LABORATORY
UPDATE for ALUMNI
NSCL FRIB
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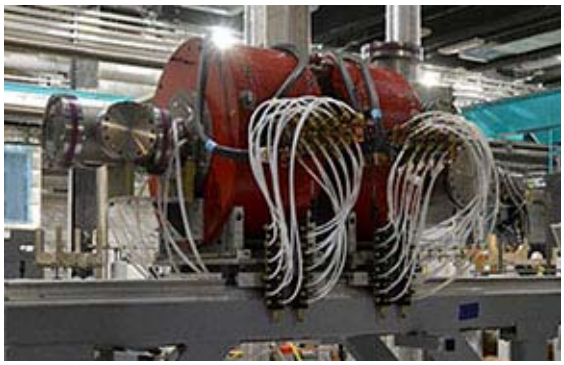
FRIB makes first beam from ARTEMIS ion source



On 14 October, the first FRIB ion beam was produced from the Advanced Room-TEMperature Ion Source (ARTEMIS). Above, ARTEMIS is shown on the platform at the time of its installation in April 2016.

The Facility for Rare Isotope Beams Project has reached a new milestone: the extraction of the first ion beam from its Advanced Room-TEMperature Ion Source (ARTEMIS). On 12 October, FRIB staff turned on ARTEMIS for the first time, and the successful testing resulted in the first ion beam produced on 14 October.

ARTEMIS is FRIB's first accelerator component to be installed, which took place back in April. It is one of two electron cyclotron resonance (ECR) ion sources that FRIB will use to produce ions from elements: one room-temperature ECR (ARTEMIS) will support general-purpose operations and one superconducting ECR (SC-ECR) will provide high intensity for all elements including heavy ion beams like uranium.

Above is an updated photo of the same area in October 2016 that shows ARTEMIS behind fencing and shielding as it undergoes testing.

In the ion source, neutral atoms are vaporized into a hot plasma, which knocks electrons off the atoms and ionizes them. The resulting ions are contained with electric and magnetic fields. Once ions of appropriate energy are produced, they will be extracted into the FRIB accelerator.

Now that ARTEMIS is installed and is being successfully tested, the next step is to complete the installation of the FRIB front end to receive and transport the extracted beam of ions for further acceleration.

FRIB installs first cryomodule into linear accelerator tunnel

The Facility for Rare Isotope Beams installed the first of 48 cryomodules into its linear accelerator tunnel on 29 September.

On 29 September, the Facility for Rare Isotope Beams installed the first of 48 cryomodules into its linear accelerator tunnel. When FRIB is in production, the linear accelerator will drive a beam of stable atomic nuclei up to half the speed of light to strike a target area, and the resulting collision will produce rare isotopes.

This installation involved the β=0.085 cryomodule, which is FRIB's first completed and tested cryomodule. It is approximately 20 feet long and weighs approximately 26,000 pounds.

The linear accelerator is made of cryomodules, which contain superconducting radio frequency (SRF) cavities that accelerate the beam while operating at temperatures hundreds of degrees below zero. The β=0.085 cryomodule contains eight superconducting radiofrequency (SRF) β=0.085 quarter-wave resonators, three superconducting focusing solenoids and three beam-position monitors.

Watch a video of the installation.

Civil construction continues ten weeks ahead of schedule with several significant technical installations complete

FRIB civil construction continues to progress 10 weeks ahead of schedule, with an increasing number of technical installations. This aerial shot of the construction site was taken 7 July 2016.

FRIB construction continues to move ten weeks ahead of schedule, with an increasing number of technical installations enabling technical milestones.

The Advanced Room-TEMperature Ion Source (ARTEMIS) high-voltage platform is complete, which enabled ARTEMIS to make its first beam on 14 October (see story above). On 29 September, the first of 48 cryomodules was installed in FRIB's linear accelerator tunnel (see story above).

Additionally, the radio frequency quadrupole (RFQ) has been delivered, and will be set on the stand in the linear accelerator (linac) tunnel starting 17 October. The RFQ prepares the beam for further acceleration in the linac. The turnover of the front-end area is scheduled for 16 December, in which all conventional utilities will be operational. Other notable technical installations include:

High-voltage platform LCW skids

The high-voltage platform low-conductivity water (LCW) skids have been installed and commissioned. They have been piped to the high-voltage platforms utilizing chilled water from a temporary 20-ton chiller. The LCW skids remove particles from the water to

Cryogenic cold box

After 900 miles of travel, the installation of the 100,000-pound vertical cryogenic cold box was completed in August. The cold box was built in Oklahoma, but could only travel during daylight due to Department of Transportation rules. To avoid traffic concerns around Chicago, the cold box ultimately arrived in Michigan by way of the Lake Michigan car ferry SS Badger.

The cold box will be used to cool helium to an extremely low temperature, which will in turn cool cryomodules in the linac tunnel. Cryomodules must be cold to make the cavities inside them superconducting. When the cavities are superconducting, there is no resistance, which means there will be virtually no heat loss with an electrical current, making FRIB more energy-efficient as it accelerates rare isotope beams.

Cabling and piping

Cabling continues to move along, with 1,786 total cables pulled out of the estimated 11,261. To date, 37,696 linear feet of direct current (DC) cables and

bring the conductivity of the water down to a level that is acceptable for the equipment.

The 100,000-pound vertical cryogenic cold box arrived at FRIB on 10 August. The cold box was built in Oklahoma and arrived in Michigan by way of the Lake Michigan car ferry SS Badger.

183,086 linear feet of low-voltage cables have been pulled.

Warm-helium piping installation continues in the compressor room and the cold-box room. Non-conventional utilities (NCU) piping is currently 82 percent complete, and is continuing in the target facility and ground floor. On the building exterior, metal panel installation progresses on the west side, roofing continues on the east side of the target facility, and stone caps are being set at the planter walls.

Using cranes, vertical cryogenic transfer lines were lowered into the cold box room through a roof hatch. Each of the three transfer lines will deliver liquid helium to a segment of the linear accelerator.

FRIB office tower is complete

The FRIB office tower 3 addition is complete.

The FRIB office tower 3 addition is complete, and people are moving into the new space.

The parking lot, sidewalk, and new bike loops have been installed around the exterior of the building, and only a few items remain to reach final completion. Office furniture is being installed on all floors, and the audio-visual contractor is working diligently to get the conference rooms functioning.

The seating in the auditorium has been installed, along with the motorized projection screens. Final commissioning is also taking place and is slated to be complete by the end of October.

DOE Office of Project Assessment review held 28-30 June

The DOE-SC Office of Project Assessment's (OPA) review of FRIB was held 28-30 June.

The DOE-SC Office of Project Assessment's (OPA) review of FRIB was held 28-30 June. The main focus of the review was to assess overall FRIB Project progress since the last review in November 2015, with a focus on FRIB's technical progress.

The review committee was organized into five subcommittees and FRIB staff gave 51 presentations.

The OPA assessed all aspects of the FRIB Project – technical, cost, schedule, management, and environmental safety and health – and found that FRIB is overall making appropriate progress toward completion. The review committee answered all charge questions with the exception of progress on magnets affirmatively.

DOE has scheduled the next review for 6-8 December.

Nearly 4,000 attend FRIB/NSCL open house

Tours were held in the currently operational experimental areas in NSCL that will be used in FRIB experiments, and visitors could tour the FRIB facility under construction.

Nearly 4,000 members of the public attended the 20 August open house at FRIB and NSCL. The four-hour open house, made possible by 130 volunteers, offered an array of experiences for all ages.

Nearly 4,000 members of the public attended the 20 August open house at the Facility for Rare Isotope Beams and National Superconducting Cyclotron Laboratory. The "Rare Access" event included activities, demonstrations, presentations, and tours that allowed attendees to learn more about a world-leading science facility in operation (NSCL) and one in the making (FRIB). Attendees waited in long lines and weathered rainy conditions in order to attend the event. At some points, the lines extended about a quarter mile!

The four-hour open house, made possible by 130 volunteers, offered an array of experiences for all ages. Tours were held in the currently operational experimental areas in NSCL that will be used in FRIB experiments, and visitors could tour the FRIB facility under construction.

Several hands-on activities and demonstrations showed the fields of FRIB and NSCL research, including playing the Isotopolis video game, operating an electromagnetic accelerator, smashing model

Additionally, scientists were on-hand to talk about their work on the frontiers of rare-isotope research, and several educational videos were shown in the "FRIB Theater."

In the presentation hall, speakers gave presentations on the NSCL/FRIB Laboratory, the science being explored, and career opportunities for young people.

This was the first public open house to show the public both NSCL and FRIB.

To see highlights of the day, check out the photo gallery and the time-lapse video.

Tours were held in the currently operational experimental areas in NSCL that will be used in FRIB experiments, and visitors could tour the FRIB facility under construction.

“nuclei” made of magnetic marbles, and operating a control system like a cyclotron operator.

The open house provided several hands-on activities and demonstrations that showed the fields of FRIB and NSCL research.

FRIB honors MSU College of Engineering for its support

FRIB hosted a special event on 9 May to recognize the MSU College of Engineering’s contributions to FRIB.

The College of Engineering has collaborated with FRIB on materials quality testing, including testing the element niobium that is being used to build superconducting radio frequency resonator cavities, which are core components of the linear accelerator. Researchers from the college will use a $1.1 million grant from the U.S. Department of Energy’s Office of High Energy Physics to continue studying the niobium superconducting resonators.

Niobium is used specifically to make the tunnels, or cavities, through which rare isotope ions fly at about half the speed of light. The same material also is used to make cavities that accelerate sub-atomic particles, such as electrons and positrons, to nearly the speed of light. When the particles are accelerated through the underground tunnels of an accelerator such as FRIB, they go through a series of twists and turns to control the beam before reaching the final destination. Any defect in the niobium can interfere with the superconducting process and slow things down.

As part of the recognition program, Thomas Bieler of the Department of Chemical Engineering and Materials Science in the College of Engineering presented on the college’s materials-quality testing efforts, while Georg Bollen, FRIB Experimental Systems Division director, discussed future collaboration opportunities at FRIB. FRIB Laboratory Director Thomas Glasmacher and College of Engineering Dean Leo Kempel also made remarks during the event.

Additionally, FRIB presented the College of Engineering with a special award in appreciation of the successful collaboration between the two units. FRIB Cavity Fabrication Group Leader Chris Compton and FRIB graduate student Di Kang participated in the award presentation in recognition of their role in this important partnership. As cavity fabrication lead, Chris has been the primary liaison between FRIB and the college, and Di is a graduate student in FRIB’s niobium materials science group. He performed the majority of the quality measurements as part of acceptance inspections of FRIB’s incoming niobium material.

“FRIB has been, and will continue to be, a transformational project on the campus of Michigan State University," said Leo Kempel, dean of the MSU College of Engineering. "This new project reaffirms the close collaboration between material science and FRIB in making the devices used by high-energy physicists at MSU, and from around the world, the best system possible.”

“Partnering with the MSU College of Engineering has been instrumental in developing our superconducting radio frequency cavities, which are core components of FRIB’s linear accelerator,” said Thomas Glasmacher, FRIB laboratory director. “We are extremely fortunate to be able to collaborate with MSU experts to build what will be the world’s most-powerful rare isotope accelerator, and we look forward to future collaborations.”

Exotic Beam Summer School held 17-24 July at NSCL

This year, forty graduate students attended the Exotic Beam Summer School to learn about challenges in low-energy nuclear physics and interdisciplinary subjects such as medical applications.

The fifteenth Exotic Beam Summer School (EBSS2016) was held at the National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University on 17-24 July.

The aim of this annual school is to introduce students and young researchers to various facets of the science of exotic nuclei, including nuclear structure, nuclear astrophysics, fundamental interactions, and the application of nuclear science and technology. This year, forty graduate students attended the school to learn about challenges in low-energy nuclear physics and interdisciplinary subjects such as medical applications.

As a unique feature of the EBSS series, hands-on activities were organized in the afternoons and, this year, students learned beam optics, particle identification, particle yield estimates, data acquisition and electronics, astrophysics simulations, and nuclear theory.

These hands-on activities were geared towards preparing students for an actual experiment at NSCL. From Friday through Saturday, students ran an in-beam gamma-ray experiment with GRETINA and S800 spectrograph using the ^{36}Ar beam from the NSCL Coupled Cyclotron Facility.

The EBSS series is sponsored by the U.S. Department of Energy, the National Science Foundation, and following laboratories: Oak Ridge National Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Argonne National Laboratory, Michigan State University, and the Association for Research at University Nuclear Accelerators.

More details of EBSS2016 including lecture slides are available online.

FRIB participates in the 'science of teams' study through MSU Eli Broad College of Business

by John Hollenbeck, University Distinguished Professor, Eli Broad Professor of Management

Over the last four years, FRIB has been involved in a joint venture with researchers at the Eli Broad College of Business to study how to derive the advantages of working in teams while avoiding some of the disadvantages. This research is funded by the National Science Foundation and examines how one's position in both the formal and informal organizational network impacts individual and team outcomes. Formal networks are captured using organization charts, and informal networks were captured via both surveys and the use of wearable sensor technology.

Historically, the organizational goals of cost effectiveness and efficiency were contrasted with the alternative goals of innovativeness and differentiation. Some organizations competed by being the best on efficiency, whereas other organizations competed instead on innovativeness. However, organizations are increasingly under pressure to pursue both sets of goals simultaneously, and today, the key to organizational success hinges on accomplishing both objectives.

Nowhere is the pressure to pursue goals related to both efficiency and innovation greater that than the fields of science. Many fields of science are undertaking complex problems of vast scope, and innovative solutions demand the integration of knowledge spread across many individuals. However, traditional sources of funding for scientific work are under pressure, requiring universities and federal funding agencies to increase efficiency.

Many organizations have responded to this challenge by turning to flexible and loosely structured team-based organizations. Although there is great potential for the use of team-based structures in the pursuit of science, groups create their own unique problems that have been well documented over the last sixty years. This would include issues related to social distraction, lack of accountability, social loafing, biased information processing, conformity pressures, group polarization, and interpersonal conflict.

Recognizing the potential virtues and liabilities associated with team-driven science, the National Research Council recently released a report entitled "Enhancing the Effectiveness of Team Science." This report concluded that:

"While the increasing size of team-based research projects brings greater scientific expertise and more advanced instrumentation to a research question, it also increases the time required for communication and coordination of work. If these challenges are not recognized and addressed, projects may fail to achieve their scientific goals" (National Research Council, 2015, p. 1).

In upcoming issues of the Laboratory Update for Alumni, we will describe the major findings that have emerged from this program of research at FRIB, and where this work is headed in the future. Specifically, we will focus on the questions:

• How does the number and nature of one's formal ties impact job performance and leadership emergence?
• How does the number and nature of one's informal ties affect job performance and leadership emergence?
• How does the method of data collection to assess ties (survey versus wearable sensor) affect the relationships between ties and outcomes?
• Moving forward, how might the number and nature of ties to organizations external to FRIB interact with internal ties at FRIB to affect outcomes?

Alumni spotlight: Giuseppe Lorusso

Giuseppe Lorusso

Giuseppe Lorusso received his PhD from Michigan State University in 2010 under the mentorship of Professor Hendrik Schatz, and working in close collaboration with the group of Professor Paul Mantica. His research at the National Superconducting Cyclotron Laboratory was focused on decay spectroscopy of proton- and neutron-rich isotopes and the study of their role in the astrophysical r and rp process.

After graduation he become a postdoc fellow at the Institute of Physical and Chemical Research (RIKEN), where he continued the exploration of the nuclear chart as a member of the EUroball RIken Cluster Array (EURICA) program, which reported production and study of hundreds of isotopes.

In 2015, Giuseppe joined the National Physical Laboratory (NPL) in the United Kingdom, a world-class center of excellence in measurement science best known for the development of the radar, computer network packet switching, atomic clocks and, more recently, the world's first room-temperature maser.

At NPL, Giuseppe's main research interest is exploring the usefulness of radioactive isotopes, supporting the expansion of the range and quantities of isotopes available for practical uses. Currently, his established research areas include the study of diagnostic, internal radiotherapy, and theranostic isotopes, nuclear forensics, and a near-future goal is to study isotopes relevant to energy generation and energy storage. The core component of his research involves the use of laser-driven plasma accelerators, a promising technology toward making particle accelerators a commonplace tool, and the development of detection technology to improve measurement of nuclear and atomic data, such as cryogenic detectors using coupled dielectric resonators and superconducting quantum-interference technology.

Giuseppe is also a visiting lecturer at the department of physics of the University of Surrey, a position that allows an important link between fundamental and applied science in line with the NPL formal objective "… to bring scientific knowledge to bear practically upon our everyday industrial and commercial life…"

Giuseppe lives in Teddington, England, a town on the north bank of the River Thames and home to the Hampton Court Palace residence of King Henry VIII. Teddington is conveniently located at a short journey from London, where Giuseppe practices tango and is a member of the Scotch whiskey society, and not far from the south coast of England where Giuseppe practices sailing.

Giuseppe was recently featured in an article in *Science* magazine.

We want to hear from you

Like this issue's story about Giuseppe Lorusso, we want to feature at least one story each issue about you—our FRIB/NSCL alumni. Let us know what you are up to!

Email story tips about you and/or your fellow alumni to alumni@frib.msu.edu. Tell us about discoveries, business ventures, partnerships, awards, and other professional developments, and we may feature them in a future issue. Also let us know if there are other types of laboratory updates you'd like to see in future alumni issues.

Contributors this issue

- Brad Bull
- Thomas Glasmacher
- John Hollenbeck
- Hiro Iwasaki
- Jessica Kolp
- Giuseppe Lorusso
- Michael Thoennessen

LOOKING AHEAD

31 October-2 November	Experimental Systems Advisory Committee (ESAC) review of FRIB
9-11 November	Accelerator Systems Advisory Committee (ASAC) review of FRIB
6-8 December	DOE Office of Project Assessment Review review of FRIB
8-9 December	Science Advisory Committee (SAC) meeting at FRIB

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Michigan State University is establishing FRIB as a national user facility for the Office of Nuclear Physics in the U.S. Department of Energy Office of Science. Operation of NSCL as a national user facility is supported by the Physics Division of the U.S. National Science Foundation.