

QuarkNet Staff Monthly Report Activities of August 2020

Centers

In addition to ongoing contacts and discussions, staff reports the following activities:

QuarkNet Educational Discussions (QED) – The staff launched a biweekly series of Wednesday evening Zoom chats for teachers to talk about teaching in the new environment of the 2020 academic year. Two have taken place, on August 12 and 26, with teachers talking about everything from use of new technology to ways to build community online—or when half the students are online, and half are physically in class. QED meetings are currently scheduled through December 9.

QuarkNet Summer Session for Teachers (SST) – Allison Hall gave the last SST presentation on August 5, concluding the series with great success. Shane sent 41 certificates of completion to teachers.

Brookhaven National Laboratory/Stony Brook University – The mentors and lead teacher met Ken on Zoom on August 19 to discuss having a short workshop at the end of the month. Gillian Winters and Ken put together an agenda but decided to postpone the workshop until later, perhaps in the autumn, as it was too close to the beginning of school for prospective participants.

Colorado State University – Shane co-facilitated a one-day virtual STEP UP workshop with Cherie Bornhorst for seven teachers on August 5.

Johns Hopkins University – The center had a virtual workshop via Zoom on August 3–6 with a variety of presentations and discussions about particle physics, education, and diversity issues. Ken joined at various times to help with “QuarkNet housekeeping” and sit in on some of the discussions.

Kansas State University – Mark and Nate assisted Penny Blue with registration of new DAQ and use of student research groups in e-Lab. Martin Shaffer recently moved and plans to reestablish cosmic ray data-taking at his new school.

Syracuse University – Ken, Shane, and Michael Fetsko facilitated a virtual CMS data workshop on August 20–21 with nine teachers in attendance.

University of Cincinnati – UC had their workshop online August 3–5; it drew large elements from Data Camp 2020, and Adam LaMee was on hand to help out. Ken helped with the opening sequence and checked in on the group from time to time after that.

University of Illinois at Chicago – Nate and Mark expanded the curated data for simple experiments used to measure the speed of muons and to explore hardware constraints on muon lifetime data. At the workshop last month, teachers developed plans to keep cosmic ray data-taking functioning. Dave shipped detector components to teachers and students at four different high schools to allow them to reposition detectors to homes while schools remain inaccessible due to COVID restrictions. A paper on the MUSE project written by students was accepted by the *Physics Teacher*. On August 10, an F1 tornado hit within 50 m of two detectors Nate operated. Mark and Nate collected data from all local detectors in operation and shared with the full center. Several schools plan to study muon fluxes to see if they can find evidence in the data of the

tornado. Mark held virtual meetings with graduated students and Nate on August 14 and August 25 to help finalize analysis and responses to reviewers' questions for the Eclipse article for *The Physics Teacher*. Students have shown remarkable dedications. One student finished the text before moving to study in Israel for a year, and the second student met with us from her dorm room at UIUC to verify all results and limit calculations.

University of Notre Dame – QuarkNet week was August 3–5, held outdoors under a tent with social distancing. Ken helped get things going and checked in when he could; the workshop was just outside his building! The group worked on using smartphones for at-home and online labs. Jeremy Wegner plans to give a talk on some of the work at the virtual Indiana AAPT meeting in September.

Virginia Center – The center met August 3–5 and split their time between STEP UP and CMS. Ken helped with QuarkNet matters and the BAMC masterclasses. He also looked in on some of the “STEP UP” activities that Mike Fetsko facilitated.

Virtual QuarkNet Center – The Virtual center met online August 12–14 for a neutrino data workshop. Shane and Ken facilitated, using the outline put together by Mike Wadness, who was unable to attend.

Cosmic Ray Studies

Statistics from e-Lab: 459 cosmic ray uploads and 15 cosmic ray plots during the July 28–August 27 interval. Mark provided help desk assistance for teachers on the following topics: registering new DAQs, replacement of detector components, agendas for short, virtual cosmic ray meetings, new accounts, operating detectors underground, updating listservs, investigating detector light leaks, and finding locations for GPS receivers in homes. Shane and Ken also participated in help desk work, especially creation of new accounts.

Mark continued to collect muon speed data with DAQ 6674 located in his home. He developed and collected data for an activity exploring the impact on results using the muon lifetime module depending on the conditions under which the DAQ collects data: trigger gates and trigger multiplicity. He distributed a draft to fellows for comments.

Edit and Mark continued to investigate and repair e-Lab errors. They repaired incorrect flux dates, searched for and cataloged future-dated uploads, transferred to and tested a semi-log plot addition to lifetime on the production server, developed a report of files used in analyses, identified a systematic bias in lifetime fits, repaired DAQ gate width reconstructed from metadata, and discussed changes to lifetime software trigger logic.

LHC Physics

Stelios Vourakis, University of Athens, sent a revised version of the online event display for the ATLAS measurement for World Wide Data Day (W2D2), which replaces the y-z view with an r-z view of muon tracks to get a better read of the angle theta made by the tracks with the beam axis. He also added the ability to find invariant masses from dimuon pairs. The LHC fellows and staff tested this beginning August 18. In the testing, Jeremy Wegner noticed that the opening angles of muon tracks in the x-y plane were small for low-mass primary state particles such as the J/Psi and much larger for higher mass particles like the Z. He plotted it and the distinction was very clear. This may be added to W2D2 or used elsewhere. On August 25, Tom sent Ken CMS

top-antitop decay data per his request. They discussed possible uses by e-mail for both the CMS e-Lab and Jupyter/Colab notebooks.

Neutrino Physics

Shane, Spencer, and Ken had a Zoom meeting on August 25 with David Martinez of South Dakota Mines and David DeMuth of Valley City State University and several of their colleagues to discuss plans and progress. The meeting was very encouraging, and the group will likely meet monthly.

Fellows

The LHC and Neutrino fellows switched from meeting weekly to meeting every other week in order to accommodate QED (see above). They are still busy, though, and in August they tested a new event display for the ATLAS W2D2 measurement. They also fixed November 12 as the date for W2D2. Jeremy Wegner and Mike Fetsko were particularly active in helping to facilitate data workshops. Joel Klammer completed his HTML5-based online version of the Quark Puzzle.

Most Cosmic Ray fellows attended their monthly meeting, now held via Zoom, on August 18. Topics discussed were: detectors hit by tornado on August 10; MUSE paper submitted to *The Physics Teacher*; ideas of new projects fellows would like to undertake; improvements to one-day through three-day virtual agendas; possibility to invite university lab groups to use our e-Lab data or even take new types of data upon request; construction of a $\cos(\theta)$ stand; systematic bias in lifetime fits; simplified e-Lab experiments for classrooms and workshops; and reflections on summer workshop and remote teaching experiences. For more details, see the University of Illinois at Chicago entry above.

Data Activities Portfolio

Deborah developed a document for guiding teacher submission of activities to the Data Activities Portfolio (DAP). This preliminary document allows teachers to better understand the DAP goals and serves as the basis for discussion via Zoom on whether a proposed activity fits with the DAP goals. A teacher can modify the activity as needed for resubmission. If the activity meets the goals, then the teacher can work with Deborah to complete the DAP activity template. Deborah met online with Helen Coyle regarding her proposed activity. Helen agreed that the activity needed revision to meet the goals. She will resubmit a modified version as time permits. Deborah responded to Kathy Race's request for clear definitions of how an activity is evaluated for meeting the NGSS standards. These definitions were applied to all of the posted activities and updated as necessary. Deborah reviewed the curriculum topics for all posted activities. There were many adjustments due to changes in the curriculum topics. Deborah is working with Ken and Shane to develop new activities to support the neutrino workshop. Under development are *Making Tracks I* (introduction to cloud chambers), *Making Tracks II* (introduction to bubble chambers), and *Particle Transformations*, which is an introduction to Feynman diagrams and rules for particle decays. *Particle Transformations* is a response to a request by a BNL-SB teacher.

Increasing Diversity

Deborah is working with a team of STEP UP ambassadors to host a STEP UP online "social hour" based on the research about underrepresented minorities.

Broader Impacts

International Collaborations – Ken gave an online presentation on doing hands-on contemporary physics with students for the African School of Fundamental Physics and Applications on August 6.

AAPT – Deborah, chair of the Committee on Contemporary Physics (CoCP), coordinated with Marla Glover, vice-chair of CoCP, on session and workshop submissions for upcoming meetings. Deborah, Shane, Ken, and Spencer worked on plans for AAPT Winter Meeting 2020.