EDUCATIONAL BENEFITS OF EUROPEAN UNION PROJECTS

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Horizon, EMPIR 2020 19ENV02 RemoteAlpha project. Partners

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Research & Innovation / Search Research Projects

Remote and real-time optical detection of alpha-emitting radionuclides in the environment

Short Name: RemoteALPHA, Project Number: 19ENV02

Man in protective workwear

COORDINATOR
Faton Krasniqi (PTB)

PARTICIPATING EURAMET NMIS AND DIS
- BFKH (Hungary)
- IFIN-HH (Romania)
- PTB (Germany)

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Gottfried Wilhelm Leibniz Universität Hannover (Germany)
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INFORMATION

PROGRAMME
EMPIR

FIELD
Environment

STATUS
in progress

CALL
2019

DURATION
2020-2023

https://www.euramet.org/research-innovation/search-research-projects/details/project/remote-and-real-time-optical-detection-of-alpha-emitting-radionuclides-in-the-environment/

IFIN-HH | RemoteALPHA | EMPIR EURAMET

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

Remote and real-time optical detection of alpha-emitting radionuclides in the environment

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PTB
Physikalisch-Technische Bundesanstalt

KORMÁNYHIVATALOK
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UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH
Universitat Politècnica de Catalunya

SZENT ISTVÁN UNIVERSITY
Szent István University

https://remotealpha.drmr.nipne.ro/

MATE HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES

This project 19ENV02 RemoteALPHA has received funding from the EMPIR programme co-financed by the Participating States and from the European Union's Horizon 2020 research and innovation programme.

Need for novel-type detection system for alpha emitters

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- Attacks on nuclear power plants
- deployment of the dirty bomb (have a shocking effect on public opinion.)
- previous serious reactor accidents (Chernobyl, Fukushima)

„…Due to the short range of alpha particles, traditional detectors which require direct interaction with the alpha particles must be used in very close proximity to a contaminated surface, around 1 cm…”

Crompton et al (2018), Sensors, 18, 1015; doi:10.3390/s18041015

A detection system to measure large-scale contamination of these radionuclides is currently not available

(Publishable Summary for 19ENV02 RemoteAlpha)

Objectives: details and *results* of the project are in Publishable Summary)

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- Two types of stand-off detection methods:

- Alpha- radioluminescence technique – a novel type optical detection method by modular mirror system, lens, photomultipliers (PMT), filters , CCD cameras. This is a passive methode

- The active, complementer method based on laser-induced fluorescence (LIF): Feasibility study

- To develop and establish a calibration system for the novel-type radioluminescence detector systems.

- To extend the optical detection system to an imaging functionality for mapping of alpha contaminations in the environment. Tripod, unmanned airborne monitoring system (UAMS) that will integrate the unmanned aerial vehicle (UAV)

https://www.euramet.org/research-innovation/search-research projects/details?tx_eurametctcp_project%5Bproject%5D=1687&cHash=c8e79ec377e929c4b2f6a6360dbc0968

•Publishable Summary Publishable Summary Remote and real-time optical detection of alpha-emitting radionuclides in the environment (19ENV02), Call 2019 0.22 MB

Alpha-radioluminescence phenomenon, its spectrum and measuring technique

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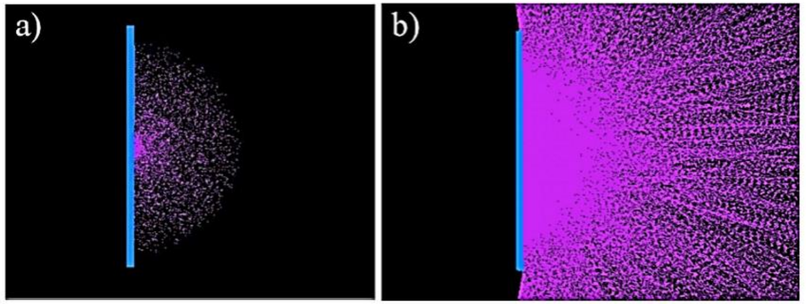
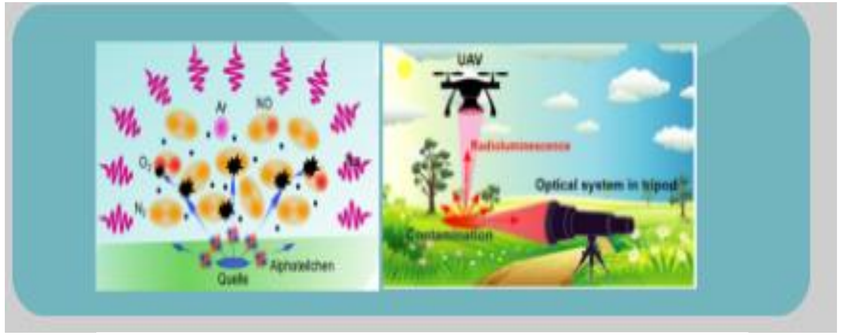


Figure 3. Model of: (**a**) Radioluminescence photons induced by alpha particles showing the hemisphere in which they are initially created by the alpha particles; (**b**) Showing the random directions in which the photons are emitted from the hemisphere in (**a**) and their longer path length—Using FRED Optical Engineering Software (Photon Engineering LLC) [11]. Reprinted with permission from the author.



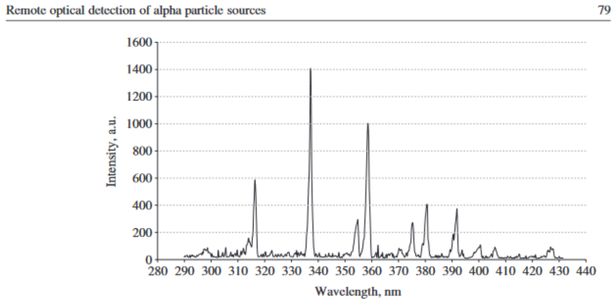
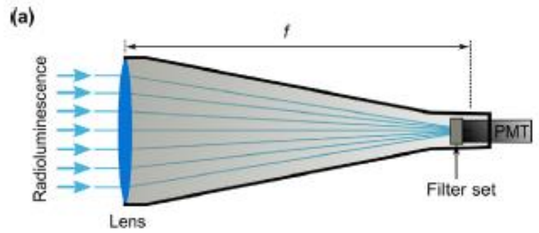
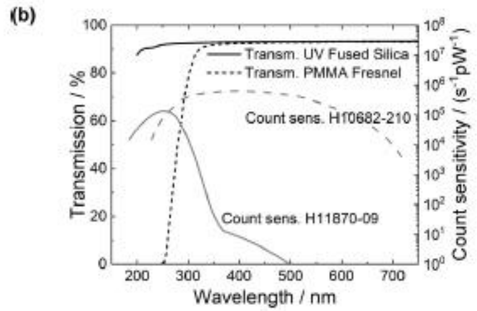


Figure 3. The optical spectrum of atmosphere alpha-radioluminescence under standard conditions.

M. Luchkov, V. Dangendorf, U. Giesen et al.





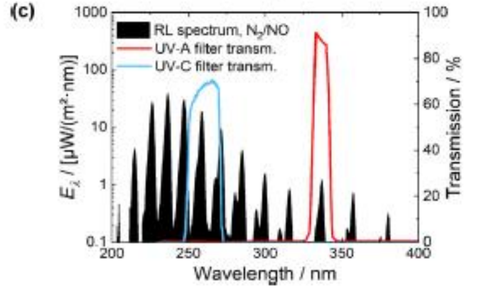
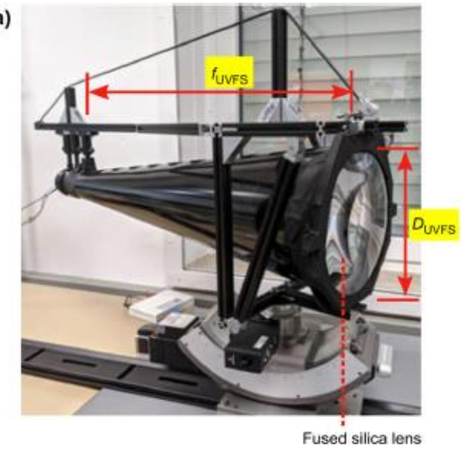


Fig. 2. (a) Schematic drawing of optical systems developed in the framework of RemoteALPHA project. Both, the UVFS- and PMMA Fresnel-lens systems share the same configuration: they utilize large receiving optics to maximize the geometrical factor, and the focal lengths have been chosen such that the radioluminescence image is not blurred substantially by the overlapping FOVs between adjacent scanning points. (b) Transmittance spectra of UVFS [22] and PMMA [23] together with the PMT count sensitivity [24,25] specified by the manufacturer. (c) Radioluminescence emission spectrum of NO measured at the PIAF at a nominal alpha particle rate of about $30 \times 10^6\,s^{-1}$ with a PTB-calibrated array spectroradiometer with UV-C and UV-A filter transmission [26,27]. The flow rate of N_2+NO was set at 2400 mL·min^{-1} with NO concentration of 5 μL·L^{-1}.

Nuclear Inst. and Methods in Physics Research, A 1047 (2023) 167895



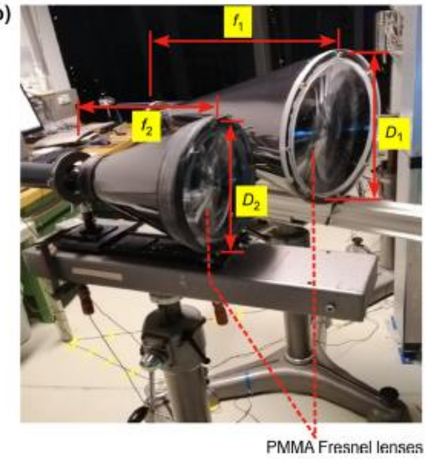


Fig. 3. Lens-based radioluminescence detection setups. (a) Fused silica lens (Abet Technologies) system mounted on a goniometer and rotation stage (Newport M-BGM160PE and RVS80CC) with D_{UVFS} = 240 mm and f_{UVFS} between 572 mm to 599 mm in a wavelength range from 236 nm to 285 nm, respectively. (b) PMMA Fresnel lens systems with lenses (Orafol Fresnel Optics) having diameters D_1 = 452.9 mm (SC 2045) and D_2 = 257.6 mm (SC 210), and nominal focal lengths f_1 = 391.5 mm and f_2 = 225.5 mm at 546 nm. All lens systems can be coupled to Hamamatsu PMTs (H10682-210 for UV-A spectral range and H11870-09 for UV-C spectral range) and UV-C filters (FR01-260/16-25, Semrock Inc.) or UV-A filters (337 nm, 10 nm band-pass filters from Edmund Optics).

MATE's participation in the project

As a consortium partner MATE *with collaboration IDEAS Science Ltd.(managing director Dr. Györgyi Bela)*

- is currently developing on-line curriculum which can be used in BSc and MSc level university education,
- this curriculum can also be integrated into the training system of CBRN specialists, persons responsible for nuclear medicine technologies, radiation safety officers, environmental protection and waste management officers too.
- the topic of the project was simultaneously introduced into the MATE education system, and the educational experiences gained in teaching the related subject will also be taken into account in the development of the above-mentioned on-line course material.

(extracting from slide of 28th WORKSHOP ON ENERGY AND ENVIRONMENT, December 8-9, 2022, Gödöllő, Hungary)

-Partecipation in measuring campaign: Bucharest, IFIN-HH (Horia Hulubei National Institute, Romania, 2023. februar) *with collaboration Crydet Ltd. (managing director Zoltán Csiki)*

- dissemination at leader hungarian institutes: Wigner Research Center for Physics, ELI-ALPS Reseach Institute

High-quality technological solutions and consulting services for environmental and security problems.

Manufacture of scintillation crystals and detectors

Educational benefits

Deeper physical foundation on

- alpha radiation (penetration depth in mediums, Bragg-Kleeman –rule, linear energy transfer (LET), the Bragg-curve, computation in Bethe-Bloch formula, measuring methods by conventional detectors: GM-tubes,

- Molecular spectroscopy of diatomic molecules (rotational, vibrational states, infrared spectroscopy, Raman spectroscopy, electronic states associated with angular momentum, indicatings, electronic selection rules, the Franck-Condon principles, quantum mechanical basics, fluorescence and Raman scatterings

- The radioluminescence measuring methods, the so-called First Positive Group of Nitrogen and the Second Negative Group of N2+ ions, optical imaging systems, the lens-PMT, filter-CCD camera systems

Conclusion

The teaching of the subject provides an excellent opportunity to broaden physics education with which the principles of spectroscopy and molecular spectroscopy in particular, as well as the teaching the methods of the fundamentals of quantum mechanics, can become attractive and important for engineering students (extracting from slide of 28th WORKSHOP ON ENERGY AND ENVIRONMENT, December 8-9, 2022, Gödöllő, Hungary)

Thank You for your kind attention!