Construction & Testing of the Terrestrial RaYs Analysis and Detection (TRYAD) Science Instrument

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TRYAD is a collaborative project between Auburn University, the Goddard Space Flight Center, and the University of Alabama Huntsville Center for Space Plasma and Aeronomic Research (CSPAR) to create a pair of Terrestrial Gamma Ray Flash (TGF) detector satellites. UAH is responsible for the satellite’s science instrument, which must detect gamma radiation emitted from thunderstorms on Earth.

Introduction

Terrestrial Gamma Ray Flashes (TGF) are sudden bursts of gamma radiation associated with lightning strikes in the Earth’s atmosphere. Their exact production mechanisms are not fully understood, so more data needs to be collected. The TRYAD team at UAH has been working on an instrument for detecting gamma radiation that will be flown onboard a pair of satellites for researching TGFs. In 2021 this science instrument was assembled and tested by a team of students at UAH.

Detector Theory

In order to detect and measure high energy gamma rays our instrument uses a plastic scintillator material that produces light when struck by ionizing radiation. This light can then be detected by an array of very sensitive silicon photomultiplier (SiPM) boards at either end of the scintillator bars.

The instrument is divided into two banks, labeled A and B. Each bank contains two plastic scintillator bars with 30 1x2 SiPM carrier boards on either end. Both banks output a signal that is processed by our data acquisition board which interfaces with the satellite avionics.

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Instrument Overview

Silicon Photomultiplier (SiPM) array.

TRYAD satellite with Science Instrument high-lighted.

Testing

We first confirmed the ability of the SiPM arrays to detect light. This was done by placing the exposed SiPM boards in a light-tight testing enclosure and flashing an LED at varying frequencies. We could then observe the signal output from the SiPMs that corresponds to each flash of the LED.

After confirming the SiPMs functioned in the LED test, the full instrument was assembled and enclosed within a light-tight metal case. The instrument was tested in the presence of radioactive samples to verify the scintillators and SiPM array’s ability to detect the light they emit.

Results

Our instrument was able to successfully generate a signal pulse in both the LED and radiation tests. This signal can now be processed by our data acquisition hardware.

We experienced varying amounts of noise between the A and B banks of the instrument. Further testing will need to be done to understand why one bank has more noise than the other.

Future Work

Work will now be focused on our data acquisition board. TRYAD will be flying a pair satellites, so two identical science instruments will now need to be produced for this mission. We continue to work closely with the team from Auburn University who is designing the satellite avionics and the Goddard Space Flight Center who assists with the Science Instrument hardware.