

Summary of the 2018 Penn Quarknet program

This year we continued our tradition of inviting 4 high school students selected from 16 applicants in the Philadelphia area to participate in our research immersion program.

Selected Quarknet Student Researchers:

David Setiwan Central HS, Philadelphia, PA

Monica Zeng Cardinal O'hare HS, Springfield, PA

Raul Kaukuntla Strath Haven HS, Swarthmore, PA

Francis Chalisery Harrition HS, Lower Merion, PA

Our student researchers built a cosmic ray tracker consisting of a pair of scintillator triggers and 32 proportional drift tubes. The detector provided millimeter precision measurements (with circa 65% accuracy) of approximately 30 thousand ionizing cosmic tracks that passed through four drift tubes.

Our program this year was successful in that our students were able to set up the scintillator cosmic ray trigger optimizing the high voltage for the photomultiplier tube readout and "time in" the coincidence trigger between two scintillator sheets separated by approximately 1 meter. They then tested, at a high voltage, the 32 aluminum drift tube sensors (1" diameter by 12" length) that had 1.5um gold wires fixed along their axial centers. They hooked up an Argon CO₂ gas system in a serial flow with a bubbler at the output and arranged the 32 tubes in two planes of 16 tubes each separated by about 60cm. By week four of the six week program the dual scintillator based cosmic ray trigger and the 32 tube readout were producing data which was read out by an FPGA that the students had learned to program, largely using code developed by last year's group. Their use of archived information from last year's group helped them move the project beyond simply recording tracking information when more than 2 tubes were triggered above threshold. They discovered ways to improve the efficiency of their tracking device, to lower noise in the system, and they invented algorithms to identify tracks within the 30X30X60cm tracking volume.

Along with the work of constructing the tracking detector the students were treated to seminars on the physics of ATLAS, the tracking, measurements and the instrumentation used in neutrino studies, theories and experiments in cosmology, as well as instrumentation talks describing the sensors and electronics that they needed to know to construct and test the cosmic ray track detector.

Steve Polgar, one of two high school teachers who has been with the program for more than 10 years, provided daily supervision of the students allowing Rick Van Berg and myself to continue to participate in our research programs for ATLAS and DUNE.

Our Quarknet award of \$3500 this year (Down from ~\$12,000 in previous years) was used to compensate Steve for his supervision, teaching and mentoring efforts. The University and our research program contributed the other costs to cover materials and the student stipends.

Regrettably this funding model will not be sufficient to continue the program going forward.

Mitch Newcomer