

Overview of the new portable ANSTO dual-flow-loop two-filter 200 L Radon-222 monitor

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EMPIR 19ENV01 traceRadon

Work Package 1: Traceable measurements of outdoor radon activity concentrations

Environmental Radon Monitoring - Overview

- Ambient outdoor [^{222}Rn] typically 1-2 orders of magnitude less than indoor
- Interest primarily in its utility as a tracer of mixing and transport, or indicator of terrestrial influence, rather than public health
- Measurement requirements for mixing/transport studies in the ABL:
 - ability to report $0.2 \text{ Bq m}^{-3} < ^{222}\text{Rn} < 200 \text{ Bq m}^{-3}$
 - hourly temporal resolution (or less)
 - consistent/reliable calibration
- Requirements for WMO GAW “baseline” studies (terrestrial influence):
 - ^{222}Rn detection limit $\leq 0.05 \text{ Bq m}^{-3}$
 - temporal resolution hourly
 - consistent/reliable calibration

Currently available environmental radon monitors

Commercial Detectors

(RAD7, AlphaGUARD, RTM 2200, Pylon AB7, ATMOS, RADIM 3AT)



ANSTO *two-filter* dual-flow-loop radon detectors

1500 L model

5000 L model

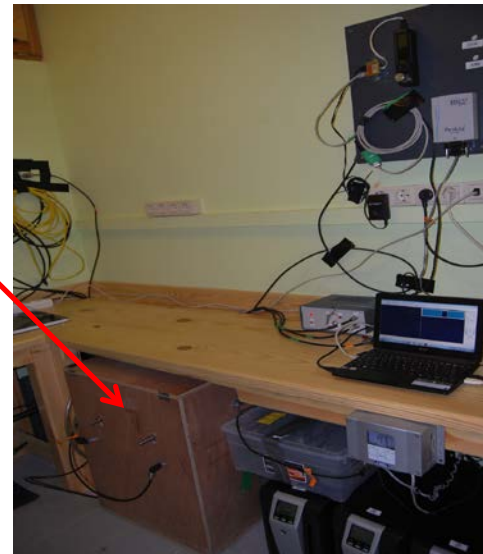


Cape Grim Baseline
Atmospheric Pollution Station

Research Grade Detectors



Atmospheric
Radon
Monitor
(ARMON;
*electrostatic
deposition*)



Heidelberg Radon Monitor
(HRM; *single-filter*)

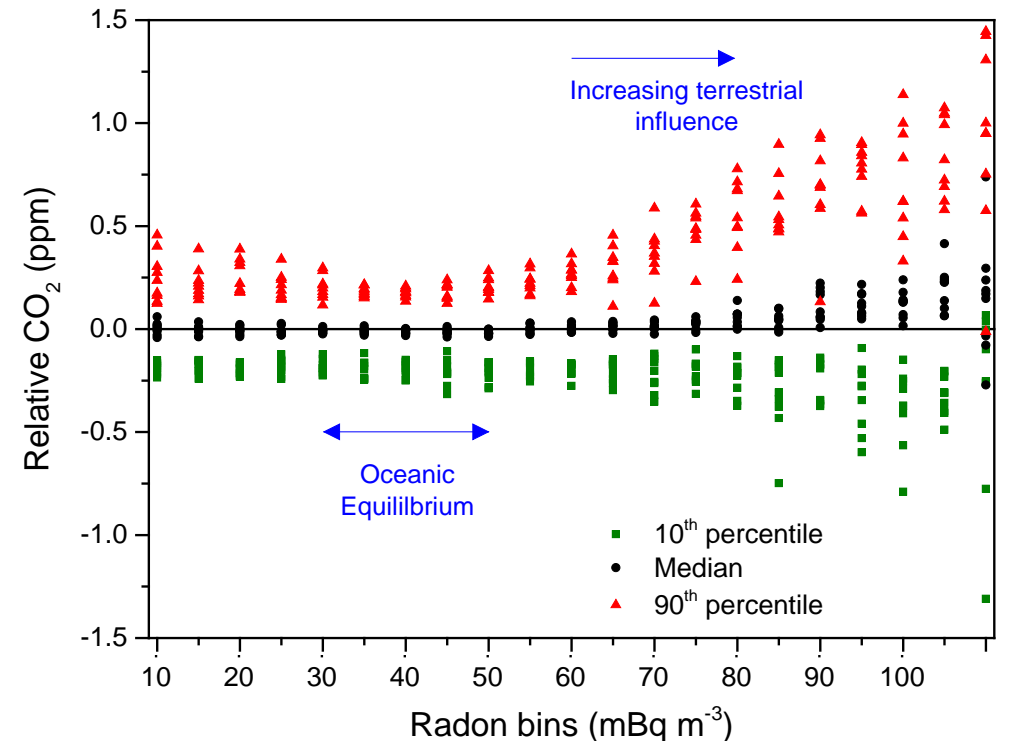
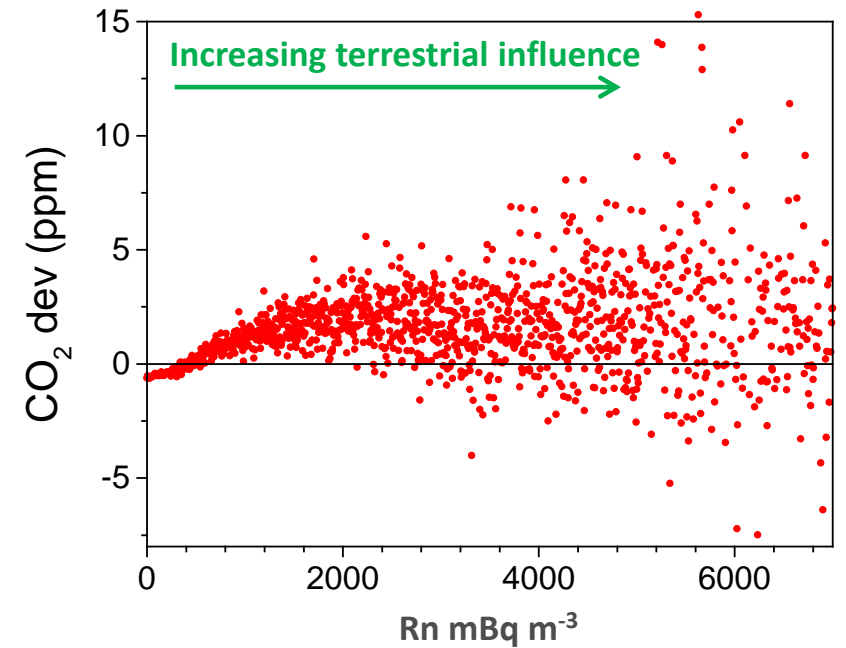
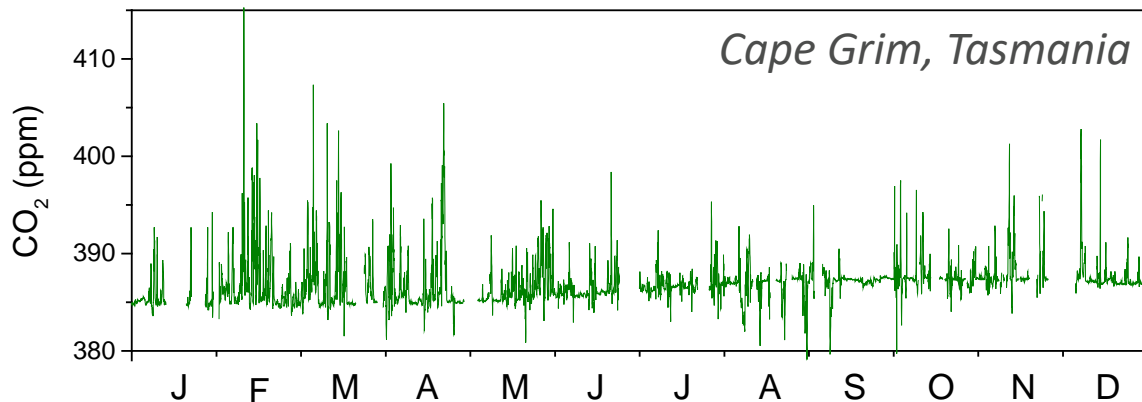
Performance comparison of available radon monitors

Instrument	Sensitivity (cpm / Bq m ⁻³)	Counting uncertainty (@4 Bq m ⁻³)	Length (m)	Comments
Commercial detectors	0.003 – 0.05	~60-240%	0.2 – 0.5	Traceable calibrations , may require separate pump and sample drying, direct measurement
ARMON	0.39	21%	0.9	Calibration not yet traceable, requires sample drying , direct measurement
HRM	20	2%	0.35	Calibrations not yet traceable, requires separate pump, indirect measurement (single filter)
ANSTO 1500 L	22	1.3 – 2.8%	3.0	Calibrations not yet traceable, requires separate pump, direct measurement, not portable
ANSTO 5000 L	98	0.7%	5.5	Calibrations not yet traceable, requires separate pump, direct measurement, not portable
Holy Grail	high	low	portable	Direct, self-contained

- **Commercial detectors:** **portable**, traceable, but **high uncertainty** for environmental conditions
- **ARMON:** **portable**, not traceable, **intermediate uncertainty** for environmental conditions
- **HRM:** **portable**, not traceable, **low uncertainty**, **requires disequilibrium / tube-loss corrections**
- **ANSTO:** **not portable**, not traceable, **low uncertainty** for environmental conditions

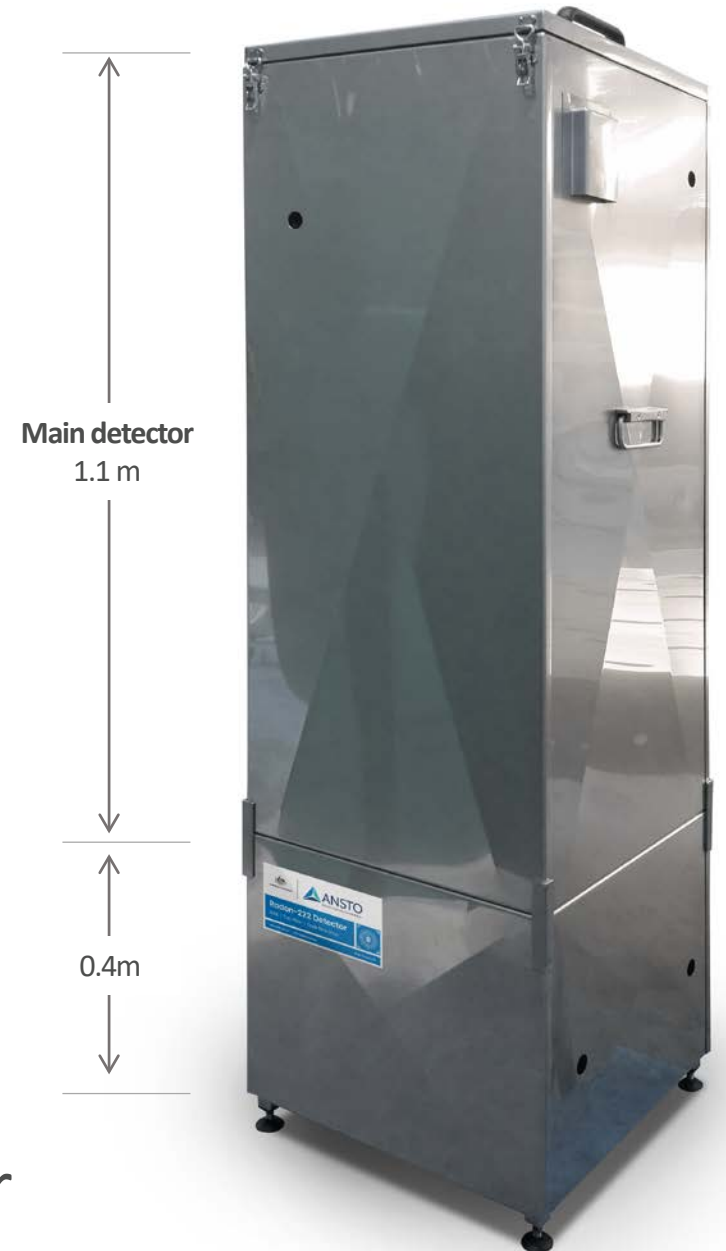
Why are low detection limits important for environmental Rn monitoring?

- ^{222}Rn in the terrestrial boundary layer ($0.5 \text{ Bq m}^{-3} - 50 \text{ Bq m}^{-3}$)
- ^{222}Rn in the remote marine boundary layer (typically $0.05 \text{ Bq m}^{-3} - 0.2 \text{ Bq m}^{-3}$)
- ^{222}Rn in the troposphere ($\sim 0 \text{ Bq m}^{-3} - 0.05 \text{ Bq m}^{-3}$)
- Detection limits $< 0.2 \text{ Bq m}^{-3}$ enable identification of long-term remote transport
- Detection limits $< 0.05 \text{ Bq m}^{-3}$ enable detection of admixtures of tropospheric or stratospheric air or transport over ice



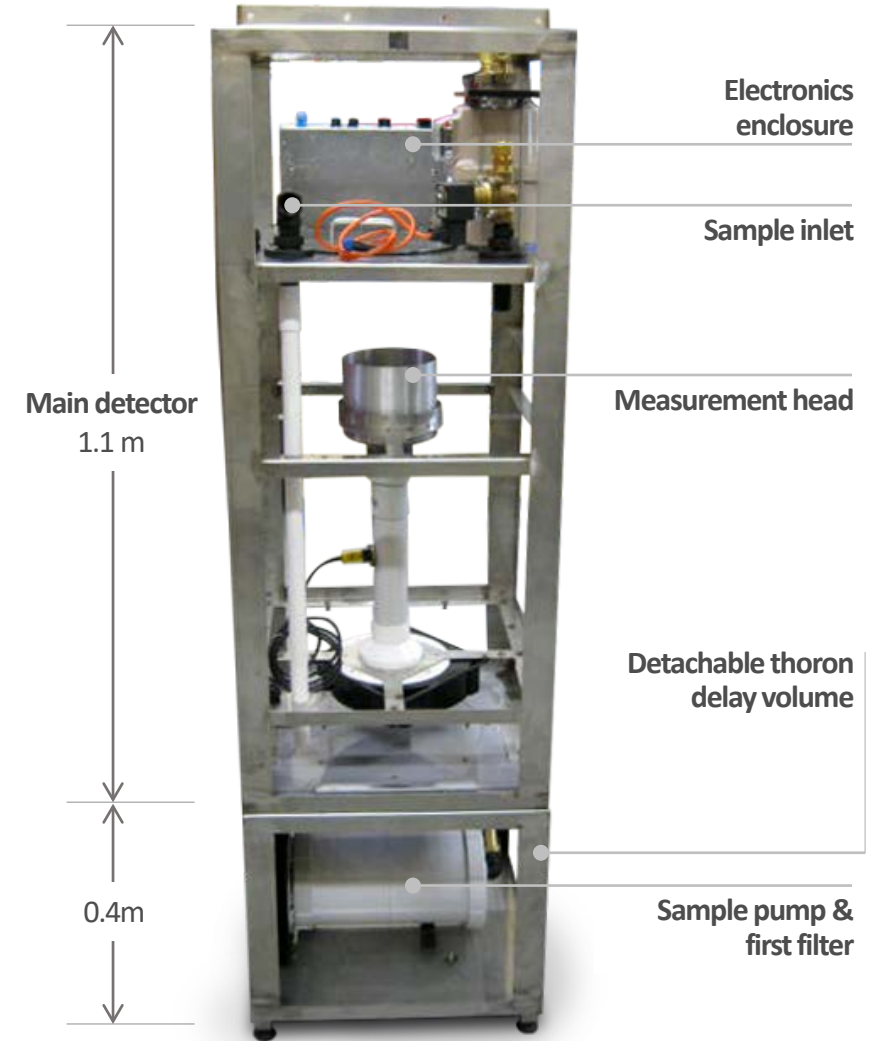
New 200 L ^{222}Rn monitor for *traceRadon*

- ANSTO **200 L** two-filter dual-flow-loop
 - 0.5 m wide, 1.5 m tall
(fits inside a 19" instrument rack)
 - 2 separate pieces (0.4 m & 1.1 m) for transport
(thoron delay volume and detector)
 - fully portable
(can be moved by 1 person in standard vehicle)
 - marine grade stainless steel
(suitable for long-term outdoor monitoring)
 - low power consumption (100W @ 240V)
 - minimal scheduled maintenance requirements for 5-yr



Performance Characteristics

- ANSTO 200 L dual-flow-loop two-filter
 - direct ^{222}Rn measurement
 - sensitivity 3 cpm / Bq m^{-3}
 - detection limit $\sim 0.13 \text{ Bq m}^{-3}$
 - counting uncertainty (@4 Bq m^{-3}) 7.4%
 - sampling flow rate 12 L min^{-1} - 15 L min^{-1}
 - *in situ*, automatic cal. / background
 - fully remotely controllable
(requires access to networked computer)
 - 45 minute response time
(correctable in post processing)
 - 30-minute temporal resolution



Summary

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ANSTO Unicorn	3	7%	1.1	Calibrations not yet traceable

- The 200 L ANSTO ²²²Rn detector represents the **state-of-the-art** in portable direct *environmental* ²²²Rn monitoring
- With the new low activity radon source, a closed-loop calibration method can be tested to reduce uncertainty (< **current 2 % - 6 %**)
- The prototype will be shipped to PTB in Nov/Dec 2020

