

Michigan State wins contest to host DOE's rare isotope beam lab

The \$550 million heavy ion accelerator will be an "incredible toy box" for nuclear physicists, says project director.

With its offer to pick up some of the project's cost, Michigan State University beat out Argonne National Laboratory and settled a longstanding rivalry to host the Department of Energy's next nuclear physics accelerator, the Facility for Rare Isotope Beams. In its 11 December announcement of the award, following a detailed merit review of the two bids, DOE acknowledged that MSU's sharing of project costs was a factor in the selection, but said the university had also delivered "the strongest proposed budget that was reasonable and realistic."

"MSU, to enhance [its] application for the FRIB, committed to securing \$94 million in local contributions to the construction of the facility and related equipment," said Terry Denbow, vice president for university relations. Further cost savings should result from the use of equipment and technology located at the National Superconducting Cyclotron Laboratory (NSCL) at MSU, he added. The university did not specify the local funding source. Construction is expected to take 10 years and cost \$550 million.

Konrad Gelbke, NSCL director and director-designate of FRIB, insisted that the MSU contribution was far from the sole factor in the lab's selection. The university has a "responsible partnership" with NSF and has co-funded a number of upgrades to NSCL, including a project that coupled its tandem accelerators, he said. The new instrument will be "an incredible toy box" for scientists, he explained, allowing them to "dial in" the production of a wide variety of rare isotopes. FRIB's superconducting linear accelerator will be unparalleled, he said, as a driver of heavy ions for in-flight fragmentation—a process in which the nuclei of heavy elements are ripped apart as they are shot through a target of lighter nuclei. The in-flight process

allows experimenters to separate quickly—in around one-millionth of a second—the short-lived isotopes that result from the collisions. By contrast, many of the world's nuclear physics accelerators, such as Canada's TRIUMF, employ the isotope separator on-line process, which often requires the chemical separation of heavy isotopes from radioactive targets. For that reason, the ISOL process is better-suited to experiments involving longer-lived isotopes, Gelbke said. FRIB will have the highest-intensity beam of any in-flight rare isotope production facility in the world, significantly surpassing the output of the Radioactive Isotope Beam Factory at Japan's RIKEN accelerator facility, he said.

Good news for Michigan

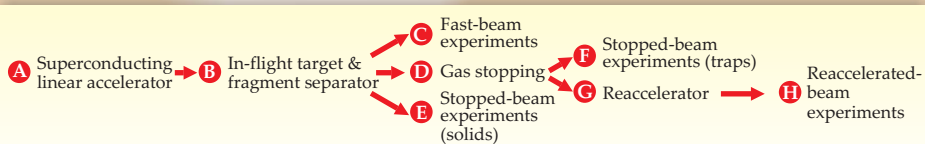
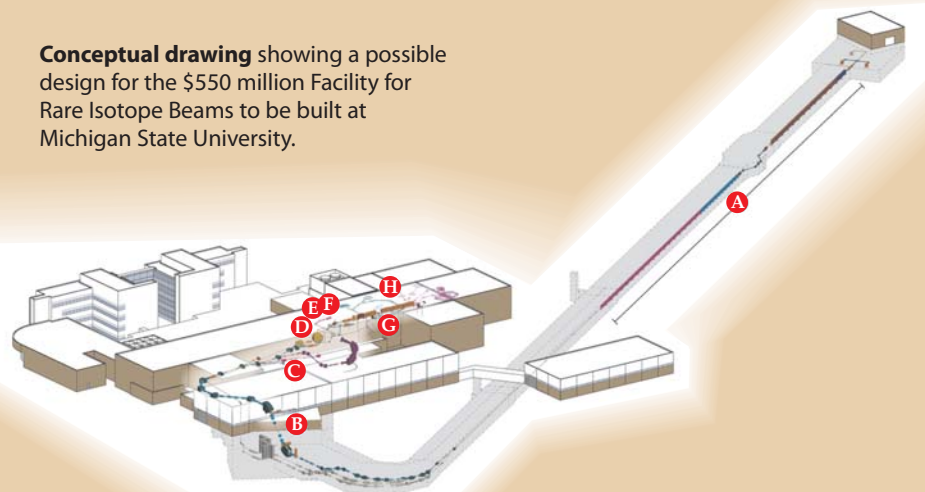
The award was a rare piece of good news for Michigan, whose automobile-dependent economy has been ravaged by the recession. Governor Jennifer Granholm (D) said the design and construction of the lab will create 5800 jobs, and once completed, the lab will employ 300 scientists and staff. Another

220 new "spinoff" jobs are also anticipated. A study commissioned by MSU estimated that FRIB's economic impact will total \$1 billion over the next two decades. Millions of dollars in new grants will fund research for about 1000 scientists, postdocs, and graduate students.

MSU president Lou Anna K. Simon said that more detailed final design work on FRIB will begin immediately, with construction anticipated to begin in 2013. The new facility will dwarf NSCL's existing two-cyclotron facility, which has an annual operating budget of \$20.5 million.

FRIB is a downsized version of the Rare Isotope Accelerator, a \$1.1 billion project that DOE's Office of Science had once labeled as its highest-priority future facility for nuclear physics. In 2006, however, DOE abruptly canceled RIA on grounds that it was too expensive and duplicated existing or planned experimental capabilities elsewhere. FRIB was then floated by the DOE-NSF Nuclear Science Advisory Committee (NSAC), with a price tag set at half RIA's. The redesigned facility's

Conceptual drawing showing a possible design for the \$550 million Facility for Rare Isotope Beams to be built at Michigan State University.



200 MeV/nucleon driver accelerator is half the energy of RIA's, and FRIB will lack the multi-user capability of RIA, a feature that was deemed duplicative. FRIB also will be equipped with less experimental equipment than RIA, Gelbke said. Some of NSCL's equipment is compatible with the smaller FRIB driver and will be incorporated into the new machine for additional savings.

The origins of FRIB can be traced to a 1996 long-range planning exercise by NSAC, which first identified a need for a next-generation nuclear structure and astrophysics laboratory in the US. In the wake of RIA's cancellation, a National Research Council study commissioned by the two agencies confirmed that a more powerful rare isotope beam instrument was needed if the US was to remain competitive in nuclear physics, and said that a machine could be designed without overlapping with existing and planned nuclear science capabilities abroad. With those findings in hand, NSAC produced a review in 2007 affirming that "technical advances" made since RIA's design would permit

"a world class facility" to be built at half the earlier machine's estimated cost, albeit with a more limited suite of capabilities. The NSAC urged that development and construction of FRIB's linac, which it said accounts for about 80% of the project costs, get underway as soon as possible.

Other applications

The research conducted at FRIB will involve experimentation with intense beams of rare isotopes, and in addition to basic research is expected to have applications in materials science, medicine, and nuclear weapons stockpile stewardship and nonproliferation. The facility will be especially well-suited to generating sizeable amounts of short-lived isotopes for nuclear medicine, and Gelbke said he expects to have "fruitful interactions" with MSU's nuclear medicine group. But FRIB is likely to be too expensive to become a source for commercial quantities of radioisotopes. DOE's weapons labs have shown interest in FRIB's ability to mimic on a tiny scale isotopic changes that occur in ma-

terials during underground nuclear tests; experimental results could help designers further refine the codes they use to simulate nuclear explosions. So too might FRIB be useful for helping determine how the high-energy neutrons to be produced in Lawrence Livermore National Laboratory's National Ignition Facility will activate component materials of the 192-beam laser, Gelbke added.

MSU recently embarked on an NSCL upgrade that includes a new low-energy linac for nuclear astrophysics experiments and a 10 000-square-foot expansion of experimental space. Due for completion in 2010, the upgrade will allow experimenters to use fast, stopped, and re-accelerated beams of rare isotopes. That capability will give researchers new tools to work with until FRIB's completion.

The university still must negotiate a cooperative agreement with DOE and complete a required environmental review of the site. As with all multi-year federal projects, funding is contingent on annual appropriations by Congress.

David Kramer

Commercial optical traps emerge from biophysics labs

Traditionally custom-built, optical tweezers are now available off-the-shelf for single-molecule research and clinical applications.

What if determining your blood type took a few seconds and a few dozen red blood cells instead of several minutes and milliliters of blood? To that end, one company is building on a two-decades-old invention that harnesses laser radiation to noninvasively trap and manipulate submicroscopic particles.

Arryx Inc, which is developing the new assay, is among a handful of companies that have begun to commercialize optical tweezers. An invention by Bell Labs physicists, optical tweezers are best known for their role in determining DNA's elasticity and other benchmark single-molecule studies. Those experiments were done with custom-built instruments with diffraction-limited resolution, and some with subpiconewton sensitivity. Now new commercial optical tweezers are being targeted to researchers and medical institutions that don't want to build their own.

The AFM analogy

In an optical tweezer system, a particle is pushed by the momentum from a tightly focused laser beam and trapped by the gradient forces of the beam's refracted light. The trapping force acts against

thermal fluctuations, light scattering forces, or—in the case of some single-molecule force measurements—motile biological specimens that are tethered to an optically trapped spherical substrate. In addition to an IR laser source, chosen to minimize photodamage to biomolecules, modern optical tweezers are often fitted with high-powered optical microscopes, electro/acousto-optic feedback devices, software controls, and microfluidic chambers.

Up until the 1990s, many people were still building atomic force microscopes by themselves, says physicist Torsten Jähnke, chief technology officer of Germany-based JPK Instruments AG. The company makes AFMs and also optical tweezers designed for particle-tracking and force measurements. Jähnke adds that the reason people are buying AFMs now is because "they are flexible, modular, and easy to use," which, he says, is now happening with optical tweezers.

"There's been quite some competition coming up in the tweezers market in the last two or so years," says Michael Gögler, a product manager at German microscope manufacturer Carl Zeiss AG.

Coupled with a UV laser, Zeiss's optical tweezers can, among other things, guide sperm to egg for in vitro fertilization. A similar instrument was available in the 1990s from now defunct Cell Robotics Inc. The demise of that company, says Gögler, may be blamed in part on its premature entry into an unprepared market. Back then, optical tweezers were a tool almost exclusive to physicists, he says. "But with the growing popularity of interdisciplinary research, a lot more techniques get to be known to the biology community."

The current market for optical tweezers is in biological research, says Kishan Dholakia, a biophysicist at Scotland's University of St. Andrews. At this stage, Dholakia says he thinks optical tweezers are "a top-end research tool." His own optical tweezers patent uses acousto-optic modulators to generate multiple traps. He says that single-molecule force measurements and the building of tissue scaffolds are among the applications for the instrument, which has been commercialized by UK-based equipment provider Elliot Scientific Ltd.

"Truly exciting new results about the