

The Radon Calibration Laboratory at the Federal Office for Radiation Protection (BfS)

T.R. Beck, H. Buchröder, J. Döring, E. Foerster, V. Schmidt

Bundesamt für Strahlenschutz (Federal Office for Radiation Protection)

Lecturer: Elisabeth Foerster

International Intercomparison Exercise on Natural Radiation Measurements under Field
Conditions

LaRUC, 23-27 May 2011

Functions and objectives

- **Coordinating office for the surveillance of elevated natural radioactivity**
- **Determination of radiation exposures resulting from radon and radon progenies**
- **Recognized metrological reference laboratory for radon-222 and short-lived radon progenies (secondary standard)**
- **Quality assurance for the measurement of radon and radon progenies in Germany**

Program for Quality Assurance

- **Scientific investigations on metrological fundamentals**
- **Evaluation and development of measurement methods**
- **Type testing**
- **Calibration service for measurement devices**
- **Interlaboratory comparisons for passive radon monitors**

Laboratory for Radon-222 activity concentration

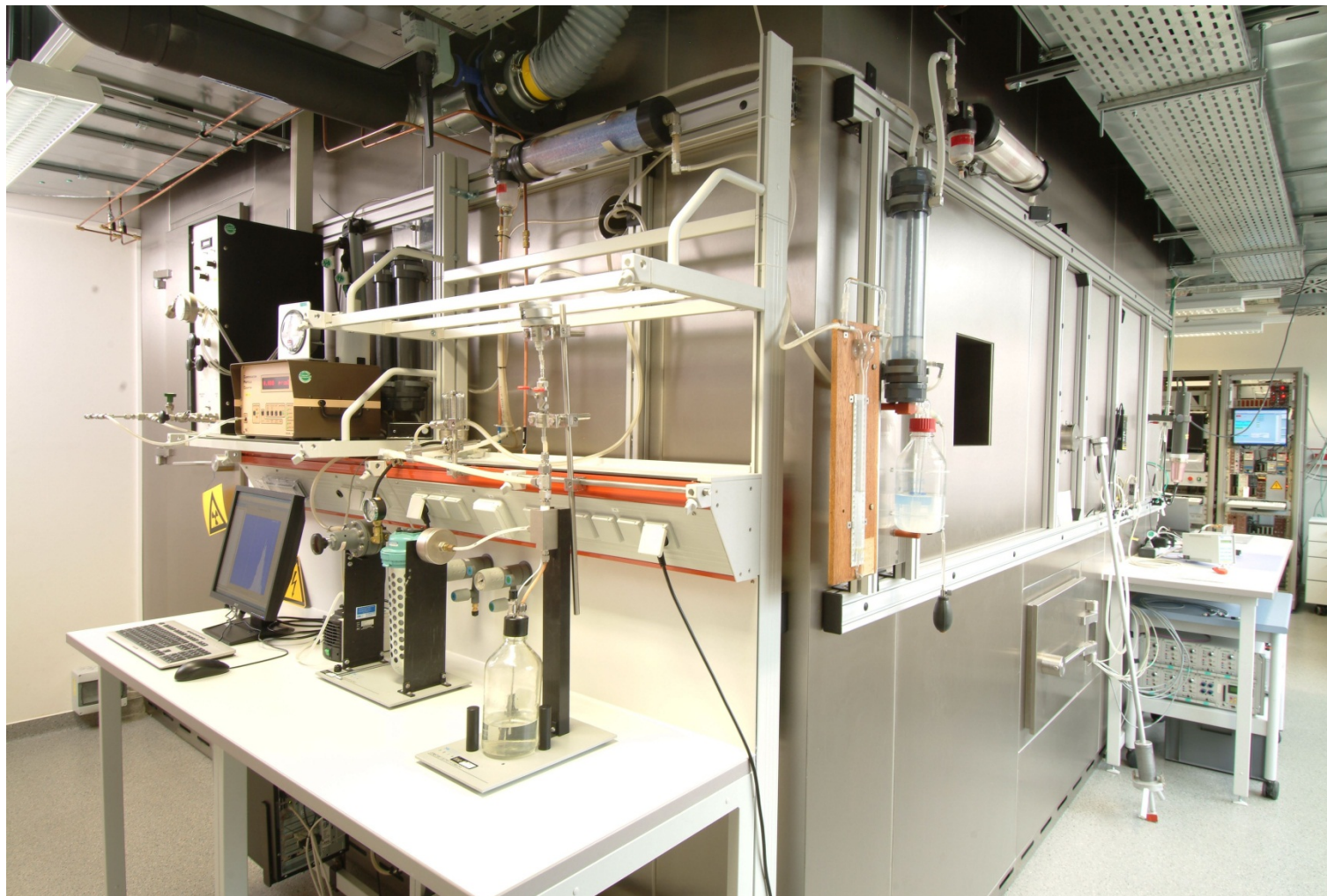


Walk-in radon chamber
(Volume: 11 m³)



Barrels
(Volume: 0.4 m³)

Laboratory for the Potential Alpha-Energy Concentration of the Short-Lived Radon-222 progenies (PAEC)



Walk-in PAEC chamber (volume: 30 m³)

| Verantwortung für Mensch und Umwelt | ■ ■ ■ ■ ■ ■ ■ ■

Radon Calibration Laboratory at BfS



Accreditation:

by the German
accreditation body
according to
**DIN EN ISO/IEC 17025:
2005**

Measurands:

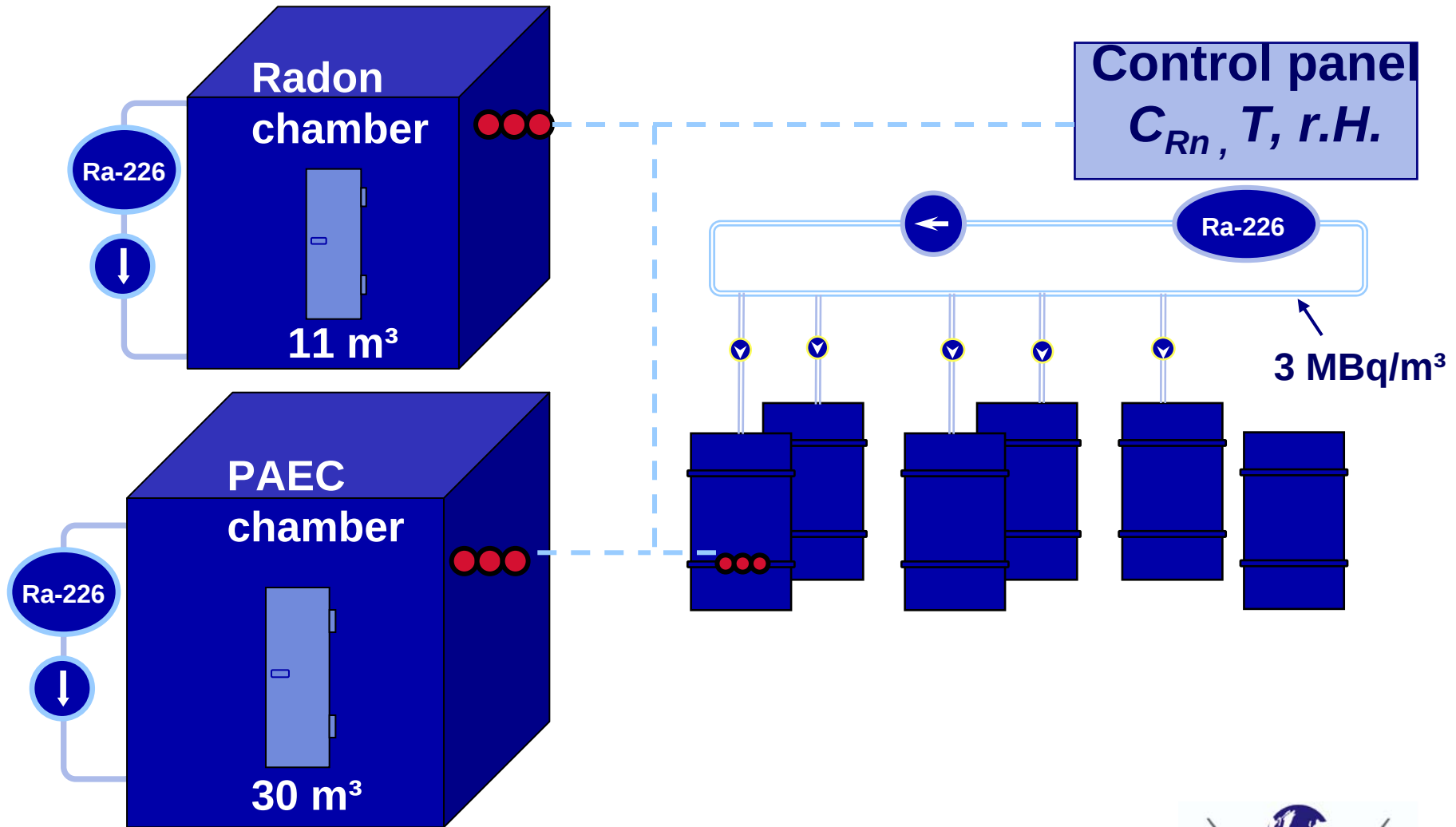
- Activity concentration of radon-222 in air (C_{Rn})
- Potential alpha energy concentration of radon-222 short-lived decay products (C_P or $PAEC$)

Traceability: to the National Standards at the German
National Metrology Institute „Physikalisch-
Technische Bundesanstalt“ (PTB)

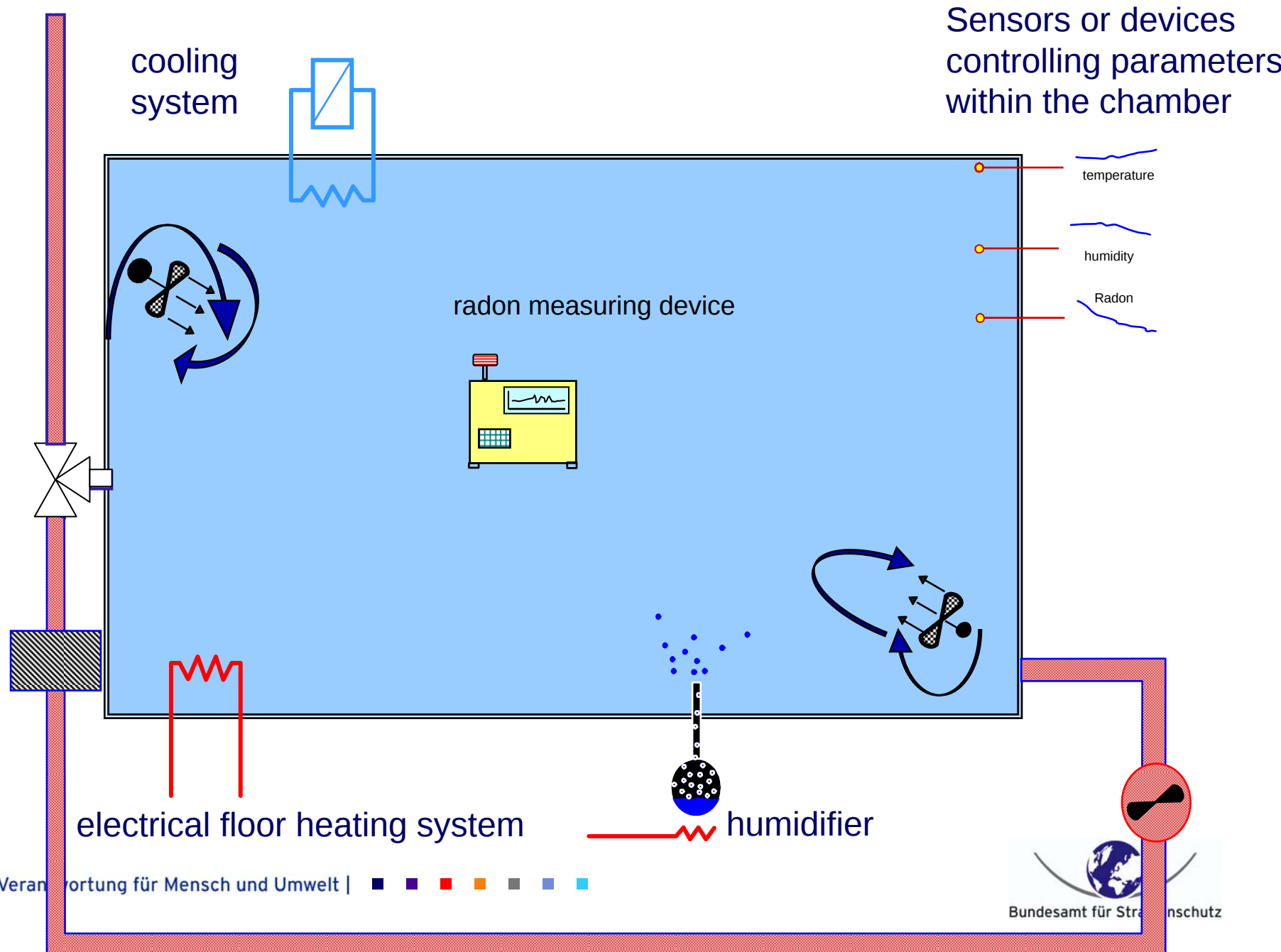
Technique and equipment

2 chambers

set of 400 l containers



Radon chamber / PAEC chamber



Sensors or devices
controlling parameters
within the chamber



Measurement parameters and their range of adjustment (Radon chamber)

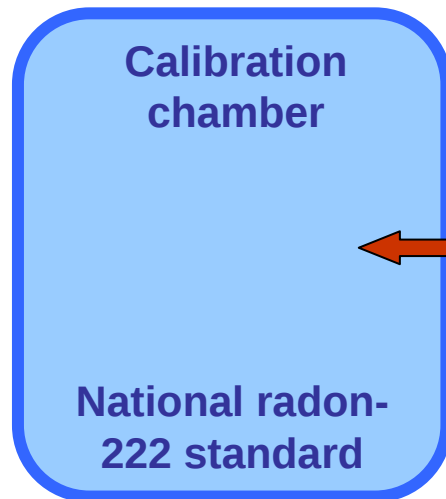
Measurement parameter	Range of adjustment
Radon-222 activity concentration C_{Rn}	50 ... 100 000 Bq/m ³
Air temperature	-5 ... 50 °C
Relative humidity	10 ... 95 %

Measurement parameters and their range of adjustment (PAEC chamber)

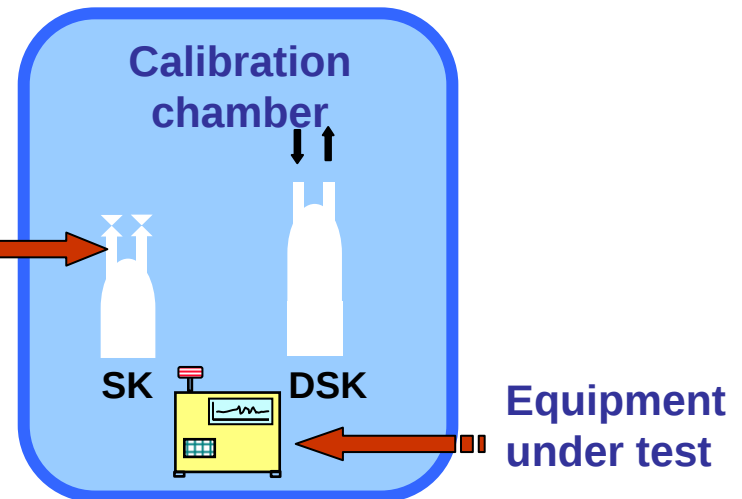
Measurement parameter	Range of adjustment
Radon-222 activity concentration C_{Rn}	50 ... 100 000 Bq/m ³
Air temperature	-5 ... 50 °C
Relative humidity	10 ... 95 %
Air pressure	Atmospheric pressure (not adjustable)
Potential alpha-energy concentration of the short-lived radon-222 progenies (<i>PAEC</i>)	0.3 ... 640 µJ/m ³
Particle concentration of the aerosol	200 ... 200 000 particles/cm ³
Equilibrium factor	0.1 ... 0.9
Unattached fraction of <i>PAEC</i>	< 1 ... 90 %
Air flow velocity (turbulence)	0 ... 1 m/s

Traceability C_{Rn}

**Physikalisch-
Technische
Bundesanstalt
(PTB)**



**Radon
Calibration
Laboratory at
BfS**



SK : Scintillation chamber
DSK: Flow-thru scintillation chamber

Radon-222 activity concentration: Budget of the measurement uncertainty

	Range of measurand	Best measurement uncertainty of the reference measurement *)
Activity concentration of radon-222 in air	50 Bq/m ³ to 1000 Bq/m ³	12 %
	1000 Bq/m ³ to 10000 Bq/m ³	7 %
	10000 Bq/m ³ to 100000 Bq/m ³	6 %

*) The extended relative measurement uncertainty results from the standard uncertainty of measurement multiplied with a coverage factor $k=2$. It was determined in accordance with DAkkS-DKD-3“Angabe der Messunsicherheit bei Kalibrierungen”, 2010, Deutsche Akkreditierungsstelle GmbH, Braunschweig (German translation of publication EAL-R2 „Expression of the Uncertainty of Measurement in Calibration“).

Interlaboratory Comparison

Test items:

**Passive radon measuring devices using
solid state nuclear track detectors,
electrets or
activated charcoal**

Frequency of performance: Annually since 2003

Announcement: <http://www.bfs.de>

Participation:

**National and international institutions (in order to fulfil
the requirement of validation)**

Number of devices and groups

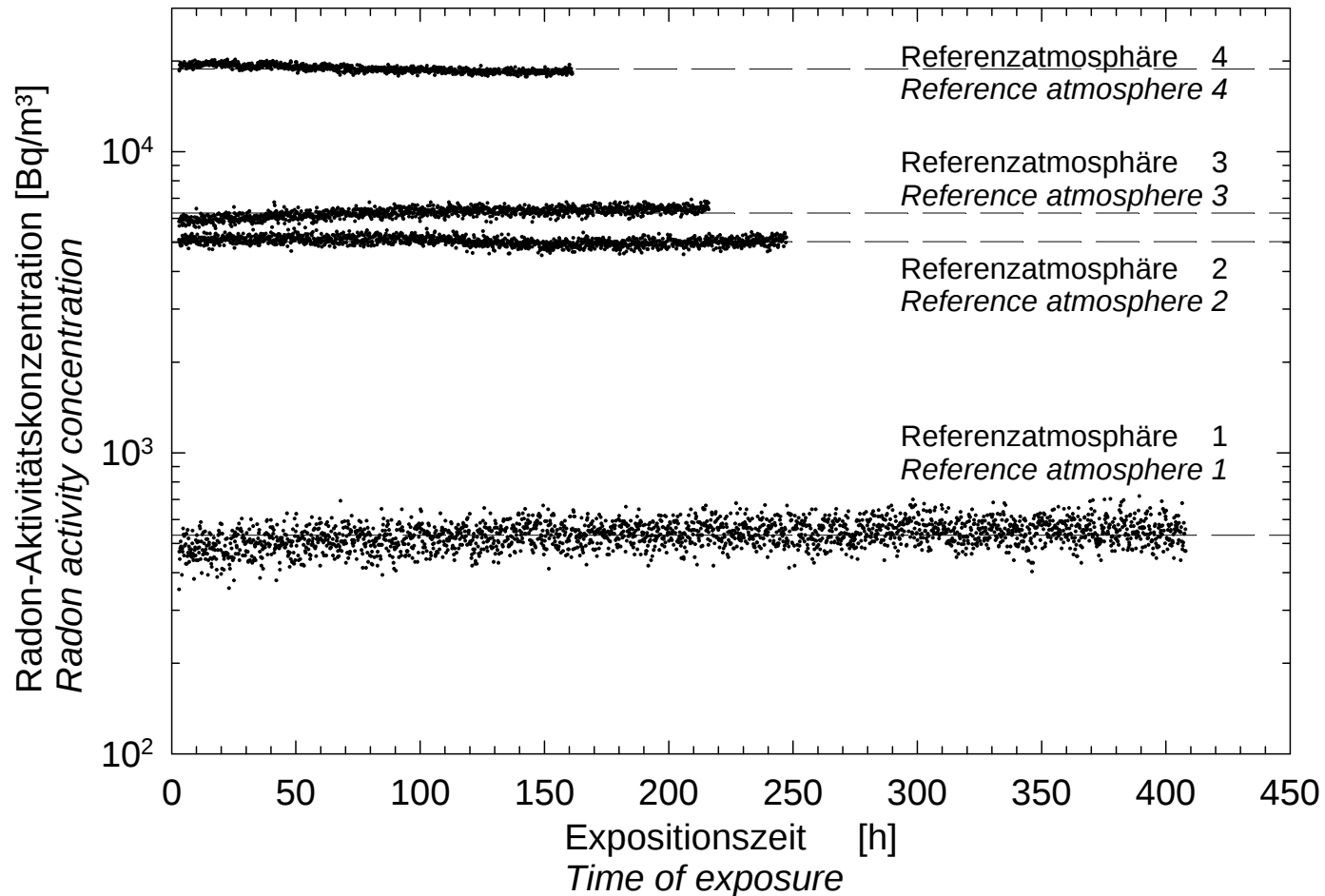
Type of detector	Devices to be submitted	Number of exposure groups	“Transit” group	Exposure duration
SSNTD	35	4	Yes	1 ... 3 weeks
Electret	24	3	Yes	1 ... 3 weeks
Activated charcoal	8	1	No	48 hours / 72 hours

Exposure data 2010 (SSNTDs, electrets)

No.	t [h]	$C_{\text{Rn,Ref}}$ [Bq·m ⁻³]	$P_{\text{Rn,Ref}}$ [kBq·h·m ⁻³]	$U (C_{\text{Rn,Ref}})$ [%]	r.H. [%]	T [°C]
1	408	439	234	12	20	20.6
2	474	1644	1224	7	13	20.7
3	216	4380	1330	7	10	20.6
4	162	9068	3023	7	21	20.9

$U[\%]$...extended relative uncertainty of $C_{\text{Rn,Ref}}$ with coverage factor $k=2$
(95% confidence level)

Time variation of radon activity concentrations (SSNTDs, electrets)



Number of participants in 2010: 27

SSNTDs (24 sets)



Electrets (4 sets)

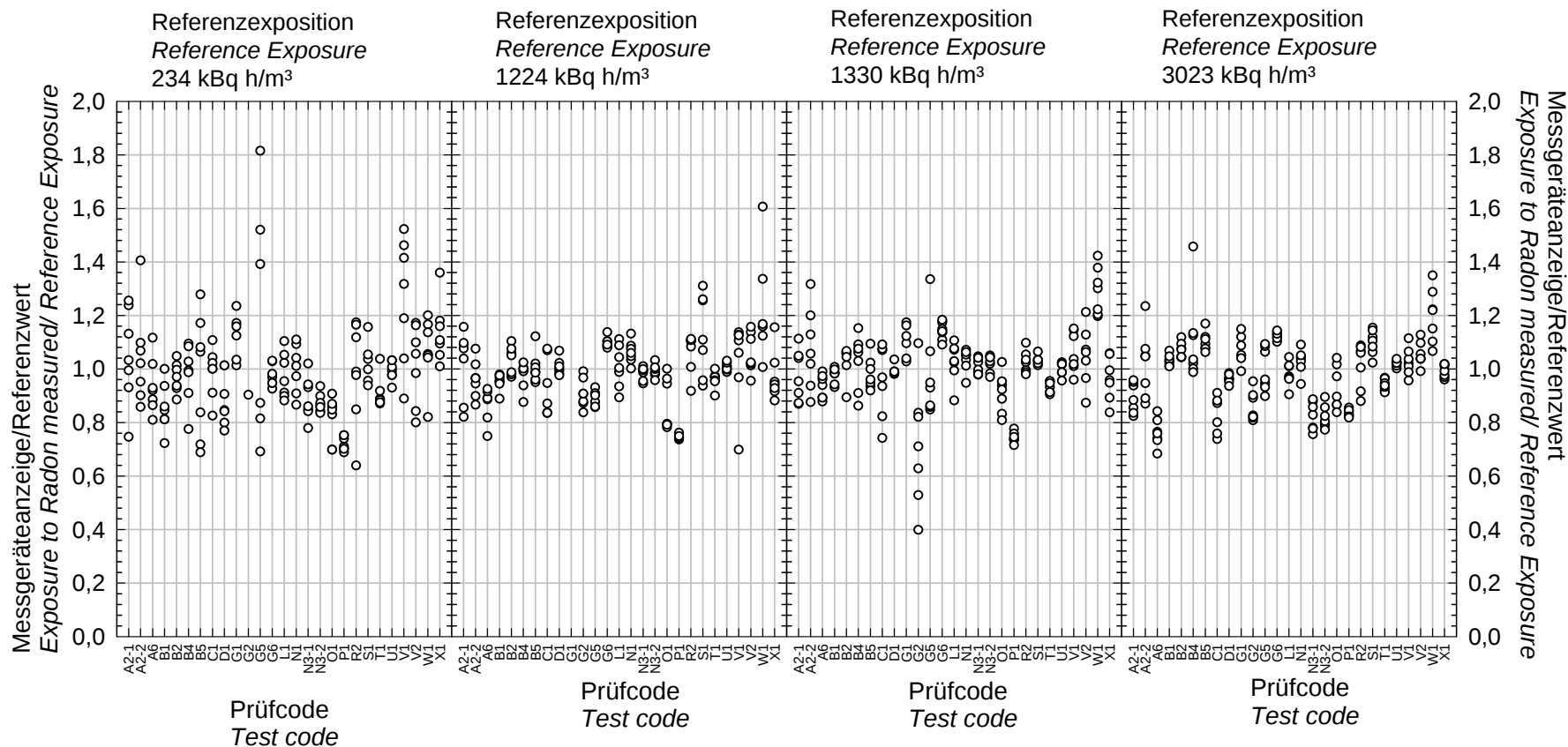


Charcoal detectors (6 sets)



Interlaboratory Comparison 2010

Relative Error (SSNTDs, electrets)



Interlaboratory Comparison of Passive radon detectors at BfS

Messgeräte zur Bestimmung der Radon-Aktivitätskonzentration oder der Radonexposition - Vergleichsprüfung 2010

Instruments to Measure Radon Activity Concentration or Exposure to Radon - Interlaboratory Comparison 2010

Fachbereich
Strahlenschutz und Umwelt

Thomas Beck
Helmut Buchbinder
Joachim Döring
Elisabeth Foerster
Volkmar Schmidt



Interlaboratory Comparison of Passive Radon Detectors

Operation plan for the Interlaboratory Comparison of Passive Radon Detectors

Since 2003 the German Federal Office for Radiation Protection (BfS) regularly conducts interlaboratory comparisons for passive radon measurement devices using track-etch detectors (SSNTD), electret ion chambers or charcoal in order to assure the quality of radon measurements. The measurement devices will be exposed in the **calibration chamber** of the German Federal Office for Radiation Protection (BfS). The BfS calibration laboratory is accredited by the **German Calibration Service (DMS)** for measuring the activity concentration of radon-222 in air and the potential alpha energy concentration of short-lived decay products. The participants submit their devices to BfS for testing. Submitted sets will be divided at random into a certain number of exposure groups and will be exposed to different radon-222 activity concentrations of up to 10 kBq/m³ under normal room conditions (temperature: 20°C – 25°C, relative humidity: 30% – 60%). The exposures to radon reach values of up to 3500 kBq·h/m³. One supplementary group is used to determine the effects of transportation and storage during the comparison (transit group). This transit group comprises devices which are transported and stored under the same conditions as the other devices but are not exposed in reference atmospheres. Devices using charcoal will be returned to the laboratories right after exposure, while the other devices will be returned after all exposures have been accomplished. The participants will be asked to evaluate their devices and report the measurement results to the Federal Office for Radiation Protection. BfS prepares the final assessment after it has received all measurement results. To this end, the measurement results are compared with the reference exposures. All laboratories which participate in the intercomparison will obtain a certificate of participation stating their measurement results and the corresponding reference exposures. They will also receive a final report which includes the results of all participants in anonymous form with detailed information on the conditions of exposure.

BfS is committed to treating the data received and established confidentially. Results will be disclosed exclusively in anonymous form. The intercomparison is arranged such that the requirements of the different detector types are taken into account. Please find the numbers of exposure groups and devices as well as exposure data in the following tables.

Table 1: Number of devices which have to be sent

	SSNTD radon monitors	Electret radon monitors	Charcoal radon monitors
Numbers of exposure groups and measurement devices per group			
Number of exposure groups	4	3	1
Number of devices which have to be submitted for each type and by each participant	35	24	6

Table 2: Exposure data

	SSNTD radon monitors	Electret radon monitors	Charcoal radon monitors

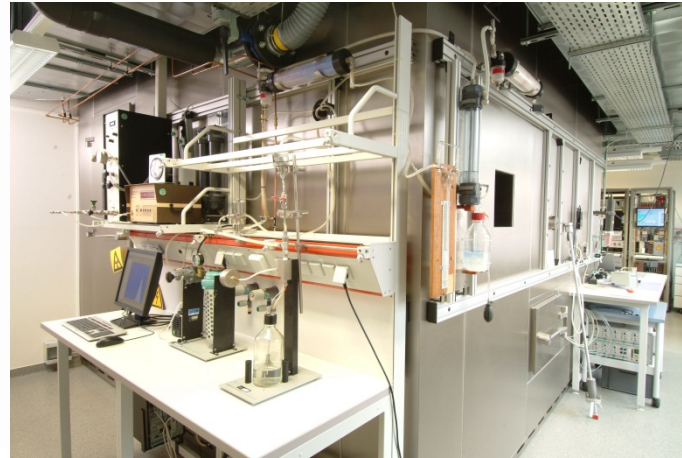
urn:
nbn:de:0221-201008113016

[http://www.bfs.de/de/ion/radon/fachinfo_messung/
vergleichspruefungen.html](http://www.bfs.de/de/ion/radon/fachinfo_messung_vergleichspruefungen.html)

The Radon Calibration Laboratory at BfS



Deutsche
Akkreditierungsstelle
D-K-15063-01-00



<http://www.bfs.de/de/ion/radon/labor.html>