Leptoquark Searches at Tevatron

Guoliang Wang/FSU

for the

CDF, DØ Collaborations

DIS'97 at Chicago
April 15, 1997

Outline:

- Introduction
- 1st Gen. Scalar LQ
- 2nd Gen. Scalar LQ
- 3rd Gen. Scalar LQ
- Vector LQ
- Conclusions

Intoduction:

- Many extensions beyond SM predict leptoquarks
- Leptoquarks are exotic particles:
  - Have fractional charge
  - Carry both lepton and baryon number
  - Mediate an interaction between leptons and quarks

1st gen. $\begin{pmatrix} u \\ d \end{pmatrix}$ LQ1 $\begin{pmatrix} e \\ \nu_e \end{pmatrix}$

2nd gen. $\begin{pmatrix} c \\ s \end{pmatrix}$ LQ2 $\begin{pmatrix} \mu \\ \nu_\mu \end{pmatrix}$

3rd gen. $\begin{pmatrix} t \\ b \end{pmatrix}$ LQ3 $\begin{pmatrix} \tau \\ \nu_\tau \end{pmatrix}$

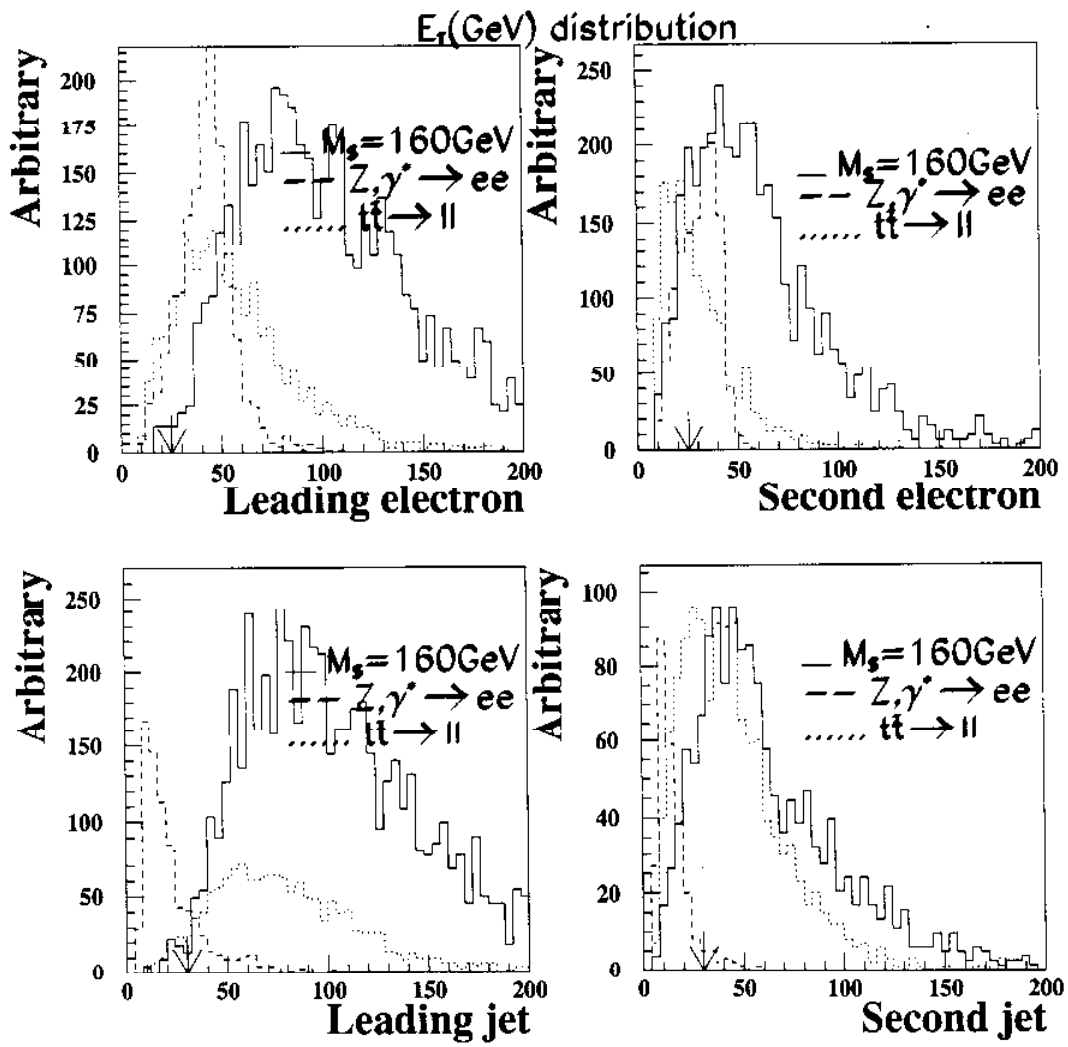
1st Gen. SLQ: eejj

- Selection:

  2e, *one central*; ≥2 jets;

  Z veto, M(ee) < 76 GeV or >106 GeV

- Acceptance: 24% for M=200 GeV

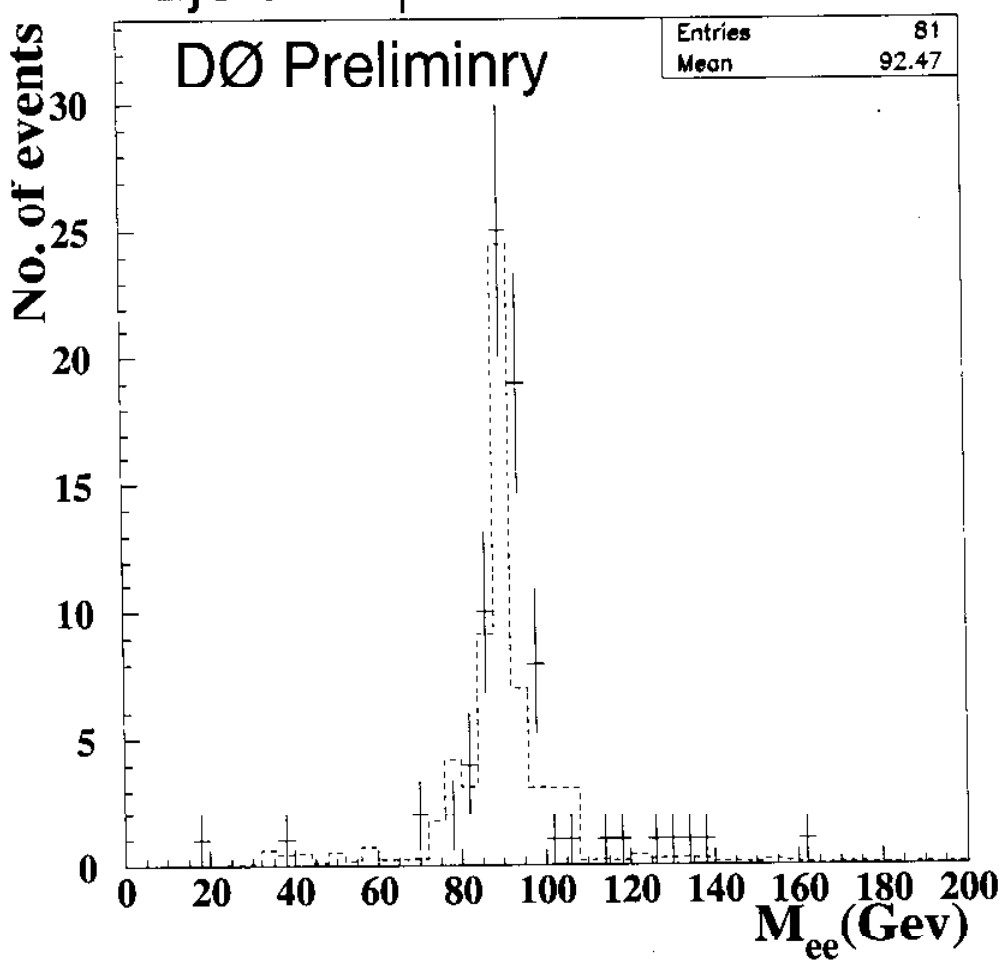


1st Gen. SLQ: eejj

Mee: Loose Selection:

2 e: $E_T > 25$ GeV

2jets: $E_T > 15$ GeV

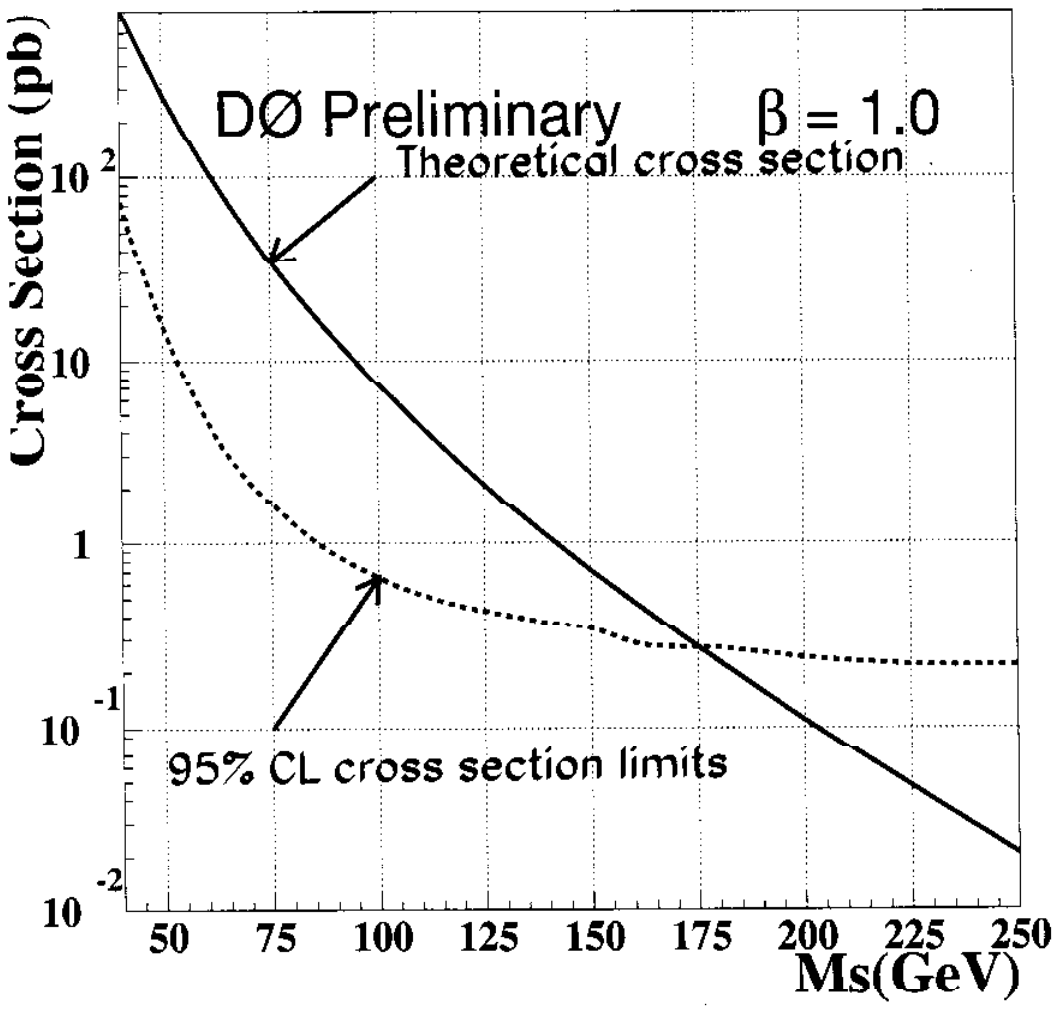


1st Gen. SLQ: eejj

L = 118pb^{-1}

Data: 3 events

Background: 2.9 ± 1.1



Cross section:

Blümlein, Boos, Kryukov, DESY 96-174

CTEQ3M, λ_{QCD}=158MeV, $Q^2 = \hat{s}$

1st Gen. SLQ: eνjj

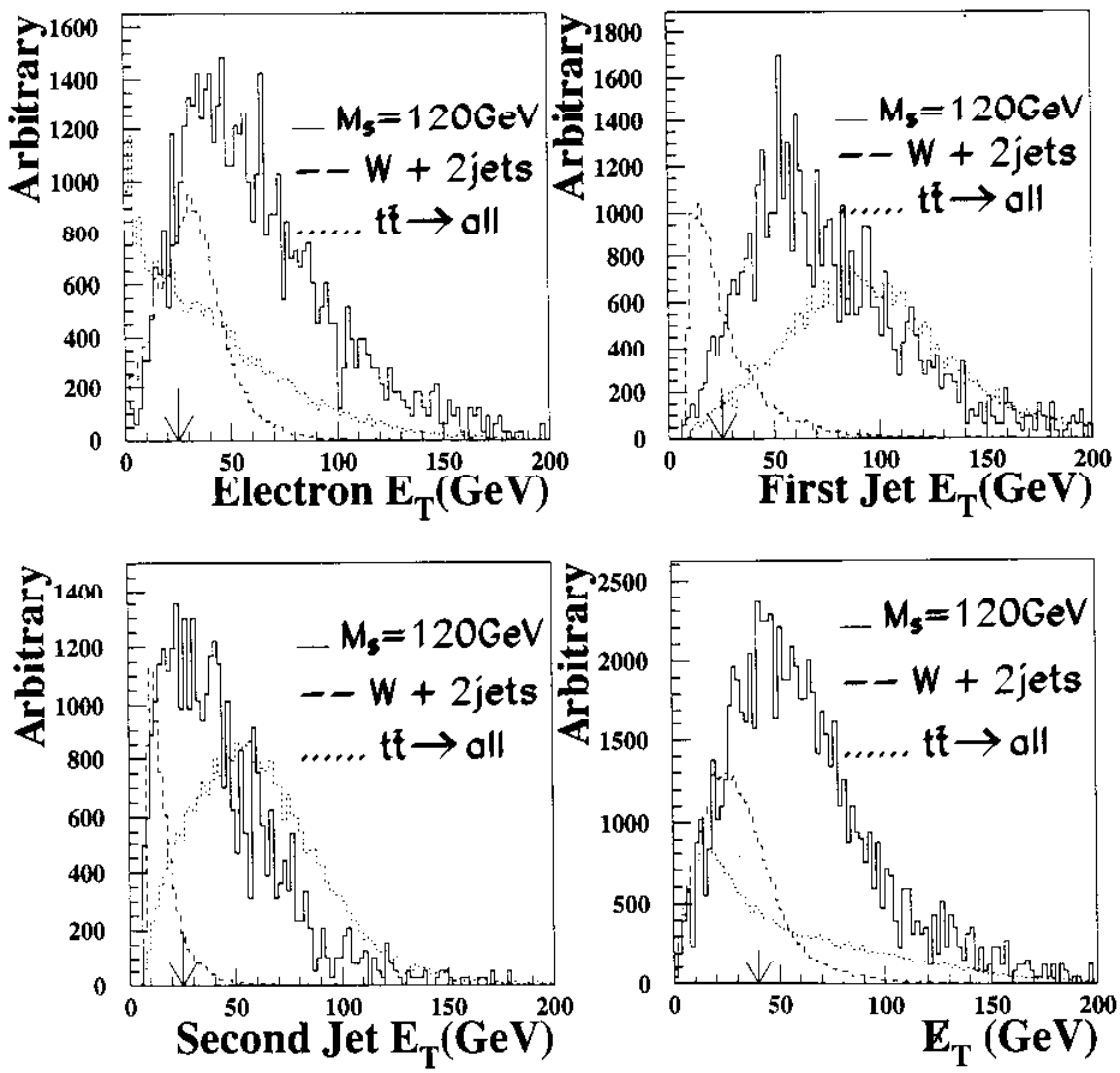
- Selection:

  1e; ≥2 jets; $\not{E}_T$;

  $\sum E_t^{jets} + E_t^e > 170$ GeV

  $M_T(e\nu) > 100$ GeV

- Acceptance: 14% for M = 200 GeV



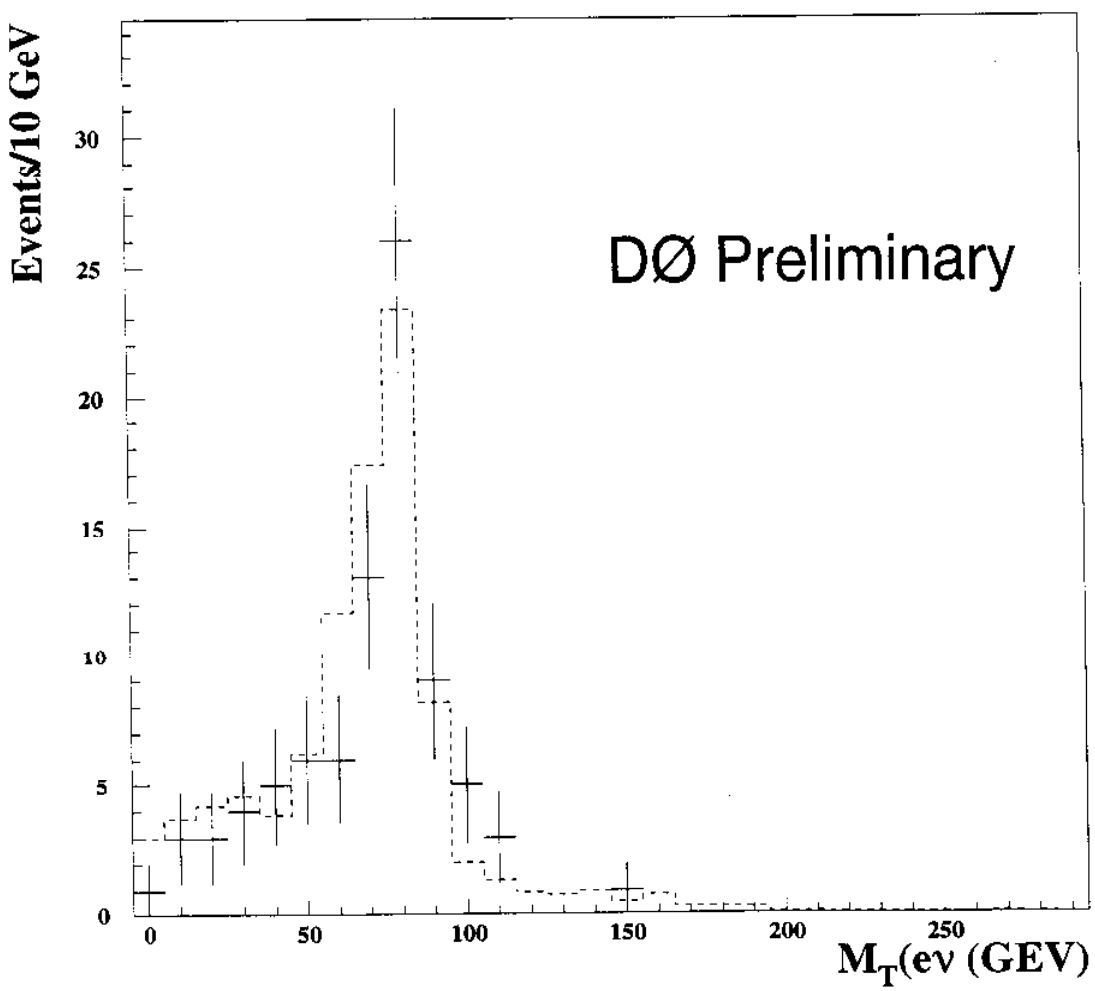
1st Gen. SLQ: eνjj

M_T: Loose Selection

1e: $E_T > 25$ GeV

2jets: $E_T > 25$ GeV

$\not{E}_T$: > 40 GeV

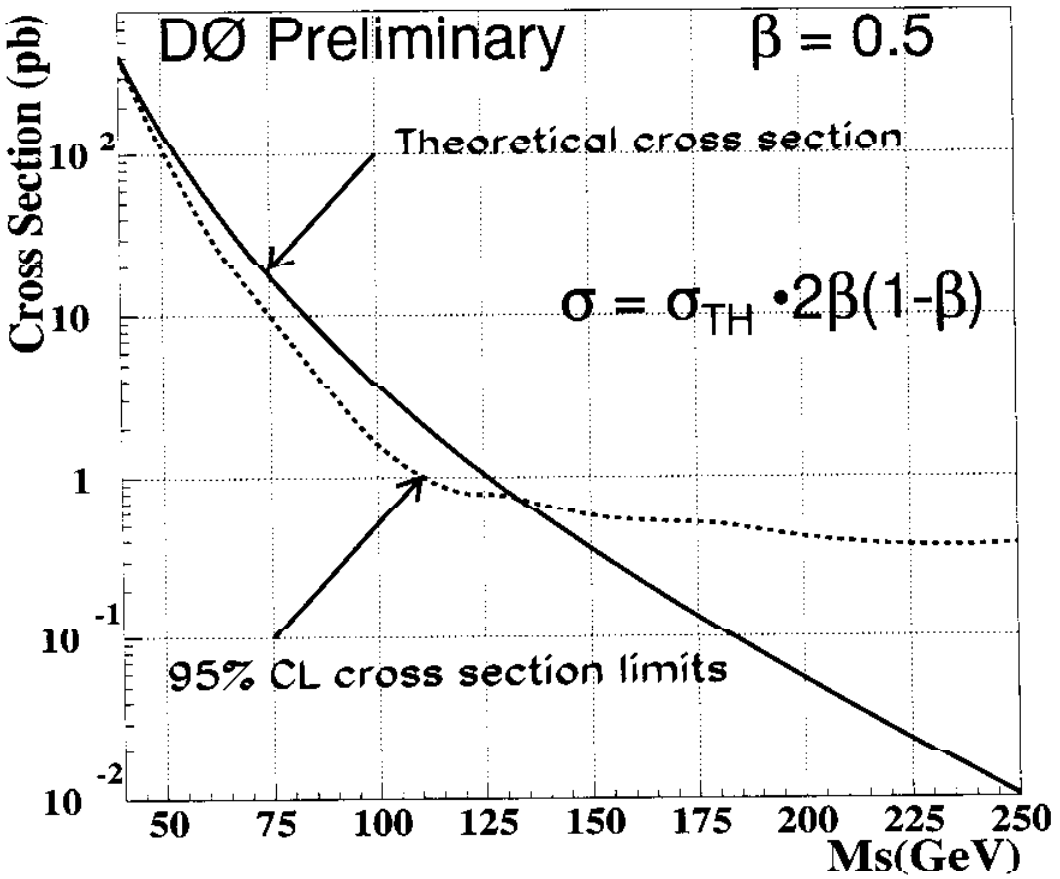


1st Gen. SLQ: eνjj

L = 104 pb^{-1}

Data: 3 events

Backgrounds: 4.0 ± 1.1



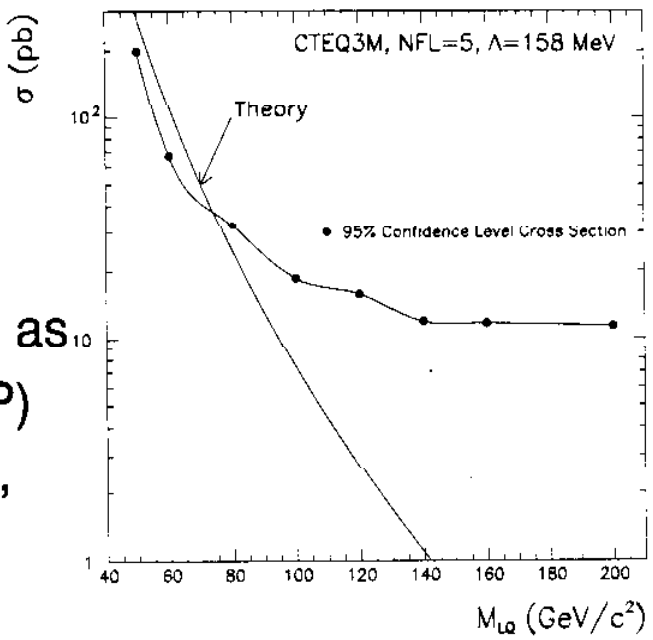
Cross section:

Blümlein, Boos, Kryukov, DESY 96-174

CTEQ3M, λ_{QCD}=158MeV, $Q^2 = \hat{S}$

1st Gen. SLQ: $\nu\nu jj$

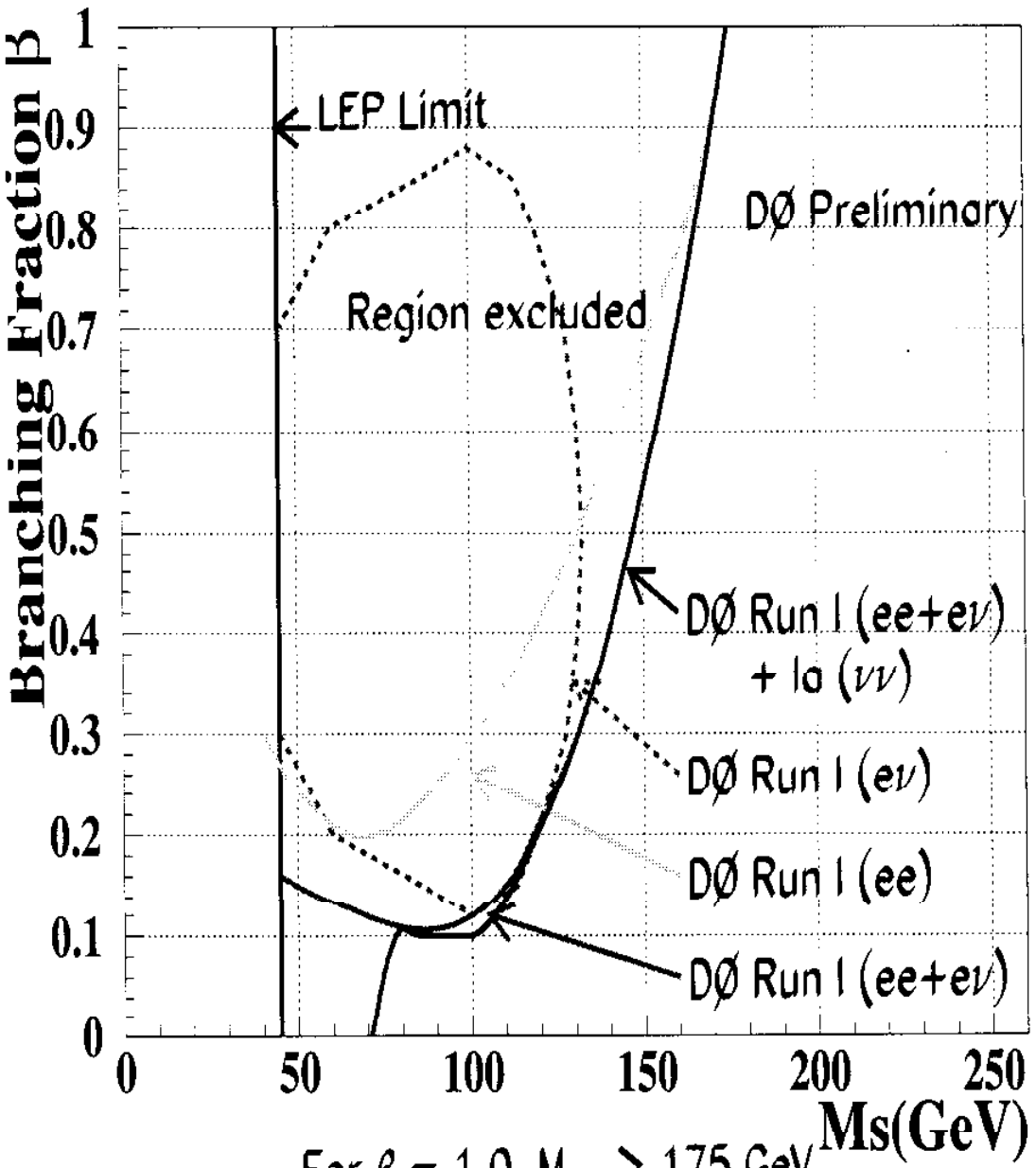
- L = 7.4 pb^{-1} (run Ia)
- Selection:
  - ❒ 2 jets, $E_T > 30$ GeV
  - ❒ "ν", $\not{E}_T > 40$ GeV
  - ❒ charged lepton veto
    - ☛ The same selection as $\tilde{t}\bar{\tilde{t}} \to c\bar{c}$(LSP)(LSP)
      Phys. Rev. Lett. 72, 2222 (1996)
- Test our sensitivity
  Use LQ signal MC
- Data: 3 events
  Bkgs: 3.5 ± 1.2



- M > 71 GeV

- Cross section: Blümlein, Boos, Kryukov, DESY 96-174 $Q^2 = \hat{s}$

1st Gen. SLQ: Mass limits

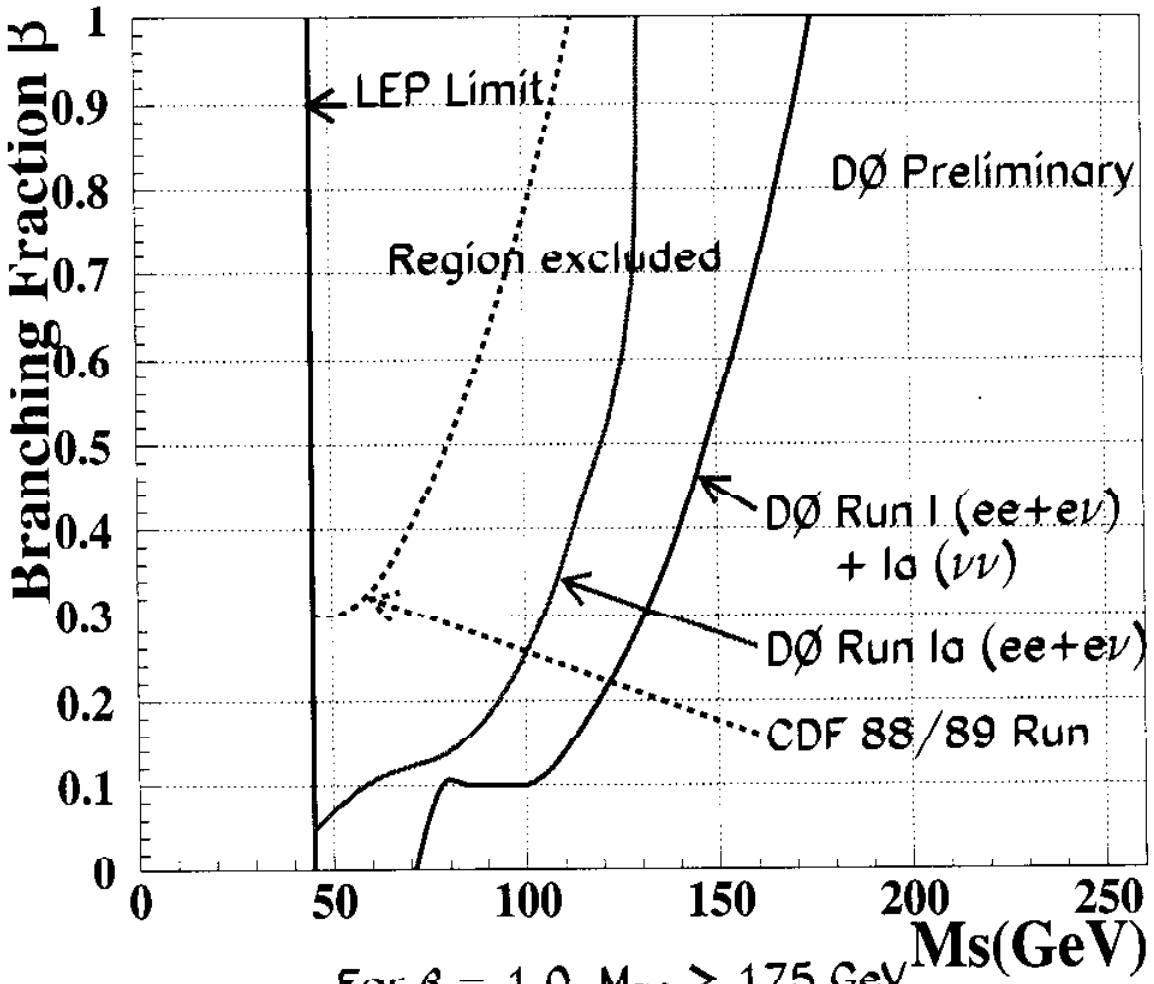


For $\beta = 1.0$, $M_{SLQ} > 175$ GeV

For $\beta = 0.5$, $M_{SLQ} > 147$ GeV

For $\beta = 0.0$, $M_{SLQ} > 71$ GeV

1st Gen. SLQ: Mass limits



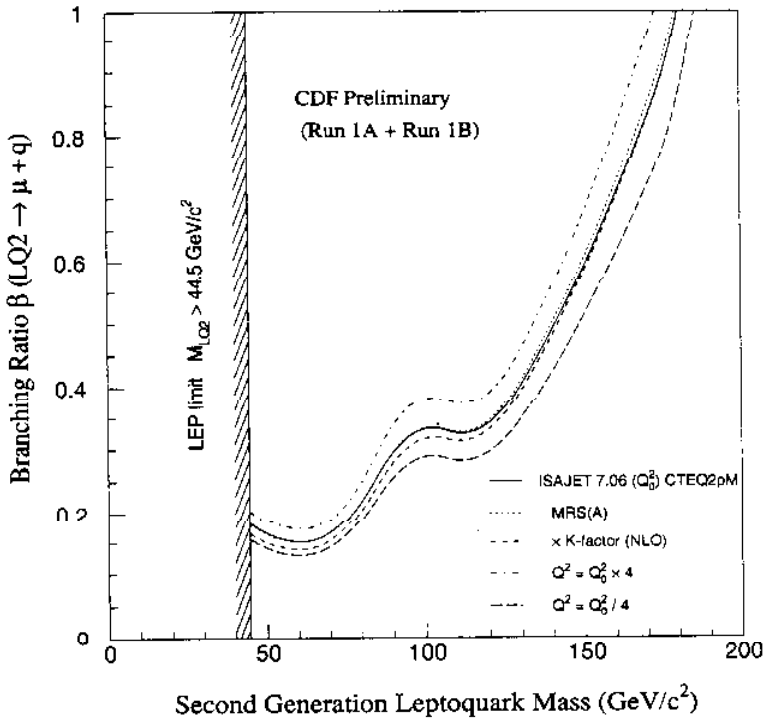
For β = 1.0, M_{SLQ} > 175 GeV

For β = 0.5, M_{SLQ} > 147 GeV

For β = 0.0, M_{SLQ} > 71 GeV

2nd Gen. SLQ:

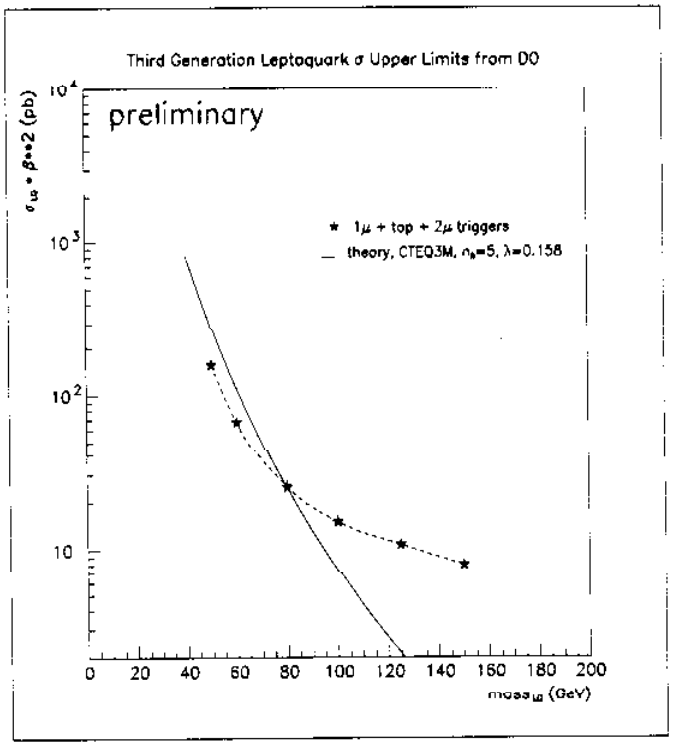
- ***CDF: 70 pb^{-1}***
  - ❒ 2μ + 2jets
    p_T^{μ}>20 GeV
    E_T^{j}>20 GeV
    Z veto
  - ❒ Data: 4
    Bkgs: 4.8 (DY)
  - ❒ M>180 (β=1.0)
    M>140 (β–0.5)



- ***DØ: 94.4 pb^{-1}***
  - ❒ 2μ + 2jets
    p_T^{μ}>15 GeV
    E_T^{j}>20 GeV
    Scalar E_T sum > 100GeV
    phi gap cuts
    Z veto, constrained mass fit
  - ❒ Data: 0
    Bkgs: 0.9 ± 0.2
  - ❒ M>178 GeV (β=1.0)

3rd Gen. SLQ: $\nu\nu jj$

- ***DØ: 86pb^{-1}***
- Selection(for -1/3 charge LQ3):
  - ❒ ≥ 2 jets, ≥1 with soft muon tag
    - untagged jet, E_T> 25 GeV
    - tagged jet, E_T > 10GeV
  - ❒ $\not{E}_T$ > 35 GeV
- Data: 2 events
  Bkgs: 2.8 ± 0.7
  M > 80 (β=0.0)



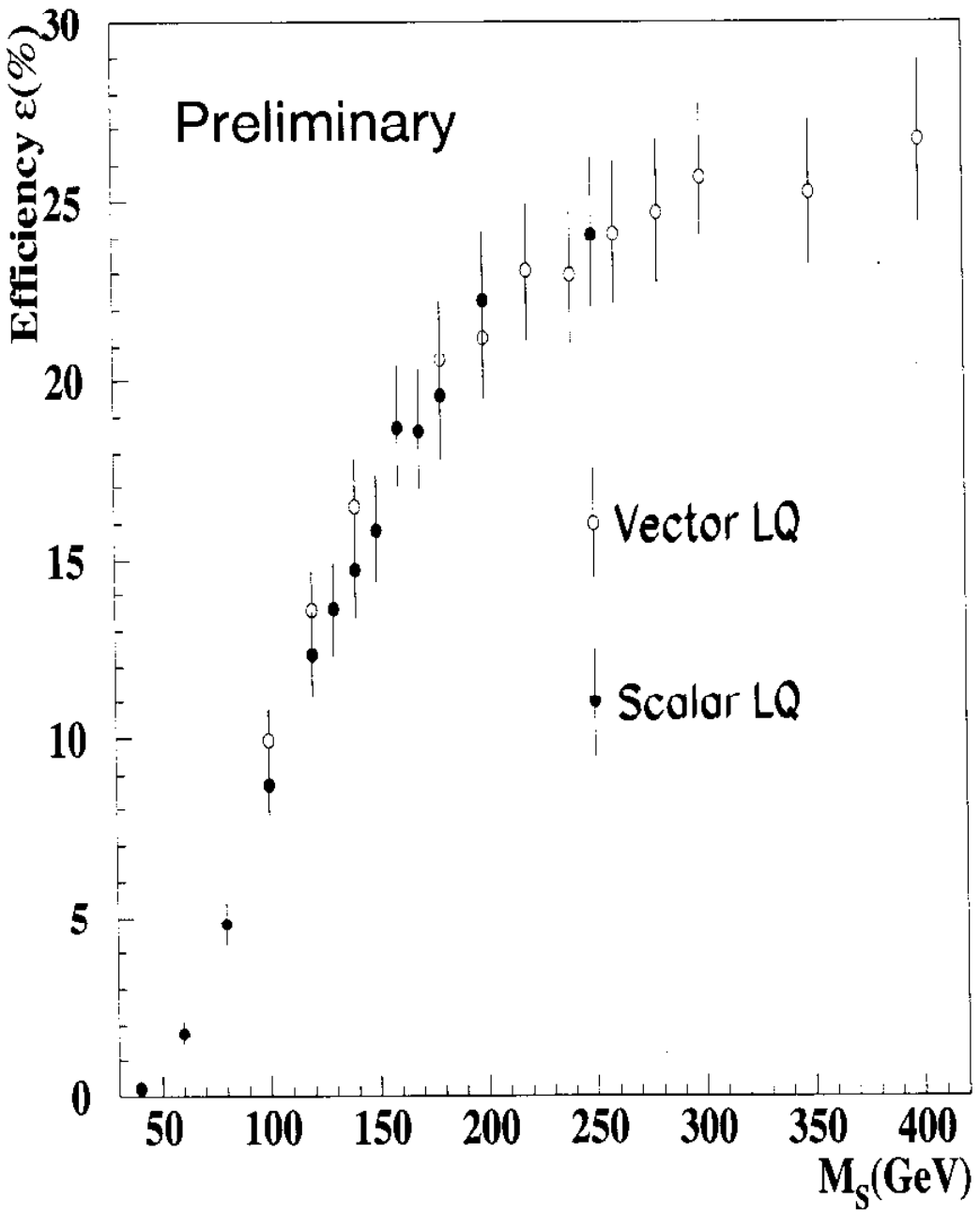
- ***CDF: 110pb^{-1}***
  2τ + 2 jets(for 2/3 charge LQ3):
  Data: 1 events
  Bkgs: $2.4^{+1.2}_{-0.6}$ (from Z→ττ + jets)
  M > 99 (β=1.0)

1st Gen. VLQ:

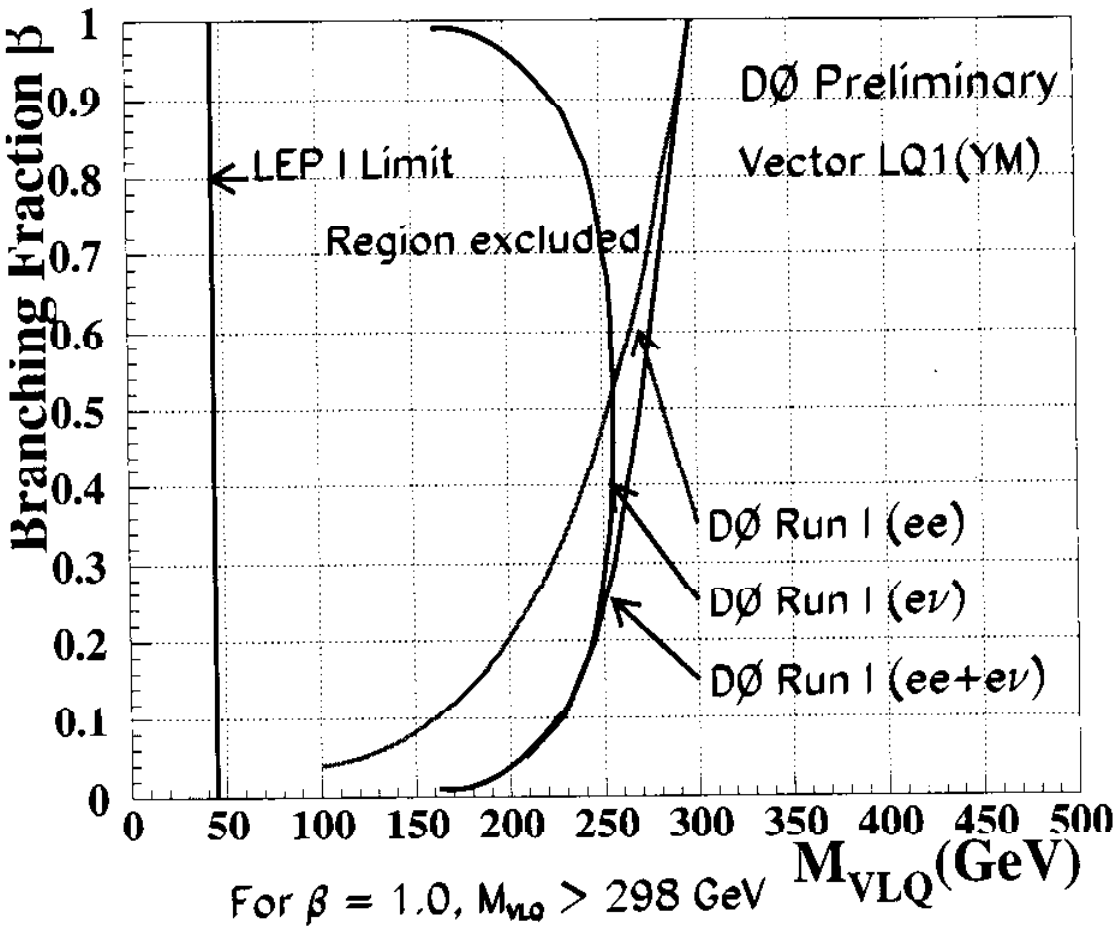
- Two anomalous couplings (κ, λ)
  - ☞ (0,0) "Yang-Mills"
  - ☞ (1,0) "Minimal Vector"
- Compare with 1st Gen. SLQ:
  - ❒ Cross section of VLQ much larger
  - ❒ Kinematic distribution: same
  - ❒ Optimization gives similar selection

⇨ Use the same selection as our 1st gen. scalar LQ.

1st Gen. VLQ:


Preliminary
Efficiency ε(%)
30
25
20
15
10
5
0
50
100
150
200
250
300
350
400
M_S(GeV)
Vector LQ
Scalar LQ

1st Gen. VLQ: (Yang-Mills) Limits



For $\beta = 1.0$, $M_{VLQ} > 298$ GeV

For $\beta = 0.5$, $M_{VLQ} > 270$ GeV

Conclusions:

- ***Scalar Leptoquark:***
  - First Generation (DØ)
    - $\beta = 1.0$, $M > 175$ GeV
    - $\beta = 0.5$, $M > 147$ GeV
    - $\beta = 0.0$, $M > 71$ GeV
  - Second Generation (CDF, DØ)
    - $\beta = 1.0$, $M > 180$ GeV
    - $\beta = 0.5$, $M > 140$ GeV
  - Third Generation (CDF,DØ)
    - 2/3 charged, $M > 100$ GeV
    - -1/3 charged, $M > 80$ GeV
- ***Vector Leptoquark:***
  - First Generation (Yang-Mills) (DØ)
    - $\beta = 1.0$, $M > 298$ GeV
    - $\beta = 0.5$, $M > 270$ GeV
- ***We're still working, so stay tuned:***
  - NLO theoretical cross section
  - Optimize selection at higher mass range