IMPACT: International Journal of Research in
Engineering & Technology
ISSN(P): 2347–4599; ISSN(E): 2321–8843
Vol. 7, Issue 10, Oct–2019, 13–18

MONITORING OF IONIZING RADIATION USING GEIGER AND NaI (TL) CRYSTAL SCINTILLATOR FOR ENVIRONMENTAL STUDY

Inacio Malmonge Martin

Research Scholar, Department of Physics, Technological Institute of Aeronautics, Brazil

Received: 04 Oct 2019 **Accepted:** 15 Oct 2019 **Published:** 31 Oct 2019

ABSTRACT

In August and September 2019, the intensity of environmental ionizing radiation was monitored every minute at ITA campus in São José dos Campos, Brazil. A Russian and Chinese tube Geiger and a Talio-activated sodium iodide scintillating crystal was used in this monitoring. The monthof August was very dry and cold while in early September, the rains appeared in the region. These measurements show the interference of the presenceof rainfall on the variation of intensity in the local ionizing radiation. This fact observed experimentally using proportional counters and scintillators of low coast and easy operation facilitates research in ITA and other high school institutions in Brazil regarding studies of environmental ionizing radiation.

KEYWORDS: *Geiger Proportional Counters, Crystal Scintillators, Monitoring Environmental Ionizing Radiation*

INTRODUCTION

To monitor environmental ionizing radiation from anywhere on the ground/air interface, proportional counters (Geiger) and/or Tallium activated Na Ior CsI scintillating crystals can be used. In the case of Geiger, they depend on the sensitive tubes that are manufactured. They depend on the gas inside, the internal pressure of this gas andthe high operating voltage of this pipe. The best and cheapest Geiger tubes are made in Russiaand China. Nowadays, Geiger-associated electronics are found in international trade market at reasonable prices. The Arduino electronic system can be used for this task of feeding and acquisition of data measurements. Geiger can only show the count per unit time of the environmental ionizing radiation from the site to a previously chosen energy range. Sodium iodide or cesium iodide crystal (thallium-activated) allows to measure local environmental ionizing radiation by the scintillation process. This process with a more elaborate electronics allows determining the radiation energy being measured. Environmental ionizing radiation consists of photons and particles that vary depending on local geology, surface height relative to sea leveland primary – secondary cosmic radiation. It is also function of atmospheric pressure and relative humidity, drought and local rainfall regime. This environmental ionizing radiation strongly depends on the presence of radon gas intensity at the measurement site[1] and[2].

MATERIALS AND METHODS

For continuous monitoring of environmental ionizing radiation in the energy range between 100 keV and 10 MeV, one Geiger with Russian tube, one Geiger with Chinese tube, and one crystal NaI(Tl) Sodium iodide scintillator was used. Figure 1 shows the Russian tube and the Chinese glass tube that belongs to Geiger counter. An Arduino electronic system built in ITA is responsible for providing high voltage of 400 VDC and making data acquisition every minute. In the case of the scintillator, a crystal 3 inches high by 3 inches in diameter coupledwith a photomultiplier (PM) and one PC were used.

The voltage employed is 650 VDC and data acquisition with electronics was provided by Aware INC. (USA)[3].The Geiger detector which is a proportional counter measures everything charged from 100 keV to 10 MeV providing counts/time. The scintillator measures x-rays and gamma rays in the same energy range, also providing counts/time. For this monitoring, one minute was chosen as a unit of time[4].

RESULTS

From the beginning of August until September 9, 2019, the ionizing radiation measurements were realized at the ITA campus in São José dos Campos, Brazil. These measurements performed with two Geiger and one Sodium Iodide scintillator indicated variations with rainfall that arrived between August 31 until September 9, 2019 at this location. Figure 2 shows on the vertical scale the count rate/minute of Geiger China as a functionof time in minutes on the horizontal axis. It is observed that this Geiger tube can detect natural visible light, highlighting day/night cycles during the monitoring[5].

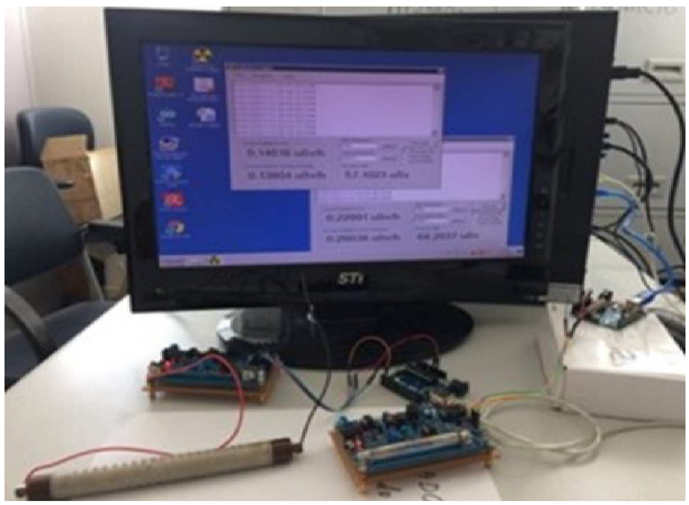

Figure 1: View of the Two (Russian and Chinese) Tubes for Geiger and Pc with Associated Electronics.

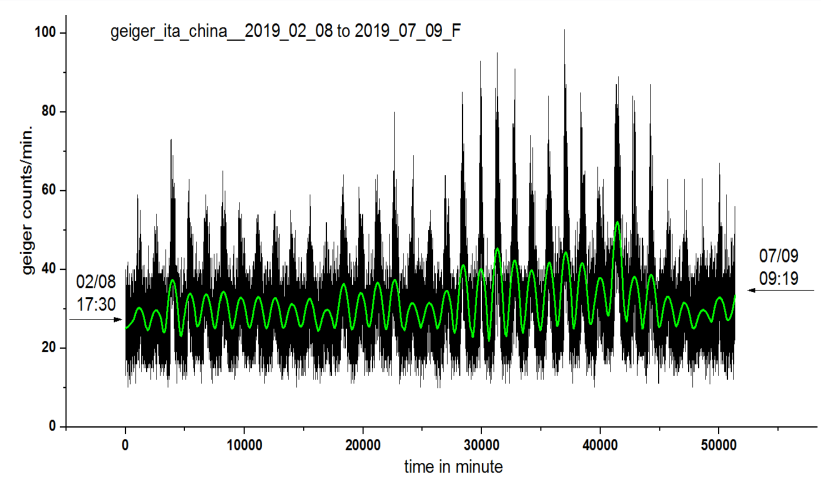

Figure 2: Monitoring of Ionizing Radiation with Geiger Chinese Tube. The Green Line Consists of 1 Day Smoothing.

It can be noted that between the times of 30,000 to 42,000 minutes, there were rains and drizzles with visible little increase in the measured counts.In Figure 3, the monitoring measurements are placed using the Geiger with the Russian tube. Due to the sensitive area and the larger tube size, the average count increases by a factor of 3, which is around 90 counts per minute while the Chinese tube counts in the order of 30 counts per minute. The Russian tube cannot see visible light, so it has no clear day/night variation cycles. In terms of radiation dose in microsievert/hour (µSv/h). These measurements in counts/minute correspond on dose in the region of **0.25 µSv/h**.

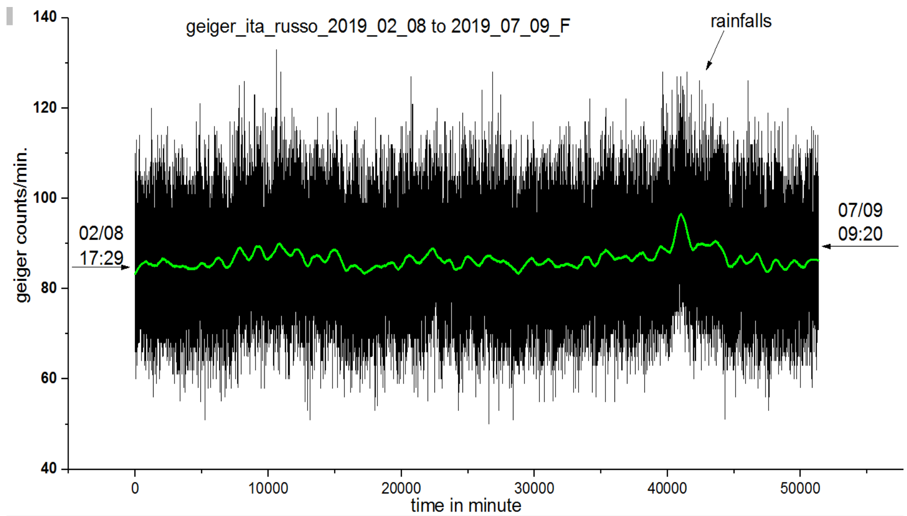

Figure 3: Measurements of Ionizing Radiation on ITA Campus with a Russian Tube Geiger. The Green Line Corresponds to 1 Day Smoothing.

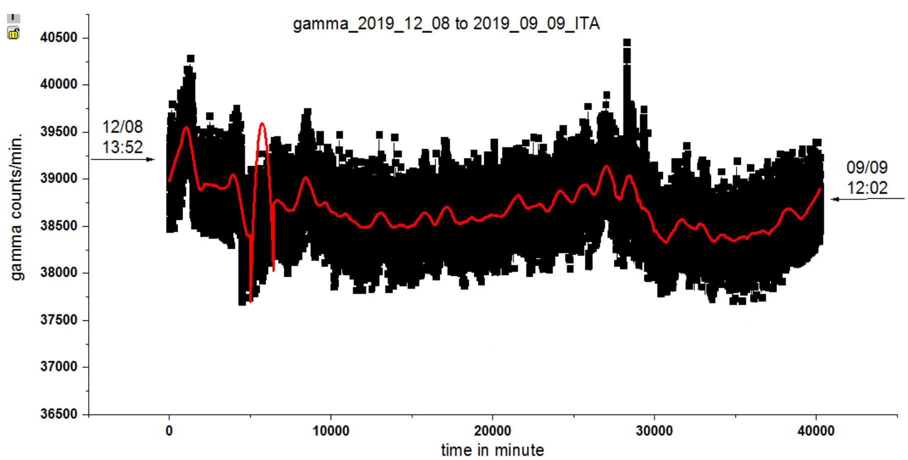

Figure 4: Monitoring of Ionizing Radiation with Crystal Scintillator of NaI(Tl). Red Line Corresponds to 1 Day Smoothed Points.

During the time interval of ~ 40,000 minutes, there was a day of heavy rain and drizzle, which is observed in Figure 3, shows that the Russian Geiger also evidenced the presence of rain with increased ionizing radiation. Figure 4 shows the environmental ionizing radiation measurements are now performed at the same location and time period using the NaI (Tl) scintillator. Note that the definition of the presence of ionizing radiation is better and the presence of rain also causes the intensity to vary, seen in the graph at times of ~ 5000 and ~ 30000 minutes.

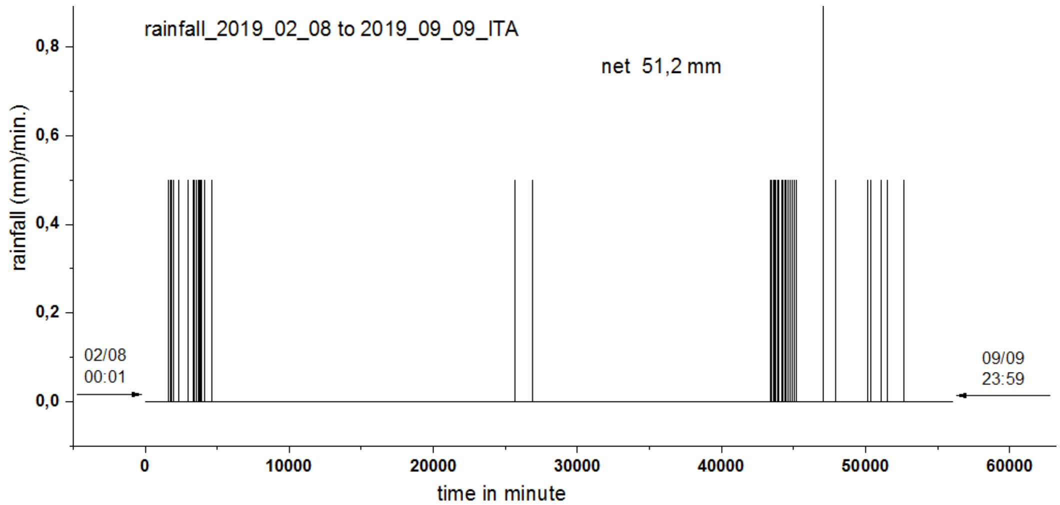

Figure 5: Monitoring of Rainfalls to each Minute during 2019/02/08 to 2019/09/09 in ITA Campus.

Figure 5 shows the variation of rainfall intensity every 1 minute observed in the same place and in the same period of measurement of the ionizing environmental radiation. Rain was measured by an electronic tilting rainfall system performed at the ITA for this purpose. Previously, there was calibration in the ITA laboratory by the ATMOSRAD research group and school students[6] and[7].

Looking at the rainfall graph above, it can be seen that during the early days of August and the last days of August, there was moderate rainfall and drizzle. However, between August 5 and 28, nothing rained in the region. This rainfall dynamics is well revealed when we look at all graphs of environmental ionizing radiation monitoring presented in this paper.

CONCLUSIONS

In this work, the very good ability to measure environmental ionizing radiation was verified using a Geiger proportional counter built with a Russian tube of 16 cm length and 2 cm diameter. A very simple and inexpensive electronic system (Arduino) lends itself to feeding and acquiring data from these measurements. The Geiger constructed with smaller Chinese tube 7 cm long by 1 cm in diameter was hampered by the presence of internal gas used that also detect visible light. Several tests were performed, but he always observed the visible light, as Figure 1 presented in this work. The ionizing radiation measurements observed from 12/08 to 09/09 of 2019 with the NaI (Tl) scintillating crystal clearly indicate the interference of rainfall on the variation of the intensity of environmentalionizing radiation. It follows that most of this radiation comes from the radon gas exhaling from the earth's surface.

ACKNOWLEDGEMENT

Thanks to CNPq (National Counsel of Technological and Scientific Development) and CAPES (Coordination for the Improvement of Higher Education Personnel) by the fellowship grant support to the group's researchers and the ITA Division of Fundamental Sciences for supporting this research. Thanks also to INCT-FNA-ITA to support this research at ITA.

REFERENCES

1. *Van et al. 1988. "Measurements of Natural Radioactivity at Different Atmospheric Depths." Geophysics Magazine 28: 262–266.*
2. *Flakus, F. N. (1982). Detecting and Measuring Ionizing Radiation- A Short History. IAEA bulletin, 23(4), 31–36.*
3. *Fujinami, N. 2009. "Study of Radon Progeny Distribution and Radiation Dose Rate in the Atmosphere." Japan Journal Health Physics 44 (1): 88–94.*
4. *B. J. Boardman, Aware Electronic Corp., P.O. Box 4299, Wilmington DE 19807, USA, www.aw-el.com, 2015.*
5. *Martin et al. – Monitoring of Ionizing Radiation Using Geiger Instrument During February to April 2015 in São José Dos Campos, SP, Brazil; Journal of Environmental Science and Engineering A, 4(6): 282–285, doi: 10.17265/2162–5298/2015.06.002, 2016.*
6. *Vilela et al. – A low cost experiment to identify variations in the concentration of environmental radon, Physics Education, 54 (5): 1,5, IOPscience, June 18, 2019.*
7. *M. Martin, A. A. Gusev, M. Alves and W. N. Spjeldvik – Radiation fallout in the rainy seasons in tropics; COSPAR paper A1.1-0140-14 seção STW-L-031, 40th Scientific Assembly, Moscow, Russia, 2014.*
8. *Martinet al. – Measurements of X and gamma radiation at ground level and their correlation with atmospheric parameters; International Journal of Agriculture and Forestry, ISSN 2165–8846, 3(4): 138–141 doi:10.5923/j.env.20130304.03, 2013.*

AUTHOR PROFILE

Inacio Malmonge Martin graduate school in UNESP – Universityof São Paulo State in Brazil in 1967 andreceivedhis PhD degree in physicsfromUniversite Toulouse III (Paul Sabatier) in 1974, France.. He iscurrentlyassociate professor in thephysicsdepartamentat Instituto Tecnológico de Aeronáutica (ITA).