

NEW MEASUREMENT-STRATEGIES FOR RADON IN SOIL AND IN WATER

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**RADON MEASUREMENTS IN WATER, IN SOIL, INDOORS
REQUIRE
A MULTITUDE OF SAMPLING METHODS AND
APPARATUS**

**OUR AMBITIOUS GOAL IS TO DESCRIBE A
A SINGLE SAMPLING METHOD USEFUL
FOR ANY TYPE OF R_n MEASUREMENT**

THE MOST IMPORTANT PROPERTIES OF ANY Rn SAMPLER
ARE
THE Rn-SOLUBILITY-**S** AND THE Rn-DIFFUSIVITY-**D**

MEDIUM	SOLUBILITY-S	DIFFUSIVITY-D (cm²/s)
Air	1	10⁻¹
Water	0.25	10⁻⁵
Organic liquids	10-20	10⁻⁵

**SHORTCOMINGS OF THE WATER SAMPLES:
RADON LOSS DURING SAMPLING, DEPLOYMENT
AND ANALYSIS**

**TO AVOID WATER SAMPLING, PLASTICS-BASED
SAMPLERS HAVE BEEN PROPOSED:**

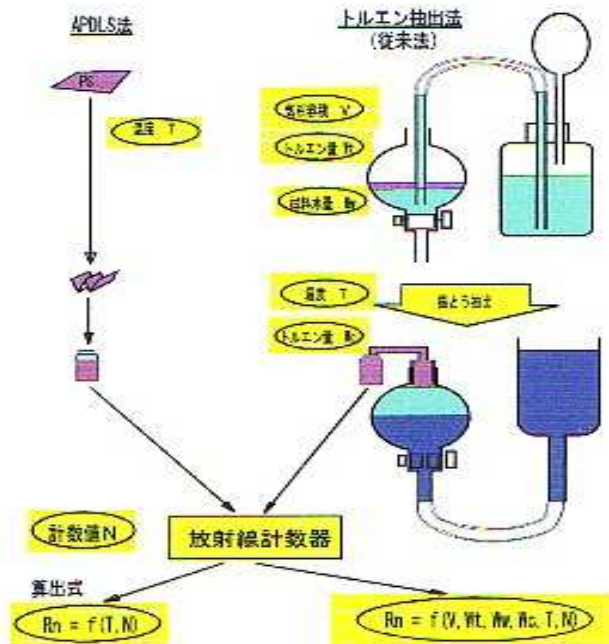
- Rubber** (Guerin et al.,1995)
- Polyethylene** (Tommasino, 1998)
- Polycarbonate** (Pressyanov et al., 1999)
- Polystyrene** (Saito et al. 2000)

ポリスチレンを吸収材にした ラドンの最新測定技術

ライフサイエンスグループ

ラドンとは岩石から出てくる不活性気体。地下水、地質、土木および自然放射線被曝など調査研究に利用されている主要な天然放射性元素です。

ラドン測定のための抽出剤として、従来法のトルエン溶剤に替えてポリスチレンを利用する安全で容易な測定技術 APDLS 法を開発しました。実験は従来法に比べ格段にシンプルで、有害なトルエン溶剤に触れる操作もなく安全です。



商品化された APDLS フィルム
株式会社理化学研究所

**A PS-film exposed in-water and dissolved
in a scintillation liquid (Saito et al.' 2000)**

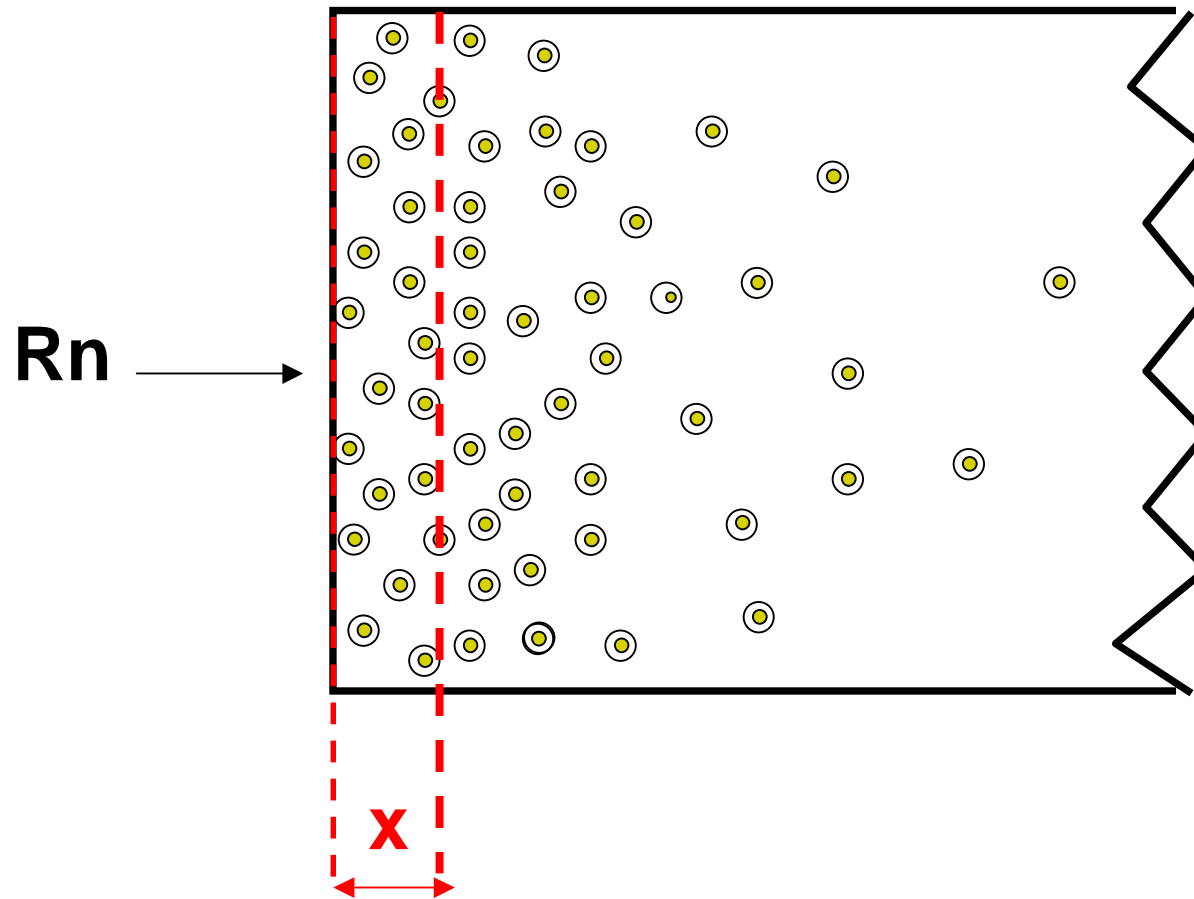
PC-foils for Rn-sampling
in water, followed track
etching (Pressyanov, 1999)





PE-films for in-water-radon sampling , followed by gamma spectrometry (Tommasino, 1998)

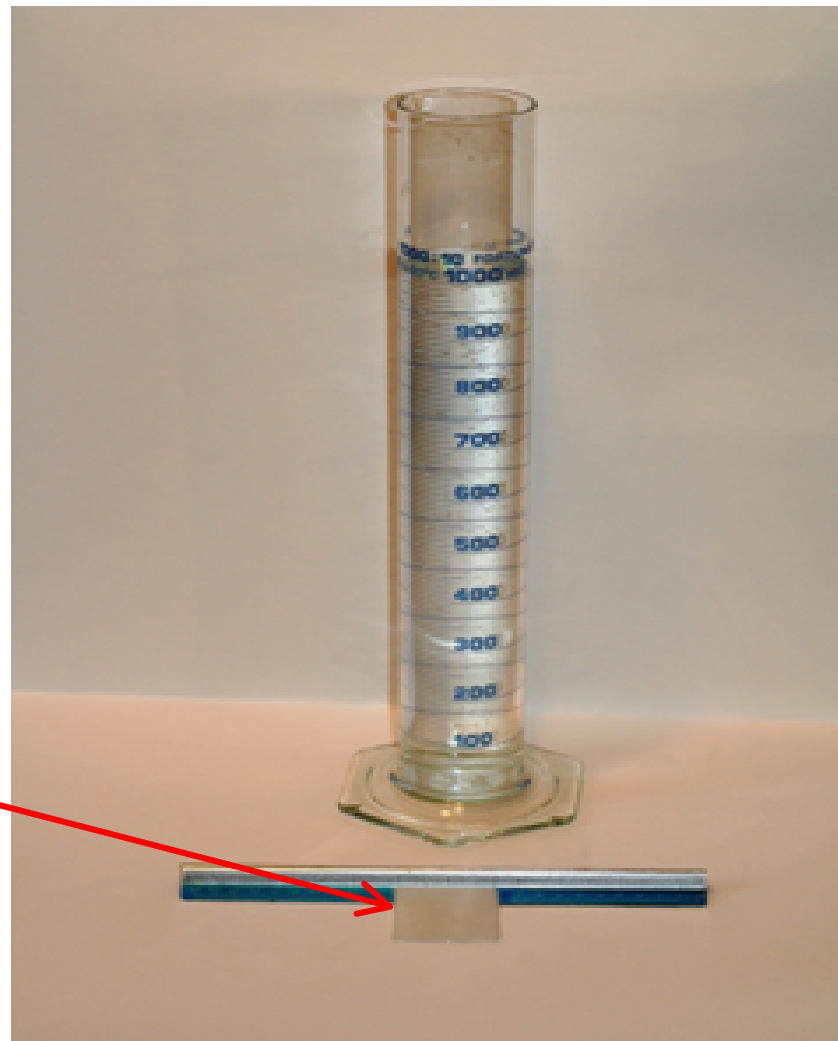
MEDIUM	SOLUBILITY-S	DIFFUSIVITY-D (cm²/s)
Water	0.25	~10⁻⁵
Rubber, Polyethylene	4-20	10⁻⁶x10⁻⁷
Polystyrene, Polycarbonate	20-100	~10⁻¹⁰



For film thickness $x \ll L$ (Diffusion length):
 R_n -sorption fast and temperature-independent

The large and fast Rn-sorption by PC-films for active measurements (even by the G.M. counter) of radon in water, in soil, etc., etc.

**PC-film-stack
(=1 liter of water)**

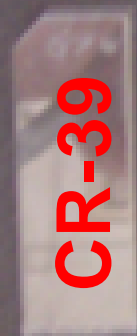


PASSIVE Rn-MONITORS FOR LONG-TERM-MEASUREMENTS

- too bulky and a poor response linearity for in-soil-radon**
- no good for Rn-measurements in water or humid/wet soil**



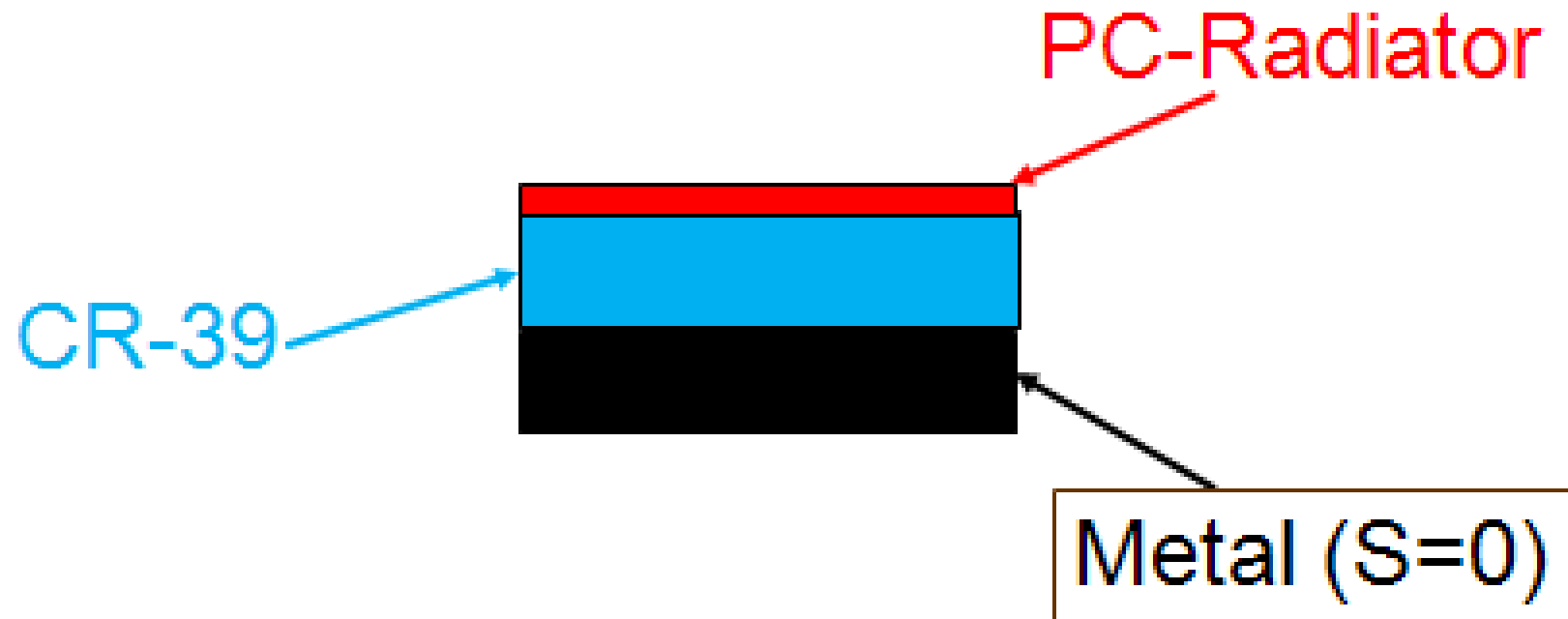
FILM-BADGES: LONG-TERM-MEASUREMENTS BY TRACK-DETECTORS



Solubility ~ 1
Detector

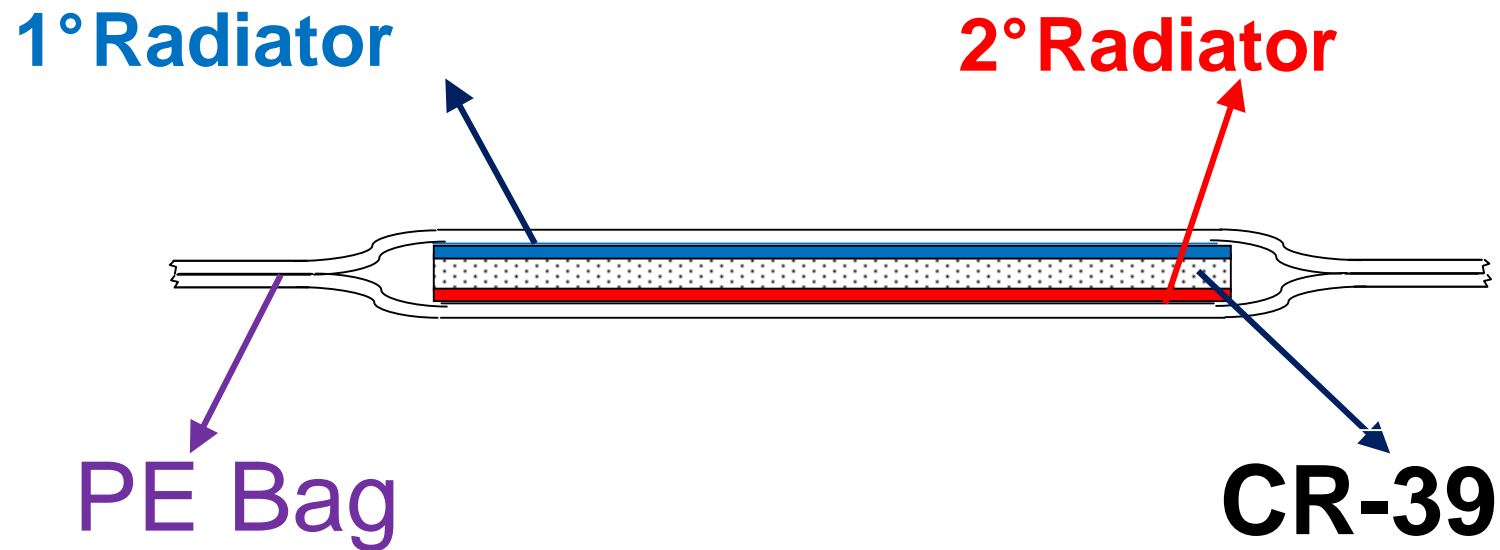


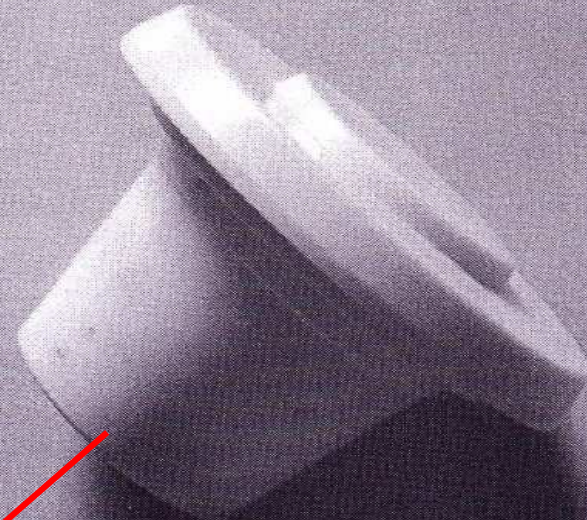
Solubility ~ 80
Radiator



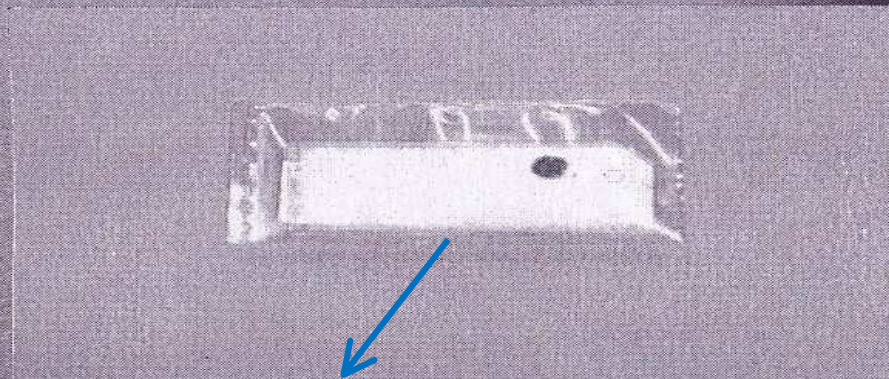
A multi-response-badge since it can't have a number of responses < 2

A multi-response-badge in a heat-sealed PE-bag for in-water- and in-soil-radon measurements



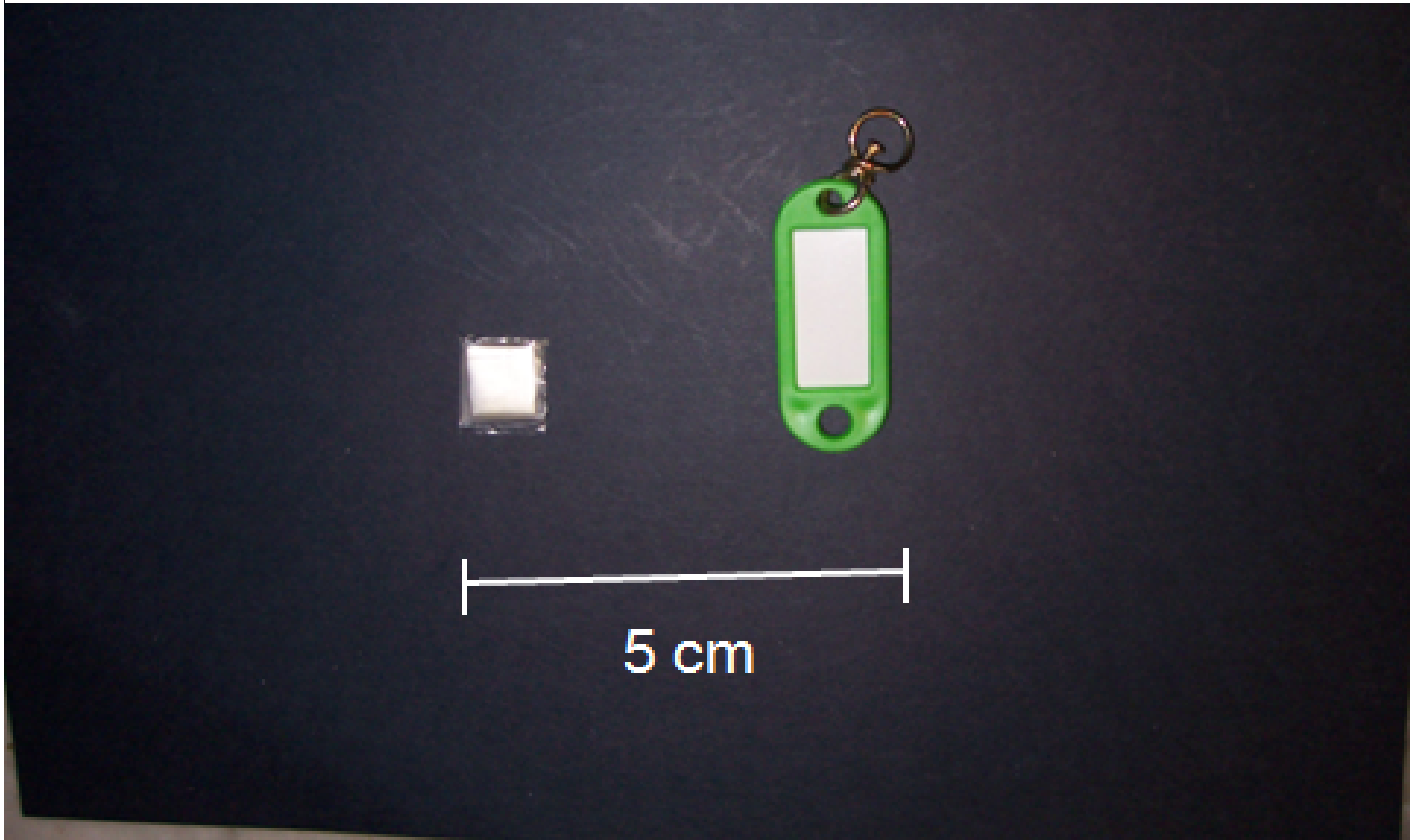


$R = 0.8 \text{ tracks.m}^3/(\text{cm}^2.\text{Bq.h})$



$R_{PC} = 0.8 \text{ tracks.m}^3/(\text{cm}^2.\text{Bq.h})$
 $R_{CR-39} = 0.01 \text{ tracks.m}^3/(\text{cm}^2.\text{Bq.h})$

- Compact (**aspirin-size**) for soil measurements
 - wide response linearity
 - directly-in-water Rn-measurements



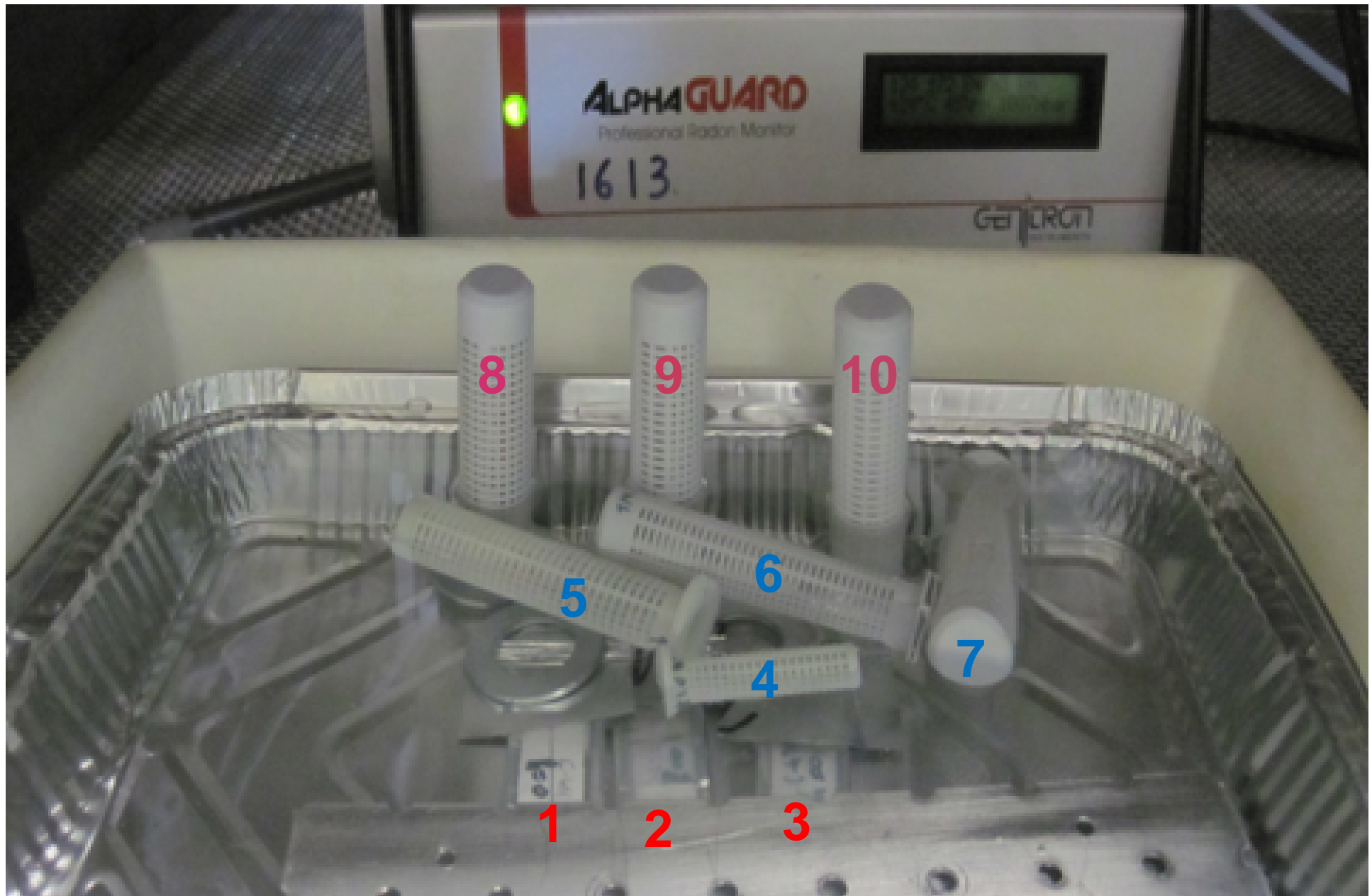
A label-based back-up-detector



Cylinder-enclosed badges for toilette water-tank

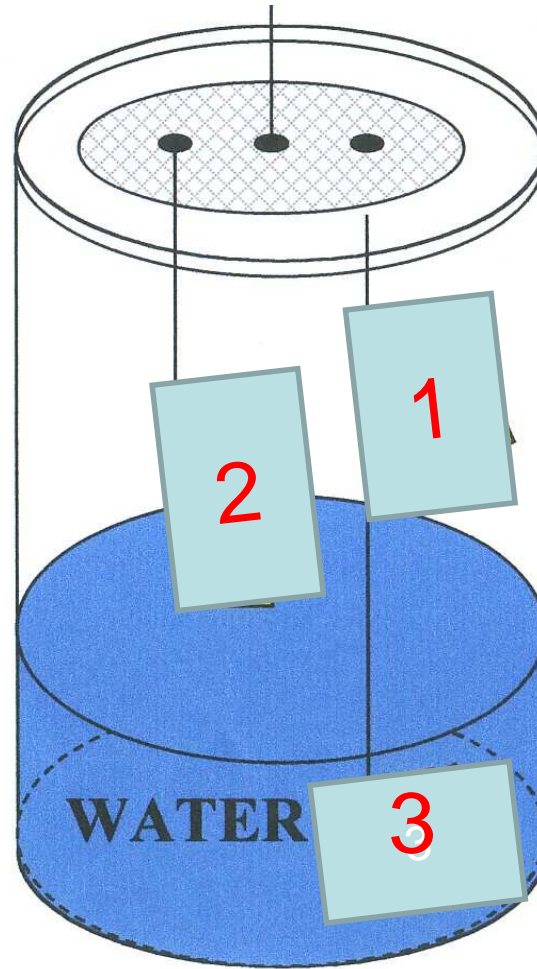


- 1. (At a few-cm-water depth) Ideal for well-water**
- 2. (Floating) Sensitive to the water-flushing rate**



(1,2,3) in water, (4,5,6,7) floating, (8,9,10) standing
LLD < 1 Bq/l

**Under equilibrium conditions:
The same response signal for 1, 2, and 3**



**Calibration for in-water measurements
can be made in air**

Sampling by Rn-absorption in solids for short-term (active) measurements and long-term (passive) measurements of:

- **Radon in soil with accurate and wide response linearity**

- **Radon in water, in wet soil, in mud, etc, etc.**