

QuarkNet Staff Monthly Report
Activities of October 2023

The staff meet remotely every Tuesday to discuss QuarkNet matters in general and every Wednesday for technical issues. In addition, the staff reports the following activities:

Centers

Catholic University of America –Laurent Rigal and Ken met on Zoom on October 6 to discuss making measurements with students using the Cosmic Watch. They decided on a student survey of Laurent’s school, Eleanor Roosevelt High School in Greenbelt, Maryland, using Cosmic Watch detectors. Ken brought four pairs of Cosmic Watches to ERHS on October 17. Students in Laurent’s research class went to several different parts of the school to take data. They were somewhat plagued by reliability issues but still were able to get readings. Ken left one pair with Laurent so his students could continue their investigations. On October 18, Ken had a discussion with Shruti Chugh of Clarksburg High School in Clarksburg, Maryland about World Wide Data Day (W2D2). Ken went to the school on October 26 to work with Shruti and one of her colleagues: they facilitated a rapid but effective W2D2 CMS measurement in one hour with about 30 students.

Colorado State University – Shane met up with the center for their workshop in New Mexico on October 14-16. The group traveled to New Mexico for the annular solar eclipse on October 14 and for a tour of Los Alamos National Laboratory on October 16. They brought along two telescopes for eclipse viewing, and they collected cosmic ray data during the eclipse. Also, they met up with a group of physicists from the Los Alamos area, including Virtual Center mentor Danielle McDermott and former QuarkNet PI Dan Karmgard, for an informal discussion and Q&A session.

Hampton University/College of William and Mary/George Mason University – The “Virginia Center” held a one-day workshop at William and Mary on October 28 which Ken attended. Josh Erlich and lead teachers Mike Fetsko and Maria Niland did most of the facilitation with Ken playing a supporting role.

Lawrence Berkeley National Laboratory and University of California Santa Cruz – Ken met via Zoom on October 19 to plan half- to one-day center meetings sometime in winter 2023. LBNL needs to have a teacher day and UCSC needs to restart their program.

Rice University/University of Houston – Deborah and Shane met via Zoom with Frank Geurts (Rice mentor) and Carolyn Nichol (Rice Office of STEM Engagement) on October 6 to discuss plans for the needs assessment workshop that will take place on December 16. The Rice Office of STEM Engagement will help recruit teachers for the workshop.

University of Illinois Chicago/Chicago State University – Mark zoomed with Nate on October 4-5 to discuss efforts in New Mexico. He then met Nate at Fermilab on October 16 to receive the traveling array from him after his visit to New Mexico Stem Night. Nate and Mark discussed AAPT plans and posters, Moon Shadow result cross checks and error estimates, the trip to New Mexico during Balloon Fiesta, revised color coding in PyEQUIP, and plans for new freshman researchers. Mark reanalyzed Moon Shadow data from New Trier as a cross check.

University of New Mexico – Shane and Nate traveled to New Mexico October 10-13 for a multi-purpose trip to support this center and to do outreach. They assembled a new cosmic ray detector and delivered it to a school and visited two QuarkNet teachers and four physical science classes at 21st Century Public Academy in Albuquerque. While there, they did several QuarkNet activities

with the students and introduced them to the cosmic ray detector. On October 12, Nate and Shane participated in the STEMarts Lab Space Messengers as described below in Broader Impacts.

University of Notre Dame – Ken participated in Notre Dame Monday meetings on October 16 and 23. The latter meeting was held online as Pat Mooney was ill and unable to lead the in-person meeting. The group discussed the rapidly approaching Science Spooktacular science exhibition for families: they tried to arrange for a few teachers to represent QuarkNet, but there was not enough time and schedules were not open. One of the teachers in the meeting, Tom Guthrie, did attend Science Spooktacular and reported back so the center could be prepared for next year. Mitch and Ken met via Zoom with Notre Dame astrophysicist Borja Anguino about a possible future astrophysics masterclass.

University of Puerto Rico – Ken visited Centro Residencial de Oportunidades Educativas Mayagüez (CROEM) in Puerto Rico and teacher Danelix Cordero and her students on October 20, where they worked together to understand the students’ data from a Cosmic Watch on a balloon flight. On October 21, Ken helped mentors Daniel Gutierrez and Hector Mendez facilitate a workshop at University of Puerto Rico, Mayagüez. The afternoon portion of the workshop was focused on cosmic ray detectors that were being transferred to two teachers, and Ken coached the participants in refurbishing the counters. On October 22, Ken used the opportunity of being in Mayagüez to have lunch with Sudhir Malik and one of his students. Sudhir is a reliable masterclass moderator and an important collaborator in IRIS-HEP. On October 23, Ken visited the teachers who received the detectors, Yesenia Torres at Escuela Ramon Jose Davila in Coamo and Monica Lopez at Casa de Los Niños Montessori in Fajardo. They made great progress in setting up the detectors with their students but had software issues with EQUIP. Edit Peronja subsequently helped the two teachers remotely with this.

Data Activities Portfolio

Deborah, Ken, Spencer, and Shane met on October 5, 19, and 26 on Zoom to continue work on the *Angles and Dimuons* activity for the Data Activities Portfolio. *Angles and Dimuons* is derived from a previous World Wide Data Day measurement.

Cosmic Ray Studies

Mark, Dave, Spencer, and Ken had a hybrid meeting with Juan Estrada, Javier Tiffenburg, and Ana Martina Botti of Fermilab to learn about and discuss a new, small camera-based cosmic ray detector they have been developing. It is too early to make use of but the concept looks promising.

Statistics from the e-Lab during October 2023: 326 cosmic ray uploads 15 cosmic ray plots, and 9 posters. An analysis report finds 1487 analyses run (in analysis-day units) during the same period. The number of days each analysis was run are 12 Flux, 1 Lifetime, 4 Performance, 3 Shower, and 6 Time of Flight. Mark provided help desk assistance for teachers on the following cosmic ray topics: EQUIP and PyEQUIP installation, creating student research groups, muography background, debugging noisy CRMD counters, and creating posters.

Mark focused on two analysis projects: the Moon Shadow experimental results, and the Non-invasive Archaeometry Using Muons (NAUM) pyramid website. Mark verified Moon Shadow results at schools in preparation for presentations at AAPT in January 2024. He edited student poster drafts and calculated signal-to-background sensitivities.

After a long discussion on October 11 of needed code changes for the pyramid project, Edit and Mark have been systematically working through the NAUM pyramid website and event display developed with QuarkNet summer interns. Currently, the website correctly displays data from simulated events. Edit and Mark are designing modifications to generalize the code to be able to handle future real detector data, to fix detector rotation code, to establish an electronic logbook that captures and reflects changes in the detector geometry, orientation, and internal configuration, and to establish surveyed positions for the photon detectors. Also, they updated the content on the NAUM website, including the new QuarkNet logo. The website, NAUMProject.org, redirects to <https://i2u2.org/elab/cosmic/pyramid>.

QuarkNet interns Jensen and Yashas carried out a detailed research project: measuring the muon rate dependence due to extreme air quality, defined by 2.5 micron particulate matter density, correcting for pressure, humidity, and temperate effects. After several rounds of Mark's edits, the paper was submitted to Fermi publications on October 5.

Edit continues to help teachers install EQUIP or PyEQUIP on new computer systems. Mark continues to collect data with three detectors: 6119 for upward-muon search data, 6148 for large shower array data. and 6674 for Moon Shadow data (on hold). Mark flipped counter positions of the detector 6119 on October 2 and plans to collect data to form a set spanning hundreds of days for e-Lab teachers to use in the classrooms, so each student can calculate muon speed with their own data set.

Dave and Mark assisted with the Fermilab Outdoor Fair on October 22.

LHC Physics

The LHC fellows met with Ken on Zoom on October 26 to continue planning International Masterclasses and World Wide Data Day. They focused on W2D2 as it is coming up on November 9 but not exclusively: registration for IMC begins November 10. Several LHC fellows stepped up to volunteer to both participate in W2D2 at their schools and help to moderate videoconferences.

Neutrino Physics

The Neutrino fellows met with Spencer and Shane on October 17 via Zoom to continue improving the NOvA masterclass measurement and masterclass videoconferences based on feedback from teachers and students.

International Masterclasses

Work continued on ramping up International Masterclasses and World Wide Data Day. Ken sent a Newdle poll to Fermilab masterclass moderators to pick a day and time to discuss a major revision to Fermilab masterclass videoconferences. By the end of October, 11 moderators had responded. Ken sent three W2D2 Memos in October to help teachers and moderators in their roles. Registration was set to close on November 1: in October, 16 moderators and 61 classes had registered.

Broader Impacts

International Collaborations – Ken had a Zoom discussion on October 13 with collaborators in Mexico about making a new proposal to Notre Dame International for workshops in Mexico based on masterclasses and cosmic ray studies. They agreed to submit a proposal, which is due November 30.

Ken had a Zoom meeting with Uta Bilow on October 25 to plan for the upcoming IPPOG meeting and the associated International Masterclasses Steering Group meeting. Ken also met on Zoom with the International Organizing Committee for the African School of Fundamental Physics and Applications to begin discussions on selecting a site for ASP 2026.

Cosmic Rays at Pyramid – Mark calculated correction factors necessary to account for muon trajectories that are not normal to the planes. Almost all materials for construction have been delivered to the University of Virginia. Shipping the first detector to Mexico will be delayed until January 2024. Edit and Mark have been modifying the NAUM website to handle many data files and to use initialization material on pedestals and ADC channel mapping to tracker cells.

Fermilab Outreach: Dave and Mark assisted with the Fermilab Outdoor Fair on October 22.

Needs Assessment Workshop @ Rice – Shane and Deborah worked with Frank Geurts and Carolyn Nichol of Rice University to develop a needs assessment workshop as described above in the Centers section.

Space Messengers @ Balloon Fiesta – On October 12, Nate and Shane participated in the STEMarts Lab Space Messengers temporary installation coordinated by Agnes Chavez at the Balloon Museum in Albuquerque, associated with the 2023 Balloon Fiesta. During this Space Messengers event, they introduced attendees to the cosmic ray detector, discussed cosmic rays, and discussed how physicist and balloonist Victor Hess used balloons in the discovery of cosmic rays.