

African Conference on Fundamental and Applied Physics, ACP2023

Topic :

Indoor radon and ambient equivalent dose measurements using a locally manufactured low-cost smart electronic device and validation with reference instruments

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1. Abstract

This work reports the realization of a low-cost smart electronic device for Gamma ionizing radiation monitoring and its implementation in real-time external ambient dose rate detection and indoor radon tracing. The device is developed according to the principle of nuclear signal processing in order to obtain the standard radiation protection signal (a slow positive logic pulses) and calibrated in the presence of Cesium (^{137}Cs). The device uses a ZP 1200 Geiger-Müller (GM) tube detector, low-cost components namely the microcontroller board, the DHT11 temperature (T) and relative humidity (RH) sensor and XBee-based Internet of Things (IoT) wireless transmission modules. The environmental radiation monitoring and nuclear security developed device is also low energy consumption, easily deployable in the

field (in-situ), adapted for real-time measurements and data transmission to a remote-controller PC.

A first comparative analysis of the data obtained from the developed survey meter was carried out with those of an in-situ gamma spectrometry chain (outdoor reference method) previously used at the same place and under the same conditions in Yaoundé-Cameroon. This analysis gave an acceptable mean value of 64.30 nGy/h, of the developed device, compared to 50.67 nGy/h of the gamma spectrometer.

The indoor reference device measures radon concentration, temperature, and relative humidity in indoor spaces. Typically, the developed device also provides data of atmospheric parameters (T, RH) and the ambient dose equivalent rate. From this ambient dose equivalent rate (in $\mu\text{Sv/h}$), radon activity concentration (in Bq/m^3) is deducted using standard and recognized conversion coefficients. The coefficients vary according to the ambient radiation strength and are ranging from 5500 to 8900 (Bq/m^3)/($\mu\text{Sv/h}$). The developed device and the indoor reference instrument were exposed during one month in several dwellings in the city of Yaoundé, and periodic average values of 27.51 °C (developed device) and 26.19 °C (RadonEye) for temperature, 74.10 % (developed device) and 73.00 % (RadonEye) for relative humidity, and 1499.19 Bq/m^3 (developed device) and 1464.91 Bq/m^3 (RadonEye) of cumulated radon activity concentrations, for a 24 hours exposure period were evaluated. Statistical analyzes carried out on the results of these two devices provide a linear regression coefficient of $R^2 = 0.9978$. This shows a good agreement between the data of the developed device and the reference instrument RadonEye. The prototype thus developed is simple, precise, and made for Environmental radiation protection.

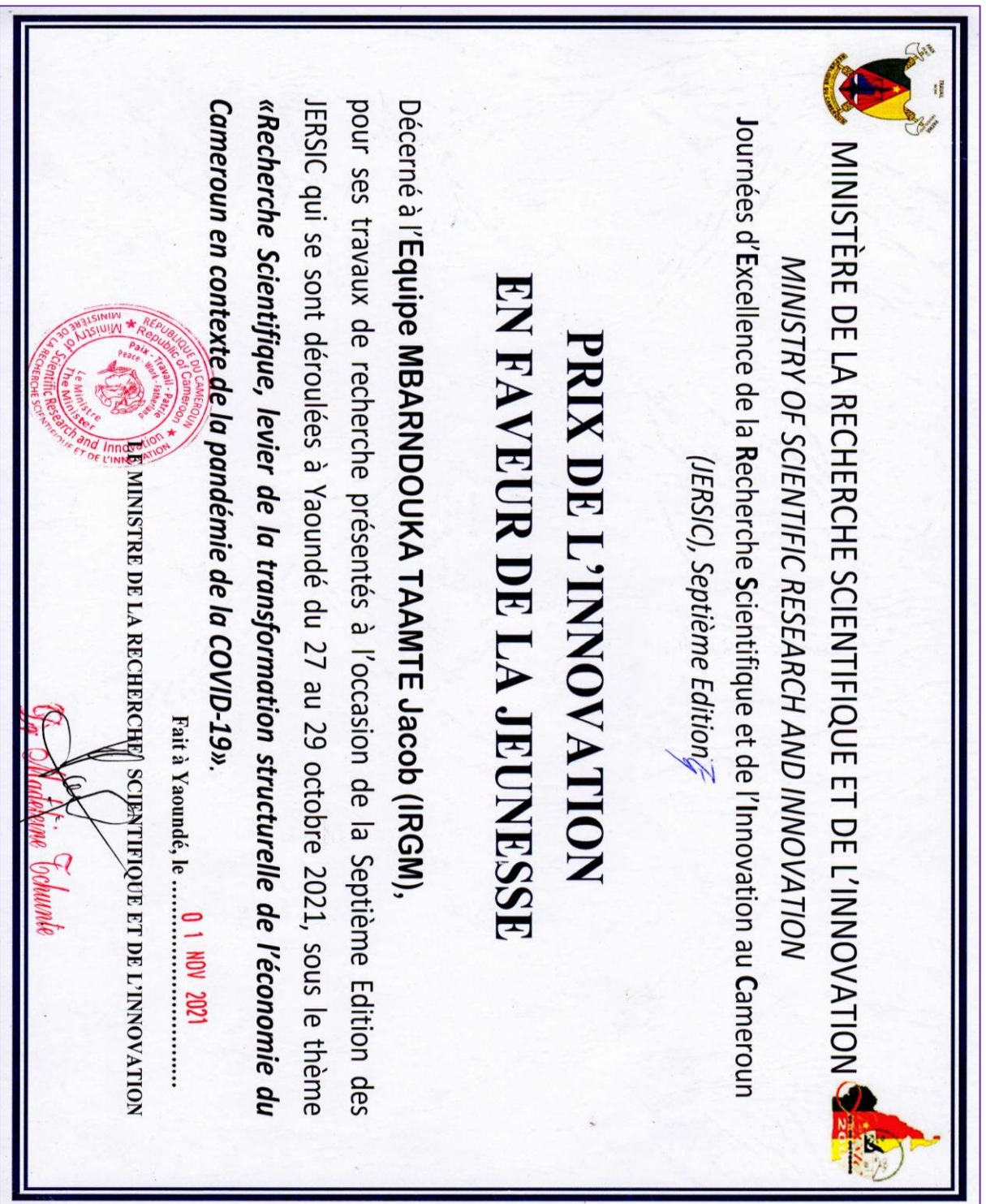
Keywords: Radiation monitoring, radon tracing, smart electronic device, Internet of Things (IoT), Geiger-Müller (GM) tube detector, temperature and relative humidity sensor

2. Prizes for scientific excellence won

- Best Prize of young professional radiation protection scientist, awarded in **2022** at the sixth African congress organized in Ghana by the IRPA : (International Radiation Protection Association) following the creation of a device for measuring environmental radioactivity and radon gas ;



- Special prize of innovation in favor of youth, awarded by the Ministry of Scientific Research and Innovation during the 7th edition of the Days of Excellence in Scientific Research and Innovation in Cameroon (**JERSIC**) **2021**, For the realization of Innovative Electronic Devices at Low Cost dedicated to Environmental Monitoring in Real Time: Application to the measurement of Air Quality, Radiation Protection and Nuclear Safety ;



3. Other certificates

African School of Fundamental
Physics and Applications

Certificate of Participation

This is to certify that

Mbarndouka Taamté Jacob

attended the 7th edition of the African School of Physics,
ASP2022, on November 27 - December 9, 2022

Kevin A. Assamagan

Dr. Kétévi A. Assamagan
Brookhaven National Laboratory
Fellow of the American Physical Society
Fellow of the African Academy of Sciences
Fellow of the South African Institute of Physics

A. Muronga

Prof. Azwini Ndini Muronga
Executive Dean: Faculty of Science
Nelson Mandela University
Former Director, Soweto Science Center
Former President of the South African Institute of Physics



IAEA
International Atomic Energy Agency
Atoms for Peace

----- THIS IS TO CERTIFY THAT -----

Mr. Jacob Mbarndouka Taante

HAS COMPLETED TRAINING THROUGH AN IAEA FELLOWSHIP IN THE FIELD OF
Radioisotopes and Radiation Technology for Industrial Applications

At the Nuclear Research Centre of Birine, Birine, Algeria

From 22 September 2019 to 17 October 2019

SHAUKAT ABDULRAZAK
DIRECTOR
DIVISION FOR AFRICA
DEPARTMENT OF TECHNICAL COOPERATION

CERTIFICATE

THIS IS TO CERTIFY THAT

MBARNDOUKA TAAMTE Jacob

Has successfully attended and participated actively on the training regarding "Radon calibration system" according to IAEA TC Project CMR 9009 on Establishing the national radon plan for controlling public exposure due to radon indoors.

**5 - 7 July 2022,
Yaounde, Cameroon**

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4. References

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