Adapting the Cosmic Watch for the Classroom

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Abstract

QuarkNet is a particle physics outreach and education program in the United States. We have learned from our own experience and from international colleagues, especially in Japan, of the usefulness of the Cosmic Watch small cosmic ray detector. We are in the process of testing multiple units and adapting them for use in laboratory investigations in high school physics classes. This presentation will report progress and prospects.

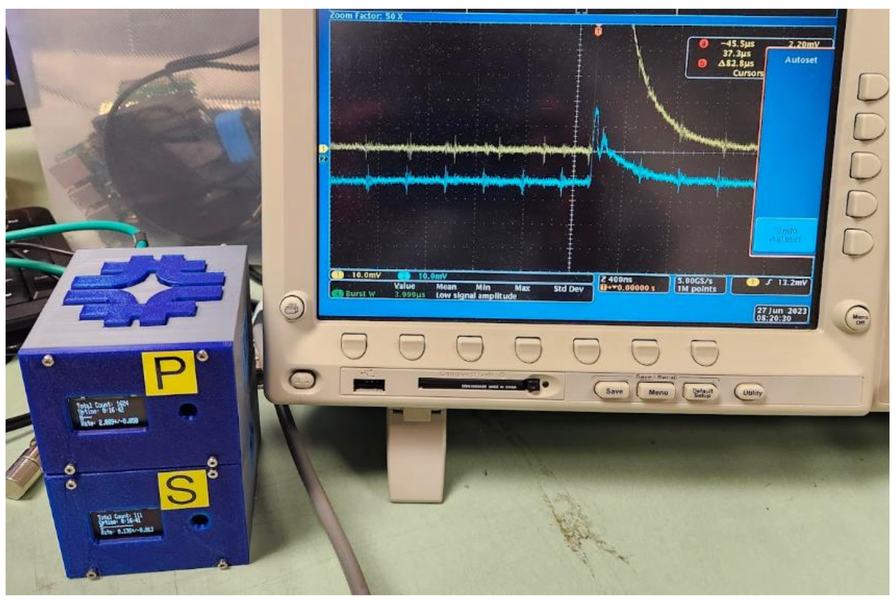

Figure 1. Two stacked Cosmic Watch cosmic ray detectors (left) with their signal traces on an oscilloscope (center and right).

Use case

The Cosmic Watch is smaller, less expensive, and electronically simpler than most cosmic ray detectors. This makes production of "class sets" of 10-20 detectors possible. The Cosmic Watch is ideal for distribution to students in a high school laboratory setting to do experiments to introduce them to cosmic ray physics.

Test 1: Two-fold coincidence rate reliability

We determined early in the process that the optimal use of the Cosmic Watch in the classroom is with two-fold coincidence, that is, with one detector triggering off the other. A concern is at what point the rate can be read reliably. Kallenberg measured rates as a function of two-fold count. He found that the rates varied over the first 5 coincident counts but flattened to a reliable number after 20 coincidences.

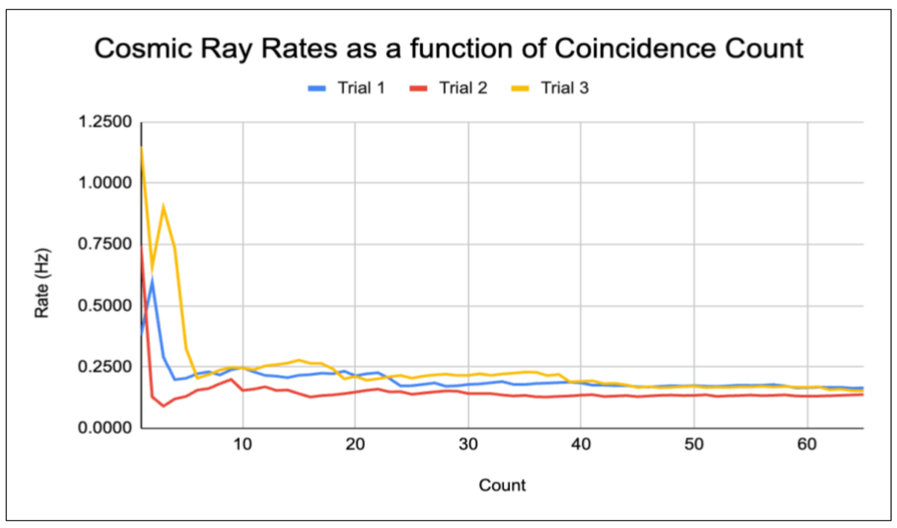

Figure 2. Two-fold rates vary greatly at first but flatten after ~20 counts.

Test 2: Zenith angle measurement

An ideal classroom experiment for the Cosmic Watch is measuring the rates with the axis of two detectors in coincidence making various angles with the zenith. Karban and McNeely made this measurement with three different sets. Their results showed that the normalized rate decreases with increasing angle, consistent with expectations

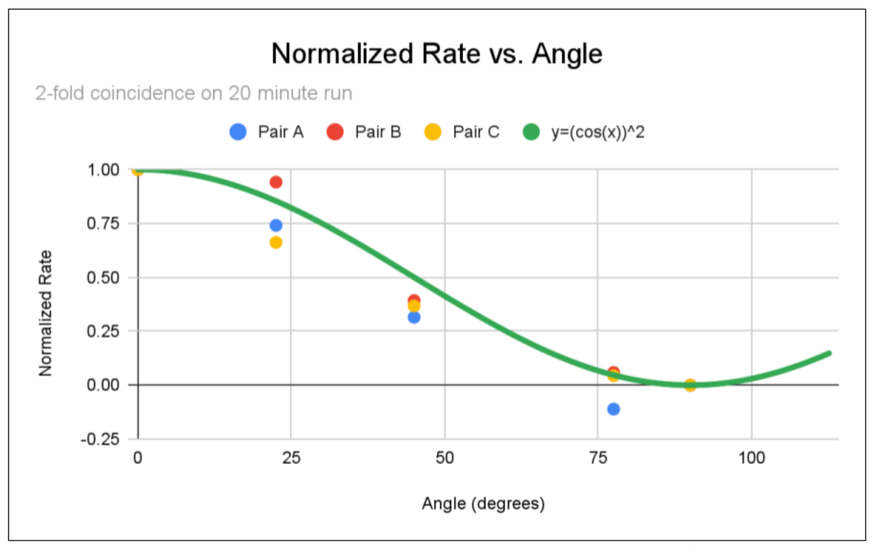

Figure 3. Cosmic ray rate as a function of zenith angle of the detectors.

Separation of counters

It is also possible for groups of students to study the effect of separation of counters on the coincidence rate. Cecire did a simple measurement with a pair of counters. He separated the counters vertically, one unit above the other, at several different heights.

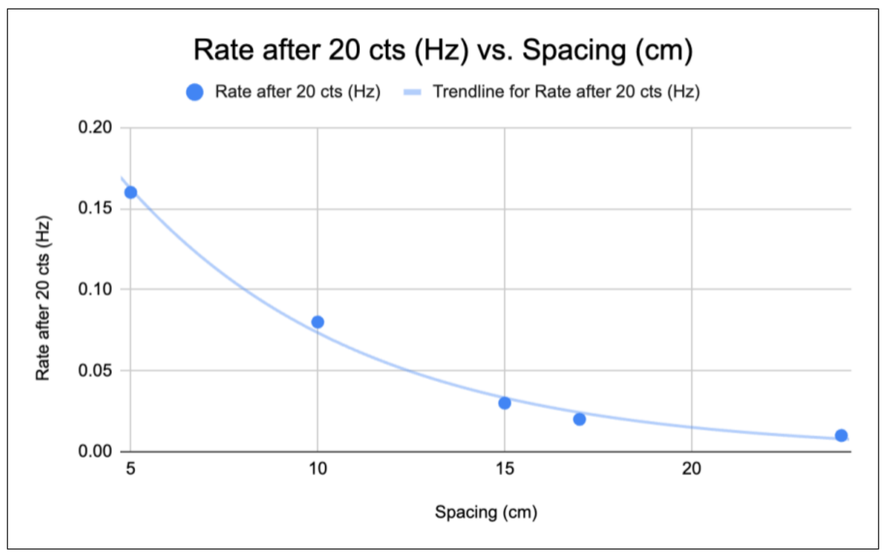

Figure 4. Decrease in rate due to decreased solid angle of acceptance as counters are vertically separated.

Conclusion

The Cosmic Watch is a viable instrument for practical experiments in a whole-class setting in high school physics. Additional work is needed to optimize robustness and reliability of the Cosmic Watch so teachers can take out class sets for a week or two and be assured that students can use them to make reliable measurements. Students and teachers will find more ways to make studies using the Cosmic Watch.

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