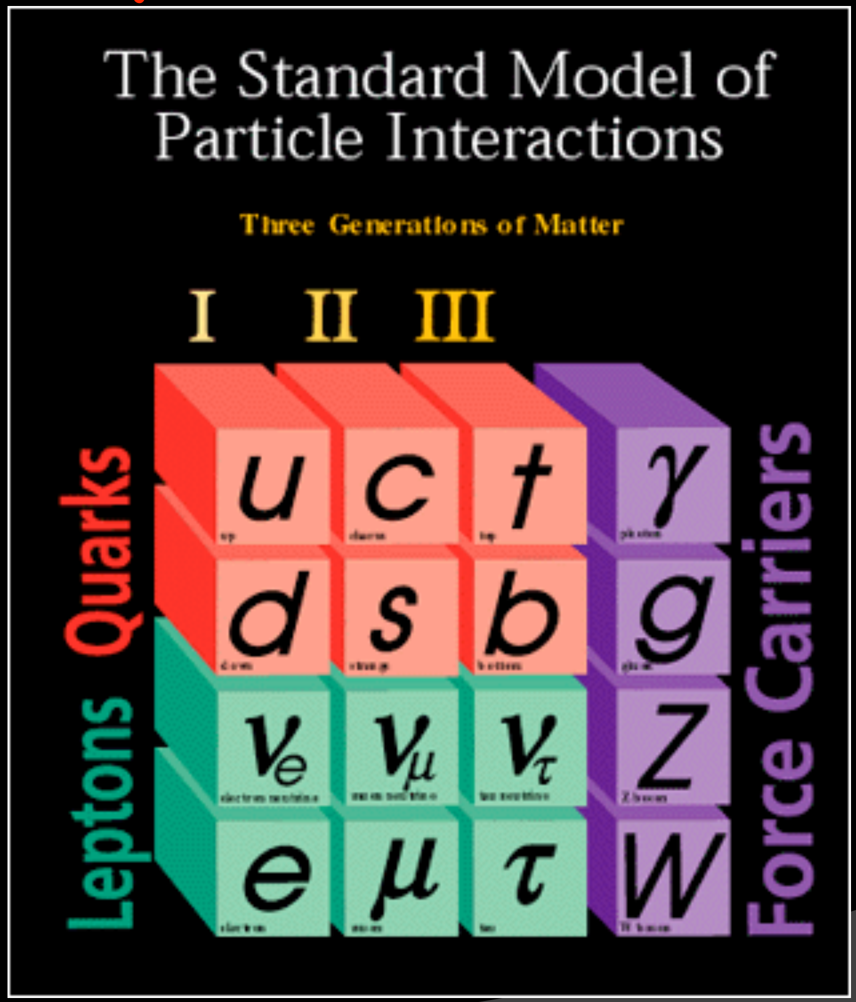
The road to SM Higgs sensitivity at the Tevatron

S. Jindariani
(FNAL)

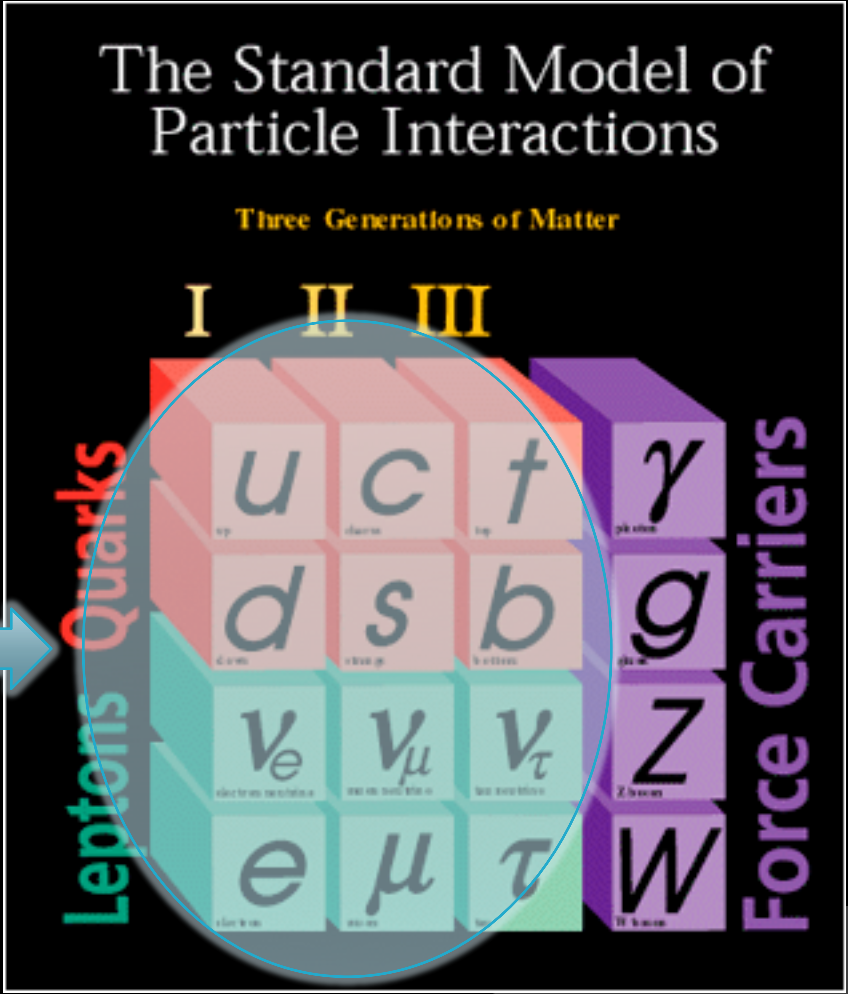
SM Higgs Trivia

Why a Higgs boson?



SM Higgs Trivia

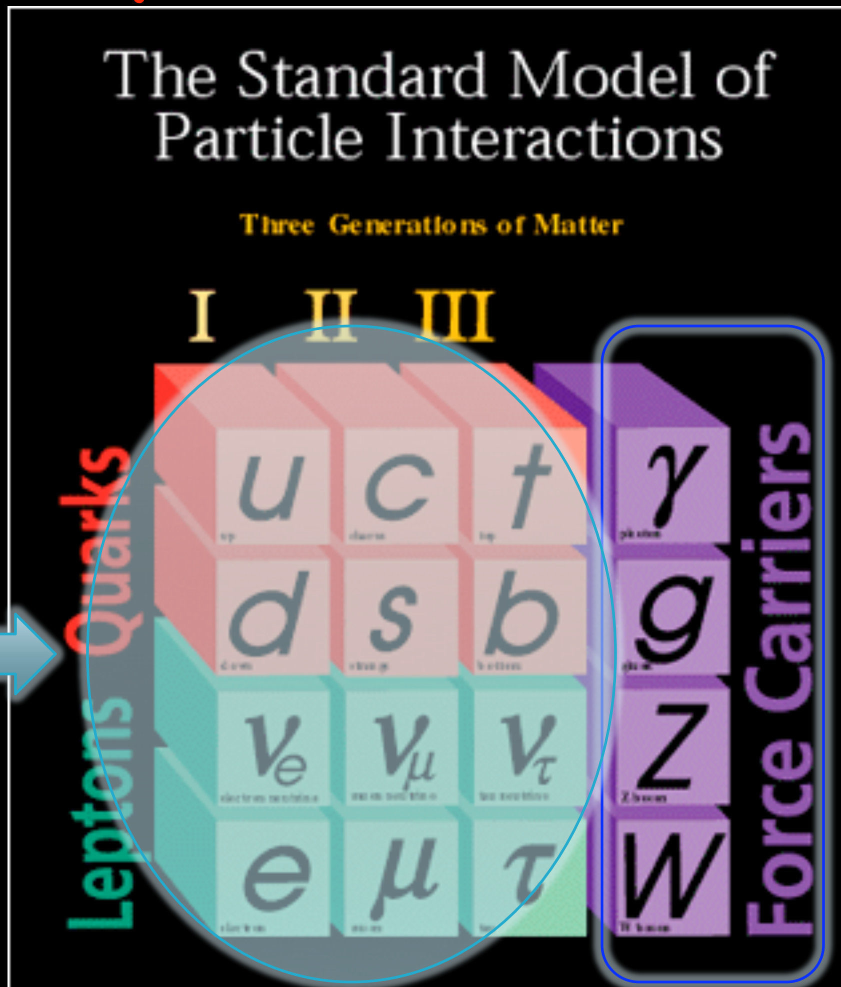
Why a Higgs boson?



Particles are massive

SM Higgs Trivia

Why a Higgs boson?

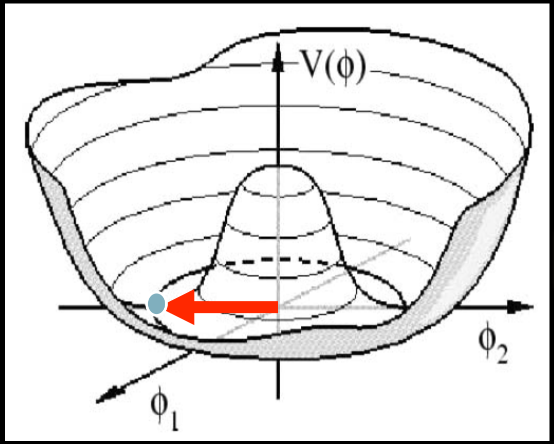


Massive W/Z vs massless γ

Particles are massive

SM Higgs Trivia

effective mass term
for the field itself



effective mass terms
for gauge bosons

Higgs field

Free lunch:

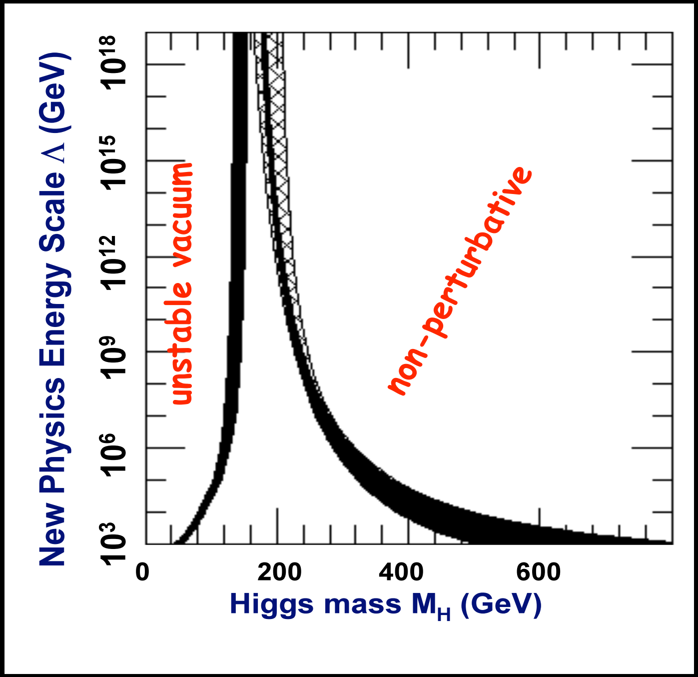
effective fermion masses

Things to remember:

- Higgs mass is the only free parameter
- Higgs likes to decay to heaviest particles it can decay to

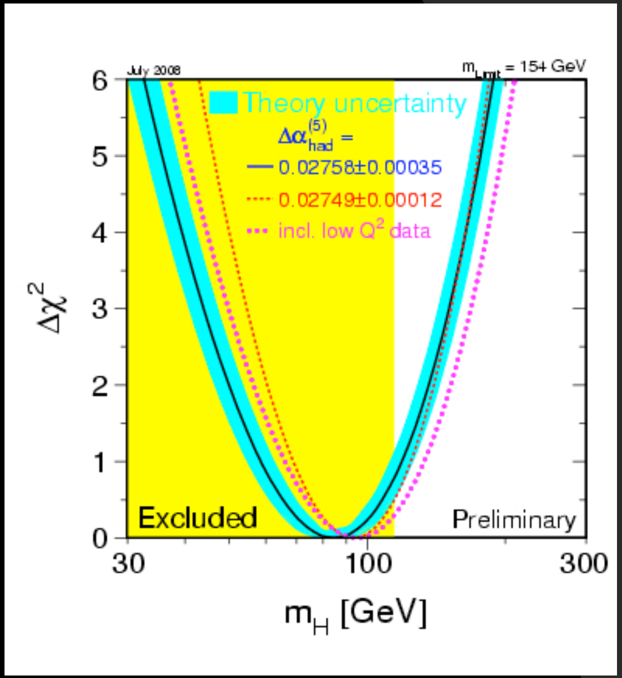
Where to look?

Theoretical constraints



SM Higgs has a very narrow window of opportunity to be self-sufficient due to a fine-tuned (apparently accidental) cancellation of large correction factors

Experimental constraints



Direct search at LEP:

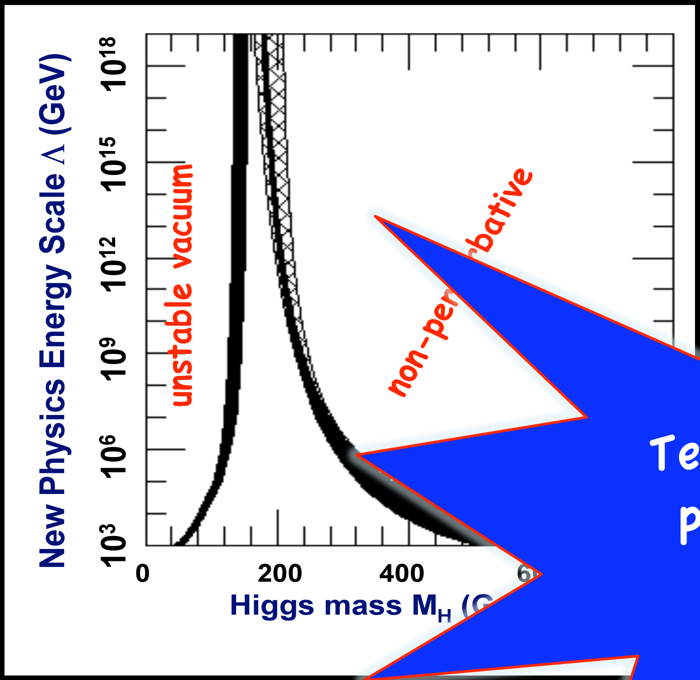
m_H>114 GeV @ 95%CL

Including indirect electroweak constraints

m_H<185 GeV @ 95%CL

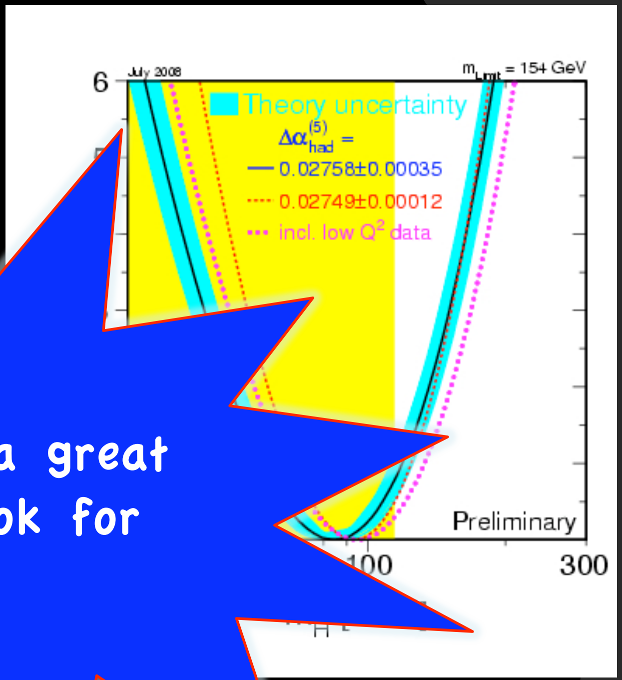
Where to look?

Theoretical constraints



SM Higgs has a very narro window of opportunity to be self-sufficient due to a fine-tuned (apparently accidental) cancellation of large correction factors

Experimental constraints



Tevatron is a great place to look for Higgs

rect s rch at LEP:

$_H$>114 Ge @ 95%CL

Indirect electroweak constraints

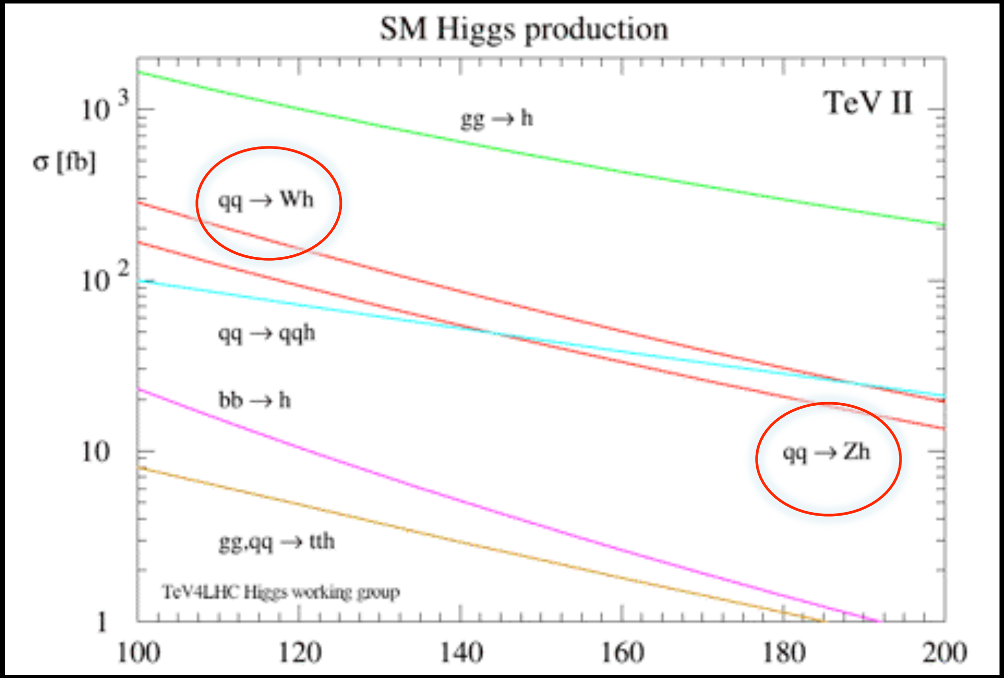
m_H<185 GeV @ 95%CL

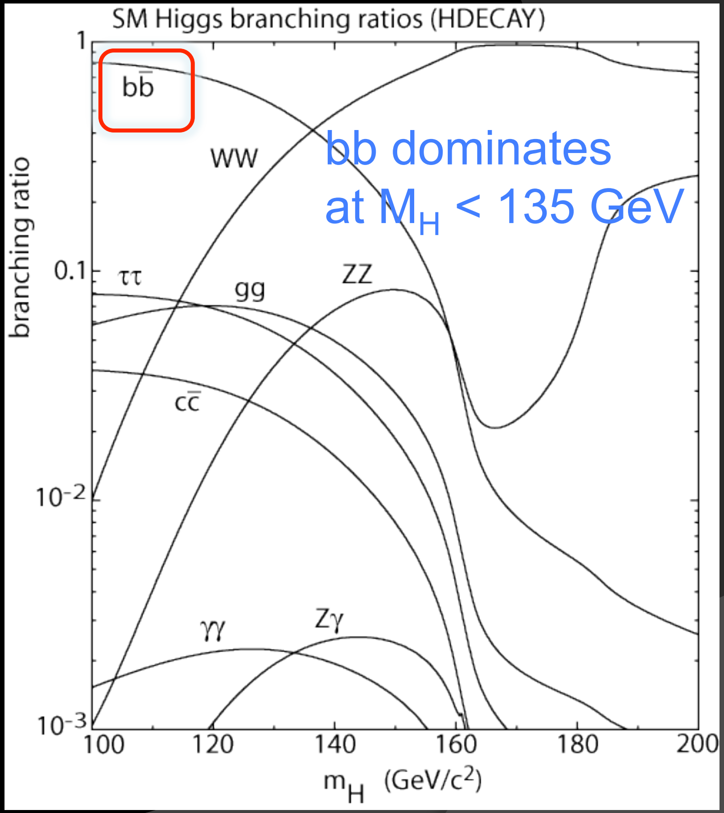
SM Higgs at the Tevatron

Production mechanisms

Decay modes:

Low Mass

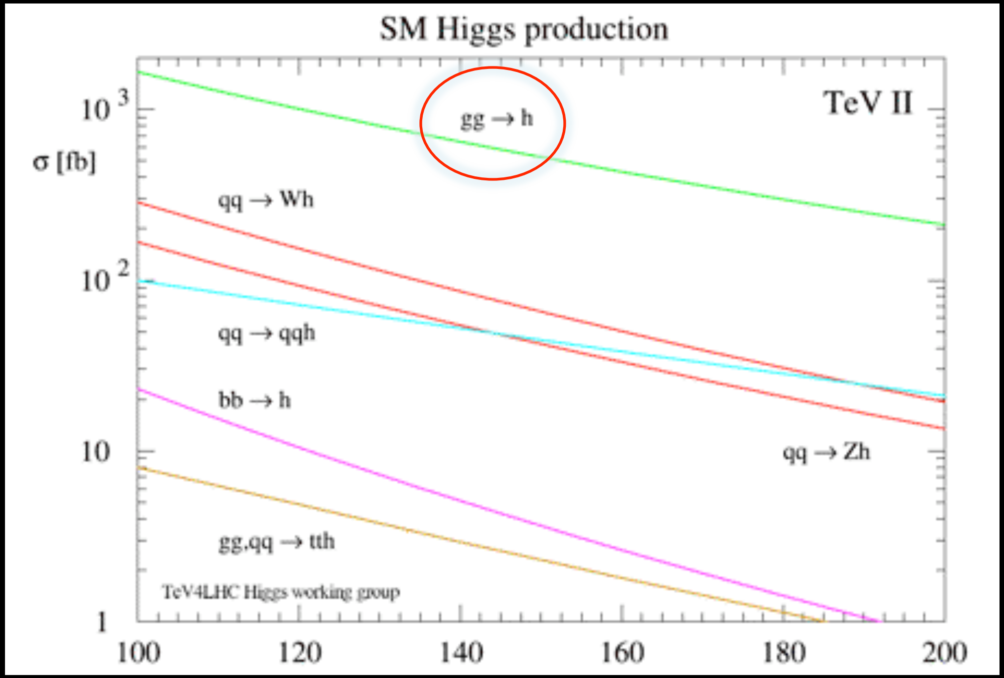


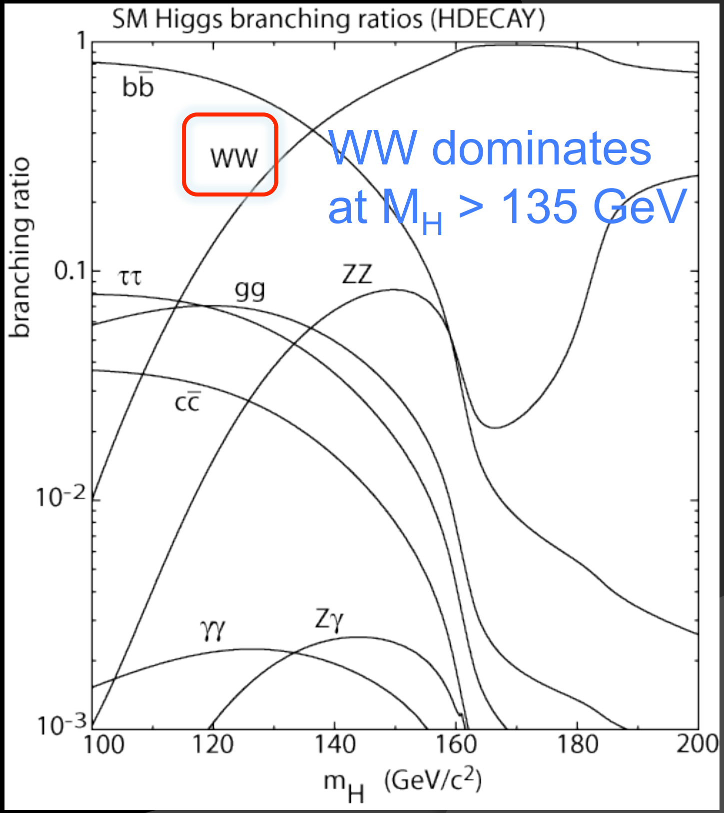


SM Higgs at the Tevatron

Production mechanisms **Decay modes:**

High Mass





Higgs at CDF

Newest CDF Higgs Results	Published CDF Higgs results	
CDF home page	Link to D0 Public Higgs Webpage	Link to CDF internal HDG webpage

SM Higgs Search	Description	Results	Datasets (fb-1)	Last Update
H -> WW* WH -> WWW*	Dileptons (OS+SS) using NN discriminant with ME Inputs	Expected cross section x BR limit/SM < 1.45 @165GeV	3.6	02/27/09
CDF combined search for low mass and high mass Higgs	We combine below-listed H->WW, WH -> lvbb, WH+ZH->MET+bb, ZH->llbb, WH -> WWW, and H -> tautau	Expected cross section x BR limit/SM < 3.2 @115GeV Expected cross section x BR limit/SM < 1.7 @165GeV	2.0 - 3.0	01/16/09
Tevatron combined high mass Higgs	We combine CDF & D0 H->WW searches	SM Higgs is excluded @ 170GeV	3.0	08/05/08
WH -> l nu b bbar	lepton, missing E_T, 2 jets (1 or 2 b-tags) using multivariate discriminants	ME+BDT Expected cross section x BR limit/SM < 5.6 @115GeV NN Expected cross section x BR limit/SM < 5.8 @115GeV Combined Expected cross section x BR limit/SM < 4.8 @115GeV	2.7	11/07/08
WH -> WWW*	2 like-sign leptons using BDT discriminant	Expected cross section x BR limit/SM < 20.1 @160GeV Expected cross section x BR limit/Fermiophbic Higgs < 8.8 @120GeV	2.7	12/12/08
VH -> MET b bbar	missing E_T, 2 jets (2 b-tags) using NN discriminant	Expected cross section x BR limit/SM < 5.6 @115GeV	2.1	11/07/08
ZH -> ll b bbar	2 leptons, 2 jets (2 b-tags) using NN discriminant	Expected cross section x BR limit/SM < 9.9 @115GeV	2.7	10/24/08
ZH -> ll b bbar	2 leptons, 2 jets (2 b-tags) using ME discriminant	Expected cross section x BR limit/SM < 15 @120GeV	2.0	07/25/08
VH-> qq b bar	4 jets (2 b-tags) using ME discriminant	Expected cross section x BR limit/SM < 37 @115GeV	2.0	04/25/08
VH,VBH,gg-> H in 2τ 2j	2τ 2j using NN discriminants	Expected cross section x BR limit/SM < 25 @115GeV	2.0	02/22/08
ttH -> lvjjbbbb	lepton, missing E_T, >= 5jets (>=3 b-tag)	cross section x BR limit (APS06 talk)	0.32	04/20/06

Updated since ICHEP'08

These are SM Higgs searches. We also search for beyond SM Higgs...

Higgs at CDF

Newest CDF Higgs Results	Published CDF Higgs results	
CDF home page	Link to D0 Public Higgs Webpage	Link to CDF internal HDG webpage

SM Higgs Search	Description	Results	Datasets (fb-1)	Last Update
H -> WW* WH -> WWW*	Dileptons (OS+SS) using NN discriminant with ME Inputs	Expected cross section x BR limit/SM < 1.45 @165GeV	3.6	02/27/09
CDF combined search for low mass and high mass Higgs	We combine below-listed H->WW, WH -> lvbb, WH+ZH->MET+bb, ZH->llbb, WH -> WWW, and H -> tautau	Expected cross section x BR limit/SM < 3.2 @115GeV Expected cross section x BR limit/SM < 1.7 @165GeV	2.0 - 3.0	01/16/09
Tevatron combined high mass Higgs	We combine CDF & D0 H->WW searches	SM Higgs is excluded @ 170GeV	3.0	08/05/08
WH -> l nu b bbar	lepton, missing E_T, 2 jets (1 or 2 b-tags) using multivariate discriminants	ME+BDT Expected cross section x BR limit/SM < 5.6 @115GeV NN Expected cross section x BR limit/SM < 5.8 @115GeV Combined Expected cross section x BR limit/SM < 4.8 @115GeV	2.7	11/07/08
WH -> WWW*	2 like-sign leptons using BDT discriminant	Expected cross section x BR limit/SM < 20.1 @160GeV Expected cross section x BR limit/Fermiophbic Higgs < 8.8 @120GeV	2.7	12/12/08
VH -> MET b bbar	missing E_T, 2 jets (2 b-tags) using NN discriminant	Expected cross section x BR limit/SM < 5.6 @115GeV	2.1	11/07/08
ZH -> ll b bbar	2 leptons, 2 jets (2 b-tags) using NN discriminant	Expected cross section x BR limit/SM < 9.9 @115GeV	2.7	10/24/08
ZH -> ll b bbar	2 leptons, 2 jets (2 b-tags) using ME discriminant	Expected cross section x BR limit/SM < 15 @120GeV	2.0	07/25/08
VH-> qq b bar	4 jets (2 b-tags) using ME discriminant	Expected cross section x BR limit/SM < 37 @115GeV	2.0	04/25/08
VH,VBH,gg-> H in 2τ 2j	2τ 2j using NN discriminants	Expected cross section x BR limit/SM < 25 @115GeV	2.0	02/22/08
ttH -> lvjjbbbb	lepton, missing E_T, >= 5jets (>=3 b-tag)	cross section x BR limit (APS06 talk)	0.32	04/20/06

Main topic today

ZH → l^+l^-bb

Fully reconstructed final state:

- H→bb and Z→ll
- Z mass window $M_{ll} \approx M_Z$

Dominant Backgrounds

- Z+jets, tt, Dibosons
- irreducible Z+bb

Small Signal (~1 event/fb^{-1})

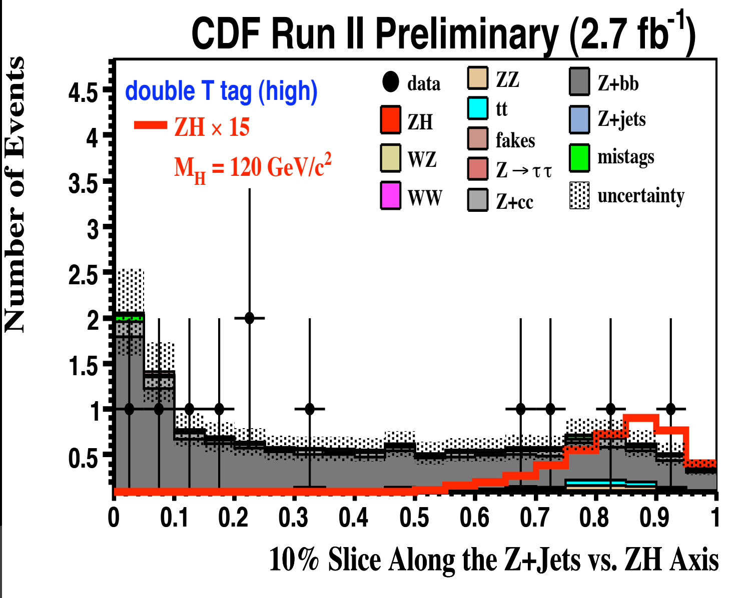
- analyze events with at least 1 btag

<u>2.7 fb-1</u>

Improved JER!

Extended lepton types!

Analysis M_H=115	Lumi (fb^{-1})	Exp limit	Obs limit
CDF NN	2.7	9.9	7.1
CDF ME	2.7	12.3	7.8
DØ BDT	4.2	8.0	9.1



WH → l ν bb

1 high P_T lepton, MET and jets

2.7 fb-1

Loose muons, forward leptons

3 b-tagging algorithms

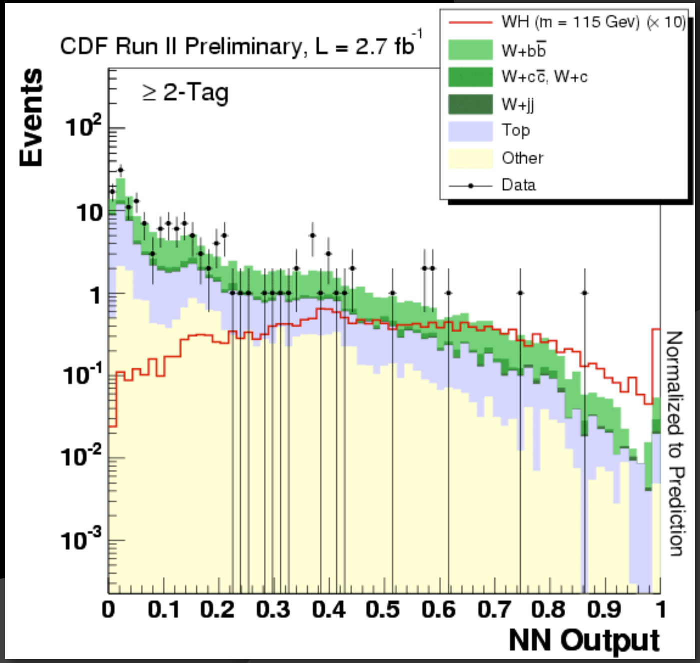
Dominant Backgrounds

- W+bb, tt, Dibosons, QCD

Signal (~3-4 event/fb^{-1})

- analyze events with at least 1 btag

ME+BDT, NN combined analyses



Analysis M_H=115	Lumi (fb^{-1})	Exp limit	Obs limit
CDF	2.7	4.8	5.6
DØ NN	2.7	6.4	6.7

VH →bb+MET

Partially reconstructed final state:

- Large MET and jets
- W/Z information missing

Dominant Backgrounds

- QCD (with fake MET), W/Z+jets, tt, Diboson

Signal (~3-4 event/fb^{-1})

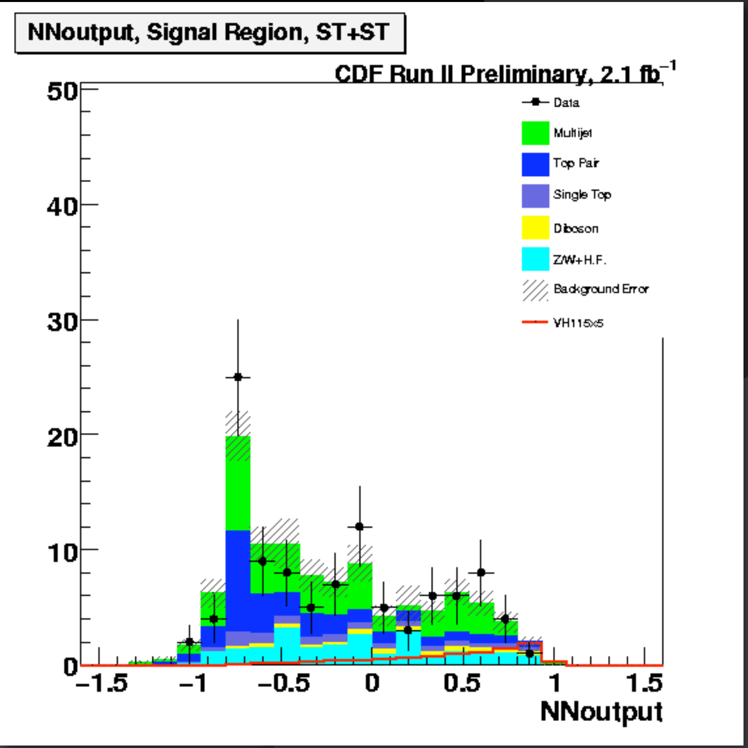
NN based analyses

2.1 fb-1

Data driven QCD model

Track based MET

Calor+Tracks jet reco



Analysis M_H=115	Lumi (fb^{-1})	Exp limit	Obs limit
CDF NN	2.1	5.6	6.9
DØ BDT	2.1	8.4	7.5

CDF low mass combined

WH→lνbb

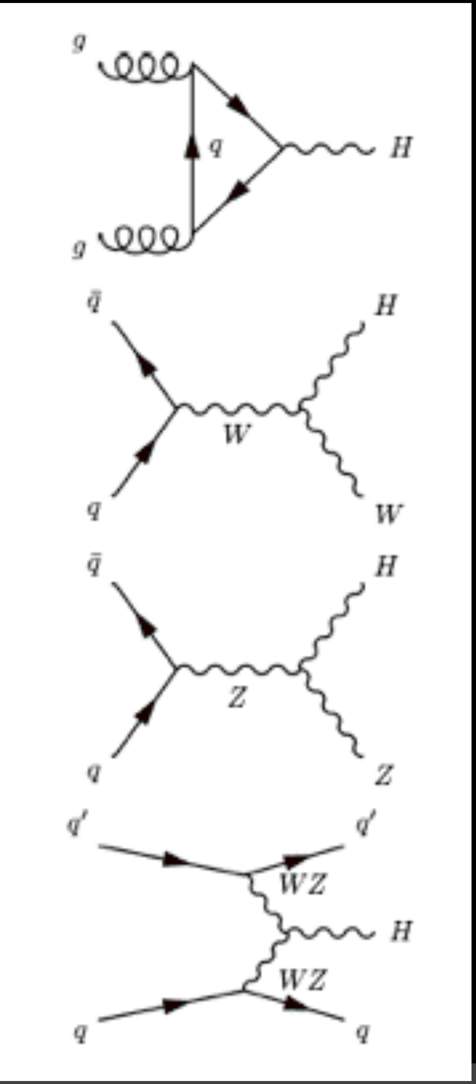
VH→bb+MET

M_H=115 GeV	Exp limit	Obs limit
CDF	3.2	3.6
DØ	3.6	3.7
Comb.	2.4	2.5

ZH→llbb

SM Higgs at the Tevatron

Production mechanisms:



@Mh=160 GeV

ggH (78 %)

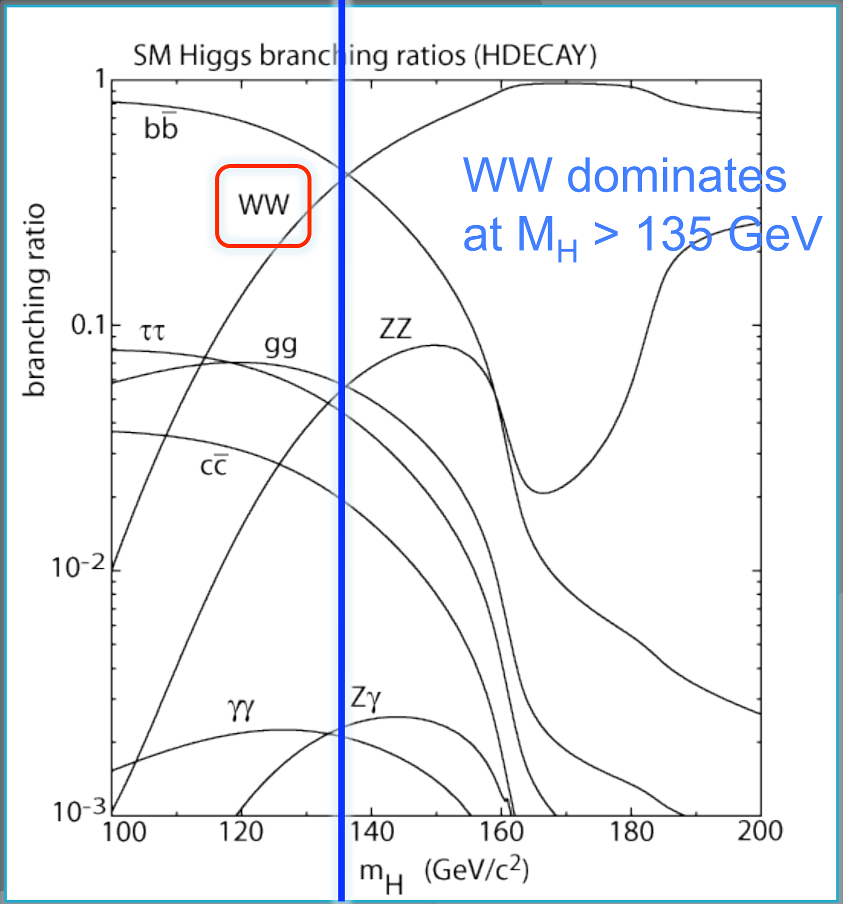
WH (9 %)

ZH (6 %)

VBF (7 %)

Decay modes:

Low Mass | High Mass

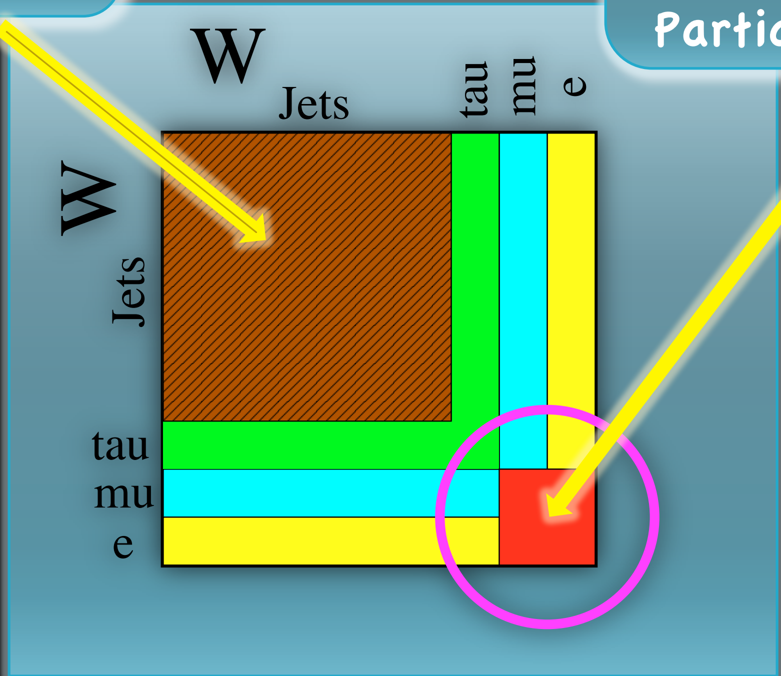


WW dominates at M_H > 135 GeV

Signature

BR(W→hadrons)~68%
But large QCD background
Not used now

BR(WW→ee,μμ,eμ)~6%
Manageable background
Easy triggers
Partially includes τ's



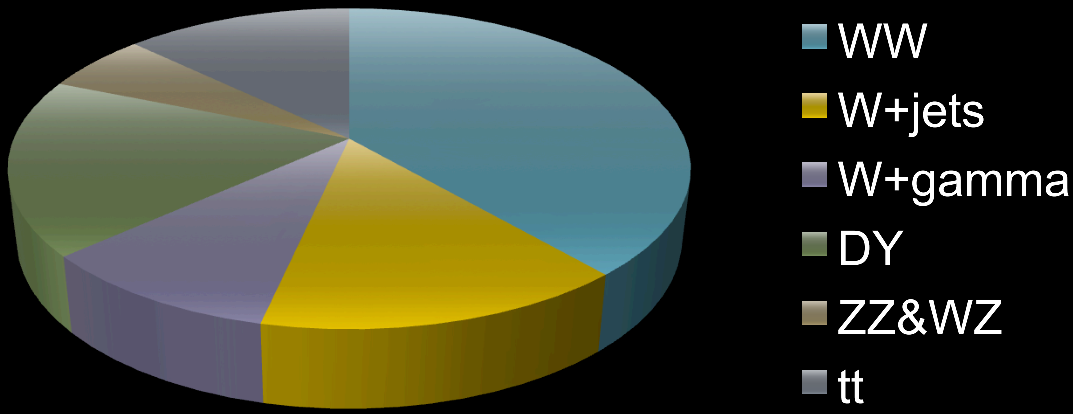
We select both W decaying leptonically

- Two well reconstructed, opposite sign, isolated electrons or muons
- Lepton transverse momentum p_{T1}>20 GeV and p_{T2}>10 GeV
- Require significant $\not{E}_T$ (neutrinos)
- M_{ll}> 16 GeV

General features:

- Most processes modeled with Pythia MC
- Cross sections normalized to (N)NLO calculations

Background composition:



WW (~40%):
Modeled using MC@NLO MC

W+jets (~15%):
Data-driven modeling

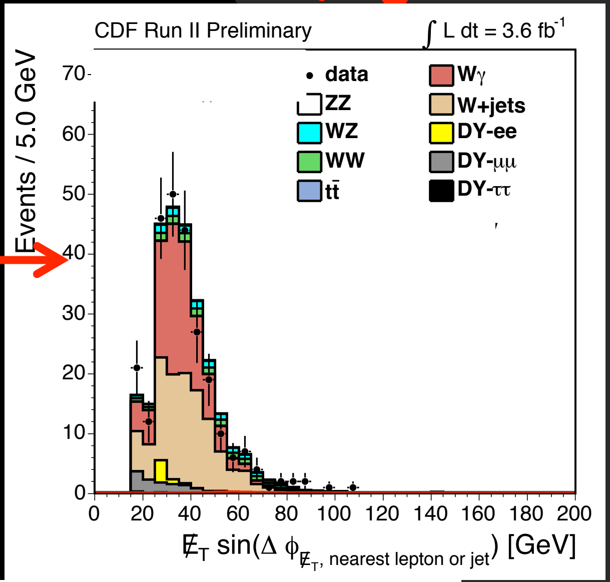
W+gamma (~10%):
Baur MC

ZZ(3%), WZ(3%), DY (~16%), tt (~13%) & Signal
Pythia MC

Background Modeling

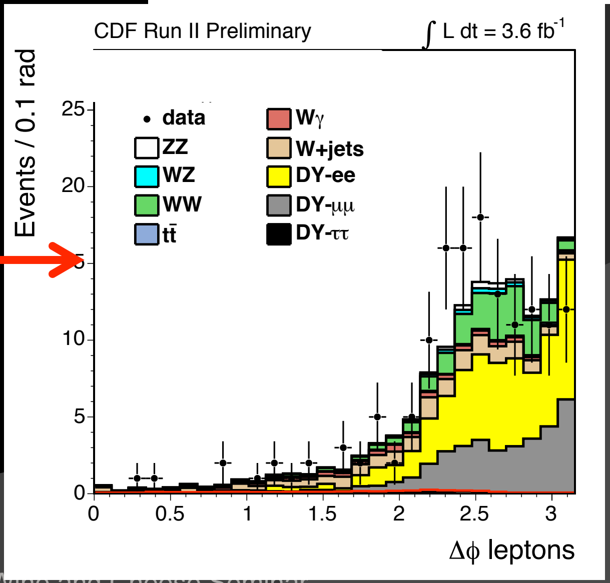
Several control regions to check background modeling:

- Same-sign region to check W+jet and W+gamma modeling



- DY control region to check trigger efficiencies, Data/MC scalefactors

- Intermediate MET regions to check DY modeling



much more... hundreds of plots...

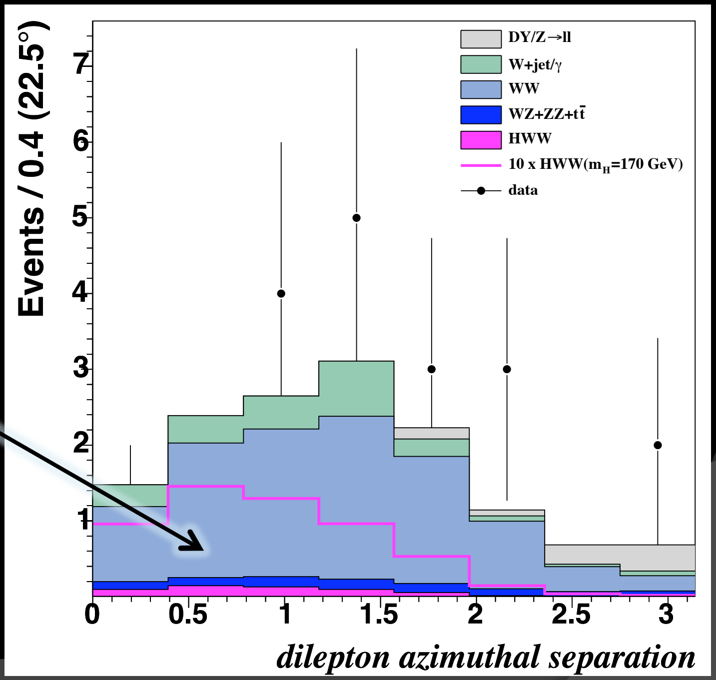
4 years ago…

CDF analysis based on 360 pb-1 of data

- primarily cut-based analysis
- used standard CDF lepton selection
- considered only gluon fusion production mechanism

Main challenge – discriminate HWW vs WW

Spin Correlations:
Lepton in HWW case go in the same direction



4 years ago…

CDF analysis based on 360 pb-1 of data

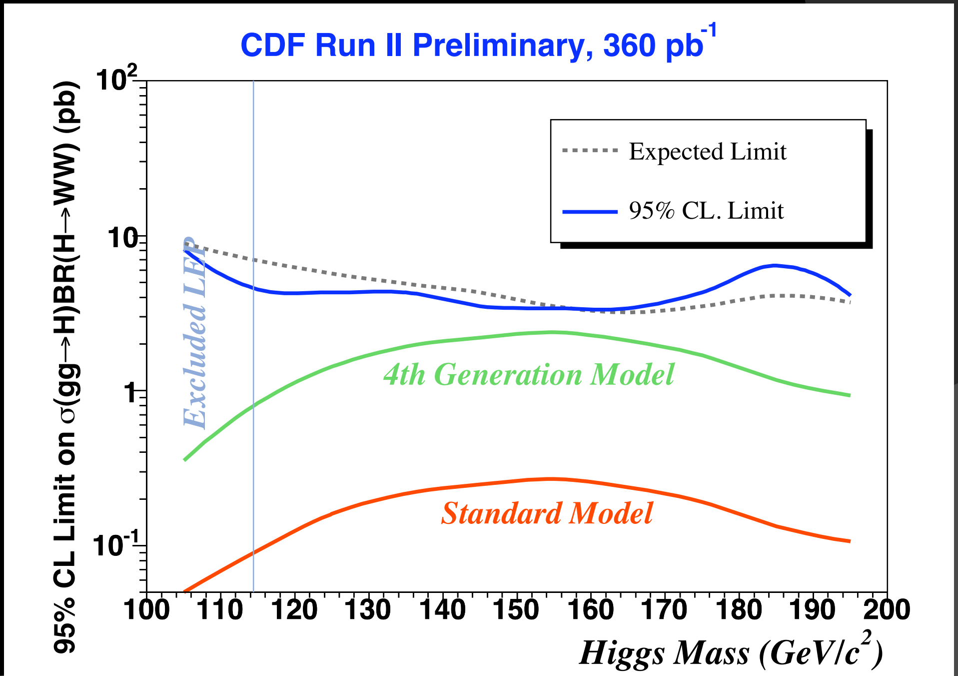
- primarily cut-based analysis
- used standard CDF lepton selection
- considered only gluon fusion production mechanism

Main challenge – discriminate HWW vs WW

Spin Correlations:
Lepton in HWW case go in the same direction

At Mh=160 GeV

Exp/ σ_{SM}: ~15



4 years ago…

CDF analysis based on 360 pb-1 of data

- primarily cut-based analysis
- used standard CDF lepton selection
- considered only gluon fusion pr… …hanism

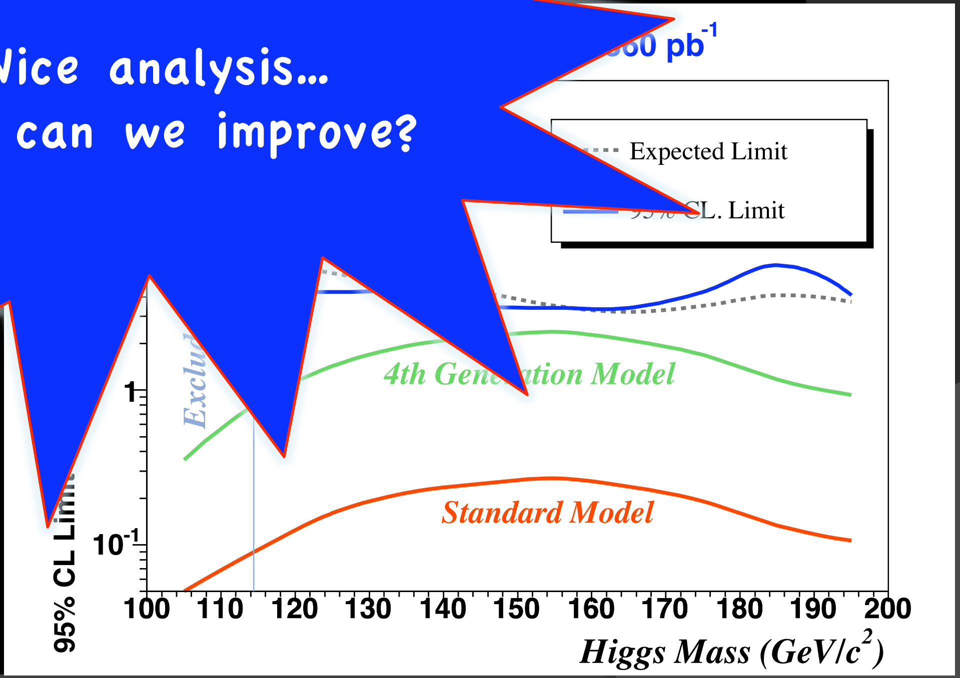
Main challenge –

Spin Correlations:
Lepton in HWW case
in the same directi…

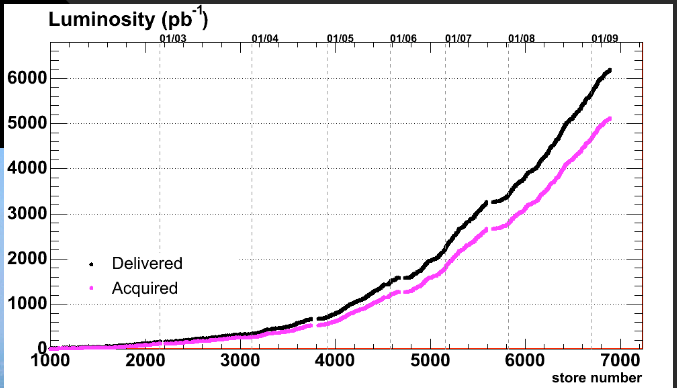
Nice analysis…
How can we improve?

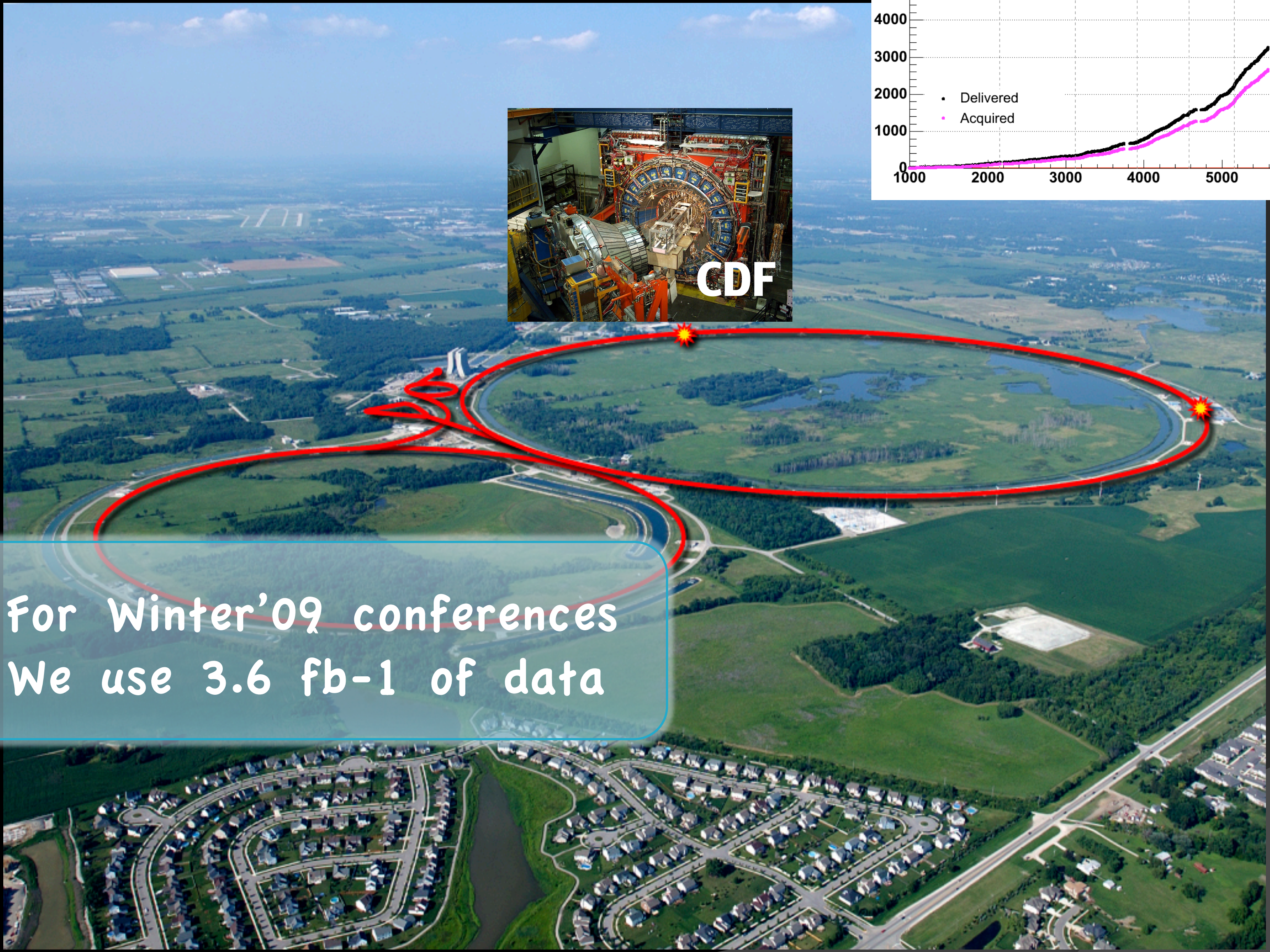
At Mh=160 GeV

Exp/σ_{SM}: ~15



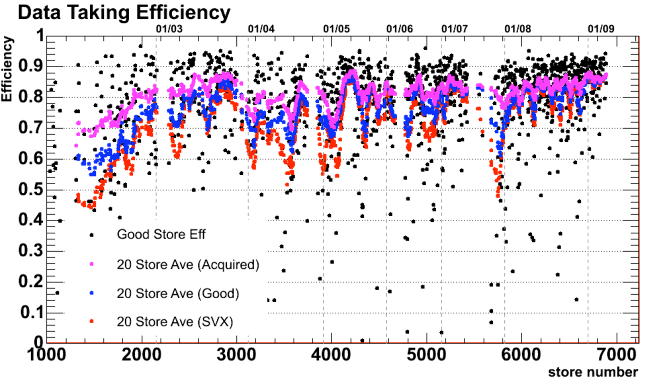
More Data





For Winter'09 conferences
We use 3.6 fb-1 of data

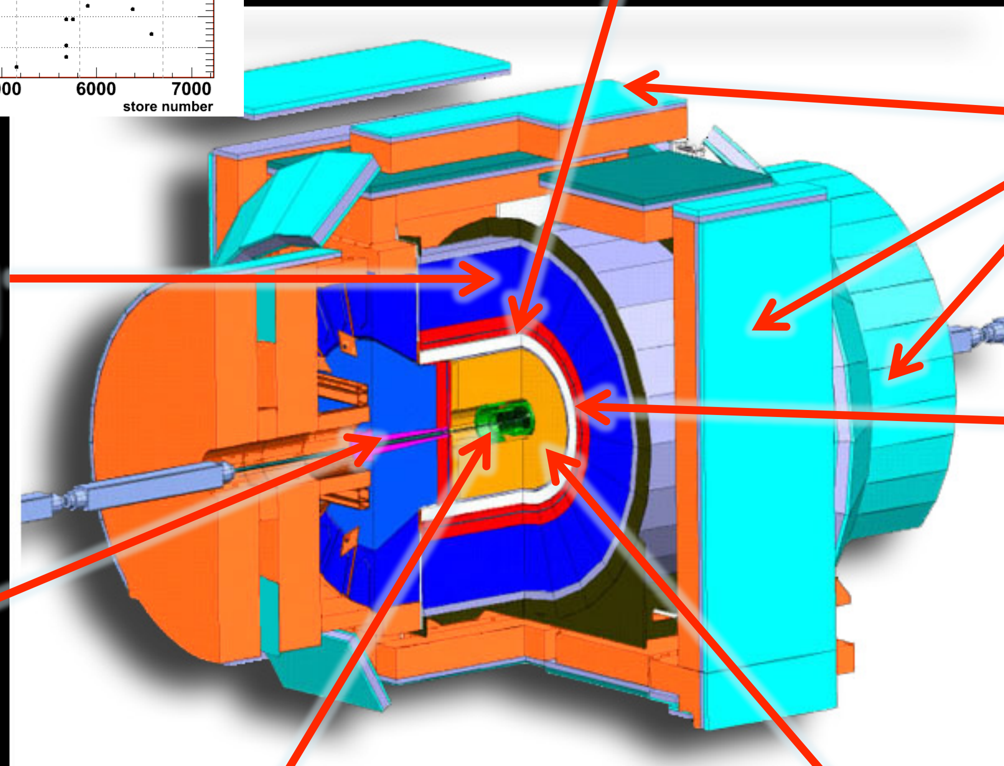
Thank you to Accelerator Division for their great work!!!



EM Calorimeter

Muon Chambers

HAD Calorimeter



Solenoid

Luminosity Monitor

Silicon Vertex Detectors

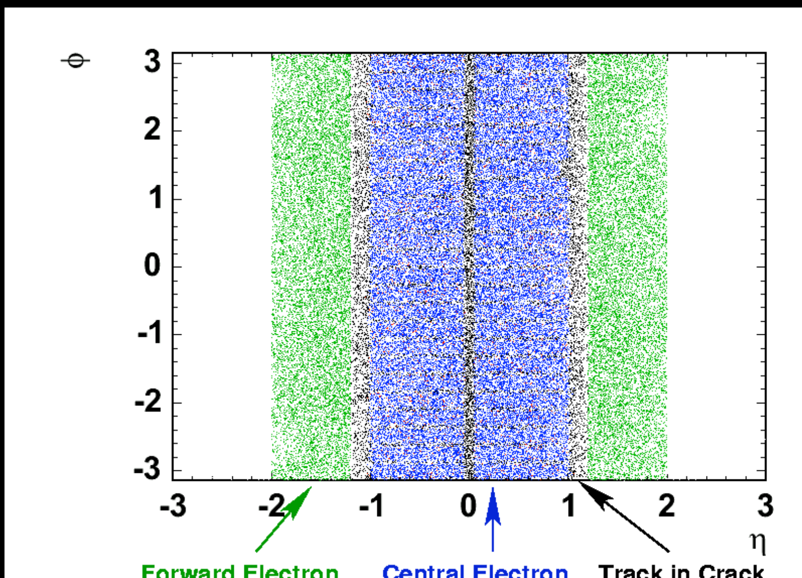
Tracking Chamber

Thank you everyone at CDF for collecting data with such high efficiency!

Extended lepton types

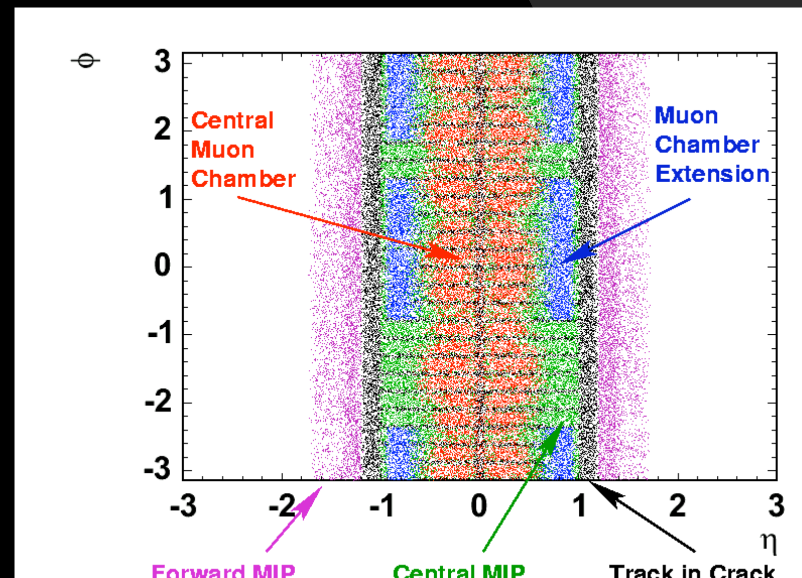
Have been presented at Fermilab W&C seminars before

Electron ID



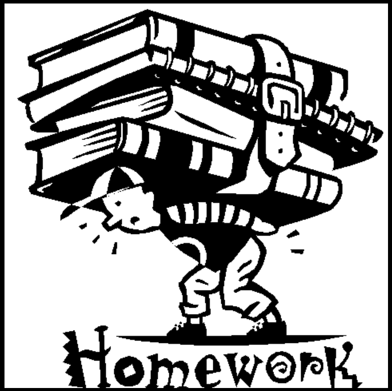
- Central Electrons
- Forward Electrons
- Isolated Tracks

Muon ID



- Central Muons (CMUP and CMX)
- Minimum Ionizing Tracks, fiducial to:
  - Central calorimeter
  - Forward calorimeter
- Isolated Tracks

A little homework



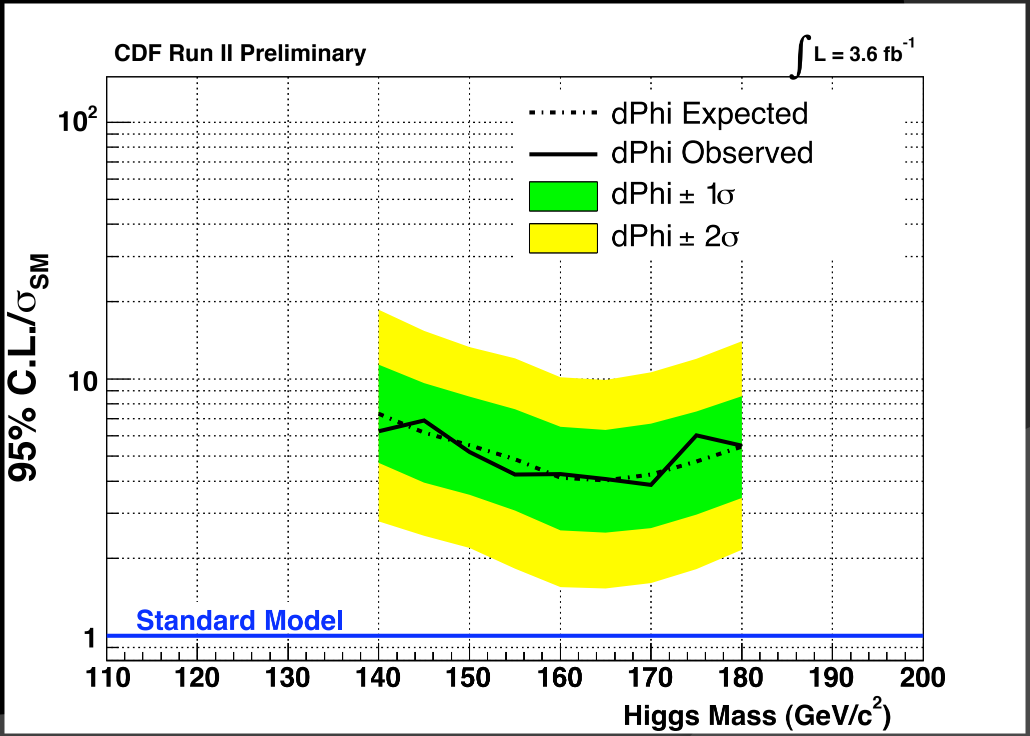
Question:

if we had the amount of data available today and the extended lepton types, where in terms of SM sensitivity would we be with the old style analysis?

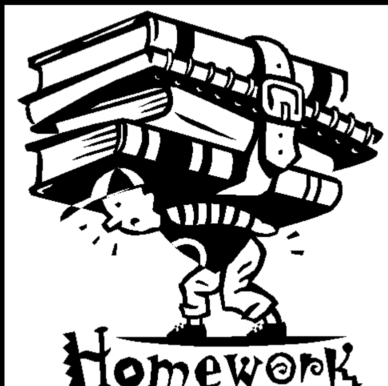
Answer:

At ~4*SM X-section

@ Mh=160 GeV



A little homework



Question:

if we had the amount of data available today and the extende lepton types, where in terms of SM sensi ity we would be wit he ol le lysis?

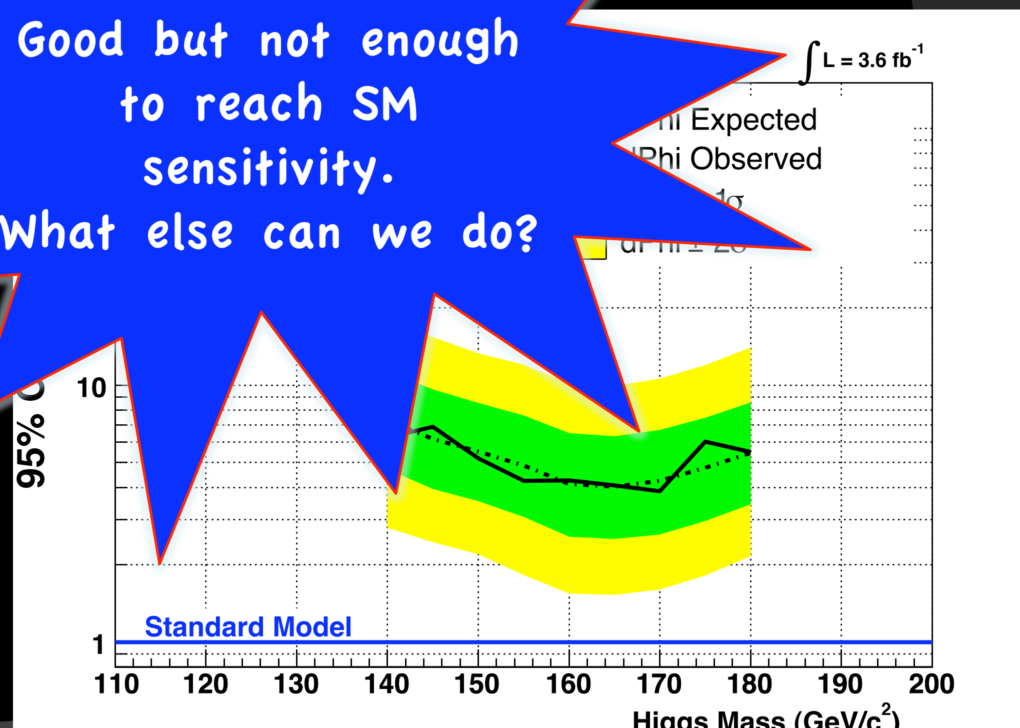
Answer:

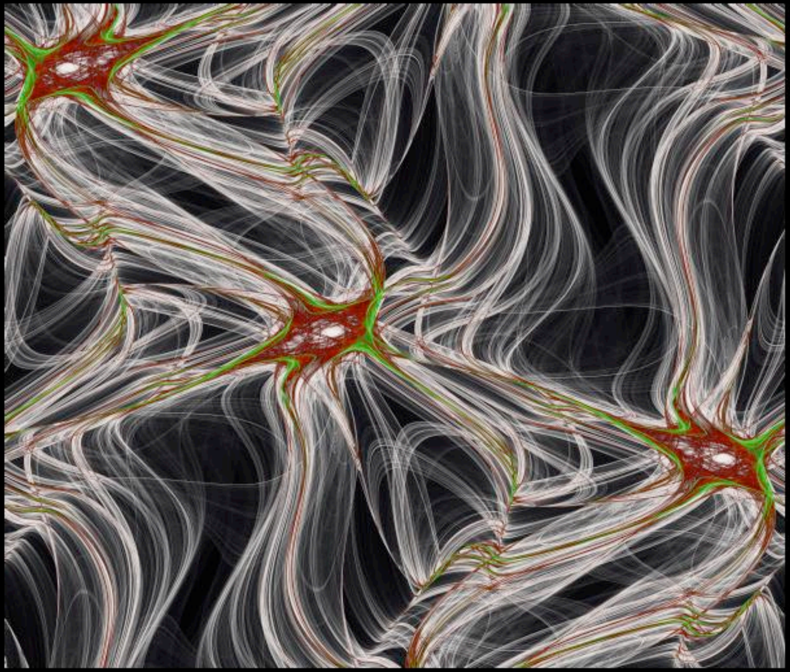
At ~4*SM X-section

@ Mh=160 GeV

Good but not enough to reach SM sensitivity.

What else can we do?





Use multivariate techniques
(Matrix Element, Neural Network)

- functions which transform multiple inputs into single discriminant tuned for identifying a single process

Matrix Element

Event-by-event probability density:

$$P(\vec{x}_{obs}) \equiv \frac{1}{<\sigma>} \int \frac{d\sigma(\vec{y})}{d\vec{y}} \varepsilon(\vec{y}) G(\vec{x}_{obs}, \vec{y}) d\vec{y}$$

- σ(y) - LO theoretical cross section
- y - true lepton 4-vector
- x_{obs} - observed lepton 4 vector
- ε – efficiency X acceptance
- G – resolution effects

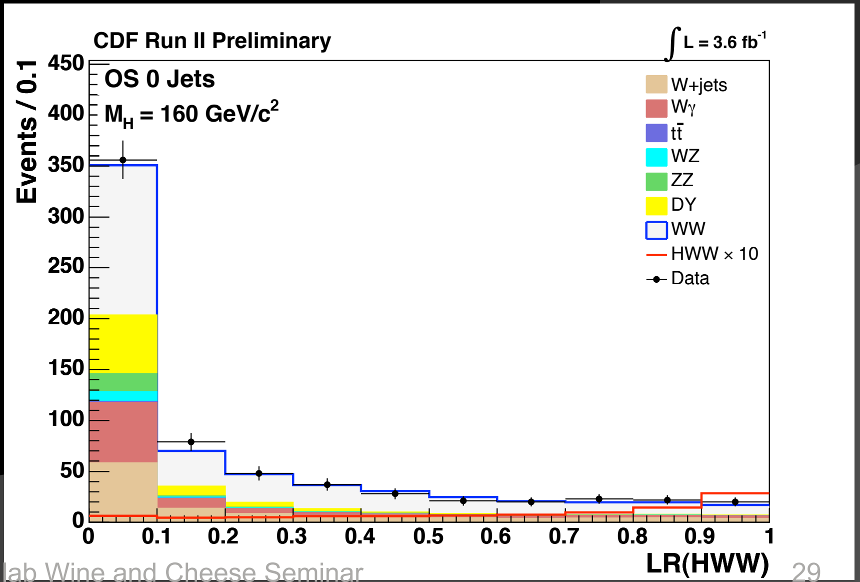
integration over missing neutrino information

Calculate likelihood for 2 processes:

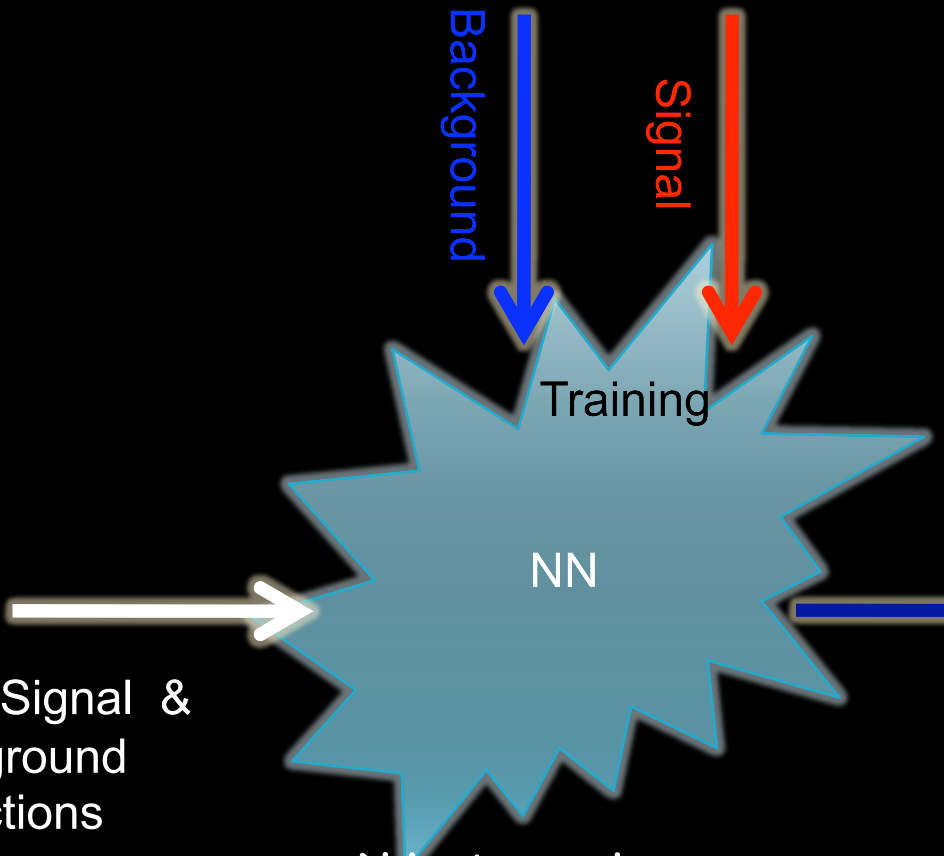
HWW (signal) and WW

Construct Likelihood Ratio:

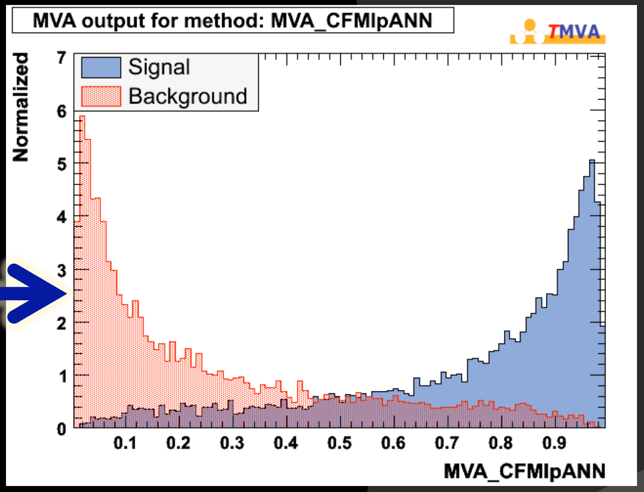
$$LR \equiv \frac{P_{Higgs}}{P_{Higgs} + \sum_i f_{bi} P_{bi}}$$



Neural Network



Data, Signal & Background predictions



Able to analyze multiple input variables

We use NeuroBayes Neural Network

Phys.Rev.Lett.102:021802,2009

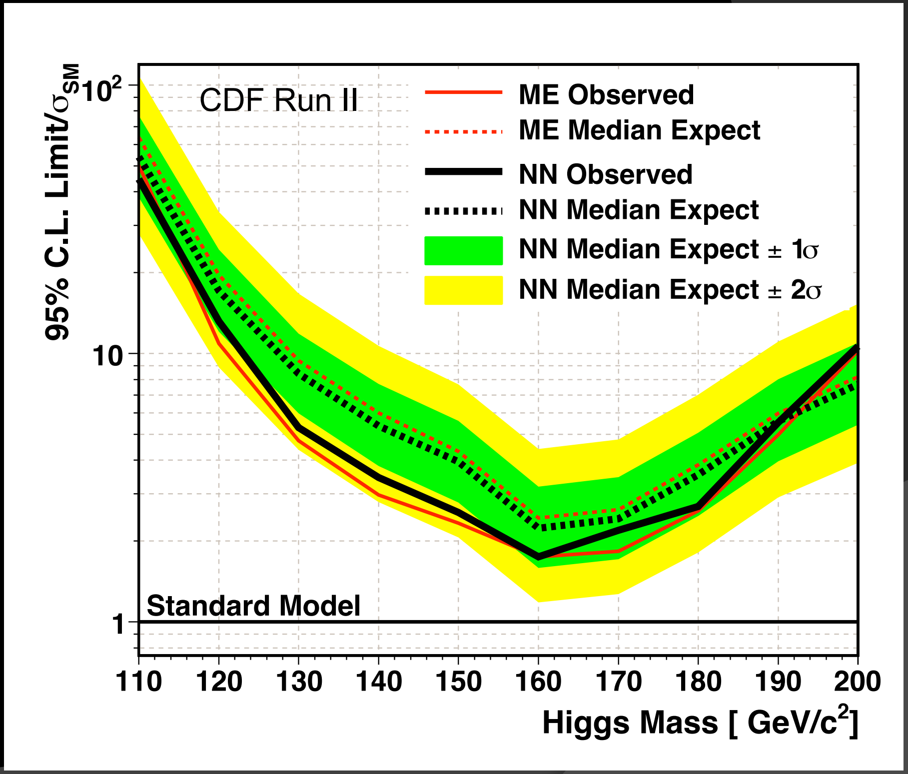
General features:

- Use both ME and NN
- Pass LRs (ME based) and kinematic variables as inputs to NN

At Mh=160 GeV

ME only:
Exp/σ_{SM}: 2.4

ME + NN:
Exp/σ_{SM}: 2.2



Phys.Rev.Lett.102:021802,2009

General features:

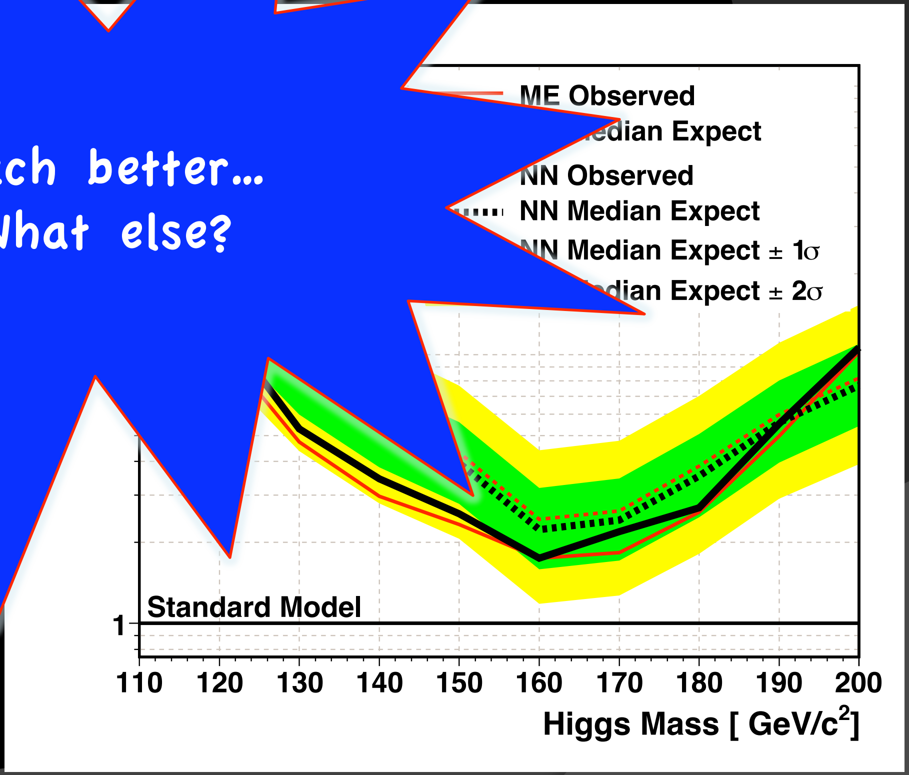
- Use both ME and NN
- Pass LRs (ME based) and kinematic ariables as inputs to NN

At Mh=160

ME only:
Exp/σ_{SM}:

ME + NN:
Exp/σ_{SM}: 2.2

Much better…
What else?

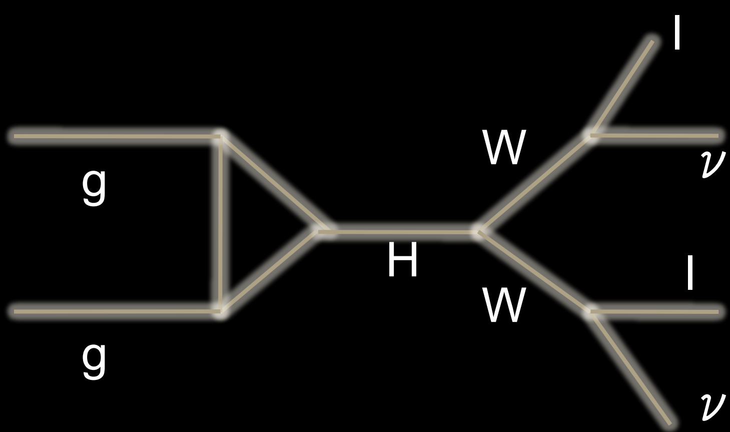


Separate 0, 1 and 2+ jet bins

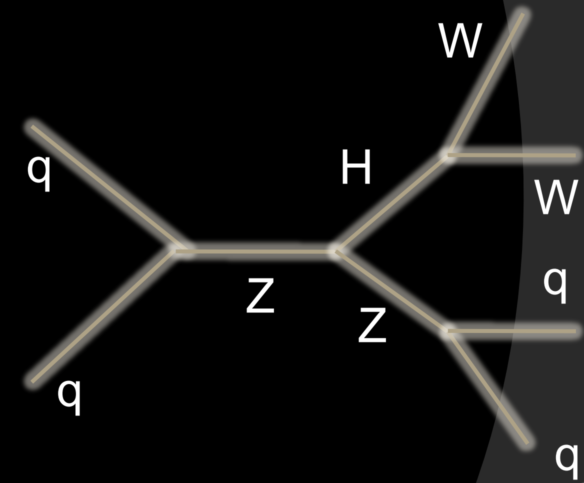
Why?

- Background and signal composition is different in each bin!

Signal:



0 jets at LO (ggH)



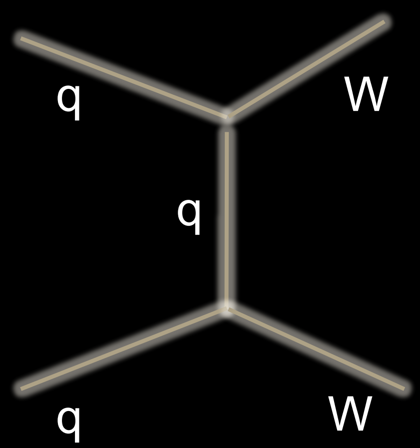
2 jets at LO (WH/ZH/VBF)

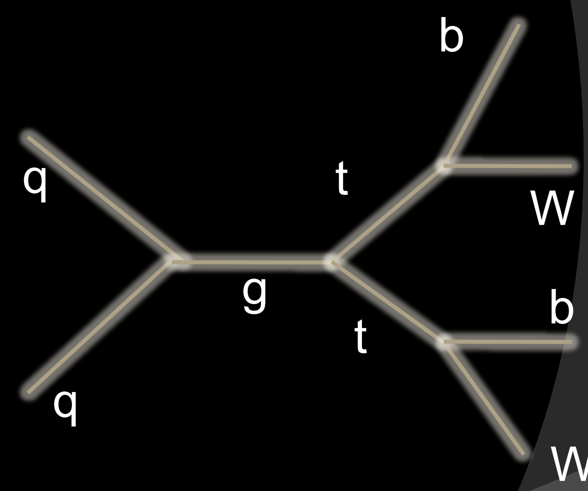
Separate 0, 1 and 2+ jet bins

Why?

- Background and signal composition is different in each bin!

Background:





0 jets at LO (<u>WW</u>, DY, W+γ)

2 jets at LO (WZ, ZZ, <u>$t\bar{t}$</u>)

Separate 0, 1 and 2+ jet bins

Why?

- Background and signal composition is different in each bin!

0 Jets:

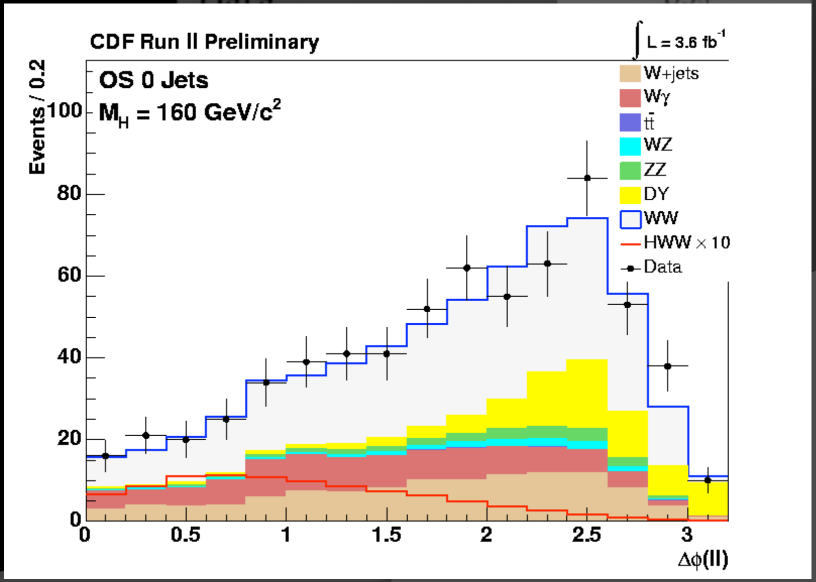
- Can make good use of the LO Matrix Element calculations
- Majority of signal from gluon fusion

CDF Run II Preliminary $\int \mathcal{L} = 3.6\ \mathrm{fb}^{-1}$

$M_H = 160\ \mathrm{GeV}/c^2$

$t\bar{t}$	1.35	$\pm$	0.21
DY	80	$\pm$	18
WW	318	$\pm$	35
WZ	14	$\pm$	1.9
ZZ	20.7	$\pm$	2.8
W+jets	113	$\pm$	27
$W\gamma$	92	$\pm$	25
Total Background	637	$\pm$	67
$gg \rightarrow H$	9.5	$\pm$	1.4
Total Signal	9.5	$\pm$	1.4
Data	654		

OS 0 Jets



Separate 0, 1 and 2+ jet bins

Why?

- Background and signal composition is different in each bin!

0 Jets:

- Can make good use of the LO Matrix Element calculations
- Majority of signal from gluon fusion

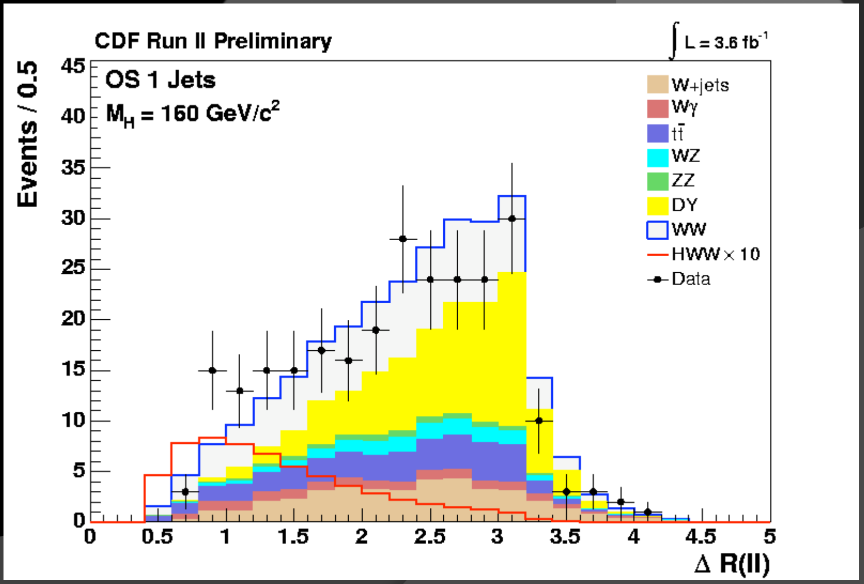
1 Jet:

- ME not so powerful here
- extra signal (VH & VBF) ~20%

CDF Run II Preliminary $\int \mathcal{L} = 3.6\ \mathrm{fb}^{-1}$

$M_H = 160\ \mathrm{GeV}/c^2$

$t\bar{t}$	34.9	±	5.5
DY	85	±	27
WW	85.3	±	9.1
WZ	14.5	±	2.0
ZZ	5.48	±	0.75
W+jets	40	±	10
$W\gamma$	13.2	±	4.0
Total Background	278	±	35
$gg \to H$	4.70	±	0.72
WH	0.661	±	0.086
ZH	0.244	±	0.032
VBF	0.381	±	0.061
Total Signal	5.98	±	0.78
Data	262		



Separate 0, 1 and 2+ jet bins

Why?

- Background and signal composition is different in each bin!

0 Jets:

- Can make good use of the LO Matrix Element calculations
- Majority of signal from gluon fusion

1 Jet:

- ME not so powerful here
- extra signal (VH & VBF) ~20%

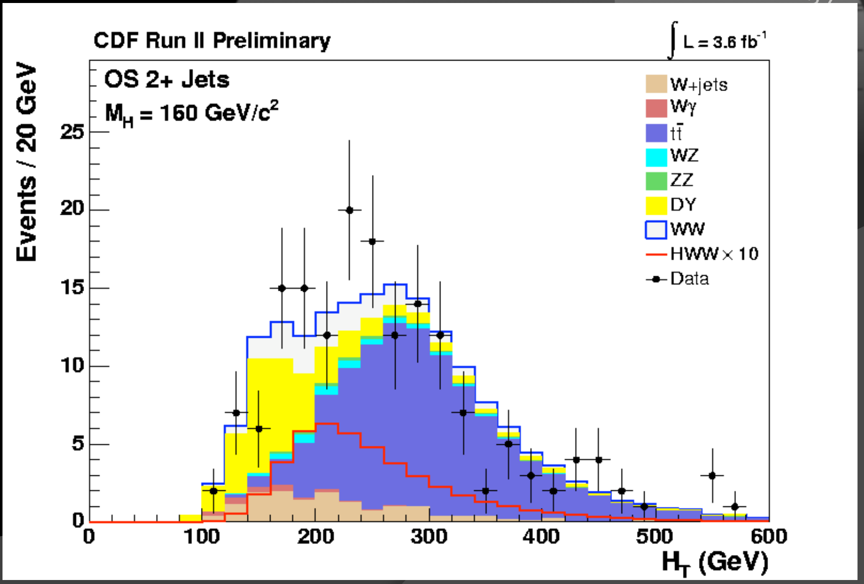
2+ Jets:

- $t\bar{t}$ is main background
- extra signal (VH & VBF) ~60%

CDF Run II Preliminary $\int \mathcal{L} = 3.6\ \mathrm{fb}^{-1}$

$M_H = 160\ \mathrm{GeV}/c^2$

tt	100	±	17
DY	33	±	11
WW	17.6	±	4.0
WZ	3.76	±	0.52
ZZ	1.62	±	0.22
W+jets	14.7	±	4.0
$W\gamma$	2.12	±	0.70
Total Background	173	±	23
$gg \to H$	1.75	±	0.30
WH	1.39	±	0.18
ZH	0.693	±	0.090
VBF	0.70	±	0.11
Total Signal	4.53	±	0.52
Data	169		



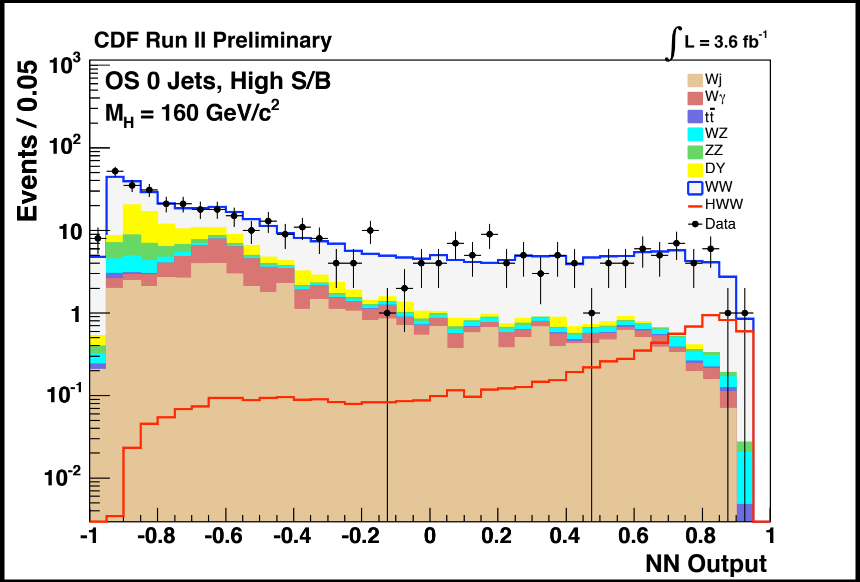
0-jets Neural Network

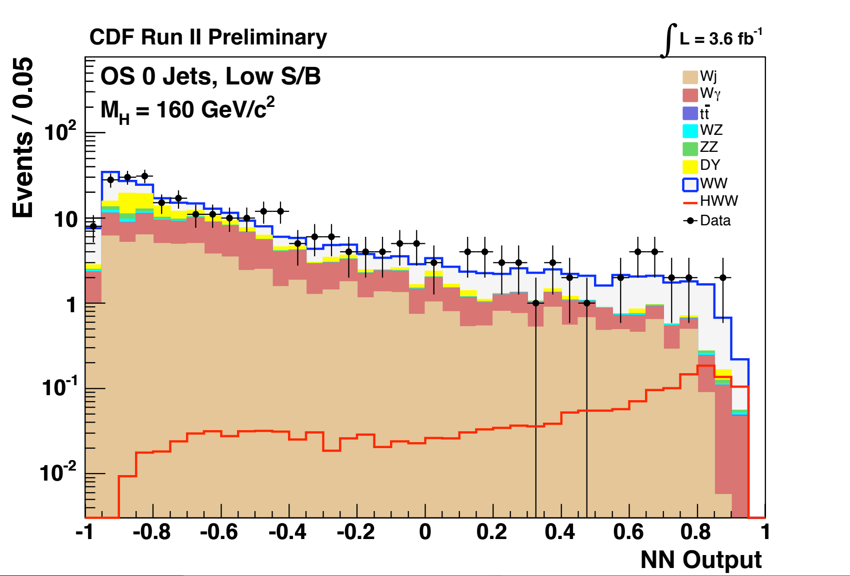
Use LRs and kinematic variables as inputs to the NN:

- LR_HWW
- LR_WW
- ΔR between leptons
- Δφ between leptons
- H_T- scalar sum of lepton E_T and MET

- Forward leptons have higher background than other leptons
- Separate into 2 channels, with and without forward leptons: High S/B and Low S/B

- Train NN on weighted sum of all backgrounds at each M_H





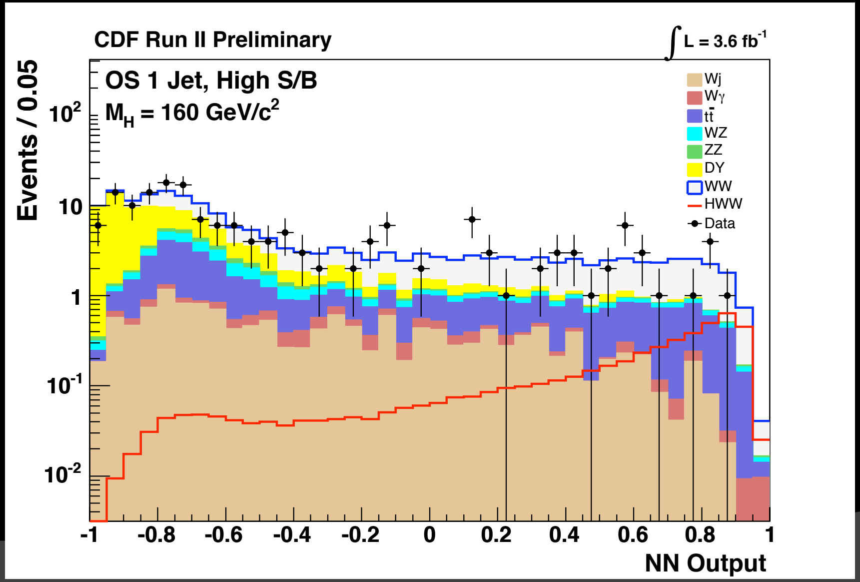
1-jet Neural Network

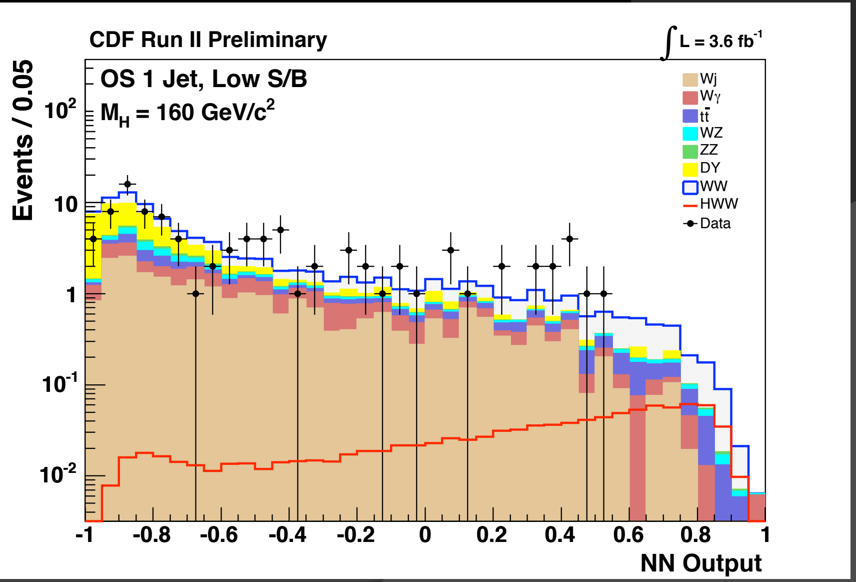
Use kinematic variables as inputs to the NN:

- ΔR between leptons
- H_T - scalar sum of leptons E_T, jet E_T and MET
- M(ll) – dilepton invariant mass
- $p_T(l_1)$ and $p_T(l_2)$ – transverse momentum of leptons
- $E(l_1)$ – energy of the most energetic lepton
- $M_T(llE_T)$ – transverse mass of 2 leptons and $(E_T, E_T^X, E_T^Y, 0)$
- MetSpec = $\not{E}_T$ if $\Delta\varphi(\not{E}_T$, lepton or jet$)>\pi/2$

  $\not{E}_T \times \sin\varphi$ if $\Delta\varphi(\not{E}_T$, lepton or jet$)>\pi/2$

20% of signal from VH and VBF





2+jets Neural Network

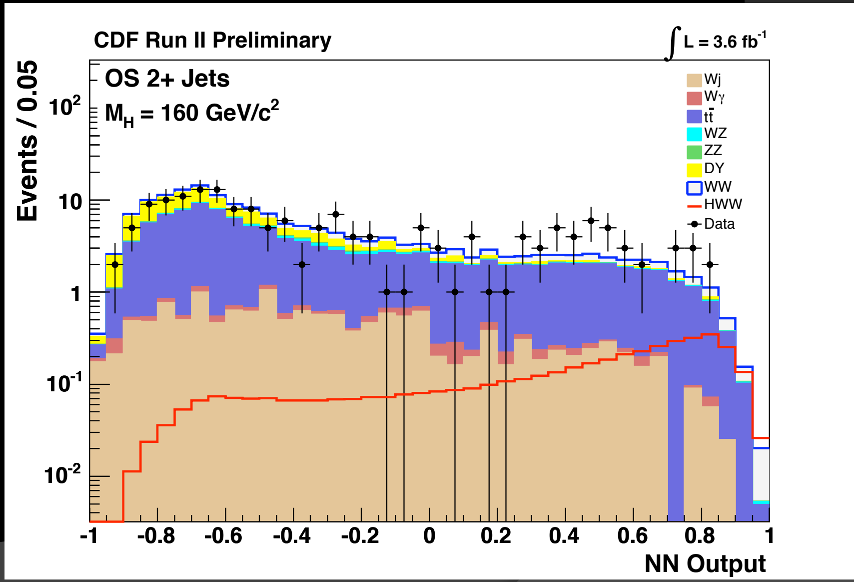
Use anti-btag requirement to reduce ttbar background

Use kinematic variables as inputs to the NN:

- ΔR between leptons
- $\Delta\varphi$ between leptons
- H_T - scalar sum of leptons E_T, jet E_T and MET
- M(ll) – dilepton invariant mass
- $p_T(l_1)$ and $p_T(l_2)$ – transverse momentum of leptons
- Σp_T^{jet} – vector sum of first and second jet p_T
- $\Delta\varphi(p_{l1}+p_{l2}, \not{E}_T)$

60% of signal from VH and VBF

No High S/B and Low S/B separation



Combining Jet Bins

Individual sensitivities:

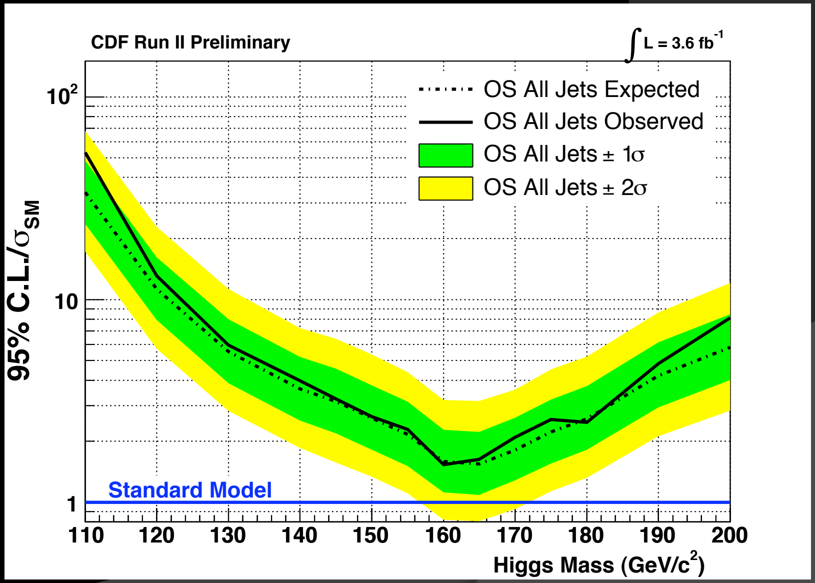
0 jets: Exp/σ_{SM}: 2.39

1 jet: Exp/σ_{SM}: 2.89

2+ jets: Exp/σ_{SM}: 3.71

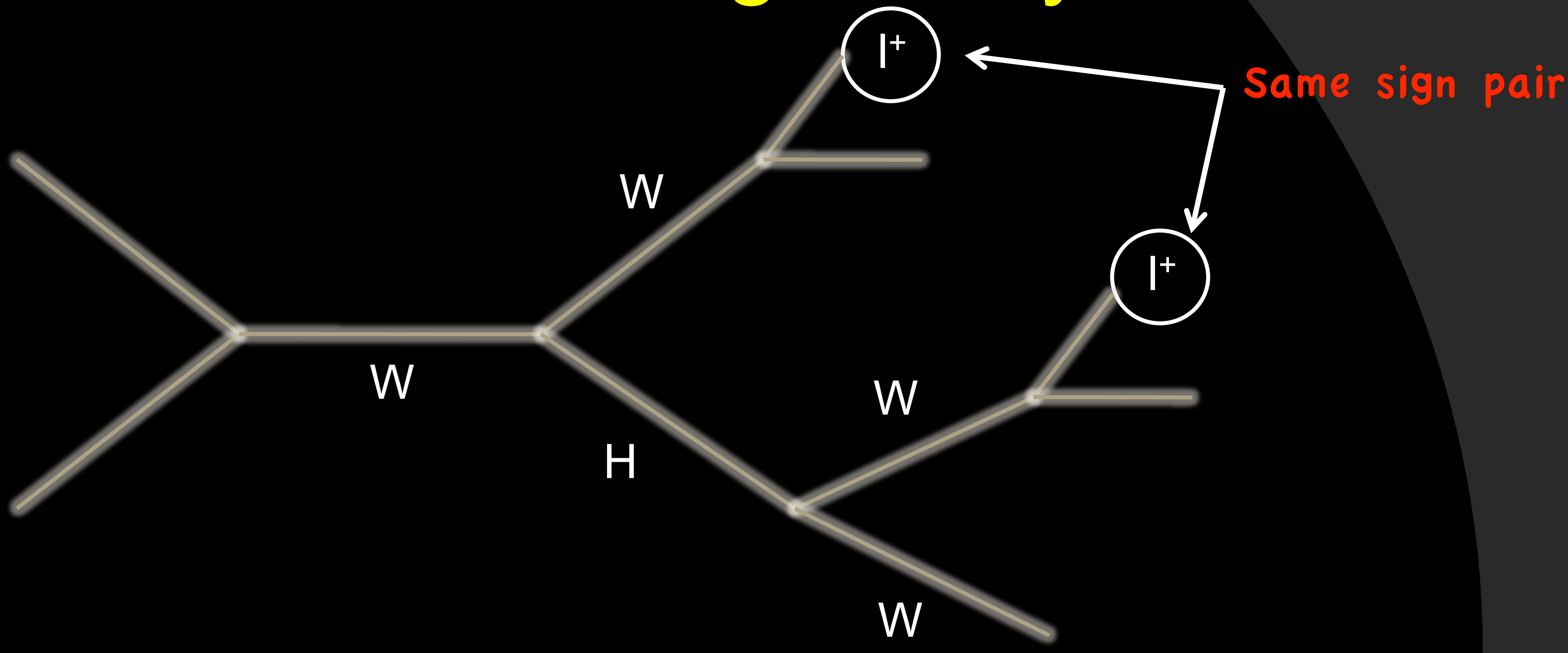
At Mh=160 GeV

Exp/σ_{SM}: 1.59
Obs/σ_{SM}: 1.53



Add other final states

Same-sign analysis



Main Background – Fakes

- Lepton p_{T1}>20 GeV and p_{T2}>20 GeV
- No forward electrons
- Njets ≥ 1
- No MeT cut (DY contribution is small)

CDF Run II Preliminary $\int \mathcal{L} = 3.6\ \text{fb}^{-1}$

$M_H = 160\ \text{GeV}/c^2$

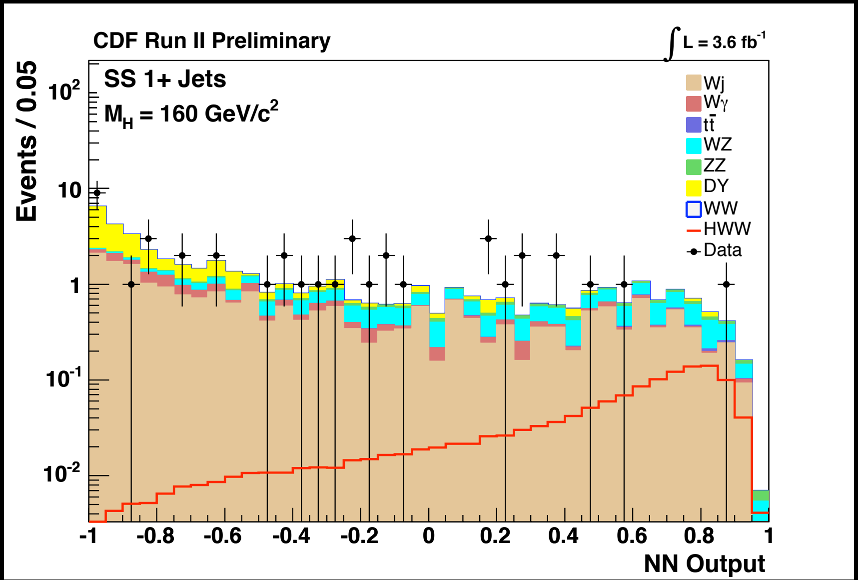
$t\bar{t}$	0.11	±	0.03
DY	11.99	±	3.65
WW	0.020	±	0.005
WZ	6.82	±	0.93
ZZ	1.44	±	0.20
W+jets	22.45	±	6.73
$W\gamma$	3.23	±	1.00
Total Background	**46.07**	±	**8.02**
WH	1.19	±	0.16
ZH	0.19	±	0.02
Total Signal	**1.38**	±	**0.18**
Data	**41**		

SS 1+ Jets

SS Neural Network

Use 13 kinematic variables as inputs to the NN:

MET, $\Delta\varphi_{ll}$, ΣE_T^{jets}, H_T, M(ll), $p_T(l_1)$ and $p_T(l_2)$, MetSpec, Et^{jet1} , Et^{sig} , $\Delta\varphi$(l or j, $\not{E}_T$), $p_T(l_1+l_2)$, E^{lep1}

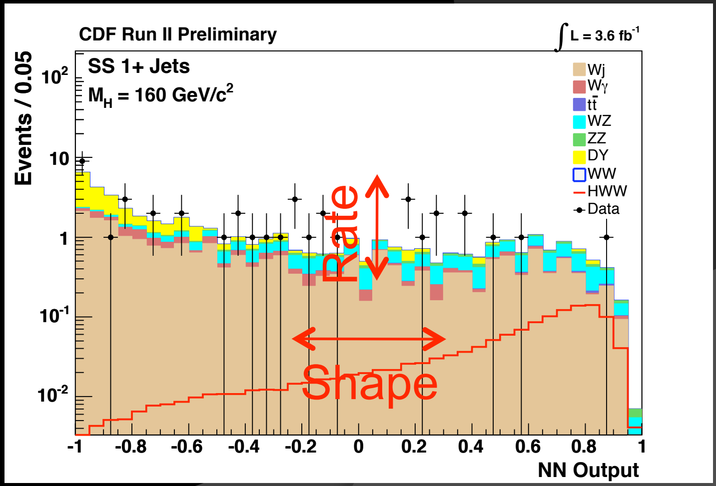


Adds ~ 5% to the sensitivity

Systematic Uncertainties

Two classes of systematics:

- Rate Systematics
  - affect only normalization of the templates. Do not affect the shapes.
  - dominating - theoretical x-section uncertainties
    - range 10-30% for different signal and background templates



- Shape Systematics
  - modify shape of the NN output
  - studied, but so far found to be negligible (JES, PDF modeling, Pt scale)

CDF High Mass Combination

Uses latest gg→H cross-section calculation by:

Florian *et* Grazzini (arXiv:0901.2427)

Latest MSTW2008 pdf
NNLL QCD
NLO b-quark treatment
2-loop ewk corrections

Total 6 channels:

0jets (High and Low S/B)

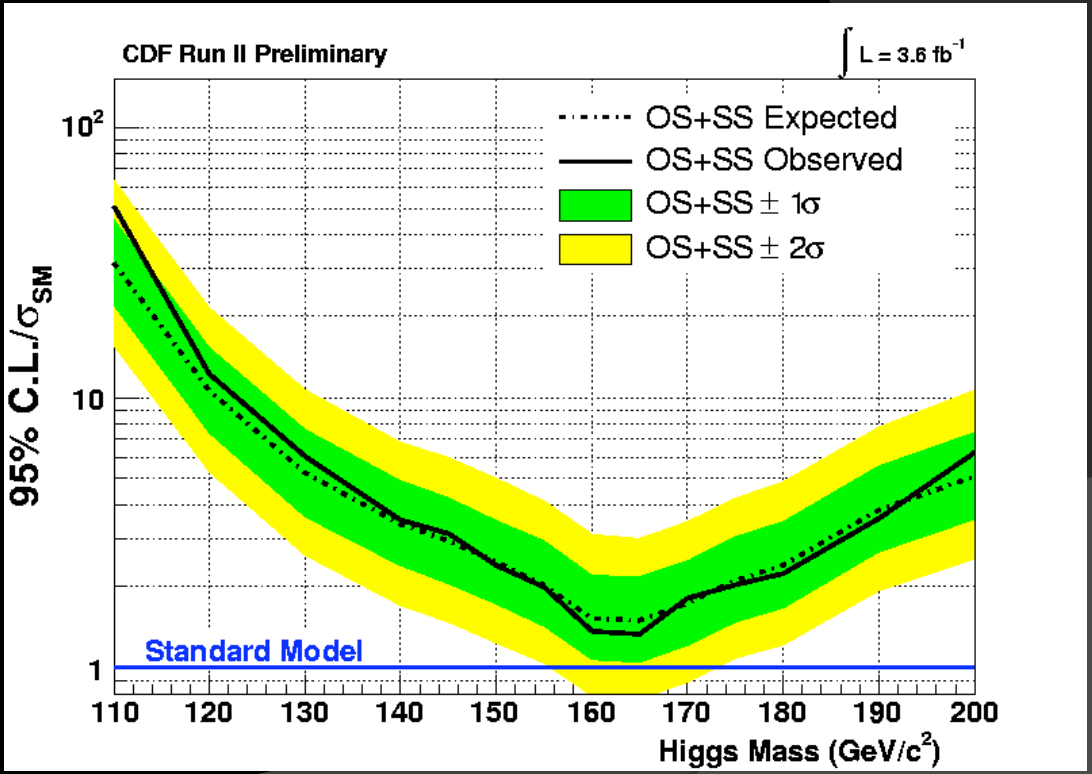
1 jet (High and Low S/B)

2 jets and Same Sign

At Mh=160 GeV

Exp/σ_{SM}: 1.52

Obs/σ_{SM}: 1.37



Future Prospects

Improvements expected for Summer 2009

Likelihood based lepton ID

- Preliminary studies promise 10% improvement in electron acceptance with same background

Hadronic Taus

- Good background modeling but currently not very good sensitivity

Low MET region

- Need very good modeling of DY

Low M_{ll} region

Trileptons

- Studies in progress

Future Prospects

Improvements expected for Summer 2009

Likelihood based lepton ID

- Preliminary studies promise 10% improvement in electron acceptance with same background

Hadronic Taus

- Good background modeling but currently not very good sensitivity

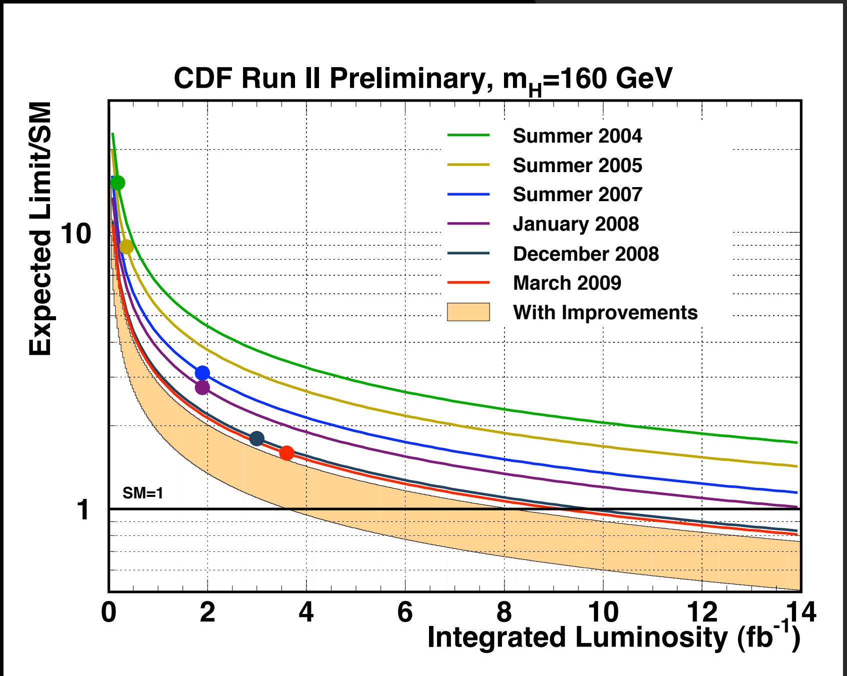
Low MET region

- Need very good modeling of DY

Low M_{ll} region

Trileptons

- Studies in progress



Future Prospects

Improvements expected for Summer 2009

Likelihood based lepton ID

- Preliminary studies promise 10% improvement in electron acceptance with same background

Hadronic Taus

- Good background modeling but currently not very good sensitivity

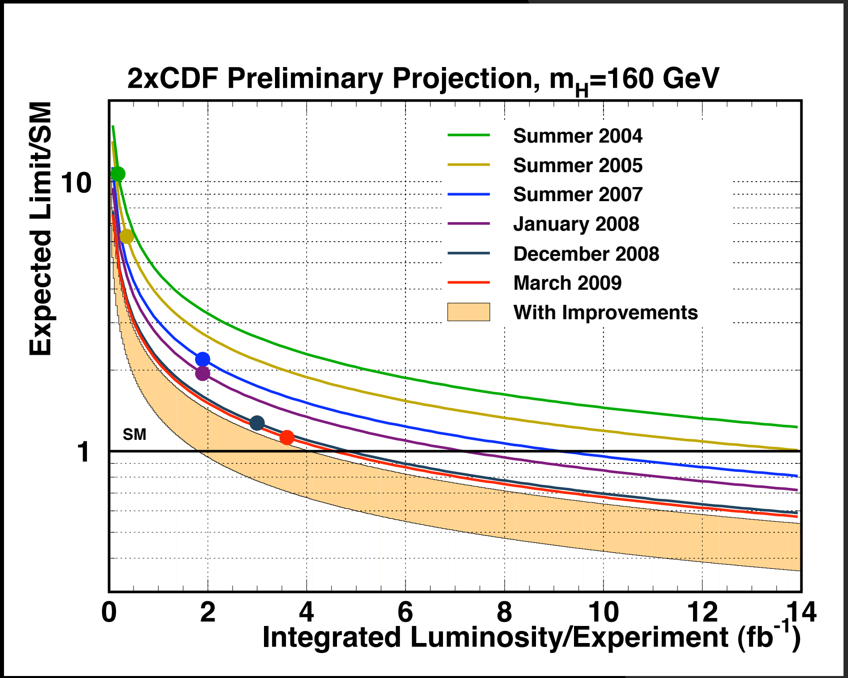
Low MET region

- Need very good modeling of DY

Low M_{ll} region

Trileptons

- Studies in progress



And of course combine results with our colleagues from D0 …

Tevatron High Mass Combination

Thank you everyone in TeV Higgs combination group!

CDF and D0 combination:

- Not just $\sqrt{2}$ factor, many systematics are correlated between experiments
- Combined using Bayesian and CLs methods – similar results

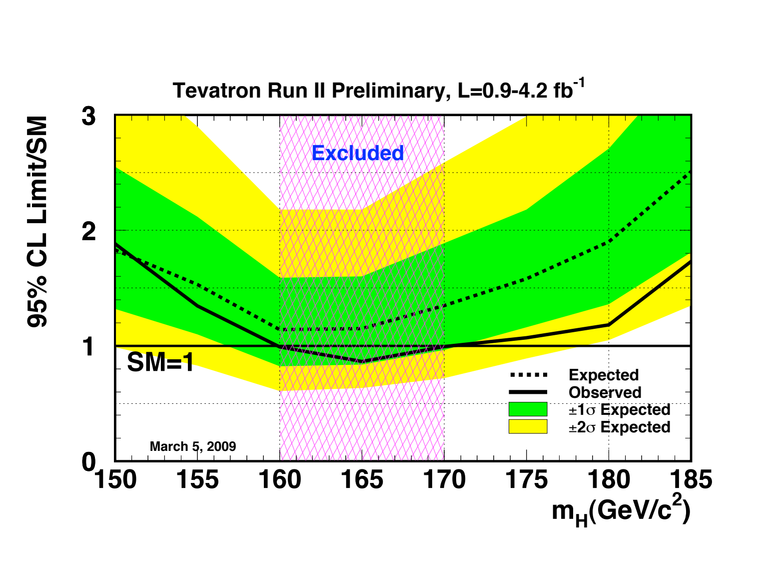
Tevatron High Mass Combination

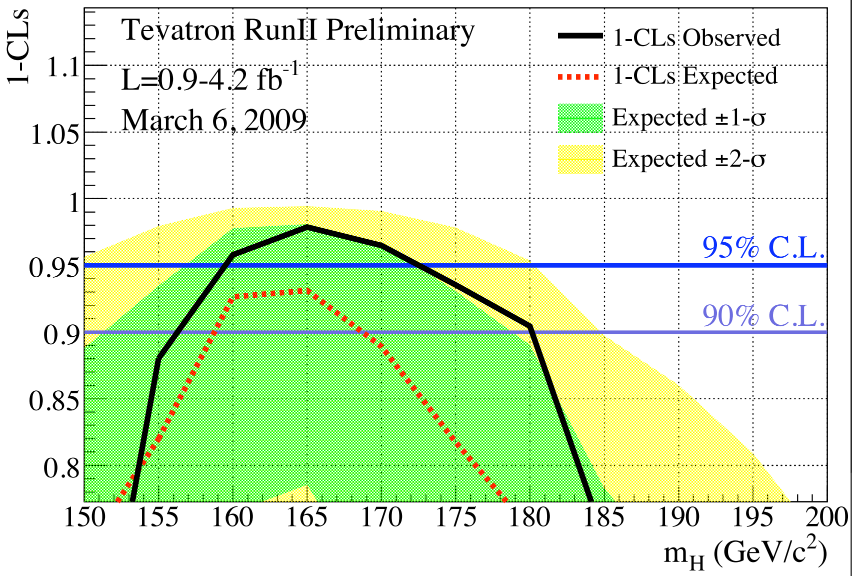
CDF and D0 combination:

Thank you everyone in TeV Higgs combination group!

- Not just √2 factor, many systematics are correlated between experiments
- Combined using Bayesian and CLs methods - similar results

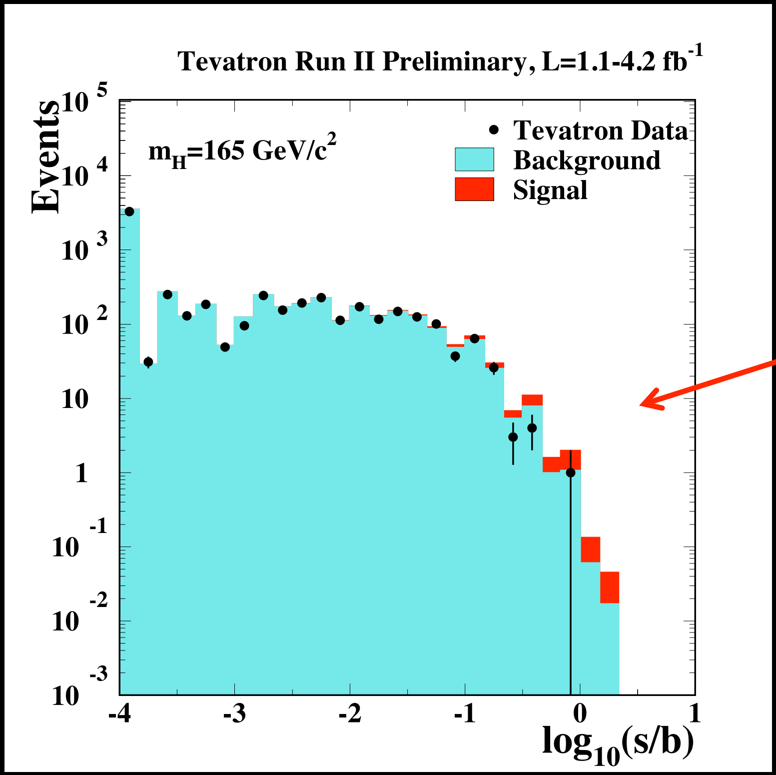
http://tevnphwg.fnal.gov/results/SM_Higgs_Winter_09/



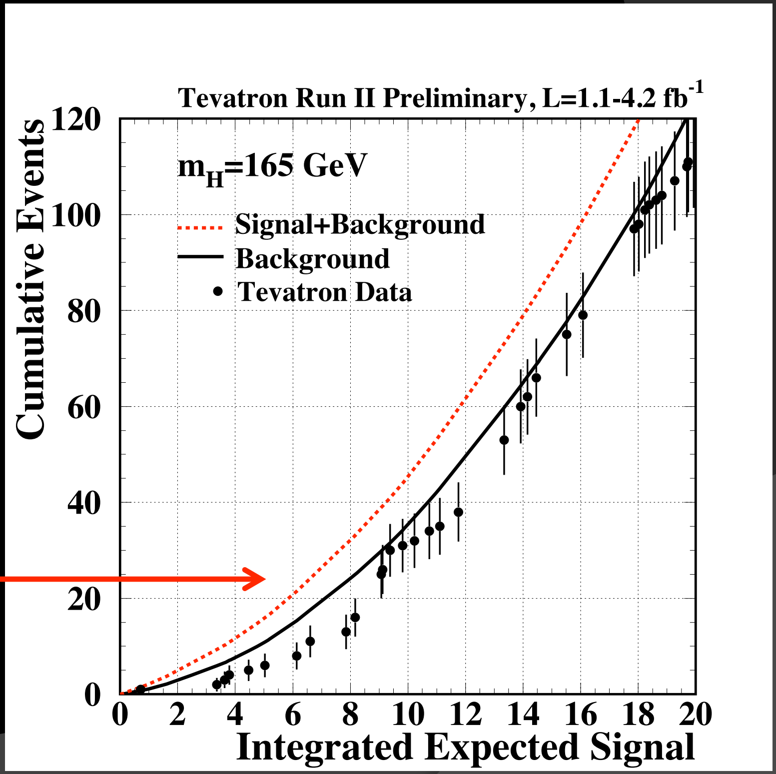


We exclude SM Higgs in mass range 160-170 GeV at 95% CL

Tevatron High Mass Combination



Events in all search channels sorted by the "Signal/Background"



Cumulative distributions of data, background and signal+background

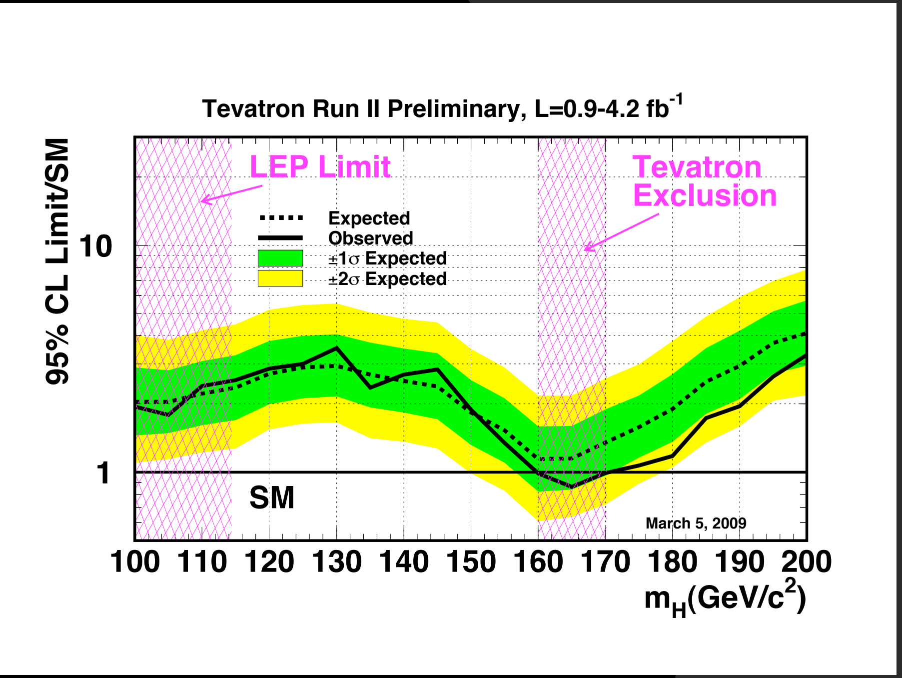
Conclusions

- Great results in both low and high mass sectors

- SM Higgs exclusion in the range 160-170 GeV @95% CL

- Better than 3xSM sensitivity at all masses below 190 GeV
- 2.4*SM @115 GeV

- Stay tuned for further Tevatron improvements in Higgs searches



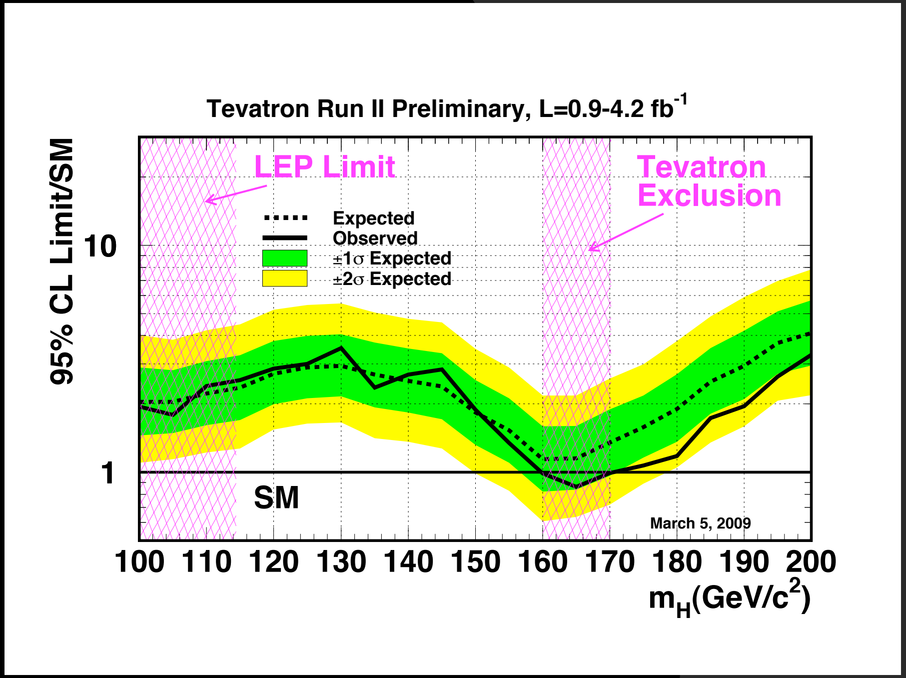
Conclusions

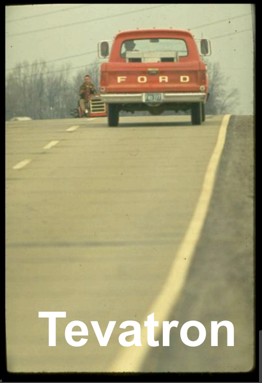
- Great results in both low and high mass sectors

- SM Higgs exclusion in the range 160-170 GeV @95% CL

- Better than 3xSM sensitivity at all masses below 190 GeV
- 2.4*SM @115 GeV

- Stay tuned for further Tevatron improvements in Higgs searches





vs