New component design could reduce cost of proposed Facility for Rare Isotope Beams

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A superconducting triple-spoke cavity is prepared for electropolishing in a clean room. Argonne National Laboratory photo.

Researchers at the DOE's Argonne National Laboratory have developed new state-of-the-art techniques that will lead to significant improvements in the performance of superconducting niobium cavities. Argonne's superconducting spoke cavities can operate at lower temperatures and at higher magnetic fields than previous designs, translating into a potential savings in the cost of a heavy-ion linear accelerator, such as that required for the proposed Facility for Rare Isotope Beams (FRIB).

An electromagnetic cavity consists of a space surrounded by an electrical conductor. When an electromagnetic (EM) wave that shares the cavity's

natural frequency enters, it bounces back and forth within the cavity, creating a phenomenon known as resonance. As more wave energy enters the cavity, it combines with and reinforces the standing wave, increasing its intensity and producing very large EM fields.

Instead of the elliptical superconducting cavities typically used on electron linear accelerators, Argonne's researchers have turned to "triple-spoke" cavities, in which three perpendicular niobium pipes intersect the cavity's shell, creating a region of high acceleration but low surface magnetic field at the center. This design also offers excellent mechanical stability and good accelerating efficiency, said Argonne accelerator physicist Michael Kelly, who helped to develop the cavities.

Development of these superconducting cavities began more than 10 years ago when DOE first identified the need for a rare isotope beam facility in the United States. Since then, however, Argonne's physicists and engineers have developed a number of methods to improve the performance of the cavities.

"By using electropolishing, high-temperature baking and clean-room assembly techniques, we were able to significantly boost the capabilities of these cavities," Kelly said. "Taken as a whole, these techniques have enabled us to reduce the length of the accelerator by a factor of two or three. Additional improvements over the next couple of years may further reduce the cost of certain kinds of accelerators by as much as 20 to 30 percent." The current construction budget for FRIB totals approximately $550 million dollars.

"New projects such as the proposed rare isotope beam facility would be prohibitively expensive without the results we are generating from our work," added Jerry Nolen, Argonne Distinguished Fellow.

The team of Argonne scientists involved in this project includes Kenneth

Shepard, Petr Ostroumov, Mike Kelly and Jean Delayen, currently of Thomas Jefferson National Accelerator Facility.

Argonne is one of the sites competing for FRIB, a research facility for the study of rare isotopes that would revolutionize humanity's understanding of nuclei, the core of matter and the fuel of stars.

Argonne is collaborating with several national laboratories and universities on its proposal. Walter Henning, an Argonne Distinguished Fellow who is leading Argonne's bid, expects DOE's Office of Science to issue a call for proposals for the rare isotope beams facility in about a month or two with the winning proposal being selected by the summer. An "Advance Notice" for the publication in February of a draft proposal request was recently announced on DOE's website.

If Argonne is selected to build the rare isotope beams facility, conceptual design could begin in 2009, with the commencement of construction likely by 2011.

Source: Argonne National Laboratory