^{160}Tb β^- decay

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 176, 1 (2021)	1-May-2021

Parent: ^{160}Tb: E=0.0; J$^\pi$=3$^-$; T$_{1/2}$=72.3 d *2*; Q(β^-)=1836.0 *11*; %β^- decay=100.0
^{160}Tb-Q(β^-): From 2021Wa16.
Additional information 1.
The decay scheme shown in the drawings is due primarily to 1968Lu10.

^{160}Dy Levels

The K^π=1$^-$ and 2$^-$ bands are strongly Coriolis-mixed (1968Gu06).

E(level)[†]	J$^\pi$[‡]	T$_{1/2}$	Comments
0.0[#]	0$^+$	stable	
86.7877[#] *3*	2$^+$	2.02 ns *1*	T$_{1/2}$: weighted average of: 2.03 ns *2* (1972Lo01) $\gamma\gamma$(t); 1.97 ns *4* (1971Ab05) $\beta\gamma$(t), (ce)(ce)(t), γce(t); 2.02 ns *10* (1969Fo08) $\gamma\gamma$(t); 2.01 ns *5* (1968Ku03) γce(t); 2.02 ns *9* (1966Fu03) γce(t); 2.00 ns *4* (the mean of three values reported by 1965Me08) $\beta\gamma$(t),γce(t); 1.99 ns *4* (1965Gu02) $\gamma\gamma$(t); 1.99 ns *5* (1963Li04) βce(t); 1.92 ns *5* (1963Fo02) βce(t); 2.059 ns *16* (1963De21) γce(t). Other: 1981Is14, 1970Mo39, 1964Do06, 1962Ri07, 1960El07, 1952Mc03.
283.8220[#] *11*	4$^+$	103 ps *5*	g=+0.350 *20* g: From 1996Al02, IPAC. This value is based on T$_{1/2}$=104.8 ps *25*, used by these authors in their analysis. This value is quite close to that (104 ps *4*) adopted in this evaluation. T$_{1/2}$: weighted average of 101 ps *9* (1971Ab05 γce(t), βce(t), (ce)(ce)(t)), 95 ps *10* (1970Mo39 $\gamma\gamma$(t)), 112 ps *11* (1966Ay01 $\gamma\gamma$(t)), 107 ps *15* (1963Li04 γce(t), βce(t)). Other: 1961Bu15.
581.1[#] *7*	6$^+$		
966.1686[@] *13*	2$^+$		g=+0.324 *25* g: from 1995Al22, IPAC. The value, g=+0.317 *12*, reported by these authors has been adjusted by the evaluator to be consistent with the somewhat different T$_{1/2}$ value adopted here, namely T$_{1/2}$=1.31 ps *9*. (in their work, 1995Al22 use T$_{1/2}$=1.340 ps *25*.) Others: 0.28 *4* (1969Si01, IPAC) and 0.27 *10* (1975Kh03, IPAC). In these latter two studies, the g factors were reported to be 0.18 *6* and 0.16 *7*, respectively, based on the value T$_{1/2}$=2.1 ps *6* for this level. The listed values were computed by the evaluator using the adopted T$_{1/2}$ value. T$_{1/2}$: in their studies, 1975Kh03 and 1969Si01 use T$_{1/2}$=2.1 ps *6*, taken from B(E2)=0.069 *20*, reported by 1965Yo04 in Coul. ex. This is quite different from the value adopted in the present evaluation (see ^{160}Dy Adopted Levels). 1972Ab09 report T$_{1/2}$≤14 ps.
1049.1017[@] *17*	3$^+$		
1155.812[@] *21*	4$^+$		
1264.7470[&] *16*	2$^-$	≤10 ps	T$_{1/2}$: from 1972Ab09.
1285.59[a] *10*	1$^-$		
1286.694[&] *24*	3$^-$		
1288.66[@] *3*	5$^+$		
1358.666[a] *4*	2$^-$	2.70 ns *14*	T$_{1/2}$: from 1972Ab09.
1386.436[&] *19*	4$^-$		
1398.940[a] *23*	3$^-$		
1535.151[a] *23*	4$^-$		
1555.83 *24*	1$^+$,2$^+$		

Continued on next page (footnotes at end of table)

^{160}Tb β^- decay (continued)

^{160}Dy Levels (continued)

† Calculated from a least-squares fit to the listed Eγ values.
‡ From Adopted Levels.
# Band(A): ground-state band.
@ Band(B): γ-vibrational band.
& Band(C): K$^\pi$=2$^-$ octupole-vibrational band. The dominant two-quasiparticle component in this band has configuration=(π 7/2[523] − π 3/2[411]).
[a] Band(D): K$^\pi$=1$^-$ octupole-vibrational band. The two-quasiparticle state with configuration=(ν 5/2[642] − ν 3/2[521]) is the major component in the makeup of this band.

β^- radiations

Measured values of Eβ and relative Iβ include:

1954Ke35 Eβ	1954Ke35 Iβ	1957Na03 Eβ	1957Na03 Iβ	1959Gr93 Eβ	1959Gr93 Iβ	1963Wu01 Eβ	1963Wu01 Iβ	1964Ha26 Eβ	1964Ha26 Iβ
280 *40*	19			250 *30*	12	274 *30*	9		
461 *20*	19	455 *20*	22	460 *20*	18	464 *20*	14		
		575 *10*	42	565 *10*	39	562 *15*	42		
				858 *10*	31	868 *10*	34		
								1552	0.12 *3*
		1765 *20*	0.4	1710 *30*	0.4	1740 *30*	0.4	*1745*	0.34 *4*

E(decay)	E(level)	Iβ$^-$†	Log *ft*	Comments
(280.2 *11*)	1555.83	0.00105 *17*	11.66 *7*	av Eβ=78.72 *35*
(300.8 *11*)	1535.151	0.235 *6*	9.412 *13*	av Eβ=85.16 *35*
(437.1 *11*)	1398.940	4.48 *10*	8.662 *11*	av Eβ=129.49 *37*
(449.6 *11*)	1386.436	1.015 *21*	9.347 *10*	av Eβ=133.70 *38*
(477.3 *11*)	1358.666	9.92 *20*	8.444 *10*	av Eβ=143.14 *38*
(547.3 *11*)	1288.66	0.030 *11*	11.27[1u] *16*	av Eβ=180.95 *39* Iβ$^-$: value computed assuming the split of γ intensity between the 1002 and 1005 γ′s reported by 1984Ch34.
(549.3 *11*)	1286.694	3.43 *7*	9.111 *10*	av Eβ=168.15 *39* Iβ$^-$: value computed assuming the split of γ intensity between the 1002 and 1005 γ rays reported by 1984Ch34.
(550.4 *11*)	1285.59	0.0154 *13*	11.46 *4*	av Eβ=168.54 *39* Log *ft*: from systematics, one expects log *ft*≥12.8 for a ΔJ^π=2, no transition.
(571.3 *11*)	1264.7470	45.4 *10*	8.047 *10*	av Eβ=175.91 *39*
(680.2 *11*)	1155.812	0.214 *6*	10.634 *13*	av Eβ=215.29 *41*
(786.9 *11*)	1049.1017	6.49 *16*	9.373 *11*	av Eβ=255.22 *42*
(869.8 *11*)	966.1686	28.1 *6*	8.891 *10*	av Eβ=286.99 *43*
(1552.2 *11*)	283.8220	0.15 *5*	12.09 *15*	av Eβ=566.36 *47*
(1749.2 *11*)	86.7877	<1.2	>11.4	av Eβ=651.02 *48*

† Absolute intensity per 100 decays.

^{160}Tb β^- decay (continued)

γ(^{160}Dy)

Iγ normalization: Value calculated by requiring that the sum of the I(γ+ce) values of the four γ transitions feeding the g.s. be 100%.

1991Go22 have measured the relative intensities of a number of conversion-electron lines, using a precisely calibrated mini-orange electron spectrometer. The uncertainties quoted for these relative intensities range from ≈3.7% for the strongest lines to ≈35% for the weakest. These data do not affect the multipolarity assignments for the relevant γ rays to any significant extent and are not given here.

2008Ya10 measured ^{160}Dy L X-ray intensity ratios following decay and photoionization.

There is an extensive volume of published work on the mixing ratios of the γ rays emitted following the decay of ^{160}Tb. Not including those based solely on measured α values, some of the more recent (post-1970) publications in this field are: from the decay of oriented ^{160}Tb nuclei– 1974Fo27, 1979Gr22, 1982Kr04, 1989Ma39; from $\gamma\gamma(\theta)$ studies– 1971Kr02, 1973Ga10, 1976Bh06, 1982Ha58, 1984Si16, 1991Ma11, 1996Al02 (in conjunction with an IPAC-based measurement of the g factor of the second excited state); and from ce(K)-$\gamma(\theta)$-–1973Za04. An excellent discussion of these mixing ratios appears in 1989Ma39.

1986AdZX observe the following γ rays, which they assign for the first time to the decay of ^{160}Tb: 53.51 (K x ray?); 73.59; 97.82; 99.72; 148.75; 320.50; 707.54; 728.27; 1265.3; 1358.7 and 1556.6. With the exception of the 1556.6 γ, these transitions are not incorporated into the present ^{160}Dy level scheme.

Iγ(x-ray) (relative to Iγ(879.38γ)=100) (1986Me07)

		I(x-ray)			I(x-ray)
Dy L_S	x ray	0.90 *6*	Dy $K\alpha$	x ray	53.0 *7*
Dy L_α	x ray+		Dy $K\beta_1$	x ray+	
Dy L	x ray(eta)	15.5 *7*	Dy $K\beta_3$	x ray	10.70 *15*
Dy L_β	x ray	14.9 *6*	Dy $K\beta_2'$	x ray	2.76 *6*
Dy L_γ	x ray	2.62 *11*	Dy $K\beta$	x ray	13.50 *17*

E_γ[@]	I_γ[†#f]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	α[ad]	Comments
[x]1.11[g] *5*								E_γ: deduced by 1995KaZX from low-energy conversion-electron lines assigned as N-shell lines. γ placed by these authors between the 1286.7, 3^- level and the 1285.6, 1^- level. This γ would then have mult=E2. However, even assuming a reasonable upper limit for the speed of this putative E2 (namely, that it is a "rotational" one), the implied partial half-life is many orders of magnitude larger than those of the other deexciting γ's. This suggests that the decay of the initial state through this branch is negligibly small. The evaluator has not adopted this placement and regards this γ as questionable.
[x]10.05[g] *25*								E_γ: deduced by 1995KaZX from low-energy conversion-electron lines assigned as L-shell lines. γ placed by these authors between the 1285.6, 1^- level and a 1275.5, 0^+ level. However, the 0^+ level is located elsewhere, and no level is otherwise located at this energy. The evaluator has not adopted this placement and regards this γ as questionable.
86.7877[&] *3*	43.7 *4*	86.7877	2^+	0.0	0^+	E2	4.63	α(K)=1.565 *22*; α(L)=2.35 *4*; α(M)=0.565 *8* α(N)=0.1266 *18*; α(O)=0.01511 *22*; α(P)=6.50×10^{-5} *9*

^{160}Tb β^- decay (continued)

$\gamma(^{160}$Dy) (continued)

E_γ[@]	I_γ[†#f]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	α[ad]	Comments
								I_γ: weighted average of 44.6 *13* (1984Ch34), 43.3 *3* (1986Me07) and 44.5 *5* (1992Si23) (1983Ji01 do not quote an $I\gamma$ value for this γ). 1992Si23 quote $\Delta I\gamma$=0.15, but this appears unreasonably small as well as inconsistent with related values given elsewhere in their paper. The evaluator has assigned an uncertainty of 1% to the $I\gamma$ value of these authors in carrying out the weighted average. Others: 45 *7* (1968Lu10), 43.2 *23* (1970Ke07), 43.3 *23* (1972Mc10), 38.8 *5* (1974La15), 46.3 *7* (1979Hn02).
93.919 *6*	0.188 *6*	1358.666	2^-	1264.7470	2^-	E2	3.43	α(K)=1.307 *19*; α(L)=1.632 *23*; α(M)=0.391 *6* α(N)=0.0877 *13*; α(O)=0.01051 *15*; α(P)=5.40×10^{-5} *8*
176.49 *3*	0.0205 *11*	1535.151	4^-	1358.666	2^-	(E2)	0.360	α(K)=0.230 *4*; α(L)=0.1005 *14*; α(M)=0.0237 *4* α(N)=0.00534 *8*; α(O)=0.000667 *10*; α(P)=1.065×10^{-5} *15* I_γ: 1983Ji01 do not report an $I\gamma$ value for this γ.
197.0341[&] *10*	17.22 *9*	283.8220	4^+	86.7877	2^+	E2	0.248	α(K)=0.1659 *24*; α(L)=0.0638 *9*; α(M)=0.01495 *21* α(N)=0.00338 *5*; α(O)=0.000426 *6*; α(P)=7.89×10^{-6} *11* I_γ: 1984Ch34 report $I\gamma$=19.23 *37*. This value is quite different from the other three values and has not been included in the average. δ: 1989Ma39 report δ(M3/E2)=+0.024 *8* for this transition. This leads to B(M3)(W.u.) of the order of 3×10^7, which is much larger than the upper limit of 10 from RUL.
215.6452[&] *11*	13.35 *5*	1264.7470	2^-	1049.1017	3^+	E1	0.0399	α(K)=0.0337 *5*; α(L)=0.00486 *7*; α(M)=0.001063 *15* α(N)=0.000243 *4*; α(O)=3.44×10^{-5} *5*; α(P)=1.721×10^{-6} *24* δ: 1989Ma39 report δ(M2/E1)=+0.0046 *53*. Others: −0.010 *9* (1982Kr04), +0.016 *8* (1979Gr22), −0.003 *6* (1974Fo27), −0.22 *2* (1984Si16), −0.18 *10* (1971Kr02), −0.20 *5* (1967Ja04). From RUL, however, one expects δ<0.0021. This transition is assumed here to be pure E1.
230.628 *13*	0.268 *3*	1386.436	4^-	1155.812	4^+	(E1)	0.0335	α(K)=0.0284 *4*; α(L)=0.00407 *6*; α(M)=0.000890 *13* α(N)=0.000204 *3*; α(O)=2.88×10^{-5} *4*; α(P)=1.457×10^{-6} *21*
237.64 *9*	0.020 *7*	1286.694	3^-	1049.1017	3^+			I_γ: from 1984Ch34.
239.7 *6*	0.007 *3*	1288.66	5^+	1049.1017	3^+	E2	0.1305 *22*	α(K)=0.0928 *15*; α(L)=0.0292 *5*; α(M)=0.00679 *12* α(N)=0.00154 *3*; α(O)=0.000198 *4*; α(P)=4.62×10^{-6} *8* E_γ,I_γ: from 1984Ch34. Mult.: from ^{160}Ho ε decay.
242.5 *8*	0.025 *3*	1398.940	3^-	1155.812	4^+			
246.489 *16*	0.069 *3*	1535.151	4^-	1288.66	5^+	(E1)	0.0283	α(K)=0.0239 *4*; α(L)=0.00342 *5*; α(M)=0.000747 *11* α(N)=0.0001711 *24*; α(O)=2.43×10^{-5} *4*; α(P)=1.237×10^{-6} *18*
(297.3)	0.031 *16*	581.1	6^+	283.8220	4^+	E2	0.0663	α(K)=0.0496 *7*; α(L)=0.01297 *19*; α(M)=0.00299 *5* α(N)=0.000678 *10*; α(O)=8.91×10^{-5} *13*; α(P)=2.58×10^{-6} *4* E_γ: the 581.1 level, known to decay via a single branch with $E\gamma$=297.24 *8*, is populated in β^- decay. The 297 γ, although obscured in the γ-ray

From ENSDF

$^{160}_{66}Dy_{94}$-4

^{160}Tb β^- decay (continued)

$\gamma(^{160}Dy)$ (continued)

E_γ[@]	I_γ[†#f]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ[e]	α[ad]	Comments
									spectrum from ^{160}Tb decay, must thus be present. The listed value is from the level-energy difference. I_γ: from intensity balance at the 581.1 level. Mult.: from adopted values.
298.5783[&] *17*	86.8 *6*	1264.7470	2^-	966.1686	2^+	E1	[bc]	0.01740	α(K)=0.01475 *21*; α(L)=0.00208 *3*; α(M)=0.000455 *7* α(N)=0.0001044 *15*; α(O)=1.489×10^{-5} *21*; α(P)=7.77×10^{-7} *11* δ: 1989Ma39 report δ(M2/E1)=+0.0188 *24* for this γ. This implies B(M2)(W.u.)≥6.6, which exceeds the RUL limit of 1. Other δ values: −0.024 *14* (1982Kr04), +0.023 *18* (1979Gr22), −0.011 *29* (1974Fo27), +0.22 *6* (1984Si16), −0.048 *24* (1976Bh06), −0.021 *7* (1973Ga10), +0.005 10 (1971Kr02).
309.561 *15*	2.867 *12*	1358.666	2^-	1049.1017	3^+	E1+M2	−0.013 *7*	0.01598 *25*	α(K)=0.01354 *21*; α(L)=0.00191 *3*; α(M)=0.000418 *7* α(N)=9.58×10^{-5} *16*; α(O)=1.369×10^{-5} *22*; α(P)=7.17×10^{-7} *12* δ: from 1989Ma39. Others: −0.025 *25* (1982Kr04), −0.06 *3* (1979Gr22), −0.020 *14* (1974Fo27).
337.32 *3*	1.127 *9*	1386.436	4^-	1049.1017	3^+	E1+M2	+0.028 *13*	0.0131 *4*	α(K)=0.0111 *3*; α(L)=0.00157 *5*; α(M)=0.000343 *11* α(N)=7.87×10^{-5} *24*; α(O)=1.13×10^{-5} *4*; α(P)=5.96×10^{-7} *19* δ: from 1989Ma39. Others: −0.006 *33* (1982Kr04), +0.034 *27* (1979Gr22), +0.039 *32* (1974Fo27).
349.92 *11*	0.048 *3*	1398.940	3^-	1049.1017	3^+				
379.41 *8*	0.047 *2*	1535.151	4^-	1155.812	4^+				
392.514 *26*	4.44 *3*	1358.666	2^-	966.1686	2^+	E1+M2	+0.018[b] *6*	0.00902 *14*	α(K)=0.00766 *12*; α(L)=0.001067 *17*; α(M)=0.000233 *4* α(N)=5.35×10^{-5} *9*; α(O)=7.69×10^{-6} *12*; α(P)=4.13×10^{-7} *7* δ: from 1989Ma39. Others: −0.016 *16* (1982Kr04), −0.018 *17* (1979Gr22), −0.043 *15* (1974Fo27), −0.07 (1984Si16), +0.005 *70* (1971Kr02).
432.66 *12*	0.077 *3*	1398.940	3^-	966.1686	2^+				
486.06 *5*	0.281 *5*	1535.151	4^-	1049.1017	3^+	E1+M2	+0.04 *3*	0.0056 *4*	α(K)=0.0048 *3*; α(L)=0.00066 *5*; α(M)=0.000144 *10* α(N)=3.32×10^{-5} *24*; α(O)=4.8×10^{-6} *4*; α(P)=2.63×10^{-7} *19* δ: from 1989Ma39.
682.31 *4*	1.98 *3*	966.1686	2^+	283.8220	4^+	E2		0.00704	α(K)=0.00581 *9*; α(L)=0.000962 *14*; α(M)=0.000214 *3* α(N)=4.91×10^{-5} *7*; α(O)=6.94×10^{-6} *10*; α(P)=3.32×10^{-7} *5* δ: 1989Ma39 report δ(M3/E2)=+0.004 *17* for this transition. From RUL<10, one expects δ<0.001.
707.6 *10*	0.033 *17*	1288.66	5^+	581.1	6^+	E2		0.00647	α(K)=0.00535 *8*; α(L)=0.000875 *13*; α(M)=0.000194 *3* α(N)=4.47×10^{-5} *7*; α(O)=6.32×10^{-6} *10*; α(P)=3.06×10^{-7} *5* E_γ,I_γ: from 1984Ch34. Mult.: from ^{160}Ho ε decay.
765.28 *4*	7.11 *4*	1049.1017	3^+	283.8220	4^+	E2+M1	−13.8 *9*	0.00544	α(K)=0.00452 *7*; α(L)=0.000720 *10*; α(M)=0.0001595 *23*

γ(^{160}Dy) (continued)

E_γ[@]	I_γ[†#f]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	δ[e]	α[ad]	Comments
									α(N)=3.67×10^{-5} *6*; α(O)=5.21×10^{-6} *8*; α(P)=2.60×10^{-7} *4* δ: from 1989Ma39. Others: −8.3 *+7−9* (1982Kr04), −9.0 *+24−50* (1979Gr22), −7.7 *+6−7* (1974Fo27), −7 *+5−20* (1971Kr02).
872.03 *6*	0.723 *12*	1155.812	4$^+$	283.8220	4$^+$	M1+E2	+5.0 *+20−11*	0.00419 *10*	α(K)=0.00351 *9*; α(L)=0.000536 *11*; α(M)=0.0001181 *25* α(N)=2.72×10^{-5} *6*; α(O)=3.90×10^{-6} *9*; α(P)=2.03×10^{-7} *6* δ: from ^{160}Ho ε decay (25.6 min+5.02 h). 1989Ma39 report δ=−0.95 *+8−11*, but state that this value may be incorrect because the γ is very weak and probably affected by the close-lying strong 879 γ. Other: −0.70 *30* (1979Gr22), but 1998Kr07 point out that the second value of δ deduced from the data of 1979Gr22 is +5.0 *+24−13*.
879.378[&] *2*	100.0 *2*	966.1686	2$^+$	86.7877	2$^+$	E2+M1	−16.6 *5*	0.00400	α(K)=0.00335 *5*; α(L)=0.000513 *8*; α(M)=0.0001132 *16* α(N)=2.61×10^{-5} *4*; α(O)=3.73×10^{-6} *6*; α(P)=1.93×10^{-7} *3* δ: from 1989Ma39. Others: −16.7 *+13−16* (1982Kr04), −12.8 *15* (1979Gr22), −18 *+4−8* (1974Fo27), −14.5 *15* (1976Bh06), −16.3 *13* (1973Ga10), −13.5 *17* (1972Zu03), −11.5 *19* (1971Kr02).
962.311[&] *3*	32.6 *3*	1049.1017	3$^+$	86.7877	2$^+$	E2+M1	−13.8 *3*	0.00331	α(K)=0.00278 *4*; α(L)=0.000416 *6*; α(M)=9.17×10^{-5} *13* α(N)=2.11×10^{-5} *3*; α(O)=3.04×10^{-6} *5*; α(P)=1.603×10^{-7} *23* δ: from 1989Ma39. Others: −11.0 *12* (1982Kr04), −37 *+17−109* (from 1979Gr22, as recomputed by 1989Ma39), −8.4 *+17−27* (1976Bh06), −18 *5* (1971Kr02).
966.166[&] *2*	83.4 *4*	966.1686	2$^+$	0.0	0$^+$	E2		0.00327	α(K)=0.00274 *4*; α(L)=0.000411 *6*; α(M)=9.05×10^{-5} *13* α(N)=2.09×10^{-5} *3*; α(O)=3.00×10^{-6} *5*; α(P)=1.583×10^{-7} *23*
1002.88 *4*	3.45[‡] *2*	1286.694	3$^-$	283.8220	4$^+$	E1+M2	−0.013 *9*	1.24×10^{-3}	α(K)=0.001063 *16*; α(L)=0.0001411 *21*; α(M)=3.06×10^{-5} *5* α(N)=7.06×10^{-6} *11*; α(O)=1.032×10^{-6} *15*; α(P)=5.93×10^{-8} *9*

$^{160}_{66}Dy_{94}$-6

$\gamma(^{160}$Dy) (continued)

E_γ[@]	I_γ[†#f]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ[e]	α[ad]	Comments
									δ: from 1989Ma39. Others: −0.009 *15* (1982Kr04), +0.094 *21* (1979Gr22), −0.004 *17* (1974Fo27), −0.11 *+10−11* (1984Si16), +0.005 *4* (1996Al02).
1005.0 *10*	0.13[‡] *3*	1288.66	5$^+$	283.8220	4$^+$	M1+E2	+7.1 *+8−10*	0.00306	α(K)=0.00257 *4*; α(L)=0.000381 *6*; α(M)=8.37×10^{-5} *13* α(N)=1.93×10^{-5} *3*; α(O)=2.78×10^{-6} *5*; α(P)=1.484×10^{-7} *23* Mult.,δ: from ^{160}Ho ε decay.
1069.09 *5*	0.332 *5*	1155.812	4$^+$	86.7877	2$^+$	E2		0.00265	α(K)=0.00223 *4*; α(L)=0.000328 *5*; α(M)=7.20×10^{-5} *10* α(N)=1.659×10^{-5} *24*; α(O)=2.39×10^{-6} *4*; α(P)=1.290×10^{-7} *18* δ: 1989Ma39 report δ(M3/E2)=+0.02 *4*. 1994SlZZ, from $\gamma(\theta)$ on oriented ^{160}Ho nuclei, report δ(M3/E2)=−0.079 *21*. However, from RUL, using reasonable estimates of B(E2) of the 1069 γ, the evaluator concludes that δ(M3/E2) is probably less than 0.0013. See the discussion on the 1069 γ in the ^{160}Ho ε Decay (25.6 m+5.02 h) data set.
1102.60 *3*	1.932 *11*	1386.436	4$^-$	283.8220	4$^+$	E1+M2	+0.0049 *12*	1.04×10^{-3}	α(K)=0.000892 *13*; α(L)=0.0001179 *17*; α(M)=2.56×10^{-5} *4* α(N)=5.90×10^{-6} *9*; α(O)=8.63×10^{-7} *12*; α(P)=4.99×10^{-8} *7*; α(IPF)=1.86×10^{-6} *3* I_γ: average of three values. 1992Si23 do not report an Iγ value for this γ. δ: from 1989Ma39. Others: −0.085 *40* (1982Kr04), −0.013 *46* (1979Gr22), −0.156 *25* (1974Fo27), +0.05 *+14−17* (1984Si16), −0.020 *22* (1996Al02).
1115.12 *3*	5.20 *5*	1398.940	3$^-$	283.8220	4$^+$	E1(+M2)	+0.001 *3*	1.02×10^{-3}	α(K)=0.000874 *13*; α(L)=0.0001154 *17*; α(M)=2.50×10^{-5} *4* α(N)=5.78×10^{-6} *8*; α(O)=8.45×10^{-7} *12*; α(P)=4.89×10^{-8} *7*; α(IPF)=2.87×10^{-6} *4* δ: from 1989Ma39. Others: −0.013 *8* (1982Kr04), +0.011 *14* (1979Gr22), 0.000 *12* (1974Fo27), −0.002 *+60−58* (1984Si16), +0.010 *4* (1996Al02).
1177.954[&] *3*	49.4 *2*	1264.7470	2$^-$	86.7877	2$^+$	E1+M2	−0.0207[bc] *23*	9.44×10^{-4}	α(K)=0.000795 *12*; α(L)=0.0001048 *15*; α(M)=2.27×10^{-5} *4* α(N)=5.24×10^{-6} *8*; α(O)=7.67×10^{-7} *11*; α(P)=4.45×10^{-8} *7*; α(IPF)=1.557×10^{-5} *22* δ: from 1989Ma39. Others: −0.062 *4* (1982Kr04), −0.015 *8* (1979Gr22), −0.031 *12* (1974Fo27), +0.09 *2* (1984Si16), +0.047 *21* (1973Ga10), +0.02 *2* (1971Kr02).

$^{160}_{66}$Dy$_{94}$-7

$\gamma(^{160}Dy)$ (continued)

E_γ[@]	I_γ[†#f]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	δ[e]	α[ad]	Comments
1199.89 *3*	7.92 *4*	1286.694	3^-	86.7877	2^+	E1+M2	−0.008 *3*	9.19×10^{-4}	α(K)=0.000767 *11*; α(L)=0.0001010 *15*; α(M)=2.19×10^{-5} *3* α(N)=5.05×10^{-6} *7*; α(O)=7.40×10^{-7} *11*; α(P)=4.29×10^{-8} *6*; α(IPF)=2.35×10^{-5} *4* δ: from 1989Ma39. Others: +0.026 *5* (1982Kr04), −0.050 *11* (1979Gr22), −0.017 *8* (1974Fo27), −0.05 *6* (1984Si16).
1251.27 *5*	0.352 *3*	1535.151	4^-	283.8220	4^+	E1(+M2)	−0.01 *3*	8.78×10^{-4} *16*	α(K)=0.000712 *13*; α(L)=9.36×10^{-5} *18*; α(M)=2.03×10^{-5} *4* α(N)=4.68×10^{-6} *9*; α(O)=6.86×10^{-7} *14*; α(P)=3.99×10^{-8} *8*; α(IPF)=4.61×10^{-5} *7* I_γ: Iγ=0.300 *8* (1992Si23) excluded from the average. δ: from 1989Ma39. Others: −0.118 *85* (1982Kr04), +0.02 *+19−12* (1979Gr22).
1271.873[&] *5*	24.73 *7*	1358.666	2^-	86.7877	2^+	E1+M2	+0.0166[bc] *25*	8.65×10^{-4}	α(K)=0.000693 *10*; α(L)=9.11×10^{-5} *13*; α(M)=1.97×10^{-5} *3* α(N)=4.56×10^{-6} *7*; α(O)=6.67×10^{-7} *10*; α(P)=3.88×10^{-8} *6*; α(IPF)=5.58×10^{-5} *8* δ: from 1989Ma39. Others: −0.029 *5* (1982Kr04), +0.026 *9* (1979Gr22), −0.003 *12* (1974Fo27), +0.05 *+3−2* (1984Si16), −0.003 *26* (1973Ga10), −0.03 *3* (1971Kr02).
1285.58 *10*	0.051 *4*	1285.59	1^-	0.0	0^+	E1		8.55×10^{-4}	α(K)=0.000678 *10*; α(L)=8.91×10^{-5} *13*; α(M)=1.93×10^{-5} *3* α(N)=4.46×10^{-6} *7*; α(O)=6.53×10^{-7} *10*; α(P)=3.80×10^{-8} *6*; α(IPF)=6.25×10^{-5} *9*
1299.3 *3*	0.0181 *18*	1386.436	4^-	86.7877	2^+				I_γ: average of 0.0193 *14* (1986Me07) and 0.0160 *19* (1992Si23) only. Values of 0.0051 *19* (1983Ji01) and 0.030 *3* (1984Ch34) not included in this average.
1312.14 *4*	9.51 *12*	1398.940	3^-	86.7877	2^+	E1+M2	−0.015 *3*	8.42×10^{-4}	α(K)=0.000656 *10*; α(L)=8.61×10^{-5} *12*; α(M)=1.87×10^{-5} *3* α(N)=4.31×10^{-6} *6*; α(O)=6.31×10^{-7} *9*; α(P)=3.67×10^{-8} *6*; α(IPF)=7.63×10^{-5} *11* I_γ: the four Iγ values included in the average form two distinct groupings, namely 9.35 *4* (1983Ji01), 9.44 *4* (1986Me07) and 9.87 *20* (1984Ch34), 9.86 *5* (1992Si23). δ: from 1989Ma39. Others: +0.013 *6* (1982Kr04), −0.045 *11* (1979Gr22), −0.017 *8* (1974Fo27), +0.19 *+7−5* (1984Si16).

$^{160}_{66}Dy_{94}$-8

^{160}Tb β^- decay (continued)

γ(^{160}Dy) (continued)

E_γ[@]	I_γ[†#f]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α[ad]	Comments
1468.6 *3*	0.0019 *5*	1555.83	$1^+,2^+$	86.7877	2^+	(E2)	1.48×10^{-3}	α(K)=0.001204 *17*; α(L)=0.0001680 *24*; α(M)=3.67×10^{-5} *6* α(N)=8.47×10^{-6} *12*; α(O)=1.234×10^{-6} *18*; α(P)=6.96×10^{-8} *10*; α(IPF)=6.29×10^{-5} *9* E_γ,I_γ: from 1986AdZX. Mult.: from adopted gammas.
1556.6 *4*	0.0016 *2*	1555.83	$1^+,2^+$	0.0	0^+			E_γ,I_γ: from 1986AdZX.

[†] Unless otherwise indicated, the listed γ-ray intensities represent weighted averages of the values reported by 1983Ji01, 1984Ch34, 1986Me07 and 1992Si23. For other studies in which precise Iγ values for ^{160}Tb decay are reported, see, e.g., 1974La15 and 1979Hn02.

[‡] Most studies report only Iγ(1002+1005). The Iγ values given here for these two γ's are based on Iγ(1002+1005)=3.579 *13* (weighted average of values from 1983Ji01, 1986Me07 and 1992Si23), and the split in intensity between them reported by 1984Ch34.

[#] 1996Ch55 present an evaluation of Iγ data for many of the γ's in the ^{160}Tb decay. However, they do not appear to have included the data from 1992Si23 in their evaluation; and their results are not incorporated here.

[@] Weighted average of the data of 1968Lu10, 1970Ke07, and 1972Mc10, unless noted otherwise.

[&] Value recommended for γ-ray energy calibration purposes by 2000He14.

[a] Theoretical values, calculated assuming the listed multipolarities. For a number of the E1+M2 transitions, there is the possibility of an E3 admixture as well. In these cases, the α values may be in error. Conversion coefficients have been measured for a number of the γ transitions. These are not given here. See 1968Lu10, for example, for such information. For a recent report of measured α values (mainly α(K)exp), see 1994MiZY.

[b] The δ values determined from the nuclear-orientation studies of 1989Ma39 differ considerably from those obtained from the $\gamma\gamma(\theta)$ experiments. 1982Kr04 suggest that the differences in the δ values from nuclear-orientation studies and from $\gamma\gamma(\theta)$ experiments might be explained by including a small E3 admixture in the E1+M2 transitions.

[c] Both 1982Kr04 and 1989Ma39 point out that these transitions may have sizeable E3 admixtures, their deduced E3/E1 mixing ratios being larger than the M2/E1 ratios. As pointed out by 1989Ma39, because of the relatively large errors associated with the δ values from the $\gamma\gamma(\theta)$ data, definitive conclusions regarding E3 components in these transitions must await new, more precise measurements.

[d] Additional information 2.

[e] Additional information 3.

[f] For absolute intensity per 100 decays, multiply by 0.301 *6*.

[g] Placement of transition in the level scheme is uncertain.

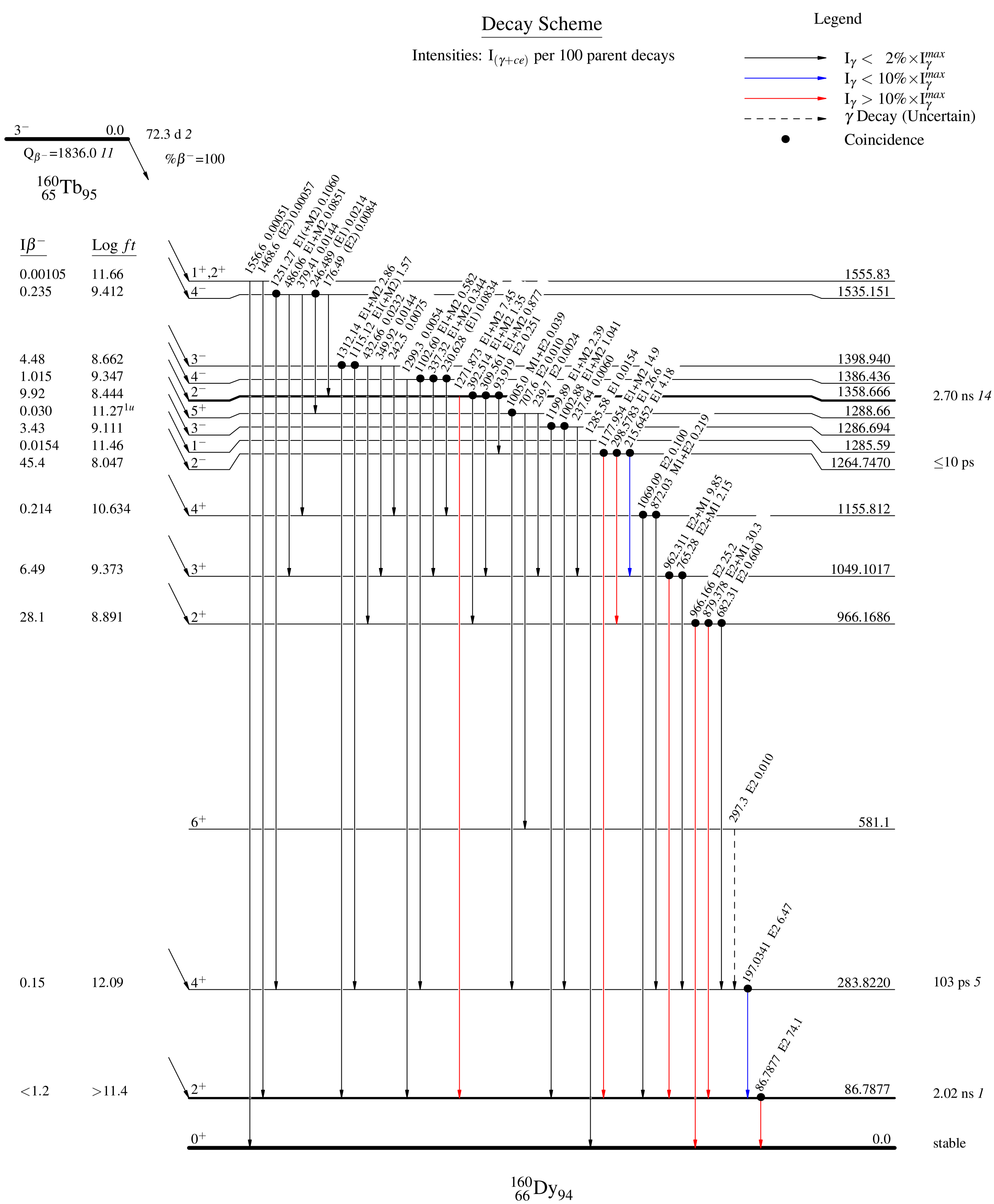
[x] γ ray not placed in level scheme.

$^{160}_{66}Dy_{94}$-9

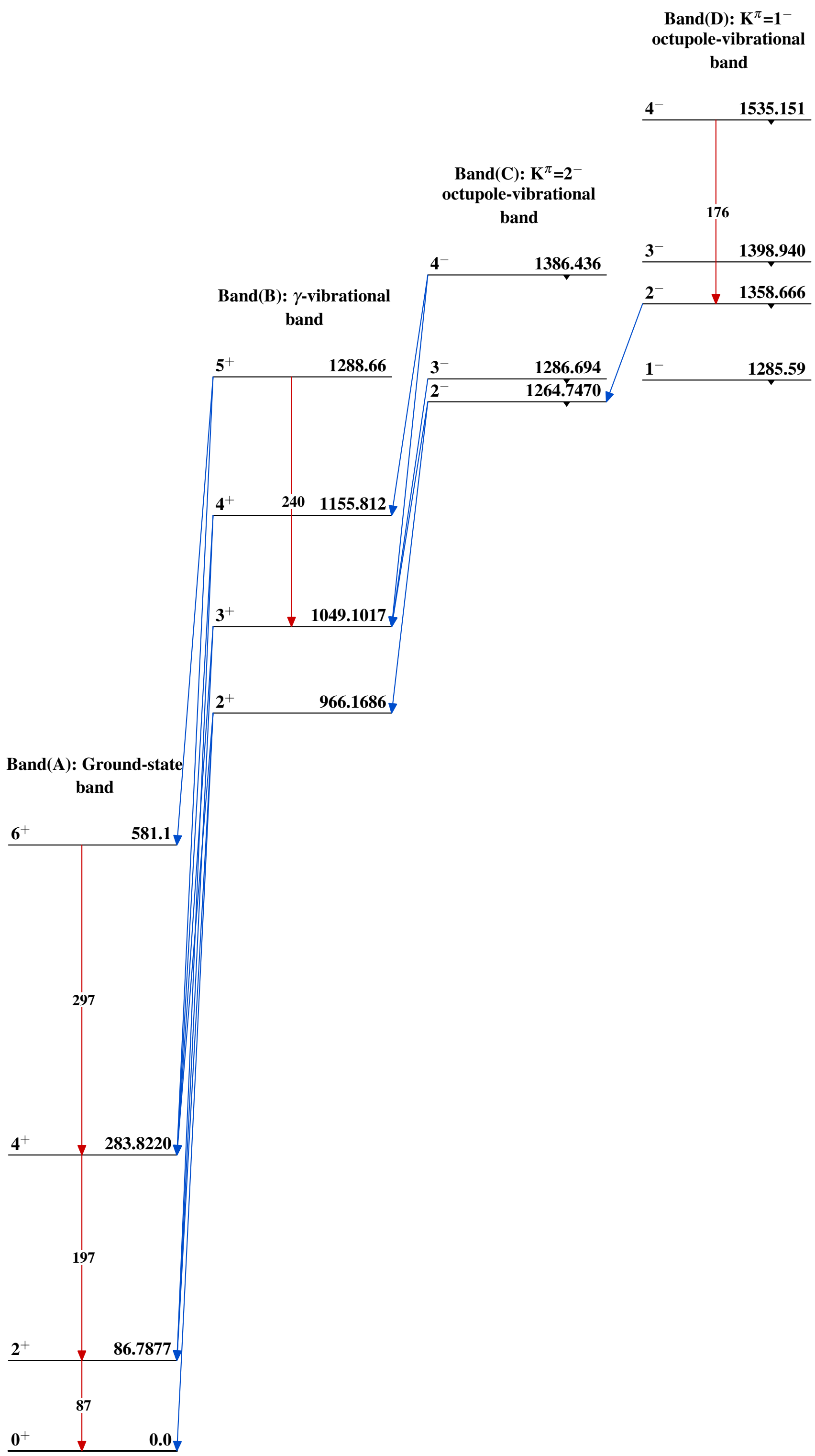
^{160}Tb β^- decay

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays



^{160}Tb β^- decay



$^{160}_{66}Dy_{94}$