

QuarkNet Staff Monthly Report
Activities of April and May 2023

Staff meet remotely every Tuesday to discuss QuarkNet matters in general and every Wednesday to discuss technical issues. The QuarkNet Educational Discussions (QED) group met on April 5 on Zoom with a talk about gravitational waves by Quynh Lan Nguyen, University of Notre Dame and on May 17, with a talk about dark matter Peggy Norris, retired from SURF. Shane, Ken, and Spencer met at Fermilab on May 25 to plan the upcoming Lead Teacher Camp and summer workshops at centers. While there, they chatted with mentors Hector Mendez, University of Puerto Rico, Bob Wilson, Colorado State University, and Camillio Mariani, Virginia Tech. In addition, staff reports the following activities:

Centers

Black Hills State University/SURF – Shane met with Chad Ronish of SURF via Zoom on April 28 to plan for upcoming center activities and outreach. Shane traveled to South Dakota on May 12-13 for an outreach effort on the Cheyenne River Reservation (May 12) and a NOvA masterclass (May 13) with students who participated in a Girls in Science event hosted by SURF.

Catholic University of America – Ken met on Zoom with mentors Katryna Andrusik and Angela McRae on May 16 to firm up plans for the summer workshop.

Colorado State University – Ken met on Zoom with teacher Matthew Leach on April 17 to answer his questions about use of the Cosmic Watches he borrowed.

Hampton University, College of William and Mary, and George Mason University – Lead teachers Maria Niland and Mike Fetsko and mentor Josh Erlich had a videoconference with Ken on April 19. They developed ideas about recruiting teachers and what the summer workshop might look like. They also assigned action items.

Kansas State University – Jim Deane has joined the Cosmic Ray Fellows and is organizing virtual bimonthly meetings for the center. Mark joined on April 12 to help with detector commissioning, and Shane joined on May 10 to support the process. On May 23, Shane met via Zoom with KSU lead teachers to plan the upcoming summer meeting/field trip.

Lawrence Berkeley National Laboratory – Kathy Race and Ken met with LBNL mentor Tony Spadafora and masterclass leaders Heather Gray and Miha Muskinja on Zoom to work together on the QuarkNet Center feedback form and discuss any issues that arose.

Middle Florida (UF) – Ken met on Zoom with University of Florida mentors Philip Chang and Paul Avery on April 21 about planning a summer program and bringing in teachers who might have previously participated with Florida Tech and teachers in the Orlando area.

University of Alabama – Ken met on Zoom with prospective mentor Sergei Gleyzer on April 18 to describe the first year of a QuarkNet program. The University of Alabama is joining QuarkNet.

University of California Irvine – Shane and Ken met with mentor Pedro Ochoa on Zoom on May 22 to discuss plans for the summer workshop.

University of Illinois Chicago/Chicago State University – Many students contributed to the Moon Shadow analysis. Data taking continued at four sites. Mark finished analysis of seven months of data at his telescope set at 26 degrees above the horizon. Staff held an analysis meeting attended by nine students and three teachers at New Trier High School on April 23. The group identified and repaired errors in Excel spreadsheets and developed plans to complete the analysis at the June 14-15 summer workshop.

University of Minnesota – Shane and lead teacher Jon Anderson presented at the AAPT Minnesota section meeting on April 22 in Minneapolis. Jon and Shane shared many resources and opportunities with attendees, including QuarkNet data activities, e-Labs, and opportunities for high school teachers.

University of New Mexico – Shane met with cosmic fellow Nate Unterman and New Mexico artist/educator Agnes Chavez via Zoom on April 27 and May 23 to discuss plans for the summer workshop. The focus will be on cosmic rays incorporating elements of art and virtual reality. Workshop participants will plan an exhibition for a STEM event at the Albuquerque Balloon Fiesta in October 2023. Shane and Nate met once again via Zoom on May 30 to plan some of the specifics regarding the cosmic ray measurements to be taken during the summer workshop.

University of Notre Dame – Ken participated in a Monday teacher meeting on April 17. The meeting centered on accepting high school students for the summer program. On April 24, Jeremy Wegner and his students discovered a Forbush cosmic ray flux decrease with their detector; they then checked other data in the Cosmic Ray e-Lab and found simultaneous recorded decreases by schools in Illinois and Idaho.

University of South Dakota – Shane and Ken met via Zoom on April 10 with mentor Jing Liu of the University of South Dakota. They discussed his next steps in forming the new USD QuarkNet Center.

University of Washington – Shane and Ken met on Zoom on April 18 with mentor Shih-Chieh Hsu and lead teacher Tseveldorj Oyuntugs to discuss the summer program and new teacher recruitment.

Virtual QuarkNet Center – The Virtual Center had their monthly meeting on May 23, and Ken joined in. They discussed their online summer workshop, and Ken was able to provide information about National Workshop offerings, e.g the New Questions in Particle Physics Workshop, introduced this year.

Coding

We had the final two (of eight) Saturday Coding workshops on May 13 and May 20 and have had 34 registrants in total. Coding Camps 1 & 2 are taking form and nearly filled. The virtual CC1 is in its fourth year and will be mostly like previous iterations. This summer will only be the second CC2, in-person at Fermilab and is still evolving as we process input from last year’s experiences, content consultants, and work to incorporate some additional topics. Those include research on AI ethics and increasing the alternatives to Google Colab for schools lacking access.

The six IRIS-HEP-funded smaller coding workshops around the country are starting to take form. Most will be in-person, 3-days, at a university with an IRIS-HEP collaborator, and host 12 K12 teacher participants. Three will be at existing QuarkNet centers (Rice, Washington, & UPRM), one at a new QuarkNet center (Alabama), and one at a non-QuarkNet site (Princeton). Another will be a virtual “easy entry” experience that coding fellows have dubbed *Coding Camp Zero*. The Alabama workshop helped longtime collaborator Dr. Sergei Gleyzer to initiate and mentor the new QuarkNet center there.

Cosmic Ray Studies

During April there were 504 cosmic ray uploads and 12 cosmic ray plots. An Analysis Report finds 5173 analyses run (in analysis-day units) during the same period. The number of days each analysis was run are 27 Flux, 13 Lifetime, 3 Advanced Lifetime, 4 Performance, 9 Shower, and 1 Time-of-Flight. Mark provided help desk assistance for teachers on the following topics: a data alert for Coronal Mass Ejection (CME) on April 21, new CRMD commissioning, uploading, GPS installation and updates, repair of bad GPS data, and suggested use of wider gate widths.

During May there were 674 cosmic ray uploads, 35 cosmic ray plots and 6 posters. An Analysis Report finds 5084 analyses run (in analysis-day units) during the same period. The number of days each analysis was run are 25 Flux, 18 Lifetime, 2 Advanced Lifetime, 7 Performance, 14 Shower, and 9 Time-of-Flight. Mark provided help desk assistance for teachers on the following topics, interpreting performance plots, uploading split files, GPS installation and updates, and explaining how disabling controls is responsible for a missing channel.

Jeff Rodriguez created [a map](#) and compiled one-page summaries of reports by International Muon Week participants. He also created 3D animated plots to compare rates world-wide that had been corrected by Jeff and Mark to normalize rates between detectors.

Mark tested Cosmic Watch pairs for use in setup for 2-fold operation and longevity in data collection. He collected data on rates versus counter vertical separation. Mark maintained the Fermi DAQs weekly: 6119 collecting single muon upward-muon search data; and 6148 collecting large shower array data. Mark also collected Moon Shadow data with DAQ 6674 in Geneva.

Mark and Professor Hart (Rockford University) discussed advertising Hart's students' large sample of decays from one million muons. Mark also verified decay distributions from his Fermilab sample of 110K decays. Both samples will be added to the list of golden files referenced by the simple experiments link in Drupal. Nate is updating his list of golden files for flux experiments.

Ken met on Zoom with teacher Matthew Leach from the Colorado State center on April 17 to answer his questions about use of the Cosmic Watches he borrowed

An article by Don Lincoln on muography was on the cover of the April edition of *The Physics Teacher*. It included an insert box by Mark describing experiments by QuarkNet teachers, as well as a description of the pyramid project. Mark selected two QuarkNet Fermilab high school summer interns to join in developing event displays for the pyramid project.

Fellows met March 29th, April 26th, and May 24th. Jim Deane joined the Fellows group. Discussion topics included summer workshop planning, Nicole and Jim to shadow other presenters, PyEQUIP/EQUIP installation instructions separated into three version (Mac, PC, and Pi), small PyEQUIP GUI bug, International Muon Week results and new 3D global plot, pyramid project progress and April *Physics Teacher* article by Don, Moon Shadow, Kansas Storms, an analysis of a CME21 event, and planning for 2023 and 2024 eclipses. At the May meeting Joe Wise gave a talk about his Radio-CRMD project, on location from Butan. Planning for summer cosmic ray workshops is almost complete. Nate will facilitate at UIC and UNM. Nicole will shadow Nate at UNM. Other possible cosmic workshops include Catholic University, University of Wisconsin-Madison, and University of Puerto Rico-Mayaguez.

Data Activities Portfolio

Deborah, Ken, Shane and Spencer met several Thursdays in April and May. Work progressed on activities to support the summer workshop season. Deborah uploaded Spanish Language versions for *Dice*, *Histograms and Probability*,

International Masterclasses

The following Fermilab masterclass videoconferences were held in April:

- April 18 (CMS) - Mexico City, moderated by Ken and one physicist.
- April 22 (ATLAS) - Lawrence Berkeley National Laboratory, moderated by fellow Jeremy Wegner - the physicist had a family emergency but Jeremy handled it very well.

The full schedule of Fermilab videoconferences and a list of the moderators with images can be found at <https://quarknet.org/content/videoconferences>.

LHC Physics

Ken attended a seminar at Notre Dame via Zoom on April 17 with some new and interesting preliminary results from CMS that might be useful for a new summer workshop. The LHC fellows met with Ken on Zoom on April 25. The group discussed the positives and negatives of the videoconference quiz in the Fermilab masterclasses, summer workshops, and improvements to masterclasses. Staff expect the LHC fellows will have a major role in summer center workshops.

Neutrino Physics

Ken, Spencer, and Shane met with David Martinez of the South Dakota School of Mines and Technology, along with two graduate students, via Zoom on April 25 and May 25 to discuss progress on the ProtoDUNE masterclass. David will ask the NOvA collaboration for more data at an upcoming collaboration meeting.

The Neutrino fellows met with Spencer and Shane on April 18 and May 16 via Zoom to begin planning for summer workshops and other efforts.

Broader Impacts

American Physical Society (APS) April Meeting – Shane attended the APS April Meeting in Minneapolis, MN on April 16 where he presented a talk on particle physics masterclasses, attended several sessions, and visited with several QuarkNet contacts, including lead teachers, mentors, educators, and other physicists.

CERN Beamline for Schools Competition – Over several months Mark assisted a group of high school students at Phillip’s Exeter Academy with a proposal to the CERN Beamline for Schools competition to build a beamline magnet from fixed NdFeB magnets: “A Radially and Rotationally Adjustable Magnetic Mangle for Particle Beams,” submitted on April 12.

Cosmic Rays at Pyramid – Biweekly collaboration meetings continued. Electricity for the north tunnel was installed early April, so functioning lights returned to the tunnel. Archeologists began

using the power the very next day. Mark recruited a UIC undergrad to join the anticipated team of QuarkNet summer interns who will develop the experiment's event display. Mark and Edit discussed factorization of computing tasks for the interns. Our request for Air Force transport is now in the Office of the Secretary of Defense. We explored the machining of a second support frame at UIC. Mark helped Dominican University students analyze rates collected in the pyramid with a QuarkNet detector for a student presentation at APS on April 14.

Indiana AAPT Meeting - Ken participated in the Indiana AAPT meeting on April 15 in Kokomo. Ken, Jeremy Wegner of the Notre Dame Center and Marla Glover of the Purdue Center, both LHC fellows, gave a presentation about QuarkNet in Indiana and meeting Indiana Physics Standards.

International Collaborations – On April 11 and 25 and on May 9 and 23, Ken participated in videoconferences of the International Organizing Committee of the African Conference on Fundamental and Applied Physics (ACP) to be held in George, South Africa. He and Jesutofunmi Fajemesin met on Zoom on April 19 and May 1 to work on arranging for speakers for ACP in Education and Communications.

Ken visited CERN May 2-8 as a stop on his way to the IPPOG meeting in Sofia, Bulgaria. While at CERN, Ken met with Tom McCauley to discuss CMS masterclasses and related data activities. The next day, he met Junjie Zhu of the University of Michigan and Jeff Wiener of CERN to discuss the QuarkNet and University of Michigan collaboration with the CERN summer teacher programs. He also met former IPPOG co-Chair and QuarkNet Advisory Board member Steve Goldfarb and Chilufya Mwewa of Brookhaven National Laboratory, who did much to make a masterclass in her home country of Zambia possible.

The International Particle Physics Outreach Group (IPPOG) - The meeting in Sofia took place May 9-13. Prior to the meeting Ken co-chaired the IPPOG Masterclasses-to-New-Countries online meeting with Uta Bilow while at CERN, and Mark gave a virtual presentation which summarized QuarkNet cosmic ray activities to the IPPOG Global Cosmic Group. During the meeting, Uta and Ken co-chaired the Masterclass Steering Group meeting. Shane and Spencer gave a presentation on the NOvA masterclass via Zoom. Also, Virtual Center teacher Charlie Payne and retired SURF physicist Peggy Norris presented the XENON-1T dark matter masterclass they are developing via Zoom. Subsequently, Uta and Ken presented an International Masterclasses report to IPPOG.

Outreach Activity on Cheyenne River Reservation in South Dakota – On May 12, Shane and Chad Ronish, along with others from SURF Education and Outreach, visited physics and chemistry classes at Cheyenne-Eagle Butte school on the Cheyenne River Reservation. During this visit, Chad and Shane led students through Data Activities Portfolio other activities that introduced students to particle physics and research at SURF.