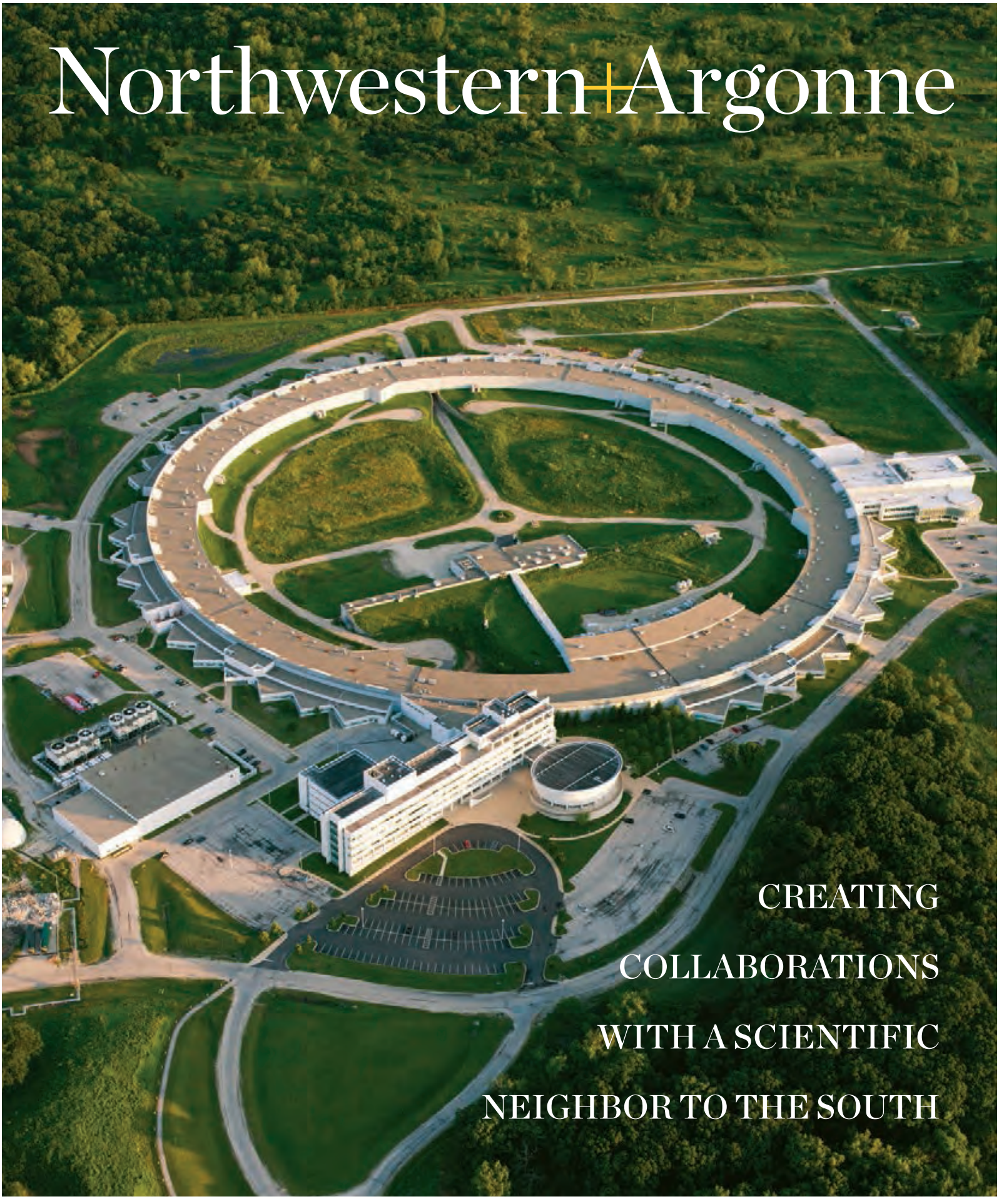
Northwestern+Argonne



CREATING COLLABORATIONS WITH A SCIENTIFIC NEIGHBOR TO THE SOUTH

Each day around 8 a.m., a small group of Northwestern graduate students piles into two cars. They make their way south from campus and drive along the highway, talking about their research, before turning west on Interstate 55. After an hour's drive they pass by the Waterfall Glen Forest Preserve and enter an area that's very different from Northwestern's campus: Argonne National Laboratory, a 1,500-acre complex that houses some of the most high-tech facilities in the world and is one of the nation's oldest and largest science research centers. The students drive across grounds filled with steam pipelines, brick buildings, and the occasional white deer to join their professors—including the more than 40 McCormick faculty members affiliated with Argonne—to conduct research in nearly every engineering area, from civil engineering to materials science.

Earlier this year the two institutions created the Northwestern-Argonne Institute for Science and Engineering, which will expand opportunities for Northwestern students and faculty to perform research at Argonne. The institute will allow for scientist exchanges, joint research projects, and easier access to facilities.

"This institute formalizes a partnership that has been successful for many years," says Julio M. Ottino, dean of McCormick. "It will allow us to bring collaboration to a new level. Strengthening the ties between Argonne and Northwestern will contribute to Chicago's reputation as a leader in science and technology."

The institute builds on current collaborations in fields ranging from solar cell development to high-performance computing. In 2009 the Argonne-Northwestern Solar Energy Research (ANSER) Center was formed to revolutionize conversion of sunlight into electricity and fuels. That center was funded by the US Department of Energy as an Energy Frontier Research Center. McCormick and Argonne have been involved in two other such centers, the Institute for Atom-Efficient Chemical Transformations and the Center for Electrical Energy Storage. In addition, the two institutions already share researchers (they offer a yearly Early Career Investigator Award to promising researchers at Northwestern and Argonne) and frequently hold symposiums where joint researchers present their work. Now they hope to make even more connections.

"One of the great strengths of the national laboratory systems is our ability to develop thoughtful collaborations with our colleagues in academia," says Eric Isaacs, director of Argonne. "This joint initiative will create some great new opportunities for Argonne's scientists and engineers to cross disciplinary lines, join forces with Northwestern researchers, and do the kinds of groundbreaking research that can fuel American innovation and technological competitiveness in this global economy."

The brightest X-ray beam around

Michael Bedzyk was an early beneficiary of the Northwestern–Argonne relationship: when he arrived at the University in 1991 he received a joint appointment with the two institutions. Why did the professor (and now chair) of materials science and engineering want to split his time between opposite ends of Chicago?

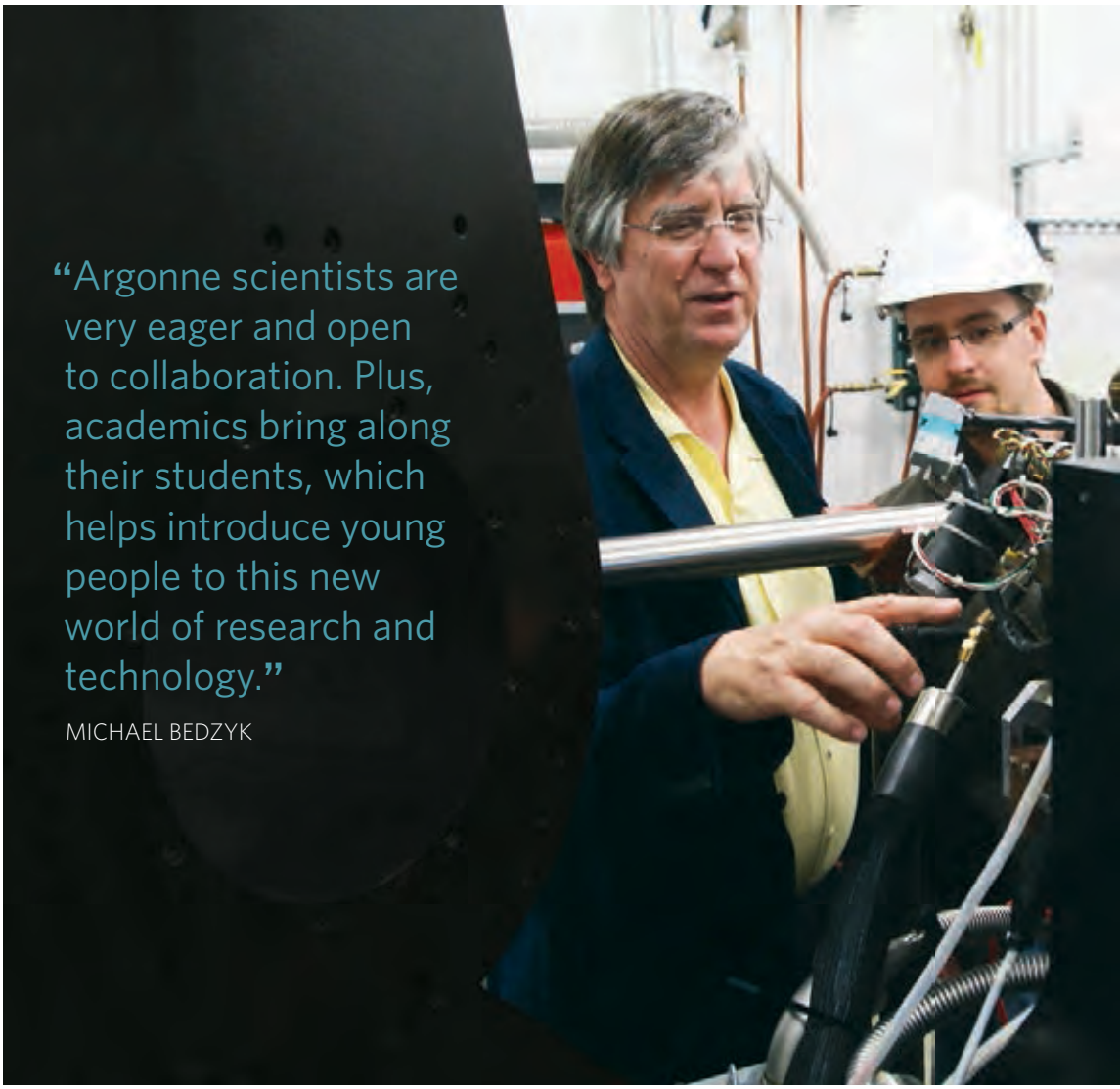
"The Advanced Photon Source," Bedzyk says.

That, for many researchers, is Argonne's main attraction. The APS is the brightest X-ray beam in this hemisphere. It accelerates electron bunches around a one-kilometer ring at close to the speed of light. The electron bunches pass through undulating magnetic fields that produce intense X-ray beams. Scientists and engineers harness those beams to conduct research at the atomic scale. "We are very fortunate at Northwestern to be situated near the highest-intensity X-ray sources available in this hemisphere," Bedzyk says.

When the APS was built, Northwestern joined with DuPont and Dow Chemical Company to build a research facility there that could access a beamline from the source. That beamline has produced a wealth of research for Bedzyk. His first experiment used X-ray reflectivity and standing waves to locate ions at the interfaces between water and mineral surfaces. That research, which Bedzyk still pursues, has implications in understanding how contaminants are transported in groundwater. Bedzyk has also used the beamline to examine ultrathin films and study atomic-scale reactions on their surfaces under different chemical conditions.

"These X-rays have a very high penetration power," Bedzyk says. "They can be used to look at surfaces that are buried underwater and at gas-solid interfaces. There is no other way to look at those buried surfaces under chemical reaction conditions with atomic-scale resolution."

Bedzyk has worked with collaborators to study films that are multiferroic (meaning their properties can be changed by applying an electric current or magnetic field) and could have implications in the electronics industry. He also works with McCormick professors Mark Hersam, Harold Kung, and Chris Wolverton within the Center for Electrical Energy Storage to investigate new anode materials for lithium batteries.



Anodes are the electrodes that collect positive lithium ions and are usually made of graphite. Replacing the graphite with other materials can improve the quality of the battery. Bedzyk's group X-rays the solid-electrolyte interface to understand just how the interactions work. "Argonne has been an extremely valuable resource to our research," he says.

Bedzyk travels to Argonne about once a week and enjoys collaborating within a community outside the University. He and other Northwestern faculty members and graduate students often participate in Argonne's workshops and conferences. "It's a focal point for bringing people together," he says. "Argonne scientists are very talented and open to collaboration. Plus, academics bring along their students, which helps introduce young people to this new world of research and technology."

For Bedzyk's graduate student Martin McBriarty, the APS offered access to specialized equipment for experiments that can be performed at only a few other places in the world. "During the first week of orientation it became very clear that Argonne was an extremely important and unique resource for research at Northwestern," he says. "I chose to work with Professor Bedzyk largely because I wanted to make use of the APS in my own research. Our experiments give us insight into the structure of surfaces and interfaces at the atomic scale, which is increasingly important in fields like catalysis, battery technology, and next-generation electronics. I'm fascinated by this unique view of interesting materials systems in action."

Research, with teaching

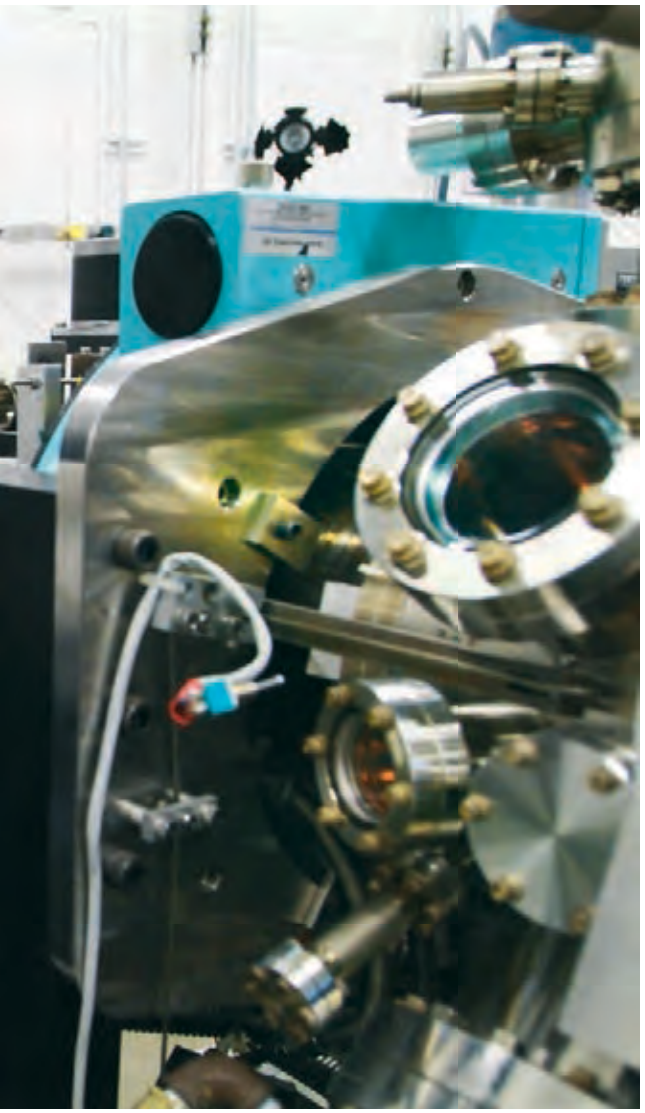
Access to students like McBriarty is what lured Amanda Petford-Long to her joint Northwestern-Argonne appointment. The professor of materials science and engineering arrived at Argonne from the University of Oxford in 2005 and wanted to continue teaching along with research. "I love teaching," she says. "I enjoyed being responsible for students at Oxford, and I didn't want to give up that opportunity."

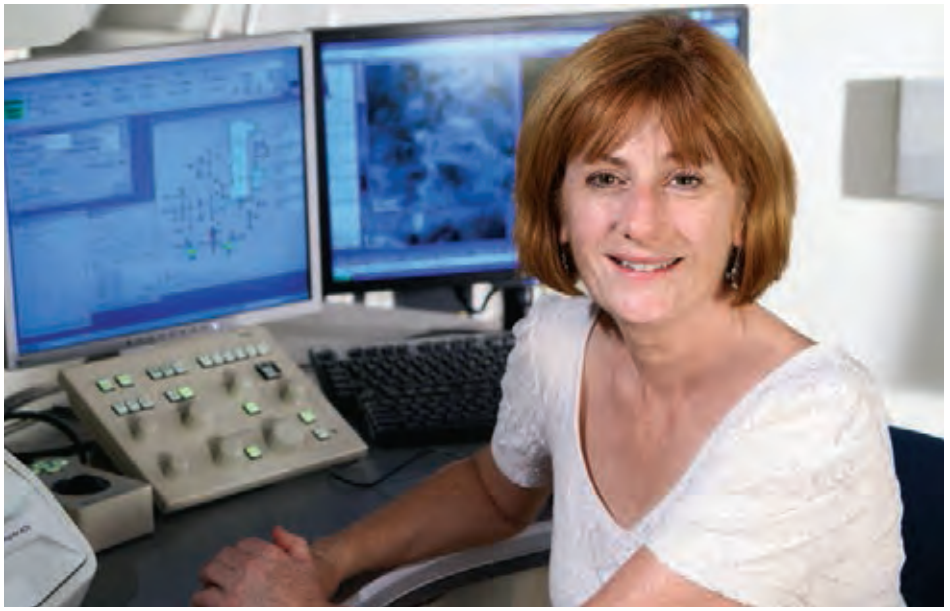
She was an adjunct faculty member at Northwestern before becoming a full professor in 2008. Now she teaches at the University every other year and has a cohort of Northwestern graduate students. "I think it's beneficial for the students because they get access to my research and my group," she says.

Petford-Long directs Argonne's Center for Nanoscale Materials and uses electron microscopy—which illuminates materials at the nanoscale with an electron—to study the behavior of multiferroic films; she applies heat and cold and (like Bedzyk) magnetic and electric fields to see how the materials react. "The kind of research we're doing is very fundamental," she says. "These materials could ultimately be used for computer memory or information storage, but we need to understand how the material behaves."

Petford-Long has had several collaborations with faculty from Northwestern's Department of Materials Science and Engineering, including David Seidman, Walter P. Murphy Professor, and Lincoln Lauhon, associate professor. She is also involved in a collaborative project that uses electron microscopy to examine what happens when glass is heated to create crystallines. After this process is completed, images can be stored in the glass, which, with its high resolution and dynamic range, could be useful in mammogram image plating.

"I really welcome the collaboration," she says. "Argonne has very good scientists and a lot of capabilities and expertise that aren't available at Northwestern. But the collaboration also benefits Argonne enormously. Having high-quality





universities around means we can attract high-quality collaborations and have access to professors and their research capabilities and interests."

Increasing the quality of collaboration

That neatly sums up the goal of the Northwestern-Argonne Institute for Science and Engineering. The partnership's first order of business is identifying liaisons from the two institutions who can help make connections. Then, if all goes as planned, this winter the institute will begin offering minisabbaticals that will allow McCormick professors to take a quarter off from teaching to conduct research and create new relationships at Argonne. (McCormick offers a similar sabbatical program with the University's Feinberg School of Medicine that has borne several new collaborations.) The two institutions also hope to organize more joint conferences and cofund graduate students, an arrangement that would offer more opportunities to Northwestern students while giving Argonne researchers access to young talent.

"Argonne is already connected with the University of Chicago, which manages the laboratory," Ottino says. "With this agreement, we hope to create an axis of cutting-edge research in the Chicago area that includes our strengths in engineering. It will make connections easier and more effective, and everyone will benefit."

M Emily Ayshford

Left: Michael Bedzyk and graduate student Martin McBriarty at Argonne's Advanced Photon Source
Top: The Advanced Photon Source
Above: Amanda Petford-Long