Overview and new advances of RADSIM, a research project for the generation and validation of numerical models for the prediction of radon entry into buildings based on a characterization of the terrain and a typological definition of construction in Spain

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Prague. September 19 – 21, 2023

ULPGC Universidad de Las Palmas de Gran Canaria | Departamento de Física

UAB Universitat Autònoma de Barcelona

UC LaRUC Laboratorio de Radiactividad Ambiental

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CSIC CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS
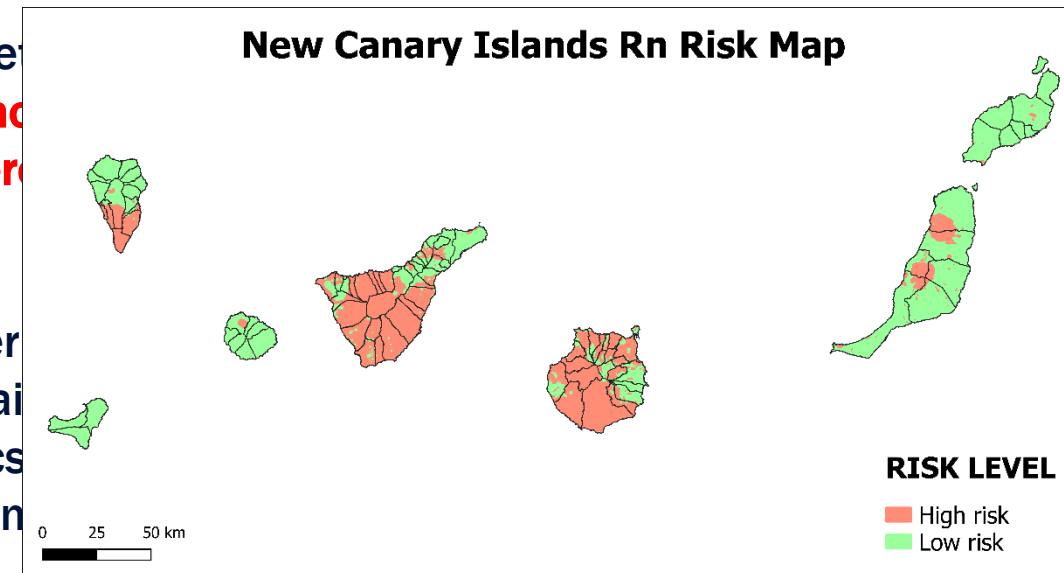
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Introduction.
Objectives and Scope.
Description of Working Packets
Concluding remarks
Status

✓ The implementation of the EU Directive 2013/59 BSS in Spain entails a series of actions leading to a National Plan against Radon.

✓ This plan is preceded by the delineation of radon risk areas in Spain and the adoption of measures for the prevention of radon in these areas by national, regional and municipal authorities.

✓ This plan encourages research actions leading to a be[tter] dynamics of radon. One important research subject is to kno[w] the ground to buildings and its distribution in the differe[nt] physical and constructive parameters.

✓ In this talk I will expose the main objectives and character[istics] (**RADSIM**) financed by the Nuclear Security Council of Spai[n] precisely to obtain a better understanding of the dynamics transfer from the ground to the dwellings, and its distribution

See Talk by C. Briones in this session: "Identification of radon risk areas based on geological data and terrestrial gamma radiation maps on the island of Tenerife"

New Canary Islands Rn Risk Map

RISK LEVEL

High risk
Low risk

0   25   50 km

RADSIM: Radon simulation Project 2021-2024

CSN project for the generation and validation of a numerical model for the prediction of radon entry into buildings based on a characterization of the terrain and a typological definition of construction in Spain.

Project funded by CSN. Started on March. 2021.

3 university groups with experience on soil-gas radon measurements and radon metrology: ULPGC, UCAN, UAB and the IETCC-CSIC

Main goal

Conducting a **theoretical-experimental study in real field conditions** that allows the **development of a valid computer tool** for the **simulation of radon generation, transport, inmission and accumulation processes in buildings**, and as well as for the analysis of the effectiveness of **prevention techniques and remediation** of radon-affected sites.

Specific goals

1. Selection of 2 experimental study cases for the calibration of the theoretical models developed.

2. Identification of the significant variables to be measured and elaboration of a systematic procedure for data collection including its quality control.

3. Theoretical development of numerical models analyzing the most suitable software alternatives.

4. Validation of the theoretical models using the data obtained in the experimental and intercomparison phase of the two types of models.

Working Packets to obtain the experimental data for calibration and validation of the models (UCAN and ULPGC).

WP1: Selection of two cases of experimental studies to calibrate and validate the models.

WP2: Typological characterization of the construction characteristics of the selected sites.

WP3: Radiological characterization of inner spaces and terrain under the building

WP4: Characterization of the terrain gas permeability in both study cases.

WP5: Continuous monitoring of differential pressures, temperature and atmospheric pressure for 6 months at the sites.

WP6: Monitoring of the land surrounding the Saelices site dump to characterize the case of a contaminated land in which remedial actions have been carried out.

Working Packets for the development and validation of calculation models (UAB and IETCC-CSIC)

WP7 Development of simulation models of radon levels in closed spaces adapted to the sites.

WP8: Verification and validation of the simulation models developed.

WP9: Application of the models to the assessment of the effectiveness of mitigation measures.
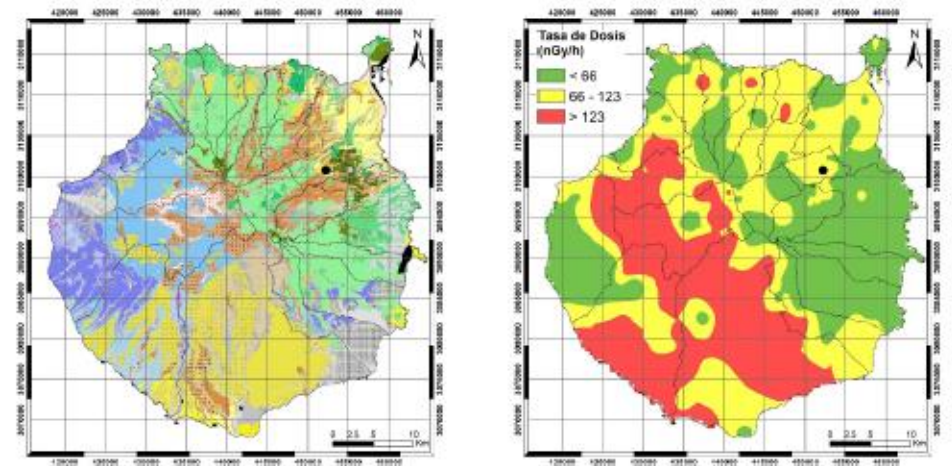
WP10: Coordination .

RADSIM Timeline

WP1: Selection of case studies for model validation. ULPGC, UC, UAB

Location 1. Experimental module of the Natural Radiation Laboratory (LNR) located at the ENUSA facilities in Saelices El Chico (Ciudad Rodrigo, Salamanca).

Location 2. Dwelling located in the municipality of Valsequillo (Gran Canaria).
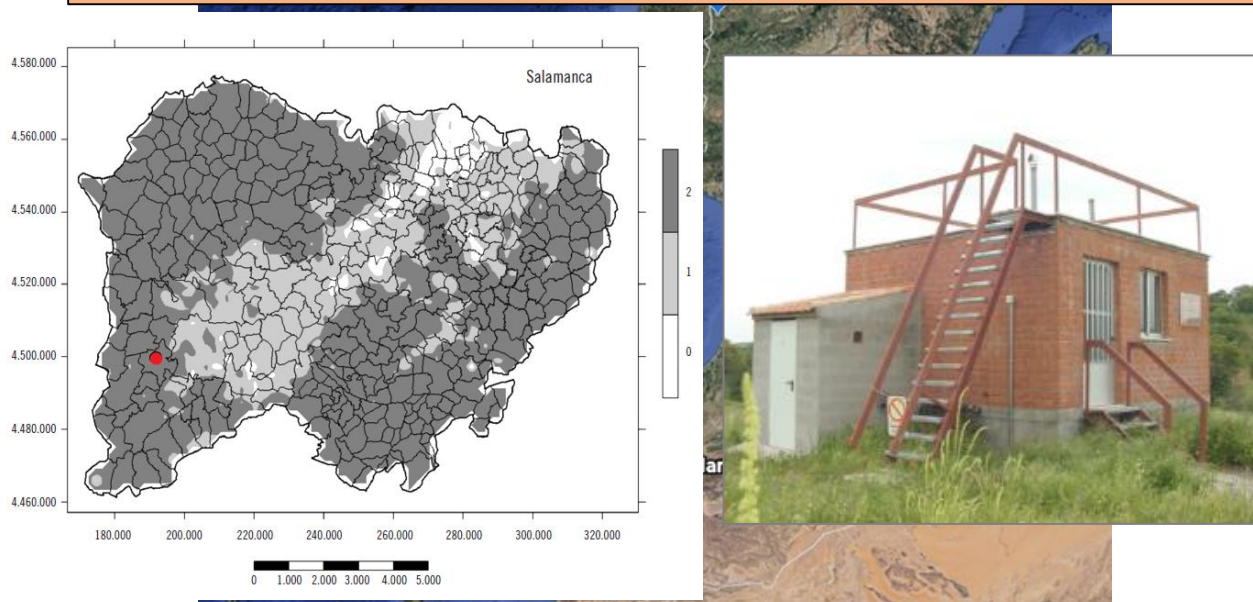
This Module was specifically conceived for carrying out radon studies in a uranium-bearing area.
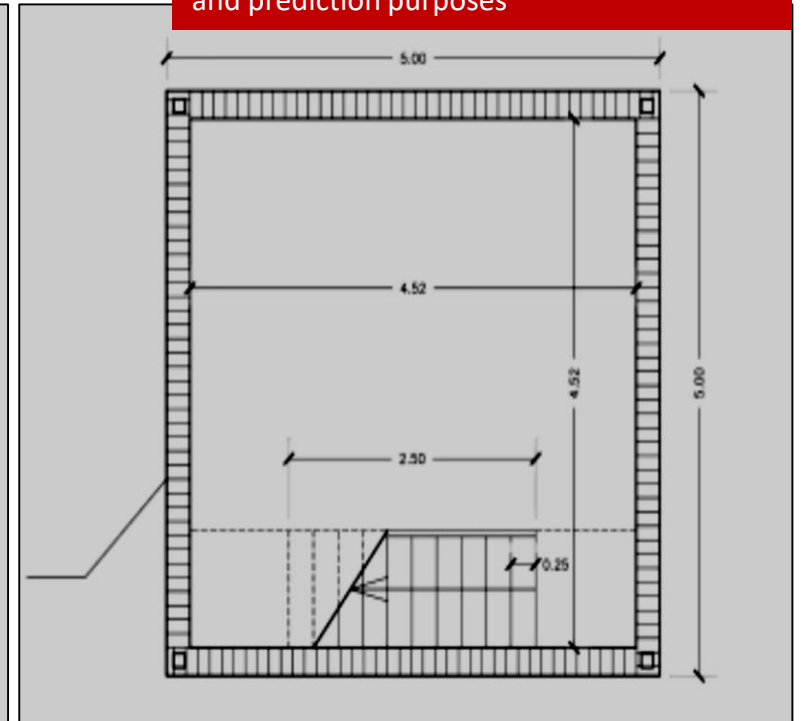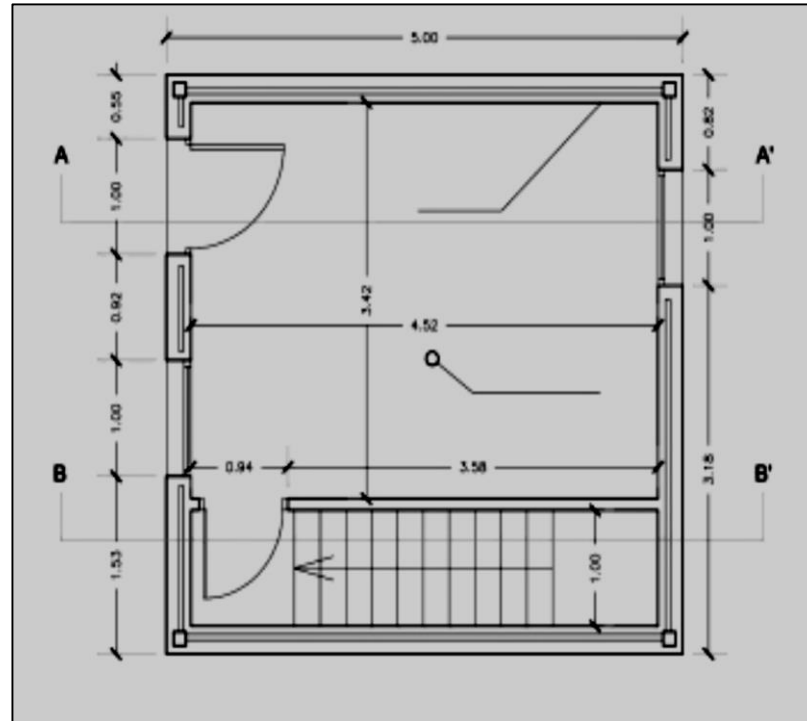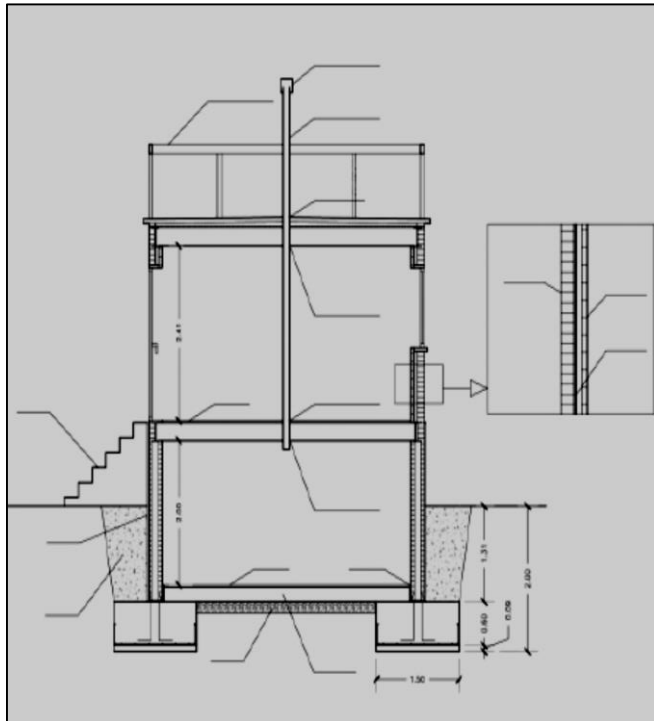
Project WP Progress Level

WP2: Typological characterization of the construction characteristics of the selected locations. UC, ULPGC, IETcc-CSIC.

Location 1. Saelices. Characterization of the construction typology 100% by design
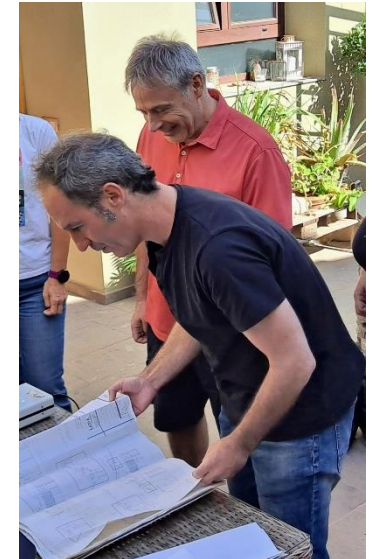
See Talk by D. Rábago in this session: "Parameters monitorization in a Pilot House to provide data for indoor radon simulation and prediction purposes"

Project WP Progress Level

WP2: Typological characterization of the construction characteristics of the selected locations. UC, ULPGC, IETcc-CSIC.

Location 2. Valsequillo. Characterization of the construction typology being developed by the IETcc-CSIC. Inspection visit to collect data from June 7 to 10, 2022.

| bathroom | DM
bedroom
SCOUT 1 +PASIVOS | SC
Lounge–kitchen
SCOUT 2 +PASIVOS | Outdoor yard

Well 180 m depth

PATH
BD
SCOUT 3 +PAH
BODEGA · semi-underground warehouse | bedroom |
| bedroom | bedroom | | | Bathroom · bedroom |

Degree of compliance: 100%

See poster by J.T. Santana wednesday afternoon session: "Monitoring of the spatial and temporal variation of radon in an inhabited house, subjected to an underground source of radon from a well. Case study of Valsequillo in Gran Canaria."

Project WP Progress Level

WP3: Radiological characterization of the interior spaces and the seating area. UC, ULPGC

Parameters measured at the two locations:

- Exposure rates at 1 m from the ground.
- Soil isotopic concentration (^{226}Ra, etc.).
- Instantaneous soil concentration and permeability.
- Radon concentration indoors.
- Temporal variation of radon concentration in the soil (Barasol)
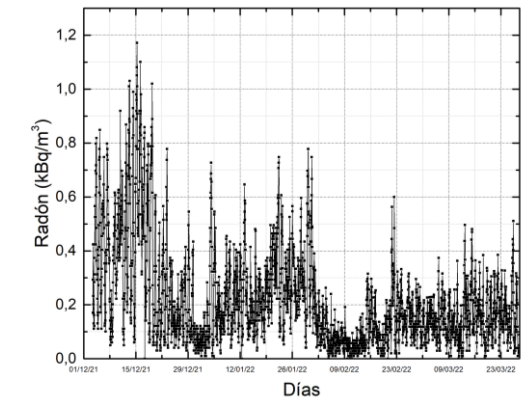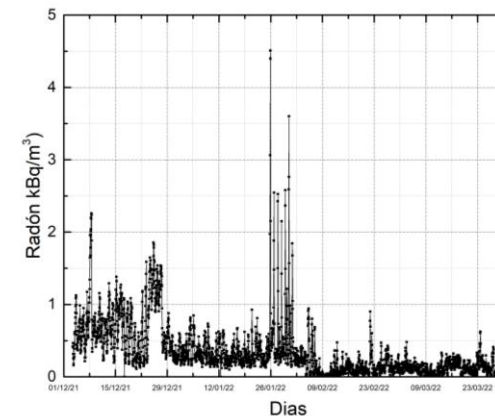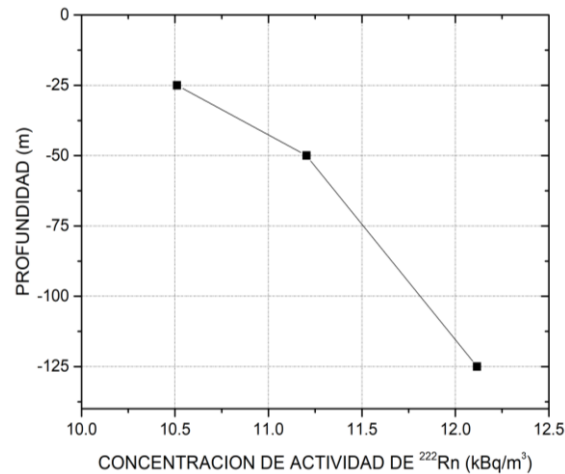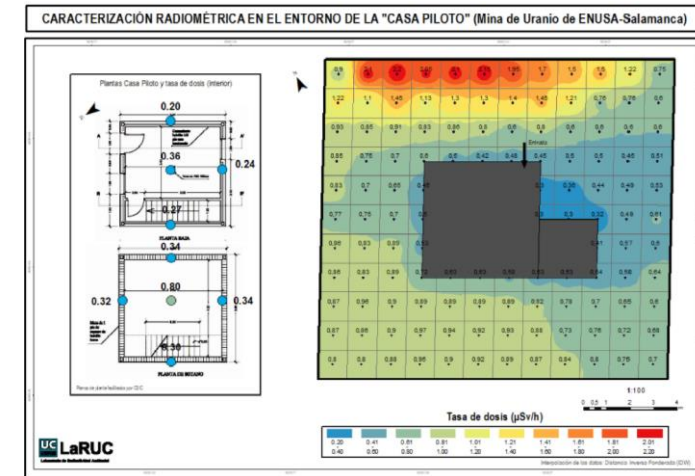
Project WP Progress Level

WP4: Characterization of the gas permeability of the settlement soil in the study cases. ULPGC, UC, Geomnia.

Geotechnical study in the two locations carried out by Geomnia:

- Geological Characterization.
- Laboratory calculation of intrinsic permeability by different methods:
- Granulometry and porosity
- Granulometry, porosity and humidity
- Texture
- In situ high vacuum test.
- Analysis of the volumetric water content in the soil.

Degree of compliance :
Site 1: 100%
Site 2: 100%

Project WP Progress Level

WP5: Continuous monitoring of differential pressures, temperature and atmospheric pressure for 6 months in Saelices (Gran Canaria, optional). UC (ULPGC, opcional)

Emplazamiento 1. Saelices:

Complete weather monitoring: Local station PCE-138 FWS20, PCE Instruments. Measurement of Wind Speed, Temperature, Pressure, Humidity, Solar Radiation, Evaporation. Rain. 8 month series.

Measurement of differential pressures between different rooms. 6 month series.
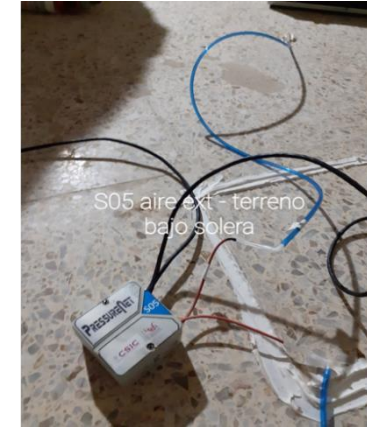

Emplazamiento 2. Valsequillo:

Complete weather monitoring: Sarad Equipment, Measurement of Temperature, Pressure and Humidity, 12-month series. The rest of the parameters can be obtained from the nearest AEMET station (Telde-Doramas Forestry Center).

Measurement of differential pressures between different rooms. It has not been possible to do it due to restrictions in the installation of the sensors.

Estación 'TELDE-CENTRO FORESTAL DORAMAS'

- Tabla comparativa 2023 vs. 2022.
- Histórico de datos horarios, desde 01/12/2019 hasta 23/02/2023.
- Tabla de datos meteorológicos principales.
- Estaciones próximas.
- Gráfica de temperaturas.
- Gráfica de precipitaciones acumuladas.
- Gráfica de precipitaciones.
- Ubicación de la estación TELDE-CENTRO FORESTAL DORAMAS.
- Acrónimos y términos utilizados.
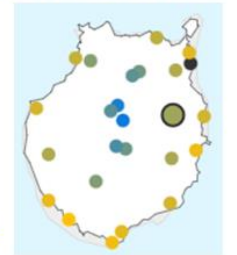
La estación meteorológica está próxima al municipio de 'Telde', a una altitud de 344 msnm., y cerca de Malpaís, Tecén, Barranco de la Palma, Presa de Salvaindia, Lomo Magullo, Tecén de Valsequillo, Caserío Casa Blanca, Vista Alegre, Montaña de las Palmas, Lomo Bristol....

Degree of compliance : 100%

Project WP Progress Level

WP6 Monitoring of the land surrounding the waste dump at the Saelices site to characterize the case of a contaminated land in which remedial actions have been carried out. UC.

Site 1. Saelices:

Terrain monitoring for 6 months with a Barasol equipment.
6 month series. Indoor and outdoor radon concentration data. Continuous monitoring.
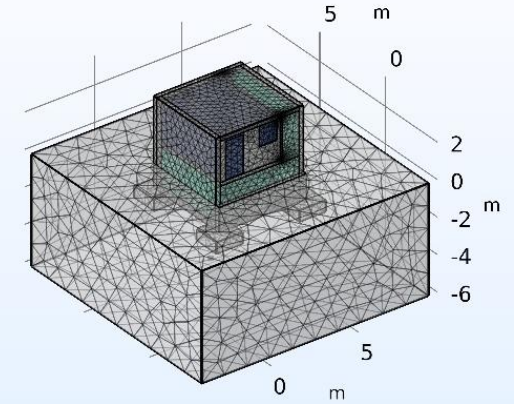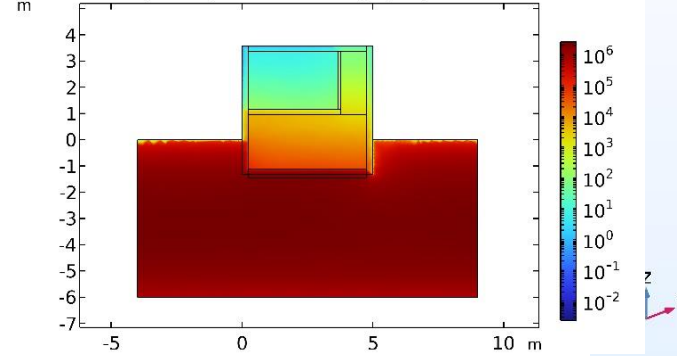
Degree of compliance :
100%

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Project WP Progress Level

Degree of compliance : 20%

WP7 Development of simulation models for radon levels in closed areas, adapted to the sites. UAB, IETcc-CSIC.

First version of the **RAGENA** models from the UAB, and **Comsol Multiphysics from the IETCC-CSIC** for the **location of Saelices** under stationary conditions. Initial tests are being carried out with old data of the radon concentration in the basement and on the ground floor of the module available under simplified conditions.

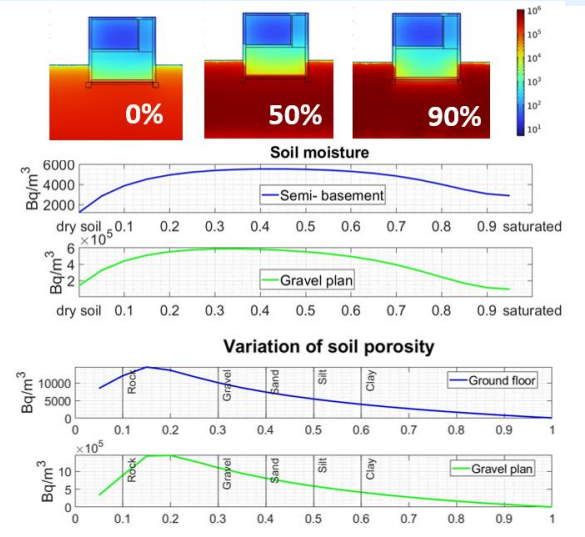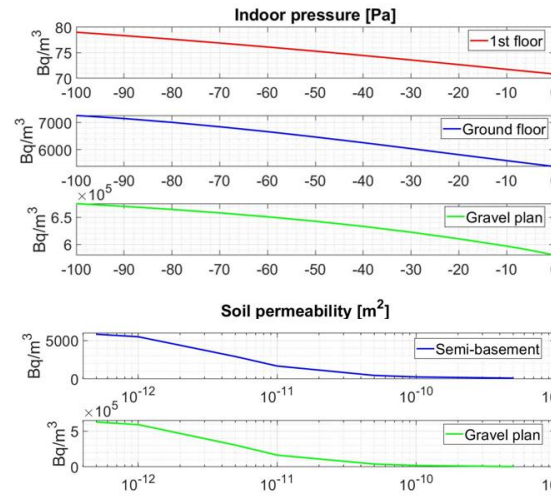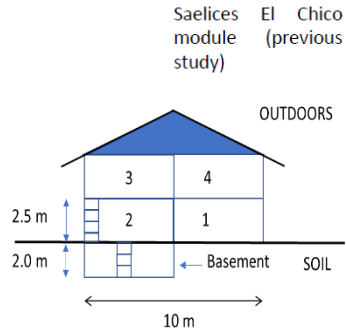Section: XY (Center). Concentration (Bq/m³) + Total flux lines
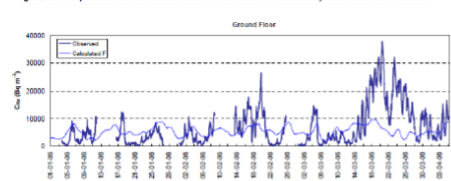

The RAGENA model

Measured (A) → Indirect info (B) → Reference configuration (C)

Figura 8: Comparación de las concentraciones de radón modelizada y observada en el sótano.

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UC UNIVERSIDAD DE CANTABRIA

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geomnia

Project WP Progress Level

WP8: Validation of simulation models. UAB, IETcc-CSIC

It was decided to build a laboratory accumulation model to carry out an intercomparison of the codes under controlled conditions in order to calibrate them.

- Hermetic high-density methacrylate accumulation chamber.

- Concrete slab characterized in content of ^{226}Ra and exhalation of ^{222}Rn.

- 5 cm thickness of basaltic or phonolitic soil fully characterized in its mechanical and radiological properties.
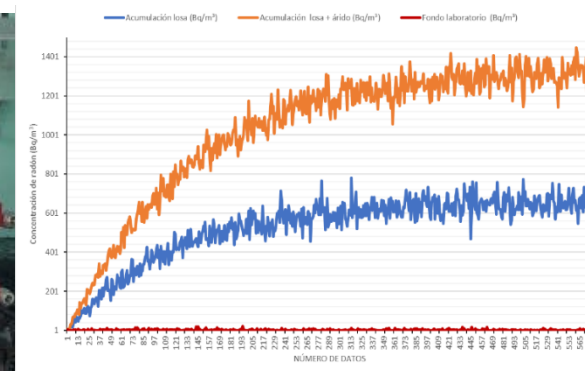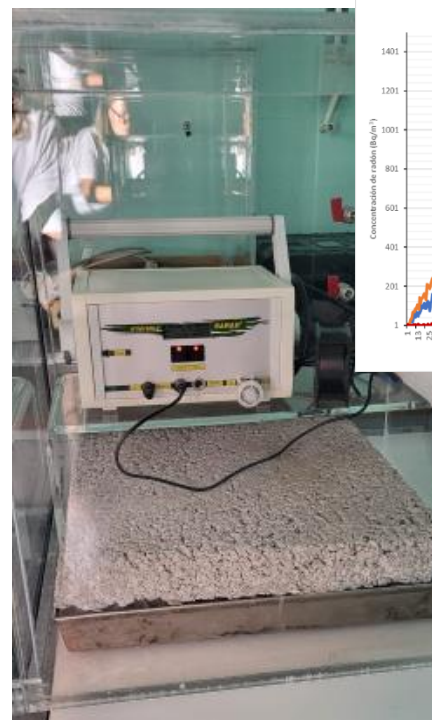
The validation of the codes with the experimental data of the project will be carried out in the last months of the project once all the data has been homogenized.

Degree of compliance : 60%

WP9: Application of models to the assessment of the effectiveness of mitigation measures. UAB, IETcc-CSIC

It is planned to carry out remediation at one of the sites and to analyze the predictive capacity of the codes. The validation of the codes with the experimental data of the project will be carried out in the last months of the project once all the data has been homogenized.

Degree of compliance : 0%

WP10: Quatity of meassurements.

Calibration of ULPGC measurement equipment in the UC chamber.

1 Sarad RTM 1688-2 Team

4 Sarad Scout Teams

20 Trace detectors for intercomparison of the ULPGC CR-39 reading Radosys 2000 equipment

Thank you very much for your attention!

More technical details in the following talks

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