

**Project Name**

Exploring New Horizons: Science And Engineering Everywhere, At Anytime And For Everyone

**Principal Investigator** Monica Bugallo

**Campus** Stony Brook University

**Year of Project** 2013

**Tier** Tier Three

**Overview Summary**

A multidisciplinary approach including Electrical and Computer Engineering, Physics and Astronomy, and Science Education that focuses on underrepresented students through our collaboration with the Women In Science and Engineering program and the Center of Science and Mathematics Education.

**Outcomes Summary**

Website containing information for Summer Camp and targeted courses available [here](#).

**Project Abstract**

This project aims to engage students in Science, Technology, Engineering and Mathematics (STEM) research and learning activities by building and using modern cyber-tools in a simple and attractive way. Our ultimate goal is to engage students in the passion, challenge and opportunity of exploring the science of detection of ultra high-energy cosmic rays through innovative technology involving building and operating tools (hardware and software) and analyzing data from the research experiments. The keystone of the project is a highly interactive webportal and a set of software applications (apps) that allow for mobile access to all resources of the project and networking of the participants; cloud computing for science and engineering everywhere and at anytime; and large data sets to perform analysis activities of the underlying experiment and to carry out assessment of the project.

Building upon the lessons learned from the initial IITG phase, this expansion project will focus on: (a) expanding the range of research and learning activities offered to participants; (b) integrating the use of cutting-edge and user friendly applications and new technologies into the delivery of the activities as well as

into the development of research projects; and (c) implementing a research component to investigate the effectiveness and impact of the proposed program.

#### Previous accomplishments (first phase of the IITG grant)

Motivated by the scientific goal of detecting ultra-high energy cosmic rays, we offered fellowships to undergraduate students to work on two different topics: (a) exploring the world of Android apps to perform analysis of cosmic ray data; and (b) evaluation of micro controllers and ARM-based computers to be used as a platform for data acquisition of the cosmic ray experiment.

With the tools and materials developed with the research projects, we offered a Women In Science and Engineering (WISE) workshop entitled *What Are Atoms Made Of?* where students explored through hands-on activities and live demonstrations the universe of small objects, and developed a game, in the form of apps, that combined quarks to form objects such as protons and neutrons.

The main tool for the success of our pilot program was the building and use of a webportal, which was developed by the PI team and undergraduate students, and where our participants (instructors, undergraduate fellows, and participants of the WISE workshop) shared their findings and materials.

The assessment of this first phase (through surveys to all participants) revealed that students had significantly acquired new technological and scientific knowledge through the offered activities.

#### Expansion phase

With this expansion project, we will introduce new ingredients to continue offering STEM everywhere, at anytime, and for everyone.

- New science topics: We will still focus on the detection of cosmic ray activity but with particular emphasis on the study of cosmic ray flux and its correlation with solar activity.
- New collection tools: We will design and build weather stations based on sensor technology and acquisition systems based on Arduino or Raspberry Pi computers.
- New cyber-tools: To enable larger number of participants and to facilitate the delivery of activities, we will offer analysis of data through the improved webportal (see Communication Plan), as well as through apps accessible through mobile technology that will facilitate our data on the go. The existing webportal still offers limited service capabilities.
- New learning activities: We have already introduced experiments and activities through projects and workshops. For this phase we will create new activities and lessons to meet the new demands (new research topics, new collection tools, and new cyber-tools) and to reach larger audiences.

#### Science and Engineering everywhere, at anytime and for everyone

- New research in learning: We will attempt to determine the impact on participants' learning of contemporary STEM topics through the use of innovative approaches to the collection, transmission and dissemination of scientific information and processes in learning settings.

Possible topics for research projects as well as for educational mini-courses that we will be offering can be summarized as follows (see the Timeline Estimate for a more detailed schedule of activities):

- Discovering The Sub Atomic World: Learn the elements that constitute matter through electronic games and puzzles that will be created as apps.

- **Sensors: What Are They And What Are They For?:** Learn about sensors (e.g. temperature) and how to build cosmic ray flux detectors with them. Students will use Arduino-based technology to learn how to read data from the systems that they will build.
- **Acquiring Data On The Go!**: Learn about programming applications to collect, upload and access data using Arduino or Raspberry Pi technologies. This will also involve implementation of apps and cyber-tools for the webportal as interfaces of the collection devices.
- **Data Analysis, Is This For Geeks Only?:** Using Raspberry Pi technology, students will learn how to program data upload tools and small analysis tools.

These topics will allow offering of yearlong research projects for graduate and undergraduate students, who will also help create materials for offering mini-courses (delivered during the Spring semester) on the subjects of interest. We will create a natural instructional chain linking faculty, and graduate and undergraduate students. Faculty will inspire and train underrepresented graduate students, who will be involved in research but also in the development of the curriculum and the instruction of some activities. These students will help mentoring underrepresented undergraduate students who will assist in the offerings through their participation in yearlong projects. The team of faculty, and graduate and undergraduate students will offer the courses to an audience of undergraduate students, with emphasis on underrepresented groups. The PI team and a graduate student in the Science Education program will conduct the research to assess the project's impact (see Assessment Plan for details).

#### The team

The team is formed by a multidisciplinary group of faculty and staff from different departments including Electrical and Computer Engineering, Physics and Astronomy, and Science Education. The Division of Information Technology will provide training through workshops and technology support for the team, and the Center for Science and Mathematics Education (CESAME) and the WISE program will help and assist recruiting participants and advise on the proposed activities.

Our program will reach other SUNY campuses through collaborations with Dr. David Meisel from SUNY Geneseo and Dr. Vivek Jain from SUNY Albany. We have committed to offer some of our activities at their institutions, which in turn will serve as proof of concept of our pursued idea of science and engineering everywhere, at anytime and for everyone.

#### Expected outcomes

Short-term outcomes will include new materials in the form of hardware and software and presentations related to the projects for delivery of the courses. Long-term outcomes will include better motivation of our students for the STEM and high technology workplace as well as academic life as faculty. We will use as measures of success surveys at the beginning and end of the activities and evaluations from our assessment specialist team (see Assessment Plan).

The results of the project will be disseminated by our webportal and by submission of papers to journals and by giving presentations at conferences and other institutions (see Communication Plan).

#### Reports and Resources

- [Project website](#)
- [Mid-project report](#)
- [Project outcomes report](#)

**Assessment, Understanding, Monitoring Student Progress**

- Course Evaluation

**Discipline Specific Pedagogy**

- STEM

**Instructional Design**

- Mobile Learning