Modelling of the Setup for Carbon Analysis of Soil Sample

A.V. Andreev[1,2*], and TANGRA Collaboration

[1]*Joint Institute for Nuclear Research (JINR), Dubna, Russia*

[2]*Faculty of Physics, Lomonosov Moscow State University (MSU), Moscow, Russia*

* *Corresponding author email:andreev.av20@physics.msu.ru*

Accurate determining the concentration of carbon in soil today remains an important task for various fields of science. The special role of soil in food production, as well as its participation in regulating the chemical composition of the atmosphere, makes it necessary to research it. Chemical methods are commonly used to determine carbon concentration in soil, but they require specific preparations. Nowadays, nuclear physics offers new methods of soil research, based on so-called neutron gamma analysis. This method involves irradiating the material with neutrons and measuring the characteristic gamma peaks' energies for a particular isotope. By the area of gamma peaks, it is possible to determine the amount of a substance in a sample.

There are two different types of typical system for neutron gamma analysis: mobile setup [1], which can move on field collecting data and stationary setup researching a specimen of material[2]. These configurations consist of a neutron source, a gamma detector (detectors), electronics, and a data acquisition system.

When substances are irradiated with neutrons with the energy of 14 MeV, characteristic gamma peaks occur. The gamma spectrum provides information about the chemical composition of the substance. To determine carbon, a peak corresponding to neutron inelastic scattering on ^{12}C with energy of 4440 keV is used.

Calculations of the spectra and installation simulation are done in the Geant4, a toolkit that models the passage of elementary particles through matter using the Monte Carlo method, developed at CERN.[3] Modelled spectra in Geant4 sometimes demonstrate notable deviation from the experimental data. However, this issue can be resolved by separately modeling neutron transport and generating gamma-quantum. This work involves computer modelling of the setup for carbon analysis of soil sample in toolkit Geant4.

1. A. Kavetskiy, G. Yakubova, S. A. Prior et al. //Applied Radiation and Isotopes.–2019.– Vol. 150.–P. 127-134.
2. E.A. Razinkov, V.Y. Aleksakhin, Yu.N. Rogov et al.// Mining Journal.– 2022. No. 2. –P. 51-56.
3. Geant4 v. 10.01, p. 2. https://geant4.web.cern.ch/support/download_archive?page=3.