

Penn QuarkNet 2012 Summary

Our 2012 program began Monday June 25, and closed Friday August 3 this year. Mark Baron and Steve Polgar our two Lead Teachers, each with several years experience in the Penn QuarkNet program, provided day to day continuity and took responsibility for organizational details. Rick Van Berg and I kept in close contact, providing advice and technical expertise where appropriate while keeping up with our day to day research responsibilities. Rick and I gave seminars on research, electronics for nuclear radiation and imaging detectors, and on the Sudbury Neutrino Detector. Brig Williams and John Alison talked on the ATLAS detector and the Higgs Discovery, Larry Gladney about Dark Energy and Dark Matter and Simon Hastings on the physics of PET detectors to mention a few of our QuarkNet seminars.

Generally, a student day would start off with a morning meeting where plans for project work reports and seminars for the day would be discussed. During the first three weeks there were seminars nearly every day, thanks to the fact that our QuarkNet program overlaps with the Penn Summer Science Academy (PSSA), a physics-based outreach program for high school students, our QuarkNet students were able to attend both QuarkNet specific seminars and those given for the PSSA. At the end of July we took a field trip to Brookhaven National Laboratory where Helio Takai set up visitations to the Phenix detector at RHIC, Brookhaven's instrumentation group and the Light Source. In addition we had a lunch discussion group with George Redlinger a SUSY expert.

Our students, Will Giguere, Kai Chang, Erik Laping and Chris Bove were chosen from among 24 applicants. They were probably the most capable group that we have had in our program in terms of their ability to understand the scope of the Cosmic Ray Muon Telescope project, divide up the work amongst themselves, document their results for next year's students, and present the state of their progress in bi-weekly presentations.

The main goal of each year's program is to immerse our student researchers in a realistic HEP related experimental physics project. We have found an appropriate level of challenge (and available equipment) in the design and construction a proportional drift tube based a cosmic ray telescope. The accomplishments of this year's group include the following: Set up a plastic scintillator trigger coincidence to determine a start time for the multi-plane proportional tube based cosmic ray tower; refurbish and assemble 4 planes of 16 proportional drift tubes, including plumbing (gas connections), checking for leaks, applying HV and using a radiation source and digital oscilloscope to determine the proper operating voltage for each tube; attach front end electronics boards to the tubes and set thresholds high enough to minimize noise but low enough to be efficient in the detection of the first few primary drift electrons from passage of ionizing particles (tracks) through the tubes; attach a custom data acquisition system to the front end electronics and "time it in" so that signals from the tubes arrive within one microsecond of the scintillator based coincidence trigger; design firmware to be installed in the Field Programmable Gate Array (FPGA) that reads out tube hit and time information into the computer; create a track finding program that uses data from the proportional drift tubes to reconstruct the position of cosmic ray tracks within the cosmic ray tower; reference work done in years past and

document present work clearly enough that next year's group can have an excellent starting point and reference for their implementation of a similar Cosmic Ray Telescope.

Five weeks into this year's program we asked our students for a critique: Did they feel sufficiently challenged and pushed to organize their work to be highly efficient or was the scope of the program too broad or too vague? They responded that they were enjoying the challenge we presented, and were quite happy with their team mates and felt privileged to be part of the program. They encouraged us to keep the project as it is so that each group member is personally challenged to learn new things and participate at their personal highest level. They enjoyed our frequent "check-ins" where we would explain things that might speed them up and help refocus them if things weren't going well.

I should emphasize that our two paid Teachers, Marc Baron and Steve Polgar are crucial to maintaining day to day continuity in our QuarkNet program. Rick and I are significantly engaged in our research programs and need to be free to travel during the course of the QuarkNet program. There are occasions where both of us are not at Penn for one or two days. This year we needed to go to each of the HEP professors and request money from their discretionary funds to help meet expenses for our two teachers. In the end our costs were still somewhat higher and we had to find additional funds. Our hope is that next year's QuarkNet grant will be large enough to cover salaries for our two teachers for six weeks.

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