CLASSE Looks Ahead

A Conversation with Ritchie Patterson

PHYSICS, DIRECTOR OF CLASSE

In 2006, *Connecting with Cornell* highlighted the Cornell Laboratory for Accelerator-based Sciences and Education (CLASSE), showcasing Cornell's wide-ranging expertise in particle physics, accelerator technologies, and x-ray sciences.

CLASSE continues a stellar trajectory in 2012, as the center welcomes a new director, Ritchie Patterson, whose Cornell career spans undergraduate student, CHESS operator, and Department of Physics faculty member and chair. Patterson's research centers on experimental particle physics using the Large Hadron Collider near Geneva, Switzerland.

ERNIE FONTES: Why the move from chairperson of the Department of Physics to director of CLASSE, taking the reins from retiring director Maury Tigner?

PATTERSON: CLASSE is pushing the boundaries in the physics of beams and accelerators, in exploring the cosmos, and in developing x-ray tools that enable new discoveries and inventions in the biomedical, materials, and environmental sciences. And students are deeply involved in all of this outstanding research. It's a fantastic privilege for me to be a part of the groundbreaking science at CLASSE and to continue a strong commitment to training the next generation of scientists.

Will you describe the activities of CLASSE?

CLASSE is tremendous! CLASSE encompasses research and education projects involving dozens of faculty, hundreds of staff and undergraduate and graduate students, and thousands of collaborators and CHESS facility users from around the world.

Right now, we have more than 25 externally funded ongoing projects in CLASSE. I invite readers to follow the news of CLASSE scientists. These innovators are probing symmetries that guide the universe, producing and sustaining beams of incredibly closely packed particles, developing energy-efficient ways to accelerate particles, and pushing the fundamental limits of light sources and other accelerators.

Less publicized but vitally important are the hundreds of completed and ongoing PhD thesis projects at CLASSE. Cornell is one the few universities in the country that is preparing accelerator physicists equipped to build x-ray sources crucial to scientific progress in many fields.

One CLASSE project is an ERL prototype. What is the ERL, and what will it bring to the Cornell community?

The Energy Recovery Linac will be a first-of-its-kind high-energy x-ray source, using accelerator technology invented and being perfected here at Cornell.

Maury Tigner proposed in 1965 that highly tuned resonant cavities could be used both to accelerate and decelerate charged particles. During deceleration, the energy of the particles is recovered and recycled.

Realizing this elegant idea was beyond existing technical capabilities, 10 years ago CLASSE started an NSF-funded R&D project to build a prototype source. As the prototype nears its goals, we've developed a technical design plan for a full-scale facility.

Last summer we hosted six international workshops exploring how an ERL opens new avenues for research that uses continuous-duty coherent beams of ultrashort x-ray pulses. This helped us to clarify a science case for such a facility.

Cornell faculty and students were key participants looking forward to a powerful new tool on campus for investigating all types of materials, from airplane wings to cell membranes, and from pollution in plant tissue to matter under earth-core pressures.

Recent ERL press releases tout some major technical milestones. What do these milestones predict about the future of a new x-ray light source at Cornell?

CLASSE is building accelerator components that were only a dream when the R&D project began. These components are now exceeding world performance records. While we have more work to do, our technical accomplishments show that an ERL is within our reach.

The milestones demonstrate that CLASSE has innovative, world-leading capabilities—and talent—and that Cornell's Ithaca campus, with outstanding research and education, is the best place in the world to build a first-of-a-kind facility.

Given the uncertainties we hear about funding for science, are you confident that CLASSE can continue making progress in the coming years?

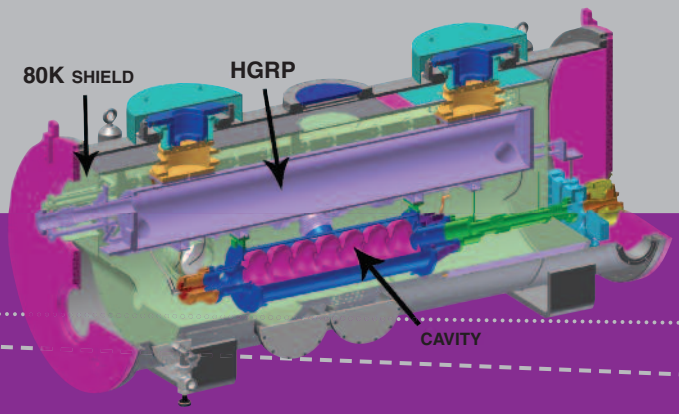
Success in funding follows a solid track record and vision. Cornell has been a leader in accelerator-based sciences for over four decades, consistently building a trail of innovative and daring "firsts." As long as our faculty and students generate and substantiate new ideas, I am confident that CLASSE will continue to grow.

Will you comment on the educational projects and initiatives that CLASSE supports?

It's essential to the health of our nation to get citizens, and especially young students, engaged and excited about science, technology, engineering, and math—the STEM fields. And I can think of no better place for young people to discover that excitement than here at CLASSE and Cornell. CLASSE has two full-time science educators, Lora Hine and Erik Herman, designing and delivering education and outreach programs. Each year, thousands of elementary and high school students participate in our programs at the lab and in the community.

We also support summer research experiences for college students from across the country. I am always excited about getting more girls and young women into science, so I've just committed to hosting the Northeast Conference for Undergraduate Women in Physics, which will bring over a hundred promising young scientists to campus in early 2013.

www.classe.cornell.edu



To see the smallest details
ERL MILESTONES

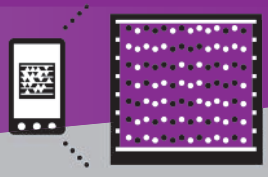
Future technology—from computer chips to pharmaceuticals—depends on seeing the smallest features. The Cornell ERL will enable scientists to visualize motion at the molecular level in cells; study the smallest details of metals, ceramics, polymers, and other materials; and follow chemical reactions in ways never before possible. With these capabilities, ERL x-ray beams will help scientists develop more efficient engines, batteries, photovoltaics, and fuel cells; analyze pollutants and environmental toxins; create energy-efficient materials and technologies; and much more. The ERL will be a new type of continuous-duty, short-pulse x-ray source, using ultracompact electron bunches and a superconducting linear accelerator (linac) that will accelerate and recycle particle energy.

To prove that such a source is possible, CLASSE has been designing and building unique photoinjector and superconducting cavities. This NSF-funded prototyping project has been achieving milestones—and, in some cases, extending world records—every day!

Milestone 1: A continuous-duty current of 50 milliamperes from the laser-driven photocathode electron gun sets a new world record and exceeds the levels needed by one of the ERL operating modes. The full-scale ERL operating mode of 100 mA is within sight.

Milestone 2: The brightness of the prototype gun, produced by the core of the electron bunches (the central two-thirds of the electrons), already equals what is needed for a full ERL. Better values are expected when the injector voltage is increased. This super-bright core was unexpected at the start of the project. The discovery could dramatically advance the capabilities of an ERL over existing sources.

Milestone 3: Superconducting accelerating cavities need to be extraordinarily efficient for an ERL linac to recover and reuse electron beam energy. The first ERL prototype accelerating cavity achieved an efficiency surpassing ERL requirements. If a church bell or chime were this efficient, it would ring for a whole year after a single strike!



Photos in this article: CHESS; Frank DiMeo