ACSF

The David R. Atkinson Center for a Sustainable Future (ACSF) is a bold initiative to focus the brightest minds from all disciplines—from the humanities to engineering—on creating new approaches, techniques, and technologies to advance solutions to some of society's most complex challenges and pressing problems.

Wendy Wolford, Development Sociology, is the center's new associate director of economic development. Wolford is an example of the interconnected work ACSF faculty fellows do in sustainability. Her research covers the political economy of development, social movements and resistance, agrarian societies, political ecology, land use, land reform, and critical ethnography, all with a regional concentration in Latin America, particularly Brazil. She is the author of a 2010 book on Brazil's Movement of Rural Landless Workers, *This Land is Ours Now: Social Mobilization and the Meanings of Land in Brazil.*

University Photography

// www.acsf.cornell.edu

CNF

Encompassing physical sciences, engineering, and life sciences with a strong interdisciplinary emphasis, the Cornell NanoScale Science and Technology Facility (CNF) supports a broad range of nanoscale science and technology projects.

CNF is a national center that provides state-of-the-art resources and expert staff. CNF holds an annual meeting with research presentations, keynote speakers, poster sessions, and corporate soirees, offering an excellent opportunity for colleagues to learn about the exciting research by CNF users over the year.

To mark its 35th anniversary in 2012, CNF planned a special celebration for July, in lieu of its annual fall meeting. The guest speaker was William Brinkman, director of the Office of Science at the U.S. Department of Energy.

Charles Harrington Photography

// www.cnf.cornell.edu

ISS

The Institute for the Social Sciences (ISS) encourages collaborations among social scientists across disciplinary and institutional boundaries and engages the Cornell community in discussing current topics in the field.

The newest interdisciplinary ISS theme project, *Immigration: Settlement, Integration, and Membership*, expands the theoretical frontier of immigration studies at Cornell. Opportunities for public participation during 2012 included a seminar series and workshops on labor immigration, the Dream Act, second-generation issues, new immigrant destinations, and the trend toward the criminalization of immigration.

University Photography

// www.socialsciences.cornell.edu

SHC

Cornell's Society for the Humanities (SHC) brings distinguished visiting fellows, Cornell faculty, and graduate student fellows together each year to pursue research on an interdisciplinary focal theme. The focal theme for the 2012-2013 academic year will be RISK@Humanities.

Fellows will reflect on how the humanities converse with biological, ecological, economic, and technological approaches to risk. The year will feature a fellowship jointly sponsored by the Society and the Atkinson Center for a Sustainable Future.

SHC is home to the Central New York Humanities Corridor, a cross-disciplinary research collaboration among humanists at Cornell, Syracuse University, and the University of Rochester, funded by the Andrew W. Mellon Foundation.

Renate Ferro

// www.arts.cornell.edu/sochum

Associate director Wendy Wolford

A CNF Poster Session

Project leader Michael Jones-Correa

"Panic Hits Home"

CMM

Research at the Center on the Microenvironment and Metastasis (CMM) aims to unravel cancer's complexity and understand the interaction of mechanical forces and chemical cues in cancer metastasis. The center pursues experimental and theoretical approaches derived from the physical sciences in order to address major questions and barriers in understanding and treating cancer.

Project one, led by Claudia Fischbah-Teschl and Vivek Mittal, integrates physical sciences and cancer biology approaches to enhance understanding of the mechanisms behind tumor vascularization. Project two, led by Cynthia Reinhart-King and Paraskevi Giannakakou, focuses on how chemical and mechanical forces in tumors enable and increase cell migration during metastasis. Project three, led by Michael King and David Nanus, focuses on understanding the fundamental physical mechanisms of circulating tumor cell adhesion to inflamed endothelium under flow.

Frank DiMeo

// www.cmm.cornell.edu

EMC²

The Energy Materials Center at Cornell (EMC²) advances the science of energy conversion and storage. Faculty from chemistry, materials science, chemical engineering, and physics work with postdocs and student researchers to grow materials for new generations of batteries and fuel cells. The center uses new techniques, such as in-situ liquid TEM, to analyze complex oxides.

The U.S. Department of Energy's Office of Basic Energy Sciences supports the core research of EMC². With support from New York State and others, the center works with industrial partners, including General Motors, Subaru, and Primet Precision Materials, to adopt novel materials into advanced energy technologies.

EMC

// www.emc2.cornell.edu

CCMR

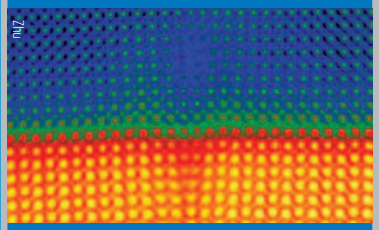
The Cornell Center for Materials Research (CCMR) is a springboard for innovative materials science and engineering research. CCMR Shared Facilities offer world-class materials characterization, analysis, and processing equipment. Electron and optical microscopy, spectroscopy and electronic measurements, and surface analysis and characterization are all available at the center.

CCMR Microscopy Facilities host an annual competition for the best image produced using an electron microscope. In the 2011 competition, Pinshane Huang (advisor David Muller, Applied and Engineering Physics) won the Overall Award for Visual Impact, using the FEI Spirit to produce polycrystalline graphene that resembles an atomic patchwork quilt.

Huang

// www.ccmr.cornell.edu/facilities

First-place winners include Byungki Jung, (advisor Michael Thompson, Materials Science and Engineering); Kaifu Bian (advisor Tobias Hanrath, Chemical Engineering); Ye Zhu (advisor David Muller, Applied and Engineering Physics); and Amy Blakeley (advisor Lara Estroff, Materials Science and Engineering). Recently announced 2012 winners can be found at www.ccmr.cornell.edu/facilities/contestimages/winners12.


Zhu

Project leader Cynthia Reinhart-King

Director Héctor Abruña

Graphene

Strain-induced ferroelectricity and strain relocation

CLASSE Looks Ahead

A Conversation with Ritchie Paterson

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?

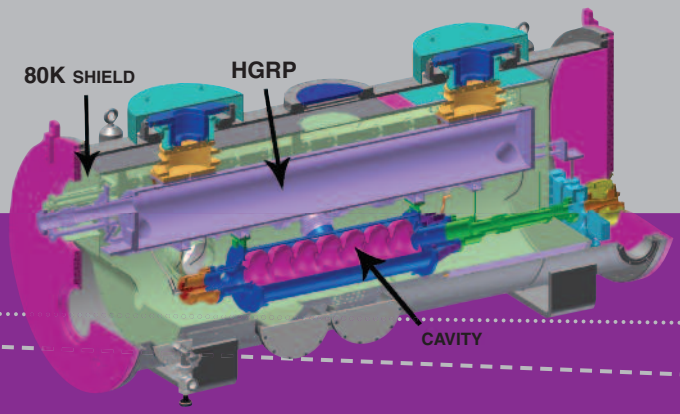
Success in funding follows a solid track record and vision. Cornell has been a leader in accelerator-based sciences for over four decades, consistently building a trail of innovative and daring "firsts." As long as our faculty and students generate and substantiate new ideas, I am confident that CLASSE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