

MAR 06, 06

LEPTOQUARKS @ LHC

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DESY

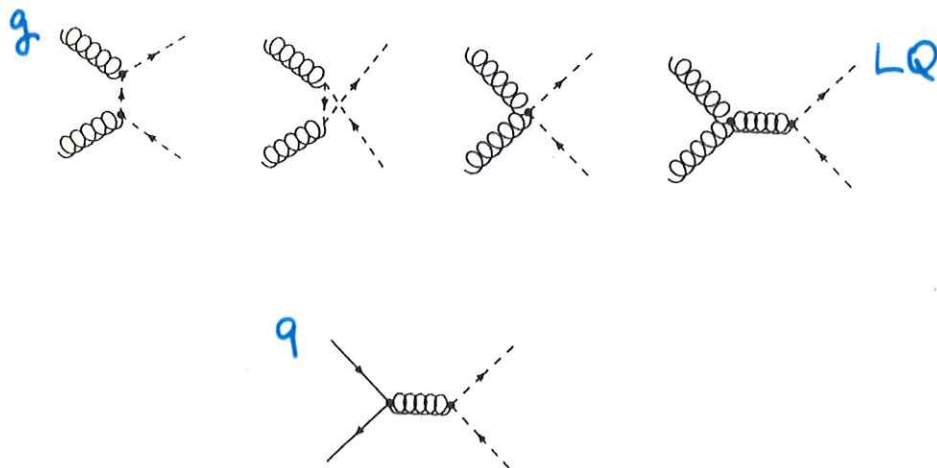
WHY: $\sum_n Q_{em,n}^2 (Q_L - Q_R)_n = 0$

- ONLY INTIMATE CONTACT OF L & Q.

→ REASONS: • GUT'S ?
• COMPOSITENESS ?

DO MASSIVE LQ-STATES EXIST ?

LHC: $\sigma \propto \alpha_s^2$



Tab. 1 Quantum numbers of leptoquarks [4].

leptoquark (Φ)	spin	F	colour	T_3	Q_{em}	$\lambda_L(lq)$	$\lambda_R(lq)$	$\lambda_L(\nu q)$
S_1	0	-2	$\bar{3}$	0	1/3	g_{1L}	g_{1R}	$-g_{1L}$
\bar{S}_1	0	-2	$\bar{3}$	0	4/3	0	\bar{g}_{1R}	0
\bar{S}_3	0	-2	$\bar{3}$	+1	4/3	$-\sqrt{2}g_{3L}$	0	0
				0	1/3	$-g_{3L}$	0	$-g_{3L}$
				-1	-2/3	0	0	$\sqrt{2}g_{3L}$
R_2	0	0	3	1/2	5/3	h_{2L}	h_{2R}	0
				-1/2	2/3	0	$-h_{2R}$	h_{2L}
\bar{R}_2	0	0	3	1/2	2/3	\bar{h}_{2L}	0	0
				-1/2	-1/3	0	0	\bar{h}_{2L}
$V_{2\mu}$	1	-2	$\bar{3}$	1/2	4/3	g_{2L}	g_{2R}	0
				-1/2	1/3	0	g_{2R}	g_{2L}
$\bar{V}_{2\mu}$	1	-2	$\bar{3}$	1/2	1/3	\bar{g}_{2L}	0	0
				-1/2	-2/3	0	0	\bar{g}_{2L}
$U_{1\mu}$	1	0	3	0	2/3	h_{1L}	h_{1R}	h_{1L}
$\bar{U}_{1\mu}$	1	0	3	0	5/3	0	\bar{h}_{1R}	0
$\bar{U}_{3\mu}$	1	0	3	+1	5/3	$\sqrt{2}h_{3L}$	0	0
				0	2/3	$-h_{3L}$	0	h_{3L}
				-1	-1/3	0	0	$\sqrt{2}h_{3L}$

BUCHMÜLLER,
RÜCKL, WYLER
1987.

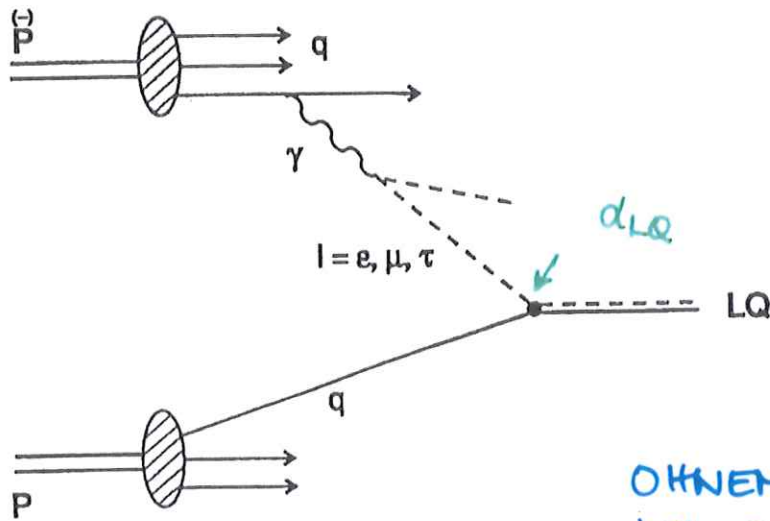
$F = 3B + L$

Tab. 2 Branching ratios for final states arising from the decays of leptoquarks associated with the first ($l = e$) and second ($l = \mu$) family. The sequence of branching fractions given in the second and third row refers to the assumptions $\lambda_L = \lambda_R, \lambda_L = 0$, and $\lambda_R = 0$, respectively [4].

states	$l^+l^- + 2jets$	$l\nu + 2jets$	$\nu\bar{\nu} + 2jets$
$S_1 \quad U_1$	$\frac{4}{9} \quad 1 \quad \frac{1}{4}$	$\frac{4}{9} \quad 0 \quad \frac{1}{2}$	$\frac{1}{9} \quad 0 \quad \frac{1}{4}$
$R_2^{2/3} \quad V_2^{1/3}$	$\frac{1}{4} \quad 1 \quad 0$	$\frac{1}{2} \quad 0 \quad 0$	$\frac{1}{4} \quad 0 \quad 1$
$S_3^{1/3} \quad U_3^{2/3}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{4}$
$\bar{S}_1 \quad S_3^{4/3} \quad R_2^{5/3} \quad \bar{R}_2^{2/3}$ $V_2^{4/3} \quad \bar{V}_2^{1/3} \quad \bar{U}_1 \quad U_3^{5/3}$	1	0	0
$S_3^{-2/3} \quad \bar{R}_2^{-1/3} \quad \bar{V}_2^{-2/3} \quad U_3^{-1/3}$	0	0	1

DELAY
PATTERN

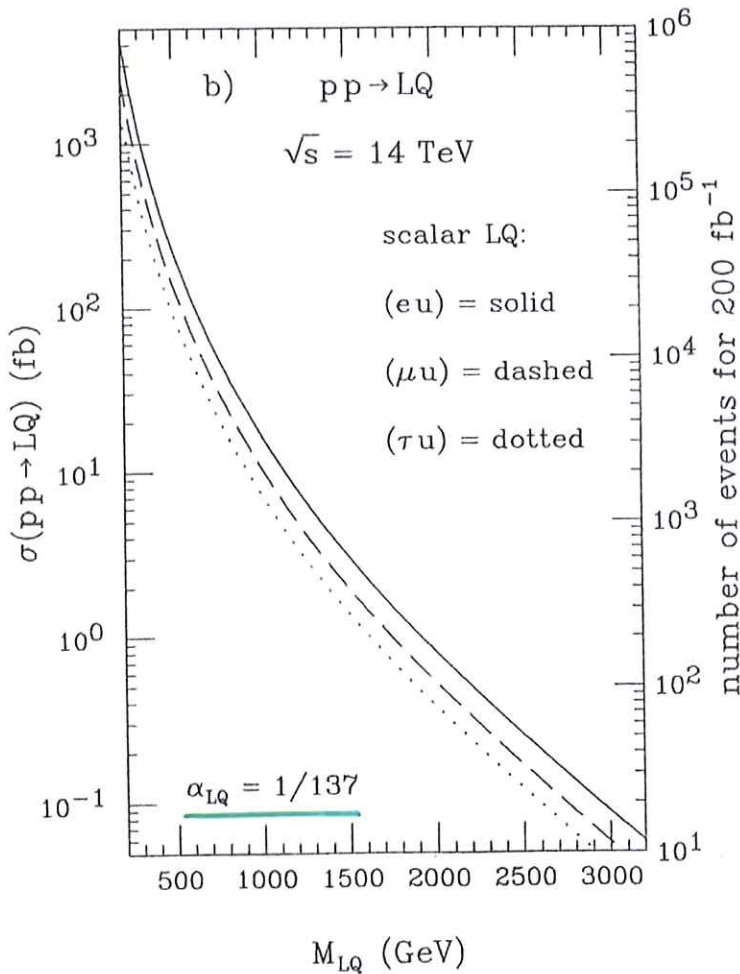
SINGLE PRODUCTION:



YUKAWA-TYPE

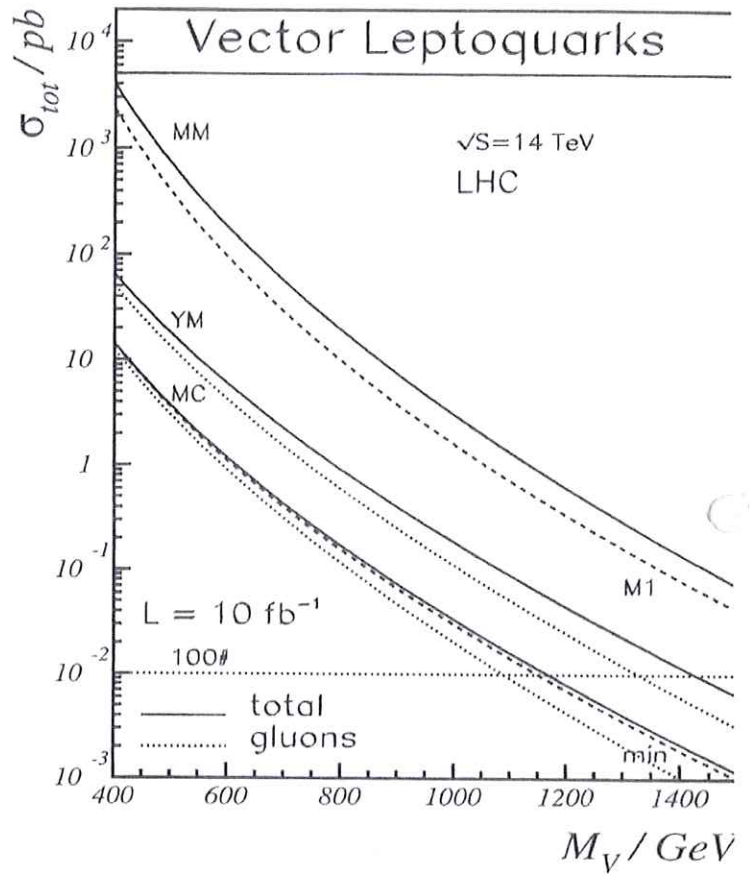
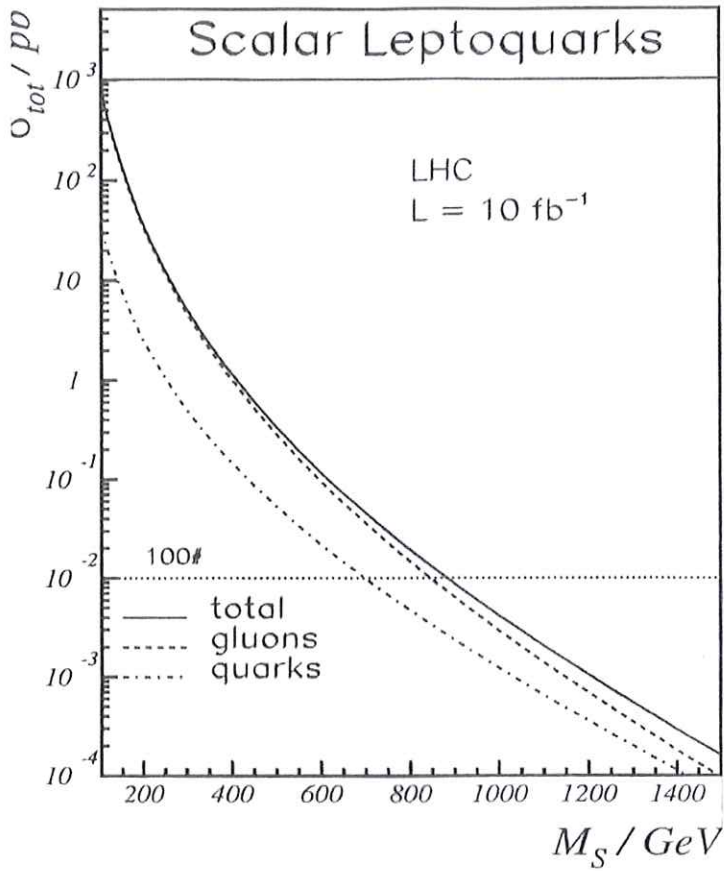
OHNEMUS, RUDAZ,
WALSH, ZERWAS

1994

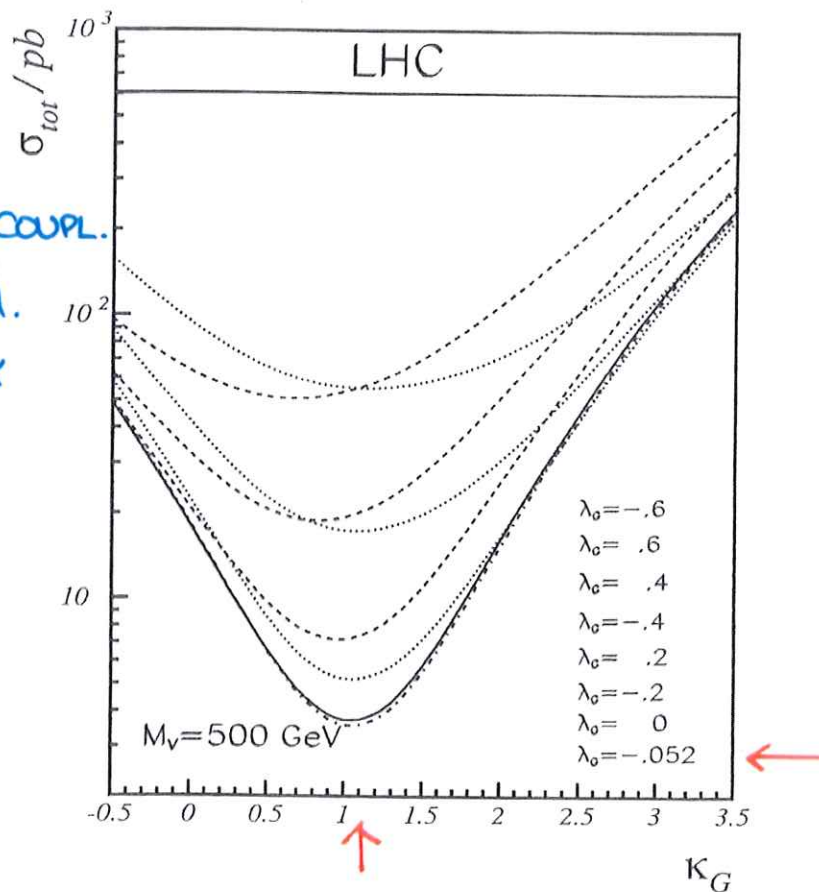


PAIR PRODUCTION :

JB, BOOS, KRYUKOV , 1997

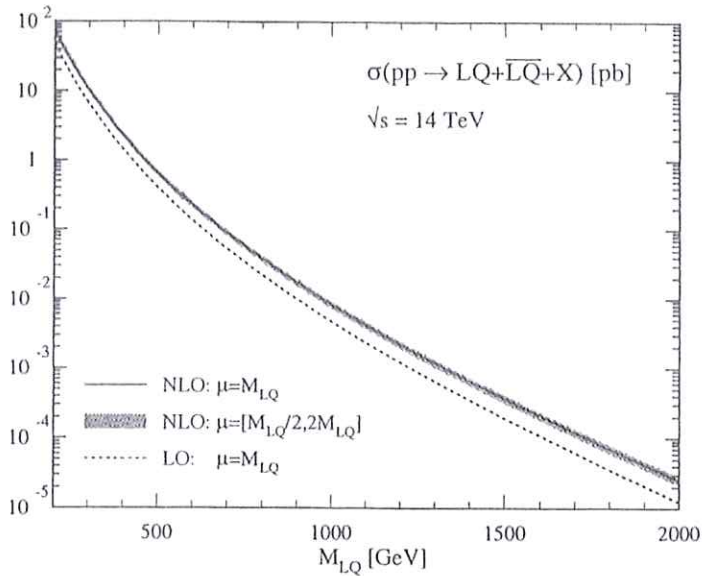
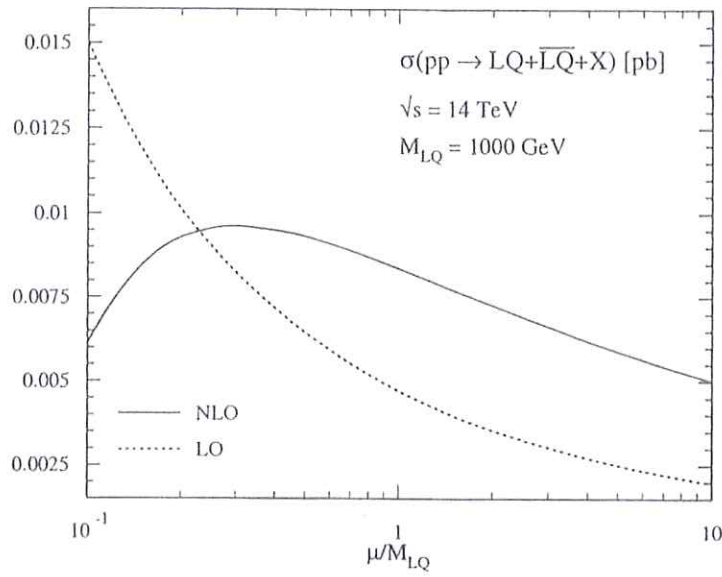


VECTORS :
 ANOMALOUS COUPL.
 κ, λ - PARAM.
 DO STRONGLY
 MATTER



$O(\alpha_s)$ CORRECTION : SCALARS

KRAMER, PLEHN,
SPIRA, ZERWAS,
2005

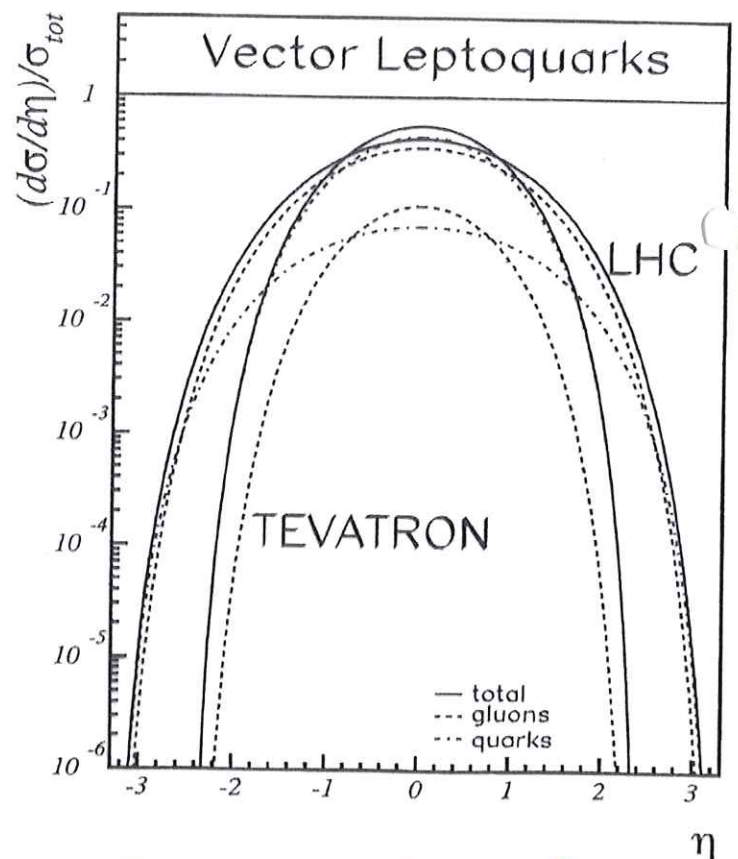
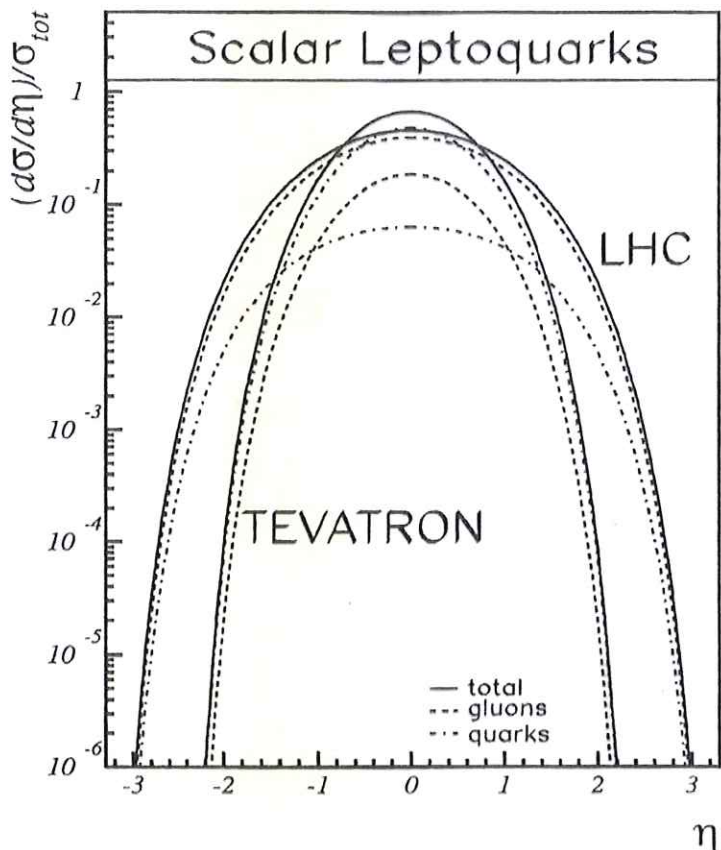
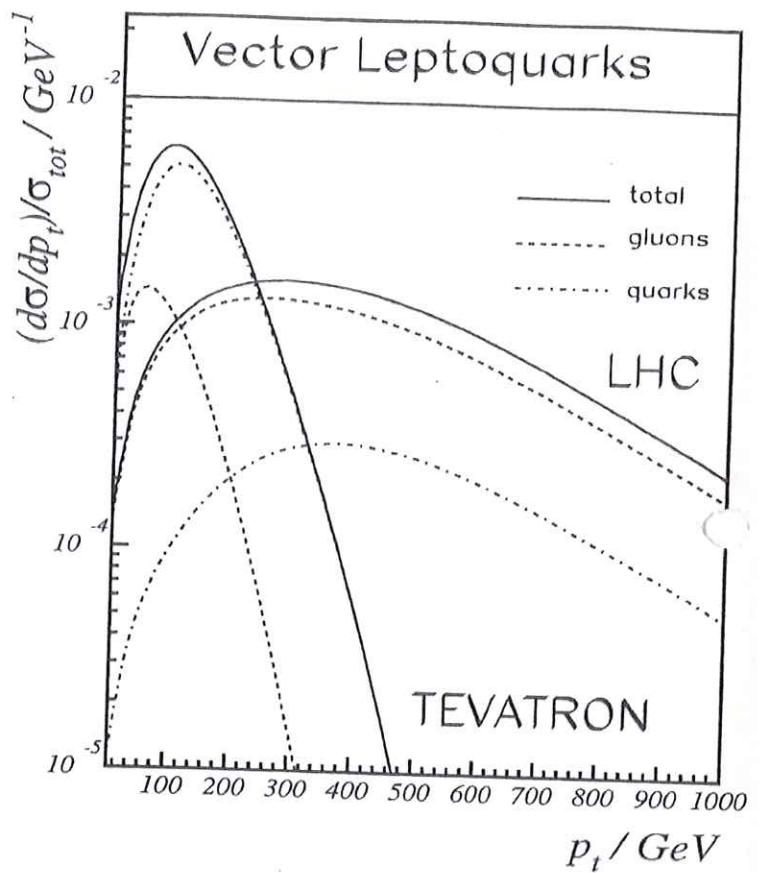
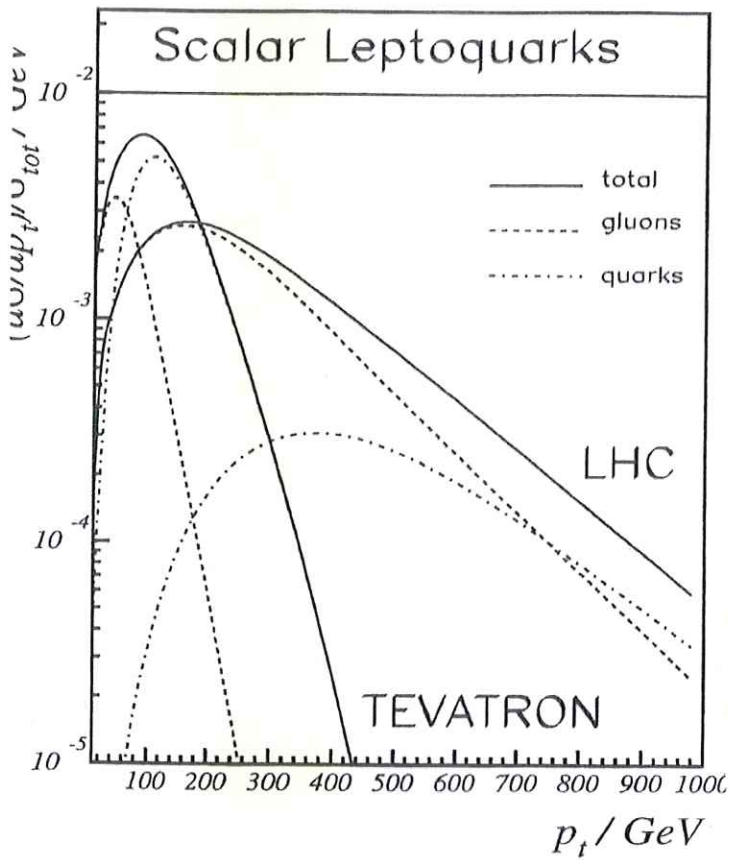


↓ K-FACTORS

1.5 ... 2.0

M_{LQ} [GeV]	CTEQ6(LO/NLO)				MRST2002
	σ_{LO} [fb]	σ_{NLO} [fb]	$gg : q\bar{q} : qq$	K	σ_{NLO} [fb]
200	0.500×10^2	0.742×10^2	0.94 : 0.05 : 0.01	1.48	0.779×10^2
400	0.140×10^1	0.224×10^1	0.91 : 0.10 : -0.01	1.60	0.243×10^1
600	0.135	0.225	0.88 : 0.15 : -0.03	1.67	0.245
800	0.219×10^{-1}	0.378×10^{-1}	0.84 : 0.19 : -0.03	1.73	0.406×10^{-1}
1000	0.471×10^{-2}	0.836×10^{-2}	0.82 : 0.22 : -0.04	1.77	0.879×10^{-2}
1200	0.121×10^{-2}	0.221×10^{-2}	0.81 : 0.24 : -0.05	1.83	0.226×10^{-2}
1400	0.349×10^{-3}	0.655×10^{-3}	0.79 : 0.26 : -0.05	1.88	0.650×10^{-3}
1600	0.109×10^{-3}	0.210×10^{-3}	0.78 : 0.28 : -0.06	1.93	0.201×10^{-3}
1800	0.357×10^{-4}	0.713×10^{-4}	0.77 : 0.29 : -0.06	2.00	0.656×10^{-4}
2000	0.122×10^{-4}	0.253×10^{-4}	0.77 : 0.30 : -0.07	2.07	0.222×10^{-4}

DIFFERENTIAL DISTRIBUTIONS:



LHC vs TEVATRON:

quark domination: lower S
gluon — 4 — higher S

SENSITIVITIES: PAIR PRODUCTION

Collider	Mode	\sqrt{S}	Luminosity	Q	Scalar Leptoquarks		Vector Leptoquarks	
					100#	10#	100#	10#
TEVATRON	$p\bar{p}$	1.8 TeV	$100pb^{-1}$		140	200	170	225
TEV33	$p\bar{p}$	2.0 TeV	$1fb^{-1}$		210	290	290	370
LHC	pp	14 TeV	$10fb^{-1}$		900	1200	1200	1500
HERA	ep	314 GeV	$100pb^{-1}$	1/3	-	50	50	60
				5/3	45	60	60	75
				1/3	45	60	60	75
				5/3	55	75	70	85
LEP \otimes LHC	ep	1.26 TeV	$1fb^{-1}$	1/3	125	180	180	240
				5/3	165	225	210	270
LINAC e^+e^-	$\gamma^*\gamma^*$ WWA	500 GeV	$10fb^{-1}$	1/3	90	120	120	155
				5/3	135	185	170	210
LINAC e^+e^-	$\gamma\gamma$ Compton	500 GeV	$10fb^{-1}$	1/3	160	180	175	190
				5/3	200	205	200	205
LINAC e^+e^-	$\gamma^*\gamma^*$ WWA	1 TeV	$10fb^{-1}$	1/3	140	195	285	345
				5/3	220	325	435	470
LINAC e^+e^-	$\gamma\gamma$ Compton	1 TeV	$10fb^{-1}$	1/3	300	340	390	405
				5/3	400	405	410	410

Table 2: Accessible mass ranges for leptoquark pair production (GeV) for $M_{S,V} \geq 45$ GeV. For the case of vector leptoquarks the mass ranges correspond to $\kappa_G = 1.3, \lambda_G = -0.21$ at the TEVATRON, and the minimum vector coupling $\kappa_G = 1, \lambda_G = 0$ for all other cases.

CURRENT LIMITS:

β charged lepton FS fract.

β	SCALARS	VECTORS
1	256 GeV	246 GeV
0.5	234 GeV	233 GeV
0	117 GeV	144 GeV

1ST FAMILY

