

QuarkNet Staff Monthly Report
Activities of March 2023

The 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 March 8 on Zoom. In addition, the staff reports the following activities:

Centers

Colorado State University – Shane helped facilitate a MINERvA Masterclass on March 4.

Hampton University, College of William and Mary, and George Mason University – Lead teachers Maria Niland and Mike Fetsko had a videoconference with Ken on March 28. They discussed recruitment of new teachers, especially in central and southeast Virginia, and what the summer workshop might look like.

Kansas State University – Dave and Mark helped several teachers with a GPS cabling plan and PyEQUIP installation. They helped Jim Deane prepare an agenda for the center meeting on Saturday March 4. Mark joined the workshop via Zoom for an hour to answer detector questions. Jim has agreed to join the Cosmic Ray Fellows.

Lawrence Berkeley National Laboratory – Ken, mentor Tony Spadafora, and lead teacher Laurie Kerrigan met on Zoom to plan the LBNL summer QuarkNet program. Again, it will be centered on a virtual workshop and lecture series for students, Physics In and Through Cosmology, but will also include an in-person one-day workshop for teachers at the lab or nearby.

University of Illinois Chicago/Chicago State University – Four sites in the UIC/CSU center continue to collect and analyze Moon Shadow data. Nine students, two teachers, and Mark participated in an analysis meeting at Ida Crown Jewish Academy on March 19. Mark and the group calculated the momentum kick a particle receives from the Earth's magnetic field (assuming a dipole field) and found it more consistent with predictions from the Tibet group than with those from MINOS. The bending of muons in the air shower greatly affects the size of the moon's cosmic ray shadow.

University of Minnesota – Teachers and students a second pilot NOvA masterclass on March 11. Three Neutrino fellows joined to learn about the measurement and provide feedback. Center mentor Greg Pawloski worked with Neutrino fellow Mike Plucinski and Shane to create the latest iteration of this masterclass.

University of Mississippi – Ken went to Ole Miss on March 24 to participate in the Belle II masterclass. He acted mostly as a student in learning mode but also had a chance to talk with mentors Jake Bennett and Lucien Cremaldi and met two teachers from Oxford High School, one of whom may join QuarkNet.

University of Notre Dame – Ken participated in Monday teacher meetings on March 6, 13, 20, and 27. The emphasis in the meetings shifted to the summer program, with mentors and student applications at the top of the agenda. On March 20, Nicolas Arnaud of IN2P3 Orsay and VIRGO visited Ken and gave a presentation on gravitational waves in the teacher meeting. Nicolas stayed the next day and gave an HEP seminar in the Department of Physics and Astronomy. Jeremy Wegner and Ken had a Zoom meeting with Notre Dame Anthropology Chair Mark Schurr on March 1 to get advice on next steps for the Muographic Investigation of Mound Archaeology (MIMA) project started in the summer 2022 program to use cosmic ray detectors to non-destructively study the structure of Native American mounds. Ken worked with Tom Loughran, who now manages undergraduate laboratories in the Department of Physics and Astronomy, to try out and learn more

about the Compton experiment in order for Ken to build a Data Activity based on an activity originally created by Rick Dower in the Boston Center. Ken participated in the Physics and Astronomy Outreach Committee meeting on March 21.

University of Wisconsin – On March 7 Dave and Mark discussed Cosmic Watch activities with three teachers in Wisconsin and provided contact information for teacher Jeff Paradis in Milwaukee.

Cosmic Ray Studies

During March there were 760 cosmic ray uploads and 42 cosmic ray plots. In the same period, 4235 analyses were run (in analysis-day units). The number of days each analysis was run are 27 Flux, 13 Lifetime, 5 Advanced Lifetime, 9 Performance, 15 Shower, and 8 Time-of-Flight. Mark provided help desk assistance for teachers on the following topics: DAQ 5000 debugging, identifying bad cables, plateauing, debugging bad DAQ, running PyEQUIP, upload failures, calculating consistent rates for International Muon week, PMT temperature dependence, Lifetime analysis, geometry history, inefficient counters, and pressure sensor. Jeff Rodriguez compiled one-page summaries from International Muon Week participants as well as a 3D histogram of average rates. Mark scaled all data to a standard configuration, to allow world-wide comparisons. On March 7, Dave and Mark met with Wisconsin teachers Rachel Lancor, Brian Lancor, and Robert Young, who have used Cosmic Watch activities with their classes. We also provided them contact information for the University of Wisconsin center. On March 9, Dave and Mark met with Georgia Schwender and the two Fermilab artists in residence: Ricardo Mondragon and Roger Zare. They explored how to use cosmic ray data in their sculpture and musical artwork. They were particularly interested in live data. On March 14 Dave and Mark met via Zoom with three teachers from the Stanford Online High School. Kalee Tock wishes to measure cosmic rays on a balloon flight at the next solar eclipse. After discussing our 2017 eclipse experiences and sharing our Physics Teacher publication, we connected them with Peggy Norris of Sanford Lab. They also expressed interest in joining a QuarkNet center so we shared UCSC and LBNL contact info. Dave and Mark provided much help for Terry Hart at Rockford University, testing and eventually replacing his 5000 DAQ, GPS system, and power supply. The original components were no longer functional. Dave and Mark assisted the group at Miranda House, University of Delhi by debugging their DAQ 6434 from afar. Dave and Mark have asked for updates on the status of DAQ 7045 which is under license. DAQ 6434 came with a full detector purchase, and is not covered by a license; however, we intend to send a replacement DAQ.

Mark maintained the Fermilab DAQs weekly: 6119 collecting single muon upward-muon search data; and 6148 collecting large shower array data. DAQ 6410 was used to debug PyEQUIP and to collect data for lifetime measurements by users without detectors. Data from 6410 stacked runs enabled scaling of International Muon Week data on Cosmic Watch and other non-QuarkNet detectors to the standard QuarkNet detector. Mark also collected Moon Shadow data with DAQ 6674 in Geneva.

The Cosmic Ray Fellows met on March 29 and discussed: summer workshop planning, EQUIP/PyEQUIP installation tests on Macs, PCs and Raspberry Pis, International Muon Week results, Moon Shadow and Storm Tracking projects, and Radio shower detectors.

LHC Physics

The LHC fellows met with Ken on Zoom on March 28. Most of the discussion was a post-mortem on the nearly-completed International Masterclasses 2023, some of which actually led to modifications for the last few Fermilab masterclass videoconferences. Ken worked on making the measurement

of dimuon opening angles into a QuarkNet Data Activity using ATLAS data. We have used this measurement, originally proposed by Jeremy Wegner, for several years in World Wide Data Day.

Neutrino Physics

The Neutrino fellows met with Shane on March 28 on Zoom to debrief the NOvA masterclass pilots that took place at the University of Minnesota on March 11 and the University of California at Irvine on March 25.

International Masterclasses

Shane, Spencer, and Ken made adjustments to the Fermilab masterclass videoconference schedule as needed and worked to be sure that all of the videoconferences were successful. Ken helped facilitate a MINERvA masterclass orientation on Zoom on March 4 with teachers and leaders from the University of Puerto Rico. Also, working with Uta Bilow, Ken oriented Benard Mulilo of the University of Zambia and Chiufya Mwewa of BNL and CERN to help them get ready for their ATLAS masterclass in Lusaka.

The following Fermilab masterclass videoconferences were held in March:

- March 2 (CMS) - Constantine, Algeria, moderated by Ken and one physicist.
- March 3 (ATLAS) - Oklahoma State and Louisiana Tech, moderated by Ken, a fellow, and two physicists.
- March 4 (ATLAS) - UC Santa Cruz, moderated by a fellow and a physicist.
- March 4 (MINERvA) - Colorado State, moderated by Shane and a physicist.
- March 5 (CMS) - Johns Hopkins, moderated by a fellow and a physicist.
- March 7 (MINERvA) - Sanford Lab/Black Hills State, moderated by two fellows and a physicist.
- March 9 (ATLAS) - SMU, moderated by Ken, a fellow, and two physicists.
- March 9 (CMS) - Singapore, moderated by Ken and a physicist.
- March 10 (CMS) - Honolulu and Mexico City, moderated by a fellow and two physicists.
- March 10 (MINERvA) - Valencia, Spain, moderated by Spencer and a physicist.
- March 11 (CMS) - Northeastern, William and Mary, Hermosillo, and Medellin, moderated by a fellow and two physicists.
- March 11 (CMS) - Orange CA and UWashington, moderated by Ken and a physicist.
- March 11 (NOvA pilot) - University of Minnesota, moderated by a physicist.
- March 14 (ATLAS) - Northern Illinois, moderated by two fellows.
- March 15 (MINERvA) - Canandaigua NY, moderated by Spencer and a physicist.
- March 16 (CMS) - multiple schools in Shanghai and beyond, moderated by Ken, a fellow, and a physicist.
- March 18 (CMS) - Purdue and Purdue Northwest, moderated by Ken and two physicists.
- March 25 (ATLAS) - Coimbra, Evora, and Lisbon, Portugal, moderated by a fellow and two physicists.
- March 25 (ATLAS/CMS) - Oklahoma State and Rice, moderated by three fellows and one physicist.
- March 25 (CMS) - Montelibano, Cuenca, and Quito, Ecuador, moderated by two fellows and two physicists.
- March 25 (MINERvA) - Constantine, Algeria and Kolkata, India, moderated by Shane and two physicists.

- March 25 (MINERvA) - UMN-Duluth, Puerto Rico-Mayaguez, moderated by Shane and two physicists.
- March 30 (CMS) - Osorio, Brazil, moderated by Ken and two physicists.
- March 31 (CMS) - Kansas State and Puebla, Mexico, moderated by Ken and two physicists.
- March 31 (ATLAS) - Oklahoma State, moderated by Ken and a physicist.

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

Coding

The Coding fellows are planning an increased number of workshops this summer, thanks to additional support from IRIS-HEP. We'll have returns of Coding Camp 1 (virtual) and Coding Camp 2 (at Fermilab) along with new additions of Coding Camp 0 (virtual), for interested-but-cautious teachers, and six 2-3 day workshops at universities around the country where IRIS-HEP collaborators are located. Some of those six events will help existing QuarkNet centers reach a broader audience while the others are targeted to support potential centers or those lacking critical mass of participants in recent years.

We're also underway with a series of Saturday half-day virtual workshops for teachers to refresh their coding skills in advance of the more formal offerings this summer.

Data Activities Portfolio

Deborah, Ken and Shane met on several Thursdays in March. Work progressed on activities to support the summer workshop season.

Broader Impacts

CERN Beamline for Schools Competition – Ken had a videoconference with CERN engineer Markus Joos, students from Discovery High School in Camas, Washington, and their teacher to discuss their ideas for a beamline experiment at CERN or DESY.

Cosmic Rays at Pyramid – Biweekly collaboration meetings continued. Congressman Bill Foster's office sent our request for help in transporting the detector to Mexico to the Air Force. The first CAEN processor board passed readout tests, so the rest of the boards were ordered. Electricity for the north tunnel will be installed in early April. The group decided to install fiber optics as an internet backup via Starlink in case the cell phone hot-spot solution proves to be inadequate.

International Collaborations – Uta Bilow and Ken met on Zoom March 6 with Pauline Gagnon, retired from CERN, to help her plan an ATLAS masterclass demonstration in Eindhoven, Netherlands in April. Ken had a follow-up meeting with Pauline on April 31. Uta and Ken also met on Zoom on March 7 with Philip Kuznetsov and his colleagues in Kharkiv to help them plan their CMS masterclass. Ken participated in videoconferences on March 14 and 28 to help plan the African Conference on Fundamental and Applied Physics (ACP) 2023 to be held in George, South Africa. Shane and Ken had a Zoom meeting on March 22 with French physicist Claire David, whom they had met in the African School of Fundamental Physics and Applications (ASP) 2022, to help her establish an ATLAS masterclass for students in Accra, Ghana.

Outreach Efforts in the Los Angeles Area – Shane worked with students at the STEM Academy of Boyle Heights in Los Angeles on March 30. He also met with the principal, assistant principal, and science teacher to discuss potential future collaborations between QuarkNet and the school.