RemoteALPHA

EURAMET

19ENV02 RemoteALPHA

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

F. Krasniqi (PTB), Coordinator

The 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.

19ENV02 RemoteALPHA denotes the EMPIR project reference.

PTB Messen ▪ Forschen ▪ Wissen

Budapest Főváros Kormányhivatala

IFIN-HH

ALFA RIFT

Leibniz Universität Hannover

Tampere University

UPC Universitat Politècnica de Catalunya BarcelonaTech

MATE Hungarian University of Agriculture and Life Sciences

Motivation: Emergency Response

RemoteALPHA supports…

Emergency actions and strategies **for radiological emergencies** involving accidental or deliberate dispersion of **alpha emitting radionuclides** in the **environment.**

Measures required by the European Directive 2013/59/EURATOM

Safety standards for the protection against the dangers arising from the ionising radiation:
The European Directive 2013/59/EURATOM

Article 97

Emergency Management System

-Member states should ensure that account is taken of the fact that emergencies may occur in their territory…
-The emergency management system shall provide for the establishment of emergency response plans…

Article 98

Emergency Preparedness

-Member States shall ensure that emergency response plans are established in advance for the various types of emergencies…
-Member States shall ensure that emergency response plans are tested and revised at regular intervals…

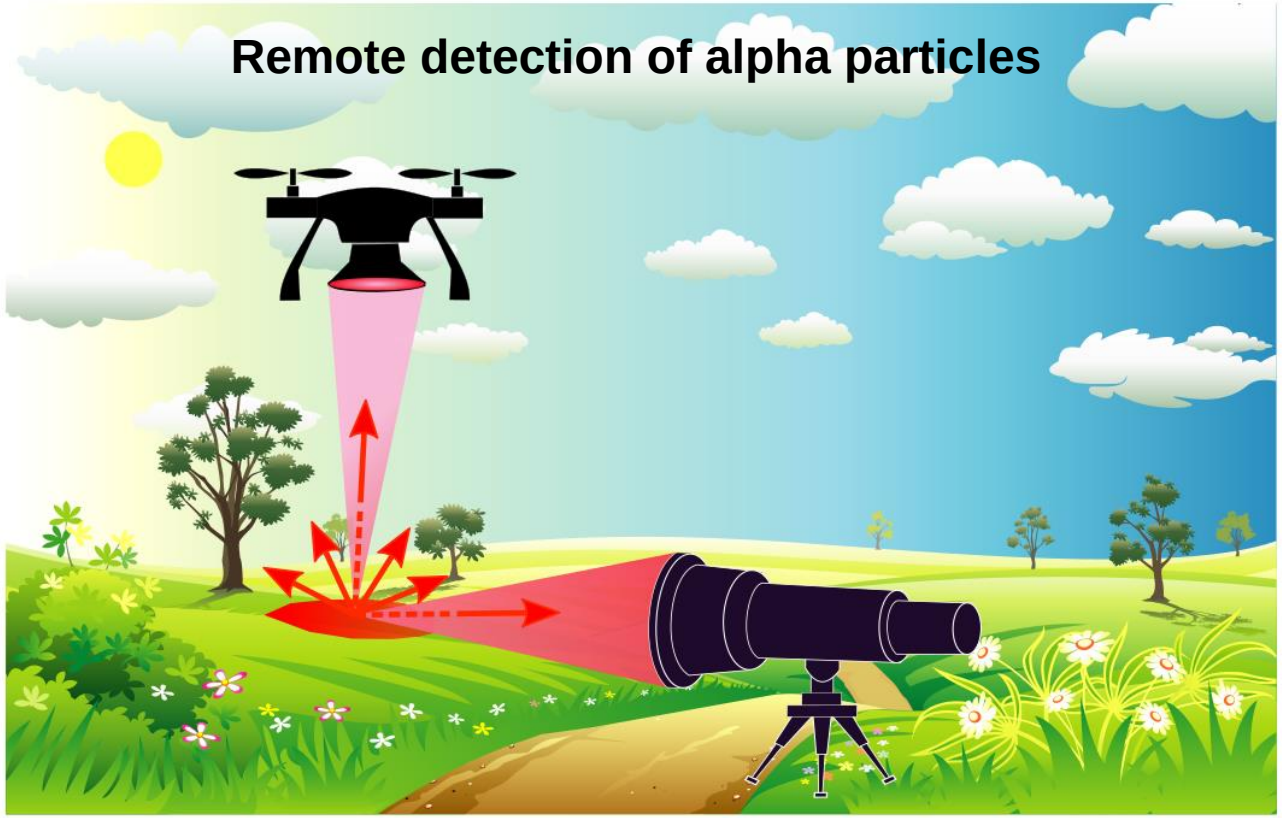
Article 99

International Cooperation

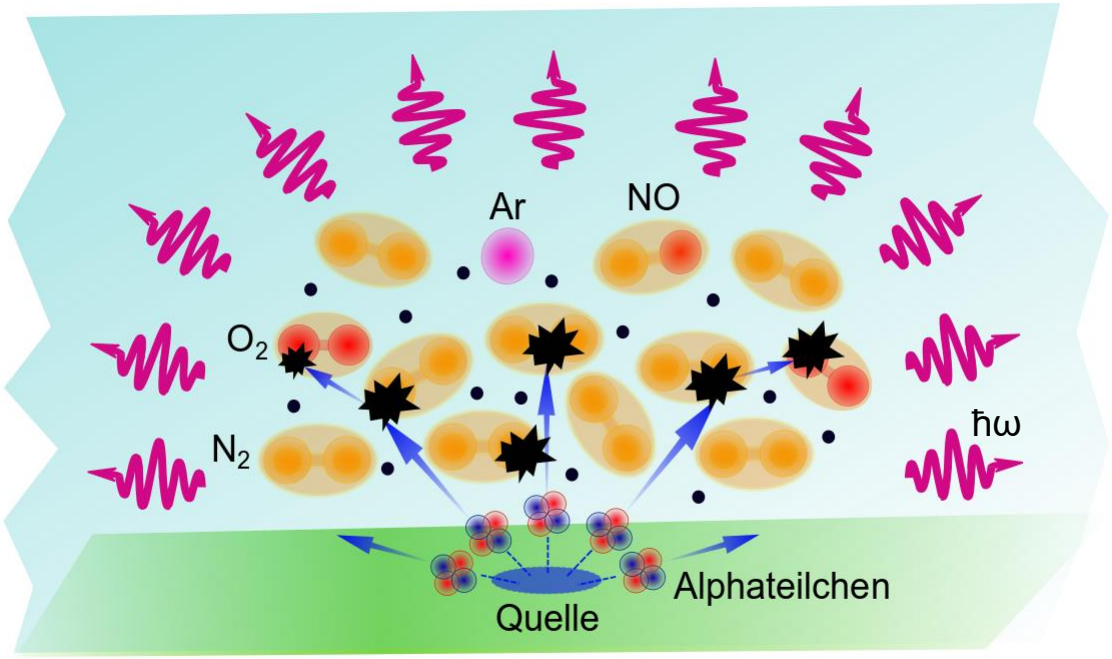
Member States shall cooperate with other Member States and with third countries in addressing possible emergencies on its territory which may affect other Member States or third countries…

Detection of alpha particles

http://www.argonelectronics.com/blog/the-value-of-applied-learning-for-radiation-safety-training



Radioluminescence at a glance



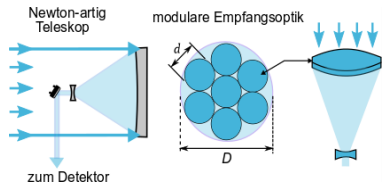
Schematic representation of air ionization by α-particles and radioluminescence.

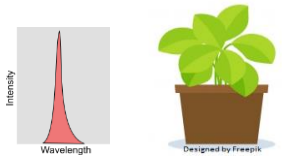
Air molecules emit fluorescent light (radioluminescence) in the UV range between 200 nm and 400 nm.

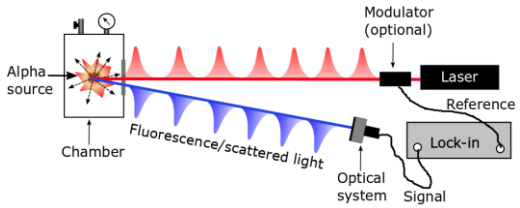
<u>Range in air:</u>

α-particles	→	0,04 m
UV light	→	500 m

Technical workpackages







RemoteALPHA: 01.09.2020 - 31.08.2023

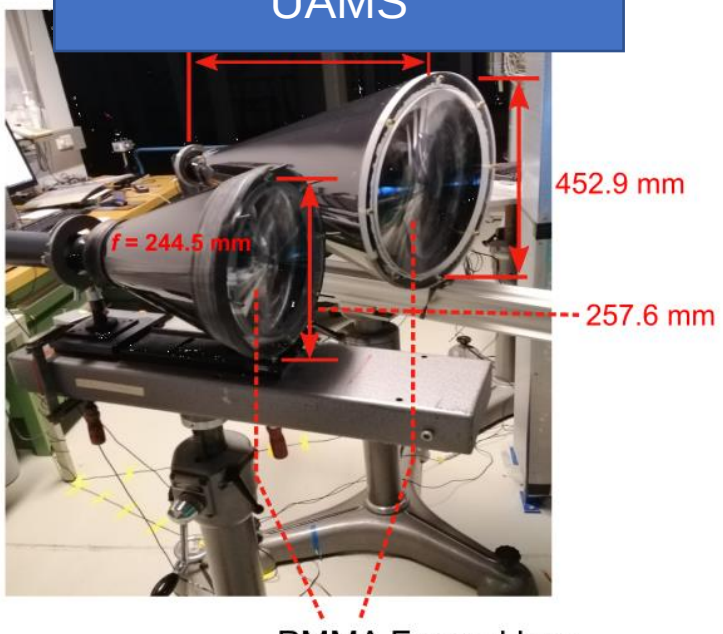
WP1	New instruments for the optical detection of alpha emitters in the environment
WP2	Calibration system for the novel radioluminescence detector systems
WP3	Mapping alpha contamination in the environment using UAVs
WP4	Feasibility study on laser-based techniques for alpha emitter detection

Instrumentation and methods

Novel radioluminescence detection systems for emergency management

Scanning tripod system

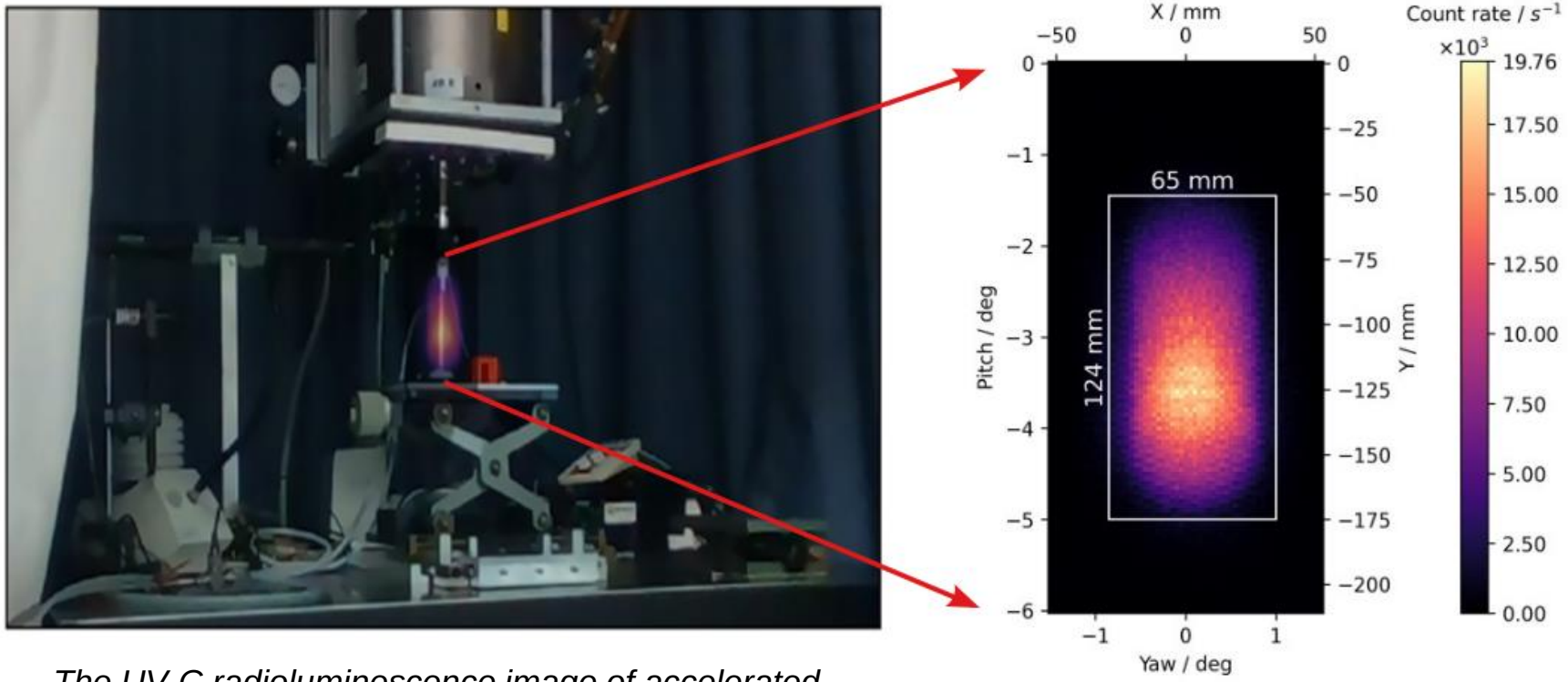
UAMS



Modular mirror system

M. Luchkov, V. Dangendorf, U. Giesen and F. Krasniqi (PTB)

Characterization of optical detection systems at the PTB Ion Accelerator Facility (PIAF)

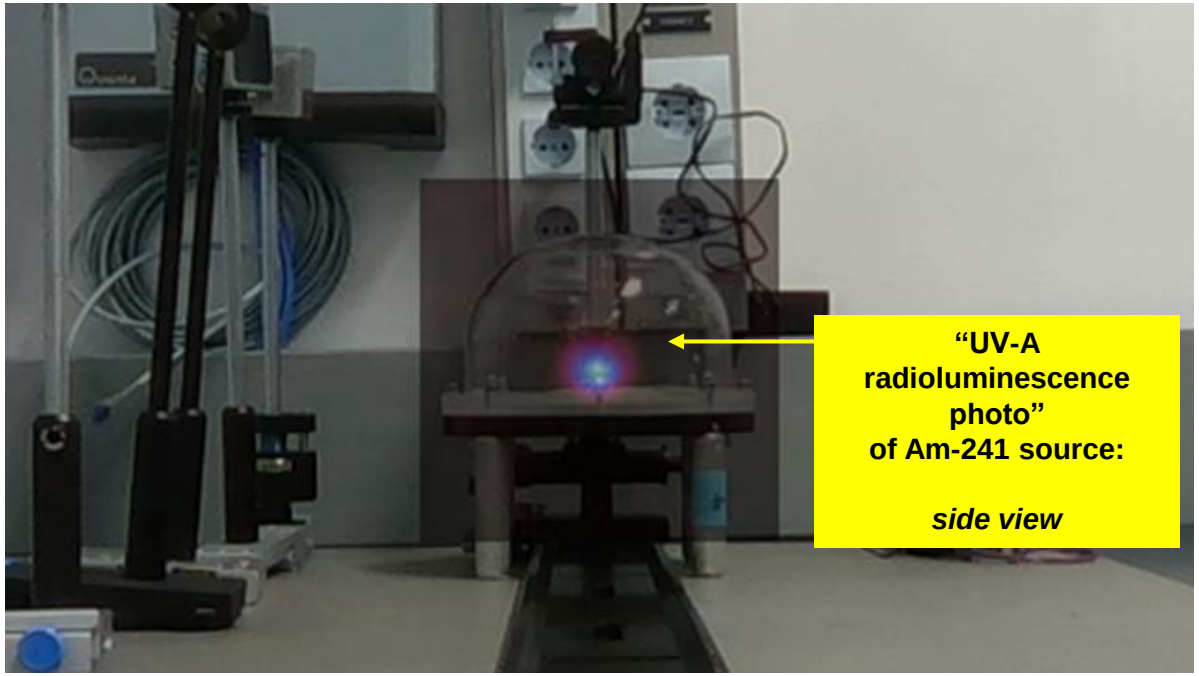


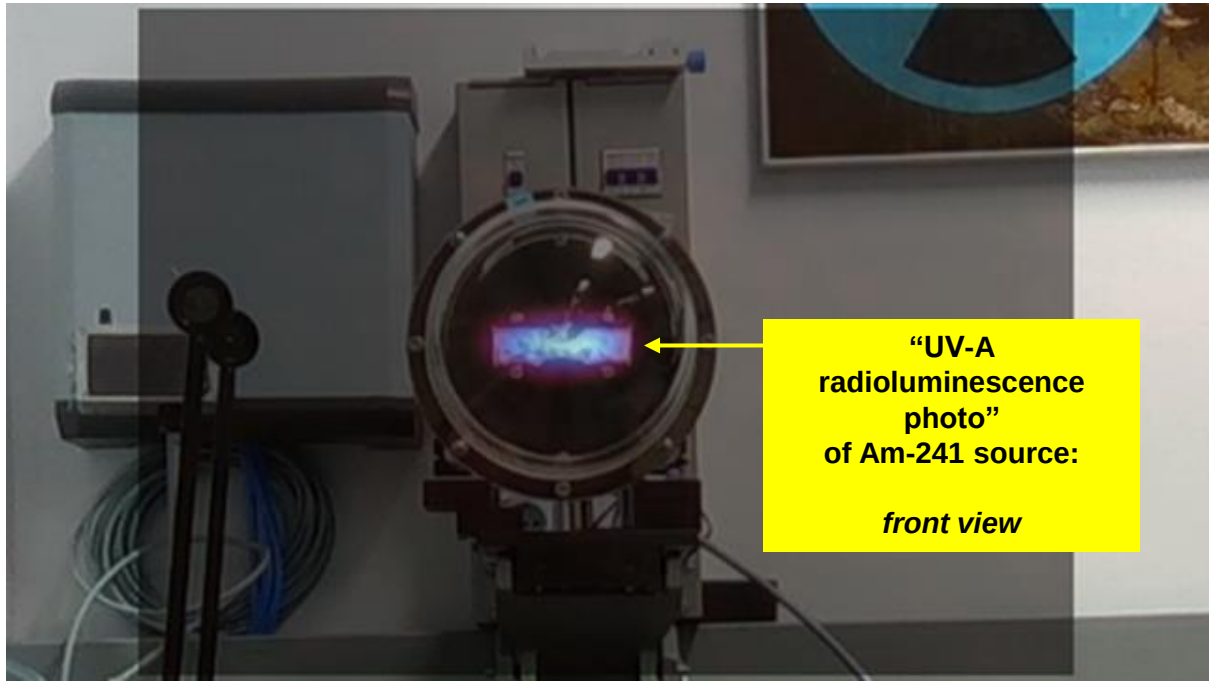
The UV-C radioluminescence image of accelerated (E_α=8.3 MeV) alpha particles.

PTB
M. Luchkov,
V. Dangendorf,
U. Giesen,
F. Krasniqi

IFIN-HH
C. Olaru

Characterization of optical detection systems with extended Am-241 sources



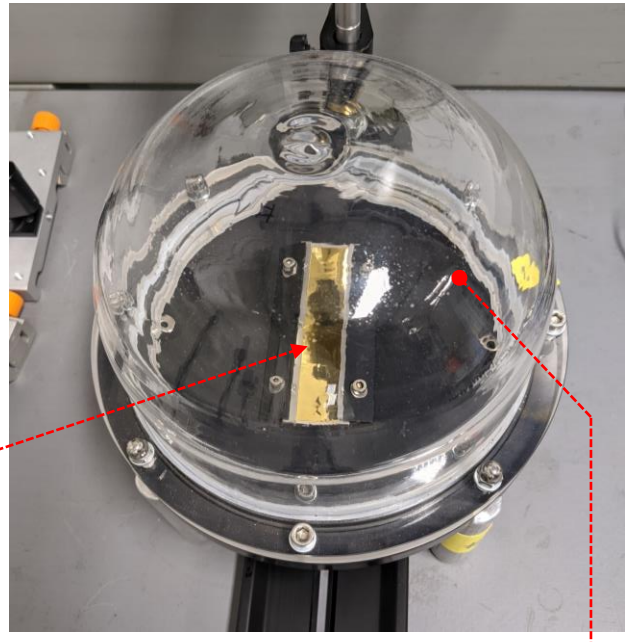


M. Luchkov, V. Dangendorf, U. Giesen, F. Langner, C. Olaru, M. Zadehrafi, A. Klose, K. Kalmankoski, J. Sand, S. Ihantola, H. Toivonen, C. Walther, S. Röttger, M.-R. Ioan, J. Toivonen and F. S. Krasniqi,

Novel optical technologies for emergency preparedness and response: mapping contaminations with alpha-emitting radionuclides,

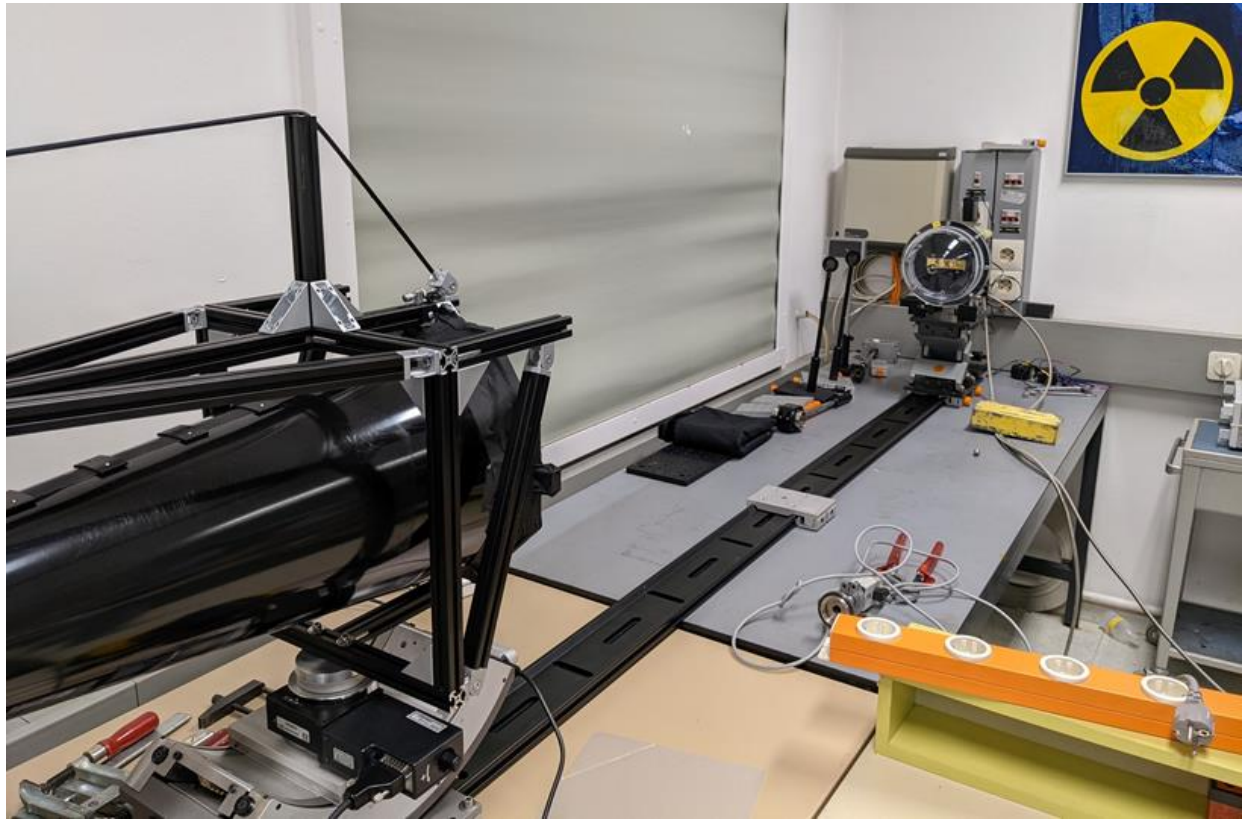
Nucl. Instr. Meth. Phys. Res. A **1047**, 167895 (2023)

Characterization of optical detection systems with extended Am-241 sources



Am-241 source (980 kBq, active area: 20 mm x 100 mm) **designed and provided by IFIN-HH**.

UV-transmissive box to comply with radiation protection protocols in EU designed by PTB, UPC, LUH and IFIN-HH, **built by PTB**.

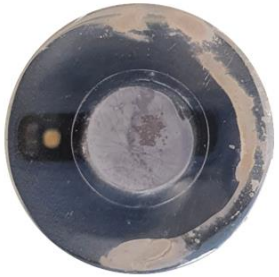


Experiments at the PTB: M. Luchkov and V. Dangendorf

Calibration systems for the novel-type radioluminescence detector systems: Activity standard

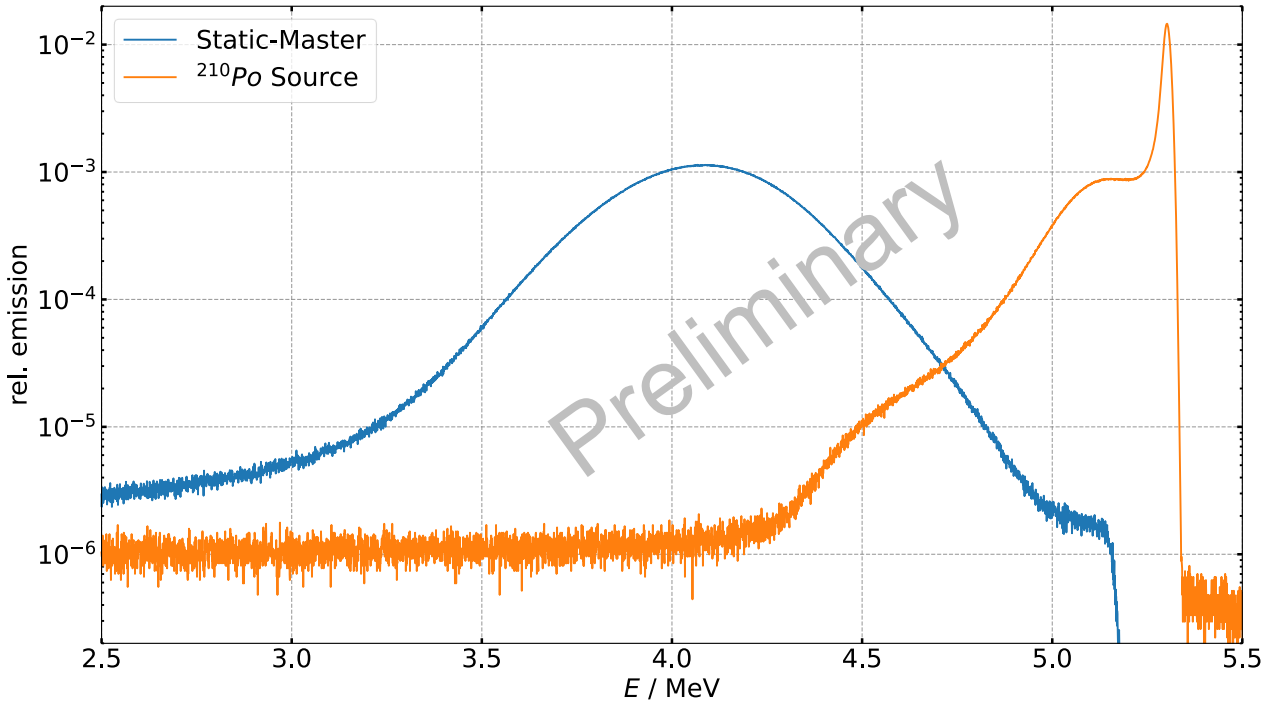
Extensively characterized ^{210}Po source for the determination of the radioluminescence yield

PTB: Florian Mertes, Anja Honig, Stefan Röttger



Preparation of the Po-210 source, from left to right:

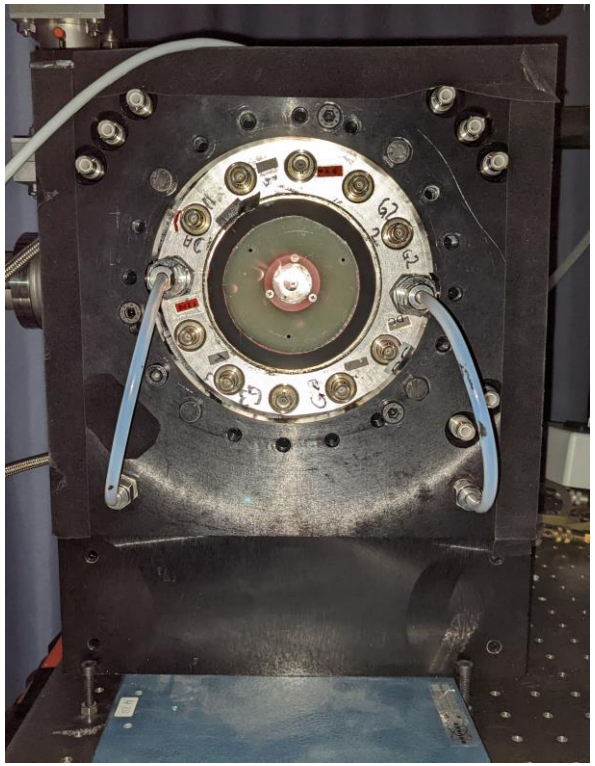
- Silver target in PMMA holder,
- Silver target in holder in the Po-210 solution,
- **Po-210 source on silver target**.

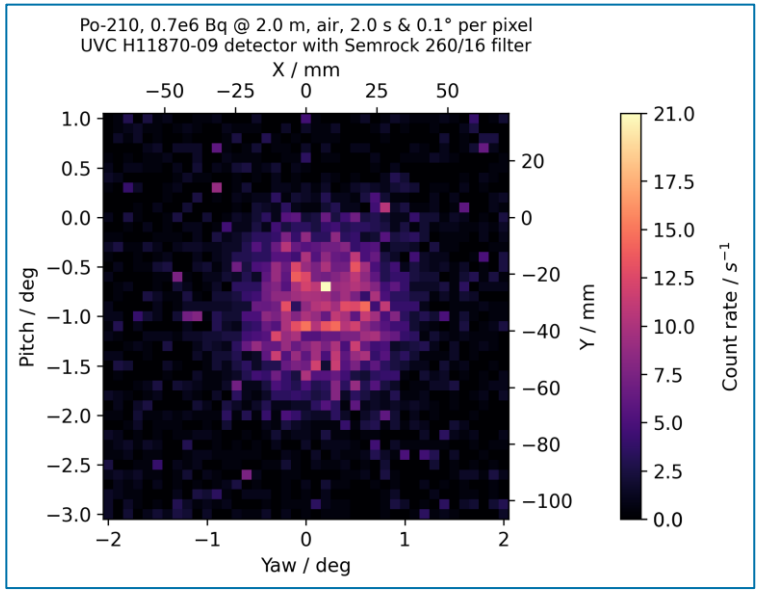


Alpha emission spectra measured with a silicon surface barrier detector

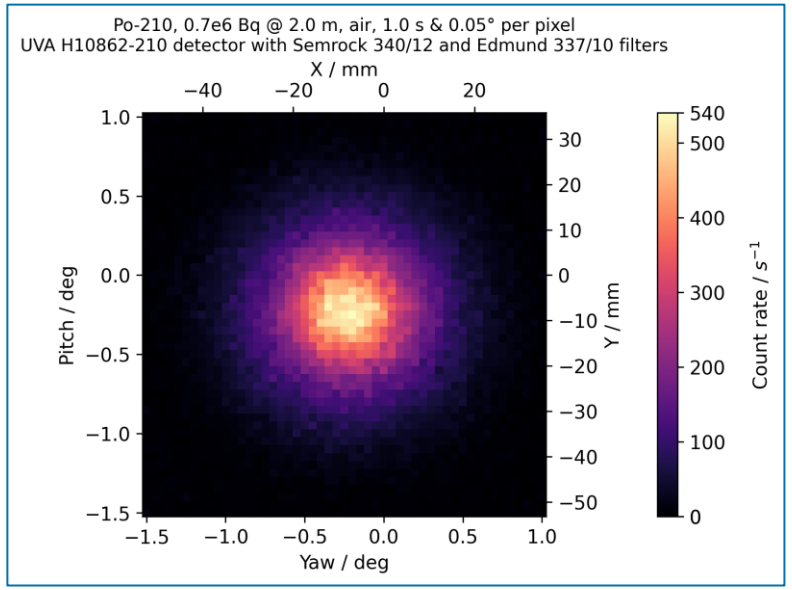
Calibration systems for the novel-type radioluminescence detector systems: Activity standard

Po-210: 700 kBq (23. Feb 2022)





UV-C with 260 nm filter
Counting time per pixel: 2 s
Max. count rate: (21 ± 3) s^{-1}



UV-A with 337 nm filter
Counting time per pixel: 1 s
Max. count rate: (540 ± 23) s^{-1}

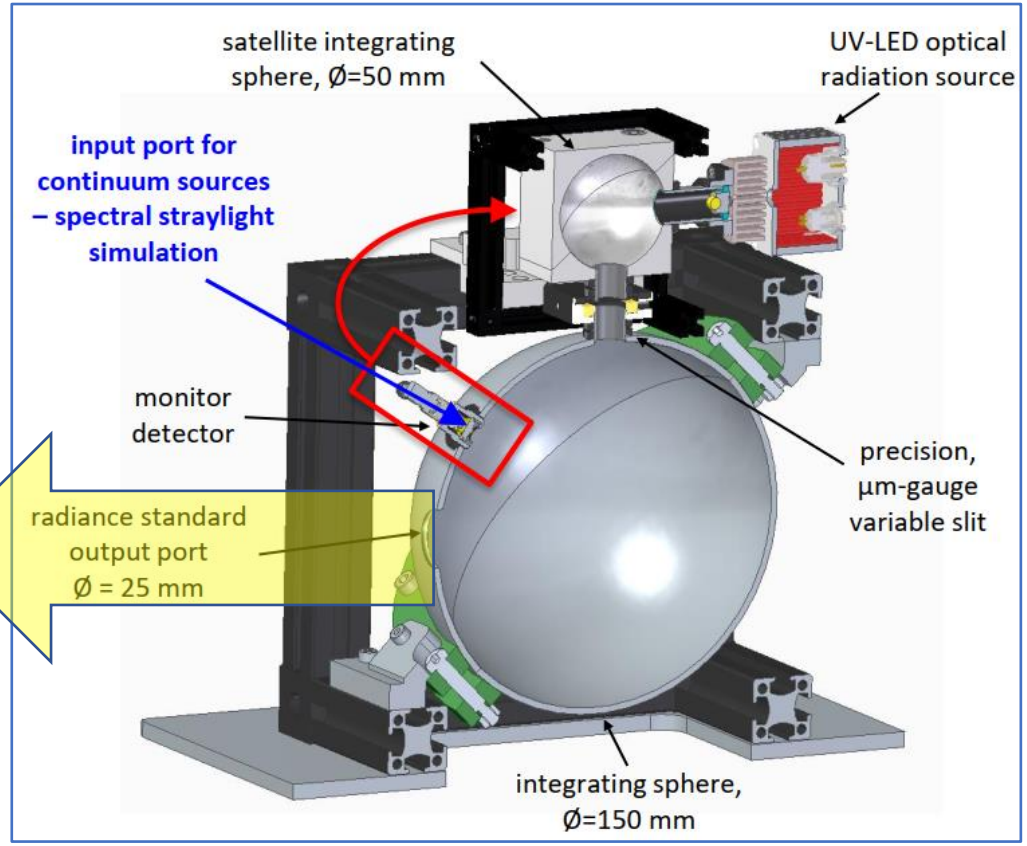
M. Luchkov, S. Röttger, V. Dangendorf, U. Giesen, F. Krasniqi (PTB)

Calibration system for the novel-type radioluminescence detector systems: Radiant standard

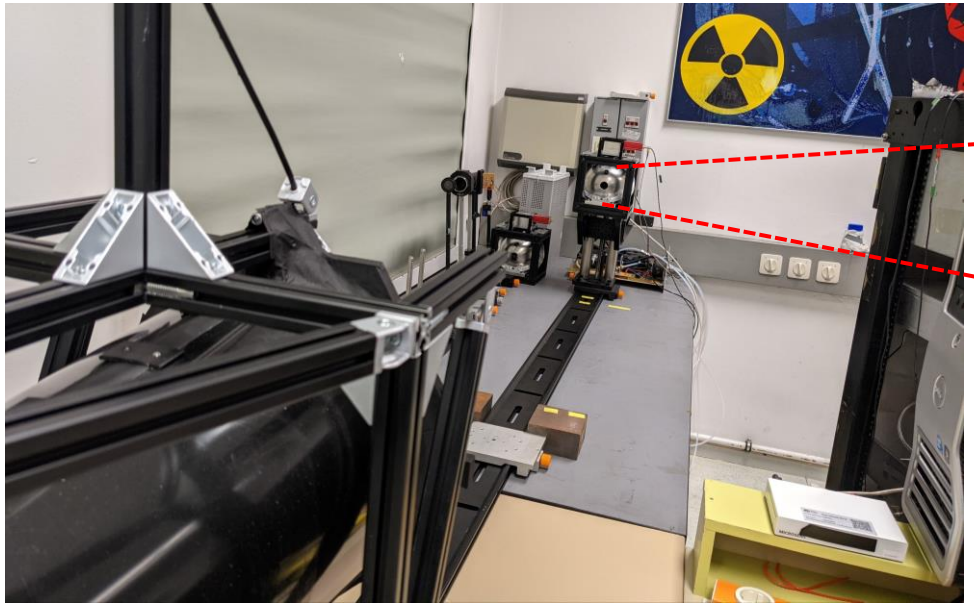
Novel UV radiation standard for calibration of UV-A and UV-C radioluminescence detection systems.

Radiant standard **simulates an alpha emitter**

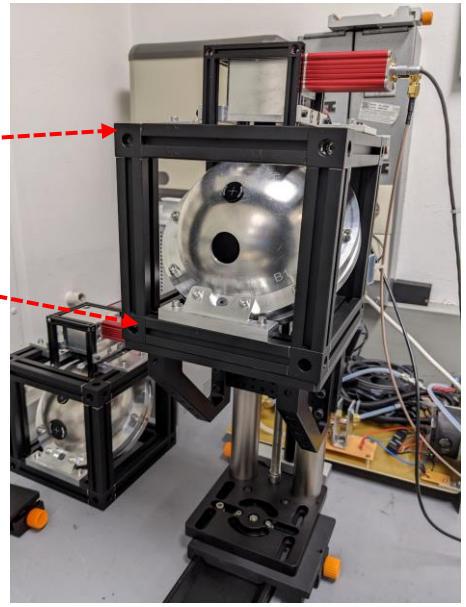
R. D. Taubert, P. Tesch und A. Förster
(PTB)



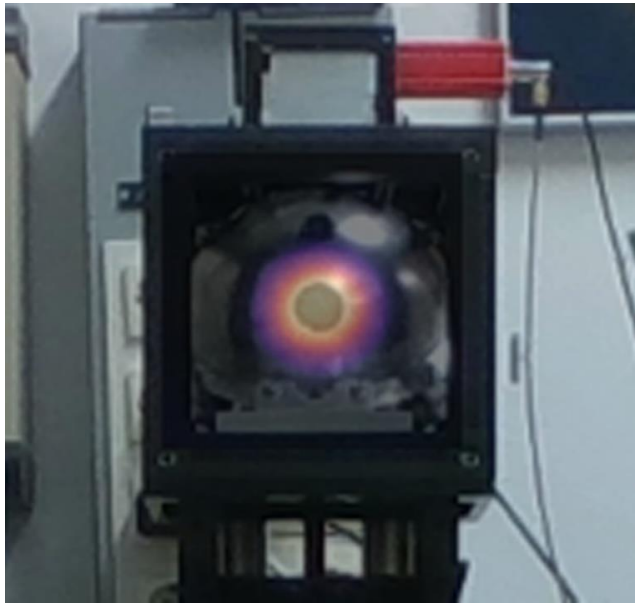
Measuremenets with radiant standard



Measurements with UVFS lens system



Radiant standard



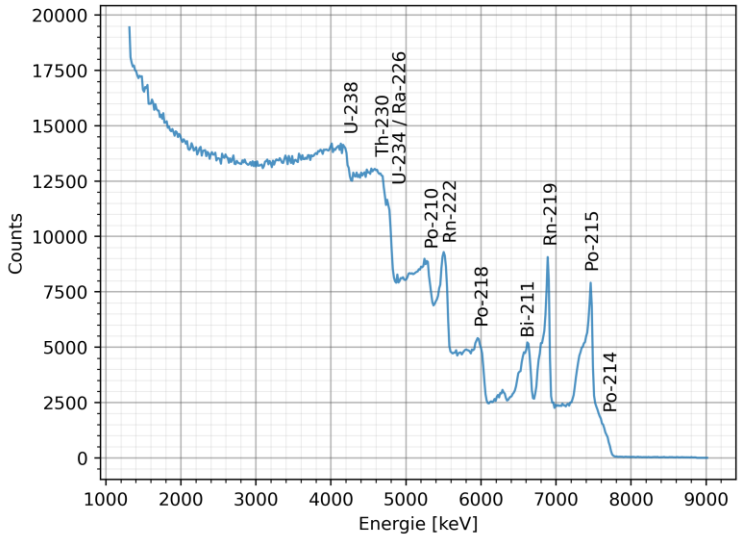
Radiant standard

RS260 (**UV-C**): Simulates point source equivalent activity from **500 kBq to 5 GBq**
RS340 (**UV-A**): Simulates point source equivalent activity from **80 kBq to 800 MBq**

UV photons vs. Activity → Radiant standard + Po-210 Activity standard

Development of environmental samples

...for studying detection limits of the optical detection setup(s)

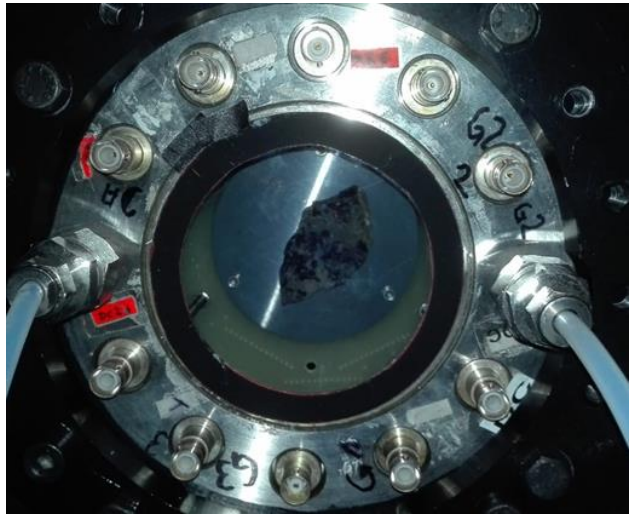


Alpha spectrum measured with grid ionization chamber

Well characterized pitchblende samples.

Annika Klose, Clemens Walther (LUH)

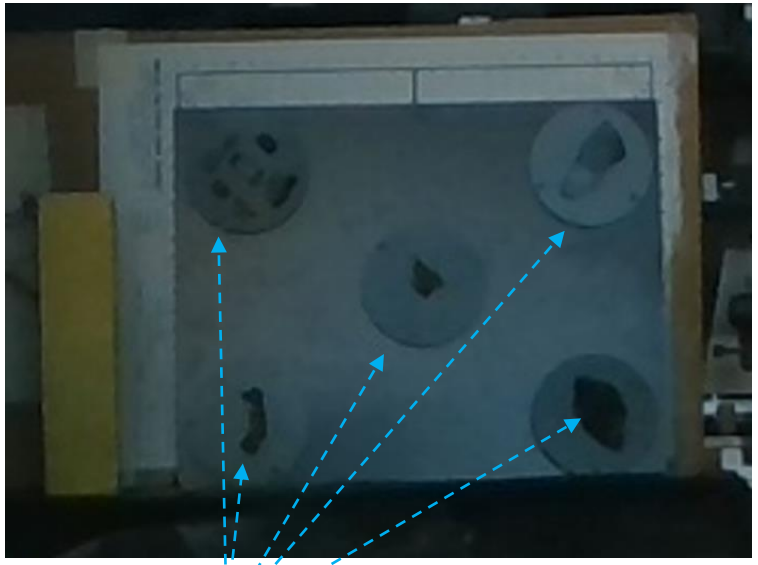
		Detectable alpha particles per second			
		Alpha-Track		Grid Ionisation Chamber	
Sample ID	Area / cm^2	total	per cm^2	total	per cm^2
K	**13,1**	**1002,8**	**76,8**	**1330,3**	**101,8**



Experiments at the PTB
Radioluminescence in N_2 and N_2/NO gas atmospheres

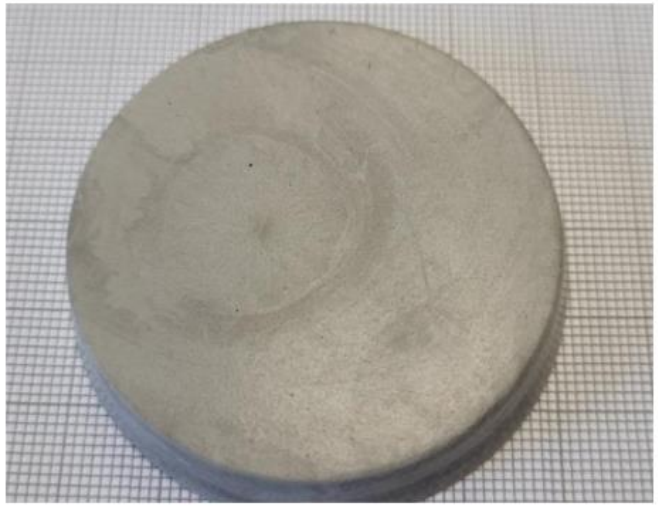
A. Klose (LUH)
M. Luchkov (PTB)
V. Dangendorf (PTB)
F. Krasniqi (PTB)

Development of environmental samples



Pechblende minerals
(80 Bq/cm² to 105 Bq/cm²)

UVA radioluminescence i
(measurement in air, counting time per pixel: 20 s).



Concrete poured with an Am-241 solution
(A. Klose, C. Walther | LUH)

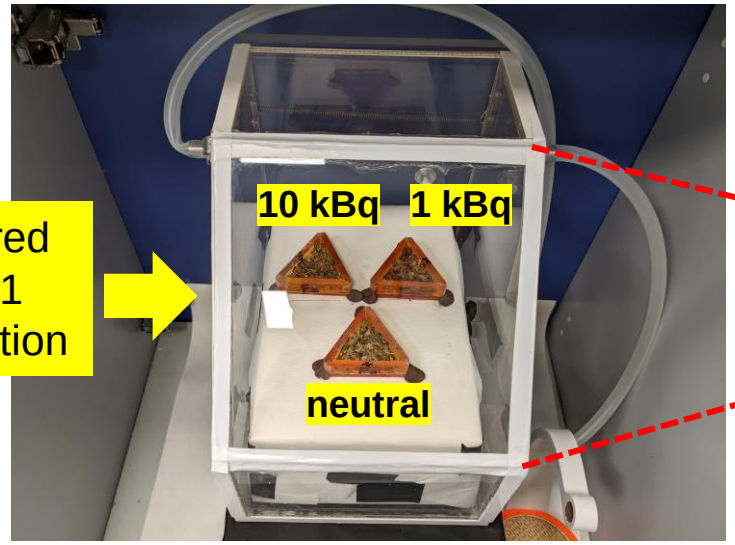
A. Klose, M. Luchkov, V. Dangendorf, F. Krasniqi, A. Lehnert and C. Walther,

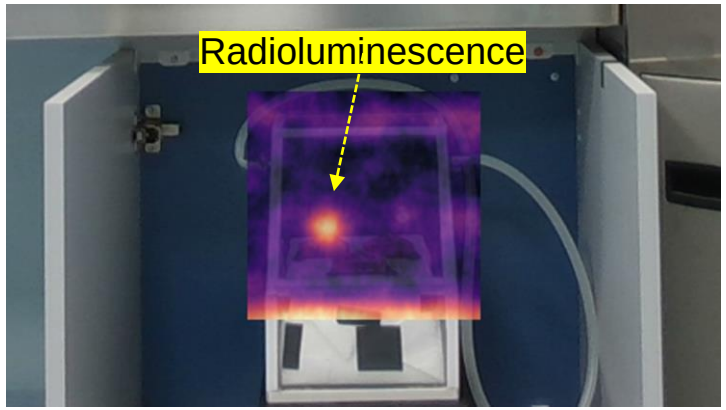
On the way to remote sensing of alpha radiation: radioluminescence of pitchblende samples,

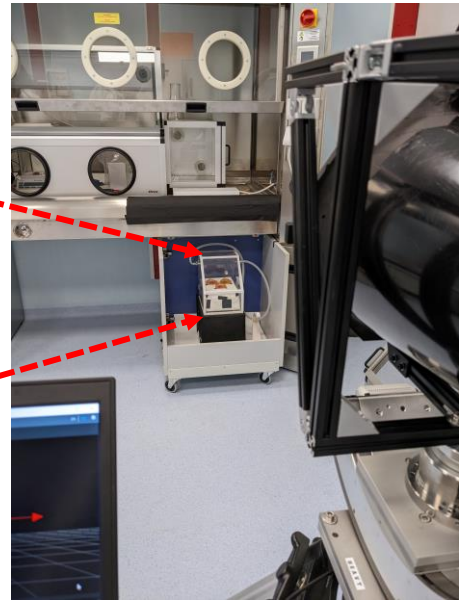
J. Radioanal. Nucl. Chem. 331, 5401 (2022)

Development of environmental samples

Leaves poured with Am-241 standard solution







Experiments at IFIN-HH (February 2023)

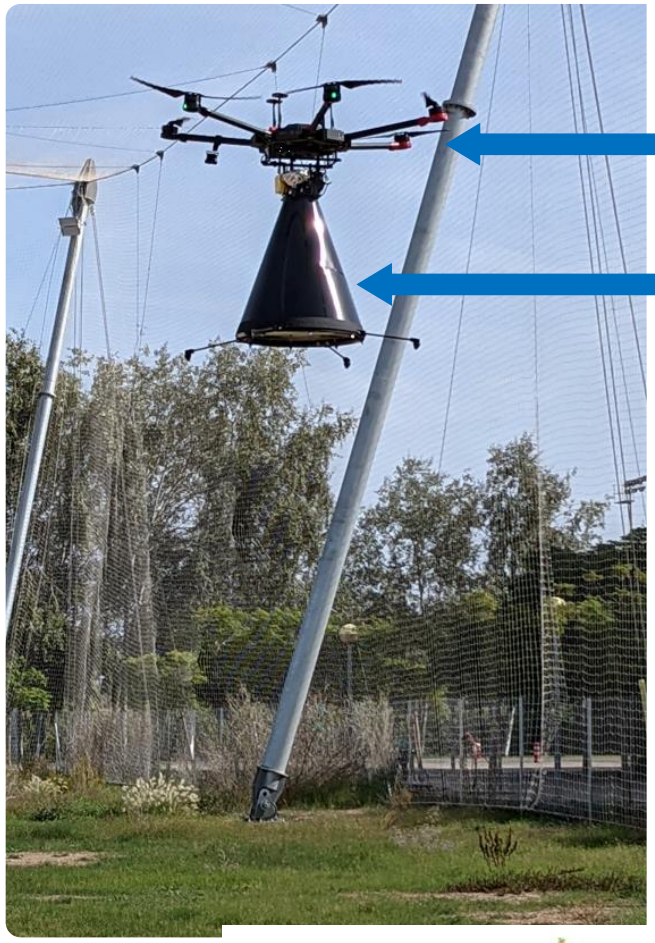
Radioluminescence from sand, soil, and leaves pipetted with standard solution of Am-241

PTB
M. Luchkov

IFIN-HH
C. Olaru,
M. Zadehrafi

MATE
I. Nikolényi,
Z. Gémesi

Tests of the Unmanned Aerial Monitoring System (UAMS)



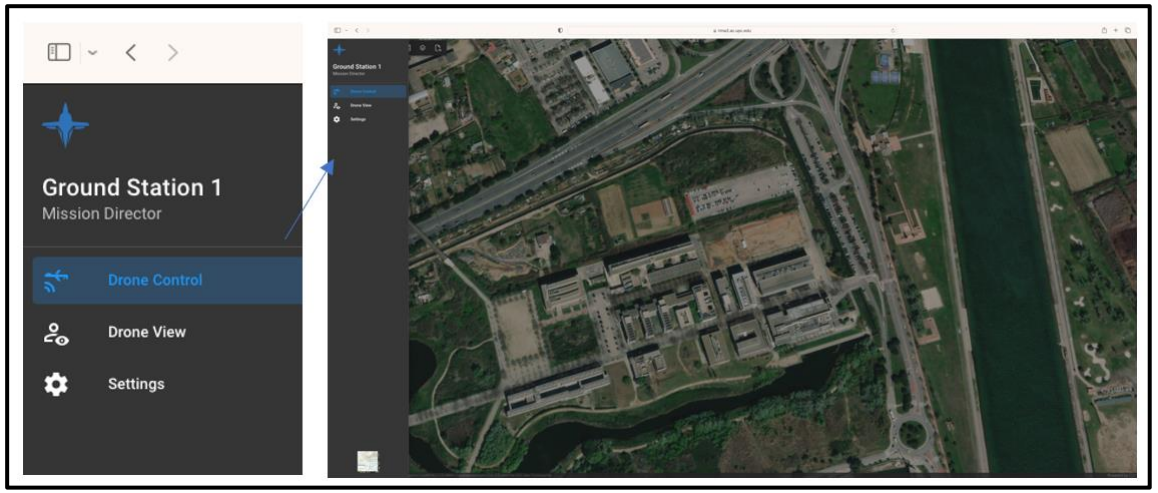
UAV: DJI Matrice 600 Pro

Fresnel lens-based radioluminescence detection system

Characterization of UAMS at the UPC DroneLab in Castelldefels

UPC & PTB

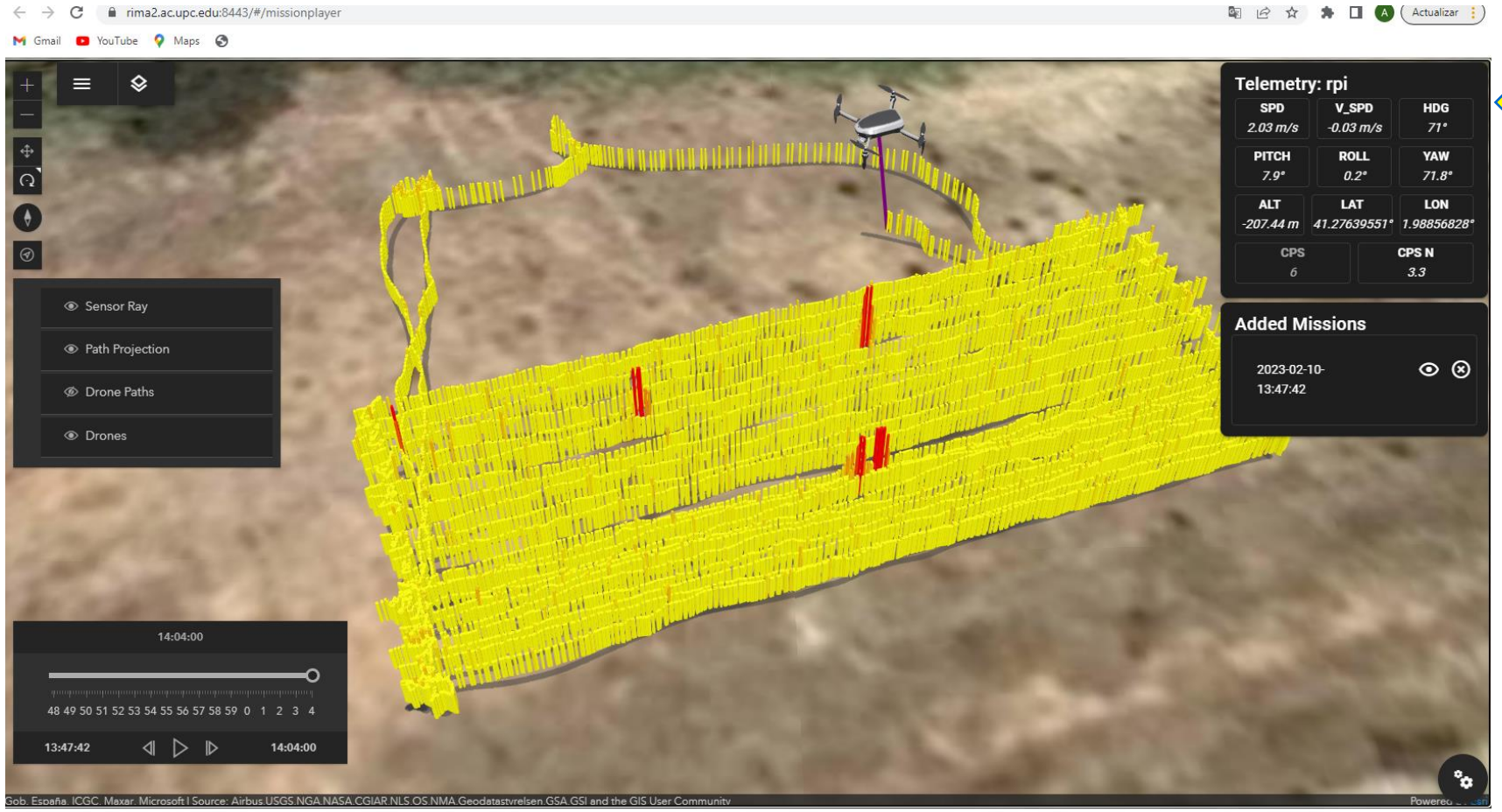
(ongoing)



Software for on-line visualization: RIMA-Spec

UPC: Pablo Royo-Chic, Arturo Vargas

Tests of the UAMS: preliminary results with UV-C sources simulating alpha emitters



Detection of 5 hidden "sources" (UV-C diodes simulating alpha emitters)

Height: **5 m**
Flight speed: **1 m/s**

Flight duration for the scanning of suspected area: **15 min**

Arturo Vargas, Pablo Royo-Chic (UPC)

Summary

- ✓ Two radioluminescence detection systems have been optimized for emergency management involving alpha emitting radionuclides.
- ✓ A Po-210 activity standard has been developed and used to calibrate the radioluminescence detection systems.
- ✓ A radiant standard which simulates alpha sources has been calibrated with the activity standard.
- ✓ Four sets of “alpha-active” environmental samples have been developed:
  Pitchblende minerals, leaves, soil and sand.
  (Concrete samples will be commissioned in March 2023).
- ✓ Unmanned Aerial Monitoring System (UAMS) has been assembled and tested.
  Comisioning will be concluded in April 2023.

Thank you!

Dr. Faton Krasniqi
Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
Bundesallee 100
38116 Braunschweig

Telefon:0531 592-6320
E-Mail: faton.krasniqi@ptb.de
www.ptb.de