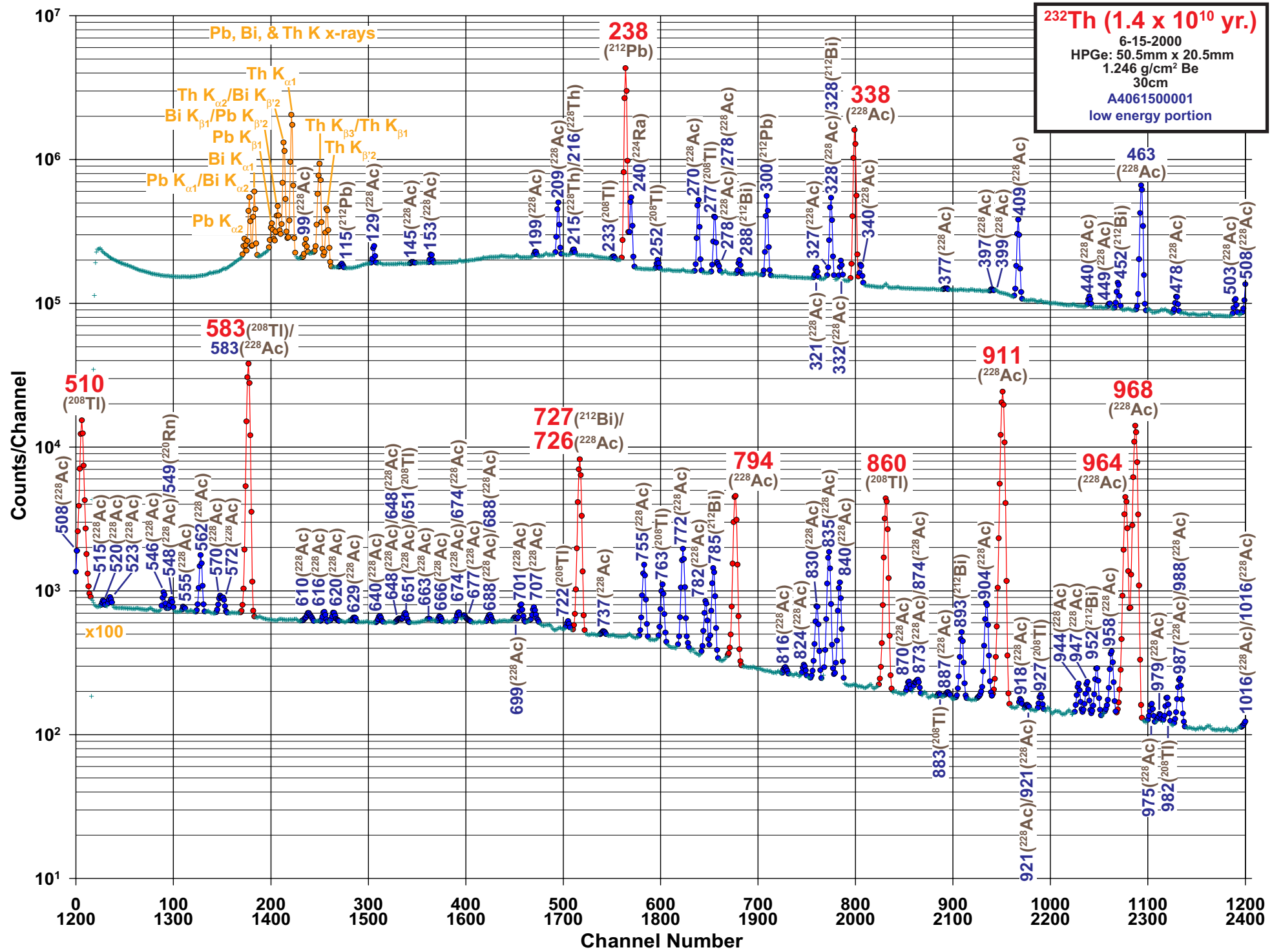
232Th (1.4 x 10^10 yr.)
6-15-2000
HPGe: 50.5mm x 20.5mm
1.246 g/cm² Be
30cm
A4061500001
low energy portion
Pb, Bi, & Th K x-rays
Th Kα1
Th Kα2/Bi Kβ'2
Bi Kβ1/Pb Kβ'2
Pb Kβ1
Bi Kα1
Pb Kα1/Bi Kα2
Pb Kα2
Th Kβ3/Th Kβ1
Th Kβ'2
238 (212Pb)
338 (228Ac)
463 (228Ac)
583 (208Tl)/ 583 (228Ac)
510 (208Tl)
727 (212Bi)/ 726 (228Ac)
911 (228Ac)
968 (228Ac)
794 (228Ac)
860 (208Tl)
964 (228Ac)
x100
Counts/Channel
Channel Number
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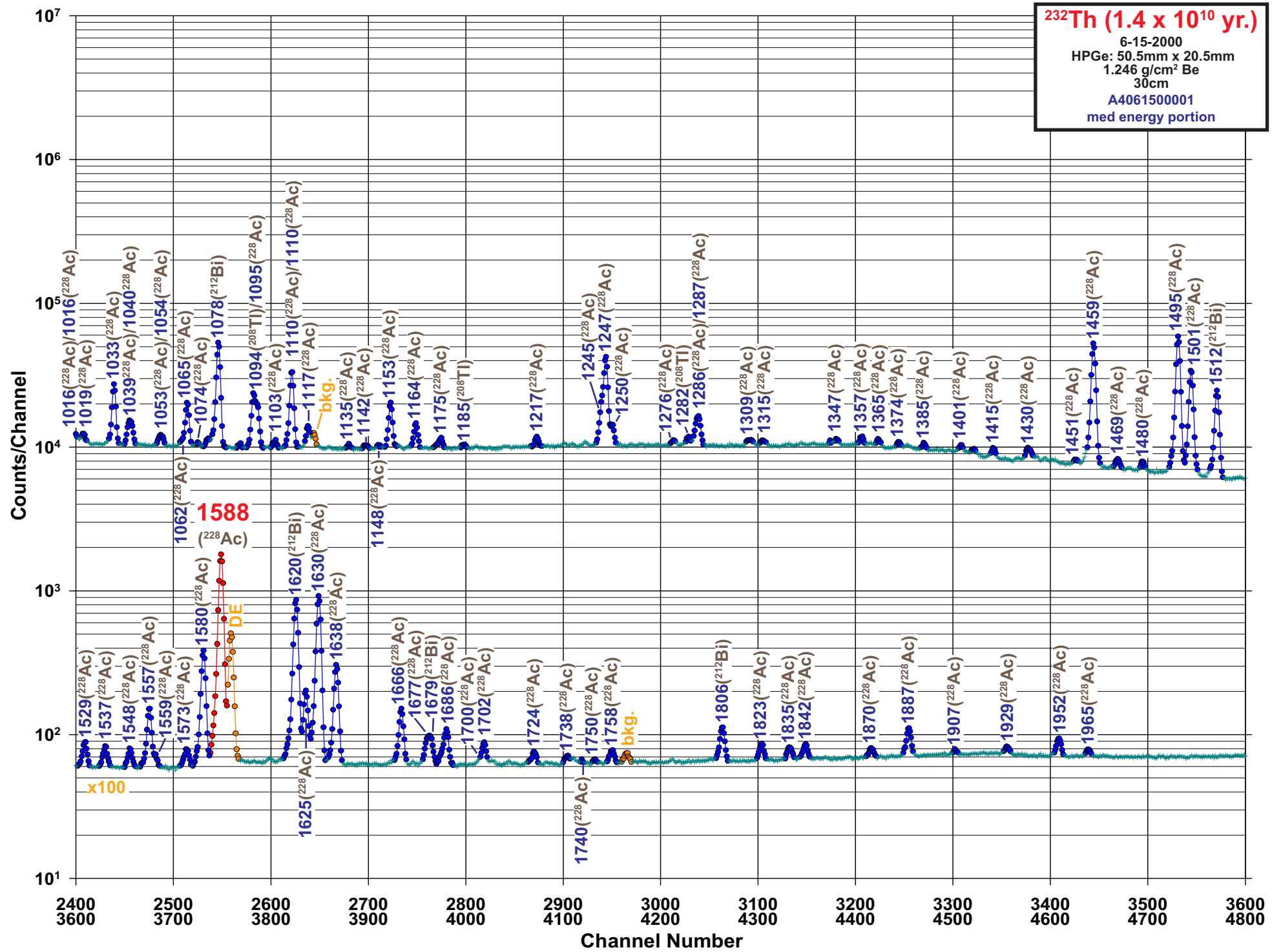

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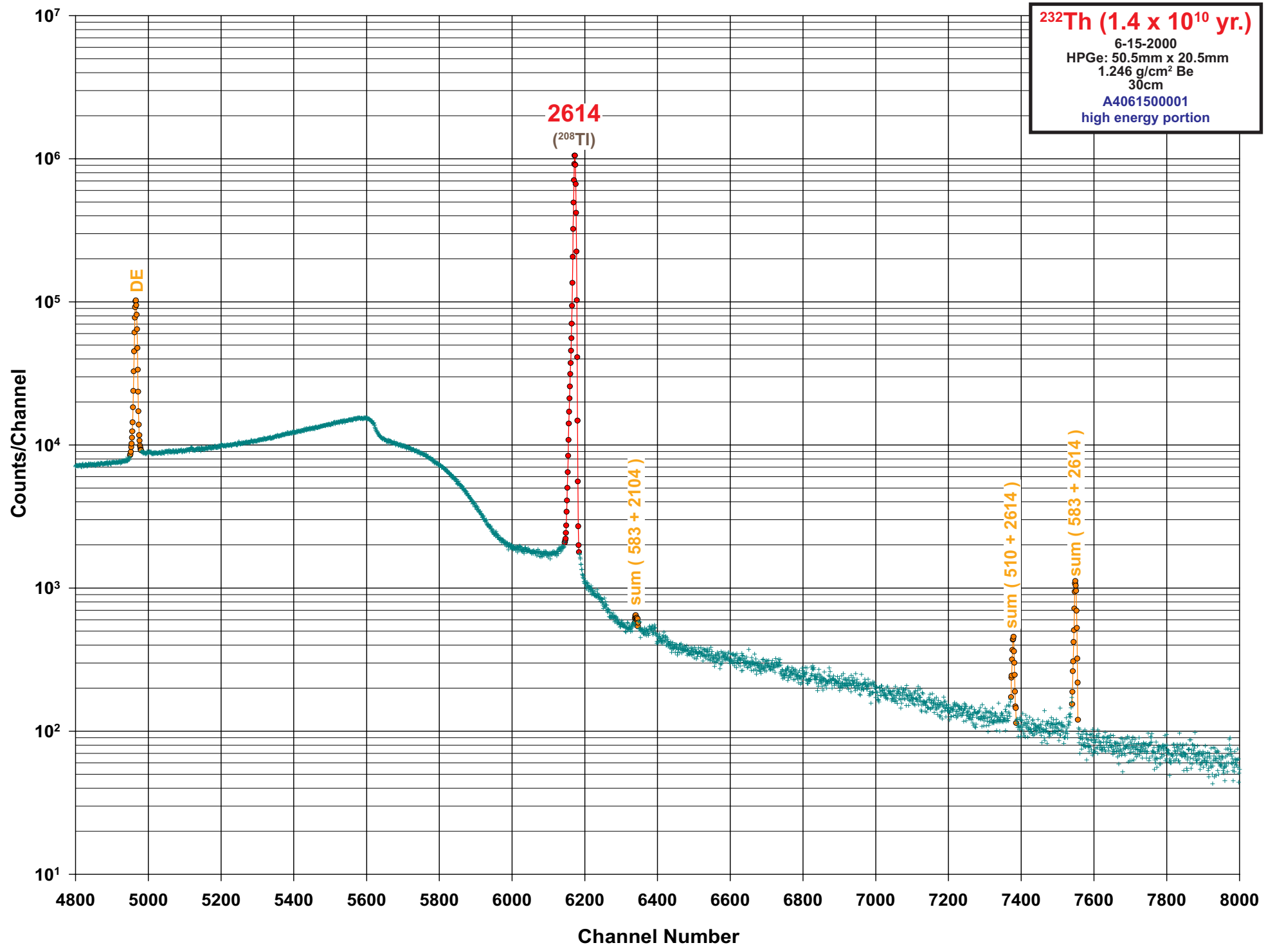

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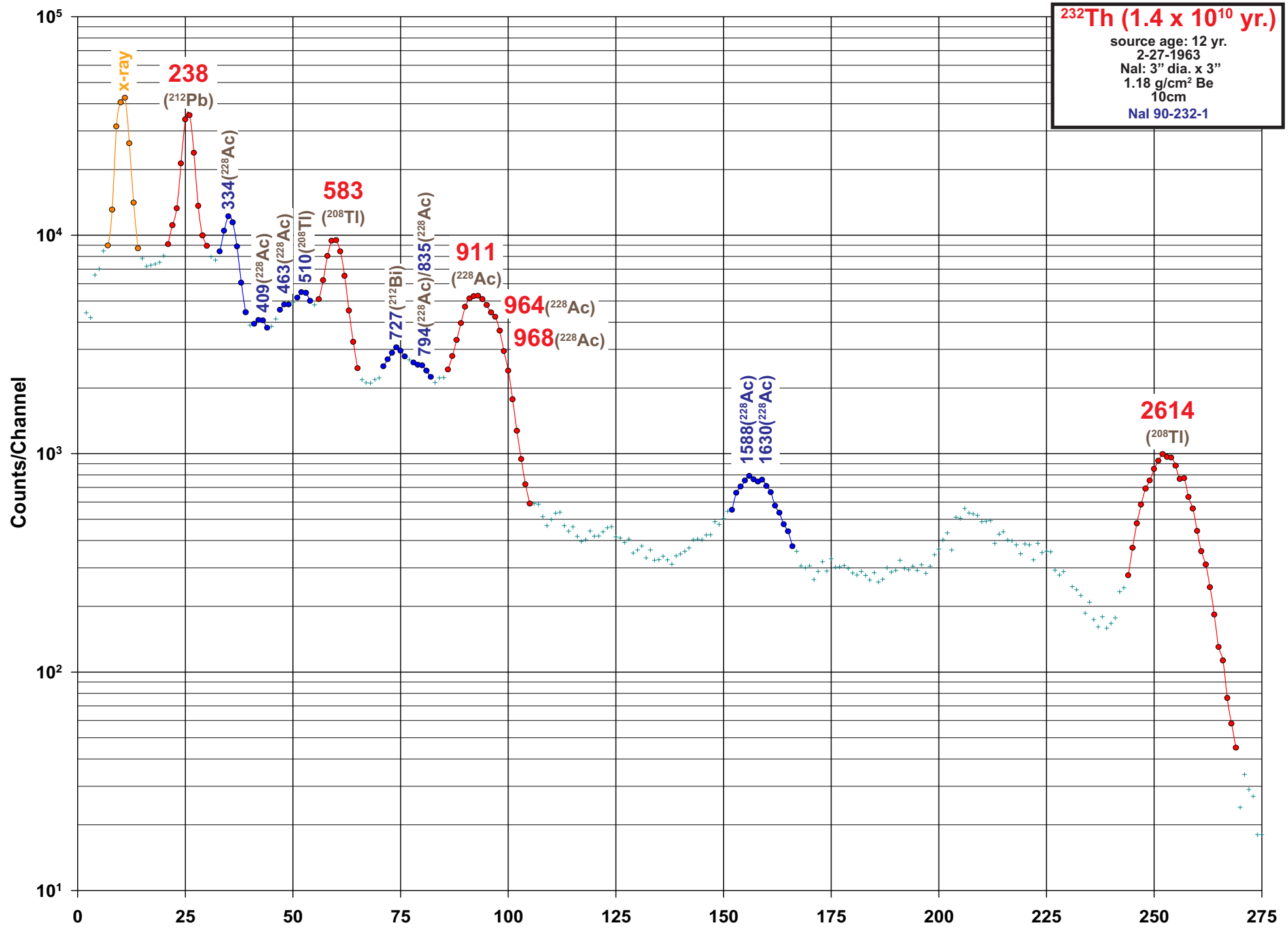

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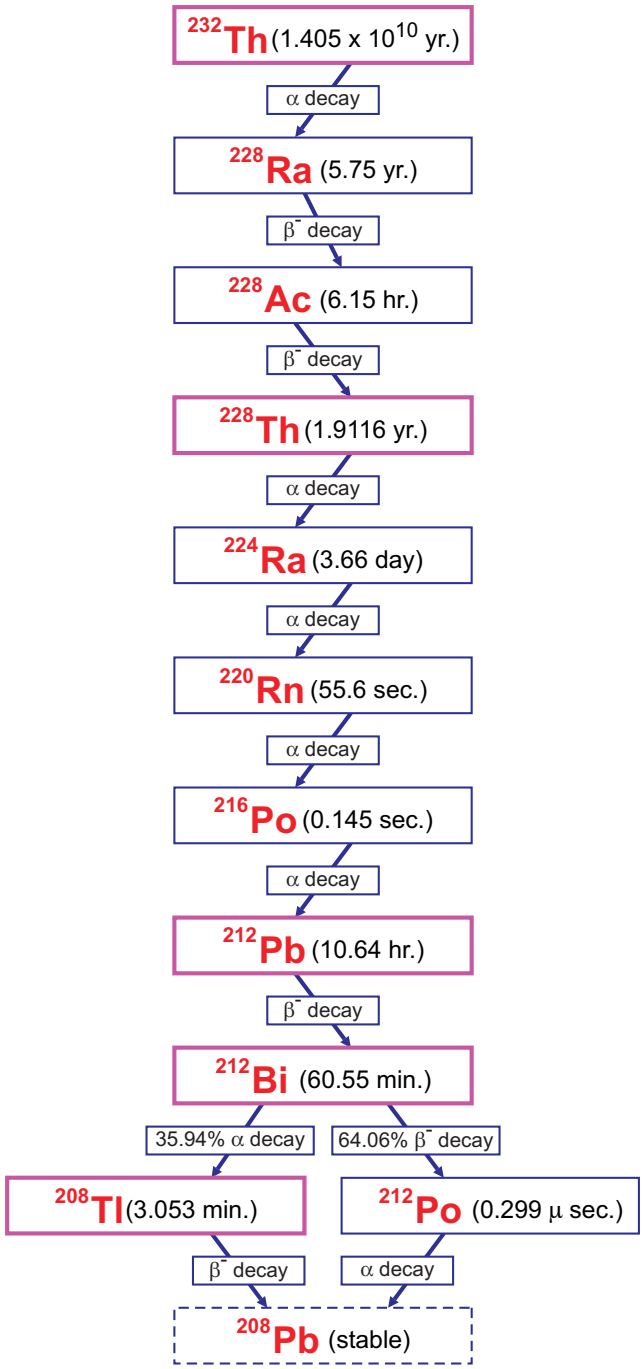
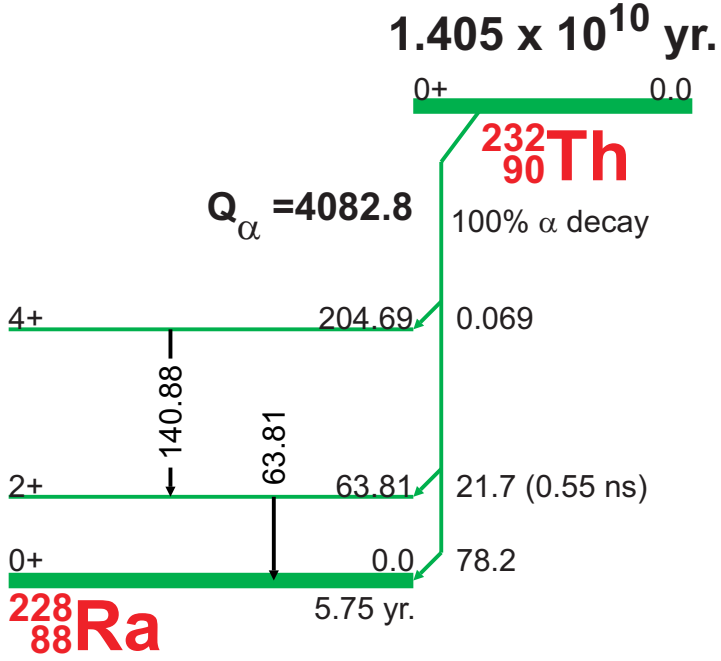
^{232}Th Decay Chain

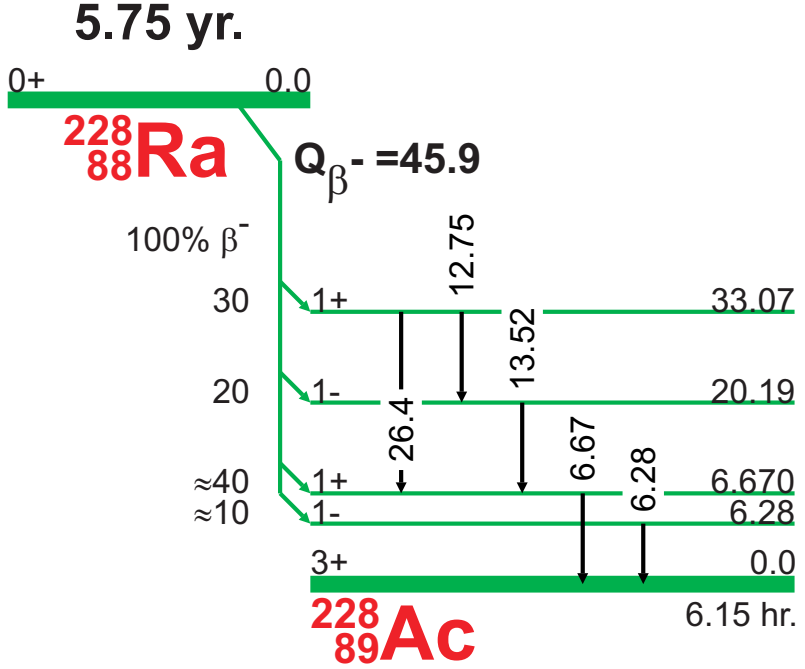


^{232}Th (1.4 x 10^{10} yr.) Decay Scheme



Based on 8/31/1999 NNDC/BNL Data

^{228}Ra (5.75 yr.) Decay Scheme



Based on 8/5/1999 NNDC/BNL Data

GAMMA-RAY ENERGIES AND INTENSITIES

Nuclide: ^{232}Th — Half Life: 1.405x10^{10}(6) yr.

E_γ (keV)	σ E_γ	① I_γ	② σI_γ	Level	
63.81	0.01	0.263	0.013	63.81	α
140.88	0.01	0.021	0.004	204.69	α

E_γ, σE_γ, I_γ, σI_γ, Levels from ENSDF Database as of August 30, 1999

① These Iγ are per 100 Decays of ^{232}Th.

② Normalization factor is 1.000, and its uncertainty is taken to be 0.0.

GAMMA-RAY ENERGIES AND INTENSITIES

Nuclide: ^{228}Ra — Half Life: 5.75(3) yr.

E_γ (keV)	σ E_γ	① I_γ	② σI_γ	Level	
6.28	0.03			6.28	β–
6.67	0.02			6.670	β–
12.75	0.05	0.30	0.06	33.07	β–
13.52	0.02	1.60		20.19	β–
15.15	0.08				β–
15.5	0.2	0.16	0.03		β–
16.2	0.1	0.72	0.08		β–
26.4	0.1			33.07	β–
30.6	0.1				β–

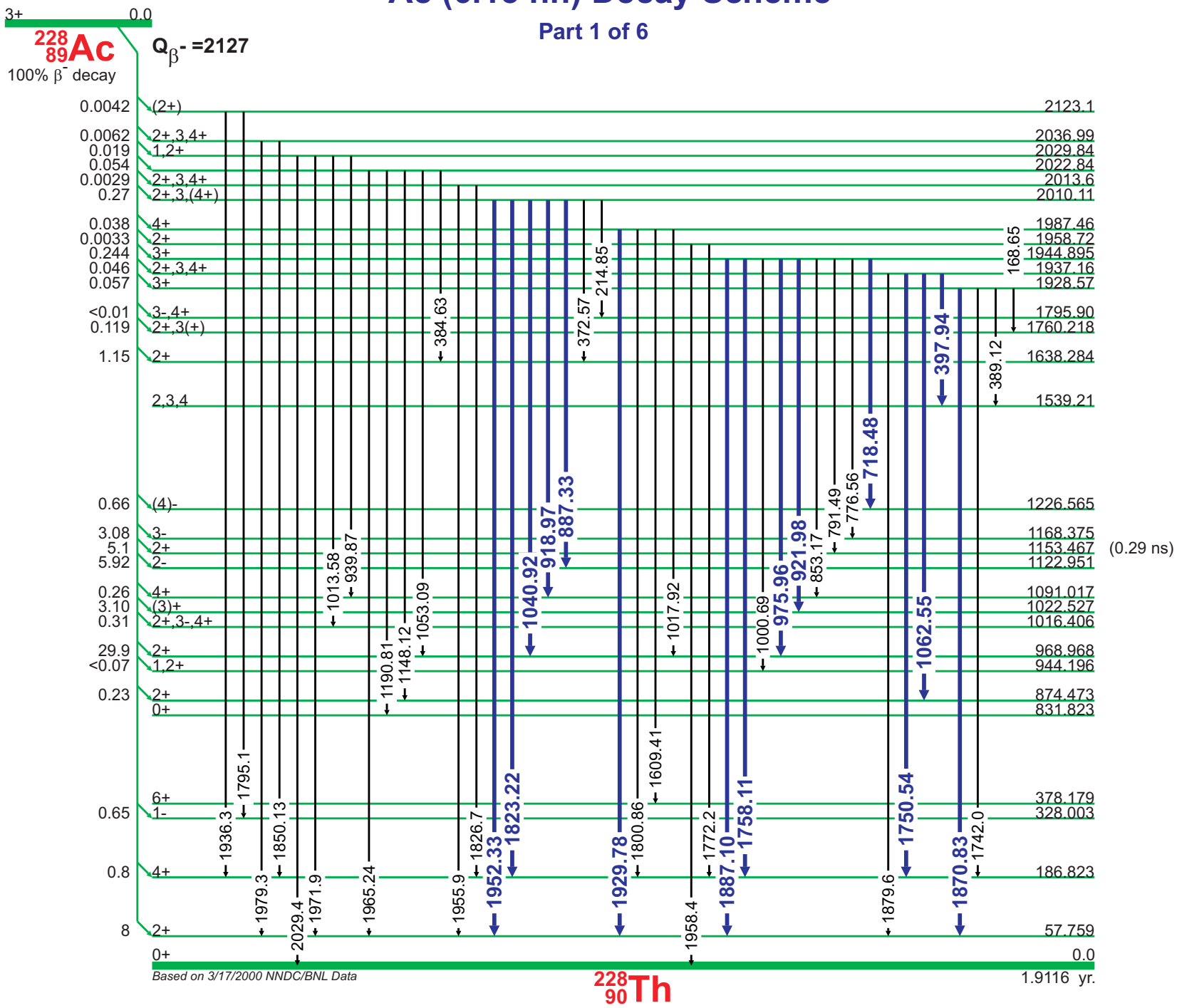
E_γ, σE_γ, I_γ, σI_γ, Levels from ENSDF Database as of August 31, 1999

① These Iγ are per 100 Decays of ^{228}Ra.

② Normalization factor is 0.016, and its uncertainty is taken to be 0.0.

^{228}Ac (6.15 hr.) Decay Scheme

Part 1 of 6



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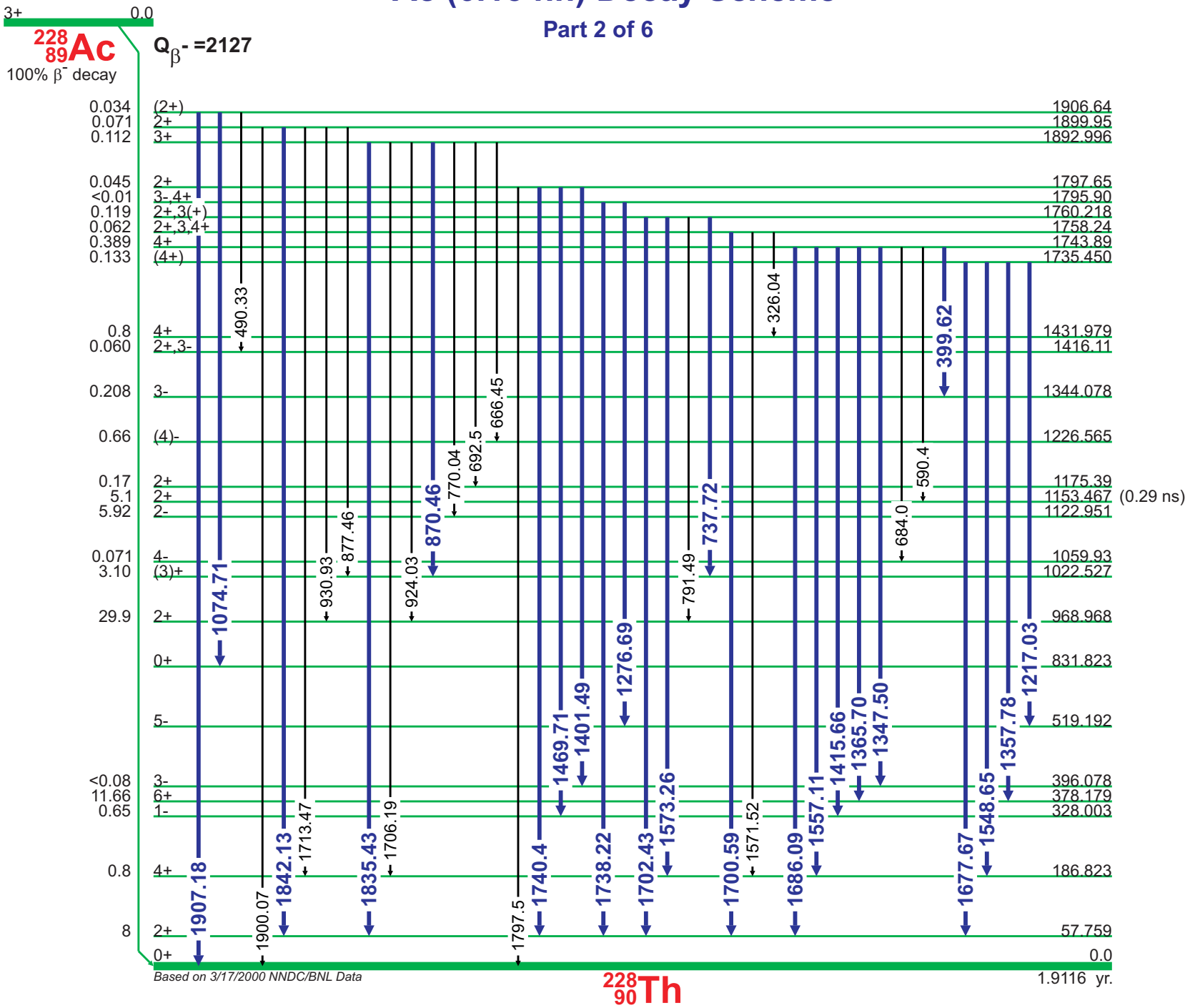
^{228}Ac (6.15 hr.) Decay Scheme

Part 2 of 6



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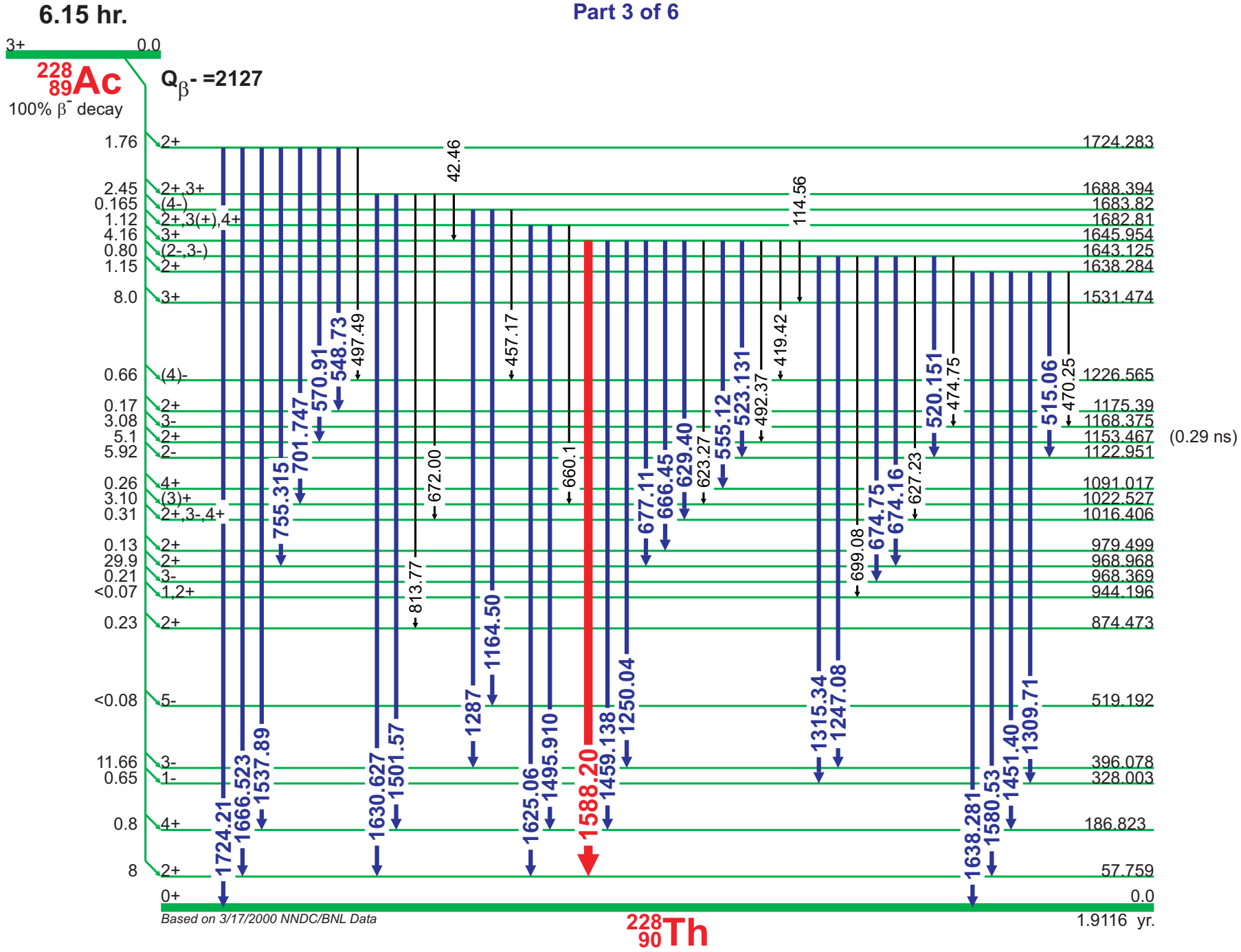
^{228}Ac (6.15 hr.) Decay Scheme

Part 3 of 6



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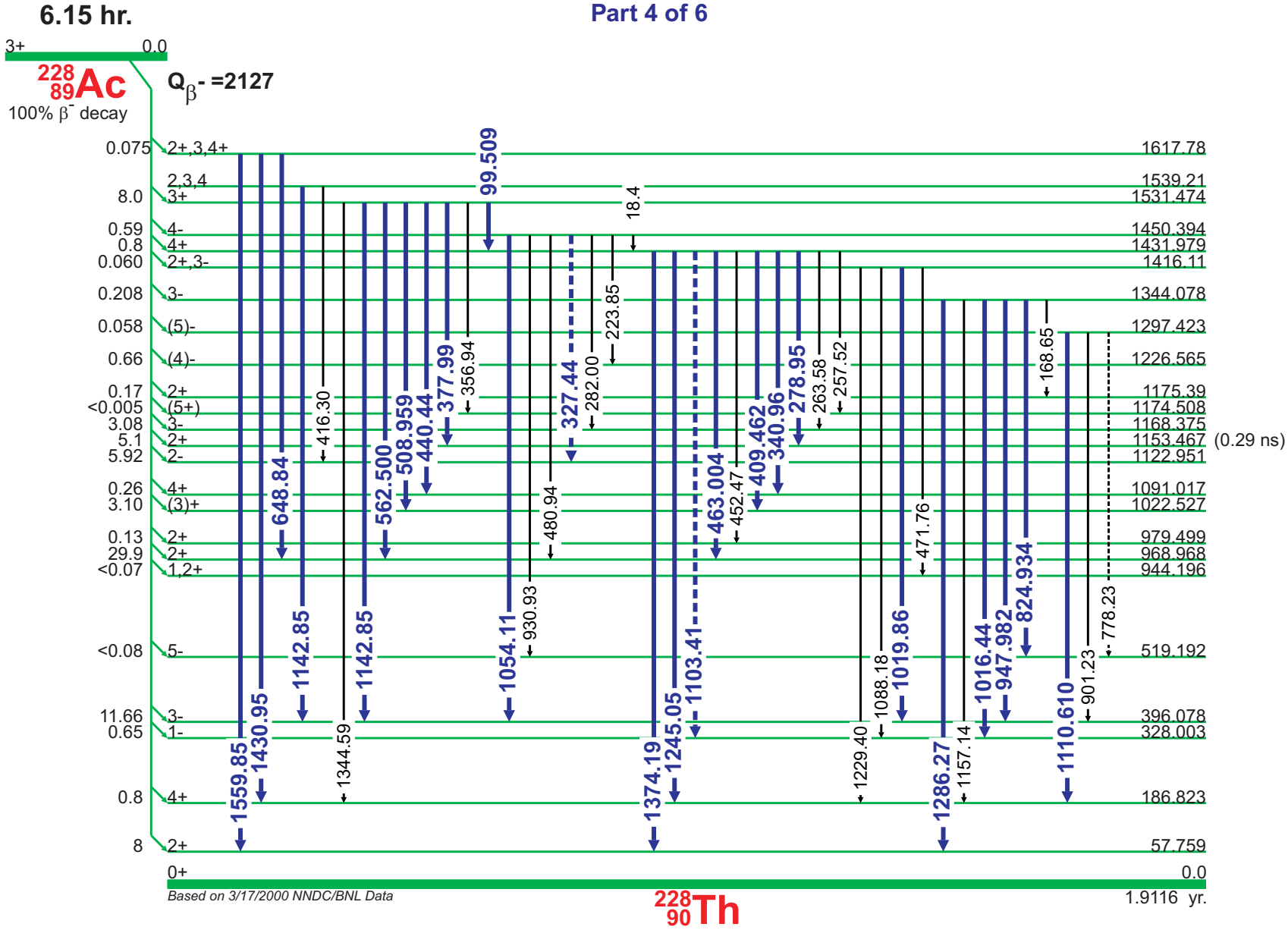
^{228}Ac (6.15 hr.) Decay Scheme

Part 4 of 6



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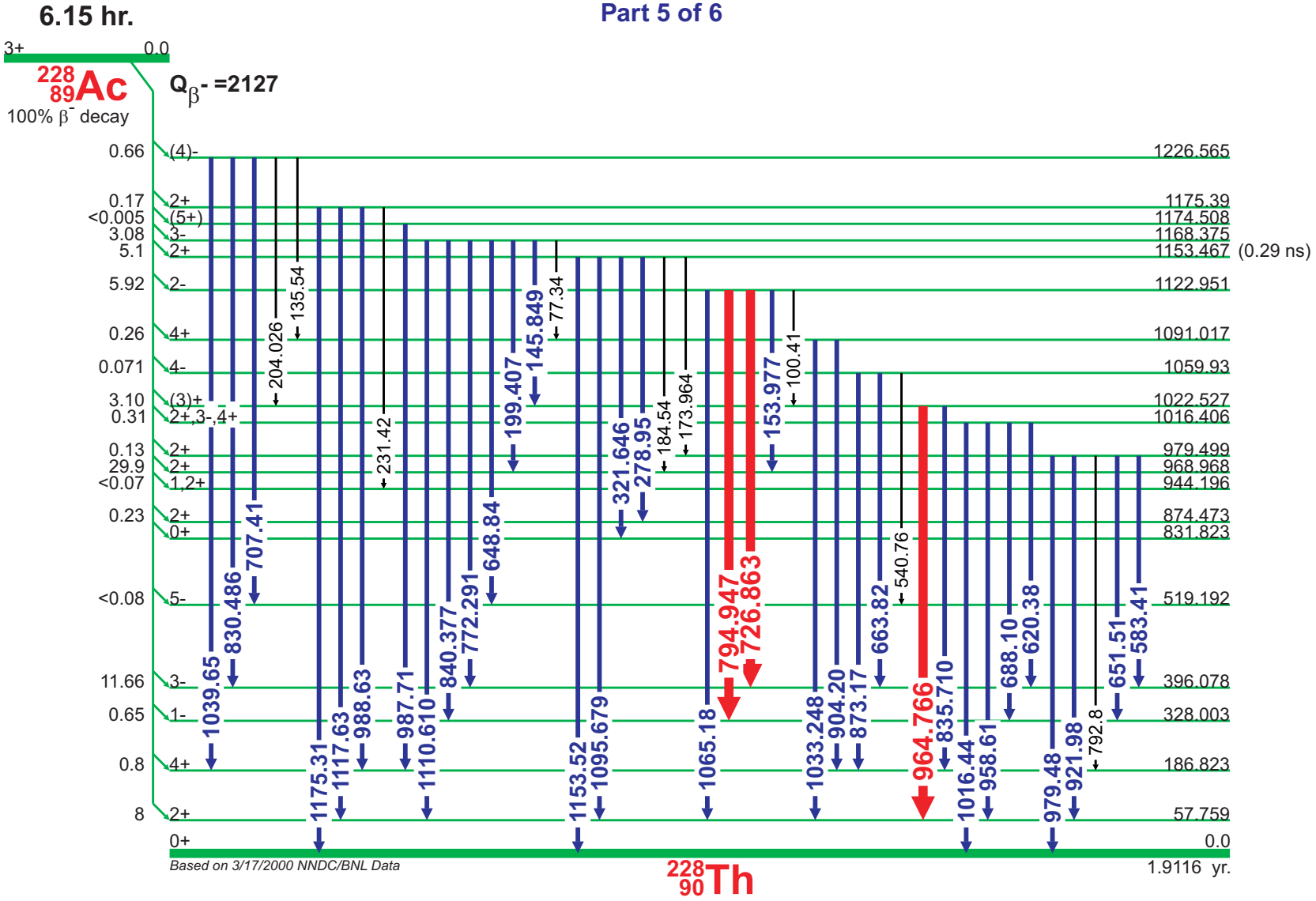
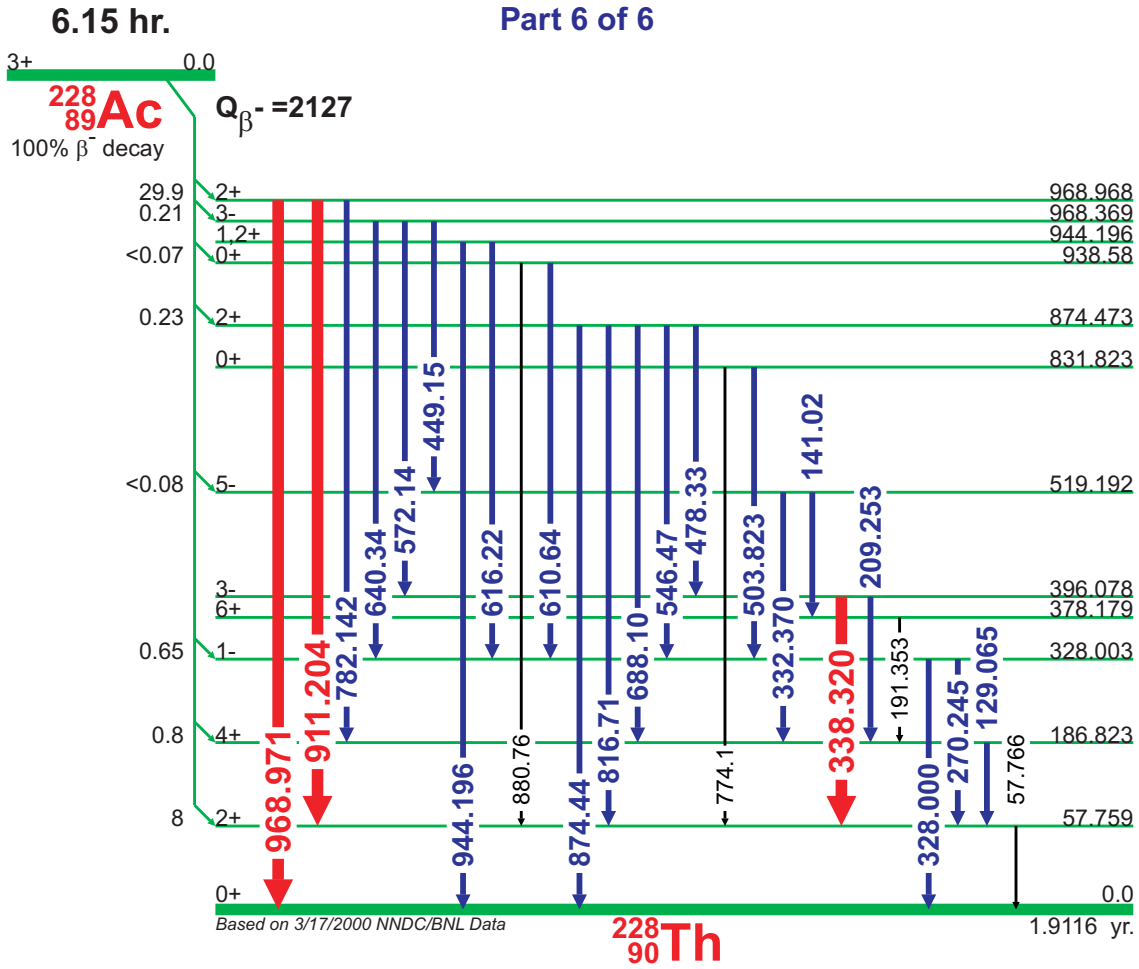
^{228}Ac (6.15 hr.) Decay Scheme

Part 5 of 6



^{228}Ac (6.15 hr.) Decay Scheme

Part 6 of 6



GAMMA-RAY ENERGIES AND INTENSITIES (page 1 of 4)

Nuclide: ^{228}Ac — E_γ, σE_γ, I_γ, σI_γ, Levels- from ENSDF Database as of March 17, 20 — Half Life: 6.15(2) hr.

E_γ (keV)	σE_γ	① I_γ	② σI_γ	Level	
18.4		0.014	0.004	1,450.394	β–
42.46	0.05	0.009	0.003	1,688.394	β–
56.96	0.05	0.019	0.004		β–
57.766	0.005	0.47	0.03	57.759	β–
77.34	0.03	0.026	0.005	1,168.375	β–
99.509	0.006	1.26	0.07	1,531.474	β–
100.41	0.03	0.093	0.013	1,122.951	β–
114.56	0.07	0.009 8	0.002 1	1,645.954	β–
129.065	0.001	2.42	0.09	186.823	β–
135.54	0.05	0.018	0.004	1,226.565	β–
137.91	0.05	0.024	0.005		β–
141.02	0.03	0.050	0.008	519.192	β–
145.849	0.010	0.158	0.008	1,168.375	β–
153.977	0.010	0.722	0.021	1,122.951	β–
168.65	0.10	0.010	0.003	1,344.078	β–
168.65	0.10	0.003 0	0.000 7	1,928.57	β–
173.964	0.013	0.035	0.005	1,153.467	β–
184.54	0.02	0.070	0.008	1,153.467	β–
191.353	0.010	0.123	0.008	378.179	β–
199.407	0.010	0.315	0.005	1,168.375	β–
204.026	0.010	0.112	0.015	1,226.565	β–
209.253	0.006	3.89	0.07	396.078	β–
214.85	0.10	0.029	0.004	2,010.11	β–
223.85	0.10	0.054	0.005	1,450.394	β–
231.42	0.10	0.025	0.004	1,175.39	β–
257.52	0.10	0.030	0.003	1,431.979	β–
263.58	0.10	0.040	0.004	1,431.979	β–
270.245	0.002	3.46	0.06	328.003	β–
278.95	0.05	0.160	0.021	1,153.467	β–
278.95	0.05	0.031	0.005	1,431.979	β–
282.00	0.03	0.072	0.019	1,450.394	β–
321.646	0.008	0.226	0.011	1,153.467	β–
326.04	0.20	0.033	0.005	1,758.24	β–
327.44		0.12	0.04	1,450.394	β–
328.000	0.006	2.95	0.12	328.003	β–
332.370	0.004	0.40	0.04	519.192	β–
338.320	**0.003**	**11.27**	**0.19**	**396.078**	β–
340.96	0.05	0.369	0.021	1,431.979	β–
356.94	0.10	0.017 0	0.001 8	1,531.474	β–
372.57	0.20	0.006 7	0.001 5	2,010.11	β–
377.99	0.10	0.025	0.003	1,531.474	β–
384.63	0.20	0.006 7	0.001 5	2,022.84	β–
389.12	0.15	0.010 3	0.001 5	1,928.57	β–
397.94	0.10	0.027	0.003	1,937.16	β–
399.62	0.10	0.029	0.003	1,743.89	β–
409.462	0.006	1.92	0.04	1,431.979	β–
416.30	0.20	0.013 2	0.002 1	1,539.21	β–
419.42	0.10	0.021	0.003	1,645.954	β–
440.44	0.05	0.121	0.008	1,531.474	β–
449.15	0.05	0.048	0.005	968.369	β–
452.47	0.10	0.015	0.005	1,431.979	β–
457.17	0.15	0.015 0	0.002 3	1,683.82	β–
463.004	0.006	4.40	0.07	1,431.979	β–
466.40	0.10	0.029	0.003		β–
470.25	0.20	0.013	0.003	1,638.284	β–
471.76	0.15	0.033	0.003	1,416.11	β–
474.75	0.10	0.022	0.003	1,643.125	β–
478.33	0.05	0.209	0.015	874.473	β–
480.94	0.20	0.023	0.005	1,450.394	β–
490.33	0.15	0.011 1	0.002 3	1,906.64	β–
492.37	0.10	0.023 5	0.002 3	1,645.954	β–
497.49	0.15	0.005 9	0.001 8	1,724.283	β–
503.823	0.013	0.182	0.012	831.823	β–
508.959	0.017	0.45	0.05	1,531.474	β–
515.06	0.10	0.049	0.005	1,638.284	β–
520.151	0.016	0.067	0.005	1,643.125	β–
523.131	0.016	0.103	0.008	1,645.954	β–
540.76	0.10	0.026	0.003	1,059.93	β–
546.47	0.05	0.201	0.013	874.473	β–
548.73	0.15	0.023	0.003	1,724.283	β–

① These Iγ are per 100 Decays of ^{228}Ac.

② Normalization factor is 1.000, and its uncertainty is taken to be 0.0.

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GAMMA-RAY ENERGIES AND INTENSITIES (page 2 of 4)

Nuclide: ^{228}Ac — E_γ, σE_γ, I_γ, σI_γ, Levels- from ENSDF Database as of March 17, 20 — Half Life: 6.15(2) hr.

E_γ (keV)	σ E_γ	① I_γ	② σ I_γ	Level	
555.12	0.10	0.046	0.005	1,645.954	β–
562.500	0.004	0.87	0.03	1,531.474	β–
570.91	0.10	0.182	0.024	1,724.283	β–
572.14	0.08	0.150	0.016	968.369	β–
583.41	0.05	0.111	0.010	979.499	β–
590.4		0.017	0.003	1,743.89	β–
610.64	0.10	0.023	0.005	938.58	β–
616.22	0.03	0.080	0.005	944.196	β–
620.38	0.05	0.080	0.005	1,016.406	β–
623.27	0.20	0.011	0.003	1,645.954	β–
627.23	0.20	0.014	0.003	1,643.125	β–
629.40	0.05	0.045	0.005	1,645.954	β–
634.18	0.10	0.010 6	0.002 1		β–
640.34	0.03	0.054	0.005	968.369	β–
648.84	0.10	0.040	0.004	1,168.375	β–
648.84	0.10	0.040	0.004	1,617.78	β–
651.51	0.03	0.090	0.008	979.499	β–
660.1	0.3	0.005	≈	1,682.81	β–
663.82	0.10	0.028	0.006	1,059.93	β–
666.45	0.10	0.057	0.006	1,645.954	β–
666.45	0.10	0.005	0.002	1,892.996	β–
672.00	0.15	0.026	0.008	1,688.394	β–
674.16		0.109	≤	1,643.125	β–
674.75		0.109	≤	1,643.125	β–
677.11	0.10	0.062	0.005	1,645.954	β–
684.0		0.019	0.005	1,743.89	β–
688.10	0.05	0.067	0.005	874.473	β–
688.10	0.05	0.067	0.005	1,016.406	β–
692.5		0.005 6	0.000 7	1,892.996	β–
699.08	0.15	0.037	0.005	1,643.125	β–
701.747	0.014	0.173	0.010	1,724.283	β–
707.41	0.05	0.155	0.015	1,226.565	β–
718.48	0.15	0.019	0.004	1,944.895	β–
726.863	**0.015**	**0.62**	**0.08**	**1,122.951**	**β–**
737.72	0.05	0.037	0.004	1,760.218	β–
755.315	0.004	1.00	0.03	1,724.283	β–
770.04		0.006 3	0.000 8	1,892.996	β–
772.291	0.005	1.49	0.03	1,168.375	β–
774.1	0.2	0.06	≈	831.823	β–
776.56	0.10	0.019	0.006	1,944.895	β–
778.23		0.022	0.006	1,297.423	β–
782.142	0.005	0.485	0.019	968.968	β–
791.49	0.25	0.010	0.003	1,760.218	β–
791.49	0.25	0.013	0.003	1,944.895	β–
792.8		0.08	≈	979.499	β–
794.947	**0.005**	**4.25**	**0.07**	**1,122.951**	**β–**
813.77	0.15	0.007 0	0.001 6	1,688.394	β–
816.71	0.10	0.030	0.003	874.473	β–
824.934	0.023	0.050	0.005	1,344.078	β–
830.486	0.008	0.540	0.021	1,226.565	β–
835.710	0.006	1.61	0.06	1,022.527	β–
840.377	0.007	0.91	0.04	1,168.375	β–
853.17	0.10	0.003 1	0.000 4	1,944.895	β–
853.17	0.10	0.008 8	0.001 8		β–
870.46	0.04	0.044	0.004	1,892.996	β–
873.17	0.15	0.031	0.006	1,059.93	β–
874.44	0.07	0.047	0.010	874.473	β–
877.46	0.10	0.014	0.003	1,899.95	β–
880.76	0.10	0.006 2	0.001 8	938.58	β–
887.33	0.10	0.027	0.003	2,010.11	β–
901.23	0.15	0.016	0.003	1,297.423	β–
904.20	0.04	0.77	0.03	1,091.017	β–
911.204	**0.004**	**25.8**	**0.4**	**968.968**	**β–**
918.97	0.10	0.027	0.003	2,010.11	β–
921.98	0.10	0.014 7	0.002 1	1,944.895	β–
921.98	0.10	0.014 7	0.002 1	979.499	β–
924.03		0.007 5	0.001 0	1,892.996	β–
930.93	0.10	0.012 4	0.001 8	1,450.394	β–
930.93	0.10	0.012 4	0.001 8	1,899.95	β–
939.87	0.15	0.009	0.003	2,029.84	β–

① These Iγ are per 100 Decays of ^{228}Ac.

② Normalization factor is 1.000, and its uncertainty is taken to be 0.0.

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GAMMA-RAY ENERGIES AND INTENSITIES (page 3 of 4)

Nuclide: ^{228}Ac

E_γ, σE_γ, I_γ, σI_γ, Levels- from ENSDF Database as of March 17, 20

Half Life: 6.15(2) hr.

E_γ (keV)	σ E_γ	① I_γ	② σ I_γ	Level	
944.196	0.014	0.095	0.008	944.196	β–
947.982	0.011	0.106	0.008	1,344.078	β–
958.61	0.04	0.28	0.04	1,016.406	β–
964.766	**0.010**	**4.99**	**0.09**	**1,022.527**	**β–**
968.971	**0.017**	**15.8**	**0.3**	**968.968**	**β–**
975.96	0.05	0.050	0.005	1,944.895	β–
979.48	0.10	0.026	0.003	979.499	β–
987.71	0.20	0.077	0.013	1,174.508	β–
988.63	0.20	0.077	0.013	1,175.39	β–
1,000.69	0.15	0.005		1,944.895	β–
1,013.58	0.20	0.004 6	0.001 3	2,029.84	β–
1,016.44	0.15	0.019	0.003	1,016.406	β–
1,016.44	0.15	0.019	0.003	1,344.078	β–
1,017.92	0.20	0.005 7	0.001 3	1,987.46	β–
1,019.86	0.10	0.021	0.004	1,416.11	β–
1,033.248	0.009	0.201	0.013	1,091.017	β–
1,039.65	0.15	0.044	0.009	1,226.565	β–
1,040.92	0.15	0.044	0.009	2,010.11	β–
1,053.09	0.20	0.013	0.004	2,022.84	β–
1,054.11	0.20	0.018	0.005	1,450.394	β–
1,062.55	0.15	0.010	0.003	1,937.16	β–
1,065.18	0.04	0.132	0.010	1,122.951	β–
1,074.71	0.15	0.010	0.003	1,906.64	β–
1,088.18	0.15	0.005 9	0.001 3	1,416.11	β–
1,095.679	0.020	0.129	0.010	1,153.467	β–
1,103.41	0.10	0.015 0	0.002 3	1,431.979	β–
1,110.610	0.010	0.285	0.023	1,168.375	β–
1,110.610	0.010	0.019	0.010	1,297.423	β–
1,117.63	0.10	0.054	0.008	1,175.39	β–
1,135.24	0.15	0.009 8	0.001 5	1,531.474	β–
1,142.85	0.15	0.0103	0.002 1	1,539.21	β–
1,148.12	0.15	0.005 9	0.001 3	2,022.84	β–
1,153.52	0.04	0.139	0.010	1,153.467	β–
1,157.14	0.15	0.007 0	0.001 3	1,344.078	β–
1,164.50	0.08	0.065	0.005	1,683.82	β–
1,175.31	0.10	0.024	0.003	1,175.39	β–
1,190.81	0.20	0.006 2	0.001 6	2,022.84	β–
1,217.03	0.10	0.021	0.003	1,735.450	β–
1,229.40	0.15	0.007 5	0.002 3	1,416.11	β–
1,245.05	0.20	0.095	0.018	1,431.979	β–
1,247.08	0.04	0.50	0.03	1,643.125	β–
1,250.04	0.10	0.062	0.005	1,645.954	β–
1,276.69	0.10	0.014	0.003	1,795.90	β–
1,286.27	0.20	0.050	0.010	1,344.078	β–
1,287.68	0.20	0.080	0.015	1,683.82	β–
1,309.71	0.20	0.019	0.006	1,638.284	β–
1,315.34	0.10	0.015	0.003	1,643.125	β–
1,337.33	0.20	0.004 9	0.001 5		β–
1,344.59	0.15	0.009 0	0.001 8	1,531.474	β–
1,347.50	0.15	0.015	0.003	1,743.89	β–
1,357.78	0.15	0.020	0.004	1,735.450	β–
1,365.70	0.15	0.014	0.003	1,743.89	β–
1,374.19	0.10	0.014	0.004	1,431.979	β–
1,378.23	0.10	0.005 9	0.001 8		β–
1,385.39	0.10	0.010 6	0.002 1		β–
1,401.49	0.10	0.012	0.003	1,797.65	β–
1,415.66	0.10	0.021	0.004	1,743.89	β–
1,430.95	0.10	0.035	0.007	1,617.78	β–
1,434.22	0.15	0.008 0	0.002 3		β–
1,438.01	0.10	0.005 9	0.001 5		β–
1,451.40	0.15	0.010 6	0.002 1	1,638.284	β–
1,459.138	0.015	0.83	0.08	1,645.954	β–
1,469.71	0.15	0.020	0.004	1,797.65	β–
1,480.37	0.15	0.016	0.003		β–
1,495.910	0.020	0.86	0.04	1,682.81	β–
1,501.57	0.05	0.46	0.03	1,688.394	β–
1,529.05	0.10	0.057	0.006		β–
1,537.89	0.10	0.047	0.005	1,724.283	β–
1,548.65	0.04	0.038	0.004	1,735.450	β–
1,557.11	0.04	0.178	0.013	1,743.89	β–

① These Iγ are per 100 Decays of ^{228}Ac.

② Normalization factor is 1.000, and its uncertainty is taken to be 0.0.

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

Nuclide: ^{228}Ac

E_γ, σE_γ, I_γ, σI_γ, Levels- from ENSDF Database as of March 17, 20

Half Life: 6.15(2) hr.

E_γ (keV)	σ E_γ	① I_γ	② σ I_γ	Level	
1,559.85	0.20	0.020	0.004	1,617.78	β–
1,571.52	0.20	0.005 7	0.001 6	1,758.24	β–
1,573.26	0.05	0.033	0.003	1,760.218	β–
1,580.53	0.03	0.60	0.04	1,638.284	β–
1,588.20	**0.03**	**3.22**	**0.08**	**1,645.954**	**β–**
1,609.41	0.15	0.007 7	0.001 5	1,987.46	β–
1,625.06	0.05	0.255	0.018	1,682.81	β–
1,630.627	0.010	1.51	0.04	1,688.394	β–
1,638.281	0.010	0.47	0.03	1,638.284	β–
1,666.523	0.013	0.178	0.013	1,724.283	β–
1,671.64	0.15	0.004 1	0.001 3		β–
1,677.67	0.03	0.054	0.005	1,735.450	β–
1,684.01	0.20	0.015	0.005		β–
1,686.09	0.07	0.095	0.008	1,743.89	β–
1,700.59	0.20	0.010 1	0.002 3	1,758.24	β–
1,702.43	0.05	0.048	0.005	1,760.218	β–
1,706.19	0.10	0.008 5	0.001 0	1,892.996	β–
1,713.47	0.20	0.005 4	0.001 0	1,899.95	β–
1,721.4	0.3	0.005 7	0.002 1		β–
1,724.21	0.04	0.029	0.003	1,724.283	β–
1,738.22	0.25	0.018	0.004	1,795.90	β–
1,740.4	0.3	0.011	0.003	1,797.65	β–
1,742.0	0.3	0.008 0	0.002 3	1,928.57	β–
1,745.28	0.20	0.006 5	0.000 8		β–
1,750.54	0.20	0.008 0	0.000 8	1,937.16	β–
1,758.11	0.10	0.035	0.004	1,944.895	β–
1,772.2	0.3	0.001 8	0.000 5	1,958.72	β–
1,784.4	0.3	0.005 9	0.001 0		β–
1,787.3	0.5	0.001 3	0.000 5		β–

E_γ (keV)	σ E_γ	① I_γ	② σ I_γ	Level	
1,795.1	0.5	0.002 1	0.000 8	2,123.1	β–
1,797.5	0.5	0.002 1	0.000 8	1,797.65	β–
1,800.86	0.20	0.004 4	0.000 8	1,987.46	β–
1,823.22	0.10	0.044	0.004	2,010.11	β–
1,826.7	0.3	0.002 1	0.000 8	2,013.6	β–
1,835.43	0.10	0.038	0.004	1,892.996	β–
1,842.13	0.10	0.042	0.004	1,899.95	β–
1,850.13	0.20	0.004 4	0.000 8	2,036.99	β–
1,870.83	0.10	0.024 3	0.002 3	1,928.57	β–
1,879.6	0.3	0.001 3	0.000 5	1,937.16	β–
1,887.10	0.05	0.090	0.008	1,944.895	β–
1,900.07	0.20	0.002 8	0.000 5	1,899.95	β–
1,907.18	0.20	0.011 9	0.001 0	1,906.64	β–
1,915.9	0.4	0.000 8	0.000 3		β–
1,919.5	0.3	0.002 1	0.000 5		β–
1,929.78	0.20	0.019 9	0.002 1	1,987.46	β–
1,936.3	0.3	0.002 1	0.0005	2,123.1	β–
1,944.20	0.20	0.002 1	0.000 5		β–
1,952.33	0.15	0.059	0.005	2,010.11	β–
1,955.9	0.5	0.000 8	0.000 3	2,013.6	β–
1,958.4	0.3	0.001 5	0.000 5	1,958.72	β–
1,965.24	0.20	0.020 4	0.001 8	2,022.84	β–
1,971.9	0.3	0.003 6	0.000 8	2,029.84	β–
1,979.3	0.3	0.001 8	0.000 5	2,036.99	β–
2,000.9	0.5	0.001 0	0.000 3		β–
2,029.4	0.5	0.001 8	0.000 5	2,029.84	β–

① These Iγ are per 100 Decays of ^{228}Ac.

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