EASY WAY OF MEASURE RADIATION

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Abstract: There are easy ways of measure radiation by the amateur measuring methods using easily obtainable components. Similar results can be achieved as compared with the commercial and expensive measuring systems. This paper deals with these methods and gives the guidance for their implementation and possible application by using free software.

Keywords: Radiation, Dosimeter, Geiger, Scintillation Detector, Photomultiplier

1. INTRODUCTION

In practice, we are normally interested in measuring of radiation dose by dosimeters or instantaneous values of radiation by intensimeter systems. In addition to the quantitative measurement of particle radiation is necessary to know energy of particles and thereby determine the specific radioisotope. For this purpose are used scintillation detectors.

2. DOSIMETRIC MEASUREMENTS

Dosimeters measure exposure to radiated energy. The ionizing radiation is cumulative for human body, so the damage is related to the total dose received. The unit of ionizing radiation dose is Sv, witch is equal to biological effect of the specific radiation. The dosimeters are based on chemical, luminescent, quartz or electrical principles. The dosimeters based on the electrical principle are better for accurate measurements and especially for measurement using computer technology.

Figure 1: Dosimetric Measurement System

Most of them are based on the Geiger-Muller counter, which is a particle detector. The low pressure gas inside the counter tube is ionized by alpha, beta particles or gamma rays. The counter tube is equipped with two electrodes, which are connected to high voltage source. The current pulses are created by the short-term changes of conductivity of counter tube gas. These pulses are amplified by the amplifier. The output can be connected to an electronic counter or otherwise processed. The interesting variant is use of the computer and ordinary sound card as an analog input. The sampling frequency a sensitivity of the sound card input is sufficient for this purpose. Dosimetric measurement can be carry out by the specific software. The advantage are adjusting various parameters of measurement, the possibilities to record and the measurement of the instantaneous values – intensity of radiation in Sv/h. The example of dosimeter with the Russian Geiger-Muller tube СБМ-19 is depicted in Figure 1.

The measuring system is consisted of the probe in aluminum tube and the source of 450 VDC. The current pulses from probe are transformed into voltage pulses that can be reproduced by the piezo speaker, blink of the LED or imported to the sound card of computer. In the case of using the sound card is convenient to use one of the available free software for processing the measured data. The best option is the free software pack created by Italian scientists – Theremino. At first it is necessary to unify the input signal by the AudioInput software. The print screen of the GUI of AudioInput software is shown in Figure 2.

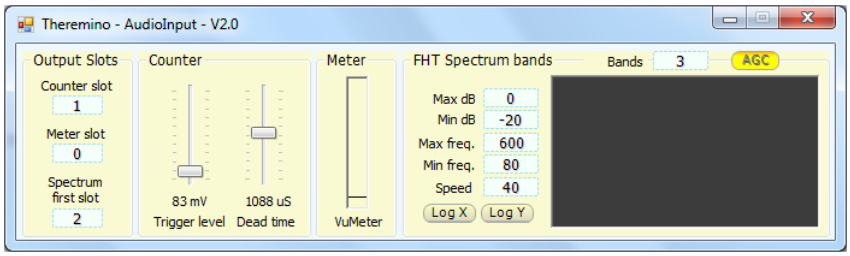

Figure 2: Theremino AudioInput Software

The trigger level and dead time of the input signal can be set. This modified signal is further processed with Theremino Geiger software. The sample of the graphic interface of this software is shown in Figure 3. The specific type of Geiger tube may be chosen and there can be set the correction coefficients for calibration and accurate measurement. The mean value of the radiation dose may be represented in the graph or instantaneous values of intensity in Sv/h can be calculated and shown in "measuring device".

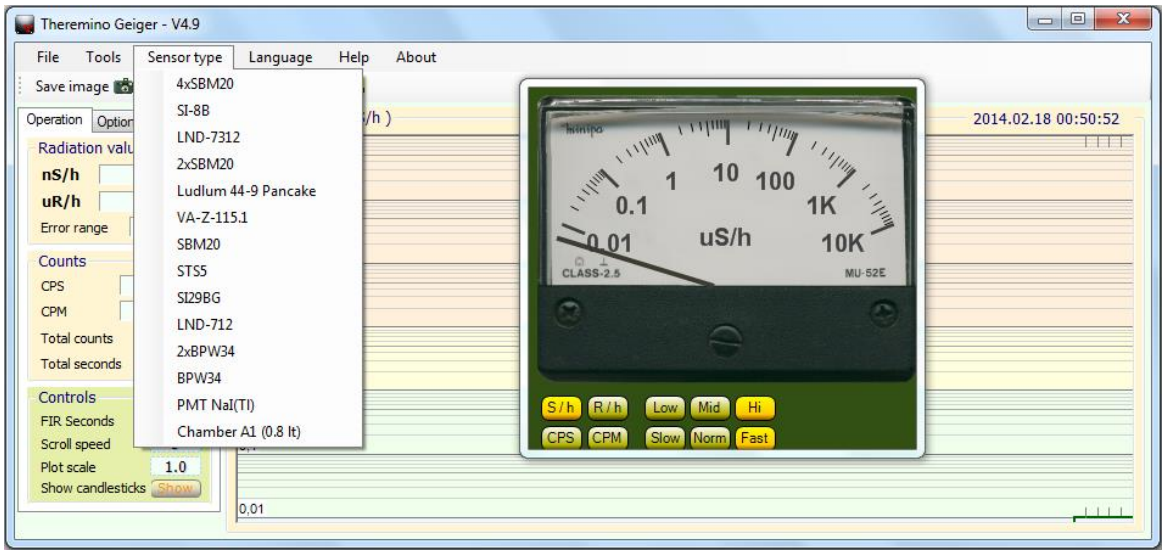

Figure 3: Theremino Geiger Software

Another dosimeter with integrated impulse counter was created as a stand-alone unit for measuring radiation. Using the Geiger tube is Philips 18504 type, which can also measure alpha particles. The counter of dosimeter can be incremented up to value 999,999. So this dosimeter can be used for long-term measurements of background radiation or high levels of radiation. The dosimeter is created in a compact laboratory design and is powered via the USB port or external 5 VDC supply unit. And photography of form is depicted in Figure 4. The output signal of impulses can be provided in analog form for the sound card input or in digital interface RS-232.

Figure 4: Dosimeter with Integrated Impulse Counter

3. SCINTILLATION DETECTORS

Number of individual particles and also their energy can be measurement by the scintillation detectors. Radiation dose is determined by the number of detected particles. Specific radioisotope may be designated from the measured spectrum of energies detected particles. Only detection of gamma particles (gamma-ray spectroscopy) and some high-energy beta particles are the major disadvantage of this measuring principle.

Figure 5: Scintillation Detector with Photomultiplier

The very principle of this method is based on the creation of a short flash of light or UV radiation when the particles pass through the mass of scintillation detector. The accuracy and sensitivity of measurement is dependent on the volume of the detector. Currently detector materials are made from organic or inorganic materials. An example can be organic crystals from aromatic hydrocarbons, organic liquids, plastic and inorganic crystals – most often activate alkali metal halides. In the case of our detector is used small crystal of sodium iodide (NaI) activated by cesium. The short flash generated in the crystal is represented by only one or a few photons. For the detection and measurement is required this flash convert to measurable current. The only one device that allows this conversion is the photomultiplier, which is vacuum tube with photocathode using the photoelectric effect. The secondary released electrons from the photocathode sequentially fall to the next dynode of different voltage potential. The gain of each dynode of our photomultiplier ФЭУ-74А is approximately 10 and in the photomultiplier is placed 11 dynodes. So when the impact of photons on the photocathode is caught, the output of photomultiplier provides the current pulse of several to tens of nA. This current impulse is amplified using the operation amplifier and further processed, for example by the sound card of computer. The accelerating voltage for the photomultiplier tube is chosen so that each dynode potential is from 100 to 150 V. Thus, the result accelerating voltage is selected at 1.500 V and with a very high level of stabilization (ripple maximum 1 V). The detection crystal, photomultiplier and the total design solution in the aluminum tube is shown in Figure 5.

The MCA free software again made by Theremino is used for the measurement of individual pulses and spectrum of energies of detected particles. The sound card is used as the analog to digital converter. The pulses are analyzed by the software and by the peak value is assigned energy. For the correct operation of software is necessary to calibrate measured energies with the known radioisotopes. The sample of MCA software GUI with measured spectrum of the radioisotope Cesium-137 is depicted in Figure 6.

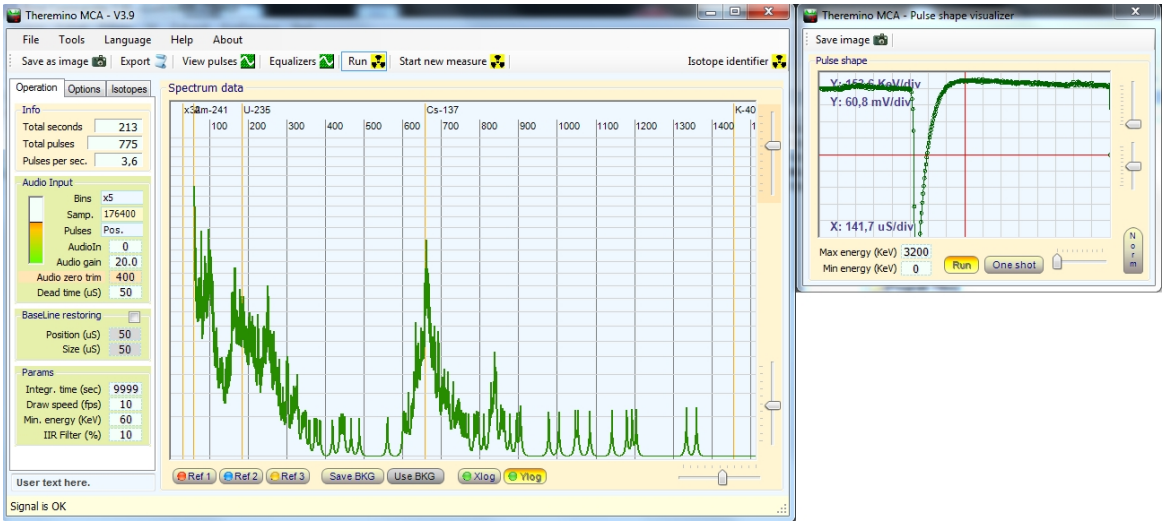

Figure 6: Theremino MCA Software with measured energy spectrum of Cs-137

4. CONCLUSION

The paper describes interesting methods to measure of radiation dose and energies of particles by the easily obtainable components (Aukro.cz, Ebay.com etc). The free Theremino software contains source code, so it can be adapted to the needs of the user.

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