



LRT 2026
York, UK

Radon
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Conclusions

Updates on International Radon Network for Low-background Experiments

Low Radioactive Techniques (LRT 2026)
York, UK

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Radon Overview

Radon Introduction

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Introduction

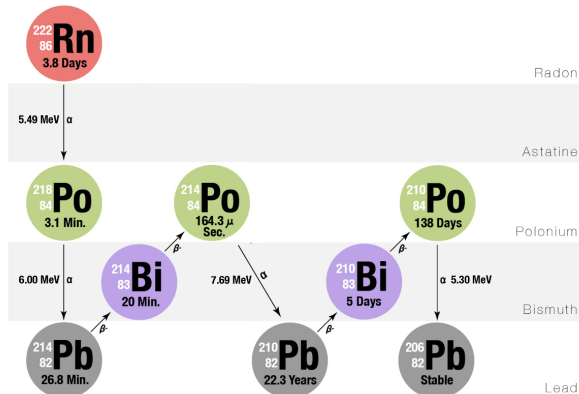
Backgrounds

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Radon Overview

Radon-induced backgrounds in rare-event physics

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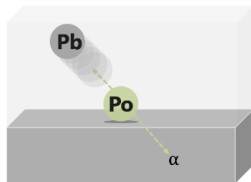
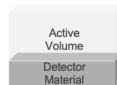
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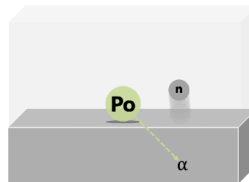
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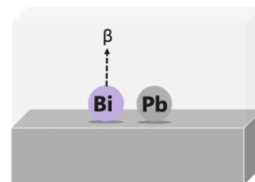
Conclusions



Nuclear Recoil



Neutron Production



Electron Recoil

Same radon. Different backgrounds.



Radon Overview

Where does contamination come from?

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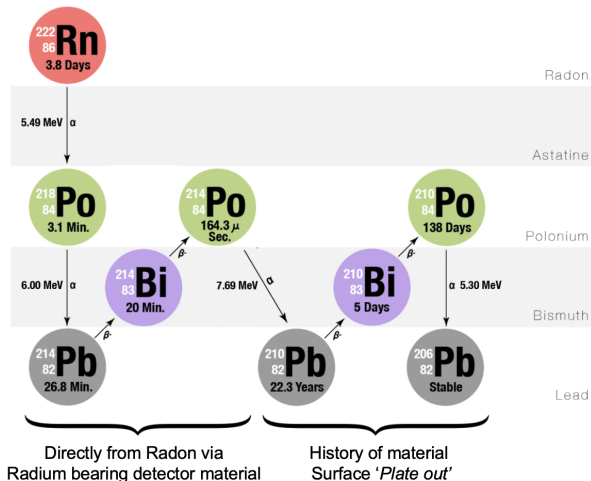
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Origin of Contamination



How do we control radon?

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Radon Emanation
Radon Suppression
Active Removal

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Construction Phase

Emanation

Material screening
and radon budgeting

Suppression

Treatments to reduce emanation
and plate-out

Detector Operation

Removal

Active filtration
and purification

Tagging

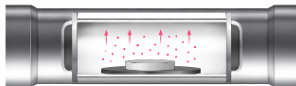
Identify and reject
radon-induced backgrounds



Radon emanation facilities fundamentally use a three-step process:

1 Emanation:

Accumulation of radon from sample of interest inside emanation chamber



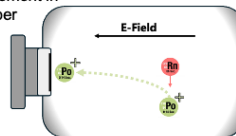
2 Transfer:

Transfer of radon from the emanation chamber to the detector chamber

- Concentration Line
- Closed loop
- Purge transfer
- Liquification
- In chamber

3 Detection

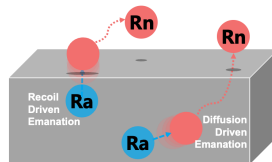
Radon measurement in detector chamber





Large global radon emanation ecosystem

- University of Windsor ultra-sensitive radon assay facility (A. Emara)
- Boulby Underground Laboratory radon emanation facility (A. Hamer)
- SNOLAB Rn-222 screening capability (N. Fatemighomi)
- DREAMR Radon Facility, ANU
- 600 L radon chamber, LP2I Bordeaux
- Cold Radon Emanation Facility (CREF), RAL
- Carleton nOble Liquid Detector Laboratory (COLD Lab) Radon Emanation
- *And more...*



- Detector-relevant conditions can significantly impact emanation rates
 - Carrier gas
 - Temperature, pressure
 - Humidity
 - Surface roughness
 - Porosity



Radon Strategies

Radon Suppression Treatments

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Radon Emission

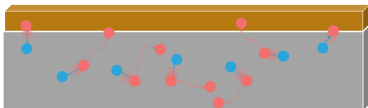
Radon Suppression

Active Removal

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Coating treatments

- Barrier layers to suppress radon emanation
- Example: Epoxy coatings, copper coatings, aluminized Mylar, EVOH...
- Coating based radon barriers for future liquid xenon detectors (S. Armbruster)
- Testing radon mitigating surface coatings in Xenoscope - a 2.6 meter long liquid xenon TPC (M. Noia)



Surface cleaning treatments

- Treatments to remove radon plate-out and progeny contamination
- Example: Electropolishing, acid etching, plasma cleaning, ultrasonic cleaning...
- Hydrofluoric acid-free Titanium etching for rare-event searches (P. Knights)
- **Work in progress:** ANU ultrafast laser polishing of titanium for radon emanation suppression with (ANU-TDLI Collab)



Radon Strategies

Active Radon Removal

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Radon Emanation

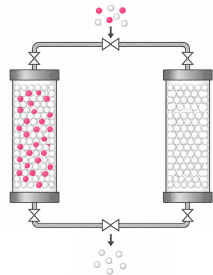
Radon Suppression

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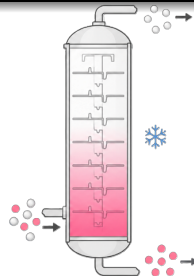
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Microporous adsorbents

- Preferentially adsorbs onto sorbents
- **Applications extend to underground laboratory environments**
- **Demonstration of Efficient Radon Removal by Silver-Zeolite (M. Piro)**
- **Development of new radon adsorbents - Update of the IRENE Project (H. Tedjiti)**



Cryogenic distillation

- Separated using volatility differences
- Widely used in liquid noble gas detectors
- **Low-background Program of PandaX-20T experiment (Y. Meng)**
- **Radiopurity and cleanliness control in the XLZD rare event observatory (F. Dastgiri)**



International Radon Network

Need for technical radon collaboration

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Independent radon mitigation efforts across the community





International Radon Network

Radon Zero Backgrounds Network

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Prof. José Busto
AMU/CPPM/CNRS



Dr. Robert Renz
Marcelo Gregorio
ANU

Objective: Address radon as a *shared technical challenge* through open, cross-experiment collaboration to accelerate progress towards the ultimate sensitivity goals of low-background physics

1 Shared technical data

- Material emanation data
- Radon sorbents and suppliers
- Relevant technical contacts

2 Standardise performance metrics

- Filtration
- Emanation
- Intercomparison studies

3 Platform for technical collaboration

- Workshops alongside established conferences
- Cross-community and experiment discussions
- Connect established expertise with the next generation



International Radon Network

Confirmed Community Support

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E/Prof Arthur McDonald
SNOLAB



Prof Yasuo Takeuchi
Kobe University



A/Prof Marie-Cécile Piro
University of Alberta



Dr. Hardy Simgen
Max Plank Institute



Prof Rueben Saakyan
UCL



Prof. Stuart Batten
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**Metal Organic
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Prof. Richard Robson
(2025 Nobel Laureate)
Research Group



Prof Yue Meng
SJTU



Prof Christian Weinheimer
University of Münster



Prof Michela Lai
Queen's University



Dr. Monica Sisti
INFN Milano



Dr. Ivan Štekl
Czech Technical Uni



Dr. Luca Scotto
CNRS/LPHE

And More...

Wide support across dark matter, $0\nu\beta\beta$ and underground physics communities



Ongoing Efforts

Technical Collaboration Objectives

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Emanation data
Intercomparison
Technical
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Updates on the three technical collaboration objectives:

- 1 Shared technical data
- 2 Standardisation and intercomparison
- 3 Platform for technical collaboration



Shared Technical Data

Radon Emanation Review

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- Review in preparation: *Radon emanation measurements for low-background experiments: methodologies, facilities, and future directions*
- Catalogue of radon emanation facilities and measurement methodologies
- Compilation of published emanation measurements by material class
- Development of an open, shared technical database

Open call

Please get in touch if you are interested in contributing to the review paper or sharing emanation data.





Standardise performance metrics

Intercomparison

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- Intercomparison studies across filtration facilities
- **Filtration standard:** common definitions for adsorption constant (k) and breakthrough time (τ_{50}), using Carboxen 564 as a reference material
- Similar intercomparison effort planned using a standard radon emanation sample

Secured Funding

AUD 13k ARC Centre of Excellence for Dark Matter Particle Physics Special Initiatives **funding secured for reference samples and intercomparison logistics**



Figure: Carboxen 564 reference material for interlaboratory studies



Technical Collaboration

Developing cross-community efforts

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Shared materials

- AgFER Silver zeolite developed at **Kobe University** (Y. Takeuchi)
- Samples shared with **CPPM** and **CYGNO** experiment (**LNGS**)

Shared tools

- Independent review of radon calculations, efficiencies and uncertainties (**ANU-TDLI collaboration**)
- Developement towards an open framework for radon-budget calculations

Shared techniques

- Direct in-chamber radon-220 emanation : **ANU-UCL collaboration**
- Radon surface emanation supression at **Stawell Underground Physics Laboratory (SUPL)**
- **Work in progress:** Vacuum Swing Adsorption R&D for radon removal at SUPL

Continued technical exchange

- Technical collaborations are still developing and open to new discussions
- Dedicated technical discussions planned at the **DUPHy 2027 Workshop** in Paris



Conclusions and Community Call

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- Radon remains a **major technical challenge** across low-background physics
- Radon is a **shared technical problem** and collaboration is possible without sharing sensitive physics data
- The Radon Zero Background Network provides an **experiment-agnostic technical hub** for cross-community radon efforts

Community Call

- Join the **intercomparison studies** across radon facilities
- Help build the **open access radon database** by contributing shareable measurements



Radon Rob



Contact Info