



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

p MASS (atomic mass units u)

The mass is known much more precisely in u (atomic mass units) than in MeV. See the next data block.

<u>VALUE (u)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.007276466812 ± 0.000000000090	MOHR	12	RVUE 2010 CODATA value
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1.00727646677 ± 0.00000000010	MOHR	08	RVUE 2006 CODATA value
1.00727646688 ± 0.00000000013	MOHR	05	RVUE 2002 CODATA value
1.00727646688 ± 0.00000000013	MOHR	99	RVUE 1998 CODATA value
1.007276470 ± 0.0000000012	COHEN	87	RVUE 1986 CODATA value

p MASS (MeV)

The mass is known much more precisely in u (atomic mass units) than in MeV. The conversion from u to MeV, $1 u = 931.494\,061(21) \text{ MeV}/c^2$ (MOHR 12, the 2010 CODATA value), involves the relatively poorly known electronic charge.

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
938.272046 ± 0.000021	MOHR	12	RVUE 2010 CODATA value
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
938.272013 ± 0.000023	MOHR	08	RVUE 2006 CODATA value
938.272029 ± 0.000080	MOHR	05	RVUE 2002 CODATA value
938.271998 ± 0.000038	MOHR	99	RVUE 1998 CODATA value
938.27231 ± 0.00028	COHEN	87	RVUE 1986 CODATA value
938.2796 ± 0.0027	COHEN	73	RVUE 1973 CODATA value

$$|m_p - m_{\bar{p}}|/m_p$$

A test of *CPT* invariance. Note that the comparison of the \bar{p} and p charge-to-mass ratio, given in the next data block, is much better determined.

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<7 × 10⁻¹⁰	90	1 HORI	11	SPEC $\bar{p}e^-$ He atom
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
<2 × 10 ⁻⁹	90	1 HORI	06	SPEC $\bar{p}e^-$ He atom
<1.0 × 10 ⁻⁸	90	1 HORI	03	SPEC $\bar{p}e^-$ ⁴ He, $\bar{p}e^-$ ³ He
<6 × 10 ⁻⁸	90	1 HORI	01	SPEC $\bar{p}e^-$ He atom
<5 × 10 ⁻⁷		2 TORII	99	SPEC $\bar{p}e^-$ He atom

¹ HORI 01, HORI 03, HORI 06, and HORI 11 use the more-precisely-known constraint on the \bar{p} charge-to-mass ratio of GABRIELSE 99 (see below) to get their results. Their results are not independent of the HORI 01, HORI 03, HORI 06, and HORI 11 values for $|q_p + q_{\bar{p}}|/e$, below.

² TORII 99 uses the more-precisely-known constraint on the \bar{p} charge-to-mass ratio of GABRIELSE 95 (see below) to get this result. This is not independent of the TORII 99 value for $|q_p + q_{\bar{p}}|/e$, below.

\bar{p}/p CHARGE-TO-MASS RATIO, $|\frac{q_{\bar{p}}}{m_{\bar{p}}}|/(\frac{q_p}{m_p})$

A test of *CPT* invariance. Listed here are measurements involving the *inertial* masses. For a discussion of what may be inferred about the ratio of \bar{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 \bar{p} 's.

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.99999999991 ± 0.00000000009	GABRIELSE 99	TRAP	Penning trap
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1.0000000015 ± 0.0000000011	³ GABRIELSE 95	TRAP	Penning trap
1.000000023 ± 0.000000042	⁴ GABRIELSE 90	TRAP	Penning trap

³ Equation (2) of GABRIELSE 95 should read $M(\bar{p})/M(p) = 0.999\,999\,9985$ (11) (G. Gabrielse, private communication).

⁴ GABRIELSE 90 also measures $m_{\bar{p}}/m_{e^-} = 1836.152660 \pm 0.000083$ 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 .

$(|\frac{q_{\bar{p}}}{m_{\bar{p}}}| - \frac{q_p}{m_p})/ \frac{q_p}{m_p}$

A test of *CPT* invariance. Taken from the \bar{p}/p charge-to-mass ratio, above.

<u>VALUE</u>	<u>DOCUMENT ID</u>
(-9 ± 9) × 10⁻¹¹ OUR EVALUATION	

$|q_p + q_{\bar{p}}|/e$

A test of *CPT* invariance. Note that the comparison of the \bar{p} and p charge-to-mass ratios given above is much better determined. See also a similar test involving the electron.

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<7 × 10⁻¹⁰	90	⁵ HORI 11	SPEC	$\bar{p}e^-$ He atom
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
<2 × 10 ⁻⁹	90	⁵ HORI 06	SPEC	$\bar{p}e^-$ He atom
<1.0 × 10 ⁻⁸	90	⁵ HORI 03	SPEC	$\bar{p}e^-$ ⁴ He, $\bar{p}e^-$ ³ He
<6 × 10 ⁻⁸	90	⁵ HORI 01	SPEC	$\bar{p}e^-$ He atom
<5 × 10 ⁻⁷		⁶ TORII 99	SPEC	$\bar{p}e^-$ He atom
<2 × 10 ⁻⁵		⁷ HUGHES 92	RVUE	

⁵ HORI 01, HORI 03, HORI 06, and HORI 11 use the more-precisely-known constraint on the \bar{p} charge-to-mass ratio of GABRIELSE 99 (see above) to get their results. Their results are not independent of the HORI 01, HORI 03, HORI 06, and HORI 11 values for $|m_p - m_{\bar{p}}|/m_p$, above.

⁶ TORII 99 uses the more-precisely-known constraint on the \bar{p} charge-to-mass ratio of GABRIELSE 95 (see above) to get this result. This is not independent of the TORII 99 value for $|m_p - m_{\bar{p}}|/m_p$, above.

⁷ HUGHES 92 uses recent measurements of Rydberg-energy and cyclotron-frequency ratios.

$|q_p + q_e|/e$

See BRESSI 11 for a summary of experiments on the neutrality of matter.
See also “*n* CHARGE” in the neutron Listings.

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>COMMENT</u>
$<1 \times 10^{-21}$	⁸ BRESSI 11	Neutrality of SF ₆
• • • We do not use the following data for averages, fits, limits, etc. • • •		
$<3.2 \times 10^{-20}$	⁹ SENGUPTA 00	binary pulsar
$<0.8 \times 10^{-21}$	MARINELLI 84	Magnetic levitation
$<1.0 \times 10^{-21}$	⁸ DYLLA 73	Neutrality of SF ₆
⁸ BRESSI 11 uses the method of DYLLA 73 but finds serious errors in that experiment that greatly reduce its accuracy. The BRESSI 11 limit assumes that $n \rightarrow p e^- \nu_e$ conserves charge. Thus the limit applies equally to the charge of the neutron.		
⁹ SENGUPTA 00 uses the difference between the observed rate of rotational energy loss by the binary pulsar PSR B1913+16 and the rate predicted by general relativity to set this limit. See the paper for assumptions.		

p MAGNETIC MOMENT

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

<u>VALUE (μ_N)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$2.792847356 \pm 0.000000023$	MOHR 12	RVUE	2010 CODATA value
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$2.792847356 \pm 0.000000023$	MOHR 08	RVUE	2006 CODATA value
$2.792847351 \pm 0.000000028$	MOHR 05	RVUE	2002 CODATA value
$2.792847337 \pm 0.000000029$	MOHR 99	RVUE	1998 CODATA value
$2.792847386 \pm 0.000000063$	COHEN 87	RVUE	1986 CODATA value
2.7928456 ± 0.0000011	COHEN 73	RVUE	1973 CODATA value

\bar{p} MAGNETIC MOMENT

A few early results have been omitted.

<u>VALUE (μ_N)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-2.792845 ± 0.000012	DISCIACCA 13	TRAP	Single \bar{p} , Penning trap

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

-2.7862 ±0.0083	PASK	09	CNTR	\bar{p} He ⁺ hyperfine structure
-2.8005 ±0.0090	KREISSL	88	CNTR	\bar{p} ²⁰⁸ Pb 11→10 X-ray
-2.817 ±0.048	ROBERTS	78	CNTR	
-2.791 ±0.021	HU	75	CNTR	Exotic atoms

$$(\mu_p + \mu_{\bar{p}}) / \mu_p$$

A test of *CPT* invariance.

VALUE (units 10 ⁻⁶)	DOCUMENT ID	TECN	COMMENT
0±5	DISCIACCA	13	TRAP Single \bar{p} , Penning trap

p ELECTRIC DIPOLE MOMENT

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

VALUE (10 ⁻²³ ecm)	EVTS	DOCUMENT ID	TECN	COMMENT
< 0.54		¹⁰ DMITRIEV	03	Uses ¹⁹⁹ Hg atom EDM

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

- 3.7 ± 6.3	CHO	89	NMR	TI F molecules
< 400	DZUBA	85	THEO	Uses ¹²⁹ Xe moment
130 ± 200	¹¹ WILKENING	84		
900 ± 1400	¹² WILKENING	84		
700 ± 900	1G HARRISON	69	MBR	Molecular beam

¹⁰DMITRIEV 03 calculates this limit from the limit on the electric dipole moment of the ¹⁹⁹Hg atom.

¹¹This WILKENING 84 value includes a finite-size effect and a magnetic effect.

¹²This WILKENING 84 value is more cautious than the other and excludes the finite-size effect, which relies on uncertain nuclear integrals.

p ELECTRIC POLARIZABILITY α_p

For a very complete review of the "polarizability of the nucleon and Compton scattering," see SCHUMACHER 05. His recommended values for the proton are $\alpha_p = (12.0 \pm 0.6) \times 10^{-4} \text{ fm}^3$ and $\beta_p = (1.9 \mp 0.6) \times 10^{-4} \text{ fm}^3$, almost exactly our averages.

VALUE (10 ⁻⁴ fm ³)	DOCUMENT ID	TECN	COMMENT
11.2 ±0.4 OUR AVERAGE			
10.65±0.35±0.36	MCGOVERN	13	RVUE χ EFT + Compton scattering
12.1 ±1.1 ±0.5	¹³ BEANE	03	EFT + γp
11.82±0.98 ^{+0.52} _{-0.98}	¹⁴ BLANPIED	01	LEGS $p(\vec{\gamma}, \gamma)$, $p(\vec{\gamma}, \pi^0)$, $p(\vec{\gamma}, \pi^+)$
11.9 ±0.5 ±1.3	¹⁵ OLMOSDEL...	01	CNTR γp Compton scattering
12.1 ±0.8 ±0.5	¹⁶ MACGIBBON	95	RVUE global average

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

- 11.7 ± 0.8 ± 0.7 ¹⁷ BARANOV 01 RVUE Global average
 12.5 ± 0.6 ± 0.9 MACGIBBON 95 CNTR γp Compton scattering
 9.8 ± 0.4 ± 1.1 HALLIN 93 CNTR γp Compton scattering
 10.62^{+1.25+1.07}_{-1.19-1.03} ZIEGER 92 CNTR γp Compton scattering
 10.9 ± 2.2 ± 1.3 ¹⁸ FEDERSPIEL 91 CNTR γp Compton scattering
¹³ BEANE 03 uses effective field theory and low-energy γp and γd Compton-scattering data. It also gets for the isoscalar polarizabilities (see the erratum) $\alpha_N = (13.0 \pm 1.9^{+3.9}_{-1.5}) \times 10^{-4} \text{ fm}^3$ and $\beta_N = (-1.8 \pm 1.9^{+2.1}_{-0.9}) \times 10^{-4} \text{ fm}^3$.
¹⁴ BLANPIED 01 gives $\alpha_p + \beta_p$ and $\alpha_p - \beta_p$. The separate α_p and β_p are provided to us by A. Sandorfi. The first error above is statistics plus systematics; the second is from the model.
¹⁵ This OLMOSDELEON 01 result uses the TAPS data alone, and does not use the (re-evaluated) sum-rule constraint that $\alpha + \beta = (13.8 \pm 0.4) \times 10^{-4} \text{ fm}^3$. See the paper for a discussion.
¹⁶ MACGIBBON 95 combine the results of ZIEGER 92, FEDERSPIEL 91, and their own experiment to get a “global average” in which model errors and systematic errors are treated in a consistent way. See MACGIBBON 95 for a discussion.
¹⁷ BARANOV 01 combines the results of 10 experiments from 1958 through 1995 to get a global average that takes into account both systematic and model errors and does not use the theoretical constraint on the sum $\alpha_p + \beta_p$.
¹⁸ FEDERSPIEL 91 obtains for the (static) electric polarizability α_p , defined in terms of the induced electric dipole moment by $\mathbf{D} = 4\pi\epsilon_0\alpha_p\mathbf{E}$, the value $(7.0 \pm 2.2 \pm 1.3) \times 10^{-4} \text{ fm}^3$.

p MAGNETIC POLARIZABILITY β_p

The electric and magnetic polarizabilities are subject to a dispersion sum-rule constraint $\bar{\alpha} + \bar{\beta} = (14.2 \pm 0.5) \times 10^{-4} \text{ fm}^3$. Errors here are anticorrelated with those on $\bar{\alpha}_p$ due to this constraint.

VALUE (10^{-4} fm^3)	DOCUMENT ID	TECN	COMMENT
2.5 ± 0.4 OUR AVERAGE	Error includes scale factor of 1.2.		
3.15 ± 0.35 ± 0.36	MCGOVERN	13	RVUE χ EFT + Compton scattering
3.4 ± 1.1 ± 0.1	¹⁹ BEANE	03	EFT + γp
1.43 ± 0.98 ^{+0.52} _{-0.98}	²⁰ BLANPIED	01	LEGS $p(\vec{\gamma}, \gamma)$, $p(\vec{\gamma}, \pi^0)$, $p(\vec{\gamma}, \pi^+)$
1.2 ± 0.7 ± 0.5	²¹ OLMOSDEL...	01	CNTR γp Compton scattering
2.1 ± 0.8 ± 0.5	²² MACGIBBON	95	RVUE global average

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

2.3 ± 0.9 ± 0.7	²³ BARANOV	01	RVUE Global average
1.7 ± 0.6 ± 0.9	MACGIBBON	95	CNTR γp Compton scattering
4.4 ± 0.4 ± 1.1	HALLIN	93	CNTR γp Compton scattering
3.58 ^{+1.19+1.03} _{-1.25-1.07}	ZIEGER	92	CNTR γp Compton scattering
3.3 ± 2.2 ± 1.3	FEDERSPIEL	91	CNTR γp Compton scattering

- ¹⁹ BEANE 03 uses effective field theory and low-energy γp and γd Compton-scattering data. It also gets for the isoscalar polarizabilities (see the erratum) $\alpha_N = (13.0 \pm 1.9_{-1.5}^{+3.9}) \times 10^{-4} \text{ fm}^3$ and $\beta_N = (-1.8 \pm 1.9_{-0.9}^{+2.1}) \times 10^{-4} \text{ fm}^3$.
- ²⁰ BLANPIED 01 gives $\alpha_p + \beta_p$ and $\alpha_p - \beta_p$. The separate α_p and β_p are provided to us by A. Sandorfi. The first error above is statistics plus systematics; the second is from the model.
- ²¹ This OLMOSDELEON 01 result uses the TAPS data alone, and does not use the (re-evaluated) sum-rule constraint that $\alpha + \beta = (13.8 \pm 0.4) \times 10^{-4} \text{ fm}^3$. See the paper for a discussion.
- ²² MACGIBBON 95 combine the results of ZIEGER 92, FEDERSPIEL 91, and their own experiment to get a “global average” in which model errors and systematic errors are treated in a consistent way. See MACGIBBON 95 for a discussion.
- ²³ BARANOV 01 combines the results of 10 experiments from 1958 through 1995 to get a global average that takes into account both systematic and model errors and does not use the theoretical constraint on the sum $\alpha_p + \beta_p$.

p CHARGE RADIUS

This is the rms electric charge radius, $\sqrt{\langle r_E^2 \rangle}$.

Most measurements of the radius of the proton involve electron-proton interactions, and most of the more recent values agree with one another. The most precise of these is $r_p = 0.879(8) \text{ fm}$ (BERNAUER 10). The CODATA 10 value (MOHR 12), obtained from the electronic results, is $0.8775(51)$. However, a measurement using muonic hydrogen finds $r_p = 0.84087(39) \text{ fm}$ (ANTOIGNINI 13), which is 13 times more precise and seven standard deviations (using the CODATA 10 error) from the electronic results.

Since POHL 10 (the first μp result), there has been a lot of discussion about the disagreement, especially concerning the modeling of muonic hydrogen. Here is an incomplete list of papers: DERUJULA 10, CLOET 11, DISTLER 11, DERUJULA 11, ARRINGTON 11, BERNAUER 11, and HILL 11.

Until the difference between the ep and μp values is understood, it does not make sense to average the values together. For the present, we give both values. It is up to workers in this field to solve this puzzle.

VALUE (fm)	DOCUMENT ID	TECN	COMMENT
0.84087 ± 0.00026 ± 0.00029	ANTOIGNINI 13	LASR	μp -atom Lamb shift
0.8775 ± 0.0051	MOHR 12	RVUE	2010 CODATA, ep data
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.879 ± 0.005 ± 0.006	BERNAUER 10	SPEC	$ep \rightarrow ep$ form factor
0.912 ± 0.009 ± 0.007	BORISYUK 10		reanalyzes old ep data
0.871 ± 0.009 ± 0.003	HILL 10		z-expansion reanalysis
0.84184 ± 0.00036 ± 0.00056	POHL 10	LASR	See ANTOIGNINI 13
0.8768 ± 0.0069	MOHR 08	RVUE	2006 CODATA value
0.844 $\begin{smallmatrix} +0.008 \\ -0.004 \end{smallmatrix}$	BELUSHKIN 07		Dispersion analysis
0.897 ± 0.018	BLUNDEN 05		SICK 03 + 2γ correction
0.8750 ± 0.0068	MOHR 05	RVUE	2002 CODATA value
0.895 ± 0.010 ± 0.013	SICK 03		$ep \rightarrow ep$ reanalysis

0.830 ±0.040 ±0.040	²⁴ ESCHRICH	01	$ep \rightarrow ep$
0.883 ±0.014	MELNIKOV	00	1S Lamb Shift in H
0.880 ±0.015	ROSENFELDR.	00	ep + Coul. corrections
0.847 ±0.008	MERGELL	96	ep + disp. relations
0.877 ±0.024	WONG	94	reanalysis of Mainz ep data
0.865 ±0.020	MCCORD	91	$ep \rightarrow ep$
0.862 ±0.012	SIMON	80	$ep \rightarrow ep$
0.880 ±0.030	BORKOWSKI	74	$ep \rightarrow ep$
0.810 ±0.020	AKIMOV	72	$ep \rightarrow ep$
0.800 ±0.025	FREREJACQ...	66	$ep \rightarrow ep$ (CH ₂ tgt.)
0.805 ±0.011	HAND	63	$ep \rightarrow ep$

²⁴ ESCHRICH 01 actually gives $\langle r^2 \rangle = (0.69 \pm 0.06 \pm 0.06) \text{ fm}^2$.

p MAGNETIC RADIUS

This is the rms magnetic radius, $\sqrt{\langle r_M^2 \rangle}$.

VALUE (fm)	DOCUMENT ID	TECN	COMMENT
0.777±0.013±0.010	BERNAUER	10 SPEC	$ep \rightarrow ep$ form factor
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.876±0.010±0.016	BORISYUK	10	reanalyzes old $ep \rightarrow ep$ data
0.854±0.005	BELUSHKIN	07	Dispersion analysis

p MEAN LIFE

A test of baryon conservation. See the “ p Partial Mean Lives” section below for limits for identified final states. The limits here are to “anything” or are for “disappearance” modes of a bound proton (p) or (n). See also the 3ν modes in the “Partial Mean Lives” section. Table 1 of BACK 03 is a nice summary.

LIMIT (years)	PARTICLE	CL%	DOCUMENT ID	TECN	COMMENT
>5.8 × 10²⁹	n	90	²⁵ ARAKI	06 KLND	$n \rightarrow$ invisible
>2.1 × 10²⁹	p	90	²⁶ AHMED	04 SNO	$p \rightarrow$ invisible
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
>1.9 × 10 ²⁹	n	90	²⁶ AHMED	04 SNO	$n \rightarrow$ invisible
>1.8 × 10 ²⁵	n	90	²⁷ BACK	03 BORX	
>1.1 × 10 ²⁶	p	90	²⁷ BACK	03 BORX	
>3.5 × 10 ²⁸	p	90	²⁸ ZDESENKO	03	$p \rightarrow$ invisible
>1 × 10 ²⁸	p	90	²⁹ AHMAD	02 SNO	$p \rightarrow$ invisible
>4 × 10 ²³	p	95	TRETYAK	01	$d \rightarrow n + ?$
>1.9 × 10 ²⁴	p	90	³⁰ BERNABEI	00B DAMA	
>1.6 × 10 ²⁵	p, n		^{31,32} EVANS	77	
>3 × 10 ²³	p		³² DIX	70 CNTR	
>3 × 10 ²³	p, n		^{32,33} FLEROV	58	

²⁵ ARAKI 06 looks for signs of de-excitation of the residual nucleus after disappearance of a neutron from the s shell of ¹²C.

²⁶ AHMED 04 looks for γ rays from the de-excitation of a residual ¹⁵O* or ¹⁵N* following the disappearance of a neutron or proton in ¹⁶O.

²⁷ BACK 03 looks for decays of unstable nuclides left after N decays of parent ¹²C, ¹³C, ¹⁶O nuclei. These are “invisible channel” limits.

- ²⁸ ZDESENKO 03 gets this limit on proton disappearance in deuterium by analyzing SNO data in AHMAD 02.
- ²⁹ AHMAD 02 (see its footnote 7) looks for neutrons left behind after the disappearance of the proton in deuterons.
- ³⁰ BERNABEI 00B looks for the decay of a $^{128}_{53}\text{I}$ nucleus following the disappearance of a proton in the otherwise-stable $^{129}_{54}\text{Xe}$ nucleus.
- ³¹ EVANS 77 looks for the daughter nuclide ^{129}Xe from possible ^{130}Te decays in ancient Te ore samples.
- ³² This mean-life limit has been obtained from a half-life limit by dividing the latter by $\ln(2) = 0.693$.
- ³³ FLEROV 58 looks for the spontaneous fission of a ^{232}Th nucleus after the disappearance of one of its nucleons.

\bar{p} MEAN LIFE

Of the two astrophysical limits here, that of GEER 00D involves considerably more refinements in its modeling. The other limits come from direct observations of stored antiprotons. See also “ \bar{p} Partial Mean Lives” after “ p Partial Mean Lives,” below, for exclusive-mode limits. The best (lifetime/branching fraction) limit there is 7×10^5 years, for $\bar{p} \rightarrow e^- \gamma$. We advance only the exclusive-mode limits to our Summary Tables.

<i>LIMIT</i> (years)	<i>CL%</i>	<i>EVTS</i>	<i>DOCUMENT ID</i>	<i>TECN</i>	<i>COMMENT</i>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
$>8 \times 10^5$	90		³⁴ GEER	00D	\bar{p}/p ratio, cosmic rays
>0.28			GABRIELSE	90 TRAP	Penning trap
>0.08	90	1	BELL	79 CNTR	Storage ring
$>1 \times 10^7$			GOLDEN	79 SPEC	\bar{p}/p ratio, cosmic rays
$>3.7 \times 10^{-3}$			BREGMAN	78 CNTR	Storage ring
³⁴ GEER 00D uses agreement between a model of galactic \bar{p} production and propagation and the observed \bar{p}/p cosmic-ray spectrum to set this limit.					

ρ DECAY MODES

See the “Note on Nucleon Decay” in our 1994 edition (*Phys. Rev.* **D50**, 1173) for a short review.

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. For N decays, p and n indicate proton and neutron partial lifetimes.

Mode	Partial mean life (10^{30} years)	Confidence level
Antilepton + meson		
τ_1 $N \rightarrow e^+ \pi$	> 2000 (n), > 8200 (p)	90%
τ_2 $N \rightarrow \mu^+ \pi$	> 1000 (n), > 6600 (p)	90%
τ_3 $N \rightarrow \nu \pi$	> 112 (n), > 16 (p)	90%
τ_4 $p \rightarrow e^+ \eta$	> 4200	90%
τ_5 $p \rightarrow \mu^+ \eta$	> 1300	90%
τ_6 $n \rightarrow \nu \eta$	> 158	90%
τ_7 $N \rightarrow e^+ \rho$	> 217 (n), > 710 (p)	90%
τ_8 $N \rightarrow \mu^+ \rho$	> 228 (n), > 160 (p)	90%
τ_9 $N \rightarrow \nu \rho$	> 19 (n), > 162 (p)	90%
τ_{10} $p \rightarrow e^+ \omega$	> 320	90%
τ_{11} $p \rightarrow \mu^+ \omega$	> 780	90%
τ_{12} $n \rightarrow \nu \omega$	> 108	90%
τ_{13} $N \rightarrow e^+ K$	> 17 (n), > 1000 (p)	90%
τ_{14} $p \rightarrow e^+ K_S^0$		
τ_{15} $p \rightarrow e^+ K_L^0$		
τ_{16} $N \rightarrow \mu^+ K$	> 26 (n), > 1600 (p)	90%
τ_{17} $p \rightarrow \mu^+ K_S^0$		
τ_{18} $p \rightarrow \mu^+ K_L^0$		
τ_{19} $N \rightarrow \nu K$	> 86 (n), > 2300 (p)	90%
τ_{20} $n \rightarrow \nu K_S^0$	> 260	90%
τ_{21} $p \rightarrow e^+ K^*(892)^0$	> 84	90%
τ_{22} $N \rightarrow \nu K^*(892)$	> 78 (n), > 51 (p)	90%
Antilepton + mesons		
τ_{23} $p \rightarrow e^+ \pi^+ \pi^-$	> 82	90%
τ_{24} $p \rightarrow e^+ \pi^0 \pi^0$	> 147	90%
τ_{25} $n \rightarrow e^+ \pi^- \pi^0$	> 52	90%
τ_{26} $p \rightarrow \mu^+ \pi^+ \pi^-$	> 133	90%
τ_{27} $p \rightarrow \mu^+ \pi^0 \pi^0$	> 101	90%
τ_{28} $n \rightarrow \mu^+ \pi^- \pi^0$	> 74	90%
τ_{29} $n \rightarrow e^+ K^0 \pi^-$	> 18	90%

Lepton + meson

τ_{30}	$n \rightarrow e^- \pi^+$	> 65	90%
τ_{31}	$n \rightarrow \mu^- \pi^+$	> 49	90%
τ_{32}	$n \rightarrow e^- \rho^+$	> 62	90%
τ_{33}	$n \rightarrow \mu^- \rho^+$	> 7	90%
τ_{34}	$n \rightarrow e^- K^+$	> 32	90%
τ_{35}	$n \rightarrow \mu^- K^+$	> 57	90%

Lepton + mesons

τ_{36}	$p \rightarrow e^- \pi^+ \pi^+$	> 30	90%
τ_{37}	$n \rightarrow e^- \pi^+ \pi^0$	> 29	90%
τ_{38}	$p \rightarrow \mu^- \pi^+ \pi^+$	> 17	90%
τ_{39}	$n \rightarrow \mu^- \pi^+ \pi^0$	> 34	90%
τ_{40}	$p \rightarrow e^- \pi^+ K^+$	> 75	90%
τ_{41}	$p \rightarrow \mu^- \pi^+ K^+$	> 245	90%

Antilepton + photon(s)

τ_{42}	$p \rightarrow e^+ \gamma$	> 670	90%
τ_{43}	$p \rightarrow \mu^+ \gamma$	> 478	90%
τ_{44}	$n \rightarrow \nu \gamma$	> 28	90%
τ_{45}	$p \rightarrow e^+ \gamma \gamma$	> 100	90%
τ_{46}	$n \rightarrow \nu \gamma \gamma$	> 219	90%

Three (or more) leptons

τ_{47}	$p \rightarrow e^+ e^+ e^-$	> 793	90%
τ_{48}	$p \rightarrow e^+ \mu^+ \mu^-$	> 359	90%
τ_{49}	$p \rightarrow e^+ \nu \nu$	> 17	90%
τ_{50}	$n \rightarrow e^+ e^- \nu$	> 257	90%
τ_{51}	$n \rightarrow \mu^+ e^- \nu$	> 83	90%
τ_{52}	$n \rightarrow \mu^+ \mu^- \nu$	> 79	90%
τ_{53}	$p \rightarrow \mu^+ e^+ e^-$	> 529	90%
τ_{54}	$p \rightarrow \mu^+ \mu^+ \mu^-$	> 675	90%
τ_{55}	$p \rightarrow \mu^+ \nu \nu$	> 21	90%
τ_{56}	$p \rightarrow e^- \mu^+ \mu^+$	> 6	90%
τ_{57}	$n \rightarrow 3\nu$	> 0.0005	90%
τ_{58}	$n \rightarrow 5\nu$		

Inclusive modes

τ_{59}	$N \rightarrow e^+$ anything	> 0.6 (n, p)	90%
τ_{60}	$N \rightarrow \mu^+$ anything	> 12 (n, p)	90%
τ_{61}	$N \rightarrow \nu$ anything		
τ_{62}	$N \rightarrow e^+ \pi^0$ anything	> 0.6 (n, p)	90%
τ_{63}	$N \rightarrow 2$ bodies, ν -free		

$\Delta B = 2$ dinucleon modes

The following are lifetime limits per iron nucleus.

τ_{64}	$pp \rightarrow \pi^+ \pi^+$	> 0.7	90%
τ_{65}	$pn \rightarrow \pi^+ \pi^0$	> 2	90%
τ_{66}	$nn \rightarrow \pi^+ \pi^-$	> 0.7	90%
τ_{67}	$nn \rightarrow \pi^0 \pi^0$	> 3.4	90%
τ_{68}	$pp \rightarrow e^+ e^+$	> 5.8	90%
τ_{69}	$pp \rightarrow e^+ \mu^+$	> 3.6	90%
τ_{70}	$pp \rightarrow \mu^+ \mu^+$	> 1.7	90%
τ_{71}	$pn \rightarrow e^+ \bar{\nu}$	> 2.8	90%
τ_{72}	$pn \rightarrow \mu^+ \bar{\nu}$	> 1.6	90%
τ_{73}	$nn \rightarrow \nu_e \bar{\nu}_e$	> 1.4	90%
τ_{74}	$nn \rightarrow \nu_\mu \bar{\nu}_\mu$	> 1.4	90%
τ_{75}	$pn \rightarrow$ invisible	> 0.000021	90%
τ_{76}	$pp \rightarrow$ invisible	> 0.00005	90%

\bar{p} DECAY MODES

	Mode	Partial mean life (years)	Confidence level
τ_{77}	$\bar{p} \rightarrow e^- \gamma$	$> 7 \times 10^5$	90%
τ_{78}	$\bar{p} \rightarrow \mu^- \gamma$	$> 5 \times 10^4$	90%
τ_{79}	$\bar{p} \rightarrow e^- \pi^0$	$> 4 \times 10^5$	90%
τ_{80}	$\bar{p} \rightarrow \mu^- \pi^0$	$> 5 \times 10^4$	90%
τ_{81}	$\bar{p} \rightarrow e^- \eta$	$> 2 \times 10^4$	90%
τ_{82}	$\bar{p} \rightarrow \mu^- \eta$	$> 8 \times 10^3$	90%
τ_{83}	$\bar{p} \rightarrow e^- K_S^0$	> 900	90%
τ_{84}	$\bar{p} \rightarrow \mu^- K_S^0$	$> 4 \times 10^3$	90%
τ_{85}	$\bar{p} \rightarrow e^- K_L^0$	$> 9 \times 10^3$	90%
τ_{86}	$\bar{p} \rightarrow \mu^- K_L^0$	$> 7 \times 10^3$	90%
τ_{87}	$\bar{p} \rightarrow e^- \gamma \gamma$	$> 2 \times 10^4$	90%
τ_{88}	$\bar{p} \rightarrow \mu^- \gamma \gamma$	$> 2 \times 10^4$	90%
τ_{89}	$\bar{p} \rightarrow e^- \rho$		
τ_{90}	$\bar{p} \rightarrow e^- \omega$	> 200	90%
τ_{91}	$\bar{p} \rightarrow e^- K^*(892)^0$		

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.

———— Antilepton + meson ————

$\tau(N \rightarrow e^+ \pi)$		τ_1					
LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN	
>2000	n	90	0	0.27	NISHINO	12	SKAM
>8200	p	90	0	0.3	NISHINO	09	SKAM
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●							
> 540	p	90	0	0.2	MCGREW	99	IMB3
> 158	n	90	3	5	MCGREW	99	IMB3
>1600	p	90	0	0.1	SHIOZAWA	98	SKAM
> 70	p	90	0	0.5	BERGER	91	FREJ
> 70	n	90	0	≤ 0.1	BERGER	91	FREJ
> 550	p	90	0	0.7	³⁵ BECKER-SZ... 90	IMB3	
> 260	p	90	0	< 0.04	HIRATA	89C	KAMI
> 130	n	90	0	< 0.2	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	³⁶ BARTELT	83	SOUD
> 0.5	n	90	1	0.3	³⁶ BARTELT	83	SOUD
> 5.8	p	90	2		³⁷ KRISHNA...	82	KOLR
> 5.8	n	90	2		³⁷ KRISHNA...	82	KOLR
> 0.1	n	90			³⁸ GURR	67	CNTR

³⁵ This BECKER-SZENDY 90 result includes data from SEIDEL 88.

³⁶ Limit based on zero events.

³⁷ We have calculated 90% CL limit from 1 confined event.

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

$\tau(N \rightarrow \mu^+ \pi)$

T2

LIMIT (10 ³⁰ years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN
>1000	<i>n</i>	90	1	0.43	NISHINO 12	SKAM
>6600	<i>p</i>	90	0	0.3	NISHINO 09	SKAM
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 473	<i>p</i>	90	0	0.6	MCGREW 99	IMB3
> 90	<i>n</i>	90	1	1.9	MCGREW 99	IMB3
> 81	<i>p</i>	90	0	0.2	BERGER 91	FREJ
> 35	<i>n</i>	90	1	1.0	BERGER 91	FREJ
> 230	<i>p</i>	90	0	<0.07	HIRATA 89C	KAMI
> 100	<i>n</i>	90	0	<0.2	HIRATA 89C	KAMI
> 270	<i>p</i>	90	0	0.5	SEIDEL 88	IMB
> 63	<i>n</i>	90	0	0.5	SEIDEL 88	IMB
> 76	<i>p</i>	90	2	1	HAINES 86	IMB
> 23	<i>n</i>	90	8	7	HAINES 86	IMB
> 46	<i>p</i>	90	0	<0.7	ARISAKA 85	KAMI
> 20	<i>n</i>	90	0	<0.4	ARISAKA 85	KAMI
> 59	<i>p</i> (free)	90	0	0.2	BLEWITT 85	IMB
> 100	<i>p</i>	90	1	0.4	BLEWITT 85	IMB
> 38	<i>n</i>	90	1	4	PARK 85	IMB
> 10	<i>p, n</i>	90	0		BATTISTONI 84	NUSX
> 1.3	<i>p, n</i>	90	0		ALEKSEEV 81	BAKS

$\tau(N \rightarrow \nu \pi)$

T3

LIMIT (10 ³⁰ years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN
> 16	<i>p</i>	90	6	6.7	WALL 00B	SOU2
>112	<i>n</i>	90	6	6.6	MCGREW 99	IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 39	<i>n</i>	90	4	3.8	WALL 00B	SOU2
> 10	<i>p</i>	90	15	20.3	MCGREW 99	IMB3
> 13	<i>n</i>	90	1	1.2	BERGER 89	FREJ
> 10	<i>p</i>	90	11	14	BERGER 89	FREJ
> 25	<i>p</i>	90	32	32.8	³⁹ HIRATA 89C	KAMI
>100	<i>n</i>	90	1	3	HIRATA 89C	KAMI
> 6	<i>n</i>	90	73	60	HAINES 86	IMB
> 2	<i>p</i>	90	16	13	KAJITA 86	KAMI
> 40	<i>n</i>	90	0	1	KAJITA 86	KAMI
> 7	<i>n</i>	90	28	19	PARK 85	IMB
> 7	<i>n</i>	90	0		BATTISTONI 84	NUSX
> 2	<i>p</i>	90	≤ 3		BATTISTONI 84	NUSX
> 5.8	<i>p</i>	90	1		⁴⁰ KRISHNA... 82	KOLR
> 0.3	<i>p</i>	90	2		⁴¹ CHERRY 81	HOME
> 0.1	<i>p</i>	90			⁴² GURR 67	CNTR

³⁹In estimating the background, this HIRATA 89C limit (as opposed to the later limits of WALL 00B and MCGREW 99) does not take into account present understanding that the flux of ν_μ originating in the upper atmosphere is depleted. Doing so would reduce the background and thus also would reduce the limit here.

⁴⁰We have calculated 90% CL limit from 1 confined event.

⁴¹We have converted 2 possible events to 90% CL limit.

⁴²We have converted half-life to 90% CL mean life.

$\tau(p \rightarrow e^+ \eta)$

T4

<i>LIMIT</i> (10 ³⁰ years)	<i>PARTICLE</i>	<i>CL%</i>	<i>EVTS</i>	<i>BKGD EST</i>	<i>DOCUMENT ID</i>	<i>TECN</i>
>4200	<i>p</i>	90	0	0.44	NISHINO	12 SKAM
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 81	<i>p</i>	90	1	1.7	WALL	00B SOU2
> 313	<i>p</i>	90	0	0.2	MCGREW	99 IMB3
> 44	<i>p</i>	90	0	0.1	BERGER	91 FREJ
> 140	<i>p</i>	90	0	<0.04	HIRATA	89C KAMI
> 100	<i>p</i>	90	0	0.6	SEIDEL	88 IMB
> 200	<i>p</i>	90	5	3.3	HAINES	86 IMB
> 64	<i>p</i>	90	0	<0.8	ARISAKA	85 KAMI
> 64	<i>p</i> (free)	90	5	6.5	BLEWITT	85 IMB
> 200	<i>p</i>	90	5	4.7	BLEWITT	85 IMB
> 1.2	<i>p</i>	90	2		⁴³ CHERRY	81 HOME

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

$\tau(p \rightarrow \mu^+ \eta)$

T5

<i>LIMIT</i> (10 ³⁰ years)	<i>PARTICLE</i>	<i>CL%</i>	<i>EVTS</i>	<i>BKGD EST</i>	<i>DOCUMENT ID</i>	<i>TECN</i>
>1300	<i>p</i>	90	2	0.49	NISHINO	12 SKAM
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 89	<i>p</i>	90	0	1.6	WALL	00B SOU2
> 126	<i>p</i>	90	3	2.8	MCGREW	99 IMB3
> 26	<i>p</i>	90	1	0.8	BERGER	91 FREJ
> 69	<i>p</i>	90	1	<0.08	HIRATA	89C KAMI
> 1.3	<i>p</i>	90	0	0.7	PHILLIPS	89 HPW
> 34	<i>p</i>	90	1	1.5	SEIDEL	88 IMB
> 46	<i>p</i>	90	7	6	HAINES	86 IMB
> 26	<i>p</i>	90	1	<0.8	ARISAKA	85 KAMI
> 17	<i>p</i> (free)	90	6	6	BLEWITT	85 IMB
> 46	<i>p</i>	90	7	8	BLEWITT	85 IMB

$\tau(n \rightarrow \nu \eta)$

T6

<i>LIMIT</i> (10 ³⁰ years)	<i>PARTICLE</i>	<i>CL%</i>	<i>EVTS</i>	<i>BKGD EST</i>	<i>DOCUMENT ID</i>	<i>TECN</i>
>158	<i>n</i>	90	0	1.2	MCGREW	99 IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 71	<i>n</i>	90	2	3.7	WALL	00B SOU2
> 29	<i>n</i>	90	0	0.9	BERGER	89 FREJ
> 54	<i>n</i>	90	2	0.9	HIRATA	89C KAMI
> 16	<i>n</i>	90	3	2.1	SEIDEL	88 IMB
> 25	<i>n</i>	90	7	6	HAINES	86 IMB
> 30	<i>n</i>	90	0	0.4	KAJITA	86 KAMI
> 18	<i>n</i>	90	4	3	PARK	85 IMB
> 0.6	<i>n</i>	90	2		⁴⁴ CHERRY	81 HOME

⁴⁴We have converted 2 possible events to 90% CL limit.

$\tau(N \rightarrow e^+ \rho)$

T7

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>710	<i>p</i>	90	0	0.35	NISHINO	12 SKAM
>217	<i>n</i>	90	4	4.8	MCGREW	99 IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 70	<i>n</i>	90	1	0.38	NISHINO	12 SKAM
> 29	<i>p</i>	90	0	2.2	BERGER	91 FREJ
> 41	<i>n</i>	90	0	1.4	BERGER	91 FREJ
> 75	<i>p</i>	90	2	2.7	HIRATA	89C KAMI
> 58	<i>n</i>	90	0	1.9	HIRATA	89C KAMI
> 38	<i>n</i>	90	2	4.1	SEIDEL	88 IMB
> 1.2	<i>p</i>	90	0		BARTELT	87 SOUD
> 1.5	<i>n</i>	90	0		BARTELT	87 SOUD
> 17	<i>p</i>	90	7	7	HAINES	86 IMB
> 14	<i>n</i>	90	9	4	HAINES	86 IMB
> 12	<i>p</i>	90	0	<1.2	ARISAKA	85 KAMI
> 6	<i>n</i>	90	2	<1	ARISAKA	85 KAMI
> 6.7	<i>p</i> (free)	90	6	6	BLEWITT	85 IMB
> 17	<i>p</i>	90	7	7	BLEWITT	85 IMB
> 12	<i>n</i>	90	4	2	PARK	85 IMB
> 0.6	<i>n</i>	90	1	0.3	⁴⁵ BARTELT	83 SOUD
> 0.5	<i>p</i>	90	1	0.3	⁴⁵ BARTELT	83 SOUD
> 9.8	<i>p</i>	90	1		⁴⁶ KRISHNA...	82 KOLR
> 0.8	<i>p</i>	90	2		⁴⁷ CHERRY	81 HOME

⁴⁵ Limit based on zero events.

⁴⁶ We have calculated 90% CL limit from 0 confined events.

⁴⁷ We have converted 2 possible events to 90% CL limit.

$\tau(N \rightarrow \mu^+ \rho)$

T8

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>160	<i>p</i>	90	1	0.42	NISHINO	12 SKAM
>228	<i>n</i>	90	3	9.5	MCGREW	99 IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 36	<i>n</i>	90	0	0.29	NISHINO	12 SKAM
> 12	<i>p</i>	90	0	0.5	BERGER	91 FREJ
> 22	<i>n</i>	90	0	1.1	BERGER	91 FREJ
>110	<i>p</i>	90	0	1.7	HIRATA	89C KAMI
> 23	<i>n</i>	90	1	1.8	HIRATA	89C KAMI
> 4.3	<i>p</i>	90	0	0.7	PHILLIPS	89 HPW
> 30	<i>p</i>	90	0	0.5	SEIDEL	88 IMB
> 11	<i>n</i>	90	1	1.1	SEIDEL	88 IMB
> 16	<i>p</i>	90	4	4.5	HAINES	86 IMB
> 7	<i>n</i>	90	6	5	HAINES	86 IMB
> 12	<i>p</i>	90	0	<0.7	ARISAKA	85 KAMI
> 5	<i>n</i>	90	1	<1.2	ARISAKA	85 KAMI
> 5.5	<i>p</i> (free)	90	4	5	BLEWITT	85 IMB
> 16	<i>p</i>	90	4	5	BLEWITT	85 IMB
> 9	<i>n</i>	90	1	2	PARK	85 IMB

$\tau(N \rightarrow \nu \rho)$

τ_9

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>162	p	90	18	21.7	MCGREW	99 IMB3
> 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
> 27	p	90	5	1.5	HIRATA	89C KAMI
> 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		⁴⁸ CHERRY	81 HOME
> 0.6	n	90	2		⁴⁸ CHERRY	81 HOME

⁴⁸We have converted 2 possible events to 90% CL limit.

$\tau(p \rightarrow e^+ \omega)$

τ_{10}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>320	p	90	1	0.53	NISHINO	12 SKAM
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>107	p	90	7	10.8	MCGREW	99 IMB3
> 17	p	90	0	1.1	BERGER	91 FREJ
> 45	p	90	2	1.45	HIRATA	89C KAMI
> 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	⁴⁹ BARTELT	83 SOUD
> 9.8	p	90	1		⁵⁰ KRISHNA...	82 KOLR
> 2.8	p	90	2		⁵¹ CHERRY	81 HOME

⁴⁹Limit based on zero events.

⁵⁰We have calculated 90% CL limit from 0 confined events.

⁵¹We have converted 2 possible events to 90% CL limit.

$\tau(p \rightarrow \mu^+ \omega)$

τ_{11}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>780	p	90	0	0.48	NISHINO	12 SKAM

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

>117	p	90	11	12.1	MCGREW	99	IMB3
> 11	p	90	0	1.0	BERGER	91	FREJ
> 57	p	90	2	1.9	HIRATA	89C	KAMI
> 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

$\tau(n \rightarrow \nu \omega)$

τ_{12}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>108	n	90	12	22.5	MCGREW	99 IMB3

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

> 17	n	90	1	0.7	BERGER	89	FREJ
> 43	n	90	3	2.7	HIRATA	89C	KAMI
> 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		⁵² CHERRY	81	HOME

⁵²We have converted 2 possible events to 90% CL limit.

$\tau(N \rightarrow e^+ K)$

τ_{13}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>1000	p	90	6	4.7	KOBAYASHI	05 SKAM
> 17	n	90	35	29.4	MCGREW	99 IMB3

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

> 85	p	90	3	4.9	WALL	00	SOU2
> 31	p	90	23	25.2	MCGREW	99	IMB3
> 60	p	90	0		BERGER	91	FREJ
> 150	p	90	0	<0.27	HIRATA	89C	KAMI
> 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
> 1.3	n	90	0		ALEKSEEV	81	BAKS

$\tau(p \rightarrow e^+ K_S^0)$

τ_{14}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>120	p	90	1	1.3	WALL	00 SOU2
> 76	p	90	0	0.5	BERGER	91 FREJ

$\tau(p \rightarrow e^+ K_L^0)$ τ_{15}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

>51	p	90	2	3.5	WALL	00 SOU2
>44	p	90	0	≤ 0.1	BERGER	91 FREJ

$\tau(N \rightarrow \mu^+ K)$ τ_{16}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
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>1600	p	90	13	13.2	REGIS	12 SKAM
> 26	n	90	20	28.4	MCGREW	99 IMB3

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

>1300	p	90	3	3.9	KOBAYASHI	05 SKAM
> 120	p	90	0	<1.2	WALL	00 SOU2
> 120	p	90	4	7.2	MCGREW	99 IMB3
> 54	p	90	0		BERGER	91 FREJ
> 120	p	90	1	0.4	HIRATA	89C KAMI
> 3.0	p	90	0	0.7	PHILLIPS	89 HPW
> 19	p	90	3	2.5	SEIDEL	88 IMB
> 1.5	p	90	0		⁵³ BARTELT	87 SOUD
> 1.1	n	90	0		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		⁵⁴ BARTELT	83 SOUD
> 0.4	n	90	0		⁵⁴ BARTELT	83 SOUD
> 5.8	p	90	2		⁵⁵ KRISHNA...	82 KOLR
> 2.0	p	90	0		CHERRY	81 HOME
> 0.2	n	90			⁵⁶ GURR	67 CNTR

⁵³BARTELT 87 limit applies to $p \rightarrow \mu^+ K_S^0$.

⁵⁴Limit based on zero events.

⁵⁵We have calculated 90% CL limit from 1 confined event.

⁵⁶We have converted half-life to 90% CL mean life.

$\tau(p \rightarrow \mu^+ K_S^0)$ τ_{17}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

>150	p	90	0	<0.8	WALL	00 SOU2
> 64	p	90	0	1.2	BERGER	91 FREJ

$\tau(p \rightarrow \mu^+ K_L^0)$ τ_{18}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

>83	p	90	0	0.4	WALL	00 SOU2
>44	p	90	0	≤ 0.1	BERGER	91 FREJ

$\tau(N \rightarrow \nu K)$

τ_{19}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>2300	p	90	0	1.3	KOBAYASHI 05	SKAM
> 86	n	90	0	2.4	HIRATA 89C	KAMI
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 26	n	90	16	9.1	WALL 00	SOU2
> 670	p	90			HAYATO 99	SKAM
> 151	p	90	15	21.4	MCGREW 99	IMB3
> 30	n	90	34	34.1	MCGREW 99	IMB3
> 43	p	90	1	1.54	⁵⁷ ALLISON 98	SOU2
> 15	n	90	1	1.8	BERGER 89	FREJ
> 15	p	90	1	1.8	BERGER 89	FREJ
> 100	p	90	9	7.3	HIRATA 89C	KAMI
> 0.28	p	90	0	0.7	PHILLIPS 89	HPW
> 0.3	p	90	0		BARTELT 87	SOUD
> 0.75	n	90	0		⁵⁸ 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		⁵⁹ BARTELT 83	SOUD
> 0.1	p	90	0		⁵⁹ BARTELT 83	SOUD
> 5.8	p	90	1		⁶⁰ KRISHNA... 82	KOLR
> 0.3	n	90	2		⁶¹ CHERRY 81	HOME

⁵⁷ This ALLISON 98 limit is with no background subtraction; with subtraction the limit becomes $> 46 \times 10^{30}$ years.

⁵⁸ BARTELT 87 limit applies to $n \rightarrow \nu K_S^0$.

⁵⁹ Limit based on zero events.

⁶⁰ We have calculated 90% CL limit from 1 confined event.

⁶¹ We have converted 2 possible events to 90% CL limit.

$\tau(n \rightarrow \nu K_S^0)$

τ_{20}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>260	n	90	34	30	⁶² KOBAYASHI 05	SKAM

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

> 51	n	90	16	9.1	WALL 00	SOU2
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⁶² We have doubled the $n \rightarrow \nu K_S^0$ limit given in KOBAYASHI 05 to obtain this $n \rightarrow \nu K_S^0$ limit.

$\tau(p \rightarrow e^+ K^*(892)^0)$

τ_{21}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>84	p	90	38	52.0	MCGREW	99 IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>10	p	90	0	0.8	BERGER	91 FREJ
>52	p	90	2	1.55	HIRATA	89C KAMI
>10	p	90	1	<1	ARISAKA	85 KAMI

$\tau(N \rightarrow \nu K^*(892))$

τ_{22}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>51	p	90	7	9.1	MCGREW	99 IMB3
>78	n	90	40	50	MCGREW	99 IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>22	n	90	0	2.1	BERGER	89 FREJ
>17	p	90	0	2.4	BERGER	89 FREJ
>20	p	90	5	2.1	HIRATA	89C KAMI
>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		⁶³ BATTISTONI	82 NUSX

⁶³We have converted 1 possible event to 90% CL limit.

————— Antilepton + mesons —————

$\tau(p \rightarrow e^+ \pi^+ \pi^-)$

τ_{23}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>82	p	90	16	23.1	MCGREW	99 IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>21	p	90	0	2.2	BERGER	91 FREJ

$\tau(p \rightarrow e^+ \pi^0 \pi^0)$

τ_{24}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>147	p	90	2	0.8	MCGREW	99 IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •						
> 38	p	90	1	0.5	BERGER	91 FREJ

$\tau(n \rightarrow e^+ \pi^- \pi^0)$

τ_{25}

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>52	n	90	38	34.2	MCGREW	99 IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>32	n	90	1	0.8	BERGER	91 FREJ

$\tau(p \rightarrow \mu^+ \pi^+ \pi^-)$ **T26**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>133	p	90	25	38.0	MCGREW 99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •						
> 17	p	90	1	2.6	BERGER 91	FREJ
> 3.3	p	90	0	0.7	PHILLIPS 89	HPW

$\tau(p \rightarrow \mu^+ \pi^0 \pi^0)$ **T27**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>101	p	90	3	1.6	MCGREW 99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •						
> 33	p	90	1	0.9	BERGER 91	FREJ

$\tau(n \rightarrow \mu^+ \pi^- \pi^0)$ **T28**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>74	n	90	17	20.8	MCGREW 99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>33	n	90	0	1.1	BERGER 91	FREJ

$\tau(n \rightarrow e^+ K^0 \pi^-)$ **T29**

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

———— Lepton + meson ————

$\tau(n \rightarrow e^- \pi^+)$ **T30**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>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

$\tau(n \rightarrow \mu^- \pi^+)$ **T31**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>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

$\tau(n \rightarrow e^- \rho^+)$ **T32**

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

$\tau(n \rightarrow \mu^- \rho^+)$ **T33**

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

$\tau(n \rightarrow e^- K^+)$ **T34**

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

$\tau(n \rightarrow \mu^- K^+)$ **T35**

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

———— Lepton + mesons ————

$\tau(p \rightarrow e^- \pi^+ \pi^+)$ **T36**

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

$\tau(n \rightarrow e^- \pi^+ \pi^0)$ **T37**

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

$\tau(p \rightarrow \mu^- \pi^+ \pi^+)$ **T38**

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

$\tau(n \rightarrow \mu^- \pi^+ \pi^0)$ **T39**

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

$\tau(p \rightarrow e^- \pi^+ K^+)$ **T40**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>75	<i>p</i>	90	81	127.2	MCGREW	99 IMB3

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

>20	<i>p</i>	90	3	2.50	BERGER	91B FREJ
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$\tau(p \rightarrow \mu^- \pi^+ K^+)$ **T41**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>245	<i>p</i>	90	3	4.0	MCGREW	99 IMB3

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

> 5	<i>p</i>	90	2	0.78	BERGER	91B FREJ
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————— **Antilepton + photon(s)** —————

$\tau(p \rightarrow e^+ \gamma)$ **T42**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>670	<i>p</i>	90	0	0.1	MCGREW	99 IMB3

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

>133	<i>p</i>	90	0	0.3	BERGER	91 FREJ
>460	<i>p</i>	90	0	0.6	SEIDEL	88 IMB
>360	<i>p</i>	90	0	0.3	HAINES	86 IMB
> 87	<i>p</i> (free)	90	0	0.2	BLEWITT	85 IMB
>360	<i>p</i>	90	0	0.2	BLEWITT	85 IMB
> 0.1	<i>p</i>	90			⁶⁴ GURR	67 CNTR

⁶⁴We have converted half-life to 90% CL mean life.

$\tau(p \rightarrow \mu^+ \gamma)$ **T43**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>478	<i>p</i>	90	0	0.1	MCGREW	99 IMB3

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

>155	<i>p</i>	90	0	0.1	BERGER	91 FREJ
>380	<i>p</i>	90	0	0.5	SEIDEL	88 IMB
> 97	<i>p</i>	90	3	2	HAINES	86 IMB
> 61	<i>p</i> (free)	90	0	0.2	BLEWITT	85 IMB
>280	<i>p</i>	90	0	0.6	BLEWITT	85 IMB
> 0.3	<i>p</i>	90			⁶⁵ GURR	67 CNTR

⁶⁵We have converted half-life to 90% CL mean life.

$\tau(n \rightarrow \nu\gamma)$

T44

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>28	<i>n</i>	90	163	144.7	MCGREW	99 IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>24	<i>n</i>	90	10	6.86	BERGER	91B FREJ
> 9	<i>n</i>	90	73	60	HAINES	86 IMB
>11	<i>n</i>	90	28	19	PARK	85 IMB

$\tau(p \rightarrow e^+\gamma\gamma)$

T45

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

$\tau(n \rightarrow \nu\gamma\gamma)$

T46

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>219	<i>n</i>	90	5	7.5	MCGREW	99 IMB3

————— **Three (or more) leptons** —————

$\tau(p \rightarrow e^+e^+e^-)$

T47

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>793	<i>p</i>	90	0	0.5	MCGREW	99 IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>147	<i>p</i>	90	0	0.1	BERGER	91 FREJ
>510	<i>p</i>	90	0	0.3	HAINES	86 IMB
> 89	<i>p</i> (free)	90	0	0.5	BLEWITT	85 IMB
>510	<i>p</i>	90	0	0.7	BLEWITT	85 IMB

$\tau(p \rightarrow e^+\mu^+\mu^-)$

T48

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>359	<i>p</i>	90	1	0.9	MCGREW	99 IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •						
> 81	<i>p</i>	90	0	0.16	BERGER	91 FREJ
> 5.0	<i>p</i>	90	0	0.7	PHILLIPS	89 HPW

$\tau(p \rightarrow e^+\nu\nu)$

T49

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>17	<i>p</i>	90	152	153.7	MCGREW	99 IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>11	<i>p</i>	90	11	6.08	BERGER	91B FREJ

$\tau(n \rightarrow e^+ e^- \nu)$ **T50**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>257	<i>n</i>	90	5	7.5	MCGREW 99	IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 74	<i>n</i>	90	0	< 0.1	BERGER 91B	FREJ
> 45	<i>n</i>	90	5	5	HAINES 86	IMB
> 26	<i>n</i>	90	4	3	PARK 85	IMB

$\tau(n \rightarrow \mu^+ e^- \nu)$ **T51**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>83	<i>n</i>	90	25	29.4	MCGREW 99	IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>47	<i>n</i>	90	0	< 0.1	BERGER 91B	FREJ

$\tau(n \rightarrow \mu^+ \mu^- \nu)$ **T52**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>79	<i>n</i>	90	100	145	MCGREW 99	IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>42	<i>n</i>	90	0	1.4	BERGER 91B	FREJ
> 5.1	<i>n</i>	90	0	0.7	PHILLIPS 89	HPW
>16	<i>n</i>	90	14	7	HAINES 86	IMB
>19	<i>n</i>	90	4	7	PARK 85	IMB

$\tau(p \rightarrow \mu^+ e^+ e^-)$ **T53**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>529	<i>p</i>	90	0	1.0	MCGREW 99	IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 91	<i>p</i>	90	0	≤ 0.1	BERGER 91	FREJ

$\tau(p \rightarrow \mu^+ \mu^+ \mu^-)$ **T54**

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>675	<i>p</i>	90	0	0.3	MCGREW 99	IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>119	<i>p</i>	90	0	0.2	BERGER 91	FREJ
> 10.5	<i>p</i>	90	0	0.7	PHILLIPS 89	HPW
>190	<i>p</i>	90	1	0.1	HAINES 86	IMB
> 44	<i>p</i> (free)	90	1	0.7	BLEWITT 85	IMB
>190	<i>p</i>	90	1	0.9	BLEWITT 85	IMB
> 2.1	<i>p</i>	90	1		⁶⁶ BATTISTONI 82	NUSX

⁶⁶We have converted 1 possible event to 90% CL limit.

$\tau(p \rightarrow \mu^+ \nu \nu)$ **T55**

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

$\tau(p \rightarrow e^- \mu^+ \mu^+)$

T56

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

$\tau(n \rightarrow 3\nu)$

T57

See also the “to anything” and “disappearance” limits for bound nucleons in the “*p* Mean Life” data block just in front of the list of possible *p* decay modes. Such modes could of course be to three (or five) neutrinos, and the limits are stronger, but we do not repeat them here.

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>0.00049	<i>n</i>	90	2	2	⁶⁷ SUZUKI	93B KAMI
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>0.0023	<i>n</i>	90			⁶⁸ GLICENSTEIN	97 KAMI
>0.00003	<i>n</i>	90	11	6.1	⁶⁹ BERGER	91B FREJ
>0.00012	<i>n</i>	90	7	11.2	⁶⁹ BERGER	91B FREJ
>0.0005	<i>n</i>	90	0		LEARNED	79 RVUE

⁶⁷ The SUZUKI 93B limit applies to any of $\nu_e \nu_e \bar{\nu}_e$, $\nu_\mu \nu_\mu \bar{\nu}_\mu$, or $\nu_\tau \nu_\tau \bar{\nu}_\tau$.

⁶⁸ GLICENSTEIN 97 uses Kamioka data and the idea that the disappearance of the neutron’s magnetic moment should produce radiation.

⁶⁹ The first BERGER 91B limit is for $n \rightarrow \nu_e \nu_e \bar{\nu}_e$, the second is for $n \rightarrow \nu_\mu \nu_\mu \bar{\nu}_\mu$.

$\tau(n \rightarrow 5\nu)$

T58

See the note on $\tau(n \rightarrow 3\nu)$ on the previous data block.

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>0.0017	<i>n</i>	90			⁷⁰ GLICENSTEIN	97 KAMI

⁷⁰ GLICENSTEIN 97 uses Kamioka data and the idea that the disappearance of the neutron’s magnetic moment should produce radiation.

————— Inclusive modes —————

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

T59

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>0.6	<i>p, n</i>	90			⁷¹ LEARNED	79 RVUE

⁷¹ The electron may be primary or secondary.

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

T60

<u>LIMIT</u> (10^{30} years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>12	<i>p, n</i>	90	2		^{72,73} CHERRY	81 HOME
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 1.8	<i>p, n</i>	90			⁷³ COWSIK	80 CNTR
> 6	<i>p, n</i>	90			⁷³ LEARNED	79 RVUE

⁷² We have converted 2 possible events to 90% CL limit.

⁷³ The muon may be primary or secondary.

$\tau(N \rightarrow \nu \text{anything})$ T61

Anything = π , ρ , K , etc.

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN
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• • • We do not use the following data for averages, fits, limits, etc. • • •

>0.0002	p, n	90	0		LEARNED	79 RVUE
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$\tau(N \rightarrow e^+ \pi^0 \text{anything})$ T62

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN
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>0.6	p, n	90	0		LEARNED	79 RVUE
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$\tau(N \rightarrow 2 \text{ bodies}, \nu\text{-free})$ T63

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN
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• • • We do not use the following data for averages, fits, limits, etc. • • •

>1.3	p, n	90	0		ALEKSEEV	81 BAKS
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———— **$\Delta B = 2$ dinucleon modes** ————

$\tau(pp \rightarrow \pi^+ \pi^+)$ T64

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN	COMMENT
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>0.7	90	4	2.34	BERGER	91B FREJ	τ per iron nucleus
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$\tau(pn \rightarrow \pi^+ \pi^0)$ T65

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN	COMMENT
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>2.0	90	0	0.31	BERGER	91B FREJ	τ per iron nucleus
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$\tau(nn \rightarrow \pi^+ \pi^-)$ T66

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN	COMMENT
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>0.7	90	4	2.18	BERGER	91B FREJ	τ per iron nucleus
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$\tau(nn \rightarrow \pi^0 \pi^0)$ T67

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN	COMMENT
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>3.4	90	0	0.78	BERGER	91B FREJ	τ per iron nucleus
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$\tau(pp \rightarrow e^+ e^+)$ T68

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN	COMMENT
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>5.8	90	0	<0.1	BERGER	91B FREJ	τ per iron nucleus
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$\tau(pp \rightarrow e^+ \mu^+)$ T69

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN	COMMENT
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>3.6	90	0	<0.1	BERGER	91B FREJ	τ per iron nucleus
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$\tau(pp \rightarrow \mu^+ \mu^+)$ **T70**

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

$\tau(pn \rightarrow e^+ \bar{\nu})$ **T71**

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

$\tau(pn \rightarrow \mu^+ \bar{\nu})$ **T72**

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

$\tau(nn \rightarrow \nu_e \bar{\nu}_e)$ **T73**

We include "invisible" modes here.

<u>LIMIT</u> (10^{30} years)	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
>1.4	90			⁷⁴ ARAKI	06 KLND	$nn \rightarrow$ invisible

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

>0.000042	90			⁷⁵ TRETAYAK	04 CNTR	$nn \rightarrow$ invisible
>0.000049	90			⁷⁶ BACK	03 BORX	$nn \rightarrow$ invisible
>0.000012	90			⁷⁷ BERNABEI	00B DAMA	$nn \rightarrow$ invisible
>0.000012	90	5	9.7	BERGER	91B FREJ	τ per iron nucleus

⁷⁴ ARAKI 06 looks for signs of de-excitation of the residual nucleus after disappearance of two neutrons from the s shell of ^{12}C .

⁷⁵ TRETAYAK 04 uses data from an old Homestake-mine radiochemical experiment on limits for invisible decays of ^{39}K to ^{37}Ar .

⁷⁶ BACK 03 looks for decays of unstable nuclides left after NN decays of parent ^{12}C , ^{13}C , ^{16}O nuclei. These are "invisible channel" limits.

⁷⁷ BERNABEI 00B looks for the decay of a $^{127}_{54}\text{Xe}$ nucleus following the disappearance of an nn pair in the otherwise-stable $^{129}_{54}\text{Xe}$ nucleus. The limit here applies as well to $nn \rightarrow \nu_\mu \bar{\nu}_\mu$, $nn \rightarrow \nu_\tau \bar{\nu}_\tau$, or any "disappearance" mode.

$\tau(nn \rightarrow \nu_\mu \bar{\nu}_\mu)$ **T74**

See the preceding data block. "Invisible modes" would include any multi-neutrino mode.

<u>LIMIT</u> (10^{30} years)	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
>1.4	(CL = 90%) OUR LIMIT						

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

>0.000006	90	4	4.4	BERGER	91B FREJ	τ per iron nucleus
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$\tau(pn \rightarrow \text{invisible})$ **T75**

This violates charge conservation as well as baryon number conservation.

<u>VALUE</u> (10^{30} years)	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
>0.000021	90	⁷⁸ TRETAYAK 04	CNTR

⁷⁸ TRETAYAK 04 uses data from an old Homestake-mine radiochemical experiment on limits for invisible decays of ^{39}K to ^{37}Ar .

$\tau(pp \rightarrow \text{invisible})$

T76

This violates charge conservation as well as baryon number conservation.

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	CL%	DOCUMENT ID	TECN
>0.00005	90				⁷⁹ BACK	03 BORX

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

>0.00000055	90				⁸⁰ BERNABEI	00B DAMA
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⁷⁹BACK 03 looks for decays of unstable nuclides left after NN decays of parent ^{12}C , ^{13}C , ^{16}O nuclei. These are "invisible channel" limits.

⁸⁰BERNABEI 00B looks for the decay of a $^{127}_{52}\text{Te}$ nucleus following the disappearance of a pp pair in the otherwise-stable $^{129}_{54}\text{Xe}$ nucleus.

\bar{p} PARTIAL MEAN LIVES

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

$\tau(\bar{p} \rightarrow e^- \gamma)$

T77

VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT
> 7×10^5	90	GEER 00	APEX	8.9 GeV/c \bar{p} beam

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

>1848	95	GEER 94	CALO	8.9 GeV/c \bar{p} beam
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$\tau(\bar{p} \rightarrow \mu^- \gamma)$

T78

VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT
> 5×10^4	90	GEER 00	APEX	8.9 GeV/c \bar{p} beam

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

> 5.0×10^4	90	HU 98B	APEX	8.9 GeV/c \bar{p} beam
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$\tau(\bar{p} \rightarrow e^- \pi^0)$

T79

VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT
> 4×10^5	90	GEER 00	APEX	8.9 GeV/c \bar{p} beam

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

>554	95	GEER 94	CALO	8.9 GeV/c \bar{p} beam
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$\tau(\bar{p} \rightarrow \mu^- \pi^0)$

T80

VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT
> 5×10^4	90	GEER 00	APEX	8.9 GeV/c \bar{p} beam

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

> 4.8×10^4	90	HU 98B	APEX	8.9 GeV/c \bar{p} beam
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$\tau(\bar{p} \rightarrow e^- \eta)$

T81

VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT
> 2×10^4	90	GEER 00	APEX	8.9 GeV/c \bar{p} beam

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

>171	95	GEER 94	CALO	8.9 GeV/c \bar{p} beam
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$\tau(\bar{p} \rightarrow \mu^- \eta)$ **T82**

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$>8 \times 10^3$	90	GEER 00	APEX	8.9 GeV/c \bar{p} beam
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$>7.9 \times 10^3$	90	HU 98B	APEX	8.9 GeV/c \bar{p} beam

$\tau(\bar{p} \rightarrow e^- K_S^0)$ **T83**

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
>900	90	GEER 00	APEX	8.9 GeV/c \bar{p} beam
• • • We do not use the following data for averages, fits, limits, etc. • • •				
> 29	95	GEER 94	CALO	8.9 GeV/c \bar{p} beam

$\tau(\bar{p} \rightarrow \mu^- K_S^0)$ **T84**

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$>4 \times 10^3$	90	GEER 00	APEX	8.9 GeV/c \bar{p} beam
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$>4.3 \times 10^3$	90	HU 98B	APEX	8.9 GeV/c \bar{p} beam

$\tau(\bar{p} \rightarrow e^- K_L^0)$ **T85**

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$>9 \times 10^3$	90	GEER 00	APEX	8.9 GeV/c \bar{p} beam
• • • We do not use the following data for averages, fits, limits, etc. • • •				
>9	95	GEER 94	CALO	8.9 GeV/c \bar{p} beam

$\tau(\bar{p} \rightarrow \mu^- K_L^0)$ **T86**

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$>7 \times 10^3$	90	GEER 00	APEX	8.9 GeV/c \bar{p} beam
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$>6.5 \times 10^3$	90	HU 98B	APEX	8.9 GeV/c \bar{p} beam

$\tau(\bar{p} \rightarrow e^- \gamma \gamma)$ **T87**

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$>2 \times 10^4$	90	GEER 00	APEX	8.9 GeV/c \bar{p} beam

$\tau(\bar{p} \rightarrow \mu^- \gamma \gamma)$ **T88**

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$>2 \times 10^4$	90	GEER 00	APEX	8.9 GeV/c \bar{p} beam
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$>2.3 \times 10^4$	90	HU 98B	APEX	8.9 GeV/c \bar{p} beam

$\tau(\bar{p} \rightarrow e^- \rho)$ **T89**

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
>200	90	⁸¹ GEER 00	APEX	8.9 GeV/c \bar{p} beam

⁸¹ This GEER 00 measurement has been withdrawn; see GEER 00C.

$\tau(\bar{p} \rightarrow e^- \omega)$ 790					
VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT	
>200	90	GEER	00	APEX	8.9 GeV/c \bar{p} beam

$\tau(\bar{p} \rightarrow e^- K^*(892)^0)$ 791					
VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT	

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

>1 × 10 ³	90	⁸² GEER	00	APEX	8.9 GeV/c \bar{p} beam
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⁸² This GEER 00 measurement has been withdrawn; see GEER 00C.

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