FRIB LABORATORY UPDATE for USERS

April 2018

FRIB and NSCL Laboratory Directors: Letter to FRIB User community about MSU developments

Dear FRIB and NSCL Users,

We want to take a moment to address significant developments at Michigan State University since our last issue in December 2017.

On 24 January, Larry Nassar, a former MSU physician, was sentenced to 40 to 175 years in prison for seven counts of felony criminal sexual conduct. On 5 February, he was sentenced to an additional 40 to 125 years in prison for three counts of criminal sexual conduct in another Michigan county. More than 200 survivors of his abuse spoke during his sentencing hearings, sharing their heart-wrenching personal stories. In total, more than 260 survivors have reported being abused by Nassar.

First and foremost, we extend our sincerest sympathy to the survivors of Nassar's horrific actions, and admire and commend them for their courage in speaking out publicly. As part of the MSU community, we are deeply sorry for the abuse Nassar's victims suffered, and for the pain and anguish it caused and continues to cause.

Following Nassar's sentencing, MSU President Lou Anna K. Simon resigned. The MSU Board of Trustees named an interim president on 31 January, former Michigan Governor John Engler. President Engler assumed the role in early February.

The FRIB Project team remains committed to delivering FRIB for the user community, enabling forefront nuclear science on Day One. We also remain committed to delivering FRIB for the American taxpayers, who entrusted us with this project and all that it promises. The NSCL Operations staff is likewise dedicated to delivering reliable and forefront research opportunities to the user community. Overarching those commitments is our promise as a laboratory, honoring the courage of the survivors, to be brave enough to always do what is right to ensure that our students, faculty, staff, and user community are safe and supported here.

Please do not hesitate to contact us if you have any questions or concerns during this time. We will continue to keep you apprised of developments.

Thank you for your continued commitment to and support of FRIB.

Sincerely,
Thomas Glasmacher
FRIB Laboratory Director and FRIB Project Director

Bradley Sherrill
NSCL Laboratory Director

Technical installation progress

Preparations underway for second Accelerator Readiness Review

FRIB's first Accelerator Readiness Review was successfully completed in July 2017. The second Accelerator Readiness Review (ARR02) of FRIB is scheduled for 30 May. The purpose of the review is to independently assess FRIB readiness for step 2 of the phased FRIB beam commissioning plan. The assessment will be provided to the FRIB Laboratory Director and the MSU President for their authorization to proceed.

The review will examine linac segment (LS) 1, which is capable of accelerating heavy ion beams to energies to the design energy of 1.46 MeV/u. It will focus on the first three cryomodules (β=0.041) downstream of the front end, the warm diagnostic boxes between the cryomodules, the commissioning diagnostic station (D-station), and the access control system. This will be the first beam accelerated by the FRIB cryomodule. The D-station is utilized only for this stage. Once this stage is completed, it will be removed, and one more cryomodule (β=0.085) will be installed after the beam commissioning.

To prepare for ARR02, FRIB staff has worked on component installation and testing. Testing involves delivering qualified and tested components to the commissioning managers. Following that, Device Readiness Reviews (DRR) are conducted before integrated testing without the beam. The DRR is a system/device review of non-beam hazards. After the DRR, cryomodule cooldown and integrated system testing will be conducted to demonstrate that all systems (cryogenics, cryomodules, radio frequency, vacuum, diagnostics, controls, magnets, and facility support) operate properly and are ready for beam.

The ARR02 review committee is comprised of reviewers affiliated with national laboratories, and the review will be observed by representatives from Michigan State University, the U.S. Department of Energy, Fermi National Accelerator Laboratory, and the European Spallation Source.

Following the ARR02, the next phase will focus on the rest of LS1 and the straight line dump and the 45-degree line dump of folding segment 1.

FRIB cryogenic plant complete, first liquid helium made, and preparations underway for first cold beam

The FRIB cryogenic plant was completed in December 2017. It is now operational, and is on track to operate in 2018.

As reported in the last issue, the FRIB cryogenic plant made its first liquid helium at 4.5 kelvin (K) in November 2017, and was completed in December 2017.

It is now operational, and is on track to operate in 2018. The plant's system utilities are in place, and the commissioning and performance testing of the warm compressor is finished.

Acceptance tests for the 4 K cold box were also successfully completed. The cold box met the performance modes required by contract: maximum capacity, maximum liquefaction, and maximum refrigeration.

Making cold helium is critical to operating FRIB's linear accelerator. FRIB's beam-accelerating cryomodules contain superconducting radio frequency cavities and magnets that must operate at temperatures hundreds of degrees below zero to be superconducting. The cold helium will make the cavities and magnets superconducting.

LBNL builds state-of-the-art magnet for FRIB accelerator

magnet. FRIB partnered with the Berkeley Center for Magnet Technology (BCMT) at the Lawrence Berkeley National Laboratory (LBNL) to design and build the

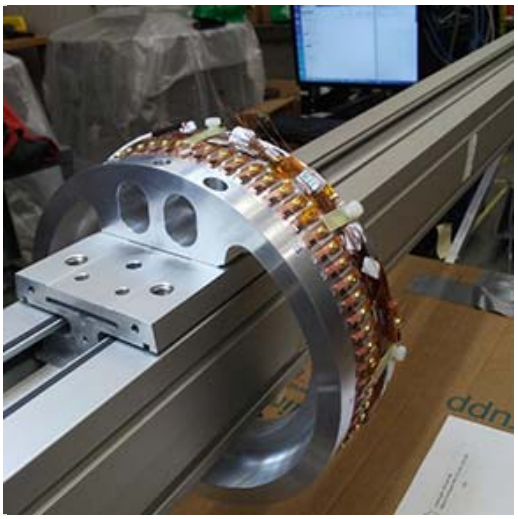
FRIB partnered with the Berkeley Center for Magnet Technology at the Lawrence Berkeley National Laboratory to design and build a state-of-the-art magnet.

FRIB's heavy-ion beam will begin with a high-performance source of heavy ions, the electron cyclotron resonance (ECR) source. A key component of the ECR source is an advanced superconducting state-of-the-art magnet. The magnet arrived at FRIB on 12 December 2017.

"I am delighted that LBNL has built, successfully tested, and delivered the superconducting cold mass magnet for the FRIB ECR," said Thomas Glasmacher, FRIB Project director. "It has been a very good experience for us to work with the LBNL team on this magnet. I particularly appreciate the transparency with which the LBNL team has communicated with the FRIB team, and LBNL's commitment to a high-quality product that was delivered within cost."

For more information, see the article on the LBNL website.

FRIB builds quadrupole field mapper system for separator magnets; first of its kind for laboratory



FRIB has designed and build a field mapper for use on the large-bore quadrupole magnets of the fragment separator.

The FRIB magnet department and fragment separator group, together with NSCL physicists' support, have designed and built a field mapper for use on the large-bore quadrupole magnets of the fragment separator, which will remove contaminants from the beam and collect the desired isotopes for research. The mapper design is the first of its kind for the laboratory. It will be used to scan the magnetic field inside of each magnet to produce a map that can be used to describe its field in three dimensions.

The FRIB separator magnets will operate at high magnetic fields that saturate the return yokes; hence, it becomes difficult to accurately predict the magnetic field behavior using simulation models. Saturation effects weaken the magnetization of ferromagnetic materials, which in turn causes distortions in the field distribution.

The availability of measured magnetic field maps is important for confirming the magnet's field quality, for its alignment, and for efficient fragment separator beam-tuning during operation.

The mapper consists of 72 Hall sensors that are evenly spaced in a circular pattern about a ring (see figure). A motorized linear slide system passes the ring through the bore as it acquires field data.

Each Hall sensor measures magnetic field at a select point and is accurately positioned in order to obtain good magnet alignment about the separator. The first design of its kind for the laboratory, past designs have relied on using a single probe that is rotated about the beam axis in order to measure the field about the circle. Such a scheme takes more time and makes it difficult to keep the probe along a circular orbit. The circle of fixed probes avoids such problems and also cuts down the amount of scanning time.

Target module mechanical tests underway

The heavy-ion beam will travel through FRIB's linear accelerator and strike the target to create rare isotopes.

FRIB's target module assembly installed in the vacuum test chamber for mechanical tests.

FRIB's target module assembly is complete and it has passed first mechanical tests.

The target module accommodates a rotating carbon target disk system inside a copper heat exchanger.

The target module uses a shielded vacuum-compatible servo motor and is designed to be remotely maintained.

Several mechanical tests of the target module have already been performed including both in-air and in-vacuum rotation tests up to 1,000 revolutions-per-minute. Preparations for testing up to 5,000 revolutions-per-minute are underway. Such speed will be required for full-power operation.

All FRIB cryomodules now in production

FRIB continues technical construction, and another significant milestone has been reached with all cryomodules now in production. Cryomodules are key components of FRIB's superconducting linear accelerator (linac). As of the end of March, 18 of 46 have been installed in the linac tunnel.

FRIB continues technical construction, and another significant milestone has been reached with all cryomodules now in production and three of them are on track to be reviewed for beam-acceleration readiness in the second Accelerator Readiness Review (ARR02) at the end of May 2018.

The linear accelerator consists of 46 cryomodules that will deliver the heavy ion beam to its target where rare isotopes will be produced.

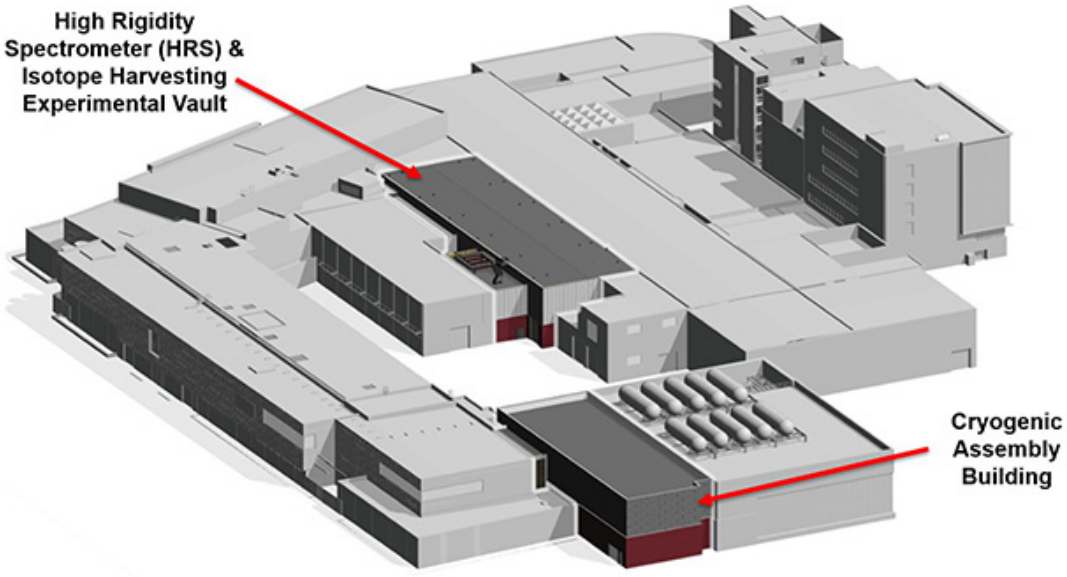
A total of 324 superconducting resonators assembled in the cryomodules will be cooled down with liquid helium to accelerate the beam. There are six different types of cryomodules and four different types of resonators, and each type is currently in production. As of now, 18 cryomodules have been installed in the FRIB tunnel, and the rest will be finished and installed by end of 2019.

ARR02 will provide independent input to the FRIB laboratory director and the MSU president for their authorization to operate the first three cryomodules (β=0.041) in linac segment 1 for commissioning with beam. These cryomodules and support systems were already installed and the FRIB team is finalizing preparation for the cryomodule cool-down.

FRIB is on the leading edge of cryomodule manufacturing with its highly trained staff and advanced production facility. There are two horizontal cryomodule test facilities that are supported by an independent helium refrigeration system for the purpose of cold testing.

FRIB has also established a supply chain for the production of cryomodules that provides access to specialty technical components for cryomodules and other linear accelerator devices. FRIB trains cryogenic students in its state-of-the-art facilities to give them a unique experience and prepare them for jobs in the industry.

MSU trustees authorize FRIB to proceed with two additions



On 16 February, the MSU Board of Trustees authorized FRIB to proceed with two new additions to the facility.

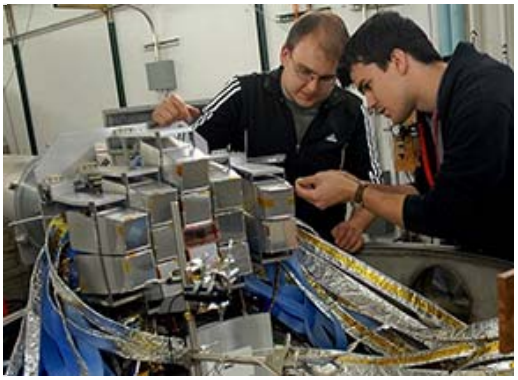
On 16 February, the MSU Board of Trustees authorized FRIB to proceed with two new additions to the facility that will expand FRIB's discovery potential and enable isotope harvesting.

• A 31,000-square-foot High Rigidity Spectrometer HRS and Isotope Harvesting Vault to house research equipment for isotope harvesting and to provide experimental space for the FRIB science program. Read more about the HRS phased approach and isotope harvesting opportunities at FRIB in the stories below.

• A 14,000-square-foot Cryogenic Assembly Building adjacent to the existing Superconducting Radio Frequency Highbay for the maintenance of cryomodules and to perform research pertaining to cryogenic engineering. The current cryomodule assembly space in the east highbay will become research space for the reaccelerated beam program when the FRIB cryomodule production completes in 2019.

The board's planning approval means FRIB has a defined scope, schedule, and project budget for the additions. Having received the board's approval, FRIB will proceed with the construction process.

Kyle Brown wins the 2017 Dissertation Award in Nuclear Physics



Kyle Brown (left) works with graduate student Juan Manfredi (right), on the setup of the High Resolution Array for Kyle's thesis experiment. Kyle won the 2017 Dissertation Award in Nuclear Physics.

The 2017 Dissertation Award in Nuclear Physics was awarded to Kyle Brown of Washington University at

Of the many interesting aspects of his dissertation, one highlight is a 3-particle + 1 gamma coincidence experiment in which he proved that the dominant decay of the isobaric analog state in ^{8}B is the prompt 2-proton emission to the isobaric analog state in ^{6}Li. Other interesting studies in his dissertation include the first data on ^{17}Na, a complete reanalysis of the A = 7, T = 3/2 isobars, and studies of the one- and two-proton decaying states in ^{8}B, ^{9}B, ^{9}C, ^{16}F, ^{16}Ne and ^{17}Ne. Kyle's dissertation was characterized by excellent experimental work that was matched with insightful analyses.

Since completing his dissertation, Kyle accepted a Hansen Postdoctoral Research Fellowship at the NSCL, where he is currently running an experimental campaign probing the isospin dependence of nucleon

St. Louis for his “For elucidating the continuum structure of light proton-rich nuclides using invariant mass spectroscopy” dissertation.

His thesis experiments were done at MSU using the High Resolution Array (HiRA). In his dissertation, Kyle studied the continuum structure of light nuclei using the invariant-mass technique.

effective masses. Kyle received his B.S. in chemistry in 2012 from Indiana University, and was awarded the Charles D. Coryell Award in Nuclear Chemistry from the American Chemical Society for his undergraduate thesis entitled "N/Z composition of fragments produced in binary decay of projectile-like fragments.” He attended Washington University in St. Louis for his graduate studies in nuclear chemistry. As a graduate student he received the GAANN Fellowship in 2013, and in 2014 was awarded with the Graduate Research Fellowship from the National Science Foundation.

FRIB research well represented at Stewardship Science Academic Programs Symposium

The National Nuclear Security Administration (NNSA) of the U.S. Department of Energy sponsors the Stewardship Science Academic Programs (SSAP) as a means to ensure that expertise is maintained in scientific and engineering disciplines critical to the long-term viability of the nation’s nuclear stockpile in the absence of explosive testing. A two-day symposium highlighting the accomplishments of the SSAP was held in Bethesda, Maryland, on 21-22 February.

One of the major research programs under SSAP is the Stewardship Science Academic Alliances, which supports basic science research in properties of materials under extreme conditions, low-energy nuclear science, and radiochemistry. A number of FRIB users have received grants under this program, and they actively participated in the symposium. Oral presentations were given by 13 FRIB users from eight different academic institutions, covering research progress related to neutron capture, fission, and novel instrumentation. Poster presentations were also made by participating students and post-docs, with 35 of the posters made by young scientists engaged in FRIB-related science.

The NNSA publishes an annual report on SSAP activities, and the 2018 Annual Report highlights the FRIB-related research work of Professor Robert Grzywacz (University of Tennessee) and Professor William Lynch (Michigan State University). Student profiles of Rebecca Lewis (Michigan State University, advisor Professor Sean Liddick) and Zachary Matheson (Michigan State University, advisor Professor Witold Nazarewicz) are also included in the report. The SSAP annual reports are available online.

ESHAC review held 13-14 March

Members of the FRIB Environmental, Safety and Health Advisory Committee: (left to right) John Anderson, Don Cossairt, and Frank Kornegay.

A review of the FRIB Environmental, Safety and Health Advisory Committee (ESHAC) was held 13-14 March. The meeting focused on the approach for hazard control and mitigation, the Functional Safety program, and recommendations from prior reviews.

ESHAC found that the FRIB Project’s proposed approach to hazard mitigation and functional safety is well positioned, and that previous recommendations have been appropriately addressed.

ESHAC also supported seeking outside experts for advice on lithium stripper safety, along with collecting lessons learned from other facilities.

Nuclear Physics DC Day 2018 held 9 April

The participants at the seventh annual Nuclear Physics DC Day are briefed at a breakfast gathering prior to the congressional meetings.

The seventh annual "Nuclear Physics DC Day" occurred on 9 April. This year's event, where members of the nuclear science community get the chance to visit with members of their congressional delegations and discuss the importance of nuclear science, was the best attended yet for what have become an annual tradition. Over 100 (102 to be exact) nuclear physicists from 33 different states participated with about 40 from the low-energy nuclear physics community. They met with staffers from 110 different House and Senate offices.

The community's specific asks for FY19 were:

• Support for continued strong funding for the U.S. Department of Energy (DOE) Office of Science in FY19, consistent with the spending caps enacted in the Bipartisan Budget Act ($6.6B).

• Support for "modest growth" of the DOE Nuclear Physics program consistent with the recommendations of the 2015 DOE/National Science Foundation (NSF) Nuclear Science Advisory Committee Long Range Plan ($715M in FY19).

• Support continued increases for the NSF to realize cutting-edge opportunities and support facilities and single investigators ($8.45B in FY19).

The feedback from the meetings was very positive, and the staffers were in general very supportive of basic science research. Such meetings are essential as they show Congress the direct impact that funding for basic science has on researchers and students from their states and districts.

Please consider participating next year. Also encourage your graduate students and postdocs as it is a valuable experience for them.

SOLARIS white paper now available on ANL website

by Ben Kay, Calem Hoffman, and Birger Back, Argonne National Laboratory

The silicon-array mode is an evolution of the HELical Orbit Spectrometer (HELIOS) concept developed and implemented at ANL some ten years ago. This

The SOLARIS white paper is now posted on the ANL website. It portrays the scientific scope of SOLARIS as a powerful instrument for direct reaction studies.

The idea of including a solenoidal spectrometer in the ReA instrument portfolio has been proposed and discussed at the Low Energy Community meetings for several years. This culminated in a workshop on ReA Solenoidal Spectrometer Projects, which was held at Argonne National Laboratory (ANL) in March 2017. Over 50 members of the low energy community shared their ideas regarding charged-particle spectroscopy techniques with ReA beams. The SOLARIS spectrometer was born out of these discussions and a white paper has been prepared and made available online.

SOLARIS is a dual-mode solenoidal spectrometer. It brings together two instruments designed for the FRIB era, a silicon-array solenoidal spectrometer, and an in-field active-target time projection chamber. SOLARIS will be designed to easily switch between the two modes of operation and couple, in the first instance, to the ReA6 beam line at NSCL and subsequently FRIB.

spectrometer concept has proven to be a powerful, high-resolution technique for transfer-reaction studies with exotic beams.

The active-target mode places the Active-Target Time Projection Chamber (AT-TPC) developed by NSCL inside the solenoid. The AT-TPC was recently commissioned using a ReA beam. In this mode of operation, direct reactions can be studied with very weak beams, on the order of 100s of beam particles per second, due to the thick target and outstanding geometrical efficiency. It can also be used to great advantage in reactions leading to complex many-body final states.

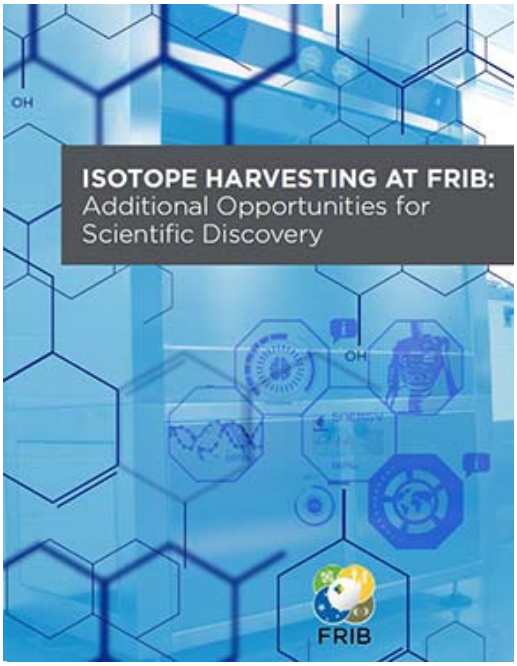
The white paper portrays the scientific scope of SOLARIS as a powerful instrument for direct reaction studies. It exploits the full dynamic range of ReA in the sense that measurements can be carried with a broad range of beam energies and intensities. This will enable research that covers all major areas of scientific enquiry FRIB plans to address: nuclear structure, nuclear astrophysics, tests of fundamental symmetries, and the societal benefits and applications of nuclear science.

The project benefits significantly from the availability of a large-bore superconducting solenoid with a maximum field of 4 T, procured by Argonne National Laboratory and poised to make the trip to Michigan State University. The white paper presents details on the conceptual designs of the solenoid spectrometer operating in both the silicon-array and active-target modes and presents ideal timelines and budgets for the project. The white paper precedes a full proposal to the DOE, in a collaboration led by Argonne National Laboratory, NSCL, FRIB, and the University of Connecticut.

Isotope harvesting white paper released

Their interest is rooted in the opportunity to access unused by-product radioisotopes from FRIB as a background operation while the facility is delivering exotic nuclei to other experiments. This concept is termed “isotope harvesting,” and after a series of biennial workshops, the group of interested researchers coalesced the scientific goals of isotope harvesting into a white paper titled “Isotope Harvesting at FRIB: Additional opportunities for scientific discovery.”

The white paper highlights many of the research projects that the wide selection of isotopes at FRIB can facilitate. Some examples include harvesting isotopes for plant and soil sciences, medicine, stewardship science, radio-thermal generators, and many others. The projects are diverse in their



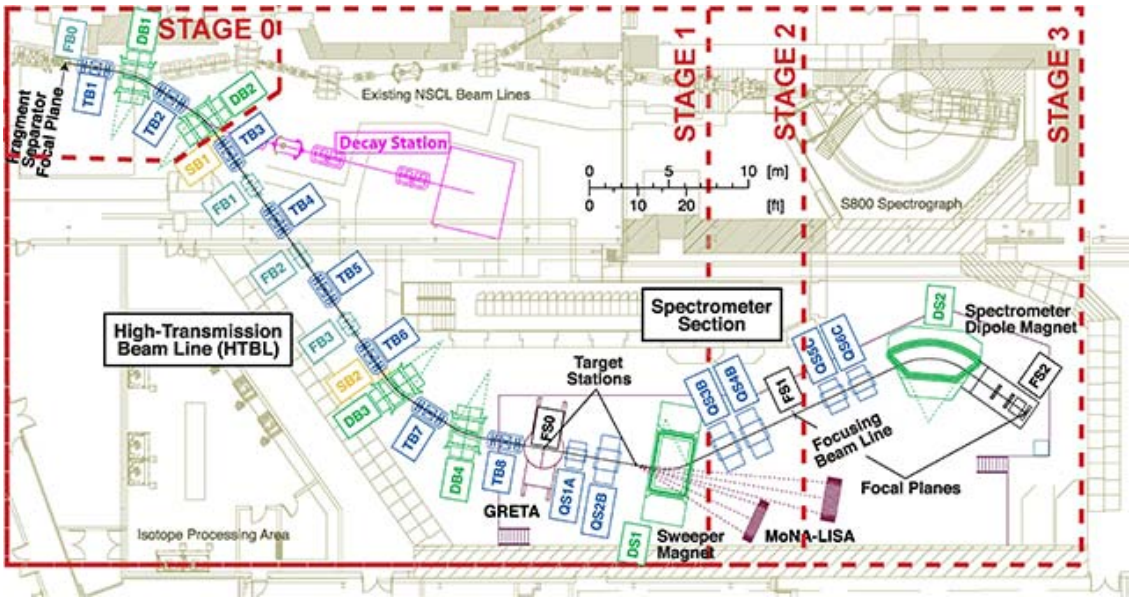
The white paper titled "Isotope Harvesting at FRIB: Additional opportunities for scientific discovery" highlights many of the research projects that the wide selection of isotopes at FRIB can facilitate.

Since the conception of the FRIB Project, a subset of the nuclear-science community has focused on the new radiochemistry that FRIB will enable.

applications and goals. The white paper also gives an outline for how to implement the harvesting idea at FRIB, by tapping into the beam-dump cooling and off-gas streams and chemically extracting the induced radio isotopes. As FRIB comes online, its isotope harvesting has the opportunity broaden the impact of FRIB to fields well beyond nuclear physics.

The white paper is posted online, and hard copies are available by emailing Greg Severin at severin@frib.msu.edu.

A staged approach for the High Rigidity Spectrometer



This image shows a possible staged approach for the High Rigidity Spectrometer.

Over the past year, the High Rigidity Spectrometer (HRS) working group has developed a staged approach for the construction of the full HRS. This staged approach is aimed at increasing the scientific opportunities with the implementation of each stage, while enabling a broad physics program for a large user community in each stage. The figure above provides an overview of the staged approach.

In stage 0, the first section of the high-transmission beamline (HTBL) is built, which includes two quadrupole triplets and two dipole magnets. Stage 0 allows for the construction of the other stages of the HRS without impeding the delivery of beams to other experimental stations at FRIB. It also delivers beam to the anticipated Decay Station Experiment Vault and enables its full science program.

In stage 1, the HTBL is completed, and the Sweeper Magnet section is put in place. Stage 1 enables 42 percent of the full science program of the HRS, including in-beam gamma-ray spectroscopy with the Gamma-Ray Energy Tracking Array (GRETA) up to mass number 100 and the invariant-mass spectroscopy program op to mass number 132.

In stage 2, two additional quadrupole magnets will be placed, extending the beamline and enhancing the resolutions. It enables 61 percent of the full science program of the HRS, including experiments up to mass number 180. In stage 3, the spectrometer dipole section is added, enabling the full HRS science program.

The HRS working group is presently working on a conceptual design report, in which the details of the whole project, including the staged approach, are presented.

In anticipation of the HRS, as well as the Isotope Harvesting Vault, the MSU Board of Trustees approved the construction of a High Rigidity Spectrometer and Isotope Harvesting Vault on 16 February. The construction of this vault will commence in early spring of 2018. The new vault will be situated in between the main highbay and the south highbay.

Researcher joins FRIB as part of new collaboration between nuclear physics and the statistical sciences

Witek Nazarewicz (FRIB Chief Scientist) and Léo Neufcourt (Research Associate)

A new collaboration between nuclear physics and the statistical sciences at MSU is bringing together FRIB and the Department of Statistics and Probability (STT), and FRIB users will benefit from the partnership.

As part of that collaboration, Léo Neufcourt, an expert in statistics, probability theory, and applied mathematics, has accepted an appointment as a research associate at MSU. It will be a joint position shared between FRIB and STT.

Léo will engage in diverse research efforts within FRIB, including uncertainty quantification for models in theoretical and experimental nuclear physics, as well as in modeling related to facility development .and isotope beam production. Uncertainty quantification is a way to estimate an outcome or a model when no model can be made to match experimental data exactly

“This collaboration will serve to enhance the experiments at FRIB and the real-world applications of our research,” said Thomas Glasmacher, FRIB laboratory director.

“I am very excited to be part of the FRIB Project through this partnership,” Léo said. “Uncertainty quantification has become decisive in nuclear physics to compare experiments and theories, and our Bayesian methods should provide a new perspective on several challenging FRIB problems such as mass models or beam tuning, with an honest and tractable estimation of error bars.”

Léo obtained a Ph.D. in statistics at Columbia University after graduating from a cross-disciplinary program at Ecole Polytechnique in France. He has been a visiting researcher at Universidad de Valparaíso in Chile, where he worked in the stochastic modeling group, creating mathematical models of systems which appear to behave randomly but follow precise probabilistic laws. He’s also worked as a quantitative analyst and a consultant in the financial industry, where he focused on building quantitative models for financial markets.

For more information, read the online article.

News from the FRIB Users Executive Committee

by Heather Crawford, FRIB Users Organization Chair



Newly elected and re-elected members of the FRIB Users Organization Executive Committee (from left): Heather Crawford, Andrew Rogers, and Alexander Volya.

The FRIB Users Organization Executive Committee elections wrapped up in early January of this year.

We'd like to welcome Andrew Rogers (University of Massachusetts, Lowell) as the new member of the Operations subcommittee and Alexander Volya (Florida State University) as the new theory representative. Heather Crawford (LBNL) was re-elected as a general member, and as committee chair. Andrew and Alexander join the UEC with the departure of Filomena Nunes (MSU/NSCL, theory representative) and Lee Sobotka (Washington University in St. Louis) — we thank them very much for their service!

FRIB Theory Alliance announces two faculty bridge positions

by David Dean, Oak Ridge National Laboratory

Saori Pastore

Maria Piarulli

One of the pillars of the FRIB Theory Alliance (FRIB-TA) involves establishing new faculty positions in nuclear theory at forefront research institutions. The Bridge faculty are outstanding young theorists who develop exceptional theoretical research relevant to rare isotope science. Bridge faculty are 100 percent employees of their home institution, with all the associated benefits. Bridge faculty are expected to build a research group, attract federal funding and have teaching duties, just as all other faculty at their home institution. In addition, bridge faculty are expected to contribute significantly to the scientific program at FRIB and be spokespersons for FRIB theory, nationally and internationally. They will also spend a significant amount of time at FRIB.

We are excited to announce that our first two FRIB-TA Faculty Bridge positions will reside at the Washington University – St. Louis (WUSL). Dr. Saori Pastore received her PhD from Old Dominion University in 2010 and was a post-doctoral fellow at Argonne National Laboratory, the University of South Carolina, and Los Alamos National Laboratory. Her expertise involves applications of quantum Monte Carlo to describe light nuclei and weak transitions. Dr. Maria Piarulli will join WUSL from her current post-doctoral position at Argonne National Laboratory. She received her PhD in August 2015 from Old Dominion University. Her research interests focus on the development of

FRIB-TA provides partial support for these positions during the first five years of the appointment. This bridging mechanism also enables a close coupling of the FRIB-TA and FRIB to a broad university network of researchers, their post-doctoral associates, and students.

chiral effective field theory potentials and their application in quantum Monte Carlo calculations. WUSL collaborated with the student newspaper to publish a feature about Drs. Pastore and Piarulli.

Please join me in welcoming these outstanding new bridge faculty to the Theory Alliance family.

Nuclear Structure 2018 and Low-Energy Community Meeting 2018 conferences to be held 5-11 August

The Nuclear Structure 2018 (NS2018) conference will be held on 5-10 August 2018, in East Lansing, Michigan. NS2018 will be hosted by NSCL/FRIB at MSU. The focus of the conference will be nuclear structure physics at the extremes of isospin, spin and excitation energy.

A block of rooms has been reserved at the Marriot Residence Inn in East Lansing. Also a block of rooms has been reserved on campus at MSU's Owen Graduate Hall to offer a reduced price accommodation for participating students. Rate information will be provided in the second announcement.

The conference will consist of invited talks, contributed talks, and a poster session.

Immediately following the NS2018 conference, the annual Low-Energy Community Meeting (LECM) will be held at the same venue as the conference. The meeting will begin in the afternoon of 10 August and will conclude on 11 August. Please note that while there is no registration fee associated with the LECM, a separate registration is required.

Summer schools stimulate science study

A number of summer schools are planned for 2018 to allow students and young researchers the opportunity to explore the world of science. Among the planned educational events:

NS^3 NUCLEAR SCIENCE SUMMER SCHOOL
13-19 May 2018
Michigan State University

NS^3 Nuclear Science Summer School is a summer school for undergraduate students that aims to introduce the participants to the field of nuclear science. NS^3 will be hosted by MSU and will offer lectures and hands-on activities covering selected nuclear science topics. The school activities will take place at NSCL and will include lectures by local and visiting researchers, nuclear physics labs, a tour of the facility, discussions with graduate students and faculty, and more.

The goals of NS^3 are to:
• Introduce basic nuclear science concepts through dedicated lectures and through experimental and theoretical techniques
• Offer a visit to a cutting-edge research facility and an opportunity to meet its researchers
• Present current research topics and open questions in nuclear science
• To observe every-day activities at a major research facility and learn from the experiences of current graduate students

Participation in NS^3 is funded by the National Science Foundation, NSCL, and JINA-CEE.

FRIB THEORY ALLIANCE SUMMER SCHOOL: "NEUTRON STAR MERGERS FOR NON-EXPERTS: GW170817 IN THE MULTI-MESSENGER ASTRONOMY AND FRIB ERAS"
16-18 May 2018

Michigan State University

Recently, a neutron star merger was observed with gravitational waves and electromagnetically at frequencies from radio to gamma rays. This event (GW170817) advances nuclear astrophysics and heralds a new era in multi-messenger astronomy. To allow a broader audience to better appreciate these developments, a summer school will be held 16-18 May, at FRIB in East Lansing, Michigan.

The school is intended for an inclusive audience of graduate students, postdocs, and senior researchers working in nuclear physics, astrophysics, astronomy, and related areas.

The school is organized by the FRIB Theory Alliance. Application information is found on the event website.

U.S. PARTICLE ACCELERATOR SCHOOL: SUMMER 2018 SESSION

4-15 June 2018

Michigan State University

The U.S. Particle Accelerator School (USPAS) is a national graduate program that provides graduate-level training and workforce development in the science of particle beams and their associated accelerator technologies that are not otherwise available to the scientific and engineering communities. Its courses are intensive learning experiences that allow students to learn complicated and difficult material in a reasonably short time period. The USPAS also promotes the development and publication of textbooks in accelerator science and technology.

USPAS summer 2018 session courses run in parallel so students may take one two-week full course or two one-week half courses to earn credit from Michigan State University. Courses include:

- Fundamentals of Accelerator Physics and Technology with Simulations and Measurements Lab
- Accelerator Physics
- Classical Mechanics and Electromagnetism
- Femtosecond Electron Sources for Ultrafast Sciences
- Industrial Applications of Accelerators
- Superconducting Accelerator Magnets
- Fundamentals of Ion Sources
- Radiation Physics, Regulation and Management
- Cryogenic Process Engineering

To apply and for more details on the USPAS summer 2018 session, visit the program website.

EXOTIC BEAM SUMMER SCHOOL 2018

24-30 June 2018

Lawrence Berkeley National Laboratory

The aim of the Exotic Beam Summer School 2018 (EBSS2018) is to educate young researchers on the excitement and challenges of rare isotope beam science. Through these schools, the research community will be able to more fully exploit the opportunities created by the next-generation exotic beam facilities, such as FRIB.

A unique feature of this summer school series is the hands-on activities where students spend their afternoons in the laboratory, learning about the techniques and instrumentation needed to carry out experiments with radioactive beams. Among the hands-on activities that students will be involved in for EBSS are measurements with FIONA (a device is designed to measure the mass numbers of individual atoms of superheavy elements), gamma-ray tracking detectors, the VENUS (Versatile ECR ion source for Nuclear Science)/AECR (Advanced Electron Cyclotron Resonance) ion sources, and the University of California, Berkeley Neutron Generator. In the mornings, lectures on a variety of topics (experimental, theoretical, and applied) will be given by expert speakers. A more detailed program will be posted on the school website.

EBSS2018 is sponsored by the U.S. Department of Energy, the National Science Foundation, and the following laboratories: Argonne National Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Oak Ridge National Laboratory, the National Superconducting Cyclotron Laboratory at Michigan State University, and the Association for Research and University Nuclear Accelerators. To apply and for more details on EBSS2018, visit the school website.

TALENT: TRAINING IN ADVANCED LOW ENERGY NUCLEAR THEORY

16 July to 6 August 2018

Henan Normal University (Xinxiang, Henan, China)

The 2018 Nuclear TALENT course on Many-Body Methods for Nuclear Physics, from Structure to Reactions, will be held at Henan Normal University, Xinxiang, Henan, China, from 16 July to 6 August. The last three days are set aside for a

workshop. Visit the event website for details. The course is part of the Training in Advanced Low-Energy Nuclear Theory (TALENT) initiative to develop a comprehensive program for training in low-energy nuclear theory.

This is the very first time a Nuclear TALENT course has been organized in China. The deadline for applications is 20 April. The three-week program is intended for students (theorists and experimentalist) who have begun on their master of science degree or PhD thesis projects in nuclear physics. Knowledge of advanced quantum mechanics is expected. The TALENT initiative aims at providing an advanced and comprehensive training to graduate students and junior researchers in low-energy nuclear theory.

It is the goal and motivation of this course to introduce and develop the nuclear structure tools needed to carry out forefront research using the shell model and many-body methods like Coupled Cluster (CC) theory and the in-medium Similarity Renormalization Group (IMSRG) method as central tools, with applications to both structure and reaction theory studies. After completion, the organizers' goal is that the participants have understood the overarching ideas behind central theoretical tools used to analyze nuclear structure experiments.

This three-week TALENT course on nuclear theory will focus on the many-body methods for nuclear structure and reactions, focusing on nuclear shell model and coupled cluster theory and in-medium SRG with applications to structure and reactions. Via hands-on projects and series of exercises, the participants will have been exposed to central methods and theoretical models used in modern nuclear theory.

The organizers are:

• Chunwang Ma, Henan Normal University
• Furong Xu, School of Physics, Peking University
• Shan-Gui Zhou, Institute of Theoretical Physics, Chinese Academy of Sciences

FRIB Theory Alliance topical programs scheduled

FRIB-TA Topical Program: Connecting bound state calculations with the scattering and reaction theory
"From bound states to the continuum: Connecting bound state calculations with scattering and reaction theory" will be organized by Calvin Johnson (SDSU), Kristina Launey (LSU), Pierre Descouvmont (Université Libre de Bruxelles), Marek Płoszajczak (Ganil), Sofia Quaglioni (LLNL), and Jimmy Rotureau (MSU). This program will pull together experts in scattering and reaction theory, in bound state structure calculations, and especially those working on the boundary, to summarize the state of the art and to identify and lower the technical barriers to move from bound state calculations to the continuum. The program will run from 11-22 June 2018. Additional information will be posted soon.

FRIB-TA Topical Program: Implication of the neutron star merger GW170817 and its associated Kilonova for r-process nucleosynthesis
R. Surman (Notre Dame), A. Aprahamian (Notre Dame), G.C. McLaughlin (NCSU) and A. Frebel (MIT) will organize a program on implications of the neutron star merger GW170817 and its associated Kilonova for r-process nucleosynthesis. This program builds on a 2016 r-process Topical Program and is especially timely given the extraordinary GW170817 observations. The program will run from 16-27 July 2018. Additional information will be posted soon.

American Physical Society Division of Physics of Beams newsletter available

The American Physical Society (APS) Division of Physics of Beams (DPB) has released its annual newsletter for 2017, available for download on the APS website.

The newsletter contains the latest in the field, including up-and-coming projects, conferences, and potential collaborators. Feature articles focus on art history using synchrotron radiation, the history of Fermilab, machine learning

for accelerators, and the latest on the European X-ray free-electron laser, MAX IV Laboratory, and the Synchrotron-Light for Experimental Science and Applications in the Middle East. The newsletter contains information for those in the accelerator physics and user community.

In addition to the newsletter, find out more about the APS DPB on its website. This includes advocating for the accelerator field and facilitating many important opportunities for the community including IPAC, NAPAC and the PRAB journal. DPB members are the first to receive the DPS newsletter, delivered straight to their inboxes. Information about becoming a member can be found on the DPS website.

To offer suggestions or ideas for future articles, email Alysson Vrielink at vrielink@stanford.edu.

First publications from ReA3

Three groups have now published results from rare isotope experiments using ReA3.

A collaboration between Oregon State University, the Australian National University, and the National Superconducting Cyclotron Laboratory recently reported the results of an important and new experiment [Physical Review C97, 021602(R) (2018)] to study the capture probability using the unique capabilities of the ReA3 accelerator. The NSCL website features a summary.

A group from Indiana University, Western Michigan University and NSCL recently published results on “Probing the fusion of neutron-rich nuclei with re-accelerated radioactive beams” [Phys. Rev. C 97, 031601(R) (2018)]. This experimental demonstrated how low-intensity re-accelerated radioactive beams could be used for fusion studies.

The first results from the AT-TPC were published by a collaboration between NSCL, Notre Dame, Saha Institute, and CEA Saclay. The experiment studied resonance protron scattering on the rare isotope 46Ar and explored the nature of the shell closure at N=28. The paper “Study of spectroscopic factors at N=29 using isobaric analogue resonances in inverse kinematics” appeared in Physics Letters B, Volume 778, on 10 March 2018.

Contributors this issue

- Birger Back
- Heather Crawford
- David Dean
- Thomas Glasmacher
- Peter Grivins
- Calem Hoffman
- Hiro Iwasaki
- Benjamin Kay
- Paul Mantica
- Witek Nazarewicz
- Mauricio Portillo
- Greg Severin
- Brad Sherrill
- Betty Tsang
- Remco Zegers

LOOKING AHEAD

15-17 May	DOE-SC Office of Project Assessment Review of FRIB
5-10 August	Nuclear Structure 2018 Conference in East Lansing, Michigan
0-11 August	Low Energy Community Meeting at FRIB/NSCL in East Lansing, Michigan

The FRIB Laboratory Update for Users is published by the FRIB Laboratory and distributed via email.
Please email questions, comments, and contributions to communications@frib.msu.edu.

Facility for Rare Isotope Beams | Michigan State University | 640 South Shaw Lane | East Lansing, MI 48824 | (517) 355-9672 | frib.msu.edu

Michigan State University is establishing FRIB as a scientific user facility for the Office of Nuclear Physics in the U.S. Department of Energy Office of Science.