Gamma Field Measurement at AJ4CO Observatory

Dave Typinski, October, 2018

This article details the equipment and procedures used at AJ4CO Observatory to measure, record, and analyze the ambient gamma radiation field within the observatory.

Instrumentation

The AJ4CO gamma instrument is based around a Victoreen CD V-700 Model 6B low range Geiger-Mueller survey meter, an example of which is shown in Fig. 1. These survey meters were produced in the tens of thousands in the early 1960s for the US Office of Civilian Defense.

Figure 1 – The Victoreen CD V-700 Model 6B low range Geiger-Mueller survey meter.

The GM tube's beta shield is left in the closed position so that only gamma radiation is detected. See Appendices 1 through 4 for more details of the survey meter.

The V-700 6B was designed to use four NEDA 13 (D-cell) batteries to provide +3 VDC and -3 VDC. In operation at AJ4CO Observatory, the batteries have been replaced by two HP 6216A regulated DC power supplies (see Fig. 2). Any well-regulated 3 VDC power supply could be used in lieu of the HP supplies.

Figure 2 – The HP 6216A 0-30 VDC regulated power supply.

The V-700's audio output is fed to a Creative Labs SoundBlaster SB-1090 X-Fi 5.1 USB sound card's Line Input jack (see Fig. 3).

Figure 3 – The Creative Labs SoundBlaster SB-1090 X-Fi 5.1 USB external sound card.

This audio connection requires an adapter cable that can be made from a Switchcraft 2501F (Mouser P/N 502-2501F) connector and a Switchcraft 35HDNN (Mouser P/N 502-35HDNN) 3.5mm TRS connector. The center

connection from the V-700 audio connector is connected to the tip of the TRS plug, the ground of the V-700 connector is connected to the sleeve of the TRS connector. Generic small-guage zip cord style speaker wire is used here as shown in Fig. 4.

Figure 4 – Custom-made audio adapter cable. The male end on this cable is a mono (tip sleeve, or TS) 3.5 mm plug that happened to be on hand. The stereo (tip, ring, sleeve or TRS) equivalent is recommended to facilitate data acquisition from a second instrument on the second audio channel, if desired.

A diagram of the complete hardware setup is shown in Fig. 5.

A Windows PC is used to host the sound card and the data acquisition software. Data acquisition is performed by Radio-SkyPipe (RSP) version 2.7.1. RSP is configured to use a 12 kHz audio sample rate, the "pulse detector" detection method, and an RSP sample period of 1 s. Data is saved in 24-hour files.

The sound card's Line In gain (via Windows audio control) is set to 20% to avoid spurious counts. RSP records data continuously in 24-hour data files, recording one record per second containing the number of gamma counts observed in that second.

When operating properly, the number of counts should be between 10 and 20 counts per *minute*. The real time RSP display should look similar to Fig 6.

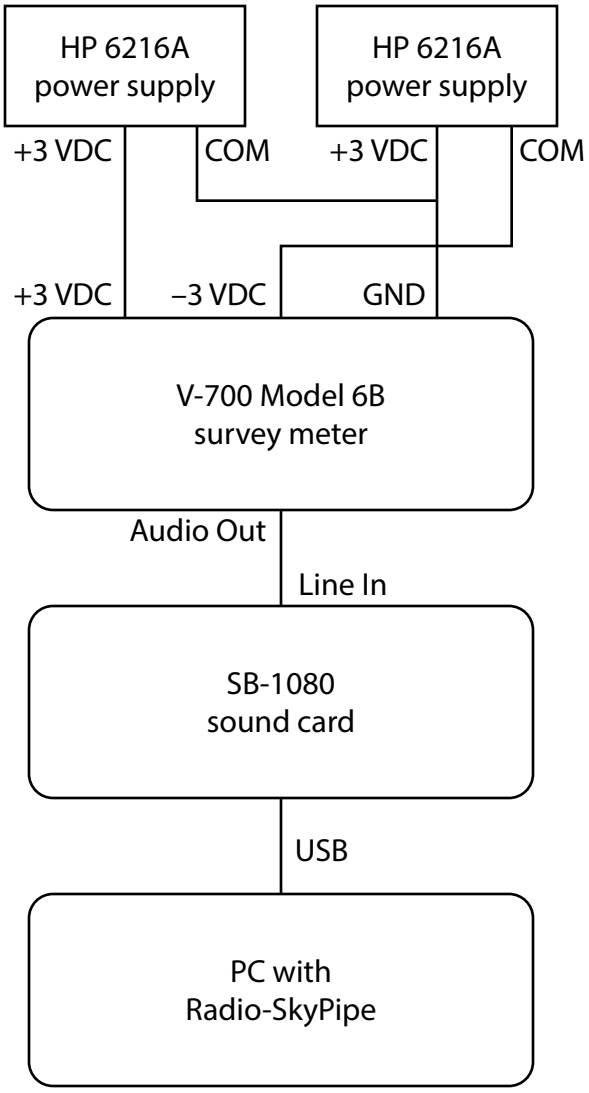

Figure 5 – System diagram of the AJ4CO gamma radiation data acquisition and recording system.

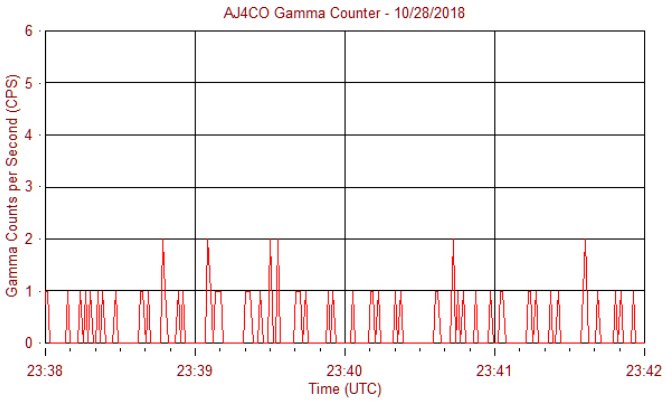

Figure 6 – RSP real time display of gamma counts being recorded. This is equivalent to an average of ~16 counts per minute (CPM).

(2017).

Data Analysis

Data analysis is performed using Mathematica to bulk-process multiple daily data files. The immediate goal is to duplicate previous observations by others to see if the gamma flux varies with the amount of solar activity.

First, the gamma counts are binned to produce the histogram and plots shown in Figs. 7 though 9.

For the GM tube used in the survey meter, 600 CPM is equivalent to 1 mR/hr if the gamma radiation being observed originates from cobalt 60 (1.17 and 1.33 MeV) or cesium 137 (0.66 MeV) decay. This proportionality contant is inaccurate for gamma radiation outside this range of energies.

A conversion from counts per minute (CPM) to Roentgens per hour (R/hr) is made to produce the plots shown in Figs. 10 and 11.

Discussion

As solar activity decreases, the solar wind becomes thinner, decreasing the density of the radiation shielding against comic rays. The AJ4CO gamma data to date, what little there is, shows possible agreement with the decrease in solar activity at the tail end of solar cycle 24 from 2017 to 2018. Many more years of data is required before any conclusion can be formed.

References

[1] Little and Leinbach, *The Riometer—A Device for the Continuous Measurement of Ionospheric Absorption*, Proc IRE (1959).

[2] Typinski, *AJ4CO Station Description*, SUG