FRIB

# LABORATORY
## UPDATE FOR USERS

JULY
2015

*Above-ground steel placements started in April 2015, and masonry work started in June on the northeast end of the project.*

## FRIB civil construction nine weeks ahead of schedule; work advances above ground and below

*Story contributed by Brad Bull, Conventional Facilities and Infrastructure Division Director*

FRIB civil construction is currently nine weeks ahead of schedule.

Structural steel placement for the linear accelerator tunnel lid was completed in June. So far, 55 percent of the required structural steel for the project has been installed, with 1,550 tons of steel placed. The steel used for the tunnel lid is the largest rolled steel sections that can be purchased in the United States.

Additionally, mass backfill is nearing completion on the east end of the tunnel lid, as crews work to completely enclose the linac tunnel underground. Overall, 50,101 tons of backfill has been placed, marking 71-percent completion.

Mechanical, electrical, and plumbing (MEP) systems installation also is ongoing within the linac tunnel, and underground MEP systems installation in the linac support building has begun as well.

The surface building is being constructed in two halves in order to accelerate readiness of the east section of the building. This will allow the front end to be installed 16 months earlier than originally planned in the project baseline. Structural steel for the surface building has been erected at the east end of

*See* **CONSTRUCTION** *on Page 6*

## Welcome to this issue

We send these quarterly updates to keep you apprised of the latest happenings at the FRIB Laboratory. We also invite story contributions from users. This issue features an article on the JENSA Collaboration from Kelly Chipps at Oak Ridge National Laboratory. Please email suggestions, questions, and story contributions to communications@frib.msu.edu.

## Developments in transition to FRIB Laboratory

*Story contributed by Thomas Glasmacher, FRIB Laboratory Director*

In the last issue we announced that MSU President Lou Anna K. Simon had reorganized the reporting functions for the National Superconducting Cyclotron Laboratory and the FRIB Project. FRIB now reports to the MSU executive vice presidents and NSCL reports through FRIB. The reorganization signals the transition to a unified FRIB Laboratory organization, the next step in realizing an advanced rare isotope beam facility for the nuclear science community.

As part of the ongoing transition, some additional roles have changed:

• Brad Sherrill is now NSCL director.

• Michael Thoennessen is now associate laboratory director for user relations. Read more about Michael later in this issue.

Former longtime NSCL Director Konrad Gelbke stepped down as director in May. We are so grateful to Konrad for 23 years of excellent leadership that brought the laboratory where it is today.

## NSCL Program Advisory Committee meeting held May 20-21

*Story contributed by Brad Sherrill, NSCL Director*

The 39th meeting of the NSCL Program Advisory Committee (PAC39) was held on May 20-21. A total of 48 proposals were considered for 8,277 hours of beam time. The number of hours requested was a near record and the 336 experimenters was the second highest ever. The committee considered each proposal in detail and recommended allocation of 3,885 hours for 26 experiments. The time recommended for approval at each PAC is limited so that the facility backlog is not much more than two years. The list of all NSCL approved experiments is posted at: publicapps.nscl.msu.edu/completedexperiments/experiments

Every PAC meeting includes an outside observer, who is there to represent the user community. The observer for PAC39 was Heather Crawford from Lawrence Berkeley National Laboratory. Her observations can be found at: nscl.msu.edu/users/PAC39-Crawford-Signed2.pdf .

For PAC39 the committee members where: Ani Aprahamian, University of Notre Dame; Jill Berryman, PAC Administrator (non-voting); C.J. (Kim) Lister, University of Massachusetts Lowell; Augusto Macchiavelli, Lawrence Berkeley National Laboratory; Joseph Natowitz, Texas A&M University; Erich Ormand, Lawrence Livermore National Laboratory; Hendrik Schatz, NSCL; Brad Sherrill, non-voting convener; Philip Woods, The University of Edinburgh; Alan H. Wuosmaa, University of Connecticut.

## 2015 NSAC Nuclear Physics Long Range Plan: a status report

*Story contributed by Witek Nazarewicz, FRIB Chief Scientist*

The resolution meeting of the 2014-2015 Nuclear Science Advisory Committee Long Range Plan Working Group took place April 16-20 in Kitty Hawk, North Carolina, to finalize a prioritized set for recommendations for the Long Range Plan. The first part of the meeting was devoted to receiving more science input, with the rest of the meeting being held in executive session. There were several presentations relevant to FRIB, including overviews of science, facility, infrastructure and instrumentation, and workforce. The working group adopted a prioritized set of recommendations, which will allow the nuclear physics community in the United States to optimize science and reach new exciting horizons. The final Long Range Plan report, containing final recommendations, science sections, and supporting discussion, is due October 2015. The input documents and the schedule for past and upcoming activities can be found on the Argonne site at phy.anl.gov/nsac-lrp/.

## Michael Thoennessen is associate laboratory director for user relations

On June 1, Michael Thoennessen took over the role as associate laboratory director for user relations from Brad Sherrill, who became NSCL director. The associate laboratory director for users assists the laboratory director to ensure that the scientific goals of NSCL and FRIB are achieved. In addition to interacting with the FRIB Users Organization, Michael will also foster the relationships with laboratory alumni.

Jill Berryman retains her position as manager for user relations. Jill assists users in conducting experiments at the NSCL and takes care of communication with users though the FRIB User Organization. Jill will be happy to answer any questions regarding the experimental program at the NSCL or the laboratory. Please contact her if you need assistance of any kind. As NSCL director, Brad is responsible for ensuring that the NSCL meets it scientific mission to serve the user community.

## Low-Energy Community Meeting set for August at Michigan State

*Story contributed by Alexandra Gade, FRIB Chief Scientist*

The annual Low-Energy Community Meeting will be held August 21-22 at Michigan State University. The meeting program will begin on Friday morning at 9 a.m. and continue until about 1 p.m. on Saturday, August 22. The program is posted at 2015.lecmeeting.org/program.htm.

A number of satellite meetings are planned: The community meeting will be preceded on Thursday, August 20, by a one-day workshop on science opportunities with the aspired energy upgrades of ReA3 to ReA6-12 (people.nscl.msu.edu/~iwasaki/rea6.html). On Thursday evening, AIRIS and SECAR collaboration meetings will take place, and the HRS working group will meet on Friday evening. A GRETINA users workshop discussing the future siting of the device for its next science campaigns will be held immediately after the community meeting on Saturday, August 22.

The Low-Energy Community Meeting provides an excellent opportunity for nuclear scientists to interact and discuss future plans, initiatives, and facilities. Registration is open at 2015.lecmeeting.org/registration.php.

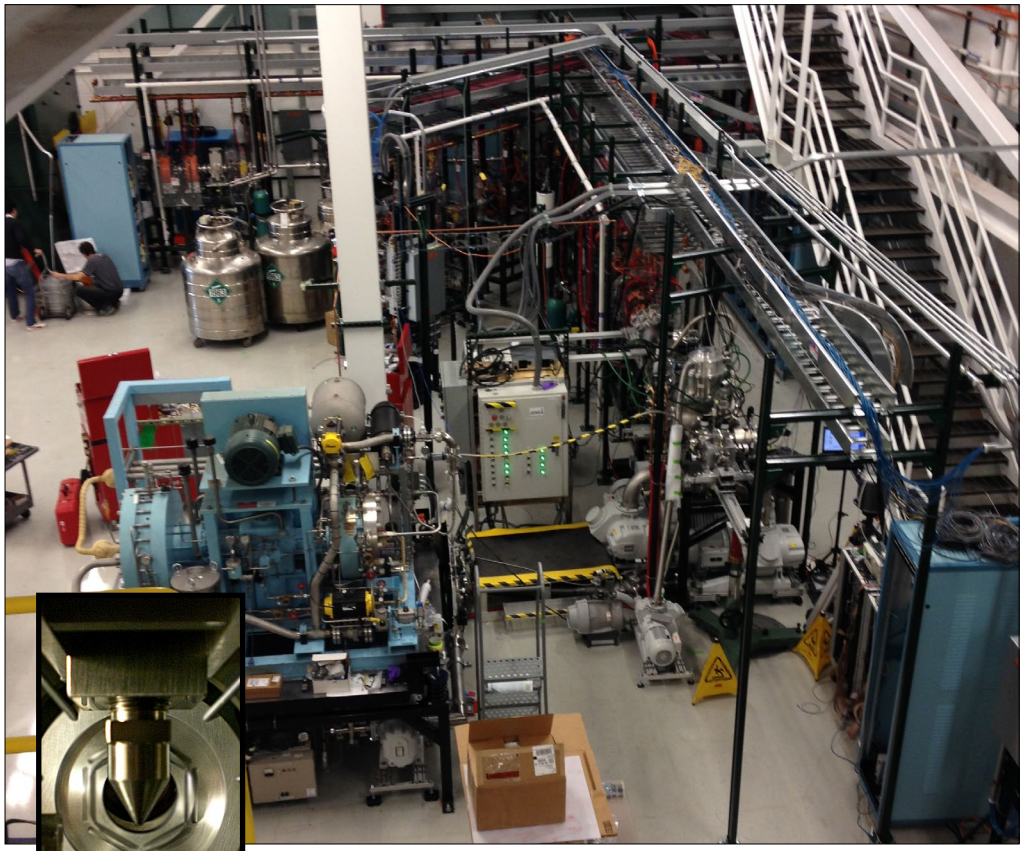
# Jet Experiments in Nuclear Structure and Astrophysics (JENSA) gas jet target commissioned for use with FRIB beams

*Story contributed by Kelly Chipps, Oak Ridge National Laboratory, for the JENSA Collaboration*

Scattering and transfer reaction measurements involving light nuclei, such as those common in nuclear astrophysics and structure experiments, require targets that are spatially localized so that the angular distribution of reaction products can be measured. These experiments, along with direct-capture measurements, also benefit from an optimum balance of target nucleus number density and thickness to maximize count rates while minimizing reaction product energy loss and straggling.

In inverse kinematics, target optimization is difficult to achieve, since the light target isotopes necessary (e.g., hydrogen, helium) cannot be easily made into targets. Traditional solid targets are often plagued with contaminants (such as carbon and oxygen) or require backing materials like aluminum or nickel that contribute substantially to straggling and background. Gas targets can eliminate some of the difficulties, but introduce others. Gas cells, for example, require thin windows which worsen energy and angular resolution, and windowless gas targets, achieved via differential pumping, are too spatially extended along the beam axis to allow angular distributions to be measured.

An advantageous solution to these difficulties is a supersonic gas jet target, which allows for a high density of target nuclei within a highly confined region. No windows or backing materials are present to produce unwanted background events, gas purity is high and the amount of contamination is well controlled, and the small target size allows for high-resolution measurements of energy and angle. Gas forced through a laval nozzle (pictured) has the high density and small dimensions necessary for a jet target, and various pumping stages, in conjunction with a diaphragm compressor, handle the flow and recirculate the gas within the system.



*Above: A view of the JENSA system as installed in the ReA3 hall. Visible on the right is the dedicated beamline, with the target chamber, series of vacuum pumps, and the control panel. On the left is the industrial compressor, used to return the gas to the high pressures required to feed the jet. Left: A close-up photograph of the JENSA jet nozzle and gas receivers inside of the target chamber. Detector mounts are visible in the background.*

A dense, supersonic gas jet target, coupled with charged-particle and gamma detector arrays, presents exciting opportunities for precision measurements with modest intensities of the exotic reaccelerated radioactive beams anticipated at FRIB. The Jet Experiments in Nuclear Structure and Astrophysics (JENSA) Collaboration has designed, built, and commissioned such a supersonic gas jet target system for use with FRIB beams. The JENSA system is currently installed on a dedicated beamline in the ReA3 hall (pictured). JENSA can incorporate large arrays of charged particle and gamma ray detectors, and in the future will become the dedicated target for the SECAR recoil separator to facilitate cutting-edge capture reaction measurements for astrophysics. The collaboration is also investigating the utility of a second gas jet target system in the higher-energy reaccelerated beam hall for use with the wide variety of instruments anticipated for that hall.

For more information,please visit the JENSA webpage at jensajet.org.

*Participants of the FRIB-China workshop pose for a photo.*

## FRIB-China workshop on Physics of Nuclei and Hadrons held in May at NSCL

*Story contributed by Witek Nazarewicz, FRIB Chief Scientist*

The first FRIB-China workshop on Physics of Nuclei and Hadrons took place May 28-30 at NSCL. The goal was to explore various forms of collaborative endeavors in experiment and in theory relevant to the FRIB science program. The workshop, chaired by Paweł Danielewicz, was organized by a joint U.S.-China committee. It was sponsored by NSCL, FRIB, MSU's Department of Physics and Astronomy, and CUSTIPEN. There were 72 participants, including 21 attendees from China.

The plenary part of the scientific program covered the recent progress in collaborative efforts tied to FRIB and in the interdisciplinary connections. Prospects for FRIB-China collaborative efforts were discussed in a separate session featuring talks by Dr. Timothy Hallman (DOE-SC) and Prof. Yanlin Ye (Chair, Nuclear Physics Society of China). The parallel sessions were devoted to meetings of eight working groups: (i) Nuclear Structure/Direct Reaction Experiments, (ii) Facilities, (iii) Nuclear Astrophysics Experiments, (iv) Fundamental Interactions Experiments, (v) Nuclear Structure Theory, (vi) Central Nuclear Reactions/EOS, (vii) QCD Theory, and (viii) Education. The working group reports were presented during the last day of the workshop.

The outcome of the workshop was a set of resolutions passed unanimously. These include:

• Establishment of an FRIB-China Task Force.

• Establishment of a prestigious FRIB-China postdoctoral fellowship based on the postdoctoral fellowship program in China.

• Launching a series of regular topical workshops on joint initiatives. This activity will be critical for educating our communities on the needs and opportunities.

The material generated during the workshop can be found on the CUSTIPEN website custipen.pku.edu.cn/meeting/1st-frib-china-workshop.html. The final report will contain working group reports, resolutions, and related discussion. This document will be essential for the success of the FRIB-China project. The second FRIB-China workshop on Physics of Nuclei and Hadrons will take place in China late 2016.

## FRIB Theory Alliance begins initial phase

*Story contributed by Filomena Nunes, Theoretical Nuclear Science Department Head, for the FRIB Theory Alliance steering commiteee*

The FRIB Theory Alliance officially began activity on June 1, the start date of the Department of Energy Office of Science grant, marking the initial phase of this project.

The FRIB Theory Alliance, a proposal put forth by the steering committee to bring focus to theory related to FRIB, is supported by the Low Energy Town Meeting and was presented at the Long Range Plan 2015 resolution meeting. As part of the activities for the first year, the steering committee will develop a charter, identify a process for selecting sites for permanent bridge positions, and explore opportunities to develop large-scale international collaborations.

We have already conducted a search for a national FRIB theory fellow (the selected candidate Diego Lonardoni will move to Los Alamos in the fall), and we are on the verge of announcing another FRIB theory fellow position, this one located at MSU. Another important component of the FRIB theory alliance is education. The FRIB theory alliance will formally join TALENT, and work with U.S. universities across the country to develop bilateral protocols that will allow participating institutions to transfer credits and share teaching.

In addition, early next year, the FRIB Theory Alliance will have an inaugural meeting at MSU, to bring together the national nuclear theory community. We are looking forward to a very busy year!

## Collaboration of researchers explores harvesting long-lived isotopes for off-line experiments

*Story contributed by Dave Morrissey, Associate Director for Operations*

The vast majority of rare isotope beams used in experiments at NSCL and that will be produced at FRIB only live for a few seconds or less. The properties of these short-lived isotopes are generally unknown and make them interesting to study. However, a very large number of longer-lived isotopes that have important uses in medical research (and other applications) are not collected during normal operations. Therefore, a collaboration of researchers at Hope College in Holland, Michigan, and Washington University in St. Louis, Missouri, are working with Dave Morrissey from NSCL to develop systems and to solve problems associated with harvesting the unused isotopes at now at NSCL, and eventually FRIB, for off-line experiments.

The candidate isotopes and the long-term needs for isotope harvesting, including appropriate laboratory space at FRIB, continue to be defined in an ongoing series of user workshops chaired by this collaboration, and an infrastructure planning request has been made to MSU.

As for the current isotope-harvesting work at NSCL, several isotopes were identified by the collaboration of researchers as important for medical imaging work and potentially available at NSCL including 67Cu (2.58-day half-life) and 48V (16-day half-life). A series of studies was carried out to produce the isotopes under various conditions in the A1900, collect them in water and send water samples to Hope College and Washington University for measurement, purification and chemical binding into biomolecules. The team from Hope College (Professor Graham Peaslee, postdoc Aranh Pen and several undergraduate students) designed and built an end-station to fill, irradiate and collect samples of 100 milliliters of water. The collection system does not have any metal parts in contact with the water so that only metallic elements delivered by the beam will remain in the water. The collection system was published earlier last year in Nuclear Instruments and Methods (DOI: 10.1016/j.nima.2014.02.010). In the meantime, the group from Washington University in St. Louis (Professor Suzanne Lapi, graduate student Tara Mastren and several undergraduate students) developed chemical-processing schemes to purify the copper and vanadium samples, removing all the unwanted isotopes that might be present, and to attach the collected radioisotopes to biological molecules for testing.

The A1900 provided relatively pure samples of 67Cu to the collection station in the first run, and a low-purity sample in a second run that would be expected in a typical harvesting experiment. The first experiment was very successful, and the report of this work was published in Nature/Scientific Reports last October (DOI: 10.1038/srep06706). The second mixed sample of 67Cu was chemically separated and samples of a radioactive antibody were injected into mice and the distribution of the activity in different biological materials was determined. These experiments made up part of the thesis of Tara Mastren who successfully completed her degree in December 2014.

The next step in this work is the construction of a new system to collect long-lived isotopes from the cooling water in the NSCL A1900 beam blocker. The beam blocker is at the exit of the first large bending magnet of the A1900 and is often used to intercept the unused primary beam and protect downstream components of the A1900. The mechanical design is complete and they plan to install the new collection device in fall 2015.

## First ATTPC workshop held at NSCL in May

*Story contributed by Daniel Bazin, Senior Physicist*

The first workshop on Active Targets and TPC (time projection chambers) for Nuclear Physics Experiments was held at NSCL May 18-20. The aim of this workshop was to regroup physicists and engineers to discuss ideas, needs and aspects of using active targets and TPCs in our domain of nuclear physics.

Active targets, detectors where the detector gas is also the target, present great advantages when studying reactions where the particles emitted have very low energies as is common in inverse kinematics. Combined with a TPC they provide a gain in sensitivity by orders of magnitude, essential for the study of the most exotic systems. Other applications of TPCs are tailored to the specific needs of particular experiments, such as radioactive charged particle decay. Since these detectors can be built in virtually any shape and size, they are extremely versatile and can be adapted to numerous experimental needs. The imaging of tracks requires high granularity electronics with a large number of channels, and a wide dynamic range to adapt to the large domain of energy loss.

The talks presented covered a wide range of topics, from theoretical reviews of relevant nuclear physics topics, to talks on the specific technology used in this type of detectors. A total of 58 participants joined the meeting, for which a website is available at indico.fnal.gov/conferenceDisplay.py?confId=8976.

The program, abstracts, and talks presented are available for download.

The rapid evolution of experiments and techniques in this domain has incited the organizers to organize a follow-up workshop in about two years at a location to be decided.


*Participants of the Joint U.S.-Korea Exploratory Workshop pose for a photo during the May 14-15 workshop at FRIB.*

## FRIB hosts joint workshop to explore scientific opportunities with Korean scientists

*Story contributed by Paul Mantica, Deputy Laboratory Director and Deputy Project Manager*

FRIB hosted a Joint U.S.-Korea Exploratory Workshop on Opportunities for Collaborations in Nuclear Science, May 14-15. The workshop included representatives from the DOE-SC, FRIB, NSCL, and the Korean scientific community.

Throughout the day-and-a-half workshop, participants presented on various nuclear science topics and discussed opportunities for future collaborations. The workshop concluded with Dr. Jeong, director of the Korean Rare Isotope Science Project, and Thomas Glasmacher, FRIB Laboratory director, sharing their vision on the next steps in realizing increased collaboration between the two countries in areas of scientific research associated with rare isotopes.

A follow-on meeting between DOE-SC and the Korean equivalent, the Ministry of Science, ICT, and Future Planning, took place in June in Washington, D.C. Actively engaging and encouraging potential users is important, since contributions outside of the project baseline may accelerate the construction of new instrumentation that will allow FRIB to realize its full science potential.

### Coming next issue

- SECAR project started
- Low-Energy Community Meeting followup
- ReA3 operation
- User initiatives: High Rigidity Spectrometer

### Looking ahead

**August 21-22**
Low-Energy Community meeting at MSU

**September 2-4**
Experimental Systems Advisory Committee (ESAC)

**November 17-18**
DOE Office of Project Assessment Review

**December 1-3**
Accelerator Systems Advisory Committee (ASAC)

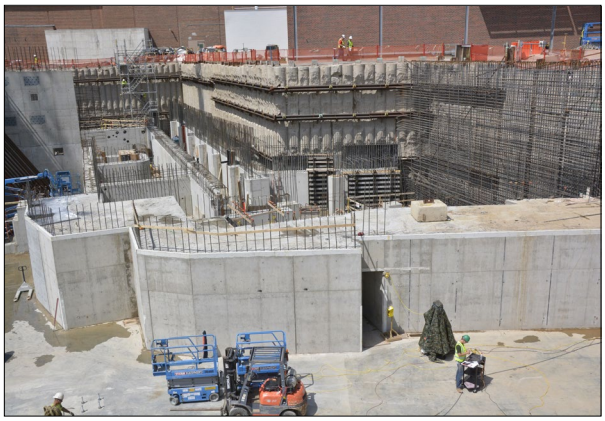
**December 7**
President's Project Advisory Committee (PPAC)

**CONSTRUCTION** *from Page 1*

the building. Masonry work on the exterior enclosure has also started.

In the target area, concrete placements continue. Sixty-one percent of concrete placements for the project are complete, with 26,201 yards placed. Recently, 742 yards of concrete were placed to create the labyrinth wall between the tunnel and target area. Concrete work in the tunnel area continues, with a new wall being placed almost every other day.

*Keep up with construction progress at* ***frib.msu.edu/cameras****.*



*Recently, 742 yards of concrete were placed to create the labyrinth wall between the tunnel and the target area.*

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*The Facility for Rare Isotope Beams is supported by the Office of Science of the U.S. Department of Energy. The Office of Science is the single largest supporter of basic research in the physical sciences in the United States, and is working to address some of the most pressing challenges of our time. For more information, please visit science.energy.gov.*