April 19, 1997

APS(F9.02), Washington D.C.

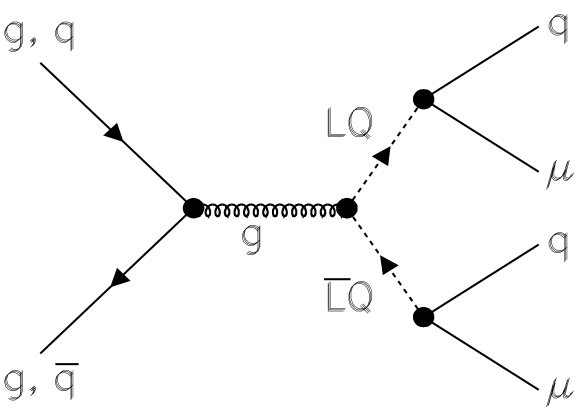
Second Generation Leptoquark Search at Collider Detector at Fermilab

Hisanori Sam Kambara

Université de Genève, Switzerland
(CDF Collaboration, Fermilab)

- Motivation and Method
- Data Sample and Event Selection
- Signal Detection Efficiencies
- Background and Systematics
- Limit and Conclusions

Motivation



- **Motivation**:
  Second generation Leptoquark Search.

- **Production**:
  $q\bar{q}$, $gg \rightarrow LQ$ **pair production at** $p\bar{p}$.

- **Decay**:
  Dilepton (muon) + Dijet decay channel.

Method

- Data and Signal:
  High p_T Dimuon events with Dijets.
  · p_T $(\mu) > 20$ GeV/c .
  · E_T $(jets) > 30, 15$ GeV .
  · Dimuon invariant mass cut:
  ($M_{\mu\mu} < 10$ GeV/c^2 , $76 < M_{\mu\mu} < 106$ GeV/c^2)

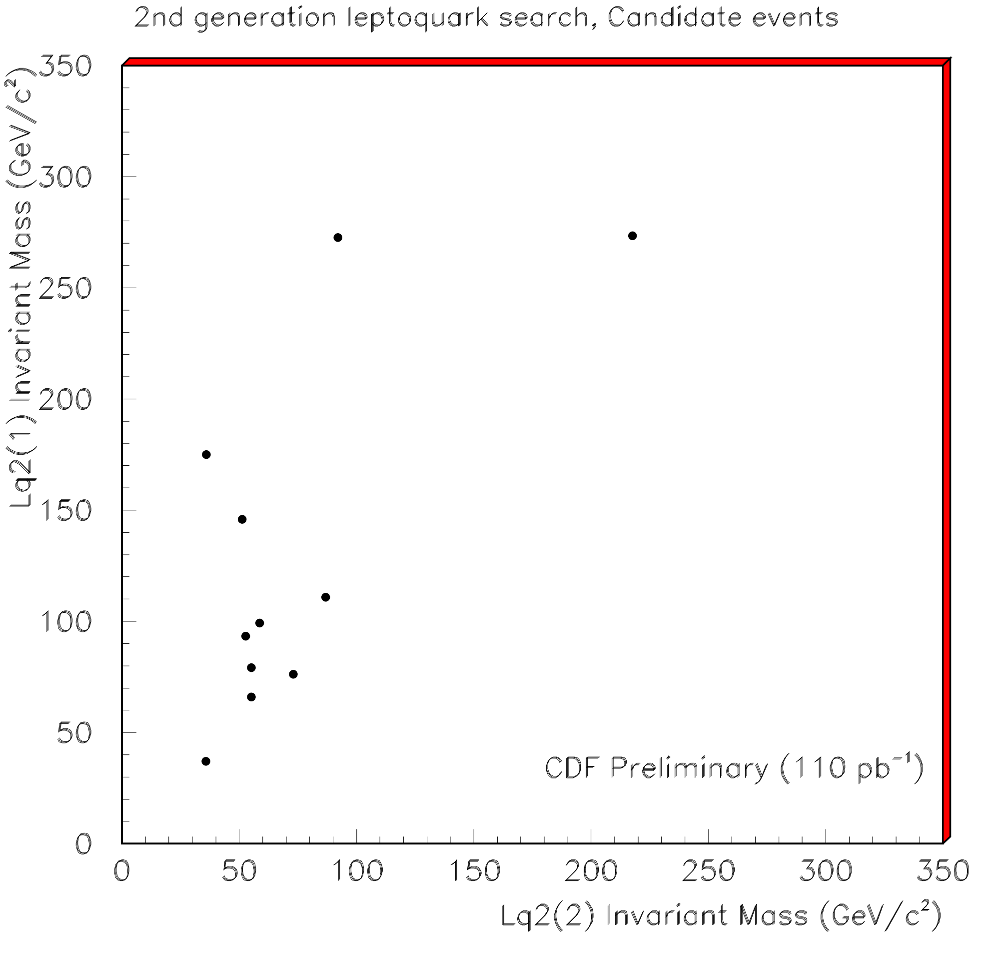
- Data Sample:
  1A+B (110 pb^{-1}) with CDF.

- Signal and Background:
  11 signal candidate events selected; 14.0 background events expected.

- Mass Constraint cuts: (An additional cut)
  LQ_2 pair mass balancing requirement
  $\Rightarrow$ Suppresses the background substantially.

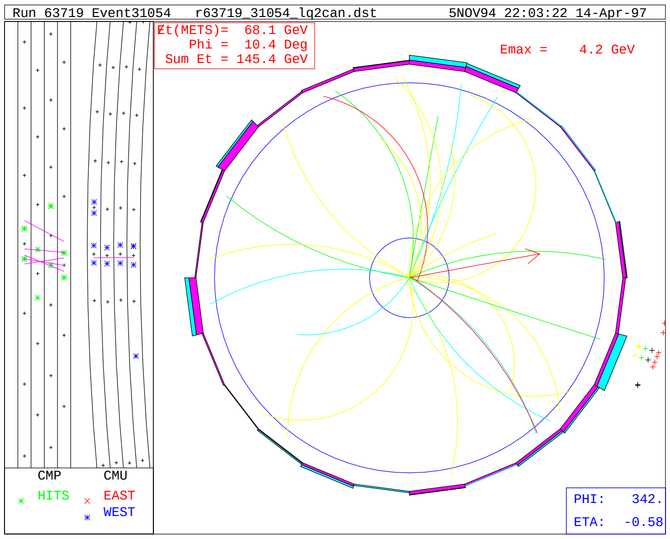
- No Evidence of Excess:
  $\Rightarrow$ Preliminary cross section limit.

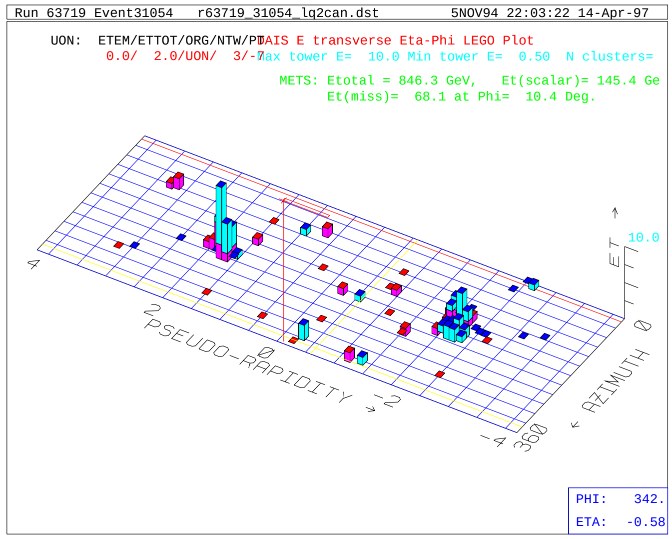
Candidate event distributions



- 11 events passes the cuts from Run 1A+B.
- Displayed on LQ_2 (1) v.s. LQ_2 (2) plane.
- LQ_2 (1) is the larger invariant mass LQ_2 by definition.

A Candidate Event Display





- CDF event display for
  - CTC tracking (left)
  - Calorimeter LEGO (right)
- Run 63719 Event 31054 (Run 1B)

Background

Type	Expected
Drell-Yan	12.08 ± 1.8
$t\bar{t}$	$1.28^{+0.17}_{-0.18}$
$b\bar{b}$	$0.0^{+1.59}_{-0.0}$
WW	0.06 ± 0.01
$Z \to \tau_+ \tau_-$	0.27 ± 0.19
Fake muon	0.28 ± 0.22
total background	14.0 ± 1.8

- Total expected background 14.0 ± 1.8, **without** pair mass balancing constraint.
- 11 events passing the cuts from data.
- $\Rightarrow$ With mass constraint cut, expected background is suppressed at high mass.
- Example: at $M(LQ) = 200\mathrm{GeV}/c^2$, $N_{bkgnd} = 0.28$ Events.

Fit for the reconstructed LQ_2 mass

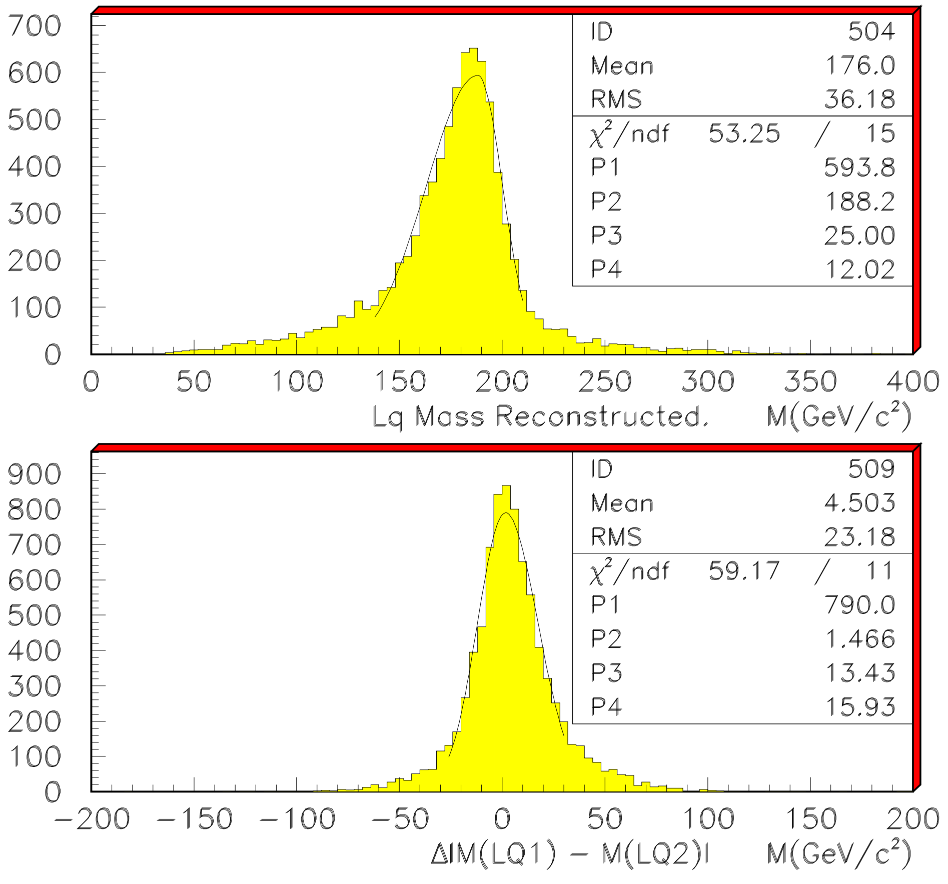
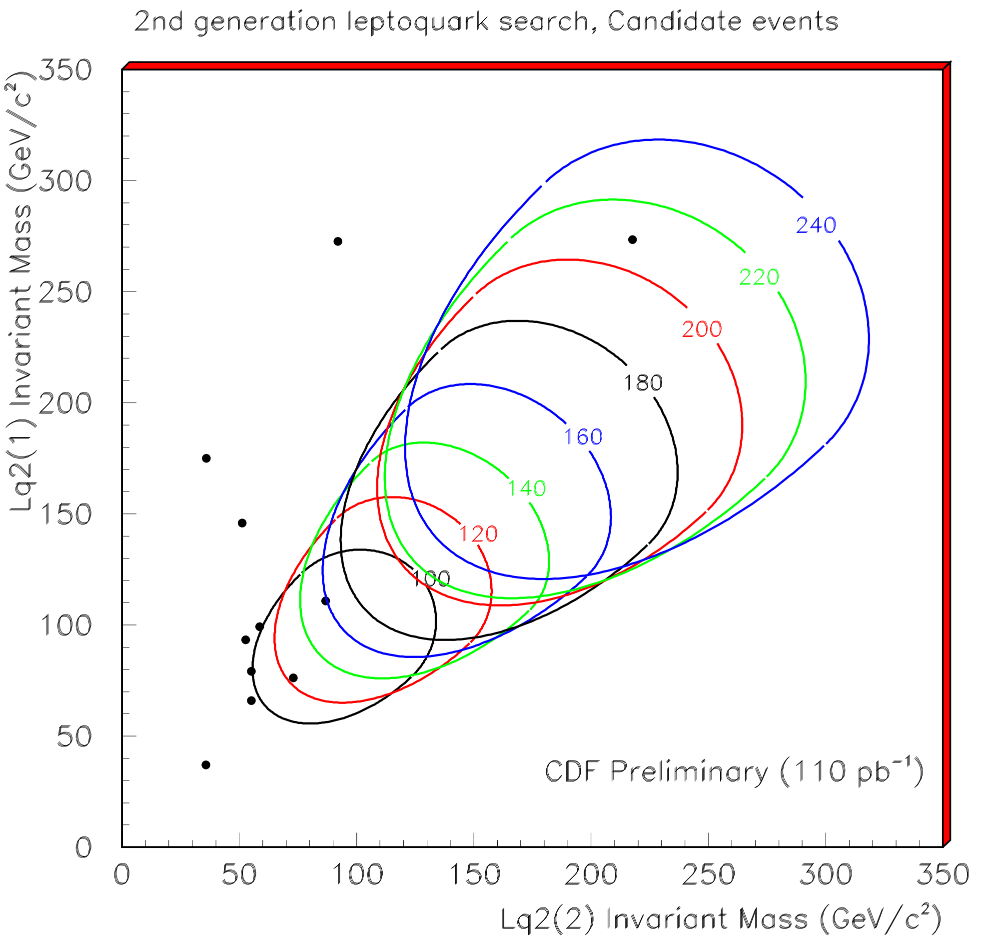


Figure 1: Pythia v5.7, M(LQ) = 180 GeV/c^2 .

- Use the MC to define a region in the M_1 v.s. M_2.
- $(M_1 + M_2)/2, \Delta(M_1 - M_2)/2$ distributions.
- Mass deviation for LQ_2 pair mass constraint.

Candidate event distributions with mass constraint



- Mass distribution of the LQ_2 candidate events.
- With pair mass constraint cut.
- $\Rightarrow$ Suppresses the background substantially.

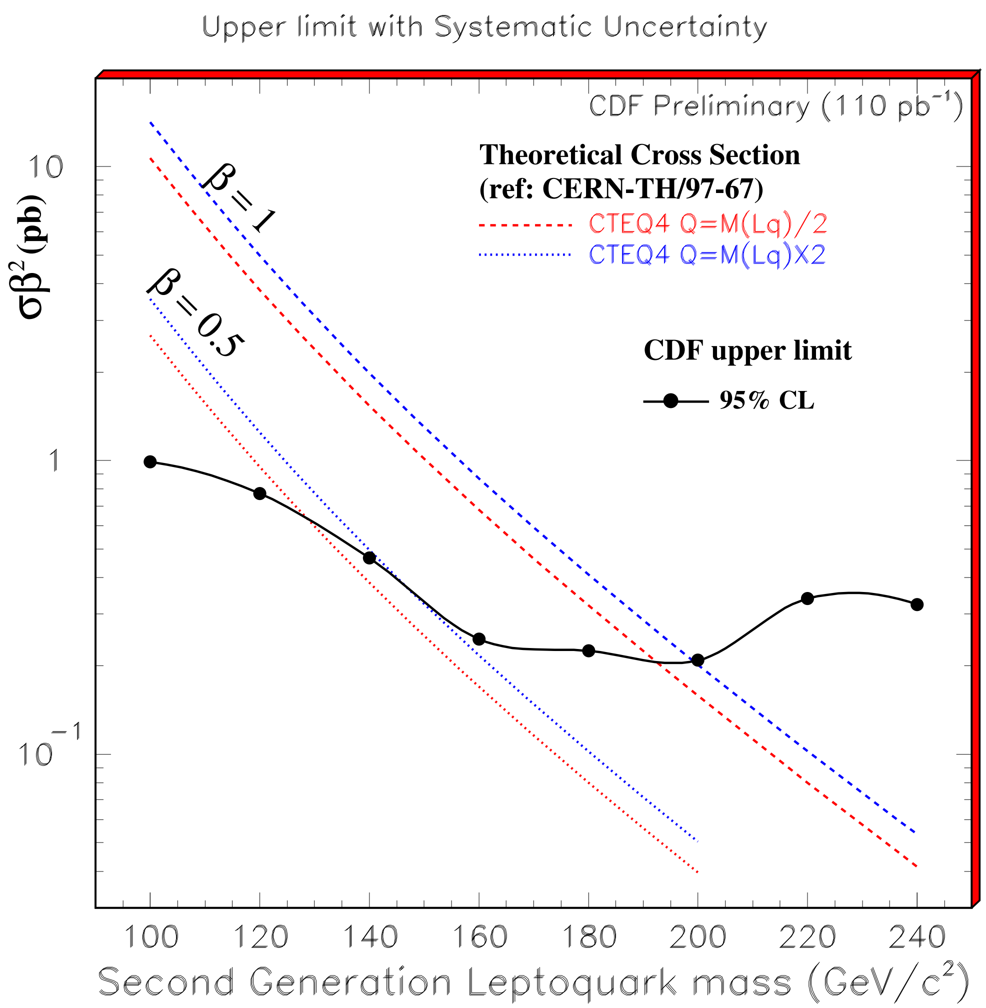
Upper limit

LQ_2 mass (GeV/c^2)	120	160	200	240
Signal detection efficiency, ε_{total}	0.090	0.125	0.148	0.158
Expected Bkgnd (w/ Mass Const.)	3.77	1.14	0.279	0.091
Expected Signal ($= \sigma_{Lq2} \cdot \mathcal{L} \cdot \varepsilon_{total}$)	36.4	9.15	2.55	0.717
Theoretical σ_{Lq2} (pb) CTEQ4L	3.75	0.681	0.161	0.0422
Experimental Upper limit with systematic uncertainty				
N of Events observed	2	0	0	1
$N_{CL=95\%}(poisson + gaussian)$	7.43	3.29	3.28	5.45
Cross section upper limit (pb)	0.713	0.240	0.203	0.310

- Cross sections of LQ_2 and upper limit.
- $\mathcal{L} = 110\ \mathrm{pb}^{-1}$.
- σ_{Lq2} calculated with CTEQ-4L†.LQ$_2$ production cross section for $\beta = 1.0$ (all charged lepton decay).
- Conservative Systematic error at 20%:
  (Gluon radiation, Q^2 scale, E(jet) scale, Detector simulation, Structure function, MC statatistics, $\mathcal{L}$, etc.)

† CERN-TH/97-67, M. Spira, et.al.

Upper limit (systematic error included)



$95\% C.L.$ upper limits on σ_{Lq2} function of the leptoquark mass. Systematic uncertainty of 20 % included. No background subtracted.

Summary

- Run 1A+B data of 110 pb^{-1} fully analysed.
- 11 possible events over 14.0 expected background events.
- With LQ_2 pair mass constrain, no evidence of excess events.
- Systematic uncertainty included, no background subtraction.
- Preliminary cross section limits for $MLQ_2 = 200$ GeV/c^2 is at 0.2 pb.
- Mass limit depends on the theoretical model.