Executive Summary

The 3-year Research Project MetroRADON (Metrology for Radon Monitoring) started in June 2017 and is funded within the European Metrology Programme for Innovation and Research (EMPIR). The purpose of the project is to develop reliable techniques and methodologies to enable SI traceable radon activity concentration measurements. More information about the tasks of the project can be found in the 1st newsletter and on the MetroRADON website. First results were discussed already in the previous status reports and highlight newsletters, which can be found on the MetroRADON website.

Due to the relevance and topicality of the subject, the consortium of 17 partners from national metrology institutes and research institutes was expanded with currently 8 official collaborating institutions and an Industry Interest Group of 29 companies was initiated. In addition, co-operations with existing networks (e.g. EURADOS) and research programmes were established. The high interest in collaboration and in the topics of MetroRADON confirms the importance of the project for a variety of European stakeholders in the field of radon.

This status report describes the status and work done so far in the project, focused on the latest results structured by work packages. In addition some of the dissemination activities at conferences and first reports are listed and linked. The highlights are summarized also in the 5th Newsletter. The project will come to its end in May 2020. The final phase 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.

All the mentioned material is also available on the MetroRADON website and directly linked in this status report.

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Workshops and Training course to present and discuss the MetroRADON results

To present the results of MetroRADON, two workshops and a training course will take place in 2020.

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, which is composed by the European Commission JRC workshop about “Challenges in the implementation of EU-BSS” (*27-28 February 2020, Vienna)* and the European Radon Association (ERA)-workshop on “Radon Research” (*24 February 2020, Vienna*). 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 WP1/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!

Development of novel procedures for the traceable calibration of radon measurement instruments at low activity concentrations (WP1)

The aim of work package 1 (WP1) is (i) to develop radon gas activity standards for the realization of reference fields for radon activity concentration in air, (ii) to undertake two CCRI(II) comparisons of existing radon gas primary standards at different European NMIs/DIs for ^{222}Rn and ^{220}Rn in the range of a few kBq and (iii) to develop novel procedures in order to calibrate radon measurement instruments traceable to primary standards in a range of activity concentrations (100 Bq/m^3 to 300 Bq/m^3) with relative uncertainties ≤ 5 % (k=1). This activity range is relevant for regulations defined by the European Council Directive 2013/59/EURATOM for indoor radon concentrations at workplaces (article 54) and dwellings (article 74).

A main part of WP1 is the development of emanation sources with constant, stable emanations and activity measurements of the emanated radon traceable to primary standards.

PTB has produced new emanation sources based on electrodeposition and ion implantation of ^{226}Ra. First measurements of the emanation stability of ^{222}Rn from implanted ^{226}Ra sources show excellent stability against changes of humidity. The evaluation of the emanation stability of electrodeposited ^{226}Ra also against changes of temperature are ongoing at PTB. To determine the emanation coefficient from gamma ray spectra of the ^{226}Ra sources, PTB currently conducts the feasibility of using Bayesian methods to determine the emanation coefficient and associated uncertainties of the ^{222}Rn emanation. The measurements are performed using portable, solid-state scintillation detectors and commercially available systems-on-a-chip (SoCs).

CEA has prepared emanation sources of ^{222}Rn and ^{220}Rn with a relative standard uncertainty of 2 %. ^{226}Ra and ^{228}Th liquid sources were respectively used to prepare these sources by precipitation techniques. The powder of the precipitation is safely placed between 2 filters and composes the emanation source. The influence of the humidity, temperature, and air pressure on the emanation rate was investigated.

CEA has also developed and tested a method for direct and traceable measurement of the activity concentration of ^{222}Rn and ^{220}Rn in an air flow. The device is composed by a loop inside which the gas circulates. The device is already in use for measurements.

CMI with the help of SUJCHBO have developed and tested a long term stable radon low activity emanation flow-through source based on a mass flow controller. Radon is released from the solid phase with high emanation power (0.998(10)). The radon source (emanator) is in the form of polymer foil on a stainless-steel plate and is enclosed in an aluminium alloy cylindrical case equipped with two ball valves at each end and placed in the middle of the case.

Several comparisons of new produced sources with each other and with the measurement in an air flow as well as with ^{222}Rn gas standards are currently performed at CEA.

Within another main aim of WP1, comparisons of existing radon gas primary standards at European NMIs/Dis in the few kBq range have been performed. The ^{222}Rn comparison is registered at EURAMET under the number 1475 and at BIPM as EURAMET.RI(II)-S8Rn-222. The samples have been measured and reported by the participants. They agreed on these results shown in Figure 1. Currently the participants are describing their method in order to clarify the report. The report will be available at the MetroRADON website when finished.

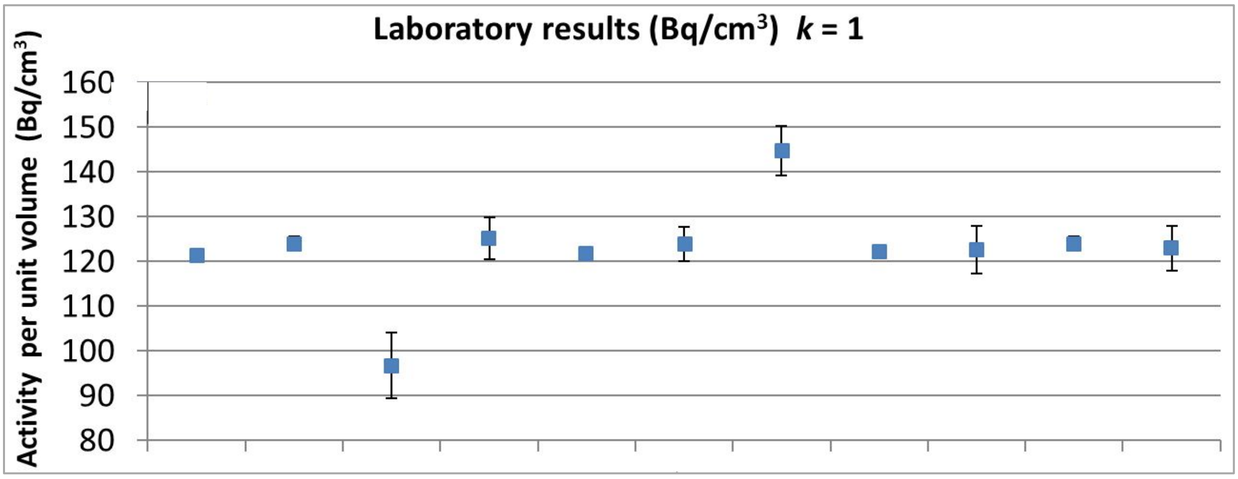

Figure 1: Reported and agreed results by the participants from the comparison (EURAMET 1475; EURAMET.RI(II)-S8Rn-222).

At the very moment, a comparison for ^{220}Rn activity is ongoing at the LNHB facility, applying the LNHB measurement set-up for quantifying ^{220}Rn in a gas-flow as well as in parallel the PTB method of measurements of the ^{220}Rn emanation from electrodeposited ^{228}Th sources.

A third main aim of WP1 is the development of traceable procedures for the calibarion of radon measurement instruments at low activity concentrations. Parallel to the source developments, the work is under way at the calibration chambers to ensure that the new emanation sources can be included into radon tight gas circuits at the different calibration chambers.

SÚJCHBO, v.v.i. developed the new calibration procedure for calibration of continuous measuring devices in the time stable radon atmosphere in the range of radon activity concentration from 100 Bq/m^3 to 300 Bq/m^3. The document "Intercomparison of European radon calibration facilities in the reference radon chamber of SUJCHBO" and was distributed to all the intercomparison participants in advance. The uncertainty for the new calibration procedure was calculated. The expanded uncertainty (k=2) is 2 %, according to EA 04/02. This new calibration procedure is applied in the WP5 (Validation of traceability of European radon calibration facilities) in this time. From the September 2019 to March 2020 eight European laboratories are participating in the intercomparison measurement.

The presentation "The equipment for testing of measuring devices at the low-level radon activity concentration" was presented at the 9th International Conference on Protection against Radon at Home and at Work in Prague (September 16 – 20, 2019). The presentation is available at the Documents Section at the MetroRADON website.

Already in the last newsletter, BfS reported on the establishment of a reference facility for the performance of the quantity radon activity concentration in air on a high metrological level, which serves to disseminate the quantity by calibration to European reference laboratories. Using a radon emanation source provided by the Czech Metrology Institute (CMI), the reference facility particularly enables stable and reproducible concentrations in the range below 300 Bq/m³. The radon activity concentrations can be adjusted and kept constant over a long period of time with an uncertainty of about 1,9 % (K=2).

The reference facility was used to calibrate an instrument (calibration object: AlphaGuard DS2000) for WP5. For this purpose, the instrument was exposed to four different radon activity concentrations in air within a range between 100 Bq/m³ and 300 Bq/m³. Each of the set radon values was kept constant for about four days. The indications of the instrument are linear correlated with the activity concentrations (Figure 2). The calibration factor *k* is defined as

$$k = \frac{R_\text{S}}{C_\text{ref}},$$

with R_s as being the indication of the calibration object corrected for temperature and air pressure, and C_ref as the reference activity concentration. The calibration factor *k* was derived from the linear regression

$$R_\text{S} = a_0 + kC_\text{ref}$$

by a least square fit. A calibration factor of 1.028 ± 0.008 was determined. The uncertainty is given here for a coverage factor of K=1 (standard uncertainty). The relative standard uncertainty is about 0.8 %, and thus below the target uncertainty of 5 % (K=1) for low radon concentrations as required by the objectives of the EMPIR project. The considerations on the uncertainty assume that the contribution of the reference radon activity concentration C_ref to the uncertainty is low compared to the variations of the instrument indications, R_s. Thus the uncertainties of C_ref are already contained in the variations of R_s and an explicit consideration of these is not necessary.

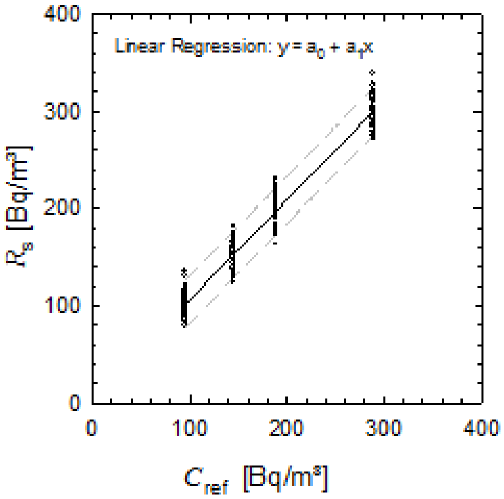

Figure 2: Indications R_s of the calibration object vs. reference activity concentration (dashed lines show the prediction interval).

The Swiss reference test site for the realization of reference atmospheres for radon activity concentration in air is located at Federal Institute of Metrology METAS. The radon test site consists of the following modules: Carrier gas, Mass-flow controllers, ^{226}Ra emanation sources, Radon chamber

Due to a constant volume flow through the ^{226}Ra emanation source, the test site produces a time-stable and traceable radon reference atmosphere inside the chamber. The activity concentration level of radon inside the chamber is controlled by adjusting the volume flow. Inside the chamber, long-term stable radon concentration levels between 300 and 100,000 Bq/m^3 can be established. The chamber is equipped with monitoring instruments for temperature, air pressure and humidity. Figure 3 presents the calibration sequence of a radon measurement instrument. The instrument background level was measured in a radon free atmosphere. Afterwards the instrument was calibrated at three different radon reference concentration levels: 300, 2000 and 15000 Bq/m^3. After the stabilisation time of the radon atmosphere, the radon concentration level was kept constant for more than four hours. The deviation of the instrument is within <4 % from the calculated reference concentration level.

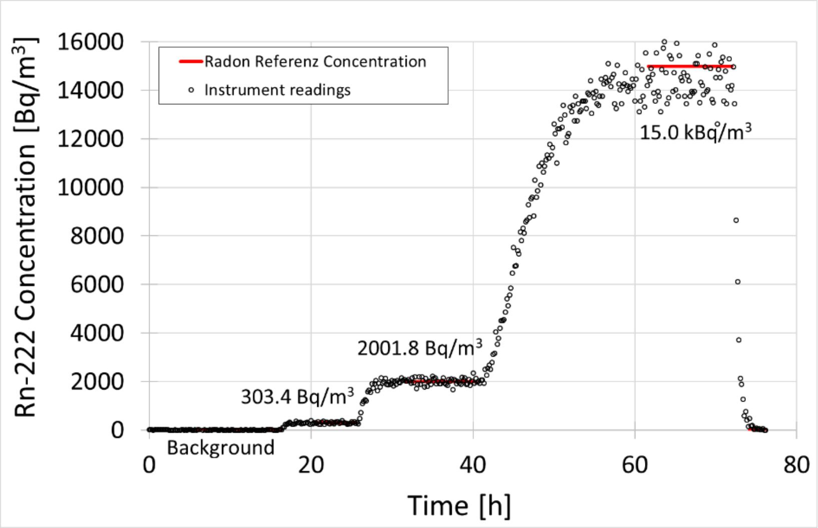

Figure 3: Calibration sequence of a radon measurement instrument at METAS reference test site

IRSN investigated the stability and the reproducibility of low activity radon concentration for long-term operation in its radon chamber BACCARA. 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 4.

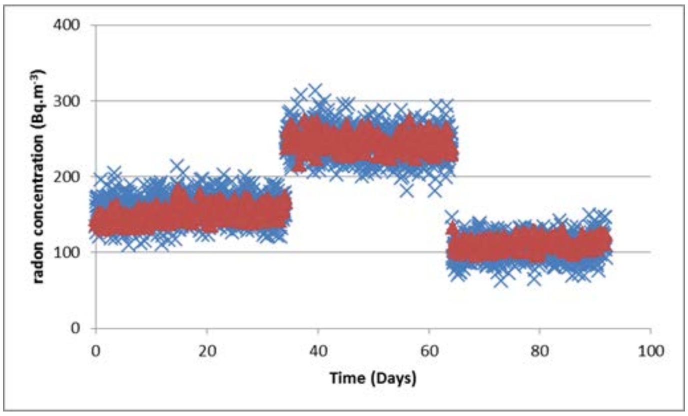

Figure 4: Reading of two different instruments in radon chamber BACARA at IRSN

IFIN-HH wrote a first version of a general calibration procedure for radon measuring instruments, in a wide range of activity concentrations, including for the requested interval of (100-300) Bq m^{-3}. The procedure is included in the quality management system.

IFIN-HH had several recent dissemination actions - ICRM EB meeting and the General seminar at IFIN-HH, an article published and several presentations at a workshop of the department (see below).

Influence of thoron and its progeny on radon end-user measurements and radon calibrations (WP2)

The aim of WP2 is to investigate and reduce the influence of thoron (^{220}Rn) and its progeny on radon (^{222}Rn) end-user measurements and radon calibrations.

STUK has made the cross-interference testing of radon instruments in their 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). SUBG has carried-out experimental study of thoron cross-interference in SUBG radon/thoron exposure facility of 6 active and 10 passive radon monitors. Results of the experiments carried-out in STUK and SUBG are under data processing and the full analysis will be completed as all participants that provided instruments/detectors for testing send their protocols with results.

SUBG and BEV-PTP have studied experimentally the response of radon/thoron measurement instruments at different environmental temperatures (between 5 ^{0}C and 45 ^{0}C) in thoron, radon and radon+thoron atmospheres. The experiments were carried-out in the SUBG radon/thoron exposure facility. The tested instruments were the monitors AlphaGuard PQ2000 PRO capable to measure both radon and thoron. These instruments are used as reference radon/thoron monitors for experiments/tests made in SUBG and BEV-PTP within MetroRADON.

SUBG has completed the analysis of experiments on the partition coefficient and diffusion of radon in different plastics within the temperature range of 5-31 ^{0}C. The results were published (open access) in International Journal of Environmental Research and Public Health.

SUBG has studied different possible applications of the invention made within MetroRADON (Bulg. Pat. Appl. Reg. Nr. 12897/19.03.2019). Experiments were made with detectors that use Makrofol N and such based on activated charcoal. Results were presented at the 33rd AARST International Radon Symposium, 9-11 September 2019, Denver, CO, USA and at the 9th Conference on Protection against Radon at Home and Work, 16-20 September 2019, Prague, Czech Republic.

Outcomes of WP2 for the second half of 2019 were reported as follows:

Two open access articles were accepted for publication/published in peer-reviewed journals: S. Georgiev, K. Mitev, C. Dutsov, T. Boshkova, I. Dimitrova. Partition Coefficients and Diffusion Lengths of ^{222}Rn in Some Polymers at Different Temperatures. *International Journal of Environmental Research and Public Health*, 16 (2019) 4523; D. Pressyanov, D. Dimitrov. The Problem with Temperature Dependence of Radon Diffusion Chambers with Anti-Thoron Barrier. Romanian Journal of Physics (in press)).

An oral presentation entitled: Highly Sensitive Passive Detectors for Short-Term Pre- and Post-Mitigation Measurements (by D. Pressyanov) was presented at the 33rd International Radon Symposium AARST 2019 ,9-11 September 2019, Denver, CO, USA and the full-text paper was accepted (after peer-review) for publication in the on-line Proceedings (open access).

An oral presentation entitled: Highly Sensitive Passive Radon Detector with Compensated Temperature Dependence and Thoron Interference (by D. Pressyanov, D. Dimitrov, I. Dimitrova) was presented at the 9th International Conference on Protection against Radon at Home and at Work, 16-20 September 2019, Prague, Czech Republic.

All contributions are available at the Documents Section at the MetroRADON website.

Comparison and harmonization of radon measurement methodologies in Europe (WP3)

The aims of WP3 are (i) to collect and analyse meta-information on radon surveys performed and existing radon databases in European countries, (ii) to evaluate if the data and methodologies are comparable and (iii) how they could be harmonized in case of methodical inconsistency.

Overview and analysis of indoor radon surveys

The activities within this task have been completed with the preparation of a report about indoor radon surveys in Europe. 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: a) designs of surveys performed in Europe are not comparable; b) measurement methods are comparable between surveys; c) data management, statistical analysis and mapping are somewhere in the middle.

Overview and analysis of geogenic radon surveys in Europe

A report about geogenic radon surveys in Europe summarised all the activities was carried out in this task. The main findings are: 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; 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 GRP-Geogenic Radon Potential.

The Deliverable D3 *“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”* has been prepared and will be published soon. It reports the results of the activities developed the above mentioned two tasks and reports.

All reports are available at the Documents Section at the MetroRADON website.

Intercomparisons of indoor radon and geogenic radon measurements under field conditions

A paper titled *"Intercomparison of indoor radon measurements under field conditions in the framework of MetroRADON European project"* has been prepared and will be submitted in International Journal of Environmental Research and Public Health. It reports the results of the intercomparison exercise. The report about the intercomparison exercise is available at the Documents Section at the MetroRADON website.

Development of options for harmonisation of indoor and geogenic radon data including practical examples

The aim of this task is to develop options for harmonisation of indoor and geogenic radon data, and where appropriate practical examples are used. Within the activities the representativeness of indoor Rn measurements over different sampling periods (different durations and seasons of the year) is evaluated and examples, where using top-down harmonisation for indoor and geogenic radon data and procedures may be reasonable, are discussed. These activities are in progress.

Another activity was to test the comparability between existing short-term and long-term radon measurement data in order to assess the feasibility of data merging and therefore data expansion. Data sets from Belgium, Austria and Italy are 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 and for track etch 2 months. Figure 5 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.

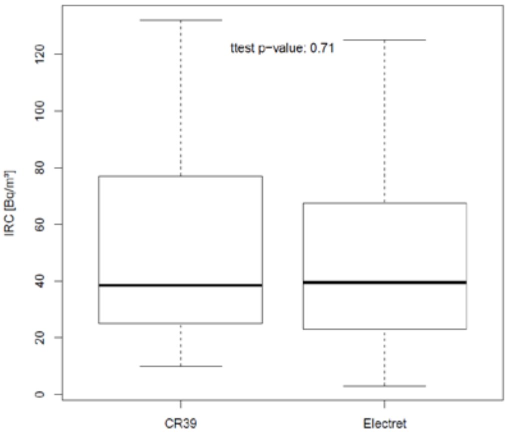

Figure 5: Indoor radon concentrations (IRC) distribution measured with CR 39 and Electret devices at same measurement locations

Radon priority areas and the development of the concept of a geogenic radon hazard index (WP4)

The aim of this work package is to analyse and develop methodologies for the identification of radon priority areas, to investigate the relationships between indoor Rn concentrations and quantities related to geogenic Rn, including soil exhalation and to develop the concept of a "geogenic radon hazard index" (GRHI) as a tool to help identify radon priority areas. In the following the work and results of two main activities in the last months are summarised.

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

The European BSS define radon priority areas (RPA) as these ones in which it is expected that the annual average indoor radon concentration exceeds the national reference level in a significant numbers of dwellings (Art. 103, 3). As a complementary approach, IRSN and UC proposed RPA identification through presence of very high indoor Rn concentrations, i.e. possibly several 1 000 Bq/m³. The idea has been exemplified 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 (geology, uranium concentration, Rn transport properties). These classes serve a as base of the French radon action plan (see Figure 6).

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 - once again - that also areas which have not been delineated as of high radon priority, cannot be understood as free from radon hazard, and must therefore also be given appropriate attention in radon policy (see example Figure 6).

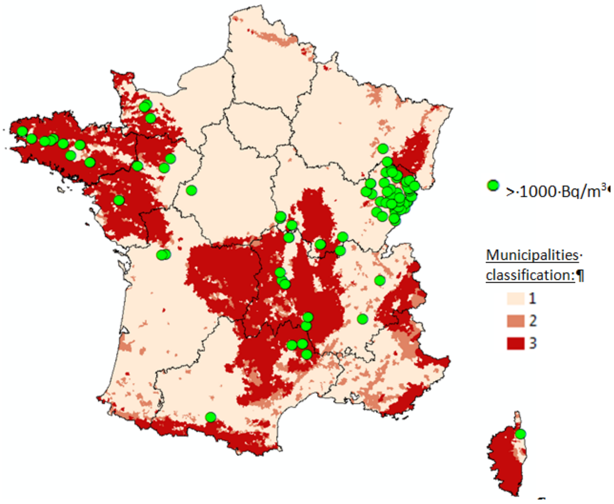

Figure 6: Locations of radon outliers in French areas of class 1 and 2, i.e. areas not defined as RPA.

Consistency of radon priority areas across borders

The definition of radon priority areas (RPAs) in different countries results from different Rn policies (related to different ways to interpret and to implement the European BSS) and different availability of data of predictor quantities. Therefore, RPAs defined by countries individually will not be consistent across borders, in general. This can lead to problems in communicating radon issues and impair credibility.

The problem has been studied on the examples of the borders between Franc and Belgium, France and Switzerland, France and Spain and Spain and Portugal. As a summary, consistency across French-Belgian and French-Swiss borders was poor, while French-Spain appeared consistent. For the Spanish-Portuguese border, the situation is inconclusive given the available data. Figure 7 and 8 show RPA classifications in the inconsistent (France - Switzerland) and consistent cases (France - Spain).

The reasons for the inconsistencies are not quite clear yet. Even with different classification schemes, leading to attribution of different classes, consistency would imply a consistent pattern across borders as long as predictors (mainly geology) are equal on either side (statistically speaking, classes of both schemes should be contingent).

Further discussion of this situation is certainly necessary. As a remark, a similar inconsistency has been observed between Belgium and Germany in regions sharing the same geology, in this case not for indoor radon but for the geogenic Rn potential. The phenomenon is under investigation.

The findings point to a challenge to generate a common scheme of RPA classification across borders.

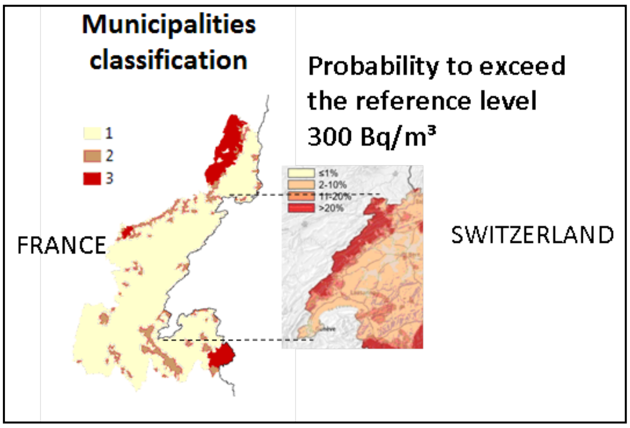

Figure 7: Inconsistency in RPA classificiation across the French- Swiss border

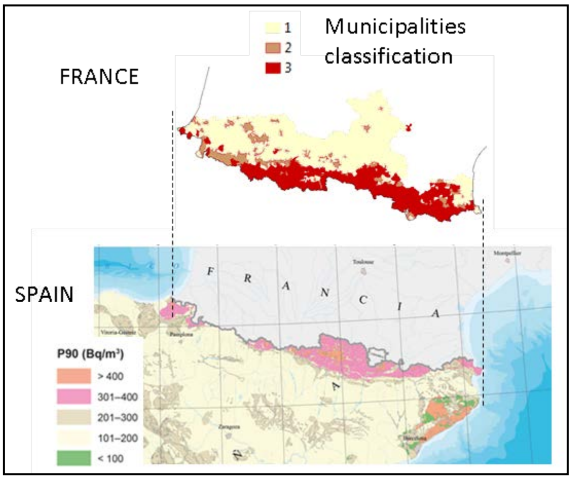

Figure 8: Consistency in RPA classification across the French-Spanish border

Validation of traceability of European radon calibration facilities (WP5)

The aim of WP5 is to validate the traceability of existing European radon calibration facilities over the ranges from 100 Bq/m^3 to 300 Bq/m^3 and 300 Bq/m^3 to 10 000 Bq/m^3. In WP5 international comparisons will be performed that will fulfill the need to provide confidence in the capability of European radon calibration facilities in the field of radon activity concentration measurements in air.

Validation of traceability, performance and precision of European radon calibration facilities in the range from 300 Bq/m^3 to 10 000 Bq/m^3

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.

The German Federal Office for Radiation Protection (BfS) has sent an electronic radon instrument AlphaGuard as transfer comparison device consecutively to each of the participating facilities. The facility exposes the device to radon atmospheres with activity concentrations of about 400 Bq/m^3, 1000 Bq/m^3 and 6000 Bq/m^3. 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 9 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/m^3 the dispersion is up to 10 % around the mean ratio across all participants; for a concentration level of 6000 Bq/m^3 the dispersion reduces to about 5 %. At higher concentrations, the standard uncertainties reported by participants also decrease.

The compilation of all results and the final evaluation of the performance and precision of the European radon calibration facilities will be completed in the coming months and shared at next MetroRADON newsletter and on the MetroRADON website.

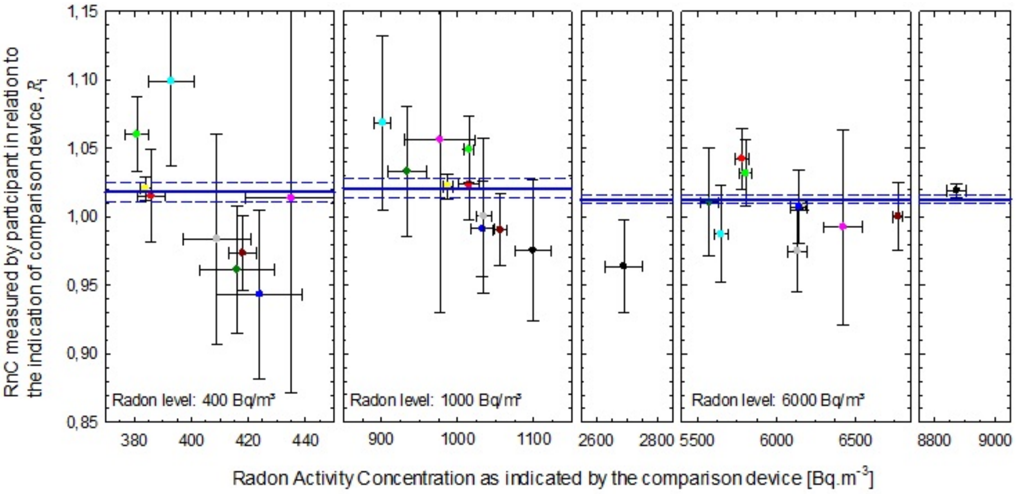

Figure 9: The radon activity concentration (RnC) measured by the participant in relation to the indication of the transfer comparison device (AlphaGuard) provided by BfS (preliminary assessment including standard uncertainty); each of the diagrams shows a different concentration level; each colour represents the results of a participating facility; blue line: mean ratio across all participants for the respective concentration level including standard uncertainty (dashed line)

Validation of the traceability of European radon calibration facilities at stable radon atmospheres in the range from 100 Bq/m³ to 300 Bq/m³

The new calibration procedure for calibration of the continuous measuring devices in the time stable radon atmosphere in the range of radon activity concentration from 100 Bq/m³ to 300 Bq/m³ was developed. The document "Intercomparison of European radon calibration facilities in the reference radon chamber of SUJCHBO" was distributed to all the intercomparison participants in advance.

An intercomparison measurement in cooperation with selected European laboratories is performed in the SUJCHBO Laboratory within WP5. The objective of this task is to verify secondary standards used for the calibration of terminal equipment. The secondary standards are calibrated in radon activity concentrations between 100 Bq/m³ to 300 Bq/m³. A report summarising results will be prepared for each calibration separately (calibration sheet). After the Intercomparison is finished, a final report summarised all results will be prepared.

The intercomparison is realised in the reference radon atmosphere, which is prepared in the Low-Level Radon Chamber in SÚJCHBO, v.v.i.. Individual laboratories send their secondary standards to SÚJCHBO according to an agreed schedule. The intercomparison is realised based on the equipment and approach which were developed in framework of WP1. The organisations which participate in the intercomparison are SÚJCHBO, v.v.i., BEV-PTP, UPC, IRSN, STUK, IFIN-HH, CLOR, BfS. The intercomparison began in October 2019, and the last calibration is planned at the end of February 2020.

MetroRADON at conferences and publications

MetroRADON results were presented at several conferences, e.g. at the Asia Oceania Geosciences Society (AOGS) 16th Annual Meeting, Singapore, 28 July - 2 August 2019; 33rd International Radon Symposium AARST 2019 ,9-11 September 2019, Denver, CO, USA; 9th International Conference on Protection against Radon at Home and at Work, 16-20 September 2019, Prague, Czech Republic; International Conference on Radiation Applications (RAP 2019), 16-19 September 2019, Belgrade, Serbia.

Several papers were accepted/published within MetroRADON framework in the second half of 2019:

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. http://www.nipne.ro/rjp/accpaps/F67B7966B7DA2A2153AA322BF8616305E1B2D9CF.pdf?wb48617274=1D202978

Mertes, F., Röttger, S., Röttger, A., 2020. A new primary emanation standard for Radon-222. Applied Radiation and Isotopes 156 108928, in press. https://www.sciencedirect.com/science/article/abs/pii/S096980431930346X?via%3Dihub

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. http://rrp.infim.ro/IP/AP411.pdf

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. https://doi.org/10.5281/zenodo.3555047

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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 "*Harmonisation of radon measurement methodologies and radon priority areas*", Vienna, 25-26 February 2020

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

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

Relevant upcoming conferences with MetroRADON contribution:

8th international conference on radionuclide metrology – low level radioactivity measurements and techniques (ICRM-LLRMT 2020), Gran Sasso, 20 – 24 April 2020

European Geosciences Union General Assembly 2020 (EGU 2020), Vienna, 3 – 8 May 2020

IRPA 15 – Bridging Radiation Protection Culture and Science – Widening Public Empathy, Seoul, 11 – 15 May

VII Terrestrial Radioisotopes in Environment International Conference on Environmental Protection (TREICEP 2020), Veszprem, 18 – 22 May

15th International Workshop on the Geological Aspects of Radon Risk Mapping (GARRM 2020), Prague, 22 – 24 September 2020

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

Figure 10: The MetroRADON consortium at project meeting in Paris, September 2019

Further contact and information:

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