Experiment 17   Name:
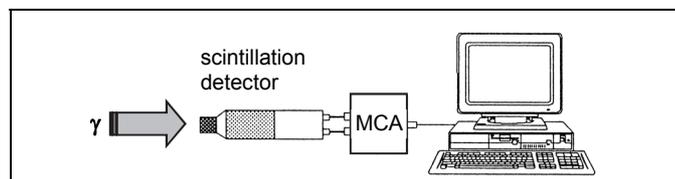
Gamma Spectrometry

……………………………………………...

Aim

- To measure the γ spectrum of an unknown source using the known γ spectrum of a calibration source with cobalt-60.
- To identify the unknown source from its measured γ spectrum.

Set-up

The set-up consists of a scintillation detector, connected to a computer by means of a multi-channel analyser (MCA), a calibration source of cobalt-60 (^{60}Co) and an unknown source.

Read the information on page 20-21 of the booklet *ISP Experiments* about gamma spectrometry and the characteristics of the γ spectrum of ^{60}Co.

The computer registers the γ spectrum in one measuring run. The registered spectrum then has to be calibrated by using the known values of the photon energy in the two photo peaks of the γ spectrum of ^{60}Co (the calibration source).

Software

Measuring – The MCA software has already been started up. On the screen you see the measuring window: window 1. This window is used for measuring the γ spectra of the sources. Measuring starts by clicking on the *start button*: ▶ . The registration of a spectrum automatically takes 180 s.
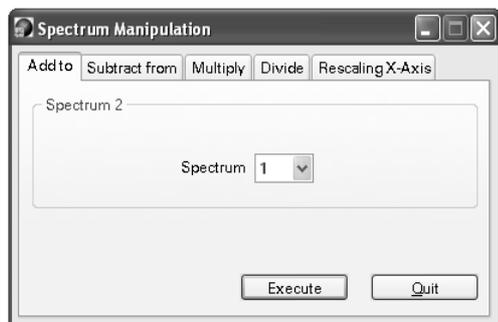

Figure 1 – Window choice screen

Figure 2 – Spectrum manipulation screen

Moving Spectra – After having measured a spectrum, the data *cannot* be saved. However, a measured spectrum can be moved from the measuring window to a storage window.

You can choose this storage window by clicking on its number in the window choice screen (see Figure 1). Next, click on the button *move spectrum*: ➔ . With this, you will enter the spectrum manipulation screen (see Figure 2). Select spectrum 1 and click on *execute*. The measured spectrum has now been copied from the measuring window (window 1) to the chosen storage window. Next, go back to the measuring window (window 1) and reset by clicking on the button *clear*: ✖ .

Background Correction – The stored spectrum can be corrected for the background radiation: select the stored spectrum and click on *background correction*: ── . Next, in the menu *spectrum* select spectrum 2: the spectrum of the background radiation (see measuring task 1).

Measurements

1 You are first going to measure the background radiation spectrum. So, the spectrum without a source in the equipment set-up. This spectrum can be subtracted from the measured spectra of the sources at a later stage.

Position both sources at a distance of about 1 m from the detector, and start the measurement. After 180 s, move the measured spectrum to storage window 2 (see the instructions above).

2 Position the calibration source underneath the detector, and start the measurement. On the screen, the γ spectrum of ^{60}Co will emerge: horizontally over 1024 channels the energy from low to high, and vertically the intensity. After 180 s, move the measured spectrum to storage window 3, and correct for the background radiation.

Observe the screen during the registration of the spectrum, and check whether you recognise the different parts of the γ spectrum of ^{60}Co.

3 Position the unknown source underneath the detector, and start the measurement. After 180 s, move the measured spectrum to storage window 4, and correct for the background radiation.

4 In order to identify the unknown source, you have to determine the energy of the γ photons in the photo peak of its spectrum: this photon energy is characteristic for the nuclide in the unknown source. This can be done by calibrating the measured γ spectrum with the help of the known γ-photon energies in the two photo peaks of the ^{60}Co spectrum. These energy values (1332 and 1173 keV) will be used to assign an energy value to each of the 1024 channels.

- Open the menu *spectrum > energy calibration*.
- Click on the first cell of the table (*channel*) and double click on the middle of the left-hand photo peak of the ^{60}Co spectrum. Which channel number does now appear in the table?

Channel number left-hand photo peak of ^{60}Co: ………

- Enter the energy value of this left-hand photo peak in the table (*value*). Select keV in the menu *unit*.
- Click on the second cell of the table (*channel*) and double click on the middle of the right-hand photo peak of the ^{60}Co spectrum. Which channel number does now appear in the table?

Channel number right-hand photo peak of ^{60}Co: ………

- Enter the energy value of this right-hand photo peak in the table (*value*) and select keV (*unit*).
- In order to make the calibration more accurate, we will add a third point with an energy value of 0 keV. Which channel number would correspond to this energy value? Enter this channel number and energy value in the third row of the table.
- Finally, subsequently choose *fit*, and *set*. The ^{60}Co spectrum is now calibrated. Use the cursor to check whether the photo peaks in the ^{60}Co spectrum do indeed have the correct energy value.

Assignments

1 To identify the unknown source, we will determine the energy of the γ photons in the photo peak of its spectrum. Because you know the energy difference between the photo peaks of ^{60}Co, and because you know the number of channels between these photo peaks (see measurement task 4), you can calculate the energy per channel.

Energy per channel: ……… keV

How many channels lie between the photo peak in the spectrum of the unknown source and the left-hand photo peak in the ^{60}Co spectrum? So, how large is the energy difference ΔE between these two photo peaks? And thus, what is the energy value $E_{f,x}$ of the photo peak in the spectrum of the unknown source?

Number of channels in between: ………

Energy difference: ΔE = ……… keV

Energy photo peak: $E_{f,x}$ = ……… keV

2 The table below shows the energy of the γ photons emitted by different nuclides. Use this table and the result of Assignment 1 to identify the nuclide in the unknown source. In doing this, remember that the energy calibration is only based on the two photo peaks of ^{60}Co, and is therefore somewhat inaccurate. A calibration with a larger number of photo peaks from known isotopes would result in an improved accuracy.

nuclide	^{133}Ba	^{22}Na	^{137}Cs	^{54}Mn
photon energy (keV)	356	1275 and 510	662	835

The nuclide in the unknown source is ……… with a characteristic photon energy of ……… keV.

3 When seeing the spectrum of the unknown source, could you have said beforehand which of the four nuclides from the table would not qualify? If so, which nuclide and why?

………

4 Open the storage window with the ^{60}Co spectrum. By using the right-hand mouse button you will be able to display the spectrum of the unknown source in the same screen: *overlay windows > select from list > spectrum 4 on > accept*. Move the cursor to the middle of the photo peak in the spectrum of the unknown source, and read the energy value of this photo peak. Compare this energy value to the result of Assignment 1.

Energy photo peak: $E_{f,x}$ = ……… keV

Note

You can print the registered γ spectra by choosing *print > spectrum*.