RadonNet, 23IND07 : Radon metrology: Sensor networks for large buildings and future cities

The goal of the project is to eliminate preventable lung cancer from radon (^{222}Rn) by improving indoor air quality in Europe through the development of advanced sensor networks and calibration techniques: ultimately leading to more energy-efficient and healthier buildings for the future ➔ **Reducing radon risk, as easily as using a thermostat**

Needs and objectives

- Radon concentration limits are defined at 300 Bq·m^{-3} by Directive 2013/59/Euratom
- Efficient ventilation is necessary to mitigate radon risks and maintain indoor air quality; balancing energy efficiency and radiation protection is the key
- Smart sensor networks need to monitor variations in radon levels; improving sensor metrology for cost-effective and efficient calibration is a priority

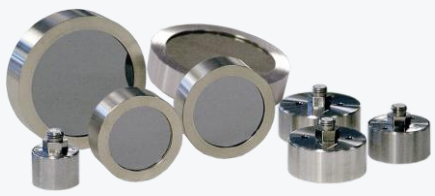
Utilizing fast-response connected devices with precise calibration standards via a network is the best solution to support cost-effective radon mitigation

Calibrated radon network for cost-effective mitigation and a healthy future for European citizens

Scientific research and excellence through four work packages

WP1: New concepts and methods for radon concentration measurements

- *Current state of the art*: Costly detectors unsuitable for direct radon mitigation
- *Progress beyond the state of the art*: Developing novel sensor concepts and methodologies to detect and measure radon activity concentration indoor; based on three detection concepts:



Silicon-semiconductors

Pulse ion chamber

Inorganic porous scintillators

- Improving response time (< 5 min), sensitivity (< 50 Bq·m^{-3}) and reduce measurement uncertainty (< 20%)
- Creating high-precision measurement sensors with a focus on miniaturization, connectivity and cost-effectiveness

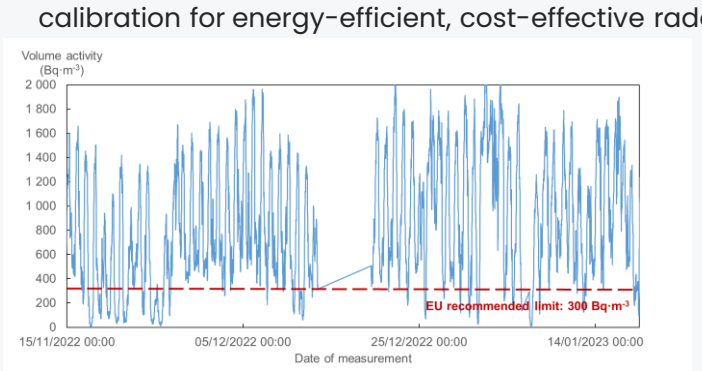
WP2: Traceable, *in situ* operando calibration procedures

- *Current state of the art*: Costly calibration in laboratory, no time response consideration, dynamic range and linearity is missing (RadonNORM and TraceRadon output)

- *Progress beyond the state of the art*:
  - Developing traceable, *in situ* operando calibration procedures
  - Achieving less than 10% calibration uncertainty at an activity concentration level of 50 Bq·m^{-3}
  - Considering response time, linearity, and dynamic range testing in the calibration procedures. Using technology and knowledge gained from WP1

WP3: Network of radon sensors

- *Current state of the art*: No radon sensor network and corresponding calibration for energy-efficient, cost-effective radon mitigation

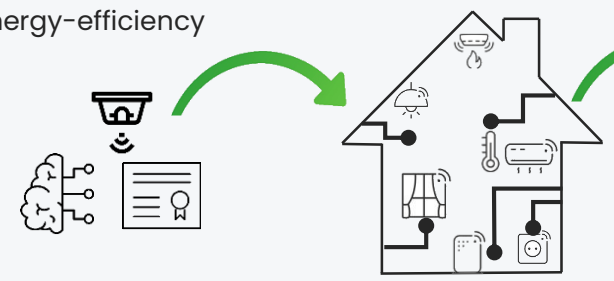


Example of collected data: Mitigation is not linked to radon measurement

- *Progress beyond the state of the art*:
  - Developing a quality-assured sensor network for large buildings and future cities using sensors from WP1 and calibration from WP2
  - Developing a data collection testbed, associated analysis, and analytical methods to extract the background, perform anomaly detection, and determine data analysis locations within sensor networks

WP4: Extended network for risk mitigation with energy saving

- *Current state of the art*: Ventilation for radon mitigation; not compatible with energy-efficiency



- *Progress beyond the state of the art*:
  - Developing an extension of the radon sensor network from WP3, integrating various sensor networks in connected buildings to optimize energy use, air quality management, and radiation protection
  - Extending the testbed from WP3 to incorporate data from other sensors, including novel air quality sensors
  - Investigating synergies between air quality and radon measurements, indoor and outdoor radiation measurements, and other sensor networks

Creating Impact (**WP5**)

Output and early impact

- *Dissemination*: Training course, 2 workshops, at least 10 publications and 12 presentations at international conferences
- *Metrology*: New standards for *in situ* and cost effective calibration, new measurement techniques and methodology for time response and linearity
- *Recommendation*: Calibration of a radon sensor network as support to Directive 2013/59/Euratom
- Industries: Prototypes of connected radon sensors and associated radon standards

Long-term and wider impact

- *Economic*: New radon *in situ* calibration techniques for radon will reduce cost and increase measurement reliability for a cost effective mitigation
  - Proposing solutions for the development of radon mitigation industry in Europe (does not exist in EU while in USA it is under development with a target of 2 million buildings per year)
  - Reducing healthcare costs: for 1 € spent on radon mitigation an estimated 11-20 € will be saved
- *Social: Improving national radon action plans and lowering the amount of lung cancers cases*
- *Research: High sensitivity sensors and techniques for space studies such as radon adsorption or desorption on the Moon*

Stakeholder support

Radioprotection Institutes

National Metrology Institutes

Private Companies

Ministries and Norms

Universities

Management and consortium (**WP6**)

- 16 participants: complementary expertise from 7 NMIs and DIs, 4 universities, a radioprotection authority with the help of 3 SMEs and a large company for prototype industrialisation

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