Executive Summary

The 3-year Research Project MetroRADON (Metrology for Radon Monitoring), funded within the European Metrology Programme for Innovation and Research (EMPIR) will come to its end in May 2020.

The purpose of the project is to develop reliable techniques and methodologies to enable SI traceable radon activity concentration measurements. More information can be found on the MetroRADON website.

The results gained within the project need to be shared and discussed with the stakeholders. Results were already presented at several conferences all over Europe and published in reports and peer reviewed papers. More dissemination activities will follow in the next months. Two workshops and a training course will take place to inform the relevant stakeholders to present the MetroRADON results – we hope you will join us!

The final phase of the project has started and all results including the final report will be shared with you at the end of the project. We will inform you in the last Newsletter in May this year.

This newsletter highlights some recent actions from the project, lists some of the dissemination activities and announces the upcoming MetroRADON events. Details of the project tasks and results are discussed in the "Status Report" that can also be found on the website. All the mentioned material is available on the Document section of the MetroRADON website and directly linked in this newsletter.

MetroRADON collaborators

DiMEILA Centro Ricerche INAIL, Italy

EURADOS, international

Istituto Superiore di Sanità, Italy

LIFE-Respire-Consortium, international

Radonova, Sweden

University of Babeș-Bolyai, Romania

Universidade de Coimbra, Portugal

University of Novi Sad, Serbia

Partnership

BEV-PTP: Physikalisch-Technischer Prüfdienst des Bundesamts für Eich- und Vermessungswesen, Austria (coordinator)

BFKH: Budapest Főváros Kormányhivatala, Hungary

CEA: Commissariat à l'énergie atomique et aux énergies alternatives, France

CMI: Cesky Metrologicky Institut, Czech Republic

IFIN-HH: Institutul National de Cercetare-Dezvoltare pentru Fizica si Inginerie Nucleara "Horia Hulubei", Romania

PTB: Physikalisch-Technische Bundesanstalt, Germany

STUK: Sateilyturvakeskus, Finland

VINS: Institut Za Nuklearne Nauke Vinca, Serbia

AGES: Österreichische Agentur für Gesundheit und Ernährungssicherheit, Austria

BfS: Bundesamt für Strahlenschutz, Germany

CLOR: Centralne Laboratorium Ochrony Radiologicznej, Poland

IRSN: Institut de Radioprotection et de Surete Nucleaire, France

JRC: Joint Research Centre - European Commission, Europe

SUJCHBO: Státní ústav jaderné, chemické a biologické ochrany, v.v.i., Czech Republic

SUBG: Sofiiski Universitet Sveti Kliment Ohridski, Bulgaria

UC: Universidad de Cantabria, Spain

METAS: Eidgenössisches Institut für Metrologie, Switzerland

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

HIGHLIGHTS

Upcoming MetroRADON workshops and training course

To present the results of MetroRADON, two workshops and a training course will take place in spring 2020. We invite all our stakeholders from national authorities, industry, scientific sector, end users and all other interested parties to participate!

25-26 February 2020, Vienna

Workshop about "Harmonisation of radon measurement methodologies and radon priority areas" (results of WP2/WP3/WP4). This workshop will be part of the European Radon Week 2020. More details can be found in the first announcement.

This workshop is already fully booked! Presentations and summary will be provided after the workshop on the MetroRADON website and in the next newsletter!

12 May 2020, Berlin

Workshop "New procedures for radon monitoring" – Results of MetroRADON WP 1/WP2/WP5

13 May 2020, Berlin

Training seminar for radon instrument calibration and measurements (WP2/WP5).

We invite all our stakeholders from national authorities, industry, scientific sector, end users and all other interested parties to participate.

More details can be found here. We will share the first announcement and the registration details with you as soon as they are out!

Overview and analysis of indoor and geogenic radon surveys

The results of the literature research and the additional carried out survey via questionnaires on performed indoor radon and geogenic radon surveys in Europe are summarised in the *"Report on indoor and geogenic radon surveys in Europe, including their strategies, the methodologies employed, inconsistencies in the results, and potential methodologies to harmonise data and reduce inconsistencies"* which will be published soon.

Main conclusions from both literature overview and questionnaires on performed indoor radon surveys in Europe are that overall design of surveys are quite diverse and that it is difficult to find two completely same approach to survey. Often, some of the critical information regarding the design is missing and make it hard to evaluate the survey. By looking at three main aspects of the survey: design, measurement methods and data analysis, it can be summarised that the designs of surveys performed in Europe are not comparable, the measurement methods are comparable between surveys and data management, statistical analysis and mapping are somewhere in the middle.

The main findings regarding geogenic radon surveys are, that relatively much information is available on the status of geogenic Rn surveys in European countries, as well as about methodology. On the other hand not many countries have embarked into geogenic Rn surveys and therefore European coverage is poor. Surveys and data sets about quantities are available in many countries, which can serve as predictors (U concentration) or proxies (ADR-Ambient Dose Rate) of the Geogenic Radon Potential.

Stability testing of long-term operation of a radon chamber

The stability and the reproducibility of low activity radon concentration for long-term operation in the IRSN radon chamber BACCARA was tested. The traceability of the radon activity concentration to a radon standard is done via an AlphaGuard, calibrated with a radon gas standard (coming from LNH). The relative combined standard uncertainty on the radon activity concentration was under 5 % (k=1). Example of the readings of two different instruments is shown in Figure 1.

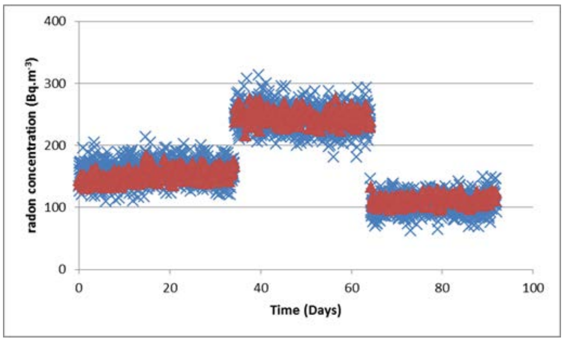

Fig. 1: Reading of two different instruments in radon chamber BACARA at IRSN

Comparison of existing radon gas primary standards according to CCRI(II) rules

The ^{222}Rn comparison within MetroRADON (registered at EURAMET under the number 1475 and at BIPM as EURAMET.RI(II)-S8Rn-222) has been carried out and results were reported and agreed by the participants (Figure 2). The report will be available at the MetroRADON website soon!

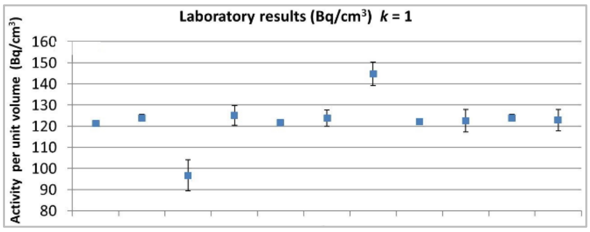

Fig. 2: Reported and agreed results by the participants from the comparison (EURAMET 1475; EURAMET.RI(II)-S8Rn-222).

Cross-interference testing of radon instruments in the thoron chamber

Cross-interference testing of radon instruments was done in the STUK thoron chamber. The active instruments tested are: AlphaGuard, AlphaE, Corenium Pro, Airthings Wave, Airthings Wave plus, Corentium Home, RadonEye RD200, RadonEye +2. The passive detectors tested include: AlphaRadon (Ireland), Radonova (Sweden), Eurofins Environment Testing (Sweden), STUK (Finland). In addition an experimental study of thoron cross-interference in SUBG radon/thoron exposure facility of 6 active and 10 passive radon monitors was carried-out. The results of the experiments are under data processing and the full analysis. Results will be shared at MetroRADON website as soon as available!

Radon priority areas based on the occurrence of extreme indoor radon concentration

A complementary approach to define radon priority areas (RPA) could be by identification through presence of very high indoor Rn concentrations, i.e. possibly several 1 000 Bq/m³. The method was tested in France and Spain, where such cases occur regionally. In France, extremes in high-background (BG) areas were distinguished from ones in comparatively low BG areas. The latter are called *outliers*, because they appear not to belong to the BG population. Three classes of BG had been defined previously on geogenic criteria as basis for the French radon action plan (Figure 3). In high BG areas, extremes occur mainly in certain granite of the Variscan orogeny. In low-BG regions, particular karstic limestone areas are affected by radon extremes. In Spain, affiliation of radon extremes with geology seems more complicated: The frequency of extremes is high in the Variscan part of the Iberian Peninsula, and also in instances in little-suspect geological regions. The analysis suffers from partly low sampling density, in particular in regions not previously suspected as RPA. Therefore, the probability to find an extreme if its there, is lower than if sample size was higher. Still, the results highlight that also areas which have not been delineated as of high radon priority, cannot be understood as free from radon hazard, and should therefore also be given appropriate attention in radon policy.

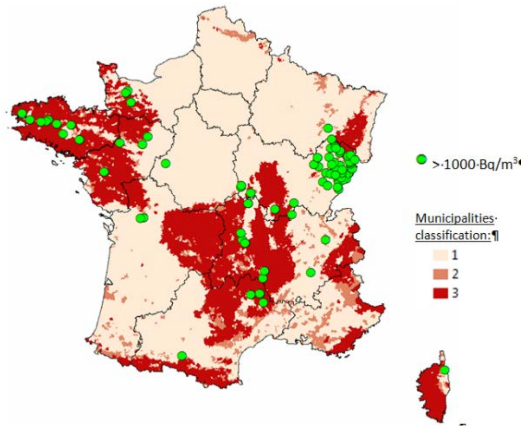

Fig. 3: Locations of radon outliers in French areas of class 1 and 2, i.e. areas not defined as RPA.

Comparability testing of short-term and long-term radon measurement data

To assess the feasibility of data merging and data expansion of short-term and long-term radon measurement data, some analysis were performed. Data sets from Belgium, Austria and Italy were used for this exercise. In Italy indoor radon measurements were carried out in 24 buildings with two systems at the same location (electret and track etch). The exposure time for electret was 1 week, for track etch 2 months. Figure 4 shows, that the two populations have similar distributions and in both cases the p-value of the t-test is far higher than 0.05 which suggests that the two populations are similar. But still for one sample location the two measurement techniques may show significant differences.

For Austria and Belgium data from national and regional surveys with different measurement methods were evaluated for their comparability and potential for merging. For Belgium, it was concluded that the merging is feasible, while for Austria the comparability was not sufficient. Additional evaluations are ongoing and more details will be summarised in a report and shared at the MetroRADON website as soon as available.

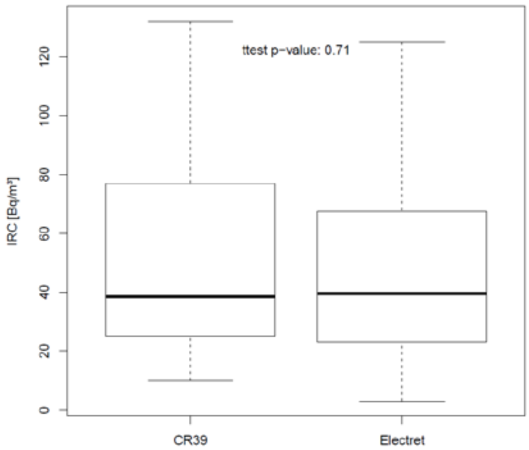

Fig.4: Indoor radon concentrations (IRC) distribution measured with CR 39 and Electret devices at same measurement locations

MetroRADON inter-laboratory comparison

The MetroRADON inter-laboratory comparison to validate the traceability, performance and precision of European radon calibration facilities is nearing completion.

In the last 2 years, 15 institutions calibrating measuring instruments for the quantity radon activity concentration in air have participated in the comparison. The participating facilities are located in 13 European countries, which provides an excellence cross-section to validate the performance in terms of the measurement quality for radon in the air in Europe.

An electronic radon instrument AlphaGuard as transfer comparison device was sent consecutively to each of the participating facilities. The facility exposes the device to radon atmospheres with activity concentrations of about 400 Bq/m³, 1000 Bq/m³ and 6000 Bq/m³. The average value of the radon activity concentration indicated by the transfer comparison device is set in relation to the reference value determined by the facility for the respective radon atmosphere. These ratios are used to evaluate the closeness of agreement between the calibration results.

Figure 5 shows the preliminary results. The dispersion of the values decreases with increasing the level of the radon activity concentration. For a concentration level of 400 Bq/m³ the dispersion is up to 10 % around the mean ratio across all participants; for a concentration level of 6000 Bq/m³ the dispersion reduces to about 5 %. At higher concentrations, the standard uncertainties reported by participants also decrease. The figure shows preliminary assessment including standard uncertainty; each of the diagrams shows a different concentration level; each colour represents the results of a participating facility; blue line: mean ratio across all participants for the respective concentration level including standard uncertainty (dashed line).

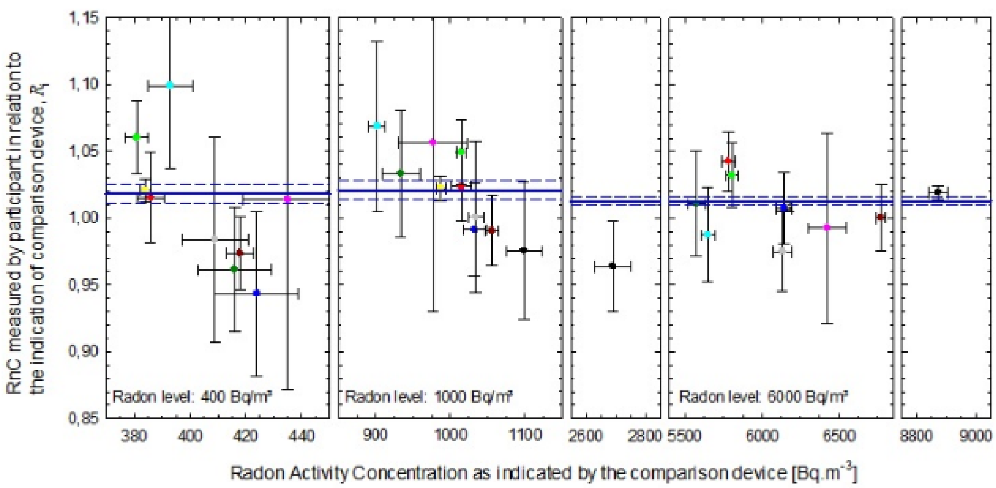

Fig. 5: The radon activity concentration (RnC) measured by the participant in relation to the indication of the transfer comparison device (AlphaGuard) provided by BfS

MetroRADON – publications

MetroRADON results were presented at several **conferences**, e.g. 33rd International Radon Symposium AARST 2019 , September 2019, Denver, USA; 9th International Conference on Protection against Radon at Home and at Work, September 2019, Prague, Czech Republic

Several open access **peer-reviewed papers** were published by MetroRADON partners:

Pressyanov, D., Dimitrov, D., 2020. The problem with temperature dependence of radon diffusion chambers with anti-thoron barrier. Romanian Journal of Physics 65 (1-2), in press.

Mertes, F., Röttger, S., Röttger, A., 2020. A new primary emanation standard for Radon-222. Applied Radiation and Isotopes 156 108928, in press.

Sahagia, M., Stanescu, G., Luca, A., Antohe, A., Calin, MR., Radulescu, I., 2019. Education and training tradition at IFIN-HH in radon measurement and evaluation of its radiological impact. Romanian Reports in Physics 71 (4) 906.

Maringer FJ., Wiedner H. and Cardellini F., 2020. An innovative quick method for tracable measurement of radon-222 in drinking water. Applied Radiation and Isotopes 155, 108907.

Sabot, B., Rodrigues, M. and Pierre, S., 2020. Experimental facility for the production of reference atmosphere of radioactive gases (Rn, Xe, Kr, and H isotopes). Applied Radiation and Isotopes 155, 108934.

Bossew, P., 2019. Radon priority areas and radon extremes – Initial statistical considerations. Radiation Environment and Medicine 8(2), 94-104.

Georgiev, S., Mitev, K., Dutsov, C., Boshkova, T., Dimitrova, I., 2019. Partition Coefficients and Diffusion Lengths of ^{222}Rn in Some Polymers at Different Temperatures. International Journal of Environmental Research and Public Health 16(22), 4523.

Pressyanov, D., Santiago Quindos Poncela, L., Georgiev, S., Dimitrova, I., Mitev, K., Sainz, C., Fuente, I., Rabago, D., 2019. Testing and calibration of CDs as radon detectors at highly variable radon concentrations and temperatures. International Journal of Environmental Research and Public Health 16(17), 3038.

Presentations, posters and reports can be also found in the Documents Section on the MetroRADON website.

MetroRADON – upcoming events

MetroRADON **workshops** and **training course**:

Workshop "New procedures for radon monitoring", Berlin, 12 May 2020

Training seminar for radon instrument calibration and measurements (WP2/WP5), Berlin, 13 May 2020

More details can be found in the Upcoming Activities Section on the MetroRADON website.

Further information and contact

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Fig. 6: The MetroRADON consortium at project meeting in Paris, September 2019