डॉ बी आर अम्बेडकर
राष्ट्रीय प्रौद्योगिकी संस्थान जालंधर
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# Estimation of the Unattached fraction and equilibrium factor of radon, thoron in Jaipur and Ajmer provinces of Rajasthan

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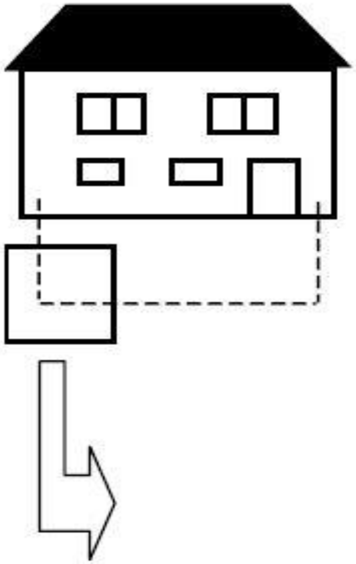
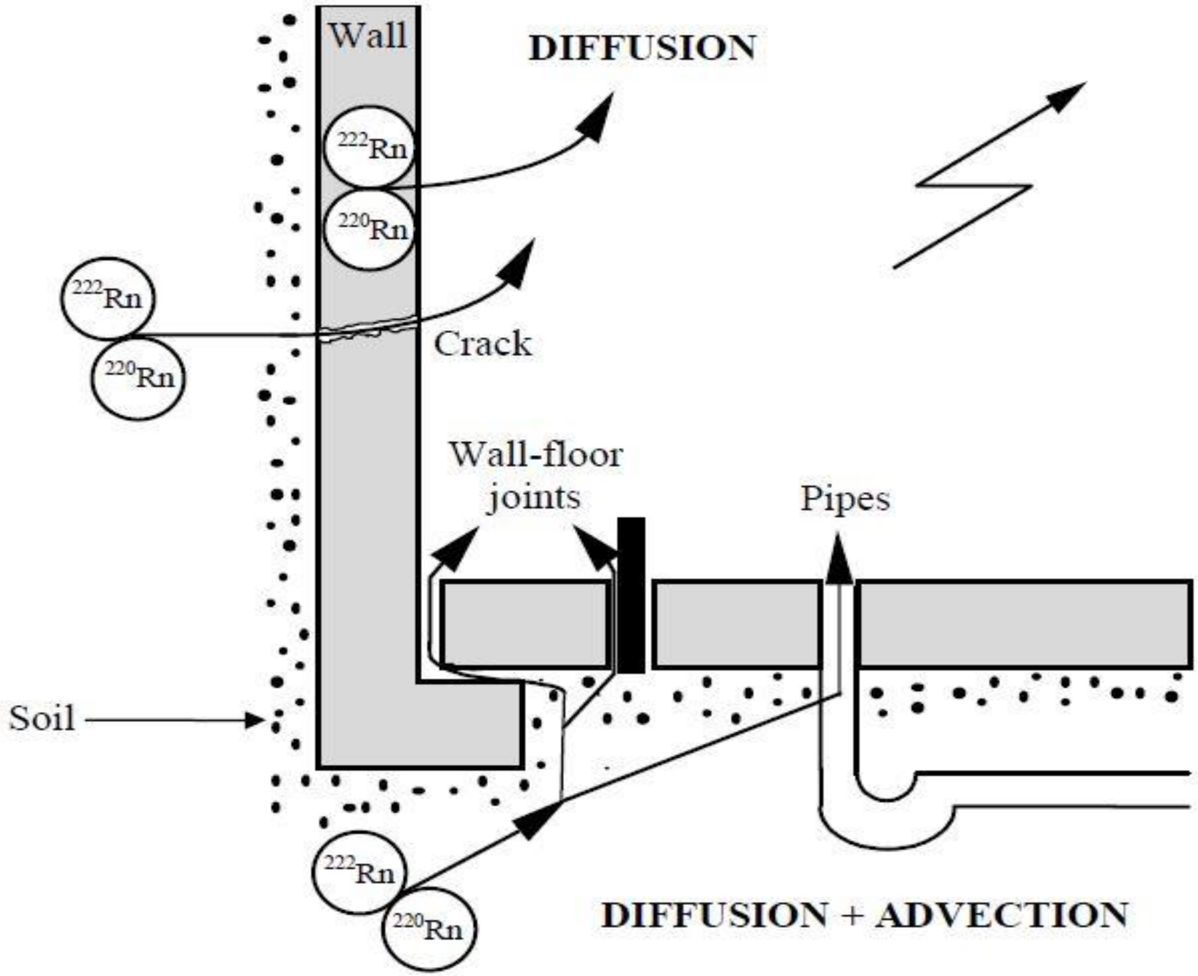
# Introduction



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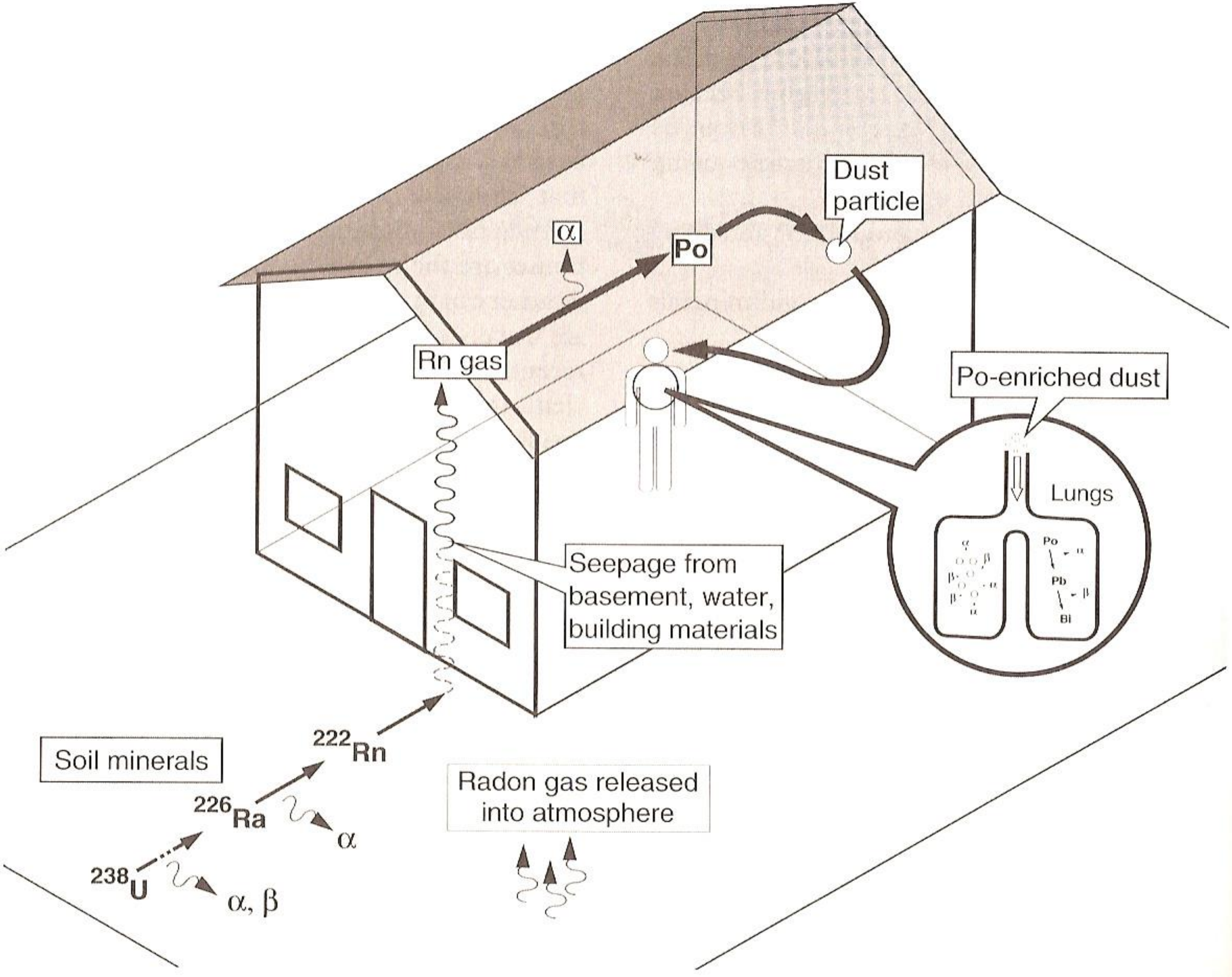
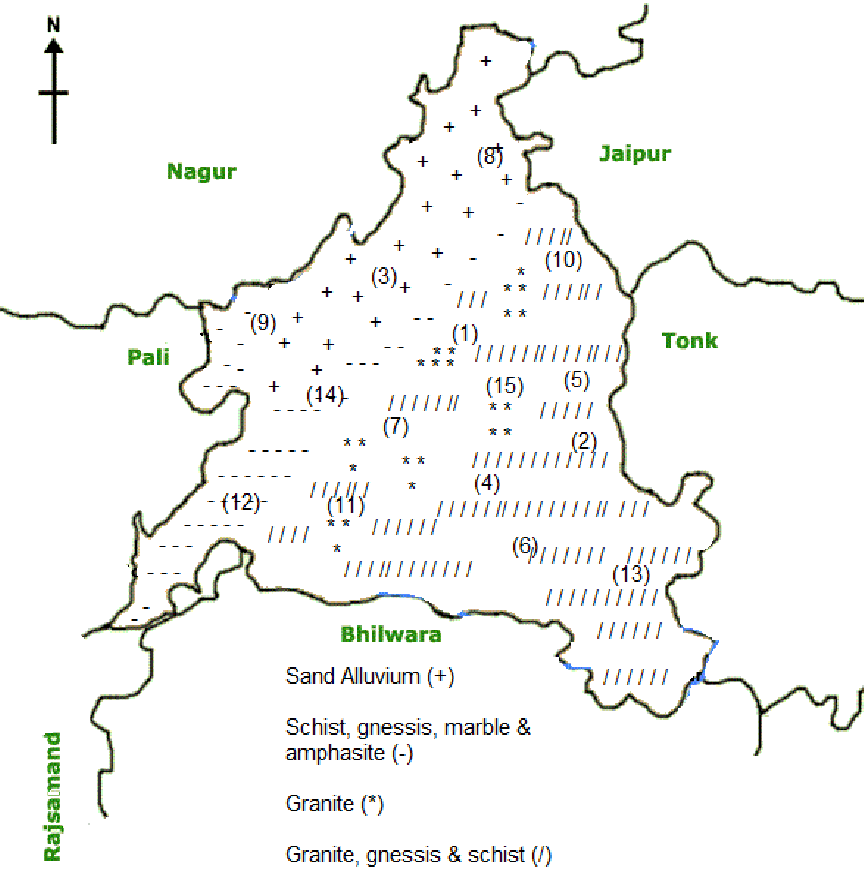


α
Po
Dust particle
Rn gas
Po-enriched dust
Lungs
Po
α
Pb
β
Bi
Seepage from basement, water, building materials
$^{222}Rn$
Soil minerals
$^{226}Ra$
α
Radon gas released into atmosphere
$^{238}U$
α, β

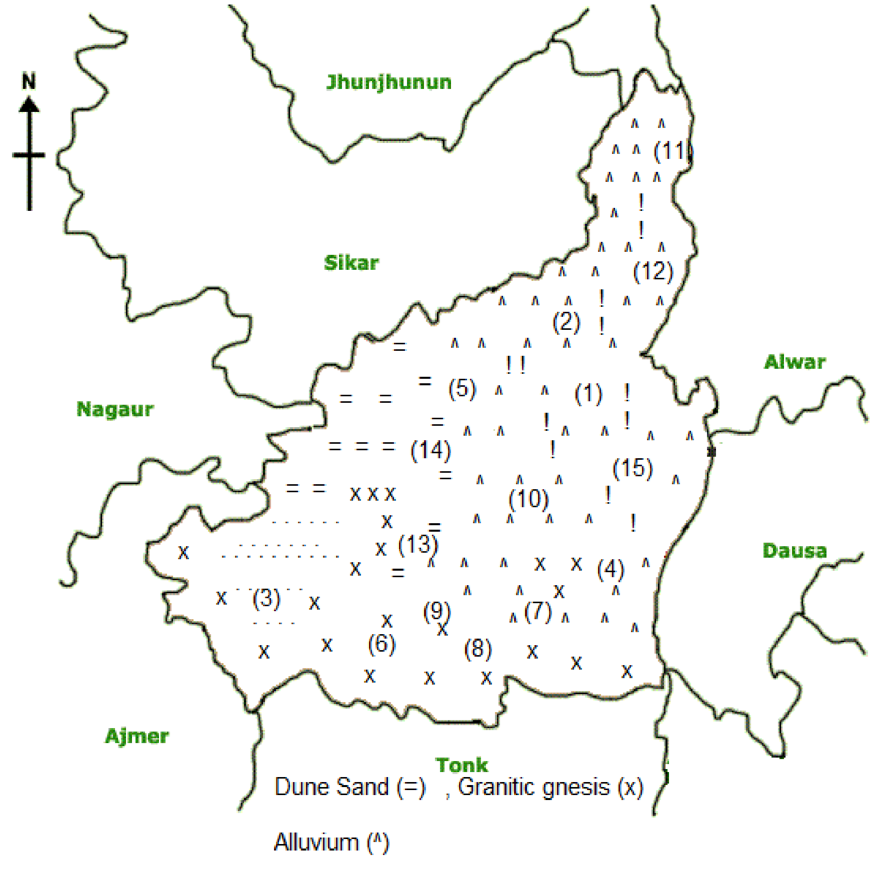
# Objective and Significance

- The objective of this study is to study the seasonal variation in the levels of radon, thoron and their progenies.
- This study presents the use of the passive dosimeters to directly measure the EEC of radon and thoron.

# Study Area




Ajmer district

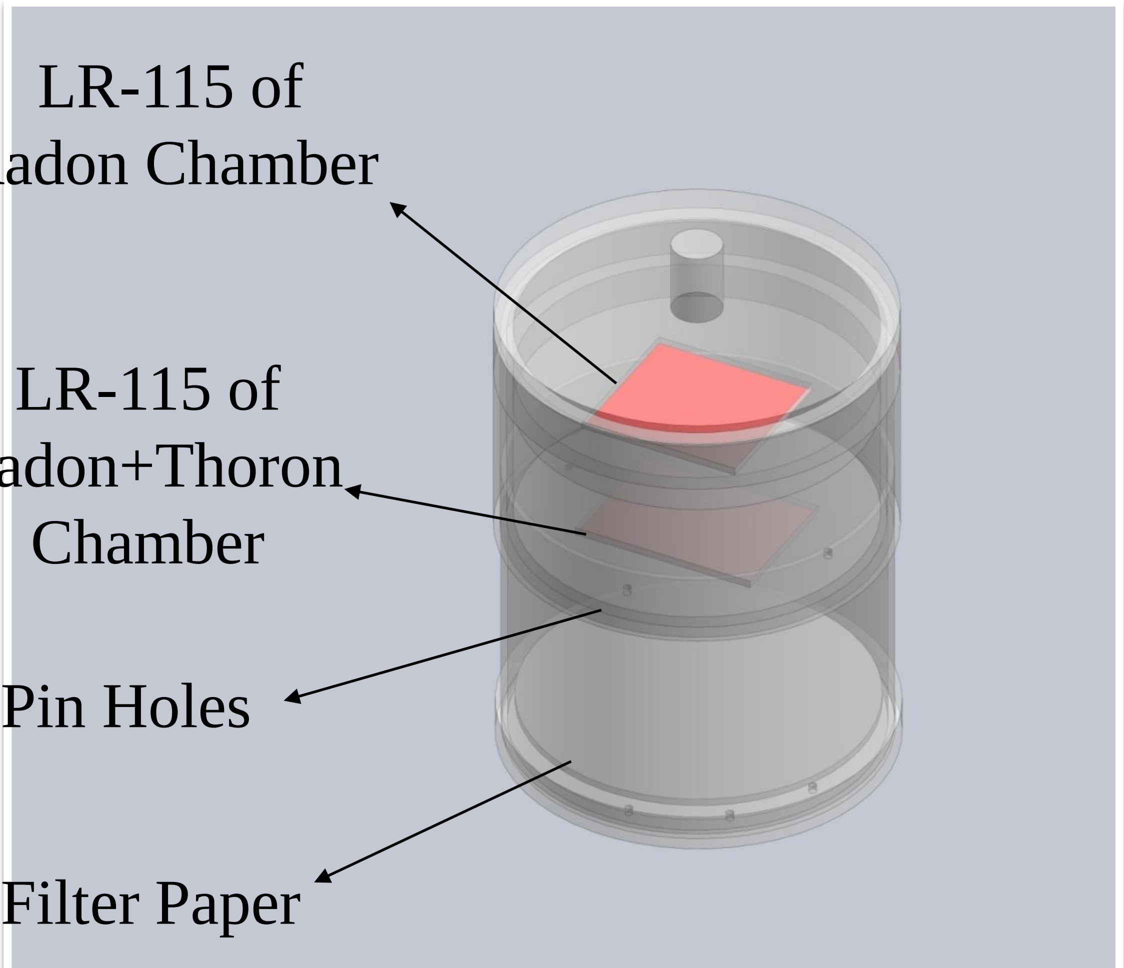



Jaipur district

# Research Methodology

1. Research design
2. Data Collection
3. Data Analysis

# Pin hole cup dosimeter



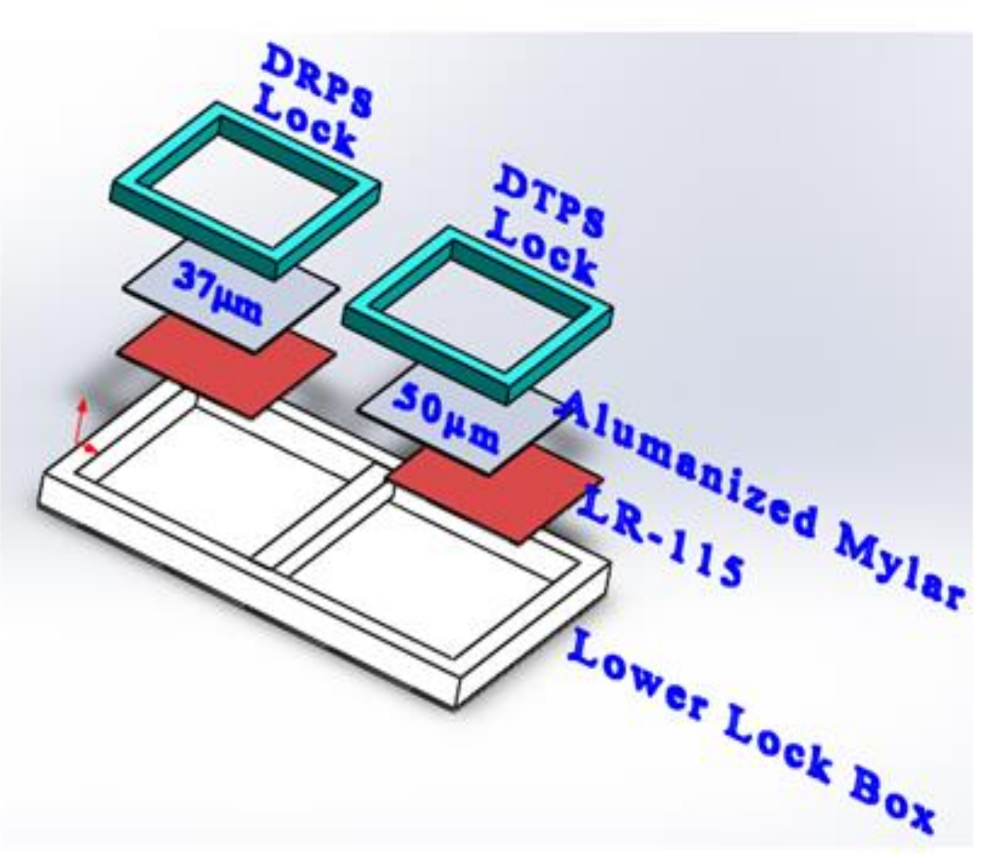

- A pin-hole based $^{222}Rn/^{220}Rn$ discrimination technique.

# Working

- This LR-115 track detector based device has a single face for gas entry.
- The device has two identical cylindrical chambers of length of 4.1 cm and radius 3.1 cm which are separated by the pinhole based $^{222}$Rn/$^{220}$Rn discriminating plate.
- It is experimentally confirmed that the configuration with 4 pin-holes, each having 1mm diameter and 2mm length, is best suited as it has $^{220}$Rn cut off of about 98% with $^{222}$Rn transmission of about 97% .

*B.K. Sahoo, B.K. Sapra, S.D. Kanse, J.J. Gaware, Y.S. Mayya. A New pin-hole discriminated $^{222}$ Rn/$^{220}$ Rn passive measurement device with single entry face, Radiation Measurements 58 (2013) 52-60.

# Direct Radon and Thoron progeny sensors (DTPS and DRPS)




DTPS having 50 μm absorber is sensitive to alpha particles of $^{212}Po$ (8.78 MeV)

&

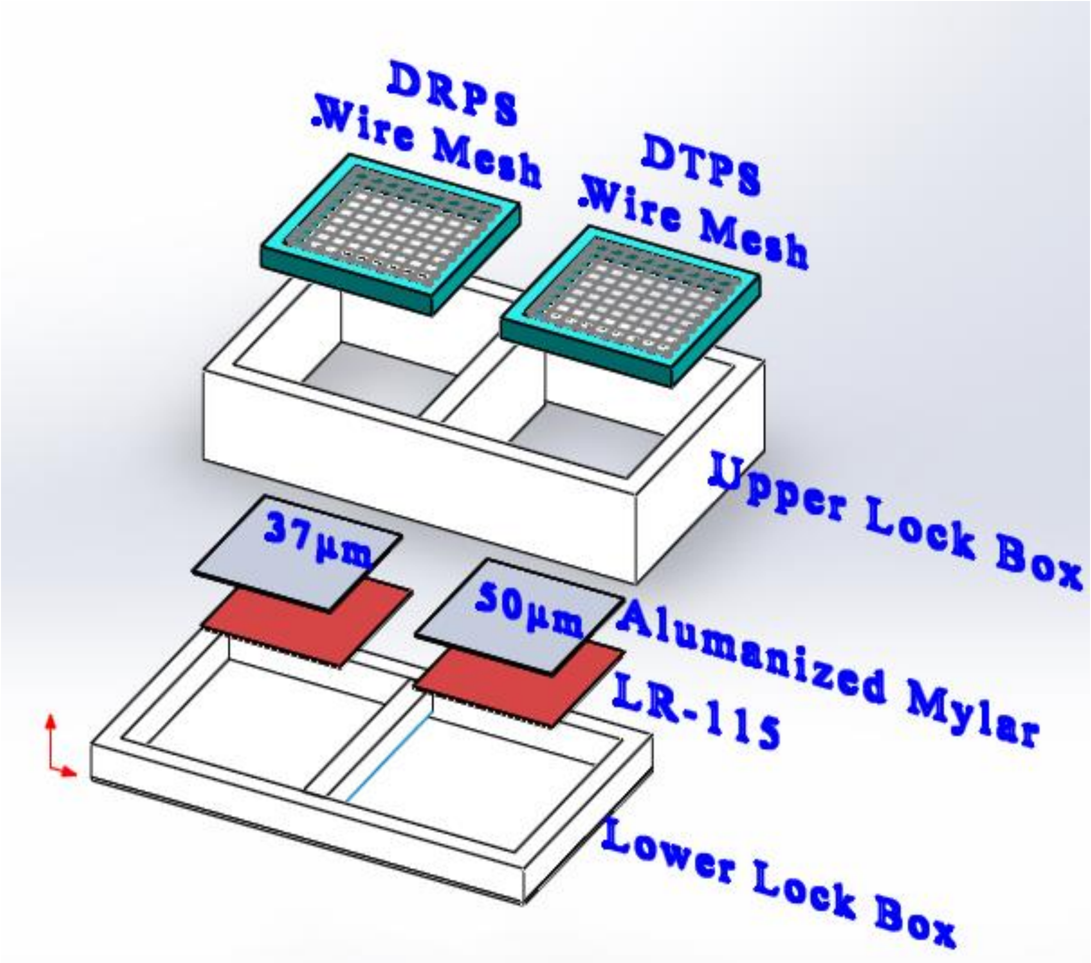
DRPS having 37 μm absorber is sensitive to alpha particles of $^{214}Po$ (7.69 MeV)

# Working

- The concept of DTPS is based on registering solely the alpha tracks originating from the deposited activity of $^{212}Po$.
- Since the system is intended for use in the deposition mode, Aluminized polyethylene is chosen as the absorber material to avoid uncontrolled static charges from affecting the deposition rates.
- In DTPS Aluminized Mylar of thickness 50μm to detect mainly 8.78 MeV α-particles emitted from $^{212}Po$.
- In DRPS the absorber is a combination of Aluminized Mylar and cellulose nitrate of effective thickness 37 μm to detect mainly 7.67 MeV α-particles emitted from $^{214}Po$.

Rosaline Mishra, Y.S. Mayya, Study of a deposition based direct thoron progeny sensor (DTPS) technique for estimating equilibrium equivalent thoron concentration (EETC)in indoor environment, Radiation Measurements 43 (2008) 1408 – 1416.

# Wire-mesh capped DRPS/DTPS




- Based on detection of only the coarse fraction of progeny concentration

# Working

- Wire-mesh capped DRPS/DTPS consists of DTPS/DRPS capped with mesh type wire Screen.
- The mesh type wire Screen consists of 200 type wire mesh (79 mesh $cm^{-1}$, wire diameter: 0.005 cm).
- 1cm is the optimum distance between the capped wire mesh and the DTPS/DRPS placed inside, so that the contribution of tracks created by alpha particles emitted by the fine fraction captured on the wire mesh in the DTPS/ DRPS is negligible.

Y.S. Mayya, Rosaline Mishra, B.K. Sapra, Wire-mesh capped deposition sensors: Novel passive tool for coarse fraction flux estimation of radon thoron progeny in indoor environments Science of the Total Environment 409 (2010) 378–383.

# Protocols adopted

- The pin hole cup dosimeter and progeny sensors were hanged from the ceiling and at least 20-30 cm away from adjacent wall for a minimum of 90 days.
- The exposed films were then etched in an etching bath using 2.5N NaOH solution at 60$^{o}$C for 90 mins.
- The tracks recorded in this SSNTD films were then counted using a spark counter.

# Results

$C_{Rn}$ is Indoor radon and $EERC_T$, $EERC_A$, $EERC_{Un}$ are total, attached and unattached equilibrium equivalent progeny concentration. $F_R$ and $f_R$ is respectively the equilibrium factor and unattached fraction of radon.

| **Parameter** | $C_{Rn}$ (Bq m$^{-3}$) | $EERC_T$ (Bq m$^{-3}$) | $EERC_A$ (Bq m$^{-3}$) | $EERC_{Un}$ (Bq m$^{-3}$) | $F_R$ | $f_R$ |
|---|---|---|---|---|---|---|
| Average | 42±3 | 22±2 | 20±2 | 2±1 | 0.52±0.12 | 0.05±0.01 |
| G. Mean | 38±2 | 18±1 | 16±1 | 3±1 | 0.47±0.11 | 0.06±0.01 |
| Min | 9±1 | 4±1 | 3±1 | 1±1 | 0.33±0.10 | 0.02±0.01 |
| Max | 78±5 | 61±3 | 55±5 | 7±1 | 0.78±0.12 | 0.09±0.01 |

# Thoron progeny variation with different seasons

$C_{Tn}$ is indoor thoron, $EETC_T$, $EETC_A$, $EETC_{Un}$ are total, attached and unattached equilibrium equivalent progeny concentration. $F_T$ and $f_T$ is respectively the equilibrium factor and unattached fraction of thoron.

| **Parameter** | $C_{Tn}$ (Bq $m^{-3}$) | $EETC_T$ (Bq $m^{-3}$) | $EETC_A$ (Bq $m^{-3}$) | $EETC_{Un}$ (Bq $m^{-3}$) | $F_T$ | $f_T$ |
|---|---|---|---|---|---|---|
| Average | 74±4 | 3.5±0.2 | 3.0±0.2 | 0.5±0.2 | 0.07±0.01 | 0.03±0.01 |
| G. Mean | 55±3 | 2.2±0.1 | 1.9±0.1 | 0.3±0.1 | 0.04±0.01 | 0.04±0.01 |
| Min | 7±1 | 0.2±0.1 | 0.2±0.1 | BDL | BDL | BDL |
| Max | 114±12 | 16.8±0.3 | 14.3±0.2 | 1.7±0.3 | 0.11±0.03 | 0.14±0.02 |

# Conclusions

- The average value of the equilibrium factor of radon and thoron comes out to be 0.47 and 0.04.
- The average value of the unattached fraction of radon and thoron has been calculated to be 0.06 and 0.04.
- The thoron levels are higher than the radon levels in the studied dwellings.
- The study also points out the significance of the thoron measurements.

# Publications

Journal of Environmental Radioactivity 148 (2015) 67–73

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## Journal of Environmental Radioactivity

journal homepage: www.elsevier.com/locate/jenvrad


## Estimation of EEC, unattached fraction and equilibrium factor for the assessment of radiological dose using pin-hole cup dosimeters and deposition based progeny sensors

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A B S T R A C T

High concentration of radon ($^{222}$Rn), thoron ($^{220}$Rn) and their decay products in environment may increase the risk of radiological exposure to the mankind. The $^{222}$Rn, $^{220}$Rn concentration and their separate attached and unattached progeny concentration in units of EEC have been measured in the dwellings of Muktsar and Mansa districts of Punjab (India), using Pin-hole cup dosimeters and deposition based progeny sensors (DTPS/DRPS). The indoor $^{222}$Rn and $^{220}$Rn concentration was found to vary from 21 Bqm$^{-3}$ to 94 Bqm$^{-3}$ and 17 Bqm$^{-3}$ to 125 Bqm$^{-3}$. The average EEC (attached + unattached) of $^{222}$Rn and $^{220}$Rn was 25 Bqm$^{-3}$ and 1.8 Bqm$^{-3}$. The equilibrium factor for $^{222}$Rn and $^{220}$Rn in studied area was 0.47 ± 0.13 and 0.05 ± 0.03. The equilibrium factor and unattached fraction of $^{222}$Rn and $^{220}$Rn has been calculated separately. Dose conversion factors (DCFs) of different models have been calculated from unattached fraction for the estimation of annual effective dose in the studied area. From the experimental data a correlation relationship has been observed between unattached fraction ($f_p^{Rn}$) and equilibrium factor ($F_{Rn}$). The present work also aims to evaluate an accurate expression among available expression in literature for the estimation of $f_p^{Rn}$.

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# Exposure assessment of natural uranium from drinking water

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rsc.li/process-impacts

The uranium concentration in the drinking water of the residents of the Jaipur and Ajmer districts of Rajasthan has been measured for exposure assessment. The daily intake of uranium from the drinking water for the residents of the study area is found to vary from 0.4 to 123.9 µg per day. For the average uranium ingestion rate of 35.2 µg per day for a long term exposure period of 60 years, estimations have been made for the retention of uranium in different body organs and its excretion with time using ICRP's biokinetic model of uranium. Radioactive and chemical toxicity of uranium has been reported and discussed in detail in the present manuscript.

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# Estimation of terrestrial radionuclide concentration and effect of soil parameters on exhalation and emanation rate of radon

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ABSTRACT

The soil samples collected from the different locations of the Jaipur and Ajmer districts of Rajasthan have been analysed for $^{232}Th$, $^{226}Ra$ and $^{40}K$ content using gamma spectrometry. The average concentration of the $^{232}Th$, $^{226}Ra$ and $^{40}K$ in soil samples comes out to be 69, 55 and 884 Bq kg$^{-1}$. The Emanation and Exhalation rate of the $^{222}Rn$, $^{220}Rn$ from the collected soil samples have been measured. As the $^{222}Rn$ and $^{220}Rn$ originates from the solid grains of the medium and migrate through its pore space, it is expected to get affected by various soil parameters. An attempt has been made to see the effect of physical soil parameters on the Exhalation and Emanation rate of the $^{222}Rn$ and $^{220}Rn$. The results of the present study show the dominance of the soil parameters on the $^{222}Rn$, $^{220}Rn$ emanation and migration through the medium.

Thank you
for your kind attention!