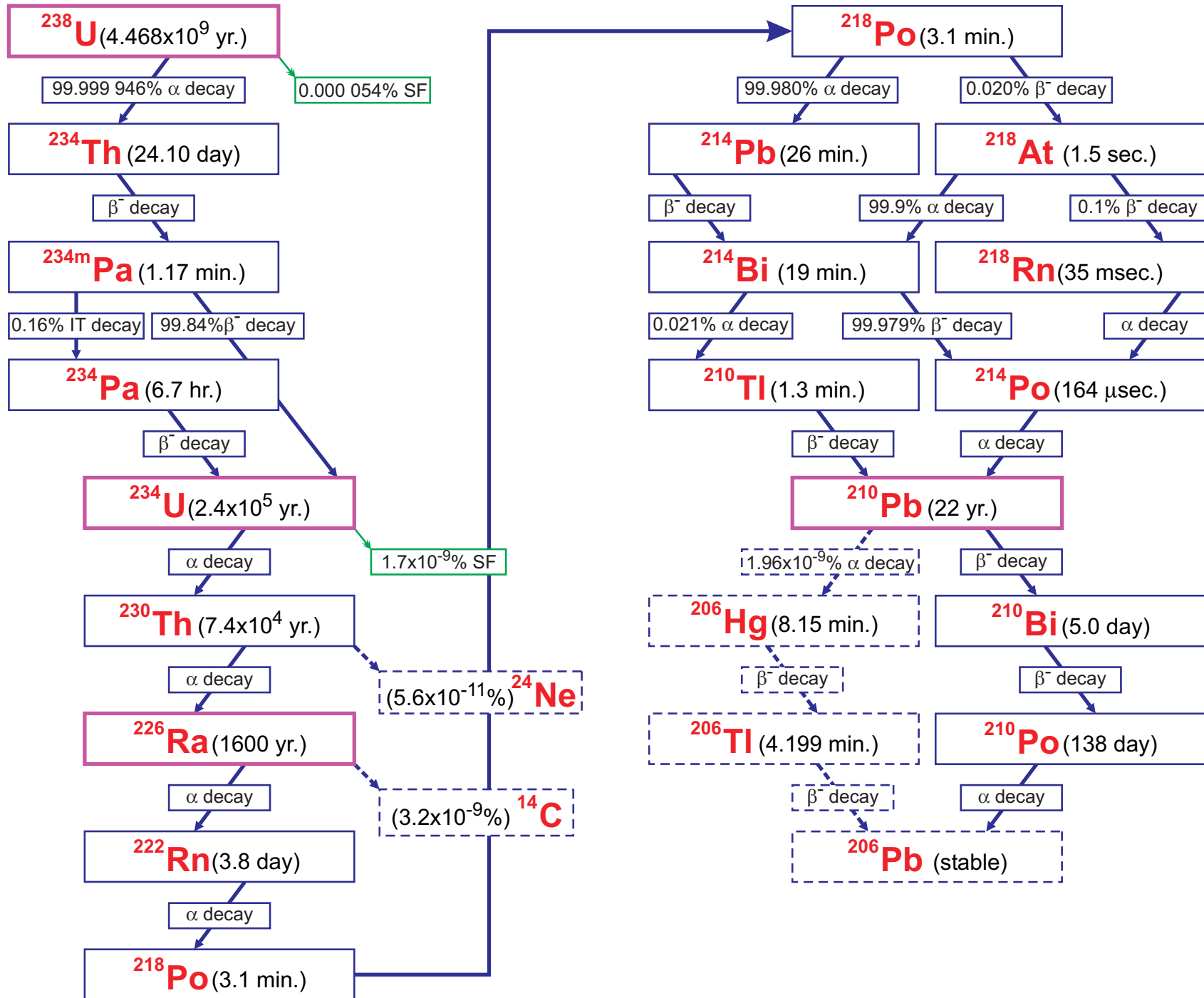
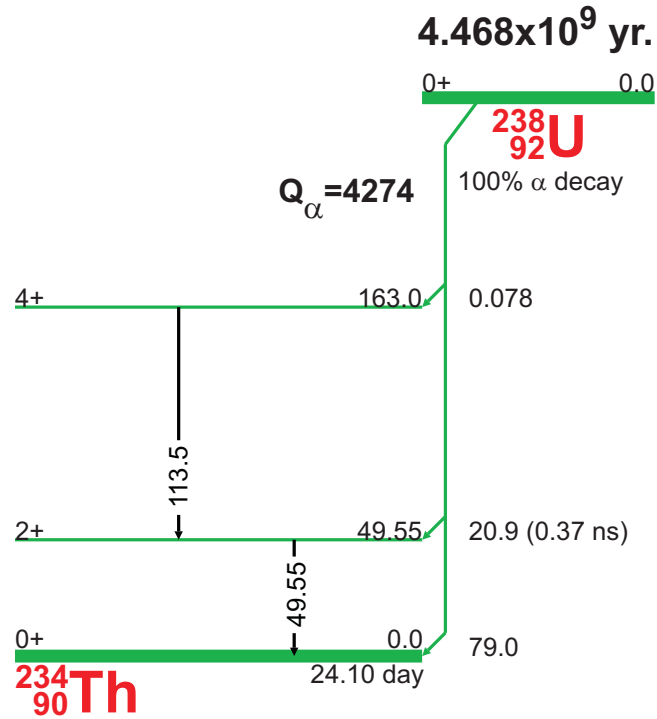


# <sup>238</sup>U Decay Chain



## $^{238}\text{U}$ ( $4.47 \times 10^9$ yr.) Decay Scheme



## GAMMA-RAY ENERGIES AND INTENSITIES

Nuclide:  $^{238}\text{U}$ Half Life:  $4.468 \times 10^9$  (3) yr.

$E_\gamma$ (keV)	$\sigma E_\gamma$	$I_\gamma$	$\sigma I_\gamma$	Level	$\alpha$
49.55	0.06	0.064	0.008	49.55	$\alpha$
113.5	0.1	0.010 2	0.001 5	163.0	$\alpha$

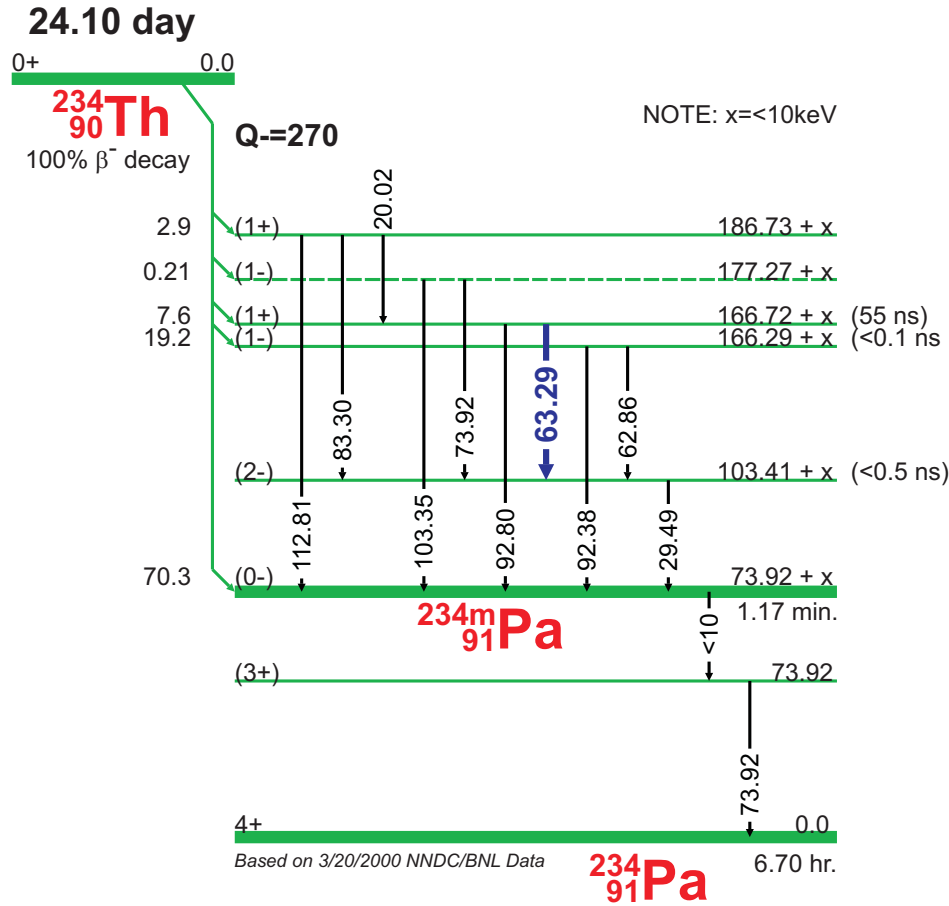
$E_\gamma$ ,  $\sigma E_\gamma$ ,  $I_\gamma$ ,  $\sigma I_\gamma$  Levels from ENSDF Database as of September 7, 1999

① These  $I_\gamma$  are per 100 Decays of  $^{238}\text{U}$ .

② Normalization factor is 1.0, and its uncertainty is taken to be 0.0.



# <sup>234</sup>Th (24.10 day) Decay Scheme



## GAMMA-RAY ENERGIES AND INTENSITIES

Nuclide: **<sup>234</sup>Th**

Half Life: 24.1(3) day

E <sub>γ</sub> (keV)	σ E <sub>γ</sub>	① I <sub>γ</sub>	② σ I <sub>γ</sub>	③ Level	
10	<			73.92+X	β-
20.02	0.02	0.009 9	0.002 6	186.73+X	β-
29.49	0.02	0.001 58	0.000 13	103.41+X	β-
57.75	0.10	0.007	0.004		β-
62.86	0.02	0.021	0.003	166.29+X	β-
63.29	0.02	4.8	0.5	166.72+X	β-
73.92	0.02	0.017 2	0.001 3	73.92	β-
73.92				177.27+X	β-
83.30	0.05	0.079	0.004	186.73+X	β-
87.02	0.06	0.019	0.003		β-
92.00	0.05				β-
92.38	0.01	2.81	0.15	166.29+X	β-
92.80	0.02	2.77	0.15	166.72+X	β-
103.35	0.10	0.004 2	0.001 2	177.27+X	β-
103.71	0.06				β-
108.00	0.05	0.010 6	0.001 3		β-
112.81	0.05	0.277	0.020	186.73+X	β-
132.9					β-
184.8		0.013	0.007		β-

E<sub>γ</sub>, σ E<sub>γ</sub>, I<sub>γ</sub>, σ I<sub>γ</sub>, Levels from ENSDF Database as of March 20, 2000

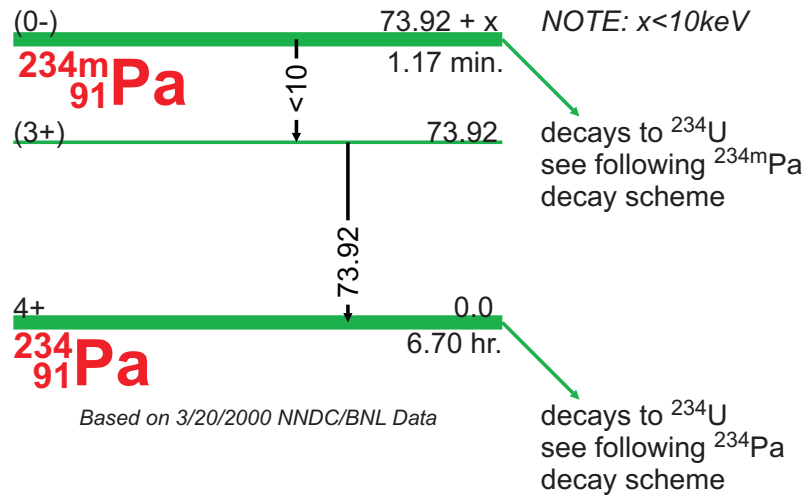
① These I<sub>γ</sub> are per 100 Decays of <sup>234</sup>Th.

② For total uncertainty add 7.6% systematic component in quadrature, based on the normalization factor 0.0066(5)

③ x<10keV



## $^{234}\text{Pa}$ IT Decay Scheme



## GAMMA-RAY ENERGIES AND INTENSITIES

Nuclide:  $^{234}\text{Pa}$ 

Half Life: 1.17(3) min.

$E_\gamma$ (keV)	$\sigma E_\gamma$	$I_\gamma$	$\sigma I_\gamma$	Level
<10.				73.92 + x
73.92	0.02			73.92

$E_\gamma$ ,  $\sigma E_\gamma$ ,  $I_\gamma$ ,  $\sigma I_\gamma$ , Levels from ENSDF Database as of March 20, 2000

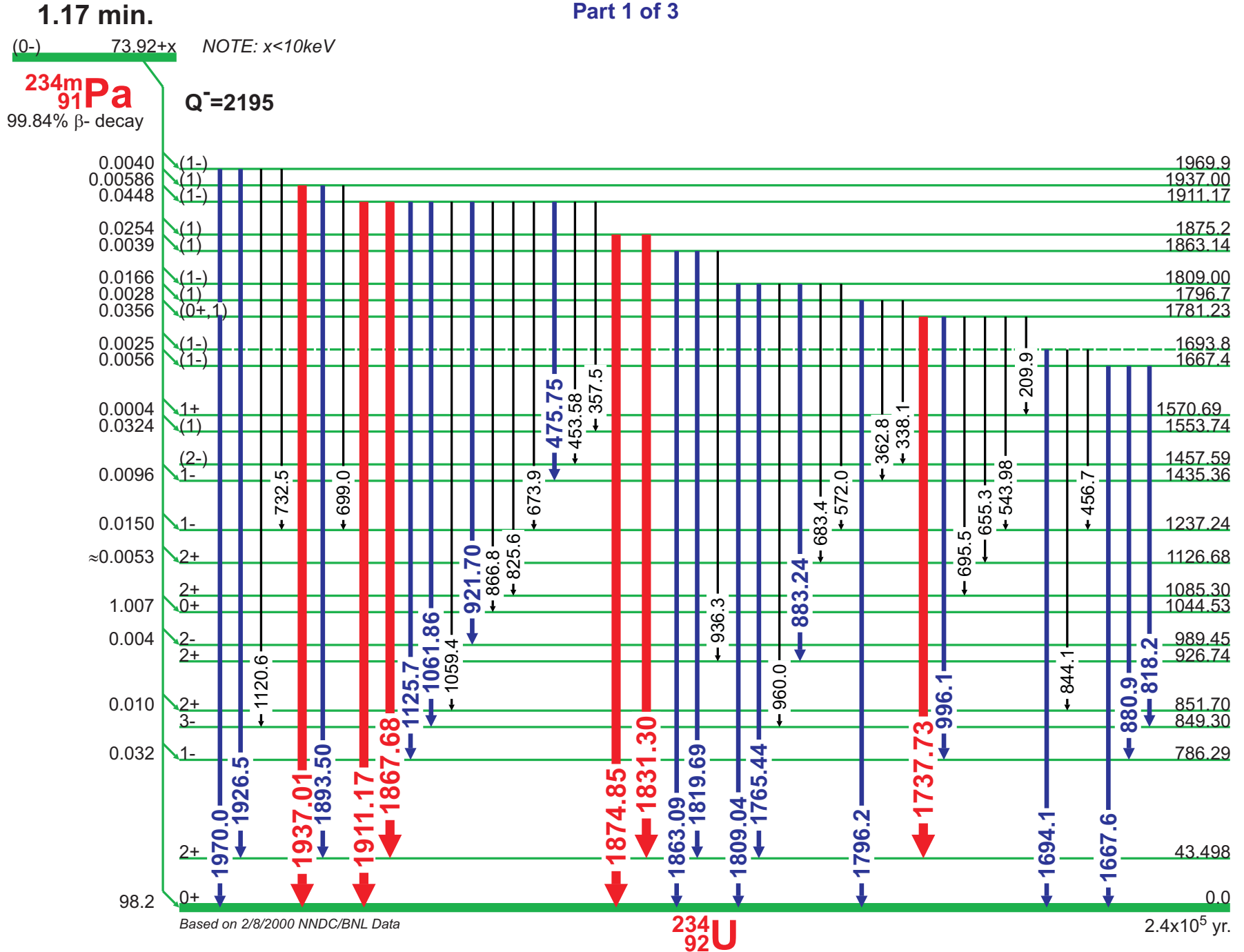
① These  $I_\gamma$  are per 100 Decays of  $^{234}\text{Pa}$ .

② For total uncertainty add 25% systematic component in quadrature, based on the normalization factor 0.0016(4)



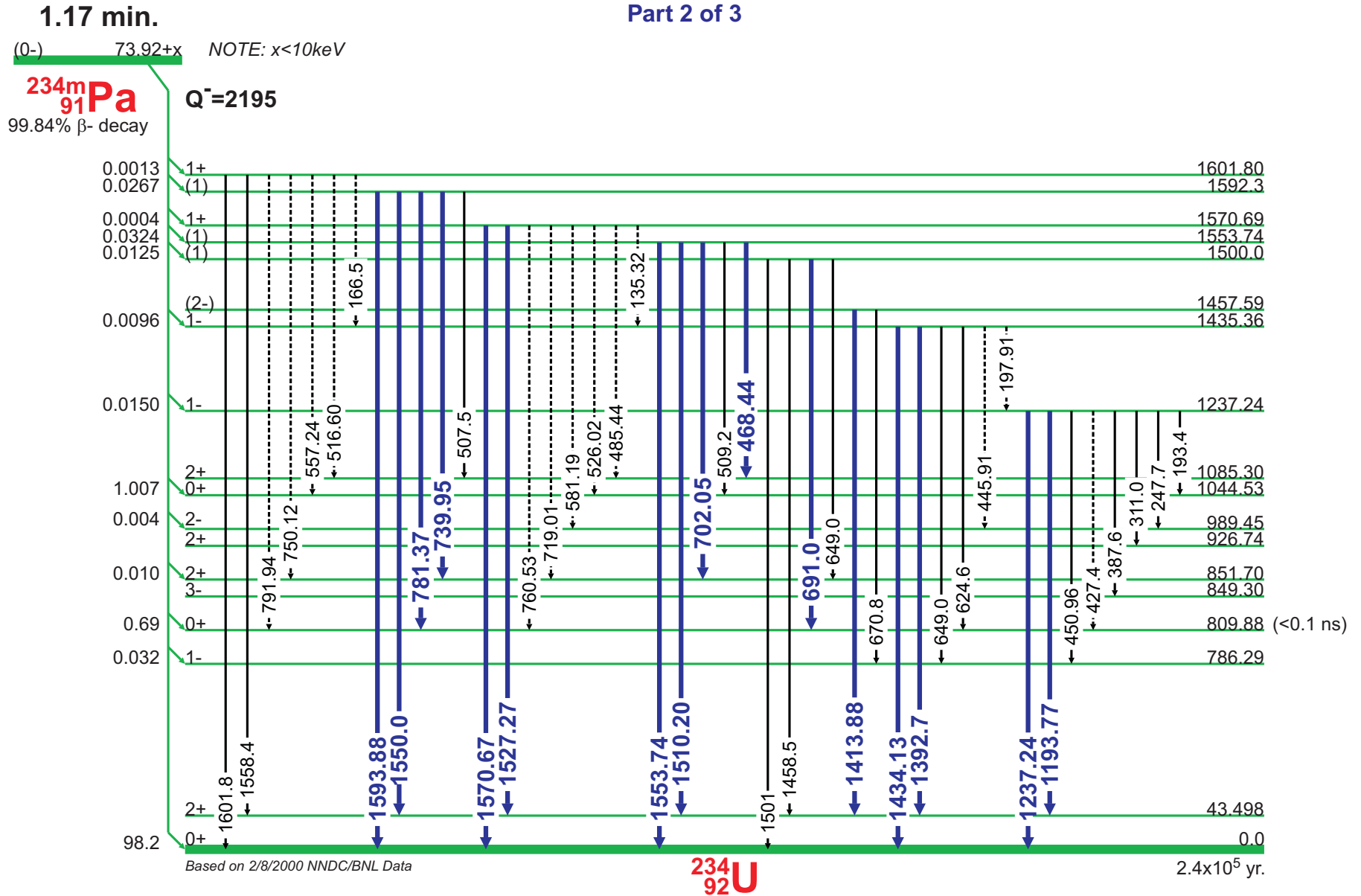
# <sup>234m</sup>Pa (1.17 min.) Decay Scheme

Part 1 of 3



# 234mPa (1.17 min.) Decay Scheme

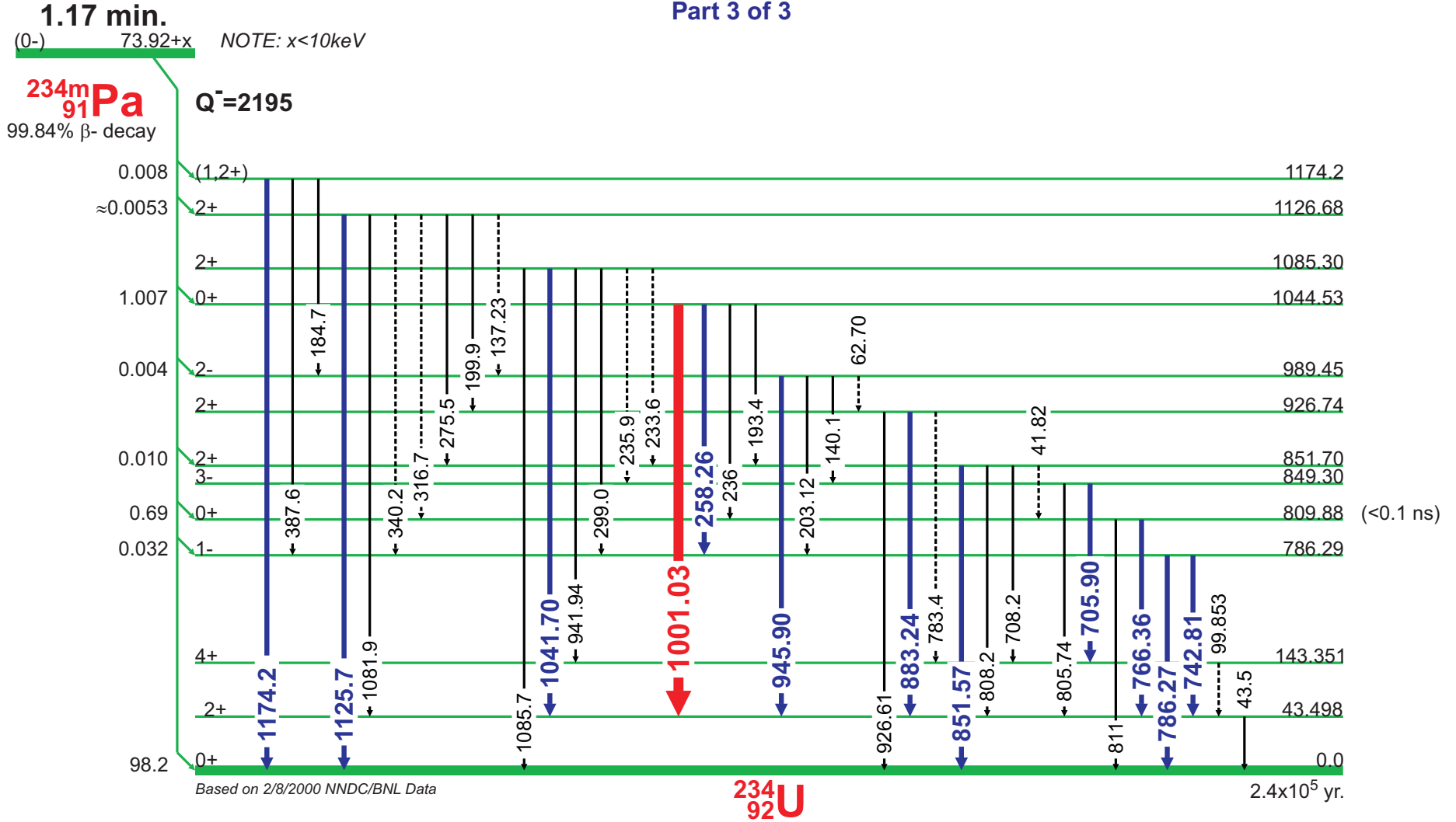
Part 2 of 3





# <sup>234m</sup>Pa (1.17 min.) Decay Scheme

Part 3 of 3



## GAMMA-RAY ENERGIES AND INTENSITIES (page 1 of 2)

Nuclide: **<sup>234m</sup>Pa**E<sub>γ</sub>, σE<sub>γ</sub>, I<sub>γ</sub>, σI<sub>γ</sub>, Levels- from ENSDF Database as of February 8, 2000

Half Life: 1.17(3) min.

E <sub>γ</sub> (keV)	σ E <sub>γ</sub>	<sup>①</sup> I <sub>γ</sub>	<sup>②</sup> σ I <sub>γ</sub>	Level	
41.82				851.7	β-
43.5	0.2			43.498	β-
62.70	0.01	0.001 2	0.000 4	989.45	β-
99.853	0.003			143.351	β-
135.32	0.08	0.000 004 3	0.000 000 5	1,570.69	β-
137.23	0.05	0.000 047	0.000 018	1,126.68	β-
140.1	1.0	0.001 28	0.000 15	989.45	β-
166.5	0.1	0.000 000 24	0.000 000 07	1,601.8	β-
184.7	0.5	0.001 70	0.000 15	1,174.2	β-
193.4	0.8	0.000 15	0.000 03	1,237.24	β-
193.4	0.8	0.000 56	0.000 16	1,044.53	β-
197.91	0.15	0.000 027	0.000 007	1,435.36	β-
199.9	1.0	0.000 57	0.000 12	1,126.68	β-
203.12	0.10	0.001 02	0.000 20	989.45	β-
209.9	0.4	0.001 31	0.000 15	1,781.23	β-
233.6	0.2			1,085.3	β-
235.9	0.3	0.000 08	0.000 04	1,085.3	β-
236	1			1,044.53	β-
243.5	0.8	0.000 50	0.000 10		β-
247.7	0.8	0.000 244	0.000 019	1,237.24	β-
258.26	0.10	0.072 8	0.000 4	1,044.53	β-
275.5	0.8	0.000 31	0.000 06	1,126.68	β-
299.0	1.0	0.000 64	0.000 13	1,085.3	β-
311.0	1.0	0.000 087	0.000 010	1,237.24	β-
316.7	0.1	0.000 18	0.000 05	1,126.68	β-
338.1	0.8	0.001 12	0.000 23	1,796.7	β-
340.2	0.1	0.000 07	0.000 03	1,126.68	β-
357.5	1.0	0.000 79	0.000 17	1,911.17	β-
362.8	1.0	0.000 68	0.000 15	1,796.7	β-
387.6	0.8	0.000 465	0.000 020	1,237.24	β-
387.6	0.8	0.000 95	0.000 16	1,174.2	β-
427.4	0.2	0.000 020	0.000 005	1,237.24	β-
445.91	0.10	0.000 030	0.000 007	1,435.36	β-
450.96	0.10	0.003 00	0.000 16	1,237.24	β-
453.58	0.10	0.001 90	0.000 16	1,911.17	β-
456.7	1.0	0.000 71	0.000 15	1,693.8	β-

E <sub>γ</sub> (keV)	σ E <sub>γ</sub>	<sup>①</sup> I <sub>γ</sub>	<sup>②</sup> σ I <sub>γ</sub>	Level	
468.44	0.10	0.002 30	0.000 16	1,553.74	β-
475.75	0.10	0.002 29	0.000 15	1,911.17	β-
485.44	0.07	0.000 019 0	0.000 001 9	1,570.69	β-
507.5	1.0	0.001 56	0.000 15	1,592.3	β-
509.2	0.8	0.002 1	0.000 3	1,553.74	β-
516.60	0.06	0.000 013	0.000 003	1,601.8	β-
526.02	0.10	0.000 009 2	0.000 001 2	1,570.69	β-
543.98	0.10	0.003 59	0.000 17	1,781.23	β-
557.24	0.06	0.000 008 6	0.000 002 0	1,601.8	β-
557.3	1.0	0.000 71	0.000 16		β-
572.0	1.0	0.000 87	0.000 17	1,809	β-
581.19	0.10	0.000 081	0.000 010	1,570.69	β-
624.6	1.0	0.000 142	0.000 015	1,435.36	β-
647.7	0.8	0.001 56	0.000 15		β-
649.0	1.0	0.001 02	0.000 23	1,500	β-
649.0	1.0	0.000 041	0.000 008	1,435.36	β-
655.3	1.0	0.001 38	0.000 15	1,781.23	β-
670.8	1.0	0.000 37	0.000 09	1,457.59	β-
673.9	1.0	0.000 64	0.000 13	1,911.17	β-
683.4	1.0	0.000 57	0.000 12	1,809	β-
691.0	0.3	0.007 8	0.000 7	1,500	β-
695.5	1.0	0.001 56	0.000 15	1,781.23	β-
699.0	1.0	0.000 79	0.000 16	1,937	β-
702.05	0.10	0.007 08	0.000 17	1,553.74	β-
705.90	0.10	0.004 0	0.000 5	849.3	β-
708.2	1.0	0.000 7	<	851.7	β-
719.01	0.07	0.000 026	0.000 003	1,570.69	β-
732.5	1.0	0.001 29	0.000 15	1,969.9	β-
739.95	0.10	0.011 7	0.000 3	1,592.3	β-
742.81	0.03	0.080	0.004	786.29	β-
750.12	0.06	0.000 018	0.000 004	1,601.8	β-
760.3	1.0	0.001 56	0.000 15		β-
760.53	0.15	0.000 004 3	0.000 000 9	1,570.69	β-
766.36	0.02	0.294	0.012	809.88	β-
781.37	0.10	0.007 78	0.000 18	1,592.3	β-
783.4	0.1	0.000 038	0.000 007	926.74	β-

① These I<sub>γ</sub> are per 100 Decays of <sup>234m</sup>Pa.

② For total uncertainty add systematic component of 0.004% in quadrature, based on the normalization factor 0.000 999 84(4)

## GAMMA-RAY ENERGIES AND INTENSITIES (page 2 of 2)

Nuclide: **<sup>234m</sup>Pa**E<sub>γ</sub>, σE<sub>γ</sub>, I<sub>γ</sub>, σI<sub>γ</sub>, Levels- from ENSDF Database as of February 8, 2000

Half Life: 1.17(3) min.

E <sub>γ</sub> (keV)	σE <sub>γ</sub>	① I <sub>γ</sub>	② σ I <sub>γ</sub>	Level	
786.27	0.03	0.048 5	0.001 9	786.29	β-
791.94	0.05	0.000 010	0.000 003	1,601.8	β-
805.74	0.10	0.004 3	0.000 5	849.3	β-
808.2	0.5	0.003 0	0.000 3	851.7	β-
811		EO		809.88	β-
818.2	0.5	0.001 0	0.000 3	1,667.4	β-
825.6	0.5	0.001 4	0.000 3	1,911.17	β-
844.1	0.8	0.001 08	0.000 23	1,693.8	β-
851.57	0.10	0.006 2	0.000 6	851.7	β-
866.8	1.0	0.001 06	0.000 22	1,911.17	β-
880.9	0.5	0.003 8	0.000 5	1,667.4	β-
883.24	0.04	0.001 8	0.000 3	926.74	β-
883.24	0.04	0.001 7	0.000 5	1,809	β-
887.28	0.10	0.007 08	0.000 13		β-
921.70	0.10	0.012 69	0.000 14	1,911.17	β-
926.61	0.10	0.001 23	0.000 13	926.74	β-
936.3	1.0	0.001 8	0.000 5	1,863.14	β-
941.94	0.10	0.002 49	0.000 11	1,085.3	β-
945.90	0.10	0.009 9	0.001 0	989.45	β-
960.0	1.0	0.000 9	0.000 3	1,809	β-
996.1	2.0	0.004 1	0.000 7	1,781.23	β-
<b>1,001.03</b>	<b>0.03</b>	<b>0.837</b>	<b>0.010</b>	<b>1,044.53</b>	<b>β-</b>
1,041.70	0.10	0.001 20	0.000 10	1,085.3	β-
1,059.4	0.8	0.001 09	0.000 22	1,911.17	β-
1,061.86	0.10	0.002 29	0.000 12	1,911.17	β-
1,081.9	1.0	0.000 89	0.000 19	1,126.68	β-
1,085.7	1.0	0.000 48	0.000 09	1,085.3	β-
1,120.6	0.8	0.001 70	0.000 15	1,969.9	β-
1,125.7	0.5	0.003 5	0.000 6	1,911.17	β-
1,125.7	0.5	0.000 53	0.000 13	1,126.68	β-
1,174.2	1.0	0.001 90	0.000 19	1,174.2	β-
1,193.77	0.03	0.013 47	0.000 13	1,237.24	β-
1,220.37	0.10	0.000 90	0.000 10		β-
1,237.24	0.10	0.005 29	0.000 10	1,237.24	β-
1,353.0	1.5	0.000 62	0.000 13		β-

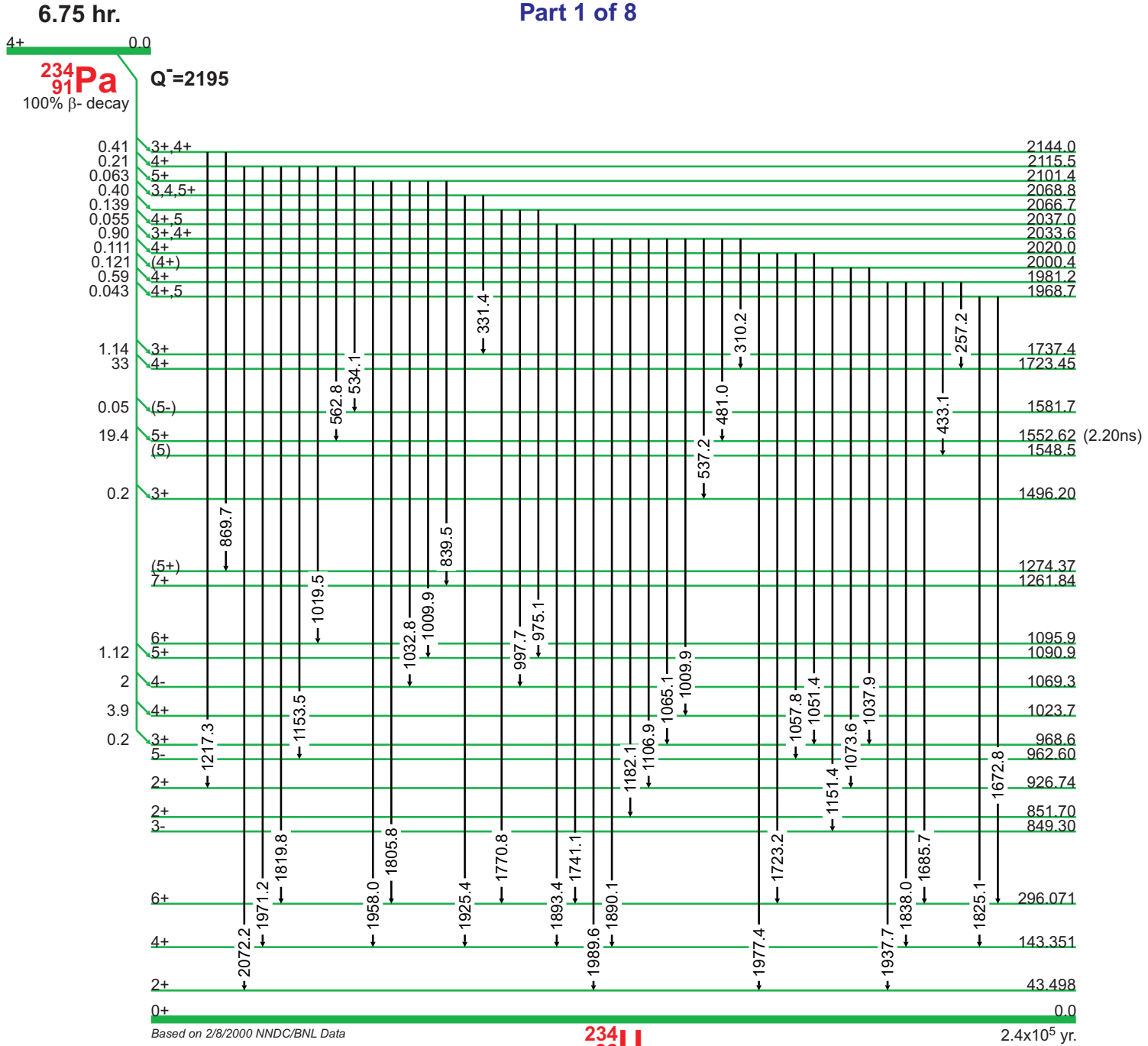
E <sub>γ</sub> (keV)	σE <sub>γ</sub>	① I <sub>γ</sub>	② σ I <sub>γ</sub>	Level	
1,392.7	1.0	0.003 44	0.000 20	1,435.36	β-
1,413.88	0.10	0.002 29	0.000 10	1,457.59	β-
1,434.13	0.10	0.009 68	0.000 13	1,435.36	β-
1,458.5	1.5	0.001 8	0.000 5	1,500	β-
1,501	2	0.001 3	≈	1,500	β-
1,510.20	0.10	0.012 87	0.000 16	1,553.74	β-
1,527.27	0.10	0.002 39	0.000 09	1,570.69	β-
1,550.0	1.0	0.001 84	0.000 15	1,592.3	β-
1,553.74	0.10	0.008 08	0.000 13	1,553.74	β-
1,558.4	1.0	0.000 75	0.000 16	1,601.8	β-
1,570.67	0.10	0.001 10	0.000 08	1,570.69	β-
1,593.88	0.10	0.002 69	0.000 10	1,592.3	β-
1,601.8	1.5	0.000 47	0.000 22	1,601.8	β-
1,667.6	1.0	0.000 82	0.000 17	1,667.4	β-
1,694.1	1.0	0.000 45	0.000 09	1,693.8	β-
1,720.5	1.5	0.000 32	0.000 15		β-
1,732.2	1.5	0.001 8	0.000 3		β-
<b>1,737.73</b>	<b>0.10</b>	<b>0.021 1</b>	<b>0.000 3</b>	<b>1,781.23</b>	<b>β-</b>
1,759.81	0.10	0.001 4	0.000 7		β-
1,765.44	0.10	0.008 68	0.000 13	1,809	β-
1,796.2	1.0	0.000 31	0.000 06	1,796.7	β-
1,809.04	0.10	0.003 69	0.000 08	1,809	β-
1,819.69	0.10	0.000 90	0.000 07	1,863.14	β-
1,831.30	0.10	0.017 2	0.000 3	1,875.2	β-
1,863.09	0.10	0.001 20	0.000 06	1,863.14	β-
<b>1,867.68</b>	<b>0.10</b>	<b>0.009 18</b>	<b>0.000 13</b>	<b>1,911.17</b>	<b>β-</b>
<b>1,874.85</b>	<b>0.10</b>	<b>0.008 18</b>	<b>0.000 13</b>	<b>1,875.2</b>	<b>β-</b>
1,893.50	0.10	0.002 18	0.000 07	1,937	β-
<b>1,911.17</b>	<b>0.10</b>	<b>0.006 28</b>	<b>0.000 10</b>	<b>1,911.17</b>	<b>β-</b>
1,926.5	1.0	0.000 44	0.000 09	1,969.9	β-
<b>1,937.01</b>	<b>0.10</b>	<b>0.002 89</b>	<b>0.000 07</b>	<b>1,937</b>	<b>β-</b>
1,970.0	1.5	0.000 55	0.000 12	1,969.9	β-

① These I<sub>γ</sub> are per 100 Decays of <sup>234m</sup>Pa.

② For total uncertainty add systematic component of 0.004% in quadrature, based on the normalization factor 0.000 999 84(4)

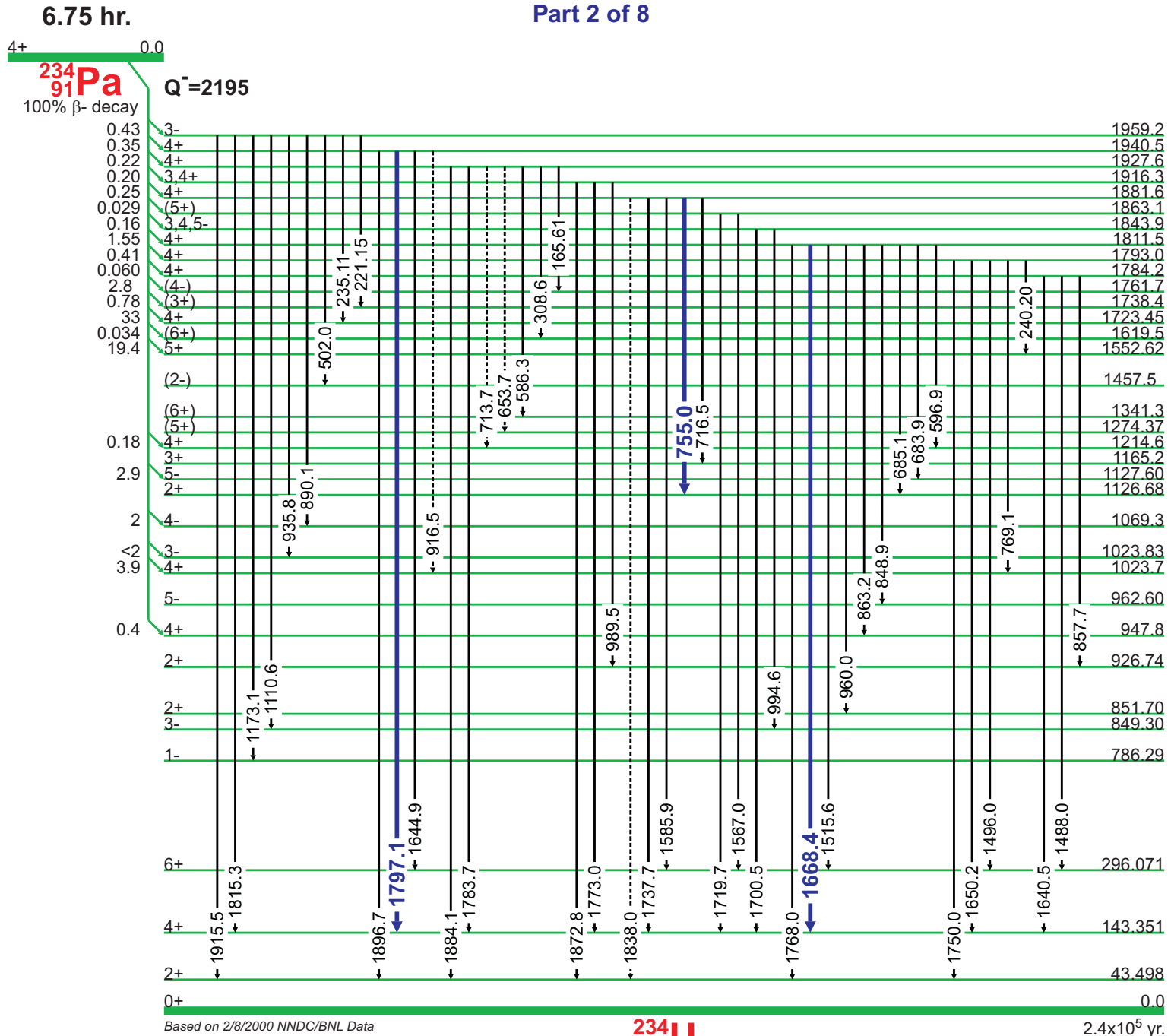
# <sup>234</sup>Pa (6.75 hr.) Decay Scheme

Part 1 of 8



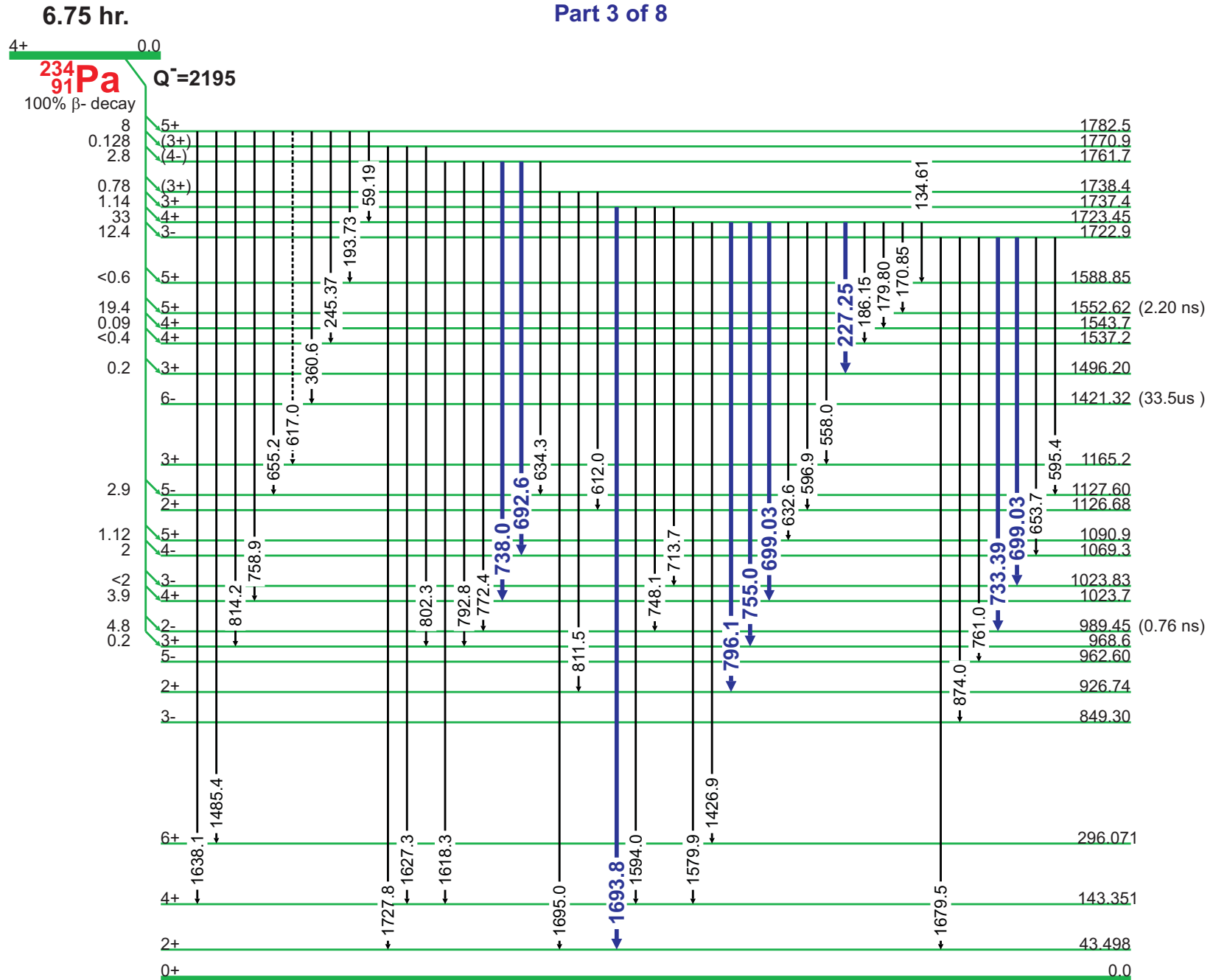
# <sup>234</sup>Pa (6.75 hr.) Decay Scheme

Part 2 of 8



# <sup>234</sup>Pa (6.75 hr.) Decay Scheme

Part 3 of 8



Based on 2/8/2000 NNDC/BNL Data

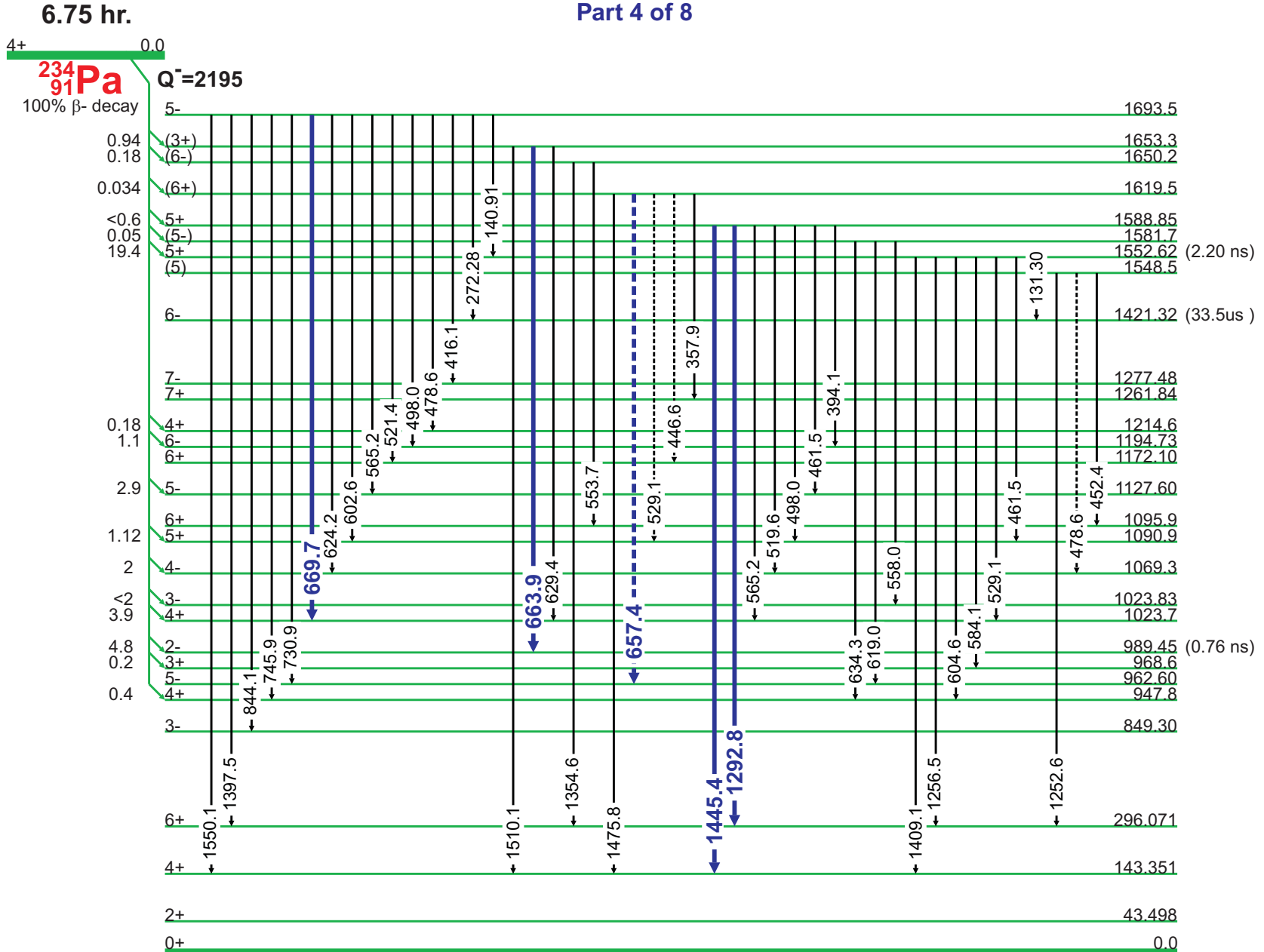


2.4x10<sup>5</sup> yr.



# <sup>234</sup>Pa (6.75 hr.) Decay Scheme

Part 4 of 8



Based on 2/8/2000 NNDC/BNL Data

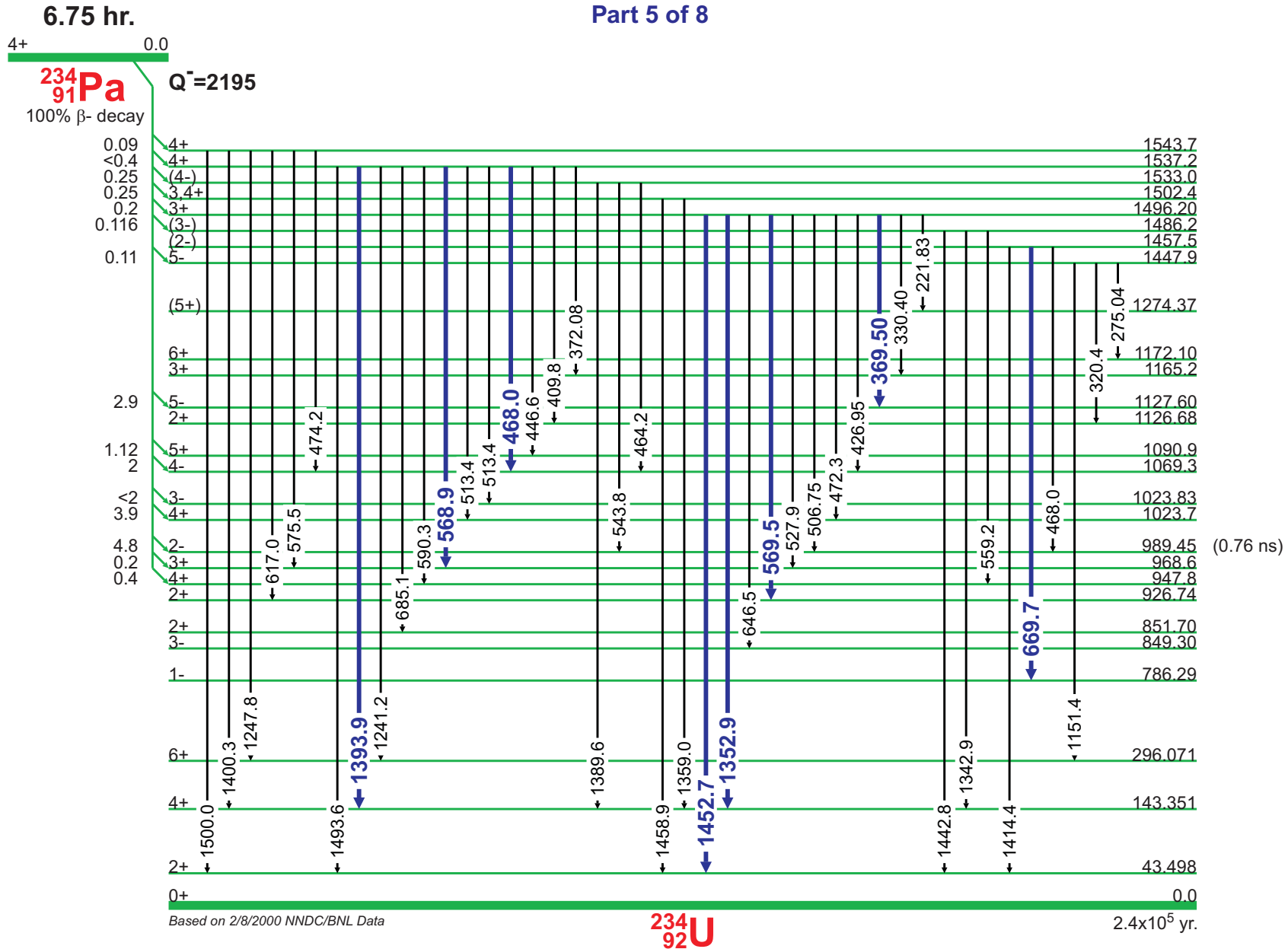


2.4x10<sup>5</sup> yr.



# <sup>234</sup>Pa (6.75 hr.) Decay Scheme

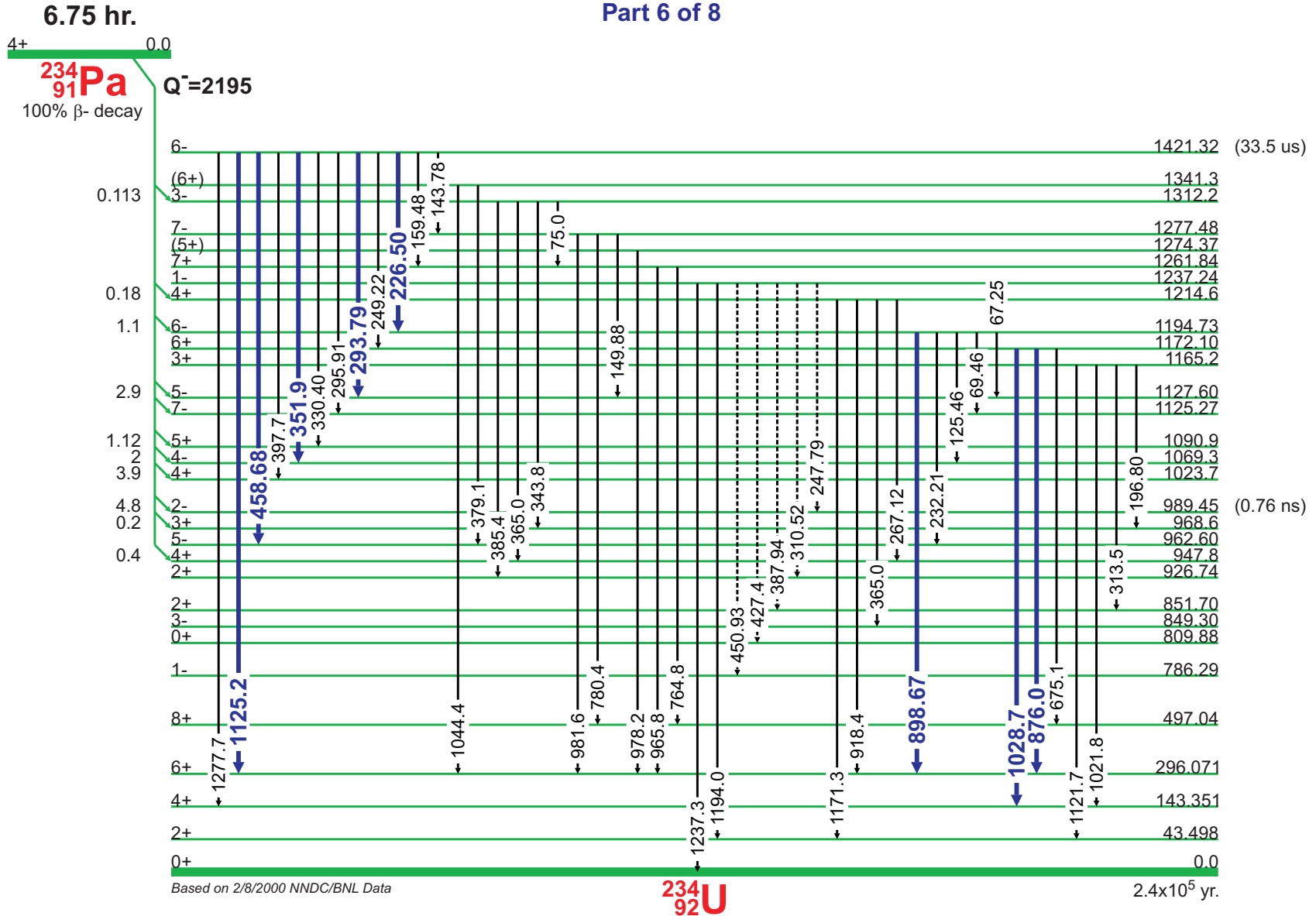
Part 5 of 8





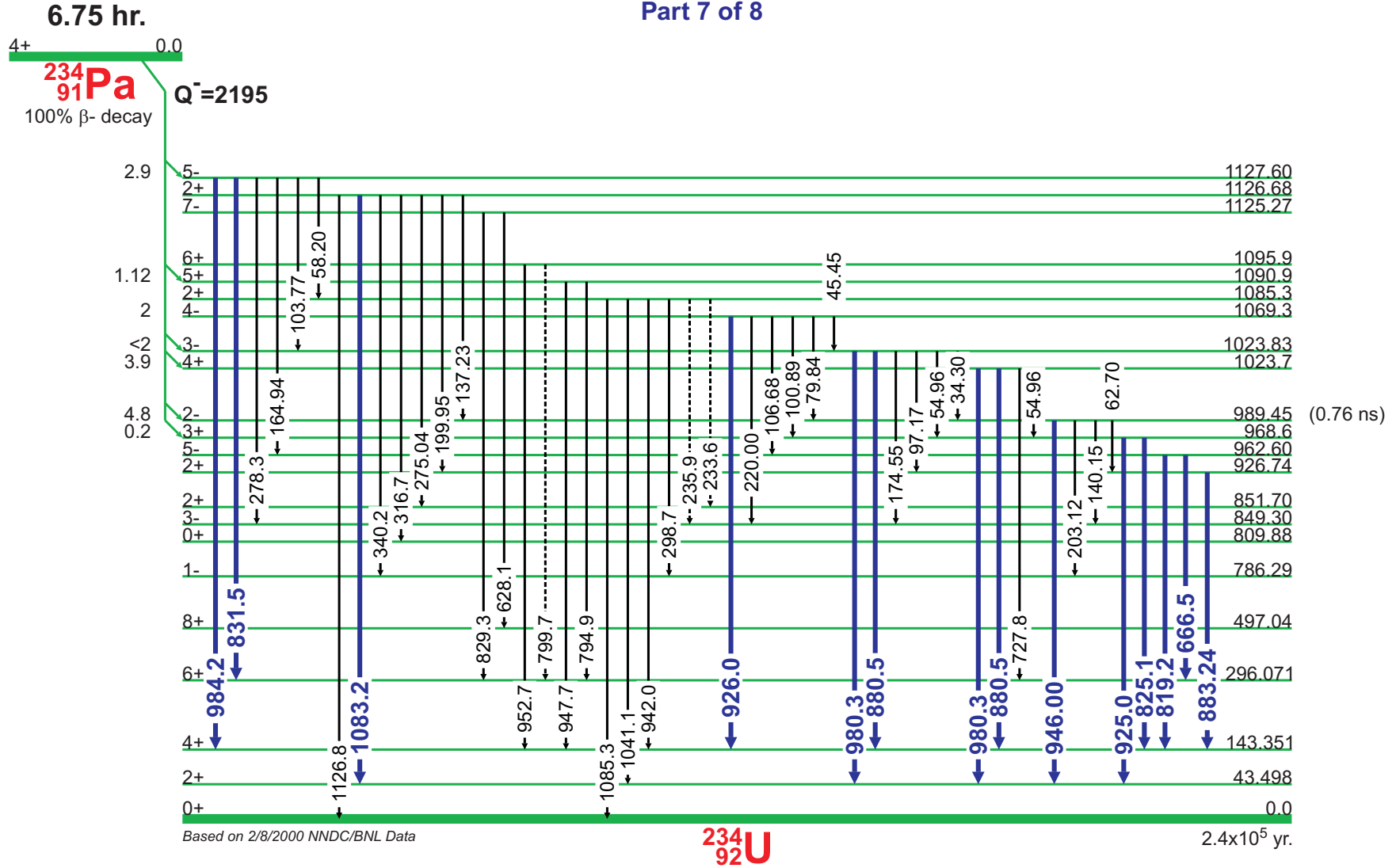
# <sup>234</sup>Pa (6.75 hr.) Decay Scheme

Part 6 of 8



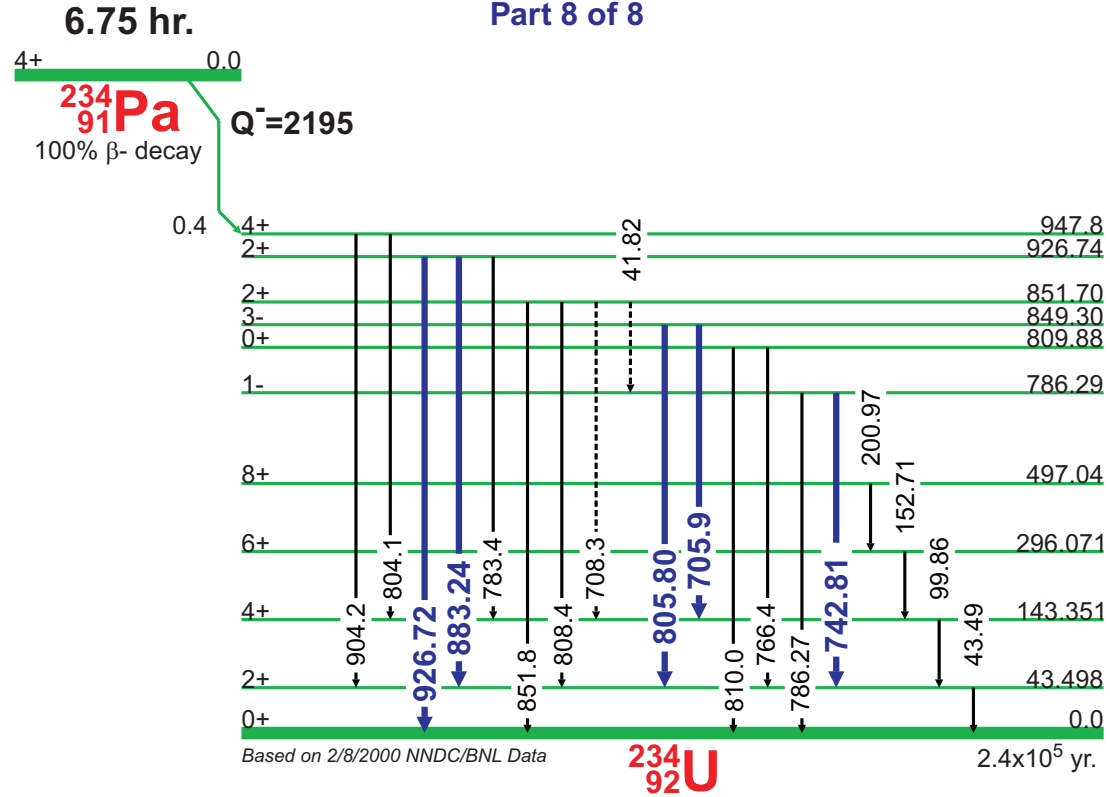
# <sup>234</sup>Pa (6.75 hr.) Decay Scheme

Part 7 of 8



# <sup>234</sup>Pa (6.75 hr.) Decay Scheme

Part 8 of 8



# GAMMA-RAY ENERGIES AND INTENSITIES (page 1 of 6)

Nuclide: **<sup>234</sup>Pa**
 $E_\gamma$ ,  $\sigma E_\gamma$ ,  $I_\gamma$ ,  $\sigma I_\gamma$  Levels- from ENSDF Database as of February 8, 2000

Half Life: 6.7(5) hr.

$E_\gamma$ (keV)	$\sigma E_\gamma$	$I_\gamma$	$\sigma I_\gamma$	Level	
34.30	0.04			1,023.83	$\beta^-$
41.82	0.11			851.70	$\beta^-$
43.49	0.02	0.12	0.03	43.498	$\beta^-$
45.45	0.05	0.027	0.008	1,069.3	$\beta^-$
54.96	0.10	0.009	$\leq$	1,023.83	$\beta^-$
54.96	0.10	0.009	$<$	1,023.7	$\beta^-$
55.45	0.05	0.027	0.008		$\beta^-$
58.20	0.06	0.008 5	0.002 7	1,127.60	$\beta^-$
59.19	0.05	0.032	0.010	1,782.5	$\beta^-$
62.70	0.01	1.5	0.4	989.45	$\beta^-$
67.25	0.10	0.036	0.010	1,194.73	$\beta^-$
69.46	0.05	0.018	0.007	1,194.73	$\beta^-$
75.0	0.3			1,312.2	$\beta^-$
79.84	0.02	0.06	0.02	1,069.3	$\beta^-$
97.17	0.10	0.24	0.08	1,023.83	$\beta^-$
99.86	0.02	3.2	0.5	143.351	$\beta^-$
100.89	0.02	0.12	0.02	1,069.3	$\beta^-$
103.77	0.02	0.24	0.03	1,127.60	$\beta^-$
106.68	0.05	0.036	0.010	1,069.3	$\beta^-$
125.46	0.01	0.78	0.09	1,194.73	$\beta^-$
131.30	0.01	18.0		1,552.62	$\beta^-$
134.61	0.02	0.11	0.02	1,723.45	$\beta^-$
137.23	0.05	0.027	0.008	1,126.68	$\beta^-$
140.15	0.02	0.50	0.05	989.45	$\beta^-$
140.91	0.03	0.31	0.03	1,693.5	$\beta^-$
143.78	0.02	0.32	0.03	1,421.32	$\beta^-$
149.88	0.03	0.07	0.02	1,277.48	$\beta^-$
152.71	0.02	6.0	0.4	296.071	$\beta^-$
159.48	0.02	0.65	0.07	1,421.32	$\beta^-$
164.94	0.05	0.05	0.02	1,127.60	$\beta^-$
165.61	0.05	0.07	0.02	1,927.6	$\beta^-$
170.85	0.02	0.50	0.05	1,723.45	$\beta^-$
174.55	0.03	0.16	0.02	1,023.83	$\beta^-$
179.80	0.08	0.044	0.015	1,723.45	$\beta^-$
186.15	0.02	1.76	0.10	1,723.45	$\beta^-$
193.73	0.03	0.49	0.06	1,782.5	$\beta^-$

$E_\gamma$ (keV)	$\sigma E_\gamma$	$I_\gamma$	$\sigma I_\gamma$	Level	
196.80	0.05	0.07	0.02	1,165.2	$\beta^-$
199.95	0.05	0.07	0.02	1,126.68	$\beta^-$
200.97	0.03	0.90	0.09	497.04	$\beta^-$
203.12	0.03	1.23	0.10	989.45	$\beta^-$
220.00	0.08	0.14	0.02	1,069.3	$\beta^-$
221.15	0.10	0.05	0.02	1,959.2	$\beta^-$
221.83	0.10	0.07	0.02	1,496.20	$\beta^-$
226.50	0.03	4.2	0.3	1,421.32	$\beta^-$
227.25	0.03	5.8	0.3	1,723.45	$\beta^-$
232.21	0.03	0.18	0.02	1,194.73	$\beta^-$
233.6	0.2			1,085.3	$\beta^-$
235.11	0.03	0.11	0.02	1,959.2	$\beta^-$
235.9	0.3			1,085.3	$\beta^-$
240.20	0.10	0.05	0.02	1,793.0	$\beta^-$
245.37	0.02	0.75	0.08	1,782.5	$\beta^-$
247.79	0.07	0.000 37	0.000 03	1,237.24	$\beta^-$
249.22	0.01	2.5	0.3	1,421.32	$\beta^-$
257.2	0.1	0.05	0.02	1,981.2	$\beta^-$
267.12	0.05	0.18	0.02	1,214.6	$\beta^-$
272.28	0.05	1.08	0.10	1,693.5	$\beta^-$
275.04	0.10			1,447.9	$\beta^-$
275.04	0.10	0.09	0.02	1,126.68	$\beta^-$
278.3	0.1	0.04	0.01	1,127.60	$\beta^-$
293.79	0.05	3.0	0.2	1,421.32	$\beta^-$
295.91	0.08	0.14	0.02	1,421.32	$\beta^-$
298.7	0.2	0.013	0.005	1,085.3	$\beta^-$
308.6	0.2	0.021	0.005	1,927.6	$\beta^-$
310.2	0.1	0.07	0.01	2,033.6	$\beta^-$
310.52	0.10	0.000 134	0.000 014	1,237.24	$\beta^-$
313.5	0.1	0.10	0.01	1,165.2	$\beta^-$
316.7	0.1	0.10	0.01	1,126.68	$\beta^-$
320.4	0.1	0.052	0.006	1,447.9	$\beta^-$
330.40	0.05	0.46	$\approx$	1,496.20	$\beta^-$
330.40	0.05	0.3	$\approx$	1,421.32	$\beta^-$
331.4	0.1	0.07	0.01	2,068.8	$\beta^-$
340.2	0.1	0.040	0.008	1,126.68	$\beta^-$

① These  $I_\gamma$  are per 100 Decays of <sup>234</sup>Pa.

② For total uncertainty add systematic component of 9.7% in quadrature, based on the normalization factor 1.03(10)

## GAMMA-RAY ENERGIES AND INTENSITIES (page 2 of 6)

Nuclide: **<sup>234</sup>Pa**
 $E_\gamma$ ,  $\sigma E_\gamma$ ,  $I_\gamma$ ,  $\sigma I_\gamma$  Levels- from ENSDF Database as of February 8, 2000

Half Life: 6.7(5) hr.

$E_\gamma$ (keV)	$\sigma E_\gamma$	$I_\gamma$	$\sigma I_\gamma$	Level	
343.8	0.2	0.034	0.007	1,312.2	$\beta^-$
351.9	0.1	0.41	0.03	1,421.32	$\beta^-$
357.9	0.1	0.036	0.010	1,619.5	$\beta^-$
360.6	0.3	0.018	0.006	1,782.5	$\beta^-$
365.0	0.3	0.018	0.006	1,312.2	$\beta^-$
365.0	0.3			1,214.6	$\beta^-$
369.50	0.05	2.47	0.15	1,496.20	$\beta^-$
372.0	0.1	1.22	0.08	1,537.2	$\beta^-$
379.1	0.1	0.04	0.01	1,341.3	$\beta^-$
385.4	0.1	0.04	0.01	1,312.2	$\beta^-$
387.94	0.06	0.000 71	0.000 04	1,237.24	$\beta^-$
394.1	0.1	0.09	0.01	1,588.85	$\beta^-$
397.7	0.3	0.027	0.006	1,421.32	$\beta^-$
401.8	0.2	0.036	0.010		$\beta^-$
409.8	0.1	0.34	0.03	1,537.2	$\beta^-$
416.1	0.1	0.036	0.010	1,693.5	$\beta^-$
425.3	0.2	0.036	0.010		$\beta^-$
426.95	0.05	0.45	0.03	1,496.20	$\beta^-$
427.4	0.4	0.000 031	0.000 008	1,237.24	$\beta^-$
433.1	0.1	0.09	0.01	1,981.2	$\beta^-$
446.6	0.1	0.11	0.01	1,619.5	$\beta^-$
446.6	0.1			1,537.2	$\beta^-$
450.93	0.04	0.003 9	0.001 9	1,237.24	$\beta^-$
452.4	0.3	0.027	0.008	1,548.5	$\beta^-$
458.68	0.05	1.13	0.06	1,421.32	$\beta^-$
461.5	0.1	0.034	0.010	1,588.85	$\beta^-$
461.5	0.1			1,552.62	$\beta^-$
464.2	0.1	0.031	0.010	1,533.0	$\beta^-$
468.0	0.1			1,457.5	$\beta^-$
468.0	0.1	0.22	0.02	1,537.2	$\beta^-$
472.3	0.1	0.36	0.02	1,496.20	$\beta^-$
474.2	0.2	0.036	0.010	1,543.7	$\beta^-$
478.6	0.1			1,548.5	$\beta^-$
478.6	0.1	0.12	0.01	1,693.5	$\beta^-$
481.0	0.1	0.31	0.02	2,033.6	$\beta^-$
498.0	0.1	0.06	0.01	1,693.5	$\beta^-$

$E_\gamma$ (keV)	$\sigma E_\gamma$	$I_\gamma$	$\sigma I_\gamma$	Level	
498.0	0.1			1,588.85	$\beta^-$
502.0	0.1	0.027	0.008	1,959.2	$\beta^-$
506.75	0.05	1.29	0.08	1,496.20	$\beta^-$
513.4	0.1	0.75	$\approx$	1,537.2	$\beta^-$
513.4	0.1	0.38	$\approx$	1,537.2	$\beta^-$
519.6	0.1	0.39	0.03	1,588.85	$\beta^-$
521.4	0.1	0.74	0.05	1,693.5	$\beta^-$
527.9	0.1	0.39	0.03	1,496.20	$\beta^-$
529.1	0.3	0.09	0.03	1,619.5	$\beta^-$
529.1	0.3			1,552.62	$\beta^-$
534.1	0.1	0.08	0.01	2,115.5	$\beta^-$
537.2	0.1	0.08	0.01	2,033.6	$\beta^-$
543.8	0.1	0.13	0.02	1,533.0	$\beta^-$
553.7	0.1	0.044	0.015	1,650.2	$\beta^-$
558.0	0.2	0.09	0.02	1,723.45	$\beta^-$
558.0	0.2			1,581.7	$\beta^-$
559.2	0.2	0.07	0.02	1,486.2	$\beta^-$
562.8	0.3	0.036	0.010	2,115.5	$\beta^-$
565.2	0.1	1.03	0.06	1,693.5	$\beta^-$
565.2	0.1			1,588.85	$\beta^-$
568.9	0.2	3.6	0.4	1,537.2	$\beta^-$
569.5	0.1	8.2	0.8	1,496.20	$\beta^-$
575.5	0.1	0.027	0.008	1,543.7	$\beta^-$
584.1	0.1	0.18	0.02	1,552.62	$\beta^-$
586.3	0.1	0.07	0.01	1,927.6	$\beta^-$
590.3	1.0	0.036	0.010	1,537.2	$\beta^-$
595.4	0.2	0.09	0.02	1,722.9	$\beta^-$
596.9	0.1	0.20	0.02	1,811.5	$\beta^-$
596.9	0.1			1,723.45	$\beta^-$
602.6	0.1	0.54	0.03	1,693.5	$\beta^-$
604.6	0.3	0.05	0.02	1,552.62	$\beta^-$
612.0	0.1	0.38	0.03	1,738.4	$\beta^-$
617.0	0.2			1,782.5	$\beta^-$
617.0	0.2	0.05	0.02	1,543.7	$\beta^-$
619.0	0.2	0.036	0.010	1,581.7	$\beta^-$
624.2	0.1	0.35	0.03	1,693.5	$\beta^-$

① These  $I_\gamma$  are per 100 Decays of <sup>234</sup>Pa.

② For total uncertainty add systematic component of 9.7% in quadrature, based on the normalization factor 1.03(10)

# GAMMA-RAY ENERGIES AND INTENSITIES (page 3 of 6)

Nuclide: **<sup>234</sup>Pa**E<sub>γ</sub>, σE<sub>γ</sub>, I<sub>γ</sub>, σI<sub>γ</sub> Levels- from ENSDF Database as of February 8, 2000

Half Life: 6.7(5) hr.

E <sub>γ</sub> (keV)	σE <sub>γ</sub>	<sup>①</sup> I <sub>γ</sub>	<sup>②</sup> σI <sub>γ</sub>	Level	
628.1	0.1	0.24	0.04	1,125.27	β-
629.4	0.1	0.35	0.05	1,653.3	β-
632.6	0.2	0.036	0.010	1,723.45	β-
634.3	0.2	0.13	0.02	1,761.7	β-
634.3	0.2			1,581.7	β-
643.2	0.2	0.027	0.008		β-
646.5	0.1	0.11	0.01	1,496.20	β-
653.7	0.1	0.46	0.06	1,927.6	β-
653.7	0.1			1,722.9	β-
655.2	0.2	0.13	0.02	1,782.5	β-
657.4	0.1	0.39	0.03	1,619.5	β-
659.8	0.1	0.27	0.02		β-
663.9	0.1	0.54	0.07	1,653.3	β-
666.5	0.1	1.16	0.07	962.60	β-
669.7	0.1	0.99	0.05	1,693.5	β-
669.7	0.1	0.000 5	<	1,457.5	β-
675.1	0.1	0.100	0.010	1,172.10	β-
683.9	0.2	0.15	0.03	1,811.5	β-
685.1	0.2	0.14	0.03	1,811.5	β-
685.1	0.2			1,537.2	β-
692.6	0.1	1.24	0.07	1,761.7	β-
699.03	0.05	3.6	0.2	1,723.45	β-
699.03	0.05			1,722.9	β-
705.9	0.1	2.3	0.1	849.30	β-
708.3	0.2	0.023	0.008	851.70	β-
711.5	0.1	0.15	0.02		β-
713.7	0.1	0.14	0.02	1,927.6	β-
713.7	0.1			1,737.4	β-
716.5	0.2	0.031	0.008	1,881.6	β-
727.8	0.2	0.11	0.01	1,023.7	β-
730.9	0.2	0.63	0.08	1,693.5	β-
733.39	0.05	6.9	0.4	1,722.9	β-
738.0	0.1	1.15	0.07	1,761.7	β-
742.81	0.03	2.1	0.1	786.29	β-
745.9	0.1	0.32	0.03	1,693.5	β-
748.1	0.3	0.10	0.02	1,737.4	β-

E <sub>γ</sub> (keV)	σE <sub>γ</sub>	<sup>①</sup> I <sub>γ</sub>	<sup>②</sup> σI <sub>γ</sub>	Level	
755.0	0.1	1.22	0.06	1,881.6	β-
755.0	0.1			1,723.45	β-
758.9	0.1	0.25	0.02	1,782.5	β-
761.0	0.2	0.07	0.02	1,722.9	β-
764.8	0.2	0.20	0.04	1,261.84	β-
766.4	0.2	0.07	0.03	809.88	β-
769.1	0.1	0.19	0.01	1,793.0	β-
772.4	0.2	0.07	0.02	1,761.7	β-
778.6	0.2	0.045	0.008		β-
780.4	0.2	0.90	0.04	1,277.48	β-
783.4	0.1	0.30	0.03	926.74	β-
786.27	0.03	1.19	0.06	786.29	β-
792.8	0.3	0.044	0.010	1,761.7	β-
794.9	0.2	0.67	0.08	1,090.9	β-
796.1	0.1	2.6	0.2	1,723.45	β-
799.7	0.2			1,095.9	β-
802.3	0.2	0.031	0.008	1,770.9	β-
804.1	0.1	0.6	0.2	947.8	β-
805.80	0.05	2.52	0.15	849.30	β-
808.4	0.3	0.036	0.010	851.70	β-
810.0	0.7			809.88	β-
811.5	0.1	0.12	0.01	1,738.4	β-
814.2	0.1	0.31	0.02	1,782.5	β-
819.2	0.1	1.88	0.10	962.60	β-
824.2	0.2	1.2	0.1		β-
825.1	0.2	1.88	0.10	968.6	β-
829.3	0.2	0.36	0.10	1,125.27	β-
831.5	0.1	4.1	0.2	1,127.60	β-
839.5	0.1	0.031	0.007	2,101.4	β-
844.1	0.1	0.42	0.03	1,693.5	β-
846.1	0.2	0.05	0.01		β-
848.9	0.2	0.027	0.007	1,811.5	β-
851.8	0.1	0.07	0.02	851.70	β-
857.7	0.2	0.036	0.007	1,784.2	β-
863.2	0.2	0.07	0.02	1,811.5	β-
869.7	0.1	0.20	0.02	2,144.0	β-

① These I<sub>γ</sub> are per 100 Decays of <sup>234</sup>Pa.

② For total uncertainty add systematic component of 9.7% in quadrature, based on the normalization factor 1.03(10)

# GAMMA-RAY ENERGIES AND INTENSITIES (page 4 of 6)

Nuclide: **<sup>234</sup>Pa**E<sub>γ</sub>, σE<sub>γ</sub>, I<sub>γ</sub>, σI<sub>γ</sub> Levels- from ENSDF Database as of February 8, 2000

Half Life: 6.7(5) hr.

E <sub>γ</sub> (keV)	σE <sub>γ</sub>	<sup>①</sup> I <sub>γ</sub>	<sup>②</sup> σI <sub>γ</sub>	Level	β-
874.0	0.3	0.036	0.007	1,722.9	β-
876.0	0.1	2.52	0.02	1,172.10	β-
880.5	0.1	4.2	≈	1,023.83	β-
880.5	0.1	6.2	≈	1,023.7	β-
883.24	0.04	9.6	0.6	926.74	β-
890.1	0.4	0.027	0.007	1,959.2	β-
898.67	0.05	3.24	0.21	1,194.73	β-
904.2	0.1	0.34	0.02	947.8	β-
916.5	0.2	0.024	0.006	1,940.5	β-
918.4	0.1	0.099	0.010	1,214.6	β-
920.5	0.2	0.029	0.007		β-
925.0	0.1	7.8	0.5	968.6	β-
926.0	0.2	1.8	1.2	1,069.3	β-
926.72	0.15	7.2	0.9	926.74	β-
935.8	0.2	0.066	0.007	1,959.2	β-
942.0	0.3	0.045	0.007	1,085.3	β-
946.00	0.03	13.4	0.8	989.45	β-
947.7	0.2	1.62	0.15	1,090.9	β-
952.7	0.1	0.08	0.01	1,095.9	β-
960.0	0.1	0.07	0.01	1,811.5	β-
965.8	0.1	0.47	0.03	1,261.84	β-
975.1	0.1	0.027	0.007	2,066.7	β-
978.2	0.3	0.090	0.021	1,274.37	β-
980.3	0.1	2.7	≈	1,023.83	β-
980.3	0.1	1.8	≈	1,023.7	β-
981.6	0.3	0.7	0.2	1,277.48	β-
984.2	0.1	1.62	0.15	1,127.60	β-
989.5	0.1	0.10	0.01	1,916.3	β-
992.0	0.2	0.08	0.02		β-
994.6	0.3	0.06	0.02	1,843.9	β-
997.7	0.3	0.045	0.010	2,066.7	β-
1,009.9	0.3	0.066	0.010	2,101.4	β-
1,009.9	0.3			2,033.6	β-
1,019.5	0.4	0.027	0.007	2,115.5	β-
1,021.8	0.2	0.14	0.03	1,165.2	β-
1,023.6	0.2	0.06	0.02		β-

E <sub>γ</sub> (keV)	σE <sub>γ</sub>	<sup>①</sup> I <sub>γ</sub>	<sup>②</sup> σI <sub>γ</sub>	Level	β-
1,025.3	0.2	0.05	0.02		β-
1,028.7	0.1	0.57	0.03	1,172.10	β-
1,032.8	0.2	0.018	0.004	2,101.4	β-
1,035.9	0.2	0.026	0.009		β-
1,037.9	0.2	0.018	0.006	2,000.4	β-
1,041.1	0.2	0.032	0.010	1,085.3	β-
1,044.4	0.2	0.031	≈	1,341.3	β-
1,051.4	0.2	0.06	0.01	2,020.0	β-
1,057.8	0.3	0.018	≈	2,020.0	β-
1,065.1	0.1	0.027	0.007	2,033.6	β-
1,073.6	0.2	0.10	0.01	2,000.4	β-
1,083.2	0.1	0.50	0.03	1,126.68	β-
1,085.3	0.3	0.027	0.007	1,085.3	β-
1,106.9	0.2	0.08	0.01	2,033.6	β-
1,110.6	0.1	0.06	0.01	1,959.2	β-
1,121.7	0.1	0.25	0.03	1,165.2	β-
1,125.2	0.1	0.36	0.07	1,421.32	β-
1,126.8	0.1	0.30	0.03	1,126.68	β-
1,151.4	0.3	0.032	0.009	2,000.4	β-
1,151.4	0.3			1,447.9	β-
1,153.5	0.3	0.045	0.007	2,115.5	β-
1,171.3	0.1	0.090	0.010	1,214.6	β-
1,173.1	0.1	0.045	0.007	1,959.2	β-
1,182.1	0.2	0.009	≈	2,033.6	β-
1,194.0	0.2	0.021	0.005	1,237.24	β-
1,217.3	0.1	0.22	0.02	2,144.0	β-
1,220.4	0.2	0.06	0.01		β-
1,237.3	0.3	0.009	<	1,237.24	β-
1,241.2	0.1	0.23	0.02	1,537.2	β-
1,247.8	0.2	0.022	0.005	1,543.7	β-
1,252.6	0.2	0.018	0.007	1,548.5	β-
1,256.5	0.1	0.059	0.006	1,552.62	β-
1,277.7	0.2	0.044	0.007	1,421.32	β-
1,292.8	0.1	0.46	0.03	1,588.85	β-
1,296.4	0.2	0.029	0.006		β-
1,301.2	0.2	0.018	0.004		β-

① These I<sub>γ</sub> are per 100 Decays of <sup>234</sup>Pa.

② For total uncertainty add systematic component of 9.7% in quadrature, based on the normalization factor 1.03(10)

# GAMMA-RAY ENERGIES AND INTENSITIES (page 5 of 6)

Nuclide: **<sup>234</sup>Pa**E<sub>γ</sub> σE<sub>γ</sub> I<sub>γ</sub> σI<sub>γ</sub> Levels- from ENSDF Database as of February 8, 2000

Half Life: 6.7(5) hr.

E <sub>γ</sub> (keV)	σ E <sub>γ</sub>	I <sub>γ</sub>	σ I <sub>γ</sub>	Level	
1,327.0	0.2	0.018	0.004		β-
1,342.9	0.2	0.012	0.004	1,486.2	β-
<b>1,352.9</b>	<b>0.1</b>	<b>1.15</b>	<b>0.05</b>	<b>1,496.20</b>	<b>β-</b>
1,354.6	0.2	0.13	0.03	1,650.2	β-
1,359.0	0.1	0.15	0.02	1,502.4	β-
1,389.6	0.2	0.07	0.02	1,533.0	β-
<b>1,393.9</b>	<b>0.1</b>	<b>2.1</b>	<b>0.1</b>	<b>1,537.2</b>	<b>β-</b>
1,397.5	0.2	0.08	0.02	1,693.5	β-
1,400.3	0.1	0.18	0.02	1,543.7	β-
1,409.1	0.2	0.044	0.008	1,552.62	β-
1,414.4	0.2	0.002 7	<	1,457.5	β-
1,426.9	0.1	0.16	0.02	1,723.45	β-
1,442.8	0.2	0.031	0.006	1,486.2	β-
<b>1,445.4</b>	<b>0.1</b>	<b>0.32</b>	<b>0.03</b>	<b>1,588.85</b>	<b>β-</b>
<b>1,452.7</b>	<b>0.1</b>	<b>0.80</b>	<b>0.05</b>	<b>1,496.20</b>	<b>β-</b>
1,458.9	0.1	0.09	0.02	1,502.4	β-
1,475.8	0.2	0.008	0.003	1,619.5	β-
1,485.4	0.2	0.030	0.006	1,782.5	β-
1,488.0	0.2	0.013	0.005	1,784.2	β-
1,493.6	0.1	0.10	0.01	1,537.2	β-
1,496.0	0.2	0.036	0.008	1,793.0	β-
1,500.0	0.2	0.011	0.003	1,543.7	β-
1,507.3	0.2	0.020	0.004		β-
1,510.1	0.2	0.009	<	1,653.3	β-
1,515.6	0.2	0.07	0.01	1,811.5	β-
1,520.7	0.2	0.009	≈		β-
1,538.8	0.2	0.013	0.003		β-
1,550.1	0.1	0.07	0.01	1,693.5	β-
1,567.0	0.2	0.011	0.002	1,863.1	β-
1,579.9	0.1	0.07	0.02	1,723.45	β-
1,585.9	0.1	0.14	0.01	1,881.6	β-
1,594.0	0.1	0.31	0.02	1,737.4	β-
1,618.3	0.2	0.009	0.003	1,761.7	β-
1,627.3	0.1	0.075	0.008	1,770.9	β-
1,638.1	0.1	0.21	0.01	1,782.5	β-
1,640.5	0.3	0.010	0.003	1,784.2	β-

E <sub>γ</sub> (keV)	σ E <sub>γ</sub>	I <sub>γ</sub>	σ I <sub>γ</sub>	Level	
1,644.9	0.2	0.010	0.003	1,940.5	β-
1,650.2	0.2	0.005	<	1,793.0	β-
1,655.7	0.1	0.026	0.003		β-
1,664.8	0.3	0.018	0.006		β-
<b>1,668.4</b>	<b>0.1</b>	<b>0.76</b>	<b>0.05</b>	<b>1,811.5</b>	<b>β-</b>
1,672.8	0.1	0.034	0.010	1,968.7	β-
1,679.5	0.1	0.076	0.016	1,722.9	β-
1,685.7	0.1	0.31	0.02	1,981.2	β-
<b>1,693.8</b>	<b>0.2</b>	<b>0.69</b>	<b>0.07</b>	<b>1,737.4</b>	<b>β-</b>
1,695.0	0.3	0.27	0.06	1,738.4	β-
1,700.5	0.2	0.10	0.01	1,843.9	β-
1,719.7	0.2	0.018	0.005	1,863.1	β-
1,723.2	0.2	0.015	0.003	2,020.0	β-
1,727.8	0.2	0.020	0.004	1,770.9	β-
1,737.7	0.2	0.074	0.008	1,881.6	β-
1,741.1	0.2	0.048	0.006	2,037.0	β-
1,743.2	0.2	0.033	0.007		β-
1,750.0	0.1	0.064	0.007	1,793.0	β-
1,757.5	0.1	0.024	0.005		β-
1,768.0	0.3	0.020	0.004	1,811.5	β-
1,770.8	0.2	0.067	0.015	2,066.7	β-
1,773.0	0.2	0.067	0.015	1,916.3	β-
1,783.7	0.2	0.025	0.006	1,927.6	β-
<b>1,797.1</b>	<b>0.1</b>	<b>0.24</b>	<b>0.02</b>	<b>1,940.5</b>	<b>β-</b>
1,805.8	0.3	0.005	0.002	2,101.4	β-
1,815.3	0.3	0.009	0.003	1,959.2	β-
1,819.8	0.3	0.004	0.001	2,115.5	β-
1,825.1	0.3	0.009	0.003	1,968.7	β-
1,830.8	0.3				β-
1,838.0	0.2	0.004	0.001		β-
1,838.0	0.2	0.041	0.009	1,981.2	β-
1,849.8	0.2	0.028	0.006		β-
1,872.8	0.2	0.035	0.008	1,916.3	β-
1,884.1	0.3	0.015	0.004	1,927.6	β-
1,890.1	0.2	0.14	0.01	2,033.6	β-
1,893.4	0.3	0.006	≈	2,037.0	β-

① These I<sub>γ</sub> are per 100 Decays of <sup>234</sup>Pa.

② For total uncertainty add systematic component of 9.7% in quadrature, based on the normalization factor 1.03(10)



## GAMMA-RAY ENERGIES AND INTENSITIES (page 6 of 6)

Nuclide: **<sup>234</sup>Pa**E<sub>γ</sub> σE<sub>γ</sub> I<sub>γ</sub><sup>①</sup> σI<sub>γ</sub><sup>②</sup> Levels- from ENSDF Database as of February 8, 2000

Half Life: 6.7(5) hr.

E <sub>γ</sub> (keV)	σ E <sub>γ</sub>	I <sub>γ</sub> <sup>①</sup>	σ I <sub>γ</sub> <sup>②</sup>	Level	
1,896.7	0.2	0.10	0.02	1,940.5	β-
1,915.5	0.3	0.020	0.004	1,959.2	β-
1,925.4	0.2	0.30	0.04	2,068.8	β-
1,927.9	0.4	0.054	0.010		β-
1,935.2	0.4	0.009	≈		β-
1,937.7	0.3	0.04	0.01	1,981.2	β-

E <sub>γ</sub> (keV)	σ E <sub>γ</sub>	I <sub>γ</sub> <sup>①</sup>	σ I <sub>γ</sub> <sup>②</sup>	Level	
1,958.0	0.4	0.009 9	0.002 6	2,101.4	β-
1,971.2	0.4	0.002 7	≈	2,115.5	β-
1,977.4	0.4	0.016	0.004	2,020.0	β-
1,989.6	0.4	0.007	0.003	2,033.6	β-
2,072.2	0.4	0.004	0.002	2,115.5	β-

① These I<sub>γ</sub> are per 100 Decays of <sup>234</sup>Pa.

② For total uncertainty add systematic component of 9.7% in quadrature, based on the normalization factor 1.03(10)

