Nuclear Physics Laboratory

Coincident Compton scattering

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1 Introduction

The goal of this excercise is that students learn the full experimental chain of: detector set up, calibration, measurement, data analysis and disemination of the results. In addition the students will familiarize with the techinque of coincidence measurements.

2 Experimental setup

The experimental setup consists of two NaI scintillation detectors. One of the detectors acts as the scatterer - the incoming gamma Compton scatters in the detector material and mostly escapes the detector, due to its small size, while the recoil electron is absorbed and its energy can be measured. The second detector measures the energy and the angle of the scattered gamma. Each detector has a dedicated high voltage unit and the voltage specifications are given in the lab by the teacher. The detector signals are read out via flash analog to digital converter (FADC) and stored in the personal computer. The signal analysis and energy reconstruction are performed offline using dedicated software.

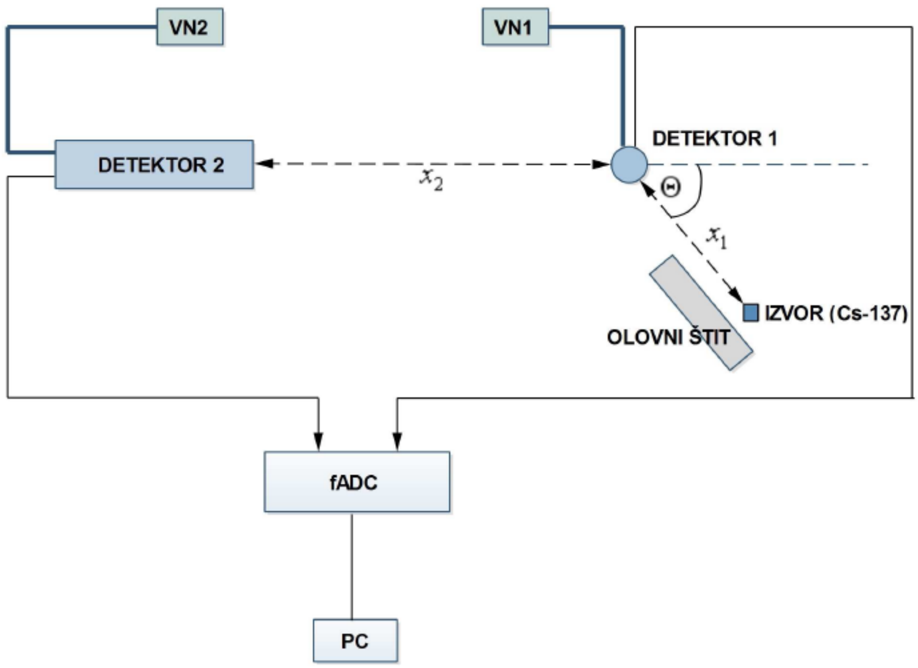

Figure 1: The sheme of the experimental setup.

3 Assignments

1. Set up the experiment according to the given scheme
   (a) Place the detectors and connect the cables
   (b) Turn the NIM crate power switch ON and start the data acquision software
   (c) Place the ^{22}Na test source between the detectors
   (d) Set the voltage on the first detector and monitor signals on the oscilloscope
   (e) Set the voltage on the second detector and monitor signals on the oscilloscope
   (f) Observe coincident signals on the oscilloscope
2. System calibration
   (a) Set the data acquisition to SINGLE mode
   (b) Record the events from the known sources to acquire sufficent statistics for calibration in each detector (sources: ^{60}Co, ^{137}Cs, ^{241}Am, ^{22}Na
   (c) Measure the background spectrum for 30 minutes.
   (d) Determine the calibration curve energy vs. channel using photo-peaks (background subtracted) from the known sources.
   (e) Determine the energy resolution curve for each detector using widths of the photo-peaks of the calibration sources.
3. Measurement
   (a) Set the data acquisition to COINCIDENCE mode
   (b) Place the second detector at the angle of 45 degrees
   (c) Place the ^{137}Cs source in the collimator
   (d) Measure the spectra for 10 minutes and estimate the coincidence data rate.
   (e) Repeat previous steps for the second detector at 90 degrees and 135 degrees.
   (f) Start the measurement and measure appropriate statistics for the three angles.
   (g) Estimate the angular resolution of each detector based on the solid angle coverage.
4. Analysis
   (a) Determine the optimal set of cuts for the anaylsis.
   (b) For each of the three data sets determine: energy of the scattered electron, energy of the scattered photon.

(c) Plot the measured mean energy of the scattered photon vs. mean scattering angle. Plot the associated errors. Compare (overlay) the measured points with the theory values calculated using Klein-Nishina relation.

5. Written report - provide a written report according to the given instructions.