FRIB LABORATORY UPDATE for USERS

November 2015

Welcome to new FRIB Laboratory Update for Users format

The FRIB Laboratory Update for Users has been upgraded to a new format to increase readability on any device.

Now, you will receive a “teaser” email that will highlight what stories are featured in the latest issue. By clicking “READ MORE” you will be directed to the story in the full newsletter, which will open in a web browser. By making the newsletter web-based, you will be able to enjoy the “responsive” qualities of the template, meaning the newsletter layout will “respond” for maximum readability on whichever device type you are using (desktop, tablet, or mobile phone).

If you prefer to print the newsletter, the template has been enhanced so it will print well from your browser; you may just need to adjust the scaling so the pages break to your liking.

We hope you enjoy the new format. Please direct comments or questions to communications@frib.msu.edu.

2015 NSAC Long Range Plan recommends FRIB completion, initiation of science program, operation of NSCL user program

“In preparation for the FRIB era, much work remains to be done at existing facilities: the nation’s flagship NSF nuclear science facility NSCL; DOE’s facilities, ATLAS and Jefferson Lab, which have world-unique capabilities; and the university labs.”

“In addition to (…) facilities, the community has developed exciting ideas for new equipment key to the future research effort. Not all can be realized immediately, but a targeted suite to address the highest priority research programs is needed. Instruments such as GRETA, HRS, and SECAR (a recoil spectrometer for nuclear astrophysics research) will be essential to realize the scientific reach of FRIB.” *(Nuclear Structure and Reactions, Sec. 3)*

Low-energy nuclear theory

“Before FRIB comes online, it is essential to ensure

The 2015 Long Range Plan for Nuclear Science "Reaching for the Horizon" was accepted unanimously at the October 15-16 meeting of the Nuclear Science Advisory Committee.

At the October 15-16 meeting of the Nuclear Science Advisory Committee, the 2015 Long Range Plan for Nuclear Science "Reaching for the Horizon" was accepted unanimously.

The report provides strong support for FRIB completion, initiation of its science program, targeted instrumentation, FRIB theory, and educational initiatives. The report also identified outstanding opportunities for the National Science Foundation in the effective utilization of NSCL and its upgrades. Below are some FRIB-related excerpts from the report.

Summary and recommendations

"Expeditiously completing the Facility for Rare Isotope Beams (FRIB) construction is essential. Initiating its scientific program will revolutionize our understanding of nuclei and their role in the cosmos. (…)" *(Recommendation I, Sec. 1)*

"We recommend the establishment of a national FRIB theory alliance. This alliance will enhance the field through the national FRIB theory fellow program and tenure-track bridge positions at universities and national laboratories across the U.S." *(Initiatives, Sec. 1)*

"Before the transition, NSCL will remain the premier national user facility for rare isotope research in the U.S., with unique rare isotope reacceleration capabilities following fast beam fragmentation." *(Resources, Sec. 1)*

Science

"FRIB will provide unprecedented access to key regions of the nuclear chart where the new measurements will challenge established concepts, highlight shortcomings, and, inevitably, guide the development of a new theoretical picture of atomic nuclei."

that a strong theory initiative is put in place to enable the success of the experimental program. (...) The proposal is for a distributed FRIB Theory Alliance, a theory effort involving many institutions throughout the country and tightly coupled to experiment. This theory alliance will enhance the field through two new initiatives: (i) the national FRIB theory fellow program and (ii) the FRIB tenure-track bridge program. The full establishment of the FRIB Theory Alliance is critical to the success of FRIB." *(Theoretical Nuclear Physics, Sec. 6)*

FRIB and its equipment

"There are a number of key upgrade possibilities after FRIB is completed. Space has been left in the linac tunnel to accommodate additional cryomodules, which would raise the production energy from 200 MeV/nucleon to 400 MeV/nucleon. This critical upgrade would increase the secondary beam yields by an order of magnitude. Other upgrade options are an ISOL production target, a second injector for simultaneous beam operation, and a doubling of the experimental floor space for future research equipment." *(Facilities for Nuclear Structure and Nuclear Astrophysics, Sec. 7)*

"FRIB has to be equipped with state-of-the-art new equipment to take full advantage of its novel capabilities. (…) GRETA will play a central role by adding significant new capabilities to existing facilities, such as ATLAS, NSCL, and ARUNA facilities, and as a centerpiece at FRIB for the physics opportunities with both fast-fragmentation and reaccelerated beams. (…) multiple additional capabilities for important programs that cannot be addressed with existing equipment or existing facilities are under study. These include (…) the proposed Separator for Capture Reactions (SECAR), key to modeling novae, X-ray bursts, and neutron star phenomena. Another key addition to FRIB is the proposed High-Rigidity Spectrometer (HRS), which would enable in-flight reaction experiments with the most neutron-rich nuclei available from FRIB." *(Detectors for Nuclear Structure and Nuclear Astrophysics, Sec. 7)*

ReA3 is fully commissioned

The National Superconducting Cyclotron Laboratory's reaccelerator, ReA3, was fully commissioned in the spring of this year after the installation of the third cryomodule. The third cryomodule has eight superconducting resonators and three superconducting solenoids, and ReA3 can now provide heavy-ion beams with energies from 300 keV/u up to 3 MeV/u for all ions.

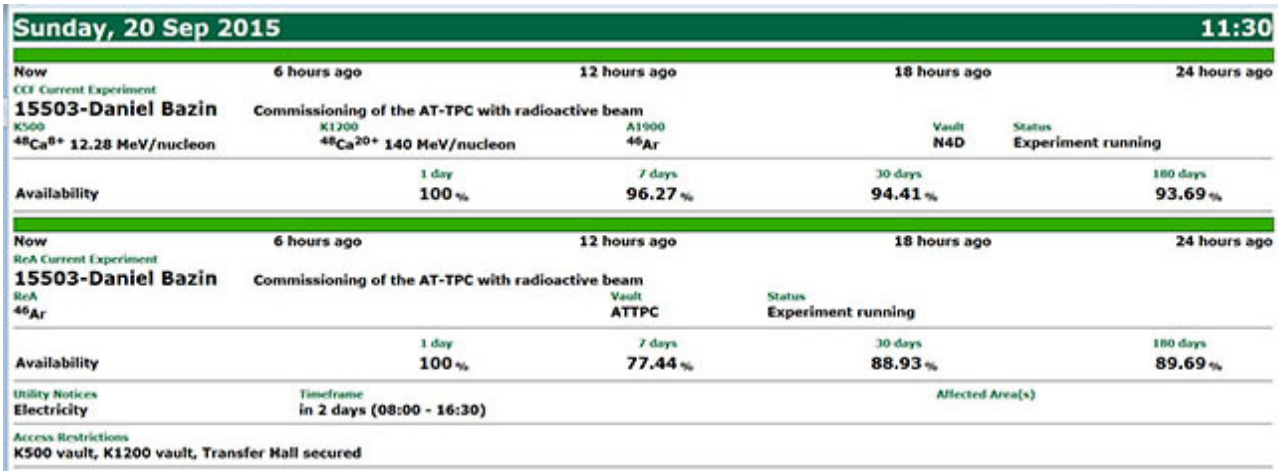
The linear accelerator was fully commissioned as well as the three beam lines in the new experimental hall. The new Cooler-Buncher was also constructed with a design based on several existing devices at the laboratory to collect the rare ions produced by the coupled cyclotron facility (CCF) and group them into bunches for the electron-beam ion trap (EBIT) ion source. The EBIT then works to strip the electrons from a batch of the rare ions in order to most efficiently accelerate the ions.

Prior to the first run with a rare-ion beam from ReA3 in September, several accelerator-physics studies were recently completed, including: calibration of the resonators, an absolute beam energy measurement of the accelerated beam was performed, and extensive studies of the most efficient beam extraction from the EBIT were carried out.

The experimental program with ReA3 began with an experiment to measure proton scattering by the exotic ion 46-Ar with the new active-target time-projection-chamber (AT-TPC). An important feature of the proposed experiments is that they generally require calibration of the experimental equipment by running a stable ion beam before running the rare-ion beam produced in the A1900 and delivered to ReA3. Thus, ReA3 will usually begin running a stable ion to the experiment before the rare-ion beam is produced by the coupled-cyclotrons and the A1900. This mode of operation will place more demands on the preparation and tuning of the reaccelerator for each experiment.

The first experiment was completed in September with the delivery of a rare-isotope 46-Ar beam for more than one week. The rare-isotope beam was produced by the coupled cyclotrons, separated with the A1900, thermalized in a gas cell, passed to the Cooler-Buncher, charge-bred in the EBIT and then reaccelerated by ReA3 and then delivered to the AT-TPC.

The second experiment was completed in early October. This time a stable beam of 39-K was used to calibrate a new set of fission-fragment detectors and then reactions with a rare-isotope beam of 46-K were measured. This experiment also required the entire CCF/ReA3 facility to run for about a week and was very successful.



ReA3 is now fully commissioned and the user program has started successfully. The experimental program with ReA3 began with an experiment to measure proton scattering by the exotic ion 46-Ar with the new active-target time-projection-chamber (AT-TPC). The figure (above) is an image of the hallway display that shows the green bars for the simultaneous operation of both accelerator systems for the AT-TPC experiment.

Low-energy nuclear science community gathers at MSU

Above is a group picture taken during one of the plenary sessions of the 2015 Low Energy Community Meeting at MSU in August.

With more than 200 registered participants, the 2015 Low Energy Community Meeting (LECM) was held August 21-22 on Michigan State University's campus in East Lansing, Michigan. Also this year, the community's annual gathering provided an excellent opportunity for nuclear scientists to interact and discuss progress, emerging opportunities, new initiatives, and facilities.

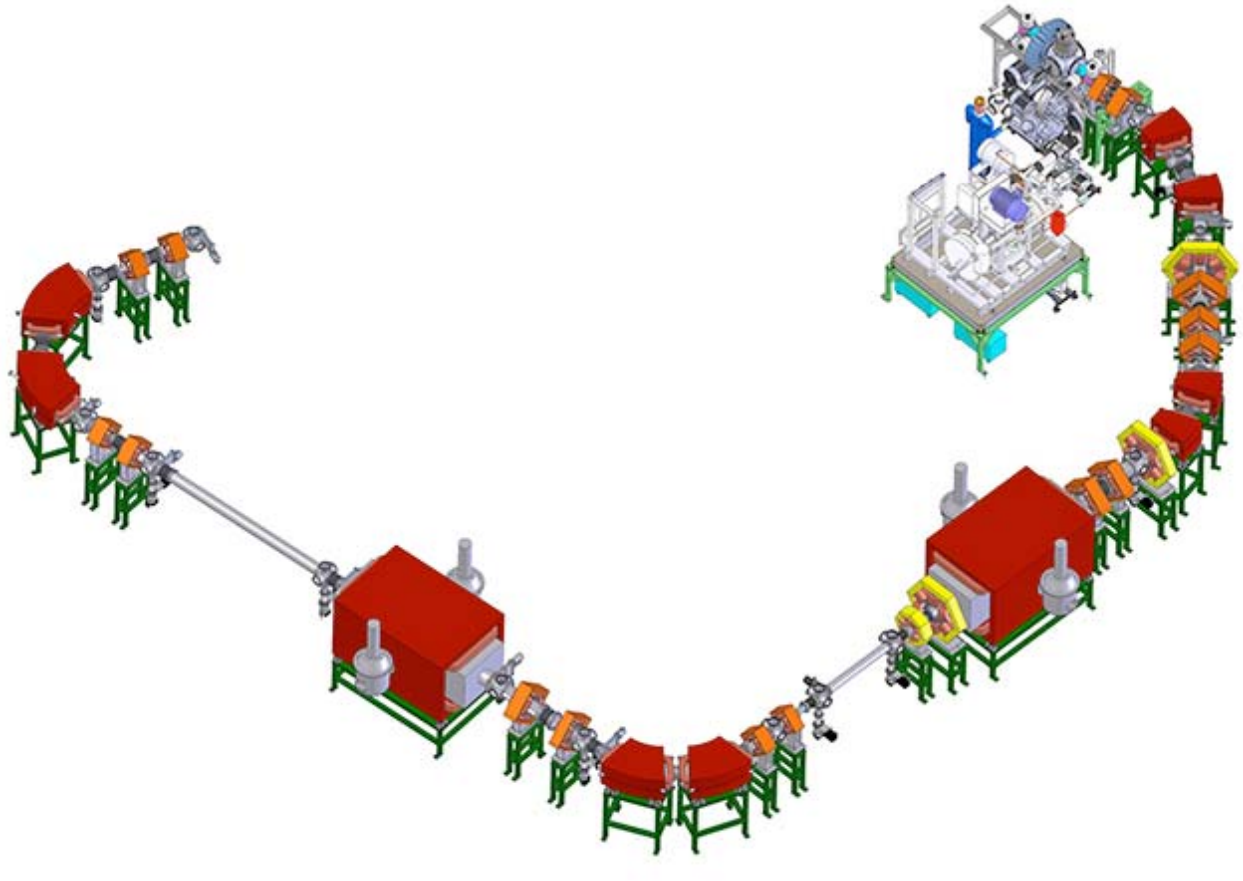
During plenary sessions, presentations were given on the ongoing Nuclear Science Advisory Committee (NSAC) long-range plan activity, the equivalent exercise of the isotope program (NSAC-I), progress in nuclear theory and nuclear astrophysics, and on the status of NSCL/FRIB, ATLAS/ANL and two ARUNA laboratories, Texas A&M and FSU. Time was allocated for working group meetings on focused initiatives, with their summaries posted on the LECM website.

Representatives from both funding agencies, the U.S. Department of Energy and the National Science Foundation, presented their perspectives and listened to the plans of the community. The meeting's resolutions reaffirmed timely completion of FRIB and initiation of its full science program as the highest priority of the field. In addition, the community expressed the need for effective operations, upgrades, and support of NSCL, ATLAS/ANL and ARUNA, respectively, endorsed the energy upgrades to ReA, reiterated the importance of GRETA, SECAR, and the high-rigidity spectrometer (HRS) for the FRIB science program, and acknowledged the important role of nuclear theory.

Mini-workshops on ANL's planned inflight radioactive ion separator AIRIS, the astrophysical separator SECAR for FRIB, and the planned HRS for FRIB were held. The γ-ray spectroscopy community met right after the LECM to initiate discussions on the siting of the γ-ray tracking array GRETINA after 2016.

The LECM was preceded by a one-day workshop on the science opportunities with ReA6-12, the energy upgrade to NSCL's ReA3 reaccelerator. The event was very well attended with more than 70 registered participants, underlining the long-standing interest of the community in this unique opportunity. After an overview of the existing ReA facility, 14 speakers presented exciting science programs that can be realized when reaccelerated beams with energies above the Coulomb barrier are made available in the near future at NSCL and later at FRIB. This workshop initiated the writing of a whitepaper that will summarize the broad science programs that will be enabled with energy upgrades of ReA to 6 and 12 MeV/u beam energies (quoted for uranium). Information on how to get involved is available on the ReA web page.

SECAR Recoil Separator for Astrophysical Reactions Project has started



The Separator for Capture Reactions (SECAR) recoil separator will enable direct measurements of astrophysical reactions of low-energy protons and alpha particles with radioactive nuclei at FRIB in connection with the JENSA Gas Jet Target, a development led by the Colorado School of Mines, and radioactive beams from the ReA3 reaccelerator.

Direct measurements of astrophysical reactions of low-energy protons and alpha particles with radioactive nuclei are needed to interpret astronomical observations of X-ray bursts, Novae, and other extreme stellar environments. The goal is to answer questions about the nature of stellar explosions, neutron stars, and the origin of the elements. The SECAR (Separator for Capture Reactions) recoil separator will enable such measurements at FRIB in connection with the JENSA Gas Jet Target, a development led by the Colorado School of Mines, and radioactive beams from the ReA3 reaccelerator.

Following a successful technical, cost, schedule, and management review conducted jointly by the DOE's Office of Science and the National Science Foundation in fall 2014, the first phase of the SECAR project started on March 1 with support from DOE-SC.

SECAR is a multi-institutional project with the University of Notre Dame leading overall design and separator systems procurement, Louisiana State University leading the development of focal-plane detection systems, Oak Ridge National Laboratory leading development of the gas jet target interface, and Michigan State University leading installation and commissioning. The project progresses nicely with the ion optical design and component specifications completed. The project is on track to initiate the first major procurements this fall. Project completion is planned for the end of fiscal year 2021.

The SECAR collaboration is open to scientists interested in measurements of astrophysical reaction rates at FRIB – scientists interested in joining should contact Michael Smith, deputy project manager (msmith@xrayburst.com), any member of the SECAR Collaboration Council, or join the next collaboration meeting. For more information, visit the SECAR website.

Laboratory commemorates 50 years since the first beam from the K50 cyclotron

Gabe Blosser, son of Cyclotron Laboratory founder Henry Blosser, participated in the celebration. He recounted memories of his father's tenure at the laboratory and shared how his father influenced his professional path.(Photos courtesy of Michigan State University.)

The FRIB Laboratory marks a significant anniversary in 2015—50 years since the first beam from the K50 cyclotron.

In mid-1957 the MSU Physics department finalized its decision to build a cyclotron to accelerate heavy ions, like carbon-12, to about 40 MeV. In early 1958, it hired Henry Blosser—after two senior scientists had refused offers—as director of a laboratory with one member (him) to build that device.

It took only until December 1958 to submit a proposal asking for funds to the Atomic Energy Commission (AEC). That was a hard ask: the 30-year-old director was unknown as was the laboratory itself, the university had scant infrastructure, and the federal government was in a budget crunch. It was not until October 1961, following proposals to three different government agencies, that funds finally arrived from the National Science Foundation (NSF).

There followed a chaotic time of hiring staff, building a laboratory, and building a cyclotron. As related in a 1965 proposal to NSF, in January 1965 "all was in place, and in front of a large crowd of the interested —students, wives, children, and girlfriends—the startup began. The magnet, trim coils, and ion source were turned on, and the radio frequency warmup began. But in a few minutes a severe internal water leak interrupted the process. Similar problems occurred for the next ten days, and by a February 11 startup attempt, not one visitor was present. This attempt went exceptionally smoothly. With the computed settings, the beam was soon at the maximum radius."

MSU President Lou Anna K. Simon (second from left) and FRIB Laboratory Director Thomas Glasmacher (far right), present Associate Director of Science for Nuclear Physics at the U.S. Department of Energy Timothy Hallman (left), and National Science Foundation Deputy Division Director for the Division of Nuclear Physics Bradley Keister, tokens of appreciation for their support over the years of NSCL and FRIB.

To commemorate this significant anniversary in the history of the FRIB Laboratory, a special celebration was held on October 8. Former and current laboratory employees, users and colleagues, and other honored guests joined together to celebrate a half-century of nuclear-physics accomplishments at MSU, and look forward to the next frontier — FRIB.

The morning program included a presentation of "Up from Nothing: The Michigan State University Cyclotron Laboratory," a book about the history of the Cyclotron Laboratory by Sam Austin; original compositions by MSU College of Music faculty and alumni; and memories from those who spearheaded the nuclear physics accomplishments at MSU.

The celebration concluded with special remarks focused on the history of nuclear physics at MSU and how it has fostered strong relationships between the university, the National Science Foundation and the U.S. Department of Energy. Speakers included MSU President Lou Anna K. Simon, National Science Foundation Deputy Division Director for the Division of Physics Bradley Keister and U.S. Department of Energy Office of Science Associate Director of Science for Nuclear Physics Timothy Hallman. The program also included the premiere of the "50 Years of Beam at MSU" video.

Program elements available online

- "Up From Nothing: The Michigan State University Cyclotron Laboratory" by Sam Austin is available for purchase from MSU Press.
- The "50 Years of Beam at MSU" video is online.
- View photos of the event: "50 Years of Beam at MSU" gallery.

This achievement gave the laboratory a reputation for the ability to do things quickly and do things well. It permitted the development of a unique research program, with light ions, not heavy ions as proposed, that evolved and grew greatly in strength and influence on the worldwide scene. It opened the door to today's laboratory.

The composers' music is available online

- "Chart of the Nuclides" - Mark Sullivan
- "Separation Anxiety" - Benjamin R. Fuhrman
- "The Atomic Wait" - Matthew Schoendorff
- "Three Isotopes" - Mark Sullivan
- "Mind the Gaps" - Benjamin R. Fuhrman
- "Kaleisotope" - Matthew Schoendorff
- "Neutron Star" - Mark Sullivan

Konrad Gelbke honored with symposium, endowment

Several of Konrad Gelbke's former graduate students and postdocs presented him on October 8 with a check representing $50,000 that had been donated as of that date to an endowment fund in his name. First row: Sally Ejakov (nee Gaff), Konrad's last graduate student; Dave Bowman, postdoc; Konrad Gelbke; Yeong-duk Kim, graduate student; Damian Handzy, graduate student. Second row: David Fields, graduate student, Graham Peaslee, postdoc; Larry Phair, graduate student; Romualdo de Souza, postdoc; Mike Lisa, graduate student. Third row: Thomas Glasmacher, NSCL Fellow and postdoc; Terry Awes, Konrad's first graduate student.

Following the 50 Years of Beam at MSU celebration on October 8, a scientific symposium honoring former NSCL/FRIB Director Konrad Gelbke was held at the Wharton Center. The symposium honored Konrad's remarkable career and outstanding leadership that brought the laboratory where it is today. The speakers and session chairs were Konrad's former graduate students and postdocs who moved on to diverse careers in academia, national laboratories, and industry. In addition, Konrad's broader impact on the U.S. nuclear physics community was highlighted by representatives from the National Science Foundation and the U.S. Department of Energy.

In the evening following the symposium, a special dinner honoring Konrad took place at the Kellogg Center. During the dinner, the Konrad Gelbke Endowment for Science Students was publicly announced. Damian Handzy (MSU PhD '95), one of Konrad's former graduate students and recipient of the 2015 MSU College of Natural Sciences Outstanding Alumnus Award, acted as master of ceremonies for the evening and was involved in arranging the endowment.

Damian said, "When one of Konrad's former post-docs suggested we start an endowment in his name, I immediately jumped on the idea — it's the perfect way to honor the man who taught and trained so many scientists and who spearheaded the tremendous growth of Michigan State's Nuclear Physics program."

While the genesis of the endowment was Konrad's former students and postdocs, many others contributed as well – 50 donors in all established the initial funding.

The endowment will fund science students according to guidelines yet to be established by Konrad. Donations to this endowment can be made by contacting Corey Longley at longleyc@cns.msu.edu.

Civil construction is 10 weeks ahead of schedule

A view of the project from the west.

A view of cryo line installation in the tunnel.

FRIB civil construction continues to progress swiftly. The tunnel and surface building are 10 weeks ahead of the baseline schedule, with a goal of starting installation of front-end equipment in November. The linear accelerator tunnel lids have been completed, and the surface-building exterior is rapidly developing as masonry, roofing, and metal panel installation take place. Roofing has been completed on the far east end of the building, and is continuing to progress westward. Interior masonry work is progressing on the ground floor, lower subfloor and the upper second floor. Overhead mechanical, electrical, and plumbing installation is occurring on the ground floor and the upper second floor. Interior painting continues, and workers have been fireproofing the structural steel on the first floor.

On the west end of the tunnel lid, vertical ductbank shafts and formed piers are being installed, while backfilling continues in the target area. To date, backfill is 70-percent complete, with 56,250 tons placed so far. Utility trenches in the cryogenic area have been installed, and concrete slab-on-grade in the cryogenic compressor area is partially complete. Fifteen of the 56 substation pieces have been placed on the second floor. Nonconventional utilities piping (NCU) installation began in August, and is currently 25 percent complete. NCU components such as hangers and sections of welded pipe are being prefabricated in an offsite warehouse that has a controlled environment, which is located 10 minutes from the construction site.

This fabrication shop expedites production and provides additional storage, allowing for bulk purchase and shipping of NCU materials.

Looking ahead through December, overhead mechanical, electrical, and plumbing installation will continue moving westward on all levels of the building. Additionally, masonry and roofing will continue to progress toward the west end of the building. Backfill will be placed for the target area as well as the remainder of the linac tunnel. Exterior aluminum entrances and exterior metal panels are to be installed, along with switchgear, substations, air handlers, cooling towers, and exhaust fans.

Keep up on construction progress by visiting frib.msu.edu/cameras.

Some of the electrical substation pieces have been set.

U.S.-China-FRIB website launched

Following up on resolutions of the very successful "FRIB-China Workshop on Physics of Nuclei and Hadrons," a task force of U.S. and Chinese scientists was formed to assess a path forward towards realizing the many possible collaborative efforts in the area of radioactive ion beams.

Visit US-China-RIB.org to learn about the science areas, the task force members, future meetings, working groups, and much more.

Contributors this issue

- Sam Austin
- Brad Bull
- Alexandra Gade
- Dave Morrissey
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- Hendrik Schatz

FRIB Theory Alliance launches new website

The website of the national FRIB Theory Alliance has been launched.

Visit the site to learn about ongoing and planned activities. The FRIB Theory Alliance will be officially launched at the inaugural meeting in 2016.

For information about the current FRIB theory fellow search, read the online posting.

Looking ahead

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)
January 12-14, 2016	DOE Operations Cost Review

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.

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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.