Detection of Cosmic Particles at Vaughn College

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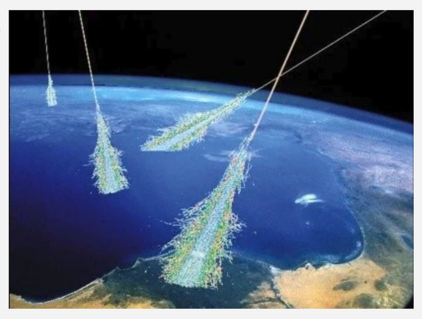
ABSTRACT

Two major reasons to study cosmic rays include radiation hardening to protect electronics and understanding potential health risks of low-level radiation especially at high altitudes. This cosmic ray detector has been constructed to remain Vaughn and detect cosmic particles for years to come. The system includes an acrylic scintillator, a photomultiplier tube (PMT), power distribution unit (PDU), and a data acquisition (DAQ) board. Further, the data can be uploaded to the Quarknet Cosmic Ray E-Lab to be integrated with cosmic ray data from other locations in NYC to reconstruct cosmic showers.



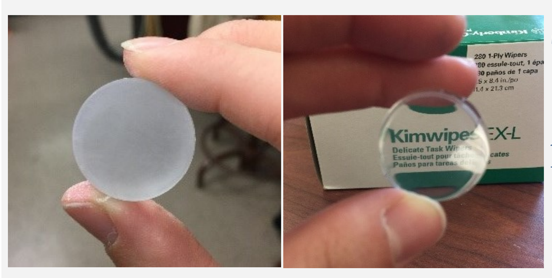
WHAT IS A COSMIC RAY?

When a star explodes, a charged particle races through the galaxy at nearly the speed of light. The galactic cosmic ray (GCR) makes its way to the Earth's atmosphere as if in a pinball machine. When the GCR interacts with the Earth's atmosphere, it decays into a shower of secondary particles. This detector is able to count the muon particles of a cosmic ray shower.

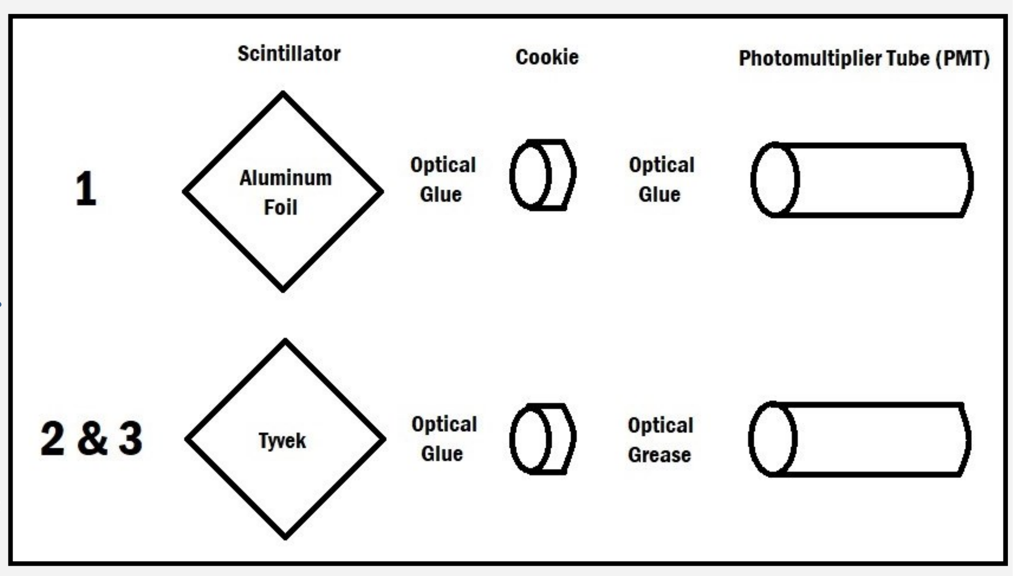
WHY STUDY COSMIC RAYS?

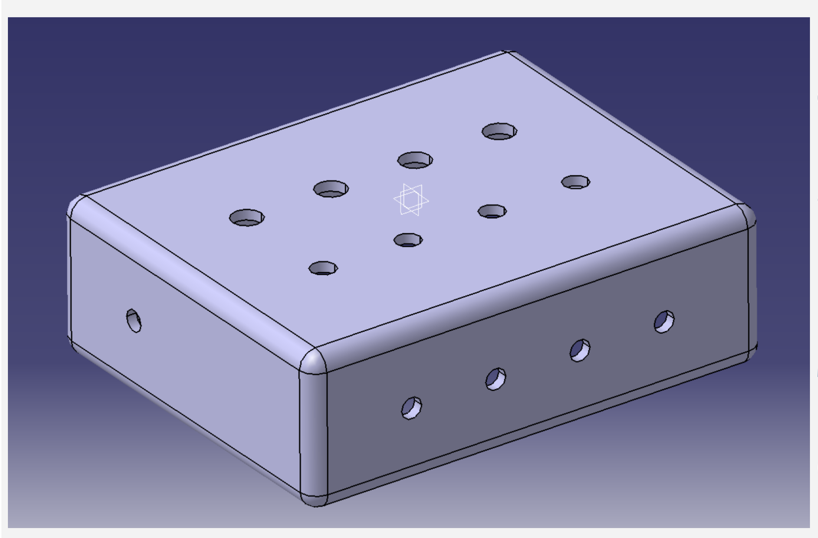
There is about 1 muon, a particle of cosmic ray decay, per cm^2 per minute at sea level. However, there is greater exposure to cosmic rays at higher altitudes. Electronics, especially Integrated Circuit (IC) chips can fail or their memory can be corrupted when a cosmic event occurs. Intel has proposed radiation hardening by creating a chip with a built-in detector that prompts the microprocessor to

CONSTRUCTION



The SCINTILLATOR begins as a square piece of fluorescent acrylic which must be sanded and polished as any imperfections will absorb the light of a muon. Then, an acrylic cookie was glued to the scintillator to act as a window to the photomultiplier tube (PMT). The scintillator was wrapped in a reflective material and then a black material. Finally, the PMT was glued or greased to the cookie, a PVC support was assembled, and the entire counter was covered in thick black plastic and tape to keep out outside light.

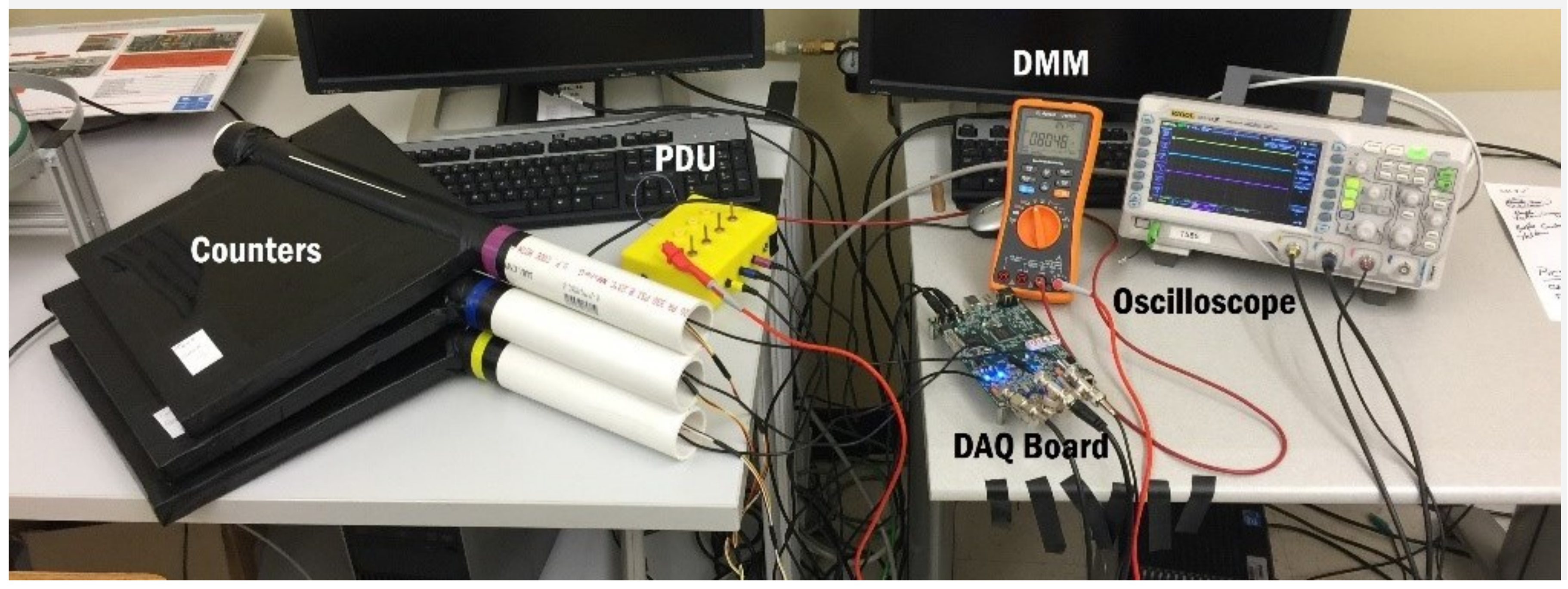




The POWER DISTRIBUTION UNIT (PDU) is a voltage divider circuit used to

CONSTRUCTION (continued)

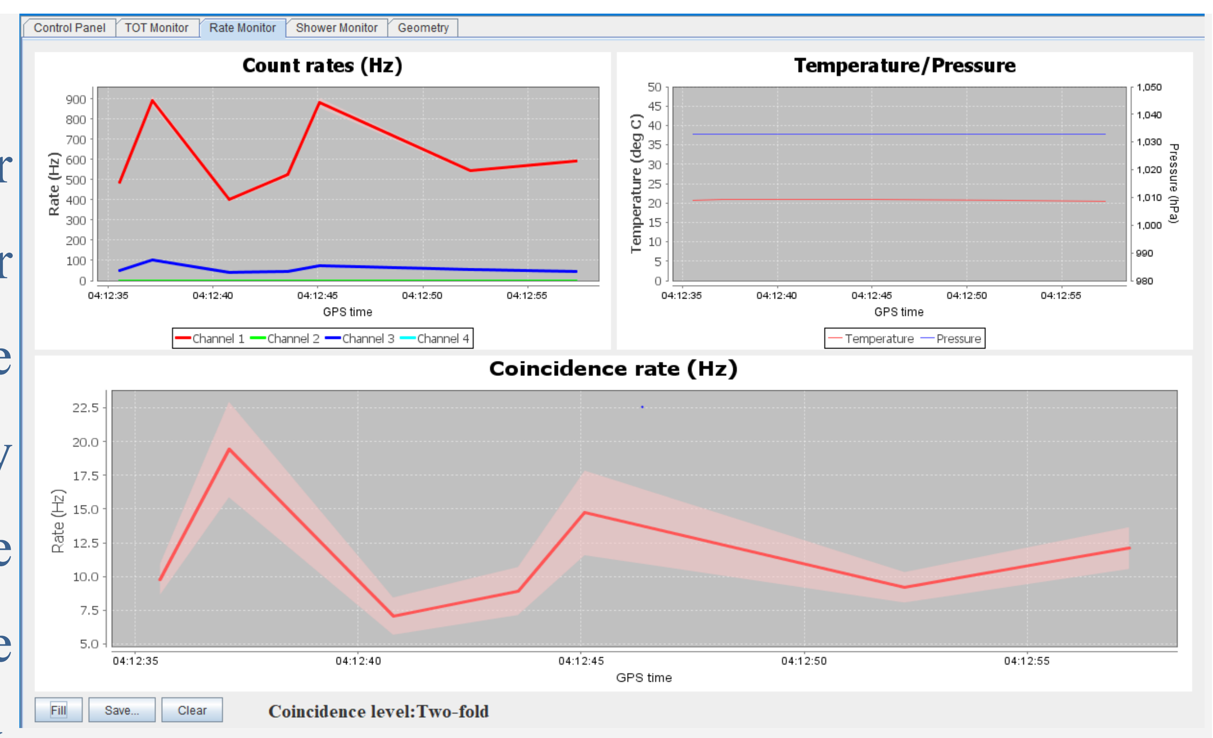
The PHOTOMULTIPLIER TUBE (PMT) consist of a cathode, a series of dynodes, and an anode which work together to amplify the number of electrons. The gain of electrons is a function of the applied voltage by the PDU. The PMT was wired to a coaxial BNC for signal to the DAQ and oscilloscope, and a stereo cable was used to plug into the PDU. Finally, all the components were connected



DETECTING COSMIC PARTICLES

A falling edge trigger was set on the oscilloscope in order to prevent it from detecting dark pulses. It was clear that Counters 1 and 2 have stronger signals than Counter 3. Additionally, using Ohm's Law, the current out of the PMT was calculated. Using EQUIP software and the DAQ Board, data collection and analysis was performed. Using the GPS module and by inputting several measurements, the DAQ is able to output a time and location stamp every time a coinci-

CONCLUSION



Counter 3 may have lower performance for a number of reasons. First of all, the acrylic is over twenty years old. The abundance of crazing on its surface absorbs light. Additionally, the joint is greased and the photomultiplier tube could be sagging. The expected cosmic ray rate is 13 Hz. From the EQUIP Coincidence rate graph, the cosmic

ACKNOWLDGEMENTS

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Courtland, Rachel. "Radiation Hardening 101: How to Protect Nuclear Reactor Electronics." *IEE Spectrum: Technology, Engineering and Science News,* IEE Spectrum, 22 Mar. 2011, spectrum.iee.org