Lifetime of the 14.4 keV State in ^{57}Fe

Introduction

When a system is in a state A and can decay into a lower energy state B (we will limit ourselves to the case where only a single decay channel is available) the rate of decay is given by:

$dN/dt = - \lambda N$

λ has the dimensions of $(time)^{-1}$ and $1/\lambda$ is the "mean life", or "lifetime" of the state A.

The purpose of this experiment is to measure the lifetime of the 14.4 keV state in ^{57}Fe. This 14.4 keV gamma ray is of special significance because this is the radiation that exhibits the Mossbauer effect, which is another experiment in this laboratory.

Procedure

1. Step by step set up the electronics as shown in the diagram. Develop the logic diagram in your notebook sketching the output of each module as you go along. Vary gains and other parameter on the electronics as necessary.
2. Test the system by having one leg both start and stop the TAC with a delay imposed in the stop branch. Observe the TAC spectrum on an oscilloscope and also on the multichannel analyzer (PHA). Vary the delay and using the time scale on the scope calibrate the PHA.
3. Go back to having the BaF_2 start and the plastic stop the TAC and start spectrum.

Data analysis

1. Fit the spectrum to A + Be**(-t/τ). τ is the mean life of the state. Compare to the accepted value.