



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

### **p MASS (atomic mass units u)**

The mass is known much more precisely in u (atomic mass units) than in MeV. The conversion from u to MeV,  $1 \text{ u} = 931.494013 \pm 0.000037 \text{ MeV}/c^2$  (MOHR 99, the 1998 CODATA value), involves the relatively poorly known electronic charge.

<u>VALUE (u)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>1.00727646688 ± 0.00000000013</b>	MOHR	99	RVUE 1998 CODATA value
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
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; see the previous data block. The conversion from u to MeV,  $1 \text{ u} = 931.494013 \pm 0.000037 \text{ MeV}/c^2$  (MOHR 99, the 1998 CODATA value), involves the relatively poorly known electronic charge.

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>938.271998 ± 0.000038</b>	MOHR	99	RVUE 1998 CODATA value
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
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  $\bar{p}/p$  charge-to-mass ratio, given below, is much better determined.

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>&lt;6 × 10<sup>-8</sup></b>	90	<sup>1</sup> HORI	01	SPEC $\bar{p}e^-$ He atom
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
<5 × 10 <sup>-7</sup>		<sup>2</sup> TORII	99	SPEC $\bar{p}e^-$ He atom
<sup>1</sup> HORI 01 uses the more-precisely-known constraint on the $\bar{p}$ charge-to-mass ratio of GABRIELSE 99 (see below) to get this result. This is not independent of the HORI 01 value for $ q_p + q_{\bar{p}} /e$ , below.				
<sup>2</sup> 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>
<b>0.99999999991 ± 0.00000000009</b>	GABRIELSE	99 TRAP	Penning trap
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1.0000000015 ± 0.0000000011	<sup>3</sup> GABRIELSE	95 TRAP	Penning trap
1.000000023 ± 0.000000042	<sup>4</sup> GABRIELSE	90 TRAP	Penning trap
<sup>3</sup> Equation (2) of GABRIELSE 95 should read $M(\bar{p})/M(p) = 0.999\,999\,9985$ (11) (G. Gabrielse, private communication).			
<sup>4</sup> 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 $1836.152701 \pm 0.000037$ .			

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

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

<u>VALUE</u>	<u>DOCUMENT ID</u>
<b><math>(-9 \pm 9) \times 10^{-11}</math> OUR EVALUATION</b>	

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

A test of *CPT* invariance. Note that the  $\bar{p}/p$  charge-to-mass ratio, 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>
<b><math>&lt; 6 \times 10^{-8}</math></b>	90	<sup>5</sup> HORI	01 SPEC	$\bar{p}e^-$ He atom
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
$< 5 \times 10^{-7}$		<sup>6</sup> TORII	99 SPEC	$\bar{p}e^-$ He atom
$< 2 \times 10^{-5}$		<sup>7</sup> HUGHES	92 RVUE	
<sup>5</sup> HORI 01 uses the more-precisely-known constraint on the $\bar{p}$ charge-to-mass ratio of GABRIELSE 99 (see above) to get this result. This is not independent of the HORI 01 value for $ m_p - m_{\bar{p}} /m_p$ , above.				
<sup>6</sup> 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.				
<sup>7</sup> HUGHES 92 uses recent measurements of Rydberg-energy and cyclotron-frequency ratios.				

$$|q_p + q_e|/e$$

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>COMMENT</u>
<b>&lt;1.0 × 10<sup>-21</sup></b>	<sup>8</sup> DYLLA 73	Neutrality of SF <sub>6</sub>
• • • We do not use the following data for averages, fits, limits, etc. • • •		
<3.2 × 10 <sup>-20</sup>	<sup>9</sup> SENGUPTA 00	binary pulsar
<0.8 × 10 <sup>-21</sup>	MARINELLI 84	Magnetic levitation
<sup>8</sup> Assumes that $q_n = q_p + q_e$ .		
<sup>9</sup> 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  $\Lambda$  Listings.

<u>VALUE (<math>\mu_N</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>2.792847337 ± 0.000000029</b>	MOHR	99	RVUE 1998 CODATA value
• • • We do not use the following data for averages, fits, limits, etc. • • •			
2.792847386 ± 0.000000063	COHEN	87	RVUE 1986 CODATA value
2.7928456 ± 0.0000011	COHEN	73	RVUE 1973 CODATA value

### **p̄ MAGNETIC MOMENT**

A few early results have been omitted.

<u>VALUE (<math>\mu_N</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>-2.800 ± 0.008 OUR AVERAGE</b>			
-2.8005 ± 0.0090	KREISSL	88	CNTR $\bar{p}$ <sup>208</sup> 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. Calculated from the  $p$  and  $\bar{p}$  magnetic moments, above.

<u>VALUE</u>	<u>DOCUMENT ID</u>
<b>(-2.6 ± 2.9) × 10<sup>-3</sup> OUR EVALUATION</b>	

## $\rho$ ELECTRIC DIPOLE MOMENT

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

VALUE ( $10^{-23}$ ecm)	EVTS	DOCUMENT ID	TECN	COMMENT
– <b>3.7± 6.3</b>		CHO	89 NMR	TI F molecules
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
< 400		DZUBA	85 THEO	Uses $^{129}\text{Xe}$ moment
130 ± 200		<sup>10</sup> WILKENING	84	
900 ± 1400		<sup>11</sup> WILKENING	84	
700 ± 900	1G	HARRISON	69 MBR	Molecular beam

<sup>10</sup> This WILKENING 84 value includes a finite-size effect and a magnetic effect.

<sup>11</sup> This WILKENING 84 value is more cautious than the other and excludes the finite-size effect, which relies on uncertain nuclear integrals.

## $\rho$ ELECTRIC POLARIZABILITY $\bar{\alpha}_\rho$

In the 2004 *Review*, we will probably switch to listing measurements of  $\bar{\alpha}_\rho + \bar{\beta}_\rho$  and  $\bar{\alpha}_\rho - \bar{\beta}_\rho$  instead of  $\bar{\alpha}_\rho$  and  $\bar{\beta}_\rho$  separately.

VALUE ( $10^{-4}$ fm <sup>3</sup> )	DOCUMENT ID	TECN	COMMENT
<b>12.0 ± 0.7 OUR AVERAGE</b>			
11.82 ± 0.98 <sup>+0.52</sup> / <sub>-0.98</sub>	<sup>12</sup> BLANPIED	01 LEGS	$\rho(\vec{\gamma}, \gamma)$ , $\rho(\vec{\gamma}, \pi^0)$ , $\rho(\vec{\gamma}, \pi^+)$
11.9 ± 0.5 ± 1.3	<sup>13</sup> OLMOSDEL...	01 CNTR	$\gamma\rho$ Compton scattering
12.1 ± 0.8 ± 0.5	<sup>14</sup> MACGIBBON	95 RVUE	global average
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
11.7 ± 0.8 ± 0.7	<sup>15</sup> BARANOV	01 RVUE	Global average
12.5 ± 0.6 ± 0.9	MACGIBBON	95 CNTR	$\gamma\rho$ Compton scattering
9.8 ± 0.4 ± 1.1	HALLIN	93 CNTR	$\gamma\rho$ Compton scattering
10.62 <sup>+1.25+1.07</sup> / <sub>-1.19-1.03</sub>	ZIEGER	92 CNTR	$\gamma\rho$ Compton scattering
10.9 ± 2.2 ± 1.3	<sup>16</sup> FEDERSPIEL	91 CNTR	$\gamma\rho$ Compton scattering

<sup>12</sup> BLANPIED 01 gives  $\bar{\alpha}_\rho + \bar{\beta}_\rho$  and  $\bar{\alpha}_\rho - \bar{\beta}_\rho$ . The separate  $\bar{\alpha}_\rho$  and  $\bar{\beta}_\rho$  are provided to us by A. Sandorfi. The first error above is statistics plus systematics; the second is from the model.

<sup>13</sup> This OLMOSDELEON 01 result uses the TAPS data alone, and does not use the (re-evaluated) sum-rule constraint that  $\bar{\alpha} + \bar{\beta} = (13.8 \pm 0.4) \times 10^{-4} \text{ fm}^3$ . See the paper for a discussion.

<sup>14</sup> 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.

<sup>15</sup> 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  $\alpha_\rho + \beta_\rho$ .

<sup>16</sup> FEDERSPIEL 91 obtains for the (static) electric polarizability  $\alpha_\rho$ , defined in terms of the induced electric dipole moment by  $\mathbf{D} = 4\pi\epsilon_0\alpha_\rho\mathbf{E}$ , the value  $(7.0 \pm 2.2 \pm 1.3) \times 10^{-4} \text{ fm}^3$ .

## $\rho$ MAGNETIC POLARIZABILITY $\bar{\beta}_\rho$

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  $\bar{\alpha}_\rho$  due to this constraint.

In the 2004 *Review*, we will probably switch to listing measurements of  $\bar{\alpha}_\rho + \bar{\beta}_\rho$  and  $\bar{\alpha}_\rho - \bar{\beta}_\rho$  instead of  $\bar{\alpha}_\rho$  and  $\bar{\beta}_\rho$  separately.

VALUE ( $10^{-4} \text{ fm}^3$ )	DOCUMENT ID	TECN	COMMENT
<b>1.6 <math>\pm</math> 0.6 OUR AVERAGE</b>			
$1.43 \pm 0.98^{+0.52}_{-0.98}$	17 BLANPIED	01 LEGS	$\rho(\vec{\gamma}, \gamma), \rho(\vec{\gamma}, \pi^0), \rho(\vec{\gamma}, \pi^+)$
$1.2 \pm 0.7 \pm 0.5$	18 OLMOSDEL...	01 CNTR	$\gamma\rho$ Compton scattering
$2.1 \pm 0.8 \pm 0.5$	19 MACGIBBON	95 RVUE	global average
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$2.3 \pm 0.9 \pm 0.7$	20 BARANOV	01 RVUE	Global average
$1.7 \pm 0.6 \pm 0.9$	MACGIBBON	95 CNTR	$\gamma\rho$ Compton scattering
$4.4 \pm 0.4 \pm 1.1$	HALLIN	93 CNTR	$\gamma\rho$ Compton scattering
$3.58^{+1.19+1.03}_{-1.25-1.07}$	ZIEGER	92 CNTR	$\gamma\rho$ Compton scattering
$3.3 \pm 2.2 \pm 1.3$	FEDERSPIEL	91 CNTR	$\gamma\rho$ Compton scattering
17 BLANPIED 01 gives $\bar{\alpha}_\rho + \bar{\beta}_\rho$ and $\bar{\alpha}_\rho - \bar{\beta}_\rho$ . The separate $\bar{\alpha}_\rho$ and $\bar{\beta}_\rho$ are provided to us by A. Sandorfi. The first error above is statistics plus systematics; the second is from the model.			
18 This OLMOSDELEON 01 result uses the TAPS data alone, and does not use the (re-evaluated) sum-rule constraint that $\bar{\alpha} + \bar{\beta} = (13.8 \pm 0.4) \times 10^{-4} \text{ fm}^3$ . See the paper for a discussion.			
19 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.			
20 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 $\alpha_\rho + \beta_\rho$ .			

## $\rho$ CHARGE RADIUS

VALUE (fm)	DOCUMENT ID	COMMENT
<b>0.870 <math>\pm</math> 0.008 OUR AVERAGE</b>		
$0.830 \pm 0.040 \pm 0.040$	21 ESCHRICH	01 $e\rho \rightarrow e\rho$
$0.883 \pm 0.014$	MELNIKOV	00 1S Lamb Shift in H
$0.865 \pm 0.020$	MCCORD	91 $e\rho \rightarrow e\rho$
$0.862 \pm 0.012$	SIMON	80 $e\rho \rightarrow e\rho$
$0.880 \pm 0.030$	BORKOWSKI	74 $e\rho \rightarrow e\rho$
• • • We do not use the following data for averages, fits, limits, etc. • • •		
$0.880 \pm 0.015$	ROSENFELDR.	00 $e\rho$ + Coul. corrections
$0.847 \pm 0.008$	MERGELL	96 $e\rho$ + disp. relations
$0.877 \pm 0.024$	WONG	94 reanalysis of Mainz $e\rho$ data
$0.810 \pm 0.020$	AKIMOV	72 $e\rho \rightarrow e\rho$
$0.800 \pm 0.025$	FREREJACQ...	66 $e\rho \rightarrow e\rho$ ( $\text{CH}_2$ tgt.)
$0.805 \pm 0.011$	HAND	63 $e\rho \rightarrow e\rho$
21 ESCHRICH 01 actually gives $\langle r^2 \rangle = (0.69 \pm 0.06 \pm 0.06) \text{ fm}^2$ .		

## $p$ MEAN LIFE

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

<u>LIMIT</u> (years)	<u>PARTICLE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>&gt;1.6 \times 10^{25}</math></b>	<b><math>p, n</math></b>		22,23 EVANS	77	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
$>4 \times 10^{23}$	$p$	95	TRETYAK	01	$d \rightarrow n + ?$
$>1.9 \times 10^{24}$	$p$	90	24 BERNABEI	00B DAMA	
$>3 \times 10^{23}$	$p$		23 DIX	70 CNTR	
$>3 \times 10^{23}$	$p, n$		23,25 FLEROV	58	

<sup>22</sup> Mean lifetime of nucleons in <sup>130</sup>Te nuclei.

<sup>23</sup> Converted to mean life by dividing half-life by  $\ln(2) = 0.693$ .

<sup>24</sup> BERNABEI 00B looks for the decay of a <sup>128</sup><sub>53</sub>I nucleus following the disappearance of a proton in the otherwise-stable <sup>129</sup><sub>54</sub>Xe nucleus. The  $p$  decay is to neutrinos or to “nothing,” and thus doesn’t conserve charge as well as baryon number.

<sup>25</sup> Mean lifetime of nucleons in <sup>232</sup>Th nuclei.

## $\bar{p}$ 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  $7 \times 10^5$  years, for  $\bar{p} \rightarrow e^- \gamma$ . We advance only the exclusive-mode limits to our Summary Tables.

<u>LIMIT</u> (years)	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
$>8 \times 10^5$	90		26 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

<sup>26</sup> 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.

## $\rho$ DECAY MODES

See the "Note on Nucleon Decay" in our 1994 edition (Phys. Rev. **D50**, 1673) for a short review.

The "partial mean life" limits tabulated here are the limits on  $\tau/B_i$ , where  $\tau$  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
<b>Antilepton + meson</b>		
$\tau_1$ $N \rightarrow e^+ \pi$	$> 158$ ( $n$ ), $> 1600$ ( $p$ )	90%
$\tau_2$ $N \rightarrow \mu^+ \pi$	$> 100$ ( $n$ ), $> 473$ ( $p$ )	90%
$\tau_3$ $N \rightarrow \nu \pi$	$> 112$ ( $n$ ), $> 25$ ( $p$ )	90%
$\tau_4$ $p \rightarrow e^+ \eta$	$> 313$	90%
$\tau_5$ $p \rightarrow \mu^+ \eta$	$> 126$	90%
$\tau_6$ $n \rightarrow \nu \eta$	$> 158$	90%
$\tau_7$ $N \rightarrow e^+ \rho$	$> 217$ ( $n$ ), $> 75$ ( $p$ )	90%
$\tau_8$ $N \rightarrow \mu^+ \rho$	$> 228$ ( $n$ ), $> 110$ ( $p$ )	90%
$\tau_9$ $N \rightarrow \nu \rho$	$> 19$ ( $n$ ), $> 162$ ( $p$ )	90%
$\tau_{10}$ $p \rightarrow e^+ \omega$	$> 107$	90%
$\tau_{11}$ $p \rightarrow \mu^+ \omega$	$> 117$	90%
$\tau_{12}$ $n \rightarrow \nu \omega$	$> 108$	90%
$\tau_{13}$ $N \rightarrow e^+ K$	$> 17$ ( $n$ ), $> 150$ ( $p$ )	90%
$\tau_{14}$ $p \rightarrow e^+ K_S^0$	$> 120$	90%
$\tau_{15}$ $p \rightarrow e^+ K_L^0$	$> 51$	90%
$\tau_{16}$ $N \rightarrow \mu^+ K$	$> 26$ ( $n$ ), $> 120$ ( $p$ )	90%
$\tau_{17}$ $p \rightarrow \mu^+ K_S^0$	$> 150$	90%
$\tau_{18}$ $p \rightarrow \mu^+ K_L^0$	$> 83$	90%
$\tau_{19}$ $N \rightarrow \nu K$	$> 86$ ( $n$ ), $> 670$ ( $p$ )	90%
$\tau_{20}$ $n \rightarrow \nu K_S^0$	$> 51$	90%
$\tau_{21}$ $p \rightarrow e^+ K^*(892)^0$	$> 84$	90%
$\tau_{22}$ $N \rightarrow \nu K^*(892)$	$> 78$ ( $n$ ), $> 51$ ( $p$ )	90%
<b>Antilepton + mesons</b>		
$\tau_{23}$ $p \rightarrow e^+ \pi^+ \pi^-$	$> 82$	90%
$\tau_{24}$ $p \rightarrow e^+ \pi^0 \pi^0$	$> 147$	90%
$\tau_{25}$ $n \rightarrow e^+ \pi^- \pi^0$	$> 52$	90%
$\tau_{26}$ $p \rightarrow \mu^+ \pi^+ \pi^-$	$> 133$	90%
$\tau_{27}$ $p \rightarrow \mu^+ \pi^0 \pi^0$	$> 101$	90%
$\tau_{28}$ $n \rightarrow \mu^+ \pi^- \pi^0$	$> 74$	90%
$\tau_{29}$ $n \rightarrow e^+ K^0 \pi^-$	$> 18$	90%

### Lepton + meson

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

### Lepton + mesons

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

### Antilepton + photon(s)

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

### Three (or more) leptons

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

### Inclusive modes

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



### $\Delta B = 2$ dinucleon modes

The following are lifetime limits per iron nucleus.

$\tau_{64}$	$pp \rightarrow \pi^+ \pi^+$	$> 0.7$	90%
$\tau_{65}$	$pn \rightarrow \pi^+ \pi^0$	$> 2$	90%
$\tau_{66}$	$nn \rightarrow \pi^+ \pi^-$	$> 0.7$	90%
$\tau_{67}$	$nn \rightarrow \pi^0 \pi^0$	$> 3.4$	90%
$\tau_{68}$	$pp \rightarrow e^+ e^+$	$> 5.8$	90%
$\tau_{69}$	$pp \rightarrow e^+ \mu^+$	$> 3.6$	90%
$\tau_{70}$	$pp \rightarrow \mu^+ \mu^+$	$> 1.7$	90%
$\tau_{71}$	$pn \rightarrow e^+ \bar{\nu}$	$> 2.8$	90%
$\tau_{72}$	$pn \rightarrow \mu^+ \bar{\nu}$	$> 1.6$	90%
$\tau_{73}$	$nn \rightarrow \nu_e \bar{\nu}_e$	$> 0.000012$	90%
$\tau_{74}$	$nn \rightarrow \nu_\mu \bar{\nu}_\mu$	$> 0.000006$	90%
$\tau_{75}$	$pp \rightarrow$ neutrinos	$> 0.00000055$	90%

### $\bar{p}$ DECAY MODES

Mode	Partial mean life (years)	Confidence level
$\tau_{76}$	$\bar{p} \rightarrow e^- \gamma$	$> 7 \times 10^5$ 90%
$\tau_{77}$	$\bar{p} \rightarrow \mu^- \gamma$	$> 5 \times 10^4$ 90%
$\tau_{78}$	$\bar{p} \rightarrow e^- \pi^0$	$> 4 \times 10^5$ 90%
$\tau_{79}$	$\bar{p} \rightarrow \mu^- \pi^0$	$> 5 \times 10^4$ 90%
$\tau_{80}$	$\bar{p} \rightarrow e^- \eta$	$> 2 \times 10^4$ 90%
$\tau_{81}$	$\bar{p} \rightarrow \mu^- \eta$	$> 8 \times 10^3$ 90%
$\tau_{82}$	$\bar{p} \rightarrow e^- K_S^0$	$> 900$ 90%
$\tau_{83}$	$\bar{p} \rightarrow \mu^- K_S^0$	$> 4 \times 10^3$ 90%
$\tau_{84}$	$\bar{p} \rightarrow e^- K_L^0$	$> 9 \times 10^3$ 90%
$\tau_{85}$	$\bar{p} \rightarrow \mu^- K_L^0$	$> 7 \times 10^3$ 90%
$\tau_{86}$	$\bar{p} \rightarrow e^- \gamma \gamma$	$> 2 \times 10^4$ 90%
$\tau_{87}$	$\bar{p} \rightarrow \mu^- \gamma \gamma$	$> 2 \times 10^4$ 90%
$\tau_{88}$	$\bar{p} \rightarrow e^- \rho$	—
$\tau_{89}$	$\bar{p} \rightarrow e^- \omega$	$> 200$ 90%
$\tau_{90}$	$\bar{p} \rightarrow e^- K^*(892)^0$	—

## $\rho$ PARTIAL MEAN LIVES

The “partial mean life” limits tabulated here are the limits on  $\tau/B_i$ , where  $\tau$  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 ————

#### $\tau(N \rightarrow e^+ \pi)$

$\tau_1$

<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>
<b>&gt; 158</b>	<b><math>n</math></b>	<b>90</b>	<b>3</b>	<b>5</b>	MCGREW	99 IMB3
<b>&gt;1600</b>	<b><math>p</math></b>	<b>90</b>	<b>0</b>	<b>0.1</b>	SHIOZAWA	98 SKAM

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

> 540	$p$	90	0	0.2	MCGREW	99 IMB3
> 70	$p$	90	0	0.5	BERGER	91 FREJ
> 70	$n$	90	0	$\leq 0.1$	BERGER	91 FREJ
> 550	$p$	90	0	0.7	<sup>27</sup> 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	<sup>28</sup> BARTELT	83 SOUD
> 0.5	$n$	90	1	0.3	<sup>28</sup> BARTELT	83 SOUD
> 5.8	$p$	90	2		<sup>29</sup> KRISHNA...	82 KOLR
> 5.8	$n$	90	2		<sup>29</sup> KRISHNA...	82 KOLR
> 0.1	$n$	90			<sup>30</sup> GURR	67 CNTR

<sup>27</sup> This BECKER-SZENDY 90 result includes data from SEIDEL 88.

<sup>28</sup> Limit based on zero events.

<sup>29</sup> We have calculated 90% CL limit from 1 confined event.

<sup>30</sup> We have converted half-life to 90% CL mean life.

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

$\tau_2$

<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>
<b>&gt;473</b>	<b><math>p</math></b>	<b>90</b>	<b>0</b>	<b>0.6</b>	MCGREW	99 IMB3
<b>&gt;100</b>	<b><math>n</math></b>	<b>90</b>	<b>0</b>	<b>&lt;0.2</b>	HIRATA	89C KAMI

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

> 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
>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

<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>
<b>&gt;112</b>	<b><i>n</i></b>	<b>90</b>	<b>6</b>	<b>6.6</b>	MCGREW	99 IMB3
<b>&gt; 25</b>	<b><i>p</i></b>	<b>90</b>	<b>32</b>	<b>32.8</b>	HIRATA	89C KAMI

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

> 16	<i>p</i>	90	6	6.7	WALL	00B	SOU2
> 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
>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		<sup>31</sup> KRISHNA...	82	KOLR
> 0.3	<i>p</i>	90	2		<sup>32</sup> CHERRY	81	HOME
> 0.1	<i>p</i>	90			<sup>33</sup> GURR	67	CNTR

<sup>31</sup> We have calculated 90% CL limit from 1 confined event.

<sup>32</sup> We have converted 2 possible events to 90% CL limit.

<sup>33</sup> We 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>
<b>&gt;313</b>	<b><i>p</i></b>	<b>90</b>	<b>0</b>	<b>0.2</b>	MCGREW	99 IMB3

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

> 81	$p$	90	1	1.7	WALL	00B	SOU2
> 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		<sup>34</sup> CHERRY	81	HOME

<sup>34</sup>We 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>
<b>&gt;126</b>	<b><math>p</math></b>	<b>90</b>	<b>3</b>	<b>2.8</b>	MCGREW	99 IMB3

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

> 89	$p$	90	0	1.6	WALL	00B	SOU2
> 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

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

**T6**

<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>
<b>&gt;158</b>	<b><math>n</math></b>	<b>90</b>	<b>0</b>	<b>1.2</b>	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		<sup>35</sup> CHERRY	81	HOME

<sup>35</sup>We 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>
<b>&gt;217</b>	<b><math>n</math></b>	<b>90</b>	<b>4</b>	<b>4.8</b>	MCGREW	99 IMB3
<b>&gt; 75</b>	<b><math>p</math></b>	<b>90</b>	<b>2</b>	<b>2.7</b>	HIRATA	89C KAMI

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

> 29	<i>p</i>	90	0 2.2	BERGER	91	FREJ
> 41	<i>n</i>	90	0 1.4	BERGER	91	FREJ
> 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	<sup>36</sup> BARTELT	83	SOUD
> 0.5	<i>p</i>	90	1 0.3	<sup>36</sup> BARTELT	83	SOUD
> 9.8	<i>p</i>	90	1	<sup>37</sup> KRISHNA...	82	KOLR
> 0.8	<i>p</i>	90	2	<sup>38</sup> CHERRY	81	HOME

<sup>36</sup> Limit based on zero events.

<sup>37</sup> We have calculated 90% CL limit from 0 confined events.

<sup>38</sup> We have converted 2 possible events to 90% CL limit.

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

**T8**

<i>LIMIT</i> (10 <sup>30</sup> years)	<i>PARTICLE</i>	<i>CL%</i>	<i>EVTS</i>	<i>BKGD EST</i>	<i>DOCUMENT ID</i>	<i>TECN</i>
<b>&gt;228</b>	<b><i>n</i></b>	<b>90</b>	<b>3</b>	<b>9.5</b>	MCGREW	99 IMB3
<b>&gt;110</b>	<b><i>p</i></b>	<b>90</b>	<b>0</b>	<b>1.7</b>	HIRATA	89C KAMI

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

> 12	<i>p</i>	90	0 0.5	BERGER	91	FREJ
> 22	<i>n</i>	90	0 1.1	BERGER	91	FREJ
> 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**

<i>LIMIT</i> (10 <sup>30</sup> years)	<i>PARTICLE</i>	<i>CL%</i>	<i>EVTS</i>	<i>BKGD EST</i>	<i>DOCUMENT ID</i>	<i>TECN</i>
<b>&gt;162</b>	<b><i>p</i></b>	<b>90</b>	<b>18</b>	<b>21.7</b>	MCGREW	99 IMB3
<b>&gt; 19</b>	<b><i>n</i></b>	<b>90</b>	<b>0</b>	<b>0.5</b>	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		<sup>39</sup> CHERRY	81	HOME
> 0.6	<i>n</i>	90	2		<sup>39</sup> CHERRY	81	HOME

<sup>39</sup>We have converted 2 possible events to 90% CL limit.

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

$\tau_{10}$

<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>
<b>&gt;107</b>	<b><i>p</i></b>	<b>90</b>	<b>7</b>	<b>10.8</b>	MCGREW	99 IMB3

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

> 17	<i>p</i>	90	0	1.1	BERGER	91	FREJ
> 45	<i>p</i>	90	2	1.45	HIRATA	89C	KAMI
> 26	<i>p</i>	90	1	1.0	SEIDEL	88	IMB
> 1.5	<i>p</i>	90	0		BARTELT	87	SOUD
> 37	<i>p</i>	90	6	5.3	HAINES	86	IMB
> 25	<i>p</i>	90	1	<1.4	ARISAKA	85	KAMI
> 12	<i>p</i> (free)	90	6	7.5	BLEWITT	85	IMB
> 37	<i>p</i>	90	6	5.7	BLEWITT	85	IMB
> 0.6	<i>p</i>	90	1	0.3	<sup>40</sup> BARTELT	83	SOUD
> 9.8	<i>p</i>	90	1		<sup>41</sup> KRISHNA...	82	KOLR
> 2.8	<i>p</i>	90	2		<sup>42</sup> CHERRY	81	HOME

<sup>40</sup>Limit based on zero events.

<sup>41</sup>We have calculated 90% CL limit from 0 confined events.

<sup>42</sup>We have converted 2 possible events to 90% CL limit.

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

$\tau_{11}$

<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>
<b>&gt;117</b>	<b><i>p</i></b>	<b>90</b>	<b>11</b>	<b>12.1</b>	MCGREW	99 IMB3

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

> 11	<i>p</i>	90	0	1.0	BERGER	91	FREJ
> 57	<i>p</i>	90	2	1.9	HIRATA	89C	KAMI
> 4.4	<i>p</i>	90	0	0.7	PHILLIPS	89	HPW
> 10	<i>p</i>	90	2	1.3	SEIDEL	88	IMB
> 23	<i>p</i>	90	2	1	HAINES	86	IMB
> 6.5	<i>p</i> (free)	90	9	8.7	BLEWITT	85	IMB
> 23	<i>p</i>	90	8	7	BLEWITT	85	IMB

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

$\tau_{12}$

<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>
<b>&gt;108</b>	<b><i>n</i></b>	<b>90</b>	<b>12</b>	<b>22.5</b>	MCGREW	99 IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 17	<i>n</i>	90	1	0.7	BERGER	89 FREJ
> 43	<i>n</i>	90	3	2.7	HIRATA	89C KAMI
> 6	<i>n</i>	90	2	1.3	SEIDEL	88 IMB
> 12	<i>n</i>	90	6	6	HAINES	86 IMB
> 18	<i>n</i>	90	2	2	KAJITA	86 KAMI
> 16	<i>n</i>	90	1	2	PARK	85 IMB
> 2.0	<i>n</i>	90	2		<sup>43</sup> CHERRY	81 HOME

<sup>43</sup>We have converted 2 possible events to 90% CL limit.

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

$\tau_{13}$

<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>
<b>&gt; 17</b>	<b><i>n</i></b>	<b>90</b>	<b>35</b>	<b>29.4</b>	MCGREW	99 IMB3
<b>&gt;150</b>	<b><i>p</i></b>	<b>90</b>	<b>0</b>	<b>&lt;0.27</b>	HIRATA	89C KAMI
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 85	<i>p</i>	90	3	4.9	WALL	00 SOU2
> 31	<i>p</i>	90	23	25.2	MCGREW	99 IMB3
> 60	<i>p</i>	90	0		BERGER	91 FREJ
> 70	<i>p</i>	90	0	1.8	SEIDEL	88 IMB
> 77	<i>p</i>	90	5	4.5	HAINES	86 IMB
> 38	<i>p</i>	90	0	<0.8	ARISAKA	85 KAMI
> 24	<i>p</i> (free)	90	7	8.5	BLEWITT	85 IMB
> 77	<i>p</i>	90	5	4	BLEWITT	85 IMB
> 1.3	<i>p</i>	90	0		ALEKSEEV	81 BAKS
> 1.3	<i>n</i>	90	0		ALEKSEEV	81 BAKS

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

$\tau_{14}$

<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>
<b>&gt;120</b>	<b><i>p</i></b>	<b>90</b>	<b>1</b>	<b>1.3</b>	WALL	00 SOU2
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 76	<i>p</i>	90	0	0.5	BERGER	91 FREJ

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

$\tau_{15}$

<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>
<b>&gt;51</b>	<b><i>p</i></b>	<b>90</b>	<b>2</b>	<b>3.5</b>	WALL	00 SOU2
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>44	<i>p</i>	90	0	$\leq 0.1$	BERGER	91 FREJ

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

$\tau_{16}$

LIMIT ( $10^{30}$ years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN
>120	$p$	90	0	<1.2	WALL	00 SOU2
>120	$p$	90	4	7.2	MCGREW	99 IMB3
> 26	$n$	90	20	28.4	MCGREW	99 IMB3
>120	$p$	90	1	0.4	HIRATA	89C KAMI

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

> 54	$p$	90	0		BERGER	91 FREJ
> 3.0	$p$	90	0	0.7	PHILLIPS	89 HPW
> 19	$p$	90	3	2.5	SEIDEL	88 IMB
> 1.5	$p$	90	0		<sup>44</sup> 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		<sup>45</sup> BARTELT	83 SOUD
> 0.4	$n$	90	0		<sup>45</sup> BARTELT	83 SOUD
> 5.8	$p$	90	2		<sup>46</sup> KRISHNA...	82 KOLR
> 2.0	$p$	90	0		CHERRY	81 HOME
> 0.2	$n$	90			<sup>47</sup> GURR	67 CNTR

<sup>44</sup> BARTELT 87 limit applies to  $p \rightarrow \mu^+ K_S^0$ .

<sup>45</sup> Limit based on zero events.

<sup>46</sup> We have calculated 90% CL limit from 1 confined event.

<sup>47</sup> We have converted half-life to 90% CL mean life.

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

$\tau_{17}$

LIMIT ( $10^{30}$ years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN
>150	$p$	90	0	<0.8	WALL	00 SOU2

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

> 64	$p$	90	0	1.2	BERGER	91 FREJ
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$\tau(p \rightarrow \mu^+ K_L^0)$

$\tau_{18}$

LIMIT ( $10^{30}$ years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN
>83	$p$	90	0	0.4	WALL	00 SOU2

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

>44	$p$	90	0	$\leq 0.1$	BERGER	91 FREJ
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$\tau(N \rightarrow \nu K)$

$\tau_{19}$

LIMIT ( $10^{30}$ years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID	TECN
>670	$p$	90			HAYATO	99 SKAM
> 86	$n$	90	0	2.4	HIRATA	89C KAMI



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

> 26	<i>n</i>	90	16	9.1	WALL	00	SOU2
>151	<i>p</i>	90	15	21.4	MCGREW	99	IMB3
> 30	<i>n</i>	90	34	34.1	MCGREW	99	IMB3
> 43	<i>p</i>	90	1	1.54	48 ALLISON	98	SOU2
> 15	<i>n</i>	90	1	1.8	BERGER	89	FREJ
> 15	<i>p</i>	90	1	1.8	BERGER	89	FREJ
>100	<i>p</i>	90	9	7.3	HIRATA	89C	KAMI
> 0.28	<i>p</i>	90	0	0.7	PHILLIPS	89	HPW
> 0.3	<i>p</i>	90	0		BARTELT	87	SOUD
> 0.75	<i>n</i>	90	0		49 BARTELT	87	SOUD
> 10	<i>p</i>	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		50 BARTELT	83	SOUD
> 0.1	<i>p</i>	90	0		50 BARTELT	83	SOUD
> 5.8	<i>p</i>	90	1		51 KRISHNA...	82	KOLR
> 0.3	<i>n</i>	90	2		52 CHERRY	81	HOME

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

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

50 Limit based on zero events.

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

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

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

$\tau_{20}$

<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>
<b>&gt;51</b>	<b><i>n</i></b>	<b>90</b>	<b>16</b>	<b>9.1</b>	WALL	00 SOU2

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

$\tau_{21}$

<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>
<b>&gt;84</b>	<b><i>p</i></b>	<b>90</b>	<b>38</b>	<b>52.0</b>	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

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

$\tau_{22}$

<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>
<b>&gt;51</b>	<b><i>p</i></b>	<b>90</b>	<b>7</b>	<b>9.1</b>	MCGREW	99 IMB3
<b>&gt;78</b>	<b><i>n</i></b>	<b>90</b>	<b>40</b>	<b>50</b>	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	<i>p</i>	90	3	2	KAJITA	86	KAMI
> 6	<i>n</i>	90	2	1.6	KAJITA	86	KAMI
> 5.8	<i>p</i> (free)	90	10	16	BLEWITT	85	IMB
> 9.6	<i>p</i>	90	7	6	BLEWITT	85	IMB
> 7	<i>n</i>	90	1	4	PARK	85	IMB
> 2.1	<i>p</i>	90	1		<sup>53</sup> BATTISTONI	82	NUSX

<sup>53</sup>We have converted 1 possible event to 90% CL limit.

### ————— Antilepton + mesons —————

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

**T23**

<u>LIMIT</u> (10 <sup>30</sup> years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
<b>&gt;82</b>	<b><i>p</i></b>	<b>90</b>	<b>16</b>	<b>23.1</b>	MCGREW	99 IMB3

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

>21	<i>p</i>	90	0	2.2	BERGER	91	FREJ
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#### $\tau(p \rightarrow e^+ \pi^0 \pi^0)$

**T24**

<u>LIMIT</u> (10 <sup>30</sup> years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
<b>&gt;147</b>	<b><i>p</i></b>	<b>90</b>	<b>2</b>	<b>0.8</b>	MCGREW	99 IMB3

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

> 38	<i>p</i>	90	1	0.5	BERGER	91	FREJ
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#### $\tau(n \rightarrow e^+ \pi^- \pi^0)$

**T25**

<u>LIMIT</u> (10 <sup>30</sup> years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
<b>&gt;52</b>	<b><i>n</i></b>	<b>90</b>	<b>38</b>	<b>34.2</b>	MCGREW	99 IMB3

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

>32	<i>n</i>	90	1	0.8	BERGER	91	FREJ
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#### $\tau(p \rightarrow \mu^+ \pi^+ \pi^-)$

**T26**

<u>LIMIT</u> (10 <sup>30</sup> years)	<u>PARTICLE</u>	<u>CL%</u>	<u>EVTS</u>	<u>BKGD EST</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
<b>&gt;133</b>	<b><i>p</i></b>	<b>90</b>	<b>25</b>	<b>38.0</b>	MCGREW	99 IMB3

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

> 17	<i>p</i>	90	1	2.6	BERGER	91	FREJ
> 3.3	<i>p</i>	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>
<b>&gt;101</b>	<b><math>p</math></b>	<b>90</b>	<b>3</b>	<b>1.6</b>	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>
<b>&gt;74</b>	<b><math>n</math></b>	<b>90</b>	<b>17</b>	<b>20.8</b>	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>
<b>&gt;18</b>	<b><math>n</math></b>	<b>90</b>	<b>1</b>	<b>0.2</b>	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>
<b>&gt;65</b>	<b><math>n</math></b>	<b>90</b>	<b>0</b>	<b>1.6</b>	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>
<b>&gt;49</b>	<b><math>n</math></b>	<b>90</b>	<b>0</b>	<b>0.5</b>	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>
<b>&gt;62</b>	<b><math>n</math></b>	<b>90</b>	<b>2</b>	<b>4.1</b>	SEIDEL	88 IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>12	$n$	90	13	6	HAINES	86 IMB
>12	$n$	90	5	3	PARK	85 IMB

$\tau(n \rightarrow \mu^- \rho^+)$  **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>
<b>&gt;7</b>	<b><i>n</i></b>	<b>90</b>	<b>1</b>	<b>1.1</b>	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>
<b>&gt;32</b>	<b><i>n</i></b>	<b>90</b>	<b>3</b>	<b>2.96</b>	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>
<b>&gt;57</b>	<b><i>n</i></b>	<b>90</b>	<b>0</b>	<b>2.18</b>	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>
<b>&gt;30</b>	<b><i>p</i></b>	<b>90</b>	<b>1</b>	<b>2.50</b>	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>
<b>&gt;29</b>	<b><i>n</i></b>	<b>90</b>	<b>1</b>	<b>0.78</b>	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>
<b>&gt;17</b>	<b><i>p</i></b>	<b>90</b>	<b>1</b>	<b>1.72</b>	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>
<b>&gt;34</b>	<b><i>n</i></b>	<b>90</b>	<b>0</b>	<b>0.78</b>	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>
<b>&gt;75</b>	<b><math>p</math></b>	<b>90</b>	<b>81</b>	<b>127.2</b>	MCGREW	99 IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>20	$p$	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>
<b>&gt;245</b>	<b><math>p</math></b>	<b>90</b>	<b>3</b>	<b>4.0</b>	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>
<b>&gt;670</b>	<b><math>p</math></b>	<b>90</b>	<b>0</b>	<b>0.1</b>	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			<sup>54</sup> GURR	67 CNTR

<sup>54</sup>We 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>
<b>&gt;478</b>	<b><math>p</math></b>	<b>90</b>	<b>0</b>	<b>0.1</b>	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			<sup>55</sup> GURR	67 CNTR

<sup>55</sup>We 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>
<b>&gt;28</b>	<b><math>n</math></b>	<b>90</b>	<b>163</b>	<b>144.7</b>	MCGREW	99 IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>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>
<b>&gt;100</b>	<b><math>p</math></b>	<b>90</b>	<b>1</b>	<b>0.8</b>	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>
<b>&gt;219</b>	<b><math>n</math></b>	<b>90</b>	<b>5</b>	<b>7.5</b>	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>
<b>&gt;793</b>	<b><math>p</math></b>	<b>90</b>	<b>0</b>	<b>0.5</b>	MCGREW	99 IMB3

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

>147	$p$	90	0	0.1	BERGER	91 FREJ
>510	$p$	90	0	0.3	HAINES	86 IMB
> 89	$p$ (free)	90	0	0.5	BLEWITT	85 IMB
>510	$p$	90	0	0.7	BLEWITT	85 IMB

$\tau(p \rightarrow e^+ \mu^+ \mu^-)$  **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>
<b>&gt;359</b>	<b><math>p</math></b>	<b>90</b>	<b>1</b>	<b>0.9</b>	MCGREW	99 IMB3

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

> 81	$p$	90	0	0.16	BERGER	91 FREJ
> 5.0	$p$	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>
<b>&gt;17</b>	<b><math>p</math></b>	<b>90</b>	<b>152</b>	<b>153.7</b>	MCGREW	99 IMB3

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

>11	$p$	90	11	6.08	BERGER	91B FREJ
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$\tau(n \rightarrow e^+ e^- \nu)$  **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>
<b>&gt;257</b>	<b><math>n</math></b>	<b>90</b>	<b>5</b>	<b>7.5</b>	MCGREW	99 IMB3

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

> 74	$n$	90	0	< 0.1	BERGER	91B FREJ
> 45	$n$	90	5	5	HAINES	86 IMB
> 26	$n$	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>
<b>&gt;83</b>	<b><math>n</math></b>	<b>90</b>	<b>25</b>	<b>29.4</b>	MCGREW	99 IMB3

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

>47	$n$	90	0	< 0.1	BERGER	91B FREJ
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$\tau(n \rightarrow \mu^+ \mu^- \nu)$

**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>
<b>&gt;79</b>	<b><i>n</i></b>	<b>90</b>	<b>100</b>	<b>145</b>	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>
<b>&gt;529</b>	<b><i>p</i></b>	<b>90</b>	<b>0</b>	<b>1.0</b>	MCGREW	99 IMB3
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
> 91	<i>p</i>	90	0	$\leq 0.1$	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>
<b>&gt;675</b>	<b><i>p</i></b>	<b>90</b>	<b>0</b>	<b>0.3</b>	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		<sup>56</sup> BATTISTONI	82 NUSX

<sup>56</sup>We 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>
<b>&gt;21</b>	<b><i>p</i></b>	<b>90</b>	<b>7</b>	<b>11.23</b>	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>
<b>&gt;6.0</b>	<b><i>p</i></b>	<b>90</b>	<b>0</b>	<b>0.7</b>	PHILLIPS	89 HPW

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

**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>
<b>&gt;0.00049</b>	<b><i>n</i></b>	<b>90</b>	<b>2</b>	<b>2</b>	<sup>57</sup> SUZUKI	93B KAMI
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
>0.0023	<i>n</i>	90			<sup>58</sup> GLICENSTEIN	97 KAMI
>0.00003	<i>n</i>	90	11	6.1	<sup>59</sup> BERGER	91B FREJ
>0.00012	<i>n</i>	90	7	11.2	<sup>59</sup> BERGER	91B FREJ
>0.0005	<i>n</i>	90	0		LEARNED	79 RVUE

<sup>57</sup> The SUZUKI 93B limit applies to any of  $\nu_e \nu_e \bar{\nu}_e$ ,  $\nu_\mu \nu_\mu \bar{\nu}_\mu$ , or  $\nu_\tau \nu_\tau \bar{\nu}_\tau$ .

<sup>58</sup> GLICENSTEIN 97 uses Kamioka data and the idea that the disappearance of the neutron's magnetic moment should produce radiation.

<sup>59</sup> 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**

<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. • • •

>0.0017     $n$                       90                                      <sup>60</sup> GLICENSTEIN 97    KAMI

<sup>60</sup> 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>
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>0.6             $p, n$                       90                                      <sup>61</sup> LEARNED            79    RVUE

<sup>61</sup> 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>
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>12             $p, n$                       90                      2                                      <sup>62,63</sup> CHERRY            81    HOME

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

> 1.8             $p, n$                       90                                      <sup>63</sup> COWSIK            80    CNTR

> 6                 $p, n$                       90                                      <sup>63</sup> LEARNED            79    RVUE

<sup>62</sup> We have converted 2 possible events to 90% CL limit.

<sup>63</sup> The muon may be primary or secondary.

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

**T61**

Anything =  $\pi, \rho, K$ , 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>
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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

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

**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>
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>0.6             $p, n$                       90                      0                                      LEARNED            79    RVUE

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

**T63**

<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. • • •

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



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

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

<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>
<b>&gt;0.7</b>	<b>90</b>	<b>4</b>	<b>2.34</b>	BERGER	91B FREJ	$\tau$ per iron nucleus

$\tau(pn \rightarrow \pi^+ \pi^0)$  **T65**

<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>
<b>&gt;2.0</b>	<b>90</b>	<b>0</b>	<b>0.31</b>	BERGER	91B FREJ	$\tau$ per iron nucleus

$\tau(nn \rightarrow \pi^+ \pi^-)$  **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>
<b>&gt;0.7</b>	<b>90</b>	<b>4</b>	<b>2.18</b>	BERGER	91B FREJ	$\tau$ per iron nucleus

$\tau(nn \rightarrow \pi^0 \pi^0)$  **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>
<b>&gt;3.4</b>	<b>90</b>	<b>0</b>	<b>0.78</b>	BERGER	91B FREJ	$\tau$ per iron nucleus

$\tau(pp \rightarrow e^+ e^+)$  **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>
<b>&gt;5.8</b>	<b>90</b>	<b>0</b>	<b>&lt;0.1</b>	BERGER	91B FREJ	$\tau$ per iron nucleus

$\tau(pp \rightarrow e^+ \mu^+)$  **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>
<b>&gt;3.6</b>	<b>90</b>	<b>0</b>	<b>&lt;0.1</b>	BERGER	91B FREJ	$\tau$ per iron nucleus

$\tau(pp \rightarrow \mu^+ \mu^+)$  **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>
<b>&gt;1.7</b>	<b>90</b>	<b>0</b>	<b>0.62</b>	BERGER	91B FREJ	$\tau$ 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>
<b>&gt;2.8</b>	<b>90</b>	<b>5</b>	<b>9.67</b>	BERGER	91B FREJ	$\tau$ 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>
<b>&gt;1.6</b>	<b>90</b>	<b>4</b>	<b>4.37</b>	BERGER	91B FREJ	$\tau$ per iron nucleus

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

**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>
>0.000012	90			<sup>64</sup> BERNABEI	00B DAMA	
>0.000012	90	5	9.7	BERGER	91B FREJ	$\tau$ per iron nucleus

<sup>64</sup> 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**

<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>
>0.000006	90	4	4.4	BERGER	91B FREJ	$\tau$ per iron nucleus

**$\tau(pp \rightarrow \text{neutrinos})$**

**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>
>0.00000055	90			<sup>65</sup> BERNABEI	00B DAMA	

<sup>65</sup> BERNABEI 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. Note that the decay doesn't conserve charge as well as baryon number.

**$\bar{p}$  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.

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

**T76**

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
> $7 \times 10^5$	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

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

**T77**

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
> $5 \times 10^4$	90	GEER 00	APEX	8.9 GeV/c $\bar{p}$ beam
••• We do not use the following data for averages, fits, limits, etc. •••				
> $5.0 \times 10^4$	90	HU 98B	APEX	8.9 GeV/c $\bar{p}$ beam

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

**T78**

<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
> $4 \times 10^5$	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

$\tau(\bar{p} \rightarrow \mu^- \pi^0)$ <span style="float: right;"><b>T79</b></span>					
<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&gt;5 × 10<sup>4</sup></b>	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 <sup>4</sup>	90	HU	98B	APEX	8.9 GeV/c $\bar{p}$ beam
$\tau(\bar{p} \rightarrow e^- \eta)$ <span style="float: right;"><b>T80</b></span>					
<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&gt; 2 × 10<sup>4</sup></b>	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
$\tau(\bar{p} \rightarrow \mu^- \eta)$ <span style="float: right;"><b>T81</b></span>					
<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&gt;8 × 10<sup>3</sup></b>	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 <sup>3</sup>	90	HU	98B	APEX	8.9 GeV/c $\bar{p}$ beam
$\tau(\bar{p} \rightarrow e^- K_S^0)$ <span style="float: right;"><b>T82</b></span>					
<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&gt;900</b>	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
$\tau(\bar{p} \rightarrow \mu^- K_S^0)$ <span style="float: right;"><b>T83</b></span>					
<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&gt;4 × 10<sup>3</sup></b>	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 × 10 <sup>3</sup>	90	HU	98B	APEX	8.9 GeV/c $\bar{p}$ beam
$\tau(\bar{p} \rightarrow e^- K_L^0)$ <span style="float: right;"><b>T84</b></span>					
<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&gt;9 × 10<sup>3</sup></b>	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
$\tau(\bar{p} \rightarrow \mu^- K_L^0)$ <span style="float: right;"><b>T85</b></span>					
<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&gt;7 × 10<sup>3</sup></b>	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 × 10 <sup>3</sup>	90	HU	98B	APEX	8.9 GeV/c $\bar{p}$ beam
$\tau(\bar{p} \rightarrow e^- \gamma\gamma)$ <span style="float: right;"><b>T86</b></span>					
<u>VALUE (years)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&gt;2 × 10<sup>4</sup></b>	90	GEER	00	APEX	8.9 GeV/c $\bar{p}$ beam

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

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

$\tau(\bar{p} \rightarrow e^- \rho)$  T88

VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT
$>200$	90	<sup>66</sup> GEER	00 APEX	8.9 GeV/c $\bar{p}$ beam
<sup>66</sup> This GEER 00 measurement has been withdrawn; see GEER 00C.				

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

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

$\tau(\bar{p} \rightarrow e^- K^*(892)^0)$  T90

VALUE (years)	CL%	DOCUMENT ID	TECN	COMMENT
$>1 \times 10^3$	90	<sup>67</sup> GEER	00 APEX	8.9 GeV/c $\bar{p}$ beam
<sup>67</sup> This GEER 00 measurement has been withdrawn; see GEER 00C.				

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