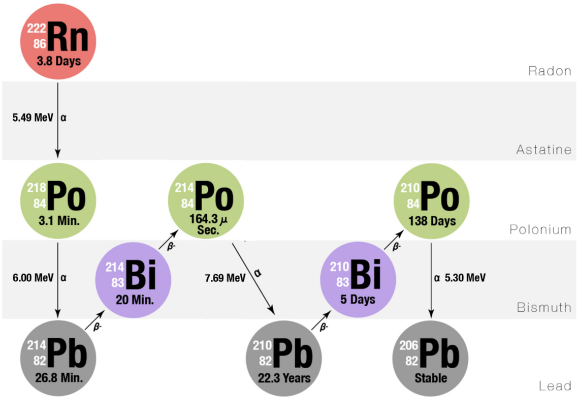
International Radon Network for Low-background Experiments

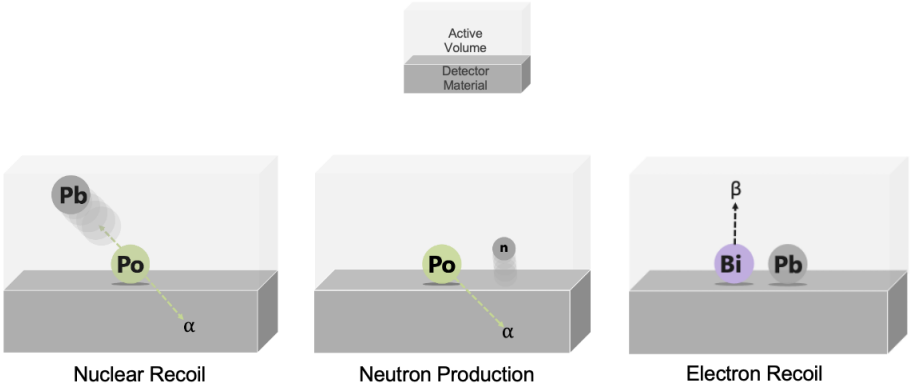
Identification of Dark Matter (IDM 2026)
Zaragoza, Spain

R.R. Marcelo Gregorio[a], **J. Busto**[b], L.J. Bignell[a], G.J. Lane[a], A.G. McLean[c], N.J.C. Spooner[d], and H. Tedjditi[b]

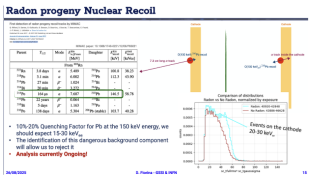
[a]Australian National University
[b]Centre de Physique des Particules de Marseille (CPPM)
[c]Adelaide University
[d]University of Sheffield



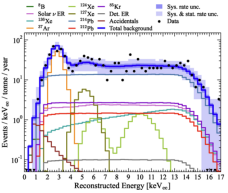
Radon Overview
Radon-induced Backgrounds



Radon Overview
Backgrounds Examples

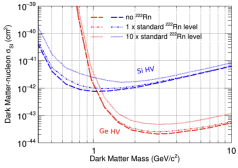


CYGNO (LIME) Gas TPC
Directional Dark Matter Detector



LZ Dual Phase Xenon
Dark Matter Detector

Crystal Scintillator
Dark Matter Detectors



SuperCDMS Cryogenic
Solid-state Dark Matter Detector

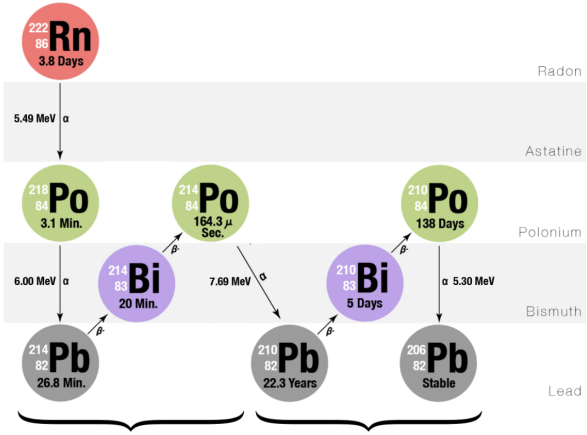
NEXT-100
0νββ Detector

And More…

Different detectors. Same radon problem.

Radon Overview

Where does contamination come from?



How do we control radon?

Construction Phase

Emanation

Material screening
and radon budgeting

Suppression

Treatments to reduce emanation
and plate-out

Detector Operation

Removal

Active filtration
and purification

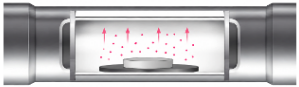
Tagging

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

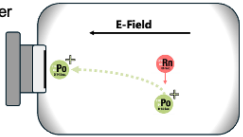


2 Transfer: Transfer of radon from the emanation chamber to the detector chamber

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

3 Detection

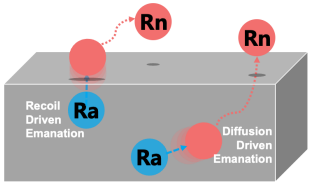
Radon measurement in detector chamber



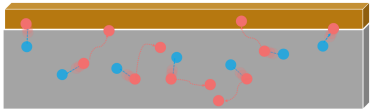
Example radon emanation facilities

- Detecting Radon Emanating and Mitigating Radon (DREAMR)
- 600 L radon chamber at LP2I (Bordeaux)
- Boulby UnderGround Screening Facility (BUGS)
- Cold Radon Emanation Facility (CREF)
- Carleton nOble Liquid Detector Laboratory (COLD Lab) Radon Emanation
- *And more...*

Large global radon emanation ecosystem



- Detector-relevant conditions can significantly impact emanation rates
  - Carrier gas
  - Pressure
  - Humidity
  - Temperature
  - Porosity



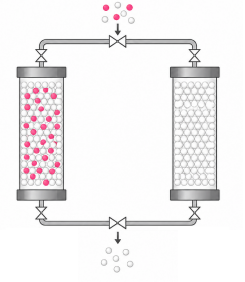
Coating treatments

- Barrier layers to suppress radon emanation
- Example: Epoxy coatings, copper coatings, aluminized Mylar, EVOH, helium implantation...

Surface cleaning treatments

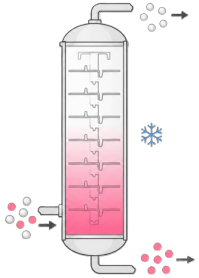
- Treatments to remove radon plate-out and progeny contamination
- Example: Electropolishing, acid etching, plasma cleaning, ultrasonic cleaning...

Radon Strategies
Active Radon Removal



Microporous adsorbents

- Radon preferentially adsorbs onto sorbents
- Medium passes while radon is retained
- **Applications extend to underground laboratory environments**



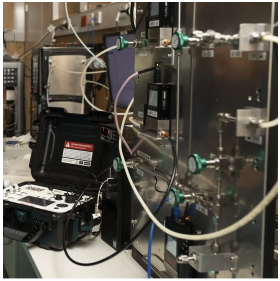
Cryogenic distillation

- Radon separated using volatility differences
- Continuous purification of medium
- Widely used in liquid noble gas detectors

Example radon filtration facilities

- Detecting Radon Emanating and Mitigating Radon (DREAMR)
- CPPM Radon Adsorption Test Bench
- Laboratory 222 (Kobe University)
- SJTU Radon Filtration Facility
- *And more...*

Global radon filtration ecosystem



- **Radon sorbent candidates**
  - Activated Charcoal
  - 5A MS Zeolite
  - Silver Zeolite
  - Metal Organic Framework...

Independent radon mitigation efforts across the community

International Radon Network

Technical Collaboration Objectives

Prof. José Busto

CPPM / CNRS

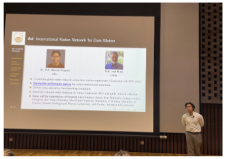
Dr. Robert Renz
Marcelo Gregorio

Australian National University

Aim: Accelerate progress towards the ultimate sensitivity goals of low-background physics through international technical collaboration

1. **Shared database**
   - Material emanation data
   - Radon sorbents and suppliers
   - Suppression techniques
   - Relevant technical contacts
2. **Standardise performance metrics**
   - Filtration
   - Emanation
   - Intercomparison studies
3. **Platform for technical collaboration**
   - Workshops alongside established conferences
   - Cross-community discussions
   - Connect established expertise with the next generation

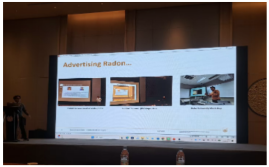
Advertising radon...



CYGNUS International Workshop 2026

Prof Neil Spooner

CYGNO x CYGNUS-Oz Workshop



Panda X Open Meeting

IDM 2026

International Radon Network

Confirmed Community Support

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
Monash

Metal Organic Framework Expert
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/LPNHE

And More...

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

Ongoing Efforts

Review Paper on Radon Emanation Facilities

Writing: Radon emanation measurements for low-background experiments: methodologies, facilities, and future directions

Separation and Purification Technology 382 (2026) 134640

Contents lists available at ScienceDirect

Separation and Purification Technology

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

Review

Exploring the science of radon adsorption: Materials, methodologies, and emerging directions

Oleksandra Veselska [a], Shefali Vaidya [a], Olivier Llido [b], Miroslav Macko [a], Irena Déroche [c], Sandrine Bourrelly [d], José Busto [e,*]

[a] Institute of Experimental and Applied Physics, Czech Technical University in Prague, Prague, CZ-11000, Czech Republic
[b] CEA, DES, IRESNE, DER, Cadarache, Saint-Paul-lez-Durance, F-13108, France
[c] Université de Haute-Alsace, ISSEC, CNRS UMR 7361, Mulhouse, F-68100, France
[d] Aix-Marseille Université, MADIREL, Marseille, F-13013, France
[e] Aix-Marseille Université, CNRS/INSPE, CP3M, Marseille, F-13284, France

ARTICLE INFO

Communicated by Harvey Y. Huang

ABSTRACT

Radon, a radioactive noble gas, poses significant health risks due to its link to lung cancer and presents a major challenge in low-background physics experiments, where its decay products contribute to background noise.

Ongoing Efforts
Standardisation and Intercomparison

- Intercomparison studies for both emanation and filtration facilities
- Establish reporting standards to improve reproducibility between laboratories
- **Filtration standard**: proposed common adsorption constant (k) and breakthrough time τ_{50} definitions using the reference material Carboxen 564[a]
- Pilot DREAMR Radon Facility at Australian National University

[a] O. Veselska et al., *Separation and Purification Technology* 382 (2026) 134640

Figure: Carboxen 564 reference material for interlaboratory studies

Radon Zero Backgrounds Workshop

- Planned strategically alongside established conferences and meetings
- Cross-community technical discussions on radon detection and mitigation

DUφ
Deep Underground Physics

Scheduled alongside the established DUPhy Meeting
Planned June/July 2027 in Paris

Conclusions and Community Call

- Radon remains a major challenge
- Independent radon efforts exist across the community
- International technical coordination can accelerate progress towards future sensitivity goals

Ongoing efforts

- Shared radon database and website under development
- Review paper on radon emanation facilities
- Pilot intercomparison studies at the DREAMR Facility
- *Radon Zero Backgrounds* Workshop x DUPhy 2027
- **SUPL radon mitigation case study**
- **Research translation and industry engagement**

Open Call

Experiments, laboratories, researchers and ECRs across the radon and low-background physics community

Radon Rob
Australian National University

Contact Info