

# STUDY OF THE INFLUENCE OF EXTERNAL FACTORS ON RADON CONCENTRATION IN THE AIR

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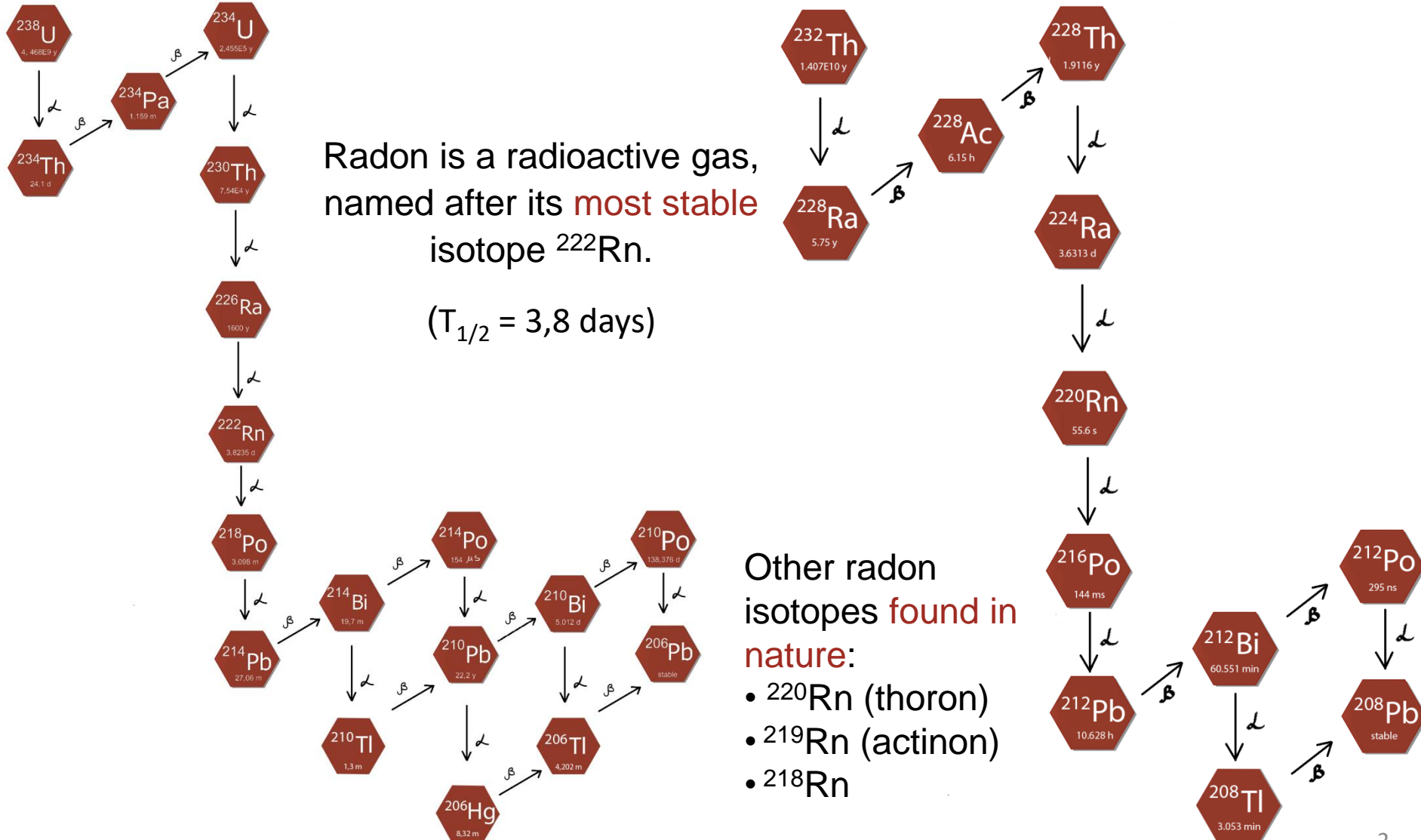
*Saint Petersburg*  
2025

Radon is a radioactive gas,  
named after its **most stable**  
isotope  $^{222}\text{Rn}$ .

( $T_{1/2} = 3,8$  days)

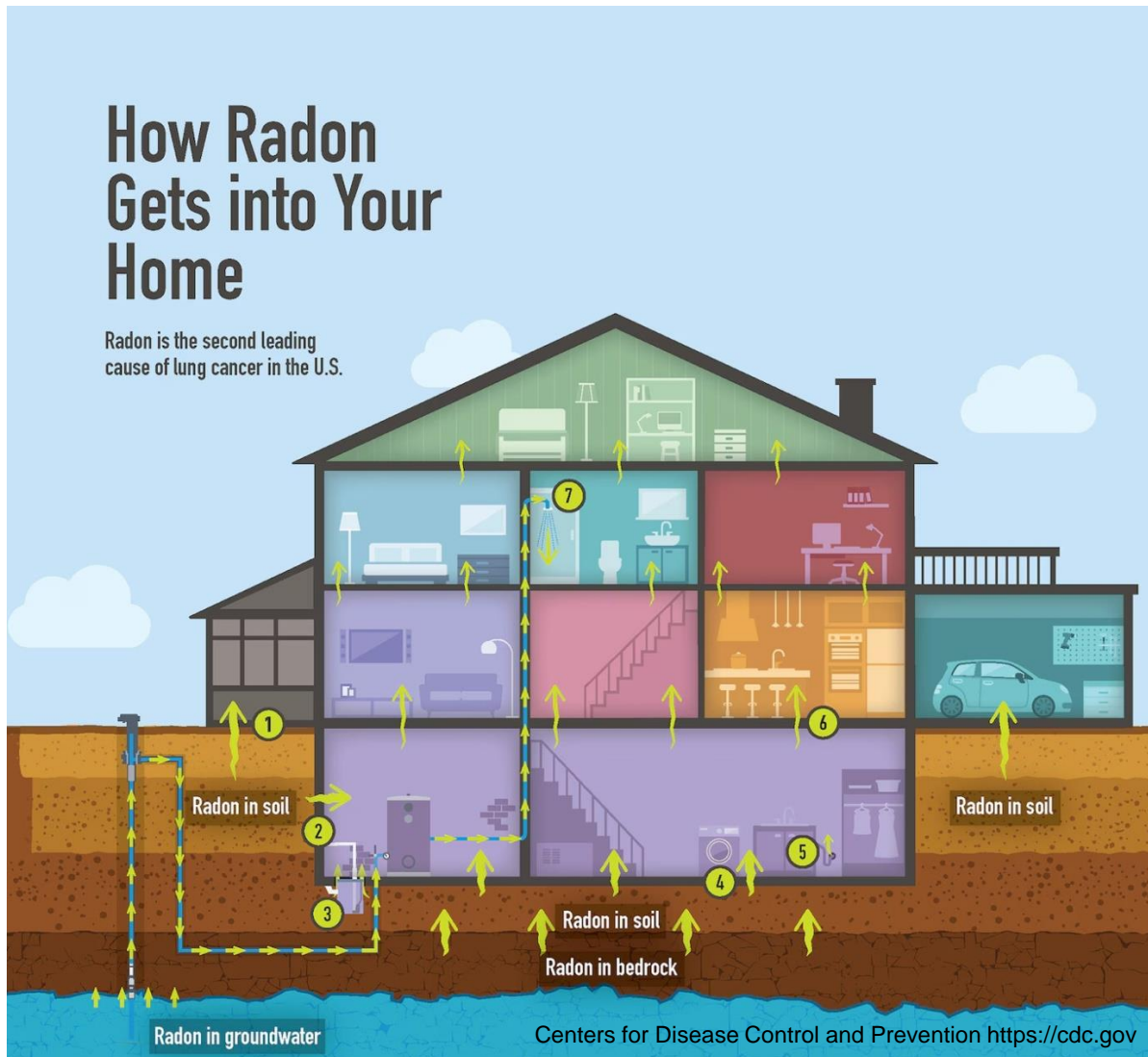
Other radon  
isotopes **found in**  
**nature:**

- $^{220}\text{Rn}$  (thoron)
- $^{219}\text{Rn}$  (actinon)
- $^{218}\text{Rn}$

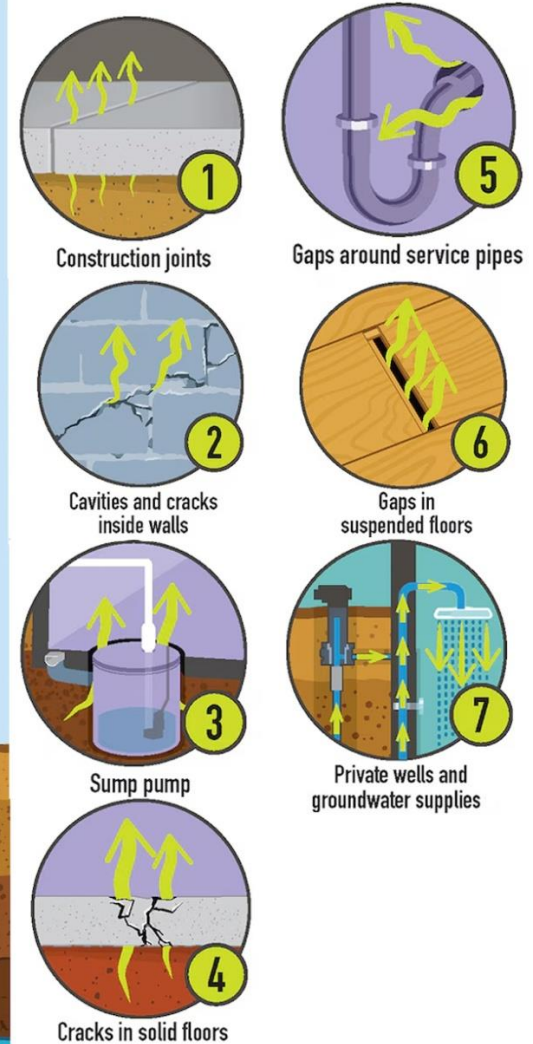


## How Radon Gets into Your Home

Radon is the second leading cause of lung cancer in the U.S.



Centers for Disease Control and Prevention <https://cdc.gov>



HPБ-99/2009 (Russian safety standards): the limit is 200 Bq/m<sup>3</sup> 3

## **Aim:**

To study the processes of radon formation in materials and environments

## **Objectives:**

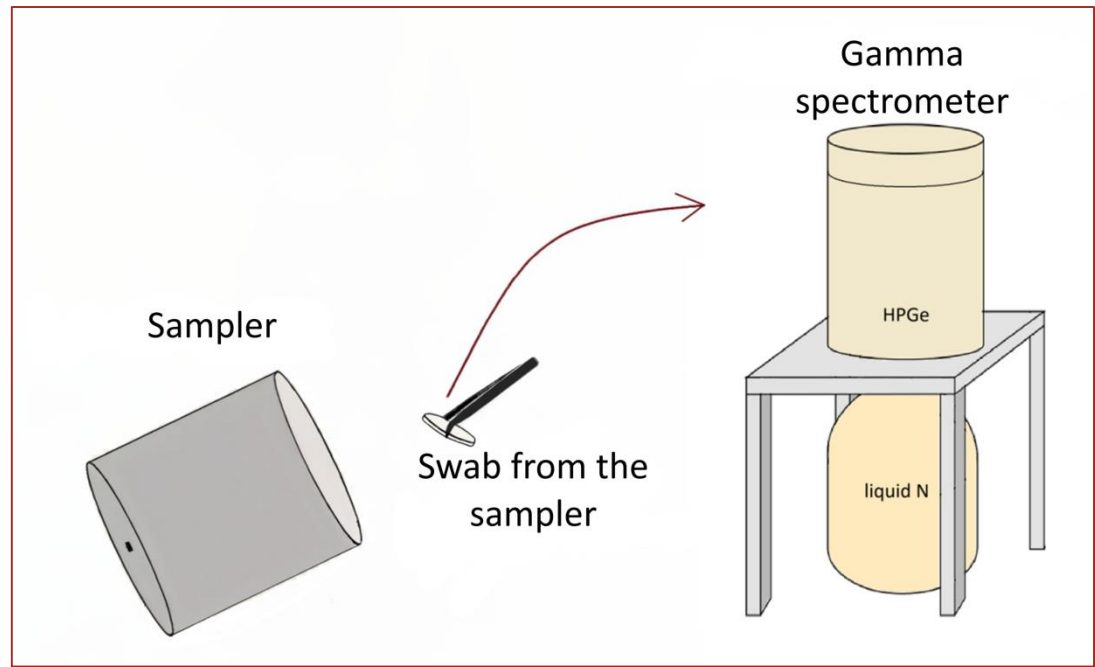
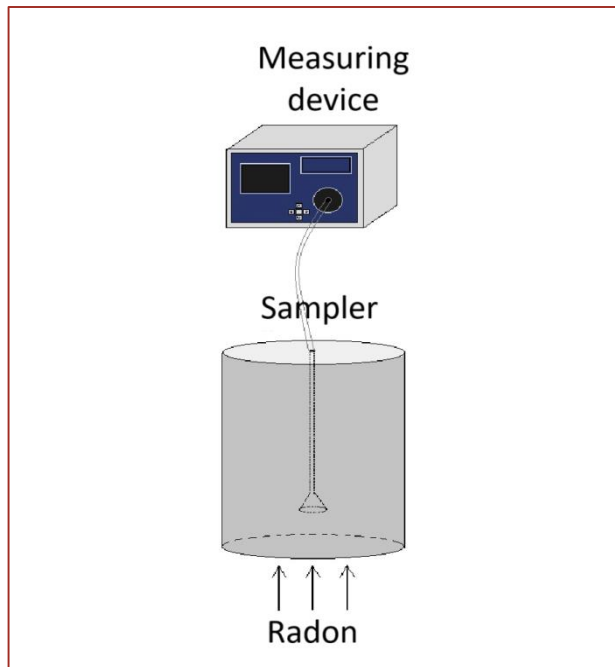
- To carry out long-term monitoring of radon volumetric activity in the Educational Laboratory of Nuclear Processes at SPbU (former Cyclotron Laboratory)
- To establish the influence of environmental parameters on indoor radon concentration

## Sampling

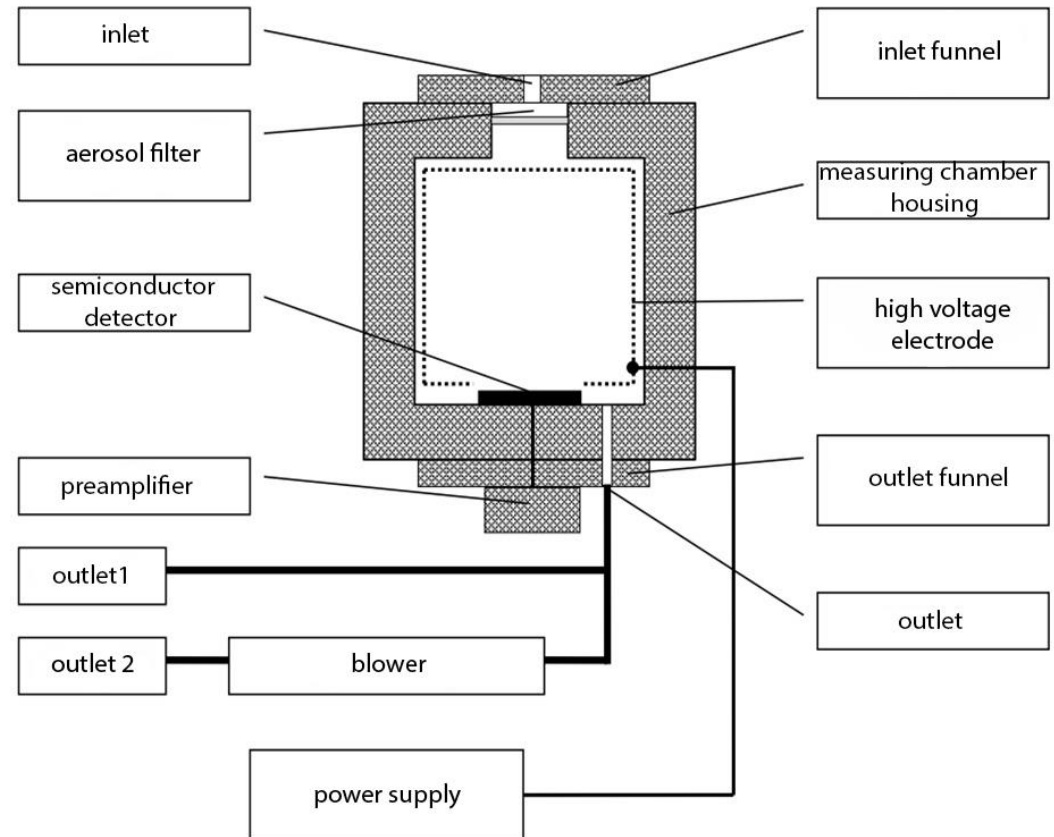
Four locations in the Educational Laboratory of Nuclear Processes (former Cyclotron Laboratory) were selected for air sampling:

- first floor of the building
- third floor of the building
- sampler №1 (near sampler) – located in the basement of the Cyclotron pump room
- sampler №2 (far sampler) – located in the basement of the Cyclotron pump room

Diagrams of experimental setups:



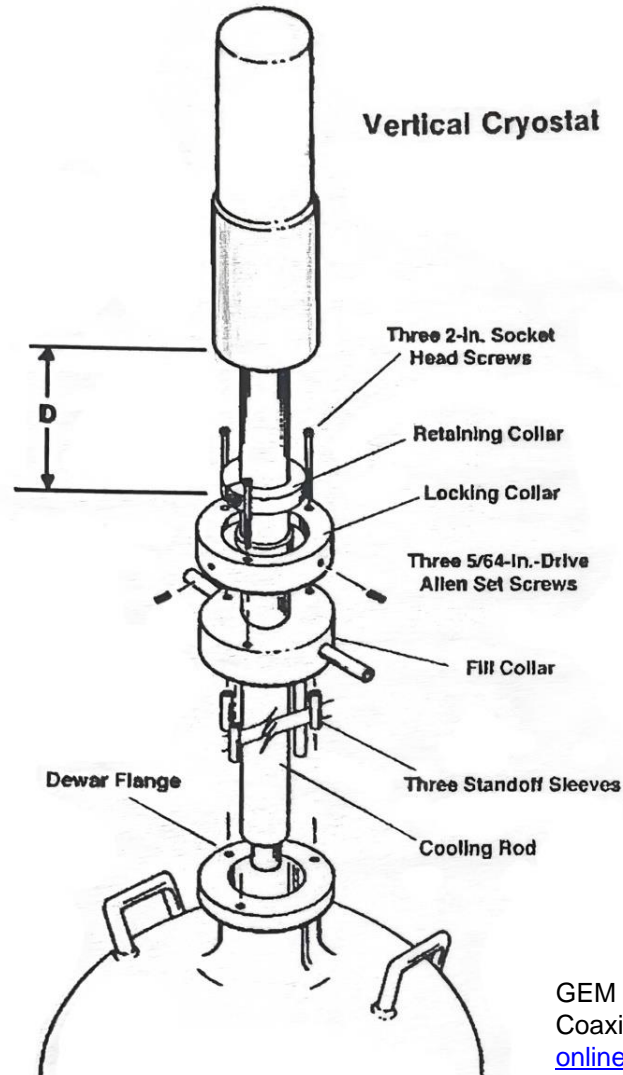
## Radon measurement device



The measurements were carried out for a year and a half

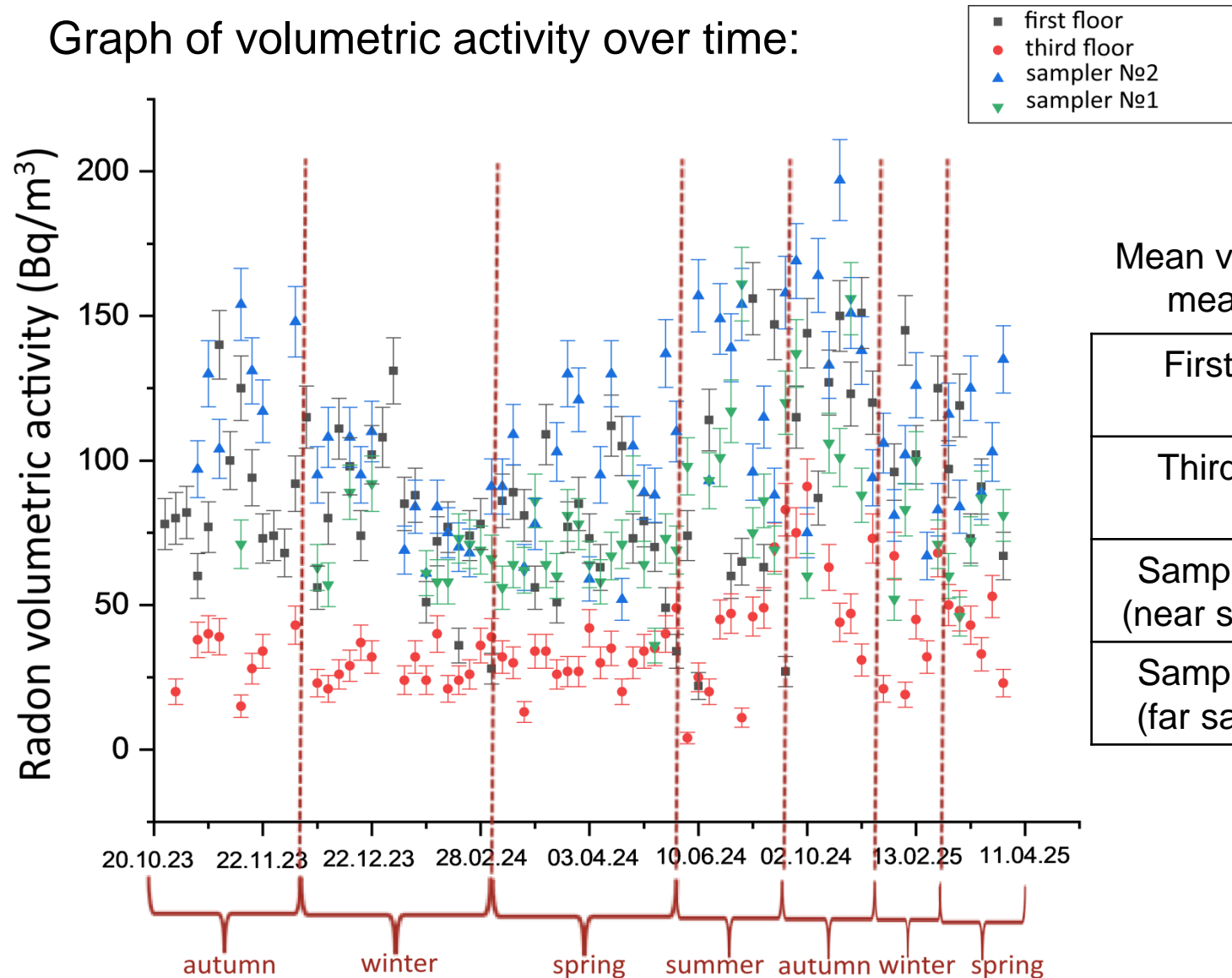
Комплекс измерительный для мониторинга радона, торона и их дочерних продуктов «АльфаРад плюс». Руководство по эксплуатации БВЕК 590000.001 РЭ, 2021.

## Cooling and mounting system for a high-purity germanium detector



GEM Series, HPGe (High-Purity Germanium) Coaxial Detector System <https://www.ortec-online.com>

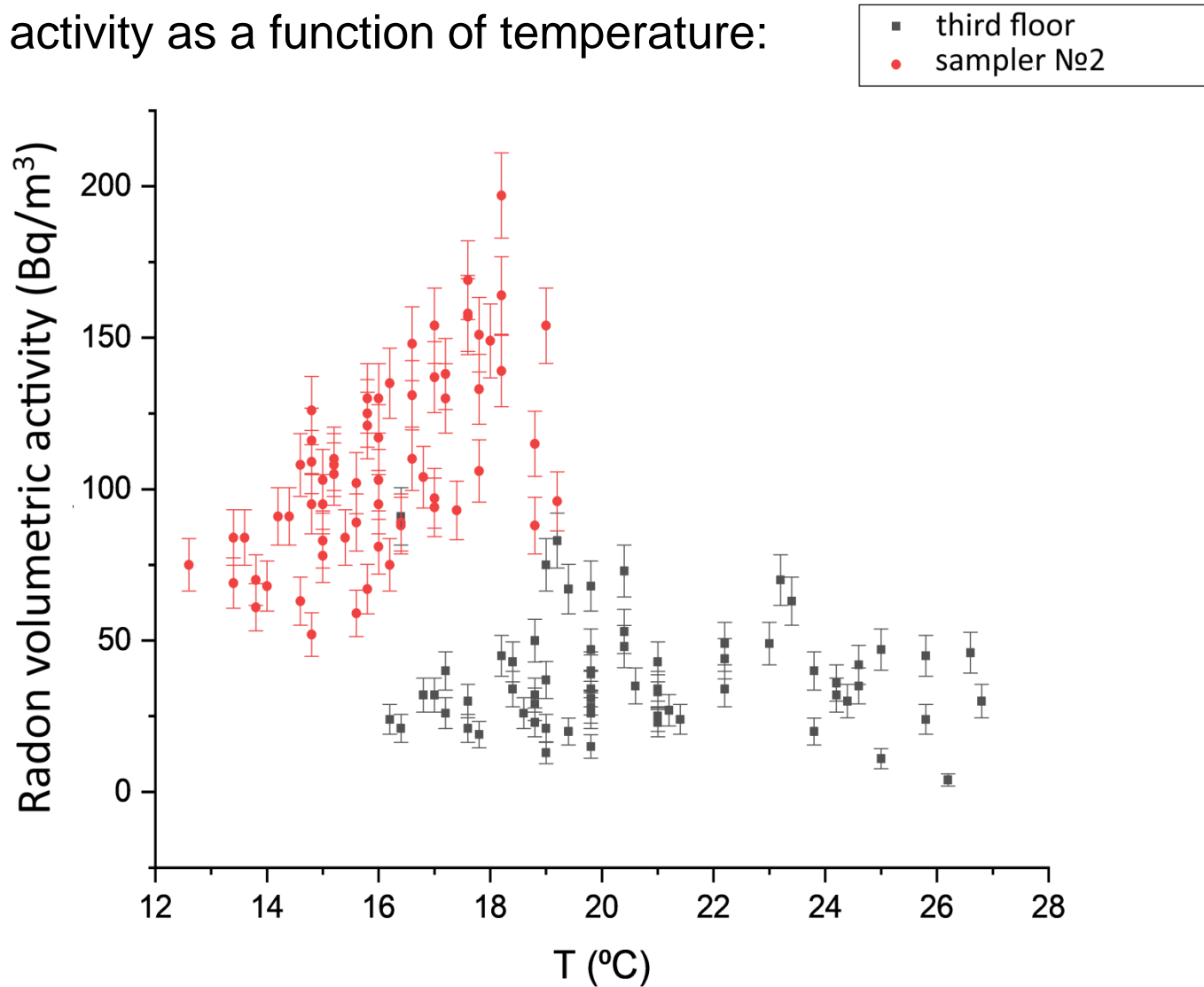
Graph of volumetric activity over time:



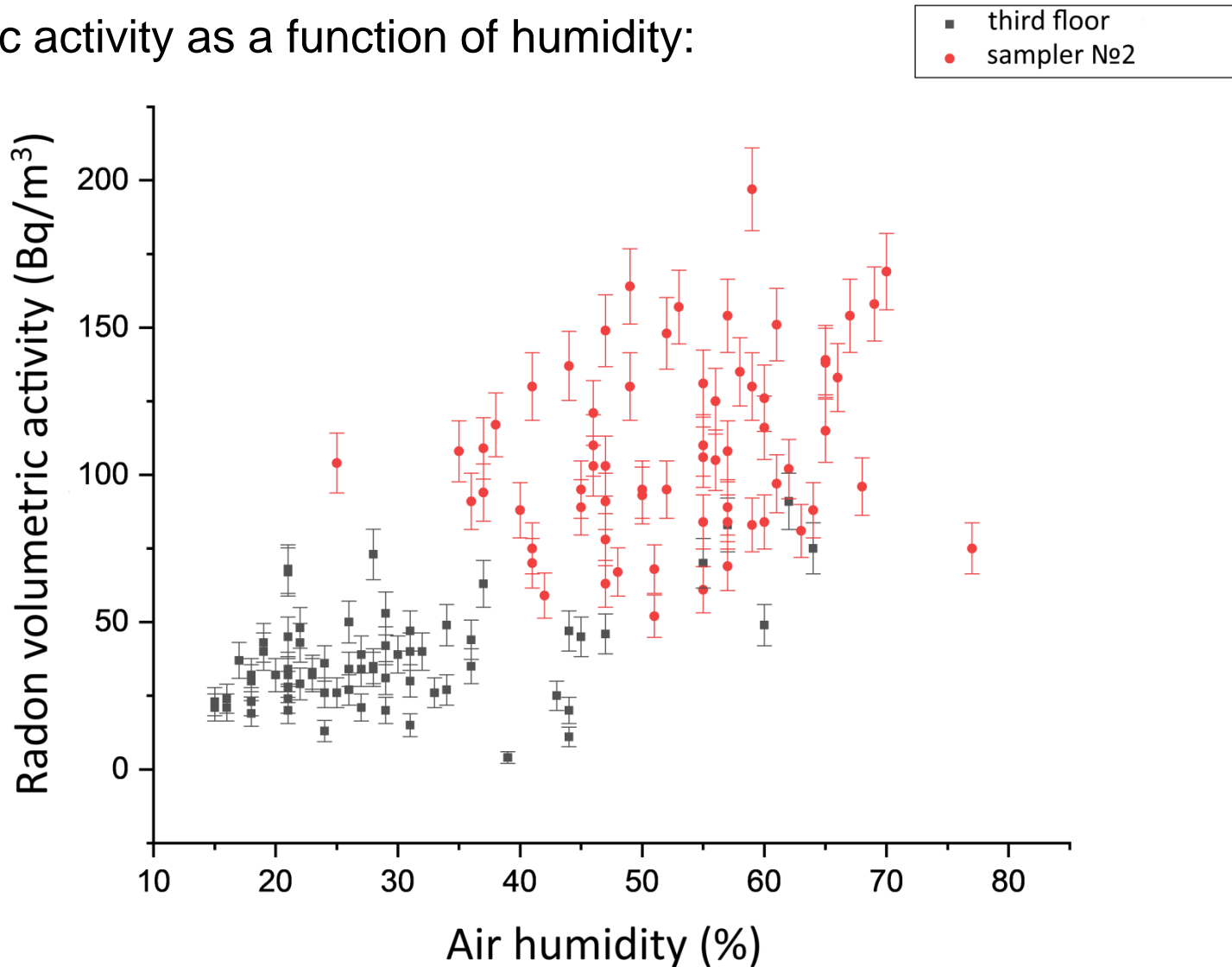
Mean values over the entire measurement period:

First floor	$(89 \pm 1) \text{ Bq/m}^3$
Third floor	$(37 \pm 1) \text{ Bq/m}^3$
Sampler №1 (near sampler)	$(79 \pm 1) \text{ Bq/m}^3$
Sampler №2 (far sampler)	$(108 \pm 1) \text{ Bq/m}^3$

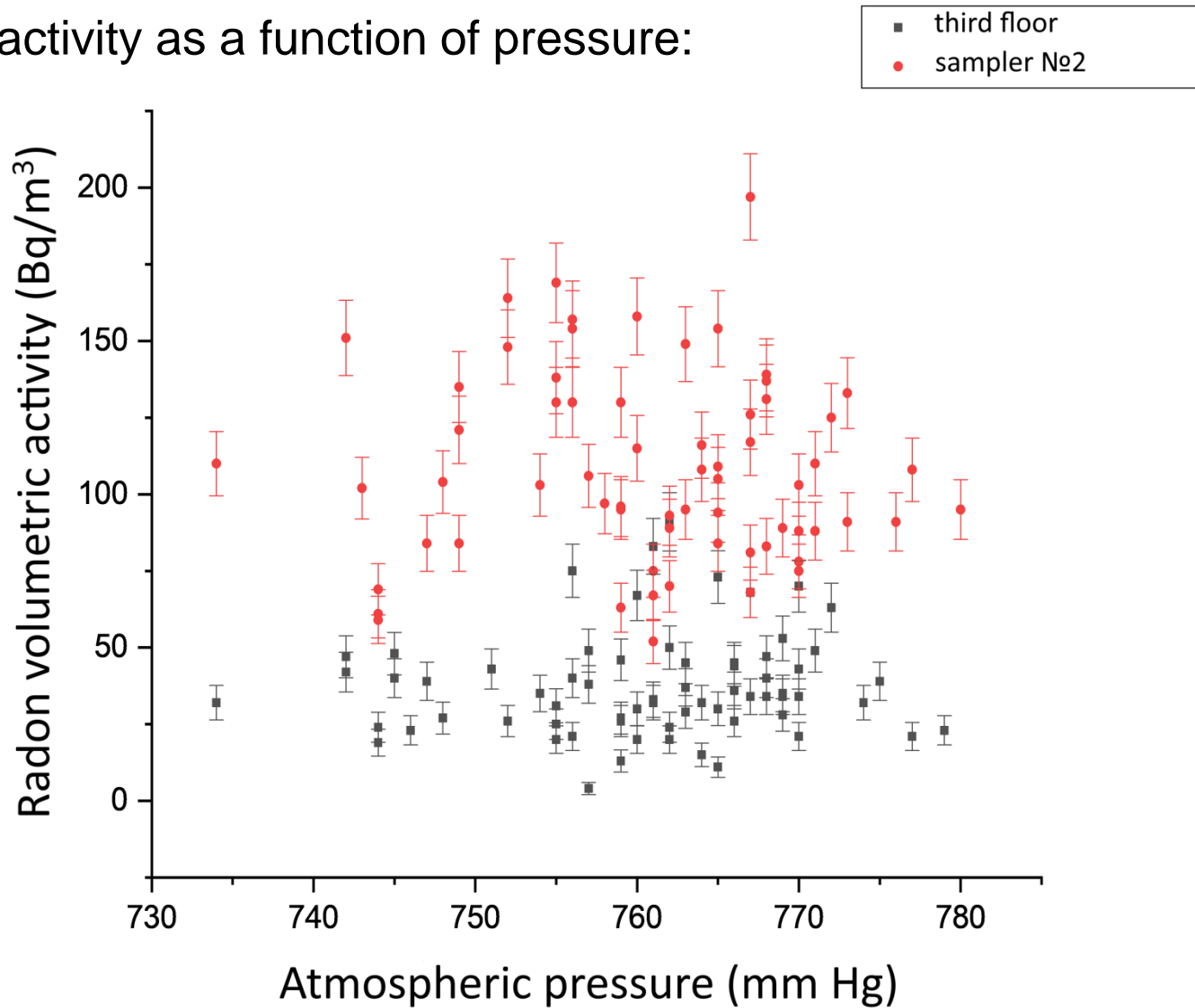
Volumetric activity as a function of temperature:



Volumetric activity as a function of humidity:

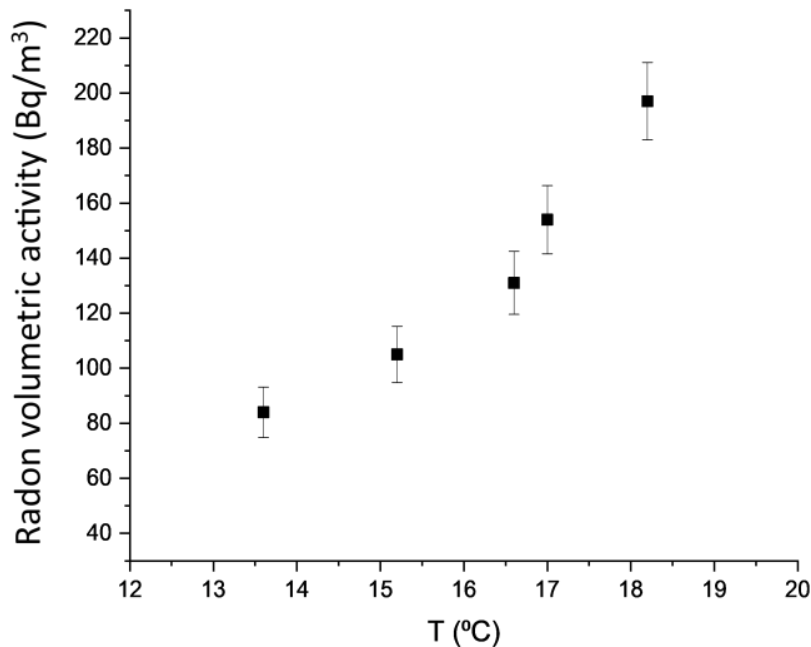


Volumetric activity as a function of pressure:

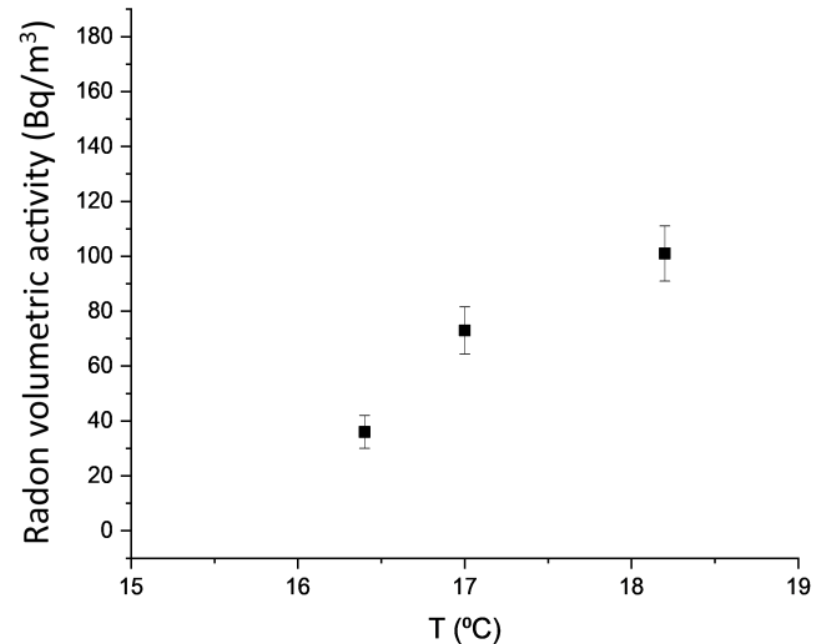


## Volumetric activity as a function of temperature

Sampler №2 (far sampler)



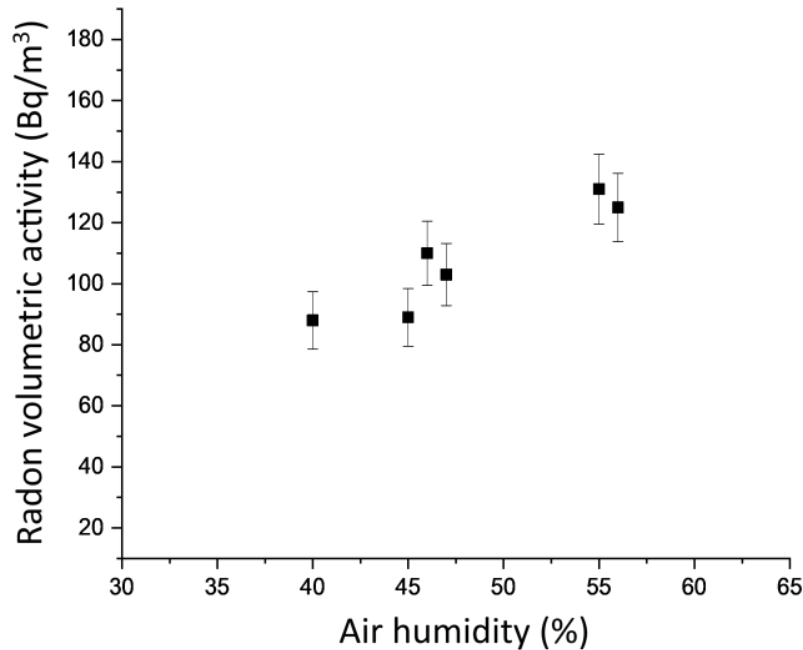
Sampler №1 (near sampler)



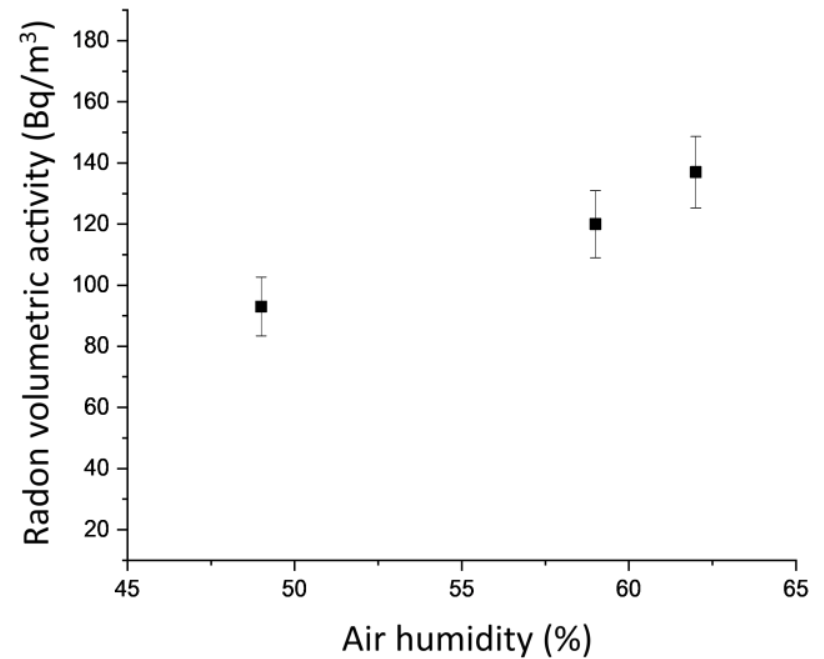
Humidity, pressure = const

## Volumetric activity as a function of humidity

Sampler №2 (far sampler)



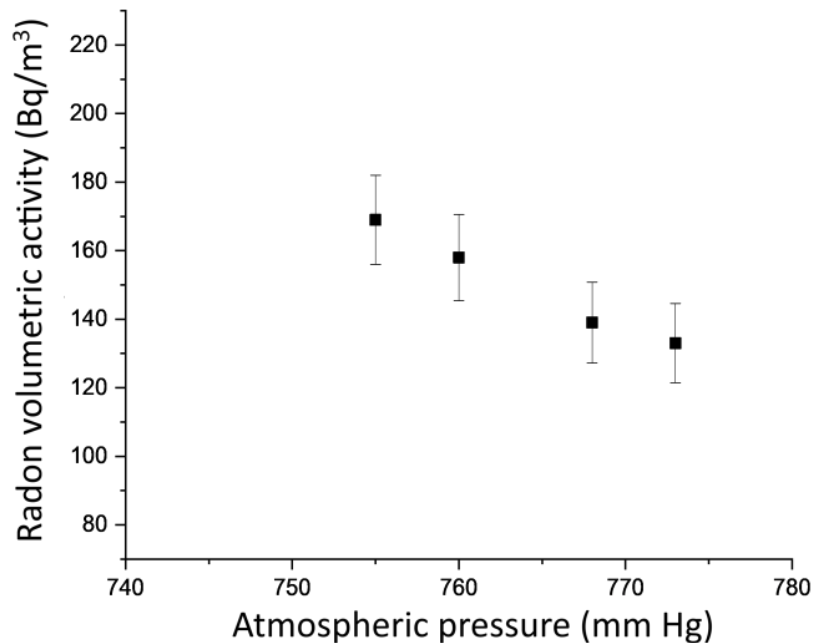
Sampler №1 (near sampler)



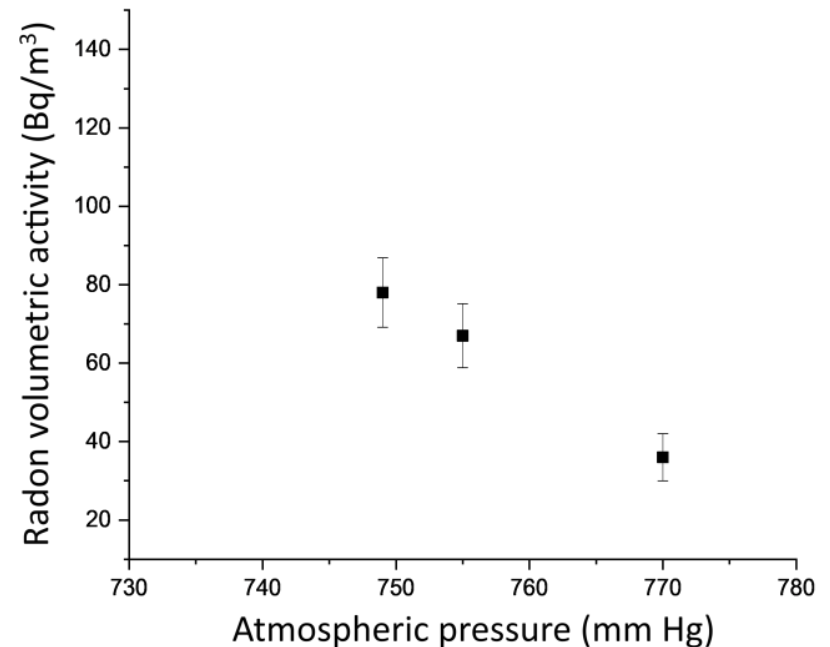
Temperature, pressure = const

## Volumetric activity as a function of pressure

Sampler №2 (far sampler)



Sampler №1 (near sampler)



Temperature, humidity = const

An **energy efficient building** is a building designed in such a way as to minimize energy consumption

Building type	Mean volumetric activity, Bq/m <sup>3</sup>
Panel and brick houses from 1970s-1990s (more than 5 floors)	21
Houses from 1930s-1960s (2-5 floors)	33
Energy efficient houses built after 2000	49



[spb.pronovostroy.ru](http://spb.pronovostroy.ru)

Radon concentration in conventional and new energy efficient multi-storey apartment houses: results of survey in four Russian cities: Nature, 2020.

Primorsky district, year of commissioning is 2023. 10th floor. Cast-in-Place concrete wall systems.

	Living room	Kitchen	Bathroom
VA, Bq/m <sup>3</sup>	144±15	141±14	147±16

Krasnoselsky district, year of commissioning is 1998. 1st floor. Panel building.

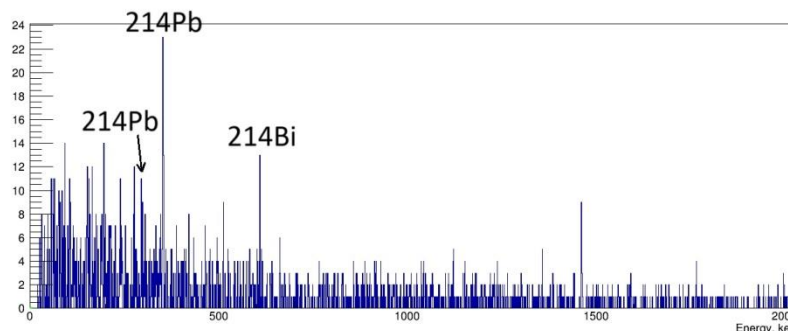
	Living room	Kitchen	Bedroom	Kid's room
VA, Bq/m <sup>3</sup>	47±9	39±8	34±7	41±8

Primorsky district, year of commissioning is 1979. 5th floor. Panel building.

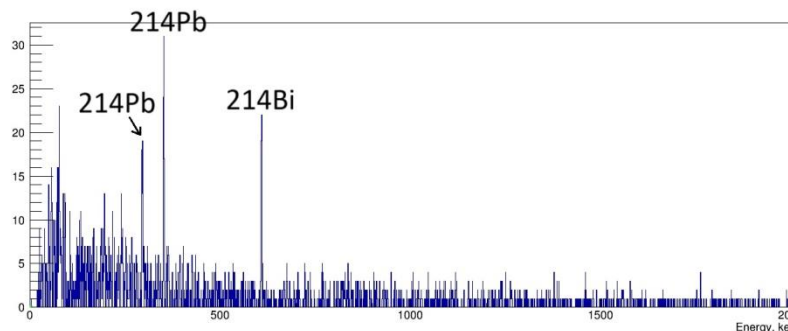
	Living room	Kitchen	Bedroom	Kid's room	Bathroom
VA, Bq/m <sup>3</sup>	35±7	12±3	14±5	18±4	10±2

## Gamma spectra of the swabs taken from the inner surface of the sampler

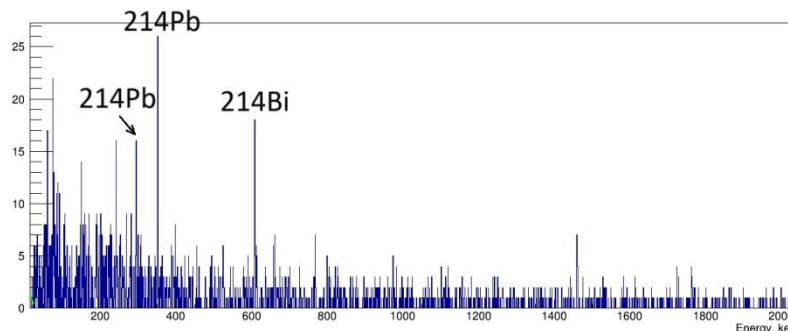
Energy and efficiency calibration was carried out using a  $^{152}\text{Eu}$  source



19.08.2024



09.09.2024



12.11.2024

## Activity of radon decay products

The deposition process of radon decay products in the samplers is stationary

Isotope	Activity, Bq
$^{214}\text{Pb}$	$14 \pm 3$
$^{214}\text{Pb}$	$31 \pm 4$
$^{214}\text{Bi}$	$71 \pm 12$

Isotope	Activity, Bq
$^{214}\text{Pb}$	$46 \pm 6$
$^{214}\text{Pb}$	$46 \pm 5$
$^{214}\text{Bi}$	$199 \pm 21$

Isotope	Activity, Bq
$^{214}\text{Pb}$	$22 \pm 4$
$^{214}\text{Pb}$	$20 \pm 3$
$^{214}\text{Bi}$	$71 \pm 12$

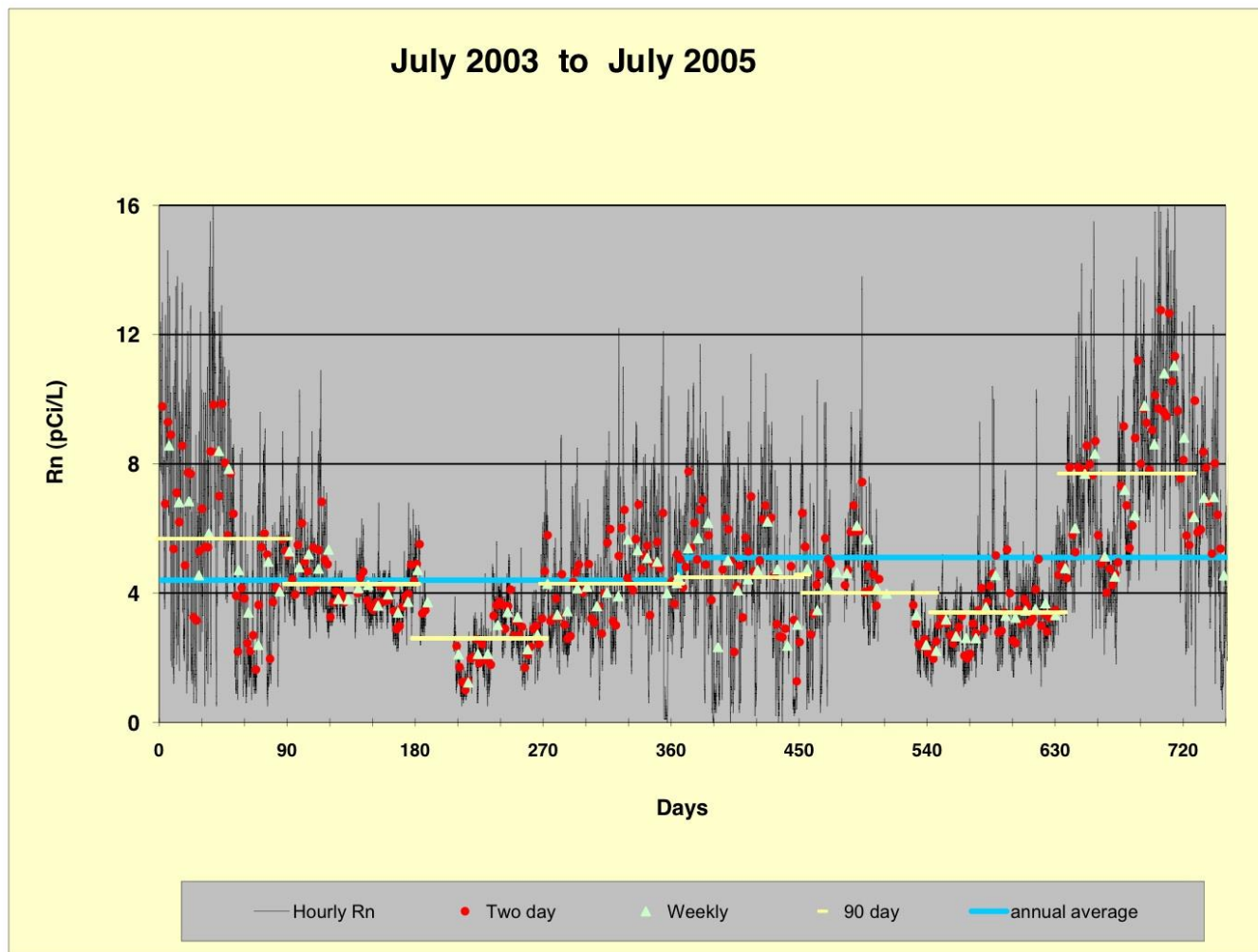
Three weeks  
between  
measurements

More than two  
months  
between  
measurements

- There are seasonal fluctuations in the volumetric activity of radon.
- Radon volumetric activity increases as temperature and humidity increase.
- Radon volumetric activity decreases as atmospheric pressure increases.
- Radon tends to accumulate more in energy efficient buildings.
- The deposition process of radon decay products in the samplers is stationary.

**Thank you for your attention!**

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**spbu.ru**



<https://www.sltrib.com>