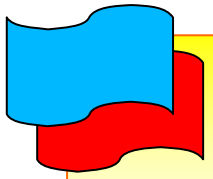


Higgs→WW* Search with Matrix Element Methods at CDF

Shih-Chieh Hsu

For CDF Collaboration

University of California, San Diego

UCSD

CDF II

XLIInd Recontres De Moriond

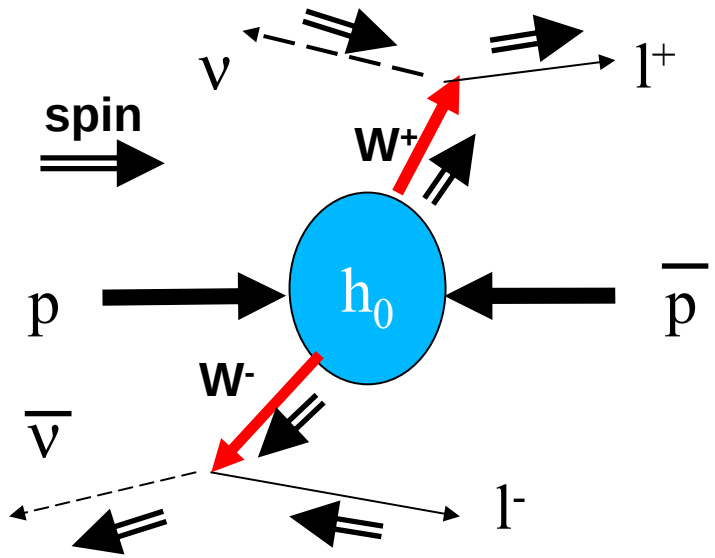
Electroweak Interactions and Unified Theories

Mar 132007

La Thuile, Italy

Introduction

- **Spin 0 Physics**



- **mH=160GeV/c² at 1fb⁻¹**

- **Dilepton+ $\not\!\!E_T$ Final States**
  BR(WW->llνν)=5.4% (l=e, μ, e_τ, μ_τ)
- **Dominant channel for high mass Standard Model Higgs**

m_h(GeV/c²)	130	**160**	200
σ_{NNLL}(pb)[a]	0.56	**0.43**	0.21
BR(H→WW)	0.29	**0.90**	0.73

[a]hep-ph/0306211 Catani, et. al.

MC Study

Cut Base: S/B=1.7/44.5(D0)
2.2/36.0(CDF)

Optimize
m_{ll}, $\not\!\!E_T$, ΣE_T → **$P(\phi_{ll})$**

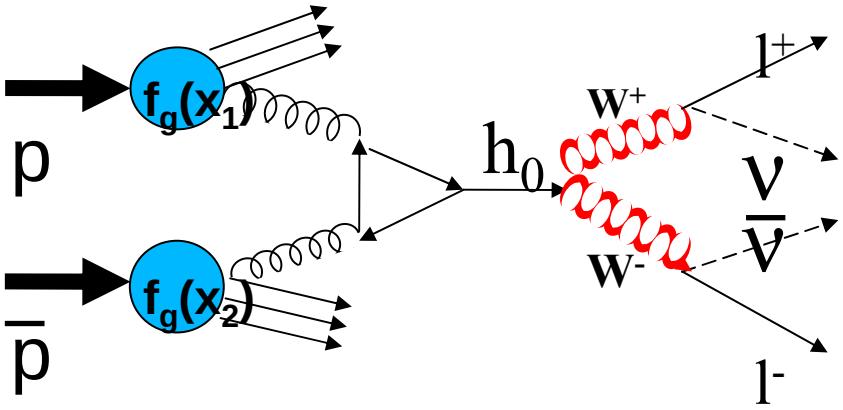
ME Methods: S/B ~ 4/290

$\not\!\!E_T$>25GeV → $P(l^+,l^-,E_T)$
m_{ll}>25GeV/c²
NJets<1 → **P(Ps/(Ps+Pb))**

Matrix Element Methods

Event Probability Density

$$P(x_{obs}) = \frac{1}{<\sigma>} \int \frac{d\sigma_{th}(y)}{dy} \epsilon(y) G(x_{obs}, y) dy$$



8 Integration d.o.f:

12 four body decay
2 parton energy fraction
2 parton level system p_T
-4 four-mom conservation
-4 dilepton angles(δ function)

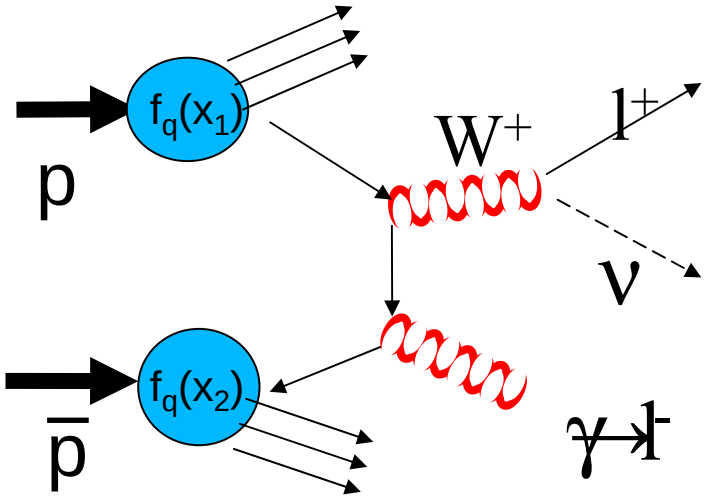
$\mathbf{x_{obs}}$: $\vec{L}^+$, $\vec{L}^-$, $\not{E}_{Tx}$, $\not{E}_{Ty}$
y : true value
σ_{th} : MCFM LO Parton Level Xsec

ε : efficiency
G : Resolution
<σ>: Normalization

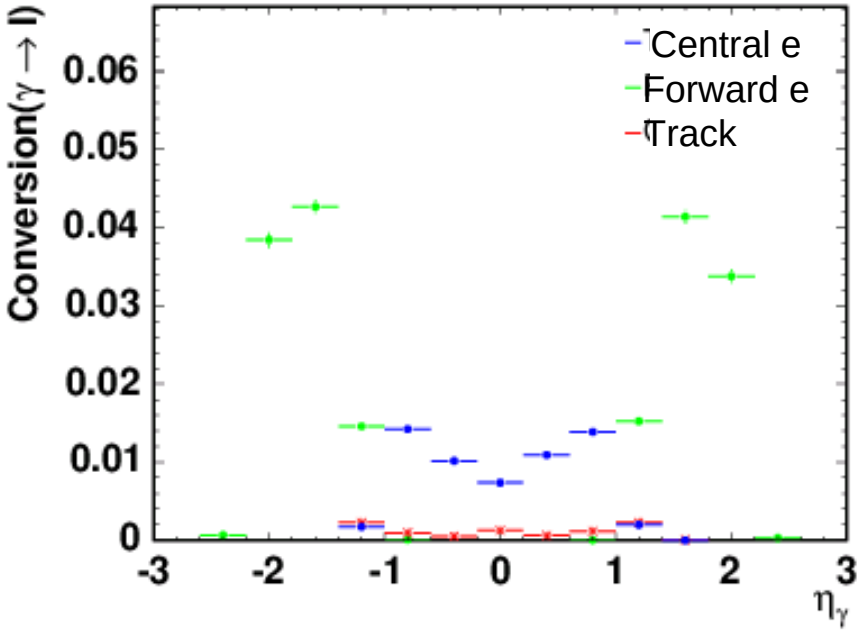
More Event Probabilities

- **Implementation:** WW, ZZ, Wγ, W+1parton
- **Other Bkg:** WZ, DY, $t\bar{t}$
- **Using Pythia to extract ε(γ/Parton->lepton)**

Example of Wγ



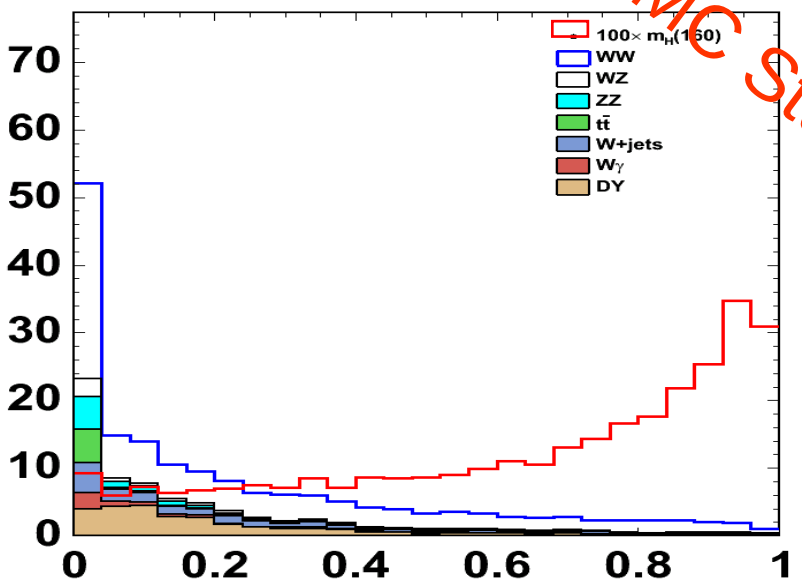
ε(γ→l)

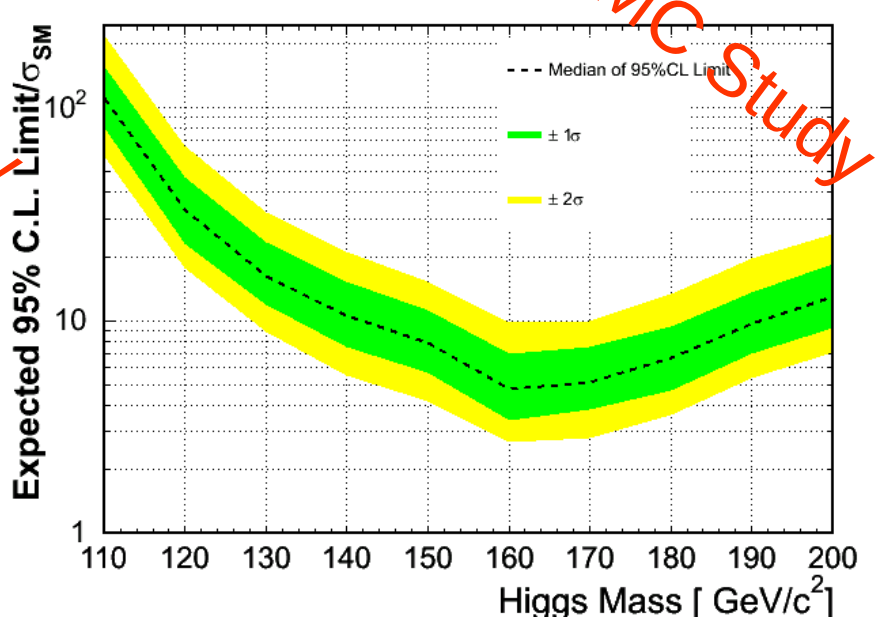


Likelihood Ratio Discriminator

$$R_{\mathcal{L}} = \frac{P_s}{P_s + k_{bi} P_{bi}}$$

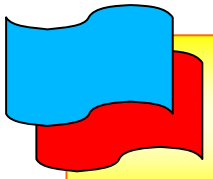
$\Sigma k_{bi}=1$





Probability Calculation Model doesn't need to be perfect

Imperfection of efficiency and transfer function is included in Discriminator Template

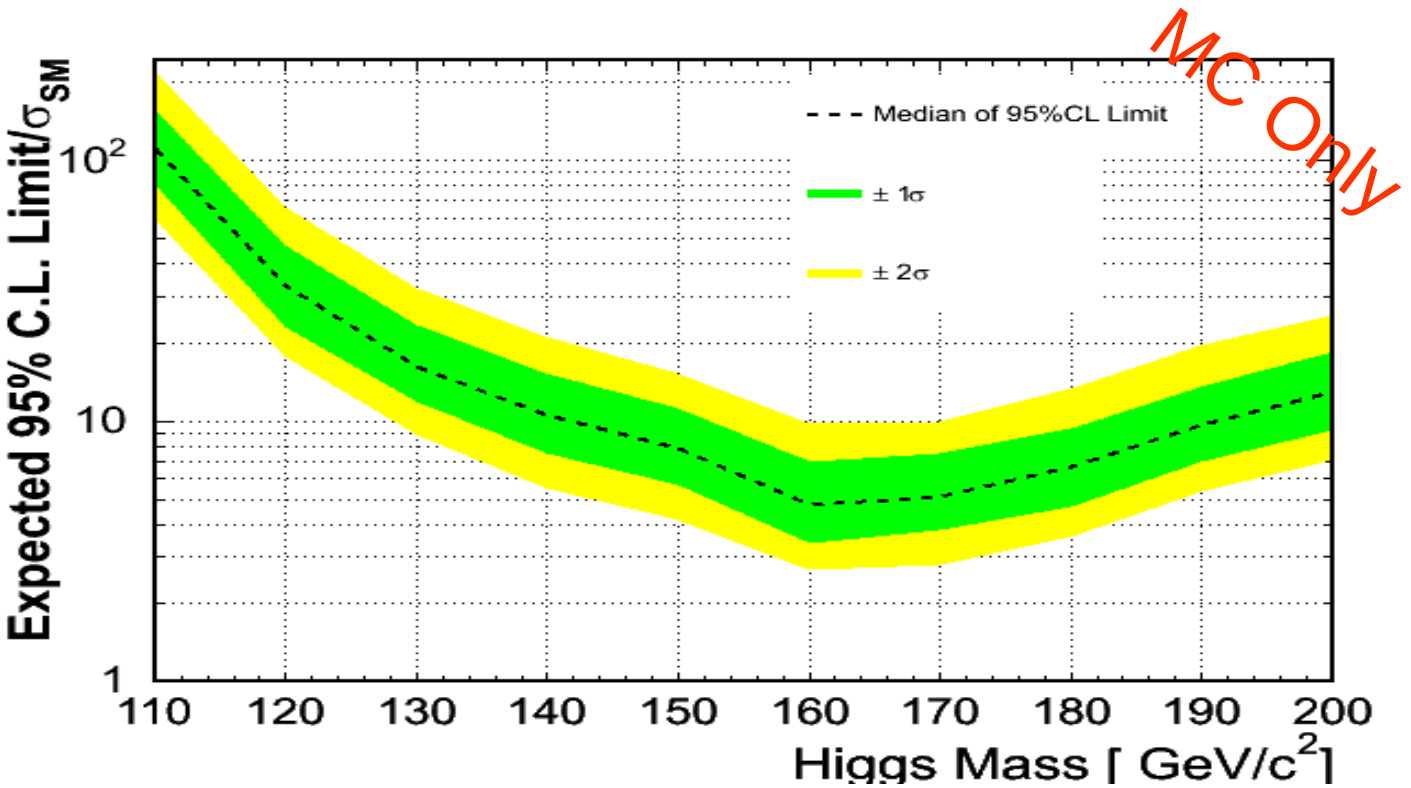


Summary

- **We developed the matrix element methods with WW channels for Standard Model Higgs search**
- **The ratio of expected 95%C.L. limit to NNLL Standard Model cross section could reach 5 for m_H=160 GeV/c^2 at 1fb^{-1}**
- **Good direction to go: lower mll cut, include forward tracking, better lepton ID…**
- **Easy application to other model dependent searches, e.g. ZZ production is on-going.**

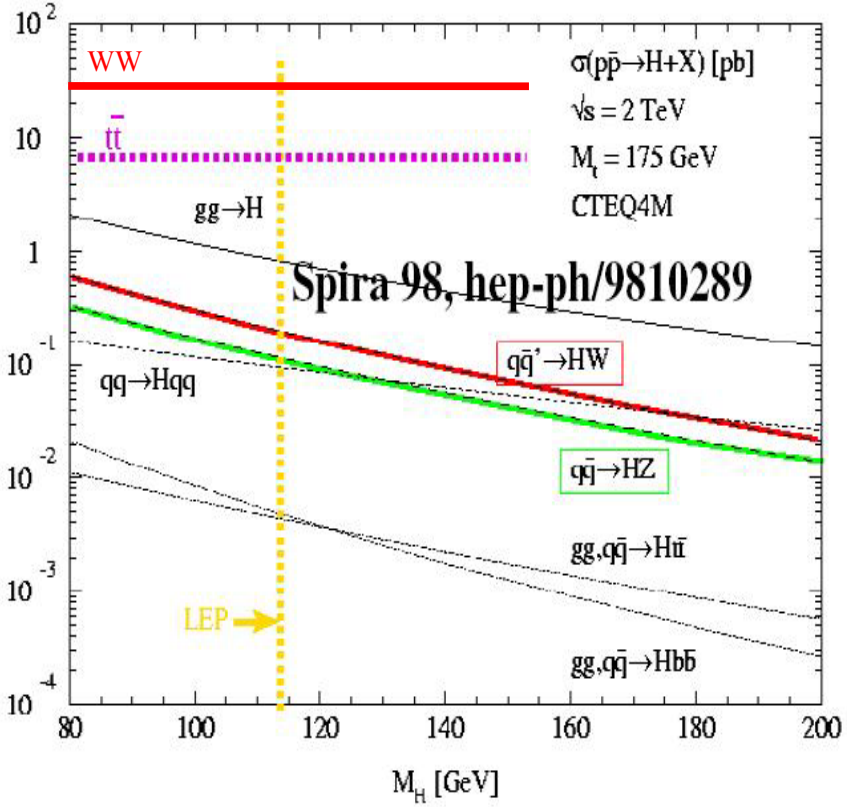
Sensitivity

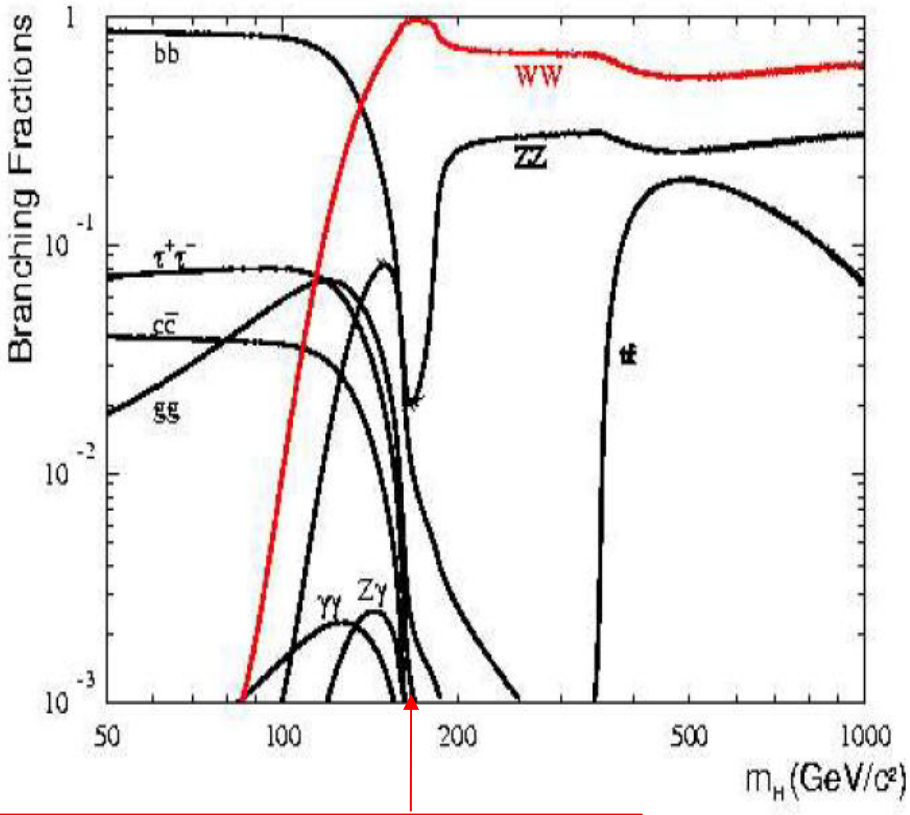
- **Binned Maximum likelihood fit with flat prior**
- **The systematics are included**
- **Expected 95% C.L. Limit is normalized to NNLL Cross Section**



Higgs to WW* Poduction

- **Production at Tevatron**
- **Higgs Decay**

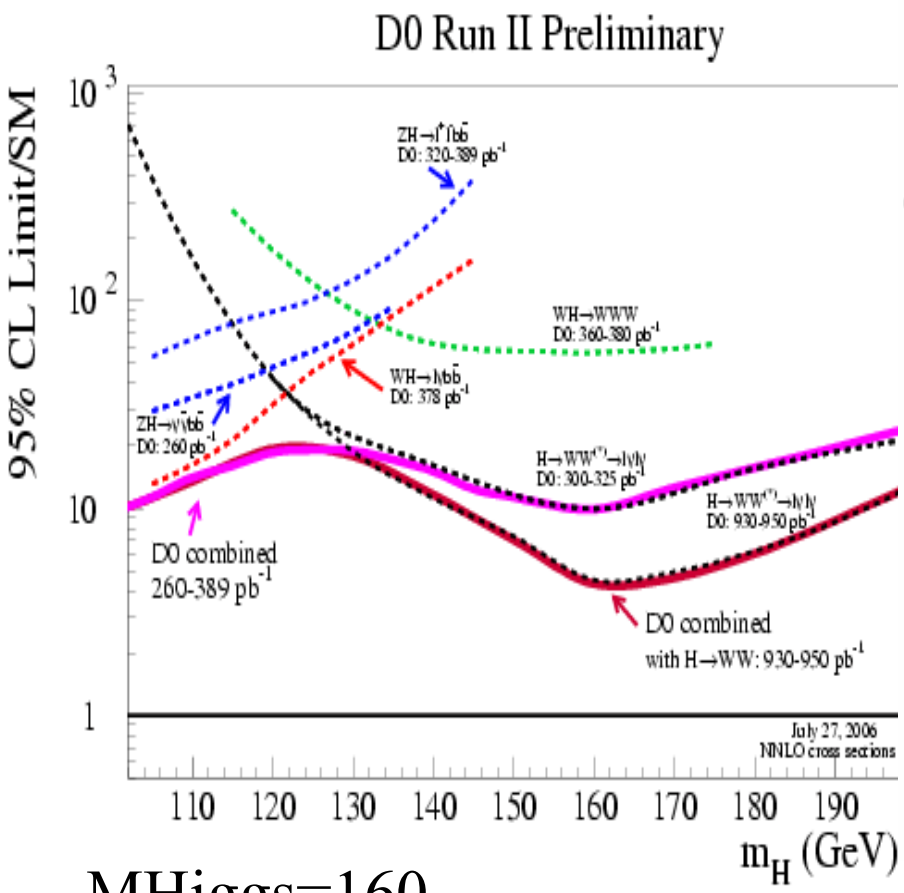




WW is the most sensitive channel at Higgs mass 160GeV

Higgs Searches

- **D0** ICHEP2006

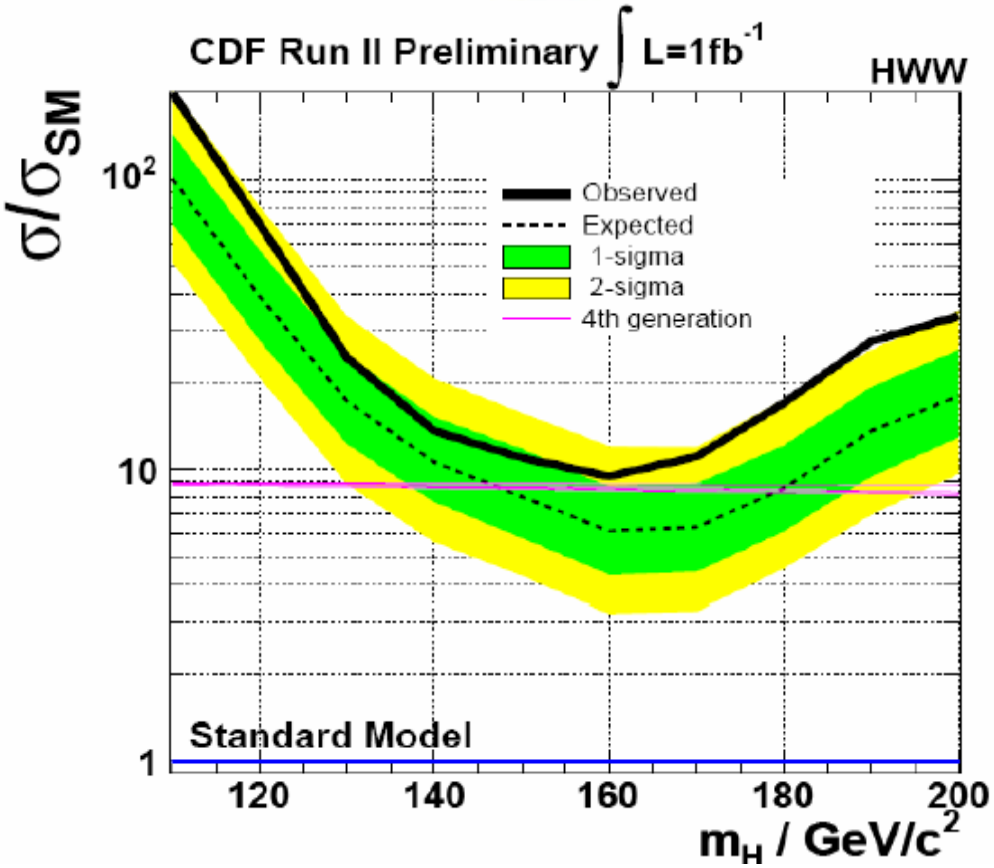


MHiggs=160

Ns=1.7 Nb=44.5 Obs=37

σ_{exp}/σ_{SM}~5 σ_{obs}/σ_{SM}=4

- **CDF** Moriond Ewk 2007



Ns=2.2 Nb=36.0 Obs=49

σ_{exp}/σ_{SM}~5 σ_{obs}/σ_{SM}=11