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STUDY AND MONITORING OF IONIZING RADIATIONS USING GEIGER RUSSIAN TUBE AND ARDUINO ELECTRONIC SYSTEM IN THE REGION OF SÃO JOSÉ DOS CAMPOS, BRAZIL

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ABSTRACT
The ionizing radiation is mainly the result of radon gas, the telluric radiation and the primary and secondary cosmic radiation produced at the interface of the ground level and the low atmosphere. However, it is difficult to separate over time the intensity of the ionizing radiation from each component as the energies overlap. The telluric radiation consists of decay products of ^{238}U, ^{235}U, ^{40}K, and ^{232}Th which is constant in each specific region. During the period of 11/06/2018 to 02/28/2019 it was possible to measure the intensity of the ionizing radiation every minute, with the aid of a simple system developed in the Physics Department of the Technological Institute of Aeronautics (ITA), composed of a Russian Geiger and Arduino electronic system.

***Keywords**: Ionizing Radiation, Russian tube Geiger, telluric and cosmic radiation.*

I. INTRODUCTION

Low energy ionizing radiation (α, β, X and gamma rays) in the local environment depends on the presence of radionuclides and radon gas around the region. Ionizing radiations with energy above 12eV (E> 12 eV) can pull electrons from an atom in the environment where they move. Its geological origin is largely the result of the decay of radioactive isotopes of potassium (^{40}K), uranium (^{238}U) and thorium (^{232}Th). During radioactive decay, the nuclei can emit alpha, beta, gamma or X-ray radiation. Moreover, natural radioactive isotopes belonging to each decay series mentioned above are formed. The ^{235}U has a half-life of 713 million years, while the ^{238}U has a half-life of 4.5 billion years. Thereby, there is in environment a smaller amount of ^{235}U comparing to ^{238}U.

The other major source of ionizing radiation at the soil / air interface is the radon gas (^{222}Rn), which is also formed by the decay of uranium and thorium. The radioactive decay of radon produces ^{218}Po, ^{214}Pb and ^{214}Bi, and these isotopes can be observed in the air near the ground by the presence of alpha, X and gamma particles. An important fact related to radon is that during rainfall, the concentration close to the ground may increase due to the transport of this gas by raindrops.

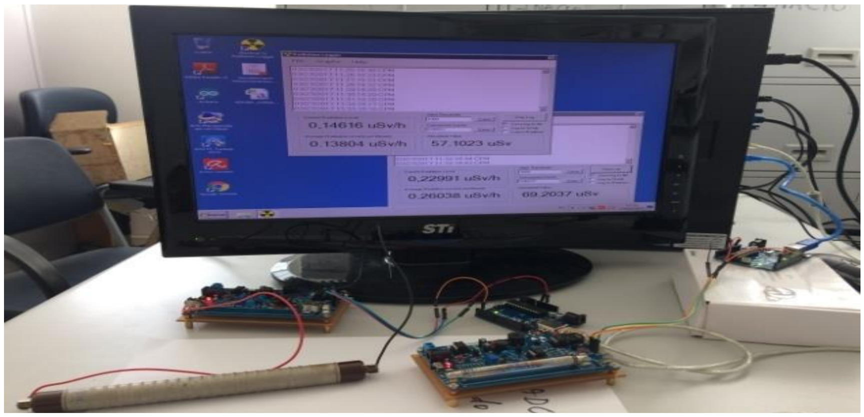
The radiation of the cosmic component (primary and secondary) produced in the lower atmosphere varies little over time. However, it varies greatly with latitude and height above the Earth's surface. This cosmic radiation produces "extensive air showers" composed of particles and photons of energy that reach the surface of the Earth. Artificial ionizing radiations are those produced by humans in a variety of activities such as medicine, dentistry and research in industry. However, radiation sources are, in principle, confined and under control at a specific location.

II. METHOD & MATERIAL

A simple system was developed for the detection of ionizing radiation where a Geiger is used with Russian tube 16 centimeters long by 2 centimeter diameter with internal pressure of 3 atmospheres, both subject to voltage of 500 VDC, together with the Arduino electronics, a scale-type pluviometer rain gauge was used to measure daily rainfall in mm / min. Then the measurements of the ionizing radiation initiated on 09/09/2018 until 02/28/2019 are being carried out.

The monitors are being performed by means of ionizing radiation counts per minute. With the data obtained from the monitors, graphs are generated where the analysis is done through the software Excel and Origin 1.5, and can then monitor the intensity of the ionizing radiation at the soil / air interface.

Figure 01:

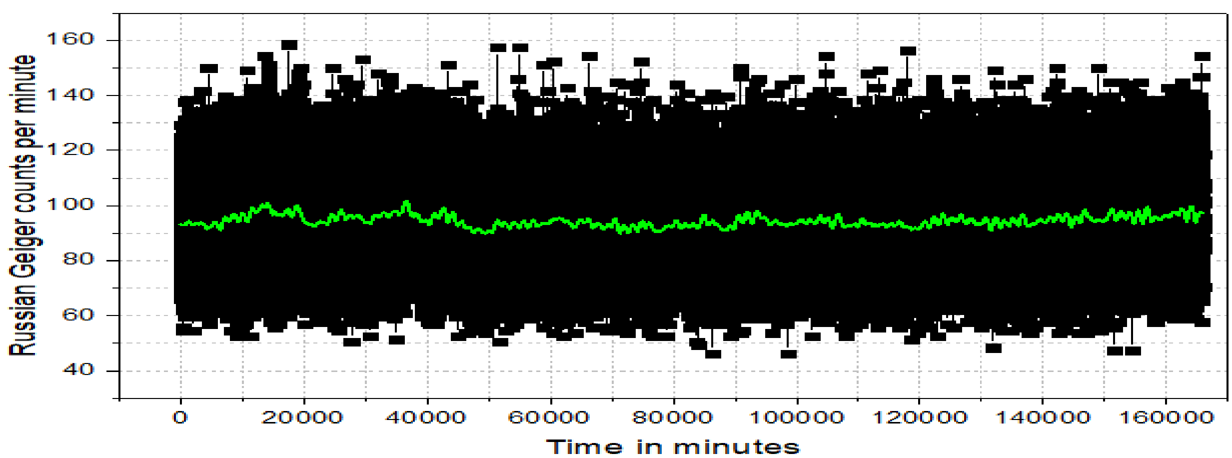


View of the RussianGeiger Ceramic Tube with the arduino system

III. RESULT & DISCUSSION

Ionizing radiation was monitored at the soil / air interface during the period from November 6, 2018 to February 28, 2019, where the count of the Geiger Russian tube was analyzed every minute. It is observed when analyzing the graphs that the Geiger Russian tube manages very well to measure the variations night / day of the period without rains. The "smooth" in green represents the variation of the intensity of the radiation per day.The figure 2 below shows the result of the entire analyzed period.

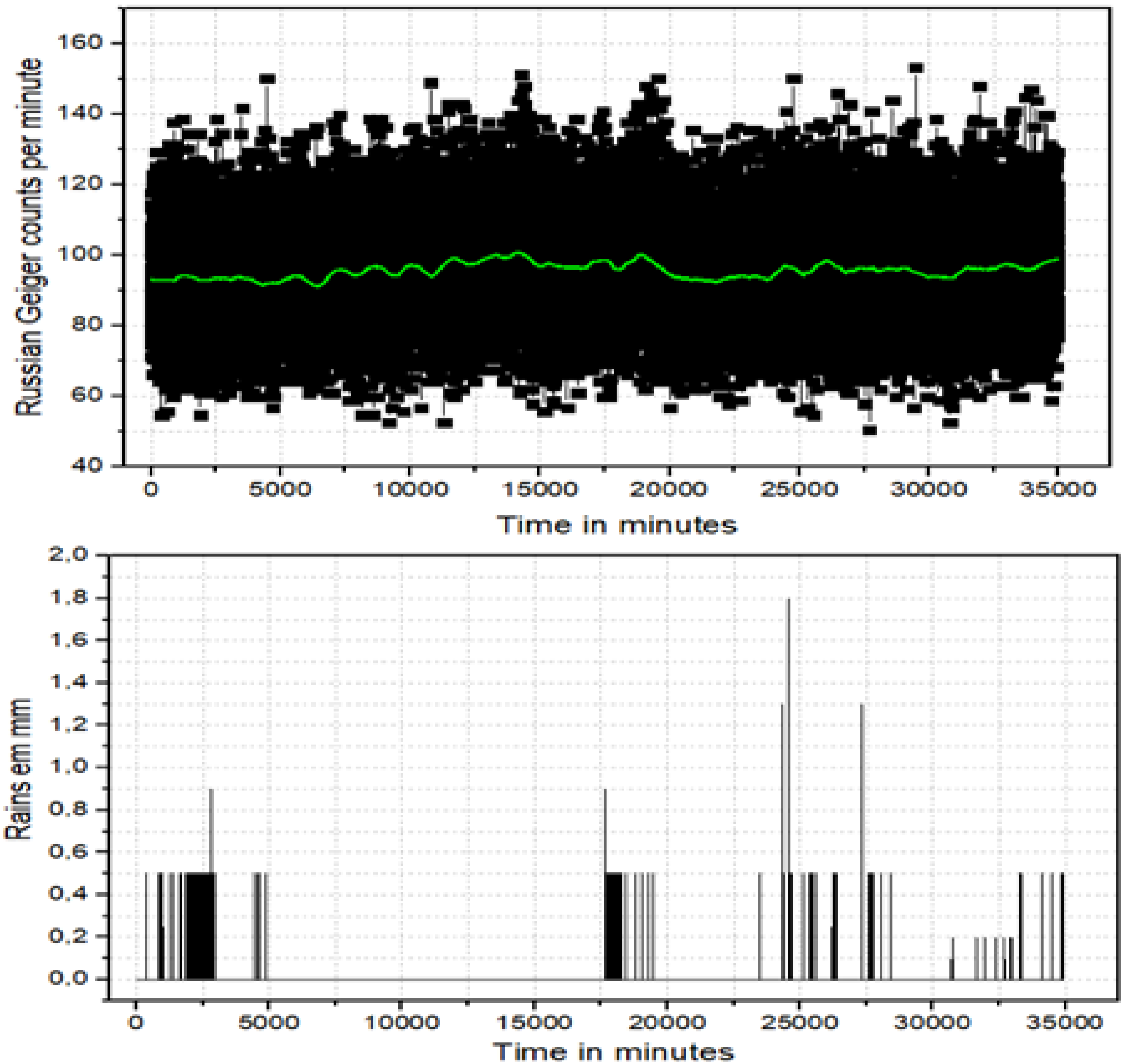
Figure 02:



Monitoring the Russian Geiger tube count per minute during the day 11/06/2018 to 02/28/2019. The green line corresponding to 1 day smoothed curve

Figure 3 shows the measurements in the period from November 6, 2018 to November 30, 2018. Periods of drought can be observed between 5000 and 15000 minutes, representing the high variation of the intensity of the ionizing radiation. Then between the periods of 25000 to 35000 there was much rain and the low variation of the radiation could be noticed. The correlation between the climate and the intensity of the radiation can be seen in figure 3.

Figure 03:



Monitoringthe Geiger Russian tube count per minute correlated with rainfall during the day period 11/06/2018 to 11/30/2018. The green line corresponding to 1 day smoothed curve

The figure 4 shows the monitoring results for the month of December of the year 2018.

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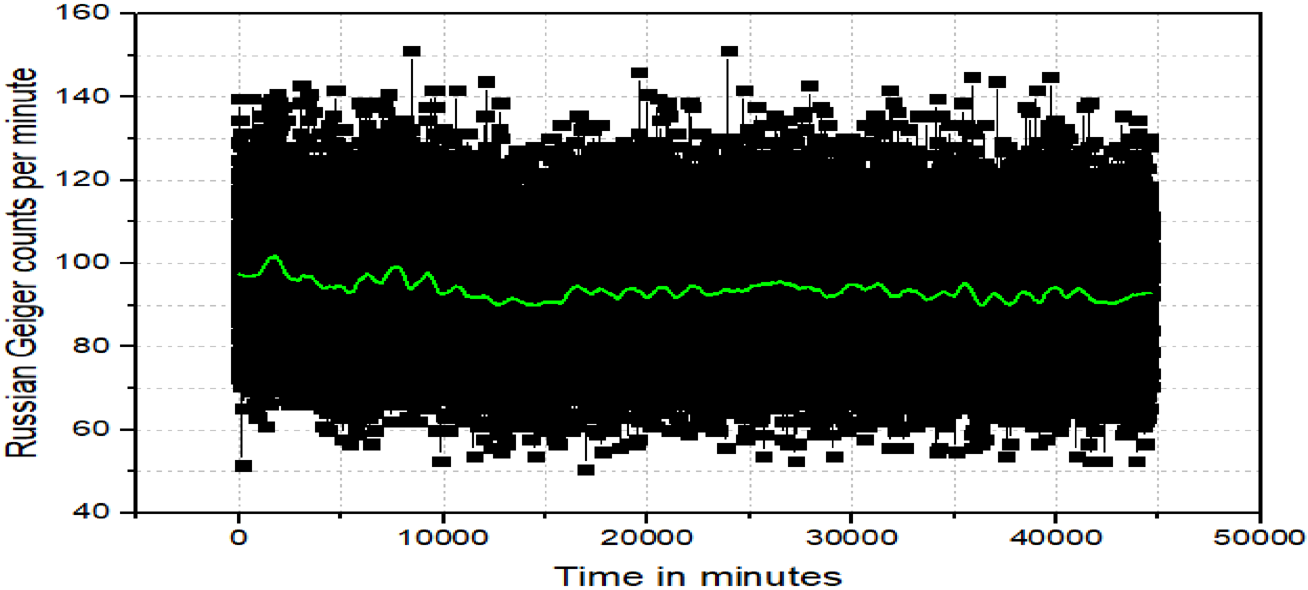
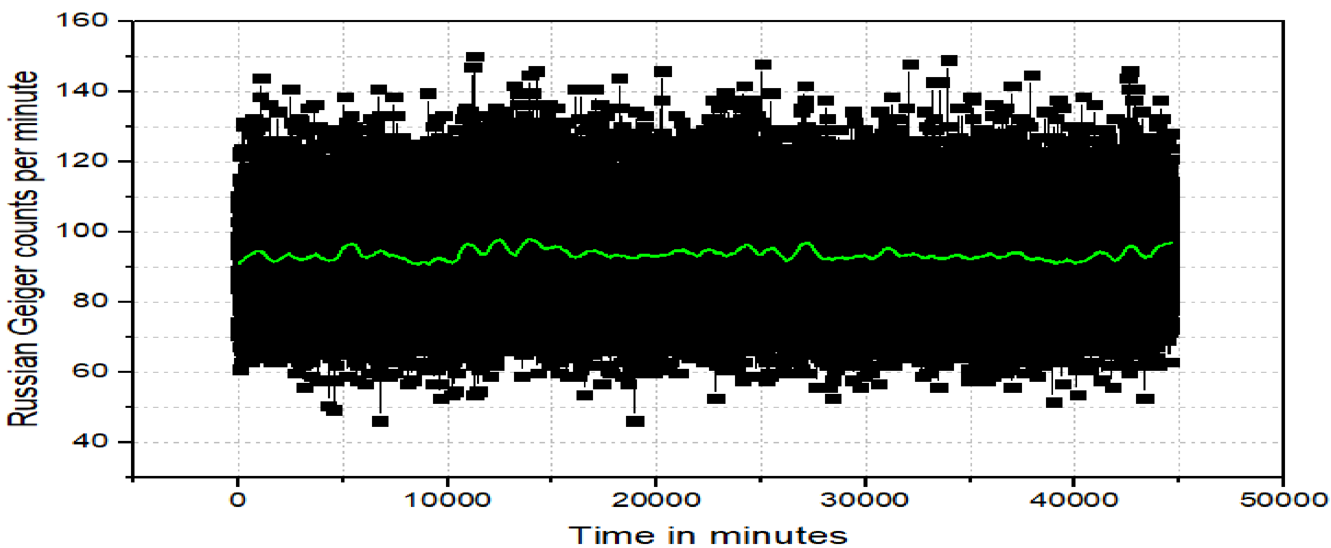
Figure 04:



Monitoring the Geiger Russian tube count per minute during the day 12/01/2018 to 12/31/2018.The green line corresponding to 1 day smoothed curve.

Figure 05 shows the monitored results inJanuary of the year 2019

Figure 05:



Monitoring the Geiger Russian tube count per minute during the day 01/01/2019 to 01/31/2019. The green line corresponding to 1 day smoothed curve.

Figure 06 shows the monitored results inFebruary of the year 2019.

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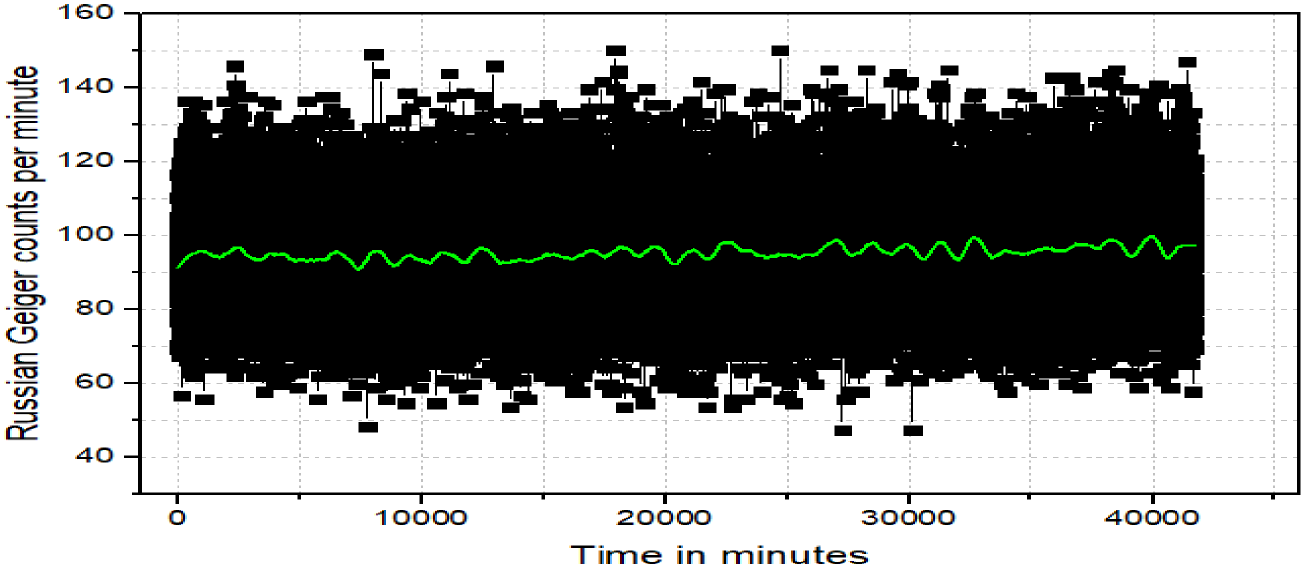
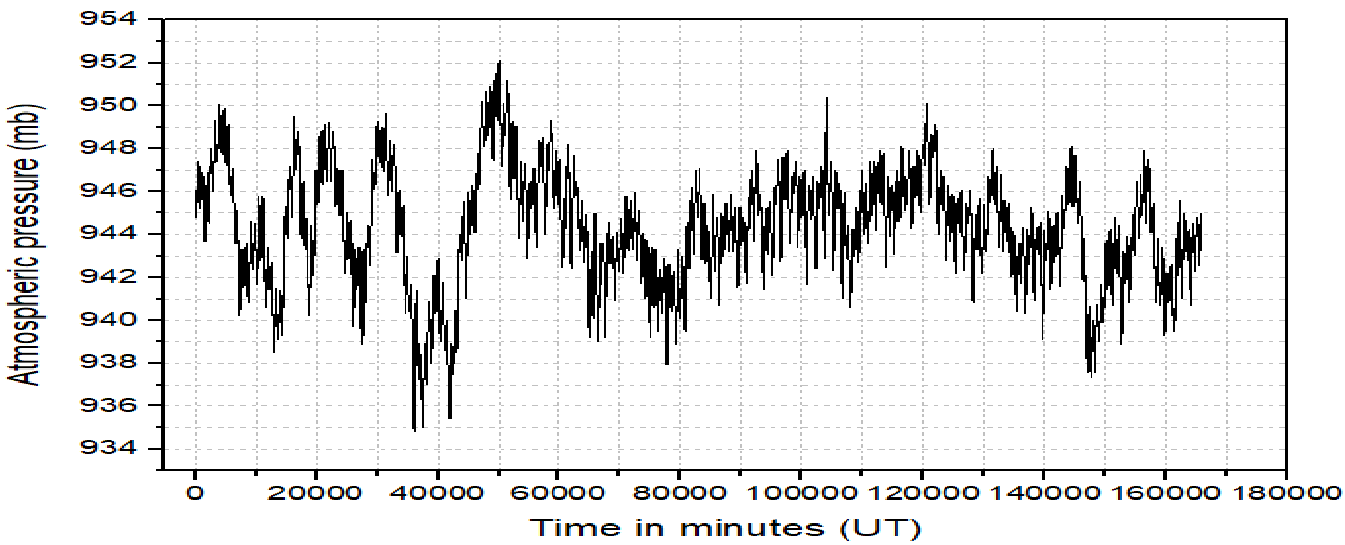
Figure 06:



Monitoring the Geiger Russian tube count per minute during the day 02/01/2019 to 02/28/2019. The green line corresponding to 1 day smoothed curve.

With the aid of the system mounted and used to monitor the intensity of the ionizing radiation at the soil / air interface, it was also possible to monitor the relative humidity and atmospheric pressure.
Figure 7 shows the monitoring of atmospheric pressure every minute during the period from November 6, 2018 to February 28, 2019.

Figure 07:



Monitoring of atmospheric pressure every minute during the period from 06 November 2018 to 28 February 2019

Figure 8 shows the average relative humidity variation at each minute during the period from November 06, 2018 to February 28, 2019

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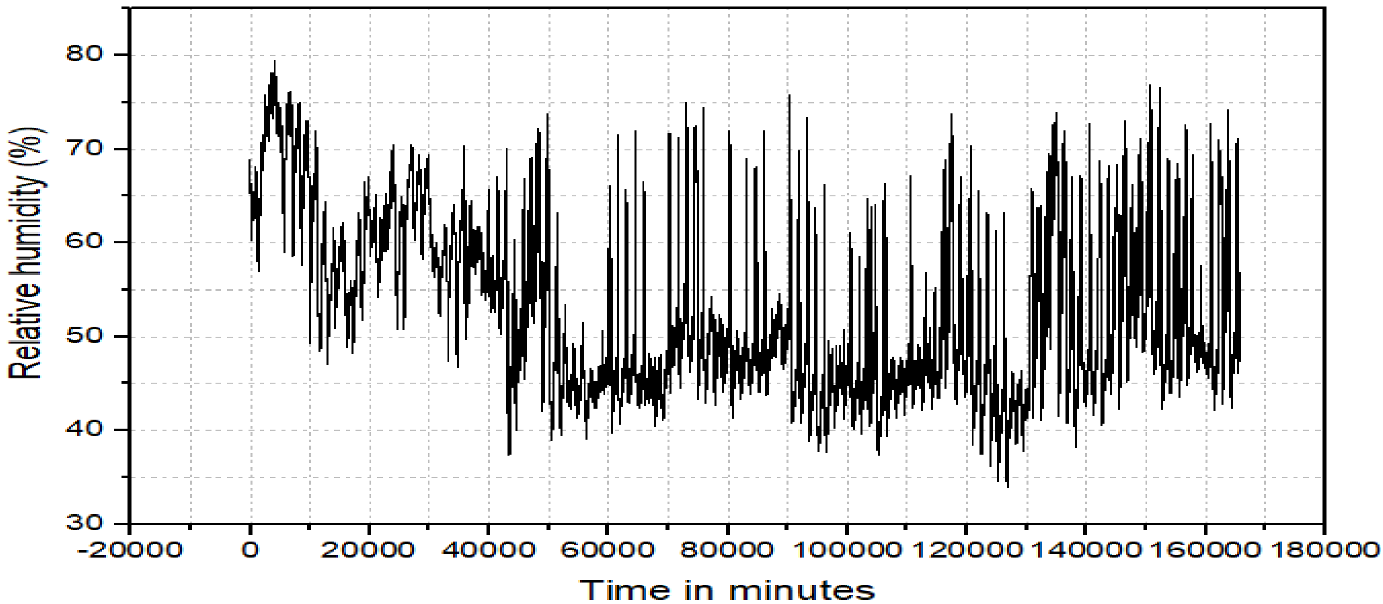
Figure 08:



Relative humidity monitoring per minute during the period from 06 November 2018 to 28 February 2019

IV. CONCLUSION

A simple system was developed, consisting of a Geiger with Russian pipe along with the associated Arduino electronics where it is possible to acquire data from minute to minute and can perform environmental radiation monitors. Soon this facilitates the verification of atmospheric phenomena and their variations in time. It was also possible to verify that during the dry season the exhalation of radon gas emits gamma radiation and alpha particles in the region. As a conclusion, the intensity of ionizing radiation and rainfall in mm / min, in the region, was measured by a simple and very low cost process with interest for teaching and research.

V. ACKNOWLEDGEMENTS

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