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trace Radon

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Introduction to the new calibration sources and their performance

EMPIR 19ENV01 traceRadon

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***19ENV01 traceRadon** denotes the EMPIR project reference.*

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Activities A1.3.3 & A1.3.4

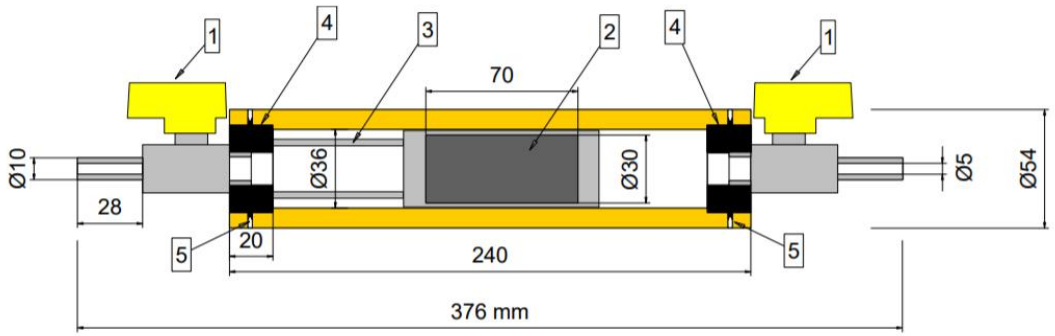
PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin
Budapest Főváros Kormányhivatala
CMI Czech Metrology Institute
ENEA Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile
IFIN-HH
NPL National Physical Laboratory
AGES
LOR
ICOS Atmosphere Thematic Centre
ICOS Carbon Portal
INESCTEC
European Commission Joint Research Centre
University of BRISTOL
UC Universidad de Cantabria
UPC
ideas

Low-level Rn-222 emanating sources

- Radon measurement techniques are simple, efficient and precise.
- Levels of relevant activity concentration in European dwellings are laid down (300 $Bq \cdot m^{-3}$).
- Developing and improving of calibration procedures is still actual.

Low-level Rn-222 emanating sources

- Stainless steel cylindrical case, ball valves.
- Steel tray with Ra-226 placed in the middle of this cylindrical case - radon releases from this thin layer.
- Flow-through mode.
- The emanation coefficient was determined by measuring the activity of the RnDP (Pb-214/Bi-214) - the activity of Ra-226 is almost equal to 1.
- The detection
- eciency of the gamma photons was calculated by the MCNP code (Monte Carlo N-Particle Transport).



1 – ball valve
2 – emanator
3 – holder
4 – flange
5 – retaining screw
Material: Dural, brass, stainless steel, Teflon, epoxy resin

Low-level Rn-222 emanating sources

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

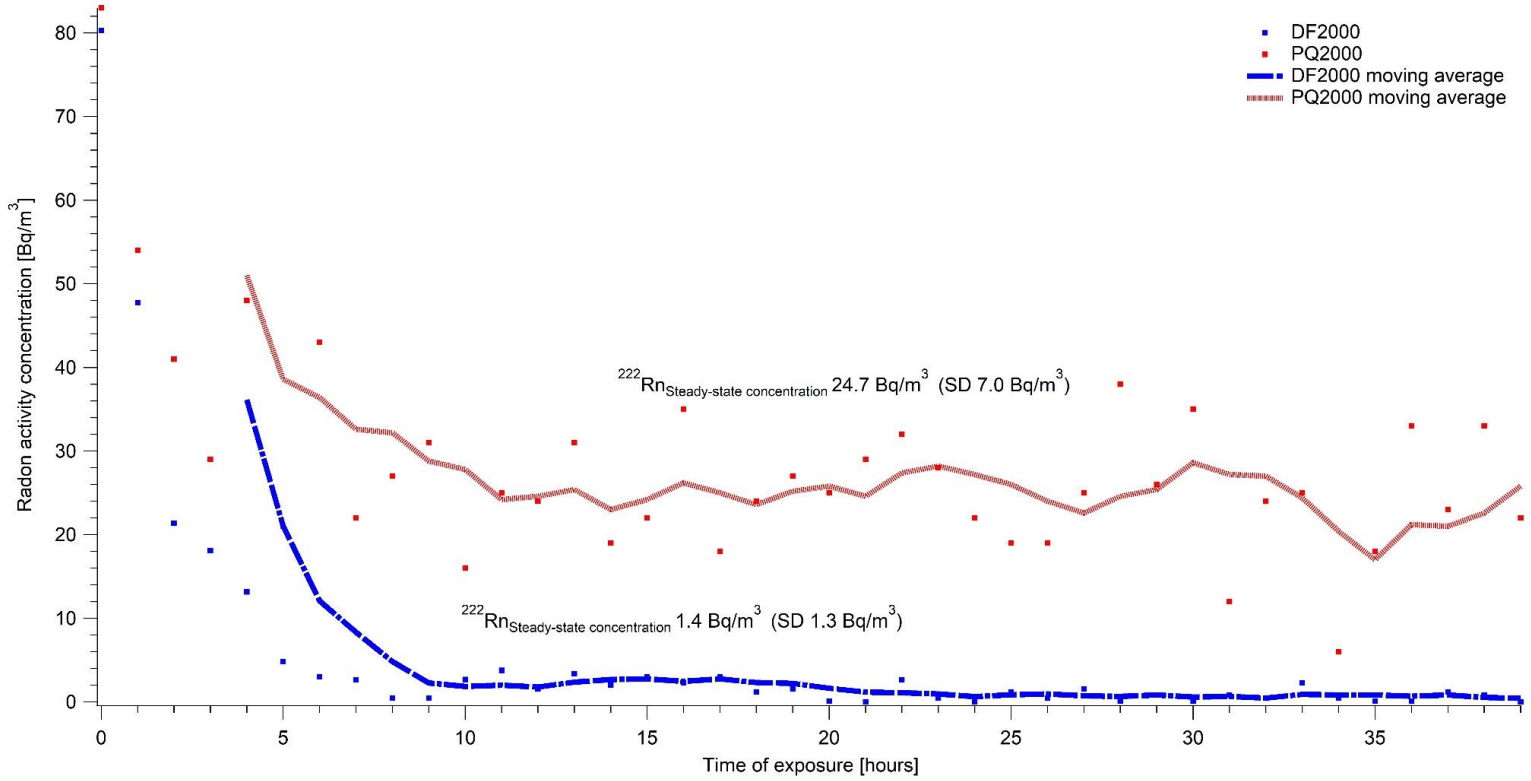
Pracoviště: Oblastní inspektorát Praha, Radiová 1136/3, 102 00 Praha 10
Oddělení výroby standardních radionuklidových zdrojů, Radiová 1288/1a
tel. +420 266 020 460

CERTIFIKÁT
etalonu aktivity

Číslo certifikátu: 1035-SE-40175-21 **Typ: RF 1** **Výrobní číslo: 230321-221458**

Radionuklid: Ra-226
Poločas Ra-226: 1600 (7) let
Aktivita: 1,136 (17) kBq
Poločas Rn-222: 3,8232 (8) dní
Radonová výdejnost: 0,0023 (1) Bq/s
Emanační schopnost: 0,9552 (19)
Radionuklidové nečistoty: -
Vnitřní objem mezi ventily: 200 (5) cm^3
Referenční datum: 1. 4. 2021

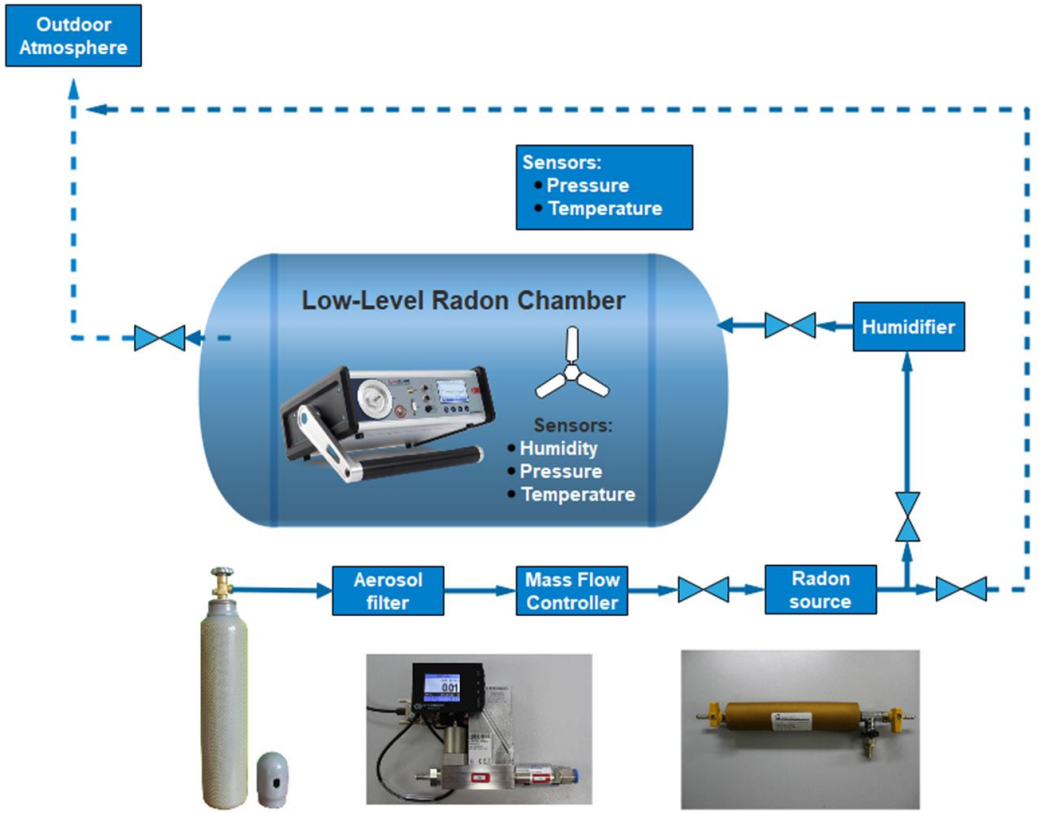
Low-level Rn-222 emanating sources – background test



Low-level Rn-222 emanating sources – laboratory calibration

Achieving of low-level radon activity concentration:

- ❑ Constant dotting of radon.
- ❑ Defined ventilation.
- ❑ Radon free air.

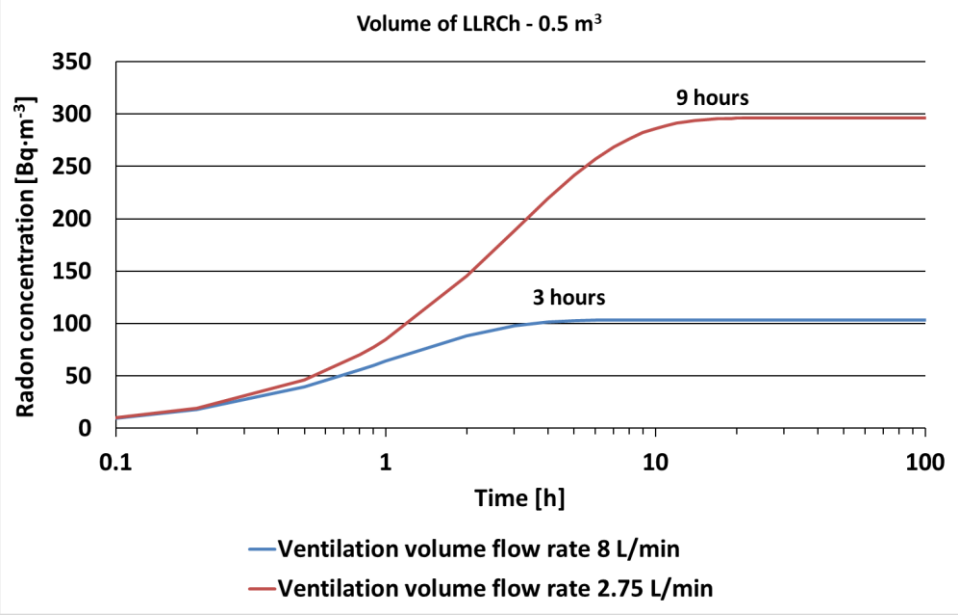


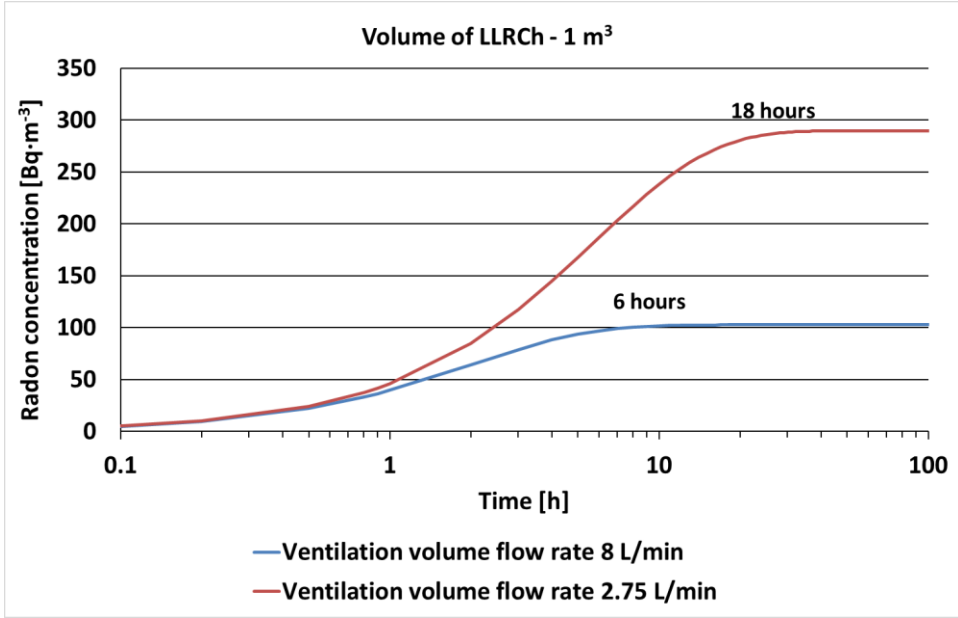
Low-level Rn-222 emanating sources – The reference level of radon

- Model of constant radon input and constant ventilation:

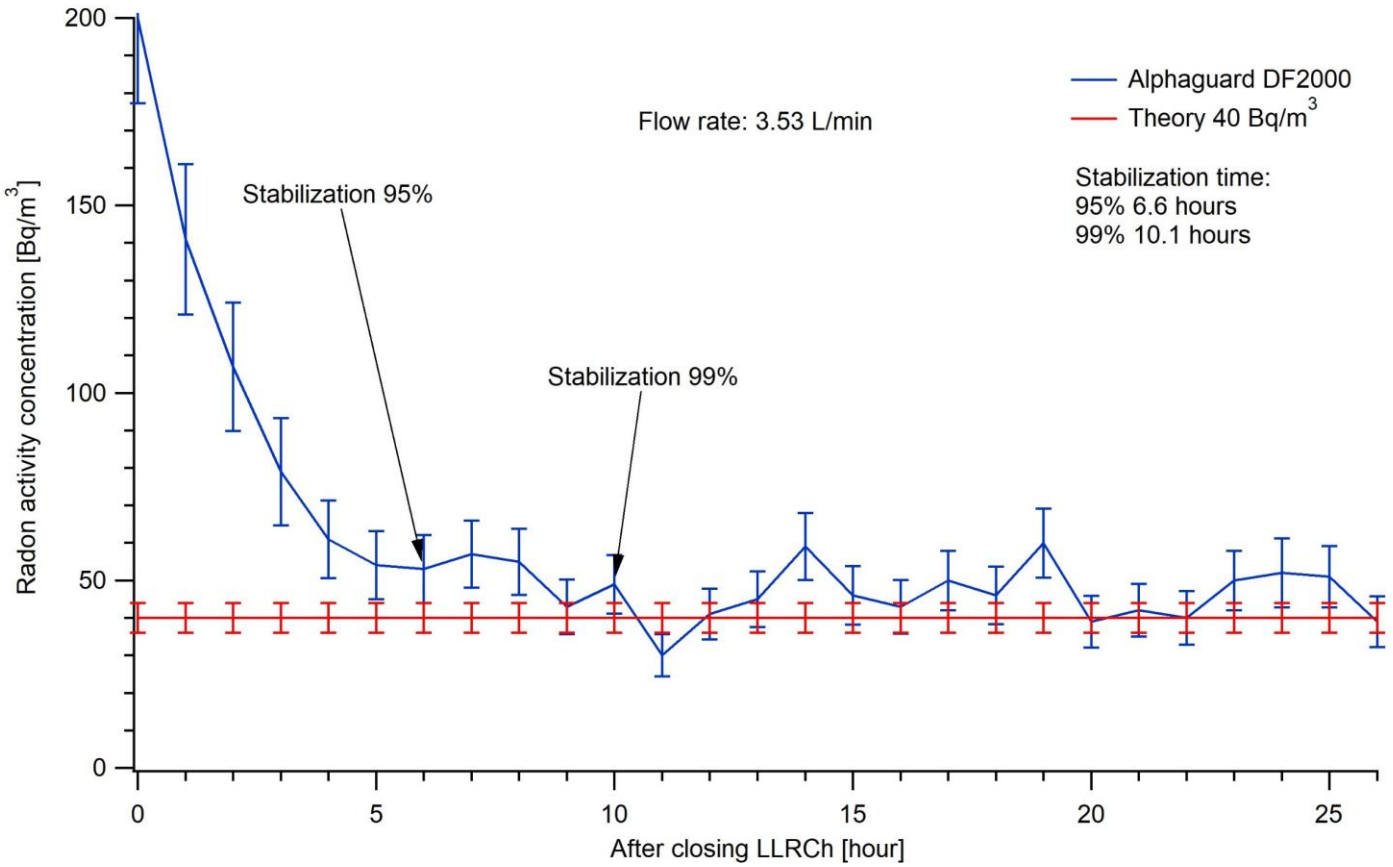
$$a(t) = a_o \,.\, e^{-(\lambda+k).t} + \frac{R}{V(k+\lambda)}\left(1 - e^{-(\lambda+k).t}\right)$$

$a(t)$	*radon activity concentration in time t ($Bq \cdot m^{-3}$)*
a_0	*radon activity concentration in time zero ($Bq \cdot m^{-3}$)*
λ	*radon decay constant (h^{-1})*
k	*air exchange intensity (h^{-1})*
t	*time (h)*
R	*radon input rate ($Bq \cdot h^{-1}$)*
V	*volume of radon chamber (m^3)*

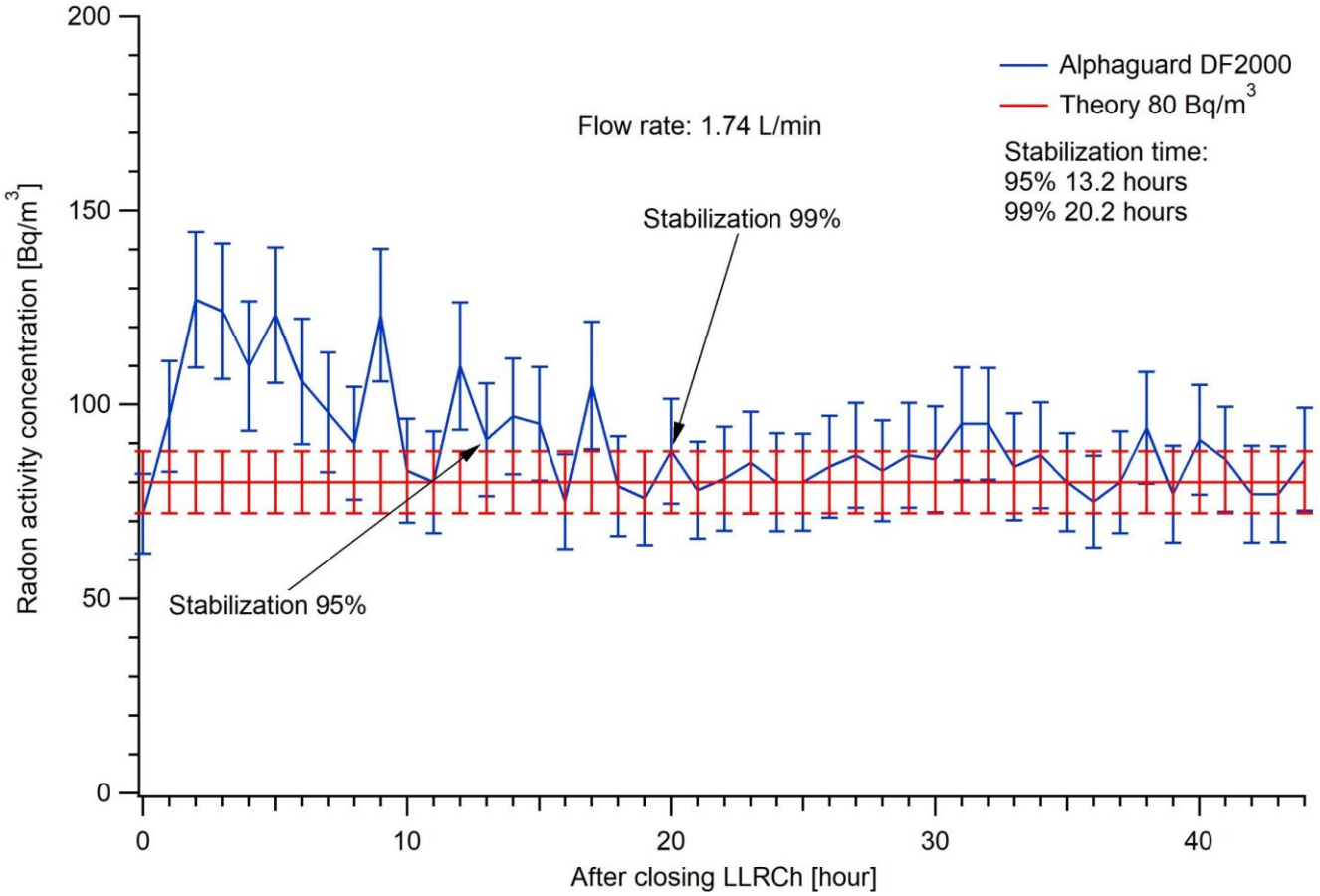




Low-level Rn-222 emanating sources



Low-level Rn-222 emanating sources



Low-level Rn-222 emanating sources – field calibration

Radon activity concentration 1 – 20 $Bq \cdot m^{-3}$

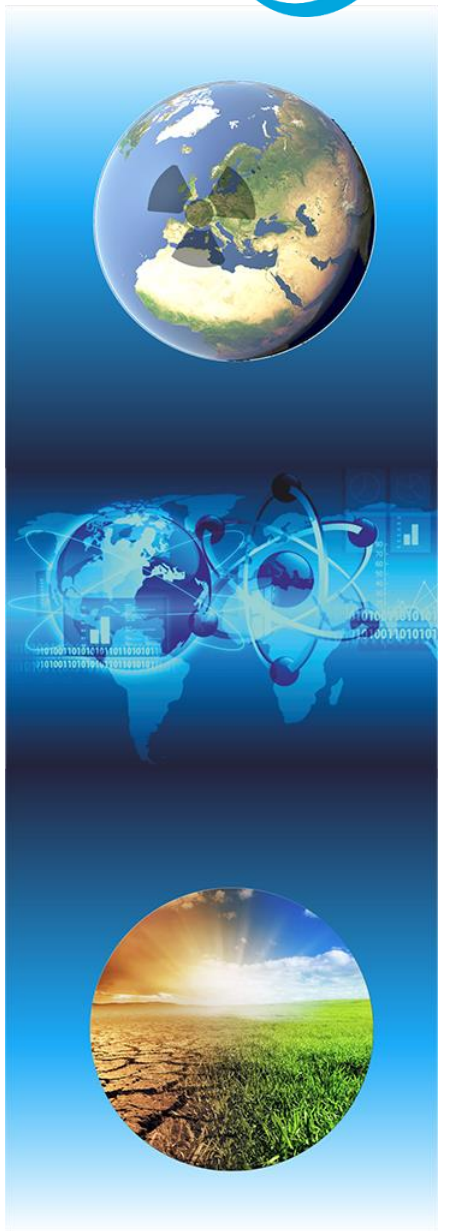
Maximal flow rate: 10 L/min

Only for devices in flow measuring regime

Outdoor air → Radon source → Radon monitors

Inversion weather

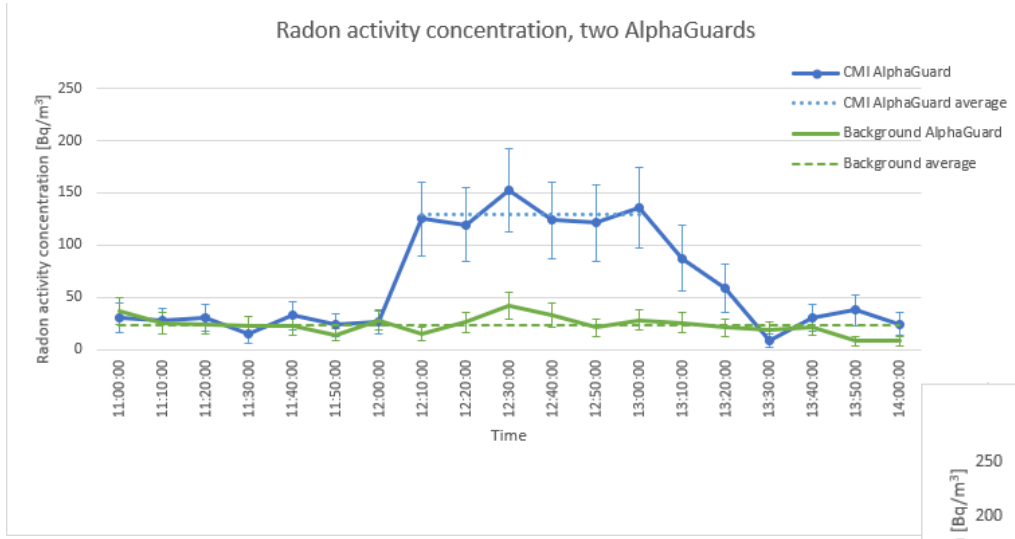
necessary to know the background activity of radon monitor

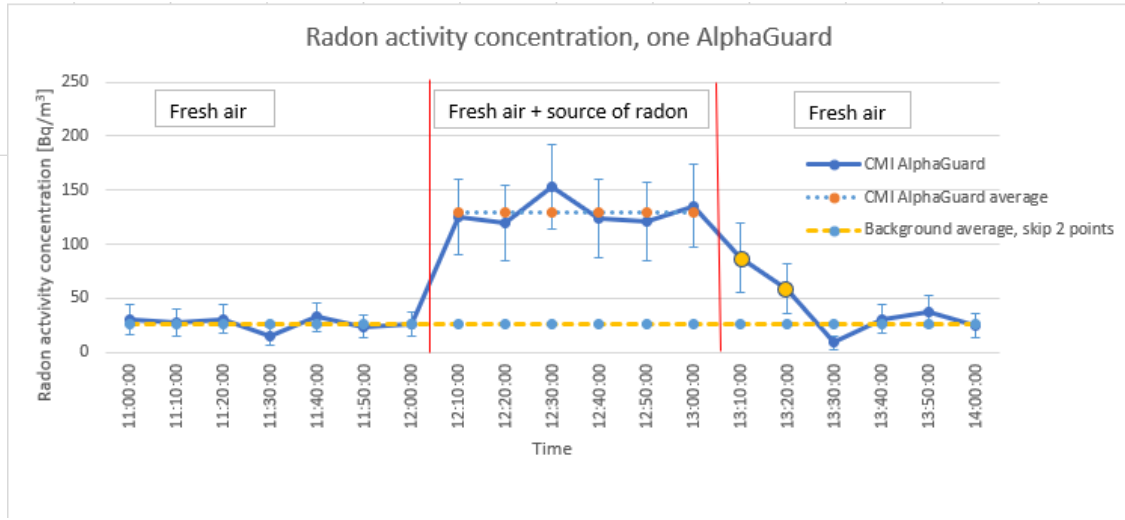


Low-level Rn-222 emanating sources – field calibration

Average: 23 Bq·m^{-3}
Maximum: 360 Bq·m^{-3}

Low-level Rn-222 emanating sources – field calibration

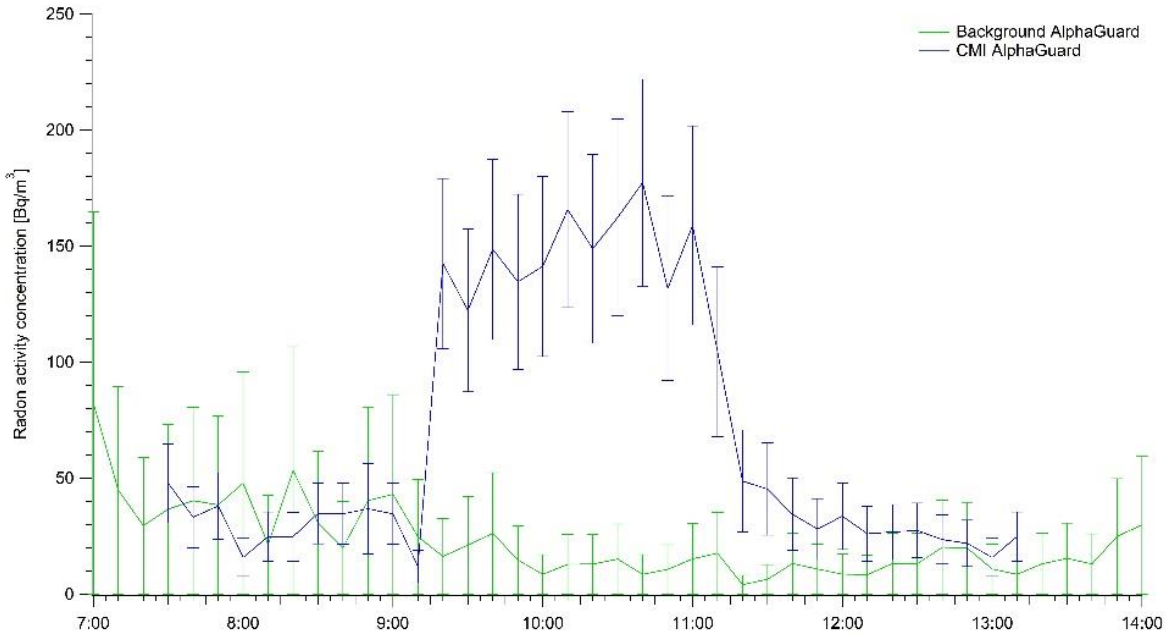




Crucial parameters – Field calibration

- The background activity of the measuring device has to be known (should be analyzed in the radon free atmosphere, no more than 10 $Bq \cdot m^{-3}$),
- have to be checked the flow rate value of the measuring device (the SUJCHBO AlphaGuard was checked by Gilibrator-2 – calibrated by the CMI),
- calibration should be performed at the lowest radon concentration in the outdoor atmosphere (8:00 a.m. – 6:00 p.m.),
- in the case of using a CMI flow source, it is necessary to replace the atmosphere in the source at least 100 times during minimally 30 minutes and immediately use the source for calibration.

Crucial parameters – Field calibration



Parameter	Value
Background activity	2 Bq·m^{-3}
Set flow rate value	1 L/min
Measured flow rate value	1,156 L/min
Source radon activity concentration	119,4 ± 6 Bq·m^{-3}

The result is 120.1 ± 27.9 Bq·m^{-3} after subtracting the background activity and outdoor radon concentration from the average results, representing the time when the radon source is connected to the AlphaGuard.

Field calibration