Search for Leptoquarks in $p\bar{p}$ Collisions at D0

- Introduction
- Search for First Generation Leptoquarks in the 2 electrons + 2 jets channel
- Search for Second Generation Leptoquarks in the 2 muons + 2 jets channel

Data taken between Sep. 2002 and Jan. 2003

Luminosity $\approx$ 41 pb^{-1}

Production and decay modes

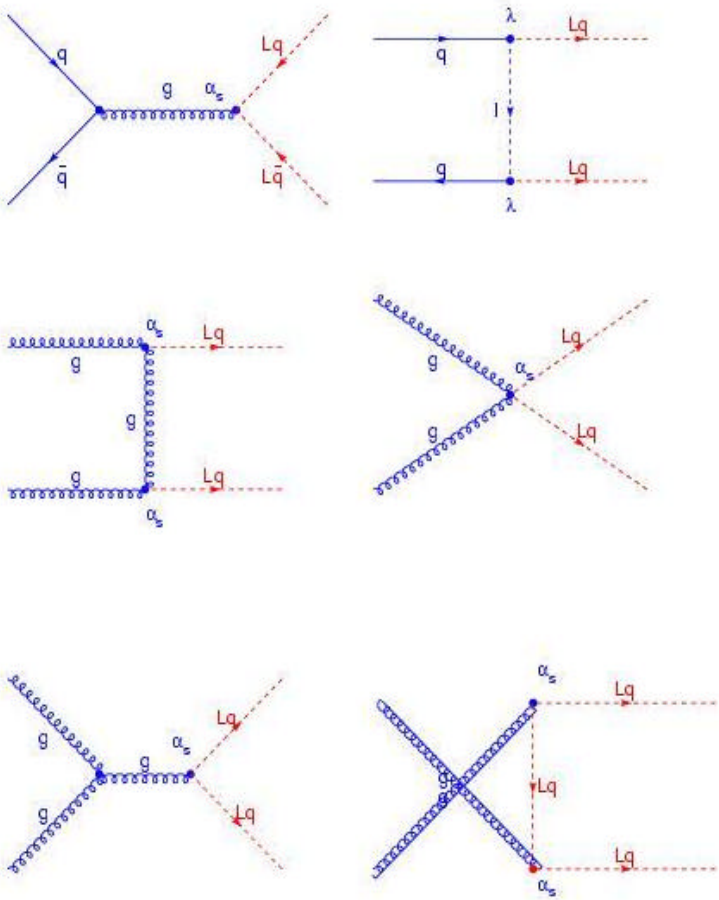
- **Production**
  - $q\bar{q} \rightarrow LQ + \overline{LQ}$
  - $qg \rightarrow LQ + \overline{LQ}$
  - $gg \rightarrow LQ + \overline{LQ}$

- **Decay**

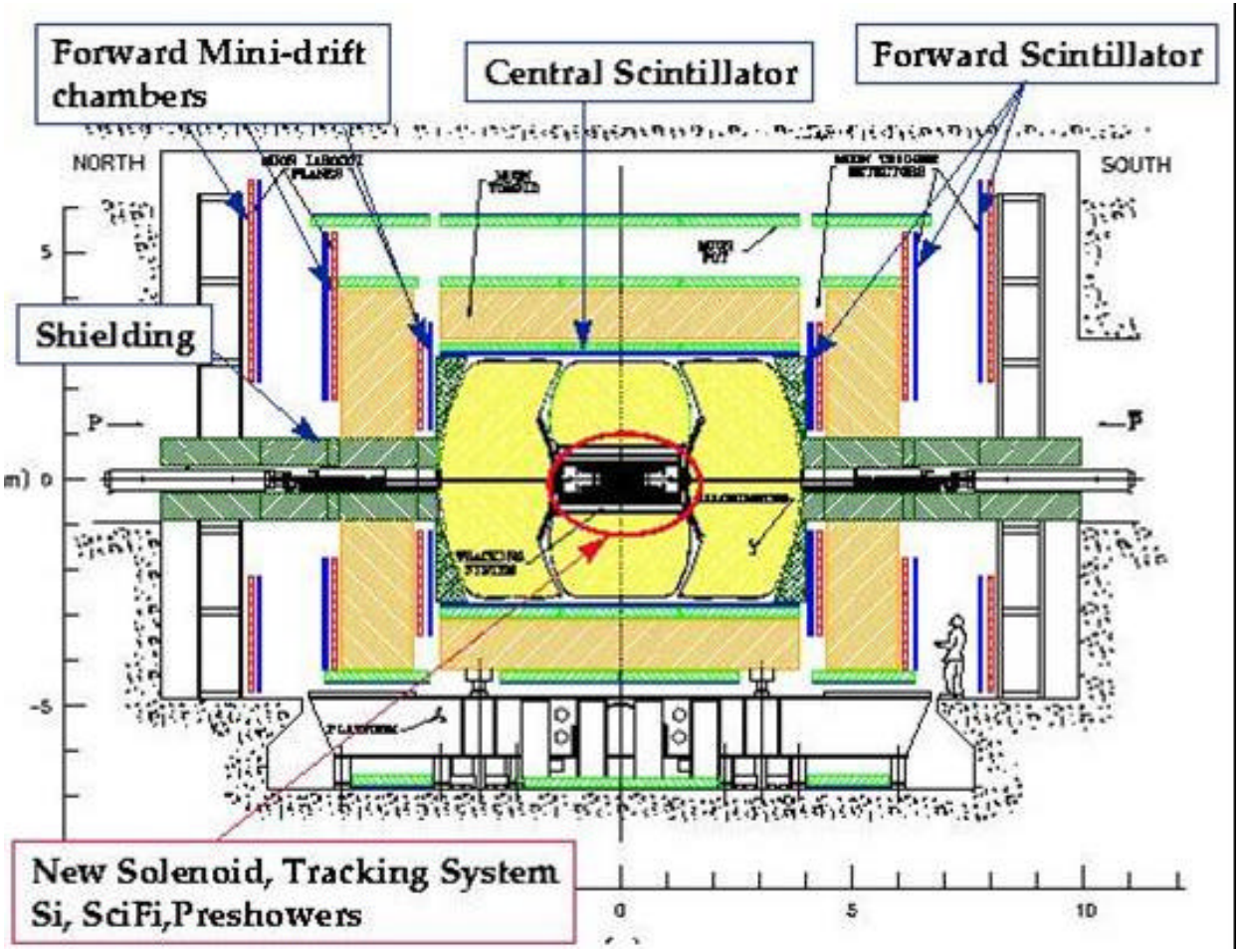
if b = ***Br(LQ->lq)***

and $1-b$ = ***Br(LQ->nq)***

  - $LQ\,\overline{LQ} \rightarrow l^+l^-qq$ $\quad b^2$
  - $LQ\,\overline{LQ} \rightarrow \nu\nu qq$ $\quad (1-b)^2$
  - $LQ\,\overline{LQ} \rightarrow l\nu qq$ $\quad 2b\,(1-b)$



D0 detector


Forward Mini-drift chambers
Central Scintillator
Forward Scintillator
NORTH
SOUTH
Shielding
New Solenoid, Tracking System
Si, SciFi,Preshowers
5
-5
0
5
10

Search for first generation Leptoquark in the channel 2e + 2jets

- Trigger (Level 3) 1 electron with E_T > 20 GeV

  Integrated Luminosity = 43 ± 4 pb^{-1}
- 2 isolated EM clusters with E_T>25GeV + at least 1 track
- At least 2 jets with E_T>20 GeV and $|\eta|$<2.5
- Z veto (M_{2EM} <75 GeV or M_{2EM}>105GeV)

	trigger	+ 2 EM with ≥ 1track	+ >2jets	+ Z veto
Nb events	70873	2093	37	6

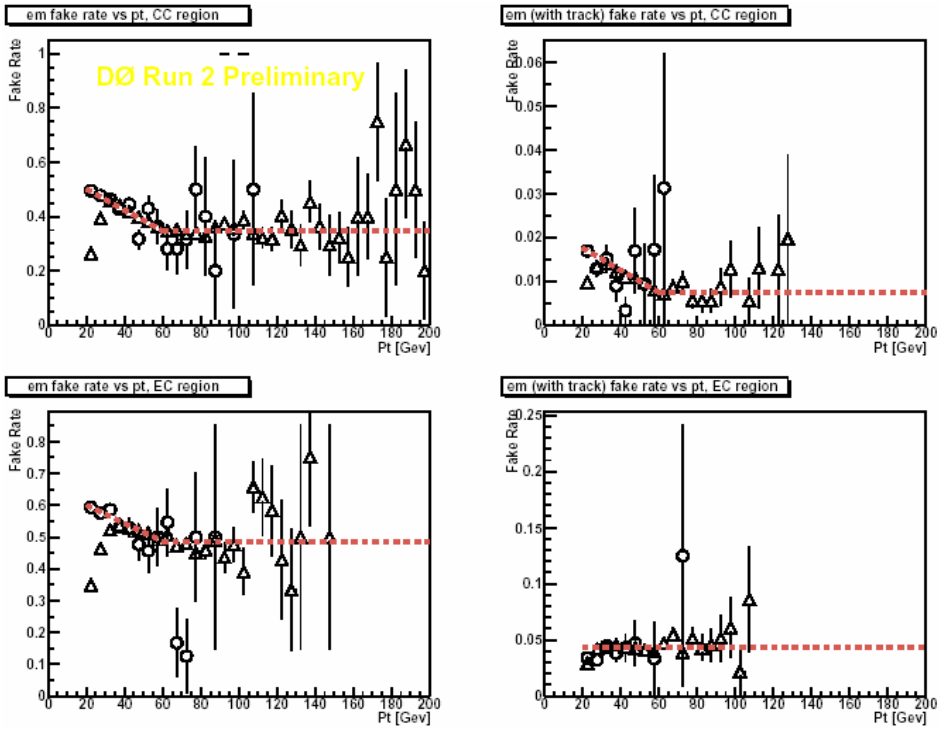
Backgrounds

- QCD : events with ≥4jets with 2 jets which fake an electron
  Instrumental background determined from data

for jets with high EM fraction :

fake rate ≈ 0.01 in the central cal.

fake rate ≈ 0.05 in the end caps



E_T of the EM cluster

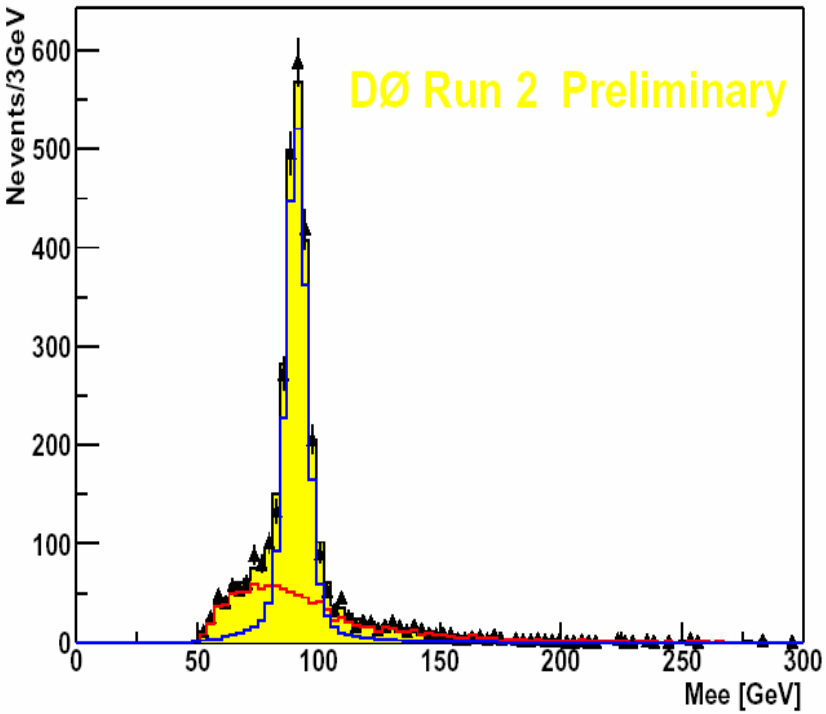
❖ Drell-Yan/Z

PYTHIA LO cross section scaled by a K factor=1.2

❖ Top

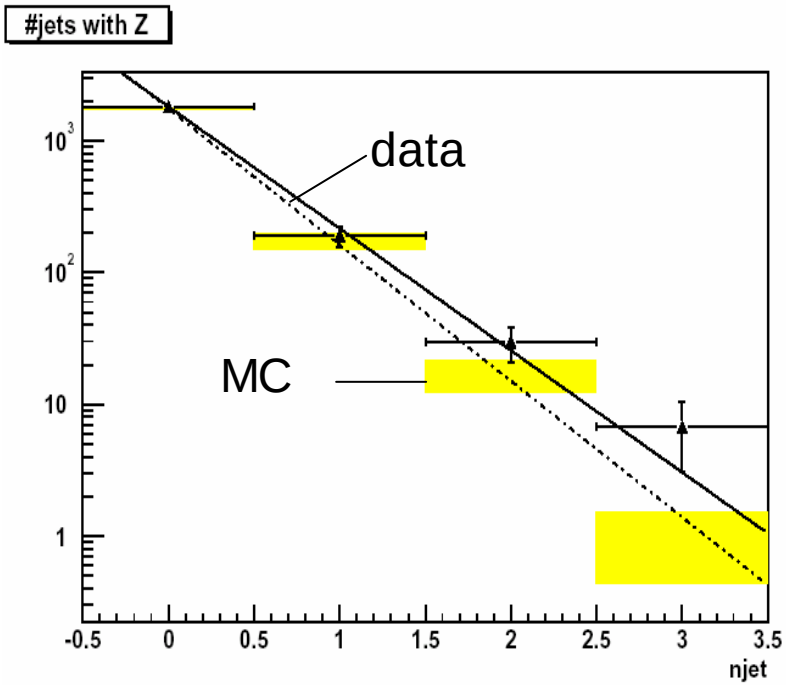
PYTHIA with s * BR(2 electrons)= 0.109 pb

M(2EM)



Data (triangles) : 3207 events
Background : 3217±346 events
(QCD + DY/Z)

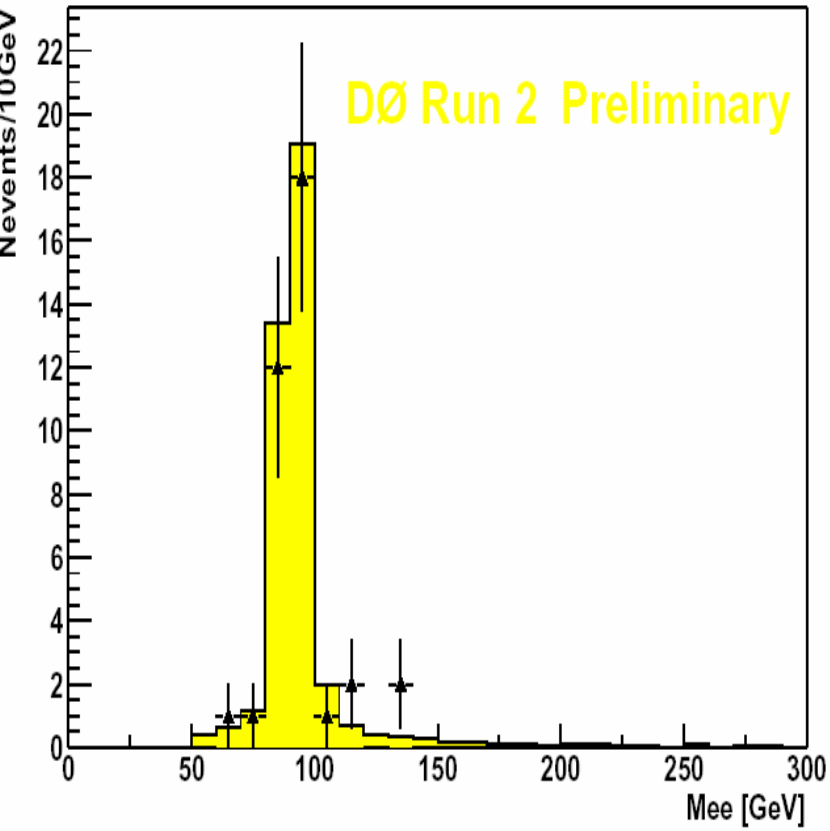
Berend's scaling



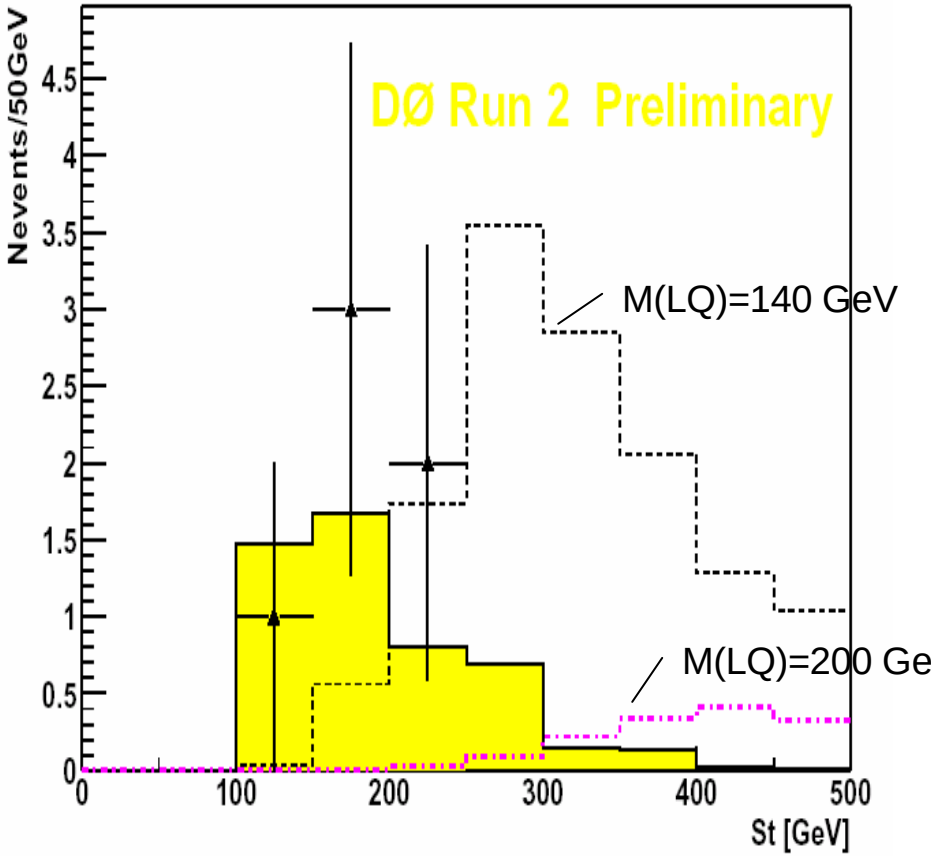
Nb of jets associated with a Z
(QCD back. is substracted)

Scaling factor 1.4 per jet

2EM (≥ 1track) + ≥2 jets



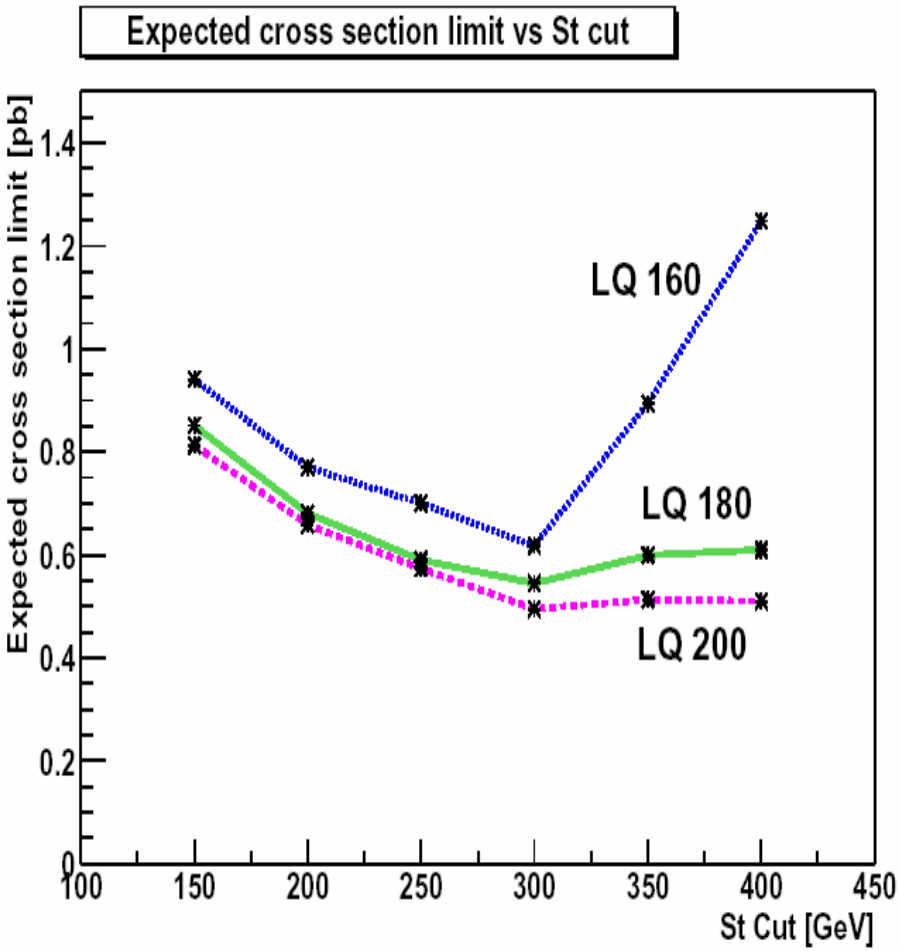
M(2M)



$S_T = E_T(EM1) + E_T(EM2) + E_T(jet1) + E_T(jet2)$

(after Z veto)

Expected σ limit as function of S_T cut

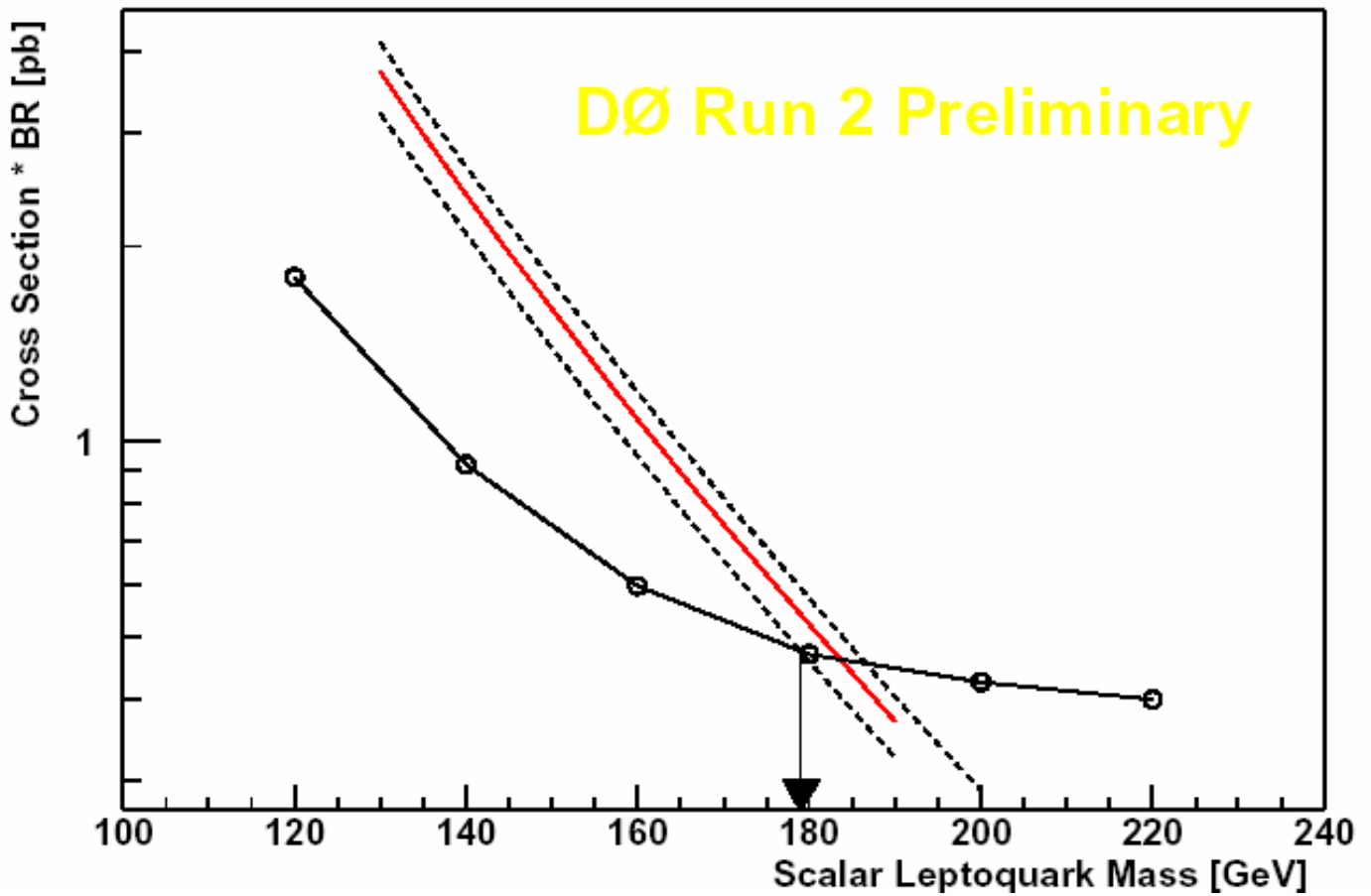


	S_T >300 GeV
Data	0
Total Bck	0.34 ± 0.06
QCD fake	0.09 ± 0.03
DY/Z	0.17± 0.05
Top	0.08 ± 0.02

$120 \leq M_{LQ} \leq 220$ GeV

$4.6\% \leq \varepsilon \leq 18.5\%$

Results



$\sigma * \beta = 0.47$ pb at 95% CL

$M(LQ) > 179$ GeV/c^2 if $\beta=1$

Search for second generation Leptoquark in the channel $2\mu + 2jets$

- DATA : di-muon trigger

Cuts	2 isol. m with P_T>15GeV and opposite charge M(mm)>60Gev	≥ **1 jet** $\|\eta\| < 2.4$ **E_T>20 GeV**	≥ **2 jets** $\|\eta\| < 2.4$ **E_T > 20 GeV**
Data	1194	165	18

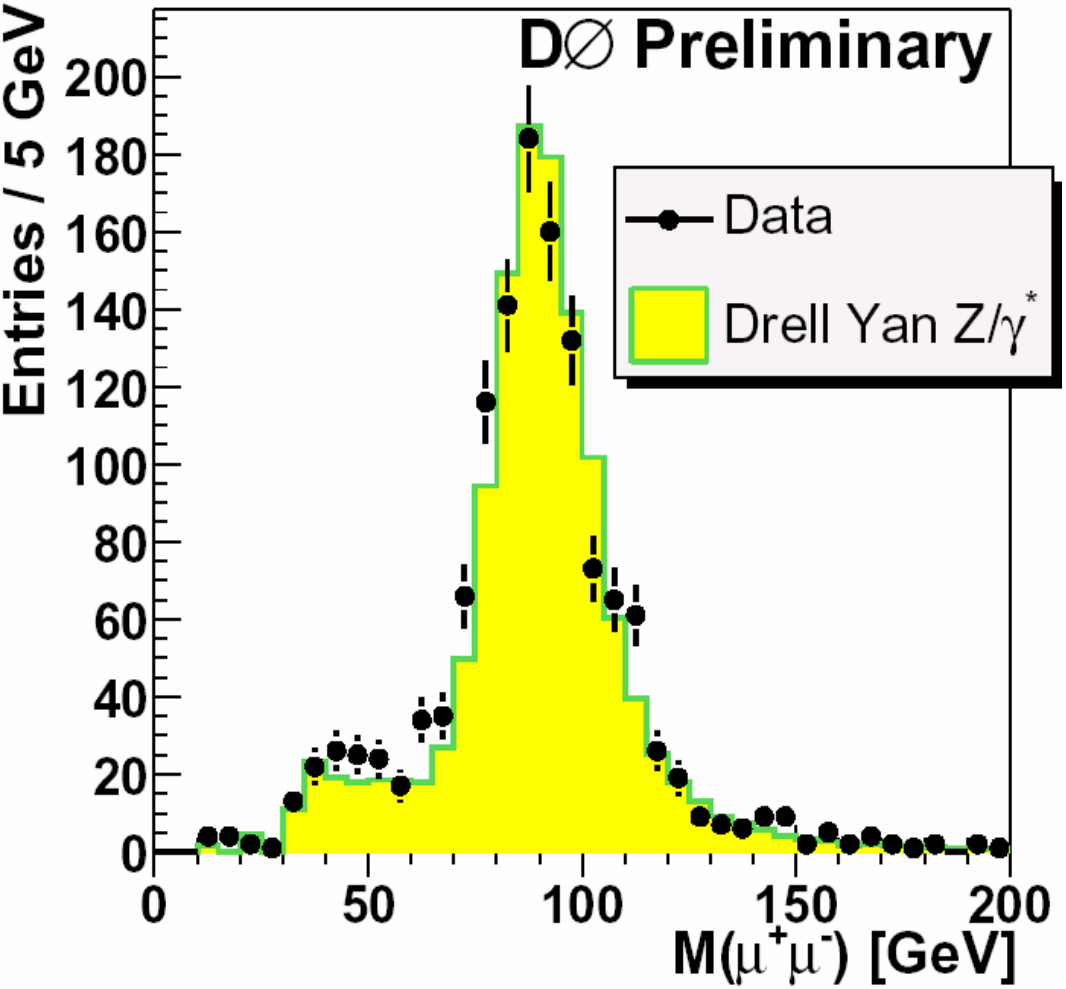
- Background and Signal generated with PYTHIA

Drell-Yan/Z

$t\bar{t}$

Instrumental background (muons from b's which fake isolation criteria) < 5 % of the total

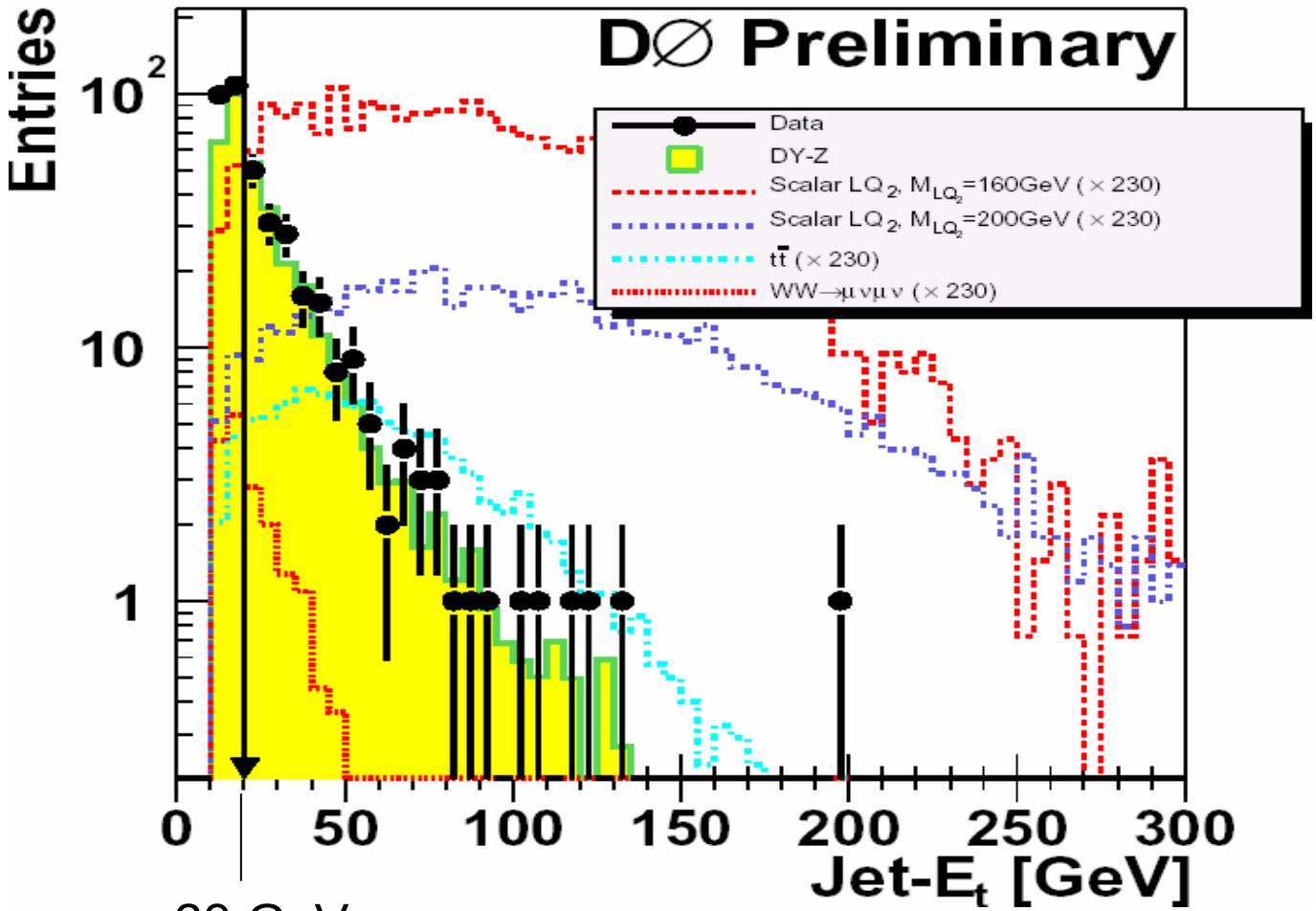
Monte Carlo Normalization



- Fit DY/Z MC to data for $M(\mu\mu) \in [75\text{-}105]$GeV
- Use σ*BR measured in Run 1 * correction factor from the scaling to CM energy (1.8TeV — 1.96TeV)

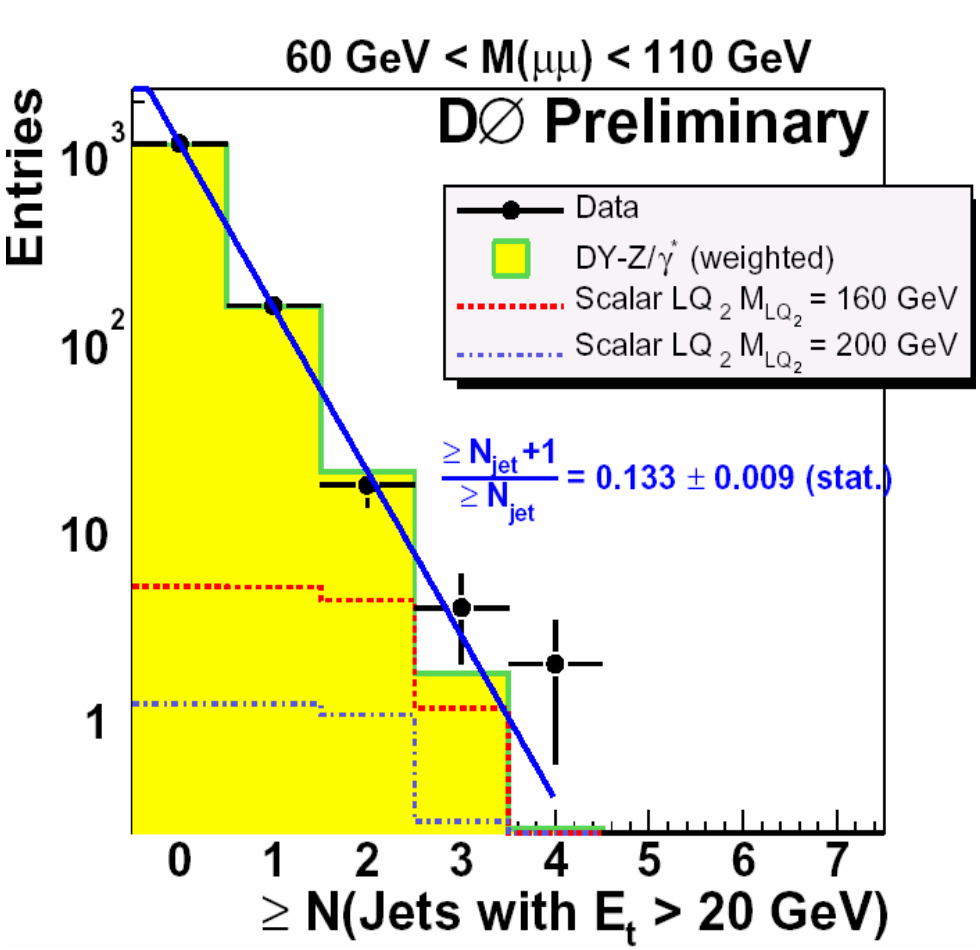
$$L\frac{e_{data}}{e_{MC}} \approx 21.2\,pb^{-1}$$

E_t of the 2 most energetic jets for $\mu\mu$ events



20 GeV

Jet multiplicity in DY-Z events



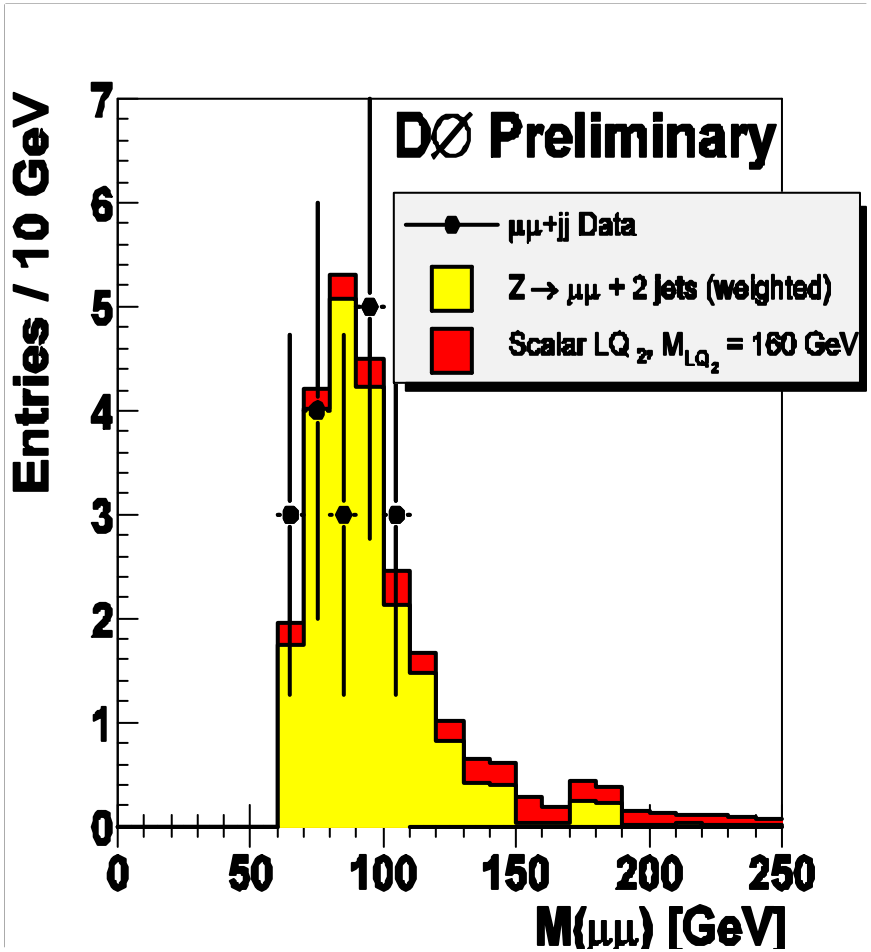
$$\frac{\text{Events with } {}^{3}\ \mathbf{N_{jet}} + \mathbf{1}}{\text{Events with } {}^{3}\ \mathbf{N_{jet}}} =$$

In MC: 0.114 ± 0.002

In Data: 0.133 ± 0.009

Factor 1.17 per jet

Results



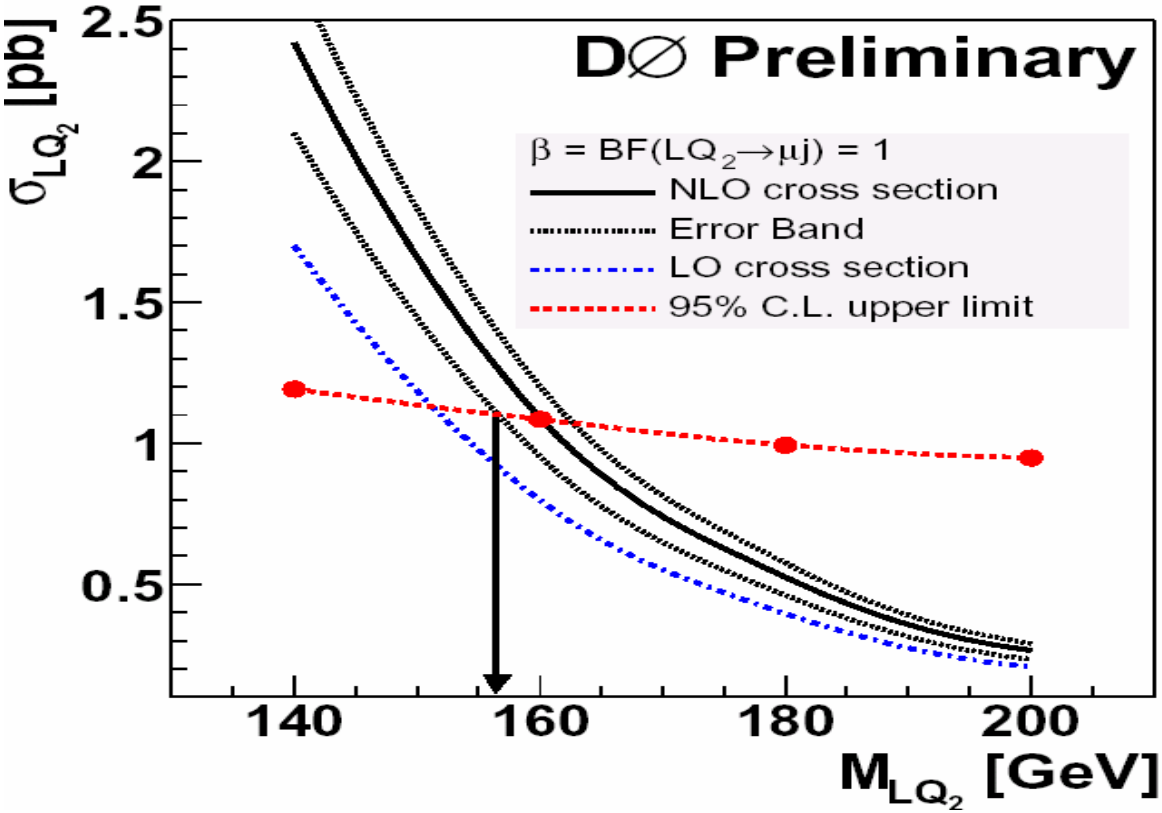
M(μμ)>110 GeV	
Data	0
DY/Z	4.0±0.6 *
$t\bar{t}$	0.074 ±0.002*

* statistical errors

$160 \leq M_{LQ} \leq 200$ GeV/c²

$15.4\% \leq e \leq 17.6\%$

Results



M(LQ) > 157 GeV/^{2} if β=1 at 95% CL

Summary

- DØ has searched for first and second generation Leptoquarks in the l^+l^- 2jets channels using data corresponding to an integrated luminosity of the order of 41 pb^{-1}
- No excess of data compared to SM predictions has been found
- Uppers limits of the Leptoquarks masses have been determined

at 95% CL :

Search for first generation Leptoquark in ee 2jets

$M(LQ_1) > 179\ GeV/c^2$ if $\beta=1$

Search for second generation Leptoquark in $\mu\mu$ 2jets

$M(LQ_2) > 157\ GeV/c^2$ if $\beta=1$

- Soon the results will be better than those of Run I as:
  - analyses of other LQ decay channels are in progress
  - more luminosity will be used