## The Metro Radon project as support for the implementation of the EURATOM Basic Safety Standards

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v.16.9.19

INTERNATIONAL CONFERENCE ON RADIATION APPLICATIONS

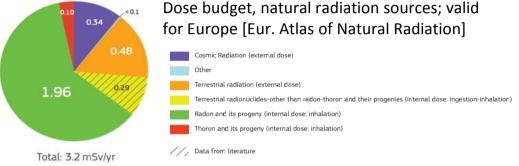
In Physics, Chemistry, Biology, Medical Sciences, Engineering and Environmental Sciences September 16-19, 2019 | 88 Rooms Hotel | Belgrade | Serbia

### Content

- Motivation
- EURATOM-BSS
- Metro Radon: philosophy and structure
- Some results

### Motivation

 Indoor radon: on average, most important contribution to dose from ionizing radiation



- Risk proven by epidemiological studies In Europe estimated about 62,000 lung cancer fatalities per year attributed to Rn [Gaskin et al., Envir. Health Perspectives 125, 5 (2018)].
- Consequence: Limit Rn exposure by regulations, where possible
- For EU: EURATOM Basic Safety Standards (BSS)
- Decisions in Rn policy to ensure compliance with BSS can be economically & politically costly → must be QAed
- Rely on technical steps from measurement to data evaluation, which must be QAed.
- Deficiencies identified  $\rightarrow$  research projects to fill the gaps.

### **EURATOM-BSS**

#### **EURATOM Basic Safety Standards (BSS)**

Council Directive 2013/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L:2014:013:TOC (OJ L, 17.01.2014)

#### Articles dealing with Radon

- Reference level (RL) = 300 Bq/m<sup>3</sup> for workplaces (Art.54) and dwellings (Art.74).
- National Rn Action Plan (Art. 103): to be established by MS, to deal with Rn risk, considering annex XVIII; Rn prevention and RPA.
- Radon priority areas (RPA) (Art. 103) = areas where the annual mean Rn concentration is expected > RL in a significant number of buildings. RPAs to be identified. Motivated by priority principle.
- Art.54: Measurements in workplaces to be carried out in RPA in basement and ground floor room, and considering annex XVIII.
- Art.74: MS shall "promote action" to identify dwellings > RL and "encourage" remediation. MS shall ensure information about indoor Rn exposure, health risks, importance of measuring and possibilities for remediation.
- Revision, update acc. state of knowledge (Preamble 6&11)

Long-term goal: reduction of lung cancer attributable to Rn



mandatory for EU member states (MS): has to be transposed into national law

#### Annex XVIII:

Details about Rn Action plan

- Priority principle (§6)
- Ensure administrative efficiency (§5,11,12)
- Indoor Rn survey and RPA methodology (§1,2)
- Identification of relevant workplaces (§3)
- Remediation and prevention (§7,8,11)
- Communication, information, public awareness (§10)
- Review of action plan (§9)

### Metro Radon - structure

6/2017 – 5/2020, funded by EU Horizon 2020 programme; Organised by EURAMET (Regional Metrology Organisation of Europe); 350 person-months, 2.26 M€.

#### Structure of Metro Radon: 7 Work Packages (WPs)

- Novel procedures for traceable calibration of radon (<sup>222</sup>Rn) measurement instruments at low concentrations = 100-300 Bq/m<sup>3</sup>, with <5% uncertainty (k=1). Reference sources, comparison of Rn gas standards, constant Rn conc. in reference chambers
- 2. Influence of thoron (<sup>220</sup>Rn) on Rn measurement and calibration
- 3. Comparison and harmonization of Rn measurement procedures in Europe Meta-information about Eur. indoor & geogenic Rn surveys, intercomparisons exercises, problem of inconsistencies and possible harmonization
- 4. Radon priority areas (RPA)

Definitions, estimation, uncertainty, relationship indoor – geogenic Rn, Rn extremes, geogenic Rn hazard index (GRHI), retrospective methods

- 5. Validation of traceability of European Rn calibration facilities
- 6. Creating impact

Knowledge transfer, stakeholders, training

7. Management & coordination



WP 1,2,5: classical metrology, WP 3+4: link to BSS requirements.

Details of WPs and WP tasks in <a href="http://metroradon.eu/">http://metroradon.eu/</a>

### Overall goals at end of project and beyond

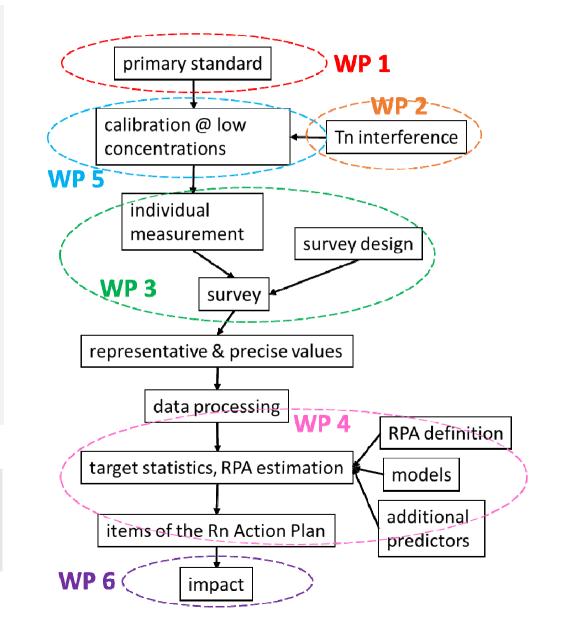
### Main goal: QA in the chain calibration $\rightarrow$ measurement $\rightarrow$ evaluation $\rightarrow$ Rn map $\rightarrow$ decision

- WP 1: A metrological gap in Europe is closed by realizing traceable radon reference atmospheres in the activity concentration range from 100-300 Bq/m<sup>3</sup>, while minimising uncertainties.
- WP 2: Thoron/progenies sensitivity on radon monitors under real conditions and consequences for design of radon surveys are known and possible technical solutions to correct thoron related bias on radon monitors are available.
- WP 3: Overview of radon situation within EU MS and approaches to improve harmonisation of indoor and geogenic data that exist, to harmonise the radon protection standards of the EU citizens.
- WP 4: Methodologies to identify RPA are analysed and further developed to assist MS in the implementation of a quality assured delineation of RPA.
- WP 5: Information about the validation of traceability of the European radon calibration facilities and recommendations on calibration and measurement procedures exist.

### Metro Radon rationale

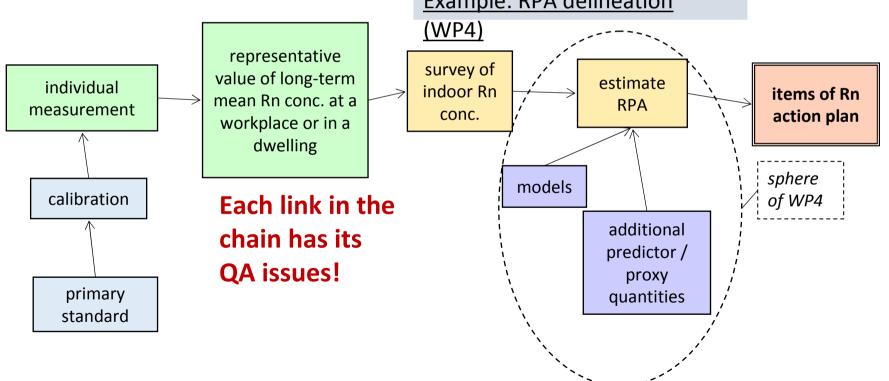
- "supply chain" which leads to a QAed "end product", e.g.,
- Decision about compliance with Reference Levels;
- Delineation of Radon Priority Areas satisfying a certain level of confidence;
- ...
- general: Items of Rn Action Plan
- $\Rightarrow$  All links of the chain must be quality assured!

From the point of view of BSS, not a particular value of Rn conc. is the requested end product, but certain action.



## "Supply Chain"

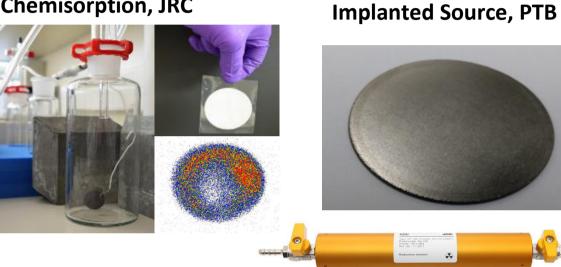
- Pathway from correctly measured individual Rn concentrations to a reliable enduser product, i.e. items of Rn action plans aimed to reduce Rn exposure.
- For the overall purpose of reduction of Rn exposure, one is not interested in actual Rn concentrations; but these being correctly measured, is a condition of the validity of all subsequent aggregation steps, which serve the end-user product.



### Selected results: WP 1

### **Design and use of new sources**

### **Chemisorption**, JRC



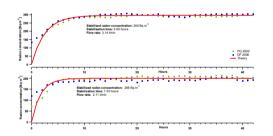
### Flow-through source, CMI

#### <sup>220</sup>Rn flow-through source, CEA



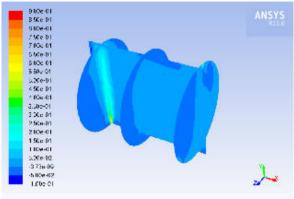
#### New sources in chambers

Evaluate stable and repeatable Rnatmospheres in range 100-300 Bq/m<sup>3</sup>

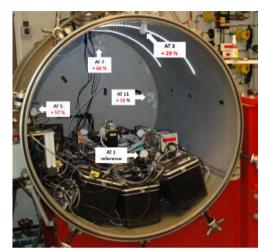




### Selected results: WP 2



Contours of Y Velocity (m5): (Time=5:0011e+02) Ju 04, 2018 ANSYS Fluent 15:0 (3d, do pbms, rise transient) Homogeneity testing of Rn-220 atmosphere (Sofia University)

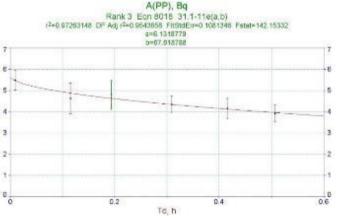


#### Calibration of radon/thoron monitors BACCARA chamber, IRSN



Field measurements to assess influence of thoron (BEV)

Report: Review of potential techniques and materials to reduce the influence of thoron on radon measurements and calibrations; http://metroradon.eu/wpcontent/uploads/2018/07/Review-techniques-to-reduceinfluence-of-thoron.pdf



#### Testing of Rn-220 barriers

- literature review (report available);
- quantitative data obtained for 11 polymeric materials (Sofia University)

### Selected results: WP 3 / 1

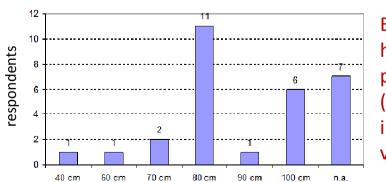
### Questionnaires on indoor and geogenic radon measurement

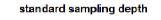
Example: geogenic questionnaire

Questionnaire on geogenic radon surveys Metro RADON Questions about sampling & measuring technique, number of samples available, territorial coverage, definition of "sampling point", sampling depth, permeability measurement, other geogenic quantities, etc. projecti

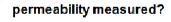
Institutions from 19 countries responded.

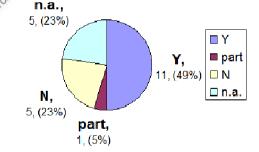
Considerable methodological differences! -Even if most use the Czech protocol or similar.





Evidently, this causes harmonization problems (comparability, interpretability of values)





Ground Permeability is necessary to calculate the empirical geogenic radon potential (GRP)

### Selected results: WP 3 / 2

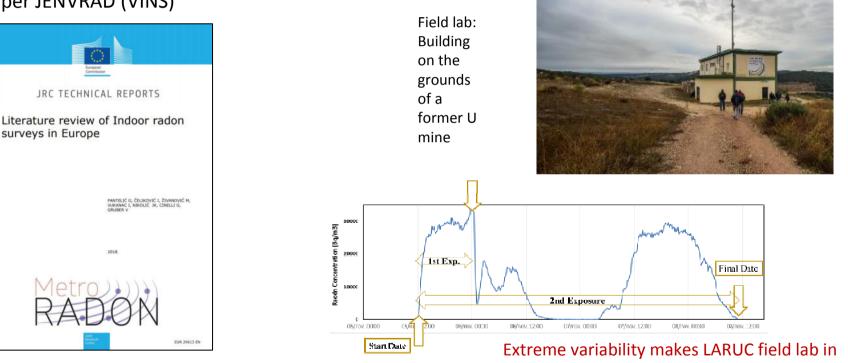
#### Literature Review of Indoor **Radon surveys in Europe**

Published as JRC technical report; paper JENVRAD (VINS)

surveys in Europe

#### Intercomparison exercise under field conditions

LARUC, Spain (UC); 20 participants



#### Report:

http://publications.jrc.ec.europa.eu/repository/ bitstream/JRC114370/jrc114370 final metrora don jrc114370.pdf

Report: http://metroradon.eu/wpcontent/uploads/2019/05/Report WP3 3 3 MetroRADON Int ercomparison final-1.pdf

Saelices El Chico a perfect study site

### Selected results: WP 4 / 1

#### The Geogenic Radon Hazard Index GRHI

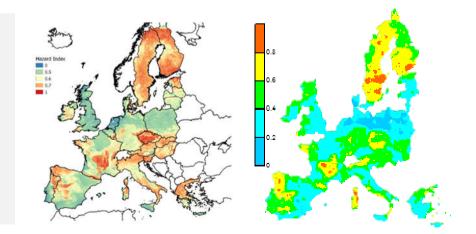
- Concept:
  - A universally applicable tool to quantify the susceptibility of an area to geogenic Rn;
  - A quantity which measures the contribution of geogenic factors to the potential risk that exposure to indoor Rn causes;
  - A quantity which measures the availability of geogenic Rn at surface level;
  - A measure of "Rn proneness" or "Rn priorityness" of an area due to geogenic factors.
  - It shall serve as quantity to compare the geogenic radon hazard at different locations. A European GRHI map can be generated which may serve to delineate radon priority areas on European scale.

#### • Properties:

- The GRHI should be independent of regionally available datasets;
- still, if possible taking advantage of the information contained in them;
- it should be applicable irrespective borders.
- Most importantly, it should be an optimal predictor for the geogenic contribution to indoor Rn.

#### 2 trials with different methods:

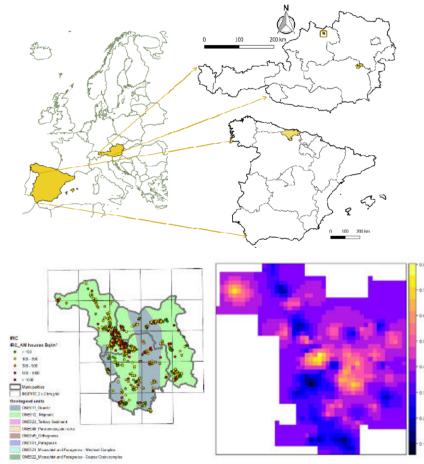
- Left: MARS machine learning, predictors: petrography, hydrogeological classes, hydraulic conductivity soil type, silt and clay content, available water capacity, coarse fraction, bulk density, geographical location.
- Right: GLM, predictors: simplified geology, fine fraction, soil pH, bulk density, K2O and In(U) conc.
   Patterns quite similar!



### Selected results: WP 4 / 2

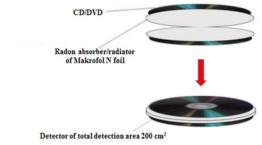
#### **Radon mapping exercise**

3 regions in Austria and Spain, different size, different Rn characteristic; employ different mapping methods (AGES)



### Testing of CD/DVDs as retrospective radon detectors for radon mapping

Improvement of methodology (Sofia University) and long-term exposure at LARUC (UC); Usability for RPA delineation?





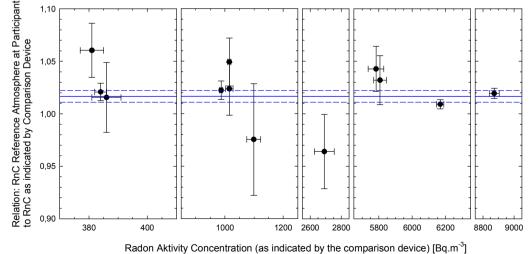
### Selected results: WP 5

dress, tel. no. and e-mail, scientists/operators, contact perso	n:			
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In case of a public-law or private organization: What is the main business field (e.g. education and train health, occupational health and safety)?	ing, environmental protection,	, public		
calibration procedures accredited by some institution? If yes: Which institution is it?	🗆 Yes	□ No		
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Questionnaire for identification and evaluation of European radon calibration facilities (CMI) Intercomparison exercise with reference instrument in different calibration facilities

(Alpha Guard, 400, 1000, 6000 Bq/m<sup>3</sup>), BfS





### Achievements WP 6 - Impact

- Target: at least 10 conference presentations (status 9/2019: about 30)
- At least 10 peer reviewed papers (status 9/2019: 5 published, several in prep.)
- 2 newsletters per year (status: 4 newsletters and status reports; next: Autumn 2019) – subscription at website!
- Newsletter, reports, presentations, papers etc. – available at website: www.metroradon.eu

#### metroRADON RADON **3rd NEWSLETTER** MetroRADON Partnership esearch Project MetroRADON **BEV-PTP:** Physikalisch-Technischer Prüfdien mts für Eich- und Vermessungsv Radon Monitoring) started in tria (coordinator) is funded within the European **BFKH:** Budapest Főváros Kormányhivatala ramme for Innovation and Re-The purpose of the project is CEA: Commissariat à l'énergie atomique et aux ole techniques and methodoloénergies alternatives, Franci traceable radon activity con CMI: Cesky Metrologicky Institut, Czech Republic ements. More information the MetroRADON website IFIN-HH: Institutul National de Cercetare-De tare pentru Fizica si Inginerie Nucleara "Horia Hulubei", Romania ance and topicality of the subrtium of 17 partners from Na-PTB: Physikalisch-Technische Bundesanstalt, Ger ev Institutes and research instiaded with currently seven offi-STUK: Sateilyturvakeskus, Finland ng institutions and an Industry VINS: Institut Za Nuklearne Nauke Vinca Serbia of 26 companies was initiated. AGES: Österreichische Agentur für Gesundheit und operations with existing net-Welcome to MetroRADON Ernährungssicherheit, Austria earch programmes were estab-RADON interest in collaboration and in RK: Bundesamt für Strahlenschutz Germany The Durations, Ont and Directive and Am (EUD/J7004 (EU-2005) modes new challenges for MetroRADON confirms the im-CLOR: Centralne Laboratorium Ochrony Radiolofor other up, of other masses or do and other has hit hereps. He for find they, for gicznej, Poland e project for a variety of Eurosponse of the public states (by radiation) the part of legal mattering in the paper size. For IU nember mate levels of relevant activity concentration can are lott down in the DUlers in the field of radon. First re-IRSN: Institut de Radioprotection et de Surete N some distances ESS shall not record some fighted, now redited for preventions for eithling removability ented at several conferences all leaire, Franci and an analysis with these families because ground states have balle developed. nd are available as reports on the JRC: Joint Research Centre - European Commiss hered point website The 302 will provide 52 travelike metrological resources (collocation, and metaarcheed) er highlights some actions from SUJCHBO: Státní ústav jaderné, chemické a biologhas it is an attack as a first which we add of a first take to be a section of an attack as a section ické ochrany, v.v.i., Czech Republic the new 11-108 in Europe. In a dollars, the compaction of the partiest will contribute to the project and lists some of the SUBG: Sofiiski Universitet Sveti Kliment Ohridski, activities. Details of the project the courdon of metrological influenceuts for rulog in Dances sections for the LOUIS COM explanation of the redenantice plan requester to the new European Directive. Bulgaria esults are discussed in the "Stat can also be found on the web-UC: Universidad de Cantabria, Spain tioned material is available on Register your enabling receive the methodological residence METAS- Fidgenössisches Institut für Metrologie section of the MetroRADON Radiation of the local discourse for the end of Named 1 (10) of the process research of providing and ectly linked in this newsletter the overage radius level in the country (WAN), that sheet Wangs, actual, our stanges, this MetroRADON collaborators corresponds to about the to the Grouperd people dying per year by local means classed by sides represent the logil logic methods of the new DLDWS defenses and exight have t erested in collaborating with **DiMEILA Centro Ricerche INAIL, Ital** Schmid<sup>1</sup> or want to join the Industry Inlasts of adapt protection for Parameter object. The in one of the main the object cover EURADOS, international the new RU-ROS, which have to be implemented by national legislatives in the coming lease contact us! Istituto Superiore di Sanità, Ital -Redonova Sweden Hannah Wiedner, JRP coordinator University of Babes-Bolyai, Romani Bundesamt für Eich- und Vermessungsw Universidade de Coimbra, Portugal Physikalisch-Technischer Prüfdienst contact@metroradon.eu University of Novi Sad, Serbia

50%

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EMPIR

#### Research Gate

MetroRADON - Metrology for Radon Monitoring (EMPIR 16ENV10)

🦚 F. J. Maringer · 🔘 Philippe Cassette · 🔘 Nathalie Michielsen · <u>Show all 41 collaborators</u>

**Goal:** 1. Development of novel procedures for the traceable calibration of radon (222Rn) measurement instruments at low activity concentrations (100 Bq/m3 to 300 Bq/m3) with relative uncertainties  $\leq$  5 % (k=1)

### WP 6 – Impact / 2

### Stakeholder involvement

- National Authorities
- European and International Bodies (IAEA, WHO, ERA, ICRP, IRPA, HERCA, EURADOS etc.)
- Standard Bodies and Committees
- Industry: Industry Interest Group has been formed, workshop summer 2019 (PTB)

### Workshops & training for interested stakeholders in 2020:

- Workshop for results of WP2/WP3/WP4; combined with JRC-workshop (national authorities, scientific sector) 25.-28. February 2020, Vienna (AGES, JRC)
- Workshop for results of WP1/WP2/WP5 (industry, authorities, scientific sector) 12. May 2020, Berlin (PTB)
- Training seminar for radon instrument calibration and measurements WP2/WP5 (end users)
  13. May 2020, Berlin (UC)

### You are invited to collaborate and to follow the project!

#### 17 partners, 9 collaborators

- AGES Austrian Agency for Health and Food Safety & National Radon Centre
- BEV Austrian metrology institute
- BFKH Hungarian metrology institute
- BfS German radiation protection authority
- CEA French atomic energy commission, Laboratoire Henri Becquerel = national metrology institute
- CLOR Polish central laboratory for radiological research
- CMI Czech metrology institute
- EURADOS European Radiation Dosimetry Group
- IFIN-HH Romanian metrology institute
- INAIL Italian national institute for labour security
- IRSN French radioprotection authority
- ISS Italian health institute,
- JRC Joint Research Centre of the European Commission
- Life-RESPIRE consortium
- LNR Coimbra Laboratory for natural radioactivity, university Coimbra, Portugal
- METAS Swiss metrology institute
- PTB Physikalisch-technische Bundesanstalt
- Radonova, Sweden
- SMU Slovak institute of metrology
- STUK Finnish radiation & nuclear safety authority
- SUBG Sofia university, Bulgaria
- SÚJCHBO Czech National Institute for Nuclear, Chemical, and Biological Protection
- UBB Babes Bolyai university, Cluj, Romania
- UC University of Cantabria, Spain; LARUC Laboratory of radioactivity
- UNS University Novi Sad, Serbia
- VINC Vinča institute of Nuclear Science, Serbia



# Thank you!





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http://metroradon.eu/