CDF Run II 実験 現状報告1

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For the CDF Collaboration

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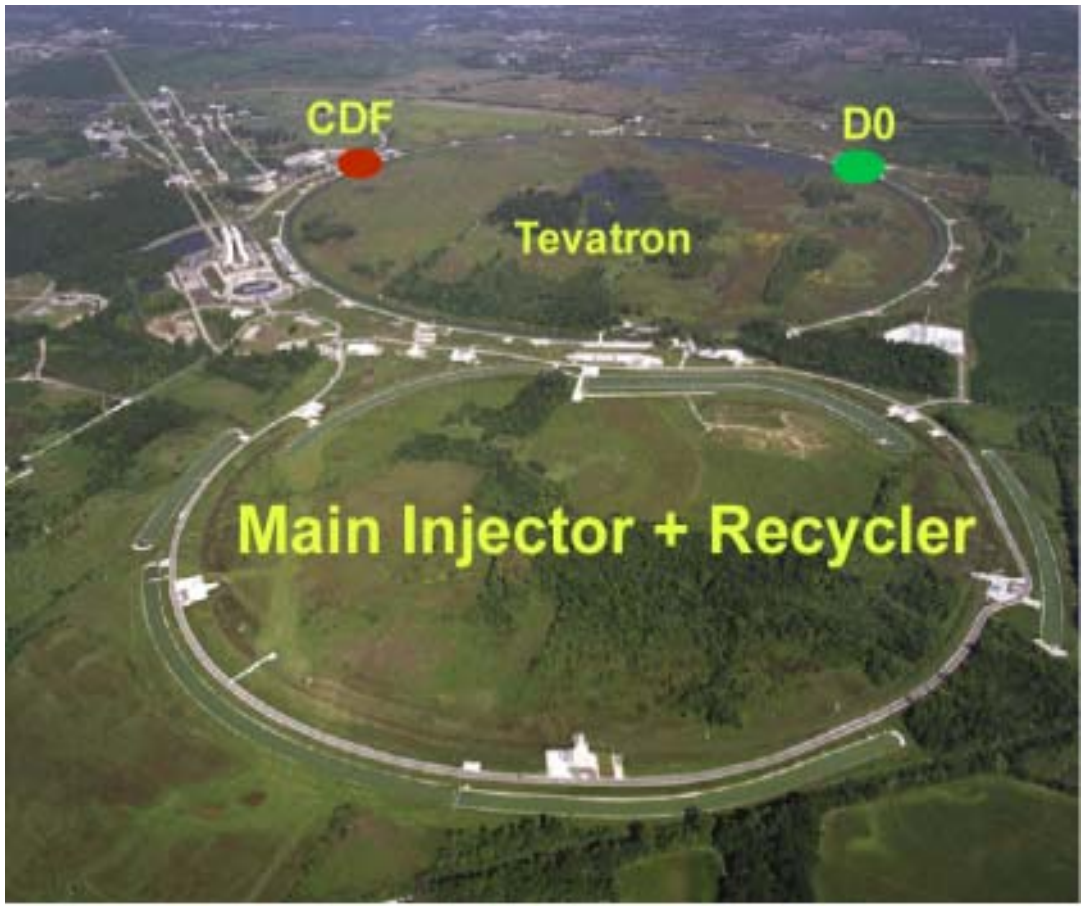
- Outline of Tevatron status and CDF Run II experiment
- Status of Electroweak physics
- Status of QCD physics
- Status of Beyond SM physics
- Summary

Tevatron Upgrade

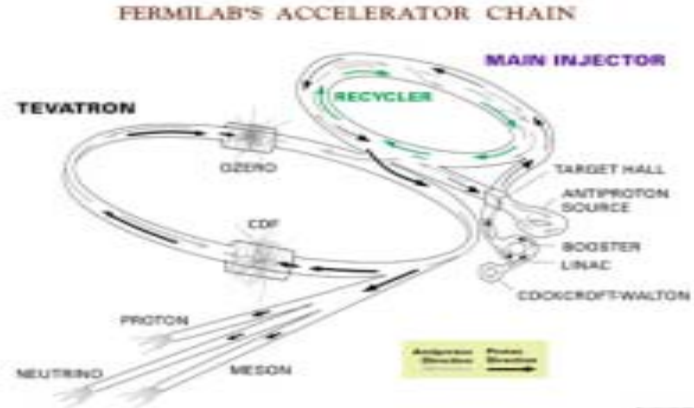


Main Injector

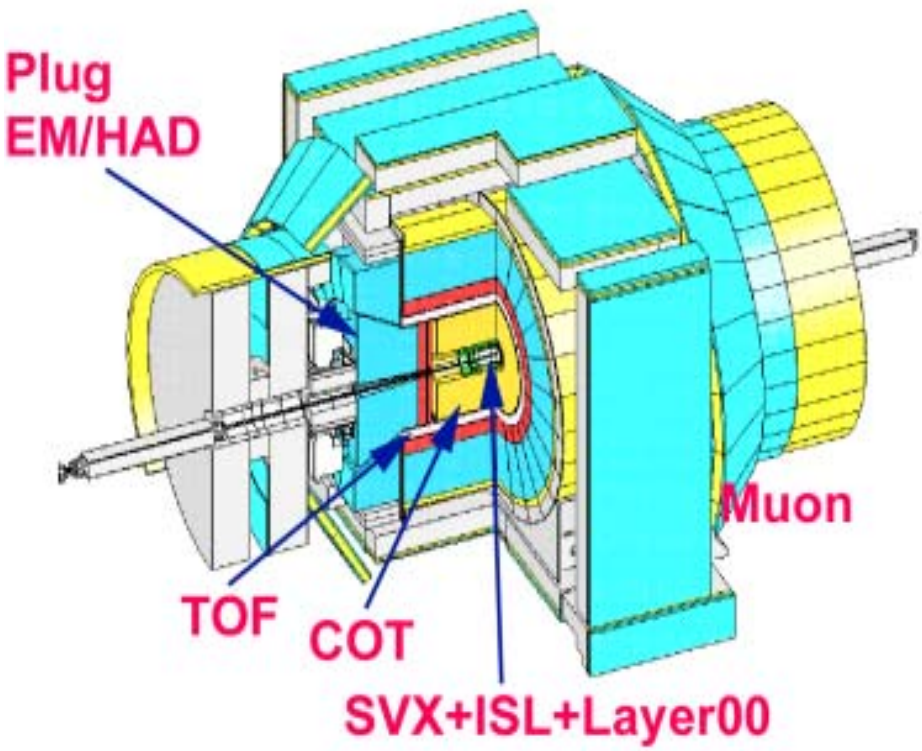
- 反陽子生成率の向上
- ビーム強度の増加

Recycler ring

- 反陽子の再利用
- 今夏に稼動開始予定



CDF Upgrade

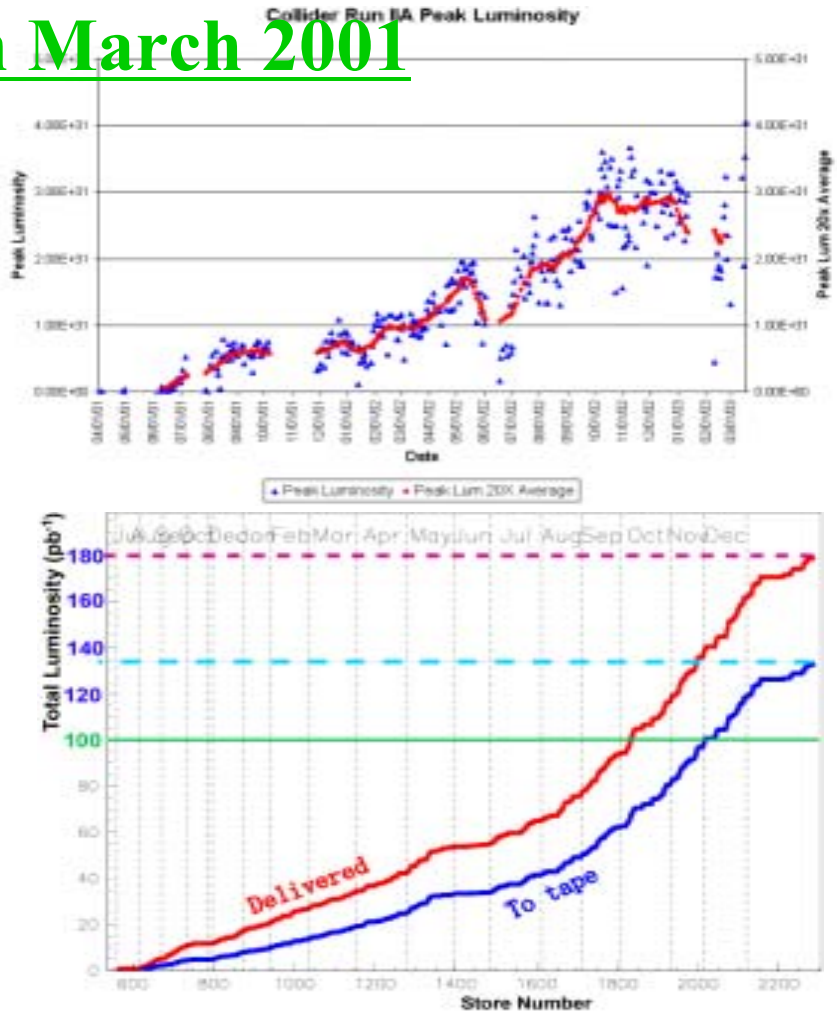


- **SVX+ISL+Layer00**
  - 3-D reconstruction
  - extend to $|\eta| = 2$
- **COT**
- **Plug EM/HAD**
  - gas → scintillator tiles
- **TOF**
  - new installed
- **Muon system**
  - extend to $|\eta| = 1.5$
- **Trigger system**

Status of Run II experiment

Tevatron operations started in March 2001

- Collides 36×36 protons and pbars @ 980 GeV
- Luminosity goals for Run IIa:
  - 5-8×10^{31} $cm^{-2}sec^{-1}$ w/o Recycler
  - 2×10^{32} $cm^{-2}sec^{-1}$ with Recycler
- Achieved by Mar.2003
  - 4.1×10^{31} $cm^{-2}sec^{-1}$ in Mar. 2003
  - 180pb^{-1} delivered
  - 140pb^{-1} are on tape



Electroweak Physics

- **Cross section measurement**
- **Forward-Backward asymmetry**
- **Diboson process**

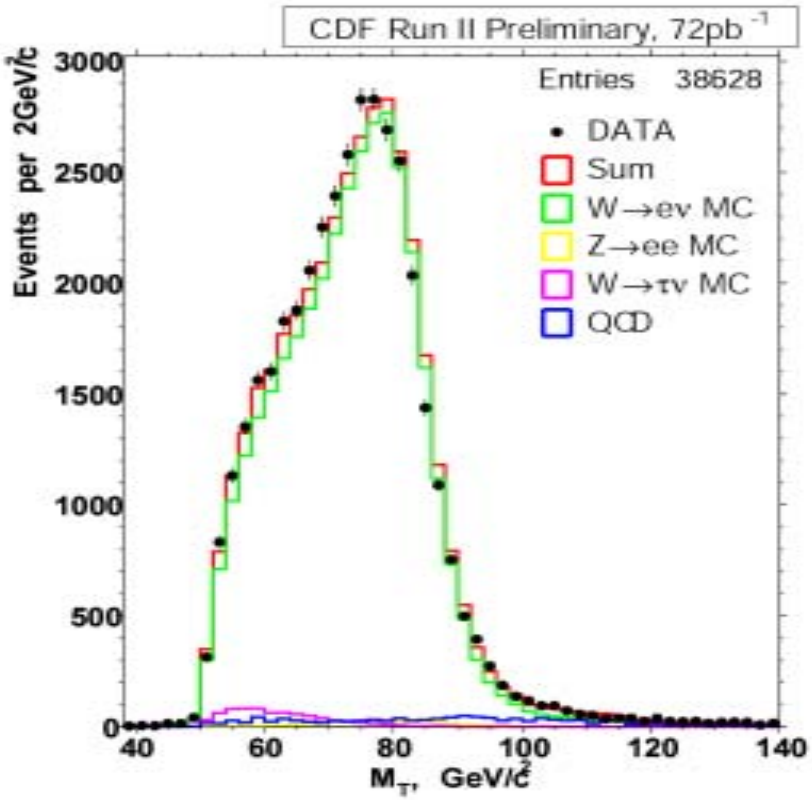
$\sigma \cdot BR(W \rightarrow e \nu_e)$

Event selection

- One isolated central electron with $E_T > 25$GeV & $P_T > 10$GeV/c
- Missing $E_T > 25$ GeV

38628 candidates in ~72 pb^{-1}

Backgrounds – 6.4% by QCD



$$\sigma \cdot BR(W \rightarrow e \nu_e) = 2.64 \pm 0.01_{stat} \pm 0.09_{sys} \pm 0.16_{lum} \text{ nb}$$

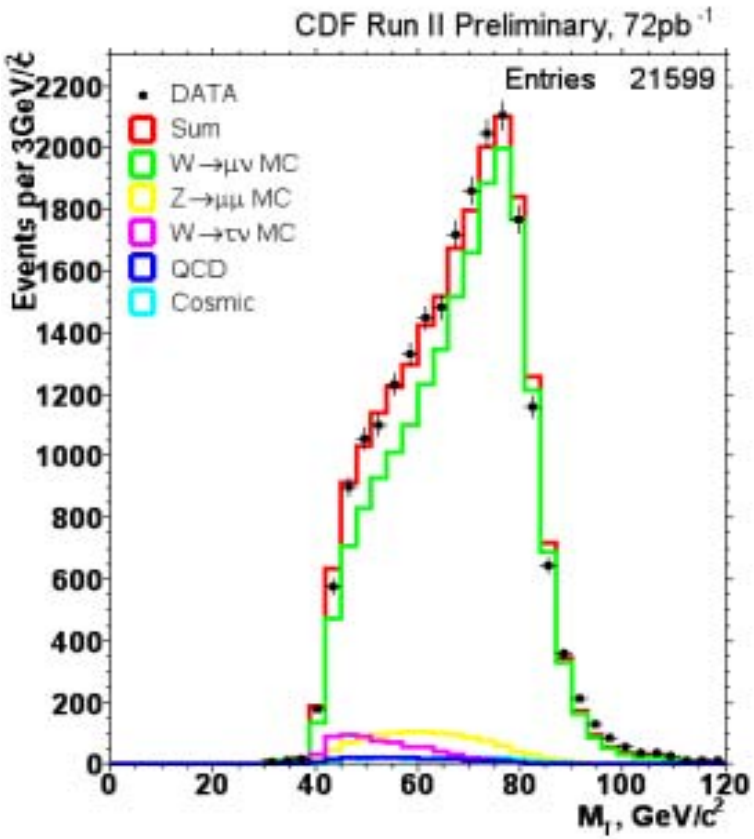
$\sigma \cdot BR(W \rightarrow \mu \nu_\mu)$

Event selection

- One isolated central μ with $P_T > 20$ GeV/c
- Missing $E_T > 20$ GeV
- Remove cosmic contamination

21599 candidates in ~72 pb^{-1}

Backgrounds – 11% by $Z^0 \rightarrow \mu\mu$



$$\sigma \cdot BR(W \rightarrow \mu \nu_\mu) = 2.64 \pm 0.02_{stat} \pm 0.12_{sys} \pm 0.16_{lum} \text{ nb}$$

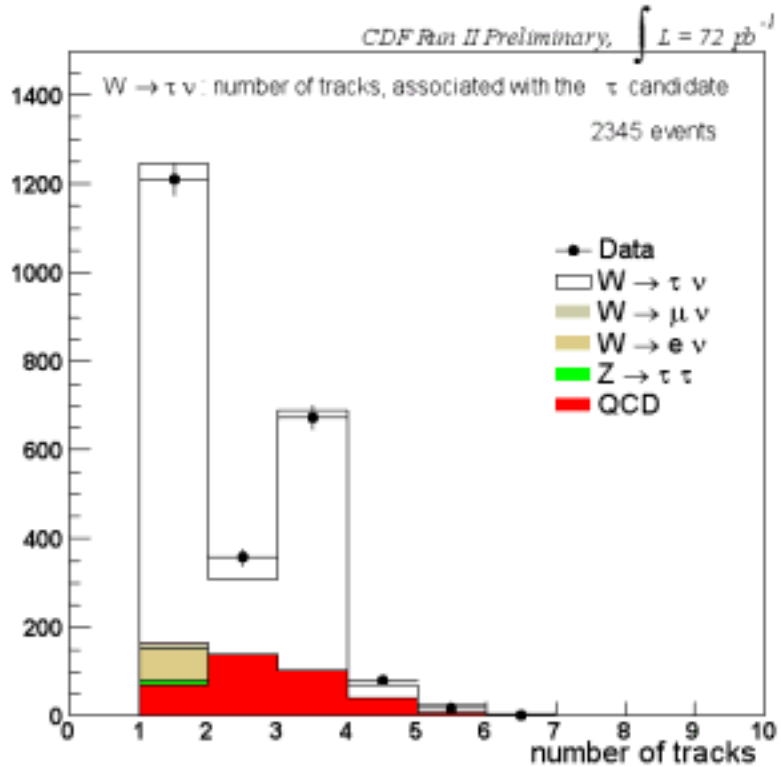
$\sigma \cdot BR(W \rightarrow \tau \nu_\tau)$

Event Selection

- One isolated central τ with $E_T > 25$GeV
- Missing $E_T > 25$ GeV
- electron removal

2345 candidates in ~72 pb^{-1}

Backgrounds – 26% by QCD & $W \rightarrow e \nu$



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

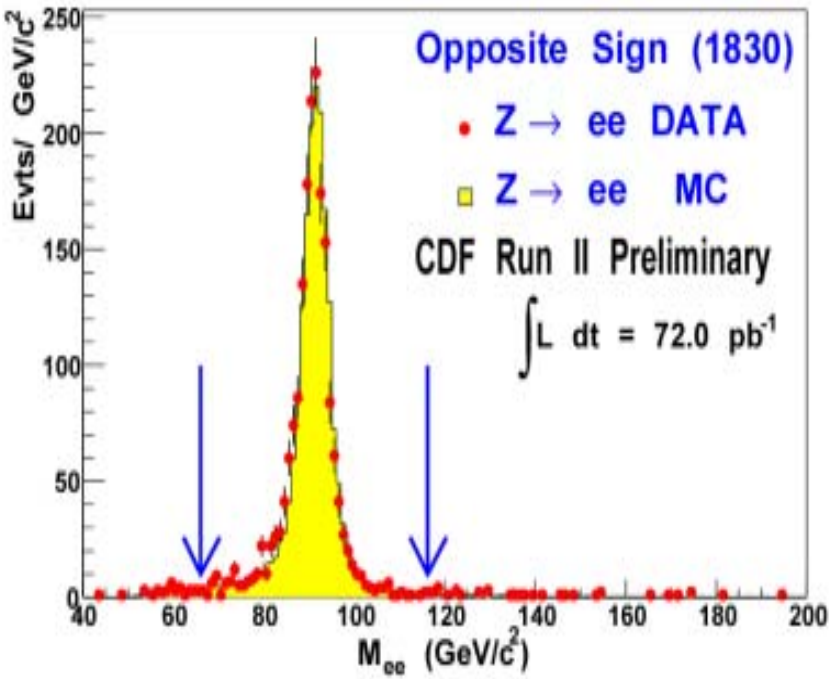
$\sigma \cdot BR\,(Z^0 \rightarrow e^+e^-)$

Event Selection

- Two isolated central electrons with E_T>25GeV & P_T>10GeV/c

1830 candidates in ~72pb^{-1}

Backgrounds – 0.5% by QCD Dijet events



$$\sigma \cdot BR\,(Z^0 \rightarrow e^+e^-) = 267.0 \pm 6.3_{stat} \pm 15.2_{sys} \pm 16.0_{lum}\ pb$$

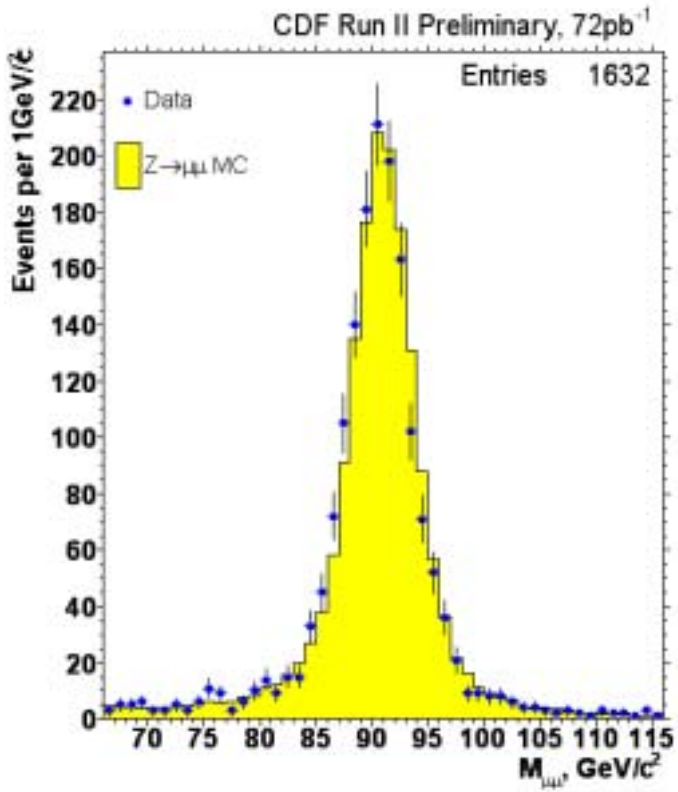
$\sigma \cdot BR(Z^0 \rightarrow \mu^+\mu^-)$

Event Selection

- One isolated central μ + one isolated μ with $P_T > 20$GeV/c
- Remove cosmic contamination

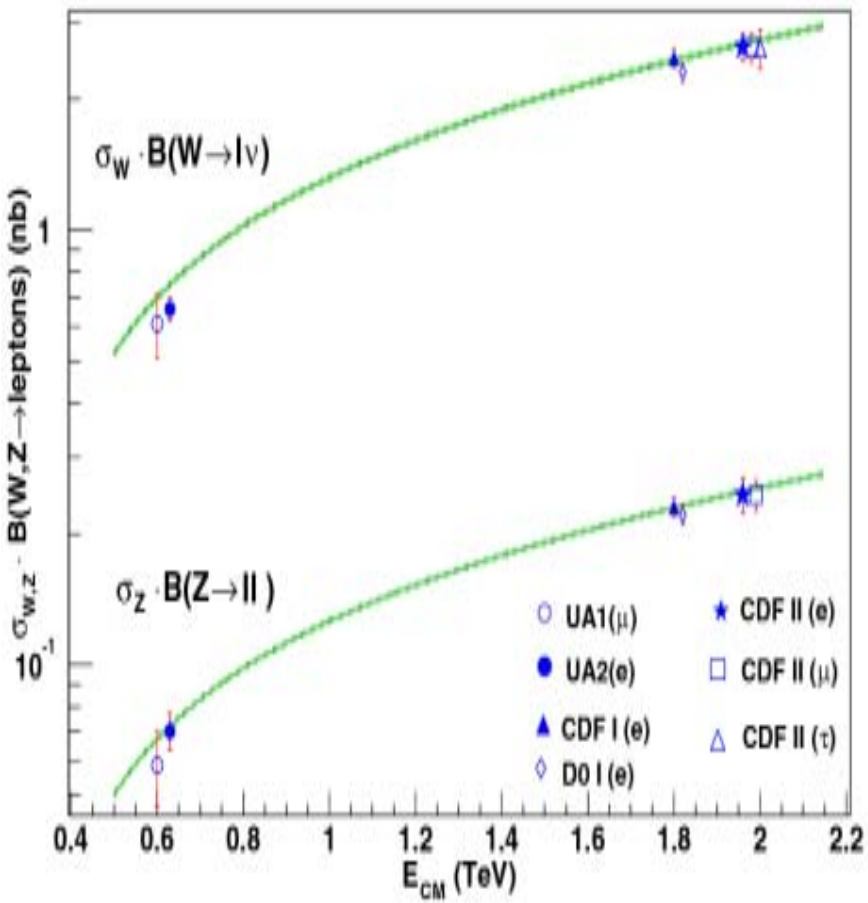
1632 candidates in ~72 pb^{-1}

Backgrounds – 0.83% by cosmic



$$\sigma \cdot BR(Z^0 \rightarrow \mu^+\mu^-) = 246 \pm 6_{stat} \pm 12_{sys} \pm 15_{lum} \text{ pb}$$

Results of σ_W and σ_Z



$$R_\ell = \frac{\sigma(p\bar{p} \to W)\Gamma(Z)\Gamma(W \to \ell\nu)}{\sigma(p\bar{p} \to Z)\Gamma(W)\Gamma(Z \to \ell\ell)} = \frac{N_W \varepsilon_Z A_Z}{N_Z \varepsilon_W A_W}$$

$$R_\mu = \sigma(W \to \mu\,\nu) / \sigma(Z \to \mu\,\mu) = 10.69 \pm 0.27_{stat} \pm 0.33_{sys}$$

$$R_e = \sigma(W \to e\,\nu) / \sigma(Z \to ee) = 9.88 \pm 0.24_{stat} \pm 0.47_{sys}$$

W width

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

Electron : $\Gamma(W) = 2.29 \pm 0.06_{stat} \pm 0.10_{sys}$ GeV

Muon: $\Gamma(W) = 2.11 \pm 0.05_{stat} \pm 0.07_{sys}$ GeV

$\Gamma(W) = 2.118 \pm 0.042$ GeV (PDG fit)

$\frac{\Gamma(Z \to ee)}{\Gamma(Z)} = 3.3632 \pm 0.0042\ \%$ (PDG) $\quad \Gamma(W \to e\nu) = 226.4 \pm 0.3$ MeV (PDG)

$\frac{\sigma(p\bar{p} \to W)}{\sigma(p\bar{p} \to Z)} = 3.39 \pm 0.03$ (hep - ph/0211080)

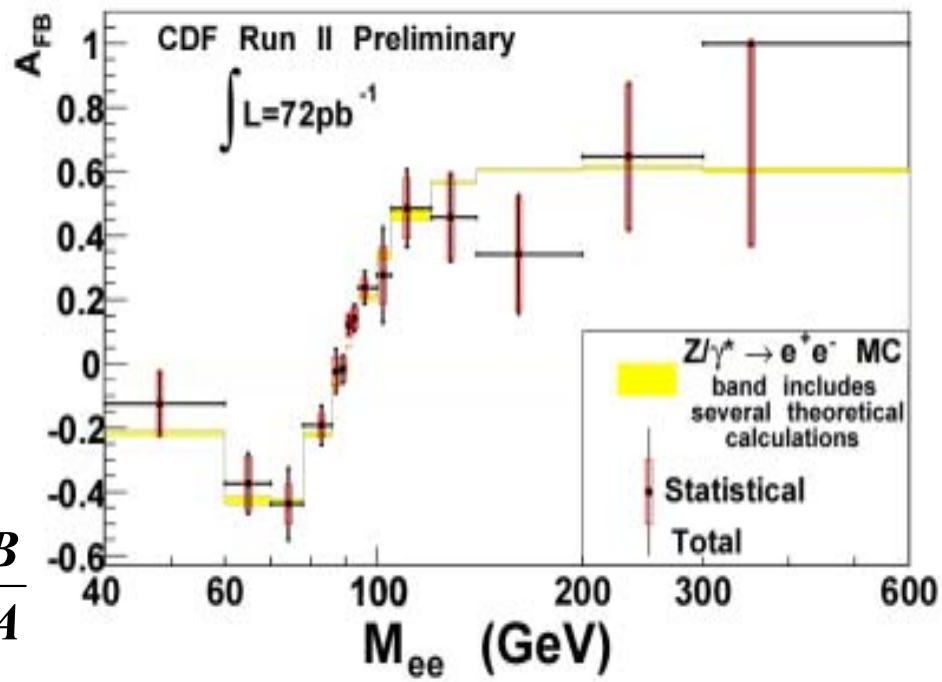
A_{FB} with $Z^0 \rightarrow e^+e^-$

Forward-Backward charge asymmetry

$$\frac{d\sigma(\bar{q}q \rightarrow Z/\gamma \rightarrow \ell^+\ell^-)}{d\cos\theta} = A(1+\cos^2\theta) + B\cos\theta$$

- **Direct probe V,A**
- **Constrains the properties of new heavy neutral gauge bosons**

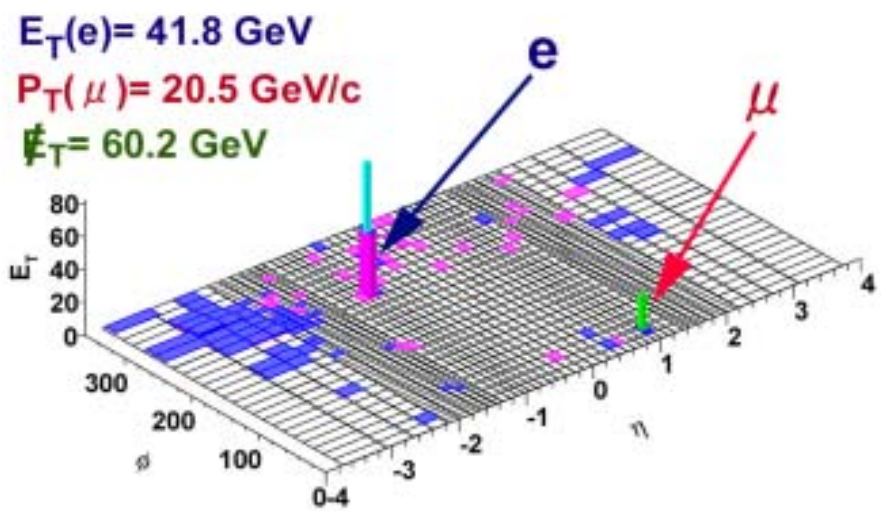
$$A_{FB} = \frac{N_F - N_B}{N_F + N_B} = \frac{\sigma(\cos\theta > 0) - \sigma(\cos\theta < 0)}{\sigma(\cos\theta > 0) + \sigma(\cos\theta < 0)} = \frac{3B}{8A}$$



$W^+W^- \rightarrow l\nu\,\nu$

Event Selection

- Two isolated high P_T central e or μ with opposite charge
- Missing Et > 25 GeV
- Z veto ($76<M_{ll}<106$ GeV/c^2)
- Jet veto

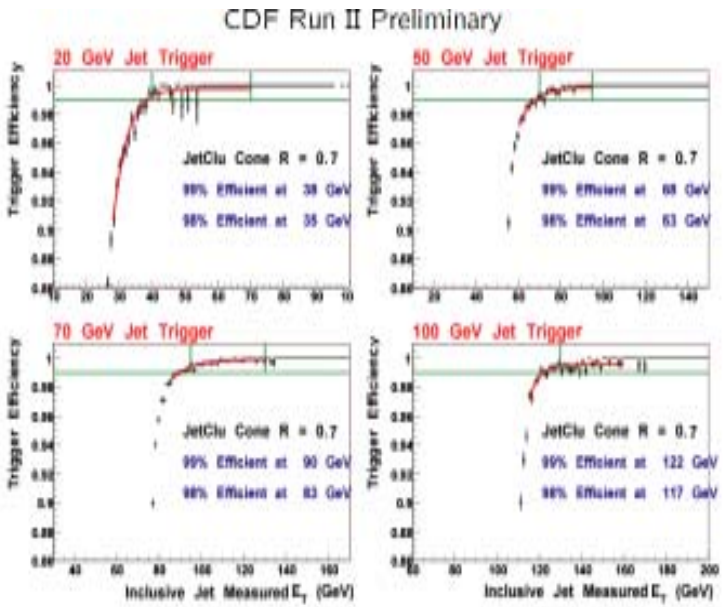


Source	ee	μ μ	e μ	ll
Backgrounds	0.29±0.13	0.46±0.18	0.77±0.60	1.52±0.64
WW→ll ν ν	0.54±0.12	0.65±0.14	1.55±0.34	2.74±0.59
Data	1	0	1	2

QCD Physics

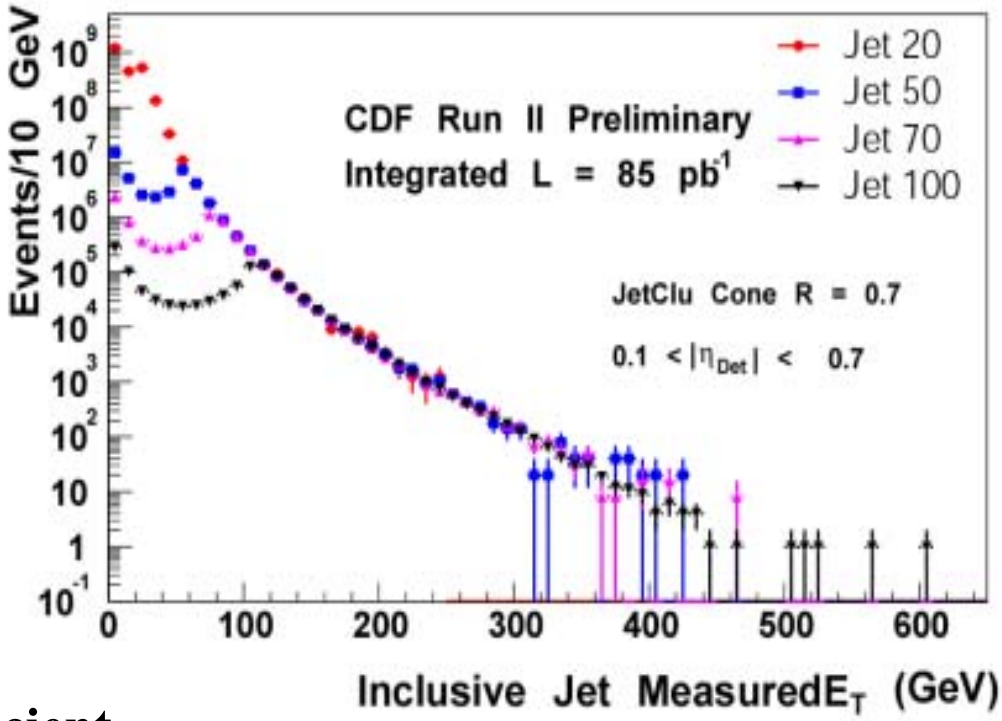
- **Inclusive jet cross section**
- **Dijet mass**
- **Study of jet shapes and E-flows in inclusive dijet production**
- **Diffractive dijet production**

Inclusive jet cross section

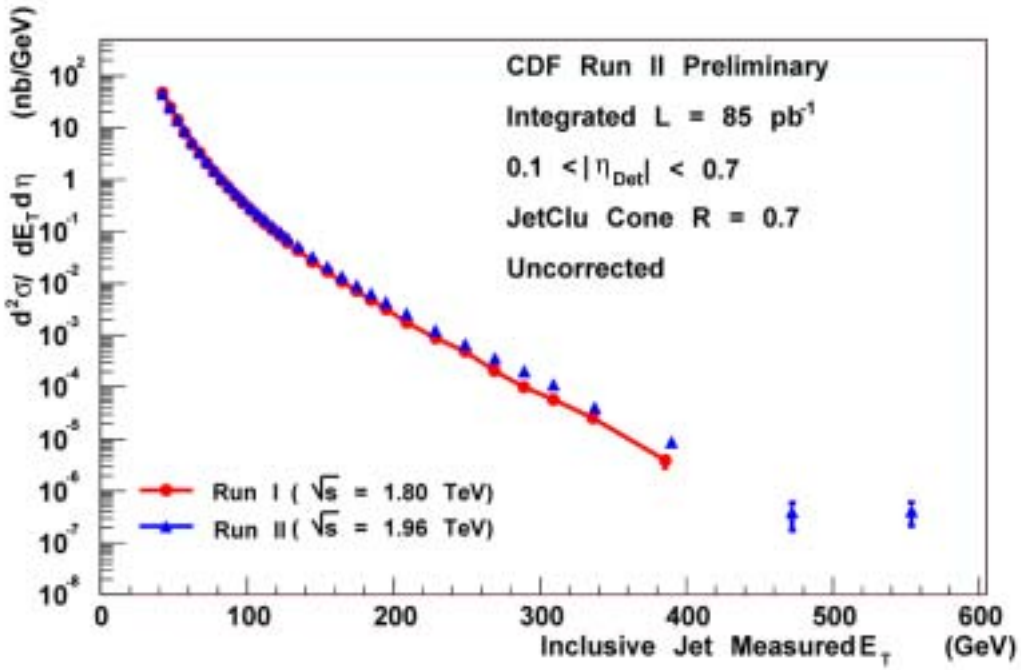


- Use cone algorithm (cone = 0.7)
- Missing E_T significance cut
  ($E_T^{missing} / \sqrt{(\Sigma E_T)}$)
- $E_{tot} < 2000$GeV
- Different E_T triggers
- Use data when trigger is 99% efficient

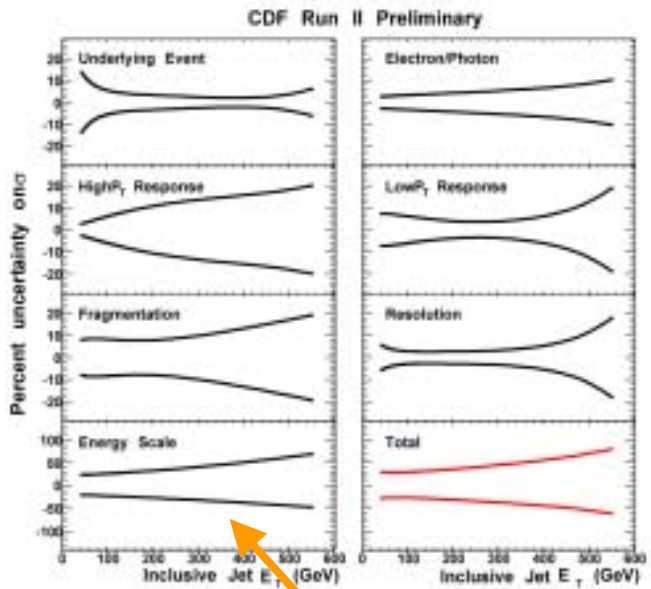
Jet E_T Spectrum



Inclusive jet cross section



Systematic uncertainties

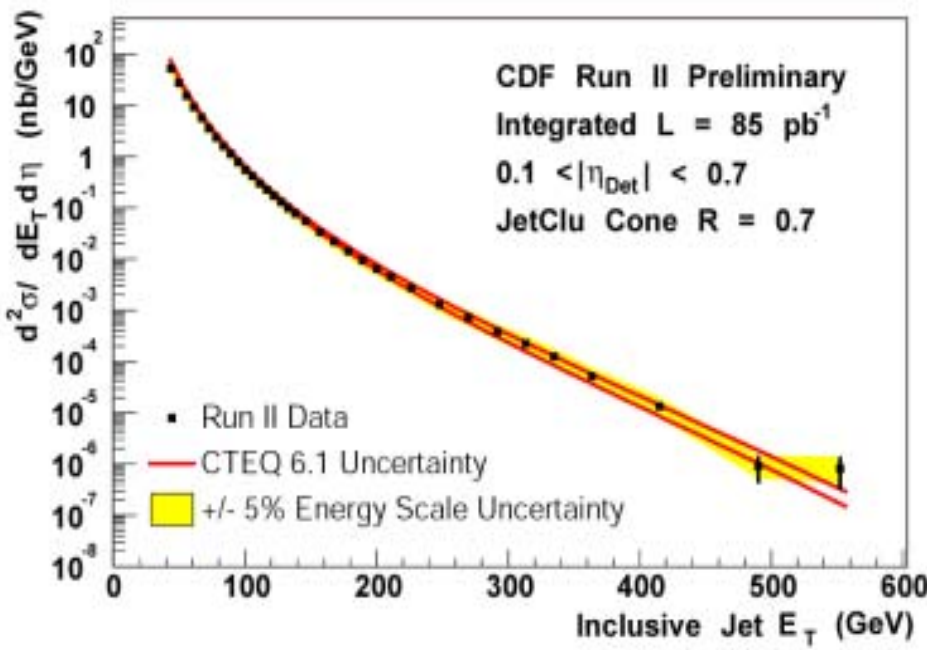


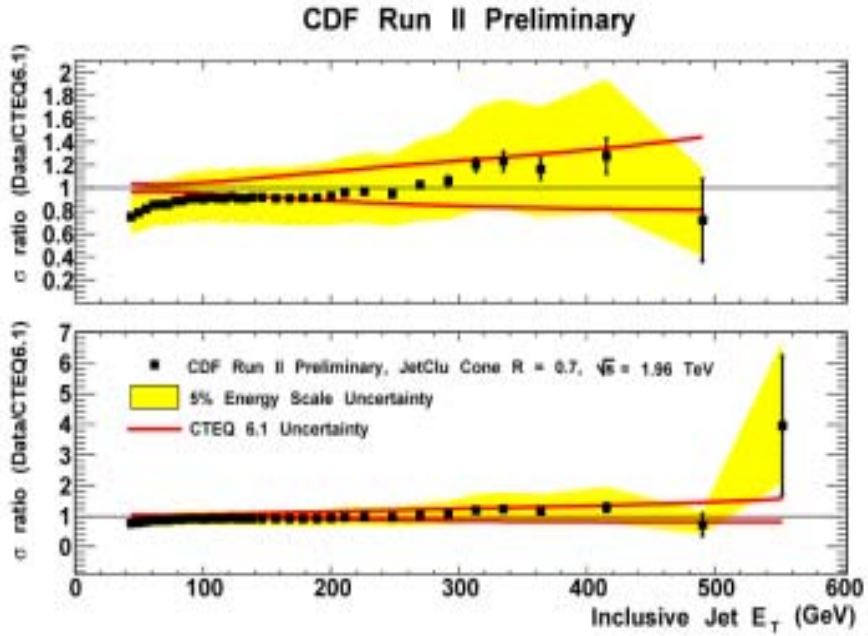
Run II data extends Run I results by ～ 150 GeV

Largest uncertainty
→ energy scale (～5%)

Inclusive jet cross section

Fit to cross section



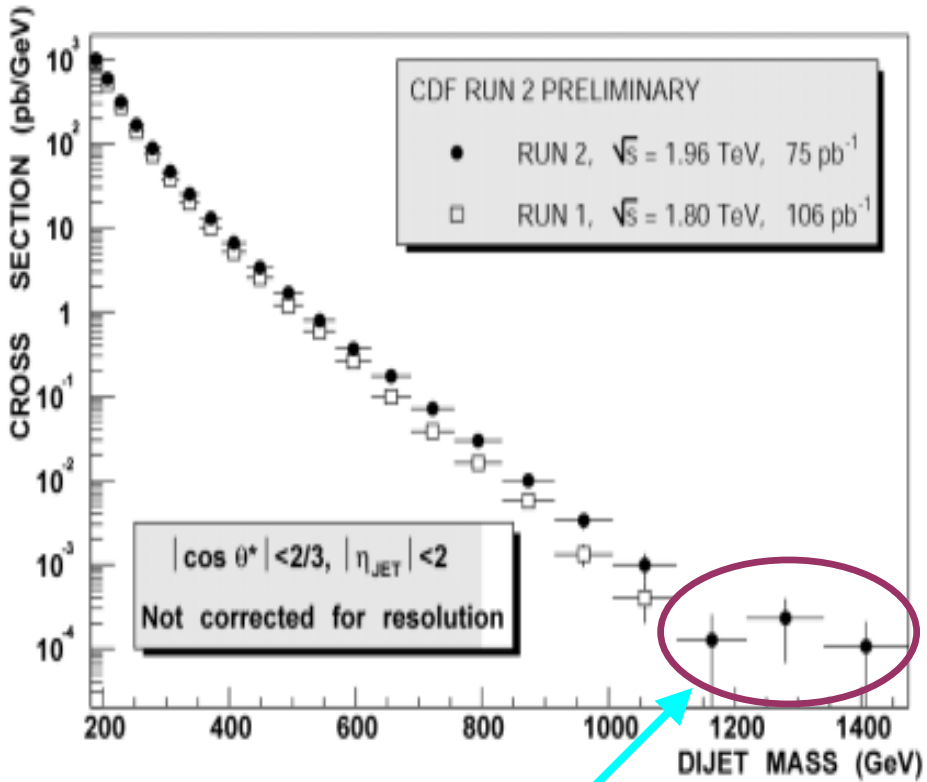


Best fit to central jet cross section provide by CTEQ6.1 PDF

Dijet mass

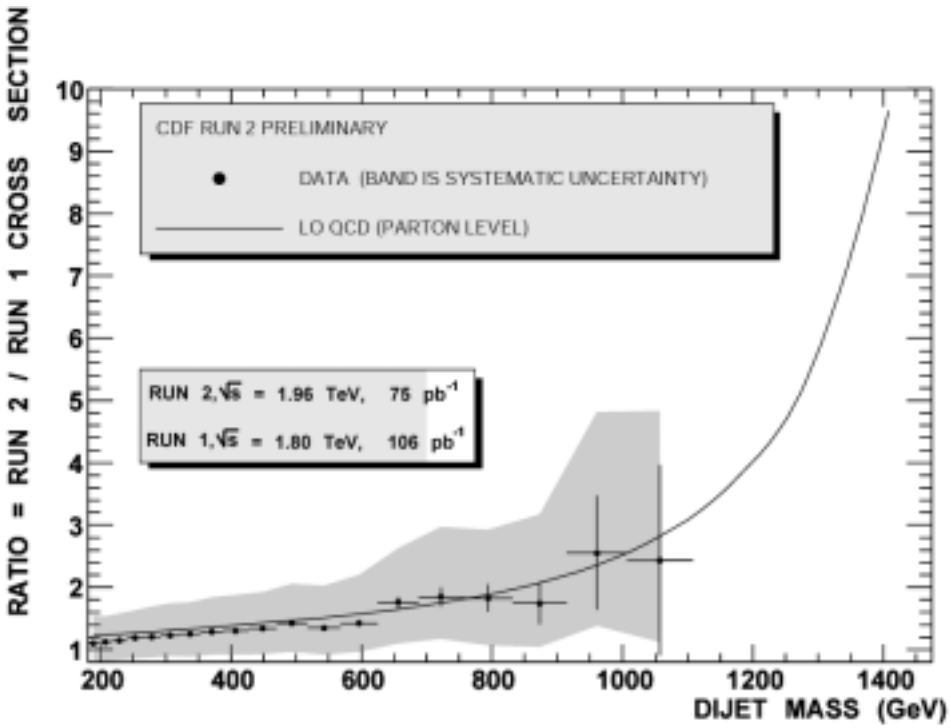
Dijet event selection

- Two highest E_T jets within $|\eta| < 2.0$
- $|\cos\theta^*| < 2/3$
  $(\cos\theta^* = \tanh([\eta_1 - \eta_2]/2))$



Larger dijet mass events than Run I

Dijet mass



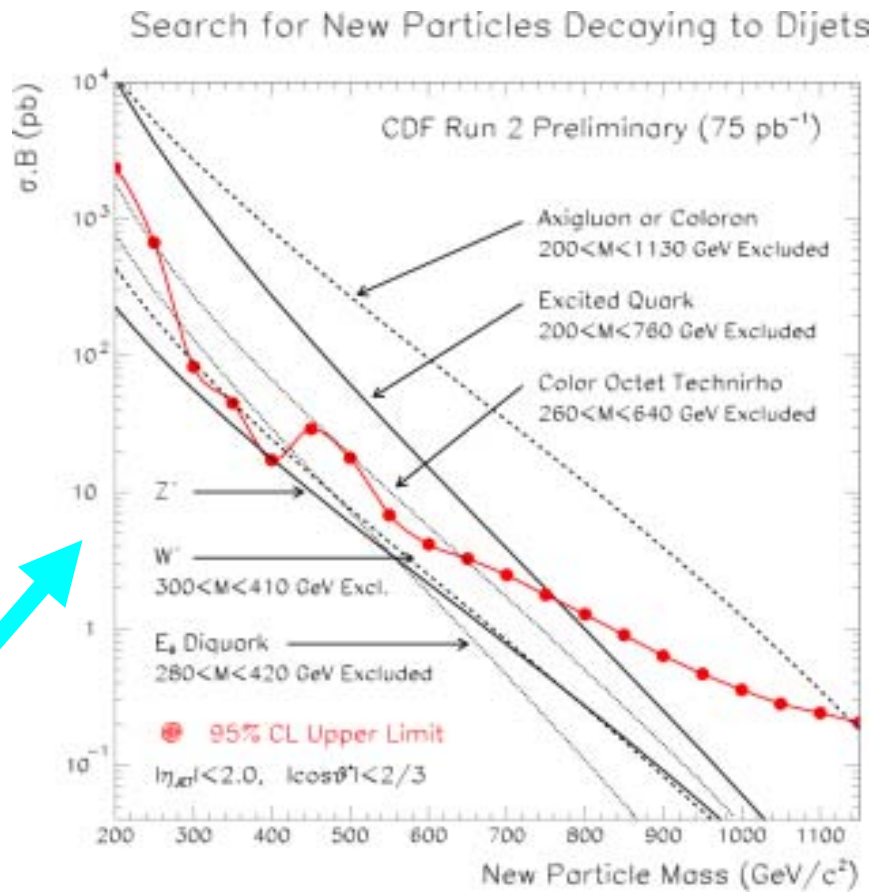
Dijet mass distribution from Run II has a higher cross section than Run I

Ratio agrees with theory to ～10% in rate, (～2% in Energy scale)

Dijet mass

Search for new particles decaying dijets

Model	Particle	Production/Decay	J^P(color) & I? 2
Chiral Color SU(3)L x SU(3)R	Axigluon A	$q\bar{q} \to A \to q\bar{q}$	$1^+(8)$ .05 M
Extended Technicolor	Coloron C	$q\bar{q} \to C \to q\bar{q}$	1 (8) .05 M
Composite Fermions	Excited Quark q^*	$qq \to q^* q \to qqg$	$1/2^+(3)$ .02 M
Superstring Inspired E6 Models	Diquarks D, D^c	$u\bar{u} \to D(\bar{D}) \to d\bar{d}$	$0^+(\bar{3})$ .004 M

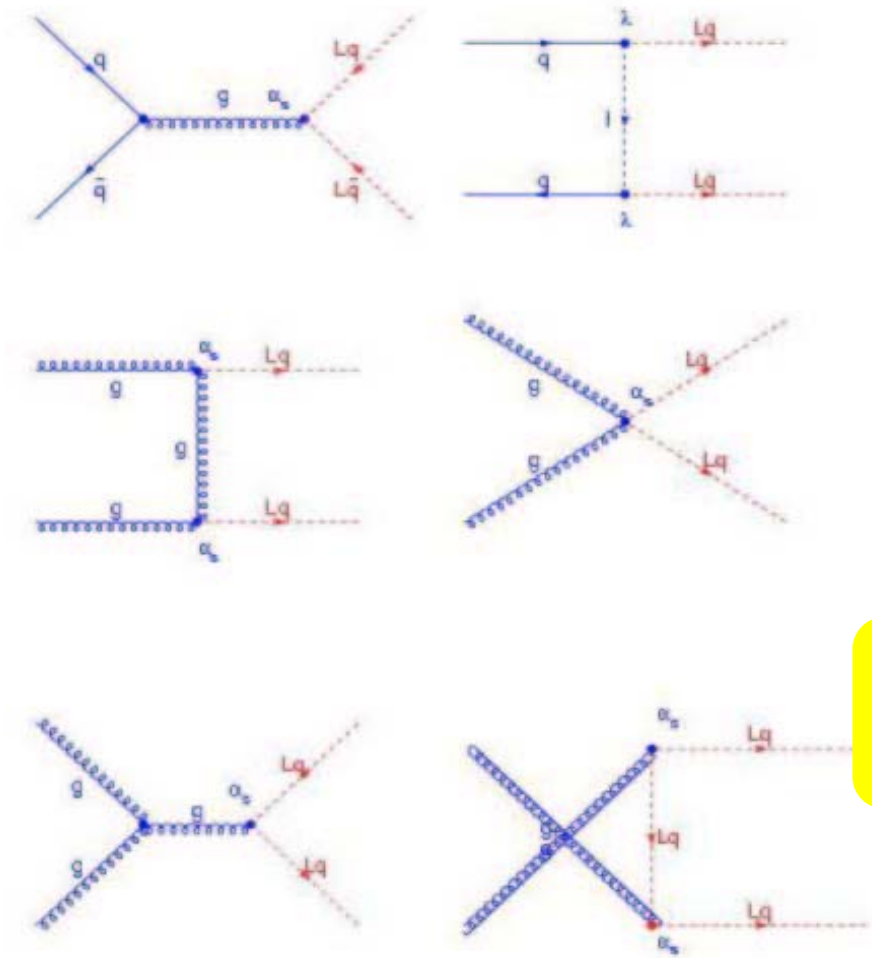


Set 95% C.L upper limits on cross section

Beyond SM physics

- **Search for LeptoQuarks**
- **Search high mass dilepton events**
- **Search for high-E_T di-photon events**
- **Charged massive particles**
- **Search for doubly-charged Higgs**

Search for Leptoquarks



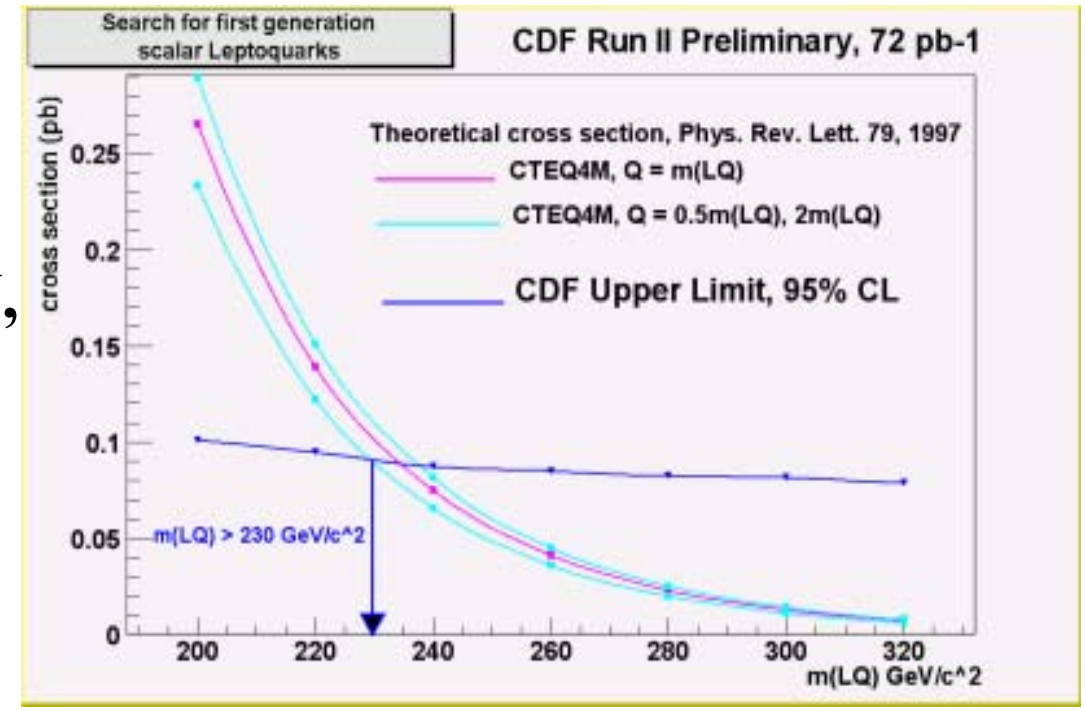
- Leptoquarks(LQ) generally pair produced and to decay into a lepton and a quark of the same generation
- β=Br(LQ→lq) is model dependent

Search for (LQ)(LQ)→(ej)(ej) (Assuming β=1)

Search for LeptoQuarks in the eejj channel

Event Selection

- Two central e with E_T>25GeV
- Two jets with E_T^{j1}>30GeV, E_T^{j2}>15GeV
- Removal Z→ee ($76<M_{ee}<106$ GeV/c^2)
- $\Sigma E_T(e_i)$ > 85 GeV
- $\Sigma E_T(j_i)$ > 85GeV
- $\Sigma (E_T(e_i)+E_T(j_i))$ > 200 GeV



0 event in ~72pb^{-1}

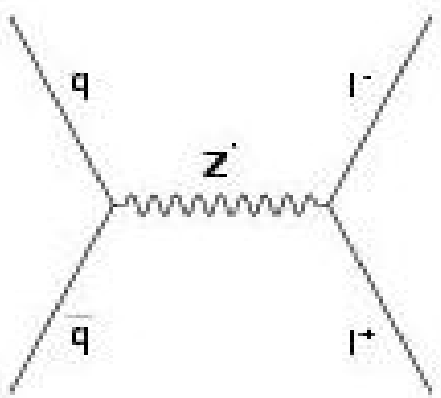
M_{LQ} < 230 GeV/c^2 excluded @95% C.L

High mass dilepton events

Search for new particle productions in high mass dilepton events

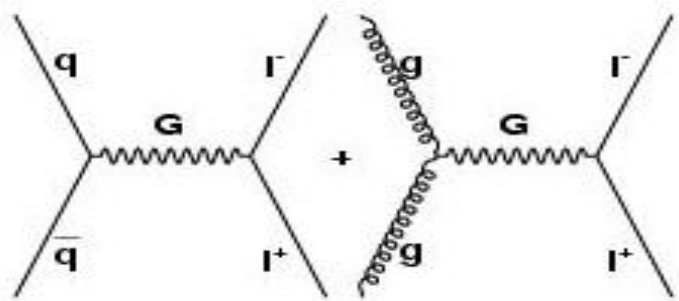
New neutral gauge boson Z′

various extensions of the SM parameter M(Z')



Randall–Sundrum Graviton G (ExtraDimensions)

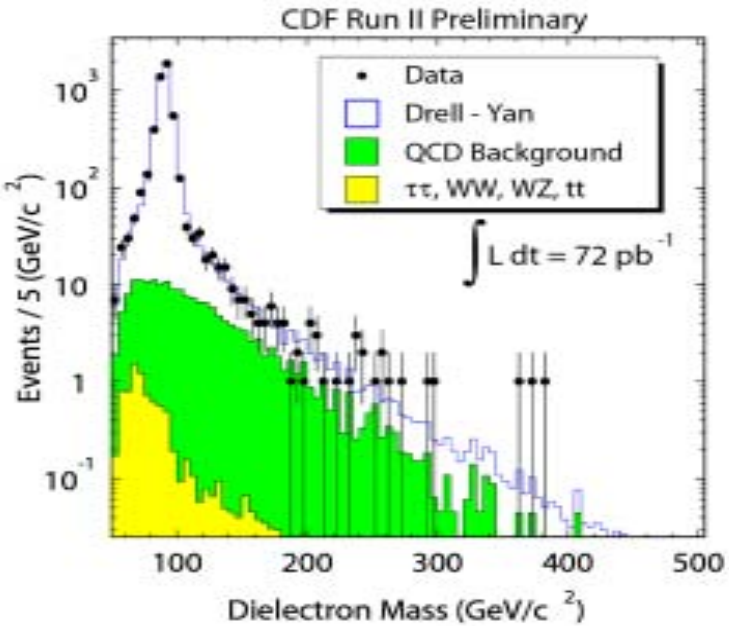
- Excited graviton 5-dimensions and spin-2 bosons
- Free parameters: M_G and k/M_{plank}



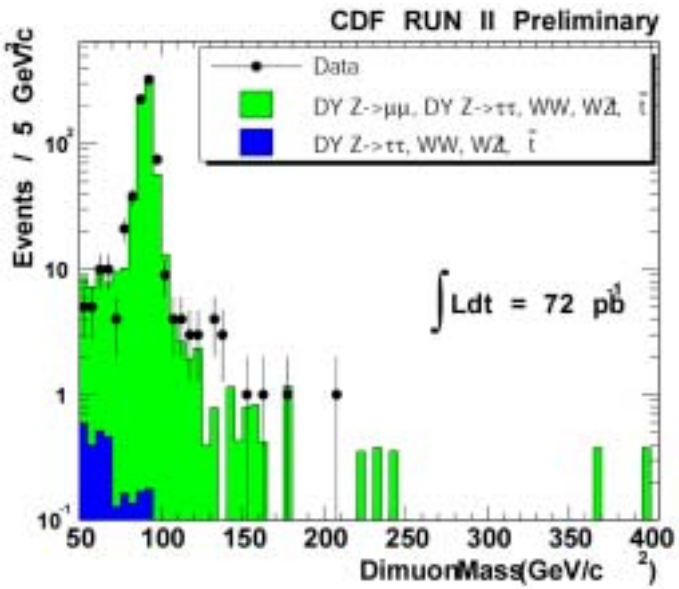
High mass dilepton events

– Drell-Yan production spectrum –

- dielectron -



- dimuon -

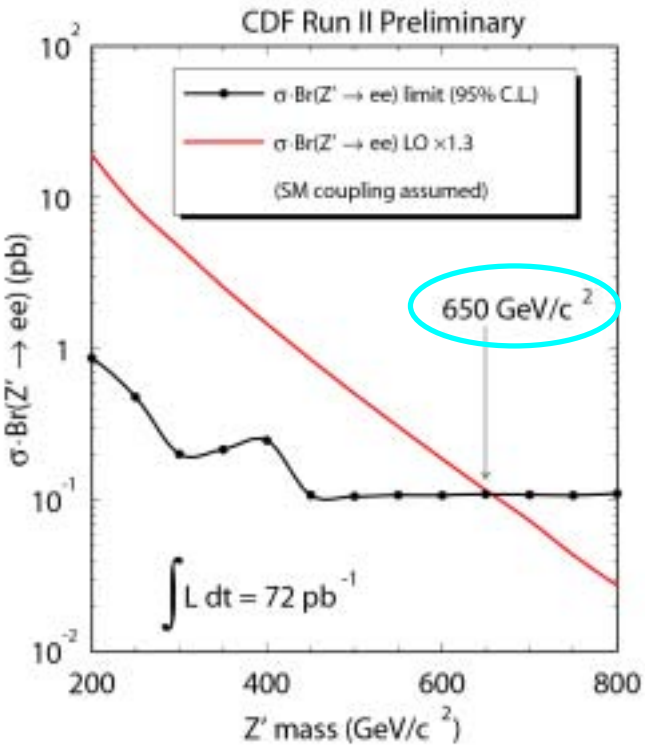


Data consistent with SM background

High mass dilepton events

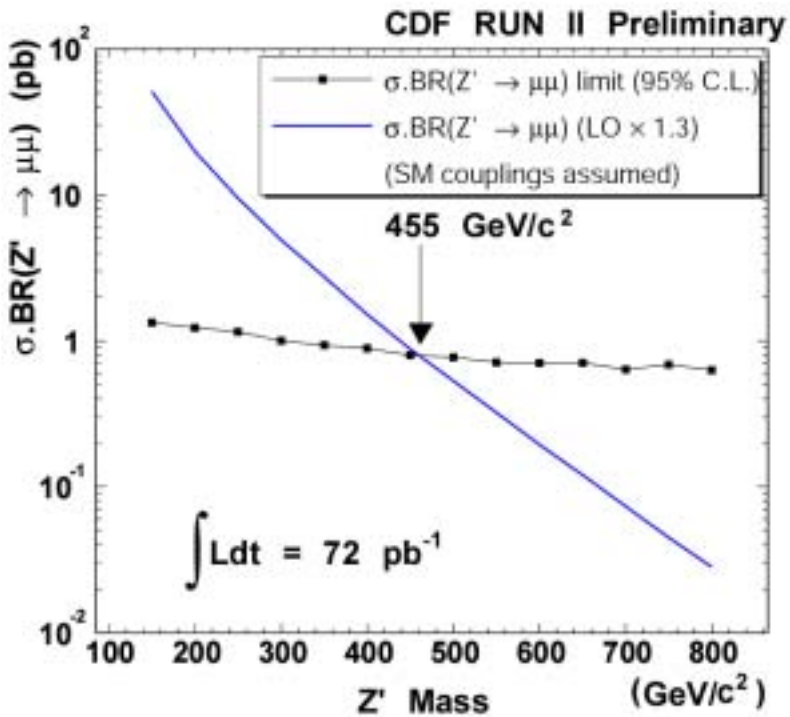
– Limits on Z′ –

- dielectron -



Run I : $M_{Z'} > 640$ GeV/c²

- dimuon -

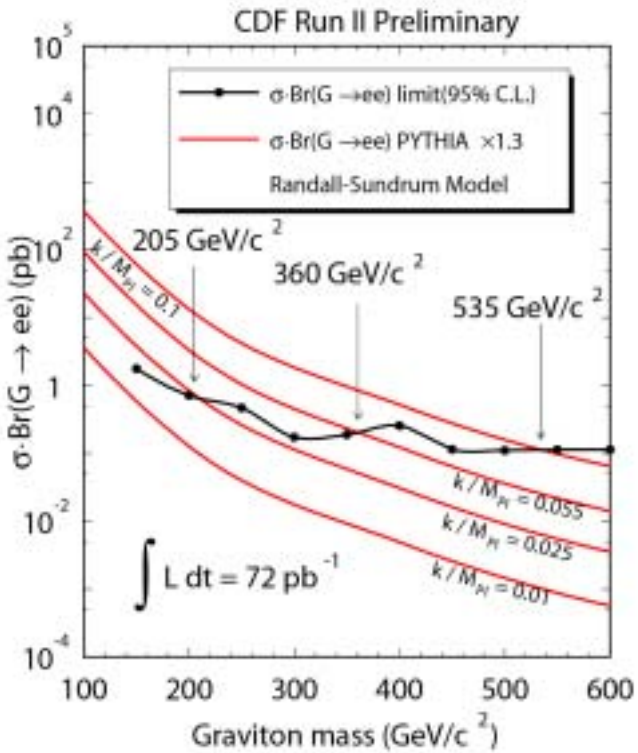


Run I : $M_{Z'} > 575$ GeV/c²

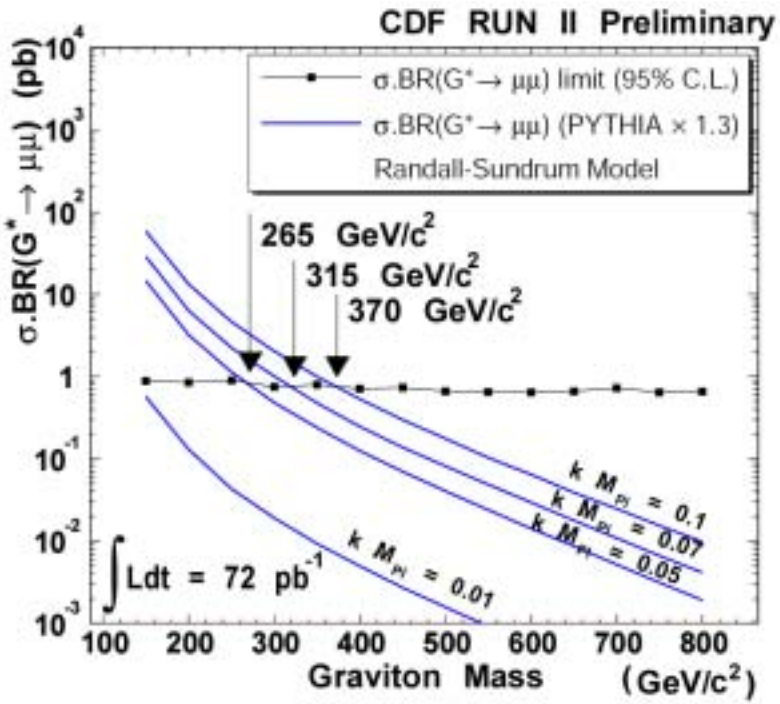
High mass dilepton events

Limits on Randall-Sundrum Graviton

- dielectron -



- dimuon -



Summary

- CDF Run II 実験は、２００１年3月より始まり順調に稼動して、２００３年3月までに約140pb^{-1}のデータを取得した。
- 今夏には、～ 200pb^{-1}のデータを用いた新しい結果を発表する予定。

乞うご期待！！