Fermi National Accelerator Laboratory

FERMILAB-Conf-95/184-E
D0

Search for First and Second Generation Leptoquarks at D0

S. Abachi et al.

Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510

July 1995

Submitted to the *International Europhysics Conference on High Energy Physics (HEP95)*, Brussels, Belgium, July 27-August 2, 1995

Operated by Universities Research Association Inc. under Contract No. DE-AC02-76CHO3000 with the United States Department of Energy

CONF-95-184-E

Search for First and Second Generation Leptoquarks at DØ*

S. Abachi,[12] B. Abbott,[34] M. Abolins,[23] B.S. Acharya,[41] I. Adam,[10] D.L. Adams,[35] M. Adams,[15] S. Ahn,[12] H. Aihara,[20] J. Alitti,[37] G. Álvarez,[16] G.A. Alves,[8] E. Amidi,[27] N. Amos,[22] E.W. Anderson,[17] S.H. Aronson,[3] R. Astur,[39] R.E. Avery,[29] A. Baden,[21] V. Balamurali,[30] J. Balderston,[14] B. Baldin,[12] J. Bantly,[4] J.F. Bartlett,[12] K. Bazizi,[7] J. Bendich,[20] S.B. Beri,[32] I. Bertram,[35] V.A. Bezzubov,[33] P.C. Bhat,[12] V. Bhatnagar,[32] M. Bhattacharjee,[11] A. Bischoff,[7] N. Biswas,[30] G. Blazey,[12] S. Blessing,[13] P. Bloom,[5] A. Boehnlein,[12] N.I. Bojko,[33] F. Borcherding,[12] J. Borders,[36] C. Boswell,[7] A. Brandt,[12] R. Brock,[23] A. Bross,[12] D. Buchholz,[29] V.S. Burtovoi,[33] J.M. Butler,[12] D. Casey,[36] H. Castilla-Valdez,[9] D. Chakraborty,[39] S.-M. Chang,[27] S.V. Chekulaev,[33] L.-P. Chen,[20] W. Chen,[39] L. Chevalier,[37] S. Chopra,[32] B.C. Choudhary,[7] J.H. Christenson,[12] M. Chung,[15] D. Claes,[39] A.R. Clark,[20] W.G. Cobau,[21] J. Cochran,[7] W.E. Cooper,[12] C. Cretsinger,[36] D. Cullen-Vidal,[4] M.A.C. Cummings,[14] D. Cutts,[4] O.I. Dahl,[20] K. De,[42] M. Demarteau,[12] R. Demina,[27] K. Denisenko,[12] N. Denisenko,[12] D. Denisov,[12] S.P. Denisov,[33] W. Dharmaratna,[13] H.T. Diehl,[12] M. Diesburg,[12] G. Di Loreto,[23] R. Dixon,[12] P. Draper,[42] J. Drinkard,[6] Y. Ducros,[37] S.R. Dugad,[41] S. Durston-Johnson,[36] D. Edmunds,[23] J. Ellison,[7] V.D. Elvira,[12,‡] R. Engelmann,[39] S. Eno,[21] G. Eppley,[35] P. Ermolov,[24] O.V. Eroshin,[33] V.N. Evdokimov,[33] S. Fahey,[23] T. Fahland,[4] M. Fatyga,[3] M.K. Fatyga,[36] J. Featherly,[3] S. Feher,[39] D. Fein,[2] T. Ferbel,[36] G. Finocchiaro,[39] H.E. Fisk,[12] Yu. Fisyak,[24] E. Flattum,[23] G.E. Forden,[2] M. Fortner,[28] K.C. Frame,[23] P. Franzini,[10] S. Fuess,[12] A.N. Galjaev,[33] E. Gallas,[42] C.S. Gao,[12,*] S. Gao,[12,*] T.L. Geld,[23] R.J. Genik II,[23] K. Genser,[12] C.E. Gerber,[12,§] B. Gibbard,[3] V. Glebov,[36] S. Glenn,[5] B. Gobbi,[29] M. Goforth,[13]

*Submitted to the International Europhysics Conference on High Energy Physics (HEP 95), Brussels, Belgium, 27 July - 2 August 1995.

A. Goldschmidt,[20] B. Gómez,[1] P.I. Goncharov,[33] H. Gordon,[3] L.T. Goss,[43] N. Graf,[3]
P.D. Grannis,[39] D.R. Green,[12] J. Green,[28] H. Greenlee,[12] G. Griffin,[6] N. Grossman,[12]
P. Grudberg,[20] S. Grünendahl,[36] W. Gu,[12,*] G. Guglielmo,[31] J.A. Guida,[39] J.M. Guida,[3]
W. Guryn,[3] S.N. Gurzhiev,[33] P. Gutierrez,[31] Y.E. Gutnikov,[33] N.J. Hadley,[21] H. Haggerty,[12]
S. Hagopian,[13] V. Hagopian,[13] K.S. Hahn,[36] R.E. Hall,[6] S. Hansen,[12] R. Hatcher,[23]
J.M. Hauptman,[17] D. Hedin,[28] A.P. Heinson,[7] U. Heintz,[12] R. Hernández-Montoya,[9]
T. Heuring,[13] R. Hirosky,[13] J.D. Hobbs,[12] B. Hoeneisen,[1,¶] J.S. Hoftun,[4] F. Hsieh,[22] Ting Hu,[39]
Tong Hu,[16] T. Huehn,[7] S. Igarashi,[12] A.S. Ito,[12] E. James,[2] J. Jaques,[30] S.A. Jerger,[23]
J.Z.-Y. Jiang,[39] T. Joffe-Minor,[29] H. Johari,[27] K. Johns,[2] M. Johnson,[12] H. Johnstad,[40]
A. Jonckheere,[12] M. Jones,[14] H. Jöstlein,[12] S.Y. Jun,[29] C.K. Jung,[39] S. Kahn,[3] G. Kalbfleisch,[31]
J.S. Kang,[18] R. Kehoe,[30] M.L. Kelly,[30] A. Kernan,[7] L. Kerth,[20] C.L. Kim,[18] S.K. Kim,[38]
A. Klatchko,[13] B. Klima,[12] B.I. Klochkov,[33] C. Klopfenstein,[39] V.I. Klyukhin,[33]
V.I. Kochetkov,[33] J.M. Kohli,[32] D. Koltick,[34] A.V. Kostritskiy,[33] J. Kotcher,[3] J. Kourlas,[26]
A.V. Kozelov,[33] E.A. Kozlovski,[33] M.R. Krishnaswamy,[41] S. Krzywdzinski,[12] S. Kunori,[21]
S. Lami,[39] G. Landsberg,[12] R.E. Lanou,[4] J-F. Lebrat,[37] A. Leflat,[24] H. Li,[39] J. Li,[42] Y.K. Li,[29]
Q.Z. Li-Demarteau,[12] J.G.R. Lima,[8] D. Lincoln,[22] S.L. Linn,[13] J. Linnemann,[23] R. Lipton,[12]
Y.C. Liu,[29] F. Lobkowicz,[36] S.C. Loken,[20] S. Lökös,[39] L. Lueking,[12] A.L. Lyon,[21] A.K.A. Maciel,[8]
R.J. Madaras,[20] R. Madden,[13] I.V. Mandrichenko,[33] Ph. Mangeot,[37] S. Mani,[5] B. Mansoulié,[37]
H.S. Mao,[12,*] S. Margulies,[15] R. Markeloff,[28] L. Markosky,[2] T. Marshall,[16] M.I. Martin,[12]
M. Marx,[39] B. May,[29] A.A. Mayorov,[33] R. McCarthy,[39] T. McKibben,[15] J. McKinley,[23]
T. McMahon,[31] H.L. Melanson,[12] J.R.T. de Mello Neto,[8] K.W. Merritt,[12] H. Miettinen,[35]
A. Milder,[2] A. Mincer,[26] J.M. de Miranda,[8] C.S. Mishra,[12] M. Mohammadi-Baarmand,[39]
N. Mokhov,[12] N.K. Mondal,[41] H.E. Montgomery,[12] P. Mooney,[1] M. Mudan,[26] C. Murphy,[16]
C.T. Murphy,[12] F. Nang,[4] M. Narain,[12] V.S. Narasimham,[41] A. Narayanan,[2] H.A. Neal,[22]
J.P. Negret,[1] E. Neis,[22] P. Nemethy,[26] D. Nešić,[4] D. Norman,[43] L. Oesch,[22] V. Oguri,[8]
E. Oltman,[20] N. Oshima,[12] D. Owen,[23] P. Padley,[35] M. Pang,[17] A. Para,[12] C.H. Park,[12]
Y.M. Park,[19] R. Partridge,[4] N. Parua,[41] M. Paterno,[36] J. Perkins,[42] A. Peryshkin,[12] M. Peters,[14]
H. Piekarz,[13] Y. Pischalnikov,[34] A. Pluquet,[37] V.M. Podstavkov,[33] B.G. Pope,[23] H.B. Prosper,[13]

S. Protopopescu,[3] D. Pušeljić,[20] J. Qian,[22] P.Z. Quintas,[12] R. Raja,[12] S. Rajagopalan,[39]
O. Ramirez,[15] M.V.S. Rao,[41] P.A. Rapidis,[12] L. Rasmussen,[39] A.L. Read,[12] S. Reucroft,[27]
M. Rijssenbeek,[39] T. Rockwell,[23] N.A. Roe,[20] P. Rubinov,[39] R. Ruchti,[30] S. Rusin,[24]
J. Rutherfoord,[2] A. Santoro,[8] L. Sawyer,[42] R.D. Schamberger,[39] H. Schellman,[29] J. Sculli,[26]
E. Shabalina,[24] C. Shaffer,[13] H.C. Shankar,[41] R.K. Shivpuri,[11] M. Shupe,[2] J.B. Singh,[32]
V. Sirotenko,[28] W. Smart,[12] A. Smith,[2] R.P. Smith,[12] R. Snihur,[29] G.R. Snow,[25] S. Snyder,[39]
J. Solomon,[15] P.M. Sood,[32] M. Sosebee,[42] M. Souza,[8] A.L. Spadafora,[20] R.W. Stephens,[42]
M.L. Stevenson,[20] D. Stewart,[22] D.A. Stoianova,[33] D. Stoker,[6] K. Streets,[26] M. Strovink,[20]
A. Taketani,[12] P. Tamburello,[21] J. Tarazi,[6] M. Tartaglia,[12] T.L. Taylor,[29] J. Teiger,[37]
J. Thompson,[21] T.G. Trippe,[20] P.M. Tuts,[10] N. Varelas,[23] E.W. Varnes,[20] P.R.G. Virador,[20]
D. Vititoe,[2] A.A. Volkov,[33] A.P. Vorobiev,[33] H.D. Wahl,[13] G. Wang,[13] J. Wang,[12,*] L.Z. Wang,[12,*]
J. Warchol,[30] M. Wayne,[30] H. Weerts,[23] F. Wen,[13] W.A. Wenzel,[20] A. White,[42] J.T. White,[43]
J.A. Wightman,[17] J. Wilcox,[27] S. Willis,[28] S.J. Wimpenny,[7] J.V.D. Wirjawan,[43] J. Womersley,[12]
E. Won,[36] D.R. Wood,[12] H. Xu,[4] R. Yamada,[12] P. Yamin,[3] C. Yanagisawa,[39] J. Yang,[26]
T. Yasuda,[27] C. Yoshikawa,[14] S. Youssef,[13] J. Yu,[36] Y. Yu,[38] Y. Zhang,[12,*] Y.H. Zhou,[12,*]
Q. Zhu,[26] Y.S. Zhu,[12,*] Z.H. Zhu,[36] D. Zieminska,[16] A. Zieminski,[16] and A. Zylberstejn[37]

[1]Universidad de los Andes, Bogotá, Colombia

[2]University of Arizona, Tucson, Arizona 85721

[3]Brookhaven National Laboratory, Upton, New York 11973

[4]Brown University, Providence, Rhode Island 02912

[5]University of California, Davis, California 95616

[6]University of California, Irvine, California 92717

[7]University of California, Riverside, California 92521

[8]LAFEX, Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro, Brazil

[9]CINVESTAV, Mexico City, Mexico

[10]Columbia University, New York, New York 10027

[11]Delhi University, Delhi, India 110007

[12]Fermi National Accelerator Laboratory, Batavia, Illinois 60510

[13]Florida State University, Tallahassee, Florida 32306

[14]University of Hawaii, Honolulu, Hawaii 96822

[15]University of Illinois at Chicago, Chicago, Illinois 60607

[16]Indiana University, Bloomington, Indiana 47405

[17]Iowa State University, Ames, Iowa 50011

[18]Korea University, Seoul, Korea

[19]Kyungsung University, Pusan, Korea

[20]Lawrence Berkeley Laboratory and University of California, Berkeley, California 94720

[21]University of Maryland, College Park, Maryland 20742

[22]University of Michigan, Ann Arbor, Michigan 48109

[23]Michigan State University, East Lansing, Michigan 48824

[24]Moscow State University, Moscow, Russia

[25]University of Nebraska, Lincoln, Nebraska 68588

[26]New York University, New York, New York 10003

[27]Northeastern University, Boston, Massachusetts 02115

[28]Northern Illinois University, DeKalb, Illinois 60115

[29]Northwestern University, Evanston, Illinois 60208

[30]University of Notre Dame, Notre Dame, Indiana 46556

[31]University of Oklahoma, Norman, Oklahoma 73019

[32]University of Panjab, Chandigarh 16-00-14, India

[33]Institute for High Energy Physics, 142-284 Protvino, Russia

[34]Purdue University, West Lafayette, Indiana 47907

[35]Rice University, Houston, Texas 77251

[36]University of Rochester, Rochester, New York 14627

[37]CEA, DAPNIA/Service de Physique des Particules, CE-SACLAY, France

[38]Seoul National University, Seoul, Korea

[39]State University of New York, Stony Brook, New York 11794

[40]SSC Laboratory, Dallas, Texas 75237

[41]Tata Institute of Fundamental Research, Colaba, Bombay 400005, India

[42]University of Texas, Arlington, Texas 76019

[43]Texas A&M University, College Station, Texas 77843

(July 1995)

ABSTRACT

A search for first and second generation pair produced scalar leptoquarks has been done with the DØ detector at Fermilab's $p\bar{p}$ machine with $\sqrt{s} = 1.8$ TeV. Leptoquarks are assumed to be strictly generational; for example, a first generation leptoquark couples only to the electron, its neutrino, and the u and d quarks. 95% C.L. mass limits of 133 GeV/c^2 and 120 GeV/c^2 for respective 100% and 50% decay branching ratios to electron plus quark for first generation scalar leptoquarks have been published. The preliminary results of a search for second generation scalar leptoquarks in the absence of a signal are mass limits of 111 GeV/c^2 and 89 GeV/c^2 for 100% and 50% decay branching ratios to muon plus quark. A feature of these mass limits is that they are independent of the unknown coupling of the leptoquark to leptons and quarks. The detection threshold for e^+e^- and e-p machines depends on the strength of this coupling.

I. INTRODUCTION

Leptoquarks are exotic particles with both color and lepton quantum numbers. They are bosons that appear as spin = 0 or spin = 1 particles in many SUSY, GUT and composite models [1]. The coupling constant of leptoquarks to leptons and quarks is an unknown parameter, λ, in the theory, but experimental constraints [2] require the coupling, $\lambda^2/4\pi$, to be on the order $0.1\alpha_{em}$ for masses of the leptoquark that can be probed with the current DØ data. Since leptoquarks have color, they can be produced via the strong interaction as leptoquark - anti-leptoquark pairs. For light leptoquarks ($\lesssim$ 1-100 TeV) the coupling of the leptoquark to fermions is required to be generational; for example, a first generation leptoquark may only couple to electrons, electron neutrinos, u and d quarks. This restriction is required to prevent leptoquarks from contributing to the violation of the limits on the branching ratio of rare decays such as $K^+ \rightarrow e^+\nu$. The expected signatures for light first generation leptoquark pairs are: two electrons plus at least two jets, one electron plus missing transverse energy ($\not\!\!E_T$) plus at least two jets, and $\not\!\!E_T$ plus two or more jets. The expected signatures for a second generation leptoquark pair are the same except the electrons are replaced by muons. The leptons, $\not\!\!E_T$, and jets in leptoquark events are also expected to be well isolated from each other in general.

II. ANALYSIS

A description of the DØ detector is given elsewhere [3]. Also, details of the first generation analysis can be found in a recent publication [4]. This report will cover the analysis for the second generation leptoquark search. Only those signatures which contain at least one muon are dealt with here.

The data used in this analysis, representing 12.7 pb^{-1}, were taken between September of 1992 and May of 1993 during the 1992-1993 Tevatron collider run. Two data sets were selected, one for the dimuon leptoquark signature and one for the single muon leptoquark signature. Both data sets were required to pass a trigger with a muon and jet requirement. The hardware portion of the trigger required a muon with transverse momentum (p_T) > 3 GeV/c and $\mid \eta \mid < 2.4$, and one jet tower (0.2×0.2 radians in $\eta \times \phi$) with transverse energy (E_T) > 5 GeV. In the software portion of the trigger, one muon with $p_T > 8$ GeV/c and one jet with $E_T > 15$ GeV were required. The initial data samples had 665 events in the dimuon event sample and 2912 events in the single muon sample.

The event selection for the two muon leptoquark signature is given in table 1. The event selection for the single muon leptoquark signature is given in table III. The muon quality cuts mentioned in both tables 1 and III are for rejecting cosmic muons and also combinatorics which are reconstructed out of stray hits in the muon chambers. The muon isolation cut mentioned in table 1 requires that there is no jet within 0.65 radians of the muon(s) in question and that the amount of energy in the neighborhood of the muon not exceed about three to four times the expected energy from a minimum ionizing particle. For the single muon selection the isolation requirement is the same except no jet within 0.7 radians of the muon in question is allowed. The expected number of background for the cuts used in the two muon event selection was estimated to be about 1.8±0.7 events from Drell-Yan and $b\bar{b}$ production.

The detector cleanup cuts in the single muon analysis are used to eliminate those events that have badly measured jets or large amounts of electronic noise in the calorimeter which are more problematical in measuring $\not\!\!E_T$. The back to back cut between the muon and the $\not\!\!E_T$, $|\ \pi - \Delta\phi_{\mu,\not E_T}\ | > 0.2$ rad, in table III is designed to eliminate W associated events and primarily events with badly measured muon momentum, since these events are expected to have the $\not\!\!E_T$ back to back in ϕ with the muon. The number of expected background events for the cuts given in table III was estimated to be about 2.4±1.0 events from $W \rightarrow \mu\nu$ plus jets, $b\bar{b}$ production, Z plus jets where one muon was missed, and heavy quark decays of W where the heavy quarks decay semileptonically to muons.

With no observed events, the upper limit on the cross section was calculated as in equation 2.1.

$$\beta^2 \times \sigma^{\mu\mu} = N_{\mu\mu}^{95\%\ CL} / (\epsilon_{\mu\mu} \cdot L)$$
$$2\beta\,(1-\beta) \times \sigma^{\mu\nu} = N_{\mu\nu}^{95\%\ CL} / (\epsilon_{\mu\nu} \cdot L) \tag{2.1}$$

Here β is the branching fraction for leptoquark decay to muon plus quark. The total efficiency for the two signatures is represented by $\epsilon_{\mu\mu}$ and $\epsilon_{\mu\nu}$. L is the integrated luminosity which was 12.7 pb^{-1} for this analysis. The kinematic efficiencies for detecting leptoquarks were determined from ISAJET [5] Monte Carlo processed with GEANT [6]. The muon detection efficiency was determined from a study of the data. And the trigger efficiency was determined from the data and a study of the leptoquark Monte Carlo processed with a simulation of the DØ trigger. The total preliminary efficiency for the two muon plus two jet leptoquark signature varied from 0.35% to 8.7% for masses ranging from 45 to 200 GeV/c^2. For the single muon plus $\not\!\!E_T$ plus two jet signature, the total efficiency varied from 0.14% to 5.12% for the same mass range.

The number of expected events with no events seen was calculated according to the method by Cousins and Highland [7] using the total uncertainty on $\epsilon \cdot L$ given in table III. These uncertainties are the total systematic and statistical uncertainties added in quadrature. The preliminary 95% CL limits on the number of expected events, $N_{\mu\mu}^{95\%\ CL}$ and $N_{\mu\nu}^{95\%\ CL}$, are also given for each mass in table III along with the upper limit on the measured cross section times the appropriate branching ratio factors.

III. RESULTS AND CONCLUSION

Comparing the measured upper limit on the cross section with the theoretical cross section from ISAJET with Morfin and Tung leading order parton distribution functions (pdf), the DØ preliminary mass limit from the combined signal for 100% branching of leptoquark to muons was determined to be 111 GeV/c^2. For 50% branching, the mass limit was 89 GeV/c^2. The branching fraction vs. leptoquark mass excluded region is given in figure 1 for the dimuon, single muon and combined signatures. The LEP limit of 45 GeV/c^2 is also given in Fig. 1. Our limit extends to a branching fraction of $\beta = 0.17$ at the LEP mass limit. The mass limits depend somewhat on the choice of pdf, momentum transfer scale (we have assumed the ISAJET default $Q^2 = \hat{s}$ for this analysis), and higher order effects [8] which we have chosen not to include. Using the theoretical cross section (default ISAJET with CTEQ2pM pdf's) used by CDF in Ref. [9] for the mass limits they quote, our combined mass limits become 119 and 97 GeV/c^2 for $\beta = 1.0$ and 0.5.

The DØ total integrated luminosity has changed since the publication of reference 4 due to an update of the total inelastic cross section (averaged new CDF and E710) used to calculate the luminosity. The new luminosity is 13.8 pb^{-1} for the first generation leptoquark search. The mass limits for first generation leptoquarks are now 131 GeV/c^2 for 100% branching of leptoquark to electron and 118 GeV/c^2 for 50% branching.

ACKNOWLEDGMENTS

We thank the Fermilab Accelerator, Computing, and Research Divisions, and the support staffs at the collaborating institutions for their contributions to the success of this work. We also acknowledge the support of the U.S. Department of Energy, the U.S. National Science Foundation, the Commissariat à L'Energie Atomique in France, the Ministry for Atomic Energy and the Ministry of Science and Technology Policy in Russia, CNPq in Brazil, the Departments of Atomic Energy and Science and Education in India, Colciencias in Colombia, CONACyT in Mexico, the Ministry of Education, Research Foundation and KOSEF in Korea and the A.P. Sloan Foundation.

* Visitor from IHEP, Beijing, China.

‡ Visitor from CONICET, Argentina.

§ Visitor from Universidad de Buenos Aires, Argentina.

¶ Visitor from Univ. San Francisco de Quito, Ecuador.

REFERENCES

[1] J.L. Hewett and S. Pakvasa, *Phys. Rev.* **D 37** (1988) 3165 and references therein.

[2] J.L. Hewett and T.G. Rizzo, *Phys. Rev.* **D 36** (1987) 3367.

[3] S. Abachi, *et al*, *Nucl. Instr. and Meth.* **A 338** (1994) 185.

[4] S. Abachi, *et al*, *Phys. Rev. Lett.* **72** (1994) 965.

[5] F.E. Paige and S. D. Protopopescu. BNL-37066, 1985, unpublished.

[6] R. Brun and F. Carminati, CERN, Long Writeup W5013, July, 1993.

[7] R.D. Cousins and V.L. Highland, *Nucl. Instr. and Meth.* **A 320** (1992) 331.

[8] M. de Montigny and L. Marleau, Phys. Rev. D**40**, 2869 (1989); Phys. Rev. D **40**, 3616 (1989).

[9] F. Abe *et al.*, FERMILAB-PUB-95-050-E, submitted to Phys. Rev. Lett.

TABLES

TABLE I. The event selection for the two muon leptoquark signature

Selection cut	Number of events surviving cut
Trigger selection	665
Two muons with $p_T > 25$ GeV/c	173
Two muons: $\mid \eta \mid < 1.7$; one muon: $\mid \eta \mid < 1.0$	93
One muon passes muon quality cuts	31
Two muons pass muon isolation cut	15
Two jets $E_T > 25$ GeV	0

TABLE II. The event selection for the single muon leptoquark signature

Selection cut	Number of events surviving cut
Trigger selection	2912
Detector cleanup	2097
One muon $p_T > 20$ GeV/c	1806
One muon: $\mid \eta \mid < 1.0$	1347
One muon passes muon quality cuts	403
$\not\!\!E_T > 25$ GeV leaves	295
One muon passes isolation cut	127
$\mid \pi - \Delta\phi_{\mu, \not\!\!E_T} \mid > 0.2$ rad	69
Two jets $E_T > 25$ GeV	18
Transverse mass for muon and $\not\!\!E_T > 95$ GeV/c^2	0

TABLE III. The preliminary total uncertainty (Err) from the second generation analysis and the 95% CL for the upper limit on the number of expect events and measured cross section

Mass (GeV/c^2)	45	75	100	150	200
$\mathrm{Err}_{\mu\mu}(\%)$	33.7	23.0	21.6	20.2	20.5
$\mathrm{Err}_{\mu\nu}(\%)$	19.5	15.4	15.3	15.9	16.9
$N_{\mu\mu}^{95\%\ CL}$	3.83	3.28	3.24	3.21	3.21
$N_{\mu\nu}^{95\%\ CL}$	3.19	3.11	3.11	3.12	3.14
$\beta^2 \times \sigma^{\mu\mu}(\mathrm{pb})$	85.4	9.60	5.22	3.14	2.9
$2\beta(1-\beta) \times \sigma^{\mu\nu}(\mathrm{pb})$	183	26.2	11.8	6.90	4.83

FIGURES

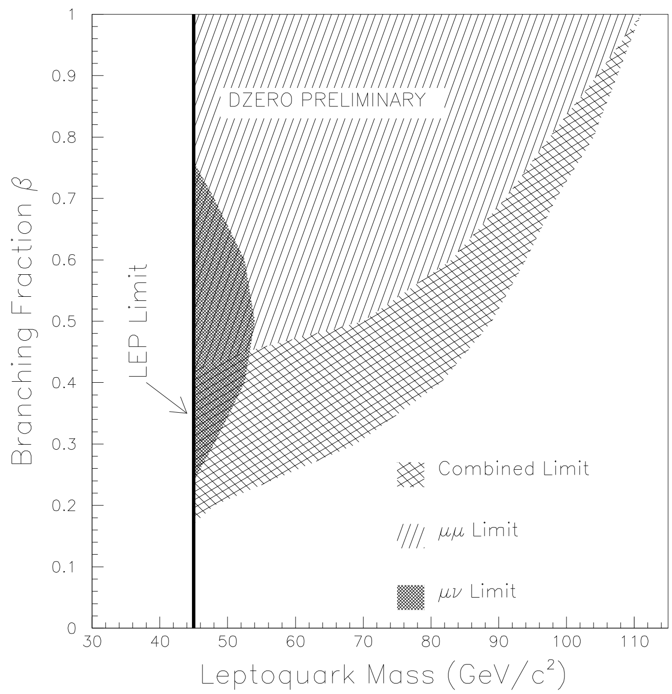

FIG. 1. The DØ preliminary 95% CL excluded region of branching fraction vs leptoquark mass