transform quantum

transforming quantum
from vision to reality

Steven Koester
MiNIC (U Minnesota)

Robert Westervelt
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Concept:

Enabling quantum information, science, and technology via network-wide nanofabrication infrastructure and expertise.

Approach:

Rethink current methods to develop **quantum-specific** best practices.

Engage students, teaching, professionals at the intersection of quantum information sciences and nanofabrication.

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https://hbar.uchicago.edu/tq/

- Many activities have been through the Global Quantum Leap (GQL) AccelNet program, led by the University of Minnesota:
- Three main activities ongoing / planned:
  - Student / faculty exchanges coordinated and funded through the GQL,
  - Bootcamps, short courses for K-12, undergrads, teachers and professionals,
  - New: Workshop on Quantum Engineering Infrastructure II (WQEI 2).

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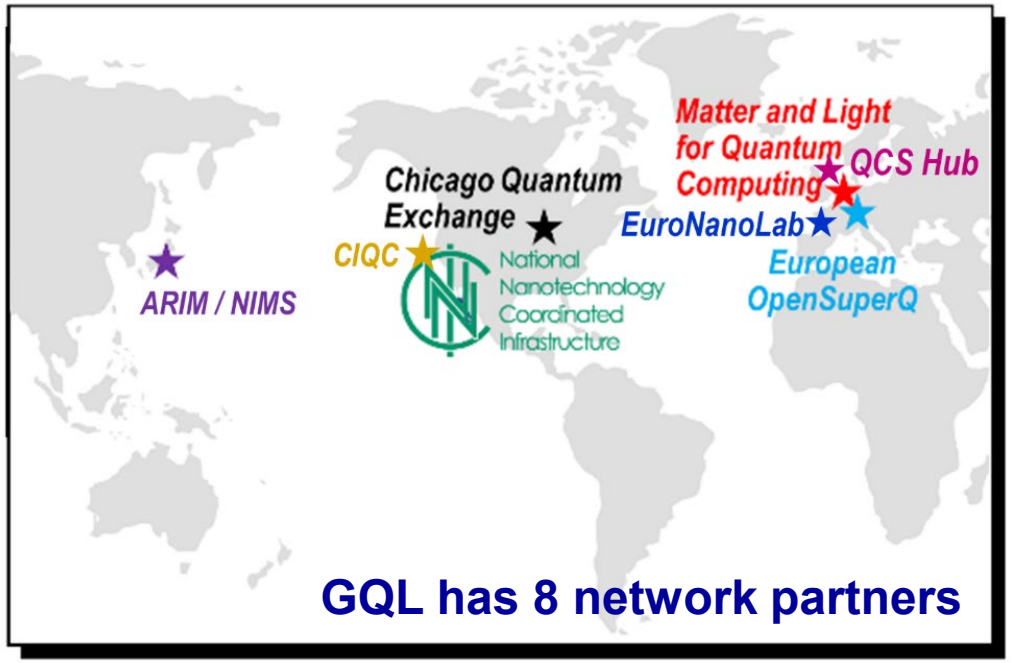
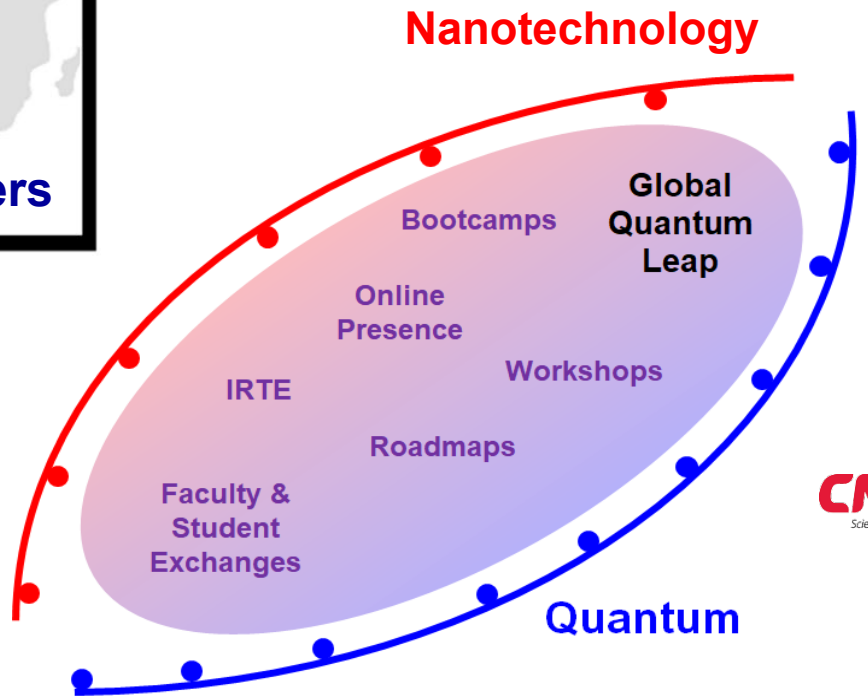


- The Global Quantum Leap (GQL) is funded through the NSF AccelNet program and creates a network-of-networks in the fields of **nano-fabrication** and **quantum computing & information sciences:**



GLOBAL QUANTUM LEAP

MiNIC
Midwest Nano Infrastructure Corridor

UMN lead institution

CNF Cornell NanoScale Science and Technology Facility
SENIC Southeastern Nanotechnology Infrastructure Corridor
SHyNE Soft and Hybrid Nanotechnology Experimental Resource

- **GQL trains nano- and quantum scientists to work in diverse, international environments.**

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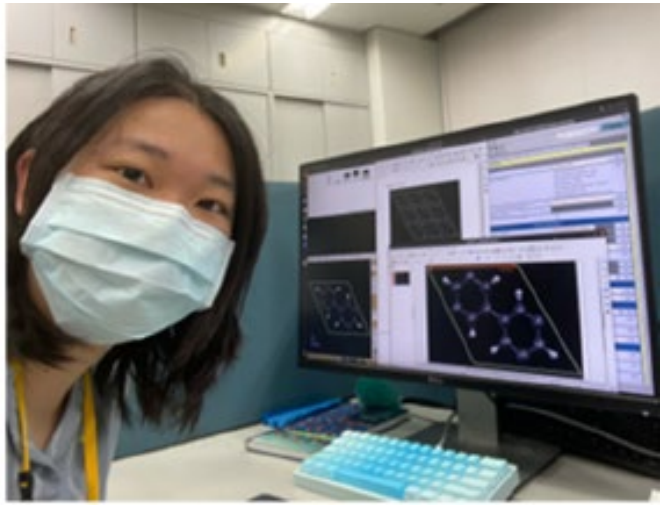
Summer 2022, International Research and Training Experience (IRTE): NIMS, Tsukuba Japan

- 2 students, 1 postdoc participant.
- Very good feedback despite concerns about COVID.

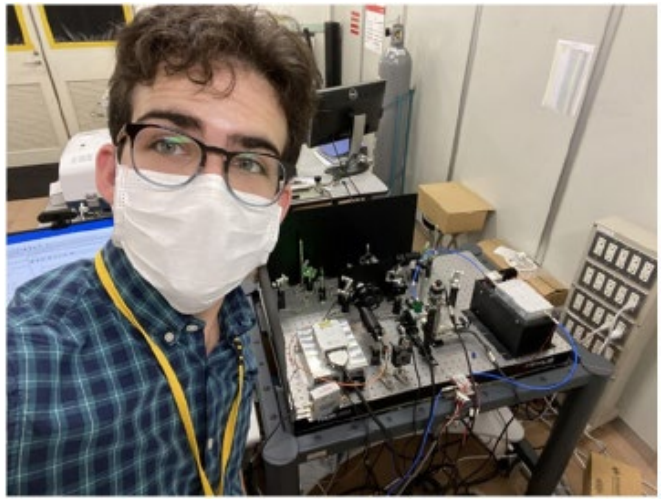
https://www.globalquantumleap.org/irte-22-experiences

"Great opportunity to collaborate & work with researchers worldwide."



Veronica Show
Harvey Mudd

"Scientifically and socially transformative."



Aulden Jones
Georgia Tech

"Best experience one could have."

Zizwe Chase
University of Illinois - Chicago

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Lynn Rathbun, Cornell University - Coordinator

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Summer 2022, organized four research-specific exchange projects

- Student exchange: FZ Jülich to University of Minnesota
- Student exchange: UC Berkeley to University of Tokyo
- Student exchange: Oxford University to U Oregon
- Postdoc exchange: Delft University to Cornell

ML4Q

Quantum Computing & Simulation Hub

CHICAGO QUANTUM EXCHANGE

Justus Teller
Julich → UMN

Isabel Sacksteder
UC Berkeley → U Tokyo

Ellis Ainley
Oxford U → U Oregon

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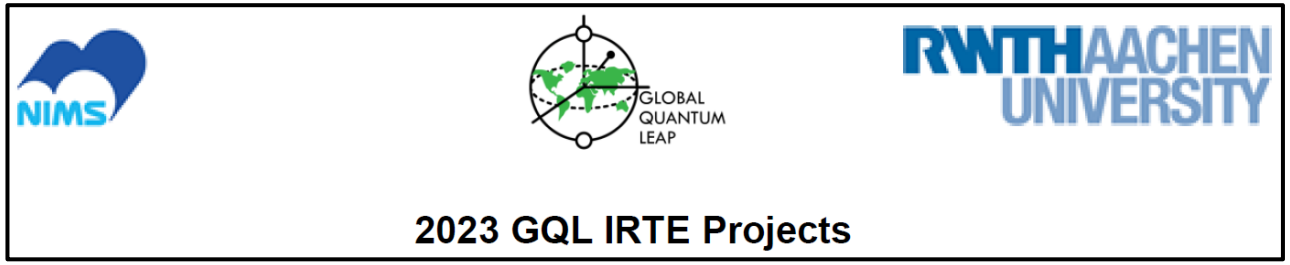
Summer 2023, Ran 2 IRTE programs in Germany and Japan:



- **Project 1 (Japan):** Coherent control of electron spin in diamond for quantum device application
- **Project 2 (Japan):** Fabrication and characterization of moiré superlattice devices
- **Project 3 (Japan):** Theory and simulation of nano-patterned 2D materials
- **Project 4 (Germany):** Mapping of local valley splitting in Si/SiGe by forming a quantum dot by magneto-spectroscopy and pulse spectroscopy at 10 mK
- **Project 5 (Germany):** Pre-characterization of electron shuttle devices at 4 K and 10 mK
- **Project 6 (Germany):** Topological Quantum Error Correction
- **Project 7 (Germany):** Quantum Neural Networks and Machine Learning
- **Project 8 (Germany):** Spin Qubits in Graphene Quantum Dots

Tremendous response to program.

In total:

- 94 applications requested
- 43 applications received
- 19 recommendations requested
- 14 short-short listed
- 6 US students chosen for program

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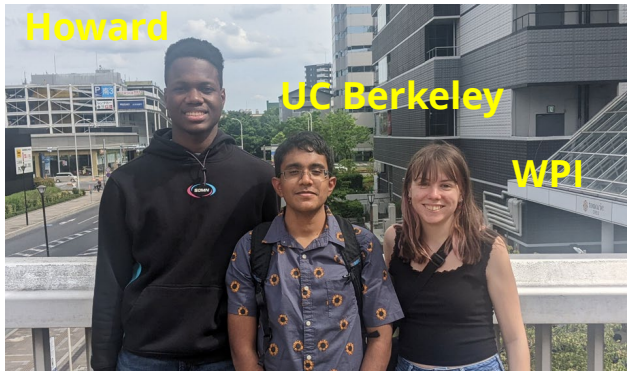
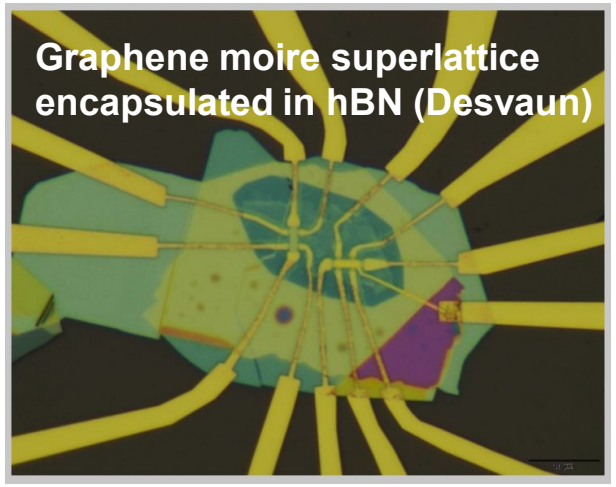
Summer 2023, IRTE program:





Feedback from mentors:

"I am very satisfied with this first experience…we are planning to write up a research paper on his research results, which is a remarkable outcome for an undergraduate internship."

"Sammy was…fully integrated into the group.'"

"I will be happy to participate as a host group again next year, and I will be happy to encourage colleagues of mine, too."

https://ml4q.de/ml4qa/

While in Germany, I recorded an episode for ML4Q podcast to promote GQL and NNCI.

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New opportunities:

- Two 2024 International Research and Training Experience (IRTE) opportunities open to students at US universities:
  - 10-week summer program in quantum materials: NIMS @ Tsukuba, Japan (4 students).
  - 10-week summer program in quantum information at RWTH Aachen University in Aachen, Germany (4 students).
  - Applications due by November 22, 2023. Applications can be requested by emailing Lynn Rathbun at LCR2@cornell.edu or skoester@umn.edu.

See pre-announcement and program details below. Applications available soon:
https://www.globalquantumleap.org/irte-program

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https://sites.google.com/umn.edu/quantum/home

- MiNIC hosted a 10 day program designed for undergraduate students to introduce them to key topics in quantum phenomena and their computing devices.
- The program ran from 7/31/23 through 8/11/23, at the University of Minnesota, and involved:
  - tutorials on quantum devices and concepts,
  - a computer lab to learn how to program an actual quantum computer,
  - presentations from industry on recent advances in chip,
  - lab tours,
  - visits to local high-tech companies.

MiNIC
Midwest Nano Infrastructure Corridor

NSF DMREF MATERIALS FOR OUR FUTURE

KYUNG HEE UNIVERSITY

GLOBAL QUANTUM LEAP

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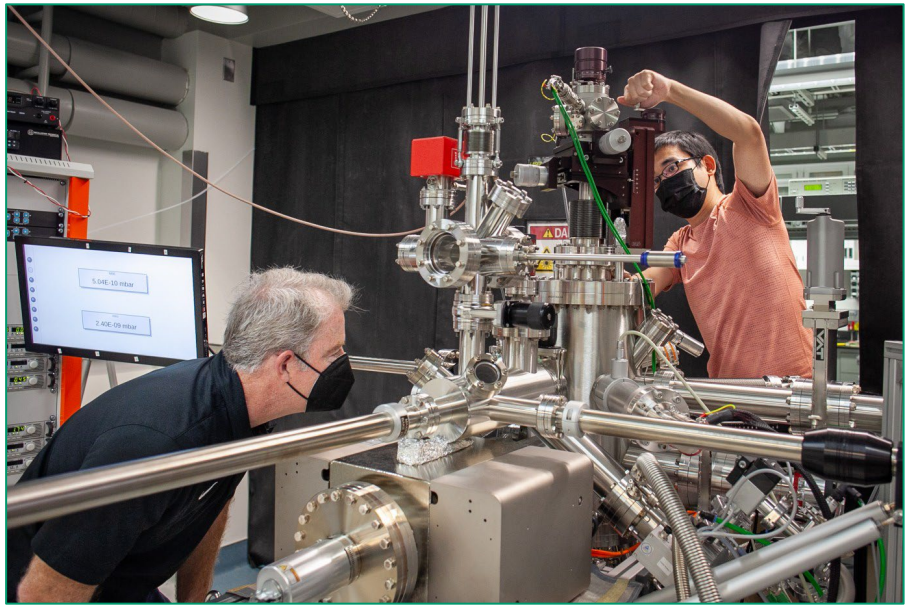
Bootcamps, workshops, other activities:



TeachQuantum

- Targeting teachers in K-12, especially high school
- 6-week summer research experience
- Multi-year immersive program
- Real-world quantum research environments
- Facilitates teaching quantum-focused STEM concepts and activities

Support: NSF Quantum Leap Challenge Institute for Hybrid Quantum Architectures & Networks (HQAN)
Apply via UIUC, UChicago & UW - Madison

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Bootcamps, workshops, other activities:

CHICAGO QUANTUM EXCHANGE

Quantum Science, Networking, and Communications

- 8-week course in quantum technology
- Targeting early-career & mid-career with bachelor's degree in science
- Quantum information processing, quantum networks and communication, technical demonstrations and simulations

Intensive Quantum Engineering and Technology

- 4-day course in quantum engineering
- Targeting current professionals in transition to quantum careers
- Master's or higher degree recommended

Support: NSF Quantum Leap Challenge Institute for Hybrid Quantum Architectures & Networks (HQAN)
Apply via CQE @ UChicago

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2024 quantum internships:

IBM Research Global Internship Program

Accepting applications for 2024:

- Interns for software development, hardware engineers, and research scientists
- Internships from May 20 to Aug. 9, 2024, or June 17 to Sept. 6, 2024
- US-based only. See https://research.ibm.com/blog/2024-quantum-internships

Fermilab SQMS Quantum Undergraduate Internship

- Participate in DOE National Quantum Initiative research effort
- Application: Dec 18, 2023 – Feb 23, 2024
- Program: June 17 – Aug 3, 2024
- Salary: $600/wk; support for travel & accommodations
- See https://internships.fnal.gov/sqms-quantum-undergraduate-internship/

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New!! Workshop on Quantum Engineering Infrastructure II: Follow-up to 2021 event will help drive infrastructure development for NNCI and US in general:

Workshop on Quantum Engineering Infrastructure II

Sunday, March 3, 2024, Minneapolis, MN

- This workshop will be held in person from Mar 3, 2024
- Sunday before the APS March Meeting in Minneapolis, MN.
- On the campus of the University of Minnesota.

3 main goals:

(1) Review the outcomes from the 2021 workshop (WQEI I) and evaluate progress toward recommendations,
(2) Understand how new developments have altered the needs and best practices for quantum fabrication,
(3) Provide a vision for the future of quantum fabrication infrastructure, particularly in light of the CHIPS & Science Act and other infrastructure investments

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If anyone has suggestions for additional quantum-related interactions within the NNCI community, feel free to reach out to us at:

Steven Koester: skoester@umn.edu

Andrew Cleland: anc@uchicago.edu

Bob Westervelt: westervelt@seas.harvard.edu

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