Radon in thermal waters and radon risk in chosen thermal water spas in V4 countries - preliminary results

Slovakia

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^{222}Rn research in thermal spas

The territory of V4 countries is rich in thermal springs. Some boreholes reach a depth of 2000 m and temperatures of water up to 70°C. ^{222}Rn concentrations in some thermal waters can exceed 1000 Bq/l, however this concentration is not constant.
Slovakia has about 20 spa areas, which use thermal water. Balneotherapy workplaces have higher indoor radon activity concentration (RAC).

Guide values of RAC in the air of thermal spas (Government Ordinance no. 345/2006)

RAC defined by legislation	$\overline{RAC}$**/year**
Investigative value of RAC	400 Bq.m^{-3}
Guide value of radon to implement the actions	1000 Bq.m^{-3}

Annual effective dose for some spa workers exceeds 1 mSv / year, which is in accordance with applicable laws of V4 countries sufficient condition for the regular dosimetric control. These workers may be classified as radiation workers of category B or category A if it exceeds annual effective dose of 6 mSv / year. (Government Ordinance no. 345/2006)

Radiation protection of staff working with geothermal water is very actual.
5.12.2013 – Council Directive 2013/59 / Euratom - imposes an obligation to deal with the increased RAC and create action plans for radon in individual countries

Project V4: participants

„ Radon in thermal waters and radon risk in chosen thermal water spas in V4 countries“ - project of International Visegrad fund No.: 21320324

- long tradition in use of thermal baths
- monitoring of radon variations in waters and thermal spas

- RADON v.o.s., Praha, Czech Republic (CZ)

- The Henryk Niewodniczanski Institute of Nuclear Physics of Polish Academy of Sciences, Kraków, Poland (PL)

- Social Organisation for Radioecological Cleanliness, Veszprém, Hungary (H)

- Faculty of Mathematics, Physics and Informatics, Department of Nuclear Physics and Biophysics, Comenius University, Bratislava, Slovakia (SK)

Our aims

- Observation of radon concentration in thermal waters and air of thermal spas (indoor radon)
- Radon variations analysis
- Development of measuring methods for radon in thermal waters
- Assessment of annual effective doses from radon for emloyees, patients and users of thermal spas
- Enhancement of radon concentration monitoring and protection of spa employees

- harmonization and elaboration of common measuring protocols

- scientific support of national action plans for radon under the new European regulations

Locations – chosen V4 thermal spas

- measurements are carried out in 11 spas of V4 countries:

CZ - 1
HU - 3
PL - 3
SK - 4

- detectors are placed in rooms with large amounts of thermal water and in the rooms for the personal of spa

- 1 – 3 months exposure of detectors

- ownerships of the spas are currently private and spa directors have enabled us to measure only if they remain anonymous → baths are marked with the identification number only

Measuring methods for ^{222}Rn in thermal water

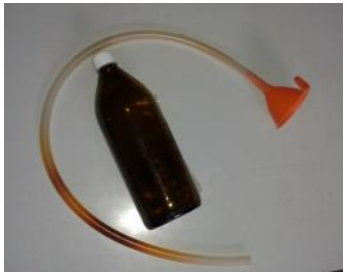
Slovak laboratory uses the vacuum emanometric method using Lucas chamber with a volume of 125 ml.

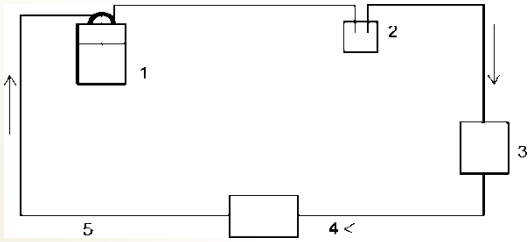
$$RAC = \frac{n_{vz} - n_p}{\epsilon_d V \epsilon_p} \cdot e^{\lambda t_{om}} \cdot \frac{\lambda t_m}{1 - e^{-\lambda t_m}}$$

Sampling:

1l glass bottle simply dipped into water

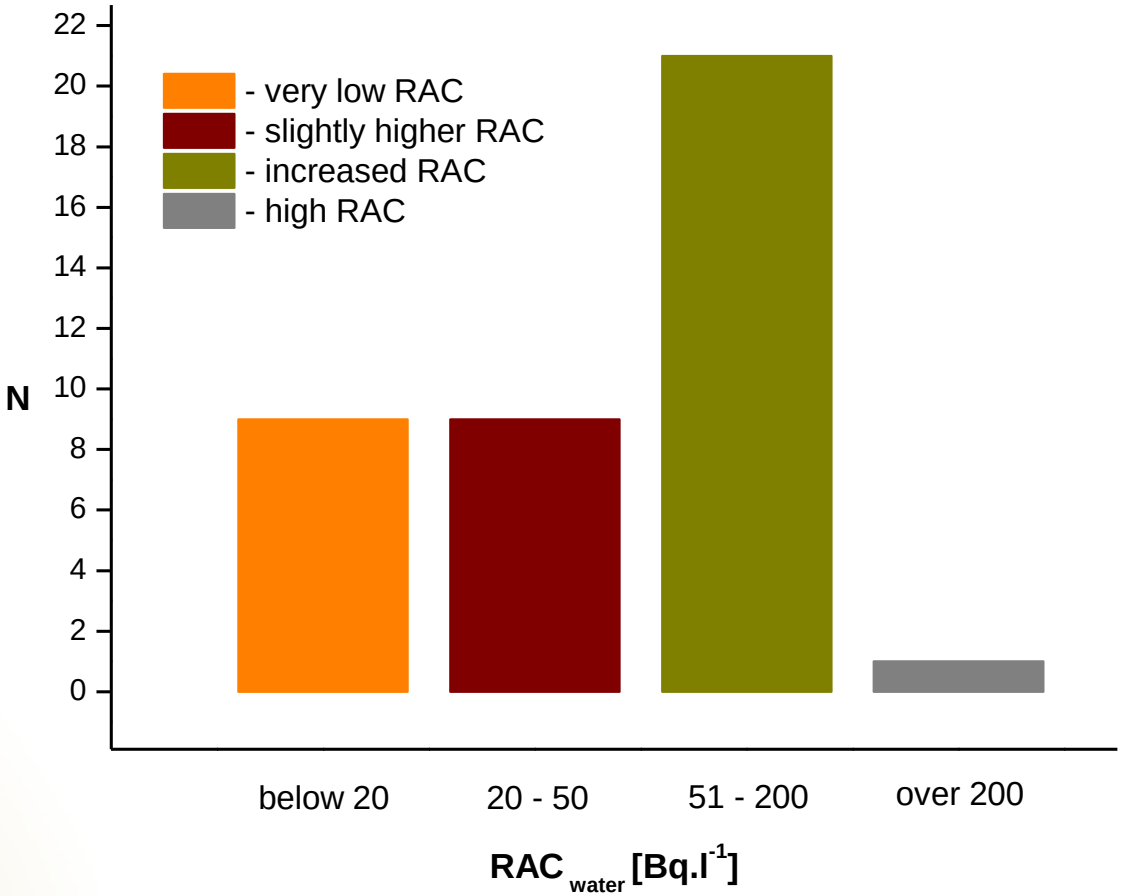
or water flown in by a plastic funnel (tap water)



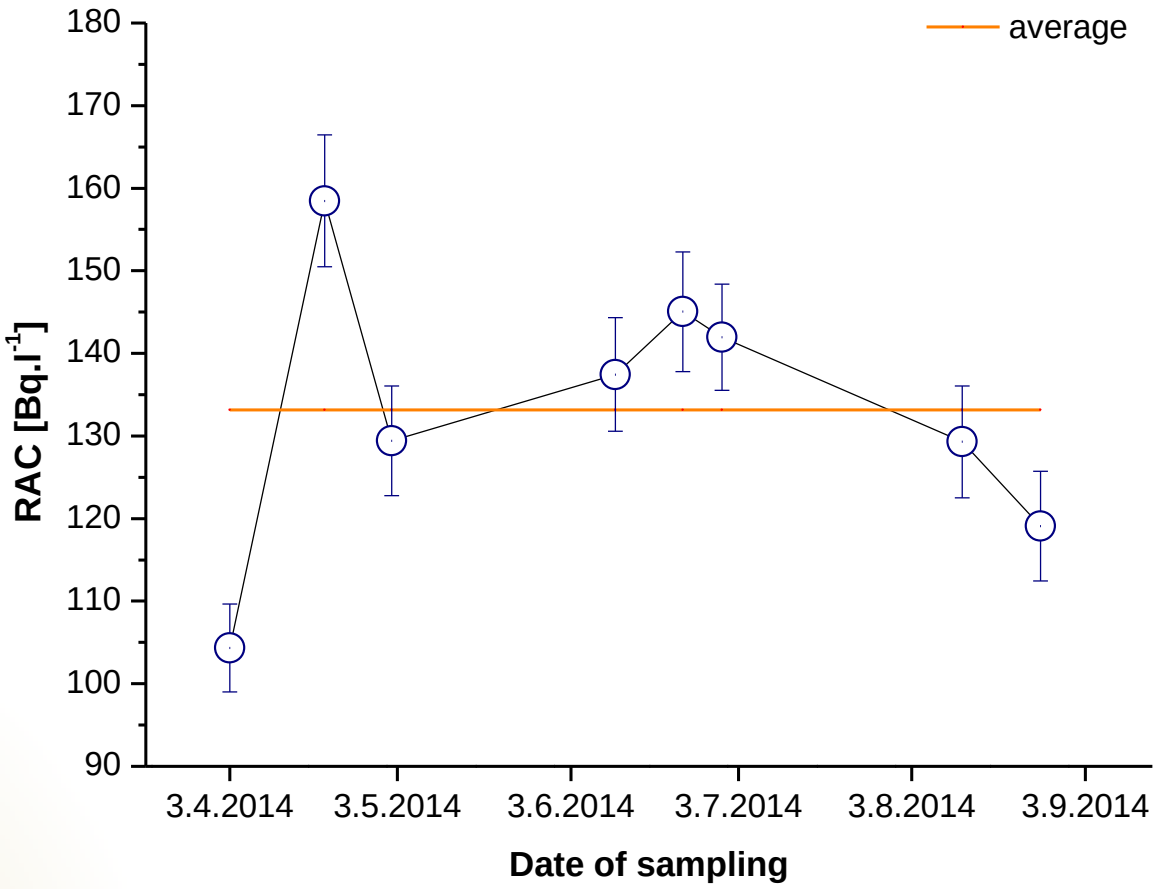


Emanometric determination (^{222}Rn is transferred into a scintillation chamber)

Thermal waters (Slovakia) - RAC



Variability of the chosen thermal water source



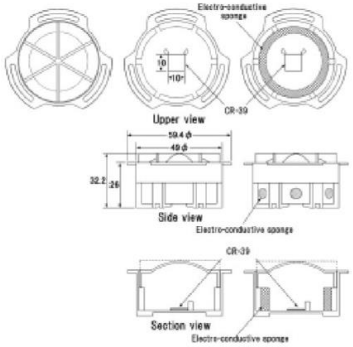
„Indoor radon“ measurement with track detectors

- comparison of three types of track detectors (English, Hungarian, Czech)
- 1 – 3 months exposition of detectors

NRPB (National Radiological Protection Board)

- CR 39 plastic film placed inside antistatic holder

Raduet (Radosys)

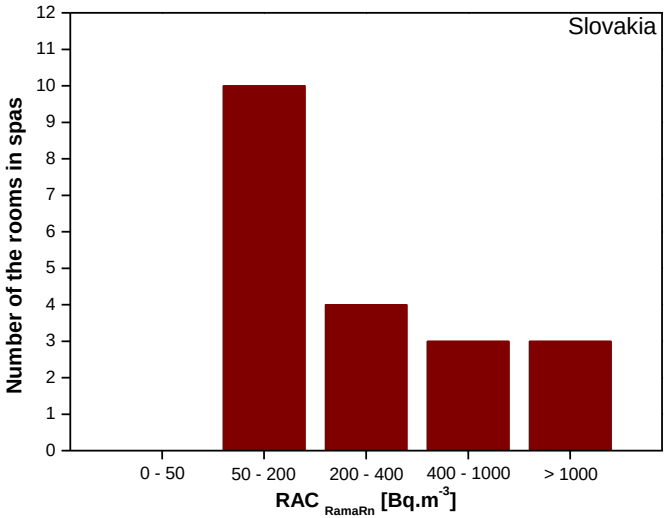


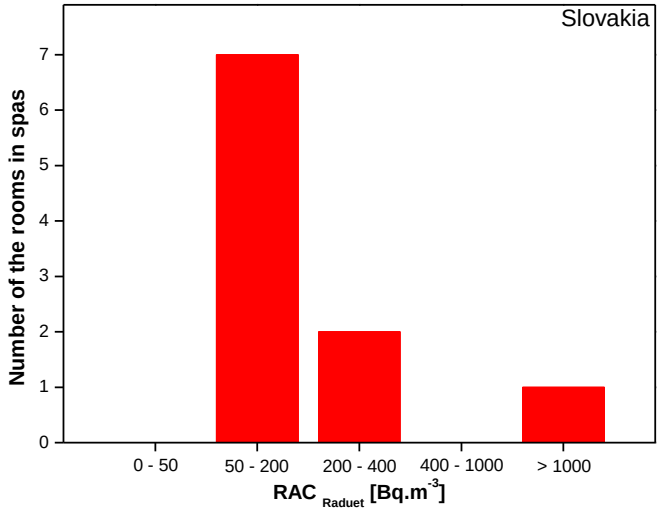
- CR 39 plastic film
- track detectors, which are able to measure at once ^{222}Rn and ^{220}Rn

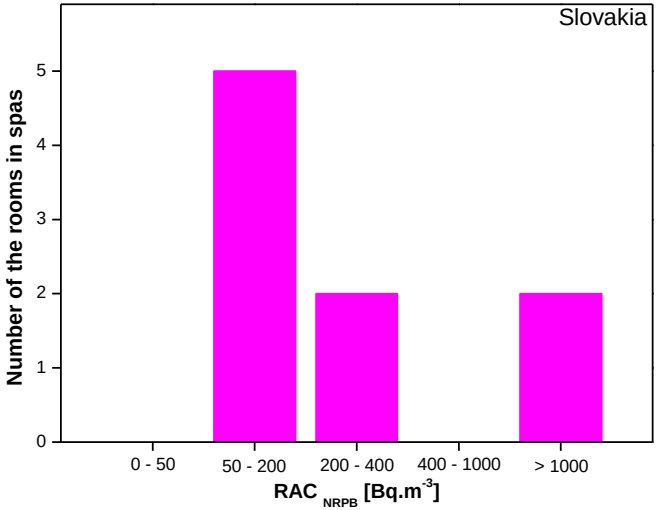
RAMARN (SÚJBO Kamenná)

- Kodak LR 115 film is located at the bottom of the diffusion chamber

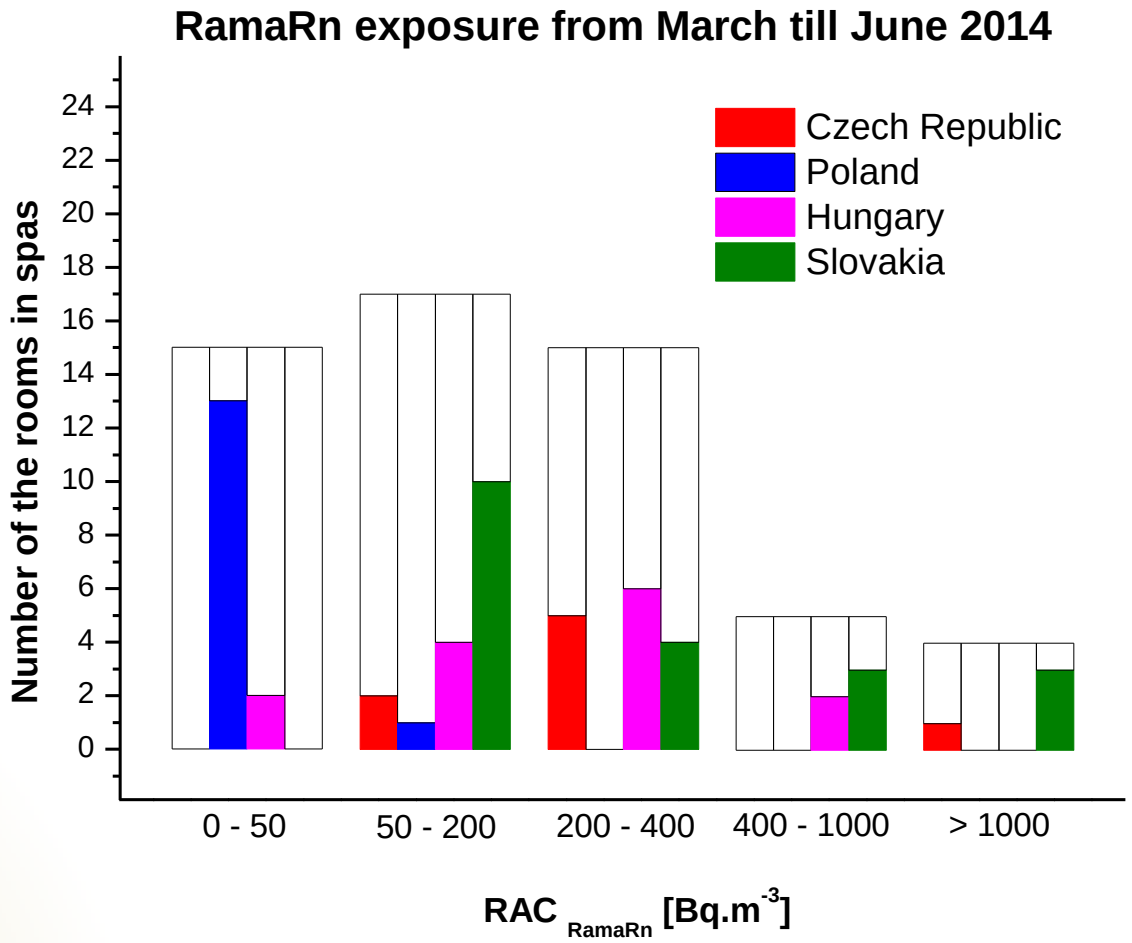
Results of the first exposure (RamaRn, Raduet, NRPB)





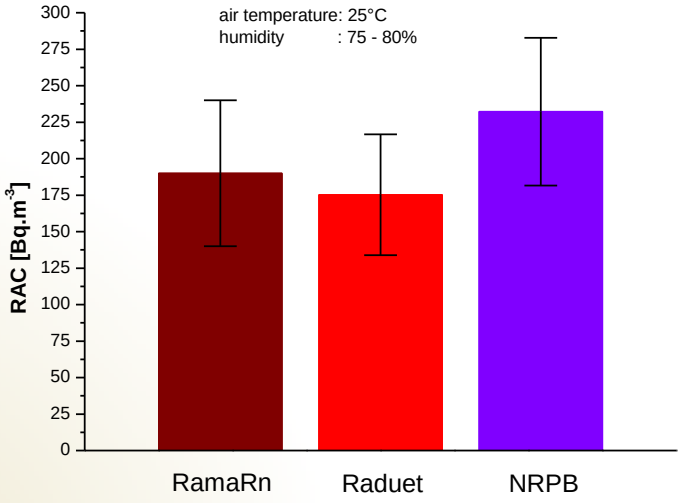


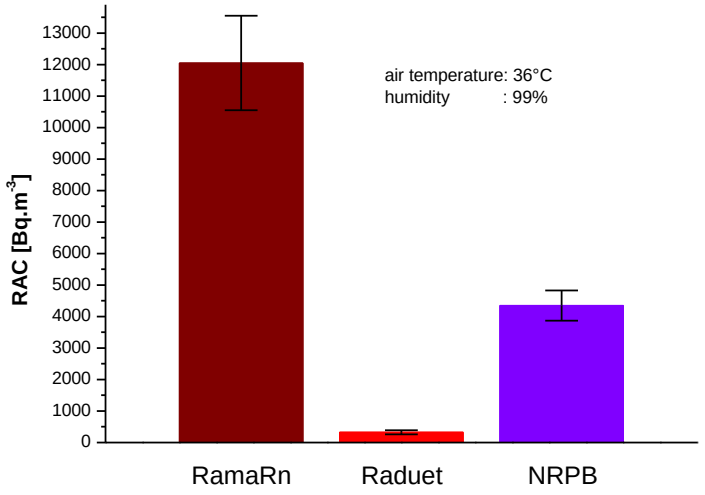
Results of the first exposure – international comparison



Detectors - comparison (Slovakia)

RamaRN-s	average A_{RN} [Bq.m^{-3}]		difference
[Bq.m^{-3}]	1. exposure	2. exposure	[Bq.m^{-3}]
< 400	169 ± 53	158 ± 40	***11***
400 - 1000	547 ± 113	470 ± 68	***77***
> 1000	7183 ± 903	4560 ± 273	***2623***





Slovak extrems - yet

RAC - thermal waters

- 8 sources with RAC more than 100 $Bq.l^{-1}$
- 1 source with RAC more than 200 $Bq.l^{-1}$

RAC – „indoor radon“ + seasonal decrease

- 3 places with RAC between 400 – 1000 $Bq.m^{-3}$
- 3 places with RAC more than 1000 $Bq.m^{-3}$.

decreases

$(12050 \pm 1500)Bq.m^{-3} \rightarrow (6770 \pm 330)Bq.m^{-3}$
$(8100 \pm 1000)Bq.m^{-3} \rightarrow (5850 \pm 370)Bq.m^{-3}$
$(1400 \pm 210)Bq.m^{-3} \rightarrow (1060 \pm 120)Bq.m^{-3}$

Conclusions

- We expect the acquisition of data on seasonal variations of radon in the spa facilities
- We will obtain information about the variability of radon in thermal waters. Data about radon variability in thermal waters are not available yet.
- There will be recommended repetition to improve methods of measurement of RAC in waters
- Conclusions will be made from the use of integral detectors for measuring radon in the air of spa facilities
- The results will be provided to leadership of the spas in order to decrease efective dose from radon
- Details for concretization of action plans


Visegrad Fund
Thank you for your attention !
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