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# BREAKING BARRIERS, BUILDING BRIDGES

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# Beckman Institute

for Advanced Science and Technology

## Contents

### Breaking barriers, building bridges.

At first, breaking and building seem to be two actions in opposition to one another. But at the Beckman Institute, they share a common meaning.

Beckman scientists break barriers between disciplines and build innovative research programs. Outreach staff and volunteers break down scientific jargon for the public and build programs to support students in STEM.

Any way you look at it, the results point to the same thing: connections, collaborations, and advancements that couldn't occur any other way.

Read condensed news stories to learn more about Beckman's advancements in the 2022-23 academic year. For more details and full stories, visit [go.beckman.illinois.edu/AR2022](https://go.beckman.illinois.edu/AR2022).



Message from the director 1

### Collaboration: Building bridges among disciplines

What's small and smart and worn all over? 4

Research reveals another reason to love reading 5

Image contest winners: Hossain, Nath 6-7

Charles Schroeder wins Beckman's Vision and Spirit Award 8

Molecular teamwork makes the organic dream work 9

### Diversity: Breaking down barriers to access

Researchers, Big Tech companies tackle speech accessibility 12

(dis)Ability Design Studio opens at the Beckman Institute 13

Image contest winners: Mullen, Park 14-15

Empowering women in medical imaging 16

Accessible medical imaging for diverse communities 17

2023 Beckman Institute Open House 18-19

### Exploration: On the cutting edge of technologies, tools, and trends

Boosting astronaut fitness on NASA's mission to Mars 22

Beckman Institute, Grainger Engineering leading \$10M DOE grant 23

Image contest winners: Josek, Gillette 24-25

New center at the Beckman Institute breaks barriers in imaging technology 26

Beckman seed funding enables exploration 27

\$30M NSF grant supports whole-cell modeling 28

First-of-its-kind study links past experience to teenage girls' need for belonging 29

A culture of collaboration 30

Reaching the community 31

Beckman by the numbers 32-33

Bonus Beckman content: Scan QR codes throughout the report to access journal articles, watch videos, and see Beckman faculty members featured in notable media outlets.



*Editor's note: Cathy Murphy, the Larry R. Faulkner Endowed Chair in Chemistry and head of the University of Illinois Department of Chemistry, became the interim director of the Beckman Institute in August. Murphy succeeds physicist Nadya Mason, who is now dean of the Pritzker School of Molecular Engineering at the University of Chicago.*

*Murphy is a highly regarded scientist and an experienced administrator. She even met Arnold Beckman when she was a postdoctoral researcher at the California Institute of Technology's Beckman Institute. She's a member of both the U.S. National Academy of Sciences and the American Academy of Arts and Sciences.*

Dear Beckman friends and supporters,

I am so excited to have joined the Beckman Institute as its interim director. While I have collaborated with Beckman faculty for 13 years as a research affiliate, this is my first opportunity to truly immerse myself in the institute's vast spaces and interdisciplinary community.

I want to thank Nadya Mason for her service to the University of Illinois and to the Beckman Institute. As director, she used the institute's mission and core values to make decisions large and small that propelled the institute forward. I plan to do the same.

Three of these core values have been especially evident throughout the last year: collaboration, diversity, and exploration. This report shares the stories of the researchers who are upholding those values each day when they come to work at Beckman.

Beckman's mission and core values will continue to guide us through this leadership transition. They remind us to open our minds to new collaborations. They encourage us to pursue equity and address important societal problems. Personally, they inspire me to maintain a learner's mindset in the coming days, weeks, and months.

Most importantly, Beckman's core values help our researchers do critical work, now and in the future. I can't wait to be a part of it.

Sincerely,

Cathy Murphy  
Interim Director



# COLLABORATION

*Building bridges among disciplines.*

Interdisciplinary collaborations are a trademark of the Beckman Institute, where researchers from more than 40 different academic departments come together to make discoveries that wouldn't be possible anywhere else.

This year, research partnerships among university units, within the local community, and alongside local organizations demonstrated the transformative impact of collaboration to produce better innovations, embrace bold scientific questions, and transform campus research into a lively community conversation.



Beckman Facilities Team



*“Prioritize building teams and developing new ideas rather than seeking personal or singular recognition on shared projects.”*

*— Charles Schroeder, professor and 2023 Vision and Spirit Award winner*





## What's small and smart and worn all over?

It's not a riddle, but a list of attributes Nancy McElwain envisioned as she searched for a data collection tool compatible with her youngest research participants.

A research professor of human development and family studies, McElwain is interested in how infant-parent relationships shape children's social, emotional, and physiological development. Because children cannot self-report or operate smart devices on their own, McElwain collaborated with electrical and computer engineering professors Mark Hasegawa-Johnson and Romit Roy Choudhury. Together, the research trio developed LittleBeats.

Concealed in the front pocket of an infant-sized shirt, LittleBeats enables remote data collection from the comfort of a participant's home. The wearable device captures audio data, which enables researchers to record parent-child interactions without the intrusion of video. Pairing audio with electrocardiogram provides insight into stress regulation. The device also includes a motion sensor. All data is collected in the context of children's everyday interactions with parents and siblings.

With child development researchers suggesting metrics to track and engineers designing algorithms to meet those needs, LittleBeats is a testament to the innovation made possible through interdisciplinary collaboration. The collaboration also allows HDFS students to study the basics of machine learning and gives ECE students insight into real-world applications of their algorithms.



"I'm very appreciative for Beckman being the place where we feel at home doing this interdisciplinary research. We've benefited immensely from the highly collaborative environment."

Nancy McElwain



## Research reveals another reason to love reading

How can we stay mentally sharp as we age? Read a book.

Beckman Institute researchers investigated the potential benefits of reading in improving memory. They found that regular, engaged leisure reading can strengthen memory skills in older adults, laying the groundwork for lifestyle choices that preserve our mental abilities as we age.

Liz Stine-Morrow, a Beckman researcher and faculty member in the Department of Educational Psychology, led the study, which appears in the journal *Frontiers in Psychology*.

Participants from the local community read books from a preselected list for 90 minutes a day, five days a week, for eight weeks. Participants were evaluated on cognitive skills, including working and episodic memory, in Stine-Morrow's Adult Learning Lab at the Beckman Institute. Incontrovertibly, the study demonstrated that regular, engaged reading strengthened older adults' memory skills in comparison to an active control group.

Stine-Morrow's interdisciplinary team of Beckman colleagues included Dr. Daniel Llano, a professor of molecular and integrative physiology; and Aron Barbey, a professor of psychology. Book selections were made in partnership with the Champaign Public Library's Adult Services Department.

The causal link between reading and memory opens new avenues for future treatments to prevent cognitive impairment with aging, and perhaps reduce the risk for conditions such as Alzheimer's disease.

"There's promise in engaging fully in the stimulating things that we already do in our lives. That's probably the best pathway to maintaining our mental abilities and offsetting the effects of aging on cognitive health," Stine-Morrow said.



(From left) Shuk Han Ng, a visiting research data manager; Giavanna McCall, a graduate student in educational psychology; Ilber Manavbasi, a research staff member; and Liz Stine-Morrow.

"Leisure reading, the kind that really sucks you in, is good for you, and it helps build the mental abilities on which reading depends."

Liz Stine-Morrow

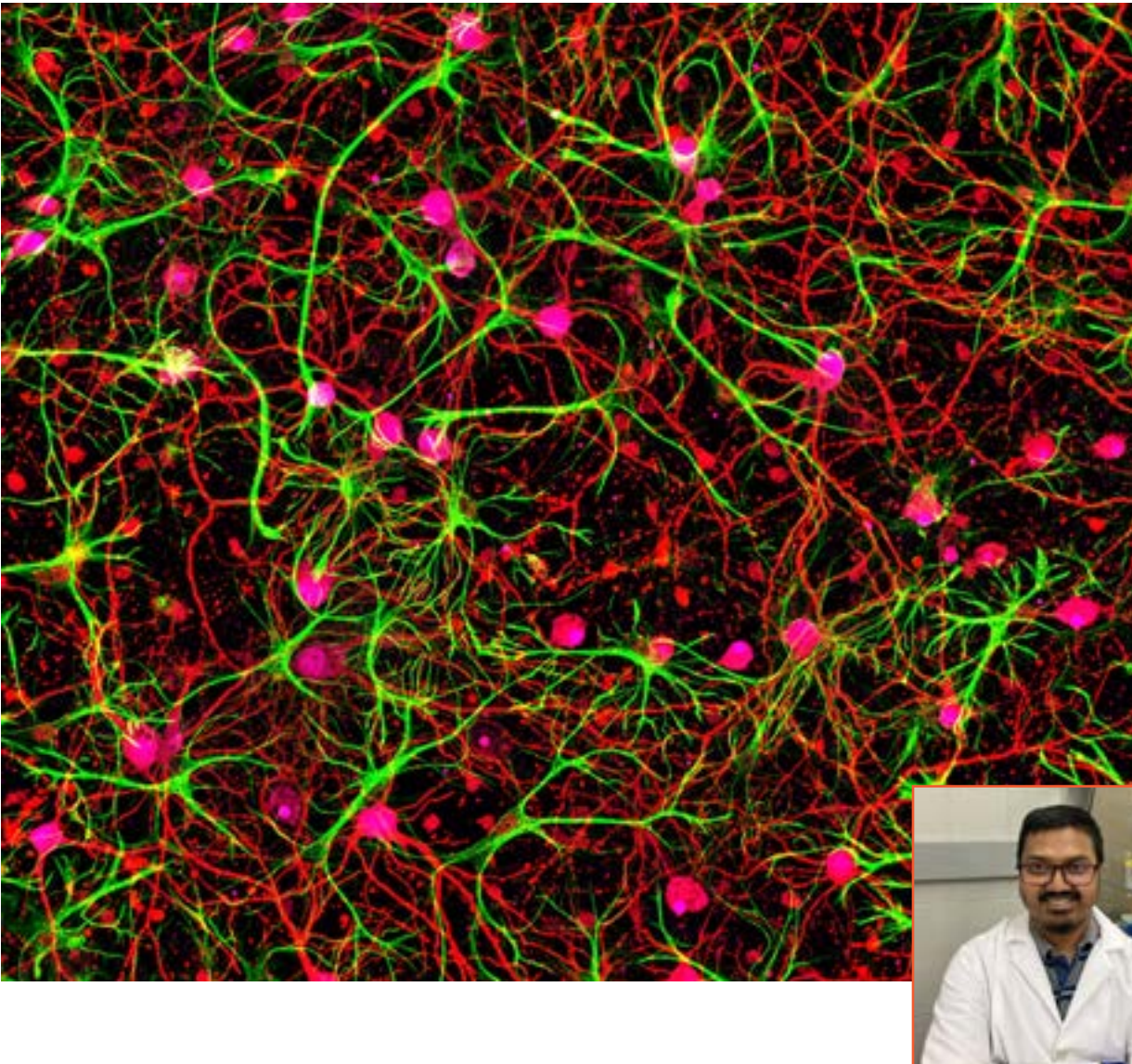




## Research Image Contest winners

This year, six submissions to the 2023 Beckman Institute Research Image Contest were selected for display in the Beckman Institute Atrium. The creative collaborations, unique perspectives, and scientific curiosity associated with the winning images offer a colorful sample of Beckman's diverse research enterprise.

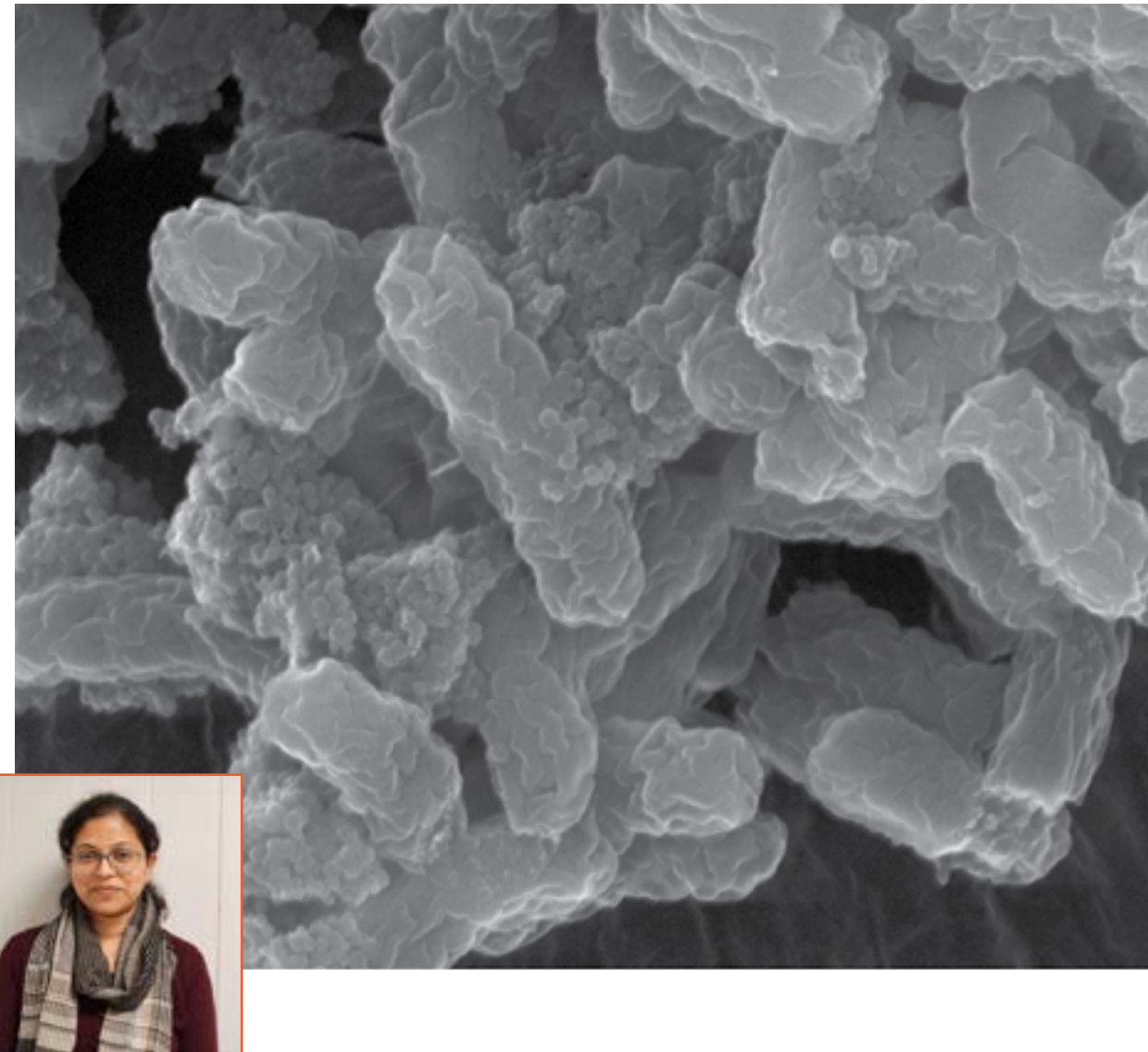
### Time Under Tension



The human brain's 86 billion neurons strain under constant tension, enabling its neuronal network to generate enough mechanical force to lift a 2-pound weight. This image depicts a network of several hundred rat hippocampal neurons (red) surrounded by astrocytes (green). The force of the network pictured is on the order of 100 nanonewtons, which is roughly 5 million times weaker than the force needed to type on a computer.

**Md Saddam Hossain** is a graduate researcher in the Department of Mechanical Science and Engineering. At the Beckman Institute, Hossain collaborates with Professor Taher Saif within the Neurotechnology for Memory and Cognition Working Group. This image was generated with a laser confocal microscope in the Beckman Institute Microscopy Suite.

### Nanoplastics and Bacteria are in a Bind



Nanoplastics are the emerging contaminants in our ecosystem. At less than 100 nanometers long, the tiny plastics interact with bacteria by binding to the cell surface. This image depicts how clusters of polystyrene-based nanoparticles bind to the surface of the food-borne pathogen *E. coli*.

**Jayashree Nath** is a postdoctoral researcher collaborating with Professor Pratik Banerjee in the Department of Food Science and Human Nutrition. This image was generated with an environmental scanning electron microscope in the Beckman Institute Microscopy Suite.



## Charles Schroeder wins Beckman's Vision and Spirit Award

Embracing interdisciplinary collaboration is the key to emulating Arnold Beckman, believes Charles Schroeder, the James Economy Professor in materials science and engineering and a professor in chemical and biomolecular engineering. Schroeder is the winner of the 2023 Beckman Institute Vision and Spirit Award.

The award includes \$50,000 in research funding and honors institute founder Arnold O. Beckman by recognizing a faculty member who has fostered collaboration in their research and exemplifies his vision. Beckman and his wife, Mabel, gave \$40 million to the University of Illinois Urbana-Champaign in the 1980s to create the Beckman Institute.

Former Beckman Director Nadya Mason announced the award at an April 10, 2023, ceremony at the institute. It was the 123rd anniversary of Arnold Beckman's birth.

Schroeder sees relationships and diverse collaborations as a linchpin of scientific research. Former Beckman Director Jeff Moore inspired him with the idea of "super collaborators" when Schroeder joined Beckman five years ago.

In that time, "my research program has undergone a fundamental transformation by becoming highly collaborative with shared projects on diverse topics with multiple colleagues and research groups across campus and beyond," Schroeder said. "In many ways, this award recognizes the collaborative spirit and culture in the Beckman Institute."

Schroeder and his colleagues will use the funding to support ongoing collaborations and forge new directions of inquiry.

*"Prioritize the pursuit of excellence at all levels — including relationship building — while seeking to move the field forward with new ideas."*

Charles Schroeder

## Molecular teamwork makes the organic dream work

Beckman Institute researchers led by chemical and biomolecular engineering professor Ying Diao triggered cooperative behavior in organic semiconductors. This energy- and time-saving phenomenon may enhance the performance of smartwatches, solar cells, and other organic electronics.

Diao and colleague Daniel Davies, the study's lead author and a former Beckman Institute researcher, study organic electronic devices, which rely on semiconductors made from molecules like hydrogen and carbon rather than inorganic ones like silicon. One such device is a solar cell: a wafer-thin window cling that converts sunlight into electricity. Solar cells' flexibility and ability to contour to uneven surfaces are "an important part of the future of organic electronic devices," Davies said.

An important step toward designing dynamic organic electronics is fashioning dynamic organic semiconductors. For that to happen, the semiconductor molecules must cooperate.

Dominoes inspired the researchers' approach to trigger teamwork in a semiconductor crystal. Applying heat to rearrange the clusters of hydrogen and carbon atoms — or alkyl chains — spooling out from a molecule's core caused the core to tilt, triggering a crystal-wide chain of collapse.

Using heat to rearrange the molecules' alkyl chains also caused the crystal to shrink. In an electronic device, this translates to an easy, temperature-induced on-off switch. Additional applications have yet to be fully realized, but for now, the researchers are thrilled with the first step.

Unlocking the potential of molecular collaboration was possible through teamwork on an international scale, with contributing researchers hailing from Purdue University, the Chinese Academy of Sciences, and Argonne National Laboratory.

This research appears in the journal *Nature Communications*.



(From left) Daniel Davies and Ying Diao

"Our research brings semiconductors to life by unlocking the same dynamic qualities that natural organisms like viruses use to adapt and survive."

Ying Diao







# DIVERSITY

## *Breaking down barriers to access.*

Diverse people and perspectives must be present in every stage of the scientific process. Inclusive brainstorming environments and user-focused designs empower researchers at all levels.

This year, creative research projects, new faces, and updated spaces at the Beckman Institute demonstrated the power of diverse thinking to propel science forward.



*“Creating an intentionally immersive environment of disability is impactful for all involved. It drives research and innovation that’s closely connected to the disability experience.”*

*— Adam Bleakney,  
a Beckman researcher,  
the head coach of the  
UIUC men and women’s  
wheelchair track and  
road-racing team,  
and the coach of the  
U.S. Paralympic  
Track and Field Team*





## Researchers, Big Tech companies tackle speech accessibility

In fall 2022, the University of Illinois Urbana-Champaign announced the Speech Accessibility Project, a new research initiative to make voice recognition technology more useful for people with a range of diverse speech patterns and disabilities. Amazon, Apple, Google, Meta, and Microsoft are all supporting the project. Several nonprofit organizations whose communities will benefit from the initiative are also involved.

The project is collecting speech samples from individuals representing a diversity of speech patterns. Researchers and specialized partner organizations are recruiting paid volunteers to contribute recorded voice samples. The Beckman team created a de-identified dataset to train machine learning models to better understand a wide variety of speech patterns.

Mark Hasegawa-Johnson, a professor of electrical and computer engineering, is leading the project at the Beckman Institute. The UIUC team also includes Heejin Kim, a research professor in linguistics; Clarion Mendes, a clinical professor in speech and hearing science and a speech-language pathologist; and several Beckman staff members, including information technology professionals who built a secure repository for the speech samples.



“We’ve created a uniquely interdisciplinary team with expertise in linguistics, speech, AI, security, and privacy to help us meet this important challenge,” Hasegawa-Johnson said.

As of summer 2023, the project is almost halfway through its first phase of gathering voice recordings from people with Parkinson’s. The project will also recruit people with ALS, Down syndrome, cerebral palsy, and people who have had a stroke.

“Speech interfaces should be available to everybody, and that includes people with disabilities.”

Mark Hasegawa-Johnson



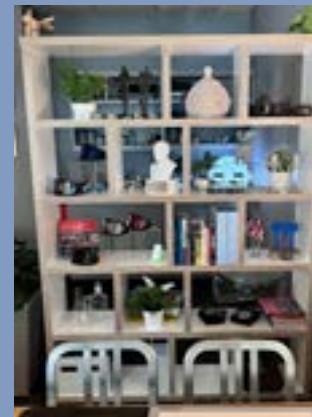
## (dis)Ability Design Studio opens at the Beckman Institute

The new (dis)Ability Design Studio supports interdisciplinary design research centered around the lived experiences of people with disabilities. It’s a partnership between Beckman and the University of Illinois Urbana-Champaign’s Disability Resources & Educational Services.

“We’re focusing on ability,” said industrial design professor Deana McDonagh, the chair of Graphic Design in the School of Art and Design in the College of Fine and Applied Arts and a researcher at the Beckman Institute. “The studio is designed to welcome members of the disability community as contributors to knowledge.”

The studio’s funding comes from the Beckman Institute Vision and Spirit Award, which McDonagh received in 2022. She co-directs the studio with Adam Bleakney, a research affiliate in Beckman and DRES and the head coach of the UIUC men and women’s wheelchair track and road-racing team and coach for the U.S. Paralympic Track and Field Team. The studio in Beckman complements the Human Performance and Mobility Maker Lab within DRES, which Bleakney leads in developing assistive tools and technologies for individuals with disabilities.

Among diverse scientific pursuits, the studio will serve as north campus’ base to design the hands-free wheelchair of the future, an ongoing, National Science Foundation-funded project including Elizabeth Hsiao-Wecksler, a Beckman researcher and the Donald Biggar Willett Faculty Scholar in Mechanical Science and Engineering; Bob Norris, a clinical associate professor of industrial and enterprise systems engineering; and Jeannette Elliott, a physical therapist in DRES. The wheelchair debuted at the Beckman Institute at a reception last fall.



“This partnership will have a very real impact on the lives of individuals with disabilities.”

Adam Bleakney





## Research Image Contest winners

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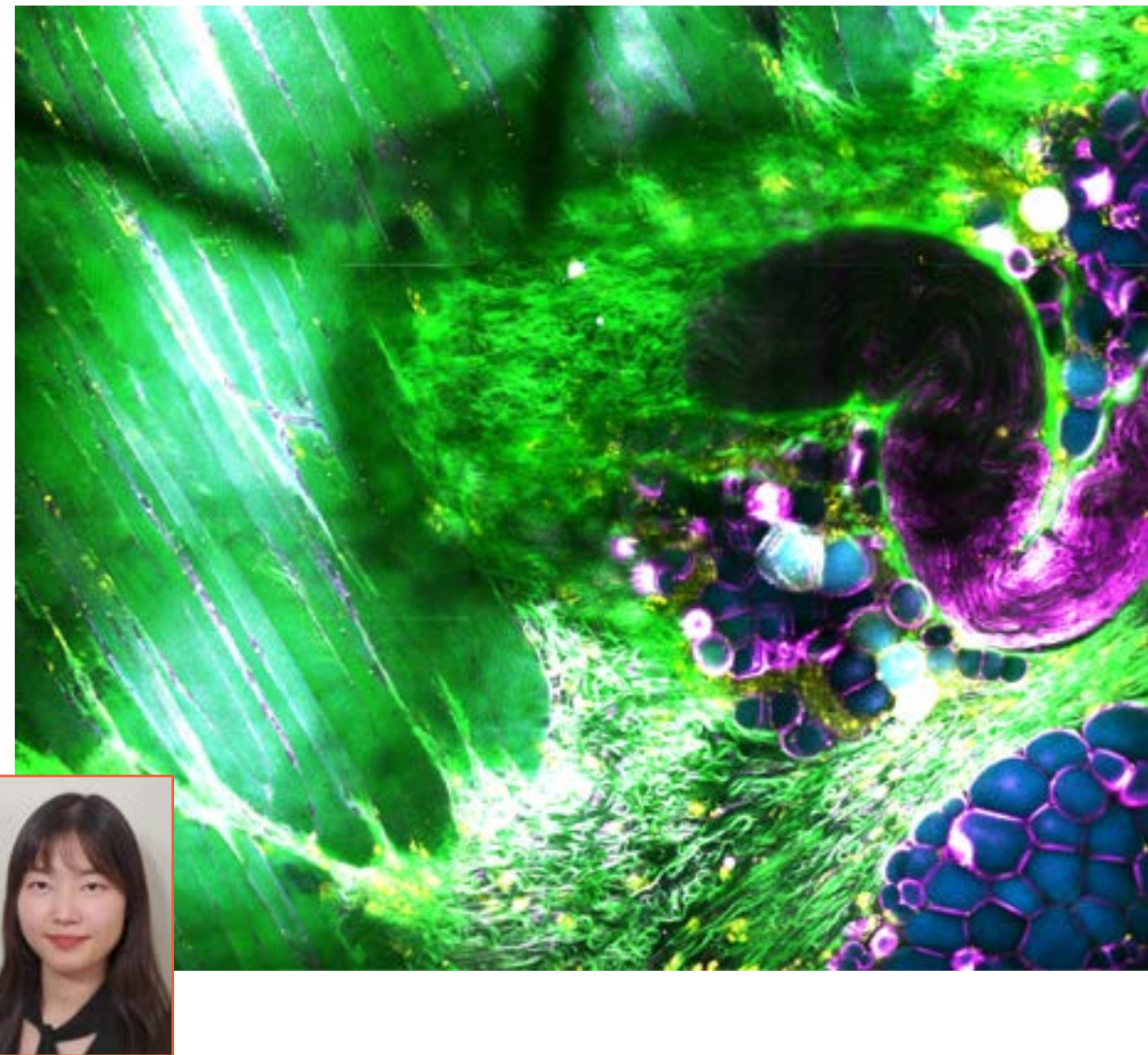
### Spectrum of Thought: Poi Spinner's Cognitive Dance



This image blends physical flow movements with cognitive development. It depicts a luminous projection representing an infinite cerebral spin, illustrating the connective mind-body spark that fuels mental growth. This artistic representation portrayal accentuates the synergies among exercise, technology, and cognition for enhancing brain health.

**Sean Mullen** is an associate professor of kinesiology and community health and the director of the Exercise, Technology, and Cognition Lab. At the Beckman Institute, he conducts research within the Cognition, Lifespan Engagement, Aging, and Resilience Working Group. To create this image, a picture was taken of Mullen spinning LED lights attached to short tethers, a performance art called poi. Mullen used AI software to augment the image and generated a pixie to replace his silhouette.

### Flora, Fibers, and Fluorescence



Resembling a rainforest canopy, mouse muscle fibers appear as elongated green structures, arranged in bundles with a distinct striated, or streaked, pattern. The fibers are separated by adipose tissue (cyan), nerve fibers (magenta), and other connective tissues, adding a burst of floral color to the scene. This image enables label-free visualization of the in-depth muscle tissue, offering a more accurate representation of its structure and composition without stains or dyes.

**Jaena Park** is a graduate student in the Department of Bioengineering. At the Beckman Institute, she collaborates with Professor Stephen Boppart in the Biophotonics Imaging Laboratory. This image was captured with a Simultaneous Label-free Autofluorescence-Multiharmonic, or SLAM, microscope, a laboratory-built microscope in the BIL.





Each year, up to three graduate students receive the Nadine Barrie Smith Memorial Fellowship. The fellowship supports female engineering students conducting medical imaging research at the Beckman Institute and is named for the late Barrie Smith, a prominent researcher who earned her Ph.D. in biophysics from the University of Illinois Urbana-Champaign in 1996. A reflection from a 2023 winner is excerpted here.

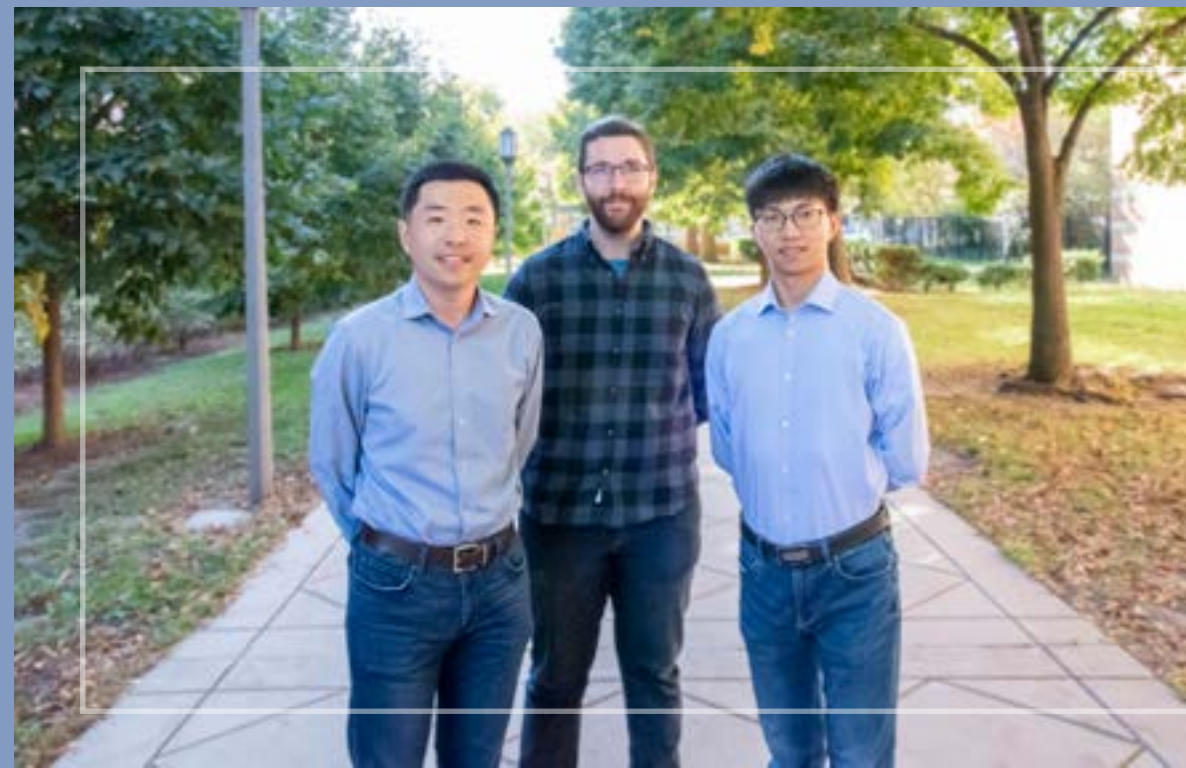
## Empowering women in medical imaging

I recently learned that while Nadine was pursuing her Ph.D., she was a part of the same lab that I am in now. Sure enough, if I go on the lab website and look through the publications, I can see her thesis. She would have been working on that thesis when I was born. Something about the way those threads have woven their way to this present moment strikes me as rather incredible.

Now, I am honored and grateful to join her legacy through the generosity of this fellowship. Like Nadine, my work deals in diagnostic ultrasound — specifically, in being able to better track breast cancer through chemotherapy by designing a small electronic implant that can communicate with ultrasound systems. It is my sincere hope that this work can one day make life a little easier for breast cancer patients, much like this fellowship will make life a little easier for me. Those little things, I find, add up very quickly.

This fellowship has given me an award I can wear with honor and pride as I move forward, beyond this summer and beyond its immediate financial impact. I look forward to the chance to carry some of Nadine’s memory with me, as I now will.

**Jenna Cario**, Ph.D. student in electrical and computer engineering



(From left) Pengfei Song, Matthew Lowerison, and Ph.D. student Zhijie Dong

## Accessible medical imaging for diverse communities

Beckman researchers are developing a device that can instantly add 3D capabilities to 2D ultrasound imaging systems. The device is designed to make affordable, high-quality medical imaging more accessible to diverse communities.

Pengfei Song, an assistant professor of electrical and computer engineering and bioengineering, is leading the project, which is supported by a four-year, \$2 million award from the National Institute of Biomedical Imaging and Bioengineering at the National Institutes of Health.

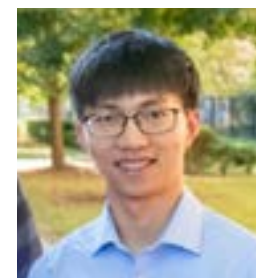
The researchers’ proposed device uses a clip-on technique to easily integrate with the 2D ultrasound probes that most clinics already own. 3D systems are mainly used in high-end facilities for specialized care.

“With 3D ultrasound, you can capture the whole object and surrounding environment, and you have landmarks to know exactly what you’re looking at,” said Matthew Lowerison, a Beckman Institute Postdoctoral Fellow in the Song Lab.

Aptly named FASTER, the device is designed to instantly enable real-time 3D ultrasound imaging for clinics in diverse communities, especially those where such imaging is cost prohibitive.

Small, fast-tilting mirrors allow FASTER to sweep the ultrasonic waves while the probe itself remains stationary, a key innovation that aims to make 3D imaging systems faster and more compact.

“It’s all about thinking creatively,” Song said. “If you can’t move the source, move the signal.”

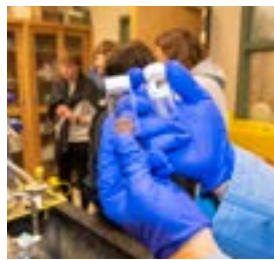


**“We want 3D ultrasound imaging to be a possibility wherever 2D ultrasound imaging is used. We hope that access to 3D technology will drastically improve the level of care that clinics can offer.”**

**Zhijie Dong, a Ph.D. student in the Song Lab**



# 2023 BECKMAN INSTITUTE OPEN HOUSE



## 2023 Beckman Institute Open House

The 2023 Beckman Institute Open House invited campus and community members to engage with the institute's research, people, and — for the first time in four years — physical space.

Guests explored the Illinois MRI Exhibit and took selfies with the first-ever human MRI scanner. They toured the (dis)Ability Design Studio, built molecules from scratch in the Molecule Maker Lab, and watched a film about institute founder Arnold O. Beckman in the auditorium.

More than 30 unique exhibits allowed visitors to engage with science in creative ways, including:

- Using ultrasound to uncover a secret design in a replica of human tissue;
- Playing with larger-than-life molecules in a virtual reality simulation;
- Operating a microscope to see insects up close;
- Extracting DNA from strawberries; and
- 3D-printing with chocolate.

A science scavenger hunt encouraged guests to roam from the basement to the third floor, tracking progress with a stamp-and-paper handout or through the Beckman app. New this year, a set of exhibits flagged for younger visitors helped more than 1,000 K-12 students play through science.

Open house was made possible by nearly 300 Beckman Institute volunteers, researchers, and staff members who donated their time, energy, and creativity.

**48** PIZZAS and  
**120** HOT DOGS enjoyed

**300** new BECKMAN  
APP users

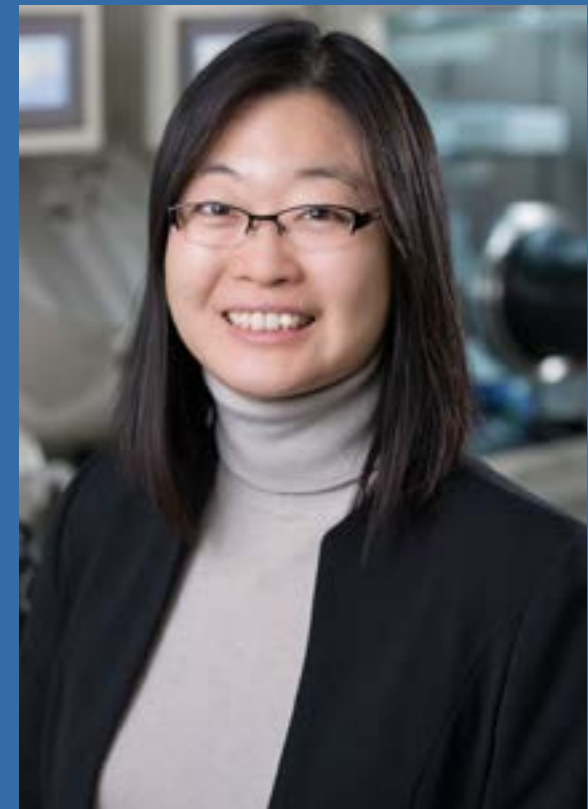
**340** SCAVENGER HUNTS  
completed

**2,400** STICKER SHEETS  
distributed





# EXPLORATION



*“Imagine an intelligent cereal crop that could rewire its own anatomy to become cactus-like during periods of extreme drought. That’s the future we are hoping to create. ... It would open up the ability to reimagine reality.”*

*— Ying Diao, a professor and Beckman researcher*

## *On the cutting edge of technologies, tools, and trends.*

Leveraging the diverse perspectives and interdisciplinary teams at Beckman allows us to advance beyond what has already been accomplished to break scientific barriers across fields.

This year, Beckman researchers made first-of-their-kind discoveries, asked bold scientific questions, and pushed the boundaries of exploratory science — on Earth and beyond.







## Boosting astronaut fitness on NASA's mission to Mars

Exercise looks a little different en route to the Red Planet, so Professor Marni Boppart got creative.

Boppart and her colleagues at the Beckman Institute received \$1 million from the NASA-funded Translational Research Institute for Space Health to explore the regenerative power of cells in space. Their research will help protect human health aboard Orion, the spacecraft destined to ferry the first woman and first person of color from the Earth to the moon, establish humanity's first long-term lunar presence, and eventually trek to the Red Planet.

"Even the most intense exercise protocols performed in space are not sufficient to overcome the negative impacts of microgravity," Boppart said. "Alternatives to traditional exercise, ideally based on exercise principles, are required."

Boppart believes the extracellular vesicles our bodies generate after exercising, and the chemicals they contain, can trigger the restorative effects of exercise — even when no exercise has occurred. She aims to use extracellular vesicles generated naturally by volunteers on Earth, or even artificially, to replicate the restorative effect of exercise in astronauts, enabling their muscles to make post-recovery gains without ever having to lift a space-suited finger.

Her interdisciplinary collaborators at the Beckman Institute include Justin Rhodes, a professor of psychology; Taher Saif, a professor of mechanical science and engineering; Jonathan Sweedler, a professor of chemistry; and Hyun Joon Kong, a professor of chemical and biomolecular engineering. UIUC professor of kinesiology and community health Nicholas Burd is a co-investigator.

Research for this project began in October 2023.

**"Our work will directly test the ability of extracellular vesicles released after exercise to protect human health in space."**

Marni Boppart



## Beckman Institute, Grainger Engineering leading \$10M DOE grant

The University of Illinois received \$10.65 million from the U.S. Department of Energy to help meet President Biden's goal of reaching a net-zero emissions economy by 2050. As a result of this grant, the Beckman Institute and The Grainger College of Engineering are housing the Energy Frontier Research Center for Regenerative Energy-Efficient Manufacturing of Thermoset Polymeric Materials to address the fundamental scientific challenges facing manufacturing and end-of-life management of thermoset plastics.

Nancy Sottos, the department head of materials science and engineering, Swanlund Endowed Chair, and Center for Advanced Study Professor, will serve as the principal investigator and center director. Her team aims to revolutionize thermoset polymeric materials' life cycles.

"When you recycle or reuse plastic, it is often not as good as the original. It gets contaminated, and the polymer network actually changes and ages with time," Sottos said. "What we want to do is understand that process so we can make polymers with the needed properties and performance."

The researchers are combining additive manufacturing, like 3D printing, with a novel, energy-efficient curing process known as frontal polymerization that requires less energy to make thermoset plastics.

Additional Beckman collaborators include Jeff Baur, the Founder Professor of aerospace engineering and affiliate professor of materials science and engineering; Randy Ewoldt, a mechanical science and engineering professor and Kritzer Faculty Scholar; Philippe Geubelle, the Bliss Professor of aerospace engineering; Jeff Moore, the Stanley O. Ikenberry Research Professor of Chemistry; and Sameh Tawfik, an associate professor of mechanical science and engineering.



**"It's absolutely essential that we get a handle on the end of life in the beginning, when we're manufacturing."**

Nancy Sottos

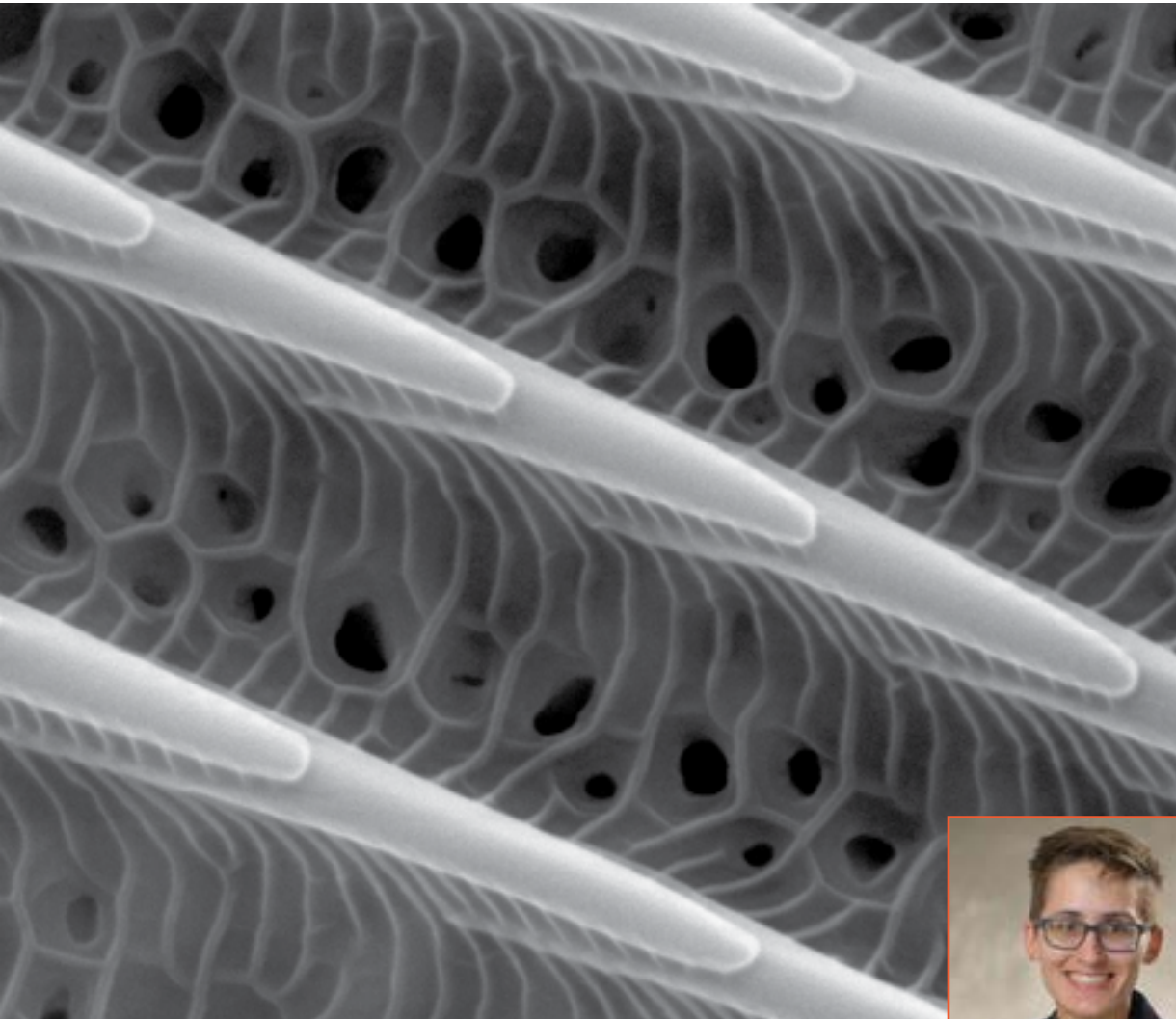




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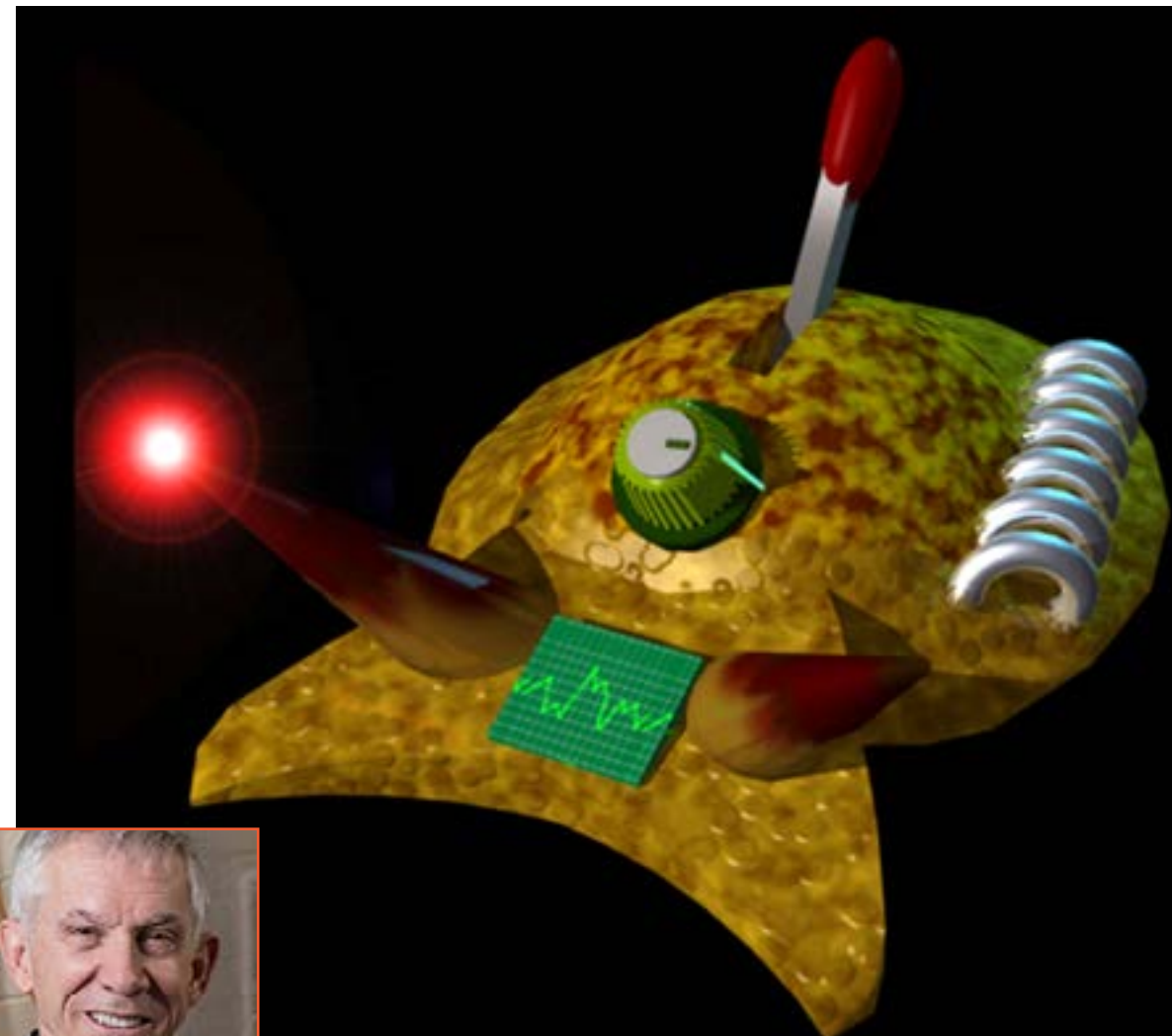
### Tiger Scale



If you pick up a tiger swallowtail butterfly by its wings, you might notice what looks to be dust on your fingertips. That dust is made of small structures called scales. This image depicts a single tiger swallowtail scale magnified by 30,000 times. The scale's lattice structure gives color to the butterfly's wings; engineers have used it as a source of bioinspiration to add color to fabricated items.

**T. Jousek** joined the Beckman Institute as a microscopist in June 2022. This image was generated with an environmental scanning electron microscope in the Beckman Institute Microscopy Suite.

### Cyberslug



Cyberslug represents the simulation of decision-making circuits in the brain of the California sea slug, a predatory mollusk. When foraging, the slug weighs its hunger and experience against the qualities of potential prey; similarly, this agent-based software makes cost-benefit decisions. This image represents one of the first computational entities to simulate simple self-awareness.

**Rhanor Gillette** is a professor emeritus of molecular and integrative physiology and a researcher in the Neurotechnology for Memory and Cognition Working Group at the Beckman Institute. This image was generated by **Mikhail Voloshin**, who is an alumnus of Gillette's lab.





## New center at the Beckman Institute breaks barriers in imaging technology

In fall 2022, Beckman researchers received funding from the National Institute of Biomedical Imaging and Bioengineering of the National Institutes of Health to establish the nationally recognized Center for Label-free Imaging and Multiscale Biophotonics, or CLIMB.

The center focuses on developing optical and computational imaging technologies for clinical use in addition to advancing research on human healthcare and disease. Its development was a collaboration between

Stephen Boppart, a professor of electrical and computer engineering and bioengineering; Mark Anastasio, a professor and head of bioengineering; Rohit Bhargava, a professor of bioengineering; the late Gabriel Popescu, who was a professor of electrical and computer engineering; and additional colleagues in the U.S. and internationally.

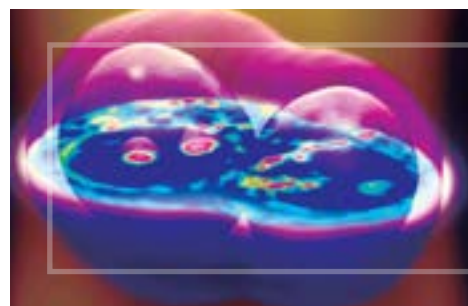
“Traditionally, people have used dyes, stains, and labels in microscopy to provide contrast, but those can be toxic and interfere with the cells and the very processes we are investigating. The

questions arose: ‘What signals can we extract from cells, molecules, and tissues in a label-free manner?’ ... If we can take advantage of that, it can lead to many benefits,” Boppart said.

One such benefit is that technologies developed for label-free microscopy can immediately be incorporated into human studies. The five-year award also enables collaboration projects, service projects, education, outreach, and training.



The late Gabriel “Gabi” Popescu contributed to the development of CLIMB before his unexpected passing in June 2022. The center is a tribute to his legacy.



“With CLIMB, we hope to improve human health and advance our fundamental understanding of human biology and disease. That would ultimately be the significant reward and impact to the scientific community and to patients.”  
Stephen Boppart



## Beckman seed funding enables exploration

This year, the Beckman Institute funded three projects as part of its new research seed grants program, which kick-starts bold research directions that cross disciplines to answer questions that could not be addressed by individuals or departments.

Proposals may request up to \$150,000 for two years. Seeded projects are expected to lead to externally funded proposals after their initial two-year term, at which point they will continue to grow, mature, and gain more interdisciplinary collaborators.

The proposals funded this year will:

- Pair AI with brain imaging technologies to better diagnose, monitor, and treat diseases.
- Guide the metabolisms of food, feed, and fuel crops to adapt in extreme environments.
- Understand the relationship between prenatal maternal stress and infants’ neurological development in underrepresented communities.

Each project includes multiple lead investigators, and each addresses a novel scientific question — or adds a new spin to an existing research area.

“I feel especially proud and excited about the fact that our work is probably the first in Beckman’s history to focus on underserved, minority women, who have been underrepresented in research studies, and to have the leadership of women scientists,” said Andréa Aguiar, a research assistant professor in comparative biosciences and seed grant recipient.

The Beckman Institute offers two additional grants on a rolling basis: outreach and engagement grants, which go beyond research to foster education, outreach, and community-building; and bridge grants, which capture the needs of Beckman’s full- and part-time researchers not covered by existing grants.



Andréa Aguiar

“Ours is the first attempt in the world to develop next-generation AI-powered brain mapping technologies capable of unraveling the structural, functional, and molecular fingerprints of brain function and diseases.”

Zhi-Pei Liang, the Franklin W. Woeltge Professor in electrical and computer engineering and seed grant recipient







## \$30M NSF grant supports whole-cell modeling

Researchers, policymakers, and Minecraft players can engage with Beckman’s Science and Technology Center for Quantitative Cell Biology, supported by a \$30 million U.S. National Science Foundation grant announced in September.

One of four STCs funded by a five-year, \$120 million NSF investment, the center will develop whole-cell models to transform our understanding of how cells function. It is located at the Beckman Institute, where principal investigator Professor Zan Luthey-Schulten and co-PI Martin Gruebele conduct their research.

Whole-cell models can help predict a cell’s response to mutations or environmental changes; situate cells in space and time; model genetic processes; and explain how cells respond to drugs and pathogens.

Models developed through the center will be shared with the scientific community, industry partners, policymakers, and members of the public. To inspire the next generation of scientists, the center will partner with Minecraft, a 3D, open-world video game where players can simulate and investigate a living cell.

“We plan to improve the program to the point where cellular biology can be taught in computer labs across the world, akin to Ms. Frizzle and her Magic School Bus exploring microscopic cells,” said Luthey-Schulten, the Murchison-Mallory Endowed Chair in Chemistry and a professor of physics.

The center draws on and directs many individuals’ expertise. Project collaborators are affiliated with 10 UIUC departments and research institutes as well as external academic and industry partners.

“The challenge to build functioning cell models is beyond any individual or even informal collaborative group. It requires a center structure,” said Gruebele, the James R. Eiszner Endowed Chair in Chemistry and a professor of physics.

**“Now is the right time to start such a moon-shot effort. ... Whole-cell models are now at the transition point between what is possible already and what is not yet possible. This center will make that transition and move beyond it.”**

Zan Luthey-Schulten



## First-of-its-kind study links past experience to teenage girls’ need for belonging

A Beckman study led by psychology professor Karen Rudolph is among the first to demonstrate that past experiences with bullying, friendlessness, and other forms of social exclusion directly affect teenage girls’ need for approval and belonging in their peer group. Making this connection is a critical first step in designing intervention programs to improve teenagers’ mental health.



“For some girls, the need to belong becomes a driving force in their relationships, increasing their susceptibility to mental health disorders like anxiety and depression, and, potentially, their vulnerability to peer pressure,” Rudolph said.

To better understand how teenage girls’ peer experiences early in life might influence their sensitivity to interpersonal pressures as adolescents, Rudolph and doctoral student Haley Skymba designed a study to observe trends in a cohort of 89 girls averaging 16 years old.

The patterns they found demonstrated that teenage girls’ interpersonal needs are indeed a product of past experiences. Knowing teenage girls’ peer history, then, may lead to a more informed understanding of how to nurture their interpersonal needs.

“This study is invaluable in our efforts to identify who is the most vulnerable, and pinpoint when and where that vulnerability originates,” Rudolph said.

This research appears in the *Journal of Research on Adolescence*.



Haley Skymba



The Beckman Institute’s video about this research won a 2023 Mid-America Regional Emmy Award. Scan the QR code to watch it.





# BUILDING BRIDGES

# INSIDE AND OUT

## A culture of collaboration

Beckman was designed as a place to gather and connect — a place that fully includes each of its members. This year, Beckman took important steps to strengthen its commitment to inclusivity, respond to feedback, and clearly communicate changes to its community members.

Starting this year, new Beckman Institute employees received a suite of onboarding materials including an activity checklist; a PDF full of resources, links, and relevant contact information; a link to watch a welcome video; and the chance to take a new-to-Beckman tour of the building.

Recurring and themed events offered opportunities for students, staff, faculty members, and administrators to come together over crafts like pumpkin painting, coffee and cookies from the Beckman Café, and even ping-pong in the new wellness room on Beckman's fourth floor.

The institute also inaugurated its first Diversity, Equity, and Inclusion Committee. Its members have already made several improvements, like opening the gates to the Beckman Garden, providing menstruation materials in all restrooms, and improving communications about Beckman's lactation space. The DEI Committee and Beckman's leadership have many more plans for the future.



## Reaching the community

Interdisciplinary collaborations should happen inside and outside Beckman's walls, says Lexie Kesler, the institute's first full-time staff member dedicated to outreach. She believes that the spirit of teamwork behind scientific discovery should be embraced to share that science with others.

When Kesler joined the institute in June 2022, one of the first steps for the communications and outreach team involved developing a relationship-forward outreach strategy centered around teamwork, trust-building, visibility, science literacy, and inclusivity.

Following these five key principles generated a portfolio of outreach opportunities, including:

- Lesson plans and activities tailored to students in pre-K through high school.
- An MRI fact-checking game to encourage independent navigation through the Illinois MRI Exhibit.
- A suite of tools to strengthen Beckman researchers' science communication skills.

More than 34 local, governmental, and international groups toured the institute this year. A total of 27 outreach events welcomed community groups into the building, took Beckman students and faculty members on the road to local schools, and provided professional development for internal research groups and STEM educators alike.

"Outreach allows us to physically bridge the gap between Beckman and Champaign-Urbana — to engage with new spaces and invite others into the building. I view our community partners as collaborators in every way, whether they are K-12 classrooms, summer camps, or another kind of local organization," Kesler said.



Lexie Kesler







# A BETTER WORLD THROUGH INTERDISCIPLINARY COLLABORATION AND INNOVATION

## OUR MISSION


The Beckman Institute is a community of scholars and a physical space to foster interdisciplinary collaboration, inspire bold scientific risk-taking, and nurture new ideas and discoveries. The institute was founded to reduce barriers between traditional science and technology disciplines in order to yield research advances that otherwise would not occur. Beckman community members accomplish this mission by adhering to our core values.

## CORE VALUES

- EXCELLENCE
- COLLABORATION
- INTEGRITY
- TRANSDISCIPLINARITY
- EXPLORATION
- DIVERSITY



<b>154</b> staff members	<b>78</b> postdocs
<b>190</b> faculty members	<b>321</b> undergraduate students
<b>487</b> graduate students	<b>9</b> visiting scholars

 **29** patents issued to Beckman faculty and staff members during calendar year 2022, with 56 more pending

 **429** publications written by full- and part-time faculty members during calendar year 2022



**Beckman Institute for Advanced Science  
and Technology**

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## New face, same place: Beckman Café gets a makeover

The Beckman Café has been a core part of the Beckman Institute from the beginning. Now, it's going through a complete renovation that will bring the space up to modern standards and will offer ample opportunities for coming together over a meal or a cup of coffee.

The café closed in August for its full renovation and is expected to reopen in late 2024. The new space will include glass walls, bright and welcoming decor, and a standalone coffee shop.

When it's done, community members will be able to grab a tall seat to do some work or connect with their colleagues over a fresh and filling meal. The café is adding a dining room perfect for larger, more formal groups. A chef will join the current café management team and will help update the menu.

Generous gifts from Beckman supporters and researchers are making this project possible. Want to make your mark? Learn more about giving a gift at [Beckman.illinois.edu/give](https://Beckman.illinois.edu/give)