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## NSF Approves New C.U. X-Ray System

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The National Science Foundation has given Cornell the green light to begin development of an Energy Recovery Linac (ERL), a new advanced synchrotron radiation X-ray source that has far-reaching implications for biology, chemistry and a host of other disciplines.

The proposed ERL will feed into the Cornell Electron Storage Ring (CESR) underneath Alumni Field but will produce X-rays with greater capabilities than the University's current synchrotron radiation source can provide.

Synchrotron radiation is X-ray and other electromagnetic radiation emitted when fast-moving electrons are suddenly deflected by a magnetic field. The University uses CESR as its current source of X-rays, but the technology of this and other storage rings is a mature one, limited in the brilliance of the X-rays it can produce.

Earlier this month, the NSF awarded Cornell scientists \$18 million to prototype critical components of the ERL.

"The X-ray beams produced by the new source will be roughly a thousand times better in brightness, coherence and pulse duration than currently is possible," said Sol Gruner, principal investigator for the project and director of Cornell High Energy Synchrotron Source (CHESS), according to Cornell's news service.

Because the ERL emits brighter, more coherent X-ray beams in quicker bursts, biologists, chemists and other scientists can use it to study smaller structures and quicker processes. The roughly two dozen scientists from CHESS and Cornell's Laboratory of Elementary Particle Physics (LEPP) collaborating on this project expect to complete prototyping by 2008. From there, they will seek funds to build a full-scale ERL facility.

The new X-ray source uses accelerator physics and superconducting microwave technology, in which LEPP is world-renowned.

For many years, Cornell scientists have made incremental improvements to the brightness, coherence and pulse duration of X-rays produced at CESR.

However, according to Maury Tigner, LEPP director and co-principal investigator on the project, "We're about at the limits. If we want to improve desirable qualities, we have to think of a different approach."

In CESR and other storage rings, complex magnets guide fast-moving electrons into a roughly circular path. Other magnets posted at various locations around the ring cause a

wobble in the electron beam, generating X-rays.

Electrons circulate around the ring for hours but diffuse over time because of collisions with gas atoms and other electrons and because of emissions from the synchrotron radiation. As these particles make repeated trips around CESR, they spread into an electron cloud that emits X-rays of decreasing brilliance, coherence and pulse duration.

Tigner explained that while CESR saves the particles that are in the beam; the proposed ERL arrangement would save the energy that belongs to the beam.

In the proposed ERL facility, electron beams would be accelerated to almost the speed of light in a linear accelerator (linac) many hundreds of meters long. These electrons would then feed into the existing storage ring, where they would emit X-rays. After circulating the storage ring just once, they would pass through the linac again where their energy would be recovered and used to accelerate the next group of electrons through the ERL. The spent electrons would be discarded after each cycle.

The ERL would produce X-rays with much higher brightness, coherence and pulse duration, enabling research impossible with existing X-ray sources.

Applications of the ERL range from investigating protein structure and DNA folding to studying photosynthetic processes and chemical reactions.

Using the ERL, scientists can make X-ray microscopies and holographies to probe nanometer structures in biological, synthetic and natural materials.

Researchers have even proposed using the ERL to analyze paintings, migration patterns of certain fish and ink from manuscripts written by monks hundreds of years ago, according to Gruner.

If built, the ERL facility will attract researchers and scientists from all over the world. The intense collaboration required for the project is something few universities can pull off, Gruner said, adding that numerous departments from four or five of Cornell's colleges are actively working together on the ERL and that the University administration has been very supportive.

Joseph Choi grad is one of several students assisting professors with the prototyping of the ERL.

"It's also wonderful to know that the NSF is interested and willing to fund research in accelerator physics and new technology for light sources," said Choi, who is writing a computer program to simulate the electron beam's front-to-end passage through the linac. He added, "I was happy for the many faculty and staff members who worked so hard for the proposal of the ERL."

Tigner emphasized the potential of this project for Cornell.

"I think the main point is, if we are successful it will be a great thing for Cornell," he said. "So many different departments and scientists will be able to use this thing. [It will] put us way ahead in the competitive world."

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