SYNERGY

BECKMAN INSTITUTE FOR ADVANCED SCIENCE AND TECHNOLOGY

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IMAGINING POSSIBILITIES WITHOUT BOUNDARIES 1989-2009 20 BECKMAN INSTITUTE

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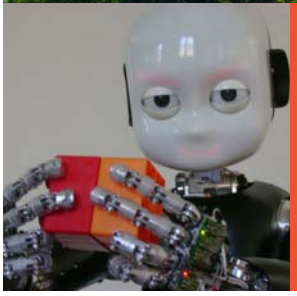

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20th Anniversary Symposium a Time for Reflection and Renewal

Former Directors, Researchers Return for Event; Nobel Laureate Susumu Tonegawa Symposium Keynote Speaker

Images: (left) Aerial view of the Beckman Institute site, 1962. (center) Beckman Institute south walkway, 2008. (right) Arnold Beckman visits the Institute construction site.

The impact of research that has taken place inside the walls of the Beckman Institute over the past 20 years has been felt in the fields of technology, neuroscience, human cognition, and medicine. It has helped to make electronic devices more efficient and medical instruments more effective, improved the quality of life for older adults and the quality of products for manufacturers, and advanced our knowledge of science in a wide variety of the disciplines studied at the University of Illinois.

Research at Beckman has, in short, been as successful as the people who envisioned and funded an interdisciplinary research center at Illinois hoped it would be. What happens in the next twenty years could leave a larger footprint in the world of science.

Paul Braun has been at Beckman as a postdoctoral researcher or faculty member for 15 of the Institute's 20 years and is co-chair of the "Visions for the Future" session of the Beckman Institute's 20th Anniversary Symposium, set for Oct. 5-7. Braun thinks that future depends on the Institute being as leading-edge in the next 20 years in the way it does science as it was 20 years ago when Beckman helped pioneer the concept of interdisciplinary research.

"The Institute is a really interesting place to not only do new science but to think about new ways to do science," Braun said. "In the next 20 years there is significant potential that the Institute can be a leader in doing that."

Braun said the formation of three research themes in 1994 helped solidify the concept of interdisciplinary research into something tangible. After a few years, those broad themes started to include results produced by researchers from diverse disciplines working together in new ways addressing new topics.

"In some sense I think the Institute can declare victory," Braun said. "Which leads me to think about well, what's next? The Institute could continue to do this kind of work very well and probably will. But this may also be an opportunity to say 'can we at the Institute lead the science on how to do science?'"

The Institute's future directions, as well as its research history and current efforts will be explored during the Beckman Institute's 20th Anniversary Symposium. The Symposium will be the scientific bookend to a nearly year-long celebration of the people and the science that have made for two decades of successful interdisciplinary research at the Beckman Institute.

Twenty years may seem like a long time in the nanosecond world of science we live in today. But for people like Karl Hess who were part of the founding of the Beckman Institute, the events surrounding the building and the opening of the Beckman Institute are still vivid in his mind.

"I still can see the huge hole in the ground that is now the basement of the building and I remember the improvised on-site office that Ted Brown used to direct the project," Hess said. "I remember the progress reports to Dr.

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Aerial view of the Beckman Institute, 1995.

Beckman and his kindness and, of course, the big opening ceremony with presentations in the Krannert center and a dinner in the atrium of the Institute."

That dinner and other opening events were held in the first week of April 1989, less than three years after the announcement of Arnold and Mabel Beckman's $40M gift toward building of the Beckman Institute at the University of Illinois. In April of this year a celebratory event was held to celebrate the 20th anniversary of the official opening. In October the scientific research that lies at the heart of the Beckman mission will be the focus, with the symposium featuring world-renowned scientists from the Institute and across the United States.

It will bring together many of the people who helped make groundbreaking research happen at Beckman over the past 20 years, including former and present Beckman researchers, all three of the Institute's former Directors, as well as a Nobel Laureate for the keynote address.

"The participation in this event of so many of the people who have helped make or are still helping to make the Beckman Institute what it is testifies to the value of the work that goes on here," said Interim Institute Director Tamer Başar.

The list of keynote speakers reflects the truly interdisciplinary nature of research at the Beckman Institute, as they come from varied disciplines in the biological and physical sciences.

The opening keynote lecture on Monday, Oct. 5, will be given by Susumu Tonegawa, who won the Nobel Prize for Physiology or Medicine in 1987 for his discovery of the genetic principle for generation of antibody diversity. Tonegawa is a leading researcher in the genetic, cellular, and neural system mechanisms that underlie cognitive functions.

The Institute could continue to do this kind of work very well and probably will. But this may also be an opportunity to say 'can we at the Institute lead the science on how to do science?'"

Beckman faculty member Paul Braun on the Beckman Institute's 20th Anniversary Symposium

Tuesday's keynote speaker is Dr. Thomas R. Insel, Director of the National Institute of Mental Health (NIMH). Insel has been NIMH Director since 2002, a position where he oversees a budget of $1.3B per year. He has served as a professor of psychiatry and director of the Center for Behavioral Neuroscience at Emory University. Insel is a leading researcher in the area of obsessive-compulsive disorder.

The keynote address for Wednesday's final day of the symposium will be delivered by Charles M. Lieber, the Mark Hyman Professor of Chemistry at Harvard University. Lieber's research at Harvard takes an interdisciplinary approach to nanoscale science and technology topics, using what he describes as a "bottom-up paradigm" to assemble "virtually any kind of device or functional system, ranging from ultra-sensitive medical sensors to powerful nanocomputers."

A reception will be held on Monday, followed by welcoming remarks by Başar and Tonegawa's opening keynote lecture. Tuesday's events will feature Insel's talk, followed by a retrospective with Beckman Institute Founding Director Ted Brown and his successors, Jiri Jonas and Pierre Wiltzius. The afternoon session will provide a look back at research milestones and reflections from Beckman alumni such as Hess.

Wednesday's Symposium will be led off by Lieber's address, then feature perspectives from each of the four research themes at the Institute. It will be followed by "Visions for the Future" talks by Beckman researchers John Rogers, Todd Coleman, and Gene Robinson.

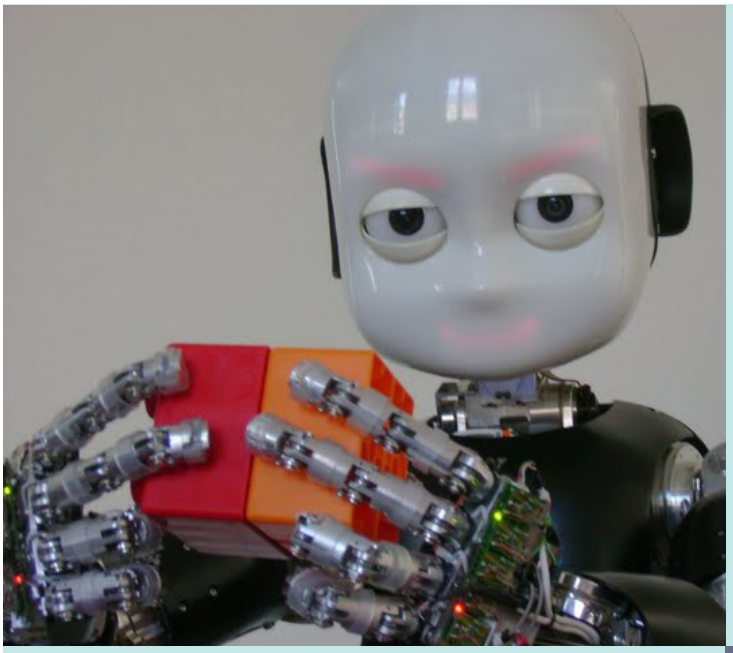
"There is great potential for the Institute," Braun said. "The key is to not let this become stale in the sense that we still do this work better than other people. But the rest of the world is realizing that we have the right model. Now is the time for us to do the next thing. Hopefully that will be some of the discussions that come up during the "Visions for the Future."

Hess will be speaking about research milestones at the Institute. He said understanding Beckman's past is essential for its future success.

"The history of the Institute contains the key for its continual renewal," he said.

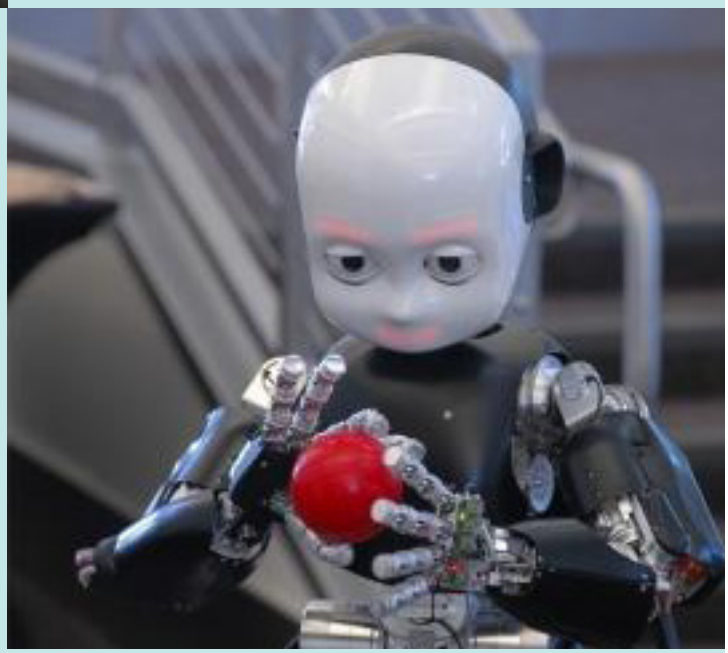
Braun said looking forward is also essential.

"The Institute is a great place to try new ways to do science," Braun said. "I don't know that I have the answer (as to how) but this is the perfect laboratory for doing that."



Levinson Group Only U.S. Lab Awarded Highly Advanced iCub Robot

Congratulations! A New Addition to the Beckman Family



The "adoption" process is almost complete, "parenting" classes have been taken and now all that is left is to wait for the new addition to the "family" to arrive from Europe. Adoption, parenting, and family are all analogies in the case of the new addition because it is built of metal and plastic but made to act, respond, and learn like a human child.

Sometime this fall the Beckman Institute will become home to a unique new student from Europe – the only one of its kind in the United States – in the form of a highly-advanced humanoid robot. If all goes as planned, in late October an "iCub" robot from a European "robot consortium" will go through the final phase of its adoption process and join Artificial Intelligence group member

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Stephen Levinson's Language Acquisition and Robotics Laboratory.

The iCub will learn about language as a child does: through interactions with the world around it, by learning about its own body movements and motor skills, and by absorbing knowledge from its "parent-teachers", aka the members of Levinson's lab.

The iCub, as described by the RobotCub project that created it, is a "full-fledged humanoid robot 'child' with sophisticated motor skills and several sources of sensory information." Levinson's lab was one of seven research entities awarded a free iCub – estimated to cost about €200,000 – in an open call competition put out by the RobotCub project.

The robot is so special in its capabilities that the Department of Defense wanted one to share among its research groups, but its proposal wasn't accepted. The proposal from the Language Acquisition and Robotics Laboratory was accepted, thanks to Levinson's area of research.

"People all over the world are clamoring to get these robots," Levinson said. "The fact that we're getting one is amazing."

Not only will Levinson's lab have the only iCub in the United States and North America, it will also be the only research group in the world using one to study language acquisition. That fact, as much as anything, is why the lab's proposal was selected to receive one of the humanoid robots.

"That is the thing that really attracted them," Levinson said. "We were very specific about language acquisition."

When it arrives, this new addition to Levinson's robot family will mark a huge leap up the robotics evolutionary ladder for the lab. The lab's current lineup of three robots, known as Trilobots, feature wheels, sensors, and platforms for electronic equipment, but have limitations on their sensing and learning capabilities. The concept behind the iCub is to use its human-like motor skills, physical and sensing capabilities, and highly advanced open source software programming to recreate the learning processes of young children.

"The idea is that the richer the sensory motor periphery of the robot, the more elaborate learning that can take place," Levinson said. "We simply want to experiment on that basis."

Levinson said the new robot can reach, grasp, feel, and look with enhanced sensing abilities that most other robots, including his lab's trio of Trilobots, just don't possess. The new robot will not only be able to pick up a ball and learn its meaning, but also learn to distinguish properties such as whether the ball is hard or soft and rough or smooth, as a child does.

"The visual sense, the enhanced proprioception of the hands and arms, and even the legs, all of this provides a much richer input from which we hope we can learn a great deal more," Levinson said. "Therefore there is much more information coming in and that allows it to build a more elaborate mental model of the world."

> I CAN HONESTLY SAY THAT THIS IS THE MOST EXCITING EVENT IN MY ENTIRE RESEARCH CAREER.
>
> – STEPHEN LEVINSON

The RobotCub project is associated with the second European Network for the Advancement of Artificial Cognitive systems, Interaction and Robotics, or EUCogII for short, and funded by the European Commission. EUCogII is a European network for researchers in artificial cognitive systems and related areas that funds educational outreach programs.

The mission of RobotCub, which bills itself as an international project on humanoid cognitive systems, from its beginning in 2004 was to create a robot that functions as closely as possible to a human child in order to advance our understanding of how it is humans learn. The RobotCub project's stated goal is to develop a cognitive humanoid robot that is an "open-systems research platform for enactive cognition" toward promoting and enhancing research.

Toward that goal, robots have been adopted into labs across Europe to advance research in areas of artificial cognitive systems, cognitive neuroscience, and developmental psychology. The RobotCub project (**http://www.robotcub.org**) put out an open call in 2007. Levinson met David Vernon, then head EUCogII, at a conference and after hearing about his work on robotics and language acquisition, Vernon suggested he send in a proposal.

Giorgio Metta, an Assistant Professor at the University of Genoa and member of RobotCub, said the seven winners of the open call prize were given an iCub free of charge for 99 years to pursue research.

"Stephen's proposal was chosen by a panel of six experts as worth receiving one of the iCubs," Metta said. "We will be delivering the iCub before the end of 2009, as soon as we can in fact."

Learning how to operate and program an iCub to get the most out of it is not easy. So graduate students Lydia Majure and Logan Niehaus of Levinson's lab got the enviable assignment of spending part of their summer on the Italian Riviera – learning the ways of a humanoid robot by day and getting their fill of squid and octopus at night.

The robot consortium, consisting of several European universities and laboratories including the Italian Institute of Technology and the Laboratory for Integrated Advanced Robotics (LIRA) at the University of Genoa, sponsors the school, which trains attendees on operating and programming the iCub robot. The robot consortium provided the robots, the training, and even the hotel and meals in the fishing town of Sestri Levante on the Italian Riviera where the school was held.

"Because of where we were it was seafood every night," Niehaus said. "I had never had squid or octopus before and we were having that close to every other day."

Majure loved the fare.

"I was thrilled. I love consuming cephalopods, especially when they're fried," she said. "Logan was complaining by the end about wanting some chicken, though. To each his own I suppose."

But even the delicious sea creatures took a back seat for Majure to her first encounter with the robot.

"The most exciting part of the school was actually seeing the robot for the first time," Majure said.

The iCub robot is a metallic and plastic version of a human toddler, with anthropomorphically correct metallic body parts covered by a plastic "skin". It can sit and crawl, has 53 degrees of freedom (compared to 20 degrees for the lab's

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The most exciting part of the school was actually seeing the robot for the first time.

– Lydia Majure

current robots) in its articulated hands for manipulating objects and gesturing. It has approximately the same dimensions as a two-and-a-half year-old child (around three feet tall and weighing approximately 30 lbs.) and its eyes, ears, and hands have sensors that provide sight, sound, and touch.

The training school consisted of working on project development for the robot's software, and included writing some software code that could be useful later on when the robot arrives and the Levinson lab starts doing experiments.

"They want to make a system that is neurologically and psychologically feasible," Niehaus said of the RobotCub project. "Over the past four years they have slowly built this up and revamped it. We put a small piece in that is part of a larger project.

"We learned how to program for this robot system, which actually turned out to be extremely simple. We can focus on research and not writing software, at least not worrying about the nuts and bolts of programming this robot."

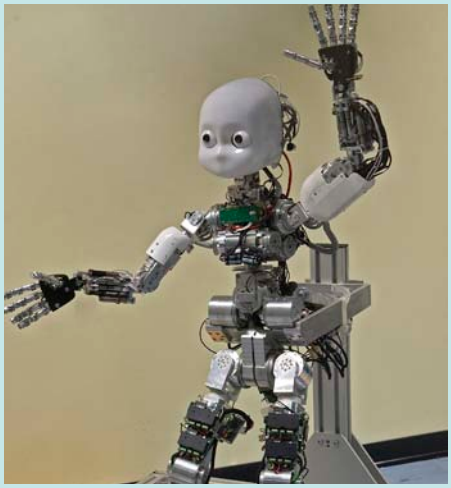
Majure said the training they got in Italy will allow the lab to start taking advantage of the robot's capabilities almost as soon as it is delivered.

"It was really valuable for learning how to use the robot and the associated software interfaces," she said. "That experience probably saved us a ton of time in learning the basics of the platform. Now, when the robot arrives this fall, I'm hoping that we can get straight to work on our research."

Majure said that the robot's motor skills and sensory capabilities will allow the lab to explore new lines of research.

"There are many new capabilities that this robot has which will increase our ability to research cognition," she said. "For example, due to being able to move its head and track objects, we can build multisensory models of its immediate surroundings. We can investigate motor babbling (learning kinematics by random exploration of motion range) and learning by object manipulation."

Levinson said funding for the trip came from Illinois graduate Bruce Wonnacott and his venture capital fund. Two more students from the lab will go to Italy in October. Levinson was hoping to have the robot delivered for his Director's Seminar talk discussing the new addition on Sept. 16, or by the Beckman Institute 20th Anniversary Symposium Oct. 5-7.



"What Giorgio has told me repeatedly is that they can't be rushed," Levinson said. "They've got to do the assembly carefully and they've got to test it."

Once the iCub is delivered and gets used to its new surroundings at Beckman, experiments will begin.

"This is important and should be emphasized: we are not going to program the robot to do anything. We're going to program it to learn to do things," Levinson said. "What we're interested in doing is to understand how the brain implements the mind and how the mind controls activities and how those activities can be made purposeful. We are not trying to do any specific thing."

One thing the lab will try to do is to program it to learn how to walk, something none of the labs around the world have tried to do. Currently an iCub can stand with a framework attached to prevent it from falling; programming one to learn how to walk was a task the robot consortium asked of Levinson's lab.

"We made a commitment to EU cognition that we were going to try, if possible, to get the robot to learn how to walk," Levinson said. "I know the robot hasn't learned to walk but I don't think anybody has even written a program to make it walk. That is one thing that we have not done before but we will try to do.

"It is going to do many things, all of which merge together with the common goal of language acquisition."

Even the task of programming an iCub to learn how to walk has ramifications for language acquisition in Levinson's lab.

"We're going to try and do a complete sensory motor integration so that even things like walking will have a great deal to do with language," Levinson said. "Walking is a form of spatial reasoning and spatial reasoning is an important underlying principle of natural language.

"Walking is a goal in the sense that people walk so it would be nice if the robot walked. But what we're really exploring is the adaptive control mechanism that would allow stable walking and ultimately allow us to develop a sense of spatial reasoning from that. It is this basic underlying theory that we are trying to develop."

Levinson has been engaged in research, either in industry at Bell Labs, or at the University of Illinois, for more than 30 years.

"I can honestly say that this is the most exciting event in my entire research career," he said. "Unqualified, I can say that it is. And I've been at it for awhile."

This is important and should be emphasized: we are not going to program the robot to do anything. We're going to program it to *learn* to do things.

– Stephen Levinson

Delicate Operation

Installation of $3.2M Magnet Successful Milestone in Ongoing Facilities Switch

The crane operator used careful precision to avoid hitting the emerald glass bay windows on the north side of the Beckman Institute when delivering the 3T whole body magnet in July 2009.

Tracey Wszalek and Mike Smith stood on the edges of the ground-level opening to the Beckman Institute basement watching as a skilled crane operator cautiously lowered a brand new $3.2M, 14-ton magnetic resonance imaging (MRI) machine into the concrete pit with just a foot or two to spare on each of the four sides. With the crane coming perilously close to the emerald green bay windows on the Institute's north side, the magnet was lowered down onto stacks of plastic and wood pallets in the basement, from where it was eventually moved into its location in the new Beckman basement facilities for the Institute's Biomedical Imaging Center (BIC).

For Wszalek, Associate Director of BIC, and Smith, Associate Director for Operations at the Beckman Institute, the installation of the new magnet marked yet another milestone in the more than year long switch of BIC's facilities with those of Beckman's Illinois Simulator Laboratory. And another success as the newest addition to the BIC MRI lineup, a whole-body 3T MRI scanner from Siemens called the MAGNETOM Trio, was installed on July 8th and ramped up and running smoothly a couple of days later.

For their parts, Smith and Wszalek said they weren't worried as the expensive new magnet was moved from the truck to the basement opening and into the pit. For one reason, Beckman didn't take possession until it was installed and working properly. Secondly, both were confident in the people and planning that were integral to the operation.

"It was terribly exciting," Wszalek said of the installation of the new magnet. "It is amazing how quickly you can become attached to some hunk of metal, but I think it is because of the possibilities it represents. Then you marvel at the coming together of so many trades and disciplines to make something happen. I was confident that Mike had the right people."

"If you come up with a sound plan and you have the right crew of people to do it, and you put the right team together and you manage them and respect their opinions, you really don't have a lot to fear," Smith said.

The successful installation was just one of many moves over the past year as the BIC facility is being relocated from its original building on the south campus into the Beckman Institute and the Illinois Simulator Laboratory (ISL) is being moved into the former BIC building.

Much of the complicated switch has been accomplished but there is still more work to do, including moving the ISL's driving simulator from the basement into the south campus building. Moving the driving simulator out will allow BIC's 3T head-scanner magnet to be moved into the basement (planned for Oct. 10th), marking the final step in the operation. Installing and ramping up the state-of-the-art Siemens Trio magnet was a milestone indicating the process is nearing completion.

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Smith said the magnet was shipped by air from Germany to Chicago in a trailer truck that also contained its accompanying pieces. It was moved into place July 8th, with a cloudburst delaying things for an hour or so. Just as workers were attaching the crane cables to the magnet rain forced them to re-cover the magnet with the accordion-like shell of the trailer until the storm passed.

Once the skies cleared and the magnet was lowered into the basement, it was moved from the bottom of the pit to the specially-designed room in a process called "cribbing" that involved using plastic crates and wooden beams and boards for support, and hydraulic jacks combined with old-fashioned manpower to muscle the 28,000-pound machine into place.

> It's amazing to see it sitting there running. All the prep work was worth it. The machine is providing *fabulous* images and the site was prepared phenomenally well.
>
> – Tracey Wszalek, BIC Associate Director

Special radio frequency (RF) shielded rooms were built for the incoming magnets to ensure safety and prevent vibration effects from the instruments. The new magnet was ramped up and running a few days after its installation, followed by testing and training procedures.

BIC research scientist Harish Sharma and Beckman Institute faculty member and MRI researcher Brad Sutton checked out the new machine in a process called acceptance testing. In August BIC technicians who will be operating the machine were given training by Siemens personnel and it was tested with human subjects.

Wszalek expects it to be ready for experiments by the first week of October. As with the installation, the performance of the new magnet so far has been flawless.

The new 3T whole-body scanner sits installed and ready for ramping up on July 13, 2009.

"It's incredibly complex and had to be orchestrated down to the minute," she said. "It's amazing to see it sitting there running. All the prep work was worth it. The machine is providing *fabulous* images and the site was prepared phenomenally well."

Among its many capabilities, the Trio can do the same type of brain imaging as the Allegra headscanner but Wszalek said researchers who have been using the Allegra will continue to do so for their current projects and then switch to the Trio for new ventures. The Trio will not only offer more comprehensive imaging possibilities than the Allegra but it also features wireless sensors for monitoring pulse and oxygenation, heart rate, and respiration that will make for better imaging for some projects.

"You don't introduce current or any other electrical noise into your system," Wszalek said of the wireless sensors. "We hadn't used that on any other system. It is important for some folks because they will use that information as they design their experiments, say if motion is an issue."

Within 24 hours of the magnet being installed, the two wall holes it was moved through were each enclosed with RF-shield walls, surrounded by gypsum walls on either side. In addition to the RF-shielded room and a console room for the Trio, the renovation work included creating a reception area, a lockerroom and rooms for test subject preparation.

Those were all part of the original plans for putting BIC's facilities into the basement. However, because of rapidly increasing interest in using those facilities and because of several successful and pending grants, more plans involving BIC are on the table. Grant proposals for the acquisition of an animal magnet are pending, while BIC's staff and its space within the Institute are growing.

Plans are being made for more space for BIC in room 1215. BIC's mock magnets, which familiarize test subjects with the actual magnets, were located in room 1215B as part of the move. In order to create room for BIC's growing staff, plans are under way to turn 1215A, a conference room, into space for personnel and to create offices for BIC staff along the south side of Beckman next to the rotunda.

Hopefully, that project will go as smoothly as the switch of BIC and ISL has gone.

"I'm very happy," Smith said. "Everything worked exactly as I thought it would. We're either ahead of schedule or on schedule."

SYNERGY is a publication of the External Relations office of the Beckman Institute for Advanced Science and Technology at the University of Illinois at Urbana-Champaign. Each issue will spotlight the people and science that make the Institute one of the premier facilities for interdisciplinary research in the world.

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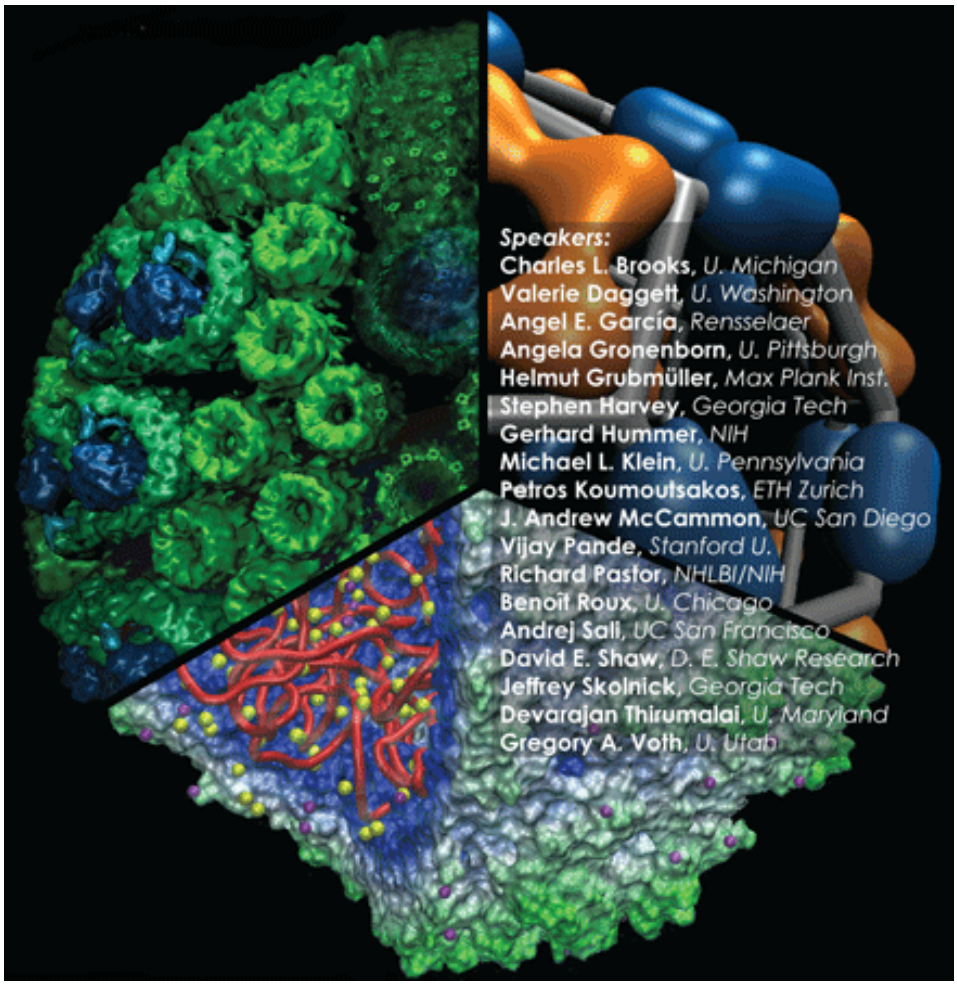
TCB Celebrates 20 years as a Unique Science Resource



As the Beckman Institute celebrates 20 years of leading the way in doing interdisciplinary research, one of its key groups is marking a similar milestone. Twenty years ago, the Theoretical and Computational Biophysics group (TCB) was funded as a National Institutes of Health Resource for Macromolecular Modeling and Bioinformatics.

Klaus Schulten

Led by Professor Klaus Schulten, TCB has been the gold standard when it comes to doing computational modeling of biology, providing cutting-edge visualizations of molecular scale biological structures and processes since 1989. TCB has developed and refined software programs such as VMD and NAMD that have over the years allowed researchers worldwide to perform molecular dynamics simulations with ever-greater detail and accuracy.

To celebrate their two decades of success and look ahead to the future, TCB will be playing host to a 20th anniversary symposium titled "Computational Biology of the Cell - The Next Decade." The symposium, set for Sept. 21-23 at the Beckman Institute, will feature some of the most prominent scientists in the field.

The TCB group describes this symposium as an opportunity for people to discuss, and take advantage of, advancements such as petascale computing and new algorithms for even greater breakthroughs in computational modeling in the future.

The introduction to the symposium states: "We need to prepare ourselves for the challenges and opportunities of the next decade. This one-of-a-kind symposium 'Computational Biology - The Next Decade' will give us the freedom to explore what's ahead."

More than 20 speakers are slated to talk at the three-day symposium.

ALUMNI PROFILE

(William Greenough) basically taught me everything I know about neuroplasticity in the brain. All the techniques that are in my lab now I learned here.

– Jeffrey Kleim

Jeffrey Kleim came to the University of Illinois and the Beckman Institute for one reason: William Greenough.

That's because Greenough, Co-chair of Beckman's Biological Intelligence research theme, was, Kleim said, "the guru of plasticity."

Kleim is currently an Associate Professor of Neuroscience at the University of Florida. He earned his master's and Ph.D. at Illinois, working for almost five years in the Greenough Laboratory located in the Beckman Institute. He says he learned about everything from neuroscience topics such as brain plasticity to using experimental tools like electron microscopy from Greenough.

"He basically taught me everything I know about neuroplasticity in the brain," Kleim said. "All the techniques that are in my lab now I learned here."

Kleim said after that earning his undergraduate degree he applied to the University of Illinois, but his main goal was to join the Greenough Lab. Getting the invitation to join Greenough's lab was, Kleim said, "like getting called up to the big leagues.

"If you are in the minors and you get called up to pitch, it was like that. It was very exciting. He was a world-famous guy so to get accepted to work in his lab was just remarkable. He also, simply put, is just a very nice guy."

Kleim returned to Illinois in June for the Greenough Symposium and events related to Greenough's retirement as a professor. It was a time to honor his mentor's contributions as a teacher and researcher, but also to remember his time at Beckman working in the Greenough Lab in the mid-1990s.

"The group that I was here with was a lot of fun," Kleim said during an interview at Beckman. "We worked hard and we played hard. We would work here till midnight every night and we would go to this bar down the street and have last call and then go home and get up and do it all over again. We did that for *years*. I walked in the bar last night for the first time in 10 years and the bartender remembered me. We used to sit around and drink beer and talk science. Science was work and it was fun. It was just a remarkable time."

The reason Kleim came to Illinois and Beckman and the reason he returned for the symposium was because of his regard for Greenough both personally and professionally. Those feelings haven't changed in the decade since he left.

"The thing about Bill is he's not just a great mentor but he would also attract all these incredibly brilliant people, so you found yourself in this environment that he created that was just like a scientific Disneyland," Kleim said. "It was unbelievable that I got to work here, and I knew when I left that I probably would never have that kind of experience again. It was that good."

The experience laid the foundation for Kleim's current research.

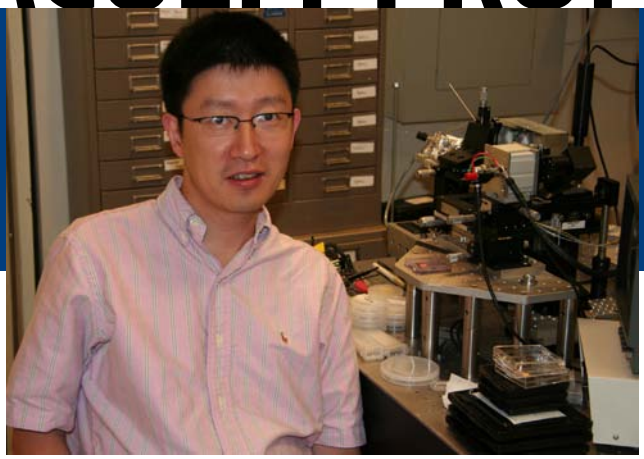
"All of my work in graduate school was about how motor learning in an intact nervous system is affected by the way that neurons were connected, looking at plasticity and neural connections," he said. "I spent most of my graduate career looking at plasticity within motor brain areas and when I left I went on to try and apply that plasticity to a damaged brain, to find out how relearning might be accomplished by the same neuromechanisms that account for learning in a normal brain."

At Florida Kleim's research includes working to develop therapies that optimize plasticity toward enhancing recovery after stroke. The goal of the therapies, which include drugs and electrical stimulation, is to induce the type of mechanisms that lead to learning in a normal brain to have the same effect on an injured brain.

Kleim has written a book, "Neuroplasticity and Rehabilitation," that is scheduled to be published in the fall of 2009. It will serve as a tool for clinicians working to rehabilitate patients with brain injuries.

"It's all based on the kinds of things that I learned when I was here and in my own research," Kleim said. "It's applying what Bill has been working on for the last 40 to 50 years to a medical problem."

FACULTY PROFILE



We have a long-term dream of reinventing the optical microscope in order to see things that are much smaller than what we can image right now.
— Nicholas Fang

Nicholas Fang is part of a small group of researchers from around the world who are dramatically expanding the power of light microscopes through a technique called "superlensing."

"We have a long-term dream of reinventing the optical microscope in order to see things that are much smaller than what we can image right now," said Fang, a member of the 3-D Micro- and Nanosystems group at the Beckman Institute.

The importance of this research area and of Fang's position as a leader in it was underscored last year when he was chosen as a *Technology Review* 2008 Young Innovator. This honor goes to young scientists who are changing the world though their innovations.

For Fang, the honor was for his development of the first optical "superlens" that patterns nanoscale silver gratings on microscope parts for high-resolution imaging of nanoscale structures like the organelles of a cell. This technique allows the capture of visible light waves from objects smaller than the wavelength of light (approximately 400 nanometers) – something that isn't possible with optical microscopes without using what is called a tag to illuminate the sample.

Fang said superlensing has resolved structures on a scale that is 10 times higher than the best light microscopes and someday, he expects, it will allow a view of cellular dynamics at a scale of 15 nanometers. This would provide scientists studying topics like cancer growth for the first time a window into such processes as they occur in real time without using a tag.

"We thought it was not even possible to see something below 400 nanometers, basically the comparable dimensions to the organelles in cells," Fang said. "We started to realize that it is possible to use novel materials, metamaterials (like silver gratings), to excite a unique surface wave. With this surface wave, and using a thin film of silver, we may be able to focus it down to 30 nanometers and below. We want to make this as convenient as the optical microscope but offer 10 times better resolution."

Fang said there are between 10 to 20 research groups around the world working on advancing light microscopy through similar techniques in order to give scientists unparalleled visual access to the biological world at the nanoscale.

"We are all pursuing this dream but in different manners," he said. "We are not all using metamaterials but our goal is the same: we want to see something in real-time without using very expensive equipment but still offer more insight about life science."

The *Technology Review* award wasn't Fang's only honor coveted by young American scientists. He also earned an NSF Early Career Award for his development of a nanoimprinting technology used for nanofabrication. Fang also has applied superlensing techniques to acoustics for improving ultrasound imaging and toward applications such as structural testing, medical screening, and so-called "cloaking" technology that could be used in submarines.

For such a young researcher, Fang has already staked out some high-profile turf. He's done so while working in areas he never expected to, like optics and acoustics, when he was earning physics degrees back in his hometown of Nanjing, China.

"They were so well-developed I thought would not even touch them," he said. "My instructors in optics class asked once who would pursue a career in optics and no one raised their hand because we thought everything had been taught."

Fang's parents are both engineers in China but it wasn't until he came to the United States that he decided to turn his research that way, earning a Ph.D. in mechanical engineering from UCLA.

"Originally physics textbooks only considered those materials systems as theoretical," Fang said. "But now because of the advancement of technology we have much better tools, better capabilities to bring the imagined from the textbook to something engineered and practical."

Despite his prestigious early career honors, Fang isn't slowing down in his quest to turn the theoretical into the practical. He is currently embarking on a collaboration with Beckman colleague Rohit Bhargava in the area of tissue engineering. They are seeking to engineer artificial cancer models – Fang calls it "cancer in a test tube" – that would mimic the proliferation of cancer cells in tissue. In this collaboration, as with the superlensing projects, Fang's goal is to provide a clearer picture of how the world works at the smallest scales.

"It has to mimic, to the maximum extent, a cellular environment," Fang said. "My philosophy is rather simple: we want to simplify this picture of how cancer develops."

HONORS & AWARDS

Boppart Named Fellow of SPIE

Beckman Institute faculty member Stephen Boppart has been chosen as a Fellow of the SPIE - The International Society for Optical Engineering. Boppart was one of 59 SPIE members honored with the distinction of Fellow for what the SPIE says is the Fellows' "outstanding contributions and service to the international optics community." Boppart is a Co-chair of the Integrative Imaging research at the Beckman Institute and the lead person for the campus-wide Imaging Initiative. The SPIE Web site says it is "an international society advancing an interdisciplinary approach to the science and application of light." Boppart's research focus is on biophotonics and optical imaging, with clinical research in novel medical technologies, including using optical coherence tomography for future medical applications.

Beckman Faculty Members Awarded CAS Professorships

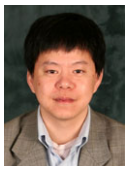
Gillette

Robinson

Beckman Institute faculty members Martha Gillette and Gene Robinson have been awarded Center for Advanced Study (CAS) Professorships pending approval by the Board of Trustees. Gillette and Robinson are both members of the NeuroTech group at the Institute. The mission of CAS, according to its Web site, is to bring together "scholars from diverse disciplines and backgrounds, encouraging and rewarding excellence in all areas of academic inquiry."The CAS offers University of Illinois faculty a chance to take time off to pursue research or creative projects, and the opportunity to help shape campus research programs by advising campus leaders on topics.

Hernando Wins ISMRM Rabi Award

Diego Hernando from the Bioimaging Science and Technology group at Beckman has won the prestigious Isidor I. Rabi Award from the International Society of Magnetic Resonance in Medicine (ISMRM). Hernando won the award for his paper "Robust Water/Fat Separation in the Presence of Large Field Inhomogeneities Using a Graph Cut Algorithm" following a competition that culminated with a poster and oral presentation at the 17th Annual Scientific Meeting of the ISMRM held in Hawaii in April. Hernando is a graduate student working on his Ph.D. in electrical engineering at the University of Illinois. The award named after Nobel Laureate Isidor I. Rabi and recognizes achievements in basic research in magnetic resonance, especially those involving new technical developments. Co-authors of the paper along with Hernando are Beckman faculty member Zhi-Pei Liang, fellow Liang research group member Justin Haldar, and Dr. Peter Kellman, staff scientist at the National Institutes of Health.



Wang wins NSF Early Career Award

Yingxiao (Peter) Wang of Beckman's Bioimaging Science and Technology group has been awarded a National Science Foundation Early Career Award grant. Wang's one-year grant is for the development of a molecular stress biosensor for studying mechanotransduction, the cellular process that converts mechanical signals into biochemical responses. Wang is an assistant professor in the Department of Bioengineering at the University of Illinois.

Leckband Elected Fellow of American Chemical Society

The American Chemical Society's first class of fellows includes four University of Illinois faculty members, including Beckman Institute researcher Deborah Leckband, a member of the 3-D Micro- and Nanosystems group. Leckband's research involves topics such as molecular force measurements, biological interactions, bio-adhesion, and interfacial phenomena in biology.

Voss Wins Doolen Scholarship

Michelle Voss, a member of the Human Perception and Performance Laboratory at the Beckman Institute, won a Paul D. Doolen graduate scholarship for the study of aging. Voss, who is a Beckman Graduate Fellow, will receive a $5,000 award to continue her studies in the area of aging.

Trio of Beckman Researchers Earn HP Labs Award

Ahuja

Huang

Han

Three Beckman Institute researchers were chosen for awards as part of the HP 2009 HP Labs Innovation Research Program. Earning awards were Narendra Ahuja of the Artificial Intelligence group, Jiawei Han and Thomas Huang of the Image Formation and Processing group. They were chosen as part of a group of 60 professors who will take part in the HP program, which is designed to create opportunities for colleges, universities, and research institutes around the world to conduct breakthrough collaborative research with HP. The University of Illinois will collaborate with HP Labs on a research initiative focused on data mining and multidimensional text database analysis technology.

Beckman Well-represented at Lemelson Prize

The Beckman Institute was well-represented at the 2009 Lemelson-Illinois Student Prize awards with a graduate student among the finalists and Beckman faculty among the advisers for the student finalists, including the winner. John Wright was the winner of the 2009 Lemelson-Illinois Student Prize, given to outstanding student inventors at the University of Illinois. Wright's advisers are Beckman faculty members Robert Fossum and Yi Ma. Ben Blaiszik, a graduate student with Beckman's Autonomous Materials Systems (AMS) group, was one of the eight finalists. Jang-Ung Park, whose adviser is Beckman faculty member John Rogers, was also a finalist. Blaiszik is a graduate student in the Department of Mechanical Science and Engineering. Blaiszik was co-author with AMS faculty members Jeff Moore, Scott White, and Nancy Sottos, and fellow grad student Mary Caruso of a 2008 paper in Advanced Functional Materials that reported on a major advance in the researchers' work with self-healing materials. The University of Illinois is one of only four institutions in the country to award a Lemelson Prize. The Lemelson-Illinois Student Prize is part of the Lemelson-MIT Awards and Innovations program.

RECENT BECKMAN INSTITUTE RESEARCH
IN THE NEWS

Schulten Talks to Earth and Sky about How Birds Navigate

August 06 – Klaus Schulten of Beckman's Theoretical and Computational Biophysics group talks about how birds navigate in an interview with Earth & Sky, the show that broadcasts scientific voices to global outlets.

Earth and Sky

Writing Channels into a Porous Matrix

August 03 – Scientists at Illinois led by Beckman researcher Paul Braun have used a laser to write a hydrophilic pathway into a three-dimensional hydrophobic porous matrix, a technique with potential uses for selective transportation of aqueous and oily phases in 3-D microfluidic systems.

Chemistry World

DNA for Directing and Switching off Chemotherapy

July 28 – Beckman researcher Yi Lu and colleagues at Illinois have combined an established way of packaging drugs with a way of recognizing cancer cells to create a novel, highly targeted drug-delivery system, and for the first time demonstrated a way to "turn off" drug delivery by disrupting the targeting ability of the molecules.

Chemistry World

Granick Fills in Einstein's Theory about Bropwnian Motion in Liquids

July 26 – Steve Granick of the Beckman Institute's 3-D Micro- and Nanosystems group used fluorescence microscopy to look at Brownian motion in liquids and found results that he says "change the rules of the diffusion game" and challenge part of Albert Einstein's 1905 theory about the effect.

U of I News Bureau

Exercise and Aging

July 27 – Work by the Beckman Institute's Arthur Kramer shows that the decline of abilities like working memory and executive attention can be slowed not only by cognitive exercises but even by moderate physical exercise.

Boston Globe

Considering Future Human-Android Interactions

July 18 – In a new article in *Perspectives on Psychological Science*, psychologist Neal J. Roese and computer scientist Eyal Amir, a Beckman affiliate, investigate what human-android interactions may be like in 50 years.

Scientist Live

Can Gaming Slow Mental Decline in the Elderly?

July 13 – "Video games are very integrative in nature," says cognitive psychologist Chandramallika Basak, a postdoctoral research associate at the U. of I.'s Beckman Institute. "You have to multitask a lot."

Time Magazine

Mind, Movement, and Memory

July 13 – Research shows that simple exercises can enhance memory, mood, and problem-solving abilities. "There is increasing evidence that our thoughts and emotions are affected by how we move," says Beckman researcher and U. of I. psychology professor Alejandro Lleras.

Parade Magzine

Kramer speaks at National Press Club on Aging Brain

June 29 – Beckman researcher Art Kramer recently spoke at the National Press Club in Washington, DC on June 24, 2009. Kramer took part in a discussion on "The Science of Staying Sharp: Healthy Functioning in the Aging Brain." The findings discussed were from the report "Enrichment Effects on Adult Cognitive Development: Can the Functional Capacity of Older Adults be Preserved and Enhanced?" published in the APS journal *Psychological Science in the Public Interest*.

US News & World Report

Clayton Makes New Finding about Memory in Songbird Brain

June 26 – Research by David Clayton of the Beckman Institute's NeuroTech group has provided a new picture of memory in the songbird brain. Clayton, who led a successful effort to have the whole genome of the zebra finch songbird sequenced, found that gene expression in the songbird brain was changed in unexpected ways after hearing another songbird's song.

U of I News Bureau

Can Computer Games Boost Brain Power?

June 26 – The jury's still out on computer games to boost brain power. "There needs to be much more research that asks whether these memory-training or reasoning-training products actually translate into living a higher quality life: being able to work longer, being able to drive longer, being able to live independently," says Arthur Kramer, a Co-chair of the Human-Computer Intelligent Interaction research theme at the Beckman Institute.

KING-Channel 5

Schulten Reports on Molecule That May Play Role in Bird Navigation

June 22 – Beckman Institute researcher Klaus Schulten was principal investigator on a study showing that a toxic molecule may play a critical role in bird navigation, including the mysterious process that allows them to "see" the Earth's magnetic field.

U of I News Bureau

Kramer's Study Cited in New York Times

June 15 – A study by Beckman Institute researcher Art Kramer showing the beneficial effects of aerobic exercise on working memory, attention, and executive skills in older adults is cited in a *New York Times* article.

New York Times

New Technology Could Hide Submarines

June 15 – A new invisibility cloak for sound could help doctors find tiny tumors or hide submarines from enemy sonar. "Our focus is not about dampening noise, but to guide sound waves around structures," says Nicholas Fang, a Beckman researcher and professor of mechanical science and engineering at the U. of I. Fang is a co-author, with U. of I. graduate research assistant Shu Zhang and Leilei Yin, a microscopist at the Beckman Institute, of a paper that appears in the journal Physical Review Letters.

Discovery Channel News

Aluminum-oxide Nanopore Beats Other Materials for DNA Analysis

June 2 – Fast and affordable genome sequencing has moved a step closer with a new solid-state nanopore sensor being developed by a team at Illinois led by Rashid Bashir, a Beckman affiliate and U. of I. professor of electrical and computer engineering and bioengineering.

U of I News Bureau

Faster Protein Folding Achieved Through Nanosecond Pressure Jump

June 1 – Beckman Institute researcher Martin Gruebele is co-author of a paper in *Nature Methods* that reports on a new technique for inducing protein folding that is up to 100 times faster than previous methods. Gruebele, a member of Beckman's Nanoelectronics group, says the method provides for a "kinder, gentler way" of inducing proteins to fold, a discovery that could help guide more accurate computer simulations of the process.

U of I News Bureau

continued on page 14

BECKMAN IN THE NEWS
CONTINUED

Fang Develops First Acoustic Superlens
June 1 – Theorists have been working on materials that bend sound waves backward for several years. Such a metamaterial has now been built by a group led by Beckman researcher and U. of I. mechanical science and engineering professor Nicholas Fang, whose sound-focusing device is an aluminum array of narrow-necked resonant cavities whose dimensions are tuned to interact with ultrasound waves.

Technology Review

TCB Playing Role in Fight against Swine Flu
May 27 – Klaus Schulten of the Beckman Institute's Theoretical and Computational Biophysics (TCB) group is leading a study of the swine flu virus, using the molecular dynamics simulation program developed by TCB to gain new, molecular-level insights into the virus.

TACC

Evidence of Macroscopic Quantum Tunneling Detected in Nanowires
May 27 – Researchers at Illinois including Beckman affiliate Alexey Bezryadin have demonstrated that an entire collection of superconducting electrons in an ultrathin superconducting wire is able to 'tunnel' as a pack from a state with a higher electrical current to one with a notably lower current, providing more evidence of the phenomenon of macroscopic quantum tunneling.

U of I News Bureau

Kids Catch Science Bug with Bugscope
May 27 – Kids like creepy, crawly things. Researchers from the University of Illinois at Urbana-Champaign are taking advantage of this to teach kids science using the Beckman Institute's Bugscope program.

Medill Reports

Body Movements Can Influence Problem Solving, Researchers Report
May 27 – Alejandro Lleras, a member of the Beckman Institute's Human Perception and Performance group, conducted a study that showed, for the first time, that body movement can influence how a person solves a complex problem.

U of I News Bureau

Scientists Discover Ultrasonic Communication Among Frogs
May 11 – Albert Feng, a professor of molecular and integrative physiology in the U. of I.'s Beckman Institute, was among a group of scientists who discovered a frog species living in rushing streams and waterfalls in east-central China that could detect and produce ultrasounds.

PhysOrg.com

Miniaturizing Solar Technology With Flexible Photovoltaic Cells
April 28 – The science and commercial applications of Beckman Institute faculty member John Rogers' research involving ultrathin solar cells is featured in a special Business of Green section in the *New York Times*. The research has produced a unique method for making efficient, flexible solar cells for mass production.

The New York Times

Beckman Researchers Yu, Wang Develop Nanoneedle
April 28 – Beckman Institute faculty members Min-Feng Yu and Ning Wang and their collaborators have developed a membrane-penetrating nanoneedle that is a new and powerful tool targeted delivery of molecules, and works as an electrochemical probe and optical biosensor.

U of I News Bureau

Hoddeson Co-authors Book on Fermilab
April 28 – Beckman affiliate and U. of I. history professor Lillian Hoddeson is a co-author of "Fermilab: Physics, the Frontier and Megascience."

Symmetry Magazine

Self-assembled Nanowires Could Make Chips Smaller and Faster
April 21 – Beckman affiliate and U. of I. electrical and computer engineering professor Xiuling Li and graduate research assistant Seth Fortuna have found a new way to make transistors smaller and faster by devising the first metal-semiconductor field-effect transistor fabricated with a self-assembled, planar gallium-arsenide nanowire channel.

U of I News Bureau

WSJ Reports on Simons Work with Attention and Change Blindness
April 20 – Experiments show just how inattentive we are to most of what we experience. Daniel Simons, a Beckman researcher and psychology professor at Illinois, working with Christopher Chabris, asked viewers to watch people tossing a basketball around, some wearing a black shirt, others a white, and to count the number black-shirt tosses. Amazingly, half of the viewers, focusing on their toss counting, failed to notice that someone had sauntered through the middle of the scene wearing a gorilla suit.

The Wall Street Journal

Researcher Identifies Signaling Networks that Set Up Genetic Code
April 15 – Beckman Institute researcher Zaida Luthey-Schulten reports in the Proceedings of the National Academy of Sciences on research that identified and visualized the signaling pathways in protein-RNA complexes that help determine the genetic code in organisms.

U of I News Bureau

Chemists Gear Up for a New Generation of Supercomputers
April 10 – Klaus Schulten, leader of the Theoretical and Computational Biophysics group at Beckman, has developed a code for molecular dynamics simulations on parallel computing systems. His group has already been allotted time on Blue Waters, a petascale supercomputer under construction at the U. of I.'s National Center for Supercomputing Applications.

Chemical & Engineering News

Metamaterials Focus Ultrasound
April 10 – Beckman Institute researchers Nicholas Fang, Leilei Yin, and collaborators have focused ultrasound using a network of Helmholtz resonators, cavities with short necks that house resonating waves.

Physics World

Senior Odyssey Team Featured
March 23 – The Senior Odyssey problem-solving program developed by Beckman Institute researcher Elizabeth Stine-Morrow is the subject of a feature story in Sunday's *News-Gazette*. Senior Odyssey serves as both an aging intervention program and an experimental study, with team members competing in tournaments.

News-Gazette

Beckman Researchers Develop High-tech Ink
March 23 – Beckman Institute faculty members John Rogers and Jennifer Lewis are part of a collaboration that developed an ink that uses silver nanoparticles to create flexible, stretchable and spanning microelectrodes. The printed microelectrodes can withstand repeated bending and stretching with minimal change in their electrical properties, making them useful for many emerging technologies.

Science Magazine

Kramer Study Challenges Thinking on Early Retirement for Air Traffic Controllers
March 9 – Beckman Institute faculty member Art Kramer reports on results showing that older air traffic controllers in Canada perform as well as their younger counterparts on complex, job-related tasks because their experience offsets the issues that come with normal age-related cognitive decline. Kramer's results, published in the Journal of Experimental Psychology, challenge the conventional thinking behind the United States' mandatory retirement age of 56 for air traffic controllers.

U of I News Bureau

Physical Fitness Improves Spatial Memory, Increases Size of Brain Structure
February 25 – A new study from Beckman faculty member Art Kramer and University of Pittsburgh researcher Kirk Erickson is the first to demonstrate that exercise can affect hippocampus size and memory in humans.

Newsweek