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NEAR-GROUND MEASUREMENTS OF GAMMA RADIATION (0.2 TO 10.0) SEM IN SÃO JOSÉ DOS CAMPOS, SP, BRAZIL

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ABSTRACT

In the period from August 1 to October 30, 2024, the region of São José dos Campos, SP, Brazil, experienced large variations in the intensity and quality of the air close to the Earth's soil. This fact happened due to the great drought and high temperatures with intense fires in Brazil and also in this region of the Paraíba Valley. Continuous measurements were then made every minute in this region. In this experimental work, the measurements of the counts per minute of gamma radiation one meter above the ground are presented. Several spectra were also carried out at the same time and place to identify radiation with different burning clouds present at the site. The analysis and discussions of the measured results are done in this work.

Keywords: Gamma Radiation. Environmental Measurements. São José dos Campos.

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INTRODUCTION

The presence of gamma radiation close to the Earth's soil in the energy range of (0.2 – 10) MeV comes from 3 possible sources, i.e., secondary cosmic rays, primordial radiation from the Earth, and the presence of lightning at the measurement site [1-3]. Secondary cosmic radiation is produced in the Earth's atmosphere at heights of 14-17 km vertical from the measurement site, called the Pfotzer maximum [4], by primary cosmic rays. The Earth also during its formation produced several nuclides that emit gamma radiation in this energy range. Lightning also produces this radiation in the measured region [5]. The gamma radiation spectrum analyzer within a chosen energy range shows the number of gamma photons at each photon energy. This allows you to determine what energy peaks exist in the measurement region [6]. Using a gamma-ray scintillator it is possible with specific electronics and radioactive sources of various energies to determine the integrated photon count in a given energy range. Thus, it is possible to evaluate the dose of gamma ray radiation in that energy range of the measurement site. This dose is variable in all regions of the Earth's surface [7].

MATERIAL AND METHODS

To measure gamma radiation between 0.2 to 10 MeV (million Volt electrons), a 3x3-inch gamma-ray scintillator of Thallium-activated Sodium Iodide was used and protected with a 1 mm thick aluminum casing. This scintillator associated with its own electronics counted the number of pulses detected in the scintillator every minute. A computer recorded and saved this parameter in a memory, always as a function of time [8]. Figure 1 shows the detector composed of the scintillator, associated electronics and the computer with the graph of a given time of measurements with a 1-minute step between them.

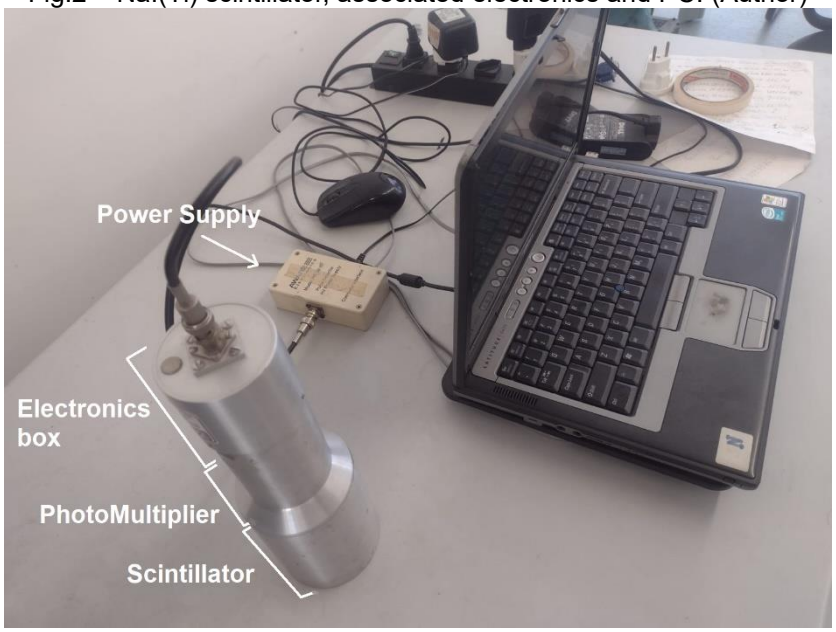
Fig. 1: View of gamma scintillator with associated electronics and computer. (Autor)



On the computer screen, the intensity of pulses measured as a function of the time interval chosen for each measurement appears. The black box above the photomultiplier is

all the electronics needed to receive the data of this measurement, for more information see [9]. Using radioactive sources between (.2 to 10) MeV and black box circuits, one can calibrate the lower and upper level of the energy range of the measured photons. You can also put the measurement voltage of the photons between 500 and 1500 Volts.

Fig.2 – NaI(Tl) scintillator, associated electronics and PC. (Author)

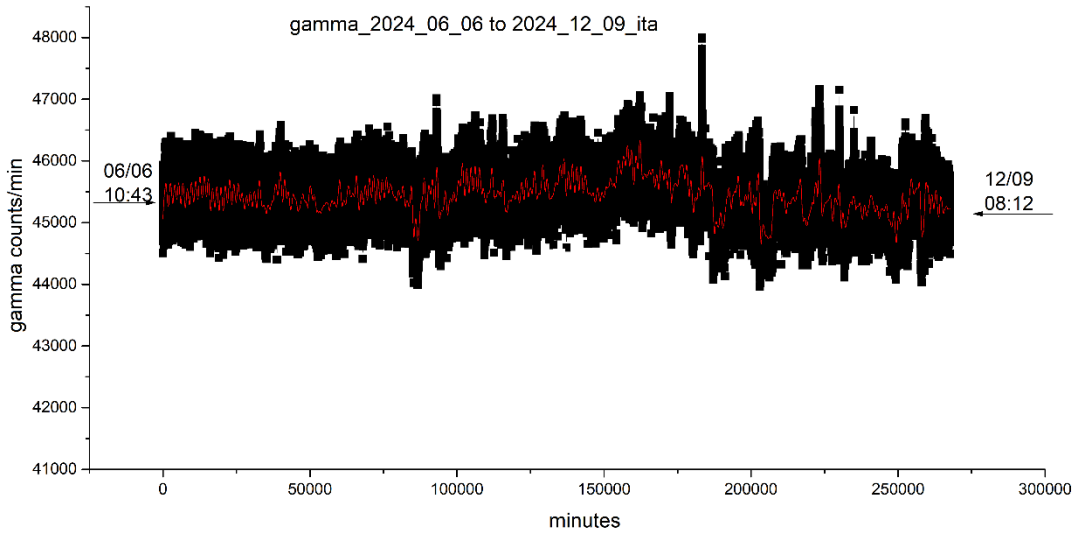


In Figure 2 you can see the electronica, photomultiplier and NaI(Tl) scintillator set with greater clarity, now with the electronics box in white. This integrated gamma radiation detection system will spend at least a month making continuous measurements in ITA's Atmosrad laboratory.

RESULTS AND DISCUSSIONS

The gamma radiation measurements were made at the Technological Institute of Aeronautics (ITA) at the Atmosrad laboratory during the specified period 06/06/2024 to 09/12/2024. Figure 3 shows the general graph of these measurements, vertically relating gamma photon counts per minute as a function of the passage of time, also with measurements of the past of one minute.

Fig. 3 – Measurements of gamma radiation intensity between 06/06 and 09/12 of 2024. (Author)



This continuous monitoring of gamma radiation in the same location and conditions shows two periods that are well related. From 06/06/2024 to 150000 minutes, the influence of dry weather and smoke from fires is noticeable, figure 4, in the region of the municipality of São José dos Campos.SP.

Fig. 4 – View of the intensity of smoke from the fires in São José dos Campos, SP. (Author)



Between the period of 150,000 minutes and 270,000 minutes there are more variations in radiation intensity with influences of clouds and rainfall in the region. The main result of this work was to show in terms of variations in the intensity of gamma radiation in the region with very dry weather, smoke from fires and cloudy and rainy weather. The year 2024 was quite different in terms of drought and fires in the Vale do Paraíba region and the rains in October, November and December 2024.

CONCLUSION

From June to December 2024, the region of São José dos Campos, SP, went through a dry period, fires that threw a large amount of smoke into the lower atmosphere and cloudy weather with above-normal rainfall. This behavior of the air observed in the lower atmosphere of the region was also noted in the profile of the variation of the gamma radiation intensity between (0.2 – 10) MeV monitored in the same period and place. It is then experimentally proven that dry, cloudy and rainy weather alter the profile of gamma radiation near the Earth's surface.

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