Single Channel Analyzer
SCA

Objective:

To gather a gamma spectrum of two known sources Cs-137 and Co-60 and an unknown source. Then using the known gamma photo peaks of the two sources in relation to the channel they were found in, determine the gamma peak(s) of the unknown source. Also to determine the resolution of the scintillation detector used in the experiment.

Introduction:

An energy spectrum of a source can be divided up into small segments of electron Volts. By slowly sweeping through and gathering counts for each of the small segments a spectrum can be created which will show the photopeak of a radioactive source as well the interactions of the gamma rays with matter and represented by the Compton valley, Compton edge, and the backscattering peak. The SCA is a tool used to perform such a task. Before using the G-M tube counts were observed without any regard for the energy level for each particle or ray. A scintillation detector is designed to detect the energy level of each individual emission. An addition write up is available which explains the process of detection for the NaI(T1) scintillation detector in more detail.

Procedure:

In this experiment the St-360 is used in conjunction with the ST-450. All wiring has already been made for the experiment. What will be happening is that the ST-450 supplies the high voltage to the Scintillation tube and detects the signal coming from the tube. It then amplifies this signal according to the gain adjustments and compares it to a reference voltage which is being supplied and slowly incremented by the ST360.

1. The adjustments on the ST450 should be checked to assure that they match our own settings so that your results may be fairly compared to our own.

Fine Gain	10.0	Coarse gain	4
Window	1%	Baseline	66.2
High Voltage	568		

2. Start the program which controls the ST360. Setup the following

High Voltage	200	Number of runs	100
Step voltage	10 and enabled	Time	20 seconds

3. On the ST450 turn it on, and turn on the High Voltage and Ext Scan. Do not select integral mode. The ST450 is not ready to be controlled by the ST360.

4. Start off by first acquiring a spectrum of the unknown source. Save the data.
5. Obtain spectrums for the two known sources Cs-137 and Co-60.

Data Analysis

Graph the spectrums for each source with the voltage, which also represents the channel number, along the x-axis. Determine the channel number for the gamma photo peaks for each source. The energy for the primary gamma rays for the two known sources are

Cs-137 662keV

Co-60 1173kev, 1333keV

Plot energy vs. channel number for Co60 and Cs137. Fit the data using a binomial fit.
Using the fitted equation and the channel numbers of the peak(s) of the unknown source determine the energy of the peak(s).
From this and the included Gamma energies Data determine the unknown source.

The resolution of the detector is determined by first finding from your graph the channel number for the centroid peak. Then determine the channel numbers at the FWHM, full width half maximum, position on each side of the peak.

The resolution of the detector is determined from the

$$\frac{difference\ of\ FWHM\ channels}{centroid\ channel}$$

APPENDIX E

List of Commonly Observed Gamma Energies

This is a table of commonly-observed gamma energies, arranged by increasing gamma energy. The parent isotope and its half life are listed with the gamma energy. The key gamma energy for an isotope has an asterisk following it. Each isotope is listed once with its complete set of gamma energies. The gamma decay fraction is listed in parentheses It represents the number of gammas of that energy emitted per decay of the parent nucleus (as a percentage and not a fraction in this table).

Energy	Element	Half Life	Associated gammas
35.5 (4.1)	Sb-125		427.9*(30)
44.8 (31)	Pu-241		148.6*(96)
46.5*(3.9)	***Pb-210***	***22.3 y***	(U-238)
56.3 (9)	Pu-241		148.6*(96)
59.5*(35)	***Am-241***	***433 y***	***26.3***
63.3 (3.8)	Th-234		(U-238) 92.6*(5.4)
67.8 (42)	Ta-182		1221.4*(27)
69.7 (2.6)	Gd-153		97.4*(31)
79.1 (7.1)	Ag-108m		722.9*(91)
80.1 (2)	Ce-144		133.5*(11)
81.0 (33)	Ba-133		356.0*(62)
84.4*(1.2)	***Th-228***	***1.913 y***	***(Th-232)***
86.5*(31)	***Eu-155***	***4.71 y***	***105.3***
88.0*(3.7)	***Cd-109***	***462.0 d***	
88.4 (13)	La-138		1435.8*(68)
92.6*(5.4)	***Th-234***	***24.1 d***	***(U-238) 63.3***
93.3*(38)	***Ga-67***	***3.260 d***	***184.6 300.2 393.5 209***
93.4 (3.5)	Ac-228		(Th-232) 911.1*(27.7)
97.4*(31)	***Gd-153***	***241.6 d***	***103.2 69.7***
98.9*(11)	***Au-195***	***186.12 d***	***129.8***
100.1 (14)	Ta-182		1221.4*(27)
103.2 (22)	Gd-153		97.4*(31)
103.7 (30)	Pu-241		148.6*(96)
105.3 (20)	Eu-155		86.5*(31)
121.1 (17)	Se-75		264.7*(60)
121.8 (28)	Eu-152		1408.0*(21)
122.1*(86)	***Co-57***	***271.8 d***	***136.5 14.4***
123.1*(40)	***Eu-154***	***8.59 y***	***1274.5 723.3 1004.8 873.2 996.3 247.9***
129.8 (0.8)	Au-195		98.9*(11)
133.5*(11)	***Ce-144***	***284.6 d***	***80.1 696.5 (Pr-144)***
136 (57)	Se-75		264.7*(60)
136.5 (11)	Co-57		122.1*(86)
140.5*(90)	***Tc-99m***	***6.01 h***	
148.6*(94)	***Pu-241***	***14.4 y***	***44.8 103.7 44.2 56.3***
176.3 (6.9)	Sb-125		427.9*(30)
184.6 (20)	Ga-67	3.260 d	93.3*(38)
185.7*(54)	***U-235***	***7.04×10^{8} y***	***194.9 205.3 163.4***
190.3*(16)	***In-114 m***	***49.51 d***	***558.4 725.2***
192.3 (3.1)	Fe-59		1099.2*(56)

Energy	Element	Half Life	Associated gammas
201.3 (84)	Lu-176		308.9*(93)
209 (2.2)	Ga-67		93.3*(38)
209.3 (4.4)	Ac-228		(Th-232) 911.1*(27.7)
210.6 (11.3)	Th-227		(U-235) 236*(11.5)
222.1 (7.6)	Ta-182		1221.4*(27)
236*(11.5)	***Th-227***	***18.72 d***	***(U-235) 210.6***
238.6*(45)	***Pb-212***	***10.64 h***	***(Th-232)***
241.0*(4)	***Ra-226***	***3.66 d***	***(Th-232)***
244.7 (7)	Eu-152		1408.0*(21)
247.9 (6.6)	Eu-154		123.1*(40)
255.1*(1.9)	***Sn-113***	***115.1 d***	***391.7 (In-113m)***
264.7*(60)	***Se-75***	***119.78 d***	***121.1 136 279.5 400.7***
269.5*(13.6)	***Ra-223***	***11.435 d***	***(U-235)***
271.2*(10.6)	***Rn-219***	***3.96 s***	***(U-235) 401.8***
276.4 (6.9)	Ba-133		356.0*(62)
277.4 (6.8)	Tl-208		(Th-232) 2614.7*(100)
279.2*(77)	***Hg-203***	***46.61 d***	
279.5 (25)	Se-75		264.7*(60)
284.3 (6)	I-131		364.5*(81)
295.2 (19.2)	Pb-214		(U-238) 351.9*(37.2)
300.1 (4)	Th-228		2614.5*
300.2 (16)	Ga-67		93.3*(38)
302.8 (19)	Ba-133		356.0*(62)
308.9*(93)	***Lu-176***	***3.6×10^{10} y***	***201.8***
320.1*(9.8)	***Cr-51***	***27.7 d***	
338.3 (11.4)	Ac-228		(Th-232) 911.1*(27.7)
344.3 (27)	Eu-152		1408.0*(21)
351.1*(12.9)	***Bi-211***	***2.14 m***	***(U-235)***
352.0*(37.2)	***Pb-214***	***26.8 m***	***(U-238) 295.2***
356.0*(62)	***Ba-133***	***10.53 y***	***81 302.8 383.9 276.4***
364.5*(81)	***I-131***	***8.04 d***	***637 284.3 722.9***
383.9 (8.7)	Ba-133		356.0*(62)
391.7*(65)	***In-113m***	***1.658 hr***	
393.5 (4.5)	Ga-67		93.3*(38)
400.7 (12)	Se-75		264.7*(60)
401.8 (6.5)	Rn-219		(U-235) 271.2*(10.6)
416.9 (32)	In-116		1293.6*(75)
427.9*(30)	***Sb-125***	***2.758 y***	***600.6 635.9 463.4 176.3 35.5 606.6***
433.9 (90)	Ag-108m		722.9*(91)
442.9*(16)	***I-128***	***25 m***	***526.6***
463.4 (10)	Sb-125		427.9*(30)
477.6 (10)	***Be-7****	***53.3 d***	
510.8 (21.6)	Tl-208		(Th-232) 2614.7*(100)
511.0 (180)	Na-22		1274.5*(100)
511.0 (30)	Co-58		810.8*(99)
511.0 (2.8)	Zn-65		1115.5*(50.8)
511.0 (0.6)	Ag-108		633*(1.8)
526.6 (1.5)	I-128		442.9*(16)
558.4 (4.5)	In-114 m		190.3*(16)
563.2 (8.4)	Cs-134		795.8*(85.4)
569.3 (15.4)	Cs-134		795.8*(85.4)
569.7*(98)	***Bi-207***	***38.0 y***	***1063.6 1770.2***
583.1 (84.2)	Ti-208		(Th-232) 2617.5*(100)
600.6 (18)	Sb-125		427.9*(30)
602.7*(98)	***Sb-124***	***60.2 d***	***1691 722.8 645.9 2091 1368.2***
604.7 (97.6)	Cs-134		795.8*(85.4)
606.6 (5)	Sb-125		427.9*(30)
609.3*(46.3)	***Bi-214***	***19.9 m***	***(U-238) 1764.5 1120.3 1238.1 2204.2***
614.4 (91)	Ag-108m		722.9*(91)
633*(1.8)	***Ag-108***	***2.39 m***	***433.9 511***
635.9 (11)	Sb-125		427.9*(30)
637.0 (7.3)	I-131		364.5*(81)

Energy	Element	Half Life	Associated gammas
645.9 (7.3)	Sb-124		602.7*(98)
657.8 (4.4)	***Ag-110***	***24.6 s***	
661.6*(90)	***Ba-137m***	***2.55 m***	
661.6*(85)	***Cs-137***	***30.17 y***	
696.5 (1.5)	***Pr-144***	***17.3 m***	***133.5*(11) (Ce-144)***
722.8 (11)	Sb-124		602.7*(98)
722.9*(91)	***Ag-108m***	***130 y***	***614.4 433.9 79.2***
722.9 (1.8)	I-131		364.5*(81)
723.3 (19)	Eu-154		123.1*(40)
725.2 (4.5)	In-114 m		190.3*(16)
727.2*(11.8)	***Bi-212***	***60.6 m***	***(Th-232)***
778.9 (13)	Eu-152		1408.0*(21)
788.7 (32)	***La-138***	***1.05 x 10^{11}y***	
795.8*(85.4)	***Cs-134***	***2.065 y***	***604.7 801.9 569.3 563.3***
801.9 (8.7)	Cs-134		795.8*(85.4)
810.8*(99)	***Co-58***	***70.88 d***	***863.9 511***
818.7 (15)	In-116	54.2 m	1293.6*(75)
834.8*(100)	***Mn-54***	***312.2 d***	
860.4 (12.5)	Tl-208		(Th-232) 2614.7*(100)
863.9 (1.8)	Co-58		810.8*(99)
873.2 (12)	Eu-154		123.1*(40)
889.3 (100)	Sc-46		1120.5*(100)
898.0 (93)	Y-88		1836.0*(99)
911.1*(27.7)	***Ac-228***	***6.15 h***	***(Th-232) 969.1 338.3 209.3 93.4***
964.0 (15)	Eu-152		1408.1*(21)
969.1 (16.6)	Ac-228		(Th-232) 911.1*(27.7)
996.3 (11)	Eu-154		123.1*(40)
1004.8 (18)	Eu-154		123.1*(40)
1063.6 (75)	Bi-207		569.7*(98)
1085.8 (10)	Eu-152		1408.0*(21)
1097.3 (54)	In-116		1293.6*(75)
1099.2*(56)	***Fe-59***	***44.51 d***	***1291.6 192.3***
1112.0 (13)	Eu-152		1408.0*(21)
1115.5*(50.8)	***Zn-65***	***243.8 d***	***511***
1120.3 (15.1)	Bi-214		(U-238) 609.3*(46.3)
1120.5 (100)	Sc-46		889.3*(100)
1121.3 (35)	Ta-182		1221.4*(27)
1173.2 (100)	Co-60		1332.5*(100)
1189.1 (16)	Ta-182		1221.4*(27)
1221.4****(27)***	***Ta-182***	***114.43 d***	***67.8 1121.3 1189.1 100.1 222.1 1230.9***
1238.1 (5.9)	Bi-214		(U-238) 609.3*(46.3)
1274.**5 ******(100)***	***Na-22***	***2.605 y***	***511***
1274.5 (36)	Eu-154		123.1*(40)
1291.6 (43)	Fe-59		1099.2*(56)
1293.6 *(75)	***In-116***	***54.2 min***	***1097.3 416.9 2112.1 818.7 1507***
1332.5*(100)	***Co-60***	***5.271 y***	***1173.2*(100)***
1368.2 (2.5)	Sb-124		602.7*(98)
1408.0*(21)	***Eu-152***	***13.48 y***	***121.8 344.3 964 1112 778.9 1085.8 244.7***
1434.1*(100)	***V-52***	***3.76 m***	
1435.8*(68)	***La-138***	***1.05 x 10^{11} y***	***88.4 788.7***
1460.8*(11)	***K-40***	***1.28 x 10^{9} y***	
1507.4 (10)	In-116	54.2 m	1293.6*(75)
1691*(49)	***Sb-124***		***602.7*(98)***
1764.5 (15.8)	Bi-214		(U-238) 609.3*(46.3)
1770.2 (6.8)	Bi-207		569.7*(98)
1779*(100)	***Al-28***	***2.25 m***	
1836.1*(99)	***Y-88***	***106.6 d***	***898.1***
2091 (5.7)	Sb-124	60.2 d	602.7*(98)
2112.1 (18)	In-116		1293.6*(75)
2204.2 (5)	Bi-214		(U-238) 609.3*(46.3)
2614.7*(100)	***Tl-208***	***183 s***	***(Th-232) 583.1 510.8 860.5 277.4***
2677.9 (2)	Rb-88		1836.0*