October, 28, 2017

QCC QuarkNet Center and Cosmic Ray Group 2017 Annual Report

For period Sep 1, 2016 – August 31, 2017

In 2016-2017 two high school teachers and six college students from 5 different colleges participated.

BASIS Independent High School, Brooklyn, NY

A QCC Center Lead Teacher from BASIS Brooklyn participated as follows. During spring 2017 a one day cosmic ray workshop was organized and held at QCC with three potential associate teachers from Bayside High School. The teacher and his high school students built a mechanical frame to rotate Quarknet detectors and measured muon flux as a function of zenith angle for International Cosmic Day. During summer 2017 completed an 8 week research appointment at QCC including 1 week QuarkNet data camp at Fermilab. A plan of activities was developed for the year-2 three-week institute for associate teachers. Monte Carlo computer simulations of cosmic ray showers using Corsika were completed on a LINUX machine simulating proton collisions in the upper atmosphere at 10^17 and 10^18 eV incident energies; histograms were filled for quantities of types of secondaries, associated energies, times of arrival, and shower lateral distribution. Using QuarkNet detectors muon showers were measured with 1m to 10m detector baselines. For the CUNY Cosmic Ray Array assisted the QCC machinist waterjet cut 1m long scintillators. Co-authored, presented, and published a paper in conference proceedings of the America Society of Engineering Education, Mid Atlantic Section.

Cardozo High School, Bayside, NY

A QCC Center Lead Teacher from Cardozo participated as follows. During summer 2017 completed a 3 week research appointment at QCC. Helped develop a plan of activities for the year-2 associate teachers institute. Learned how to use the Quarknet detector including plateauing and measuring flux; measured muon flux during the 2017 total solar eclipse with the Quarknet detector in Lenoir City, Tennessee, a location in the path of totality; compared results to muon flux measured the day before eclipse to establish a baseline. Baseline and eclipse measurements were uploaded to E-lab and analyzed. To determine if the QuarkNet DAQ, PDU and 4 counters could be powered up by a laptop USB an ammeter was used and measured the current draw; the laptop's USB output power specification was found to be too low; proposed the purchase of a power supply which could be used in the field to power up the Quarknet detector. Helped build scintillator counters for the CUNY Cosmic Ray Array.

QCC College Student Participation

A computer science student worked with the Quarknet detector for the entire year making cosmic ray measurements and teaching other students how to use the detector. Wrote a

Python computer program to read in DAQ data and plot flux; the program plots atmospheric pressure data recorded by the DAQ and overlays it on the muon data. Measured muon flux variations during the March 2017 winter storm "Stella" and demonstrated a strong anti-correlation between atmospheric pressure and muon flux. Published a research abstract in the 2017 American Geophysical Union conference, won the QCC competition for best undergraduate research project and was chosen to represent the college at the CCURI undergraduate research conference in Texas, 2017. Co-authored a paper published in a conference proceedings of the America Society of Engineering Education, 2017. Was funded in part by an NSF Space Weather research grant at QCC.

A chemical engineering student worked with the Quarknet detector for the entire year. He made 4 PDU voltage divider circuits to power up detectors under test for the CUNY array. Setup a DropBox account to automatically upload QuarkNet data from one detector's PC to DropBox, and download it to another PC; this data management project is being evaluated for use with the CUNY Cosmic Ray Array. Plotted results of material reflectivity tests performed at BNL on aluminum foil, white Tyvek, and colored print Tyvek for potential wrapping materials for the CUNY Array. Created electronic schematics for test setups to characterize scintillator efficiency and PMT dark rates. Wrapped 1m long counters.

St. John's University Student participation

A social sciences major minoring in physics worked with the Quarknet detectors for two semesters. Built several 1m long cosmic ray counters for the CUNY Array; this included working with the QCC machinist to waterjet cut, mill, sand, and polish the plastic to 2000+ grit. Wrapped and wired up the first set of 4 prototype detectors with a QuarkNet DAQ, and began recording muon shower data. Reggie has measured the light tightness of CUNY Array counters using the QuarkNet DAQ as a data acquisition system.

Suffolk County Community College (SCCC) and Stony Brook University Student Participation

A physical sciences student worked with the Quarknet detector for the academic year and completed a 10 week internship in cosmic ray research in the Brookhaven Lab CCI program. Retrofitted MARIACHI cosmic ray scintillator detectors at SCCC with a Quarknet DAQ and measured muon flux rates. At BNL measured dark rates and gain of 90 photomultiplier tubes for use in the CUNY cosmic ray array. Presented research posters at the SUNY-SURC 2017 conference and the Long Island STEM HUB symposium at Brookhaven Lab. Co-authored a paper published in conference proceedings of the America Society of Engineering Education, Mid Atlantic Section.

An engineering student worked with the Quarknet detector for two semesters and completed a 10 week internship in cosmic ray research at Brookhaven Lab. At BNL used the QuarkNet DAQ

and two counters in a "muon telescope" setup to test the efficiency of 1m long scintillators acquired from Fermilab surplus for the CUNY Array -- plotted efficiency as a function of distance from the PMT. Retrofitted a 5 ft. long dark box and measured its light tightness. Co-authored a paper published in conference proceedings of the America Society of Engineering Education, Mid Atlantic Section. Was funded in part by a NASA Space Weather research grant at QCC.

Northern Illinois University

An environmental sciences student worked in the QCC Center for 3 weeks during the summer. On two computers installed the LINUX operating system, the Corsika, and COSMOS Monte Carlo simulation programs for cosmic ray showers. Ran simulations of proton collisions in the upper atmosphere at 10^{17} - 10^{19} eV incident energies, filled histograms for quantities of types of secondaries, associated energies, times of arrival, and shower lateral distributions.

Queensborough Community College Faculty

The QCC Center P.I. and mentor managed all the student and teacher projects in the QCC Quarknet center, is participating in a collaboration with the BNL Electronic Detector Group, involved two students in projects at BNL, managed the design and construction of the CUNY cosmic ray array. Attended four conferences and published three related papers.