



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

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>
1.007276466879 ± 0.000000000091	MOHR	16	RVUE 2014 CODATA value
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1.007276466812 ± 0.000000000090	MOHR	12	RVUE 2010 CODATA value
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 ± 0.000000012	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, $1 u = 931.494 0054(57) \text{ MeV}/c^2$ (MOHR 16, the 2014 CODATA value), involves the relatively poorly known electronic charge.

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
938.2720813 ± 0.0000058	MOHR	16	RVUE 2014 CODATA value
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
938.272046 ± 0.000021	MOHR	12	RVUE 2010 CODATA value
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

¹HORI 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, $|q_{\bar{p}}|/(q_p/m_p)$

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	¹ GABRIELSE 95	TRAP	Penning trap
1.000000023 ± 0.000000042	² GABRIELSE 90	TRAP	Penning trap

¹ Equation (2) of GABRIELSE 95 should read $M(\bar{p})/M(p) = 0.999\,999\,9985$ (11) (G. Gabrielse, private communication).

² 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 .

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

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

<u>VALUE</u>	<u>DOCUMENT ID</u>
$(-9 \pm 9) \times 10^{-11}$ 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>
$< 7 \times 10^{-10}$	90	¹ HORI 11	SPEC	$\bar{p}e^-$ He atom
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$< 2 \times 10^{-9}$	90	¹ HORI 06	SPEC	$\bar{p}e^-$ He atom
$< 1.0 \times 10^{-8}$	90	¹ HORI 03	SPEC	$\bar{p}e^-$ ⁴ He, $\bar{p}e^-$ ³ He
$< 6 \times 10^{-8}$	90	¹ HORI 01	SPEC	$\bar{p}e^-$ He atom
$< 5 \times 10^{-7}$		² TORII 99	SPEC	$\bar{p}e^-$ He atom
$< 2 \times 10^{-5}$		³ HUGHES 92	RVUE	

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 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.

² 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.

³ 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 × 10⁻²¹	¹ BRESSI 11	Neutrality of SF ₆
• • • We do not use the following data for averages, fits, limits, etc. • • •		
<3.2 × 10 ⁻²⁰	² SENGUPTA 00	binary pulsar
<0.8 × 10 ⁻²¹	MARINELLI 84	Magnetic levitation
<1.0 × 10 ⁻²¹	¹ DYLLA 73	Neutrality of SF ₆

¹ 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.

² 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>
2.7928473508 ± 0.0000000085	MOHR 16	RVUE	2014 CODATA value
• • • We do not use the following data for averages, fits, limits, etc. • • •			
2.792847356 ± 0.000000023	MOHR 12	RVUE	2010 CODATA value
2.792847356 ± 0.000000023	MOHR 08	RVUE	2006 CODATA value
2.792847351 ± 0.000000028	MOHR 05	RVUE	2002 CODATA value
2.792847337 ± 0.000000029	MOHR 99	RVUE	1998 CODATA value
2.792847386 ± 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		¹ 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		² WILKENING	84	
900 ± 1400		³ WILKENING	84	
700 ± 900	1G	HARRISON	69	MBR Molecular beam

¹ DMITRIEV 03 calculates this limit from the limit on the electric dipole moment of the ¹⁹⁹Hg atom.

² This WILKENING 84 value includes a finite-size effect and a magnetic effect.

³ 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 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	¹ BEANE	03	EFT + γp
11.82±0.98 ^{+0.52} _{-0.98}	² BLANPIED	01	LEGS $p(\vec{\gamma}, \gamma)$, $p(\vec{\gamma}, \pi^0)$, $p(\vec{\gamma}, \pi^+)$
11.9 ±0.5 ±1.3	³ OLMOSDEL...	01	CNTR γp Compton scattering
12.1 ±0.8 ±0.5	⁴ MACGIBBON	95	RVUE global average
●●● We do not use the following data for averages, fits, limits, etc. ●●●			
11.7 ±0.8 ±0.7	⁵ 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	⁶ FEDERSPIEL	91	CNTR γp Compton scattering

- ¹ 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 $\beta_N = (-1.8 \pm 1.9_{-0.9}^{+2.1}) \times 10^{-4} \text{ fm}^3$.
- ² 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.
- ³ 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.
- ⁴ 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.
- ⁵ 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 $\alpha_p + \beta_p$.
- ⁶ 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	¹ BEANE	03	EFT + γp
1.43 ± 0.98 $_{-0.98}^{+0.52}$	² BLANPIED	01	LEGS $p(\vec{\gamma}, \gamma)$, $p(\vec{\gamma}, \pi^0)$, $p(\vec{\gamma}, \pi^+)$
1.2 ± 0.7 ± 0.5	³ OLMOSDEL...	01	CNTR γp Compton scattering
2.1 ± 0.8 ± 0.5	⁴ MACGIBBON	95	RVUE global average
• • • We do not use the following data for averages, fits, limits, etc. • • •			
2.3 ± 0.9 ± 0.7	⁵ 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 $_{-1.25}^{+1.19} + 1.03$	ZIEGER	92	CNTR γp Compton scattering
3.3 ± 2.2 ± 1.3	FEDERSPIEL	91	CNTR γp Compton scattering

- ¹ 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 $\beta_N = (-1.8 \pm 1.9_{-0.9}^{+2.1}) \times 10^{-4} \text{ fm}^3$.
- ² 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.
- ³ 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.
- ⁴ 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.

⁵ 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 $r_p = 0.879(8)$ fm (BERNAUER 10). The CODATA 14 value (MOHR 16), obtained from the electronic results, is 0.8751(61). Compared to this CODATA value, however, a measurement using muonic hydrogen finds $r_p = 0.84087(39)$ fm (ANTOIGNINI 13), which is 16 times more precise but differs by 5.6 standard deviations (using the CODATA 14 error).

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, HILL 11, LORENZ 14, KARSHENBOIM 14A, and PESET 15.

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.

See our 2014 edition (*Chinese Physics C* **38** 070001 (2014)) for values published before 2003.

<u>VALUE (fm)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.8751 ± 0.0061	MOHR	16	RVUE 2014 CODATA value
0.84087 ± 0.00026 ± 0.00029	ANTOIGNINI	13	LASR μp -atom Lamb shift
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.895 ± 0.014 ± 0.014	¹ LEE	15	SPEC Just 2010 Mainz data
0.916 ± 0.024	LEE	15	SPEC World data, no Mainz
0.8775 ± 0.0051	MOHR	12	RVUE 2010 CODATA, ep data
0.875 ± 0.008 ± 0.006	ZHAN	11	SPEC Recoil polarimetry
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 + 0.008 - 0.004	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

¹ Authors also provide values for combinations of all available data.

p MAGNETIC RADIUS

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

<u>VALUE (fm)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$0.776 \pm 0.034 \pm 0.017$	¹ LEE	15	SPEC Just 2010 Mainz data
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.914 ± 0.035	LEE	15	SPEC World data, no Mainz
0.87 ± 0.02	EPSTEIN	14	Using ep , en , $\pi\pi$ data
$0.867 \pm 0.009 \pm 0.018$	ZHAN	11	SPEC Recoil polarimetry
$0.777 \pm 0.013 \pm 0.010$	BERNAUER	10	SPEC $ep \rightarrow ep$ form factor
$0.876 \pm 0.010 \pm 0.016$	BORISYUK	10	Reanalyzes old $ep \rightarrow ep$ data
0.854 ± 0.005	BELUSHKIN	07	Dispersion analysis

¹ Authors also provide values for a combination of all available data.

 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.

<u>LIMIT (years)</u>	<u>PARTICLE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$> 5.8 \times 10^{29}$	n	90	¹ ARAKI	06	KLND $n \rightarrow$ invisible
$> 2.1 \times 10^{29}$	p	90	² AHMED	04	SNO $p \rightarrow$ invisible
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
$> 1.9 \times 10^{29}$	n	90	² AHMED	04	SNO $n \rightarrow$ invisible
$> 1.8 \times 10^{25}$	n	90	³ BACK	03	BORX
$> 1.1 \times 10^{26}$	p	90	³ BACK	03	BORX
$> 3.5 \times 10^{28}$	p	90	⁴ ZDESENKO	03	$p \rightarrow$ invisible
$> 1 \times 10^{28}$	p	90	⁵ AHMAD	02	SNO $p \rightarrow$ invisible
$> 4 \times 10^{23}$	p	95	TRETYAK	01	$d \rightarrow n + ?$
$> 1.9 \times 10^{24}$	p	90	⁶ BERNABEI	00B	DAMA
$> 1.6 \times 10^{25}$	p, n		^{7,8} EVANS	77	
$> 3 \times 10^{23}$	p		⁸ DIX	70	CNTR
$> 3 \times 10^{23}$	p, n		^{8,9} FLEROV	58	

¹ ARAKI 06 looks for signs of de-excitation of the residual nucleus after disappearance of a neutron from the s shell of ^{12}C .

² AHMED 04 looks for γ rays from the de-excitation of a residual $^{15}\text{O}^*$ or $^{15}\text{N}^*$ following the disappearance of a neutron or proton in ^{16}O .

³ BACK 03 looks for decays of unstable nuclides left after N decays of parent ^{12}C , ^{13}C , ^{16}O nuclei. These are “invisible channel” limits.

⁴ ZDESENKO 03 gets this limit on proton disappearance in deuterium by analyzing SNO data in AHMAD 02.

⁵ AHMAD 02 (see its footnote 7) looks for neutrons left behind after the disappearance of the proton in deuterons.

⁶ 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.

⁷ EVANS 77 looks for the daughter nuclide ^{129}Xe from possible ^{130}Te decays in ancient Te ore samples.

⁸ This mean-life limit has been obtained from a half-life limit by dividing the latter by $\ln(2) = 0.693$.

⁹ 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.

LIMIT (years)	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$>8 \times 10^5$	90		¹ 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

¹ 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.

p 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		
$\tau_1 \quad N \rightarrow e^+ \pi$	$> 2000 (n), > 8200 (p)$	90%
$\tau_2 \quad N \rightarrow \mu^+ \pi$	$> 1000 (n), > 6600 (p)$	90%
$\tau_3 \quad N \rightarrow \nu \pi$	$> 1100 (n), > 390 (p)$	90%
$\tau_4 \quad p \rightarrow e^+ \eta$	> 4200	90%
$\tau_5 \quad p \rightarrow \mu^+ \eta$	> 1300	90%
$\tau_6 \quad n \rightarrow \nu \eta$	> 158	90%
$\tau_7 \quad N \rightarrow e^+ \rho$	$> 217 (n), > 710 (p)$	90%
$\tau_8 \quad N \rightarrow \mu^+ \rho$	$> 228 (n), > 160 (p)$	90%
$\tau_9 \quad N \rightarrow \nu \rho$	$> 19 (n), > 162 (p)$	90%
$\tau_{10} \quad p \rightarrow e^+ \omega$	> 320	90%
$\tau_{11} \quad p \rightarrow \mu^+ \omega$	> 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}	$N \rightarrow \nu K$	$> 86 (n), > 5900 (p)$	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}	$n \rightarrow \nu \gamma$	> 550	90%
τ_{45}	$p \rightarrow e^+ \gamma \gamma$	> 100	90%
τ_{46}	$n \rightarrow \nu \gamma \gamma$	> 219	90%

Antilepton + single massless

τ_{47}	$p \rightarrow e^+ X$	> 790	90%
τ_{48}	$p \rightarrow \mu^+ X$	> 410	90%

Three (or more) leptons

τ_{49}	$p \rightarrow e^+ e^+ e^-$	> 793	90%
τ_{50}	$p \rightarrow e^+ \mu^+ \mu^-$	> 359	90%
τ_{51}	$p \rightarrow e^+ \nu \nu$	> 170	90%
τ_{52}	$n \rightarrow e^+ e^- \nu$	> 257	90%
τ_{53}	$n \rightarrow \mu^+ e^- \nu$	> 83	90%
τ_{54}	$n \rightarrow \mu^+ \mu^- \nu$	> 79	90%
τ_{55}	$p \rightarrow \mu^+ e^+ e^-$	> 529	90%
τ_{56}	$p \rightarrow \mu^+ \mu^+ \mu^-$	> 675	90%
τ_{57}	$p \rightarrow \mu^+ \nu \nu$	> 220	90%
τ_{58}	$p \rightarrow e^- \mu^+ \mu^+$	> 6	90%
τ_{59}	$n \rightarrow 3\nu$	$> 5 \times 10^{-4}$	90%
τ_{60}	$n \rightarrow 5\nu$		

Inclusive modes

τ_{61}	$N \rightarrow e^+$ anything	> 0.6 (n, p)	90%
τ_{62}	$N \rightarrow \mu^+$ anything	> 12 (n, p)	90%
τ_{63}	$N \rightarrow \nu$ anything		
τ_{64}	$N \rightarrow e^+ \pi^0$ anything	> 0.6 (n, p)	90%
τ_{65}	$N \rightarrow 2$ bodies, ν -free		

 $\Delta B = 2$ dinucleon modes

The following are lifetime limits per iron nucleus.

τ_{66}	$pp \rightarrow \pi^+ \pi^+$	> 72.2	90%
τ_{67}	$pn \rightarrow \pi^+ \pi^0$	> 170	90%
τ_{68}	$nn \rightarrow \pi^+ \pi^-$	> 0.7	90%
τ_{69}	$nn \rightarrow \pi^0 \pi^0$	> 404	90%
τ_{70}	$pp \rightarrow K^+ K^+$	> 170	90%
τ_{71}	$pp \rightarrow e^+ e^+$	> 5.8	90%
τ_{72}	$pp \rightarrow e^+ \mu^+$	> 3.6	90%
τ_{73}	$pp \rightarrow \mu^+ \mu^+$	> 1.7	90%
τ_{74}	$pn \rightarrow e^+ \bar{\nu}$	> 260	90%
τ_{75}	$pn \rightarrow \mu^+ \bar{\nu}$	> 200	90%
τ_{76}	$pn \rightarrow \tau^+ \bar{\nu}_\tau$	> 29	90%
τ_{77}	$nn \rightarrow \nu_e \bar{\nu}_e$	> 1.4	90%
τ_{78}	$nn \rightarrow \nu_\mu \bar{\nu}_\mu$	> 1.4	90%
τ_{79}	$pn \rightarrow$ invisible	$> 2.1 \times 10^{-5}$	90%
τ_{80}	$pp \rightarrow$ invisible	$> 5 \times 10^{-5}$	90%

\bar{p} DECAY MODES

Mode	Partial mean life (years)	Confidence level
$\tau_{81} \quad \bar{p} \rightarrow e^- \gamma$	$> 7 \times 10^5$	90%
$\tau_{82} \quad \bar{p} \rightarrow \mu^- \gamma$	$> 5 \times 10^4$	90%
$\tau_{83} \quad \bar{p} \rightarrow e^- \pi^0$	$> 4 \times 10^5$	90%
$\tau_{84} \quad \bar{p} \rightarrow \mu^- \pi^0$	$> 5 \times 10^4$	90%
$\tau_{85} \quad \bar{p} \rightarrow e^- \eta$	$> 2 \times 10^4$	90%
$\tau_{86} \quad \bar{p} \rightarrow \mu^- \eta$	$> 8 \times 10^3$	90%
$\tau_{87} \quad \bar{p} \rightarrow e^- K_S^0$	> 900	90%
$\tau_{88} \quad \bar{p} \rightarrow \mu^- K_S^0$	$> 4 \times 10^3$	90%
$\tau_{89} \quad \bar{p} \rightarrow e^- K_L^0$	$> 9 \times 10^3$	90%
$\tau_{90} \quad \bar{p} \rightarrow \mu^- K_L^0$	$> 7 \times 10^3$	90%
$\tau_{91} \quad \bar{p} \rightarrow e^- \gamma \gamma$	$> 2 \times 10^4$	90%
$\tau_{92} \quad \bar{p} \rightarrow \mu^- \gamma \gamma$	$> 2 \times 10^4$	90%
$\tau_{93} \quad \bar{p} \rightarrow e^- \omega$	> 200	90%

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	¹ 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	<i>p</i>	90	0	0.3	HAINES	86	IMB
> 31	<i>n</i>	90	8	9	HAINES	86	IMB
> 64	<i>p</i>	90	0	<0.4	ARISAKA	85	KAMI
> 26	<i>n</i>	90	0	<0.7	ARISAKA	85	KAMI
> 82	<i>p</i> (free)	90	0	0.2	BLEWITT	85	IMB
> 250	<i>p</i>	90	0	0.2	BLEWITT	85	IMB
> 25	<i>n</i>	90	4	4	PARK	85	IMB
> 15	<i>p, n</i>	90	0		BATTISTONI	84	NUSX
> 0.5	<i>p</i>	90	1	0.3	² BARTELT	83	SOUD
> 0.5	<i>n</i>	90	1	0.3	² BARTELT	83	SOUD
> 5.8	<i>p</i>	90	2		³ KRISHNA...	82	KOLR
> 5.8	<i>n</i>	90	2		³ KRISHNA...	82	KOLR
> 0.1	<i>n</i>	90			⁴ GURR	67	CNTR

¹ This BECKER-SZENDY 90 result includes data from SEIDEL 88.

² Limit based on zero events.

³ We have calculated 90% CL limit from 1 confined event.

⁴ We have converted half-life to 90% CL mean life.

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

τ_2

<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	<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

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

τ_3

<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>
> 390	<i>p</i>	90	52.8		ABE 14E	SKAM
>1100	<i>n</i>	90	19.1		ABE 14E	SKAM

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

> 16	p	90	6	6.7	WALL	00B	SOU2
> 39	n	90	4	3.8	WALL	00B	SOU2
> 10	p	90	15	20.3	MCGREW	99	IMB3
> 112	n	90	6	6.6	MCGREW	99	IMB3
> 13	n	90	1	1.2	BERGER	89	FREJ
> 10	p	90	11	14	BERGER	89	FREJ
> 25	p	90	32	32.8	¹ HIRATA	89C	KAMI
> 100	n	90	1	3	HIRATA	89C	KAMI
> 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		² KRISHNA...	82	KOLR
> 0.3	p	90	2		³ CHERRY	81	HOME
> 0.1	p	90			⁴ GURR	67	CNTR

¹In 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.

²We have calculated 90% CL limit from 1 confined event.

³We have converted 2 possible events to 90% CL limit.

⁴We have converted half-life to 90% CL mean life.

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

T4

<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>
>4200	p	90	0	0.44	NISHINO	12 SKAM

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

> 81	p	90	1	1.7	WALL	00B	SOU2
> 313	p	90	0	0.2	MCGREW	99	IMB3
> 44	p	90	0	0.1	BERGER	91	FREJ
> 140	p	90	0	<0.04	HIRATA	89C	KAMI
> 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		¹ CHERRY	81	HOME

¹We have converted 2 possible events to 90% CL limit.

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

T5

<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>
>1300	p	90	2	0.49	NISHINO	12 SKAM

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

> 89	p	90	0	1.6	WALL	00B	SOU2
> 126	p	90	3	2.8	MCGREW	99	IMB3
> 26	p	90	1	0.8	BERGER	91	FREJ
> 69	p	90	1	<0.08	HIRATA	89C	KAMI
> 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

<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>
>158	n	90	0	1.2	MCGREW	99 IMB3

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

> 71	n	90	2	3.7	WALL	00B	SOU2
> 29	n	90	0	0.9	BERGER	89	FREJ
> 54	n	90	2	0.9	HIRATA	89C	KAMI
> 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		¹ CHERRY	81	HOME

¹We have converted 2 possible events to 90% CL limit.

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

τ_7

<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	p	90	0	0.35	NISHINO	12 SKAM
>217	n	90	4	4.8	MCGREW	99 IMB3

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

> 70	n	90	1	0.38	NISHINO	12	SKAM
> 29	p	90	0	2.2	BERGER	91	FREJ
> 41	n	90	0	1.4	BERGER	91	FREJ
> 75	p	90	2	2.7	HIRATA	89C	KAMI
> 58	n	90	0	1.9	HIRATA	89C	KAMI
> 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	<i>n</i>	90	1	0.3	¹ BARTELT	83	SOUD
> 0.5	<i>p</i>	90	1	0.3	¹ BARTELT	83	SOUD
> 9.8	<i>p</i>	90	1		² KRISHNA...	82	KOLR
> 0.8	<i>p</i>	90	2		³ CHERRY	81	HOME

¹ Limit based on zero events.

² We have calculated 90% CL limit from 0 confined events.

³ 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

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

T9

<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	<i>p</i>	90	18	21.7	MCGREW	99 IMB3
> 19	<i>n</i>	90	0	0.5	SEIDEL	88 IMB

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

> 9	<i>n</i>	90	4	2.4	BERGER	89 FREJ
> 24	<i>p</i>	90	0	0.9	BERGER	89 FREJ
> 27	<i>p</i>	90	5	1.5	HIRATA	89C KAMI
> 13	<i>n</i>	90	4	3.6	HIRATA	89C KAMI
> 13	<i>p</i>	90	1	1.1	SEIDEL	88 IMB
> 8	<i>p</i>	90	6	5	HAINES	86 IMB
> 2	<i>n</i>	90	15	10	HAINES	86 IMB
> 11	<i>p</i>	90	2	1	KAJITA	86 KAMI
> 4	<i>n</i>	90	2	2	KAJITA	86 KAMI
> 4.1	<i>p</i> (free)	90	6	7	BLEWITT	85 IMB
> 8.4	<i>p</i>	90	6	5	BLEWITT	85 IMB
> 2	<i>n</i>	90	7	3	PARK	85 IMB
> 0.9	<i>p</i>	90	2		¹ CHERRY	81 HOME
> 0.6	<i>n</i>	90	2		¹ CHERRY	81 HOME

¹ We 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	¹ BARTELT	83 SOUD
> 9.8	p	90	1		² KRISHNA...	82 KOLR
> 2.8	p	90	2		³ CHERRY	81 HOME

¹ Limit based on zero events.² We have calculated 90% CL limit from 0 confined events.³ We 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		¹ CHERRY	81 HOME

¹ We 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>
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>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>
• • • 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>
>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		¹ 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		² BARTELT	83	SOUD
> 0.4	n	90	0		² BARTELT	83	SOUD
> 5.8	p	90	2		³ KRISHNA...	82	KOLR
> 2.0	p	90	0		CHERRY	81	HOME
> 0.2	n	90			⁴ GURR	67	CNTR

¹ BARTELT 87 limit applies to $p \rightarrow \mu^+ K_S^0$.

² Limit based on zero events.

³ We have calculated 90% CL limit from 1 confined event.

⁴ We have converted half-life to 90% CL mean life.

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

τ_{17}

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. • • •

>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}

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. • • •

>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}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN
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>5900	p	90	0	1.0	ABE	14G	SKAM
> 86	n	90	0	2.4	HIRATA	89C	KAMI

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

> 540	p	90	0	0.9	ASAKURA	15	KLND
>2300	p	90	0	1.3	KOBAYASHI	05	SKAM
> 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	¹ 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		² BARTELT	87	SOUD
> 10	p	90	6	5	HAINES	86	IMB

> 15	<i>n</i>	90	3 5	HAINES	86	IMB
> 28	<i>p</i>	90	3 3	KAJITA	86	KAMI
> 32	<i>n</i>	90	0 1.4	KAJITA	86	KAMI
> 1.8	<i>p</i> (free)	90	6 11	BLEWITT	85	IMB
> 9.6	<i>p</i>	90	6 5	BLEWITT	85	IMB
> 10	<i>n</i>	90	2 2	PARK	85	IMB
> 5	<i>n</i>	90	0	BATTISTONI	84	NUSX
> 2	<i>p</i>	90	0	BATTISTONI	84	NUSX
> 0.3	<i>n</i>	90	0	³ BARTELT	83	SOUD
> 0.1	<i>p</i>	90	0	³ BARTELT	83	SOUD
> 5.8	<i>p</i>	90	1	⁴ KRISHNA...	82	KOLR
> 0.3	<i>n</i>	90	2	⁵ CHERRY	81	HOME

¹ This ALLISON 98 limit is with no background subtraction; with subtraction the limit becomes $> 46 \times 10^{30}$ years.

² BARTELT 87 limit applies to $n \rightarrow \nu K_S^0$.

³ Limit based on zero events.

⁴ We have calculated 90% CL limit from 1 confined event.

⁵ 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	<i>n</i>	90	34	30	¹ KOBAYASHI 05	SKAM

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

> 51	<i>n</i>	90	16	9.1	WALL	00	SOU2
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¹ We have doubled the $n \rightarrow \nu K^0$ 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	<i>p</i>	90	38	52.0	MCGREW	99	IMB3

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

>10	<i>p</i>	90	0	0.8	BERGER	91	FREJ
>52	<i>p</i>	90	2	1.55	HIRATA	89C	KAMI
>10	<i>p</i>	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	<i>p</i>	90	7	9.1	MCGREW	99	IMB3
>78	<i>n</i>	90	40	50	MCGREW	99	IMB3

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

>22	<i>n</i>	90	0	2.1	BERGER	89	FREJ
>17	<i>p</i>	90	0	2.4	BERGER	89	FREJ
>20	<i>p</i>	90	5	2.1	HIRATA	89C	KAMI
>21	<i>n</i>	90	4	2.4	HIRATA	89C	KAMI
>10	<i>p</i>	90	7	6	HAINES	86	IMB
> 5	<i>n</i>	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		¹ BATTISTONI	82	NUSX

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

————— Antilepton + mesons —————

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

T23

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

T24

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

T25

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

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
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$\tau(n \rightarrow \mu^+ \pi^- \pi^0)$ **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	<i>n</i>	90	17	20.8	MCGREW 99	IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>33	<i>n</i>	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	<i>n</i>	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	<i>n</i>	90	0	1.6	SEIDEL 88	IMB
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>55	<i>n</i>	90	0	1.09	BERGER 91B	FREJ
>16	<i>n</i>	90	9	7	HAINES 86	IMB
>25	<i>n</i>	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	<i>n</i>	90	0	0.5	SEIDEL 88	IMB
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>33	<i>n</i>	90	0	1.40	BERGER 91B	FREJ
> 2.7	<i>n</i>	90	0	0.7	PHILLIPS 89	HPW
>25	<i>n</i>	90	7	6	HAINES 86	IMB
>27	<i>n</i>	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

$\tau(p \rightarrow \mu^- \pi^+ K^+)$ **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	p	90	3	4.0	MCGREW 99	IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 5	p	90	2	0.78	BERGER 91B	FREJ

————— **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	p	90	0	0.1	MCGREW 99	IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>133	p	90	0	0.3	BERGER 91	FREJ
>460	p	90	0	0.6	SEIDEL 88	IMB
>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			¹ GURR 67	CNTR

¹We 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	p	90	0	0.1	MCGREW 99	IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>155	p	90	0	0.1	BERGER 91	FREJ
>380	p	90	0	0.5	SEIDEL 88	IMB
> 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			¹ GURR 67	CNTR

¹We 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>
>550		90			TAKHISTOV 15	SKAM
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 28	n	90	163	144.7	MCGREW 99	IMB3
> 24	n	90	10	6.86	BERGER 91B	FREJ
> 9	n	90	73	60	HAINES 86	IMB
> 11	n	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	p	90	1	0.8	BERGER 91	FREJ

$\tau(n \rightarrow \nu \gamma \gamma)$ T46

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

————— Antilepton + single massless —————

$\tau(p \rightarrow e^+ X)$ T47

VALUE (10^{30} years)	CL%	DOCUMENT ID	TECN
>790	90	TAKHISTOV 15	SKAM

$\tau(p \rightarrow \mu^+ X)$ T48

VALUE (10^{30} years)	CL%	DOCUMENT ID	TECN
>410	90	TAKHISTOV 15	SKAM

————— Three (or more) leptons —————

$\tau(p \rightarrow e^+ e^+ e^-)$ T49

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

$\tau(p \rightarrow e^+ \mu^+ \mu^-)$ T50

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

$\tau(p \rightarrow e^+ \nu \nu)$ T51

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN
>170	<i>p</i>	90			¹ TAKHISTOV	14 SKAM

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

> 17	<i>p</i>	90	152	153.7	MCGREW	99 IMB3
> 11	<i>p</i>	90	11	6.08	BERGER	91B FREJ

¹ Allowed events at 90% CL are 459.

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

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>
>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

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

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>
>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

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

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>
>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

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

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>
>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

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

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>
>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		¹ BATTISTONI	82 NUSX

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

$\tau(p \rightarrow \mu^+ \nu \nu)$ **T57**

<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>
>220	p	90			¹ TAKHISTOV 14	SKAM
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 21	p	90	7	11.23	BERGER 91B	FREJ

¹ Allowed events at 90% CL are 286.

$\tau(p \rightarrow e^- \mu^+ \mu^+)$ **T58**

<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	p	90	0	0.7	PHILLIPS 89	HPW

$\tau(n \rightarrow 3\nu)$ **T59**

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	n	90	2	2	¹ SUZUKI 93B	KAMI
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>0.0023	n	90			² GLICENSTEIN 97	KAMI
>0.00003	n	90	11	6.1	³ BERGER 91B	FREJ
>0.00012	n	90	7	11.2	³ BERGER 91B	FREJ
>0.0005	n	90	0		LEARNED 79	RVUE

¹ The SUZUKI 93B limit applies to any of $\nu_e \nu_e \bar{\nu}_e$, $\nu_\mu \nu_\mu \bar{\nu}_\mu$, or $\nu_\tau \nu_\tau \bar{\nu}_\tau$.

² GLICENSTEIN 97 uses Kamioka data and the idea that the disappearance of the neutron’s magnetic moment should produce radiation.

³ The first BERGER 91B limit is for $n \rightarrow \nu_e \nu_e \bar{\nu}_e$, the second is for $n \rightarrow \nu_\mu \nu_\mu \bar{\nu}_\mu$.

$\tau(n \rightarrow 5\nu)$ **T60**

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>
>0.0017	n	90			¹ GLICENSTEIN 97	KAMI

¹ GLICENSTEIN 97 uses Kamioka data and the idea that the disappearance of the neutron’s magnetic moment should produce radiation.

———— Inclusive modes ————

$\tau(N \rightarrow e^+ \text{ anything})$ **T61**

<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	p, n	90			¹ LEARNED 79	RVUE

¹ The electron may be primary or secondary.

$\tau(N \rightarrow \mu^+ \text{anything})$ T62

<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	p, n	90	2		1,2 CHERRY	81 HOME
> 1.8	p, n	90			2 COWSIK	80 CNTR
> 6	p, n	90			2 LEARNED	79 RVUE

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

¹ We have converted 2 possible events to 90% CL limit.

² The muon may be primary or secondary.

$\tau(N \rightarrow \nu \text{anything})$ T63

Anything = π, ρ, K , etc.

<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>
>0.0002	p, n	90	0		LEARNED	79 RVUE

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

$\tau(N \rightarrow e^+ \pi^0 \text{anything})$ T64

<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	p, n	90	0		LEARNED	79 RVUE

$\tau(N \rightarrow 2 \text{ bodies}, \nu\text{-free})$ T65

<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>
>1.3	p, n	90	0		ALEKSEEV	81 BAKS

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

———— **$\Delta B = 2$ dinucleon modes** ————

$\tau(pp \rightarrow \pi^+ \pi^+)$ T66

<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>
>72.2	90	2	4.45	GUSTAFSON	15 SKAM	per oxygen nucleus
> 0.7	90	4	2.34	BERGER	91B FREJ	per iron nucleus

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

$\tau(pn \rightarrow \pi^+ \pi^0)$ T67

<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>
>170	90			GUSTAFSON	15 SKAM	per oxygen nucleus
> 2.0	90	0	0.31	BERGER	91B FREJ	per iron nucleus

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

$\tau(nn \rightarrow \pi^+ \pi^-)$ T68

<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>
>0.7	90	4	2.18	BERGER	91B FREJ	τ per iron nucleus

$\tau(nn \rightarrow \pi^0 \pi^0)$ **T69**

<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>
>404	90			GUSTAFSON	15	SKAM per oxygen nucleus
• • • We do not use the following data for averages, fits, limits, etc. • • •						
> 3.4	90	0	0.78	BERGER	91B	FREJ per iron nucleus

 $\tau(pp \rightarrow K^+ K^+)$ **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>
>170	90	0	0.28	LITOS	14	SKAM τ per oxygen nucleus

 $\tau(pp \rightarrow e^+ e^+)$ **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>
>5.8	90	0	<0.1	BERGER	91B	FREJ τ per iron nucleus

 $\tau(pp \rightarrow e^+ \mu^+)$ **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>
>3.6	90	0	<0.1	BERGER	91B	FREJ τ per iron nucleus

 $\tau(pp \rightarrow \mu^+ \mu^+)$ **T73**

<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

 $\tau(pn \rightarrow e^+ \bar{\nu})$ **T74**

<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>
>260	90			TAKHISTOV	15	SKAM
• • • We do not use the following data for averages, fits, limits, etc. • • •						
> 2.8	90	5	9.67	BERGER	91B	FREJ τ per iron nucleus

 $\tau(pn \rightarrow \mu^+ \bar{\nu})$ **T75**

<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>
>200	90			TAKHISTOV	15	SKAM
• • • We do not use the following data for averages, fits, limits, etc. • • •						
> 1.6	90	4	4.37	BERGER	91B	FREJ τ per iron nucleus

 $\tau(pn \rightarrow \tau^+ \bar{\nu}_\tau)$ **T76**

<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>
>29	90			TAKHISTOV	15	SKAM
• • • We do not use the following data for averages, fits, limits, etc. • • •						
> 1	90			¹ BRYMAN	14	CHER

¹BRYMAN 14 uses a MCGREW 99 limit on the $p \rightarrow e^+ \nu \nu$ lifetime to extract this value.

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

T77

We include "invisible" modes here.

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN	COMMENT
>1.4	90			¹ ARAKI	06 KLND	$nn \rightarrow$ invisible
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>0.000042	90			² TRETYAK	04 CNTR	$nn \rightarrow$ invisible
>0.000049	90			³ BACK	03 BORX	$nn \rightarrow$ invisible
>0.000012	90			⁴ BERNABEI	00B DAMA	$nn \rightarrow$ invisible
>0.000012	90	5	9.7	BERGER	91B FREJ	τ per iron nucleus

¹ ARAKI 06 looks for signs of de-excitation of the residual nucleus after disappearance of two neutrons from the *s* shell of ¹²C.

² TRETYAK 04 uses data from an old Homestake-mine radiochemical experiment on limits for invisible decays of ³⁹K to ³⁷Ar.

³ BACK 03 looks for decays of unstable nuclides left after *NN* decays of parent ¹²C, ¹³C, ¹⁶O nuclei. These are "invisible channel" limits.

⁴ BERNABEI 00B looks for the decay of a ¹²⁷₅₄Xe nucleus following the disappearance of an *nn* pair in the otherwise-stable ¹²⁹₅₄Xe 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.

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

T78

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

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	CL%	DOCUMENT ID	TECN	COMMENT
>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

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

T79

This violates charge conservation as well as baryon number conservation.

VALUE (10^{30} years)	CL%	DOCUMENT ID	TECN
>0.000021	90	¹ TRETYAK 04	CNTR

¹ TRETYAK 04 uses data from an old Homestake-mine radiochemical experiment on limits for invisible decays of ³⁹K to ³⁷Ar.

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

T80

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	¹ BACK	03 BORX

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

>0.0000055	90			² BERNABEI	00B DAMA
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¹ BACK 03 looks for decays of unstable nuclides left after *NN* decays of parent ¹²C, ¹³C, ¹⁶O nuclei. These are "invisible channel" limits.

² BERNABEI 00B looks for the decay of a ¹²⁷₅₂Te nucleus following the disappearance of a *pp* pair in the otherwise-stable ¹²⁹₅₄Xe 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.

 $\tau(\bar{p} \rightarrow e^- \gamma)$ T81

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
> 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

 $\tau(\bar{p} \rightarrow \mu^- \gamma)$ T82

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
> 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

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

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
> 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

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

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
> 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

 $\tau(\bar{p} \rightarrow e^- \eta)$ T85

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
> 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

 $\tau(\bar{p} \rightarrow \mu^- \eta)$ T86

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

 $\tau(\bar{p} \rightarrow e^- K_S^0)$ T87

<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

$\tau(\bar{p} \rightarrow \mu^- K_S^0)$ **T88**

VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT
$>4 \times 10^3$	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

$\tau(\bar{p} \rightarrow e^- K_L^0)$ **T89**

VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT
$>9 \times 10^3$	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

$\tau(\bar{p} \rightarrow \mu^- K_L^0)$ **T90**

VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT
$>7 \times 10^3$	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

$\tau(\bar{p} \rightarrow e^- \gamma\gamma)$ **T91**

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

$\tau(\bar{p} \rightarrow \mu^- \gamma\gamma)$ **T92**

VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT
$>2 \times 10^4$	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

$\tau(\bar{p} \rightarrow e^- \omega)$ **T93**

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

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