THE SPANISH LABORATORY ON NATURAL RADIATION UNDER FIELD CONDITIONS (LRN)

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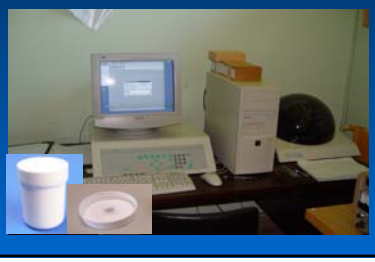
LARUC, RADON GROUP UNIVERSITY OF CANTABRIA
SPANISH NUCLEAR SAFETY COUNCIL (CSN)
SPAIN

WHERE WE ARE ...

EUROPEAN UNION COUNTRIES.

WHAT WE CAN MEASURE …



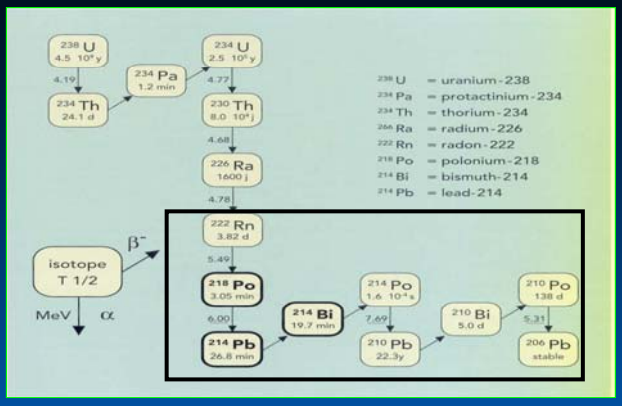
WHAT WE CAN MEASURE …



+ Alphaguard, RAD 7, Atmos 12, RM 2…

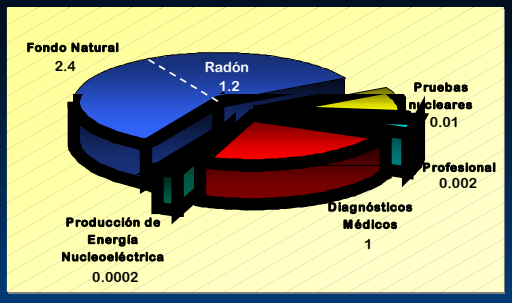
Radon origin

Serie del ^{238}U



^{238}U presente en toda la corteza terrestre
Media mundial en suelos 35 Bq Kg^{-1} (UNSCEAR 2000)

Radon origin



^{222}Rn

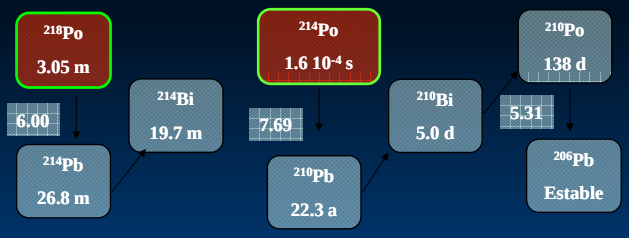
Gas noble

$T_{1/2}$ = 3.82 d

Emisor alfa (5.49 MeV)

Macroscopic movement

Radon origin

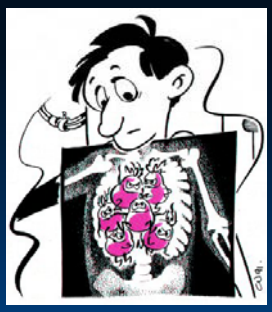


Sólids
chemically active
Short half life< 30 min

Complex behaviour
Radiological relevance

WHY RADON?

UC UNIVERSIDAD DE CANTABRIA



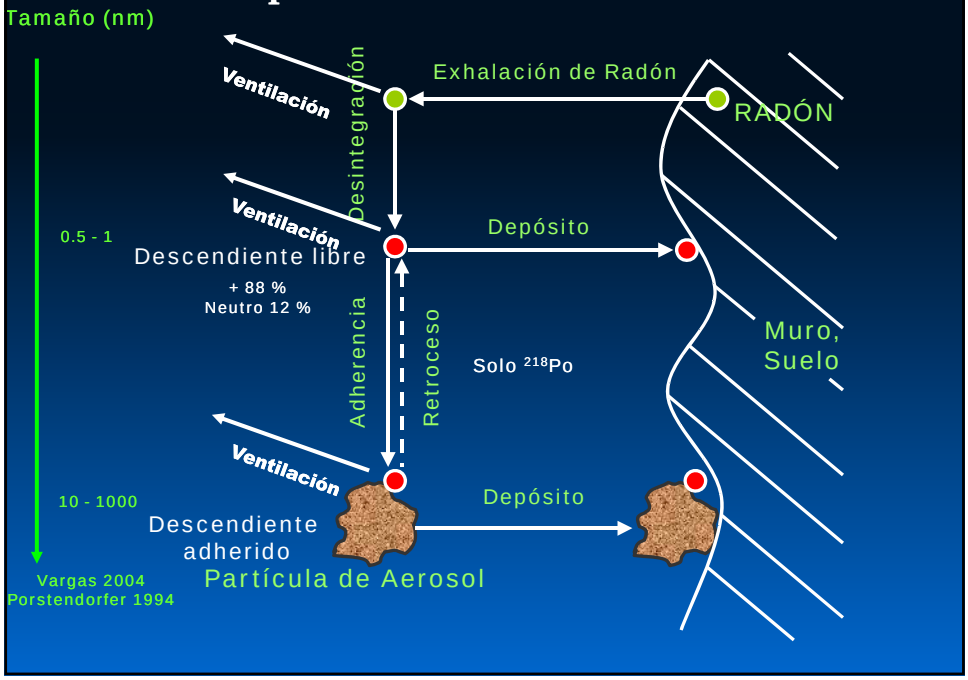
Radon inhalation (and progeny) causes alpha irradiation in the cells of the respiratory tract

Mutations, malignant transformation
Lung cancer risk

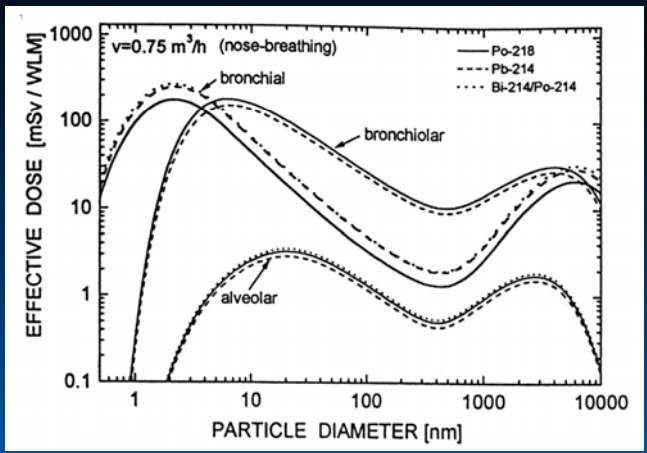
Two ways for risk assessment

-Epidemiology
-Dosimetry

Aproximación dosimétrica

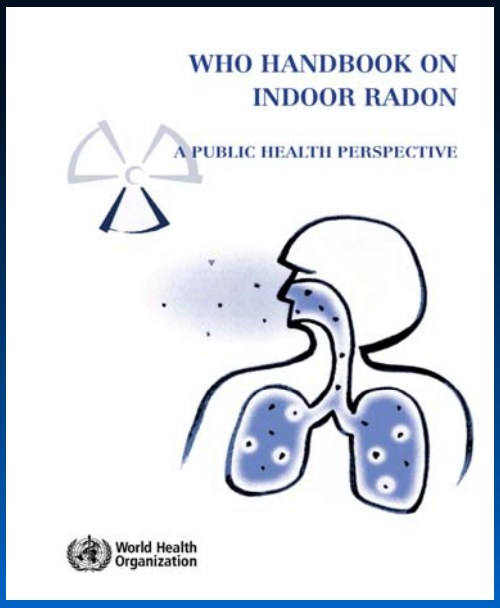


Aproximación dosimétrica



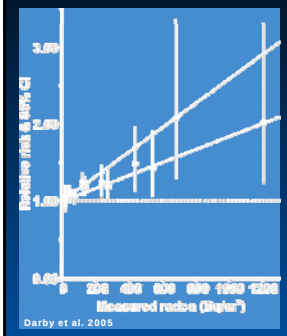
Ref: Porstendorfer and Reinniking, 1998

Aproximación epidemiológica



Aproximación epidemiológica

KEY MESSAGES



- Epidemiological studies confirm that radon in homes increases the risk of lung cancer in the general population. Other health effects of radon have not consistently been demonstrated.
- The proportion of all lung cancers linked to radon is estimated to lie between 3% and 14%, depending on the average radon concentration in the country and on the method of calculation.
- Radon is the second most important cause of lung cancer after smoking in many countries. Radon is much more likely to cause lung cancer in people who smoke, or who have smoked in the past, than in lifelong non-smokers. However, it is the primary cause of lung cancer among people who have never smoked.
- There is no known threshold concentration below which radon exposure presents no risk. Even low concentrations of radon can result in a small increase in the risk of lung cancer.
- The majority of radon-induced lung cancers are caused by low and moderate radon concentrations rather than by high radon concentrations, because in general less people are exposed to high indoor radon concentrations.

Riesgos para la salud

Aproximación epidemiológica

Aproximación dosimétrica

Factor 1-3

¿Modificar algunos factores de ponderación usados por ICRP?
-Pulmón (0.12 a 0.04)
- Partículas alfa (20 a 7)
-Regiones pulmonares

Cambios significativos en la dosimetría de otros radionucleidos

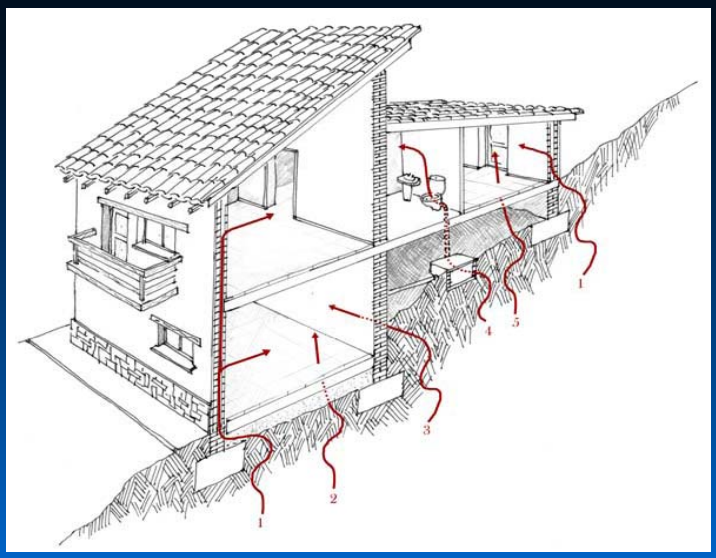
Radon origin

Transport

Diffusion — Por diferencias de concentración. Movimiento relativo del gas en el seno del material que lo contiene

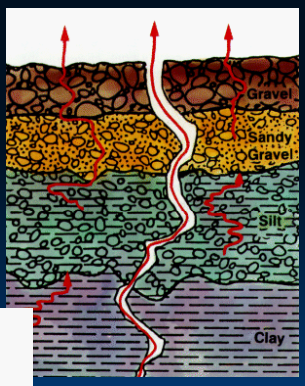
Convection — Por diferencias de presión/temperatura. El fluido que contiene al gas actúa como vehículo de transporte

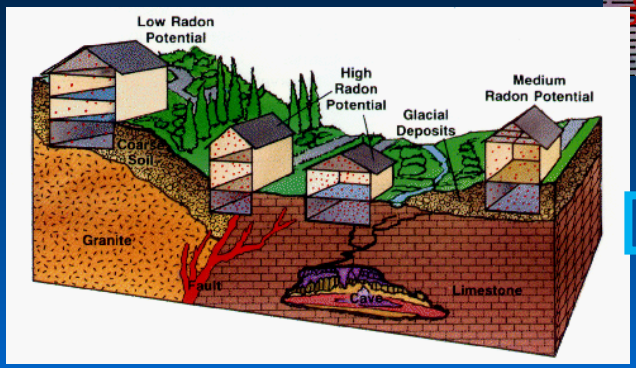
Entrance pathways in dwellings



PRODUCTION
MOVEMENT

Permeability
Humidity
Water & cracks





MEASUREMENT

RADON CONCENTRATION MAY PRESENT VARIATIONS

- OF 3 ORDERS OF MAGNITUDE

- FROM ONE BUILDING TO ANOTHER

- FROM ONE AREA TO ANOTHER

... SO MEASUREMENT CAMPAINGS ARE ESSENTIAL

METROLOGICAL GOALS

ENSURANCE THE QUALITY OF MEASUREMENTS BY PARTICIPATION/ORGANIZATION OF INTERCOMPARISON EXERCISES UNDER FIEL CONDITIONS

MEASURING OCCUPATIONAL RADON EXPOSURE AT A NATIONWIDE SCALE ACCORDING TO THE SPANISH LAW
Titulo VII *BOE 178 DE 26 DE JULIO DE 2001*

FINISHING THE NATIONAL INDOOR RADON MAP IN DWELLINGS

Prevención y mitigación

CAMPAÑAS DE MEDIDA
(interiores, suelos, materiales de construcción)

ELABORACIÓN DE MAPAS

DIAGNÓSTICO

NIVELES DE ACCIÓN

PREVENCIÓN
Viviendas NUEVAS

MITIGACIÓN
Viviendas EXISTENTES

REMEDIO
+
SEGUIMIENTO

Prevención y mitigación

Técnicas de protección

PROYECTO
RADON 10X10

Mapa Europeo de Radon

Diciembre, 2011

Radiación Natural y Radón

Riesgos
Situación radiológica
Riesgos (mortalidad)

Epidemiología
Mecanismos
Calidad en la medida
Campañas medida
Mapas

Divulgación

AUTHORITIES ⟵ SCIENTISTS ⟶ PUBLIC

Soluciones
CTE
Acciones
Coste/beneficio

Acciones de remedio
Formación
Experimentación

International Intercomparison exercise under field conditions

42 LABORATORIES

17 COUNTRIES

LABORATORIO DE RADIACTIVIDAD NATURAL

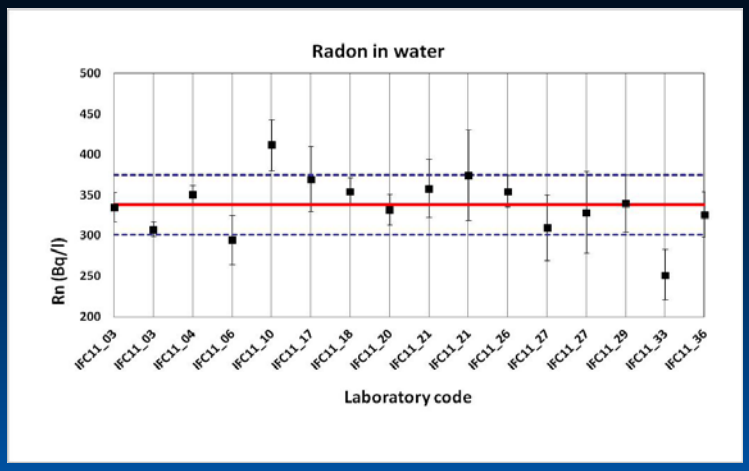
Uranium mine
Saelices el Chico
Salamanca, Spain

Country	Institution
Austria	AUSTRIAN AGENCY FOR HEALTH AND FOOD SAFETY
Belarus	Republic Center of Radiation Medicine and Human Ecology, Radiation Defence Laboratory
Belgium	Federal Agency for Nuclear Control
Czech Republic	RADON v.o.s.
France	BENC BUREAU D ETUDES NUCLEAIRES CORSE
Germany	SARAD
Germany	Bundesamt für Strahlenschutz
Germany	Bundesamt für Strahlenschutz
Hungary	RADOSYS Ltd
Hungary	University of Pannonia
Italy	Dipartimento di Scienze Ambientali – Seconda Università di Napoli
Italy	Università Europea di Roma
Italy	Mi.am srl
Italy	ARPA
Italy	ARPAcal
Italy	Università Federico II
Norway	NRPA (Norwegian Radiation Protection Authority)
Poland	Institute of Nuclear Physics PAN
Portugal	Instituto Tecnológico e Nuclear, I.P.
Portugal	Laboratory of Natural Radioactivity, University of Coimbra
Romania	University Babes-Bolyai/Environmental Radioactivity and Nuclear Dating
Romania	IFIN-HH Bucharest
Russia	
Slovenia	Jožef Stefan Institute, Department of Environmental Sciences, Radon Center
Slovenia	Institute of Occupational Safety
Spain	Grupo de Física de las Radiaciones. Departamento de Física. Universidad Autónoma de Barcelona
Spain	Universidad de Extremadura. Badajoz
Spain	Universidad de Santiago de Compostela
Spain	University of Cantabria
Spain	Universidad de Las Palmas de Gran Canarias
Spain	Lamse SL
Spain	Tecnasa
Spain	University of Extremadura. Caceres
Spain	ENUSA Industrias Avanzadas SA
Spain	CSN
Spain	CIEMAT
Spain	Instituto de Salud Carlos III
Spain	Medidas Ambientales
Spain	GEOCISA
Spain	LI2GA
Sweden	Department of soil and environment SLU University
Sweden	Gammadata Mätteknik AB
Sweden	Gammadata Instruments
Sweden	Independia Control AB
UK	HPA
UK	Jon Miles

Radon in water

No standard solution
Radon diffusion – stable Rn in water concentration
Range 300 – 400 Bq/l

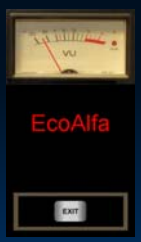
Radon in water



Different measurement techniques
Further comparisons in other ranges

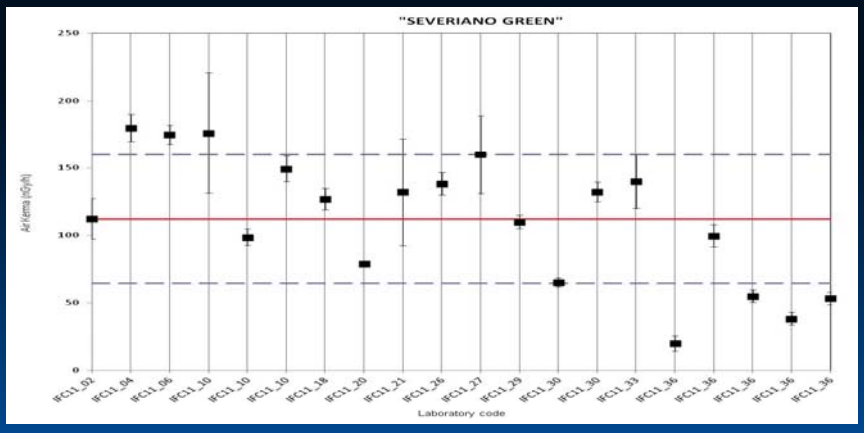
External dose rate

Easy to measure?



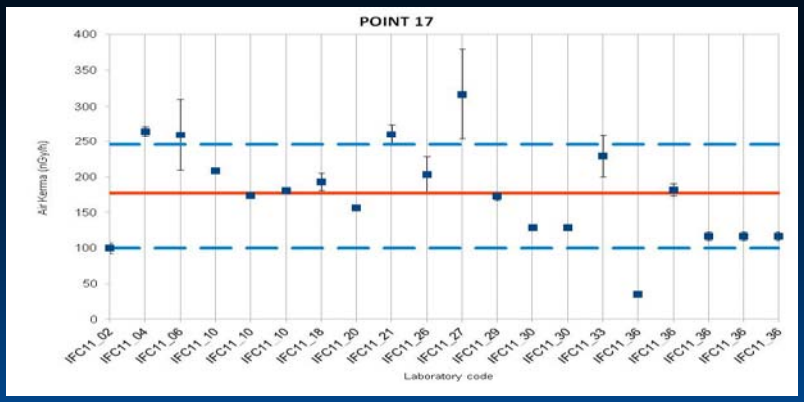
3 points – LOW/MEDIUM/HIGH dose rate
Reference CIEMAT (Spain) Reuter Stokes

External dose rate



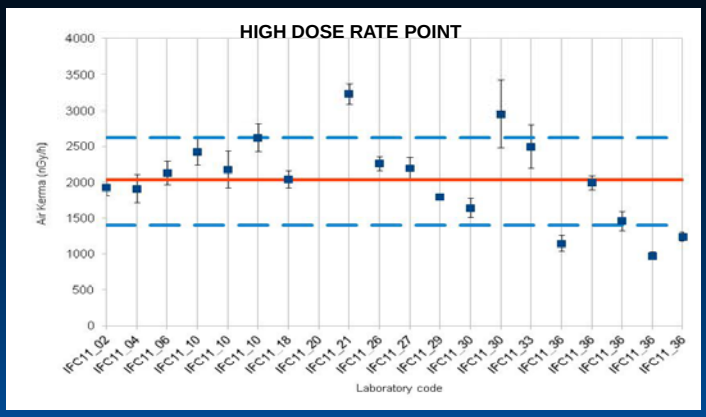
Reference 109 nGy/h
Conversion factors
Calibration/stability climatic conditions

External dose rate



Reference 180 nGy/h
Conversion factors
Calibration/stability climatic conditions

External dose rate

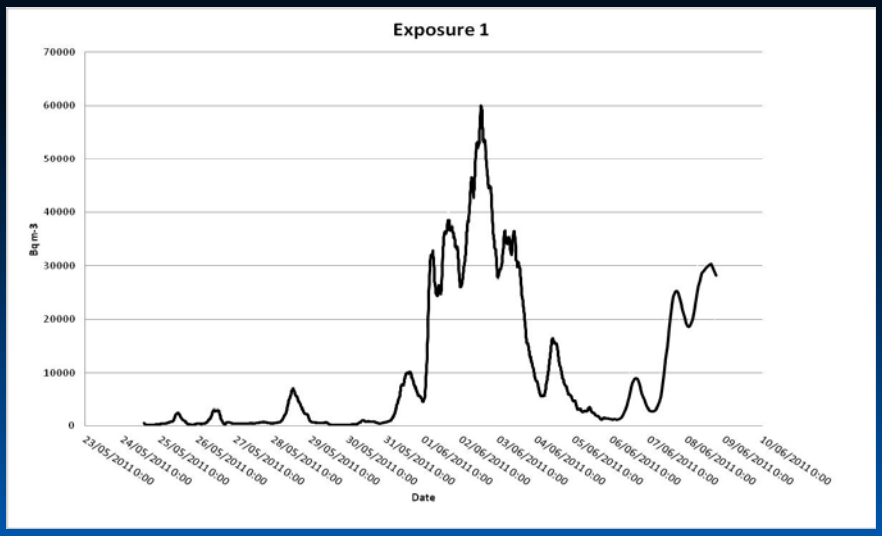


Reference 1800 nGy/h
Conversion factors
Calibration/stability climatic conditions

Indoor radon

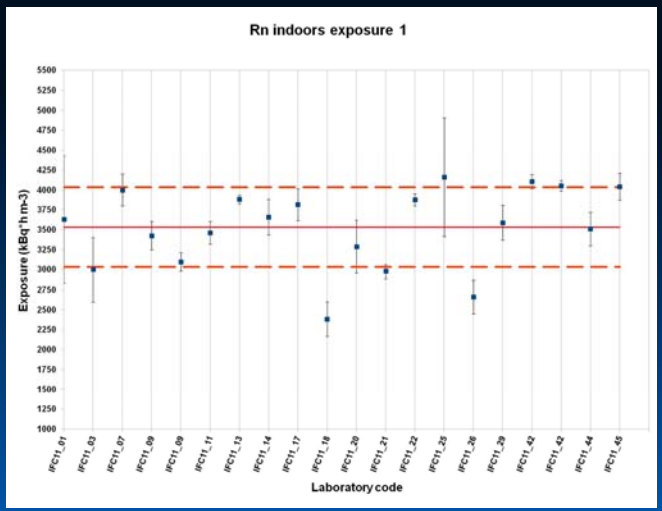
3 exposures/rooms– LOW/MEDIUM/HIGH
Reference Alphaguard/Atmos 12

Indoor radon 1



May 24th – June 8th : 3800 kBq h/m3

Indoor radon 1

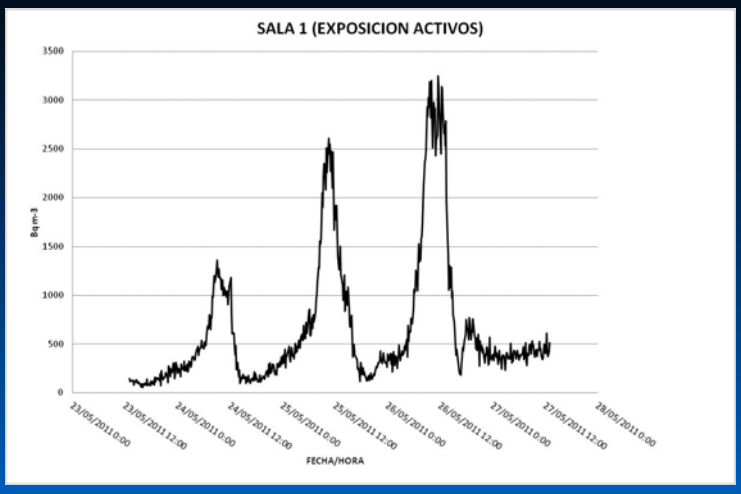


Homogenity in room

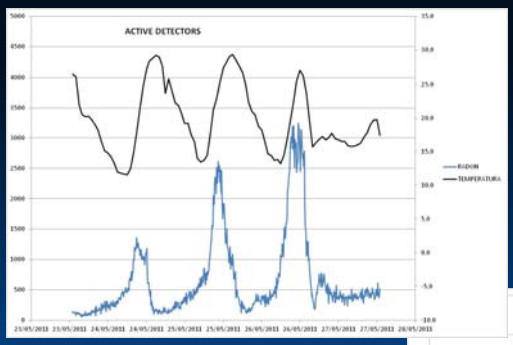
Indoor radon 1/Active devices

May 24th – May 27th

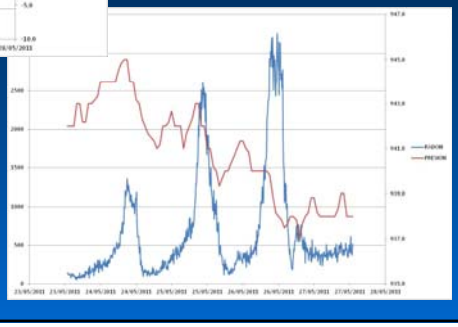
Indoor radon 1/Active devices



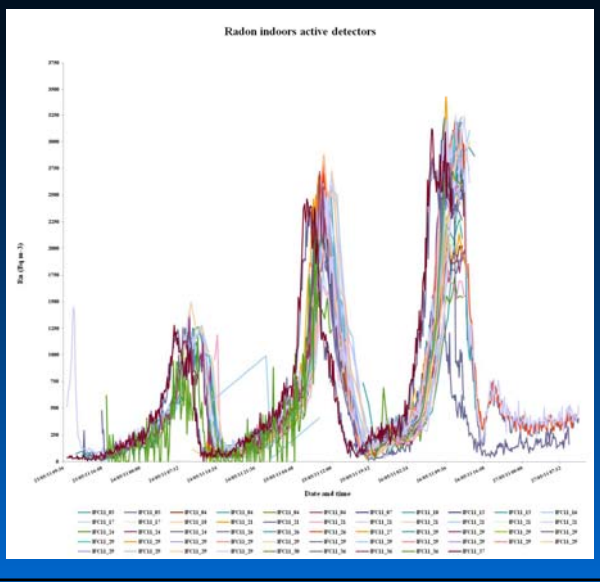
Indoor radon 1/Active devices



Dependence with climatic variables



Indoor radon 1/Active devices



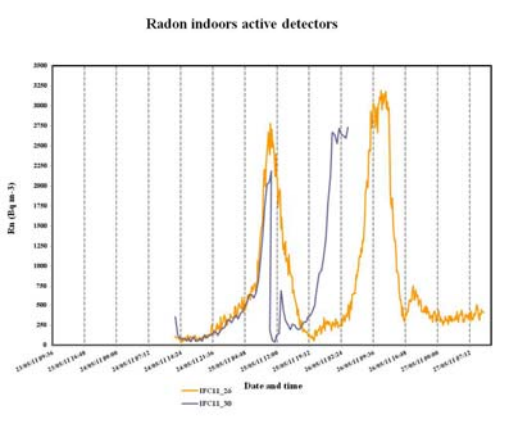
Time syncro

Homogeneity

Response/applications

Necesity of calibration

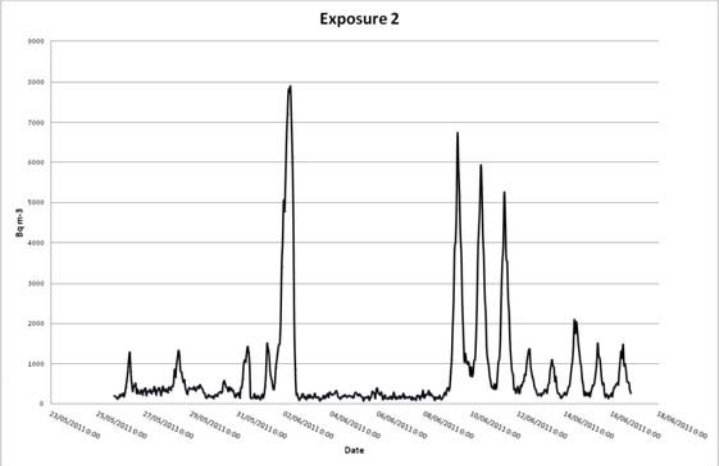
Indoor radon 1/Active devices



Example of bad function

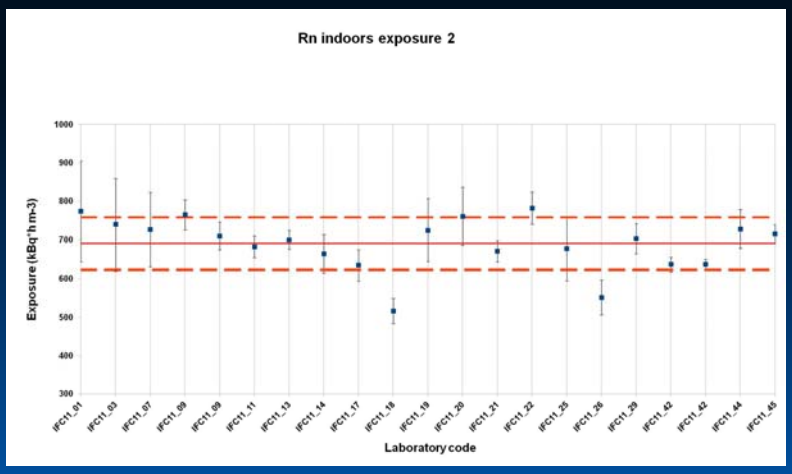
Lab application: checking actives

Indoor radon 2



May 25th – June 16th : 700 kBq h/m3

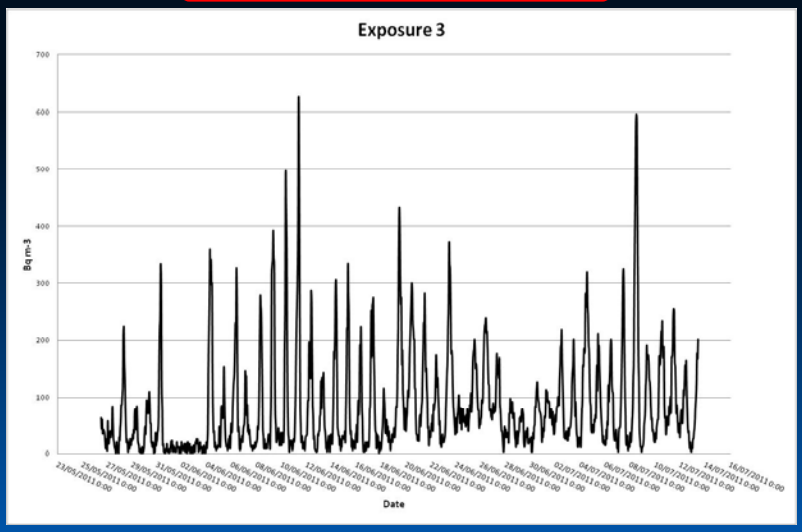
Indoor radon 2



No significant variation of CF with exposure rate

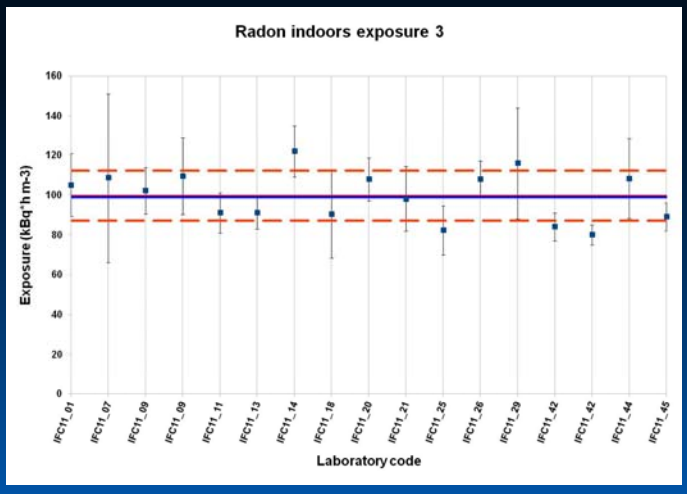
Indoor radon 3

Indoor radon 3



May 24th – July 13th : 110 kBq h/m3

Indoor radon 3



Transits between 50 - 100 kBq h/m3 !!

Radon exhalation from building materials

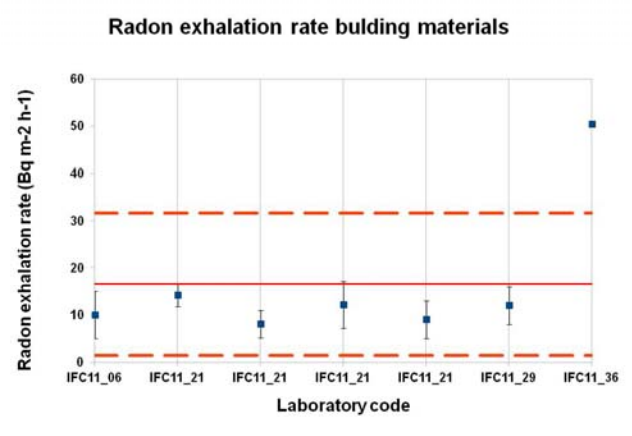
Value near detection limit

$C_{eq} \approx C_{out}$

Low leakage

Long time

Radon exhalation from building materials



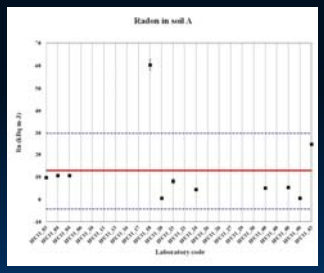
Radon in soil

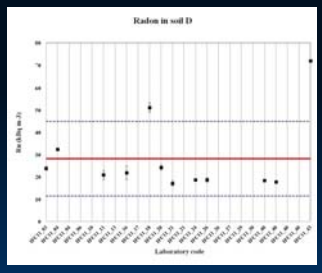
Inhomogeneous field

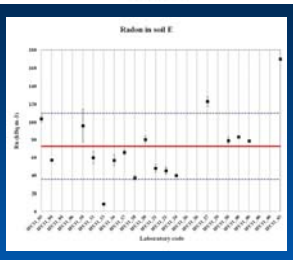
Discrepancies point to point

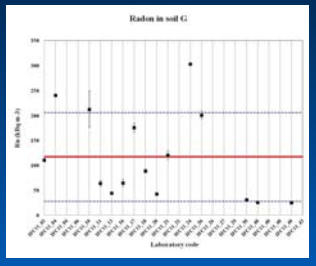
Comparison of "radon index" estimation

Radon in soil



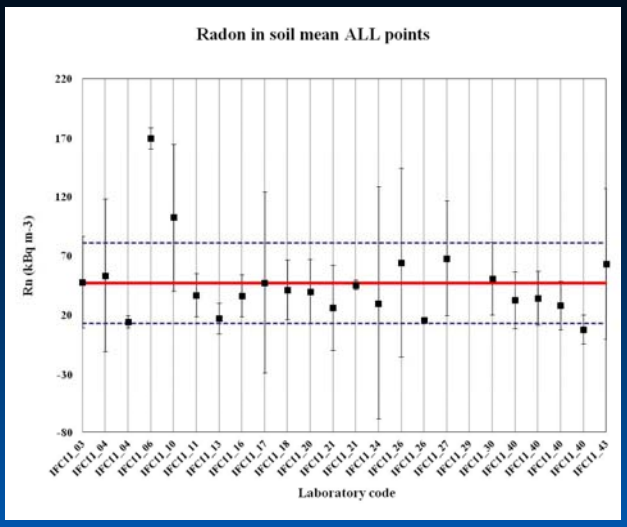






we are not agree point by point…

Radon in soil



… but, good agreement on radon potential

Conclusions

THE LRN PROVIDE US A BETTER KNOWLEDGE OF THE RESPONSE OF DETECTOR UNDER FIELD CONDITIONS, WHERE MORE VARIABLES AFFECT THE MEASUREMENT OF NATURAL RADIATION

THE LRN LET US COMPLEMENTARY TEST OF DEVICES AND SYSTEMS

NEW COMPARISONS (DOSIMETERS, ETC…) ARE PLANNED FOR THE FUTURE

IMPROVEMENTS ARE NOW ONGOING TO DEVELOP MORE EXPERIMENTS IN RADON ACTIVITIES

THE LRN WANTS TO BE A MEETING PLACE FOR RESEARCHERS IN NATURAL RADIATION

thanks for such a good experience!

THANKS FOR YOUR ATTENTION