Exercise J8 - ^{128}I decay scheme

January 28, 2024

1 Introduction

The goal of this exercise is to produce ^{128}I isotopes using neutron activation of a sample containing ^{127}I, and determination of a ^{128} decay scheme from measured γ radiation. A scintillation detector will be used. The results should be compared with literature data.

2 Required reading

1. Interaction of γ-rays with matter: photoelectric absorption, Compton scattering, pair production ([1]-2.III.A).
2. Beta-decay, energy conditions ([2]-1.3).
3. Radioactive decay law, half-life ([2]-1.11)
4. Principles of operation of scintillation detectors ([1]-8.II, 9.I)
5. Electronic signal processing (preamplifier, amplifier, multichannel analyzer) ([2]-14.1, 14.2, [1]-16.III, 18-III).
6. Energy resolution, energy calibration, efficiency calibration ([1]-4.V, 4.VI)
7. Statistical and systematical uncertainties in radiation measurements ([1]-3.II).
8. Decay schemes ([2]-1.1, 1.3).
9. Pu-Be neutron source, neutron moderation ([1]-1.V).
10. Neutron activation. How does sample activity depend on the time of activation? What is the optimal activation time?

3 Outline

1. Introduction to experimental setup: calibration sources, detectors, HV power supplies, analyzer and computer program.

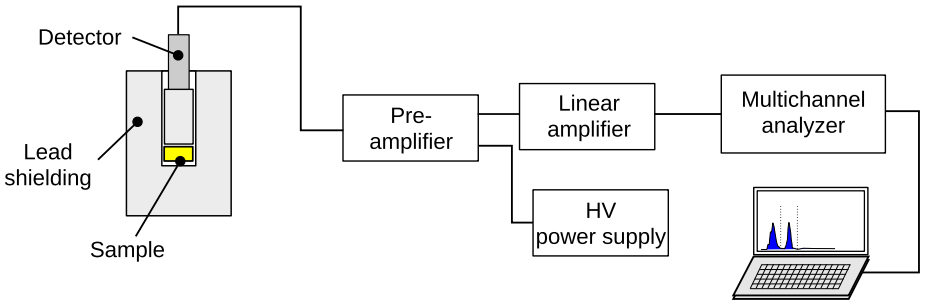

Figure 1: Overview of the experimental setup

2. Determination of measurement conditions, including optimization of detector HV and energy resolution
3. Measurement of standard calibration sources.
4. Measurement of the NaI sample before activation.
5. Activation of the sample in the neutron source.
6. Measurement of the γ spectra for the activate sample. To determine the half-life several spectra must be measured, for each the start time and length of measurement must be written.

4 Data analysis

A laboratory report is a kind of essay, and it should be written with correct spelling and grammar. It should follow logical reasoning, keeping in mind that a person that never done the exercise before, should understand what were the objectives, methods and results.

It should be structured with sections like introduction, methods, results, and conclusions. The introduction should define the purpose of the experiment, put possible hypotheses to be tested, refer to previous studies, and briefly describe the method to be used. The main part, consisting of a more detailed description of the procedure and results, should include figures, and schemes, clearly presented, including labels, legends, units, and other elements. It is not needed to copy textbook knowledge, instead, it is better to select the key information on used methods and equipment and focus on the actual experiment and results. Numerical values should be presented with uncertainties. In the conclusions, one should discuss whether the result confirms expectations or predictions, how it compares to the literature, what is the source of discrepancies, or the main component of uncertainty, if something could be improved, etc.

Main analysis steps

1. Energy calibration of the detector
2. Identification of γ rays from decay of ^{128}I, and their half-lives, and comparison with the known decay scheme.
3. Experimental uncertainty analysis.

4. Comparison of the results with literature data and discussion

References

[1] G. Knoll "Radiation detection and measurement", ed. III or IV, J. Wiley and Sons

[2] C. Leo, "Techniques for Nuclear and Particle Physics Experiments" ed. II, Springer 1994

[3] S. Brandt "Data analysis", ed. IV, Springer 2014

[4] Chart of Nuclides, www.nndc.bnl.gov/nudat3/