(IQUIST)

Illinois Quantum Information Science & Technology Center

AT THE GRAINGER COLLEGE OF ENGINEERING

2023 - 2024

The Grainger College of Engineering
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

THE GRAINGER COLLEGE OF ENGINEERING

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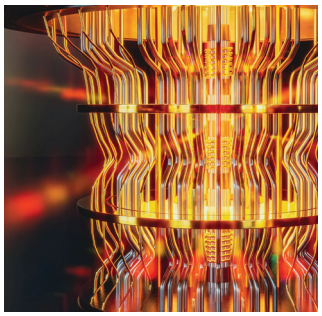

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THE MISSION of the Illinois Quantum Information Science and Technology Center (IQUIST) at the University of Illinois Urbana-Champaign is to advance quantum technology and prepare a quantum-ready workforce through cross-disciplinary research. Launched in 2018, IQUIST brings together experts to drive quantum information science (QIS) in areas like quantum computing, simulation, and sensing. The center also develops educational programs and cutting-edge quantum materials and devices. Building on the university's history of innovation, IQUIST plays a key role in the quantum revolution, collaborating with institutions and tech firms, such as the Chicago Quantum Exchange.

It's an exciting time for the 21st-century quantum revolution, and I am proud of Illinois' place in it. Our faculty lead programs with high impact, including two national-scale centers, and we have a significant footprint in two Department of Energy centers based in the state. We are also at the core of a US CHIPS and Science Microelectronics Commons and a SMART USA manufacturing institute.

The research programs on our campus address frontier challenges in quantum materials and devices, use quantum computers to solve scientific problems, build quantum networking and computing technologies, devise new algorithms and applications, and tackle fundamental science (such as quantum sensing.) Our partnerships with industry, such as the IBM-Illinois Discovery Accelerator Institute, and with fellow researchers and universities around the world ensure quantum information science continues to advance not just for us, but for all.

Quantum is for everyone, and we stand by that by expanding not only the public understanding of the field, but also its economic impact. We established the world's first public quantum network, and we are leading the develpment of the Illinois Quantum and Microelectronics Park—a first of its kind technology campus for scaling quantum computing to market value. We're not only focused on the research and technology, but also on the workforce behind it. Our graduates are highly sought after, and not just in quantum. Illinois is among the top engineering schools in the US with highly ranked degree programs. Our outreach programs educate not only our current individual students, but also future and current leaders in the field.

I am proud to serve as IQUIST Director. I will continue to build coalitions across campus and with industry focused on the development of devices, information science, and computing. With the support of our faculty and students, we will continue to co-lead and support the State of Illinois quantum ecosystem.

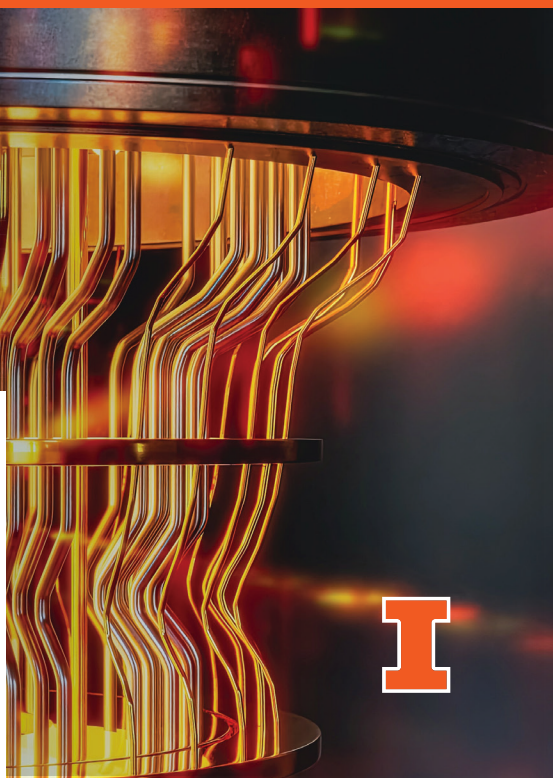
I am excited to see what we can accomplish next! For more stories and to dive even deeper into our mission to solve problems first, visit iquist.illinois.edu or follow us on LinkedIn at Illinois Quantum Information Science and Technology Center.

Brian DeMarco

Director of Illinois Quantum Information Science & Technology Center

» iquist.illinois.edu

Inside Quantum



The Grainger College of Engineering is leading the quantum revolution. With award winning, interdisciplinary faculty and multiple centers dedicated to quantum research, Grainger Engineers are preparing a quantum-ready workforce and are advancing the frontier of quantum information science and technology.

Within The Grainger College of Engineering, the Illinois Quantum Information Science and Technology Center (IQUIST) brings together experts within the university community to collaborate on driving the quantum science & technology revolution. IQUIST researchers and collaborators are working at the forefront of developing quantum devices, quantum computing algorithms, and new protocols for quantum communications. A number of institutes are affiliated with the center, including the NSF Quantum Leap Challenge Institute for Hybrid Quantum Architectures & Networks (HQAN) - a NSF Quantum Leap Challenge Institute - and The Energy Frontier Research Center (EFRC) Quantum Sensing and Quantum Materials (QSQM) which spans three institutions with additional team members and leadership from University of Illinois-Chicago and the SLAC National Accelerator Laboratory.

$160M+

In active federal funding

Outreach

- Public Quantum Network
- Q2Work
- Open Quantum Initiative (OQI) Undergraduate Fellowship
- LabEscape

Centers

- HQAN
- EFRC QSQM
- IIDAI
- Q-NEXT
- SQMS

Research Areas

- Quantum Computing
- Quantum Networking
- Quantum Sensing
- IQUIST Testbed Facility for Quantum Computing & Networking
- Distributed Processing, Network Protocols, and Software Development
- Topologically Protected Qubits
- Protected Qubits

Interdisciplinary Departments

- Aerospace Engineering
- Computer Science
- Electrical and Computer Engineering
- Materials Science and Engineering
- Mechanical Science and Engineering
- National Center for Supercomputing Applications (NCSA)
- Physics
- Chemistry
- Philosophy
- Math
- Business

Programs + Partnerships + Initiatives

NSF QLCI Hybrid Quantum Architectures and Networks
The National Science Foundation Quantum Leap Challenge Institute for Hybrid Quantum Architectures and Networks (HQAN) is one of the five NSF centers created by the 2018 National Quantum Initiative Act. Led by UIUC, HQAN integrates multidisciplinary expertise to develop hybrid, distributed quantum computing as a new paradigm. Its workforce development initiatives are inspiring and training students who will contribute to the future quantum technology and innovation ecosystem.

Q-NEXT
Q-NEXT brings together national labs, universities, and technology companies to solve cutting-edge challenges in quantum information science. Led by the U.S. Department of Energy's Argonne National Laboratory, Q-NEXT focuses on how to reliably control, store, and transmit quantum information at distances that could be as small as the width of a computer chip, or as large as the distance between Chicago and San Francisco.

Q2Work
Q2Work is a National Science Foundation-funded initiative led by UIUC and the University of Chicago to provide quantum education, programs, tools, and curricula to K-12 students. To achieve a competitive quantum workforce, future workers must gain a robust set of quantum computing skills. Q2Work is designed to accelerate progress across the quantum education community by amplifying its efforts through dissemination and collaboration.

Quantum Sensing and Quantum Materials
Quantum Sensing and Quantum Materials (QSQM) is a collaborative Energy Frontier Research Center (EFRC) spanning three institutions, including UIUC, the University of Illinois Chicago, and the SLAC National Accelerator Laboratory. QSQM draws together experts in quantum information science, physics, and materials science to develop and apply novel quantum sensing methods to unravel the mysteries of three families of quantum materials: exotic superconductors, topological crystalline insulators, and strange metals.

IBM-Illinois Discovery Accelerator Institute
The IBM-Illinois Discovery Accelerator Institute launched in 2021 with a $200 million investment by IBM, the University of Illinois, and the State of Illinois. Its initial ten-year focus is on the rapidly growing areas of hybrid cloud and AI, quantum information science and technology, and accelerated materials discovery and sustainability. Several quantum-technology projects led by IQUIST faculty are underway.

Duality
The Grainger College of Engineering is a founding member of Duality, the first accelerator program in the US exclusively focused on supporting early-stage quantum companies. This 12-month program provides startups with the critical resources they need to succeed. Based in Chicago, the program draws on the region's deep well of scientific, corporate, and industry expertise to develop practical applications in quantum technology.

Chicago Quantum Exchange
A collaboration of universities and national laboratories, the Chicago Quantum Exchange (CQE) is an intellectual hub for advancing quantum information science and engineering across the Midwest and globally. CQE members, including The Grainger College of Engineering, focus on exploiting quantum mechanics—the theory governing nature at its smallest scales. The aim is to apply research innovations to develop new types of devices, materials, and techniques for quantum communication, computing, and sensing.

The Bloch Tech Hub
The Chicago region has been named an official U.S. Regional and Innovation Technology Hub for quantum technologies, a designation that opens the door to new federal funding and recognizes the growing strength of an ecosystem poised to become the heart of the nation's quantum economy.

» iquist.illinois.edu

Grainger Engineering researchers

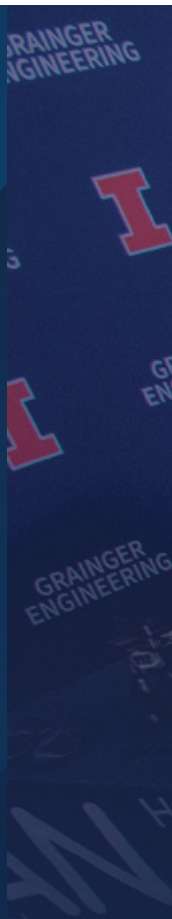
LAUNCH WORLD'S FIRST PUBLIC QUANTUM NETWORK

Story by Aaron Seidlitz

Physics professors Virginia "Gina" Lorenz and Paul Kwiat and their research teams from The Grainger College of Engineering at the University of Illinois Urbana-Champaign introduced the world's first publicly available quantum network at The Urbana Free Library on Saturday, Nov. 4.

The day's event began at 1 p.m. and connected the public to quantum science through interactive demos, while also serving up liquid nitrogen ice cream and games for participants of all ages

Although quantum science is already integrated into everyday life, through technology ranging from MRI machines to GPS, it also remains detached from many people's purview considering the complexity of the discussion.



Lorenz and Kwiat believe that now is the time for people of all ages to access this new scientific frontier in real time, to better comprehend it and imagine the new possibilities available to all of us in the 21st century.

That's why the University of Illinois partnered with the Urbana-Champaign Big Broadband (UC2B) fiber optic network and The Urbana Free Library to make real quantum connections over optical fiber.

"What I study, quantum optics, is amazing because it brings profound ideas about the universe together in experiments that fit on a table," Lorenz said. "You can see that the world follows quantum rules with just a few components that you set up and adjust with your own hands. I want people to experience that and think, 'Yeah, this is something I can do, too!'"

The local community returned the professors' enthusiasm, as a packed crowd filled the viewing room at the library with a noticeable energy to see the professors' display and witness their ingenuity.

Working with students, colleagues, and staff from Grainger Engineering, and in collaboration with the library, Lorenz and Kwiat linked the local Urbana Free Library to the Illinois campus.

> *"What I study, quantum optics, is amazing because it brings profound ideas about the universe together in experiments that fit on a table"*
>
> *- Virginia "Gina" Lorenz, (Atomic, Molecular, and Optical Physics Professor)*

Key to this mix of research and citizen science is an existing public fiber-optic network that spans Champaign and Urbana. While such networks are widely used in standard telecom technology, they can be repurposed to support quantum communication channels, even in this early stage of development. The twin cities have a public fiber-optic network – the UC2B network – that was laid with funding from the American Reinvestment and Recovery Act of 2009.

"The UC2B network started to create something special years ago, and it is wonderful to see that it's worth is still being uniquely leveraged," said Paul Hixson, former Illinois CIO and current co-chair of the UC2B board. "When we built the original fiber backbone for this community, our immediate intent was to extend high speed connectivity at an affordable price to critical community anchor institutions, and to individual households. We wanted our community to be able to participate in cutting edge developments that we knew would be coming in the near future.

"Another critical focus of the UC2B network from its beginning has always been to provide traditionally underserved communities access to these cutting-edge technologies, and it's clear that Illinois professors Lorenz and Kwiat continue to emphasize that important aspect."

Indeed, Lorenz believes that for these technologies to fully deliver on their promise, they must be available to everyone regardless of training and background.

> "We want to get everyone excited about quantum technology"
>
> *- Virginia "Gina" Lorenz, (Atomic, Molecular, and Optical Physics Professor)*

"We want to get everyone excited about quantum technology," she said. "Maybe they'll think about things in a way that scientists haven't thought about. Maybe they'll ask questions that no one has really got an answer to, even if it's something like, 'Why not use it like this?' Or perhaps they will ask important ethical questions around the technology, or be inspired to incorporate it in art."

In addition, Kwiat was instrumental in establishing a quantum network to link the University of Illinois to other institutions in the Chicago Quantum Exchange: Argonne National Laboratory, Fermilab, and the University of Chicago. The collaboration plans for connecting this research quantum network with the public network, offering additional opportunities to study the challenges of implementing networks outside laboratory conditions.

The NSF Quantum Leap Challenge Institute Hybrid Quantum Architectures and Networks provided seed funding for the project. The institute director, Illinois Physics Professor Brian DeMarco, said, "This public quantum network, a truly genius project from Gina Lorenz, is a great example of all the special things happening with quantum research at the University of Illinois right now. It highlights the power of community coming together and the importance of research initiatives such as the Illinois Quantum Information Science and Technology Center, academia-industry partnerships, and cross-institutional collaborations through the Chicago Quantum Exchange."

Those who attended the event got to see for themselves how quantum particles can "affect" each other no matter the distance between them, through a live demonstration of the experiment for which the physics Nobel prize was awarded in 2022.

Paul Kwiat

Virginia Lorenz

"The Urbana Free Library was honored to be the site of the first publicly accessibly quantum network in the world," said Celeste Choate, Urbana Free Library executive director. "Our library, and libraries in general, serve as essential community hubs, and are uniquely qualified to combine public access, technology, and educational opportunities for all ages.

"We encouraged our patrons to visit the Library for the launch event (and try some liquid nitrogen ice cream!) to engage with this new technology, which became accessible to the public at the library from then on. It is through partnerships like this – between esteemed researchers and public services – that technology can have meaningful impact."

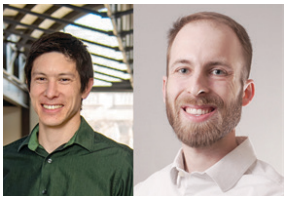
As Dean of Grainger Engineering, Rashid Bashir consistently encourages fellow researchers to push the boundaries of what's possible, knowing that support is there for those in this state and country ready to tackle society's next great challenges.

"When we discuss solving problems first, Grainger Engineers have proven time and again that this comes from curious and effective minds pushing scientific advancement forward," Bashir said. "Professors Lorenz and Kwiat have developed a truly unique public quantum network connection. This is the only of its kind, and it's going to help our state and our nation as we further establish new developments in quantum computing."

Grainger Engineers work to do one thing:

solve problems.

See how our Illinois Quantum Information Science and Technology Center leaders are changing the world for the better.



Design rules and synthesis of quantum memory candidates

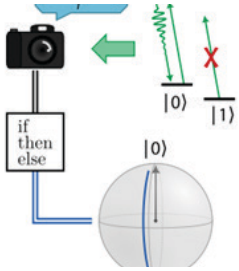
In the quest to develop quantum computers and networks, there are many components that are fundamentally different than those used today. Like a modern computer, each of these components has different constraints. However, it is currently unclear what materials can be used to construct those components for the transmission and storage of quantum information.

READ FULL STORY
mrl.illinois.edu/news/65215

Quantum at the Capitals

To help develop the quantum technologies of tomorrow, we need to educate the leaders of today. IQUIST Director Brian DeMarco has engaged with state and federal leaders with that intent.

READ FULL STORY
go.grainger.illinois.edu/QuantumattheCapitals



Covey group aiding the development of neutral atom quantum computing

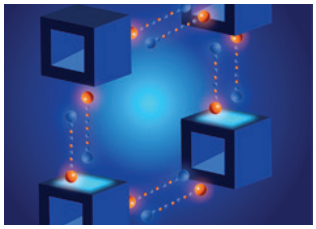
Physicists at the University of Illinois Urbana-Champaign have developed a procedure for measuring ytterbium-171 qubits that preserves them for future use.

READ FULL STORY
iquist.illinois.edu/news/59745

Bradlyn group shows how to detect higher-order topological insulators

Just like a book can't be judged by its cover, a material can't always be judged by its surface. But, for an elusive conjectured class of materials, physicists have now shown that the surface previously thought to be "featureless" holds an unmistakable signature that could lead to the first definitive observation.

READ FULL STORY
iquist.illinois.edu/news/63523



Chitambar group establishes criterion for nonlocal quantum behavior in networks

A new theoretical study provides a framework for understanding nonlocality, a feature that quantum networks must possess to perform operations inaccessible to standard communications technology. By clarifying the concept, researchers determined the conditions necessary to create systems with strong, quantum correlations.

READ FULL STORY
iquist.illinois.edu/news/chitambar-group-establishes-criterion-for-nonlocal-quantum-behavior-in-networks

IQUIST executive director testifies before U.S. House Committee on Science, Space, and Technology

The University of Illinois' Emily Edwards testified before the U.S. House Committee on Science, Space, and Technology about the importance of quantum education as the committee works to reauthorize the National Quantum Initiative Act.

READ FULL STORY
iquist.illinois.edu/news/57118

Grainger engineers bring quantum expertise to DOE InterQnet initiative

A new theoretical study provides a framework for understanding nonlocality, a feature that quantum networks must possess to perform operations inaccessible to standard communications technology. By clarifying the concept, researchers determined the conditions necessary to create systems with strong, quantum correlations.

READ FULL STORY
csl.illinois.edu/news-and-media/67009

AWARDS AND HONORS

Illinois Quantum Information Science and Technology Center

Our quantum scientists are proven leaders in their field. Whether it be in the classroom and labs or the international stage, breakthroughs in quantum science are achieved in part from their research. Meet our latest quantum faculty to earn national and global recognition for their work.

JACOB COVEY // DOE Early Career Research Program Award
physics.illinois.edu/news/Covey-DOE-Early-Career

AMANDA YOUNG // IUPAP Early Career Scientist Prize in Mathematical Physics
iquist.illinois.edu/news/69210

JACOB COVEY // NSF CAREER Award
physics.illinois.edu/news/Jacob-Covey--NSF-CAREER-Award

TAYLOR HUGHES // Elected APS Fellow
physics.illinois.edu/news/hughes-elected-APS-Fellow

Fellowships + Internships

The IQUIST Postdoctoral Scholar Program offers selected scholars an opportunity to engage in an interdisciplinary research fellowship in quantum science. Fellows are appointed annually for up to three years. 2023 awardees

Jacob Beckey
Postdoctoral Research Associate working with Prof. Felix Leditzky

Shashin Pavaskar
Postdoctoral Research Associate working with Prof. Yonatan Kahn

Bowen Shi
Postdoctoral Research Associate working with Prof. Jong Yeon Lee

Mehrdad Tahmasbi
Postdoctoral Research Associate working with Prof. Dakshita Khurana

Edelheit Summer Quantum Interns Three PhD students received the Edelheit Summer Quantum Internship Award, courtesy of a donation from Dr. Lewis S. "Lonnie" Edelheit, an alumnus of the Department of Physics

Haneul "Chloe" Kim
Postdoctoral Research Associate working with Prof. Fahad Mahmood

Kelsey Ortiz
Postdoctoral Research Associate working with Prof. Jacob Covey

Louis Schatzki
Postdoctoral Research Associate working with Prof. Angela Kou

AT GRAINGER ENGINEERING

ILLINOIS QUANTUM INFORMATION SCIENCE AND TECHNOLOGY CENTER

has got the numbers!

WE SOLVE PROBLEMS *first*

Our students are sought-after hires, our alumni are trusted leaders in the industry and our faculty are called upon to offer solutions to global-scale problems.

$160M+
IN ACTIVE FEDERAL FUNDING

45+
POSTDOCS

200+
GRADUATE STUDENTS

68
INTERDISCIPLINARY FACULTY

1st
PUBLIC QUANTUM NETWORK

Events

Engagement with peers, alumni and corporate partners through programming that brings like minded students and faculty together. People are the heart of Grainger Engineering. Involved student communities and a network of over 97,000 alumni means you'll meet some of the most brilliant, compassionate minds who will shape you into a highly-sought after engineer upon graduation.

IQUIST Seminar Series

» IQUIST Seminar Series

Fall 2023 + Spring 2024

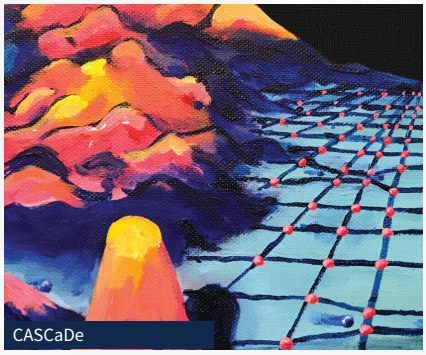
The Illinois Quantum Information Science and Technology Center hosts a series of talks about topics related to Quantum Information Sciences in its various forms, including (but not limiting to): Quantum computers, Quantum simulation, Measuring the elusive Majorana fermion, and Photons. Talks are given by professors from various universities as well as senior researchers from universities, laboratories, institutes, and industry businesses.

Young Researchers Seminar Series

» Young Researchers Seminar Series

Fall 2022 + Spring 2023

Similar to the IQUIST Seminar Series, talks related to quantum information sciences and its research are given by graduate and PhD students within IQUIST members' research groups.


CASCaDe

» CASCaDe

April 19, 2024

The Collective for Arts-Science Creativity and Discovery, creates artistic experiences that explore questions about humanity and its place in the Universe. It is comprised of university students, faculty, and staff, and groups from diverse walks of life. CASCaDe debuted this year with the performance of a fragment from Quantum Voyages: adventure tale, the presentation of creative student work from the course Where the Arts Meets Physics, connections through a many-body Quantum Entango, and contemplation of the Universe.

World Quantum Day

» World Quantum Day

April 13, 2024

IQUIST celebrated World Quantum Day on Saturday, April 13, 2024 with campus community members and the public. Events included a talk, educational activities, a quantum themed escape room (LabEscape), and the debut performance of CASCaDe.


Beyond IID

» Beyond IID

July 29-August 2, 2024

The twelfth Beyond IID in Information Theory workshop was held this summer on the Illinois campus, its first iteration in the United States. The conference focused on ideas from both classical and quantum information theory that exceed the standard consideration of "iid" (independent and identically distributed) events, carrying on the conference's traditions while showcasing elements of the quantum culture in Illinois.

Follow

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X, Instagram, LinkedIn and YouTube

WE SOLVE PROBLEMS FIRST.
NOT FOR THE GLORY,
but for the good.

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