Diboson Production Cross-sections at $\sqrt{s} = 1.96\,\mathrm{TeV}$

Aidan Robson

(University of Oxford and CDF)

on behalf of the CDF and D0 Collaborations

XXXIXth Rencontres de Moriond QCD, La Thuile

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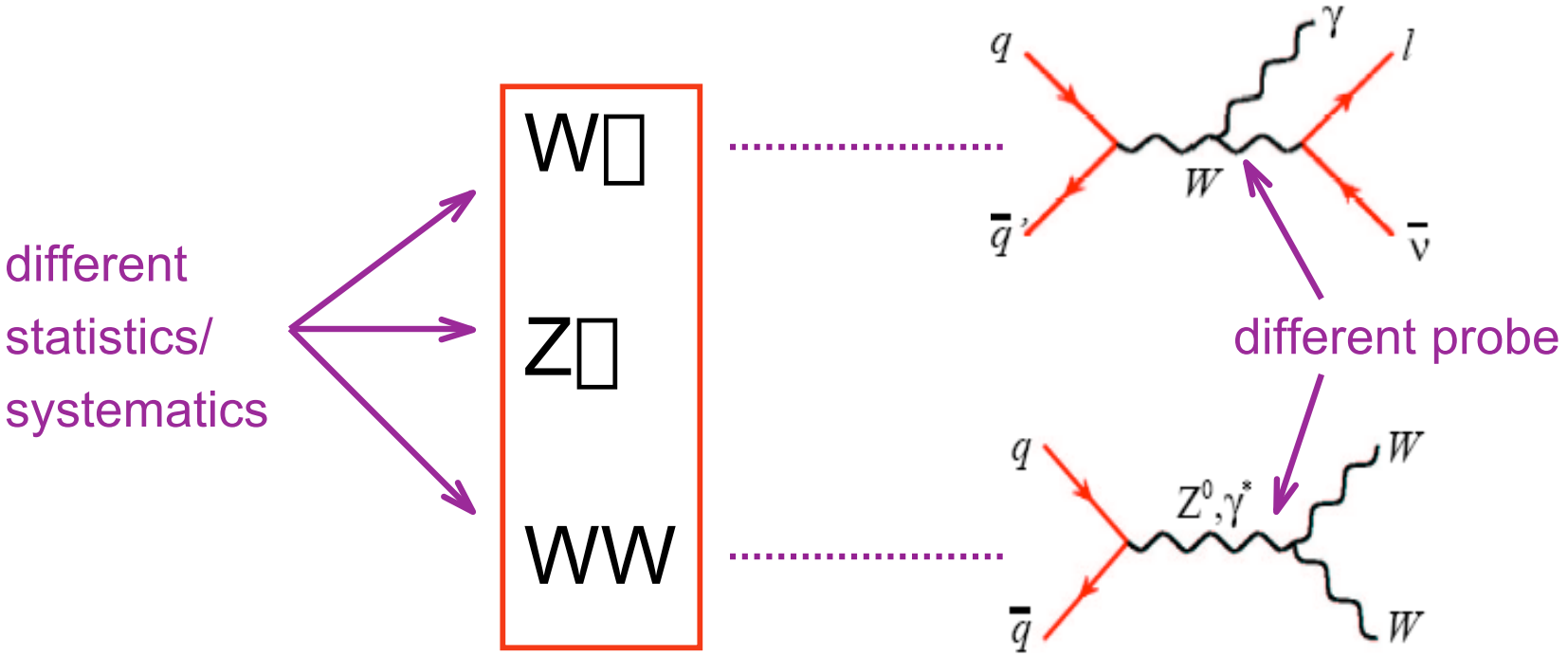
Diboson measurements

Cross-sections … □ … boson self-couplings



probes beyond SM; also important for top, H,…

$\sigma_{W/Z}$ at the Tevatron

$\sigma_{W/Z}$: basis for diboson measurements

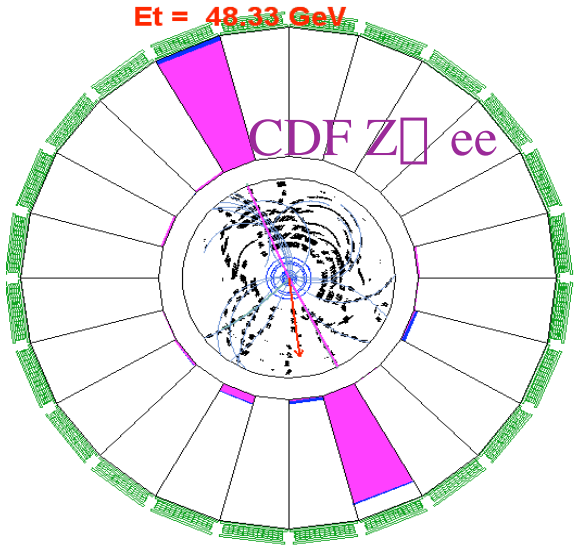
trigger

lepton ID

detector acceptance

$\not\!\!E_T$ resolution

energy scales



$\sigma \cdot Br(W \to e\nu) = 2880 \pm 20_{(stat)} \pm 130_{(sys)} \pm 290_{(lum)}$ pb (D0, 42pb^{-1}, summer 03)

$\sigma \cdot Br(Z \to ee) = 261.8 \pm 5.0_{(stat)} \pm 8.9_{(sys)} \pm 26.2_{(lum)}$ pb (D0, 117pb^{-1}, summer 03)

NNLO $Z^{\ddagger}$: 251 ± 9 pb

NNLO prediction, $W^{\ddagger}$: 2.69 ± 0.01 nb

$\sigma \cdot Br(W \to \ell\nu) = 2777 \pm 10_{(stat)} \pm 52_{(sys)} \pm 167_{(lum)}$ pb (CDF, 72pb^{-1}, winter 04)

$\sigma \cdot Br(Z/\gamma^* \to \ell\ell) = 254.3 \pm 3.3_{(stat)} \pm 4.3_{(sys)} \pm 15.3_{(lum)}$ pb (CDF, 72pb^{-1}, winter 04)

$66 < m_{ll} < 116$ GeV/c^2

NNLO $Z/\gamma^*(66<m_{ll}<116)^{\ddagger}$: 252 ± 9 pb

‡Hamberg et al., Nucl.Phys. B359, 343

Harlander et al., Phys.Rev.Lett. 88, 201801

W□

electron: E_T>25GeV, |□$_e$|<1.1, calor isolation

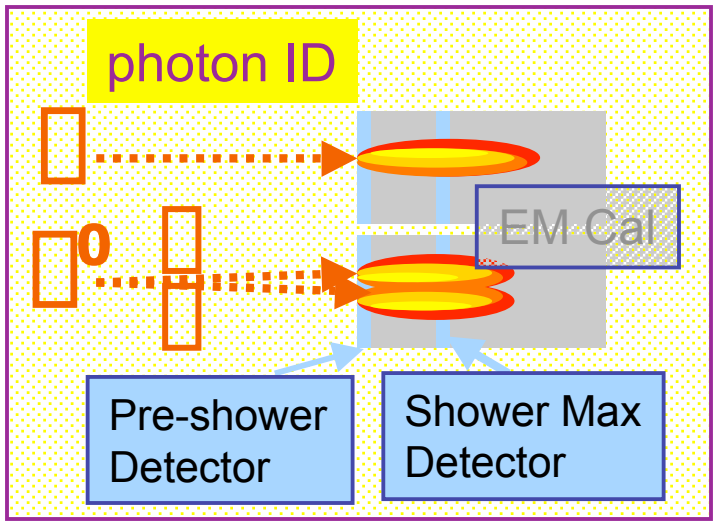
muon: p_T>20GeV/c, |□□|<1.0

extended muon coverage since last summer

$\not\!\!E_T$ >25GeV (e)
$\not\!\!E_T$ >20GeV (□)

photon: E_T>7GeV, □R(□ℓ)>0.7, |□|<1.1, calor and track isolation

fakeable!



electron: E_T>25GeV, |□$_e$|<2.3, calor isolation

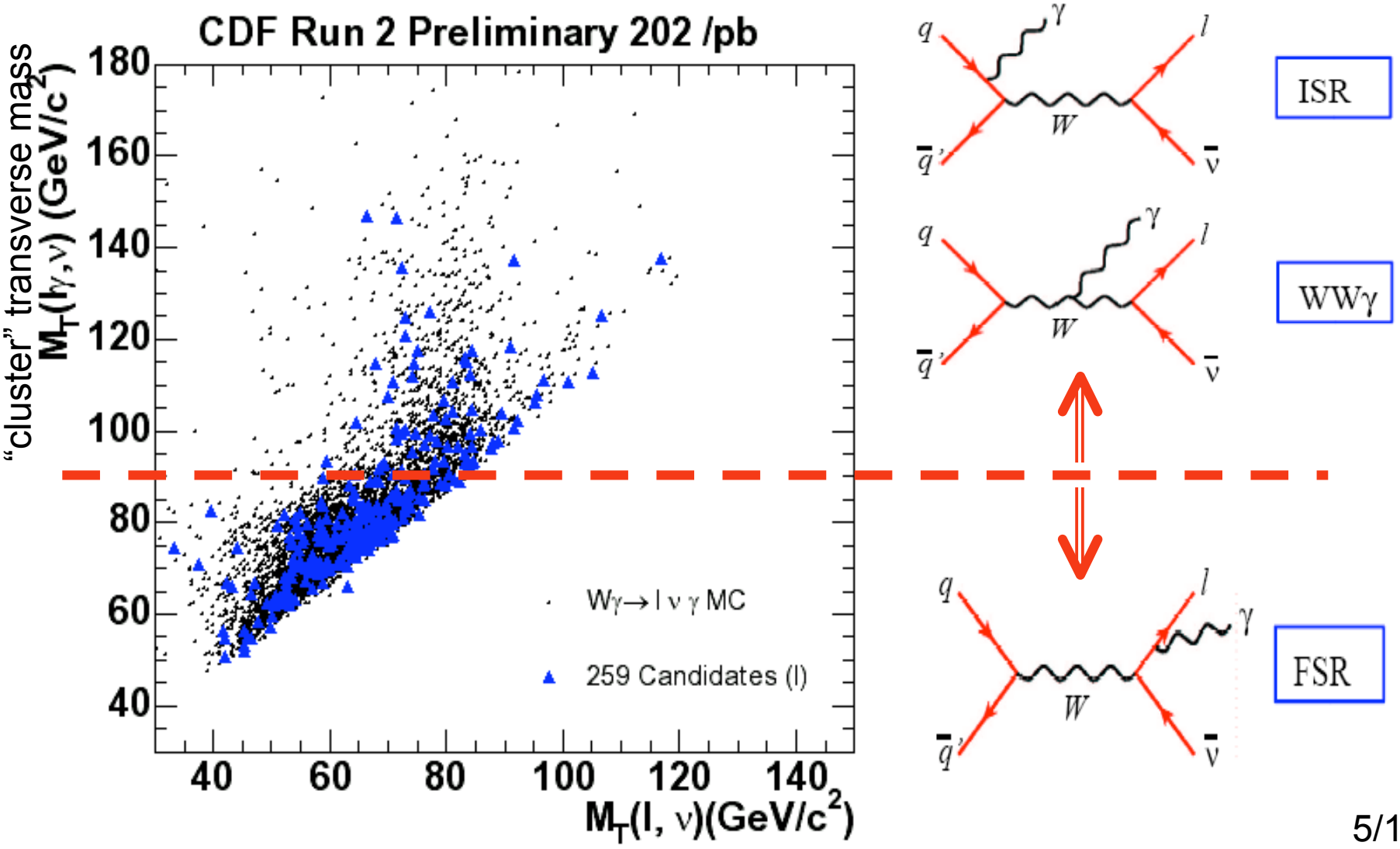
muon: p_T>20GeV/c, |□□|<2.0

new analysis

$\not\!\!E_T$ >25GeV (e)
$\not\!\!E_T$ >20GeV (□)

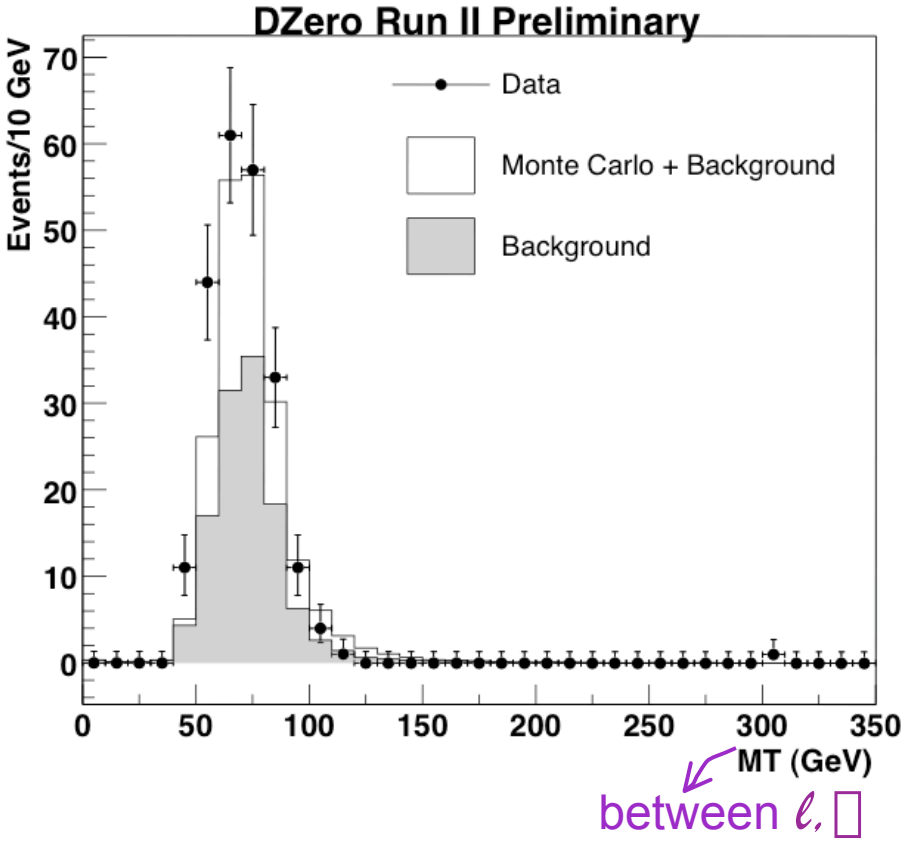
photon: E_T>8GeV, □R(□ℓ)>0.7, |□|<1.1, calor and track isolation

W□


CDF Run 2 Preliminary 202 /pb
"cluster" transverse mass $M_T(l\gamma,\nu)$ (GeV/c^2)
$M_T(l, \nu)$(GeV/c^2)
Wγ→ l ν γ MC
259 Candidates (l)
ISR
WWγ
FSR

W□

D0	N expected (e) (L=162/pb)	N expected (□) (L=82/pb)
W+jet BG	80.0 ± 7.4	31.0 ± 10.0
Z+□	-	4.7 ± 2.0
leX	3.7 ± 0.5	0.6 ± 0.6
W+□(tau)	3.4 ± 1.1	0.9 ± 0.3
Total SM	142 ± 17	67 ± 13
data	146	77



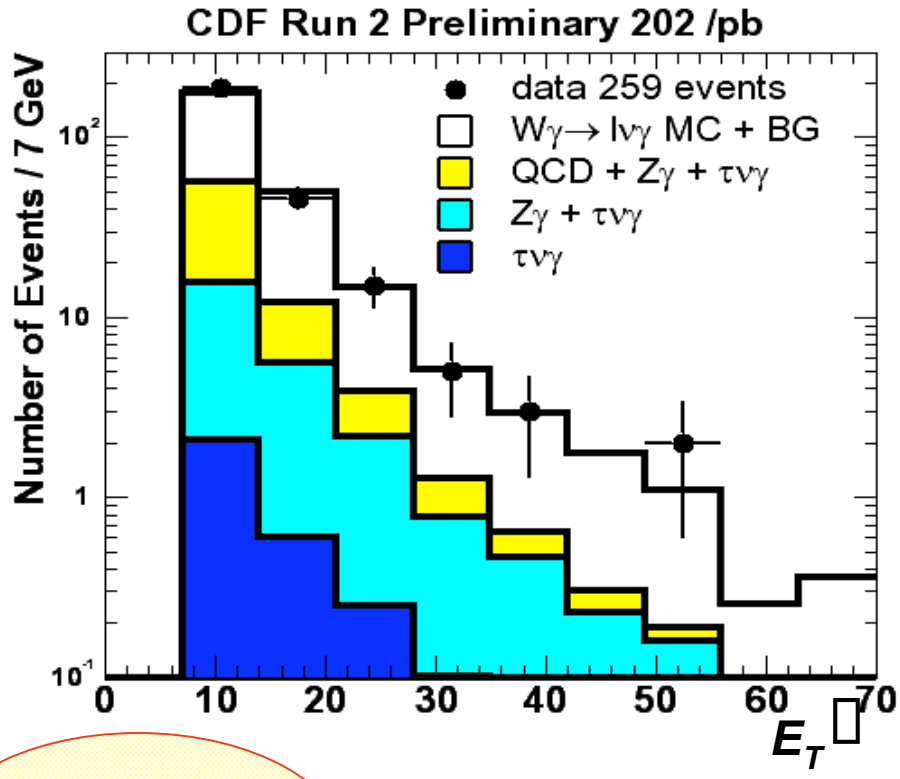
E_T□>8GeV, □R(□ℓ)>0.7

NLO prediction (Baur) = 16.4 ± 0.4 pb

□·Br(W□□ ℓ□□) = 19.3 ± 2.7$_{(stat)}$ ± 6.1$_{(sys)}$ ± 1.2$_{(lum)}$ pb (D0)

W□

CDF	N expected (e+□) (L=202/pb)
W+□MC	180.5 ± 2.1 ± 11.2
W+jet BG	49.5 ± 0.1 ± 15.0
Z+□	22.4 ± 0.4 ± 1.2
W+□(tau)	3.2 ± 0.2 ± 0.2
Total SM	255.6 ± 2.1 ± 26.4
data	259



E_T□>7GeV, □R(□ℓ)>0.7

NLO prediction (Baur) = 19.3 ± 1.4 pb

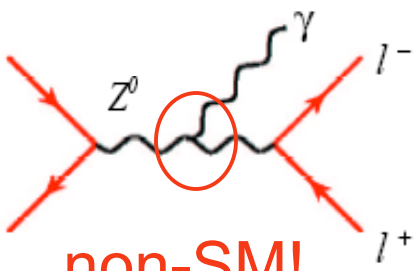
Run I results for E_T^{ℓ}>25, E_T□>25, $\not\!\!E_T$>25, no m_T cut

	Data	SM exp
e + □	16	7.6

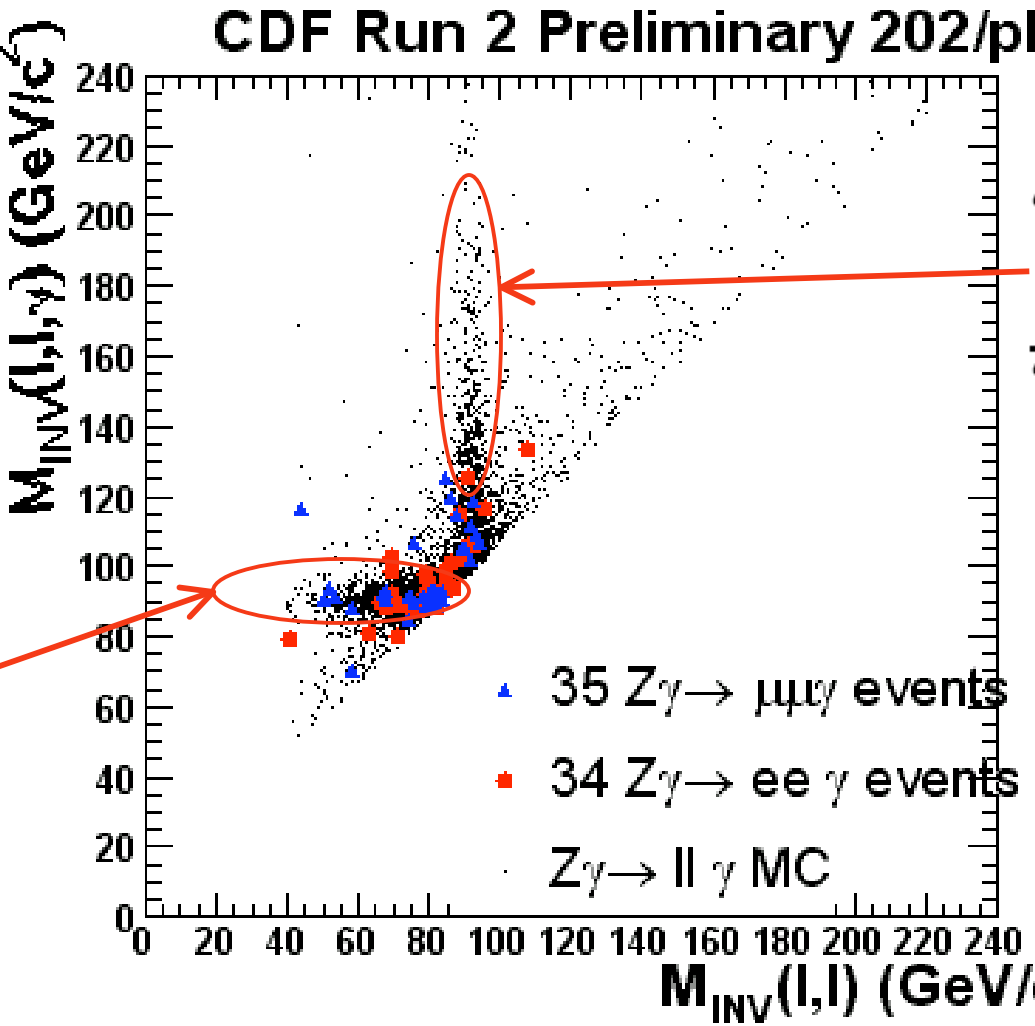
Phys. Rev. Lett. 89, 041802 (2002)

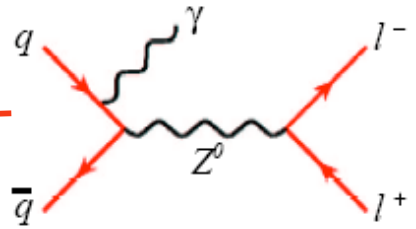
□·Br(W□□ ℓ□□) = 19.7 ± 1.7$_{(stat)}$ ± 2.0$_{(sys)}$ ± 1.1$_{(lum)}$ pb (CDF)

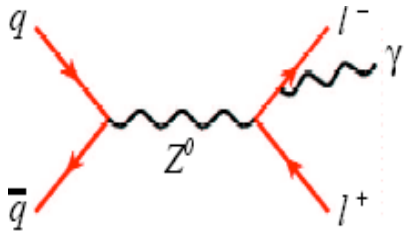
Z□


γ
Z^0
l^-
l^+

non-SM!


CDF Run 2 Preliminary 202/pb
$M_{INV}(l,l,\gamma)$ (GeV/c^2)
$M_{INV}(l,l)$ (GeV/c^2)
35 Zγ→ μμγ events
34 Zγ→ ee γ events
Zγ→ ll γ MC
0
20
40
60
80
100
120
140
160
180
200
220
240


q
γ
l^-
Z^0
$\bar{q}$
l^+


q
l^-
γ
Z^0
$\bar{q}$
l^+

Z□

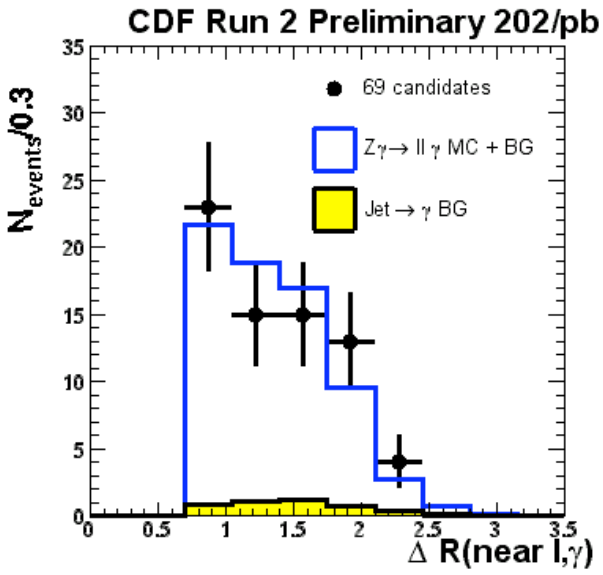
CDF (e+□)	N expected
Z+□MC	65.8 ± 3.8
Z+jet BG	4.4 ± 1.3
Fake Z+□	0.3 ± 0.2
Total SM	70.5 ± 4.0
data	69

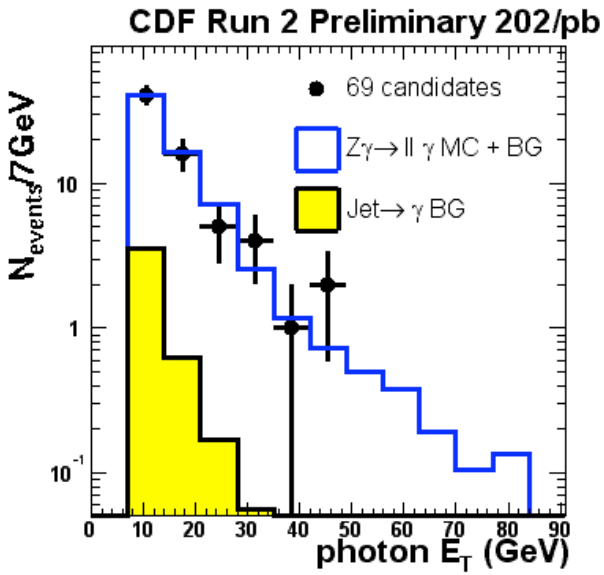
small bg!

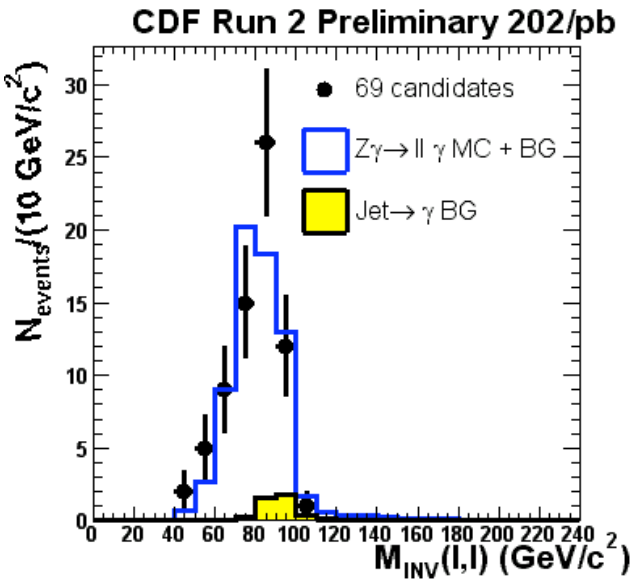
□·Br(Z□□ ℓℓ□) = 5.3 ± 0.6$_{(stat)}$ ± 0.3$_{(sys)}$ ± 0.3$_{(lum)}$ pb (CDF)

NLO prediction (Baur) = 5.4 ± 0.3 pb

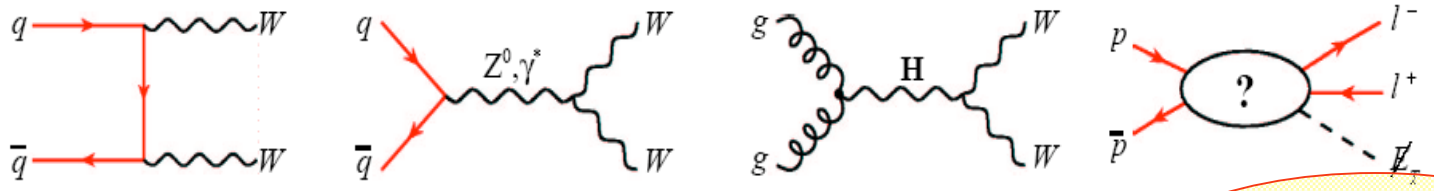
Extended □ coverage; 2nd electron may be forward, |□|<2.6







WW



New $\not\!\!E_T$ significance to recover events in Z mass window

extended coverage

"tight leptons": high purity

- 2 OS leptons + $\not\!\!E_T$ + no jet E_T>15GeV

2 CDF analyses

new analysis

"lepton+track": open acceptance

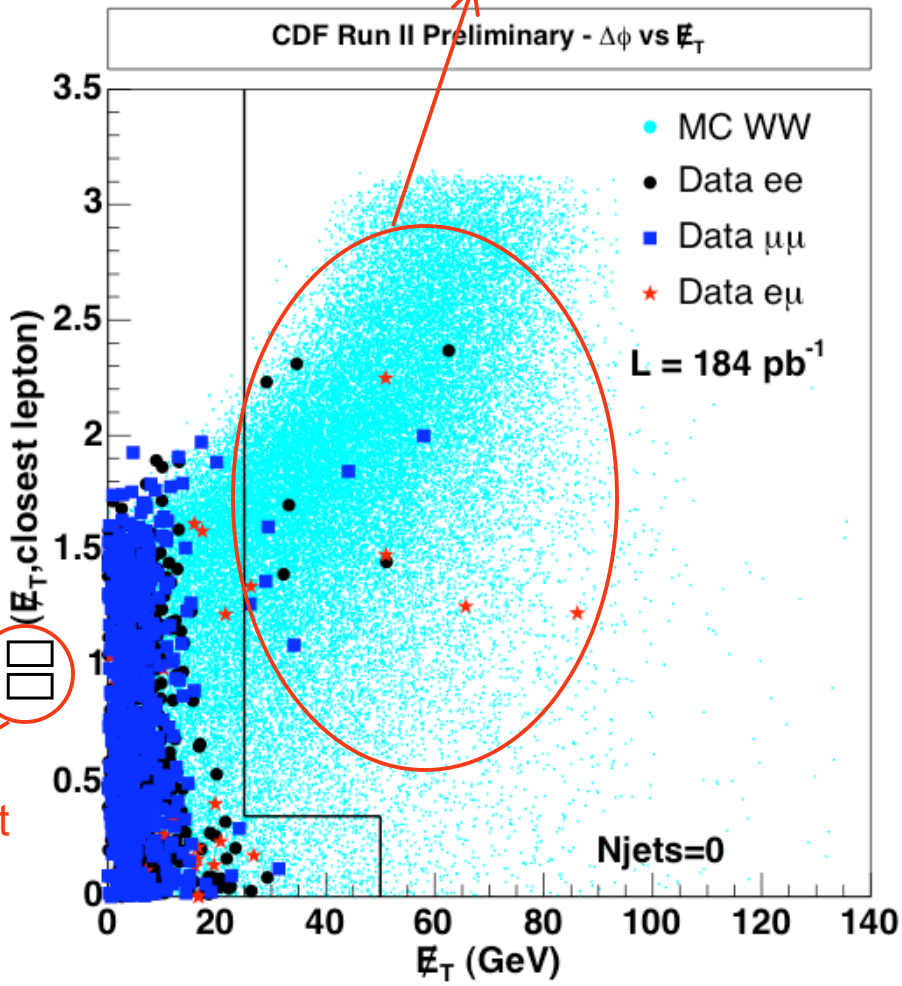
- 1 lepton + 1 high p_T track, OS + $\not\!\!E_T$ + N jets ≥ 1

WW

CDF N expected	"lepton+track" <2 jet bin	"tight leptons" 0 jet bin
WW sig MC	16.3 ± 0.4	11.3 ± 1.3
DY	1.8 ± 0.3	1.1 ± 0.4
WZ+ZZ+W	2.4 ± 0.1	1.8 ± 0.2
top	1.8 ± 0.1	0.05 ± 0.02
fakes	9.1 ± 0.8	1.1 ± 0.5
Total bkg	15.1 ± 0.9	4.8 ± 0.7
Total pred	31.5 ± 1.0	16.1 ± 1.6
observed	**39**	**17**

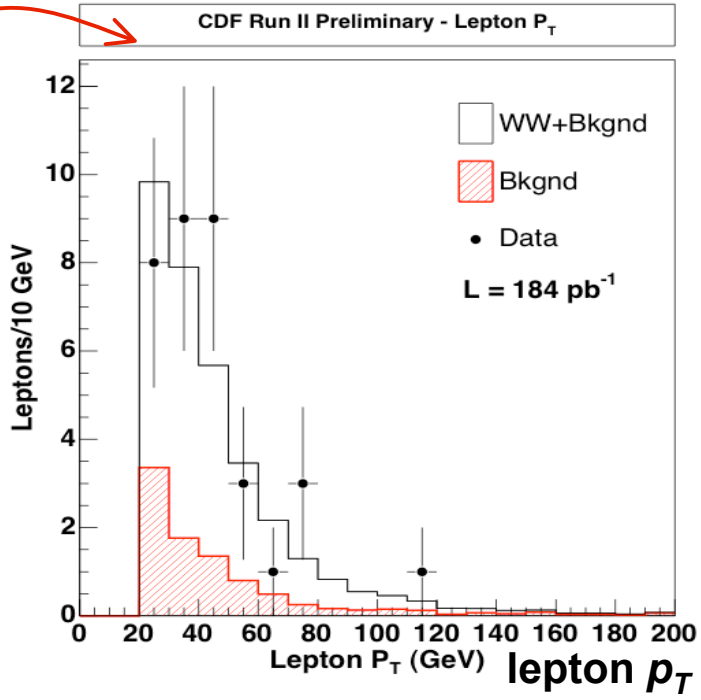
signal, "tight leptons"

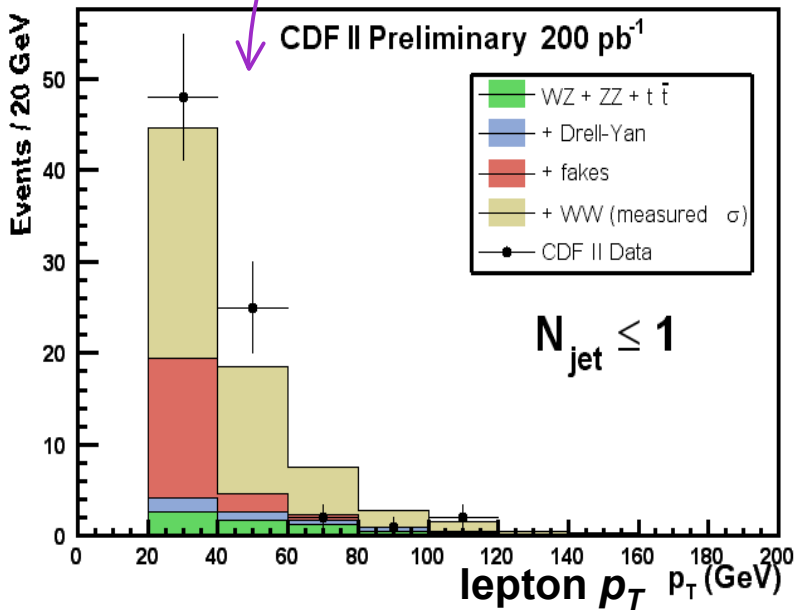
small mismeasurement



WW

CDF	lepton+track	tight leptons
N(background)	15.1 ± 0.9	4.81 ± 0.70
N(WW signal)	16.3 ± 0.4	11.3 ± 1.3
S/B	~1.1	~2.3
data	39	17





□·Br(pp̄ □ WW) =

=14.2 $^{+5.6}_{-4.9(stat)}$ ± $1.6_{(sys)}$ ± $0.9_{(lum)}$ pb

(CDF, tight e/□)

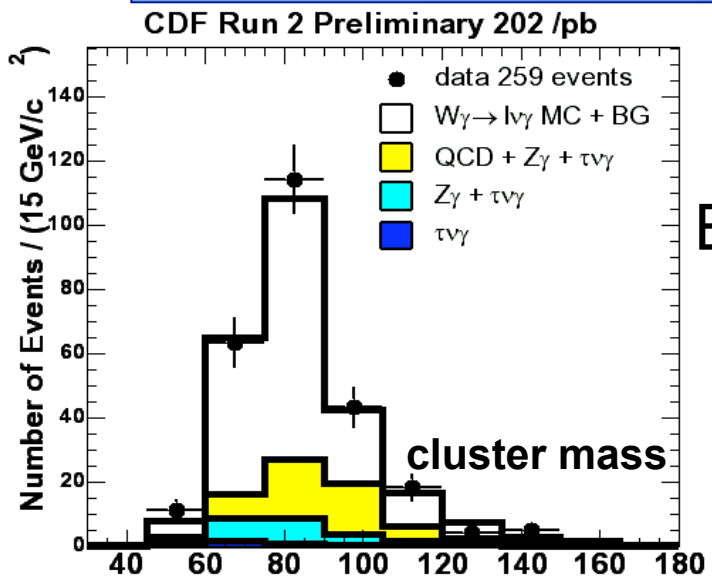
=19.4 ± $5.1_{(stat)}$ ± $3.5_{(sys)}$ ± $1.2_{(lum)}$ pb

(CDF, ℓ+track)

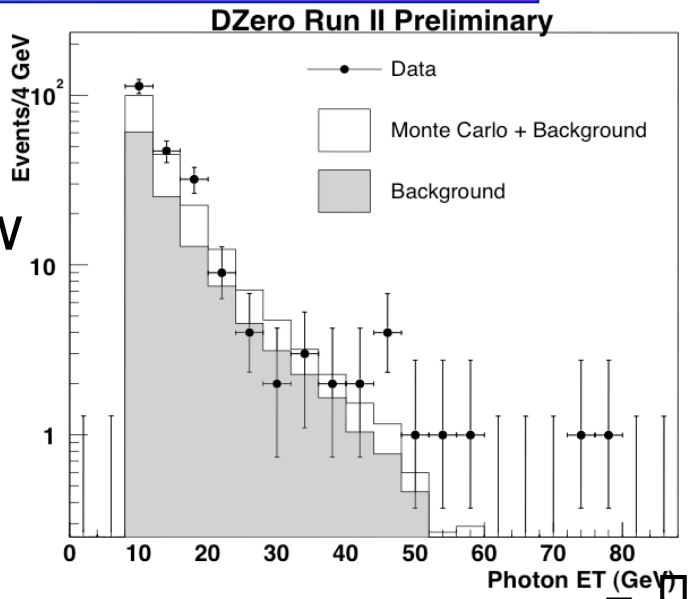
NLO prediction‡ = 12.5 ± 0.8 pb

‡J.M.Campbell, R.K.Ellis, Phys.Rev. D60: 113006,1999, hep-ph/9905386

Anomalous Coupling Limits



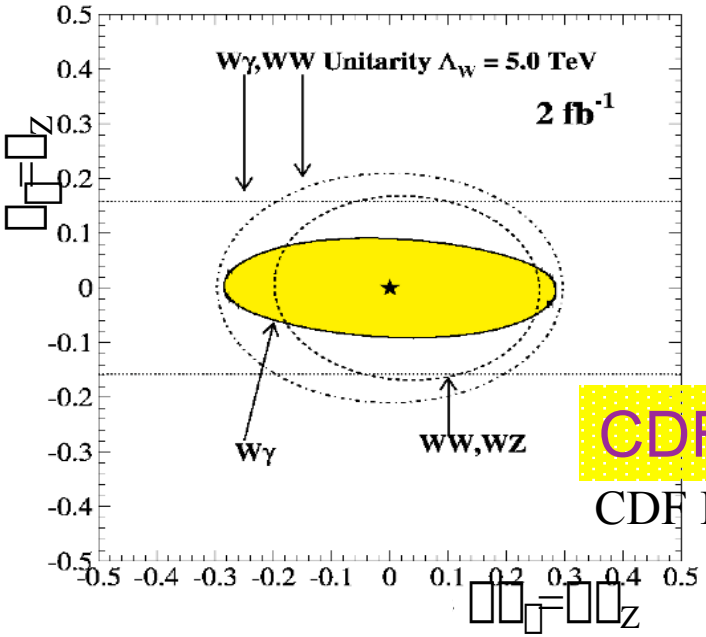
Extraction to follow



E_T

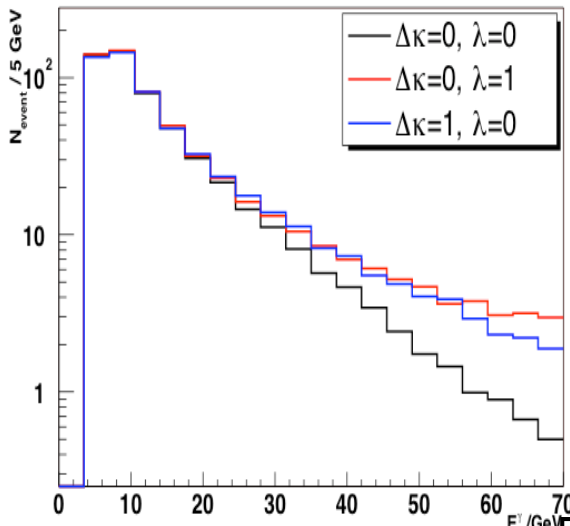
LEP limits:

	95% CL
g_1^Z	[0.949,1.034]
κ_γ	[0.895,1.069]
λ_γ	[-0.059, 0.026]



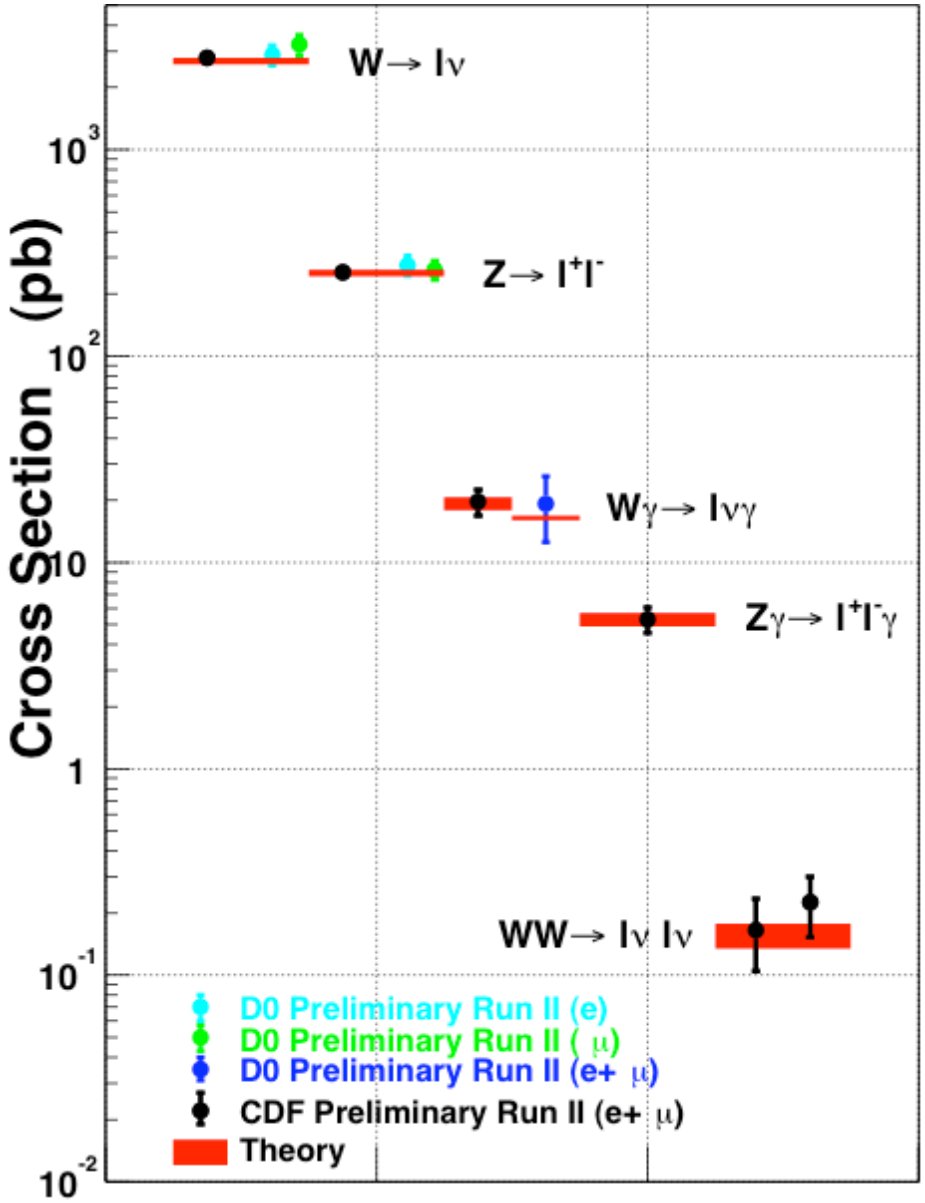
CDF projection

CDF II TDR, 1996



E_T

Outlook



Electroweak measurements setting the standard for lepton ID, detector and background understanding

Diboson cross-sections becoming precise measurements; anomalous coupling extraction will follow