



UC QuarkNet Annual Report Information September, 2012

The QuarkNet Associate Teacher Institute at the University of Cincinnati conducted its 9th annual workshop from Jun 18-22, 2012. This year's workshop included five teachers. The five associate teachers were from various schools in our tri-state area, including suburban, private, and Catholic schools. The workshop Lead Teacher was (once again) Jeff Rodriguez. This year's Institute concentrated on working with our four cosmic-ray detectors and the Cosmic Ray E-Lab, and also completing a more detailed study of Masterclass activities for classroom use.

Earlier in the year, two high schools participated in the US Masterclass at The University of Cincinnati. Twenty physics students, along with their teacher, Jeff Rodriguez, came from Anderson High School, while twenty five physics students came from McAuley High School with their teacher, Lisa Nissen.



Figure 1 UC Mentors Mike Sokoloff and Brian Meadows pose with students from Anderson and McAuley High School prior to the MASTERCLASS videoconference

Prior to Masterclass Day, they used Skype to video-conference from their schools with mentors at UC to analyze events. They toured the University of Cincinnati Physics labs, and made preparations to participate in the US Masterclass. On Thursday March 8th, they assembled for Masterclass. With the help of mentors Brian Meadows and Mike Sokoloff, the students successfully analyzed the events and presented their results. The Masterclass included an EVO session with students from Notre Dame, Palaiseau (France), and Zagreb (Croatia).

QuarkNet Teachers Marty Wells and David Whittington attended the QuarkNet Boot Camp at Fermilab in July. They worked in teams on a data analysis project using data from the Compact Muon Solenoid detector at the Large Hadron Collider. They used multiple tools to give a poster presentation on the decay paths of the Z boson. They also toured the CDF collision hall, SiDet, and the new muon lab.

Four high school students, along with QuarkNet teacher Jeff Rodriguez completed a 6 week internship working on a research project at University of Cincinnati. Two high school junior students were from a suburban public school and two were high school juniors from a Catholic high school.

The program began with Rolf Andreassen and Zach Huard giving a crash course in particle physics and learning how to use C++ and ROOT. UC Mentors Brian Meadows and Mike Sokoloff acted as facilitators, guiding the group with particle physics talks, helping through the code and analysis trying to ensure a true research experience.

The overall purpose of our research was to analyze data from the reconstruction of various decay chains from the LHCb experiment at CERN to familiarize themselves with the reconstruction software and



Figure 2 UC graduate student Zach Huard leads the students through analyzing LHCb ntuples during the analysis summer research program.

layers of detectors. After completing a tutorial on ROOT, a C++ based particle physics data analysis program that was used throughout the research, they began to work with sets of ntuples from the LHCb experiment. Each student was given a particular decay channel. Students learned new concepts such as "invariant mass", and how it should be independent of momentum, and that they were able to study this property using the ntuples. They learned to reduce backgrounds and were able to see how "clean" the signals were. Students considered and implemented "cuts" to remove unwanted background events, eventually dividing data into five ranges of momentum and transverse momentum with equal event populations. Histograms were generated for these ranges and then filled with candidates' masses.

Next, each histogram was fit with Gaussian or double Gaussian functions to extract the mean and mean error for each of the mass plots. Averages of the selected particle's mass versus the average of each momentum range were plotted to search for momentum dependency in the measurement of its mass.