

Sensor Testing for DarKNESS

Trino Jaime¹

Supervisor: Juan Estrada²,

¹University of Illinois at Chicago, Chicago, IL 60607, USA

²Fermi National Accelerator Laboratory, Batavia, IL 60510, USA

Abstract

I had the incredible opportunity to be a part of the DarkNESS project—a mission with the exciting goal of sending a CubeSat satellite into a low orbit around our planet. The mission’s purpose is to capture X-ray images of the center of the Milky Way galaxy. This is where scientists believe we might find clues about dark matter. During my time at Fermilab, I focused on creating a lab setup specifically designed for DarkNESS. This setup allowed us to test all the different parts and electronic components that would be used in the actual mission. These components being a Space Low Threshold Acquisition electronic and a Space Multi CCD module package. One of the major challenges was controlling the temperature inside a vacuum cube. To tackle this, I employed a clever technique known as Pulse Width Modulation, along with a control concept called Proportional, Integral, and Derivative. For this, I utilized a small computer called Arduino UNO and a handy board named Arduino 4 Relays Shield. Getting the vacuum cube to reach the required cold temperature and near-vacuum pressure was crucial for the tests we conducted on a Charge Coupled Device (CCD). These cameras are essential for capturing the unique images that have contents of cosmic rays. To ensure everything was going smoothly, I also developed a user-friendly computer program using Python. This program continuously kept track of the temperature and pressure inside the vacuum cube, providing real-time updates that helped us monitor the temperature and pressure. To analyze these images and identify any telltale traces left by minuscule particles, we used a Jupyter script that identified them. In the end, it was truly fulfilling to see that all the critical components of the project were thoroughly tested and that I was able to produce a component capable of assisting in this mission.