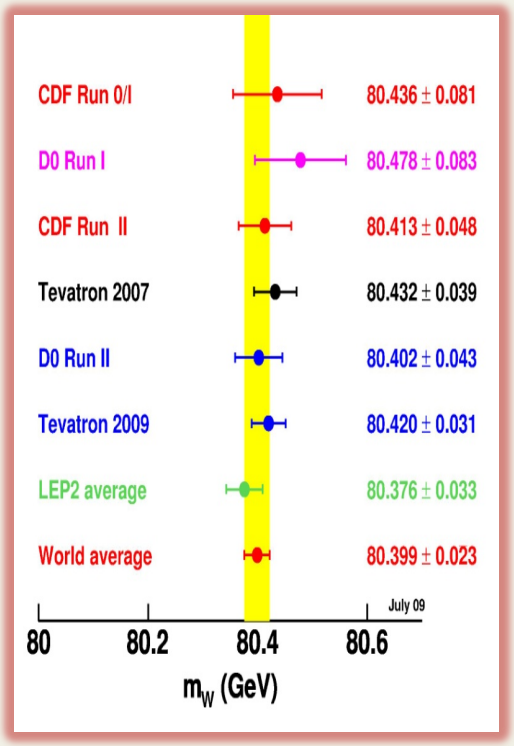
Complementarity



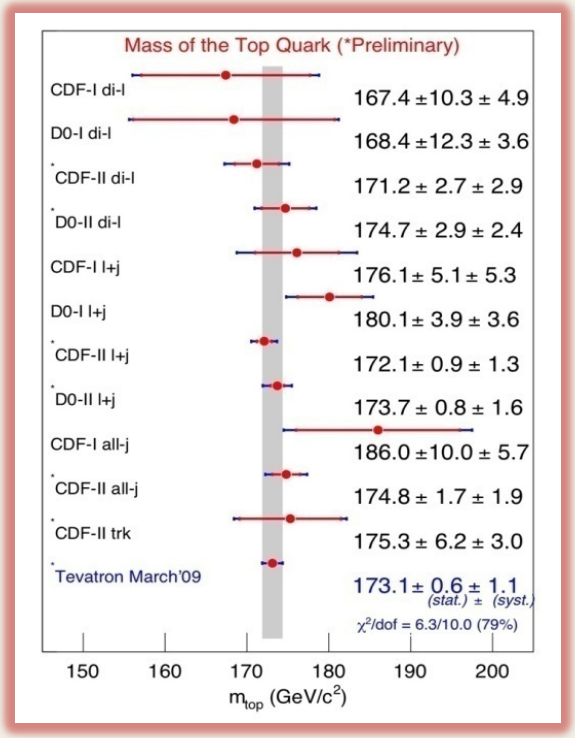
SImilar size electroweak samples (top, W, Z) for L(LHC) = 1 fb^{-1}
L(Tevatron) = 16 fb^{-1}

Future Legacy

W mass



top mass

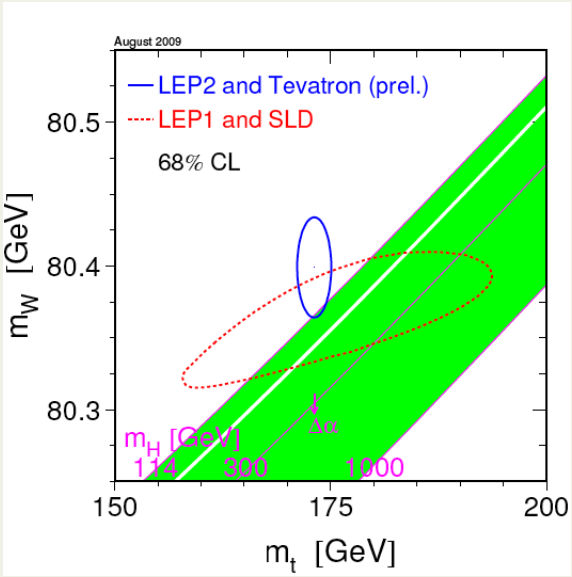


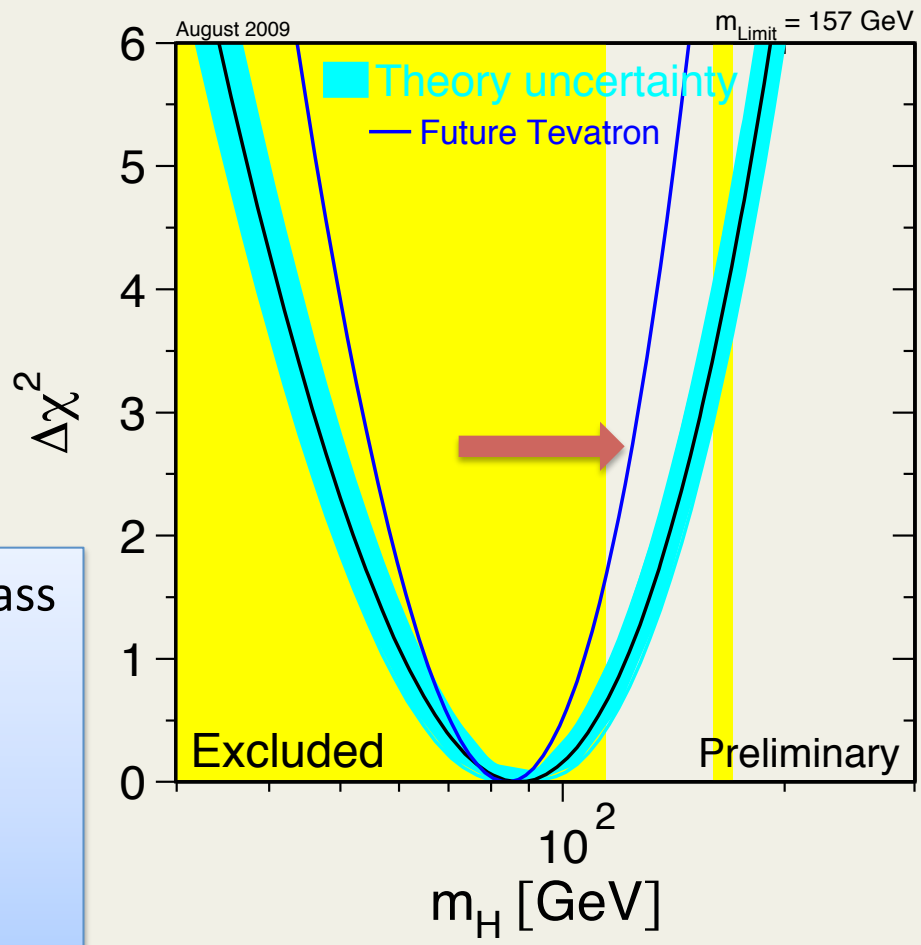
Current Tevatron precision:

0.04% 0.7%

Expect improvements (statistics + systematics) with larger data sets

Self-consistency of SM





Precision of 1 GeV for the top mass and 15 MeV for W boson mass:

m_H < 117 GeV at 95% CL

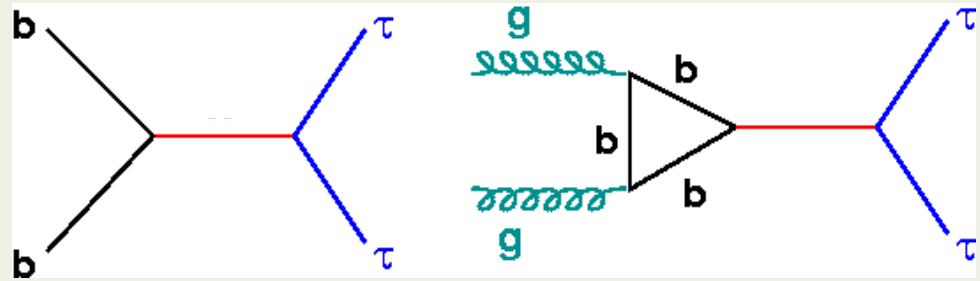
for current SM minimum.

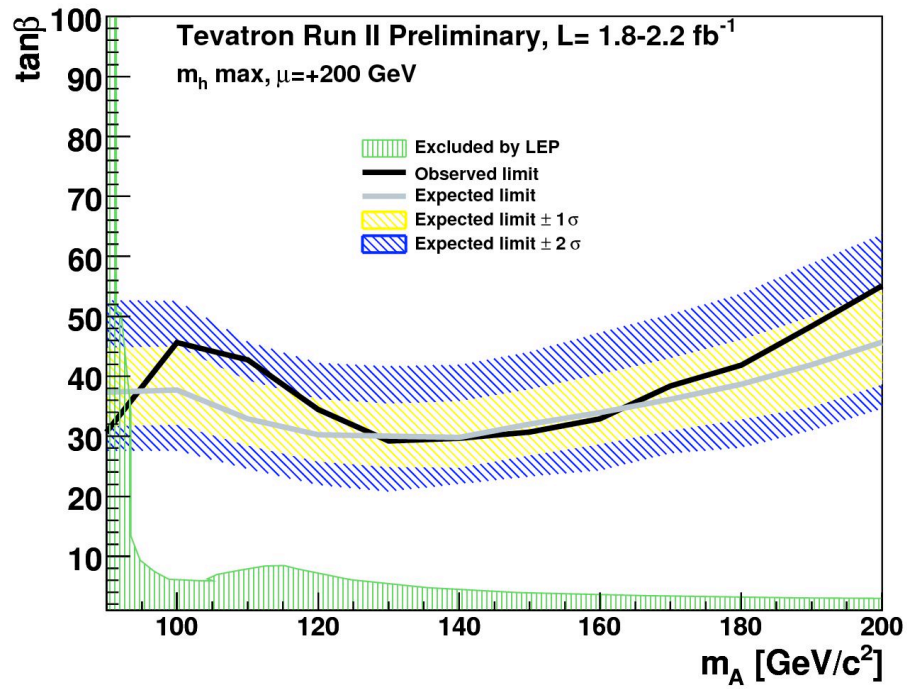
Supersymmetric Higgs

In the MSSM:

- two neutral CP-even Higgs (h,H)
- one neutral CP-odd Higgs (A)
- two charged ($H^{\pm}$)

- h should be light (<135 GeV)
- H,A nearly mass degenerate

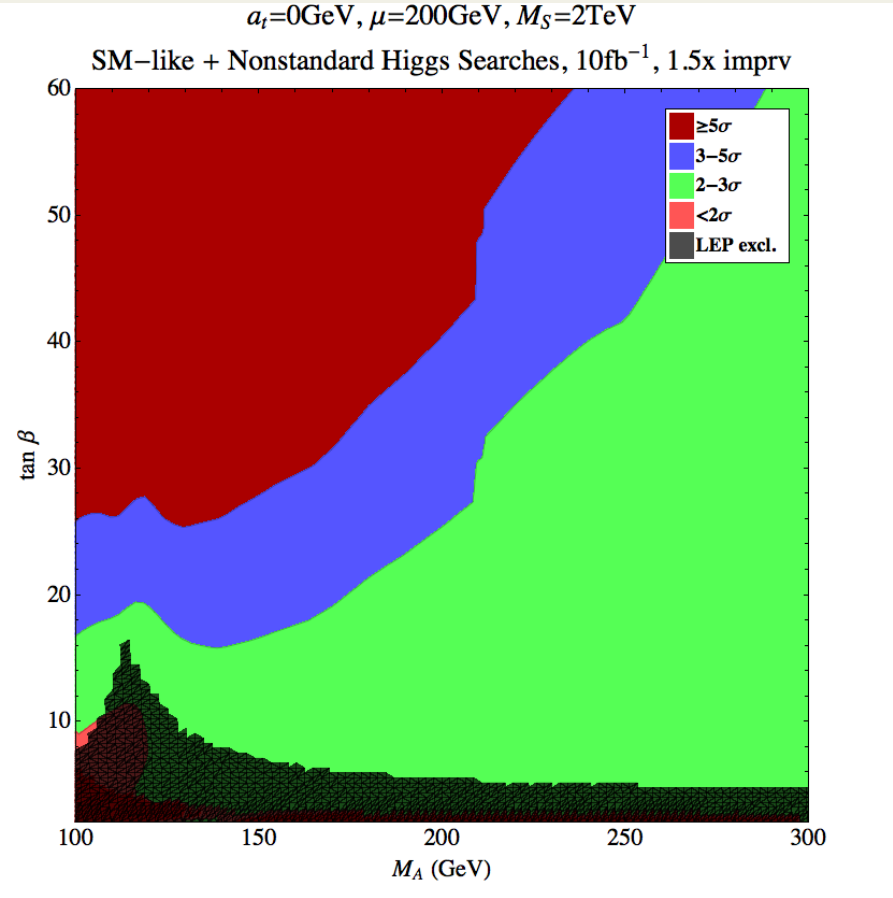


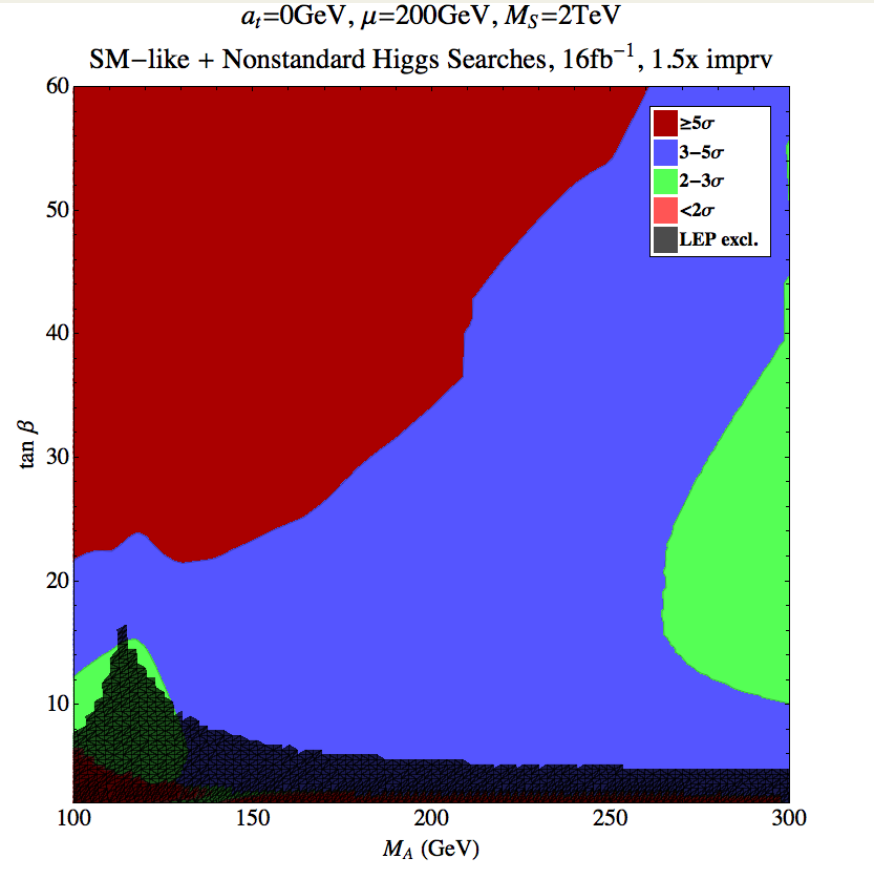


SM Higgs searches (H ➔ WW) could be used to constrain the SM-like Higgs in these models

MSSM Higgs Bosons

Minimal Mixing Scenario

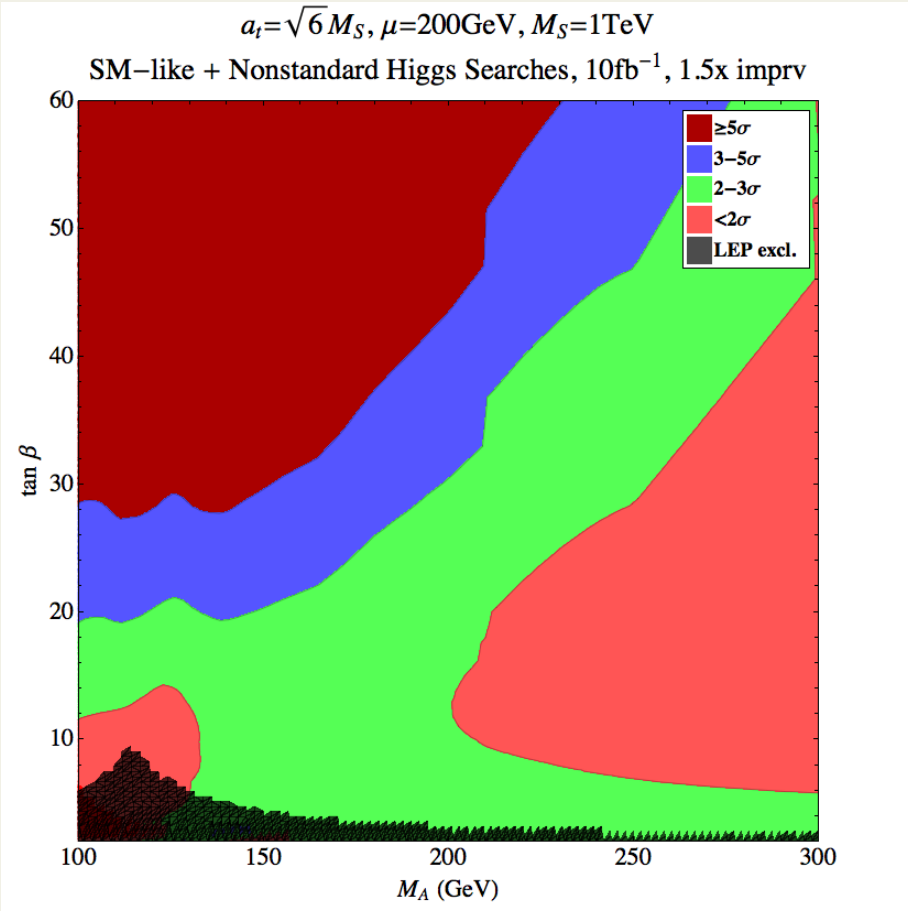


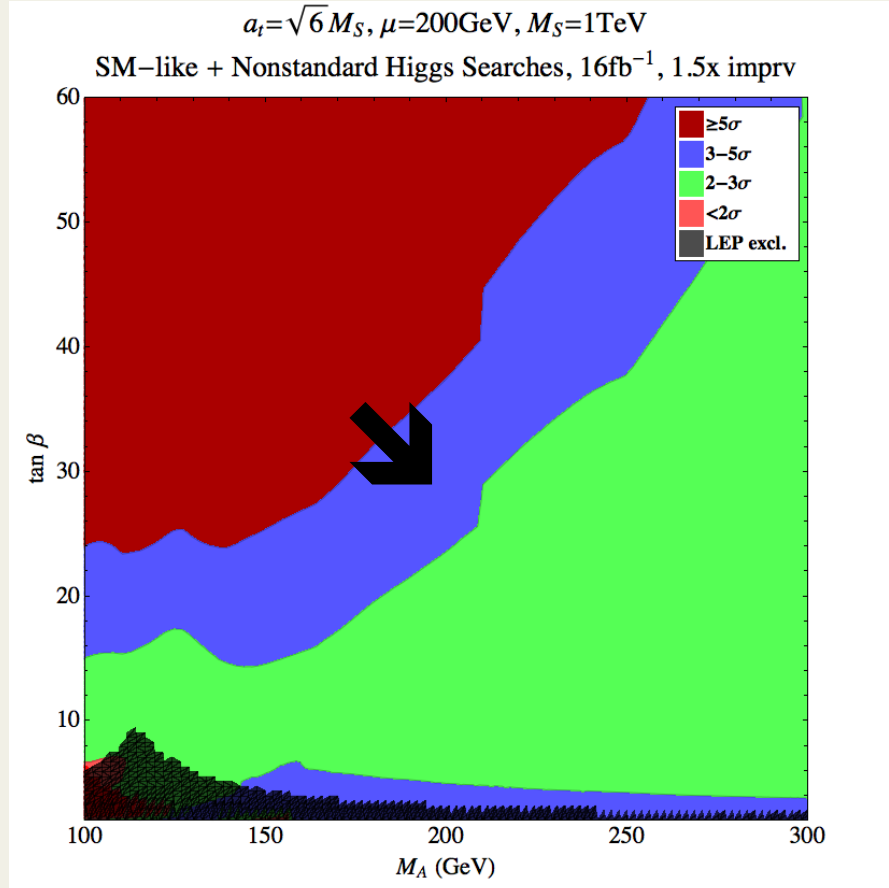


significant extension of sensitive region

MSSM Higgs Bosons

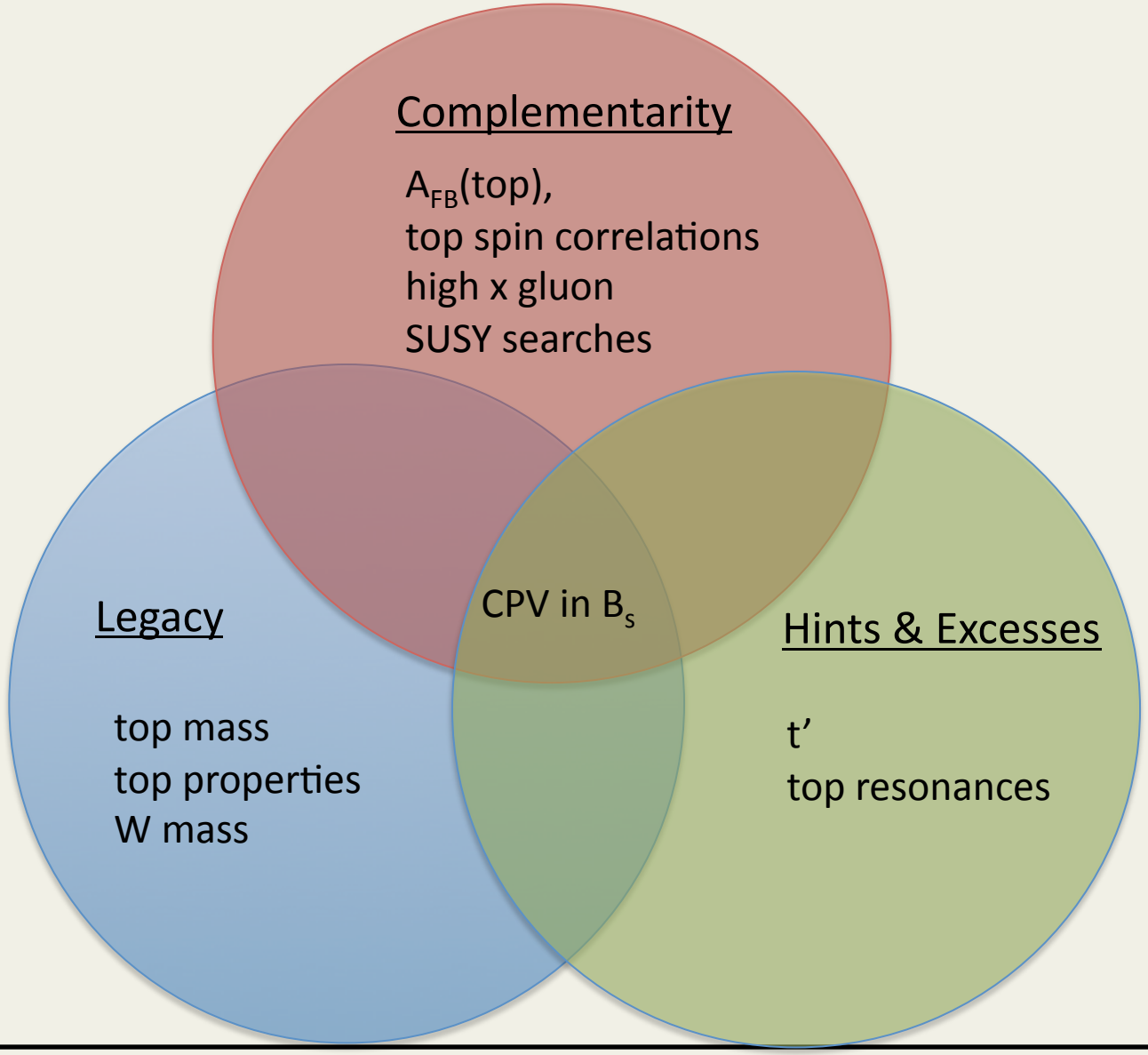
Maximal Mixing Scenario



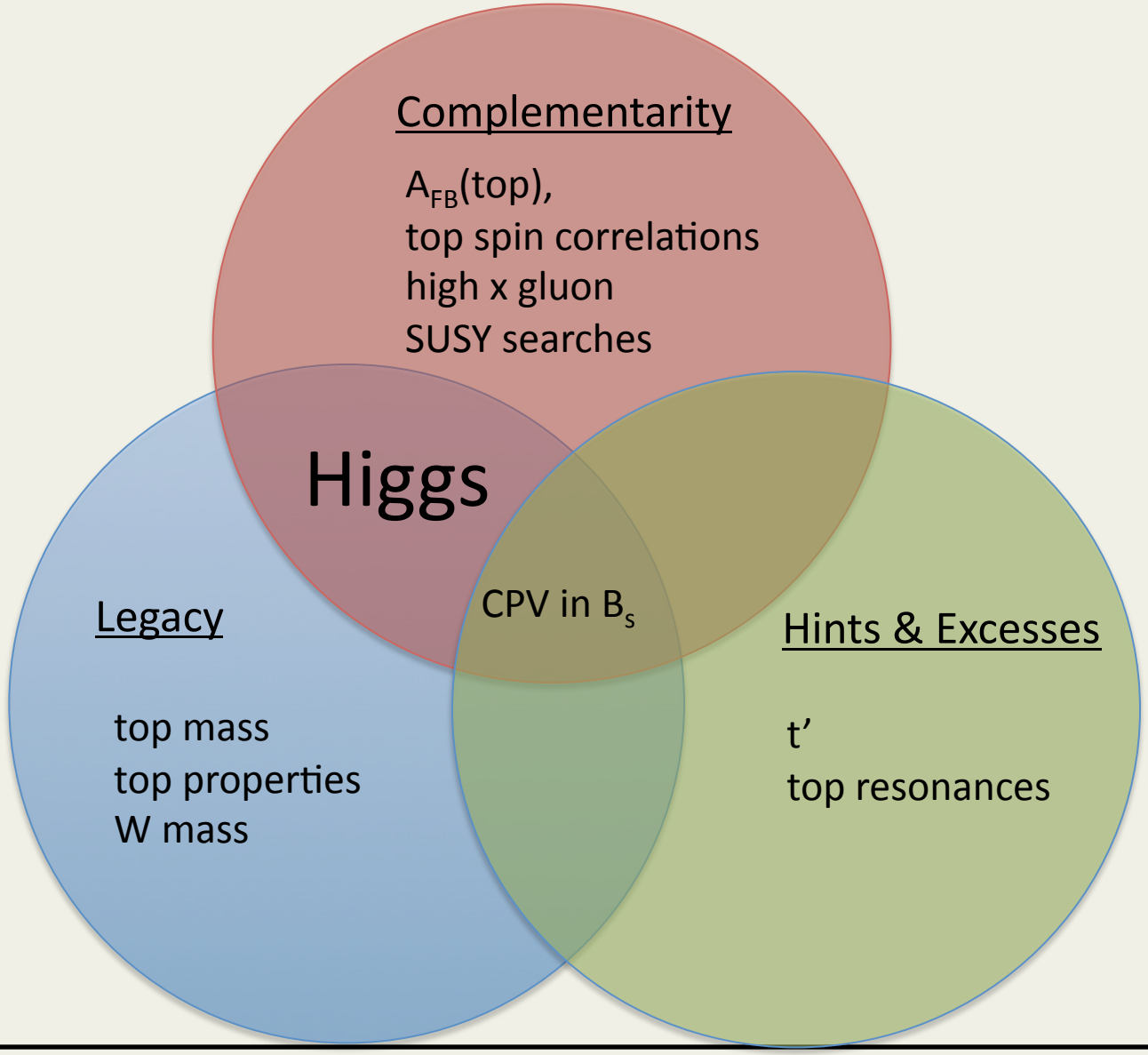


Draper, Liu, Wagner

Beyond 2011


Complementarity
A_{FB}(top),
top spin correlations
high x gluon
SUSY searches
Legacy
top mass
top properties
W mass
CPV in B_s
Hints & Excesses
t'
top resonances

Beyond 2011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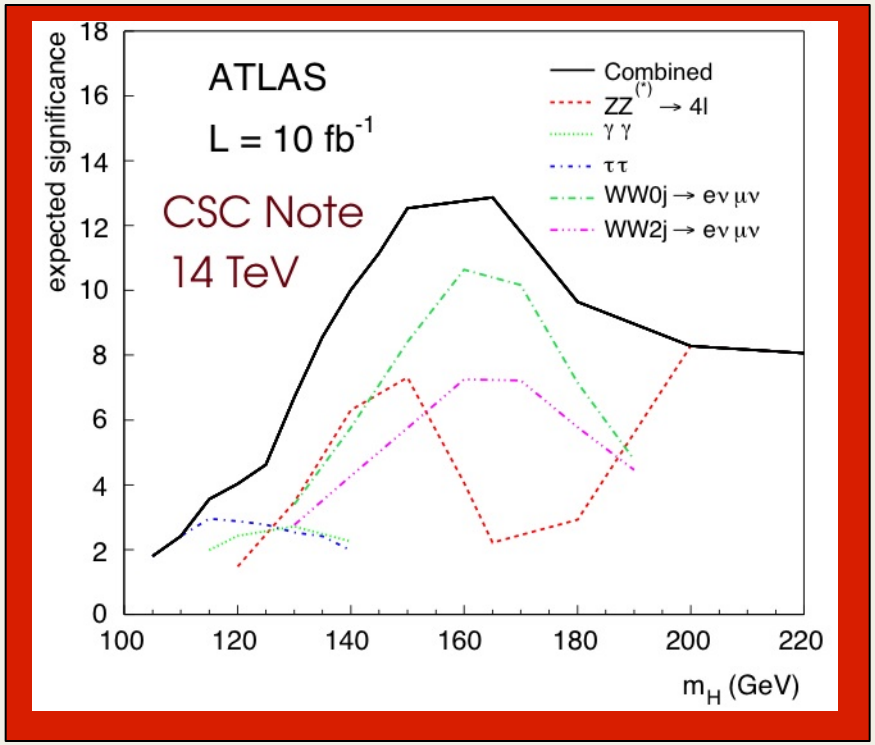
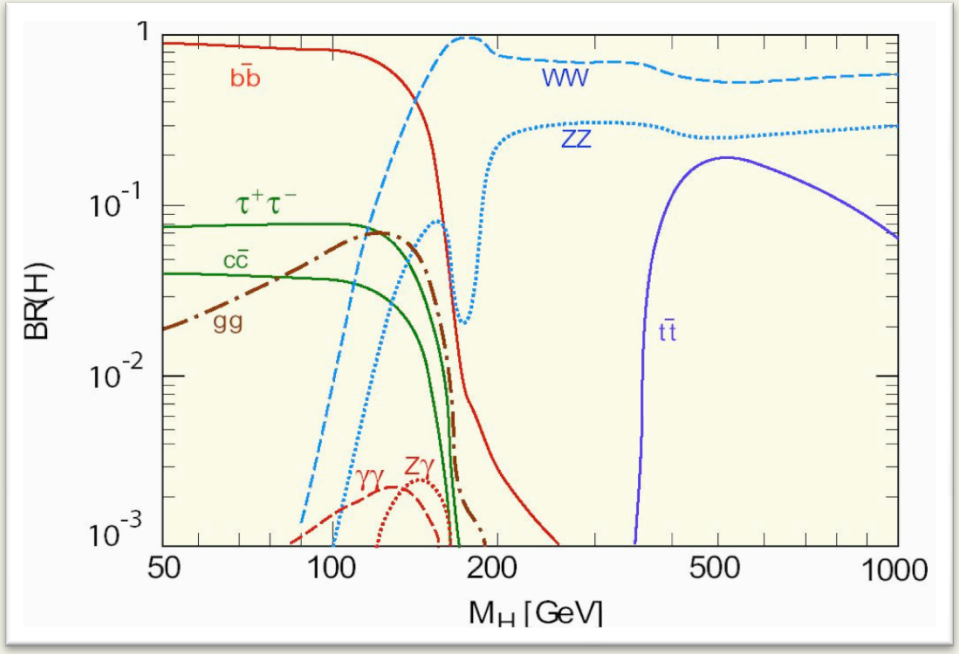
top resonances

The Nature of the SM Higgs





Without direct observation of Higgs decays into b jets, it is not possible to reach a definite conclusion about the EWSB mechanism.

Higgs Beyond 2011

Running until 2014 provides many exciting opportunities for Higgs physics:

- Finding evidence for a low mass Higgs boson in b decays is essential to understanding EWSB in the Standard Model. Unique capability of Tevatron for many years.

- Alternatively, Tevatron has the potential to exclude the SM by directly excluding Higgs masses predicted by electroweak precision data (top and W mass).

- BSM Higgs searches will be able to exclude several MSSM benchmarks scenarios or find evidence for a MSSM Higgs.