Radon Chamber

Laboratory of Environmental Radiactivity, University of Cantabria

Laboratorio de Radiactividad Ambiental, Universidad de Cantabria

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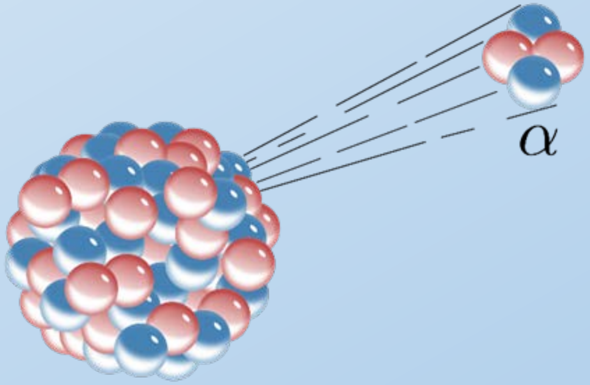
LaRUC Laboratorio de Radiactividad Ambiental

Introduction

- Most studies include radon measurements to classify the radon risk areas, to evaluate dwellings, etc.
- **Passive detectors** are commonly used to carry out long-term measurements:
  - Time-integrated concentration
- **Active detectors** are frequently used in Rn diagnostic measurement:
  - Continuous monitoring
- It is important to ensure radon measurements quality and maintain traceability to calibration standards.



Active Monitors

- Provide the radon concentration every hour, 10 minutes, etc
- Radon concentration *C* ($Bq\ m^{-3}$)

Active Monitors

- Many Technologies:
  - Silicon detectors
  - Ionization chambers
- Many prices

AlphaGUARD

Atmos12

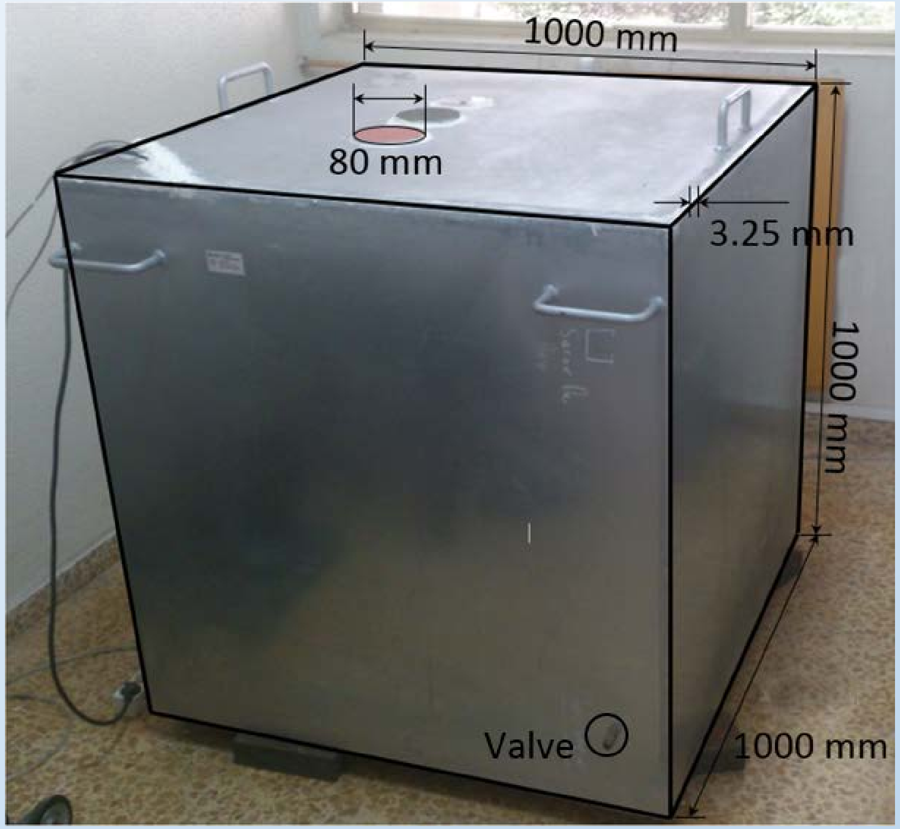
Wave

Radon Scout

RTM

Radon Chamber

Radon Chamber: Laboratory of Environmental Radioactivity, University of Cantabria (Spain)



- Stainless steel radon chamber
- Thickness of 3.25 mm
- Internal volume 1 m^3
- Top face is a lid that can be removed
- 3 circular holes to insert etched track detectors

- Radon sources: from 30 to 1100 Bq h^{-1}
- Air exchange with exterior controlled with a pump

Radon Chamber Theoretical Approach

- Theoretical approach:

$$\frac{dC}{dt} = \frac{\phi}{V} - \lambda \cdot C$$

C (Bq/m^3): radon concentration

φ (Bq/h): radon emission rate from source

V (m^3) = Chamber volume

$\lambda = \lambda_{Rn} + \lambda_e$

λ_{Rn} : Rn decay constant (0,0076 h^{-1})

λ_e : Reflects air exchange rate per hour

$$\lambda_e = \frac{F}{V}$$

F : pump flow rate

V : Rn chamber volume

Radon Chamber Theoretical Approach

Differential equation solution:

- Theoretical approach:

$$C(t) = C_0 e^{-\lambda t} + \frac{\phi}{V\lambda}(1 - e^{-\lambda t})$$

C_0 (Bq/m^3): initial radon concentration

ϕ (Bq/h): radon emission rate from source

$\lambda = \lambda_{Rn} + \lambda_e$

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Radon Chamber Theoretical Approach

Differential equation solution:

- Theoretical approach:

0

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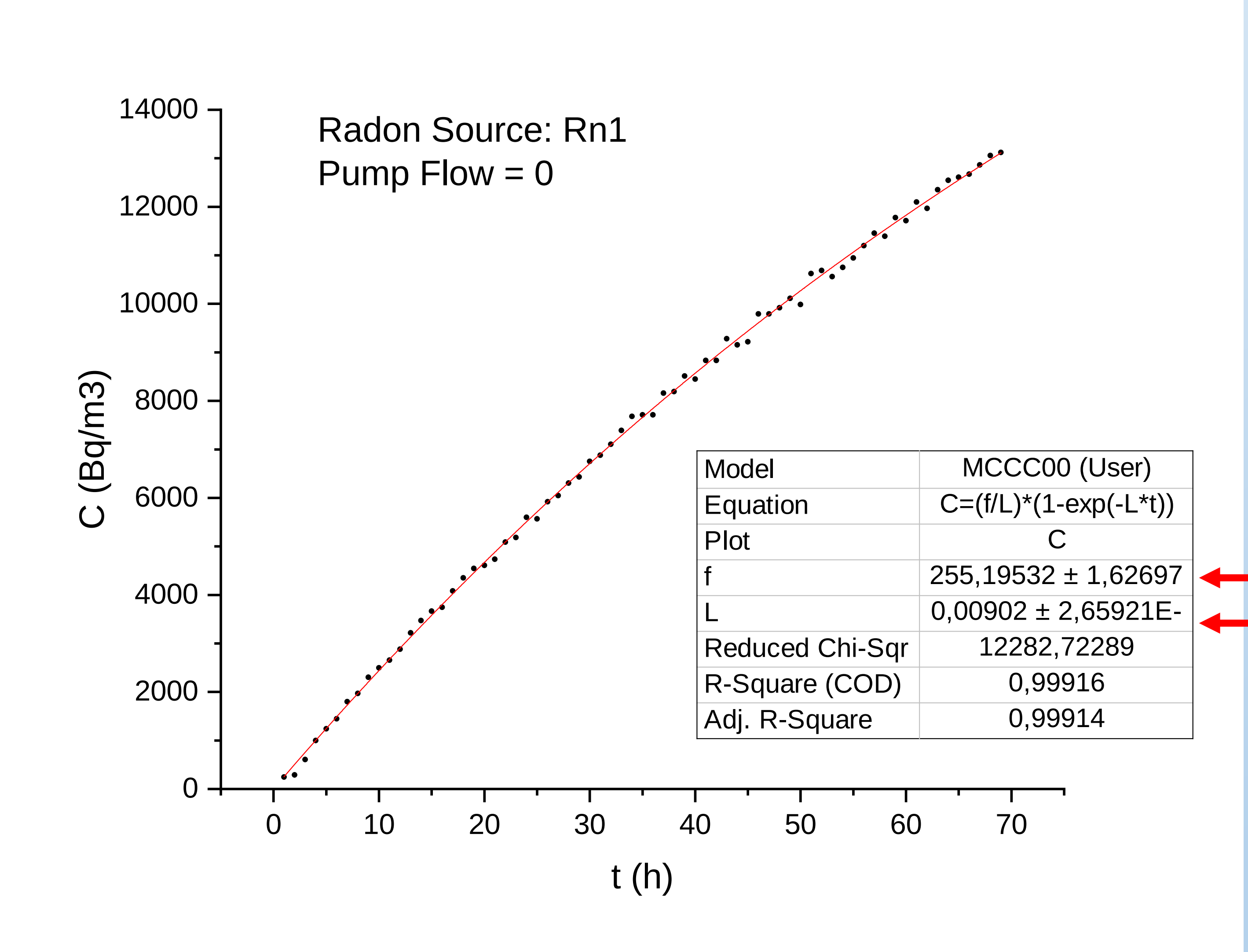
Radon Chamber Theoretical Approach



Model	MCCC00 (User)
Equation	C=(f/L)*(1-exp(-L*t))
Plot	C
f	255,19532 ± 1,62697
L	0,00902 ± 2,65921E-
Reduced Chi-Sqr	12282,72289
R-Square (COD)	0,99916
Adj. R-Square	0,99914

f → ϕ

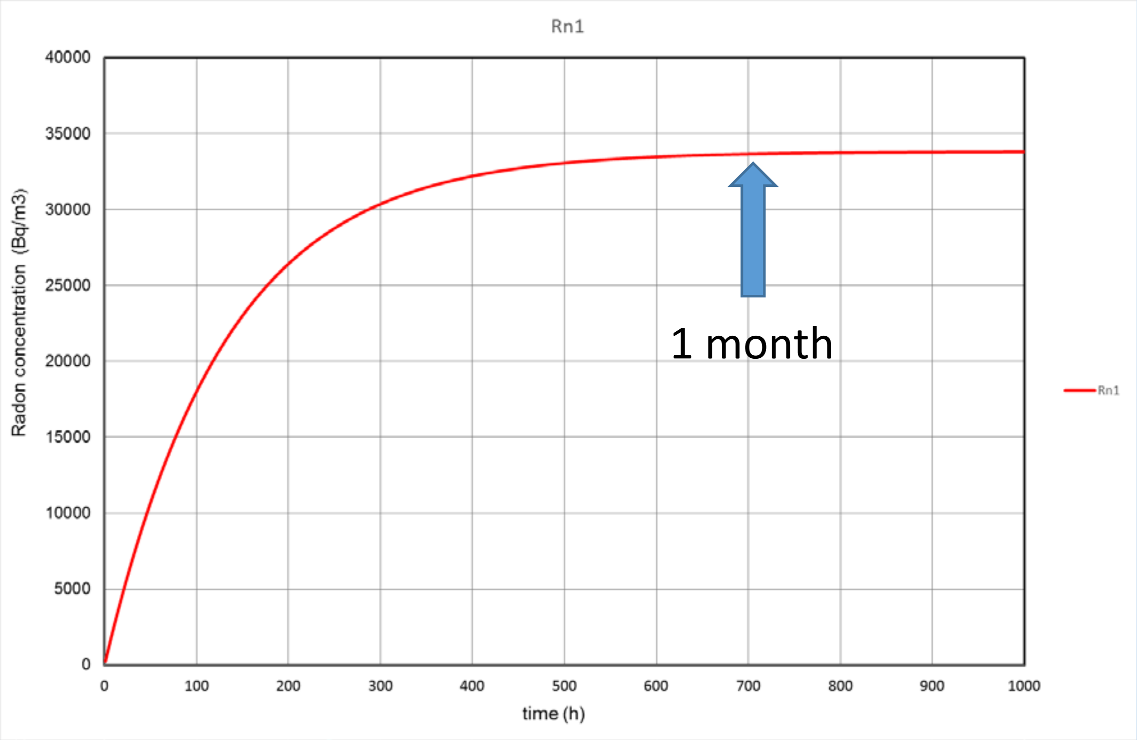
L → λ

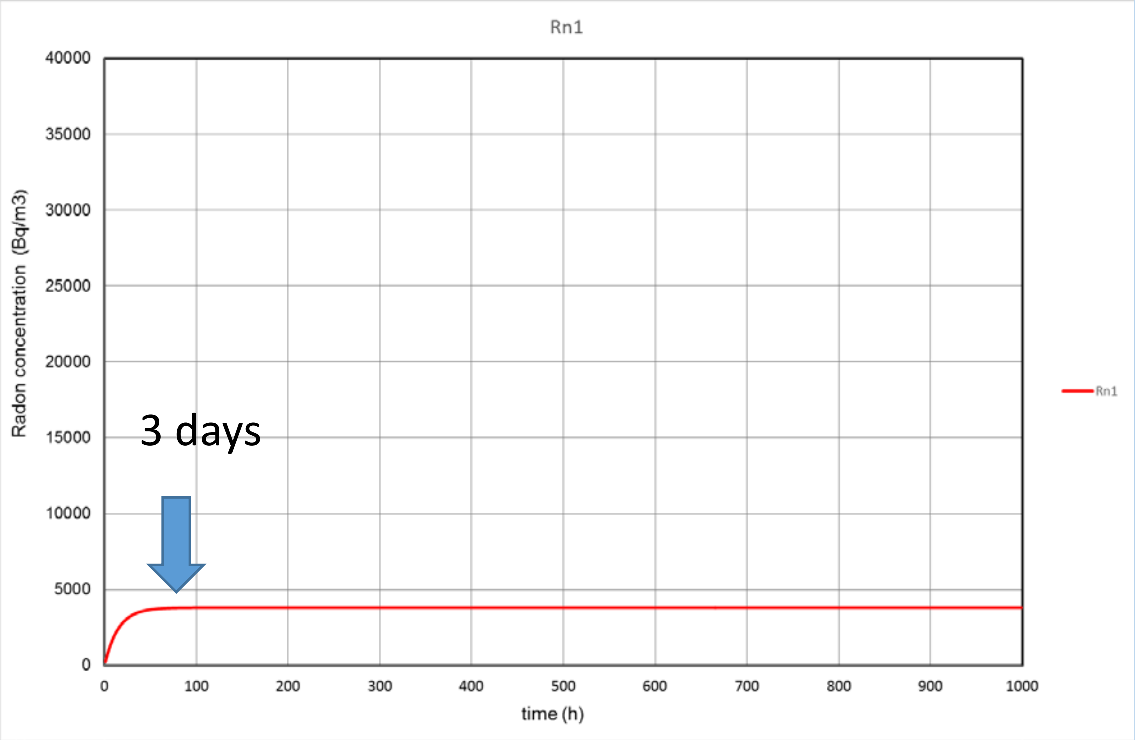
Radon Chamber Theoretical Approach

Radon source **Rn1**
ϕ= 255 Bq/h

Chamber Closed
λ = 0,0076 h $^{-1}$

Chamber with Pump
$F = 1\text{L/min}$
λ = 0,0676 h $^{-1}$





Radon Chamber Theoretical Approach

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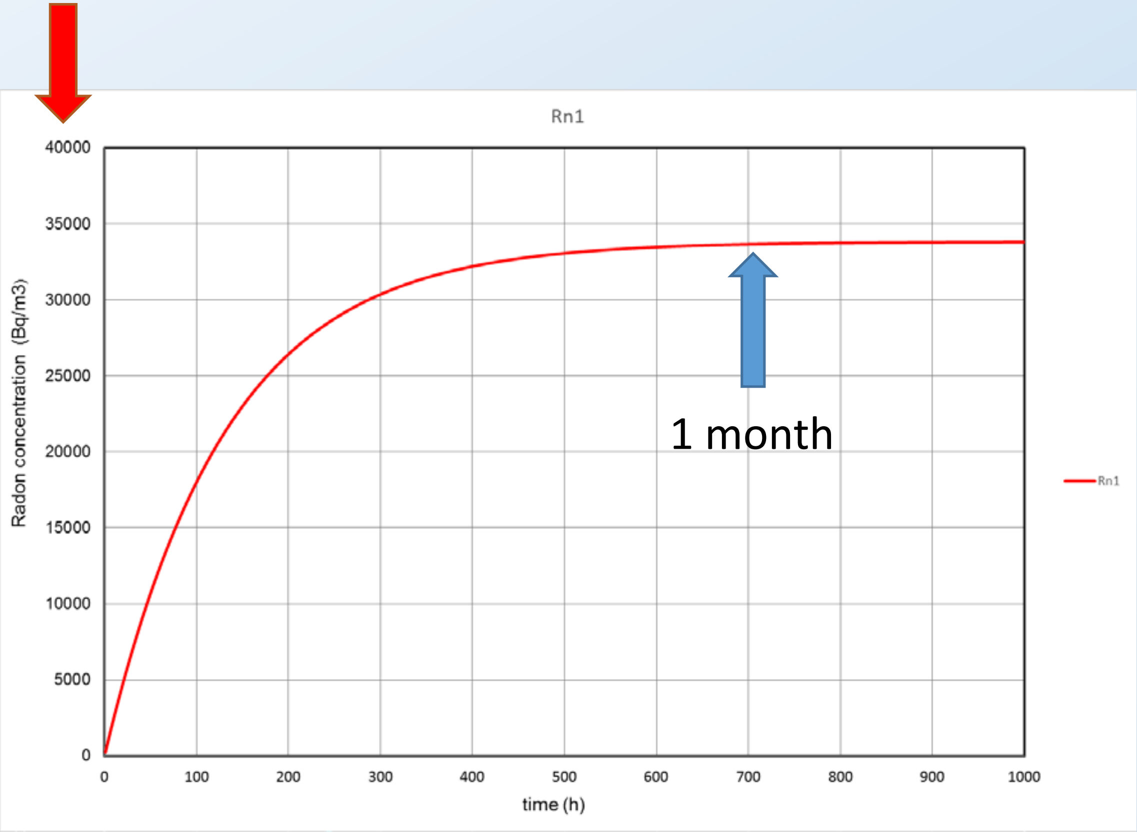
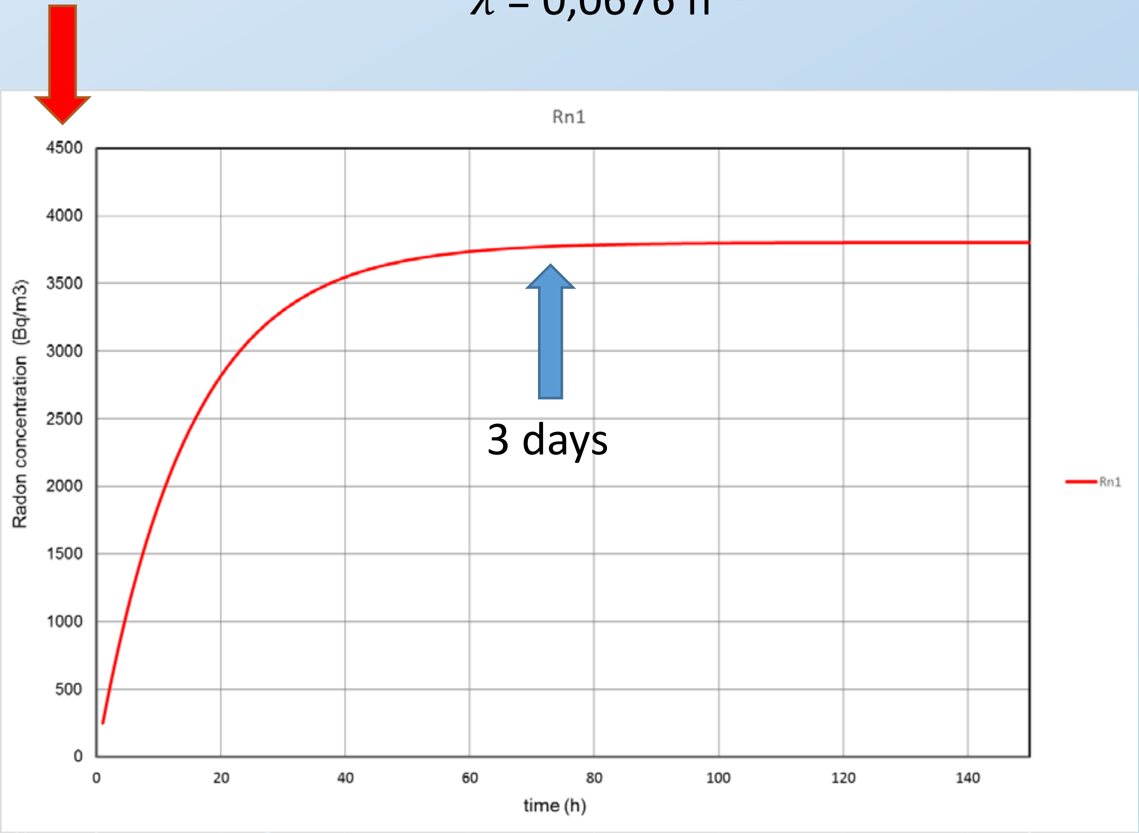
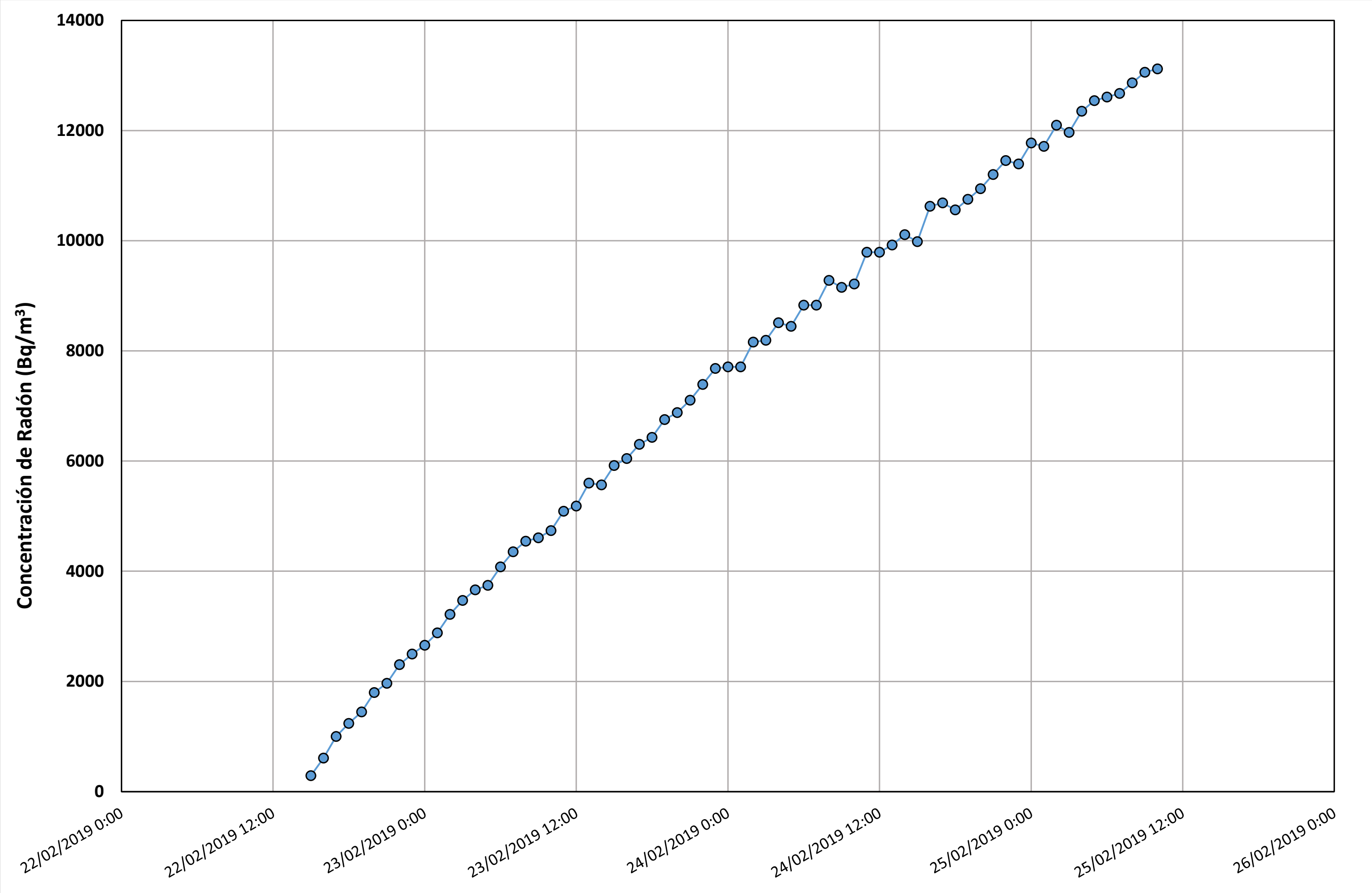




Exercise 1

Radon source **Rn1**



Calculate:

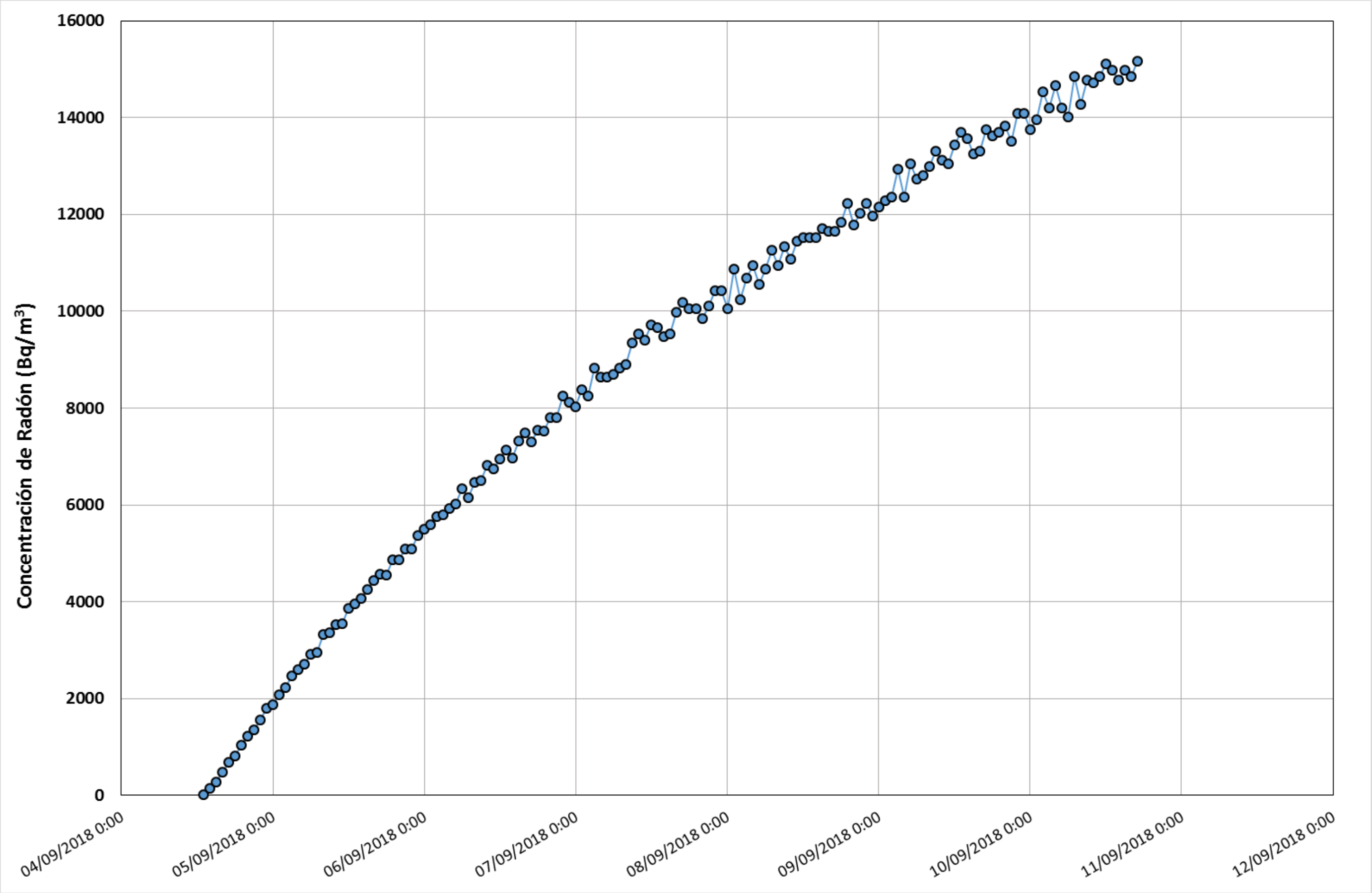
- Source Production (Bq/h)

- Lambda (1/h)

- Exposure (kBq m^{-3} h) [22/02/2019 15:00 a 25/02/2019 10:00]

Exercise 2

Radon source **Rn2**



Calculate:

- Source Production (Bq/h)
- Lambda (1/h)
- Exposure (kBq m^{-3} h)
- Track Density (tr/mm2)
- CF (kBq m-3 h/ tr/mm2)

	1st Exposure	2nd Exposure
Start	04/09/2018 13:00	04/09/2018 13:00
End	07/09/2018 17:00	10/09/2018 17:00

Calibration of Passive Detectors

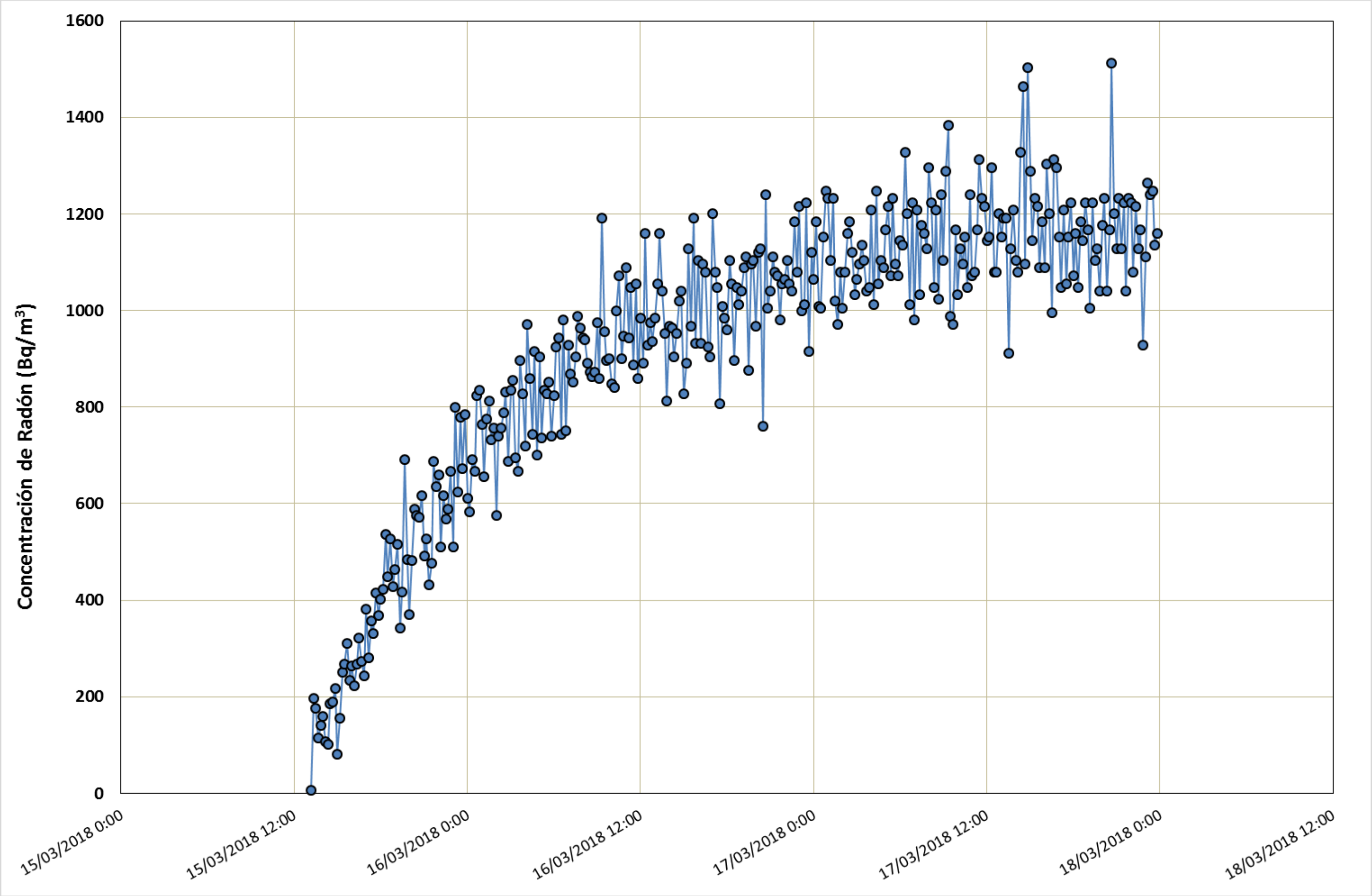
$$CF = \frac{E}{D}$$

***Radon chamber** in the lab.*

CF= Calibration factor (kBq m^{-3} h / tracks/mm^2)
E= Exposure (kBq m^{-3} h)
D= Track density (tracks/mm^2) [removed the background]

Exercise 3

Radon source **Rn5**



Calculate:

- Source Production (Bq/h)

- Lambda (1/h)

- Pump flow