

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES STUDY OF NEUTRON, GAMMA RAYS AND RADON GAS CORRELATION WITH MEASUREMENTS NEAR GROUND LEVEL IN SÃO JOSE DOS CAMPOS, SP, BRAZIL

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ABSTRACT

In April 2018 it was performed measurements of thermal and fast neutrons, gamma rays and charged particles in the ITA's campus in São José dos Campos, SP, Brazil. The measurements instruments were installed on ground/air interface, less than five meters higher the ground. In the same time interval it was measured outdoor the intensity of radon gas. In period of the measurements, there were not rainfalls and by means of an ionizing chamber (RD200) it was observed that the intensity variation of the gamma, charged particles are correlated with day/night period and with intensity of radon gas measured. The detected neutron intensity has no correlation with the intensity of gamma rays neither with the intensity of radon gas measured at the site. This paper discusses the dynamics of these measurements in terms of location and meteorology.

Keywords: *gamma rays, ionizing radiation, rainfall, radon gas.*

I. INTRODUCTION

At the ground level of Earth's surface, the ionizing radiation is composed mainly of radon gas, the telluric radiation of the soil and the radiation of the primary and secondary cosmic rays. However, it is difficult to separate over time the intensity of the ionizing radiation emanating from each component as the energies overlap. The telluric radiation is given by ^{238}U , ^{235}U , ^{40}K , ^{232}Th and is constant for each region [1]. The radon gas that comes from the disintegration of ^{238}U of Earth's crust [2] into Ra-226 to Rn-222 arriving at the isotopes ^{214}Pb , ^{214}Po and ^{214}Bi giving α and gamma radiation. The primary cosmic radiation consists mainly of galactic and extragalactic protons and from the Sun with very high energy that interacts with Earth's atmosphere producing the EAS (Extensive Air Showers) [3]. The efficiency of this interaction is maximum when it occurs at altitudes between 15 and 17 km in the tropics, which form secondary cosmic rays with muonic, mesonic, and neutronic components that reach the Earth's surface in the region [4]. Another possible source of ionizing radiation in the Earth's lower atmosphere is produced by electrical discharges between cloud-earth, earth-cloud and cloud-cloud. Gamma rays, neutrons and beta particles are all formed by the lightning cone [5,6]. Other sources of ionizing radiation are those produced in medical and dental clinics and hospitals, but these radiations are mainly controlled in small and specific areas.

II. METHOD & MATERIAL

The gamma ray detector for the energy range of 200 keV to 10.0 MeV consists of a 3-inch-by-3-inch-diameter and high Sodium Iodide scintillation crystal NaI [TI](3" x 3"), doped with Thallium. This crystal is directly coupled to a photomultiplier (PM), which registers and amplifies the pulses coming from the scintillator and with an analog digital converter (ADC) these digitized signals are recorded by a computer [7]. For continuous measures of the intensity of neutrons were used two tubes of gas He-3 filled with 4 atmospheres of internal pressure. A paraffin moderator of 10 cm radius was placed around the tubes in form of sphere to slow down their velocity/energy and increasing the efficiency of detection [8,9]. The He-3 tubes were fed with a voltage of 1500 VDC and data acquisition was performed by a special electronic set (PMI-30) manufactured by company Aware Electronics Inc., USA. Through an analogue to digital converter (ADC) the signals were amplified and digitized by PMI-30, using software coming from the same company were stored in archives .txt, using a Dell 630 laptop. To monitor measures

a graph was generated on the computer screen in same time every minute. Thus this portable set was calibrated in the range of energy and pulse height signals with neutron radioactive sources $^{241}\text{Am-Be}$, ^{252}Cf and ^{210}Po , at energies below 4.5MeV (<http://www.nist.gov/calibrations/neutron.cfm>). The method used to display each record of measurements was taking using intervals of 1 minute. So a file with days or weeks or even months of measures was saved.

The radon gas is one RD200 Smart Radon Detector (RadonEye) pulsed ion chamber with 10 minutes of update. The sensitivity of RadonEye is 1,35counts per minute equivalent 10,0 Becquerel/m³. For manager data and setting it is possible to use one Smartphone App., and for alimentation it is necessary only one 12 V adapter with a cable to the detector that automatically started. For more details of RadonEye see (<https://www.amazon.com/Radon-Detector-Home-Owner-Plus/dp/B07864XVBH>). Charged particles were also monitored via Geiger counters with Geiger-Muller tubes manufactured from China and Russian.

III. RESULT & DISCUSSION

Gamma radiation, neutrons and Geiger counter including radon gas measurements were carried out during the period of April 01 to begin of Mai of 2018, in outdoor part of container below the tower, seen in Figure 1.

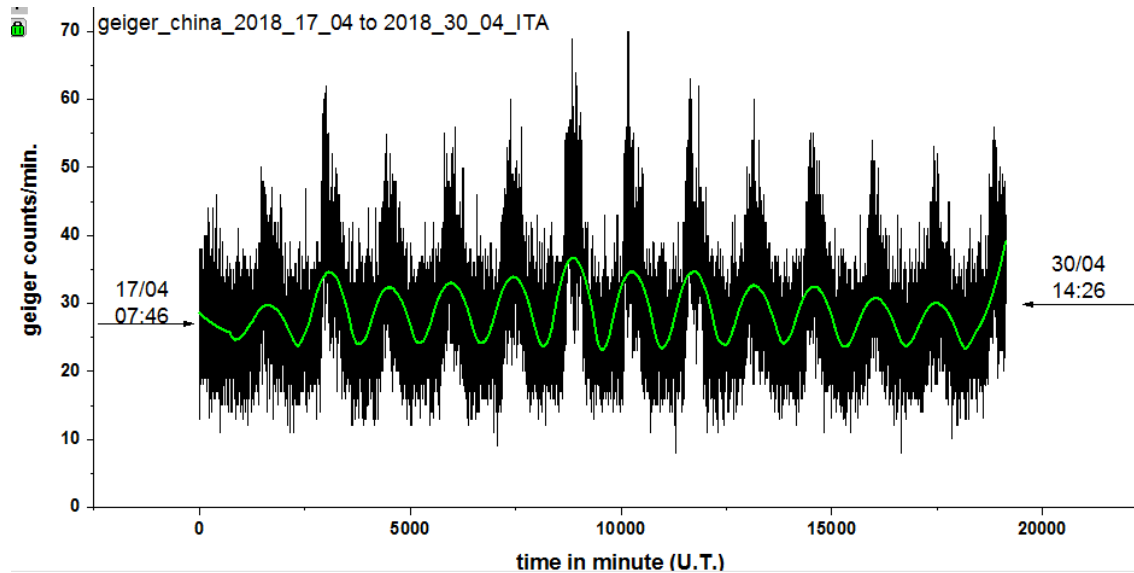
Figure 1:



Local measurement of radon and ionizing radiation near container were associated electronics is allowed.

During the interval described above, on the roof of the tower was the rain gauge that reported the intensity of rain in mm / min each minutes. The associated electronics of power supply and data acquisition it was kepted inside the container in a tower. Using the Geiger counter with a GM tube from China it is possible to see very clear the daily variation cycles showed in Figure 2.

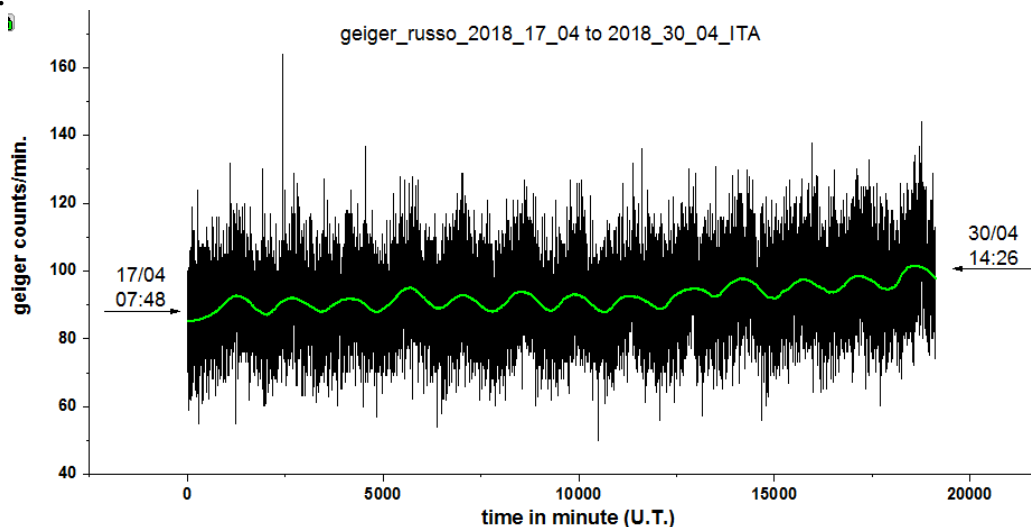
Figure 2:



Measurement of ionization radiation using Geiger-Muller China tube. Green line is smoothed points for one day.

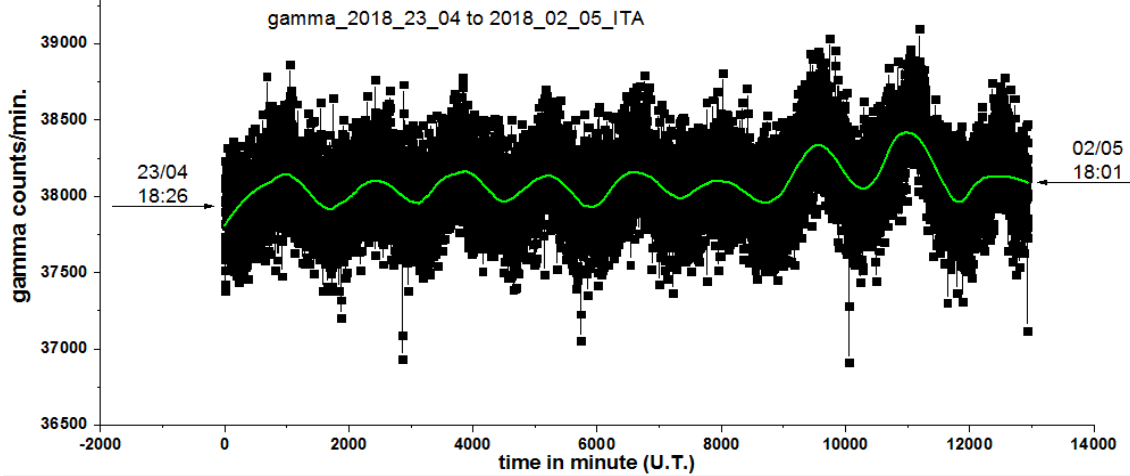
The same measurement was made using the Geiger-Muller Russian tube, presented in the Figure 3.

Figure 3:



Measurement of ionization radiation using a Geiger with GM tube manufactured in Russian. The green line correspond a smoothed curves for one day.

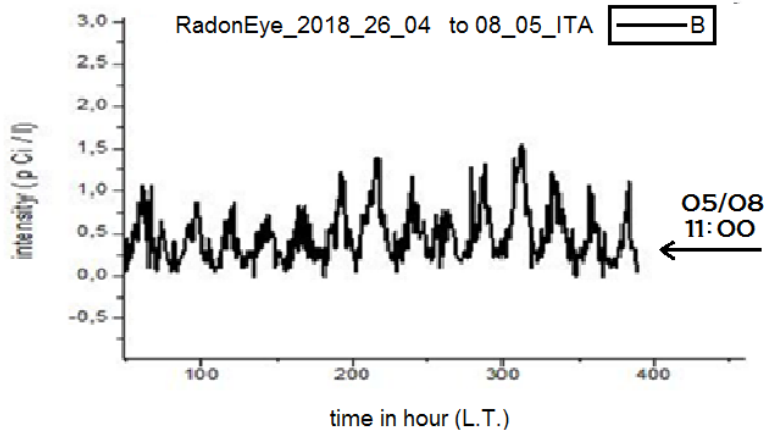
In the Figure 4 it is plotted measurements of low energy gamma rays in the same place near ground level in the tower. Those measurements shows also the daily cycles produced by radon gas in situ. Last 3 days due to greater temperature in the soil and low humidity of air the gamma rays growing up.



Monitoring of gamma ray (0.2 to 10.0) MeV using NaI(Tl) scintillator. The green line correspond 1 day smoothed value.

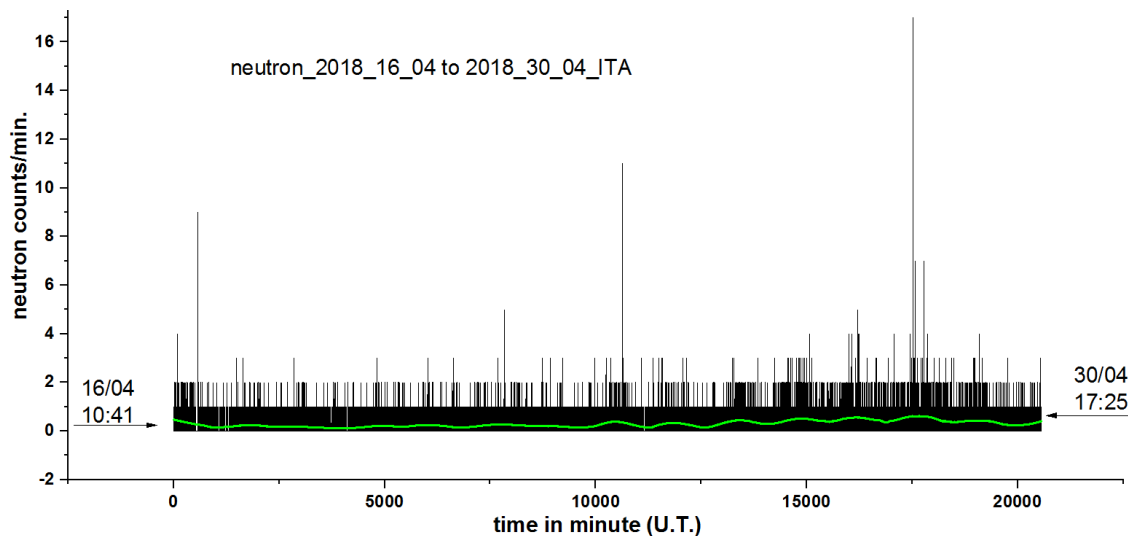
Figure 5 shows the monitoring of the radon gas in the same place of the ionizing radiation detectors. These measurements were taken outdoors with the Radon Eye RD200 operating without human interference at the site. The measurements are performed every 10 minutes and plotted on the chart every hour using software from the RD200 RadonEye itself. The end of the chart corresponds to 11:00 hours U.T. on 05/08/2018. It is observed that in the last 3 days due to high temperature in the soil ~ 30, 0 C the intensity of radon gas had a very noticeable increase. The neutron monitoring of 0.02 to 10.0 MeV was plotted in Figure 6. As there was no rain in the measurement period the increase observed at the end of April 2018

Figure 5:



Measurements of radon gas performed by the RadonEye RD200 between April 26 and May 8, 2018.

Figure 6:



Measurements of neutrons (0.02 to 10.0) MeV in the period from April 16 to April 30, 2018 in the same place as the ITA.

It can be noticed that the day / night cyclic variation of the measurements of neutrons is certainly related to the increase of the radon gas in the region mainly. However the neutrons have a cosmic component also and this possible component produced in the soil due to the presence of alpha particles present in the radon gas. These alpha particles collide with metallic material from the surface materials and produce neutrons in that energy range that was measured.

IV. CONCLUSION

It was measured in the region of São José dos Campos, SP, Brazil the intensities of gamma radiation, charged particles, thermal, epithermal and fast neutrons and radon gas. In the same period and even location was also monitored the rain intensity that was in all period zero. All measured ionizing radiations show day / night cycles with maxima around 06:00 local hours and minimums around 14:00 local hours. The measurements performed and presented in this work indicate that the greater or less exhalation of the radon gas of the local soil is responsible for the increase and the reduction of the ionizing radiations measured in the local.

V. ACKNOWLEDGEMENTS

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