

QuarkNet Center @ Colorado State University

FY 2019-2020 Annual Report

Faculty mentors: Dr. Bob Wilson, Physics Professor, Physics Department, Colorado State University

Lead teachers: Cherie Bornhorst, Teacher in Residence, Colorado School of Mines; Adam Pearlstein, Teacher in Residence, Colorado State University; and Zach Armstrong, Science Teacher, Greeley West High School

The Colorado State Quarknet Center is now in its 8th year. In the first two years of our program, we focused on cosmic ray research, and deployed 4 detectors at high schools on the Front Range. In our third year we worked to expand our program; both in membership of teachers, and to include other aspects of high energy physics, and were trained on the use of the CMS e-Lab. The focus our fourth year was classroom application; to train our teachers on the use of their CRMD's with the new EQUIP program, and hosting students for our first annual Masterclass event. Our 5th year focus was to build on the strengths and skill sets of the teachers involved with our program, and to explore even more ways to bring high energy data into the classroom. In our 6th year we added Zach Armstrong as a Lead Teacher to our group, hosted a CMS Elab workshop, and took a fieldtrip to DUNE at the Homestake Mine in South Dakota! In 2018 we held a 3 day workshop using cosmic ray muon detectors and going through the LIGO eLab. This year we lost two veteran QN members when they retired from teaching, but gained a few new teachers for our summer workshop, and lots of new interest in our upcoming 2020 summer workshop!

Masterclass@CSU:

On April 6, 2019 we hosted a 1-day Master Class workshop. Two teachers -- Kristy Bibbey from Poudre High School and Gavin Polhemus from Liberty Commons -- along with 7 of their students participated. We kicked things off with a talk on neutrinos from our advisor, Professor Bob Wilson.



We were then treated to a tour of the CSU High Energy Physics labs by a couple of student researchers: graduate student Tyler Boone and senior undergraduate and President of CSU Women In Physics Aurora Popescu. They showed us various techniques for detecting neutrinos and how they stress test their components with liquid nitrogen.



The students then worked in small groups analyzing sample data from MINERvA in order to make conclusions about carbon nuclei. Using Arachne, students sifted through actual MINERvA events to sort background from relevant nuclear decays -- ones that result in a single proton and single muon track -- which can be used to indirectly probe the nucleus from which they came. Using momentum and energy, and by invoking conservation laws, students were able to come up with some exciting conclusions about a carbon nucleus!



Finally, we had a group video conference with the Minneapolis Quarknet Center and Fermilab. The students were able to share and discuss their results, and ask followup questions with MINERvA researchers.

Quarknet@CSU Workshop:

A two day workshop was held at CSU on July 29-31, 2019, and took place in the Little Shop of Physics space at CSU.

Ken Cecire from Quarknet Central was with us, to lead us in a 1 day of cosmic ray research, and 2 days of neutrino masterclass. We had many first-year teachers participating in our summer workshop. The cosmic ray workshop gave our teachers the background necessary to understand the workings of the cosmic ray detectors,

and we completed a shielding experiment using the different levels of a parking garage structure on campus. Teachers saw how to use the interface on the computers to change settings on our detectors and we discussed how we could use the detectors in the classroom setting with high school students.



The next 2 days we spent learning about and participating in the neutrino masterclass. We heard a lecture from Professor Walter Toki about his past and current research in neutrinos. We were hands-on with many activities from the Data Portfolio.



Teachers participating in the summer workshop:
Cherie Bornhorst, Colorado School of Mines
Adam Pearlstein, Colorado State University
Zach Armstrong, Greeley West High School
Taylor Plantt, Greeley West High School
Mark McConnell, Mountain Vista High School

Matt Leach, Douglas County High School
Carlos Rivera, Poudre High School
Hannah Erdevig, Liberty Common High School