Di-Boson Production and SM/SUSY Higgs Searches at the Tevatron

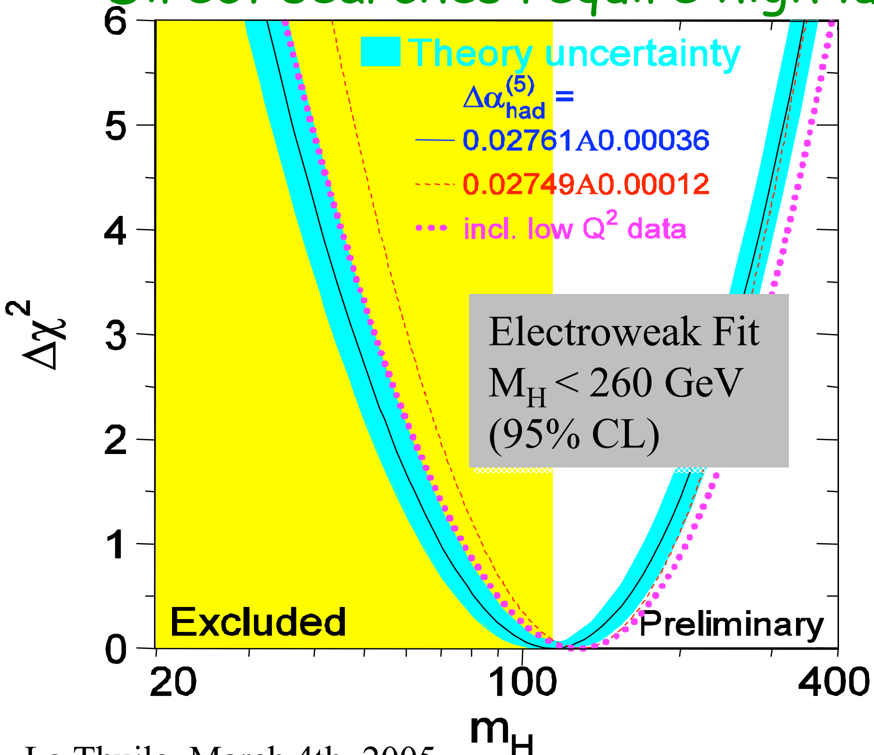
V. Daniel Elvira (Fermilab)
for the DØ & CDF Collaborations

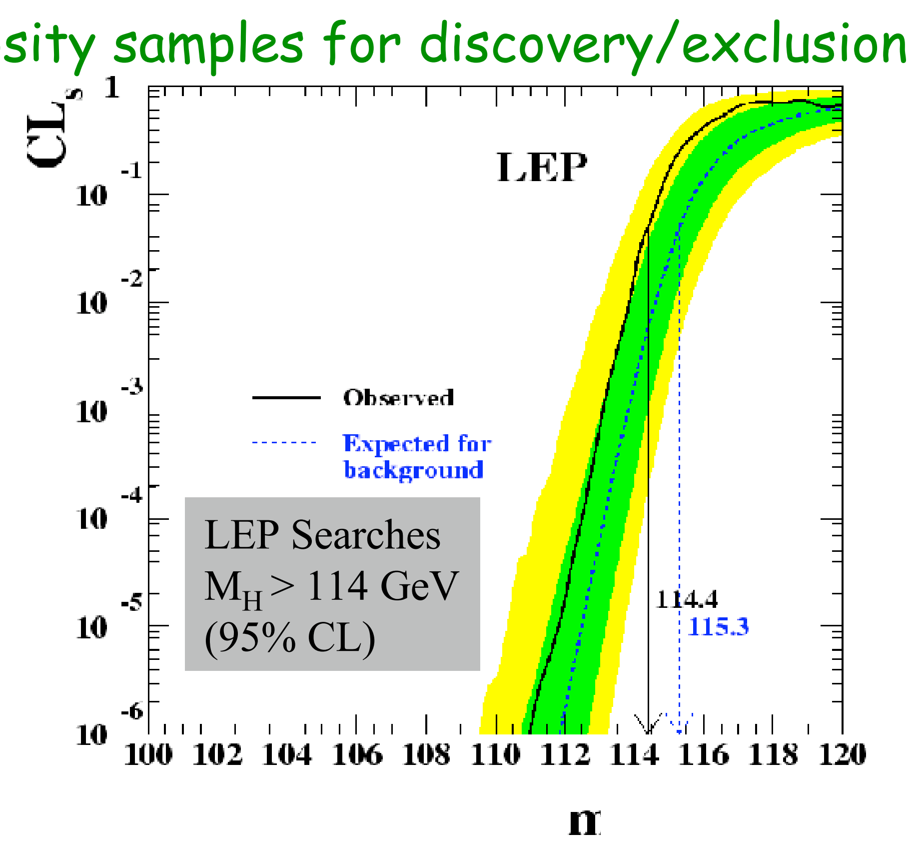
Experimental Limits on M_H

- EWWG fit updated in the Summer of 2004 (LEP, SLD, CDF, DØ)

  Light Higgs favored: $M_H = 114^{+69}_{-45}$ GeV $m_H < 260$ GeV at 95% CL
- LEP: Direct searches excluded SM Higgs below 114.4 GeV at 95% C.L.
- Tevatron: indirect searches through precision measurement of m_t, m_W.

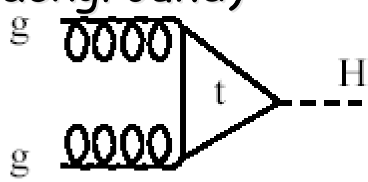
  Direct searches require high luminosity samples for discovery/exclusion



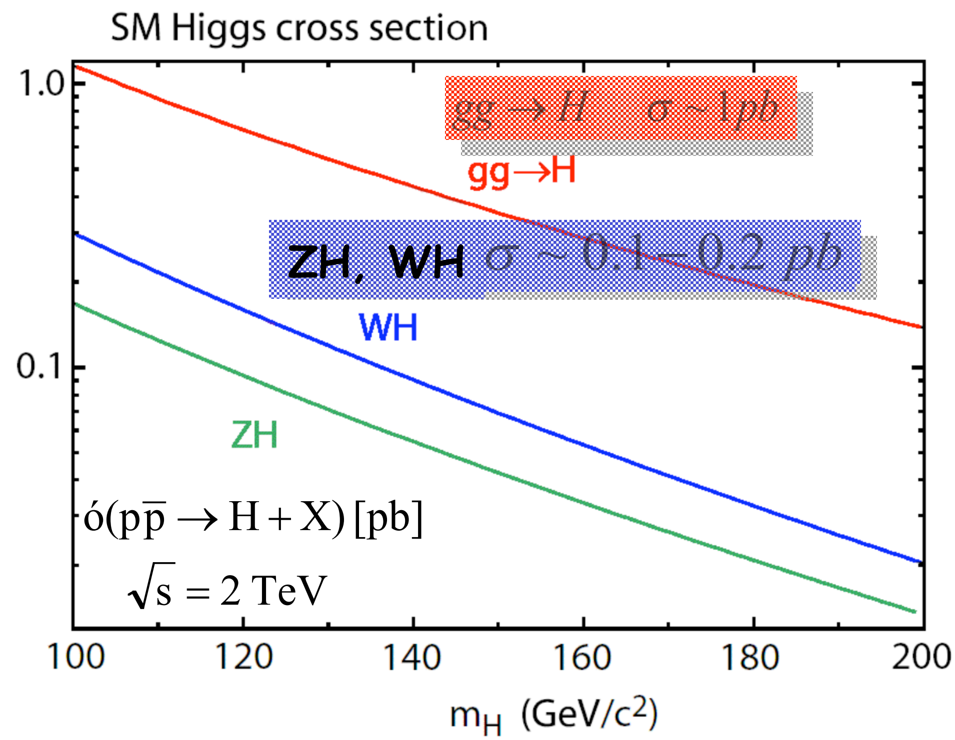


SM & SUSY Higgs Production

Gluon fusion (copious but large background)



Associated production



<u>Low Mass Search</u> (M_H < 140 GeV):

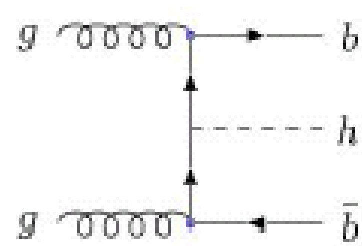
$qq \to W/Z + H \to l\nu/ll/\nu\nu + bb$

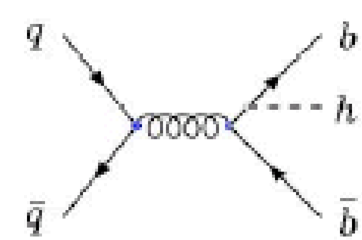
Background: W+bb, Z+bb, top

<u>High Mass Search</u> (M_H >140 GeV):

$gg \to H \to WW^{(*)} \to ll\nu\nu$

Background: WW





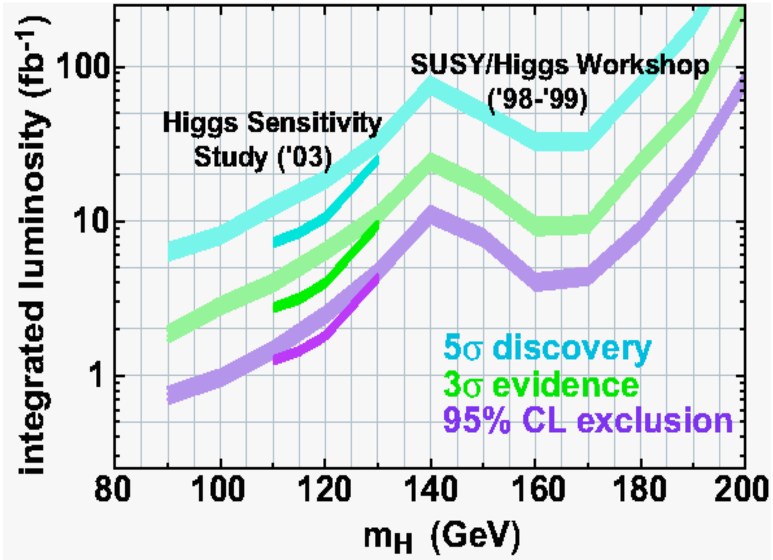
In a two Higgs-doublet SUSY model (h^0, H^0, A^0, H^{+-}), the b/t-Higgs coupling increases with tan β. Study:

$gg/qq \longrightarrow bbH(bb)$ $\quad$ $gg/qq \longrightarrow H(\tau\tau) + X$

Higgs Searches & Tevatron Status

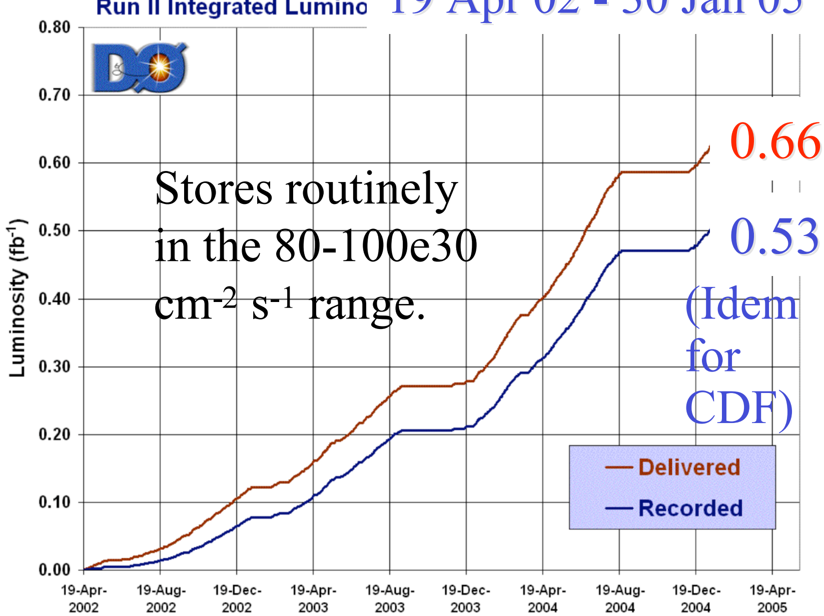
- Discovery of low mass SM Higgs (5σ) with >8-12 fb^{-1} for a 115 GeV Higgs.
- Evidence (3σ excess) for M_H= 115 GeV with >3 fb^{-1}
- Exclusion of m_H<130 GeV with >4 fb^{-1}

No sys. errors in 2003 study !



Excellent performance of the Tevatron in 2004

Need to understand high luminosity environment (triggers, reconstruction)



19 Apr 02 - 30 Jan 05

Stores routinely in the 80-100e30 cm^{-2} s^{-1} range.

0.66

0.53

(Idem for CDF)

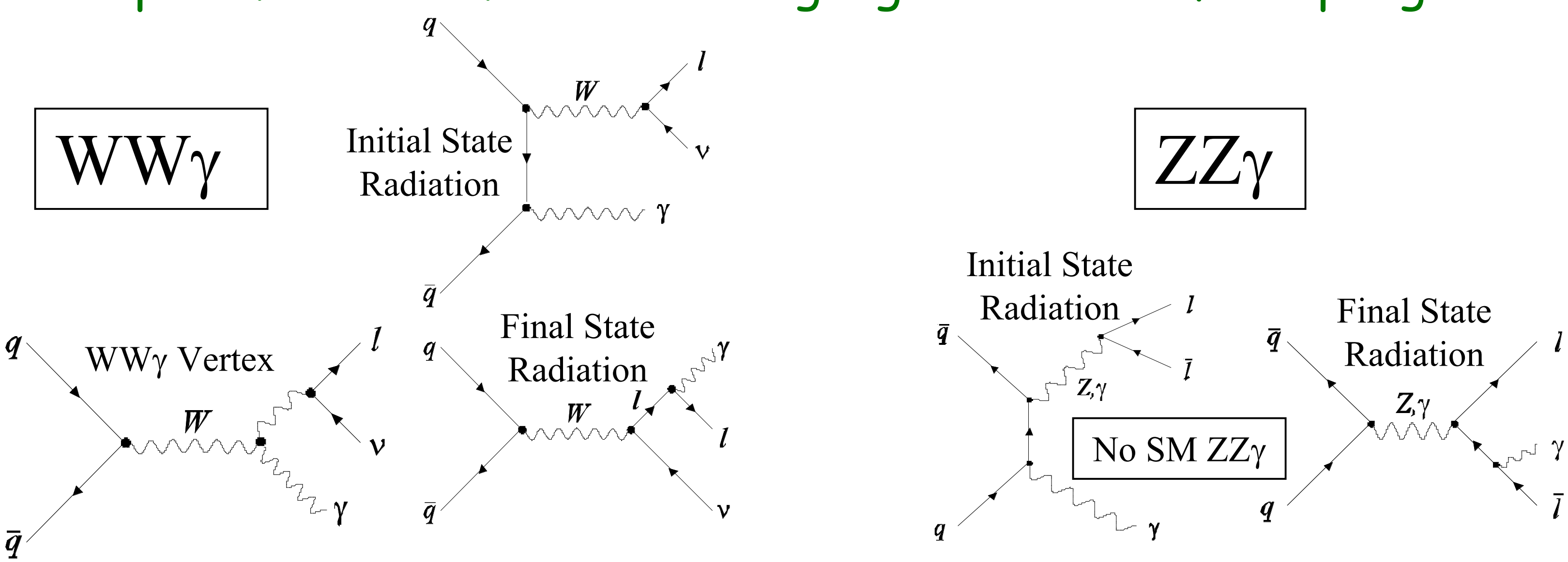
Di-Boson Production

Higgs search results presented here use 150-350 pb^{-1} of data, far less than the amount of data for Higgs discovery/exclusion

Concentrate on understanding backgrounds, γ, e, μ & jet objects, b-tagging, $\not\!\!E_T$

Di-Boson production is not only a background in Higgs searches:

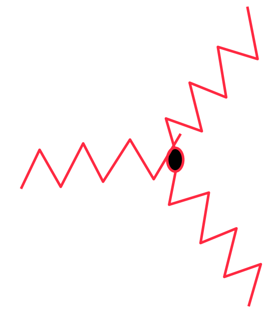
- Cross Sections provide a test of high-p_T Standard Model processes.
- A SM parameter to measure: the gauge boson "self-couplings"



Anomalous Couplings

- Effective Lagrangian for WWZ, WWγ to describe new physics in a model independent way: 3 A.C. param.

WWZ, WWγ, ZZγ Coupling



$$L_{WWV}/g_{WWV} = g_V^1 (W^\dagger_{\mu\nu} W^\mu V^\nu - W^\dagger_\mu V_\nu W^{\mu\nu}) + \kappa_V W^\dagger_\mu W_\nu V^{\mu\nu} + \frac{\lambda_V}{M_W^2} W^\dagger_{\lambda\mu} W^\mu_\nu V^{\nu\lambda}$$

- Effective Lagrangian for ZZγ : 8 A.C. param. called h_1^V, h_2^V, h_3^V, and h_4^V. CP Violating h_1^V and h_2^V , CP Conserving h_3^V and h_4^V

Unitarity violation avoided with form-factor scale λ to modify form factor at high energy: →

$$\lambda(\hat{s}) = \frac{\lambda}{(1+\hat{s}/\Lambda^2)^n}$$

Deviation from SM values: σ increase, especially for high E_T bosons (Wγ/Zγ).

SM values

$h_1^V, \ldots, h_4^V = 0$

$g_V^1 = \kappa_V = 1$, $\lambda_V = 0$

LEP and Tevatron results complementary:

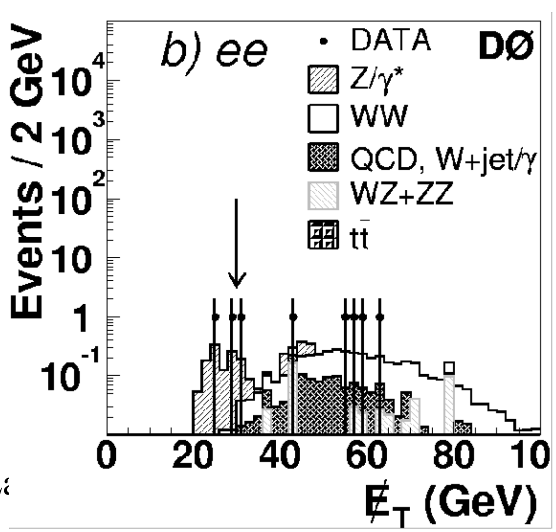
- DØ has the most restrictive limits on "h_4" and "h_2" LEP has most restrictive limits on "h_1" and "h_3".
- DØ WWγ and WWZ A.C. limits are the tightest from hadron colliders.

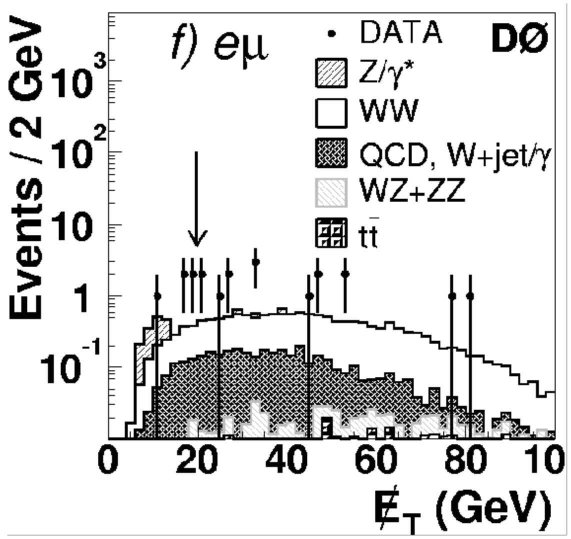
WW Cross Section

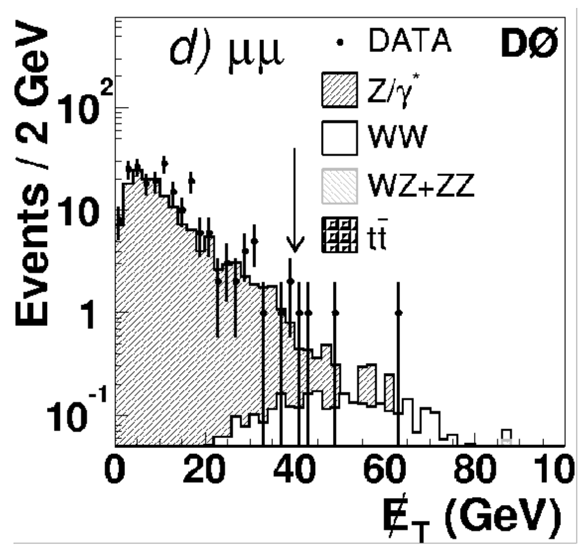
Measure $WW \to l^{+}\nu\, l'^{-}\nu$ cross section in three channels: ll' = ee, μμ, eμ
Data: 252, 224, 235 pb^{-1} (ee, μμ, eμ) from single or dilepton triggers

- Pre-selection Criteria:
  - Two oppositely charged e or μ w/ p_T>15 GeV/c. At least one has p_T>20 GeV/c
- Final cuts on:
  - $\not{E}_T$ >30, 40, & 20 GeV in ee, μμ, & eμ channels
  - Min m_T, $\Delta\phi$(jet, $\not{E}_T$), $\Delta\phi_{\mu\mu}$, ΣE_T^{jet}, outside Z window

Good agreement between data and signal (NLO)+background MC (PYTHIA, data for QCD) after data selection







WW Cross Section

Measure $WW \to l^{+}\nu\, l'^{-}\nu$ cross section in three channels: l = ee,μμ,eμ

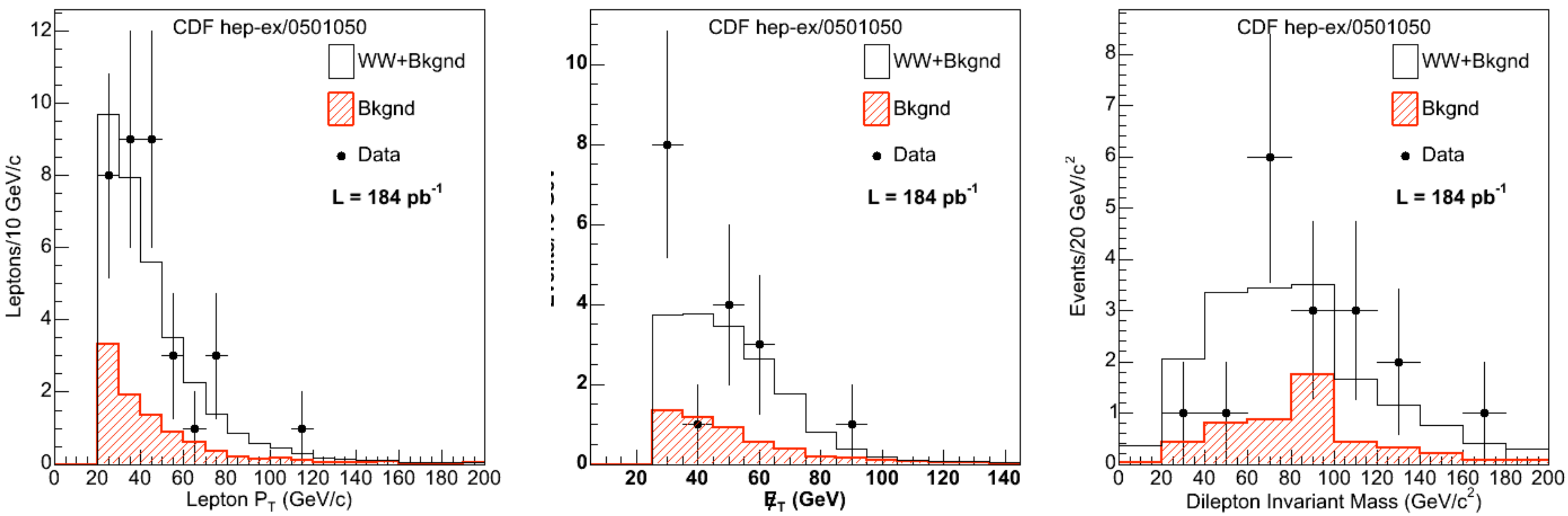
Data: 184 pb^{-1} (ee, μμ, eμ) from single lepton triggers

- Lepton Selection:
  - Two isolated leptons with opposite charge

  e or μ w/p_T>20 GeV/c.

- Event Selection:
  - $\not{E}_T$ >25 GeV in all ee, μμ, & eμ channels
  - No jets E_T>15 GeV, $\Delta\phi$(l, $\not{E}_T$), outside Z window

Good agreement between data and signal+background MC after all cuts



WW Cross Section

DØ

25 evts compared to a bkgd. exp. $8.1 \pm 0.6\,(\text{stat}) \pm 0.6\,(\text{syst}) \pm 0.5\,(\text{lum.})$

$$\sigma(WW) = 13.8^{+4.3}_{-3.8}(stat.)^{+1.2}_{-0.9}(sys.) \pm 0.9(lum.)\ \text{pb}$$

Prob. Bkgnd. Fluct. is very low ~ 5σ

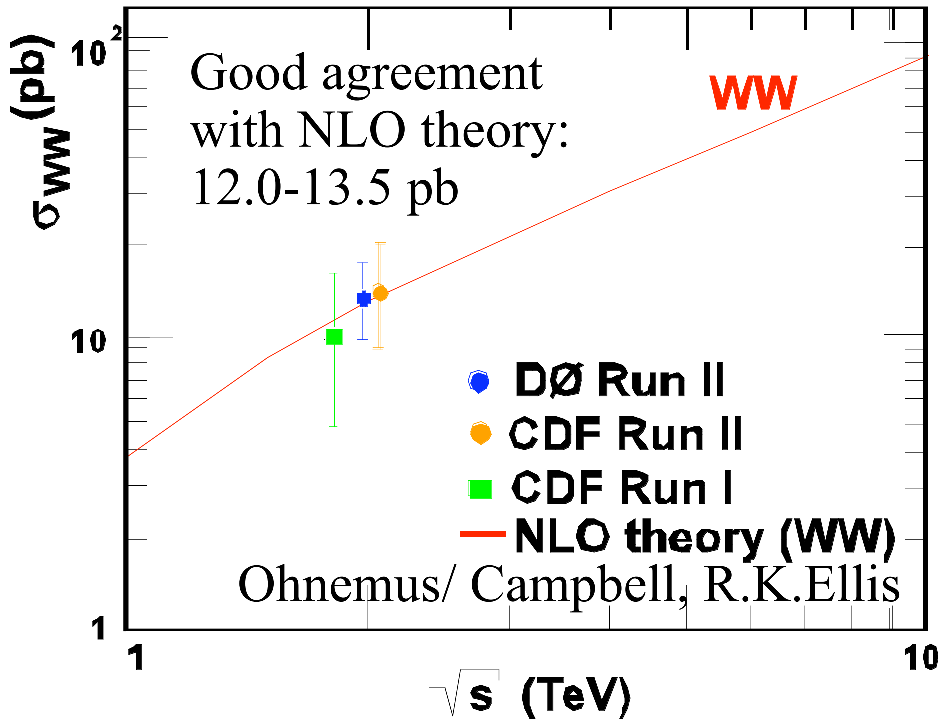
DØ Run II:
Submitted to PRL
hep-ex/0410066

CDF

17 evts compared to a bkgd. exp. $5.0 \pm^{2.2}_{0.8}$

$$\sigma(WW) = 14.6^{+5.8}_{-5.1}(stat.)^{+1.8}_{-3.0}(sys.) \pm 0.9(lum.)\ \text{pb}$$

CDF Run II:
Submitted to PRL
hep-ex/0501050

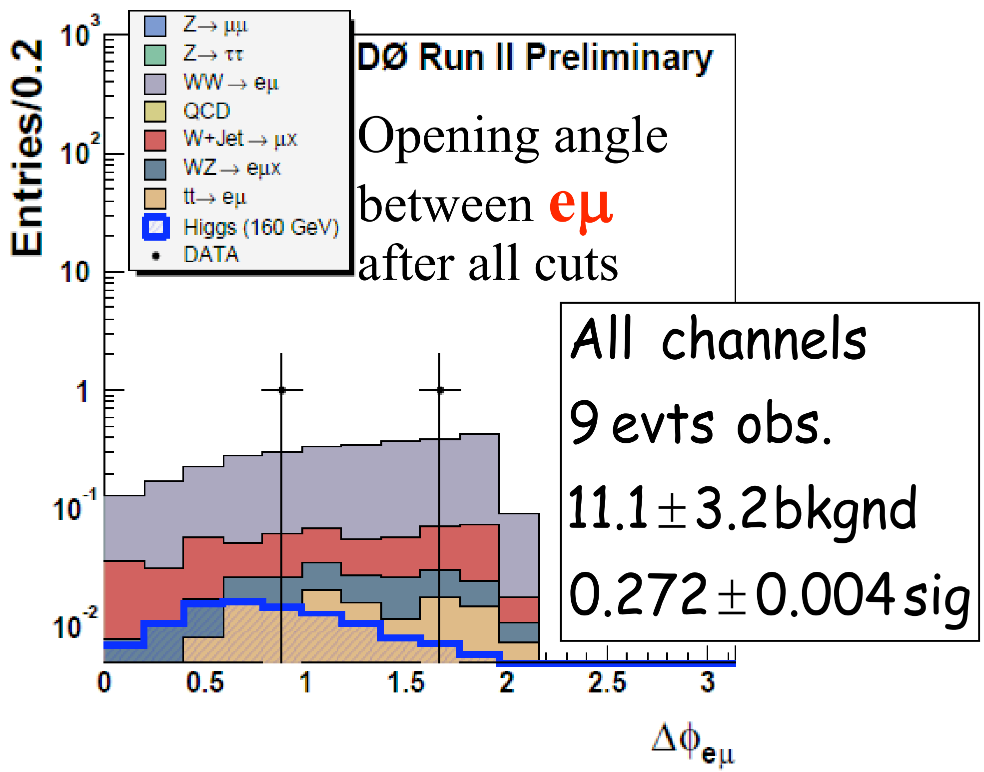


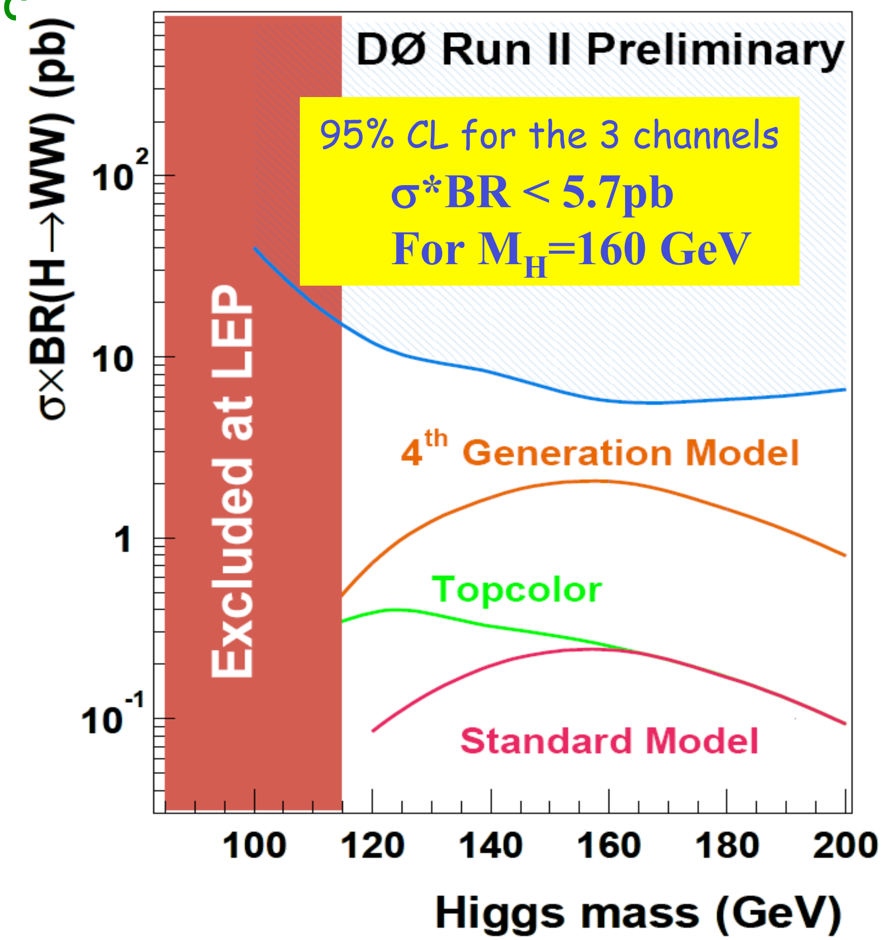
H→WW Search

Search in three channels: $H \rightarrow WW^{(*)} \rightarrow l^{+}\nu\, l'^{-}\nu$ with l = ee,μμ,eμ
Integrated luminosity 177, 158, 147 pb^{-1} for ee, μμ, eμ

Data Selection: two leptons with opposite charges, p_T >20,15 GeV , dilepton invariant mass, $p^{l1}_T + p^{l2}_T + \not{E}_T$, $\Delta\phi_{ll}$, jet veto

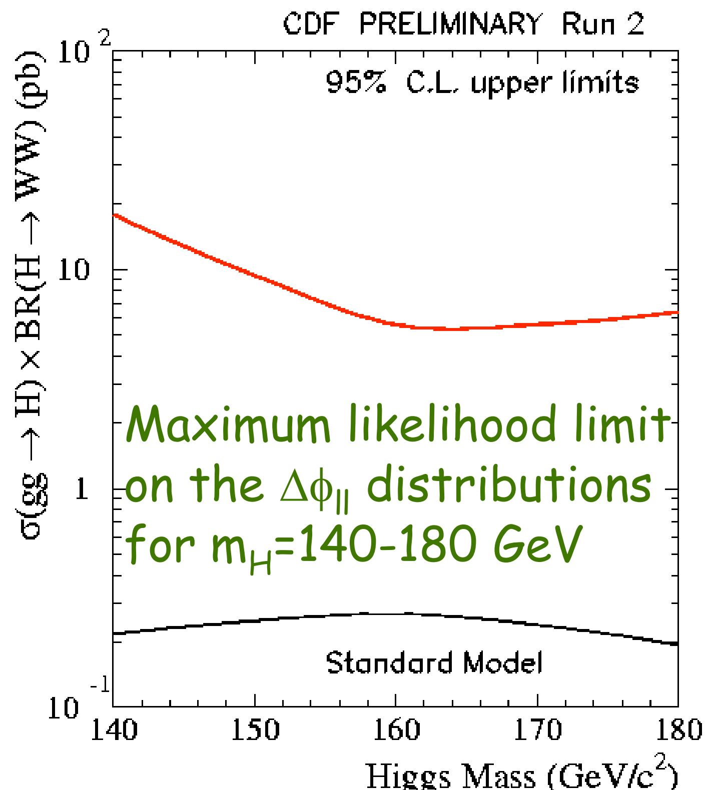
(Generators: PYTHIA, ALPGEN, MCFM)



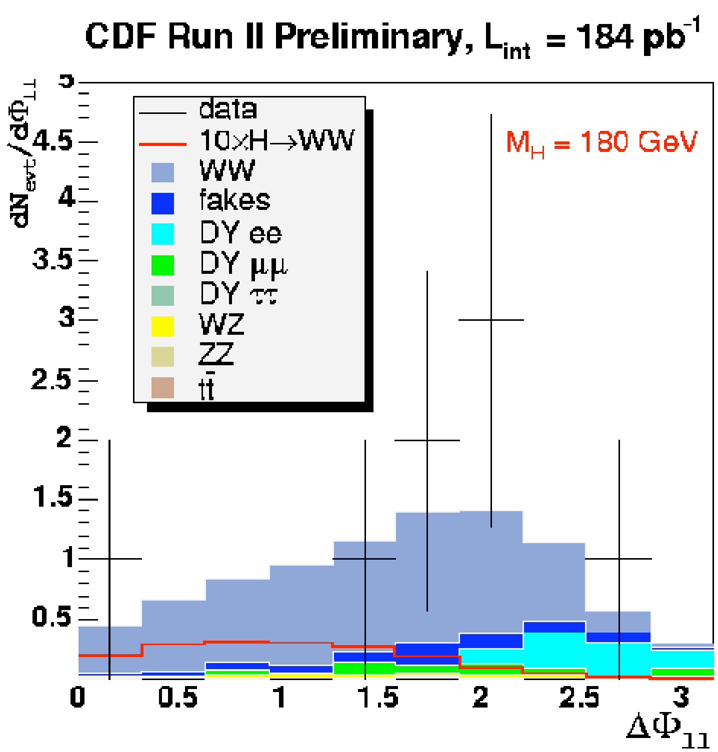


H→WW Search

Search in three channels: $H \to WW^{(*)} \to l^+\nu\ l'^-\nu$ with l = ee,μμ,eμ
From inclusive high p_T lepton triggers: integrated luminosity 184 pb^{-1}



Data Selection: two isolated leptons with opposite charges with p_T > 20 GeV, $\not{E}_T$ >25 GeV, $\Delta\phi(\not{E}_T$, l or j) , veto on jets



For m_H=180 GeV

Obs: 8 evts

Bkgnd: 8.9 ± 1 (PYTHIA, HERWIG)

Signal: 0.17 ± 0.02 (PYTHIA)

σ*BR < 5.6pb @ 95% CL For M_H=160 GeV

W + $b\bar{b}$ Search

174pb[-1] sample with one electron and $\not\!E_T$ (dominant background for WH)

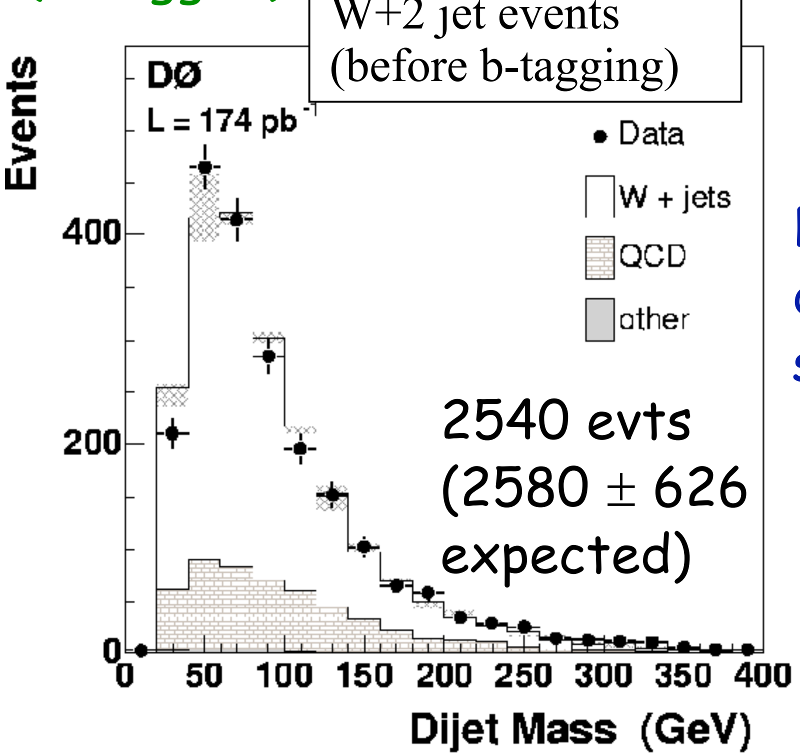
Electron: p_T > 20 GeV, $|\eta|$<1.1

Missing E_T > 25 GeV

2 jets: p_T > 20 GeV/c, $|\eta|$<2.5 (b-tagged)

Compared to ALPGEN, PYTHIA showering, and full detector simulation, Normalized to NLO x-section MCFM

W+2 jet events (before b-tagging)

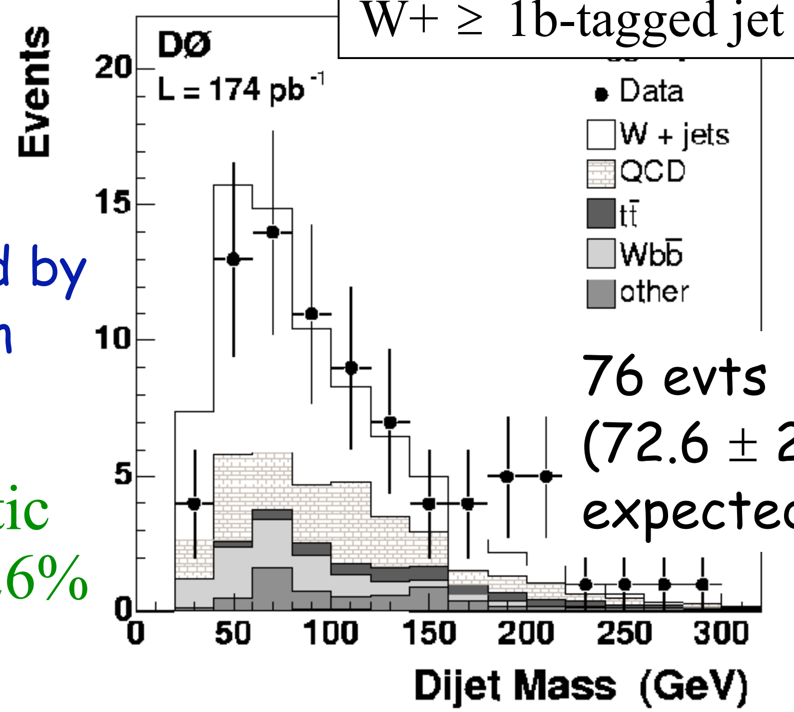


2540 evts (2580 ± 626 expected)

Data well described by simulation

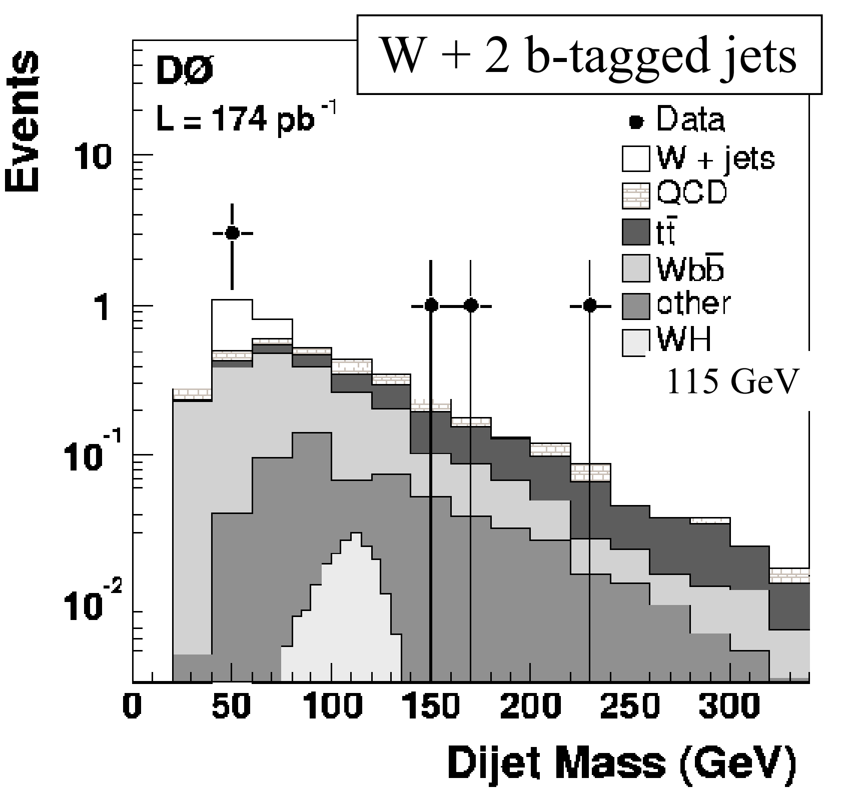
Total systematic error ~ 26%

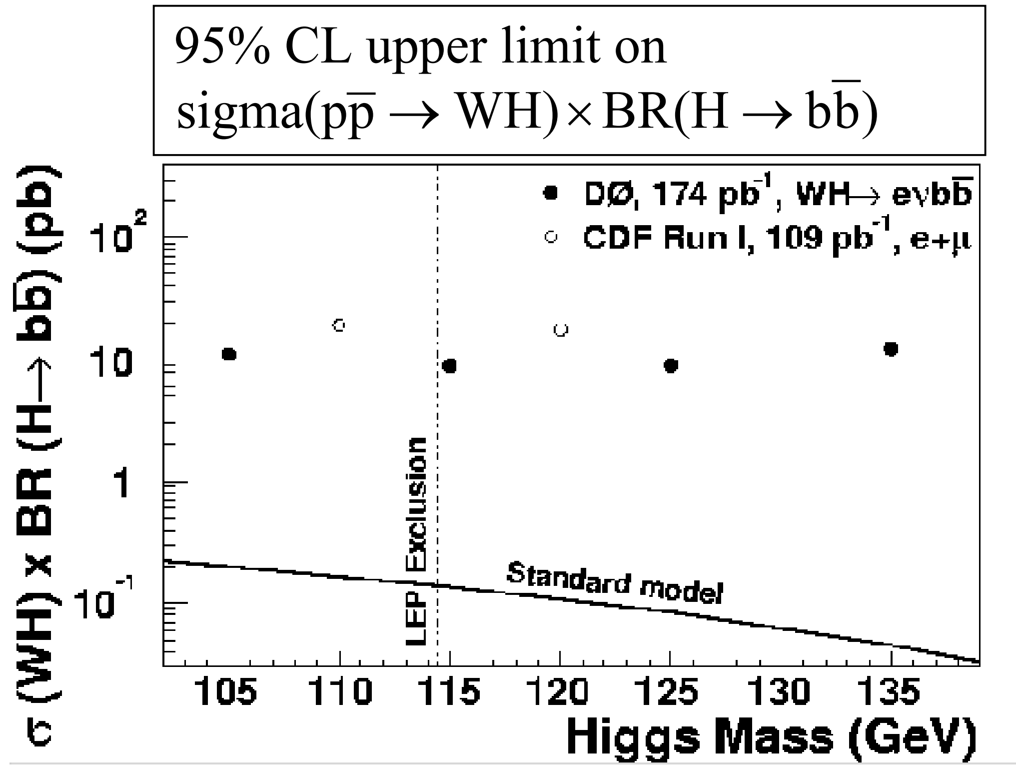
W+ ≥ 1b-tagged jet



76 evts (72.6 ± 20 expected)

W + $b\bar{b}$ Search





6 evts (4.4 ± 1.17 expected)

95% CL upper limit of 6.6 pb on $Wb\bar{b}$ production for b with p_T^b > 20 GeV/c and ΔR_{bb} >0.75

95% CL upper limit on WH production of 9.0-12.2 pb for Higgs masses of 105-135 GeV/c^2

Accepted by PRL: hep-ex/0410062

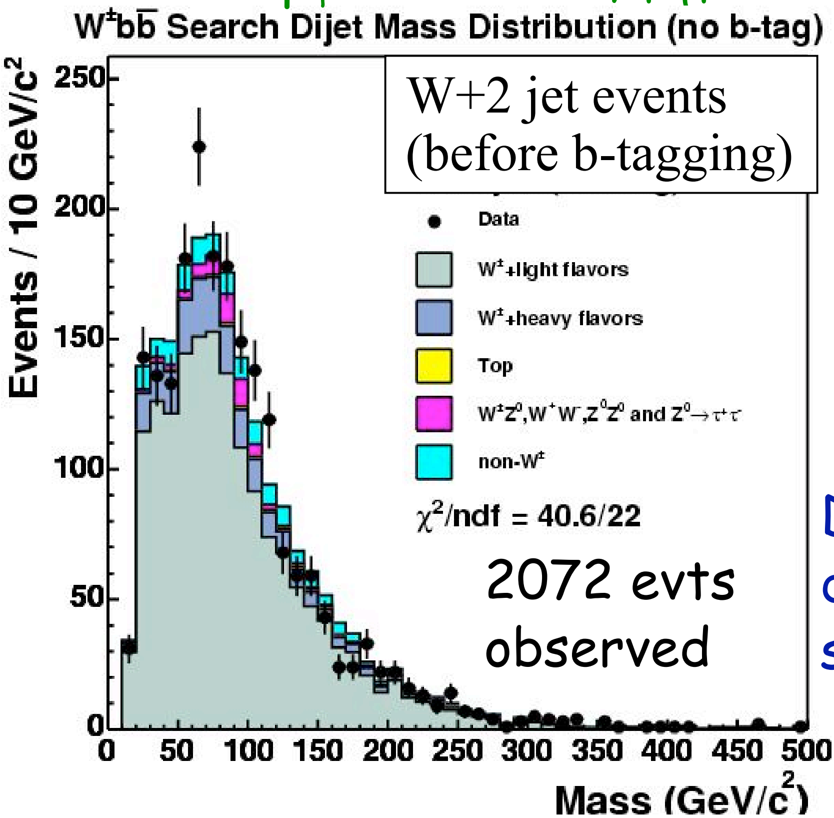
W + $b\bar{b}$ Search

162pb^{-1} sample with one electron or muon and $\not{E}_T$

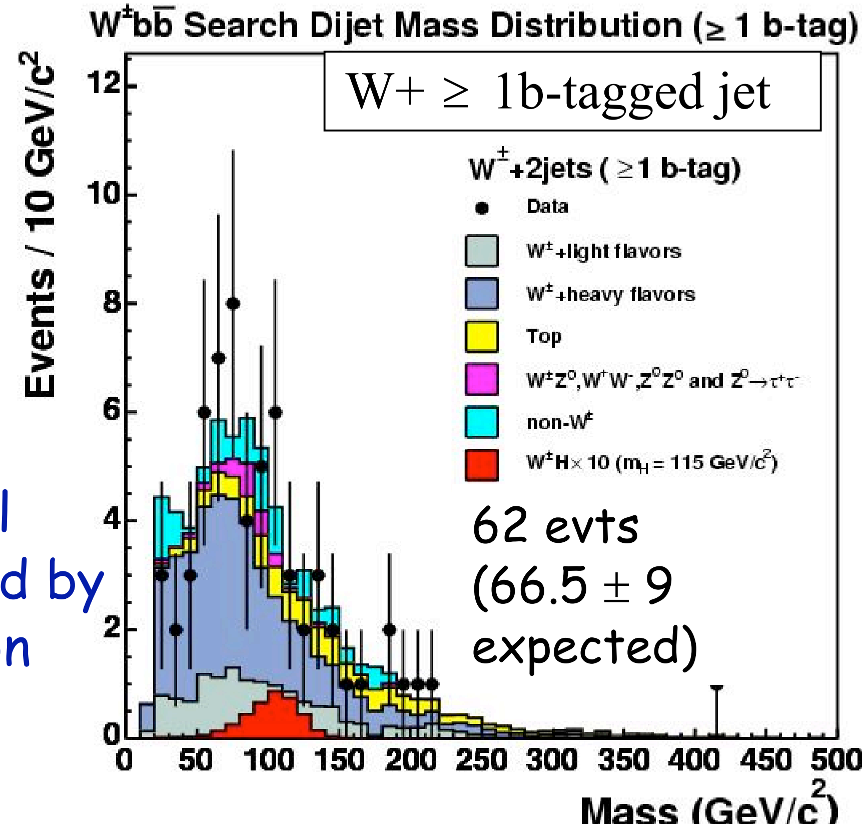
- Electron or muon: $p_T > 20$ GeV/c
- Missing $E_T > 20$ GeV
- 2 Jets: $p_T > 15$ GeV/c, $|\eta| < 2.0$

Total systematic error ~ 11%

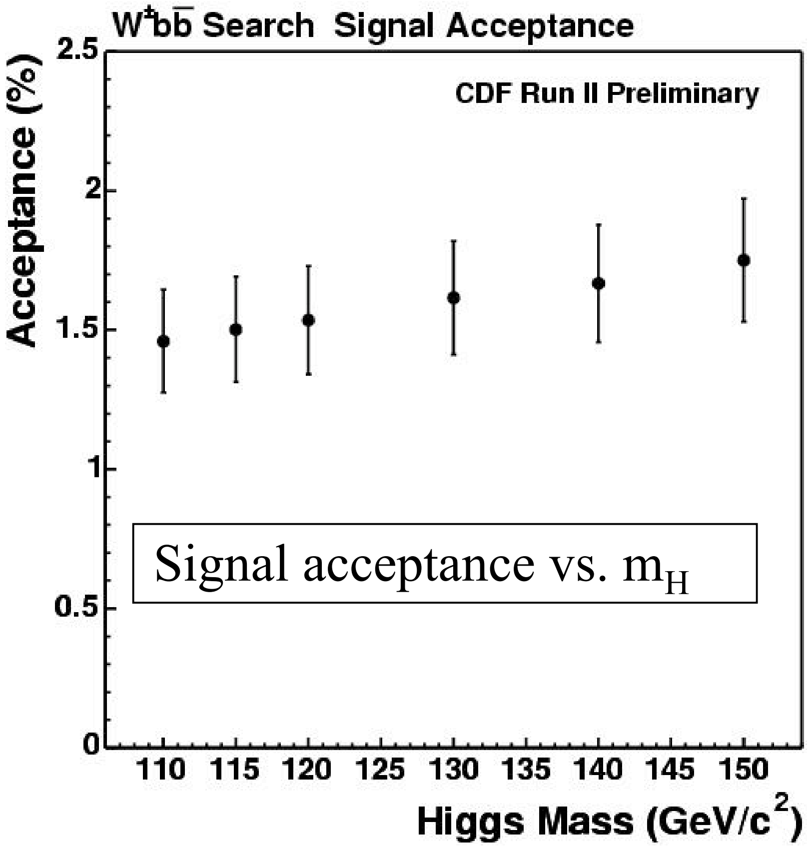
No significant peak from Higgs



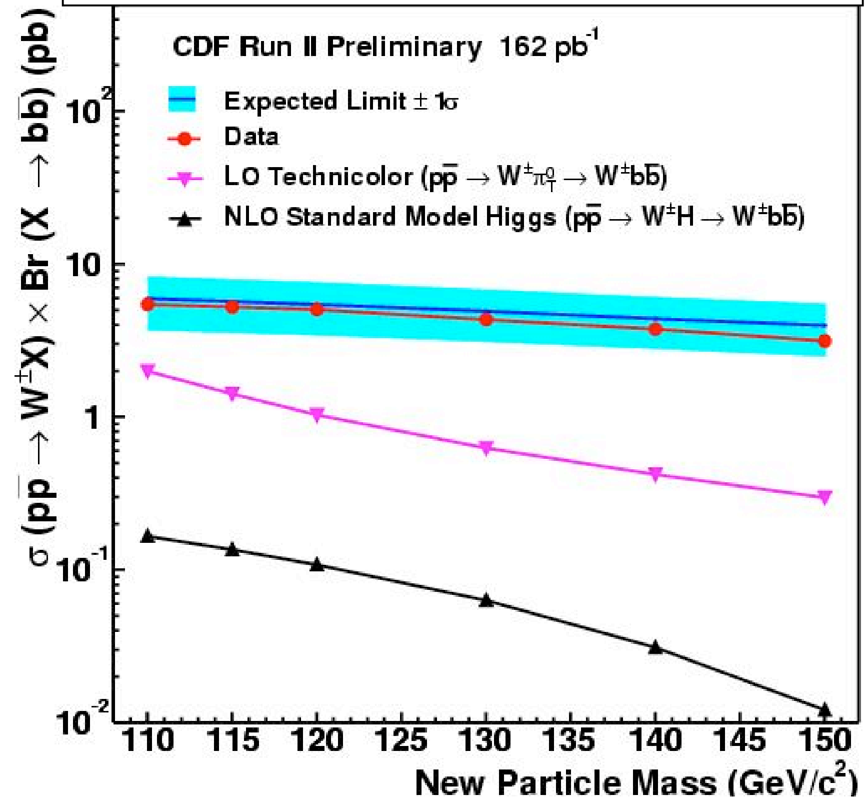
Data well described by simulation



W + $b\bar{b}$ Search



95% CL upper limit on
$\sigma(p\bar{p} \to WH) \times BR(H \to b\bar{b})$



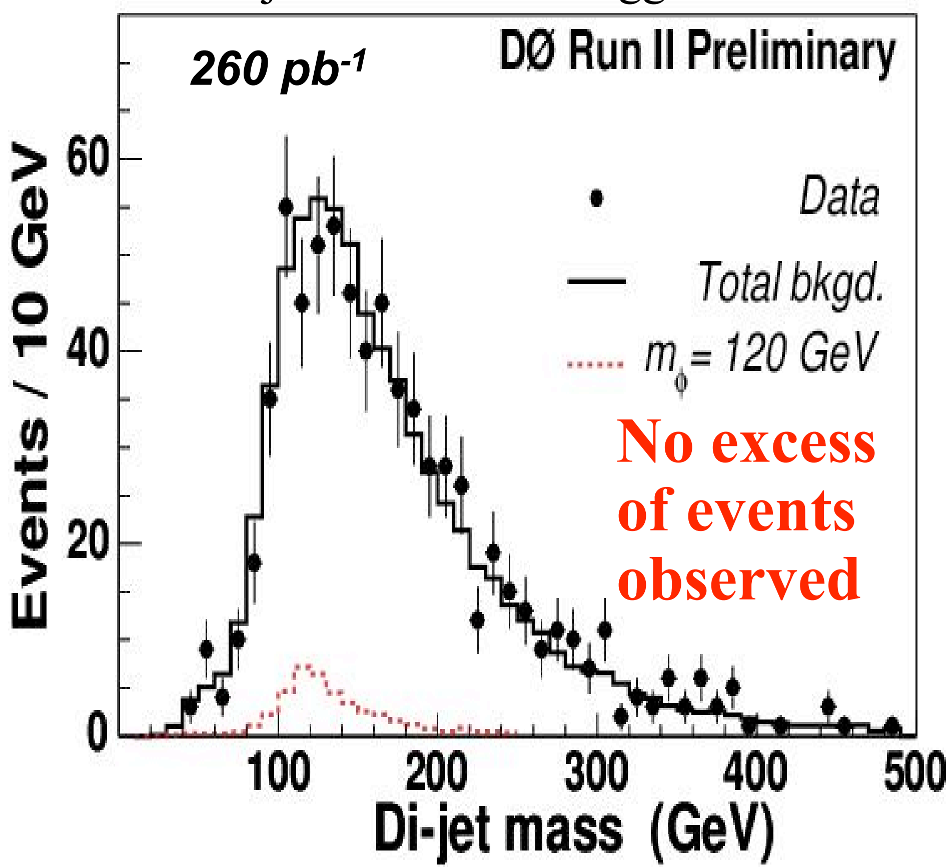
95% CL upper limit on the SM $\sigma(p\bar{p} \to WH) \times BR(H \to b\bar{b})$,
5.5 (4) pb at m_H=110 (150) GeV, is limited by statistics to one order of magnitude above that the NLO SM prediction for Higgs.

h(bb)bb Search

Search for neutral Higgs in a two-Higgs-doublet SUSY model in a 260 pb^{-1} sample of triple b-tagged multi-jet events.

- Sample Selection:
  - Trigger >3 jets with E_T>15 GeV,
  - Offline cut on E_T of leading jets optimised for each Higgs mass.
  - More than 3 b-tagged jets
- Background:
  - "QCD heavy flavor" : bbjj, ccjj, cccc, bbcc, bbbb
  - "QCD fakes" : jjjj
  - "Other" : Z(bb,cc), tt
- Theory/Simulation:
  - NLO SM Higgs production (Campbell et al., Dawson et al.), MSSM (Carena, Mrenna, Wagner), PYTHIA, MAD-GRAPH, ALPGEN

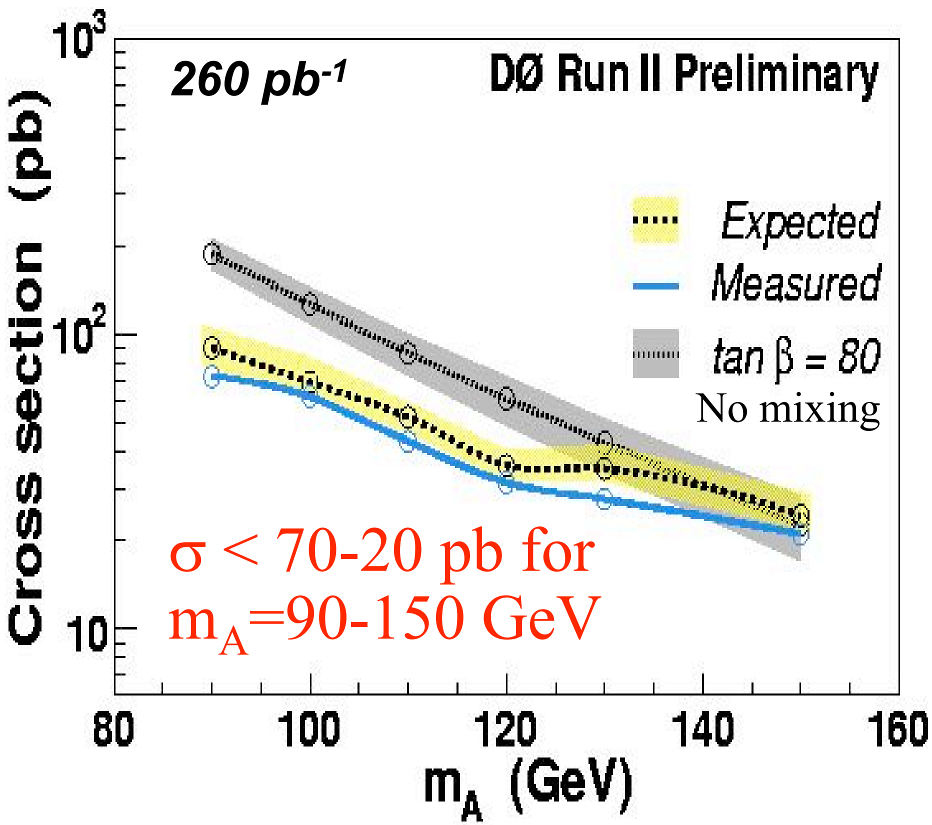
Di-jet mass in ≥ 3b-tagged events

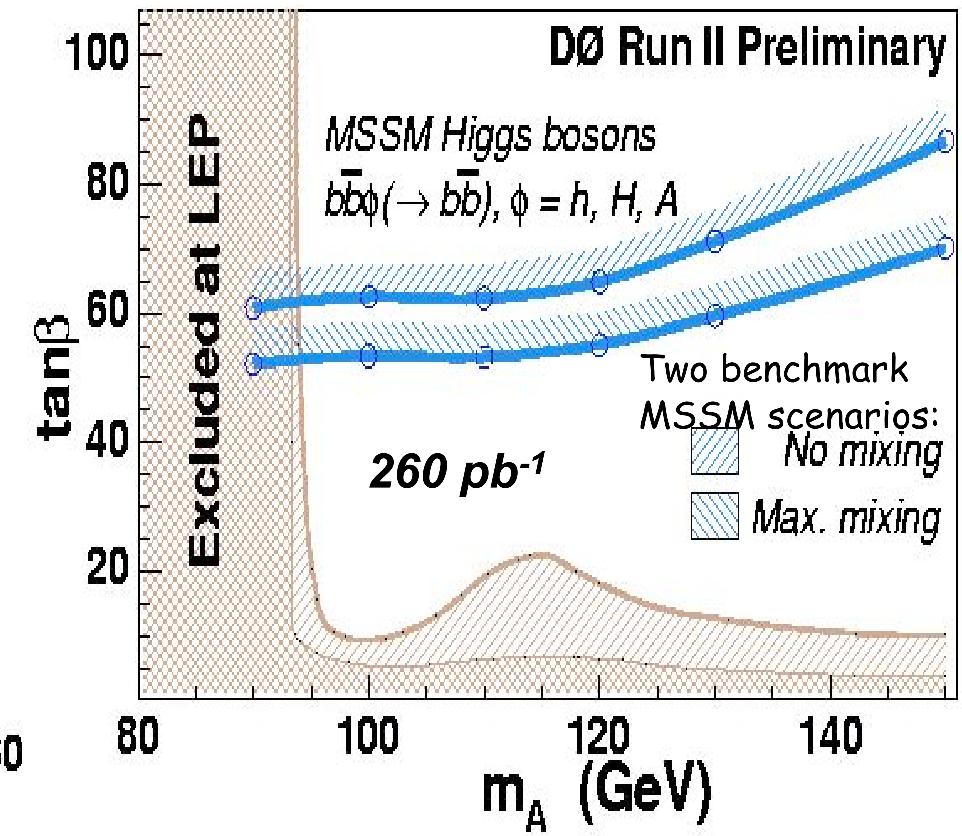


No excess of events observed

h(bb)bb Search

Limits on signal production cross section and in the tan(beta) vs. m_A (the mass of the CP-odd neutral Higgs) plane:





Exclude significant range of tan _ down to 50, depending on m_A and the MSSM scenario: (DØ Preliminary)

For m_A=120 GeV: σ < 31 pb @ 95% C.L. , tanβ < 55 @ 95% C.L. (Max Mixing)

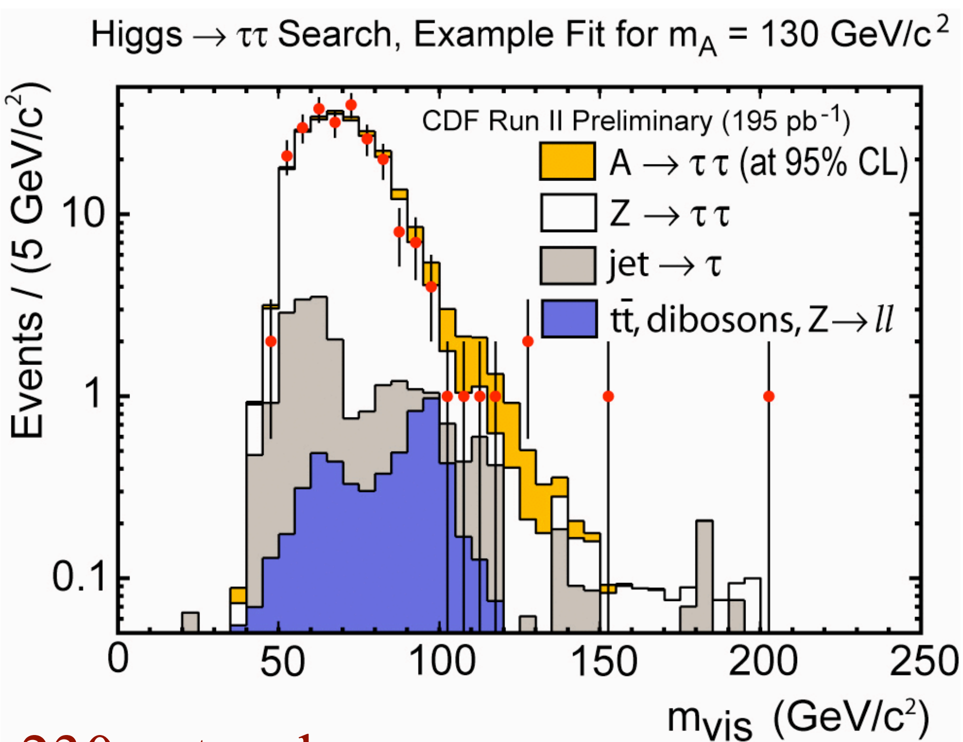
h(ττ) Search

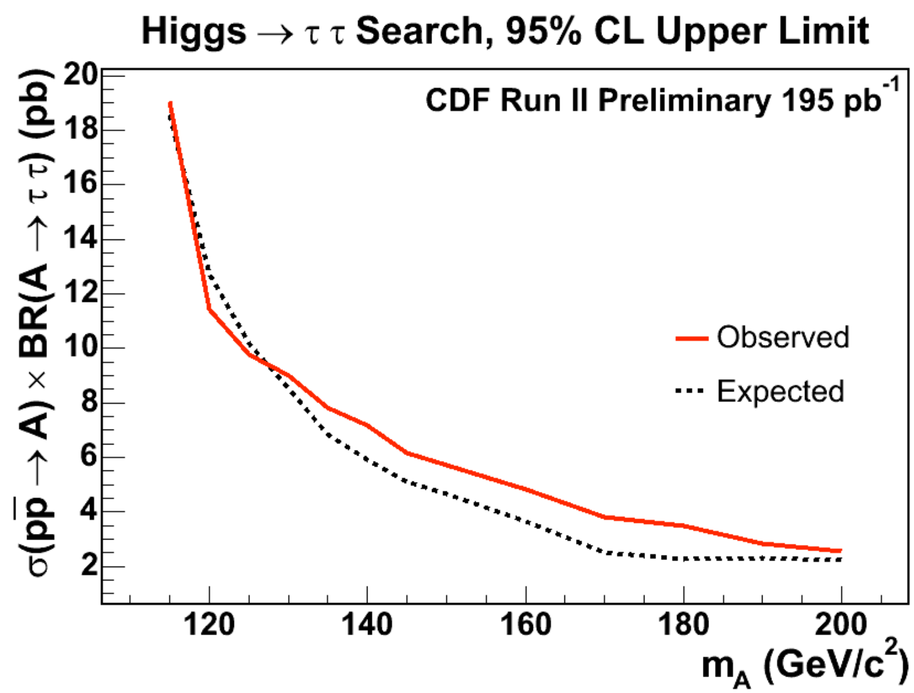
200 pb^{-1} sample from τ triggers (lepton+isolated track): two τ's, one decaying into hadrons+ν and the other to an e/μ + 2ν.

- Cuts on lepton pT, Z mass window.
- PYTHIA+ Tauola (signal simul.)

To remove light quark bkgnd:

$$\hat{H}_T = |p_T(tau)| + |p_T(tau)| + \not{E}_T > 50\,\text{GeV}$$





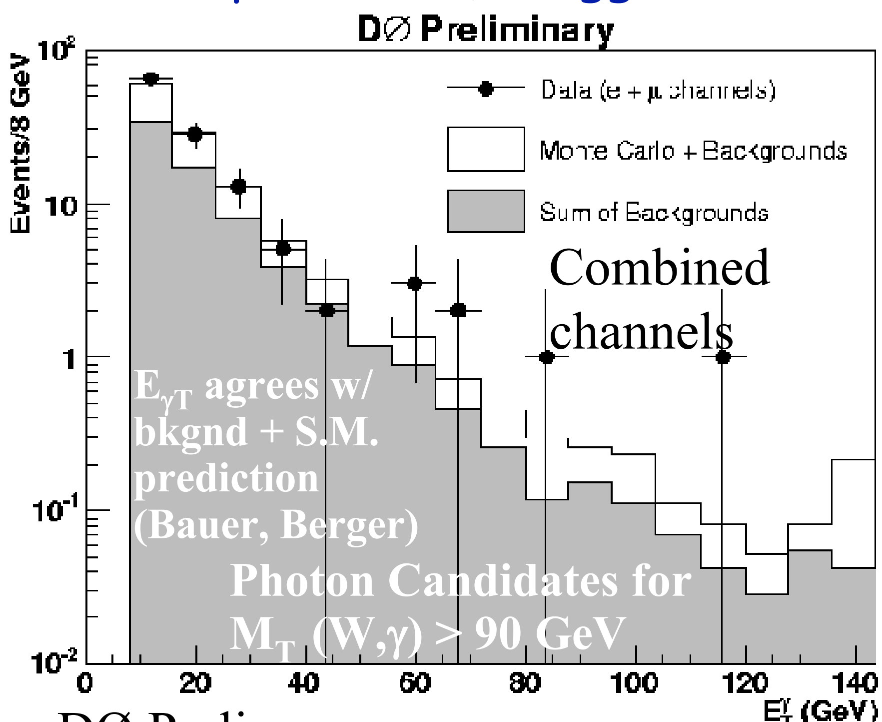
230 evts. obs.
263.6±30.1 exp.

Limit on inclusive σxBR from likelihood fit of the "partial mass" distribution:

$$m(l, tau, \not{E})$$

WWγ Couplings

Measure $W(l\nu)\gamma$ ($l = e,\mu$) x-section and WWγ anomalous couplings from 162, 134 pb^{-1} of e, μ triggers. Cuts on $E_{T\gamma,e}$, M_T, γ/l separation, $\not{E}_T$



DØ Prelim.

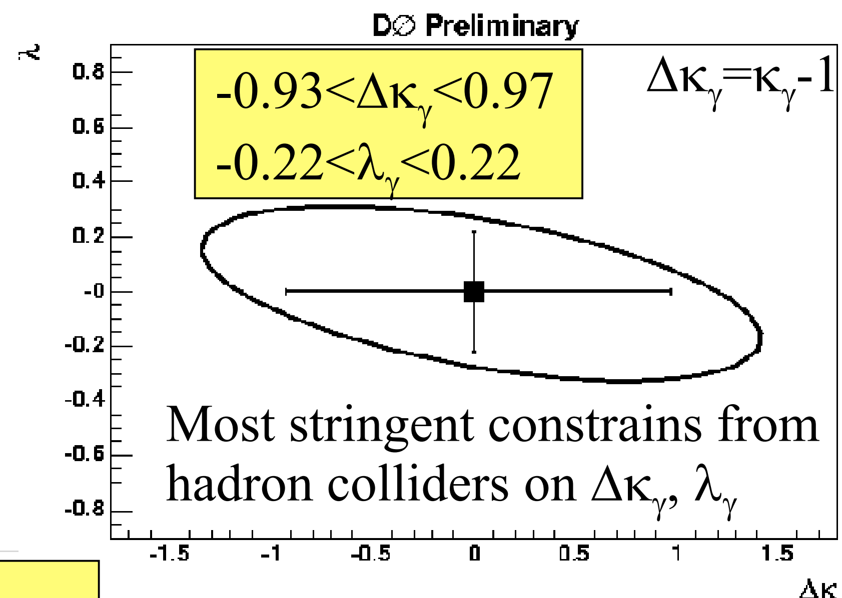
$\text{sigma}(p\bar{p} \to W^{\pm}\text{gamma}) =$

$14.8 \pm 1.6\,(\text{stat.}) \pm 1.0\,(\text{sys.}) \pm 1.0\,(\text{lum.})\ \text{pb}$

SM prediction is 16.0 ± 0.4 pb

(For $E_T(\gamma) > 8$ GeV $\Delta R_{l\gamma} > 0.7$)

Limits on anomalous couplings extracted from a binned-likelihood based on $p_T(\gamma)$.

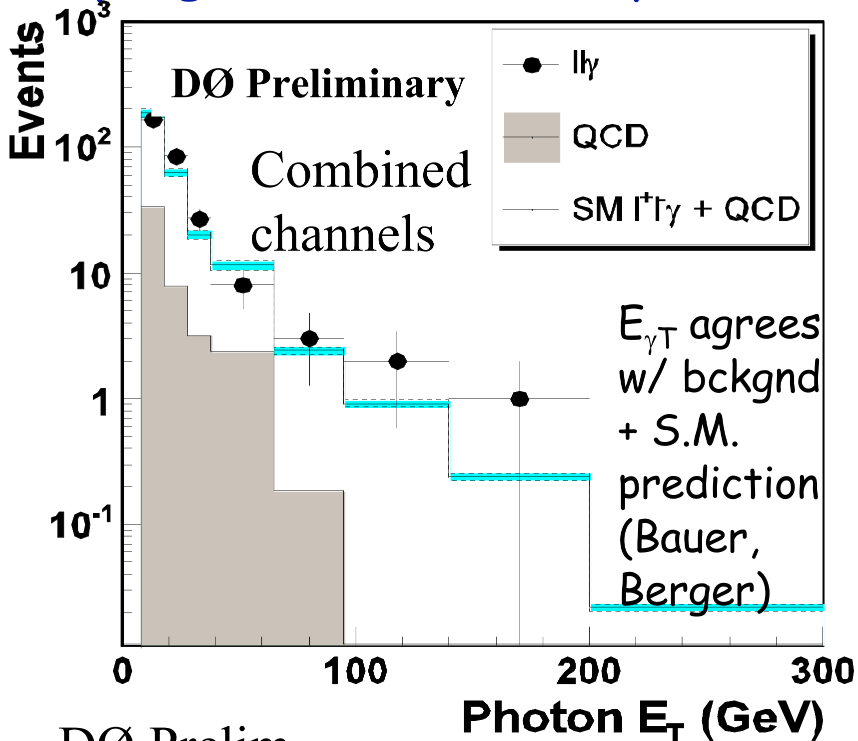


Point & bars: SM value & 95% C.L. 1D intervals

Ellipse: 95% C.L. 2D exclusion limit

$ZZ^*\gamma$ & $Z\gamma^*\gamma$ Couplings

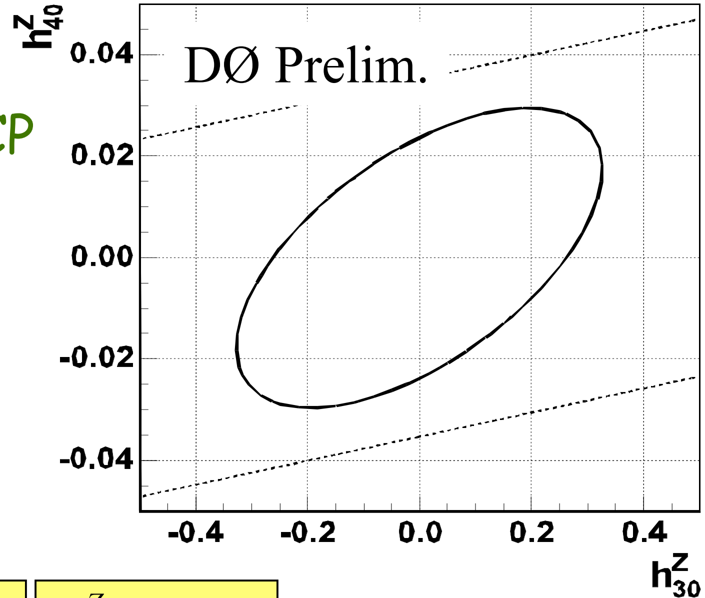
Measure $Z(ll)\gamma$ (ll = $ee,\mu\mu$) x-section and limits on $ZZ^*\gamma$ $Z\gamma^*\gamma$ anomal. couplings from 324, 286 pb^{-1} of e, μ triggers. Cuts on $E_{T\gamma,l}$,γ/l separation.



$E_{\gamma T}$ agrees w/ bckgnd + S.M. prediction (Bauer, Berger)

DØ Prelim.

Limits on CP conserving AC from likelihood based on $p_T(\gamma)$.



$\lvert h_{30}^{\gamma}\rvert < 0.22$	$\lvert h_{30}^{Z}\rvert < 0.21$
$\lvert h_{40}^{\gamma}\rvert < 0.019$	$\lvert h_{40}^{Z}\rvert < 0.019$

Tightest from hadron colliders.

(Competitive w/ LEP)

$\text{sigma}(p\bar{p} \rightarrow Z\gamma) = 4.2 \pm 0.4\,(\text{stat.}+\text{sys.}) \pm 0.3\,(\text{lum.})\,\text{pb}$

agrees well with $3.9^{+0.1}_{-0.2}$ (NLO Calculations)

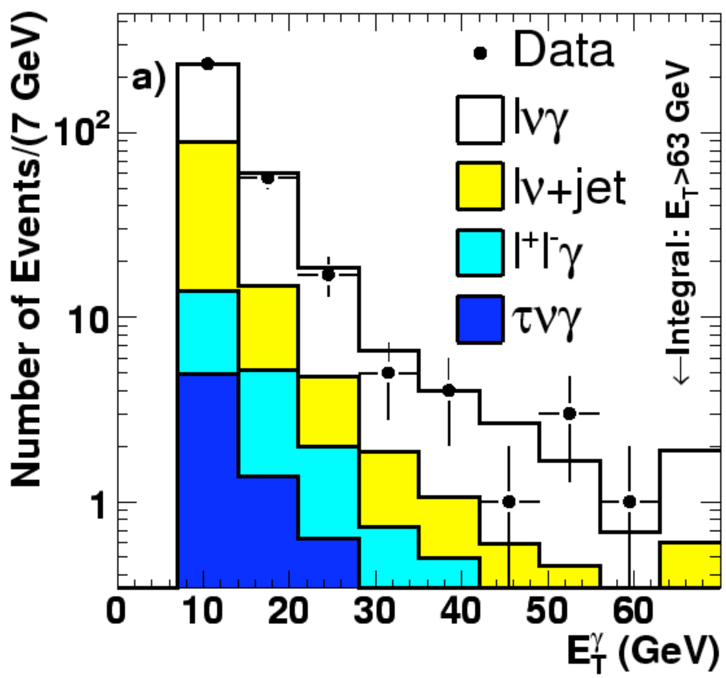
$E_T(\gamma) > 8$ GeV $M(l^+l^-) > 30$ GeV/c^2 $\Delta R_{l\gamma} > 0.7$

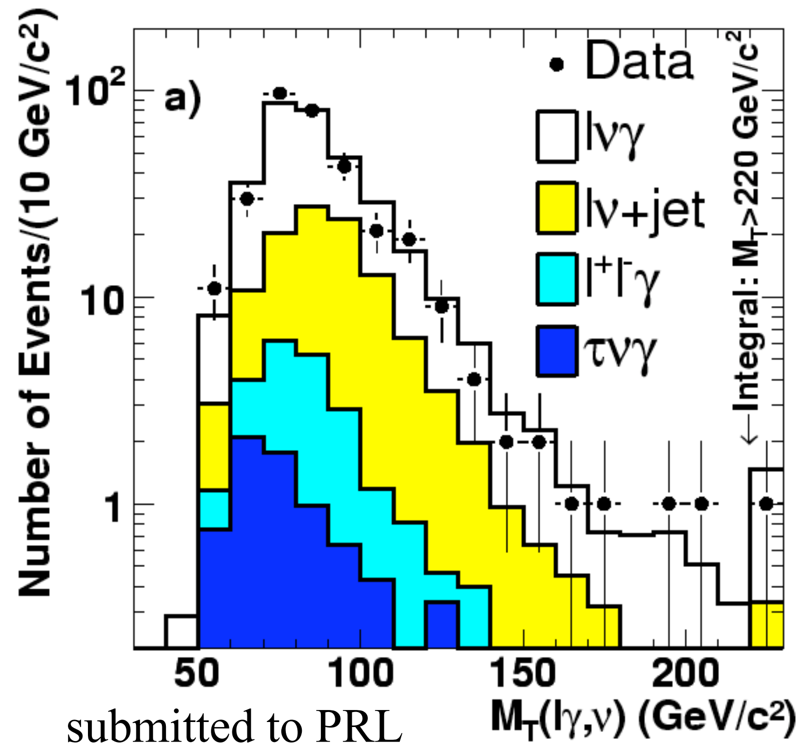
Ellipse: 95% C.L. 2D exclusion contour

Lines: Const. from Unitary

Wγ Production

Measure $W(l\nu)\gamma$ ($l = e,\mu$) x-section from 200 pb^{-1} of e, μ triggers.
Data Selection based on cuts applied to $E_{T\gamma,e,\mu}$, m_T, $\not{E}_T$





submitted to PRL
hep-ex/0502016

$\text{sigma}(p\bar{p} \to W^{\pm}\text{gamma}) = 18.1 \pm 3.1\,\text{pb}$

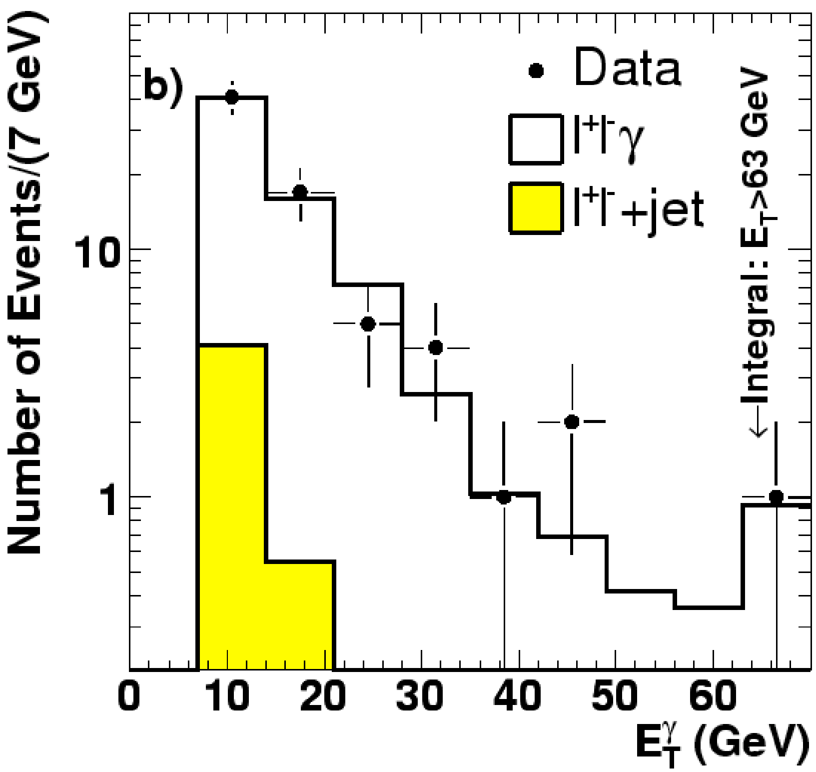
SM prediction is $19.3 \pm 1.4\,\text{pb}$

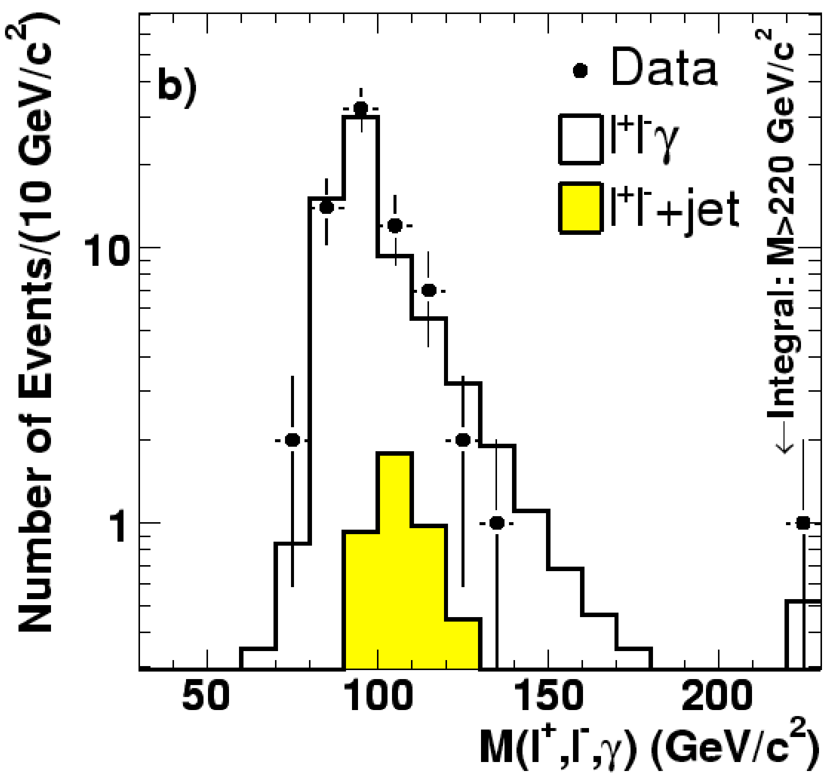
(For $E_T(\gamma) > 7$ GeV $\Delta R_{l\gamma} > 0.7$)

	e	μ
Obs:	195 (e)	128 (μ)
S+B:	194.1±19.1	142.4±9.5

Zγ Production

Measure $Z(ll)\gamma$ (ll = ee,μμ) x-section from 200 pb^{-1} of e, μ triggers.
Data Selection based on cuts applied on $E_{T\gamma,l}$, m_{ll} invariant mass.





$\text{sigma}(p\bar{p} \to Z\gamma) = 4.6 \pm 0.6$ pb

Agrees with 4.5 ± 0.3 pb (NLO Calculations)

$E_T(\gamma)$ >7 GeV $M(l^+l^-)$>40 GeV/c^2 $\Delta R_{l\gamma}$>0.7

Obs:	36 (e)	35 (μ)
S+B:	34.1±1.8	35.7±1.7

WZ/ZZ Search

DØ measured $WZ \to lll\nu$ (l = e,μ) x-section from 285-320 pb^{-1} of e, μ triggers. Sample selected with cuts on E_{Tl}, ΔR separation, m_Z window, $\not{E}_T$

- 3 evts observed (2 μμμ, 1 eee) 0.71 ± 0.08 background
- P(0.71 bkgd) -> 3 sig. Evts. is 3.5%
- "Evidence" for WZ Production

$$\sigma(p\bar{p} \to W^{\pm}Z) = \frac{N_{obs} - N_{bkgd}}{L \cdot Br \cdot \varepsilon}$$

DØ Preliminary $= 4.5^{+3.5}_{-2.6}$ pb

SM Prediction (Campbell, Ellis) $= 3.7 \pm 0.1$ pb

$\sigma(WZ + X)$ DØ Prelim. < 13.3 pb (95% C.L.)

CDF measured WZ(lllν), ZZ(llll), ZZ(llνν) (l = e,μ) x-section from 194 pb^{-1} of e, μ triggers. Sample selected with cuts on E_{Tl}, $\Delta\phi(\not{E}_T, l/jet)$, m_Z window, $\not{E}_T$ significance

$\sigma(WZ + ZZ) < 15.2$ pb at 95% C.L.

SM Prediction (NLO): 5.0 ± 0.4 pb

Combined

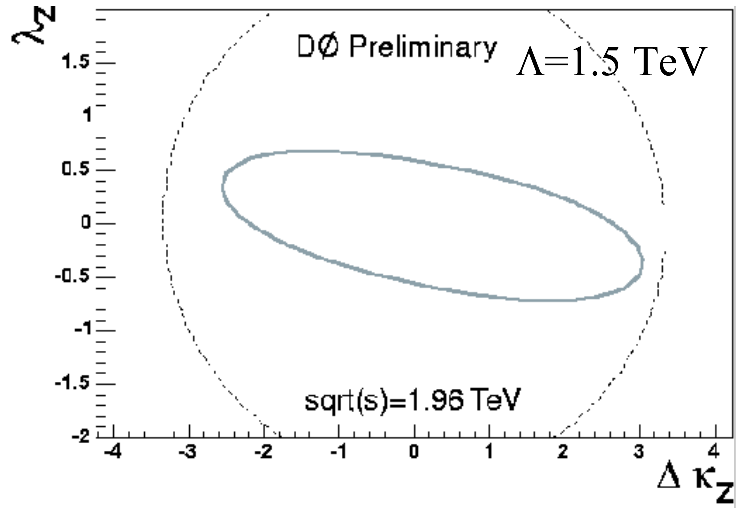
S+B: 3.33±0.43

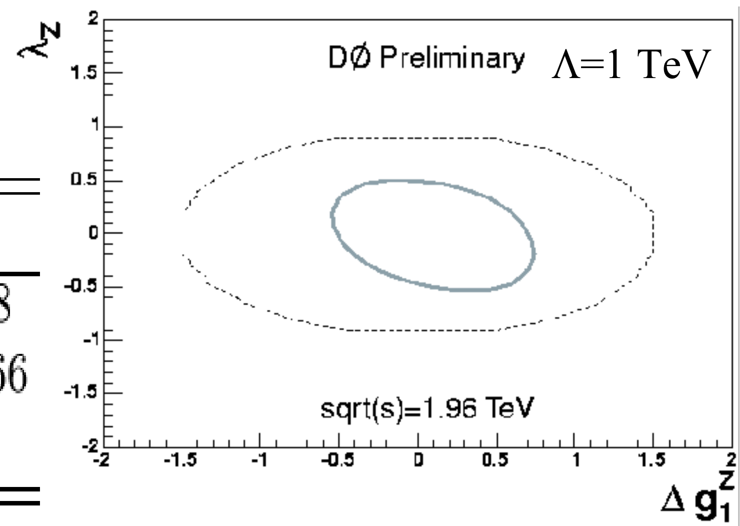
Evts. Obs: 3

(CDF Run II: hep-ex/0501021 submitted to PRD)

WWZ Couplings

- Inner contours: 2D limits. Outer contours are unitarity boundary.
- Best limits in WZ final states.
- First 2D limits in $\Delta\kappa_Z$ vs. λ_Z using WZ.
- Best limits available on Δg_1^Z, $\Delta\kappa_Z$, and λ_Z from direct, model-independent measurements.
- The DØ Run II 1D limits are ~ factor of 2-3 better than the Run I limits.





1D Limits (holding the other to 0)

$\Lambda = 1.0$ TeV	DØ Preliminary	$\Lambda = 1.5$ GeV
$-0.53 < \lambda_Z < 0.56$		$-0.48 < \lambda_Z < 0.48$
$-0.57 < \Delta g_1^Z < 0.76$	95% C.L.	$-0.49 < \Delta g_1^Z < 0.66$
$-2.0 < \Delta\kappa_Z < 2.4$		-

Conclusion & Outlook

- The hunt for the Higgs Boson has started at the Tevatron: SM & SUSY searches
- Di-Boson production Cross Sections measurements have been performed and the tightest limits on A.C. from a hadron collider have been measured by DØ.
- Need ~4 fb^{-1} per experiment to exclude $M_H < 130$ GeV
- The Tevatron has performed very well during 2004, collecting ~0.6 fb^{-1} per experiment since the beginning of Run II.
- Need to improve understanding of physics objects to meet the challenges of the high luminosity environment

End of Talk

Summary on SM Higgs Searches

- SM Results:

DØ:

95% CL for the 3 channels
σ*BR(H->WW) < 5.7pb
For M_H=160 GeV

CDF Preliminary:

95% CL for the 3 channels
σ*BR(H->WW) < 5.6pb
For M_H=160 GeV

95% CL limit:
σ*BR(WH -> eν bb) < 9.0-12.2 pb
For M_H=105-135 GeV

95% CL limit:
σ*BR(WH->e/μ ν bb) < 5.5-4.0 pb
For M_H=110-150 GeV

- SUSY Results:

σ < 70-20 pb for m_A=90-150 GeV

DØ Preliminary

Exclude significant portion of tan _ down to 50, depending on m_A and the MSSM scenario:

For m_A=120 GeV: σ < 31 pb-1 @ 95% C.L. , tanβ < 55 @ 95% C.L. (Max Mixing)

Summary on Di-Boson Production

- Measurement of σ(WW) at 1.96 TeV using dileptons

$$\mathrm{D0}: \sigma(WW) = 14.6^{+5.8}_{-5.1}(stat.)^{+1.8}_{-3.0}(sys.) \pm 0.9(lum.)\ \mathrm{pb}$$

$$\mathrm{CDF}: \sigma(WW) = 13.8^{+4.3}_{-3.8}(stat.)^{+1.2}_{-0.9}(sys.) \pm 0.9(lum.)\ \mathrm{pb}$$

DØ & CDF submitted to PRL

- Evidence for WZ production, σ(WZ) at 1.96 TeV, tightest model-independent WWZ AC Limits.

$$\mathrm{CDF}: \sigma(WZ + ZZ) < 15.2\ \mathrm{pb\ \ at\ \ 95\%\ C.L.}$$

$$\mathrm{D0}: \sigma(p\bar{p} \to \mathrm{W}^{\pm}\mathrm{Z}) = 4.5^{+3.5}_{-2.6}\ \mathrm{pb}$$

DØ Preliminary
CDF submitted to PRL

- Wγ production, tightest WWγ AC limits in Had. Coll.

$$\mathrm{D0: sigma}(p\bar{p} \to \mathrm{W}^{\pm}\mathrm{gamma}) = 14.8 \pm 1.6\,(\mathrm{stat.}) \pm 1.0\,(\mathrm{sys.}) \pm 1.0\,(\mathrm{lum.})\ \mathrm{pb}$$
$$\mathrm{CDF}: \quad = 18.1 \pm 3.1\ \mathrm{pb}$$

$$\mathrm{D0}: -0.93 < \Delta\kappa_{\gamma} < 0.97$$
$$-0.22 < \lambda_{\gamma} < 0.22$$

DØ preliminary

- Zγ production, tightest AC Limits in Had. Coll.

$$\mathrm{D0: sigma}(p\bar{p} \to \mathrm{Zgamma}) = 4.2 \pm 0.4\,(\mathrm{stat.+sys.}) \pm 0.3\,(\mathrm{lum.})\ \mathrm{pb}$$
$$\mathrm{CDF}: \quad = 4.6 \pm 0.6\ \mathrm{pb}$$

$$D0: |h^{\gamma}_{30}| < 0.22 \quad |h^{Z}_{30}| < 0.21$$
$$|h^{\gamma}_{40}| < 0.01 \quad |h^{Z}_{40}| < 0.019$$

LEP & DØ Coupling Results

LEP EWK Working Group
hep-ex/0412015

$$-0.105 < \Delta\kappa_\gamma < 0.069$$
$$-0.059 < \lambda_\gamma < 0.026$$
$$-0.051 < \Delta g_1^Z < 0.034$$

$$-0.056 < h_{10}^\gamma < 0.055$$
$$-0.045 < h_{20}^\gamma < 0.025$$
$$-0.049 < h_{30}^\gamma < 0.008$$
$$-0.002 < h_{40}^\lambda < 0.034$$

$$-0.13 < h_{10}^Z < 0.13$$
$$-0.078 < h_{20}^Z < 0.071$$
$$-0.20 < h_{30}^Z < 0.07$$
$$-0.05 < h_{40}^Z < 0.12$$

$$\mathrm{D0}: -0.93 < \Delta\kappa_\gamma < 0.97$$
$$-0.22 < \lambda_\gamma < 0.22$$

1D Limits (holding the other to 0)

$\Lambda = 1.0$ TeV	DØ Preliminary	$\Lambda = 1.5$ GeV
$-0.53 < \lambda_Z < 0.56$		$-0.48 < \lambda_Z < 0.48$
$-0.57 < \Delta g_1^Z < 0.76$	95% C.L.	$-0.49 < \Delta g_1^Z < 0.66$
$-2.0 < \Delta\kappa_Z < 2.4$		-

$$D0: |h_{30}^\gamma| < 0.22$$
$$|h_{40}^\gamma| < 0.019$$

$$|h_{30}^Z| < 0.21$$
$$|h_{40}^Z| < 0.019$$

The Run II Tevatron

Accelerator Improvements: (Main Injector, Recycler, etc.)

- Higher c-of-m energy

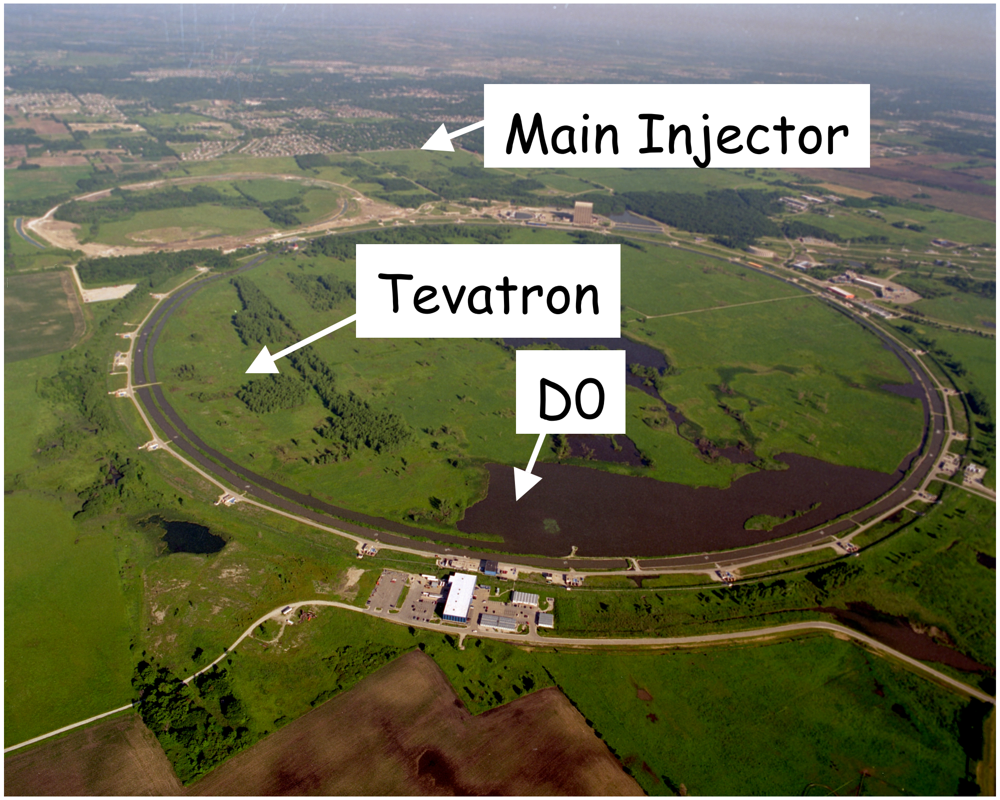
$\sqrt{s}$ = 1.8 TeV → 1.96 TeV

20-30% increase in the SM Higgs cross section

- Higher antiproton intensity

6x6 → 36x36 bunches
3.6 μs → 396 ns

Luminosity: 100 pb^{-1} (Run I)
> 4 fb^{-1} (Run II)



The D0 Detector Upgrade

Added a 2T Magnetic Field

Track p_T, Lepton ID, Jet Calibrations

New Silicon & Fiber Tracking Detectors

Secondary Vertex ID, Tracking

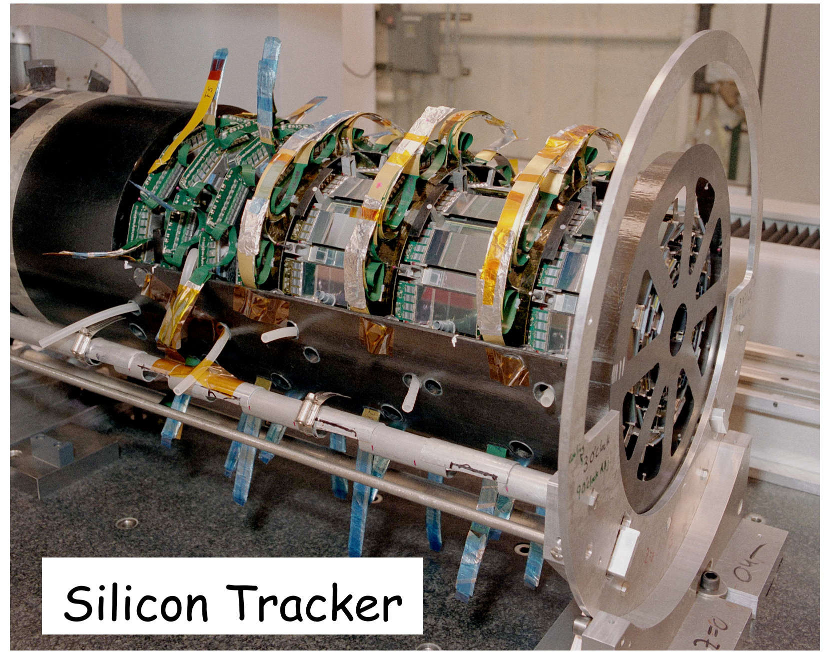
Preshower Detector

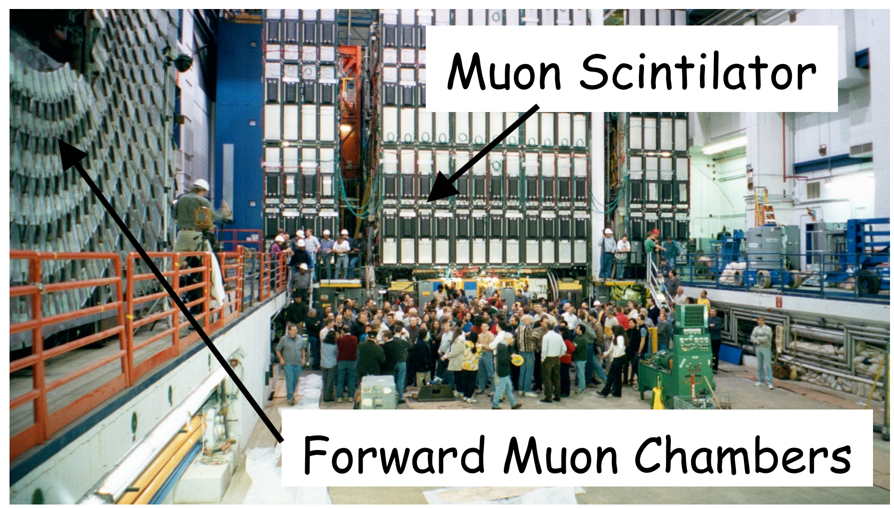
Improved electron ID

Trigger/DAQ Upgrade

Better Efficiency for difficult signals

Finding the Higgs will require all components of the detector





Detector Characteristics

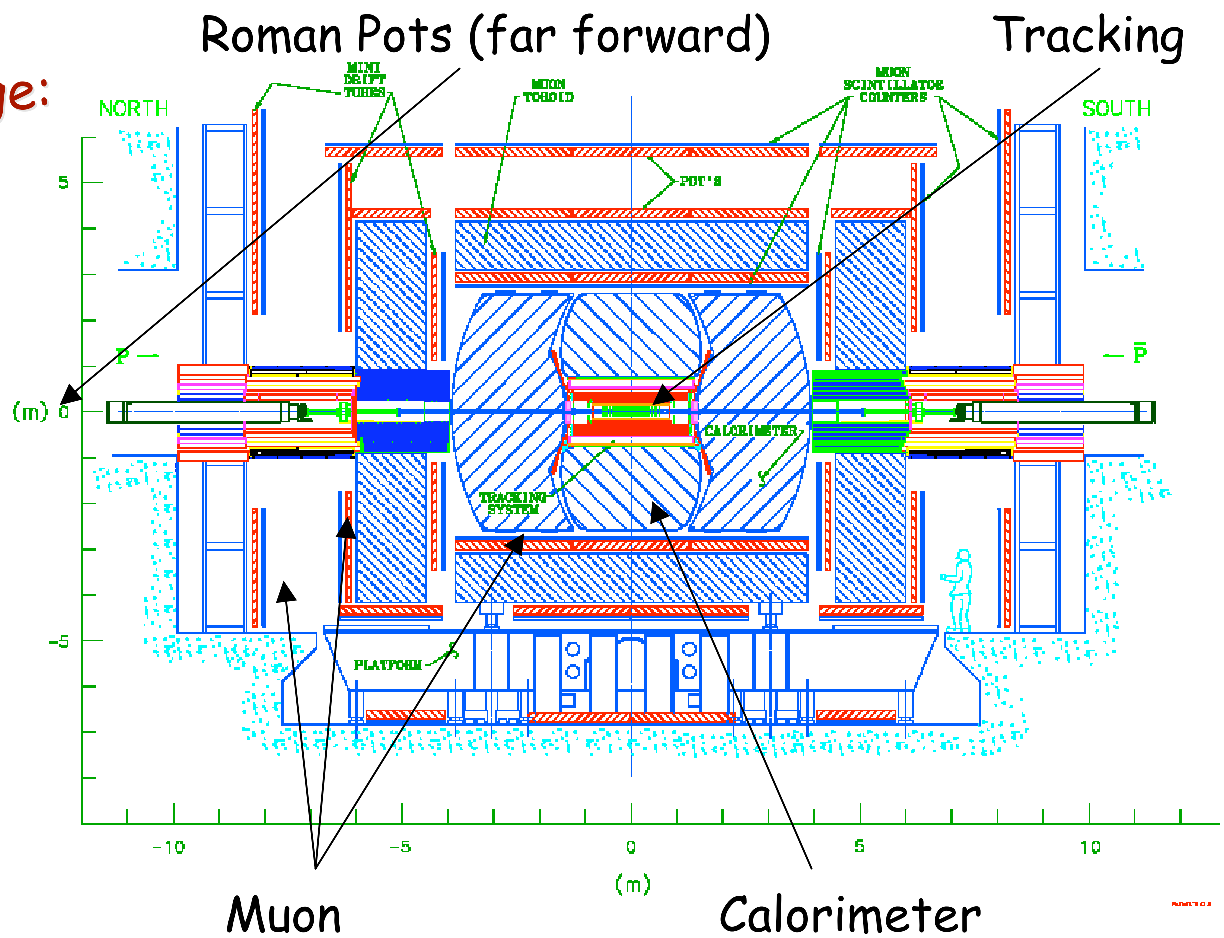
Tracking:

Full SMT & CFT coverage:

$|\eta|<2$

Impact parameter resolution: 15μm

(p_{Ttrk} > 10 GeV)



Calorimetry:

$|\eta|<4$, $\Delta\eta\times\Delta\phi=0.1\times0.1$

EM resol = $15\%/\sqrt{E}$

HAD resol= $50\%/\sqrt{E}$

Muons:

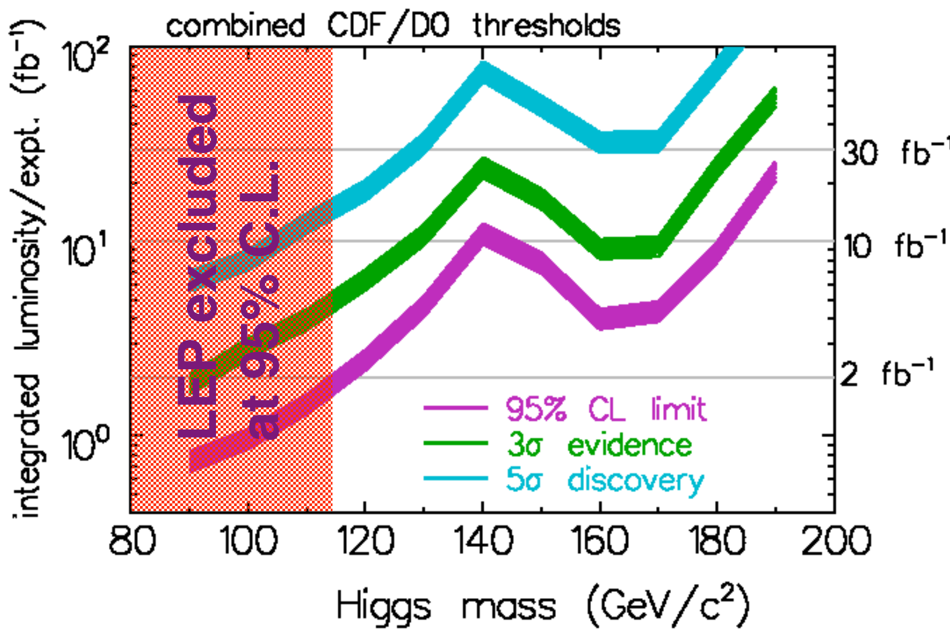
$|\eta|<2$

$\delta p/p = 0.2 \oplus 0.003p$

Higgs Sensitivity Study I

The Higgs discovery potential for Run II was evaluated in 1999, using a parameterized fast detector simulation. (Joint CDF/D0/theorists effort).

- Low mass SM Higgs may be discovered (5σ): i.e. 15 fb^{-1} for a 115 GeV Higgs.
- Assumptions: D0 & CDF data combined, 55% b-tagging efficiency (central region, high p_T), 10% dijet mass resolution.



hep-ph/0010338

Higgs Sensitivity Study II

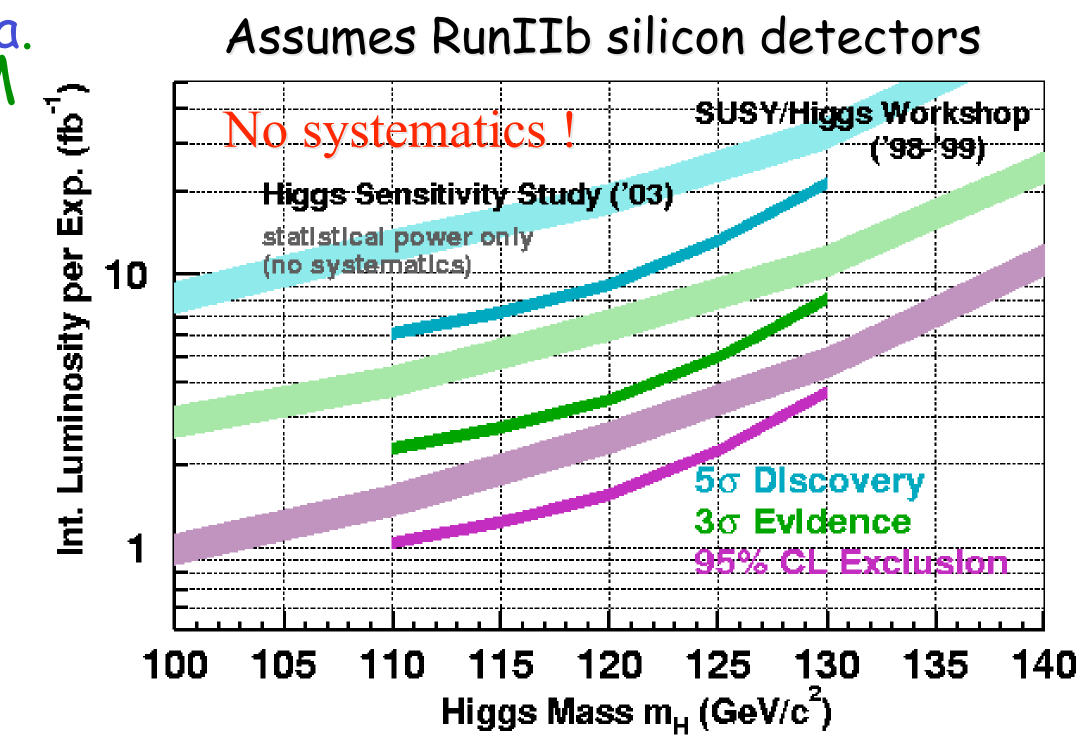
......and re-evaluated in 2003, using a detailed detector simulation and the Run IIa data experience.

Additions: fit the entire m_{bb} distribution, neural network method for background rejection, use QCD background from data.

- Discovery of low mass SM Higgs (5σ) with >8 fb^{-1} for a 115 GeV Higgs (caveat: systematics, RunIIb detectors !).

- Evidence (3σ excess) for M_H= 115 GeV with 3 fb^{-1}

- Exclusion of m_H<130 GeV



Higgs Sensitivity Study II

With Luminosities 3-8 fb^{-1} , the Run II Tevatron will make very important statements about the nature of the Higgs Boson.

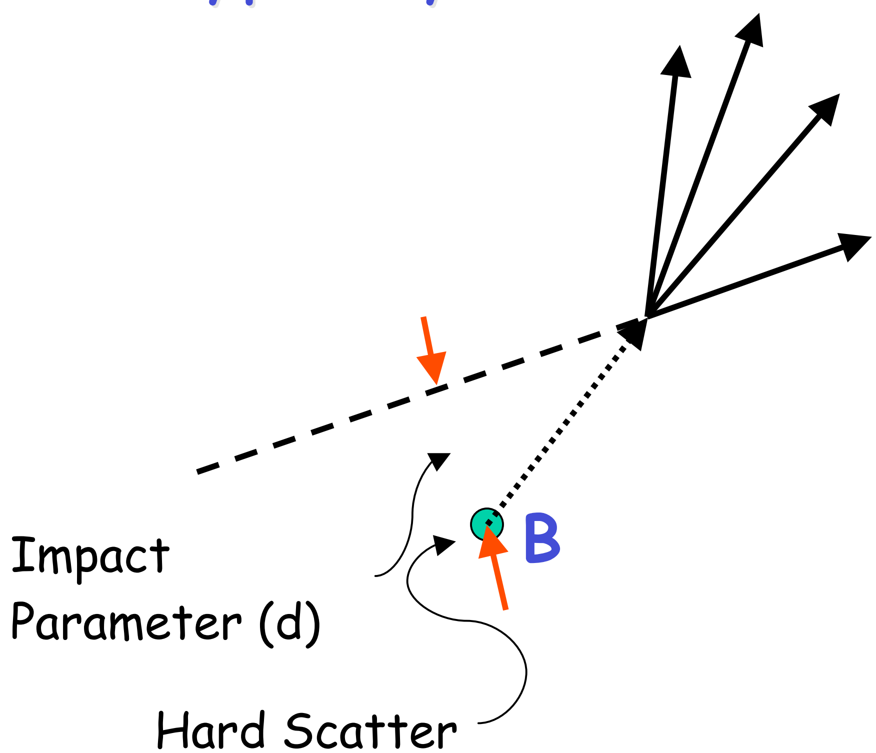
Current TeV performance: **b-jet tagging eff. ~ 40-45%** (encouraging for a 1st of version of our tagging tools !) , M_{bb}~15% (a lot of room for improvement)

(Sources for improvement: better jet calibration, tracking reconstruction, advanced jet algorithms.)

Past experience (LEP, TeV)……we can do better than expected !

b-tagging

Three different algorithms are being developed at D0. Typically based on:



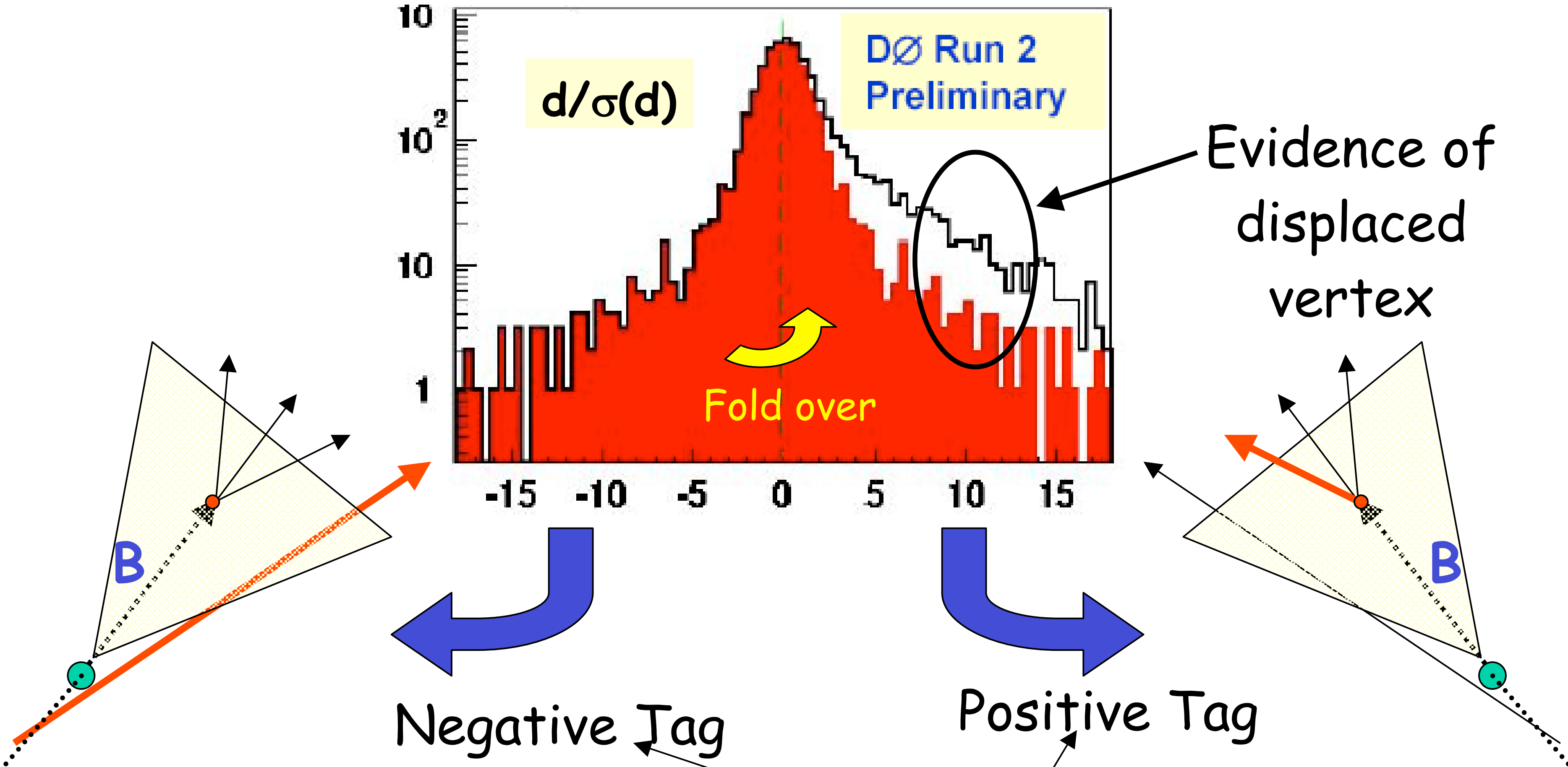
- Higgs contain b-quark jets
- b-quark jet contains a B meson which
  - Has finite life time
  - Travels some distance from the vertex before decaying

Impact Parameter Significance

$$d/\sigma(d)$$

b-tagging

Data enhanced in heavy flavor (high p_{Trel} μ)



Track intersects jet axis before/after the primary vertex