OPPA PROJECT: MODERNIZATION OF PRACTICAL EDUCATION OF CTU FNSPE NUCLEAR ENGINEERING STUDENTS – TWO SELECTED EXERCISES

Petr Průša, Ladislav Musílek

The Faculty of Nuclear Sciences and Physical Engineering, Prague

The project under the title OPPA CZ.2.17/3.1.00/36038 “Modernization of Practical Education of CTU FNSPE Nuclear Engineering students” provides an opportunity to innovate existing exercises and set up new experimental exercises. The Department of Dosimetry and Application of Ionising Radiation has prepared or innovated the following exercises: The statistical character of radioactive decay; The anti-Compton spectrometer; n-γ pulse-shape analysis; 60Co-activity measurement by coincidence method; TL dosimetry and radiochromic films; and Time spectrometry as a coincidence substitute. We have selected two exercises for presentation here.The “Statistical character of radioactive decay” exercise demonstrates that the number of decays (or pulses) per unit of time is a random variable following a Poisson distribution. Thanks to MCS (multi-channel scaler) adopted five years ago, students have been able to perform a large number of measurements (10 000), and they obtain results with low statistical uncertainty. Our recent innovation is based on measuring the time between a randomly selected point in time and the arrival of the pulse. This time is also a random variable, but it follows a Pascal distribution. This exercise employs only a time-to-amplitude converter (TAC) and a multi-channel analyser (MCA) and some basic NIM modules. Nevertheless, the results are convincing.The students use a double-source method for GM detector dead-time (τ) measurement. The method is reliable if we assume a low count-rate, and non-cumulative and constant dead-time. However, there is a pedagogical flaw – the method lacks an illustrative nature. The student has to accept that the dead-time exists and is non-cumulative. Believing this, he obtains a system of 4 equations with 4 unknowns. The student calculates τ by solving these equations.We therefore decided to introduce a different method, which is based on time spectrometry. The students measure the time spectrum between two consecutive pulses using a delay line, a TAC, a discriminator, and an MCA. A clearly visible gap can be seen between time 0 and τ in the spectrum. Thus, it is obvious that, after the pulse, the next one cannot be detected for a certain time (τ); it is not just a matter of “believing”. Additionally, we show the students that the assumption of dead time constancy has only limited validity. Finally, the same experimental setup can demonstrate the existence of satellite pulses, if there is imperfect quenching.