The logo for the Visegrad Fund consists of four black dots arranged in a square pattern. Each dot is accompanied by a small flag: the top dot is Poland's flag (white over red), the left dot is the Czech Republic's flag (white, red, and blue triangles), the bottom-left dot is Slovakia's flag (white, blue, and red horizontal stripes with a red shield containing a white cross), and the bottom-right dot is Hungary's flag (red, white, and green horizontal stripes).

Visegrad Fund

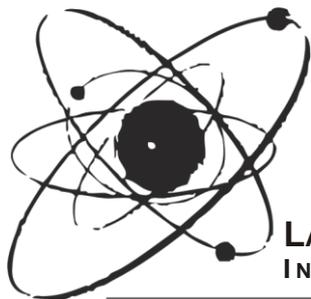
Radon in thermal waters and radon risk
in chosen thermal water spas in V4 countries

Final Meeting

November 27-28 2014; Bratislava, Slovakia



The Henryk Niewodniczański
INSTITUTE of NUCLEAR PHYSICS
Polish Academy of Sciences



LER

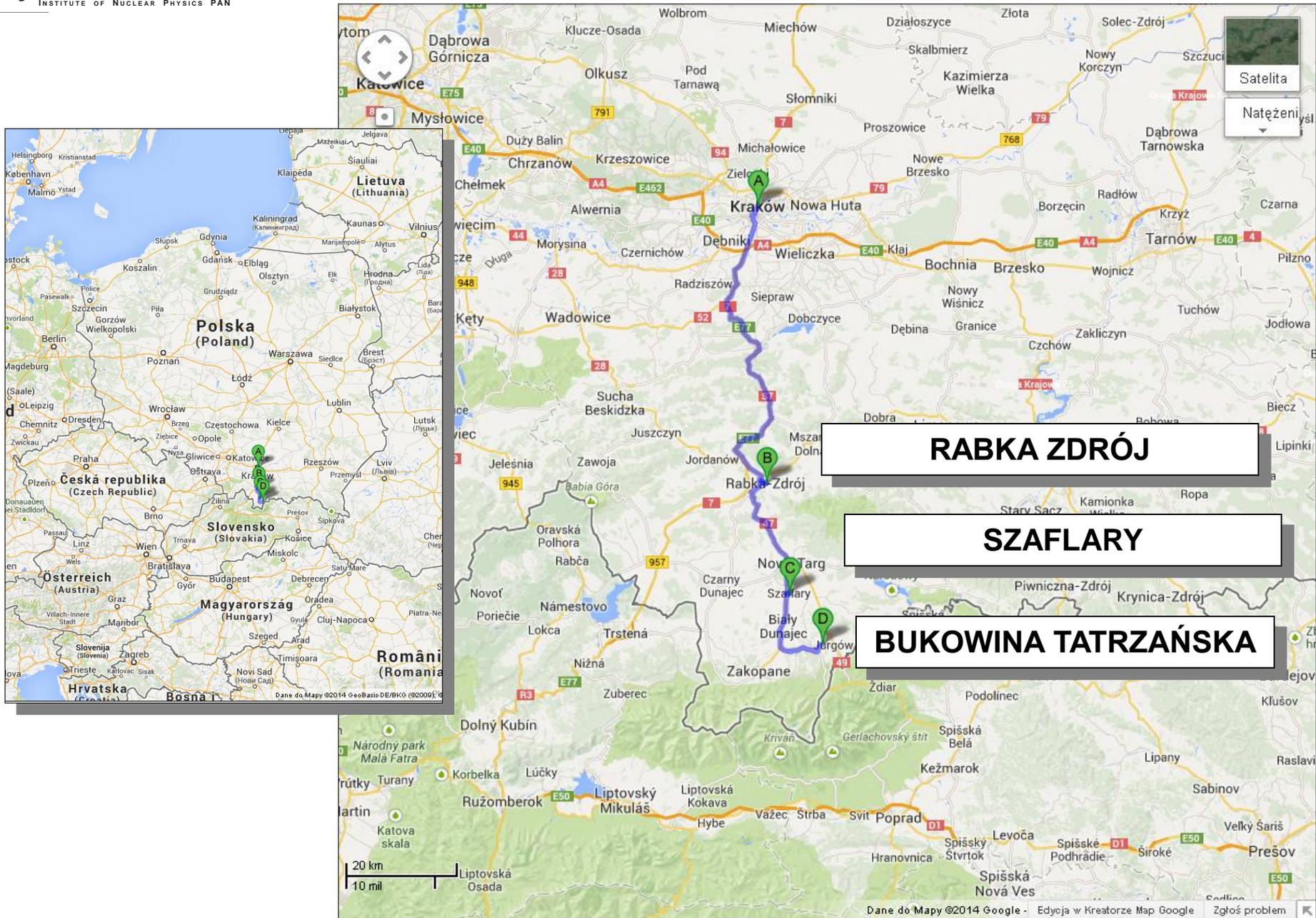
LABORATORY OF RADIOMETRIC EXPERTISE
INSTITUTE OF NUCLEAR PHYSICS PAN

Krzysztof Kozak, Jadwiga Mazur, Dominik Grządziel, Mariusz Mroczek

Partial results from our measurements of:

- Radon concentration in the air of SPA buildings
- Radon concentration in thermal water

CHOSEN SPAS IN POLAND





Placing track detectors:

- Two rooms with therapeutic thermal baths (108D, 109D)
- One nurses room for background measurements (104D)



Water sampling

Uzdrowisko Rabka S.A.



UJĘCIE „IG-2”

Skład chemiczny wody leczniczej z ujęcia „IG-2” ze złoża „Rabka Zdrój” w miejscowości Rabka Zdrój zawiera w 1 dm³:

ANIONY			KATIONY		
Chlorki	Cl ⁻	14358 mg	Sód	Na ⁺	9600 mg
Bromki	Br ⁻	79,92mg	Potas	K ⁺	90 mg
Jodki	I ⁻	20 mg	Lit	Li ⁺	10 mg
Siarczany (VI)	SO ₄ ²⁻	8 mg	Amon	NH ₄ ⁺	16 mg
Wodorowęglany	HCO ₃ ⁻	1525,26mg	Wapń	Ca ²⁺	89,78 mg
Azotany (V)	NO ₃ ⁻	0,308 mg	Magnez	Mg ²⁺	58,35 mg
			Bar	Ba ²⁺	2,1 mg
			Stront	Sr ²⁺	48 mg
			Żelazo	Fe ²⁺	9,35 mg
			Mangan	Mn ²⁺	<0,1 mg

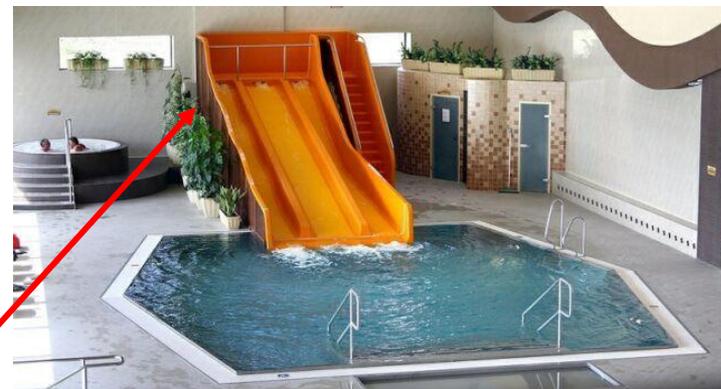
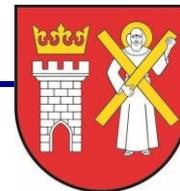
SKŁADNIKI NIEZDYSOCJOWANE:
 Kwas metakrzemowy H₂SiO₃ 16,90 mg/dm³
 Kwas metaborowy HBO₂ 486 mg/dm³

Suma składników stałych: 26417,83 mg/dm³
 Wśród anionów przeważa jon chlorkowy Cl⁻ 93,90% miliwali.
 Wśród kationów przeważa jon sodowy Na⁺ 96,45% miliwali.
 Ponadto woda zawiera 12,48 mg/dm³ bromków, 20 mg/dm³ jodków.

Na tej podstawie badaną wodę należy scharakteryzować jako:
 2,64% wodę chlorkowo-sodową, jodkową.

Solanka stosowana w kąpielach leczniczych oraz inhalacjach. Woda oraz zabiegi dostępne w Zakładzie Przyrodolecznictwa Uzdrowiska Rabka S.A.



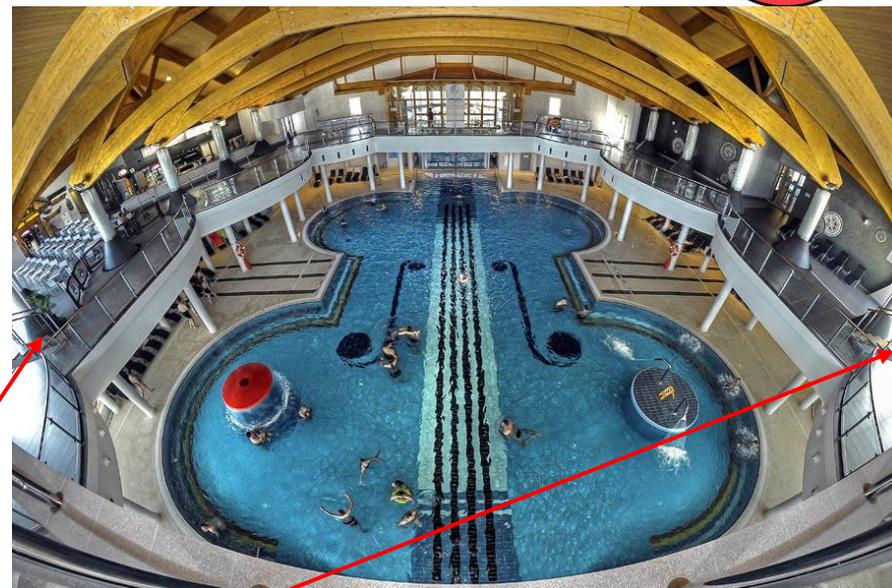
Placing track detectors:

- Open place under the slide
- Lifeguard open room
- Upper terrace
- Upper dressing room - BACKGROUND
- Lower dressing room - BACKGROUND



Water sampling

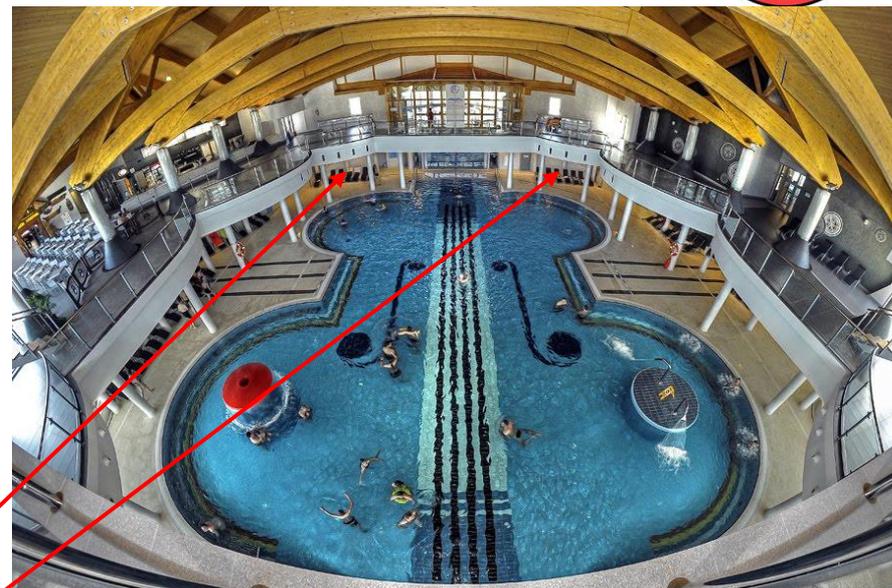




Placing track detectors:

- Swimming pool, upper terrace
- Swimming pool, ground
- Lifeguard room - BACKGROUND
- Children swimming pool

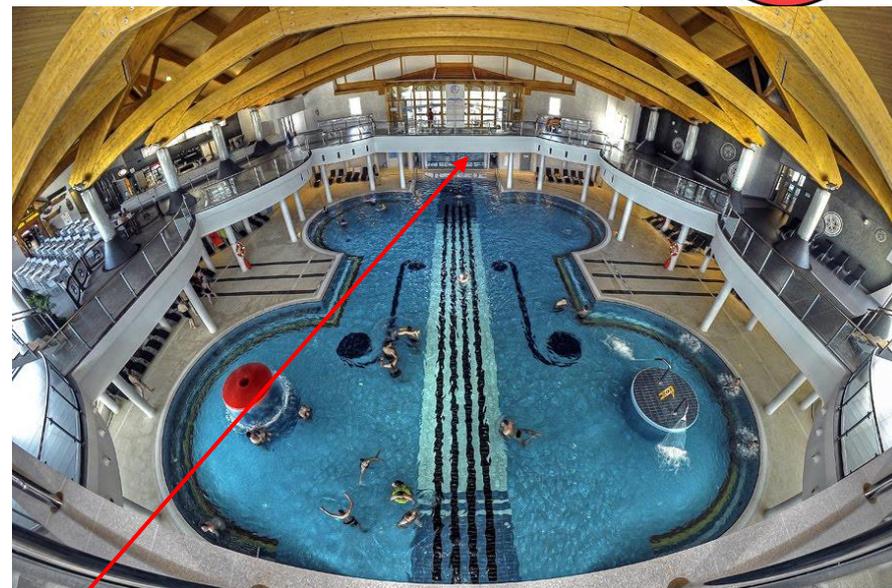




Placing track detectors:

- Swimming pool, upper terrace
- Swimming pool, ground
- Lifeguard room - BACKGROUND
- Children swimming pool





Placing track detectors:

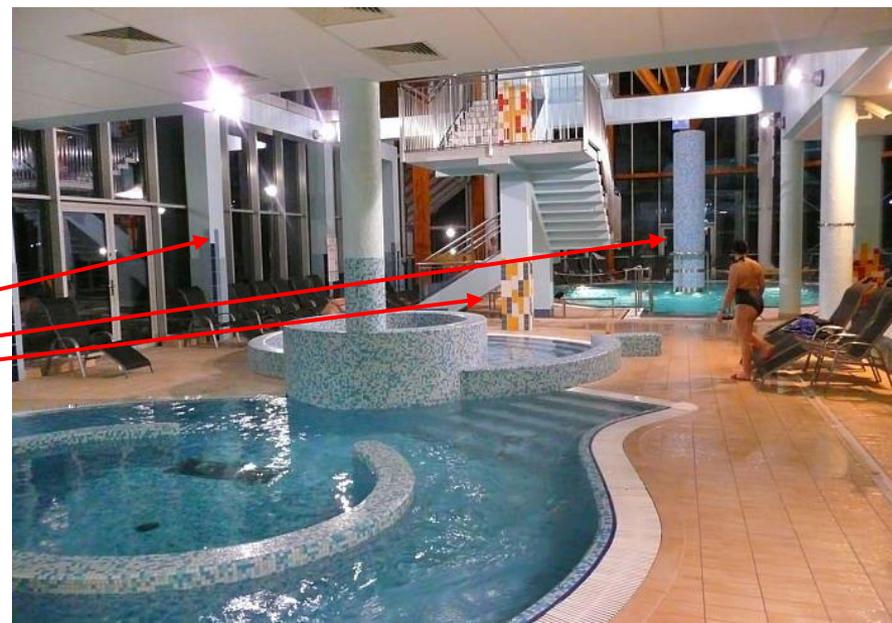
- Swimming pool, upper terrace
- Swimming pool, ground
- Lifeguard room - BACKGROUND
- Children swimming pool





Placing track detectors:

- Swimming pool, upper terrace
- Swimming pool, ground
- Lifeguard room - BACKGROUND
- Children swimming pool



Water sampling

Ujęcie wody termalnej
Bukowina Tatrzańska PIG/PNIG-1

Zakład górniczy "Bukowina"
34-530 Bukowina Tatrzańska
ul. Sportowa



	March – May 2014				June – August 2014
	Average value from all detectors	Average value from RAMARN detectors	Average value from RADUET detectors	Average value from NRPB detectors	Average value from RAMARN detectors
Place	Bq/m ³				Bq/m ³
Room 108D	43	25	53	62	31
Room 109D	50	33	54	70	46
Room 104D - BG	34	33	37		48

Radon concentration - results of RAMARN detectors [Bq/m³]

Rabka all rooms	I exposure	II exposure
Arithmetic Mean	30	41
Median	28	37
Standard Deviation	7	21
Minimum	25	20
Maximum	40	85

Results - Szaflary

	March – May 2014				June – August 2014
	Average value from all detectors	Average value from RAMARN detectors	Average value from RADUET detectors	Average value from NRPB detectors	Average value from RAMARN detectors
Place	Bq/m ³				Bq/m ³
Lifeguard open room	33	28	39	37	23
Open place under the slide	43	25	51	71	37
Upper terrace	60	43	55	99	32
Upper dressing room - BG	36	30	34	45	30
Lower dressing room - BG	50	30	64	56	60

Radon concentration taken from RAMAR detectors

[Bq/m³]

Szaflary all rooms	I exposure	II exposure
Arithmetic Mean	31	34
Median	28	30
Standard Deviation	12	14
Minimum	25	20
Maximum	60	60

Results - Bukowina

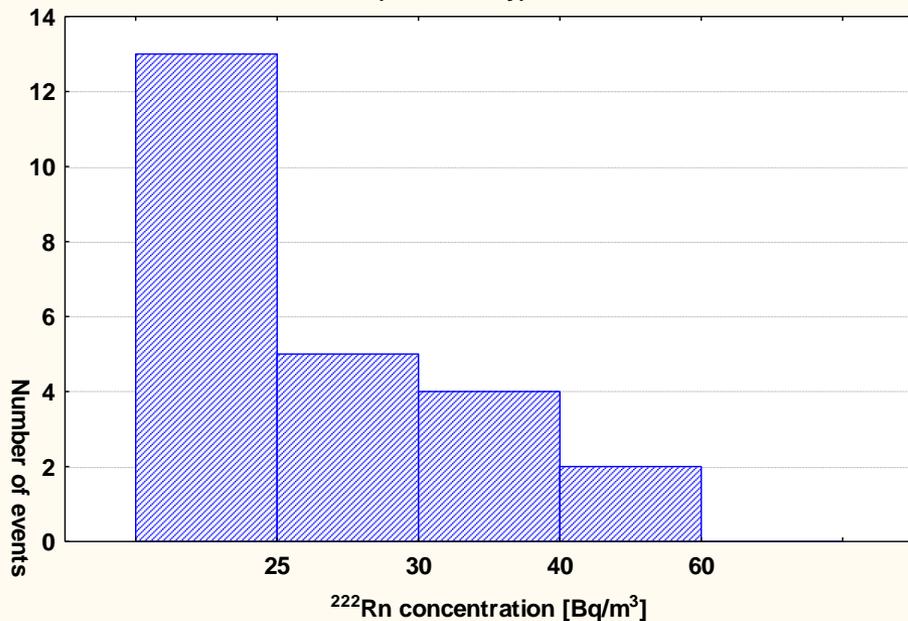
	March – May 2014				June – August 2014
	Average value from all detectors	Average value from RAMARN detectors	Average value from RADUET detectors	Average value from NRPB detectors	Average value from RAMARN detectors
Place	Bq/m ³				Bq/m ³
Swimming pool, upper terrace	42	50	30	40	26
Swimming pool, ground		← 33			20
Children swimming pool	27	25	32		20
Lifeguard room - BG	41	25	39	59	56

Radon concentration taken from RAMAR detectors [Bq/m³]

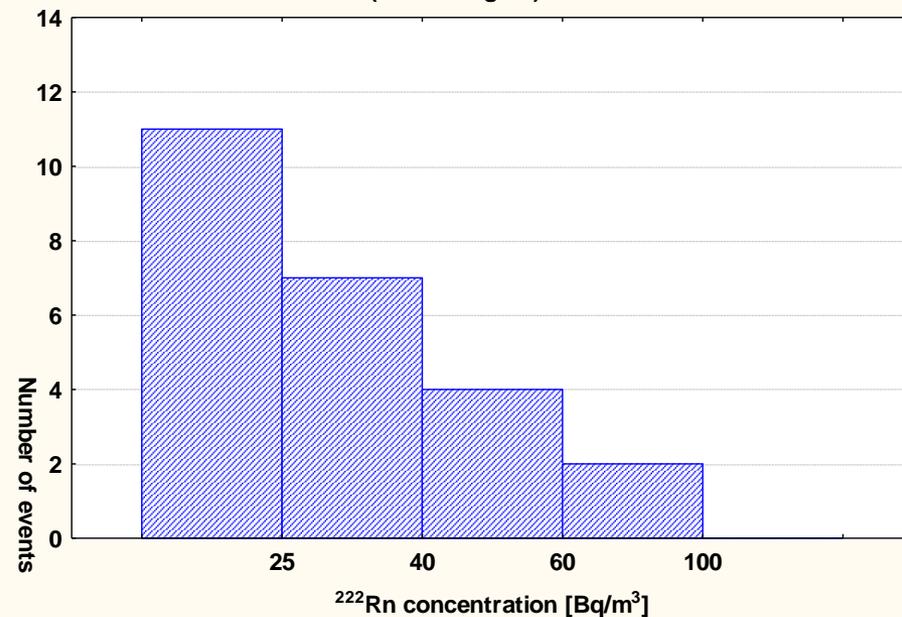
Bukowina all rooms	I exposure	II exposure
Arithmetic Mean	33	30
Median	25	20
Standard Deviation	13	25
Minimum	25	20
Maximum	60	92

Statistical Analysis	I exposure	II exposure
	Bq/m³	
Arithmetic Mean	31	35
Median	25	28
Standard Deviation	10	20
Minimum	25	20
Maximum	60	92

Concentration distributions or radon from all RAMARN detectors in I exposure (March - May)

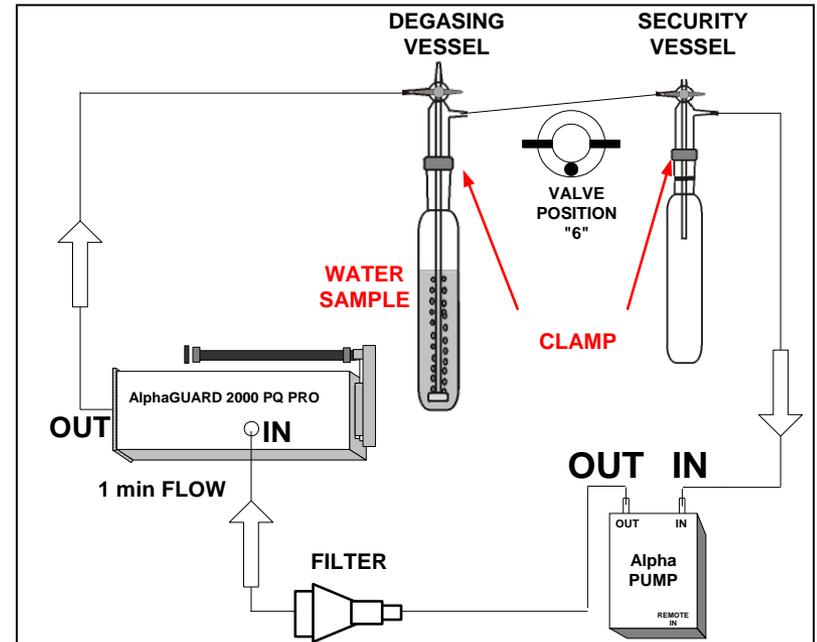


Concentration distributions or radon from all RAMARN detectors in II exposure (June - August)



AquaKIT Method

LSC Method



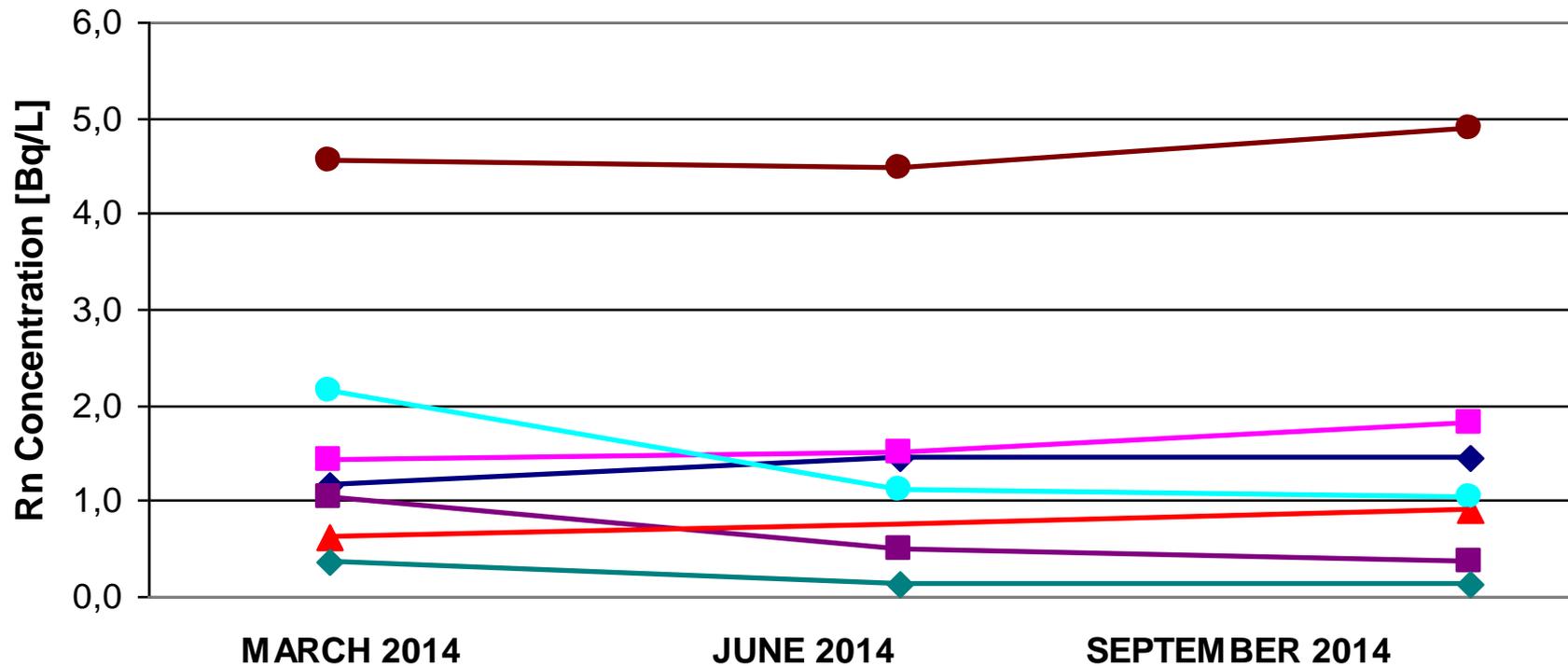
Results from water samples

March	LSC		AG		Percentage Difference
	Rn [Bq/L]	Error [Bq/L]	Rn [Bq/L]	Error [Bq/L]	
Place of Sampling					
Rabka Tap Water Room108D	1,2	0,1	1,3	1,2	8%
Rabka Tap Water Room109D	1,4	0,1	1,6	1,3	13%
Rabka Water Intake IG2	0,6	0,1	1,3	1,2	54%
Szaflary Intake	2,2	0,1	2,8	1,7	21%
Szaflary Swimming Pool	1,0	0,1	1,1	1,3	9%
Bukowina Water Intake	4,6	0,4	3,9	2,1	18%
Bukowina Swimming Pool	0,4	0,03	0,7	1,4	43%

September	LSC		AG		Percentage Difference
	Rn [Bq/L]	Error [Bq/L]	Rn [Bq/L]	Error [Bq/L]	
Place of Sampling					
Rabka Tap Water Room108D	1,5	0,1	2,0	1,2	25%
Rabka Tap Water Room109D	1,8	0,1	1,9	1,1	5%
Rabka Water Intake IG2	0,9	0,1	0,8	0,8	13%
Szaflary Intake	1,0	0,1	1,0	0,9	0%
Szaflary Swimming Pool	0,4	0,1	0,5	0,7	20%
Bukowina Water Intake	4,9	0,1	4,5	1,9	9%
Bukowina Swimming Pool	0,1	0,02	0,2	0,4	50%

June	LSC	
Place of Sampling	Rn [Bq/L]	Error [Bq/L]
Rabka Tap Water Room108D	1,4	0,1
Rabka Tap Water Room109D	1,5	0,1
Rabka Water Intake IG2		
Szaflary Intake	1,1	0,1
Szaflary Swimming Pool	0,5	0,1
Bukowina Water Intake	4,5	0,2
Bukowina Swimming Pool	0,1	0,03

Distribution of radon concentration in water (LSC method)



Statistical data from all places and LSC method

Statistical Analysis	March	June	September
	Bq/L		
Arithmetic Mean	1,6	1,5	1,5
Median	1,2	1,3	1,0
Standard Deviation	1,4	1,5	1,6
Minimum	0,4	0,1	0,1
Maximum	4,6	4,5	4,9

...and it's all for now...



Thank you for your attention!