Heavy Charged Lepton Searches

NODE=S025

Charged Heavy Lepton MASS LIMITS

NODE=S025205

Sequential Charged Heavy Lepton ($L^{\pm}$) MASS LIMITS

NODE=S025MS

These experiments assumed that a fourth generation $L^{\pm}$ decayed to a fourth generation ν_L (or L^0) where ν_L was stable, or that $L^{\pm}$ decays to a light ν_ℓ via mixing.

NODE=S025MS

See the "Quark and Lepton Compositeness, Searches for" Listings for limits on radiatively decaying excited leptons, *i.e.* $\ell^* \rightarrow \ell\gamma$. See the "WIMPs and other Particle Searches" section for heavy charged particle search limits in which the charged particle could be a lepton.

NODE=S025MS;CHECK LIMITS

VALUE (GeV)	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*	
>100.8	95	ACHARD	01B	L3	Decay to νW	
>101.9	95	ACHARD	01B	L3	$m_L - m_{L^0} > 15$ GeV	OCCUR=2
• • • We do not use the following data for averages, fits, limits, etc. • • •						
> 81.5	95	ACKERSTAFF	98C	OPAL	Assumed $m_{L^{\pm}} - m_{L^0} > 8.4$ GeV	
> 80.2	95	ACKERSTAFF	98C	OPAL	$m_{L^0} > m_{L^{\pm}}$ and $L^{\pm} \rightarrow \nu W$	OCCUR=2
< 48 or > 61	95	[1] ACCIARRI	96G	L3		OCCUR=3
> 63.9	95	ALEXANDER	96P	OPAL	Decay to massless ν's	OCCUR=2
> 63.5	95	BUSKULIC	96S	ALEP	$m_L - m_{L^0} > 7$ GeV	
> 65	95	BUSKULIC	96S	ALEP	Decay to massless ν's	OCCUR=2
none 10–225		[2] AHMED	94	CNTR	H1 Collab. at HERA	
none 12.6–29.6	95	KIM	91B	AMY	Massless ν assumed	
> 44.3	95	AKRAWY	90G	OPAL		
none 0.5–10	95	[3] RILES	90	MRK2	For (m_{L^0}-m_{L^0})> 0.25–0.4GeV	
> 8		[4] STOKER	89	MRK2	For $(m_{L^+} - m_{L^0})$= 0.4 GeV	
> 12		[4] STOKER	89	MRK2	For m_{L^0}=0.9 GeV	OCCUR=2
none 18.4–27.6	95	[5] ABE	88	VNS		
> 25.5	95	[6] ADACHI	88B	TOPZ		
none 1.5–22.0	95	BEHREND	88C	CELL		
> 41	90	[7] ALBAJAR	87B	UA1		
> 22.5	95	[8] ADEVA	85	MRKJ		
> 18.0	95	[9] BARTEL	83	JADE		
none 4–14.5	95	[10] BERGER	81B	PLUT		
> 15.5	95	[11] BRANDELIK	81	TASS		
> 13.		[12] AZIMOV	80			
> 16.	95	[13] BARBER	80B	CNTR		
> 0.490		[14] ROTHE	69	RVUE		

[1] ACCIARRI 96G assumes LEP result that the associated neutral heavy lepton mass > 40 GeV. NODE=S025MS;LINKAGE=Q

[2] The AHMED 94 limits are from a search for neutral and charged sequential heavy leptons at HERA via the decay channels $L^- \rightarrow e\gamma$, $L^- \rightarrow \nu W^-$, $L^- \rightarrow eZ$; and $L^0 \rightarrow \nu\gamma$, $L^0 \rightarrow e^- W^+$, $L^- \rightarrow \nu Z$, where the W decays to $\ell\nu_\ell$, or to jets, and Z decays to $\ell^+\ell^-$ or jets. NODE=S025MS;LINKAGE=P

[3] RILES 90 limits were the result of a special analysis of the data in the case where the mass difference $m_{L^-} - m_{L^0}$ was allowed to be quite small, where L^0 denotes the neutrino into which the sequential charged lepton decays. With a slightly reduced $m_{L^{\pm}}$ range, the mass difference extends to about 4 GeV. NODE=S025MS;LINKAGE=O

[4] STOKER 89 (Mark II at PEP) gives bounds on charged heavy lepton (L^+) mass for the generalized case in which the corresponding neutral heavy lepton (L^0) in the SU(2) doublet is not of negligible mass. NODE=S025MS;LINKAGE=N

[5] ABE 88 search for L^+ and $L^- \rightarrow$ hadrons looking for acoplanar jets. The bound is valid for $m_\nu < 10$ GeV. NODE=S025MS;LINKAGE=M

[6] ADACHI 88B search for hadronic decays giving acoplanar events with large missing energy. $E_{cm}^{ee} = 52$ GeV. NODE=S025MS;LINKAGE=J

[7] Assumes associated neutrino is approximately massless. NODE=S025MS;LINKAGE=I

[8] ADEVA 85 analyze one-isolated-muon data and sensitive to τ <10 nanosec. Assume B(lepton) = 0.30. E_{cm} = 40–47 GeV. NODE=S025MS;LINKAGE=H

[9] BARTEL 83 limit is from PETRA e^+e^- experiment with average $E_{cm} = 34.2$ GeV. NODE=S025MS;LINKAGE=G

[10] BERGER 81B is DESY DORIS and PETRA experiment. Looking for $e^+e^- \rightarrow L^+L^-$. NODE=S025MS;LINKAGE=D

[11] BRANDELIK 81 is DESY-PETRA experiment. Looking for $e^+e^- \rightarrow L^+L^-$. NODE=S025MS;LINKAGE=E

[12] AZIMOV 80 estimated probabilities for $M+N$ type events in $e^+e^- \rightarrow L^+L^-$ deducing semi-hadronic decay multiplicities of L from e^+e^- annihilation data at $E_{cm} = (2/3)m_L$. Obtained above limit comparing these with e^+e^- data (BRANDELIK 80). NODE=S025MS;LINKAGE=B

[13] BARBER 80B looked for $e^+e^- \rightarrow L^+L^-$, $L \rightarrow \nu_L^+ X$ with MARK-J at DESY-PETRA. NODE=S025MS;LINKAGE=C

[14] ROTHE 69 examines previous data on μ pair production and π and K decays. NODE=S025MS;LINKAGE=A

Stable Charged Heavy Lepton ($L^{\pm}$) MASS LIMITS

NODE=S025MSS
NODE=S025MSS

VALUE (GeV)	CL%	DOCUMENT ID		TECN
>102.6	95	ACHARD	01B	L3
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$>$ 28.2	95	[15] ADACHI	90C	TOPZ
none 18.5–42.8	95	AKRAWY	90O	OPAL
$>$ 26.5	95	DECAMP	90F	ALEP
none m_{μ}–36.3	95	SODERSTROM	90	MRK2

OCCUR=2

[15] ADACHI 90C put lower limits on the mass of stable charged particles with electric charge Q satisfying $2/3 < Q/e < 4/3$ and with spin 0 or 1/2. We list here the special case for a stable charged heavy lepton.

NODE=S025MSS;LINKAGE=A

Charged Long-Lived Heavy Lepton MASS LIMITS

NODE=S025MLL
NODE=S025MLL

VALUE (GeV)	CL%	DOCUMENT ID		TECN	CHG	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>574	95	CHATRCHYAN	13AB	CMS		Leptons singlet model
>102.0	95	ABBIENDI	03L	OPAL		pair produced in e^+e^-
$>$ 0.1		[16] ANSORGE	73B	HBC	−	Long-lived
none 0.55–4.5		[17] BUSHNIN	73	CNTR	−	Long-lived
none 0.2–0.92		[18] BARNA	68	CNTR	−	Long-lived
none 0.97–1.03		[18] BARNA	68	CNTR	−	Long-lived

OCCUR=2

[16] ANSORGE 73B looks for electron pair production and electron-like Bremsstrahlung.

NODE=S025MLL;LINKAGE=X

[17] BUSHNIN 73 is SERPUKHOV 70 GeV p experiment. Masses assume mean life above 7×10^{-10} and 3×10^{-8} respectively. Calculated from cross section (see "Charged Quasi-Stable Lepton Production Differential Cross Section" below) and 30 GeV muon pair production data.

NODE=S025MLL;LINKAGE=Y

[18] BARNA 68 is SLAC photoproduction experiment.

NODE=S025MLL;LINKAGE=W

Doubly-Charged Heavy Lepton MASS LIMITS

NODE=S025MDC
NODE=S025MDC

VALUE (GeV)	CL%	DOCUMENT ID		TECN	CHG
• • • We do not use the following data for averages, fits, limits, etc. • • •					
none 1–9 GeV	90	[19] CLARK	81	SPEC	++

[19] CLARK 81 is FNAL experiment with 209 GeV muons. Bounds apply to μ_P which couples with full weak strength to muon. See also section on "Doubly-Charged Lepton Production Cross Section."

NODE=S025MDC;LINKAGE=Z

Doubly-Charged Lepton Production Cross Section (μN Scattering)

NODE=S025DB

NODE=S025DB

VALUE (cm^2)	EVTS	DOCUMENT ID		TECN	CHG
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<6. \times 10^{-38}$	0	[20] CLARK	81	SPEC	++

[20] CLARK 81 is FNAL experiment with 209 GeV muon. Looked for μ^+ nucleon $\rightarrow \overline{\mu}^0_P X$, $\overline{\mu}^0_P \rightarrow \mu^+\mu^-\overline{\nu}_{\mu}$ and $\mu^+ n \rightarrow \mu^{++}_P X$, $\mu^{++}_P \rightarrow 2\mu^+\nu_{\mu}$. Above limits are for $\sigma \times$BR taken from their mass-dependence plot figure 2.

NODE=S025DB;LINKAGE=A

REFERENCES FOR Heavy Charged Lepton Searches

NODE=S025

CHATRCHYAN	13AB	JHEP 1307 122	S. Chatrchyan *et al.*	(CMS Collab.)	REFID=55042
Also		JHEP 2211 149 (errat.)	S. Chatrchyan *et al.*	(CMS Collab.)	REFID=61972
ABBIENDI	03L	PL B572 8	G. Abbiendi *et al.*	(OPAL Collab.)	REFID=49550
ACHARD	01B	PL B517 75	P. Achard *et al.*	(L3 Collab.)	REFID=48288
ACKERSTAFF	98C	EPJ C1 45	K. Ackerstaff *et al.*	(OPAL Collab.)	REFID=45808
ACCIARRI	96G	PL B377 304	M. Acciarri *et al.*	(L3 Collab.)	REFID=44863
ALEXANDER	96P	PL B385 433	G. Alexander *et al.*	(OPAL Collab.)	REFID=44914
BUSKULIC	96S	PL B384 439	D. Buskulic *et al.*	(ALEPH Collab.)	REFID=44906
AHMED	94	PL B340 205	T. Ahmed *et al.*	(H1 Collab.)	REFID=44044
KIM	91B	IJMP A6 2583	G.N. Kim *et al.*	(AMY Collab.)	REFID=41499
ADACHI	90C	PL B244 352	I. Adachi *et al.*	(TOPAZ Collab.)	REFID=41322
AKRAWY	90G	PL B240 250	M.Z. Akrawy *et al.*	(OPAL Collab.)	REFID=41140
AKRAWY	90O	PL B252 290	M.Z. Akrawy *et al.*	(OPAL Collab.)	REFID=41425
DECAMP	90F	PL B236 511	D. Decamp *et al.*	(ALEPH Collab.)	REFID=41035
RILES	90	PR D42 1	K. Riles *et al.*	(Mark II Collab.)	REFID=41258
SODERSTROM	90	PRL 64 2980	E. Soderstrom *et al.*	(Mark II Collab.)	REFID=41187
STOKER	89	PR D39 1811	D.P. Stoker *et al.*	(Mark II Collab.)	REFID=40837
ABE	88	PRL 61 915	K. Abe *et al.*	(VENUS Collab.)	REFID=40614
ADACHI	88B	PR D37 1339	I. Adachi *et al.*	(TOPAZ Collab.)	REFID=40668
BEHREND	88C	ZPHY C41 7	H.J. Behrend *et al.*	(CELLO Collab.)	REFID=40863
ALBAJAR	87B	PL B185 241	C. Albajar *et al.*	(UA1 Collab.)	REFID=40256
ADEVA	85	PL 152B 439	B. Adeva *et al.*	(Mark-J Collab.)	REFID=10618
Also		PRPL 109 131	B. Adeva *et al.*	(Mark-J Collab.)	REFID=10619
BARTEL	83	PL 123B 353	W. Bartel *et al.*	(JADE Collab.)	REFID=10611
BERGER	81B	PL 99B 489	C. Berger *et al.*	(PLUTO Collab.)	REFID=10322
BRANDELIK	81	PL 99B 163	R. Brandelik *et al.*	(TASSO Collab.)	REFID=10602
CLARK	81	PRL 46 299	A.R. Clark *et al.*	(UCB, LBL, FNAL+)	REFID=10603
Also		PR D25 2762	W.H. Smith *et al.*	(LBL, FNAL, PRIN)	REFID=12174
AZIMOV	80	JETPL 32 664	Y.I. Azimov, V.A. Khoze	(PNPI)	REFID=10597
		Translated from ZETFP 32 677.			
BARBER	80B	PRL 45 1904	D.P. Barber *et al.*	(Mark-J Collab.)	REFID=10598
BRANDELIK	80	PL 92B 199	R. Brandelik *et al.*	(TASSO Collab.)	REFID=10318
ANSORGE	73B	PR D7 26	R.E. Ansorge *et al.*	(CAVE)	REFID=10556
BUSHNIN	73	NP B58 476	Y.B. Bushnin *et al.*	(SERP)	REFID=10561
Also		PL 42B 136	S.V. Golovkin *et al.*	(SERP)	REFID=10562
ROTHE	69	NP B10 241	K.W. Rothe, A.M. Wolsky	(PENN)	REFID=10550
BARNA	68	PR 173 1391	A. Barna *et al.*	(SLAC, STAN)	REFID=10547

OTHER RELATED PAPERS

PERL 81 SLAC-PUB-2752 M.L. Perl (SLAC) REFID=10626
Physics in Collision Conference.