Third Generation Leptoquark Study

status report (0)

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1. **Introduction of Run I Result**
2. **Discussion**

Documents from Run I

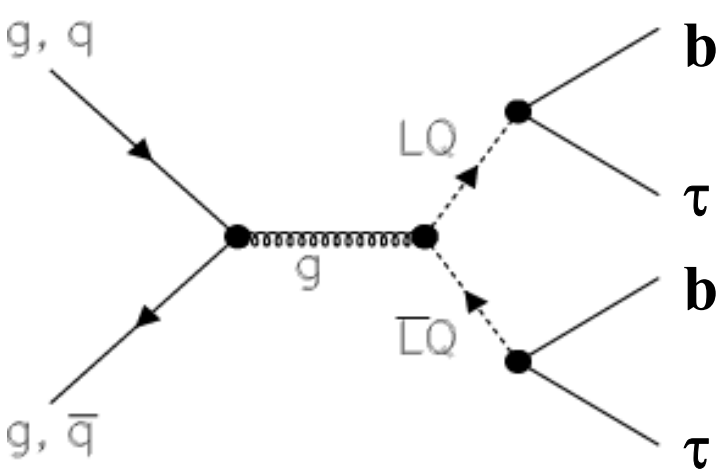
- **3rd Generation LQ_3s in di-tau,**
  - **Search for Third Generation Leptoquarks in p anti-p Collisions at s**(1/2) = 1.8 TeV,**
    Phys. Rev. Lett. 78, 2906 (1997).
    - **CDF note 3597 : first note**
    - **CDF note 3840 : update with 110 pb^{-1}**
    - **CDF note 3950 : publication draft**

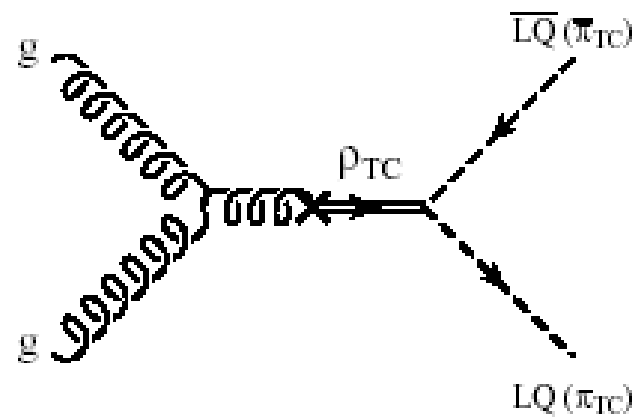
- **Technicolor Case,**
  - **Search for Third-Generation Leptoquarks from Technicolor Models in p anti-p Collisions at s**(1/2) = 1.8 TeV,**
    Phys. Rev. Lett. 82, 3206 (1999).
    - **CDF note 3933 : first note**
    - **CDF note 4730 : publication draft**

Introduction to LQ_3 with tau

- **Production:**
  - Gluon-gluon fusion: $gg \rightarrow LQ_3\overline{LQ}_3$
  - Quark anti-quark annihilation: $q\overline{q} \rightarrow LQ_3\overline{LQ}_3$
  - (Optional) Technicolor: $gg(q\overline{q}) \rightarrow g \rightarrow \rho_{TC} \rightarrow LQ_3(\pi_{TC})\ \overline{LQ}_3(\pi_{TC})$
- **Decay:**
  - Two charged lepton (di-tau) + di-jet. Most ssensitive to $\beta = 1$
  - One charged lepton (tau) + neutrino + di-jet. $\beta = 0.5$ if $M_{LQ3} >> M_{top}$
  - 2 neutrinos + di-jet. $\beta = 0.0$

β is the BR of charged lepton decay.

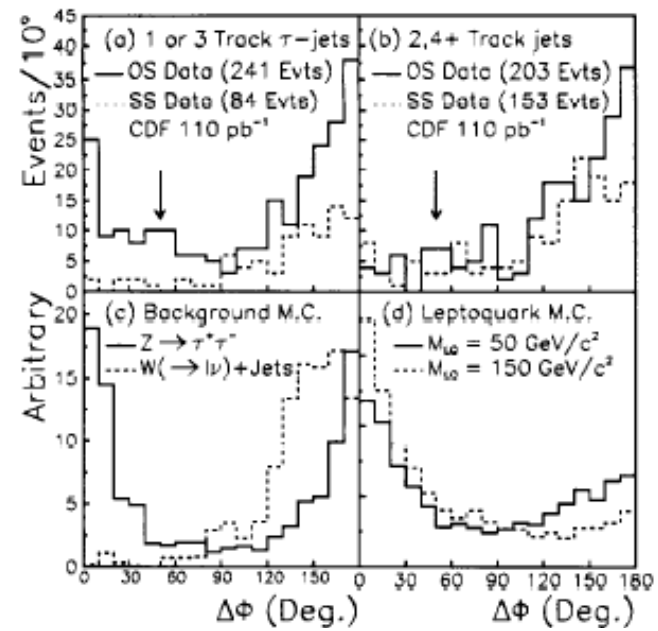


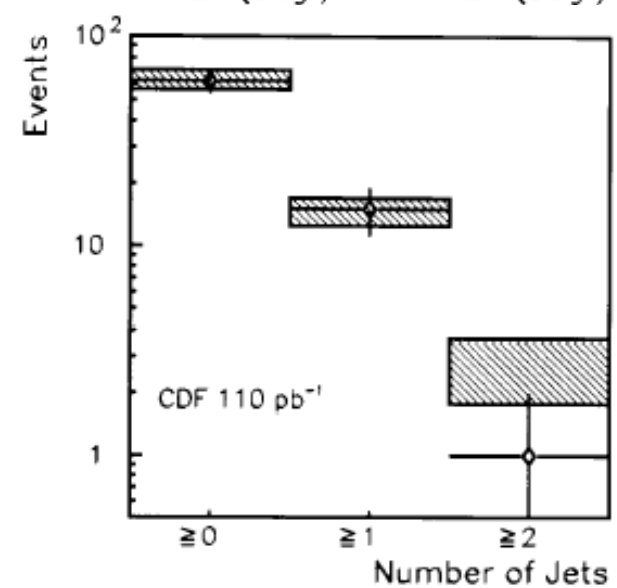


Event Selection

Signature $\tau_l \tau_h$ + 2 *b*-jets

1. High pt lepton trigger
2. ID ***e*** or μ in $|\eta| < 1$ w/ $p_T > 20$
3. ID hadronic tau (see next)
4. Isolation for lepton and tau
   - ***e***, μ: Less than 10% of Et within ***dR*=0.4**
   - τ : No charged tracks w/ $p_T > 1$ in 10°-30°
5. Z^0 removal
   - **70 < *M*(*l*,seed track of τ_h) < 110**
6. $\Delta\Phi$**(MEt, *l*) < 50°**
7. At least 2 jets
   - w/ $E_T > 10$, $|\eta| < 4.2$

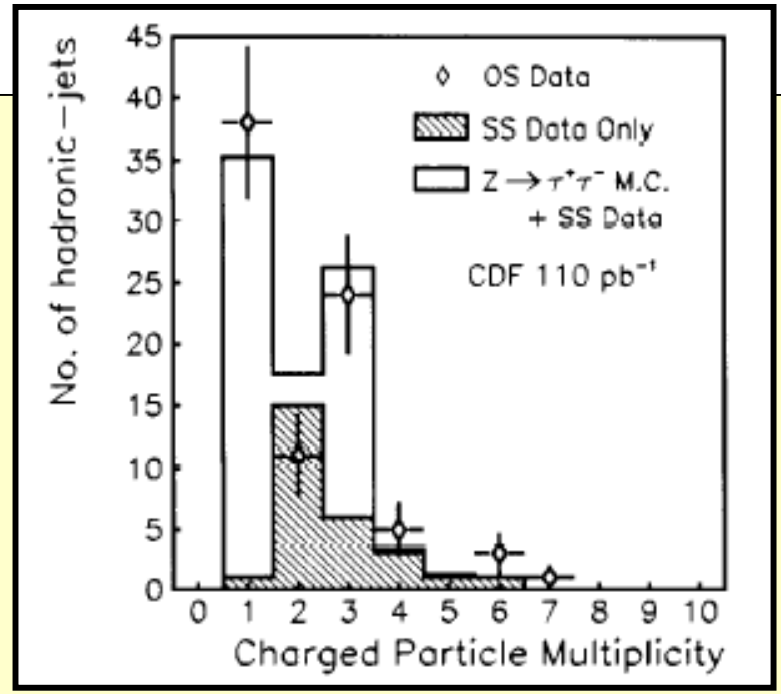




Hadoronic tau selection

- Jets that do not pass electron criteria are candidates.
- Charged particles w/ $\boldsymbol{p_T > 1}$ in a 10° cone satisfy
  - There are 1 or 3 charged particles.
  - If there are 3, sum $\boldsymbol{p_T > 20}$ and $\boldsymbol{M_{recon} < 2}$.
  - Seed track must have $\boldsymbol{p_T > 10}$ and must not point to wrong region of cal.
- The charge defined as the sum of the charge in 10° cone. Or, seed track charge if not equal to +/-1.
- $\boldsymbol{\varepsilon = 59\%}$ for $\boldsymbol{E_T > 40}$. (32% for $\boldsymbol{15 < E_T < 20}$)

Background Estimation



- Real $\tau^+\tau^-$ BG: N_{MC}
  - $Z^0 \to \tau^+\tau^-$ + **jets**
  - $t\,\bar{t}$
  - Di-boson
- Fake $\tau^+\tau^-$ BG:
  - Estimate by Same-sign $l+\tau$: N_{SS}
- Total BG: $N_{OS} = N_{SS} + N_{MC}$

Signal of Efficiency and X-sec

- Scalar LQ_3 by **ISAJET** and Vector LQ_3 by **PYTHIA** at 1997.

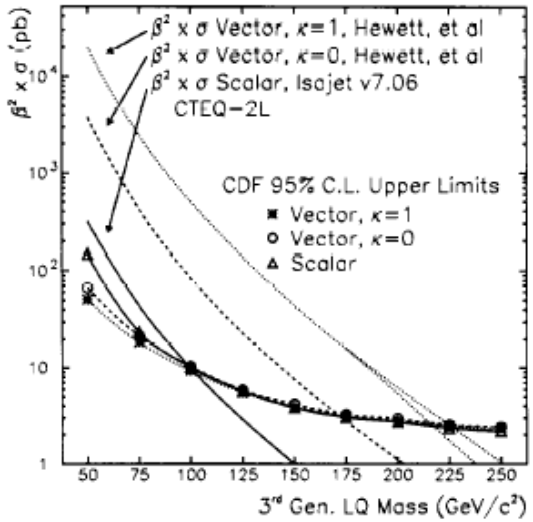
M_{LQ}	Scalar ε_{LQ}	Scalar δ_{tot}	Scalar $\beta^2\sigma$ (pb)		Vector $\kappa = 0$ $\beta^2\sigma$ (pb)		Vector $\kappa = 1$ $\beta^2\sigma$ (pb)	
(GeV/c^2)	(%)	(%)	limit	LO	limit	LO	limit	LO
50	0.029	27	150	320	67	3700	51	19000
75	0.16	16	24	44	22	420	18	2400
100	0.38	18	10	9.8	10	84	9.3	510
125	0.66	15	5.7	2.9	5.9	23	5.5	140
150	0.96	11	3.8	1.0	4.2	7.6	3.9	44
175	1.2	11	3.1	0.39	3.2	2.8	3.1	16
200	1.3	10	2.7	0.16	3.0	1.1	2.8	6.2
225	1.6	11	2.3	0.070	2.5	0.47	2.5	2.5
250	1.7	10	2.2	0.031	2.4	0.20	2.4	1.0

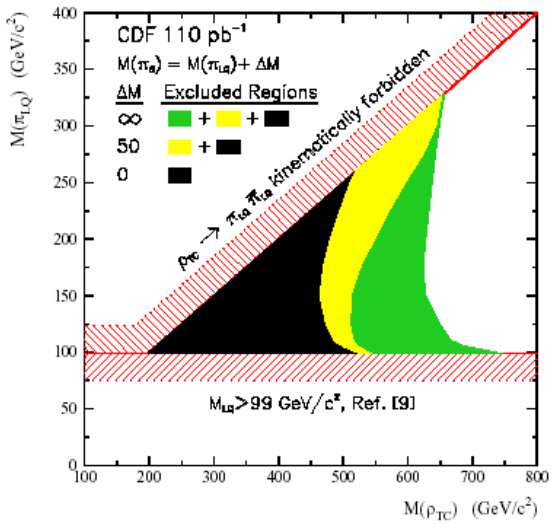
Anomalous chromomagnetic moments

ε_{LQ3}: Vector/Scalar = 2.3(3.1) for M_{LQ3} = 50 and κ = 0(1)

95% C.L. Limit

110±8 pb^{-1}





- **One candidate event survived.**
- Background : **2.4+1.3-0.6** (mainly $Z^0 \to \tau\tau$+**jets**)
- Scalar LQ_3: $M_{LQ3} > 99$
- Vector LQ_3 (κ=0): $M_{LQ3} > 170$
- Vector LQ_3 (κ=1) : $M_{LQ3} > 225$ (not couple $\nu_\tau t$)
  $M_{LQ3} > 217$ (couple $\nu_\tau t$)
- Technicolor LQ_3: $M(\pi_{LQ3}) > 465$

Discussion and Plan