

## **QCC Quarknet Center 2020 Annual Report**

### **2020 summer remote workshop activities**

The workshop included activities to learn about the design, assembly, and functionality of a cosmic ray data acquisition circuit, DAQ, being built by students and teachers in the QCC cosmic ray lab. It consists of a front-end electronics circuit board (DAQ FE) to receive, amplify, and select signals from photomultiplier tubes; an Arduino Mega microcontroller to digitize signal amplitudes and record their times of arrival, a GPS antenna and receiver to keep track of UTC time, atmospheric pressure and temperature sensors, a digital LCD counter display, and a Raspberry Pi single board computer to automatically upload the cosmic ray data to the internet.

For the first project teachers were provided with electronic components and instructed to wire them together, install operating software, and use the Arduino to turn on and off an LED light bulb at a regular rate, and record the data. The Arduino is connected via USB to a computer, the LED is wired in series with a resistor to limit its current to 30 mA; jumper wires connected the LED to a breadboard, and the breadboard to the Arduino pins. The LED is flashed at various rates. Next the computer is replaced with the Raspberry Pi via USB; the *Raspian* operating System is downloaded onto the micro SD card; the Raspberry Pi is connected to a computer monitor via HDMI, keyboard and mouse, and wirelessly logged onto the internet. The LED bulb is flashed on and off at regular rates and data uploaded to the internet.

A second project involved reading published papers, and presentations, on Arduino based cosmic ray DAQs designed by other educational groups. This included doing a literature search, reading the materials, and summarizing the technical information on their electronics and/or coding which limits their time stamping resolution capabilities.

### **Surplus plastic scintillator and photomultiplier tubes obtained from UCLA**

17 used plastic scintillator sheets, and photomultiplier tubes, were donated and shipped to QCC from a UCLA particle physics group; they were originally part of a muon test stand for large hadron collider detector development activities.