SEARCH FOR LEPTON FLAVOR VIOLATIONS AT ZEUS

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representing the ZEUS collaboration

Outline:

- Introduction.B.R.W. Model
- Low mass and high mass LQs
- Features of LFV events
- Results on low mass LQs
- Results on high mass LQs
- Conclusions

INTRODUCTION

Evidence of neutrino oscillations → Lepton Flavor could be violated also for charged leptons.

Lepton Flavor Violation (LFV) foreseen by many extensions of the Standard Model(GUT, Leptoquark, SUSY Models violating R-Parity..).

HERA has peculiar advantages to look for such phenomena: e.g. both lepton and quark in the initial state.

B.R.W. MODEL

LFV could be mediated by Leptoquarks (LQs)(or s-quarks in R-parity violating SUSY).

Framework for interpreting the results of the search:

phenomenological Buchmüller-Rück-Wyler (BRW) Leptoquark Model.

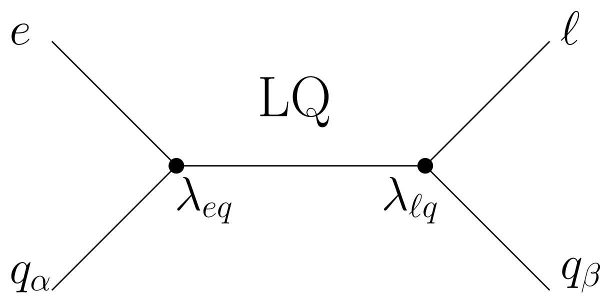
- Invariant under $SU(3)_c \times SU(2)_L \times U(1)_Y$
- Couples to LH or RH leptons but not to both
- Fixed branching ratios to eq, νq
- 14 LQ, classified according to fermion number $F = 3B + L = 0, \pm 2$;

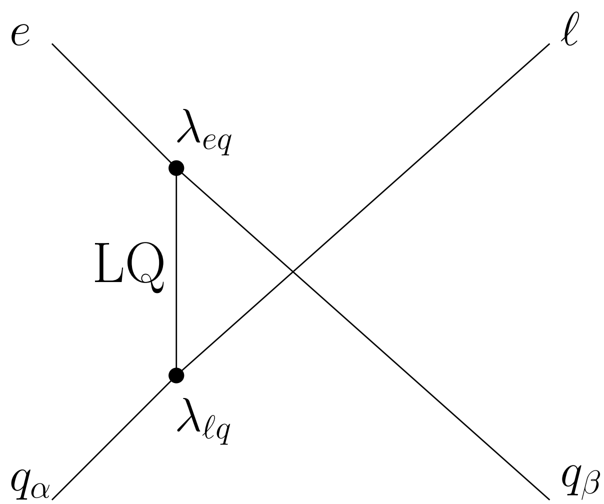
7 scalar, 7 vector with Isospin 0, 1/2, 1, helicity L or R

Model non-diagonal in lepton families $\rightarrow$ LFV.

LFV Mechanisms

s- channel and u- channel contributions to LFV





Low mass LQs can be
resonantly produced.
s channel dominates,
the production occurs at $x = M_{LQ}^2/s$
$M_{LQ}^2 < s \to \sigma_{NWA} \propto \lambda_{eq}^2 B_{lq_\beta}$
(Narrow Width Approximation)(NWA)
The experimental signature exhibits
a high p_t isolated lepton and
a peak in the invariant mass
of the lepton-jet system.

Due to the dominance of valence quark contributions only $F = 0$ LQs are considered for e^+p data and only $|F| = 2$ LQs are considered for e^-p data.

For high mass LQs both s and u channel contribute.

$M^2_{LQ} >> s \rightarrow \sigma_{CI} \propto [\frac{\lambda_{eq_\alpha}\lambda_{lq_\beta}}{M^2_{LQ}}]^2$

(Contact Interaction Approximation)

The spectrum of the isolated leptons is softer compared to the previous case. Both $F = 0$ and $|F| = 2$ LQs are considered for both e^+p and e^-p samples.

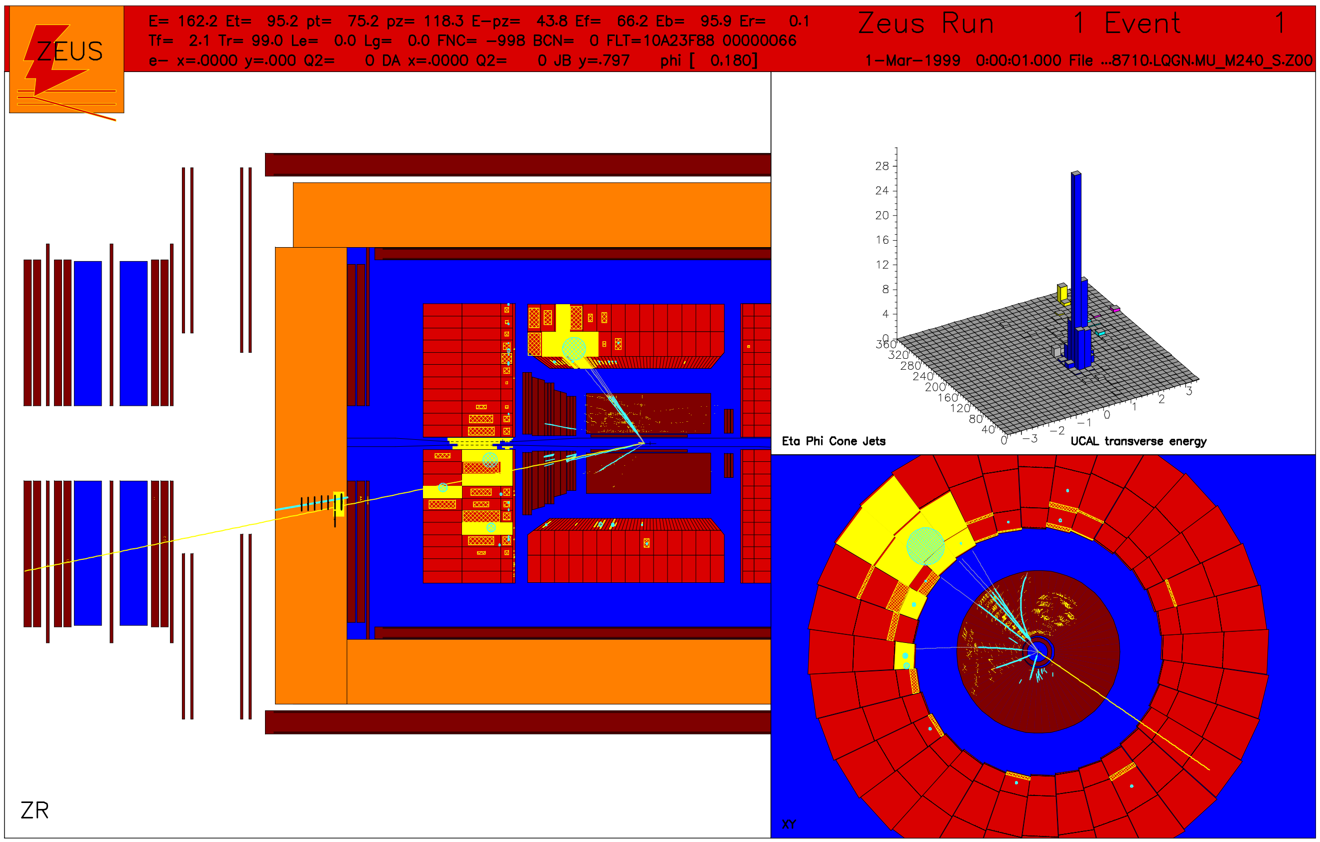
Background from Standard Model includes Deep Inelastic Scattering (Neutral and Charged Currents), Direct and Resolved Photoproduction, lepton pair production.

FEATURES OF LFV EVENTS $e - \mu$

$e - \mu$ transitions

The electron or positron in the initial state has to be replaced by an isolated muon in the missing P_t direction.

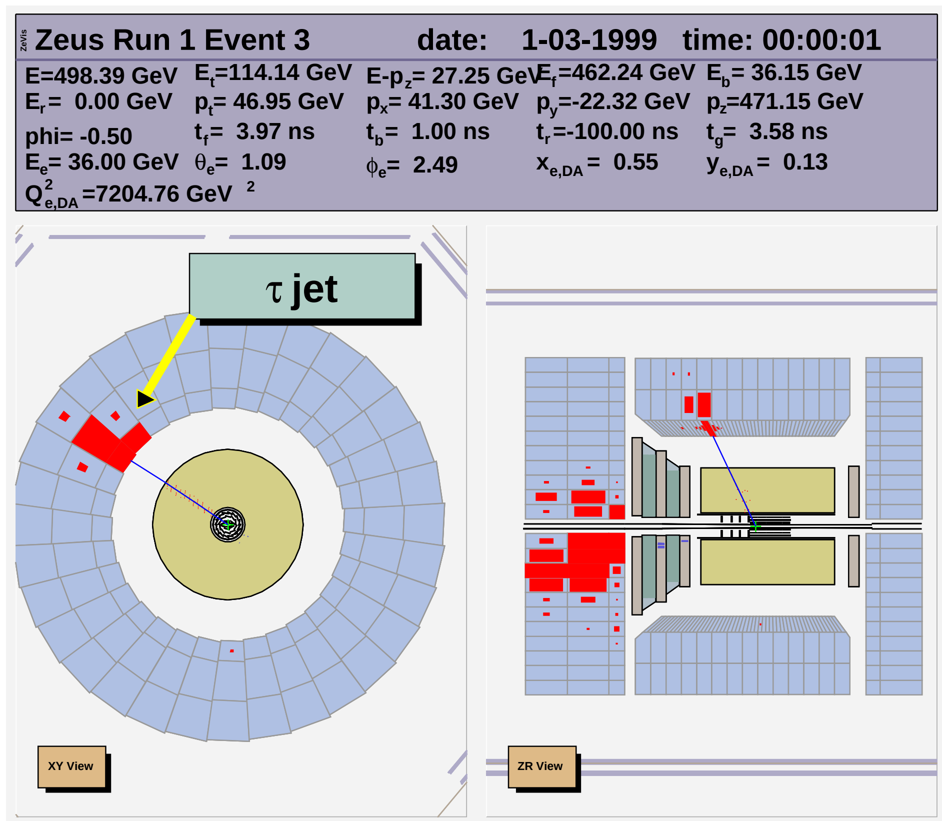
Simulated LFV event



FEATURES OF LFV EVENTS $e - \tau$

$e - \tau$ transitions

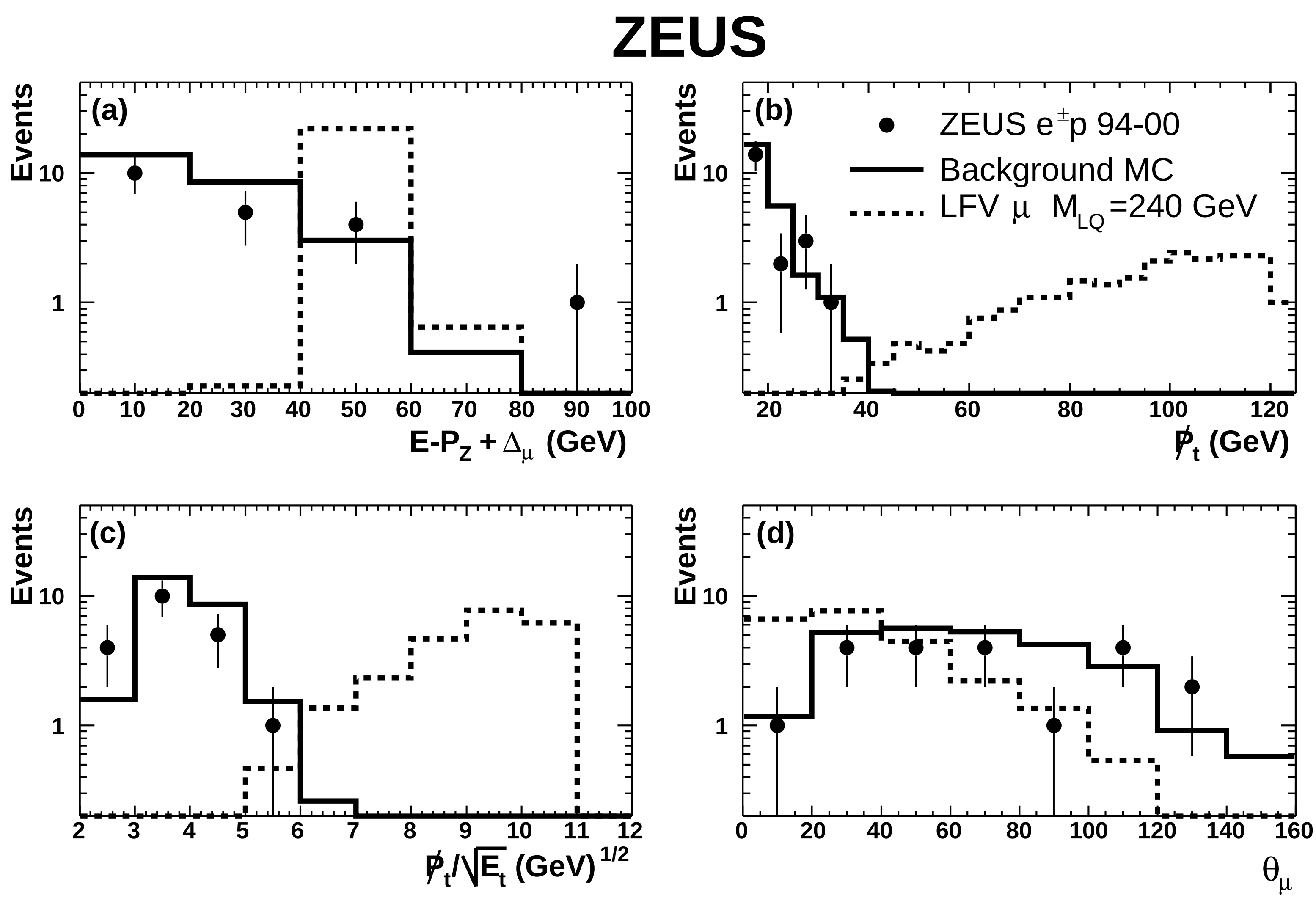
The electron or positron in the initial state has to be replaced by an isolated tau in the missing P_t direction, which can be identified, according to the decay channel, via a high p_t e or a high p_t μ or narrow jet, in the missing P_t direction.



Simulated LFV event

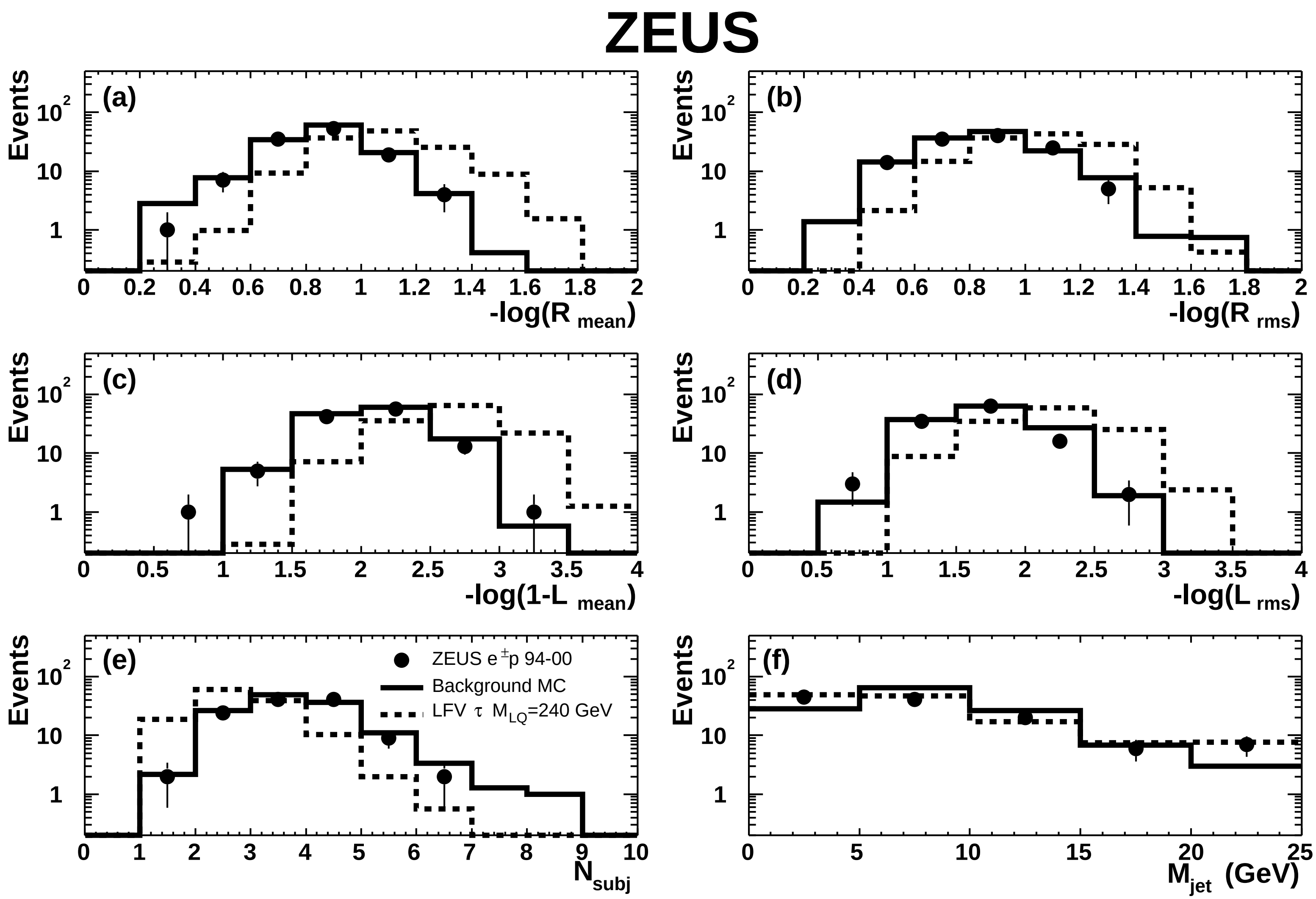
For the $e - \tau$ transition tau leptonic and hadronic channels were considered, a multivariate technique (Tau Finder based on Discriminant) already used in the isolated tau search was optimized and employed.

CONTROL PLOTS



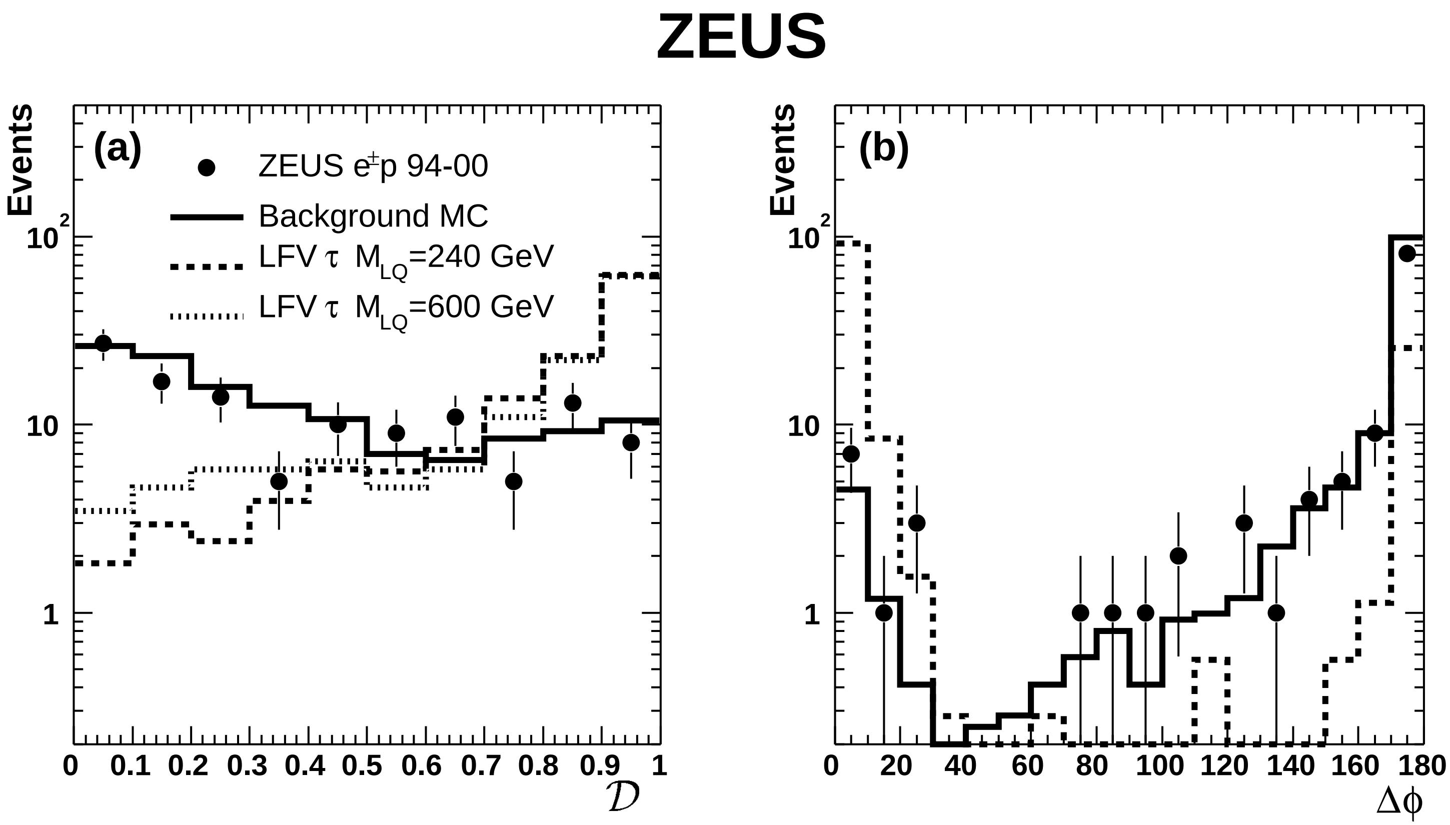
Comparison between data and SM MC for the search for $e-\mu$

MORE CONTROL PLOTS



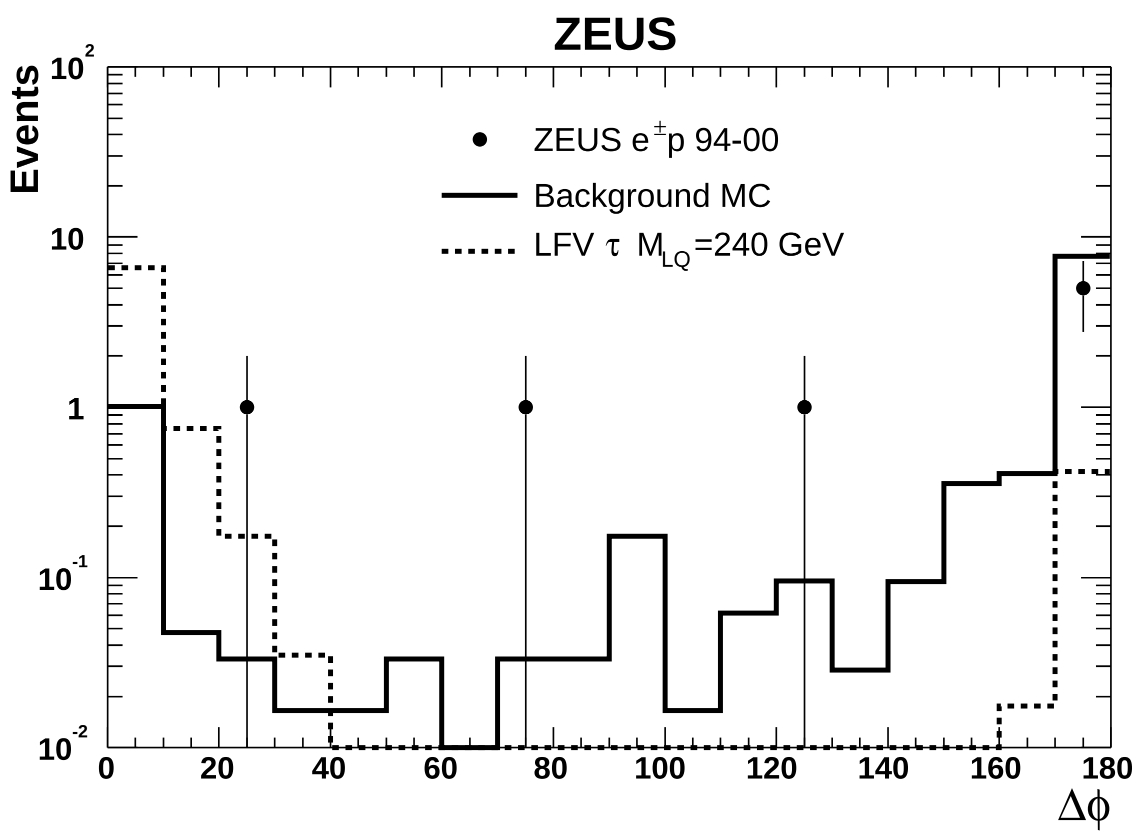
Comparison between data and SM MC for the search for $e - \tau$ (hadronic τ channels)(jet variables used in the discriminant)

HADRONIC τ PRESELECTION



Discriminant (D) and $\Delta\phi$ after hadronic $e - \tau$ preselection

HADRONIC τ FINAL SELECTION



$\Delta\phi$ of events with $D > 0.9$ after hadronic $e - \tau$ preselection

RESULTS

The whole HERA I luminosity has been analyzed looking for LFV:
112.8 $pb^{-}1$ taken with $e^{+}p$
16.7 $pb^{-}1$ taken with $e^{-}p$

Results of the search for $e-\mu$ transitions

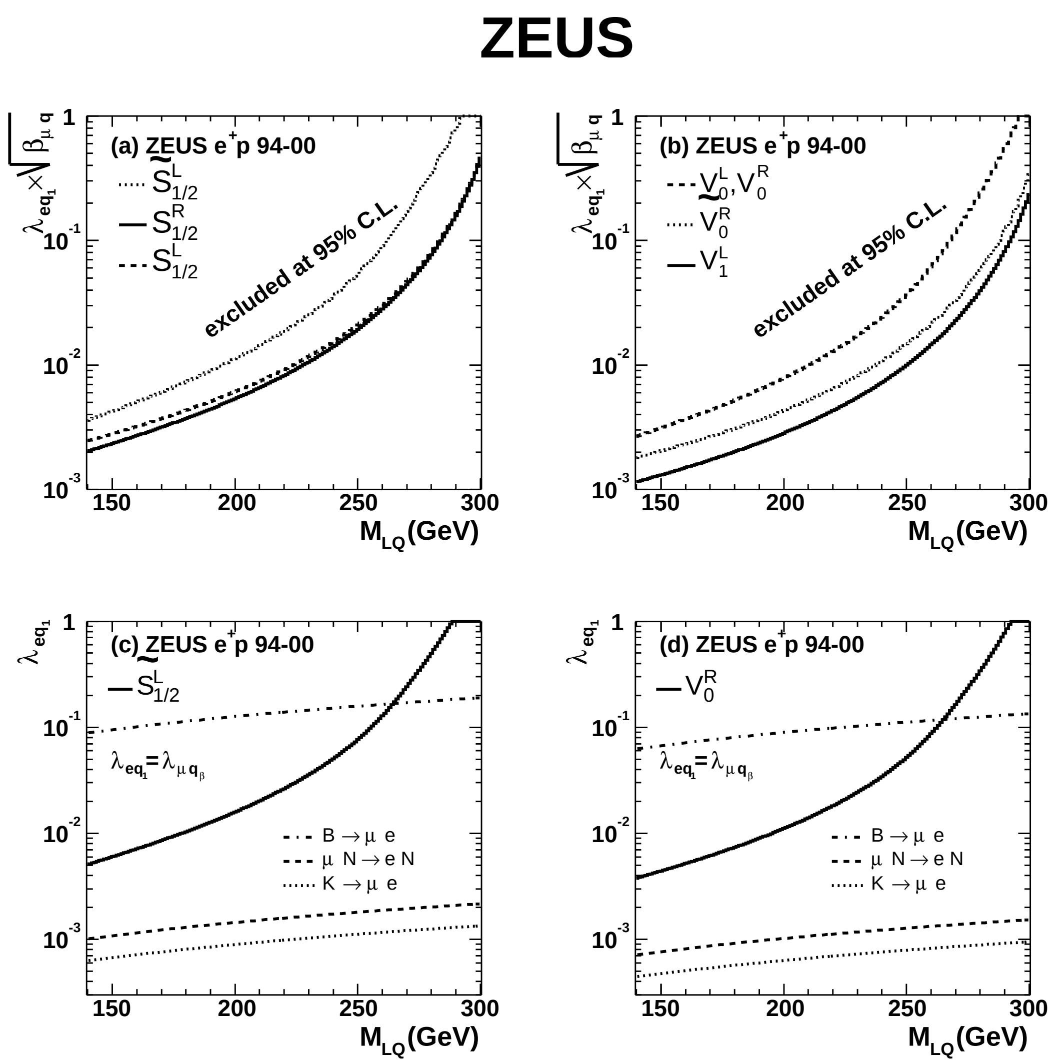
No event was found while 0.87 ± 0.15 were expected from simulation of SM processes.

Results of the search for $e-\tau$ transitions

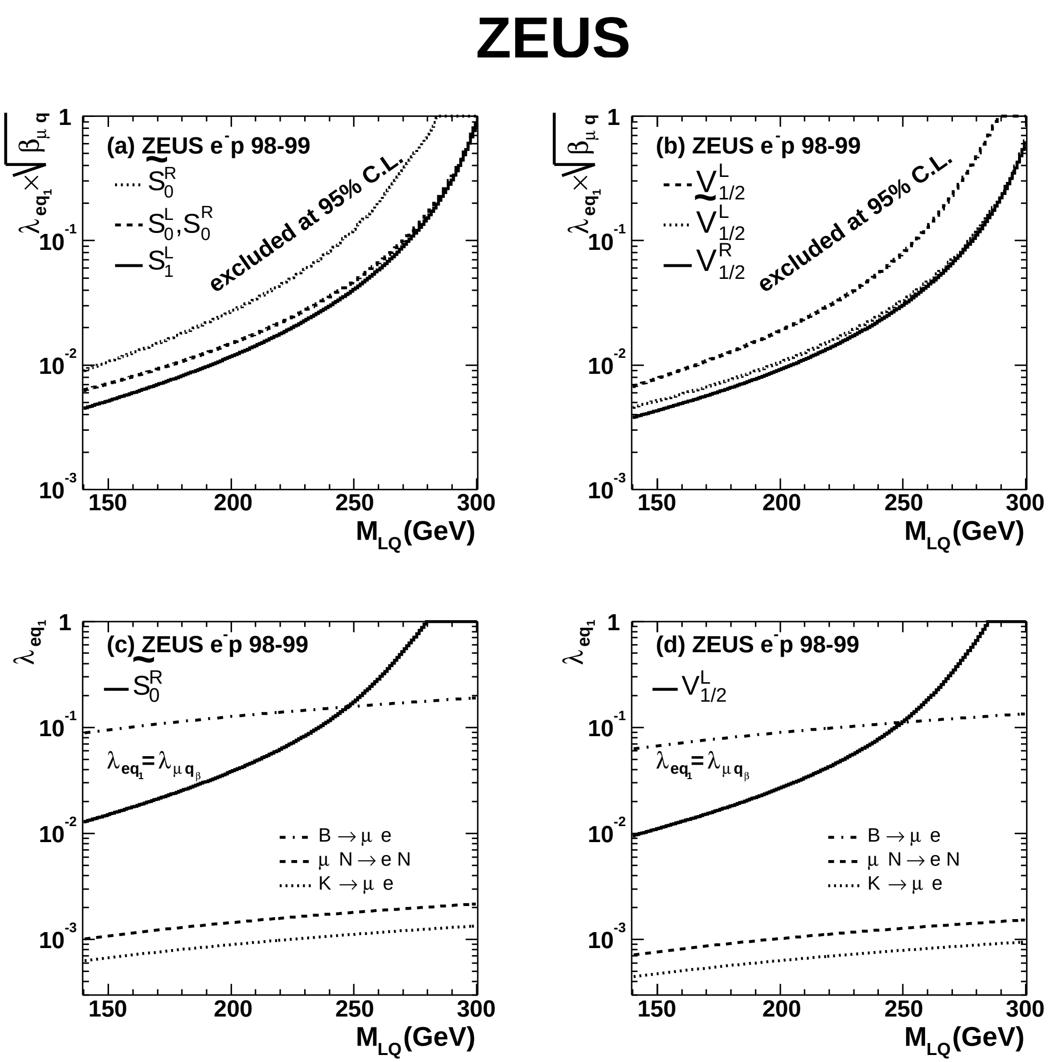
No event was found looking for the e, μ and hadronic decay channel of the τ, while 2.3 ± 0.5 were expected from simulation of SM processes.

Such results were converted into limits within the BRW model:
Ref. DESY-05-016 (January 2005).

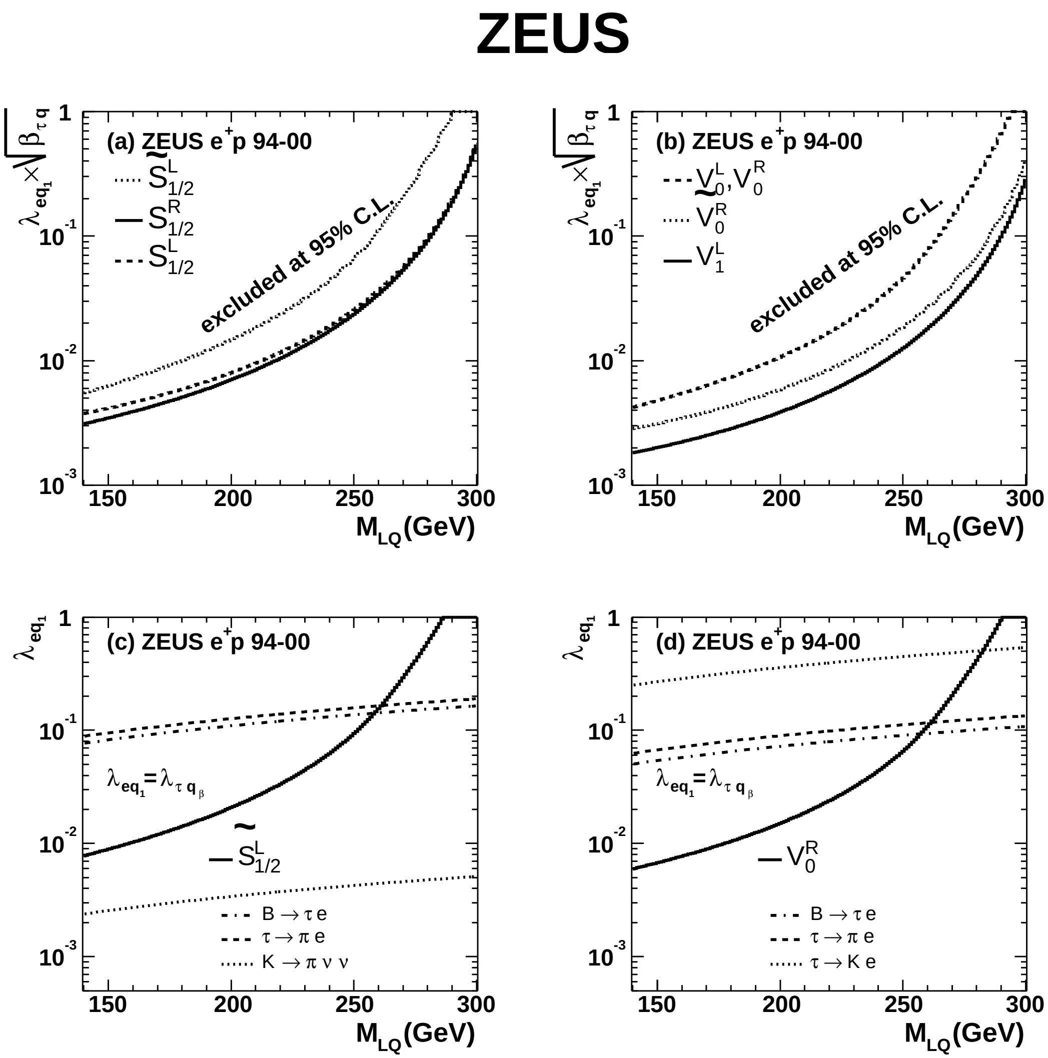
RESULTS FOR LOW MASS LQS $e-\mu$ $F=0$



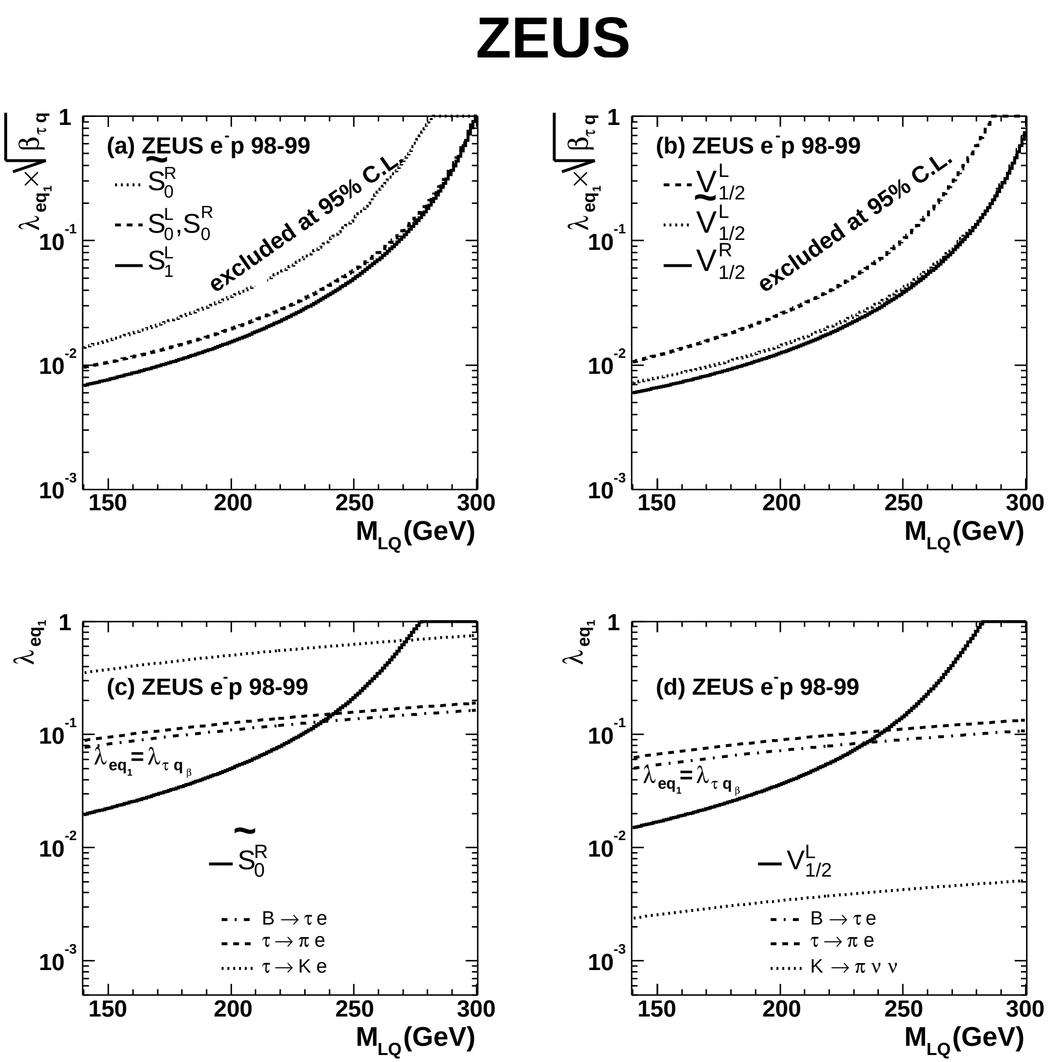
RESULTS FOR LOW MASS LQS $e - \mu$ $|F| = 2$



RESULTS FOR LOW MASS LQS $e - \tau$ $F = 0$



RESULTS FOR LOW MASS LQS $e - \tau$ $|F| = 2$



LOW MASS LQS - LIMITS ON MASSES

LQ type	$\tilde{S}^L_{1/2}$	$S^L_{1/2}$	$S^R_{1/2}$	V^L_0	V^R_0	$\tilde{V}^R_0$	V^L_1
$e-\mu$ limit on M_{LQ} (GeV)	273	293	293	274	278	296	299
$e-\tau$ limit on M_{LQ} (GeV)	270	291	291	271	276	294	298

95 % C.L. lower limits on M_{LQ} $F=0$ LQs $e-\mu$, $e-\tau$ $\lambda_{eq_1}=\lambda_{lq}=0.3$.

LQ type	S^L_0	S^R_0	$\tilde{S}^R_0$	S^L_1	$V^L_{1/2}$	$V^R_{1/2}$	$\tilde{V}^R_{1/2}$
$e-\mu$ limit on M_{LQ} (GeV)	278	284	261	281	269	289	289
$e-\tau$ limit on M_{LQ} (GeV)	275	281	257	278	265	287	286

95 % C.L. lower limits on M_{LQ} $|F|=2$ LQs $e-\mu$, $e-\tau$ $\lambda_{eq_1}=\lambda_{lq}=0.3$.

LOW MASS LQS-LIMITS ON COUPLINGS

LQ type	$\tilde{S}^L_{1/2}$	$S^L_{1/2}$	$S^R_{1/2}$	V^L_0/V^R_0	$\tilde{V}^R_0$	V^L_1
$e-\mu$ limit on $\lambda_{eq_1}\sqrt{\beta_{\mu q}}$	0.054	0.021	0.019	0.037	0.015	0.010
$e-\tau$ limit on $\lambda_{eq_1}\sqrt{\beta_{\tau q}}$	0.066	0.026	0.024	0.046	0.019	0.013

95 % C.L. upper limits on $\lambda_{eq_1}\sqrt{\beta_{lq}}$ $F=0$ LQs M_{LQ}=250 GeV $e-\mu$, $e-\tau$.

LQ type	S^L_0/S^R_0	$\tilde{S}^R_0$	S^L_1	$V^L_{1/2}$	$V^R_{1/2}$	$\tilde{V}^R_{1/2}$
$e-\mu$ limit on $\lambda_{eq_1}\sqrt{\beta_{\mu q}}$	0.047	0.12	0.041	0.080	0.030	0.033
$e-\tau$ limit on $\lambda_{eq_1}\sqrt{\beta_{\tau q}}$	0.058	0.15	0.049	0.10	0.038	0.042

95 % C.L. upper limits on $\lambda_{eq_1}\sqrt{\beta_{lq}}$ $|F|=2$ LQs M_{LQ}=250 GeV $e-\mu$, $e-\tau$.

RESULTS FOR HIGH MASS LQS

$e \to \mu$ ZEUS $e^{\pm}p$ 94-00 $F = 0$

$\alpha\beta$	$S^L_{1/2}$ $e^-\bar{u}$ e^+u	$S^R_{1/2}$ $e^-(\bar{u}+\bar{d})$ $e^+(u+d)$	$\tilde{S}^L_{1/2}$ $e^-\bar{d}$ e^+d	V^L_0 $e^-\bar{d}$ e^+d	V^R_0 $e^-\bar{d}$ e^+d	$\tilde{V}^R_0$ $e^-\bar{u}$ e^+u	V^L_1 $e^-(\sqrt{2}\bar{u}+\bar{d})$ $e^+(\sqrt{2}u+d)$
1 1	$\mu N \to eN$ 5.2×10^{-5} **1.2**	$\mu N \to eN$ 2.6×10^{-5} **1.0**	$\mu N \to eN$ 5.2×10^{-5} **1.7**	$\mu N \to eN$ 2.6×10^{-5} **1.0**	$\mu N \to eN$ 2.6×10^{-5} **1.0**	$\mu N \to eN$ 2.6×10^{-5} **0.8**	$\mu N \to eN$ 0.8×10^{-5} **0.4**
1 2	$D \to \mu\bar{e}$ 2.4 **1.3**	$K \to \mu\bar{e}$ 2×10^{-5} **1.0**	$K \to \mu\bar{e}$ 2×10^{-5} **1.8**	$K \to \mu\bar{e}$ 1×10^{-5} **1.2**	$K \to \mu\bar{e}$ 1×10^{-5} **1.2**	$D \to \mu\bar{e}$ 1.2 **1.0**	$K \to \mu\bar{e}$ 1×10^{-5} **0.5**
1 3	*	$B \to \mu\bar{e}$ 0.4 **1.8**	$B \to \mu\bar{e}$ 0.4 **1.9**	$B \to \mu\bar{e}$ 0.2 **1.5**	$B \to \mu\bar{e}$ 0.2 **1.5**	*	$B \to \mu\bar{e}$ 0.2 **1.5**
2 1	$D \to \mu\bar{e}$ 2.4 **3.6**	$K \to \mu\bar{e}$ 2×10^{-5} **2.4**	$K \to \mu\bar{e}$ 2×10^{-5} **3.1**	$K \to \mu\bar{e}$ 1×10^{-5} **1.3**	$K \to \mu\bar{e}$ 1×10^{-5} **1.3**	$D \to \mu\bar{e}$ 1.2 **1.2**	$K \to \mu\bar{e}$ 1×10^{-5} **0.6**
2 2	$\mu N \to eN$ 9.2×10^{-4} **5.7**	$\mu N \to eN$ 1.3×10^{-3} **3.1**	$\mu N \to eN$ 3×10^{-3} **3.8**	$\mu N \to eN$ 1.5×10^{-3} **1.9**	$\mu N \to eN$ 1.5×10^{-3} **1.9**	$\mu N \to eN$ 4.6×10^{-4} **2.8**	$\mu N \to eN$ 2.7×10^{-4} **1.1**

$e \to \mu$		ZEUS $e^{\pm}p$ 94-00					$F = 0$
$\alpha\beta$	$S^L_{1/2}$ $e^- \bar{u}$ $e^+ u$	$S^R_{1/2}$ $e^- (\bar{u} + \bar{d})$ $e^+ (u + d)$	$\tilde{S}^L_{1/2}$ $e^- \bar{d}$ $e^+ d$	V^L_0 $e^- \bar{d}$ $e^+ d$	V^R_0 $e^- \bar{d}$ $e^+ d$	$\tilde{V}^R_0$ $e^- \bar{u}$ $e^+ u$	V^L_1 $e^- (\sqrt{2}\bar{u} + \bar{d})$ $e^+ (\sqrt{2}u + d)$
2 3	*	$B \to \bar{\mu} e K$ 0.3 **4.3**	$B \to \bar{\mu} e K$ 0.3 **4.2**	$B \to \bar{\mu} e K$ 0.15 **2.9**	$B \to \bar{\mu} e K$ 0.15 **2.9**	*	$B \to \bar{\mu} e K$ 0.15 **2.9**
3 1	*	$B \to \mu \bar{e}$ 0.4 **4.4**	$B \to \mu \bar{e}$ 0.4 **4.4**	V_{ub} 0.12 **1.5**	$B \to \mu \bar{e}$ 0.2 **1.5**	*	V_{ub} 0.12 **1.5**
3 2	*	$B \to \bar{\mu} e K$ 0.3 **5.8**	$B \to \bar{\mu} e K$ 0.3 **5.8**	$B \to \bar{\mu} e K$ 0.15 **2.2**	$B \to \bar{\mu} e K$ 0.15 **2.2**	*	$B \to \bar{\mu} e K$ 0.15 **2.2**
3 3	*	$\mu N \to e N$ 1.3×10^{-3} **7.6**	$\mu N \to e N$ 3×10^{-3} **7.6**	$\mu N \to e N$ 1.5×10^{-3} **3.9**	$\mu N \to e N$ 1.5×10^{-3} **3.9**	*	$\mu N \to e N$ 2.7×10^{-4} **3.9**

Limits at 95% C.L. on $\frac{\lambda_{eq_\alpha}\lambda_{\mu q_\beta}}{M^2_{LQ}}$ for $F = 0$ LQs (TeV^{-2}). First column: quark generations coupling to $LQ - e$ and $LQ - \mu$. ZEUS results in third line (bold). Low-energy process providing the most stringent constraint and the corresponding limit in first and second lines. ZEUS limits enclosed in a box if better than the low-energy constraints. Cases marked with * correspond to processes where coupling to a t quark is involved.

$e \to \mu$			ZEUS $e^{\pm}p$ 94-00			$\|F\| = 2$
$\alpha\beta$	S_0^L $e^- u$ $e^+ \bar{u}$	S_0^R $e^- u$ $e^+ \bar{u}$	$\tilde{S}_0^R$ $e^- d$ $e^+ \bar{d}$	S_1^L $e^-(u+\sqrt{2}d)$ $e^+(\bar{u}+\sqrt{2}\bar{d})$	$V_{1/2}^L$ $e^- d$ $e^+ \bar{d}$	$V_{1/2}^R$ $e^-(u+d)$ $e^+(\bar{u}+\bar{d})$	$\tilde{V}_{1/2}^L$ $e^- u$ $e^+ \bar{u}$
1 1	$\mu N \to eN$ 5.2×10^{-5} **1.6**	$\mu N \to eN$ 5.2×10^{-5} **1.6**	$\mu N \to eN$ 5.2×10^{-5} **2.1**	$\mu N \to eN$ 1.7×10^{-5} **0.9**	$\mu N \to eN$ 2.6×10^{-5} **0.9**	$\mu N \to eN$ 1.3×10^{-5} **0.5**	$\mu N \to eN$ 2.6×10^{-5} **0.6**
1 2	$K \to \pi\nu\bar{\nu}$ 10^{-3} **2.5**	$D \to \mu\bar{e}$ 2.4 **2.5**	$K \to \mu\bar{e}$ 2×10^{-5} **2.6**	$K \to \mu\bar{e}$ 1×10^{-5} **1.2**	$K \to \mu\bar{e}$ 1×10^{-5} **1.6**	$K \to \mu\bar{e}$ 1×10^{-5} **1.2**	$D \to \mu\bar{e}$ 1.2 **1.8**
1 3	*	*	$B \to \mu\bar{e}$ 0.4 **2.9**	V_{ub} 0.24 **1.4**	$B \to \mu\bar{e}$ 0.2 **2.2**	$B \to \mu\bar{e}$ 0.2 **2.2**	*
2 1	$K \to \pi\nu\bar{\nu}$ 10^{-3} **2.1**	$D \to \mu\bar{e}$ 2.4 **2.1**	$K \to \mu\bar{e}$ 2×10^{-5} **2.5**	$K \to \mu\bar{e}$ 1×10^{-5} **1.1**	$K \to \mu\bar{e}$ 1×10^{-5} **0.9**	$K \to \mu\bar{e}$ 1×10^{-5} **0.5**	$D \to \mu\bar{e}$ 1.2 **0.6**
2 2	$\mu N \to eN$ 9.2×10^{-4} **5.7**	$\mu N \to eN$ 9.2×10^{-4} **5.7**	$\mu N \to eN$ 3×10^{-3} **3.8**	$\mu N \to eN$ 2.5×10^{-3} **1.8**	$\mu N \to eN$ 1.5×10^{-3} **1.9**	$\mu N \to eN$ 6.7×10^{-4} **1.6**	$\mu N \to eN$ 4.6×10^{-4} **2.8**

$e \to \mu$			ZEUS $e^{\pm}p$ 94-00				$\lvert F\rvert = 2$
$\alpha\beta$	S_0^L $e^- u$ $e^+ \bar{u}$	S_0^R $e^- u$ $e^+ \bar{u}$	$\tilde{S}_0^R$ $e^- d$ $e^+ \bar{d}$	S_1^L $e^-(u+\sqrt{2}d)$ $e^+(\bar{u}+\sqrt{2}\bar{d})$	$V_{1/2}^L$ $e^- d$ $e^+ \bar{d}$	$V_{1/2}^R$ $e^-(u+d)$ $e^+(\bar{u}+\bar{d})$	$\tilde{V}_{1/2}^L$ $e^- u$ $e^+ \bar{u}$
2 3	*	*	$B \to \bar{\mu} e K$ 0.3 **4.4**	$B \to \bar{\mu} e K$ 0.15 **2.2**	$B \to \bar{\mu} e K$ 0.15 **2.9**	$B \to \bar{\mu} e K$ 0.15 **2.9**	*
3 1	*	*	$B \to \mu \bar{e}$ 0.4 **3.1**	$B \to \mu \bar{e}$ 0.4 **1.5**	$B \to \mu \bar{e}$ 0.2 **0.9**	$B \to \mu \bar{e}$ 0.2 **0.9**	*
3 2	*	*	$B \to \bar{\mu} e K$ 0.3 **5.9**	$B \to \bar{\mu} e K$ 0.15 **3.0**	$B \to \bar{\mu} e K$ 0.15 **2.2**	$B \to \bar{\mu} e K$ 0.15 **2.2**	*
3 3	*	*	$\mu N \to e N$ 3×10^{-3} **7.7**	$\mu N \to e N$ 2.5×10^{-3} **3.9**	$\mu N \to e N$ 1.5×10^{-3} **4.0**	$\mu N \to e N$ 6.7×10^{-4} **4.0**	*

Limits at 95% C.L. on $\frac{\lambda_{eq_\alpha}\lambda_{\mu q_\beta}}{M_{LQ}^2}$ for $|F| = 2$ LQs (TeV^{-2}). First column: quark generations coupling to $LQ - e$ and $LQ - \mu$.

$e \to \tau$	ZEUS $e^{\pm}p$ 94-00						$F = 0$
$\alpha\beta$	$S^L_{1/2}$ $e^-\bar{u}$ e^+u	$S^R_{1/2}$ $e^-(\bar{u}+\bar{d})$ $e^+(u+d)$	$\tilde{S}^L_{1/2}$ $e^-\bar{d}$ e^+d	V^L_0 $e^-\bar{d}$ e^+d	V^R_0 $e^-\bar{d}$ e^+d	$\tilde{V}^R_0$ $e^-\bar{u}$ e^+u	V^L_1 $e^-(\sqrt{2}\bar{u}+\bar{d})$ $e^+(\sqrt{2}u+d)$
1 1	$\tau \to \pi e$ 0.4 **1.8**	$\tau \to \pi e$ 0.2 **1.5**	$\tau \to \pi e$ 0.4 **2.7**	$\tau \to \pi e$ 0.2 **1.7**	$\tau \to \pi e$ 0.2 **1.7**	$\tau \to \pi e$ 0.2 **1.3**	$\tau \to \pi e$ 0.06 **0.6**
1 2	**1.9**	$\tau \to Ke$ 6.3 **1.6**	$K \to \pi\nu\bar{\nu}$ 5.8×10^{-4} **2.9**	$\tau \to Ke$ 3.2 **2.1**	$\tau \to Ke$ 3.2 **2.1**	**1.6**	$K \to \pi\nu\bar{\nu}$ 1.5×10^{-4} **0.8**
1 3	*	$B \to \tau\bar{e}$ 0.6 **3.2**	$B \to \tau\bar{e}$ 0.6 **3.3**	$B \to \tau\bar{e}$ 0.3 **2.6**	$B \to \tau\bar{e}$ 0.3 **2.6**	*	$B \to \tau\bar{e}$ 0.3 **2.6**
2 1	**6.0**	$\tau \to Ke$ 6.3 **4.1**	$K \to \pi\nu\bar{\nu}$ 5.8×10^{-4} **5.2**	$\tau \to Ke$ 3.2 **2.3**	$\tau \to Ke$ 3.2 **2.3**	**2.1**	$K \to \pi\nu\bar{\nu}$ 1.5×10^{-4} **0.9**
2 2	$\tau \to 3e$ 5 **10**	$\tau \to 3e$ 8 **5.6**	$\tau \to 3e$ 17 **6.5**	$\tau \to 3e$ 9 **3.4**	$\tau \to 3e$ 9 **3.4**	$\tau \to 3e$ 3 **5.5**	$\tau \to 3e$ 1.6 **2.1**

$e \rightarrow \tau$			ZEUS $e^{\pm}p$ 94-00				$F = 0$
$\alpha\beta$	$S^L_{1/2}$ $e^-\bar{u}$ e^+u	$S^R_{1/2}$ $e^-(\bar{u}+\bar{d})$ $e^+(u+d)$	$\tilde{S}^L_{1/2}$ $e^-\bar{d}$ e^+d	V^L_0 $e^-\bar{d}$ e^+d	V^R_0 $e^-\bar{d}$ e^+d	$\tilde{V}^R_0$ $e^-\bar{u}$ e^+u	V^L_1 $e^-(\sqrt{2}\bar{u}+\bar{d})$ $e^+(\sqrt{2}u+d)$
2 3	*	$B \rightarrow \tau\bar{e}X$ 14 **8.1**	$B \rightarrow \tau\bar{e}X$ 14 **7.8**	$B \rightarrow \tau\bar{e}X$ 7.2 **5.5**	$B \rightarrow \tau\bar{e}X$ 7.2 **5.5**	*	$B \rightarrow \tau\bar{e}X$ 7.2 **5.5**
3 1	*	$B \rightarrow \tau\bar{e}$ 0.6 **7.8**	$B \rightarrow \tau\bar{e}$ 0.6 **7.2**	V_{ub} 0.12 **2.5**	$B \rightarrow \tau\bar{e}$ 0.3 **2.5**	*	V_{ub} 0.12 **2.5**
3 2	*	$B \rightarrow \tau\bar{e}X$ 14 **11**	$B \rightarrow \tau\bar{e}X$ 14 **10**	$B \rightarrow \tau\bar{e}X$ 7.2 **4.2**	$B \rightarrow \tau\bar{e}X$ 7.2 **4.2**	*	$B \rightarrow \tau\bar{e}X$ 7.2 **4.2**
3 3	*	$\tau \rightarrow 3e$ 8 **15**	$\tau \rightarrow 3e$ 17 **14**	$\tau \rightarrow 3e$ 9 **8.1**	$\tau \rightarrow 3e$ 9 **8.1**	*	$\tau \rightarrow 3e$ 1.6 **8.1**

Limits at 95% C.L. on $\frac{\lambda_{eq_\alpha}\lambda_{\tau q_\beta}}{M^2_{LQ}}$ for $F = 0$ LQs (TeV^{-2}). First column: quark generations coupling to $LQ - e$ and $LQ - \tau$.

$e \to \tau$	ZEUS $e^{\pm}p$ 94-00						$\|F\| = 2$
$\alpha\beta$	S_0^L $e^- u$ $e^+ \bar{u}$	S_0^R $e^- u$ $e^+ \bar{u}$	$\tilde{S}_0^R$ $e^- d$ $e^+ \bar{d}$	S_1^L $e^-(u+\sqrt{2}d)$ $e^+(\bar{u}+\sqrt{2}\bar{d})$	$V_{1/2}^L$ $e^- d$ $e^+ \bar{d}$	$V_{1/2}^R$ $e^-(u+d)$ $e^+(\bar{u}+\bar{d})$	$\tilde{V}_{1/2}^L$ $e^- u$ $e^+ \bar{u}$
1 1	G_F 0.3 **2.5**	$\tau \to \pi e$ 0.4 **2.5**	$\tau \to \pi e$ 0.4 **3.5**	$\tau \to \pi e$ 0.1 **1.4**	$\tau \to \pi e$ 0.2 **1.4**	$\tau \to \pi e$ 0.1 **0.8**	$\tau \to \pi e$ 0.2 **1.0**
1 2	$K \to \pi\nu\bar{\nu}$ 5.8×10^{-4} **4.0**	**4.0**	$\tau \to Ke$ 6.3 **4.4**	$K \to \pi\nu\bar{\nu}$ 2.9×10^{-4} **1.9**	$K \to \pi\nu\bar{\nu}$ 2.9×10^{-4} **2.8**	$\tau \to Ke$ 3.2 **2.0**	**3.1**
1 3		*	$B \to \tau\bar{e}$ 0.6 **5.1**	V_{ub} 0.12 **2.6**	$B \to \tau\bar{e}$ 0.3 **4.0**	$B \to \tau\bar{e}$ 0.3 **4.0**	*
2 1	$K \to \pi\nu\bar{\nu}$ 5.8×10^{-4} **3.2**	**3.2**	$\tau \to Ke$ 6.3 **4.3**	$K \to \pi\nu\bar{\nu}$ 2.9×10^{-4} **1.8**	$K \to \pi\nu\bar{\nu}$ 2.9×10^{-4} **1.4**	$\tau \to Ke$ 3.2 **0.8**	**1.0**
2 2	$\tau \to 3e$ 5 **10**	$\tau \to 3e$ 5 **10**	$\tau \to 3e$ 17 **6.5**	$\tau \to 3e$ 14 **3.2**	$\tau \to 3e$ 9 **3.5**	$\tau \to 3e$ 4 **2.8**	$\tau \to 3e$ 3 **5.1**

$e \to \tau$		ZEUS $e^{\pm}p$ 94-00					$\lvert F\rvert = 2$
$\alpha\beta$	S_0^L $e^- u$ $e^+ \bar{u}$	S_0^R $e^- u$ $e^+ \bar{u}$	$\tilde{S}_0^R$ $e^- d$ $e^+ \bar{d}$	S_1^L $e^-(u+\sqrt{2}d)$ $e^+(\bar{u}+\sqrt{2}\bar{d})$	$V_{1/2}^L$ $e^- d$ $e^+ \bar{d}$	$V_{1/2}^R$ $e^-(u+d)$ $e^+(\bar{u}+\bar{d})$	$\tilde{V}_{1/2}^L$ $e^- u$ $e^+ \bar{u}$
2 3	*	*	$B \to \tau \bar{e} X$ 14 **8.3**	$B \to \tau \bar{e} X$ 7.2 **4.1**	$B \to \tau \bar{e} X$ 7.2 **5.4**	$B \to \tau \bar{e} X$ 7.2 **5.4**	*
3 1	*	*	$B \to \tau \bar{e}$ 0.6 **5.3**	$B \to \tau \bar{e}$ 0.3 **2.7**	$B \to \tau \bar{e}$ 0.3 **1.6**	$B \to \tau \bar{e}$ 0.3 **1.6**	*
3 2	*	*	$B \to \tau \bar{e} X$ 14 **11**	$B \to \tau \bar{e} X$ 7.2 **5.5**	$B \to \tau \bar{e} X$ 7.2 **4.1**	$B \to \tau \bar{e} X$ 7.2 **4.1**	*
3 3	*	*	$\tau \to 3e$ 17 **15**	$\tau \to 3e$ 14 **7.6**	$\tau \to 3e$ 9 **7.6**	$\tau \to 3e$ 4 **7.6**	*

Limits at 95% C.L. on $\frac{\lambda_{eq_\alpha}\lambda_{\tau q_\beta}}{M_{LQ}^2}$ for $|F| = 2$ LQs (TeV^{-2}). First column: quark generations coupling to $LQ - e$ and $LQ - \tau$.

CONCLUSIONS

- ZEUS has looked for events with Lepton Flavor Violation using the whole statistics of HERA I
- No evidence for Lepton Flavor Violation has been found, neither of $e - \mu$ nor of $e - \tau$ transitions
- Limits have been set for Leptoquarks mediating LFV
- These limits are competitive with low energy experiments and often improve them, especially for the $e - \tau$ transition, since existing limits from rare decays are less stringent than for muons, and when heavy quarks are involved.
- HERA II should increase the sensitivity to LFV. Polarized electron/positron beams permit tu study LH or RH LQs.