

Hartnell College Employee Innovative grant award

Project Completion Report

This report lists the work accomplished for the activities described in the proposal.

Two Hartnell STEM students were hired to help prepare this research project and one student assisted at the workshop. A third student also assisted the project and helped to assemble and test the detector prototypes for proper functionality.

The Hartnell students were: Daniel Ramos, Rommel Niduaza and Adrian Knox

The project students participated and carried out the following physics experiments and related outreach activities for the project.

Below is a list of experimental activities and workshop activities completed.

Worked on the development of cosmic ray detector and electronic components for the Salinas Airshower Learning And Discovery project (SALAD).

- 1) Assembled and tested 3 detector modules for 3x3 mm² silicon photomultiplier from AdvanSiD.
- 2) Made extensive test and evaluation of electronic circuit boards for analog comparator components.
- 3) Made measurements with electronic circuit boards, detectors to measure cosmic ray signals.
- 4) Assembled and extensively tested 7-segment LED display, MAXIM 7221 led controller and Arduino microcontroller programs.
- 5) A field trip to Salinas High School to conduct outreach activities to recruit potential students to attend the SALAD workshop was made on 4/6/15.
- 6) Implemented SALAD outreach workshop on Saturday 4/25/15
Total attendance: 13 students and 1 high school science teacher
- 7) Implemented SALAD outreach workshop on Saturday 5/2/15
Total attendance: 10 students and 1 high school science teacher
- 8) A workshop syllabus was written that describes the detail assembly and parts of the cosmic ray detectors modules.
- 9) A survey to obtain student feedback for the workshop was also conducted.

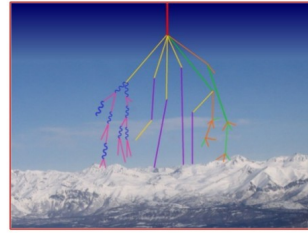
Workshop Activities included:

Hands-on work in using

- a) oscilloscopes,
- b) signal generator,
- c) experiment to determine the speed of light using optical fibers,
- d) cosmic ray photomultiplier detectors,
- e) silicon photomultiplier detectors,
- f) preamplifier,
- g) high voltage power supply,
- h) analog signal comparator circuits
- i) electronic circuit assembly,
- j) arduino microcontroller programming,
- k) linux on Raspberry Pi computer, and
- l) electronic soldering.

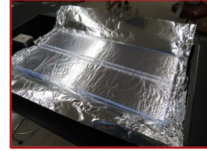
Salinas AirShower Learning And Discovery Project (SALAD)

Assembly and Parts Syllabus

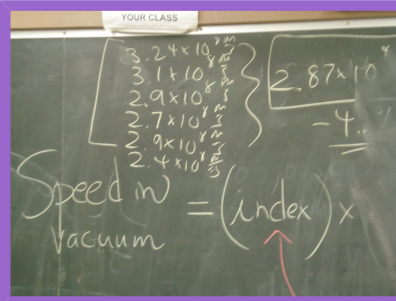


A cosmic ray primary particle encounters particles (atoms, molecules) in the atmosphere and impart its energy to produce additional secondary cosmic ray particles forming a particle airshower (these secondary particles include: muons, electrons, positrons, neutrons and more ...).

The secondary particles can be measured using a special plastic material, a plastic scintillator. This material is embedded with fluorescence molecules that can emit light when energy is imparted, from the energetic secondary particles, as they transverse the scintillator. The light is very faint and occurs briefly and it normally needs a sensitive and fast light sensor, a photomultiplier detector, to measure it.



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Group photo: Salinas High School students and teacher, 4/25/15





Group photo: Salinas High School students and teacher, 5/2/15

Summary of survey questions and students' responses.

1) Please describe in a couple of sentences your overall experience at the workshop.

"Very interesting and it was full of bits of useful information. I am very pleased and wish to continue this project."

"The experience was wonderful, I learned a large amount."

"The workshop is very enlightening. It is also very confusing. If there was another one, I would probably come and be confused again."

"I have learned many things , and I have really enjoyed the learning process."

"I was very interested in the experiments we we're trying. It was very enjoyable & I would do it again."

"I was very intrigued by the information."

"I really enjoyed this workshop. It wasn't too difficult to do the labs or the work with any of the equipment."

"I personally really enjoyed the cosmic ray workshop, it was fun and very easy to follow."

2) Please describe 2 things you have learned at this workshop.

"It is necessary for a cosmic ray to hit both panels in order to be considered a "real" cosmic ray. There needs to be a certain amount of voltage supplied to the circuit for it to be in the threshold."

"I learned about building a cosmic ray box, and about electronics."

"I have learned what a photomultiplier is."

I have also learned a bunch of physics stuff that I will probably have to learn next year."

"I have learned about cosmic ray detectors and circuit boards. During this workshop I have learned about the cosmic ray detectors created by both Hartnell and UC Davies. I also learned about the cosmic ray components. In addition I have learned about circuit boards, and their components such as resistors, input and output."

"I learned how to code using arduino. I also learned how to operate linux."

"1) Oscilloscopes 2) Led/arduino."

"I learned how we detect cosmic rays and some basic coding."

"-What cosmic rays are and how we detect"

-A brief look into computer programming

-Arduino lab"

3) Please describe 2 things you would like to learn more about after this workshop.

"More on the coding involved. More on the theory of the circuits."

"I would like to learned more about soldering and parts building."

"After this workshop, I would like to learn more about the High Voltage Biasing supply and what someone could do with it. I would also like to learn more about the comparator."

"After completing this workshop I wish to learn more about circuits, and how they work. I also want to learn how personally build machines such as cosmic ray detectors."

"I would like to learn more about coding. I would also like to do more work using LEDs."

"1) Soldering"

2) Voltage"

"I would like to learn more about coding and what else you can do with the Arduino."

“-I would definitely look into programming
-May some more background on Cosmic ray detection.”

4) Please indicate if you would recommend this workshop to other students, why or why not?

“I would strongly recommend this to other students because it is extremely beneficial, in that the techniques have a lot different applications.”

“Yes, it is one experience to have.”

“I would recommend this workshop to other students. As I said before, It is very enlightening and interesting.”

“I would recommend this workshop to friends because I know many people who would benefit from this workshop, and who enjoy activities such as this workshop.”

“Yes, I would recommend this.”

“Yes, it very resourceful.”

“I would recommend this workshop to other students because I learned a lot and enjoyed.”

“I would and will recommend this workshop to others as it was very informative and a great hands on experience.”

Salinas AirShower Learning And Discovery Project (SALAD)

Activities 4/25/15

Practice with Oscilloscopes

Morning activities

- 1) Welcome and Introduction
- 2) Using function generator
- 3) Speed of light in optical fibers
- 4) lunch at 12:00PM

Circuit setup

Afternoon activities

- 7) Analog Devices AD8561 comparator circuit
- 8) Monovibrator circuit 74LS221
- 9) AND logic device 74LS08
- 10) National Semiconductor LMH6559 amplifier

Cosmic ray detector introduction

Afternoon activities

- 5) Berkeley Lab cosmic ray box
- 6) Hartnell silicon photomultiplier setup

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graph LR
    S[Scintillator] --> SiPM1[SiPM]
    S --> SiPM2[SiPM]
    SiPM1 --> C[Comparator & AND Logic Circuit]
    SiPM2 --> C
    C --> O[Oscilloscope]
  
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Related Materials

- 1) Berkeley Cosmic Ray box, <http://cosmic.lbl.gov/>
- 2) Hartnell College SALAD project, <https://youtu.be/Cy6HAK1gOo4>, <https://youtu.be/ID-gw7UOgI4>
<http://meetings.aps.org/Meeting/APR15/Session/K6.9>
<http://meetings.aps.org/Meeting/APR15/Session/J6.8>
- 3) AdvanSiD silicon photomultiplier, <http://advansid.com/products/product-detail/asd-ngb-nuv-3s-p>

Salinas AirShower Learning And Discovery Project (SALAD)

Activities 5/2/15

Practice with arduino microcontroller

Morning Activities parallel session with Circuit Setup

- 1) Beginning arduino exercises
- 2) arduino 7-segment display introduction
- 3) Beginning Linux commands on PC and Raspberry Pi computers
- 4) Lunch at 12:00PM

Circuit setup

Morning activities parallel session with Practicing with arduino microcontroller

- 1) UltraVolt XS series power supply
- 2) Analog Devices AD8561 comparator circuit
- 3) Monovibrator circuit 74LS221
- 4) AND logic device 74LS08
- 5) National Semiconductor LMH6559 amplifier
- 6) Lunch at 12:00PM

Practice with soldering circuit boards

1:00PM to 2:00PM

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graph LR
    S[Scintillator] --> SiPM1[SiPM]
    S --> SiPM2[SiPM]
    SiPM1 --> C[Comparator & AND Logic Circuit]
    SiPM2 --> C
    C --> O[Oscilloscope]
  
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Related Materials

- 1) Hartnell College SALAD project, <https://youtu.be/Cy6HAK1gOo4>, <https://youtu.be/ID-gw7UOgI4>
<http://meetings.aps.org/Meeting/APR15/Session/K6.9>
<http://meetings.aps.org/Meeting/APR15/Session/J6.8>
- 2) <http://playground.arduino.cc/>
- 3) <https://www.raspberrypi.org/>