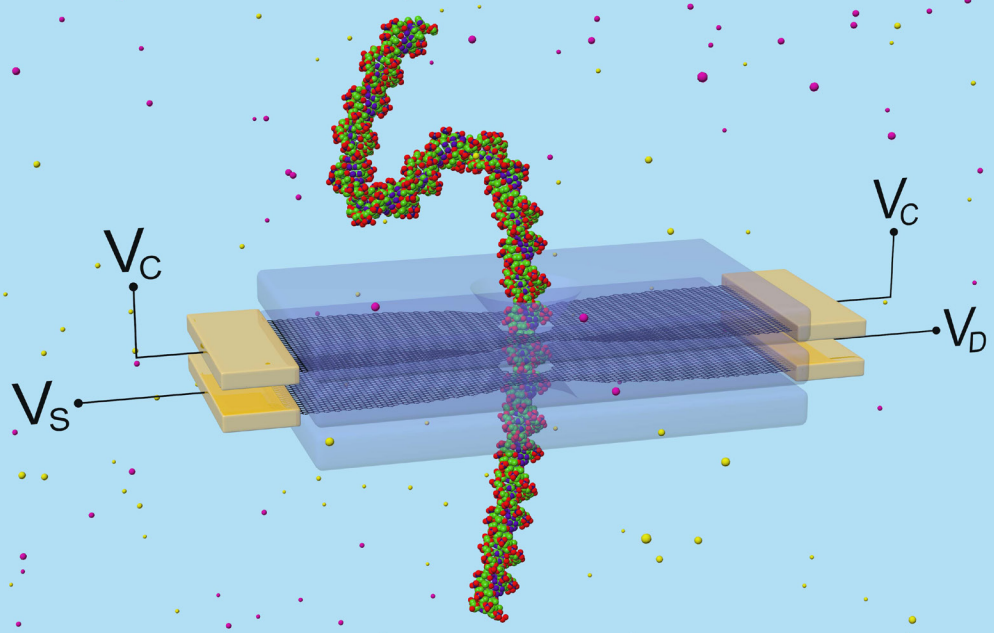
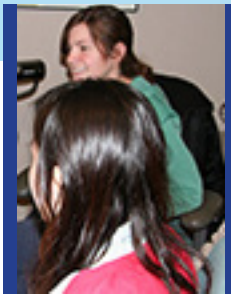
# SYNERGY

BECKMAN INSTITUTE FOR ADVANCED SCIENCE AND TECHNOLOGY • ISSUE 23 • WINTER 2013




*A trio of Beckman Institute researchers are thrust into the forefront of the quest for a fast, low-cost method of sequencing the human genome.* *See page 2.*



*Users of the Beckman Institute's Microscopy Suite receive expert training and, quite often, views of their samples they can't get anywhere else.*

*Page 5*

*An original member of John Rogers' research group, Matt Meitl is now a technical manager at his former advisor's start-up company, Semprius.*

*Page 7*

*Sarah Erickson-Bhatt has a personal motivation for making breast cancer diagnoses and procedures less invasive and more accurate.*

*Page 8*

# Solid Road to DNA Sequencing Future

## *Beckman Researchers Lead Effort to Develop Nanopore Technology*

The recent agreement between the University of Illinois and the British firm Oxford Nanopore Technologies, Ltd. may someday be considered historic, in terms of the impact the research could potentially have on the worlds of business, medicine, and science. And if the research behind the agreement delivers the Holy Grail of genomic medicine — low-cost, accurate, full genome sequencing of human DNA — it will be thanks to solid state nanopore technology developed by researchers from the Beckman Institute.

Oxford Nanopore Technologies (ONT) announced agreements in January with American and British universities to license DNA sequencing technology and to fund future research. The co-Principal Investigators (PIs) on the project at the University of Illinois are Beckman researchers Jean-Pierre Leburton, Aleksei Aksimentiev, and Rashid Bashir.

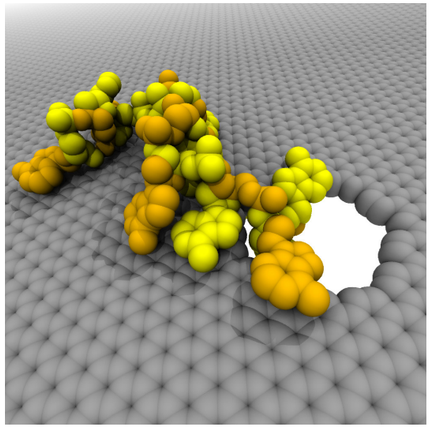
The Illinois technology has its origins in a white paper proposal to the National Science Foundation (NSF) in 2002 that included Leburton and Beckman colleague Klaus Schulten titled "A Nanometer-scale Gene Chip," as well as a 2007 paper by Leburton reporting on a semiconductor membrane that could be used for sequencing.

Several Beckman and Illinois researchers have contributed over the years in developing solid state nanopore technology, but Leburton, Aksimentiev, and Bashir will lead this effort, funded by ONT for developing the DNA sequencing method. Their mission is to create what has been a long sought-after goal in genomics research: low-cost, fast, reliable, and highly accurate sequencing of a person's whole genome.

It is often referred to as personal genomics, and predicted to be an essential facet of a healthcare future focused around personalized medicine. If the research achieves its goal, the impact will be felt in both the business and medical worlds. Estimates of the potential profits for the business that is first in what has been a race to produce the technology are in the billions of dollars.

Current methods have reduced sequencing costs greatly, in some cases to below $5,000, with promises of less than $1,000 in 2013. Bashir, who is Director of the Micro and Nanotechnology Laboratory where fabrication work on the nanopore sensor will be taking place, said a DNA sequencer could perhaps someday be done for less than $100. That would make the technology available on a worldwide scale.

"Something like this can have very broad applications, being able to sequence DNA at a very low cost," Bashir said. "So it really brings this area of personalized medicine to the forefront and to reality. There is actually nothing that we know of in history that has been cost-reduced so much. About 10 years ago the cost of sequencing the entire human genome was about a billion dollars."



*Molecular dynamics simulation of DNA permeation through a graphene nanopore. Image courtesy Aleksei Aksimentiev.*

## The Technology

The Illinois technology being developed potentially has numerous advantages over other methods, including that it is solid state, multilayer, and does not require splitting the DNA into two strands, or denaturing, and amplifying the DNA molecule, as happens in current methods. The basic design is a solid-state, multilayer semiconductor membrane that uses nanopores about the diameter of a single DNA molecule (roughly a billionth of a meter wide). Using electric fields, single DNA molecules are passed through the nanopore, and a detector reads the sequence.

"So a DNA molecule is electrically charged, and you put this membrane in fluid with DNA on one side," Bashir said. "And as long as there is one pore and DNA is driven through that pore like spaghetti, the molecule unwinds, uncoils, and eventually one end finds the nanopore and it transfers through."

The white paper proposal in 2002 (which led to NSF funding the project) by Leburton, Schulten, and others called for a "revolutionary type of silicon integrated circuit that incorporates Metal-Oxide-Semiconductor (MOS) technology with an on-chip nanometer-scale mechanism for probing the electrical activity of DNA."

One of the unique aspects of the method being developed is that it offers electrical tunability. It goes back to a design Leburton and his group reported on in 2007 of a semiconductor membrane — built from silicon layers — that can be used to regulate the flow of charged ions and molecules, thus enabling control of the pore electrically.



"It provides electrical tunability of the membrane, which people at that time hadn't thought about," Leburton said. "The second fact is the multilayer structure, where each layer can be energized differently. The membrane can also be made of different materials and with different voltage forces. That is unique."

Leburton is from the Department of Electrical and Computer Engineering (ECE), while Bashir is faculty in ECE and Bioengineering, and Aksimentiev is faculty in the Department of Physics. As to their roles in this project, Leburton is the theorist who also does computer device modeling, while Bashir is an experimentalist who will be fabricating the technology, and Aksimentiev does computer modeling that has included breakthrough molecular dynamics simulations.

Aksimentiev uses supercomputers and specially developed programs tailored for nanopore simulations that have enabled the creation *in silico* of the intricate dance of a DNA strand making its way through a nanopore. In 2008 he led a team that used several supercomputers, including those at Oak Ridge National Laboratory, to simulate the shape of DNA going through a single nanopore. He said the work using molecular dynamics simulations to model the process of DNA translocation through a nanopore dates back a decade.

*Co-principal investigators (from left), Aleksei Aksimentiev, Jean-Pierre Leburton, and Rashid Bashir discuss plans for the nanopore DNA sequencing project they are leading.*

"Our modeling approach permits obtaining detailed and precise information about nanopore systems that are not accessible through experiments," Aksimentiev said. "My role in the nanopore project at Illinois has been in exploring various nanopore systems for applications in nano-biotechnology, which include but is not limited to designing and refining new approaches for biosensing with nanopores, and providing microscopic interpretation to the results of experimental measurements."

## The Agreement

Oxford Nanopore Technologies is well-known in the business of genomic technology, and licenses its products to biotechnology giant Illumina. ONT has developed both biological and solid state nanopore sensors, and announced a plan to produce a "strand sequencing" DNA sequencer the size of a memory stick by the end of the year. It does not yet offer DNA sequencing for humans, which requires a higher threshold for accuracy than sequencing for animals or crops.

The research and licensing agreements are separate. The sponsored research agreement is funding the research of the three co-PIs, who are integrating their research in this area. The licensing agreement is for a package of patents and patent applications.

Several Illinois researchers have been working on nanopore sensor technology, and there had been enough success in the area for the University to create a proposal seeking an outside partner or partners to help develop the technology, and license the patents through the Office of Technology Management (OTM) at Illinois.

ONT, which has worked with the other universities such as Harvard and Oxford, turned out to be that partner. Steve Wille is associate director and senior technology manager at OTM. He said the fact that Illinois can do both modeling and experimental testing of the design made the technology attractive to ONT.

"The inventors had both modeled and experimentally demonstrated a very difficult, very important invention that can have tremendous consequences for healthcare," Wille said. "It is great that UIUC has three PIs working in different technology areas, which together can help create an extremely useful device for healthcare."

In addition to the three co-PIs, the list of Beckman faculty members working on nanopore sensor technology includes Schulten and Narayana Aluru, and former faculty member Greg Timp. Bashir said several researchers on campus have contributed greatly to the presence of Illinois as a leader in solid state nanopore technology research.

"At the U. of I. we have great expertise in this area beyond these three people," Bashir said. "It's unlikely you would find that many people working on nanopores at any other place."

## Research Lines

If successful, the solid state nanopore they are developing will be something completely different in the field of biomedicine.

"The basic idea is that the nanopore becomes a tool to analyze single DNA molecules one molecule at a time," Bashir said. "The Holy Grail is to be able to take the DNA from a cell and chop it into fragments, and sequence each fragment directly without having to amplify the molecule. Or take the entire molecule and sequence it directly without having to amplify it at all.

"The nanopore offers a possibility of 'can I conceptually take a molecule, pass it through the pore, and, as it's passing through, get the sequence directly from that single molecule?' And that would certainly be revolutionary."

Leburton said his idea for the multilayer membrane was based on the way nature uses biological membranes, and could

*continued next page*

be used for other types of sensing, although this agreement is only for DNA sequencing.

"What we try to do is actually mimic, with semiconductor nanotechnology, the functionality of a human membrane," he said. "The human cell is actually a biological machine, and the interaction of this human cell with the outside is through this membrane. The membrane has a pore so it can exchange with the outside a certain amount of biological or biochemical information.

"So what we propose in this patent is replacing whatever this bi-lipid layer, this membrane, is with a semiconductor membrane that provides even more functionality. Now we not only have the ability to make multilayer structures, so each layer would have a specific function, but we can also energize with particular biases or current going through it. So we make each layer sensitive to any kind of biochemical agent that would go through the pore."

Leburton said that could enable a broad range of applications, for example, in diagnostics, dialysis, and drug delivery.

"I don't think people have understood that yet, because it is at the crossroads between semiconductor nanotechnology and biology," Leburton said.

That crossroads is where the next generation of biomedical instruments will be coming from. The potential of what their technology — if it is successfully developed and commercialized — can do for medicine in the future is something that excites all three researchers.

"For me the theoretical part is interesting as a physicist but also I wish to find applications of my work," Leburton said. "This is one that will certainly be very beneficial for humanity and society."

"I'm excited about seeing the impact of my research efforts in everyday life and the well-being of people," Aksimentiev said.

Bashir mentioned lower costs, including less than $100, as one of the biggest boosts for medicine, on a grand scale.

"I think clearly this is going to have an impact worldwide in all areas of health and medicine," Bashir said. "If the cost comes down this low you can truly have genetic-based information, molecular information to understand heterogeneity of disease, for early detection, to look at all sorts of things like plants, bacteria, and other microbe organisms. Sequencing is not just for humans. Sequencing is for any biological entity.

"The cost of sequencing coming down is going to have a broad impact in agriculture, animal diseases, all sorts of things. For example when you have an outbreak of a certain virus, or a certain pathogen, if you can isolate it and sequence it from individuals, it definitely gives you so much more information, which strain it is, which exact variation. Right now it is relatively expensive. Something like this would make it very cheap and very easy to do."

# OPEN HOUSE 2013

The biennial Beckman Institute Open House will be held on March 8-9, in conjunction with Engineering Open House at the University of Illinois.

The 2013 Beckman Open House will feature more than 30 exhibits on four floors and the basement, showcasing the research work that takes place at Beckman.

The last Beckman Open House, held in 2011, featured a number of new exhibits such as the Language Acquisition and Robotics group's iCub humanoid robot, Bert. Estimates of more than 5,000 visitors made it the largest ever Open House at the Institute. Also new last time around was a popular display from the Marine Biology Lab on the third floor.

For 2013, a second aquarium exhibit from a completely different research project will help turn the third floor into a marine world, showing how sea creatures are helping to advance science that will help humans. Once again this year, there will be 3-D displays, exhibits that take visitors into the human mind, and ones featuring varied imaging methods.


beckman.illinois.edu/events/open-house

*Ron Carbinari of the Illinois Simulator Laboratory (center) looks on as a visitor steers a virtual airplane in the flight simulator during the Beckman Institute Open House 2011.*



## A Week in the Life of the

# Beckman Institute Microscopy Suite

Peering intently at a monitor, two young researchers from the Department of Physics are getting their first look at microscale wires being developed for use in a particle detector experiment at the Large Hadron Collider in Switzerland.

Ihnjea Choi, a postdoctoral researcher, and graduate student Pedro Montuenga from the Nuclear Physics group are involved in a research and development project for the famous CERN collider that probably makes them the envy of many young physics researchers. But during this week in late November in the Beckman Institute's Microscopy Suite basement location, they are novices, learning how to operate the facility's scanning electron microscope (SEM) for the first time.

*Department of Crop Sciences students Sumin Kim (foreground) and Stella Kim (right) receive instructions from Cate Wallace of the Microscopy Suite on how to use the facility's scanning electron microscope (SEM).*

And, along with their trainer, microscopist Cate Wallace, they are anxiously awaiting their first views of what these four small tungsten wires look like when brought into focus on the facility's SEM. With its magnification power of up to 800,000 times for data collection and 200,000 times for rendering meaningful, publishable images, that first glimpse of one's sample at those scales and with high resolution is often an exciting moment for researchers using the SEM.

Choi and Montuenga are seated, faces a foot away from the screen of one of the two monitors providing images and information from the SEM, which itself is a couple of feet away to the right, with a heavy metal skin protecting the people using it from the x-rays emanating from inside. Wallace stands between the SEM and the pair, providing guidance by both word and expert movements of the keyboard mouse. A green circle and crosshairs move over the screen as they search the sample. For now, she is like a driver's ed teacher, sometimes letting her students do the driving and sometimes taking the wheel herself.

"Just take the contrast and drag it down," she advises before taking over the mouse and showing them how to adjust the image. Slowly, with each screen refreshment, a rough cylindrical object starts to appear. "Drag it up a little bit. Now you can see something."

"Yeah that's the wire," Montuenga said.

"But we don't know which wire," Wallace responds.

"This should be the first one," Montuenga says, and with another refresh, "Oh, wow."

Their attention is split between the instructions for operating the SEM and the screen before them, as they try to replicate Wallace's mastery of the machine. "We had a crash course yesterday," Montuenga said.

While the two physicists are using the SEM as part of a project looking for the smallest known particles, another pair of students from the Department of Crop Sciences used it a little later to look at something much bigger: pollen grains. They were trying to find a perfect representative of their sample for a paper being submitted to a peer-reviewed journal.

Sumin Kim and Stella Kim also got a crash course in use of the SEM, with Wallace guiding them through their initial efforts at getting a high-resolution magnified image of a pollen grain — one that would look as close as possible to how it does in nature.

Wallace has tried "pumping" the SEM to add humidity to it, so the samples will be full and lifelike when they image them, and now they are waiting with each screen refreshment and increase in magnification for the grains to appear.

Sumin Kim sees it first. "That's it, that's a pollen grain. I'm excited it's working."

Microscopy Suite manager Scott Robinson enters the SEM room to check on the progress. "That looks like what we saw yesterday, the same little dudes."

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Sumin Kim agrees, then asks, "Can we make them fat again?" — a request that draws chuckles.

Unfortunately, giving them a fat, natural look proved difficult, so Wallace and Robinson later conferred on ways to make that happen and invited the Kims back for another try.

## Equipment, Staff Make for a Unique Resource

Those processes go on every day in the Microscopy Suite, which serves faculty and student users from materials science, engineering, and the biological sciences, to name a few. The instruments in the Suite include four main modes of imaging: light microscopy, scanned probe microscopy, electron microscopy, and x-ray computed tomography (CT). A confocal Raman imaging system was added in the past year for three-dimensional information on the location of molecules in tissue samples and in materials such as polymers.

Between the state-of-the-art equipment and staff, the Microscopy Suite is able, Robinson said, to meet a variety of needs and serve users like no place else on campus.

"We are really lucky to have all these different pieces of equipment and we're lucky to have multiple ways of imaging something for someone," he said. "Sometimes it's simple and sometimes it's not, but our mission to translate what they want done, give them results on a system, and then evaluate how those results came out."

In addition to Robinson and Wallace, Microscopy Suite staff helping its users includes Leilei Yin, Dianwen Zhang, and Mark Bee. Zhang also does training, as well as making adjustments to the equipment, as he explained while helping a postdoc from the Rogers Research Group on the confocal system.

"Most of the time I do the training and then they can directly handle it after training," Zhang said. "For some special cases like this one, where we have to modify things, then I have to improvise a technique."

"We have a *great* team," Robinson said. "We are aware that in some cases we are more expensive than other places, but we have a great team and we have great equipment."

That allows the Suite to adapt to users' needs, such as trying the transmission electron microscope (TEM) when the SEM isn't getting the job done.

"We can just take them down the hall and let them look at it in the TEM," Robinson said. "Something that has a particle size that is small, sometimes you can do it on the atomic force microscope. We have all these options, including micro-CT, so it's just awesome.

"We have such a good crew and such good equipment, so we have to take that extra step. Sometimes we have to follow through and make sure that what we did worked. It's our job to say 'Yes.' And that's the way I look at it."

*Microscopy Suite manager Scott Robinson helps Angela Early from Autonomic Materials Inc. preparing samples for the scanning electron microscope (SEM).*

## User Friendly

The atmosphere in the Suite is informal and collegial. The staff works with users in training and problem-solving. And Robinson's office there is busy with those stopping by for help and advice on using the equipment.

One who stopped by during the week was Jason Patrick of the Autonomous Materials Systems (AMS) group. Patrick was in the process of submitting a paper to *Nature Materials*, and had used the micro-computed tomography (Micro-CT) instrument in the Suite to look at vascular networks used in self-healing materials.

"Ever since I came to Beckman, the Microscopy Suite been really, really helpful," Patrick said. "Micro-CT for instance, there's no way to see inside the vascular networks and these samples because they are not translucent. So that was really the only way that we could visualize them."

A fellow AMS group member is Amanda Jones, who uses the Suite for visualizing such materials as complex polymer matrices in research aimed at developing self-healing batteries. She often pops into Robinson's office seeking advice, such as when she asked about using the Suite's diamond knife for extremely small scale cutting of samples

"I've done that a lot of times before," Jones said of her pop-in visits. "Normally he will come in and help me whenever I need it, but I'm trying to be a big kid and do it myself."

Jones has been a user of the facility for four years. She describes Robinson and the Suite as "awesome.

"Scott's always around. He trains you and then you are free to use it. Usually if I'm doing something, especially something really important, he always comes in and helps me get things *just* right."



## Beckman Alumni Profile:

# Matt Meitl

**Degree:** Ph.D., Materials Science and Engineering, 2007
**Then:** Rogers Research Group
**Now:** Technical Manager, Semprius

The chance to someday apply what he was learning as an engineering student at the University of Illinois drew Matt Meitl to materials science, and to a researcher who has gained international fame for his groundbreaking innovations in electronics, industry, and medicine.

As he was finishing his bachelor's degree in Materials Science and Engineering, Meitl heard a talk from John Rogers, who was working as an industry researcher. Shortly thereafter, Rogers joined Illinois and became a Beckman Institute faculty member. He went on to create a research portfolio with exciting new discoveries like stretchable silicon for applications such as implantable health monitors and solar cells. And Meitl was there from the start.

"A year before I started grad school I heard John give a talk at the University, and the work struck me as innovative, impressive, and having far-reaching real-world applicability," Meitl said. "It was the kind of work I wanted to learn how to do, so when I heard he might accept a faculty position at Illinois, I held out for a chance to join his group. It worked out great."

Great may be an understatement. Meitl ended up being the new professor's first graduate student in the Rogers Research Group (which has a mission of "Science that brings Solutions to Society"). He then went on to become one of the first half-dozen employees at Semprius, a start-up company Rogers co-founded in North Carolina for manufacturing new solar cell technology.

Meitl has made the most of his opportunities as part of the Rogers Research Group and as an employee at Semprius, where he has been ever since earning his Ph.D. five years ago with a focus on transfer-printing and microscale hybrid materials systems.

Meitl is technical manager of cell development at Semprius, and a leader in transferring Semprius' printable photovoltaic cell technology to its fabrication facility. He already holds nearly 20 patents and patents pending, and says his work at Illinois led directly to his current efforts at Semprius.

"I think the most significant contributions I made at Illinois were in the physics that govern a process that we refer to as micro transfer printing," Meitl said. "My biggest technical accomplishments at Semprius flowed from the skills and knowledge I gained at Illinois to a great extent. The same transfer printing process and fabrication techniques we developed at Illinois can be applied to high-efficiency multi-junction solar cells."

> " My biggest technical accomplishments at Semprius flowed from the skills and knowledge I gained at Illinois ..."
> — Matt Meitl

Meitl said the solar cells are combined with high-efficiency concentrating lens arrays to create the solar module.

"Both the cells and the lens array are produced using techniques that were inspired by the techniques we developed at Illinois — the cells very directly so and the lenses in a more roundabout way," he said. "The high efficiency of both cells and lenses enabled for the first time a commercial solar module to surpass 33.3% efficiency."

The similarities between working at Semprius and in the Rogers group include more than technology development.

"Research at Illinois and Semprius each required fast, high-quality, cutting-edge results, and both organizations had the ability to produce them," Meitl said.

Meitl credits Rogers for the environment he found in the group.

"Professor Rogers himself makes the group so great," Meitl said. "He establishes a fast-paced, results-oriented culture that attracts some really talented students that learn from each other and sharpen each other's skills. It's great to be a part of a team like that where big things happen on a regular basis. I was fortunate to get that opportunity."

Meitl may have been fortunate, but he also took advantage of opportunity — as he is doing again, as part of a cutting-edge technology company. He urges students with a similar opportunity to join a start-up.

"I'd say go for it!" Meitl said. "It's a thrilling ride to blaze a trail in your field that might lead to some really big things; you can generate some jobs and keep on innovating. Find a good team that has a good vision and some good resources, or start building that team yourself. If you have the desire to go that direction and the beginnings of an idea how to do it, you should make that leap."

# FELLOWS CORNER

## SARAH ERICKSON-BHATT

Before entering college, Sarah Erickson-Bhatt underwent a life-altering event. Her response was to try and make others' lives better.

Erickson-Bhatt is a Beckman Fellow with a research focus on the development of biomedical applications, specifically toward solving a major problem in breast cancer diagnosis. Currently, performing biopsies for breast cancer diagnoses involves highly invasive procedures such as tissue resection and a wait time for laboratory results that only add to the patient's worries.

Beckman Institute researcher Stephen Boppart has been working on developing a real-time non-invasive or minimally invasive optical imaging system for breast cancer diagnosis, so it was fitting that Erickson joined him in the effort as one of the newest members of the Beckman Fellows program.

"My current research is focused on optical methods — using visible and near infrared light — in order to distinguish between cancerous and noncancerous tissue," Erickson-Bhatt said of her work.

Erickson-Bhatt's research focuses on two major issues involving cancer diagnosis: distinguishing between benign and malignant tissue masses, and between cancerous and healthy tissue during surgical procedures. That twin focus is driven by a single motivation based on that life-changing event.

"I lost my mother to breast cancer and that drew my attention toward the biomedical field," she said. "As soon as that happened, I decided to apply physics to scientific and engineering methods toward the diagnosis of breast cancer."

Erickson-Bhatt got a degree at the University of South Florida in physics, then went on to earn a Ph.D. in Biomedical Engineering at Florida International. It was there that she did postdoctoral work developing a handheld optical imaging device for imaging breast cancer non-invasively.

Boppart has been pursuing the same goal for a decade now using optical coherence tomography (OCT). Erickson-Bhatt applied to the Beckman Fellows program in order to work with Boppart as her main collaborator.

While both the method she worked on at Florida International and Boppart's technique involve optical imaging, Erickson says they are different approaches.

"The methods are very different actually," she said. "What I worked on was diffuse optical where you can go deeper into the tissue, whereas OCT — what I'm now doing in Steve's lab — can only image 1, maybe 2 mm, into the tissue. So it's used intraoperatively."

That means surgeons will be able to image tissue during a procedure without having to send a tissue sample off to a lab for further analysis. In that aspect, the approaches of Erickson-Bhatt and Boppart are very much in tune.

"This enables the surgeon to know when he's removing breast tumor what part is tumor and what part is normal tissue," she said. "By using a method like optical coherence tomography the surgeon can then determine how much tissue to remove and also determine if lymph nodes are positive or negative for cancer."

The Beckman Fellows program enables postdoctoral researchers time to do research free of teaching or other duties.

"Being free of those other duties really helps me be able to focus on research and be able to think creatively and innovatively to do the kind of research that I am excited and passionate about," she said.

Erickson-Bhatt worked in Boppart's labs at Beckman with his research group members and used a lab at Carle Hospital's Mills Breast Cancer Institute in getting a portable OCT system ready for clinical trials. Those trials got under way in January with patients at Carle Hospital in Urbana.

> "... if, during the procedure, they can use a method to determine whether or not it is cancer, that is what I want to see happen."
> — Sarah Erickson-Bhatt

Erickson-Bhatt is part of the 2012 class of Fellows, arriving at Beckman in August. Her future plans are to become a tenured professor with her own research program after her days as a Beckman Fellow are done. However, there is one thing she hopes to accomplish before leaving the program: having the technology proven as an effective intraoperative tool for surgeons.

"Many times they have to have follow-up surgeries, but if, during the procedure, they can use a method to determine whether or not it is cancer, *that* is what I want to see happen," she said.



# HONORS & AWARDS

### Lyding Receives Pioneer in Nanotechnlogy Award

Beckman Institute researcher Joseph Lyding was awarded the 2012 IEEE Pioneer in Nanotechnology Award for "advances in atomic resolution nanofabrication and discovery of the deuterium isotope effect." One of Lyding's most well-known discoveries was that deuterium could be used to extend the life of computer chips, an innovation that is now used worldwide in electronic devices such as cell phones.

### Technical Achievement Award to Bashir

Rashid Bashir of the 3D Micro- and Nanosystems group has been recognized with the 2012 IEEE Engineering in Medicine and Biology Society (EMBS) Technical Achievement Award for "significant contributions to the development of micro and nanoscale biosensors." Bashir is an Abel Bliss Professor of Electrical and Computer Engineering and of Bioengineering and Director of the Micro and Nanotechnology Laboratory.

### Schulten Given Distinguished Service Award

Beckman Institute researcher Klaus Schulten has been awarded the Biophysical Society's Distinguished Service Award for 2013. Schulten is leader of the Theoretical and Computational Biophysics (TCB) group.

### Huang, Sligar, Rogers Named Swanlund Chairs

Three Beckman Institute faculty members have been named Swanlund Chairs, the highest endowed title at the University of Illinois. The three are Thomas Huang, John Rogers, and Stephen Sligar.

### Schulten, Kale Honored with Fernbach Award

Klaus Schulten and Laxmikant Kale of the Theoretical and Computational Biophysics group have been honored with the 2012 Sidney Fernbach Award from the IEEE Computer Society for their "outstanding contributions to the development of widely used parallel software for large biomolecular systems simulation."

### Cohen Named AAAS Fellow



Neal Cohen of the Cognitive Neuroscience group has been named as a 2012 Fellow of the American Association for the Advancement of Science. Cohen, who also is Illinois Director of the Center for Nutrition, Learning, and Memory (CNLM) located at Beckman, was honored for his "pioneering research on memory and amnesia, distinguishing brain systems and psychological characteristics that distinguish declarative and procedural memory."

### Huang Wins Best Student Paper Award

Jia-Bin Huang has won the ICPR2012 Best Student Paper Award for the 21st International Conference on Pattern Recognition. Huang is a student in the group of Beckman Institute researcher Narendra Ahuja.

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

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**Front cover:** *A DNA molecule in solution passes through a nanopore in a membrane made of two sheets of graphene sandwiched between three dielectric materials in this visualization of an early version of the method researchers are working on. Rendering by Anuj Girdhar. Image courtesy Jean-Pierre Leburton.*

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RECENT BECKMAN INSTITUTE RESEARCH

# IN THE NEWS

### Mapping Emotional Intelligence in the Brain

January 22 — Aron Barbey of the Cognitive Neuroscience group led a study of Vietnam veterans that provides the first detailed map of brain regions associated with emotional intelligence.

*U of I News Bureau*

### Using Sense of Smell for Biodetection Technology

January 9 — An article on the use of smell as a method in biodetection technologies refers to the work of Beckman Institute researcher Kenneth Suslick.

*Equities.com*

### Team Solves DNA Repair Mystery

December 14 — Taekjip Ha led a study that has discovered how a DNA-repair protein matches up a broken DNA strand with an intact region of double-stranded DNA.

*U of I News Bureau*

### Downsizing Inductors for Integrated Curcuits

December 13 — The size of an important component of integrated circuits, inductors, has been reduced thanks to new design techniques developed by Xiuling Li of the Nanoelectronics and Nanomaterials group.

*U of I News Bureau*

### Rogers Demonstrates Transient Electronics

December 12 — Beckman Institute researcher John Rogers demonstrated the amazing capabilities of transient electronics — a technology that he was a leader in developing — at an IEEE conference in San Francisco.

*IDG*

### Self-healing Approach to Battery Safety

December 10 — The work of researchers from the Beckman Institute's Autonomous Materials Systems group is featured in a Department of Energy story on incorporating self-healing materials in lithium batteries for improved safety.

*DOE*

### New Materials Self-assemble in Synchronized Dance

November 26 — Beckman Institute researcher Steve Granick co-led a team that used tiny particles called Janus spheres to create a new class of dynamic materials that can synchronize their movements as they self-assemble into a spinning microtube. Granick developed Janus spheres, which had previously been shown to be capable of self-assembly of static structures.

*U of I News Bureau*

### Diamond Tips Improve Small Scale Manufacturing

November 19 — William King of the 3D Micro- and Nanosystems group has been working to improve nanofabrication methods, most recently by developing a nano-tip for thermal processing made entirely out of diamond.

*Engineering at Illinois*

### Cells Power Biological Machines

November 15 — Beckman Institute researcher Rashid Bashir led a team that developed miniature non-electronic biological machines, or "bio-bots", that are biocompatible, meaning they could have important medical applications.

*U of I News Bureau*

### Exercise Offers Benefits to Aging Brain

November 7 — The work of Justin Rhodes is featured in an article about the benefits exercise offers the elderly in protecting against the effects of brain shrinkage.

*Discovery Channel*

### Sense of Control Can Lessen Distortions of Time

November 6 — Beckman Institute researcher Alejandro Lleras has found that having a sense of control over events can reduce the influence of emotions on time perception.

*U of I News Bureau*

### Brain Waves Predict Video Game Aptitude

October 24 — Beckman Fellow Kyle Mathewson and Beckman faculty members Gabriele Gratton and Monica Fabiani found that they could predict success on an unfamiliar video game just by looking at the brain waves of study participants. BI Director Art Kramer and researchers Ed Maclin and Kathy Low also collaborated on the study and paper.

*U of I News Bureau*

### Electronics that Dissolve in Fluids

September 27 — John Rogers of the 3D Micro- and Nanosystems group led a multi-university project that developed biodegradable electronics technology that is high performance but also biocompatible and capable of completely dissolving in water or bodily fluids.

*U of I News Bureau*

### Insight into the Sense of Smell

September 19 — Beckman Institute researcher Klaus Schulten led a study that found that the vibration of an odorant molecule's chemical bonds contributes to our ability to distinguish smells.

*U of I News Bureau*

### Do Gadgets Really Threaten Planes?

September 10 — Beckman Institute researcher Daniel Simons and his collaborator Christopher Chabris weigh in on whether or not to allow electronic devices to be used during airline takeoffs and landings.

*Wall Street Journal*



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