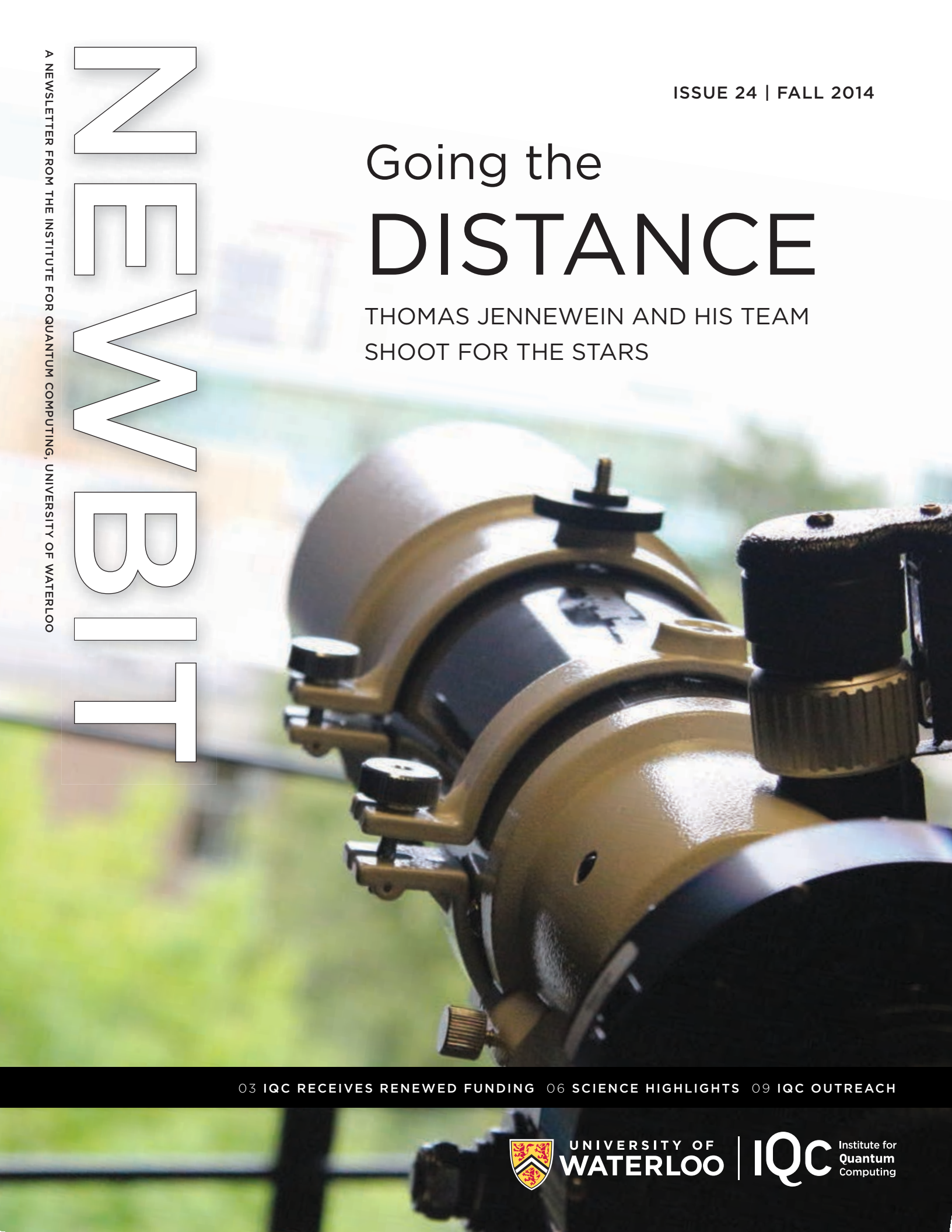
NEWSBIT

A NEWSLETTER FROM THE INSTITUTE FOR QUANTUM COMPUTING, UNIVERSITY OF WATERLOO

ISSUE 24 | FALL 2014

Going the DISTANCE

THOMAS JENNEWEIN AND HIS TEAM SHOOT FOR THE STARS



UNIVERSITY OF WATERLOO | IQC Institute for Quantum Computing

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UNIVERSITY OF WATERLOO | IQC Institute for Quantum Computing

IN this issue

ON THE COVER

Looking out one of Jennewein's labs.

Cover Photo by: IQC

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publisher
IQC COMMUNICATIONS & STRATEGIC INITIATIVES

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FROM THE EDITOR

We received good news again on the funding front over the spring term – we were awarded $25M by the provincial government. (See the story *Renewed investments in world leading technology research* on the next page.) With this funding we can continue to publish groundbreaking research and offer outreach and education opportunities to a variety of audiences.

Many of those outreach and education programs ran this summer. We continue to attract the best and brightest undergraduate students to the Undergraduate School on Experimental Quantum Information Processing (USEQIP) and high school students to the Quantum Cryptography School for Young Students (QCSYS) each year. USEQIP is now in its sixth year and QCSYS is in its seventh. One of our QCSYS students was even highlighted in *HuffPost*.

In terms of research, faculty member **THOMAS JENNEWEIN**'s research has recently gained a lot of attention. His microsatellite mission has not only garnered media attention, but the Canadian Space Agency awarded him a grant to train and develop Canadian graduate students through space science and technology projects. Jennewein's labs – all three of them – are the subject of our Lazaridis Centre feature article in this edition.

We decided to add a new feature to *NewBIT* and it starts with this issue. We will share the story of one of our extraordinary students who chose to complete his research at IQC. Inside we will introduce you to **ZAK WEBB**. We hope you enjoy the addition.

JODI SZIMANSKI, *Senior Communications Manager*

Renewed investments in world-leading technology research

IQC will continue its work to become the world leader in the field of quantum information science and to develop the technologies that will fundamentally impact the ways in which we work, communicate and live, thanks to the renewal of both federal and provincial government funding.

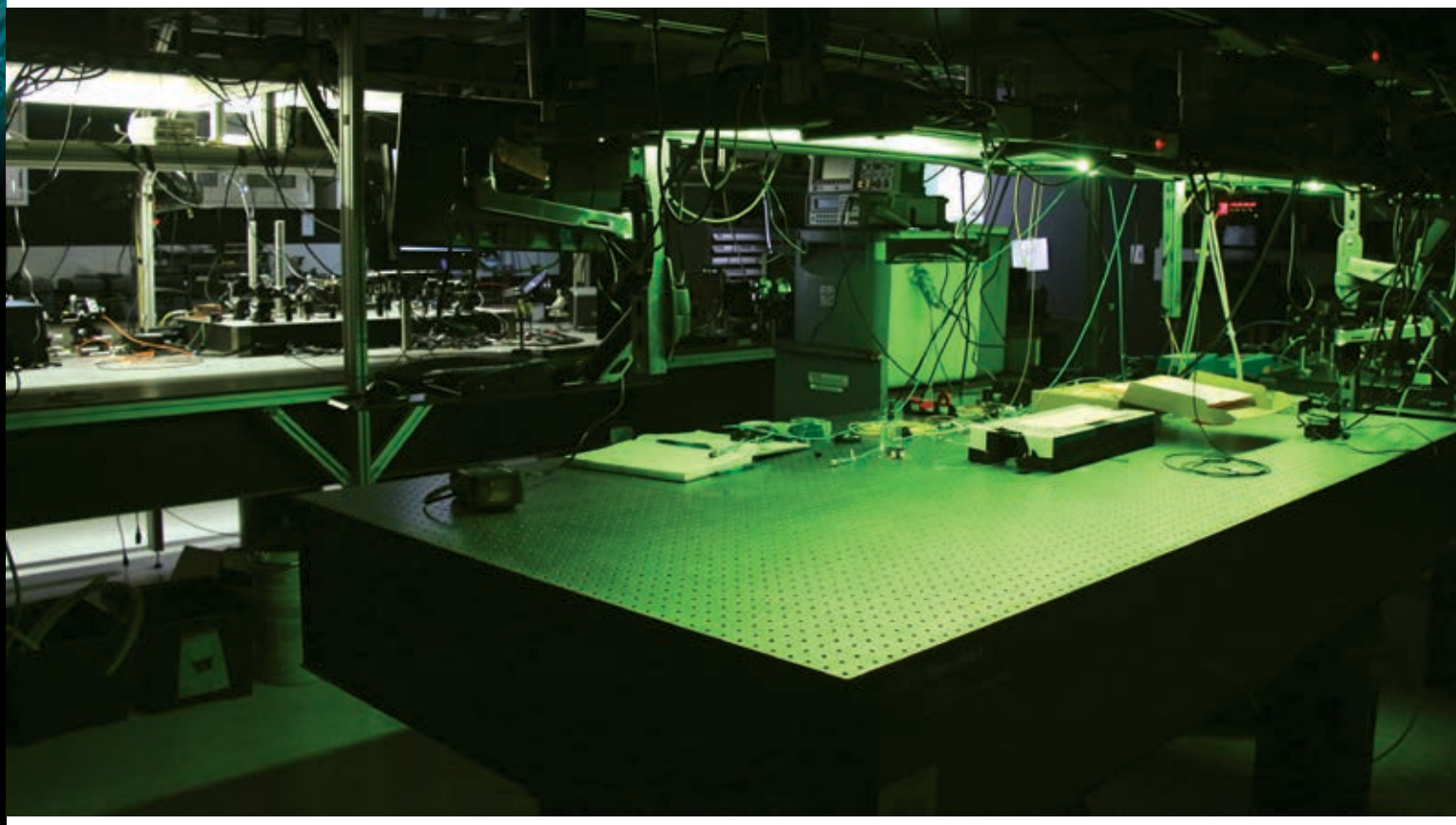
In the last *NewBit* we mentioned that on February 11, the Government of Canada announced its Economic Action Plan 2014 and in it, IQC received $15 million over the next three years. On July 14, the Province of Ontario renewed its investment in IQC over the next five years as part of its 2014 budget. The committed investment is $25 million.

"Ontario's renewed support for IQC further positions Waterloo to take full advantage of the opportunities of quantum information science and technologies," said **RAYMOND LAFLAMME**, executive director of IQC. "The discoveries in our labs and the technologies our researchers are creating will drive the growth of the Quantum Valley with entirely new quantum industries growing and thriving here."

The Province of Ontario made a $50 million investment in IQC in 2006. With the provincial investments, the investments in IQC total more than $400 million thanks to the both levels of government, Mike and Ophelia Lazaridis, the University of Waterloo and other generous supporters. ■

IQC researchers hard at work

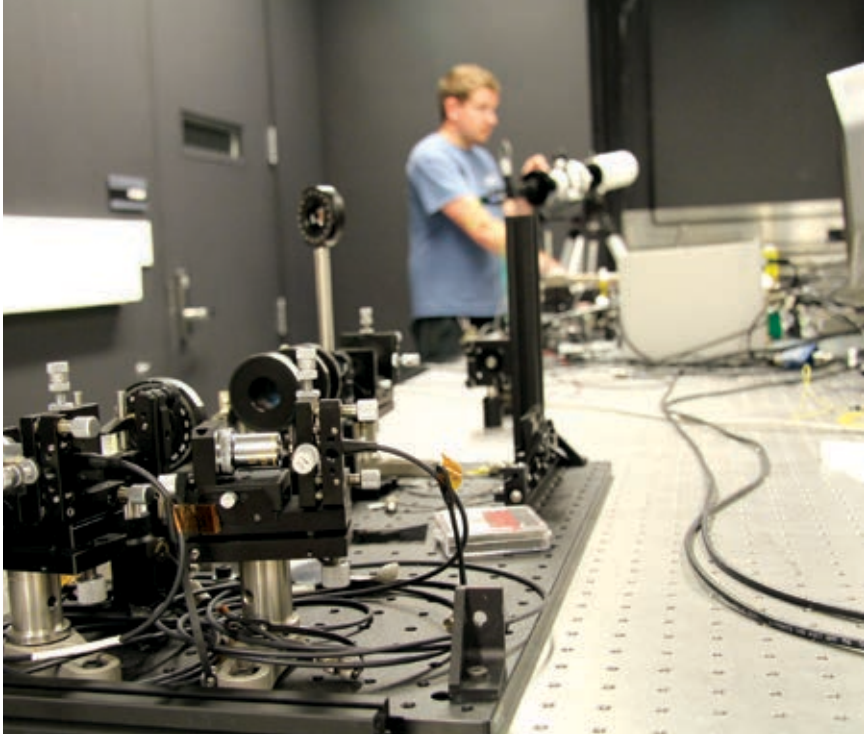
Lasers, crystals and qubits



The lights are off and there is a green glow in the lab. This is where **THOMAS JENNEWEIN** and his team advance quantum communication technology using photons. They use these particles of light to build components for a future quantum internet.

A quantum internet will allow us to send qubits around the world between different locations and devices. A large network, similar to today's internet, a quantum internet will use quantum signals for more secure communications. The research could one day lead to quantum computing in the cloud once universal quantum computers are deployed.

One of the major research projects in Jennewein's lab involves global distance Quantum Key Distribution (QKD). The microsatellite project led by Jennewein will demonstrate a link from the ground to space to expand the distance of coverage more than the few hundreds of kilometres currently possible. Recently, the group completed work on the transmission of quantum signals from a building to a moving vehicle 800 meters away; a key step toward the full-scale realization.



ABOVE
CHRIS PUGH

LEFT
SASCHA AGNE

FAR LEFT
MARTA PALUCKA (Nicolaus Copernicus University) working with **AIMEE GUNTHER** and **ROLF HORN**.

Together with the Canadian Space Agency and COM-DEV, the team tested how space radiation affected the QKD components. They are also building a prototype system and they continue to build ground-based test-systems. This summer they began work to test the system longer distances (about 35 km) at a nearby lake. Next year, the goal is to have an airborne receiver.

In Jennewein's labs you can find sources of single photons, photon detectors, crystals, telescopes and many other optical components. Jennewein's group uses the polarization of a single photon to encode quantum information. Photons are useful for quantum communication because they can travel relatively far to send and retrieve information.

The team creates single photon qubits using extremely weak laser pulses. They then transmit the qubits through free space with a direct line of sight between the source and receiver.

Jennewein's team started moving over to the Mike & Ophelia Lazaridis Quantum-Nano Centre in December of 2013. The team is currently spread through three labs; more space than they previously had in RAC1. The last of the equipment, with the exception of the ground-station dome on the roof of RAC1, moved in September.

One of the labs has a very unique feature. The team uses it to build the satellite prototypes. It includes a small window opening for testing a freespace link from the lab to a shed on the rooftop of the Centre for Environmental and Information Technology (EIT). This allows the team to conduct quick tests without having to take the whole system outside.

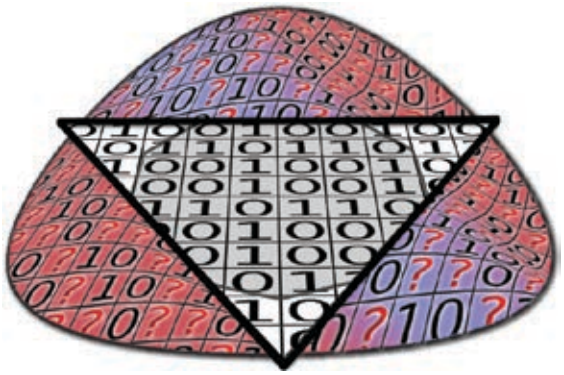
Jennewein appreciates that everything in the Lazaridis Centre is extremely high quality and offers a very controlled environment. "The lack of control of the parameters can affect the alignment of the systems," he stated. "When stringent temperature, humidity and vibration controls are in place, it simplifies the experiments." ■

SCIENCE HIGHLIGHTS

IQC faculty, postdoctoral fellows and students continue to conduct internationally recognized quantum information science research. Here is a sampling of their cutting-edge research published in academic journals over the past term.

Weird magic ingredient for quantum computing

NATURE 10:1038 (2014)



The triangular region contains quantum states that are not magic and do not exhibit contextuality. States outside the triangle do exhibit contextuality and may be useful as a resource in the magic-state model of quantum computing.

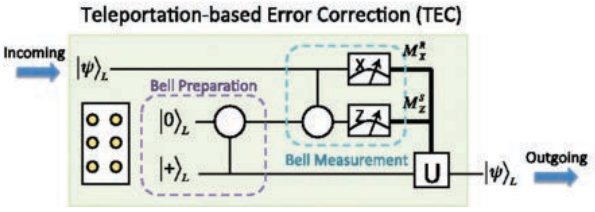
Faculty member **JOSEPH EMERSON** and postdoctoral fellows **MARK HOWARD** and **JOEL WALLMAN** confirmed theoretically that contextuality, a weird aspect of quantum theory, is a necessary resource required for achieving the advantages of quantum computation. The magic is in the particular approach to building noise-resistant quantum computers known as magic-state distillation. This extra ingredient boosts the power of a quantum device to achieve the improved processing power of a universal quantum computer. The identification of these magic states as contextual allows researchers to clarify the trade-offs involved in different approaches to building quantum devices. The results of this study may also help to design new algorithms that exploit the special properties of these magic states more fully.

WEB **http://bit.ly/contextuality** ■

A new architecture for long-distance quantum communication

PHYS. REV. LETT. 112, 250501 (2014)

A promising approach to achieve long-distance quantum communication is the use of quantum repeaters. Currently, there are three classes of approaches all with varying degree of resource requirement and consequences on the transmission rate of secure keys. One of these approaches uses quantum encoding to systematically correct photon losses and eliminates two-way classical communication between all repeater stations. This promises extremely high key generation rates. Along with researchers from Yale, Duke and Harvard universities, faculty member **NORBERT LÜTKENHAUS** investigated a fault-tolerant architecture for this latest approach in the paper *Ultrafast and Fault-Tolerant Quantum Communication across Long Distances* published in *Physical Review Letters* in June.



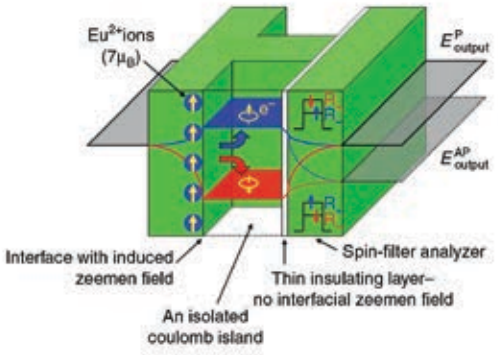
The TEC procedure consists of Bell state preparation and Bell measurement at the encoded level. Each line in the circuit represents an encoding block and the CNOT gate has a transversal implementation for CSS codes.

The researchers used a teleportation-based error correction (TEC) protocol within each repeater station to correct photon loss errors, as well as errors introduced during the manipulation of the qubits. The advantage of this approach is that it could deliver significantly higher rates in the generation of secret keys over large distances.

WEB **http://bit.ly/TECProcedure** ■

SPINTRONICS AND ENERGY HARVESTING

NATURE COMMUNICATIONS 5: 3682 (2014)



Electron energy diagram across the junction

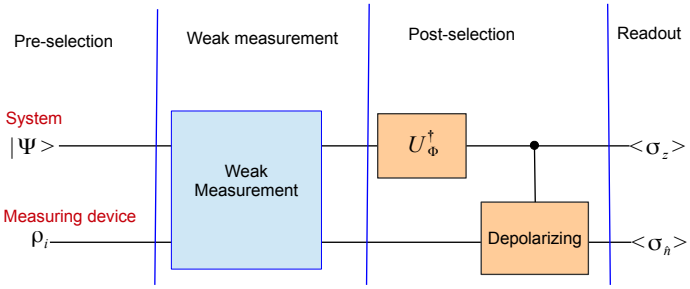
Magnetic insulators have two very interesting properties: they can selectively allow the passage of electrical current containing electrons with only one type of spin through them – known as the spin-filtering effect; and when they are interfaced with a low-dimensional electronic system, they can generate a very large effective magnetic field at the interface. The magnetic field could be as large as tens of Tesla, which is the equivalent of the largest man-made magnets. Faculty member **GUO-XING MIAO** and colleagues from the Korea Institute of Science and Technology (KIST), Northeastern University and the Massachusetts Institute of Technology (MIT) recently detected this interface field and spin current. The team reported these measurements in the paper *Spin regulation in composite spin-filter barrier devices*. Their findings could be practical for actively regulating spin flows in electronic devices, known as spintronics, and for energy harvesting. The paper was published in April in *Nature Communications*.

WEB **http://bit.ly/spintronics** ■

Post-selection and weak measurements

NEW JOURNAL OF PHYSICS 16 (2014)

Post-selection – the technique of conditioning measurement statistics by considering experiments meet a certain outcome criteria — is a powerful theoretical and experimental tool in quantum information. Previously, weak measurements with post-selection were mostly limited to optics experiments and the method used is outside the scope of implementation schemes using nuclear magnetic resonance, electron spins and rare-earth crystals. However postdoctoral fellows **DAWEI LU** and **AHARON BRODUTCH** along with Executive Director **RAYMOND LAFLAMME** and visitors from the University of Science and Technology of China and Tsinghua University developed and demonstrated the first experiment of a weak measurement with post-selection on an NMR quantum processor. This experiment can help those studying and exploiting post-selection and weak measurements in systems where projective measurements are difficult to accomplish experimentally. The paper, *Experimental realization of post-selected weak measurements on an NMR quantum processor*, was published in *New Journal of Physics* in May.



Conceptual circuit for post-selected weak measurements

WEB **http://bit.ly/weakmeasure** and **http://bit.ly/weakmeasurevideo** ■

SCIENCE HIGHLIGHTS

TALKS

Watching *Gravity* with a former astronaut

IQC members were thrilled to watch the Oscar-winning movie *Gravity* with former astronaut and president of the Canadian Space Agency **STEVE MacLEAN**. Following the movie MacLean, who is also an IQC associate member, shared stories about orbital waste and its role in the film, as well as his last launch and the effects on a human body. The IQC Graduate Student Association (IQC GSA) organized the April 2 event.

Credit: National Aeronautics and Space Administration

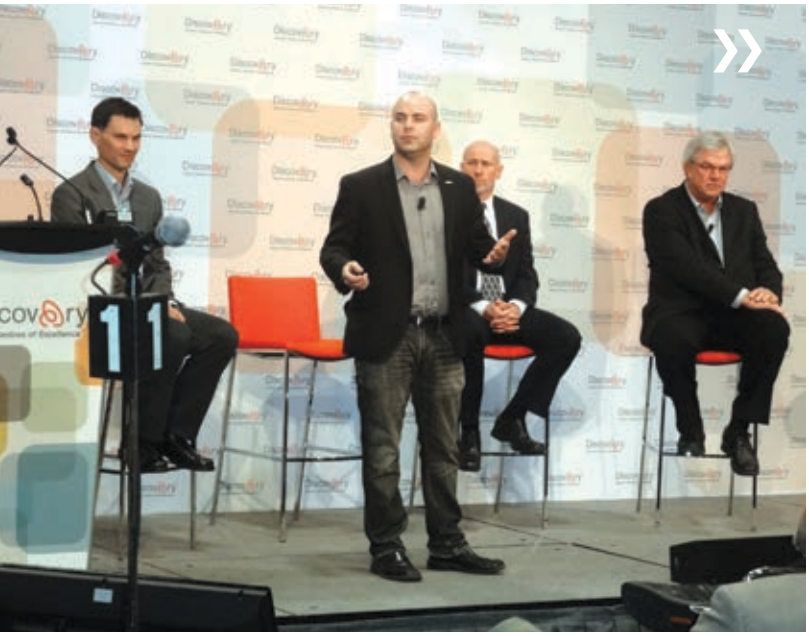
WEB See the Question and Answer session with MacLean **http://bit.ly/MacLeanQA** ■

CAREERS OUTSIDE OF ACADEMIA

To help IQC graduate students learn more about careers in quantum information science and technology, the IQC GSA introduced the Quantum Industry Lectures series. Former IQC members **JONATHAN HODGES** and **PHIL KAYE** both returned to IQC to share their experiences.

Hodges, now VP engineering for Diamond Nanotechnologies, talked about his research and the day-to-day realities of industry on May 6. Kaye presented a different perspective on June 17 about his work with the Government of Canada. ■

IQC OUTREACH



IQC AT OCE DISCOVERY 2014

The Ontario Centres of Excellence (OCE) held their annual Discovery conference at the Metro Toronto Convention Centre May 12-13. The leading innovation-to-commercialization conference invited Deputy Director, Academic **MICHELE MOSCA** to speak with five other cybersecurity experts on a panel about the issues and opportunities surrounding the field. Quantum science was the topic of another panel as well; it focused on how quantum physics is propelling new fundamental insights about the natural world and how they are setting the stage for revolutionary technologies in the future. Executive in Residence **ROBERT CROW** moderated the panel which included Senior Manager, Scientific Outreach **MARTIN LAFOREST** and the Perimeter Institute's **DAMIAN POPE** and **MICHAEL DUSCHENES**. ■

« The panel focused on Quantum with Pope, Laforest, Duschenes and Crow

Top-notch high school student rejoined research team

MILES CRANMER returned for his second summer to work in **THOMAS JENNEWEIN**'s lab with PhD students **ELENA ANISIMOVA** and **AIMEE GUNTHER**. He gained valuable lab experience through modeling an optical system and testing irradiated single-photon detectors. The team also brought Cranmer along to take part in a long-distance optical link test as part of the microsatellite project.

One of the projects Cranmer worked on will be used for future scientific outreach presentations. He adapted an animated simulation of Satellite Quantum Key Distribution that included photon loss and noise. Cranmer began his undergraduate studies at McGill University in September. ■

SHAD
UNCOMMON PURPOSE

Exploring the fantastic world of quantum mechanics

Fifteen SHAD summer program high school students at the University of Waterloo campus tour took part in the six-hour "Peering into the fantastic world of quantum mechanics" workshop in July. PhD students **SARAH KAISER** and **JOHN DONAHUE** led the workshop focused on the fundamentals of quantum mechanics and its applications. The workshop included a Bell test experiment for the students to perform. This famous experiment is a way to measure the strangeness and surprising consequences of quantum entanglement. ■

High school students learn the key to quantum cryptography

PhD students **AIMEE GUNTHER** and **CHRIS PUGH**, along with Senior Manager, Scientific Outreach, **MARTIN LAFOREST**, introduced high school students to classical cryptography and quantum cryptography. The three groups from the University of Waterloo Catalyst program even had the opportunity to create their own key during the Quantum Key Distribution demonstration. ■

« Pugh talking to students attending Catalyst

Eager high school teachers visit IQC

This summer 45 dedicated teachers participating in the Perimeter Institute's Einstein Plus workshop visited IQC. PhD student **CHRIS PUGH** spoke about the research happening in the labs before leading a tour where various students spoke about specific research happening in the Lazaridis Centre labs. ■

ICE CREAM AND QUANTUM

On May 25, IQC hosted the Guelph-Kitchener-Waterloo chapters of Canadian Association for Girls in Science, a group for girls ages 8-12 who are interested in science. Master's student **OLIVIA DI MATTEO** and PhD students **COREY RAE MCRAE**, **CAROLYN EARNEST**, **SARAH KAISER**, **AIMEE GUNTHER** and **RAZIEH ANNABESTANI** had fun helping the girls make liquid nitrogen ice cream. IQC students used lasers to teach quantum cryptography and let the girls play with a levitating superconducting train to learn about superconducting qubits. ■

Quantum, computer science and society

The CENTRE for EDUCATION in MATHEMATICS and COMPUTING

The University of Waterloo's Centre for Education in Mathematics and Computing invited Senior Manager, Scientific Outreach, **MARTIN LAFOREST** to speak at two workshops during the spring term. At the end of May CEMC hosted 60 girls in grades 9 and 10 for the Workshop in Computer Science for Young Students. A week later, 60 grades 10 and 11 students attended their Auckland workshop – a mathematics enrichment program open to the top scorers in CEMC internationally-recognized math and computing contests. For both workshops, Laforest spoke about quantum mechanics and the impact of quantum information in computer science and society. ■

A mind-bending collaboration

Once again, Executive Director **RAYMOND LAFLAMME** partnered with Kitchener–Waterloo Symphony Music Director **EDWIN OUTWATER** to present *Quantum: Music at the Frontier of Science* in April. This time the two reunited at the Howard L. Schrott Center for Butler University's ArtsFest. The multimedia mash-up of art and science included the Indianapolis Symphony Orchestra, visuals and narration that explores how music works at nature's most fundamental level. ■

CONFERENCES

Undergrads get a crash course in quantum science

IQC hosted 22 undergraduate students from institutions from nine countries for two weeks. The Undergraduate School for Experimental Quantum Information Processing (USEQIP) gives undergraduate students the chance to learn and discuss the theoretical and experimental study of quantum information. Not only did students get to spend time working with IQC members on experiments in various labs, they also had the opportunity to attend lectures by IQC faculty **RAYMOND LAFLAMME**, **DAVID CORY**, **MICHELE MOSCA**, **MICHAL BAJCSY**, **JONATHAN BAUGH**, **ANDREW CHILDS**, **THOMAS JENNEWEIN**, **KEVIN RESCH** and **CHRISTOPHER WILSON**. ■

7 years of exceptional high school students

In its seventh year, the Quantum Cryptography School for Young Students (QCSYS) welcomed 42 students from six Canadian provinces and five different countries. Students had the opportunity to learn about the cutting-edge field of quantum cryptography through lectures and demonstrations. Internationally renowned faculty and students get involved in the program each year to make it one of the most prestigious programs in the field. ■

UPCOMING EVENTS

AAAS Annual Meeting

San Jose, California
February 12-16, 2015

WEB **http://meetings.aaas.org/**

Quantum Simulations

Benasque, Spain
February 22-27, 2015

WEB **http://www.benasque.org/2015qs**

3rd ETSI Workshop on Quantum-Safe Cryptography

Seoul, South Korea
October 5-7, 2015 ■

Around the INSTITUTE

student PROFILE: **Zak Webb**

Bringing together physics, math and computer science

ZAK WEBB always knew he wanted to get a degree in physics. During his undergrad at the University of Washington he took enough math and computer science courses to build up three majors. While finishing a mandatory research project with Dave Bacon (now a Senior Software Engineer at Google), Webb realized that there was one thing in common in all three subject areas – quantum.

He wanted to work with someone with a physics background working with quantum algorithms for his graduate studies. He found **ANDREW CHILDS** at IQC. "Andrew works on new ways to think about quantum computing like continuous time quantum walks," said Webb. "This big, heady idea – the continuum of time – it was clear Andrew understands physics and likes doing quantum information, so I wanted to work with him."

Throughout his PhD research Webb has worked with various physical models related to particles moving and interacting on a graph. His current research attempts to show that several questions related to these models cannot be solved efficiently even on a quantum computer. Many problems currently known to be infeasible on a quantum computer require different interactions depending on where particles are located, and Webb's research simplifies these results so that only one type of interaction is required. Such simple interactions then require more complicated graphs, but Webb's eventual goal is to make the underlying graph as simple as possible. Essentially, Webb is trying to find the simplest physical model that cannot be solved with a quantum computer to give realistic bounds on quantum computing's power. ■

FROM THE IQC GSA

Lots of fun events kept IQC students busy this summer, including the annual IQC Laser Tag Shootout, a trip to Canada's Wonderland to ride the Leviathan, and a rowdy day of paintball.

For the fall, the IQC GSA planned a fall orientation event for new graduate students (featuring free food and drinks), as well as another episode of the Quantum Industry Lecture Series, where former IQC grads chat about the jobs they have now.

To keep up on upcoming IQC GSA events, bookmark our IQC GSA Google Calendar.

WEB **http://bit.ly/IQCGSACalendar**

Corey Rae McRae ■

Grad students playing with lasers outside the lab.

TOURS/VISITS

Honorary Doctorate recipient tours IQC

RONALD RIVEST was awarded an honourary DMATH by the University of Waterloo on June 13. Following the ceremony, Deputy Director, Academic, **MICHELE MOSCA** and Senior Manager, Scientific Outreach, **MARTIN LAFOREST** gave Rivest a tour of the Lazaridis Centre. Rivest is best known for co-inventing the RSA public key encryption and digital signature schemes in 1977. ■

Laforest, Rivest, Mosca and **DOUG STINSON**, David R. Cheriton School of Computer Science and Centre for Applied Cryptographic Research

THE FUTURE OF QUANTUM COMPUTING

The University of Guelph hosted this year's Canadian Quantum Information Students' Conference (June 23-27). As part of the conference PhD students **JOEL KLASSEN** and **TOMAS JOCHYM-O'CONNOR** organized a trip to IQC for a tour of the Lazaridis Centre and a talk. Many attendees noted that the highlight of the conference was the discussion led by Executive Director **RAYMOND LAFLAMME** and postdoctoral fellow **ROLF HORN**. They focused on the future of quantum computing in industry and academia and the interplay between those two domains. ■

Ambassadors visit IQC

This summer brought two international Ambassadors to IQC: his Excellency Arno Riedel, the Ambassador of Austria to Canada and his Excellency Rafael Barak, the Ambassador of Israel to Canada. Faculty member **THOMAS JENNEWEIN** had the opportunity to personally show the Ambassador of his birth country, Barak, his lab. ■

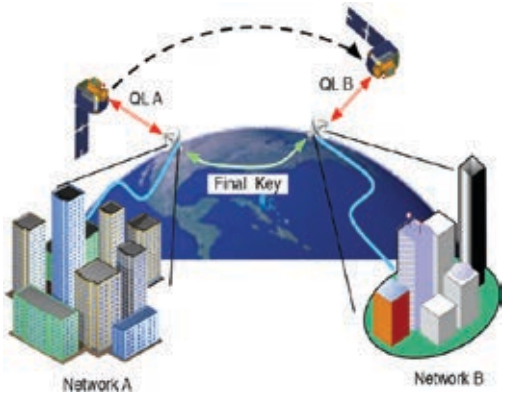
Around THE INSTITUTE

IN THE NEWS

Progress toward a quantum communication satellite

For three years, **THOMAS JENNEWEIN**'s team has worked on the microsatellite mission, Quantum EncrYption and Science Satellite (QEYSSat), in cooperation with industry partners and funded primarily by the Canadian Space Agency. The mission objectives are to demonstrate the generation of encryption keys through the creation of quantum links between ground and space, and to conduct tests of long-distance quantum entanglement. The creation of these quantum links demonstrates technology that could be the basis of a quantum communication network. SPIE, the international society for optics and photonics, published an article by Jennewein, postdoctoral fellow **BRENDON HIGGINS** and Senior Technical Associate **ERIC CHOI** in May about their proposed microsatellite mission.

WEB **http://bit.ly/SPIEmicrosatellite** ■



A satellite can be used as a trusted node to bridge the large distance between two city-wide networks. To distribute a cryptographic key securely, Network A communicates with the satellite over a quantum link (QLA) and later Network B uses a similar link (QLB).

High-achieving student attended QCSYS

HuffPost's The Blog featured an exceptional student who attended the Quantum Cryptography School for Young Students (QCSYS). Doina Oncel's blog described **MAYA BURHANPURKAR**'s achievements including: the top Grand Platinum award at the national science fair for the development of a cardio-protective drug for athletes and seniors (age 12), the Queen Elizabeth II Diamond Jubilee Medal (age 12), Canada's Top 20 Under 20 Award (age 13) and by 13 she also developed the first apparatus able to confirm the existence of the time-integral of distance.

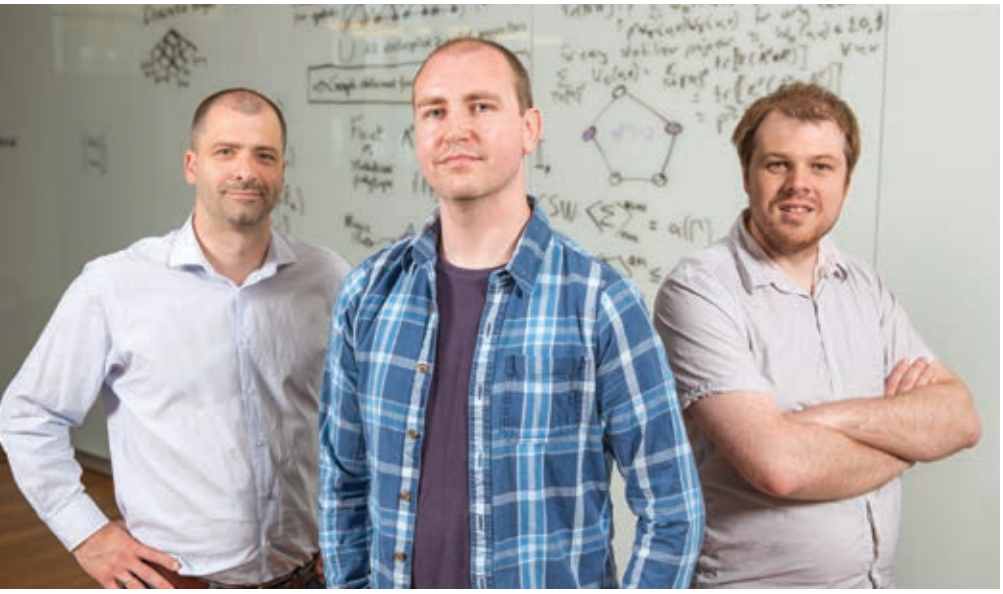
WEB **http://bit.ly/QCSYSOncel** ■

LAZARIDIS: FOCUSED FIRMLY ON THE FUTURE

In June, the *Globe and Mail* interviewed **MIKE LAZARIDIS** about "Canada's next computing revolution" and his role in recent investments in quantum research in Waterloo Region. Lazaridis spoke about the importance of attracting the top innovative minds to Canadian research institutes, like IQC. He referred to the BlackBerry story as proof that a Canadian multinational enterprise could lead an industry. It seems he has not lost the drive to produce another leader in cutting-edge industries with his commitment to invest in the next quantum revolution and build the Quantum Valley in Waterloo.

WEB **http://bit.ly/nextcomputingrevolution** ■

QUANTUM COMPUTING: THE 'MAGIC' INGREDIENT



Emerson, Howard and Wallman

In a study published by *Nature*, postdoctoral fellows **MARK HOWARD** and **JOEL WALLMAN** along with faculty member **JOSEPH EMERSON** proved that the contextuality theory is a necessary resource to achieve the so-called magic required for universal quantum computation. In the same issue, Stephen D. Bartlett wrote a piece titled *Quantum computing: Powered by magic* providing an overview and his thoughts about the paper. He included unanswered questions about what else contextuality powers and the power of states with vanishingly small amounts of magic. However he sees the paper's promise in its ability to help researchers design better architectures for quantum machines.

WEB **http://bit.ly/magicingredient**

NEW COURSES/WORKSHOPS

SIR ANTHONY LEGGETT LECTURE SERIES

For the eighth consecutive year, Sir **ANTHONY LEGGETT** offered a lecture series on the Physics of Superconducting Devices. His 12 lectures covered the microscopic Bardeen, Cooper, Schrieffer (BSC) theory of superconductivity, as well as the physics of the Josephson effect.

WEB Find recordings of all the lectures on YouTube at: **http://bit.ly/2014Leggett**

CryptoWorks21

Throughout July, CryptoWorks21 offered a series of workshops. To build students' professional skills, one of the workshops focused on intellectual property protection and management, as well as commercialization and entrepreneurship. Technical skills workshops included fundamentals of cryptography, an introduction to quantum computing for cryptography students, quantum cryptography tools and the implementation of quantum communication.

WEB **http://bit.ly/CW21cryptography**

CryptoWorks21 participants presenting their ideas for commercialization

Around THE INSTITUTE

AWARDS AND FELLOWSHIPS

IQC faculty receive Early Researcher Awards

Matteo Mariantoni

Christopher Wilson

Congratulations to faculty **MATTEO MARIANTONI** and **CHRISTOPHER WILSON** for their Early Researcher Awards from the Ontario Research Fund. John Milloy, Minister of Government Services and Government House Leader, visited the Perimeter Institute on April 4 to announce the recipients.

The funding will aid Wilson's research in quantum information, quantum optics and non-linear dynamics, while Mariantoni explores superconducting quantum circuits for applications in quantum information processing. ■

CFI supports experimental hybrid quantum platform

In April, the Canada Foundation of Innovation (CFI) announced $200,000 in funding for Canada Excellence Research Chair **DAVID CORY**'s experimental platform where spin and superconducting quantum systems can be engineered together. At the announcement **ED HOLDER**, Minister of State (Science and Technology), stated: "Canadian researchers need state-of-the-art tools in order to undertake world-class research. Our government believes significant investment in these tools is essential to making scientific breakthroughs." The funding comes through the John R. Evans Leaders Fund. ■

WATROUS RECEIVES FUNDING BOOST

Faculty member **JOHN WATROUS** and eight other Waterloo researchers received funding from the NSERC Discovery Accelerator Supplements grant program. President **FERIDUN HAMDULLAHPUR**, VP Research **GEORGE DIXON** and **PETER BRAID**, MP for Kitchener-Waterloo, spoke at the announcement, as did fellow grant winner **ZHONGWEI CHEN**, a professor of chemical engineering. ■

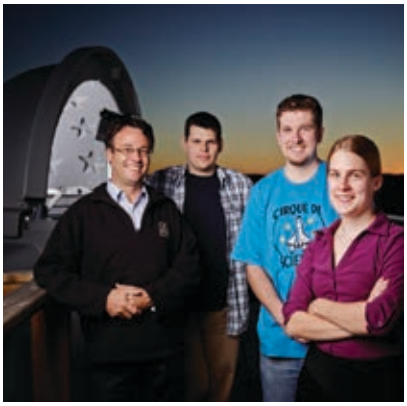
Watrous speaks at the NSERC Discovery Grants announcement on July 17

High standards of scholarly achievement at IQC

NSERC Vanier Canada Graduate Scholarships are awarded to students who demonstrate leadership skills and a high standard of scholarly achievement. Two IQC graduate students were named in August: PhD student **TOMAS JOCHYM-O'CONNOR** and IQC alumna **MEGAN AGNEW**.

The funding will help Jochym-O'Connor continue his work developing a set of tools for the physical implementation of fault-tolerant quantum error correction. ■

Moving closer to space flight



Jennewein and some of his PhD students

In May, the Canadian Space Agency awarded a group of IQC researchers led by Associate Professor **THOMAS JENNEWEIN** a $250,000 grant to train and develop Canadian grad students through a space science and technology project. The funding will support a demonstration of Quantum Key Distribution (QKD) between a receiver payload on an airborne platform and a transmitter on the ground. This project takes Jennewein's team one step closer to demonstrating space-based QKD as part of the proposed QEYSSat microsatellite mission. ■

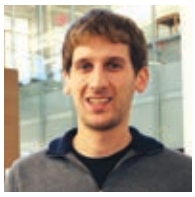
IQC award winners Donohue, Gunther, McRae, Kothari and Jochym-O'Connor

RESEARCH AND OUTREACH ACTIVITIES AWARDED

Two PhD students were recognized with an IQC Achievement Award for their exceptional achievements: **TOMAS JOCHYM-O'CONNOR** for his research using concatenated quantum codes for universal fault-tolerant quantum communication, and **ROBIN KOTHARI** for his work on simulating Hamiltonian dynamics using ideas from simulations of continuous query model.

IQC awarded this term's IQC David Johnston Award for Scientific Outreach to PhD students **COREY RAE MCRAE**, **JOHN DONOHUE** and **AIMEE GUNTHER**. McRae and Gunther are both active advocates for encouraging girls in science and many other outreach activities, and McRae also leads the IQC Graduate Student Association. Donohue volunteers his time teaching at both the Undergraduate School for Experimental Quantum information Processing (USEQIP) and the Quantum Cryptography School for Young Students (QCSYS) and working with Let's Talk Science. ■

Jonathan Lavoie



Mike Mazurek

Two IQC students recognized for creative research

Two IQC students were recognized for their creative research presented in their thesis at the June convocation for the Faculty of Science. **MIKE MAZUREK** was awarded the Dean of Science Award for his Master's thesis and **JONATHAN LAVOIE** received the WB Pearson Medal for his PhD thesis. ■

Around THE INSTITUTE

ARRIVALS

(April - August)

Staff

Mai-Britt Mogensen
Brian Neill
Emma Cullen

Students

Sascha Agne
Hemant Katiyar
Alex Parent

Postdocs

Taisiya Mineeva
Joshua Combes
Taehyun Yoon
Kassem Kalach
Rainer Stohr
Milad Khoshnegar

Long-Term Visitors

Simon Forest
Nicolas C. Menicucci
Callum Croal
Krtin Kumar
Xinhua Peng
Xuan Wang
Laura Mancinska
Ben Criger
Anthony Leggett
Tae Hee Kim
Gregor Weihs ■

FACULTY @ IQC

21 +
2 Research Assistant Professors
1 Visiting Professor

From 11 different countries.

10 THEORISTS

14 EXPERIMENTALISTS

IQC's cross-disciplinary research means our faculty work in multiple areas of **Quantum Information Processing**.

COMPUTING MATERIALS SENSORS COMMUNICATIONS

DEPARTMENTS

APPLIED MATH

COMBINATRONICS AND OPTIMIZATION

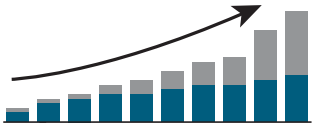
ELECTRICAL & COMPUTER ENGINEERING

CHEMISTRY

COMPUTER SCIENCE

PHYSICS & ASTRONOMY

IQC maintains a strong group of **theorists** and has increased its number of **experimentalists**.



PUBLICATIONS IN 2013

The faculty at IQC consistently produce **over 100 publications each year**.

In 2013, IQC produced
114 publications

221 COLLABORATORS

12,450 CITATIONS

185 INTERNATIONAL COLLABORATIVE INSTITUTIONS

PQCrypto 2014

6th International Conference on Post-Quantum Cryptography

PQCrypto was hosted at the Mike & Ophelia Lazaridis Quantum-Nano Centre at the University of Waterloo, October 1-3.

Watch the videos of the recorded talks for both the conference and the summer school.

WEB **http://bit.ly/PQCryptoPlaylist**
http://bit.ly/PQCryptoSchoolPlaylist ■

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INSTITUT TUTTE INSTITUTE

A NEWSLETTER FROM THE **INSTITUTE FOR QUANTUM COMPUTING**, **UNIVERSITY OF WATERLOO**, WATERLOO, ONTARIO, CANADA

NanoMRI Conference

July 27-31, 2015

Hosted by the Institute for Quantum Computing

Join us at the NanoMRI Conference to discuss the varied approaches to imaging spins on the nanometer scale. We will explore applications to the physical and biological sciences as well as quantum information.

uwaterloo.ca/nanomri

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LOOK FOR THE NEXT ISSUE OF **NewBit** COMING IN THE WINTER!

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