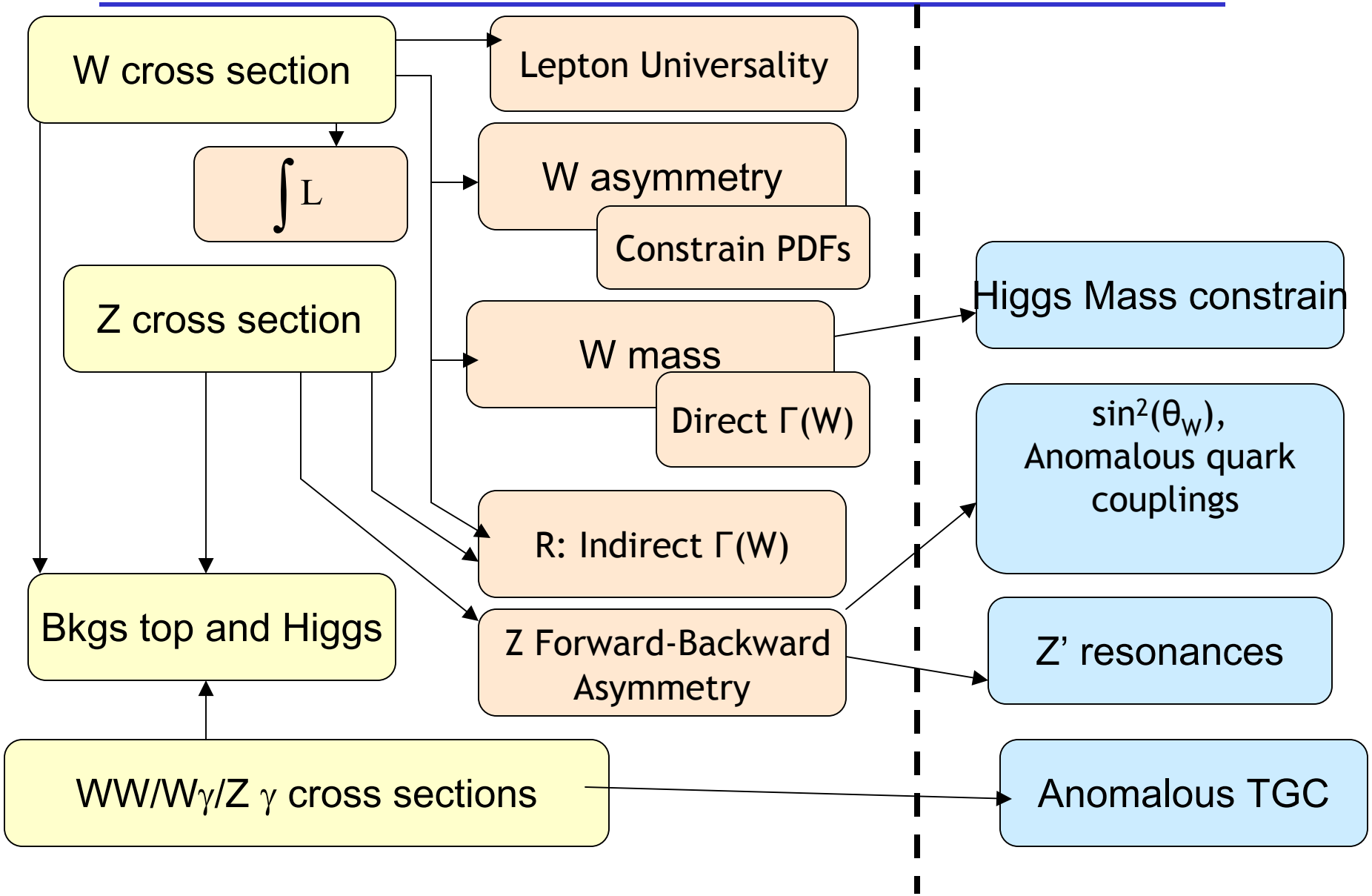
Electroweak results at the Tevatron

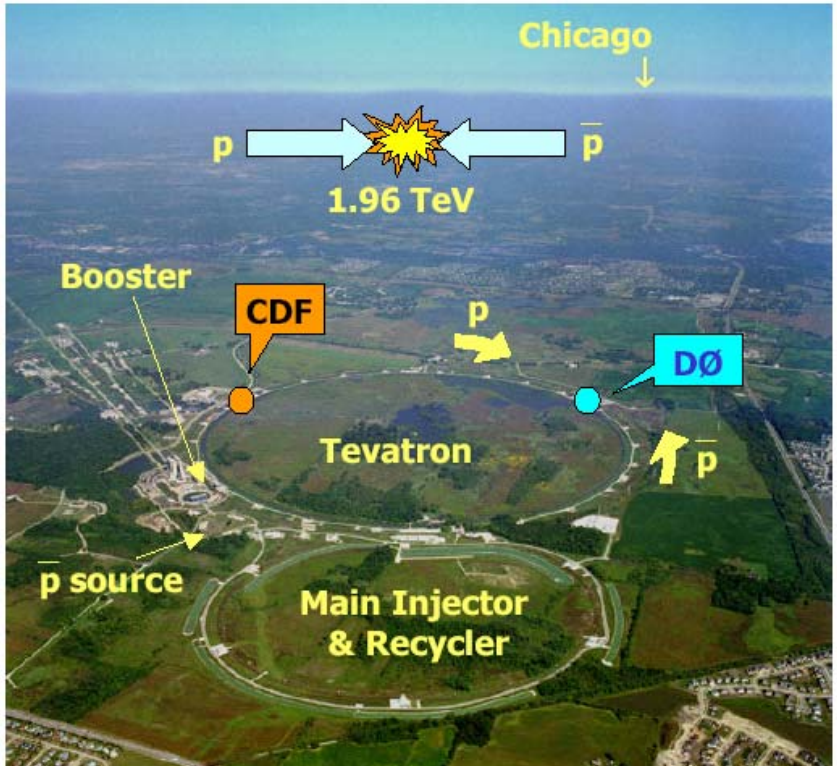
Susana Cabrera for the CDF and D0 collaborations

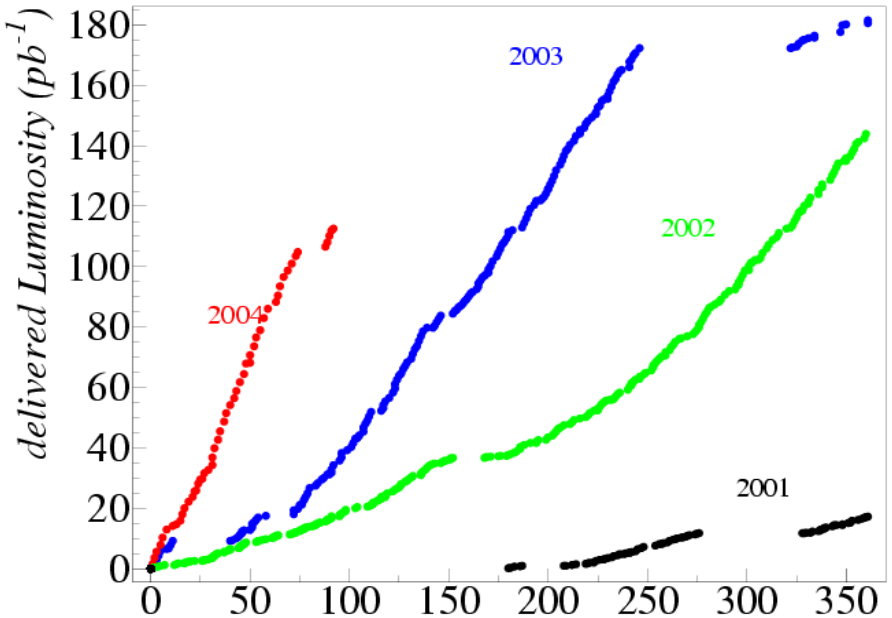
XXIIth International Workshop on Deep-Inelastic Scattering

Electroweak Physics at Run II and Beyond SM



TheTevatron collider in Run 2





•Tevatron is a proton-antiproton collider operating with E_{beam}=980 GeV

$$\sqrt{s} = 1.96\text{TeV} \quad \text{RunII (1.8TeV RunI)}$$

•36 p and p bunches →396 ns between bunch crossing.

•Increased instantaneous luminosity:

•Typical(moving target): 4-5 x 10^{31} cm^{-2} s^{-1}

•Record: ~7.2 x 10^{31} cm^{-2} s^{-1}

•Tevatron has delivered in total ~450 pb^{-1}

•Medium term: FY2003

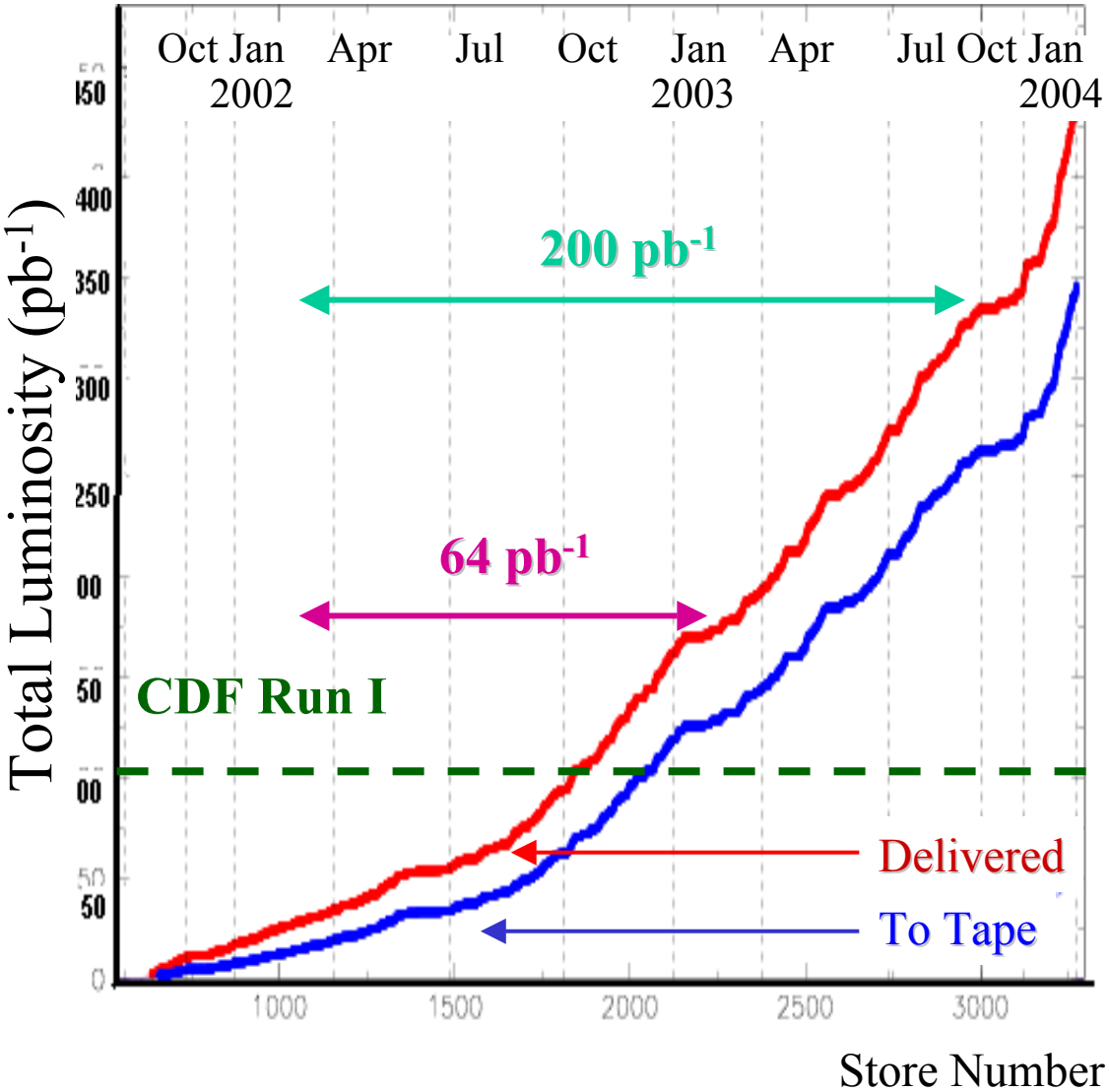
•Base goal: 230 pb^{-1} Design: 310 pb^{-1}

•Long term, by the end of FY09

•Base goal: 4.4 fb^{-1} Design: 8.5 fb^{-1}

Run II Luminosity:CDF

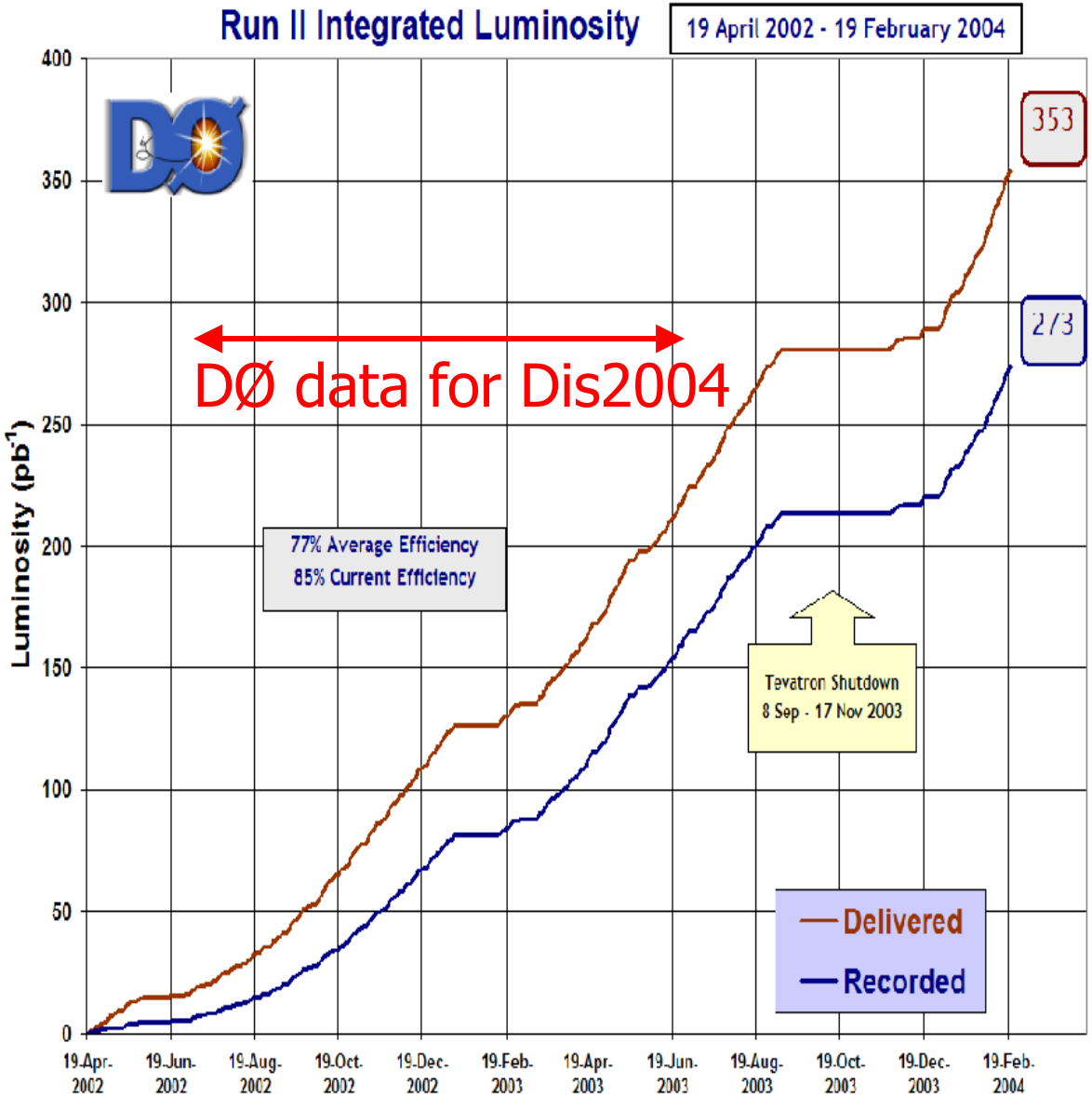
- ~350pb^{-1} on tape.
- Data taking efficiency > 80%
- Dead time typically <5%
- $\delta\mathcal{L}$ ~ 6% (from σ_{inel}& acceptance systematic)
- **Physics** Analyses:
  - Between 64 and 200 pb^{-1} taken Mar 2002 – Sep 200



Run II Luminosity:DØ

- DØ has ~273pb^{-1} on tape.
- Data taking efficiency around 85% with full detector readout.
- $\delta\mathcal{L}$ ~ 6.5% (from σ_{inel})
  - $\delta\mathcal{L}$ ~ 10% (2003 results)

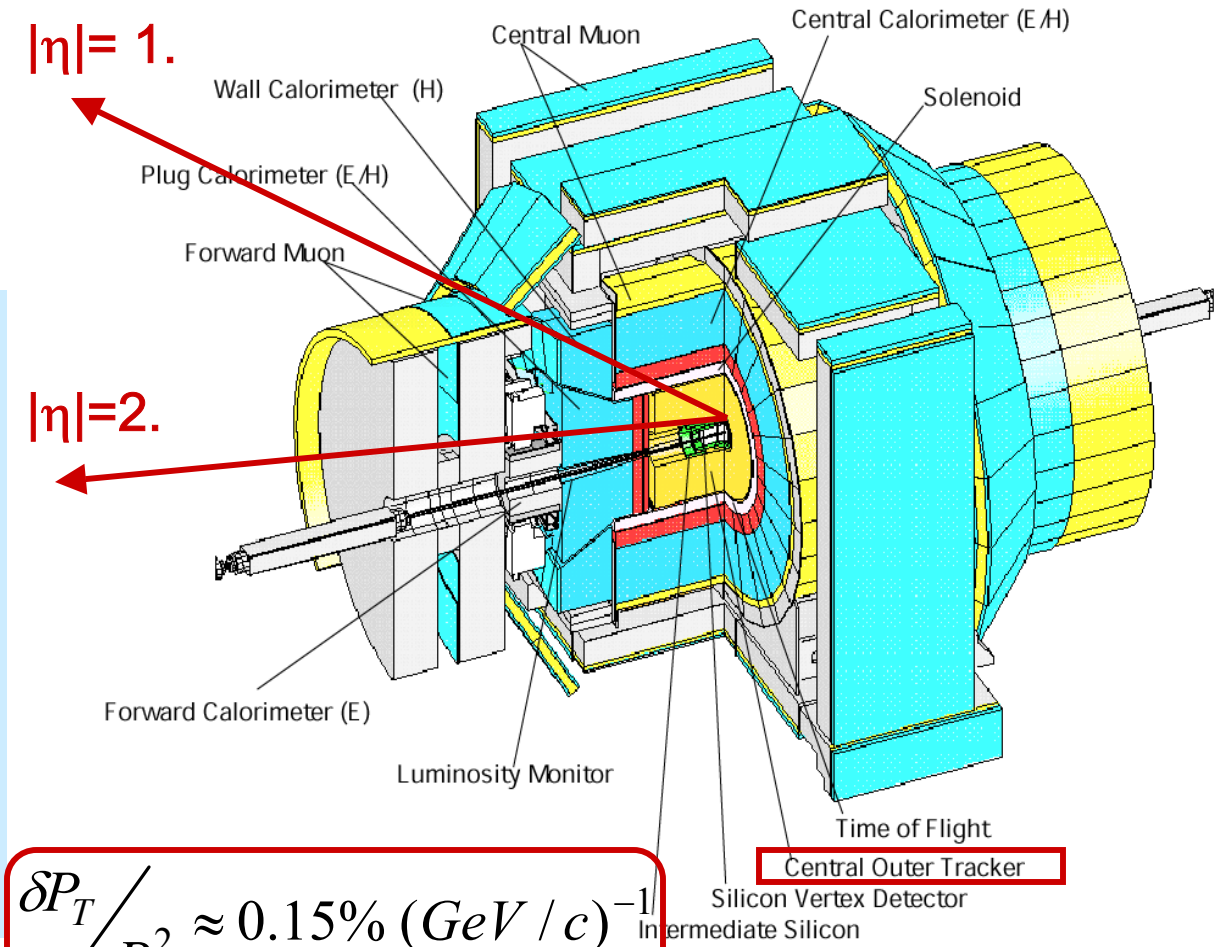
➡Between 14 and 160 pb^{-1} taken July 2002 – Sep 2003



CDF Run II Detector

From Run I:
- Solenoid
- Central muon system
- Central calorimeter

New For Run II:
- Front-end DAQ
- Trigger:Track (L1) and Displaced Track (L2)
- Silicon Tracker (8 Layers) ($|\eta| < 2.0$)
- Central Outer Tracker ($|\eta| < 1.0$)
- Plug Calorimeters ($1.0 < |\eta| < 3.6$)
- Extended Muon Coverage ($|\eta| < 1.5$, gaps filled in)



$$\frac{\delta P_T}{P_T^2} \approx 0.15\% \, (GeV/c)^{-1}$$

e & μ at CDF Run II

Central e: $|\eta|<1.2$

Et>20-25 GeV

EM cluster + Drift chamber track,Pt>10 GeV

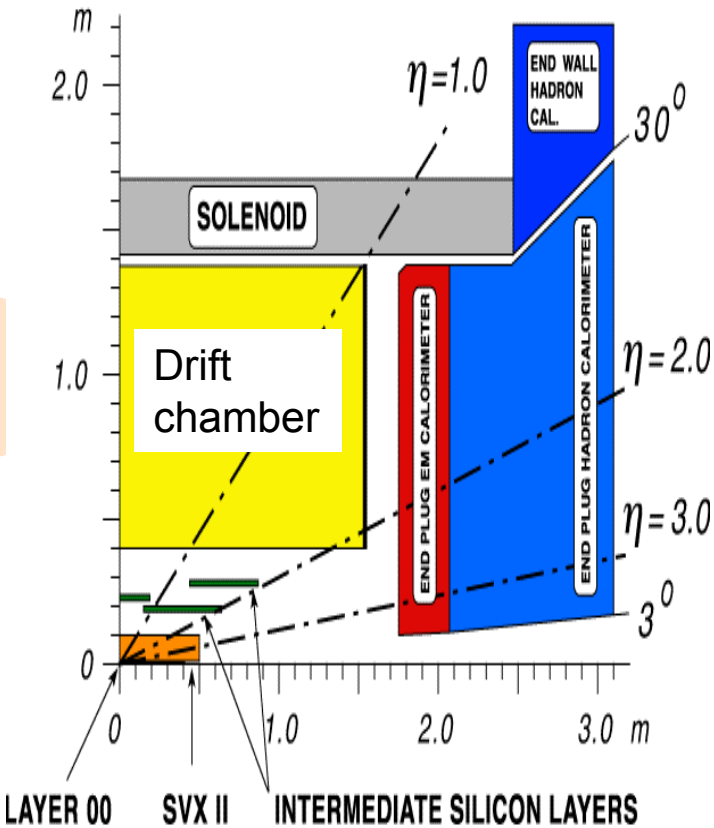
Plug e: $1.2<|\eta|<2.0$-2.8

EM cluster (+ Silicon track)

εmeasured with Z→ee

Trigger ε: 100%, Et>30 GeV

ID ε : >[80-94]%



Loose μ:

High Pt isolated track pointing to a gap in the μ- coverage $|\eta|<1.2$

MIP requirements.

Tight μ :

pointing to a μ -stub $|\eta|<1$.

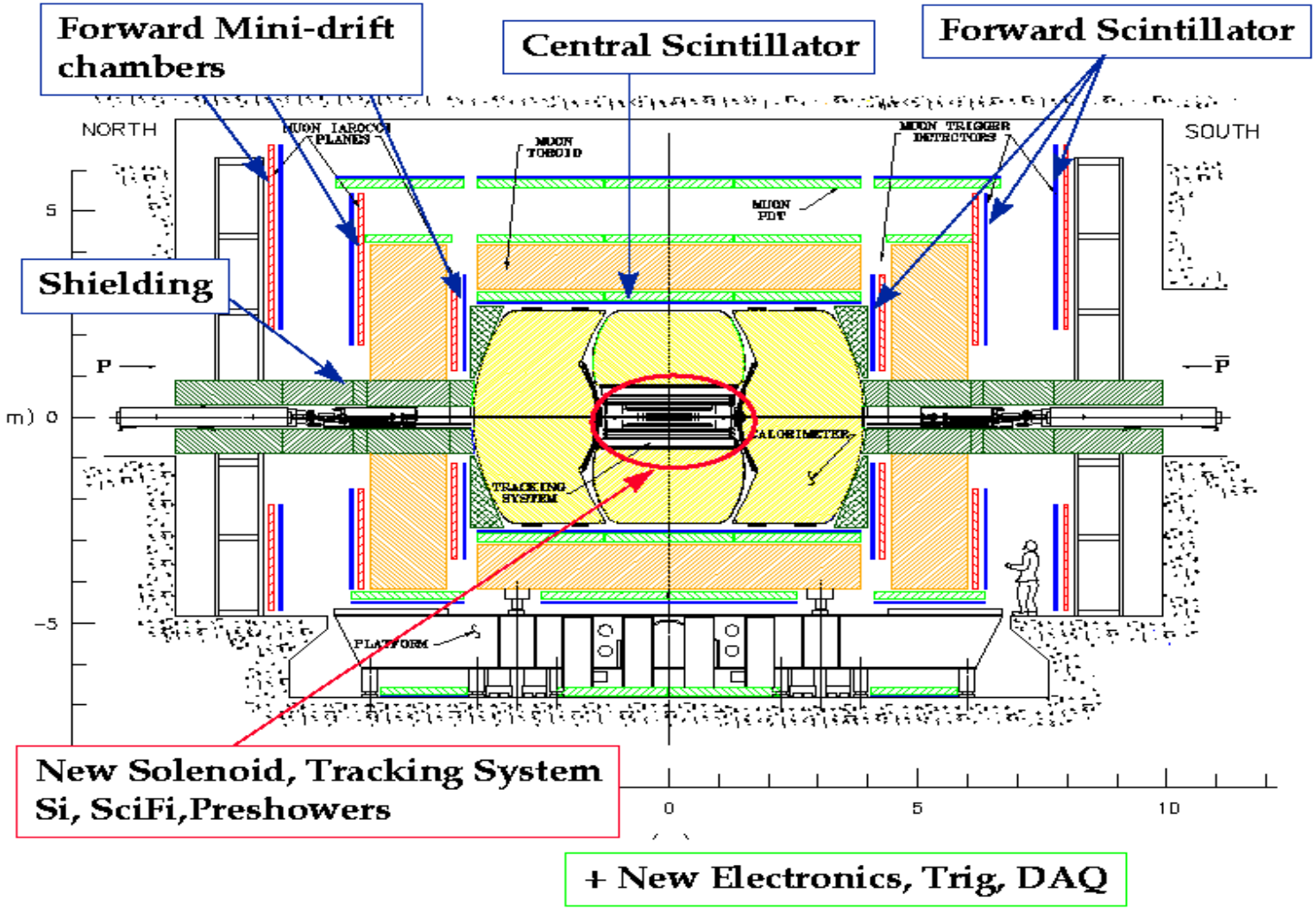
ε measured with Z→μ μ

Trigger ε: 88%-95%

ID ε : 85%-90%

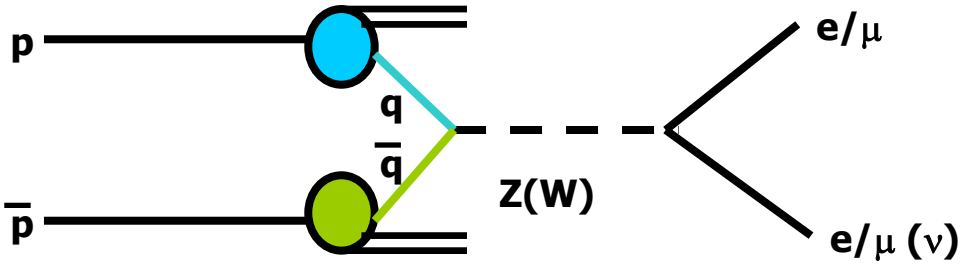
- e&μ mis-identification probability measured with dijet events
- Veto cosmics using timing information and track information.
- Veto μ from jets (mostly b) using calorimeter-Iso and track-Iso

Overview of DØ Detector



- Excellent calorimetry, hermetic detector.
- Upgraded μ system for better μ -ID

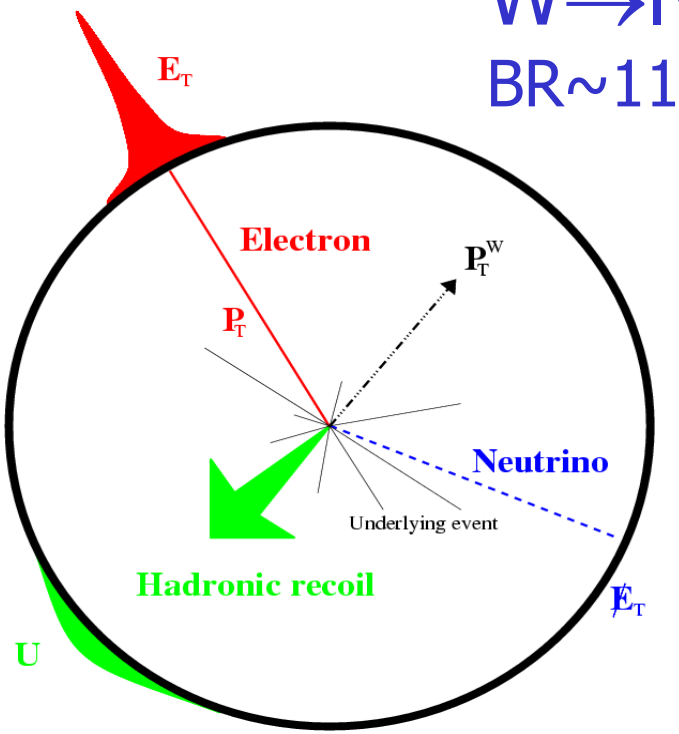
W/Z Physics at the Tevatron.



- W/Z production: qq dominated.
- RunII: millions of Ws and 100ks of Zs.
- Leptonic decay modes to avoid high QCD background

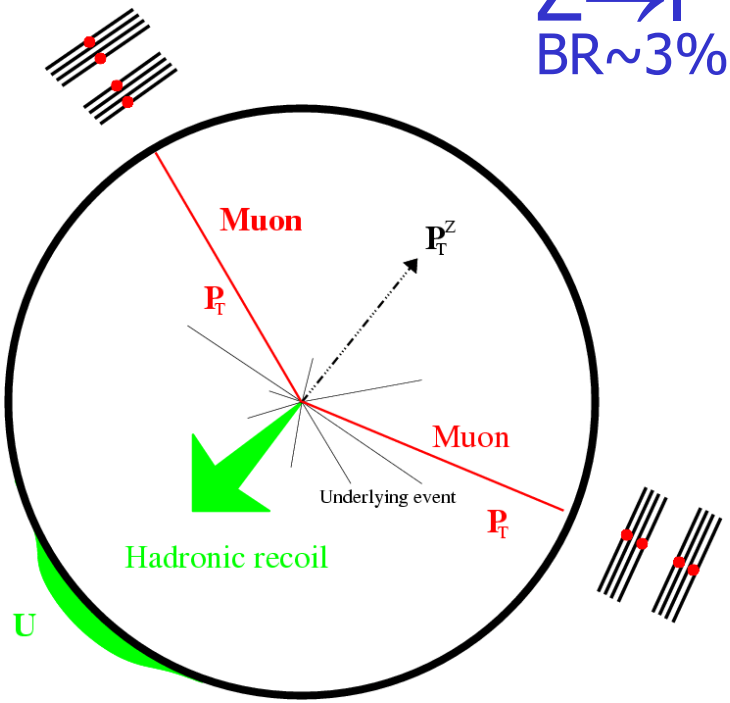
$W \rightarrow l\nu$

BR~11%



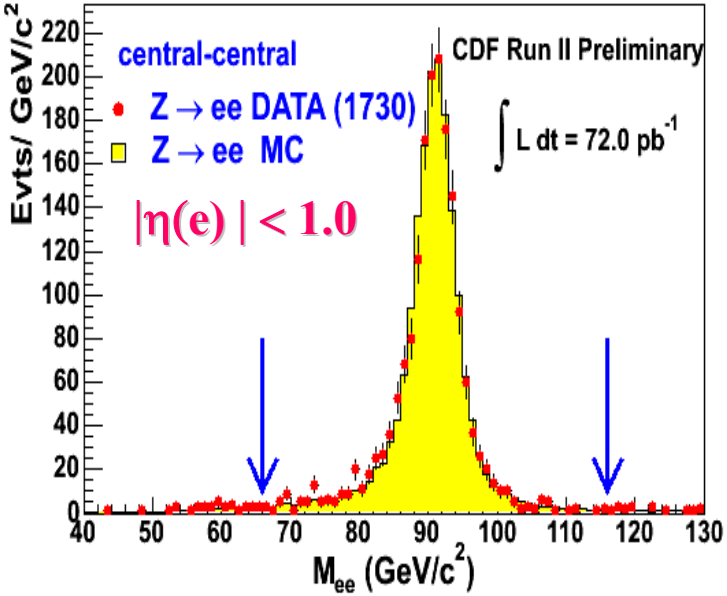
$Z \rightarrow l^+l^-$

BR~3%

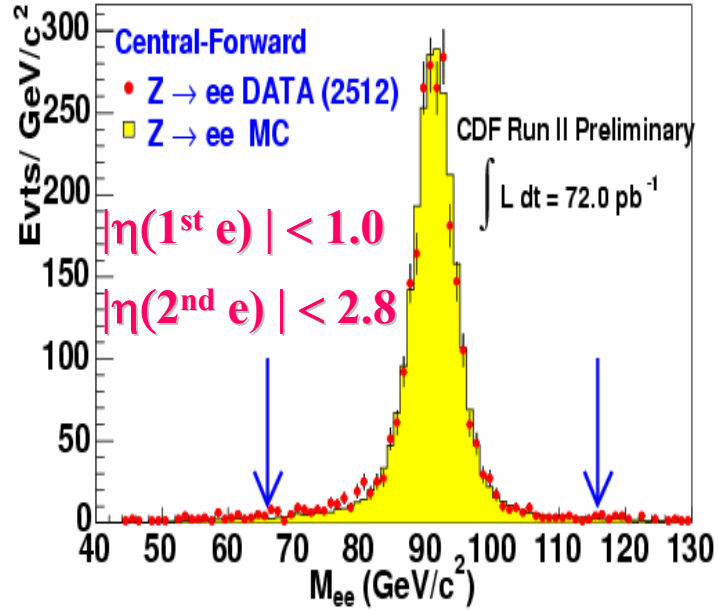


L~ 72pb^{-1}

CDF $\sigma \times BR(Z \rightarrow e^+e^-)$



Extended coverage in the forward $|\eta| < 2.8$



Number of candidates		A x ε
$Z/\gamma^* \rightarrow e^+ e^-$ CC	1730	(22.74 ± 0.48)%
$Z/\gamma^* \rightarrow e^+ e^-$ CP	2512	

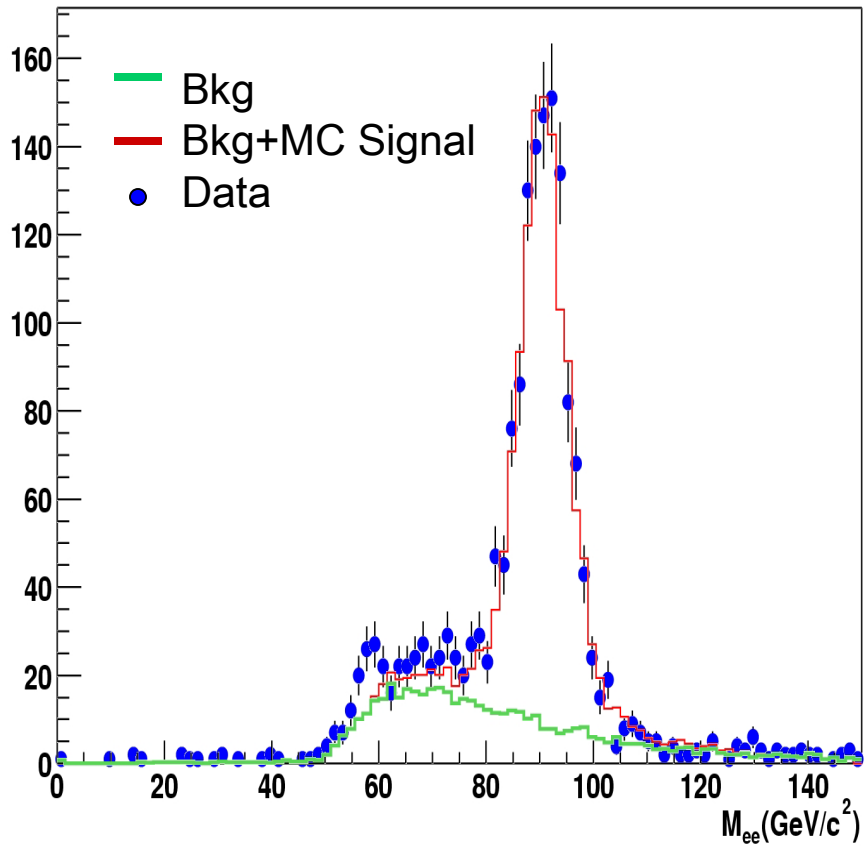
- $66 < m(\ell\ell)/GeVc^{-2} < 116$
- Small backgrounds from QCD, $Z/W \rightarrow \tau$ less than 1.5%: 62±18
- Systematics : ~5.7%(2003)↓ ~2% (improved material description)

$\sigma BR(Z \rightarrow ee)$=250.5±3.8 pb (NNLO theory: Martin,Roberts,Stirling,Thorne)

$$\sigma \cdot BR(p\bar{p} \rightarrow Z/\gamma^* \rightarrow ee) = 255.2 \pm 3.9(stat)^{+5.5}_{-5.4}(syst) \pm 15.3(lum)\ \text{pb}$$

L~ 41.6pb^{-1} DØ $\sigma\times BR(Z\rightarrow e^+e^-)$

- $Z \rightarrow e^+ e^-$ signal:
  - –2 isolated central electrons $|\eta|<1.1$ with $E_t>25$ GeV
  - –No track match requirement, but shower shape and EmFrac requirements.
- $70 < m(\ell\ell)/GeVc^{-2} < 110$
- QCD bkg shape from data, by fitting signal and bkg distributions.
- 1139 candidates after bkg substraction.
- A x ε=9.3%



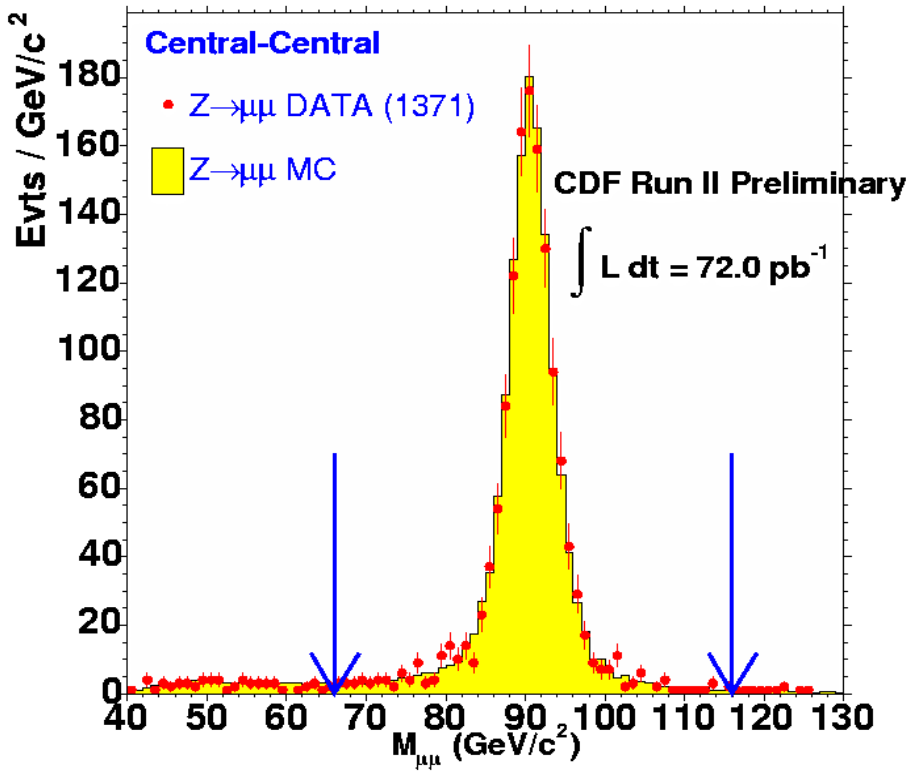
$\sigma BR(Z\rightarrow ee)$=250.5±3.8 pb (NNLO theory: Martin,Roberts,Stirling,Thorne)

$$\sigma \cdot \mathrm{BR}(Z \rightarrow ee) = 275.2 \pm 9(stat) \pm 9(syst) \pm 28(lum)\ \mathrm{pb}$$

L~ 72pb^{-1}

CDF $\sigma \times BR(Z \rightarrow \mu^+\mu^-)$

- $Z \rightarrow \mu^+ \mu^-$ signal:
  - –Two opposite charge μ's Pt>20GeV : Both: isolation + MIP +track quality
  - –1st μ: + stub in CMUP or CMX.
  - –Cosmic veto: timing plus d_0
- $66 < m(\ell\ell)/GeVc^{-2} < 116$
- Small backgrounds from QCD, $Z/W \rightarrow \tau$, cosmics (μ) less than 1.5% (13.3+13.5-11.8)
- Systematics : ~4.8%(2003)↓ ~2.8%

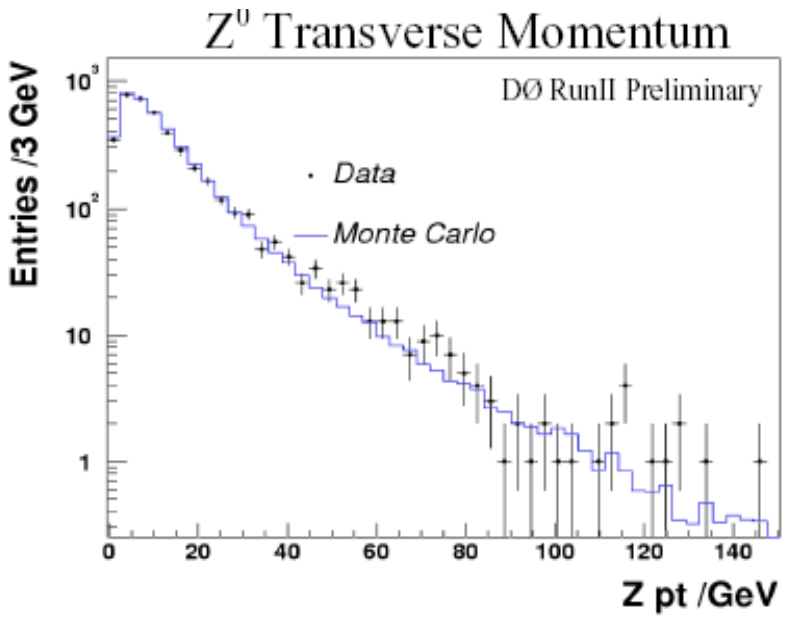


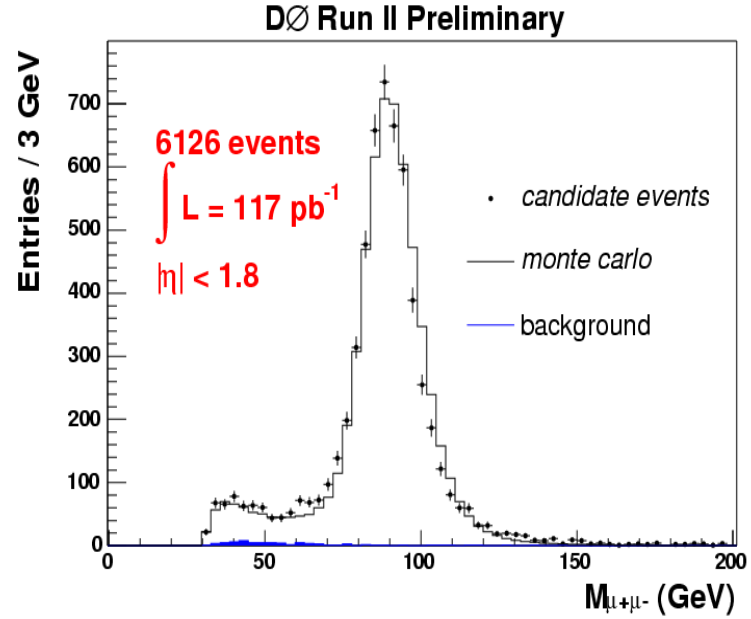
Number of candidates		A x ε
$Z/\gamma^* \rightarrow \mu^+ \mu^-$	1785	(10.18 ± 0.28)%

$\sigma BR(Z \rightarrow \mu\mu)$=250.5±3.8 pb (NNLO theory: Martin,Roberts,Stirling,Thorne)

$$\sigma \cdot BR\,(p\bar{p} \rightarrow Z/\gamma^* \rightarrow \mu\mu) = 248.9 \pm 5.9(stat)^{+7.0}_{-6.2}(syst) \pm 14.9(lum)\ pb$$

L~ 117pb^{-1} DØ $\sigma \times BR(Z \rightarrow \mu^+\mu^-)$



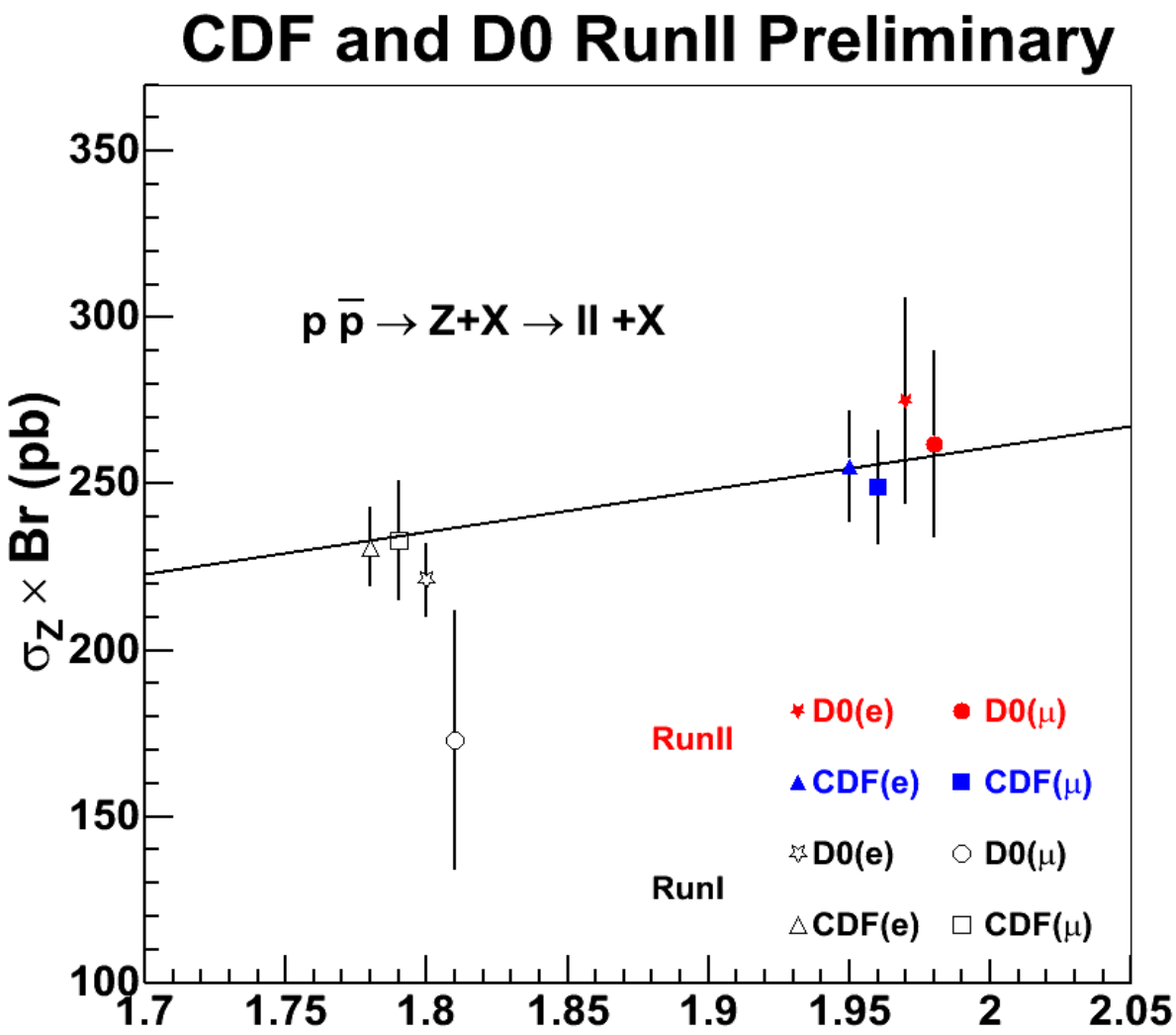


- $Z \rightarrow \mu^+ \mu^-$ signal: Two opposite charge μ's Pt>15GeV , at least 1 μ isolated,cosmic veto: timing plus d_0
- $m(\ell\ell)/GeVc^{-2} > 30$
- Very low Backgrounds: QCD bb (0.6 ± 0.3)% $Z \rightarrow \tau\tau$ (0.5 ± 0.1)%
- 6126 candidates after bkg substraction $A \times \varepsilon = 16.40\%$

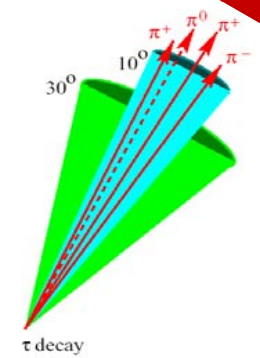
$\sigma BR(Z \rightarrow \mu\mu) = 250.5 \pm 3.8$ pb (NNLO theory: Martin,Roberts,Stirling,Thorne)

$$\sigma \cdot BR(Z \rightarrow \mu\mu) = 261.8 \pm 5.0(stat) \pm 8.9(syst) \pm 26.2(lum)\ pb$$

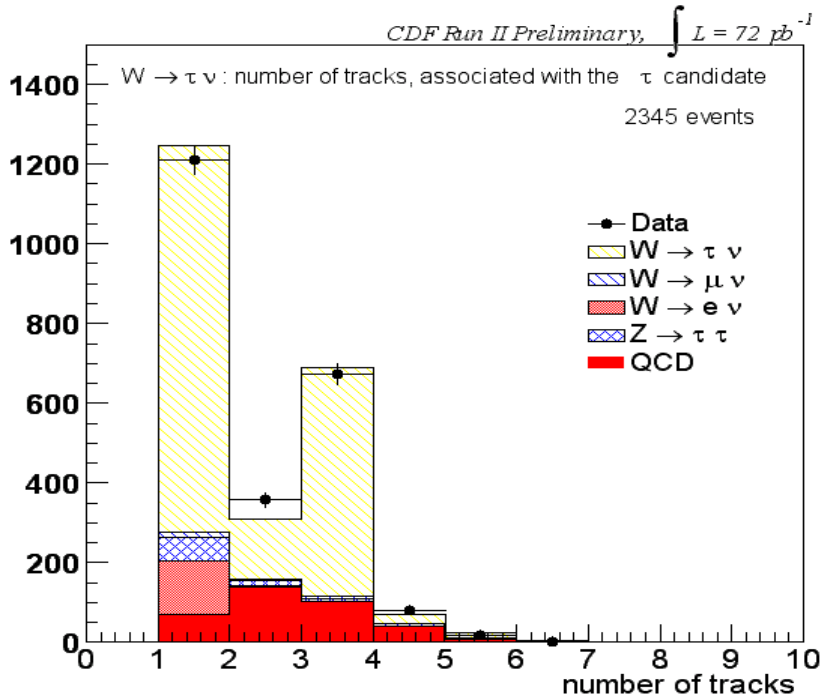
Summary CDF & DØ $\sigma \times BR(Z \rightarrow l^+l^-)$

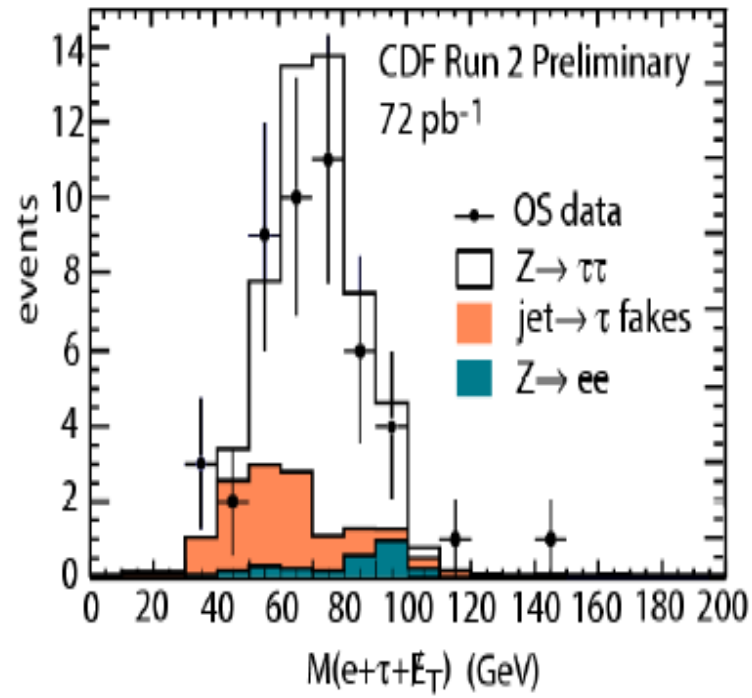


L~ 72pb^{-1} CDF $W\rightarrow\tau\nu_t$ and $Z\rightarrow\tau_h^+\tau_\ell^-$ Signals



- Count tracks in 10° τ -cone and veto tracks in 30° isolation cone
- Reconstruct π^0 candidates in Shower Max detector
- Combined mass < m(τ)
- $W\rightarrow\tau\nu_t$: 2345 in ~72 pb^{-1}Background ~ 26 % (dominated QCD)





$$\sigma\cdot BR(W\rightarrow\tau\nu) = 2.62 \pm 0.07_{stat} \pm 0.21_{sys} \pm 0.16_{lum} nb$$

L~ 41(e)pb^{-1}

DØ $\sigma \times BR(W \rightarrow l\nu)$

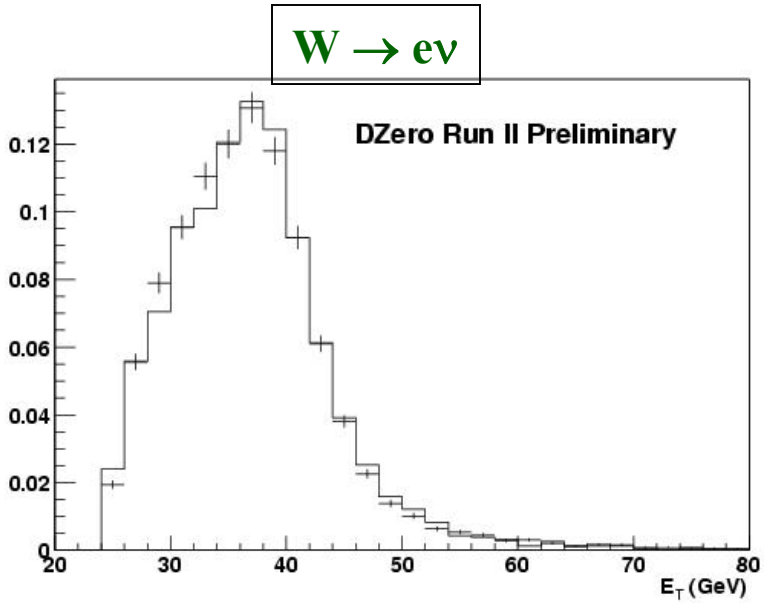
L~ 17.3 (μ) pb^{-1}

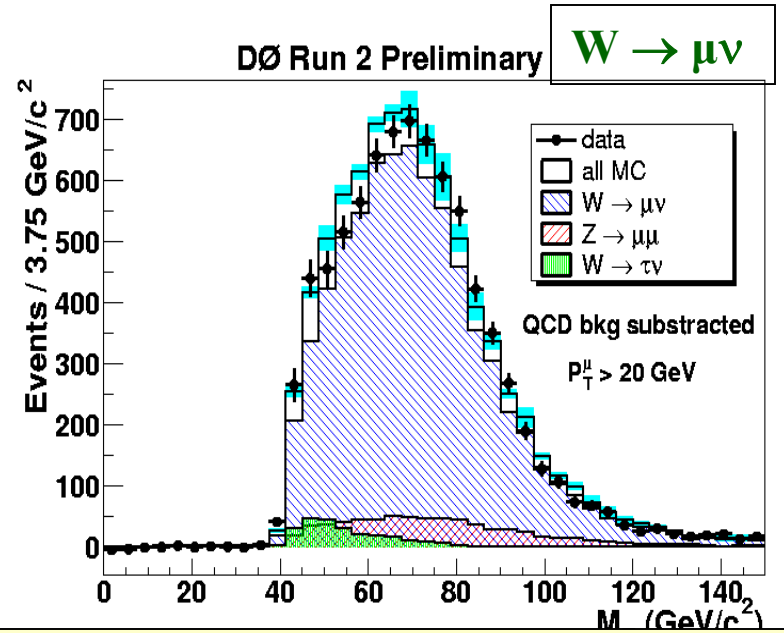
1 tight central e isolated E_t>25 GeV Met>25 GeV

Candidate events	Bkg	AXε
27400	~5%	18.4%

1 tight μ isolated P_t>20 GeV Met>20 GeV

Candidate events	Bkg	AXε
8305	~11.8 %	13.2%





$\sigma BR(W \rightarrow l\nu)$=2687±40 pb (NNLO theory: Martin,Roberts,Stirling,Thorne)

$$\sigma \cdot \mathrm{BR}(p\bar{p} \rightarrow W \rightarrow e\nu) = 2844 \pm 21_{\mathrm{stat}} \pm 128_{\mathrm{syst}} \pm 167_{\mathrm{lum}}\ \mathrm{pb}$$

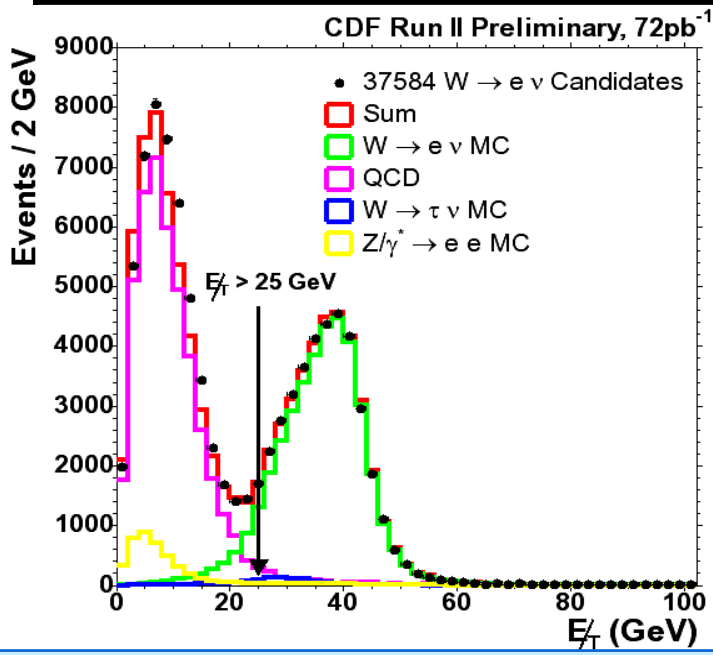
$$\sigma \cdot \mathrm{BR}(p\bar{p} \rightarrow W \rightarrow \mu\nu) = 3226 \pm 128_{\mathrm{stat}} \pm 100_{\mathrm{syst}} \pm 322_{\mathrm{lum}}\ \mathrm{pb}$$

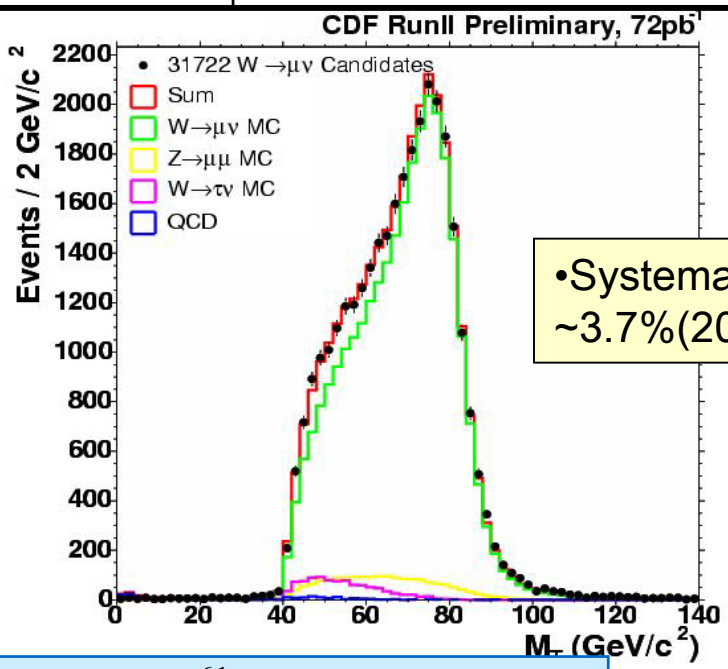
L~ 72pb^{-1}

CDF $\sigma \times BR(W \rightarrow l\nu)$

1 tight central e isolated E_t>25 GeV Met>25 GeV 1 tight μ isolated P_t>20 GeV Met>20 GeV

Candidate events		Estimated Bkg	Acceptance x efficiency
$W \rightarrow \mu\nu$	31,722	$(10.6 \pm 0.4)\%$	$(14.39 \pm 0.32)\%$
$W \rightarrow e\nu$	37,574	$(4.4 \pm 0.8)\%$	$(17.94 \pm 0.35)\%$





•Systematics :
~3.7%(2003)↓ ~2.2%

$$\sigma \cdot BR\ (p\bar{p} \rightarrow W \rightarrow e\nu) = 2782 \pm 14_{stat}\ ^{+61}_{-56}{}_{syst} \pm 167_{lum}\ pb$$

$$\sigma \cdot BR\ (p\bar{p} \rightarrow W \rightarrow \mu\nu) = 2772 \pm 16_{stat}\ ^{+64}_{-60}{}_{syst} \pm 166_{lum}\ pb$$

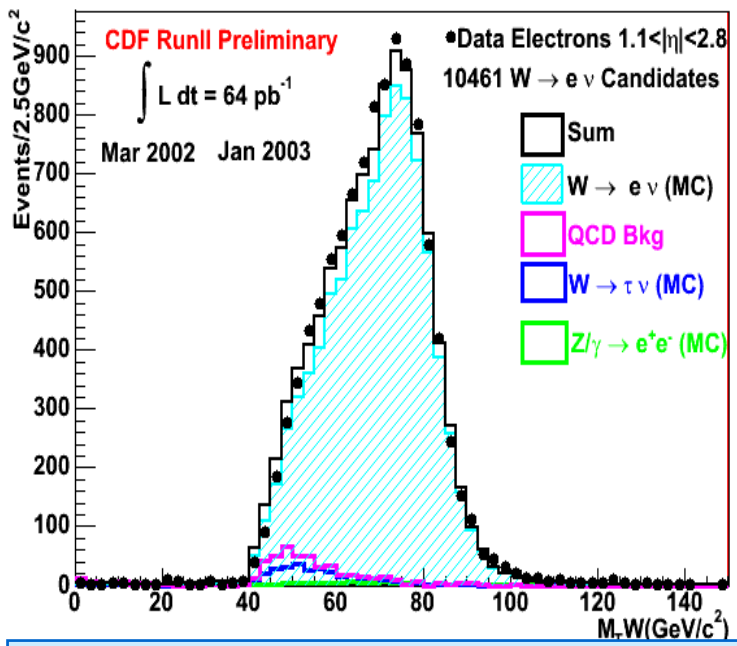
$\sigma BR(W \rightarrow l\nu)$=2687±40 pb (NNLO theory: Martin,Roberts,Stirling,Thorne)

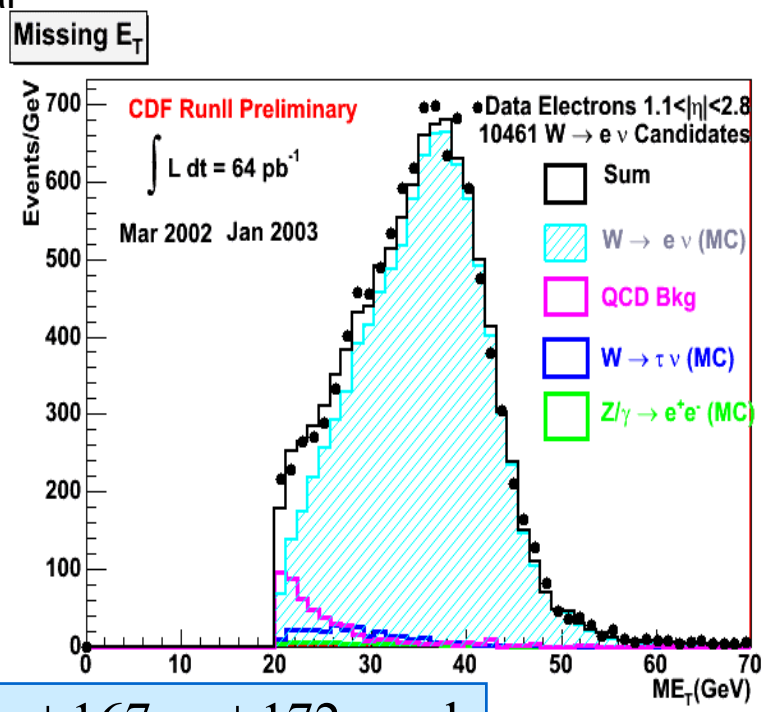
L~ 64pb^{-1}

CDF $\sigma\times BR(W\rightarrow e\nu)$ PLUG

- Electron: Plug EM cluster: Et>20, 1.1<|η|<2.8
  - ID:Had/Em,E/P and cal-Iso.
  - Silicon track matched with shower-max plug detector
- Met>20
- Trigger: Met>15 & Plug EM cluster: Et>20
- Main systematics: plug energy scale, PDF,material

Candidates	10461
QCD bkg	495±62 ±247
Z	87±13
$W\rightarrow\tau\nu$	324±23

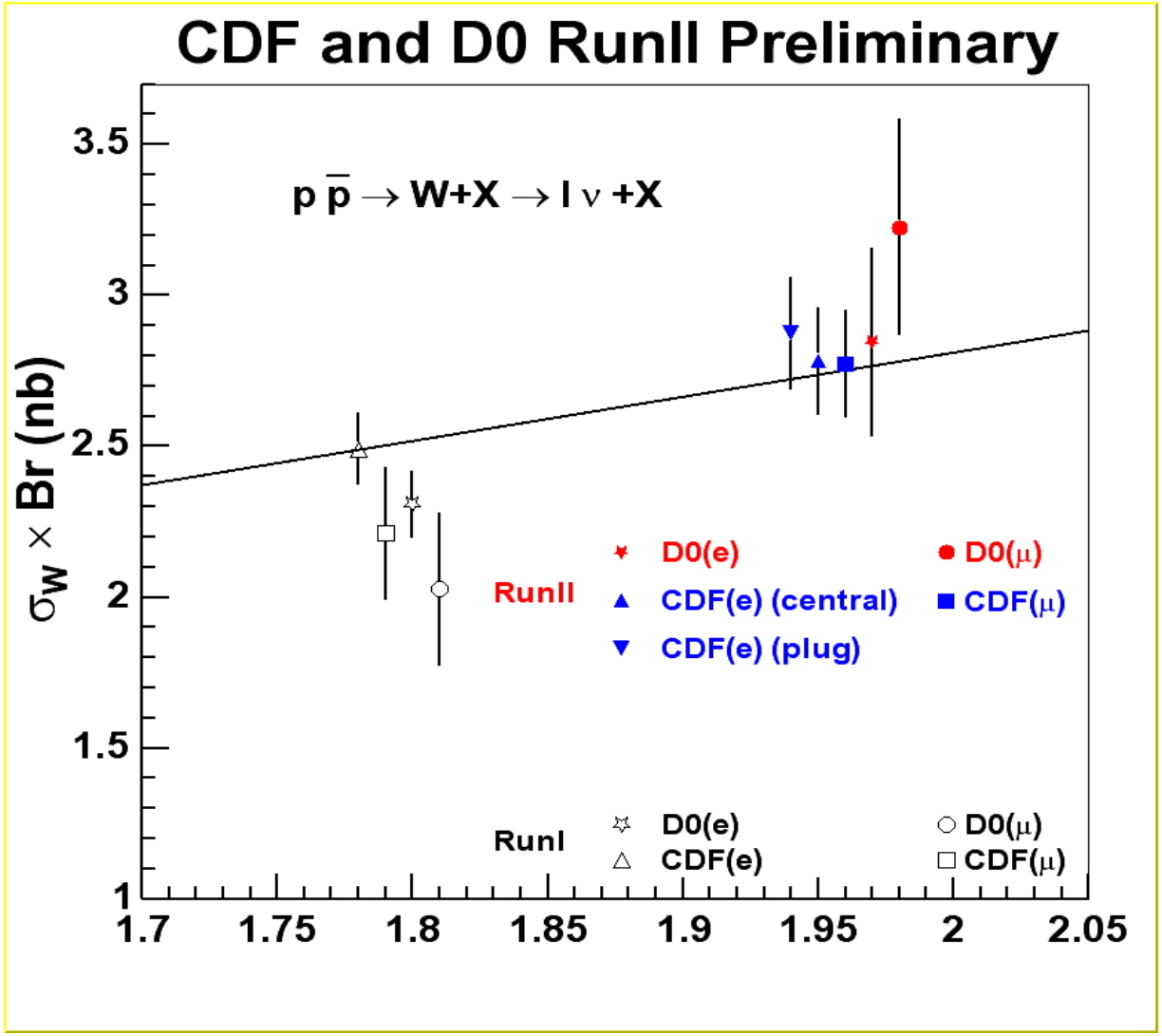




$$\sigma(p\bar{p}\rightarrow W)\cdot \mathrm{BR}(W\rightarrow e\nu) = 2874 \pm 34_{\mathrm{stat}} \pm 167_{\mathrm{syst}} \pm 172_{\mathrm{lum}}\ \mathrm{pb}$$

$\sigma BR(W\rightarrow l\nu)$=2687±40 pb (NNLO theory: Martin,Roberts,Stirling,Thorne)

Summary CDF & DØ $\sigma \times BR(W \rightarrow l\nu)$

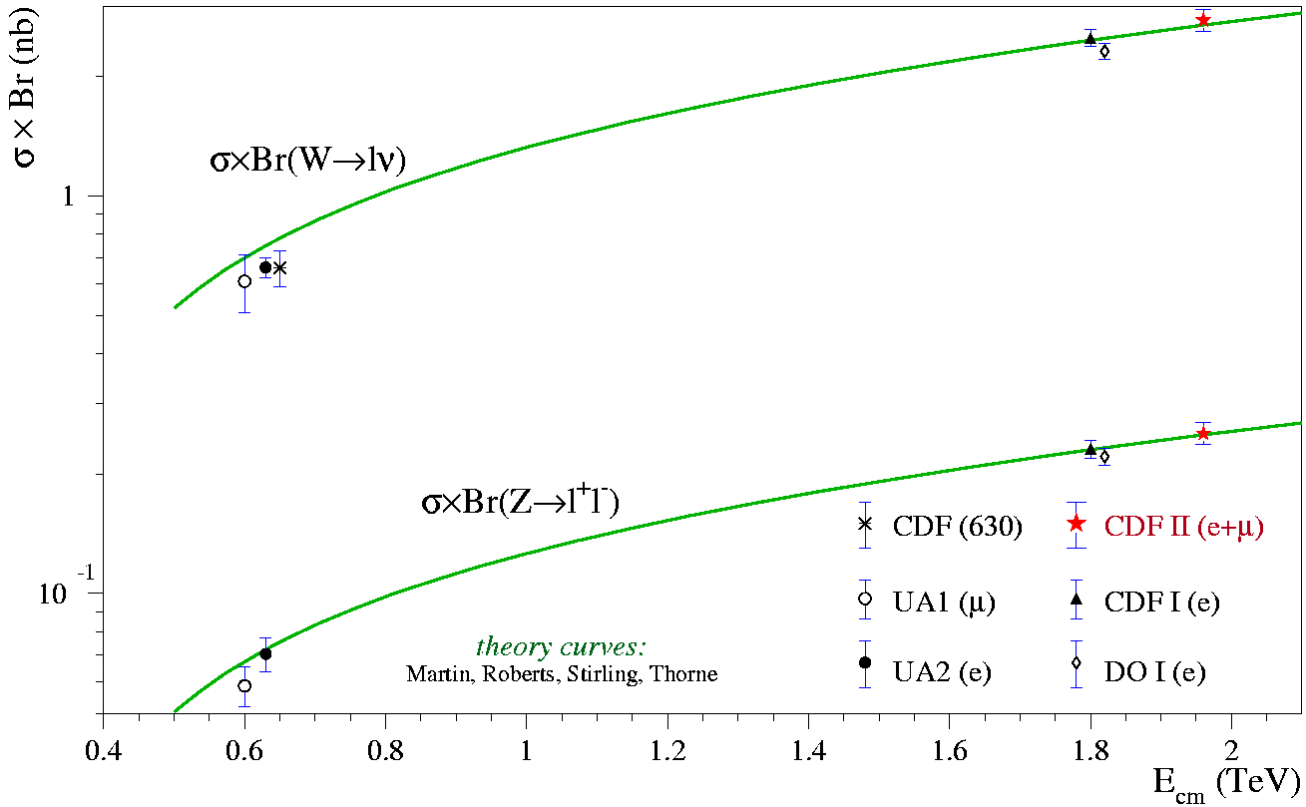


Summary CDF & DØ

Channel $\rightarrow \nu\mu$	$N_{candidates}$ & Purity	$\int L\ pb^{-1}$	εXA
CDF $W\rightarrow e\nu$	37.6K (95%)	72	17.94%
CDF_{plug} $W\rightarrow e\nu$	10.4K (90%)	64	5.2%
DØ $W\rightarrow e\nu$	27.4K (90%)	41	18.40%
CDF $W\rightarrow \mu\ \nu$	31.7K (90%)	72	14.39%
DØ $W\rightarrow \mu\ \nu$	8.3K (88%)	17	13.20%
CDF $Z\rightarrow ee$	4242 (1.5%)	72	22.74%
DØ $Z\rightarrow ee$	1139(--)	41	9.30%
CDF $Z\rightarrow \mu\mu$	1785 (1.5%)	72	10.18%
DØ $Z\rightarrow \mu\mu$	6126 (1.1%)	117	16.40%

Combining e and μ channels

- Assuming lepton universality, combine W and Z results
  - correlated systematics effects accounted for



$$\sigma(p\bar{p} \to Z/\gamma^* \to \ell\ell) = 254.3 \pm 3.3(stat) \pm 4.3(syst) \pm 15.3(lum)\,\text{pb}$$

$$\sigma(p\bar{p} \to W \to \ell\nu) = 2777 \pm 10(stat) \pm 52(syst) \pm 167(lum)\,\text{pb}$$

Re & Rμ →R→ BR(W→ℓν) and Γ(W)

$$R_e = 10.86 \pm 0.18(stat) \pm 0.16(sys) \quad R_\mu = 11.10 \pm 0.27(stat) \pm 0.17(syst)$$

$$R = \frac{\sigma(p\bar{p} \to W \to \ell\nu)}{\sigma(p\bar{p} \to Z \to \ell\ell)} = 10.93 \pm 0.15(stat) \pm 0.13(sys)$$

$$R = \frac{\sigma(p\bar{p} \to W)}{\sigma(p\bar{p} \to Z)} \cdot \frac{\Gamma(Z)}{\Gamma(Z \to \ell\ell)} \cdot \frac{\Gamma(W \to \ell\nu)}{\Gamma(W)}$$

3.3677±0.024
NNLO (PDG)

From LEP:
(3.366 ± 0.0002)%

$$\mathrm{BR}(W \to \ell\nu) = 0.1093 \pm 0.0021$$

Using NNLO calculation
Γ(W→ℓν)=226.4 ±0.4 MeV (PDG):

$$\Gamma(W) = 2071 \pm 40 \text{ MeV}$$

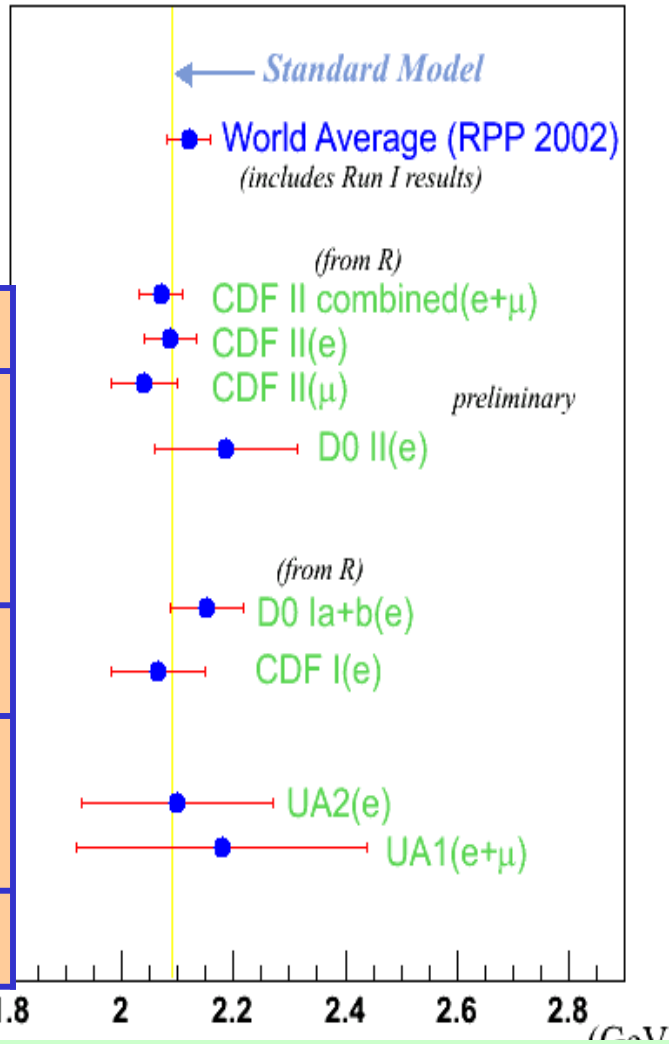
CDF & DØ BR(W→ℓν) and Γ(W)

	CDF(e+μ) L=72pb^{-1}	D0(e) L=42pb^{-1}
R	$10.93 \pm 0.15_{stat} \pm 0.13_{sys}$ ‡	$10.34 \pm 0.35_{stat} \pm 0.49_{sys}$ ‡
BR(W→ℓν$_\ell$)	0.1055 ± 0.0038	0.1035 ± 0.0062

‡NNLO@1.96 : 10.66 ± 0.05 (J.Stirling)

Using the NNLO calculation of Γ(W→ℓν$_\ell$)

Γ(W)	(2071± 40) MeV	(2187± 128) MeV



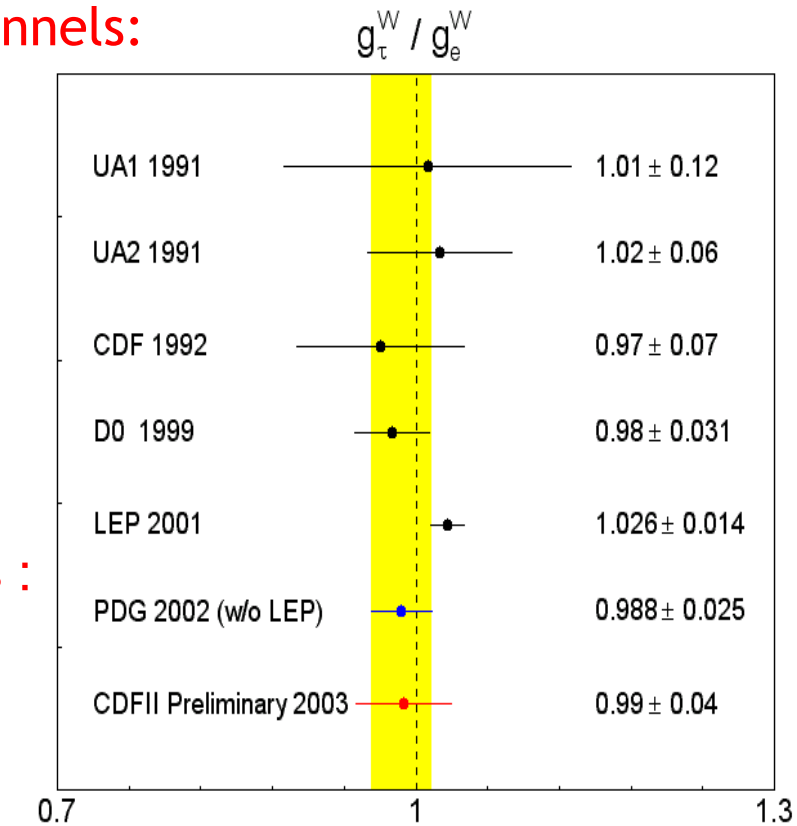
Current World Ave: 2092 ± 40 MeV **LEP direct measurement : 2150 ± 91 MeV**

μ-e Universality in W Decays

- Calculate R separately for e and μ channels:

$$U = \frac{R_\mu}{R_e} = \frac{g_\mu^2}{g_e^2} = 1.022 \pm 0.036$$

$$g(\mu)/g(e) = 1.011 \pm 0.018$$

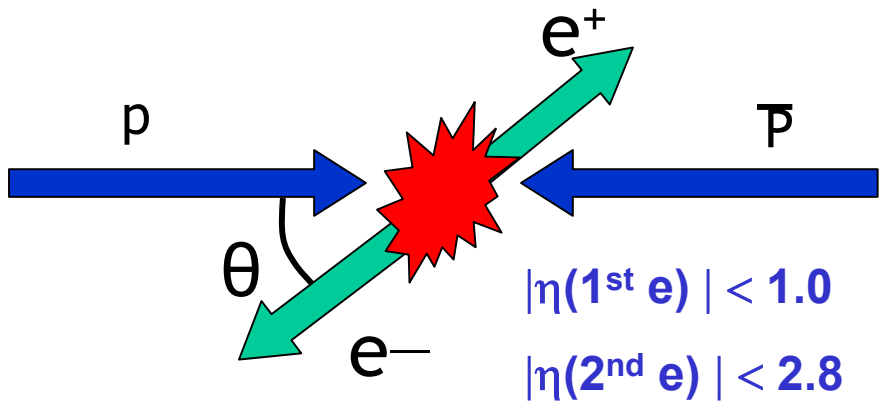


- From W → eν and W → t ν cross sections :

$$\frac{BR(W \to \tau\, \nu)}{BR(W \to e\, \nu)} = 0.99 \pm 0.04_{stat} \pm 0.07_{sys}$$

$$g(\tau)/g(e) = 0.99 \pm 0.02(stat) \pm 0.04(sys)$$

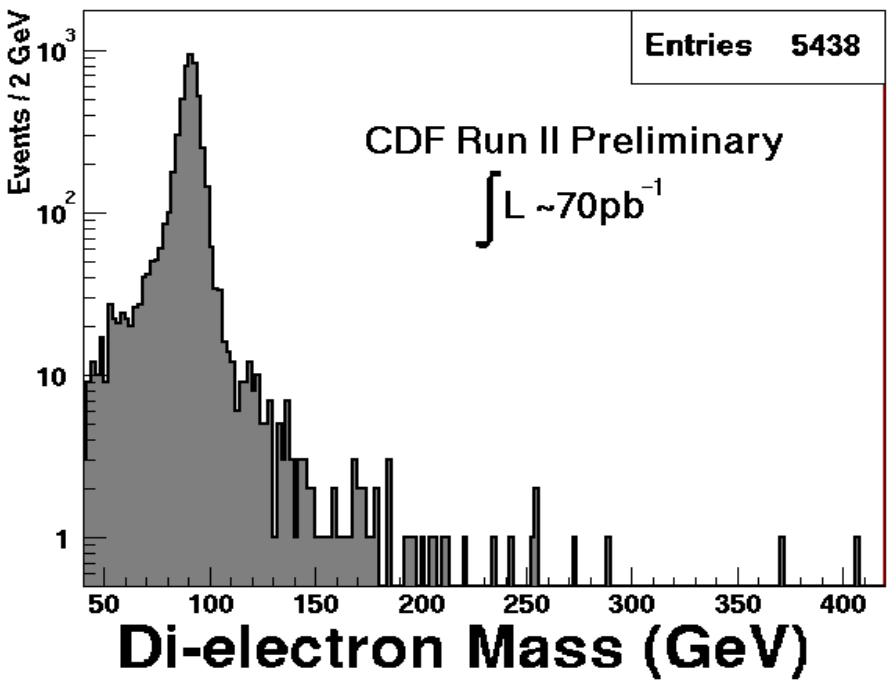
Forward-backward asymmetry

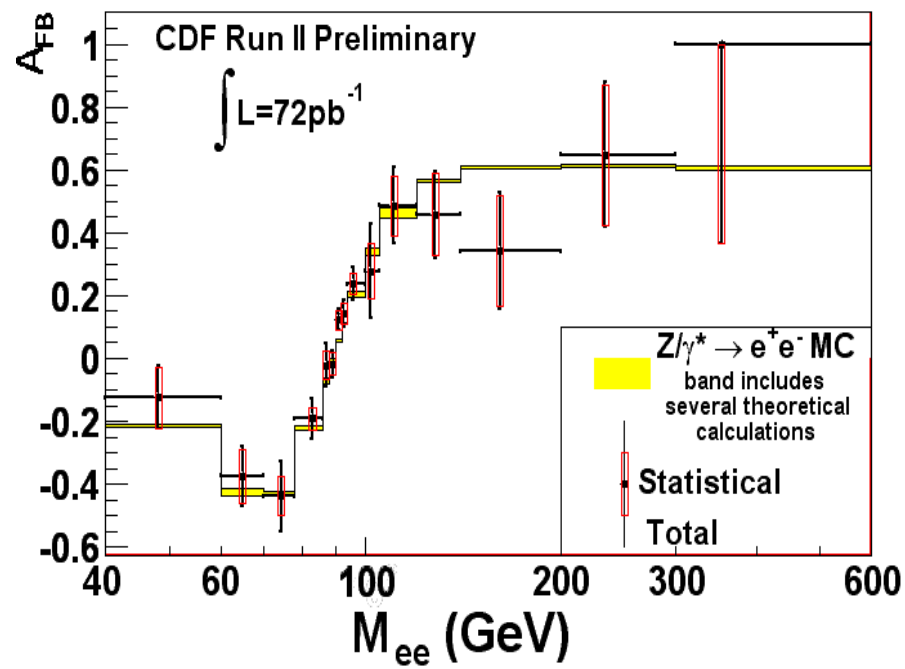


- Unique at Tevatron (off Z pole)
- Directly probes V,A $\rightarrow \sin^2\theta_W$,u, d couplings to Z
- Sensitive to New Physics: agreement with SM prediction.

$$A_{fb} = \frac{\sigma(\cos\theta > 0) - \sigma(\cos\theta < 0)}{\sigma(\cos\theta > 0) + \sigma(\cos\theta < 0)}$$

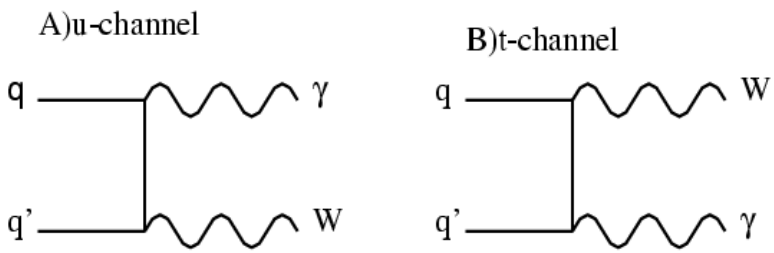
5438 candidates in ~ 72 pb^{-1}

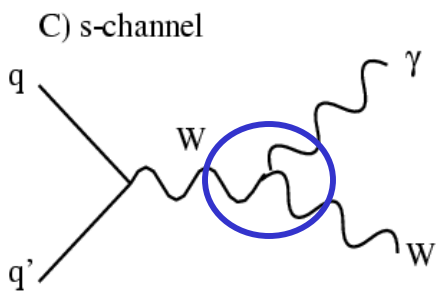


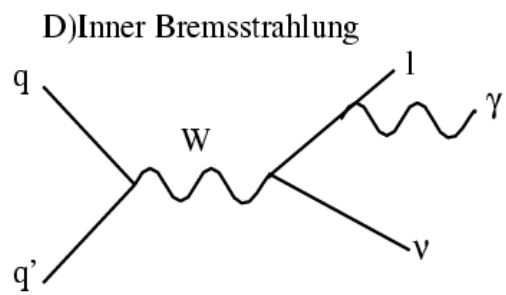


Di-boson Production and TGC

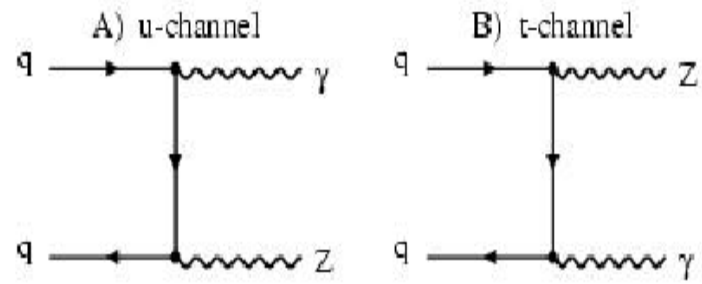
$qq' \rightarrow W\gamma$ TGC WW γ

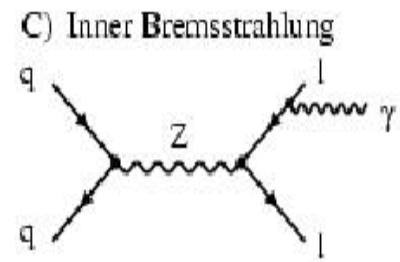


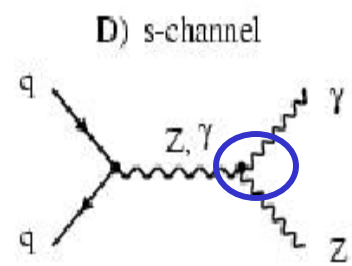




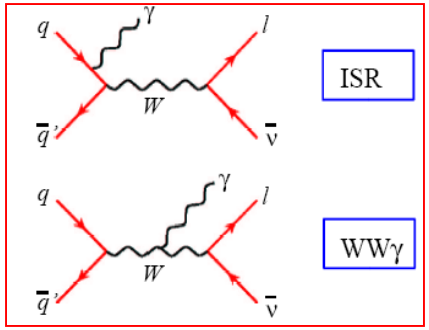
$qq \rightarrow Z\gamma$ TGC $Z\gamma\gamma$ $ZZ\gamma$







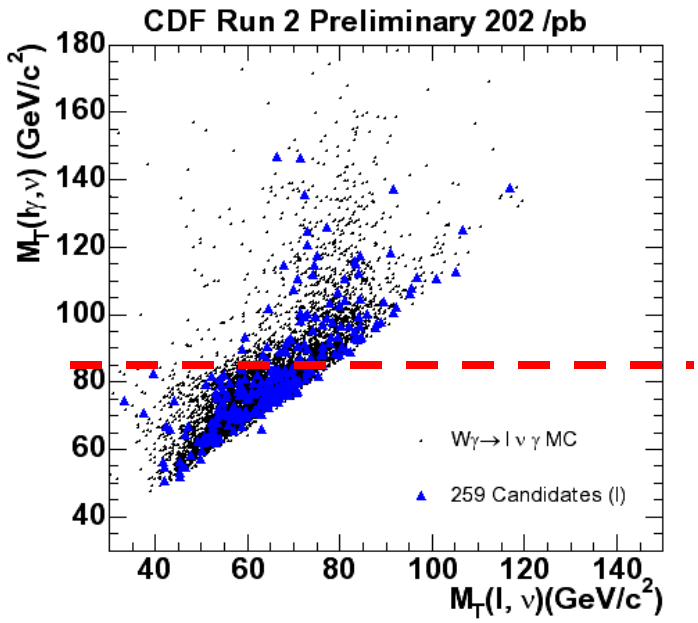
DiBoson Production: Wγ

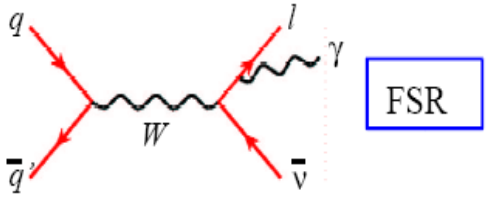


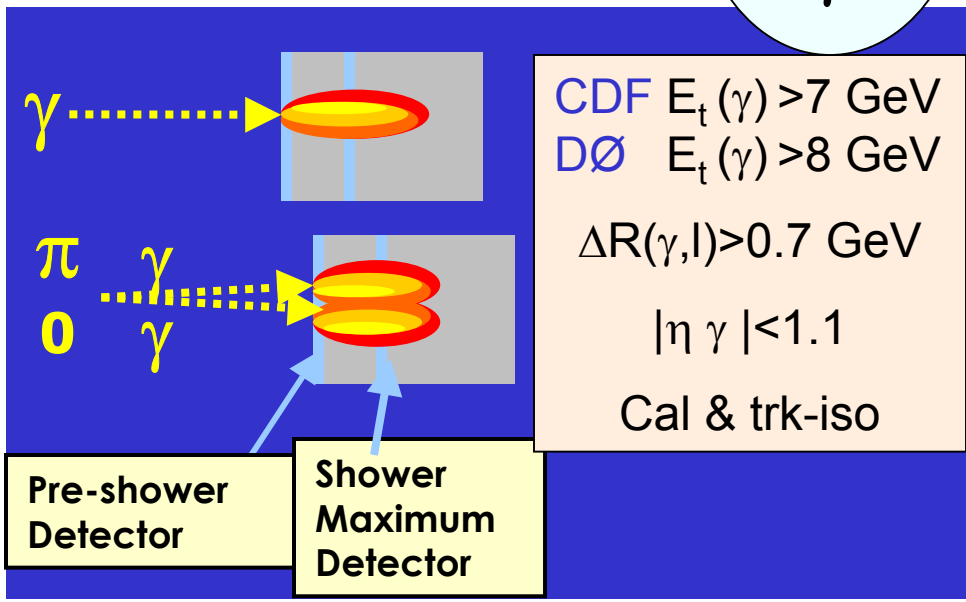
First: Select W →lν

W(→eν)
Et(e) >25 GeV, cal-iso
CDF $|\eta_e|$<1.1 DØ $|\eta_e|$<2. 3
Et>25 GeV
W(→μν)
Pt(μ)> 20 GeV,
CDF $|\eta_\mu|$<1.0 DØ $|\eta_\mu|$<1.6
Et>20 GeV

Then: select γ







CDF $E_t(\gamma)$ >7 GeV
DØ $E_t(\gamma)$ >8 GeV

$\Delta R(\gamma,l)$>0.7 GeV

$|\eta_\gamma|$<1.1

Cal & trk-iso

CDF: Wγ

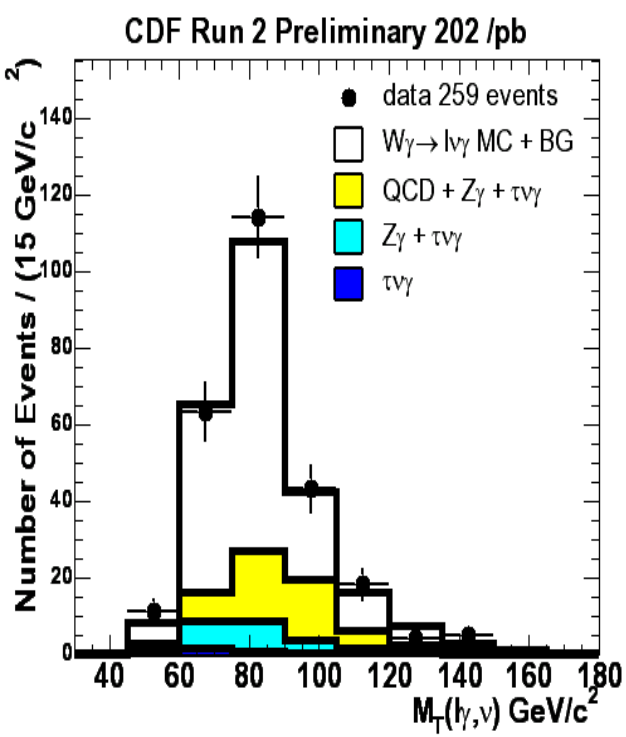
	N expected (L=202/pb)
N(W+g) MC	180.51 ± 2.08 ± 11.2
Tot Bkg	75.12 ± 0.46 ± 15.00
Total SM	255.63 ± 2.13 ± 26.43
Data	259

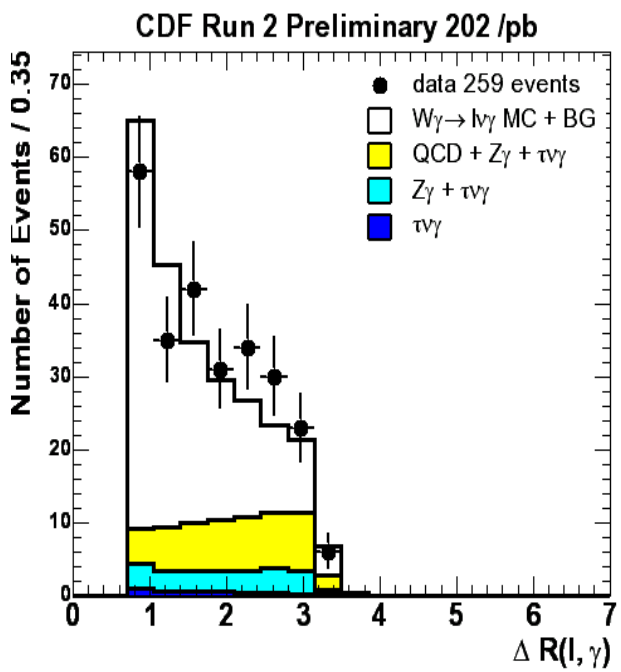
W+jet	49.52 ± 0.10 ± 14.95
Zγ	22.37 ± 0.38 ± 1.2
Wg→τν g	3.23 ± 0.24 ± 0.17

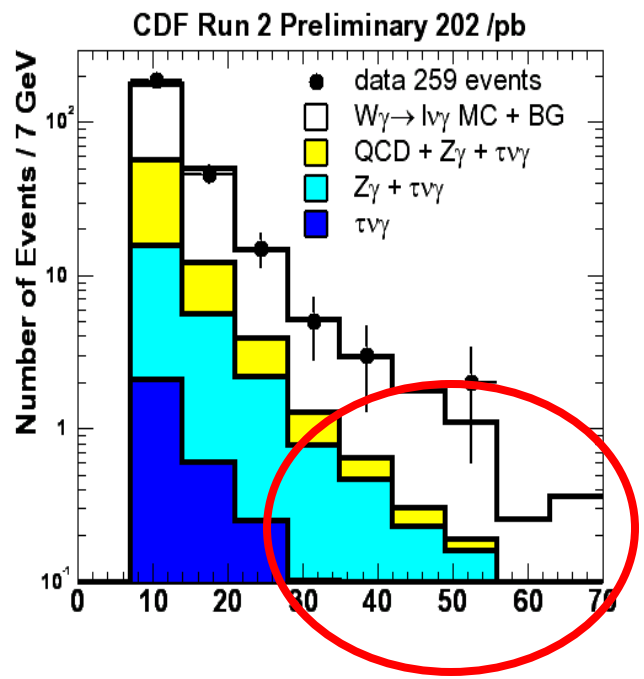
$$\sigma \cdot BR(pp \rightarrow W\gamma \rightarrow \ell\nu_\ell \gamma) = 19.3 \pm 1.3 \text{ pb}$$

NLO prediction (U. Baur):

$\sigma(W\gamma)\times BR(W\rightarrow l\nu)$ = 19.7± 1.7 (stat) ± 2.0 (sys) ± 1.1 (lumi) pb







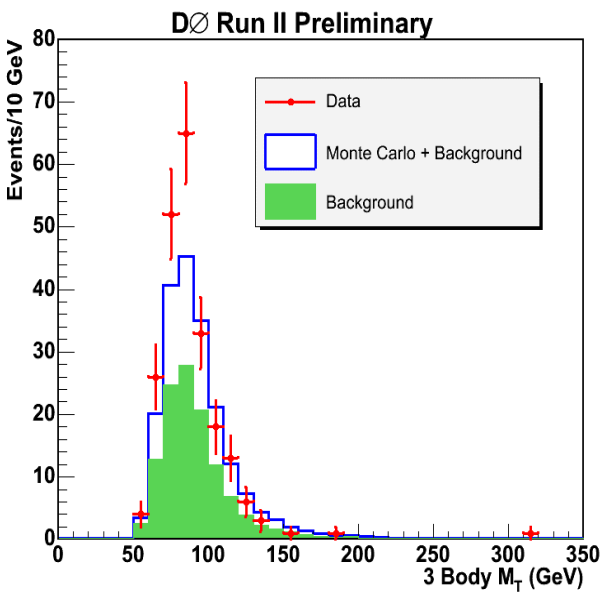
DØ Wγ

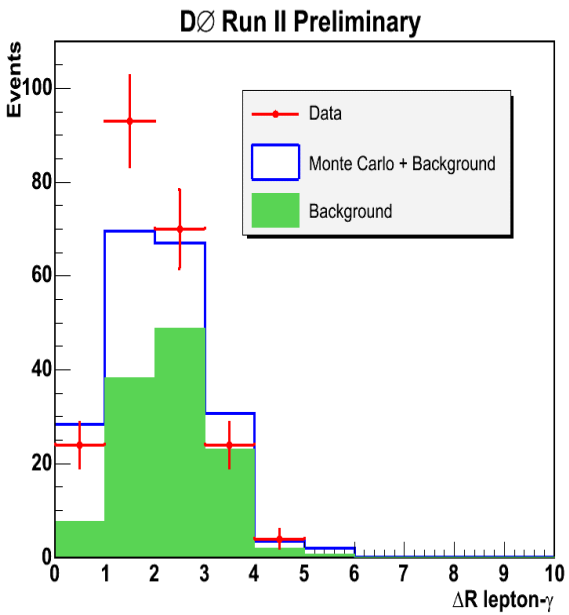
	(e) 162/pb	μ(82/pb)
Total B	87.1±7.5	37.±10.
Total SM	142±17	67±13
data	146	77

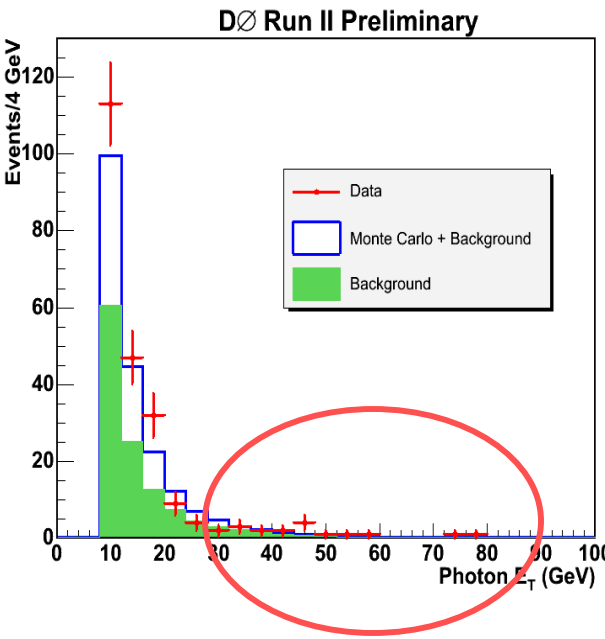
W+jets	80.0±7.4	30.1 ±10.0
Z+ γ	-	4.7±2.0
leX	3.7±0.5	0.6 ±0.6
W(τν)γ	3.4±1.1	0.9 ±0.3

$\sigma \cdot BR(pp \rightarrow W\gamma \rightarrow \ell\nu_\ell \gamma) = 16.4 \pm 0.4\,pb$ NLO prediction (U. Baur):

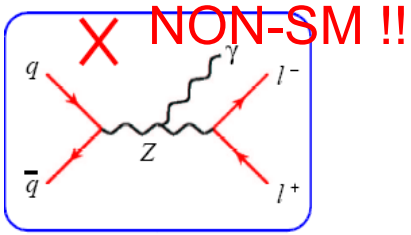
$\sigma(W\gamma)\times BR(W\rightarrow l\nu)$ = 19.3± 2.7 (stat) ± 6.1 (sys) ± 1.2 (lumi) pb

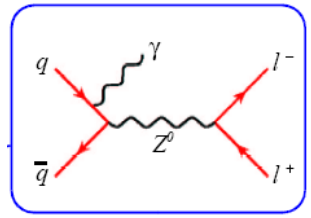


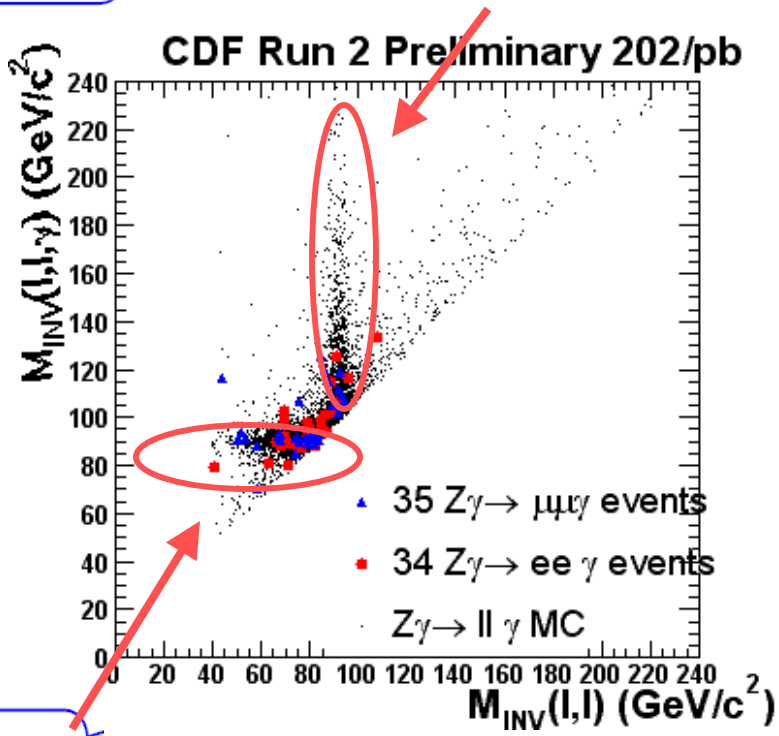


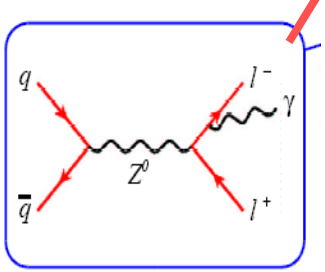


DiBoson: Z γ









First: Select $Z \to l^+l^-$

$Z \to e^+e^-$: Et(e) >25 GeV, $|\eta_e|$<2.8

$Z \to \mu^+\mu^-$: Pt >20 GeV, $|\eta_\mu|$<1.1

M_{ll}>40 GeV

Then: select γ

$E_t(\gamma)$ >7 GeV

$\Delta R(\gamma,l)$>0.7 GeV

$|\eta\ \gamma|$<1.1

Cal & trk-iso

CDF: Z γ

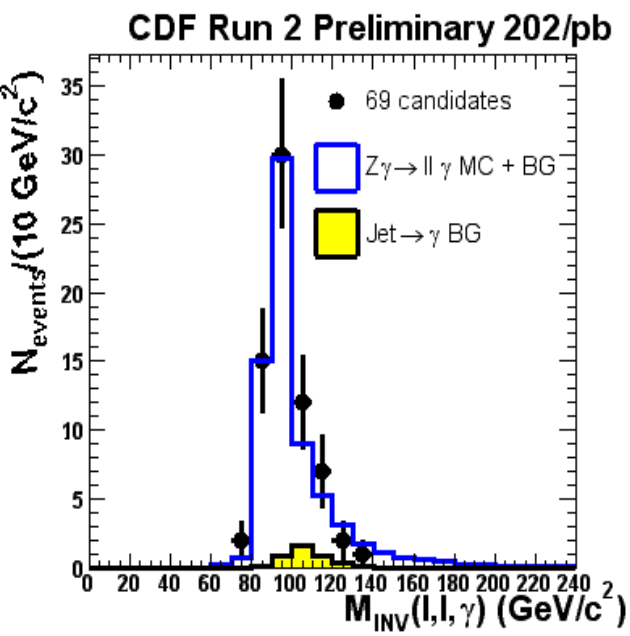
	e + μ
N(Z+g MC)	65.76 ±3.76
N(background)	4.70 ± 1.34
Total	70.46 ±4.00
data	69

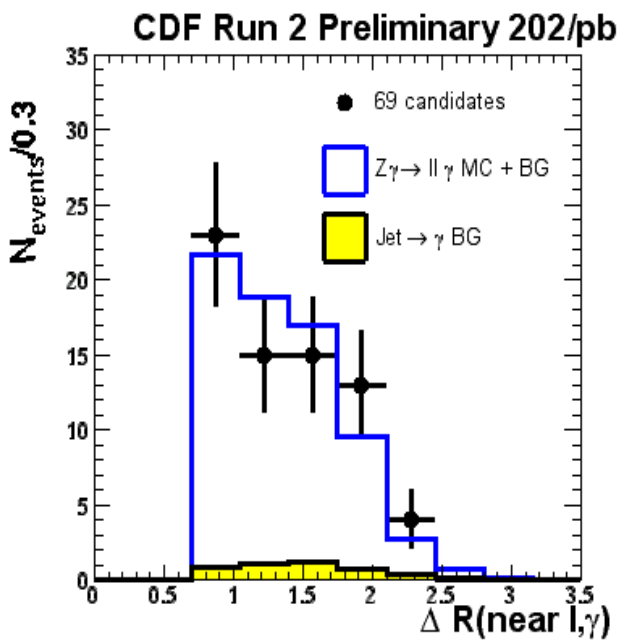
Z+jet	4.44 ± 1.33
Others	0.26 ± 0.2

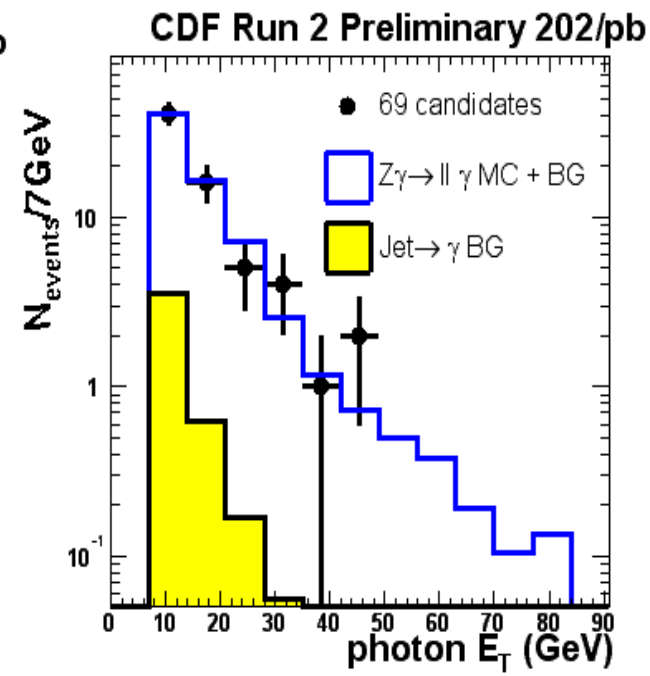
$\sigma(Z\gamma)\times BR(Z\rightarrow ll)$ =5.3± 0.6 (stat) ± 0.4 (sys)± 0.3 (lumi) pb

NLO prediction(U. Baur): (LO + ET(γ) dependent k –factors):

$\sigma\cdot BR(p\bar{p} \rightarrow Z\gamma \rightarrow \ell\ell\gamma) = 5.4 \pm 0.4$ pb







CDF: WW (Two approaches)

$$\sigma(p\bar{p} \rightarrow WW \rightarrow l^{+}\nu l^{-}\bar{\nu})$$

Two complementary approaches

Dileptons: l^{+}, l^{-}: identified e,μ

- Reject $76<M_{ll}<106$ & $\not{E}_T / \Sigma E_T < 3$
- $\not{E}_T > 25$
- No High Et jets
- Opposite sign & Isolation

High S/B

(Identified e,μ) + track

- Reject $\not{E}_T / \Sigma E_T < 5.5$ in all M_{ll}
- $\not{E}_T > 25$
- Njets<=1
- Opposite sign & Isolation

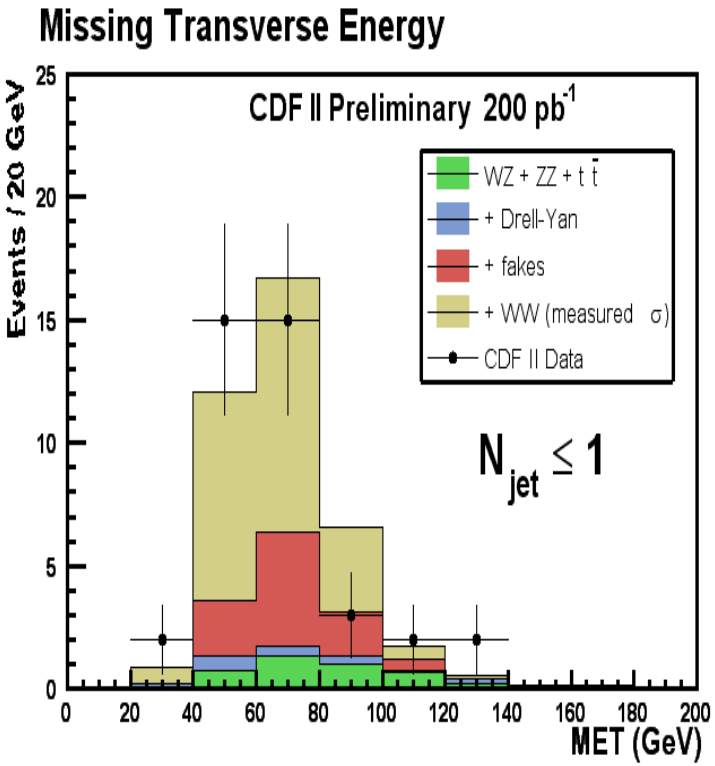
Increased acceptance

$E_T / \Sigma E_T$ ✂ Bkg with instrumental $\not{E}_T$

✂ DY, Zττ
✂ WZ/ZZ, Zττ
✂ top dilepton
✂ Fakes

CDF: WW cross section

	l+track	e,μ
WW	16.3±0.4	11.3 ±1.3
DY	1.8±0.3	1.82 ±0.4
WZ+ZZ	2.4±0.1	0.76 ±0.06
Wγ	-	1.05±0.19
Fakes	9.1±0.8	1.08±0.49
Bkg	15.1±0.9	4.77±0.70
WW+Bkg	31.5±1.0	16.1±1.6
Data	39	17

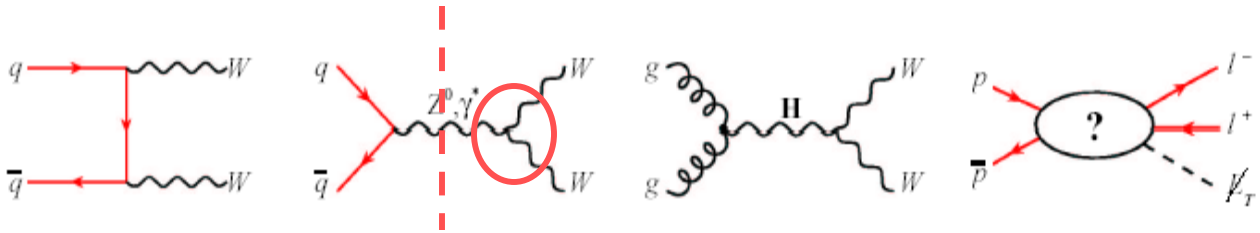


NLO (MFCM, Ellis& Campbell) σ^{WW}=12.5±0.8 pb

e,μ $$\sigma(p\bar{p} \rightarrow WW) = 14.3^{+5.6}_{-4.9}(stat) \pm 1.6(syst) \pm 0.9(lum)\ pb$$

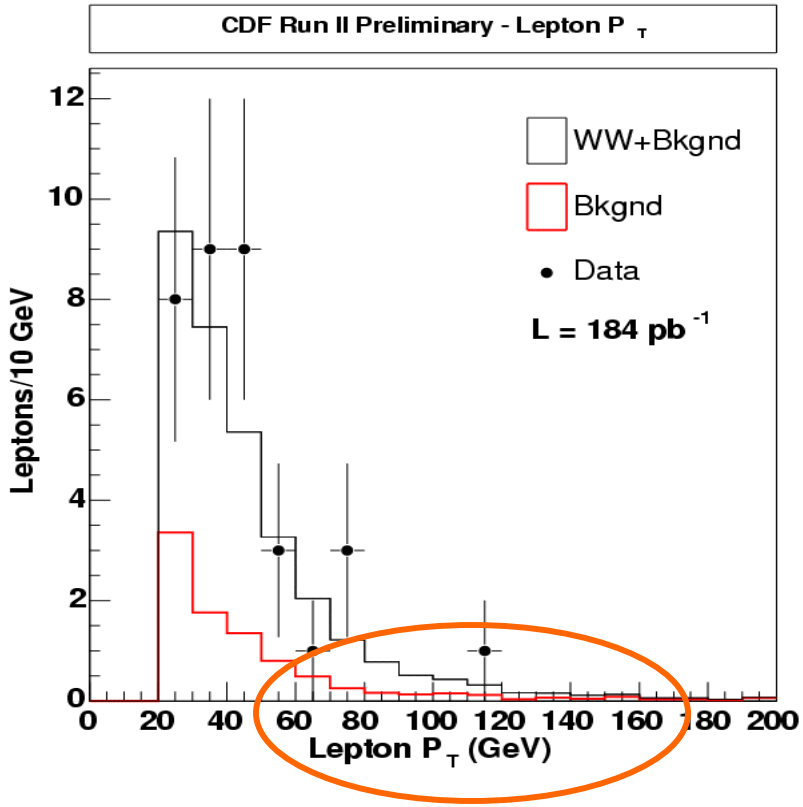
l+track $$\sigma(p\bar{p} \rightarrow WW) = 19.4 \pm 5.1(stat) \pm 3.5(syst) \pm 1.2(lum)\ pb$$

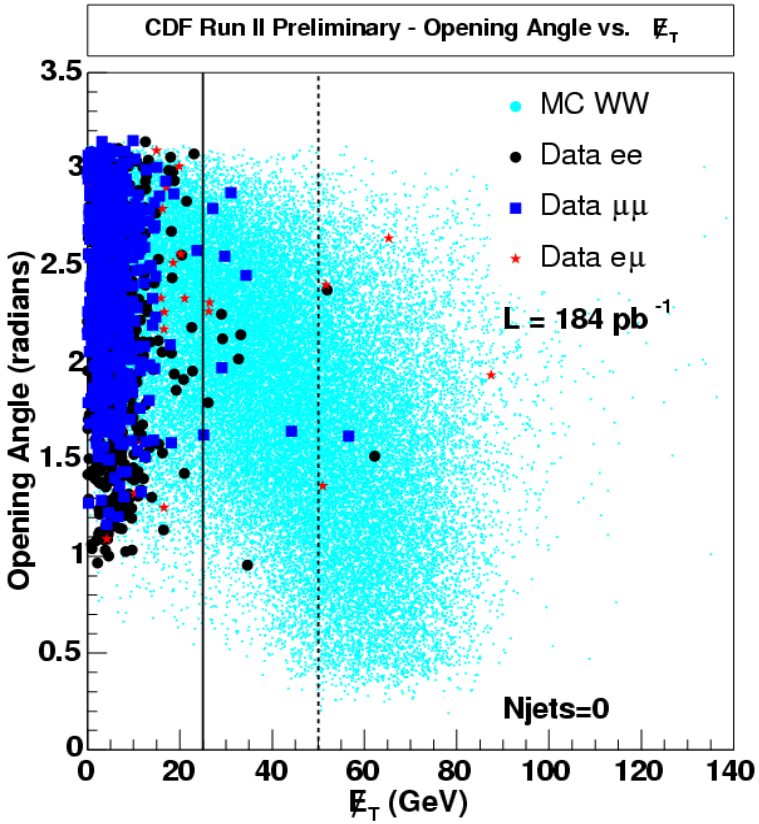
CDF: WW Beyond SM



Anoumalous TGC WWZ/WWγ

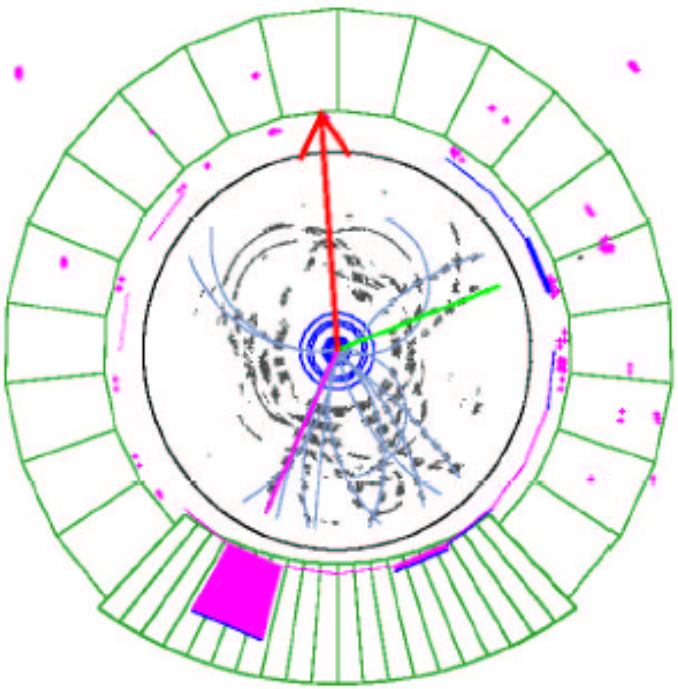
gg→H→WW 140<M_H<180GeV/c^2





CDF: WW →eμνν candidate

- eμ channel has little Standard Model background
- Signal/Background ≈ 4

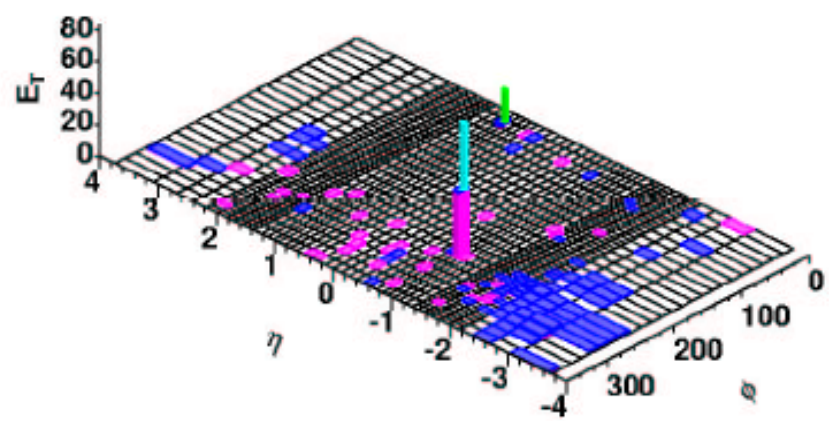


Run 155364 Event 3494901 : $WW \to e^+\nu_e\mu^-\bar{\nu}_\mu$ Candidate

$p_T(e) = 42.0$ GeV/c; $p_T(\mu) = 20.0$ GeV/c; $M_{e\mu} = 81.5$ GeV

$\not{E}_T = 64.8$ GeV; $\Phi(\not{E}_T) = 1.6$

$\Delta\Phi(\not{E}_T, \text{lepton}) = 1.3$; $\Delta\Phi(e,\mu) = 2.4$; Opening-Angle(e,μ)=2.6

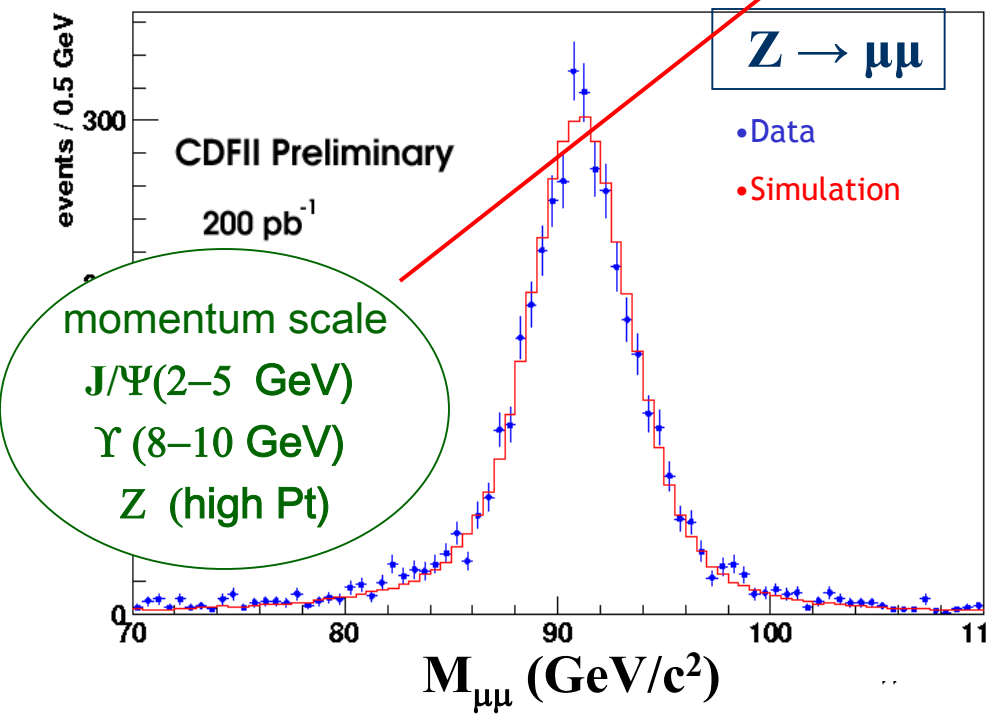


W mass prospects

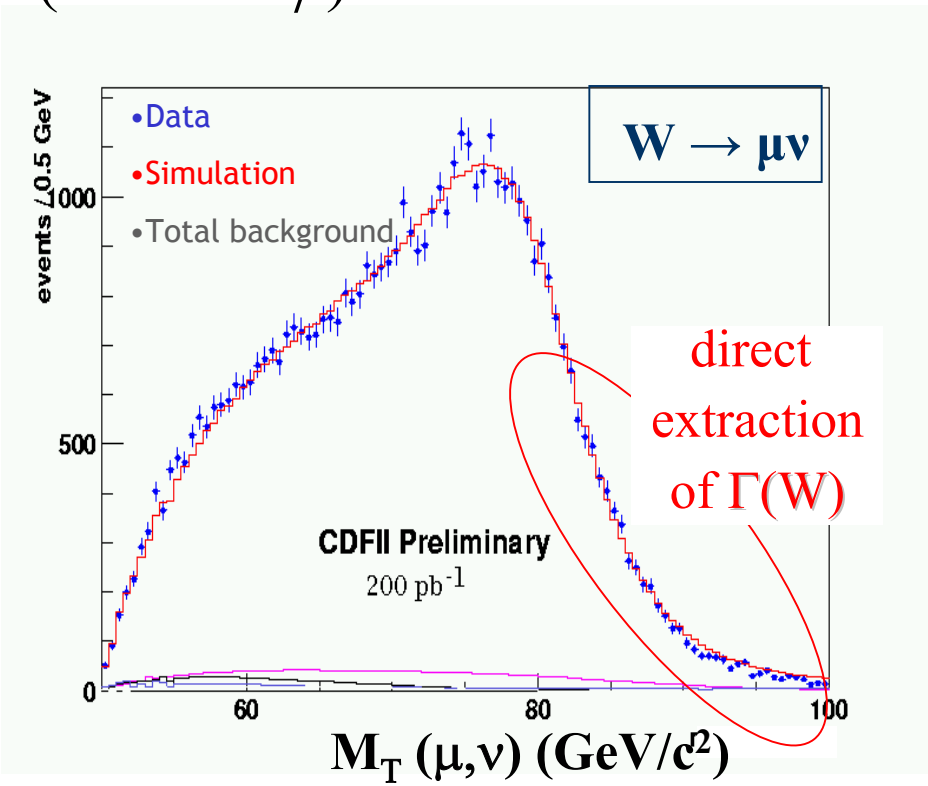
- CDF Run I (μ) $m_W = 80.465 \pm 100(\text{stat}) \pm 103(\text{sys})$ MeV
- CDF Run II for 250/pb estimate (μ): = X ± 55(stat) ± 80(sys) MeV

Calorimeter:
right energy scale
and resolution

$$M_T = \sqrt{2 p_t E_T^{miss} (1 - \cos\Delta\phi)}$$



momentum scale
J/Ψ(2–5 GeV)
ϒ (8–10 GeV)
Z (high Pt)



direct
extraction
of Γ(W)

Conclusions

- Electroweak measurements at the Tevatron:
  - Benchmarks to understand the CDF & DØ detectors.
  - Important backgrounds for Top and Higgs physics.
  - Ideal scenario to test the Standard Model.
    - Please tune in to the talks:
      - Higgs (S.Beauceron) SUSY (K.Kurca) Leptoquarks (D.Ryan) and other (A.Pompos) searches at the Tevatron.
    - Diboson Production cross section measurements $\rightarrow$ anomalous TGC.
- Expect full set of publications based on 200 /pb between now and the end of 2004.

Backup slides

Electron Reconstruccion

Calorimeter + tracking information

- Central electron: $|\eta|<1.2$
  - EM cluster + COT track
- Plug electron: $1.2<|\eta|<1.8$
  - EM cluster (+ Silicon track)
- Isolation: fraction of E in a cone 0.4
- Loose electrons: Et>20-25 GeV, Pt>10 GeV, Ehad/Eem, track quality and fiducial requirements.
- Tight electrons: +E/P, shower profiles, track:showerMax matching
- ε measured with $Z\rightarrow ee$
  - Trigger ε: 100%, Et>30 GeV
  - ID ε : tight e >80% , loose e >94%

- Large fractional energy deposit in EM sector. Track match requirement.
- Isolation: fraction of energy in hollow cone between 0.2 –0.4
- Shower shape distribution,E/P
- ε measured with $Z\rightarrow ee$
  - Trigger ε: 100% above 30 GeV
  - ID ε > 90%, track matching included.
  - E/P:75-80%

Mis-identification probability measured with dijet events

Muon Reconstruccion

Calorimeter + tracking + μ stub information.

- Loose muon:
  - High Pt isolated track pointing to a gap in the muon coverage $|\eta|<1.2$
  - MIP requirements.
- Tight muon:
  - High Pt isolated track pointing to a muon stub $|\eta|<1$.
- ε measured with $Z\rightarrow\mu\,\mu$
  - Trigger ε: 88%(CMUP)-95%(CMX)
  - ID ε : 85%(CMUP)-90%(CMX)

- μ-track measured twice:
  - Toroidal spectrometer: position and timing information before & after the magnet.
    - Precision Pt measured in central fiber tracker
  - Track match: position and P.
- ε measured with $Z\rightarrow\mu\,\mu$
  - Trigger ε: 50% (single μ)
  - Tracking ε > 95%.

Mis-identification probability measured with dijet events
Veto cosmics using timing information and track information.
Veto μ from jets (mostly b) using isolation: calorimeter (CDF & DØ)and track (DØ)

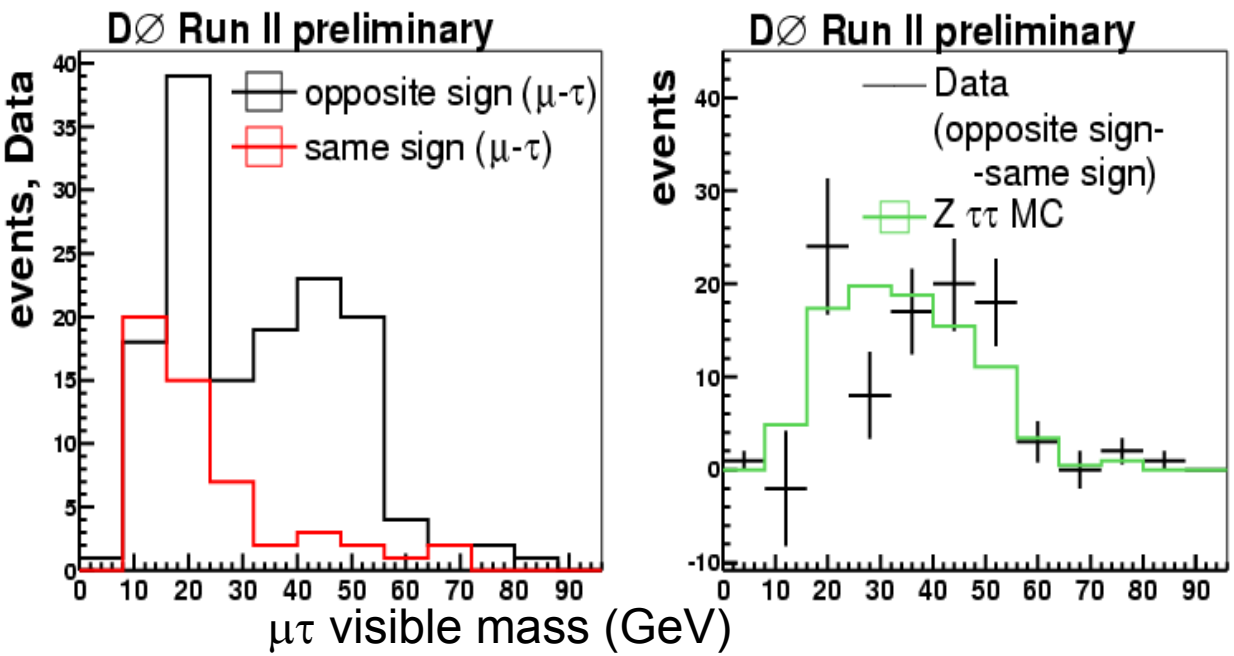
$\mathcal{L} = 68\ pb^{-1}$

DØ $Z \rightarrow t_h^+ t_\ell^-$ Signals

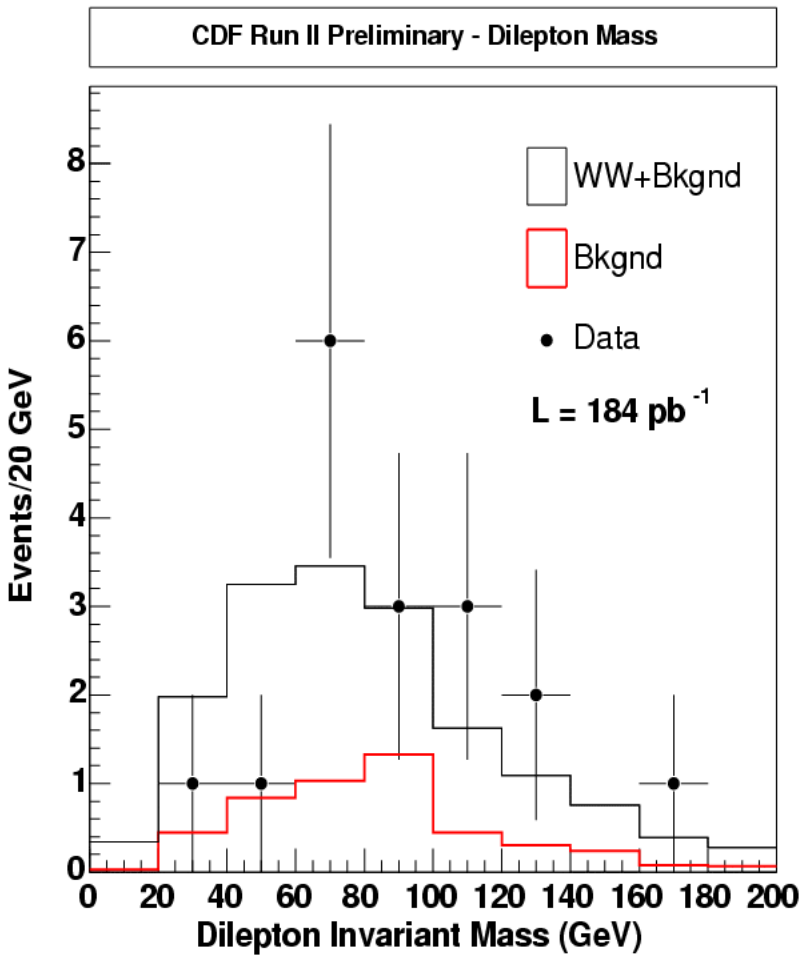
$$Z \rightarrow \tau\ (\rightarrow \mu\nu\nu)\ \tau\ (\rightarrow \pi^{\pm}\nu + n\pi^0)$$

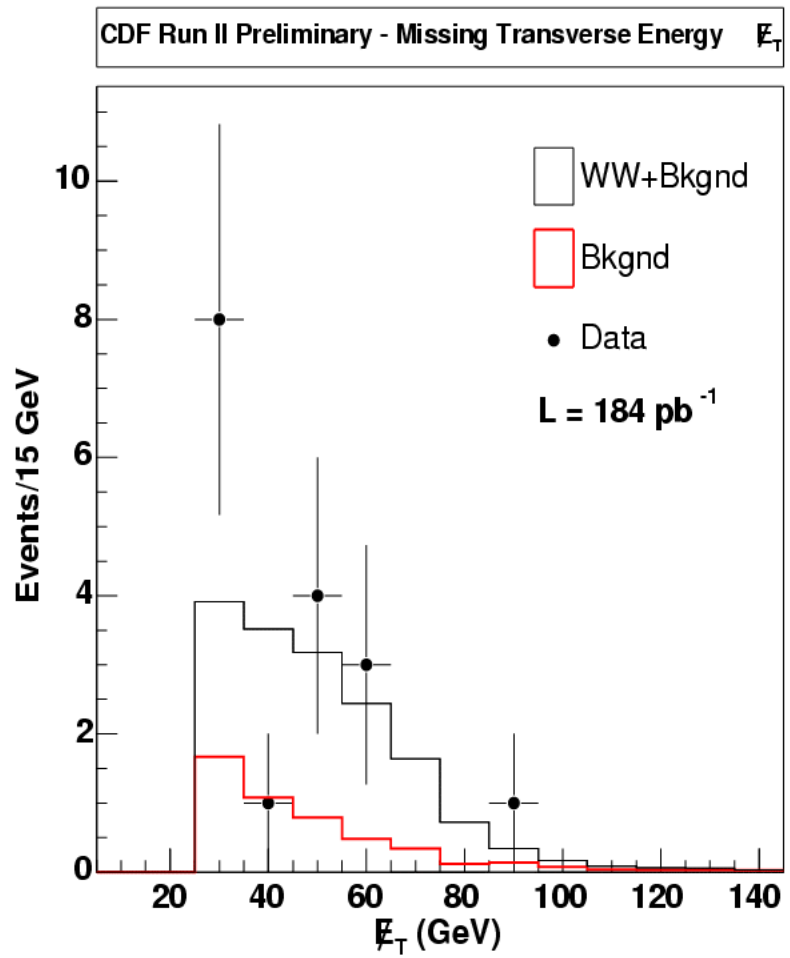
Backgrounds

- QCD μ from bb or π/K decay
- $W \rightarrow \mu\nu$ or $\tau\nu$ + jet
- $Z \rightarrow \mu\mu$

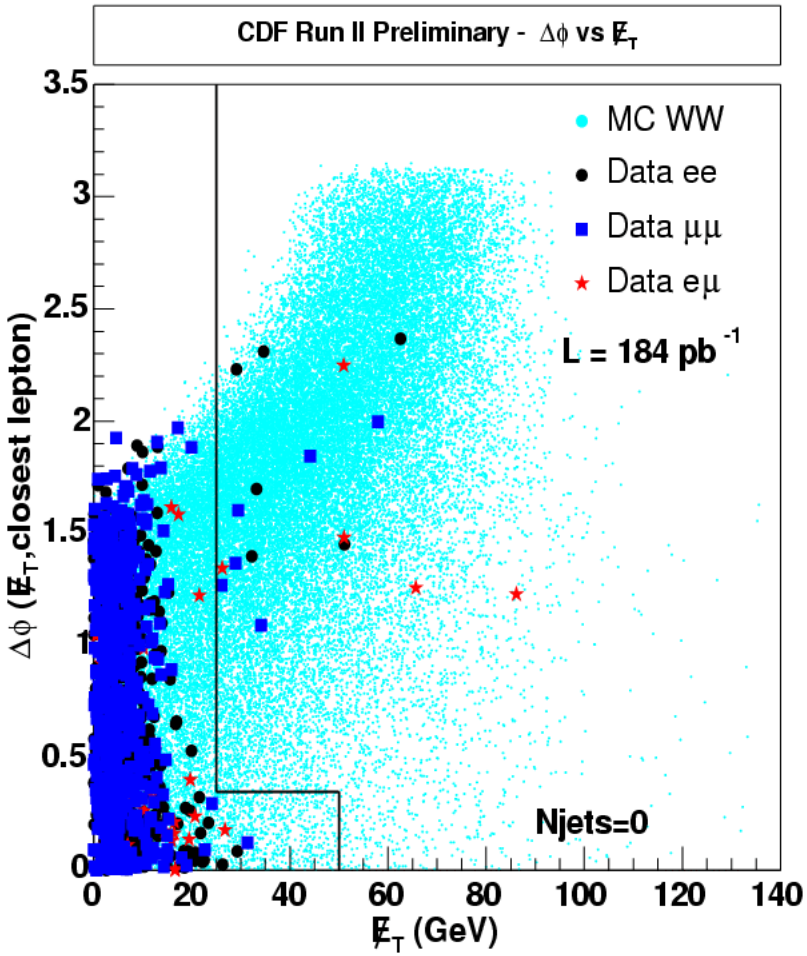


CDF: WW (III)


CDF Run II Preliminary - Dilepton Mass
WW+Bkgnd
Bkgnd
Data
L = 184 pb -1
Events/20 GeV
Dilepton Invariant Mass (GeV)
0
1
2
3
4
5
6
7
8
0
20
40
60
80
100
120
140
160
180
200


CDF Run II Preliminary - Missing Transverse Energy $\not{E}_T$
WW+Bkgnd
Bkgnd
Data
L = 184 pb -1
Events/15 GeV
$\not{E}_T$ (GeV)
0
2
4
6
8
10
20
40
60
80
100
120
140

CDF: WW (IV)

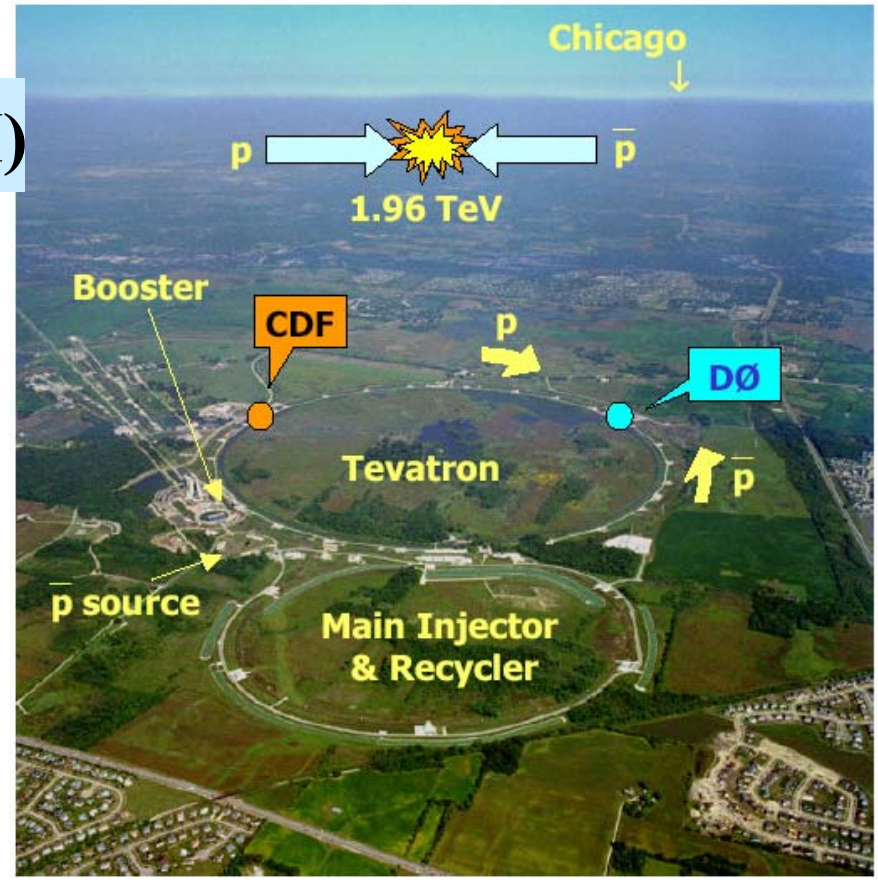

CDF Run II Preliminary - Δφ vs ∅E_T
MC WW
Data ee
Data μμ
Data eμ
L = 184 pb^-1
Njets=0
Δφ (∅E_T,closest lepton)
∅E_T (GeV)
0
0.5
1
1.5
2
2.5
3
3.5
0
20
40
60
80
100
120
140

TheTevatron collider in Run 2

- Tevatron is a proton-antiproton collider operating with E_{beam}=980 GeV

$$\sqrt{s} = 1.96\text{TeV RunII}(1.8\text{TeV RunI})$$

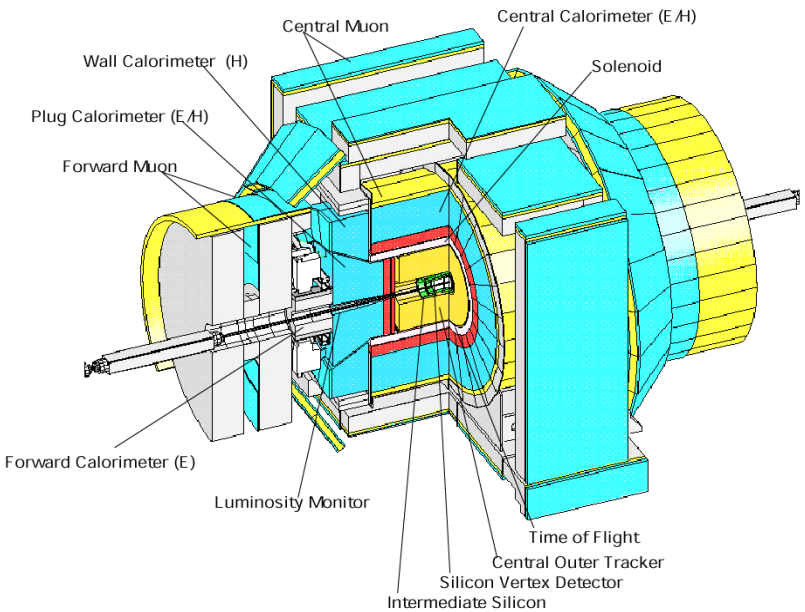
- 36 p and p bunches →396 ns between bunch crossing.
  - Run $\overline{1}$: 6x6 bunches with 3.5μs
- Increased instantaneous luminosity:
  - Typical: 4-5 x 10^{31} cm^{-2} s^{-1}
  - Record: 6.1 x 10^{31} cm^{-2} s^{-1}
- Tevatron has delivered ~430 pb^{-1}
- Long term, by the end of FY09
  - Base goal: 4.4 fb^{-1}
  - Design: 8.5 fb^{-1}

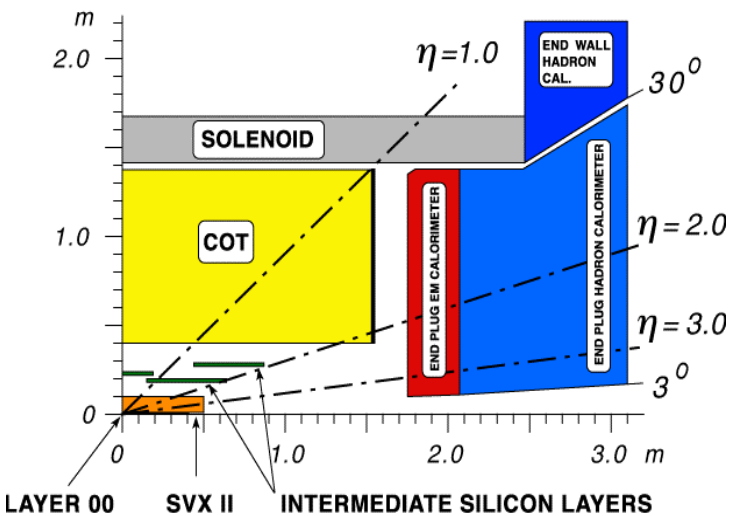


CDF Run II Detector

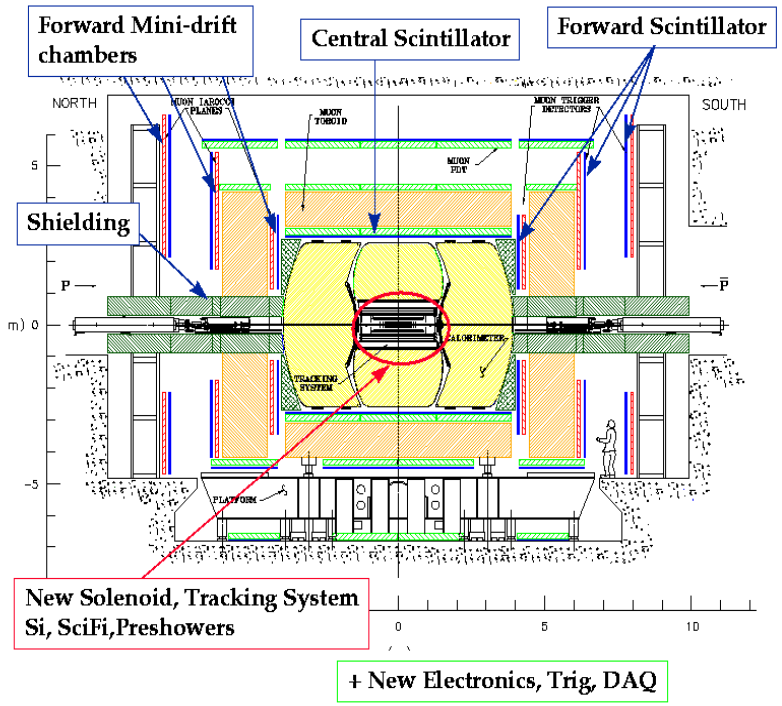
From Run I:
- Solenoid
- Central muon system
- Central calorimeter

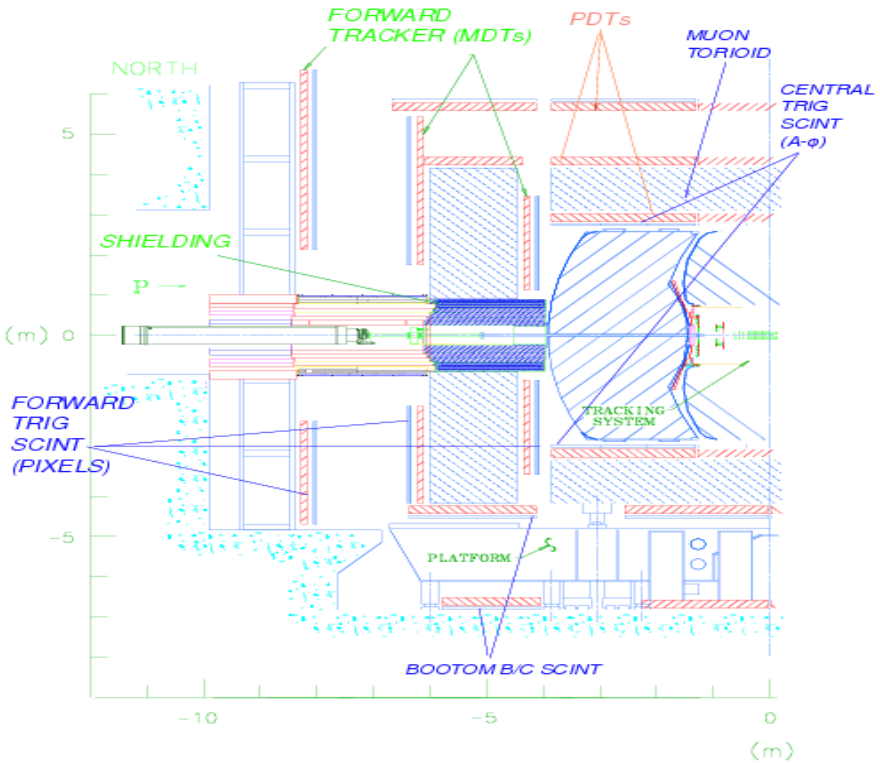
New For Run II:
- Front-end DAQ
- Trigger:Track (L1) and Displaced Track (L2)
- Silicon Tracker (8 Layers) ($|\eta| < 2.0$)
- Central Outer Tracker ($|\eta| < 1.0$)
- Plug Calorimeters ($1.0 < |\eta| < 3.6$)
- Extended Muon Coverage ($|\eta| < 1.5$, gaps filled in)





Overview of DØ Detector





- New Inner tracking (silicon tracker, scintillating fiber tracker,preshowers) with 2T superconducting solenoid
- Excellent calorimetry, hermetic detector.
- Upgraded μ system for better μ -ID
- Faster readout electronics, new trigger and DAQ.