RESPIRE

Radon real time
monitoring system

ISTITUTO NAZIONALE
DI GEOFISICA E VULCANOLOGIA

LIFE Project
RESPIRE – LIFE 16 EN/it/000553

# LIFE-RESPIRE radon indoor measurements

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# radon indoor measurement techniques

## Passive dosimeters

Passive radon detectors are the most commonly used methods of testing buildings for radon gas. Suitable for both homes and workplaces, single-use passive detectors are simply left in place for a certain amount of time before being posted back for laboratory analysis.

At first, for a more quickly result, a 2-day screening test was carried out which provided a good indication on the possible high radon concentrations eventually present in the studied sites.

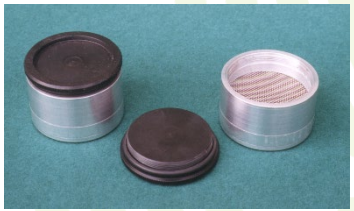
In the second phase, where possible, testing are carried out over a three month period, as this will take into account fluctuations in indoor radon concentrations.

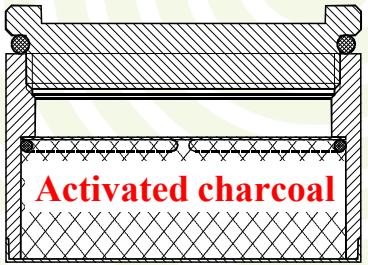
# radon indoor measurement techniques

## PASSIVE Detectors

**Track-etch**. Suitable for prolonged exposition (**months**). Their employment fulfils European Directive 2013/59 Euratom of 5/12/2013 that European countries must transpose before 6/2/2018

**Activated charcoal canisters**.
Suitable for short exposition (**48h**), activity measurements in laboratory by means of $\gamma$ spectrometry





# radon indoor measurement techniques

## ACTIVE Detectors

Digital radon monitors are useful to carry out long-term measurements in a building or have several different areas to test.

Digital monitors do not need to be sent back to the laboratory for radon analysis.

These radon testing devices can be <u>particularly useful for carrying out continuous monitoring after mitigation work has been completed</u>, being sure that the system is performing as expected and that radon concentrations remain at an acceptable level.

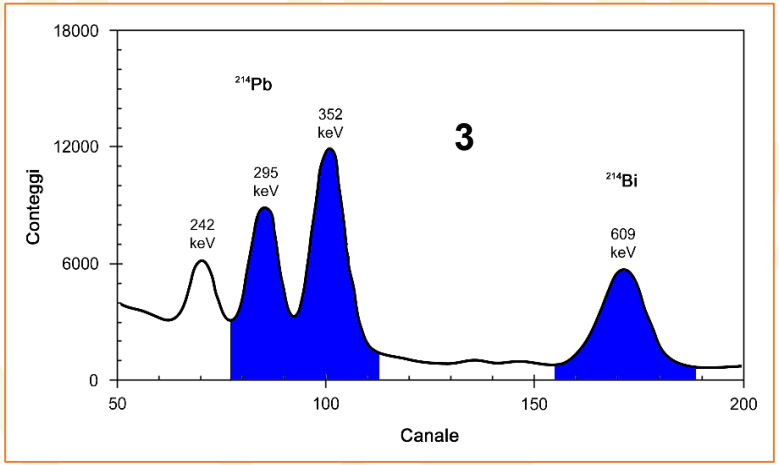
α–decay revealing sensors (INGV, Algade, Airthings, ecc.)


# Radon indoor measurements techniques using γ spectrometer

**Low full-scale γ spectrometer with NaI (Tl) detector**
(**1**) for radon indoor and dissolved radon in groundwater measurements with passive techniques.

(**2**) Pulse acquired by a multi-channel analyzer (Silena Mod. CATO)
(**3**) obtaining the spectrum shown in the diagram.

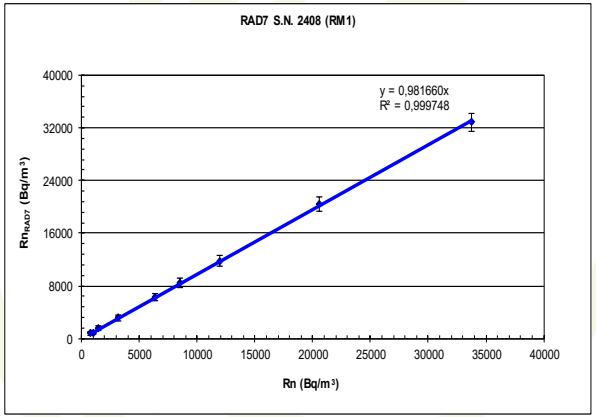

The contribution obtained from $^{214}$Pb e $^{214}$Bi (blue areas), short-**half-life radon daughters**, allow to calculate the indoor or dissolved radon activity.



# Intercalibrations


Layout of calibration facility when many instruments are to be simultaneously calibrated.
Radon concentration, temperature and RH are varied to study the instrument linearity.

1. Radon chamber (RC);
2. Drying and humidifying devices;
3. Multichannel analyser/Multiscaler;
4. INGV sensor;
5. RAD7 (Durridge) sensor;
6. Secondary RC containing many smaller sensors (Corentium, AER Plus)

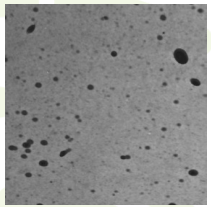



RAD7 linearity (at low AH) and correction (1/0,982) to the internal calibration coefficient

# radon indoor measurement techniques using track-etch

The Radosys RSK are small cylinders made of PVC consisting of a container (diffusion chamber) in which is housed a particular polymer sensitive to alpha radiation emitted by $^{222}Rn$. They are not harmful and can be easily handled without any danger. As a result of the analyses, the average concentration of indoor radon in the exposure period is obtained.

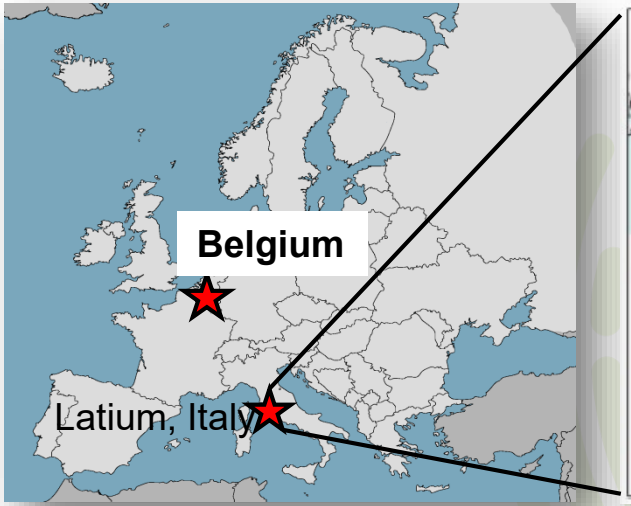
## Passive detector Radosys RSK type device

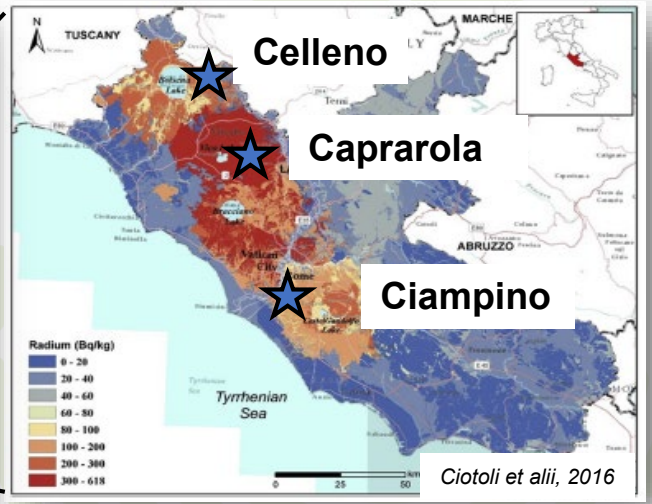
Computerized analysis of the CR-39 by means of an electron microscope for the automatic traces detection and obtaining the concentration of average radon indoor during the exposure period.

# radon indoor main targets

**The projects takes place in 4 European areas (Belgium and Italy), each characterized by different levels of indoor radon** activities. The main goal is to develop **a cost-effective and eco-friendly solution** for Radon real-time measurement and remediation to **keep indoor Radon levels below 100 Bq/m³ level** (as indicated in European Directive 2013/59/EURATOM).




Belgium: Ardenne




Latium:

- Celleno
- Caprarola
- Ciampino

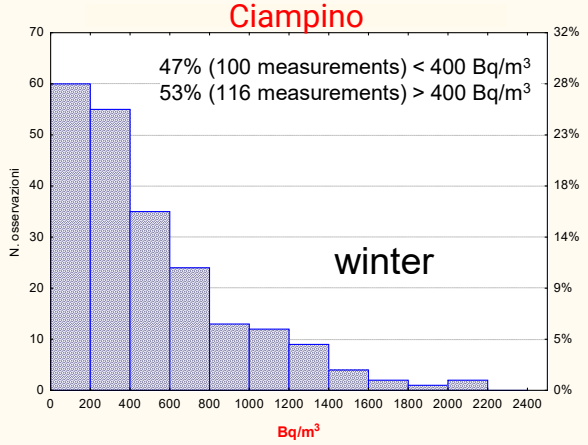
# Prime campagne di screening

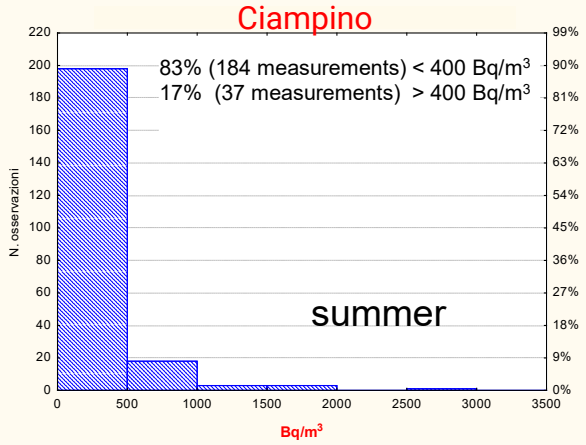
| CIAMPINO | Mean | Median | Min | Max | Lower Quartile | Upper Quartile | Dev. Std. |
|---|---|---|---|---|---|---|---|
| Rn (Bq/m³) | 93 | 58,3 | 10,9 | 483,5 | 41,9 | 105 | 94 |
| **66** Rn indoor measurements in 1**5 public buildings** – **previous surveys**: | | | | | | | |
| Rn (Bq/m³) | 1624 | 479,5 | 12 | 25400 | 207 | 1268 | 4320 |

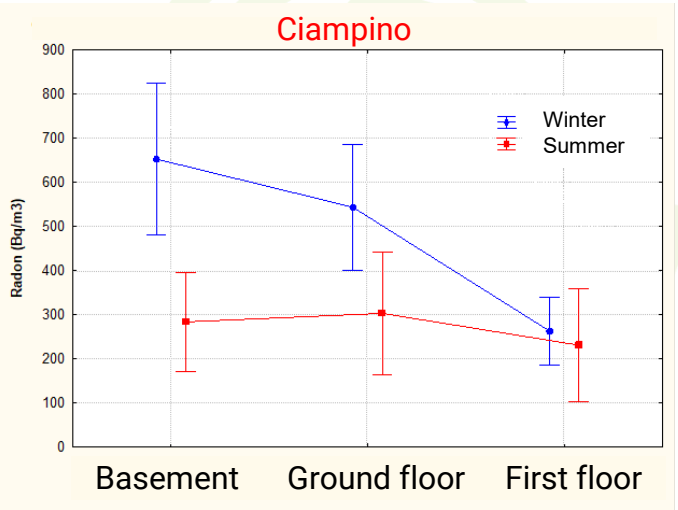
| CELLENO | Mean | Median | Min | Max | Lower Quartile | Upper Quartile | Dev. Std. |
|---|---|---|---|---|---|---|---|
| Rn (Bq/m³) | 540,7 | 252 | 12 | 25400 | 103 | 521,5 | 1392 |
| **180** Rn indoor measurements: **100 private dwellings** and **30 public buildings** | | | | | | | |

| CAPRAROLA | Mean | Median | Min | Max | Lower Quartile | Upper Quartile | Dev. Std. |
|---|---|---|---|---|---|---|---|
| Rn (Bq/m³) | 677,6 | 364,7 | 14,2 | 5800 | 211 | 818 | 835 |
| **82** Rn indoor measurements: **30 private dwellings** and **5 public buildings** | | | | | | | |

# Ciampino municipality (RM, Italy)



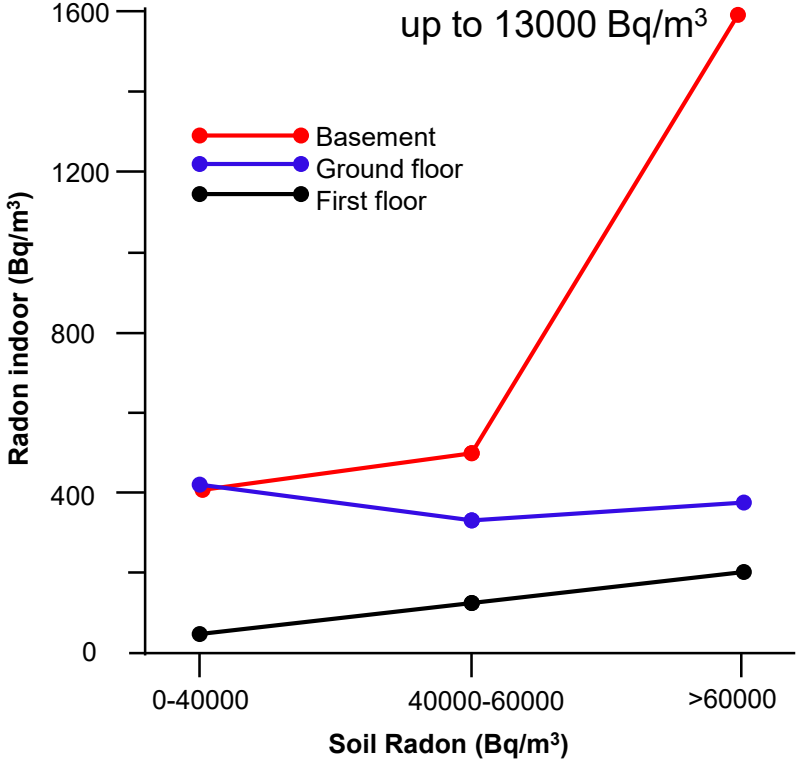




The seasonal trend in the yearly average radon indoor levels referred to first and upper floors is negligible

# Ciampino municipality (RM, Italy)

## Soil radon– indoor radon relationship

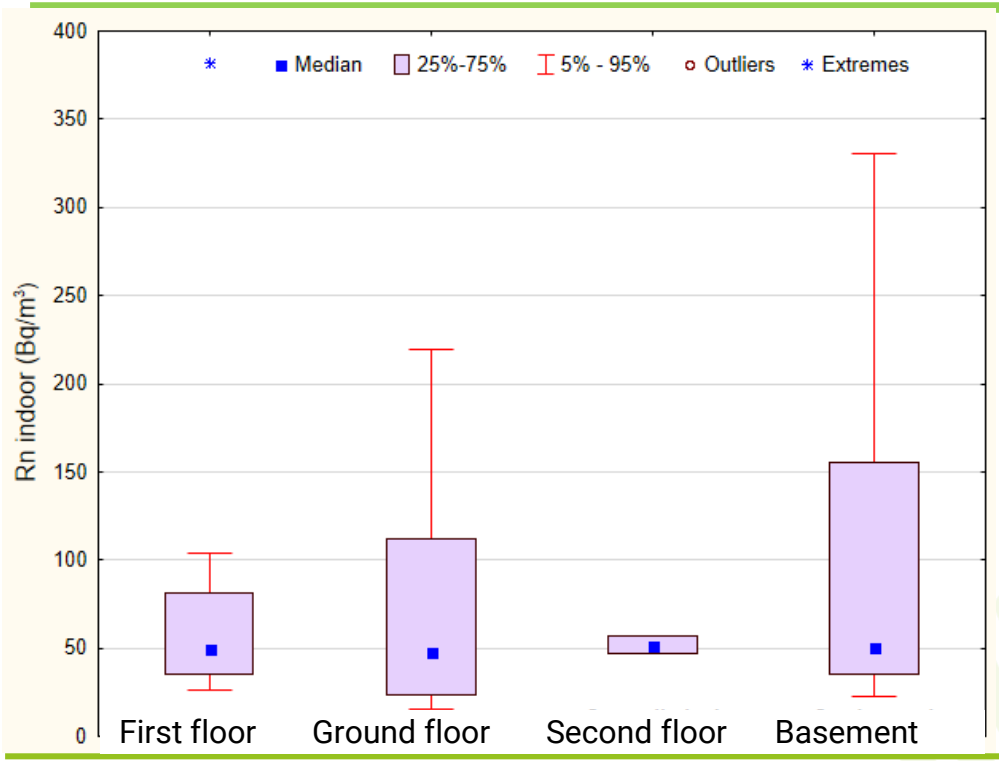



Dots represent the average values of radon indoor levels within each of the three classes of soil radon content.

60000 Bq/m$^3$ corresponds to the geochemical and statistic anomalous threshold.

# Ciampino municipality (RM, Italy)

## 2018 radon indoor survey

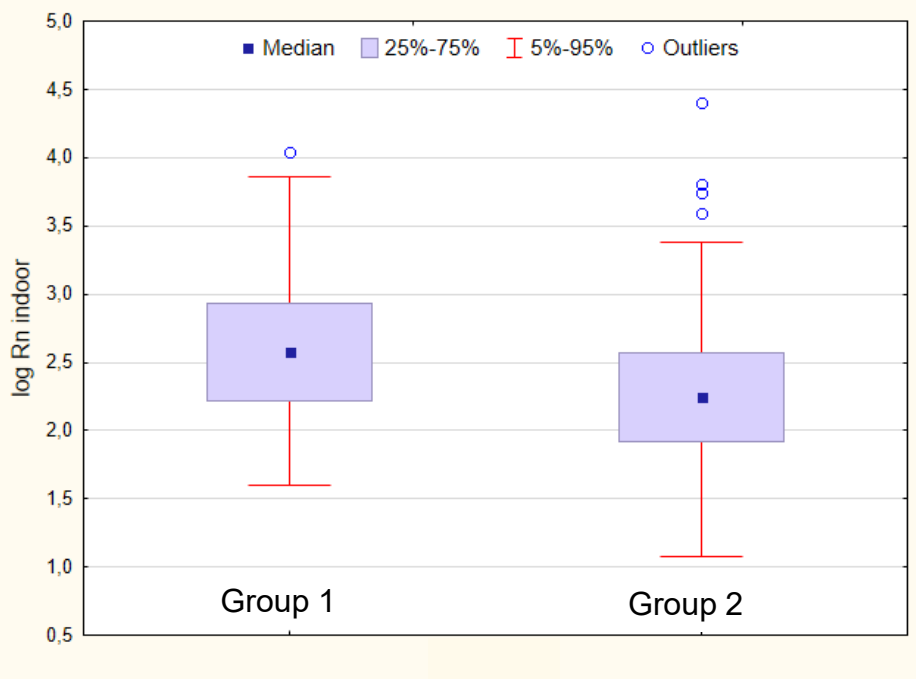


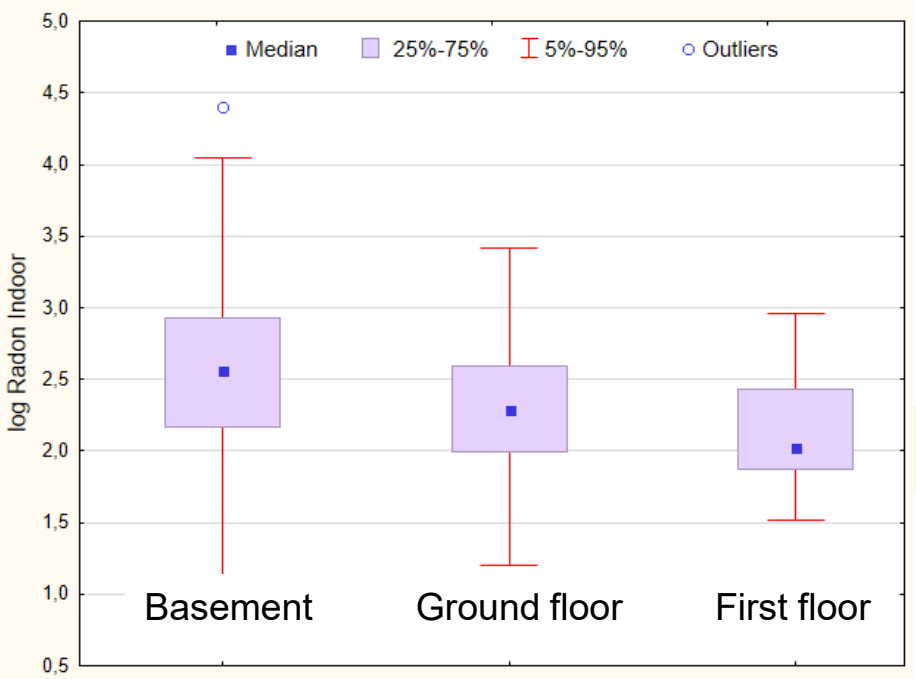

2018 survey - Activated charcoal canisters

We carried out 66 radon indoor measurements in public buildings (11 among schools, townhall and cemetery)

# Celleno municipality (VT, Italy)

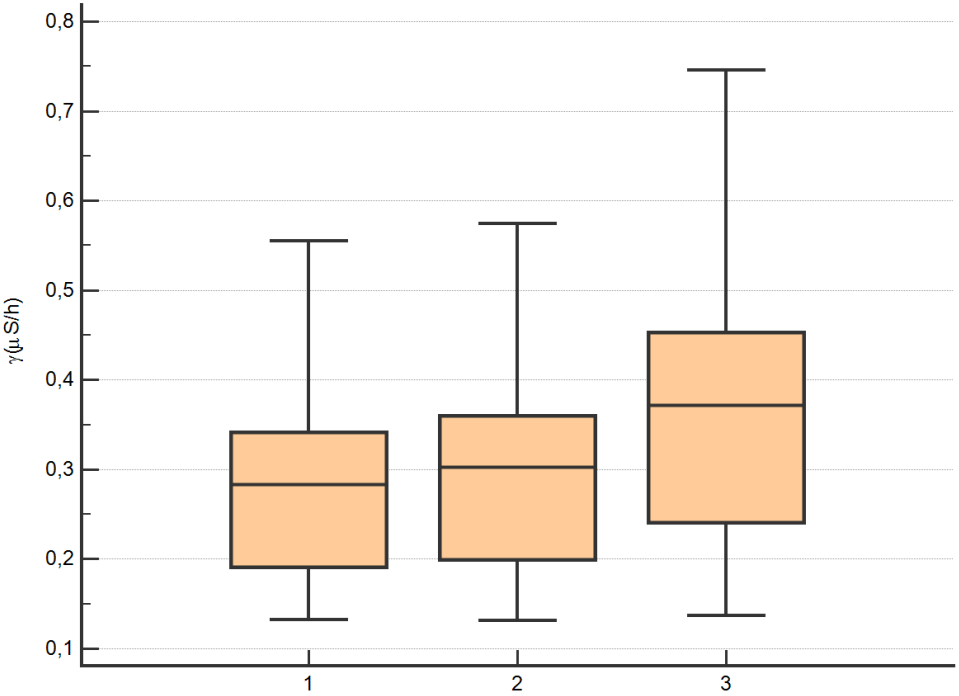
## Radon indoor vs floor level



# Celleno municipality (VT, Italy)

## Gamma indoor measurements

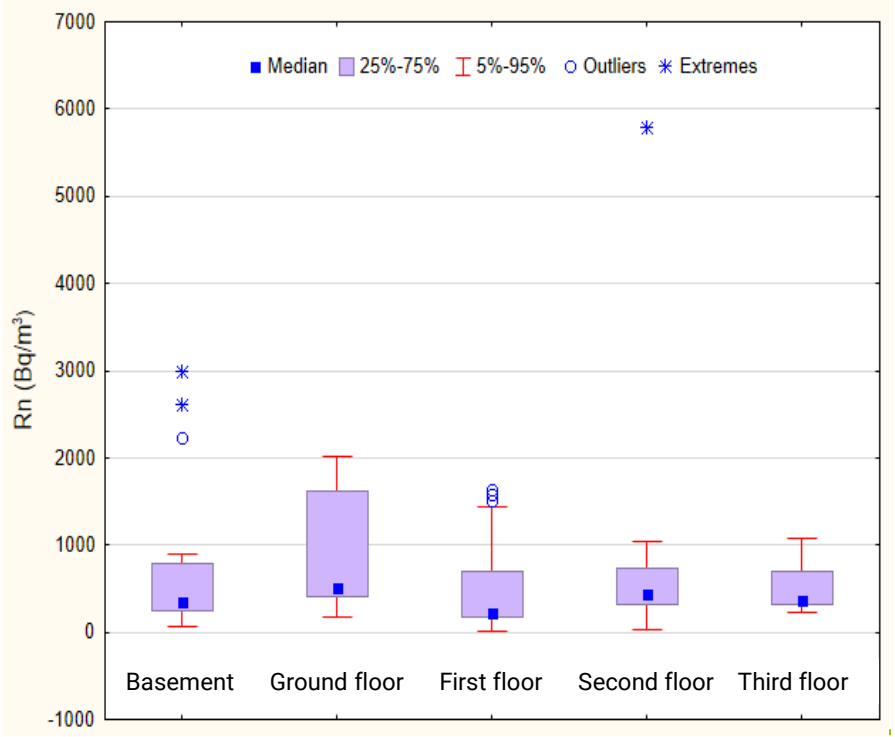


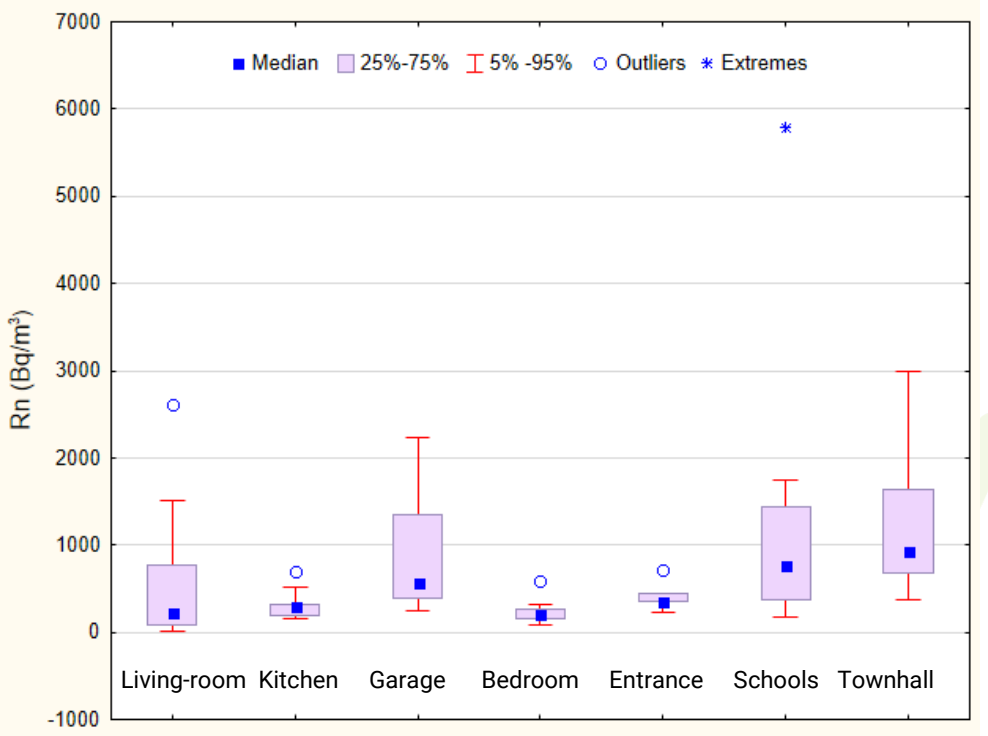

Gamma indoor survey were carried out in the Celleno and Caprarola municipalities and will provide information about the source of radon, especially in in the higher floors that are not affected by the ground soil/rock, and will be a support for citizens and for the development of researches on radon risk prevention.

**1** = center of the room, on the floor (**34 Measurements**)
**2** = center of the room, 1m above the floor (**35 Measurements**)
**3** = on the walls (**36 Measurements**)

# Caprarola municipality (VT, Italy)

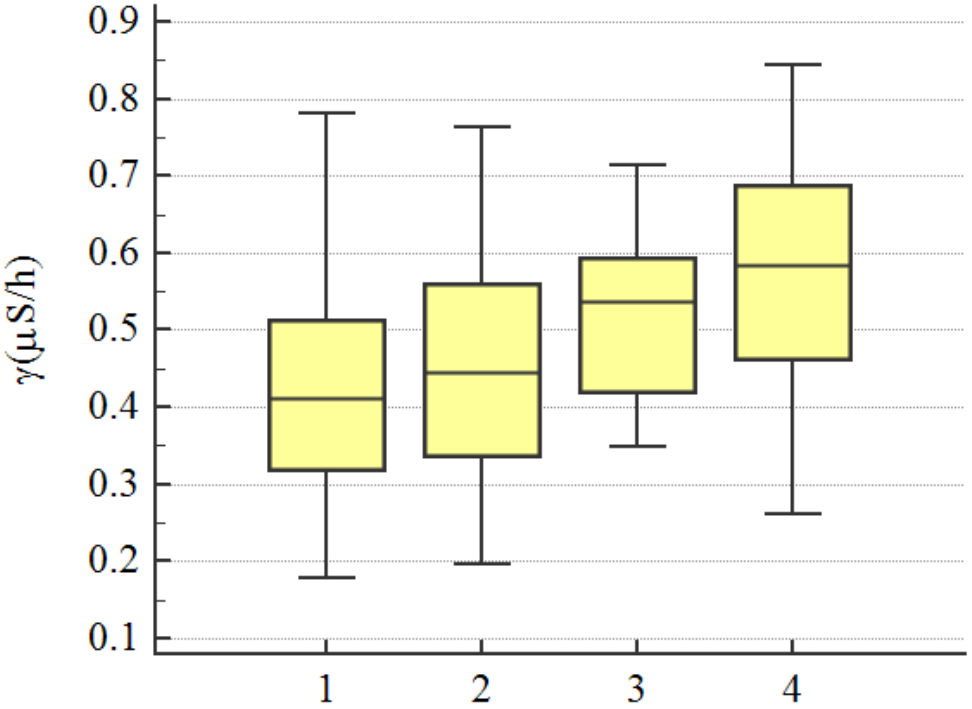
## Radon indoor vs floor level (left) and different spaces/rooms (right)



# Caprarola municiality (VT, Italy)

## gamma indoor radiation




## Gamma indoor

**1** = center of the room, on the floor (**35 measurements**)

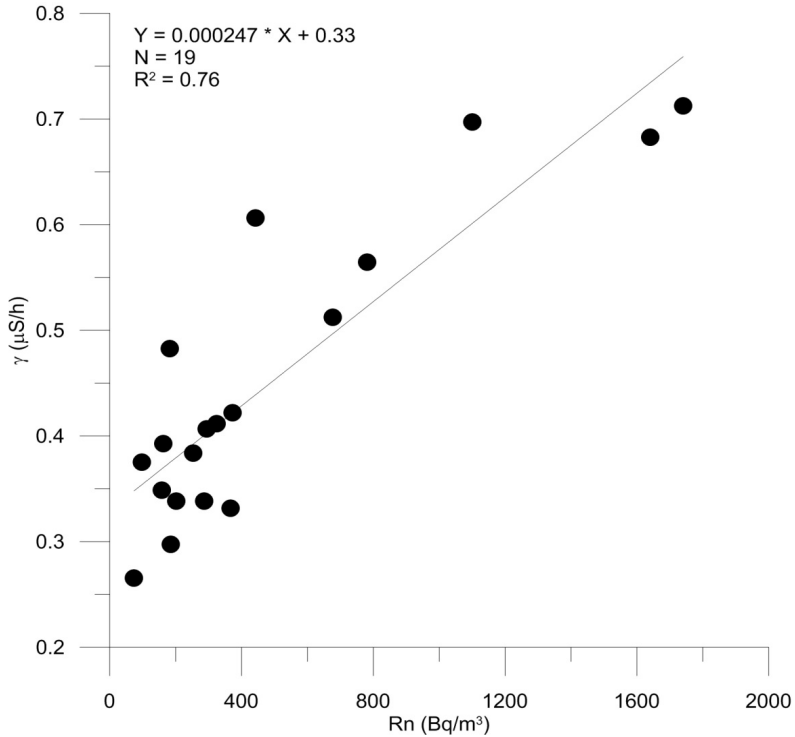
**2** = center of the room, 1m above the floor (**35 measurements**)

**3** = 1.5m wall distance (**13 measurements**)

**4** = on the wall (**37 measurements**)

# Caprarola municipality (VT, Italy)

## gamma indoor radiation



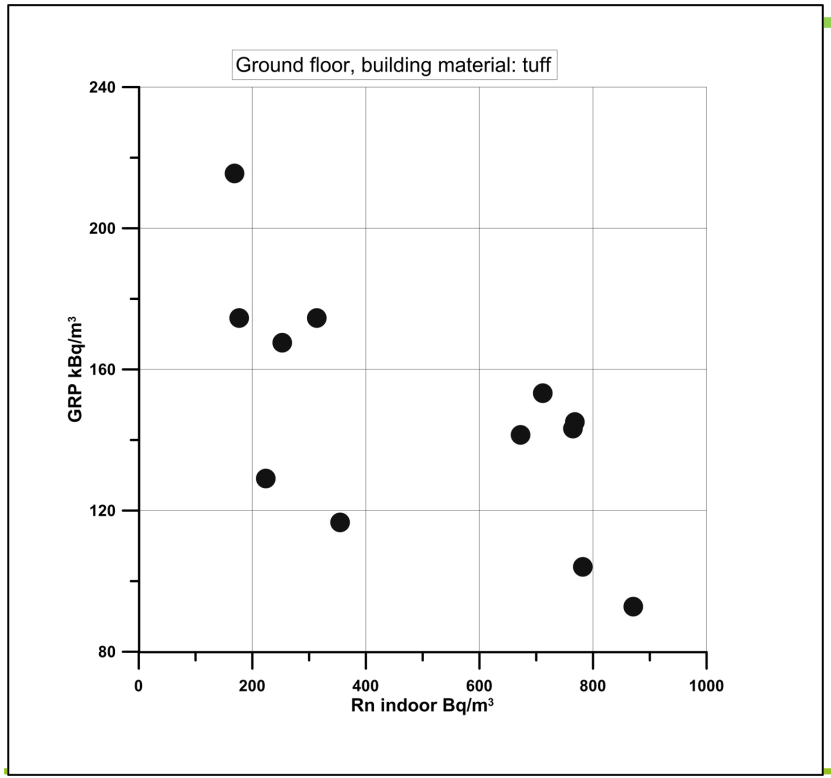

## Gamma indoor vs. Radon indoor

Indoor gamma radiation survey was conducted in the same buildings of the indoor survey.

The graph of the figure shows a good relationship between indoor gamma dose rate and indoor radon concentrations, thus confirming the contribution of the building materials.

# Caprarola municipality (VT, Italy)

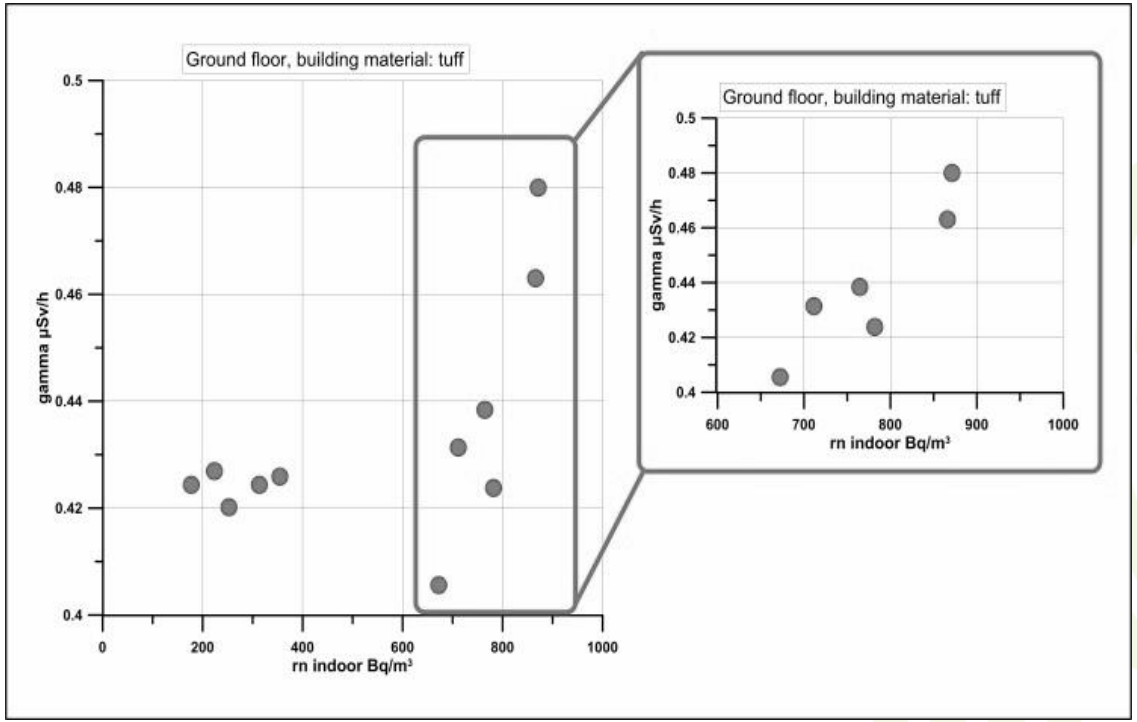
## Rn indoor versus GRP




The graph between GRP vs indoor radon does not show the expected correlation in which as radon increases in the soil, the concentration of indoor radon also increases. This because Rn in the buildings can be affected by a substantial contribution of external factors (i.e., anthropic and meteorological parameters).

# Caprarola municipality (VT, Italy)

## Rn indoor vs Gamma radiation




Left figure shows the relationship between gamma ray values vs indoor radon. In this case a clear relationship is not evident, but if we consider the indoor radon values above 600 Bq/m$^3$, a positive linear correlation between the two parameters is shown (right figure). This can be linked to the building material that affects both variables.

# Indoor radon long-term passive monitoring at Caprarola, Celleno and Ciampino municipalities

In the period from 15th November to 7th December 2018, long-term indoor radon surveys by using passive detectors (Radosys RSK) were carried out in public and private buildings of the Municipality of Caprarola, Celleno (VT) and Ciampino (RM) municipalities.


In the 3 municipalities involved in the Respire project, after a campaign of awareness and information to citizens, it was offered the opportunity to participate in the monitoring of indoor radon in their homes for free.


CITTÀ DI CIAMPINO

INFORMAZIONE ALLA CITTADINANZA

MONITORAGGIO MEDIO TERMINE (4 MESI) RADON INDOOR
COMUNE DI CIAMPINO
PROGETTO LIFE RESPIRE – SAPIENZA CNR-IGAG INGV

A seguito dell'aggiudicazione del **Progetto LIFE-RESPIRE** grazie al quale il Comune di Ciampino è stato scelto per condurre indagini scientifiche circa la presenza di **RADON**, gas cancerogeno emanato dalle rocce vulcaniche, si offre la possibilità ai cittadini di monitorare gratuitamente la concentrazione di Radon nella propria abitazione/ufficio.
Il monitoraggio verrà svolto tramite l'uso di piccoli DOSIMETRI, che saranno esposti all'interno dello stabile per circa 4 mesi da personale incaricato dall'**Istituto Nazionale di Geofisica e Vulcanologia**.

Il posizionamento dei dosimetri sarà effettuato da personale ricercatore specializzato nel corso dell'ultima settimana di Novembre 2018.

PER INFORMAZIONI E PRENOTAZIONI RIVOLGERSI ALLA SEGUENTE MAIL:
**geochimicaroma1@gmail.com**

*Abbiamo a cuore la tua salute!*

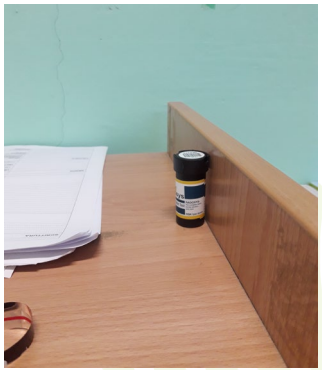
RESPIRE

REALIZZATO CON IL CONTRIBUTO FINANZIARIO DEL PROGRAMMA LIFE DELL'UNIONE EUROPEA LIFE 16 / ENV / IT / 000553 - RESPIRE

# Indoor radon long-term passive monitoring at Caprarola, Celleno and Ciampino municipalities

This initiative was successful and dosimeters were placed in almost 150 private homes and 18 public buildings, including 12 schools:

- **Caprarola: 100 private and 5 public buildings;**
- **Ciampino: 19 private and 11 public buildings;**
- **Celleno: 22 private and 2 public buildings.**



The surveys will be replicated in the same buildings during the spring-summer period, in order to have a wide spectrum of measurement values and to highlight a possible seasonality in the variation of the average values of the indoor radon concentration.

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# Thanks for your attention