PHGN 326
Experiment 1:

Building and testing of a NaI(Tl) detector

Purpose:

In order to familiarize you with scintillation detectors, in this experiment we want you to put one together and test its important parameters. The basic principles and a construction manual can be found in the handout

Procedure:

1. Select a scintillation crystal and photomultiplier tube (PMT). Check your selection with the instructor.
2. Mount the crystal as described in the handout.
3. We will use two radioactive gamma sources for this experiment: 137-Cs and 60-Co. To get all necessary information about the gamma energies emitted from these nuclei, use the www. Go to **http://nucleardata.nuclear.lu.se/nucleardata/toi**. Print out all the information about these nuclei.
4. Mount the NaI(T1) detector and the 137-Cs source with a distance of app. 30 cm. The center of the source should be on the same height as the center of the detector crystal. Connect the photomultiplier base (base) to the photomultiplier (PM) connector.
5. Connect the high voltage (HV) input of the PM base to the HV output of the HV power supply.
6. Connect the anode output of the PM base to the oscilloscope. Signals visible?
7. Turn on the HV power supply (screw/switch on the back side should be on positive). Try if you see signals turning up the voltage in +lo0 V steps. Maximum + 1000 Volts!!!
8. Take notes of the results and sketch the signals on the oscilloscope at + 1000 V. Rise time, fall time, noise?
9. Using the same HV, have a look at the dynode signal and sketch it. Why different polarity?
10. Return to the anode signal and connect it to the spectroscopy amplifier input. Turn on the power of the NIM bin and check input signal polarity.
11. Connect the oscilloscope to the amplifier output (unipolar). Sketch the signal.
12. Connect the unipolar output with the ADCMCA input and start a measurement. Adjust amplification so that you can clearly see the photo peak in the spectrum. Sketch the spectrum. Check the signal again on the oscilloscope. Voltage of photo peak?
13. Determine the count rate (net) in the photo peak region at your given distance.
14. Check if the l/r^2 law at several distances applies.
15. Another important parameter is the resolution of the detector-system. In order to get this you have to measure the full width half maximum (FWHM) of the photo peak and divide the value you get by the peak position. It should be of the order of 10%.
16. Try several integration (pulse shaping) times at your main amplifier and measure the resolution again.
17. Select the gain at the main amplifier in a way that the gamma rays expected from the 60-Co source will also fit in your MCA spectrum. Print the 137-0 spectrum.
18. Change to the 60-Co source. Measure a spectrum, print and explain the features.
19. Use the known peaks from both sources to compute an energy calibration for these detector and electronics settings.
20. **Start** over again with a different scintillator and photomultipliertube.