**Low-background, digital gamma-rays spectrometer with active shield equipped with beta plastic scintillation detector – a system for the simultaneous detection of gamma and beta radiation emitters and cosmic rays**

**Mietelski Jerzy Wojciech,1 Kierepko Renata,1,\* Gorzkiewicz Krzysztof, Wójcik Gargula Anna,1 Błażej Sylwia1**

*1Institute of Nuclear Physics Polish Academy of Sciences, ul. Radzikowskiego 152, 31-342 Krakow, Poland*

\* *e-mail: renata.kierepko@ifj.edu.pl*

In various fields of science, industry, and medicine, researchers aim for analyses that yield the most detailed knowledge about the subjects they study. The most desirable analyses are non-destructive, allowing for measurement planning based on the acquired results. Such methods are invaluable in emergencies or when studying extremely valuable and unique material samples, such as meteorites and historical artifacts.

In 2018, at the Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN) a low-background digital gamma-ray spectrometer equipped with a Broad Energy Germanium (BEGe) detector (by Canberra, USA), a multi-layer passive shield and five large plastic scintillators (by Scionix, The Netherlands) as a cosmic veto system was developed. The system is used for detecting gamma emitters, as well as muon flux registration [1, 2, 3]. Data acquisition is conducted using the CAEN DT5725 digitizer with CoMPASS software, while off-line analysis is performed with specially developed code, VETO [1]. In 2024, the additional small scintillation detector (model number: 20BM100/0.75-E2-EJ200-X, by Scionix) was installed inside the passive shield and integrated with the system as the seventh detector. The measured sample is located between this scintillation detector and the BEGe detector. Due to the event-by-event registration with time resolution of 5 ns this system allows for off-line analyses of any logical condition between the detectors, in particular to study the simultaneous detection of gamma quanta and beta particles. It also allows to investigate delays between signal registrations in different detectors, providing insights into nuclear source processes. Furthermore, the addition of the scintillation detector improved the efficiency of the active shield. Performed tests indicated that the new system (consists of 6 scintillation detectors) reduced the background count rate from 1.43 cps to 0.85 cps, representing a reduction of 40.4% across the entire spectrum. The contribution of the beta detector was estimated to be at 7.4%.

The preliminary results obtained from the newly developed system in the context of environmental samples as well as both the advantages and disadvantages of the approach taken will be presented.

This work has been partially carried out within the framework of the EUROfusion Consortium, funded by the European Union via the Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion) and in the framework of the international project co-financed by the Polish Ministry of Education and Science, as program "PMW", contracts 5235/HEU - EURATOM/2022/2 and 5253/HEU-EURATOM/2022/2.

1. J. Radioanal. Nucl. Ch., 322 (2019) 1311–1321, doi: [10.1007/s10967-019-06853-7](http://dx.doi.org/10.1007/s10967-019-06853-7)
2. J. Radioanal. Nucl. Ch., 333 (2024) 3529-3539, doi: [10.1007/s10967-024-09412-x](http://dx.doi.org/10.1007/s10967-024-09412-x)
3. Appl. Sci., 11 (2021) 7916, doi: [10.3390/app11177916](http://dx.doi.org/10.3390/app11177916)