AN INNOVATIVE TRAINING SOLUTION FOR RADIATION PREPAREDNESS

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28th WORKSHOP ON ENERGY AND ENVIRONMENT

December 8-9, 2022, Gödöllő, Hungary

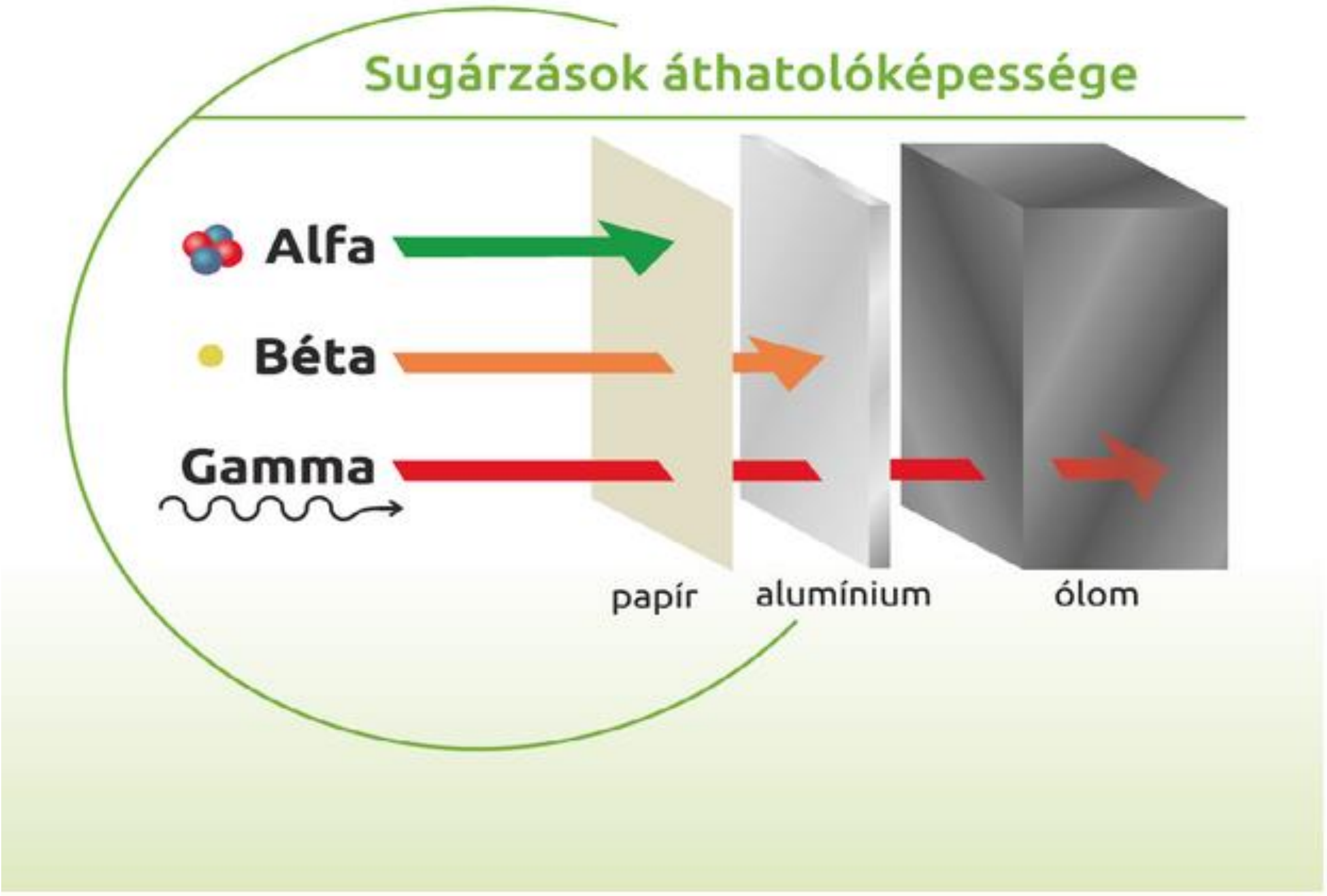
MATE
MAGYAR AGRÁR- ÉS ÉLETTUDOMÁNYI EGYETEM

Attention on the remote measurability of radioactive materials

- Attacks on nuclear power plants
- deployment of the dirty bomb (have a shocking effect on public opinion.)
- previous serious reactor accidents (Chernobyl, Fukushima)
- Malfunctions (for example Paks: April 10-11. 2003: 30 fuel cartridges were damaged (Hamvas,I.(2007) https://slideplayer.hu/slide/11252168/

Sükösd Csaba: https://slideplayer.hu/slide/2089781/

Problems and need of the remote measurability of alpha –emitting radiactive materials



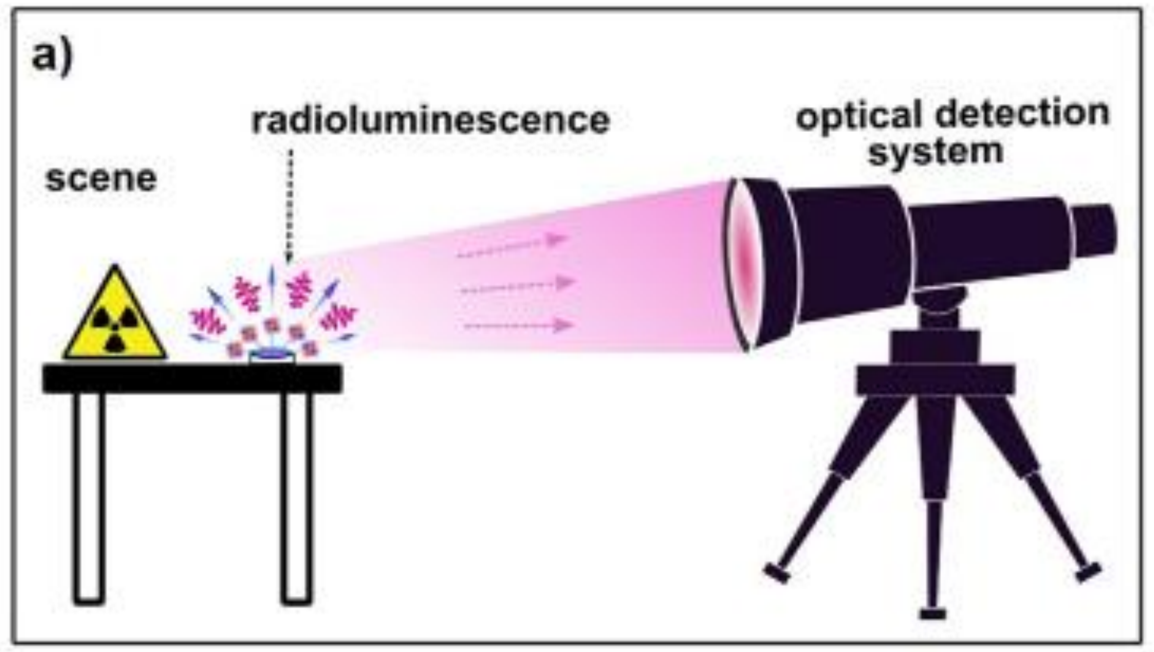
https://rhk.hu/sugarvedelem

Penetration of radioactive radiation (sheet of paper, aluminum and lead)

- The range of alpha radiation in air is only a few cm.
- Their outdoor remote detection is not possible with traditional detectors,
- Direct contact with the source is necessary
- „…Alpha particles represent the biggest risk to soft biological tissues compared to all nuclear decay products due to their high energy, large mass and high linear energy transfer….” (Puslishable Summary https://www.euramet.org/research-innovation/search-research-projects/details/project/remote-and-real-time-optical-detection-of-alpha-emitting-radionuclides-in-the-environment/
- Currently, there is no suitable measuring system available for the detection of large-scale area pollution of alpha emitting materials.

A possible way to measure remotally alpha active materials by radioluminescence (Baschenko, S. 2004 J. Radiol. Prot. 24 75)

Nuclear Inst. and Methods in Physics Research, A 987 (2021) 164821



Remote optical detection of alpha particle sources 77

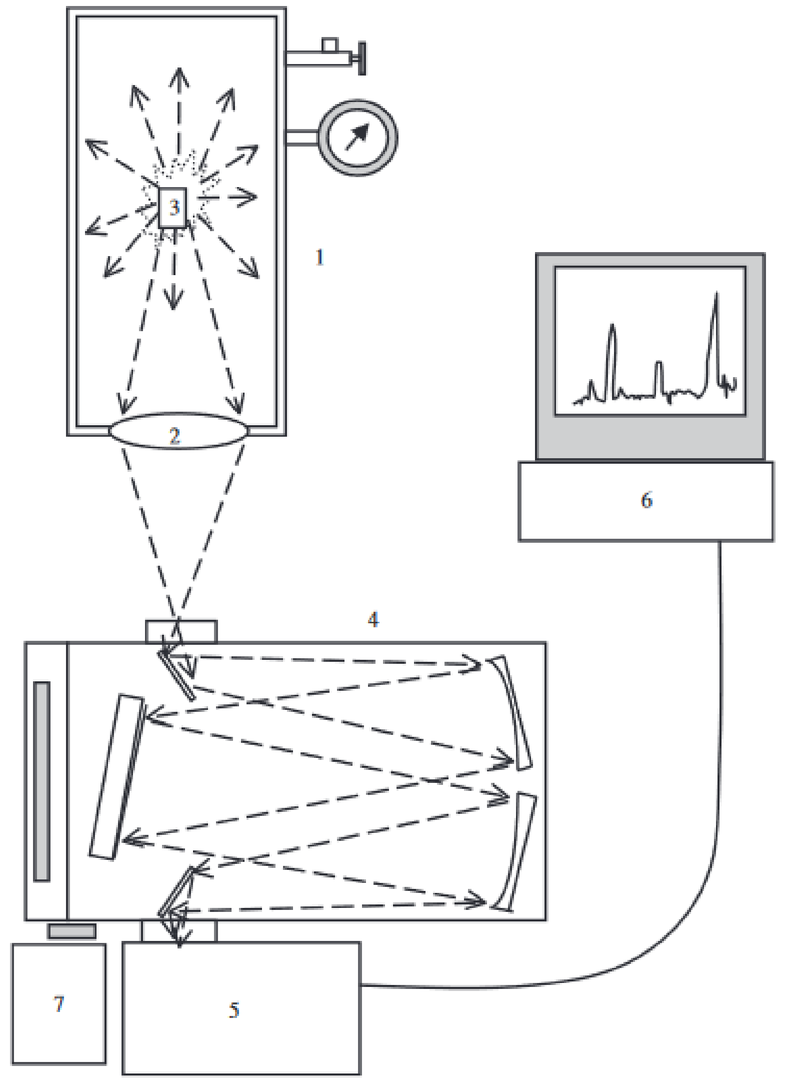


Figure 1. The scheme of the experimental set-up for the atmosphere alpha-radioluminescence phenomenon spectral investigation: 1—chamber diameter 400 × 1500 mm^3; 2—window-lens diameter 200 mm, $F = 500$ mm; 3—alpha particle source; 4—monochromator; 5—photodetector; 6—PC; 7—stepping motor.

Remote optical detection of alpha particle sources 79

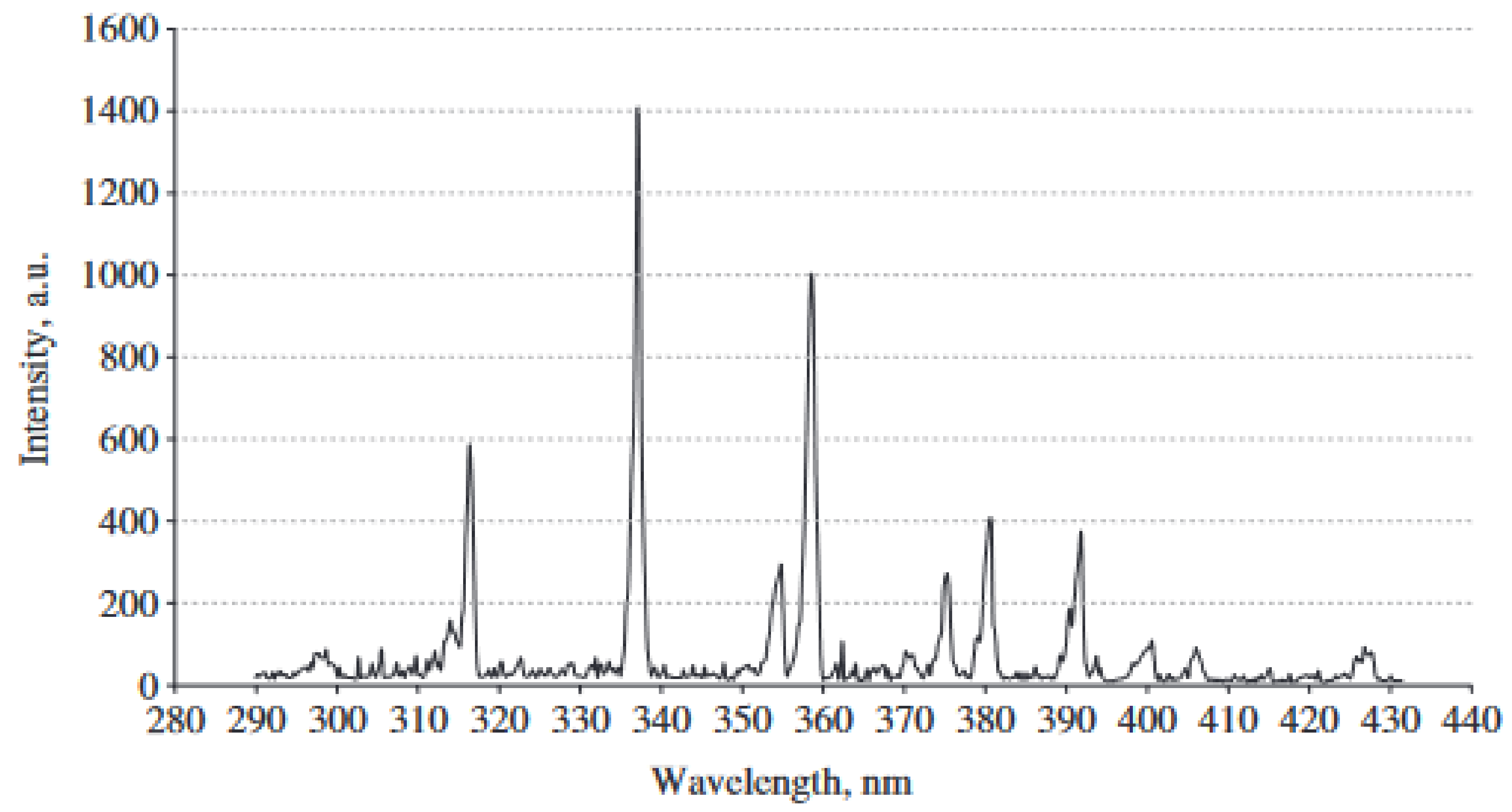


Figure 3. The optical spectrum of atmosphere alpha-radioluminescence under standard conditions.

Figure up: Krasniqi et al (2021): Standoff UV-C imaging of alpha particle emitters Nuclear Inst. In Physics Research A

A collaborative work between 8 EU institutions: EMPIR 2020 19ENV02 „RemoteAlpha” project

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

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)

OTHER PARTICIPANTS

Alfa Rift Oy (Finland)
Gottfried Wilhelm Leibniz Universität Hannover (Germany)
Szent István University (Hungary)
Tampereen korkeakoulusäätiö sr (Finland)
Universitat Politècnica de Catalunya (Spain)

INFORMATION

PROGRAMME
EMPIR

FIELD
Environment

STATUS
in progress

CALL
2019

DURATION
2020-2023

- To develop a new method and instrumentation for the optical detection of alpha particle emitters in
the environment by air radioluminescence a detection range of more than two metres.
- 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.
- To prepare and run a feasibility study for a laser-induced fluorescence spectroscopic method for the detection of alpha emitters.
- To facilitate the take up of the results by stakeholders and provide input to relevant standardisation
bodies and radiation protection authorities
- (Extracting from Publishable Summary)

Poster on IRPA Congress, 2022.

6th European Congress on Radiation Protection
30 May – 3 June 2022
Budapest Congress Centre
Budapest, Hungary

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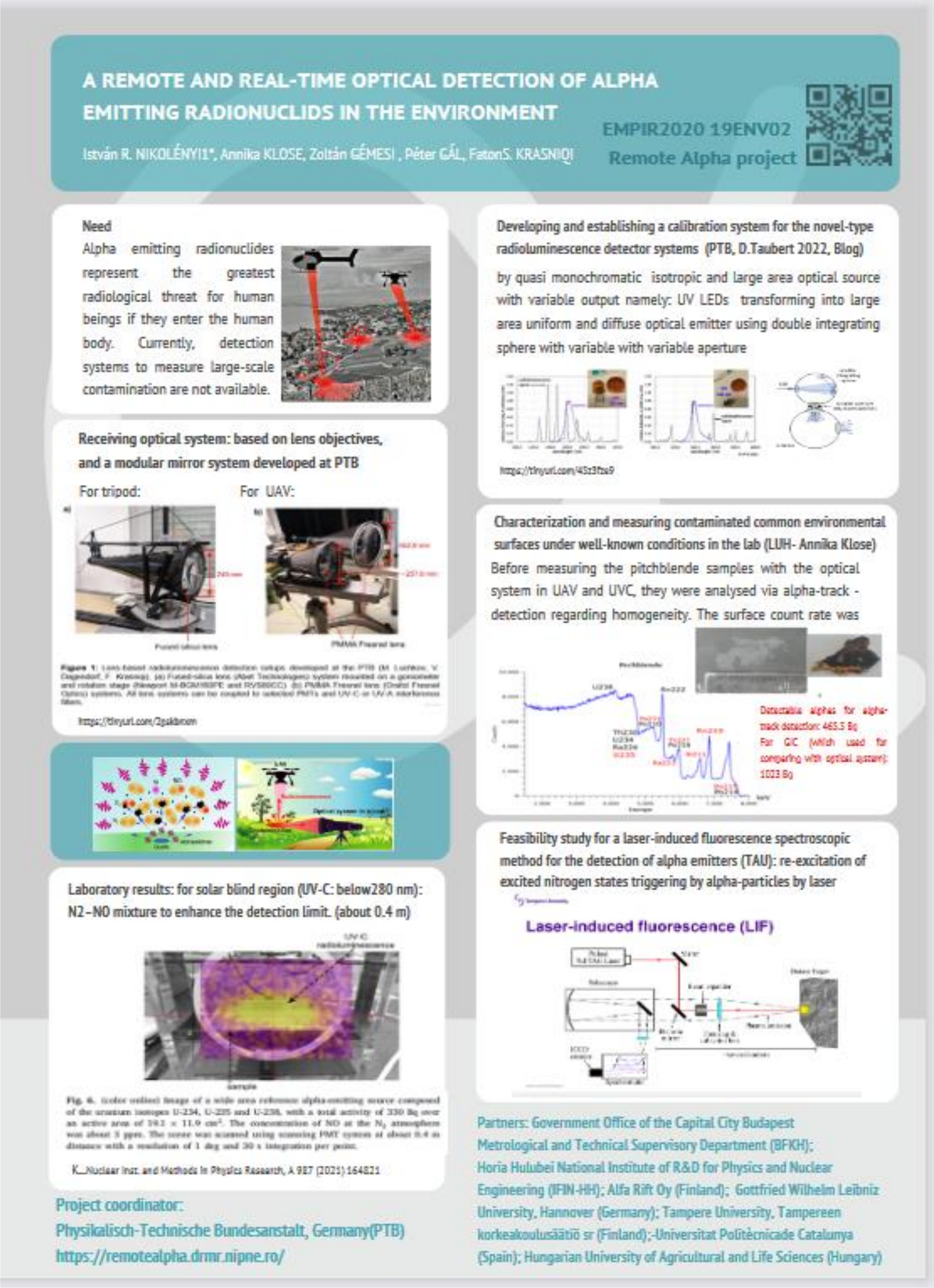
A REMOTE AND REAL-TIME OPTICAL DETECTION OF ALPHA EMITTING RADIONUCLIDS IN THE ENVIRONMENT

EMPIR2020 19ENV02
Remote Alpha project

István R. NIKOLÉNYI1*, Annika KLOSE, Zoltán GÉMESI , Péter GÁL, FatonS. KRASNIQI

Need
Alpha emitting radionuclides represent the greatest radiological threat for human beings if they enter the human body. Currently, detection systems to measure large-scale contamination are not available.

Receiving optical system: based on lens objectives, and a modular mirror system developed at PTB
For tripod: For UAV:

https://tinyurl.com/2gakbxem

Laboratory results: for solar blind region (UV-C: below280 nm): N2–NO mixture to enhance the detection limit. (about 0.4 m)

Developing and establishing a calibration system for the novel-type radioluminescence detector systems (PTB, D.Taubert 2022, Blog)
by quasi monochromatic isotropic and large area optical source with variable output namely: UV LEDs transforming into large area uniform and diffuse optical emitter using double integrating sphere with variable with variable aperture

Characterization and measuring contaminated common environmental surfaces under well-known conditions in the lab (LUH- Annika Klose)
Before measuring the pitchblende samples with the optical system in UAV and UVC, they were analysed via alpha-track - detection regarding homogeneity. The surface count rate was

Feasibility study for a laser-induced fluorescence spectroscopic method for the detection of alpha emitters (TAU): re-excitation of excited nitrogen states triggering by alpha-particles by laser

Laser-induced fluorescence (LIF)

Project coordinator:
Physikalisch-Technische Bundesanstalt, Germany(PTB)
https://remotealpha.drmr.nipne.ro/

Partners: Government Office of the Capital City Budapest Metrological and Technical Supervisory Department (BFKH); Horia Hulubei National Institute of R&D for Physics and Nuclear Engineering (IFIN-HH); Alfa Rift Oy (Finland); Gottfried Wilhelm Leibniz University, Hannover (Germany); Tampere University, Tampereen korkeakoulusäätiö sr (Finland);-Universitat Politècnicade Catalunya (Spain); Hungarian University of Agricultural and Life Sciences (Hungary)

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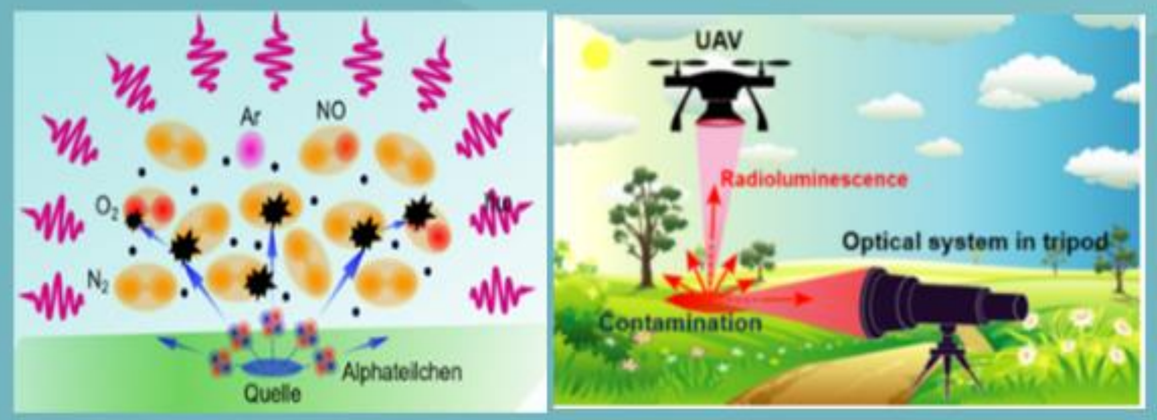

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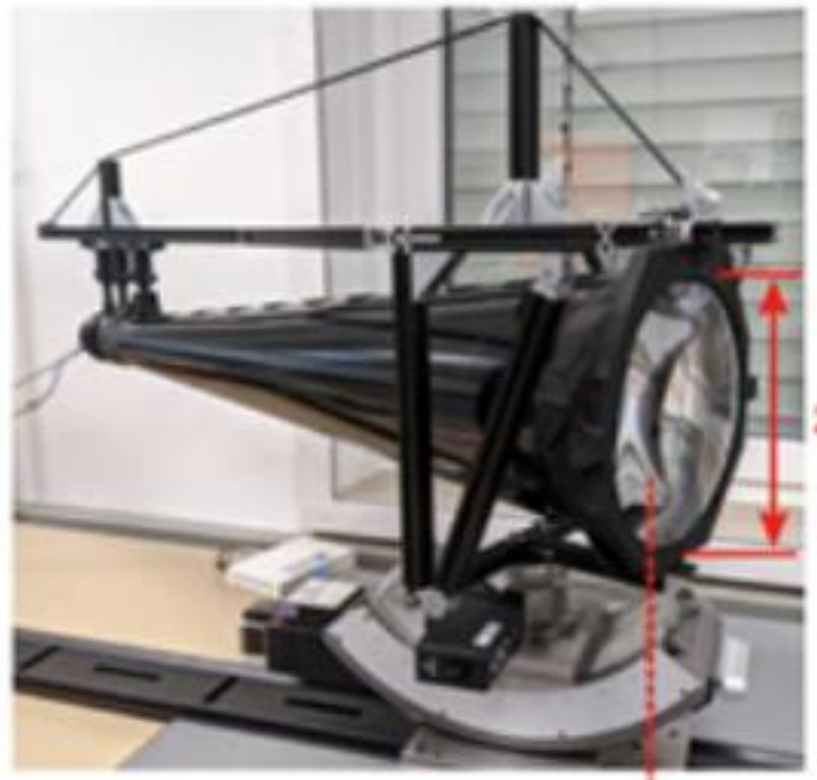

b)

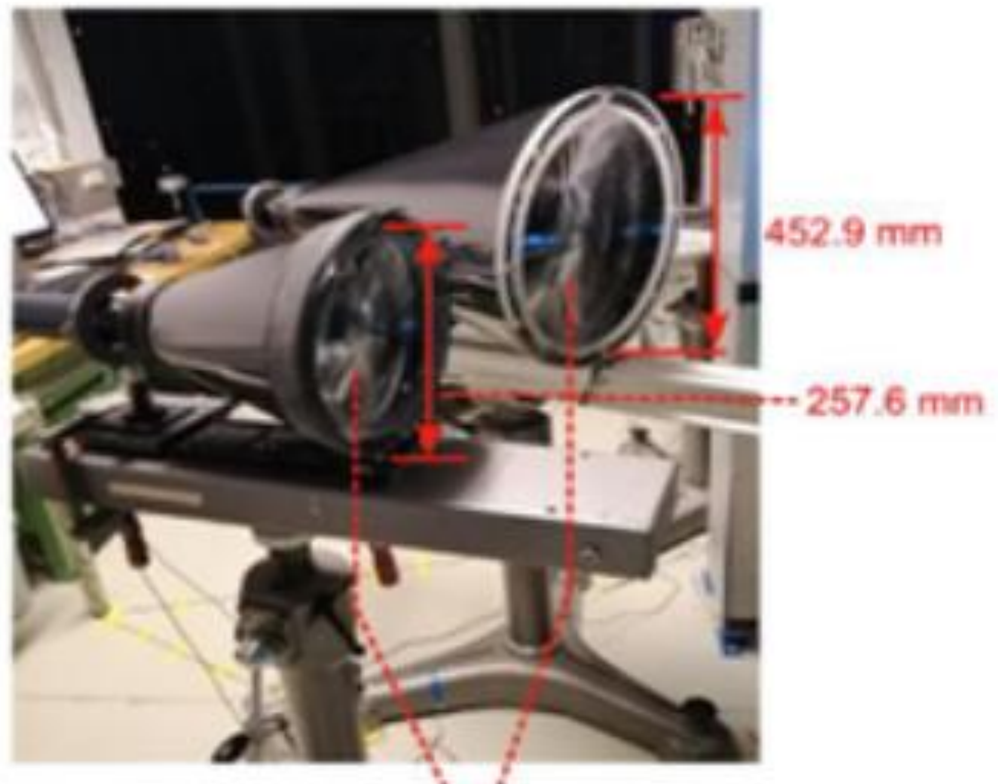

Figure 1: Lens-based radioluminescence detection setups developed at the PTB (M. Luchkov, V. Dagendorf, F. Krasniqi). (a) Fused-silica lens (Abet Technologies) system mounted on a goniometer and rotation stage (Newport M-BGM160PE and RVS80CC). (b) PMMA Fresnel lens (Orafol Fresnel Optics) systems. All lens systems can be coupled to selected PMTs and UV-C or UV-A interference filters.

https://tinyurl.com/2pskbnxm

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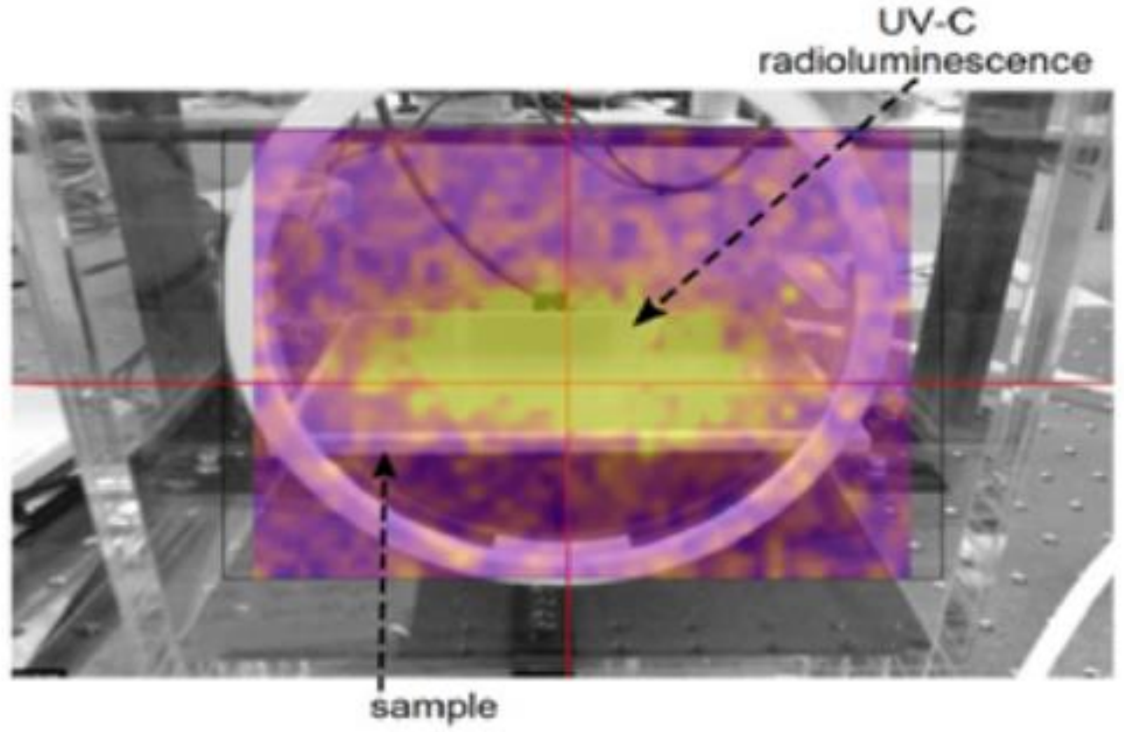

Fig. 6. (color online) Image of a wide area reference alpha-emitting source composed of the uranium isotopes U-234, U-235 and U-238, with a total activity of 330 Bq over an active area of 19.1 × 11.9 cm^2. The concentration of NO at the N_2 atmosphere was about 3 ppm. The scene was scanned using scanning PMT system at about 0.4 m distance with a resolution of 1 deg and 30 s integration per point.

K_Nuclear Inst. and Methods in Physics Research, A 987 (2021) 164821

Project coordinator:

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Some elements of the calibration infrastructure

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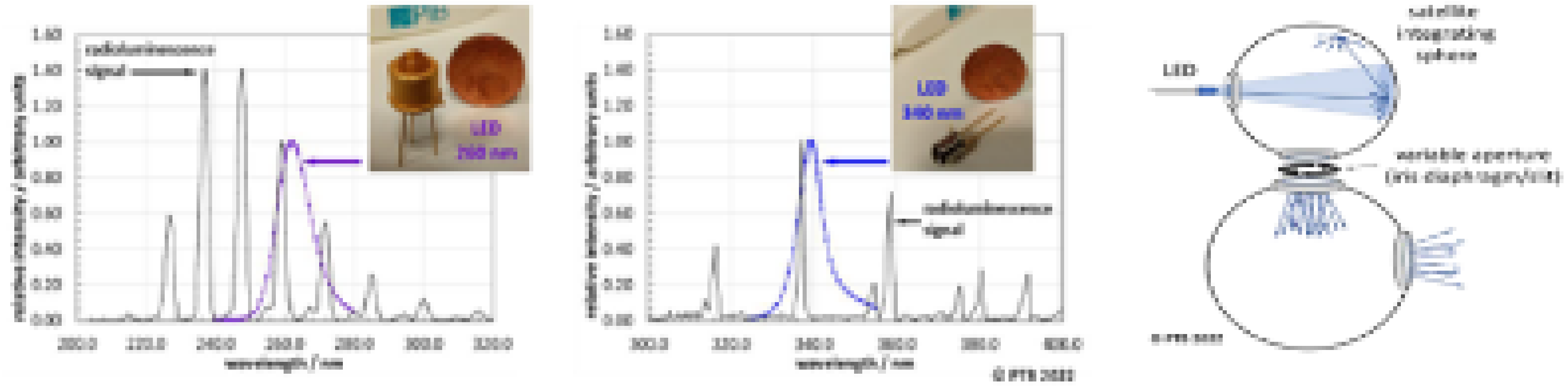

https://tinyurl.com/45z3fze9

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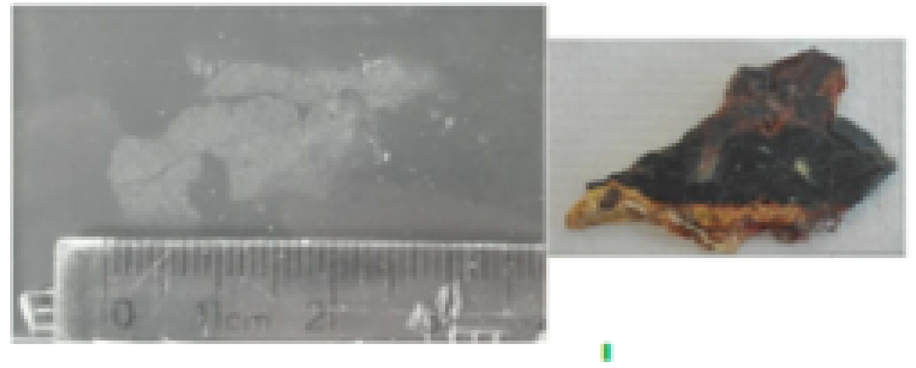
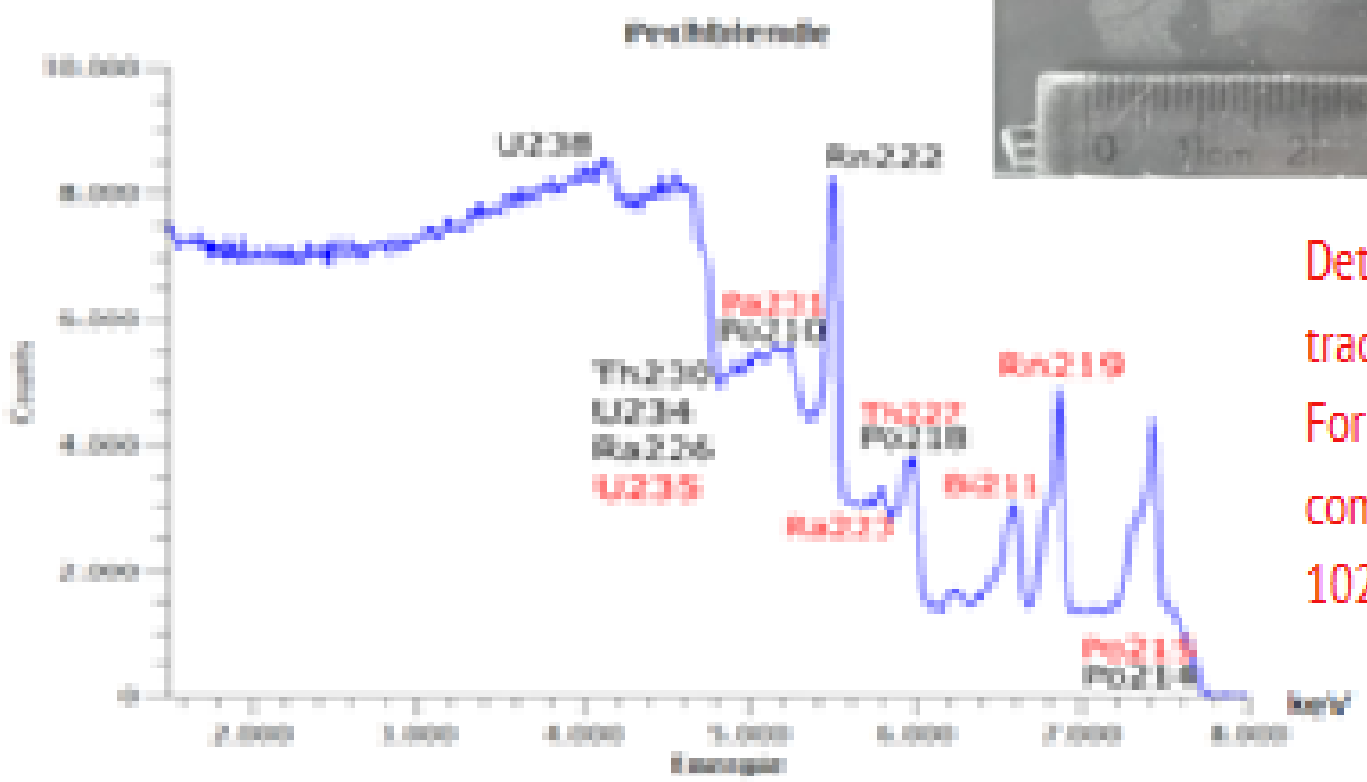
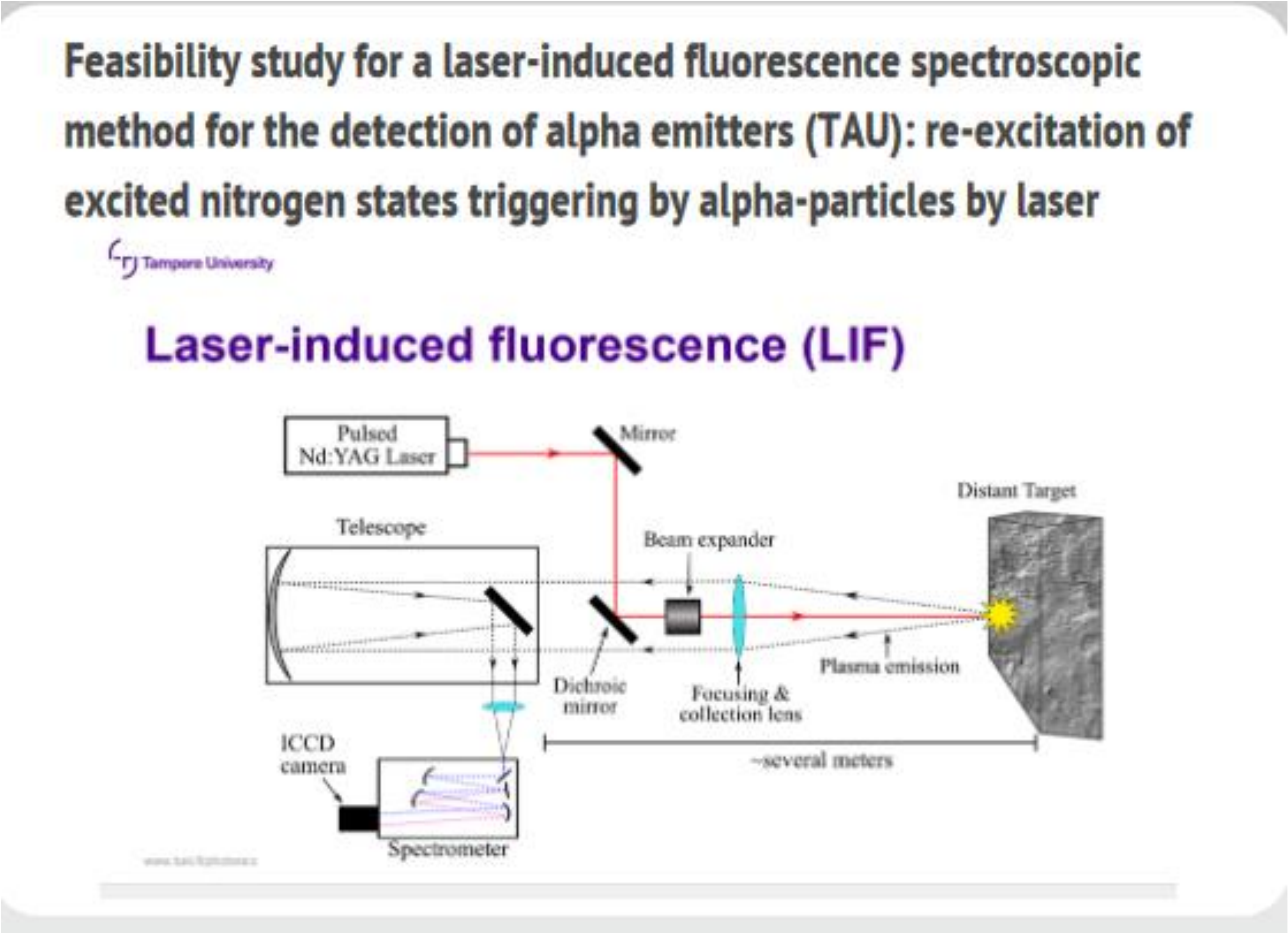




Detectable alphas for alpha-track detection: 465.5 Bq
For GIC (which used for comparing with optical system): 1023 Bq

An active method: laser-induced fluorescence (LIF) – feasibility study



Partners: Government Office of the Capital City Budapest Metrological and Technical Supervisory Department (BFKH); Horia Hulubei National Institute of R&D for Physics and Nuclear Engineering (IFIN-HH); Alfa Rift Oy (Finland); Gottfried Wilhelm Leibniz University, Hannover (Germany); Tampere University, Tampereen korkeakoulusäätiö sr (Finland);-Universitat Politècnicade Catalunya (Spain); Hungarian University of Agricultural and Life Sciences (Hungary)

Partecipation of MATE

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As a consortium partner MATE *with collaboration IDEAS Science Kft.(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.

The planned e-trainig course for RemoteAlpha project

MAGYAR AGRÁR- ÉS ÉLETTUDOMÁNYI EGYETEM

RemoteAlpha e-traning

István Nikolényi, Györgyi Bela, Zoltán Gémesi

E-learning contents

- 12 db short, practical, video lessons to review by end of January
- 3-4 learning paths will be defined: incl. link to other free online courses
- Reading guides
- Excercices

Evaluation

Participants Survey after the training

E-Learning Evaluation

Exit this survey

* 1. Which e-learning course would you like to give feedback about?

* 2. What key messages do you think the course was trying to get across?

* 3. Has using the course led to/will lead to you changing any of your behaviour and/or practice?

- Yes
- No

4. If yes, please give us examples

ABOUT THE COURSE

Course Description

Day(s) & Time(s): Six-modules course.
Target Audience: Lessons for Bsc. or Msc. level university students. Training material for CBRN practitioners, people responsible nuclear medicine technologies, radiation safety officers, environmental and waste management officers.
Topics covered: This course is designed to acquaint the student to Alpha instrument and measurements required to detect, monitor, map and record, and analyze alpha emitters, with special emphasis on the introduction of optical remote methods.
Course materials: e-learning materials, video contents, charts and infographics, simulation software Learning goals: This course will provide both theoretical as well as practical knowledge. Why the course content is significant, useful, or relevant:
The field of alpha radiation detection instrumentation has seen some significant developments in recent years. This 5-modules course will begin with a review of the basics of alpha instruments and then present a detailed overview of RemoteAlpha project innovation. The course will present the results of the RemoteAlpha
project and the findings of the international literature.
Learning Outcomes
Course-level learning outcomes: All persons need an understanding of radioactive materials, implementing radiation monitoring programs how radiation is categorized, detected, and measured.
Prerequisites or Major Connections
None, but basic knowledge of high school physics and chemistry is recommended.
Teaching Philosophy

Teaching the subject of the project at MATE

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- Starting this September, MATE introduced the topic of the project into its educational system in the form of a so-called *optional course-unit (called by C – course unit)* .

- Name of the course-unit: „Remote sensing and measurement of radioactive materials"

- Subject code: MATER91N GOD-HU-N=C subject=EL00

- Dates: every Thursday

Educational experiences

MATE
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•Although we do not require stronger prerequisites for completing the subject, *during* ***university-level training***, in addition to the presentation of the special results of the subject, the students' affinity for deeper physical and spectroscopic principles must also be taken into account.

In particular, this requires the design of the curriculum for optical measurement systems and the basics of molecular spectroscopy in such a way that a comprehensive study of the literature on the subject becomes possible after completing the course. Therefore, during the course, where possible, several calculation examples are used, mainly to practice the nomenclature of electronic states and transitions, but also to deepen the properties and measurability of radioactive decays and alpha radiation, as well as radioluminescence, and to develop a more detailed, nuanced physical picture.

•However, we also consider it desirable to establish a strong physical background at the user level too - where the aim of the more concise negotiation method is primarily to effectively explain the results and possibilities - and we also want to contribute to the understanding of this with feedback verification questions.

•An additional need arose: the discussion of the technical criteria for the installation of the optical system on a drone and some aspects of production technology, specifically for the technical engineering courses, with which we would also like to ask the project partners for help.

The importance of the subject

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.

Thank You for your kind attention!