p

$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$ Status: ∗∗∗∗

p MASS

The mass is known much more precisely in u (atomic mass units) than in MeV; see the footnote. The conversion from u to MeV, 1 u = 931.49432±0.00028 MeV, involves the relatively poorly known electronic charge.

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
938.27231±0.00028	[1] COHEN	87	RVUE	1986 CODATA value
• • • We do not use the following data for averages, fits, limits, etc. • • •				
938.2796 ±0.0027	COHEN	73	RVUE	1973 CODATA value

[1] The mass is known much more precisely in u: $m = 1.007276470 \pm 0.000000012$ u.

$\overline{p}$ MASS

See, however, the next entry in the Listings, which establishes the $\overline{p}$ mass much more precisely.

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
938.22 ±0.04 OUR AVERAGE				
938.30 ±0.13	ROBERTS	78	CNTR	
938.229±0.049	ROBERSON	77	CNTR	
938.179±0.058	HU	75	CNTR	Exotic atoms
938.3 ±0.5	BAMBERGER	70	CNTR	

$\overline{p}/p$ MASS RATIO, $m_{\overline{p}}/m_p$

A test of *CPT* invariance. GABRIELSE 90 below measures the ratio of *inertial* masses. For a discussion of what may be inferred about the ratio of $\overline{p}$ and p *gravitational* masses, see ERICSON 90; they obtain an upper bound of 10^{-6}–10^{-7} for violation of the equivalence principle for $\overline{p}$'s.

VALUE	DOCUMENT ID		TECN	COMMENT
0.999999977±0.000000042	[2] GABRIELSE	90	TRAP	Penning trap

[2] GABRIELSE 90 also measures $m_{\overline{p}}/m_{e^-} = 1836.152660 \pm 0.000083$ and $m_p/m_{e^-} = 1836.152680 \pm 0.000088$. Both are completely consistent with the 1986 CODATA (COHEN 87) value for m_p/m_{e^-} of 1836.152701 ± 0.000037. We use the CODATA values of the proton and electron masses (they come from an overall fit to a variety of data on the fundamental constants) and don't try to take into account more recent measurements involving the masses.

$(m_p - m_{\overline{p}})\ /\ m_{\text{average}}$

A test of *CPT* invariance. Calculated from the $\overline{p}/p$ mass ratio, above.

VALUE	DOCUMENT ID
$(2\pm4) \times 10^{-8}$ OUR EVALUATION	

$\left|q_p + q_{\overline{p}}\right|/e$

A test of *CPT* invariance. See also a similar test involving the electron.

VALUE	DOCUMENT ID		TECN
$<2 \times 10^{-5}$	[3] HUGHES	92	RVUE

[3] HUGHES 92 uses recent measurements of Rydberg-energy and cyclotron-frequency ratios.

$|q_p + q_e|/e$

See DYLLA 73 for a summary of experiments on the neutrality of matter.
See also "n CHARGE" in the neutron Listings.

VALUE (units 10^{-21})	DOCUMENT ID		COMMENT
<1.0	[4] DYLLA	73	Neutrality of SF_6
• • • We do not use the following data for averages, fits, limits, etc. • • •			
<0.8	MARINELLI	84	Magnetic levitation

[4] Assumes that $q_n = q_p + q_e$.

p MAGNETIC MOMENT

See the Note on Baryon Magnetic Moments in the Λ Listings.

VALUE (μ_N)	DOCUMENT ID		TECN	COMMENT
2.792847386±0.000000063	COHEN	87	RVUE	1986 CODATA value
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.7928456 ±0.0000011	COHEN	73	RVUE	1973 CODATA value

$\overline{p}$ MAGNETIC MOMENT

A few early results have been omitted.

VALUE (μ_N)	DOCUMENT ID		TECN	COMMENT
−2.800 ±0.008 OUR AVERAGE				
−2.8005±0.0090	KREISSL	88	CNTR	$\overline{p}$ ^{208}Pb 11→ 10 X-ray
−2.817 ±0.048	ROBERTS	78	CNTR	
−2.791 ±0.021	HU	75	CNTR	Exotic atoms

$(\mu_p - |\mu_{\overline{p}}|)\ /\ |\mu_{\mathrm{average}}|$

A test of CPT invariance. Calculated from the p and $\overline{p}$ magnetic moments, above.

VALUE	DOCUMENT ID
$(-2.6\pm2.9)\times10^{-3}$ OUR EVALUATION	

p ELECTRIC DIPOLE MOMENT

A nonzero value is forbidden by both T invariance and P invariance.

VALUE (10^{-23} e cm)	EVTS	DOCUMENT ID		TECN	COMMENT
− 3.7± 6.3		CHO	89	NMR	Tl F molecules
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 400		DZUBA	85	THEO	Uses ^{129}Xe moment
130 ± 200		[5] WILKENING	84		
900 ±1400		[6] WILKENING	84		
700 ± 900	1G	HARRISON	69	MBR	Molecular beam

[5] This WILKENING 84 value includes a finite-size effect and a magnetic effect.
[6] This WILKENING 84 value is more cautious than the other and excludes the finite-size effect, which relies on uncertain nuclear integrals.

p ELECTRIC POLARIZABILITY $\overline{\alpha}_p$

VALUE (10^{-4} fm^3)	DOCUMENT ID		TECN	COMMENT
10.2 ±0.9 OUR AVERAGE				
9.8 ±0.4 ±1.1	HALLIN	93	CNTR	γp Compton scattering
$10.62^{+1.25}_{-1.19}{}^{+1.07}_{-1.03}$	ZIEGER	92	CNTR	γp Compton scattering
10.9 ±2.2 ±1.3	[7] FEDERSPIEL	91	CNTR	γp Compton scattering

[7] FEDERSPIEL 91 obtains for the (static) electric polarizablity α_p, defined in terms of the induced electric dipole moment by $\mathbf{D} = 4\pi\epsilon_0\alpha_p\mathbf{E}$, the value $(7.0\pm2.2\pm1.3)\times10^{-4}$ fm^3.

*CITATION: L. Montanet et al., Physical Review D50, 1173 (1994) and 1995 off-year partial update for the 1996 edition (URL: http://pdg.lbl.gov/)

p MAGNETIC POLARIZABILITY $\overline{\beta}_p$

The electric and magnetic polarizabilities are subject to a dispersion sum-rule constraint $\overline{\alpha} + \overline{\beta} = (14.2 \pm 0.5) \times 10^{-4}$ fm^3.

VALUE (10^{-4} fm^3)	DOCUMENT ID		TECN	COMMENT
4.0 ±0.9 OUR AVERAGE				
4.4 ±0.4 ±1.1	HALLIN	93	CNTR	γp Compton scattering
$3.58^{+1.19}_{-1.25}{}^{+1.03}_{-1.07}$	ZIEGER	92	CNTR	γp Compton scattering
3.3 ±2.2 ±1.3	FEDERSPIEL	91	CNTR	γp Compton scattering

MINIREVIEW GOES HERE

p MEAN LIFE

A test of baryon conservation. See the "p Partial Mean Lives" section below for limits that depend on decay modes. p = proton, n = bound neutron.

LIMIT (years)	PARTICLE	DOCUMENT ID		TECN
>1.6 × 10^{25}	***p, n***	[8,9] EVANS	77	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$>3 \times 10^{23}$	p	[9] DIX	70	CNTR
$>3 \times 10^{23}$	p, n	[9,10] FLEROV	58	

[8] Mean lifetime of nucleons in ^{130}Te nuclei.
[9] Converted to mean life by dividing half-life by ln(2) = 0.693.
[10] Mean lifetime of nucleons in ^{232}Th nuclei.

$\overline{p}$ MEAN LIFE

The best limit by far, that of GOLDEN 79, relies, however, on a number of astrophysical assumptions. The other limits come from direct observations of stored antiprotons. See also "$\overline{p}$ Partial Mean Lives" after "p Partial Mean Lives," below.

LIMIT (years)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>0.28			GABRIELSE	90	TRAP	Penning trap
>0.08	90	1	BELL	79	CNTR	Storage ring
$>1 \times 10^{7}$			GOLDEN	79	SPEC	$\overline{p}/p$, cosmic rays
$>3.7 \times 10^{-3}$			BREGMAN	78	CNTR	Storage ring

p DECAY MODES

For N decays, p and n distinguish proton and neutron partial lifetimes. See also the "Note on Proton Mean Life Limits" in these Full Listings.

The "partial mean life" limits tabulated here are the limits on τ/B_i, where τ is the total mean life and B_i is the branching fraction for the mode in question.

	Mode	Partial mean life (10^{30} years)	Confidence level
	Antilepton + meson		
τ_1	$N \rightarrow e^+ \pi$	> 130 (n), > 550 (p)	90%
τ_2	$N \rightarrow \mu^+ \pi$	> 100 (n), > 270 (p)	90%
τ_3	$N \rightarrow \nu \pi$	> 100 (n), > 25 (p)	90%
τ_4	$p \rightarrow e^+ \eta$	> 140	90%
τ_5	$p \rightarrow \mu^+ \eta$	> 69	90%
τ_6	$n \rightarrow \nu \eta$	> 54	90%
τ_7	$N \rightarrow e^+ \rho$	> 58 (n), > 75 (p)	90%
τ_8	$N \rightarrow \mu^+ \rho$	> 23 (n), > 110 (p)	90%
τ_9	$N \rightarrow \nu \rho$	> 19 (n), > 27 (p)	90%
τ_{10}	$p \rightarrow e^+ \omega$	> 45	90%

τ_{11}	$p \to \mu^+ \omega$	> 57	90%
τ_{12}	$n \to \nu \omega$	> 43	90%
τ_{13}	$N \to e^+ K$	> 1.3 (n), > 150 (p)	90%
τ_{14}	$p \to e^+ K^0_S$	> 76	90%
τ_{15}	$p \to e^+ K^0_L$	> 44	90%
τ_{16}	$N \to \mu^+ K$	> 1.1 (n), > 120 (p)	90%
τ_{17}	$p \to \mu^+ K^0_S$	> 64	90%
τ_{18}	$p \to \mu^+ K^0_L$	> 44	90%
τ_{19}	$N \to \nu K$	> 86 (n), > 100 (p)	90%
τ_{20}	$p \to e^+ K^*(892)^0$	> 52	90%
τ_{21}	$N \to \nu K^*(892)$	> 22 (n), > 20 (p)	90%
	Antilepton + mesons		
τ_{22}	$p \to e^+ \pi^+ \pi^-$	> 21	90%
τ_{23}	$p \to e^+ \pi^0 \pi^0$	> 38	90%
τ_{24}	$n \to e^+ \pi^- \pi^0$	> 32	90%
τ_{25}	$p \to \mu^+ \pi^+ \pi^-$	> 17	90%
τ_{26}	$p \to \mu^+ \pi^0 \pi^0$	> 33	90%
τ_{27}	$n \to \mu^+ \pi^- \pi^0$	> 33	90%
τ_{28}	$n \to e^+ K^0 \pi^-$	> 18	90%
	Lepton + meson		
τ_{29}	$n \to e^- \pi^+$	> 65	90%
τ_{30}	$n \to \mu^- \pi^+$	> 49	90%
τ_{31}	$n \to e^- \rho^+$	> 62	90%
τ_{32}	$n \to \mu^- \rho^+$	> 7	90%
τ_{33}	$n \to e^- K^+$	> 32	90%
τ_{34}	$n \to \mu^- K^+$	> 57	90%
	Lepton + mesons		
τ_{35}	$p \to e^- \pi^+ \pi^+$	> 30	90%
τ_{36}	$n \to e^- \pi^+ \pi^0$	> 29	90%
τ_{37}	$p \to \mu^- \pi^+ \pi^+$	> 17	90%
τ_{38}	$n \to \mu^- \pi^+ \pi^0$	> 34	90%
τ_{39}	$p \to e^- \pi^+ K^+$	> 20	90%
τ_{40}	$p \to \mu^- \pi^+ K^+$	> 5	90%
	Antilepton + photon(s)		
τ_{41}	$p \to e^+ \gamma$	> 460	90%
τ_{42}	$p \to \mu^+ \gamma$	> 380	90%
τ_{43}	$n \to \nu \gamma$	> 24	90%
τ_{44}	$p \to e^+ \gamma \gamma$	> 100	90%
	Three leptons		
τ_{45}	$p \to e^+ e^+ e^-$	> 510	90%
τ_{46}	$p \to e^+ \mu^+ \mu^-$	> 81	90%
τ_{47}	$p \to e^+ \nu \nu$	> 11	90%
τ_{48}	$n \to e^+ e^- \nu$	> 74	90%
τ_{49}	$n \to \mu^+ e^- \nu$	> 47	90%
τ_{50}	$n \to \mu^+ \mu^- \nu$	> 42	90%
τ_{51}	$p \to \mu^+ e^+ e^-$	> 91	90%
τ_{52}	$p \to \mu^+ \mu^+ \mu^-$	> 190	90%
τ_{53}	$p \to \mu^+ \nu \nu$	> 21	90%
τ_{54}	$p \to e^- \mu^+ \mu^+$	> 6	90%
τ_{55}	$n \to 3\nu$	> 0.0005	90%
	Inclusive modes		
τ_{56}	$N \to e^+$ anything	> 0.6 (n, p)	90%
τ_{57}	$N \to \mu^+$ anything	> 12 (n, p)	90%
τ_{58}	$N \to \nu$ anything		
τ_{59}	$N \to e^+ \pi^0$ anything	> 0.6 (n, p)	90%
τ_{60}	$N \to$ 2 bodies, ν-free		

$\Delta B = 2$ dinucleon modes

The following are lifetime limits per iron nucleus.

τ_{61}	$p p \to \pi^+ \pi^+$	> 0.7	90%
τ_{62}	$p n \to \pi^+ \pi^0$	> 2	90%
τ_{63}	$n n \to \pi^+ \pi^-$	> 0.7	90%
τ_{64}	$n n \to \pi^0 \pi^0$	> 3.4	90%
τ_{65}	$p p \to e^+ e^+$	> 5.8	90%
τ_{66}	$p p \to e^+ \mu^+$	> 3.6	90%
τ_{67}	$p p \to \mu^+ \mu^+$	> 1.7	90%
τ_{68}	$p n \to e^+ \overline{\nu}$	> 2.8	90%
τ_{69}	$p n \to \mu^+ \overline{\nu}$	> 1.6	90%
τ_{70}	$n n \to \nu_e \overline{\nu}_e$	> 0.000012	90%
τ_{71}	$n n \to \nu_\mu \overline{\nu}_\mu$	> 0.000006	90%

$\overline{p}$ DECAY MODES

	Mode	Partial mean life (years)	Confidence level
τ_{72}	$\overline{p} \to e^- \gamma$	> 1848	95%
τ_{73}	$\overline{p} \to e^- \pi^0$	> 554	95%
τ_{74}	$\overline{p} \to e^- \eta$	> 171	95%
τ_{75}	$\overline{p} \to e^- K^0_S$	> 29	95%
τ_{76}	$\overline{p} \to e^- K^0_L$	> 9	95%

p PARTIAL MEAN LIVES

The "partial mean life" limits tabulated here are the limits on τ/B_i, where τ is the total mean life for the proton and B_i is the branching fraction for the mode in question.

Decaying particle: p = proton, n = bound neutron. The same event may appear under more than one partial decay mode. Background estimates may be accurate to a factor of two.

$\tau(N \to e^+ \pi)$ — τ_1

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>550	***p***	**90**	**0**	**0.7**	[11] BECKER-SZ...	90	IMB3
>130	***n***	**90**	**0**	**<0.2**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 70	p	90	0	0.5	BERGER	91	FREJ
> 70	n	90	0	≤ 0.1	BERGER	91	FREJ
>260	p	90	0	<0.04	HIRATA	89C	KAMI
>310	p	90	0	0.6	SEIDEL	88	IMB
>100	n	90	0	1.6	SEIDEL	88	IMB
> 1.3	n	90	0		BARTELT	87	SOUD
> 1.3	p	90	0		BARTELT	87	SOUD
>250	p	90	0	0.3	HAINES	86	IMB
> 31	n	90	8	9	HAINES	86	IMB
> 64	p	90	0	<0.4	ARISAKA	85	KAMI
> 26	n	90	0	<0.7	ARISAKA	85	KAMI
> 82	p (free)	90	0	0.2	BLEWITT	85	IMB
>250	p	90	0	0.2	BLEWITT	85	IMB
> 25	n	90	4	4	PARK	85	IMB
> 15	p, n	90	0		BATTISTONI	84	NUSX
> 0.5	p	90	1	0.3	[12] BARTELT	83	SOUD
> 0.5	n	90	1	0.3	[12] BARTELT	83	SOUD
> 5.8	p	90	2		[13] KRISHNA...	82	KOLR
> 5.8	n	90	2		[13] KRISHNA...	82	KOLR
> 0.1	n	90			[14] GURR	67	CNTR

[11] This BECKER-SZENDY 90 result includes data from SEIDEL 88.
[12] Limit based on zero events.
[13] We have calculated 90% CL limit from 1 confined event.
[14] We have converted half-life to 90% CL mean life.

$\tau(N \to \mu^+ \pi)$ τ_2

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>100	***n***	**90**	**0**	**<0.2**	HIRATA	89C	KAMI
>270	***p***	**90**	**0**	**0.5**	SEIDEL	88	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 81	*p*	90	0	0.2	BERGER	91	FREJ
> 35	*n*	90	1	1.0	BERGER	91	FREJ
>230	*p*	90	0	<0.07	HIRATA	89C	KAMI
> 63	*n*	90	0	0.5	SEIDEL	88	IMB
> 76	*p*	90	2	1	HAINES	86	IMB
> 23	*n*	90	8	7	HAINES	86	IMB
> 46	*p*	90	0	<0.7	ARISAKA	85	KAMI
> 20	*n*	90	0	<0.4	ARISAKA	85	KAMI
> 59	*p* (free)	90	0	0.2	BLEWITT	85	IMB
>100	*p*	90	1	0.4	BLEWITT	85	IMB
> 38	*n*	90	1	4	PARK	85	IMB
> 10	*p*, *n*	90	0		BATTISTONI	84	NUSX
> 1.3	*p*, *n*	90	0		ALEKSEEV	81	BAKS

$\tau(N \to \nu \pi)$ τ_3

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
> 25	***p***	**90**	**32**	**32.8**	HIRATA	89C	KAMI
>100	***n***	**90**	**1**	**3**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 13	*n*	90	1	1.2	BERGER	89	FREJ
> 10	*p*	90	11	14	BERGER	89	FREJ
> 6	*n*	90	73	60	HAINES	86	IMB
> 2	*p*	90	16	13	KAJITA	86	KAMI
> 40	*n*	90	0	1	KAJITA	86	KAMI
> 7	*n*	90	28	19	PARK	85	IMB
> 7	*n*	90	0		BATTISTONI	84	NUSX
> 2	*p*	90	≤ 3		BATTISTONI	84	NUSX
> 5.8	*p*	90	1		[15] KRISHNA...	82	KOLR
> 0.3	*p*	90	2		[16] CHERRY	81	HOME
> 0.1	*p*	90			[17] GURR	67	CNTR

[15] We have calculated 90% CL limit from 1 confined event.
[16] We have converted 2 possible events to 90% CL limit.
[17] We have converted half-life to 90% CL mean life.

$\tau(p \to e^+ \eta)$ τ_4

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>140	***p***	**90**	**0**	**<0.04**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 44	*p*	90	0	0.1	BERGER	91	FREJ
>100	*p*	90	0	0.6	SEIDEL	88	IMB
>200	*p*	90	5	3.3	HAINES	86	IMB
> 64	*p*	90	0	<0.8	ARISAKA	85	KAMI
> 64	*p* (free)	90	5	6.5	BLEWITT	85	IMB
>200	*p*	90	5	4.7	BLEWITT	85	IMB
> 1.2	*p*	90	2		[18] CHERRY	81	HOME

[18] We have converted 2 possible events to 90% CL limit.

$\tau(p \to \mu^+ \eta)$ τ_5

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>69	***p***	**90**	**1**	**<0.08**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>26	*p*	90	1	0.8	BERGER	91	FREJ
> 1.3	*p*	90	0	0.7	PHILLIPS	89	HPW
>34	*p*	90	1	1.5	SEIDEL	88	IMB
>46	*p*	90	7	6	HAINES	86	IMB
>26	*p*	90	1	<0.8	ARISAKA	85	KAMI
>17	*p* (free)	90	6	6	BLEWITT	85	IMB
>46	*p*	90	7	8	BLEWITT	85	IMB

$\tau(n \rightarrow \nu\eta)$ τ_6

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>54	***n***	**90**	**2**	**0.9**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>29	*n*	90	0	0.9	BERGER	89	FREJ
>16	*n*	90	3	2.1	SEIDEL	88	IMB
>25	*n*	90	7	6	HAINES	86	IMB
>30	*n*	90	0	0.4	KAJITA	86	KAMI
>18	*n*	90	4	3	PARK	85	IMB
> 0.6	*n*	90	2		[19] CHERRY	81	HOME

[19] We have converted 2 possible events to 90% CL limit.

$\tau(N \rightarrow e^+\rho)$ τ_7

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>75	***p***	**90**	**2**	**2.7**	HIRATA	89C	KAMI
>58	***n***	**90**	**0**	**1.9**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>29	*p*	90	0	2.2	BERGER	91	FREJ
>41	*n*	90	0	1.4	BERGER	91	FREJ
>38	*n*	90	2	4.1	SEIDEL	88	IMB
> 1.2	*p*	90	0		BARTELT	87	SOUD
> 1.5	*n*	90	0		BARTELT	87	SOUD
>17	*p*	90	7	7	HAINES	86	IMB
>14	*n*	90	9	4	HAINES	86	IMB
>12	*p*	90	0	<1.2	ARISAKA	85	KAMI
> 6	*n*	90	2	<1	ARISAKA	85	KAMI
> 6.7	*p* (free)	90	6	6	BLEWITT	85	IMB
>17	*p*	90	7	7	BLEWITT	85	IMB
>12	*n*	90	4	2	PARK	85	IMB
> 0.6	*n*	90	1	0.3	[20] BARTELT	83	SOUD
> 0.5	*p*	90	1	0.3	[20] BARTELT	83	SOUD
> 9.8	*p*	90	1		[21] KRISHNA...	82	KOLR
> 0.8	*p*	90	2		[22] CHERRY	81	HOME

[20] Limit based on zero events.
[21] We have calculated 90% CL limit from 0 confined events.
[22] We have converted 2 possible events to 90% CL limit.

$\tau(N \rightarrow \mu^+\rho)$ τ_8

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>110	***p***	**90**	**0**	**1.7**	HIRATA	89C	KAMI
> 23	***n***	**90**	**1**	**1.8**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 12	*p*	90	0	0.5	BERGER	91	FREJ
> 22	*n*	90	0	1.1	BERGER	91	FREJ
> 4.3	*p*	90	0	0.7	PHILLIPS	89	HPW
> 30	*p*	90	0	0.5	SEIDEL	88	IMB
> 11	*n*	90	1	1.1	SEIDEL	88	IMB
> 16	*p*	90	4	4.5	HAINES	86	IMB
> 7	*n*	90	6	5	HAINES	86	IMB
> 12	*p*	90	0	<0.7	ARISAKA	85	KAMI
> 5	*n*	90	1	<1.2	ARISAKA	85	KAMI
> 5.5	*p* (free)	90	4	5	BLEWITT	85	IMB
> 16	*p*	90	4	5	BLEWITT	85	IMB
> 9	*n*	90	1	2	PARK	85	IMB

$\tau(N \rightarrow \nu\rho)$ τ_9

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>27	***p***	**90**	**5**	**1.5**	HIRATA	89C	KAMI
>19	***n***	**90**	**0**	**0.5**	SEIDEL	88	IMB

• • • We do not use the following data for averages, fits, limits, etc. • • •

>9	n	90	4	2.4	BERGER	89	FREJ
>24	p	90	0	0.9	BERGER	89	FREJ
>13	n	90	4	3.6	HIRATA	89C	KAMI
>13	p	90	1	1.1	SEIDEL	88	IMB
>8	p	90	6	5	HAINES	86	IMB
>2	n	90	15	10	HAINES	86	IMB
>11	p	90	2	1	KAJITA	86	KAMI
>4	n	90	2	2	KAJITA	86	KAMI
>4.1	p (free)	90	6	7	BLEWITT	85	IMB
>8.4	p	90	6	5	BLEWITT	85	IMB
>2	n	90	7	3	PARK	85	IMB
>0.9	p	90	2		[23] CHERRY	81	HOME
>0.6	n	90	2		[23] CHERRY	81	HOME

[23] We have converted 2 possible events to 90% CL limit.

$\tau(p \to e^+ \omega)$ — τ_{10}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>45	***p***	**90**	**2**	**1.45**	HIRATA	89C	KAMI

• • • We do not use the following data for averages, fits, limits, etc. • • •

>17	p	90	0	1.1	BERGER	91	FREJ
>26	p	90	1	1.0	SEIDEL	88	IMB
>1.5	p	90	0		BARTELT	87	SOUD
>37	p	90	6	5.3	HAINES	86	IMB
>25	p	90	1	<1.4	ARISAKA	85	KAMI
>12	p (free)	90	6	7.5	BLEWITT	85	IMB
>37	p	90	6	5.7	BLEWITT	85	IMB
>0.6	p	90	1	0.3	[24] BARTELT	83	SOUD
>9.8	p	90	1		[25] KRISHNA...	82	KOLR
>2.8	p	90	2		[26] CHERRY	81	HOME

[24] Limit based on zero events.
[25] We have calculated 90% CL limit from 0 confined events.
[26] We have converted 2 possible events to 90% CL limit.

$\tau(p \to \mu^+ \omega)$ — τ_{11}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>57	***p***	**90**	**2**	**1.9**	HIRATA	89C	KAMI

• • • We do not use the following data for averages, fits, limits, etc. • • •

>11	p	90	0	1.0	BERGER	91	FREJ
>4.4	p	90	0	0.7	PHILLIPS	89	HPW
>10	p	90	2	1.3	SEIDEL	88	IMB
>23	p	90	2	1	HAINES	86	IMB
>6.5	p (free)	90	9	8.7	BLEWITT	85	IMB
>23	p	90	8	7	BLEWITT	85	IMB

$\tau(n \to \nu \omega)$ — τ_{12}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>43	***n***	**90**	**3**	**2.7**	HIRATA	89C	KAMI

• • • We do not use the following data for averages, fits, limits, etc. • • •

>17	n	90	1	0.7	BERGER	89	FREJ
>6	n	90	2	1.3	SEIDEL	88	IMB
>12	n	90	6	6	HAINES	86	IMB
>18	n	90	2	2	KAJITA	86	KAMI
>16	n	90	1	2	PARK	85	IMB
>2.0	n	90	2		[27] CHERRY	81	HOME

[27] We have converted 2 possible events to 90% CL limit.

$\tau(N \to e^+ K)$ — τ_{13}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>150	***p***	**90**	**0**	**<0.27**	HIRATA	89C	KAMI
>1.3	***n***	**90**	**0**		ALEKSEEV	81	BAKS

• • • We do not use the following data for averages, fits, limits, etc. • • •

> 60	p	90	0		BERGER	91	FREJ
> 70	p	90	0	1.8	SEIDEL	88	IMB
> 77	p	90	5	4.5	HAINES	86	IMB
> 38	p	90	0	<0.8	ARISAKA	85	KAMI
> 24	p (free)	90	7	8.5	BLEWITT	85	IMB
> 77	p	90	5	4	BLEWITT	85	IMB
> 1.3	p	90	0		ALEKSEEV	81	BAKS

$\tau(p \to e^+ K^0_S)$ τ_{14}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>76	***p***	**90**	**0**	**0.5**	BERGER	91	FREJ

$\tau(p \to e^+ K^0_L)$ τ_{15}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>44	***p***	**90**	**0**	**≤ 0.1**	BERGER	91	FREJ

$\tau(N \to \mu^+ K)$ τ_{16}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>120	***p***	**90**	**1**	**0.4**	HIRATA	89C	KAMI
> 1.1	***n***	**90**	**0**		BARTELT	87	SOUD
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 54	p	90	0		BERGER	91	FREJ
> 3.0	p	90	0	0.7	PHILLIPS	89	HPW
> 19	p	90	3	2.5	SEIDEL	88	IMB
> 1.5	p	90	0		[28] BARTELT	87	SOUD
> 40	p	90	7	6	HAINES	86	IMB
> 19	p	90	1	<1.1	ARISAKA	85	KAMI
> 6.7	p (free)	90	11	13	BLEWITT	85	IMB
> 40	p	90	7	8	BLEWITT	85	IMB
> 6	p	90	1		BATTISTONI	84	NUSX
> 0.6	p	90	0		[29] BARTELT	83	SOUD
> 0.4	n	90	0		[29] BARTELT	83	SOUD
> 5.8	p	90	2		[30] KRISHNA...	82	KOLR
> 2.0	p	90	0		CHERRY	81	HOME
> 0.2	n	90			[31] GURR	67	CNTR

[28] BARTELT 87 limit applies to $p \to \mu^+ K^0_S$.

[29] Limit based on zero events.

[30] We have calculated 90% CL limit from 1 confined event.

[31] We have converted half-life to 90% CL mean life.

$\tau(p \to \mu^+ K^0_S)$ τ_{17}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>64	***p***	**90**	**0**	**1.2**	BERGER	91	FREJ

$\tau(p \to \mu^+ K^0_L)$ τ_{18}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>44	***p***	**90**	**0**	**≤ 0.1**	BERGER	91	FREJ

$\tau(N \to \nu K)$ τ_{19}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>100	***p***	**90**	**9**	**7.3**	HIRATA	89C	KAMI
> 86	***n***	**90**	**0**	**2.4**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 15	n	90	1	1.8	BERGER	89	FREJ
> 15	p	90	1	1.8	BERGER	89	FREJ
> 0.28	p	90	0	0.7	PHILLIPS	89	HPW
> 0.3	p	90	0		BARTELT	87	SOUD
> 0.75	n	90	0		[32] BARTELT	87	SOUD
> 10	p	90	6	5	HAINES	86	IMB
> 15	n	90	3	5	HAINES	86	IMB
> 28	p	90	3	3	KAJITA	86	KAMI
> 32	n	90	0	1.4	KAJITA	86	KAMI

> 1.8	p (free)	90	6	11	BLEWITT	85	IMB
> 9.6	p	90	6	5	BLEWITT	85	IMB
> 10	n	90	2	2	PARK	85	IMB
> 5	n	90	0		BATTISTONI	84	NUSX
> 2	p	90	0		BATTISTONI	84	NUSX
> 0.3	n	90	0		[33] BARTELT	83	SOUD
> 0.1	p	90	0		[33] BARTELT	83	SOUD
> 5.8	p	90	1		[34] KRISHNA...	82	KOLR
> 0.3	n	90	2		[35] CHERRY	81	HOME

[32] BARTELT 87 limit applies to $n \rightarrow \nu K^0_S$.

[33] Limit based on zero events.

[34] We have calculated 90% CL limit from 1 confined event.

[35] We have converted 2 possible events to 90% CL limit.

$\tau(p \rightarrow e^+ K^*(892)^0)$ τ_{20}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>52	**p**	**90**	**2**	**1.55**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>10	p	90	0	0.8	BERGER	91	FREJ
>10	p	90	1	<1	ARISAKA	85	KAMI

$\tau(N \rightarrow \nu K^*(892))$ τ_{21}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>22	**n**	**90**	**0**	**2.1**	BERGER	89	FREJ
>20	**p**	**90**	**5**	**2.1**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>17	p	90	0	2.4	BERGER	89	FREJ
>21	n	90	4	2.4	HIRATA	89C	KAMI
>10	p	90	7	6	HAINES	86	IMB
> 5	n	90	8	7	HAINES	86	IMB
> 8	p	90	3	2	KAJITA	86	KAMI
> 6	n	90	2	1.6	KAJITA	86	KAMI
> 5.8	p (free)	90	10	16	BLEWITT	85	IMB
> 9.6	p	90	7	6	BLEWITT	85	IMB
> 7	n	90	1	4	PARK	85	IMB
> 2.1	p	90	1		[36] BATTISTONI	82	NUSX

[36] We have converted 1 possible event to 90% CL limit.

$\tau(p \rightarrow e^+ \pi^+ \pi^-)$ τ_{22}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>21	**p**	**90**	**0**	**2.2**	BERGER	91	FREJ

$\tau(p \rightarrow e^+ \pi^0 \pi^0)$ τ_{23}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>38	**p**	**90**	**1**	**0.5**	BERGER	91	FREJ

$\tau(n \rightarrow e^+ \pi^- \pi^0)$ τ_{24}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>32	**n**	**90**	**1**	**0.8**	BERGER	91	FREJ

$\tau(p \rightarrow \mu^+ \pi^+ \pi^-)$ τ_{25}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>17	**p**	**90**	**1**	**2.6**	BERGER	91	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 3.3	p	90	0	0.7	PHILLIPS	89	HPW

$\tau(p \rightarrow \mu^+ \pi^0 \pi^0)$ τ_{26}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>33	**p**	**90**	**1**	**0.9**	BERGER	91	FREJ

$\tau(n \to \mu^+ \pi^- \pi^0)$ τ_{27}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>33	***n***	**90**	**0**	**1.1**	BERGER	91	FREJ

$\tau(n \to e^+ K^0 \pi^-)$ τ_{28}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>18	***n***	**90**	**1**	**0.2**	BERGER	91	FREJ

$\tau(n \to e^- \pi^+)$ τ_{29}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>65	***n***	**90**	**0**	**1.6**	SEIDEL	88	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>55	*n*	90	0	1.09	BERGER	91B	FREJ
>16	*n*	90	9	7	HAINES	86	IMB
>25	*n*	90	2	4	PARK	85	IMB

$\tau(n \to \mu^- \pi^+)$ τ_{30}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>49	***n***	**90**	**0**	**0.5**	SEIDEL	88	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>33	*n*	90	0	1.40	BERGER	91B	FREJ
> 2.7	*n*	90	0	0.7	PHILLIPS	89	HPW
>25	*n*	90	7	6	HAINES	86	IMB
>27	*n*	90	2	3	PARK	85	IMB

$\tau(n \to e^- \rho^+)$ τ_{31}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>62	***n***	**90**	**2**	**4.1**	SEIDEL	88	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>12	*n*	90	13	6	HAINES	86	IMB
>12	*n*	90	5	3	PARK	85	IMB

$\tau(n \to \mu^- \rho^+)$ τ_{32}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>7	***n***	**90**	**1**	**1.1**	SEIDEL	88	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>2.6	*n*	90	0	0.7	PHILLIPS	89	HPW
>9	*n*	90	7	5	HAINES	86	IMB
>9	*n*	90	2	2	PARK	85	IMB

$\tau(n \to e^- K^+)$ τ_{33}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>32	***n***	**90**	**3**	**2.96**	BERGER	91B	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 0.23	*n*	90	0	0.7	PHILLIPS	89	HPW

$\tau(n \to \mu^- K^+)$ τ_{34}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>57	***n***	**90**	**0**	**2.18**	BERGER	91B	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 4.7	*n*	90	0	0.7	PHILLIPS	89	HPW

$\tau(p \to e^- \pi^+ \pi^+)$ τ_{35}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>30	***p***	**90**	**1**	**2.50**	BERGER	91B	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 2.0	*p*	90	0	0.7	PHILLIPS	89	HPW

$\tau(n \to e^- \pi^+ \pi^0)$ — τ_{36}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>29	***n***	**90**	**1**	**0.78**	BERGER	91B	FREJ

$\tau(p \to \mu^- \pi^+ \pi^+)$ — τ_{37}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>17	***p***	**90**	**1**	**1.72**	BERGER	91B	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 7.8	*p*	90	0	0.7	PHILLIPS	89	HPW

$\tau(n \to \mu^- \pi^+ \pi^0)$ — τ_{38}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>34	***n***	**90**	**0**	**0.78**	BERGER	91B	FREJ

$\tau(p \to e^- \pi^+ K^+)$ — τ_{39}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>20	***p***	**90**	**3**	**2.50**	BERGER	91B	FREJ

$\tau(p \to \mu^- \pi^+ K^+)$ — τ_{40}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>5	***p***	**90**	**2**	**0.78**	BERGER	91B	FREJ

$\tau(p \to e^+ \gamma)$ — τ_{41}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>460	***p***	**90**	**0**	**0.6**	SEIDEL	88	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>133	*p*	90	0	0.3	BERGER	91	FREJ
>360	*p*	90	0	0.3	HAINES	86	IMB
> 87	*p* (free)	90	0	0.2	BLEWITT	85	IMB
>360	*p*	90	0	0.2	BLEWITT	85	IMB
> 0.1	*p*	90			[37] GURR	67	CNTR

[37] We have converted half-life to 90% CL mean life.

$\tau(p \to \mu^+ \gamma)$ — τ_{42}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>380	***p***	**90**	**0**	**0.5**	SEIDEL	88	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>155	*p*	90	0	0.1	BERGER	91	FREJ
> 97	*p*	90	3	2	HAINES	86	IMB
> 61	*p* (free)	90	0	0.2	BLEWITT	85	IMB
>280	*p*	90	0	0.6	BLEWITT	85	IMB
> 0.3	*p*	90			[38] GURR	67	CNTR

[38] We have converted half-life to 90% CL mean life.

$\tau(n \to \nu \gamma)$ — τ_{43}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>24	***n***	**90**	**10**	**6.86**	BERGER	91B	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 9	*n*	90	73	60	HAINES	86	IMB
>11	*n*	90	28	19	PARK	85	IMB

$\tau(p \to e^+ \gamma\gamma)$ — τ_{44}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>100	***p***	**90**	**1**	**0.8**	BERGER	91	FREJ

$\tau(p \rightarrow e^+ e^+ e^-)$ τ_{45}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>510	***p***	**90**	**0**	**0.3**	HAINES	86	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>147	*p*	90	0	0.1	BERGER	91	FREJ
> 89	*p* (free)	90	0	0.5	BLEWITT	85	IMB
>510	*p*	90	0	0.7	BLEWITT	85	IMB

$\tau(p \rightarrow e^+ \mu^+ \mu^-)$ τ_{46}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>81	***p***	**90**	**0**	**0.16**	BERGER	91	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 5.0	*p*	90	0	0.7	PHILLIPS	89	HPW

$\tau(p \rightarrow e^+ \nu\nu)$ τ_{47}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>11	***p***	**90**	**11**	**6.08**	BERGER	91B	FREJ

$\tau(n \rightarrow e^+ e^- \nu)$ τ_{48}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>74	***n***	**90**	**0**	**< 0.1**	BERGER	91B	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>45	*n*	90	5	5	HAINES	86	IMB
>26	*n*	90	4	3	PARK	85	IMB

$\tau(n \rightarrow \mu^+ e^- \nu)$ τ_{49}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>47	***n***	**90**	**0**	**< 0.1**	BERGER	91B	FREJ

$\tau(n \rightarrow \mu^+ \mu^- \nu)$ τ_{50}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>42	***n***	**90**	**0**	**1.4**	BERGER	91B	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 5.1	*n*	90	0	0.7	PHILLIPS	89	HPW
>16	*n*	90	14	7	HAINES	86	IMB
>19	*n*	90	4	7	PARK	85	IMB

$\tau(p \rightarrow \mu^+ e^+ e^-)$ τ_{51}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>91	***p***	**90**	**0**	**≤ 0.1**	BERGER	91	FREJ

$\tau(p \rightarrow \mu^+ \mu^+ \mu^-)$ τ_{52}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>190	***p***	**90**	**1**	**0.1**	HAINES	86	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>119	*p*	90	0	0.2	BERGER	91	FREJ
> 10.5	*p*	90	0	0.7	PHILLIPS	89	HPW
> 44	*p* (free)	90	1	0.7	BLEWITT	85	IMB
>190	*p*	90	1	0.9	BLEWITT	85	IMB
> 2.1	*p*	90	1		[39] BATTISTONI	82	NUSX

[39] We have converted 1 possible event to 90% CL limit.

$\tau(p \rightarrow \mu^+ \nu\nu)$ τ_{53}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>21	***p***	**90**	**7**	**11.23**	BERGER	91B	FREJ

$\tau(p \rightarrow e^- \mu^+ \mu^+)$ τ_{54}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>6.0	***p***	**90**	**0**	**0.7**	PHILLIPS	89	HPW

$\tau(n \to 3\nu)$ τ55

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>0.00049	***n***	**90**	**2**	**2**	[40] SUZUKI	93B	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>0.00003	*n*	90	11	6.1	[41] BERGER	91B	FREJ
>0.00012	*n*	90	7	11.2	[41] BERGER	91B	FREJ
>0.0005	*n*	90	0		LEARNED	79	RVUE

[40] The SUZUKI 93B limit applies to any of $\nu_e \nu_e \overline{\nu}_e$, $\nu_\mu \nu_\mu \overline{\nu}_\mu$, or $\nu_\tau \nu_\tau \overline{\nu}_\tau$.

[41] The first BERGER 91B limit is for $n \to \nu_e \nu_e \overline{\nu}_e$, the second is for $n \to \nu_\mu \nu_\mu \overline{\nu}_\mu$.

$\tau(N \to e^+ \text{ anything})$ τ56

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>0.6	***p, n***	**90**			[42] LEARNED	79	RVUE

[42] The electron may be primary or secondary.

$\tau(N \to \mu^+ \text{ anything})$ τ57

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>12	***p, n***	**90**	**2**		[43,44] CHERRY	81	HOME
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 1.8	*p, n*	90			[44] COWSIK	80	CNTR
> 6	*p, n*	90			[44] LEARNED	79	RVUE

[43] We have converted 2 possible events to 90% CL limit.

[44] The muon may be primary or secondary.

$\tau(N \to \nu \text{ anything})$ τ58

Anything = π, ρ, K, etc.

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>0.0002	*p, n*	90	0		LEARNED	79	RVUE

$\tau(N \to e^+ \pi^0 \text{ anything})$ τ59

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>0.6	***p, n***	**90**	**0**		LEARNED	79	RVUE

$\tau(N \to 2 \text{ bodies}, \nu\text{-free})$ τ60

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>1.3	*p, n*	90	0		ALEKSEEV	81	BAKS

$\tau(pp \to \pi^+ \pi^+)$ τ61

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>0.7	**90**	**4**	**2.34**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(pn \to \pi^+ \pi^0)$ τ62

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>2.0	**90**	**0**	**0.31**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(nn \to \pi^+ \pi^-)$ τ63

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>0.7	**90**	**4**	**2.18**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(nn \to \pi^0 \pi^0)$ τ64

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>3.4	**90**	**0**	**0.78**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(pp \to e^+ e^+)$ τ65

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>5.8	**90**	**0**	**<0.1**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(pp \to e^+\mu^+)$ τ66

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>3.6	**90**	**0**	**<0.1**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(pp \to \mu^+\mu^+)$ τ67

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>1.7	**90**	**0**	**0.62**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(pn \to e^+\overline{\nu})$ τ68

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>2.8	**90**	**5**	**9.67**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(pn \to \mu^+\overline{\nu})$ τ69

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>1.6	**90**	**4**	**4.37**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(nn \to \nu_e\overline{\nu}_e)$ τ70

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>0.000012	**90**	**5**	**9.7**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(nn \to \nu_\mu\overline{\nu}_\mu)$ τ71

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>0.000006	**90**	**4**	**4.4**	BERGER	91B	FREJ	τ per iron nucleus

$\overline{p}$ PARTIAL MEAN LIVES

The "partial mean life" limits tabulated here are the limits on $\overline{\tau}/\mathrm{B}_i$, where $\overline{\tau}$ is the total mean life for the antiproton and B_i is the branching fraction for the mode in question.

$\tau(\overline{p} \to e^-\gamma)$ τ72

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>1848	95	GEER	94	CALO	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to e^-\pi^0)$ τ73

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>554	95	GEER	94	CALO	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to e^-\eta)$ τ74

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>171	95	GEER	94	CALO	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to e^-K^0_S)$ τ75

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>29	95	GEER	94	CALO	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to e^-K^0_L)$ τ76

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>9	95	GEER	94	CALO	8.9 GeV/c $\overline{p}$ beam

p REFERENCES

GEER	94	PRL 72 1596	+Marriner, Ray+	(FNAL, UCLA, PSU)
HALLIN	93	PR C48 1497	+Amendt, Bergstrom+	(SASK, BOST, ILL)
SUZUKI	93B	PL B311 357	+Fukuda, Hirata, Inoue+	(KAMIOKANDE Collab.)
HUGHES	92	PRL 69 578	+Deutch	(LANL, AARH)
ZIEGER	92	PL B278 34	+Van de Vyver, Christmann, DeGraeve+	(MPCM)
Also	92B	PL B281 417 (erratum)	Zieger, ..., Van den Abeele, Ziegler	(MPCM)
BERGER	91	ZPHY C50 385	+Froehlich, Moench, Nisius+	(FREJUS Collab.)
BERGER	91B	PL B269 227	+Froehlich, Moench, Nisius+	(FREJUS Collab.)
FEDERSPIEL	91	PRL 67 1511	+Eisenstein, Lucas, MacGibbon+	(ILL)
BECKER-SZ...	90	PR D42 2974	Becker-Szendy, Bratton, Cady, Casper+	(IMB-3 Collab.)
ERICSON	90	EPL 11 295	+Richter	(CERN, DARM)
GABRIELSE	90	PRL 65 1317	+Fei, Orozco, Tjoelker+	(HARV, MANZ, WASH, IBS)
BERGER	89	NP B313 509	+Froehlich, Moench+	(FREJUS Collab.)
CHO	89	PRL 63 2559	+Sangster, Hinds	(YALE)
HIRATA	89C	PL B220 308	+Kajita, Kifune, Kihara+	(Kamiokande Collab.)
PHILLIPS	89	PL B224 348	+Matthews, Aprile, Cline+	(HPW Collab.)
KREISSL	88	ZPHY C37 557	+Hancock, Koch, Koehler, Poth+	(CERN PS176 Collab.)
SEIDEL	88	PRL 61 2522	+Bionta, Blewitt, Bratton+	(IMB Collab.)
BARTELT	87	PR D36 1990	+Courant, Heller+	(Soudan Collab.)
Also	89	PR D40 1701 erratum	Bartelt, Courant, Heller+	(Soudan Collab.)
COHEN	87	RMP 59 1121	+Taylor	(RISC, NBS)
HAINES	86	PRL 57 1986	+Bionta, Blewitt, Bratton, Casper+	(IMB Collab.)
KAJITA	86	JPSJ 55 711	+Arisaka, Koshiba, Nakahata+	(Kamiokande Collab.)
ARISAKA	85	JPSJ 54 3213	+Kajita, Koshiba, Nakahata+	(Kamiokande Collab.)
BLEWITT	85	PRL 55 2114	+LoSecco, Bionta, Bratton+	(IMB Collab.)
DZUBA	85	PL 154B 93	+Flambaum, Silvestrov	(NOVO)
PARK	85	PRL 54 22	+Blewitt, Cortez, Foster+	(IMB Collab.)
BATTISTONI	84	PL 133B 454	+Bellotti, Bologna, Campana+	(NUSEX Collab.)
MARINELLI	84	PL 137B 439	+Morpurgo	(GENO)
WILKENING	84	PR A29 425	+Ramsey, Larson	(HARV, VIRG)
BARTELT	83	PRL 50 651	+Courant, Heller, Joyce, Marshak+	(MINN, ANL)
BATTISTONI	82	PL 118B 461	+Bellotti, Bologna, Campana+	(NUSEX Collab.)
KRISHNA...	82	PL 115B 349	Krishnaswamy, Menon+	(TATA, OSKC, INUS)
ALEKSEEV	81	JETPL 33 651	+Bakatanov, Butkevich, Voevodskii+	(PNPI)
		Translated from ZETFP 33 664.		
CHERRY	81	PRL 47 1507	+Deakyne, Lande, Lee, Steinberg+	(PENN, BNL)
COWSIK	80	PR D22 2204	+Narasimhan	(TATA)
BELL	79	PL 86B 215	+Calvetti, Carron, Chaney, Cittolin+	(CERN)
GOLDEN	79	PRL 43 1196	+Horan, Mauger, Badhwar, Lacy+	(NASA, PSLL)
LEARNED	79	PRL 43 907	+Reines, Soni	(UCI)
BREGMAN	78	PL 78B 174	+Calvetti, Carron, Cittolin, Hauer, Herr+	(CERN)
ROBERTS	78	PR D17 358		(WILL, RHEL)
EVANS	77	Science 197 989	+Steinberg	(BNL, PENN)
ROBERSON	77	PR C16 1945	+King, Kunselman+	(WYOM, CIT, CMU, VPI, WILL)
HU	75	NP A254 403	+Asano, Chen, Cheng, Dugan+	(COLU, YALE)
COHEN	73	JPCRD 2 663	+Taylor	(RISC, NBS)
DYLLA	73	PR A7 1224	+King	(MIT)
BAMBERGER	70	PL 33B 233	+Lynen, Piekarz+	(MPIH, CERN, KARL)
DIX	70	Thesis Case		(CASE)
HARRISON	69	PRL 22 1263	+Sandars, Wright	(OXF)
GURR	67	PR 158 1321	+Kropp, Reines, Meyer	(CASE, WITW)
FLEROV	58	DOKL 3 79	+Klochkov, Skobkin, Terentev	(ASCI)