FRIB LABORATORY UPDATE for USERS December 2019

2020 vision: Bringing the FRIB Project home and transitioning to user operations mindset

by Thomas Glasmacher, FRIB Laboratory Director

Happy holidays! As we end 2019 we want to take a moment to reflect on what we accomplished this year and look ahead with excitement to the start of a new decade – one that will mark the start of FRIB user operations in support of the scientists who will make the discoveries.

Technical installation progressing toward completion

The FRIB Project remains on schedule for early completion in 2021 and is about 92 percent complete. The project team delivered the planned milestones in 2019, demonstrating the integration of the cryogenic plant, superconducting radio-frequency cryomodules, controls and beam physics in February by accelerating beams through the first third of the linear accelerator – 15 of 46 total cryomodules – to 10 percent of FRIB's final beam energy. In this phase of commissioning, FRIB became the world's highest-energy continuous-wave hadron linear accelerator (linac). In August 2019, the radio-frequency quadrupole was conditioned above 100 kW, the CW power needed to achieve the FRIB mission goal of accelerating uranium beams. Our next major commissioning milestone – commissioning the second third of the FRIB linear accelerator – is slated for early 2020 following completion of our fourth Accelerator Readiness Review (ARR04).

We marked additional technical achievements this year:

• In September 2019, the thickness of the liquid lithium film in the charge stripper was measured for the first time by the online electron-beam diagnostics system. The electron beam traverses the lithium film simultaneously with the heavy-ion beam, allowing a continuous and online thickness measurement. FRIB

is the first accelerator in the world to use liquid lithium as a charge stripper.

• The first half-wave resonator cryomodule, which makes up two-thirds of the FRIB linac, was energized in the linac tunnel, met performance specifications, and is ready for beam operations.

• In October 2019, all of the cryomodules in linac segment 2 were installed and cooled to 2 K. The first folding segment of the linac was completed, connecting the first and second linac segments.

• In cryoplant operations, the 4 Kelvin cryoplant is complete and makes helium, and the 2 K coldbox is complete and cools the linac. Twenty-eight (of 46 total) cryomodules have been cooled to 2 K and 4.5 K.

• Cryomodule production is ramping down, as 41 of 46 cryomodules have been installed in the linac tunnel as of November 2019, and all but two have been tested.

• FRIB site-restoration work and construction on two MSU-funded building additions are nearing completion. The High Rigidity Spectrometer (HRS) and Isotope Harvesting Vault will house research equipment for isotope harvesting and provide experimental space for the FRIB science program. The Cryogenic Assembly Building will provide additional research and maintenance space.

FRIB science community engaged and preparing for science

Looking back on 2019, we are thankful for the nuclear science community's support of FRIB and engagement in determining the laboratory's future. In August, the low-energy nuclear physics community at the Low Energy Community Meeting (LECM) at Duke University resolved that FRIB and FRIB instrumentation are top priorities. The user community also made the science case for the 400 MeV/u energy upgrade of FRIB in 2019 in the FRIB400 whitepaper. The energy upgrade was subsequently endorsed at the LECM where the resolution stated it was "extremely compelling and would significantly expand the science opportunities at FRIB."

Looking ahead to 2020, we are excited to support users in preparing for science at FRIB. The "FRIB First Experiments: Proposal Preparation" workshop in May 2020 signals how close we are to user operations. We hope to see many of you there and look forward to your proposals in response to the first FRIB Call for Proposals later in the year.

The current experimental program at NSCL continues to support the rare isotope user community on the way to FRIB. NSCL operated more than 5,000 hours, successfully completing 30 experiments in 2019. There were approximately 25 PhDs this year based on NSCL research and over 200 undergraduate students participating in various laboratory activities.

Outreach, education, and workforce training

The FRIB Laboratory again hosted several summer schools for science exploration. Fourteen undergraduate students from thirteen universities spent a week at NSCL learning about nuclear science at Nuclear Science Summer School (NS3), funded by NSF and JINA-CEE. JINA-CEE also hosted the First Frontiers Summer School for early-career scientists in nuclear physics, astrophysics, or astronomy, and partnered with the University of Notre Dame in the week-long Physics of Atomic Nuclei program for high school students and teachers.

The second Training in Advanced Low Energy Nuclear Theory (TALENT) course was held at FRIB, and The FRIB Theory Alliance hosted a summer school on machine learning in physics applications, and a two-week topical program "Hadronic electric dipole moments in the FRIB era: From the proton to protactinium."

We appreciate the opportunity to leverage FRIB to help meet the nation's workforce development needs. The Accelerator Science and Engineering Traineeship (ASET) program and the MSU Cryogenic Initiative continue at FRIB. In support of the program, we were pleased to have speakers from several national laboratories present several more ASET seminars in 2019.

On track for future success

The DOE-SC Office of Project Assessment (OPA) held its independent project reviews of the FRIB Project in May and November and found the project is making appropriate progress toward completion.

At the OPA closeout, DOE-SC Associate Director for Nuclear Physics Tim Hallman commented that we are getting to the most exciting part of the project – the final sprint where we have to stay on our toes to bring FRIB home for the nation. We have about 100 weeks till project completion, so the countdown is on. There is no longer the luxury of time or resources to make adjustments as there was earlier in the project. He also spoke about the future – envisioning the FRIB ribbon cutting and the scientific discoveries that lie ahead. He reminded that it will continue requiring everyone working together to deliver on the promise to taxpayers, and what a shared accomplishment it will be.

An exciting development this year was the National Science Foundation endorsing stand-alone ReA6 operation in 2021. This was a recommendation of the NSCL Site Visit panel in August. ReA6 operation will offer a variety of long-lived isotope beams, with the development priorities set by a Program Advisory Committee Meeting in March. There is about one year left of operation of the NSCL Coupled Cyclotron Facility. Now with the NSF's decision, the user program will continue into 2021 up to almost when FRIB is ready to start its user program.

We assure you we are on our toes to bring the project to completion with our eyes toward user operations. We are humbled by the trust placed in us, and committed to working together to deliver on that trust for the nation and the nuclear science community. We can't wait to see what discoveries you make here.

Thank you all for your support of FRIB in 2019. Your hard work, advice, and enthusiasm are pushing us through the homestretch of the FRIB Project. Best wishes for happy holidays with your family and friends.

Please e-mail questions, comments and contributions to communications@frib.msu.edu.
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