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In-field Detection and Analysis of α Radiation

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Alpha-particle-emitting nuclides are very radiotoxic if inhaled or ingested. The short range of alpha particles in air (a few cm) makes the non-destructive screening of alpha emitters at a crime scene difficult and time consuming. The same limitation in range is also present in the alpha-particle screening of collected evidences in a forensic laboratory.

The thermalization of alpha particles in air, and the subsequent excitation of air molecules, produces UV-light that can be detected over long distances. Therefore, compared to the current state-of-the-art screening methods, UV-imaging is a significant step forward for alpha-particle screening in forensics [1]. Further characterization of alpha particle emitting radionuclides causing the UV-light can be continued with a position-sensitive UV-gated gamma-spectrometry technique, jointly developed by STUK and the Technical University of Tampere, Finland [2, 3].

An additional advantage related to these new techniques is that the UV-light penetrates several materials, including many plastics. Therefore, these techniques allow, for example, the analysis of samples without removing them from their sealed plastic bags, i.e. without jeopardizing the integrity of the collected samples. In conclusion, UV-based methods for remote detection and analysis of alpha-particle emitting radionuclides have the potential to both speed up the crime scene investigation and increase the safety of the personnel.

In UV imaging, the research emphasis lays on extending the image area and improving the tolerance to external lighting. Namely there are also other sources of UV light, which are often overwhelming. Our sun, for example, prevents the straightforward measurements in day light. Approach to reduce the sensitivity to the background lighting is based on restricting UV imaging to the wave lengths covering only the main peaks of nitrogen (310-390 nm). Another research line investigates the possibility to apply the so-called solar-blind part of the spectrum (240-280 nm) for imaging. Namely, atmospheric ozone absorbs radiation within this band, preventing it to reach the surface of the earth. Automated panorama imaging is studied for extending the image area.

Earlier studies employing HPGe gamma-ray detectors have proved the superiority of the UV-gamma-coincidence technique for the analysis of low-activity samples [2, 3]. In the future, liquid nitrogen or electrically cooled HPGe detector will be replaced with a fast scintillator detector that is capable to operate in room temperature. This development will improve detection capability by reducing the random coincidence rate, and it makes the UV-gamma coincidence technique more user-friendly to operate in the field.

The UV-based measurement techniques will be developed in Finland using standard calibration sources. Validation of the techniques will be made at the Institute for Transuranium Elements (JRC-ITU) using nuclear-security relevant sources not available in Finland, such as plutonium and MOX fuel.

The above described work will be carried in two EU funded projects (GIFT and MetroDECOM).

References:

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