EXPERIMENT 13.3

Mean Lifetime Measurement of the 14 keV State in ^{57}Fe with Two NaI(Tℓ) Detectors and a Time-to-Amplitude Converter (TAC)

Discussion

Figure 13.7 shows a NaI(Tℓ) pulse height spectrum of a ^{57}Co source. Shown also on the figure is the decay scheme of ^{57}Co. Most of the decays (99.8%) are by electron capture (EC) to the 136 keV ($^5/_2^-$) state in ^{57}Fe. The 136 keV state can decay directly to the ground state or cascade with a 122 keV gamma to the 14 keV ($^3/_2^-$) state and then to the ground state. The 122 keV gamma is shown as γ_1 in the figure and the 14 keV group is γ_2. Figure 13.8 shows a high resolution germanium spectrum of this isotope with the 122 and 136 keV lines resolved. Figure 13.9 shows a high resolution Si(Li) spectrum of the ^{57}Co source. The strong Kα_1 and Kβ_1 lines are from (EC) and the 14.39 keV gamma from the ($^3/_2^-$) first excited state in ^{57}Fe are clearly seen in the spectrum. In this experiment we will use the 122 keV (γ_1) to start the TAC and the 14 keV (γ_2) to stop the timing sequence. Our data will thus yield the **Mean Life** τ_m of the 14.39 keV ($^3/_2^-$) level in ^{57}Fe.

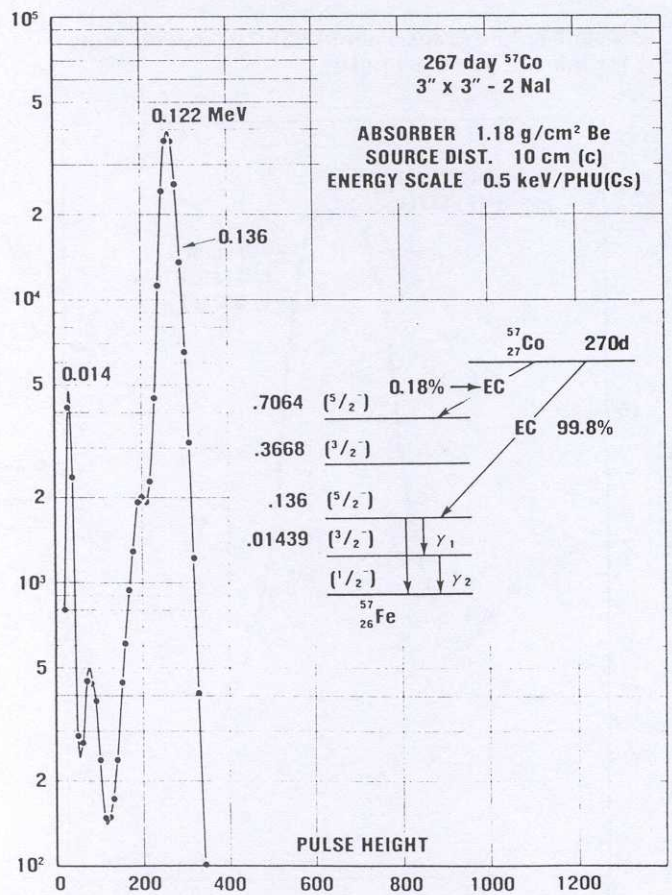

Figure 13.7. NaI(Tℓ) pulse height spectrum of a ^{57}Co source. Shown also on the figure is the decay scheme of ^{57}Co to levels in ^{57}Fe..

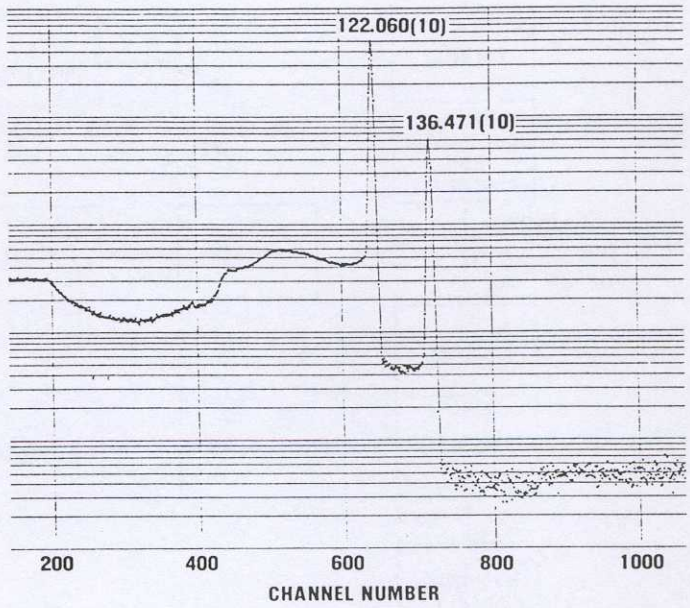

Figure 13.8. Germanium spectrum of ^{57}Co showing the resolved 136.471 and 122.060 lines.

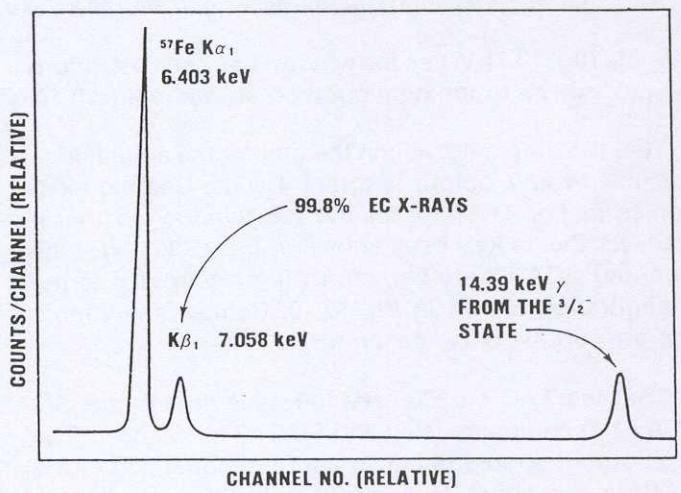

Figure 13.9. High resolution Si(Li) pulse height spectrum of a ^{57}Co source.

Experimental Procedure

1. Set up the electronics as shown in fig. 13.10. Set the high voltage supplies to their recommended values. Place the ^{57}Co source about 3 cm from each NaI(Tℓ) detector. **Note:** The TAC receives its start pulse from the top detector (γ_1). Adjust the gain of amplifier #1 so that the 122 keV gammas show an output of 4 volts. The output of amplifier #1, if fed into an MCA, should resemble fig. 13.7. Use the electronics schematic in fig. 11.11 to set the ΔE window of SCA #1 so that it brackets the 122