

# Development and Application of Advanced Techniques for Inhalation Dose Assessment in Ambient and Occupational Environments

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## Importance of Radon (Thoron) Studies

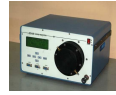
$^{222}\text{Rn}$  ( $^{220}\text{Rn}$ ): Naturally Occurring radionuclide  
Decay products - Alpha emitters - Deliver lung dose on inhalation

Build up in dwellings → Public domain issue

- Uranium exploration & mining
  - Thorium processing
  - Thorium based fuels
- Occupational + Environmental issues

## Radon Thoron Gas Measurements

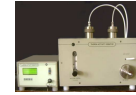
Development of Active and Passive instrumentation for radon, thoron gas measurements



Online radon monitor with  $\text{SO}_2$  and  $\text{NO}_2$  sensors



Portable Radon Monitor



Online dual cell thoron Monitor

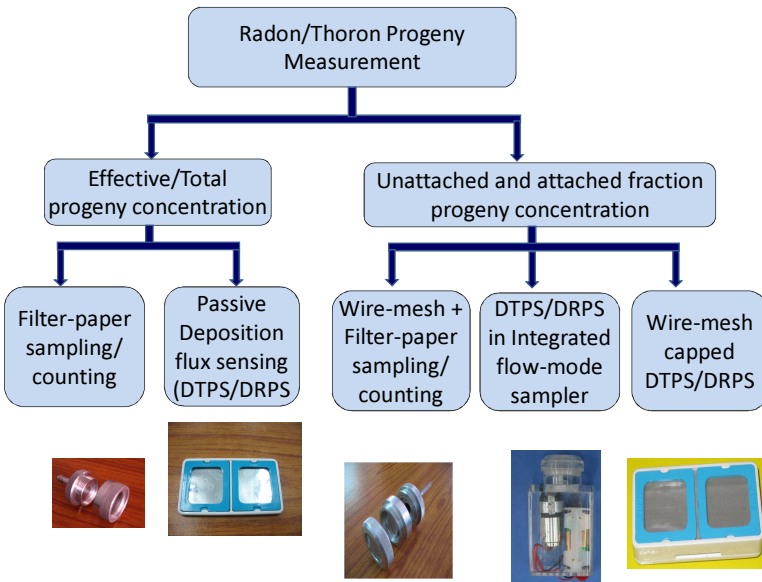


Coincidence thoron monitor

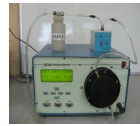


Pin-Hole dosimeter

## Decay Product Measurement - Shifting Emphasis



## Applications of Radon Monitors



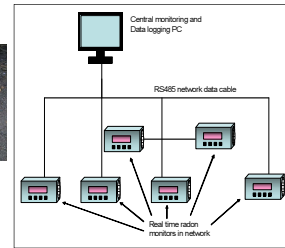
Radon emission from building materials



Soil gas measurements

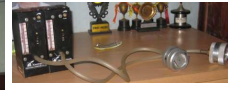


Radon flux measurement

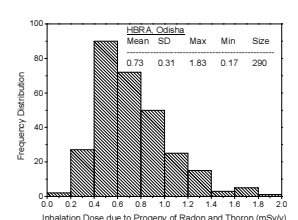
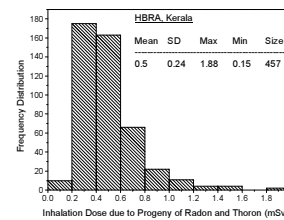


Networking of Radon Monitors in U mines

## Measurements in HBRA (Odisha and Kerala) 2010-2013

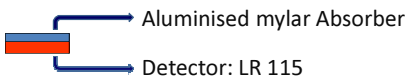


	Gamma dose rate ( $\mu\text{Sv/h}$ )	Mean ( $\mu\text{Sv/h}$ )
Kerala	Indoor: 0.13-1.18 Outdoor: 0.21-2.13	0.5
Odisha	Indoor: 0.16-0.62 Outdoor: 0.1-0.9	$\sim 10$ times higher than $\sim 0.065 \mu\text{Sv/h}$ measured in NBRA's



Inhalation dose similar to that in NBRA's (0.55 mSv/y)

## Deposition Based Progeny Sensors - Absorber based technique



• **Direct Thoron Progeny Sensor (DTPS):** (50 $\mu$  absorber)  
Selectively detects  $^{212}\text{Po}$  (8.78 MeV) alpha particles

• **Direct Radon progeny Sensor (DRPS):** (37 $\mu$  absorber)  
Mainly detects  $^{214}\text{Po}$  (7.67 MeV) alpha particles

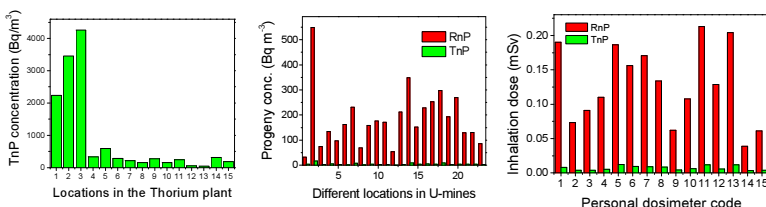
	Deposition Velocity ( $\text{m h}^{-1}$ )	Sensitivity Factor
Indoor (vent rate <2 per h)	0.075 $\pm$ 0.0072 ( $^{220}\text{Rn}$ progeny)	DTPS: 0.94 $\pm$ 0.027 Tr $\text{cm}^{-2}\text{d}^{-1}/\text{EETC}$ ( $\text{Bq m}^{-3}$ )
	0.132 $\pm$ 0.0036 ( $^{222}\text{Rn}$ progeny)	DRPS: 0.09 $\pm$ 0.0036 Tr $\text{cm}^{-2}\text{d}^{-1}/\text{EERC}$ ( $\text{Bq m}^{-3}$ )

## International Collaborations

- Scientific Collaboration  
HMZ, Munich, Germany  
INS, Serbia  
Pannonia Univ. Hungary  
Czech Tech. Univ. CR  
INAIL Dept. of Occ. Hyg., Italy  
JSI, Slovenia; RPB, Univ. of Macedonia



## Progeny Measurements in Occupational Environments



## Passive Bronchial Dosimeter - Ongoing

Combination of SSNTD+Wire mesh

Dose (mSv) = 0.0077  $T_D$

TD: track density in bronchial dosimeter

