INTERNATIONAL ATOMIC ENERGY AGENCY
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
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SMR.858 - 47

SUMMER SCHOOL IN HIGH ENERGY PHYSICS AND COSMOLOGY

12 June - 28 July 1995

SUSY SEARCH AT FERMILAB

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Test of Standard Model and

Search for New Physics at Tevatron

- Electroweak Physics
- B-physics
- Light Higgs
- Supersymmetry
- Exotics

Electroweak Physics

Transverse mass distributions for $W \to e\nu$ and $W \to \mu\nu$

Global electroweak fits : LEP precision measurements

+ · **Mtop from Tevatron**
- **ν NC**
- **SLAC Polarization**
- **W mass from $p\bar{p}$**
- **W leptonic B.R.**
- **WZγ trilinear couplings**

W mass :

fit to LEP e^+e^- data : $\Delta M_W = \pm 60$ MeV/c^2

Direct measurement :

$M_W = 80.41 \pm 0.18$ GeV/c^2 (19 pb^{-1})

Run II 2.3×10^6 W's → $\Delta M_W \sim 38$ MeV/c^2 at 2 fb^{-1}

· Dominant uncertainty = Parton Distribution Functions

W leptonic B.R., Width :

$$R = \frac{\sigma_W Br(W \to l\nu)}{\sigma_Z Br(Z \to ll)}$$

LEP → Z couplings, Theory → $\sigma W / \sigma Z$

Br ($W \to e\nu$) = 0.109 ± 0.005 (19 pb^{-1}, CDF)

standard couplings for $W \to e\nu$: **$\Gamma_W = 2.064 \pm 0.085$ GeV**

Direct measurement of Γ_W :

$M_T^W > 110$ GeV/c^2 $\Gamma_W = 2.11 \pm 0.32$ GeV

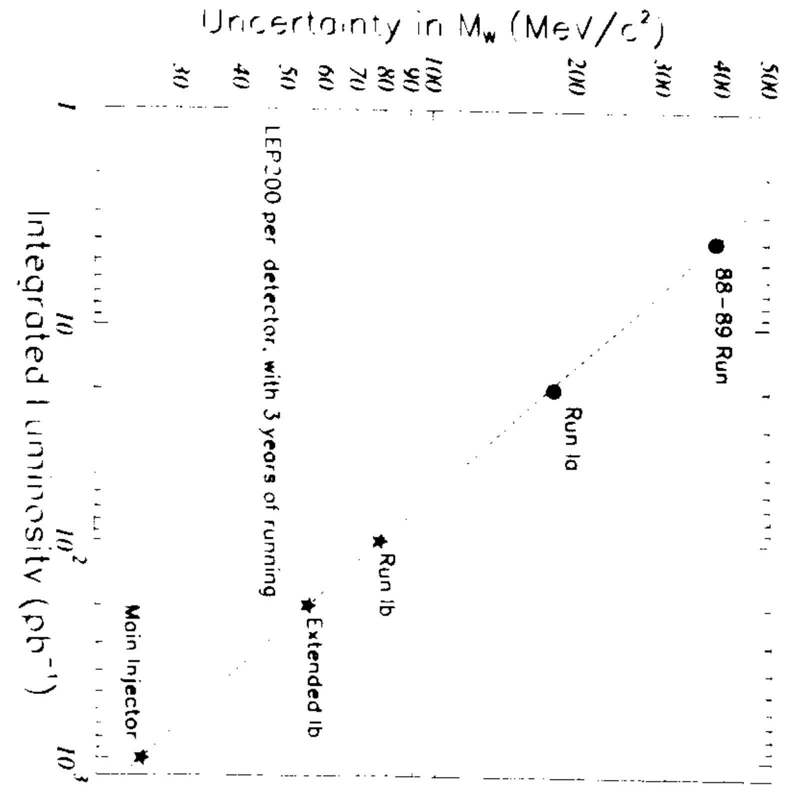
Run II → $\Delta\Gamma_W = \pm 30$ MeV (2 fb^{-1}) cf. LEP II: ± 200 MeV

Uncertainties in the W mass measurement

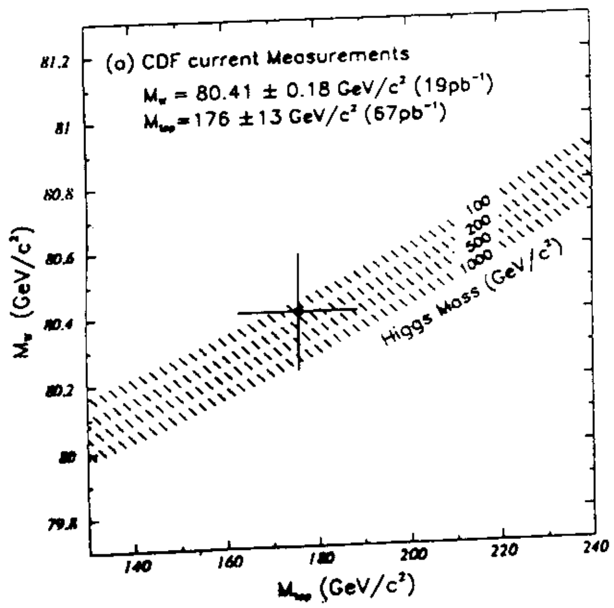
Source of Uncertainty	Uncertainty (MeV/c^2)		
	$W \to e\nu$	$W \to \mu\nu$	Common
Statistical	145^{14}	205^{20}	– –
Lepton Energy/Momentum Scale	120^{20}	50^{15}	50^{15}
Lepton Energy/Momentum Resolution	80^{8}	60^{6}	– –
Recoil modeling	60^{6}	60^{6}	60^{6}
Trigger, Event Selection	25^{10}	25^{10}	– –
Backgrounds	10^{5}	25^{10}	– –
Theoretical Model	75^{30}	75^{30}	65^{30}
Fitting	10^{5}	10^{5}	– –
Total Uncertainty	[illegible]^{42}	[illegible]	[illegible]
[illegible] Combined Uncertainty		[illegible]	

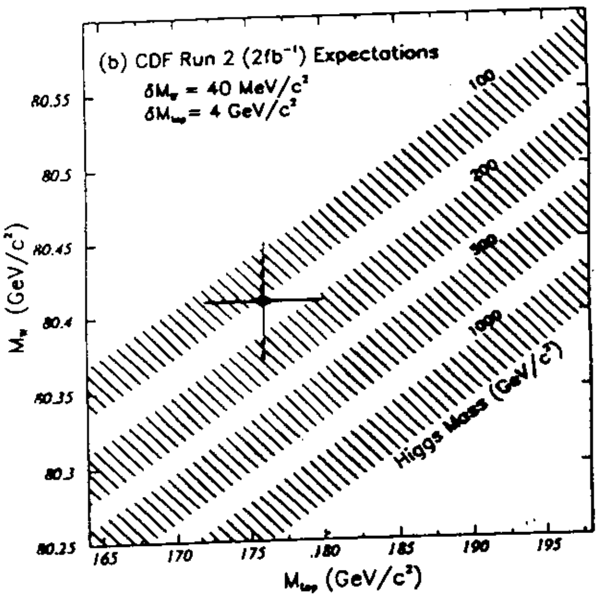
- 1 -

IF (!) the CDF Uncertainty Scales as Statistics

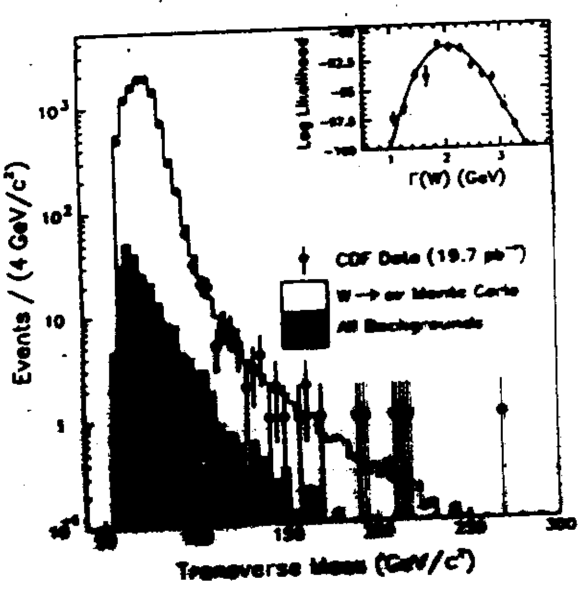


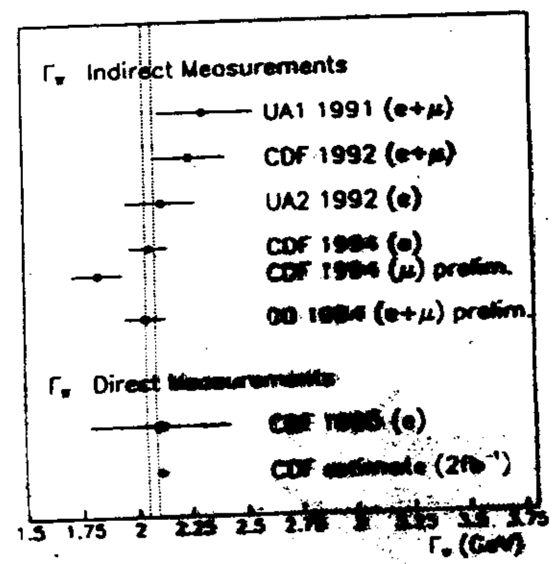
M_W - M_{top} relation with Higgs masses as a parameter

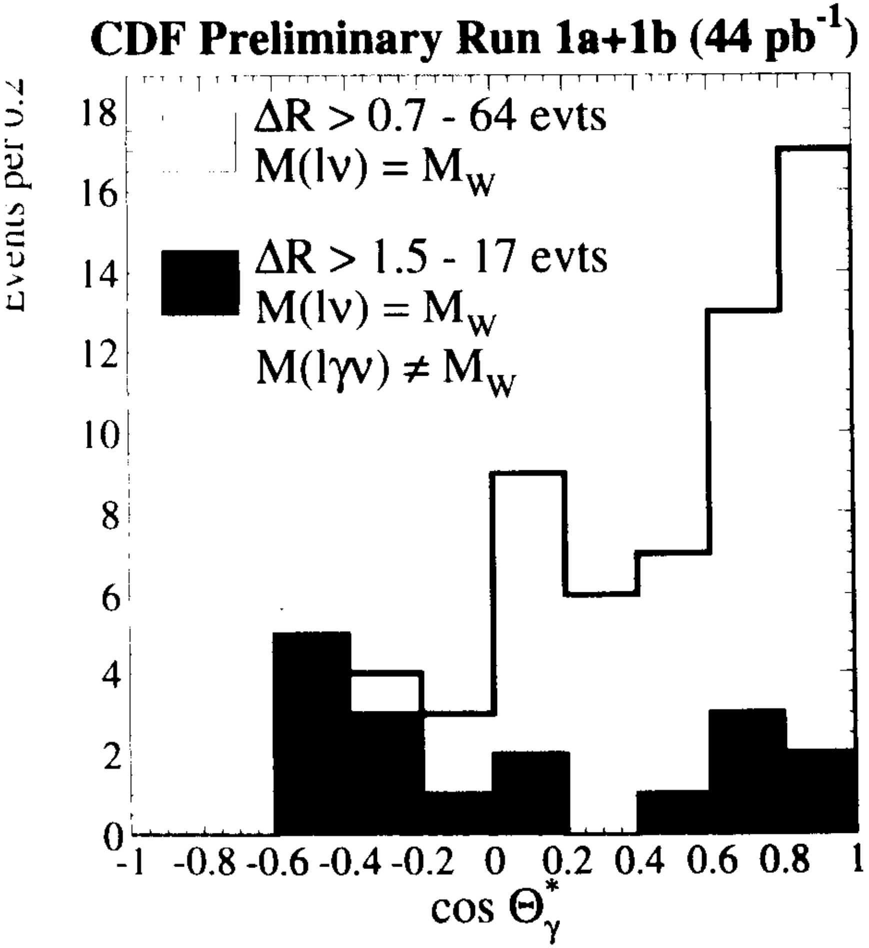




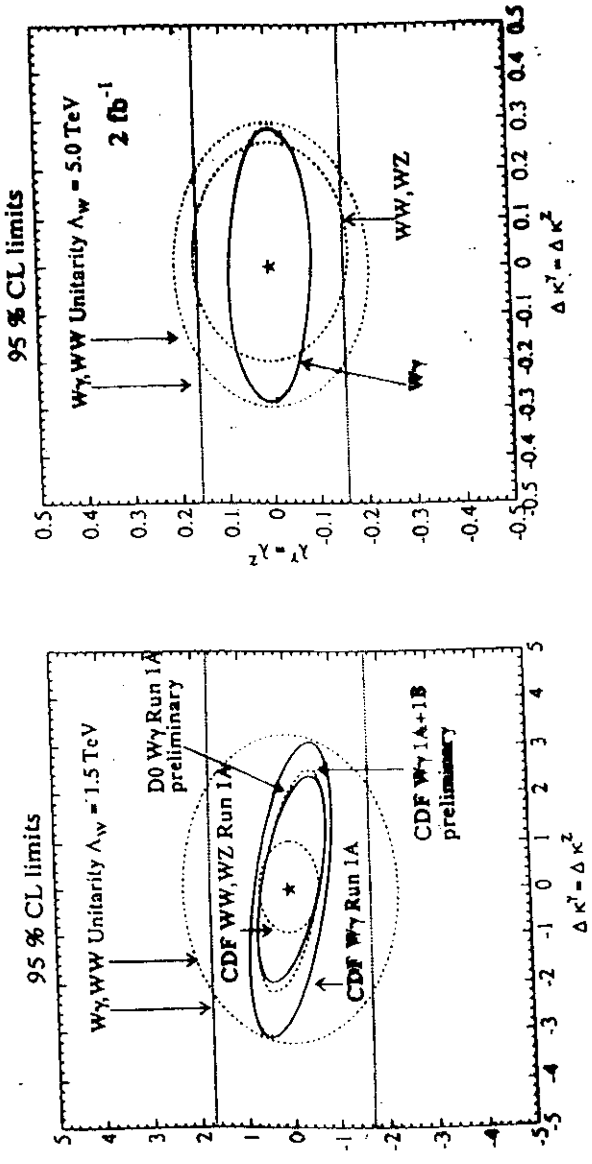
Measurements of Γ_W



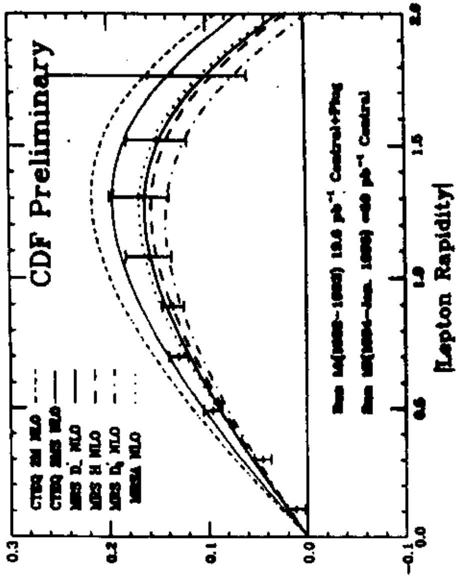


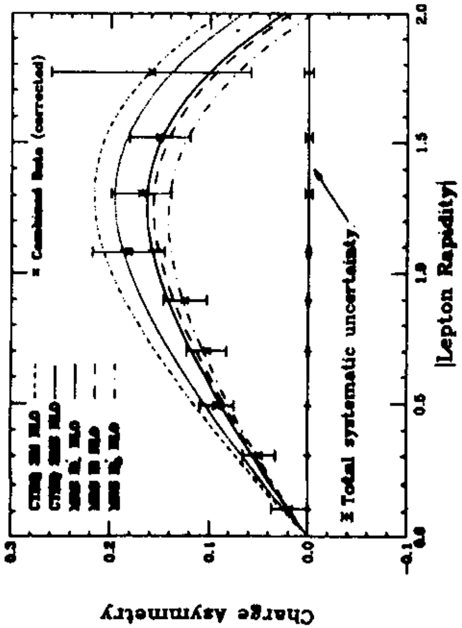


Limits on anomalous trilinear couplings



W charge asymmetry measurements





B Physics

CDF b-physics: competitve with LEP exp. and CLEO.

- Individual B hadron lifetimes
- searches for rare decays

  (Bd,s $\rightarrow \mu^+ \mu^-$; Bu $\rightarrow \mu\, \mu$K; Bd $\rightarrow \mu\, \mu$ K*)
- Bs mass
- Search for Bc in the J/ψ π and J/ψ $l\nu$ modes
- Polarization in Bd $\rightarrow$ J/ψ K* and Bs $\rightarrow$ J/ψ ϕ

In the near future (Run I)

- Measurement of Bd mixing parameter x_d
- Limits on the Bs mixing parameter x_s
- Λ_b mass
- B and quarkonium production
- Full reconstruction of $B^{\pm} \rightarrow J/\psi\ K^{\pm}$, $B^0 \rightarrow J/\psi\ K^*$

  (world largest sample)
- Lifetime measurement
- Partial reconstruction of B semileptonic decays.

Run II

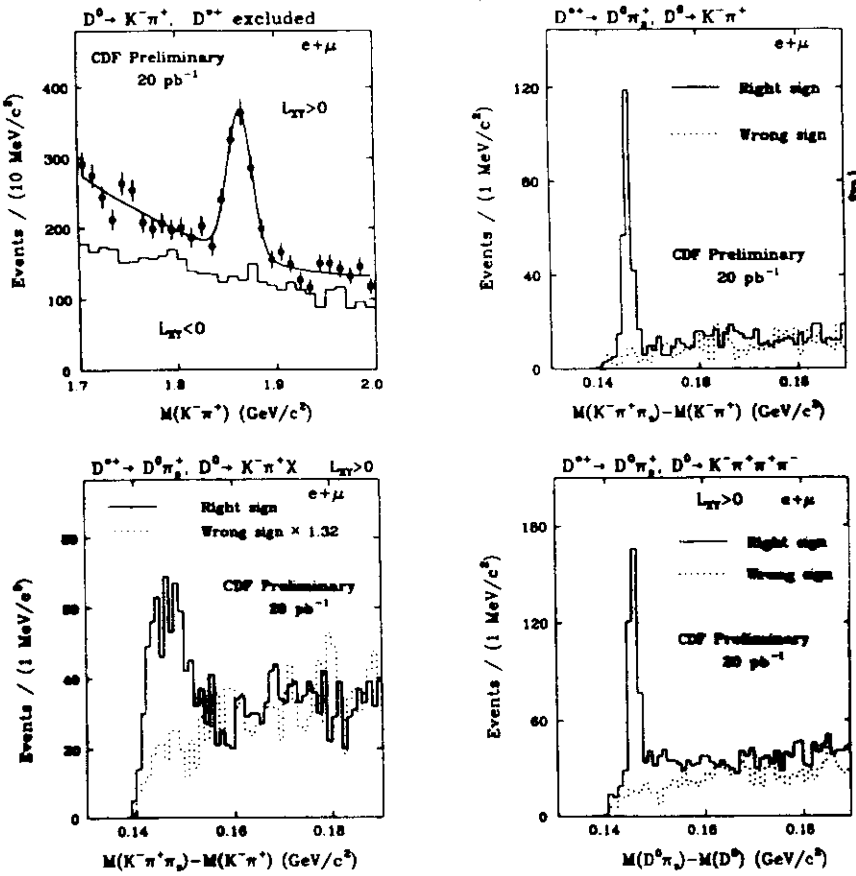
- Observation of CP violations
- Measurement of CKM matrix element ratio $|V_{td}/V_{ts}|$
- Observation of the rare decays

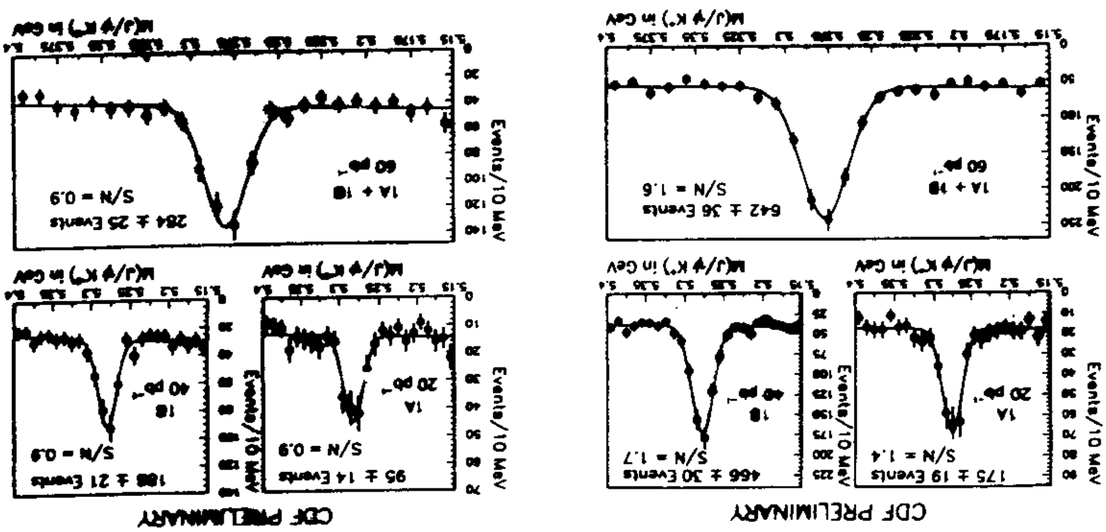
  $B_d \rightarrow \mu\, \mu\, K^*$ and $B_u \rightarrow \mu\, \mu\, K$

Charm signals associated with high p_T leptons

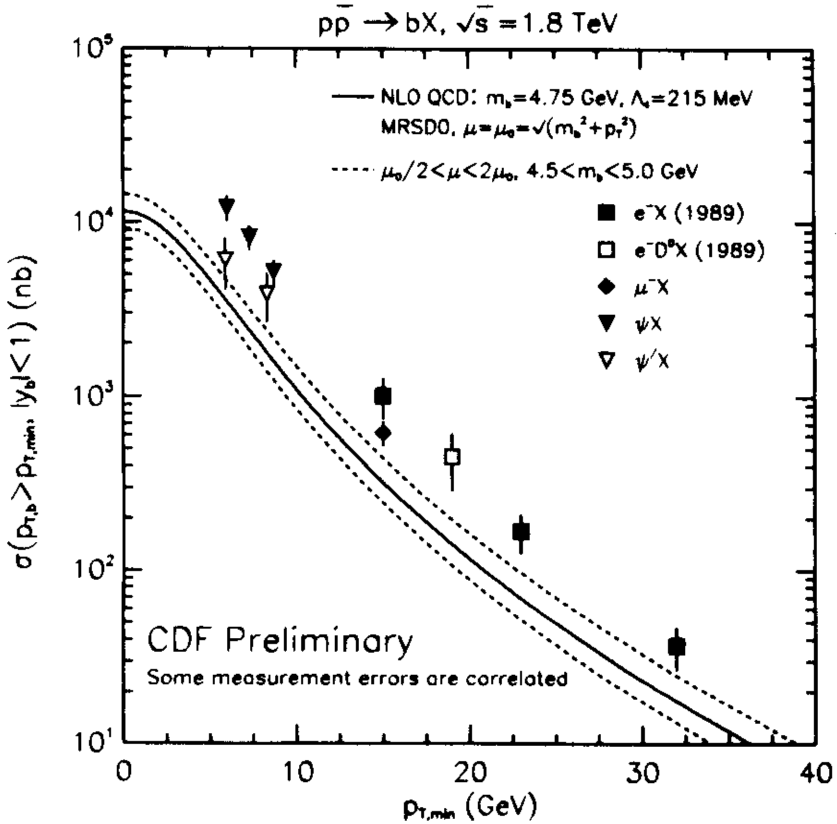
$\bar{B}^- \to l^- D^0 \bar{\nu}$ $\quad$ $\bar{B}^0 \to l^- D^{*+} \bar{\nu}$

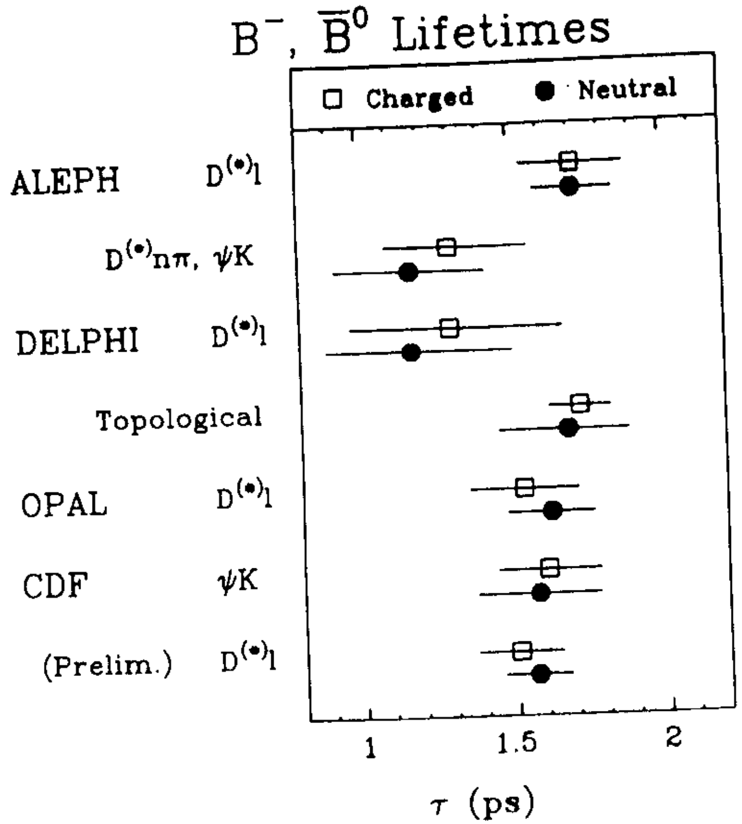
$\bar{B}^0 \to l^- D^{**} \bar{\nu}$ $\quad$ $\bar{B}^0 \to l^- D^{*+} \bar{\nu}$





Invariant mass distribution of $J/\psi K^+$ and $J/\psi K^*$


$p\bar{p} \rightarrow bX$, $\sqrt{s} = 1.8$ TeV
NLO QCD: m_b=4.75 GeV, Λ_4=215 MeV
MRSD0, $\mu=\mu_0=\sqrt{(m_b^2+p_T^2)}$
$\mu_0/2<\mu<2\mu_0$, $4.5<m_b<5.0$ GeV
e^-X (1989)
e^-D^0X (1989)
μ^-X
ψX
$\psi' X$
CDF Preliminary
Some measurement errors are correlated
$\sigma(p_{T,b}>p_{T,min}, |y_b|<1)$ (nb)
$p_{T,min}$ (GeV)


B^-, $\overline{B}^0$ Lifetimes
Charged
Neutral
ALEPH
$D^{(*)}l$
$D^{(*)}n\pi$, ψK
DELPHI
$D^{(*)}l$
Topological
OPAL
$D^{(*)}l$
CDF
ψK
(Prelim.)
$D^{(*)}l$
τ (ps)

B Physics

- **Identifications/reconstructionsof mesons**

  J/ψ : $J/\psi \to \mu^+\mu^-$ (e^+e^-)

  ψ' : $\psi' \to \mu^+\mu^-$

  $B_{u,d}$: $B^+ \to J/\psi K^+$, $J/\psi \to \mu^+\mu^-$

  $B \to J/\psi K^0$, $J/\psi \to \mu^+\mu^-$, $K^0 \to \pi^+\pi^-$

  $B \to D^0 e\nu X$, $D^0 \to K^-\pi^+$

  $B \to D^{*+} e\nu X$, $D^{*+} \to D^0\pi^+$, $D^0 \to K^-\pi^+$

  $B \to D^{*+} e\nu X$, $D^{*+} \to D^0\pi^+$, $D^0 \to K^-\pi^+\pi^0$

  B_s : $B_s \to D_s^- l^+ \nu X$, $D_s^- \to \phi\pi^-$, $\phi \to K^+K^-$

  $B_s \to J/\psi\,\phi$, $J/\psi \to \mu^+\mu^-$, $\phi \to K^+K^-$

  Upsiron: $\to \mu^+\mu^-$

- **Life times of B Mesons (stat. and syst.)**

  $\tau(B^0)$ =1.62±0.16+0.14/-0.15 ps

  $\tau(B^\pm)$ =1.63±0.20+0.15/-0.16 ps

  $\tau(B^\pm)$ / $\tau(B^0)$ = 1.01±0.19±0.17

  $\tau(B_s)$ = 1.74+1.08/-0.69±0.07 ps

- **Production Cross Sections**

  J/ψ : factor >2 higher than theory

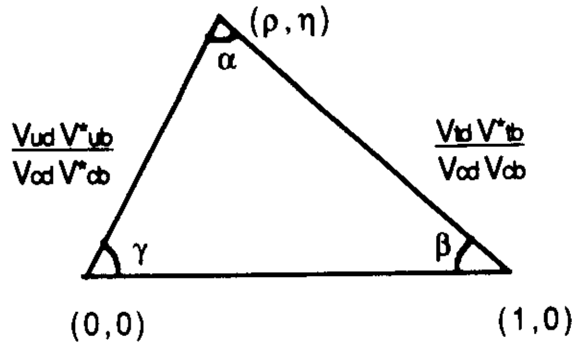
  ψ' : 22.8±3.5% from B decays

  B : factor >2 higher than theory

  Upsiron: factor 10 higher than theory

- **B^0-$\bar{B}^0$ mixing: (same/opposite sign $\mu\mu$ & $e\mu$)**

CP Violation in B decays



Decay Channels	Measured Angles
$Bd \to J/\psi Ks$	$\sin(2\beta)$
$Bs \to J/\psi\,\phi$	phase of V_{ts}
$Bd \to \pi^+\pi^-$	$\sin(2\alpha)$
$Bs \to D^-s K^+, D^+s K^-$	$\sin(2\gamma)$
$B^+ \to D^0 K^+, B^+ D^0 K^+, B^+ D^0_{CP+} K^+$	$\sin(2\gamma)$

CP violating effects due to interfaerence between

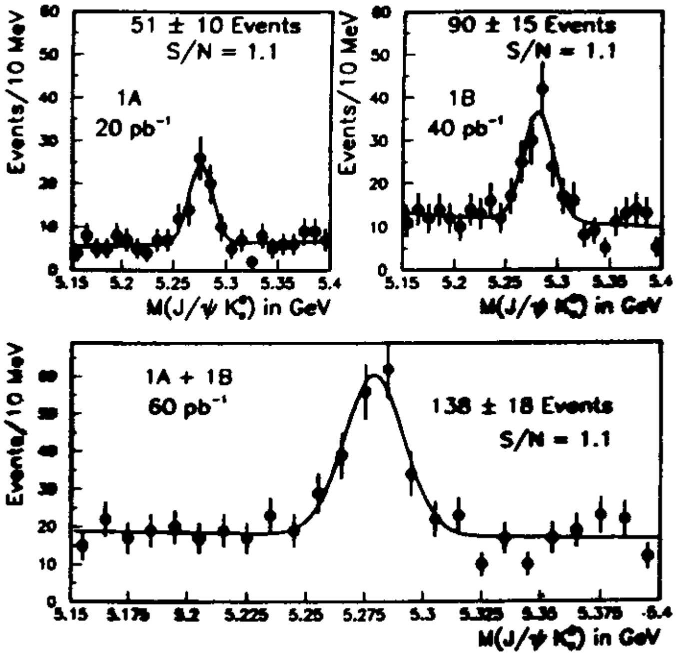
$B^0 \to f_{CP}$ and $B^0 \to B \to f_{CP}$

$$a_{CP}(t) = \frac{\Gamma(B^0_{phys}(t) \to f_{CP}) - \Gamma(\bar{B}^0_{phys}(t) \to f_{CP})}{\Gamma(B^0_{phys}(t) \to f_{CP}) + \Gamma(\bar{B}^0_{phys}(t) \to f_{CP})}$$

$$= \frac{(1-|r|^2)\cos(\Delta Mt) - 2\,\mathrm{Im}(r)\sin(\Delta Mt)}{1+|r|^2}$$

Bd → J/ψ Ks signal

CDF PRELIMINARY



$\int \mathcal{L} dt = 60 pb^{-1}$

~140 events

<Future>

Run I (120 pb^{-1})

140 × 2 ~ 300 ev.

Run II (2 fb^{-1})

10 $B^0 \to J/\psi K_s^0 / pb^{-1}$

≈ 20,000 / 2 fb^{-1}

(including e-ch. and P_T > 1.5 GeV/c)

× 4

(by improving detector coverage and SVX Triggering)

- A dimuon trigger, $P_T(\mu)$ > 2 GeV/c
- use SVX information if available

Flavor tagging efficiency in $B^0 \to J/\psi$ Ks

Tagging Method	ϵD^2 (%) (measured)	ϵD^2 (%) (expected)	Relevant Run II Upgrade
Jet Charge	1.0 ± 0.3	4.0	SVX II. Fiber tracker
Central Muon	0.7 ± 0.2	0.7	Completed CMX coverage
Non-Central Muon		0.3	Move FMU. Fiber tracking
Electron		1.0	Plug calorimeter. Fiber tracking
Same-side pion		2.0	
Opposite-side Kaon		3.0	Time of Flight

$B^0 \rightarrow \pi^+ \pi^-$: $\sin(2\alpha)$

Can we trigger the events in the $1 \times 10^{32}\ cm^{-2}\ sec^{-1}$ hadron collider environment ?

Level-1 : fast trigger processor (XFT)

$P_T > 2$ GeV with $\delta P_T / P_T^2 < 0.04\ GeV^{-1}$

$\Delta \phi$ cuts $\rightarrow$ 15 kHz

Level-2 : SVT impact parameter $\sigma_d \sim 25\ \mu m$

$d > 100\ \mu m \rightarrow 200$ Hz

Level-3 : analyze full information $\rightarrow$ 10 Hz

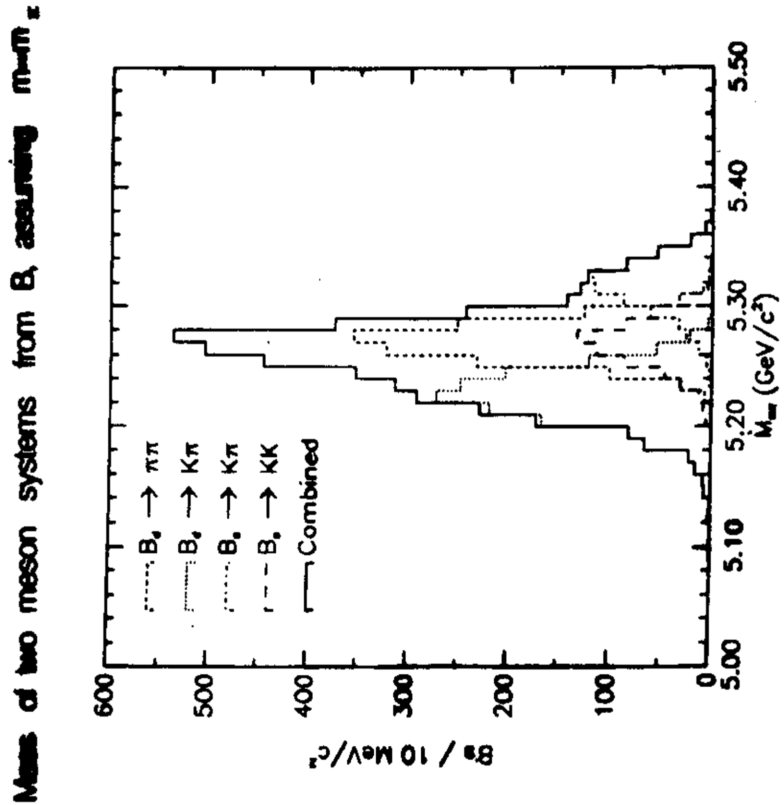
Event Reconstruction :

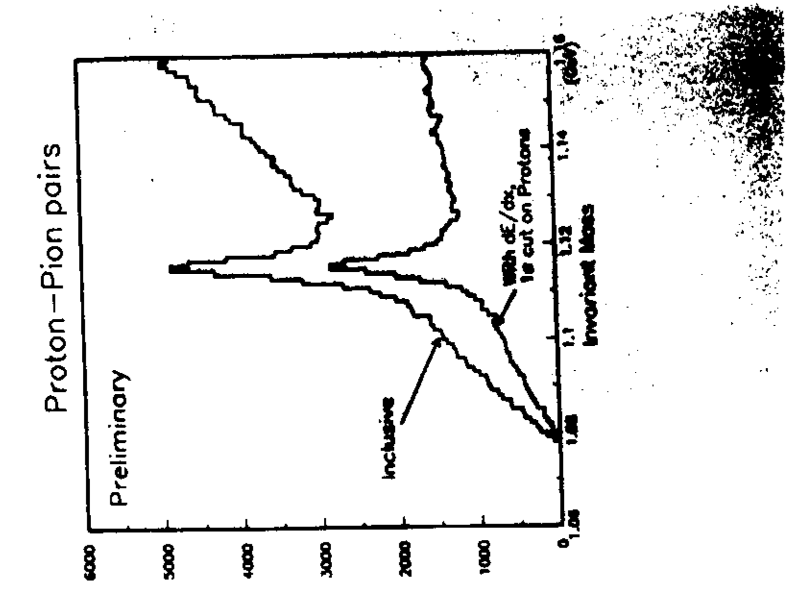
- π / K / P separation with dE/dx and TOF
- penguin contributions

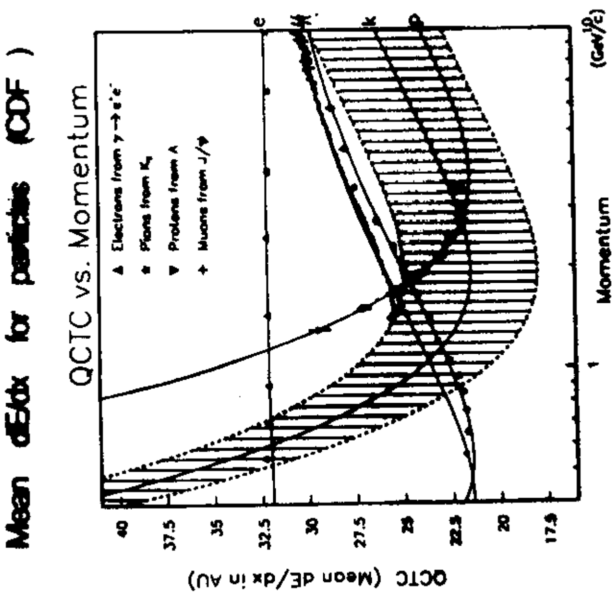
  $A_p / A_t = 0.07$ (Desphande et al.)

  if ~ 0.2 more challenging.

$\epsilon D^2 \sim 8\%$, S/N = 1/4 $\rightarrow \delta(\sin(2\alpha)) = \pm 0.10$







Determination of $\left| V_{td} \ / \ V_{ts} \right|$

CKM model : $0.11 < \left| \frac{V_{td}}{V_{ts}} \right| < 0.36$ at 95% C.L.

Past experiment : $Br(B \to \rho\gamma)/Br(B \to K^*\gamma)$ on $\Upsilon(4S)$

Tevatoron: use Bs mesons amply produced.

Bs Mixing:

$$x \equiv \Delta m/\Gamma \,;\, \Delta m = M_H - M_L \,;\, \Gamma = (\Gamma_H + \Gamma_L)/2$$

$$\frac{x_s}{x_d} = \underbrace{\frac{m_{Bs}\,\eta_{QCD}^{Bs} B_{fBs}^2}{m_{Bd}\,\eta_{QCD}^{Bd} B_{fBd}^2}} \left| \frac{V_{ts}}{V_{td}} \right|^2$$

Lattice G.T. 1.3 ± 0.2

SU(3) 1

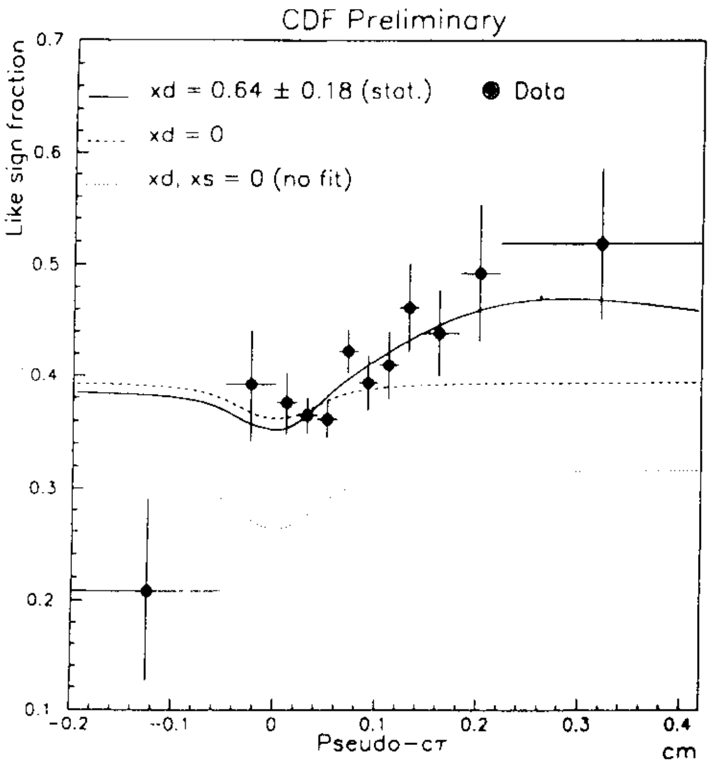
$$Prob\,(B_s \to \bar{B}_s) = \tfrac{1}{2} \exp(-t/\tau)\,[1 - \cos(x_s t/\tau)]$$

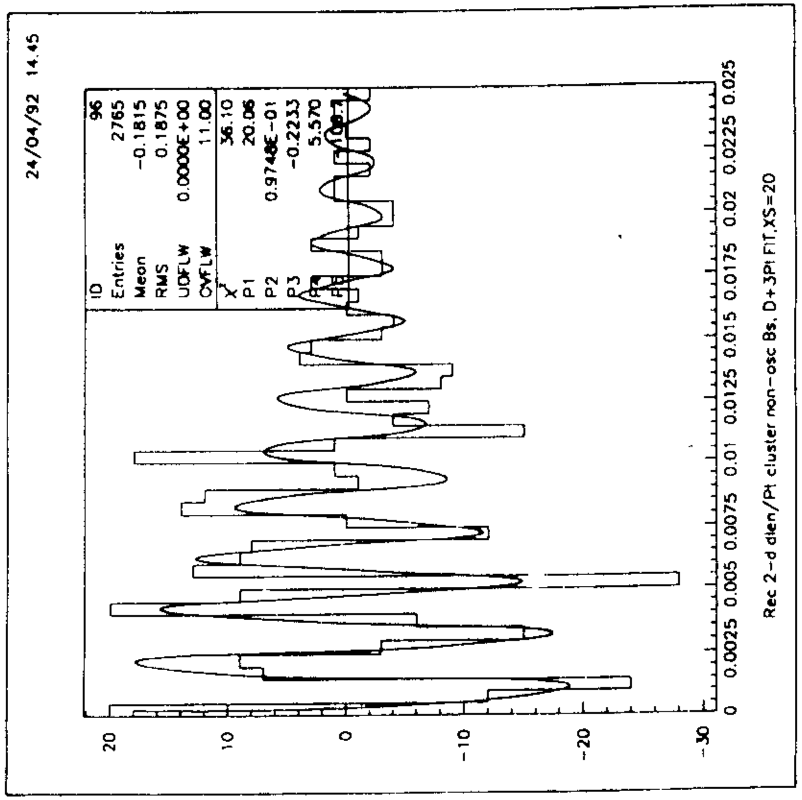
$\Delta\Gamma s/\Gamma s$:

$$\Delta\Gamma_{Bs} \ / \ \Delta m_{Bs} = -\frac{3}{2}\,\pi\,\frac{m_b^2}{m_t^2}\,\underbrace{\frac{\eta_{QCD}^{\Delta\Gamma_s}}{\eta_{QCD}^{\Delta m_s}}}_{\approx\, 1\ (\mathrm{QCD})}$$

measure $\Delta\Gamma_{Bs} \to \Delta m_{Bs}$

- cτ distribution of a flavor specific Bs mode ($Bs \to Ds l \nu$)
  ~ 2 exponetial fit
- average cτ to be compared with a single CP state ($Bs \to J/\psi\ \phi$)
- $Bs \to J/\psi\ \phi$ decomposed to two CP components via helicity analysis

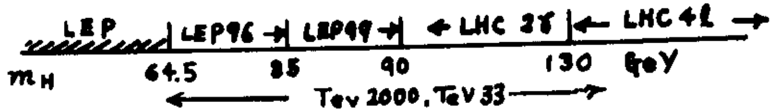

CDF Preliminary
Like sign fraction
xd = 0.64 ± 0.18 (stat.)
Data
xd = 0
xd, xs = 0 (no fit)
Pseudo-cτ
cm


24/04/92 14.45
ID 96
Entries 2765
Mean −0.1815
RMS 0.1875
UDFLW 0.0000E+00
OVFLW 11.00
Rec 2-d dlen/Pt cluster non-osc Bs, D+3Pt FIT,XS=20

B Decay Mode	Standard Model	CDF Run II
$\mu^+\mu^-K^+$	0.6×10^{-6}	1.1×10^{-7}
$\mu^+\mu^-K^{*o}$	2.9×10^{-6}	3.4×10^{-7}
$B_d \to \mu^+\mu^-$	8.0×10^{-11}	1.0×10^{-8}
$B_s \to \mu^+\mu^-$	1.8×10^{-9}	4.0×10^{-8}

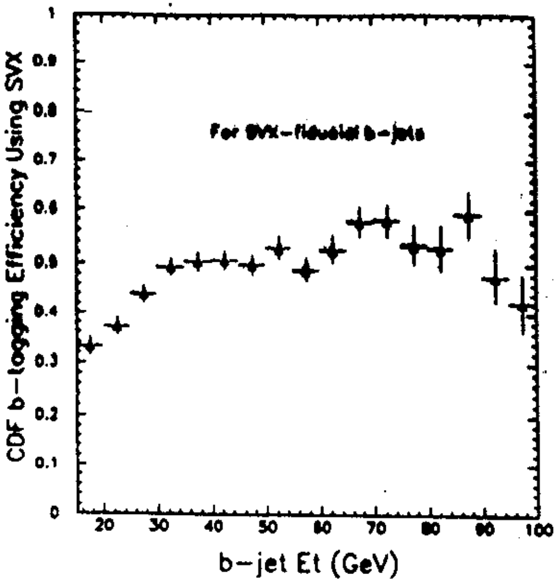
Light Higgs

Standard Higgs model : scaler doublet

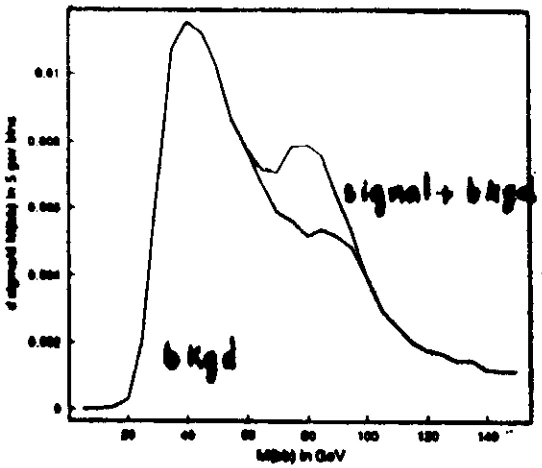


- LEP : $e^+e^- \longrightarrow ZH$
- LHC : (e.g.) $gg \longrightarrow H \longrightarrow ZZ^{(*)} \longrightarrow \ell^+\ell^-\ell^+\ell^-$
  $H \longrightarrow \gamma\gamma$
- MSSM : $h, H, A, H^\pm$
  If $m_t = 175$ GeV, $m_{\tilde{t}} < 1$ TeV
  $\longrightarrow m_H < 125$ GeV
- Tevatron : $q\bar{q}' \longrightarrow WH$
  $H \longrightarrow b\bar{b}$ (80%)
  $\tau^+\tau^-$ (7%)

Ref : Report of the Tev_2000 Study Group on Future Electroweak Physics at the Tevatron : Edited by D. Amidei and C. Brok



Present CDF b-tagging efficiency



M(bb) distribution for $WH \rightarrow Wb\bar{b}$ process and background

Process	Yield in 1 fb^{-1}	Yield in 10 fb^{-1}	Yield in 100 fb^{-1}
WH Signal (80 GeV)	6	60	600
WZ	4	40	400
$t\bar{t}$	0.8	8	80
$W^* \rightarrow tb$	4	40	400
$Wb\bar{b}$	19	190	1900
W-gluon fusion (tqb)	3	30	300
W+fakes	2	20	200

Yield for WH production and background

$\boxed{\text{Supersymmetry}}$

- SUSY - GUT (MSSM)

  $\left.\begin{array}{l} m_0,\ m_{1/2},\ A_0,\ \tan\beta,\ \mu \\ \text{RGE} \end{array}\right\} \rightarrow$ mass spectrum

- Supersymmetric partners and current mass limits

- An example of global fit of data to MSSM

- Search channels relevant to present and future Tevatron

  a) Lightest chargino using "Trilepton + $\not{E}_T$" events

  b) Gluino using "$\not{E}_T$ + multijet" events

  c) Light Top squark using "Single / Di-lepton" events

Supersymmetric partners & Higgs bosons

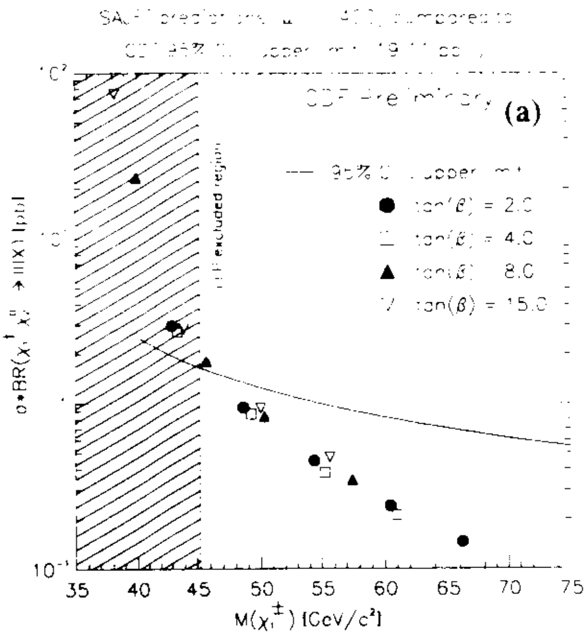
Particle Name	Spin	Physical States
squarks	0	$\tilde{d}_L, \tilde{u}_L, \tilde{s}_L, \tilde{c}_L, \tilde{b}_1, \tilde{t}_1, \tilde{d}_R, \tilde{u}_R, \tilde{s}_R, \tilde{c}_R, \tilde{b}_2, \tilde{t}_2$
sleptons	0	$\tilde{e}_L, \tilde{\nu}_{eL}, \tilde{\mu}_L, \tilde{\nu}_{\mu L}, \tilde{\tau}_1, \tilde{\nu}_{\tau L}, \tilde{e}_R, \tilde{\mu}_R, \tilde{\tau}_2$
charginos	$\frac{1}{2}$	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^\pm$
neutralinos	$\frac{1}{2}$	$\tilde{\chi}_1^0, \tilde{\chi}_2^0, \tilde{\chi}_3^0, \tilde{\chi}_4^0$
gluino	$\frac{1}{2}$	$\tilde{g}$
Higgs bosons	0	$h, H, A, H^\pm$

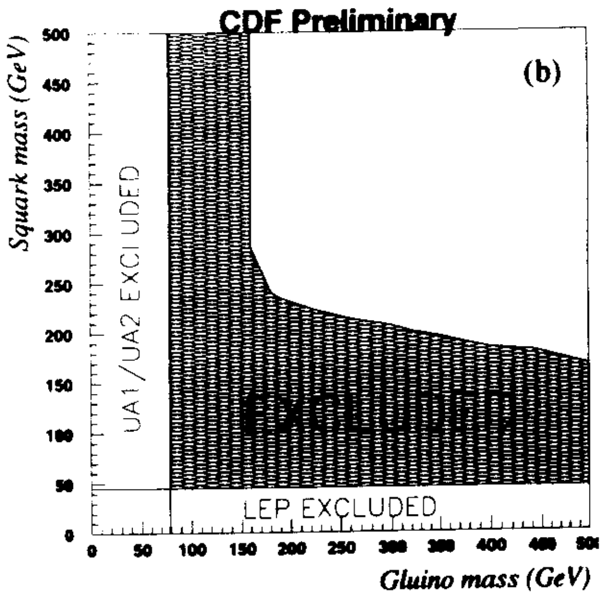
Current mass limit on supersymmetric partners

Sparticle	Mass Limit	Comments
$\tilde{g}$	160 GeV	CDF & DØ
$\tilde{q}$	220 GeV	CDF & DØ , $M_{\tilde{q}} = M_{\tilde{g}}$
$\tilde{t}_1$	45 GeV	LEP
$\tilde{\chi}_1^\pm$	47 GeV	LEP
$\tilde{\chi}_1^0$	20 GeV	LEP
$\tilde{\ell}$	45 GeV	LEP
$\tilde{\nu}$	43 GeV	LEP
h	60 GeV	LEP

Search for supersymmetric partners

Production	Key Decay Mode	Signature
$\tilde{g}\tilde{g}, \tilde{g}\tilde{q}, \tilde{q}\tilde{q}$	e.g., $\tilde{g} \rightarrow qq\tilde{\chi}_1^0$, $\tilde{q} \rightarrow qqq\tilde{\chi}_1^0$ $(M_{\tilde{q}} > M_{\tilde{g}})$	$\not{E}_T$ + multijets
$\tilde{\chi}_1^\pm \tilde{\chi}_2^0$	$\tilde{\chi}_1^\pm \rightarrow \tilde{\chi}_1^0 \ell\nu$, $\tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0 \ell\ell$,	Trilepton + $\not{E}_T$
	$\tilde{\chi}_1^\pm \rightarrow \tilde{\chi}_1^0 qq$, $\tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0 \ell\ell$,	Dilepton + $\not{E}_T$ + jets
$\tilde{t}_1\tilde{t}_1$	$\tilde{t}_1 \rightarrow \tilde{\chi}_1^\pm b$, $\tilde{\chi}_1^\pm \rightarrow \tilde{\chi}_1^0 \ell^\pm \nu$, $\tilde{\chi}_1^\mp \rightarrow \tilde{\chi}_1^0 qq$	Single lepton + $\not{E}_T$ + b's
	$\tilde{t}_1 \rightarrow \tilde{\chi}_1^\pm b$, $\tilde{\chi}_1^\pm \rightarrow \tilde{\chi}_1^0 \ell^\pm \nu$, $\tilde{\chi}_1^\mp \rightarrow \tilde{\chi}_1^0 \ell^\mp \nu$	Dilepton + $\not{E}_T$ + b's
$W/Z + h$	$h \rightarrow b\bar{b}, \tau\bar{\tau}$	2 b's or 2 τ's





Observed $\tilde{t}_1\tilde{t}_1$ cross section via single-lepton (e or μ) events as a function of stop mass.

Mass (GeV)	ϵ_{sel} (%)	ϵ_{tag} (%)	σ_{obs} (fb)
80	16	19	360
100	17	24	150
130	22	27	53
150	15	29	28

Observed $\tilde{t}_1\tilde{t}_1$ cross section via dilepton ($ee, e\mu, \mu\mu$) events as a function of stop mass

Mass (GeV)	ϵ_{sel} (%)	σ_{obs} (fb)
80	9	140
100	11	50
130	12	14
150	12	9.5

Preliminary results on maximum mass reach on SUSY particles at TEV2.

Sparticle	Tevatron 20 pb^{-1}	Tevatron 100 pb^{-1}	Main Injector 2 fb^{-1}	TeV33 10/100 fb^{-1}	Comments
$\tilde{\chi}_1^\pm$	45 GeV(*)	90 GeV	210 GeV	230/255 GeV	
$\tilde{g}$	220 GeV(*)	250 GeV(*)	390 GeV	~400/>400 GeV*	* see the text for details.
$\tilde{t}_1$	n/a	n/a	n/a	n/a	

ref: tev_2000 study group

QCD Measurements

QCD : the least precisely tested components of SM.

high statistics (E)
higher order perturbative QCD (T) $\rightarrow$ Test at a distance of 10^{-17}cm

$\rightarrow$ Possible appearance of new physics.

- Present CDF:
  - compare with LO, NLO predictions
  - D-Y and W asymmetry $\rightarrow$ PDF
  - $\alpha_s(E_T)$
    - jet cross sections
    - direct photons
    - D-Y and W, Z production with jets
    - multi - jet events
    - extraction of $\alpha_s(E_T)$
    - rapidity gap

Excess of events at high E_T:

E : energy scale, jet algorithm, etc.

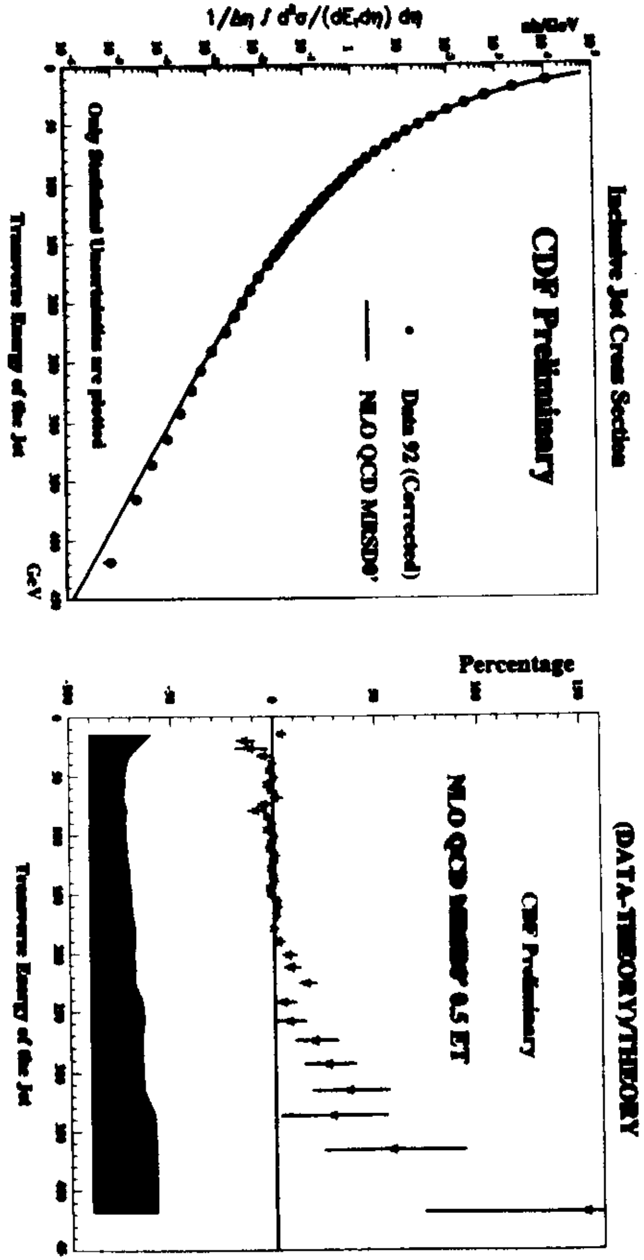
T : (i) may need for corrections to pert QCD beyond NLO

(ii) something wrong with PDF at $0.2 < x < 0.45$

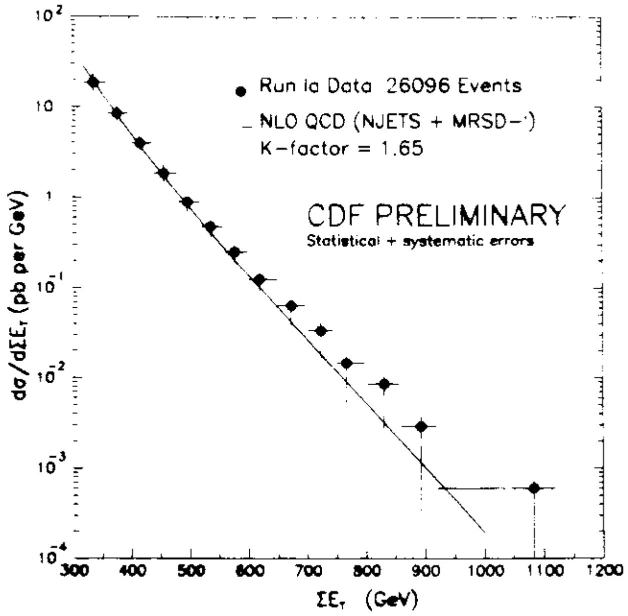
(iii) something new beyond SM

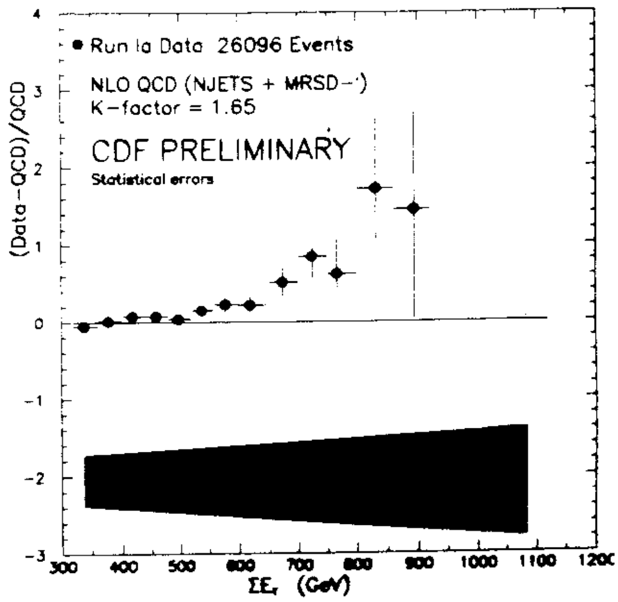
.Run II : luminosity upgrades x 50 $\rightarrow$ high-Q^2

Inclusive jet cross sections: $p\bar{p} \rightarrow$ jet + X

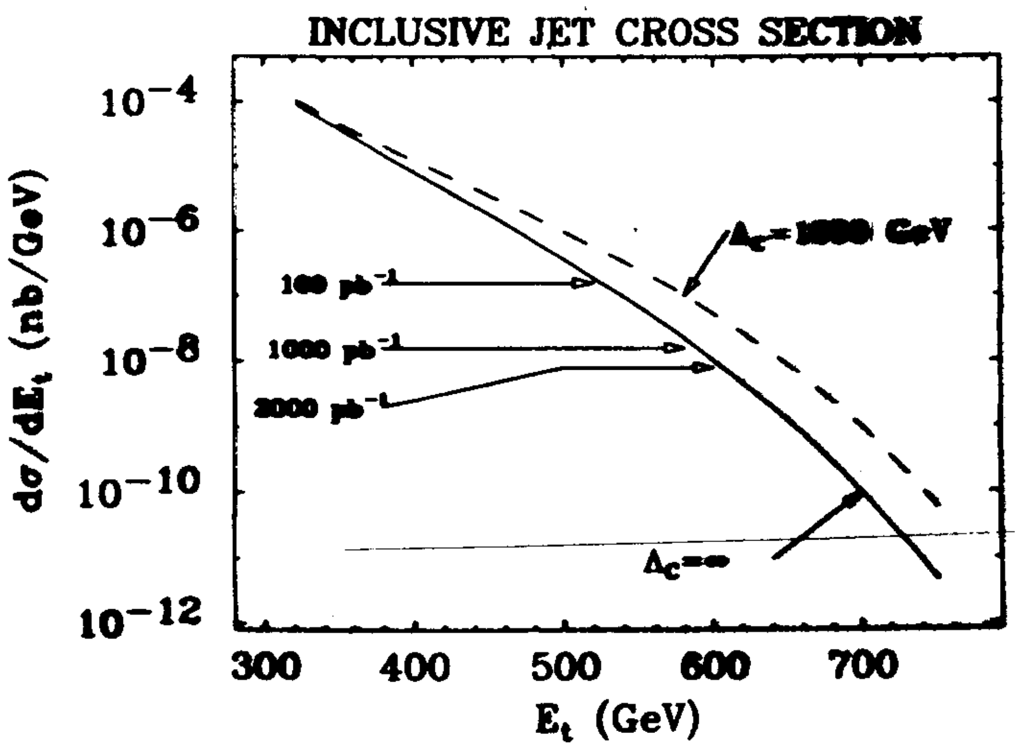


Two-jet mass distribution

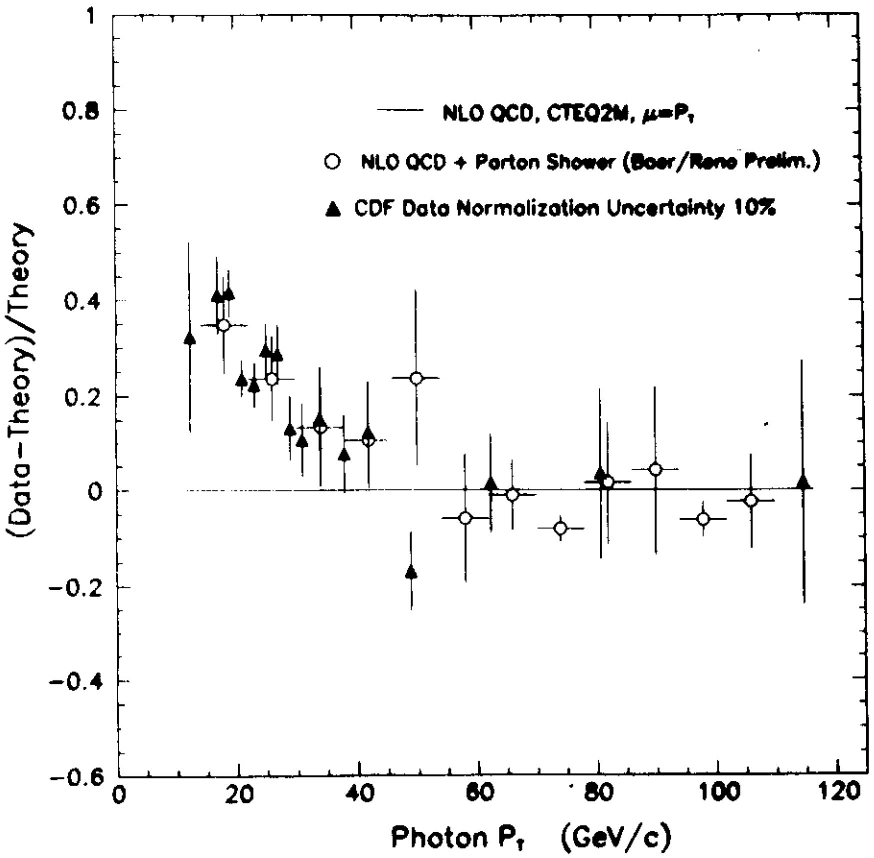




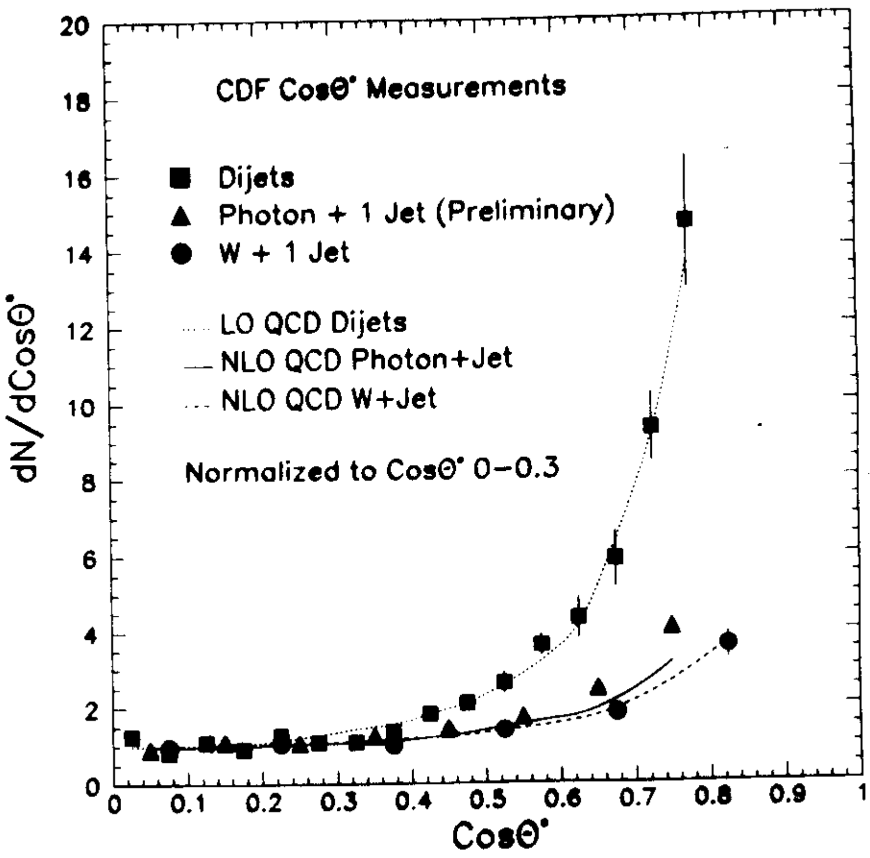
Total transverse energy distribution



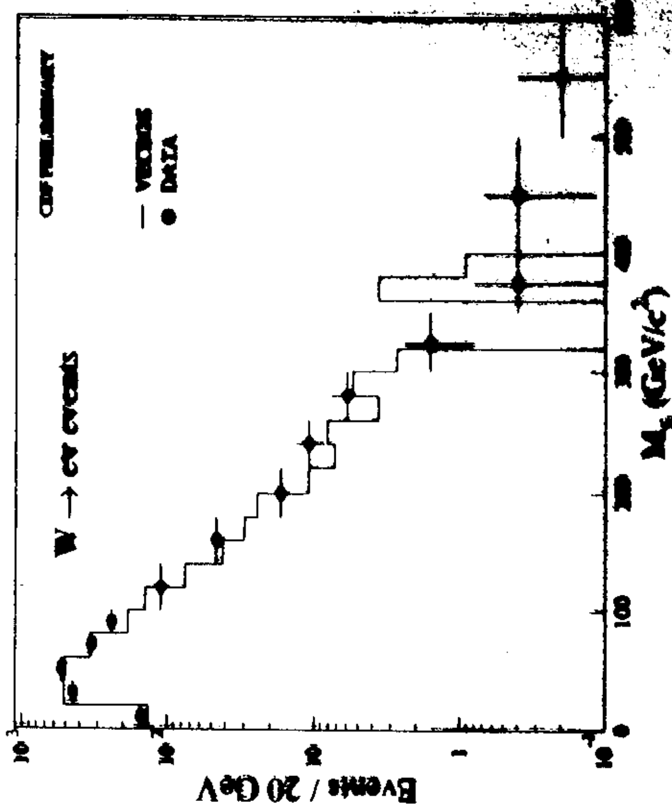
Direct photon differential cross-section



Angular distribution for dijet, photon-jet and W+1jet events

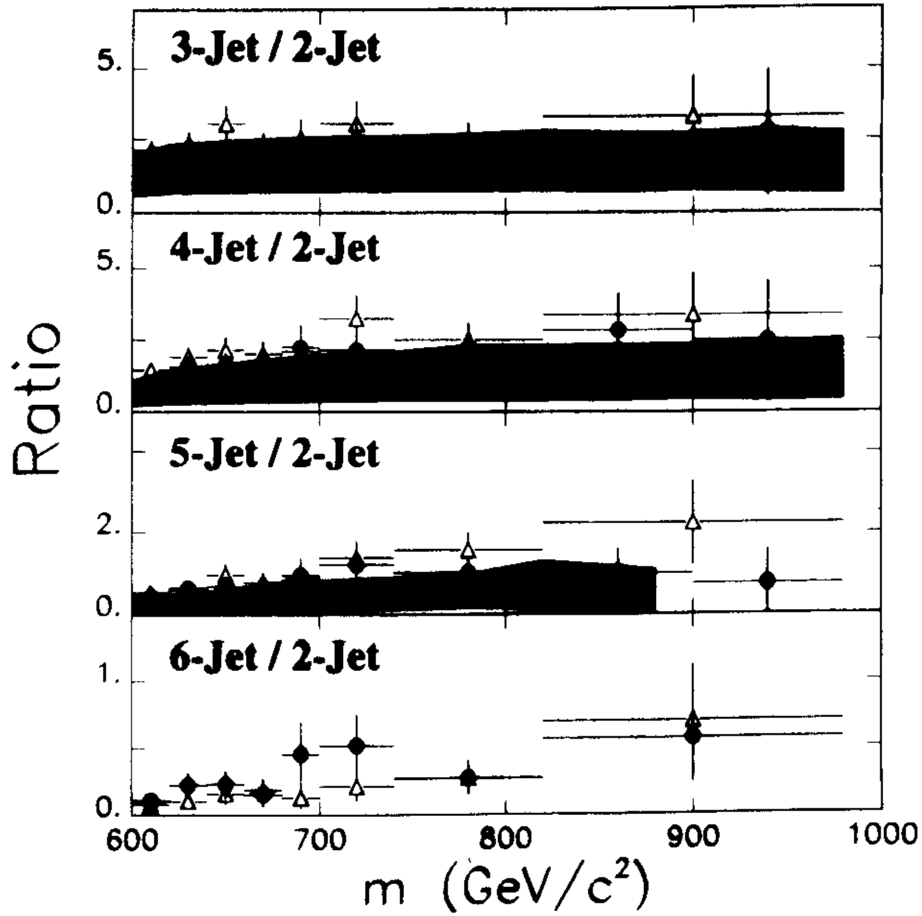


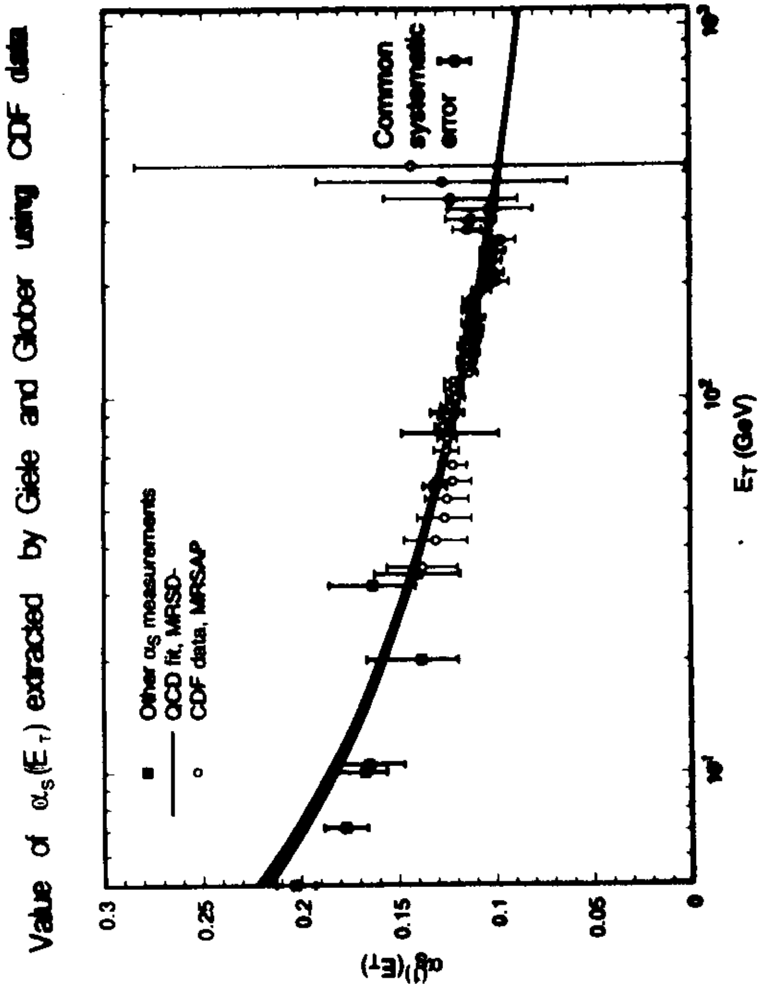
Dijet mass spectrum from W + ≥ 2 jet events



With x50 data
associate production
W + X
↳ 2j
of new particle X
will be observable
up to
$m_X \sim 250$ GeV/c²

CDF measured ratios of N-jet to 2-jet events





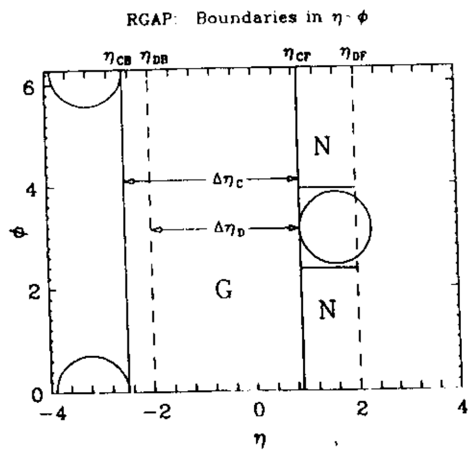
Observation of Rapidity Gap

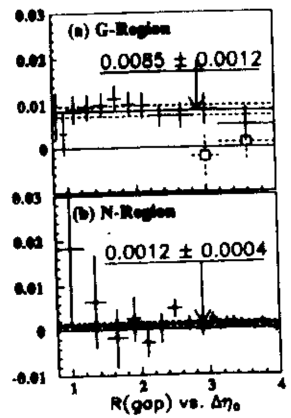
Rapidity gap: regions of rapidity space nearly devoid of particles between jets (originaly found in cosmic ray experiments).
Theory: exchange of colorless object=Pomeron

J.D.Bjorken:

$$R(gap) = \sigma_{jet}(gap) \;/\; \sigma_{jet} = 0.1 \;<|S|^2>,$$

$$3\% < |S|^2 < 30\%$$





Exotic Physics

The Standard Model
- does not predict masses of particles or the number of generations.
- does not explain the symmetry breaking scale.
- has a proiferation of arbitrary parameters.
- does not address the question of grand unification

Beyond the Standard Model

Supersymmetry

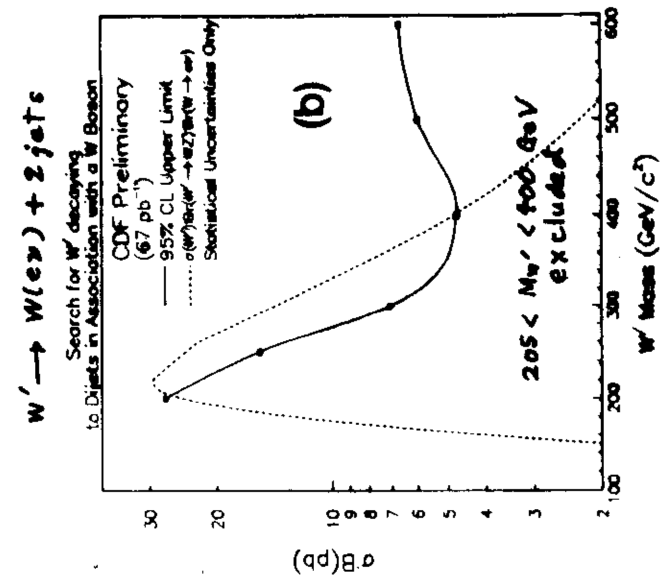
Technicolor

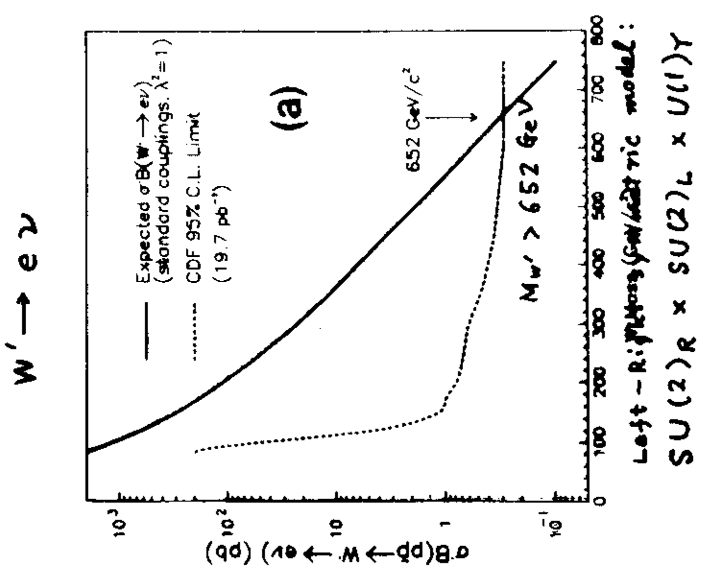
Compositeness

various schemes of Grand Unification.

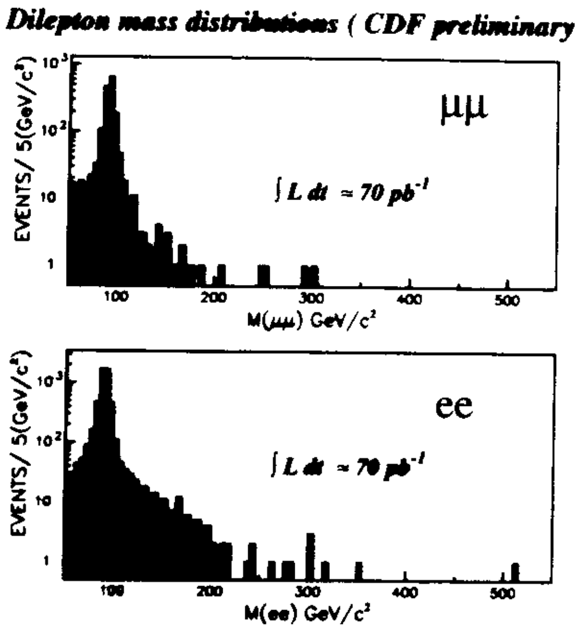
Key experimental objects :

high E_T jets, photons, isolated leptons



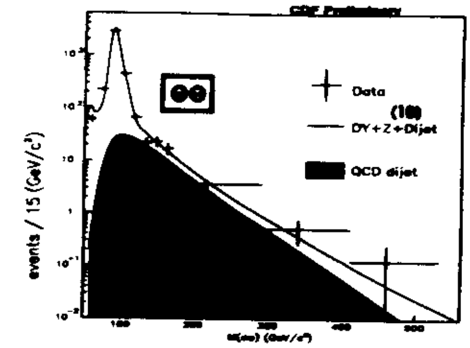


2 search



(a)

Comparison of Data with Background expectations



ee →

Mass	Drell-Yan+Z +Dijet	Data
> 300 GeV	4.7	6
> 400 GeV	0.9	1
> 500 GeV	0.2	1

μμ →

Mass	Drell-Yan + Z	Data
> 200 GeV	4.2	5
> 300 GeV	0.9	1
> 400 GeV	0.2	0

Data correspond ≡ 70 pb^{-1} (Run 1A+1B)

(b)

55

Theories with extra $U(1)$

(ex) $E_6 \longrightarrow SO(10) \times U(1)_\psi \;:\; Z_\psi$

$SO(10) \longrightarrow SU(5) \times U(1)_\chi \;:\; Z_\chi$

$SU(5) \longrightarrow SU(3)_c \times SU(2)_L \times U(1)_Y : Z$

$Z_\eta = \sqrt{\frac{3}{8}}\, Z_\chi + \sqrt{\frac{5}{8}}\, Z_\psi$ (super string inspired)

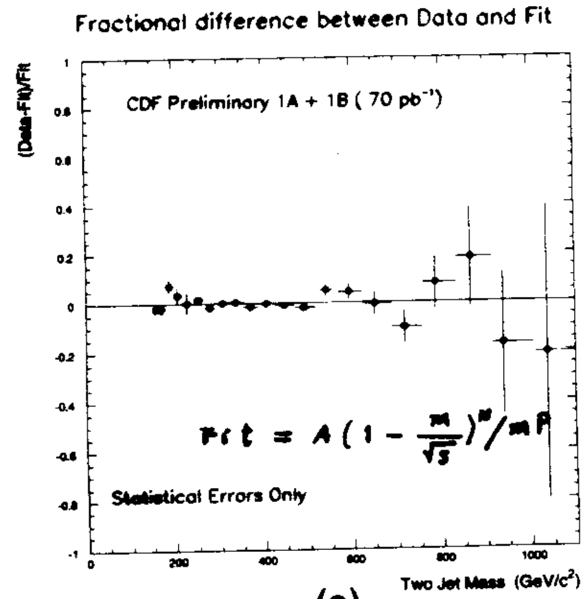
New particles decaying into dijets

a larger chiral color group : $SU(3)_L \times SU(3)_R$ axigluon

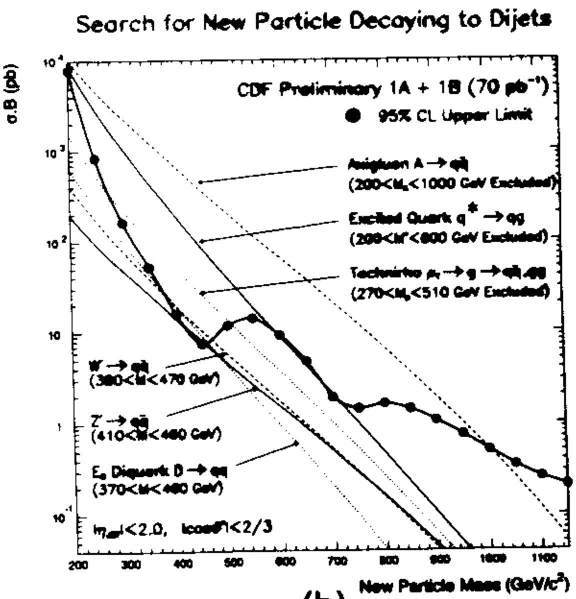
a technicolor model technirho

Superstring inspired E_6 color triplet scalar diquark

56

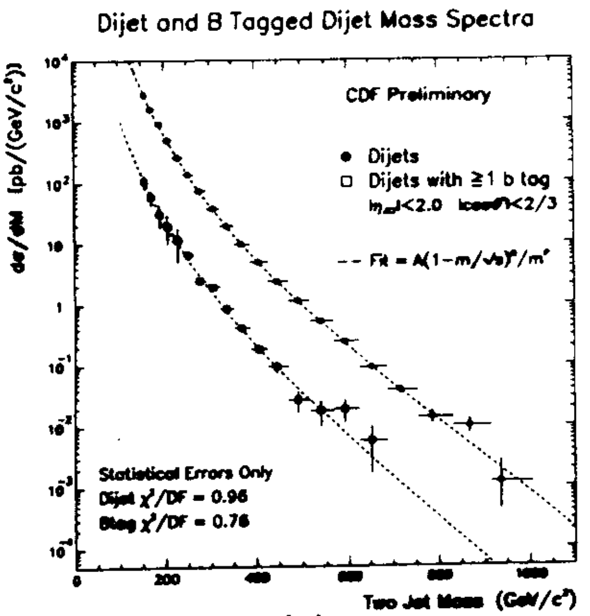


(a)



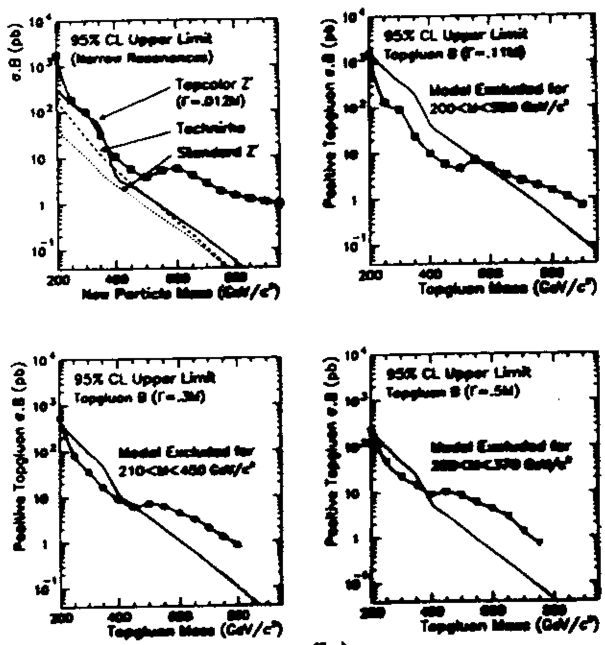
(b)

Top color theory and b-tagged dijeT search



(a)

Search for New Particles decaying to $b\bar{b}$ with b-tagged dijets



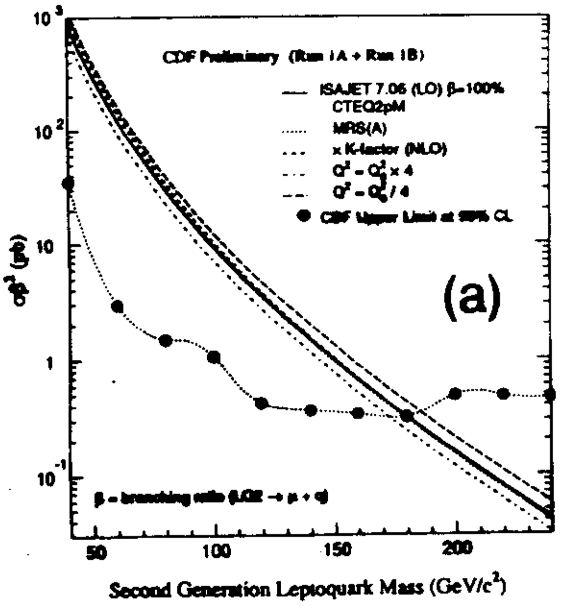
(b)

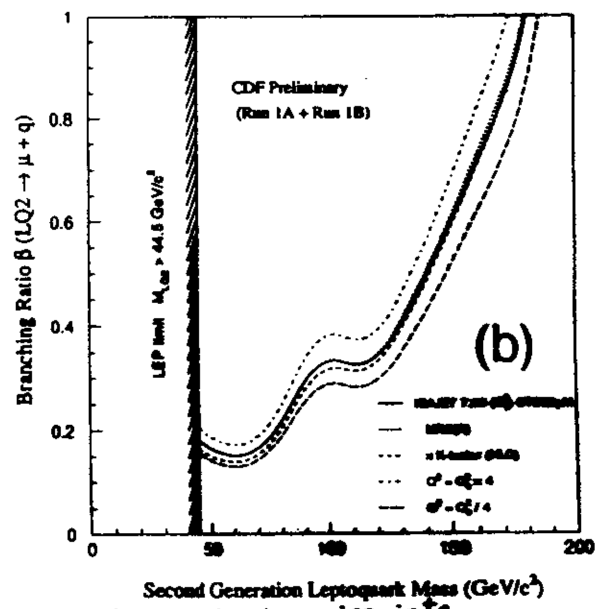
Leptoquarks

LQ I $\longrightarrow e + jet$

II $\longrightarrow \mu + jet$

III $\longrightarrow \tau + jet(b)$ $\quad$ ($Z^0 \to \tau^+\tau^-$ identified.)





β : the branching ratio for a leptoquark decaying into a charged lepton and quark

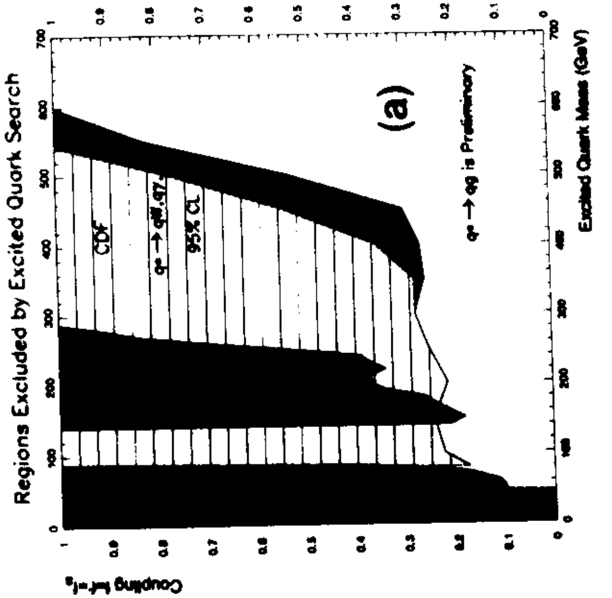
Compositeness

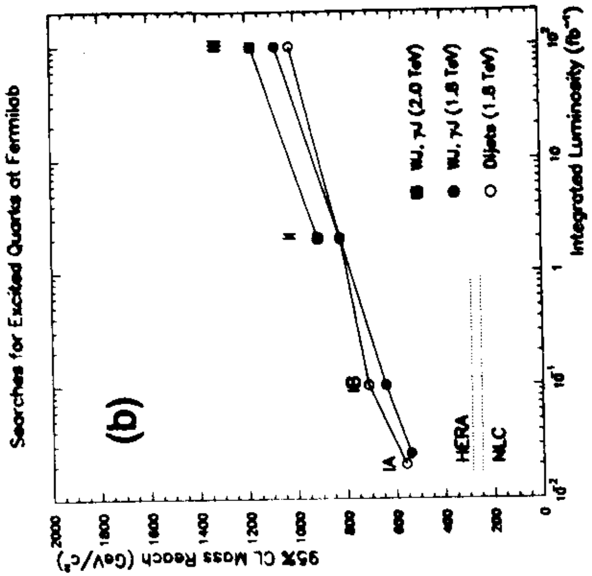
Search for contact interaction : e^+e^- $\Lambda^- > 2.2$ TeV, $\Lambda^+ > 1.7$ TeV

$\mu^+\mu^-$ $\Lambda^- > 1.6$ TeV, $\Lambda^+ > 1.4$ TeV

Search for excited quarks : γ+jet, W+jet $M_{q^*} > 540$ GeV (Run Ia)

dijet $200 < M_{q^*} < 600$ GeV excluded (Ia+Ib)





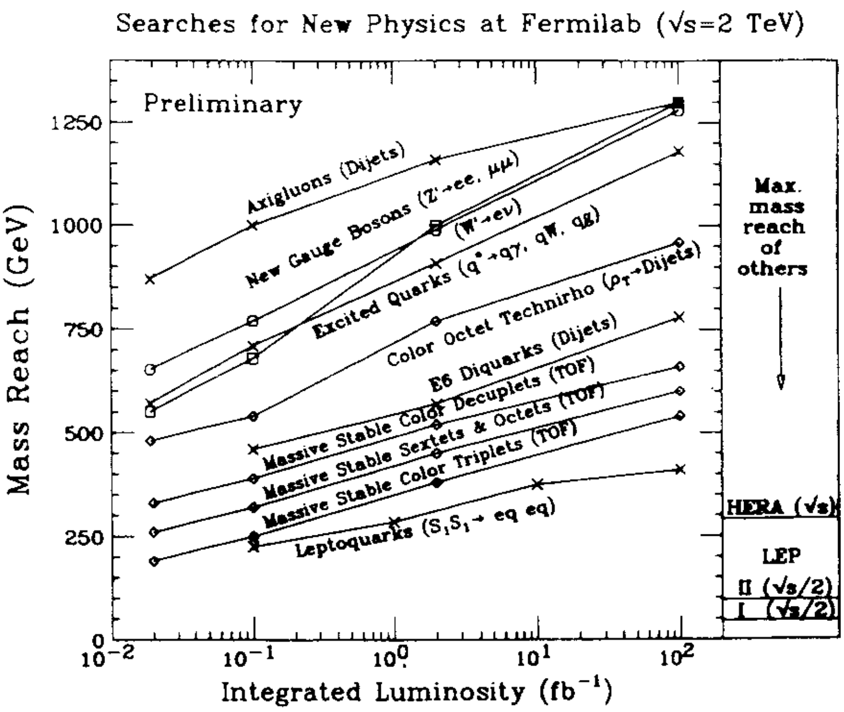
CDF Exotic Particle Searches: **Results and Run II Prospects**

Searches	current limit (Gev) set by CDF		data set	run II (GeV) with 2 fb^{-1}
$W' \to e\nu$(SM)	< 652	*	Ia (20 pb-1)	< 990
$W' \to WZ$	205<M<400	*	Ia + Ib (70 pb-1)	
$Z' \to ll$ (SM)	< 650	*	Ia + Ib (70 pb-1)	< 900
$Z\psi, Z\eta, Z\chi, Z_I$	< 415,440,425,400	*	Ia (20 pb-1)	< 800
Z_{LR}, Z_{ALRM}	< 445,420	*	Ia (20 pb-1)	< 800
Axigluon → qq	200<M<1000	*	Ia + Ib (70 pb-1)	< 1160
Techniro → dijet	270<M<510	*	Ia + Ib (70 pb-1)	200<M<770
$W' \to qq$ (SM)	380<M<470	+	Ia + Ib (70 pb-1)	200<M<720
$Z' \to qq$ (SM)	410<M<460	+	Ia + Ib (70 pb-1)	290<M<720
E_6 Diquark → qq	370<M<460	*	Ia + Ib (70 pb-1)	200<M<570
topgluon Γ=.1M	200<M<550	*	Ia (20 pb-1)	
topgluon Γ=.3M	210<M<450	*	Ia (20 pb-1)	-
topgluon Γ=.5M	200<M<370	*	Ia (20 pb-1)	
Leptoquark (μq)	< 180, (β=1)	*	Ia + Ib (70 pb-1)	< 300
Composit. Scale (qqqq)	< 1800	*	Ia + Ib (70 pb-1)	< 2200
Composit. Scale (qqll)	2200, 1700 (ee) 1600, 1400 ($\mu\mu$)	*	'88-89 (4pb-1)	< 5000
q* (W+jet, γ+jet)	< 540	*	Ia (20 pb-1)	< 820
q* → dijet	200<M<600	*	Ia + Ib (70 pb-1)	<820
massive stable ptl.,	< 140 to < 255	*	'88-89 (4pb-1)	<350/<520
susy particles	see figures in the susy section	#	Ia (20 pb-1)	

* Current world best limit in direct search mode for the model.

\+ CDF has the world best limit in another decay mode.

\# Same as *, but D0 also has comparable limits.


Searches for New Physics at Fermilab (√s=2 TeV)
Preliminary
Axigluons (Dijets)
New Gauge Bosons (Z'→ee, μμ)
(W'→eν)
Excited Quarks (q*→qγ, qW, qg)
Color Octet Technirho (ρT→Dijets)
E6 Diquarks (Dijets)
Massive Stable Color Decuplets (TOF)
Massive Stable Sextets & Octets (TOF)
Massive Stable Color Triplets (TOF)
Leptoquarks (S1S1→ eq eq)
Max. mass reach of others
HERA (√s)
LEP
II (√s/2)
I (√s/2)
Mass Reach (GeV)
Integrated Luminosity (fb⁻¹)
0
250
500
750
1000
1250
10⁻²
10⁻¹
10⁰
10¹
10²